FOUNDATION INVESTIGATION
KAIMUKI HIGH SCHOOL AUDITORIUM
HONOLULU, HAWAII
DAGS Job No. 02-16-6051.2

H-LA Job No. 5666,001.06

Prepared for

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I INTRODUCTION

This report presents the results of the foundation investigation we performed for the planned Auditorium at Kaimuki High School, Honolulu, Hawaii. The site is located about 70 feet southwest of the existing Library/Administration Building, between the cafeteria and the electric shop, as shown on the Site Plan, Plate 1.

The auditorium portion of the planned building will have a steel roof, concrete walls and concrete columns. The stage portion will have a steel roof supported on concrete bearing walls. Column loads in the auditorium will range from about 50 to about 160 kips. Wall loads in the stage area will be on the order of 15 kips per foot. Wall columns, 16 feet long, will be located on each side of the stage opening. The wall columns will carry loads of about 1100 kips.

Building plans currently show finish floor grades ranging up to about 6 feet above the existing ground surface in the auditorium portion of the building and about 3 feet above the existing ground surface in the stage area. These grades may be modified to accommodate subsurface conditons at the site as discussed in subsequent sections of this report.

II SCOPE

The scope of our work, as outlined in our proposal dated February 2, 1976, was to explore subsurface conditions, perform laboratory tests and analyze the field and laboratory data in order to:

1. Develop conclusions and recommendations regarding foundation support for the building and soil criteria for foundation design, including pile driving criteria
2. Prepare guide specifications for driven pile installation
3. Estimate settlement behavior
4. Develop recommendations for site preparation and grading, including recommendations for subgrade preparation beneath slab-on-grade floors and spread footings
5. Develop conclusions regarding the necessity of relocating an existing sewer line beneath the auditorium portion of the planned building area.

During the course of our work, we discussed our preliminary conclusions and recommendations with representatives of Harry Miyachi and Group Architects Collaborative, Project Architects; Sato and Kuniyoshi, Project Structural Engineer; and the State of Hawaii, Department of Accounting and General Services (DAGS). We transmitted preliminary subsurface data to Group Architects on March 24, 1976 and settlement data to Sato and Kuniyoshi on March 25, 1976.

III INVESTIGATION

A. Field

We investigated subsurface conditions by logging and sampling 5 test borings at the locations shown on the Site Plan. The borings were drilled by MAS Drilling Company to depths ranging from 62 to 100 feet using continuous flight auger, rotary wash and Nx-size rock coring equipment. Our field engineer logged the test borings and obtained drive-type core samples for laboratory testing. The boring logs are presented on Plates 6 through 10 in Appendix A. The soils are classified according to the Unified Soil Classification System which is explained on Plate 11.

B. Laboratory

We tested selected samples in our laboratory to determine their moisture content, dry density, shear strength, plasticity and compressibility. The results of the moisture-density, shear strength and plasticity (Atterberg Limits) tests are presented on the boring logs in the manner described in the Key to Test Data on Plate 11 (Appendix A). Plasticity test results are also plotted on Plate 12. Compressibility (consolidation) test results are presented on Plates 13 through 15.

IV SITE AND SUBSURFACE CONDITIONS

A. Surface

Most of the site is relatively level and covered with grass. There are 3 temporary structures along the southwest side of the planned building area and a paved area, about 30 by 80 feet in plan dimensions, on the northeast side. Several small utility lines and one relatively large sewer line are located at shallow depths beneath the planned building area.

B. Subsurface

Most of the site is underlain by 3 to 6 feet of old fill over about 80 feet of soft, compressible alluvial and estuary deposits. We encountered a hard coral ledge at a depth of 45 feet in Boring 3, located at the east corner of the planned building. The coral ledge apparently extends beneath only a small portion of the planned building area. We encountered basalt rock beneath the soft soils and coral ledge at depths of 78 to 87 feet below the existing ground surface. The ground water level stabilized in our test borings at Elevation +3 feet (Mean Sea Level datum).

Detailed soil conditions are shown on the boring logs in Appendix A. Subsurface profiles indicating our interpretation of subsurface conditions at two locations beneath the planned building area are presented on Plates 2 and 3.

V DISCUSSION AND CONCLUSIONS

The soft soils underlying the site will compress under any new loads. Resulting differential settlements if the building is supported on shallow foundations would be significant since planned foundation and fill loads are not uniform. Our estimate of settlement under areal loads (uniform loads extending over large areas) are presented on Plate 4. As indicated on the chart, we expect about 8 inches of settlement if 6 feet of fill is placed to raise the grade beneath the auditorium portion of the building. Shallower fills in other areas of the building would settle less. We estimate that settlement of spread footings supporting column loads of 150 kips would be on the order of 1 and 2 inches. Settlement of spread footings supporting heavier loads would be substantially greater.

We discussed our estimated settlements with the structural engineer, Mr. Richard Sato, and mutually concluded that driven piles should be used to support the building frame. 16-1/2 inch octagonal, precast, prestressed concrete piles capable of supporting loads up to 125 tons were selected, mainly because of anticipated pile lengths. Settlement of pile foundations will be negligible.

Slab-on-grade floors which bottom at or below the existing grade will not impose significant new loads on the underlying soft soils. Settlement of these floors should be slight - say, less than one-quarter inch. Floors located above the existing grade will require special consideration. The following alternatives were analyzed:

1. Lowering planned building grades to eliminate fill beneath building floors. We understand that special design for utilities and sewers, including pumps, would be necessary for this alternative. DAGS has indicated that this alternative does not appear practical in view of future maintenance costs.
2. Supporting the floors on driven piles where floor subgrades will be above existing. Settlement of pile supported floors would be negligible. Fill would be placed beneath pile-supported floors to eliminate forming. Downdrag loads on the piles (negative skin friction caused by fill settlement) would have to be considered.
3. Supporting the stage floor on adjacent piles for the building frame and the auditorium floor on spread footings bottomed at shallow depths below the existing ground surface. All fill in the building area would be eliminated. Special subgrade preparation, including replacement and compaction of some of the existing fill or alluvium would be necessary below spread footings. A system of grade-beam type footings would probably be used. Estimated settlements for various grade-beam spacings and loads are presented on Plate 5.

We understand that Alternatives 2 and 3 are still under consideration. Either alternative would be acceptable from a soil engineering standpoint. The alternative used for construction will be selected based on the structural engineer's analysis of building performance and relative costs.

Fill may be placed to raise the grade around the perimeter of the building as well as beneath pile supported floors if Alternative 2 above is selected. The existing sewer line may be damaged by settlement caused by these new fills. This sewer line and other utility lines which could be damaged by settlement or foundation construction should be abandoned or relocated.

VI RECOMMENDATIONS

A. Site Preparation and Grading

Areas to be graded should be stripped to remove existing grass. The existing pavement can be left in place unless removal is required for grading. We anticipate that the depth of stripping will generally be about 2 inches. Any pockets of loose or soft soils encountered should be excavated. Where compacted fill or rock blankets for floor slabs will be placed, the stripped surface should be scarified to a depth of 6 inches, moisture conditioned to near optimum moisture content* and compacted to 90 percent relative compaction.**

Existing on-site soils which are free of grass and organic debris can be used as fill. Imported material, if used, should be free of organic debris and rocks greater than 4 inches in maximum dimension and should be tested for unacceptable expansion potential. Fill should be placed in lifts 8 inches or less in loose thickness, moisture conditioned to near optimum moisture content and compacted to 90 percent relative compaction.

B. Shallow Foundations

Shallow foundations for support of the auditorium floor, if used, should be underlain by a blanket of compacted fill which extends at least 30 inches below the bottom of the footings. This can be

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* Optimum moisture is that moisture content which corresponds to the maximum dry density as determined by the ASTM D1557-70(C) compaction test method.

** Relative compaction refers to the dry density of the compacted material expressed as a percentage of the maximum dry density of the same material as determined by the ASTM D1557-70(C) test procedure.

constructed by excavating to a depth of 24 inches below the footing bottoms, scarifying and compacting the exposed surface, and replacing the excavated soils with properly compacted fill. The compacted fill blanket should extend at least 18 inches beyond the sides of footings.

Spread footings should be designed using an allowable bearing pressure of 2000 pounds per square foot (psf) for dead plus long term live loads. This value can be increased by one-third when considering the total of all loads, including wind or seismic. Lateral loads will be resisted by friction along the bottom of the footings and by passive pressure on the face of below-grade structural elements. A friction factor of 0.3 and a uniform passive pressure of 500 psf can be used. The upper one foot of soils should be neglected when computing passive pressure unless the footing is confined by pavements or slabs. Footings should be at least 12 inches wide and bottomed at least 12 inches below the lowest adjacent finish surface. Footings should be provided with adequate reinforcement to span local areas of poor support.

C. <u>Driven Piles</u>

Piles should be driven to practical refusal in the underlying basalt rock or coral ledge. Practical refusal for 16-1/2 inch octagonal, precast, prestressed concrete piles should be 90 blows per foot (for the last foot of driving) for 125 ton capacity piles and 50 blows per foot for 80 ton capacity piles using a hammer which develops at least 40,000 foot-pounds of energy per blow. We can revise the refusal blow count criteria for different pile capacities or hammers. Hammers which develop less than 40,000 foot-pounds of energy per blow should not be used.

We recommend that at least 10 indicator piles be driven throughout the site at locations selected by us to aid in determining production pile lengths. Five of the indicator piles should be driven near test boring locations so that we can correlate soil conditions with driving behavior. We suggest an indicator pile length of 110 feet. We estimate that most production piles will meet refusal between 90 and 100 feet below existing grade. Piles driven in the vicinity of Boring 3 will probably meet refusal between 50 and 60 feet below the existing grade. We can estimate the location of piles which will meet refusal in the coral ledge after results of the indicator pile driving are known.

A pile load test is required by the Building Code of the City and County of Honolulu where pile capacities exceed 40 tons. We recommend that at least one pile be load tested by the contractor in accordance with the ASTM D1143-69 test procedure. We should select piles to be load tested after the indicator piles are driven.

Downdrag loads will be imposed on piles driven in areas where new fill will be placed. Recommended downdrag loads for piles in or within 25 feet of areas where new fill will be placed are presented in the following table.

Thickness of New Fill, Feet	Downdrag Load on Pile, Tons
0	0
2	33
4	46
6	52

Passive soil resistance to lateral loads will be developed by pile caps, grade beams and other structural members which extend below grade. This assumes that these structural elements are poured directly against the side of clean excavations or that backfill adjacent to these elements is compacted to at least 90 percent relative compaction. Design passive resistance can be calculated using a uniform pressure of 500 pounds per square foot. The upper one foot of soil should be neglected when computing passive resistance unless the soil is confined on all sides by slabs or pavements.

Guide specifications for installation of driven piles for this project are presented in Appendix B.

D. Slab-on-Grade Floors

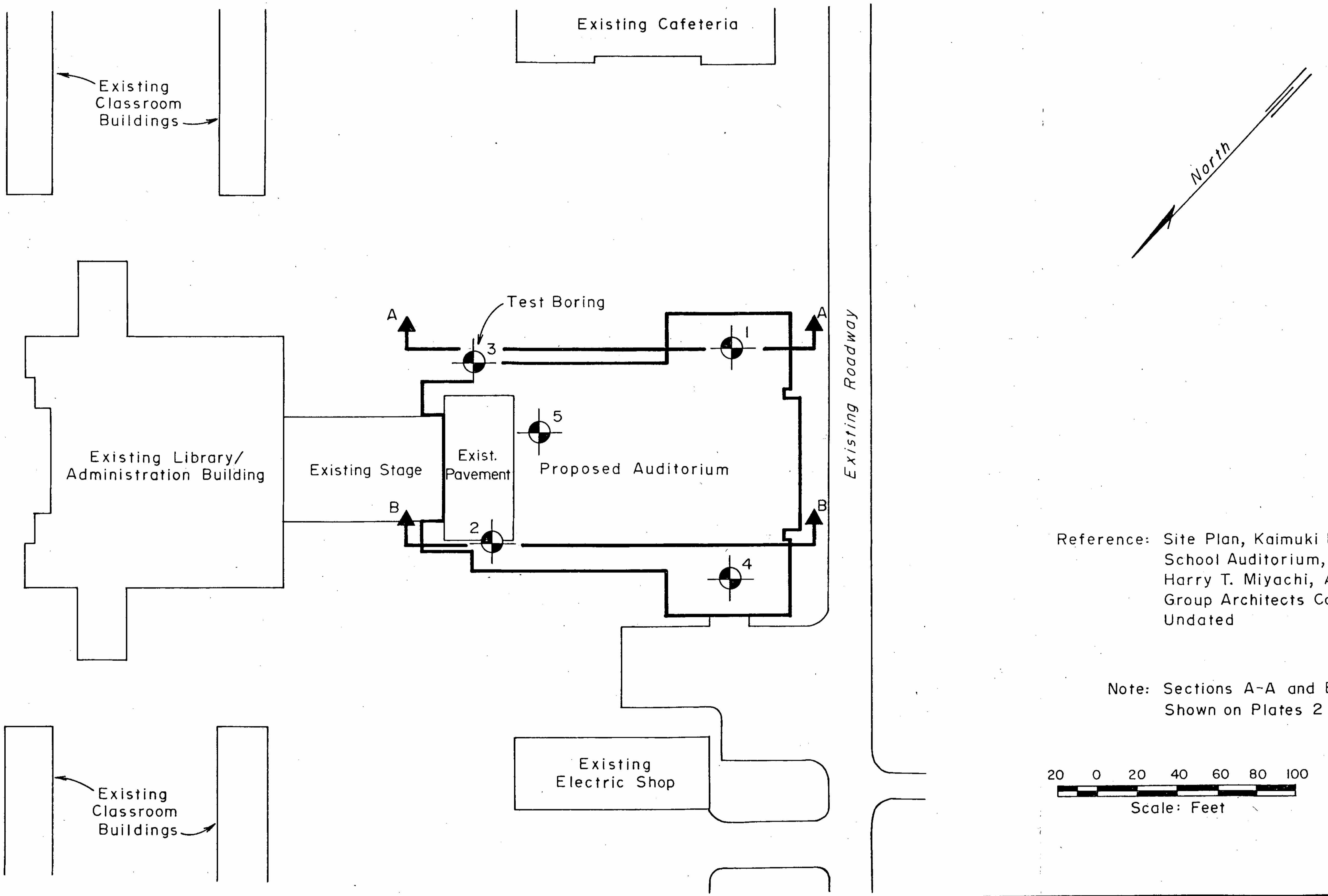
Soft soils may be encountered where slab-on-grade floors will be located below the existing grade, especially in areas such as the orchestra pit where excavations will extend several feet below the existing surface. Where encountered, the soft soils should be removed to a depth of at least 12 inches below the floor subgrade and replaced with open graded crushed rock. The rock will provide more uniform subgrade support as well as a working pad for men and light equipment. Commercially available material locally designated No. 3B-Fine would be suitable for the rock blanket.

Fill placed beneath slab-on-grade floors should be compacted to 90 percent relative compaction. The subgrade surface should be proof rolled with a smooth roller to provide a firm, nonyielding surface. Soft or yielding areas encountered during proof-rolling should be excavated and replaced with properly compacted fill or crushed rock.

Slab-on-grade floors should be underlain by at least 4 inches of clean, free draining crushed rock to provide uniform support for the slab and serve as a break to the rise of capillary moisture. No. 3B-Fine rock would be suitable. Where penetration of mosture vapor through the slab would be undesirable, a membrane should be placed between the slab and the rock blanket.

VII SERVICES DURING CONSTRUCTION

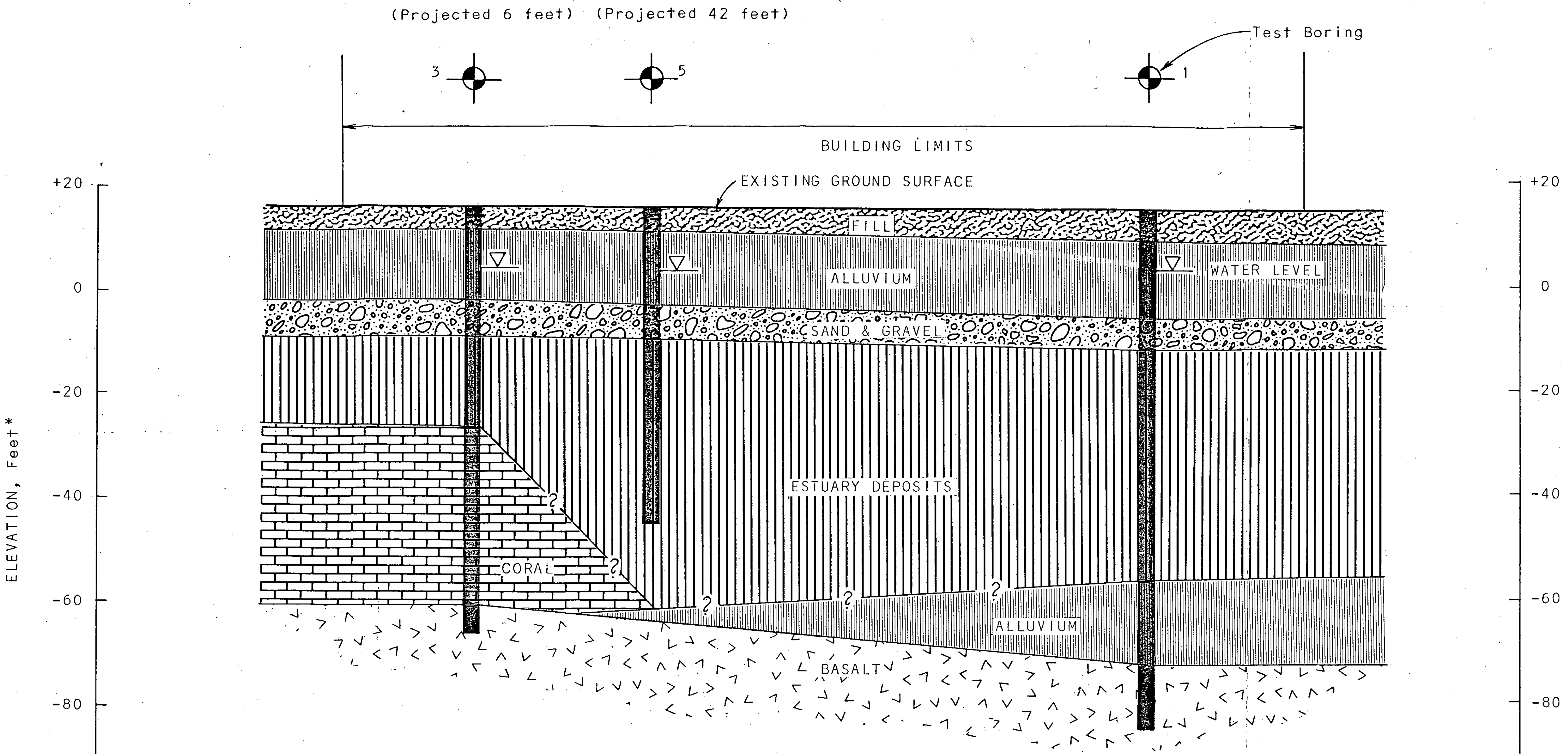
We should review project plans and specifications prior to construction to check for conformance with the intent of our recommendations. We should observe subgrade preparation beneath slab-on-grade floors and check excavations prior to placement of fill beneath shallow foundations. We should observe installation of indicator piles, review pile load tests and test data, and check installation of production piles. Details of our recommended soil engineering services during pile driving are presented in our proposal to DAGS dated February 3, 1976.



Reference: Site Plan, Kaimuki High School Auditorium, by Harry T. Miyachi, AIA, Group Architects Collaborative Undated

Note: Sections A-A and B-B Shown on Plates 2 and 3

HARDING - LAWSON ASSOCIATES *Consulting Engineers and Geologists*	SITE PLAN KAIMUKI HIGH SCHOOL AUDITORIUM Honolulu Hawaii	PLATE 1
Job No. 5666,001.06 Appr: Date 3/10/76		

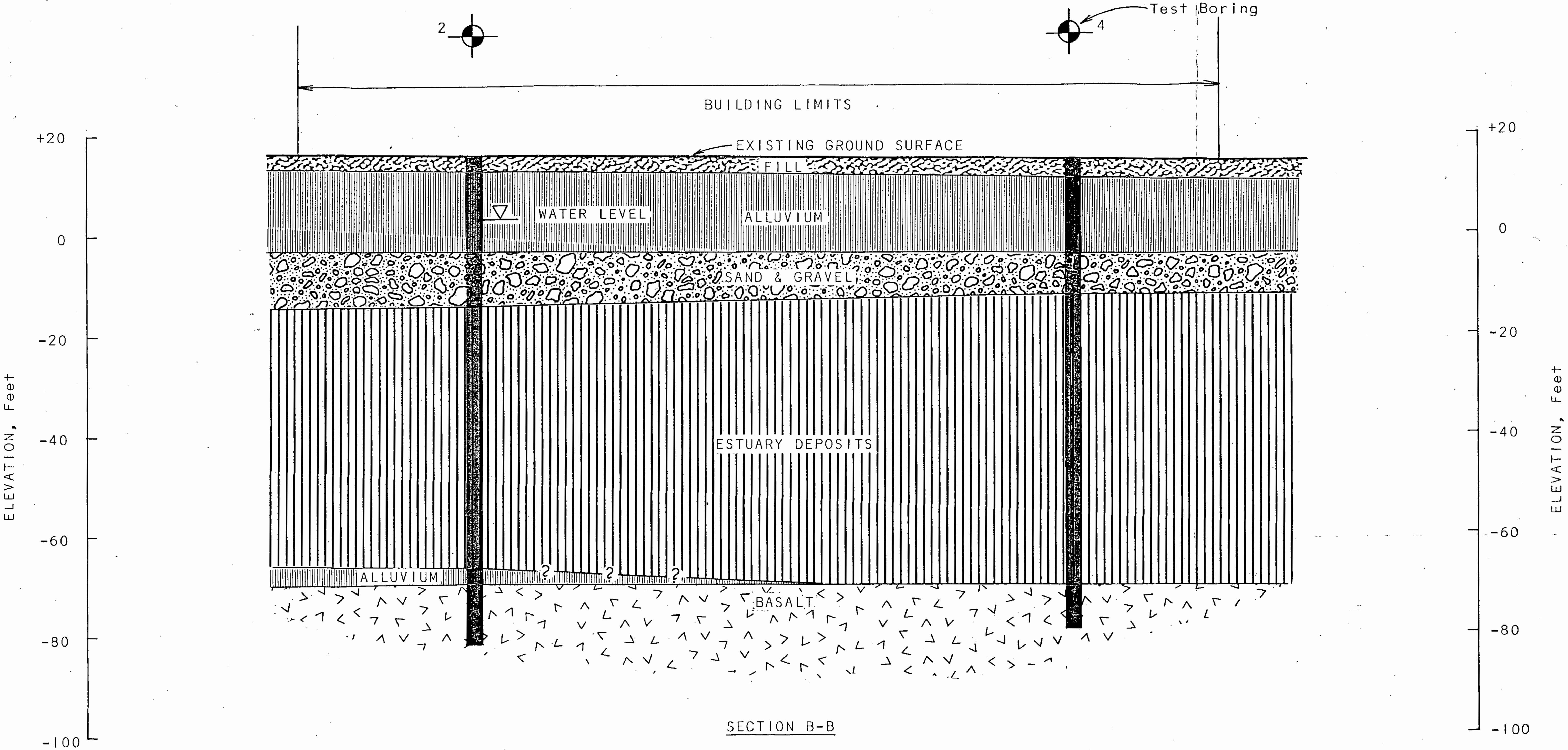


SECTION A-A

Scale: 1" = 20' Horiz. & Vert.

* Elevation Datum: Finish Floor, Existing Library/Administration Building = + 19.43 feet, from "Site Plan, Kaimuki High School Auditorium," by Harry T. Miyachi, AIA, Group Architects Collaborative, Undated

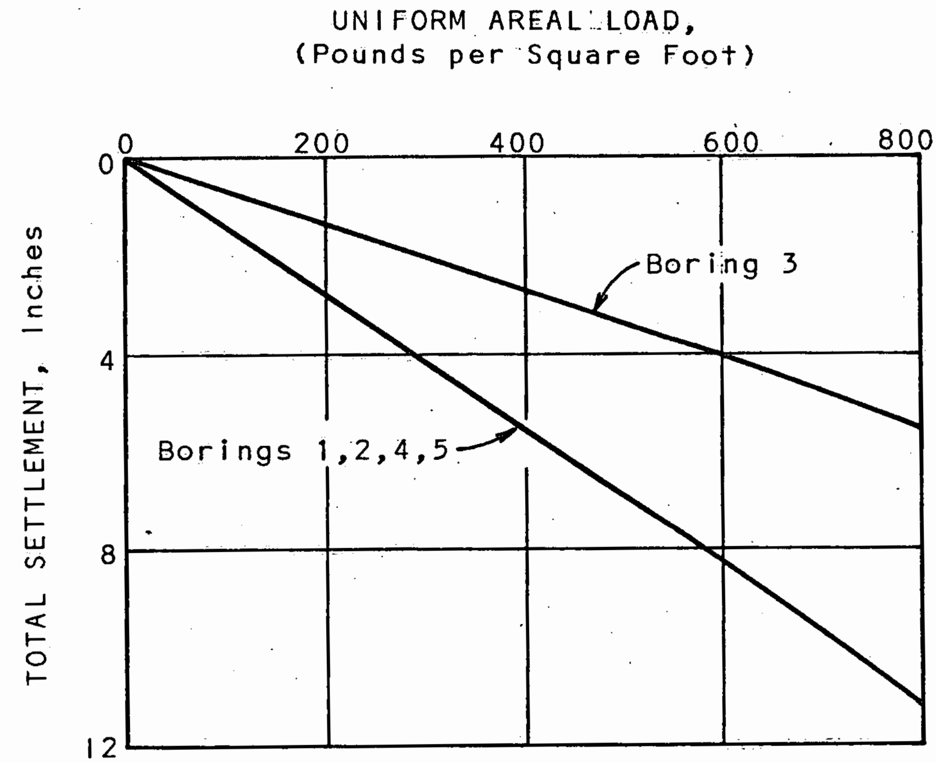
HARDING - LAWSON ASSOCIATES *Consulting Engineers and Geologists*	SUBSURFACE PROFILE SECTION A-A KAIMUKI HIGH SCHOOL AUDITORIUM	PLATE **2**
Job No. 5666,001.06 Appr. [illegible] Date 3/23/76	Honolulu Hawaii	



SECTION B-B

Scale: 1" = 20' Horiz. & Vert.

HARDING - LAWSON ASSOCIATES *Consulting Engineers and Geologists*	SUBSURFACE PROFILE SECTION B-B KAIMUKI HIGH SCHOOL AUDITORIUM	PLATE
Job No. 5666,001.06 Appr: LGcp Date 3/23/76	Honolulu Hawaii	3



NOTES:

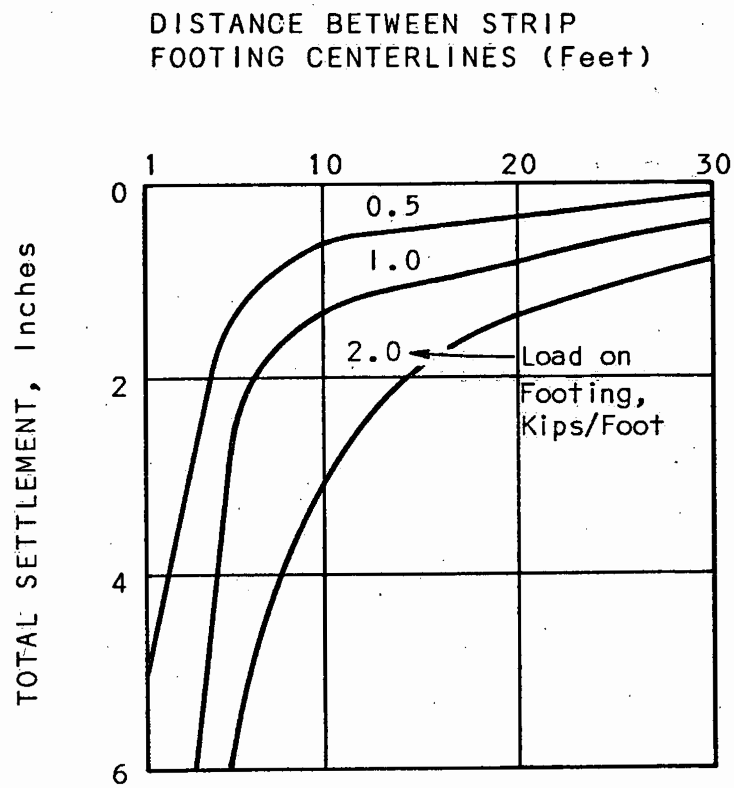
1) Loads beneath new fills and slabs should be computed using unit weights of 120 pounds per cubic foot for soil and 150 pounds per cubic foot for concrete.

2) Dead plus long-term live loads only should be included when computing settlement of slab-on-grade floors.

3) Approximately 45 percent of the total settlement indicated above will occur within 1 year; the remaining settlement will occur over a long period of time, 30 years or more.

4) Total settlements of spread footings imposing bearing pressures of 2,000 pounds per square foot will be less than 1 inch for column loads up to 100 kips. Most of this settlement will occur within 1 year.

HARDING-LAWSON ASSOCIATES *Consulting Engineers and Geologists*	SETTLEMENT CHART KAIMUKI HIGH SCHOOL AUDITORIUM	PLATE
Job No. 5666,001.06 Appr. [illegible] Date 3/25/76	Honolulu Hawaii	4



NOTES:

1) Calculations assume footings bottom in a blanket of compacted fill which extends at least 30 inches below the bottom of the footings.

2) Settlements are calculated for footings at least 12 inches wide and 12 inches deep, imposing a maximum allowable bearing pressure of 2000 pounds per square foot.

3) Approximately 45 percent of the total settlement will occur within 1 year. The remaining settlement will occur over a long period of time, on the order of 30 years.

HARDING - LAWSON ASSOCIATES *Consulting Engineers and Geologists*	STRIP FOOTING SETTLEMENT CHART KAIMUKI HIGH SCHOOL AUDITORIUM	PLATE 5
Job No. 5666,001.06 Appr: cp Date 3/25/76	Honolulu Hawaii	

APPENDIX A

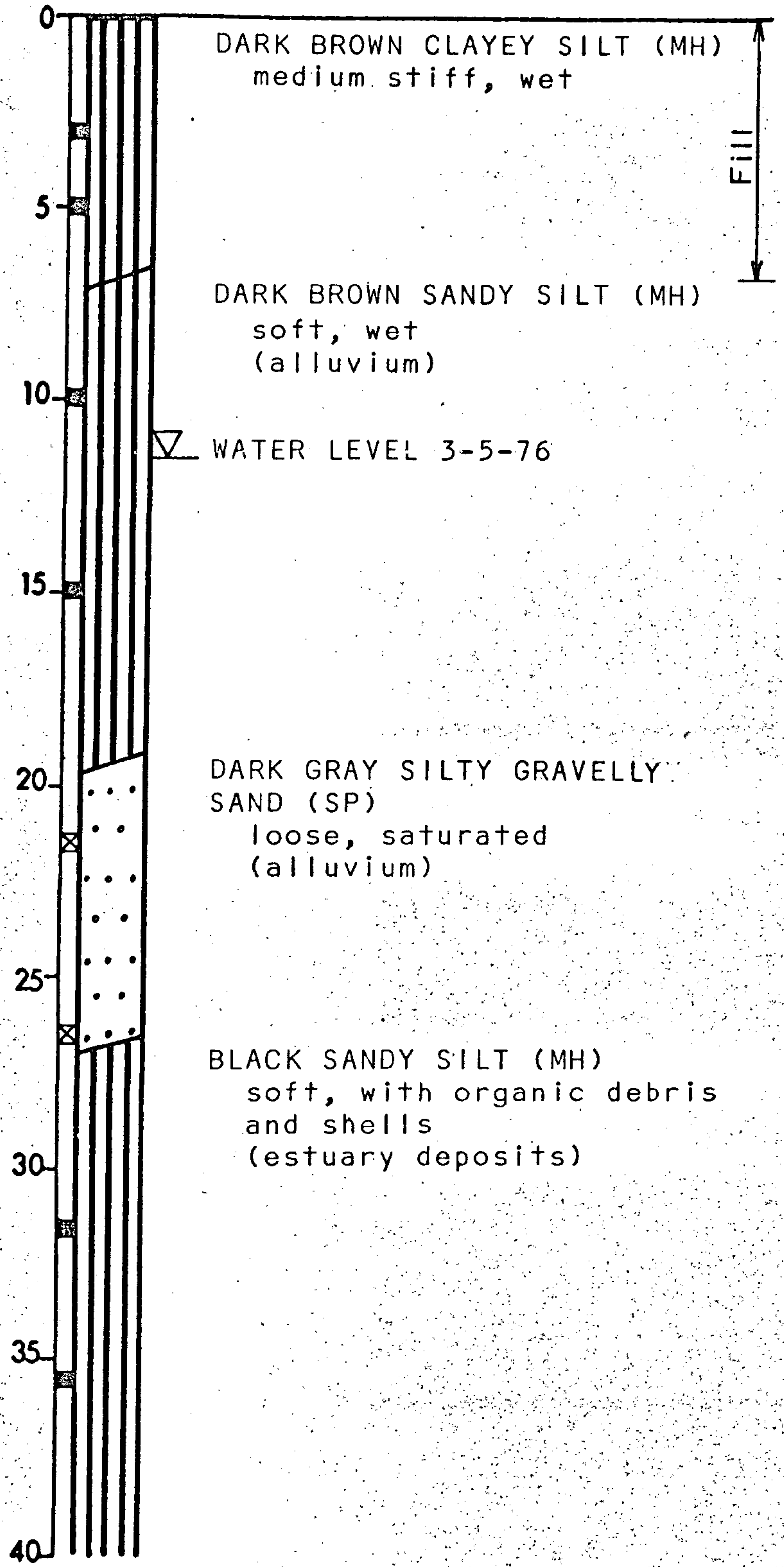
FIELD AND LABORATORY DATA

LOG OF BORING 1

Equipment: Rotary Wash

Elevation: 14.8* Date: 3/3/76

Laboratory Tests	Blows/foot	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	Cored Interval	Depth (ft)	Description
						0	DARK BROWN CLAYEY SILT (MH) medium stiff, wet (Fill, 0 to 7 ft)
	7						
	6					5	
							DARK BROWN SANDY SILT (MH) soft, wet (alluvium)
	2					10	
							▽ WATER LEVEL 3-5-76
Tx 319 (1300)	2	59.9	65			15	
						20	DARK GRAY SILTY GRAVELLY SAND (SP) loose, saturated (alluvium)
	8						
						25	
	4						BLACK SANDY SILT (MH) soft, with organic debris and shells (estuary deposits)
						30	
Tx 1008 (2000)	2	74.5	56				
	2					35	
						40	



Laboratory Tests	Blows/foot	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	Cored
	2				
	2				
	3				
	3				
	5				
Tx 590 (4000)	5	81.9	50		
	6				
	8				

(Continuation of Log)

Depth (ft)	Description
40–70	
70	DARK GRAY SILTY SAND (SM) loose (alluvium)
	LIGHT GRAY SILTY SANDY GRAVEL (GP) loose (coral gravel fragments) (alluvium)
80	DARK BROWN SANDY SILT (ML) soft (alluvium)

Laboratory Tests

Depth (ft)	Blows/foot **	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	Cored Interval
80	11	73.0	57		
85	10				
90–95				21%	90–95
95–100				40%	95–100

(Continuation of Log)

Depth (ft)	Description
80	LIGHT GRAY SANDY GRAVEL (GP) loose, (coral gravel fragments) (alluvium)
	DARK GRAY SANDY GRAVEL (GP) loose, (basalt gravel fragments) (alluvium)
85	LIGHT BROWN SANDY SILT (ML) soft (alluvium)
	DARK GRAY BASALT deeply weathered, intensely fractured, moderately hard, moderately strong
100–120	

** Field Blow Count Converted to Standard Penetration Blow Count.

* Datum: Finish Floor, Existing Library Administration Building = 19.43, from "Site Plan, Kaimuki High School Auditorium," by Henry T. Miyachi, AIA, Group Architects Collaborative, Undated.

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Job No. 5666,001.06 Appr [initials] Date 3/11/76

LOG OF BORING 1

KAIMUKI HIGH SCHOOL AUDITORIUM

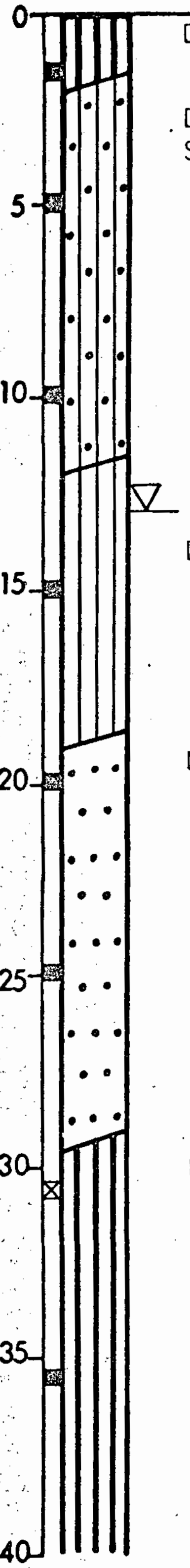
Honolulu Hawaii

PLATE 6

RF 19

LOG OF BORING 2

Equipment: Rotary Wash
Elevation: 16.1 Date: 3/4/76



Laboratory Tests	Blows/foot	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	Cored Interval	Depth (ft)	Description
						0	DARK BROWN CLAYEY SILT (MH) medium stiff, wet (Fill)
	15						DARK RED BROWN SILTY SAND (SM) loose, wet (alluvium)
Tx 1193 (860)	5	30.3	71			5	
	3	38,4	61			10	
							WATER LEVEL 3-5-76
							DARK BROWN SANDY SILT (ML) soft, saturated (alluvium)
	2					15	
							DARK GRAY GRAVELLY SAND (SP) loose (alluvium)
	10					20	
	2					25	
						30	BLACK SANDY SILT (MH) soft (estuary deposits)
	2						
	2					35	
						40	

Laboratory Tests	Blows/foot	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	Cored
	2				
Tx 203 (2500)	2	67.1	59		
	4				
	3	69.4	58		
	4				
	4				
	2				
	3				

Depth (ft)	Interval	Sample	(Continuation of Log)
40			
45			
50			
55			
60			
65			
70			
75			
80			

Laboratory Tests	Blows/foot	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	Cored Interval	Depth (ft)	Sample	(Continuation of Log)
	6					80		LIGHT GRAY SILTY GRAVEL (GM) medium dense (alluvium)
	17					85		DARK GRAY SILTY GRAVEL (GM) medium dense (rounded basalt gravel fragments) (alluvium)
				13%		90		DARK GRAY BASALT deeply weathered, intensely fractured, hard, moderately strong, with numerous clay seams
				40%		95		
						100		
						105		
						110		
						115		
						120		

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Job No. 5666,001.06 Appr. cp Date 3/23/76

LOG OF BORING 2

KAIMUKI HIGH SCHOOL AUDITORIUM

Honolulu Hawaii

PLATE 7

LOG OF BORING 3

Equipment: Rotary Wash

Elevation: 15.8 Date: 3/5/76

Depth (ft)	Laboratory Tests	Blows/foot	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	Description
0						DARK BROWN CLAYEY SILT (MH) medium stiff, wet (Fill)
	LL=59 PL=31 PI=28	12				
5		4				DARK BROWN CLAYEY SILT (MH) soft, wet (alluvium)
10	Tx 1000 (1000)	2	52.2	56		
						WATER LEVEL 3-6-76
15		2				
20		5				DARK GRAY GRAVELLY SILTY SAND (SM) loose, saturated (alluvium)
25		1				DARK GRAY SANDY SILT (ML) soft (estuary deposits)
30		2				
35		3				DARK GRAY SILTY SAND (SP) loose (estuary deposits)
40						

(Continuation of Log)

Depth (ft)	Laboratory Tests	Blows/foot	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	Description
40		2				DARK GRAY SANDY SILT (MH) soft (estuary deposits)
45		26				LIGHT GRAY GRAVELLY SAND (SP) medium dense (coral gravel fragments) partially cemented at 47'
50		33				WHITE CORALLINE LIMESTONE deeply weathered, crushed, hard, moderately strong
55		38/9"				
60					10 %	
65						
		12				LIGHT GRAY GRAVELLY SAND (SP) medium dense (uncemented coral)
70		8				
	Tx 6635 (4320)	12	15.6	96		WHITE SANDY GRAVEL (GP) dense (uncemented coral)
75		49				DARK GRAY BASALT deeply weathered, intensely fractured, hard, moderately strong
80		59			50%	

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LOG OF BORING 3
KAIMUKI HIGH SCHOOL AUDITORIUM
Honolulu Hawaii

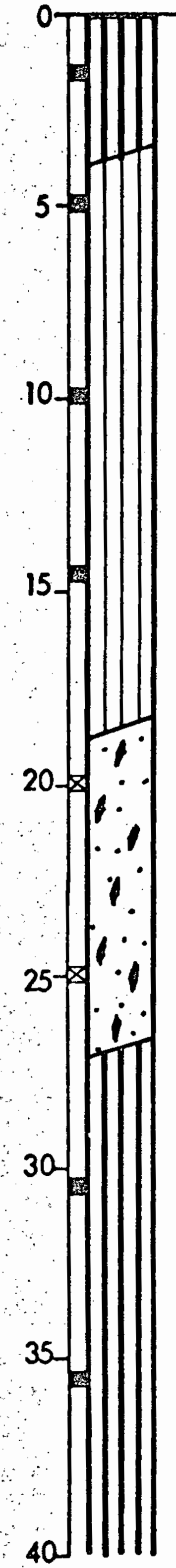
PLATE 8

RF 19

LOG OF BORING 4

Equipment: Rotary Wash
Elevation: 15.6 Date: 3/6/76

Laboratory Tests	Blows/foot	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	Cored Interval
Tx 2613 (860)	16	29.3	82		
	7				
	2	53.5	66		
	2				
	8				
	1				
Tx 398 (2000)	2	61.8	56		
	1				



DARK BROWN CLAYEY SILT (MH)
medium stiff, wet
Fill

RED-BROWN SANDY SILT (ML)
medium stiff, moist
(alluvium)

soft @ 10'

DARK GRAY SANDY GRAVEL (GP)
loose, saturated
(alluvium)

DARK GRAY SANDY SILT (MH)
soft
(estuary deposits)

Laboratory Tests	Blows/foot	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	Cored
	2	73.5	56		
	2				
	6				
	2				

Interval	Depth (ft)	Sample	(Continuation of Log)
	40		
	45		
	50		
	55		
	60		
	65		
	70		
	75		
	80		

Laboratory Tests	Blows/foot	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	Cored Interval	Depth (ft)	Sample	(Continuation of Log)
						80		
	16	34.0	91			85		DARK GRAY BASALT deeply weathered, crushed, moderately hard, moderately strong, with numerous clay seams
	45/11"					90		hard, strong @ 91'
								drilling refusal @ 93.5'
						95		
						100		
						105		
						110		
						115		
						120		

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LOG OF BORING 4
KAIMUKI HIGH SCHOOL AUDITORIUM
Honolulu Hawaii

PLATE 9

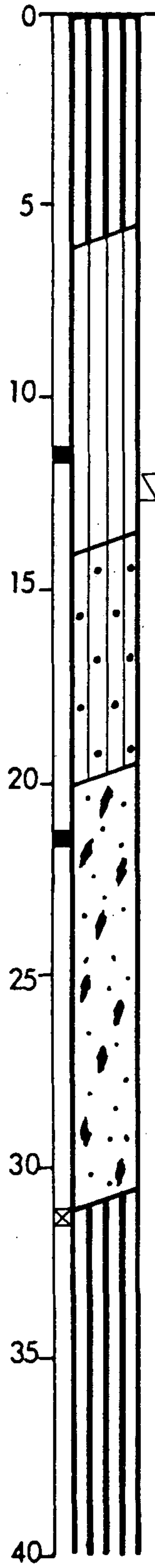
RF 19

LOG OF BORING 5

Equipment: Rotary Wash

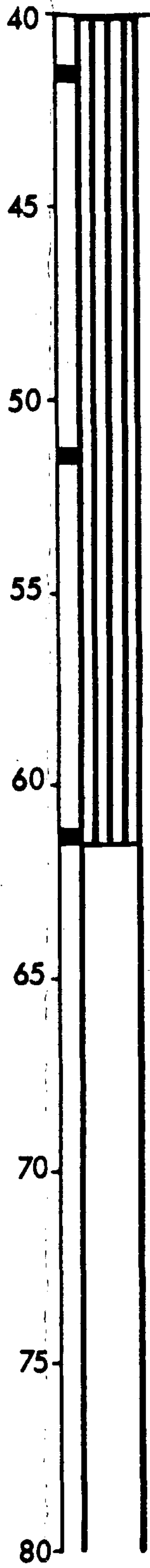
Elevation: 16.0 Date: 3/8/76

Laboratory Tests	Blows/foot	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	Cored Interval	Depth (ft)	Description
						0	DARK BROWN CLAYEY SILT (MH) medium stiff, wet (Fill, 0–6 ft)
						6	LIGHT BROWN SANDY SILT (ML) soft, wet (alluvium)
	2	51.3	68			11.5	
						12	WATER LEVEL 3-8-76
						14	DARK GRAY SILTY SAND (SM) loose, saturated (alluvium)
						20	DARK GRAY SANDY GRAVEL (GP) loose (alluvium)
	11	39.0	84			21.5	
						31	DARK GRAY SANDY SILT (MH) soft (estuary deposits)
	2					31.5	



(Continuation of Log)

Laboratory Tests	Blows/foot	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	Cored Interval	Depth (ft)
	2	61.5	64			41.5
	2					51.5
	2					61.5



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LOG OF BORING 5
KAIMUKI HIGH SCHOOL AUDITORIUM
Honolulu Hawaii

PLATE 10

MAJOR DIVISIONS				TYPICAL NAMES
COARSE GRAINED SOILS (MORE THAN HALF IS LARGER THAN #200 SIEVE)	GRAVELS (MORE THAN HALF COARSE FRACTION IS LARGER THAN NO. 4 SIEVE SIZE)	CLEAN GRAVELS WITH LITTLE OR NO FINES	GW	WELL GRADED GRAVELS, GRAVEL - SAND MIXTURES
			GP	POORLY GRADED GRAVELS, GRAVEL - SAND MIXTURES
		GRAVELS WITH OVER 12% FINES	GM	SILTY GRAVELS, POORLY GRADED GRAVEL - SAND - SILT MIXTURES
			GC	CLAYEY GRAVELS, POORLY GRADED GRAVEL - SAND - CLAY MIXTURES
	SANDS (MORE THAN HALF COARSE FRACTION IS SMALLER THAN NO. 4 SIEVE SIZE)	CLEAN SANDS WITH LITTLE OR NO FINES	SW	WELL GRADED SANDS, GRAVELLY SANDS
			SP	POORLY GRADED SANDS, GRAVELLY SANDS
		SANDS WITH OVER 12% FINES	SM	SILTY SANDS, POORLY GRADED SAND - SILT MIXTURES
			SC	CLAYEY SANDS, POORLY GRADED SAND - CLAY MIXTURES
FINE GRAINED SOILS (MORE THAN HALF IS SMALLER THAN #200 SIEVE)	SILTS AND CLAYS (LIQUID LIMIT LESS THAN 50)		ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS, OR CLAYEY SILTS WITH SLIGHT PLASTICITY
			CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
			OL	ORGANIC CLAYS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS (LIQUID LIMIT GREATER THAN 50)		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACIOUS FINE SANDY OR SILTY SOILS, ELASTIC SILTS
			CH	INORGANIC CLAYS 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

UNIFIED SOIL CLASSIFICATION SYSTEM

Consol	—	Consolidation
LL	—	Liquid Limit (in %)
PL	—	Plastic Limit (in %)
G_s	—	Specific Gravity
SA	—	Sieve Analysis
■		"Undisturbed" Sample
⊠		Bulk Sample

	Shear Strength, psf	Confining Pressure, psf	
*Tx	320	(2600)	Unconsolidated Undrained Triaxial
TxCU	320	(2600)	Consolidated Undrained Triaxial
DS	2750	(2000)	Consolidated Drained Direct Shear
FVS	470		Field Vane Shear
*UC	2000		Unconfined Compression
LVS	700		Laboratory Vane Shear

Notes: (1) All strength tests on 2.8" or 2.4" diameter samples unless otherwise indicated.

(2) * Indicates 1.4" diameter sample.

KEY TO TEST DATA

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SOIL CLASSIFICATION CHART AND KEY TO TEST DATA
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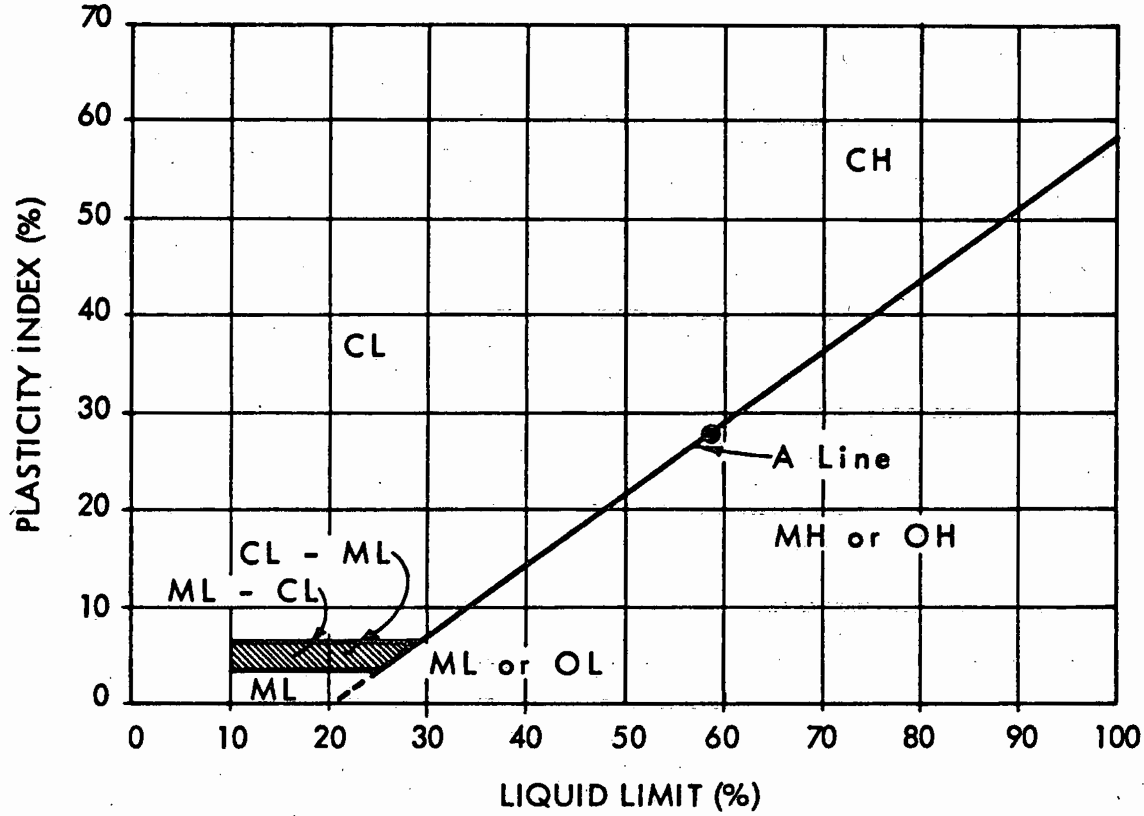
PLATE 11



Symbol	Classification and Source	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	% Passing #200 Sieve
●	DARK BROWN CLAYEY SILT (MH) Boring 3 @ 3.0	59	31	28	

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PLASTICITY CHART

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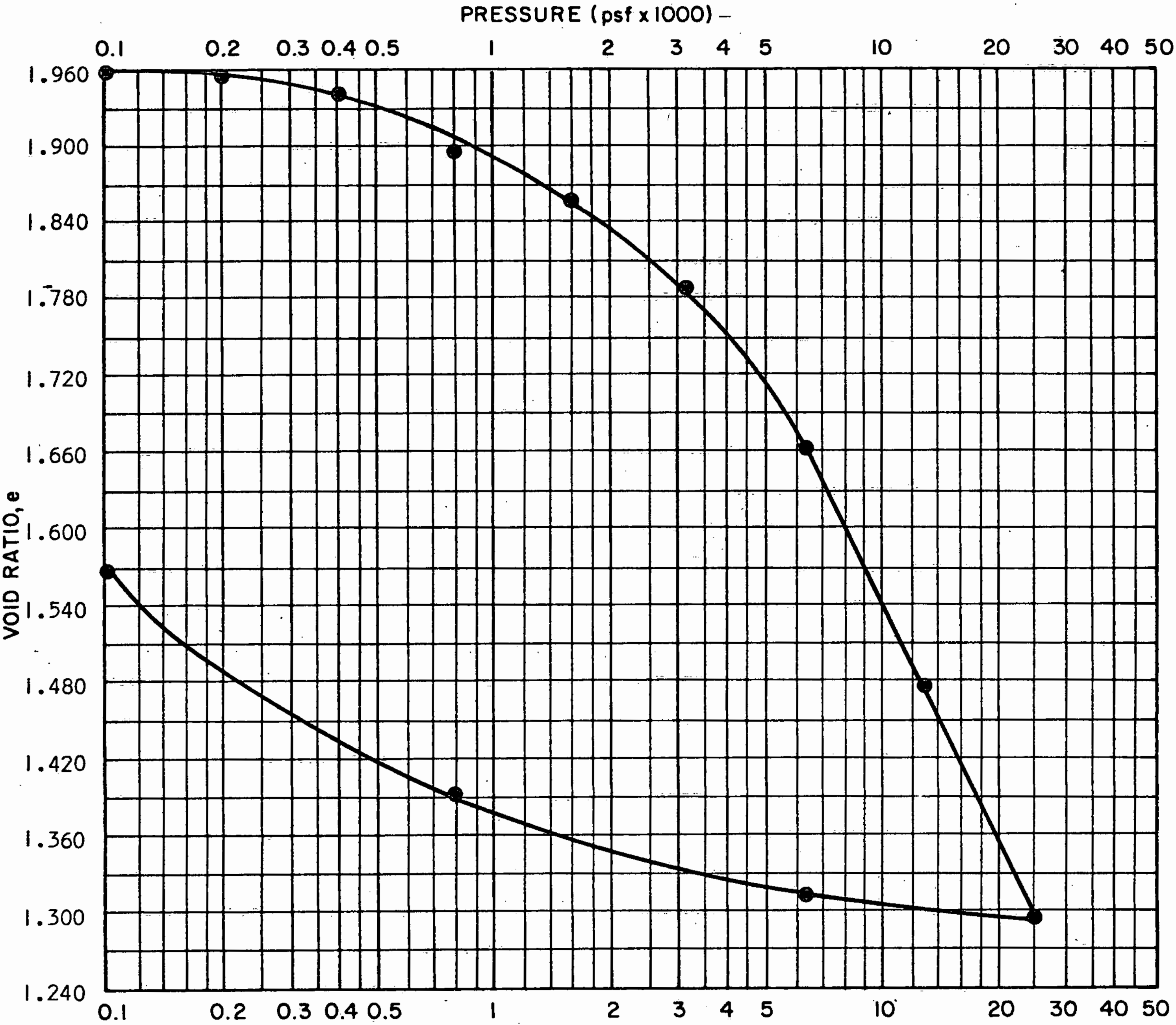
PLATE 12

N02470



TYPE OF SPECIMEN	Undisturbed		BEFORE TEST			AFTER TEST	
DIAMETER (in.) 2.43	HEIGHT (in.) 0.80		MOISTURE CONTENT	w_o	73.0 %	w_f	58.2 %
OVERBURDEN PRESS., P_o	2050	psf	VOID RATIO	e_o	1.974	e_f	1.566
PRECONSOL. PRESS., P_c	2500	psf	SATURATION	S_o	100 %	S_f	100 %
COMPRESSION INDEX, C_c	0.634		DRY DENSITY	γ_d	57 pcf	γ_d	66 pcf
LL	PL		PI			G_s	Assumed 2.70
CLASSIFICATION	BLACK VERY SANDY SILT (MH)		SOURCE		Boring 1 @ 40.3'		

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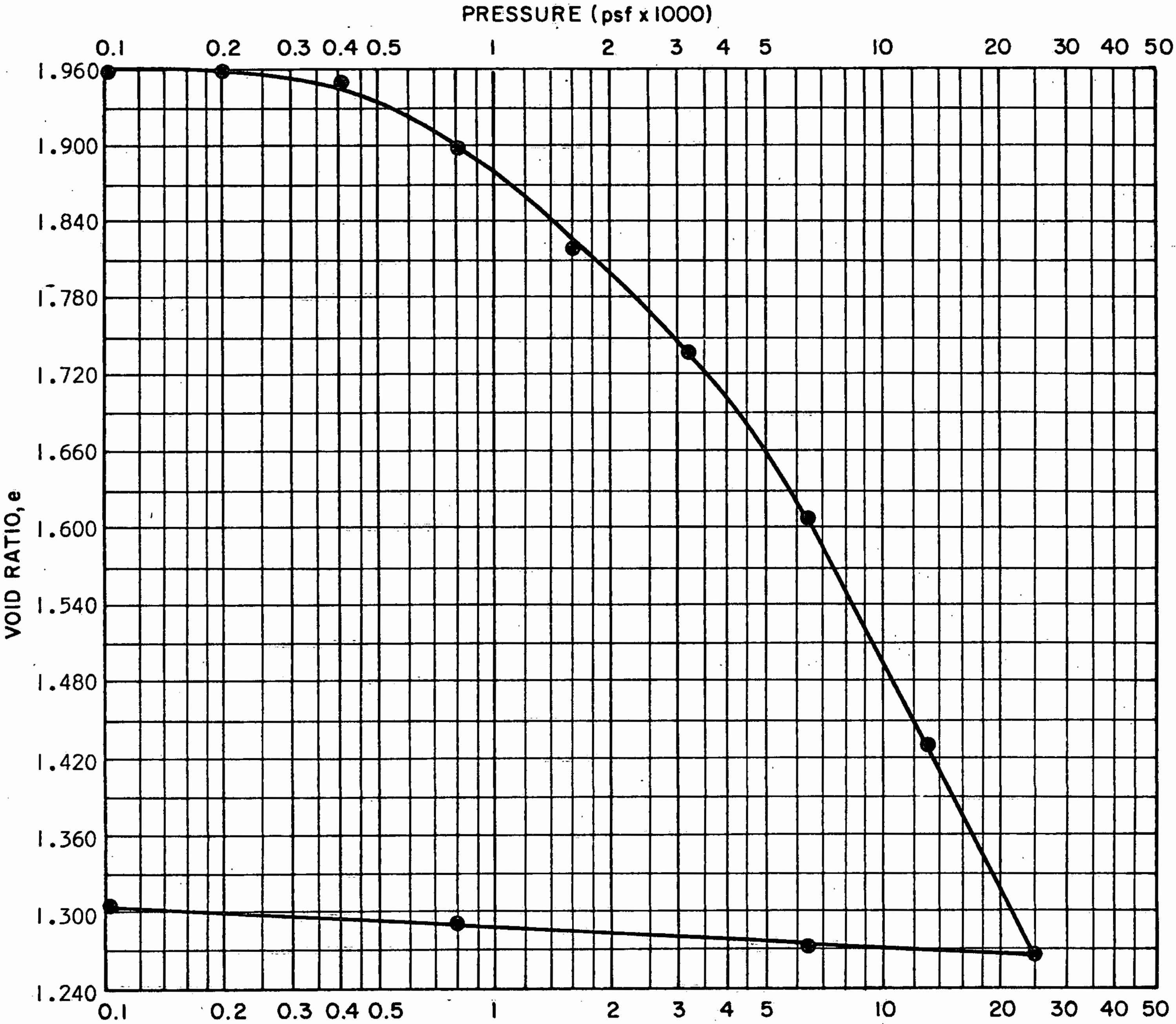
CONSOLIDATION TEST REPORT

KAIMUKI HIGH SCHOOL
AUDITORIUM

Honolulu Hawaii

PLATE 13

N02470



TYPE OF SPECIMEN Undisturbed			BEFORE TEST			AFTER TEST	
DIAMETER (in.) 2.43	HEIGHT (in.) 0.80		MOISTURE CONTENT	w_o	38.4 %	w_f	45.3 %
OVERBURDEN PRESS., P_o	880	psf	VOID RATIO	e_o	1.963	e_f	1.306
PRECONSOL. PRESS., P_c	2200	psf	SATURATION	S_o	56 %	S_f	100 %
COMPRESSION INDEX, C_c	0.590		DRY DENSITY	γ_d	61 pcf	γ_d	78 pcf
LL	PL		PI			G_s	Assumed 2.89
CLASSIFICATION DARK RED-BOWN SILTY SAND (SM)			SOURCE Boring 2 @ 9.8'				

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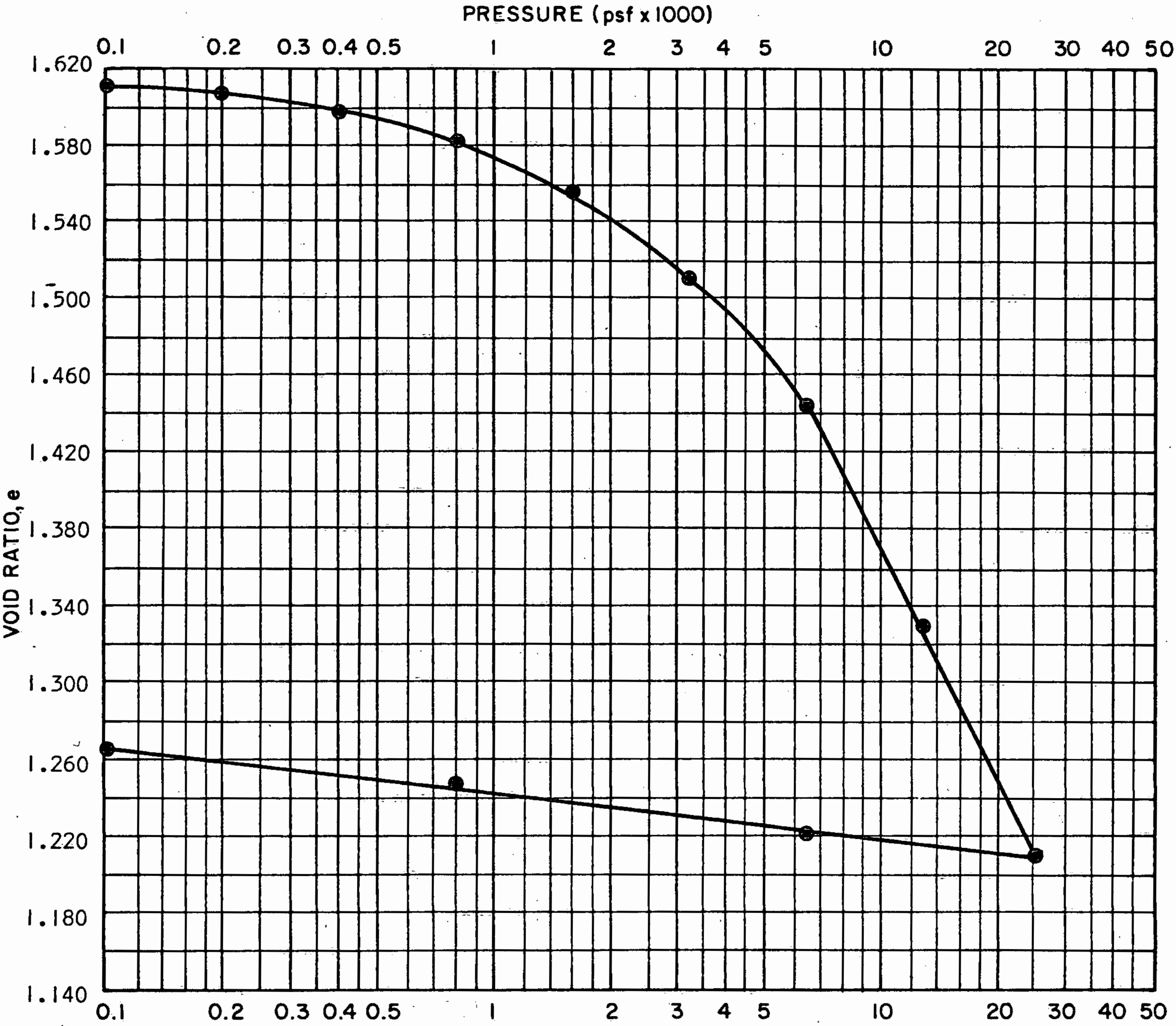
PLATE 14

N02470



TYPE OF SPECIMEN	Undisturbed			BEFORE TEST			AFTER TEST	
DIAMETER (in.)	2.43	HEIGHT (in.)	0.80	MOISTURE CONTENT	w_o	53.5 %	w_f	45.6 %
OVERBURDEN PRESS., P_o	880 psf			VOID RATIO	e_o	1.623	e_f	1.265
PRECONSOL. PRESS., P_c	3500 psf			SATURATION	S_o	92 %	S_f	100 %
COMPRESSION INDEX, C_c	0.404			DRY DENSITY	γ_d	66 pcf	γ_d	77 pcf
LL		PL		PI		G_s	Assumed 2.80	
CLASSIFICATION	RED-BROWN SANDY SILT (ML)			SOURCE	Boring 4 @ 9.8'			

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CONSOLIDATION TEST REPORT

KAIMUKI HIGH SCHOOL
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PLATE 15

N02470

APPENDIX B

SPECIFICATIONS FOR INSTALLATION OF DRIVEN PILES

1.0 GENERAL

A. This section includes furnishing and installing a driven pile foundation as indicated on the drawings and as specified herein. Subsurface conditions encountered at test borings drilled in the building area are described in the Boring Logs included on the drawings. Additional information is included in the report "Foundation Investigation, Kaimuki High School Auditorium, Honolulu, Hawaii" by Harding-Lawson Associates, dated April 2, 1976.

B. Datum shall be Mean Sea Level (MSL).

2.0 SCOPE

A. The contractor shall furnish all labor, supervision, materials, tools and equipment to install and cut off piles for the foundation as shown on the drawings and as specified herein.

B. Piles shall be 16-1/2 inch octagonal, precast, prestressed concrete as shown on the drawings.

C. All piles shall be furnshed and installed by an experienced pile contractor in accordance with the plans and these specifications and as the subsurface conditions exist at the site.

D. Measurement and Payment

1. The contractor shall submit a base bid which will include the following:

a. Furnishing all piling and splice cans based on a pile casting length of 50 feet and the requirement of two pile lengths plus one splice can for each pile location shown on the plans. The actual casting length for each pile and the number of splice cans required shall be determined by the Engineer after the installation of initial probe test piles.

b. Driving all piles based on the cutoff elevations shown on the plans and a tip elevation of -85 feet.

c. Cutting off all piles at the elevations shown on the drawings.

d. Conducting one static pile load test on a pile selected by the Engineer.

2. The base bid shall be included in the total contract bid as a basis for determining the subcontractor's award. Actual payment will be based on the unit prices used in the base bid. The contractor shall provide unit prices in the base bid for the following items:

a. Payment for furnishing piles - Unit cost per foot for piles delivered to the site.

b. Payment for driving piles - Unit cost per foot for installing piles. This price shall include all labor and equipment for driving the piles, the cost of handling them and all other work connected with the installation operation. This price shall include all predrilling or other work necessary to obtain the penetration requried by these specifications. Payment shall be made only for the length of pile remaining in place from the tip to the cutoff elevation.

c. Payment for cutting off piles - Unit cost per pile for cutting off piles and removing the cutoff section from the site.

d. Payment for splices - Unit cost per splice, including all labor, equipment and materials to install the splice.

e. Payment for static load test - Unit cost for one static load test performed in accordance with the ASTM standard method of test D1143-69.

3.0 MATERIALS - (Structural Engineer to add)

4.0 INSTALLATION

A. Location - The contractor shall set and maintain a location stake for each pile and adequate cutoff elevation stakes. Sufficient reference stakes shall be set and maintained to permit checking by the Engineer. The centers of the tops of the piles shall not deviate from the locations shown on the plans by more than three inches in any direction. Piles shall not be pulled into place after driving.

B. Alignment - The piles shall not deviate from the vertical more than 1/4 inch per foot of length.

5.0 PILE DRIVING

A. Driving Equipment - The pile and hammer shall be held firmly in proper alignment during driving operations by fixed driving leads. All piles shall be driven with a hammer maintained in good operating condition and operated according to the manufacturer's recommendations. The hammer shall deliver no less than

40,000 foot-pounds of energy per blow. The hammer, cushion, cap blocks and all driving equipment shall be inspected and approved by the Engineer prior to use.

B. Driving - Piles shall be driven continuously without interruption except for the addition of splices. Followers will be permitted only where approved by the Engineer prior to use.

G. Inspection - The contractor shall prepare a complete record of the installation of each pile using a pile record form approved by the Engineer. The contractor shall submit to the Engineer daily one copy of the record form for each pile installed that day. The Engineer will make periodic checks of the contractor's recording procedures and personnel. After being driven, piles shall be examined by the Engineer for alignment, location, damage and other irregularities. All piles which fail to meet these specifications will be rejected.

6.0 CORRECTION OF DEFECTIVE WORK

A. Cost - The correction of damaged or rejected piles shall be at the contractor's expense.

B. Approval - The contractor shall submit his plans for correcting any defective work to the Engineer for approval prior to correcting the work.

C. Additional Piles - If piles are damaged, mislocated or are otherwise unacceptable to the Engineer, additional pile(s) shall be driven. All redesign of foundation elements and additional foundation costs required by reason of improper pile installation shall be at the contractor's expense.

D. Rejected Piles - Rejected piles shall be cutoff at least one foot below the bottom of the pile cap or left in place in the foundation, as directed by the Engineer.

E. Distorted Piles - All piles distorted or heaved more than 1/4 inch by subsequent driving of adjacent piles shall be re-driven to the specified refusal blow count.

C. Driving Criteria - Piles shall be driven to refusal in the basalt encountered in the test borings at Elevation -61 feet to Elevation -72 feet or in the coral ledge encountered in Boring 3 at Elevation -26 feet. (Refusal criteria to be added when pile capacities are known.)

D. Probe Test Piles - Prior to manufacturing production piles, at least 10 probe test piles shall be driven at the locations designated by the Engineer. The probe test piles shall be cast in two increments for a combined total of 110 feet. The increment lengths shall be approved by the Engineer. The locations will be selected by the Engineer so that the probe test piles can be used as foundation piles, insofar as possible. The Engineer shall determine casting lengths for production piles based on probe test pile driving results.

E. Load Test - A static load test shall be performed on a test pile selected by the Engineer. The load test shall be performed in accordance with the ASTM standard method of test D 1143-69. The contractor shall notify the Engineer prior to performing the load test and submit the load test results to the Engineer for approval prior to start of production driving.

F. Predrilling - Predrilling may be employed at the contractor's option and expense. Holes shall extend no deeper than Elevation -20 feet and shall not have a diameter greater than 90 percent of the least cross section dimension of the pile, unless otherwise approved by the Engineer.

DISTRIBUTION

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