HARDING, MILLER, LAWSON & ASSOCIATES

FOUNDATION INVESTIGATION
MAKANI KAI MARINA
KANEOHE, OAHU, HAWAII

HML&A Job No. 3921,001.06

Prepared for

Makani Kai Development Company
Suite 702, 1136 Union Mall
Honolulu, Hawaii 96813

by

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Donald L. Schreuder
Civil Engineer - 2531

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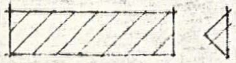
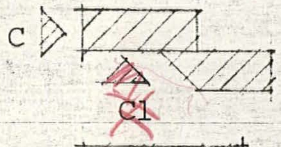
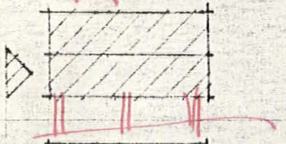
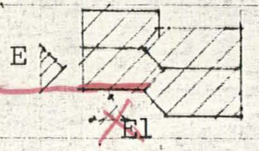
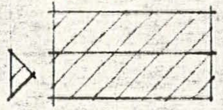
November 2, 1972

Makani Kai Preliminary Unit Design
(Floor Area Calculations)

Unit Types				No. of Units	Minimum Sq. Ft.	No. of B.R.'s	Total Sq. Ft.
Point Units	A 3		Entry Front 30'	7	1,086 (ave)	2	7,605
Point Units	B		Ent y Front 24'x50'	10	1,033	2	10,330
Full Down	C ~~C1~~		Entry Back 24x49± ~~Entry Side~~	8	1,210	3	9,680
Flat - 2 Sto y	C2		Ent y Back 24x43± PARKING UNDER	13	1,210	3	15,730
Flat - 2 Sto y	D DECK UNIT		Entry F ont 22x39½ ON PARKING DECK	14	1,272	3	17,808
Half Down	E E1		Entry Back 24x40½ ~~Entry Side~~	25	1,284	3	32,100
Flat - 2 Sto y @ St eam	F		Entry @ Back 22x41	3	1,030 + 191 (Stor)	2	3,090
Mgr. Unit				1	600	1	600
Rec. Center & Store					2,000 {1,350 650		2,000
			TOTAL	81	* Allowable		98,943 99,200

+257

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

I INTRODUCTION

This report presents the results of our foundation investigation for the Planned Makani Kai Development in Kaneohe. The property fronts on Kaneohe Bay and is bounded on the south by Keahala Stream and on the west by Wailele Road.

The configuration of the development and approximate topography of the site are shown on the Site Plan, Plate 1. The building locations and configurations on the Site Plan are taken from drawings prepared by the architect during the early design stages; we understand it is likely that they will be modified before the design is finalized.

The development will consist of about 111 two-story condominium units, built in clusters throughout the site. The living units will be of wood-frame construction and will have both structurally supported and slab-on-grade floors.

Current plans call for providing two-level, concrete parking structures at three locations; two will be located on the sloping ground in the north portion of the site and the third will be located on the flat ground just northeast of the existing marina. Each of the concrete parking structures will support clusters of living units; the wood-frame buildings will be built directly on the top deck of the parking structure. Column loads for the parking structures will range up to about 100 kips.

The scope of our work was to analyze subsurface conditions at the site in order to

1. Develop conclusions regarding the stability of the

natural slopes, as well as cut and fill slopes after the area is graded

2. Recommend suitable foundation types for the planned buildings, including soil criteria necessary for their design
3. Estimate settlement behavior of fills and foundations
4. Develop recommendations for site preparation and grading and determine the suitability of material stock-piled on the site for reuse as fill
5. Design pavement sections for parking areas and access roads

Our work on the project was authorized by your letter dated July 17, 1972. Our field work was performed during the period from July 14, 1972 to July 24, 1972. We discussed our conclusions and recommendations with you and your architect as they were developed. A progress report presenting preliminary conclusions and recommendations was submitted on August 17, 1972.

II SUMMARY

1. The northwest portion of the property is hillside terrain underlain by residual soil over basalt bedrock.

   The relatively level, southeast portion of the site is underlain by soft, alluvial and bay deposits which extend to more than 50 feet below the existing surface. The soft soils have been blanketed with about four feet of dredged fill. Piles of loose fill containing large boulders, debris and organic matter have been dumped or spread at random on the lower slopes and on the flat portion of the site.

2. The sloping portion of the property presents no unusual problems. No evidence of instability was encountered. In general, buildings can be supported on spread foundations; however, in steeper areas deep footings may be required and drilled piers may be more practical.

3. The level portion of the site will settle as the soft soils consolidate under the weight of fills and structures. The settlement behavior must be anticipated and provided for when designing foundations, utilities and drainage systems. It is likely that the lighter, wood-frame buildings can be supported on grade beam or mat type foundations, designed to tolerate the expected settlements. Piles are an obvious foundation choice for the heavier parking structure planned just north of the existing marina; however, a mat solution may be worked out depending on detailed settlement studies of the actual building configuration.

4. Existing fill (excluding the dredged fill) and the stock-piled material should be recompacted. It is likely most of this material can be reused as compacted fill when organic matter and debris have been removed. The large boulders can be used in the lower lifts of the fill if they are properly placed; however, it may be more practical to remove them.

III FIELD EXPLORATION AND LABORATORY TESTS

We explored subsurface conditions at the site with six test borings, ranging in depth from 20 to 57 feet. The borings were drilled with truck-mounted, flight auger drilling equipment. They were logged by our engineer, who obtained core samples from them for laboratory tests. The locations of the borings are indicated on Plate 1. The boring logs are presented in Appendix A, Plates 5 through 10. Soils are classified in accordance with the Unified Soil Classification System, Plate 11.

The samples were re-examined in the laboratory to verify their field classifications. Selected samples were tested to determine pertinent physical properties of the soils. Our laboratory testing program included moisture content/dry density, triaxial compression strength, Atterberg Limits and consolidation tests. The Atterberg Limits test data is presented in Appendix A, Plate 12; the consolidation test data is presented on Plate 13.

IV SITE AND SOIL CONDITIONS

A. Site Conditions

The northwest portion of the site is hillside terrain. Most of the area slopes at about 4 horizontal to 1 vertical; however, slopes are as steep as 1-1/2 horizontal to 1 vertical locally. The sloping portion of the site is generally covered with thick brush and trees. Several old houses are located along the west boundary.

The southeast portion of the site, between the sloping ground and the Keahala Stream, is a relatively level area which has been built up with stream sediments. The area was raised by placing dredged fill over the soft sediments. It is now occupied by a small marina with adjacent offices, shops and a boat works.

Recently, the west portion of the level ground has been used as a stock-pile area for soil excavated from an adjacent drainage project. Some of the stock-piled fill has been removed since our exploration, but a large amount still remains. Some of the fill contains organic matter and debris, as well as many large boulders. Fill has also been dumped on the lower slopes of the site, in the areas of Borings 1 and 5.

B. Soil Conditions

The sloping portion of the site is underlain by residual soil over weathered basalt rock. The residual soil is medium stiff to stiff clayey silt, which is moderately strong and visually appears to be slightly to moderately compressible. Basalt rock encountered in the borings was moderately to deeply weathered. Hard, massive rock was not encountered.

The lower, level portion of the site is underlain by soft silt sediments which contain organic matter (peat), sand, gravel and shells. The soft soil was encountered as deep as about 50 feet below the existing surface (Boring 3). The soft deposits no doubt pinch out at the base of the adjacent slopes; the estimated boundary of the soft soil is shown on Plate 1. Strength and consolidation tests indicate that the silt is weak and very compressible.

The borings indicate that the dredged fill over the soft sediments is about five feet thick and consists of silt and gravel of variable composition and density. Borings 1, 2 and 5 verified the presence of dumped fill in their respective areas.

Ground water was not encountered in Borings 1 and 6 on the upper slopes of the site. The remaining borings encountered ground water near elevation 0 (MLLW Datum).

V DISCUSSION AND CONCLUSIONS

Most of the sloping portion of the site can be developed without unusual problems. No evidence of instability was noted and none is expected if good grading practices are followed. We anticipate that excavations shallower than about 15 feet can be made without difficult ripping or blasting.

Buildings on the sloping ground can be supported on spread foundations. The heavier parking structures may experience some settlement; we estimate that settlements of column footings may range up to about two inches and that differential settlements between adjacent columns may be as great as three-quarters of an inch. Fills on the sloping ground should be minimized as much as possible to reduce settlements and to avoid increasing the risk of slope instability.

Where buildings are sited over relatively steep slopes (say three horizontal to one vertical or steeper) building foundations must be deepened to provide adequate confinement for the footings. In some cases, a drilled pier foundation system may be the most economical.

In the flat portion of the site, significant settlements will occur as the soft underlying soils consolidate under new and existing fill loads; the influence of the wood-frame buildings on settlement values is not significant. Actual settlements will be erratic and are difficult to accurately predict due to the random stock-piling of fill during the past several years, the presence of peat, and the variable depth of the compressible soils.

We have computed settlements for various fill depths at the three boring locations in the flat portion of the site; results are presented on Plate 2. Fill settlement will decrease to negligible values along the contact line between the sloping ground and the compressible soils, shown on Plate 1.

Post-construction settlements can be reduced by grading the site as early as possible and delaying surface construction in the lower area until a significant part of the settlement has taken place. About fifty percent of the settlement will occur in the first six months; the remaining settlement will take between five and ten years.

Surcharging the site prior to construction of surface improvements would also help reduce post-construction settlement. Since the compressible soils are deep, the surcharge would have to be quite heavy (about one foot of surcharge for each foot of fill placed) and would have to be in place for six months or more to be effective. Nevertheless, if the predicted settlements are not tolerable, we can develop a surcharge scheme when the grading plans have been developed and settlement tolerances are more accurately known.

Buildings on the low ground should be designed with special foundations to either accomodate differential settlement or permit releveling. The cost of piles is not warranted for light buildings. It is our opinion that the wood-frame buildings can be supported on grade-beam footings or on mat foundations designed to span local areas of nonuniform support. Buildings should be constructed in small clusters that will settle independently.

It is likely that the concrete parking structure adjacent to the north edge of the marina will have to be supported on piles. A mat could be used, but differential settlement across the building would be more than a foot (based on a mat pressure of 300 pounds per square foot). In addition, the building would have to be located well back from the edge of the marina to prevent overloading the bulkhead. If piles are required, driven displacement types, such as precast concrete or concrete filled steel pipe, would be most suitable. Support would be gained by friction in the stiff soils which underlie the soft sediments. We should determine if piles are needed and develop criteria for their design, when the actual location and design of the parking structure is more accurately known.

VI RECOMMENDATIONS

A. Settlement

Fill elevations required to compensate for settlement in the lower, level portion of the site (within the boundary of the soft soils) are given on the chart on Plate 3. This data should be considered when designing grading plans, utility and drainage systems and building foundations.

Actual settlements may vary appreciably from those predicted and, therefore, they should be monitored by installing and reading settlement markers. This will allow adjustment of the grading and foundation schemes, if necessary. We should determine the number and location of settlement markers when the grading plans have been completed. Details on the installation and monitoring of settlement markers are in Appendix B.

B. Site Preparation and Grading

Before grading is begun, all brush, trees and vegetation should be stripped from the surface and all debris should be removed from the areas to be graded. The upper two to four inches of soil, containing roots and vegetation, should also be stripped and removed; this material could be used as top soil in landscape areas if appropriate.

All existing fill or stock-piled material (excluding the dredged fill in the flat portion of the site) should be removed and properly placed and compacted. In the lower, level portion of the site the stock-piles of dumped material should be removed down to about elevation +3 (the surface of the dredged fill. The old fill in the areas of Borings 1 and 5 should be removed to stiff, natural ground. After removing debris and organic matter, this material should be brought to a suitable moisture content and compacted to 90 percent relative compaction.* Some of the dumped material may be expansive; we should evaluate the material during grading so that expansive material, if it is encountered, can be used in the lower lifts well below pavements, slabs and foundations.

The existing fill and stock-piled material contains many large boulders. The boulders can be used in the lower fill lifts below the depth of utilities and foundations, provided that they can be placed in such a manner that compacted fill is brought up on all sides of them. It may be more convenient to remove the boulders from the site or use them is landscaped areas.

Fills placed on slopes steeper than five horizontal to one vertical should be started on a level bench, excavated into stiff, natural soil. Subsequent fill lifts should be similarly keyed into the natural slope. In some cases, subdrains may be required at the rear of the benches and keys. We should determine the locations of subdrains, if required, when grading plans have been developed; these locations should be verified by us in the field. Typical subdrain details are included on Plate 4.

The fill slope adjacent to the stream should be no steeper than four horizontal to one vertical. Cut and fill slopes in other areas should be no steeper than two horizontal to one

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

vertical. It may be possible to steepen cut slopes in local areas where rock is exposed or where slopes are less than about five feet high. We can consult with you during development of the grading plans to determine if cut slopes can be steepened in local areas.

We recommend that the grading be completed as soon as possible to maximize the settlements that will take place before building construction is started. Surface construction in the lower areas should be delayed until settlement readings indicate that remaining settlement behavior will not be excessive for the structures.

C. Foundations

Spread foundations can be designed according to the following criteria

Bearing Pressures	
Dead loads................................	1,700 psf
Total design loads, including wind and seismic forces..................	2,500 psf
Resistance to Lateral Loads	
Friction on bottom of footings (times vertical dead load)..............	0.4
Passive pressure........................	500 psf*

*Neglect passive pressure in the top foot unless footing is confined by floor slabs or pavements on all sides. Structural backfill should be compacted to 90 percent relative compaction.

Where footings are installed on steep slopes they should be deepened to provide at least five feet of horizontal confinement at their base. We should inspect the installation of foundations so that we can adjust their depths if necessary.

We recommend that the lighter, wood-frame buildings on the flat ground be supported on grade-beam or mat type foundations designed to span local areas of nonuniform support. If the predicted settlements are excessive, it may be necessary to use structurally supported floors and provide for releveling of the structures in the future. We recommend that buildings be constructed in small clusters of one or two units that can settle independently of adjacent clusters.

D. Retaining Walls

Retaining wall footings can be deisgned using the criteria in Section VI-C. Active backfill pressures can be computed using an equivalent fluid pressure of 35 pounds per cubic foot. Walls should be provided with back drains and weep holes to prevent the buildup of hydrostatic pressure. Back drains should consist of free-draining, crushed rock which conforms to the following gradation:

Sieve Size	Percent Passing
3/4 inch	100
No. 4	0 - 10
No. 200	0 - 3

E. Slab Floors

Subgrades for slab-on-grade floors should be rolled with a smooth wheel roller to provide dense, nonyielding surfaces. Floor slabs should be underlain by four inches of <u>free-draining</u>, crushed rock to provide a capillary moisture break. The drain rock should conform to the following gradation:

Sieve Size	Percent Smaller
1-1/2 inches	90 - 100
No. 4	0 - 5
No. 200	0 - 3

Where penetration of moisture vapor through the floor would be objectionable, an impervious membrane should be installed between the drain rock and the concrete slab.

F. Asphalt Pavements

Asphalt pavements should consist of two inches of asphalt concrete over six inches of aggregate base. The aggregate base should conform to City and County of Honolulu standards and should be moisture conditioned and compacted to 95 percent relative compaction. The pavement subgrade should be scarified to a depth of six inches, moisture conditioned and compacted to 95 percent relative compaction.

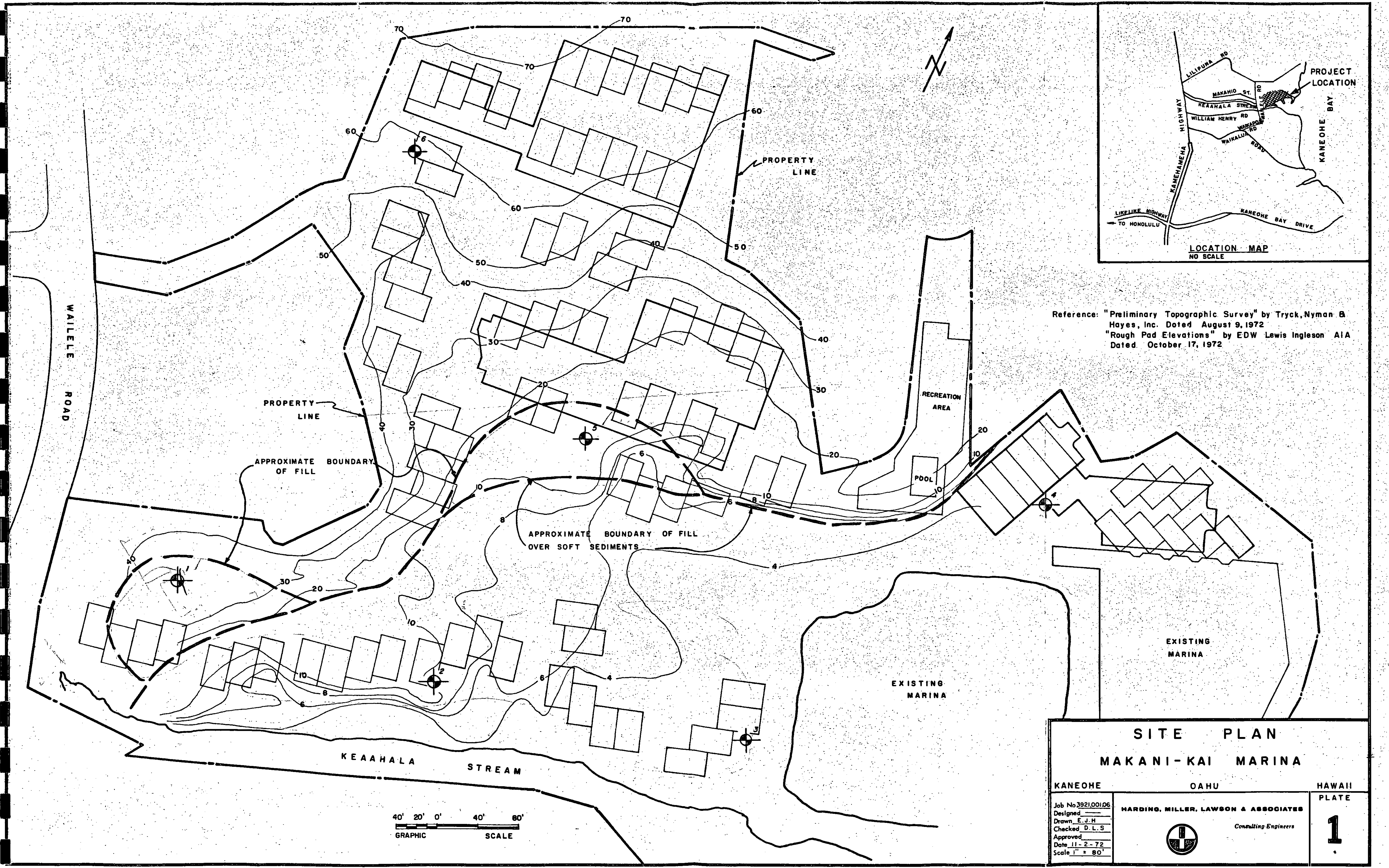
It may be necessary to use a select subbase material in areas where the supporting capacity of the subgrade is low. We should determine subbase thickness, if it is required, when the rough grading has been completed and actual subgrade soil types can be determined. It is our opinion that if the soil excavated from the sloping ground or the best stock-piled material is used in the top foot of paved areas, that select subbase material will not be required.

VII REVIEW OF PLANS AND CONSTRUCTION INSPECTION

We recommend that we review the foundation and grading plans and specifications to correlate the actual design with the intent of our recommendations.

We recommend that we intermittently inspect the placement and compaction of fill and the installation of foundations. Inspection will permit us to check compliance with the intent of our recommendations. In addition, it will enable us to detect unanticipated field conditions that might require special treatment or modifications of our recommendations.

VIII ILLUSTRATIONS



Reference: "Preliminary Topographic Survey" by Tryck, Nyman & Hayes, Inc. Doted August 9, 1972
"Rough Pad Elevations" by EDW Lewis Ingleson AIA Dated October 17, 1972

SITE PLAN

MAKANI-KAI MARINA

KANEOHE
OAHU
HAWAII

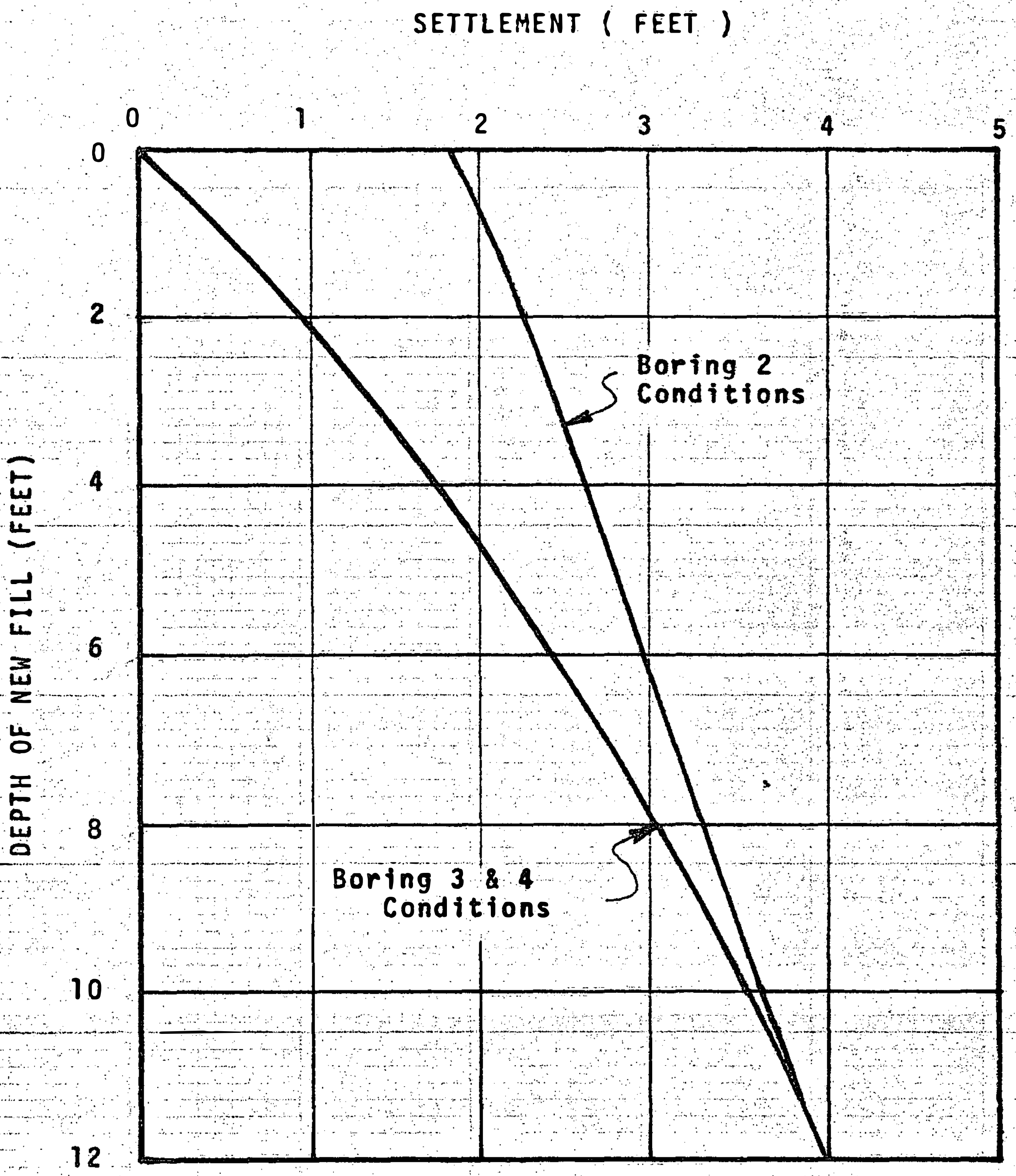
Job No 3921,001.06
Designed ———
Drawn E.J.H
Checked D.L.S
Approved
Date 11-2-72
Scale 1" = 80'

HARDING, MILLER, LAWSON & ASSOCIATES

Consulting Engineers

PLATE

1



NOTE: Settlements will be less near boundary of soft soils.

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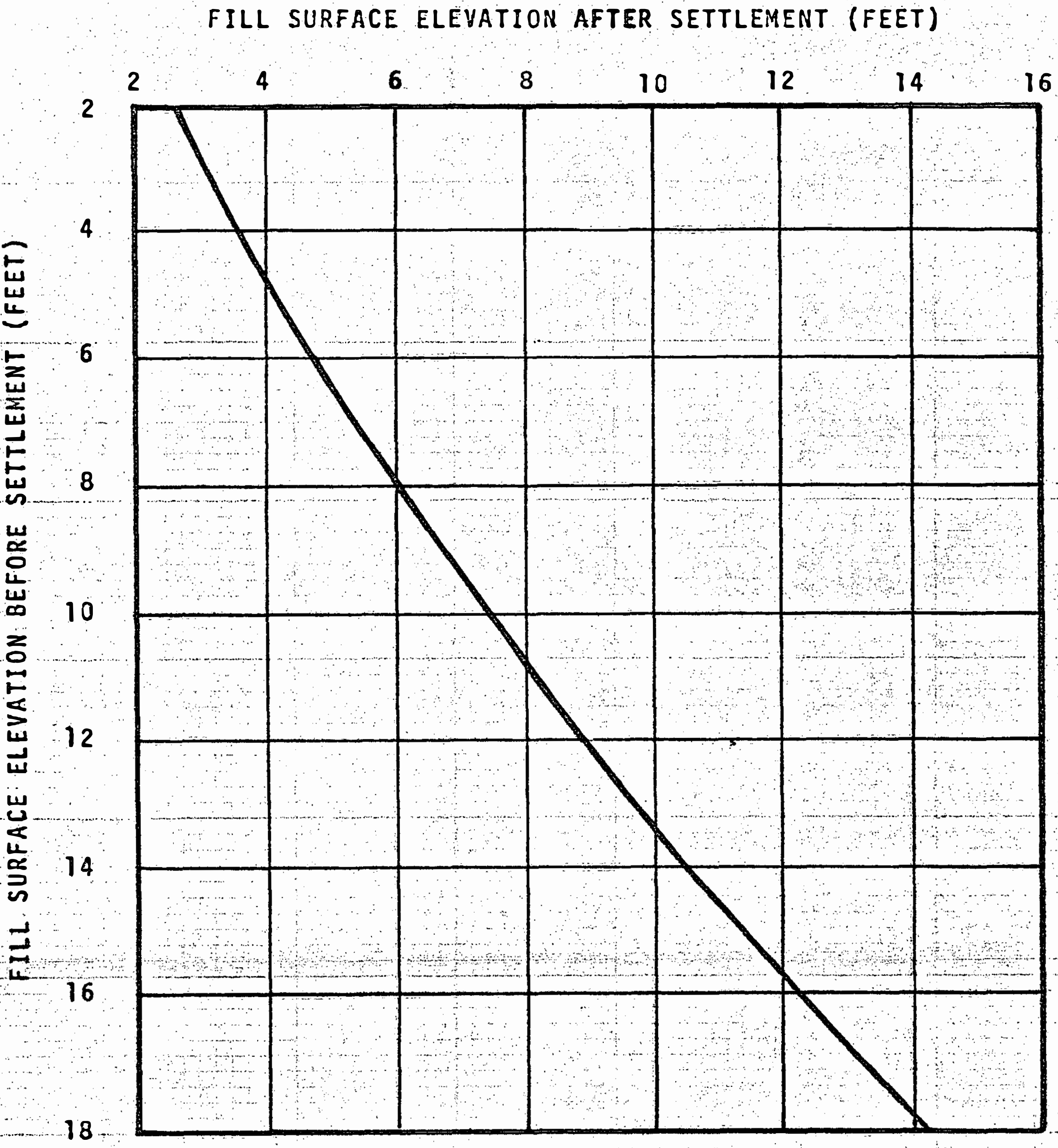
Consulting Engineers

Job No: 3921.1 Appr: DLS /ja Date 11/1/72

COMPUTED SETTLEMENTS OF FILL OVER SOFT SEDIMENTS

Makani Kai Marina
Kaneohe, Oahu, Hawaii

PLATE
2



NOTES: 1. Chart based on computed settlements at Borings 2, 3 and 4. Settlements will be less near boundary of soft soils.

2. Chart should be used when designing grading plans, utility and drainage systems and foundations in lower, level portion of site.

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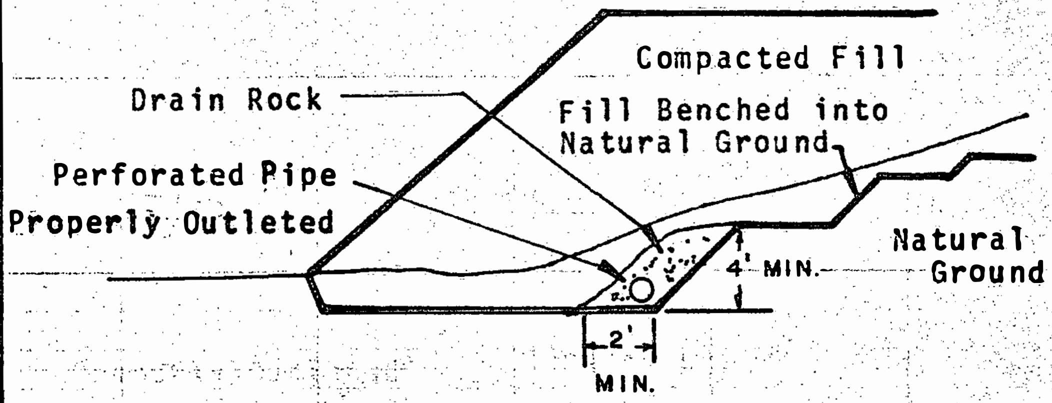
Job No: 3921.1 Appr: DS/ja Date 11/1/72

FILL SURFACE ELEVATIONS
BEFORE AND AFTER SETTLEMENT
Makani Kai Marina
Kaneohe, Oahu, Hawaii

PLATE
3



TYPICAL SUBDRAIN BENEATH SIDEHILL FILL

NO SCALE

NOTES:

1. Perforated Pipe should be 4" diameter asbestos cement or equivalent.

2. Drain Rock should conform to the following gradation

SIEVE SIZE	PERCENT PASSING
1-1/2 inch	100
3/4 inch	50 - 100
3/8 inch	15 - 55
#4	0 - 25
#200	0 - 3

3. Final location and extent of subdrains should be determined in the field by the Soil Engineer.

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TYPICAL SUBDRAIN DETAILS

Makani Kai Marina
Kaneohe, Oahu, Hawaii

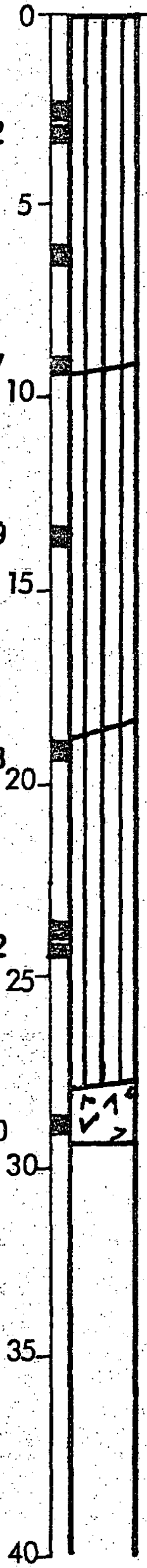
PLATE
4

LOG OF BORING 1

Equipment 4" Flight Auger

Elevation 38.0 Date 7/14/72

Laboratory Tests	Drill Rate (min/ft)	Drill Pressure (psi)	Blows/foot	Moisture Content (%)	Dry Density (pcf)
				55.0	62
				33.8	77
				37.8	79
TX 2040 (2000)				55.0	63
				60.5	62
				45.6	80



BROWN AND GREY CLAYEY SILT (MH)
stiff, moist
(with some rock fragments)

FILL

BROWN AND YELLOW CLAYEY SILT (MH)
stiff, moist

YELLOW-BROWN CLAYEY SILT (MH)
stiff, moist
(with clay seams)

BROWN AND GREY BASALT
deeply to moderately weathered, moderately strong, moderate hardness

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LOG OF BORING 1

MAKANI KAI MARINA
Kaneohe, Oahu, Hawaii

PLATE
5

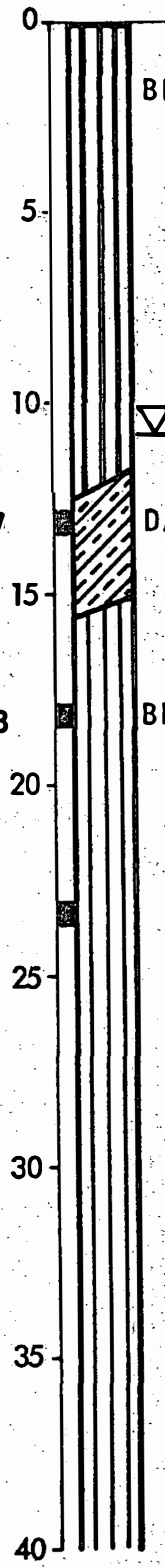
RF 2g

LOG OF BORING 2

Equipment 4" Flight Auger

Elevation 7.5 Date 7/19/72

Laboratory Tests	Drill Rate (min/ft)	Drill Pressure (psi)	Blows/foot	Moisture Content (%)	Dry Density (pcf)	Depth (ft)	Sample
TX 390 (1000)				111.0	37		
Consolidation Test LL = 64 PL = 43 PI = 21				97.6	43		



BROWN CLAYEY SILT (MH)
stiff, moist
(with rock fragments and boulders)

FILL

WATER LEVEL 7-20-72 @ 0720

DARK GREY ORGANIC SILT (OH)
very soft, saturated

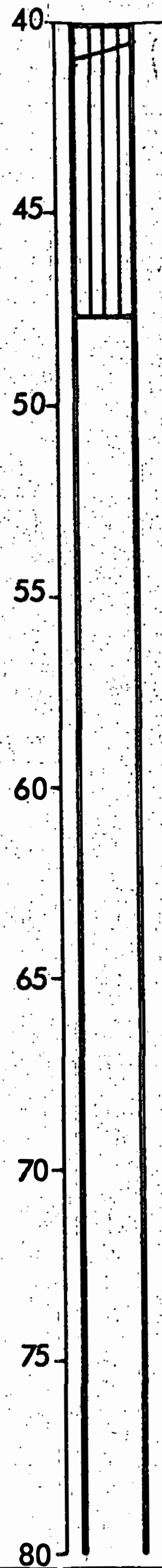
BLACK SANDY SILT (MH)
very soft saturated
(with shells and organic matter)

(with more organic matter-wood fragments - at 22')

(probe below 23.5' using standard penetration point)

Laboratory Tests	Drill Rate (min/ft)	Drill Pressure (psi)	Blows/foot	Moisture Content (%)	Dry Density (pcf)	Depth (ft)	Sample

(Continuation of Log)



(probable bottom of soft soils @ 41')

(bottom of probe)

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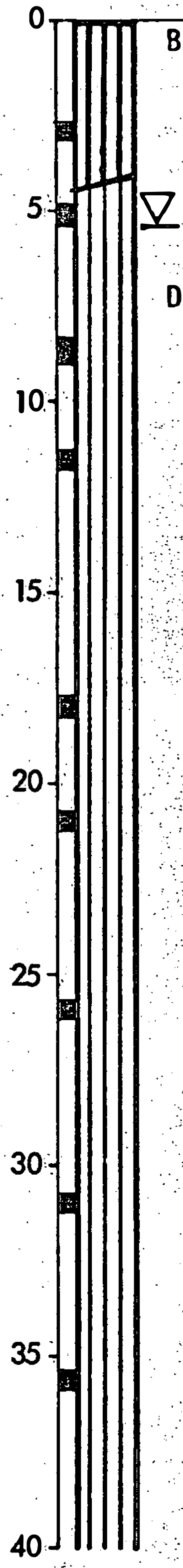
Job No: 3921,001.06 Appr: DLS /ja Date 8/17/72

LOG OF BORING 2
MAKANI KAI MARINA
Kaneohe, Oahu, Hawaii

PLATE
6

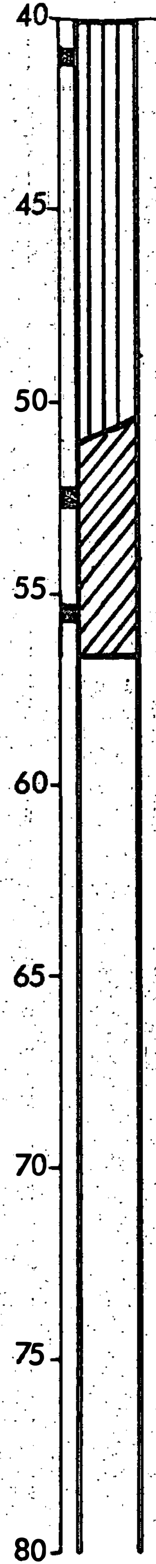
LOG OF BORING 3

Equipment 4" Flight Auger
Elevation 3.0 Date 7/14/72



Laboratory Tests	Drill Rate (min/ft)	Drill Pressure (psi)	Blows/foot	Moisture Content (%)	Dry Density (pcf)	Depth (ft) Sample	
							BROWN CLAYEY SILT (MH) medium stiff, moist (with coral fragments and shells)
				37.5	74		
							WATER LEVEL 7-21-72 @ 0730
				23.9	87		
							DARK GREY SANDY SILT (MH) very soft, saturated (with pebbles and shells)
				53.6	68		
							(very sandy @ 11')
							(with coral fragments @ 15')
							(with organic matter - wood fragments - @ 25')
							(very sandy with abundant shell fragments and organic matter @ 32')

(Continuation of Log)



Laboratory Tests	Drill Rate (min/ft)	Drill Pressure (psi)	Blows/foot	Moisture Content (%)	Dry Density (pcf)	Depth (ft) Sample	
				143.0	32		
							LIGHT GREY CLAY (CH) very stiff, saturated
TX 310 (4500)				77.6	55		
Tx 2510 (5000)				54.6	69		

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Job No: ~~3921,001.06~~ Appr: DLS / ja Date 8/17/72

LOG OF BORING 3

MAKANI KAI MARINA
Kaneohe, Oahu, Hawaii

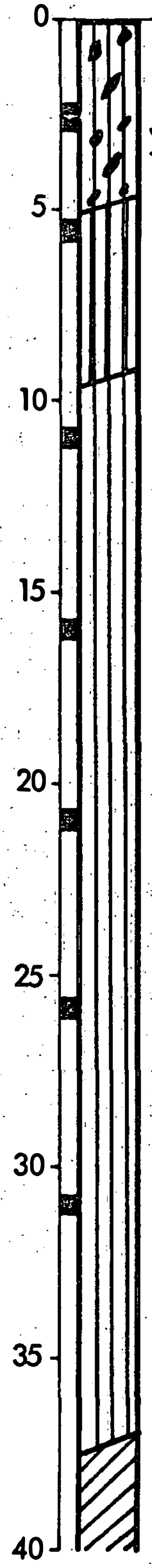
PLATE
7

RF 2g

LOG OF BORING 4

Equipment 4" Flight Auger
Elevation 3.0 Date 7/18/72

Laboratory Tests	Drill Rate (min/ft)	Drill Pressure (psi)	Blows/foot	Moisture Content (%)	Dry Density (pcf)
TX 2860 (1000)				41.0	67
TX 275 (1000)				118.0	34



GREY AND WHITE SILTY SANDY GRAVEL (GM)
loose, wet

FILL

∇ WATER LEVEL 7-21-72 @ 0715

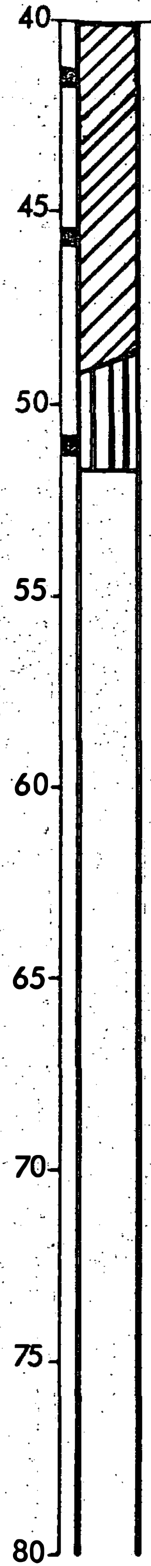
DARK GREY SILT (MH)
very soft saturated
(with peat layers and organic matter)

GREY SANDY, GRAVELLY SILT (MH)
very soft, saturated
(with coral fragments and shells)

GREY AND BROWN SANDY CLAY (CL)
medium stiff, saturated
(with rock fragments and gravel)

(Continuation of Log)

Laboratory Tests	Drill Rate (min/ft)	Drill Pressure (psi)	Blows/foot	Moisture Content (%)	Dry Density (pcf)
				55.0	74
				100.5	45
TX 1650 (5000)				69.7	60



GREY CLAYEY SILT (MH)
stiff, saturated
(with shell fragments)

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Job No: 3921,001.06 Appr: DLS /ja Date 8/17/72

LOG OF BORING 4
MAKANI KAI MARINA
Kaneohe, Oahu, Hawaii

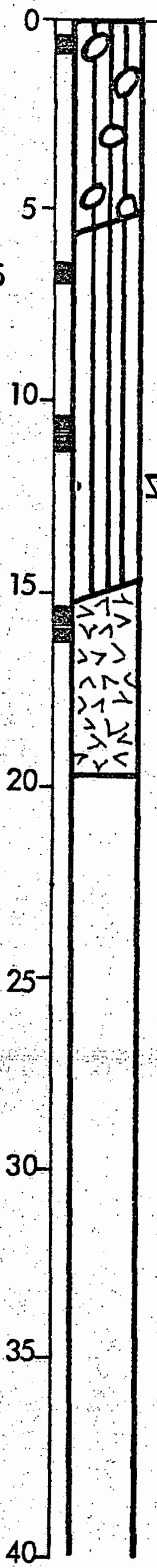
PLATE
8

LOG OF BORING 5

Equipment 4" Flight Auger

Elevation 13.6 Date 7/20/72

Laboratory Tests	Drill Rate (min/ft)	Drill Pressure (psi)	Blows/foot	Moisture Content (%)	Dry Density (pcf)
TX 2520 (1000)				44.0	76



BROWN CLAYEY SILT (MH)
stiff, dry
(with large basalt
boulders)
(GREY BROWN BASALT BOULDER
FROM 1' to 5')

FILL

BROWN CLAYEY SILT (MH)
very stiff, moist
(with small, hard, basalt
rock fragments)

∇ WATER LEVEL 7-24-72 @ 1015

GREY BASALT
moderately strong, low
hardness, moderately
weathered, closely
fractured

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Consulting Engineers

Job No: 3921,001.06 Appr: DG /ja Date 8/17/72

LOG OF BORING 5

MAKANI KAI MARINA

Kaneohe, Oahu, Hawaii

PLATE

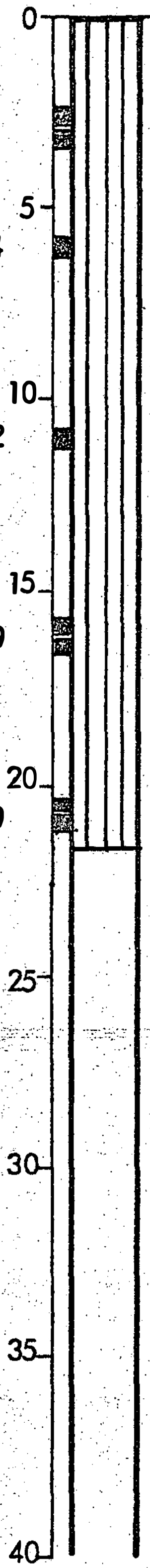
9

LOG OF BORING 6

Equipment 4" Flight Auger

Elevation 56.5 Date 7/20/72

Laboratory Tests	Drill Rate (min/ft)	Drill Pressure (psi)	Blows/foot	Moisture Content (%)	Dry Density (pcf)
LL = 64 PL = 44 PI = 20					
TX 2200 (1000)				47.3	74
TX 825 (1000)				96.0	52
TX 705 (1500)				106.0	49
TX 2240 (2000)				54.5	69



ORANGE-BROWN CLAYEY SILT (ML)
stiff, moist

(medium stiff, wet, with black and yellow streaks @ 10')

(stiff @ 20')

(no free water encountered)

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Consulting Engineers

Job No: 3921,001.06 Appr: DLS/ja Date 8/17/72

LOG OF BORING 6
MAKANI KAI MARINA
Kaneohe, Oahu, 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.

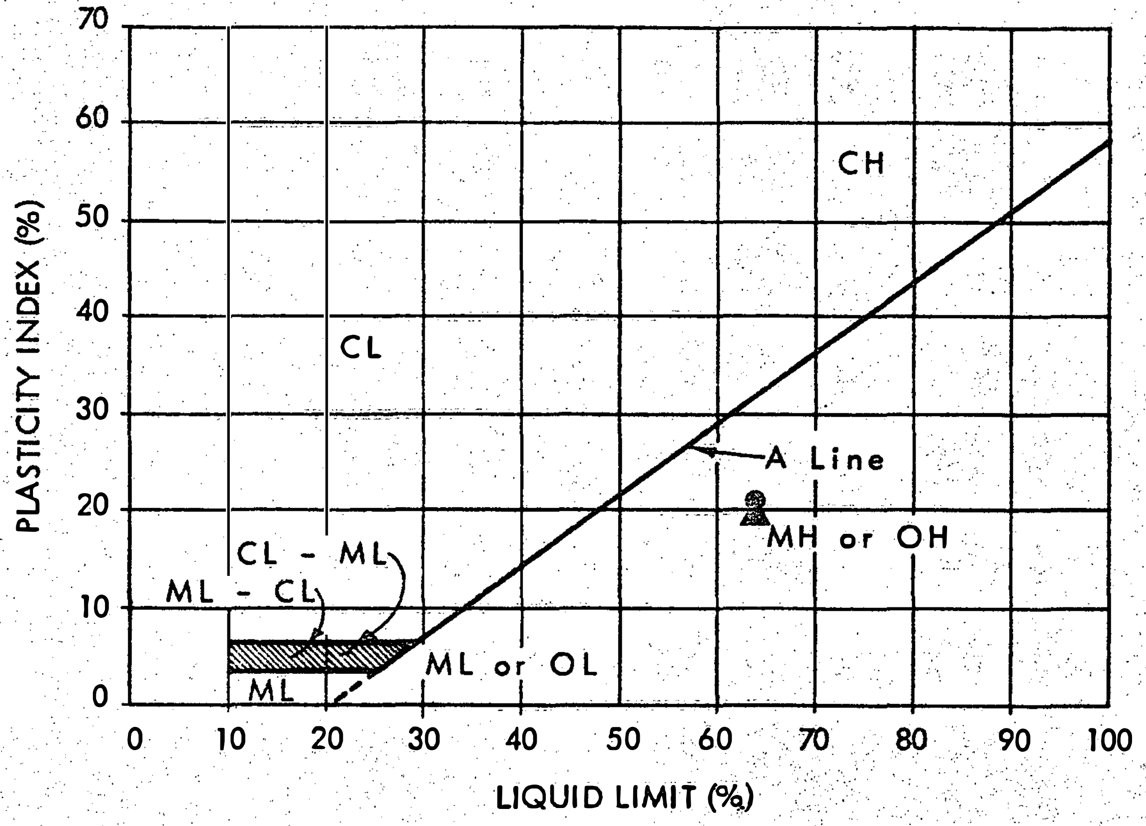
KEY TO TEST DATA

HARDING, MILLER, LAWSON & ASSOCIATES
Consulting Engineers

Job No: 3921,001.06 Appr: DS/ja Date 8/17/72

SOIL CLASSIFICATION CHART
AND
KEY TO TEST DATA

PLATE
11



Symbol	Classification and Source	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	% Passing #200 Sieve
●	BLACK SANDY SILT (MH) Boring 2 @ 17.8'	64	43	21	--
▲	ORANGE-BROWN CLAYEY SILT (ML) Boring 6 @ 2.3'	64	44	20	--

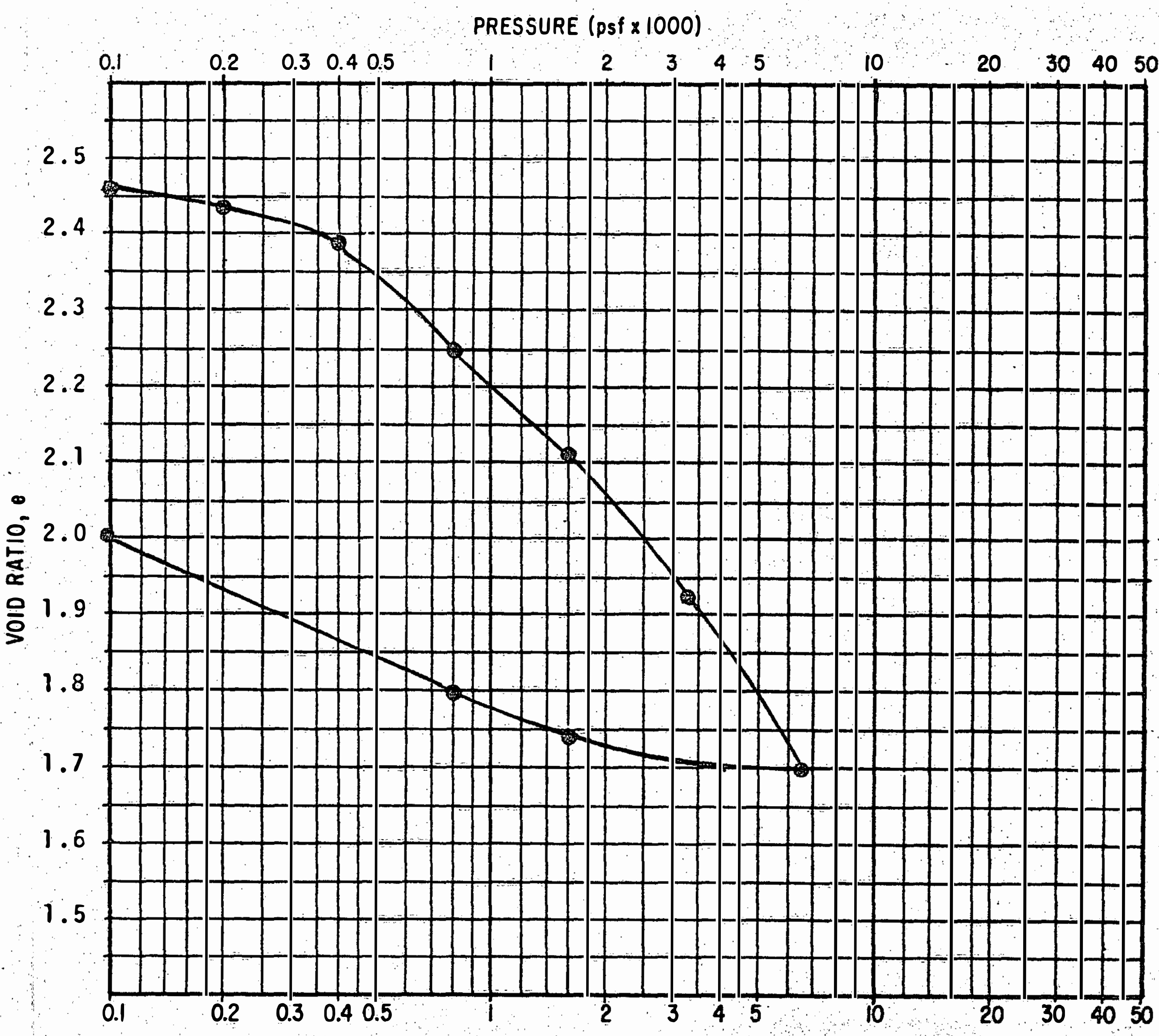
HARDING, MILLER, LAWSON & ASSOCIATES
Consulting Engineers

Job No: 3921,1 Appr: DLS/j Date 11/1/72

PLASTICITY CHART
Makani Kai Marina
Kaneohe, Oahu, Hawaii

PLATE
12

RF-30



Type of Specimen	Undisturbed			Before Test			After Test	
Diameter (in.)	2.43	Height (in.)	0.800	Moisture Content	w_o	97.6 %	w_f	81.9 %
Overburden Press., P_o	1400 psf			Void Ratio	e_o	2.51	e_f	2.00
Preconsol. Press., P_c	600 psf			Saturation	S_o	95.5 %	S_f	100 %
Compression Index, C_c	0.77			Dry Density	γ_d	43.2 pcf	γ_d	50.6 pcf

LL 64

PL 43

PI 21

G_s 2.45 assumed

Classification BLACK SANDY SILT (MH)

Source Boring 2 @ 17.8'

HARDING, MILLER, LAWSON & ASSOCIATES

Consulting Engineers

Job No: 3921.1

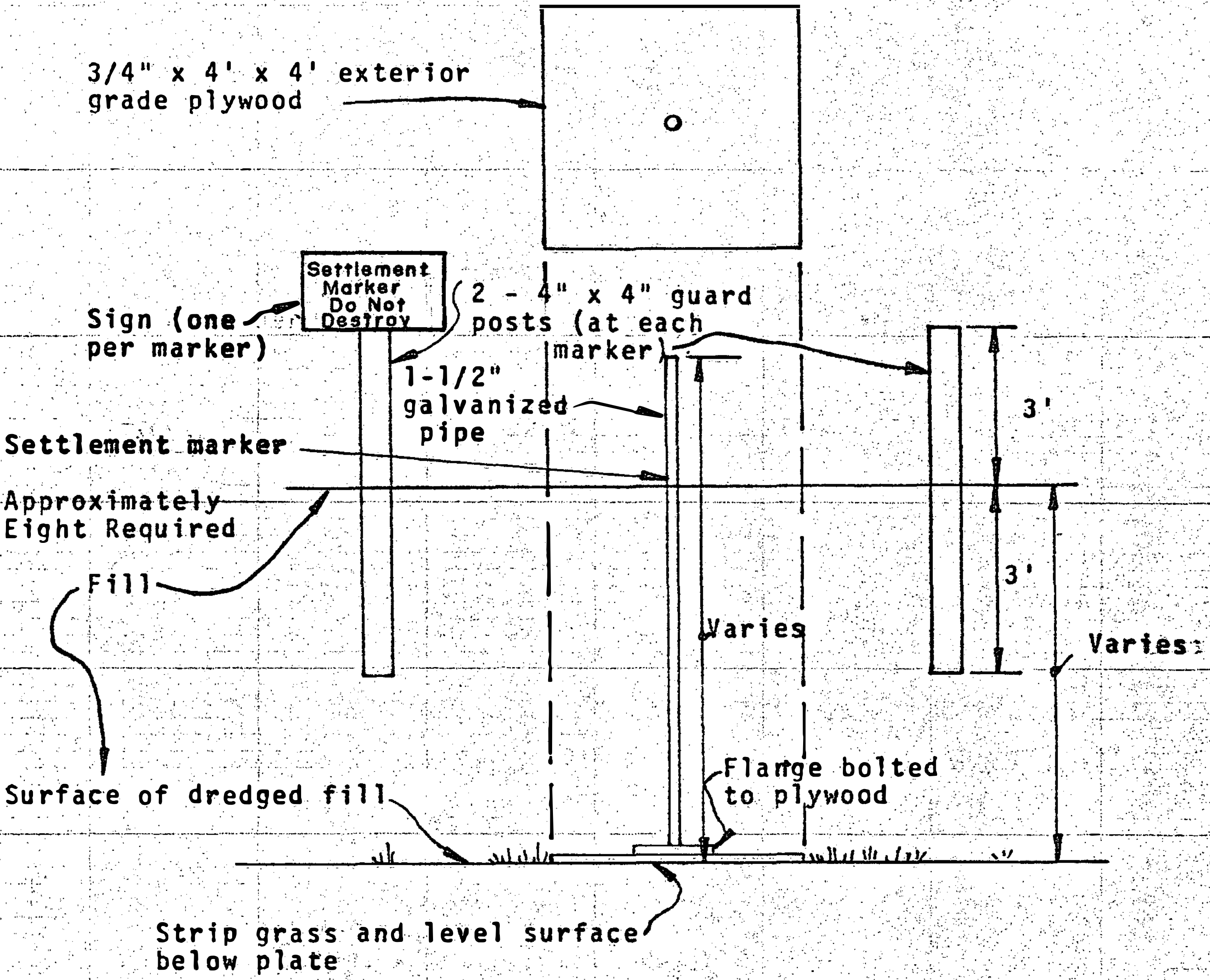
Appr: DS/ja

Date 11/2/72

CONSOLIDATION TEST REPORT

Makani Kai Marina
Kaneohe, Oahu, Hawaii

PLATE
13



NOTES:
1. Install markers when surface has been graded to elevation +3 (MLLW Datum), and take initial reading.
2. Take readings every two weeks during and after construction; note depth of fill at time of reading during construction.
3. Readings should be to nearest one-hundredth of a foot.
4. The Soil Engineer should review readings within three days of reading date.

HARDING, MILLER, LAWSON & ASSOCIATES *Consulting Engineers*	SETTLEMENT MARKER DETAILS Makani Kai Marina Kaneohe, Oahu, Hawaii	PLATE 14
Job No: 3921.1 Appr: DLh/ja Date: 11/2/72		

DISTRIBUTION

5 copies

Makani Kai Development Company
Suite 702, 1136 Union Mall
Honolulu, Hawaii 96813

Attention: Mr. Jorgen Skov

1 copy

EDW Incorporated
Suite 200, 828 Fort Street Mall
Honolulu, Hawaii 96813

Attention: Mr. Lewis Ingleson

LETTER OF TRANSMITTAL

GRAY, RHEE & ASSOCIATES, INC.
CONSULTING ENGINEERS
CIVIL / STRUCTURAL / SANITARY
116 SOUTH KING ST. • RM. 508
HONOLULU, HAWAII 96813
TELEPHONE: 521-0306

TO Division of Engineering
City & County of Honolulu
Honolulu, Hi 96813

DATE Feb. 21, 1974

ATTENTION Mr. David Nagamine

SUBJECT: MAKANI KAI MARINA
KANEOHE, OAHU, HAWAII

Gentlemen:

We are sending you ☒ **attached** ☐ **under separate cover the following items:**

No. Copies	Date	Sheet No.	Description
1	11-2-72		Copy, Foundation Investigation report by Harding, Miller
			Lawson & Associates

Action requested:

☐ **For review and comment** ☒ **As requested**

☐ **For approval** ☒ **For your use**

Remarks

Very truly yours,

Signed
Brian L. Gray

Job No. 271 (ib)

Received:

PW-DE-40 (REV.)
1/71

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

DATE 2-22 1974

FROM: Control Section

TO:

☐ CHIEF
☐ ASSISTANT CHIEF
☐ CHIEF ADMINISTRATIVE ENGR.
☐ CHIEF CONTROL ENGINEER
☐ CHIEF DRAINAGE ENGINEER
☐ CHIEF HIGHWAY ENGINEER
☐ CHIEF STRUCTURAL ENGINEER
☐ INVESTIGATOR
☐ ________________

☑ CHIEF CONSTRUCTION ENGINEER
☐ DISTRICT CONSTR. ENGR.—EAST
☐ DISTRICT CONSTR. ENGR.—WEST
☐ SERVICE
☐ FIELD SURVEY
☐ TESTING LAB
☐ SECRETARY
☐ ________________

FOR:

☐ APPROPRIATE ATTENTION AND ACTION
☐ DRAFT REPLY
☐ COMMENTS & RECOMMENDATIONS
☐ SEE ME
☐ WORK ORDER

☐ ARRANGE MEETING
☐ SIGNATURE
☑ INFORMATION
☐ FILE
☐ ________________

LOG. NO. ________________

SUSPENSE ________________