SOIL INVESTIGATION

AHUIMANU VILLA CLUSTER DEVELOPMENT

KAHALUU, OAHU, HAWAII

TAX MAP KEY: 4-7-04: 3 & 5

W.O. 696-10 FEBRUARY 23, 1978

FOR

DEVEX CORPORATION

GEOLABS-HAWAII

1553 COLBURN STREET, SUITE 202

HONOLULU, HAWAII 96817

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SUMMARY

The proposed site is generally suitable for the development of a cluster subdivision.

The filling operation in the central 3½-acre swamp area will require special treatment for the soft underlying organic clayey soils. This treatment may require removal and replacement or placement of surcharge fill over the compressible soils.

For the surcharge method utilized, the proposed fill will be subject to settlement of 2 to 3 feet. Construction of surface improvements such as roadways and utilities sensitive to vertical movements must therefore be delayed until 90 percent of the primary settlement has occurred.

Up to 2 inches of additional long-term secondary consolidation can occur following the construction of the surface improvements. The structures should be designed to tolerate this movement. Post and beam construction is recommended for this area.

INTRODUCTION

This report presents the results of a new soil investigation performed for the proposed Ahuimanu Cluster development in Kahaluu, Oahu, Hawaii.

The new subsurface investigation was taken to define the location and the consistency of the soft swampy soils in the lowlying area and to provide samples for consolidation testing and evaluation of the fill settlement characteristic of the compressible soils. These findings would be utilized to estimate the settlement rate and magnitude and to evaluate the fill slope stability during the critical construction period. This study also provides the site grading, foundation and improvement recommendations of the development project.

PLANNED DEVELOPMENT

The proposed cluster devlopment consists of about 200 residential lots of zero-lot line concept. The proposed residences will consist of one and 2-story high single-family units of wood-framed construction. Building loads are relatively light and typical for this type of construction.

Present site grading involves cutting the upper area and providing part of the fill to build up the site in the lowlying area to accommodate the proposed roadway and building construction.

Maximum height of cut is about 30 feet and fill varies from approximately 0 to 22 feet high. On-site and off-site structural improvements include construction of three additional box culverts located at the extension of Hui Io Street, access road to Hui Ulili Street and at the Ahuimanu Place crossing. The on-site flood control channel re-alignment and improvement will extend from the Hui Io Street extension to the existing rectangular open-channel section at the Kahakili Highway.

PREVIOUS INVESTIGATION

Soil investigations were performed on the proposed site between the period of April 1971 and January 1973*. A total of 15 test borings and 17 test pits were made. The borings and test pits are located on the current Site Plan, Plate 1. The previous report and data were utilize to supplement our current investigation.

SITE CONDITIONS

The proposed subdivision project site is located near the base of the Koolau mountain range, in Kahaluu, on the windward side of Oahu.

*Preliminary Soil Investigation,
Ahuimanu-Kahaluu Subdivision,
Kahaluu, Oahu, Hawaii,
Tax Map Key: 4-7-04, Parcels 3 & 4,
Ernest Hirata & Associates, Inc.,
January 30, 1973.

The total area of the site is approximately 36 acres and is roughly rectangular in plan view with an average dimension of 500 feet in width and 3000 feet in length.

The site is bounded on the northwest primarily by undeveloped land similar in character to the project areas and a residential lot midway through the site, and on the southeast by Ahuimanu Stream beyond which lies the residential lots. The intersection of Ahuimanu Place and Hui Ulili Street borders the northeast portion of the project area and the southwest portion is bordered by an eroded spur of the Koolau mountain range.

Vehicular access into and through the site is by way of a dirt road entering from Ahuimanu Place.

There are no significant existing structures present on the site except for barbed wire fences and a few wooden gates that were used to contain the horses that were kept there.

The relief is generally flat for two-thirds of the site (Phase 1, 2 & 3 areas) on the northeastern side with an average slope of about 4 percent. The remaining one-third of the site (Phase 3 & 4 areas) on the southwestern side is hilly and steep, especially close to the Koolau spur, where slopes are as steep as 50 percent. A small ridge runs along the northwestern boundary, west of the flat area, just inside of the property line.

Many swampy areas are present throughout the site especially in the lower, flatter areas within the central portion of the project site (Phase 3 area) and in the small valleys in the hilly Phase 4 area. The sources of the water in the swamp areas appear to be surface run-off from the upper areas and subsurface seepage.

Major drainage of the site is to the northeast direction by way of Ahuimanu Stream running along the eastern boundary. The surface drainage of the overall site is in a northeast and southeast direction along ditches and low areas, eventually leading to Ahuimanu Stream.

The vegetation consists of mainly grass in the wet swampy areas. The upper ground on the ridges has heavy growth of trees and grass. Trees ranging from 20 to 30 feet high are a common sight. The level Phases 1 and 2 areas on the northeastern side was a cleared grass pasture where the horses were kept.

Geology

The project site is situated near the northwestern side of the once-formed but now eroded Koolau volcanic caldera (a sunken-in crater or depression at the summit of a volcano over a mile in diameter).

After the formation of the Koolau caldera, millions of years of hot volcanic gases, stream erosion, changing sea levels and coastal erosion destroyed the eastern flank of the caldera and removed the once massive caldera filling lavas extending from near Waimanalo to beyond Kaneohe. Great amplitheater headed valleys were formed during this period of erosion all along the windward side of the Koolau mountain range born from stream erosion upon the lavas of that area.

Alluvial deposits were laid along the stream paths and on the valley floors with many swampy areas developing as water ponded in the lowlying areas.

What we see today at the upper project site are the remains of the amplitheater headed valley floors and the walls or spurs that once extended themselves distinctly from the major mountain range and divided the valleys conspicuously like those seen on the Leeward side of the Koolau mountain range. The present topography reflects a mature to old age condition by showing a relatively low rolling landscape interspersed with swampy areas and thick layers of alluvial, colluvial and residual soils.

The middle swampy areas is generally located within a wide drainage basin. The soft swampy soils appear to be recent alluvium deposited in the low areas by the present Ahuimanu Stream. The recent alluvium is generally underlain by an older alluvium and boulder gravel deposit.

An interesting feature of a landslide or soil avalanche scar is displayed near the top on the southeastern side of the spur that directly overlook the project site beyond its southwestern boundary. This scar can be seen from the top of Hui Ulili Street looking in a northwestern direction and it appears as a reddish brown triangular shaped patch among the green vegetation.

Those soil avalanches are the most common means of mass transfer in the wet regions of Hawaii coupled with steep slopes and soil layers overlying rock. This type of erosion is probably the case for most of the hilly areas of the site and especially beyond it towards the mountain range; where soil avalanche in the higher areas have deposited their colluvial slide material along and near the base of the hills.

Haphazardly structured deposits of breccia and soil can also be seen in the trail cuts and in test pit no. AT-1. This would suggest that colluvial deposits of breccia and soil have been and are being deposited throughout the area during the times of soil avalanche.

Subsurface Exploration

The subsurface conditions of the project site were explored by 12 test borings, 3 test pits and 14 shallow probings.

The borings were drilled with truck-mounted and portable drilling equipment. The test pits were excavated with a Poclain 500 track-mounted hydraulic backhoe. The shallow probings were

mainly hand-dug holes and probed with a steel rod. The field work was performed during the month of January 1978. The new boring, test pit and probing locations along with the previous test pits and borings of the above referenced soil report are shown on the Site Plans, Plates 1 and 2.

The boring, test pit and probing elevations were estimated from topographic plan.

Soil Conditions

In general, alluvial deposits were noted in the low-land flat area, and colluvial deposits over the high-land portion of the site.

In the low-land flat area, the swampy surface soil is mainly located in the central portion of the project site (Phase 3 area) as outlined on Plate 1. The swampy soil consists of 5 to 11 feet of very soft gray organic clayey silt with grass and roots. A medium stiff clayey and gravelly silt stratum underlies the soft surface layer.

Beside the swampy area, the remaining flat area at the northern portion of the project site is blanketed by a 5 to 10 feet thick layer of medium stiff brown clayey and gravelly silt. Underlying this surface layer are loose to medium dense gravelly and silty layers.

North of the project site, along the proposed off-site improvement channel alignment, Boring Nos. AB-8 and AB-9, indicated the thickness of the loose gravelly layer was about 15 to 20 feet thick. The loose gravelly layer becomes shallower toward the high ground area within the project site.

A few wet surface soil areas were also noted at the northern portion of the project. Probing Nos. AP-1 and AP-2 indicated the soft layer was about 2 feet thick.

Boring No. AB-6 drilled at the flat ground area, immediate south of the swampy zone, revealed a clayey silt layer of about 2 feet thick over a soft silty layer with some organic material down to 11 feet below the existing ground surface. The underlying soft layer disappeared toward the south and the high-ground area.

The surface soils at the northwest, high-ground area, consists of a dark brown silty clay layer about 1 to 2 feet thick. Below the surface soil is a mottled brown and light brown clayey silt layer with decomposed gravel cobbles and boulders.

The surface soil at the southern high-ground area consists of a dark brown silty clay layer. Below the surface layer, the soil becomes a mottled red and brown clayey silt with some localized areas of highly decomposed rock.

Over the high-ground area, at the southern portion of the project site, the soft organic surface soil is only located on the flat bottom of the small valley areas (as indicated by Probing Nos. AP-8 and AP-9).

Groundwater

Based on the information obtained from the new and previous soil investigations, groundwater was encountered in all of the exploratory borings located in the lowlying, level area.

In the swamp area, the groundwater level is at near the ground surface or a few inches above the surface layer.

Outside the swamp area, groundwater was encountered generally at about 3 to 10 feet below the existing ground surface and varied between elevation 60 to 100 feet. The variable groundwater condition denotes that the source of water derives from springs or seepage from the up-hill areas percolating down through the porous layers toward the stream or lowlying area.

Groundwater is at a higher elevation in the southerly high-ground area.

DISCUSSION AND RECOMMENDATIONS

General

The information obtained during our investigation indicates that the subject site is feasible for the proposed construction in so far as the recommendations contained in this report are incorporated in the design considerations, project plans and job specifications.

Except for the swamp area located within the middle section of the project development (Phase 3 area), the northern and southern sections of the site are underlain by relatively stiff soil which may be developed with normal grading operations.

Structures located within Phase 1 area may be supported by either post footings or concrete slab-on-grade. This area is available and ideal for the immediate model home construction.

In Phase 2 area, fill layer up to 8 feet is planned to be placed over the existing level ground surface. Due to the compressible nature of the underlying soils below the surface crust, settlement will occur when this amount of fill is placed. It is estimated that a waiting period of about six months would be required to obtain the 90% consolidation at this area. Post and beam foundation is highly desirable for this type of condition.

Within the Phase 2 area, there is a wet surface area, approximately 100 by 260 feet in plan dimension. The thickness of the soft material is approximately 2 feet. In order to reduce the consolidation waiting period due to filling over this soft soil, we recommend that the soft material be removed prior to site filling operation.

The southerly (mauka) portion of the development is underlain by stiff colluvial soils which may be developed with normal grading operations. Structures located within this area should be supported by post or pier footing foundations.

The middle portion of the site within the Phase 3 area contains a 3.5-acre swamp underlain by thick deposits of soft and wet organic clays and silts with high organic content. Due to the loose nature of the soils, large settlement will occur when the fill is placed. This wet area will require additional work to prepare the area for site grading development. The alternative is to remove the soft underlying material or placed additional fill on the soft area to act as a surcharge and allow sufficient time for consolidation to occur.

Swamp Area Treatments

The swamp area within the Phase 3 area affects 50 lots and approximately 1100 lineal feet of the access roadways. This wet area requires special treatment prior to site grading construction. It is our opinion that two general alternate methods are available for stabilization:

1. Removal of the soft material and replaced with compacted fill.

2. Pre-consolidation of the soft material by surcharging with additional fill.

The above two alternatives are discussed in the folliwng sections:

Removal & Replacement

This alternate that is being considered has been recommended in the previous soil investigation. It is to remove the soft materials within the 3½-acre swamp site and to replace with suitable compacted granular material. The depth of soft material removal varies from 9 to 10 feet.

We believe that the removal of the exposed swamp mud will present some construction difficulties and will be expensive.

Based on the surface reconnaissance, it appears that this swamp area may be extended to the limits as shown on Plate 1. Heavy equipments, such as dozer and pan, may not be feasible in this area. It is our opinion that clamsell or dragline equipments can be used for dredging of the soft soils. Prior to the placement of any fill, the site should be inspected by the soils engineer to determine if all of the soft materials have been removed by the dredging operations.

Granular material capable of attaining densification under water should be placed until the fill is placed to approximately 18 inches above the water level or to where a firm working surface is encountered. Fill, which may consists of on-site soils from the upper cut area or select borrow off-site, may then be placed in accordance with the requirements for structural fill.

The wet organic soils removed from the swamp area should not be used as a source of structural fill.

Surcharging Methods

Another alternate treatment of the swamp area will be to place fill over the exposed swamp area as outlined on the Site Plan as far in advance as possible before construction of utility and building foundations. Surcharge fill may be placed in this area to accelerate settlement of these soils. While grading in this area should be done first, house construction should be planned last. When the building construction in the rest of the project (Phase 1 and 2 areas; possibly Phase 4 area if utility and access roadway can be provided through Hui Io Street extension) is completed, sufficient time would have developed for the fill and the underlying soils to settle.

Our calculations based on the soil data obtained from Boring No. AB-4A indicated that if the site was brought to the planned grade with approximately 10 feet of fill, about 3 feet of total settlement will occur. About half of this settlement will occur within the first year and the remainder over a period of 20 years.

We realize that the time required to obtain pre-consolidation of the soft underlying material is not within economical reality. Therefore, it is our recommendation that surcharge fill be placed to allow the soft material to consolidate in shorter time.

If a total of 5 feet of surcharge fill were placed, sufficient consolidation would occur in about 2 years, with about 10 feet of surcharge fill, sufficient consolidation could be attained in about 18 months. These times may be decreased further by the installation of a vertical sand-drain system or increasing the height of the surcharge fill. We would be happy to consult with you and your consultants should you feel that this system is desirable.

Site Preparation - Prior to site clearance and surface vegetation removal, off-site drainage water should be diverted, where possible, around the lowlying swamp area and to permit the existing soft area to develop a firmer soil crust.

It is estimated that the undercutting of the surface vegetation and organic material and scrubbing will average 6 inches over the fill portion of the site.

The existing upper surface soil is marshy and wet, and does not have sufficient strength to support heavy construction equipments. Therefore, a working platform or drainage blanket should be established prior to the major filling of the swamp area.

Drainage Blanket and Subdrain - The above recommended surcharge method incorporates a layer of synthetic filter fabric under the drainage blanket and around a subdrain system. By placing a layer of 'Mirafi 140' fabric below the gravel drainage blanket, the drainage blanket thickness can be reduced from 18 to 12 inches above the swamp for site stablization. The fabric eliminates the strict gradation requirements of the drainage blanket since it will act as a filter medium to prevent gravel loss into the soft ground and prevent the mud and fine soil particles to contaminate the granular blanket material. It also provides tensile reinforcement to the gravel layer and permits earlier use of heavy equipments on a minimum thickness of compacted aggregate. The above specified fabric is also utilized in the perimeter and interior subdrain system.

The subdrain will facilitate pore-water dissipation and shorten the drainage path and thereby shorten the pre-consolidation waiting period.

For construction details of the subdrain and drainage blanket, refer to the enclosed Plate 3. The subdrain should have a minimum depth of 3 feet, a minimum width of 1 foot and contain a 4-inch diameter perforated pipe.

The approximate subdrain locations are shown on Plate 1. The final location should be determined in the field after site clearance of the wet area.

The drainage blanket should be constructed with granular crushed rock material with less than 10% fines passing through #200 sieve. The subdrain granular backfill should consist of crushed rock aggregate passing the ASTM Designation No.67 (or #3B Fine) gradation requirement.

Fill Placement

The fill operation can be started upon completion of the settlement gauge and site drainage installations.

The fill material above the granular drainage blanket or working platform should be placed in maximum 9-inch loose lifts and compacted to a minimum of 85% of its maximum dry density established by compacting the in-situ soil samples from a wet to dry method and as per ASTM Test Designation D-1557.

Due to the soft yielding nature of the underlying soils, the fill and surcharge should be placed in thin lifts in such rate as not to cause shear failure in the soft material.

It is estimated that the initial fill placement can be proceeded at the swamp area at a rate of about two feet per week. The controlled rate of filling should be maintained to allow the consolidating soils to gain sufficient strength to support the next lift.

The actual rate will be established in the field based on the settlement gauge readings and adjusted to meet actual field conditions.

Settlement Monitoring

It is recommended that a minimum of seven (7) settlement gauges be installed to monitor the rate and amount of settlement within the swamp fill.

The settlement gauges should be installed prior to filling operation. After the desired consolidation has taken place and the rate has decreased to an acceptable rate, the surcharge fill may be removed and construction of the roadway, utility and surface structure may begin. The settlement gauges should be installed by the soils engineer. Settlement readings should be accurately surveyed by the Project Surveyor on an intermittent basis.

Site Grading

The site to be graded shall be cleared of vegetation, debris and other deleterious materials. In areas to receive fill, the ground should be scarified to a minimum depth of 6 inches. The scarified surface shall then be brought to near optimum moisture content and compacted to a minimum of 85% density per the above mentioned standard. Structural fill shall then be placed in horizontal 9-inch loose lifts and also compacted to at least 85% of maximum density.

Since the project site is located in a high rainfall area, the on-site materials have in-place moisture of 20 to 30 percent above the optimum moisture content; therefore the site materials will have to be dried out before compacting. It is our opinion that the normal 90% compaction standard used in the other drier area should be modified to 85% for this project. The 85% compaction standard will be adequate and acceptable for the project embankment fill and light building loads anticipated.

Based on the results of our in-place densities and maximum density determination, it appears that a factor of 11 percent shrinkage should be considered for on-site cut and fill quantities.

The in-place densities at the upper cut area average about 66 p.c.f. compared to a 85% of maximum density of 73 p.c.f.

It is recommended that additional off-site borrow required should be tested and approved by the soils engineer prior to transportation to the site to assure that it is suitable for the proposed construction. The material should generally be non-expansive and should not contain large percentages of boulders, organic or deleterious matter.

Where the existing ground is greater than 5 horizontal to 1 vertical (5:1), benching and keying are required to properly bond the new fill to the slope. The filling operation should start at the lowest point and continue up in level compacted layers in accordance with the above structural fill requirements. For construction details, refer to Plate 4.

Settlements

Outside of the middle swamp area, in the lowlying level area, the underlying material is from medium stiff to loose silty and gravelly alluvial deposits. Due to the non-uniform sub-soil condition, settlement predictions in this type of soil material are difficult and empirical. The estimated settlement for 5 feet of fill will be about 3 inches and for 10 feet of fill will be about 5 inches. It is also estimated that it will take about 4 months for 50% of the above settlement to occur and about 1 year for 95% of the settlement.

At the Hui Io Street extension, anticipated roadway fill of 15 feet high will produce settlement of about 6 inches.

All the surface improvement of building and utilities construction should be delayed until the remaining long term settlement is within the tolerable limits of the structure.

To monitor the settlement and establish an earlier schedule for surface improvements, a total of 15 settlement gauges are recommended for the entire project to be located where 5 or more feet of fill are placed.

Slopes

Two horizontal to one vertical (2:1) fill and cut slopes as proposed by the present site grading plans are adequate.

To reduce the amount of run-off over the cut and fill slope, drainage bench should be provided on the slope having a vertical height greater than 20 feet.

Slopes in the lowlying area - The stability of a perimeter slope along the existing stream is a direct function of the magnitude of pore-water pressure of the underlying soils. It is estimated that the construction rate of approximately 2 feet per week will not develop excessive pore-water pressure and will maintain a factor of safety of 1.5 against slope failure. This factor of safety will increase with the dissipation of the pore-water pressure.

To minimize erosion, all slopes should be planted as soon as practicable.

Foundation

For fill over alluvial soil deposits, post and beam construction is highly recommended. Spread and wall footing foundation may be utilized if they bear on stiff in-situ soil in the cut area or on structural fill layer with less than 3 feet of fill.

For the light structural load anticipated on this project, an allowable bearing pressure of 2000 p.s.f. may be used for the footings bearing on the stiff in-situ soil or upon the compacted fill. In the Phase 3 area, the bearing value should be reduced to 1500 p.s.f. for the footing bearing on fill above the swamp.

All footings on level ground should extend a minimum of 12 inches below the final adjacent grade. Continuous footing should be reinforced with a minimum of two No.4 reinforcing bars placed at the top and bottom of the footings.

Building construction near the top of the slope area should have a minimum set-back distance of 6 feet from the outer edge of the footing foundation measured horizontally out to the slope surface.

Slab-On-Grade

Except for the Phase 1 area, slab-on-grade construction should be avoided on the fill lots with 3 or more feet of structural fill.

The on-site soil has low to moderate expansion potential. Concrete floor slab should be reinforced with a minimum of 6 x 6/10 x 10 welded wire fabric and underlain by a 4-inch thick base course layer. Slabs which will have moisture sensitive floor covering should be protected by a polyethylene vapor barrier.

Twelve-inch deep perimeter footings are required to act as a cut-off wall against the future subgrade moisture changes due to drying and wetting around the slab.

Retaining Wall

Retaining walls will be utilized at the upper southern portion of the site (Phase 4 area) where high cut and fill are planned. The foundations for retaining walls should be designed in accordance with the above recommendations for continuous wall footing foundation.

It is recommended that a subsurface drainage system be provided to prevent the build up of hydrostatic pressure behind all the retaining walls. Granular rock backfill should be utilized as backfill behind the retaining wall. This will permit the wall to be designed for an equivalent fluid pressure of 40

pounds per cubic foot for a free standing retaining wall. For the retaining wall with support at the top, 60 pounds per cubic foot equivalent fluid pressure should be used.

A frictional factor of 0.35 should be utilized to determine the sliding resistance of the retaining wall foundation. For passive pressure computation, a fluid density of 200 pounds per cubic foot may be used.

Channel Improvement

On-Site Section

The portion of the proposed storm drainage channel within the project site area located along the eastern boundary line. The channel will cut through the colluvial deposit at the high-land area and alluvial deposit at the low-land area. Based on the present grading, two to one (2:1) slope bank is anticipated in some areas along the channel. The channel wall should be designed to receive active lateral pressure equivalent to a fluid density of 70 pounds per cubic foot if granular soils are used as backfill material. To release the hydrostatic pressure against the wall and slab, a 6-inch base course layer should be placed under the slab along with weepholes in the wall and slab.

Off-Site Section

For this portion of the channel improvement, noth of the project site, it will be required to re-build the existing trapezoidal channel section to a larger rectangular section. Based on Boring Nos. AB-8 and AB-9 drilled in this area, there is a 10 to 12-foot thick surface layer of medium stiff to stiff clayey silt.

For lateral earth pressure design, an active equivalent fluid density of 40 pounds per cubic foot may be used.

CRM walls were noted along the top of the channel bank. In some areas, the total height of the CRM wall with sloping backfill is as much as 10 feet above the top of the lined channel.

The imposed loads of the existing CRM wall and its backfill together with any nearby building load within the stress effective zone should be added to the new channel wall design.

Due to the limited working area for sloping excavation, temporary sheeting will be required to protect the steep channel bank excavation. To minimize slope movements, the proposed rectangular open-channel should be constructed in short sections and immediately backfilled with granular material behind the channel wall.

Culvert Structures

At Ahuimanu Place - The existing culvert and embankment fill at this part of the roadway crossing has been constructed for a number of years. This loading will act as a surcharge fill over the underlying soft soil. In order to minimize future settlement of the new culvert, the allowable bearing capacity for the new structure is controlled by the existing over-burden load.

A bearing capacity of 1200 p.s.f. should be used at this location.

At Access Road to Hui Ulili Street - This portion of the new on-site channel improvement will cut into the existing bank. Based on the over-burden soil load, a bearing value of 1000 p.s.f. is recommended.

At Hui Io Street extension - Fill up to 16 feet is anticipated in this area. The estimated settlement caused by the new roadway embankment is about 6 inches. It is recommended that the construction of the culvert structure at this area be delayed until the new embankment fill is placed and waited until 90% of the embankment settlement has occurred.

It is anticipated that a portion of this culvert will bear on soft swampy soil. Pockets of soft organic soils located under the culvert structure should be removed and replaced with granular material. A bearing value of 1000 p.s.f. can then be used.

In order to provide a uniform support, a 2-foot layer of granular material should be provided under all of the above culvert structures.

Roadway Pavement

Based on the characteristics of the on-site soils, the following pavement section may be used for preliminary design and cost estimate purposes:

2-inch Asphalt Concrete
6-inch Base Course
12-inch Select Borrow

20-inch Total Pavement Thickness

The base course should be crushed rock or other granular material with a CBR of 85% and conforming with Section 31.2 Standard Specification for Public Work Construction or equivalent. Non-expansive select borrow should have a minimum CBR value of 25% and consist of crusher run quarry waste, mudrock, coral sand or cinder material. Both the base course and select borrow should be compacted to 95% of its maximum density.

Additional CBR tests should be performed on the actual subgrade soil samples at the time of roadway construction and the above design section can be revised accordingly.

Utility Line

Due to the anticipated settlement, it is recommended that flexible joints be used on all utility pipes.

Utility constructions in the lowlying fill areas should be delayed until the surcharge fill is removed or the ground has settled to a tolerable limit.

Design Review

The plans for foundations, lot grading and utility plans should be forwarded to the soils engineer for review and comments prior to construction to assure that the intent of our recommendations is included in the project plans and specifications.

Construction Observation

To a degree, the performance of any structure is dependent upon construction procedures and quality. Monitoring of surcharge and observation of fill placement, cut slopes and foundation excavations should be carried out by the soils engineer to permit correlation between the soil data obtained during this investigation and the actual soil conditions encountered during construction in order to minimize misunderstanding of the field forces by both the letter and spirit of our report as well as to note any subsurface conditions different from those forming the bases of our recommendations.

INVESTIGATION LIMITATIONS

Our services consist of professional opinions and recommendations made in accordance with generally accepted soil and foundation engineering principles and practices. This warranty is in lieu of all other warranties either expressed or implied.

The analyses and recommendations submitted in this report are based on our site reconnaissance, soil information derived from available data of previous investigations by others and the present investigation.

Unanticipated soil conditions are commonly encountered and cannot fully be determined by taking soil samples and test pits. These unforeseen soil conditions may require flattening of the recommended slope ratio, adding subdrain for seepage area, and that additional expenditures be made during construction to attain a properly constructed project. Some contingency fund is thus recommended to accommodate these possible extra costs.

This report has been prepared in order to assist in the evaluation of the property and to assist the architect and engineer in the design of this project. In the event any changes in the design or location of the facilities are planned, our conclusions and recommendations shall not be considered valid unless the changes are reviewed and our recommendations modified or approved by us in writing.

The following plates and appendices are attached and complete this report:

Plates 1 & 2	- Site Plans
Plate 3	- Subdrain Details
Plate 4	- Typical Fill Above Natural Slope
Appendix A	- Field Exploration
Plates A-1 thru A-16	- Boring Logs
Plate A-17	- Test Pit Logs
Plates A-18 & A-19	- Probing Logs
Appendix B	- Laboratory Testing
Plates B-1 thru B-12 & Table 1	- Laboratory Test Data

-oOo-

Respectfully submitted,

C.W. ASSOCIATES, INC.
dba GEOLABS-HAWAII

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AHUIMANU STREAM

APPOXIMATE SWAMPY AREA

B-7 B-8 B-9 B-10 B-11 B-12 B-13 B-14 B-15

AB-6 AB-7

TP-14 TP-15 TP-16 TP-17

AP-7 AP-8 AP-9 AP-10 AP-11 AP-12 AP-13 AP-14

AT-1 AT-1A AT-2

HUI 10 STREET

RECREATION AREA

Limits of Grading

APPROXIMATE LIMITS OF SWAMP AREA (WITH 5 OR MORE FEET SOFT MATERIAL)

PHASE 3 AREA

PHASE 4 AREA

SITE PLAN

AHUIMANU VILLA CLUSTER DEVELOPMENT

GEOLABS-HAWAII
Foundation & Soil Engineering • Geology

DATE 2-23-78	DRAWN BY DDM
SCALE 1" = 80'	W.O. 696-10

PLATE 1

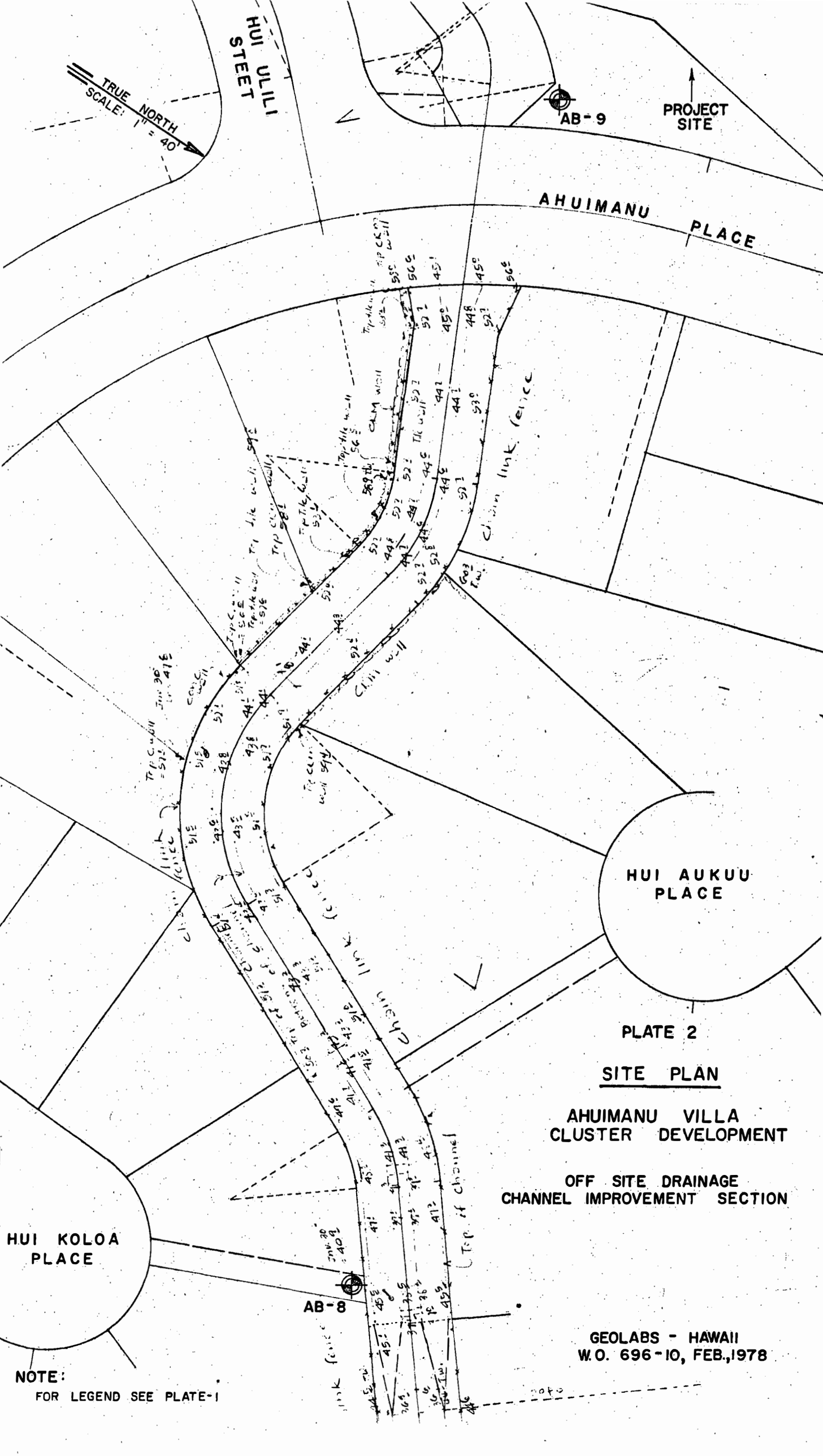


PLATE 2

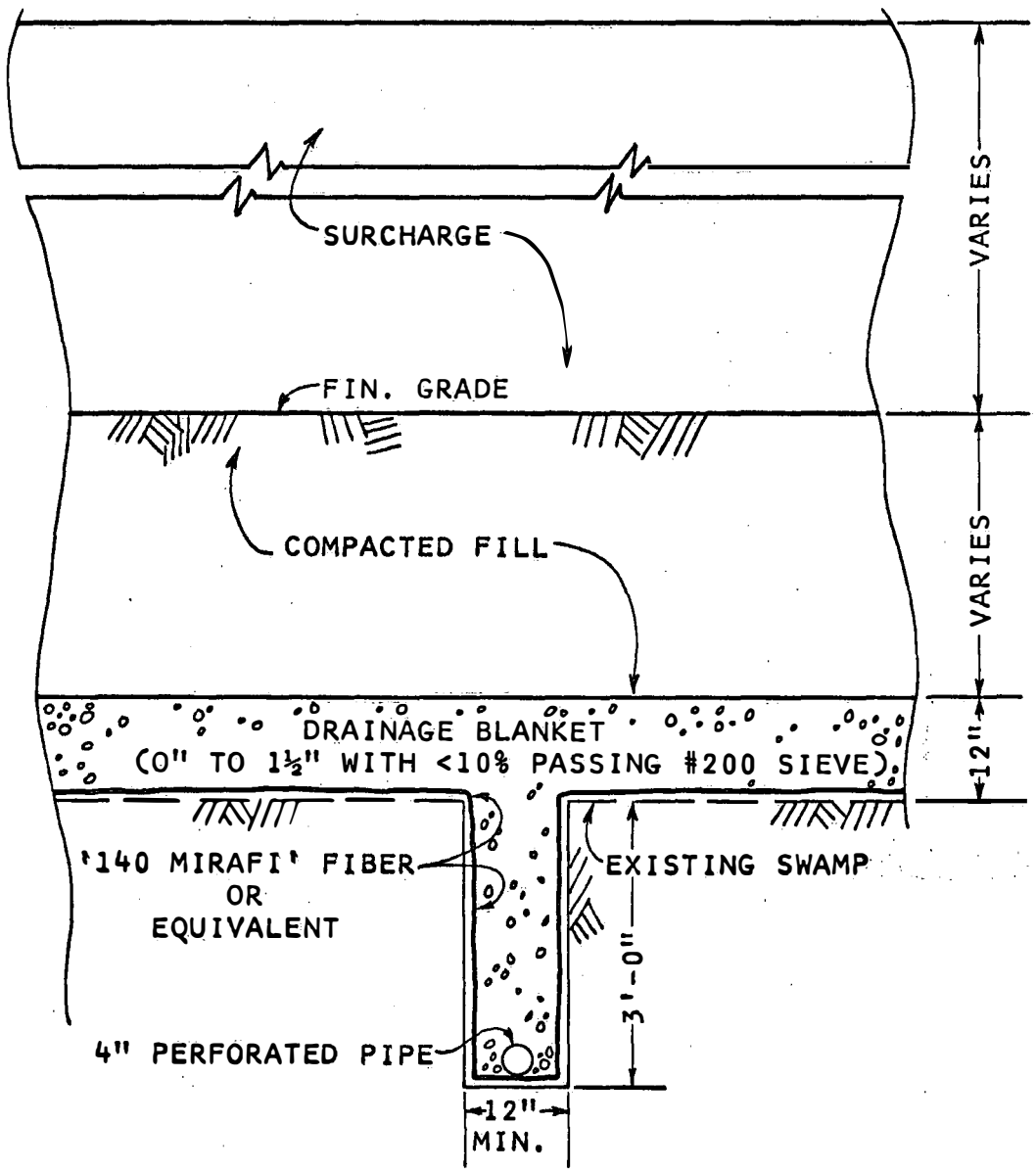
SITE PLAN

AHUIMANU VILLA
CLUSTER DEVELOPMENT

OFF SITE DRAINAGE
CHANNEL IMPROVEMENT SECTION

GEOLABS - HAWAII
W.O. 696-10, FEB., 1978

NOTE:
FOR LEGEND SEE PLATE-1



TYPICAL SECTION - SUB-DRAIN

INSTALLATION & FILL OVER SWAMP

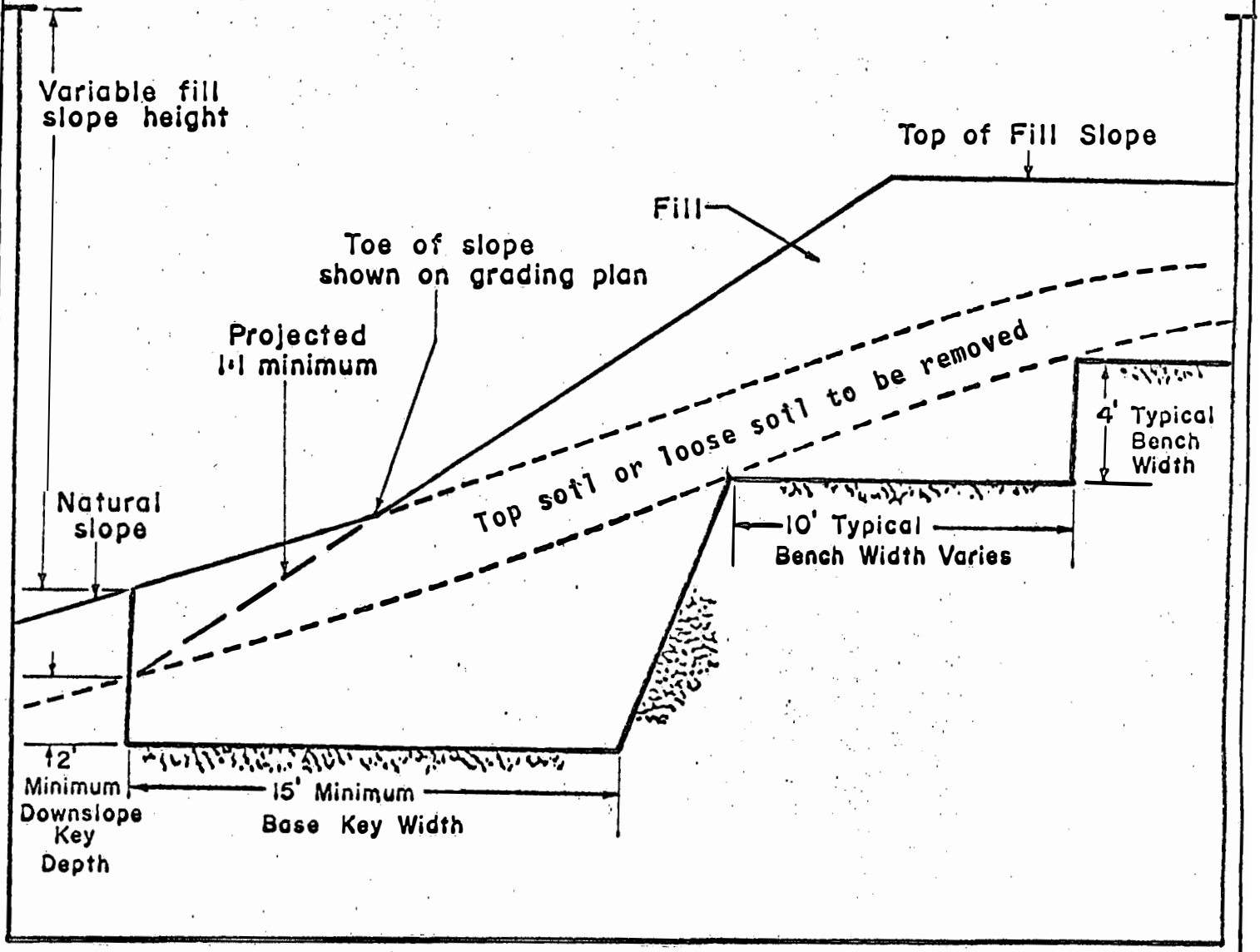
PROPOSED AHUIMANU VILLA CLUSTER DEVELOPMENT

GEOLABS-HAWAII Foundation & Soil Engineering • Geology	
DATE FEBRUARY 1978	DRAWN BY DDM
SCALE NOT TO SCALE	W.O. 696-10

PLATE 3

GENERAL GRADING RECOMMENDATIONS

TYPICAL FILL ABOVE NATURAL SLOPE



PROPOSED AHUIMANU VILLA
GLUSTER DEVELOPMENT

GEOLABS-HAWAII Foundation & Soil Engineering • Geology	
DATE FEBRUARY 1978	DRAWN BY DDM
SCALE NOT TO SCALE	W.O. 696-10

Plate 4

APPENDIX A

FIELD EXPLORATION

The subsurface conditions at the site were explored in January 1978 by drilling 12 test borings utilizing truck-mounted and portable drilling equipment. Three (3) deep test pits were dug with a Poclain 500 backhoe at the upper mauka area. In order to further delineate the soft ground areas, a total of 14 shallow probings were either dug by hand or probed by pushing a steel bar into the soft surface soils.

The depths of the borings varied from 3.0 to 24.0 feet below the existing ground surface; while the test pits were terminated at about 1 to 23 feet depths. The probings extended from 1.0 to 10.0 feet below the existing ground surface.

The locations of the borings, test pits and probings are shown on the enclosed Site Plans, Plates 1 and 2. The boring and test pit locations from the previous report are also shown on the Site Plans.

The soils were classified by visual and textural examination in the field by our engineer who continuously monitored the test pit excavation, probing and drilling operations. The classifications were done in accordance with the Unified Soil Classification System. A graphic presentation of the soils is presented in the Boring Logs, Plates A-1 through A-16. The description of the soils encountered in the test pits and probings are presented on the Test Pit and Probing Logs, Plates A-17 through A-19, along with the laboratory test results.

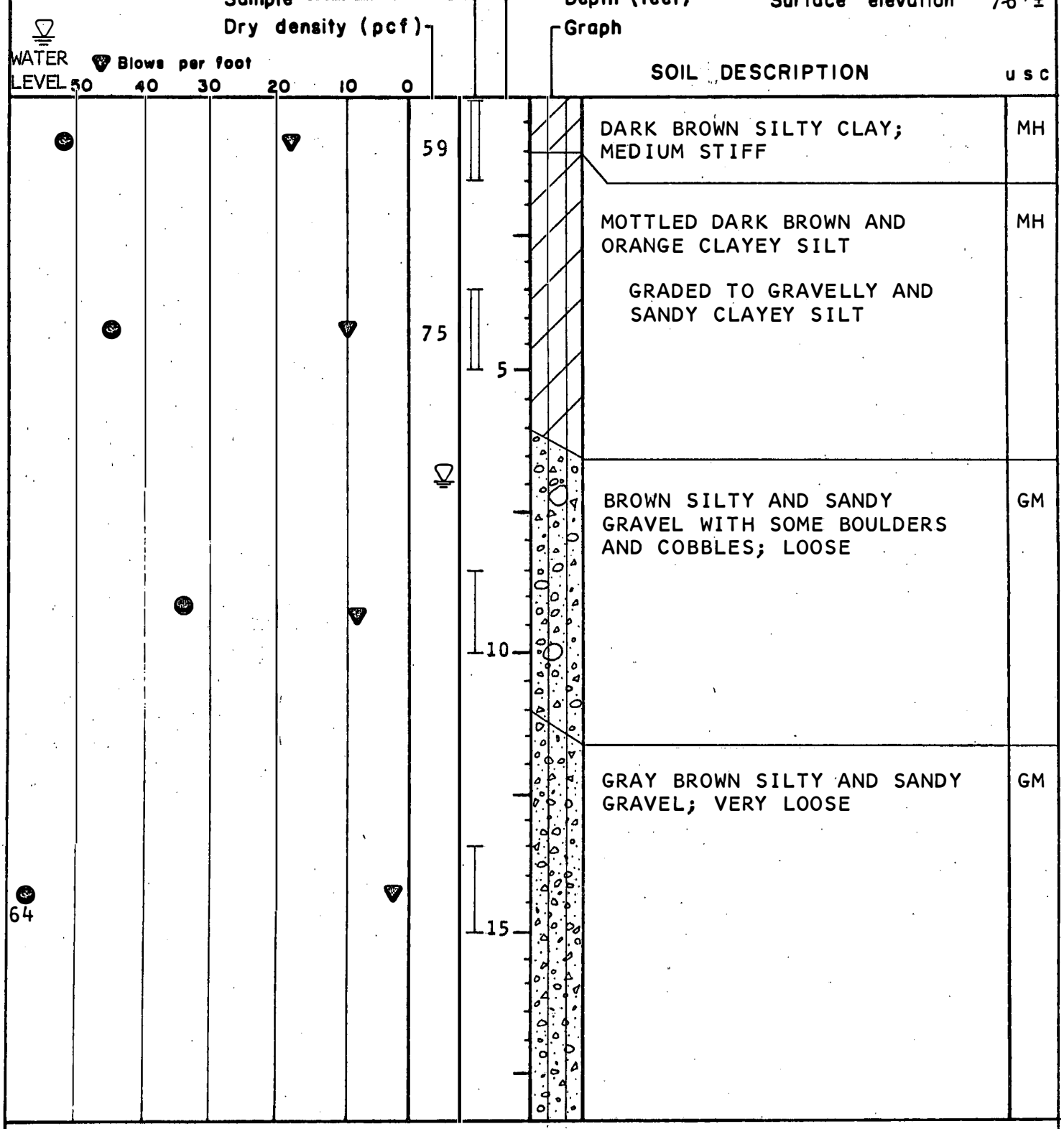
In the borings, soil samples were obtained by driving either a standard penetration or a 2.4-inch I.D. split barrel sampler with a 140-pound hammer free falling a distance of 30 inches. The blow counts used to drive the sampler the last 12 inches are shown on the Boring Logs at the appropriate sample depths.

Disturbed bulk samples were obtained from the test pits at various depths during excavation. A few undisturbed 3.0-inch diameter tube samples were taken from the test pit walls.

W.O. 696-10 FEBRUARY 1978

BORING AB-1

Surface elevation 76'±



LEGEND

- Moisture content
- I 2.0" O.D. split-spoon sample
- II Undisturbed ring sample
- X Disturbed ring sample
- Core sample
- P Sampler pushed

Plastic limit
Liquid limit
Natural water content

Driving energy 140 lb.wt., 30" drop

AHUIMANU VILLA

LOG OF BORING

DEVEX CORPORATION

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PLATE A-1

BORING AB-1

Sample — Depth (feet)
Dry density (pcf) — Graph
Surface elevation 76'±

Blows per foot
50 40 30 20 10 0

SOIL DESCRIPTION	USC
GRAY BROWN SILTY AND SANDY GRAVEL; VERY LOOSE TO DENSE	GM
BORING TERMINATED AT 19.5 FEET ON 1-16-78 WATER LEVEL: 6'-8" @ 10:15 A.M. 1-16-78	

6/6"+15/6" BOUNCING

20

LEGEND

- Moisture content
- I 2.0" O.D. split-spoon sample
- II Undisturbed ring sample
- Disturbed ring sample
- Core sample
- P Sampler pushed

Plastic limit
Liquid limit
Natural water content

Driving energy: 140 lb. wt., 30" drop

AHUIMANU VILLA

LOG OF BORING

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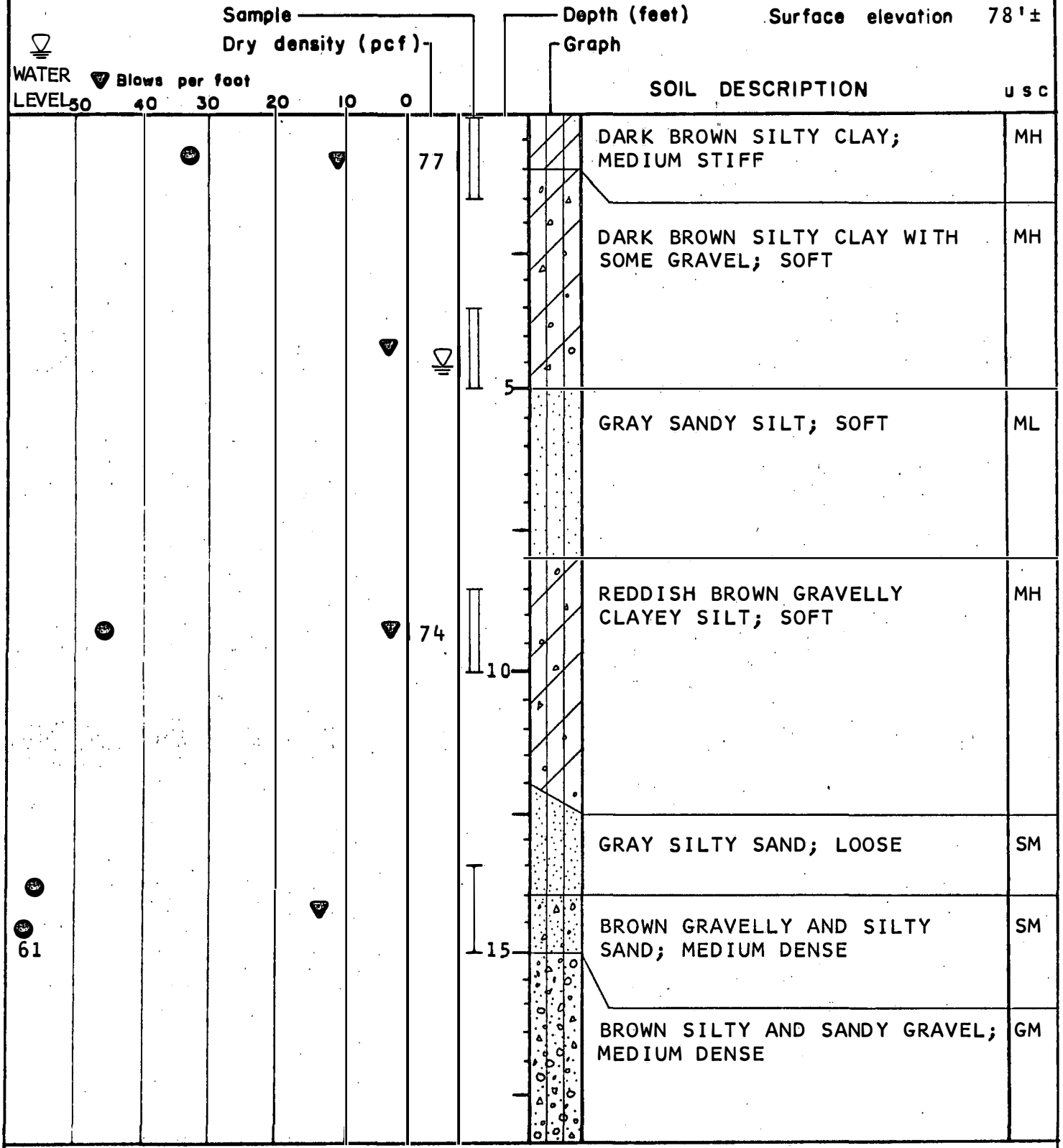
PLATE A-2

BORING AB-2



LEGEND

- Moisture content
- I 2.0" O.D. split-spoon sample
- II Undisturbed ring sample
- III Disturbed ring sample
- IV Core sample
- P Sampler pushed

Plastic limit
Liquid limit
Natural water content

Driving energy: 140 lb.wt., 30" drop

AHUIMANU VILLA

LOG OF BORING

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PLATE A-3

BORING AB-2

Surface elevation 78'±

Sample — Depth (feet)
Dry density (pcf) — Graph
Blows per foot

50	40	30	20	10	0

SOIL DESCRIPTION	USC
BROWN SILTY AND SANDY GRAVEL; MEDIUM DENSE	GM
BORING TERMINATED AT 19.9 FEET ON 1-13-78	
WATER LEVEL:	
4'-4" @ 2:30 P.M. 1-13-78	

12/6"+28/5" BOUNCING

20

LEGEND

- Moisture content
- I 2.0" O.D. split-spoon sample
- II Undisturbed ring sample
- III Disturbed ring sample
- IV Core sample
- P Sampler pushed

Plastic limit
Liquid limit
Natural water content

Driving energy: 140 lb. wt., 30" drop

AHUIMANU VILLA

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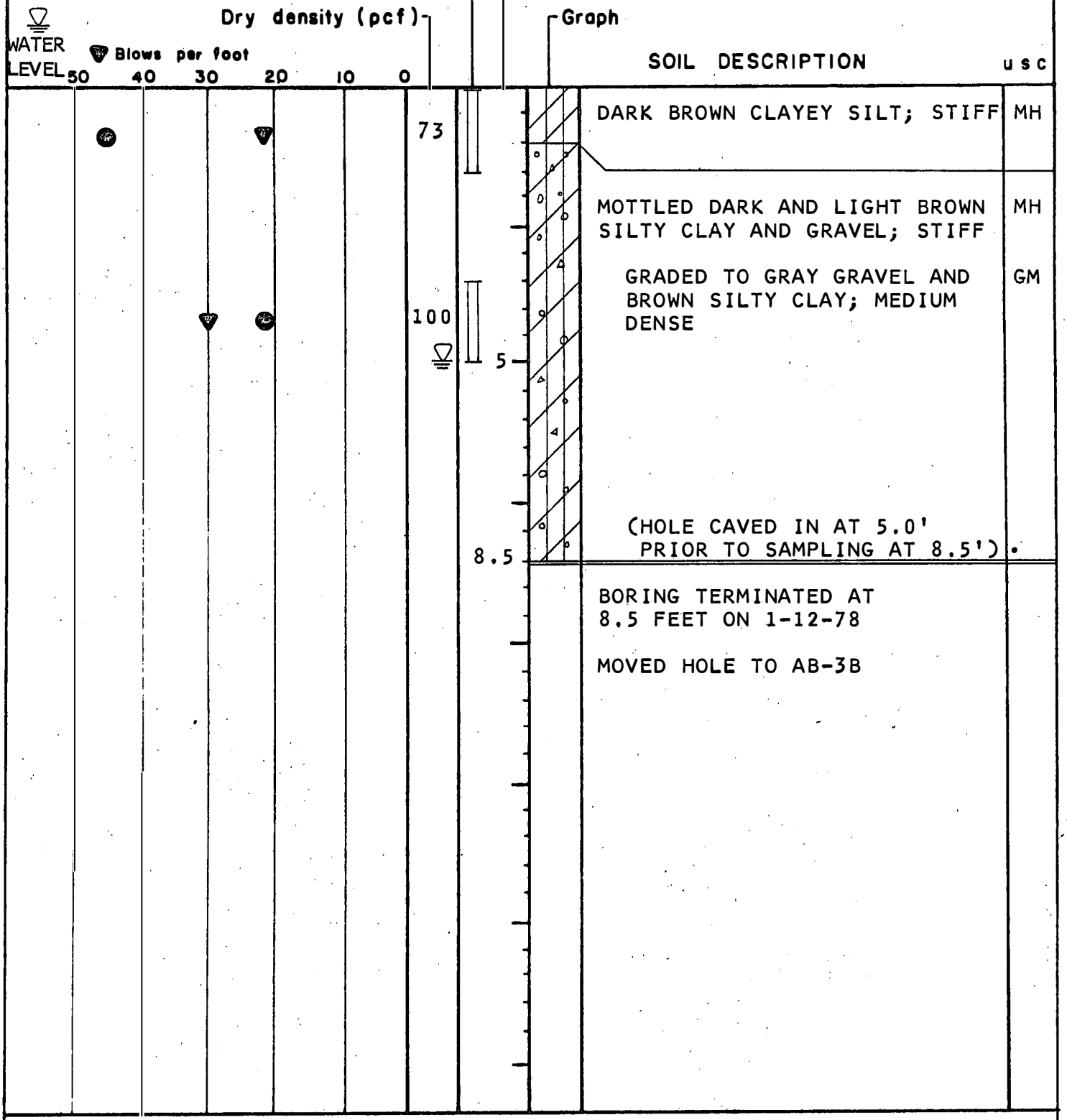
PLATE A-4

BORING AB-3

Surface elevation 88'±



SOIL DESCRIPTION	USC
DARK BROWN CLAYEY SILT; STIFF	MH
MOTTLED DARK AND LIGHT BROWN SILTY CLAY AND GRAVEL; STIFF	MH
GRADED TO GRAY GRAVEL AND BROWN SILTY CLAY; MEDIUM DENSE	GM
(HOLE CAVED IN AT 5.0' PRIOR TO SAMPLING AT 8.5')	
BORING TERMINATED AT 8.5 FEET ON 1-12-78	
MOVED HOLE TO AB-3B	

LEGEND

- Moisture content
- I 2.0" O.D. split-spoon sample
- II Undisturbed ring sample
- III Disturbed ring sample
- IV Core sample
- P Sampler pushed

Plastic limit
Liquid limit
Natural water content

Driving energy 140 lb.wt., 30" drop

AHUIMANU VILLA

LOG OF BORING

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PLATE A-5

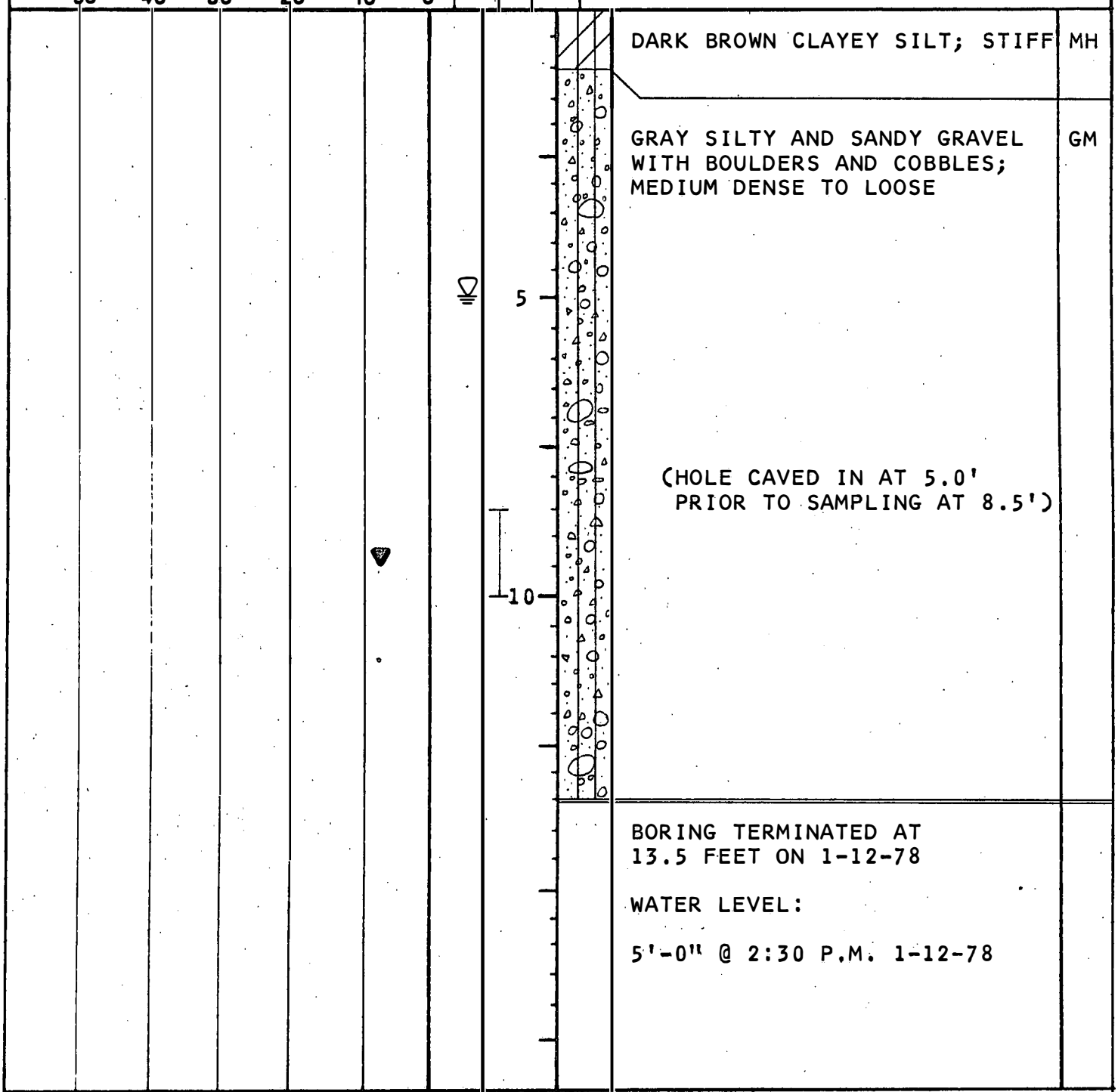
BORING AB-3B

Sample — Depth (feet) — Surface elevation 88'±

Dry density (pcf) — Graph

WATER LEVEL ▽ Blows per foot 50 40 30 20 10 0

SOIL DESCRIPTION — USC



DARK BROWN CLAYEY SILT; STIFF — MH

GRAY SILTY AND SANDY GRAVEL WITH BOULDERS AND COBBLES; MEDIUM DENSE TO LOOSE — GM

(HOLE CAVED IN AT 5.0' PRIOR TO SAMPLING AT 8.5')

BORING TERMINATED AT 13.5 FEET ON 1-12-78

WATER LEVEL:

5'-0" @ 2:30 P.M. 1-12-78

LEGEND

- Moisture content
- I 2.0" O.D. split-spoon sample
- II Undisturbed ring sample
- Disturbed ring sample
- Core sample
- P Sampler pushed

Plastic limit — Liquid limit — Natural water content

Driving energy: 140 lb. wt., 30" drop

AHUIMANU VILLA

LOG OF BORING

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PLATE A-6

BORING AB-4

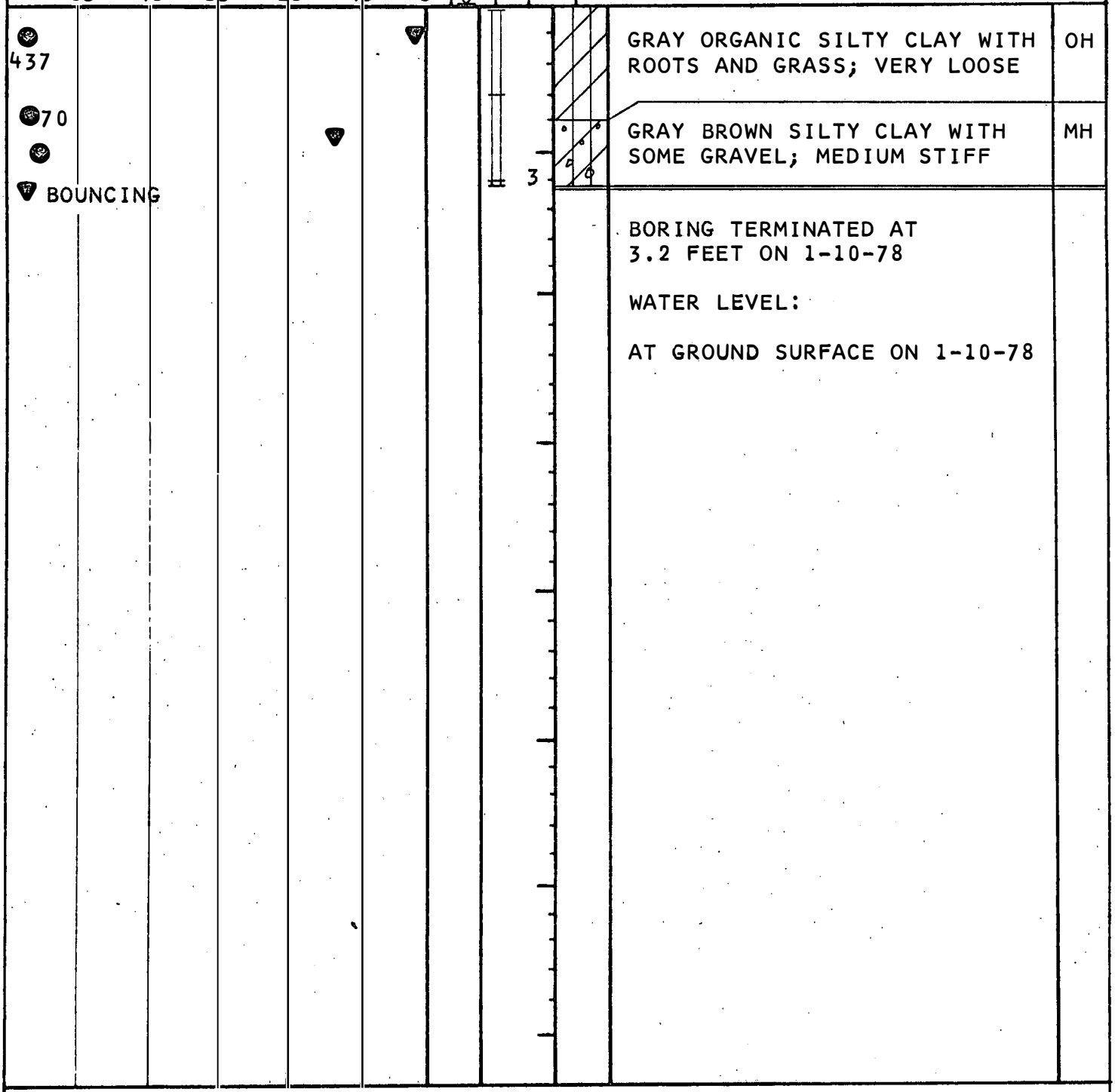
Sample — Depth (feet) — Surface elevation 94'±

Dry density (pcf) — Graph

WATER LEVEL ▽ — ▼ Blows per foot

50 40 30 20 10 0

SOIL DESCRIPTION — USC



GRAY ORGANIC SILTY CLAY WITH ROOTS AND GRASS; VERY LOOSE — OH

GRAY BROWN SILTY CLAY WITH SOME GRAVEL; MEDIUM STIFF — MH

BORING TERMINATED AT 3.2 FEET ON 1-10-78

WATER LEVEL:

AT GROUND SURFACE ON 1-10-78

LEGEND

● Moisture content

I 2.0" O.D. split-spoon sample

II Undisturbed ring sample

III Disturbed ring sample

IV Core sample

P Sampler pushed

Plastic limit —

Liquid limit —

Natural water content —

Driving energy 140 lb. wt., 30" drop

AHUIMANU VILLA

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PLATE A-7

BORING AB-4A

Sample — Depth (feet) — Surface elevation 94'±

Dry density (pcf) — Graph

WATER LEVEL ▽ — ▼ Blows per foot

WATER LEVEL	50	40	30	20	10	0	Depth (feet)	SOIL DESCRIPTION	USC
						▼ 31		GRAYISH BROWN ORGANIC SILTY CLAY WITH ROOTS; VERY SOFT	OH
● 140									
						21			
● 219						▼			
							5	GRADED TO BROWN ORGANIC SILT AND FIBERS	
● 254						▼			
						▼			
						24			
● 202					▼				
▼ 10/6"+15/1" BOUNCING					●		10	GRAYISH BROWN SILT AND GRAVEL	ML
								BORING TERMINATED AT 10.6 FEET ON 1-10-78	
								WATER LEVEL:	
								AT GROUND SURFACE ON 1-10-78	

LEGEND

- ● Moisture content
- I 2.0" O.D. split-spoon sample
- II Undisturbed ring sample
- III Disturbed ring sample
- IV Core sample
- P Sampler pushed

Plastic limit —— Liquid limit —— Natural water content

Driving energy 140 lb.wt., 30" drop W.O. 696-10 FEBRUARY 1978

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PLATE A-8

BORING AB-4B

Sample — Depth (feet) — Surface elevation 94'±

Dry density (pcf) — Graph

WATER LEVEL ▽ Blows per foot

50 40 30 20 10 0

118	39 ▽	GRAY ORGANIC CLAYEY SILT WITH ROOTS AND FIBERS; VERY SOFT	OH
	63	GRAY ORGANIC CLAYEY SILT AND PEAT; SOFT	OH
112			
72 / 74	59	GRAYISH BROWN CLAYEY SILT WITH GRASS AND SOME GRAVEL; SOFT	OH
73	59		
71		MOTTLED LIGHT BROWN AND ORANGE SANDY AND SILTY GRAVEL; MEDIUM DENSE	GM
62			
		BORING TERMINATED AT 14.0 FEET ON 1-13-78	
		WATER LEVEL:	
		1'-0" @ 12:00 P.M. 1-13-78	

5

10

LEGEND

- Moisture content
- I 2.0" O.D. split-spoon sample
- II Undisturbed ring sample
- III Disturbed ring sample
- IV Core sample
- P Sampler pushed

Plastic limit — Liquid limit — Natural water content

Driving energy 140 lb. wt., 30" drop

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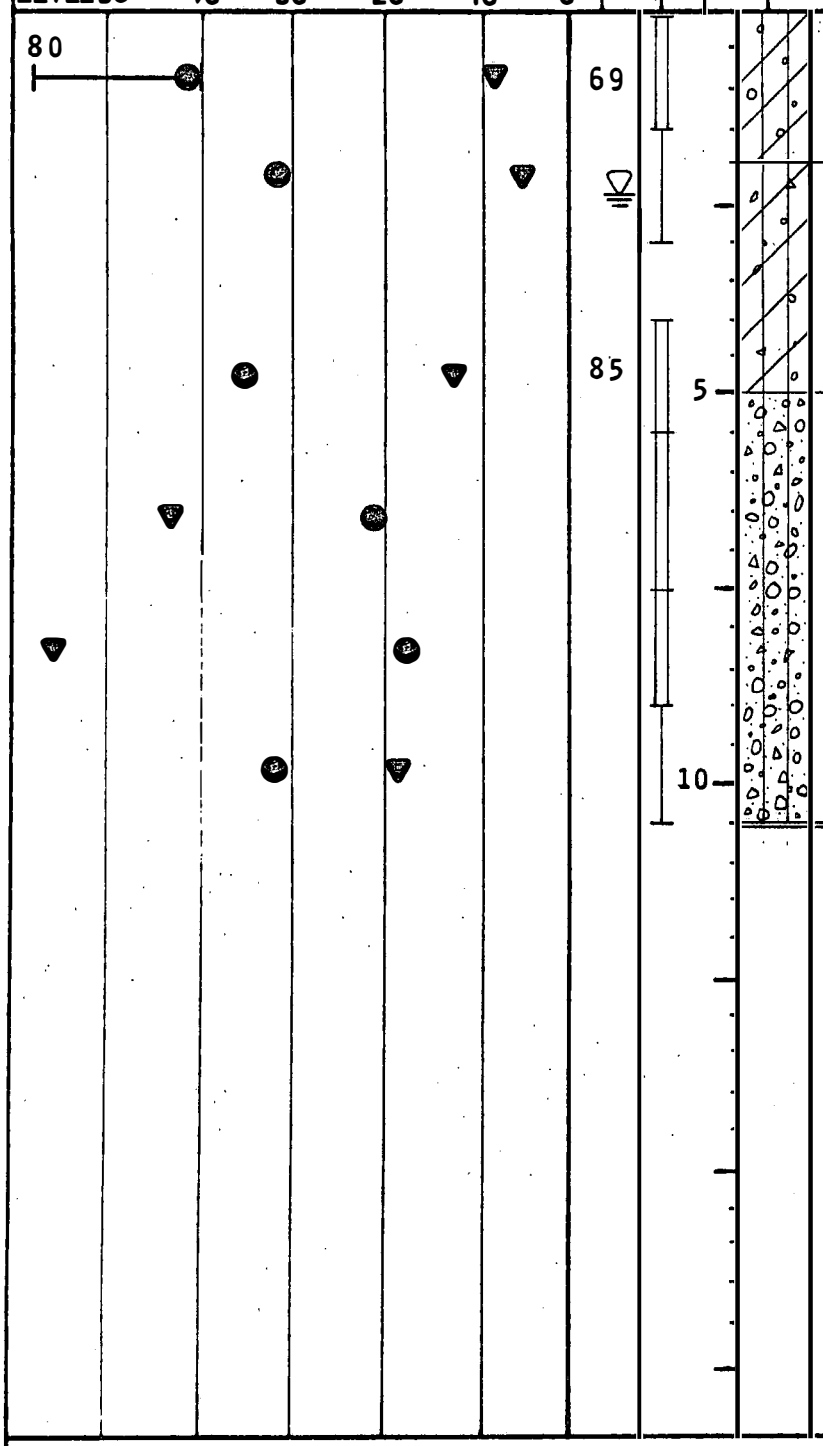
PLATE A-9

BORING AB-5

Surface elevation 99'±



SOIL DESCRIPTION	USC
DARK BROWN CLAYEY SILT WITH A FEW PEBBLES; MEDIUM STIFF	MH
MOTTLED BROWN AND LIGHT BROWN CLAYEY SILT WITH A LITTLE GRAVEL; MEDIUM STIFF	MH
BROWN SILTY AND SANDY GRAVEL; MEDIUM DENSE	GM
BORING TERMINATED AT 10.5 FEET ON 1-10-78 WATER LEVEL: 2'-8" @ 3:10 P.M. 1-10-78	

LEGEND

- Moisture content
- I 2.0" O.D. split-spoon sample
- II Undisturbed ring sample
- Disturbed ring sample
- Core sample
- P Sampler pushed

Plastic limit
Liquid limit
Natural water content

Driving energy 140 lb. wt., 30" drop

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PLATE A-10

BORING AB-6

Sample — Depth (feet) — Surface elevation 107'±

Dry density (pcf) — Graph

WATER LEVEL ▽ — Blows per foot

50	40	30	20	10	0

SOIL DESCRIPTION — USC

Sample	Blows per foot	Dry density (pcf)	Depth (feet)	SOIL DESCRIPTION	USC
		68		GRAYISH BROWN CLAYEY SILT WITH GRAVELS AND ROOTS	MH
75		57	5	GRAY ORGANIC CLAYEY AND SANDY SILT WITH LITTLE GRAVEL AND FIBERS; VERY SOFT	OH
85	79	54			
108		49	10		
58			15	GRAYISH BROWN CLAYEY AND SANDY SILT WITH SOME GRAVEL; SOFT TO MEDIUM STIFF	MH
				BORING TERMINATED AT 15.0 FEET ON 1-11-78 WATER LEVEL: 3'-3" @ 11:45 A.M. 1-11-78	

LEGEND

- Moisture content
- I 2.0" O.D. split-spoon sample
- II Undisturbed ring sample
- III Disturbed ring sample
- IV Core sample
- P Sampler pushed

Plastic limit — Liquid limit — Natural water content

Driving energy: 140 lb. wt., 30" drop

AHUIMANU VILLA

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PLATE A-11

BORING AB-7

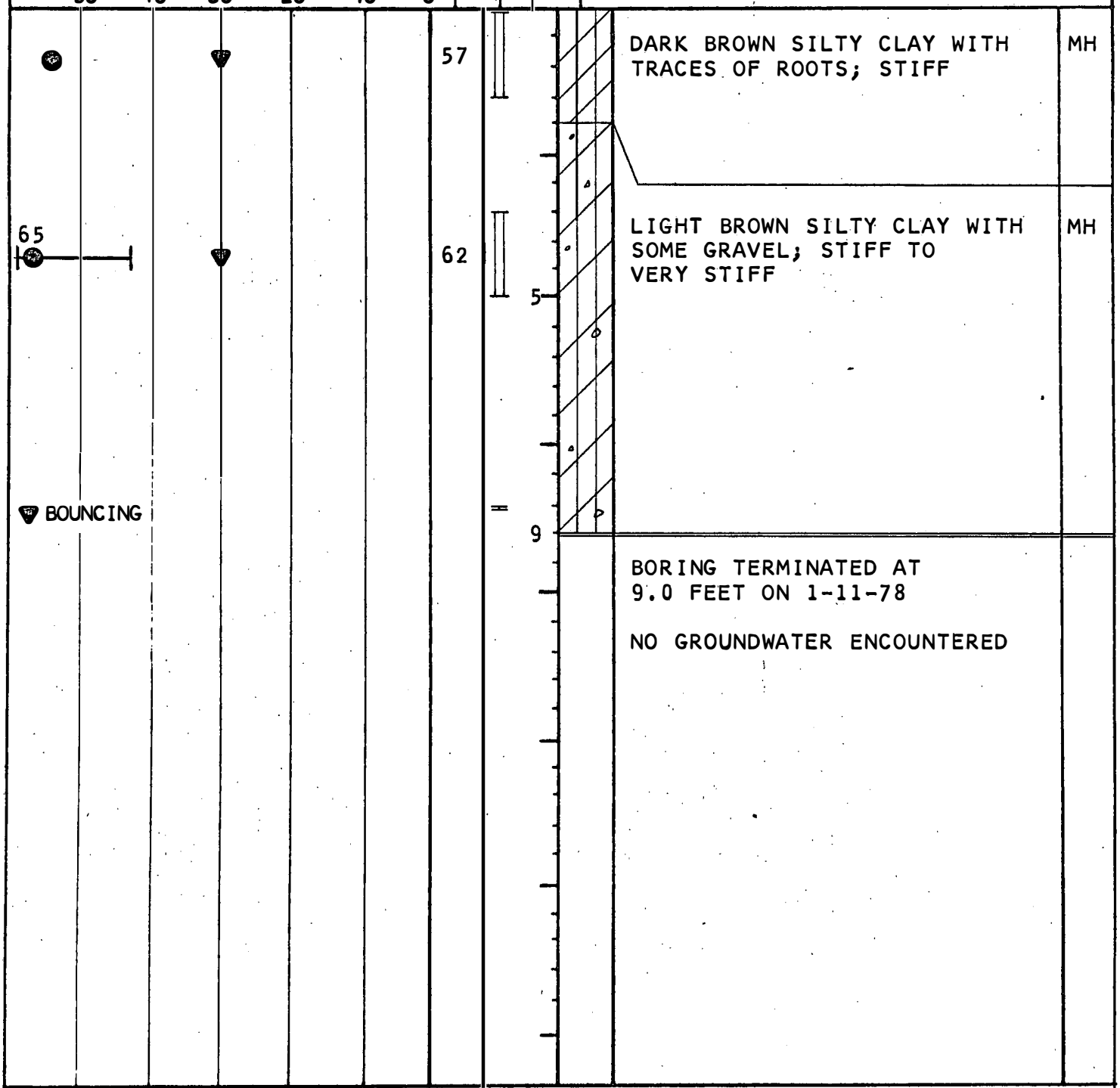
Sample — Depth (feet) — Surface elevation 117'±

Dry density (pcf) — Graph

Blows per foot

50 40 30 20 10 0

SOIL DESCRIPTION — U S C



DARK BROWN SILTY CLAY WITH TRACES OF ROOTS; STIFF — MH

LIGHT BROWN SILTY CLAY WITH SOME GRAVEL; STIFF TO VERY STIFF — MH

BORING TERMINATED AT 9.0 FEET ON 1-11-78

NO GROUNDWATER ENCOUNTERED

LEGEND

- Moisture content
- I 2.0" O.D. split-spoon sample
- II Undisturbed ring sample
- Disturbed ring sample
- Core sample
- P Sampler pushed

Plastic limit — Liquid limit — Natural water content

AHUIMANU VILLA

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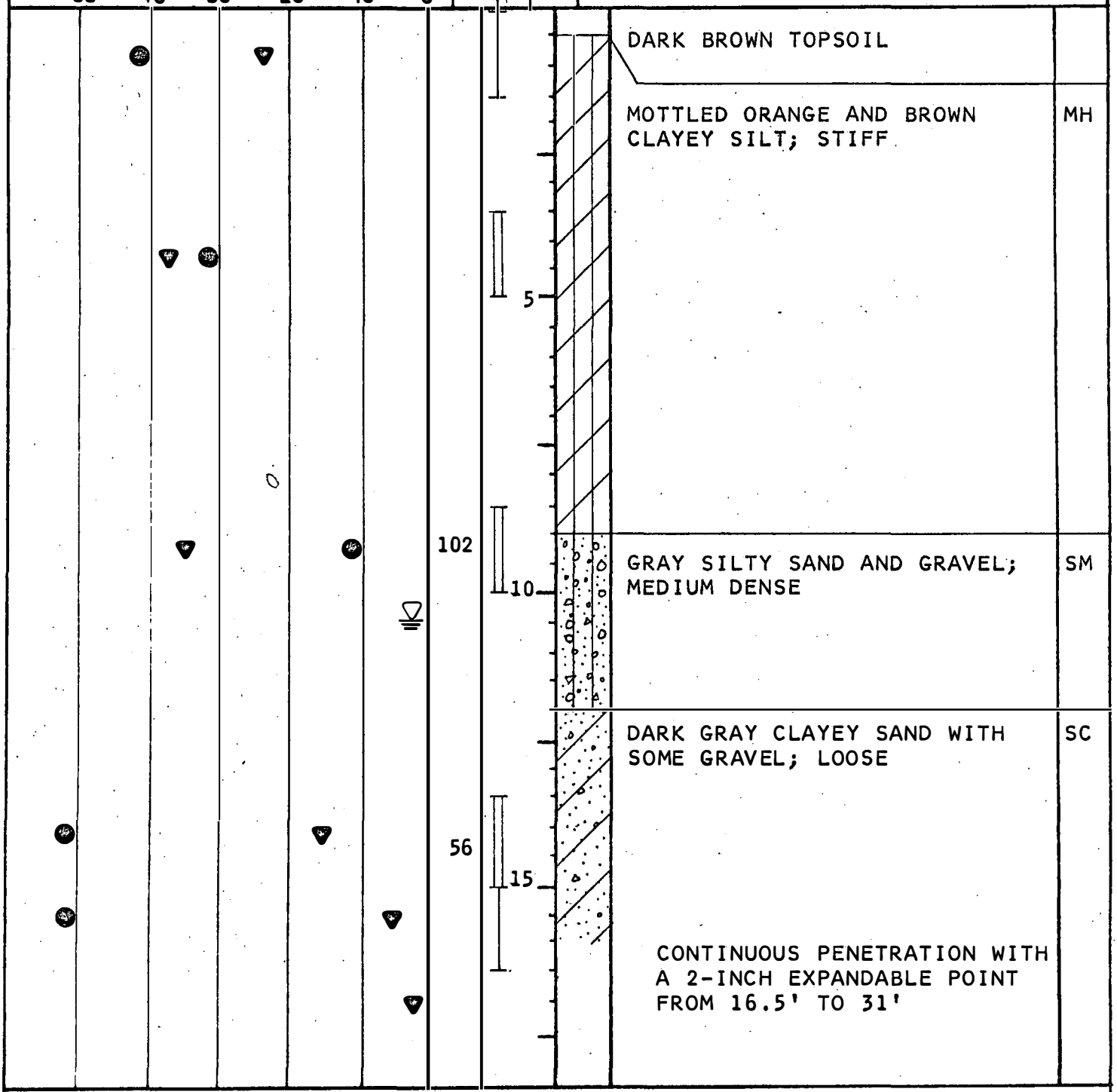
Driving energy 140 lb. wt., 30" drop W.O. 696-10 FEBRUARY 1978

PLATE A-12

BORING AB-8

Surface elevation 48'±



LEGEND

- Moisture content
- I 2.0" O.D. split-spoon sample
- II Undisturbed ring sample
- III Disturbed ring sample
- IV Core sample
- P Sampler pushed

Plastic limit
Liquid limit
Natural water content

Driving energy 140 lb. wt., 30" drop W.O. 696-10 FEBRUARY 1978

AHUIMANU VILLA

LOG OF BORING

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PLATE A-13

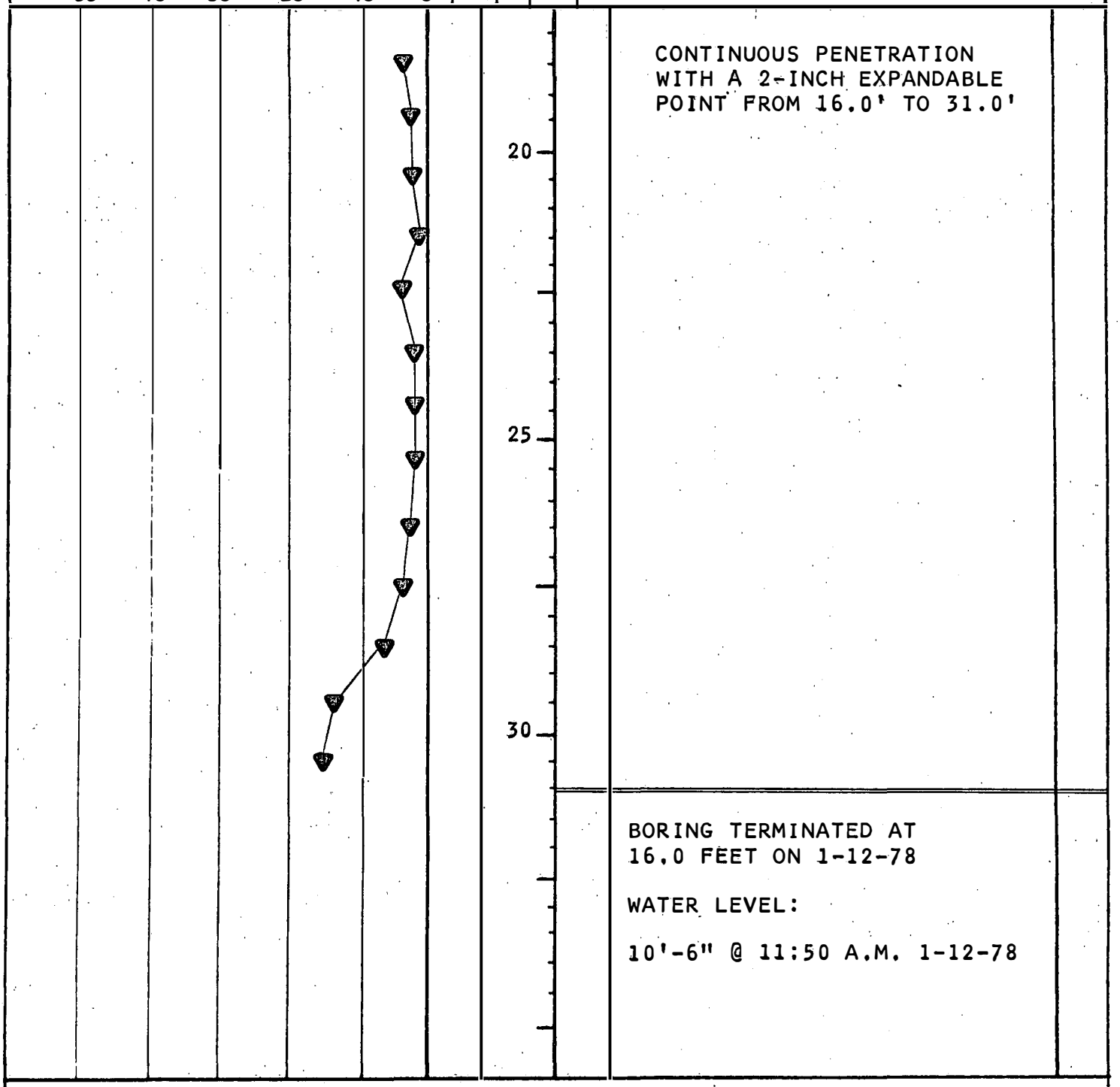
BORING AB-8

Sample — Depth (feet)
Dry density (pcf) — Graph
Surface elevation 48'±

Blows per foot
50 40 30 20 10 0

SOIL DESCRIPTION

USC



CONTINUOUS PENETRATION WITH A 2-INCH EXPANDABLE POINT FROM 16.0' TO 31.0'

BORING TERMINATED AT 16.0 FEET ON 1-12-78

WATER LEVEL:

10'-6" @ 11:50 A.M. 1-12-78

LEGEND

- Moisture content
- I 2.0" O.D. split-spoon sample
- II Undisturbed ring sample
- III Disturbed ring sample
- IV Core sample
- P Sampler pushed

Plastic limit
Liquid limit
Natural water content

Driving energy 140 lb.wt., 30" drop W.O. 696-10 FEBRUARY 1978

AHUIMANU VILLA

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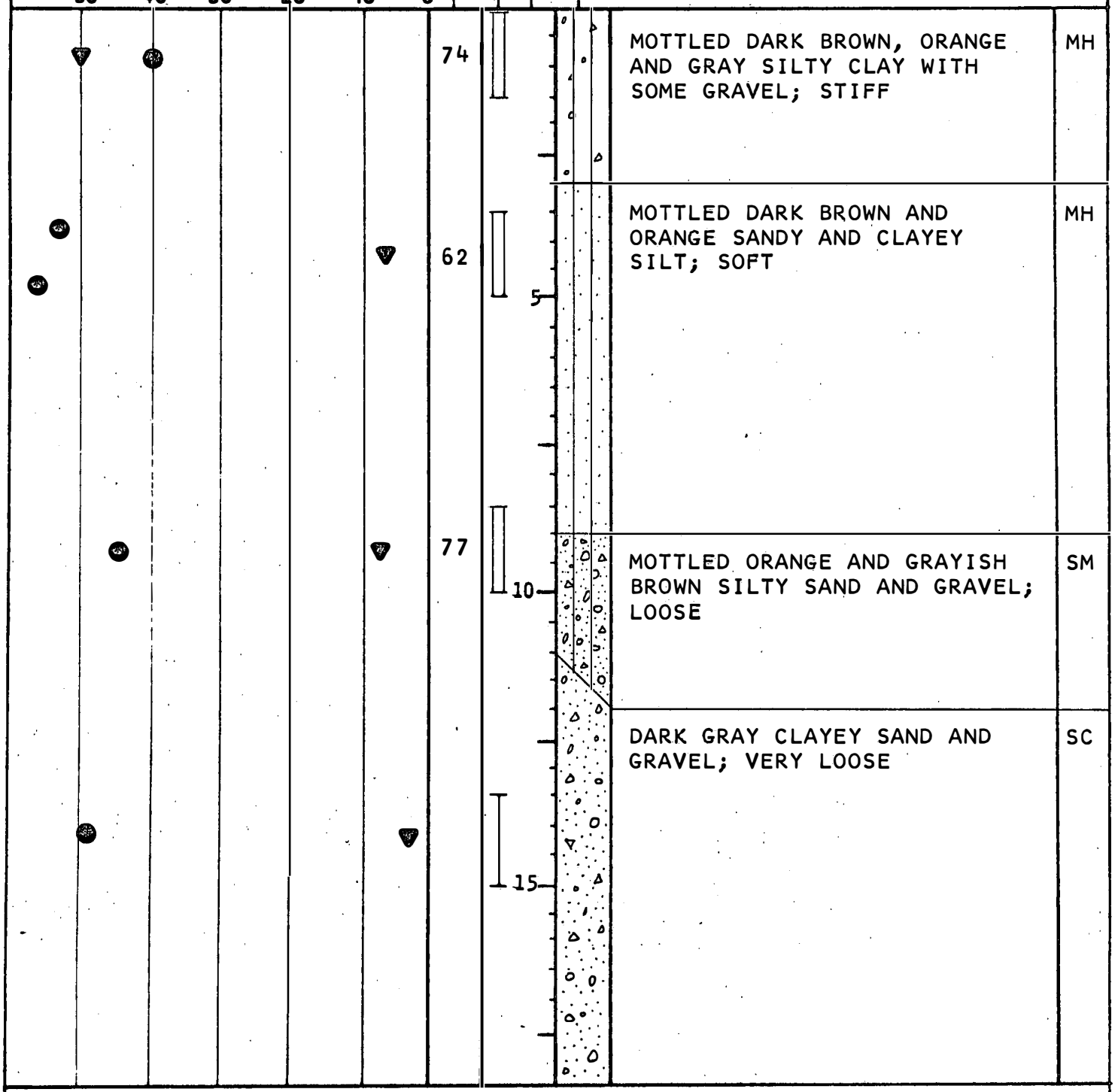
PLATE A-14

BORING AB-9

Surface elevation 58'±



SOIL DESCRIPTION	USC
MOTTLED DARK BROWN, ORANGE AND GRAY SILTY CLAY WITH SOME GRAVEL; STIFF	MH
MOTTLED DARK BROWN AND ORANGE SANDY AND CLAYEY SILT; SOFT	MH
MOTTLED ORANGE AND GRAYISH BROWN SILTY SAND AND GRAVEL; LOOSE	SM
DARK GRAY CLAYEY SAND AND GRAVEL; VERY LOOSE	SC

LEGEND

- Moisture content
- I 2.0" O.D. split-spoon sample
- II Undisturbed ring sample
- III Disturbed ring sample
- IV Core sample
- P Sampler pushed

Plastic limit
Liquid limit
Natural water content

Driving energy 140 lb. wt., 30" drop W.O. 696-10 FEBRUARY 1978

AHUIMANU VILLA

LOG OF BORING
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PLATE A-15

BORING AB-9

Sample — Depth (feet)
Dry density (pcf) — Graph
Surface elevation 58'±

Blows per foot
50 40 30 20 10 0

SOIL DESCRIPTION	USC
DARK GRAY CLAYEY SAND AND GRAVEL; VERY LOOSE	SC
GRAY SILTY AND SANDY GRAVEL; LOOSE TO MEDIUM DENSE	
BORING TERMINATED AT 24.5 FEET ON 1-16-78 WATER LEVEL: 7'-11" @ 12:15 P.M. 1-16-78	

97

6/6"+15/4"
BOUNCING

20

25

LEGEND

- Moisture content
- I 2.0" O.D. split-spoon sample
- II Undisturbed ring sample
- III Disturbed ring sample
- IV Core sample
- P Sampler pushed

Plastic limit
Liquid limit
Natural water content

Driving energy: 140 lb. wt., 30" drop

AHUIMANU VILLA

LOG OF BORING
DEVEX CORPORATION

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PLATE A-16

TEST PIT LOGS

AHUIMANU VILLA DEVELOPMENT

Test Pit No.	Surface Elevation (Feet)	Depth (Feet)	Soil Description
AT-1	200'	0'-3.0'	BROWN SILTY CLAY.
		3.0'-6.0'	MOTTLED BROWN AND RED CLAYEY SILT with a little highly decomposed rock.
		6.0'-23.0'	MOTTLED RED AND BROWN CLAYEY SILT with some localized areas of highly decomposed rock. Moisture Content: @ 7' = 52.3% @15' = 64.2%
AT-1A	225'	0'-2.0'	DARK BROWN SILTY CLAY with roots.
		2.0'-4.0'	BROWN CLAYEY SILT with some light brown clayey silt of decomposed rock origin.
		4.0'-7.0'	MOTTLED BROWN AND RED SILTY CLAY with a little pink and black highly decomposed rock. Moisture Content: @ 5' = 60.3% In-place Dry Density = 61 p.c.f. Liquid Limit = 91% Plastic Limit = 52%
AT-2	244'±	0'-1.5'	BROWN SILTY CLAY with roots.
		1.5'-17.0'	MOTTLED RED AND BROWN SILTY CLAY with little gray highly decomposed rock. Moisture Content: @ 5' = 44.2% In-place Dry Density = 77 p.c.f. Liquid Limit = 85% Plastic Limit = 53%

PLATE A-17

W.O. 696-10 FEBRUARY 1978

PROBING LOGS

AHUIMANU VILLA DEVELOPMENT

Probing No.	Surface Elevation (Feet)	Depth (Feet)	Soil Description
AP-1	76'±	0'-1.5'	GRAYISH BROWN SILTY CLAY; soft (graded to gravelly at 1.5'). Moisture Content = 78.3%
AP-2	78'±	0'-1.5'	GRAYISH BROWN SILTY CLAY; soft (graded to mottled gray and brown silty clay at 1.5'). WATER at 6". Moisture Content @ 1.5'=88.5% Liquid Limit = 106% Plastic Limit = 48%
AP-3	80'±	0'-4.0'	WATER (gravelly material encountered below water).
AP-4	85'±	0'-1.0'	GRAYISH BROWN SILTY CLAY; soft.
		1.0'-2.5'	GRAY SILTY SAND AND GRAVEL; loose.
AP-5	97'±	0'-10.0'	GRAY ORGANIC CLAYEY SILT; soft.
AP-6	100'±	0'-5.0'	GRAY ORGANIC CLAYEY SILT; soft.
AP-7	106'±	0'-2.5'	GRAYISH BROWN ORGANIC CLAYEY SILT (heavy root layers at 2.5'). Moisture Content = 68.8%
AP-8	165'±	0'-5'+	DARK BROWN TO GRAY ORGANIC CLAYEY SILT; soft. WATER at 1.0'. Moisture Content = 211% Liquid Limit = 166% Plastic Limit = 72%
AP-9	173'±	0'-5'+	BROWN TO GRAYISH BROWN CLAYEY SILT; soft.
AP-10	173'	0'-2.0'	MOTTLED GRAY AND BROWN SILTY CLAY; medium stiff.

PROBING LOGS (cont'd)

Probing No.	Surface Elevation (Feet)	Depth (Feet)	Soil Description
AP-10	173'±	2.0'-3.5'	GRAY CLAYEY SILT; soft Moisture Content at 2' = 75.4% Liquid Limit = 101% Plastic Limit = 48%
AP-11	174'±	0'-1.0'	BROWN CLAYEY SILT; medium stiff.
AP-12	176'±	0'-1.0'	BROWN CLAYEY SILT; medium stiff.
AP-13	177'±	0'-1.0'	BROWN CLAYEY SILT; medium stiff.
		1.0'-2.0'	GRAYISH BROWN CLAYEY SILT; soft (gravelly at 2.0').
AP-14	184'±	0'-4.0'	BROWN CLAYEY SILT with some Gravel; medium stiff (Log of Slope Bank).

PLATE A-19

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A P P E N D I X B

LABORATORY TESTING

Moisture content determinations were made on all the boring samples and on selected test pit and probing samples as an aid in the soil classification and in evaluating soil properties. Unit weight and Atterberg Limits determination were also performed on selected test pit and boring samples. The results of these tests are presented on the respective boring, test pit and probing logs at the appropriate sample depths.

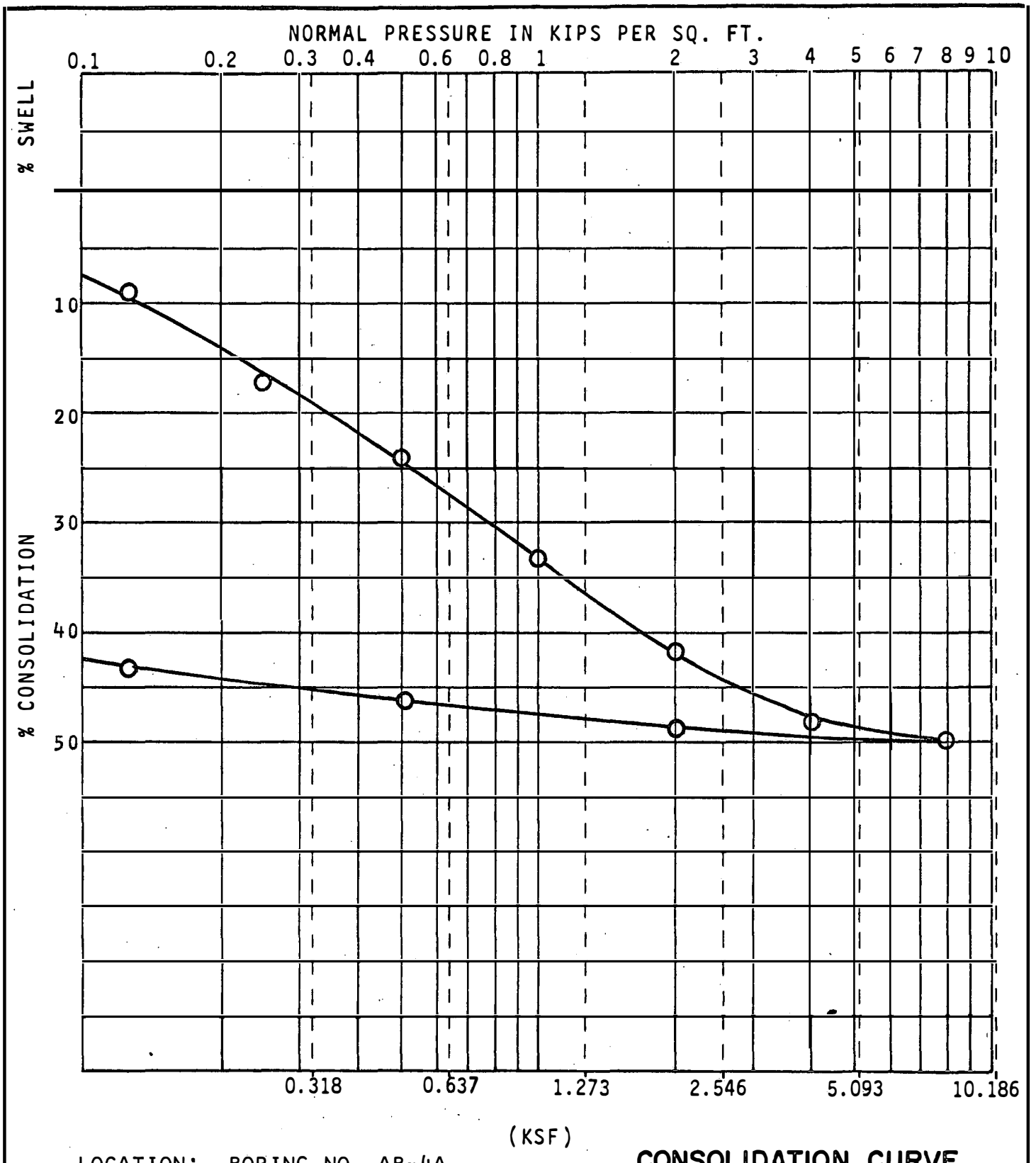
Four consolidation tests were performed on undisturbed ring samples to determine the consolidation characteristic of the on-site soft materials. The consolidation curves are shown on Plates B-1 through B-4.

Six direct shear tests were performed on selected undisturbed and remolded ring samples to evaluate the strength characteristics of the soils. The soils in the remolded ring samples were compacted to 90% of its maximum density before being tested. Direct shear tests were run at a slow strain rate of about 0.05 inch per minute and the samples were submerged in water during the test. The test results are plotted on Plates B-5 through B-10.

Five swell tests of one-inch ring samples were conducted on on-site soil samples for measuring the swell potential. The swell test results are summarized on Plate B-11.

To obtain the moisture-density relationship of the site soil as a potential source of borrow fill, a Modified Proctor curve was developed by compacting the soil samples from a wet to dry moisture condition. The maximum density & moisture curve is plotted on Plate B-12.

One California Bearing Ratio (CBR) test was performed on bulk samples of the on-site soil to evaluate the suitability of the soil as fill and pavement support. The results are given on Table 1.



LOCATION: BORING NO. AB-4A

DEPTH: 3.0 - 5.0 FEET

DESCRIPTION: GRAYISH BROWN ORGANIC SILT WITH GRASS AND ROOTS.

CONSOLIDATION CURVE

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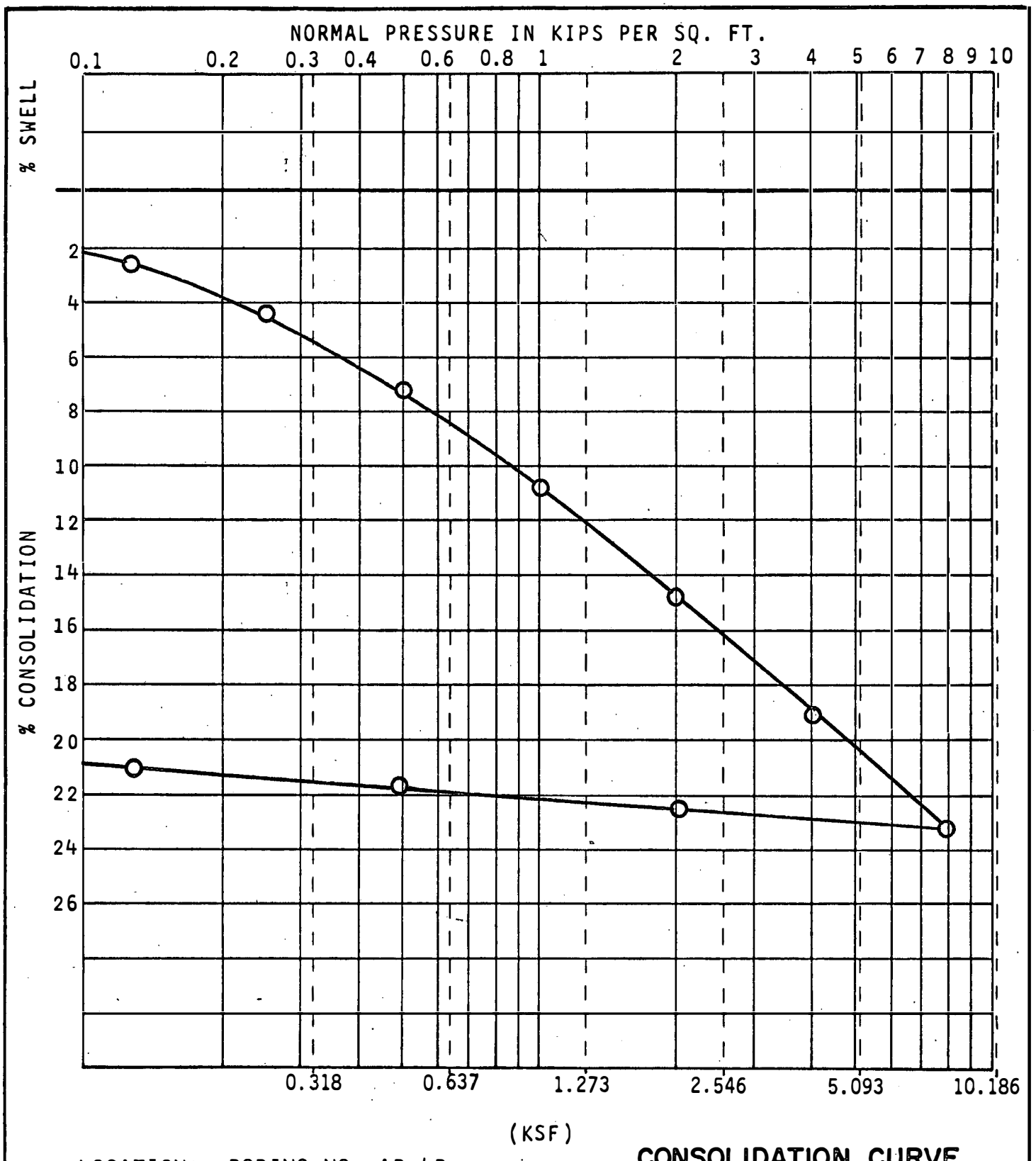
PLATE B-1



CONSOLIDATION CURVE

LOCATION: BORING NO. AB-4B

DEPTH: 5.0 - 7.0 FEET

DESCRIPTION: GRAYISH BROWN ORGANIC CLAYEY SILT WITH GRASS, ROOTS AND A FEW PEBBLE GRAVEL.

AHUIMANU VILLA CLUSTER

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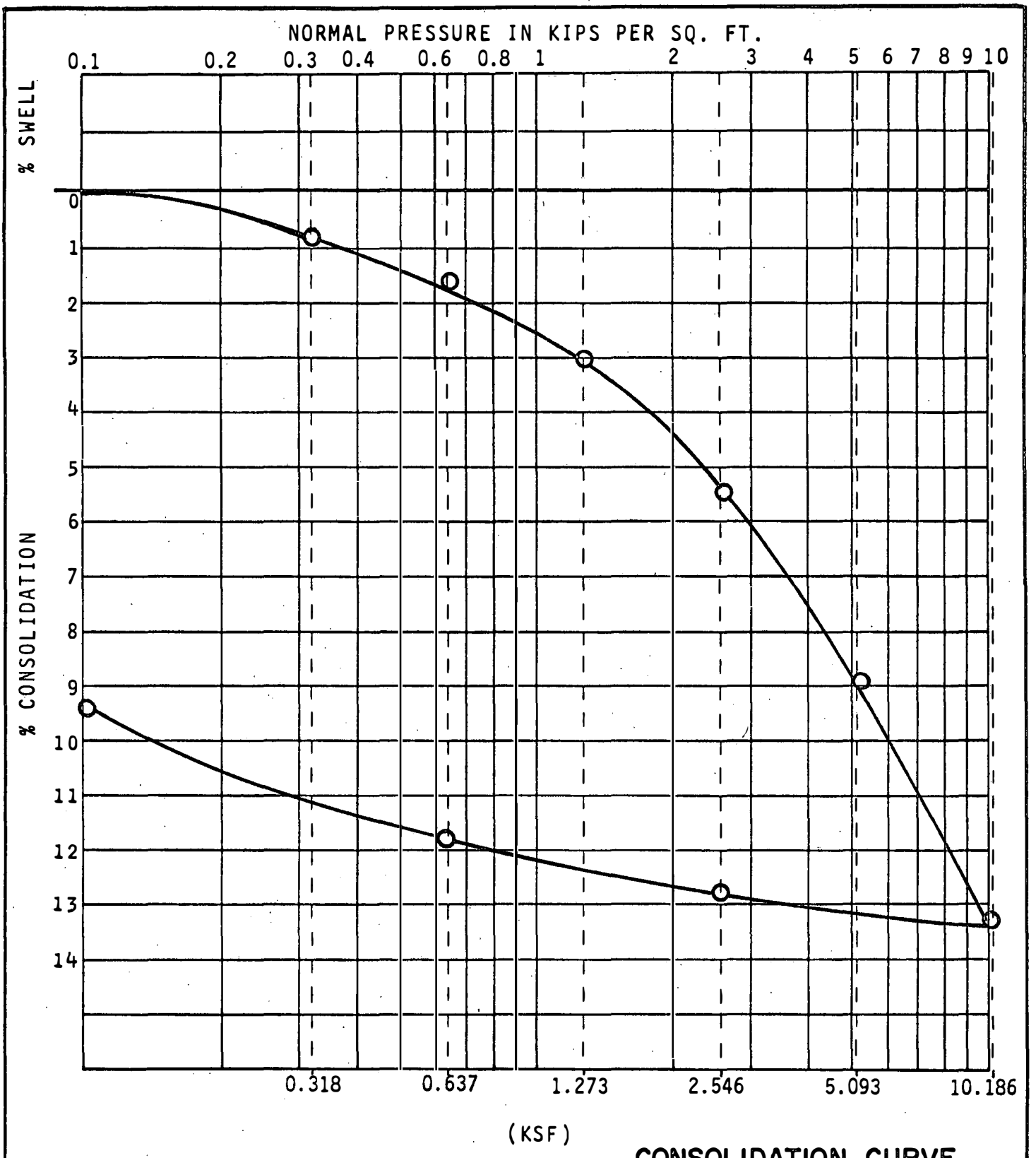
PLATE B-2



CONSOLIDATION CURVE

LOCATION: BORING NO. AB-5

DEPTH: 0 - 1.5 FEET

DESCRIPTION: BROWN CLAYEY SILT WITH SOME GRAVEL.

AHUIMANU VILLA CLUSTER

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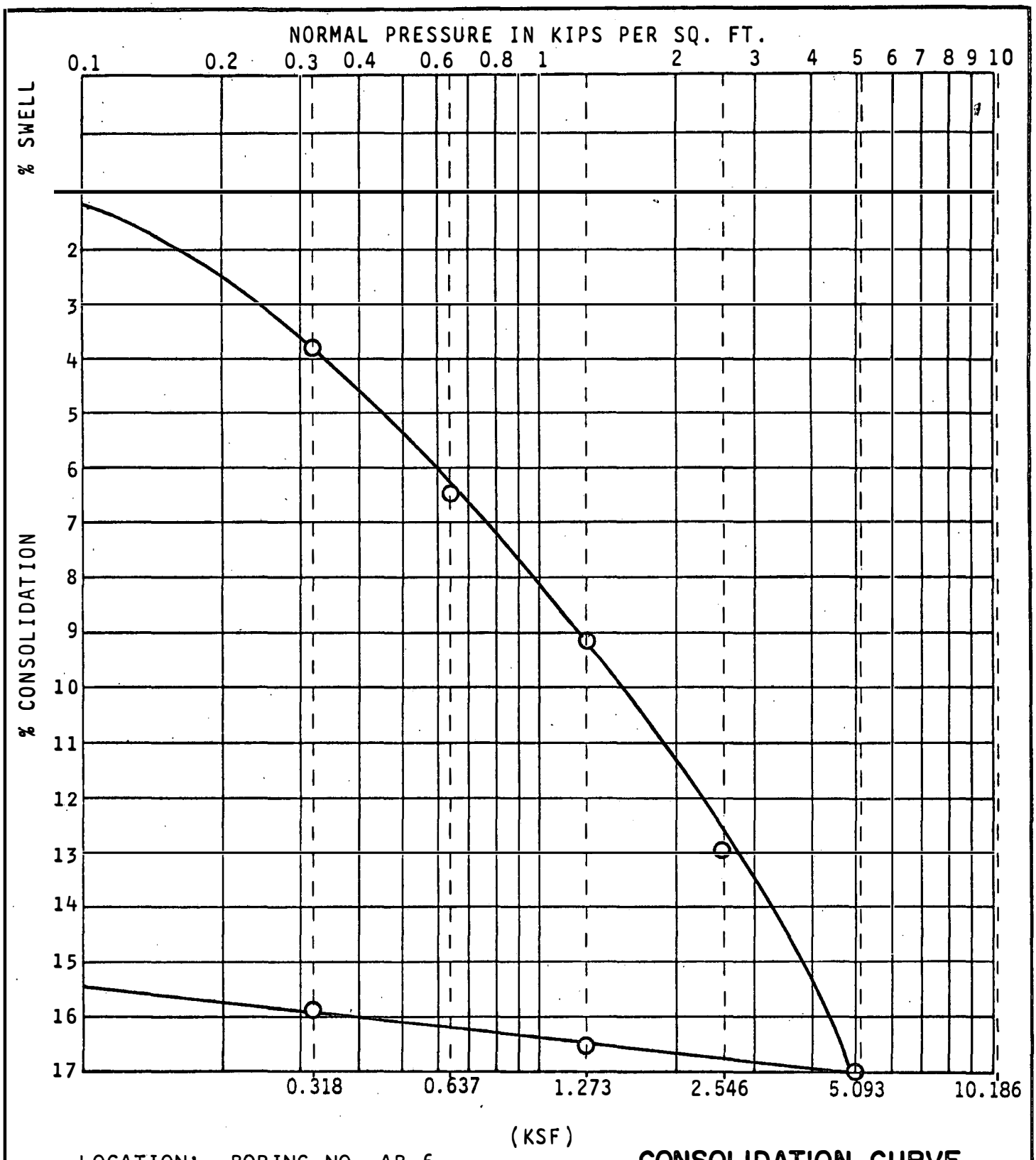
W.O. 696-10 FEBRUARY 1978 PLATE B-3



LOCATION: BORING NO. AB-6

DEPTH: 6.0 - 7.5 FEET

DESCRIPTION: DARK BROWN CLAYEY SILT WITH SOME GRAVEL.

CONSOLIDATION CURVE

AHUIMANU VILLA CLUSTER

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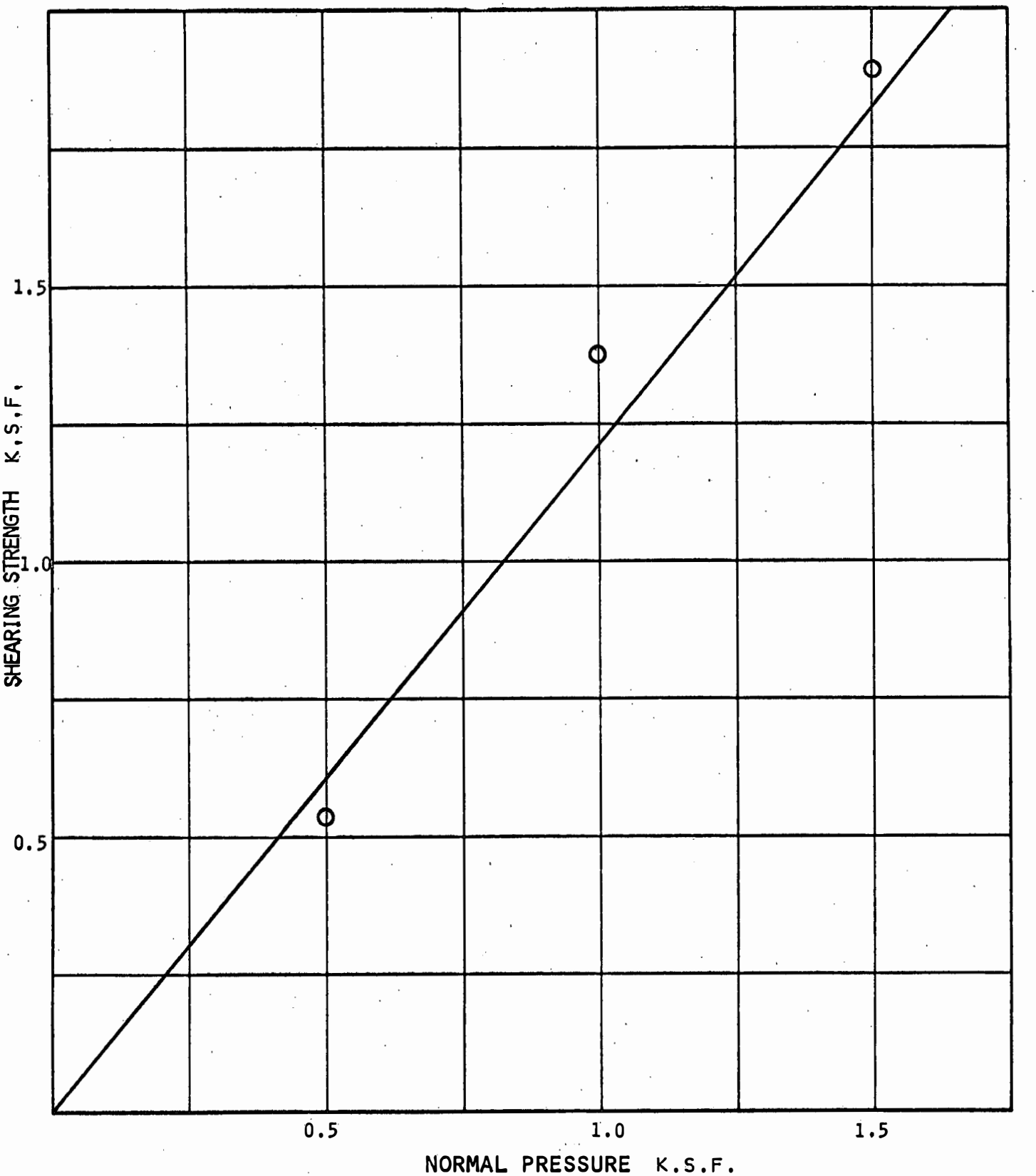

LOCATION: BORING NO. AB-5

DEPTH: 4.0 - 5.5 FEET
(PRESENCE OF GRAVEL)

DIRECT SHEAR TEST	
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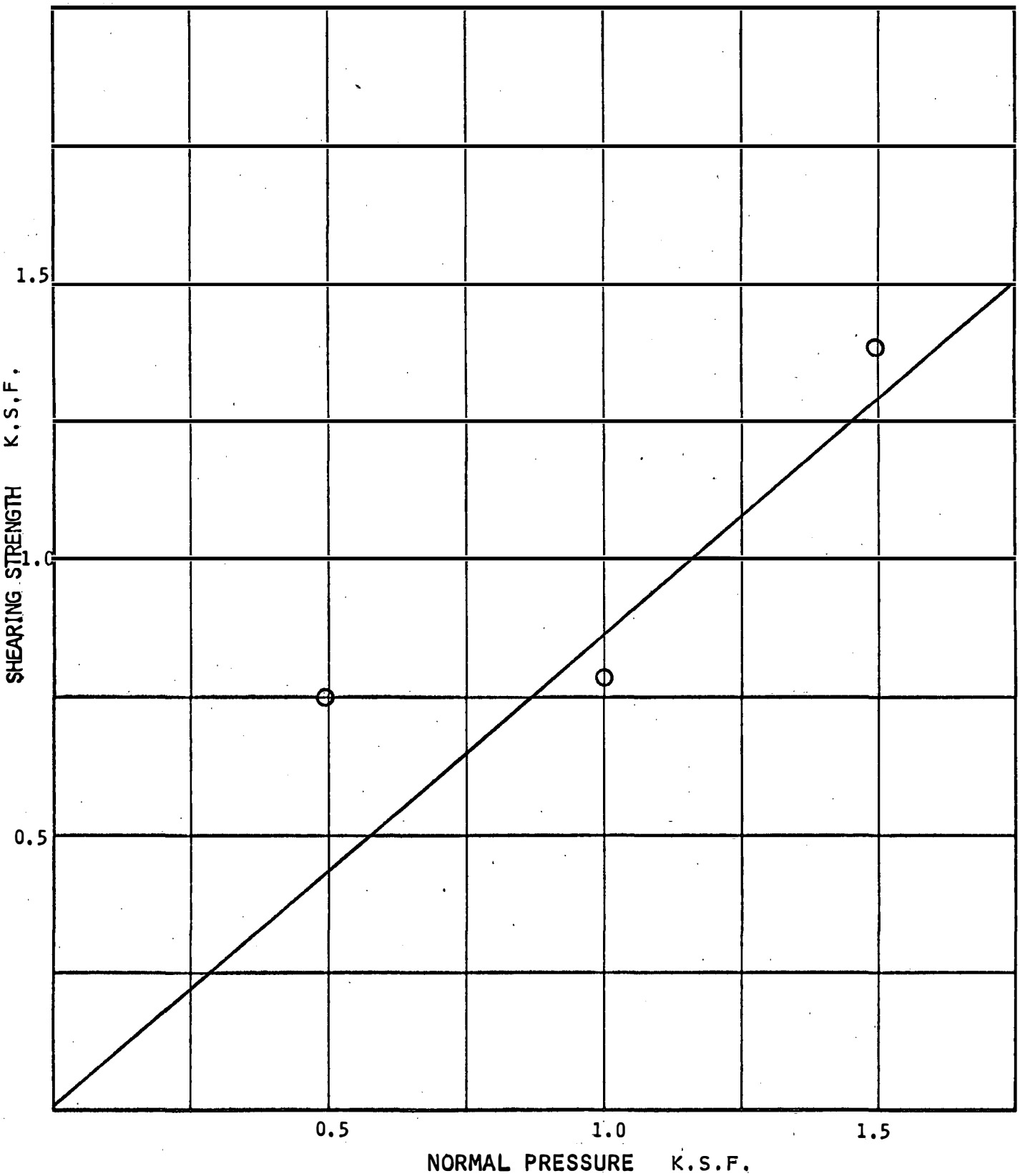
PLATE B-5



LOCATION: BORING NO. AB-7

DEPTH: 3.5 - 5.0 FEET
(PRESENCE OF GRAVEL AND DISTURBED)

DIRECT SHEAR TEST	
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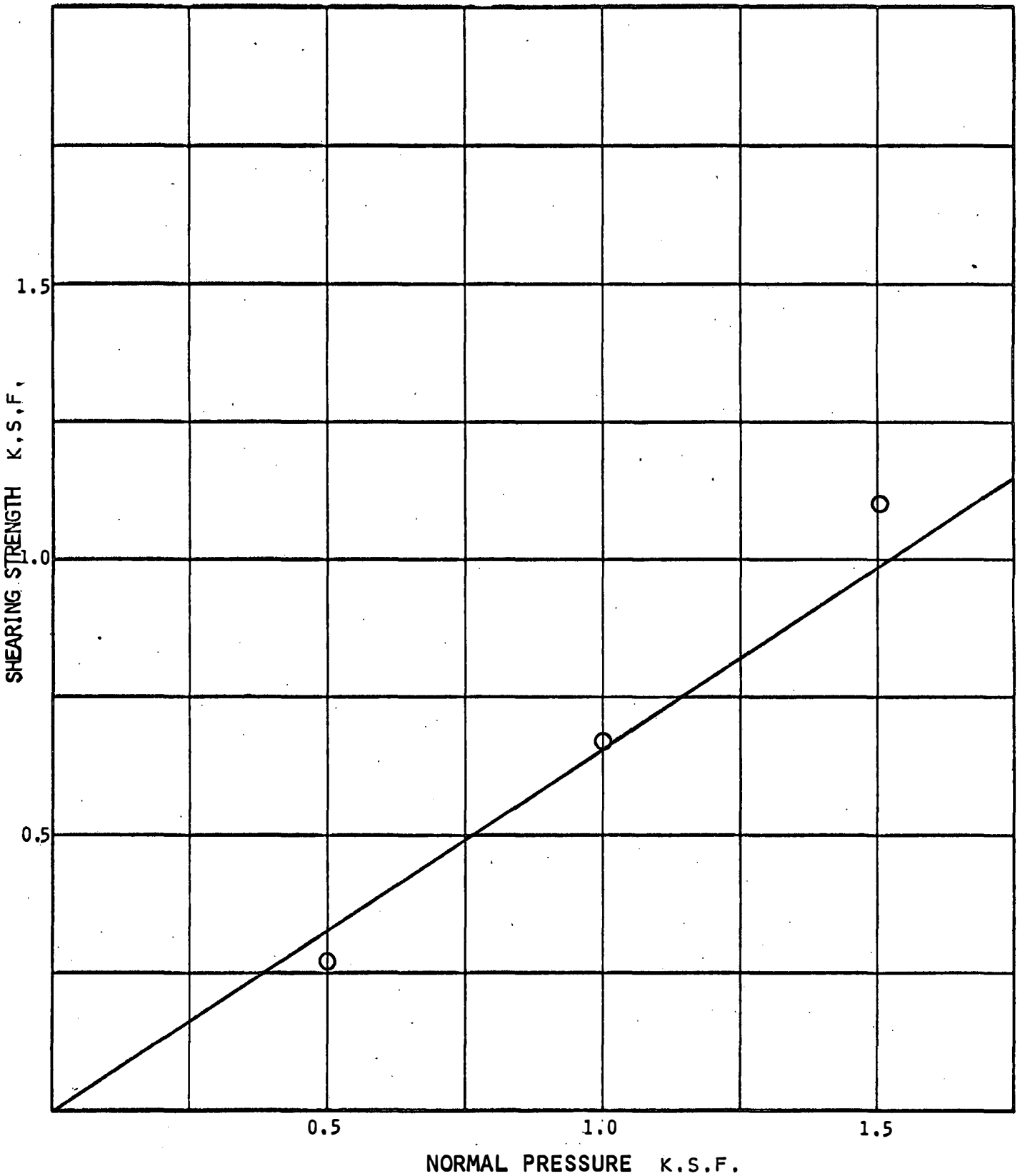
PLATE B-6



LOCATION: BORING NO. AB-8

DEPTH: 3.5 - 5.0 FEET

DIRECT SHEAR TEST	
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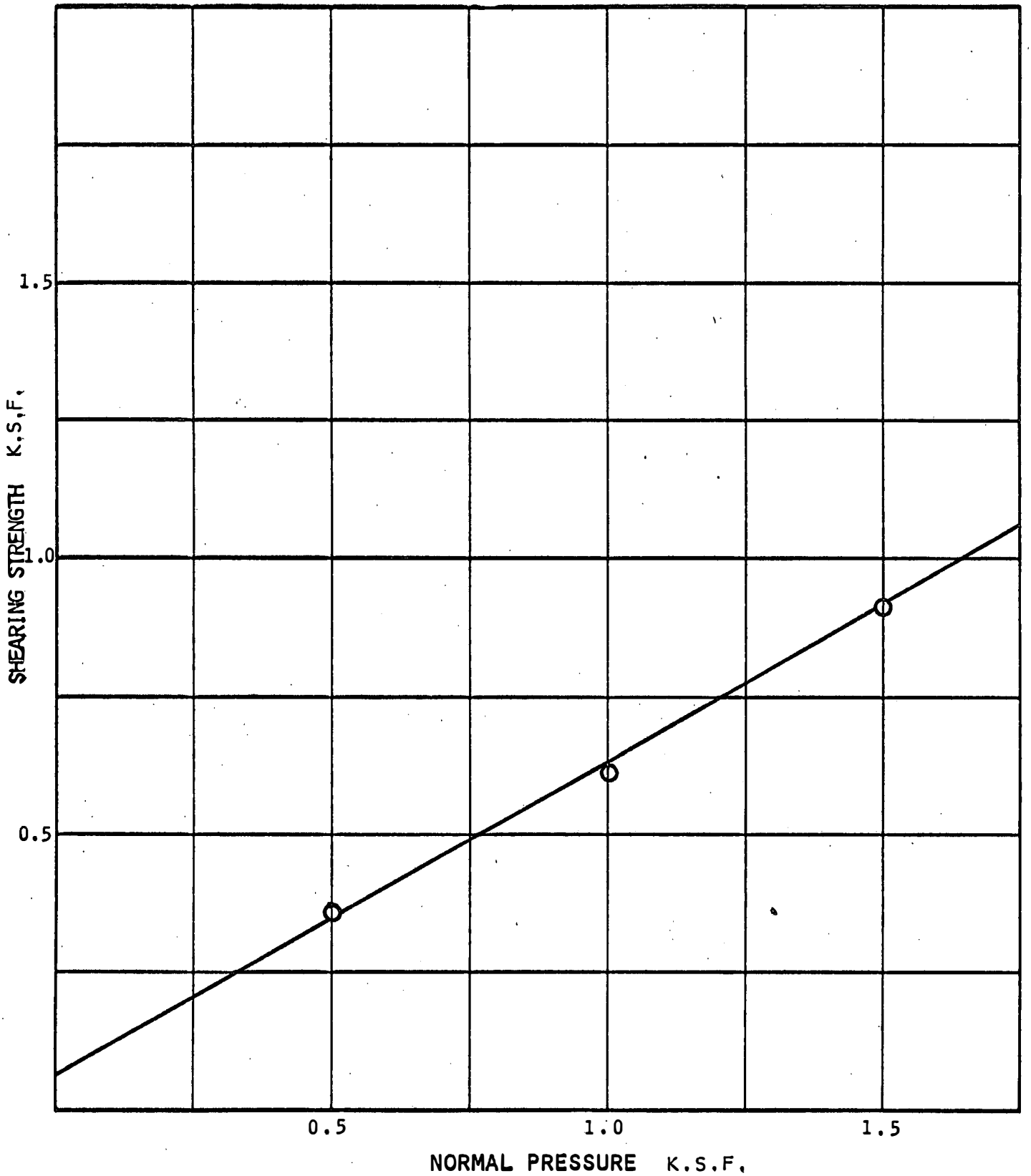
PLATE B-7



LOCATION: BORING NO. AB-9

DEPTH: 3.5 - 5.0 FEET

DIRECT SHEAR TEST	
GEOLABS-HAWAII Foundation & Soil Engineering · Geology	
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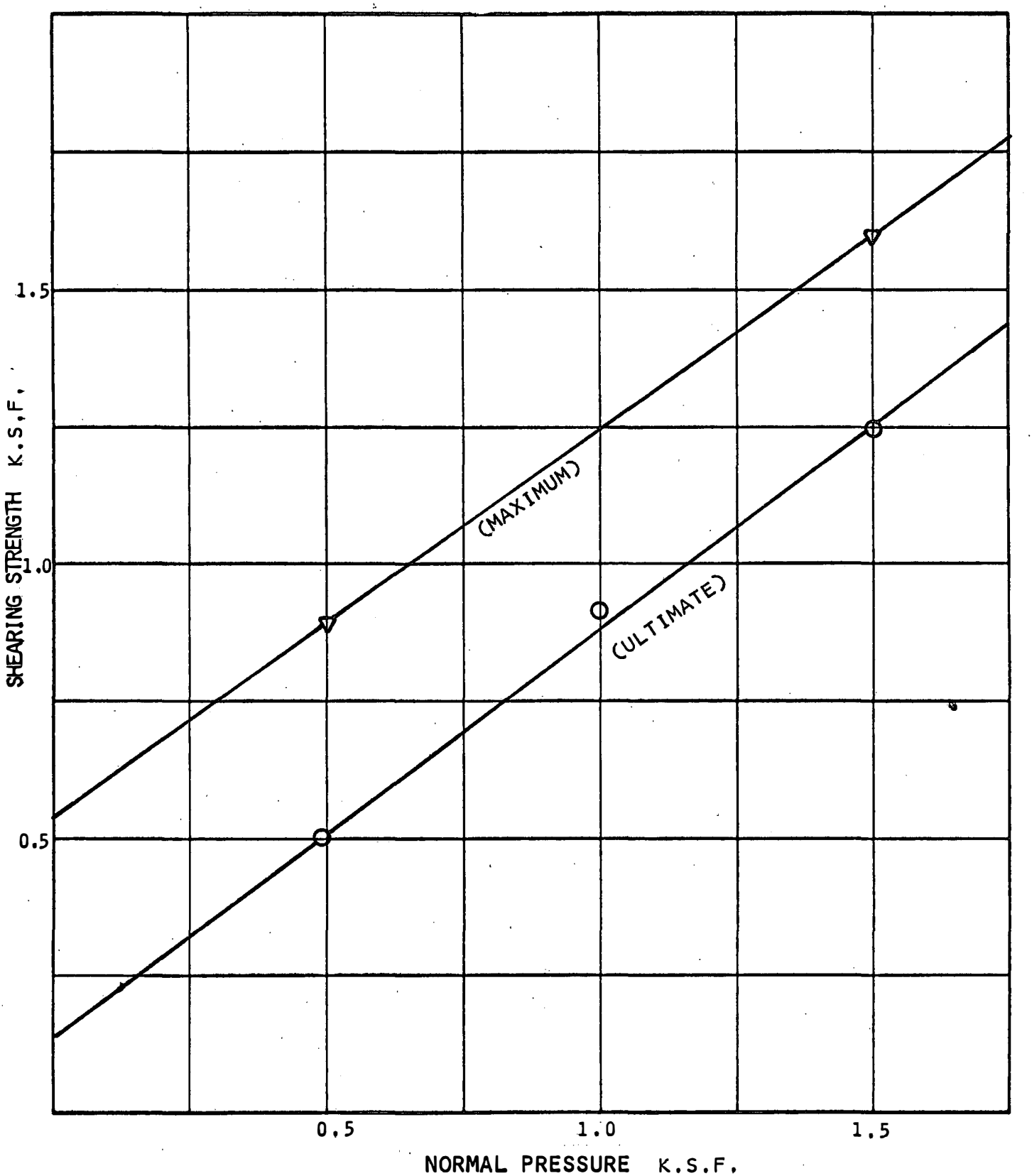
PLATE B-8



LOCATION: TEST PIT NO. AT-1A

DEPTH: @ 5 FEET (REMOLDED SAMPLES)

DIRECT SHEAR TEST	
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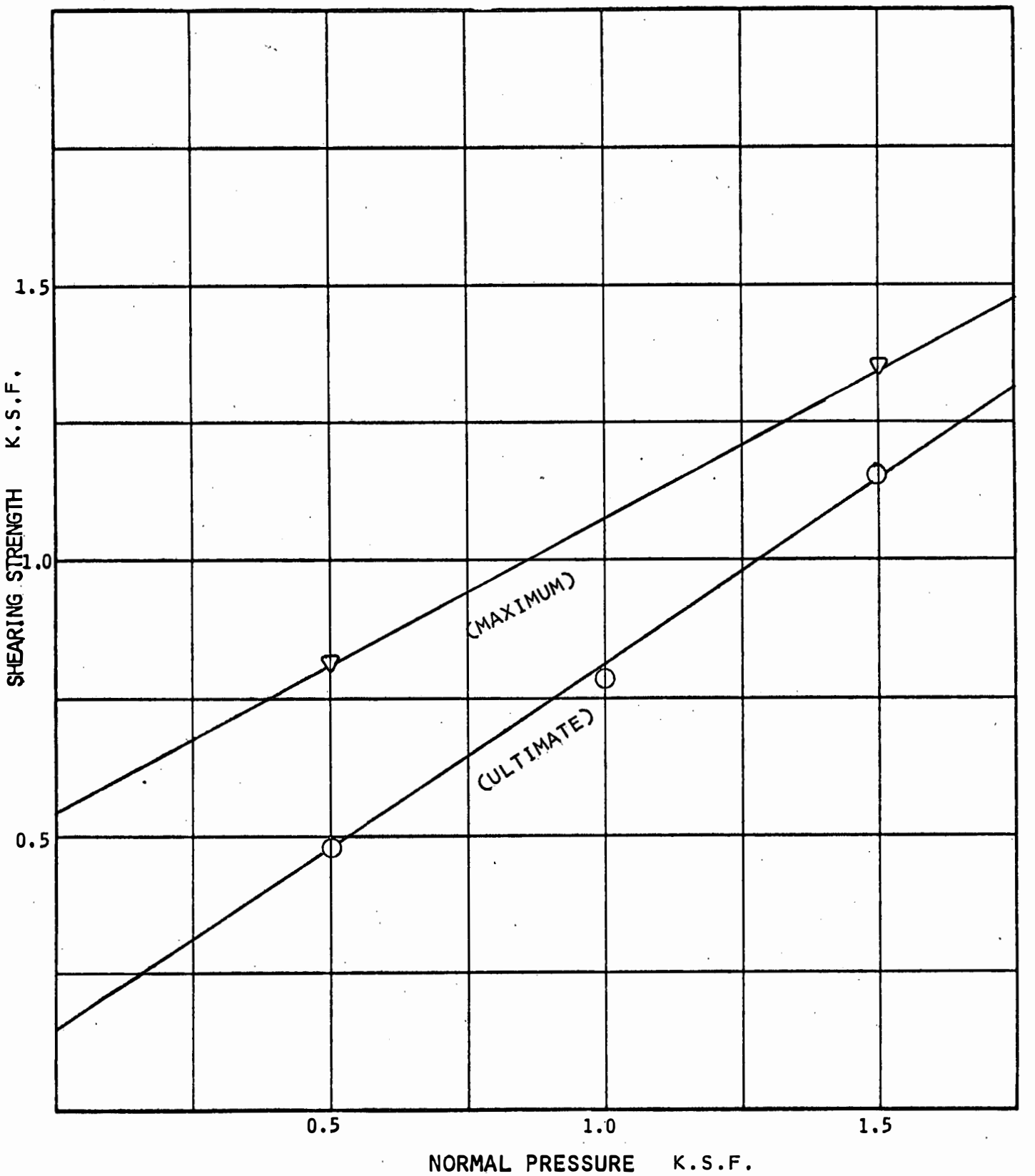
PLATE B-9



LOCATION: TEST PIT NO. AT-2

DEPTH: @ 5 FEET (REMOLDED SAMPLES)

DIRECT SHEAR TEST	
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PLATE B-10

SUMMARY OF SWELL TEST RESULTS

Location	Depth (Feet)	Soil Type	Percent Swell 1" Ring Sample Undisturbed	Percent Swell 1" Ring Sample Remolded	Initial Moisture Content (%)	Final Moisture Content (%)
AB-1	0'-1.5'	MH	3.6	-	49.1	62.2
AB-2	0'-1.5'	MH	1.3	-	31.8	44.3
AT-1A	@ 5'	MH	-	6.1	33.9	48.6
AT-2	1'-5'	MH	-	7.9	28.7	52.7
AT-2	@ 10'	MH	-	12.3	35.9	55.6

PLATE B-11

AHUIMANU VILLA CLUSTER DEVELOPMENT

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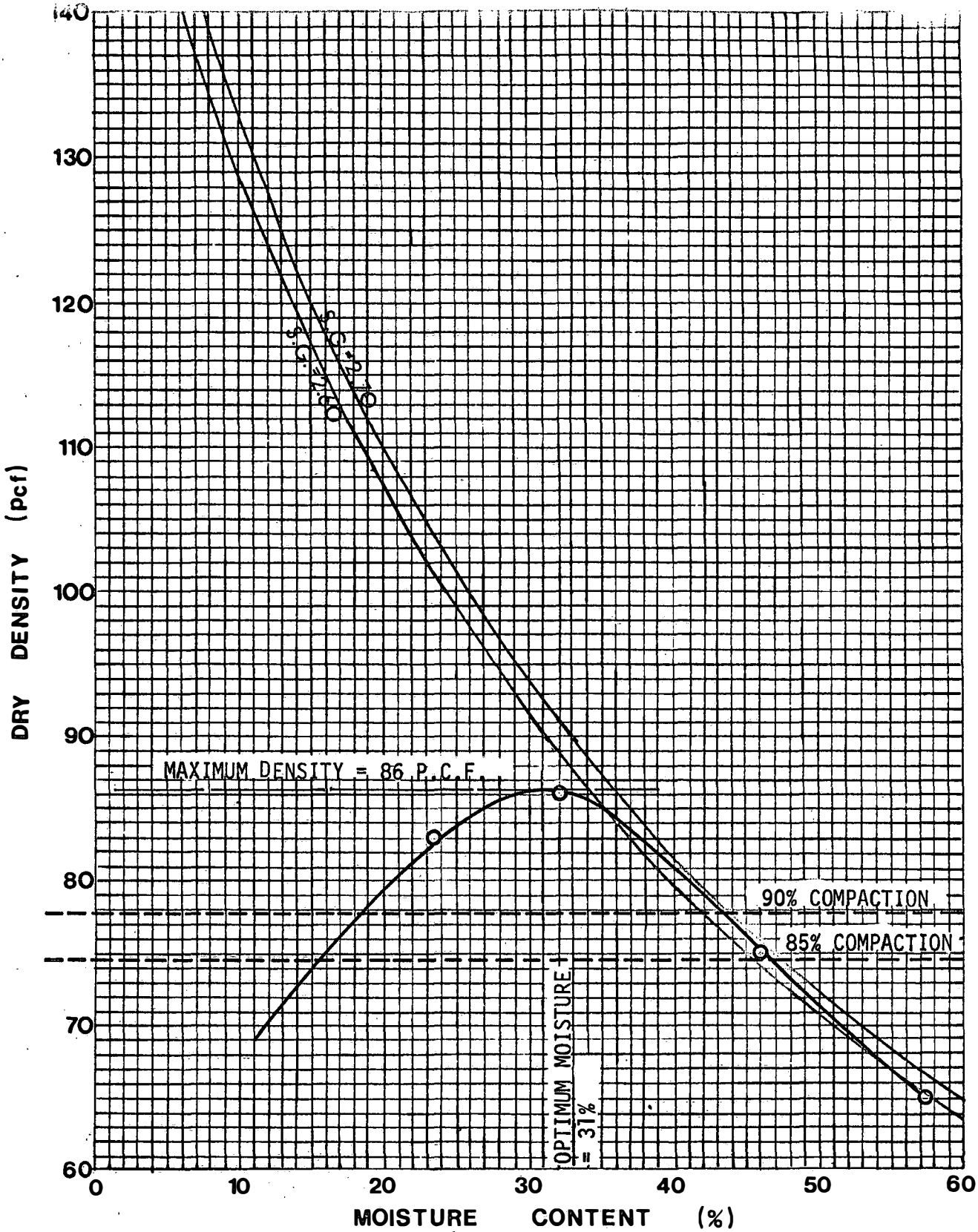

MAXIMUM DENSITY & MOISTURE CURVES

LOCATION: Test Pit TP-1

DEPTH: 1 to 5 Feet

DESCRIPTION: Reddish Brown Clayey Silt (Compaction was run from wet to dry)

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SCALE NONE	W.O. 696-10

PLATE B-12

GEOLABS-HAWAII

TABLE 1 - SUMMARY OF LABORATORY TEST RESULTS
Ahuimanu Villa Cluster Development

LOCATION	Test Pit AT-1				
SAMPLE NO.	-				
DEPTH BELOW SURFACE (FEET)	1 - 5'				
DESCRIPTION	Reddish Brown Clayey Silt				
GRADING ANALYSIS (% Passing) Sieve					
1"					
½"					
#4					
#10					
#20					
#40					
#100					
#200					
ATTERBERG LIMITS					
Air Dried Or Natural	Natural				
Liquid Limit	91				
Plastic Limit	52				
Plasticity Index	39				
IN-PLACE MOISTURE CONTENT (%)	60				
IN-PLACE DRY DENSITY (P.C.F.)	61				
UNIFIED SOIL CLASSIFICATION	MH				
SPECIFIC GRAVITY					
EXPANSION AND CBR TESTS (Surcharge - 51 P.S.F.)					
Molding Moisture Content %	58				
Molding Dry Density, P.C.F.	65				
Swell upon saturation, %	1.5				
CBR at 0.1" Penetration	1.1				
COMPACTION TEST					
(Test Designation)	ASTM D-1557				
Dry to Wet or Wet to Dry	Wet to Dry				
Max. Dry Density (P.C.F.)	86				
Optimum Moisture (%)	31				

REMARKS: