Roadway Soil Survey
CR 664 over Peace River
Polk County, Florida
FPID: 439441-1-52-01

Ardaman & Associates, Inc.

CORPORATE HEADQUARTERS
8008 S. Orange Avenue, Orlando, FL 32809 - Phone: (407) 855-3860

Branch Office Locations
Florida: Bartow, Cocoa, Fort Myers, Miami, Orlando, Port St. Lucie, Sarasota, Tallahassee, Tampa, West Palm Beach
Louisiana: Baton Rouge, New Orleans, Shreveport
Texas: Houston

MEMBERS:
ASTM International
American Concrete Institute
Geoprofessional Business Association
Society of American Military Engineers
American Council of Engineering Companies

Ardaman & Associates, Inc.

Geotechnical, Environmental and
Materials Consultants

Revised June 28, 2023
File No. 113-19-32-460177

Florida Department of Transportation (FDOT)
District One
Post Office Box 1249
Bartow, Florida 33831-1249

Attention: Mr. Andrew Newman, P.E.
District Geotechnical Construction Engineer

Subject: Roadway Soil Survey Geotechnical Report
CR 664 over the Peace River - FPID: 439441-1-52-01
Polk County

Materials & Testing CEI Support - District Wide – FPID: 198391-1-62-18
Contract CA509 – TWO No.01.77

Dear Mr. Newman:

As requested and authorized, we have completed a roadway soil survey for the referenced section of the CR 664 project. The purpose of performing this exploration was to evaluate the general subsurface conditions at selected locations in the areas of proposed roadway and drainage improvements. This report documents our findings and presents our engineering recommendations.

This report has been prepared in accordance with generally accepted geotechnical engineering practices for specific application to the project limits indicated in this report. No other warranty, expressed or implied, is made. The soils information and recommendations submitted herein are based on the data obtained from the soil borings presented on Figures 1 through 3. This report does not reflect any variations which may occur adjacent to or between the borings. The nature and extent of the variations adjacent to or between the borings may not become evident until during construction.

It is a pleasure assisting you with this project. If you have any questions, or when we may be of further assistance to you, please do not hesitate to contact us.

Very truly yours,

ARDAMAN & ASSOCIATES, INC.
Florida Registry No. 5950

Ivan Sokolic Digitally signed by Ivan Sokolic
Date: 2023.06.28 09:43:17
-04'00'

Julian J. Coronel, P.E.
Senior Engineer

Ivan F. Sokolic, P.E.
Fort Myers Branch Manager
Florida License No. 64114

9970 Bavaria Road, Fort Myers, Florida 33913 Phone: (239) 768-6600 Fax: (239) 768-0409
Florida: Bartow, Cocoa, Fort Myers, Miami, Orlando, Port St. Lucie, Sarasota, Tallahassee, Tampa, W. Palm Beach
Louisiana: Baton Rouge, New Orleans, Shreveport
Texas: Houston

TABLE OF CONTENTS

TABLE OF CONTENTS
(CONTINUED)

List of Figures:

Appendices:

1.0 INTRODUCTION

1.1 Site Location

The site for the proposed CR 664 roadway improvements is in Polk County, Florida, a little over 1 mile east of Bowling Green, Florida. Specifically, the roadway section subject of this report is located within Section 34 of Township 32 South, Range 25 East.

1.2 Project Considerations

It is our understanding that the proposed construction includes milling and resurfacing and widening the shoulders of CR 664 from approximately 700 feet west to approximately 700 feet east of the CR 664 bridge over Peace River. Upgrades to the drainage system as well as a gravity wall are also planned as part of this project.

1.3 Purpose and Scope of Project

The purposes of this exploration were to explore shallow subsurface conditions within the roadway improvement area and stormwater ponds and to provide geotechnical engineering evaluation of the conditions encountered.

We accomplished these purposes by:

1. Obtaining and evaluating readily available soil survey data.
2. Conducting hand auger and Standard Penetration Test (SPT) borings and measuring groundwater levels.
3. Reviewing recovered soil samples in our laboratory and performing tests on selected samples to aid in classification.
4. Analyzing and interpreting the field and laboratory data.
5. Performing geotechnical engineering analyses to develop recommendations for site preparation and normal seasonal high groundwater table.

1.4 Review of Available Data

1.4.1 <u>USGS Quadrangle Map</u>

The USGS Quadrangle map for "Bowling Green, Florida", issued in 2018 indicates that the majority of roadway has been elevated to about 10 feet above the river level. The river surface appears to be at an elevation of about +50 to +55 feet. Some of the land within 0.5 miles from the river is at elevation +100 feet (North American Datum of 1983).

The soil boring profiles presented in Figures 2 and 3 are plotted to depth below the ground surface. If elevations are provided to Ardaman, soil boring profiles can be plotted to elevation, if desired.

1.4.2 Soil Survey Map

Based on the Web Soil Survey, as prepared by the U.S. Department of Agriculture Soil Conservation Service, two map units are present within the project limits. These soil map units are *72—Bradenton-Felda-Chobee association, frequently flooded* and *27—Bradenton-Felda-Chobee association, frequently flooded*.

The Bradenton component is on flood plains on marine terraces on coastal plains. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is poorly drained. Water movement in the most restrictive layer is moderately low. Available water to a depth of 60 inches (or restricted depth) is low.

The Felda component is on flood plains on marine terraces on coastal plains. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is poorly drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches (or restricted depth) is low.

The Chobee component consists of soils with slopes are 0 to 2 percent. This component is on flood plains on marine terraces on coastal plains. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is very poorly drained. Water movement in the most restrictive layer is moderately low. Available water to a depth of 60 inches (or restricted depth) is moderate.

1.4.4 Potentiometric Surface Conditions

Based on a review of the map "Potentiometric Surface of Peninsular Florida, September 2008" published by the USGS, the potentiometric surface elevation of the upper Floridan Aquifer in the vicinity of the project site is approximately +75 feet, NGVD while the natural ground surface elevation appears to be approximately +65 to +70 feet, NAVD 88 from Google Earth Pro.

2.0 FIELD EXPLORATION PROGRAM

2.1 Roadway Borings

The field exploration program relative to the roadway improvements consisted of performing hand auger borings, using the methodology outlined in ASTM D-1452, along the proposed CR 664 roadway section. A summary of this field procedure is included in Appendix I.

The hand auger borings were staggered left and right at approximate 100-foot intervals (i.e. one boring per station) of the proposed roadway section of CR 664. The hand auger borings were conducted using a 3½-inch diameter manual bucket auger and were advanced to a maximum depth of 5 feet below the existing ground surface. Upon completion of drilling, the borings were backfilled with soil cuttings.

2.2 Gravity Wall and Headwall Borings

The field exploration program relative to the gravity wall and headwall consisted of performing Standard Penetration Test (SPT) borings using the methodology outlined in ASTM D-1586. The SPT borings were advanced to a depth of 12 feet below the ground surface. Split-spoon soil samples recovered during performance of the borings were visually classified in the field and representative portions of the samples were transported to our laboratory in sealed containers. Upon completion of drilling, the borings were backfilled with cement grout.

SPT borings GW-01 and GW-02 were conducted at the ends of the proposed gravity wall and SPT boring HW-01 was conducted at the location of the proposed headwall.

2.3 Groundwater Level

An attempt was made to measure the groundwater level in the boreholes after stabilization of the downhole water level. The absence of groundwater data at the hand auger boring locations indicates that groundwater was not encountered within the vertical reaches of the borings on the date drilled. However, this does not necessarily mean that groundwater would not be encountered at these locations or within the vertical reaches of the borings at some other time. Fluctuations in groundwater levels should be anticipated throughout the year primarily due to seasonal variations in rainfall and other factors that may vary from the time the borings were conducted. The groundwater levels, where encountered in the borings, are shown on Figures 2 and 3.

2.4 Test Locations

The locations of the borings were staked in the field by representatives of Ardaman and Associates using a hand-held Global Positioning System (GPS) device, aerial images, a wheel tape, and estimating distances from existing structures. Locations should be considered accurate only to the degree implied by the method of measurement used. Handheld GPS devices are typically accurate to ± 20 feet, depending on field conditions. The approximate locations of the tests performed in the field are illustrated on Figures 2 and 3.

3.0 LABORATORY TESTING PROGRAM

3.1 Visual Examination and Classification Testing

Representative soil samples obtained during our field sampling operation were packaged and transferred to our laboratory for further visual examination and classification to obtain more accurate descriptions of the existing soil strata. The roadway soil samples were visually classified in general accordance with the AASHTO Soil Classification System. The soil samples related to the gravity wall and the headwall structure were visually classified in general accordance with the Unified Soil Classification System (USCS). In addition, laboratory tests were conducted, which included water content, percent finer than #200, and Atterberg limits.

The resulting soil descriptions and the results of the tests for the roadway auger borings and SPT borings are summarized on the Roadway Soil Survey, Report of Auger Borings, and Report of Core Borings sheets, presented on Figures 1, 2 and 3.

4.0 CONCLUSIONS AND RECOMMENDATIONS

4.1 General Soil Stratigraphy

The results of the field exploration and laboratory testing programs are graphically summarized on the Roadway Soil Survey sheet (Figure 1) and the Boring Profile sheets (Figures 2 and 3). The stratification of the boring profiles represents our interpretation of the field boring logs and the results of the laboratory examination of the recovered samples. The stratification lines represent the approximate boundary between soil types. The actual transitions may be more gradual than implied.

The results of our exploration indicate that the soil conditions encountered in the borings presented on Figures 2 and 3 are appropriate for construction of the proposed roadway in accordance with standard FDOT design and construction practices. For the roadways, Soil Stratum 1 (A-3) may be considered as select material based on FDOT Standard Plans Index 120-001. However, Stratum 2 (A-2-4) may retain excess moisture and may be difficult to dry and compact. Soil Stratum 3 is very hard material such as limestone boulders.

For the gravity wall and headwall, in general, the SPT borings encountered a range of loose to dense sands, very stiff to hard silts to the termination depth of 12 feet below the existing ground surface. The soils encountered consisted of fine SAND (SP), slightly silty fine SAND (SP-SM), silty fine SAND (SM), and sandy SILT (ML and MH).

4.2 Groundwater Control

Some form of groundwater control (dewatering) may be required during construction in areas of high groundwater conditions. Positive site drainage should be established early during construction in order to reduce ponding of surface water during heavy or prolonged rainfall. Means and methods of groundwater and surface water control should be the responsibility of the contractor.

4.3 Normal Seasonal High Groundwater Level

The groundwater level is affected by a number of factors. The amount of rainfall and the drainage characteristics of the soils, the land surface elevation, relief points such as drainage ditches, lakes, rivers, swamp areas, etc., and distance to relief points are some of the more important factors influencing the groundwater level.

The normal seasonal high groundwater level each year is the level in the August-September period at the end of the rainy season during a year of normal (average) rainfall. The water table elevations associated with a flood level would be much higher than the normal seasonal high water level elevations and could occur at times outside of the August-September period. The normal high water levels would more approximate the normal seasonal high groundwater levels.

Based on our interpretation of the site conditions using our boring log data, we have estimated the normal seasonal high groundwater level at the boring locations to be at 4 feet below the existing ground surface at the time of our field exploration. If site drainage conditions are altered from those existing at the time of our borings, our estimates may not be valid.

4.4 **Proposed Gravity Wall**

The design criteria for the gravity wall, as defined by the Standard Plan Instructions for *Index 100-011 Gravity Wall*, requires the corrected average SPT blow count within 1.5 times the base width below the wall to be 10 blows/ft or greater. Assuming a maximum wall footing width of approximately 3 ¾ feet and a foundation embedment of 2 feet, we analyzed the top 7 ½ feet below the ground surface and averaged the corrected SPT blows counts at the two SPT boring locations. The test boring locations met or exceeded the required criterion of 10 blows/ft.

4.5 **Construction Considerations**

Roadway construction should be performed in accordance with the appropriate sections of the FDOT current edition of the Standard Specifications for Road and Bridge Construction. If needed, backfill should generally consist of select material compacted in accordance with the FDOT Standard Specifications for Road and Bridge Construction. In-place density tests should be performed on the fill soils to verify the specified degree of compaction. The minimum density test frequency should be in accordance with the FDOT Materials, Sampling, Testing, and Reporting Guide. Fill placement and side slopes for embankment construction are presented in the FDOT Standard Plan 120-001.

It should be noted that one of the hand auger borings was terminated prematurely due to the presence of a very hard material such as limestone boulders. These conditions may be encountered in various areas of the project. Such materials will be difficult to excavate or penetrate. The contractor shall expect to encounter these very hard materials in all excavations and shall use specialized equipment and/or procedures as necessary to facilitate penetration and/or dewatering.

FIGURE 1

Roadway Soil Survey

DATE OF SURVEY: MAY 2023
SURVEY MADE BY: ARDAMAN & ASSOCIATES, INC.
SUBMITTED BY: IVAN F. SOKOLIC, P.E.

STATE OF FLORIDA
DEPARTMENT OF TRANSPORTATION
MATERIALS AND RESEARCH

DISTRICT: ONE
ROAD NO.: CR 664
COUNTY: POLK

FINANCIAL PROJECT ID : 439441-1-52-01
PROJECT NAME: CR 664 ROADWAY WIDENING

CROSS SECTION SOIL SURVEY FOR THE DESIGN OF ROADS

SURVEY BEGINS STA. : 1002 SURVEY ENDS STA. : 1015

REFERENCE: CENTERLINE OF CONSTRUCTION CR 664

	ORGANIC CONTENT		MOISTURE CONTENT		SIEVE ANALYSIS RESULTS PERCENT PASS (%)						ATTERBERG LIMITS (%)					CORROSION TEST RESULTS				
STRATUM NO.	NO. OF TESTS	% ORGANIC	NO. OF TESTS	MOISTURE CONTENT	NO. OF TESTS	10 MESH	40 MESH	60 MESH	100 MESH	200 MESH	NO. OF TESTS	LIQUID LIMIT	PLASTIC INDEX	AASHTO GROUP	DESCRIPTION	NO. OF TESTS	RESISTIVITY ohm-cm	CHLORIDE ppm	SULFATES ppm	pH
1	--	--	--	--	--	--	--	--	--	--	--	--	--	A-3	Brown to gray fine SAND to slightly silty fine SAND	--	--	--	--	--
2	--	--	2	14.5-15.0	2	--	--	--	--	19.9-21.3	--	--	--	A-2-4	Brown to gray silty fine SAND	--	--	--	--	--
3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	LIMESTONE (rock), possible boulder	--	--	--	--	--

EMBANKMENT AND SUBGRADE MATERIAL

STRATA BOUNDARIES ARE APPROXIMATE. MAKE FINAL CHECK AFTER GRADING.

▽ - WATER TABLE ENCOUNTERED
GNE - GROUNDWATER NOT ENCOUNTERED
▼ - ESTIMATED NORMAL SEASONAL HIGH GROUNDWATER TABLE (SHGWT)

THE MATERIAL FROM STRATUM NUMBER 1 IS SELECT (A-3) MATERIAL AND APPEARS SATISFACTORY FOR USE IN SUBGRADE AND EMBANKMENT WHEN UTILIZED IN ACCORDANCE WITH FDOT STANDARD PLAN 120-002..

THE MATERIAL FROM STRATUM NUMBER 2 IS SELECT (A-2-4) MATERIAL AND APPEARS SATISFACTORY FOR USE IN THE EMBANKMENT WHEN UTILIZED IN ACCORDANCE WITH FDOT STANDARD PLAN 120-001. HOWEVER, THIS MATERIAL IS LIKELY TO RETAIN EXCESS MOISTURE AND MAY BE DIFFICULT TO DRY AND COMPACT. IT SHOULD BE USED IN THE EMBANKMENT ABOVE WATER LEVEL EXISTING AT THE TIME OF CONSTRUCTION.

LAYERS OF VERY HARD MATERIAL SUCH AS LIMESTONE (ROCK) AND BOULDERS MAY BE ENCOUNTERED IN VARIOUS AREAS OF THIS PROJECT. SUCH MATERIALS WILL BE DIFFICULT TO EXCAVATE OR PENETRATE. THE CONTRACTOR SHALL EXPECT TO ENCOUNTER THESE VERY HARD MATERIALS IN ALL EXCAVATIONS AND SHALL USE SPECIALIZED EQUIPMENT AND/OR PROCEDURES AS NECESSARY TO FACILITATE PENETRATION AND/OR DEWATERING.

THE "--" INDICATES AN UNMEASURED PARAMETER.

REVISIONS			
DATE	DESCRIPTION	DATE	DESCRIPTION

ENGINEER OF RECORD:
IVAN F. SOKOLIC, P.E. #64114
ARDAMAN AND ASSOCIATES, INC.
9970 BAVARIAN ROAD
FORT MYERS, FLORIDA 33913

LEE COUNTY
DEPARTMENT OF TRANSPORTATION

PROJECT	COUNTY	FINANCIAL PROJECT ID
CR 664	POLK	439441-1-52-01

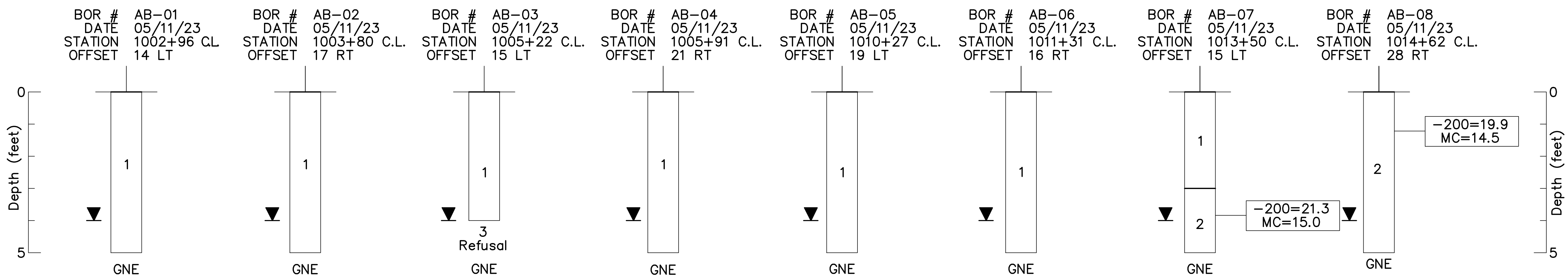
ROADWAY SOIL SURVEY

SHEET NO. GR-2

Katie.mcgee

FIGURE 2

Report of Auger Borings



STRATUM NO.	AASHTO GROUP	DESCRIPTION
1	A−3	Brown to gray fine SAND
2	A−2−4	Brown to gray silty fine SAND
3		LIMESTONE (rock), possible boulder

LEGEND

- ⌖ Approximate auger boring location
- GNE Groundwater not encountered
- −200 Percent passing the no. 200 standard sieve
- MC Percent moisture content
- A−3 AASHTO group symbol as determined by visual review and/or laboratory testing
- C.L. Centerline of Construction of CR 664
- ▼ Estimated Normal Seasonal High Groundwater Table (SHGWT)

NOTES:

Stations and offsets were estimated using Roadway Plans provided by FDOT.

Geographical GPS coordinate locations were determined using a handheld GPS unit.

Boring logs shown represent subsurface conditions within the borehole at time of drilling. No warranty as to the subsurface conditions, strata depth or soil consistency between or outside boring location is expressed or implied by this drawing.

Absence of water data on certain borings implies that no groundwater data is available, but does not necessarily mean that groundwater will not be encountered at those locations or within the vertical reaches of these borings in the future.

REVISIONS

DATE	BY	DESCRIPTION	DATE	BY	DESCRIPTION

ENGINEER OF RECORD:
IVAN F. SOKOLIC, P.E. No. 64114
ARDAMAN AND ASSOCIATES, INC.
9970 BAVARIA ROAD
FORT MYERS, FLORIDA 33913

DRAWN BY: KM
CHECKED BY: IS
DESIGNED BY: KM
CHECKED BY: IS

STATE OF FLORIDA
DEPARTMENT OF TRANSPORTATION

ROAD NO.	COUNTY	FINANCIAL PROJECT ID
CR 664	POLK	449176-1-52-01

REPORT OF AUGER BORINGS

SHEET No. GR-3

FIGURE 3

Report of Core Borings

APPROXIMATE SCALE

N

LEGEND:

- SAND: Sand with ≤ 12% fines
- Clayey SAND: Sand with 12% to 50% Clay
- Silty SAND: Sand with 12% to 50% Silt
- Sandy SILT: Sand/ Silt Mixture with > 50% Silt

▽	Water Table existing at time of boring
⊕	Soil Boring Location
-200	Percent Passing the no. 200 Standard Sieve
MC	Natural Moisture Content (%)
LL	Liquid Limit (%)
PI	Plastic Index (%)

ENVIRONMENTAL CLASSIFICATION

ASSUMED EXTREMELY AGGRESSIVE FOR DESIGN PURPOSES

GRANULAR MATERIALS		
	Safety Hammer SPT N-Value Blows/Foot	Automatic Hammer SPT N-Value Blows/Foot
Relative Density		
Very Loose	Less than 4	Less than 3
Loose	4 - 10	3 - 8
Medium	10 - 30	8 - 24
Dense	30 - 50	24 - 40
Very Dense	Greater than 50	Greater than 40

SILTS AND CLAYS		
	Safety Hammer SPT N-Value Blows/Foot	Automatic Hammer SPT N-Value Blows/Foot
Consistency		
Very Soft	Less than 2	Less than 1
Soft	2 - 4	1 - 3
Firm	4 - 8	3 - 6
Stiff	8 - 15	6 - 12
Very Stiff	15 - 30	12 - 24
Hard	Greater than 30	Greater than 24

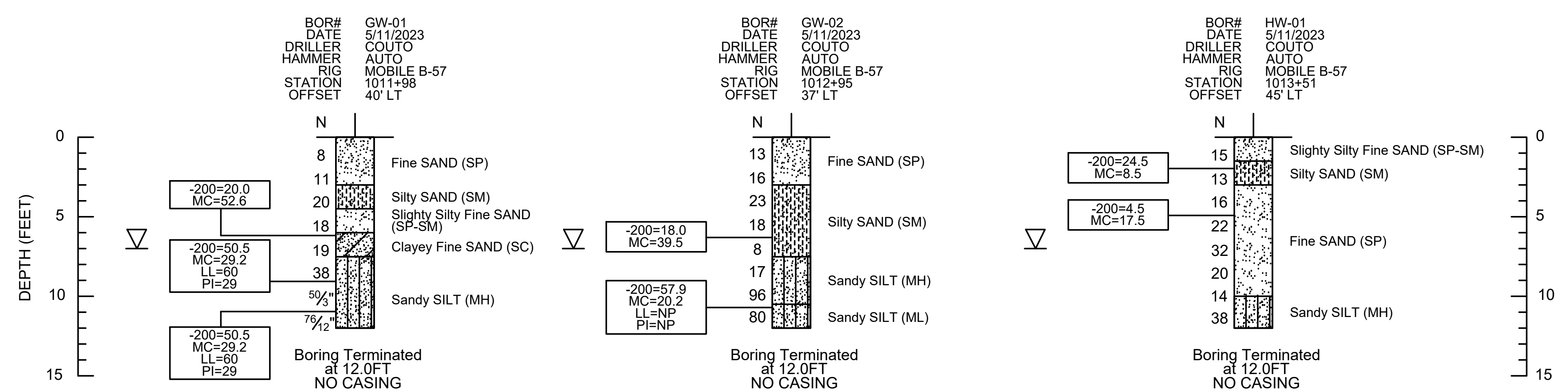
Numbers to the left of borings indicate SPT values for 12" penetration (unless otherwise noted).

50/4" Number of blows for given penetration (i.e. 50 blows for 4 inches)

Geographical GPS coordinate locations were determined using a 4 satellite minimum autonomous solution from WAAS enabled hand held GPS unit. The boring profiles shown represent subsurface condition. Strata depth of soil consistency between or outside locations is expressed or implied by this drawing.

While the borings are representative of subsurface conditions at their respective locations and for their respective vertical reaches, local variations characteristic of the subsurface materials of the region are anticipated to be encountered. The boring profiles and related information are based on the driller's logs and visual evaluation of selected samples in the laboratory. The delineation between soil types shown on the profiles is approximate and the description represents our interpretation of subsurface conditions at the designated boring locations on the particular date drilled. No warranty as to the subsurface condition, strata depth or soil consistency between or outside boring locations is expressed or implied by this drawing.

Groundwater data shown on the boring profiles represent groundwater surfaces encountered on the dates shown. Fluctuations in water table levels should be anticipated throughout the year



THE OFFICIAL RECORD OF THIS SHEET IS THE ELECTRONIC FILE DIGITALLY SIGNED AND SEALED UNDER RULE 61G15-23.004, F.A.C.

REVISIONS					
DATE	BY	DESCRIPTION	DATE	BY	DESCRIPTION

ENGINEER OF RECORD:
IVAN F. SOKOLIC, P.E. No. 64114
ARDAMAN AND ASSOCIATES, INC.
9970 BAVARIA ROAD
FORT MYERS, FLORIDA 33913

DRAWN BY:	KM
CHECKED BY:	IS
DESIGNED BY:	KM
CHECKED BY:	IS

STATE OF FLORIDA
DEPARTMENT OF TRANSPORTATION

ROAD NO.	COUNTY	FINANCIAL PROJECT ID
CR 664	POLK	449176-1-52-01

REPORT OF CORE BORINGS

SHEET No.
GR-1

APPENDIX I

Hand Auger, Auger and SPT Boring Procedures

SOIL BORING, SAMPLING AND TESTING METHODS

STANDARD PENETRATION TEST

The Standard Penetration Test (SPT) is a widely accepted method of in-situ testing of foundation soils (ASTM D-1586). A 2-foot (0.6 m) long, 2-inch (50 mm) O.D. split-barrel sampler attached tothe end of a string of drilling rods is driven 18 inches (0.45 m) into the ground by successive blowsof a 140-pound (63.5 Kg) hammer freely dropping 30 inches (0.76 m). The number of blows neededfor each 6 inches (0.15 m) of penetration is recorded. The sum of the blows required for penetration of the second and third 6-inch (0.15 m) increments penetration constitutes the test result or N- value. After the test, the sampler is extracted from the ground and opened to allow visual description of the retained soil sample. The N-value has been empirically correlated with various soil properties allowing a conservative estimate of the behavior of soils under load. The following tables relate N- values to a qualitative description of soil density and, for cohesive soils, an approximate unconfined compressive strength (Qu):

N-Value		
Safety Hammer	**Auto Hammer**	
Cohesionless Soils		***Description Relative Density***
< 4	< 3	Very loose 0 - 15%
4 - 10	3 - 8	Loose 15 - 35%
10 - 30	8 - 24	Medium 35 - 65%
30 - 50	24 - 40	Dense 65 - 85%
> 50	> 40	Very dense 85 - 100%
Cohesive Soils		***Unconfined Compressive***
< 2	< 1	Very soft < 0.25 tsf (25 kPa)
2 - 4	1 - 3	Soft 0.25 - 0.50 tsf (25 - 50 kPa)
4 - 8	3 - 6	Firm 0.50 - 1.0 tsf (50 - 100 kPa)
8 - 15	6 - 12	Stiff 1.0 - 2.0 tsf (100 - 200 kPa)
15 - 30	12 - 24	Very stiff 2.0 - 4.0 tsf (200 - 400 kPa)
> 30	> 24	Hard > 4.0 tsf (400 kPa)

The tests are usually performed at 5-foot (1.5 m) intervals. However, more frequent or continuoustesting is done by our firm through depths where a more accurate definition of the soils is required.The test holes are advanced to the test elevations by rotary drilling with a cutting bit, using circulating fluid to remove the cuttings and hold the fine grains in suspension. The circulating fluid,which is bentonitic drilling mud, is also used to keep the hole open below the water table by maintaining an excess hydrostatic pressure inside the hole. In some soil deposits, particularly highly pervious ones, flush-coupled casing must be driven to just above the testing depth to keep the hole open and/or prevent the loss of circulating fluid. After completion of a test boring, the hole is keptopen until a steady state groundwater level is recorded. The hole is then sealed by backfilling withneat cement.

Representative split-spoon samples from each sampling interval and from different strata are brought to our laboratory in air-tight jars for classification and testing, if necessary. Afterwards, the samples are discarded unless prior arrangements have been made.

POWER AUGER BORINGS

Auger borings are used when a relatively large, continuous sampling of soil strata close to the ground surface is desired. A 4-inch (100 mm) diameter, continuous flight, helical auger with a cutting head at its end is screwed into the ground in 5-foot (1.5 m) sections. It is powered by the rotary drill rig. The sample is recovered by withdrawing the auger out of the ground without rotating it. The soil sample so obtained, is described and representative samples put in bags or jars and returned to the laboratory for classification and testing, if necessary.

HAND AUGER BORINGS

Hand auger borings are used, if soil conditions are favorable, when the soil strata are to be determined within a shallow (approximately 5-foot [1.5 m]) depth or when access is not available to power drilling equipment. A 3-inch (75 mm) diameter hand bucket auger with a cutting head is simultaneously turned and pressed into the ground. The bucket auger is retrieved at approximately 6-inch (0.15 m) intervals and its contents emptied for inspection. Sometimes post- hole diggers are used, especially in the upper 3 feet (1 m) or so. The soil sample obtained isdescribed and representative samples put in bags or jars and transported to the laboratory for classification and testing, if necessary.

UNDISTURBED SAMPLING

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

Normally, we obtain undisturbed samples by pushing a 2.875-inch (73 mm) I.D., thin wall seamlesssteel tube 24 inches (0.6 m) into the soil with a single stroke of a hydraulic ram. The sampler, whichis a Shelby tube, is 30 (0.8 m) inches long. After the sampler is retrieved, the ends are sealed in thefield and it is transported to our laboratory for visual description and testing, as needed. Undisturbedsampling is noted on the boring logs as thus "U-".

LABORATORY TEST METHODS

Soil samples returned to our laboratory are looked at again by a geotechnical engineer or geotechnician to obtain more accurate descriptions of the soil strata. Laboratory testing is performed on selected samples as deemed necessary to aid in soil classification and to help define engineering properties of the soils. The test results are presented on the soil boring logs at thedepths at which the respective sample was recovered, except that grain-size distributions or selected other test results may be presented on separate tables, figures or plates as discussed in this report, the results of which will be located in an Appendix. The soil descriptions shown on the logs are based upon visual-manual procedures in accordance with local practice. Soil classification is in general accordance with AASHTO M-145 or ASTM D-3282: The Classification of Soils and Soil Aggregate Mixtures for Highway Construction Purposes and is also based on visual-manual procedures. Following is a list of abbreviations that may appear in the Remarks column on the boring logs indicating additional laboratory testing was performed, the results of which will usually be located in an Appendix.

DD: Unit Weight/Classification of Undisturbed "Shelby Tube" samples

PP: Pocket Penetrometer reading on cohesive samples in tons per sq. ft. (tsf)

k: Hydraulic Conductivity

Qu: Unconfined Compression Strength; ASTM D-2166

UU: Unconsolidated-Undrained Triaxial Test; ASTM D 2850

Consol: One-Dimensional Consolidation test performed on subsample from undisturbedsample; ASTM D-2435

THE PROJECT SOIL DESCRIPTION PROCEDURE FOR SOUTHWEST FLORIDA [(1)]

CLASSIFICATION OF SOILS FOR ENGINEERING PURPOSES

BOULDERS (>12 in [300 mm]) and COBBLES (3 in [75 mm] to 12 in [300 mm]):

GRAVEL:
- Coarse Gravel: ¾ in (19 mm) to 3 in (75 mm)
- Fine Gravel: No. 4 (4.75 mm) Sieve to ¾ in (19 mm)

Descriptive Adjectives:

0 – 5%	---	no mention of gravel in description
>5% – 15%	---	trace
>15% – 30%	---	some
>30% – 50%	---	gravelly (shell, limerock, cemented sands)

SANDS:
- Coarse Sand: No. 10 (2 mm) Sieve to No. 4 (4.75 mm) Sieve
- Medium sand: No. 40 (425 μm) Sieve to No. 10 (2 mm) Sieve
- Fine sand: No. 200 (75 μm) Sieve to No. 40 (425 μm) Sieve

Descriptive Adjectives:

0 – 5%	---	no mention of sand in description
>5% – 15%	---	trace
>15% – 30%	---	some
>30% – 50%	---	sandy

SILT/CLAY: <#200 (75 μm) Sieve

Silty or Silt: PI < 4
Silty Clayey or Silty Clay: 4 ≤ PI ≤ 7
Clayey or Clay: PI > 7

Descriptive Adjectives:

0 – 5%	---	clean (no mention of silt or clay in description)
>5% – 12%	---	slightly
>12% – 30%	---	clayey, silty, or silty clayey
>30% – 50%	---	very

ORGANIC SOILS:

Organic Content	Descriptive Adjectives:	Classification:
0 – 2.5%	no mention of organics in description	see above
2.6 – 5%	slightly organic	see above
>5 – 20%	organic	add "with organic fines" to group name
>20-75%	highly organic sand or muck sandy peat	Peat (PT)
>75%	fibrous peat	Peat (PT)

STRATIFICATION AND STRUCTURE:

Descriptive Term:	Thickness:
seam:	less than ½ in (13 mm) thick
layer:	½ to 12 in (13 to 300 mm) thick
stratum:	more than 12 in (300 mm) thick
pocket:	small, erratic deposit, usually less than 1 ft
occasional:	1 or less per ft of thickness

Descriptive Term:	Thickness:
frequent:	more than 1 per ft of thickness
calcareous:	containing calcium carbonate (reaction to diluted HCL)
hardpan:	spodic horizon usually medium dense
marl:	mixture of carbonate clays, silts, shells and sands.

ROCK CLASSIFICATION:

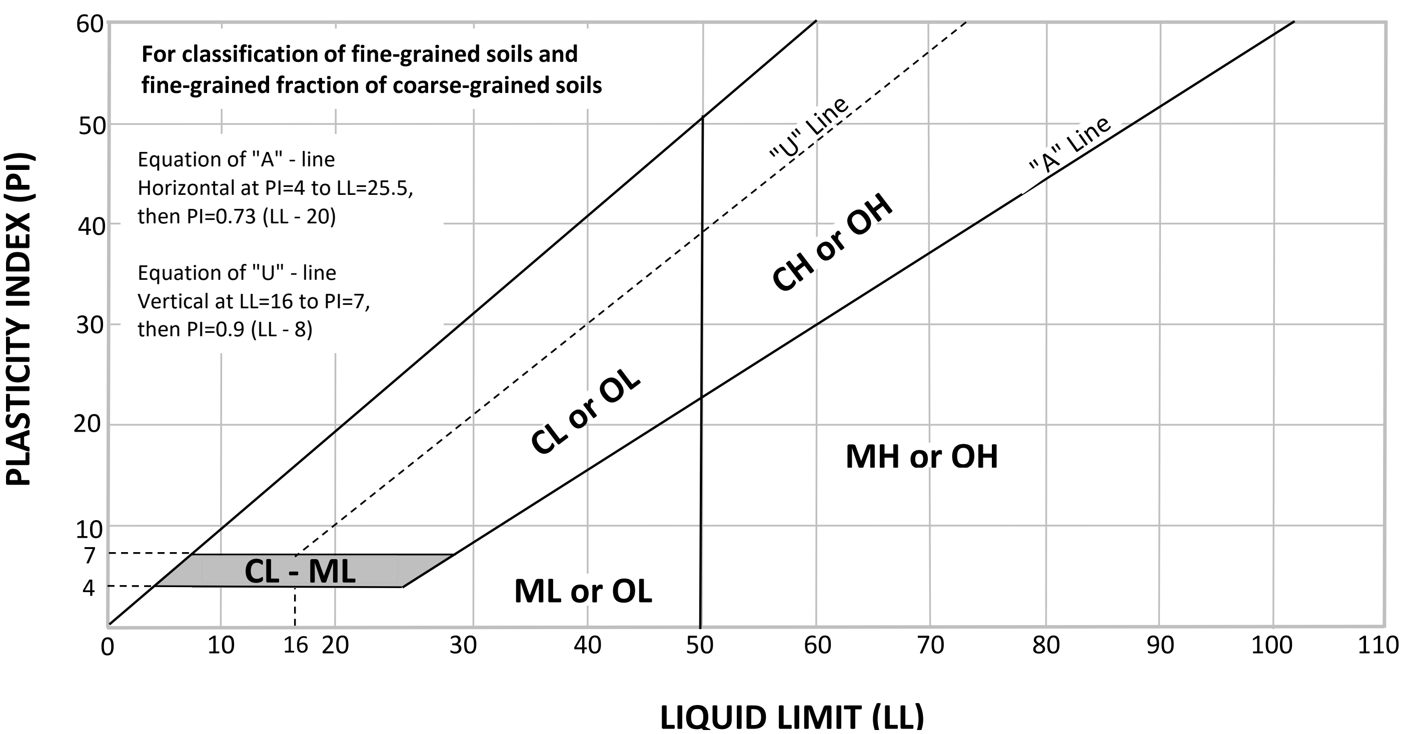
Description:
Hard Limestone or Caprock: N-values >50 bpf
Soft Weathered Limestone: N-values ≤ 50 bpf

(1) This soil description procedure was developed specifically for projects in southwest Florida because it is believed that the terminology will be better understood as a result of local practice. It is not intended to supplant other visual-manual classification procedures for description and identification of soils such as ASTM D-2488.

UNIFIED SOIL CLASSIFICATION SYSTEM (ASTM D-2487)

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [A]				Soil Classification	
				Group Symbol	**Group Name**[B]
Coarse Grained Soils: More than 50% retained on No. 200 sieve	**Gravels:** More than 50% of coarse fraction retained on No. 4 sieve	**Clean Gravels:** Less than 5% fines[C]	$C_u > 4$ and $1 < C_c < 3$[E]	GW	Well graded gravel[F]
			$C_u < 4$ and/or $1 > C_c > 3$[E]	GP	Poorly graded gravel[F]
		Gravels with Fines: More than 12% fines[C]	Fines classify as ML or MH	GM	Silty gravel[F,G,H]
			Fines classify as CL or CH	GC	Clayey gravel[F,G,H]
	Sands: 50% or more of coarse fraction passes No. 4 sieve	**Clean Sands:** Less than 5% fines[D]	$C_u \geq 6$ and $1 \leq C_c \leq 3$[E]	SW	Well graded sand[I]
			$C_u < 6$ and/or $1 > C_c > 3$[E]	SP	Poorly graded sand[I]
		Sands with Fines: More than 12% fines[D]	Fines classify as ML or MH	SM	Silty sand[G,H,I]
			Fines classify as CL or CH	SC	Clayey sand[G,H,I]
Fine Grained Soils: 50% or more passes the No. 200 sieve	**Silts and Clays:** Liquid limit less than 50	**Inorganic:**	PI > 7 and plots on or above "A" line[J]	CL	Lean clay[K,L,M]
			PI < 4 or plots below "A" line[J]	ML	Silt[K,L,M]
		Organic:	Liquid limit - oven dried (< 0.75)	OL	Organic clay[K,L,M,N]
			Liquid limit - not dried (< 0.75)	OL	Organic silt[K,L,M,O]
	Silts and Clays: Liquid limit 50 or more	**Inorganic:**	PI plots on or above "A" line	CH	Fat clay[K,L,M]
			PI plots below "A" line	MH	Elastic silt[K,L,M]
		Organic:	Liquid limit - oven dried (< 0.75)	OH	Organic clay[K,L,M,P]
			Liquid limit - not dried (< 0.75)	OH	Organic clay[K,L,M,Q]
Highly organic soils:		Primarily organic matter, dark in color, and organic odor		PT	Peat

[A] Based on the material passing the 3-in (75-mm) sieve.
[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.
[C] Gravels with 5 to 12% fines require dual symbols: GW-GM well graded gravel with silt, GW-GC well graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.
[D] Sands with 5 to 12% fines require dual symbols: SW-SM well graded sand with silt, SW-SC well graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay.
[E] $C_u = D_{60}/D_{10}$ $C_C = D_{30}^2/(D_{10} x D_{60})$
[F] If soil contains ≥ 15% sand, add "with sand" to group name.
[G] If fines classify as CL-ML, use dual symbol GC-GM or SC-SM.
[H] If fines are organic, add "with organic fines" to group name.
[I] If soil contains ≥ 15% gravel, add "with gravel" to group name.
[J] If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.
[K] If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel", whichever is predominant.
[L] If soil contains ≥ 30% plus No. 200 predominantly sand, add "sandy" to group name.
[M] If soil contains ≥ 30% plus No. 200 predominantly gravel, add "gravelly" to group name.
[N] PI ≥ 4 and plots on or above "A" line.
[O] PI < 4 or plots below "A" line.
[P] PI plots on or above "A" line.
[Q] PI plots below "A" line.

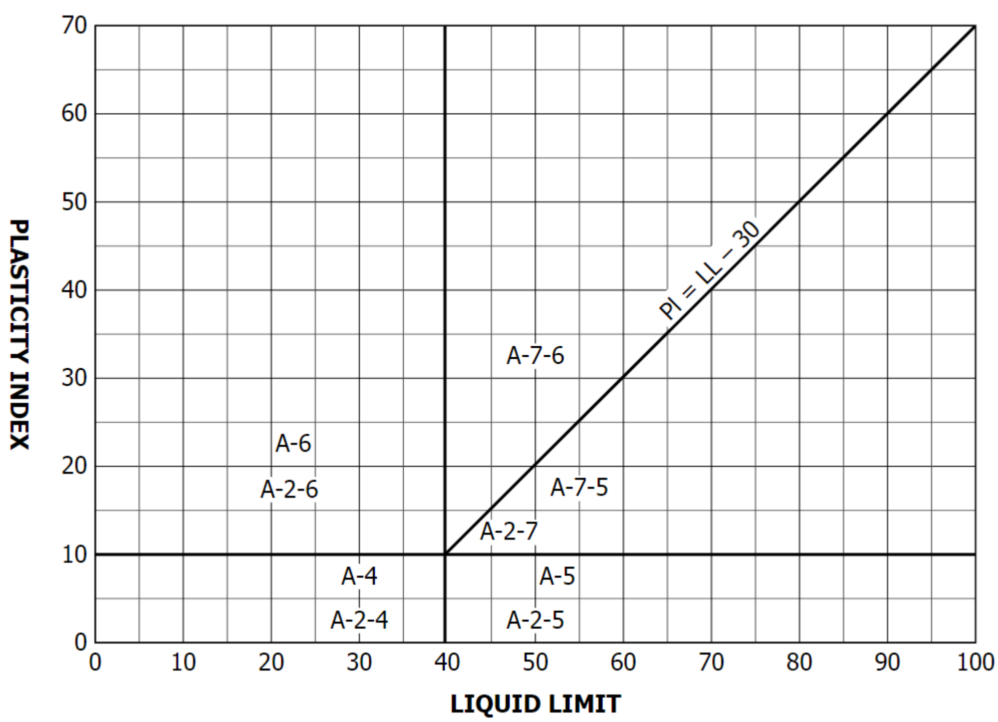


CLASSIFICATION OF SOILS AND SOIL-AGGREGATE MIXTURES FOR HIGHWAY CONSTRUCTION PURPOSES (AASHTO M145/ASTM D3282)

TABLE 2 Classification of Soils and Soil-Aggregate Mixtures

General *Classification*	Granular Materials 35 % or Less Passing 75 µm (No. 200)							*Silt*-*Clay* Materials More Than 35 % Passing 75 µm (No. 200)			
Group *Classification*	A-1		A-3	A-2				A-4	A-5	A-6	A-7
	A-1-a	A-1-b		A-2-4	A-2-5	A-2-6	A-2-7				A-7-5, A-7-6
Sieve analysis, % passing:											
2.00 mm (No. 10)	50 max	...	...	...	...	...	...	...	...	...	...
425 µm (No. 40)	30 max	50 max	51 min	...	...	...	...	...	...	...	...
75 µm (No. 200)	15 max	25 max	10 max	35 max	35 max	35 max	35 max	36 min	36 min	36 min	36 min
Characteristics of fraction passing 425 µm (No. 40):											
Liquid Limit	...		...	40 max	41 min	40 max	41 min	40 max	41 min	40 max	41 min
Plasticity Index	6 max		N.P.	10 max	10 max	11 min	11 min	10 max	10 max	11 min	11 min[A]
Usual types of significant constituent materials	*Stone* Fragments, *Gravel* and *Sand*		Fine *Sand*	Silty or Clayey *Gravel* and *Sand*				Silty Soils		Clayey Soils	
General rating as *subgrade*	Excellent to Good							Fair to Poor			

(A) Plasticity index of A-7-5 subgroup is equal to or less than LL minus 30. Plasticity index of A-7-6 subgroup is greater than LL minus 30 (see Fig. 1).



A-2 soils contain less than 35 % passing the 75-µm (No. 200) sieve.

FIG. 1 Liquid Limit and Plasticity Index Ranges for Silt-Clay Materials