MILILANI TOWN UNIT 32
PRELIMINARY SOIL REPORT
WAPIO, EWA, OAHU, HAWAII
TAX MAP KEY: 9-4-05: POR. 1

To: MILILANI TOWN, INC.

WALTER LUM ASSOCIATES, INC.
CIVIL, STRUCTURAL, SOILS ENGINEERS
DECEMBER 17, 1975

MUNICIPAL REFERENCE RECORDS CENTER
City & County of Honolulu
City Hall Annex, 950 S. King Street
Honolulu, Hawaii 96813
December 17, 1975

MR. GENE FERGUSON
Mililani Town, Inc.
P. O. Box 2780
Honolulu, Hawaii 96803

Dear Mr. Ferguson:

Subject: Mililani Town Unit 32
Preliminary Soil Report
(for site grading design considerations for residential development)
Waipio, Ewa, Oahu, Hawaii
Tax Map Key: 9-4-05: Por. 1

Transmitted herewith is our preliminary soil report for site grading design considerations for residential development at the proposed site for Mililani Town Unit 32 at Waipio, Ewa, Oahu, Hawaii.

This report includes a Boring Location Sketch, boring logs, laboratory test results, general site grading design guidelines and limitations.

Respectfully submitted,

WALTER LUM ASSOCIATES, INC.

By Ezra Koike

FM/EK: sa
# CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCOPE OF EXPLORATION</td>
<td>1</td>
</tr>
<tr>
<td>FIELD EXPLORATION</td>
<td>1</td>
</tr>
<tr>
<td>LABORATORY TESTS</td>
<td>2</td>
</tr>
<tr>
<td>SOIL DESCRIPTIONS BY OTHERS</td>
<td>2</td>
</tr>
<tr>
<td>SOIL CLASSIFICATION SYSTEM</td>
<td>2</td>
</tr>
<tr>
<td>GENERAL SITE CONDITIONS</td>
<td>3</td>
</tr>
<tr>
<td>INTERPRETATION OF SOIL CONDITIONS</td>
<td>3</td>
</tr>
<tr>
<td>DISCUSSION AND RECOMMENDATIONS</td>
<td>4</td>
</tr>
</tbody>
</table>

PROPOSED SPECIFICATION FOR EARTHWORK

APPENDICES:

A. LOGS OF BORINGS - Boring Nos. 1 thru 12
B. SUMMARY OF LABORATORY TEST RESULTS - Tables IA thru ID
C. PLASTICITY CHART
D. MOISTURE DENSITY CURVES
E. CBR TESTS
F. BORING LOCATION SKETCH
G. SUGGESTED BOULDER FILL - Figure 1
H. LIMITATIONS
MILILANI TOWN UNIT 32
PRELIMINARY SOIL REPORT

WAIPIO, EWA, OAHU, HAWAII
TAX MAP KEY: 9-4-05: POR. 1

SCOPE OF EXPLORATION

The purpose of this exploration was to evaluate general soil conditions for site grading design considerations for residential development for the proposed Mililani Town Unit 32 at Waipio, Ewa, Oahu, Hawaii.

This report includes field explorations, laboratory tests, general site grading design guidelines and limitations.

FIELD EXPLORATION

Twelve exploratory borings were made at the site. The approximate locations of these borings are shown on the Boring Location Sketch. Descriptions of the underlying soils encountered are shown on Boring Logs Nos. 1 thru 12.

Borings were made with 4-in. diameter augers using finger-type and carbide drag bits. Soil samples were recovered with 3-in. thin-wall tube samplers and standard split spoon samplers driven with a 140-lb hammer falling 30 inches.

Logs of 4 borings from "Mililani Town Unit 30," October 14, 1975, are attached for reference.
LABORATORY TESTS

Laboratory tests included: natural water content and density, unconfined compression, laboratory vane shear, Atterberg limit, specific gravity, ASTM D 1557-70 density and CBR.

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

SOIL DESCRIPTION BY OTHERS

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

August 1972:

Northern 3/4 of site
WaA, Wahiawa silty clay, 0 to 3% slopes,
Unified Soil Classification: MH

Southern 1/4 of site
LaB, Lahaina silty clay, 3 to 7% slopes,
Unified Soil Classification: CL-ML

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 about 3,200 ft west of Kamehameha Highway and 1/2 mile north of Kipapa Gulch Bridge.

The average annual rainfall at the proposed site may range around 30 to 40 inches.

The existing ground slopes down toward the southeast at gradients of about 2 to 10% with localized variations.

The site was formerly a pineapple field. At the time of the field exploration, the site was overgrown with weeds and brush and crossed by haul roads.

An unpaved access road crossed the site in an east-west direction in the northerly portion of the site.

A lined ditch, about 2 to 3 ft deep and 3 to 4 ft wide was located along the southern side of the access road. The abandoned lined ditch was broken up in places and partially buried.

An existing refuse dumping area was noted southeast of the site.

INTERPRETATION OF SOIL CONDITIONS

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

Stiff to hard, reddish-brown clayey silts and some silty clays (MH and MH-CH soils) and stiff brown clayey silts with decomposed rock to about 21 ft, the maximum depths drilled.
Clay (CH soil) pockets were encountered in some borings, generally near the surface in the southerly portions and at about 11 to 19-ft depths at the northerly portions of the site.

Water was not noted in the borings during the field explorations.

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

DISCUSSION AND RECOMMENDATIONS

The present plan is to clear and grade the site for a single-family residential development.

The preliminary grading design sketches indicated cuts and fills generally less than about 10 ft.

The refuse dumping area noted southeast of the site should be located and plotted for consideration in grading design for Unit 32. If buried rubbish or other fill materials, particularly in the southeasterly portion of site, should be detected during grading operations, they should be removed to stiff natural ground prior to filling.

Site Grading

Vegetation, rubbish, other fills and miscellaneous debris should be cleared and removed prior to site filling. Localized hard and soft pockets encountered during the site preparations should be excavated and replaced with selected soils compacted in thin lifts.
In general, selected on-site soils may be used for the construction of the proposed fills. Clayey soils that may be encountered near the surface at the southerly portions and in the deeper excavations of the northerly portions of the site should generally be placed in fills away from the face of slopes and outside of building pads.

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

1. The site should be cleared and grubbed.

2. Topsoil, rubbish and stockpiled soils should be stripped to stiff natural ground before placement of fills.

Thin layers of loose surface soils near finish or existing grade should be scarified and recompacted.

3. Hard surfaces along existing haul roads should be scarified down to stiff soils and recompacted to match the density of the surrounding soil.
4. If drainage or old irrigation ditches are encountered, the bottoms and sides of the existing drainage ditches should be stripped down to stiff natural ground or scarified and recompacted before the placement of fills.

5. 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 bench to a generally level condition. As the fill is brought up, it should continually be keyed into the stiff natural ground by cutting steps into the slopes and compacting the fill into these steps.

6. If boulders are proposed to be used in the construction of fills, they generally should be placed along the toe sections of fill slopes and outside of probable building sites. Before placement of any boulders, the subgrade should be stripped to stiff natural ground and shaped to drain. A transition layer of select granular material (6 in. to dust sizes) should be placed on the subgrade.
and the boulders should be placed on the select material. Earth fill may be used in the void spaces between boulders. A transition layer of select granular material should also be placed against the boulders before earth fills are placed against the boulders. See attached sketch, Figure 1.

7. In general, fills should be laid in 6-in. compacted layers to 90% of the maximum density determined by the ASTM D 1557-70 test method. In roadway areas, the top 2 ft of fill should be compacted to 95% of the maximum density.

8. Provisions to drain the site during and after the completion of filling operations should be included.

Slopes

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

If slope heights (top to toe) of greater than 15 ft are considered, 8-ft-wide benches should be placed at height intervals of about 15 ft. Slopes should be limited to 30 ft in height, wherever practicable.
To lessen erosion, the runoff from rainstorms should be diverted away from slopes by berms or ditches wherever practicable. Slope planting is recommended on cut and fill slopes.

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

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

In general, when clay pockets are encountered in cut slopes, the slopes should be adjusted by the use of flatter slopes or the removal of the clay "CH" soils and reconstruction of the slopes with select granular material compacted in thin lifts. The actual remedial measures should be adjusted according to field conditions.

Regrading of slopes, cutting and removing the toes of slopes, constructing walls and structures on slopes, placing utility trenches on slopes or along the toes of slopes, etc., can cause instability problems. These conditions will require special attention, otherwise, field adjustments may be required when they are detected.

Foundations
In general, light, wood-frame residential structures are contemplated.
In general, on fairly level lots, where the buildings are situated 15 ft from the tops of slopes, conventional house foundations such as beam-on-post type or slab-on-ground type foundations may be considered.

Some clayey or expansive soils may be encountered in localized areas near the surface in the southerly portions and generally in the deeper excavations in the northerly portions of the site. Beam-on-post type construction should be considered in clayey or expansive soils. Adjustments may be made in the field wherever clayey expansive soils are detected.

Other general guidelines for foundation design considerations are as follows:

1. Footings should be placed on existing stiff ground or on well-compacted fill.

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.

3. Bearing values for a given soil usually vary with the size and depths of footings. For light residential structures, bearing values of about 2000 p.s.f. may be used for footings on stiff natural ground or on compacted fill.
4. Where slab on ground construction will be over the deeper fills, house construction should be delayed as long as practicable to allow the fill and subsoils to adjust to the new load conditions.

5. Where slab on ground is considered over clayey silts, the subgrade should be scarified and recompressed at water contents above the plastic limit.

6. 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 or over some form of capillary break. 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 of the outside of the houses.

7. A few units may be partly on cut and partly on fill. For slab-on-ground construction, to lessen differential settlements that may occur, the cut area below the unit should be excavated to a depth of about 2 ft and recompressed to match the density of the fill area.
8. For slab on ground construction over clayey soils, the surface clay (CH soil) should be removed and replaced with 3 ft of select non-expansive soil below the slabs and foundations. Prior to placing and compacting the selected soil, the moisture content of the clay soils at the bottom of the excavation should be on the wet side of optimum moisture and not allowed to dry-out to lessen the heave potential.

9. If practicable, particularly where clay or expansive soils are detected, the houses should be designed with flexible superstructures to accommodate some up and down movements of the ground surface resulting from environmental or weather changes.

10. Foundations located over or adjacent to a utility trench should be designed to span over the trench or the footings should extend below the bottom of the trench.

11. Construction of retaining walls on slopes should generally be avoided.
12. Good surface drainage away from the foundations of structures should be maintained and the site should be graded to prevent the ponding of water.

Joint Details
To lessen the heave or wavy surface effects at the ground floor level, nonbearing partitions, doors, cabinets, etc., should be designed with loose fits and other precautions to allow for some future adjustments or maintenance.

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


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

3. Subbase course - 6-in. subbase course over a prepared subgrade.

Provisions in the contract documents should allow for local adjustments regarding select borrow subbase and borrow 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 placed in these low areas.

**Utilities**

Utilities should be placed after the fills are constructed. The bottoms of utility trenches should be daylighted at low points and graded to drain water, particularly near the tops and toes of slopes. The backfill of trenches should be well-compacted, particularly at the toes of slopes.

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

**Unforeseen Conditions**

Because of the variability of soil deposits, site improvements, designs and construction techniques, existing or changed conditions may be encountered that cannot be foreseen with even the most exhaustive studies of site and project conditions. These unforeseen conditions should be recognized and then evaluated so that the designs or the construction methods may be modified accordingly, if necessary.
Unforeseen or changed or undetected conditions such as soft spots, existing utility trenches, underground structures, pipes, voids or cavities, old tunnels, boulders, expansive soil pockets, seepage water, or water level changes with weather, etc., 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

MILILANI TOWN UNIT 32

I. GENERAL GRADING REQUIREMENTS

Grading work shall conform to Chapter 23 of Revised Ordinances of Honolulu, 1969 as amended.

II. SPECIFICATIONS FOR ON-SITE EARTHWORK

A. Scope of Work

The work to be performed under these specifications includes the furnishing of all labor, materials, tools and equipment for the earthwork at Mililani Town Unit 32. The work includes the preparation of the site, the excavation of materials and the placement of fill materials in accordance with the specifications and applicable plans, together with guidelines included in the preliminary soil report for this project.

B. Soil Engineer

The services of a soil testing firm shall be used. A soil technician shall be present at the site on an intermittent basis to observe grading progress and to take density tests.

A reasonable time shall be allotted to perform field and laboratory tests prior to the placement of additional fill.

The density test results shall be transmitted to the Contractor and to Mililani Town, Inc. Where low density test results are noted, the area shall be rerolled by the Contractor and retested by the Soils Engineer if, in his opinion, a test is necessary.

If the field observations and test results, in the opinion of the Soils Engineer, indicate that the earthwork is not in general conformance to the intent of the plans and soil report, the discrepancy shall be reported to the Contractor and the project representative from Mililani Town, Inc. for corrective action.
C. **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.

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

Hard surfaces such as access roadways, haul roads, etc., shall be scarified to a depth of about 12 in. and recompacted to approximately match the density of the surrounding soils.

Loose material at the bottoms and sides of drainage ditches and natural drainageways shall be stripped down to stiff natural ground before the placement of fills.

Silting basins shall be drained and loose and soft soils shall be stripped down to stiff ground and the backfill shall be compacted in accordance with Section II-E, "Placing, Spreading and Compacting Fill Material."

Where fills are constructed on sloping areas steeper than about 5 horizontal to 1 vertical, the ground at the toe of the fill shall be benched to a generally level condition. As the fill is constructed in approximately level layers, it shall continually be keyed into the stiff natural ground by cutting steps into the slopes and compacting the fill into these steps.

Known abandoned utility lines and abandoned lines encountered during construction that will be under proposed structures shall be removed and the trench recompacted to approximately match the density of the surrounding area but not less than 90% of ASTM D 1557-70 maximum density. Field adjustments may be considered where deep utility lines are encountered.

D. **Materials**

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

On-site or borrow soils shall be selected soils generally less than 6-in. maximum size, with more than about 30% fines and a plasticity index generally less than about 20.

Fill material placed in the top 2 ft of fills shall generally be less than about 3-in. maximum size with more than about 30% fines.
E. 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 blade-mixed during the spreading to attain uniformity of material and water content within each layer.

Rocks or cobbles shall not be allowed to nest and voids between rocks shall be 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 is near the optimum.

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 ASTM D 1557-70 or other comparable density tests. For fills in roadway areas, the top 2 ft of fill shall be compacted to 95% of the maximum density.

Compaction shall be with sheepsfoot rollers, multiple-wheel pneumatic-tired 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 soils 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 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.
F. **Slope Adjustments**

If clay soils are encountered in cut slopes, the slopes shall be adjusted by use of flatter slopes or by removal of the clay "CH" soils and reconstruction of the slopes with select granular materials. The actual remedial measures will depend upon field conditions.

G. **Boulder Fills**

If boulders are used for the construction of fills, they shall be generally placed along the toe sections of slopes and outside of probable building sites. The subgrade shall be stripped to stiff natural ground, shaped to drain and a transition layer of select granular material (maximum 6-in. to dust sizes) shall be placed on it. Smaller granular materials shall be used in the void spaces between boulders. A transition layer of select granular material shall be placed against the boulder fill before construction of fills.

H. **Excess Boulders**

Excess boulders not used for construction shall be removed from the project site by the contractor.

I. **Excavation**

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

J. **Unforeseen Conditions**

If unforeseen or undetected soil conditions such as soft spots, new and existing utility trenches, structure foundations, voids or cavities, boulders, seepage water or expansive soil pockets, etc., are encountered, corrective measures shall be made in the field as they are detected.

K. **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 grain-size analysis test results.
Boring Log

PROJECT: MILILANI TOWN UNIT 32
LOCATION: Waipio, Ewa, Oahu, Hawaii

* Tax Map Key: 9-4-05: Por. 1

HAMMER:
- Weight: 140 #
- Drop: 90"

SAMPLER: 2" STANDARD SPLIT SPOON

UNIFIED SOIL CLASSIFICATION

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<th>Soil</th>
<th>Description</th>
<th>Sample No.</th>
<th>Depth (ft)</th>
<th>Water Cont. %</th>
<th>Und. Comp. P.F.</th>
<th>Vane Shear Test</th>
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<td>31</td>
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* Elevation estimated from preliminary grading plan by Belt, Collins & Associates, Ltd.

NOTES:
- LL: LIQUID LIMIT
- PL: PLASTIC LIMIT
## Boring Log

**PROJECT:** MILILANI TOWN UNIT 32  
**LOCATION:** Waipio, Ewa, Oahu, Hawaii  
*Tax Map Key: 9-4-05: Por. 1*

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

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<th>DESCRIPTION</th>
<th>Depth (ft)</th>
<th>Sample No.</th>
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**ELEVATION:** 507\(\frac{1}{2}\)  
**NOTE:** LL = LIQUID LIMIT  
PL = PLASTIC LIMIT  

* Elevation estimated from preliminary grading plan by Belt, Collins & Associates, Ltd.
**Boring Log**

**PROJECT**
MILLILANI TOWN UNIT 32

**LOCATION**
Waipio, Ewa, Oahu, Hawaii

*Tax Map Key: 9-4-05: Por. 1*

**HAMMER:**
Weight 140#
Drop 90" 2" 3" 2" STANDARD SPLIT SPOON
3" 5" 3" O.D. THIN WALL TUBE

**LOCATION**
Waipio, Ewa, Oahu, Hawaii Field Party KAKU, CHOW, KAU

**Type of Boring**
AUGER (MOBILE) Diam. 4"

**Elev.**
514 ± *

**Datum**

**FINGER TYPE**

**Drill Bit**

**Driller**
W. LUM ASSOC., INC., Date No. Z-11-1

**Date**
11-21-75

**LOCATION**
Waipio, Ewa, Oahu, Hawaii Field Party KAKU, CHOW, KAU

**Type of Boring**
AUGER (MOBILE) Diam. 4"

**Elev.**
514 ± *

**Datum**

**FINGER TYPE**

**Drill Bit**

**Driller**
W. LUM ASSOC., INC., Date No. Z-11-1

**Date**
11-21-75

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**Unified Soil Classification**

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**END OF BORING @ 21.5' 11-21-75**

**PENETRATION DATA**

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<th>Penetration Test</th>
<th>3&quot; O.D. THIN WALL TUBE</th>
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**Standard Penetration Test**

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<tbody>
<tr>
<td>N (Blows per foot)</td>
</tr>
</tbody>
</table>

---

* Elevation estimated from preliminary grading plan by Belt, Collins & Associates, Ltd.

**NOTE:***

LL: LIQUID LIMIT
PL: PLASTIC LIMIT
Boring Log

PROJECT: MILLIANI TOWN UNIT 32
LOCATION: Waipio, Ewa, Oahu, Hawaii

**Tax Map Key: 9-4-05: Por. 1**

**PROJECT...**
**LOCATION...**

**HANGER:**
- Weight: 140 #
- Drop: 30'

**SAMPLER:** 2" STANDARD SPLIT SPOON

---

* Elevation estimated from preliminary grading plan by Belt, Collins & Associates, Ltd.*
Boring Log

PROJECT: MILLIANI TOWN UNIT 32
LOCATION: Waipio, Ewa, Oahu, Hawaii

* Tax Map Key: 9-4-05: Por. 1

HAMMER:
- Weight: 140#
- Drop: 30"

SAMPER:
- 2.55 - 2" STANDARD SPLIT SPOON
- 5" - 3" O.D. THIN WALL TUBE

ELEVATION: 531.2' ±

**penetration data**

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<td>2.55</td>
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* Elevation estimated from preliminary grading plan by Belt, Collins & Associates, Ltd.

**Note:** Hard drilling @ 117'-115' (Decomposed Rock?)

End of Boring @ 117.5' 11-28-75
# Boring Log

**PROJECT:** MILILANI TOWN UNIT 32  
**LOCATION:** Waipio, Ewa, Oahu, Hawaii  
* Tax Map Key: 9-4-05: Port. 1

**HAMMER:**  
- **Weight:** 140 lbs  
- **Drop:** 30 ft

**SAMPLER:**  
- 2.5S - 2" STANDARD SPLIT SPOON  
- 5" S - 5" O.D. THIN WALL TUBE

---

## PENETRATION DATA

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<tr>
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**NOTE:**  
- LLs: LIQUID LIMIT
- PLs: PLASTIC LIMIT

* Elevation estimated from preliminary grading plan by Belt, Collins & Associates, Ltd.
**Boring Log**

**PROJECT**  
MILLILANI TOWN UNIT 32

**LOCATION**  
Waipio, Ewa, Oahu, Hawaii  
*Tax Map Key: 9-4-05: Por. 1*

**HAMMER:**

- **Weight:** 140 lbs.
- **Drop:** 30"
- **SAMPLER:**
  - 2" S3 -2" STANDARD SPLIT SPOON
  - 3" 5 - 3" O.D. THIN WALL TUBE

---

### PENETRATION DATA

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<tr>
<th>Unified Soil Classification</th>
<th>Description</th>
<th>Depth (ft)</th>
<th>Sampler No.</th>
<th>Sample No.</th>
<th>Water Cont. %</th>
<th>Penetr. Test</th>
<th>Vane Shear Test</th>
<th>Standard Penetration Test</th>
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<td>MH-CH</td>
<td>STIFF TO HARD DARK REDdish BROWN SILT/CLAY</td>
<td>2.55</td>
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<td>20</td>
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<td>ML</td>
<td>STIFF MOTTLED DARK BROWN CLAYEY SILT</td>
<td>2.55</td>
<td>T-B</td>
<td>23</td>
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<td>(MH)</td>
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<td>2.55</td>
<td>T-C</td>
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<td>LL: 48</td>
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<tr>
<td>(MH)</td>
<td>STIFF MOTTLED RED BROWN SILT/CLAY w/DECOMPOSED ROCK</td>
<td>2.55</td>
<td>T-D</td>
<td>26</td>
<td>PLC: 35</td>
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<tr>
<td>(MH)</td>
<td>HARD MOTTLED BROWN SILT/CLAY</td>
<td>2.55</td>
<td>T-E</td>
<td>29</td>
<td>-</td>
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<tr>
<td>(MH)</td>
<td>DENSE MOTTLED GRAY BROWN DECOMPOSED ROCK w/SILTY SAND</td>
<td>2.55</td>
<td>T-F</td>
<td>32</td>
<td>89</td>
<td>2750</td>
<td>2500</td>
<td>40 BLOWS/0.5'</td>
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<tr>
<td>(SM)</td>
<td>END OF BORING @ 21.1'</td>
<td>2.55</td>
<td>T-G</td>
<td>26</td>
<td></td>
<td>20/0.5'</td>
<td>30/0.1'</td>
<td></td>
</tr>
</tbody>
</table>

---

*Elevation estimated from preliminary grading plan by Belt, Collins & Associates, Ltd.*
**Boring Log**

**PROJECT**  MILLILANI TOWN UNIT 32

**LOCATION**  Waipio, Ewa, Oahu, Hawaii

*Tax Map Key: 9-4-05: Por. 1*

**HAMMER:**
- **Weight:** 140#
- **Drop:** 30"

**SAMPLER:** 2" STANDARD SPLIT SPOON

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<tr>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>(MH)</td>
<td>STIFF, DARK REDDISH BROWN SILTY CLAY</td>
<td>0.0</td>
<td>8-A</td>
<td>26</td>
<td></td>
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<td>N (Blows per foot)</td>
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<td>HARD, DARK REDDISH BROWN SILTY CLAY</td>
<td>9.0</td>
<td>8-B</td>
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<td>(MH)</td>
<td>STIFF, MOTTLED BROWN SILTY CLAY</td>
<td>15.0</td>
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<tr>
<td></td>
<td>GRAY, DECOMPOSED PUKA PUKA ROCK</td>
<td>20.0</td>
<td>8-E</td>
<td></td>
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<td></td>
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<td></td>
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<td></td>
<td>ROCK FRAGMENTS</td>
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</table>

**Elevation estimated from preliminary grading plan by Belt, Collins & Associates, Ltd.**
### Boring Log

**PROJECT**  
MILILANI TOWN UNIT 32

**LOCATION**  
Waipio, Ewa, Oahu, Hawaii

- Tax Map Key: 9-4-05: Por. 1

**HAMMER:**

- Weight: 140 lb.
- Drop: 30"

**SAMPLER:**

- 2.5" 2 STANDARD SPLIT SPOON
- 5" 3 O.D. THIN WALL TUBE

---

#### PENETRATION DATA

<table>
<thead>
<tr>
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<tr>
<td>(MH) Stiff To Medium Reddish Brown Silty Clay</td>
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<td>9.1</td>
<td>23</td>
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<tr>
<td>(CH) Stiff Brown Clay</td>
<td>3.5</td>
<td>9.6</td>
<td>91</td>
<td>17</td>
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<tr>
<td>(CH) Hard Mottled Reddish Brown Clay w/ Traces of Decomposed Rock</td>
<td>5</td>
<td>9.6</td>
<td>34</td>
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</table>

* Elevation estimated from preliminary grading plan by Belt, Collins & Associates, Ltd.

---

**BORING NO.: 9**  
**Sheet No.: 1**  
**Driller:** W. LUM ASSOC. INC.  
**Date:** Nov. 20, 1975

**Field Party:** KAKU, CHOW, KALI

**Type of Boring:** AUGER (MOBILE)  
**Diam.:** 4"

**Datum:** 535 ± ft

**Drill Bit:** FINGER TYPE

**Water Level:** Not Sighted

**Time:**

**Date:** 11-20-75
**Boring Log**

**PROJECT**

MILILANI TOWN UNIT 32

**LOCATION**

Waipio, Ewa, Oahu, Hawaii

* Tax Map Key: 9-4-05: Por. 1

**HAMMER:**

Weight: 140#

Drop: 30"

**SAMPLER:**

2" STANDARD SPLIT SPOON

---

**Penetration Data:**

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<td>Stiff, reddish brown clay</td>
<td>10-A</td>
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<td>LL</td>
<td>57</td>
<td>PL</td>
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<td>(MH)</td>
<td>Hard, reddish brown clayey silt</td>
<td>10-B</td>
<td>25</td>
<td></td>
<td></td>
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<td>Trace of decomposed rock</td>
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<tr>
<td>(MH)</td>
<td>Hard, brown clayey silt</td>
<td>10-C</td>
<td>26</td>
<td></td>
<td></td>
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<td>(MH)</td>
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<td>10-D</td>
<td>25</td>
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<tr>
<td>(MH)</td>
<td>Stiff, mottled brown clayey silt</td>
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<td>21.5</td>
<td>11-20-75</td>
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**NOTE:**

LL: Liquid Limit
PL: Plastic Limit

---

* Elevation estimated from preliminary grading plan by Belt, Collins & Associates, Ltd.
**Boring Log**

**PROJECT**  
MILILANI TOWN UNIT 32

**LOCATION**  
Waipio, Ewa, Oahu, Hawaii

* Tax Map Key: 9-4-05: Por. 1

**HAMMER:**

- Weight: 140#
- Drop: 30"

**SAMPLER:**

- "2.55-2" STANDARD SPLIT SPOON
- .3" .5-.5" C.D. THIN WALL TUBE

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<tbody>
<tr>
<td>(MH)</td>
<td>STIFF, DARK REDDISH BROWN CLAYEY SILT W/SOME ROYS</td>
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<td>11-A</td>
<td>20</td>
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<td>-</td>
<td>0 10 20 30 40 BLOWS/0.5</td>
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<td>11-B</td>
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<td>END OF BORING @ 21.5' 11-21-15</td>
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*Elevation estimated from preliminary grading plan by Belt, Collins & Associates, Ltd.*
Boring Log

PROJECT     MILILANI TOWN UNIT 32
LOCATION    Waipio, Ewa, Oahu, Hawaii

* Tax Map Key: 9-4-05: Por. 1

HAMMER:
Weight          140 lb.
Drop            30"

Sampler: 2" STANDARD SPLIT SPOON

---

ELEV. = 546' +

MEDIUM TO STIFF
DARK REDDISH BROWN
SILTY CLAY

HARD
MOTTLED REDDISH BROWN
CLAYISH SILT

HARD, REDDISH TAN
CLAY

STIFF, MOTTLED RED
GRAY & BROWN
CLAYISH SILT + TRACES OF
DECOMPOSED ROCK

END OF BORING @ 21.5'
12-2-75

---

* Elevation estimated from preliminary grading plan by Belt, Collins & Associates, Ltd.

---

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<thead>
<tr>
<th>Sample No.</th>
<th>Water Cont. %</th>
<th>Wet Comp. %</th>
<th>Dry Comp. %</th>
<th>Vane Shear</th>
<th>Standard Penetration Test</th>
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<td>12-C</td>
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PENETRATION DATA

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<th>N (Blows per foot)</th>
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<td>30</td>
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Driller: W. LUM ASSOC., INC.
Date: DEC. 2, 1975
Field Party: MEYER, ASATO, KAU
Type of Boring: AUGER (MOBILE)
Diam.: 4"
**TABLE I A - SUMMARY OF LABORATORY TEST RESULTS**

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<th>BORING NO.</th>
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<td>SAMPLE NO.</td>
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<td>C</td>
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<td>DEPTH BELOW SURFACE</td>
<td>0' - 1.5'</td>
<td>10' - 11.5'</td>
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<td>DESCRIPTION</td>
<td>DARK REDISH BROWN Silty Clay</td>
<td>REDISH BROWN CLAYY Silt</td>
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**GRAIN-SIZE ANALYSIS**

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**ATTERBERG LIMITS**

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<th>Air Dried or Natural</th>
<th>NATURAL</th>
<th>NATURAL</th>
<th>NATURAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liquid Limit</td>
<td>55</td>
<td>50</td>
<td>55</td>
</tr>
<tr>
<td>Plastic Limit</td>
<td>29</td>
<td>29</td>
<td>36</td>
</tr>
<tr>
<td>Plasticity Index</td>
<td>20</td>
<td>19</td>
<td>25</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Dilatancy</th>
<th>SLOW</th>
<th>RAPID, SLOW</th>
<th>SLOW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Toughness</td>
<td>MED STIFF</td>
<td>MED STIFF</td>
<td>SOFT-MED STIFF</td>
</tr>
<tr>
<td>Dry Strength</td>
<td>MEDIUM</td>
<td>MEDIUM</td>
<td>MEDIUM</td>
</tr>
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</table>

**UNIFIED SOIL CLASSIFICATION**

| MH-CH | MH | MH |

**APPARENT SPECIFIC GRAVITY**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
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</table>

**CBR TEST**

<table>
<thead>
<tr>
<th>(Surcharge - 51 P.S.F.)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Molding Moisture, %</td>
<td></td>
</tr>
<tr>
<td>Molding Dry Density, P.C.F.</td>
<td></td>
</tr>
<tr>
<td>Swell upon saturation, %</td>
<td></td>
</tr>
<tr>
<td>CBR at 0.1&quot; Penetration</td>
<td></td>
</tr>
</tbody>
</table>

**MOISTURE-DENSITY RELATIONS OF SOILS**

<table>
<thead>
<tr>
<th>(ASTM D-1557-70, Method)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry to Wet or Wet to Dry</td>
<td></td>
</tr>
<tr>
<td>Max. Dry Density (P.C.F.)</td>
<td></td>
</tr>
<tr>
<td>Optimum Moisture (%)</td>
<td></td>
</tr>
</tbody>
</table>

**REMARKS:**

Date 12-17-75 By PT
## TABLE I - SUMMARY OF LABORATORY TEST RESULTS

<table>
<thead>
<tr>
<th>BORING NO.</th>
<th>SAMPLE NO.</th>
<th>DEPTH BELOW SURFACE</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B</td>
<td>5'-6 1/2'</td>
<td>REDDISH BROWN CLAY</td>
</tr>
<tr>
<td></td>
<td>D</td>
<td>15'-16'</td>
<td>BROWN CLAY</td>
</tr>
<tr>
<td></td>
<td>E</td>
<td>20'-21 1/2'</td>
<td>MOTTLED TAN-BROWN CLAY WITHELES OF DECOMP ROCK</td>
</tr>
</tbody>
</table>

### GRAIN-SIZE ANALYSIS (% Passing)

<table>
<thead>
<tr>
<th>Sieve</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-1/2&quot;</td>
</tr>
<tr>
<td>1&quot;</td>
</tr>
<tr>
<td>1/2&quot;</td>
</tr>
<tr>
<td>#4</td>
</tr>
<tr>
<td>#10</td>
</tr>
<tr>
<td>#20</td>
</tr>
<tr>
<td>#40</td>
</tr>
<tr>
<td>#100</td>
</tr>
<tr>
<td>#200</td>
</tr>
</tbody>
</table>

### ATTERBERG LIMITS

<table>
<thead>
<tr>
<th>Air Dried or Natural Liquid Limit</th>
<th>Natural</th>
<th>Natural</th>
<th>Natural</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liquid Limit</td>
<td>50</td>
<td>49</td>
<td>82</td>
</tr>
<tr>
<td>Plastic Limit</td>
<td>38</td>
<td>42</td>
<td>35</td>
</tr>
<tr>
<td>Plasticity Index</td>
<td>17</td>
<td>42</td>
<td>47</td>
</tr>
</tbody>
</table>

### DILATANCY

- RAPID
- SLOW

### TOUGHNESS

- MED. STIFF

### DRY STRENGTH

- MEDIUM
- MEDIUM

### UNIFIED SOIL CLASSIFICATION

- ML-MH
- MH
- CH

### APPARENT SPECIFIC GRAVITY

- 

### CBR TEST

(Surcharge - 51 P.S.F.)

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

### MOISTURE-DENSITY RELATIONS OF SOILS

(ASTM D-1557-70, Method_)

- Dry to Wet or Wet to Dry
- Max. Dry Density (P.C.F.)
- Optimum Moisture (%)

### REMARKS:

Date 12-17-75 By __________

WALTER LUM ASSOCIATES, INC.
CIVIL, STRUCTURAL, SOILS ENGINEERS
### TABLE IC - SUMMARY OF LABORATORY TEST RESULTS

<table>
<thead>
<tr>
<th>BORING NO.</th>
<th>SAMPLE NO.</th>
<th>DEPTH BELOW SURFACE</th>
<th>DESCRIPTION</th>
<th>GRAIN-SIZE ANALYSIS</th>
<th>ATTERBERG LIMITS</th>
<th>UNIFIED SOIL CLASSIFICATION</th>
<th>APPARENT SPECIFIC GRAVITY</th>
<th>CBR TEST</th>
<th>MOISTURE-DENSITY RELATIONS OF SOILS</th>
<th>REMARKS:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>5'-6'</td>
<td>DARK RED BROWN SILT CLAY</td>
<td>(% Passing)</td>
<td></td>
<td></td>
<td>2.83</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>SURFACE</td>
<td>DARK RED BROWN CLAY</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td></td>
<td>4'-5.5'</td>
<td>MOTTLED DARK BROWN CLAY</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>8'-10'</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Remarks:**

Date: 12-17-75  By: DT
# TABLE I.D - SUMMARY OF LABORATORY TEST RESULTS

<table>
<thead>
<tr>
<th>BORING NO.</th>
<th>10</th>
<th>12</th>
<th>12</th>
<th>12</th>
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</thead>
<tbody>
<tr>
<td>SAMPLE NO.</td>
<td>A 0.9.2</td>
<td>B SURFACE</td>
<td>C 9.10.5</td>
<td>10-11.5</td>
</tr>
<tr>
<td>DEPTH BELOW SURFACE</td>
<td>DARK REDDISH BROWN CLAY</td>
<td>DARK REDDISH BROWN SILTY CLAY</td>
<td>DARK REDDISH BROWN SILTY CLAY</td>
<td>MOTTLED REDDISH BROWN CLAYEN SILT</td>
</tr>
</tbody>
</table>

## DESCRIPTION

**GRAIN-SIZE ANALYSIS**

<table>
<thead>
<tr>
<th>% Passing</th>
<th>1-1/2&quot;</th>
<th>1&quot;</th>
<th>1/2&quot;</th>
<th>#4</th>
<th>#10</th>
<th>#20</th>
<th>#40</th>
<th>#100</th>
<th>#200</th>
</tr>
</thead>
</table>

**ATTERBERG LIMITS**

<table>
<thead>
<tr>
<th></th>
<th>NATURAL</th>
<th>NATURAL</th>
<th>NATURAL</th>
<th>NATURAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air Dried or Natural</td>
<td>57</td>
<td>62</td>
<td>62</td>
<td>57</td>
</tr>
<tr>
<td>Liquid Limit</td>
<td>29</td>
<td>52</td>
<td>34</td>
<td>57</td>
</tr>
<tr>
<td>Plastic Limit</td>
<td>20</td>
<td>30</td>
<td>28</td>
<td>22</td>
</tr>
</tbody>
</table>

**APPARENT SPECIFIC GRAVITY**

|        | CH     | MH     | MH     | MH     |

**CBR TEST**

<table>
<thead>
<tr>
<th>Surcharge - 51 P.S.F.</th>
<th>28.7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Molding Moisture, %</td>
<td>95.0</td>
</tr>
<tr>
<td>Molding Dry Density, P.C.F.</td>
<td>0.2</td>
</tr>
<tr>
<td>Swell upon saturation, %</td>
<td>11.7</td>
</tr>
</tbody>
</table>

## UNIFIED SOIL CLASSIFICATION

| CH | MH |

## MOISTURE-DENSITY RELATIONS OF SOILS

<table>
<thead>
<tr>
<th>ASTM D-1557-70, Method</th>
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<tbody>
<tr>
<td>Dry to Wet or Wet to Dry</td>
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<tr>
<td>Max. Dry Density (P.C.F.)</td>
<td></td>
</tr>
<tr>
<td>Optimum Moisture (%)</td>
<td></td>
</tr>
</tbody>
</table>

## REMARKS:

Date 12-17-75  
By PTL
PLASTICITY CHART

PROJECT: MILILANI TOWN - UNIT 32
LOCATION: WAIPIO, EWA, OAHU, HAWAII

"A" LINE

CL

CH

ML

CL - ML

LIQUID LIMIT

PLASTICITY INDEX

DATE 12-17-75 BY GT.

WALTER LUM ASSOCIATES, INC.
CIVIL, STRUCTURAL, SOILS ENGINEERS
MOISTURE- DENSITY CURVE (ASTM D-1557-70, METHOD A)

PROJECT: MILILANI TOWN - UNIT 32
LOCATION: WAIPIO, EWA, OAHU, HAWAII
SAMPLE NO.: 7 SURFACE
SAMPLE DESCRIPTION: DARK REDDISH-BROWN CLAY

AGGREGATE: 1/4" MINUS
MOLD SIZE: 4" x 4" x 8" H IGH
HAMMER: 10 LBS., 18" DROP
LAYERS: 5
BLOWS: 25/LAYER

WALTER LUM ASSOCIATES, INC.
CIVIL STRUCTURAL SOILS ENGINEERS

DATE 12-17-79  BY  D.T
CBR TEST

PROJECT: MILILANI TOWN - UNIT 32

LOCATION: WAIPIO, EWA, OAHU, HAWAII

SAMPLE NO: SURFACE

SAMPLE DESCRIPTION: DARK REDDISH-BROWN CLAY

TEST RESULTS:

MOLDING MOISTURE, %: 25.2
MOLDING DRY DENSITY, P.C.F: 101.2
CBR @ 0.1" PENETRATION: 29.0
DAYS SOAKED: 4

DATE 12-8-75 BY T.K

DATE 12-9-75 BY RH
CBR TEST

PROJECT: MILILANI TOWN - UNIT 32

LOCATION: WAIPAO, EWA, OAHU, HAWAII

SAMPLE NO: 12 SURFACE

SAMPLE DESCRIPTION: DARK REDOISH-BROWN Silty Clay

![Graph showing CBR Penetration Data]

**CBR PENETRATION DATA**

<table>
<thead>
<tr>
<th>PENETRATION (INCHES)</th>
<th>LOAD (LBS)</th>
<th>LOAD (PSI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.025</td>
<td>90</td>
<td>20</td>
</tr>
<tr>
<td>0.050</td>
<td>180</td>
<td>60</td>
</tr>
<tr>
<td>0.075</td>
<td>260</td>
<td>87</td>
</tr>
<tr>
<td>0.100</td>
<td>350</td>
<td>117</td>
</tr>
<tr>
<td>0.125</td>
<td>430</td>
<td>143</td>
</tr>
<tr>
<td>0.150</td>
<td>500</td>
<td>167</td>
</tr>
<tr>
<td>0.175</td>
<td>580</td>
<td>193</td>
</tr>
<tr>
<td>0.200</td>
<td>650</td>
<td>217</td>
</tr>
<tr>
<td>0.250</td>
<td>750</td>
<td>250</td>
</tr>
<tr>
<td>0.300</td>
<td>830</td>
<td>277</td>
</tr>
<tr>
<td>0.350</td>
<td>900</td>
<td>300</td>
</tr>
<tr>
<td>0.400</td>
<td>960</td>
<td>320</td>
</tr>
<tr>
<td>0.450</td>
<td>1020</td>
<td>340</td>
</tr>
<tr>
<td>0.500</td>
<td>1100</td>
<td>367</td>
</tr>
</tbody>
</table>

AGGREGATE 1/8" MINUS
HAMMER WEIGHT 10 LBS.
HAMMER DROP 18 INS.
No. OF BLOWS 56/LAYER
No. OF LAYERS 5

ADJUSTED COORDINATES

**TEST RESULTS:**

MOLDING MOISTURE, %: 28.7
MOLDING DRY DENSITY, P.C.F: 95.0
CBR @ 0.2" PENETRATION: 217.5 / 14.5
CBR @ 0.1" PENETRATION: 117.10 = 11.7

DAYS SOAKED: 5

DATE 12-15-75 BY GD

DATE 12-15-75 BY RH.
FIGURE 1

SUGGESTED BOULDER FILL

MILILANI TOWN-UNIT 32

WAIPIO, ENA, OAHU, HAWAII

WALTER LUM ASSOCIATES, INC.

CIVIL, STRUCTURAL, SOILS ENGINEERS
LIMITATIONS

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

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

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

Contract documents and specifications often prescribe supervision by the soil engineer. It should be understood by all parties that the soil engineer's actual scope of work is very limited. We as the soil engineer do not assume the day to day physical direction of the works, nor minute examination of the elements, nor do we assume the responsibility for the safety of the contractor's workmen. Supervision, inspection, control, etc., by the soil engineer generally mean taking of soil tests and making visual observations, sometimes on only an intermittent basis relating to earthwork or foundations for the project. The soil engineer does not guarantee the contractors' performance, but rather looks for general conformance to the intent of the plans and soil report. Any discrepancy noted by the soil engineer regarding earthwork or foundations will be referred to the project engineer or architect or contractor for action.

Although the soil report may comment or discuss construction techniques or procedures for the design engineer's guidance, the report should not be interpreted to prescribe or dictate construction procedures or to relieve the contractor in any way of his responsibility for the construction.