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KILI DRIVE WIDENING
SOIL EXPLORATION REPORT

MAKAHA VALLEY, WAIANAE, OAHU, HAWAII

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To:
MAKAHA VALLEY, INC.

WALTER LUM ASSOCIATES, INC.
CIVIL, STRUCTURAL, SOILS ENGINEERS

MARCH 5, 1975

MUNICIPAL REFERENCE & RECORDS CENTER

WITHDRAWN
City of Honolulu, 155 King Street
Honolulu, Hawaii 96813

WALTER LUM ASSOCIATES, INC.
CIVIL, STRUCTURAL, SOILS ENGINEERS

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March 5, 1975

MAKAHA VALLEY, INC.
c/o Sunn, Low, Tom & Hara, Inc.
Pacific Trade Center, Suite 600
190 South King Street
Honolulu, Hawaii 96813

Gentlemen:

Subject: Kili Drive Widening
Soil Exploration Report
(for site grading and roadway pavement
thickness design)
Makaha Valley, Waianae, Oahu, Hawaii

Transmitted herewith is our soil exploration report for site grading and roadway pavement design considerations for the proposed Kili Drive Widening.

This report includes a Boring Location Sketch, boring logs, laboratory test results, general roadway pavement design thickness recommendations and limitations.

Respectfully submitted,

WALTER LUM ASSOCIATES, INC.

By Ezra Koike
Ezra Koike

CM/EK:rmf

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KILI DRIVE WIDENING
SOIL EXPLORATION REPORT

MAKAHA VALLEY, WAIANAE, OAHU, HAWAII

SCOPE OF EXPLORATION

The purpose of this exploration was to evaluate general soil conditions for roadway pavement design thickness considerations for the proposed Kili Drive Widening at Makaha Valley, Waianae, Oahu, Hawaii.

This report includes field explorations, laboratory tests, general recommendations for site grading and roadway pavement thickness design and limitations.

The pavement design of the existing road was not considered in this report.

FIELD EXPLORATION

Fifteen exploratory borings were made at the proposed site. The approximate locations of the borings are shown on the Boring Location Sketch. Descriptions of the underlying soils encountered are shown on the boring logs.

The borings were made with 4-in. diameter augers using finger type bits. Soil samples were recovered with 2 and 3-in. thin-wall tubes and a 2-in. standard split spoon sampler driven with a 140-lb hammer falling 30 inches.

LABORATORY TESTS

Laboratory tests included: natural water content and density, unconfined compression, laboratory vane shear, Atterberg limit, sieve analysis and CBR.

A summary of laboratory test results is given in Tables IA thru ID.

SOIL CLASSIFICATION SYSTEM

Soil samples were visually observed and subjected to appropriate tests in the laboratory. Based on visual observations and laboratory tests, the soil descriptions given on the boring logs are generally made in accordance with the "Unified Soil Classification System."

GEOLOGIC AND SOIL CLASSIFICATIONS BY OTHERS

From a review of geologic literature and the U. S. Soil Conservation Service maps of the area, the soils are generally described by others as follows:

Stearns, H. T. and U. S. Geological Survey, "Geologic and Topographic Map, Island of Oahu," USGS 1938:

Ra - Chiefly younger alluvium

Pa - Chiefly older alluvium

U. S. Soil Conservation Service, "Soil Survey of Islands
of Kauai, Oahu, Maui, Molokai and Lanai, State of Hawaii,"

August 1972:

HeA - Haleiwa silty clay, 0 to 2% slopes,
Unified Soil Classification - MH-CH,
moderate shrink-swell potential

rST - Stony land

PuB - Pulehu stony clay loam, 2 to 6% slopes,
Unified Soil Classification - CL, SM or ML,
moderate to low shrink-swell potential

LPE - Lualualei extremely stony clay,
3 to 35% slopes, high shrink-swell potential,
Unified Soil Classification - CH

GENERAL SITE CONDITIONS

The site for the proposed project is located on the western side of Makaha Valley. The existing Kili Drive is a 24-ft wide paved roadway extending about 6,500 ft northeast from Farrington Highway.

In general, the road slopes upward to the northeast at about 0 to 5% (Sta. 0+00 to Sta. 22+00) and 5 to 10% (Sta. 22+00 to Sta. 57+00).

The existing road cuts through a knoll at about Sta. 31+00 to Sta. 44+00.

The existing cut slopes varied from about 1 horizontal to 1 vertical to about 1-1/4 horizontal to 1 vertical. The height of cut slopes varied from 0 to 25 ft or more.

A waste stabilization pond is located north of the site at about Sta. 6+00 to Sta. 13+50.

Five, 48-in. pipe culverts cross under Kili Drive at about Sta. 17+00.

Condominiums and townhouses are located around the eastern portion of the road.

Most of the site is covered with brush.

The elevation at the site generally varies from about 10 to 275 ft.

INTERPRETATION OF SOIL CONDITIONS

From the field exploration and laboratory test results, the soils encountered in the borings may be approximated as follows:

Makai Portion (Boring Nos. 1 thru 4)

A mixture of medium to stiff clayey silt and silty clay (MH and ML soils) and loose to medium silty sand (SM soil) to about 15 ft, the depth drilled.

Soft organic silt and clayey silt were noted in Boring No. 1 at about 8 to 13-ft depths.

Mauka Portion (Boring Nos. 5 thru 15)

A mixture of gravel, cobbles and boulders with clays, silts and sands to about 15 ft, the depths drilled.

Clay (CH) soils were noted close to the surface in Boring Nos. 6, 7, 11, 12 & 15.

Water was noted in Boring Nos. 1 and 2 at about 11 to 14-ft depths.

Variations to the above soil conditions are to be expected between borings and in localized areas. For more detailed descriptions of soils encountered in the borings, refer to the boring logs.

DISCUSSION AND RECOMMENDATIONS

The proposed plan is to widen the existing Kili Drive. A 20-ft median and 24-ft roadway will be added to the existing 24-ft roadway.

Some grading will be done along the existing Kili Drive from Farrington Highway up to about Sta. 10+00 and from Sta. 10+50 to Sta. 20+00 near the proposed bridge site.

A bridge structure will be constructed at about Sta. 14+50 to Sta. 16+50 to replace the existing pipe culverts.

Fills of about 5 to 15 ft are planned between Sta. 11+00 and Sta. 18+00 near the bridge structure. Fills of up to about 9 ft are planned in other areas.

Minor cuts are planned along the roadway level. Some high 1:1 cut slopes are planned between Sta. 31+00 and Sta. 37+00. The existing cut slopes are at about 1-1/4 horizontal to 1 vertical. In general, the slopes are composed of cobbles and boulders in a silt-clay matrix. Some ravelling and erosion of the slopes were noted.

Recommended Pavement Section

For light automobile traffic and drained subgrade conditions, an estimate of the roadway pavement section for the general soil conditions may be as follows:

Sta. 0+00 to Sta. 39+00

1. Wearing course - 2-in. asphaltic concrete.
2. Base course - 6-in. base course over a prepared subgrade.

Sta. 39+00 to Sta. 57+00

1. Wearing course - 2-in. asphaltic concrete.
2. Base course - 6-in. base course.

3. Subbase course - 6-in. select borrow.
4. Borrow - 12-in. borrow over a
prepared subgrade.

Clay (CH) soils should be kept 2 ft below the base course.

If practicable, in fill areas, select soils with CBR values greater than 12 and swell less than 1% should be used within the top 2 to 3 ft of the subgrade to eliminate the need for select borrow subbase or borrow courses. Estimated pavement sections are indicated on the attached Boring Location Sketch.

Because of probable variations in soil conditions, provisions should be made in the contract documents to allow for field adjustments regarding the select borrow subbase and borrow material requirements in accordance with the design standards of the City and County of Honolulu.

The subgrade should be compacted and shaped to drain. To avoid the ponding of water and softening of the subgrade, weep holes should be placed at subgrade levels thru the walls of the catch basins.

Site Grading

Grading work should be done in accordance with the requirements of the Revised Ordinances of Honolulu, 1969 As Amended, and as recommended below:

1. The area should be cleared and grubbed. Surface vegetation and miscellaneous debris should be cleared and removed prior to site filling.
2. Topsoil, stockpiled soils and loose deposits at the bottoms of drainageways should be stripped to stiff natural ground before placement of fills; loose surface soils at finish grades should be scarified and recompactd.
3. Subdrains should be placed along the bottoms of natural drainageways with laterals in a herring-bone pattern along the sides of the drainageways before placing of fills.
4. Localized soft pockets encountered during site preparation should be excavated and replaced with select material compacted in thin lifts.

5. Hard surfaces next to existing roads should be scarified down to stiff soil and recompactd to match the density of the surrounding soil.

Where fills are proposed over the existing pavement, the existing A.C. should be scarified. Pieces of A.C. about 6 in. or less may be used as fill when mixed with selected soils. The existing base course material may be stockpiled and may be used as select borrow in the pavement section.

6. Thin sidehill fills (sliver fills) on sloping areas should be avoided.
7. Fills should be constructed in approximately level layers starting at the lower end and working upward.

Where fills are made on sloping areas steeper than about 5 horizontal to 1 vertical, the ground at the toe of the fill should be benched to a generally level condition. As the fill is

brought up, it should continually be keyed into stiff natural ground by cutting steps into the slopes and compacting the fill into these steps.

9. In general, fills should be laid in 6-in. compacted layers to 90% of the maximum density determined by the AASHO T-180-73I test method.

In roadway areas, the top 2 ft of fill should be compacted to 95% of the maximum density.

Slopes

For the roadway widening, the proposed plan indicates 1 to 1 cuts are planned from Sta. 31+00 to Sta. 37+00. The existing slopes are at about 1-1/4 to 1 with heights up to about 25 ft. Materials in the slope may be described as cobbles and boulders in a silt-clay matrix. Some ravelling and erosion of the slope may be noted.

In our opinion, the present slope should not be cut and steepened to 1 to 1 without some form of slope protection, revetment or tie back.

In addition, we recommend that buildings along the top of slope be set back about 20 ft from the top of the cut to lessen the effects of slope creep.

Another alternative to slope treatment would be to not touch the slope and lessen the width of the roadway median.

In general, cut and fill slopes of 2 horizontal to 1 vertical or flatter may be used in silty or sandy (MH, ML, SM) soils.

To minimize erosion, the runoff from rainstorms should be diverted away from slopes by berms or ditches wherever practicable.

Slope planting is recommended on cut and fill slopes to minimize erosion.

Slope adjustments or other precautions may be necessary if seepage zones, expansive clay pockets or soft spots are encountered in localized areas.

Utilities

Utilities should be placed after the fills are constructed.

Utility lines should be designed with flexible joints, particularly where lines are connected to structures.

Unforeseen Conditions

Because of the variability of soil deposits, site improvements, designs and construction techniques, conditions may be encountered that cannot be foreseen with even the most exhaustive studies of

site and project conditions. These unforeseen conditions should be recognized when encountered and then evaluated so that the designs or the construction methods may be modified accordingly, if necessary.

Unforeseen or undetected conditions such as soft spots, existing utility trenches, structure foundations, voids or cavities, boulders, expansive soil pockets or seepage water, etc., may occur in localized areas and will have to be adjusted and corrected in the field as they are detected.

BORING LOGS

The stratification lines shown on each of the boring logs represent the approximate boundary between soil types and the transition may be gradual.

Symbols

Symbols used generally are in accordance with the Unified Soil Classification System.

Where a parenthesis "(MH)" is used, the soil sample was classified by visual observation of the sample recovered.

Where no parenthesis "MH" is used, the soil sample was classified from either the Atterberg limit or grain-size analysis test results.

Boring Log

PROJECT KILI DRIVE WIDENINGBORING NO. 1 Sheet No. of Driller W. LUM ASSOC., INC. Date DEC. 18, 1974LOCATION Makaha Valley, Waianae, Oahu, Hawaii Field Party KAKU, KAU, HEWType of Boring AUGER (MOBILE B-40) Diam. 4"Elev. 13' ± * Datum Drill Bit FINGER TYPE

HAMMER:

Weight 140#Drop 30"2" S - 2" O.D. THIN WALL TUBESAMPLER: 2" SS - 2" STANDARD SPLIT SPOON3" S - 3" O.D. THIN WALL TUBEWater Level 11.5'Time 1:40 PMDate 12-18-74

Unified Soil Classification	DESCRIPTION	Depth (Ft.)	Sampler	Sample No.	Plastic Limit	Water Cont. %	Liquid Limit	Unconf. Comp. P.S.F.	Vane Shear P.S.F.	PENETRATION DATA				
										Standard Penetration Test	2" & 3" O.D. THIN WALL TUBE SAMPLER			
	ELEV. = 13' ± *									N (Blows per foot)	0	10	20	30
(MH)	MEDIUM TO STIFF BROWN CLAYEY SILT	2' 3"	1-A	-	17	-	-	-	-					
MH-CH	MEDIUM, BROWN SILTY CLAY W/SOME GRAVEL	2" S	1-B	-	30	-	1510	-	-					
		3" S	1-C	29	32	57	-	1000	800					
(MH)	SOFT, MOTTLED BROWN CLAYEY SILT W/SOME SAND	10	1-D	-	44	86	90	-	-					
OH	SOFT, DARK GRAY ORGANIC SILT W/TRACES OF FIBERS	12-1874												
SP-SM	MEDIUM DENSITY BLACK & WHITE SAND W/GRAVEL	15	1-E	-	22	-	-	-	-					
	END OF BORING @ 16.5'													
	12-18-74													

NOTE:

 γ_w = WET DENSITY, P.O.F. γ_d = DRY DENSITY, P.O.F.

* Elevation estimated from cross sections by
Sunn, Low, Tom & Hara, Inc.

KILI ROAD

BORING NO. 2 Sheet No. _____ of _____

Driller W. LUM ASSOC., INC. Date DEC. 18, 1974

Field Party KAKU, KAU, HEW

Type of Boring AUGER (MOBILE B-40) Diam. 4"

Elev. 16' ± * Datum

Drill Bit FINGER TYPE

Weight 140#

Drop 30"

2" S - 2" O.D. THIN WALL TUBE
2" SS - 2" STANDARD SPLIT SPOON
3" S - 3 O.D. THIN WALL TUBE

Water Level	14.0'				
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Time 11:00 AM

Date 12-18-74

* Elevation estimated from cross sections by Sunn, Low, Tom & Hara, Inc.

3030 WAIALAE AVENUE • HONOLULU, HAWAII 96816 • PHONE 737-7931

BORING NO. 3 Sheet No. _____ of _____

Driller W. LUM ASSOC, INC. Date DEC. 18, 1974

Field Party KAKU, KAU, HEW

Type of Boring AUGER (MOBILE B-40) Diam. 4"

Elev. 19' ± * Datum

Drill Bit FINGER TYPE

Water Level	Noticed				
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Time _____
Date 12-18-74

Weight 140#

Drop 30"

2" SS. 2" O.D. THIN WALL TUBE
2" SS. 2" STANDARD SPLIT SPOON

SAMPLER:

Unified Soil Classification	DESCRIPTION	Depth (Ft.)	Sampler	Sample No.	Plastic Limit	Water Cont. %	Liquid Limit	Unconf. Comp. P.S.F.	Vane Shear P.S.F.	PENETRATION DATA					
										Standard Penetration Test					2" O.D. THIN WALL TUBE SAMPLER
										N (Blows per foot)					BLOWS/0.5'
										0	10	20	30	40	
(ML-MH)	MEDIUM STIFF, BROWN CLAYEY SILT W/SOME GRAVEL	0	2"SS	3-A	-	15	-	-	-						
(SM)	MEDIUM DENSITY, BROWN SILTY SAND W/SOME GRAVEL	5	2"SS	3-B	-	18	-	-	-						
(MH)	MEDIUM, BROWN CLAYEY SILT		2"SS	3-C	-	21	-	14240	-						5/0.5' 5/0.5'
		10				$\gamma_w = 99$									
						$\gamma_d = 82$									
			2"SS	3-D	-	22	-	-	-						
(SM)	MEDIUM DENSITY, BROWN SILTY SAND W/TRACES OF GRAVEL	15													
			2"SS	3-E	-	36	-	-	-						3/0.5' 5/0.5' 10/0.5'
	END OF BORING @ 16.5 12-18-74														
NOTE:															
γ_w = WET DENSITY, P.O.F.															
γ_d = DRY DENSITY, P.O.F.															
* Elevations estimated from cross sections by Sunn, Low, Tom & Hara, Inc.															

BORING NO. 4 Sheet No. _____ of _____

Driller W. LUM ASSOC. INC. Date DEC. 17, 1974

Field Party: KAKU, KAU

Type of Boring AUGER (MOBILE) B-40 Diam. 4"

Elev. 26' ± * Datum _____

Drill Bit FINGER TYPE

Water Level	NOT NOTICED			
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Time				
Date	12-17-74			

KILL ROAD

Boring Log

PROJECT KILI DRIVE WIDENINGBORING NO. 5 Sheet No. of Driller W. LUM ASSOC., INC. Date DEC. 16, 1974LOCATION Makaha Valley, Waianae, Oahu, HawaiiField Party KAKU, KAUType of Boring AUGER (MOBILE B-40) Diam. 4"Elev. 29' ± * Datum Drill Bit FINGER TYPE

HAMMER:

Weight 140 #Drop 30"SAMPLER: 2" STANDARD SPLIT SPOONWater Level NOT NOTICEDTime Date 12-16-74

Unified Soil Classification	DESCRIPTION	Depth (Ft.)	Sampler	Sample No.	Plastic Limit	Water Cont. %	Liquid Limit	Unconf. Comp. P.S.F.	Vane Shear P.S.F.	PENETRATION DATA				
										Standard Penetration Test				
										N (Blows per foot)				
										0	10	20	30	40
	COBBLE OR BOULDER STIFF, MOTTLED BROWN SILTY CLAY, SAND & GRAVEL			5-A	-	10	-	-	-					50/0.3
	COBBLE OR BOULDER DENSE, BROWN SILTY SAND W/ GRAVEL			5-B	-	9	-	-	-					50/0.3
(SM)	COBBLE OR BOULDER STIFF, MOTTLED BROWN SILTY CLAY W/ TRACES OF SAND & GRAVEL			5-C	-	15	-	-	-					
(MH)				5-D	-	13	-	-	-					28/0.5
	DENSE, BROWN SILTY GRAVEL W/ SAND			5-E	-	8	-	-	-					50/0.4
(GM)														58
	END OF BORING @ 16.5 12-16-74													

* Elevation estimated from
cross sections by
Sunn, Low, Tom & Hara, Inc.

Boring Log

PROJECT KILI DRIVE WIDENING

LOCATION Makaha Valley, Waianae, Oahu, Hawaii

BORING NO. 6 Sheet No. _____ of _____

Driller W. LUM ASSOC., INC. Date DEC. 16, 1974

Field Party KAKU, KAU

Type of Boring Auger (MOBILE) Diam. 4"

Flav. 46' ± * Datum

Drill Bit FINGER TYPE

Water Level	NOT				
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Time	—				
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Date	12-16-74				
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HAMMER:

Weight 140 #

Drop 30"

SAMPLER:

2" STANDARD SPLIT SPOON

Unified Soil Classification	DESCRIPTION	Depth (Ft.)	Sampler	Sample No.	Plastic Limit	Water Cont. %	Liquid Limit	Unconf. Comp. P.S.F.	Vane Shear P.S.F.	PENETRATION DATA	
										Standard Penetration Test	N (Blows per foot)
	ELEV. = 46' ± 2 *	0									
(CH)	COBBLES										
	STIFF BROWN CLAY W/ TRACES OF GRAVEL & DECOMPOSED ROCK			G-A	-	15	-	-	-		50/0.1
				G-B	ROCK FRAGMENTS					HAMMER	BOUNCES
	GRAVEL, COBBLES OR BOULDER	5		G-C	ROCK FRAGMENTS						50/0.5
											HAMMER BOUNCES
(GM)	MOTTLED BROWN SILTY GRAVEL W/ SAND & DECOMPOSED ROCK	10		G-D	-	15 20	-	-	-		50/0.2
(SM)	DENSE, TAN BROWN SILTY SAND										HAMMER BOUNCES
	COBBLES OR BOULDERS	15*		G-E	NO RECOVERY						50/0.0
	END OF BORING @ 15' 12-16-74										HAMMER BOUNCES

* Elevation estimated from cross sections by Sunn, Low, Tom & Hara, Inc.

Boring Log

PROJECT KILI DRIVE WIDENINGBORING NO. 7 Sheet No. _____ of _____Driller W. LUM ASSOC., INC. Date DEC. 13, 1974LOCATION Makaha Valley, Waianae, Oahu, HawaiiField Party KAKU, ORITA, SEAWELLType of Boring AUGER (MOBILE B-40) Diam. 4"Elev. 73' ± * Datum _____Drill Bit FINGER TYPE

HAMMER:

Weight 140 #Drop 30"

SAMPLER:

2" STANDARD SPLIT SPOONWater Level NOT NOTICED

Time _____

Date 12-13-74

Unified Soil Classification	DESCRIPTION	Depth (ft.)	Sampler	Sample No.	Plastic Limit	Water Cont. %	Liquid Limit	Unconf. Comp. P.S.F.	Vane Shear P.S.F.	PENETRATION DATA				
										Standard Penetration Test				
	ELEV. = 73' ± *									N (Blows per foot)				
										0	10	20	30	40
	COBBLES													
GL-GH	STIFF REDDISH BROWN CLAY W/TRACES OF DECOMPOSED ROCK			7-A	26	20	50	-	-					
(MH-GH)	STIFF BROWN W/TAN BROWN SILTY CLAY W/DECOMPOSED ROCK	5		7-B	-	19	-	-	-					
	COBBLES OR BOULDER			7-C	-	17	-	-	-					
(SM)	DENSE BROWN SILTY SAND W/GRAVEL													
	COBBLES OR BOULDERS													
(GM)	MEDIUM DENSITY, BROWN SILTY GRAVEL W/SAND	10		7-D	-	8	-	-	-					
	COBBLE OR BOULDER													
(GM)	DENSE BROWN SILTY GRAVEL W/SAND	15		7-E	-	8	-	-	-					
	END OF BORING @ 17'													
	12-13-74													

* Elevation estimated from cross sections by Sunn, Low, Tom & Hara, Inc.

Boring Log

PROJECT KILI DRIVE WIDENINGLOCATION Makaha Valley, Waianae, Oahu, HawaiiBORING NO. 8 Sheet No. _____ of _____Driller W. LUM ASSOC., INC. Date DEC. 13, 1974Field Party KAKU, ORITA, SEAWELLType of Boring Auger (MOBILE B-40) Diam. 4"Elev. 97' ± * Datum _____Drill Bit FINGER TYPEWater Level NOTICED

Time _____

Date 12-13-74

HAMMER:

Weight 140 #Drop 30"

SAMPLER:

2" STANDARD SPLIT SPOON

Unified Soil Classification	DESCRIPTION	Depth (Ft.)	Sampler	Sample No.	Plastic Limit	Water Cont. %	Liquid Limit	Unconf. Comp. P.S.F.	Vane Shear P.S.F.	PENETRATION DATA				
										Standard Penetration Test				
										N (Blows per foot)				
										0	10	20	30	40
(SM-SG)	DENSE, BROWN SILTY CLAY, SAND & GRAVEL			8-A	-	10	-	-	-					
	COBBLES OR BOULDER			8-B	-	11	-	-	-					
(MH-GH)	STIFF, BROWN SILTY CLAY W/ SAND, GRAVEL & DECOMPOSED ROCK			8-C	-	12	-	-	-					
	COBBLE OR BOULDER			8-D	-	16	-	-	-					
(MH)	MEDIUM, BROWN SILTY CLAY W/ SAND, GRAVEL & DECOMPOSED ROCK			8-E	-	25	-	-	-					
(GH)	HARD, MOTTLED BROWN CLAY													
	END OF BORING @ 15.5													
	12-13-74													

* Elevation estimated from cross sections by Sunn, Low, Tom & Hara, Inc.

KILI ROAD

BORING NO. 9 Sheet No. of

Driller W. LUM ASSOC., INC. Date DEC. 9, 1974

Field Party KAKU, ASATO, ORITA
1.550 (MOBILE) 1"

Type of Boring Auger B-40 Diam. 4

Elev. 126' ± * Datum

Drill Bit: FINGER TYPE

Water Level	NOT NOTICED				
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Time.				
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Date	12-9-74				
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Weight 140#

Drop 30"

2" S - 2" O.D. THIN WALL TUBE

SAMPLER: 2" SS - 2" STANDARD SPLIT SPOON

Unified Soil Classification	DESCRIPTION	Depth (Ft.)	Sampler	Sample No.	Plastic Limit	Water Cont. %	Liquid Limit	Unconf. Comp. P.S.F.	Vane Shear P.S.F.	PENETRATION DATA	
										Standard Penetration Test	2" O.D. THIN WALL TUBE SAMPLER
										N (Blows per foot)	BLOWS/0.5'
										0 10 20 30 40	
(SM)	COBBLES OR BOULDERS DENSE, BROWN, SILTY SAND W/ TRACES OF GRAVEL	2'55"		9-A	-	15	-	-	-		33/0.5'
(GM)	COBBLES OR BOULDERS MOTTLED GRAY BROWN SILTY SAND & DECOMPOSED ROCK	2'55"		9-B	-	8	-	-	-		73
(SM)	COBBLES OR BOULDERS GRAY BROWN SILTY SAND W/ GRAVEL	2'55"		9-C	-	8	-	-	-		34/0.1'
(ML)	STIFF, BROWN CLAYEY SILT W/ SAND	2'55"		9-D	-	9	-	-	-		HAMMER BOUNCES 64/0.1'
	END OF BORING @ 15.5' 12-10-14	15'		9-E	-	23 $\gamma_w = 106$ $\gamma_d = 86$	-	6150	-		14/0.5'
NOTE: γ_w = NET DENSITY, P.O.F. γ_d = DRY DENSITY, P.O.F.											

* Elevation estimated from cross sections by Sunn, Low, Tom & Hara, Inc.

BORING NO. 10 Sheet No. _____ of _____

Driller W. LUM ASSOC., INC. Date DEC. 4, 1974

Field Party SHIGENAGA, OSHIRO, ORITA
ALGER (MOBILE) 4"

Type of Boring ABACI (B-40) Diam. 1.5

Elev. 153 ± Datum

Drill Bit FINGER TYPE

Water Level	NOT NOTICED			
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Time				
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Date	12-4-74				
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Unified Soil Classification	DESCRIPTION	Depth (Ft.)	Sampler	Sample No.	Plastic Limit	Water Cont. %	Liquid Limit	Unconf. Comp. P.S.F.	Vane Shear P.S.F.	PENETRATION DATA				
										Standard Penetration Test				
										N (Blows per foot)				
										0	10	20	30	40
ML-MH	STIFF BROWN SILTY CLAY W/SAND & GRAVEL	0		10-A	-	23	-	-	-					
(SM)	MEDIUM DENSITY BROWN SILTY SAND W/GRAVEL & TRACES OF CORAL			10-B	-	15	-	-	-					
ML	STIFF BROWN CLAYEY SILT W/TRACES OF SAND, GRAVEL & CORAL	5		10-C	35	26	49	-	-					
SP-SM	MEDIUM DENSITY BROWN & WHITE SILTY SAND W/CORAL			10-D	-	31	-	-	-					
(SM)	MEDIUM DENSITY MOTTLED BROWN SILTY SAND W/CORAL & GRAVEL	10		10-E	-	13	-	-	-					
	COBBLES OR BOULDER?	15		10-F	-	3	-	-	-					
	END OF BORING @ 16.5'													
	12-4-74													

* Elevation estimated from cross sections by Sunn, Low, Tom & Hara, Inc.

Boring Log

PROJECT KILI DRIVE WIDENINGLOCATION Makaha Valley, Waianae, Oahu, HawaiiBORING NO. 11 Sheet No. of Driller W. LUM ASSOC, INC. Date DEC. 6 1974Field Party KAKU, OSHIRO, ORITAType of Boring AUGER (MOBILE) Diam. 4"Elev. 181' ± * Datum Drill Bit FINGER TYPE

HAMMER:

Weight 140#Drop 30"

SAMPLER:

2" STANDARD SPLIT SPOONWater Level NOT NOTICEDTime Date 12-9-74

Unified Soil Classification	DESCRIPTION	Depth (Ft.)	Sampler	Sample No.	Plastic Limit	Water Cont. %	Liquid Limit	Unconf. Comp. P.S.F.	Vane Shear P.S.F.	PENETRATION DATA				
										Standard Penetration Test				
										N (Blows per foot)				
										0	10	20	30	40

	ELEV. = 181' ± 7 * 0													
	STIFF, DARK BROWN CLAY W/ GRAVEL			11-A		NO RECOVERY								38/0.2'
	COBBLES OR BOULDER	5												
				11-B	-	16	-	-	-					50/0.2'
	DENSE, DARK BROWN SILTY GRAVEL W/ SAND & COBBLES OR BOULDER POCKETS	10		11-C	-	14	-	-	-					50/0.4'
		15		11-D	-	15	-	-	-					70/0.4'
	END OF BORING @ 15.4'													
	12-9-74													

* Elevation estimated from cross sections by Sunn, Low, Tom & Hara, Inc.

* Elevation estimated from cross sections by Sunn, Low, Tom & Hara, Inc.

KILI ROAD

Boring Log

PROJECT KILI DRIVE WIDENINGLOCATION Makaha Valley, Waianae, Oahu, Hawaii

HAMMER:

Weight 140 #Drop 30"

SAMPLER:

2" STANDARD SPLIT SPOONBORING NO. 12 Sheet No. of Driller W. LUM ASSOC., INC. Date DEC. 17, 1974Field Party KAKU, KAUType of Boring AUGER (MOBILE B-40) Diam. 4"Elev. 203' ± * Datum Drill Bit FINGER TYPEWater Level NOTICEDTime Date 12-17-74

Unified Soil Classification	DESCRIPTION	Depth (ft.)	Sampler	Sample No.	Plastic Limit	Water Cont. %	Liquid Limit	Unconf. Comp. P.S.F.	Vane Shear P.S.F.	PENETRATION DATA				
										Standard Penetration Test				
										N (Blows per foot)				
										0	10	20	30	40
(GH)	STIFF BROWN CLAY W/ SAND & GRAVEL			12-A	-	17	-	-	-					42
	COBBLES OR BOULDERS	5		12-B	ROCK FRAGMENTS									50/0.3
(GM)	DENSE, MOTTLED TAN BROWN SILTY GRAVEL W/ SAND & DECOMPOSED ROCK			12-C	-	10	-	-	-					75
	COBBLES OR BOULDERS	10		12-D	NO RECOVERY									50/0.0
	END OF BORING @ 13.2'													HAMMER BOUNCES
	12-17-74													

* Elevation estimated from cross sections by Sunn, Low, Tom & Hara, Inc.

* Elevation estimated from cross sections by Sunn, Low, Tom & Hara, Inc.

KILL ROAD

BORING NO. 13 Sheet No. _____ of _____

Driller W. LUM ASSOC. INC. Date DEC. 6, 1974

Field Party KAKU, OSHIRO, ORITA

Type of Boring AUGER (MOBILE) Diam. 4"

Elev. 229' ± * Datum —

Drill. Bit FINGER TYPE

Water Level	2287	1060				
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Time				
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Weight 140#

Drop. 30"

SAMPLER:

2" STANDARD SPLIT SPOON

* Elevation estimated from cross sections by Sunn, Low, Tom & Hara, Inc.

Boring Log

PROJECT KILI DRIVE WIDENINGLOCATION Makaha Valley, Waianae, Oahu, HawaiiBORING NO. 15 Sheet No. of Driller W. LUM ASSOC., INC. Date DEC. 4, 1974Field Party SHIGENAGA, OSHIRO, ORITAType of Boring AUGER (MOBILE) Diam. 4"Elev. 275' ± * Datum Drill Bit FINGER TYPEWater Level NOT RECORDEDTime Date 12-4-74

HAMMER:

Weight 140#Drop 30"SAMPLER: 2" STANDARD SPLIT SPOON

Unified Soil Classification	DESCRIPTION	Depth (Ft.)	Sampler	Sample No.	Plastic Limit	Water Cont. %	Liquid Limit	Unconf. Comp. P.S.F.	Vane Shear P.S.F.	PENETRATION DATA					
										Standard Penetration Test					
										N (Blows per foot)					
										0	10	20	30	40	
	ELEV. = 275' ± 2 *	0													
	COBBLES & BOULDERS														
(CH)	STIFF, BROWN CLAY w/ DECOMPOSED ROCK	5		15-A	-	15	-	-	-						50/0.3
(GW-GC)	DENSE, BROWN SILTY GRAVEL w/ SAND, DECOMPOSED ROCK & CLAY POCKETS			15-B	-	6	-	-	-						43/0.5
	GRAY, CLAY, SAND & GRAVEL	10		15-C	-	9	-	-	-						50/0.2
	COBBLES OR BOULDERS	15		15-D	No	RECOVERY									20/0.0
	END OF BORING @ 15'														HAMMER BOUNCES
	12-4-74														HAMMER BOUNCES

* Elevation estimated from cross sections by Sunn, Low, Tom & Hara, Inc.

* Elevation estimated from cross sections by Sunn, Low, Tom & Hara, Inc.

Boring Log

PROJECT KILI DRIVE WIDENINGLOCATION Makaha Valley, Waiānae, Oahu, HawaiiBORING NO. 14 Sheet No. of Driller W. LUM ASSOC., INC. Date DEC. 5, 1974Field Party KAKU, OSHIRO, ORITAType of Boring AUGER (MOBILE) Diam. 4"Elev. 257' ± * Datum Drill Bit FINGER TYPEWater Level NOTICEDTime Date 12-5-74

HAMMER:

Weight 140#Drop 30"SAMPLER: 2" STANDARD SPLIT SPOON

Unified Soil Classification	DESCRIPTION	Depth (Ft.)	Sampler	Sample No.	Plastic Limit	Water Cont. %	Liquid Limit	Unconf. Comp. P.S.F.	Vane Shear P.S.F.	PENETRATION DATA			
										Standard Penetration Test			
										N (Blows per foot)			
										0	10	20	30 40
SC	STIFF, MOTTLED BROWN CLAYEY SAND W/ GRAVEL & DECOMPOSED ROCK INTERSPERSED W/ COBBLES & BOULDERS NOTE: AT 5.6' DEPTH HARD DRILLING. MOVED 2' AWAY. AT 4' DEPTH HARD DRILLING. MOVED 5' AWAY.	0		14-A	-	15	-	-	-				
		5		14-B	-	18	-	-	-				
				14-C	-	20	-	-	-				
	COBBLES OR BOULDERS	10		14-D	NO RECOVERY				-				
													35% .1
													HAMMER BOUNCES
GH	STIFF, DARK BROWN CLAY W/ DECOMPOSED ROCK END OF BORING @ 16.5' 12-5-74	15		14-E	31	27	69	-	-				43

* Elevation estimated from cross sections by Sunn, Low, Tom & Hara, Inc.

KILI DRIVE WIDENING

TABLE I A - SUMMARY OF LABORATORY TEST RESULTS

BORING NO.	1	1	1	1
SAMPLE NO.		C	D (BTM.)	E
DEPTH BELOW SURFACE	SURFACE	6'-7'	10'-11.5'	15'-16.5'
DESCRIPTION	BROWN CLAY W/ SAND	BROWN SILTY CLAY W/ SOME GRAVEL	DARK GRAY ORGANIC SILT W/ TRACES OF FIBERS	BLACK & WHITE SAND W/ GRAVEL
GRAIN-SIZE ANALYSIS				
(% Passing)				
Sieve				
1"				100
1/2"				80.4
#4				56.2
#10				40.8
#20				22.8
#40				12.1
#100				7.0
#200				5.5
ATTERBERG LIMITS				
Air Dried or Natural	NATURAL	NATURAL	NATURAL	
Liquid Limit	38	57	90	
Plastic Limit	25	30	51	
Plasticity Index	13	27	39	
Dilatancy	MEDIUM	MED.-QUICK	QUICK	
Toughness	MEDIUM	MEDIUM	MED.-SLIGHT	
Dry Strength	MEDIUM	HIGH	SLIGHT	
UNIFIED SOIL CLASSIFICATION				
	CL	MH-CH	MH	SP-SM
APPARENT SPECIFIC GRAVITY				
CBR TEST				
(Surcharge-51 P.S.F.)				
Molding Moisture, %	21.1			
Molding Dry Density, P.C.F.	106.9			
Swell upon saturation, %	1.0			
CBR at 0.1" Penetration	23.0			
MOISTURE-DENSITY RELATIONS OF SOILS				
(AASHTO T-180-73I, Method)				
Dry to Wet or Wet to Dry				
Max. Dry Density (P.C.F.)				
Optimum Moisture (%)				

REMARKS:

WALTER LUM ASSOCIATES, INC.
CIVIL, STRUCTURAL, SOILS ENGINEERS

Date 2-6-75 By BT

KILI DRIVE WIDENING

TABLE 1 D - SUMMARY OF LABORATORY TEST RESULTS

BORING NO.	4	4	7
SAMPLE NO.		A	A
DEPTH BELOW SURFACE	SURFACE	2'-3.5'	2'-3.5'
DESCRIPTION	BROWN SILTY CLAY WITH TRACES OF SAND	BROWN CLAYEY SILT WITH TRACES OF SAND	REDDISH-BROWN CLAY WITH TRACES OF DECOMP. ROCK
GRAIN-SIZE ANALYSIS			
(% Passing)			
Sieve			
1"			
1/2"			
#4			
#10			
#20			
#40			
#100			
#200			
ATTERBERG LIMITS			
Air Dried or Natural	NATURAL	NATURAL	NATURAL
Liquid Limit	43	43	50
Plastic Limit	26	28	26
Plasticity Index	17	15	24
Dilatancy	MEDIUM	SLOW-MED.	MED.-QUICK
Toughness	MEDIUM	MEDIUM	HIGH
Dry Strength	MED.-HIGH	MED.-HIGH	MED.-HIGH
UNIFIED SOIL CLASSIFICATION	ML-CL	ML	CL-CH
APPARENT SPECIFIC GRAVITY			
CBR TEST			
(Surcharge-51 P.S.F.)			
Molding Moisture, %	22.7		
Molding Dry Density, P.C.F.	104.8		
Swell upon saturation, %	0.8		
CBR at 0.1" Penetration	14.3		
MOISTURE-DENSITY RELATIONS OF SOILS			
(AASHTO T-180-73I, Method)			
Dry to Wet or Wet to Dry			
Max. Dry Density (P.C.F.)			
Optimum Moisture (%)			

REMARKS:

WALTER LUM ASSOCIATES, INC.
CIVIL, STRUCTURAL, SOILS ENGINEERS

Date 2-6-75

By MT

KILI DRIVE WIDENING

TABLE IC - SUMMARY OF LABORATORY TEST RESULTS

BORING NO.	10	10	11
SAMPLE NO.	C	D (BTM)	
DEPTH BELOW SURFACE	4'-5.5'	6'-7.5'	SURFACE
DESCRIPTION	BROWN CLAYEY SILT W/ TRACES OF SAND GRAVEL & CORAL	BROWN & WHITE SILTY SAND W/ CORAL	BROWN SILTY SAND W/ GRAVEL & CLAY POCKETS
GRAIN-SIZE ANALYSIS (% Passing)			
Sieve			
1"		100	92.3
1/2"		81.7	82.0
#4		73.2	75.9
#10		62.9	70.7
#20		49.9	65.3
#40		30.2	60.3
#100		13.0	51.3
#200		9.5	46.8
ATTERBERG LIMITS			
Air Dried or Natural	NATURAL		NATURAL
Liquid Limit	49		52
Plastic Limit	35		30
Plasticity Index	14		22
Dilatancy	MED.-QUICK		MEDIUM
Toughness	MED.-SLIGHT		MEDIUM
Dry Strength	SLIGHT		MEDIUM
UNIFIED SOIL CLASSIFICATION	ML	SP-SM	SM
APPARENT SPECIFIC GRAVITY			
CBR TEST			
(Surcharge=51 P.S.F.)			
Molding Moisture, %			18.4
Molding Dry Density, P.C.F.			108.3
Swell upon saturation, %			9.5
CBR at 0.1" Penetration			3.0
MOISTURE-DENSITY RELATIONS OF SOILS (AASHTO T-180-73I, Method)			
Dry to Wet or Wet to Dry			
Max. Dry Density (P.C.F.)			
Optimum Moisture (%)			

REMARKS:

WALTER LUM ASSOCIATES, INC.
CIVIL, STRUCTURAL, SOILS ENGINEERS

Date 2-6-75 By RF

KILI DRIVE WIDENING

TABLE I D - SUMMARY OF LABORATORY TEST RESULTS

BORING NO.	14	14		
SAMPLE NO.	B	E		
DEPTH BELOW SURFACE	4'-5.3'			
DESCRIPTION	MOTTLED BROWN CLAYEY SAND W/ GRAVEL & DECOMP. ROCK	DARK BROWN CLAY WITH DECOMP. ROCK		
GRAIN-SIZE ANALYSIS				
(% Passing)				
Sieve				
1"	100			
1/2"	85.4			
#4	72.7			
#10	65.6			
#20	58.7			
#40	53.0			
#100	41.7			
#200	41.1			
ATTERBERG LIMITS				
Air Dried or Natural		NATURAL		
Liquid Limit		69		
Plastic Limit		31		
Plasticity Index		37		
Dilatancy		MED-SLOW		
Toughness		HIGH		
Dry Strength		HIGH		
UNIFIED SOIL CLASSIFICATION	SC	CH		
APPARENT SPECIFIC GRAVITY				
CBR TEST				
(Surcharge-51 P.S.F.)				
Molding Moisture, %				
Molding Dry Density, P.C.F.				
Swell upon saturation, %				
CBR at 0.1" Penetration				
MOISTURE-DENSITY RELATIONS OF SOILS				
(AASHTO T-180-73I, Method)				
Dry to Wet or Wet to Dry				
Max. Dry Density (P.C.F.)				
Optimum Moisture (%)				

REMARKS:

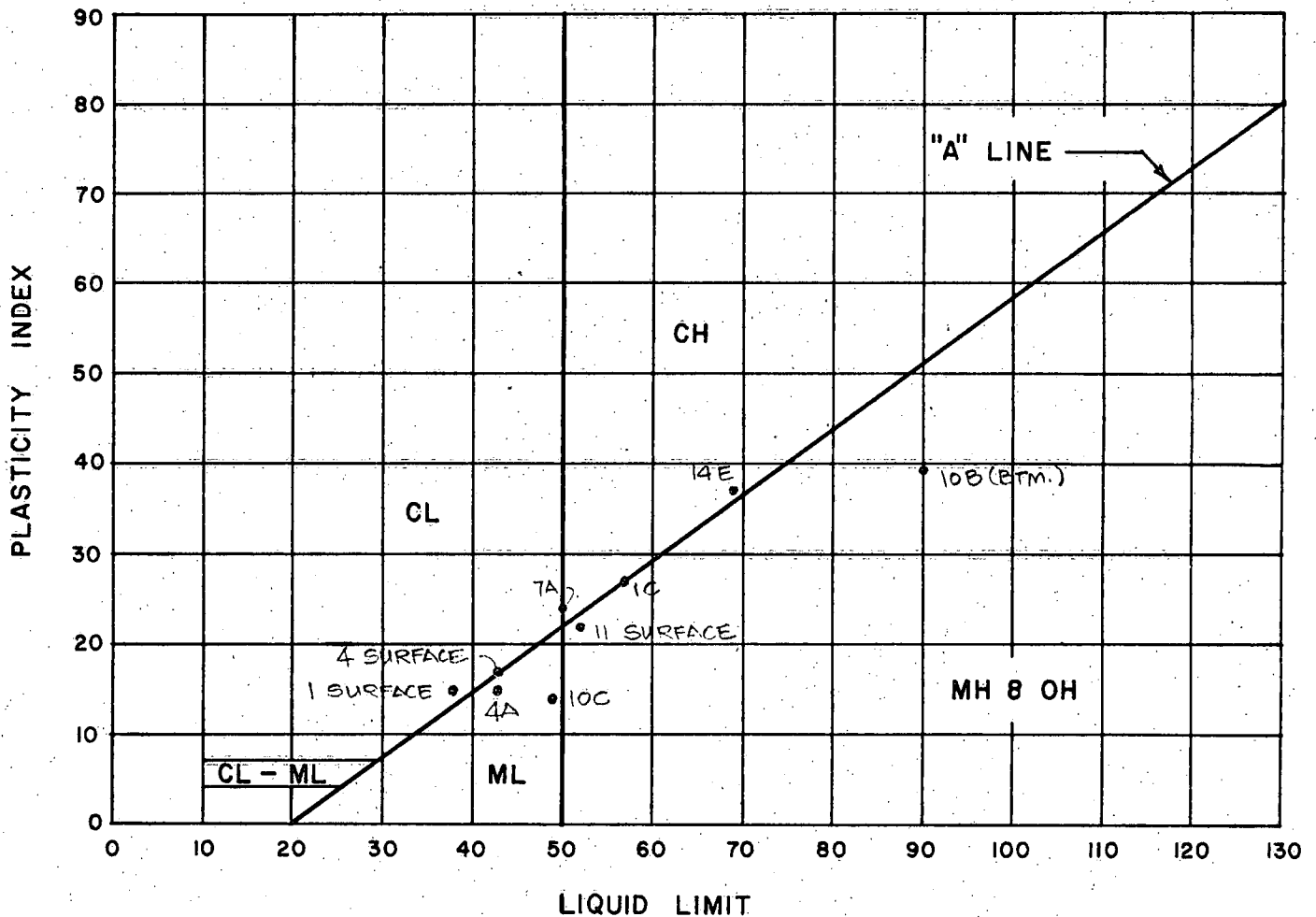
WALTER LUM ASSOCIATES, INC.
CIVIL, STRUCTURAL, SOILS ENGINEERS

Date 2-6-75 By WJ

PLASTICITY CHART

PROJECT: KILI DRIVE WIDENING

LOCATION: MAKAHA VALLEY, WAIANAE, OAHU, HAWAII



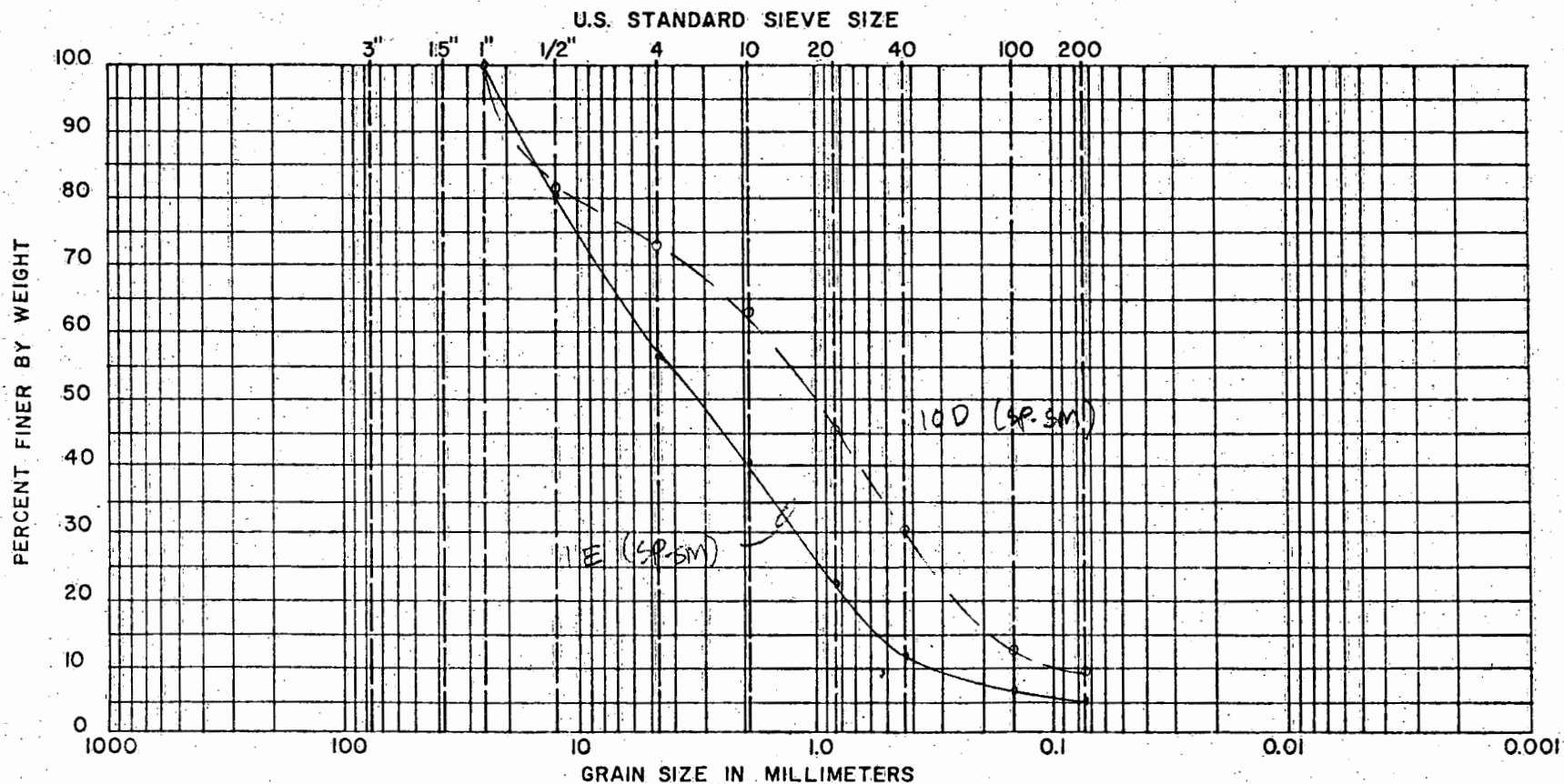
DATE 2-6-75 BY WJ

WALTER LUM ASSOCIATES, INC.
CIVIL, STRUCTURAL, SOILS ENGINEERS

GRAIN-SIZE ANALYSIS CURVE

PROJECT: KILI DRIVE WIDENING

LOCATION: MAKANA VALLEY, WAIANAE, OAHU, HAWAII



COBBLE	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

DATE 2-6-75 BY BT

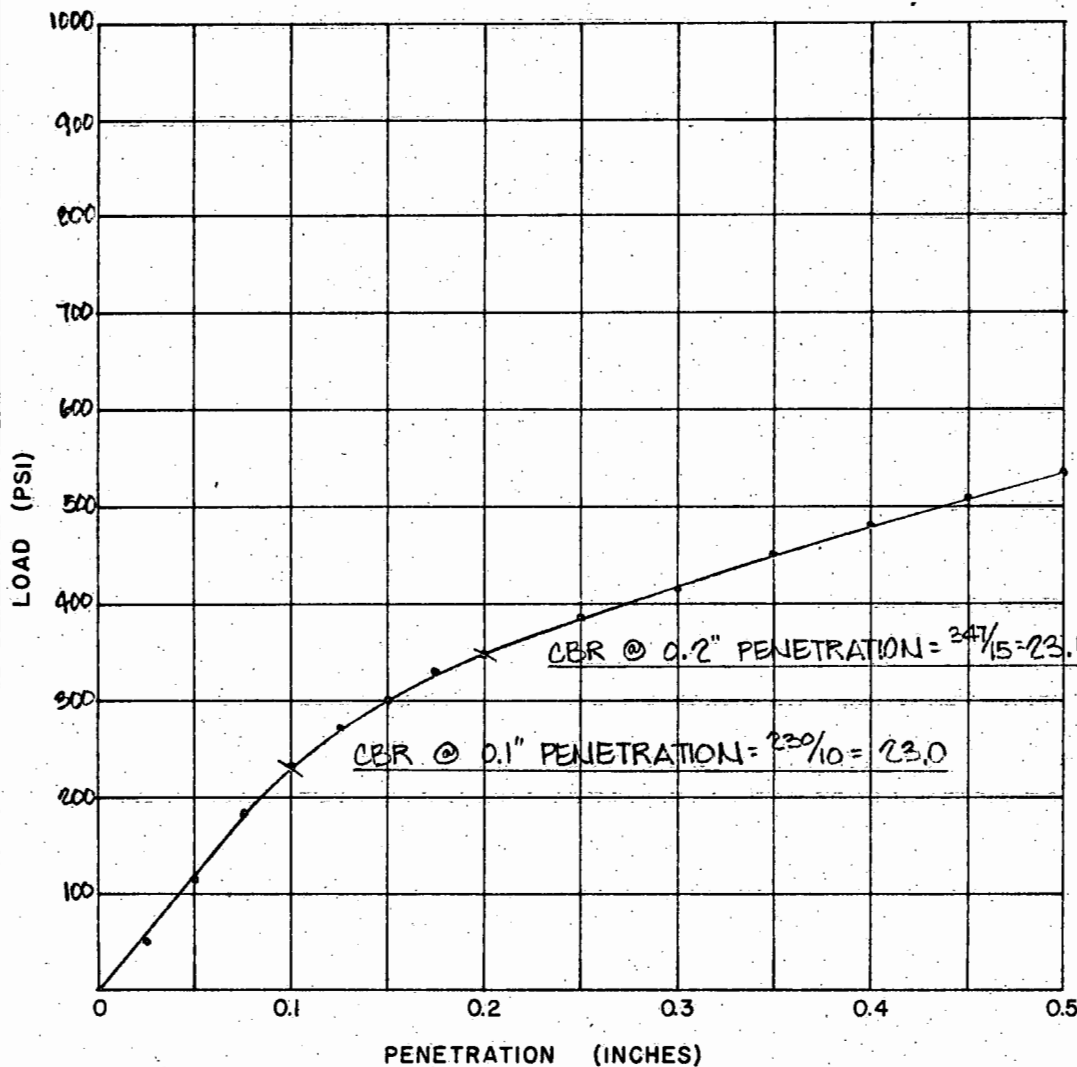
CBR TEST

PROJECT: KILI DRIVE WIDENING

LOCATION: MAKAHA VALLEY, WAIANAE, OAHU, HAWAII

SAMPLE NO: 1 SURFACE

SAMPLE DESCRIPTION: BROWN CLAY W/SAND



CBR PENETRATION DATA

PENETRATION (INCHES)	LOAD (LBS)	LOAD (PSI)
0.025	150	50
0.050	350	117
0.075	550	183
0.100	700	233
0.125	810	270
0.150	900	300
0.175	990	330
0.200	1040	347
0.250	1150	389
0.300	1245	415
0.350	1350	450
0.400	1440	480
0.450	1520	507
0.500	1610	537

AGGREGATE 1/4" MINUS
HAMMER WEIGHT 10 LBS.
HAMMER DROP 18 INS.
No. OF BLOWS 50/LAYER
No. OF LAYERS 5

TEST RESULTS:

MOLDING MOISTURE, % 21.1
MOLDING DRY DENSITY, P.C.F. 106.9
CBR @ 0.1" PENETRATION 23.0
DAYS SOAKED 4

DATE 1-11-75 BY L.Y.
DATE 1-13-75 BY N.I.

WALTER LUM ASSOCIATES, INC.
CIVIL, STRUCTURAL, SOILS ENGINEERS

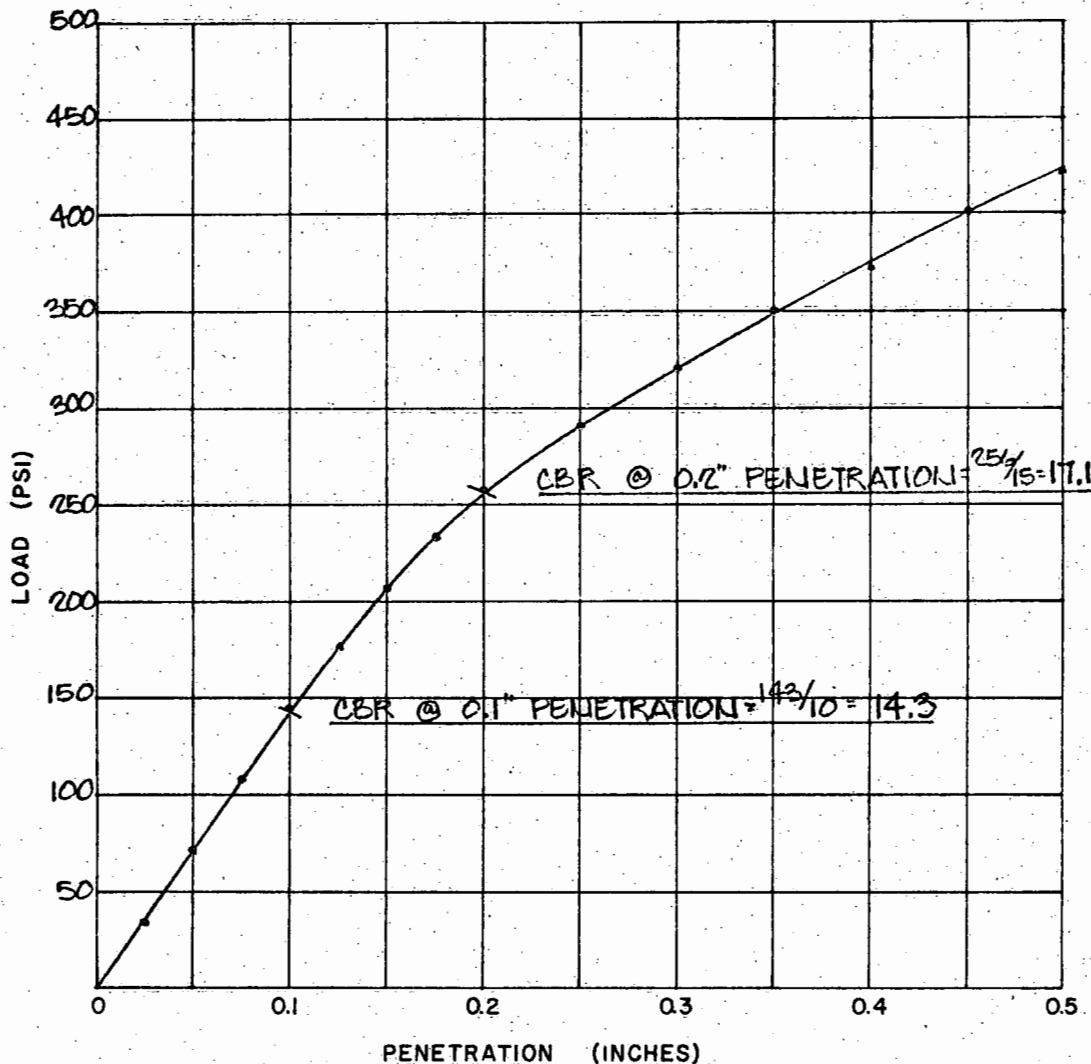
CBR TEST

PROJECT: KILI DRIVE WIDENING

LOCATION: MAKAHA VALLEY, WAIANAE, OAHU, HAWAII

SAMPLE NO: 4 SURFACE

SAMPLE DESCRIPTION: BROWN SILTY CLAY W/TRACES OF SAND



CBR PENETRATION DATA

PENETRATION (INCHES)	LOAD (LBS)	LOAD (PSI)
0.025	100	33
0.050	210	70
0.075	325	108
0.100	435	145
0.125	530	177
0.150	620	207
0.175	700	233
0.200	770	257
0.250	870	290
0.300	960	320
0.350	1050	350
0.400	1120	373
0.450	1200	400
0.500	1270	423

AGGREGATE 1/4" MINUS
HAMMER WEIGHT 10 LBS.
HAMMER DROP 18 INS.
No. OF BLOWS 56/LAYER
No. OF LAYERS 5

TEST RESULTS:

MOLDING MOISTURE, % 22.7

MOLDING DRY DENSITY, P.C.F. 104.8

CBR @ 0.1" PENETRATION 14.3

DAYS SOAKED 4

DATE 1-11-75 BY L.Y.

DATE 1-13-75 BY N.I.

WALTER LUM ASSOCIATES, INC.
CIVIL, STRUCTURAL, SOILS ENGINEERS

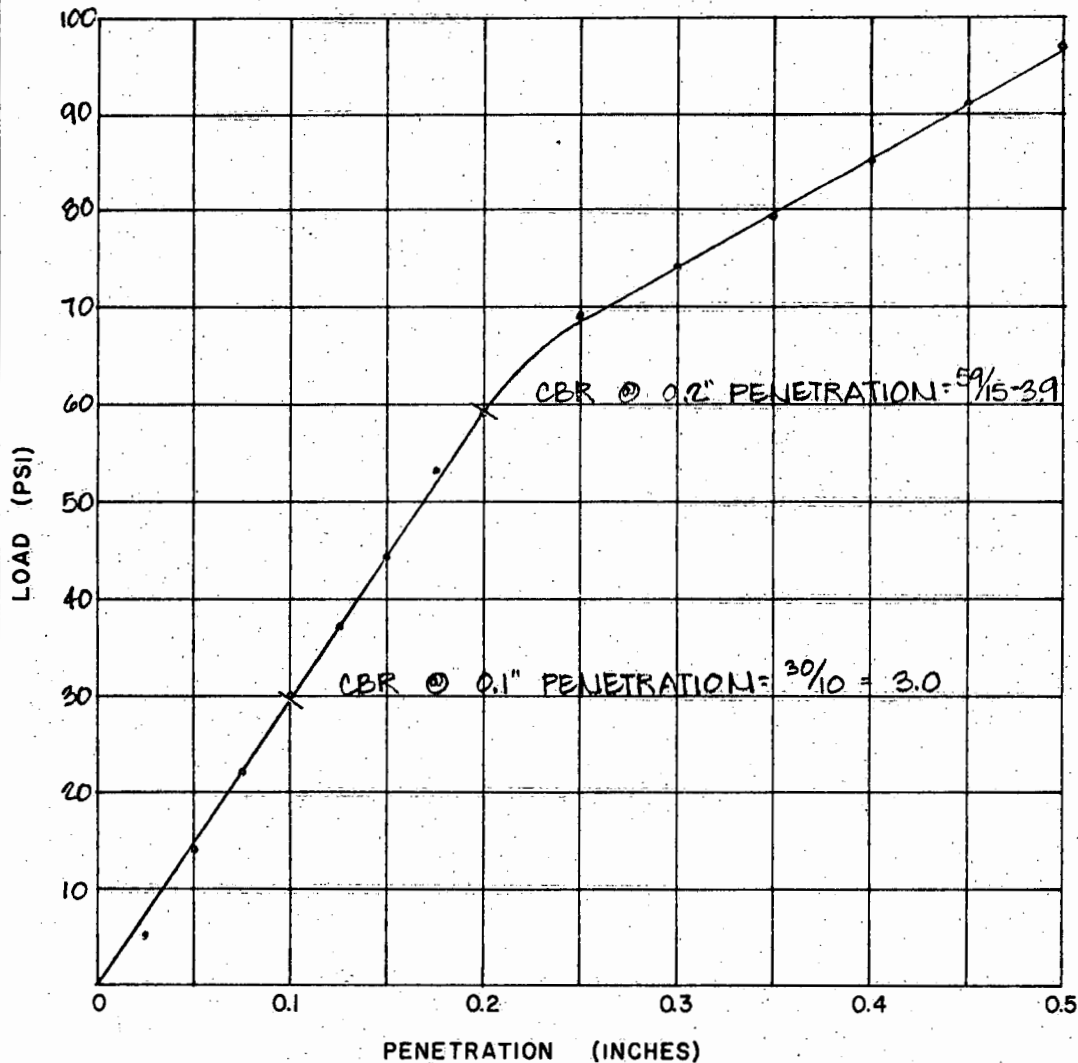
CBR TEST

PROJECT: KILI DRIVE WIDENING

LOCATION: MAKAHA VALLEY, WAIANAE, OAHU, HAWAII

SAMPLE NO: 11 SURFACE

SAMPLE DESCRIPTION: BROWN SILTY SAND W/ GRAVEL & CLAY POCKETS



CBR PENETRATION DATA

PENETRATION (INCHES)	LOAD (LBS)	LOAD (PSI)
0.025	14	5
0.050	41	14
0.075	67	22
0.100	91	30
0.125	111	37
0.150	131	44
0.175	158	53
0.200	178	59
0.250	206	69
0.300	222	74
0.350	238	79
0.400	254	85
0.450	272	91
0.500	290	97

AGGREGATE 3/4" MINUS
HAMMER WEIGHT 10 LBS.
HAMMER DROP 18 INS.
No. OF BLOWS 56/LAYER
No. OF LAYERS 5

TEST RESULTS:

MOLDING MOISTURE, % 18.4
MOLDING DRY DENSITY, P.C.F. 108.3
CBR @ 0.1" PENETRATION 3.0
DAYS SOAKED 4

DATE 1-11-75 BY L.Y.

DATE 1-13-75 BY N.I.

WALTER LUM ASSOCIATES, INC.
CIVIL, STRUCTURAL, SOILS ENGINEERS

LIMITATIONS

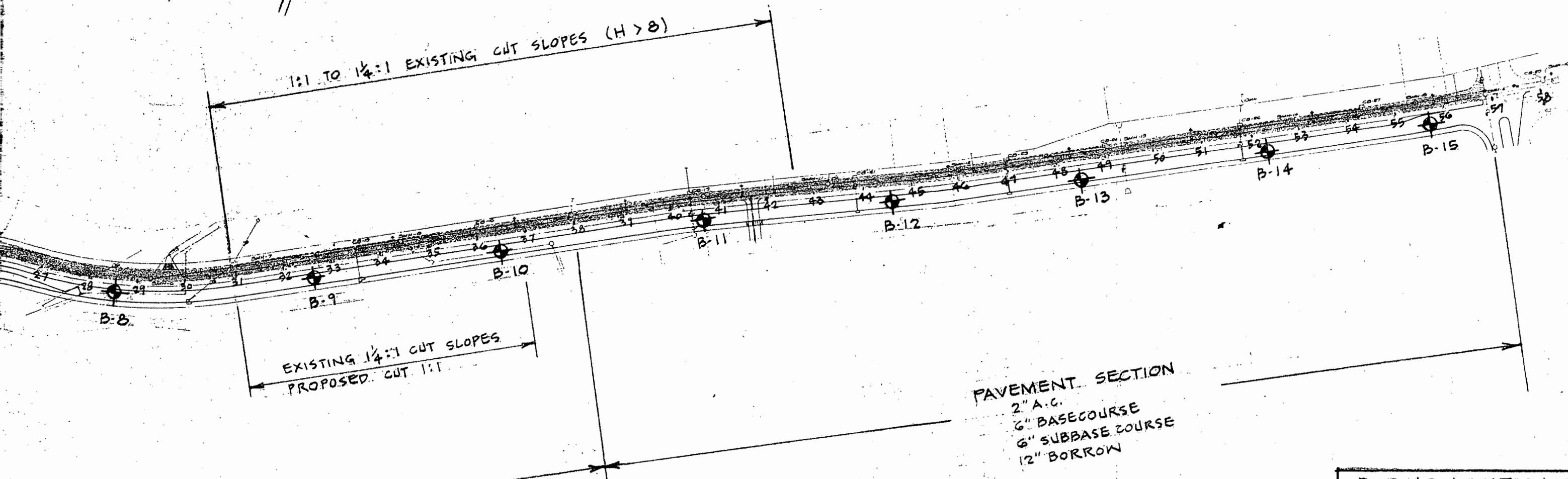
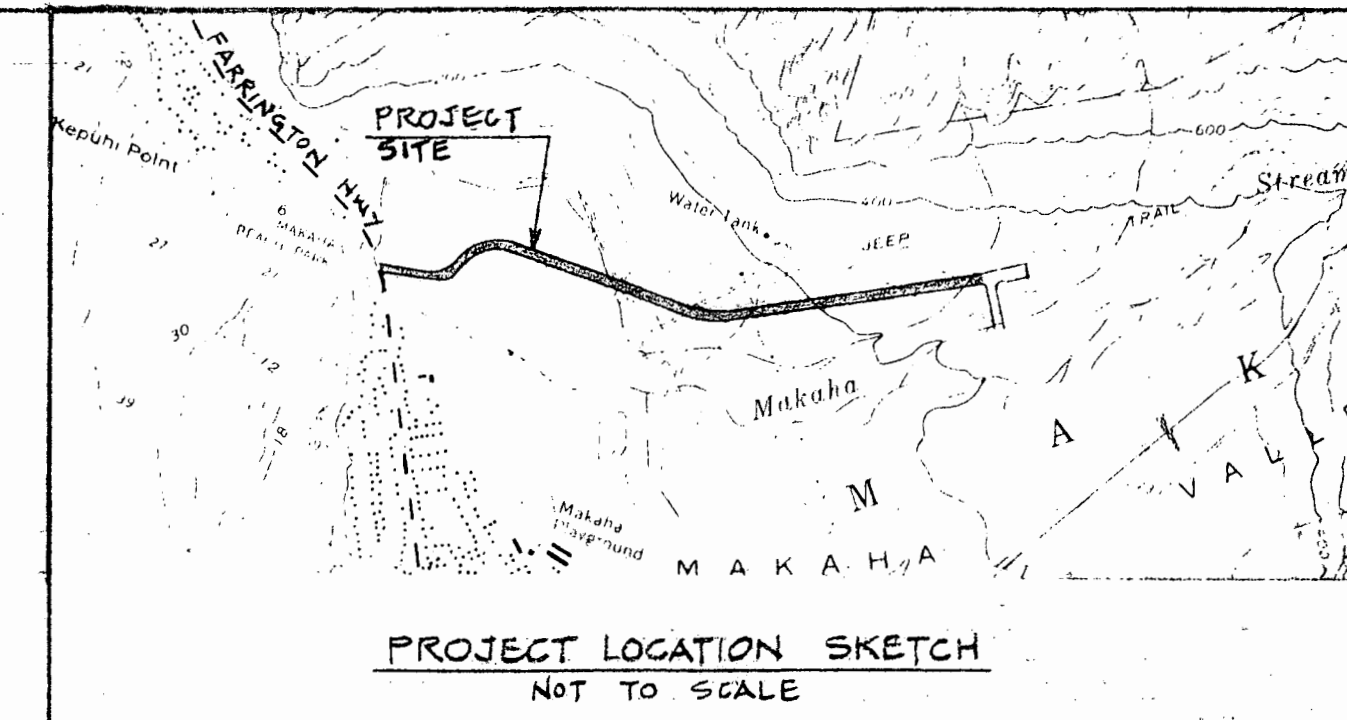
In general, soil formations are commonly erratic and rarely uniform or regular. The boring logs indicate the approximate subsurface soil conditions encountered only at the drill holes where the borings were made at the times designated on the logs and may not represent conditions at other locations or at other dates. Soil conditions and water levels may change with the passage of time and construction methods or improvements at the site.

During construction, should subsurface conditions much different from those in the borings be observed, encountered, or otherwise indicated, we should be advised immediately to review or reconsider our recommendations in light of the new developments.

If there is a substantial lapse of time between the submission of this report and the start of work at the site, or if conditions have changed due to natural causes, plan changes, or construction operations at or adjacent to the site, it is recommended that this report be reviewed to determine the applicability of the recommendations considering the time lapse, changed conditions, and changes in the state of the art of soil engineering.

Our professional services were performed, findings obtained and recommendations prepared in accordance with generally accepted engineering practices. This warranty is in lieu of all other warranties expressed or implied.

NORTH
SCALE: 1" = 200'



PAVEMENT SECTION
2" A.C.
6" BASECOURSE
6" SUBBASE COURSE
12" BORROW

NOTE:
THE BOUNDARIES FOR THE DIFFERENT PAVEMENT THICKNESS IS ONLY AN APPROXIMATION.
ADJUSTMENTS SHOULD BE MADE IN THE FIELD WHEN THE GRADING IS NEAR THE SUBGRADE.

BORING LOCATION SKETCH KILI DRIVE WIDENING MAKAHA VALLEY, WAIANAE, OAHU, HAWAII		
Dr. _____	WALTER LUM ASSOCIATES, INC. 3030 WAIKALAE AVE. CIVIL ENGINEERS PHONE 737 7931	Sheet _____
Date _____		of _____
Inv. _____		

NORTH
SCALE: 1"=200'

1:1 TO 1 1/4:1 EXISTING

EXISTING 1 1/4:1 CUT
PROPOSED: CUT 1:1

EXISTING KILL DRIVE

EXISTING 5'-48" PIPE CULVERTS

PROPOSED ROAD WIDENING

PAVEMENT SECTION
2" A.C.
6" BASE COURSE

PAVEMENT SECTION
2" A.C.
6" BASE COURSE
FILL MATERIAL
SWELL < 1%
CBR > 12

PAVEMENT SECTION
2" A.C.
6" BASE COURSE
FILL MATERIAL
SWELL < 1%
CBR > 12

