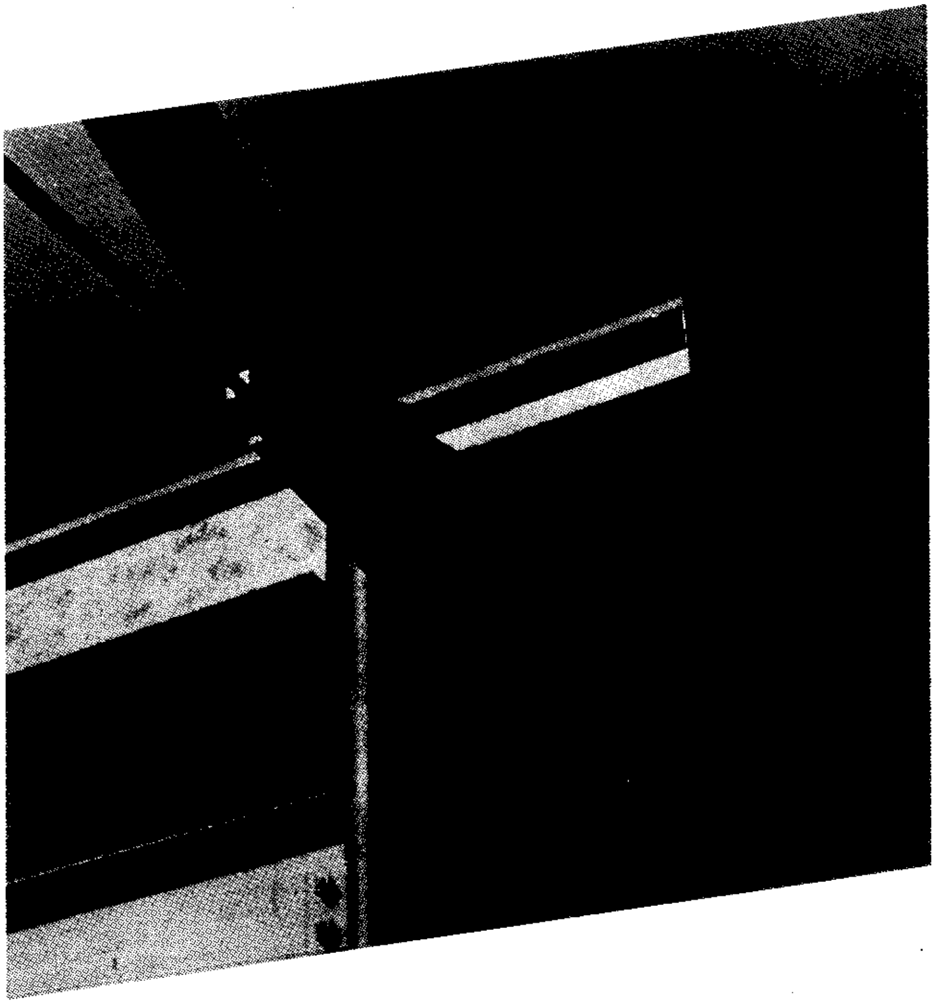
TECHNICAL PUBLICATION NO. 23

Suitability of Florida Soils to Receive Effluent from On-Site Sewage Disposal Systems



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School of Building Construction
University of Florida
1982

1853

PILOT STUDY OF FLORIDA SOILS CONCERNING THEIR SUITABILITY TO RECEIVE EFFLUENT FROM ON-SITE SEWAGE DISPOSAL SYSTEM

A report of the Construction Research Project
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EXECUTIVE SUMMARY

Purpose: The purpose of this investigation is to determine the suitability of various Florida soils to receive effluent from on site sewage disposal systems. The effect of effluent on groundwater quality and the feasibility of using existing soil survey manuals of Florida counties to design drainfields and to determine the suitability of the various soils to receive the effluent is examined.

Ground Water Investigation:

Findings: Seven test sites were chosen having septic tanks. Monitoring wells were installed at various distances from the drainfield to examine the upper levels of the ground water with respect to the concentrations of fecal coliforms, nitrates, ammonia and phosphates. The soils at all the test sites were either sands, silty sands or clayey sands. The reduction of fecal coliform bacteria was in the magnitude of 100 times within 70 feet of the drainfield at the average site. At sites where the water table was at least two feet below the drainfield, higher reduction factors were achieved. At sites having an unsaturated zone below the drainfields, ammonia from the septic tank was more readily converted to nitrates. Phosphate concentrations were high enough to cause concern if transferred directly to surface waters.

Conclusions: Other studies have shown that septic tank effluent from properly designed systems do not have a significant impact on the degredation of groundwater or of adjacent surface waters. Our study indicates no significant degredation of groundwater. We also conclude that it is better to discharge these nutrients underground in a drainfield where they can be reduced by dilution and by trees and other vegetation all the way from the drainfield to the interface with surface water than to carry these nutrients to a sewage treatment plant where they are concentrated and dumped directly in surface waters.

Recommendations: 10D-6.47(1) should be ammended to read "An existing approved sanitary sewer of a <u>public</u> sewerage system is not available." The permit should not require as a condition of approval that the facility must connect to a future public sewerage system unless that system has facilities to treat nitrates and phosphates.

Design of On Site Sewage Disposal Drainfields Using Soil Survey Manuals:

Findings: The study was limited to the soils found in the Soils Survey of Orange County. Soils were rated A through E in order of increasing percolation rates as shown in Table III of Chapter 10D-6. They were further rated 1 through 5 in order of increasing flood hazard as shown in the soil survey manual. Most Florida soils can be rated with a letter and a number, for instance "A1", thus establishing 25 possible ratings. Drainfield sizes were designed using A-E ratings and 1-5 ratings were used to determine if septic tank drainfields should be placed on any particular soil type. Type "1" has no flood hazard and requires no special contruction. Types "2" and "3" are usable with raised drainfields or if the site has been filled or drained. Types "4" and "5" are considered unsuitable for septic tanks since they are flooded at least once a year. Table "6B" rates each soil in Orange County, and Table "6C" sizes the drainfields for various types of establishments and for A-E soil ratings.

Conclusions: Use of the soils manuals of the various Florida counties provides a convenient method of drainfield design and would be a helpful aid to local officials most of whom are familiar with these manuals.

Recommendations: It is recommended that 10D-6 be ammended to provide an alternative method of design for those counties that have soil survey manuals. It is also recommended that 10D-6.46(6b) be changed to take into account soil ratings, space availability and flood conditions instead of having an arbitrary limitation on the number of units per acre. This would encourage developers to construct subdivisions on soils suitable for septic tank usage where no special construction is required. A comment was made concerning the placement of drainfields under paving. Since this was not a subject of this report, a recommendation concerning this subject is not felt to be appropriate here.

Implementation: Copies of this report were presented to the Natural Resource Committee of the House of Representatives and to a subcommittee of the Natural Resource Committee in the Senate. Professor Holland also testified before both of these committees. It is believed that this testimony helped to moderate the proposed laws on septic tank usage in Florida.

CHAPTER ONE

INTRODUCTION

1.1 OBJECTIVE

In recent years there has been a movement to eliminate or drastically reduce the use of on-site sewage disposal systems in Florida in favor of central-sewage treatment plants. Nutrients discharged from these central plants have proven harmful to our lakes and rivers. To eliminate this hazard many new sewage plants are now required to irrigate effluent over ground cover. This requires large areas of the best land in a development to be set aside for this use. The major objection to on-site systems are groundwater pollution and siting in soils that are unsuitable to receive the effluent due to low percolation rates or seasonal flooding.

Many soils in Florida are suitable for receiving the effluent of septic tanks. Soil surveys of Florida counties are now available. These surveys, made by the Soil Conservation Service and the University of Florida Agricultural Experiment Station, contain soil data that can be used to advantage to determine suitability of the various soils for the use of on-site systems. The soil survey also estimates the appropriateness of septic tanks for the various soils.

The object of this research is to investigate scientifically the groundwater pollution of effluent from existing on-site sewage systems and to provide a means of designing the required effluent system for the various soils of Orange County, Florida for Commercial, Industrial, Institutional and Residential usage.

1.2 METHODOLOGY

1.2.1)

Select seven sites for the pilot study, four sites supporting residential usage, two commercial usage and one for industrial usage.

1.2.2)

Take soil borings at each site and verify the soil classification shown in the soil survey. Determine the percolation rate, soil profile, ground water table, and permeability of the soil.

1.2.3)

Place sampling points at various locations within and downstream from the effluent drain field. Take samples from these points and test for chemical and biological constituents.

1.2.4)

Relate percolation rate with soil classification and its corresponding permeability rate in the soil survey manuals for the different sites studied.

1.2.5)

Classify soils from the study sites, relating them to the rating in Table III of Chapter 10D-6 of the Standards for Individual Sewage Disposal Facilities, State of Florida, Department of Health & Rehabilitative Services, and compare the maximum sewage flow with the estimated flow from Table I of Chapter 10D-6.

1.2.6)

Determine the sizes of the absorption fields on different soil series of Orange County, Florida and for several types of establishments including commercial, industrial, residential and institutional.

1.3 PURPOSE

The purpose of this investigation is to determine the viability of on-site sewage disposal systems. Many public officials automatically reject these systems when in many cases they may be safer environmentally and more economical than central sewage systems. Few engineers and manufacturers of sewage treatment plant equipment have actively promoted on-site systems because they have a vested interest in the design and construction of central systems. Governmental bodies need to know the facts concerning the effect of effluent from on-site systems on various soil series so that economical and environmental alternatives to central sewage systems can be considered.

CHAPTER TWO

STUDY AREAS

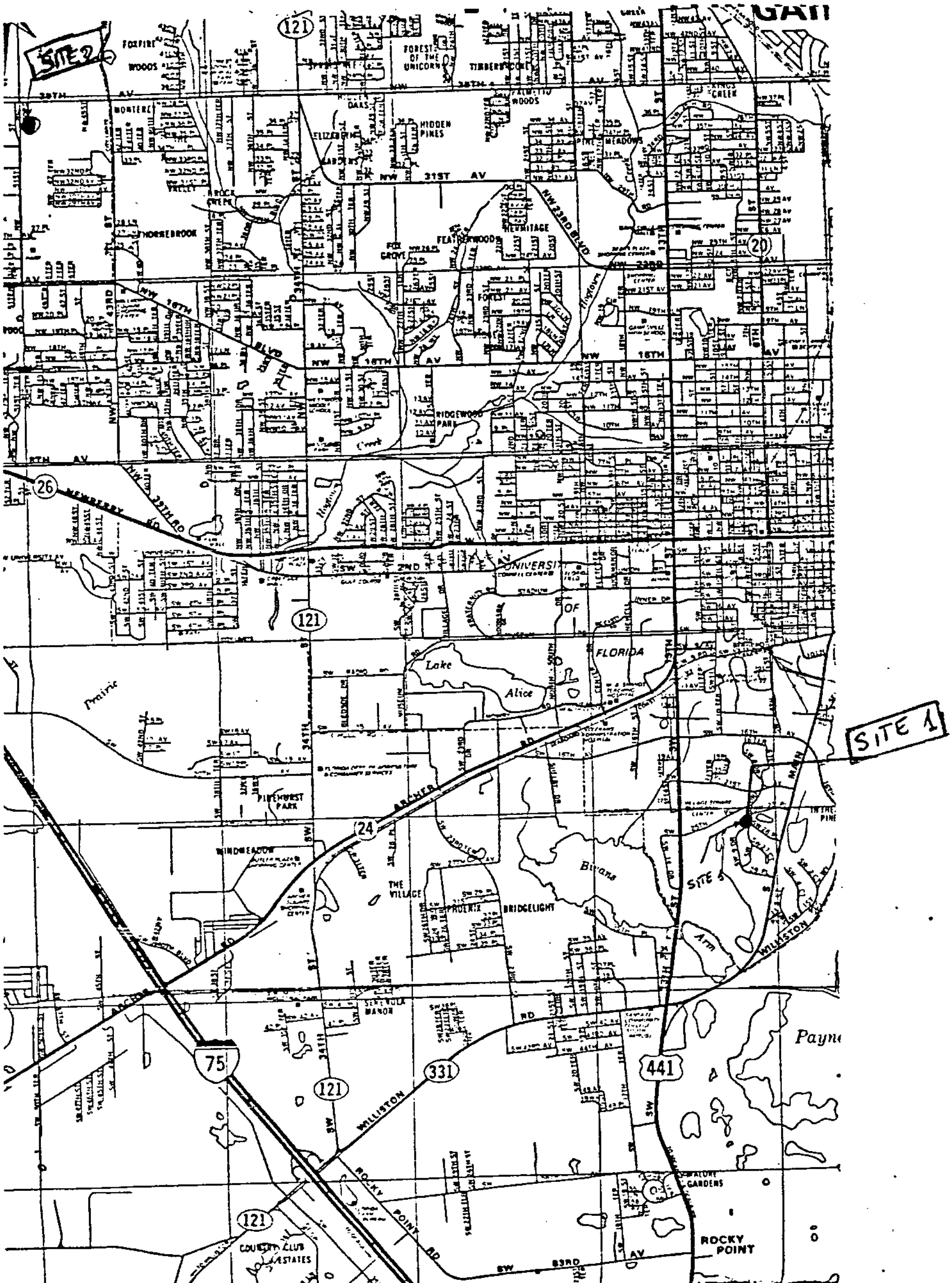
2.1 GAINESVILLE SITES

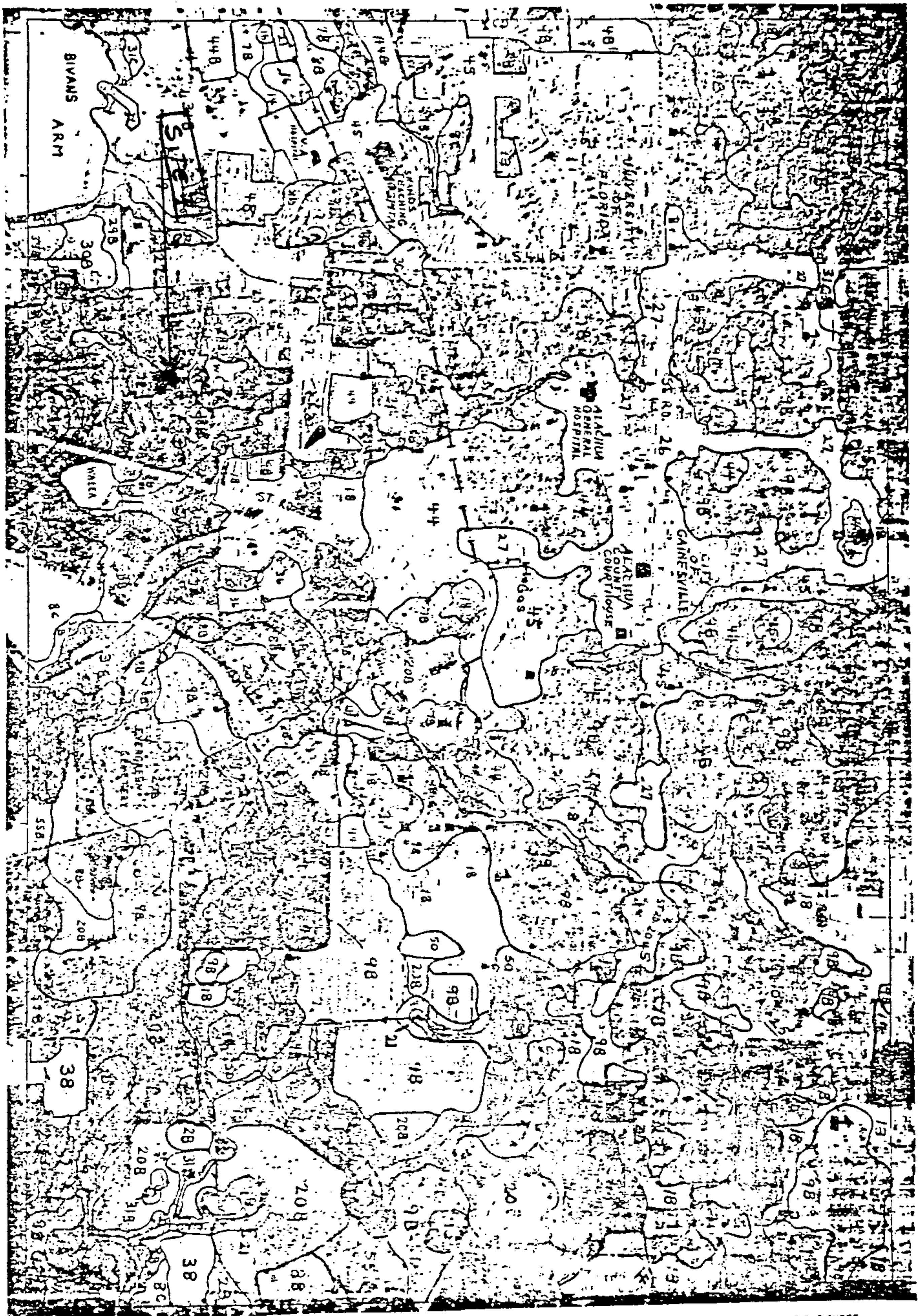
2.1.1) Site No. 1:

This site is located in the southwest area of Gainesville about half a mile east of SW 13th (SR 441) on SW 8th Dr. The site, a single family residence, owned by Harold Holland, is surrounded by dense woods. The tests were performed on the south side of the house. The capacity of the two septic tanks are 900 gallons each, and the drainfield area is 200 SF. Two persons occupy the residence. The disposal system is seven years old.

2.1.2) Site No. 2:

This site is located in the northwest area of Gainesville off NW 51st St. about a tenth of a mile south from NW 39th Ave. The house, owned by Tom Martin, is completely surrounded by a heavily wooded area. The only access to the test site was through a dirt road, no asphalt road exists to reach the house from NW 51st St. The tests were performed on the north side of the house. The capacity of the septic tank is 1,000 gallons, and the drainfield area is 400 SF. Nine people occupy the residence. The disposal system is 16 years old.


SITE 2
FOXFIRE WOODS
FOREST OF THE UNICORN
TIMBERS COVE
HIDDEN PINES
PALMETTO WOODS
PINE MEADOWS
KINGS CREEK
MONTEREY
ELIZABETH GARDENS
ROCK CREEK
THORNEBROOK
FEATHERWOOD
HERMITAGE
FOX GROVE
FOREST
RIDGEWOOD PARK
NW 39TH AV
NW 31ST AV
NW 23RD BLVD
NW 23RD
NW 16TH BLVD
NW 16TH AV
8TH AV
NEWBERRY RD
SW 2ND
UNIVERSITY OF FLORIDA
STADIUM
Lake Alice
Prairie
ARCHER RD
PINEHURST PARK
WINDMEADOW
THE VILLAGE
PHOENIX
BRIDGELIGHT
Bivans Arm
SITE 1
SITE 1
MAIN
WILLISTON RD
SERENOLA MANOR
Payne
ROCKY POINT RD
COUNTRY CLUB ESTATES
GARDENS
ROCKY POINT
SW 83RD AV
121
26
20
24
75
331
441



U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
COOPERATING WITH
STATE AGRICULTURAL EXPERIMENT STATION

APPROX. SCALE 1" = 1320'

3-81

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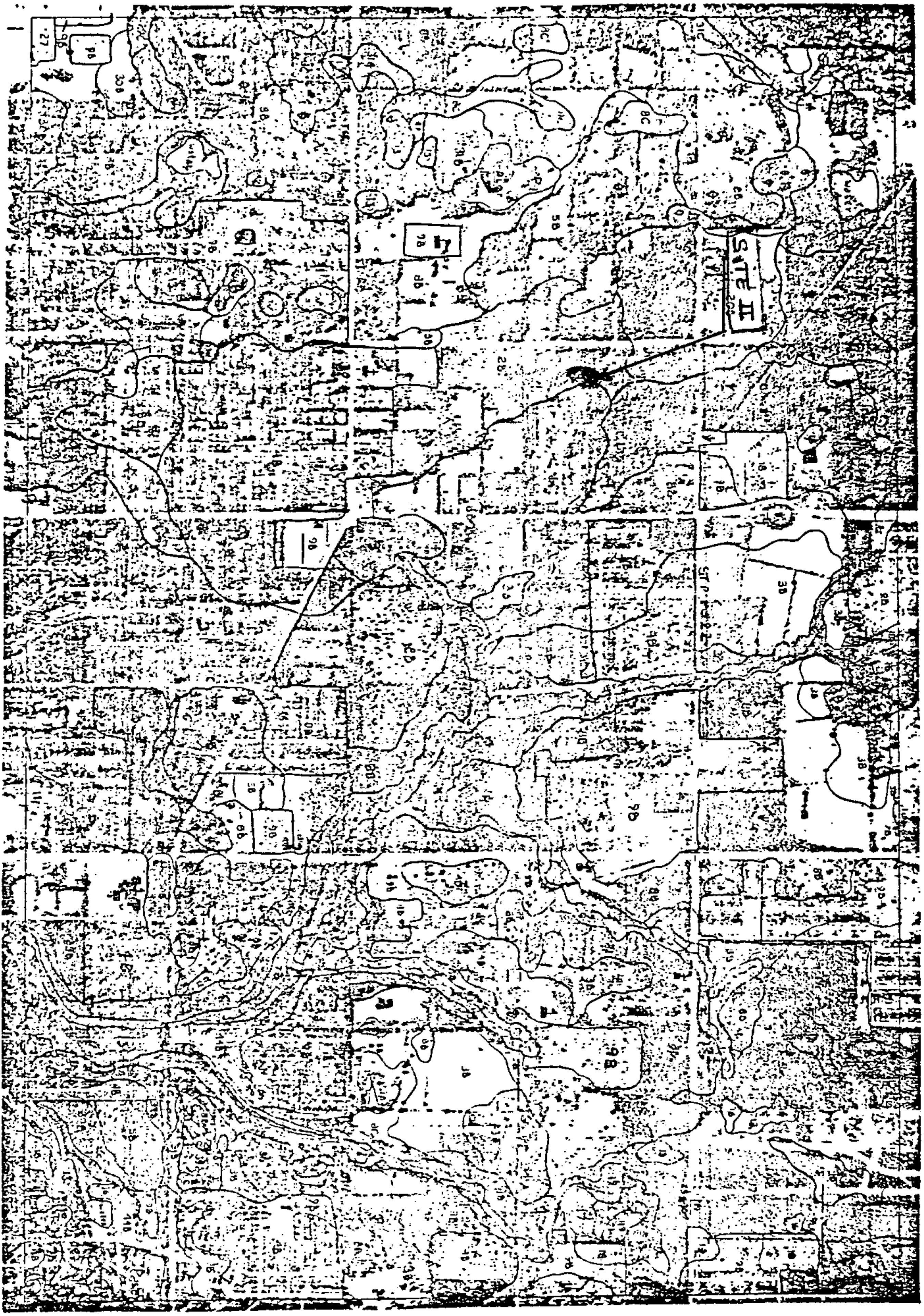
SOIL SURVEY FIELD SHEET
ALACHUA COUNTY, FLORIDA
ADVANCE COPY - SUBJECT TO CHANGE



U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
COOPERATING WITH
STATE AGRICULTURAL EXPERIMENT STATION

APPROX. SCALE 1" = 1320'

[illegible]

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57

SOIL SURVEY FIELD SHEET
ALACHUA COUNTY, FLORIDA
ADVANCE COPY - SUBJECT TO CHANGE

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2.2 ORMOND BEACH SITES

2.2.1) Site No. 1:

This site is located on State Road 40 approximately 8/10 of a mile, west of the I-95 intersection, between Tymber Creek Road and Twin River Drive. This plot of land is owned by Shirah and Sons, Inc. The site consists of a well maintained lawn next to the office building which is surrounded by Twin River Drive to the east and the parking area to the South. The capacity of the septic tank is 750 gallons and the drainfield area is 170 SF (10'x17'). Seven people are working in this office. The disposal system is nine years old.

2.2.2) Site No. 2:

This site is located on a cul-de-sac at the end of Twin River Drive about half a mile from site No. 1. It is a residential home surrounded by the Tomoka River in the rear of the house. The tests were performed on a well kept lawn to the north-northeast of the house, which is owned by Gail Coleman. The capacity of the septic tank is 1,000 gallons, and was installed approximately nine years ago. The drainfield area is 350 SF. Two people occupy the residence. The disposal system is nine years old.

2.2.3) Site No. 3:

This site is located at Hawaiian Tropic's Tanning Research Labs on Highway US 1, approximately two miles southeast of the I-95 and US 1 intersection and six miles northeast of site No. 1. The tests were performed in a well maintained lawn consisting mainly of a raised drainfield, two feet above the finish grade located in the parking area, and between the two existing buildings at this site. The capacity of the septic tanks are 1,200 gallons and 900 gallons. The drainfield area is 2,000 SF. At the present time 140 people are working in this laboratory. The disposal system is ten years old.

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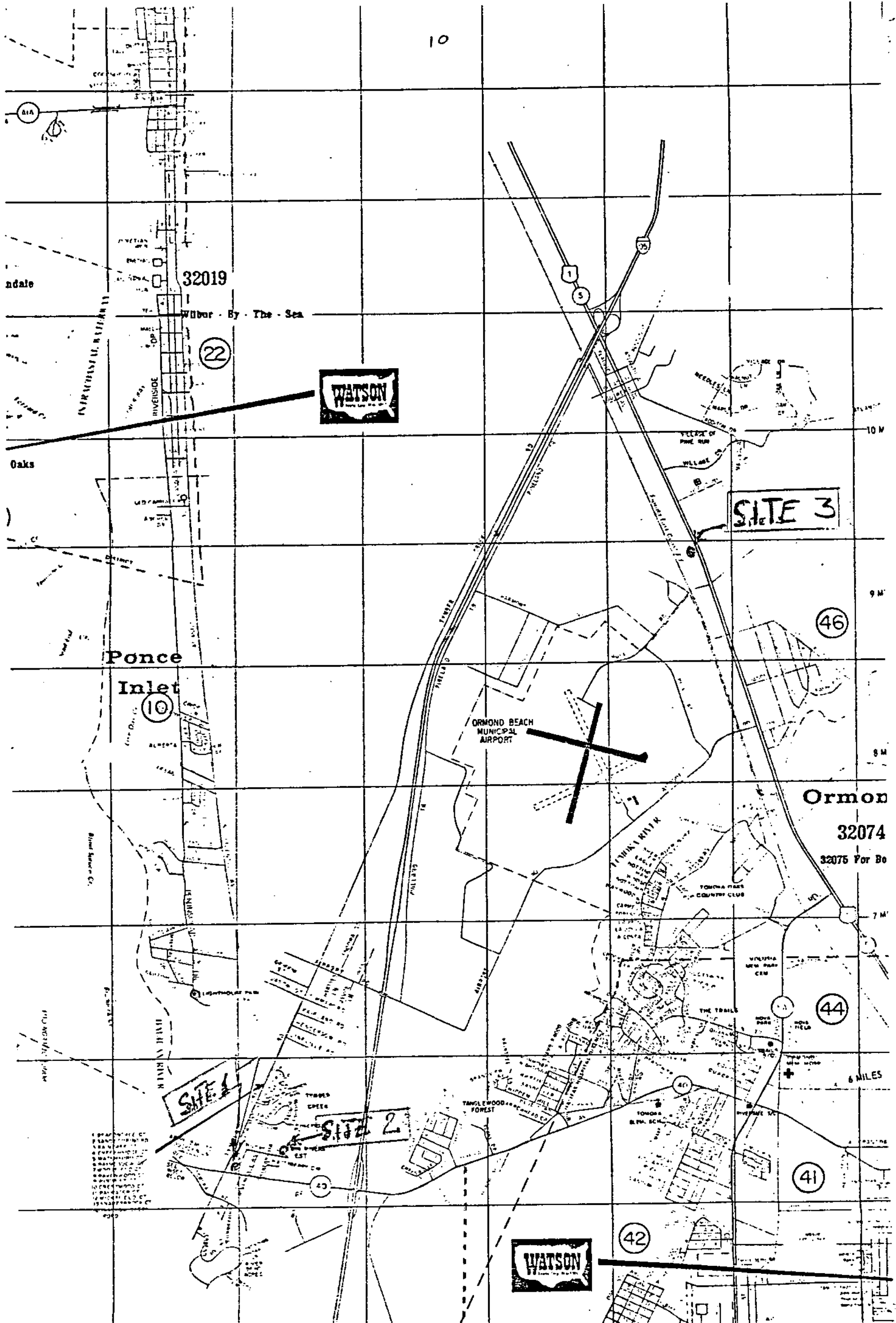
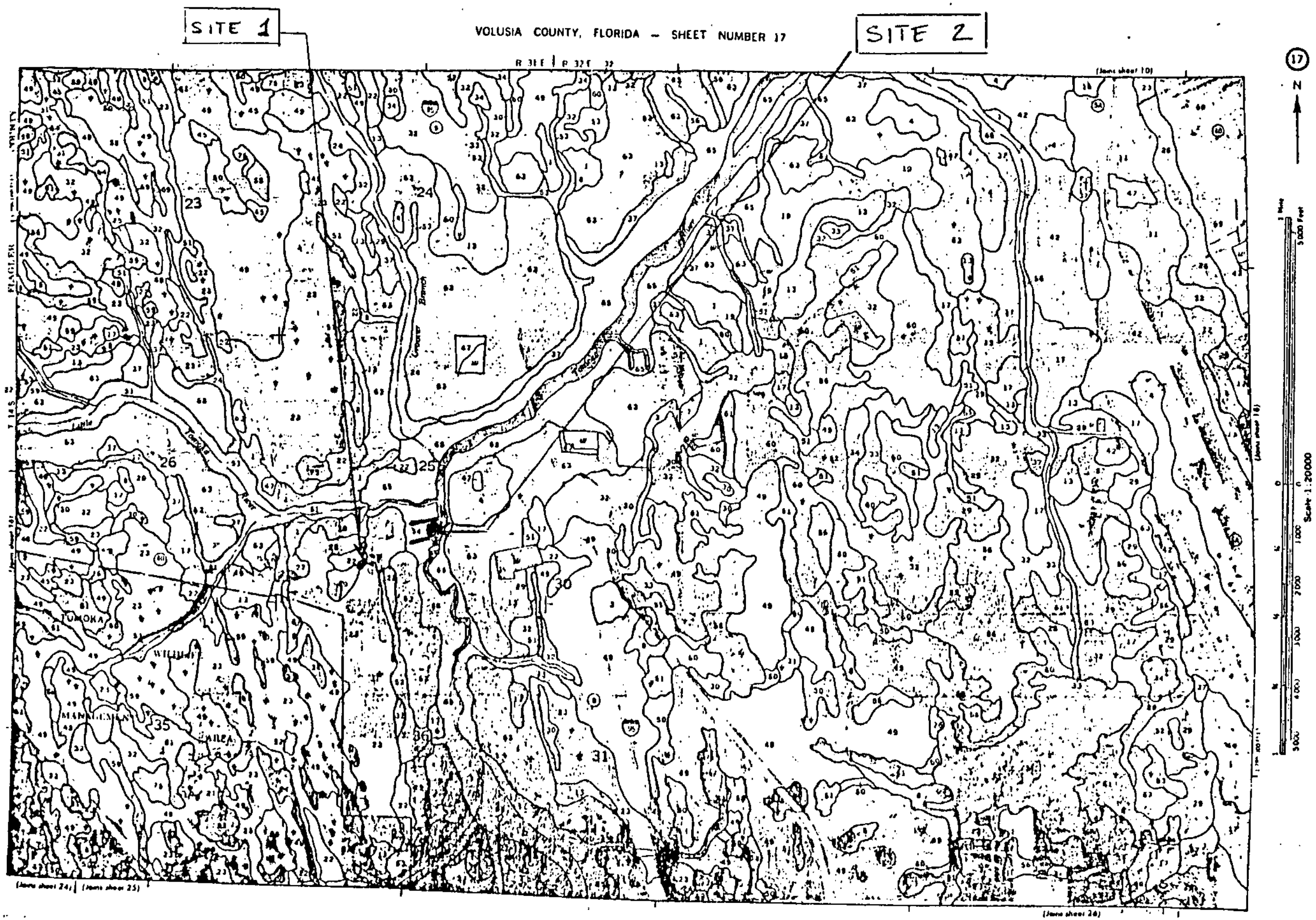
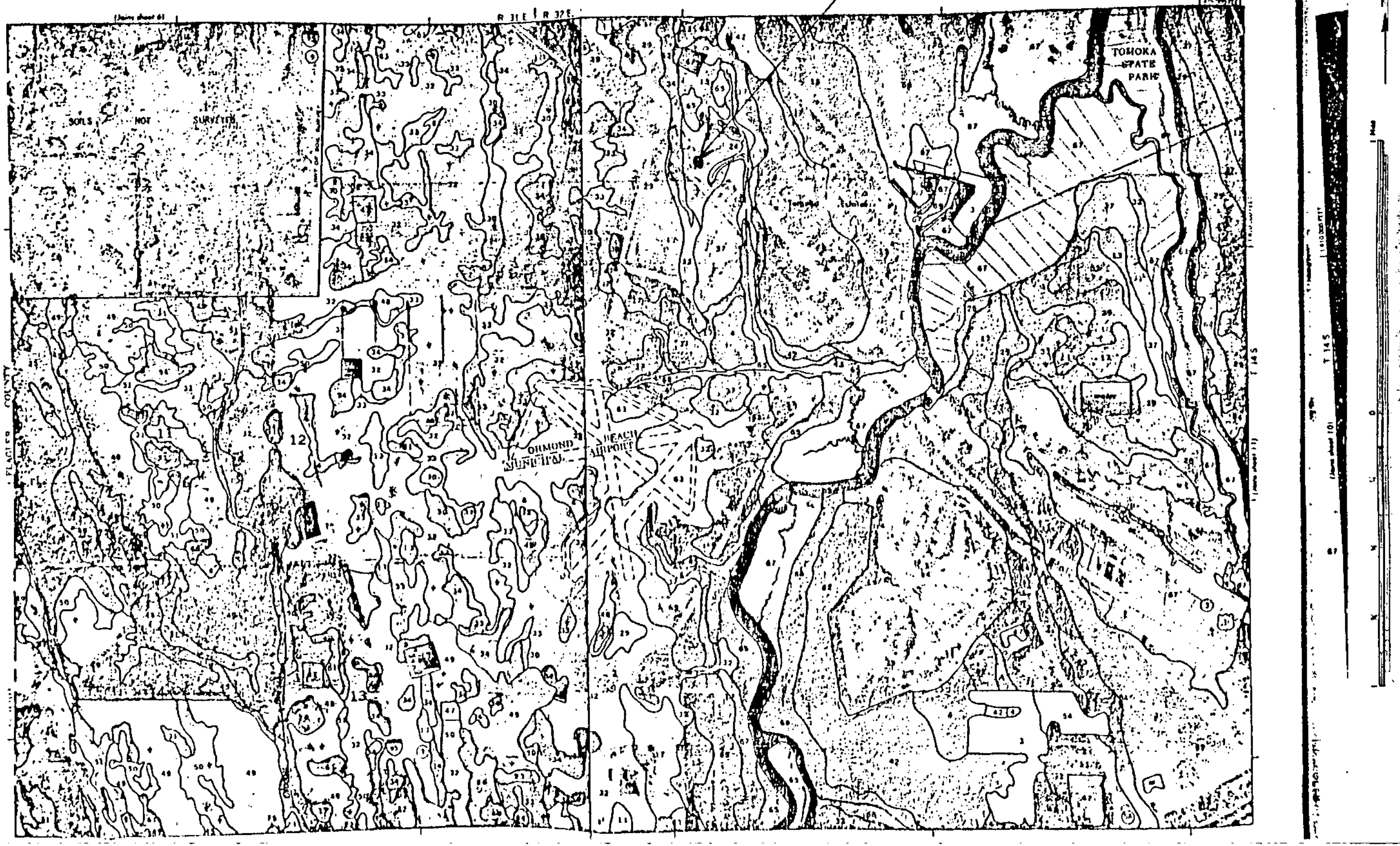

A1A
32019
Wilbur - By - The - Sea
ndale
INTRACOASTAL WATERWAY
RIVERSIDE
22
WATSON
Oaks
Ponce
Inlet
10
1
5
95
VILLAGE OF PINE RUN
SITE 3
10 M
9 M
46
ORMOND BEACH MUNICIPAL AIRPORT
8 M
Ormon
32074
32075 For Bo
TOMOKA RIVER
TOMOKA OAKS COUNTRY CLUB
7 M
44
THE TRAILS
6 MILES
TANGLEWOOD FOREST
SITE 1
SITE 2
40
41
42
WATSON

VOLUSIA COUNTY, FLORIDA – SHEET NUMBER 17



VOLUSIA COUNTY, FLORIDA - SHEET NUMBER 10

SITE 3



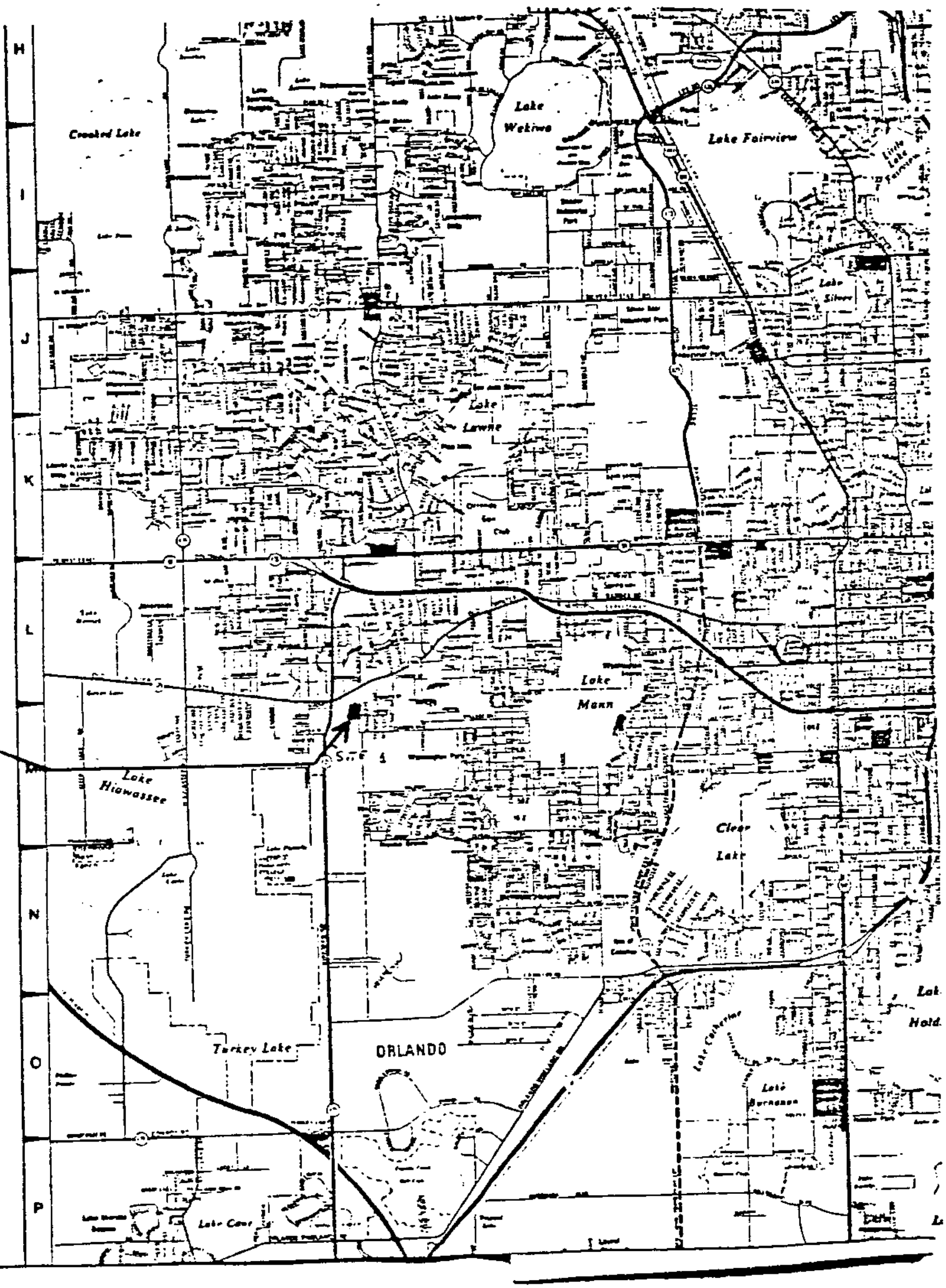
2.3 ORLANDO SITES

2.3,1) Site No. 1:

This site is on South McKinley St., three blocks south of Old Winter Garden Rd., which is approximately one mile south of Colonial Dr. (S.R. 50) and east of Kirkman Rd. The land on this site is owned by Harris Supply Co. with a total area of two acres. The only existing vegetation is located around the office building area. The rest of the area was mainly for material and equipment storage. The capacity of the septic tank is 500 gallons and the drainfield area is 360 SF (18'x20'). Nine persons work in the office during the week days.

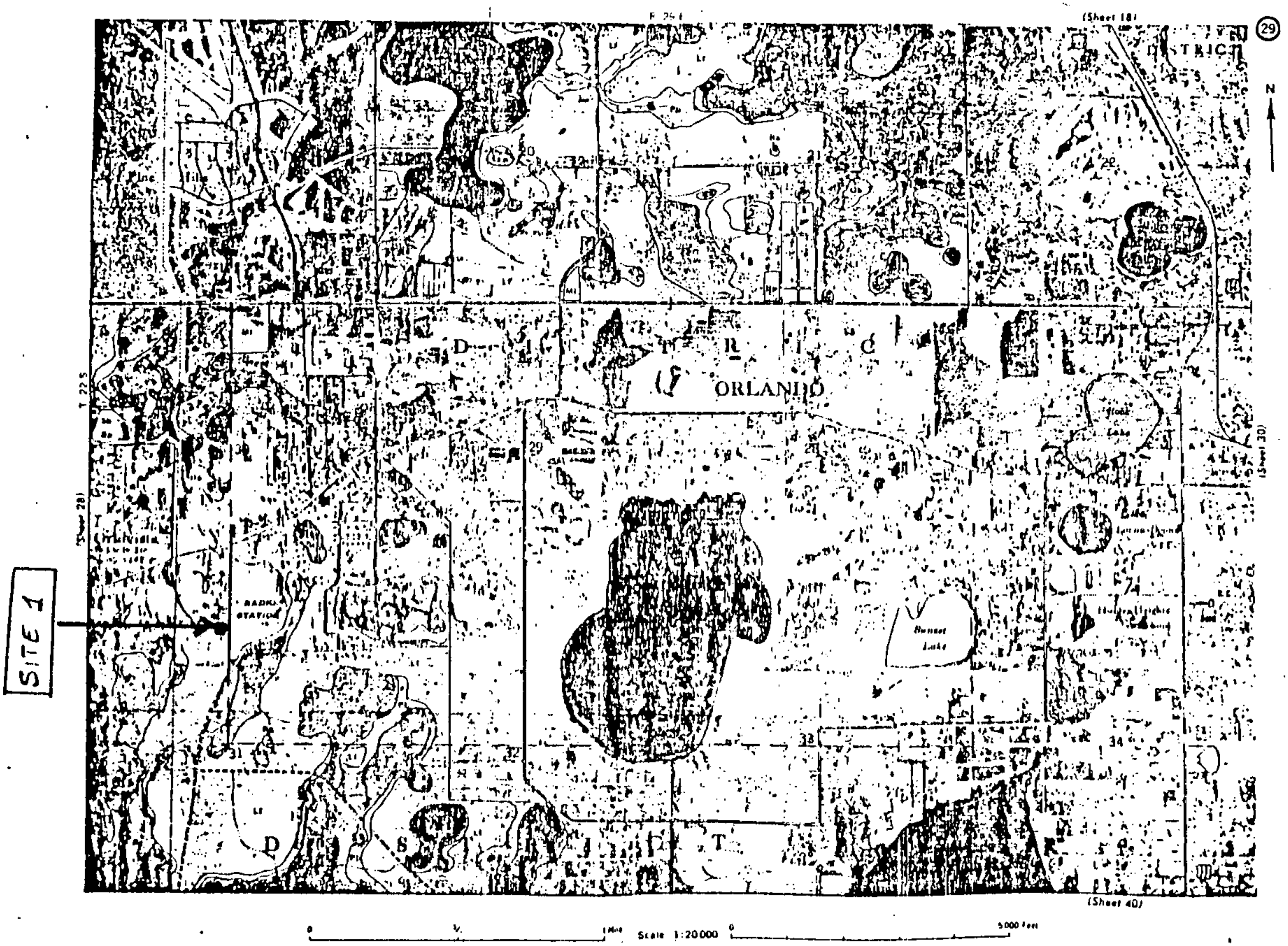
2.3.2) Site No. 2:

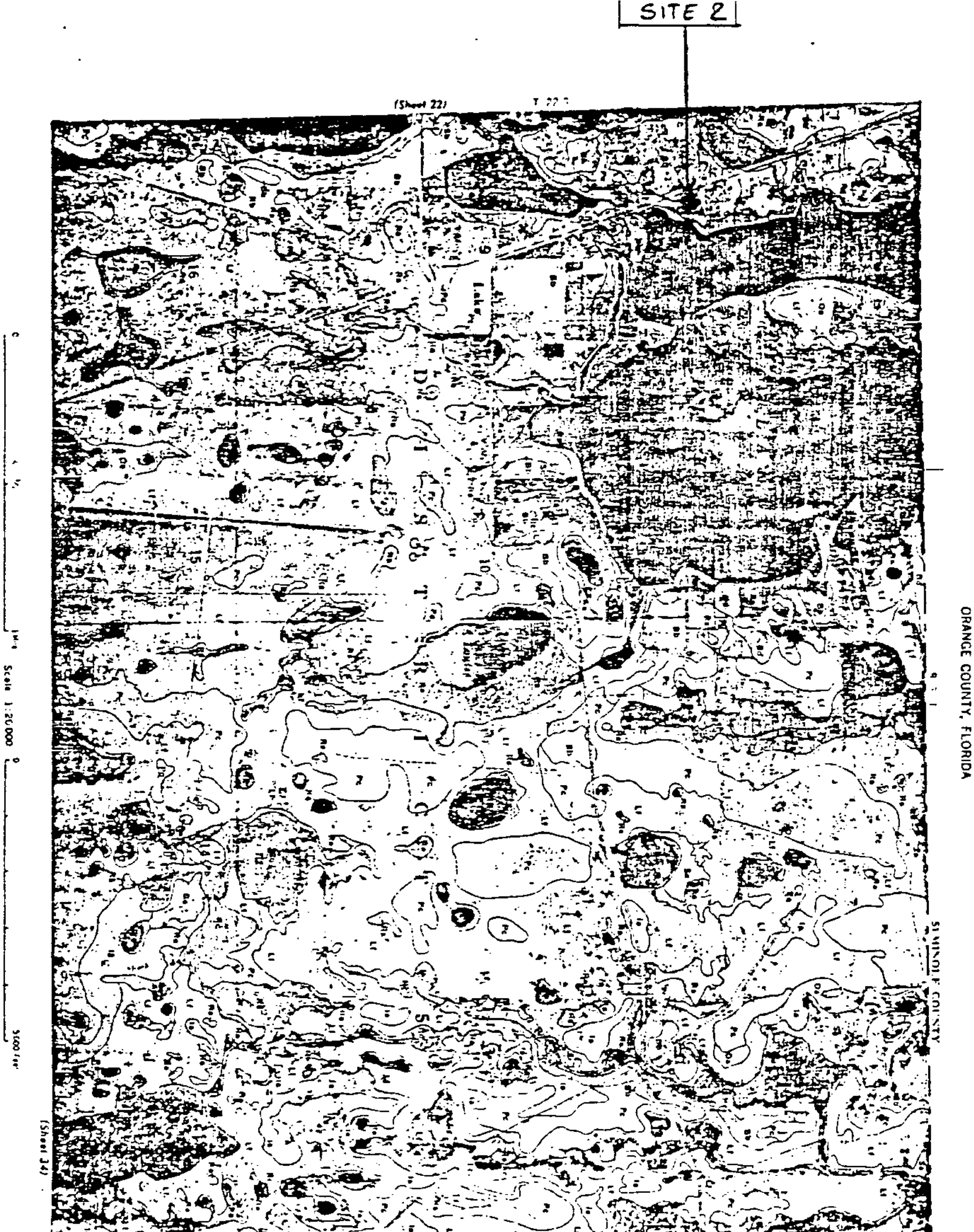
This site is located in east Orange County, two and a half miles north of State Road 50 on Orange County Road 419, shown on the map. The site is located on a tract of land next to Lake Pickett with an area of 6.5 acres and owned by Bert McCree. The vegetation over the lot is mainly made up of pines and oaks. There are a few shade trees and landscaping in the proximities of the house. The capacity of the septic tank is 540 gallons and the drainfield area is 300 SF (15'x20'). Two persons are living in this house at the present time.


H
I
J
K
L
M
N
O
P
Crooked Lake
Lake Wekiwa
Lake Fairview
Little Lake Fairview
Lake Silver
Lake Lawne
Lake Mann
Lake Hiawassee
Site 1
Clear Lake
Turkey Lake
ORLANDO
Lake Cane
Lake Catherine
Lake Burnsnon
Lak
Hold

SITE 1

ORANGE COUNTY, FLORIDA




SITE 2
(Sheet 22)
(Sheet 23)
(Sheet 24)
Scale 1:20,000
0
1 Mile
5000 Feet
SEMINOLE COUNTY
ORANGE COUNTY, FLORIDA

CHAPTER THREE

IMPACTS OF SEPTIC TANKS ON GROUND WATER QUALITY

3.1 GROUNDWATER MONITORING STRATEGIES FOR ON-SITE SEWAGE DISPOSAL SYSTEMS

Septic tanks are used for the disposal of waste water. The major objection to on-site systems is groundwater pollution. This research is carried out to investigate scientifically the groundwater pollution of effluent from existing on-site sewage systems.

3.2 COMPONENTS OF THE MONITORING PROGRAM

The two major components of the monitoring program are sampling locations & selection of variables.

3.2.1) SAMPLING LOCATIONS

In case of on-site systems the area covered from the septic tank to the lower boundary of the unsaturated zone in the leach field should be considered a part of the treatment system. Monitoring is intended to determine the effectiveness of the treatment system itself and there by quantify the output quality of the system.[1]

Seven sites were selected for this project. Four sites were supporting residential usage, and three sites were supporting commercial usage. Sampling points were placed at various locations within, upstream and downstream of the effluent's drain field. See Appendix B for the positions of wells and septic tanks. These wells were 2" in diameter and were placed so that the well screen was not less than one foot below the existing groundwater table.

3.2.2 SELECTION OF VARIABLES

Two categories of variables were considered; Health Hazardous Contamination and Nutrient Contamination.[2]

3.2.2.1 HEALTH HAZARD CONTAMINATION

The important contaminating factors from septic tank effluents are bacteria and viruses. University of Miami conducted a study of viruses. This study indicated that when septic-tank sludge particles are added to wet sludge, none appeared in the supernatant fluid from the sludge.[3] Therefore, viruses are not considered as a component for the chemical analysis of this project.

Several different kinds of bacteria could be used to evaluate the extent of pollution from an on-site system; however, a number of these bacteria are ubiquitous and would, therefore, serve poorly as indicators of contamination. Studies indicate that fecal coliforms and fecal streptococci are the most suitable indicators of fecal pollution.[4]

Fecal coliform and fecal streptococci satisfy four important criteria:

1. They are always present in very high numbers in the feces of man and warm blooded animals and are not found in abundance in areas were fecal contamination is not present.
2. Their typical survival time is sufficiently long that they are likely to be present during the treatment process.
3. They can be monitored more easily than other bacteria because standard methods for determination and pollution levels for maximum permissible concentrations have been developed.
4. They generally out number pathogenic bacteria and are therefore more likely to be detected.[5]

In this report due to the limitation of funds only fecal coliform tests are considered.

High concentrations of nitrate can be a health hazard. In 1940 it was found that drinking waters with high nitrate content often caused methemoglobinemia in infants. Environmental Protection Agency drinking water regulations require that the nitrate concentration in terms of nitrogen not exceed 10 mg/l in public water supplies.[6]

3.2.2.2 NUTRIENT CONTAMINATION

The major sources of nutrient contamination are nitrogen and phosphorus.[7] These contaminants are important because they are the major pollution source of surface waters.

The majority of nitrogen in septic tank effluent is in the form of ammonium and organic nitrogen. Ammonium constitutes about 75 percent of the total nitrogen, and organic nitrogen constitutes 25 percent of the total nitrogen. When effluent leaves the septic tank, nitrogen transforms to ammonium, and ammonium transforms to nitrite nitrogen (NO2) which is further oxidized to nitrate nitrogen(NO3).[8]

Research indicates that phosphate can be expected in septic tank effluent. Virarghayan and Warnock report that phosphate concentrations range from 6.25 to 30 ppm in septic tank effluent.[9] Water and Air Research, Inc. (1981) conducted a study on water quality impacts of septic tanks at three study lakes in central Florida. Their report indicates that septic tank use in poorly-drained areas is likely to contribute higher concentrations of phosphorus to groundwater.[10] Based on Magdoff and Keeney's Laboratory Investigation of Phosphorus Retention, Sikora and Corey (1976) estimated the depth of phosphorus penetration to be approximately 50 centimeters per year in the textured soils. This would indicate the possibility of groundwater contamination in sandy soils with high groundwater levels.[11]

3.2.2.3 OTHER VARIABLES

Past research indicates that chloride measurements have been used as an indication of the overall extent of pollution and as such can be important variables in a monitoring program. Chloride measurements are not considered as important as the bacteriological and nutrient variables previously described. This is because of chloride measurement will not give any indication of the degree of treatment provided by a leach field.[12]

There are many other variables included by past researchers but not considered in this study. Due to limitations of funds and time considerations only those variables most important to the project have been considered.

3.3 COLLECTION AND ANALYSIS OF WATER SAMPLES

Monitoring well samples for this project were obtained from various locations around Florida, namely Gainesville, Ormond Beach and Orlando. Water levels in all the wells was less than 15 feet from the surface. 166 samples were collected from 34 wells over a period of seven weeks. A hand pump was used to purge all the wells before collecting the samples. A 1½" diameter and 6" long metal tube was employed to collect the water samples. 300 ml plastic bottles were used to contain these samples.

For the purpose of clarity and to avoid mix-ups, each bottle was marked with the date, the sampling site, test sample number, the well number and the test to be performed.

E.G. SEPT 8, 1982

ORL1S1

W1

NITRATE/NITRITE, CHLORIDE

(ORL1= ORLANDO SITE 1, S1= SAMPLE NO. 1, W1= WELL NO. 1)

Before the sample water was poured into the bottle, the bottle was rinsed with the effluent from the well and after the sample water was placed in the bottle the bottle was put on ice.

Four samples were required to be taken from each well,.one for each kind of analysis to be made.

BOTTLE #1 Water from this bottle was to be used to carry out the following tests: Nitrate/Nitrite, Chloride

BOTTLE #2 Water from this bottle was to be used to carry out the following test: Ammonia

BOTTLE #3 Water from this bottle was used to assess the total phosphate contents of the sample. The bottles for this sample was specifically prepared for the test by cleaning with HCL.

BOTTLE #4 The fecal coliform was assessed from this sample.

After collecting all of these samples, they were transported immediately to the Environmental Engineering Lab at the University of Florida for analysis. From the time of collection it was of vital importance to keep all the bottle covered with ice. All analysis were run according to the standard methods. Fecal coliform tests were run by the membrane filter techniques. Samples were run within the prescribed time.

The initial analysis included the following parameters: Nitrate/Nitrite, Chloride, Ammonia, Phosphorus, and Fecal Coliform.

FOOTNOTES

CHAPTER THREE

[1] J. D. Nelson, Et Al, On Site Sewage Treatment, (Michigan, American Society of Agricultural Engineers, 1982), p. 302

[2] ibid., p. 303

[3] William Pitt., Et Al, Groundwater Quality in Selected Areas Serviced by Septic Tanks, Dade County, Florida, (Dade County, Florida, 1975), p. 75

[4] J. D. Nelson, Et Al, On Site Sewage Treatment, (Michigan, American Society of Agricultural Engineers, 1982), p. 303

[5] J. D. Nelson, Et Al, Groundwater Monitoring Strategies to Support Community Management Of On-Site Home Sewage Disposal Systems, (Ford Collins, Colorado, 1980), p. 13

[6] Clair N. Sawyer, Et Al, Chemistry For Environmental Engineering, (McGraw-Hill Book Company, 1978), p. 444

[7] J. D. Nelson, Et Al, On Site Sewage Treatment, (Michigan, American Society of Civil Engineers, 1982), p. 303

[8] James D. Nelson, Et Al, Groundwater Monitoring Strategies to Support Community Management of On-Site Home Sewage Disposal Systems, (Fort Collins, Colorado, 1980), p. 17

[9] H. S. Peavy, Et Al, Home Sewage Treatment, (Michigan, American Society of Civil Engineers, 1977), p. 223

[10] Water and Air Research, Inc., Water Quality Impacts of Septic Tanks at Three Study Lakes in Central Florida., (Gainesville, 1981), p. 2

[11] James D. Nelson, Et Al, Groundwater Monitoring Strategies to Support Community Management of On-Site Home Sewage Disposal Systems, (Fort Collins, Colorado, 1980), p. 16

[12] ibid., p. 20

CHAPTER FOUR

SOIL TESTS

4.1 SOIL TESTS PERFORMED

Two soil engineering companies were involved in the performance of soil tests: Universal Engineering Testing Co. performed the soil borings and other required tests at Gaineville's two sites. The sites at Ormond Beach and Orlando were done by Jammal and Associates (Consulting Geotechnical Engineers) of Orlando.

At each site there were several tests made, as follows:

Soil Borings
Percolation Rate
Permeability Rate
Groundwater Height

Soil borings were carried out to determine the type of soil that exists at each site. Once the soil was grouped, by the Unified System Classification, it was compared using this classification to confirm that the soil matches the soil type shown in the soil survey maps.

The percolation rates at each site were required so a relationship could be achieved to compare the maximum rate of sewage that may be applied to the effluent's bottom according to Table III of Chapter 10D-6 of the Standards for On-Site Sewage Disposal Systems. The percolation rate was also related to the permeability rate by a formula that is explained in the following chapter. This enables a comparison to be made between the value of the percolation rate and the soil survey manuals; thus, permitting a direct relationship between the soil survey manuals and Table III of Chapter 10D-6, one of the main concerns of this report.

The percolation rates were obtained following similar procedures recommended by Section 10D-6.57 (Percolation Test Procedure) of the Standards for On-Site Sewage Disposal Systems and by standard procedures which soil testing companies abide to and are approved by the State of Florida regulations.

The permeability rate or hydraulic conductivity rates were determined by taking a sample in a 4" PVC casing. The test sample was tested in a saturated state, since it was necessary to obtain the saturated hydraulic conductivity for the formula that will relate the permeability rate to the percolation rate.

The height of the groundwater table was needed to determine the accuracy of the information from the soil survey manuals.

All soil borings were required to extend below the water table depth. Most of the sites had water tables less than five feet deep, including one just over a foot, at site one in Ormond Beach.

The percolation rate was tested in 8" diameter pits. Times were taken at each one inch drop for the first three inches. The times taken for these periods were averaged. The test was performed twice, so more accurate results were provided.

4.2 RESULTS AT STUDY AREAS

The results that were obtained will be described by sites and compared with information listed in the soil survey manuals.

A summary of the test results and their comparisons in the soil survey books of Volusia, Orange, and Alachua Counties can be found in Table 4A.

4.2.1) Gainesville Site 1:

Soil Survey Maps indicates site one to be a Blichton fine sand, with a classification of "SM-SC" according to the Unified System, coinciding with the results of the soil borings performed for that site by Universal Engineering Testing Co.

The permeability rate, although not within the range indicated in the Soil Survey Manual, is acceptable. Slow percolation through Septic Tank Absorption Fields classifies it as a "severe" degree.[1]

The Water Table found in the soil borings is located at a deeper depth than that indicated in the Soil Survey Manual. The reason for this variance is due to drainage of the property by ditches and canals. Since the 0 to 1 foot range shown in the manual pertains to the seasonal high between the months of July and September. The tests were performed in mid-October.

The Blichton series characterizes itself as a poorly drained soil. It contains sandy clay loam between the 65 and 77 inch depth strata.

4.2.2) Gainesville Site 2:

According to the Survey Maps this site contains Candler sand with an "SP-SM" classification in the Unified System which matches the SW-SM classification obtained in the tests.

This soil has a fast permeability rate as shown in the tests, as well as, the survey Manuals.

The variance in depths of the water table can result from the existence of a septic effluent in the location where the tests were performed for this particular site.

The soil found in this sight is rated as a "slight" degree, which indicates it is favorable to use as a Septic Tank Absorption Field. The limitation is minor and can be overcome easily.[2]

The Candler sand characterizes itself as an excessively drained soil, ideal for building site developments and excellent for Septic Tank usage.[3]

4.2.3) ORMOND BEACH-SITE 1:

The Soils Surveys of Volusia County indicated this location to contain an Electra type soil, which is classified as an "SP" under the Unified System coinciding with the soil borings performed at this site.

As in sites one and two in Orlando, this site also classifies as "severe" for a Septic Tank Absorption Field.

Electra soils characterize themselves as poorly drained rapidly permeability at the 8 to 35 inch depth. They are closely related to the Apopka series soils.[4]

The permeability rate was found for this soil to be 1.25 inch/hr, although it does not fall within the 6.0-20.0 inch/hr range illustrated in the soil survey; it does concur for the range given for an Electra soil at 35-52 inch depth. Since the values given in soil surveys is assumed as an average for the entire area where this specific soil is found, throughout the county, a variation could occur at the site; thus, differing somewhat from the values given in the survey manuals. For this particular case the permeability rate range of 6.0-20 inch/hr could be found in the 8-35 inch depth from the soil survey manuals.[5]

The depth of the water table, although not within the range indicated in the soil survey manuals, is at a reasonable variance.

4.2.4) ORMOND BEACH - SITE 2:

The soil described in the survey for this site is a Quartzipsamments. This type of soil series are gently sloping, moderately well drained and sandy. They have been reworked and shaped by earthmoving equipment and are shaped around shallow waterways, as occurs at this site which lays next to the Tomoka River. They do not have an orderly sequence of layers; but include pockets of sand, fine sand, loamy sand within short distances.[6]

Drainage is variable, the water table is normally below 40".[7] In our tests the water table was found at 24" probably because of its proximity to the river.

Although the manuals state that Quartzipsamments have a rapid permeability, our tests show that a clayish fine sand found at twenty-eight inches slows down the permeability.

The test's data can be seen in Table 4A. The soil borings illustrate the soil classifications to be an "SP" resembling the characteristics shown by Quartzipsamments soils.

4.2.5) ORMOND BEACH - SITE 3:

According to the Soil Survey Maps, this site is shown to contain a Cassia type soil, which is classified as an "SP" in the Unified System. This classification matches with the results obtained in the soil borings.

The water table found in the soil borings at 3.8 feet is not within the range given in the Soil Survey Manuals. This occurs because the septic effluent at this site is located in an elevated absorption field, which contains two feet of fill material, so the real depth of the water table is 1.8 feet concurring with the Manual's data.

The permeability rate was recorded at 2.95 inch/hr in the tests performed.

The Cassia type soil is characterized by a somewhat poorly drained sandy soil. On-site septic systems can be mounded to maintain adequate depth above seasonal water table.[8]

4.2.6) ORLANDO - SITE 1:

According to data provided by Jammal and Associates from the tests they performed, the soil classification, SP, by the Unified System, matched the information provided in Soil Survey Manuals.[9] The soil name is St. John, this type of soil is characterized by fluctuating water tables between shallow and deep. Internal drainage is rapid when water table is low.[10]

The data obtained in different tests performed at this site are shown on Table "4A".

A St. John is classified "severe" for Septic Tank Absorption Field. This class sytem is defined for soils having one or more properties unfavorable for a particular use. Limitations are difficult to overcome and in some cases are costly. Some special design and maintenance could be required.[11]

4.2.7) ORLANDO - SITE 2

As in site No. 1, the tests from the soil borings indicated an "SP" classification, which was in accordance with the soil survey. The maps indicated this site to contain a Blanton fine sand. Data from the different tables of the Soils Surveys and the results of the tests can be seen in Table "A". These soils are moderately well drained instead of just well drained. The water table fluctuates, but during the wet season it is within 30 inches of the surface.[12]

The Blanton soil is classified "severe" for Septic Tank Absorption Field. The "severe" degree condition, as found in several other soils on the other sites, occurs mainly because of high water table.

Blanton soils can include a mixture of other soils, which would vary the water table. In well drained soils the water table is below five feet.

The permeability rate at this site, 4.95 inch/hr, is within the acceptable value for this type of soil which has a permeability rate range of 6.0 inch/hr.

TABLE 4A

COMPARISON SOIL SURVEY MANUAL AND TEST RESULTS

	SOIL SURVEY INFORMATION					TEST RESULTS				
	SOIL NAME & MAP SYMB.	SOIL CLASSIF.	SEPTIC TANK ABS. FIELD	PERM RATE in/hr	DEPTH TO HIGH W.T. (ft)	SOIL CLASSIF.	PERM RATE in/hr	PERCOL RATE min/in	DEPTH TO W.T. (ft)	OBSERVATIONS
G'VILLE-1	Blichton 31C	SM-SC	Severe Perc. Slow	2.0-6.0	0-1	SM	1.62	7.5	3.0	
G/VILLE-2	Candler 2B	SP-SM	Slight	>20	6.0	SW-SM	22.32	0.78	4.0	
ORMB-1	Electra 22	SP	Severe	6.0-20	2-3.5	SP	1.25	5.47	1.1	When samples were taken w/t depth was ± 2 ft
ORMB-2	Quartzipsamments 54	N/A	If water is controlled, high potent. for sep. tk. use	N/A	3.0	SP	0.70	13.70	2.0	Soil mixed during earth moving variable mixture of sands fill areas 2-5 thick
ORMB-3	Cassia 13	SP, SP-SM	Severe Wetness	0.6-6.0	1.5-3.5	SP	2.95	1.97	3.8	
ORL-1	St. Johns Sa	SP, SP-SM	Severe High W.T.	6.3-20.0	1-2	SP	1.85	9.78	0.7	When samples were taken w/t depth was ± 2 ft
ORL-2	Blanton Bb	SP, SP-SM	Severe; seasonal high water table	6.3-20.0	2-3	SP	4.95	1.18	3.6	Could have inclusions of other soils. In well drained soils, water table @ 5.0'

FOOTNOTES

CHAPTER FOUR

[1] Special Soil Survey Maps & Interpretations, Alachua County, FL, (USDA SCS & UF Agricultural Experiment Station, 1980) pg. 55

[2] ibid, pg. 8

[3] ibid, pg. 19

[4] Soil Survey of Volusia County, FL, USDA SCS & UF Agric. Experim. Stat., 1977, pg. 78

[5] ibid, pg. 185

[6] ibid, pg. 39

7ibid, pg.

[8] ibid, pg. 19

[9] Soil Interpretation for Urban and Recreational Uses, (Supplement to Soils Survey Orange County, FL) 1973, Tables 1-3

[10] Soil Survey of Orange County, FL, USDA, SCS & UF Agric. Experim. Stat., 1960, pg. 30

[11] Soil Interpretation for Urban and Recreational Uses, (Supplement to Soils Survey Orange County, FL) 1973, pg. 12

[12] Soil Survey of Orange County, FL, USDA, SCS & UF Agric. Experim. Stat., 1960, pg. 8

CHAPTER FIVE

RELATIONSHIP OF SOIL PERMEABILITY RATES FROM SOIL SURVEY MANUALS AND PERCOLATION RATES TAKEN AT STUDY AREAS

The percolation rate is the downward movement of water through a soil in a saturated or nearly saturate state. The most popular concept is its use to evaluate the capacity of the soil to accept effluent from a septic tank. It is usually expressed in terms of min./inch or sec./inch, a measure of time for a standard head of water to drop one inch.[1]

The permeability rate is the property of a soil that permits the transmission of fluids. It is mainly expressed in inch/min, inch/hr, ft/min or ft/day.[2] The Soil Survey Manuals expresses the permeability rate in inch/hr., the term which will be used in this report.

To design effluent fields for the different soil characteristics, the relationship between the soil's permeability rate and its percolation rate must be determined. The relationship of permeability and percolation rates is required in order to obtain a comparison of the soil's identification from the Soil Survey Manuals and apply it to Table III of Chapter 10D-6 of the Standards for Individual Sewage Disposal Facilities.

Winneburg developed an empirical relationship between the percolation rate and the saturated hydraulic conductivity (permeability rate).

$$K=40.85\ R^{-1.56} \quad (5.1)$$ [3]

where K= saturated hydraulic conductivity (cm/hr)

R= percolation rate (min/inch)

Since the permeability rate in the Soil Survey Manuals are given in $\frac{\text{inch}}{\text{hour}}$, K, must be mutltiplied by 0.394.

The above equation was developed from data for a limited area in California.[4] The test results performed at the study sites are used to confirm the constants in equation (5.1). The percolation rate which are taken at the sites are inserted in the equation and the result is compared with the permeability rate also obtained in the tests.

For future cases, the permeability rate will be known from the soil manuals and the percolation rate will be determined from the formula. So, equation 5.1 can be rewritten as follows:

(5.2) $R= {\frac{40.85}{K}}^{0.641}$, If K is given in cm/hr.

(5.3) $R= {\frac{16.08}{K}}^{0.641}$, If K is given in inch/hr.

With the use of these formulas we can assign the permeability rate given for soils located in a particular site and obtain an average percolation rate range. The permeability rate, given in the Soil Survey Manuals and used in equations (5.2) or (5.3) are range values depending on the type of the soil and the depth at which the study is required.

The percolation rate consequently will also be range values. This is confirmed from Table III of Chapter 10D-6.

From the study sites, examples of the use of equation 5.1 is illustrated.

GAINESVILLE - SITE 1

FIELD TEST DATA:

PERMEABILITY RATE: $2.25 \times 10^{-3} \frac{\text{ft}}{\text{min}} \times 12 \frac{\text{in}}{\text{ft}} \times 60 \frac{\text{min}}{\text{hr}} = \underline{1.62 \text{ inch/hr}}$

PERCOLATION RATE: $450 \frac{\text{sec}}{\text{in}} \times \frac{1 \text{ min}}{60 \text{ sec}} = 7.5 \frac{\text{min}}{\text{inch}}$

Using Fig. 5.1

$$K = 40.85 R^{-1.56}$$

$$= 40.85 (7.5)^{-1.56}$$

$$= 1.76 \text{ cm/hr} \times 0.394 \frac{\text{inch}}{\text{cm}} = \underline{0.69 \text{ inch/hr}} \approx 1.62 \text{ inch/hr}$$

GAINESVILLE - SITE 2

FIELD TEST DATA:

PERMEABILITY RATE: $3.1 \times 10^{-2} \frac{\text{ft}}{\text{min}} \times 12 \frac{\text{in}}{\text{ft}} \times 60 \frac{\text{min}}{\text{hr}} = \underline{22.32 \text{ inch/hr}}$

PERCOLATION RATE: $46 \frac{\text{sec}}{\text{in}} \times \frac{1 \text{ min}}{60 \text{ sec}} = 0.776 \frac{\text{min}}{\text{inch}}$

$$K = 40.85 R^{-1.56}$$

$$= 40.85 (0.77)^{-1.56}$$

$$= 60.67 \text{ cm/hr} \times 0.394 \text{ inch/cm} = \underline{23.90 \text{ inch/hr}} \approx 22.32 \text{ inch/hr}$$

ORMOND BEACH - SITE 1

FIELD TEST DATA:

$$\text{PERMEABILITY RATE}= 2.5\ \frac{\text{ft}}{\text{day}} \times 12\ \frac{\text{in}}{\text{ft}} \times \frac{1\ \text{day}}{24\ \text{hr}} = \underline{1.25\ \text{in/hr}}$$

$$\text{PERCOLATION RATE AVG}= 328\ \frac{\text{sec}}{\text{inch}} \times \frac{1\ \text{min}}{60\ \text{sec}} = 5.467\ \text{min/inch}$$

$$K= 40.85\ R^{-1.56}$$

$$= 40.85\ (5.467)^{-1.56}$$

$$= 2.886\ \text{cm/hr} \times 0.394\ \frac{\text{inch}}{\text{cm}} = \underline{1.14\ \text{inch/hr}} \approx 1.25\ \text{in/hr}$$

ORMOND BEACH - SITE 2

FIELD TEST DATA:

$$\text{PERMEABILITY RATE:}\quad 1.4\ \text{ft/day} \times 12\ \frac{\text{in}}{\text{ft}} \times \frac{1\ \text{day}}{24\ \text{hr}} = \underline{0.7\ \text{in/hr}}$$

$$\text{PERCOLATION RATE AVG}= 823\ \frac{\text{sec}}{\text{inch}} \times \frac{1\ \text{min}}{60\ \text{sec}} = 13.7\ \text{min/inch}$$

$$K= 40.85\ R^{-1.56}$$

$$= 40.85\ (13.7)^{-1.56}$$

$$= 0.688\ \text{cm/hr} \times 0.394\ \frac{\text{inch}}{\text{cm}} = \underline{0.27\ \text{inch/hr}} \approx 0.7\ \text{in/hr}$$

ORMOND BEACH - SITE 3

FIELD TEST DATA:

PERMEABILITY RATE: $5.9 \frac{\text{ft}}{\text{day}} \times 12 \frac{\text{in}}{\text{ft}} \times 1 \frac{\text{day}}{24\text{ hr}} = \underline{2.95\text{ in/hr}}$

PERCOLATION RATE: $118 \frac{\text{sec}}{\text{in}} \times 1 \frac{\text{min}}{60\text{ sec}} = 1.97\text{ min/in}$

$K = 40.85\ R^{-1.56}$

$= 40.85\ (1.97)^{-1.56}$

$= 14.18\text{ cm/hr} \times 0.394 \frac{\text{in}}{\text{cm}} = \underline{5.59\text{ in/hr}} \approx 2.95\text{ in/hr}$

ORLANDO - SITE 1

FIELD TEST DATA:

PERMEABILITY RATE: $3.7 \frac{\text{ft}}{\text{day}} \times 12 \frac{\text{in}}{\text{ft}} \times 1 \frac{\text{day}}{24\text{ hr}} = \underline{1.85\text{ in/hr}}$

PERCOLATION RATE: $587 \frac{\text{sec}}{\text{inch}} \times 1 \frac{\text{min}}{60\text{ sec}} = 9.78\text{ min/in}$

$K = 40.85\ R^{-1.56}$

$= 40.85\ (9.78)^{-1.56}$

$= 1.17\text{ cm/hr} \times 0.394 \frac{\text{inch}}{\text{cm}} = \underline{0.46\text{ in/hr}} \approx 1.85\text{ in/hr}$

ORLANDO - SITE 2

FIELD TEST DATA:

PERMEABILITY RATE: $9.9 \frac{ft}{day} \times 12 \frac{in}{ft} \times 1 \frac{day}{24\ hr} = \underline{4.95\ in/hr}$

PERCOLATION RATE AVG: $71 \frac{sec}{in} \times 1 \frac{min}{60\ sec} = 1.18 \frac{min}{in}$

$$K = 40.85\ R^{-1.56}$$

$$= 40.85\ (1.18)^{-1.56}$$

$$= 31.55 \frac{cm}{hr} \times 0.394 \frac{in}{cm} = \underline{12.43 in/hr} \quad 4.95\ in/hr$$

Comparision of permeability rates in the soils manuals and the field tests show a good correlation except for Orlando - Site 1 and Ormond Beach Site 1. At these sites the groundwater table was at 0.7 feet and 1.1 feet, respectively, below grade. The high water table at these sites were the cause of the variation. At sites with water tables below the field tests correlated very well with rates shown in the soils manuals as show in Table 4A.

TABLE 5A

COMPARISON OF COMPUTED AND FIELD TEST PERCOLATION RATES

SITE	PERM RATE IN/HR	COMPUTED PERC. RATE RANGE USING FORMULA 5.3 MIN/INCH	FIELD TEST PERC. MIN/INCH
G'VILLE 1	2.0-6.0	1.9-3.8	7.50
G'VILLE 2	>20	< .9	0.78
ORMB 1	6.0-20.0	.9-1.9	5.47
ORMB 2	N/A	N/A	13.70
ORMB 3	0.6-6.0	1.9-8.2	1.97
ORL 1	6.3-20.0	.9-1.8	9.78
ORL 2	6.3-20.0	.9-1.8	1.18

Table 5A compares the computed range of percolation rates using Formula 5.3 and the permeability range given in the soils manuals to the field test percolation rates. Once again good results are obtained except at the ORMB-1 na ORL-1 sites where the water table was high. The Gainesville-1 site also had a higher percolation rate than the computed range indicating slightly different field conditions than those shown in the soils manual. It appears that under water table conditions suitable for septic tanks as outlined in Chapter 10D-6, Florida Administrative Code, i.e., the water table at the wettest season at least 24 inches below the infiltration surface of the drainfield, formula 5.3 gives satisfactory results and can be used to determine the percolation range of various soils from permeability ranges listed in the soils manuals.

FOOTNOTES

CHAPTER FIVE

[1] Fairbridge and Fink, Encyclopedia of Soil Science - Part I, Vol. 12, (Dowden, Hutchinson, & Ross, Inc., Penns., 1979)

[2] ibid.

[3] Onsite Sewage Treatment, Proceedings of the 3rd National Symposium on Individual & Small Community Sewage Treatment, American Society of Agricultural Engineers, St. Joseph, Mich., 1982, p. 35

[4] ibid, p. 35

CHAPTER SIX

DETERMINATION OF REQUIRED SEPTIC TANK ABSORPTION FIELDS DESIGN

6.1 CLASSIFICATION OF SOIL'S SURVEYED WITH TABLE III OF CHAPTER 10D-6

This chapter is divided into three major sections. First, the description on how to determine the sewage capacity of the soils studied. Then, a standard procedure will be illustrated to determine the design of septic tank effluent systems for different types of soils.

The results of the percolation rates obtained from the study sites are classified according to their corresponding division of Table III of Chapter 10D-6.

Once this classification is obtained, the maximum rate of sewage that can be applied to the trench bottom is determined. This rate is multiplied by the area of the drainfield to determine the volume of the sewage effluent (in gallons per day) that can be applied to the soil.

Table 6A illusrates the different sewage capacities admissible for each type of soil studied.

The size of the drainfield required on specified sites, can be determined as follows:

1. Locate the area, where the development is planned, in the Soil Survey Map, and determine the soil's symbol that is shown on the map for that location.
2. Find the soil's name and characterization of the physical properties table in the Soil Survey Manuals and determine the permeability rate range.
3. Using equation 5.3, determine the equivalent percolation rate.

TABLE "6A"

SEWAGE CAPACITIES FOR THE SITES STUDIED

SITE	TYPE OF ESTABLISHMENT	(MIN/INCH) PERCOL. RATE FROM TESTS	(MIN/INCH) (1) CORRESP. PERC. RANGE IN TABLE II CHAPTER 10D-6	(G/SF/D) (2) MAX. RATE OF SEWAGE APPL. TO EFF. TRENCH	(SF) SIZE OF DRAINF.	(GPD) (3) MAX. VOL. OF SEWAGE ALLOWABLE	(GPD) (4) EST. DOM. SEW. FLOW	BY PERS.
G'VILLE-1	RESID-4BDRM	7.50	5-10	1.0	200	200	600	(150)
G'VILLE-2	RESID-6BDRM	0.75	2	2.0	400	800	900	(675)
ORMB-1	COMMER-OFF	5.47	5-10	1.0	170	170	375	
ORMB-2	RESID-3BDRM	13.70	10-15	0.5	350	175	450	(150)
ORMB-3	INDUST-FACT	1.97	2	2.0	2000	4000	2800	
ORL-1	COMMER-OFF	9.78	5-10	1.0	360	360	180	
ORL-2	RESID-3BDRM	1.18	2	2.0	300	600	450	(150)

NOTES:

(1) STANDARDS FOR ONSITE SEWAGE DISPOSAL SYSTEMS, CHAPTER 10D-6, TABLE III, PG. 22
(2) IBID
(3) MAX. RATE OF SEWAGE X AREA OF DRAINFIELD
(4) STANDARDS FOR ONSITE SEWAGE DISPOSAL SYSTEMS, CHAPTER 10D-6, TABLE I, PG. 17

4. Enter with this percolation rate to Table III of Chapter 10D-6, and determine the maximum rate of sewage effluent in gallons per sq. feet per day that can be applied to the soil.
5. Divide this rate into the estimated flow computed from Table I of Chapter 10D-6 to determine the size of the drainfield that is required.
6. Depending on the type of establishment that is planned for the site, the number of units can be determined. Thus, enabling the density of development to be obtained.

6.2 DESIGN OF REQUIRED DRAINFIELD AREA FOR THE VARIOUS SOILS IN ORANGE COUNTY, FLORIDA

From the five different percolation rate ranges in Table III of Chapter 10D-6, the following classification of the soils for Orange County will be developed:

PERCOLATION RATE	SOIL RATING
2 min/inch	A
2-4 min/inch	B
5-10 min/inch	C
10-15 min/inch	D
15-30 min/inch	E
30 min/inch	UNSAT.
1 min/inch & W.T. 4' BELOW DRAINFIELD	UNSAT.

The classification A to E will determine the sizes of the drainfields.

A further sub-classification of this soil rating is developed so an accurate rating according to flood hazards is obtained. They are divided in the following manner:

FLOOD HAZARD	SUBRATING
NONE	1
Once in 5-20 yrs For 7 days to 1 month	2
Once in 1-5 yrs for 7 days to 1 month	3
More than once a year for 1 to 6 months	4
More than once a year for longer than 6 months	5

Subrated soils "4" and "5" have inundated water tables at seasonal high periods. The "2" and "3" have their depths to seasonal high Water Tables between one and two feet. Finally, number "1" soils, with no flood hazards have the seasonal high water table depths greater than two feet.

Table "6B" combines both ratings discussed, for percolation rates and flood conditions.

Table "6C" only uses the 'A' to 'E' rating in determing the square footage of drainfield area required for each type of establishment shown.

In determining the areas of the drainfields, the following procedure must be utilized as well as Tables "6B" and "6C".

1. Once the soil type is known from the Soil Survey Maps, the soil rating can be obtained from Table "6B".

2. The type of establishment and the amount of people that will use this establishment must be known.

3. With the determination of the soil rating in Table "6B" and the

type of establishment from Table "6C", the size of the drainfield can be established.

There are several recommendations that should be considered from the information that is contained in Tables "6B" and "6C".

Since soils with "4" and "5" subratings have inundated water tables yearly, they should not be used for septic tanks. Similar considerations could be made with "2" and "3" soils where there exists a threat of flooding.

In Orange County's Soil Survey Manuals, all "E" soils are rates "E4", there are no "D" type soils. The "B" and "C" soils are found to be either "B1", "B2", "C1"or "C2", or "B4". These soils have limited flooding potential. Except for "B4" soils. The "B4" soils would not be acceptable for Septic Tank usage, "B1" and "C1"and "C2" would be acceptable. The "A" type soils contain all five existing subratings from "A1" to"A5". Sites with "A4" and "A5" rated soils will not be permitted for Septic Tank usage since they contain "inundated" water Tables as well as potential and prolonged flood conditions. "2" and "3" type soils could be used as Septic Tank sites only under certain conditions , such as: using elevated drainfields; or if these soils have been drained artificially by drainage ditches or canals; or if the land elevation has been raised using fill.

In conclusion, all soils rate "4" or "5" should not be permitted for Septic Tank usage. Special considerations should be made for "2" and "3" soils if septic tanks are to be used. "A1", "B1" and "C1" soils have very favorable flood conditions and the required soil conditions for Septic Tank usage.

TABLE "6B"
SOIL RATING TABLE

TYPE OF SOIL	SYMBOL	PERM RATE (in/hr)	PERC. RATE (min/in)	SOIL RATING
ADAMSVILLE	Aa, Ab, Ac	6.3-20.0	0.9-1.8	A2
ALLUVIAL	Ad	Variable	Variable	------
BLANTON	Ba to Bg	6.3-20.0	0.9-1.8	A1
	Bh	.63-2.0	3.8-8.0	G1
BRIGHTON	Bj, Bk, Bl	6.3-20.0	0.9-1.8	A5
CHARLOTTE	Ca	6.3-20.0	0.9-1.8	A4
DELRAY	Da, Dc,	6.3-20.0	0.9-1.8	A4
	Db	0.63-2.0	3.8-8.3	C4
EUSTIS	Ea, Eb	6.3-20.0	0.9-1.8	A1
EVERGLADES	Ec, Ed Ee, Ef	6.3-20.0	0.9-1.8	A5
FELDA	Fa	0.63-2.0	3.8-8.0	B4
FRESH WATER SWAMP	Fs	Variable	Variable	------
IMMOKALEE	Ia	0.63-6.3	1.8-8.0	C2
KERI & PARKWOOD	Ka	2.0-6.3	1.8-3.8	B2
LAKELAND	La, Lb, Lc, Ld, Le	6.3-20.0	0.9-1.8	A1
LEON	Lg, Lh	6.3-20.0	0.9-1.8	A2
MADE LAND	Ml	Variable	Variable	------
MANATEE	Ma	0.06-0.20	16.6-36.0	E4
MANATEE (DELRAY)	Mb, Mc	0.06-0.20	16.6-36.0	E4
ONA	Oa	6.3-20.0	0.9-1.8	A3
ORLANDO	Ob, Oc	6.3-20.0	0.9-1.8	A1
PAMLICO	Pa	6.3-20.0	0.9-1.8	A5

TYPE OF SOIL	SYMBOL	PERM RATE (in/hr)	PERC. RATE (min/in)	SOIL RATING
PLUMMER	Pb	6.3-20.0	0.9-1.8	A4
POMELLO	Pc	6.3-20.0	0.9-1.8	A1
POMPANO	Pd	6.3-20.0	0.9-1.8	A4
POMPANO	Pe, Pf	6.3-20.0	0.9-1.8	A4
RUTLEDGE	Ra, Rc	6.3-20.0	0.9-1.8	A4
RUTLEDGE	Rb	6.3-20.0	0.9-1.8	A4
StJOHNS	Sa	6.3-20.0	0.9-1.8	A3
StLUCIE	Sb	6.3-20.0	0.9-1.8	A1
SCRANTON	Sc	6.3-20.0	0.9-1.8	A3

TABLE "6C"

DRAINFIELD SIZE FOR THE VARIOUS SOIL CLASSIFICATIONS

	EST. SEWAGE FLOW (GPD)	AREA OF DRAINFIELD IN SF DEPENDING ON SOIL CLASSIFICATION					
TYPE OF ESTABLISHMENT		A	B	C	D	E	REMARKS
COUNTRY CLUB (MEMBER)	100	50	67	100	200	400	
(EMPLOYEE)	20	10	13	20	40	30	
DOCTOR'S OFFICE (PER DR.)	250	125	167	250	500	1000	
FACTORIES (GALS/PER./SHFT.)	20	10	13	20	40	80	Excl. of Ind. Waste
W/SHOWERS	35	18	23	35	70	140	
RESTAURANT (PER SEAT)	50	25	33	50	100	200	
24 HR. RESTAUR. ("")	75	38	50	75	150	300	
SINGLE SERV. REST. (")	25	13	17	25	50	100	
BAR & COCKTAIL LONGE (")	30	15	20	30	60	120	
DRIVE-IN REST. (")	50	25	33	50	100	200	
CARRY-OUT FOOD SERV. (PER 100 SF)	50	25	33	50	100	200	
ADD PER EMPLOYEE	20	10	13	20	40	80	
HOTELS (PER ROOM)	100	50	67	100	200	400	
RESORT HOTELS, CAMPS (PERS.)	75	38	50	75	150	300	
OFFICE BUILDING (PER WORKER)	20	10	13	20	40	80	
SERVICE STAT. (PER BAY)	500	250	333	500	1000	2000	
W/CAR WASH (PER BAY)	1000	500	667	1000	2000	4000	
SHOPPING CENT. (PER 100 SF)	10	5	7	10	20	40	WITHOUT FOOD OR LAV.
STADIUMS, SPORT FAC. (PER SEAT)	5	3	4	5	10	20	

TYPE OF ESTABLISHMENT	EST. SEWAGE FLOW (GPD)	AREA OF DRAINFIELD IN SF DEPENDING ON SOIL CLASSIFICATION A	B	C	D	E	REMARKS
STORES (WITHOUT FOOD SERV.)							
PRIV. TOILETS (PER. EMPL)	20	10	13	10	20	40	
PUBLI. TOILETS (10 SF)	1	.5	.7	1	2	4	
THEATERS, INDOOR (PER SEAT)	5	3	4	5	10	20	
DRIVE-IN (PER	10	5	7	10	20	40	
TRAILER/MOBILE HOME PARK (PER SPACE)	300	150	200	300	600	1200	
TRAV. TRL. (OVER-NIGHT) (PER SP.)	50	25	33	50	100	200	NO WATER AND SEW. H.U.
WITH W&S HOOFUP (PER TR. SP.)	100	50	67	100	200	400	
CHURCH (PER SEAT)	3	2	3	3	6	12	
HOSPITALS (PER BED)	200	100	133	200	400	300	
NURSING HOMES (PER PERS.)	100	50	67	100	200	400	
PARKS W/TOILETS (PER PERS.)	5	3	4	5	10	20	
W/BTH HOUSE, S&W, TOILET (PER PERS.)	10	5	7	10	20	40	
PUBLIC INSTIT. (PER PERS.)	100	50	67	100	200	400	DOES NOT INCL. SCHL OR HOSP.
SCHOOLS (PER STUDENT)							
DAY-TYPE	15	8	10	15	30	60	
+ FOR CAFETERIA	5	3	4	5	10	20	
+ DAY SHL WORKERS	15	8	10	15	30	60	
BOARDING-TYPE	75	8	50	75	150	300	
RESIDENTIAL							
SINGLE-FAM (PER BDRM)	150	75	100	150	300	600	
APARTM. (PER BDRM)	150	75	100	150	300	600	
MOBILE HOME (PER BDRM)	150	75	100	150	300	600	NOT IN A TRAIL. PARK
OTHER (PER OCCUPANT)	75	38	50	75	150	300	

6.2.1) SAMPLE PROBLEM PROCEDURE ON THE USE OF TABLES 6B AND 6C

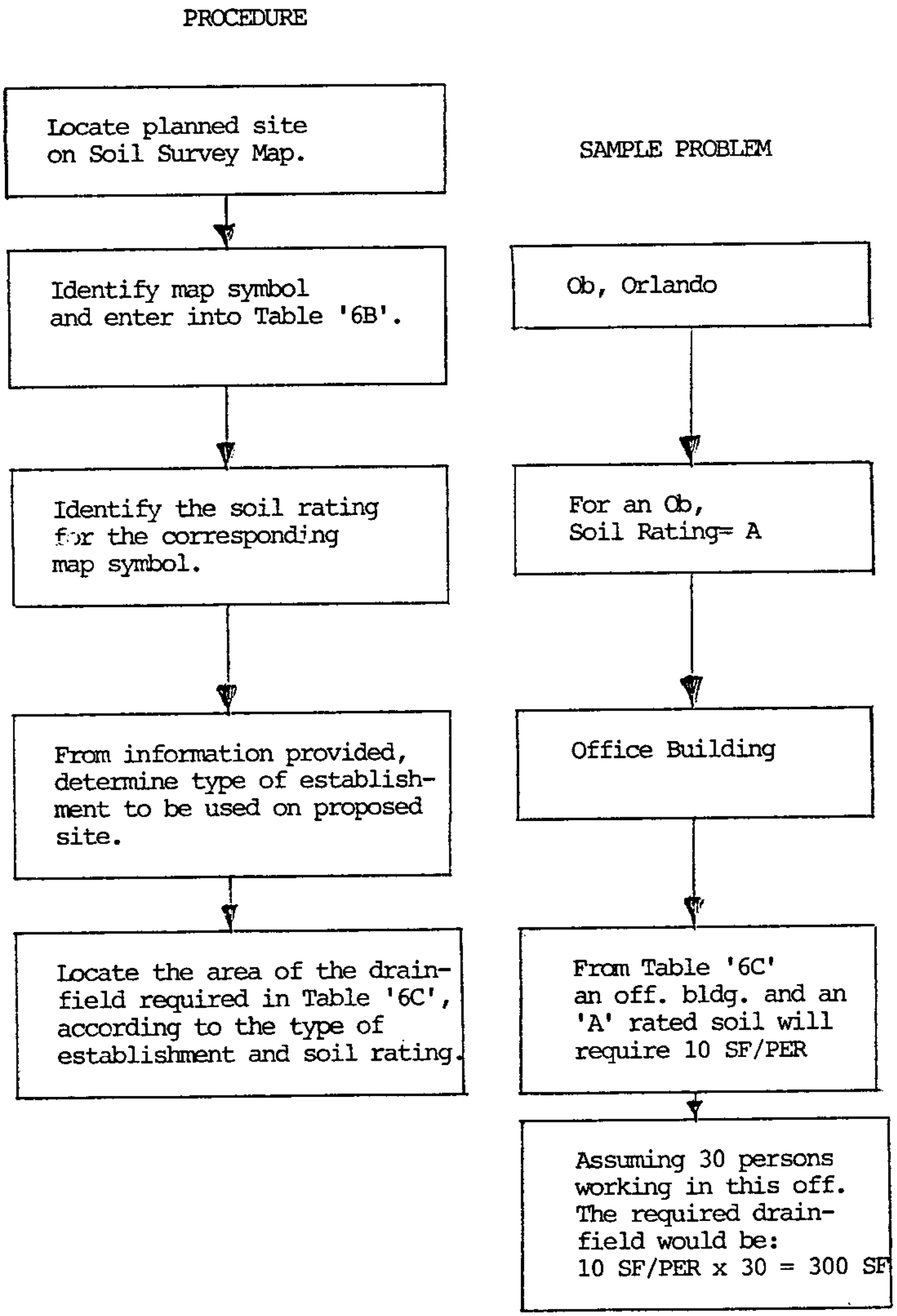
According to information provided, a developer wishes to develop a tract of land in Orange County.

Once identifying the exact location of the site and the soil symbol, enter table 6B.

The soil is identified as an Ob (Orlando). Table 6B illustrates this soil to have a permeability rate range of 6.0-20.0 inch/hr and corresponding percolation rate range 0.9-1.9, classifying it as an "A" soil rating. We also observe that it has no flood hazard, so an elevated drianfield is not required.

From the information provided by the developer it is discovered that he is planning to build a medium-size office building on the site. For this type of establishment, the column for "A" type soils is sought and it is determined from Table "6C"that for every employee who is going to work at this office building, 10 SF of drainfield area is required.

This problem can easier be understood with the use of a flow chart procedure.


PROCEDURE
Locate planned site on Soil Survey Map.
Identify map symbol and enter into Table '6B'.
Identify the soil rating for the corresponding map symbol.
From information provided, determine type of establishment to be used on proposed site.
Locate the area of the drainfield required in Table '6C', according to the type of establishment and soil rating.
SAMPLE PROBLEM
Ob, Orlando
For an Ob, Soil Rating= A
Office Building
From Table '6C' an off. bldg. and an 'A' rated soil will require 10 SF/PER
Assuming 30 persons working in this off. The required drainfield would be: 10 SF/PER x 30 = 300 SF

6.3.1) SAMPLE PROBLEM, TO DETERMINE THE DENSITY OF UNITS FOR SINGLE FAMILY RESIDENCES.

GIVEN:

1. TOTAL SITE AREA = 1 ACRE
2. HOUSE AREA = 1500 SF
3. EACH HOUSE CONTAINS 3 BEDROOMS
4. LAWN SETBACK FROM BUILDING LINE = 10' ON EACH SIDE
   25' ON FRONT
   15' ON BACK
5. PARKING AREA FOR EACH HOME = 350 SF (50'x7')
6. ROAD, SIDEWALK AREA = 30'x209' = 6270 SF
   SETBACK ALONG ROAD AREA 2090

COMPUTATIONS:

1 ACRE = 43560 SF
- 8360 SF ROADS & SIDEWALK & SETBACKS

PER HOME:
- 350 SF PARKING
- 1500 SF HOUSE AREA
- 2322 SF SETBACK
- 780 SF SETBACK BY CHAPTER 10D-6.46(2)

30248 SF

MIN. UNOBSTRUCTED AREA = 3 TIMES DRAINFIELD AREA REQUIRED (CHAPTER 10D-6.46(4))

$\frac{30248}{3}$ = 10082 SF

REQUIRED DRAINFIELD AREA FOR A 3 BDRM HOME FROM TABLE "6C"

AVAILABLE DRAINFIELD AREA:

NO. OF UNITS/ACRE	AREA AVAILABLE FOR DRAINFIELD
1	10082 SF
2	8432 SF
3	6781 SF
4	5130 SF
5	3480 SF
6	1829 SF
7	178 SF

SOIL RATING	DRAINFIELD AREA (SF)						
	NUMBER OF UNITS						
	1	2	3	4	5	6	7
"A"	225	450	675	900	1125	1350	1575
"B"	300	600	900	1200	1500	1800	2100
"C"	450	900	1350	1800	2250	2700	3150
"D"	900	1800	2700	3600	4500	5400	6300
"E"	1800	3600	5400	7200	9000	10800	12600

All drainfield areas on the left of the black dividing line are permissible areas for the number of homes on the acre of land. The areas to the right are those areas greater than the permissible. For example, the drainfield area for three homes on a 'B' rated soil is 900 SF which is less than the available drainfield area of 6781 SF.

This example also shows that more than four lots per acre can be placed on a site depending on the type of soil rating. For this particular sample, an "A" type soil can hold up to six lots on an acre. Consideration must be placed on the water table depth and the flooding condition. Any adverse conditions in one or both of these categories would prohibit the soil to be used as an absorption field. Provisions could be made to overcome these adversities, such as elevated drainfields.

6.3.2) SAMPLE PROBLEM, TO DETERMINE THE DENSITY OF UNITS FOR MULTI-FAMILY/APARTMENT TYPE RESIDENCES.

GIVEN:

1. AVG. SQUARE FOOTAGE AREA APARTMENT = 1000 SF
2. APARTMENT BUILDING CONTAINS TWO STORIES MAXIMUM
3. ASSUMED NUMBER OF UNITS PER BUILDING = 20 APTS. (10 ea. floor)
4. EACH APARTMENT WILL HAVE 2 BEDROOMS
5. CORRESPONDING PARKING AREA:
    - 2 PER APARTMENT
    - 250 SF PER CAR SPACE + 100 SF PER CAR FOR MOVING AREA
6. TOTAL SITE AREA = 1 ACRE

COMPUTATIONS:

BLDG: 100x100 = 10,000 SF + 15% CORRIDOR & OTHER AREAS = 11500 SF

DRAINFIELD SPAC: 5' FROM BLDG LINES, LIMITATIONS FROM CHAPTER 10D-6.46(2) = 2100 SF

PRK. AREA: 20 APTS x 2 CARS/APT x 350 SF/CAR = 14000 SF

CONSTRUCT. AREA = 27600 SF

SIDEWALK AREA (+15%) = 1195 SF

28795 SF

TOTAL AREA = 1 ACRE = 43560 SF

NET CONSTRUCTED AREA = - 28795 SF

USABLE AREA FOR DRAINFIELD = 14765 SF

MIN. UNOBSTRUCTED AREA = 3 TIMES DRAINFIELD AREA REQUIRED (CHAPTER 10D-6.46(4))

REAL USABLE AREA FOR DRAINFIELD = $\frac{14765 \text{ SF}}{3}$ = 4922 SF

There are several recommendations to be taken into account in this problem concerning the type of soil on which multi-family units can be used.

1. Only soils rated "A", "B" and "C" will be considered for drainfield multi-family/apartment complexes, since the majority of the "D", and "E" soils have unfavorable flood consideration and high water tables.
2. "A", "B" and "C" soils must have water table deeper than 4'0" feet from the surface or 2'0" feet from the bottom of drainfield trench.
3. Soils that have inundated water tables and are prone to floods will be considered unsatisfactory for multi-family units.

ASSUMING SOIL "A":

4922 SF of usable drainfield area.

150 SF of required drainfield area for an "A" soil and 2 bedroom apartment. (From Table "6C")

$\frac{4922}{150}$ = 32.81, Maximum No. of 2 bedroom apartments that would be permitted for this area of drainfield

CHECK: DESIGNED NO. APTS = 20 33 PERMISSIBLE = A IS SAT.

ASSUMING SOIL "B":

4922 SF of usable drainfield area.

200 SF of required drainfield for a "B" soil and 2 bedroom apartment. (From Table "6C")

$\frac{4922}{200}$ = 24.61 = 24, Maximum No. of apartments that would be permitted for this area of drainfield.

CHECK: DESIGNED NO. APRTS = 20 24 PERMISSIBLE = B IS SAT.

ASSUMING SOIL "C":

4922 SF of usable drainfield area.

300 SF of required drainfield for an "C" soil and 2 bedroom apartment. (From Table "6C")

$\frac{4922}{300} = 16.40 =$ 16, Maximum No. apartments that would be permitted for this given area of drainfield

CHECK: DESIGNATED NO. APTS = 20 16 PERMISSIBLE = C IS NOT SAT.

For this type of soil we could not use a 20 apartment complex, if the existing soil was "C" type. Flood hazard conditions should also be evaluated for the site.

CHAPTER SEVEN

RESULTS OF CHEMICAL ANALYSIS OF WELL SAMPLES

7.1 LABORATORY RESULTS: The laboratory test results and statistical analysis (Table 7.1) are in Appendix C.

7.1.1 CHLORIDE: Viraraghavan and Warnock (1976), Salvator (1972) reports that values of Chlorides in septic tanks range from 37-101 parts per million from domestic use.[1] Our studies generally confirm this result. Ormond Beach Site 3, a commercial site, shows high concentrations of chloride. This is probably due to the fact that this drainfield is being loaded to its capacity and the probability of high chloride content in the domestic water supply. Chlorides were used primarily as a tracer in this study and they indicate that, at the following sites, the listed wells were upstream of the drainfield.

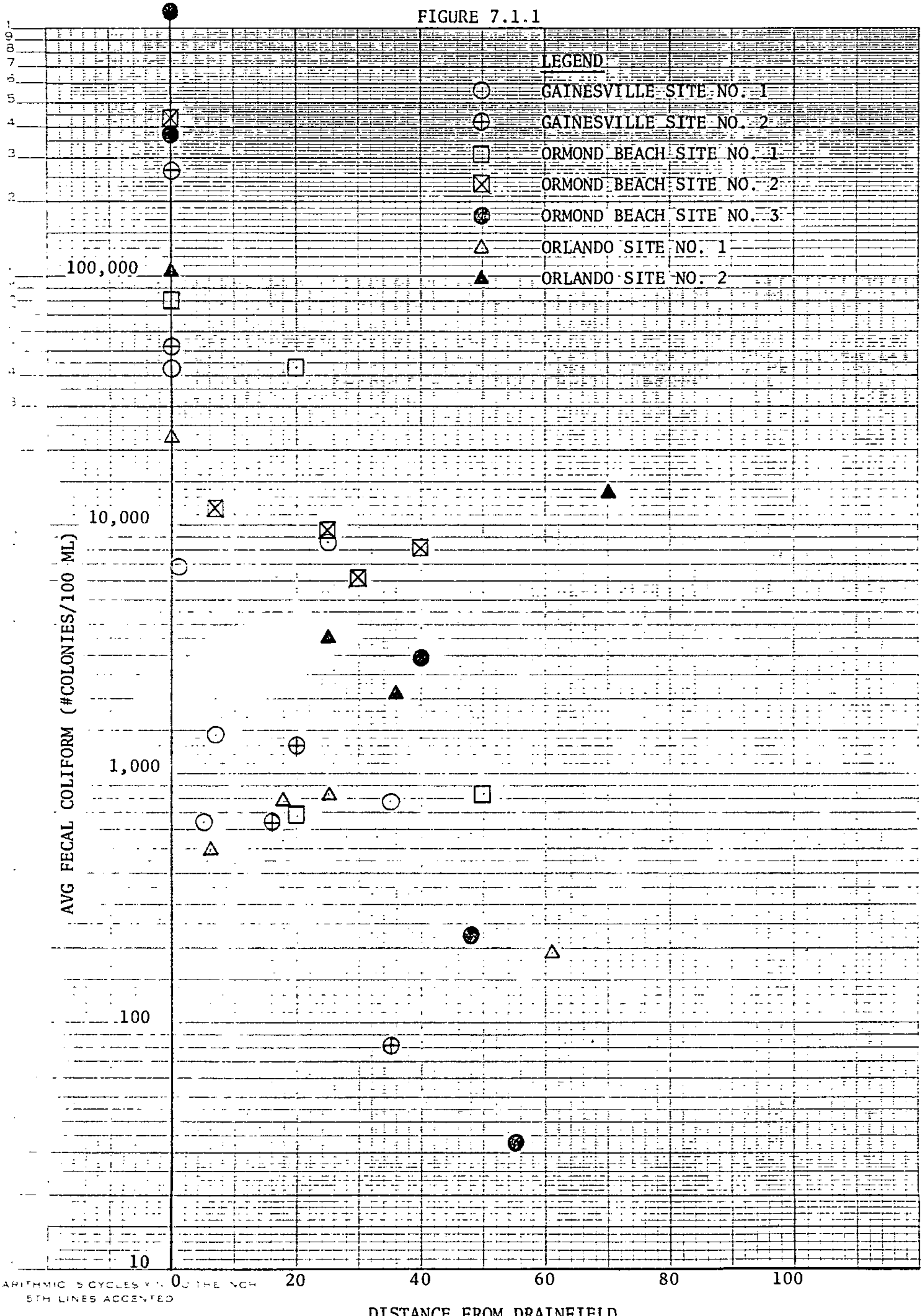
GAINESVILLE SITE 1 - WELL 5
GAINESVILLE SITE 2 - WELL 4
ORMOND SITE 1 - WELL 3
ORLANDO SITE 2 - WELL 2

Flow from the drainfield reached all the wells listed above indicating the groundwater flow to be slight. Results at the other sites were inconclusive indicating practically no flow or changes in direction of groundwater flow. Figure 7.1.5 is a plot of the chloride results.

7.1.2 FECAL COLIFORMS: Our studies indicate that Fecal Coliforms number from 40 to 2,410,000 colonies per 100 ml in septic tank effluent. Viraraghayan and Warnock (1976) report shows Fecal Coliforms numbering from 4100 to 5,200,000 per 100 ml in septic tank effluent.[2] For all the seven sites, W1 well is located either in the distribution box or directly outside the distribution box in the drainfield. All the seven graphs for fecal coliforms shown in Figure 7.1.1 indicate that on site systems are very efficient in the removal of bacteria from septic tank effluent. Past studies also confirms this result.[3] Average coliform concentrations were reduced by a factor of approximately 100 within seventy feet of the drainfield at the seven sites. The two sites with the best site conditions, Gainesville Site 2 and Ormond Beach Site 3 (because of its raised drain field) had the best reduction factors. Gainesville Site 2 had a reduction factor of approximately 160 within twenty feet of the drainfield and Ormond Beach Site 3 had a reduction factor of 400 within 55 feet of the drainfield. Figure 7.1.1 is a plot of the fecal coliform results.

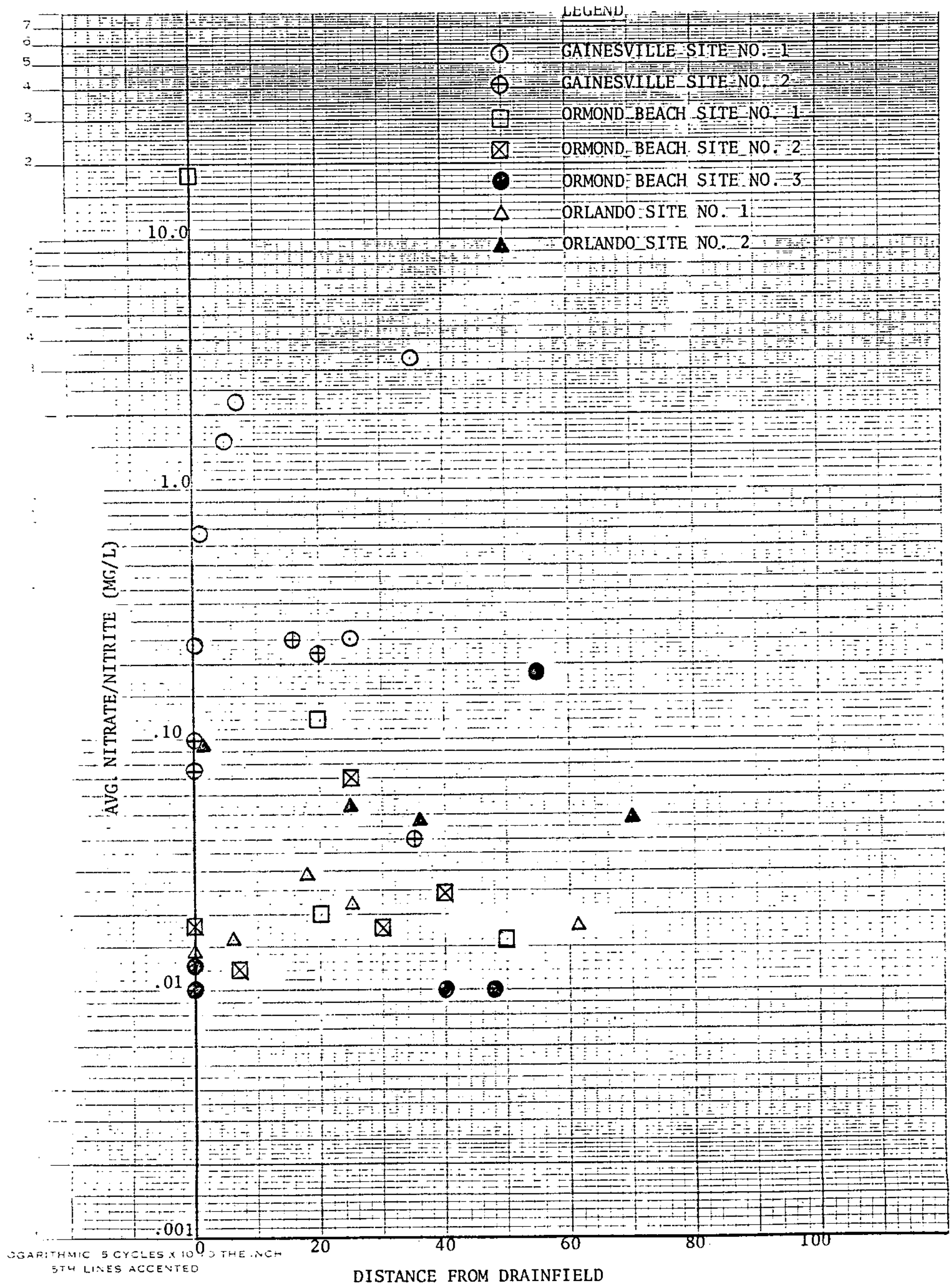
7.1.3 NITRATE/NITRITE, AMMONIA: Results of our study indicate that very little nitrate exists in the effluent as it emerges from the septic tank. Viraraghavan and Warnock (1976) and Walker et al. (1973) have published reports concerning the movement of nitrate with ground water. Both of these studies showed a rapid attenuation of ammonia with distance from the drainfield, and a corresponding increase in nitrate.[4] Our studies also confirm this result in most cases. Figure 7.1.2 shows that nitrate/nitrite concentrations decrease for Ormond Beach Site 1 and Orlando Site 2. Both of these sites have high water tables, and there is no unsaturated zone below the drainfield. Ammonia does not readily transform to nitrate under these conditions. The reduction in concentration is probably due to dilution. Figure 7.1.3 confirms the result of a rapid attenuation of ammonia with distance from the drainfield, where water table is low, allowing an unsaturated zone below the drain field. Soils with high water tables, i.e. Ormond Beach Site 2 and Orlando Site 1 & 2 show higher concentrations of ammonia at the

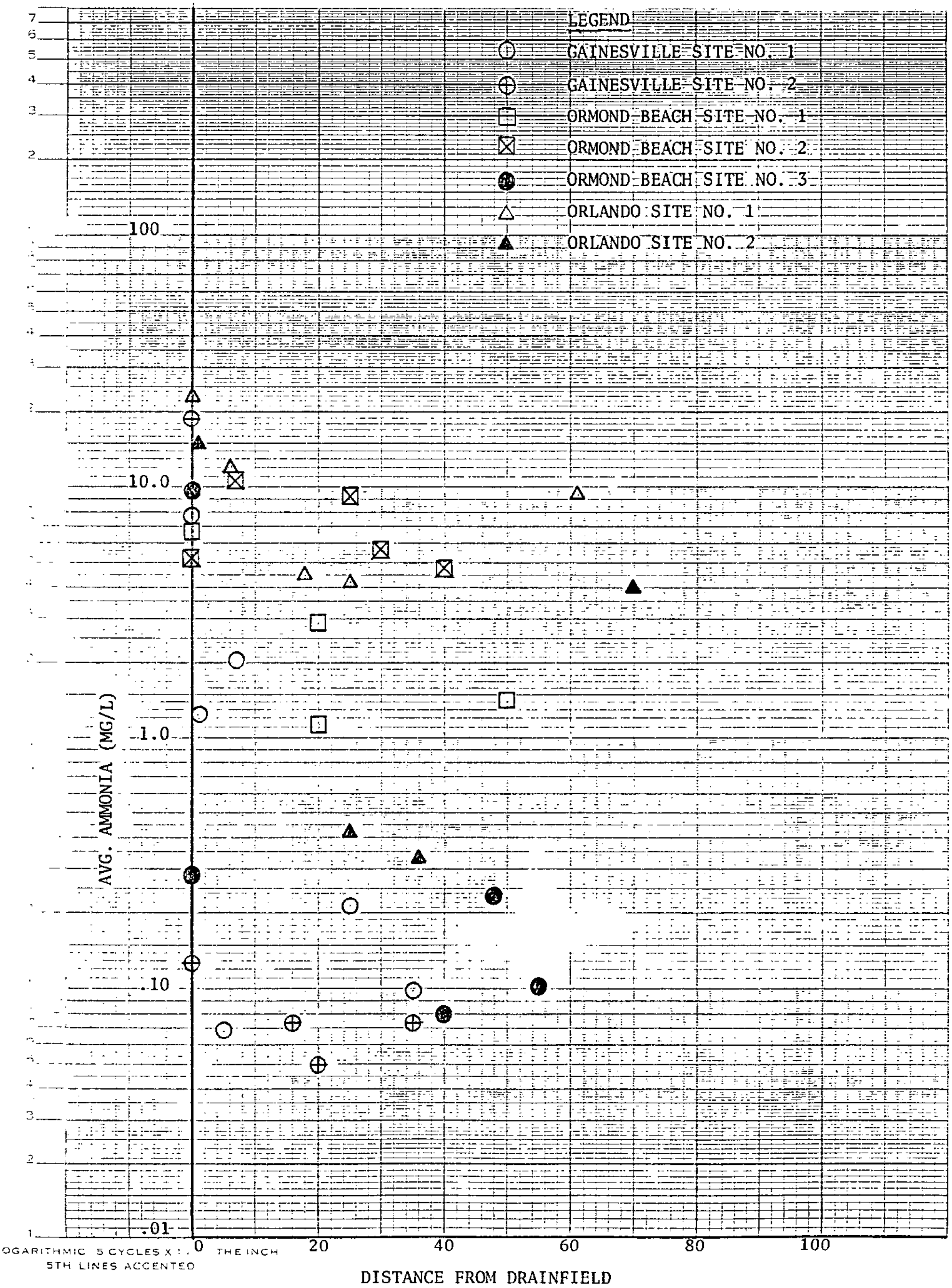
FIGURE 7.1.1


LEGEND
○ GAINESVILLE SITE NO. 1
⊕ GAINESVILLE SITE NO. 2
□ ORMOND BEACH SITE NO. 1
☒ ORMOND BEACH SITE NO. 2
● ORMOND BEACH SITE NO. 3
△ ORLANDO SITE NO. 1
▲ ORLANDO SITE NO. 2
AVG FECAL COLIFORM (#COLONIES/100 ML)
100,000
10,000
1,000
100
10
0
20
40
60
80
100
DISTANCE FROM DRAINFIELD
SEMILOGARITHMIC 5 CYCLES X ... TO THE INCH
5TH LINES ACCENTED

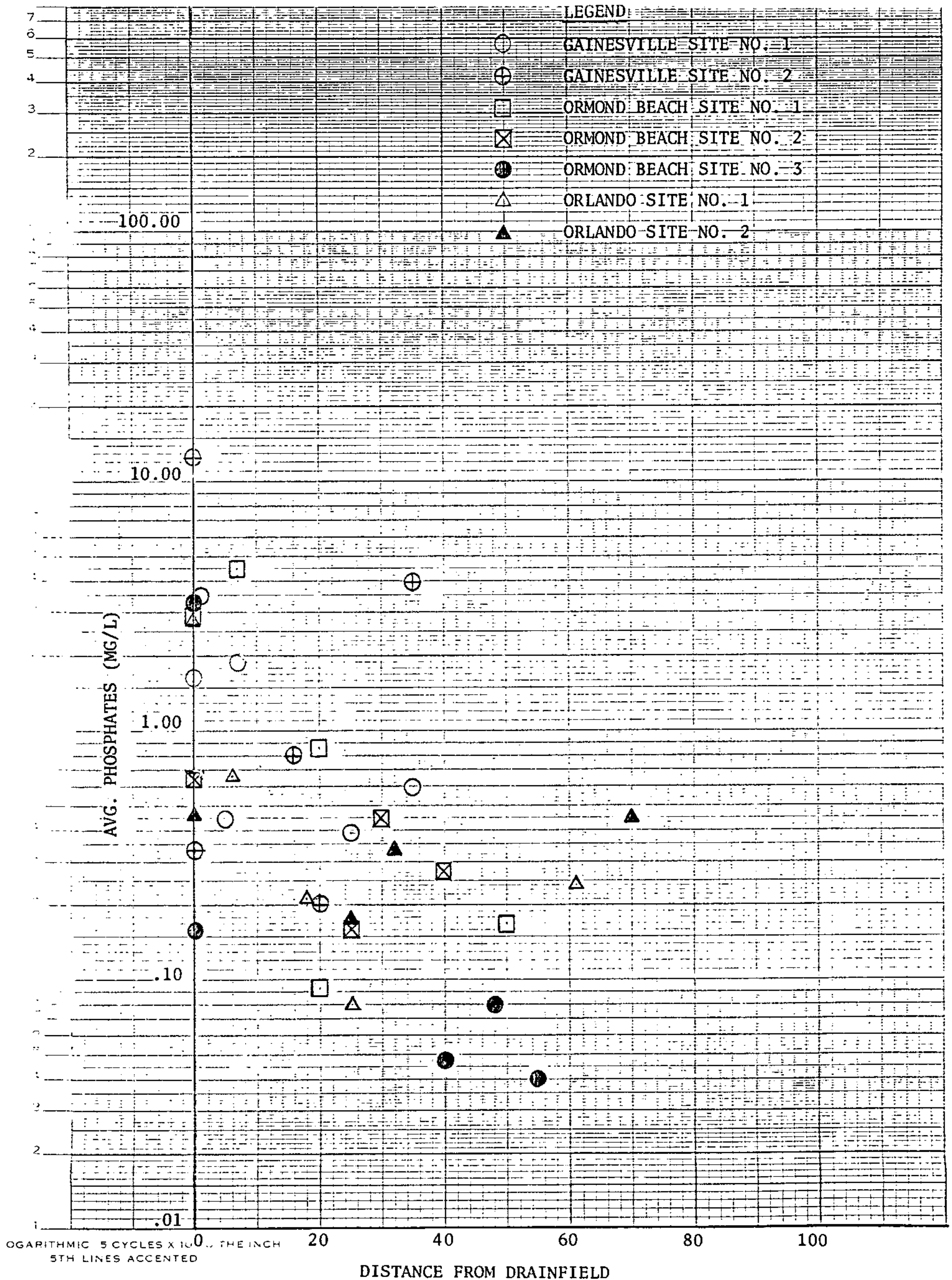
distance sampling sites. The test results indicate low concentrations of nitrate/nitrite and ammonia at all of the test sites.

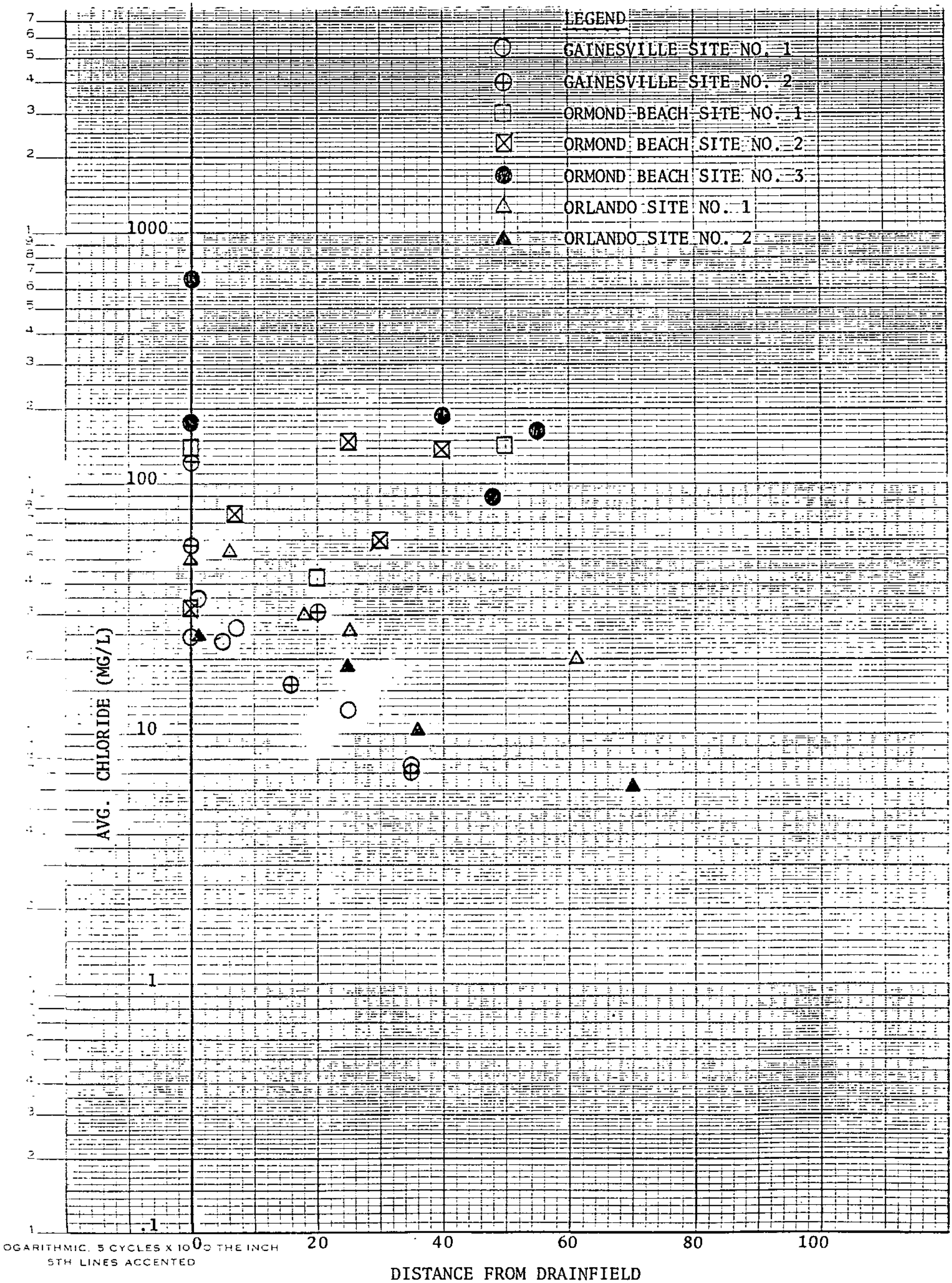
7.1.4 PHOSPHATE: Viraraghavan and Warnock report total phosphate concentration range from 6.25 to 30 ppm in septic tank effluent.[5] Figure 7.1.4 indicates a decrease in the phosphorus concentrations with the distance from the drainfield. Out of 166 samples, only four samples which are neither in the drainfield nor in the distribution box showed more than 6.25 ppm of phosphate, and 72% of the samples showed a concentration of less than 1 ppm. The raised drainfield of Ormond Beach, Site 3 is effective in phosphate removal.


LEGEND
GAINESVILLE SITE NO. 1
GAINESVILLE SITE NO. 2
ORMOND BEACH SITE NO. 1
ORMOND BEACH SITE NO. 2
ORMOND BEACH SITE NO. 3
ORLANDO SITE NO. 1
ORLANDO SITE NO. 2
AVG. NITRATE/NITRITE (MG/L)
10.0
1.0
.10
.01
.001
0
20
40
60
80
100
DISTANCE FROM DRAINFIELD
LOGARITHMIC 5 CYCLES X 10 TO THE INCH
5TH LINES ACCENTED



LEGEND
GAINESVILLE SITE NO. 1
GAINESVILLE SITE NO. 2
ORMOND BEACH SITE NO. 1
ORMOND BEACH SITE NO. 2
ORMOND BEACH SITE NO. 3
ORLANDO SITE NO. 1
ORLANDO SITE NO. 2
100
10.0
1.0
.10
.01
AVG. AMMONIA (MG/L)
0
20
40
60
80
100
DISTANCE FROM DRAINFIELD
OGARITHMIC 5 CYCLES X 1. THE INCH
5TH LINES ACCENTED


LEGEND
○ GAINESVILLE SITE NO. 1
⊕ GAINESVILLE SITE NO. 2
□ ORMOND BEACH SITE NO. 1
☒ ORMOND BEACH SITE NO. 2
● ORMOND BEACH SITE NO. 3
△ ORLANDO SITE NO. 1
▲ ORLANDO SITE NO. 2
100.00
10.00
1.00
.10
.01
AVG. PHOSPHATES (MG/L)
0
20
40
60
80
100
DISTANCE FROM DRAINFIELD
LOGARITHMIC 5 CYCLES X 10 TO THE INCH
5TH LINES ACCENTED


LEGEND
○ GAINESVILLE SITE NO. 1
⊕ GAINESVILLE SITE NO. 2
□ ORMOND BEACH SITE NO. 1
☒ ORMOND BEACH SITE NO. 2
● ORMOND BEACH SITE NO. 3
△ ORLANDO SITE NO. 1
▲ ORLANDO SITE NO. 2
1000
100
10
1
.1
AVG. CHLORIDE (MG/L)
0
20
40
60
80
100
DISTANCE FROM DRAINFIELD
OGARITHMIC. 5 CYCLES X 10 TO THE INCH
5TH LINES ACCENTED

FOOTNOTES

CHAPTER SEVEN

[1] H. S. Peavy, et. al, Home Sewage Treatment, (Michigan, American Society of Agricultural Engineers, 1977), p. 222

[2] Ibid., p. 223

[3] James D. Nelson, et. al, Ground Water Monitoring Strategies to Support Community Management of On Site Home Sewage Disposal Systems, (Fort Collins, Colorado, 1980), p. 14

[4] H. S. Peavy, et. al, Home Sewage Treatment, (Michigan, American Society of Agricultural Engineers, 1977), p. 224

[5] Ibid., p. 223

CHAPTER EIGHT

CONCLUSIONS AND RECOMMENDATIONS

8.1 GROUNDWATER QUALITY. The most important variables to incorporate in a groundwater monitoring program for on-site sewage disposal systems are fecal coliforms, nitrate and ammonia. The properly designed on-site systems are very efficient in the removal of bacteria, ammonia and phosphorus from septic tank effluent. Our study shows that the effluent from septic tanks at our sites did not degrade the ground water to an appreciable degree; however, sufficient nutrient concentrations were observed to cause concern should the nutrients be adjacent to surface waters. Phosphorus as low as 0.02 to 0.05 milligrams per liter and nitrate concentrations on the order of 0.5 milligrams per liter have been shown to cause eutrophic conditions in surface waters.[1] The concentration of phosphorus was high because of the high water table at most of the sites. In soils having low water tables phosphorus would be less critical since much of the phosphorus would be absorbed by the soil before reaching the water table.[2] Both nitrates and phosphates will be diluted by the groundwater as they move away from the septic tank system. The dilution alone may be sufficient to reduce the nutrient concentrations to safe levels. It is also probable that vegetation in the proximity of the ground water-surface water interface removes a significant amount of the nutrients before they reach the surface water. Other studies have shown septic tank effluent provides only about 3% of the total nutrient load taken by three lakes in Polk County, Florida.[3] From our studies we concluded that the effluent of properly designed septic tanks constructed in well drained soils with low water tables does not have a significant impact on the degradation of groundwater or adjacent surface waters.

8.2 USE OF SOIL SURVEY MANUALS TO DESIGN SEPTIC TANK EFFLUENT DISPOSAL SYTEMS. The use of soil survey manuals for the various counties in conjunction with the methods presented in Chapter 6 provides an excellent approach to the design of septic tank effluent drainfields. These soil manuals are now being used extensively at the county level for storm drainage design. Locating a building site on the soil maps and determining the soil type is a relatively easy procedure. Table "6B" provides a soil rating for each soil and Table "6C" gives the drainfield area per unit required for the various soil ratings.

The Use of Equation 5.3 computes a soils percolation rate from the permeability rates listed in the soils manual without the need to perform field or laboratory tests. At present a field percolation test would still be desirable until the validity of Equation 5.3 is tested on many more soils than the six soils of this pilot study. The graywater study that is now in progress should provide a large enough sample to test the validity of Equation 5.3.

The sewage design flows for residential establishments given in Table 1 of Chapter 10D-6 (See Appendix F) show values of 150 gals/day/bedroom. Current data indicate that individuals generate 40 to 50 GPD rather than 75 GPD indicated by Table 1.[4] A safety factor is desirable in order to prevent any backup in the individual septic tank system when the assumed maximum use conditions exist. It is likely, however, that all bedrooms of all housing units, will be occupied by two people at all times. With this in mind our study indicates that the requirement of subdivision density according to Section 10D-6.46(6b) of the Standards for OnSite Disposal Facilities be altered to take into account soil ratings, space availability and flood conditions. The use of a system such as shown in paragraph 6.3.1 would be useful in this regard. Presently less than 4 units per acre can be placed in any subdivision utilizing septic tanks. It is reasonable to assume that subdivisions on soils with good percolation can sustain more units per acre than subdivisions on soils having a low percolation rate. Developers who plan subdivisions on land with good soil ratings would be rewarded with more units per acre while developers using marginal land would be penalized with a less dense subdivision and increased cost in the installation of the disposal system. This system would be especially beneficial for zero lot line and condominium developments. There seems to be no arbitrary density limitation on apartments and commercial buildings in Chapter 10D-6.

8.3 OTHER RECOMMENDATIONS. It is also recommended that housing units on septic tanks not be required to hook up to central sewage unless the central system has facilities to treat nitrates and phosphates. Whereas septic tank systems tend to disperse these nutrients, central systems concentrate them and usually dispose of them directly into surface waters. This, of course, is assuming that the septic tank disposal system is operating properly.

Only soils with a "1" subrating should be used for septic tanks without special considerations. Soils with a subrating of "2" or "3" are suitable if elevated drainfields are used, if the land has been raised above flood level using fill or if the land has been drained artificially by canals or ditches. Soils with subratings of "4" or "5" should not be used with septic tanks.

8.4 <u>FUTURE STUDIES</u>. Since most of the sites on this pilot study were sites having high water tables, it would be desirable to continue the study on sites where the water tables are at least four feet below grade.

FOOTNOTES

CHAPTER EIGHT

[1] J. D. Nelson, Et Al, Ground Water Monitoring Strategies to Support Community Management of On-Site Home Sewage Disposal Systems, (Ford Collims, Colorado, 1980), p. 16

[2] ibid., p. 17

[3] Water and Air Research, Inc., Water Quality Impacts of Septic Tanks at Three Study Lakes in Central Florida, (Gainesville, 1981)

[4] Home Sewage Treatment, American Society of Agricultural Engineers, 2nd National Home Sewage Treatment Symposium, St. Joseph, Michigan, 1978, p. 90

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APPENDIX A

MONITORING WELL INSTALLATION

APPENDIX - A

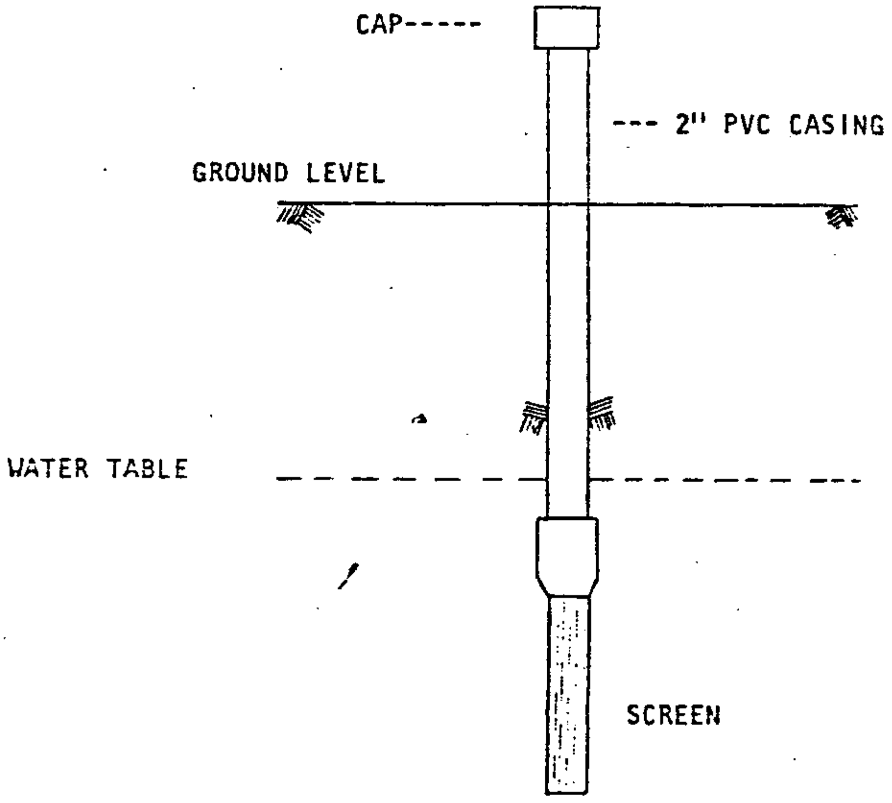
MONITORING WELL INSTALLATION

Typical installation of well is shown in Figure-1

Monitoring well casings consisted of two inch PVC pipe with an 24" slotted PVC well screen. The holes were made by using a three inch hand auger to approximately 3 feet deep. The casing and screen were installed and the one inch jet pipe was inserted through the casing. A one inch water jet was used to sink the screen and casing below the surface ground water. When the desired depth was reached, the jetting was discontinued and the casing was sealed in place by the washed out soil, eliminating the need to backfill or grout around the casing. The depth of wells varied. The well screens were not less than one feet nor more than three feet below the existing ground water table.

All wells were pumped to remove a volume of water until visible turbidity was at a minimum.

After wells were completed, they were capped. All wells were surveyed to establish their location.

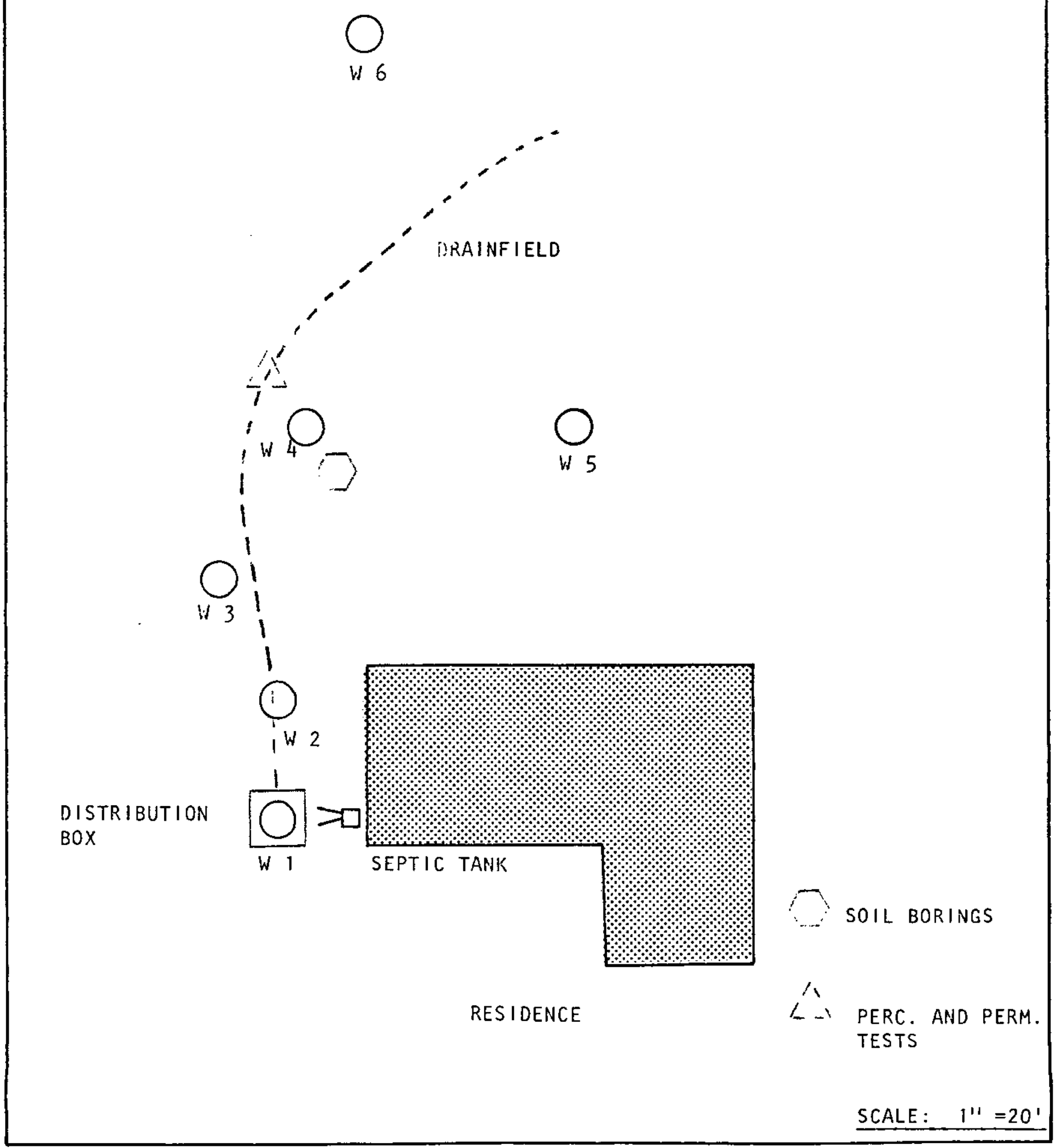


SHALLOW WELL

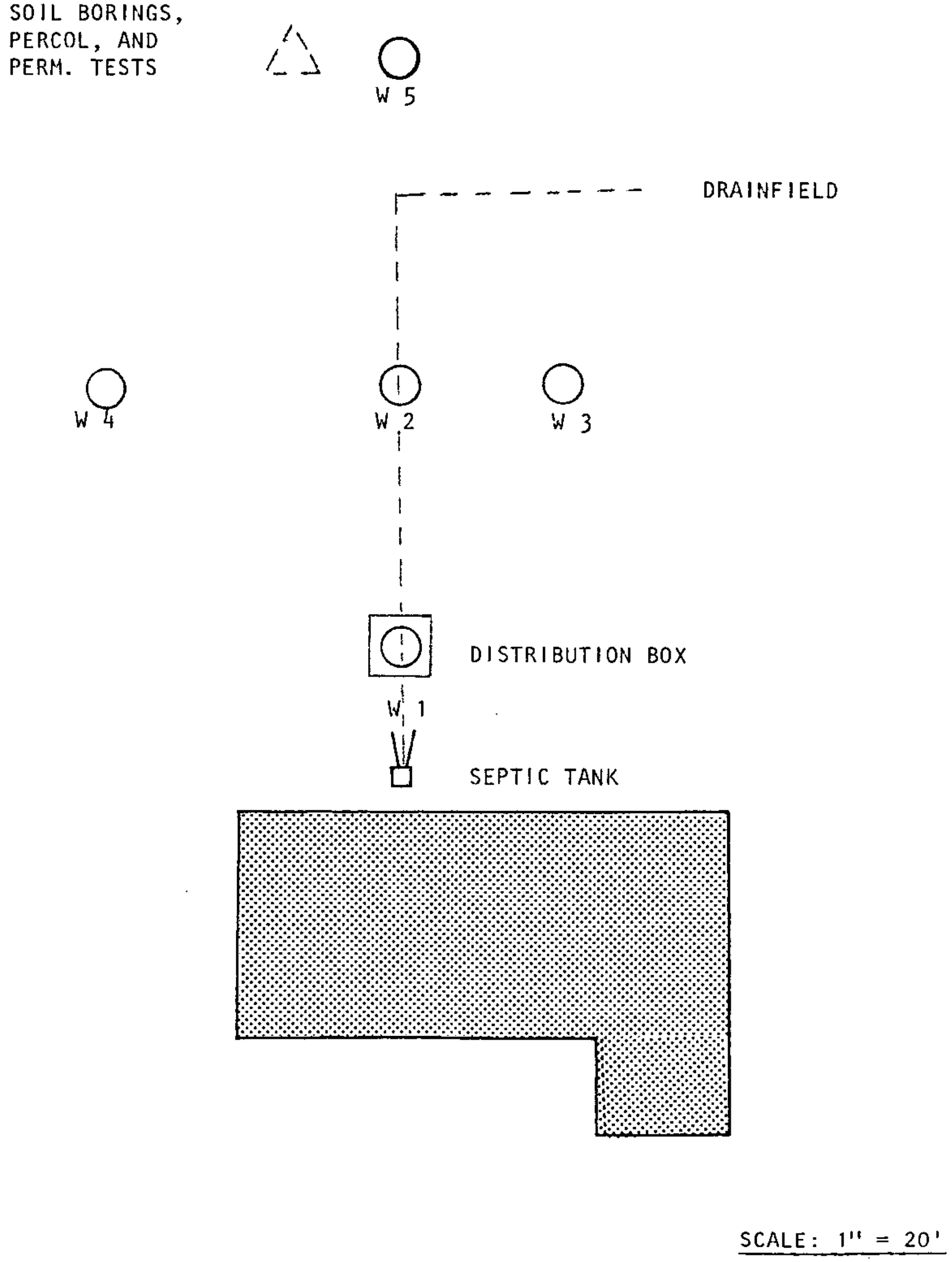
APPENDIX B

LOCATION OF SEPTIC TANK, WELLS, SOIL BORINGS

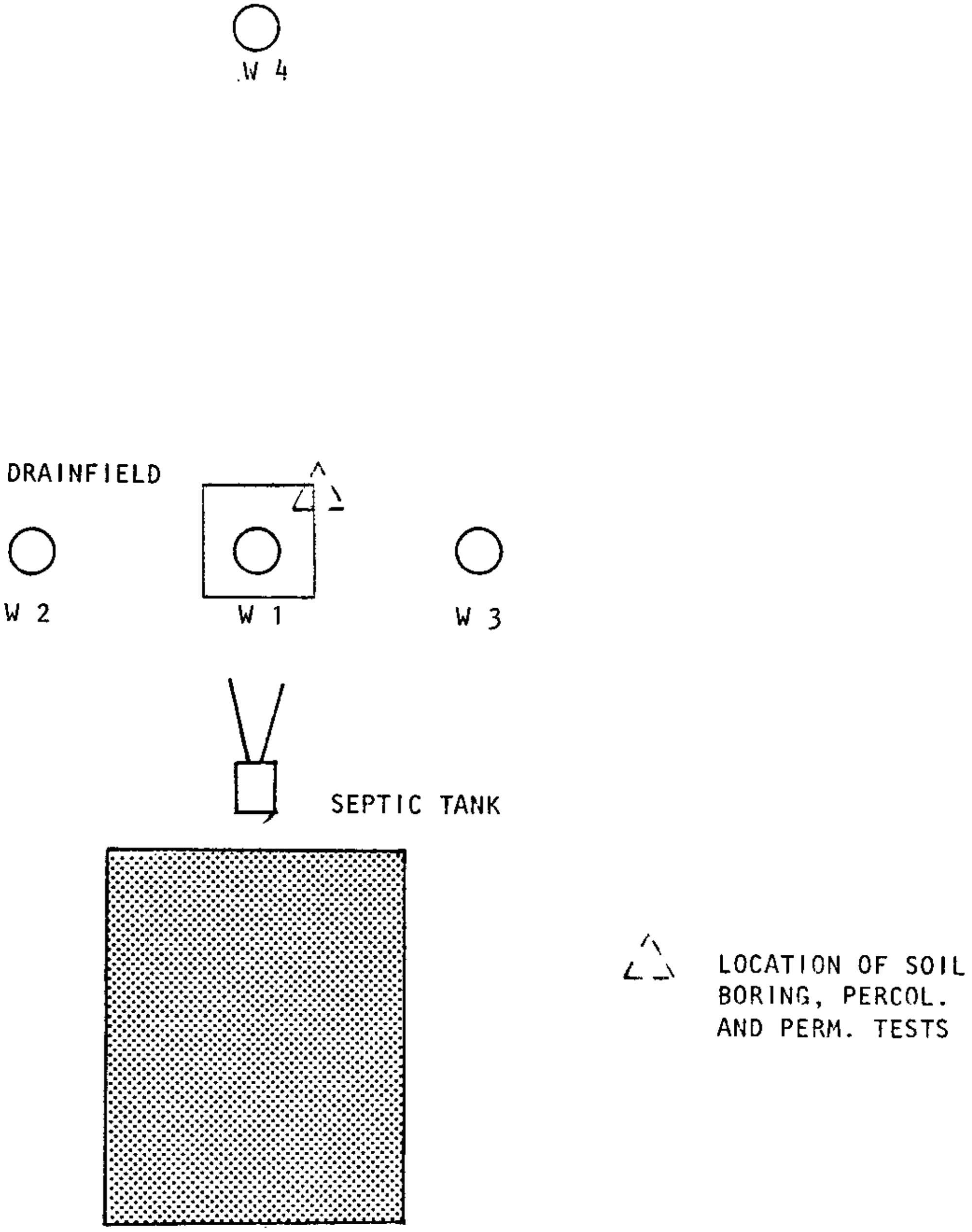
GAINESVILLE SITE 1



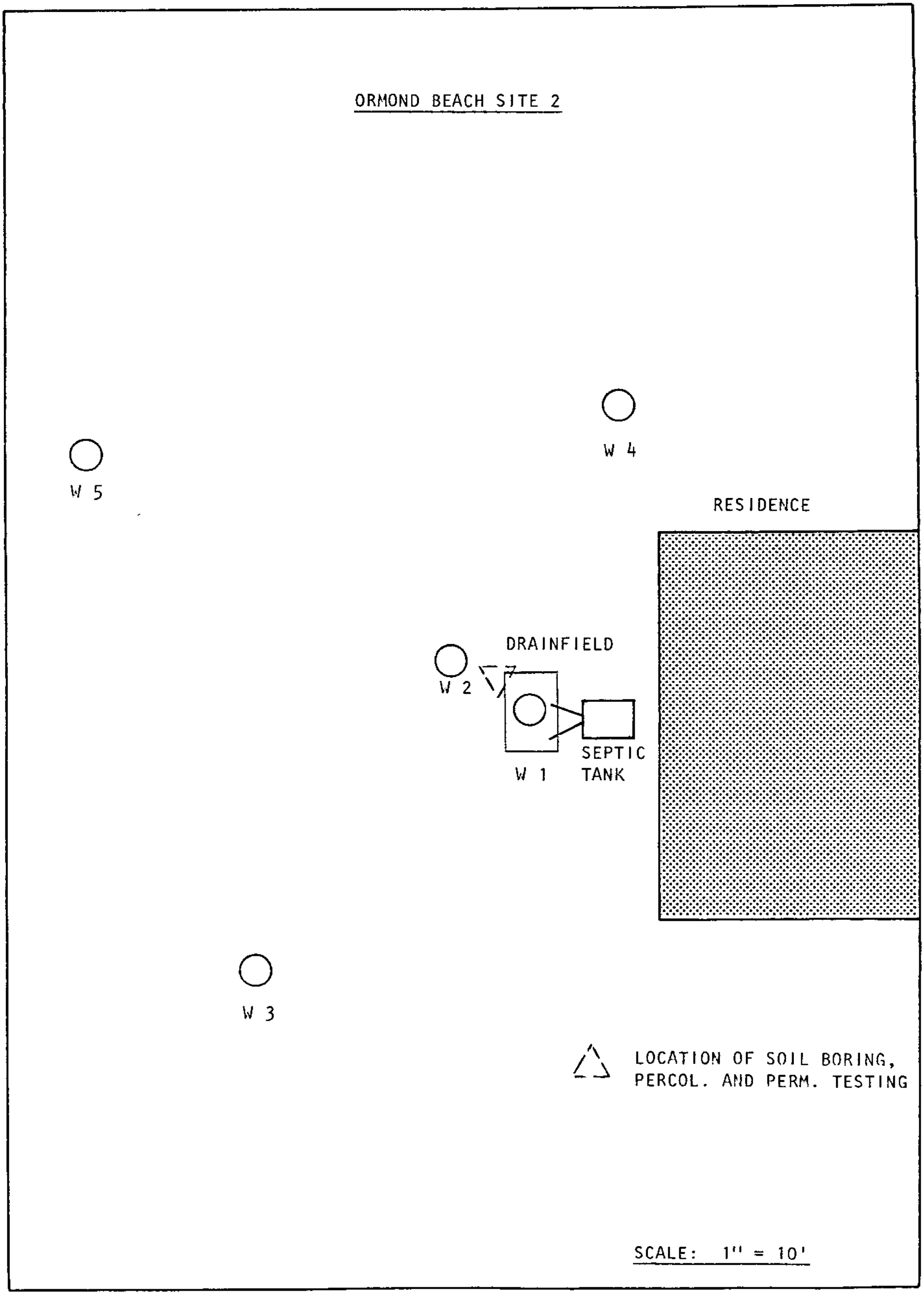
GAINESVILLE SITE 2



ORMOND BEACH SITE 1

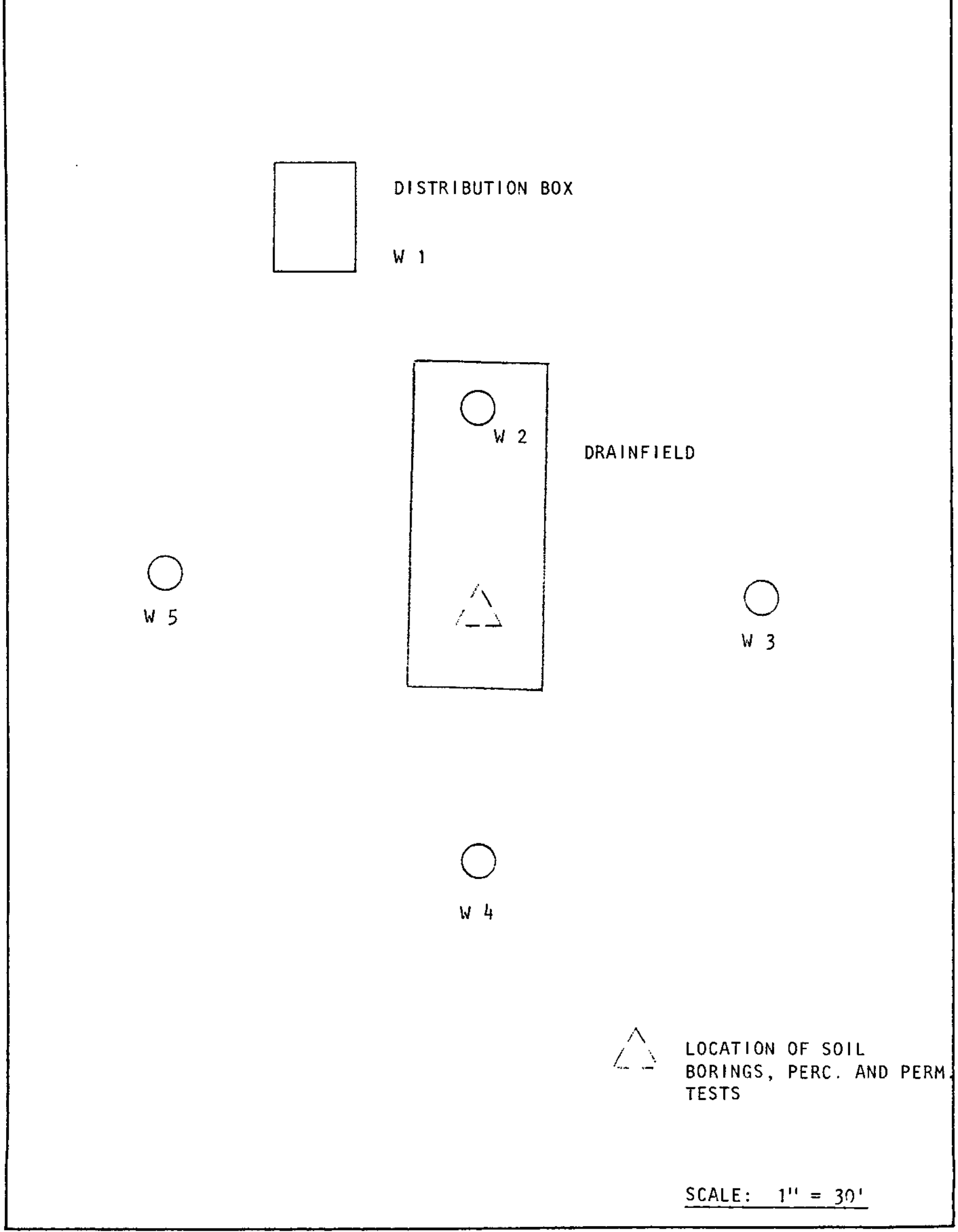


SCALE 1" = 20'

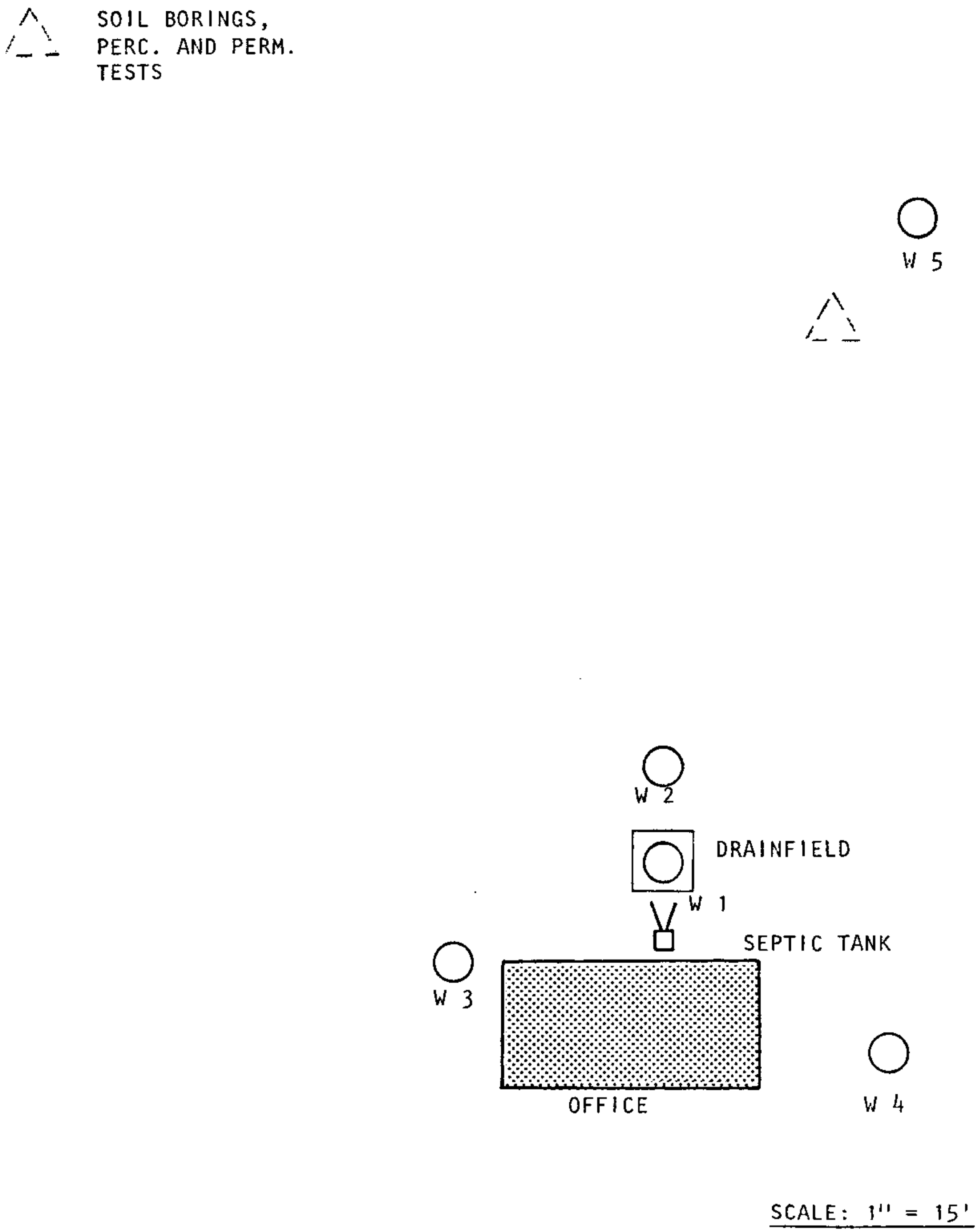


ORMOND BEACH SITE 2

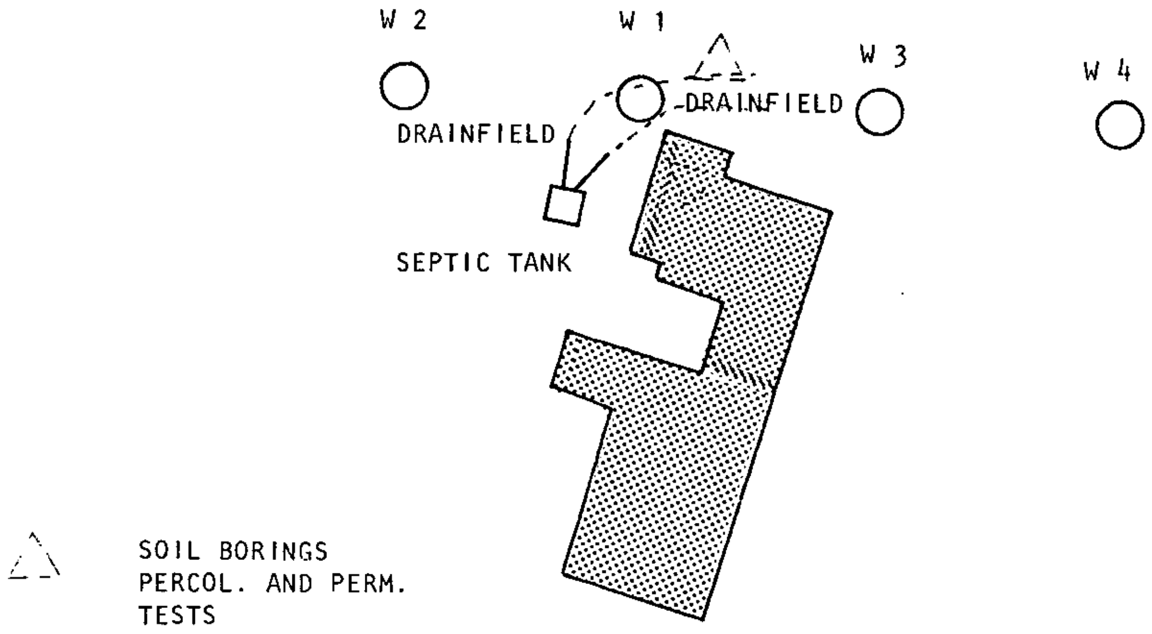
ORMOND BEACH SITE NO. 3



ORLANDO SITE 1



ORLANDO SITE 2



SCALE: 1" = 40'

APPENDIX C

LABORATORY TEST RESULTS AND STATISTICAL ANALYSIS

TABLE 7.1

STATISTICAL ANALYSIS

LOCATION WELL #	NITRATE mg/l MEAN S.D.*	AMMONIA mg/l MEAN S.D.	CHLORIDE mg/l MEAN S.D.	PHOSPHATE mg/l MEAN S.D.	FECAL COLIFORM MEAN
G1W1	0.24	7.84	23.82	1.68	42758
	0.25	7.65	13.08	1.69	
G1W2	0.67	2.38	34.92	3.44	6740
	1.16	2.66	10.36	2.92	
G1W3	1.58	0.07	23.12	0.44	636
	1.89	0.48	15.29	0.27	
G1W4	2.25	2.02	26.40	1.89	1436
	1.65	2.51	15.17	0.87	
G1W5	3.34	0.10	7.60	0.60	780
	1.98	0.05	9.28	0.07	
G1W6	0.11	0.22	12.43	3.87	8358
	0.15	0.07	7.13	4.36	
G2W1	0.08	18.89	53.80	12.38	265825
	0.11	13.40	15.71	14.90	
G2W2	0.01	0.13	120.00	0.33	52420
	0.17	0.09	16.50	0.22	
G2W3	0.22	0.05	30.96	0.20	1614
	0.21	0.03	20.35	0.29	
G2W4	0.04	0.07	7.36	3.93	82
	0.03	0.05	1.25	7.62	

LOCATION WELL #	NITRATE mg/l MEAN S.D.*	AMMONIA mg/l MEAN S.D.	CHLORIDE mg/l MEAN S.D.	PHOSPHATE mg/l MEAN S.D.	FECAL COLIFORM MEAN
G2W5	0.25	0.07	15.82	0.80	642
	0.16	0.02	6.14	0.43	
ORM1W1	18.16	6.70	139.96	2.83	80768
	18.35	4.84	18.02	2.05	
ORM1W2	0.02	2.88	41.78	0.86	43242
	0.01	3.48	20.72	1.87	
ORM1W3	0.12	1.14	41.00	0.09	678
	0.19	0.99	22.40	0.08	
ORM1W4	0.02	1.40	141.24	0.17	827
	0.01	0.81	14.46	0.26	
ORM2W1	0.02	5.20	31.40	0.64	434178
	0.01	2.09	25.16	0.75	
ORM2W2	0.012	10.59	76.12	4.42	11846
	0.01	7.39	40.67	3.76	
ORM2W3	0.02	5.62	59.88	0.44	6106
	0.01	2.82	24.84	0.28	
ORM2W4	0.07	9.15	148.64	0.16	9504
	0.11	3.07	61.80	0.13	
ORM2W5	0.02	4.84	135.7	0.27	8134
	0.01	2.27	52.99	0.28	
ORM3W1	0.01	9.66	178.98	3.33	1301320
	0.0	N/A	14.75	1.90	
ORM3W2	0.01	0.28	649.48	0.16	376294
	0.01	0.13	159.18	0.21	

LOCATION WELL #	NITRATE mg/l MEAN ---- S.D.*	AMMONIA mg/l MEAN ---- S.D.	CHLORIDE mg/l MEAN ---- S.D.	PHOSPHATE mg/l MEAN ---- S.D.	FECAL COLIFORM MEAN ----
ORM 3W3	0.01	0.23	88.34	0.08	228
	0.0	0.09	18.32	0.10	
ORM3W4	0.01	0.08	187.02	0.05	2933
	0.0	0.05	22.24	0.03	
ORM3W5	0.19	0.10	166.42	0.04	33
	0.22	0.13	13.08	0.04	
ORL1W1	0.01	22.90	49.48	2.80	20240
	0.01	8.61	9.29	2.29	
ORL1W2	0.02	11.77	53.3	0.66	494
	0.01	9.14	17.40	0.74	
ORL1W3	0.03	4.50	29.88	0.21	788
	0.03	3.77	5.63	0.17	
ORL1W4	0.02	4.21	26.15	0.08	812
	0.01	3.89	14.90	0.06	
ORL1W5	0.02	9.30	19.86	0.236	192
	0.01	10.16	15.29	0.43	
ORL2W1	0.09	14.88	24.65	0.46	111775
	0.11	9.38	19.44	0.28	
ORL2W2	0.049	0.33	10.38	0.33	2123
	0.04	0.26	5.96	0.18	
ORL2W3	0.05	0.43	18.7	0.17	3500
	0.07	0.38	1.43	0.16	
ORL2W4	0.05	3.98	5.15	0.45	13327
	0.04	4.36	2.60	0.09	

* S.D. = STANDARD OF DEVIATION

Water Chemistry Final Report

for

Department of Education Grant 121508049

November 18, 1982

J.J. McCreary, J.T. Angley, T. Bara, J. Bossart,
R.J. Dutton

FECAL COLIFORM DETERMINATION

Sample Collection:

The sample for the coliform determination was collected in a Nalgene bottle. After flushing the bottle twice, a sample was collected and kept on ice during transit to the laboratory.

Sample Analysis:

Fecal coliforms were enumerated by means of membrane filtration according to the procedures of the U.S. Environmental Protection Agency, Microbiological Methods for Monitoring the Environment Water and Wastes , EPA 600/8-78-017 (1978). Appropriate volumes of sample were first filtered through Gelman GN-6, 0.45 um, 47 mm membrane filters (Gelman Sciences, Ann Arbor, Mich.) and then placed on MF-C agar (Difco, Detroit, Mich.). After incubation at 44.5 degrees centigrade for 24 hours, dark blue colonies were scored as fecal coliforms.

PARAMETER Fecal Coliform (# Colonies/100 ml)

SAMPLE #, DATE RECEIVED

LOCATION, WELL #	S1 8-4-82	S2 8-10-82	S3 8-28-82	S4 9-7-82	S5 9-11-82
G1 W1	48,300	630	1,260	113,300	50,300
G1 W2	6,200	6,300	200	2,300	18,700
G1 W3	1,500	1,000	400	200	80
G1 W4	2,500	2,000	80	300	2,300
G1 W5	1,300	300	40	2,200	60
G1 W6	21,000	20,600	30	100	60

	S1 8-4-82	S2 8-10-82	S3 8-28-82	S4 9-5-82	S5 9-11-82
G2 W1	~~NA~~ X	560,000	10,000	310,000	183,300
G2 W2	180,000	80,000	400	1,100	600
G2 W3	5,000	2,000	100	70	900
G2 W4	0	0	30	80	300
G2 W5	1,700	1,000	200	10	300

PARAMETER Fecal Coliform (# Colonies/100 ml)

LOCATION, WELL #

SAMPLE #, DATE RECEIVED

	S1 8-6-82	S2 8-11-82	S3 8-24-82	S4 8-31-82	S5 9-7-82
ORM 1 W1	90,000	303,000	2,700	8,100	40
ORM 1 W2	31,000	185,000	140	60	10
ORM 1 W3	30	3,200	60	100	1
ORM 1 W4	5	4,000	100	30	0

	S1 8-6-82	S2 8-11-82	S3 8-24-82	S4 8-31-82	S5 9-7-82
ORM 2 W1	1,470,000	700,000	300	130	460
ORM 2 W2	8,300	50,000	200	200	530
ORM 2 W3	300	30,000	150	60	20
ORM 2 W4	360	46,700	0	460	0
ORM 2 W5	670	40,000	0	0	0

	S1 8-6-82	S2 8-11-82	S3 8-24-82	S4 8-31-82	S5 9-7-82
ORM 3 W1	196,600	2,410,000	1,500,000	2,130,000	270,000
ORM 3 W2	70	1,860,000	2,200	8,300	900
ORM 3 W3	170	570	400	0	0
ORM 3 W4	200	NA	11,300	200	30
ORM 3 W5	30	NA	0	30	70

PARAMETER Average fecal coliform (#colonies/100 ml)

LOCATION, WELL #	SAMPLE #, DATE RECEIVED				
	S1 8-7-82	S2 8-12-82	S3 8-26-82	S4 9-2-82	S5 9-10-82
ORL 1 W1	20,600	6,000	42,000	32,000	600
ORL 1 W2	700	900	470	200	200
ORL 1 W3	2,130	200	1,100	500	10
ORL 1 W4	4,000	0	30	30	0
ORL 1 W5	660	100	100	100	0

	S1	S2 8-12-82	S3 8-26-82	S4 9-2-82	S5 9-10-82
ORL 2 W1	-----	430,000	3,800	7,900	5,400
ORL 2 W2	-----	5,600	600	2,200	90
ORL 2 W3	-----	6,300	2,900	2,600	2,200
ORL 2 W4	-----	19,000	34,300	10	0

DETERMINATION OF NITRATE/NITRITE

Sample Collection:

The sample was collected in an identical manner to the collection of the pH sample. At the laboratory, the water was filtered through Whatman GF/A Glass Microfiber Filters (2.4 cm), placed into AutoAnalyzer cups and refrigerated at 4 degrees centrigrade until analyzed.

Sample Analysis:

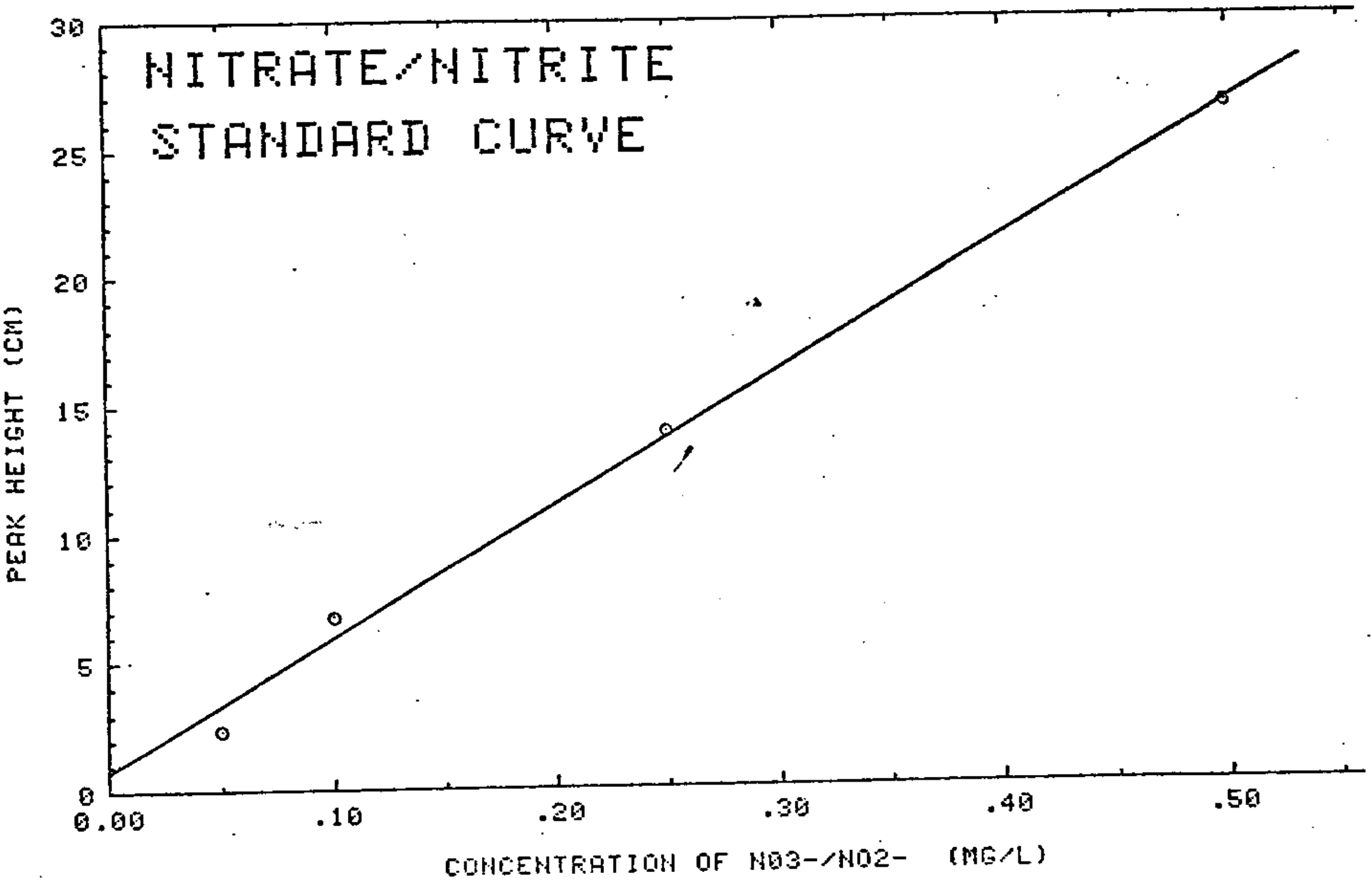
The determination of nitrate/nitrite in each sample was done according to the Methods for Chemical Analysis of Water and Wastes , EPA-600/4-79-020 (1979), Method 353.2.

Summary of the Method:

A filtered sample is passed through a column containing copper and cadmium wire to reduce nitrate to nitrite. The nitrite (that originally present plus reduced nitrate) is determined by diazotizing with sulfanilamide and coupling with N-(1-naphthyl)-ethylenediamine dihydrochloride to form highly colored azo dye which is measured colorimetrically.

Scope and Application:

This method pertains to the determination of nitrite singly, or nitrite and nitrate combined in surface and saline waters, and domestic and industrial wastes. The applicable range of this method is 0.05 to 10.0 mg/liter nitrate-nitrite nitrogen. The range may be extended with sample dilution.


NITRATE/NITRITE
STANDARD CURVE
PEAK HEIGHT (CM)
30
25
20
15
10
5
0
0.00
.10
.20
.30
.40
.50
CONCENTRATION OF NO3-/NO2- (MG/L)

PARAMETER Nitrate/Nitrite

LOCATION, WELL #	SAMPLE #, DATE RECEIVED				
	S1 8-4-82	S2 8-10-82	S3 8-28-82	S4 9-7-82	S5 9-11-82
G1 W1	0.02	<0.01	0.60	0.18	0.38
G1 W2	<0.01	<0.01	0.19	2.72	0.44
G1 W3	2.95	0.68	<0.01	4.19	0.05
G1 W4	<0.01	3.65	4.07	1.56	1.98
G1 W5	4.64	4.79	4.17	<0.01	3.10
G1 W6	<0.01	0.07	0.09	<0.01	0.37
	S1 8-4-82	S2 8-10-82	S3 8-28-82	S4 9-5-82	S5 9-11-82
G2 W1	X	0.24	<0.01	0.04	<0.01
G2 W2	<0.01	0.40	0.02	0.04	0.02
G2 W3	0.14	0.12	0.59	0.15	0.11
G2 W4	0.07	X	<0.01	0.05	0.03
G2 W5	0.26	0.38	0.43	0.11	0.06

LOCATION, WELL #	SAMPLE #, DATE RECEIVED				
	S1 8-6-82	S2 8-11-82	S3 8-24-82	S4 8-31-82	S5 9-7-82
ORM-1 W1	0.04	0.09	35.2	38.2	17.3
ORM 1 W2	<0.01	<0.01	0.03	0.03	0.02
ORM 1 W3	<0.01	<0.01	0.144	<0.01	0.44
ORM 1 W4	<0.01	0.02	0.03	<0.01	<0.01
	S1 8-6-82	S2 8-11-82	S3 8-24-82	S4 8-31-82	S5 9-7-82
ORM 2 W1	<0.01	0.03	0.03	<0.01	<0.01
ORM 2 W2	0.02	<0.01	<0.01	<0.01	<0.01
ORM 2 W3	<0.01	0.02	0.02	0.03	<0.01
ORM 2 W4	0.27	0.03	<0.01	0.03	<0.01
ORM 2 W5	0.04	0.03	0.02	0.02	<0.01
	S1 8-6-82	S2 8-11-32	S3 8-24-82	S4 8-31-82	S5 9-7-82
ORM 3 W1	<0.01	X	<0.01	<0.01	<0.01
ORM 3 W2	<0.01	X	0.02	<0.01	<0.01
ORM 3 W3	<0.01	X	<0.01	<0.01	<0.01
ORM 3 W4	<0.01	X	<0.01	<0.01	<0.01
ORM 3 W5	<0.01	X	<0.01	0.27	0.45

ARAMETER Nitrate/Nitrite

OCATION, WELL #

SAMPLE #, DATE RECEIVED

	S1 8-7-82	S2 8-12-82	S3 8-26-82	S4 9-2-82	S5 9-10-82
ORL 1 W1	<0.01	<0.01	<0.01	0.03	<0.01
ORL 1 W2	<0.01	<0.01	<0.01	0.04	<0.01
ORL 1 W3	<0.01	<0.01	0.05	0.06	<0.01
ORL 1 W4	<0.01	0.03	0.04	0.02	<0.01
ORL 1 W5	<0.01	0.03	<0.01	0.03	<0.01
	S1	S2 8-12-82	S3 8-26-82	S4 9-2-82	S5 9-10-82
ORL 2 W1	<0.01	0.27	0.15	0.03	<0.01
ORL 2 W2	<0.01	0.09	0.07	0.06	<0.01
ORL 2 W3	<0.01	0.18	0.03	0.04	<0.01
ORL 2 W4	<0.01	0.11	0.06	0.03	0.03

DETERMINATION OF AMMONIA

Sample Collection:

The sample for ammonia was collected in a Nalgene bottle and immediately acidified with H_2SO_4. The bottle was then kept on ice during the transport back to the laboratory. At the laboratory, three replicate samples were filtered through Whatman GF/A Glass Microfiber Filters (2.4 cm), stored in AutoAnalyzer cups and refrigerated at 4 degrees centigrade until analysis.

Sample Analysis:

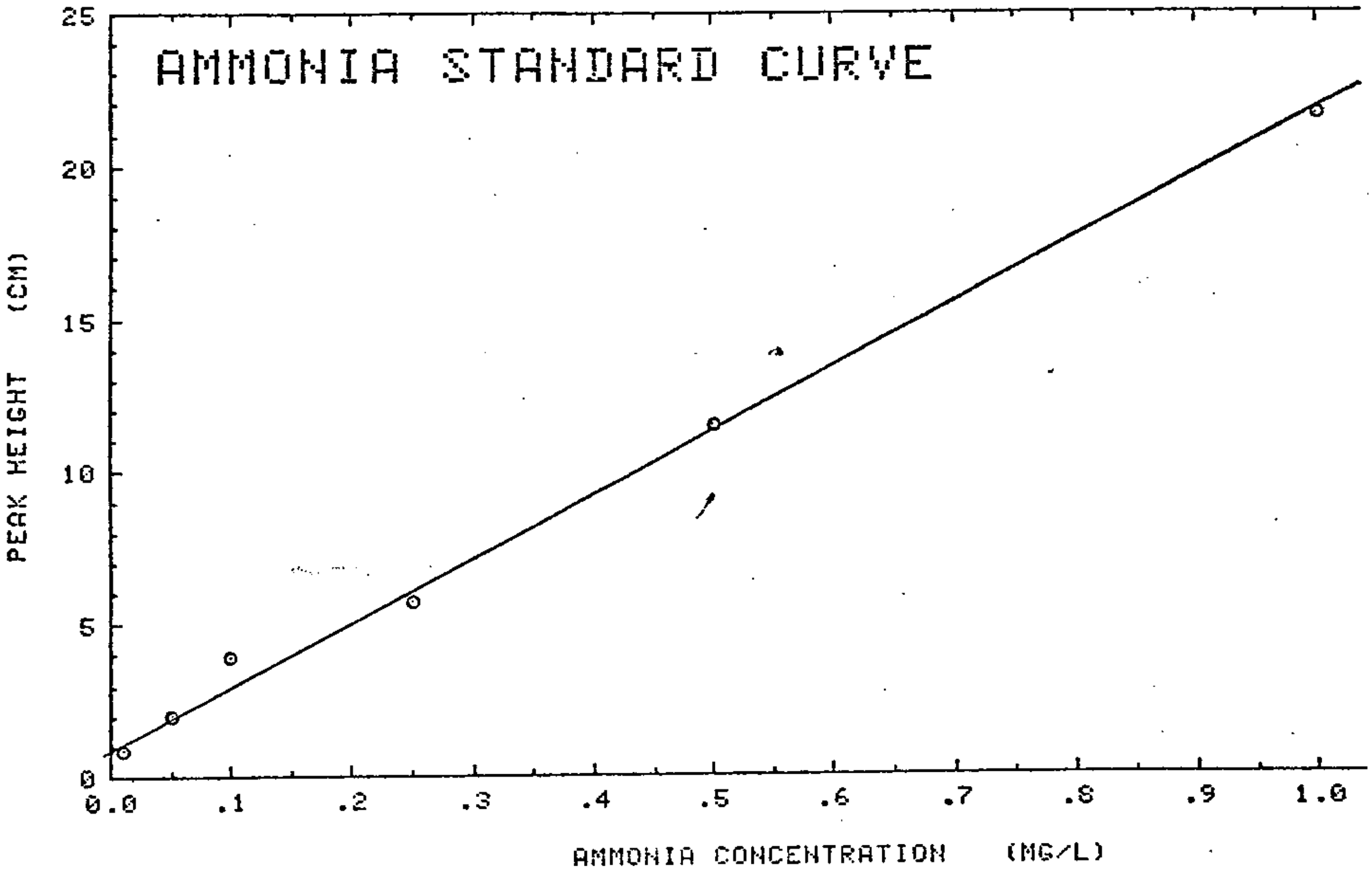
The sample was analyzed according to the <u>Methods for Chemical Analysis of Water and Wastes</u> , EPA-600/4-79-020 (1979), Method 350.1.

Summary of Method:

Alkaline phenol and hypochlorite react with ammonia to form indophenol blue that is proportional to the ammonia concentration. The blue color formed is intensified with sodium nitroprusside.

Scope and Application:

This method covers the determination of ammonia in drinking, surface, and saline waters, domestic and industrial wastes in the range of 0.01 to 2.0 mg/l NH_3 as N. This range is for photometric measurements made at 630 - 660 nm in a 15 mm or 50 mm tubular flow cell. Higher concentrations can be determined by sample dilution. Approximately 20 to 60 samples per hour can be analyzed.


AMMONIA STANDARD CURVE
25
20
15
10
5
0
PEAK HEIGHT (CM)
0.0
.1
.2
.3
.4
.5
.6
.7
.8
.9
1.0
AMMONIA CONCENTRATION (MG/L)

PARAMETER AMMONIA

LOCATION, WELL #	SAMPLE #, DATE RECEIVED				
	S1 8-4-82	S2 8-10-82	S3 8-28-82	S4 9-7-82	S5 9-11-82
G1 W1	0.27	0.36	18.33	9.70	10.53
G1 W2	0.95	1.14	7.11	1.71	1.00
G1 W3	0.05	0.09	-----	0.12	<0.01
G1 W4	1.32	6.31	0.34	0.15	0.02
G1 W5	0.05	0.18	0.08	0.09	0.09
G1 W6	0.23	0.30	0.26	0.21	0.12
	S1 8-4-82	S2 8-10-82	S3 8-28-82	S4 9-5-82	S5 9-11-82
G2 W1	0.08	17.84	37.95	19.05	19.54
G2 W2	<0.01	0.17	0.24	0.13	0.09
G2 W3	0.02	0.05	0.07	0.08	0.03
G2 W4	<0.01	0.06	0.05	0.14	0.11
G2 W5	0.11	0.08	0.05	0.06	0.07

-PARAMETER AMMONIA

LOCATION, WELL # SAMPLE #, DATE RECEIVED

	S1 8-6-82	S2 8-11-82	S3 8-24-82	S4 8-31-82	S5 9-7-82
ORM 1 W1	1.23	-----	4.08	11.45	10.04
ORM 1 W2	9.03	1.66	0.50	1.32	1.90
ORM 1 W3	0.86	1.08	0.13	-----	2.49
ORM 1 W4	0.61	1.47	1.03	-----	2.49

	S1 8-6-82	S2 8-11-82	S3 8-24-82	S4 8-31-82	S5 9-7-82
ORM 2 W1	2.34	5.63	4.86	4.96	8.20
ORM 2 W2	3.31	11.35	7.18	-----	20.51
ORM 2 W3	5.88	6.75	6.70	7.23	7.52
ORM 2 W4	9.03	11.06	3.89	10.53	11.25
ORM 2 W5	4.04	4.76	2.44	4.38	8.59

	S1 8-6-82	S2 8-11-82	S3 8-24-82	S4 8-31-82	S5 9-7-82
ORM 3 W1	-----	-----	-----	-----	9.66
ORM 3 W2	0.09	0.21	0.37	0.39	0.35
ORM 3 W3	0.21	0.25	0.28	0.10	0.33
ORM 3 W4	0.04	0.03	0.14	0.10	0.09
ORM 3 W5	<0.01	<0.01	0.09	0.33	0.08

PARAMETER AMMONIA

LOCATION, WELL #	SAMPLE #, DATE RECEIVED				
	S1 8-7-82	S2 8-12-82	S3 8-26-82	S4 9-2-82	S5 9-10-82
ORL 1 W1	28.3	24.4	27.3	7.71	26.8
ORL 1 W2	4.29	4.29	6.86	21.47	21.96
ORL 1 W3	0.443	2.57	-----	6.00	9.00
ORL 1 W4	0.12	9.43	-----	3.0	4.3
ORL 1 W5	27.3	6.9	4.3	3.0	5.0

	S1	S2 8-12-82	S3 8-26-82	S4 9-2-82	S5 9-10-82
ORL 2 W1	-----	22.9	22.9	8.6	5.1
ORL 2 W2	-----	0.3	0.7	0.2	0.1
ORL 2 W3	-----	0.03	0.7	0.2	0.8
ORL 2 W4	-----	0.3	0.6	9.4	5.6

DETERMINATION OF TOTAL PHOSPHATE

Sample Collection:

The sample was collected in an HCl-washed Nalgene bottle. After flushing the bottle twice, a sample was collected and kept on ice during transit to the laboratory. At the laboratory, approximately 30 milliliters of solution were filtered through Whatman GF/A Glass Microfiber Filters (2.4 cm), acidified with H_2SO_4 and stored at -20 degrees centigrade until analyzed.

Sample Analysis:

Phosphorus was determined according to Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020 (1979), Method 365.1.

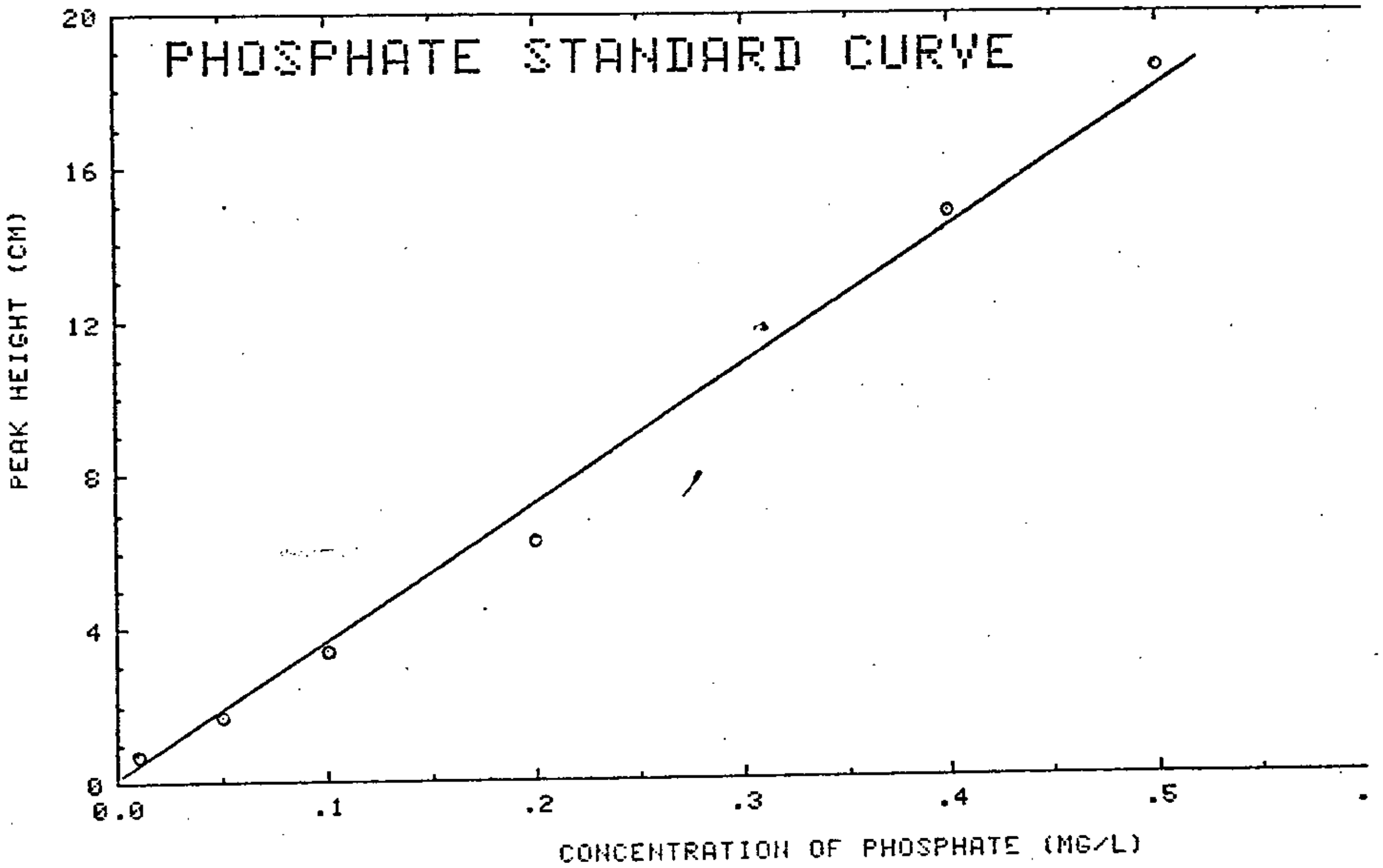
Summary of the Method:

Ammonium molybdate and antimony potassium tartrate react in an acid medium with dilute solutions of phosphorus to form an antimony-phospho-molybdate complex. This complex is reduced to an intensely blue-colored complex by ascorbic acid. The color is proportional to the phosphorus concentration.

Only orthophosphate forms a blue color in this test. Polyphosphates (and some organic phosphorus compounds) may be converted to the orthophosphate by manual sulfuric acid hydrolysis. Organic phosphorus compounds may be converted to the orthophosphate form by manual persulfate digestion. The developed color is measured automatically on the AutoAnalyzer.

Scope and Application:

The methods are usable in the 0.001 to 1.0 mg P/liter range. Approximately 20 - 30 samples per hour can be analyzed.


PHOSPHATE STANDARD CURVE
PEAK HEIGHT (CM)
20
16
12
8
4
0
0.0
.1
.2
.3
.4
.5
CONCENTRATION OF PHOSPHATE (MG/L)

ARAMETER Phosphates (mg -P/liter)

OCATION, WELL #	SAMPLE #, DATE RECEIVED				
	S1 8-4-82	S2 8-10-82	S3 8-28-82	S4 9-7-82	S5 9-11-82
G1 W1	0.97	0.36	4.62	1.43	1.02
G1 W2	2.20	1.21	7.73	2.62	-----
G1 W3	0.22	0.36	-----	0.74	-----
G1 W4	2.47	3.09	1.58	0.92	1.40
G1 W5	0.61	0.51	0.59	0.71	0.57
G1 W6	0.87	3.05	11.53	2.39	1.50
	S1 8-4-82	S2 8-10-82	S3 8-28-82	S4 9-5-82	S5 9-11-82
G2 W1	0.32	10.29	33.88	5.01	-----
G2 W2	0.07	0.18	0.61	0.46	0.34
G2 W3	0.09	0.06	0.73	0.06	0.08
G2 W4	0.51	0.66	17.56	0.61	0.32
G2 W5	0.29	0.47	1.05	1.37	0.82

PARAMETER Phosphates (mg P/Liter)

LOCATION, WELL #

SAMPLE #, DATE RECEIVED

	S1 8-6-82	S2 8-11-82	S3 8-24-82	S4 8-31-82	S5 9-7-82
ORM 1 W1	0.30	4.84	-----	2.08	4.08
ORM 1 W2	4.20	0.02	0.01	0.01	0.08
ORM 1 W3	0.09	0.02	0.04	0.23	0.08
ORM 1 W4	0.05	0.64	0.02	0.08	0.05

	S1 8-6-82	S2 8-11-82	S3 8-24-82	S4 8-31-82	S5 9-7-82
ORM 2 W1	0.27	0.31	0.25	1.98	0.38
ORM 2 W2	1.44	3.14	0.81	7.29	9.40
ORM 2 W3	0.38	0.31	0.06	0.67	0.76
ORM 2 W4	0.03	0.27	0.01	0.30	0.17
ORM 2 W5	0.04	0.08	0.15	0.38	0.71

	S1 8-6-82	S2 8-11-82	S3 8-24-82	S4 8-31-82	S5 9-7-82
ORM 3 W1	5.37	3.85	2.68	4.33	0.40
ORM 3 W2	0.03	0.17	0.02	0.07	0.53
ORM 3 W3	0.05	0.04	0.02	0.03	0.26
ORM 3 W4	0.03	0.03	0.04	0.09	-----
ORM 3 W5	0.02	0.10	0.02	0.02	-----

PARAMETER Phosphates (mg P/liter)

SAMPLE #, DATE RECEIVED

LOCATION, WELL #	S1 8-7-82	S2 8-12-82	S3 8-26-82	S4 9-2-82	S5 9-10-82
ORL 1 W1	4.59	4.70	0.20	4.12	0.41
ORL 1 W2	0.22	1.93	0.30	0.71	0.14
ORL 1 W3	0.43	0.07	0.20	0.32	0.02
ORL 1 W4	0.09	0.13	0.13	0.01	0.03
ORL 1 W5	0.03	0.06	0.01	0.08	1.00

	S1	S2 8-12-82	S3 8-26-82	S4 9-2-82	S5 9-10-82
ORL 2 W1	-----	0.51	0.83	0.30	0.20
ORL 2 W2	-----	-----	0.54 ~~154~~	0.27	0.19
ORL 2 W3	-----	-----	0.17	0.02	0.33
ORL 2 W4	-----	-----	0.54	0.43	0.37

DETERMINATION OF CHLORIDE

Sample Collection:

The sample for the determination of chloride was collected in an identical manner to the collection of the pH sample. At the laboratory, three replicates of the sample were filtered through Whatman GF/A Glass Microfiber Filters (2.4 cm), poured into plastic AutoAnalyzer cups and refrigerated at 4 degrees centigrade until analyzed.

Sample Analysis:

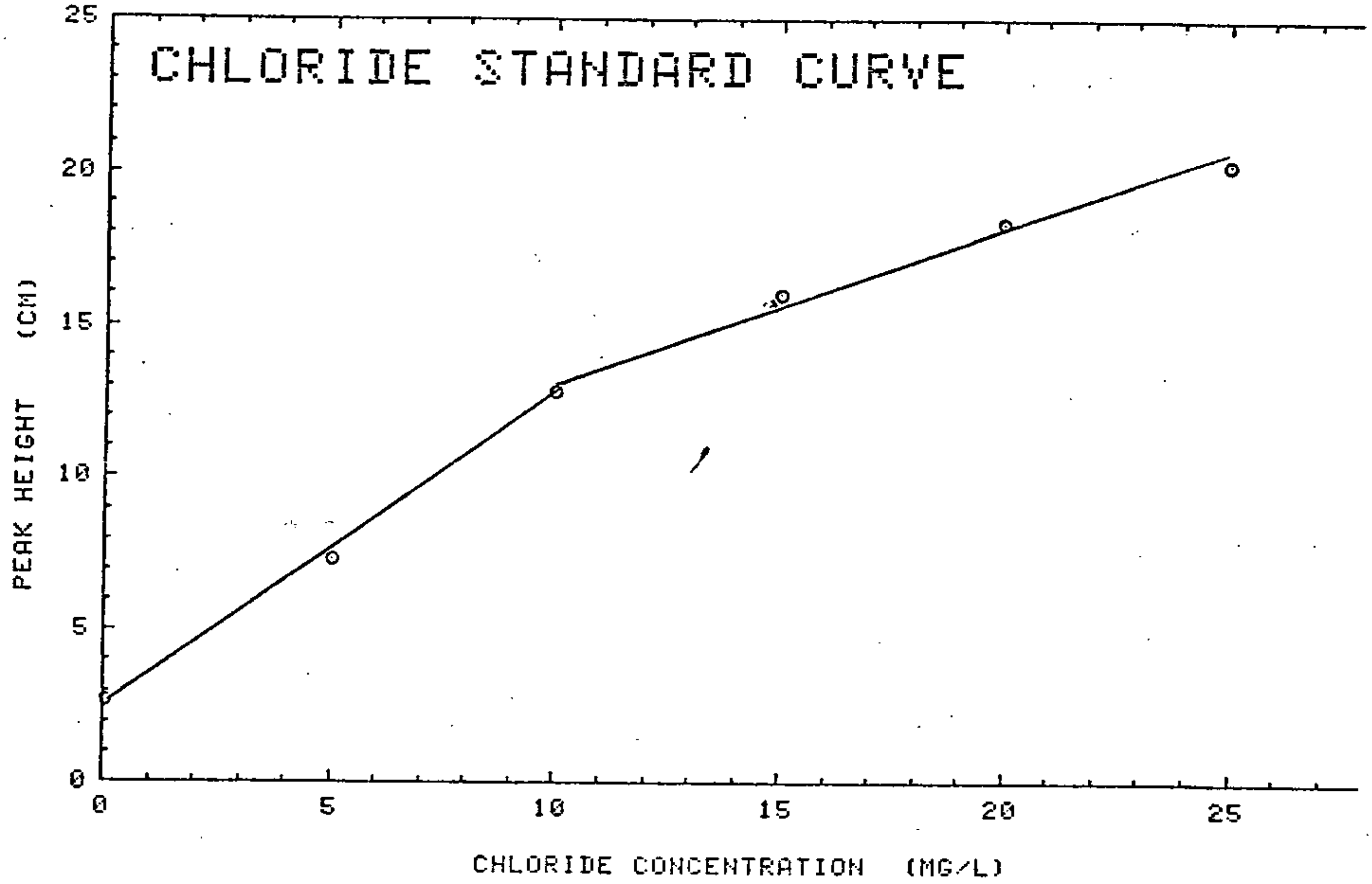
The samples were analyzed according to the procedures outlined in the _Methods for Chemical Analysis of Water and Wastes_ , EPA-600/4-79-020 (1979), Method 325.1. This method is described in summary below.

Summary of Method:

Thiocyanate ion (SCN) is liberated from mercuric thiocyanate through sequestration of mercury by chloride ion to form un-ionized mercuric chloride. In the presence of ferric ion, the liberated SCN forms highly colored ferric thiocyanate in concentration proportional to the original chloride concentration.

Scope and Application:

This automated method is applicable to drinking, surface, and saline waters, domestic and industrial wastes. The applicable range is 1 to 250 mg Cl/l. Approximately 15 samples per hour can be analyzed.


CHLORIDE STANDARD CURVE
PEAK HEIGHT (CM)
25
20
15
10
5
0
0
5
10
15
20
25
CHLORIDE CONCENTRATION (MG/L)

PARAMETER Chlorides, mg/1

LOCATION, WELL #	SAMPLE #, DATE RECEIVED				
	S1 8-4-82	S2 8-10-82	S3 8-28-82	S4 9-7-82	S5 9-11-82
G1 W1	7.4	6.7	46.3	38.8	19.9
G1 W2	16.8	23.0	46.3	49.3	39.2
G1 W3	11.2	12.3	19.8	23.4	48.9
G1 W4	16.8	24.5	52.3	24.2	14.2
G1 W5	0.4	2.7	4.8	23.7	6.4
G1 W6	6.3	6.1	9.9	21.3	18.8
	S1 8-4-82	S2 8-10-82	S3 8-26-82	S4 9-5-82	S5 9-11-82
G2 W1	X	73.3	55.3	35.0	51.6
G2 W2	104.8	107.8	115.3	131.5	143.6
G2 W3	9.6	20.3	20.9	44.9	59.1
G2 W4	7.0	8.4	8.1	7.9	5.3
G2 W5	4.9	19.2	18.4	19.1	17.5

PARAMETER Chlorides, mg/l

LOCATION, WELL #

SAMPLE #, DATE RECEIVED

	S1 8-6-82	S2 8-11-82	S3 8-24-82	S4 8-31-82	S5 9-7-82
ORM 1 W1	166.3	124.6	121.5	144.3	143.1
ORM 1 W2	23.7	38.8	21.9	53.6	70.9
ORM 1 W3	20.6	31.7	22.5	64.9	65.3
ORM 1 W4	115.9	145.2	144.4	151.4	149.3

	S1 8-6-82	S2 8-11-82	S3 8-24-82	S4 8-31-82	S5 9-7-82
ORM 2 W1	18.4	22.7	19.8	21.8	76.8
ORM 2 W2	13.8	73.7	68.1	109.7	115.3
ORM 2 W3	22.7	48.1	66.5	79.2	82.9
ORM 2 W4	132.9	177.6	47.2	194.6	190.9
ORM 2 W5	84.8	160.1	74.5	164.5	194.6

	S1 8-6-82	S2 8-11-82	S3 8-24-32	S4 8-31-82	S5 9-7-82
ORM 3 W1	170.9	169.3	184.3	202.6	167.8
ORM 3 W2	525.7	829.3	474.5	798.4	619.5
ORM 3 W3	65.0	83.9	101.7	111.3	79.8
ORM 3 W4	150.8	184.7	206.0	204.2	189.4
ORM 3 W5	146.2	169.3	179.3	175.4	161.9

PARAMETER Chloride, mg/l

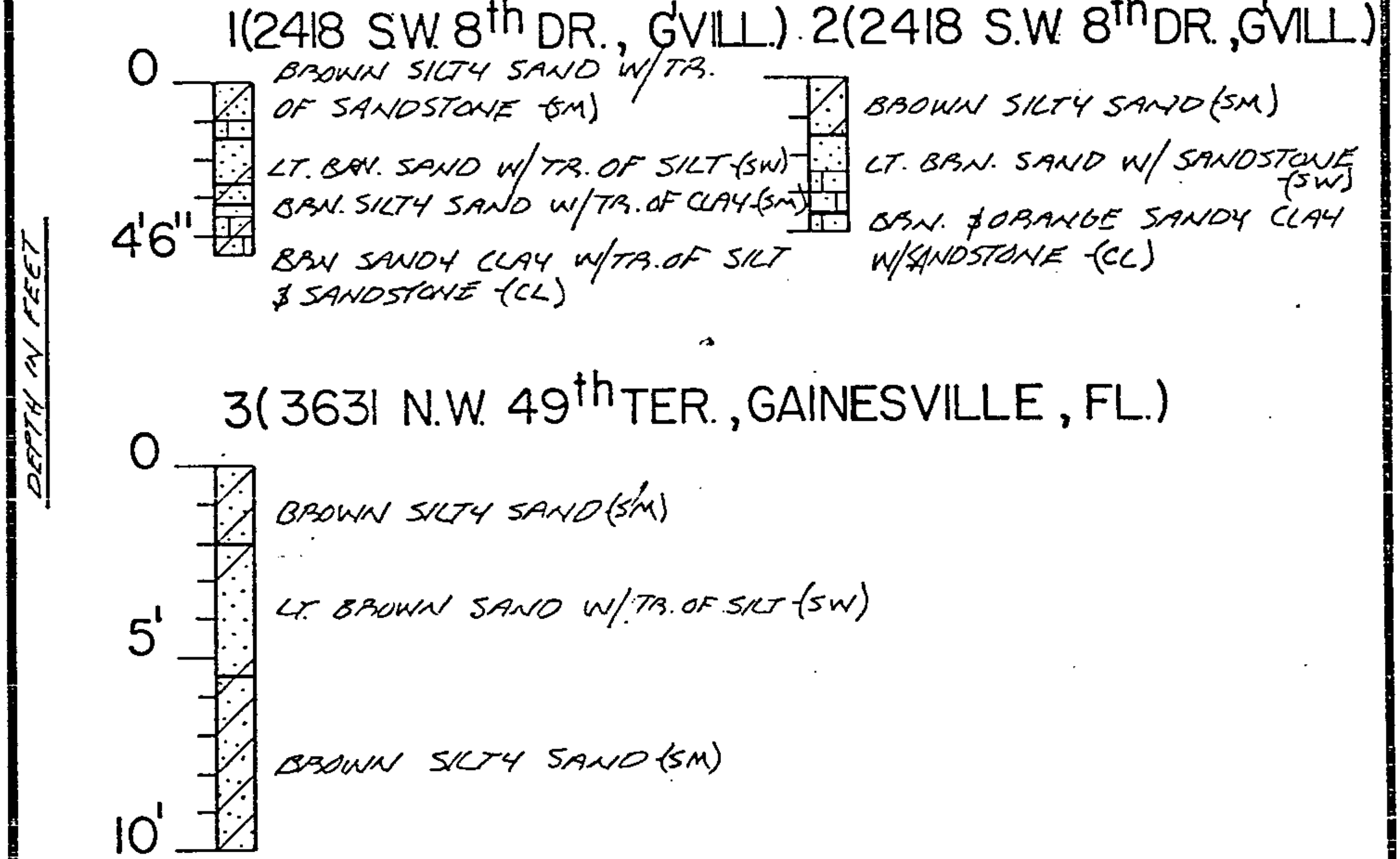
LOCATION, WELL #	SAMPLE #, DATE RECEIVED				
	S1 8-7-82	S2 8-12-82	S3 8-26-82	S4 9-2-82	S5 9-10-82
ORL 1 W1	65.0	49.0	48.7	41.3	43.4
ORL 1 W2	83.2	48.7	42.8	52.1	39.7
ORL 1 W3	24.3	25.9	27.4	36.7	35.1
ORL 1 W4	20.3	16.8	19.1	X	48.4
ORL 1 W5	19.3	24.4	7.5	5.0	43.1

	S1	S2 8-12-82	S3 8-26-82	S4 9-2-82	S5 9-10-82
ORL 2 W1	X	8.1	24.4	52.0	14.1
ORL 2 W2	X	6.4	12.5	4.8	17.8
ORL 2 W3	X	18.0	19.1	20.5	17.2
ORL 2 W4	X	2.6	6.1	7.2	8.7

APPENDIX D

SOIL BORINGS AND SOIL TEST

LOG OF BORINGS



UNIVERSAL ENGINEERING TESTING COMPANY

ORLANDO
DAYTONA BEACH
FORT MYERS
MERRITT ISLAND
GAINESVILLE
WEST PALM BEACH

TEST BORINGS

GAINESVILLE, FL.

Drawn By: H.E. Suggs	Date: 10-9-82	Scale: N/A
Checked By:	Date:	
Order No:	Report No:	Page:

GAINESVILLE SOIL BORING RESULTS

SITE No. 1: H. HOLLAND
2418 SW 8th Dr.

SITE NO. 2: T. MARTIN
3631 NW 49th Terr.

	SITE 1	SITE 2
PERGOLATION RATE	450 sec/in	46 sec/in
PERMEABILITY RATE	$2.25x10^{-3}$ ft/min	$3.10x10^{-2}$ft/min
HEIGHT OF WATER TABLE	3.0 ft.	4.0 ft.

PROJECT NAME: ______

DATE: 9/27/82

ST DEPTH: TD 6.75 (9.5") (ft.)

G.W.T. DEPTH: GWT 1.1 (ft.)

ATIC WATER LEVEL: SWL 1.0 (ft.)

GAUGE PRESSURE: GP ______ (psi)

TEST No.: ______ IDENTITY: ______

LOCATION: RADIO STATION – ORMOND BEACH

STRATA: ______

SOIL TYPE: (SP) – UNIFIED SYSTEM OF CLASSIFICATION

☐ WHEN TD IS ABOVE GWT

$H = SWL + (GP \times 2.31)$

$H = \underline{1.0} + (\underline{\quad} \times 2.31)$

$H = \underline{1.0}$ (ft.)

☐ WHEN TD IS BELOW GWT

$H = [SWL - (TD - GWT)] + (GP \times 2.31)$

$H = [\underline{\quad} - (\underline{\quad} - \underline{\quad})] + (\underline{\quad} \times 2.3$

$H = \underline{\quad}$ (ft.)

TER METER

FINAL READING ______ (gals) $V = (A - B)$

INITIAL READING ______ (gals) $V = \underline{\quad}$ (gals)

☑ VOLUMETRIC FLASK

$V = (A \times B)$

A) SIZE ______ (mls, gals.) $V = \underline{\quad}$ (ml)

B) No. REFILLS ______ (mls.) $V = \underline{\quad}$ (gals)

FOR BOREHOLE PERMEABILITY APPARATUS

LLING

STATIC HEAD

ID TEST PIPE

TOTAL DROP:

A) ______ (ft.) $V = (A \times B)$

B) ______ (gal./ft.) $V = \underline{\quad}$ (gals.)

☐ FALLING HEAD

☐ STATIC HEAD

4" ID PIPE/.75 TUBE

TOTAL DROP:

A) ______ (ft.) $V = (A \times B)$

B) ______ (gal./ft.) $V = \underline{\quad}$ (gals)

APSED TIME IN SECONDS (t) 15 (MIN.) 0 (SEC.) t = 900 (SEC.)

$K = \underline{C} \times \frac{V}{t \times H} = \underline{\quad}$

V = VOLUMN (gals.) t = TIME (sec) H = HEAD (ft.)

V = 512 mls

K = ______ (cm/sec.)

K = 2.5 (ft./

NGTH OF CASING: ______

DIAMETER: 4.0" PVC

L – STATIC WATER LEVEL IN CASING FROM TD

REFERENCE: PAGE 575 OF EARTH MANUAL Des E-18

C = 4.445 FOR 4" ID SCHEDULE 40 PVC

C = 4.926 FOR NW. STEEL CASING

$gals = \frac{V(ml)}{3785.4}$

1 cm/sec = 2834.6 ft/day

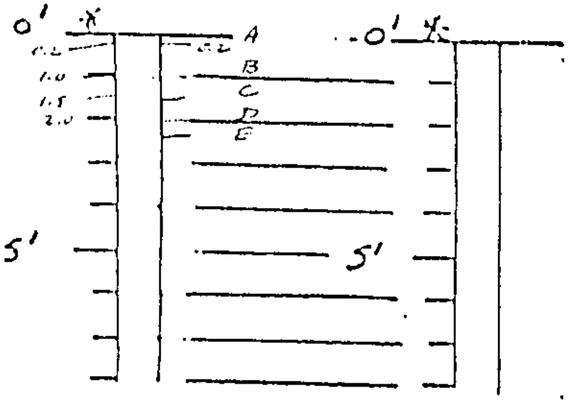
STANDARD PERCOLATION TESTS

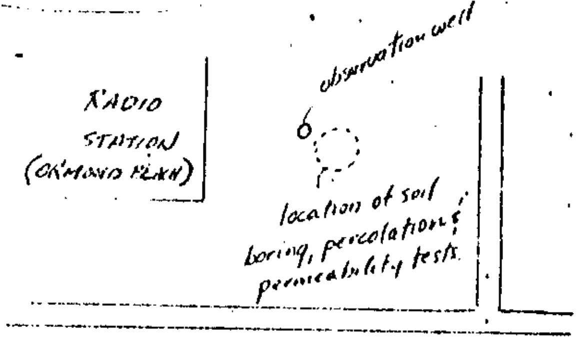
LIENT :
ILE NO :
ATE : 9/27/82

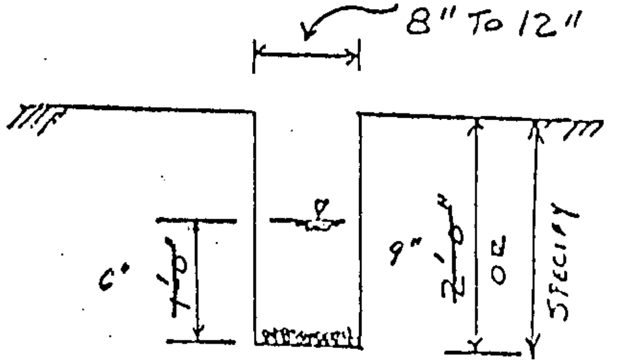
WEATHER :

TEST NO	DIAMETER OF PIT	HEIGHT OF WATER	TIME FOR DROP OF: ONE INCH	TWO INCH	THREE INCH	REMARKS
	8.0"	6.0"	115 SEC	354 SEC	514 SEC	
			MIN	MIN	MIN	GWT @ 1.1' – unable to perform test @ 2.0'
			SEC	SEC	SEC	below ground surface.
			MIN	MIN	MIN	

Perc rate = 328 sec/inch







PROCEDURE

1. Excavate a pit approximately 8 to 12 inches in diameter and with vertical sides. The pit should be excavated to 24 inches below the surface. If the ground water table is within 24 inches of the surface, abandon the pit.
2. Scratch the side of the test pit and remove all loose material from the bottom. Place approximately two inches of fine gravel in the bottom to prevent scouring.
3. Carefully fill the hole with clear water to a minimum depth of 12 inches, that is, 12 inches above the bottom of the pit. Maintain the water level there by adding water as necessary for a period of 15 minutes.
4. After 15 minutes of saturation, begin the test. With the water level at 12 inches above the bottom of the pit, measure and record the time necessary for three consecutive one-inch drop in water height. Record the time in seconds and/or minutes in the space provided above.

SOIL LEGEND

A. 0.0-0.2 greyish brown fine sand w/shell fragments & roots
B. 0.2-1.0 light greyish brown slightly silty fine sand w/ shell fragments
C. 1.0-1.5 greyish brown fine sand w/cemented shell fragments
D. 1.5-2.0 gravel
E. 2.0-2.3 brown fine sand w/streaks of dark grey organic fine sand

OUND WATER TABLE 1.1 FT.

ME ______ MIN.

PENETROMETER READING

PROJECT NAME: ____________________ DATE: 10/12/82

EST DEPTH: TD 15 (ft.)

G.W.T. DEPTH: GWT 2.0 (ft.)

TATIC WATER LEVEL: SWL 3.0 (ft.)

GAUGE PRESSURE: GP ____ (psi)

TEST No.: ________ IDENTITY: ______

LOCATION: HOUSE in ORMOND BEACH

STRATA: ________

SOIL TYPE: (SP) UNIFIED SYSTEM OF CLASSIFICATION

☐ WHEN TD IS ABOVE GWT

$H = SWL + (GP \times 2.31)$

$H = \underline{3.0} + (\underline{\quad} \times 2.31)$

$H = \underline{3.0}$ (ft.)

☐ WHEN TD IS BELOW GWT

$H = [SWL - (TD - GWT)] + (GP \times 2.31)$

$H = [\_\_\_\_ - (\_\_\_\_ - \_\_\_\_)] + (\_\_\_\_ \times 2$

$H = \_\_\_\_$ (ft.)

ATER METER

FINAL READING ________ (gals) $V = (A - B)$

INITIAL READING ________ (gals) $V =$ ______ (gals)

☐ VOLUMETRIC FLASK

$V = (A \times B)$

A) SIZE ________ (mls, gals.) $V =$ ______ (ml

B) No. REFILLS ________ (mls.) $V =$ ______ (ga

FOR BOREHOLE PERMEABILITY APPARATUS

LLING

[✓ STATIC HEAD]

ID TEST PIPE

TOTAL DROP:

A) ________ (ft.) $V = (A \times B)$

B) ________ (gal./ft.) $V =$ ________ (gals.)

☐ FALLING HEAD

☐ STATIC HEAD

4" ID.PIPE/.75 TUBE

TOTAL DROP:

A) ________ (ft.) $V = (A \times B)$

B) ________ (gal./ft.) $V =$ ______ (gals.)

LAPSED TIME IN SECONDS(t) 15 (MIN.) 0 (SEC.) t = 900 (SEC.)

$K = \underline{C} \times \frac{V}{t \times H} = $ ________

$K =$ ____________ (cm/sec.)

$K =$ 1.4 (ft

V = VOLUMN (gals.)

t = TIME (sec)

H = HEAD (ft.)

V = 850 mls

NGTH OF CASING: ________

DIAMETER: 4.0" PVC

L - STATIC WATER LEVEL IN CASING FROM TD

REFERENCE: PAGE 575 OF, EARTH MANUAL Des E-18

$1 \text{ cm/sec} = 2834.6 \text{ ft/day}$

C = 4.445 FOR 4" ID SCHEDULE 40 PVC

C = 4.926 FOR NW. STEEL CASING

$V_{gals} = \frac{V_{ml}}{3785.4}$

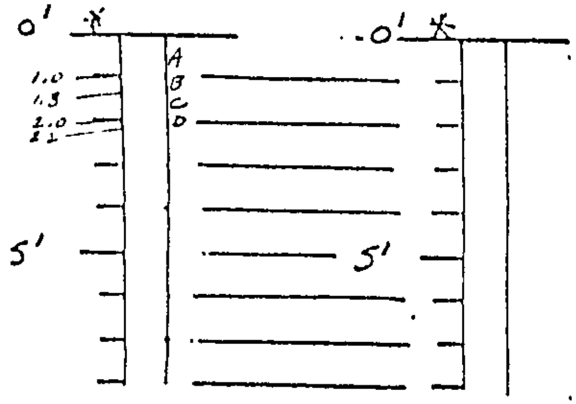
STANDARD PERCOLATION TESTS

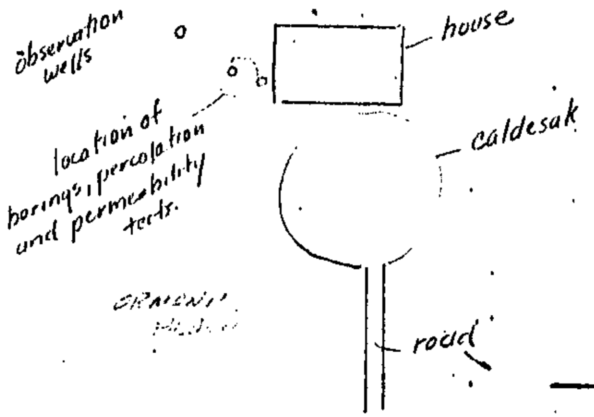
LIENT:
LE NO:
TE : 10/12/92

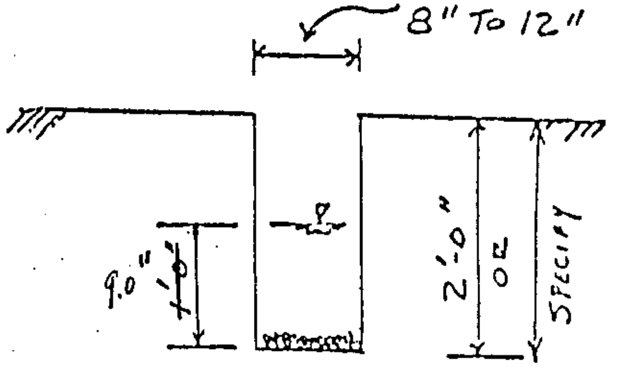
WEATHER :

TEST NO	DIAMETER OF PIT	HEIGHT OF WATER	TIME FOR DROP OF: ONE INCH	TWO INCH	THREE INCH	REMARKS
	8.0"	9.0"	300 SEC MIN	785 SEC MIN	1385 SEC MIN	
			SEC MIN	SEC MIN	SEC MIN	

perc rate = 823 sec/inch







PROCEDURE

SOIL LEGEND

. 0.0-1.0 Light brown fine sand w/shell fragments

B. 1.0-1.3 Dark Greyish Brown silty FS

C. 1.3-2.0 Light Greyish Brown fine sand

D. 2.0-2.2 Light Grey fine sand w/bluish-grey clayey fine sand

E.

OUND WATER TABLE 2.0 FT.

IME ______ MIN.

PENETROMETER READING

1. Excavate a pit approximately 8 to 12 inches in diameter and with vertical sides. The pit should be excavated to 24 inches below the surface. If the ground water table is within 24 inches of the surface, abandon the pit.
2. Scratch the side of the test pit and remove all loose material from the bottom. Place approximately two inches of fine gravel in the bottom to prevent scouring.
3. Carefully fill the hole with clear water to a minimum depth of 12 inches, that is, 12 inches above the bottom of the pit. Maintain the water level there by adding water as necessary for a period of 15 minutes.
4. After 15 minutes of saturation, begin the test. With the water level at 12 inches above the bottom of the pit, measure and record the time necessary for three consecutive one-inch drop in water height. Record the time in seconds and/or minutes in the space provided above.

TD = Test depth, in feet as measured from ground surface.

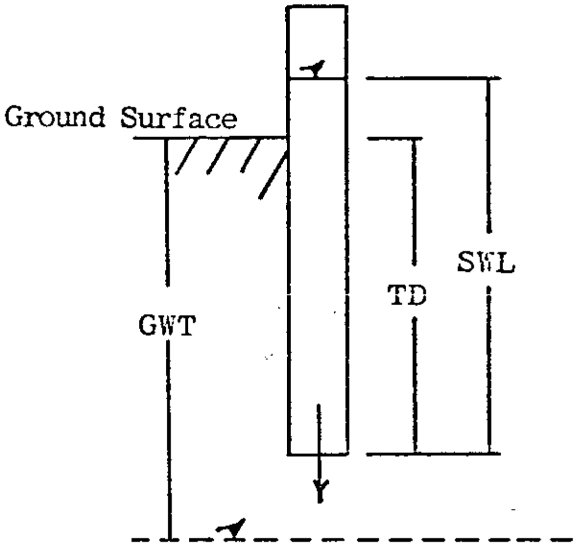
GWT = Depth to ground water level table, in feet as measured from ground surface.

SWL = Static Water Level, in feet as measured from constant water level to bottom of casing.

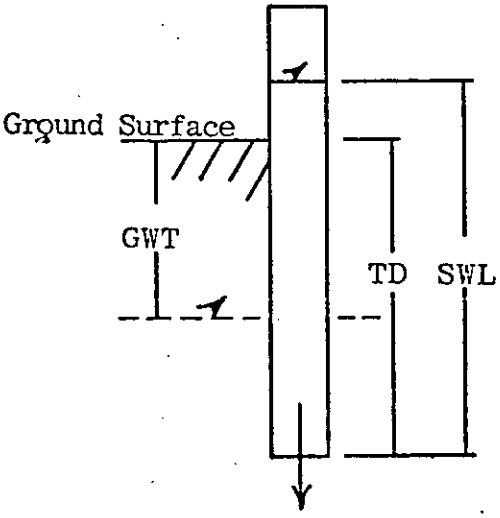
H = Head, in feet.

V = Volume, in ml.'s required to maintain constant head for 15 minutes.

TD = 3.0 ft. GWT 3.8 ft. SWL 4.0 ft.



GWT Below test depth
H = SWL



GWT Above test depth
H = SWL + GWT - TD

H = 4.0 feet V = 6365 ml.s

Permeability (k) = $\frac{0.0037V}{H}$ (Feet/Day)

K = 5.9 (Feet/Day)

Proj. No. ____________ Date 10-13-82

Proj. Name ____________

Test No. ____________ Test Loc. [illegible] Trench

Soil Description Lt Brn F.S.

CONSTANT HEAD FIELD PERMEABILITY

JAMMAL & ASSOCIATES, INC.
Consulting Geotechnical Engineers

Drawn by:	Scale:	Project No.:
Checked by:	Date:	Sheet No.:

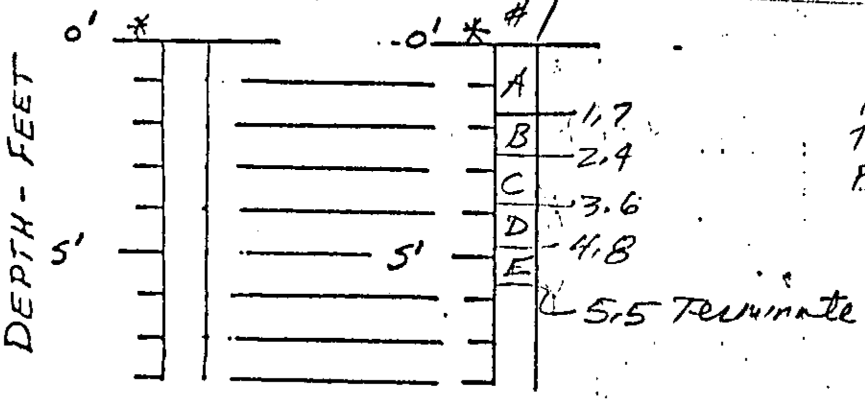
STANDARD PERCOLATION TESTS

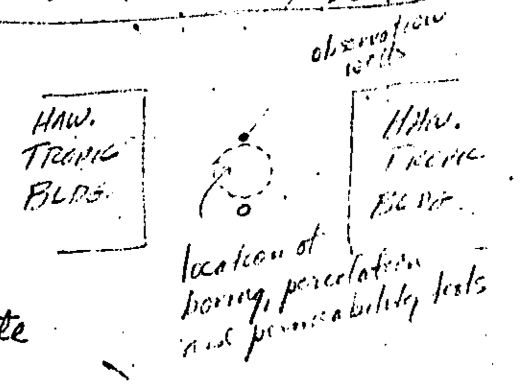
CLIENT:
FILE NO:
DATE: 10-13-82

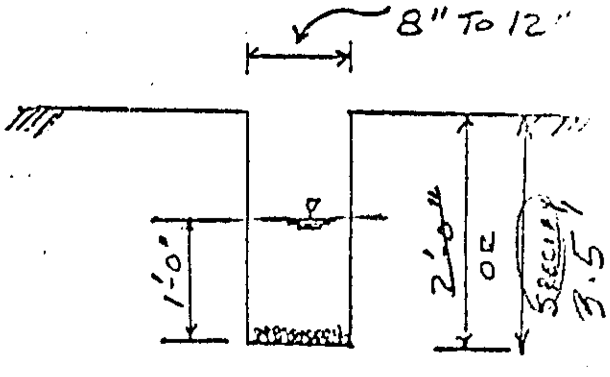
WEATHER:

TEST NO	DIAMETER OF PIT	HEIGHT OF WATER	TIME FOR DROP OF: ONE INCH	TWO INCH	THREE INCH	REMARKS
1	8"	12"	79 SEC	118 SEC	158 SEC	
			MIN	MIN	MIN	Test depth 3.5'
			SEC	SEC	SEC	
			MIN	MIN	MIN	

Perc Rate 118 sec/in







SOIL LEGEND

A. Orange-Brn to Lt Brn F.S. (fill)
B. Hard Coal + Pea Rock (Filter)
C. Lt Brn F.S. (fill) (SP)
D. Lt grey F.S.
E. Dark Brown Silty Sand

as classified according to Unified Classification

GROUND WATER TABLE 3.8 FT.

TIME ______ MIN.

* PENETROMETER READING

PROCEDURE

1. Excavate a pit approximately 8 to 12 inches in diameter and with vertical sides. The pit should be excavated to 24 inches below the surface. If the ground water table is within 24 inches of the surface, abandon the pit.
2. Scratch the side of the test pit and remove all loose material from the bottom. Place approximately two inches of fine gravel in the bottom to prevent scouring.
3. Carefully fill the hole with clear water to a minimum depth of 12 inches, that is, 12 inches above the bottom of the pit. Maintain the water level there by adding water as necessary for a period of 15 minutes.
4. After 15 minutes of saturation, begin the test. With the water level at 12 inches above the bottom of the pit, measure and record the time necessary for three consecutive one-inch drop in water height. Record the time in seconds and/or minutes in the space provided above.

PROJECT NAME: ________________

DATE: 10/7/92

(4.0')

EST DEPTH: TD 0.33 (ft.)

G.W.T. DEPTH: GWT 0.70 (ft.)

STATIC WATER LEVEL: SWL 0.33 (ft.)

GAUGE PRESSURE: GP ______ (psi)

TEST No.: ______ IDENTITY: ______

LOCATION: HARRIS CORP.

STRATA: ______

SOIL TYPE: (SP) - UNIFIED SYSTEM OF CLASSIFICATION

☐ WHEN TD IS ABOVE GWT

$H = SWL + (GP \times 2.31)$

$H - 0.33 + (\_\_\_\_ \times 2.31)$

$H - 0.33$ (ft.)

☐ WHEN TD IS BELOW GWT

$H - [SWL - (TD - GWT)] + (GP \times 2.31)$

$H - [\_\_\_\_ - (\_\_\_\_ - \_\_\_\_)] + (\_\_\_\_ \times 2.$

$H -$ ______ (ft.)

ATER METER

A) FINAL READING ______ (gals) $V = (A - B)$

B) INITIAL READING ______ (gals) $V =$ ______ (gals)

☑ VOLUMETRIC FLASK

$V = (A \times B)$

A) SIZE ______ (mls, gals.) $V =$ ______ (ml.)

B) No. REFILLS ______ (mls) $V -$ ______ (gal

FOR BOREHOLE PERMEABILITY APPARATUS

ALLING

STATIC HEAD

" ID TEST PIPE

TOTAL DROP:

A) ______ (ft.) $V = (A \times B)$

B) ______ (gal./ft.) $V -$ ______ (gals.)

☐ FALLING HEAD

☐ STATIC HEAD

4" ID PIPE/.75 TUBE

TOTAL DROP:

A) ______ (ft.) $V = (A \times B)$

B) ______ (gal./ft.) $V -$ ______ (gals)

LAPSED TIME IN SECONDS (t) 15 (MIN.) 0 (SEC.) t - 900 (SEC.)

$K - C \times \frac{V}{t \times H}$ = ______

K - ______ (cm/sec.)

K = 3.7 (ft.

V = VOLUMN (gals.) t = TIME (sec) H - HEAD (ft.)

V = 250 mls

ENGTH OF CASING: ______

DIAMETER: 4.0" PVC

WL - STATIC WATER LEVEL IN CASING FROM TD

REFERENCE: PAGE 575 OF EARTH MANUAL Des E-18

$1 \text{ cm/sec} = 2834.6 \text{ ft/day}$

C - 4.445 FOR 4" ID SCHEDULE 40 PVC

C - 4.926 FOR NW. STEEL CASING

$V_{gals} = \frac{V(ml)}{3785.4}$

JAMMAL & ASSOCIATES, INC.
Consulting Geotechnical Engineers

STANDARD PERCOLATION TESTS

LIENT : U of F

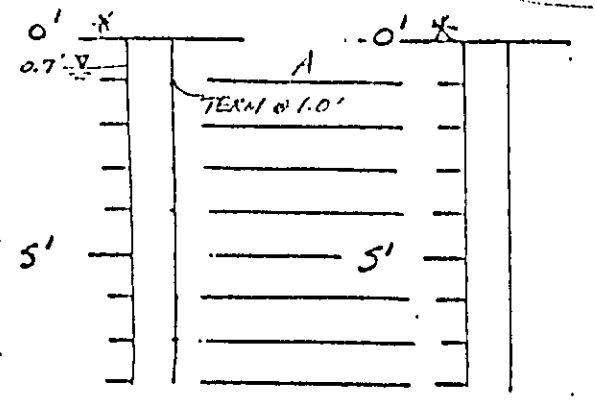
ILE NO :

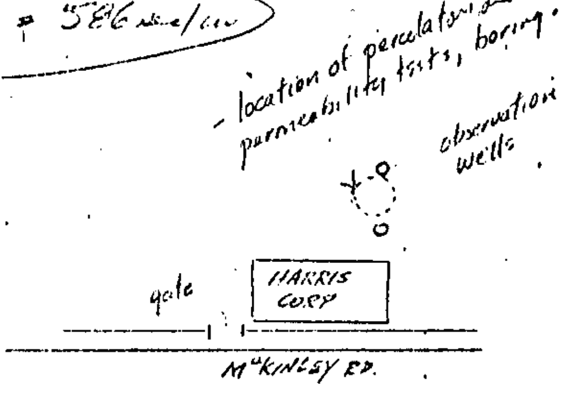
ATE : 10/7/92

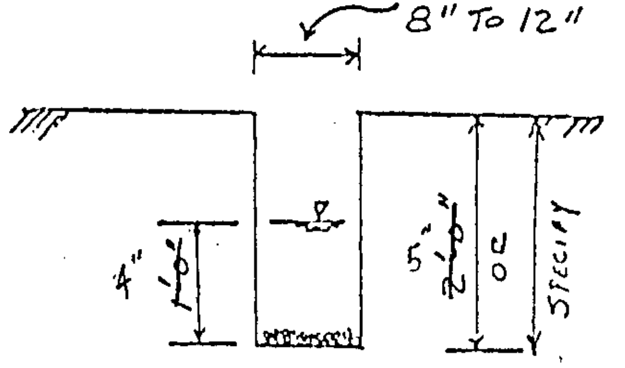
WEATHER :

TEST NO	DIAMETER OF PIT	HEIGHT OF WATER	TIME FOR DROP OF: ONE INCH	TWO INCH	THREE INCH	REMARKS
	8.0"	4.0"	220 SEC	540 SEC	1000 SEC	GWT @ 0.7' – unable to perform test @ 2.0'
			MIN	MIN	MIN	
			210 SEC	507 SEC	988 SEC	below ground surface.
			MIN	MIN	MIN	

Perc rate = 586 sec/in







SOIL LEGEND

A. Dark Grayish brown fine sand w/roots

B.

C.

D.

E.

ROUND WATER TABLE 0.7 FT.

TIME MIN.

PENETROMETER READING

PROCEDURE

1. Excavate a pit approximately 8 to 12 inches in diameter and with vertical sides. The pit should be excavated to 24 inches below the surface. If the ground water table is within 24 inches of the surface, abandon the pit.
2. Scratch the side of the test pit and remove all loose material from the bottom. Place approximately two inches of fine gravel in the bottom to prevent scouring.
3. Carefully fill the hole with clear water to a minimum depth of 12 inches, that is, 12 inches above the bottom of the pit. Maintain the water level there by adding water as necessary for a period of 15 minutes.
4. After 15 minutes of saturation, begin the test. With the water level at 12 inches above the bottom of the pit, measure and record the time necessary for three consecutive one-inch drop in water height. Record the time in seconds and/or minutes in the space provided above.

PROJECT NAME: ______________________

DATE: 10/8/92

EST DEPTH: TD 2.0 (ft.)
G.W.T. DEPTH: GWT 3.6 (ft.)
TATIC WATER LEVEL: SWL 3.0 (ft.)
GAUGE PRESSURE: GP ______ (psi)

TEST No.: ______ IDENTITY: ______
LOCATION: McGEE HOUSE
STRATA: ______
SOIL TYPE: (SP) - UNIFIED SYSTEM OF CLASSIFICATION

☐ WHEN TD IS ABOVE GWT
$H = SWL + (GP \times 2.31)$
$H = 3.0 + (\_\_\_ \times 2.31)$
$H = 3.0$ (ft.)

☐ WHEN TD IS BELOW GWT
$H = [SWL - (TD - GWT)] + (GP \times 2.31)$
$H = [\_\_\_ - (\_\_\_ - \_\_\_)] + (\_\_\_ \times 2$
$H =$ ______ (ft.)

ATER METER

)FINAL READING ______ (gals) $V = (A - B)$

)INITIAL READING ______ (gals) $V =$ ______ (gals)

☑ VOLUMETRIC FLASK $V = (A \times B)$

A) SIZE ______ (mls, gals) $V =$ ______ (ml.)

B) No. REFILLS ______ (mls.) $V =$ ______ (ga

FOR BOREHOLE PERMEABILITY APPARATUS

ALLING
☑ STATIC HEAD
" ID TEST PIPE

TOTAL DROP:

A) ______ (ft.) $V = (A \times B)$

B) ______ (gal./ft.) $V =$ ______ (gals.)

☐ FALLING HEAD
☐ STATIC HEAD
4" ID.PIPE/.75 TUBE

TOTAL DROP:

A) ______ (ft.) $V = (A \times B)$

B) ______ (gal./ft.) $V =$ ______ (gals)

LAPSED TIME IN SECONDS (t) ______ (MIN.) ______ (SEC.) $t =$ ______ (SEC.)

$K = C \times \frac{V}{t \times H} =$ ______

$V =$ VOLUMN (gals.)

$t =$ TIME (sec)

$K =$ ______ (cm/sec.)

$H =$ HEAD (ft.)

$V = 6000$ mls

$K =$ 9.9 (ft

ENGTH OF CASING: ______
DIAMETER: 4.0" PVC
WL - STATIC WATER LEVEL IN CASING FROM TD

REFERENCE: PAGE 575 OF EARTH MANUAL Des E-18

$1 \text{ cm/sec} = 2834.6 \text{ ft/day}$

$C = 4.445$ FOR 4" ID SCHEDULE 40 PVC
$C = 4.926$ FOR NW. STEEL CASING

$\text{gals} = \frac{V(ml)}{3785.4}$

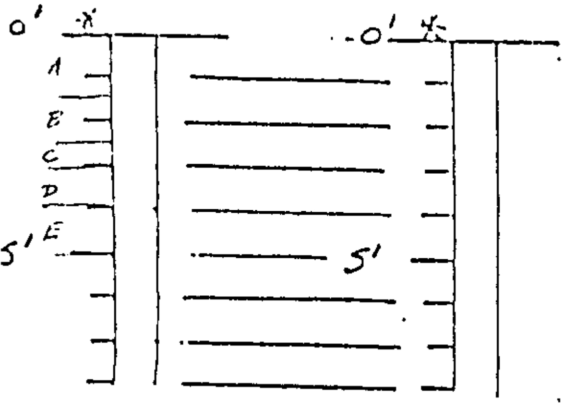
STANDARD PERCOLATION TESTS

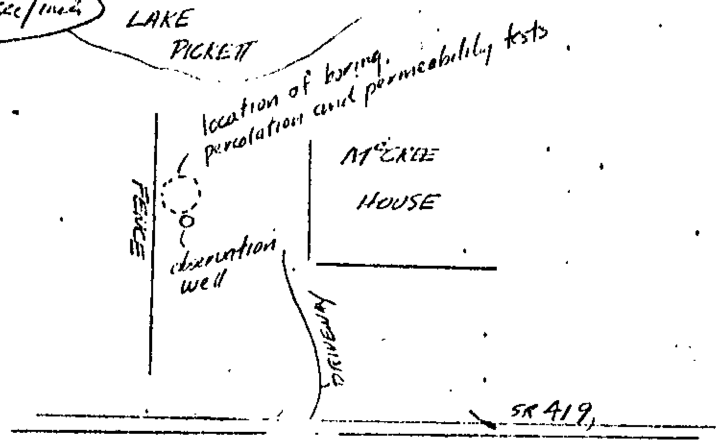
LIENT:
LE NO:
TE: 10/8/82

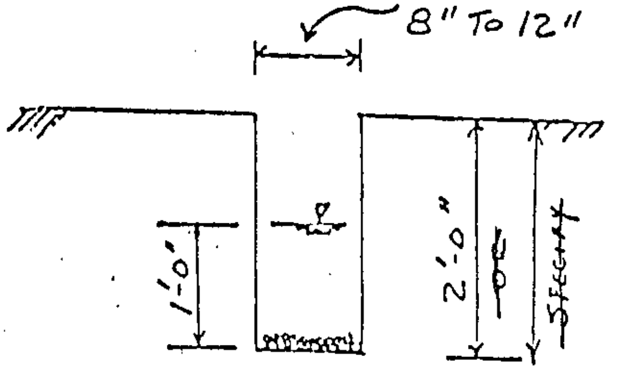
WEATHER:

TEST NO	DIAMETER OF PIT	HEIGHT OF WATER	TIME FOR DROP OF: ONE INCH	TWO INCH	THREE INCH	REMARKS
	8.0"	12.0"	32 SEC	72 SEC	105 SEC	
			MIN	MIN	MIN	
			35 SEC	75 SEC	107 SEC	
			MIN	MIN	MIN	

Perc rate = 71 sec/inch







SOIL LEGEND

. 0.0-1.5 Dark Grey slightly organic fine sand w/roots
. 1.5-2.5 Grey fine sand w/ occasional roots
. 2.5-3.0 Reddish Brown slightly silty fine sand
). 3.0-4.0 Brown fine sand
. 4.0-5.0 Light brown fine sand

UND WATER TABLE 3.6' FT.

ME ______ MIN.

PENETROMETER READING

PROCEDURE

1. Excavate a pit approximately 8 to 12 inches in diameter and with vertical sides. The pit should be excavated to 24 inches below the surface. If the ground water table is within 24 inches of the surface, abandon the pit.
2. Scratch the side of the test pit and remove all loose material from the bottom. Place approximately two inches of fine gravel in the bottom to prevent scouring.
3. Carefully fill the hole with clear water to a minimum depth of 12 inches, that is, 12 inches above the bottom of the pit. Maintain the water level there by adding water as necessary for a period of 15 minutes.
4. After 15 minutes of saturation, begin the test. With the water level at 12 inches above the bottom of the pit, measure and record the time necessary for three consecutive one-inch drop in water height. Record the time in seconds and/or minutes in the space provided ab[illegible]

APPENDIX E

TABLES RELATING TO THE SOIL'S STUDIED FROM THE SOIL SURVEY MANUALS

GAINESVILLE SITE 1

SOIL INTERPRETATIONS RECORD

USDA-SCS
8-79

31C BLICHTON FINE SAND, 5 TO 8 PERCENT SLOPES

THE BLICHTON SERIES CONSISTS OF POORLY DRAINED NEARLY LEVEL TO SLOPING SOILS IN CENTRAL FLORIDA. IN A REPRESENTATIVE PROFILE, THE SURFACE LAYER IS VERY DARK GRAY SAND ABOUT 5 INCHES THICK. THE SUBSURFACE LAYER EXTENDS TO DEPTHS OF 26 INCHES AND IS GRAY SAND. THE SUBSOIL IN THE UPPER 4 INCHES IS GRAY SANDY LOAM. DARK GRAY SANDY CLAY LOAM BETWEEN DEPTHS OF 30 TO 65 INCHES. AND GRAY SANDY CLAY LOAM TO 77 INCHES. BELOW THIS TO 81 INCHES AND DEEPER IS GRAY STRATIFIED LOAMY AND SANDY MATERIAL.

ESTIMATED SOIL PROPERTIES

DEPTH (IN.)	USDA TEXTURE	UNIFIED	AASHTO	FRACT >3 IN (PCT)	PERCENT OF MATERIAL LESS THAN 3" PASSING SIEVE NO. 4	10	40	200	LIQUID LIMIT	PLASTICITY INDEX
0-31	FS	SP-SM, SM	A-2-4, A-3	0	95-100	95-100	85-98	8-25	-	NP
31-37	SL, FSL	SM, SM-SC	A-2-4	0	95-100	95-100	85-98	20-30	<25	NP-7
37-60	SCL	SC	A-6	0	95-100	95-100	85-98	36-45	30-40	15-24
60-70	SCL, SC	SC	A-2, A-6, A-7	0	95-100	90-100	85-98	30-50	25-45	11-24
70-80	SR-SL-SCL	SM-SC, SM	A-2-4	0	95-100	90-100	80-95	20-30	<25	NP-7

DEPTH (IN.)	CLAY (PCT <2MM)	MOIST BULK DENSITY (G/CM3)	PERMEABILITY (IN/HR)	AVAILABLE WATER CAPACITY (IN/IN)	SOIL REACTION (PH)	SALINITY (MMHOS/CM)	SHRINK-SWELL POTENTIAL	EROSION FACTORS K	T	WIND EROD. GROUP	ORGANIC MATTER (PCT)	CORROSIVITY STEEL	CONCRETE
0-31	2-12	1.35-1.60	6.0-20	0.05-0.10	4.5-6.0	-	LOW	.20	5	-	1-4	HIGH	HIGH
31-37	13-20	1.55-1.70	2.0-6.0	0.10-0.15	4.5-5.5	-	LOW	.24			-		
37-60	20-35	1.60-1.70	0.2-0.6	0.10-0.15	4.5-5.5	-	MODERATE	.32					
60-70	20-45	1.60-1.70	0.2-0.6	0.10-0.15	4.5-5.5	-	MODERATE	.32					
70-80	15-25	1.55-1.70	2.0-6.0	0.08-0.12	4.5-5.5	-	LOW	.32					

FLOODING FREQUENCY	DURATION	MONTHS	HIGH WATER TABLE DEPTH (FT)	KIND	MONTHS	CEMENTED PAN DEPTH (IN)	HARDNESS	BEDROCK DEPTH (IN)	HARDNESS	SUBSIDENCE INIT. (IN)	TOTAL (IN)	HYD GRP	POTENT'L FROST ACTION
NONE			0-1.0	APPARENT	JUN-SEP	-		>60		-		D	-

SANITARY FACILITIES

SEPTIC TANK ABSORPTION FIELDS	SEVERE-WETNESS,PERCS SLOWLY
SEWAGE LAGOON AREAS	SEVERE-SEEPAGE,WETNESS
SANITARY LANDFILL (TRENCH)	SEVERE-WETNESS
SANITARY LANDFILL (AREA)	SEVERE-SEEPAGE,WETNESS
DAILY COVER FOR LANDFILL	POOR-WETNESS

BUILDING SITE DEVELOPMENT

SHALLOW EXCAVATIONS	SEVERE-CUTBANKS CAVE,WETNESS
DWELLINGS WITHOUT BASEMENTS	SEVERE-WETNESS
DWELLINGS WITH BASEMENTS	SEVERE-WETNESS
SMALL COMMERCIAL BUILDINGS	SEVERE-WETNESS
LOCAL ROADS AND STREETS	SEVERE-WETNESS
LAWNS, LANDSCAPING AND GOLF FAIRWAYS	SEVERE-WETNESS

CONSTRUCTION MATERIAL

ROADFILL	POOR-WETNESS
SAND	IMPROBABLE-THIN LAYER
GRAVEL	IMPROBABLE-TOO SANDY
TOPSOIL	POOR-TOO SANDY,WETNESS

WATER MANAGEMENT

POND RESERVOIR AREA	SEVERE-SEEPAGE
EMBANKMENTS DIKES AND LEVEES	SEVERE-SEEPAGE,PIPING,WETNESS
EXCAVATED PONDS AQUIFER FED	SEVERE-SLOW REFILL,CUTBANKS CAVE
DRAINAGE	SLOPE,CUTBANKS CAVE
IRRIGATION	WETNESS,DROUGHTY,FAST INTAKE,SLOPE
TERRACES AND DIVERSIONS	WETNESS
GRASSED WATERWAYS	WETNESS,DROUGHTY

REGIONAL INTERPRETATIONS

GAINESVILLE SITE 2

SOIL INTERPRETATIONS RECORD

USDA-SCS
9-79

2B CANDLER SAND, 0 TO 5 PERCENT SLOPES

THE CANDLER SERIES CONSISTS OF EXCESSIVELY DRAINED NEARLY LEVEL TO MODERATELY STEEP SOILS ON COASTAL PLAIN UPLANDS. TYPICALLY, THESE SOILS HAVE A DARK GRAY SAND SURFACE LAYER ABOUT 5 INCHES THICK. BELOW THIS TO DEPTHS OF 67 INCHES IS YELLOW SAND. BETWEEN DEPTHS OF 67 TO 109 INCHES IS VERY PALE BROWN SAND THAT HAS WHITE MOTTLES AND YELLOWISH BROWN LAMELLAE OR BANDS OF LOAMY SAND. BELOW THIS TO DEPTHS OF 115 INCHES IS BROWNISH YELLOW SANDY LOAM.

ESTIMATED SOIL PROPERTIES

DEPTH (IN.)	USDA TEXTURE	UNIFIED	AASHTO	FRACT >3 IN (PCT)	PERCENT OF MATERIAL LESS THAN 3" PASSING SIEVE NO. 4	10	40	200	LIQUID LIMIT	PLASTICITY INDEX
0-69	S	SP, SP-SM	A-3	0	100	95-100	75-100	2-8	-	NP
69-85	S, FS	SP-SM	A-3, A-2-4	0	100	95-100	75-100	5-12	-	AP
95-99	SL, SCL	SM	A-2-4, A-4	0	100	95-100	80-100	20-40	<30	NP-7

DEPTH (IN.)	CLAY (PCT <2MM)	MOIST BULK DENSITY (G/CM3)	PERMEABILITY (IN/HR)	AVAILABLE WATER CAPACITY (IN/IN)	SOIL REACTION (PH)	SALINITY (MMHOS/CM)	SHRINK-SWELL POTENTIAL	EROSION FACTORS K	T	WIND EROD. GROUP	ORGANIC MATTER (PCT)	CORROSIVITY, STEEL	CONCRETE
0-69	<3	1.35-1.55	>20	0.02-0.05	4.5-6.0	-	VERY LOW	.10	5	2	<1	LOW	HIGH
69-85	3-8	1.50-1.65	6.0-20	0.05-0.08	4.5-6.0	-	VERY LOW	.10					
95-99	14-30	1.55-1.65	2.0-6.0 ✓	0.10-0.15	4.5-6.0	-	LOW	.20					

FLOODING FREQUENCY	DURATION	MONTHS	HIGH WATER TABLE DEPTH (FT)	KIND	MONTHS	CEMENTED PAN DEPTH (IN)	HARDNESS	BEDROCK DEPTH (IN)	HARDNESS	SUBSIDENCE INIT. (IN)	TOTAL (IN)	HYD GRP	POTENT'L FROST ACTION
NONE			>6.0			-		>60		-		A	-

SANITARY FACILITIES

SEPTIC TANK ABSORPTION FIELDS	SLIGHT
SEWAGE LAGOON AREAS	SEVERE-SEEPAGE
SANITARY LANDFILL (TRENCH)	SEVERE-SEEPAGE,TOO SANDY
SANITARY LANDFILL (AREA)	SEVERE-SEEPAGE
DAILY COVER FOR LANDFILL	POOR-SEEPAGE,TOO SANDY

BUILDING SITE DEVELOPMENT

SHALLOW EXCAVATIONS	SEVERE-CUTBANKS CAVE
DWELLINGS WITHOUT BASEMENTS	SLIGHT
DWELLINGS WITH BASEMENTS	SLIGHT
SMALL COMMERCIAL BUILDINGS	SLIGHT
LOCAL ROADS AND STREETS	SLIGHT
LAWNS, LANDSCAPING AND GOLF FAIRWAYS	SEVERE-DROUGHTY

CONSTRUCTION MATERIAL

ROADFILL	GOOD
SAND	PROBABLE
GRAVEL	IMPROBABLE-TOO SANDY
TOPSOIL	POOR-TOO SANDY

WATER MANAGEMENT

POND RESERVOIR AREA	SEVERE-SEEPAGE
EMBANKMENTS DIKES AND LEVEES	SEVERE-SEEPAGE,PIPING
EXCAVATED PONDS AQUIFER FED	SEVERE-NO WATER
DRAINAGE	DEEP TO WATER
IRRIGATION	DROUGHTY,FAST INTAKE,SOIL BLOWING
TERRACES AND DIVERSIONS	TOO SANDY,SOIL BLOWING
GRASSED WATERWAYS	DROUGHTY

REGIONAL INTERPRETATIONS

VOLUSIA COUNTY, FLORIDA — ORMOND BEACH SITE /

TABLE 16.--PHYSICAL AND CHEMICAL PROPERTIES OF SOILS--Continued

Soil name and map symbol	Depth	Clay <2mm	Moist bulk density	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential
	In	Pct	G/cm3	In/hr	In/in	pH	Mmhos/cm	
18*:								
Daytona----------	0-36	<1-3	1.20-1.50	>20	0.02-0.05	3.6-6.0	<2	Very low
	36-47	2-6	1.35-1.60	2.0-6.0	0.10-0.15	3.6-6.0	<2	Very low
	47-80	1-4	1.45-1.70	>20	0.02-0.05	3.6-6.0	<2	Very low
Urban land.								
19---------------	0-4	1-5	1.40-1.50	>20	0.02-0.05	4.5-6.5	<2	Low--------
Deland	4-55	1-5	1.50-1.60	>20	0.02-0.05	4.5-6.5	<2	Low--------
	55-67	1-5	1.30-1.40	2.0-6.0	0.10-0.15	4.5-6.0	<2	Low--------
	67-94	1-5	1.55-1.65	0.6-2.0	0.10-0.15	3.6-5.5	<2	Low--------
20---------------	0-21	---	---	6.0-20	0.02-0.05	4.5-5.5	<2	Low--------
EauGallie	21-35	---	---	0.6-6.0	0.05-0.10	5.1-6.5	<2	Low--------
	35-52	---	---	6.0-20	0.02-0.05	5.6-7.8	<2	Low--------
	52-61	---	---	0.6-6.0	0.10-0.15	5.6-7.8	<2	Low--------
	61-65	---	---	2.0-6.0	0.05-0.10	5.6-7.8	<2	Low--------
21---------------	0-23	---	---	6.0-20	0.02-0.05	4.5-5.5	<2	Low--------
EauGallie	23-35	---	---	0.6-6.0	0.05-0.10	5.1-6.5	<2	Low--------
	35-43	---	---	6.0-20	0.02-0.05	5.6-7.8	<2	Low--------
	43-67	---	---	0.6-6.0	0.10-0.15	5.6-7.8	<2	Low--------
	67-84	---	---	2.0-6.0	0.05-0.10	5.6-7.8	<2	Low--------
22---------------	0-2	1-6	1.40-1.55	6.0-20	0.05-0.10	3.6-5.5	<2	Very low
Electra	2-35	1-6	1.45-1.70	6.0-20	0.02-0.07	3.6-5.5	<2	Very low
	35-52	1-6	1.50-1.70	0.6-2.0	0.10-0.15	3.6-5.5	<2	Very low
	52-57	1-6	1.45-1.70	6.0-20	0.07-0.10	3.6-5.5	<2	Very low
	57-70	18-38	1.60-1.75	0.2-0.6	0.10-0.15	3.6-5.5	<2	Very low
23---------------	0-7	1-4	1.35-1.50	6.0-20	0.05-0.12	3.6-5.5	<2	Low--------
Farmton	7-34	1-4	1.50-1.65	6.0-20	0.02-0.07	3.6-5.5	<2	Low--------
	34-50	2-7	1.55-1.70	0.6-2.0	0.10-0.15	3.6-5.5	<2	Low--------
	50-80	12-27	1.60-1.70	0.6-2.0	0.12-0.17	3.6-5.5	<2	Low--------
24*. Fluvaquents								
25---------------	0-34	0-2	0.20-0.30	6.0-20	0.30-0.40	4.5-6.0	>16	Low--------
Gator	34-46	14-30	1.60-1.70	0.6-2.0	0.10-0.15	6.1-8.4	2-8	Low--------
	46-52	3-12	1.60-1.70	0.6-2.0	0.10-0.15	6.1-8.4	2-4	Low--------
	52-58	2-7	1.40-1.65	6.0-20	0.03-0.05	6.1-8.4	2-4	Low--------
26---------------	0-55	---	---	6.0-20	0.03-0.07	5.1-7.3	<2	Very low
Holopaw	55-63	---	---	2.0-6.0	0.10-0.15	6.1-8.4	<2	Low--------
	63-70	---	---	6.0-20	0.05-0.10	6.6-8.4	<2	Very low
27---------------	0-60	---	---	6.0-20	0.20-0.25	4.5-5.5	<2	Low--------
Hontoon	60-65	---	---	6.0-20	0.15-0.20	4.5-5.5	<2	Low--------
28*. Hydraquents								
29---------------	0-10	1-5	1.20-1.50	6.0-20	0.05-0.08	4.5-6.0	<2	Low--------
Immokalee	10-34	1-5	1.45-1.70	6.0-20	0.02-0.05	4.5-6.0	<2	Low--------
	34-43	2-7	1.30-1.60	0.6-2.0	0.10-0.15	4.5-6.0	<2	Low--------
	43-85	1-5	1.40-1.60	6.0-20	0.02-0.05	4.5-6.0	<2	Low--------
30---------------	0-8	1-5	1.20-1.50	6.0-20	0.05-0.08	4.5-6.0	<2	Low--------
Immokalee	8-36	1-5	1.45-1.70	6.0-20	0.02-0.05	4.5-6.0	<2	Low--------
	36-50	2-7	1.30-1.60	0.6-2.0	0.10-0.15	4.5-6.0	<2	Low--------
	50-80	1-5	1.40-1.60	6.0-20	0.02-0.05	4.5-6.0	<2	Low--------
31---------------	0-15	<4	1.20-1.55	6.0-20	0.03-0.08	5.6-8.4	<2	Low--------
Malabar	15-32	1-5	1.50-1.75	6.0-20	0.05-0.10	5.6-8.4	<2	Low--------
	32-42	1-5	1.50-1.70	6.0-20	0.02-0.05	5.6-8.4	<2	Low--------
	42-80	12-25	1.60-1.70	0.6-2.0	0.10-0.15	5.6-8.4	<2	Low--------

See footnote at end of table.

- ORMOND BEACH SITE 1

TABLE 15.--ENGINEERING PROPERTIES AND CLASSIFICATIONS--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--			
			Unified	AASHTO		4	10	40	200
	In				Pct				
20----------------- EauGallie	0-21	Fine sand-------	SP, SP-SM	A-3	0	100	100	80-98	2-5
	21-35	Sand, fine sand	SP-SM, SM	A-3, A-2-4	0	100	100	80-98	5-20
	35-52	Sand, fine sand	SP, SP-SM	A-3, A-2-4	0	100	100	80-98	2-12
	52-61	Sandy loam, fine sandy loam, sandy clay loam.	SM, SM-SC, SC	A-2-4, A-2-6	0	100	100	80-98	20-35
	61-65	Sand, loamy sand, loamy fine sand.	SP-SM, SM	A-3, A-2-4	0	100	100	80-98	5-25
21----------------- EauGallie	0-23	Fine sand-------	SP, SP-SM	A-3	0	100	100	80-98	2-5
	23-35	Sand, fine sand	SP-SM, SM	A-3, A-2-4	0	100	100	80-98	5-20
	35-43	Sand, fine sand	SP, SP-SM	A-3, A-2-4	0	100	100	80-98	2-12
	43-67	Sandy loam, fine sandy loam, sandy clay loam.	SM, SM-SC, SC	A-2-4, A-2-6	0	100	100	80-98	20-35
	67-84	Sand, loamy sand, loamy fine sand.	SP-SM, SM	A-3, A-2-4	0	100	100	80-98	5-25
22----------------- Electra	0-35	Fine sand-------	SP, SP-SM	A-3	0	100	95-100	75-99	3-10
	35-52	Sand, fine sand	SP-SM, SM	A-3, A-2-4	0	100	100	80-99	8-15
	52-57	Sand, fine sand	SP-SM	A-3, A-2-4	0	100	100	80-99	5-12
	57-70	Fine sandy loam, sandy clay loam.	SC, SM-SC	A-2, A-4, A-6	0	100	100	80-99	20-45
23----------------- Farmton	0-7	Fine sand-------	SP, SP-SM	A-3	0	100	100	80-99	2-7
	7-34	Fine sand, sand	SP, SP-SM	A-3	0	100	100	80-99	2-7
	34-50	Fine sand, sand	SP-SM, SM	A-3, A-2-4	0	100	100	80-99	5-15
	50-80	Fine sandy loam, sandy loam, sandy clay loam.	SM, SM-SC, SC	A-2-4	0	100	100	80-99	15-35
24*. Fluvaquents									
25----------------- Gator	0-34	Muck------------	Pt	A-8	---	---	---	---	---
	34-46	Sandy clay loam, sandy loam, fine sandy loam.	SC, SM-SC	A-2, A-4, A-6	0	100	100	85-99	20-40
	46-52	Stratified loamy fine sand to fine sandy loam.	SM	A-2-4	0	100	100	80-99	13-20
	52-58	Fine sand, sand	SP-SM	A-3, A-2-4	0	100	100	80-99	5-12
26----------------- Holopaw	0-55	Sand------------	SP, SP-SM	A-3	0	100	95-100	70-95	2-10
	55-63	Sandy loam, sandy clay loam.	SM, SM-SC	A-2-4	0	100	95-100	70-99	15-30
	63-70	Loamy sand------	SM	A-2-4	0	100	95-100	70-99	13-20

See footnote at end of table.

ORMOND BEACH - SITE 3

TABLE 15.--ENGINEERING PROPERTIES AND CLASSIFICATIONS--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--			
			Unified	AASHTO		4	10	40	200
	In				Pct				
12----------------- Canaveral	0-9	Sand------------	SP	A-3	0	100	100	90-100	1-4
	9-80	Fine sand, sand, coarse sand.	SP	A-3	0	70-100	70-95	65-90	1-3
13----------------- Cassia	0-28	Fine sand--------	SP, SP-SM	A-3	0	100	100	90-100	2-7
	28-36	Sand, fine sand, loamy sand.	SP-SM, SM	A-3, A-2-4	0	100	100	90-100	5-20
	36-80	Sand, fine sand	SP, SP-SM	A-3	0	100	100	90-100	2-10
14----------------- Chobee	0-6	Fine sandy loam	SM-SC, SC	A-2-4	0	100	100	85-99	11-25
	6-54	Sandy clay loam		A-2-6, A-2-7, A-6, A-7	0	100	100	85-99	25-45
	54-64	Loamy sand, loamy fine sand, fine sandy loam.	SM, SM-SC, SC	A-2-4	0	100	100	80-99	12-25
15----------------- Cocoa	0-26	Sand------------	SP, SP-SM, SM	A-3, A-2-4	0	100	100	70-90	4-15
	26-30	Sand, loamy sand, loamy fine sand.	SP-SM, SM	A-2-4	0	100	100	80-90	10-25
	30	Weathered bedrock.	---	---	---	---	---	---	---
16*: Cocoa-------------	0-26	Sand------------	SP, SP-SM, SM	A-3, A-2-4	0	100	100	70-90	4-15
	26-30	Sand, loamy sand, loamy fine sand.	SP-SM, SM	A-2-4	0	100	100	80-90	10-25
	30	Weathered bedrock.	---	---	---	---	---	---	---
Urban land.									
17----------------- Daytona	0-36	Sand------------	SP, SP-SM	A-3	0	100	100	70-95	2-10
	36-47	Sand, fine sand, coarse sand.	SP-SM	A-3, A-2-4	0	100	100	70-95	5-12
	47-80	Sand, fine sand, coarse sand.	SP, SP-SM	A-3	0	100	100	70-95	4-10
18*: Daytona-----------	0-36	Sand------------	SP, SP-SM	A-3	0	100	100	70-95	2-10
	36-47	Sand, fine sand, coarse sand.	SP-SM	A-3, A-2-4	0	100	100	70-95	5-12
	47-80	Sand, fine sand, coarse sand.	SP, SP-SM	A-3	0	100	100	70-95	4-10
Urban land.									
19----------------- Deland	0-4	Fine sand--------	SP, SP-SM	A-3	0	100	100	80-99	2-7
	4-55	Sand, fine sand	SP, SP-SM	A-3	0	100	100	80-99	2-7
	55-67	Sand, fine sand	SP-SM, SM	A-3, A-2-4	0	100	100	80-99	5-15
	67-94	Sand, fine sand	SP-SM, SM	A-3, A-2-4	0	100	100	80-99	5-20

See footnote at end of table.

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TABLE 16.--PHYSICAL AND CHEMICAL PROPERTIES OF SOILS

[The symbol < means less than; > means more than. Entries under "Erosion factors--T" ap
profile. Entries under "Wind erodibility group" and "Organic matter" apply only to
Absence of an entry indicates that data were not available or were not estimated]

Soil name and map symbol	Depth	Clay <2mm	Moist bulk density	Permea-bility	Available water capacity	Soil reaction	Salinity	Shrink-swell potential
	In	Pct	g/cm3	In/hr	In/in	pH	Mmhos/cm	
1	0-62	---	---	6.0-20	0.03-0.05	4.5-6.0	<2	Very low
Apopka	62-80	---	---	0.6-2.0	0.12-0.17	4.5-6.0	<2	Very low
2	0-44	---	---	6.0-20	0.03-0.05	4.5-6.0	<2	Very low
Apopka	44-80	---	---	0.6-2.0	0.12-0.17	4.5-6.0	<2	Very low
3*.								
Arents								
4	0-95	---	---	>20	0.02-0.05	4.5-6.0	<2	Very low
Astatula								
5	0-80	---	---	>20	0.02-0.05	4.5-6.0	<2	Very low
Astatula								
6*:								
Astatula	0-95	---	---	>20	0.02-0.05	4.5-6.0	<2	Very low
Urban land.								
7	0-55	2-7	1.30-1.60	6.0-20	0.15-0.20	6.1-8.4	<2	Very low
Astor	55-82	2-7	1.50-1.70	6.0-20	0.05-0.10	6.1-8.4	<2	Very low
8	0-90	1-6	1.40-1.65	>20	0.03-0.07	3.6-7.3	<2	Very low
Basinger								
9*.								
Beaches								
10	0-5	---	---	0.2-0.6	0.18-0.20	5.6-7.3	<2	Moderate
Bluff	5-68	---	---	0.06-0.2	0.12-0.17	6.1-8.4	<2	High
11	0-5	1-3	1.30-1.40	6.0-20	0.05-0.07	5.1-7.3	<2	Low
Bulow	5-20	1-3	1.30-1.45	6.0-20	0.02-0.05	5.1-7.3	<2	Low
	20-45	1-3	1.40-1.60	6.0-20	0.02-0.05	6.1-7.3	<2	Low
	45-50	15-30	1.55-1.65	2.0-6.0	0.10-0.15	6.1-7.3	<2	Low
	50	---	---	---	---	---	---	---
12	0-9	---	---	>20	0.02-0.05	6.6-8.4	<2	Very low
Canaveral	9-80	---	---	>20	0.02-0.05	6.6-8.4	<2	Very low
13	0-28	1-4	1.30-1.55	6.0-20	0.03-0.07	4.5-6.0	<2	Low
Cassia	28-36	2-10	1.30-1.55	0.6-6.0	0.10-0.15	4.5-6.0	<2	Low
	36-80	1-5	1.40-1.60	6.0-20	0.03-0.07	4.5-6.0	<2	Low
14	0-6	---	---	2.0-6.0	0.10-0.15	6.1-7.3	<2	Low
Chobee	6-54	---	---	0.6-2.0	0.12-0.17	7.4-8.4	<2	Moderate
	54-64	---	---	6.0-20	0.06-0.10	7.4-8.4	<2	Low
15	0-26	---	---	6.0-20	0.02-0.05	5.6-7.8	<2	Very low
Cocoa	26-30	---	---	6.0-20	0.05-0.10	5.6-7.8	<2	Very low
	30	---	---	---	---	---	---	---
16*:								
Cocoa	0-26	---	---	6.0-20	0.02-0.05	5.6-7.8	<2	Very low
	26-30	---	---	6.0-20	0.05-0.10	5.6-7.8	<2	Very low
	30	---	---	---	---	---	---	---
Urban land.								
17	0-36	<1-3	1.20-1.50	>20	0.02-0.05	3.6-6.0	<2	Very low
Daytona	36-47	2-5	1.35-1.60	2.0-6.0	0.10-0.15	3.6-6.0	<2	Very low
	47-80	1-4	1.45-1.70	>20	0.02-0.05	3.6-6.0	<2	Very low

See footnote at end of table.

ORLANDO SITE 1

TABLE 1. ESTIMATED PHYSICAL PROPERTIES OF SOILS (Continued)

SOIL SERIES AND MAPPING UNIT SYMBOL	DEPTH TO SEASONAL HIGH WATER TABLE 1/	FLOOD HAZARD 2/	DEPTH FROM SURFACE OF TYPICAL PROFILE (Inches)	CLASSIFICATION			PERCENTAGE LESS THAN 3 INCHES PASSING SIEVE			LIQUID LIMIT	PLASTICITY INDEX	PERMEABILITY RATE (In./Hr.)	AVAILABLE WATER CAPACITY (In./In.)
				USDA TEXTURE	UNIFIED	AASHO	No. 10	No. 40	No. 200				
Ona Oa	1 to 2 feet	Once in 1 to 5 years for 7 days to 1 month	0-8	Fine sand	SP, SP-SM	A-3	100	80-95	2-12	NP	NP	6.3-20.0	.10-.15
			8-11	Fine sand	SM, SP-SM	A-2-4, A-3	100	85-100	8-20	NP	NP	6.3-20.0	.10-.15
			11-62	Fine sand	SP, SP-SM	A-3	100	80-95	2-10	NP	NP	6.3-20.0	.05-.10
Orlando Ob, Oc	3 to 5 feet	None	0-12	Fine sand	SM, SP-SM	A-2-4, A-3	100	85-100	10-15	NP	NP	6.3-20.0	.12-.15
			12-60	Fine sand	SP, SP-SM	A-3	100	80-95	2-12	NP	NP	6.3-20.0	.05-.12
Pamlico Pa	Inundated	More than once a year for longer than 6 months	0-18	Muck	PT	Organic	-	-	-	NP	NP	6.3-20.0	.40-.65
			18-30	Mucky fine sand	SP-SM	A-3	100	85-95	5-12	NP	NP	6.3-20.0	.15-.25
			30-48	Fine sand	SP, SP-SM	A-3	100	80-90	2-12	NP	NP	6.3-20.0	.05-.12
Plummer Pb	Inundated	More than once a year for 1 to 6 months	0-62	Fine sand	SP, SP-SM	A-3	100	80-95	2-12	NP	NP	6.3-20.0	.03-.05
Pomello Pc	1 to 3 feet	None	0-40	Fine sand	SP	A-3	100	80-95	2-4	NP	NP	6.3-20.0	.02-.05
			40-60	Fine sand	SM, SP-SM	A-2-4, A-3	100	85-95	8-20	NP	NP	.63-6.3	.10-.15
Pompano Pd	Inundated	More than once a year for 1 to 6 months	0-62	Fine sand	SP, SP-SM	A-3	100	80-95	4-12	NP	NP	6.3-20.0	.03-.05
Pompano Pe	Inundated	More than once a year for 1 to 6 months	0-36	Fine sand	SP, SP-SM	A-3, A-2-4	100	80-95	4-12	NP	NP	6.3-20.0	.02-.05
			36-62	Fine sandy clay loam, Fine sandy clay	SC, SM-SC	A-2-6, A-6	100	85-95	25-50	10-40	4-20	.63-2.0	.10-.15
Pompano Pf	Inundated	More than once a year for 1 to over 6 months		See unit Pe for estimated physical properties									
Rutlege Ba, Bc	Inundated	More than once a year for 1 to 6 months	0-20	Fine sand, mucky fine sand	SP-SM, SM	A-3	100	80-95	5-15	NP	NP	6.3-20.0	.10-.33
			20-60	Fine sand	SP, SP-SM	A-3	100	85-95	2-10	NP	NP	6.3-20.0	.05-.10
Rutlege Bb	Inundated	More than once a year for 1 to 6 months	0-22	Fine sand	SP-SM, SM	A-3	100	85-95	5-15	NP	NP	6.3-20.0	.10-.15
			22-36	Fine sand	SP, SP-SM	A-3	100	85-95	2-10	NP	NP	6.3-20.0	.05-.10
			36-62	Sandy clay loam, Fine sandy clay	SC, SM-SC	A-2-6, A-6	100	85-95	25-50	15-40	4-20	.63-2.0	.10-.15
St. Johns Sa	1 to 2 feet	Once in 1 to 5 years for 7 days to 1 month	0-9	Fine sand	SP, SP-SM	A-3	100	85-95	2-12	NP	NP	6.3-20.0	.05-.10
			9-23	Fine sand	SP, SP-SM	A-3	100	85-95	2-10	NP	NP	6.3-20.0	.02-.05
			23-29	Fine sand	SM, SP-SM	A-2-4, A-3	100	85-100	8-20	NP	NP	.63-6.3	.10-.15
			29-62	Fine sand	SP, SP-SM	A-3	100	85-95	2-12	NP	NP	6.3-20.0	.02-.05
St. Lucie Sb 5/	More than 10 feet 3/	None	0-62	Fine sand	SP	A-3	100	90-90	1-4	NP	NP	6.3-20.0	.02-.05
Scranton Sc	1 to 2 feet	Once in 1 to 5 years for 7 days to 1 month	0-12	Fine sand	SP-SM	A-2-4	100	80-90	5-12	NP	NP	6.3-20.0	.10-.15
			12-62	Fine sand	SP	A-3	100	85-95	2-4	NP	NP	6.3-20.0	.05-.10

1/ The upper surface of free water in a soil or underlying material. In some places an upper or perched water table is separated from a lower one by a dry zone. If water is above the surface, the soil is inundated (or flooded).

2/ Water from stream overflow, runoff, or seepage, standing or flowing above the soil surface.

3/ The Ba, Bc, Oa, and Sc soils as mapped in the western part of Orange County (west of Orlando) have a large number of inclusions of other soils that have similar profile characteristics in most respects, but that differ in depth to seasonal high water table. Depth to the seasonal high water table in these other soils is 5 to 4 feet.

4/ The Bd, Bb, Bg, and Bh soils as mapped in the eastern part of the county (east of Orlando) have a large number of inclusions of other soils that have similar profile characteristics in most respects, but that differ in depth to seasonal high water table. Depth to the seasonal high water table in these other soils is 0 to 1 foot in wetter inclusions and below 5 feet in the better drained inclusions.

5/ The Sb soils have a large number of inclusions of other soils that have similar profile characteristics in most respects, but that differ in depth to seasonal high water table. Depth to seasonal high water table in these other soils is 0 to 5 feet.

ORLANDO SITE /

TABLE 1. DEGREE AND KIND OF LIMITATION OF SOILS FOR SELECTED USES FOR TOWN AND COUNTRY PLANNING (Continued)

SOIL SERIES AND MAPPING UNIT SYMBOLS	SEPTIC TANK ABSORPTION FIELDS	SEWAGE LAGOONS	SHALLOW EXCAVATIONS	DWELLINGS WITHOUT BASEMENTS	EXCAVATED PONDS (GROUND WATER FED)	SANITARY LANDFILL		LOCAL ROADS AND STREETS		CAMP SITES AND PICNIC AREAS	PLAYGROUNDS	PATHS AND TRAILS
						TRENCH TYPE	AREA TYPE	PAVED	UNPAVED			
Rutlege Ra, Rb, Rc	Severe High water table Flooding	Severe Rapid Permeability High water table Flooding	Severe High water table Flooding	Severe High water table Flooding	Slight	Severe High water table Rapid Permeability Flooding	Severe High water table Rapid Permeability Flooding	Severe High water table Flooding	Severe High water table Flooding	Severe High water table Flooding	Severe High water table Flooding	Severe High water table Flooding
St. Johns Sa	Severe High water table	Severe Rapid Permeability High water table	Severe High water table	Severe High water table	Slight	Severe High water table	Severe High water table Rapid Permeability	Severe High water table	Severe High water table	Severe High water table	Severe High water table	Severe High water table
St. Lucie Sb	Slight[1/]	Severe Rapid Permeability	Severe Loose sand	Slight	Severe Deep to water table	Severe Rapid Permeability Loose sand	Severe Rapid Permeability	Slight	Severe Poor traffic- ability (Loose sand)	Severe Poor traffic- ability (Loose sand)	Severe Poor traffic- ability (Loose sand)	Severe Poor traffic- ability (Loose sand)
Scranton Sc	Severe High water table	Severe Rapid Permeability High water table	Severe High water table	Severe High water table	Slight	Severe Rapid Permeability Flooding	Severe High water table Rapid Permeability	Severe High water table	Severe High water table	Moderate High water table	Moderate High water table	Moderate High water table

[1/] Septic tank absorption fields function well in these soils; however, pollution of groundwater supplies may be a hazard in some places.

ORLANDO SITE 2

TABLE 3. ESTIMATED PHYSICAL PROPERTIES OF SOILS

SOIL SERIES AND MAPPING UNIT SYMBOL	DEPTH TO SEASONAL¹ HIGH WATER TABLE	FLOODING HAZARD²/	DEPTH FROM SURFACE OF TYPICAL PROFILE (Inches)	CLASSIFICATION			PERCENTAGE LESS THAN 3 INCHES PASSING SIEVE			LIQUID LIMIT	PLASTICITY INDEX	PERMEABILITY RATE (In./Hr.)	AVAILABLE WATER CAPACITY (In./In.)
				USDA TEXTURE	UNIFIED	AASHO	No. 10	No. 40	No. 200				
Adamsville Aa, Ac	1 to 3 feet	Once in 5 to 20 years for 3 days to 1 month	0-48	Fine sand	SP, SP-SM	A-3	100	85-95	3-12	NP	NP	6.3-20.0	.02-.05
Adamsville Ab	1 to 3 feet	One in 5 to 20 years for 3 days to 1 month	0-36 36-42	Fine sand Fine sandy clay loam	SP, SP-SM SC, SM-SC	A-3 A-2-4, A-6	100 100	85-95 85-95	3-12 25-40	NP 10-40	NP 4-20	6.3-20.0 .63-2.0	.02-.05 .10-.15
Alluvial land Al	Variable	More often than once every year for 1 to 6 months	Variable	Variable	Variable	Variable	Variable	Variable	Variable	Variable	Variable	Variable	Variable
Blanton Ba, Bc, Be, Bf³/	4 to 6 feet³/	None	0-48	Fine sand	SP, SP-SM	A-3	100	85-95	2-7	NP	NP	6.3-20.0	.02-.05
Blanton Bd, Bb³/	2 to 3 feet⁴/	None	0-48	Fine sand	SP, SP-SM	A-3	100	85-95	2-7	NP	NP	6.3-20.0	.02-.05
Blanton Bg³/	2 to 3 feet⁴/	None	0-36 36-48	Fine sand Fine sandy clay loam, Fine sandy clay	SP, SP-SM SC, SM-SC	A-3 A-2-4, A-6	100 100	85-95 85-95	2-12 25-50	NP 10-40	NP 4-20	6.3-20.0 .63-2.0	.02-.05 .10-.15
Bigston Bh³/ (Leto part; (For Blanton part see unit Bg)	2 to 3 feet⁴/	None	0-18 18-42	Fine sand Fine sandy clay loam	SP, SP-SM SC, SM-SC	A-3 A-2-4, A-6	100 100	85-95 85-95	2-12 25-40	NP 10-40	NP 4-20	6.3-20.0 .63-2.0	.05-.10 .10-.15
Borrow pits (Bp)	Variable	Variable	Variable	Variable	Variable	Variable	Variable	Variable	Variable	Variable	Variable	Variable	Variable
Brighton Bj	Inundated	More than once a year for longer than 6 months	0-30 30-48	Peat Fine sand	PT SP	Organic A-3	- 100	- 80-90	- 2-4	NP NP	NP NP	6.3-2.0 6.3-2.0	.45-.50 .02-.05
Brighton Bk	Inundated	More than once a year for longer than 6 months	0-55	Peat	PT	Organic	-	-	-	NP	NP	6.3-2.0	.45-.50
Brighton Bl	Inundated	More than once a year for longer than 6 months	0-98	Peat	PT	Organic	-	-	-	NP	NP	6.3-2.0	.45-.50
Charlotte Ca	Inundated	More than once a year for 1 to 6 months	0-48	Fine sand	SP, SP-SM	A-3	100	80-90	2-12	NP	NP	6.3-20.0	.02-.05
Delray Da, Dc	Inundated	More often than once a year for 1 to 6 months	0-12 12-48	Fine sand Fine sand	SP-SM SP	A-3 A-3	100 100	85-95 80-90	5-12 2-4	NP NP	NP NP	6.3-20.0 6.3-20.0	.15-.20 .02-.05
Delray Db	Inundated	More often than once a year for 1 to 6 months	0-12 12-16 16-48	Fine sand Fine sand Fine sandy loam, Fine sandy clay loam, Fine sandy clay	SP-SM, SM SP-SM, SP SM-SC, SC	A-3, A-2-4 A-3 A-2-4, A-6	100 100 100	80-90 80-90 85-95	5-15 2-12 15-50	NP NP 10-40	NP NP 4-20	6.3-20.0 6.3-20.0 .63-2.0	.12-.20 .05-.10 .10-.15
Eustis Ea, Eb	10 feet	None	0-48	Fine sand	SP, SP-SM	A-3	100	80-90	2-12	NP	NP	6.3-20.0	.02-.05
Everglades Ec	Inundated	More than once a year for longer than 6 months	0-14 14-48	Peat Fine sandy clay loam	PT SC, SM-SC	Organic A-2-4, A-6	- 100	- 85-95	- 25-40	NP 10-40	NP 4-20	6.3-20.0 .63-2.0	.45-.50 .10-.15
Everglades Ed	Inundated	More than once a year for longer than 6 months	0-55	Peat	PT	Organic	-	-	-	NP	NP	6.3-20.0	.45-.50

ORLANDO SITE 2

TABLE 1. DECREE AND KIND OF LIMITATION OF SOILS FOR SELECTED USES FOR TOWN AND COUNTRY PLANNING

SOIL SERIES AND MAPPING UNIT SYMBOLS	SEPTIC TANK ABSORPTION FIELDS	SEWAGE LAGOONS	SHALLOW EXCAVATIONS	DWELLINGS WITHOUT BASEMENTS	EXCAVATED PONDS (GROUND WATER FED)	SANITARY LANDFILL		LOCAL ROADS AND STREETS		CAMP SITES AND PICNIC AREAS	PLAYGROUNDS	PATHS AND TRAILS
						TRENCH TYPE	AREA TYPE	PAVED	UNPAVED			
Adamsville Aa, Ab, Ac	Severe High water table	Severe High water table Rapid Permeability	Severe High water table	Severe High water table	Slight	Severe High water table Rapid Permeability	Severe High water table Rapid permeability	Moderate High water table	Moderate Fair trafficability (Sand texture) High water table	Moderate Fair trafficability (Sand texture) High water table	Moderate Fair trafficability (Sand texture) High water table	Moderate Fair trafficability (Sand texture) High water table
Alluvial Land Ad	Severe High water table Flooding	Severe High water table Flooding	Severe High water table Flooding	Severe High water table Flooding	Slight	Severe High water table Flooding	Severe High water table Flooding	Severe High water table Flooding	Severe High water table Flooding	Severe High water table Flooding	Severe High water table Flooding	Severe High water table Flooding
Blanton Ba, Bc, Bu	Slight 1/	Severe Rapid Permeability	Severe Loose sand	Slight	Severe Deep to water table	Severe Rapid Permeability Loose sand	Severe Rapid Permeability	Slight	Severe Poor Trafficability (Loose sand)	Severe Poor Trafficability (Loose sand)	Severe Poor Trafficability (Loose sand)	Severe Poor Trafficability (Loose sand)
Blanton Bf	Moderate Strong slopes	Severe Rapid Permeability Strong slopes	Severe Loose sand	Moderate Strong slopes	Severe Deep to water table	Severe Rapid Permeability Loose sand	Severe Rapid	Moderate Strong slopes	Severe Poor trafficability (Loose sand)	Severe Poor trafficability (Loose sand)	Severe Poor trafficability (Loose sand)	Severe Poor trafficability (Loose sand)
Blanton Bb, Bl, By	Severe Seasonal High water table	Severe Rapid Permeability Seasonal high water table	Severe Sand texture Seasonal high water table	Moderate Moderately high water table	Moderate Deep to dry Seasonal high water table	Severe Rapid Permeability Moderately High water table	Severe Rapid Permeability Moderately high Water table	Moderate Moderately high Water table	Moderate Fair trafficability (Sand texture)	Moderate Fair trafficability (Sand texture)	Moderate Fair trafficability (Sand texture)	Moderate Fair trafficability (Sand texture)
Blanton and Esto Bh (Esto Part. for Blanton see Bf)	Severe Strong slopes Moderate Permeability	Severe Strong slopes	Slight	Moderate Strong slopes Moderate Shrink-swell Potential	Severe Deep to dry Seasonal high water table	Slight	Moderate Strong slopes	Moderate Strong slopes	Moderate Strong slopes	Moderate Strong slopes	Moderate Strong slopes	Slight
Borrow pits Bp	Variable	Variable	Variable	Variable	Variable	Variable	Variable	Variable	Variable	Variable	Variable	Variable
Brighton Bj, Bk, Bl, Bm	Very severe High water table Flooding	Very severe High water table Organic soil Flooding	Very severe High water table Flooding	Very severe High water table Flooding High potential subsidence Low load supporting capacity	Slight	Very severe Organic soil High water table Flooding	Very severe Organic soil High water table Flooding	Very severe Low load supporting capacity High water table Flooding	Very severe Poor trafficability (Organic soils) High water table Flooding	Very severe Poor trafficability (Organic soils) High water table Flooding	Very severe Poor trafficability (Organic soils) High water table Flooding	Very severe Poor trafficability (Organic soils) High water table Flooding

1/ Septic tank absorption fields function well in these soils; however, pollution of groundwater supplies may be a hazard in some places.

APPENDIX F

CHAPTER 10D-6 STANDARDS FOR INDIVIDUAL SERVICE DISPOSAL FACILITIES, DEPARTMENT OF HEALTH AND REHABILITATIVE SERVICES

Aug 31 1982

PROPOSED RULES OF THE
DEPARTMENT OF HEALTH AND REHABILITATIVE SERVICES
CHAPTER 10D-6
STANDARDS FOR ONSITE SEWAGE DISPOSAL SYSTEMS

FOR ADMINISTRATIVE USE ONLY

STATE OF FLORIDA

DEPARTMENT OF HEALTH AND REHABILITATIVE SERVICES

CHAPTER 10D-6, FLORIDA ADMINISTRATIVE CODE

STANDARDS FOR ONSITE SEWAGE DISPOSAL SYSTEMS

10D-6.41 General

(1) The purpose of this rule is to provide minimum standards, provisions, and requirements for the design, construction, installation, utilization, operation and maintenance of onsite sewage disposal systems used for disposal of human excreta and domestic sewage.

(2) Any onsite sewage disposal system (also referred to as system), as defined in this Chapter, hereafter designed, constructed, installed, utilized, operated and maintained in the State of Florida shall conform to the requirements of this Chapter. Any previously installed system which was inspected and approved, by the permitting authority, shall remain valid for use under the terms of the regulation and permit under which it was approved. Under emergency or epidemic conditions and when operated under its supervision, the Department of Health and Rehabilitative Services may approve temporary systems of excreta disposal which may differ with standards set forth in this Chapter.

(3) No person shall construct or install an onsite sewage disposal system without receiving prior written approval from the Department. Individual county health units may require that they be given notification of intent to repair, or may require the repairer to obtain written approval prior to making a system repair.

(4) No municipality or political subdivision of the State shall issue a building or plumbing permit for any building requiring the use of an onsite sewage disposal system unless the owner or builder has received prior written approval for such system from the Department.

(5) Buildings used or intended for human occupancy, employment or service to the public and locations where persons congregate shall provide toilet(s) connected to an approved

sewage waste disposal system. Also, property or locations where persons congregate, are employed, or where property is used by the public for temporary and short periods of duration, such as construction sites, fairs, carnivals, revivals, field locations for agricultural workers, encampments or other use shall be provided with an approved sewage waste disposal system.

(6) If additions or alterations to a building or its ownership are made which will increase sewage flow or change sewage characteristics, any onsite sewage disposal system serving such buildings shall be upgraded to comply with the provisions and requirements of these rules.

(7) When the volume of domestic sewage from an establishment exceeds five thousand (5000) gallons per day, or for any volume of industrial waste, and when kitchen wastewater flows exceed two thousand (2000) gallons per day, treatment and disposal of the total sewage flow from a building or establishment shall be in compliance with the State of Florida Department of Environmental Regulation (DER) standards and rules. Provided, consideration may be given to low density establishments where it would be difficult or impossible to consolidate flows through sewering because of layout and distribution of facilities. The table of estimated sewage flows set forth in Table I shall be the guide when determining the total daily domestic sewage flow from all sources located on one or more parcels of land.

(8) The local Department authority may require the submission of detailed construction plans, prepared by an engineer registered in the State of Florida, for any system to receive flows not exceeding five thousand (5000) gallons of sewage per day.

Name of Person Originating Proposed Rule: John Heber

Name of Supervisor or Person who Approved the Proposed Rule:

Eanix Poole

Date Proposed Rule Approved:

Specific Authority: 381.031(1)(g)3, FS

Law Implemented: 381.031, 381.061, 381.071, 381.261, 381.272, 381.291, 381.311, 386, FS

History: New

10D-6.42 Definitions

(1) Absorption surface - the total surface area of soil at the bottom and sidewalls of the soil absorption system drainfield.

(2) Aerobic sewage treatment facility - a sewage treatment plant which incorporates a means of introducing air into the sewage so as to provide aerobic biochemical stabilization during a detention period.

(3) Alternative system - any approved onsite sewage disposal system used in lieu of, including modifications to, a standard subsurface system.

(4) Approved - onsite sewage disposal system constructed and installed in compliance with technical standards and requirements of this Chapter. "Approved" installation does not imply that a disposal system will perform satisfactorily for any specific period of time.

(5) Aquifer - a geological formation, group of formations, or part of a formation (stratum) that is capable of yielding potentially usable quantities of water from wells or springs.

(6) Available - a municipal or investor-owned sewerage system shall be deemed available for connection if all of the following requirements are met:

(a) the system is not under a Department of Environmental Regulation moratorium;

(b) for estimated sewage flows of six hundred (600) or less gallons per day, a sewerage system shall be considered available if a public easement or right-of-way and an approved sewer line abuts the property, and if gravity flow can be maintained from the building drain to the sewer line.

(c) for estimated sewage flows exceeding six hundred (600) gallons per day, a sewerage system shall be considered available if a public easement or right-of-way exists, and an approved sewer line abuts the property or is within one hundred (100) feet of the property.

(7) Conditions associated with saturation - are physi-

cal soil characteristics, such as soil color or the presence of soil mottling, which can be utilized to determine the maximum expected elevation of a fluctuating water table.

(8) Department - the Department of Health and Rehabilitative Services including authorized agents of the individual county health units.

(9) Domestic sewage wastes - human and domestic wastes, liquids or matter from plumbing fixtures normally carried off by drains and sewers, including bath and toilet wastes, laundry wastes, kitchen wastes and other similar wastes from household appurtenances. Sewage wastes are further categorized as:

(a) Blackwater - waste carried off by toilets, urinals, kitchen drains, and sewers.

(b) Graywater - all domestic waste not covered in (a) above and including bath, lavatory, laundry and sink (except kitchen sink) waste.

(10) Drainfield - a system of open-jointed or perforated piping, alternative distribution units, or other treatment facilities designed to distribute effluent for filtration, oxidation and absorption by the soil within the zone of aeration.

(11) Effective capacity - the liquid volume of a sewage retention tank contained below the liquid level line.

(12) Effective soil depth - the depth of satisfactory (slight or moderate limited) soil material lying above a nonpervious soil layer such as heavy clays, hardpans, muck or bedrock. Satisfactory soils do not impede the movement of air and water or the growth of plant roots.

(13) Establishment - a housing, commercial, or institutional development including, but not limited to, a place of business, assembly, or residence, whether multiple or single family. Under most circumstances, an establishment will include all buildings, structures, mobile homes, and the land appertaining thereto.

(14) Experimental - an onsite sewage disposal system not specifically described in this Chapter which has been

submitted for review and has been approved by the Department Health Program Office.

(15) Flooding - a covering of soil surface by water from any source, such as streams overflowing their banks, runoff from adjacent or surrounding slopes, elevation of the ground water table exceeding that of the soil surface, inflow from high tides, or combinations of these. Terms also associated with flooding and used elsewhere in this Chapter are:

(a) frequent - flooding which occurs more than once every two (2) years on the average;

(b) long duration - soils are flooded for at least seven (7) consecutive days.

(c) ten (10) year flood elevation - the elevation, in feet above sea level, which approximates the level of flooding expected on a frequency of not less that the ten (10) year recurring interval, or on a frequency of not greater than a ten percent (10%) probability of occurrence in any given year, as determined from analysis of best available information.

(16) Mean high water line - is the largest normal boundry, perimeter or outline, formed by a lake, river, stream or other body of water. The mean high water line is determined by an evaluation of indicators such as vegetation, soil characteristics, and other typical shoreline features.

(17) Industrial sewage waste - wastewater not otherwise defined as domestic sewage waste. Wastewater flows exceeding two thousand (2000) gallons per day from commercial food service kitchens and wastewater from commercial laundry facilities are specifically included in this definition.

(18) Limitation ratings - U.S. Department of Agriculture (USDA) Soils Classification ratings which describe the relative suitability of soils to properly assimilate sewage effluent. The three rating categories are:

(a) Slight limited - soils with favorable properties for the use of an onsite soil absorption system.

(b) Moderate limited - soils that have properties moderately favorable for use. Limitations in this category may be overcome by site alteration involving removal of impervious or too rapidly percolating soil layers, addition of fill, or lowering of high water tables through approved drainage methods, or any combination of the above.

(c) Severe limited - soils which have one or more properties unsuitable for the use of an onsite soil absorption system.

(19) Mound system - is a sewage effluent soil absorption system in which the distribution drain pipe is elevated above the natural ground surface in an elevation of fill material placed over a specified land area.

(20) "O" Horizon - the layer of organic matter on the surface of a mineral soil. This soil layer consists of decaying plant residues.

(21) Obstructed land - those areas on a lot or property used for such purposes as pools, concrete slabs, buildings, driveways, parking and similar areas which would prohibit, hinder, or affect the installation, operation and/or maintenance of an onsite sewage disposal system.

(22) Onsite sewage disposal system (also referred to as system) - any domestic sewage treatment and disposal facility, including standard subsurface, alternative or experimental systems installed or proposed to be installed on land of the owner or on other land to which the owner or owners have the legal right to install a system.

(23) Private water supply well - a source of water which is used only by individual family living units including private homes, duplexes and multiple family type buildings of four (4) family units or less.

(24) Repair - modifications or additions to a failing system which are necessary to allow the system to function or must be made to eliminate a public health or pollution hazard. Pumping of septage from a system or making minor structural corrections to a tank or building sewer does not constitute a repair.

(25) Septage - a mixture of sludge, fatty materials,

and wastewater removed during the pumping of a wastewater treatment receptacle.

(26) Septic tank - a watertight receptacle constructed to promote separation of solid and liquid components of wastewater, to provide limited digestion of organic matter, to store solids, and to allow clarified liquid to discharge for further treatment and disposal in a soil absorption system.

(27) Standard subsurface system - an onsite sewage disposal system consisting of a septic tank, distribution box and gravity-fed drain trench or absorption bed installed below the natural ground surface.

(28) Subdivision - any tract of land divided into two (2) or more lots or parcels less than one acre in size for sale, lease or rent for residential, industrial or commercial use, regardless of whether the lots or parcels are described by reference to recorded plats, metes and bounds description, or by any other method.

(29) Surface water - water upon the surface of the earth whether contained in bounds created naturally or artificially or diffused.

(30) Temporary - a period not exceeding 90 days.

(31) Water table elevation - refers to the highest elevation of seasonal or permanent saturation of soil, which persists for a period of more than a few days during most years.

(32) Wettest season - that period of time each year in which the ground water table elevation can normally be expected to be at its highest elevation.

Name of Person Originating Proposed Rule: John Heber

Name of Supervisor or Person who Approved the Proposed Rule:

Eanix Poole

Date Proposed Rule was Approved:

Specific Authority: 381.031(1)(g)3, FS

Law Implemented: 381.031, 381.061, 381.071, 381.261, 381.272, 381.291, 381.311, 386, FS

10D-6.43 Permits

(1) System Construction Permit - no septic tank or

other onsite sewage disposal system shall be installed until an "Onsite Sewage Disposal System Construction Permit" (HRS-H Form 4016 or equivalent county form) has been obtained from the Department. Permits issued for new construction shall become void after one calendar year from the date of issue if the system has not been installed. However, if building construction has commenced, the system construction permit shall be valid concurrent with the building permit. Individual county health units may require that a construction permit also be obtained for system repairs.

(2) Final Inspection - Before covering with earth and before placing a system into service, a person installing or constructing a septic tank, drainfield, or other onsite sewage disposal system shall have the system inspected for compliance with the requirements of this Chapter. The Department shall make every reasonable effort to make the final inspection within two (2) working days after notification to the Department that the system has been installed. If the system is approved, the Department shall issue a "Final Installation Approval" notice (HRS-H Form 4016 or equivalent county form).

Name of Person Originating Proposed Rule: John Heber

Name of Supervisor or Person Who Approved the Proposed Rule:

Eanix Poole

Date Proposed Rule was Approved:

Specific Authority: 381.031(1)(g)3, FS

Law Implemented: 381.031, 381.061, 381.071, 381.261, 381.272, 381.291, 381.311, 386, FS

History: New

10D-6.44 Application for System Construction Permit

(1) No person shall cause or allow construction of a system without first applying for and obtaining a construction permit. HRS-H Form 4015, or an equivalent county form, shall be used for recording permit application information.

(2) An application shall be completed in full, signed by the owner or the owner's legally authorized representative, and shall be accompanied by all required exhibits and fees.

(3) The suitability of a lot, property, subdivision or building for the use of an onsite sewage disposal system shall be determined from an evaluation of lot size, anticipated hydraulic load on the system, soil and water table conditions, soil drainage and site topography. Necessary site investigations and tests shall be performed at the expense of the owner by an engineer who has soils training and is registered in the State of Florida, by qualified Department personnel, or other certified persons who, in the opinion of the Department, are qualified to perform such site investigations. Results of site investigations shall be entered on, or attached to, the construction permit application form for consideration by the local Department authority. The application shall also include the following data:

(a) A plan or plat of the lot or total site ownership drawn to scale, showing boundaries with dimensions, locations of residences or buildings, the onsite sewage disposal system location, the general slope of the property and any existing or proposed wells, drainage features, filled areas, obstructed areas, and surface waters such as lakes, ponds, streams or canals. The location of wells, onsite sewage disposal systems, surface waters and other pertinent facilities or features on contiguous or adjacent property if the features are within seventy-five (75) feet of the applicant lot, must also be shown.

(b) At least one (1) soil profile delineating soil characteristics within the proposed system soil absorption area to a depth of six (6) feet in accordance with USDA Soil Classification Methodology. The Department may require more than one soil profile and may require soil profiles to be more than six (6) feet deep on isolated lots where a subdivision analysis has not been performed or where marginal soils, sloping terrain or location problems are anticipated.

✳ (c) Percolation rates which may be estimated from soil characteristics including soil texture, soil structure, soil drainage and other properties relating to water movement in soils. Percolation tests, if conducted, shall be evaluated as only one of several criteria in determining soil suitability for, the absorption of wastewater effluent.

(d) Water table elevations which exist at the time of the site evaluation and estimated water table elevation during the wettest season of the year. For determining the wettest season, refer to "Climatological Data" publication for Florida.

(e) For any subdivision platted and recorded or unrecorded on or after January 1, 1972, the applicant-owner, developer or subdivider shall submit additional data which is necessary to properly perform a subdivision analysis. The following minimum data is required:

1. A general site location reference map identifying the area.

2. A plan of the subdivision clearly drawn to scale, showing lot and block arrangement, lot dimensions and lot numbering.

3. A topographic map with contour intervals to indicate surface configurations including slopes; streams or water courses; bodies of water; low, wet or marshy land and the lots on which fill is to be added.

4. Any proposed drainage plans approved by the local drainage authority.

5. All dedicated rights-of-way or recorded easements proposed for use in the installation of individual onsite sewage disposal and/or water supply systems.

6. Soil profiles, to a minimum depth of six (6) feet using the USDA Soil Classification methodology. Profiles shall be performed on a sufficient number of lots throughout the proposed subdivision to provide adequate information on the overall suitability of the subdivision for the use of onsite soil absorption systems.

(f) Subdivisions platted and recorded or unrecorded prior to January 1, 1972, will be considered on the basis of an evaluation of soil characteristics, water table elevations, history of flooding and records of service of existing installations in the same general area.

(4) The applicant shall be the permit holder and shall be held responsible for all information supplied to the Department. The attested application and site evaluation serve as the basis by which the Department determines the issuance of a construction permit. In the event of a change in any material fact given in the application which served as basis for issuing a construction permit, the permit holder will immediately file an amended application detailing such changed conditions. If the new conditions are determined to be in compliance with the standards in this Chapter, the construction permit shall be amended. If the new conditions are determined to be in non-compliance with the standards of this Chapter, the permit shall be revoked subject to the provisions of Section 10D-6.44(5).

(5) Processing of an application for permit and the denial or revocation of a construction permit shall be in compliance with requirements of Chapter 120, Florida Statutes. When a construction permit has been denied by the Department, or the Department has given notice of intent to revoke an existing constuction permit, the applicant is entitled to:

(a) Request an administrative hearing, pursuant to Section 120.57, Florida Statutes, to challenge the denial or revocation action; or

(b) Request a variance from certain requirements in this Chapter.

Name of Person Originating Proposed Rule: John Heber

Name of Supervisor or Person who Approved the Proposed Rule: Eanix Poole

Date Proposed Rule was Approved:

Specific Authority: 381.031(1)(g)3, 381.272, FS

Law Implemented: 381.031, 381.061, 381.071, 381.261, 381.272, 381.291, 381.311, 386, FS

History: New

10D-6.45 Variances

(1) The Staff Director, Health Program Office, shall appoint five persons, each with an alternate who may serve in the absence of the appointee, to review applications for variance and

recommend proper action in each case. This review group shall consist of appropriate persons as follows: one from the Department Health Program Office, one from a county health unit, one from the home building industry, one from the septic tank industry and one from the Department of Environmental Regulation. Review group members shall be appointed for a period of three years with such appointments being staggered so that no more than two members' terms expire on any one year.

(2) Applications for variance shall be submitted utilizing HRS-H Form 4054 and must be received by the Department Health Program Office at least ten (10) days prior to a scheduled quarterly public variance meeting which shall be held in a convenient Florida location. Each application shall be accompanied by supportive materials and documents such as a copy of the property deed, site evaluation data, plans and specifications for the proposed system, a statement regarding the existence of a hardship, information regarding adjacent property and any other information necessary for rendering a proper decision. A separate application must be filed for each site considered for a variance. The burden of presenting supportive facts shall be the responsibility of the applicant.

(3) Upon consideration of the merits of each application and the recommendations of the review group, the Staff Director, Health Program Office, has discretionary authority to grant a variance from certain provisions of this Chapter. Such variance may be granted to relieve or prevent excessive hardship only in cases involving minor deviation from established standards when it is clearly shown that the public health will not be impaired or that pollution of surface or ground water will not result. The decision to grant or deny a variance may be appealed through an administrative hearing.

Name of Person Originating Proposed Rule: John Heber

Name of Supervisor or Person who Approved the Proposed Rule:

Eanix Poole

Date Proposed Rule was Approved:

Specific Authority: 381.031(1)(g)3, 381.272, FS

Law Implemented: 381.031, 381.061, 381.071, 381.261, 381.272, 381.291, 381.311, 386, FS

History: New

10D-6.46 Location and Installation - All systems shall be located and installed so that with proper maintenance the systems function in a sanitary manner, do not create sanitary nuisances or health hazards and do not endanger the safety of any domestic water supply. Sewage waste and effluent from individual onsite sewage disposal systems shall not be discharged onto the ground surface or into ditches, drainage structures, surface waters, or aquifers. To prevent such discharge or health hazards:

(1) Systems shall not be located laterally within seventy-five (75) feet of any private water supply well or within one hundred (100) feet of any public water supply well as defined in Chapters 10D-4 and 17-22, FAC. Locations shall be downhill from water supply wells when practical.

(2) Systems shall not be located under buildings or within five (5) feet thereof, or within five (5) feet of property lines except where property lines abut utility easements which do not contain underground utilities, or where recorded easements are specifically provided for the installation of systems for service to more than one lot or property owner. Drain trenches, absorption beds or other drainfield systems shall not be located within ten (10) feet of potable water lines unless such lines are encased in at least six (6) inches of concrete or placed within a sleeve of similar material pipe to a distance of at least ten (10) feet from the nearest portion of the drainfield. Chapter 10D-9, FAC, shall be used to determine water distribution pipe material and installation requirements.

(3) Systems shall not be located laterally within fifty (50) feet of the mean high water line of lakes, streams, canals or other surface waters. This requirement also applies to the design high water level of drainage structures and storm water retention areas serving more than two (2) lots. This requirement does not apply to shallow swales which are not expected to contain water twelve (12) hours after a rainfall

event. Systems shall be located a minimum of fifteen (15) feet from the design high water level of individual lot storm water retention areas.

(4) Suitable, unobstructed land shall be available for the installation of drainfields. The minimum unobstructed area shall be at least three (3) times the drainfield absorption area required by Section 10D-6.48(5) and shall be in addition to the setbacks required in Subsection (2) above.

(5) Standard subsurface systems shall not be installed in fill material unless such fill has been allowed to settle for a period of at least six (6) months, or has been compacted to a density comparable to the surrounding natural soil.

(6) Onsite sewage disposal systems may be installed under the following conditions:

(a) Subdivisions of 50 or fewer lots, each lot having a minimum area of at least one-half acre and either a minimum dimension of 100 feet or a mean of at least 100 feet of the side bordering the street and the distance formed by a line parallel to the side bordering the street drawn between the two most distant points of the remainder of the lot, may be developed with a private well and individual sewage disposal system, provided satisfactory ground water can be obtained and all distance and setback, soil condition, water table elevation and other related requirements of Chapter 10D-6 are met.

1. Sequential development of contiguous subdivisions, as described in this subsection, under single ownership is prohibited.

2. Development under the provisions of this subsection shall not apply to areas where a municipal or investor-owned public sewage system is available contiguous to the proposed subdivision or within one-fourth mile thereof with public right-of-way accessibility.

(b) Residential subdivisions with a public water system may utilize individual sewage disposal facilities provided there are no more than four (4) lots per acre and that all distance and setback, soil condition, water table elevation and other related requirements which are generally applicable to the use of individual sewage disposal systems are met.

(c) Whenever onsite sewage waste disposal systems are used under the provisions of Section 10D-6.46(6)(a) or (b) the following shall apply:

1. The area of each lot under 10D-6.46(6)(a) shall consist of at least one half acre (21,780 square feet) exclusive of all paved areas and prepared road beds within public rights-of-way or easements and exclusive of streams, lakes, drainage ditches, marshes or other such bodies of surface water.

2. The determination of lot densities under 10D-6.46(6)(b) shall be made on the basis of the net acreage of the subdivision which shall exclude from the gross acreage all paved areas and prepared road beds within public rights-of-way or easements and shall also exclude streams, lakes, drainage ditches, marshes or other such bodies of surface water.

(d) All undeveloped residential lots platted prior to 1972, unless public sewage disposal facilities are available, may be developed with a minimum distance of seventy-five (75) feet between any private well and an individual sewage disposal system, or with a public water supply and an individual sewage disposal system, provided that all soil conditions, water table elevations and other non-distance related requirements of this Chapter are met, and provided that such development is done only after written notification of such intended development is given to the health department of the county in which such lots are situated.

Name of Person Originating Proposed Rule: John Reber

Name of Supervisor or Person who Approved the Proposed Rule:
Zanix Poole

Date Proposed Rule was Approved:

Specific Authority: 381.031(1)(g)3, 381.272, FS

Law Implemented: 381.031, 381.061, 381.071, 381.261, 381.272, 381.291, 381.311, 386, FS

History: New

10D-6.47 Site Evaluation Criteria - Onsite sewage disposal systems may be utilized where lot sizes are in compliance with requirements of Section 10D-6.46(6) and all of the following criteria are met:

(1) An existing approved sanitary sewer of a sewerage system is not available. However, individual onsite graywater systems may be utilized provided blackwater is disposed into a sanitary sewer system.

(2) The effective soil depth throughout the drainfield installation site extends forty-two (42) inches or more below the bottom infiltrative surface of the drainfield. Subsections (a), (b) and (c) list soil texture classes with their respective limitation ratings.

(a) Sand, loamy sand, sandy loam, loam and silt loam are considered to be slight limited soils.

(b) Silt, sandy clay loam, clay loam, silty clay loam, sandy clay and silty clay soils are considered to be moderate limited and are subject to evaluation with other influencing factors and local conditions.

(c) Clay, bedrock (includes limerock), organic soil and very course sand (when associated with a high ground water table) are severe limited soils. If severe limited soil can be replaced with slight limited soil, see Footnotes 3 and 4 of Table III for minimum requirements.

(3) The water table elevation at the wettest season of the year is at least twenty-four (24) inches below the bottom infiltrative surface of the drainfield. Evaluation of conditions associated with saturation, actual measurement of the water table during the wettest season, and U.S. Department of Agriculture Soil Conservation Service soils maps and soil interpretation records shall be used to determine water table elevations.

(4) Setbacks in Section 10D-6.46(1), (2), (3) and (4) are met.

(5) The site of the installation and the additional required unobstructed land referred to in Section 10D-6.46(4) shall not be covered with asphalt or concrete, or be subject to vehicular traffic or other activity as defined in 10D-6.42(21)

which would adversely affect the soil.

(6) The site of the installation and the additional required unobstructed land referred to in Section 10D-6.46(4) is not subject to saturation from sources such as artificial drainage of ground surfaces, driveways, roads and roof drains.

(7) The system is not subject to frequent and long duration flooding. In areas subject to infrequent flooding, the system is not subject to flooding based on ten (10) year flood elevations. U.S. Department of Agriculture Soil Conservation Service soils maps, State of Florida Water Management Districts, and Federal Emergency Management Agency Flood Insurance maps are resources that can be used to identify flood prone areas.

(8) Sites with slopes exceeding fifteen (15) percent may require site modification or the use of an alternative system.

Name of Person Originating Proposed Rule: John Heber

Name of Supervisor or Person who Approved the Proposed Rule:
Eanix Poole

Date Proposed Rule was Approved:

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History: New

10D-6.48 System Size Determinations

(1) Minimum design flows for systems servicing any building or group of buildings shall be based on the estimated daily sewage flow as determined from Table I. However, at the discretion of the local Department authority, authenticated water use data may be used in lieu of the flows set forth in Table I.

TABLE I

ESTIMATED DOMESTIC SEWAGE FLOWS

TYPE OF ESTABLISHMENT	GALLONS PER DAY (GPD)
COMMERCIAL:	

Airports	
(a) per passenger	5
(b) add per employee	20
Barber & beauty shops (per chair)	100
Bowling alleys (toilet wastes only per lane)	100
Country club	
(a) per member present	100
(b) per employee	20
Dentist offices	
(a) per wet chair	200
(b) per non-wet chair	50
Doctors offices (per doctor)	250
Factories, exclusive of industrial wastes (gallons per person per shift)	
(a) No showers provided	20
(b) Showers provided	35
Food service operations	
(a) Ordinary restaurant (per seat)	*50
(b) 24 hour restaurant (per seat)	*75
(c) Single service articles only (per seat)	*25
(d) Bar and cocktail lounge (per seat)	*30
(e) Drive-in restaurant (per car space)	*50
(f) Carry out only	
(1) per 100 square feet of floor space	*50
(2) add per employee	*20

* For food service operations, kitchen wastewater flows shall be calculated as 66 percent of the total establishment flow.

Hotels & motels	
(a) Regular (per room)	100
(b) Resort hotels, camps, cottages (per person)	75
(c) Add for establishments with self service laundry facilities (per machine)	400
Office building (per worker)	20
Service stations	

(a) per bay	500
(b) per car wash bay	1000
Shopping centers without food or laundry (per square foot of floor space)	0.1
Stadiums, race tracks, ball parks (per seat)	5
Stores (without food service)	
(a) Private toilets, for employees only (per employee)	20
(b) Public toilets (per square foot of floor space)	0.1
Theatres	
(a) Indoor, auditoriums (per seat)	5
(b) Outdoor, drive-ins (per space)	10
Trailer/Mobile Home Park (per trailer space)	300
Travel trailer/recreational vehicle park	
(a) Travel trailer (overnight), w/o water and sewer hookup (per trailer space)	50
(b) Add for water and sewer hookup (per trailer space)	100
Swimming and bathing facilities, public (per person)	10

INSTITUTIONAL:

Churches (per seat)	3
Hospitals (per bed)	200
Nursing, rest homes (per person)	100
Parks, public picnic	
(a) with toilets only (per person)	5
(b) with bathhouse, showers & toilets (per person)	10
Public institutions other than schools and hospitals (per person)	100
Schools (per student)	
(a) Day-type	15

(b) Add for showers	5
(c) Add for cafeteria	5
(d) Add for day school workers	15
(e) Boarding-type	75
Work/construction camps, semi-permanent (per worker)	50

RESIDENTIAL:

Residences

(a) Single family (per bedroom)	*150
(b) Apartment (per bedroom)	*150
(c) Mobile home not in a trailer park (per bedroom)	*150
(d) Other (per occupant)	* 75

* For residences, the volume of wastewater shall be calculated as 50 percent blackwater and 50 percent graywater.

(2) Minimum effective septic tank capacity shall be determined from Table II:

TABLE II

SEPTIC TANK CAPACITY

AVERAGE SEWAGE FLOW (Gallons/Day)	MINIMUM EFFECTIVE CAPACITY (Gallons)
0-400	750
401-500	900
501-600	1050
601-700	1200
701-800	1350
801-900	1500
901-1000	1650
1001-1250	1900
1251-1500	2200
1501-2000	2700
2001-2500	3200
2501-3000	3700
3001-3500	4300
3501-4000	4800
4001-4500	5300
4501-5000	5800

(3) Where a separate graywater system is used, the minimum effective capacity of the retention tank shall be 250 gallons with such system receiving not more than seventy five (75) gallons of flow per day. For graywater systems receiving flows greater than seventy five (75) gallons per day, minimum effective tank capacity shall be based on the average daily sewage flow plus two hundred (200) gallons for sludge storage. Design requirements for graywater retention tanks are described in Section 10D-6.54(3). Where separate graywater and blackwater systems are utilized, the size of the blackwater system can be reduced proportionally to the amount of wastewater received by the gray water system. However, the minimum capacity for septic

tanks disposing of blackwater shall be 750 gallons.

(4) Where a separate residential laundry waste system, as described in Section 10D-6.48(6) and 10D-6.54(5) is used, a twenty (20) percent size reduction in the main septic tank system shall be allowed.

(5) The minimum absorption area for standard soil absorption facilities, mound, and graywater systems shall be based on Table III. This table assumes the use of drain trenches. If absorption beds are used in lieu of drain trenches, the size of the absorption area shall be increased by 25 percent for sand, loamy sand and sandy loam soils and by 50 percent for other approved soil classes.

TABLE III

U.S. DEPARTMENT OF AGRICULTURE SOIL TEXTURAL CLASSIFICATION	PERCOLATION RATE	MAXIMUM RATE OF SEWAGE APPLICATION TO TRENCH BOTTOM (GALLONS PER SQUARE FOOT PER DAY)
Sand, Loamy Sand	Less than 2 min/inch	2.0
Sandy Loam	2-4 min/inch	1.5
Loam, Silt Loam	5-10 min/inch	1.0
Silt, Sandy Clay Loam	Greater than 10 min/inch but not exceeding 15 min/inch	0.50
Clay Loam, Silty Clay Loam, Sandy Clay, Silty Clay	Greater than 15 min/inch but not exceeding 30 min/inch	0.25

Clay, Organic Soils, Bedrock	Greater than 30 min/inch	Unsatisfactory for standard subsurface system
Very Course Sand, Gravel or Fractured Rock	Less than 1 min/inch and a water table less than 4 feet below the drainfield	Unsatisfactory for standard subsurface system

Footnotes to Table III:

1. U.S. Department of Agriculture major soil textural classification groupings and methods of field identification are explained in 10D-6.58(1)-(8). Laboratory sieve analysis of soil samples may be necessary to confirm field evaluation of specific soil textural classifications. The U.S. Department of Agriculture Soil Conservation Service "Soil Textural Triangle" shall be used to classify soil groupings based on the proportion of sand, silt and clay size particles.

2. The permeability or percolation rate of a soil within a specific textural classification may be affected by such factors as soil structure and mineralogy. Where a percolation rate is determined utilizing the percolation test procedure outlined in Section 10D-6.57, the calculated percolation test rate shall be used with Table III in sizing the drainfield area.

3. When all other site conditions are favorable, thin horizons or strata of impervious severe limited soil may be replaced with slight limited soil or soil of the same texture as the satisfactory permeable layer lying below the replaced layer. The resulting soil profile must be satisfactory to a minimum depth of fifty-four (54) inches beneath the bottom of the proposed drainfield surface. The width of the replacement area shall be at least three (3) times the drain trench width and for absorption beds shall include an area at least ten (10) feet wider than the proposed bed width. Drainfields shall be centered in the replaced area.

4. Where very coarse sand, gravel, or fractured rock directly underlies the drainfield area, and where the water table at the wettest season of the year is less than four (4) feet below the bottom infiltrative surface of the proposed drainfield, the site may be approved provided a minimum depth of twenty-four (24) inches of the rapidly percolating soil beneath the bottom infiltrative surface of the drainfield and a minimum twelve (12) inches of rapidly percolating soil contiguous to the drainfield sidewall infiltrative surfaces, is replaced with slight limited sandy loam or loam. Where such replacement method is utilized, the drainfield size shall be determined using a maximum sewage application rate of 1.0 gallons per day per square foot of drainfield.

(6) For separate residential laundry waste systems, the minimum drainfield absorption area shall be one hundred (100) square feet for a two (2) bedroom residence with an additional twenty-five (25) square feet for each additional bedroom. The permitting authority may require additional drainfield area depending on site specific conditions.

Name of Person Originating Proposed Rule: John Heber

Name of Supervisor or Person who Approved the Proposed Rule:

Eanix Poole

Date Proposed Rule was Approved:

Specific Authority: 381.031(1)(g)3, 381.272, FS

Law Implemented: 381.031, 381.061, 381.071, 381.261, 381.272, 381.291, 381.311, 386, FS

History: New

10D-6.49 Alternative Systems - When approved by the local Department authority, alternative systems may be utilized in circumstances where standard subsurface systems are not suitable or where alternative systems are more feasible. Unless otherwise noted, all rules pertaining to siting, construction, and maintenance of standard subsurface systems shall apply to alternative systems. In addition, the local permitting authority may require the submission of plans prepared by an engineer registered in the State of Florida and qualified in the field of wastewater system design prior to considering the use of any alternative system. The local permitting authority may also require the design engineer to certify that the installed system complies with the approved design and installation requirements.

(1) Organic waste composting toilets - may be approved for use provided that graywater and any other liquid and solid waste is properly collected and disposed of in accordance with standards established in this Chapter.

(2) Sanitary pit privy - shall not be permitted except at remote locations where electrical service is unavailable and in no case shall such installations be permitted for residences. Plans and specifications for sanitary pit privy system construction are available through the local Department authority.

(3) Mound soil absorption systems - may be used to overcome certain moderate limited site conditions such as high water table, infrequent flooding and shallow impervious soil. Special installation instructions or design techniques to suit a particular site may be specified on the construction permit in addition to the following general requirements.

(a) Site preparation must render the site in compliance with requirements of subsections 10D-6.47 (1)-(8).

(b) The maximum height (base to crest) of a mound system shall be forty-eight (48) inches and the bottom surface of the mound gravel drainfield shall not be subject to flooding based on ten year flood elevations.

(c) Soil used for the mound fill shall be, as near as possible, of the same or superior textural class as the natural satisfactory soil which lies above any layer that limits effective soil depth.

(d) The "O" horizon of original topsoil and vegetation must be removed from the fill site and the exposed underlying soil plowed or roughened to prevent formation of an impervious barrier between the fill and natural soil.

(e) The drainfield size shall be determined according to Section 10D-6.48(5). There shall be a minimum five (5) foot separation between the shoulder of the fill and the nearest trench or absorption bed sidewall. To taper the maximum elevation of the mound down to the toe of the slope, additional fill shall be placed at a minimum 4:1 grade, provided, that where the mound is to be sodded concurrent with its construction, the additional fill may be placed at a minimum 2:1 grade.

(f) There shall be a nine (9) to twelve (12) inch soil cap spread evenly over the drainfield gravel.

(g) The site shall be landscaped according to permit specifications and be protected from automotive traffic or other activity that could damage the system. Swales or other surface drainage structures shall be utilized to prevent water shed from mounds draining onto neighboring property.

(4) Other alternative systems - systems such as low pressure pipe systems, small diameter gravity sewers, low pressure sewer systems, alternating absorption fields, large diameter drainpipe systems, and experimental systems meeting the general requirements of this Chapter, may be approved by the Department Health Program Office where evidence exists that use of such systems will not create sanitary nuisance conditions, health hazards or pollute receiving waters. Use of an alternative or experimental system may require the establishment of procedures for routine maintenance, operational surveillance, and environmental monitoring to assure the system continues to function properly. Use of a system to serve more than one residence or commercial building under separate ownership and when located on separate lots shall require the establishment of a local sewer district, maintenance franchise, or other legally binding arrangement for the operation and maintenance of such system.

Name of Person Originating Proposed Rule: John Heber

Name of Supervisor or Person who Approved the Proposed Rule:

Zanix Poole

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History: New

10D-6.50 Maintenance - Any person owning or controlling property upon which an onsite sewage disposal system is installed shall be responsible for maintenance of the system. The following criteria is provided for guidance in proper system maintenance.

(1) Systems shall be maintained at all times to prevent seepage of sewage or effluent to the surface of the ground.

(2) Septic tanks and other sewage retention tanks require occasional cleaning. Septic tanks should be checked at least once every three years (once a year if garbage grinders are discharging to the tank) to determine if sludge needs to be removed. Tanks should be cleaned whenever the bottom of the scum layer is within eight (8) inches of the bottom of the outlet device or when the sludge level is within eighteen (18) inches of the bottom of the outlet device.

(3) Grease interceptors shall be cleaned at appropriate intervals to insure that at least fifty (50) percent of the grease retention capacity of the tank is retained.

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History: New

10D-6.51 Systems for Temporary Use

(1) The Department may approve, on a temporary basis, portable toilets, privies or holding tanks for fairs, carnivals, revivals, field locations, encampments and other locations where people congregate for short periods of time, provided the construction, maintenance, and utilization of such systems conform to the general provisions of this chapter. Portable toilets or other toilet facilities shall be provided at construction sites for the duration of construction any time workers are

present. The Department may waive or reduce any of the setback requirements of Section 10D-6.46(1)-(3), where it is determined no health hazard will result.

(2) Portable toilets shall be self-contained, have self closing doors, have screened vents and shall be designed and maintained so that insects are excluded from the waste container. Additional requirements are:

(a) The number of facilities required shall comply with the provisions of Chapters 10D-9 and 10D-10, FAC.

(b) Waste receptacles shall be watertight and made of non-absorbent, acid resistant, non-corrosive and easily cleanable material.

(c) The floors and interior walls shall have a non-absorbent finish and be easily cleanable.

(d) The inside of the structure housing the storage compartment shall be cleaned and disinfected on each service visit.

(e) Portable toilets shall be serviced weekly or at a more frequent interval to prevent the creation of insanitary conditions.

(3) Holding tanks shall be watertight and have no overflow vent at an elevation lower than the overflow level of the lowest fixture served. Additional requirements are as follows:

(a) Unless otherwise allowed by the local department authority, the projected daily sewage flow into a holding tank shall not exceed one hundred fifty (150) gallons.

(b) The minimum liquid storage capacity shall be equal to the total anticipated sewage flow for a period of seven (7) days.

(c) Holding tanks shall be designed and located to facilitate removal of contents by pumping.

(d) An applicant for a holding tank installation permit shall provide, to the local department authority, a copy of a contract with a permitted septage disposal company which states the scheduled tank pumping frequency.

(4) Persons servicing portable or temporary toilet systems shall obtain an annual permit from the Department. A servicing permit may be suspended, revoked or denied by the Department in accordance with the Administrative Procedure Act (Chapter 120, FS) for failure to comply with requirements of this Chapter. Application for a portable or temporary toilet system service permit shall be made to the Department on Form HRS-H 4012 or equivalent county form.

(5) The following equipment, maintenance and service requirements shall be complied with:

(a) Tank trucks used for servicing portable toilets, privies and holding tanks shall be provided with a dual compartment tank and shall be approved by the Department. One tank shall be used for receiving and removing wastes and shall be equipped with a suction hose having a cut-off valve not more than thirty-six (36) inches from the intake end. The second tank shall be used for clean water storage and shall be of adequate size to allow proper cleaning of each serviced unit. Water from the second tank shall be provided under pressure.

(b) Standby service equipment shall be available for use during breakdowns or emergencies. If equipment from another approved service is to be used for stand-by purposes, a written agreement between the services must be provided to the local Department authority.

(c) The waste storage compartment of a tank truck shall be maintained as necessary to prevent the creation of sanitary nuisance conditions.

(d) Persons servicing portable or temporary toilets shall place a sticker in a conspicuous place on the serviced facility which indicates the name of the company and the date and time the unit was serviced.

Name of Person Originating Proposed Rule: John Heber

Name of Supervisor or Person who Approved the Proposed Rule:

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10D-6.52 Disposal of Septage

(1) No septic tank, grease trap, privy, portable toilet, holding tank or other onsite waste disposal facility shall be cleaned or have its contents removed by a person engaged in a septage disposal service until the service person has obtained an annual written permit (Form HRS-H 4013, or equivalent county form) from the local Department authority.

(2) Application for a septage disposal service permit shall be made to the Department on Form HRS-H 4012 or equivalent county form. The following must be provided for evaluation prior to issuance of a service permit:

(a) Evidence that the applicant possesses adequate equipment such as a tank truck, pumps, appurtenances and tools for the work intended. Equipment shall be inspected and approved by the Department.

(b) The permanent location and address of the business where operations will originate and where equipment is to be stored when it is not in use.

(c) The proposed disposal method and the site to be used for disposing of onsite sewage disposal system septage.

(3) When a permit is issued, the number of said permit along with the name of the company, its address, phone number and the gallon capacity of the truck shall be prominently displayed on the service truck with three (3) inch letters. A septage disposal service permit may be suspended, revoked or denied by the Department, in accordance with the Administrative Procedure Act (Chapter 120, FS) for failure to comply with requirements of this Chapter.

(4) After septage is removed from an onsite waste disposal system, the original lid of the tank shall be put back in place, or be replaced with a new top if the original lid is broken or structurally defective. The tank lid shall be completely sealed and the ground backfilled and compacted so that the premise is left in a nuisance free condition.

(5) Septage shall be transported to the disposal site in such a manner so as to preclude leakage, spillage or the creation of a sanitary nuisance.

(6) The sludge and contents from onsite waste disposal systems shall be disposed of at a site approved by the local Department authority and by an approved disposal method such as soil injection, incineration, sanitary landfill, landspreading or discharge into a public sewerage system.

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History: New

10D-6.53 Abandonment of Systems

(1) Whenever the use of an onsite sewage disposal system is discontinued following connection to a sanitary sewer or condemnation or demolition of a building or property, the system shall be abandoned and any further use of the system for any purpose shall be prohibited. However, the Department of Environmental Regulation may approve the use of the retention tank where the tank is to become an integral part of a sanitary sewer system.

(2) The following actions shall be taken, in the order listed, to abandon an onsite sewage disposal system:

(a) The tank shall be pumped out.

(b) The bottom of the tank shall be opened or ruptured so as to prevent the tank from retaining water, and

(c) The tank shall be filled with clean sand or other suitable material.

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History: New

10D-6.54 General Standards for Treatment Receptacles

(1) Septic Tank Design - The following requirements shall apply to all septic tanks manufactured for use in Florida unless specifically exempted by other provisions of these rules.

(a) Septic tanks shall be watertight and may have single or multiple compartments, or tanks may be placed in series, to achieve required liquid capacity. The first chamber of a multi-compartment tank or the first tank of two or more tanks placed in series shall have a minimum effective liquid capacity of at least two-thirds (2/3) of the total required liquid capacity. Additional chambers shall have a minimum effective liquid capacity equal to or greater than one-half (1/2) of the liquid capacity of the first chamber.

(b) Each compartment shall have access provided by a sectional lid or manholes having a minimum area of 225 square inches. Access points shall be located so as to allow unobstructed access to the inlet and outlet devices. Access manholes shall extend to the ground surface to allow for inspection and servicing of the tank interior. Openings shall be provided with an appropriate mechanism to make them vandal and tamper proof.

(c) The liquid depth of compartments shall be at least forty-two (42) inches. Liquid depths greater than seventy-two (72) inches shall not be considered in determining the effective liquid capacity.

(d) A minimum free board or airspace of fifteen (15) percent of the volume of the holding capacity of the tank shall be provided.

(e) The inlet invert shall enter the tank two to four inches above the liquid level of the tank. A vented inlet tee, 90° ell or a baffle may be provided at the discretion of the manufacturer, to divert the incoming sewage. The inlet device, if utilized, shall have a minimum diameter of four (4) inches and shall not extend below the liquid surface more than 33 percent of the liquid depth.

(f) A vented outlet tee, 90° ell or a baffle shall be provided with a gas-baffle or other approved device to prevent solids from entering the soil absorption field. A minimum four (4) inch diameter outlet device shall extend below the liquid level a distance not less than thirty (30) percent nor greater than forty (40) percent of the liquid depth, and extend at least five (5) inches above the liquid level in order to provide scum storage.

(g) The inlet and outlet devices shall be located at opposite ends of the tank so as to be separated by the maximum distance possible and shall be attached in a watertight manner.

(h) Sewage flow between the first and second chamber of a multi-chamber tank or tanks in series shall interconnect with a minimum six (6) inch diameter vented, inverted U-fitting, 90° ell or tee. The device shall extend below the liquid surface approximately 33 percent of the liquid depth.

(i) Tanks shall be provided with a suitable legend cast or stamped into the wall at the inlet end, and within six (6) inches of the top of the wall. The legend shall identify the manufacturer, the year the tank was manufactured and indicate the effective liquid capacity of the tank in gallons.

(2) Individual home aerobic treatment plants - may be substituted for conventional septic tanks described in this section provided that:

(a) The unit to be installed is of a class or category approved by the Department Health Program Office and is identified by a manufacturer's catalogue or other suitable listing such as the National Sanitation Foundation (NSF).

(b) An appropriate electrical failure warning system is installed in a conspicuous location.

(c) Servicing equipment and replacement parts are readily available to provide for continuous operation of the system.

(d) Effluent from an individual home aerobic sewage treatment plant is disposed of on the owner's property in conformance with other requirements of this Chapter.

(3) Graywater retention tanks - when a separate system is installed to dispose of graywater, the retention tank for such system shall meet the following minimum design standards.

(a) The minimum effective capacity shall be as specified in Section 10D-6.48(3). Liquid depth shall be at least thirty (30) inches.

(b) Retention tanks shall be baffled and vented as specified in the septic tank construction standards found elsewhere in this section provided that an inlet tee, ell, or baffle shall be provided for graywater tanks.

(4) Grease interceptors - are not required for a residence. However, one or more grease interceptors are required where food is commercially prepared. The design of grease interceptors shall be based on standards found in Chapter 10D-9, FAC. The following general requirements apply when determining the proper use and installation of grease interceptors.

(a) Interceptors must be located so as to provide easy access for routine inspection, cleaning and maintenance. Manholes shall be provided over the inlet and outlet of each interceptor and be brought to finished grade.

(b) Sizing of grease interceptors shall be based on the equations below, provided that the minimum volume of any grease interceptor shall be seven hundred fifty (750) gallons.

1. Restaurants: (S) X (GM) X (ST) X (HR/2) X (LF) = effective capacity of grease interceptor in gallons.

S = number of seats in the dining area

GM = gallons of wastewater per meal (use 5 gallons)

ST = storage capacity factor (use 1.7)

HR = number of hours establishment is open

LF = loading factor (use: 1.25 interstate highways, 1.00 other freeways, 1.00 recreational areas, 0.80 main highways, and 0.50 other highways).

2. Other type establishments with commercial kitchens: (M) X (GM) X (ST) X (LF) = effective capacity of grease interceptor in gallons.

M = meals prepared per day

GM = gallons of wastewater per meal (use 5 gallons)

ST = storage capacity factor (use 1.7)

LF = loading factor (use: 1.25 with garbage disposal and dishwashing, 1.00 without garbage disposal, 0.75 without dishwashing, and 0.50 without dishwashing and garbage disposal.

(5) Laundry waste interceptor - when a separate system is installed to dispose of effluent or drainage from home washing machines only, the retention tank or interceptor for such system shall meet the following minimum standards.

(a) The minimum effective capacity shall be two hundred twenty-five (225) gallons.

(b) The interceptor shall be baffled and vented as specified in the septic tank construction standards found elsewhere in this section, provided that an inlet tee, ell, or baffle shall be provided. A series of removable screens, with mesh graduated from coarse (at the inlet end of the tank) to fine (outlet end) is recommended for lint removal.

(c) The interceptor shall not receive waste flow from kitchen fixtures or be used as a grease trap.

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History: New

10D-6.55 Construction Materials for Treatment Receptacles

(1) Concrete septic tanks - onsite wastewater treatment receptacles shall be watertight and may be built of precast or poured in place concrete which has a design mix for unit compressive strength of at least three thousand (3000) pounds per

square inch after twenty-eight (28) days curing.

(a) Precast concrete septic tanks with a capacity of twelve hundred (1200) gallons or less shall have a minimum wall and bottom thickness of two (2) inches. Precast tanks with a capacity exceeding twelve hundred (1200) gallons shall have a minimum wall and bottom thickness of three (3) inches. Precast concrete septic tanks shall contain steel reinforcing to facilitate handling. Septic tanks of concrete poured in place shall have a minimum wall and bottom thickness of four (4) inches. The bottoms of concrete septic tanks shall be monolithic and an integral part of the walls.

(b) Septic tanks with capacities of twelve hundred (1200) gallons or less shall have tops or covers of concrete with a minimum thickness of three (3) inches when precast and four (4) inches when poured in place. When capacities exceed twelve hundred (1200) gallons, the tops shall be precast with a minimum thickness of four (4) inches.

(c) Tops shall be reinforced with three-eights (3/8) inch steel reinforcing rods on six (6) inch centers in each direction. Whenever vehicular traffic is anticipated to cross over the septic tank or other onsite waste receptacle, traffic lids shall be installed with manhole covers to finished grade. Traffic lids shall be designed to support a minimum load of ten (10) tons.

(d) When approved by the local department authority, septic tanks may be built of brick or concrete block. When constructed of these materials, tanks shall have a minimum wall thickness of eight (8) inches .. The inside walls of the tanks must be plastered with cement mortar.

(2) Fiberglass reinforced plastic septic tanks - the following structural requirements are applicable to fiberglass septic tanks and tanks made of a comparable class of materials.

(a) Resins and sealants used in the tank manufacturing process shall be capable of effectively resisting the corrosive influences of the liquid components of sewage, sewage gases and soil burial. Materials used shall be formulated to withstand shock, vibration, normal household chemicals, earth and hydrostatic pressure when either full or empty.

(b) Not less than thirty (30) percent of the total weight of the tank shall be fiberglass reinforcement. Fiberglass tanks shall have a minimum wall thickness of one-fourth (1/4) inch, however, a thickness of no less than three-sixteenth (3/16) inch will be allowed in small isolated areas for tanks not exceeding a capacity of fifteen hundred (1500) gallons.

(c) Internal surfaces shall be coated with an appropriate gel coating to provide a smooth, pore-free, watertight surface.

(d) Tanks shall be constructed so that all parts of the tank meet the following mechanical requirements.

1. Ultimate tensile strength - minimum twelve thousand (12,000) PSI when tested in accordance with ASTM D 638-72, Standard Method of Test for Tensile Properties of Plastics.

2. Flexural strength - minimum nineteen thousand (19,000) PSI when tested in accordance with ASTM D 790-71, Standard Method of Test for Flexural Properties of Plastics.

3. Flexural modulus of elasticity (Tangent) - minimum eight hundred thousand (800,000) PSI when tested in accordance with ASTM D 790-71, Standard Method of Test for Flexural Properties of Plastics.

(e) A test report from an independent testing laboratory is required to substantiate that individual tank designs and material formulations meet the requirements of (d) 1, 2, and 3 above.

(f) Physical properties for tanks over 1500 gallons effective liquid capacity must be approved by the Department.

(g) Tank lids shall be securely fastened or sealed to prevent unwarranted access to the contents of the tanks.

(3) Septic tanks to be constructed of other materials shall have prior approval from the Department Health Program Office.

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History: New

10D-6.56 Construction Standards for Drainfield Systems

(1) Distribution box - where gravity flow is possible, a distribution box may be required for distributing sewage from the septic tank or other waste receptacle to the drainfield. The distribution box may be built as an integral part of the septic tank or may be a separate unit set on solid ground between the septic tank, or other sewage waste receptacle, and the drainfield.

(a) Distribution boxes shall be watertight, constructed of durable materials, have adequate structural strength, and be of sufficient size to accomodate the required number of drain pipe lines.

(b) Each drainfield line shall be connected individually to the box.

(c) The invert of inlets to the box shall be at least one (1) inch above the invert of the outlets. The invert of all outlets shall be on the same plane and shall be level with respect to each other.

(2) Header pipe - in lieu of a distribution box, a header pipe may be used when approved by the Department and installed in compliance with the following requirements:

(a) The header pipe shall conform to material standards in Chapter 10D-9, FAC, and have a minimum inside diameter of four (4) inches for gravity flow applications.

(b) The header pipe shall be laid level with direct, watertight connections to each drainfield line and the septic tank outlet pipe. The header pipe is not required to be encased in filter material.

(3) Automatic dosing - where the required area of the drainfield is greater than one thousand (1000) square feet, or

where a septic tank or sewage waste receptacle must be placed too low to permit gravity flow into a properly designed, constructed and located drainfield or absorption bed, an automatic dosing device shall be used. Plans and equipment specifications for automatic dosing systems shall be approved by the Department prior to construction or installation.

(a) Dosing systems for less than two thousand (2000) square feet of drainfield shall consist of a dosing tank that receives the flow from a septic tank or other sewage waste receptacle. This dosing tank shall be at least twenty-four (24) inches in diameter (or equivalent rectangular size) and shall be provided with one or more pumps with level controls set in accordance with the requirements set forth in (c) and (d) of this section. Two (2) pumps shall be required for commercial use.

(b) Systems having more than two thousand (2000) square feet of drainfield shall have two (2) dosing pumps, with each pump serving one half (1/2) of the total required absorption area. The pumps shall dose alternately.

(c) The volume of the dosing chamber between the pump operating levels shall be adequate to assure that the entire drainfield is dosed each cycle. The liquid volume of pipe typically used in drainfield systems is as follows:

PIPE SIZE	LIQUID VOLUME OF CONDUIT
2"	0.16 Gal/foot
4"	0.65 Gal/foot
6"	1.47 Gal/foot

(d) When a drainfield is installed in sand, loamy sand or sandy loam soils, operating levels should be adjusted to dose the drainfield four (4) times in a twenty-four hour period. For fine textured soils the drainfield should be dosed no more than two (2) times in a twenty-four hour period.

(e) A high water alarm shall be provided to warn of pump failures.

(4) Drain trenches and absorption beds - draintrenches and absorption beds are the standard subsurface drainfield systems used for disposing of effluent from septic tanks or other sewage waste receptacles. When used, these systems shall be constructed as specified below.

(a) When utilizing the standard drain trench method, the width of the trench at the bottom shall be eighteen (18) to twenty-four (24) inches. There shall be a minimum separation distance of six (6) feet between centers of the trenches.

(b) Absorption beds when approved by the local department authority may be used in lieu of the standard drain trench method. An absorption bed consists of an area in which the entire earth content of the required absorption area is removed and replaced with filter material and distribution pipe. The distance between the centers of distribution lines in standard beds shall be a maximum of three (3) feet for drain tiles and four (4) feet for block or cradle units. The distance between the side wall of the bed and the center of the outside drain line shall be one and one-half (1.5) feet for drain pipe and two (2) feet for block or cradle units.

(c) Drain tile, perforated pipe, and cradle or block units shall be installed in filter material of washed and screened gravel, stone, slag, or similar material meeting State of Florida Department of Transportation (DOT) specifications under Section 901, "Standard Specifications for Road and Bridge Construction, 1982". Filter material may vary in size from three-eights (3/8) inch to two (2) inches and shall be free of excessive fines which could clog the soil infiltrative surface. Approved standard sizes for various drainfield filter materials are:

MATERIAL	DOT SIZE NUMBER
Limestone, slag, and similar materials	3, 4, or 5

quartz rock and river gravel	3, 4, 5 or 6

(d) Filter material shall encase the distribution pipe to a minimum depth of (6) inches under the pipe and have a total depth of at least twelve (12) inches extending throughout the width of the trench or absorption bed. Whenever cradle or block units are permitted for use, the total depth of the filter material shall be at least fourteen (14) inches extending throughout the width of the bed with at least six (6) inches under the unit and eight (8) inches above the bottom of the unit.

(e) The filter material in place shall be protected from infiltration of earth backfill by an effective barrier of building paper, polyester bonded filament or other acceptable material as determined by the Department.

(f) The maximum depth from the invert of the drain pipe or distribution pipe to the finished ground surface shall not exceed twenty-four (24) inches. The minimum earth cover over the top of the drain tile, distribution box or header pipe in standard subsurface drainfields shall be six (6) inches.

(g) The inside diameter of the drain pipe used in drainfields shall be determined based on the type and design of the proposed absorption system. However, for standard gravity drainfield systems, inside pipe diameter shall not be less than four (4) inches. Pipes constructed of vitrified clay or plastic material shall conform to standards in Chapter 10D-9, FAC. When the above pipes are installed with open joints, the open joints shall be spaced no less than one-quarter (1/4) inch apart. Perforated pipe shall have a minimum perforated area of one and one-half (1.5) square inches per linear foot. Perforations shall be located in the bottom half of the pipe. However, for drainfield systems over five hundred (500) square feet in size, drainpipe perforation area and hole configuration shall be especially designed in order to assure equal effluent distribution throughout the drainfield area. All plastic pipe shall conform to the standards of ASTM D No. F 405-76B.

(h) Depending on the type of drainfield system being utilized, drainlines may be placed level or with a downward slope not exceeding one-half (1/2) inch per ten (10) feet. However, for standard gravity drainfield systems, drainlines shall be graded with a downward slope of one-quarter (1/4) inch to one-half (1/2) inch per ten feet.

(i) The maximum length of drain lines shall not exceed one hundred (100) feet and where two (2) or more drain lines are used, they shall be, as near as practical, the same length. The ends of two (2) or more drain lines in mound systems shall be connected to produce a continuous circuit. A continuous circuit arrangement is also recommended for standard drain trench and absorption bed systems.

Name of Person Originating Proposed Rule: John Heber

Name of Supervisor or Person who Approved the Proposed Rule:

Eanix Poole

Date Proposed Rule was Approved:

Specific Authority: 381.031(1)(g)3, FS

Law Implemented: 381.031, 381.061, 381.071, 381.261, 381.272, 381.291, 381.311, 386, FS

History: New

10D-6.57 Percolation Test Procedure

(1) When a percolation test is to be performed, one or more test holes shall be dug within the area proposed for a soil absorption system. Where soil conditions within the area are highly variable, a minimum of three (3) percolation test holes, uniformly spaced, shall be required.

(2) The diameter of each test hole shall be six (6) inches, dug or bored to the proposed depth of the absorption system. To expose a natural soil surface, the sides of the hole are scratched with a sharp pointed instrument and the loose material is removed from the bottom of the test hole. Two (2) inches of 1/2 to 3/4 inch gravel shall be placed in the hole to protect the bottom from scouring action when water is added.

(3) The hole must be carefully filled with at least twelve (12) inches of clear water. This depth of water shall be maintained for at least four (4) hours and preferably overnight

if clay soils are present. Automatic siphons or float valves may be employed to automatically maintain the water level during the soaking period. In sandy soils with little or no clay, soaking is not necessary. If, after filling the hole twice with twelve (12) inches of water, the water seeps completely away in less than ten minutes, the test can proceed immediately.

(4) Except for sandy soils, percolation rate measurements shall be made at least fifteen (15) hours, but no more than thirty (30) hours, after the soaking period began. Any soil that sloughed into the hole during the soaking period shall be removed and the water level adjusted to six (6) inches above the gravel (or eight (8) inches above the bottom of the hole). At no time during the test shall the water level be allowed to rise more than six (6) inches above the gravel. Immediately after adjustment, the water level is measured from a fixed reference point to the nearest 1/16 inch at thirty (30) minute intervals. The test shall be continued until two (2) successive water level drops do not vary by more than 1/16 inch. At least three (3) measurements must be made. After each measurement, the water level shall be readjusted to the six (6) inch level. The last water drop is used to calculate the percolation rate. In sandy soils or soils in which the first six (6) inches of water added, after the soaking period, seeps away in less than thirty (30) minutes, water level measurements are made at ten (10) minute intervals for a one (1) hour period. The last water level drop shall be used to calculate the percolation rate.

(5) The percolation rate is calculated for each test hole by dividing the time interval used between measurements by the magnitude of the last water level drop. This calculation results in a percolation rate in terms of minutes/inch. To determine the percolation rates for the area, the rates obtained from each hole shall be averaged. If tests in the area vary by more than twenty (20) minutes/inch, variations in soil types are indicated. Under these circumstances, percolation rates shall not be averaged. Percolation rate calculation example: If the last measured drop in water level after thirty (30) minutes is

two (2) inches, the percolation rate = 30 minutes/2 inches = 15 minutes per inch.

Name of Person Originating Proposed Rule: John Heber

Name of Supervisor or Person who Approved the Proposed Rule: Eanix Poole

Date Proposed Rule Approved:

Specific Authority: 381.031(1)(g)3, FS

Law Implemented: 381.031, 381.061, 381.071, 381.261, 381.272, 381.291, 381.311, 386, FS

History: New

10D-6.58 U.S. Department of Agriculture Soil Textural Classification System - Major USDA soil texture classifications are described below along with methods of field evaluation:

(1) Sand - This soil has a granular appearance in which the individual grain sizes can be detected. It is free flowing when in a dry condition. When air dry this soil will not form a cast and will fall apart when pressure is released. When moist, the soil forms a cast which will crumble when lightly touched. This soil cannot be ribboned.

(2) Sandy Loam - Is essentially a granular soil with sufficient silt and clay to make it somewhat coherent. Sand characteristics predominate. When dry, this soil forms a cast which readily falls apart when lightly touched. When moist, the soil forms a cast which will bear careful handling without breaking. This soil cannot be ribboned.

(3) Loam - This soil has a uniform mixture of sand, silt and clay and the grading of the sand fraction is quite uniform from coarse to fine. It is mellow and has a somewhat gritty feel, yet it is fairly smooth and slightly plastic. When air dry it forms a cast which will bear careful handling without breaking and, when moist, it forms a cast which can be handled freely without breaking. This soil cannot be ribboned.

(4) Silt Loam - Contains a moderate amount of the finer grades of sand and only a small amount of clay, over half of the particles are silt. When dry, it may appear quite cloddy, which readily can be broken and pulverized to a powder. When air

dry, this soil forms a cast which can be freely handled. When pulverized, it has a soft flourlike feel. When moist, a cast can be formed which can be freely handled. When wet, the soil runs together and puddles. This soil will not ribbon, but it has a broken appearance, feels smooth and may be slightly plastic.

(5) Silt - Is composed of over 80 percent silt size particles with very little sand and clay. When dry, it may be cloddy, it readily pulverizes to a powder, and it has a soft feel. When dry, it forms a cast which can be handled without breaking and, when moist, it forms a cast which can be freely handled. When wet, it readily puddles. This soil has a smooth feel and has a tendency to ribbon with a broken appearance.

(6) Clay Loam - Is a fine textured soil which breaks into hard lumps when dry. It contains more clay than silt loam and resembles clay in a dry condition. Identification is made on the basis of the physical behavior of moist soil. When air dry, it forms a cast which can be handled freely without breaking. When moist, it forms a cast which can be handled freely without breaking and it can be worked into a dense mass. This soil forms a thin ribbon which readily breaks, barely sustaining its own weight.

(7) Clay - This fine textured soil breaks into very hard lumps when dry and it is difficult to pulverize into a soft flourlike powder when dry. Liquification is based on cohesive properties of the moist soil. When both dry and moist, it forms a cast which can be freely handled without breaking. This soil forms a long thin flexible ribbon which can be worked into a dense, compact mass which has considerable plasticity.

(8) Organic - Identification of this soil is based on the high organic content. These soils occur in lowlands, in swamps or swales. Muck consists of thoroughly decomposed organic material with a considerable amount of mineral soil finely divided with some fibrous remains. When considerable fibrous material is present, organic soil may be classified as peat. In peaty soils, plant remains, or sometimes the wood structure, can be easily recognized. Organic soil color ranges from brown to

APPENDIX G

REFERENCE ON UNIFIED SYSTEM CLASSIFICATION

Once a soil has been classified using Table 1-2, it can be further described using the "group index." The group index utilizes the percent of soil passing a No. 200 sieve, the liquid limit, and the plasticity index. Using known values of these parameters, the group index is computed from the equation

NOT VALID

$$\text{group index} = (F - 35)[0.2 + 0.005(LL - 40)] + 0.01(F - 15)(PI - 10) \qquad (1\text{-}1)$$

where F = percentage of soil passing a No. 200 sieve

LL = liquid limit

PI = plasticity index

The group index computed from Eq. (1-1) is rounded off to the nearest whole number and is appended in parentheses to the group designation determined from Table 1-2. If the computed group index is either zero or negative, the number zero is used as the group index and should be appended to the group designation. If preferred, Fig. 1-3 may be used instead of Eq. (1-1) to determine the group index.

As a general rule, the value of soil as a subgrade material is in inverse ratio to its group index.

Unified Soil Classification System [4, 5, 6]

This system was developed by Casagrande and is utilized by the Corps of Engineers. It utilizes letter symbols to classify soils. The letter symbols are as follows:

G	gravel
S	sand
M	silt
C	clay
W	well graded
P	poorly graded
U	uniformly graded
L	low liquid limit
H	high liquid limit

Normally, two letter symbols are used to classify a soil. For example, SW indicates well graded sand. In classifying silts and clays, the liquid limit and

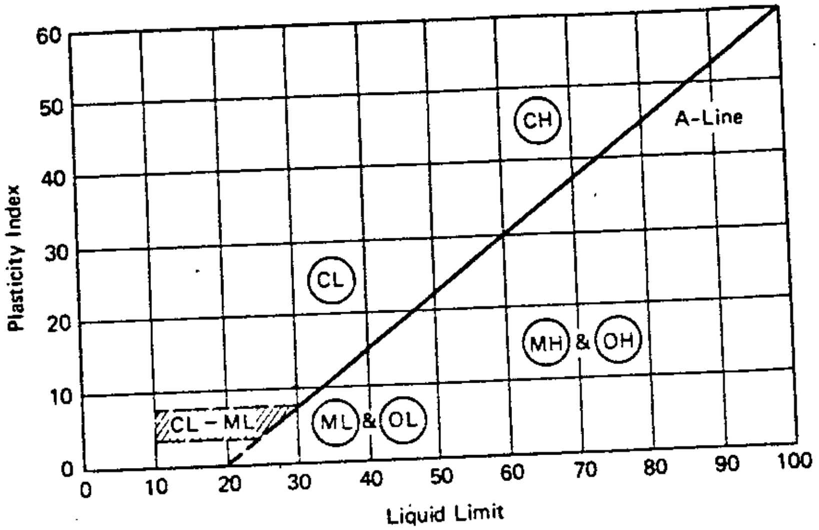


FIGURE 1-4 Plasticity chart. (From Corps of Engineers.) [6]

plastic limit are used in conjunction with the plasticity chart shown in Fig. 1-4. A chart for laboratory identification procedure is given in Fig. 1-5.

Example 1-2 illustrates the AASHTO classification system and the Unified soil classification system.

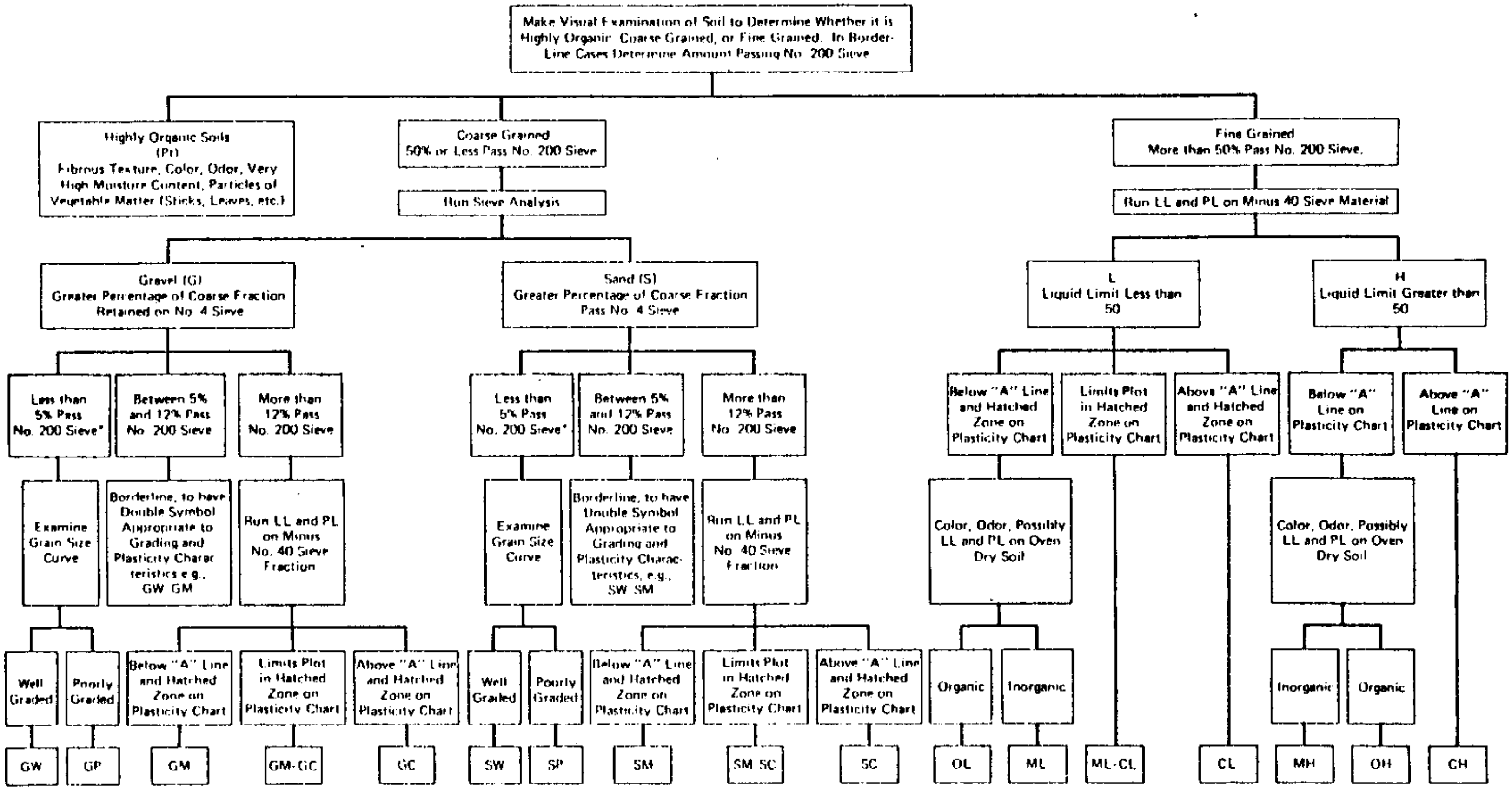
EXAMPLE 1-2

Given

A sample of soil was tested in the laboratory and the results of the laboratory tests were as follows:

1. Liquid limit = 42.3%.
2. Plastic limit = 15.8%.
3. The following sieve analysis data:

U.S. Sieve Size	*Percentage Passing*
No. 4	100
No. 10	93.2
No. 40	81.0
No. 200	60.2



Note: Sieve Sizes are U.S. Standard.
*If Fines Interfere with Free-Draining Properties use Double Symbol such as GW-GM, etc.

FIGURE 1-5 Chart for auxiliary laboratory identification procedure. (From Corps of Engineers.) [6]

Required

Classify the soil sample by

1. The AASHTO classification system.
2. The Unified soil classification system.

Solution

1. *By the AASHTO classification system:* From Table 1-2, the sample is classified as A-7. According to the AASHTO classification system, the plasticity index of the A-7-5 subgroup is equal to or less than the liquid limit minus 30, and the plasticity index of the A-7-6 subgroup is greater than the liquid limit minus 30 (see footnote under Table 1-2).

$$\text{plasticity index } (PI) = \text{liquid limit } (LL) - \text{plastic limit } (PL)$$
$$PI = 42.3 - 15.8 = 26.5\%$$
$$LL - 30 = 42.3 - 30 = 12.3\%$$
$$[PI = 26.5\%] > [LL - 30 = 12.3\%]$$

Hence, this is A-7-6 material.
From Fig. 1-3 (group index chart), with $LL = 42.3\%$ and percentage passing No. 200 sieve = 60.2%, partial group index for $LL = 5.3$. With $PI = 26.5\%$ and percentage passing No. 200 sieve = 60.2%, partial group index for $PI = 7.5$.

$$\text{Total group index} = 5.3 + 7.5 = 12.8$$

Hence, the soil is A-7-6 (13).

2. *By the Unified soil classification system:* Since the percentage passing the No. 200 sieve is 60.2%, which is greater than 50%, go to the first block (labeled "Fine-grained") in the right column of Fig. 1-5. Now, since the liquid limit is 42.3%, which is less than 50%, go downward in Fig. 1-5 to the block labeled "L." Referring next to the plasticity chart (Fig. 1-4), the sample is located above A-line and the hatched zone. Returning to Fig. 1-5, go downward to the block labeled "CL." Thus, the soil is classified, CL, according to the Unified soil classification system.

Federal Aviation Administration (FAA) Classification [6, 7]

This classification of soils is utilized by the FAA in airport construction. In this system, soil groups are designated as E-1, E-2, E-3, . . . , E-13, as determined from Table 1-3 and Fig. 1-6. As was the case with the aforementioned soil classification systems, the soil parameters of grain-size analysis,