NANAKAI GARDENS - A TURNKEY HOUSING DEVELOPMENT
HONOLULU, EWA, OAHU, HAWAII
TAX MAP KEY: 9-1-15: 8
PRELIMINARY SOIL EXPLORATION

FOR REFERENCE
not to be taken from this room

To:
RICHARD S. MATSUNAGA & ASSOCIATES, INCORPORATED

By:
WALTER LUM ASSOCIATES, INCORPORATED
CIVIL, STRUCTURAL, SOILS ENGINEERS
JUNE 10, 1970

MUNICIPAL REFERENCE & RECORDS CENTER
City & County of Honolulu
City Hall Annex, 558 S. King Street
Honolulu, Hawaii 96813
June 10, 1970

RICHARD S. MATSUNAGA & ASSOCIATES, INC.
Room 219, 547 Halekauwila Street
Honolulu, Hawaii 96813

Dear Mr. Matsunaga:

Subject: Nanakai Gardens - A Turnkey Housing Development
Preliminary Soil Report
(for foundation design purposes)
Honouliuli, Ewa, Oahu, Hawaii
Tax Map Key: 9-1-15: 8

Submitted herewith is our soil report for the proposed Nanakai Gardens, A Turnkey Housing Development at Honouliuli, Ewa, Oahu, Hawaii.

Exploration pits were excavated at the site with an Allis Chalmers AC-HD21 dozer-ripper with 2 shanks.

A lava rock hill is centrally located on the site and slopes downward in the easterly and westerly directions.

Rock outcrops are visible at various locations at the site. The soil cover is relatively thin varying from nil at the central area to as much as 5 ft in spots at the eastern and western sections. The soil cover was generally deeper at the western end. Boulders were noted throughout the site, particularly in the central and western sections.

The soils at the site are generally brown clays with gravel and boulders underlain by decomposed rock and lava rock.

Because of the rocky surface soils, site grading should be kept to a minimum, and post-and-beam construction should preferably be used where expansive soils occur near the surface. To minimize the effects of differential settlements, the foot blocks should be underpinned with select material extending 2 ft below the bottom of footings or down to rock.

For the roadway excavation, it appears that hard pockets of rock will be encountered for 2/3 or more along the proposed roadway alignment. Excavations for utilities will be difficult.
Unforeseen or undetected conditions such as soft spots or seepage water may occur in localized areas and will have to be adjusted and corrected in the field as they are detected.

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

The soil report containing a Boring Location Plan, the boring logs, laboratory test results and recommendations for site development is attached.

Respectfully submitted,

WALTER LUM ASSOCIATES, INC.

Ezra Koike
Professional Engineer
Hawaii No. 1450
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SCAPE OF EXPLORATION

The purpose of this exploration was to determine general soil conditions for the design of foundations for light one and two-story residential structures for Nanakai Gardens, a proposed Turnkey Housing Development, at Honolulu, Ewa, Oahu, Hawaii.

This report includes field exploration, laboratory tests and general recommendations for one and two-story house foundation design.

FIELD EXPLORATION

Sixteen exploration pits were made at the site. The locations of these pits are shown on Figure 1, Boring Location Plan. Also attached are the logs of borings made previously by the drilling contractors, Samson and Smock, and Samson and Zerbe, in the vicinity of this project site. The locations of these borings are shown on Figure 1.

Exploration pits were excavated at the site with an Allis Chalmers AC-HD21 dozer-ripper with 2 shanks.
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".

LABORATORY TESTS

Laboratory tests included: Atterberg limits, expansion and CBR.

A list of the standard field and laboratory test methods used for this project is given in the Appendix.

A summary of the laboratory test results is given in Table IA.

GENERAL SITE AND SOIL CONDITIONS

The project site is located along the south side of Farrington Highway and west of Nanakai Subdivision Unit I.

Keawe trees and weeds cover most of the site.

A lava rock hill is centrally located on the site and slopes downward in the easterly and westerly directions.

Rock outcrops are visible at various locations at the site. The soil cover is relatively thin varying from nil at the central area to as much as 5 ft in spots at the eastern and western sections. The soil cover was generally deeper at the western end. Boulders were noted throughout the site, particularly in the central and western sections.
Two natural drainageways, one in the eastern section and another near the western boundary cross the site in a north-south direction.

For the exploration pits, the surface soils and boulders were excavated with the dozer blade. Rippers were used in the lava rock to get an indication of rippability. In general, the dozer was able to excavate thru the clay-rock cover at the eastern and western sections except for some localized hard spots. Hard spots occur in the central section around the hill.

The soils at the site are generally brown clays with gravel and boulders underlain by decomposed rock and lava rock

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

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

DISCUSSION AND RECOMMENDATIONS

Because of the rocky surface soils, site grading should be kept to a minimum, and post-and-beam construction should preferably be used where expansive soils occur near the surface. To minimize the effects of differential settlements, the foot blocks should be underpinned with select material extending 2 ft below the bottom of footings or down to rock.

In general, the soils at the site should support the proposed low fills and light residential houses.
The on-site clay soils should generally be used in fills outside of buildings, roadways and parking areas. The clay soils should be placed away from the face of slopes generally a distance about equal to the height of the slope or at least 5 ft back from the face of the slope.

Silty soils and decomposed rock or select borrow soils imported to the site should be used to construct the outer section of slopes and in the upper 2 to 3 ft of fills.

If boulders are to be used to construct fills, they should generally be placed at the toe of slopes and outside of building areas.

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

It is essential that the site be cleared and grubbed, drained and localized soft spots removed.

Site Grading
If fill material is imported to the site, the material should be select soils generally less than 3-in. maximum size and the plasticity index generally less than 20.
The construction of fills should be done as required by Chapter 23, Revised Ordinances of Honolulu, 1961 As Amended.

The following may be used as a guide:

1. After clearing and grubbing, all topsoil and stockpiled soil should be stripped to stiff natural ground or scarified and recompacted before the placement of fills.

Soft pockets and pockets of unsuitable material should be excavated and replaced with select soils to match the density of the surrounding stiff soils.

2. Boulders should be removed and the area scarified and recompacted to a fairly level condition before the placement of fills.

3. If fills are contemplated in localized dips or natural drainageways, subdrains should be placed in a herringbone pattern along the bottom and sides of the low section before the placement of fills.

4. All fills should be constructed in approximately level layers starting at the lower end and working upward.
5. Where fills are made on sloping areas steeper than about 5 horizontal to 1 vertical, the ground at the toe of the slope should be benched to a generally level condition. As the fill is brought up, it should be continually keyed into the stiff natural ground by cutting steps into the slopes and compacting the fills into these steps.

6. All fills should be laid in 6-in. compacted layers with a relative density of at least 90% of AASHO T-180-57 density.

7. If boulders are proposed to be used in the construction of fills, they should be placed along the toe of the fill slopes. The subgrade should be shaped to drain and a layer of filter material placed on it. Boulders may be placed on the filter layer. The voids should be filled with granular material. A blanket of filter material should be placed against the boulder fill before the construction of earth fills against it. See sketch on Figure 1.
Slopes

If slopes are cut through or are constructed with on-site plastic clays, "CH" soils, slope heights should generally be kept less than about 6 to 8 ft in height with slope ratios generally about 3 horizontal to 1 vertical or flatter.

If slopes are cut in silty on-site soils, or are constructed with select borrow soils, slopes of about 2 horizontal to 1 vertical or flatter may be used.

Adjustments or other precautions may be necessary if seepage zones or soft spots are encountered in localized areas.

For protection against erosion, the runoff from rainstorms should be controlled by berms or ditches that will divert water away from slopes.

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

Slope planting is recommended where gravelly or fine soils are exposed at the face of cut and fill slopes to minimize erosion.

The tops of slopes in gravelly or fine soils will probably creep. Building foundations and retaining walls should be kept away from the tops of slopes.
Foundations

Because of the clayey surface soils, "CH", and rocky material at the site, post-and-beam construction should generally be used. To minimize the effects of heave and shrinkage of "CH" soils, excavations for the foot blocks in clay soils should be made about 18 in. square and about 2 ft deep or to rocky material if such material is encountered at shallower depths. The excavations should be backfilled with compacted well-graded granular material or coral. The foot blocks may be placed on top of the select backfill. See Figure 2.

If slab on ground is to be considered over "CH" soils, the footing excavations around the perimeter of the building should extend about 18 in. below the bottom of the footing and backfilled with compacted well-graded granular material or coral. The base course should be placed and wetted down 48 hours before the placement of slab on ground. See Figure 2.

The select backfill should be well graded from 3/4-in. to dust sizes with about 10 to 15% passing the No. 200 sieve.

The following may be used as a guide for foundation design:

1. Bearing values for a given soil vary with the size and depth of footings. For light, one and two-story residential structures, bearing values of about 1500 p.s.f. on compacted fill and 2000 p.s.f. on stiff natural ground may be used.
2. All soft spots or pockets of loose material encountered in footing excavations or below a building area should be excavated and replaced with compacted select on-site soils or select borrow materials.

3. Because of the downhill creep effect of soils on a slope, some settlements may occur near the tops of slopes. Therefore, buildings should 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 in no case closer than 5 ft from the top of a slope.

4. Construction of retaining walls on slopes should be avoided.

5. Good surface drainage away from the foundations of the proposed structures should be maintained.

Roadway

In general, a rough estimate of the roadway pavement thickness for the light residential traffic anticipated is as follows:

2. Base course - 6-in. base course.
3. Subbase course - 0-in. on rocky subgrade. 18-in. on "CH" clay subgrade.
Provisions should be made in the contract documents to allow for local adjustments regarding subbase requirements in the field as ground conditions are exposed at subgrade levels. In fill areas, the use of select soils within the top 3 ft of finish grade may be considered to reduce the thickness or eliminate the subbase course.

It is recommended that the subgrade 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 through the walls of catch basins which are placed in these low areas.
PROPOSED SPECIFICATION FOR EARTHWORK

NANAKAI GARDENS - A TURNKEY HOUSING DEVELOPMENT

General Description

This item shall consist of all clearing and grubbing, removing of existing structures, preparing of land to be filled, excavating and filling of the land, spreading, compacting and testing of the fill, and all subsidiary work necessary to complete the grading.

Clearing, Grubbing and Preparing Areas to be Filled

All vegetation, concrete slabs and rubbish shall be removed and disposed of, leaving the disturbed area with a neat, debris-free appearance.

All vegetable matter shall be removed from the surface upon which fill is to be placed. All topsoil and stockpiled soils shall be (1) stripped to stiff natural ground or (2) scarified and recompacted before the placement of fills. All topsoil encountered at finish grade shall be scarified and recompacted.

All hard surfaces along the existing access roads shall be scarified down to stiff soils and recompacted to match the density of the surrounding soil before the placement of fills.

Where fills are proposed in all sidehill areas, gullies and along drainage and irrigation ditches, all loose material along the bottom and the sides shall be stripped down to stiff natural ground before the placement of fills. All new fills shall be keyed into the stiff natural ground.
Subdrains shall be placed along the bottom and sides of the natural drainageways before the construction of fills. The final locations of subdrains should be determined in the field after clearing and grubbing.

Where fills are made on sloping areas steeper than 5 horizontal to 1 vertical, the ground at the toe of the slope shall be benched to a generally level condition. As the fill is brought up, it shall be continually keyed into the stiff natural ground by the cutting of steps into the hillside and compacting the fill into these steps. Ground slopes which are flatter than 5 horizontal to 1 vertical shall be benched when considered necessary by the Soil Engineer.

Materials

Fill materials shall consist of approved on-site or borrow soils. The soils shall contain no more than a trace of organic matter and no particles larger than 6 in. in diameter. Also, it shall contain no more than 40% gravel (#4 sieve to 3 in. sieve sizes) and no more than 10% cobbles larger than gravel and smaller than 6 in. in diameter. Fill material placed in the top 2 ft of fills shall contain no more than 30% gravel and any material larger than 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.
No rocks or cobbles shall be allowed to nest and all voids between rocks must be carefully filled and compacted with small stones or earth.

When the water content of the fill material is below that specified by the Soil Engineer, water shall be added until the water content is as specified and assures a thorough bonding during the compacting process.

When the water content of the material is above that specified by the Soil Engineer, the fill material shall be aerated by blading or by other satisfactory methods until the water content is as specified.

After each layer has been placed, mixed and spread evenly, it shall be thoroughly compacted to no less than 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 insure the obtainment of the desired density.

Field density tests shall be made by the Soil Engineer 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 as determined by the Soil Engineer. 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.

**Excavation**

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

**Boulder Fills**

If boulders are proposed to be used in 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. All voids shall be filled with smaller granular soils. A blanket of filter material shall be placed against the boulder fill before the construction of fine soil fills against it.

**Unforeseen Conditions**

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

**Rainy Weather**

No fill material shall 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 moisture content and density are as previously specified.


**NANAKAI GARDENS**

**TABLE I.A - 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>GRADING ANALYSIS (% Passing)</th>
<th>ATTERBERG LIMITS</th>
<th>UNIFIED SOIL CLASSIFICATION</th>
<th>SPECIFIC GRAVITY</th>
<th>EXPANSION AND CBR TESTS</th>
<th>COMPACTION TEST</th>
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<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>6'</td>
<td>OPEN</td>
<td>1&quot;</td>
<td>NA</td>
<td>CH</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>2</td>
<td>3</td>
<td>6'</td>
<td>OPEN</td>
<td>1/2&quot;</td>
<td>NA</td>
<td>MH</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
<td>6'</td>
<td>OPEN</td>
<td>#4</td>
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<td>NA</td>
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**Atterberg Limits**

- Air Dried or Natural
  - Liquid Limit: 72, 56, 55, 65
  - Plastic Limit: 29, 31, 23, 48
  - Plasticity Index: 45, 25, 30, 17

**Unified Soil Classification**

- CH, MH, CH, MH

**Expansion and CBR Tests**

- (Surcharge-51 P.S.F.)
  - Molding Moisture Content, %: 124.4, 134.4, 128.9, 146.4
  - Molding Dry Density, P.C.F.: 101.2, 99.5, 112.1, 64.7
  - Swell upon saturation, %: 11.8, 3.4, 7.2, 0.3
  - CBR at 0.1" Penetration: 0, 6.1, 3.1, 55.0

**Compaction Test**

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

WALTER LUM ASSOCIATES
CIVIL, STRUCTURAL, SOILS ENGINEERS
JOB: NANAKAI GARDENS

LOCATION: 

Liquid Limit

Plastic Index

"A" LINE

CL

ML

CL - ML

MH & OH

F I A T I C I T Y C H A R T
GENERAL TESTING METHODS

EXPLORATORY BORINGS AND SAMPLING

Method for soil investigation and sampling by auger borings (Tentative)

Method for thin wall tube sampling of soils (Tentative)

Method for penetration test and split barrel sampling of soils (Tentative)

LABORATORY TESTING

Grading Analysis

Sieve analysis of fine and coarse aggregates

Amount of material finer than No. 200 sieve in aggregate

Atterberg Limits

Determining the liquid limit of soils
Modified as follows: Substitute Casagrande grooving tool. Tests conducted from natural moisture content unless noted otherwise.

Determining the plastic limit of soils

Calculating the plasticity index of soils

Specific Gravity

Specific gravity of soils
Modified as follows: 500 ML Pycnometer

Expansion and CBR Tests

Expansion test and California Bearing Ratio (CBR)

Compaction Test

Moisture-Density relations of soils using a 10# rammer and an 18" drop

Unified Soil Classification

AASHO Designation: T 27-60

AASHO Designation: T 11-60

AASHO Designation: T 89-60

AASHO Designation: T 90-56

AASHO Designation: T 91-54

AASHO Designation: T 100-60

AASHO Designation: T 180-57

Section VIII - TM 5-530
"Materials Testing" by Headquarters, Dept. of the Army

Designation E-3 from "Earth Manual" by the United States Department of the Interior Bureau of Reclamation
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.

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.
LOGS OF BORINGS

MADE BY

SAMSON AND SMOCK, AND SAMSON AND ZERBE
LOG OF TEST BORING MADE
FOR CHUNG DHO AHN & ASSOCIATES
AT EWA, OAHU

OCTOBER, 1960

0' 0" to 15' 0" – Brown clay mixed with boulders
15' 0" to 17' 0" – Brown clay
17' 0" to 20' 0" – Red cinders
20' 0" to 25' 0" – Gravel
25' 0" to 50' 0" – Brown clay mixed with boulders
LOG OF TEST BORINGS MADE
FOR CHUNG DHO AHN, ENGINEER
AT EWA, OAHU

April, 1961

Hole #1
0' 0" - 3' 0" = Small boulders and brown clay (Lost water return at 3' 0")
3' 0" - 15' 0" = Small boulders and brown clay
15' 0" - 20' 0" = Boulders and brown clay
20' 0" - 33' 0" = Decomposed rock and compact cinders (Lost water return at 33' 0")
33' 0" - 47' 0" = Decomposed rock, medium hard
47' 0" - 51' 0" = Soft formation
51' 0" - 60' 0" = Medium hard formation
60' 0" - 63' 0" = Soft formation
63' 0" - 83' 0" = Medium hard formation
83' 0" - 90' 0" = Soft brown clay

Tested with water pumped from 600-gal. tank into hole. Time was 8 min. 15 sec. to empty tank.

90' 0" - 92' 0" = Soft formation
92' 0" - 100' 0" = Medium hard formation

Put water level indicator down to 50' - no indication of water. Hole did not stay open.

Hole #2
0' 0" - 1' 6" = Shelby tube sample
0' 0" - 0' 6" = 6 blows
0' 6" - 2' 0" = 8 "
1' 0" - 1' 6" = 10 "

1' 6" - 5' 0" = Brown clay and small boulders
5' 0" - 5' 6" = Split spoon sample
5' 0" - 5' 6" = 3 blows
Thereafter no penetration for 25 blows - hit boulder.

5' 6" - 20' 0" = Brown clay and small boulders (Did not lose water return)

LOT #159

NANAKAI SUBDIVISION UNIT III

HONOLULU, EWA ------ OAHU, HAWAII
NOTE:

DECAVIATION PITS WERE DECAVIATED WITH AN ALLIS CHALMERS AC-1221 DOZER/RIPER WITH 2 SHANKS.

APPROXIMATE CONDITIONS OBSERVED AT THE SITE MAY B AND C, 1972; CONDITIONS MAY CHANGE WITH TIME, WEATHER AND GRAVING AT THE SITE.
PROPOSED FOOTING FOR SLAB-ON-GROUND ON EXPANSIVE SOIL

NOTE:
The base course should be placed and wetted down for 2 days before pouring slab.

Scarify and recompact subgrade at above optimum water content and shape to drain prior to placing base course.

COMPACTED CORAL OR GRANULAR MATERIAL
(well-graded from 3/4" to dust sizes with 10 to 15% passing the No. 200 sieve)

PROPOSED FOOTING FOR POST-AND-BEAM ON EXPANSIVE SOIL

NOTE:

COMPACTED CORAL OR GRANULAR MATERIAL
(well-graded from 3/4" to dust sizes with 10 to 15% passing the No. 200 sieve)

FIGURE 2

PROPOSED FOOTING DETAILS
FOR ONE-STORY LIGHT STRUCTURES
ON EXPANSIVE SOILS

NANAKAI GARDENS
A TURKEY HOUSING DEVELOPMENT
HONOLULU, EWA, OAHU, HAWAII