FOUNDATION INVESTIGATION PHASE I FIRE FIGHTING TRAINING UNIT SITE FEASIBILITY STUDY WITH TRANSMITTAL NS GREAT LAKES IL
10/19/1987
DAMES & MOORE

FOUNDATION INVESTIGATION - PHASE I

Fire Fighting Training Unit

Site Feasibility Study

Great Lakes Naval Training Center, Illinois

For

Lester B. Knight & Associates, Inc.

Dames & Moore

7101 Wisconsin Avenue, Suite 700, Bethesda, MD 20814

October 19, 1987

DAMES & MOORE A PROFESSIONAL LIMITED PARTNERSHIP
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October 19, 1987

Lester B. Knight & Associates, Inc.
549 West Randolph Street
Chicago, IL 60606

Attn: Mr. Donald A. Lindstrom
Project Manager

Re: Foundation Investigation - Phase I
FFTU Site Feasibility Study
Great Lakes Naval Training
Center, Illinois

Gentlemen:

We are pleased to submit five copies of our report on the Phase I Foundation Investigation for the FFTU Site Feasibility Study. The purpose of this investigation was to perform a preliminary evaluation of subsurface conditions at two proposed sites--Camp Moffett and the Golf Course--and develop preliminary recommendations pertaining to foundation systems and pavement design parameters.

The scope of work for this investigation was outlined in our proposal dated September 18, 1987. As described in the proposal, results of chemical analysis of selected soil samples obtained during this investigation will be provided in a separate report.

If you have any questions or require additional information, please do not hesitate to call us.

Very truly yours,

DAMES & MOORE

Richard C. Tucker
Partner (Ltd.)

Barbara E. Cook
Project Manager

CONTENTS

INTRODUCTION

This report presents the results of Dames & Moore's preliminary (Phase I) foundation investigation of two potential sites for the proposed Fire Fighting Training Unit (FFTU) at the Great Lakes Naval Training Center, near North Chicago, Illinois. Of the two proposed sites, one is located in Camp Moffett and the other on the Golf Course, as shown in Figure 1. Both sites are suspected to be potentially contaminated by hazardous waste. Based on the results of this foundation investigation, chemical analysis of soil samples (to be submitted by Dames & Moore in a separate report), and additional studies being performed by Lester B. Knight & Associates, Inc., it is our understanding that a decision will be made whether to proceed with investigation and final design for one of the sites.

PURPOSE AND SCOPE OF WORK

The purpose of this Phase I investigation was to evaluate the subsurface conditions at two potential sites for the new FFTU, and to provide preliminary recommendations for foundation type and design capacity and parameters for pavement design for each site. In accomplishing this purpose, the scope of work (detailed in our Final Revised Proposal for Geotechnical Services dated September 18, 1987) included:

- A field exploration program consisting of drilling, sampling, and logging three borings (two 30 feet deep and one 75 feet deep) at each of the two sites.
- A laboratory testing program to evaluate the pertinent properties of the soils, including index properties, classification, and strength, compaction, and consolidation characteristics.
- Engineering analysis to develop preliminary recommendations pertaining to feasible foundation type, bearing capacity and settlement behavior, and pavement design for the proposed FFTU at each site.
- Preparation of this summary report presenting the field and laboratory data and preliminary design recommendations.

PROPOSED CONSTRUCTION

The proposed FFTU structure will be approximately 330 by 140 feet in overall plan dimensions and will consist of a 1½ story trainer building and a 1-story

classroom building connected by a central plaza. We understand that the floor levels of the trainer and classroom buildings will be approximately at existing grade, with some portions of each building extending as much as about 5 feet below grade. The plaza will overlie a basement extending about 12 feet below grade; three large concrete water tanks will extend an additional 23 feet below the basement level (i.e., 35 feet below grade). Outside the building, a relatively small area is likely to be paved for a driveway and truck turnaround, but the potential location of the paved area has not yet been identified at either site.

The trainer building will be about 130 by 135 feet in plan dimensions, with steel framing and masonry walls. Maximum column loads are expected to be about 180 kips.

The plaza will be 80 by 75 feet, and the underlying tanks will be about 50 by 60 feet in overall plan dimensions, separated into three adjoining rectangular tanks by interior walls. It is our understanding that all the tank walls and the base slab will be reinforced concrete, approximately 2 feet thick. The tanks will hold up to about 23 feet of water or wastewater, and individual tanks could potentially be emptied and filled on a frequent basis, creating differential loading across the base slab. Each tank will include a small sump pit at the bottom.

The classroom building will be about 100 by 110 feet in plan, and will be constructed with load-bearing masonry walls, including some interior walls. Wall loads are expected to be 6 kips per linear foot. The floor slab will be stepped in several increments to allow for a total difference in floor elevation of about 3½ feet over the length of the building.

SITE CONDITIONS

Surface

Camp Moffett Site - The proposed FFTU site at Camp Moffett is within the paved Drill Field, presently used as a parking lot for recreational vehicles. The building site lies at the northern terminus of Missouri Street, and is approximately 300 feet south of existing Building 1517. Available utilities information indicates that a storm sewer passes under the southern portion of the proposed building footprint. The surface of the immediate site and vicinity is relatively flat.

Golf Course Site - This proposed site lies within the practice driving range of the Golf Course, just south of the existing Fire Fighting Training Center. The building footprint lies about 50 feet south of existing Building 3311 and about 100 feet south of existing Building 3304. Available utilities information indicates no buried lines under the footprint. The site surface is grass-covered and relatively flat.

Subsurface

Available geologic information for the area indicates that the two sites are located in a terminal moraine deposit of unstratified glacial till deposited during the Wisconsin ice stage. These soils have been overconsolidated by the weight of previously overlying ice and sediments, which have since melted and eroded away. The till is underlain by Niagaran limestone bedrock at an estimated depth of about 150 to 200 feet. Specific subsurface conditions at each site are discussed below.

Camp Moffett Site - The subsurface conditions at this site were evaluated by drilling two 30-foot deep borings (CM-1 and CM-3) and one 75-foot deep boring (CM-2). The locations of these borings are shown in Figure 2; it should be noted that CM-1, CM-2, and CM-3 correspond to locations 1, 5, and 7, respectively, described in our September 18, 1987 proposal.

The site is covered with a 4-inch thick, fractured asphalt pavement. About a foot of gray sandy base course material was encountered below the pavement in CM-1, and about 1 foot and 2.5 feet of brown silty sand fill occurred below the pavement in CM-2 and CM-3, respectively. Beneath the fill, boring CM-2 penetrated about 21 feet of gray medium stiff sandy silt and medium dense silty sand with varying amounts of clay and gravel. Beneath this sand in boring CM-2 and beneath the surficial fill in the other two borings, there is a gray and brown stiff to very stiff silty clay to clayey silt, with traces and stringers of sand and gravel grading in and out, extending to the depth explored in CM-1 and CM-3 (30 feet). In CM-2 the clay grades to a hard consistency by a depth of about 45 feet, and extends to a depth of about 52 feet. At this depth lies dark gray silty fine sand, very dense in consistency, extending to a depth of about 70 feet. From 70 to 75 feet (deepest extent of CM-2) lies gray silty sandy clay, hard in consistency.

Groundwater was encountered at depths of 8, 4.5, and 13 feet in borings CM-1, CM-2, and CM-3, respectively.

Golf Course Site - The subsurface conditions at the Golf Course site were evaluated by drilling two 30-foot deep borings (GC-1 and GC-3) and one 75-foot boring (GC-2) at locations shown in Figure 3. It should be noted that GC-1, and GC-2, and GC-3 correspond to locations 1, 3, and 7, respectively, described in our September 18, 1987, proposal.

The borings encountered 4 to 6 inches of topsoil, overlying a fill layer of medium dense fine to medium sand or medium stiff to stiff silty clay, mixed with organics and pieces of wood and brick. This fill varies in thickness from 8 feet in GC-1 to 3 feet in GC-2 to 7 feet in GC-3. The fill is underlain in GC-1 and GC-3 by glacial till deposits composed of gray or gray-green silty clay with varying amounts of sand and gravel, extending to the depth explored in GC-1 and GC-3 (30 feet). In GC-2, the fill is underlain by glacially deposited medium dense brown silty sand, grading to gray at about 10 feet, and extending to a depth of about 13 feet. Beneath the sand lies stiff to very stiff gray silty clay, extending to a depth of about 73 feet, interrupted by a 3-foot sand layer encountered at about 53 feet. At 73 feet, gray medium dense sand was encountered in GC-2, extending to the explored depth of the boring at 75 feet.

Groundwater was encountered at 8.5, 4.3, and 11 feet in borings GC-1, GC-2, and GC-3, respectively.

Detailed descriptions of the soils encountered in the borings at each site are presented on the logs of borings in the Appendix. Engineering properties of the soil strata encountered during the field investigation were evaluated by laboratory testing of selected representative samples; the laboratory tests and results are also discussed in the Appendix.

DISCUSSION AND RECOMMENDATIONS

Foundations

Our engineering analyses and preliminary recommendations for the two sites are based on data compiled during the field and laboratory investigations, and on information about the proposed structure provided by Knight. It should be emphasized that these investigations are preliminary, producing a limited amount of data for each site, for use in evaluating the feasibility of each site for the

proposed FFTU construction. Prior to final design, additional confirmatory investigation of the selected site should be performed, as described in our proposal of September 18, 1987, and as may be modified by the results of this investigation.

Based on the results of our studies, we believe that at the Camp Moffett site conventional spread footings founded on the undisturbed glacial till below frost depth will be the most feasible foundation system for the proposed trainer and classroom buildings. At the Golf Course site, the buildings can be supported on spread footings founded either on the undisturbed glacial till at a depth of about 8 feet or (with a reduced bearing capacity) in the overlying fill material, or alternatively on drilled piers extending to at least 14 feet below existing grade. The water tanks below the central plaza can be supported slab-on-grade on undisturbed glacial till at a depth of about 37 feet below existing grade at either site. However, measures to resist hydrostatic uplift pressures on the base of the tanks will have to be incorporated in the design.

Camp Moffett Site - The trainer and classroom buildings spread or wall footings can be founded on undisturbed glacial till (stiff to very stiff clay and silt or medium dense sand) that lies beneath the 1.5 to 3 feet of surficial fill. Preliminary design of isolated spread footings should be based on a maximum allowable bearing pressure of 4,000 pounds per square foot (psf). Wall footings should be proportioned based on a maximum allowable bearing pressure of 3,000 psf. All footings exposed to the full effects of frost should be founded at least 3.5 feet below adjacent final grade to protect against frost action. The minimum recommended width is 18 inches for continuous wall footings and 24 inches for isolated column footings. If adjacent footings are founded at different elevations, they should be placed so that a 45° line drawn from the bottom edge of one footing does not intersect the other footing. Footings thus designed are expected to experience less than 1 inch total settlement.

The basement walls extending about 12 feet below the central plaza can be supported on wall footings proportioned for a maximum allowable bearing pressure of 6,000 psf. The base slab of the concrete tanks can be supported directly on the undisturbed very stiff clay at the excavation level of about 37 feet below grade. Due to the high water table, which was encountered as high as 4 feet below present grade, total hydrostatic uplift pressures on the base of the slab could be approximately 2,060 psf. This uplift will be resisted by the weight of the tank's

concrete walls and slab when empty (approximately 1,040 psf averaged across the base of the slab), and by the weight of the tank plus contained water when full (approximately 2,150 psf averaged across the base of the slab). The net uplift pressure of approximately 1,050 psf on the empty tanks can be resisted by increasing the weight on the slab and/or by anchoring the slab or walls. Various methods of anchoring include grouted rod anchors, helical anchors, and piles or piers. The most feasible anchoring method will be evaluated during the detailed investigation (Phase II) for the selected site, after confirmation of water levels and in conjunction with discussions of structural options with the structural engineer.

Golf Course Site - This site is blanketed by 3 to 8 feet of heterogeneous fill, based on data from the three borings drilled for this study. Relatively lightly loaded footings can be supported in this fill; isolated spread footings should be designed based on a maximum allowable pressure of 2,000 psf, and wall footings based on a maximum allowable pressure of 1,500 psf. More heavily loaded footings can be supported on the undisturbed glacial till (gray very stiff silty clay or medium dense sand) beneath the fill; isolated spread footings founded at least 8 feet below present grade can be designed based on a maximum allowable bearing pressure of 5,000 psf, and wall footings based on a maximum allowable pressure of 4,000 psf. All footings exposed to the full effects of frost should be founded at least 3.5 feet below adjacent final grade, and minimum footing widths as described for the Camp Moffett site should be observed. Footings designed as described above are expected to experience total settlement less than 1 inch.

It should be noted that footing excavations more than about 4 feet below present grade may be below the water table, requiring dewatering and stabilization of the base of the excavation. In addition, excavations deeper than 5 feet that workers will enter must have the sides sloped back or structurally braced. Because of these considerations, it may be cost-effective to support the heavier loads (such as the interior columns of the trainer building) on drilled piers rather than footings. The drilled priers may require casing to stabilize the shaft where it passes through sand layers below the water table (such as in boring GC-2). The piers can be constructed with belled bases to provide greater bearing area; the bearing level of such belled piers should be at least 14 feet below present grade. Preliminary design of these drilled peirs can be based on a maximum allowable bearing pressure of 8,000 psf.

The basement walls and the concrete tanks beneath the central plaza can be supported at this site as described for the Camp Moffett site. Because the water table was encountered as high as about 4 feet below grade at both sites, provisions to be considered for resisting hydrostatic uplift pressures on the tanks at the Golf Course site are similar to those described for the Camp Moffett site.

Pavements

To evaluate the subsurface conditions for the support of roads and parking lots, two representative bulk soil samples, one from each site, were obtained and tested for compaction and California Bearing Ratio (CBR). The samples were obtained from near-surface soils based on the assumption that final grades will not differ significantly from existing grades. The CBR test samples were compacted to approximately 95 percent of the maximum dry density as determined by ASTM D 698. Test results indicate CBR values of 6.1 and 4.5 percent for the Camp Moffett and Golf Course sites, respectively; these values can be used for preliminary design of pavement sections.

Additional Considerations

The excavation for the water tanks at either site is expected to extend to a depth of about 37 feet, or about 33 feet below the water table. Much of the excavation will be through clayey soil, which is expected to transmit relatively low quantities of water into the open excavation. However, significant zones of sandy, higher permeability soil were encountered at both sites; while these zones do not appear to be continuous water-bearing layers, they could transmit significant quantities of water to the excavation until they are depleted. Groundwater control measures will thus be required to maintain a dry work area during excavation and construction.

Additional geotechnical considerations at either site will include sloping or structural support of the excavation walls, lateral earth pressures on the basement and tank walls, and fill material and placement requirements. Recommendations pertaining to these issues as well as details of foundation design and installation will be developed during the Phase II investigation of the selected FFTU site.

In summary, geotechnical considerations for the two sites are similar in many respects. However, due to the greater depth of fill at the Golf Course site and the resulting greater depth required for the foundations, it appears that the foundation system for the Camp Moffett site is likely to be less costly than that for the Golf Course site.

* * *

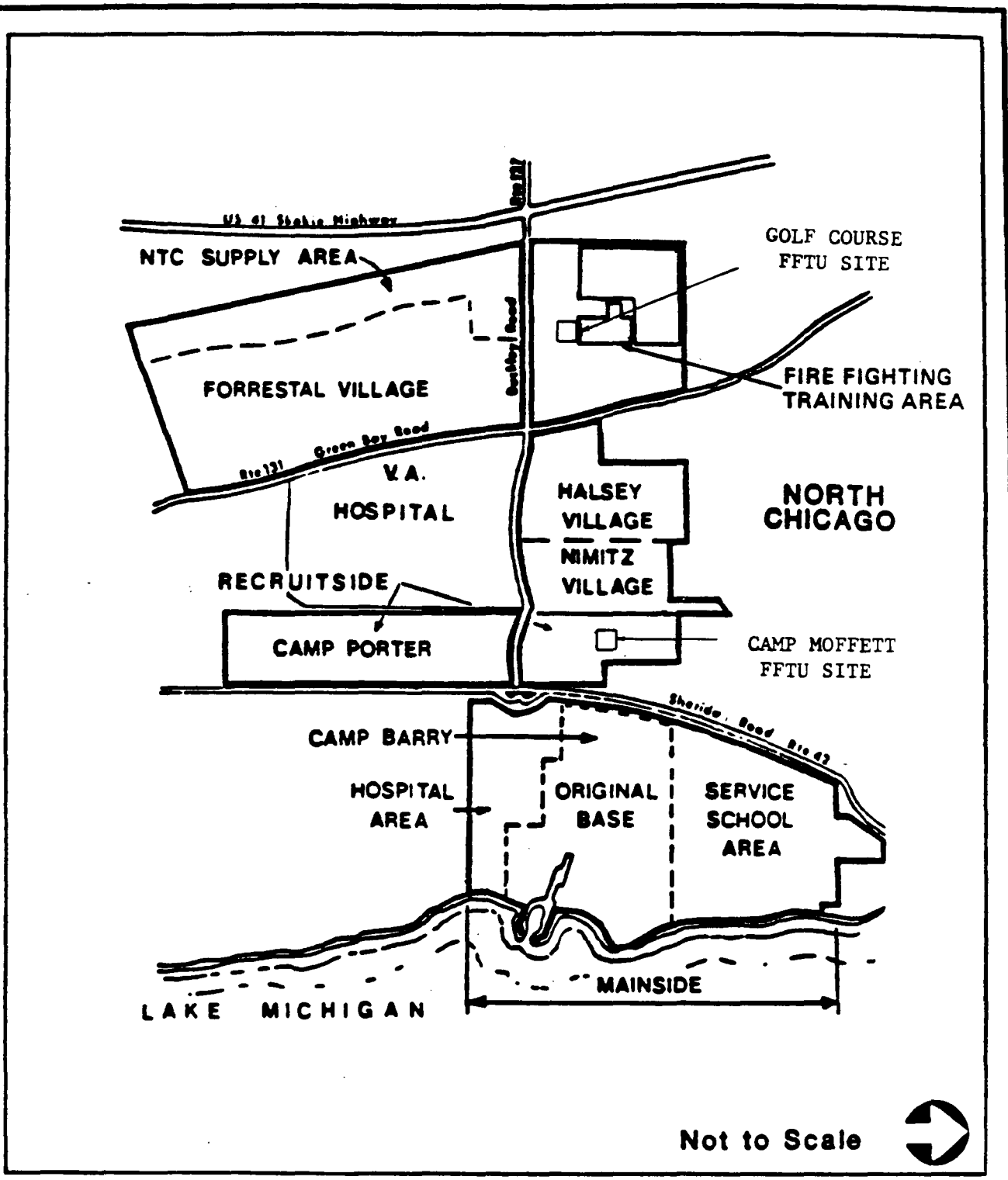

FIGURE 1
VICINITY MAP
GREAT LAKES NAVAL TRAINING CENTER

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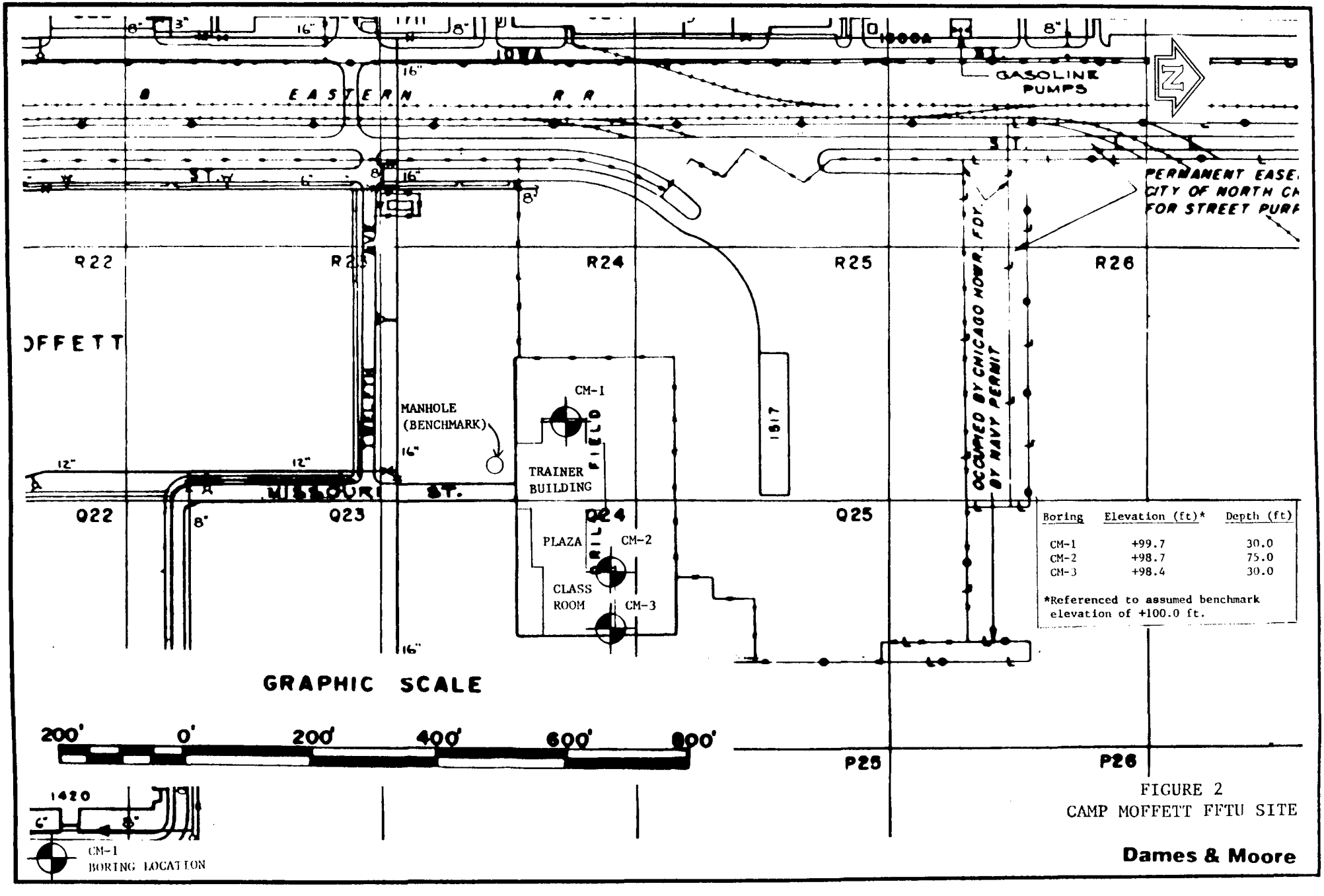

Boring	Elevation (ft)*	Depth (ft)
CM-1	+99.7	30.0
CM-2	+98.7	75.0
CM-3	+98.4	30.0

*Referenced to assumed benchmark elevation of +100.0 ft.

FIGURE 2
CAMP MOFFETT FFTU SITE

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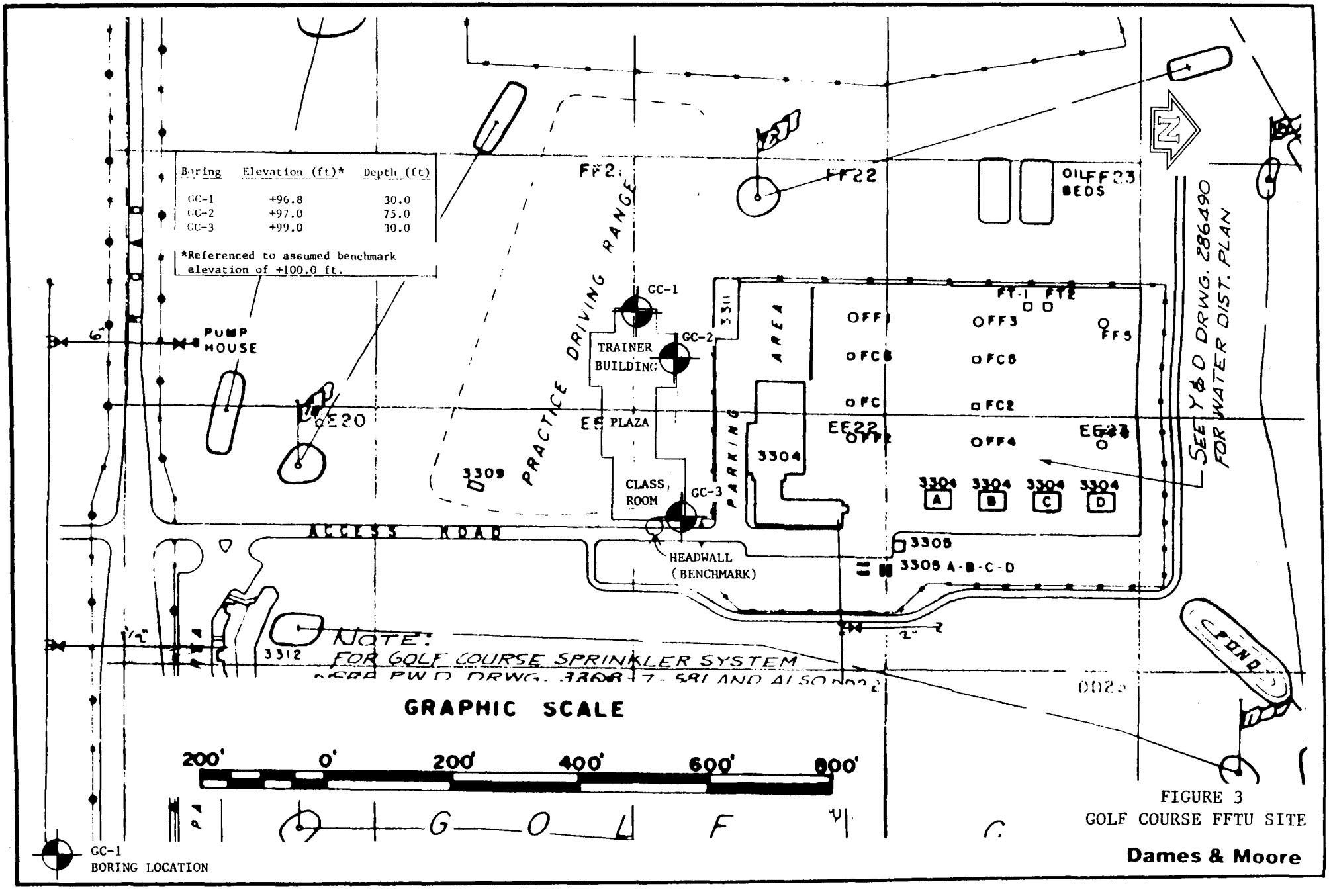

FIGURE 3
GOLF COURSE FFTU SITE

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APPENDIX

Field Exploration and Laboratory Testing

FIELD EXPLORATION

The subsurface and groundwater conditions at the two potential construction sites (Camp Moffett and Golf Course) were investigated by drilling a total of 6 test borings (3 at each site) varying in depth from 30 feet to 75 feet below existing ground surface. Detailed logs of soil conditions encountered in each test boring are presented in Plates 1 through 6, Logs of Borings. Groundwater levels were measured in all test borings and are indicated on the Boring Logs.

The locations of the test borings are shown in Figures 2 and 3 in the text of the report. The ground surface elevations shown on the Logs of Borings were provided by Peklay Surveying Co. Ltd. of Waukegan, Illinois. The borings were drilled by D&G Drilling, Inc. of New Lenox, Illinois, using a Mobile B-56 drilling rig. The borings were advanced with 3-3/8 inch i.d. hollow stem augers in the 30-foot holes, and a combination of hollow stem augers and rotary wash drilling techniques in the 75-foot holes.

The field operations were performed under the technical control of an experienced member of our geotechnical staff, who inspected the site, supervised the drilling operations, maintained a detailed log of each boring, and obtained representative samples of the soils encountered. Soils were identified and logged in accordance with the Unified Soil Classification System, which is described on Plate 7.

Representative soil samples were recovered in each boring at the intervals noted on the boring logs. The samples were obtained utilizing either the standard split-spoon sampler or a thin-walled Shelby tube sampler. The standard split spoon sampler has an inside diameter of 1-3/8 inches and an outside diameter of 2 inches, whereas the Shelby tube sampler has an inside diameter of 3 inches. The standard split-spoon sampling was performed in general accordance with ASTM Test Procedure D 1586, "Standard Method for Penetration Test and Split-Barrel Sampling of Soils." The Shelby tubes were advanced into the soil by hydraulic pressure and obtained in acordance with ASTM Test Procedure D 1587. The

number of blows required to drive the split-spoon sampler for the final 12 inches of penetration or a fraction thereof is presented on the Logs of Borings in the "Blow Count" column.

LABORATORY TESTING

Various laboratory tests were performed to classify the soils and provide data for the engineering analyses. Because of the potential chemical contamination of soils at both sites, all testing was performed by Earth Technology Corporation of Long Beach, California - a geotechnical/environmental laboratory specializing in testing of contaminated soils. The testing program included moisture and density, Atterberg limits, percent fines, consolidation, strength, compaction and CBR tests. In addition, chemical analyses of selected samples were performed as part of a separate contamination assessment; results of the chemical analyses will be provided in a separate report.

Moisture and Density Tests

Moisture and density tests were performed in conjunction with each strength and consolidation test. Additional moisture and density tests were performed to evaluate existing overburden pressures and for correlation purposes. Moisture testing was performed in accordance with ASTM Test Procedure D 2216. Results of moisture and density determinations are presented in Table A-1.

Atterberg Limits Tests

Atterberg limits tests (liquid limit, plastic limit, and plasticity index) were performed on selected samples of the fine-grained soils encountered in the test borings in accordance with ASTM Test Procedure D 4318, "Liquid Limit, Plastic Limit and Plasticity Index of Soils." The Atterberg limits tests were performed to aid in classifying the soil according to the Unified Soil Classification System and for correlation purposes. The results of the Atterberg limits tests are presented in Table A-1.

Percent Fines Tests

Percent fines tests were also performed to aid in the classification and correlation of selected samples of soils encountered in the test borings. The tests were performed in accordance with ASTM Test Procedure D 1140, "Amount of

Material in Soils Finer than the No. 200 (75-um) Sieve." The results of these tests are summarized in Table A-1.

Consolidation Tests

One-dimensional compression tests are being performed on four selected relatively undisturbed samples of fine-grained soils to evaluate their consolidation characteristics for use in settlement analyses. The tests are being performed according to the ASTM Test Procedure D 2435. At the time of submittal of this report, consolidation tests were only partially completed. The completed plots of consolidation test data will be forwarded upon receipt from the laboratory.

Shear Strength Tests

Direct shear tests (consolidated, undrained) were performed on selected soil samples to provide information relative to the strength characteristics of soils encountered in the test borings. The tests were performed in accordance with ASTM Test Procedure D 3080 under undrained conditions, and results are presented in Plates 8 through 10.

In addition, one unconfined compression test was performed on a selected relatively undisturbed sample of fine-grained soil to evaluate the undrained shear strength of the cohesive strata encountered. The unconfined compression test was conducted in accordance with ASTM Test Procedure D 2166, and results are summarized on Plate 11.

Compaction and CBR Tests

Two compaction tests (one each for the Golf Course and Camp Moffett sites) were performed on representative bulk samples of near-surface soils, to evaluate the compactive effort-moisture content-dry density relationship of onsite soils that could possibly be used as subgrades for pavements or for structural fill at the site. The compaction tests were performed in accordance with the ASTM D 698 test procedure.

After the compaction tests were performed, California Bearing Ratio (CBR) tests were performed on the same soils in accordance with ASTM D 1833. These samples were compacted to approximately 95 percent of the maximum dry density obtained from the compaction test described above.

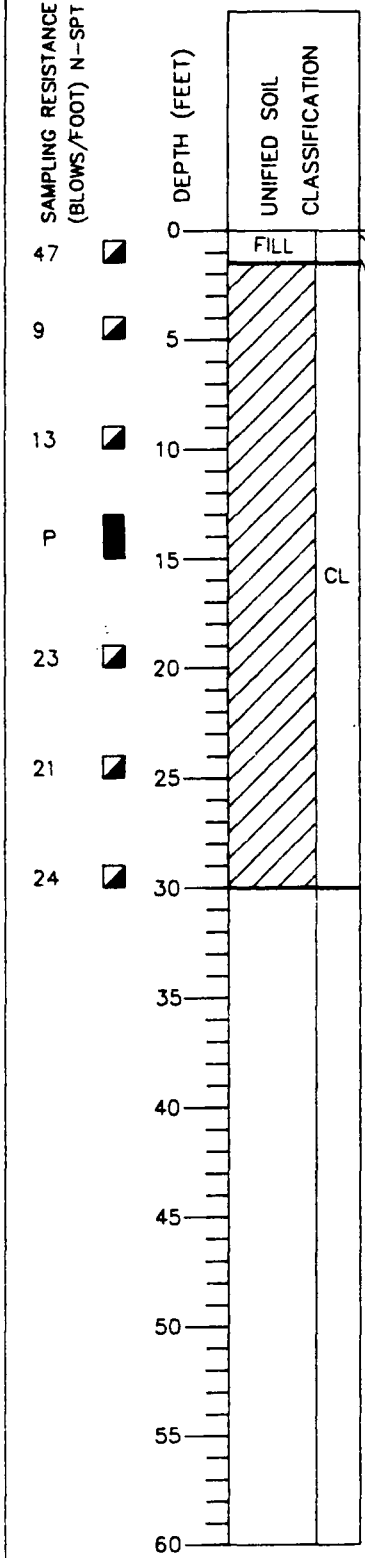
The results of the compaction tests are presented in Plates 12 and 13. CBR test results are presented in Table A-2.

The following plates and tables are attached and complete this Appendix:

Plates 1 through 6	Boring Logs
Plate 7	Unified Soil Classification System
Plate 8 through 10	Direct Shear Test Results
Plates 11	Unconfined Compression Test Results
Plate 12 and 13	Compaction Test Results
Table A-1	Summary of Index Properties
Table A-2	Summary of CBR Test Results

BORING CM-1

SURFACE ELEVATION +99.7 FT.*



DESCRIPTION

4" ASPHALT
LIGHT GRAY FINE TO COARSE SAND, TRACE SILT, DRY (DENSE) (FILL)

GRAY AND BROWN SILTY CLAY, TRACE MEDIUM TO COARSE SAND, MOIST (STIFF)

GRADING WITH TRACE FINE TO COARSE GRAVEL, WET

GRAVEL GRADING OUT

GRADING TO VERY STIFF

BORING TERMINATED AT 30.0 FT. ON 9/14/87
WATER LEVEL RECORDED AT 8.0 FT. ON 9/14/87

DRILLING METHOD: HOLLOW-STEM AUGER

*REFERENCED TO ASSUME BENCH MARK ELEVATION OF +100.0 FEET (SEE BENCH MARK LOCATION ON FIGURE 2)

▩ DISTURBED SAMPLE
■ UNDISTURBED SAMPLE
□ NO SAMPLE RECOVERED
◪ STANDARD PENETRATION TEST
▼ WATER LEVEL

REVISIONS DATE BY

DATE BY CHECKED BY

D & M JOB NO. 16215-001-5102

LOG OF BORING

PROJECT: Great Lakes
LOCATION: Camp Moffett

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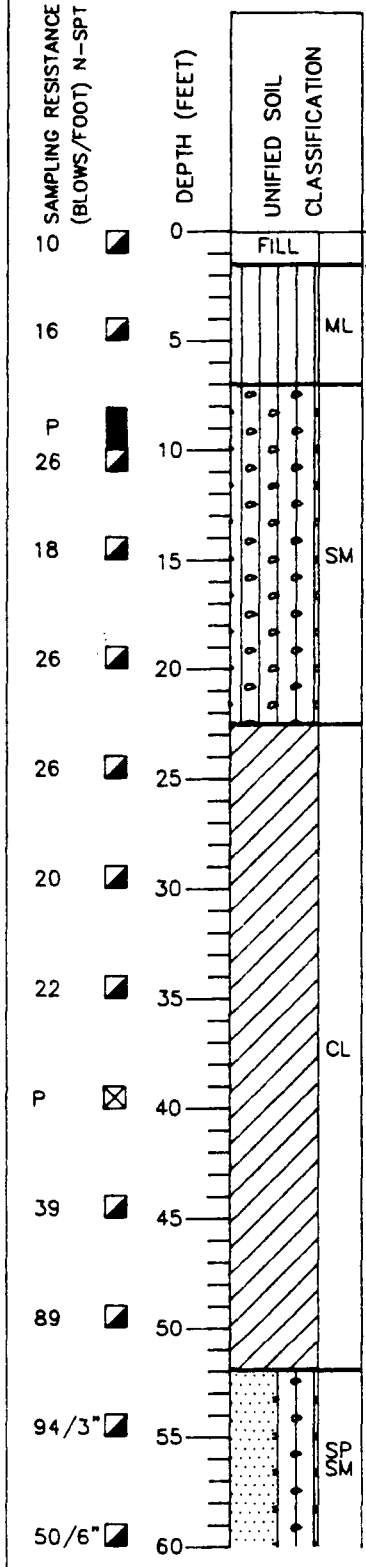
PLATE 1

BORING CM-2

SURFACE ELEVATION +98.7 FT. *



DESCRIPTION

4" ASPHALT
BROWN SILTY SAND, SOME CLAY (MEDIUM DENSE) (FILL)
LIGHT BROWN TO YELLOW CLAYEY SILT, SOME FINE TO MEDIUM SAND, WET (MEDIUM STIFF)

GRAY FINE TO COARSE SAND, LITTLE CLAYEY SILT, TRACE FINE GRAVEL, WITH LENSES AND LAYERS OF CLAYEY SILT, WET (MEDIUM DENSE)

GRADING WITH SOME CLAYEY SILT

GRAY SILTY CLAY WITH TRACE MEDIUM SAND, WET (VERY STIFF)

GRADING WITH STRINGERS OF FINE SAND, HARD

DARK GRAY FINE SAND, TRACE SILT, MOIST (VERY DENSE)

▣ DISTURBED SAMPLE
■ UNDISTURBED SAMPLE
□ NO SAMPLE RECOVERED
◪ STANDARD PENETRATION TEST
▼ WATER LEVEL

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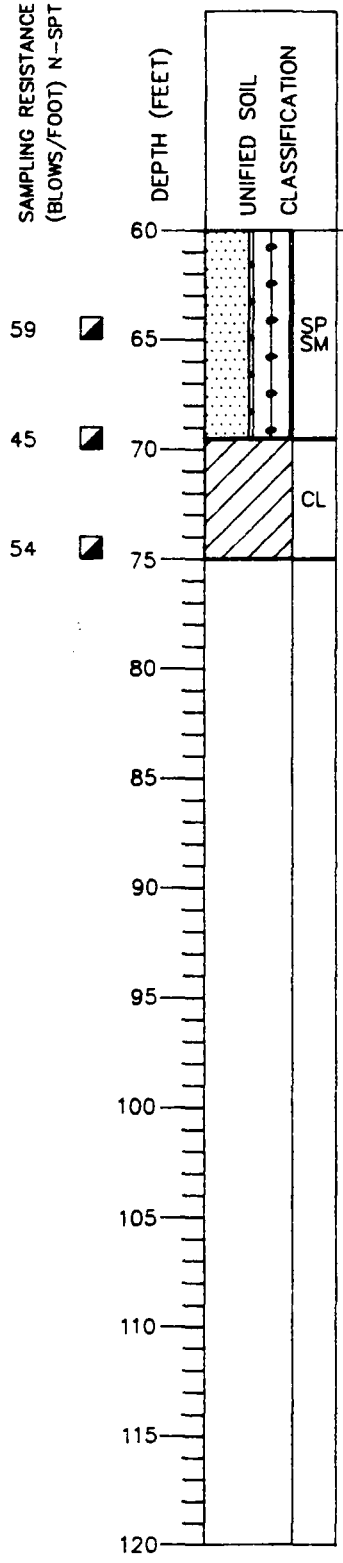
D & M JOB NO. 16215-001-5102

LOG OF BORING

PROJECT: Great Lakes
LOCATION: Camp Moffett

DAMES & MOORE
PLATE 2

BORING CM-2, Cont'd



GRAY SILTY CLAY, SOME FINE SAND, MOIST (HARD)

BORING TERMINATED AT 75.0 FT. ON 9-15-87, WATER LEVEL RECORDED AT 4.5 FT. ON 9/15/87.

DRILLING METHOD: HOLLOW-STEM AUGER TO A DEPTH OF 11.0 FEET, ROTARY WASH THEREAFTER

*REFERENCED TO ASSUMED BENCH MARK ELEVATION OF 100.0 FEET (SEE BENCH MARK LOCATION ON FIGURE 2)

- ⊠ DISTURBED SAMPLE
- ■ UNDISTURBED SAMPLE
- □ NO SAMPLE RECOVERED
- ◪ STANDARD PENETRATION TEST
- ⬇ WATER LEVEL

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LOG OF BORING

PROJECT: Great Lakes
LOCATION: Camp Moffett

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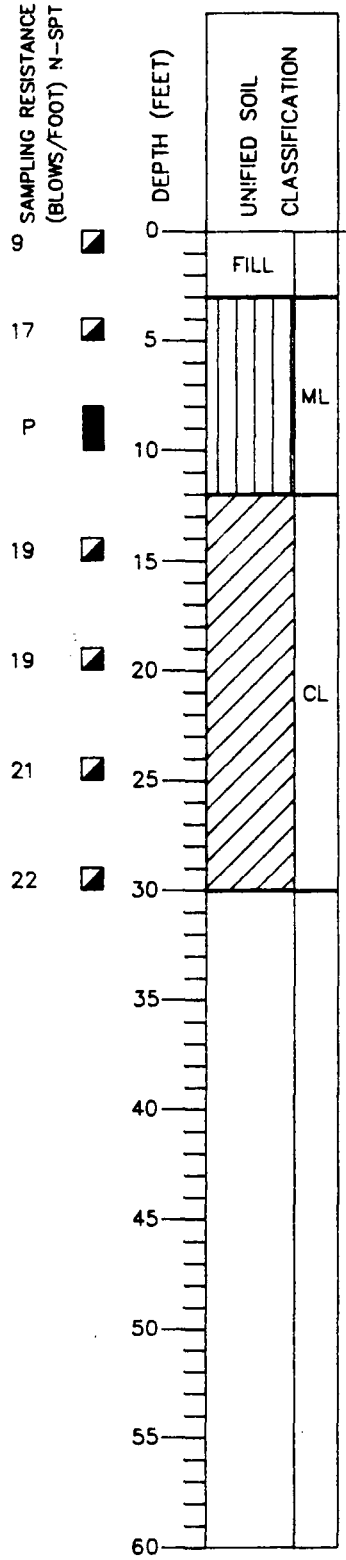
PLATE 2, Cont'd

BORING CM-3

SURFACE ELEVATION +98.4 FT.*



DESCRIPTION

LIGHT BROWN TO BLACK SILTY SAND, DAMP (LOOSE) (FILL)

GRAY AND BROWN MOTTLED CLAYEY SILT, SOME FINE SAND, MOIST (VERY STIFF)

DARK GRAY SILTY CLAY, TRACE MEDIUM SAND, MOIST (VERY STIFF)

BORING TERMINATED AT 30.0 FT. ON 9/14/87, WATER LEVEL RECORDED AT 13.5 FT. ON 9/14/87

DRILLING METHOD: HOLLOW-STEM AUGER

*REFERENCED TO BENCH MARK ELEVATION OF +100.0 FEET (SEE BENCH MARK LOCATION ON FIGURE 2)

▩ DISTURBED SAMPLE
■ UNDISTURBED SAMPLE
□ NO SAMPLE RECOVERED
◪ STANDARD PENETRATION TEST
▼ WATER LEVEL

REVISIONS DATE
BY

BY DATE
CHECKED BY

D & M JOB NO. 16215-001-5102

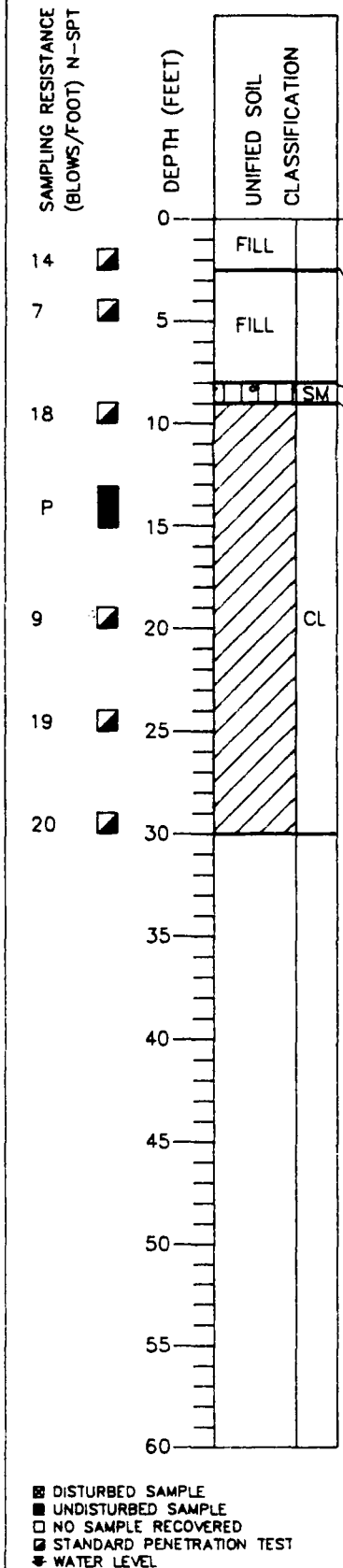
LOG OF BORING

PROJECT: Great Lakes
LOCATION: Camp Moffett

DAMES & MOORE
PLATE 3

BORING GC-1

SURFACE ELEVATION +96.8 FT.



DESCRIPTION

4" TOPSOIL
LIGHT GRAY MOTTLED CLAY, SOME SILTY SAND, SOME SHALE FRAGMENTS, PIECES OF WOOD AND BRICK, MOIST (STIFF) (FILL)

GRAY MOTTLED SILTY CLAY, TRACE MEDIUM TO COARSE SAND (MEDIUM STIFF) (FILL)

GRAY MEDIUM TO COARSE SAND, SOME SILT

GRAY SILTY CLAY, TRACE MEDIUM SAND, MOIST (VERY STIFF)

GRADING TO DARK GRAY, LITTLE COARSE SAND AND FINE GRAVEL, STIFF

GRADING TO VERY STIFF. GRAVEL GRADING OUT

BORING TERMINATED AT 30.0 FT. ON 9/16/87.
WATER LEVEL RECORDED AT 8.5 FT. ON 9/16/87.

DRILLING METHOD: HOLLOW-STEM AUGER

* REFERENCED TO ASSUMED BENCH MARK ELEVATION OF +100.0 FEET (SEE BENCH MARK LOCATION ON FIGURE 3)

⊠ DISTURBED SAMPLE
■ UNDISTURBED SAMPLE
□ NO SAMPLE RECOVERED
◪ STANDARD PENETRATION TEST
▼ WATER LEVEL

REVISIONS DATE BY

DATE BY CHECKED BY

D & M JOB NO. 16215-001-5102

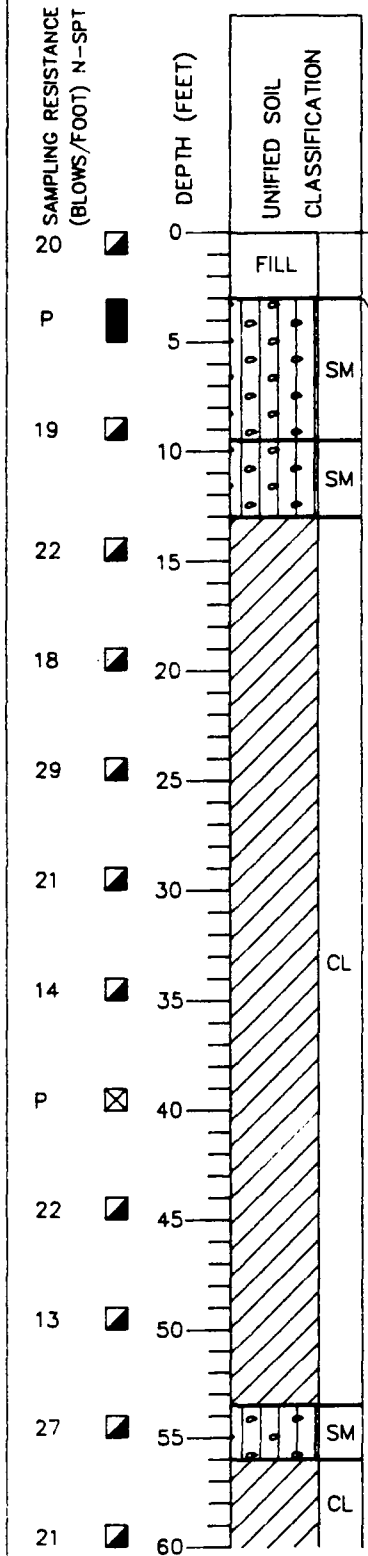
LOG OF BORING

PROJECT: Great Lakes
LOCATION: Golf Course

DAMES & MOORE
PLATE 4

BORING GC-2

SURFACE ELEVATION +97.0 FT.*



DESCRIPTION

6" TOPSOIL

RED AND BROWN SILTY SAND WITH DARK BROWN MOTTLING, MOIST (MEDIUM DENSE) (FILL)

BROWN FINE TO MEDIUM SAND, SOME SILT, WET (MEDIUM DENSE)

GRAY FINE TO COARSE SAND, LITTLE SILT, MOIST (MEDIUM DENSE)

GRAY SILTY CLAY, TRACE FINE SAND, MOIST (VERY STIFF)

GRADING WITH TRACE MEDIUM SAND

GRADING TO STIFF

GRADING TO VERY STIFF

GRADING TO STIFF

LIGHT GRAY MEDIUM SAND, SOME CLAYEY SILT, WITH SOME SHALE FRAGMENTS, WET (MEDIUM DENSE)

GRAY SILTY CLAY, TRACE MEDIUM TO COARSE SAND, MOIST (VERY STIFF)

⊠ DISTURBED SAMPLE
■ UNDISTURBED SAMPLE
□ NO SAMPLE RECOVERED
◪ STANDARD PENETRATION TEST
⌯ WATER LEVEL

REVISIONS DATE BY

DATE BY CHECKED BY

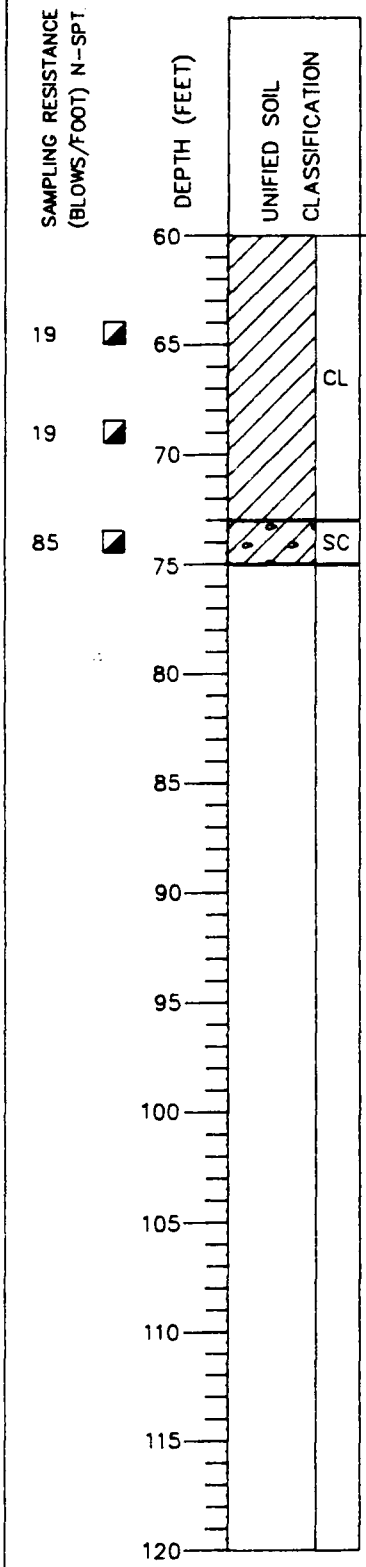
D & M JOB NO. 16215-001-5102

LOG OF BORING

PROJECT: Great Lakes
LOCATION: Golf Course

DAMES & MOORE
PLATE 5

BORING GC-2, Cont'd.



DESCRIPTION

GRADING WITH LITTLE FINE GRAVEL

GRAY FINE SAND, LITTLE SILTY CLAY, (VERY DENSE)

BORING TERMINATED AT 75.0 FT. ON 9/16/87, WATER LEVEL RECORDED AT 4.3 FT. ON 9/15/87.

DRILLING METHOD: HOLLOW-STEM AUGER TO 10.0 FEET, ROTARY WASH THEREAFTER

* REFERENCED TO ASSUMED BENCH MARK ELEVATION OF +100.0 FEET (SEE BENCH MARK LOCATION ON FIGURE 3)

⊠ DISTURBED SAMPLE
■ UNDISTURBED SAMPLE
□ NO SAMPLE RECOVERED
◪ STANDARD PENETRATION TEST
⌯ WATER LEVEL

REVISIONS DATE BY

BY DATE
CHECKED BY

D & M JOB NO. 16215-001-5102

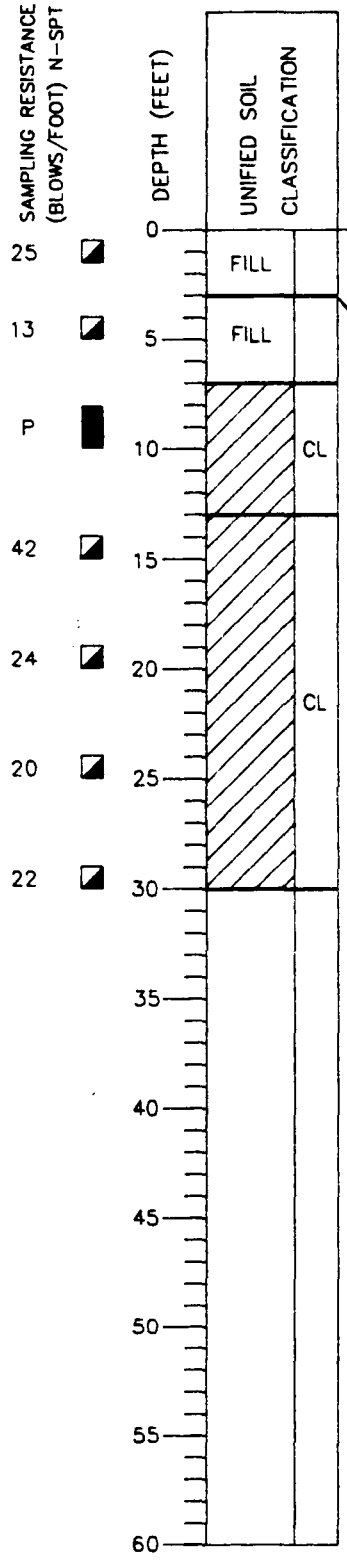
LOG OF BORING

PROJECT: Great Lakes
LOCATION: Golf Course

DAMES & MOORE
PLATE 5, Cont'd

BORING GC-3

SURFACE ELEVATION +99.0 FT.*



DESCRIPTION

4" TOPSOIL
BROWN FINE TO COARSE SAND, SOME SILT, LITTLE WHITE/GRAY MOTTLED CLAY, DAMP (MEDIUM DENSE) (FILL)

GRAY AND RED MOTTLED SILTY CLAY, WITH TOPSOIL AND ORGANICS (FILL)

GRAY-GREEN SILTY CLAY, TRACE MEDIUM SAND, LITTLE FINE GRAVEL, MOIST

DARK GRAY SILTY CLAY, TRACE MEDIUM TO COARSE SAND, TRACE FINE GRAVEL, MOIST (HARD)

GRADING TO VERY STIFF

GRAVEL GRADING OUT

GRADING WITH TRACE FINE GRAVEL

BORING TERMINATED AT 30.0 FT. ON 9/16/87 , WATER LEVEL RECORDED AT 11.0 FT. ON 9/16/87 .

DRILLING METHOD: HOLLOW-STEM AUGER

* REFERENCED TO ASSUMED BENCH MARK ELEVATION OF +100.0 FEET (SEE BENCH MARK LOCATION ON FIGURE 3)

▩ DISTURBED SAMPLE
■ UNDISTURBED SAMPLE
□ NO SAMPLE RECOVERED
◪ STANDARD PENETRATION TEST
▼ WATER LEVEL

REVISIONS DATE BY

BY DATE CHECKED BY

D & M JOB NO. 16215-001-5102

LOG OF BORING

PROJECT: Great Lakes
LOCATION: Golf Course

DAMES & MOORE
PLATE 6

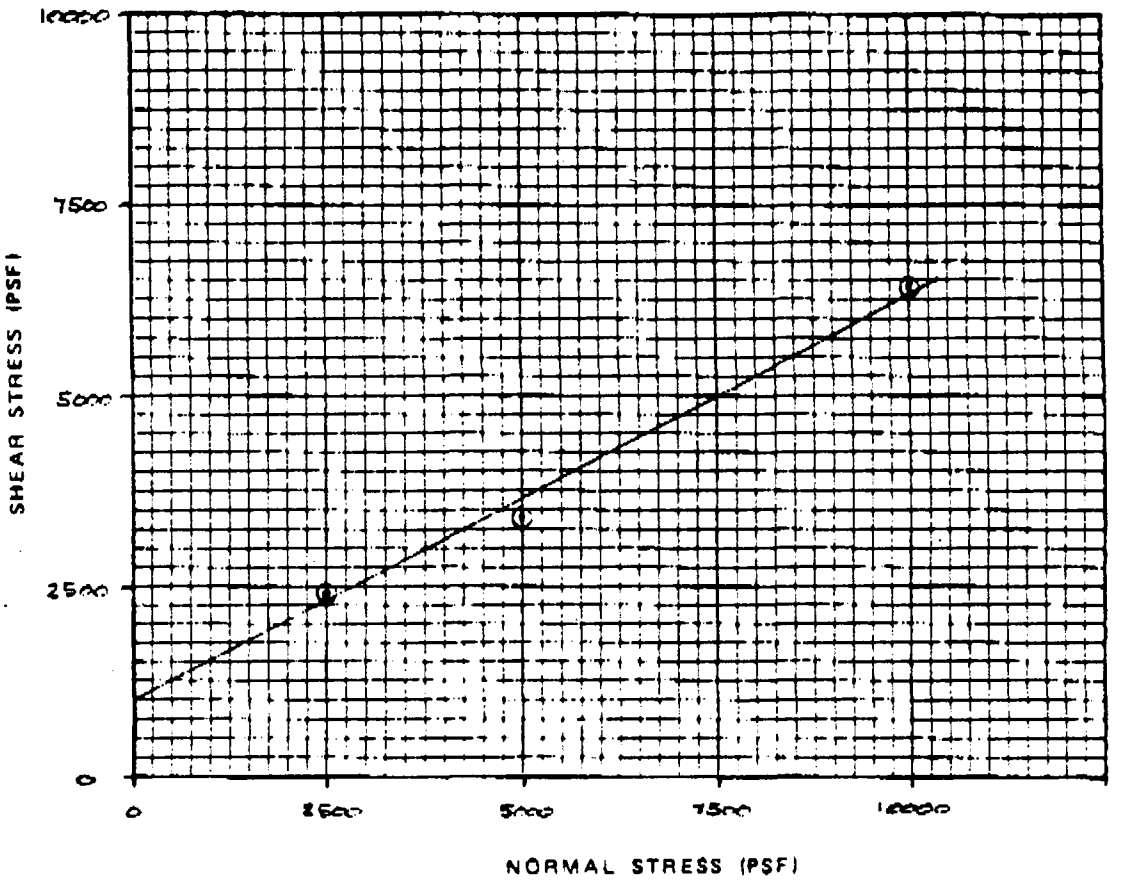
MAJOR DIVISIONS			GRAPH SYMBOL	LETTER SYMBOL	TYPICAL DESCRIPTIONS
Coarse Grained Soils More than 50% of Material is *Larger* than No. 200 Sieve Size	**Gravel and Gravelly Soils** More than 50% of Coarse Fraction *Retained* on No. 4 Sieve	**Clean Gravels** Little or No Fines		GW	Well-Graded Gravels, Gravel-Sand Mixtures, Little or No Fines
				GP	Poorly-Graded Gravels, Gravel-Sand Mixtures, Little or No Fines
		Gravels with Fines Appreciable Amount of Fines		GM	Silty Gravels, Gravel-Sand Silt Mixtures
				GC	Clayey Gravels, Gravel-Sand-Clay Mixtures
	Sand and Sandy Soils More than 50% of Coarse Fraction *Passing* No. 4 Sieve	**Clean Sand** Little or No Fines		SW	Well-Graded Sands, Gravelly Sands, Little or No Fines
				SP	Poorly-Graded Sands, Gravelly Sands, Little or No Fines
		Sands with Fines Appreciable Amount of Fines		SM	Silty Sands, Sand-Silt Mixtures
				SC	Clayey Sands, Sand-Clay Mixtures
Fine Grained Soils More than 50% of Material is *Smaller* than No. 200 Sieve Size	**Silts and Clays** Liquid Limit *Less* than 50%			ML	Inorganic Silts and Very Fine Sands, Rock Flour, Silty or Clayey Fine Sands or Clayey Silts with Slight Plasticity
				CL	Inorganic Clays of Low to Medium Plasticity, Gravelly Clays, Sandy Clays, Silty Clays, Lean Clays
				OL	Organic Silts and Organic Silty Clays of Low Plasticity
	Silts and Clays Liquid Limit *Greater* than 50%			MH	Inorganic Silts, Micaceous or Diatomaceous Fine Sands or Silty Soils
				CH	Inorganic Clays of High Plasticity, Fat Clays
				OH	Organic Clays of Medium to High Plasticity, Organic Silts
Highly Organic Soils				PT	Peat, Humus, Swamp Soils with High Organic Contents

NOTE: Dual symbols are used to indicate borderline soil classifications

PLATE 7

UNIFIED SOIL CLASSIFICATION SYSTEM

Dames & Moore



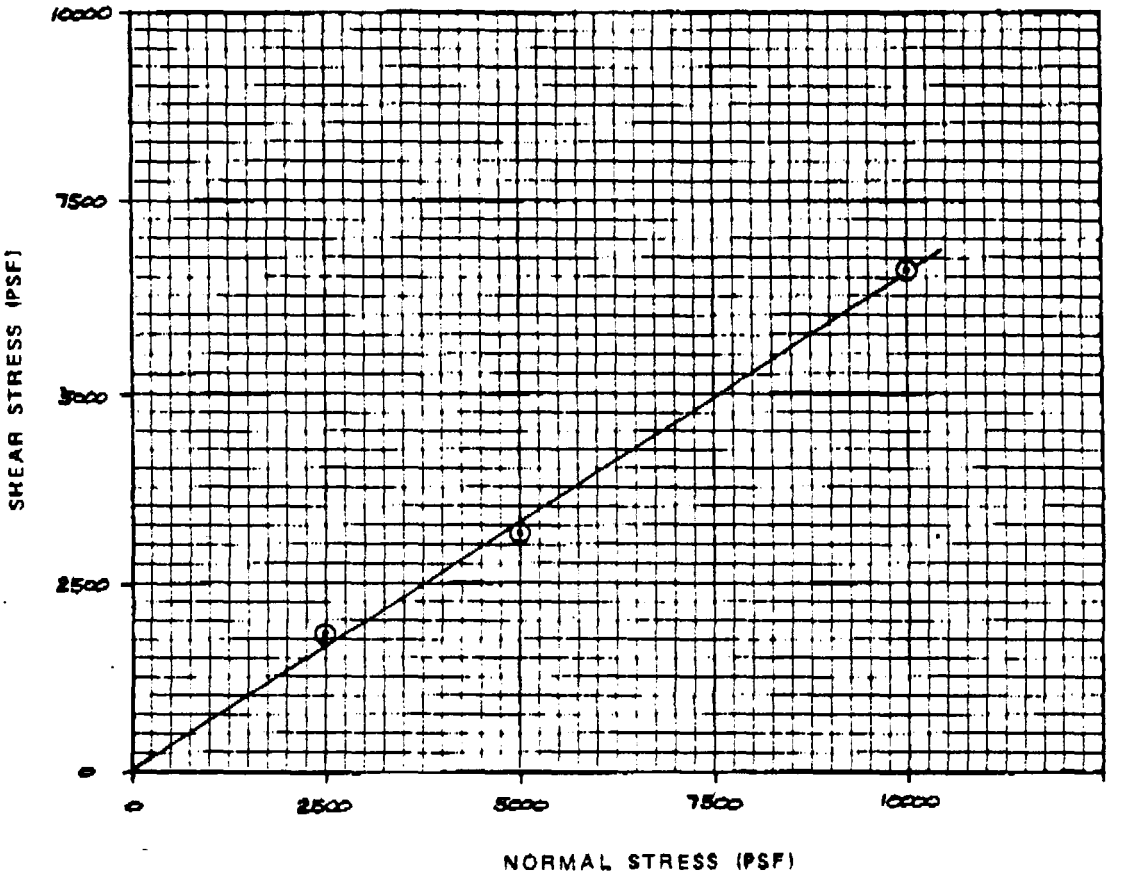
DESCRIPTION	SYMBOL	BORING NUMBER	SAMPLE NUMBER	DEPTH (FEET)	COHESION (PSF)	FRICTION ANGLE	CEMENTATION
UNDISTURBED	⊙	CM-1	3	13.5 - 14.0	1000	28°	NONE

- AVERAGE DRY DENSITY = 123.5 PCF
- AVERAGE FLUID CONTENT = 13.0 %

The Earth Technology Corporation

Project No.
JAMES J. HOGGE
GREAT LAKE NAVAL BASE

PLATE 8
DIRECT SHEAR TEST RESULTS

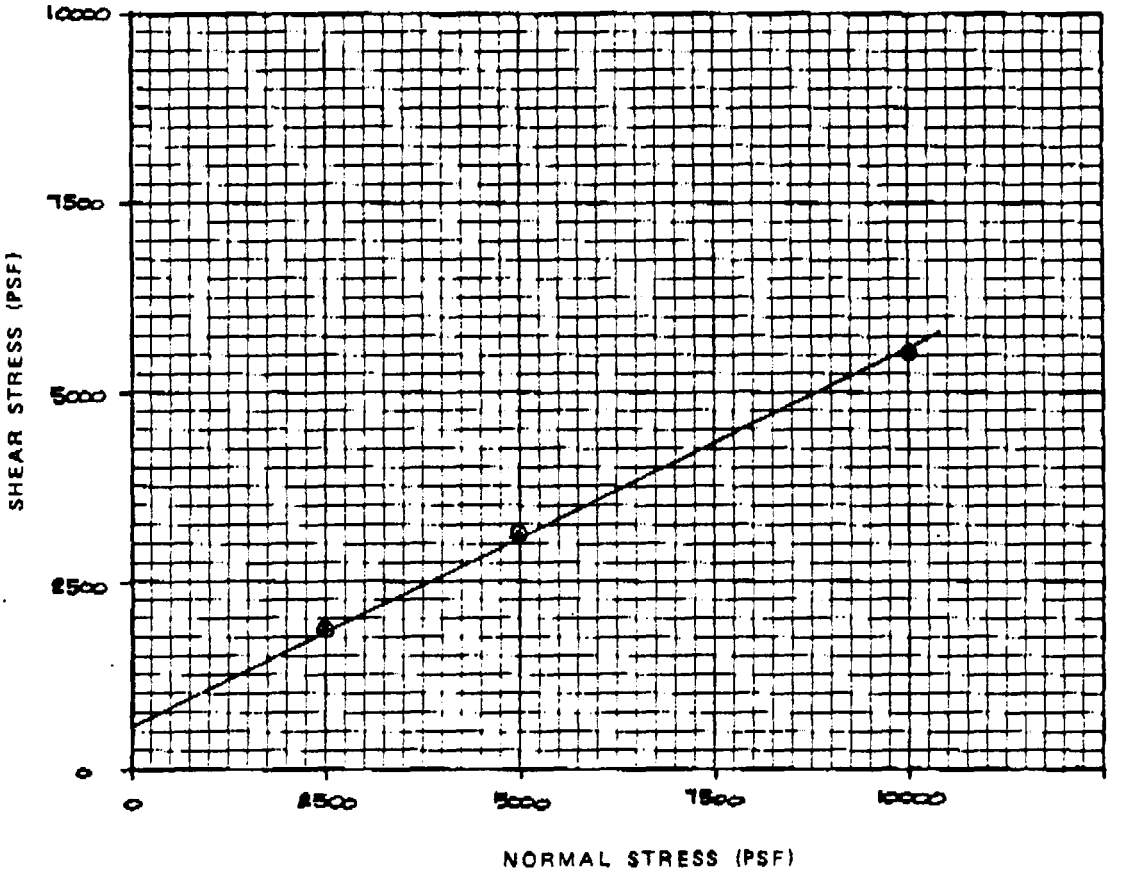


DESCRIPTION	SYMBOL	BORING NUMBER	SAMPLE NUMBER	DEPTH (FEET)	COHESION (PSF)	FRICTION ANGLE	CEMENTATION
UNDISTURBED	⊙	CM-3	S-3	8.5 - 9.0		33°	NONE

88-215-1101
The Earth Technology Corporation

Project No.
DAMES & MOORE
GREAT LAKES NAVAL BASE

PLATE 9
DIRECT SHEAR TEST RESULTS



DESCRIPTION	SYMBOL	BORING NUMBER	SAMPLE NUMBER	DEPTH (FEET)	COHESION (PSF)	FRICTION ANGLE	CEMENTATION
UNDISTURBED	●	GC-3	S-3	9.5 - 10	500	26°	

INITIAL MOISTURE CONTENT: 17 %
INITIAL DRY DENSITY: 113.5 pcf

88-215-1101 The Earth Technology Corporation	Project No. GREAT LAKES NAVAL BASE DAMES & MOORE

PLATE 10
DIRECT SHEAR TEST RESULTS

OCTOBER 1987

SUMMARY OF UNCONFINED COMPRESSION TEST

PROJECT NAME: GREAT LAKES NAVAL BASE

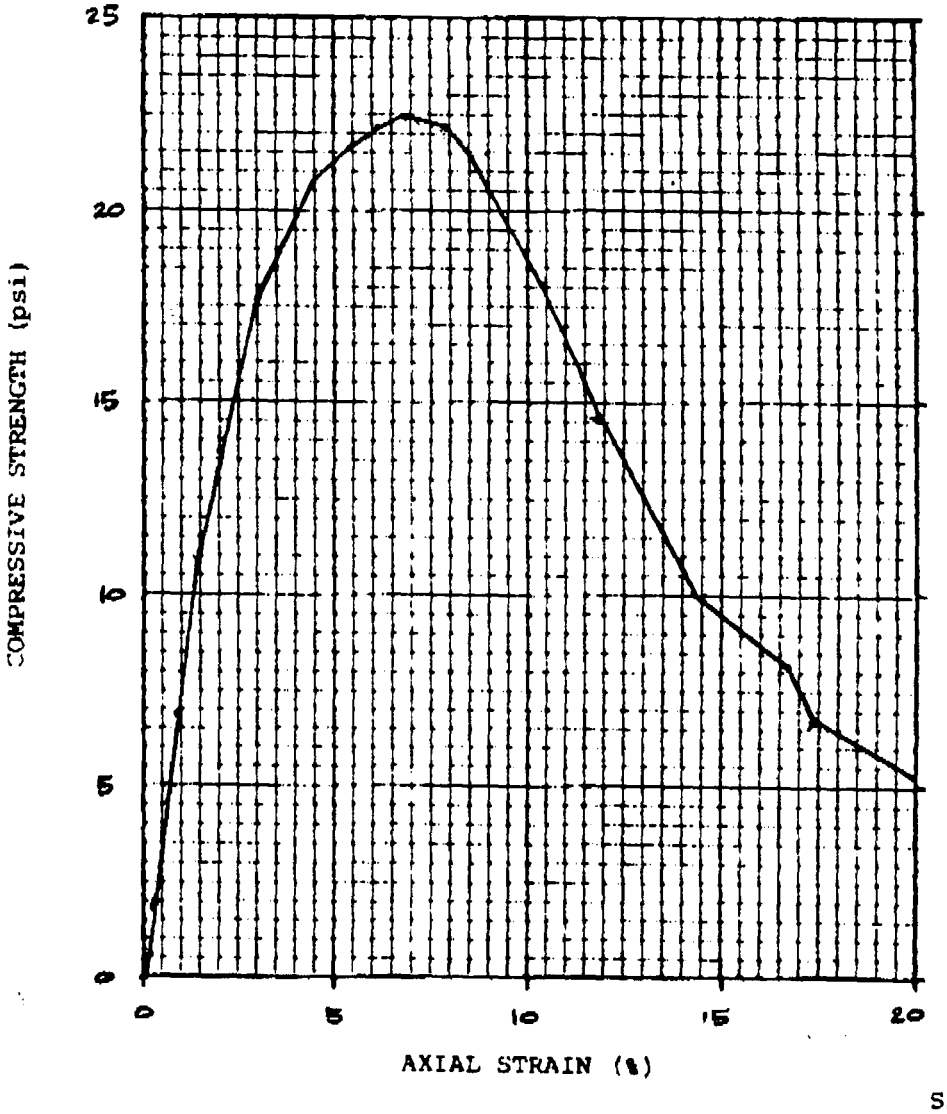
TETC NO.: 88-215-1101

PROJECT NO.:

CLIENT: DAMES & MOORE

DATE: OCTOBER 1987

SUMMARIZED BY: M. Pan



SAMPLE I.D.	DEPTH (ft.)	DRY DENSITY (pcf)	FLUID CONTENT (%)	PEAK STRENGTH (psi)
GC-1-S-4	14.5-15.0	101.5	27.5	22.4

SAMPLE FAILURE SKETCH

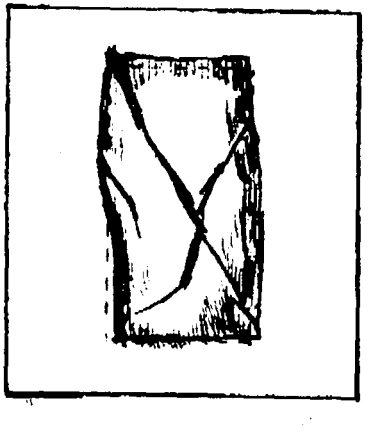


PLATE 11
UNCONFINED COMPRESSION TEST RESULTS

COMPACTION TEST RESULTS

PROJECT NAME: GREAT LAKES NAVAL BASE

TETC NO: 88-215-1101

PROJECT NO. :

CLIENT : DAMES & MOORE

DATE: OCTOBER 1987

SUMMARIZED BY: mp

SAMPLE NO.: CM-BULK

DEPTH: N/A

SOIL DESCRIPTION: SILTY CLAY

METHOD USED

METHOD 'A'
4" MOLD, SOIL PASSING NO. 4 ☒

METHOD 'B'
6" MOLD, SOIL PASSING NO. 4 ☐

METHOD 'C'
6" MOLD, SOIL PASSING ¾" ☐

METHOD 'D'
6" MOLD, SOIL PASSING ¾" WITH GRAVEL CORRECTION ☐

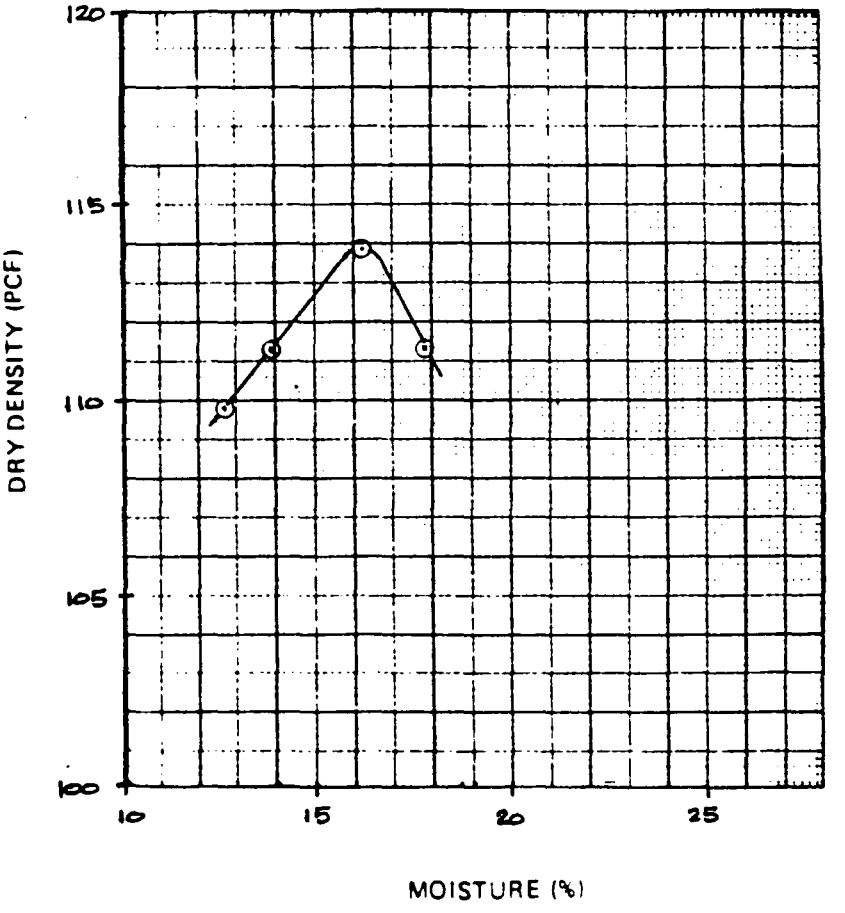
RAM NUMBER STD-1 / 5.5 lb

DROP 12 inches

NUMBER OF LAYERS 3

BLOWS/LAYERS 25

REMARKS



OPTIMUM MOISTURE %: 16

MAX DRY DENSITY PCF: 114

PLATE 12
COMPACTION TEST RESULTS

COMPACTION TEST RESULTS

PROJECT NAME: GREAT LAKES NAVAL BASE

TETC NO: 88-215-1101

PROJECT NO. :

CLIENT : DAMES & MOORE

DATE: OCTOBER 1987

SUMMARIZED BY: mp

SAMPLE NO.: GC-BULK

DEPTH: N/A

SOIL DESCRIPTION: SILTY CLAY

METHOD USED

METHOD 'A'
4" MOLD, SOIL PASSING NO. 4 ☒

METHOD 'B'
6" MOLD, SOIL PASSING NO. 4 ☐

METHOD 'C'
6" MOLD, SOIL PASSING ¾" ☐

METHOD 'D'
6" MOLD, SOIL PASSING ¾" WITH GRAVEL CORRECTION ☐

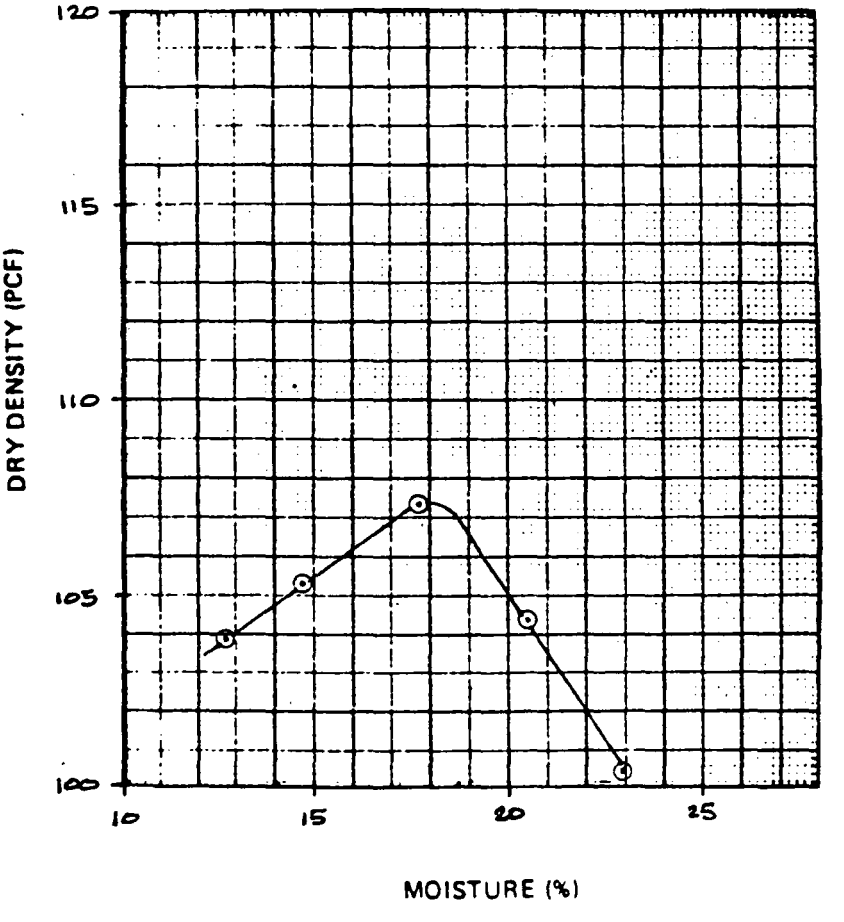
RAM NUMBER STD-1 / 5.5 lb

DROP 12 inches

NUMBER OF LAYERS 3

BLOWS/LAYERS 25

REMARKS



OPTIMUM MOISTURE %: 18.0

MAX DRY DENSITY PCF: 107.5

PLATE 13
COMPACTION TEST RESULTS

TABLE A-1

SUMMARY OF INDEX PROPERTIES

PROJECT NAME: Great Lakes Naval Base

TETC #: 88-215-1101

PROJECT NO.:

CLIENT: Dames & Moore

DATE: October 1987

SUMMARIZED BY: M. Pan

SAMPLE I.D.	DEPTH (ft)	FLUID CONTENT (%)	DRY DENSITY (pcf)	% PASSING #200 SIEVE	ATTERBERG LIMITS			REMARKS
					LIQUID LIMIT %	PLASTIC LIMIT %	PLASTICITY INDEX %	
CM-1	5	15.5						
[redacted]-1	10	15.0			26	15	11	
CM-2a	10	19.5	110.5	68				
[redacted]-2a	40	18.0			33	15	18	
[redacted]-2a	55	16.5		93				
CM-3	5	18.0						
[redacted]-1	1	17.0						
GC-1	15	21.0						
[redacted]-1	20	14.5			36	17	19	
[redacted]-2	5	20.0	103.5					
GC-2	10	14.5		16				
[redacted]-2	40	18.5			39	18	21	
GC-3	5	27.5						
[redacted]-3	15	15.0			25	14	11	
[redacted]-3	10			85				

TABLE A-2

SUMMARY OF CALIFORNIA BEARING RATIO TEST

PROJECT NAME: Great Lakes Naval Base

TEIC #: 88-215-1101

PROJECT NO.:

CLIENT: Dames & Moore

DATE: October, 1987

SUMMARIZED BY: M. Pan

SAMPLE I.D.	BEFORE TEST		SURCHARGE (lb)	SOAK (Yes/No)	SWELL in % of H*	CBR %		AFTER TEST FLUID CONTENT (%)		REMARKS
	DRY DENSITY (pcf)	FLUID CONTENT (%)				0.1"	0.2"	TOP 1"	AVERAGE	
GC-Bulk	102	17.5	10	Y	1.31	4.5	4.2	20	20.5	
CH-Bulk	109	15.5	10	Y	0.53	6.1	5.4	16.5	18.5	

* H - Height of Sample