SOILS INVESTIGATION
ENCHANTED LAKES SUBDIVISION #8-B-2
KAILUA, OAHU, HAWAII
W.O. 187 - JUNE 8, 1970
Grading Permit No. 4950

GEOLABS-HAWAII, INC.
1553 COLBURN STREET, SUITE 203
HONOLULU, HAWAII 96817

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APPENDICES

GEOLABS-HAWAII, Inc.
Geology, Soils and Foundation Engineering
1553 Colburn Street, Suite 203 • Honolulu, Hawaii 96817 • (808) 841-5064

June 8, 1970

W. O. 187

Island Construction
1020-E Keolu Drive
Kailua, Hawaii 96734

Attention: Mr. Melvin Hardy

Subject: Soils Investigation
Enchanted Lakes Subdivision #8-B-2
Kailua, Oahu, Hawaii

Gentlemen:

The following report presents the results and recommendations of a soils investigation completed at the proposed Enchanted Lakes Subdivision #8-B-2 in Kailua, Oahu, Hawaii. A site plan showing the area covered by this investigation is enclosed as Figure No. 1.

SUMMARY OF SOIL CONDITIONS

1. The site can be divided into six soil types:

   a. Hard lava rock exposed in the ridge along the north side.

   b. Rocky fill that was exposed in Test Pit 1 and along

the easterly portion of the sewer trench.

c. Stiff, clayey fill mixed with gravel and boulders together with trash exposed in Test Pit Nos. 2 to 6 and 9 to 14.

d. Loose, clayey gravel fill exposed in Test Pit Nos. 7 and 8.

e. Loose, clayey gravel mixed with boulders and fragments of finger coral exposed in Test Pit Nos. 15 and 16.

f. An underlying layer of soft to medium, compressible clay mixed with some peat encountered in most of the test pits below 8 or 10 feet.

2. On the basis of these soil types, the site can be subdivided into four areas as they relate to foundation conditions. These areas have been designated Area 1, 2, 3 and 4 as shown on Figure 1.

3. Area No. 1 - Soil Types 1-a and 1-b

No foundation problems are anticipated in this area. Remove

boulders and compact the upper 2 feet to 90% (AASHO-T-180-57).

4. Area No. 2 - Soil Types 1-c and 1-f
   Most of this area was filled 6 or 7 years ago with 8 to 12 feet of stiff clay mixed with gravel, boulders and some trash. This material overlies compressible clay which can result in foundation failures unless the foundation loads are low. The upper 3 feet of fill will need to be excavated and the boulders and deleterious material removed from the site. The upper 3 feet can be replaced with on-site granular material compacted to 90% (AASHO-T-180-57).

5. Area No. 3 - Soil Types 1-d and 1-f
   This area was filled recently with clayey gravel and overlies compressible clay which can cause foundation failures, unless the foundation loads are low. The upper 2 feet of fill should be removed and recompacted to 90% (AASHO-T-180-57).

6. Area No. 4 - Soil Types 1-e and 1-f
   This area has been recently dredged and partially refilled with gravelly clay and boulders. The upper 2 feet of fill will need to be excavated and the boulders and deleterious material removed from the site. The upper 2 feet can be replaced with on-site granular material compacted to 90% (AASHO-T-180-57).

7. Water was encountered in some of the test pits, generally 2 to 4 feet below the lake elevation. At the time of this exploration the water level was lowered, by pumping for the construction of the sewer line along the extension of Keolu Drive. It is anticipated that the water level will readjust to the approximate lake level after pumping is stopped.

SITE DESCRIPTION

The area covered by this investigation consists of approximately 14 acres located in the Enchanted Lakes area in Kailua, Oahu, Hawaii. The area is bounded on the north by a rock ridge and an abandoned rock quarry, on the east by Enchanted Lake Estate Unit 8-B-1, on the south by Enchanted Lake and on the west by Kaopo Subdivision, Unit 2.

The proposed extension of Keolu Drive cuts across the site from northeast to southwest and divides the area into nearly two equal parts. At the time of this investigation, a sewer line was being constructed in a 15 to 20-foot deep trench along the Keolu Drive right away. Exposures along this sewer trench provided verification of subsurface soil conditions exposed in the test pits. Hard lava rock similar to that exposed in the abandoned quarry was noted along the east section of the trench.

Lake mud and underlying finger coral was noted along the west portion. There appeared to be a transition from hard lava to softer, weathered basalt with some coral and mud deposits in the center section. All these formations are covered with varying thicknesses of fill material consisting of boulders, clay and gravel.

Except for the rock exposures on the north edge of the site, two-thirds of the area is covered with fill material which, we understand, was placed at various times over a period of six or seven years. The remaining third along the west edge of the site is covered with stockpiles of clayey gravel and finger coral recently dredged from the adjacent pond and marsh area.

The site slopes gently from north to south from approximate elevation 20 at the base of rock slope to elevation 6 near the lake shore. The surface is fairly smooth where the older fill has been placed and irregular where the recent stockpiles are located.

FIELD EXPLORATION

Sixteen (16) test pits south and four (4) test pits north of Keolu Drive extension were dug with a one cubic yard backhoe to depths of 6 to 20 feet. Undisturbed samples were obtained using a drive tube sample spoon with a 2.8 inch I.D. Also representative samples were obtained during the field exploration for laboratory tests. The soil material encountered in the test pits and that exposed in the sewer trench does not necessarily represent subsurface conditions at other points on the site; however, sampling procedures are believed to be representative. The soil material was classified visually in the field and representative undisturbed and disturbed samples were returned to the laboratory for a more detailed analyses.

LABORATORY TESTS

Representative samples were analyzed in the laboratory to determine classification of the material in accordance with the Unified Soil Classification System. Consolidation tests, unit weight, moisture content, and laboratory maximum density and C.B.R. tests were performed on the soil material derived from the site.

The material was too soft to run direct shear and unconfined

compression tests so the compressibility properties were determined from the consolidation tests.

Moisture content was determined for most of the samples. The stiff, clayey fill, soil type 1-c, averaged 40% to 50%, while the underlying compressible clay, soil type 1-f, ran from 70% to 100%.

Atterberg Limit Tests were performed which indicated the soft, clayey soils generally fall into the OH-MH soil classification. Hydrometer Analysis Tests were performed to determine the percentage of sand, silt and clay. Many of these tests indicated a very high content of clay. The soils were not critical with respect to expansion properties. Test results indicated less than 3 percent expansion.

Laboratory test results are presented in summary form in the appropriate spaces on the drilling logs and in the appendices which are included with this report. A discussion of the field and laboratory tests and the recommendations as derived therefrom are included in the following section.

DISCUSSION

The results of field observations, pit excavations and laboratory tests indicate six general soil types exist at the subject site. The site has been divided into four areas based upon anticipated foundation conditions. See Figure 1 for location.

Area 1 - This area lies along the north side of the site. Hard lava rock is exposed in the ridge that rises over 100 feet above the general area. The rock is exposed in a series of cut slopes and benches left from an abandoned rock quarry. The proposed 1:1 slopes with 10 to 30 feet wide benches are satisfactory as shown in Section A on grading plan dated March 19, 1970 prepared for this project.

Rocky fill composed mostly of angular quarry rock and talus lies along the base of the rock slopes and extends out 150 to 400 feet on an east-west line that crosses Keolu Drive Extension. See Figure 1 for approximate limits of Area 1. It is recommended that the large boulders and other deleterious materials be removed and the upper two feet be recompacted with on-site granular material to 90% (AASHO-T-180-57).

Area 2 - This area lies along the east portion of the site.

Stiff, clayey fill mixed with gravel and boulders together with some grass, wood, concrete blocks, wire rope and cans was encountered in Area 2 (See Figure 1). This fill was put in about 6 or 7 years ago and averages 8 to 12 feet thick.

Underlying this fill is a 6 to 8-foot layer of soft to medium compressible clay mixed with some peat. Consolidation tests on this material indicate medium to high compressibility.

It is recommended that the upper 3 feet of fill in Area 2 be excavated and all boulders and deleterious material be removed. The upper 3 feet can be replaced with on-site granular material compacted to 90% (AASHO-T-180-57). It is also recommended that foundations be designed for 800 P.S.F.

Area 3 - This is a small area along the south center portion of the site next to the lake. This area was recently filled with approximately 10 feet of clayey gravel, the upper 2 to 4 feet of which is in a loose condition. This material is also underlain with the soft clay layer described for Area 2.

It is recommended that the upper 4 feet of loose gravel and clay be excavated and the deleterious material be removed. The gravel can then be compacted to 90% (AASHO-T-180-57).

It is also recommended that foundations be designed for 800 P.S.F.

Area 4 - This area is located along the west edge of the site. This area has been recently dredged and partially refilled in the vicinity of Test Pit Nos. 10, 11 and 12 with gravelly clay and boulders. The remaining portion consisted of irregular stockpiles of recently dredged lake mud, coral fragments and cobbles.

The upper 2 feet of fill and the stockpiles will need to be excavated and the boulders and deleterious material removed from the site. The upper 2 feet can be replaced with on-site granular material compacted to 90% (AASHO-T-180-57).

RECOMMENDATIONS

I. Area 1

1. All boulders in excess of 6 inches in diameter shall be removed from the upper 2 feet of material.

2. The gravel material that exists for a depth of 2 feet should be excavated and recompacted to 90% of the laboratory maximum density per AASHO-T-180-57.

3. The bottom of the footings for the proposed

structures should be placed at a minimum depth of -12 inches from finished rough grade. The foundation soil and rock material will be capable of supporting a total loading of 3,000 P.S.F. Settlement under the foregoing conditions will be negligible.

II. Area 2

1. The upper 3 feet of existing fill material must be excavated and all boulders in excess of 6 inches in diameter and trash material shall be removed from the site.

2. The excavated material with the exception of the boulders and trash may be incorporated into the fill for this area. All granular fill material shall be compacted to 90% of the laboratory maximum density test per AASHO-T-180-57.

3. The bottom of the footings for the structures in this area shall be placed at a minimum depth of -12 inches from finished rough grade. The foundation soil material at the foregoing depth will be capable of supporting a total loading of 800 P.S.F.

4. Settlement monuments shall be placed at locations as shown on the enclosed Figure 1. Settlement monuments shall be monitored by a licensed land surveyor with results presented to the soils engineer and F.H.A. at recommended periods for evaluation. The foregoing shall be accomplished prior to construction of the apartment buildings.

III. Area 3

1. The upper 4 feet of loose gravel and clay material shall be excavated from the area and the deleterious material removed from the site.

2. The material may then be replaced and compacted to 90% of the laboratory maximum density test per AASHO-T-180-57.

3. The bottom of the footings for the structures in this area shall be placed at a minimum depth of -12 inches from finished rough grade. The foundation soil material at the foregoing depth will be capable of supporting a total loading of 800 P.S.F.

4. Settlement monuments shall be placed at locations as shown on the enclosed Figure 1. Settlement monuments shall be monitored by a licensed land surveyor with results

presented to the soils engineer and F.H.A. at recommended periods for evaluation. The foregoing shall be accomplished prior to construction of the apartment buildings.

IV. Area 4

1. The recently placed stockpiles of soil material shall be excavated from the area.

2. The exposed upper 2 feet of soil material shall be excavated and all boulders and deleterious material removed. The soil material with the exclusion of the boulders and trash may be replaced in the area compacted to 90% of the laboratory maximum density test per AASHO-T-180-57.

3. The bottom of the footings for the structures in this area shall be placed at a minimum depth of -12 inches from finished rough grade. The foundation soil material at the foregoing depth will be capable of supporting a total loading of 800 P.S.F.

4. Settlement monuments shall be placed at locations as shown on the enclosed Figure 1. Settlement monuments shall be monitored by a licensed land surveyor with results presented to the soils engineer and F.H.A. at recommended

periods for evaluation. The foregoing shall be accomplished prior to construction of the apartment buildings.

V. All earthwork including clearing and grubbing, excavation and recompaction of fill material shall be accomplished in accordance with the enclosed earthwork specifications.

VI. It is recommended that consideration by the structural engineer be given to designing a monolithic footing and slab foundation. This is particularly important in Areas 2, 3 and 4 where settlement is anticipated. If the monolithic design is not used for the structures, the slab area shall be designed as an independent floating slab with steel requirements and reinforcement as determined by the structural engineer.

VII. For areas to receive concrete slabs-on-grade, the following is recommended:

1) Six inches to eight inches of manufactured gravel beneath all concrete slabs.

2) A visqueen membrane should be included beneath all concrete slabs.

3) A 2-inch sand cushion may be placed between

the bottom of the concrete and the visqueen membrane to facilitate concrete placement.

VIII. All earthwork performed on the site shall be in accordance with the enclosed earthwork specifications, F.H.A. data sheet 79G and shall be under the continual supervision of the soils engineer.

IX. Prior to the placement of concrete in the foundations, the footing excavation shall be inspected by a soils engineer to verify the recommendations as set forth in this report.

X. Also prior to the placement of concrete in the foundations, the soils engineer shall approve site conditions based on an evaluation of the settlement monument study.

XI. It is further recommended that large boulders or rip-rap be placed along the lake boundary shoreline for protection of the lot areas.

XII. For street sections in Areas 2, 3, and 4, the design standard as set forth by the City and County of Honolulu, Department of Public Works, Design-Flexible Pavements dated October 24, 1969 should be followed. Areas 2, 3 and 4 will fall into category number II which consists of:

2 inches - AC Pavement

6 inches - Base Course

6 inches - Select Borrow Subbase

6 inches - Compacted Subgrade

All compaction to be 95% of the laboratory maximum density per AASHO-T-180-57. Also for the street design in Area 1 as delineated in this report, the foregoing standard should be followed. The Area 1 pavement will fall into category number I per the City and County of Honolulu. The foregoing will yield a section as follows:

2 inches - AC Pavement

6 inches - Compacted Base Course

6 inches - Compacted Subgrade

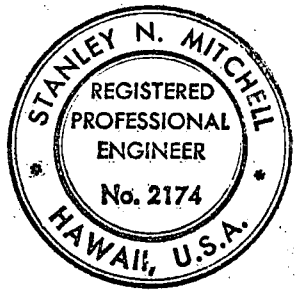
All compaction shall be 95% of the laboratory maximum density test per AASHO-T-180-57.

This opportunity to be of service is appreciated.

Respectfully submitted,

GEOLABS-HAWAII, INC.

Stanley N. Mitchell, P.E.



Ronald A. Pickering
Vice President

APPENDIX A

UNIFIED SOIL CLASSIFICATION SYSTEM

1. Drill Logs

UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS			GROUP SYMBOLS	TYPICAL NAMES
COARSE GRAINED SOILS (More than 50% material is larger than No. 200 sieve size)	GRAVELS (More than 50% of coarse fraction is larger than No 4 sieve size)	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 amt. of fines)	GM	Silty gravels, gravel-sand-silt mixtures
			GC	Clayey gravels, gravel-sand-clay mixtures
	SANDS (More than 50% of coarse fraction is smaller than No 4 sieve size)	CLEAN SANDS (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 amt. of fines)	SM	Silty sands, sand-silt mixtures
			SC	Clayey sands, sand-clay mixtures
FINE GRAINED SOILS (More than 50% material is smaller than No. 200 sieve size)	SILTS AND CLAYS Liquid Limit less than 50%		ML	Inorganic silts & very fine sands, rock flour, silty or clayey fine sands, clayey silts with slight plasticity
			CL	Inorganic clays of low to medium plasticity, gravelly clays, silty clays, lean clays
			OL	Organic silts & organic silty clays of low plasticity
	SILTS AND CLAYS Liquid Limit Greater than 50%		MH	Inorganic Silts, micaceous and diatomaceous fine Sandy or Silty soils, elastic silts.
			CH	Inorganic clay of high plasticity, fat clays
			OH	Organic clays of medium to high plasticity, organic silts
HIGHLY ORGANIC SOILS			Pt	Peat and other highly organic soils

PARTICLE SIZE LIMITS

GRAVEL		SAND			SILT	CLAY
Coarse	Fine	Coarse	Medium	Fine		

3in 3/4in. No.4 No.10 No.40 No.200 .074mm .005 mm

U.S STANDARD SIEVE SIZE

GEOLABS-HAWAII, INC.

1553 COLBURN ST., HONOLULU, H. I. TEL. 815-064

—GEOLABS, INC.—

SUBSURFACE EXPLORATION & PENETRATION LOG

Work Order No. 187 Ground Elevation 16** Hole Number T.P. 1

Project Enchanted Lakes Sub. 8-B-2 Location See Figure #1

Total Depth of Hole 6.0' Elevation of Watertable N/E* Date W.L. Gaged _____

Weight of Hammer _____ Height of Drop _____ Date Begun 5-1-70

Hole Logged By S. Mitchell Foreman _____ Date Finished 5-1-70

Notes	Depth (Ft.)	No Blows	% Moisture	Samples	Description Unified Soil Classification	Depth (Ft.)	Log	Unit Wt. Lbs/Ft.^{3} (Wet)	Phi ϕ Value	Liquid Limit	Plastic Index
	1				Dense, brown Clayey GRAVEL with 1 to 2 ft. boulders GC	1					
	2					2					
	3				Dense, brown Clayey GRAVEL with 3 ft. boulders, many rocks. GC	3					
	4					4					
	5					5					
	6				Very large boulders	6					
	7				Bottom of Pit 6 feet Too hard to dig below 6 feet	7					
	8					8					
	9					9					
	10					10					
	11					11					
	12					12					
	13					13					
	14					14					
	15					15					
	16					16					
	17					17					
	18					18					
	19					19					
	20					20					

* Not Encountered

** Taken from Grading Plan dated 3-19-70
Elevation to proposed finished rough grade = -1'

GEO-24

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SUBSURFACE EXPLORATION & PENETRATION LOG

Work Order No. 187 Ground Elevation 15** Hole Number T.P. 2
Project Enchanted Lakes Sub. 8-B-2 Location See Figure #1
Total Depth of Hole 16.5' Elevation of Watertable N/E* Date W.L. Gaged _____
Weight of Hammer _____ Height of Drop _____ Date Begun 5-1-70
Hole Logged By S. Mitchell Foreman _____ Date Finished 5-1-70

Notes	Depth (Ft.)	No Blows	% Moisture	Samples	Description Unified Soil Classification	Depth (Ft.)	Log	Unit Wt. Lbs/Ft.3 (wet)	Phi ϕ Value	Liquid Limit	Plastic Index
	1				Very stiff, brown Sandy CLAY. Dry SC	1					
	2				Very stiff, blue-gray Gravely CLAY with 1 ft. Boulders, Wood. Moist. GC	2					
	3					3					
	4				Stiff, blue-gray Sandy CLAY with shells, coral fragments, black organic material. Very moist. SC	4					
	5					5					
	6					6					
	7					7					
	8				Medium blue-gray Sandy CLAY with small rocks, coral fragments. SC-GC	8					
	9		50			9					
	10					10					
	11		74		Soft, blue-gray Silty CLAY. Very moist. CH-OH	11					
	12		71			12					
	13					13					
	14				Medium dense, brown Clayey GRAVEL. GC	14					
	15				Medium dense, blue, green, brown Clayey SAND. Very moist. SC	15					
	16				Weathered Basalt.	16					
	17				Bottom of Pit 16.5 feet	17					
	18					18					
	19					19					
	20					20					

* Not Encountered
** Taken from Grading Plan dated 3-19-70
Elevation to proposed finished rough grade = At grade

GEO-24

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SUBSURFACE EXPLORATION & PENETRATION LOG

Work Order No. 187 Ground Elevation 15** Hole Number T.P. 3

Project Enchanted Lakes Sub. 8-B-2 Location See Figure #1

Total Depth of Hole 18.0 Elevation of Watertable N/E* Date W.L. Gaged ____

Weight of Hammer ____ Height of Drop ____ Date Begun 4-29-70

Hole Logged By S. Mitchell Foreman ____ Date Finished 4-29-70

Notes	Depth (Ft.)	No Blows	% Moisture	Samples	Description Unified Soil Classification	Depth (Ft.)	Log	Unit Wt. Lbs/Ft.3 (Wet)	Phi ϕ Value	Liquid Limit	Plastic Index
	1				Medium dense, brown Clayey SAND. SC	1					
	2				Stiff, blue-gray Sandy CLAY with small rocks. CL, GC	2					
	3					3					
	4					4					
	5				Medium to stiff, blue-gray Sandy CLAY with shells. Some organic matter. Some boulders. CL, GC	5					
	6					6					
	7					7					
	8				Medium, blue-gray Sandy CLAY with shells, some gravel CL, GC.	8					
	9					9					
	10					10					
	11		81		Soft, blue-gray CLAY. CH-OH	11					
	12					12					
	13		108		Soft, blue-gray CLAY with considerable black PEAT. OH, Pt	13					
	14					14					
	15		89		Soft, gray CLAY with some brown Sandy CLAY and brown PEAT. OH, SC, Pt	15					
	16					16					
	17					17					
	18					18					
	19				Bottom of Pit 18.0 feet	19					
	20					20					

*N/E = Not Encountered

** Taken from Grading Plan dated 3-19-70
Elevation to proposed finished rough grade = -2'

GEO-24

—GEOLABS, INC.—

SUBSURFACE EXPLORATION & PENETRATION LOG

Work Order No. 187 Ground Elevation 13** Hole Number T.P. 4

Project Enchanted Lakes Sub. 8-B-2 Location See Figure #1

Total Depth of Hole 16.5 Elevation of Watertable 15.0 Date W.L. Gaged 4-29-70

Weight of Hammer ____ Height of Drop ____ Date Begun 4-29-70

Hole Logged By S. Mitchell Foreman ____ Date Finished 4-29-70

Notes	Depth (Ft.)	No Blows	% Moisture	Samples	Description Unified Soil Classification	Depth (Ft.)	Log	Unit Wt. Lbs./Ft.³ (wet)	Phi ϕ Value	Liquid Limit	Plastic Index
	1				Loose to medium dense, Clayey SAND with boulders 1 to 2 ft. Dry to slightly moist. GC	1					
	2					2					
	3				Stiff, blue-gray Gravely CLAY with some rocks. Quite moist. GC	3					
	4					4					
	5					5					
	6				Medium to stiff, blue-gray Sandy CLAY with shells. Some rocks, very moist. SC, GC	6					
	7					7					
	8					8					
	9					9					
	10				Medium to stiff, blue-gray Sandy CLAY with grass. Very moist to wet. SC	10					
	11					11					
	12		71		Soft, blue-gray CLAY with pockets of peat. Very Moist. OH, Pt	12					
	13		85			13				101	45
	14		81			14					
	15					15					
	16				Finger CORAL, Clayey SAND. Wet	16					
	17				Bottom of Pit 16.5 feet	17					
	18					18					
	19					19					
	20					20					

** Taken from Grading Plan dated 3-19-70
Elevation to proposed finished rough grade = At grade

GEO-24

—GEOLABS, INC.—

SUBSURFACE EXPLORATION & PENETRATION LOG

Work Order No. 187 Ground Elevation 12** Hole Number T.P. 5

Project Enchanted Lakes Sub. 8-B-2 Location See Figure #1

Total Depth of Hole 16.5 Elevation of Watertable N/E* Date W.L. Gaged ____

Weight of Hammer ____ Height of Drop ____ Date Begun 4-29-70

Hole Logged By S. Mitchell Foreman ____ Date Finished 4-29-70

Notes	Depth (Ft.)	No Blows	% Moisture	Samples	Description Unified Soil Classification	Depth (Ft.)	Log	Unit Wt. Lbs/Ft.3 (Wet)	Phi ϕ Value	Liquid Limit	Plastic Index
	1				Medium to stiff, brown Sandy, Gravely CLAY. Dry to moist. GC	1					
	2					2					
	3					3					
	4					4					
	5				Medium to stiff, blue-gray Sandy CLAY with shells, very moist, boulder 1 to 3 ft. across. Some wood. SC-GC	5					
	6					6					
	7					7					
	8					8					
	9				Medium blue-gray Sandy CLAY, some rocks. SC-GC	9					
	10					10					
	11					11					
	12					12					
	13		65		Medium, blue-gray CLAY with grass, organic matter. CH, OH	13					
	14					14					
	15				Soft to medium, blue-gray CLAY, organic matter, very moist. CH, OH	15					
	16		65			16					
	17				Bottom of Pit 16.5 feet	17					
	18					18					
	19					19					
	20					20					

*Not Encountered

**Taken from Grading Plan dated 3-19-70.
Elevation to proposed finished rough grade = -2'

GEO-24

—GEOLABS, INC.—

SUBSURFACE EXPLORATION & PENETRATION LOG

Work Order No. 187 Ground Elevation 5** Hole Number T.P. 6

Project Enchanted Lakes Sub. 8-B-2 Location See Figure #1

Total Depth of Hole 13.0' Elevation of Watertable N/E* Date W.L. Gaged

Weight of Hammer ____ Height of Drop ____ Date Begun 4-30-70

Hole Logged By S. Mitchell Foreman ____ Date Finished 4-30-70

Notes	Depth (Ft.)	No Blows	% Moisture	Samples	Description Unified Soil Classification	Depth (Ft.)	Log	Unit Wt. Lbs/Ft.3 (Wet)	Phi ϕ Value	Liquid Limit	Plastic Index
	1				Medium, brown Clayey SILT, rocks, chunks of asphalt pavement. Dry.	1					
	2					2					
	3					3					
	4					4					
	5				Stiff, brown Gravely CLAY with rocks. Slightly moist. GC	5					
	6					6					
	7					7					
	8					8					
	9		67		Medium, blue-gray CLAY. Very moist to wet. CH-OH	9					
	10					10					
	11				Soft, blue-gray CLAY with PEAT and many roots. Wet. CH, Pt	11					
	12		93			12					
	13					13					
	14				Bottom of Pit 13.0 feet	14					
	15					15					
	16					16					
	17					17					
	18					18					
	19					19					
	20					20					

*Not Encountered

** Taken from Grading Plan dated 3-19-70
Elevation to proposed finished rough grade = +3'

GEO-24

—GEOLABS, INC.—

SUBSURFACE EXPLORATION & PENETRATION LOG

Work Order No. 187 Ground Elevation 13** Hole Number T.P. 6A

Project Enchanted Lakes Sub. 8-B-2 Location See Figure #1

Total Depth of Hole 16.0' Elevation of Watertable N/E* Date W.L. Gaged

Weight of Hammer Height of Drop Date Begun 5-1-70

Hole Logged By S. Mitchell Foreman Date Finished 5-1-70

Notes	Depth (Ft.)	No Blows	% Moisture	Samples	Description Unified Soil Classification	Depth (Ft.)	Log	Unit Wt. Lbs./Ft.3 (Wet)	Phi. ϕ Value	Liquid Limit	Plastic Index
	1				Stiff to hard, brown Gravely CLAY with 6 to 12 in. rocks. GC	1					
	2					2					
	3				Stiff, blue-gray Gravely CLAY with 1 to 2 ft. Boulders Moist GC	3					
	4					4					
	5				Stiff, blue-green gray Gravely CLAY with shells, coral fragments, wood, moist. GC	5					
	6					6					
	7				Stiff, brown and gray Gravely CLAY. GC	7					
	8					8					
	9				Medium dense, brown Clayey GRAVEL. Well graded to 5"+ GW, GC	9					
	10					10					
	11					11					
	12		44		Stiff, green, blue, gray, brown CLAY. CL (Deeply weathered Basalt)	12					
	13					13					
	14					14					
	15				Hard, brown Clayey SILT MH (Weathered Basalt)	15					
	16					16					
	17				Bottom of Pit 16.0 feet	17					
	18					18					
	19					19					
	20					20					

* Not Encountered

** Taken from Grading Plan dated 3-19-70
Elevation to proposed finished rough grade = +2'

GEO-24

—GEOLABS, INC.—

SUBSURFACE EXPLORATION & PENETRATION LOG

Work Order No. 187 Ground Elevation 5.5** Hole Number T.P. 7
Project Enchanted Lakes Sub. 8-B-2 Location See Figure #1
Total Depth of Hole 11.0' Elevation of Watertable 10.0 Date W.L. Gaged 5-1-70
Weight of Hammer ____ Height of Drop ____ Date Begun 5-1-70
Hole Logged By S. Mitchell Foreman ____ Date Finished 5-1-70

Notes	Depth (Ft.)	No Blows	% Moisture	Samples	Description Unified Soil Classification	Depth (Ft.)	Log	Unit Wt. Lbs/Ft.³ (Wet)	Phi ϕ Value	Liquid Limit	Plastic Index
	1				Loose, dark brown Clayey GRAVEL. Slightly moist, many 1 to 2 ft rocks, wire. GC	1					
	2					2					
	3				Loose, dark brown Clayey GRAVEL. Moist GC	3					
	4					4					
	5				Medium density, brown Clayey GRAVEL. Very moist. GC	5					
	6					6					
	7					7					
	8				Wet below 8 feet.	8					
	9				Caving	9					
	10				Soft, gray CLAY, wood. OH	10					
	11					11					
	12				Bottom of Pit 11.0 feet	12					
	13					13					
	14					14					
	15					15					
	16					16					
	17					17					
	18					18					
	19					19					
	20					20					

** Taken from Grading Plan dated 3-19-70
Elevation to proposed finished rough grade = +2.5'

GEO-24

—GEOLABS, INC.—

SUBSURFACE EXPLORATION & PENETRATION LOG

Work Order No. 187 Ground Elevation 5** Hole Number T.P. 8

Project Enchanted Lakes Sub.8-B-2 Location See Figure #1

Total Depth of Hole 11.0' Elevation of Watertable 10.0 Date W.L. Gaged 5-1-70

Weight of Hammer ____ Height of Drop ____ Date Begun 5-1-70

Hole Logged By S. Mitchell Foreman ____ Date Finished 5-1-70

Notes	Depth (Ft.)	No Blows	% Moisture	Samples	Description Unified Soil Classification	Depth (Ft.)	Log	Unit Wt. Lbs/Ft.^{3} (Wet)	Phi ϕ Value	Liquid Limit	Plastic Index
	1				Loose, dark brown Clayey GRAVEL with steel cable, wood, 2-ft. boulders.	1					
	2					2					
	3				Medium dense, dark brown Clayey GRAVEL. Moist. Well graded up to 5 inches. Subrounded pebbles. Very moist. GW, GC	3					
	4					4					
	5					5					
	6					6					
	7				Medium dense to dense, dark brown Clayey GRAVEL with 2 ft. Boulders, wood. Poorly graded. Wet below 9 feet. GC Caving too fast to dig deeper than 11.0 feet.	7					
	8					8					
	9					9					
	10					10					
	11					11					
	12				Bottom of Pit 11.0 feet	12					
	13					13					
	14					14					
	15					15					
	16					16					
	17					17					
	18					18					
	19					19					
	20					20					

** Taken from Grading Plan dated 3-19-70
Elevation to proposed finished rough grade = +5'

GEO-24

—GEOLABS, INC.—

SUBSURFACE EXPLORATION & PENETRATION LOG

Work Order No. 187 Ground Elevation 16 ** Hole Number T.P. 9
Project Enchanted Lakes Sub. 8-B-2 Location See Figure #1
Total Depth of Hole 20.0 Elevation of Watertable N/E* Date W.L. Gaged
Weight of Hammer ____ Height of Drop ____ Date Begun 4-30-70
Hole Logged By S. Mitchell Foreman ____ Date Finished 4-30-70

Notes	Depth (Ft.)	No Blows	% Moisture	Samples	Description Unified Soil Classification	Depth (Ft.)	Log	Unit Wt. Lbs/Ft.³ (Wet)	Phi ϕ Value	Liquid Limit	Plastic Index
	1				Stiff to hard, brown Gravely CLAY. Dry GC	1					
	2				Stiff, brown and blue-gray Gravely CLAY, 2 to 4 ft. Boulders, wire rope. Slightly moist. GC	2					
	3					3					
	4					4					
	5				Stiff, blue-gray Gravely CLAY 6 to 12 in. rocks, wood, coral fragments. Moist GC	5					
	6					6					
	7					7					
	8				Stiff, blue-gray Sandy CLAY with shells, 2 ft Boulder. GC Coral fragments, organic matter. Moist to very moist	8					
	9					9					
	10					10					
	11					11					
	12					12					
	13					13					
	14		72		Medium, blue-gray Silty CLAY with grass. Very moist OH	14					
	15					15					
	16		48		Soft to medium, blue-gray CLAY, considerable black PEAT, tree roots. Very moist. OH, Pt	16					
	17					17					
	18				Medium to soft, brown, green and gray Peaty CLAY, some pebbles. OH, Pt	18					
	19					19					
	20				Tan and green weathered Basalt.	20					

Bottom of Pit 20.0 feet

*Not Encountered
** Taken from Grading Plan dated 3-19-70
Elevation to proposed finished rough grade = At grade

—GEOLABS, INC.—

SUBSURFACE EXPLORATION & PENETRATION LOG

Work Order No. 187 Ground Elevation 10 ** Hole Number T.P. 10
Project Enchanted Lakes Sub. 8-B-2 Location See Figure #1
Total Depth of Hole 17.0 Elevation of Watertable 13.0 Date W.L. Gaged 4-28-70
Weight of Hammer ____ Height of Drop ____ Date Begun 4-27-70
Hole Logged By S. Mitchell Foreman ____ Date Finished 4-28-70

Notes	Depth (Ft.)	No Blows	% Moisture	Samples	Description Unified Soil Classification	Depth (Ft.)	Log	Unit Wt. Lbs/Ft.3 (Wet)	Phi ϕ Value	Liquid Limit	Plastic Index
	1				Gray and brown Sandy CLAY with concrete blocks, wood, many 2 to 3 ft. boulders, wire rope, scrap metal.	1					
	2					2					
	3					3					
	4					4					
	5				4½-foot Boulders and many 1 to 2 ft. rocks with gray CLAY. GC Perched water at 5.5 ft.	5					
	6					6					
	7					7					
	8					8					
	9				Medium to soft, green, blue and gray CLAY with grass. Some sand and pebbles. OH, GC	9					
	10					10					
	11				Stiff, green-gray with brown CLAY. OH	11					
	12					12					
	13					13					
	14				Gray-white Finger Coral. Wet	14					
	15				Caving	15					
	16					16					
	17					17					
	18				Bottom of Pit 17.0 feet	18					
	19					19					
	20					20					

** Taken from Grading Plan dated 3-19-70
Elevation to proposed finished rough grade = +3'

GEO-24

—GEOLABS, INC.—

SUBSURFACE EXPLORATION & PENETRATION LOG

Work Order No. 187 Ground Elevation 15 ** Hole Number T.P. 10A

Project Enchanted Lakes Sub. 8-B-2 Location See Figure #1

Total Depth of Hole 17.5 Elevation of Watertable N/E* Date W.L. Gaged

Weight of Hammer Height of Drop Date Begun 4-30-70

Hole Logged By S. Mitchell Foreman Date Finished 4-30-70

Notes	Depth (Ft.)	No Blows	% Moisture	Samples	Description Unified Soil Classification	Depth (Ft.)	Log	Unit Wt. Lbs./Ft.³ (Wet)	Phi ϕ Value	Liquid Limit	Plastic Index
	1				Stiff, brown Sandy CLAY with 1 to 2 ft. Boulder. Some small rocks, wire rope, wood. Dry to slightly moist.	1						
	2					2					
	3					3					
	4				Stiff, blue-gray Gravely CLAY with small rocks. Moist Some 1 to 2 ft boulders. GC	4						
	5					5					
	6		41			6					
	7					7					
	8					8					
	9				Medium to stiff, blue-gray Sandy CLAY with some rocks. Very moist. GC	9					
	10					10					
	11					11					
	12				Medium, blue-gray Sandy CLAY with some black peat and small rocks. Very moist. SC, Pt	12					
	13					13					
	14					14					
	15					15					
	16					16					
	17					17					
	18				Bottom of Pit 17.5 feet	18					
	19					19					
	20					20					

*Not Encountered

**Taken from Grading Plan dated 3-19-70
Elevation to proposed finished rough grade = -1'

GEO-24

—GEOLABS, INC.—

SUBSURFACE EXPLORATION & PENETRATION LOG

Work Order No. 187 Ground Elevation 8± ** Hole Number T.P. 11

Project Enchanted Lakes Sub. 8-B-2 Location See Figure #1

Total Depth of Hole 13.0' Elevation of Watertable 12.0 Date W.L. Gaged 4-28-70

Weight of Hammer ____ Height of Drop ____ Date Begun 4-28-70

Hole Logged By S. Mitchell Foreman ____ Date Finished 4-28-70

Notes	Depth (Ft.)	No Blows	% Moisture	Samples	Description Unified Soil Classification	Depth (Ft.)	Log	Unit Wt. Lbs/Ft.3 (Wet)	Phi ϕ Value	Liquid Limit	Plastic Index
	1				Medium, brown Sandy CLAY Some wood, grass, small rocks	1					
	2					2					
	3				Medium, gray Sandy CLAY with pebbles. GC	3					
	4		52		Medium, gray Sandy CLAY with many rocks, some 2 to 3 ft. Boulders. GC	4					
	5					5					
	6					6					
	7				Soft, gray-green Silty CLAY with many tree roots. Very moist, some rocks. Considerable peat. OH, Pt, GC	7					
	8					8					
	9					9					
	10					10					
	11					11					
	12				Gray finger CORAL and shells, Silty SAND. Wet	12					
	13					13					
	14				Bottom of Pit 13.0 feet	14					
	15					15					
	16					16					
	17					17					
	18					18					
	19					19					
	20					0					

** Taken from Grading Plan dated 3-19-70
Elevation to proposed finished rough grade = +4'

GEO-24

—GEOLABS, INC.—

SUBSURFACE EXPLORATION & PENETRATION LOG

Work Order No. 187 Ground Elevation 12 ** Hole Number T.P. 11A

Project Enchanted Lakes Sub. 8-B-2 Location See Figure #1

Total Depth of Hole 15.0' Elevation of Watertable N/E* Date W.L. Gaged ____

Weight of Hammer ____ Height of Drop ____ Date Begun 4-28-70

Hole Logged By S. Mitchell Foreman ____ Date Finished 4-28-70

Notes	Depth (Ft.)	No Blows	% Moisture	Samples	Description Unified Soil Classification	Depth (Ft.)	Log	Unit Wt. Lbs/Ft.3 (Wet)	Phi ϕ Value	Liquid Limit	Plastic Index
	1				Medium, brown Gravely CLAY with concrete slabs. Dry to slightly moist. GC	1					
	2					2					
	3					3					
	4				Medium to stiff, brown Gravely CLAY with small boulders, grass, wood, etc. GC	4					
	5					5					
	6					6					
	7					7					
	8				Stiff, blue-green Sandy CLAY with shells, pebbles, boulders 1 to 3 ft. across. Moist GC	8					
	9					9					
	10					10					
	11				Stiff to very stiff, green-gray Gravely CLAY with many small rocks. GC	11					
	12					12					
	13					13					
	14		59		Very large boulder 3 to 5 ft. across set in stiff, green-gray Sandy CLAY. Moist GC	14				98	58
	15				JCH	15					
	16				Bottom of Pit 15.0 feet	16					
	17					17					
	18					18					
	19					19					
	20					20					

*Not Encountered

** Taken from Grading Plan dated 3-19-70
Elevation to proposed finished rough grade = At grade

GEO-24

—GEOLABS, INC.—

SUBSURFACE EXPLORATION & PENETRATION LOG

Work Order No. 187 Ground Elevation 8± ** Hole Number T.P. 12

Project Enchanted Lakes Sub. 8-B-2 Location See Figure #1

Total Depth of Hole 14.0' Elevation of Watertable 12.5 Date W.L. Gaged 4-28-70

Weight of Hammer _____ Height of Drop _____ Date Begun 4-28-70

Hole Logged By S. Mitchell Foreman _____ Date Finished 4-28-70

Notes	Depth (Ft.)	No Blows	% Moisture	Samples	Description Unified Soil Classification	Depth (Ft.)	Log	Unit Wt. Lbs/Ft.³ (wet)	Phi ϕ Value	Liquid Limit	Plastic Index
	1				Medium dense, brown Sandy SILT with some CLAY, pebbles and small rocks. Slightly moist. GC	1					
	2					2					
	3					3					
	4				Medium dense, brown Clayey SAND, some gravel and small boulders. Moist GC	4					
	5					5					
	6				Stiff, gray and brown Silty CLAY with many rocks and boulders 2 to 4 ft. across, some organic matter, wood. GC	6					
	7					7					
	8					8					
	9					9					
	10					10					
	11		81		Soft to medium, gray and blue-green Silty CLAY with black organic matter, some wood. CH,OH	11				109	48
	12					12					
	13				Gray Finger CORAL, shells and Silty SAND.	13					
	14					14					
	15				Bottom of Pit 14.0 feet	15					
	16					16					
	17					17					
	18					18					
	19					19					
	20					0					

** Taken from Grading Plan dated 3-19-70
Elevation to proposed finished rough grade = +2'

GEO-24

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SUBSURFACE EXPLORATION & PENETRATION LOG

Work Order No. 187 Ground Elevation 9 ** Hole Number T.P. 12A

Project Enchanted Lakes Sub. 8-B-2 Location See Figure #1

Total Depth of Hole 18.0' Elevation of Watertable N/E* Date W L. Gaged _____

Weight of Hammer _____ Height of Drop _____ Date Begun 4-30-70

Hole Logged By S. Mitchell Foreman _____ Date Finished 4-30-70

Notes	Depth (Ft.)	No Blows	% Moisture	Samples	Description Unified Soil Classification	Depth (Ft.)	Log	Unit Wt. Lbs/Ft.³ (wet)	Phi ϕ Value	Liquid Limit	Plastic Index
	1				Loose, brown Clayey GRAVEL, wood, weeds, grass, small boulders, concrete slabs. Dry	1					
	2					2					
	3					3					
	4				Stiff, brown Gravely CLAY 2 to 3 ft boulders. Slightly moist. GC	4					
	5					5					
	6				Stiff, blue-gray Gravely CLAY with shells, rocks, wire rope, wood, 1 to 2 ft. Boulders. Moist GC	6					
	7					7					
	8					8					
	9				Stiff, blue-gray Sandy CLAY with shells, lots of wood, logs. Moist. SC	9					
	10					10					
	11					11					
	12					12					
	13					13					
	14				Medium, gray CLAY, many shells, some peat, very moist OH, Pt	14					
	15				Soft to medium, gray CLAY, many shells, moist to wet. OH, Pt	15					
	16					16					
	17					17					
	18					18					
	19				Bottom of Pit 18.0 feet	19					
	20					20					

*Not Encountered

** Taken from Grading Plan dated 3-19-70
Elevation to proposed finished rough grade = +1'

GEO-24

—GEOLABS, INC.—

SUBSURFACE EXPLORATION & PENETRATION LOG

Work Order No. 187 Ground Elevation 12 ** Hole Number T.P. 13
Project Enchanted Lakes Sub. 8-B-2 Location See Figure #1
Total Depth of Hole 18.5' Elevation of Watertable N/E* Date W.L. Gaged
Weight of Hammer Height of Drop Date Begun 4-27-70
Hole Logged By S. Mitchell Foreman Date Finished 4-27-70

Notes	Depth (Ft.)	No Blows	% Moisture	Samples	Description Unified Soil Classification	Depth (Ft.)	Log	Unit Wt. Lbs/Ft.3 (wet)	Phi ϕ Value	Liquid Limit	Plastic Index
	1				Loose, red Silt with gray CLAY. MH	1					
	2				Medium, gray, very moist CLAY 3½ ft. Boulder, wood.	2					
	3					3					
	4				Medium to stiff, gray-brown Sandy CLAY with organic material roots. SC, OH	4					
	5					5					
	6					6					
	7					7					
	8					8					
	9				Stiff, gray CLAY with some shells, small pebbles, moist. OH, SC	9					
	10					10					
	11					11					
	12				Medium, gray CLAY, shells very moist, small pebbles OH, SC	12					
	13				Soft to medium, gray CLAY with grass, black organic matter. Very moist CH, OH	13					
	14					14					
	15					15					
	16					16					
	17				Soft, gray Sandy CLAY with organic matter. SC	17					
	18		40			18					
	19				Bottom of Pit 18.5 feet	19					
	20					20					

*Not Encountered
** Taken from Grading Plan dated 3-19-70
Elevation to proposed finished rough grade = +1'

GEO-24

—GEOLABS, INC.—

SUBSURFACE EXPLORATION & PENETRATION LOG

Work Order No. 187 Ground Elevation _____ Hole Number T.P. 14

Project Enchanted Lakes Sub. 8-B-2 Location See Figure #1

Total Depth of Hole 19.0' Elevation of Watertable 13.5 Date W.L. Gaged 4-30-70

Weight of Hammer _____ Height of Drop _____ Date Begun 4-30-70

Hole Logged By S. Mitchell Foreman _____ Date Finished 4-30-70

Notes	Depth (Ft.)	No Blows	% Moisture	Samples	Description Unified Soil Classification	Depth (Ft.)	Log	Unit Wt. Lbs/Ft.³ (Wet)	Phi ϕ Value	Liquid Limit	Plastic Index
	1				Stiff, brown and glue-gray Gravely CLAY with 3 ft. boulder, many rocks. Dry to moist. Some wood GC	1					
	2					2					
	3					3					
	4					4					
	5				Stiff, blue-gray Gravely CLAY, some rocks, coral fragments, some wood, moist. GC	5					
	6					6					
	7					7					
	8				Stiff, blue-gray Sandy CLAY with grass, tree roots, moist. SC, CL	8					
	9					9					
	10				Medium, blue-gray CLAY with shells, many tree roots. Very moist. CH, OH	10					
	11					11					
	12				Soft, blue-gray CLAY with many decomposed roots. Very moist. CH, OH	12					
	13		72			13					
	14					14					
	15		103		Very soft, gray CLAY. Many tree roots, PEAT Very moist to wet CH, OH	15					
	16					16					
	17					17					
	18				Gray Coral Fragments and SAND. GM	18					
	19					19					
	20				Bottom of Pit 19.0 feet	0					

** Taken from Grading Plan dated 3-19-70
Elevation to proposed finished rough grade = +2'

GEO-24

—GEOLABS, INC.—

SUBSURFACE EXPLORATION & PENETRATION LOG

Work Order No. 187 Ground Elevation 12 ** Hole Number T.P. 15

Project Enchanted Lakes Sub. 8-B-2 Location See Figure #1

Total Depth of Hole 20.0' Elevation of Watertable 16.0 Date W.L. Gaged 5-1-70

Weight of Hammer ____ Height of Drop ____ Date Begun 5-1-70

Hole Logged By S. Mitchell Foreman ____ Date Finished 5-1-70

Notes	Depth (Ft.)	No Blows	% Moisture	Samples	Description Unified Soil Classification	Depth (Ft.)	Log	Unit Wt. Lbs/Ft.^{3} (wet)	Phi ϕ Value	Liquid Limit	Plastic Index
	1				Loose, gray Clayey GRAVEL with coral fragments and boulder 1 to 2 ft across. (Recently dredged and left in stockpiles) GC	1					
	2					2					
	3					3					
	4					4					
	5					5					
	6					6					
	7					7					
	8					8					
	9				Medium dense, gray Clayey GRAVEL with boulders 1 to 2 ft across. GC	9					
	10					10					
	11					11					
	12					12					
	13					13					
	14					14					
	15					15					
	16					16					
	17				Soft to medium, brown and gray CLAY. OH	17					
	18					18					
	19				Medium dense fragmental CORAL.	19					
	20					20					

Bottom of Pit 20.0 feet

** Taken from Grading Plan dated 3-19-70
Elevation to proposed finished rough grade = -1'

GEO-24

—GEOLABS, INC.—

SUBSURFACE EXPLORATION & PENETRATION LOG

Work Order No. 187 Ground Elevation 10 ** Hole Number T.P. 16

Project Enchanted Lakes Sub. 8-B-2 Location See Figure #1

Total Depth of Hole 17.0' Elevation of Watertable 9.0 Date W.L. Gaged 5-1-70

Weight of Hammer ____ Height of Drop ____ Date Begun 5-1-70

Hole Logged By S. Mitchell Foreman ____ Date Finished 5-1-70

Notes	Depth (Ft.)	No Blows	% Moisture	Samples	Description Unified Soil Classification	Depth (Ft.)	Log	Unit Wt. Lbs./Ft.³ (Wet)	Phi ϕ Value	Liquid Limit	Plastic Index
	1				Loose, gray Clayey GRAVEL with coral fragments. (Recently dredged and left in stockpiles) GC	1					
	2					2					
	3					3					
	4					4					
	5					5					
	6					6					
	7				Medium dense, Clayey GRAVEL. GC	7					
	8					8					
	9					9					
	10				Soft to medium, brown and gray CLAY. OH	10					
	11					11					
	12					12					
	13					13					
	14				Medium dense fragmental CORAL.	14					
	15					15					
	16					16					
	17					17					
	18				Bottom of Pit 17.0 feet	18					
	19					19					
	20					20					

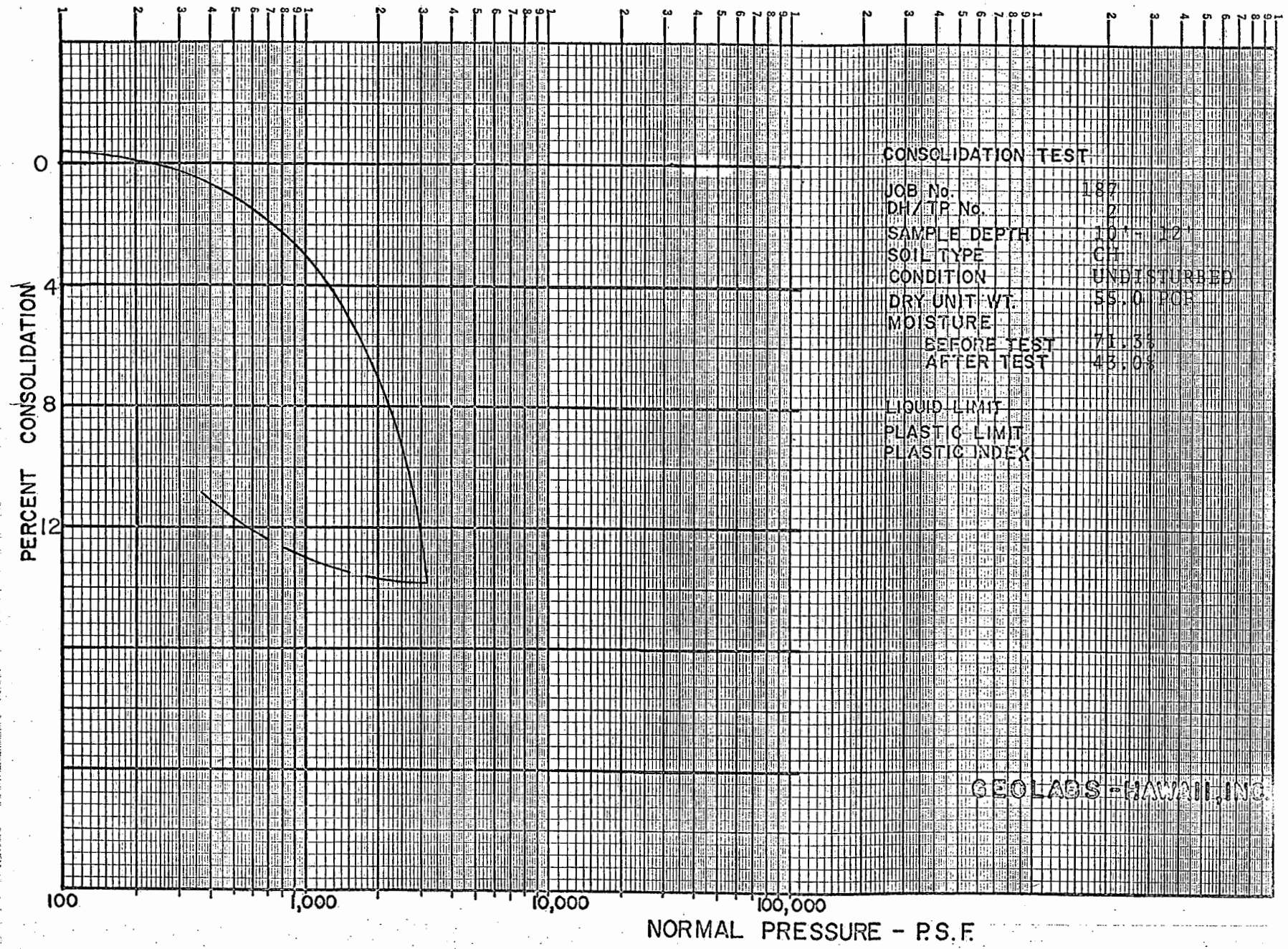
** Taken from Grading Plan dated 3-19-70
Elevation to proposed finished rough grade = -2'

GEO-24

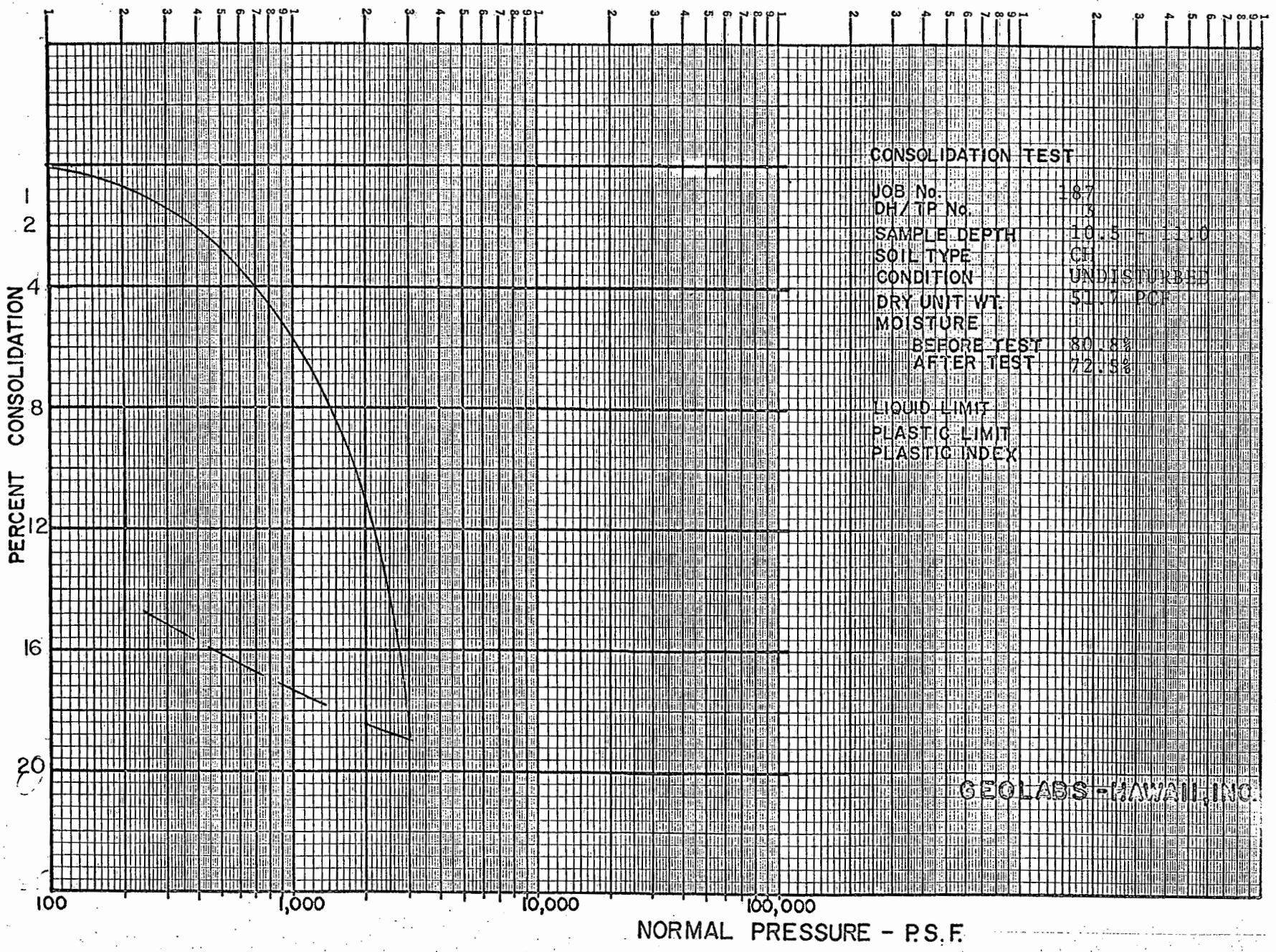
APPENDIX B

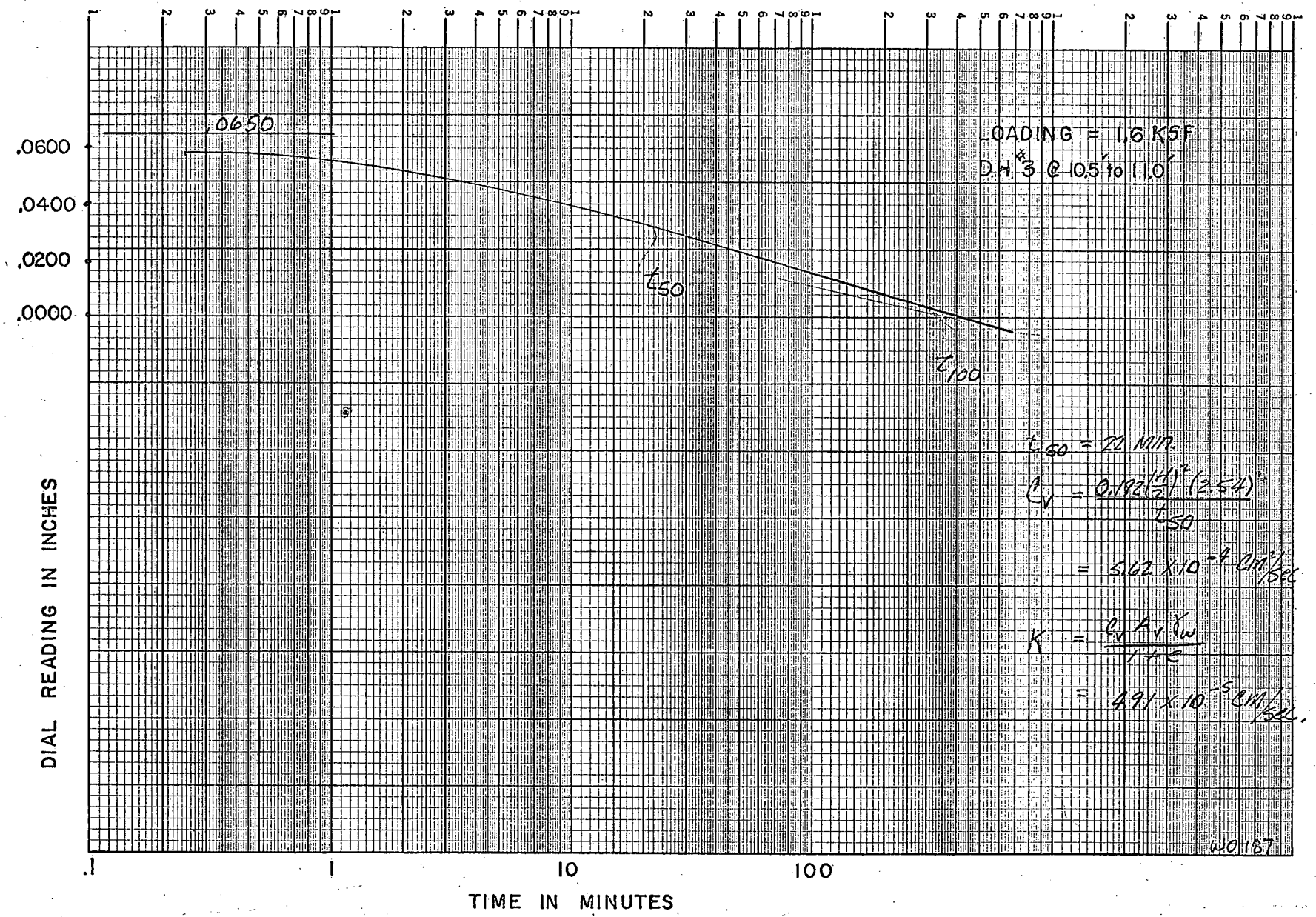
CONSOLIDATION CURVES

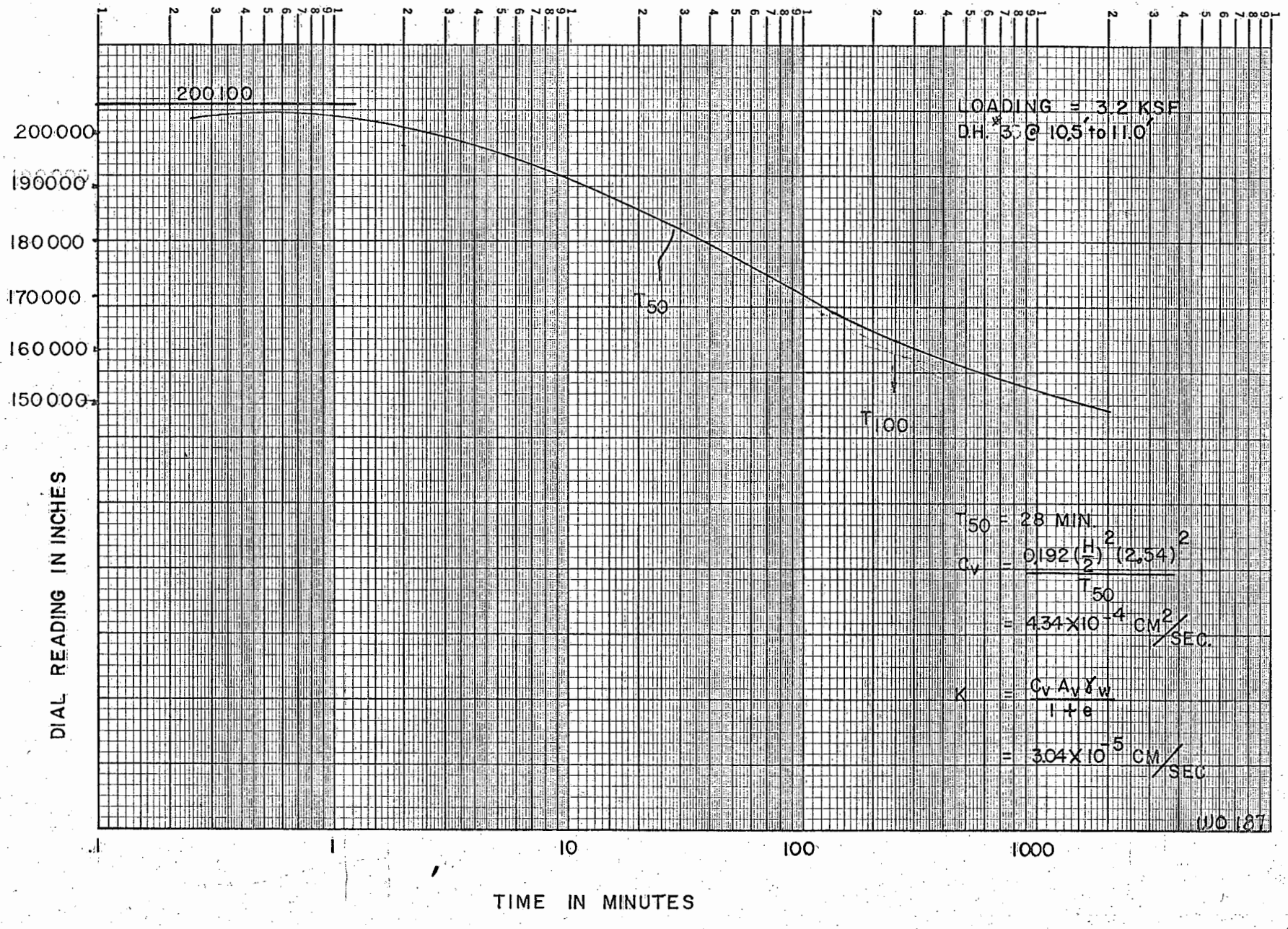
K+E SEMI-LOGARITHMIC 359-91
KEUFFEL & ESSER CO. MADE IN U.S.A.
5 CYCLES X 70 DIVISIONS



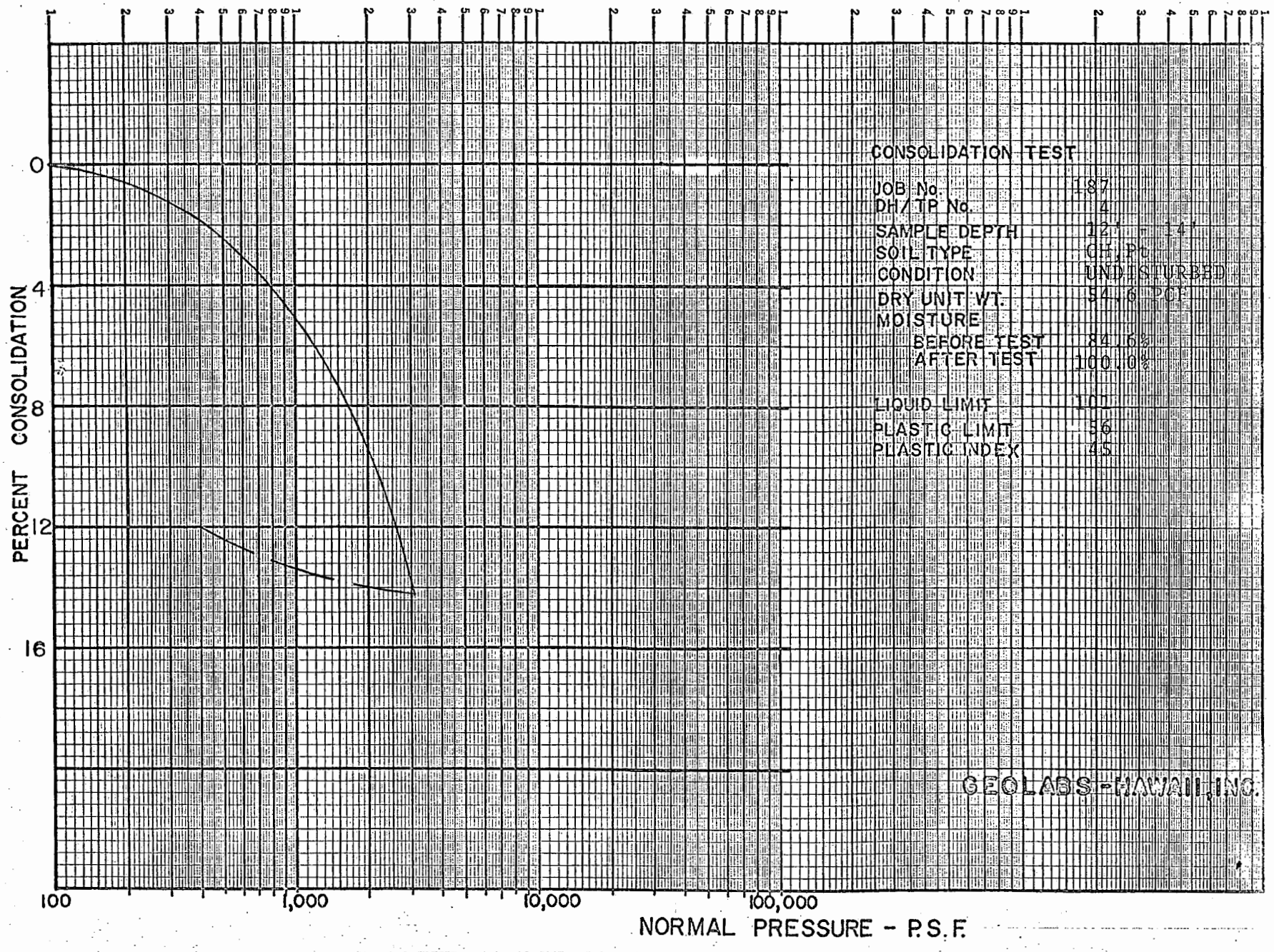
K&E SEMI-LOGARITHMIC 359-91
KEUFFEL & ESSER CO. MADE IN U.S.A.
5 CYCLES X 70 DIVISIONS



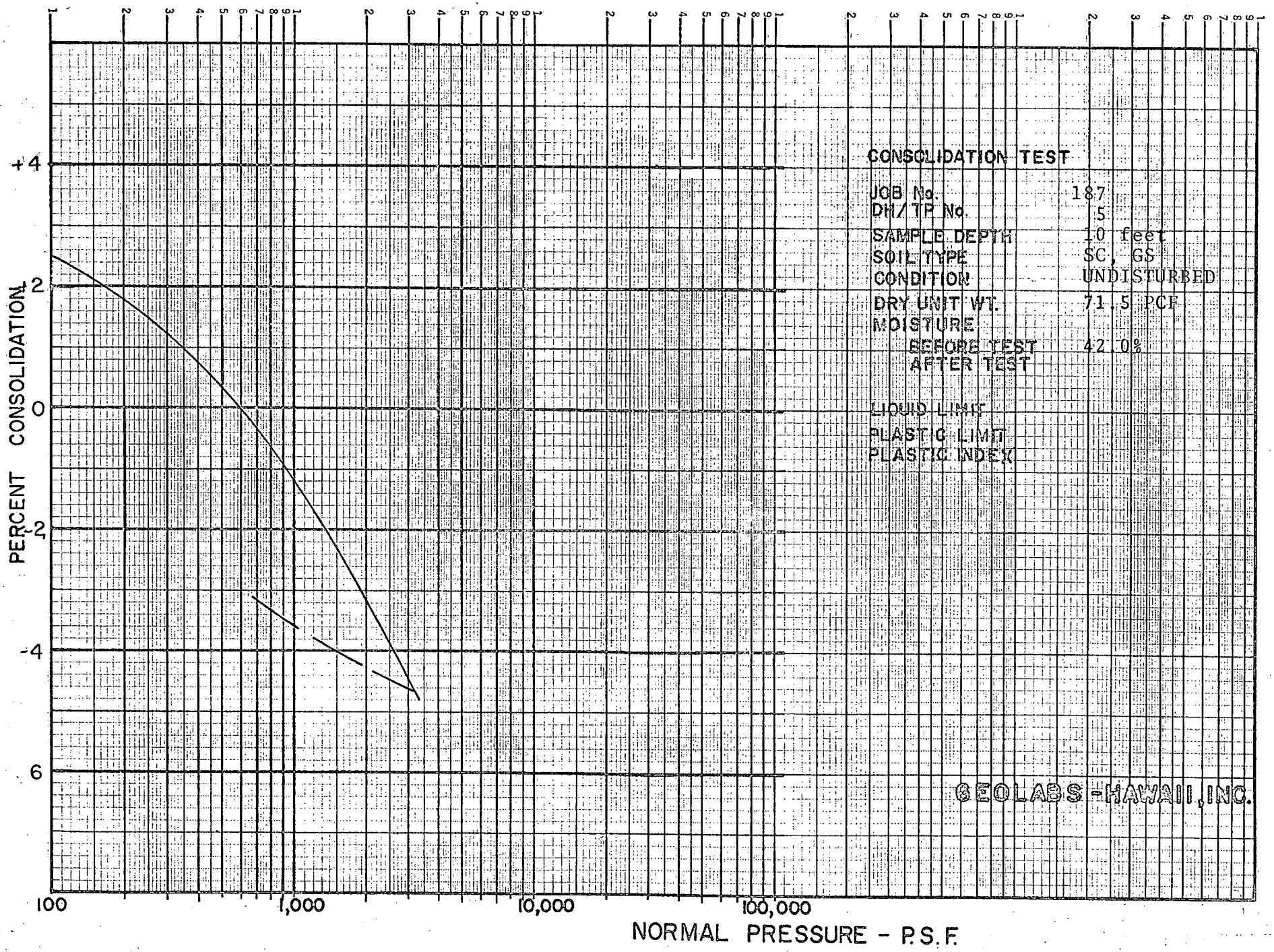


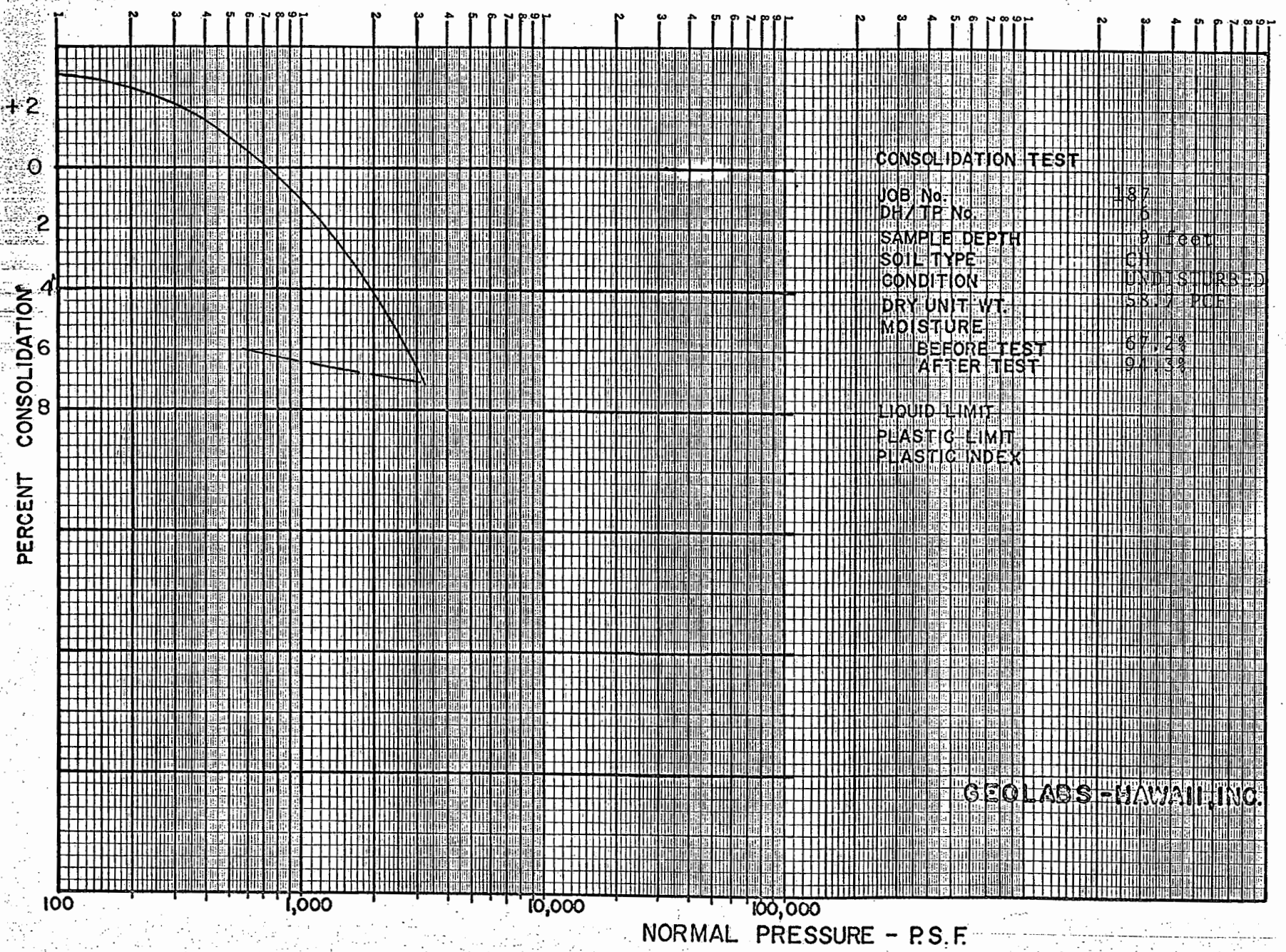


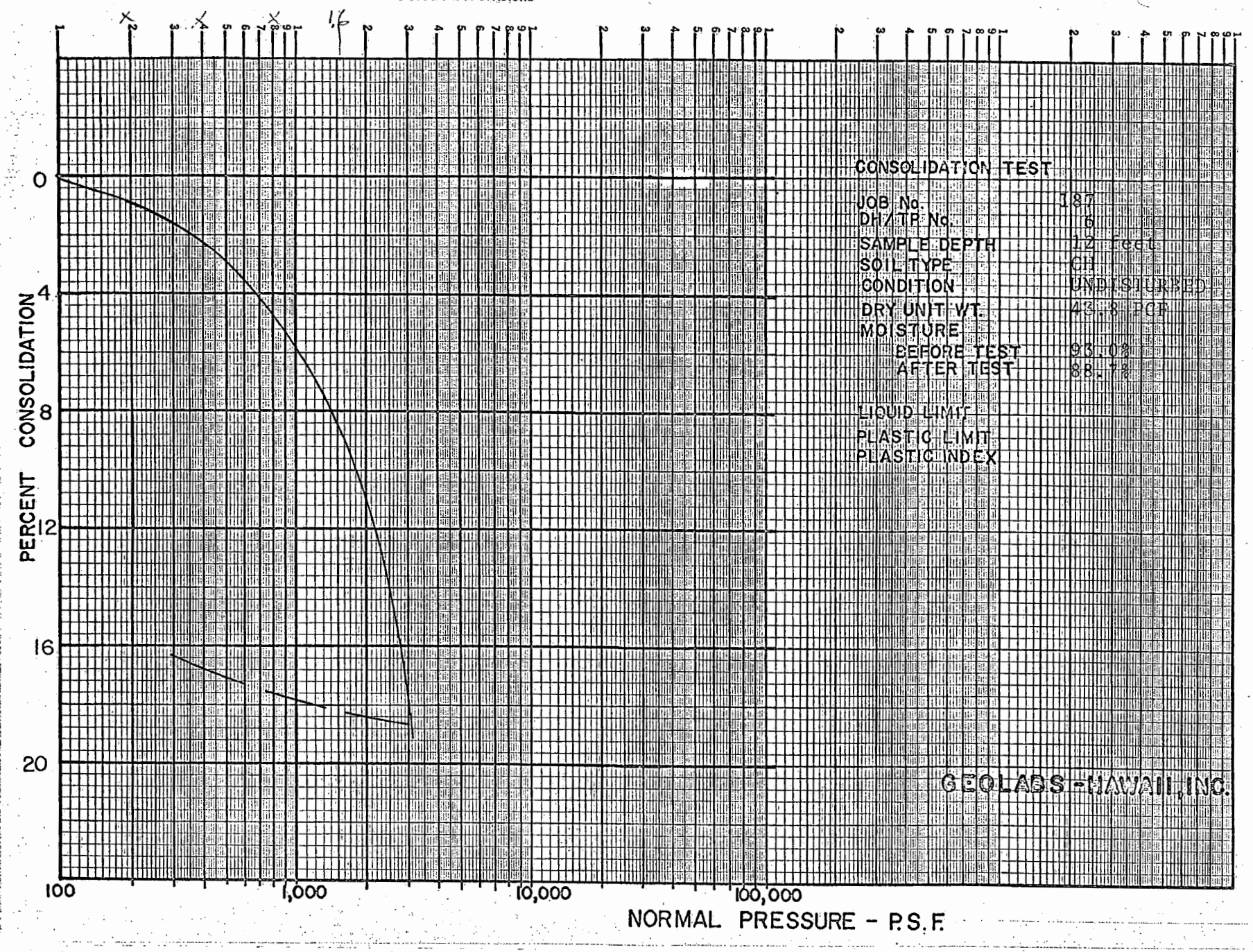
K&E SEMI-LOGARITHMIC 359-91
KEUFFEL & ESSER CO. MADE IN U.S.A.
5 CYCLES X 70 DIVISIONS



SEMI-LOGARITHMIC 359-91
KEUFFEL & ESSER CO. MADE IN U.S.A.
5 CYCLES X 70 DIVISIONS

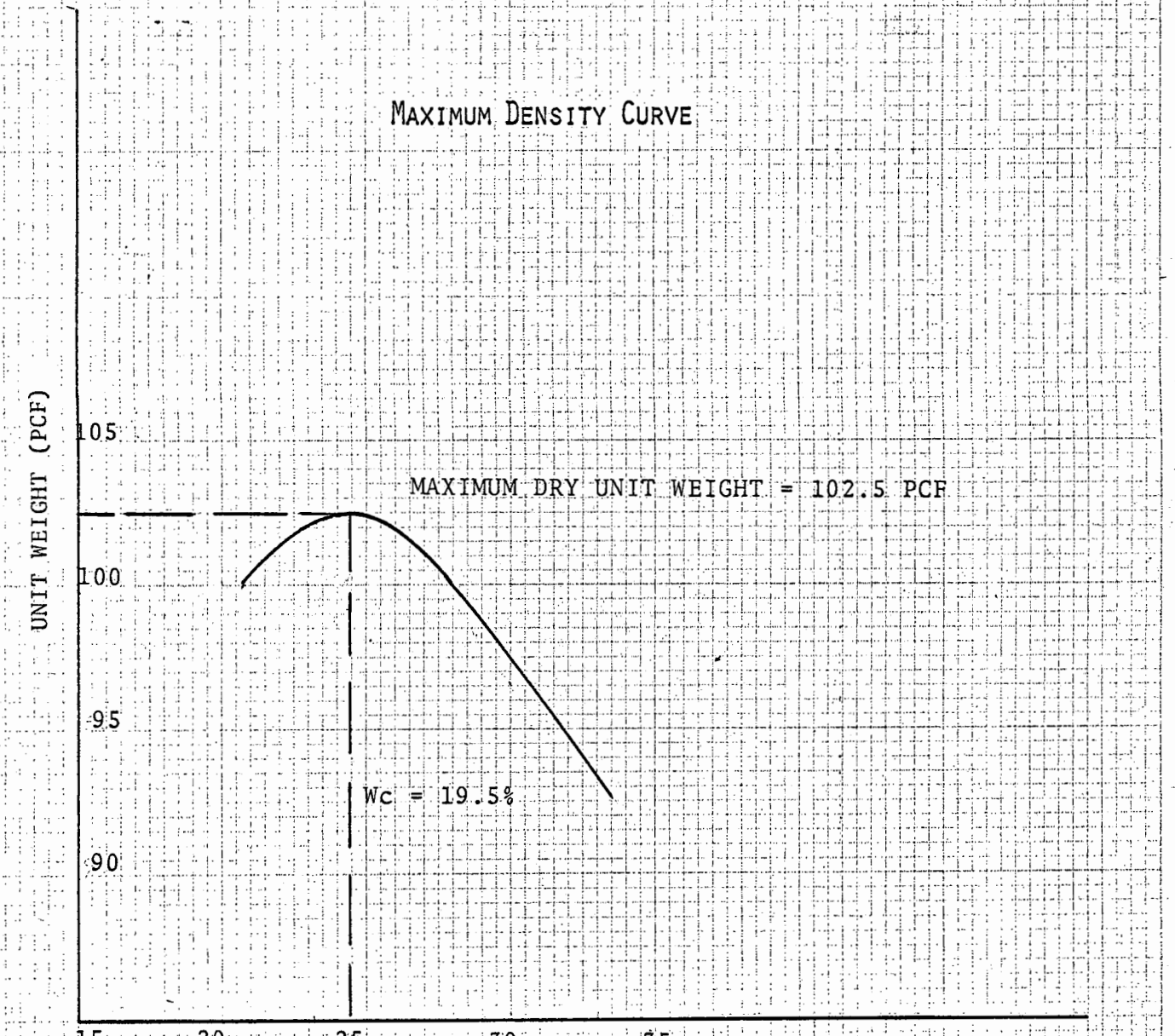



K&E SEMI-LOGARITHMIC 359-91
KEUFFEL & ESSER CO. MADE IN U.S.A.
5 CYCLES X 70 DIVISIONS
+2
0
2
4
6
8
PERCENT CONSOLIDATION
100
1,000
10,000
100,000
NORMAL PRESSURE - P.S.F.
CONSOLIDATION TEST
JOB No. 187
DH/TP No. 6
SAMPLE DEPTH 9 feet
SOIL TYPE CH
CONDITION UNDIST. PR-D
DRY UNIT WT. 58.7 PCF
MOISTURE
BEFORE TEST 67.2%
AFTER TEST 91.3%
LIQUID LIMIT
PLASTIC LIMIT
PLASTIC INDEX
GEOLABS-HAWAII, INC.


K+E SEMI-LOGARITHMIC 359-91
KEUFFEL & ESSER CO. MADE IN U.S.A.
5 CYCLES X 70 DIVISIONS
CONSOLIDATION TEST
JOB No. 187
DH/TP No. 6
SAMPLE DEPTH 12 feet
SOIL TYPE CH
CONDITION UNDISTURBED
DRY UNIT WT. 43.3 PCF
MOISTURE
BEFORE TEST 93.0%
AFTER TEST 88.7%
LIQUID LIMIT
PLASTIC LIMIT
PLASTIC INDEX
GEOLABS-HAWAII, INC.
PERCENT CONSOLIDATION
0
4
8
12
16
20
100
1,000
10,000
100,000
NORMAL PRESSURE - P.S.F.

GEOLABS-HAWAII, INC.

MAXIMUM DENSITY CURVE

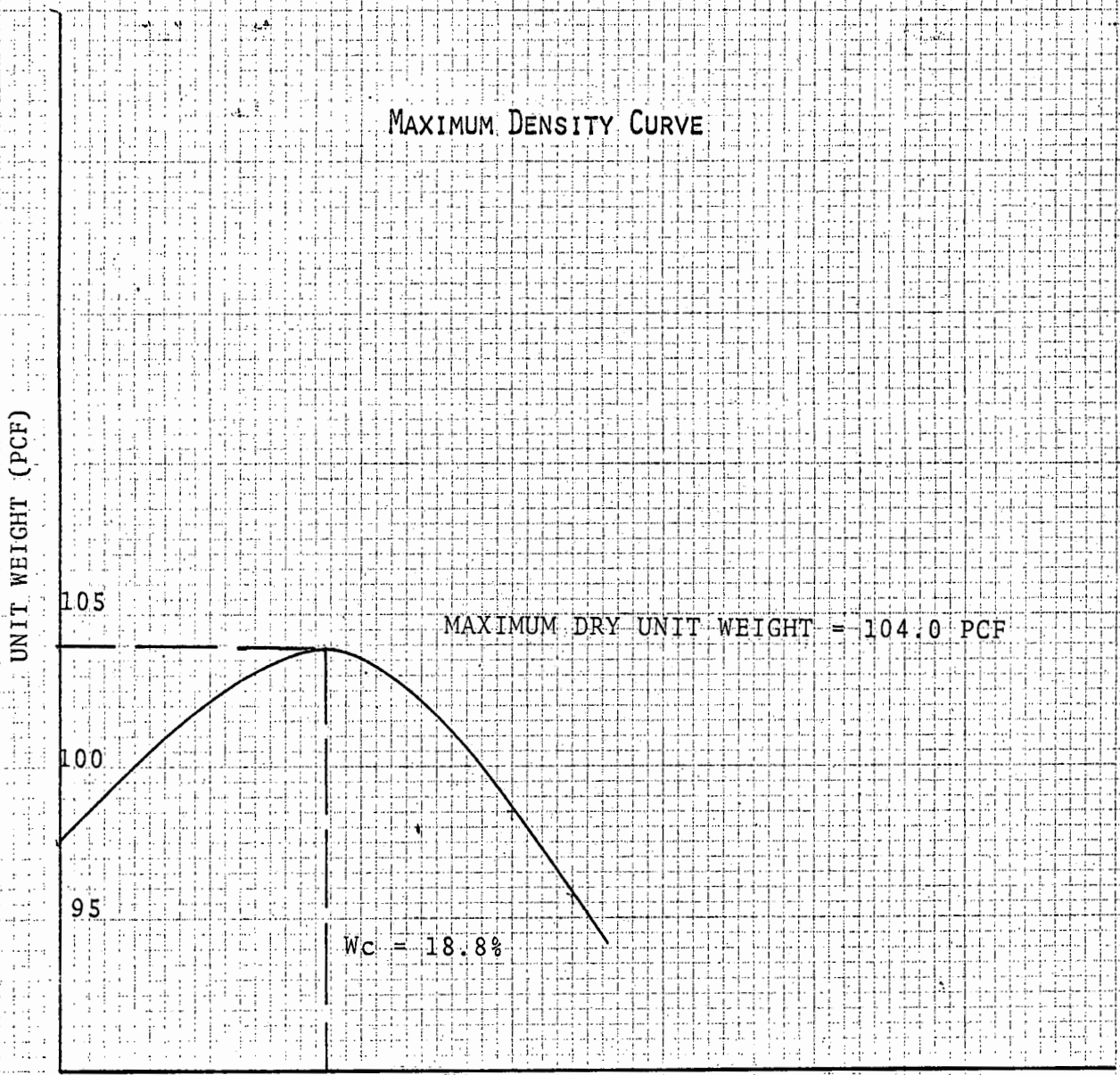


AASHO-T-180-57

SAMPLE LOCATION:	T.P. 10-A	W.O. NO.	187
SAMPLE DEPTH:	Composite 0-11 ft	CLIENT:	Hawaiian Pacific Industries
SOIL CLASS:	GC-SC	DATE:	5-18-70

GEOLABS-HAWAII, INC.

MAXIMUM DENSITY CURVE



AASHO-T-180-57

SAMPLE LOCATION: T.P. 11

SAMPLE DEPTH: 0 - 6.0 Ft

SOIL CLASS: GC

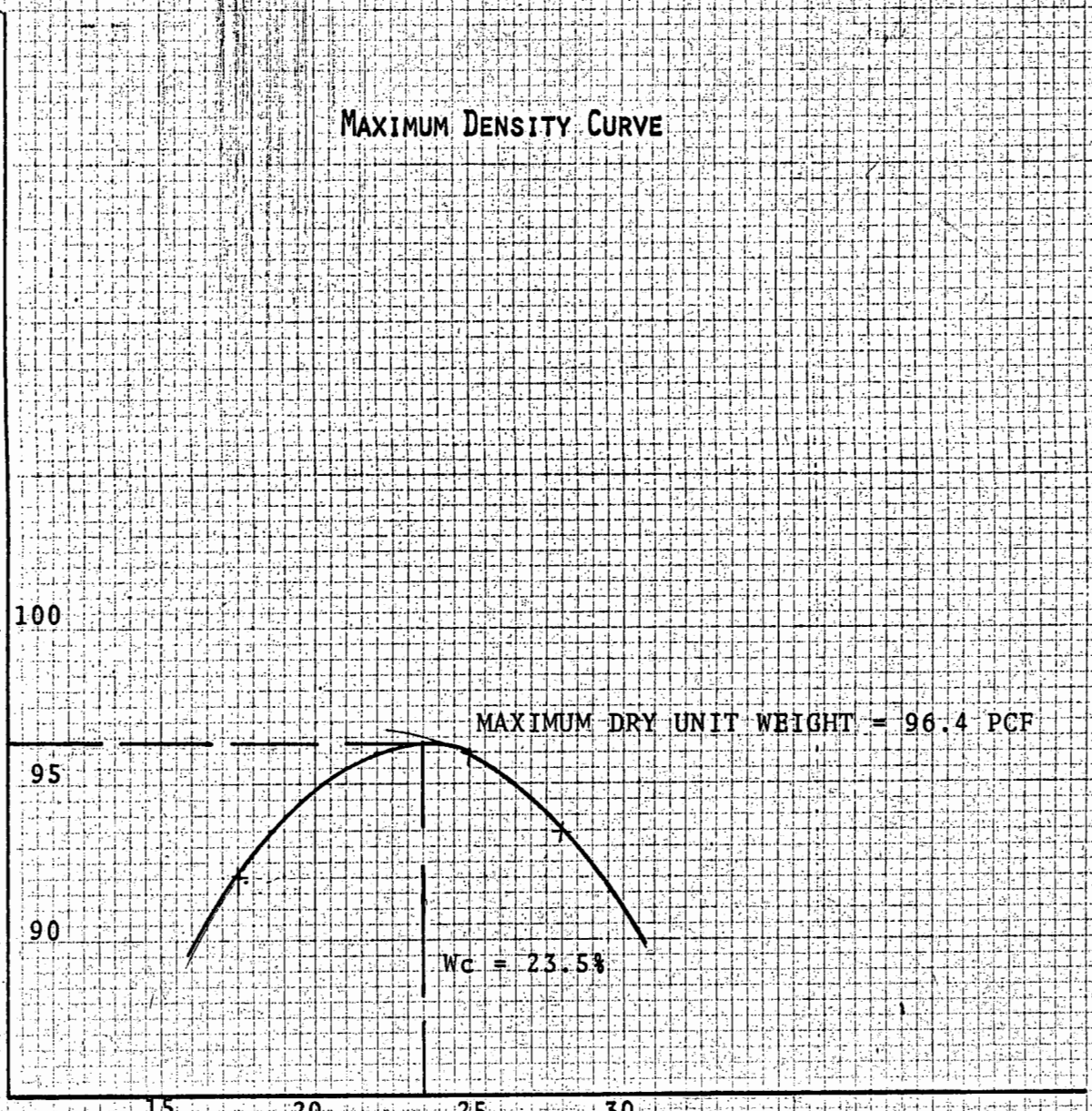
W.O. NO. 187

CLIENT: Hawaiian Pacific Industries

DATE: 5-19-70

GEOLABS-HAWAII, INC.

MAXIMUM DENSITY CURVE



AASHO-T-180-57

SAMPLE LOCATION: T.P. 13

SAMPLE DEPTH: Surface

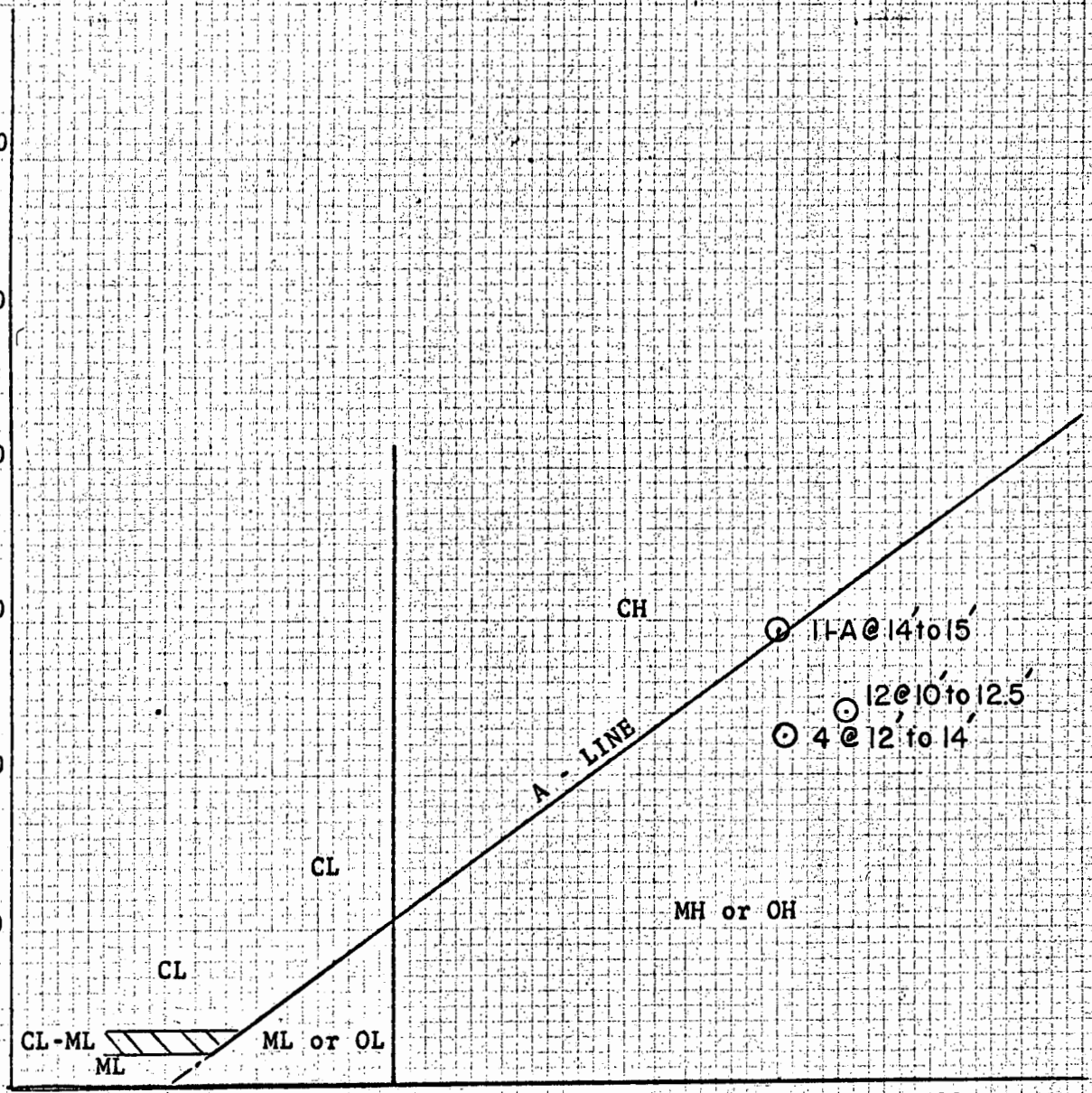
SOIL CLASS: MH

W.O. NO. 187

CLIENT: Hawaiian Pacific Industries

DATE: 5-18-70

GEOLABS-HAWAII, INC.



PLASTICITY CHART

Project: ENCHANTED LAKE 8 B2 W.O. 187

Date: 6-4-70

DIETZGEN 100% Rag Tracing Vellum

APPENDIX C

LABORATORY TEST SUMMARY

LABORATORY TEST RESULTS

Project: Enchanted Lakes Subdivision #8-B-2 W. O. No. 187

Drill Hole No.	2	3	4	5	5	6
Depth (ft.)	10-12	10.5 - 11.0	12-14	10	16	8-10
Hydrometer Tests						
% Sand						
% Silt						
% Clay						
Atterberg Limit Tests						
Liquid Limit (%)			101			
Plastic Limit (%)			56			
Plastic Index			45			
USCS			CH-Pt			
Specific Gravity						
Unconf. Str. (PSF)						
Proctor						
Max Dry Unit Wt (PCF)						
Optimum Water (%)						
Expansion (@100 PSF)						
Natural (%)	+0.3	0.0	0.0	+2.5	0.0	+2.90
Remolded (%) (85%; Wc+)						
In-Place wet (PCF)	94.2	93.4	100.7	101.7	102.9	98.0
In-Place Wc (%)	71.3	80.8	84.6	42.0	64.8	67.2
CBR						
Sample dry (PCF)						
Sample Wc						
% Expansion						
CBR @ 0.1" Penet.						

LABORATORY TEST RESULTS

Project: Enchanted Lakes Subdivision #8-B-2 W. O. No. 187

Drill Hole No.	6	9	10A	11	11A	12
Depth (ft.)	10-13	13-15	0-11	0-6	13-15	10-12.5
Hydrometer Tests						
% Sand		13	31	39	0	22
% Silt		57	26	29	38	30
% Clay		30	43	32	62	48
Atterberg Limit Tests						
Liquid Limit (%)					98	109
Plastic Limit (%)					40	61
Plastic Index					58	48
USCS	CH-Pt	OH	GC-SC	GC	CH	OH
Specific Gravity						
Unconf. Str. (PSF)						
Proctor						
Max Dry Unit Wt (PCF)			102.5	104.7		
Optimum Water (%)			19.5	18.8		
Expansion (@100 PSF)						
Natural (%)	0.0					
Remolded (%) (85%; Wc+)						
In-Place wet (PCF)	82.7					
In-Place Wc (%)	93.0	71.9	41.3	52.2	58.8	81.2
CBR						
Sample dry (PCF)			100.5	103.5		
Sample Wc			19.5	18.8		
% Expansion			4.6%	7.1%		
CBR @ 0.1" Penet.			1.0%	2.6%		

LABORATORY TEST RESULTS

Project: Enchanted Lakes Subdivision #8-B-2 W. O. No. 187

Drill Hole No.	13	14				
Depth (ft.)	3-18	15-17				
Hydrometer Tests						
% Sand	66	12				
% Silt	2	33				
% Clay	32	55				
Atterberg Limit Tests						
Liquid Limit (%)						
Plastic Limit (%)						
Plastic Index						
USCS	SC-OH	CH-OH				
Specific Gravity						
Unconf. Str. (PSF)						
Proctor						
Max Dry Unit Wt (PCF)	96.4					
Optimum Water (%)	23.5					
Expansion (@100 PSF)						
Natural (%)						
Remolded (%) (85%; Wc+)						
In-Place wet (PCF)						
In-Place Wc (%)	40.3	103				
CBR						
Sample dry (PCF)	92.7					
Sample Wc	23.5					
% Expansion	5.2%					
CBR @ 0.1" Penet.	8.4%					

APPENDIX D

FIELD AND LABORATORY TEST SPECIFICATIONS

FIELD AND LABORATORY SPECIFICATIONS

EXPLORATORY DRILLING AND SAMPLING

Method for soil investigation and sampling by auger borings (Tentative)	ASTM Designation: D 1452-63T
Method for penetration test and split barrel sampling of soils (Tentative)	ASTM Designation: D 1586-64T

LABORATORY TESTING

Grain Size Analysis

Grain size analysis of soil ±200	ASTM Designation: D 422-63

ATTERBERG LIMITS

Determining the liquid limit of soils. Tests conducted from natural moisture content unless otherwise noted.	ASTM Designation: D 423-61
Determining the plastic limit and plasticity index of soils.	ASTM Designation: D 424-59
Direct Shear (Q Test) Consolidation Tests	"Soil Testing for Engineers" by T. William Lambe

SPECIFIC GRAVITY

Specific gravity of soils Modified as follows: Le Chatelier Flask	ASTM Designation: D 854-58

CBR TESTS

Expansion test and California Bearing Ratio (CBR)	ASTM Designation: D 1883-61T ASTM Designation: D 1557-64T

PROCTOR Test

Moisture-Density relations of soils using a 10# hammer and an 18" drop	AASHO Designation: T 180-57 ASTM Designation: D 1557-64T

UNIFIED SOIL CLASSIFICATION

Suggested Method by
A. A. Wagner - ASTM Committee D-18

APPENDIX E

EARTHWORK SEPCIFICATIONS

EARTHWORK SPECIFICATIONS
ENCHANTED LAKES SUBDIVISION #8-B-2
KAILUA, OAHU, HAWAII

The work under this section includes:

1. Clearing and grubbing of site
2. Preparation of natural ground
3. Preparation of fill areas
4. Placement and control of fill operations
5. Compaction equipment
6. Supervision of earthwork
7. Seasonal requirements

1. Clearing

All areas within contract limit lines shall be cleared of trash, debris, boulders and organic matter, and such material shall be removed from the site.

2. Preparation of Natural Ground

In areas where the bottom of footings are designed on or below existing natural ground, the soils shall be scarified to a depth as determined by the soils engineer until the material is free of all boulder and uneven features and shall be precompacted as outlined in the following Section #4b.

3. Preparation of Fill Areas

All areas upon which fill is to be placed after clearing, as outlined in Section #1 of these specifications, shall be scarified until free of boulders and uneven features to a depth as determined by the soils engineer, and watered and compacted according to Section #4 of these specifications.

4. Placement of Fill

a. Material for fill shall consist of on-site soils. Fill material shall be free of all organic matter and other deleterious material, and shall not contain rocks or lumps in excess of four inches (4") in diameter within the upper 2 feet from finished rough grade.

b. Compaction of Fill

After the base for the fill has been prepared as described above, it shall be brought to the proper moisture content and compacted to not less than 90% of maximum density in accordance with the modified AASHO-T-180-57 .

c. Depth of Fill

Fill shall be place in horizontal layers which,

when compacted, will not exceed six inches (6").

5. Compaction Equipment

The soils engineer shall determine the type of compacting equipment which will attain the specified results in the most efficient manner. Sheepsfoot, vibratory, or pneumatic tire rollers may be used in the test section and the equipment which produces the specified results in the most expedient manner as determined by the soils engineer shall be employed by the contractor. The equipment used in rolling shall be in good working condition, fully ballasted, and self cleaning. Fill material placed in an unsatisfactory condition and not within the enclosed specifications shall be rejected by the soils engineer and the contractor shall rework the fill placed such that the specifications are followed.

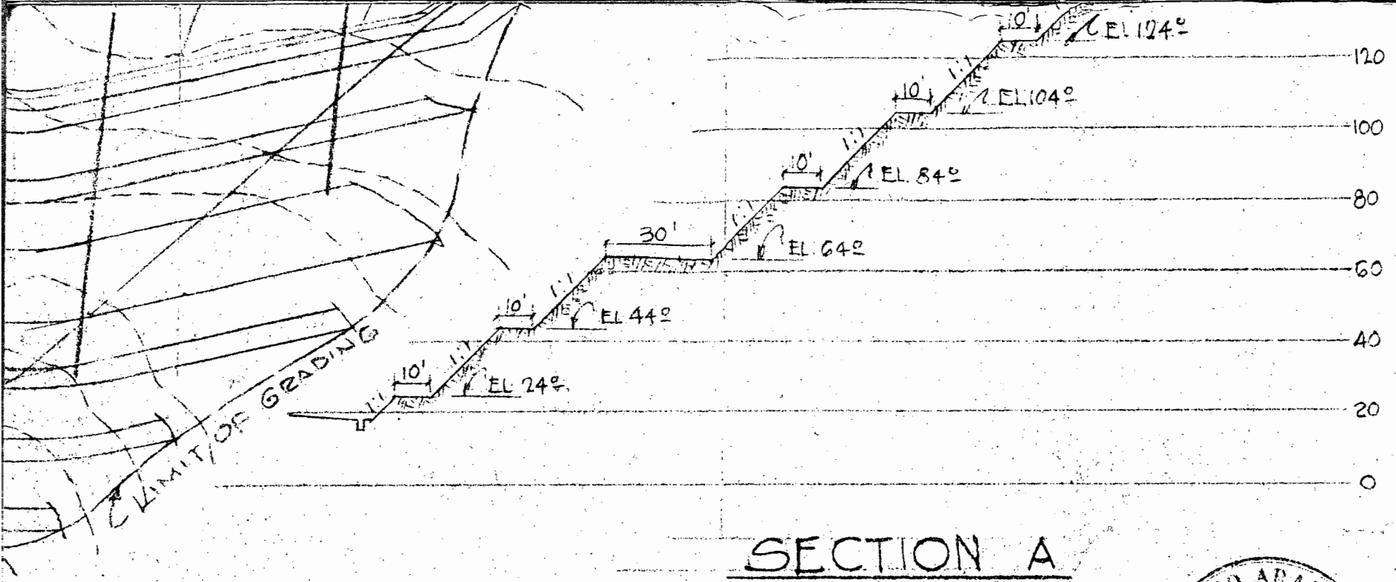
6. Supervision of Earthwork

Field density tests shall be made by the soils engineer during the earthwork operation such that he may certify that the fill was placed according to accepted specifications. In the event that field density tests of a layer or any portion thereof is less than the required density, the particular layer or portion shall be reworked until the required density is obtained.

7. Seasonal Requirements

No fill shall be placed during unfavorable weather conditions as determined by the soils engineer. After interruption of work due to heavy rain, the soils engineer shall approve previously placed fill before resumption of earth-moving operations.

SITE PLAN - FIGURE NO. 1



SECTION A
(TYPICAL)
SCALE: 1" = 40'

YASUO ARAKAKI
REGISTERED PROFESSIONAL ENGINEER
No. 654
HAWAII, U.S.A.

THIS WORK WAS PREPARED BY ME OR UNDER MY SUPERVISION

GEOLABS – HAWAII
1553 COLBURN ST. 203
HONOLULU, HAWAII
PHONE 841-5064

X TEST PIT LOCATIONS

⊙ SETTLEMENT MONUMENTS

APPROVED:

DIRECTOR & CHIEF ENGINEER — DATE

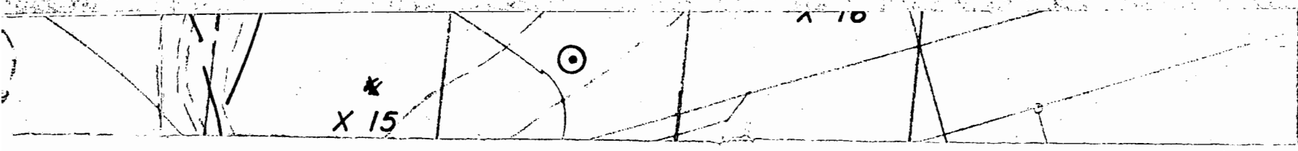
PLANNING DIRECTOR — DATE

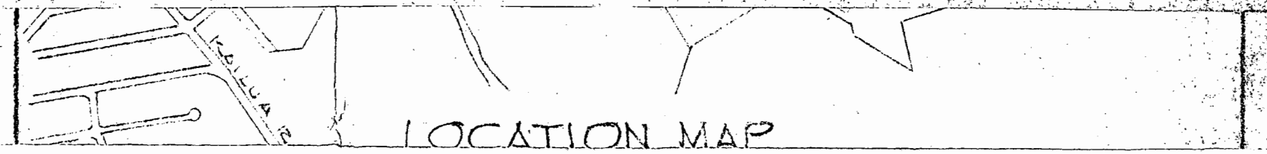
ENCHANTED LAKE ESTATES
KAELEPULU, KOOLAUPOKO, OAHU, HAWAII
UNIT 8-B2
ROUGH GRADING PLAN

BY: Y. ARAKAKI
REG. PROF. ENGR. NO. 654
DATE: 3/19/70

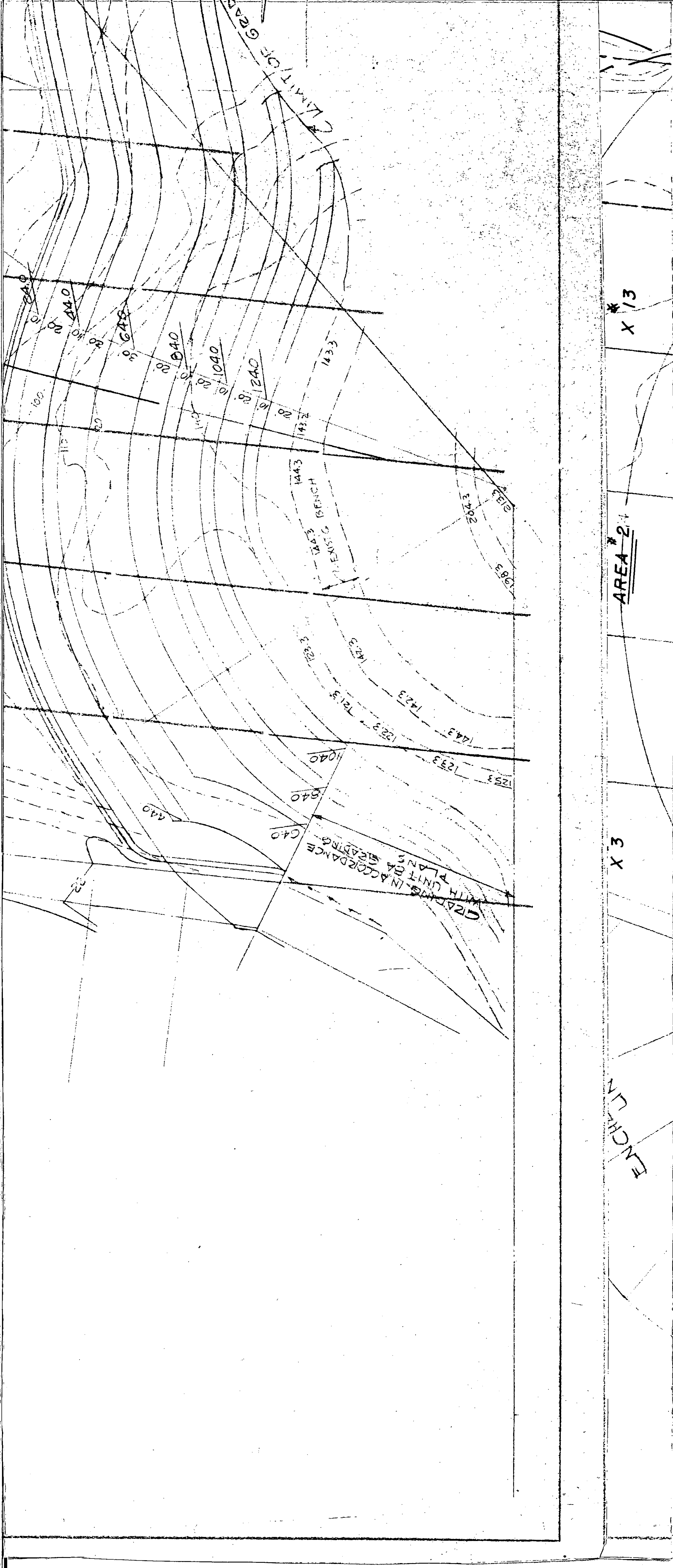
SHEET 1 OF 4

FIGURE * 1

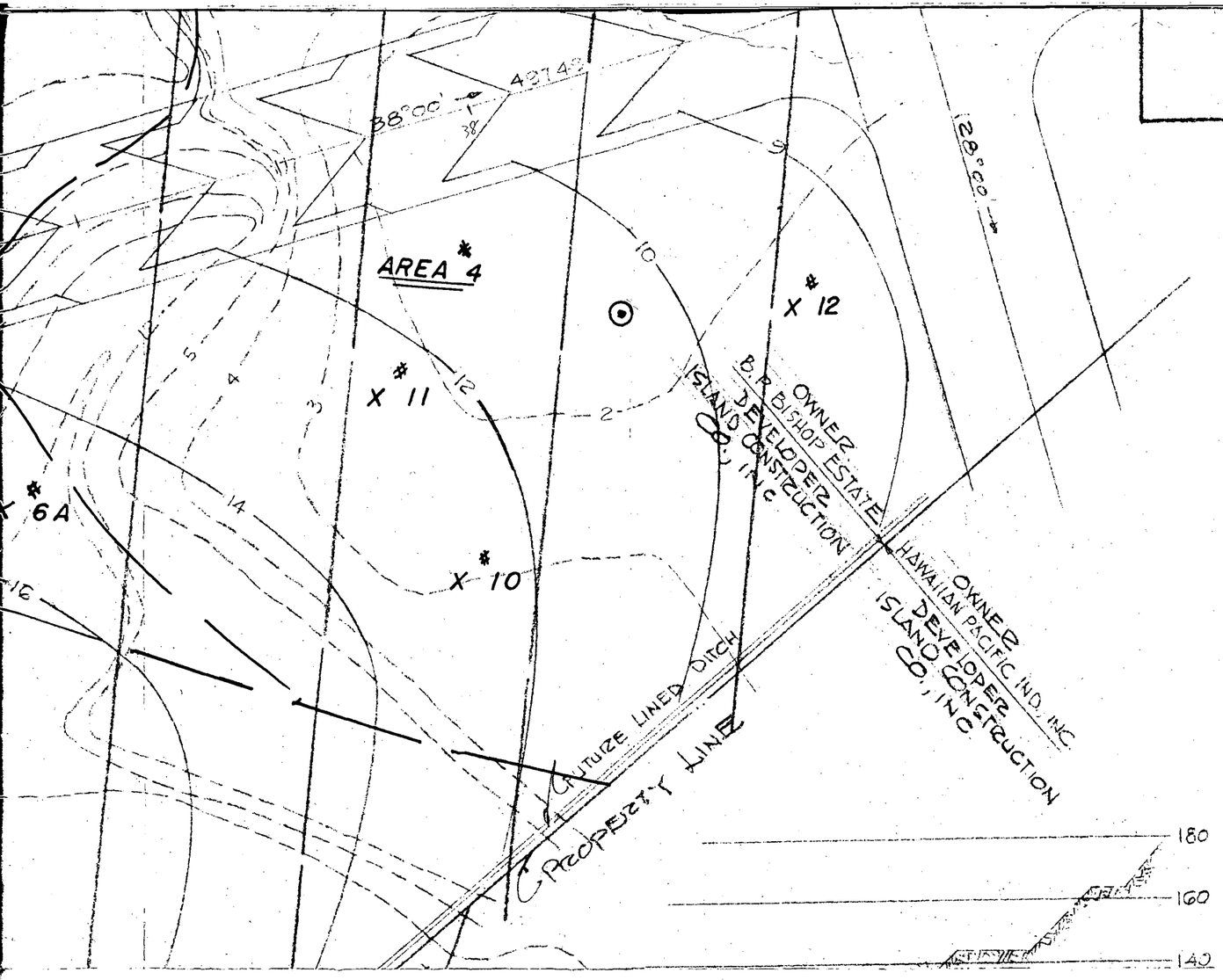




LOCATION MAP



LIMIT OF GRADING
AREA # 2
X 13
X 3
EXIST'G BENCH
143.3
144.3



500 0 500 1000 1500 2000

SCALE IN FEET

OWNER: B.P. BISHOP ESTATE
DEVELOPER: ISLAND CONSTRUCTION CO.
TAX MAP KEY: 4-2-02:3

GRADING NOTES

1. All grading work shall be done in accordance with Chapter 23 Revised Ordinances, 1961 as amended and the Soils Report for Enchanted Lake Estates Unit 3 and supplementary Soil Reports.
2. The Contractor shall be responsible for the cleaning and removal of all silt and debris generated by the grading work and deposited and accumulated within downstream waterways, ditches and drain pipes, and on public roadways. The Contractor agrees to reimburse the City and County of Honolulu, for all costs expended in the performance of the above work, if required for public health and safety, or made necessary by non-performance by the Developer and/or Contractor.
3. The Contractor at his expense shall keep the project and surrounding area free from dust nuisance. The City may require supplementary measures as necessary.
4. All slopes shall be planted with grass for slope protection. Planting shall commence as soon as practical following just behind the grading work.
5. Finish Grade elevation at Lake boundary shall not be greater than Elevation 20.

KEOLU DRIVE

HAMAKUA DRIVE

PROPOSED ROAD EXTENSION

BENCH MARK
ELEV. 6.11
TOP OF BRASS PIN IN EXISTING
ST. MONUMENT

AREA #1

X #1

X #2

X #9

X #14

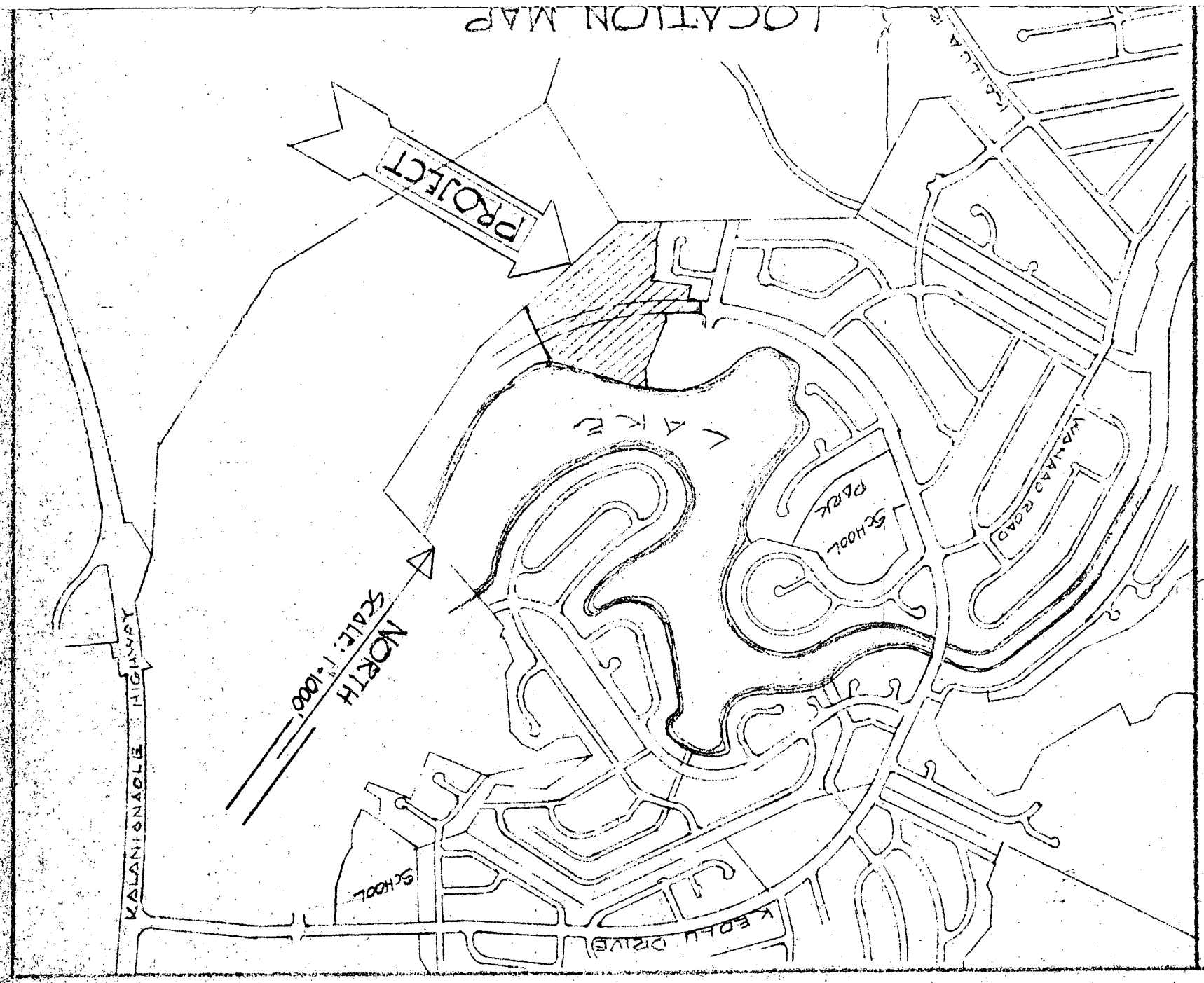
X #6A

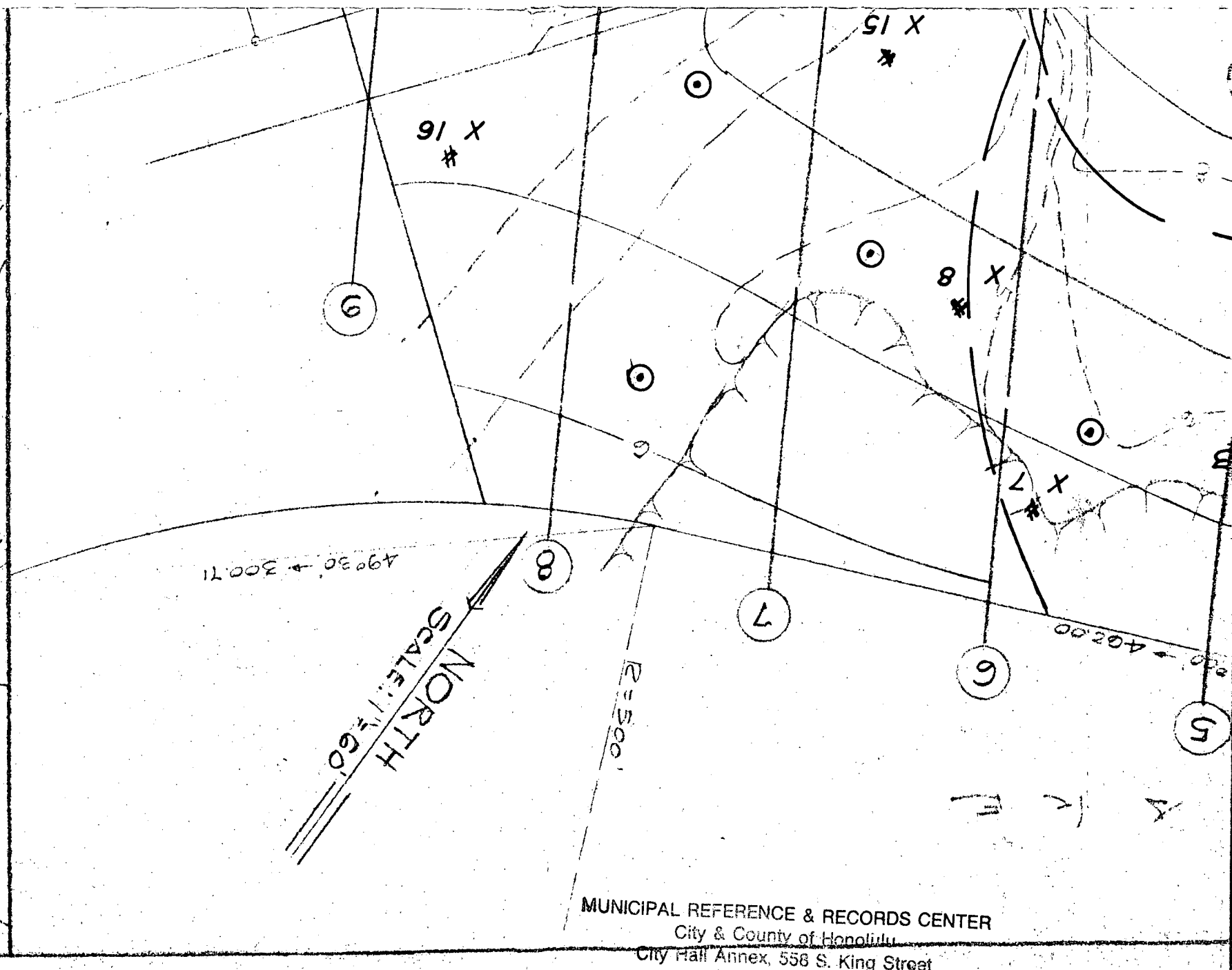
51° 22' - 84.27

A

A'

LOCATION MAP





CENTER

L A K E

1 2 3 4 5 6

S 35° 35' E 290.00

LAKE BOUNDARY

S 61° 00' E 402.00

TOP OF EXISTING BANK

AREA #3

AREA #2

X #3
X #4
X #5
X #6
X #7
X #8
X #10 A
X #11 A
X #12 A
X #13

PORTION OF
ENCHANTED LAKE ESTATES
UNIT 8B-1

CEO–10 (REV. 5/69)

CITY AND COUNTY OF HONOLULU
DEPARTMENT OF PUBLIC WORKS

DATE _____ 19__

FROM:

TO:

- ☐ DIRECTOR
- ☐ DEPUTY DIRECTOR
- ☐ PROGRAM COORDINATOR
- ☐ ADMINISTRATIVE SERVICES
- ☐ CLERICAL AND SPECIAL SERVICES
- ☐ PUBLIC WORKS PERSONNEL
- ☐ PUBLIC WORKS FISCAL
- ☐ _____
- ☐ _____
- ☐ CHIEF – ENGINEERING
- ☐ CHIEF – LAND SURVEY & ACQUISITION
- ☐ CHIEF – ROAD MAINTENANCE
- ☐ CHIEF – SEWERS
- ☐ CHIEF – AUTO. EQUIPMENT SERVICES
- ☐ CHIEF – REFUSE COLLECTION & DISPOSAL
- ☐ _____
- ☐ _____

FOR:

- ☐ APPROPRIATE ATTENTION AND ACTION
- ☐ DRAFT REPLY
- ☐ COMMENTS & RECOMMENDATIONS
- ☐ SEE ME
- ☐ ARRANGE MEETING
- ☐ SIGNATURE
- ☐ INFORMATION
- ☐ FILE

LOG. NO. _____ SUSPENSE _____

Murphy Young –

I noticed that this report and other soils reports do not contain a pavement design. Wouldn't it be advisable to ask the developers through their design engineers to include the pavement design in the soils report? This would then give the design engineers ~~the~~ the criteria for the thickness of select borrow.

J. C. Prutto
7/14/70

PW-DE-40
2/69

CITY AND COUNTY OF HONOLULU
DEPARTMENT OF PUBLIC WORKS
DIVISION OF ENGINEERING

DATE JUL 15 1970 19__

FROM: H. J. YOUNG, Chief

TO:

- ☐ YOUNG, H. J.
- ☑ LING, W.
- ☐ CHUN, RAY
- ☐ KIDO, K.
- ☑ MURAKAMI, T.
- ☑ NAKAGAWA, H.
- ☐ _____
- ☐ NISHIZAWA, R.
- ☐ PAHK, C.
- ☐ TAKAMATSU, D.
- ☐ TOKUSHIGE, W.
- ☐ INVESTIGATOR
- ☐ SECRETARY
- ☐ _____

FOR:

- ☐ APPROPRIATE ATTENTION AND ACTION
- ☑ DRAFT REPLY
- ☑ COMMENTS & RECOMMENDATIONS
- ☐ SEE ME
- ☐ WORK ORDER
- ☐ ARRANGE MEETING
- ☐ SIGNATURE
- ☐ INFORMATION
- ☐ FILE
- ☐ _____

LOG. NO. _____ SUSPENSE _____

Murphy Young

Return
Thanks
7/17/70

J. C. Prutto
7/16/70

Flesh

Pls follow-up on
Mr. Prutto's request.

HAWAIIAN PACIFIC INDUSTRIES, INC.
A Division of Lone Star Cement Corporation

1020-E Keolu Drive, Kailua, Hawaii 96734
(Area Code 808) 261-0876

4897

RECEIVED
DEPT. OF PUBLIC WORKS
JUL 13 8 16 AM '70
TO DEP 205
Engrg

July 6, 1970

RECEIVED
1970 JUL 14 AM 11 55
OF ENGINEERING

Mr. Albert Zane
Director Chief Engineer
Department of Public Works
City and County of Honolulu
Honolulu, Hawaii 96813

Dear Mr. Zane:

Subject: Enchanted Lake Estates Unit 8-B-2
Soil Investigation Report

Transmitted herewith for your review and records is a copy of the soil investigation report for the subject subdivision.

The proposed grading plan has been submitted to your office for review and approval.

Very truly yours,

HAWAIIAN PACIFIC INDUSTRIES, INC.

Melvin R. Hardy

Melvin R. Hardy
Vice President

MRH:jt