AHUIMANU HEIGHTS ESTATES - PRELIMINARY SOIL REPORT
KAHALUU, KOOLAUPOKO, OAHU, HAWAII
TAX MAP KEY: 4-7-31: 7, 9 & 10

FOR REFERENCE
not to be taken from this room

To:
WATSON LEE, INCORPORATED

WALTER LUM ASSOCIATES, INC.
CIVIL, STRUCTURAL, SOILS ENGINEERS
JUNE 28, 1972
MR. WATSON LEE  
Watson Lee, Inc.  
33 South King Street, Suite 512  
Honolulu, Hawaii 96813

Dear Mr. Lee:

Subject: Ahuimanu Heights Estates  
Preliminary Soil Report  
(for residential development)  
Kahaluu, Koolaupoko, Oahu, Hawaii  
Tax Map Key: 4-7-31: 7, 9 & 10

In accordance with your request, soil explorations were made to determine general soil conditions at the proposed residential development site for Ahuimanu Heights Estates, Kahaluu, Koolaupoko, Oahu, Hawaii.

The site is covered with tall grass, brush and trees. A gully crosses thru the central portion of the site.

The surface soils at the site may be generally described as medium to stiff reddish-brown clayey silts and silty clays ("MH" soils) mixed with some decomposed rocks.

The present plan is to fill the gully. Construction of fills, particularly in the gully, should be done with care. Subdrains along low spots and granular fills along the toe of the slope should be used.

Settlement gages should be installed to monitor the performance of fills over the existing gully.

The proposed light residential houses may be supported either directly on the stiff existing ground or on compacted fills constructed from the on-site soils.

The earthwork should be done in accordance with the requirements of Chapter 23, Revised Ordinances of Honolulu, 1961 As Amended, and the recommendations contained herein.

June 28, 1972
This report includes a Boring Location Plan, boring logs, laboratory test results, recommendations and limitations.

Respectfully submitted,

WALTER LUM ASSOCIATES, INC.

Ezra Koike
Professional Engineer
Hawaii No. 1450

EK:rmf
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SCOPE

The purpose of this exploration was to determine general soil conditions for residential development for the proposed Ahuimanu Heights Estates. This report includes field explorations, laboratory tests and general recommendations and limitations for site grading and residential foundation design considerations.

FIELD EXPLORATION

Eight exploratory borings were made at the site. The locations of these borings are shown on the Boring Location Plan. Descriptions of the underlying soils encountered are shown on the boring logs.

Borings were made with 3 and 4-in. diameter augers using a carbide drag bit or a finger type bit. Soil samples were recovered with 2-in. diameter thin-wall tube samplers and a 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, Atterberg limit, grain-size analysis, AASHTO T-180-57 density, expansion and CBR.

A summary of the 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."

GENERAL SITE CONDITIONS

The proposed site is located in Kahaluu along the south side of Ahuimanu Road across the intersection of Poomau Street.

The proposed site is covered with tall grass and trees. Wire fences, several horses and an existing house were noted on the site.

The existing ground generally slopes down from west to east at about a 3% grade with variations in localized areas.

A gully crosses the central portion of the site and slopes down toward the east at about a 6% grade with side slopes of about 40 to 60% grades.
INTERPRETATION OF SOIL CONDITIONS

From the field explorations and laboratory test results, the soils may be generally described as follows:

Medium to stiff reddish-brown clayey silts and silty clays ("MH" soils) mixed with some decomposed rocks to about 25 ft, the depth drilled.

Water was noted at about 10 to 13-ft depths in the borings during the field explorations.

For more detailed descriptions of soils encountered in the borings, refer to the boring logs.

DISCUSSION AND RECOMMENDATIONS

In general, the proposed plan is to cut portions of the higher ground and fill the gully and grade the site for residential development.

Cuts and fills over most of the site will vary from little to about 10 ft.
Fills from little to about 24 ft are planned in the gully area.

Before fills are placed in the gully or drainageway, trenches should be cut in a herringbone pattern and subdrains placed in the trenches to provide drainage paths for the bottom and sides of the drainageway.
Loose or soft soils along the bottom and sides of the gully and particularly at the toe of slopes should be stripped to firm ground.
Settlement gages should be installed to monitor the performance of fills over the drainageway. After allowing the ground to consolidate for 3 to 6 months or when settlement gages show negligible rates of settlements, building construction may proceed over the compacted fill.

Because of decomposed rocks, some boulders may be encountered in the deeper excavations. The boulders may be used to construct rock buttresses at the toes of slopes. See Figure 1.

High moisture soils may be encountered in the deeper cuts. If used for the construction of fills, compaction may be difficult. A minimum density of 85% of AASHO density is recommended, and 90% wherever practicable.

A grassed storm water retention basin about 8 ft deep with a spillway at the southern edge is planned for Lot 12.

The responsibility for the design construction and maintenance of these temporary structures should be left to the contractor.

Site Grading

In general, the on-site soils may be used for the construction of the proposed fills. Grading work should be done in accordance with the requirements of Chapter 23, Revised Ordinances of Honolulu, 1961 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. Loose surface and stockpiled soils should be stripped to stiff natural ground before the placement of fills. Loose surface soils at finish grade should be scarified and recompacted.

3. Localized soft pockets encountered during the site preparation should be excavated and backfilled with compacted select material.

4. Thin sidehill fills (sliver fills) on sloping areas should be avoided.

5. Where fills are proposed on sidehill areas, gullies and natural drainageways, loose material at the bottom and sides should be stripped down to stiff natural ground before the placement of fills. New fills should be keyed into the stiff natural ground.
6. Where fills are proposed in natural drainageways or gullies, trenches should be cut in a herringbone pattern along the bottom and sides before the placement of fills. Subdrains should be placed in the trenches. The locations of subdrains should be determined in the field after clearing and grubbing.

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.

8. If boulders are proposed to be used in the construction of fills, they should be generally placed along the toe sections of fill slopes and outside of probable building sites. Before placing any boulders, the subgrade should be
stripped to stiff natural ground and shaped to drain. A layer of filter material should be placed on the subgrade and the boulders placed on the filter layer. The void spaces between boulders should be filled with granular material. A blanket of filter material should be placed against the boulders before earth fills are placed against the boulders. See the attached sketch, Figure 1.

9. Fills should be laid in 6-in. compacted layers to 90% of the maximum density determined by the AASHO T-180-57 test method.

However, the on-site soils from the deeper cut areas generally will have relatively high water contents and may be difficult to compact. In such cases, the construction of fills should be compacted in one-foot or thinner layers to the maximum density obtainable in the laboratory at the water content approximating the field moisture condition. In addition, the relative density of the compacted soil should be greater than 85% of AASHO T-180-57 density.
10. Provisions should be included to drain the site during and after filling operations.

Slopes

In general, cut and fill slopes of 2 horizontal to 1 vertical or flatter should be used.

If slope heights (top to toe) of greater than 20 ft are considered, 8-ft-wide benches should be placed at height intervals of about 15 ft.

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

The surface of fill slopes should be compacted by cat-tracking or with a sheepsfoot roller.

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.
Foundations

For the proposed light residential structures, conventional house foundations such as slab-on-ground or post-and-beam construction may be used.

General recommendations for foundation design are as follows:

1. Bearing values for a given soil usually vary with the size and depth of footings. For light residential structures, bearing values of about 1500 p.s.f. may be used for footings on stiff natural ground or on compacted fills.

2. Soft spots or pockets of loose material encountered in footing excavations or below the building area should be excavated and replaced with well-graded granular material such as coral or other approved material.

3. Concrete slabs on ground should be placed over a base course of 4 in. of well-graded gravel less than 3/4-in. and greater than 1/4-in. in size. The subgrade should be compacted and shaped to a level surface or to drain, if practicable, and generally
should be kept slightly higher than the finish grade outside the building.

4. Because of the downhill creep effect of soils on a slope, some settlements may occur near the tops of slopes. Buildings should generally be placed about 15 ft from the tops of slopes. This distance may be reduced for lower slope heights, e.g., 10 ft for 10-ft-high slopes, but generally not closer than 5 ft from the top of any slope.

5. Construction of retaining walls on slopes should generally be avoided.

6. Good surface drainage away from the foundations of structures should be maintained and the site should be graded to prevent the ponding of water.

Roadway

In general, an estimate of the roadway pavement thickness for the light automobile traffic anticipated is as follows:

2. Base course - 6-in. base course.

3. Subbase course - 6-in. select material over a prepared subgrade.

Provisions should be made in the contract documents to allow for local adjustments regarding select borrow subbase and borrow material requirements in the field in accordance with the design standards of the City and County of Honolulu. In fill areas, the use of select soils within the top 2 to 3 ft of the subgrade may reduce the thickness of or eliminate the need for the select borrow subbase or borrow courses.

The subgrade should be compacted and shaped to drain. To avoid the ponding of water and softening of the subgrade at low points, weep holes should be placed at subgrade levels thru the walls of the catch basins which are placed in these low areas.

Existing Cesspools

Cesspools may be encountered generally near locations where old residences were located. Cesspools encountered should be flagged in the field, located on the plans and then backfilled.
Before backfilling, sludge should be removed from the bottom of the cesspool. Backfill material should generally be fairly well-graded granular material. The materials should be placed in thin level layers and rammed into place or compacted with vibratory equipment. The top 3 ft should be constructed with soils similar to the surrounding soils and should be constructed in 6-in. compacted layers.

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
Unforeseen or undetected conditions such as soft spots, seepage water or expansive soil pockets may occur in localized areas and will have to be adjusted and corrected in the field as they are detected.

Site Regrading
After mass grading work is done and cuts and fills are made according to the grading plans, regrading at some future date should be avoided unless done under the guidance of a Soils Engineer.
PROPOSED SPECIFICATION FOR EARTHWORK

AHUIMANU HEIGHTS ESTATES

General Description

This item shall consist of clearing and grubbing, preparing of land to be filled, excavating and filling of the land, spreading, compacting and testing of the fill, and subsidiary work necessary for grading the site.

Clearing, Grubbing and Preparing Areas to be Filled

Vegetation, rubbish and miscellaneous material shall be removed and disposed of, leaving the disturbed area with a neat, debris-free appearance.

Loose surface and stockpiled soils shall be stripped to stiff natural ground before the placement of fills. Loose surface soils encountered at finish grade shall be scarified and recompacted.

The bottom and sides of gullies or natural drainageways shall be stripped down to stiff natural ground before the placement of fills.

Trenches shall be cut in a herringbone pattern and subdrains placed in the trenches to provide drainage paths for the bottom of the drainageway.
Materials

Fill material shall consist of selected on-site soils or approved borrow soils. The soils shall contain no more than a trace of organic and deleterious matter.

Borrow soils shall be select soils generally less than 3-in. maximum size, with more than 30% fines and a plasticity index generally less than 20.

Fill material placed in the top 2 ft of fills shall contain less than 30% gravel.

Placing, Spreading and Compacting Fill Material

The selected fill material shall be placed in level layers which, when compacted, shall not exceed 6 inches. Each layer shall be spread evenly and thoroughly blade-mixed during the spreading to insure uniformity of material and water content within each layer.

Rocks or cobbles shall not be allowed to nest and voids between rocks shall be carefully filled and compacted with small stones or earth.

When the water content of the fill material is well below the optimum for compacting purposes, water shall be added until the water content assures a thorough bonding during the compacting process.

When the water content of the material is well above the optimum for compacting purposes, the fill material shall be aerated by blading or by other satisfactory methods until the water content is near the optimum.
After each layer has been placed, mixed and spread evenly, it shall be compacted to 90% of maximum density in accordance with AASHO Test No. T-180-57 or other comparable density tests. Compaction shall be with sheepsfoot rollers, multiple-wheel pneumatic-tired rollers or other acceptable rollers which shall be able to compact the fill to the specified density. Rolling shall be accomplished while the fill material is at the specified water content. The rolling of each layer shall be continuous over its entire area and the roller shall make sufficient passes to obtain the desired density.

Field density tests shall be made to get an indication of the compaction of the fill. Where sheepsfoot rollers are used, the soil may be disturbed to a depth of several inches. Density readings shall be taken as often as necessary in the compacted material below the disturbed surface. When these readings indicate that the density of any layer of fill or portion thereof is below the required 90% density, that layer or portion shall be reworked until the required density has been obtained.

The fill operation shall be continued in 6-in. compacted layers, as specified above, until the fill has been brought to the finished slopes and grades as shown on the accepted plans.

Compaction of High Moisture Fill Material

The on-site soils from the deeper cut areas with relatively high water contents will be difficult to compact.
When used for the construction of fills, these soils shall be compacted in one-foot layers to the maximum density obtainable in the laboratory at the water content approximating the field moisture condition. In addition, the relative density of the compacted soil shall be greater than 85% of AASHO Test No. T-180-57.

Boulder Fills

If boulders are used for the construction of fills, they shall be generally placed along the toe section of slopes. The subgrade shall be stripped to stiff natural ground, shaped to drain and a layer of filter material shall be placed on it. Nesting of boulders shall be avoided. Voids shall be filled with smaller granular soils. A blanket of filter material shall be placed against the boulder fill before construction of fills against it.

Backfilling of Old Cesspools

The following procedures shall be followed for backfilling:

1. **Sludge Removal**

   Remove the sludge from the bottom of the old cesspool by (a) pumping or (b) by clamshell or any other suitable way. The material shall be disposed of away from the site. The completeness of removal shall be verified by probing and the sludge shall be less than 12 in. at the bottom.
(2) **Granular Fill (below 3 ft from finish grade)**

Use granular material, graded from 6 to 0 inches. The fines passing the No. 200 sieve shall be less than 10%. The materials shall be placed in thin layers (12 in. maximum) and compacted with vibratory equipment to 90% of AASHO T-180-57 density. Ramming each layer into place with a clamshell bucket will be allowed. The granular fill shall be wetted before placement into the cesspools. Sufficient compaction tests shall be conducted to verify that 90% compaction is obtained by the construction method selected.

(3) **Top 3 Ft of Fill**

Linings encountered in the cesspools within the top 3 ft from finish grade shall be removed. The fill within the top 3 ft from finish grade shall be constructed from onsite soil in thin layers (6-in. compacted thickness) to 90% of AASHO T-180-57 density. The material at finish grade shall blend with the surrounding soil.

**Excavation**

Suitable material from excavation shall be used in the fill and unsuitable material from excavation shall be disposed of.
Unforeseen Conditions

If unforeseen or undetected critical soil conditions such as soft spots, seepage water or expansive soil pockets are encountered, corrective measures shall be made in the field as they are detected.

Rainy Weather

Fill material shall not be placed, spread or rolled during unfavorable weather conditions. When the work is interrupted by heavy rain, fill operations shall not be resumed until field tests indicate that the water content and density are as previously specified.
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 sieve analysis test results.
# Boring Log

**PROJECT**: AHUIMANU HEIGHTS ESTATES  
**LOCATION**: Kahaluu, Koolaupoko, Oahu, Hawaii  
**Tax Map Key**: 4-7-31: 7, 9 & 10  

**HAMMER**:  
- **Weight**: 140*  
- **Drop**: 30”  
**SAMPLE**: 2” STANDARD SPLIT SPOON  

## United Soil Classification

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*Elevation Estimated  
From Contour Map  
Dated 4-28-72
**Boring Log**

**PROJECT:** AHIUMANU HEIGHTS ESTATES  
**LOCATION:** Kahaluu, Koolaupoko, Oahu, Hawaii  
**Tax Map Key:** 4-7-31: 7, 9 & 10

**HAMMER:**  
Weight: 140 lbs  
Drop: 50"

**SAMPLER:** 2" STANDARD SPLIT SPOON

---

**LOCATION**  
Kahaluu, Koolaupoko, Oahu, Hawaii  
Validated by: M. W. Meyer, Kaku, Radowich

**ELEVATION** from Adjacent Contour Map  
Dated 4-28-72

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*Elevation Estimated from Contour Map  
Dated 4-28-72
Boring Log

**PROJECT**: AHUIMANU HEIGHTS ESTATES

**LOCATION**: Kahaluu, Koolaupoko, Oahu, Hawaii

**Tax Map Key**: 4-7-31: 7, 9 & 10

**HAMMER**: 40#

**Weight**: 30"

**Drop**: 2" 3" 2.09.D. THIN WALL TUBE

**SAMPLER**: 2" SS 2.09. STANDARD SPLIT SPOON

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| (MH) STIFF, BROWN CLAYEY SILT W/ GRAY CLAY POCKETS | | | | | | | | | | | END OF BORING @ 21.5'

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**Elevation Estimated From Contour Map Dated 4-28-72**
# Boring Log

**PROJECT**  
AHUMANU HEIGHTS ESTATES

**LOCATION**  
Kahaluu, Koolaupoko, Oahu, Hawaii

**Tax Map Key:**  
4-7-31: 7, 9 & 10

**Driller**  
W. LUM ASSOC. INC.

**Date**  
May 22, 1972

**Type of Boring**  
MOBILE AUGER

**Drill Bit**  
FINGER TYPE

**Date of Boring**  
5-22-72

**Water Level**  
13.5

**Time**  
3:35 PM

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**UNITED SOIL CLASSIFICATION**

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**Elevation Estimated From Contour Map**  
Dated 4-28-72
**Boring Log**

**PROJECT:** AHUMANU HEIGHTS ESTATES

**LOCATION:** Kahaluu, Koolaupoko, Oahu, Hawaii

**Tax Map Key:** 4-73-31: 7, 9 & 10

**HAMMER:**
- **Weight:** 140 lbs
- **Drop:** 30".

**SAMPLER:**
- **2" S & 2" O.D. THIN WALL TUBE**
- **2" S & 2" STANDARD SPLIT SPOON**

---

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<tr>
<th>United Soil Classification</th>
<th>DESCRIPTION</th>
<th>ELEV.</th>
<th>Depth (Ft.)</th>
<th>J</th>
<th>Sample No.</th>
<th>Wet Density P.C.F.</th>
<th>Water Cont.</th>
<th>Dry Density P.C.F.</th>
<th>Hardness Comp.</th>
<th>H.C.</th>
<th>Penetration Test</th>
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*Elevation Estimated From Contour Map Dated 4-28-72*
## Boring Log

**PROJECT**  
AHUIMANU HEIGHTS ESTATES

**LOCATION**  
Kahaluu, Koolaupoko, Oahu, Hawaii

**Tax Map Key:** 4-7-31: 7, 9 & 10

### HAMMER:
- **Weight:** 40*
- **Drop:** 20"
- **Type:** 2" 5/8" O.D. THIN WALL TUBE
- **Sampler:** 2" 5/8" STANDARD SPLIT SPOON

### PENETRATION DATA

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- **Elevation Estimated From Contour Map Dated 4-28-72**
## Boring Log

**PROJECT**  
AHUIMANU HEIGHTS ESTATES

**LOCATION**  
Kahaluu, Koolaupoko, Oahu, Hawaii  
Tax Map Key:  4-7-31: 7, 9 & 10

**HAMMER:**  
Weight: 140 lb  
Drop: 30"

**SAMPLER:**  
2" S - 2" O.D. THIN WALL TUBE  
2" SW - 2" STANDARD SPLIT SPOON

---

### ELEV. = 99' ± 2"

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*Elevation Estimated  
From Contour Map  
Dated 4-28-72*
**WALTER LUM ASSOCIATES, INC.**

**Boring Log**

**PROJECT**  AHUIMANU HEIGHTS ESTATES  
**LOCATION**  Kahalu'u, Koolaupoko, Oahu, Hawaii  
**Tax Map Key**  4-7-31: 7, 9 & 10

**HAMMER:**  
- **Weight:** 140*  
- **Drop:** 30"  
**SAMPLER:**  
- **2" 5'-2" O.D. THIN WALL TUBE**

**LOCATION**  
- Kahalu'u, Koolaupoko, Oahu, Hawaii

**Field Party**  GLORY KAKU KAPUICH  
**Date**  MAY 29, 1972

**Type of Boring**  AUGER (MOBILE)  
**Diam.**  9"  
**Elev.**  92' + *  
**Datum**  
**Drill Bit**  FINGER TYPE

**Water Level**  
**Time**

**Date**  5-29-72

---

**ENHANCED PENETRATION DATA**

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<td>3/0.5', 5/0.5'</td>
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<td>30</td>
<td>3/0.5', 5/0.5'</td>
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<td>40</td>
<td>3/0.5', 5/0.5'</td>
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**UNIFIED CLASSIFICATION**

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<td>2'5&quot;</td>
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**DESCRIPTION**

- MEDIUM, MOTTLED BROWN CLAYEY SILT W/ TRACES OF OR. ROOTS
- STIFF, BROWN CLAYEY SILT
- MOTTLED TAN BROWN CLAYEY SILT
- MOTTLED BROWN CLAYEY SILT W/ DECOMPOSED ROCK
- MEDIUM, MOTTLED TAN BROWN & GRAY CLAYEY SILT W/ DECOMPOSED ROCK
- STIFF, MOTTLED REDDISH BROWN & GRAY CLAYEY SILT
- TAN, CLAYEY SILT
- MEDIUM, LAVENDER, GRAY & BROWN SILTY, CLAY W/ DECOMPOSED ROCK
- END OF BORING @ 22'  

*Elevation Estimated From Contour Map  
Dated 4-28-72
TABLE I.A - SUMMARY OF LABORATORY TEST RESULTS

| BORING NO. | SAMPLE NO. | DEPTH BELOW SURFACE | DESCRIPTION | GRAIN-SIZE ANALYSIS (% Passing) | ATTERBERG LIMITS | UNIFIED SOIL CLASSIFICATION | APPARENT SPECIFIC GRAVITY | EXPANSION AND CBR TESTS | MOISTURE-DENSITY RELATIONS OF SOILS | REMARKS:
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<td>SURFACE 5-10'</td>
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<td>MH</td>
<td></td>
<td>(Surcharge-51 P.S.F.)</td>
<td>(AASHO T-180-57 Method)</td>
<td>Date 6-19-72 By BT</td>
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<tr>
<td></td>
<td></td>
<td>D</td>
<td>LIGHT</td>
<td>BROWN CLAYEY SILT</td>
<td>NATURAL</td>
<td>MH</td>
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<td>Molding Moisture, %</td>
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<td>CLAYEY SILT CLAYEY SILT</td>
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<td>Max. Dry Density (P.C.F.)</td>
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<td>WIDERCOMP. ROCK</td>
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<td>Swell upon saturation, %</td>
<td>Optimum Moisture (%)</td>
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<td>MH</td>
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<td>CBR at 0.1&quot; Penetration</td>
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WALTER LUM ASSOCIATES, INC.
CIVIL, STRUCTURAL, SOILS ENGINEERS
# Table I-8 - Summary of Laboratory Test Results

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<td>5' - 65'</td>
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**Remarks:**

Date 6-19-72  By WJ
### Table I - Summary of Laboratory Test Results

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<th>Sample No.</th>
<th>Depth Below Surface</th>
<th>Description</th>
<th>Grain-Size Analysis (% Passing)</th>
<th>Atterberg Limits</th>
<th>Unified Soil Classification</th>
<th>Apparent Specific Gravity</th>
<th>Expansion and CBR Tests</th>
<th>Moisture-Density Relations of Soils</th>
<th>Remarks</th>
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<td>Tan &amp; Gray</td>
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**Atterberg Limits**
- Air Dried or Natural
  - Liquid Limit
  - Plastic Limit
  - Plasticity Index
  - Dilatancy
  - Toughness
  - Dry Strength

**Unified Soil Classification**

**Expansion and CBR Tests**
- (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-180-57 Method)
  - Dry to Wet or Wet to Dry
  - Max. Dry Density (P.C.F.)
  - Optimum Moisture (%)

**Remarks:**

Date: 6-19-72

By: [Signature]
# TABLE I.D - SUMMARY OF LABORATORY TEST RESULTS

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## GRAIN-SIZE ANALYSIS

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### ATTERBERG LIMITS

- **Air Dried or Natural**
  - Liquid Limit
  - Plastic Limit
  - Plasticity Index
  - Dilatancy
  - Toughness
  - Dry Strength

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## EXPANSION AND CBR TESTS

- **Surcharge-51 P.S.F.**
  - Molding Moisture, %
  - Molding Dry Density, P.C.F.
  - Swell upon saturation, %
  - CBR at 0.1" Penetration

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## MOISTURE-DENSITY RELATIONS OF SOILS

- **AASHO T-180-57 Method**
  - Dry to Wet or Wet to Dry
  - Max. Dry Density (P.C.F.)
  - Optimum Moisture (%)

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<th>WET TO DRY</th>
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## REMARKS:

Date: 6-19-73  By: B.F.
PLASTICITY CHART

PROJECT: AHUIMANU HEIGHTS ESTATES
LOCATION: KAHALUU, Koolaupoko, OAHU, HAWAII

DATE 6-19-72 BY
MOISTURE-DENSITY CURVE (AASHO T-180-57, METHOD A)

PROJECT: AHUIMANU HEIGHTS ESTATES

LOCATION: KAAHALII, KOOLOUPOKO, OAHU, HAWAII

SAMPLE NO: 0 SURFACE

SAMPLE DESCRIPTION: BROWN SILTY SAND W/GRAVEL & ROOTS

AGGREGATE: 4" MINUS
MOLD SIZE: 4" x 4.5" HIGH
HAMMER: 10 lbs., 13" DROP
LAYERS: 5
BLOWS: 251 LAYER

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

PROJECT: AHUMAHU HEIGHTS ESTATES

LOCATION: KAHALUU, KOOLAUPoko, OAHU, HAWAII

SAMPLE NO: 1 SURFACE

SAMPLE DESCRIPTION: DARK BROWN CLAYEY SILT

TEST RESULTS:

MOLDING MOISTURE, %: 37.7
MOLDING DRY DENSITY, P.C.F: 82.6
CBR @ 0.1" PENETRATION: 17.2
DAYS SOAKED: 4

LOAD (PSI)

0 50 100 150 200 250 300 350 400 450 500

PENETRATION (INCHES)

0 0.1 0.2 0.3 0.4 0.5

Load (LBS)

0.255 135 45
0.080 280 90
0.075 410 137
0.100 525 115
0.125 620 207
0.150 700 235
0.175 780 260
0.200 820 271
0.250 890 297
0.300 960 320
0.350 1020 340
0.400 1070 351
0.450 1120 372
0.500 1180 392

CBR PENETRATION DATA

AGGREGATE 3/4" MINUS
HAMMER WEIGHT 10 LBS
HAMMER DROP 18"

No. OF BLOWS 50 LAYER
No. OF LAYERS 5

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

PROJECT: AHUIMANU HEIGHTS ESTATES

LOCATION: KAHALUII, KEOLOPOKO, OAHU, HAWAII

SAMPLE NO: 5 SURFACE

SAMPLE DESCRIPTION: BROWN CLAYEY SILT

TEST RESULTS:

MOLDING MOISTURE, %: 42.4

MOLDING DRY DENSITY, P.C.F.: 74.3

CBR @ 0.1" PENETRATION: 12.8

DAYS SOAKED: 6

DATE: 5.25.72 BY WALTER LUM

DATE: 5.31.72 BY WALTER LUM
CBR TEST

PROJECT: AHUIMANU HEIGHTS ESTATES

LOCATION: KAHALUU, Koolaupoko, OAHU, HAWAII

SAMPLE NO: 0 SURFACE

SAMPLE DESCRIPTION: BROWN SILTY SAND WITH GRAVEL & ROOTS

CBR PENETRATION DATA

<table>
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<th>PENETRATION (INCHES)</th>
<th>LOAD (LBS)</th>
<th>LOAD (PSI)</th>
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<tr>
<td>0.500</td>
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</table>

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

TEST RESULTS:

MOLDING MOISTURE, %: 29.9
MOLDING DRY DENSITY, P.C.F.: 60.2
CBR @ 0.1" PENETRATION: 105
DAYS SOAKED: 4

DATE 5-19-72 BY MO
DATE 5-24-72 BY SK

WALTER LUM ASSOCIATES, INC.
CIVIL, STRUCTURAL, SOILS ENGINEERS
FIGURE 1
PROPOSED BOULDER FILL
AHUIMANU HEIGHTS ESTATES
KAHALULU, OAHU, HAWAII
TAX MAP KEY: 4-7-31: 7, 7 & 10

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

JUNE, 1972
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 and the changed conditions.

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.