GEOTECHNICAL ENGINEERING EXPLORATION
INTERSTATE ROUTE H-1 REHABILITATION, EASTBOUND LANES
WAIAU INTERCHANGE TO KAIMAKANI STREET
EWA, OAHU, HAWAII

JULY 11, 2005

Prepared for

PARSONS BRINCKERHOFF

and

STATE OF HAWAII
DEPARTMENT OF TRANSPORATION
HIGHWAYS DIVISION

W.O. 5088-00(A) & 5088-10

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THIS WORK WAS PREPARED BY
ME OR UNDER MY SUPERVISION.

Clayton S. Mimura 4-30-06
SIGNATURE EXPIRATION DATE
OF THE LICENSE

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Hawaii • California

GEOLABS, INC.
Geotechnical Engineering and Drilling Services

July 11, 2005
W.O. 5088-00(A) & 5088-10

Mr. Randall Urasaki, P.E.
Parsons Brinckerhoff
American Savings Bank Tower
1001 Bishop Street, Suite 2400
Honolulu, HI 96813

Dear **Mr. Urasaki:**

Geolabs, Inc. is pleased to submit our report entitled "Geotechnical Engineering Exploration, Interstate Route H-1 Rehabilitation, Eastbound Lanes, Waiau Interchange to Kaimakani Street, Ewa, Oahu, Hawaii," prepared for the design of the highway rehabilitation/reconstruction project.

Our work was performed in general accordance with the scope of services outlined in our revised fee proposal dated May 2, 2003 and additional fee proposal dated March 2, 2005.

Detailed discussion and specific recommendations for design are contained in the body of this report. If there is any point that is not clear, please contact our office.

Very truly yours,

GEOLABS, INC.

Clayton S. Mimura, P.E.
President

CSM:JC:cj

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EWA, OAHU, HAWAII
W.O. 5088-00(A) & 5088-10 JULY 11, 2004

SUMMARY OF FINDINGS AND RECOMMENDATIONS

Our field exploration program focused on the six settlement areas within the project limits. Our field exploration indicated that the settlement areas are generally underlain by embankment fill ranging from 10 to 56 feet thick. Soft to stiff alluvium, river deposits and weathered basalt rock formation were encountered in our borings underlying the embankment fill to the maximum depth drilled of 123 feet below the existing ground surface.

In general, the settlement in the six areas was initiated by the filling conducted during the original highway construction. The sources of settlement consist of the following:

- Fill compression by its own weight;
- Consolidation of natural soft to medium stiff alluvium;
- Fill hydro-compression saturation after completion of fill placement.

Based on results of our field exploration, laboratory testing on the soil samples and geotechnical engineering analysis, we believe that the settlement in the six areas was caused primarily by one or more of the three sources above. Additional on-going settlement, estimated up to 12 inches, may occur over a long period of time in the future.

Based on the mechanism of settlement in these six areas, the new concrete approach slab in Area 1, next to the eastern abutment wall of Waiau Interchange structure, may be constructed to replace the existing concrete approach slab. The micropile foundation system, which consists of drilling 7-inch in diameter holes with epoxy coated rebar grouted in place, is recommended to support the new approach slab.

Two pavement configurations were encountered in our borings in each of Areas 2, 3, and 4. Configuration 1, consisting of asphalt concrete pavement over aggregate base and subbase courses on the compacted subgrade, was encountered in the far left traffic lane next to the concrete median and shoulder lane. Configuration 2, consisting of asphalt concrete overlay and Portland Cement Concrete pavements over aggregate base course on the compacted subgrade was encountered in the remaining traffic lanes.

Pavement reconstruction is recommended for the existing pavement (Configuration 1), including complete removal of the pavement sections to expose the underlying subgrade soils and replacement with a new pavement section. Pavement rehabilitation is recommended for the existing remaining traffic lanes (Configuration 2), by cold-planing up to 7 inches of the existing pavement and overlay with new AC pavement sections to restore it to the required highway grade.

We also recommend that a program should be established after construction to monitor the on-going settlement in Areas 2 and 3.

Relatively thin asphalt concrete overlay on the order of 1 to 2 inches was encountered in Areas 5 and 6. We recommend that pavement rehabilitation be accomplished by cold-planing 2 inches of the existing pavement and overlay with new AC pavement sections to restore it to the required highway grade.

The text of this report should be referred to for detailed discussions and specific recommendations for design of pavements.

END OF SUMMARY OF FINDINGS AND RECOMMENDATIONS

SECTION 1.0 - GENERAL

1.1 Introduction

This report presents the results of our geotechnical engineering evaluation and analyses for the Interstate Route H-1 (Eastbound Lanes) Rehabilitation project from Waiau Interchange to Kaimakani Street in the District of Ewa on the Island of Oahu, Hawaii. The general location and vicinity of the project site are shown on the Project Location Map, Plate 1.

This report summarizes the findings from our field exploration and laboratory testing, and presents our geotechnical engineering recommendations derived from our analyses for the reconstruction/rehabilitation of existing pavements only. The findings and recommendations presented herein are subject to the limitations noted at the end of this report.

1.2 Project Considerations

The highway rehabilitation project is located along the Interstate Route H-1 Highway, eastbound lanes, between Waiau Interchange (Mile Post 10.2) and Kaimakani Street (Mile Post 12.8) in the District of Ewa on the Island of Oahu, Hawaii. The approximate limits of the highway rehabilitation project are shown on the General Site Plan, Plate 2.

It is desired to improve pavement conditions in six areas that have experienced continuous settlement over the past 30 years. The approximate limits of these six areas are shown on the Site Plans, Plates 3.1 through 3.6. Details of the location of the six areas are summarized in the following table.

Areas	Approximate Stations		Remarks
1	62+73	63+40	Approach slab behind Pearl City Viaduct abutment
2	102+30	111+10	Punanani Gulch
3	144+66	149+75	Gully next to Pearl Country Club
4	162+50	168+94	Kalauao Stream

Areas	Approximate Stations		Remarks
5	183+40	185+00	Old stream in Aiea Heights Residential area
6	193+94	194+75	Existing Double 15' × 12' Box Culvert

The existing highway within the project limits is a five-lane divided highway that was originally constructed in the early 1970s. This project has been initiated to repair the concrete pavement areas damaged due to continuous settlement that has required numerous asphalt concrete overlay and patches. The shoulder lanes within the project limits will be restored or strengthened to provide an adequate section for traffic use, where necessary.

It is desired to determine the causes of the settlement, to estimate the additional settlement in the future and to provide remedial solutions to restore the pavement back to near the original conditions. In general, settlement areas are located in old gully and stream crossings filled during the original highway construction, except Area 1. Therefore, our geotechnical engineering exploration program was focused on the compressive characteristic of the fill and natural alluvium deposits.

Based on the information provided, we understand that the as-built pavement sections consist of 9 to 9.5 inches of Portland Cement Concrete (PCC) and 12 inches of aggregate base/subbase course on compacted subgrade. The original pavement design was based on a 20-year design life. It is desired to evaluate the existing deteriorated pavement structure as compared to current approved standards. Design life of 10 years is required by the current design standard and 50 years was also used as an alternative for comparison purposes.

In addition, it is desired to inspect the existing pavement conditions along the entire project limits beyond the six settlement areas. Pavement condition survey with assistance of a GPS system was conducted within the entire project limit. Our pavement condition survey focused on identifying areas of damaged or deficient pavement and gathering the information pertaining to recommendations for improvements to the H-1 highway. Details of our pavement condition survey are presented in a separate report.

1.3 Purpose and Scope

The purpose of our geotechnical engineering services for the project was to obtain information pertaining to the surface and subsurface conditions along the highway alignment through literature research, past project experience, pavement survey, and borehole drilling. The findings and information obtained were used in the formulation of geotechnical engineering recommendations pertaining to the pavement reconstruction/rehabilitation for the highway alignment based on a design life of 10 and 50 years. The work was performed in general accordance with our revised fee proposal dated May 2, 2003 and additional fee proposal dated March 2, 2005. The scope of our work for this exploration included the following tasks and work efforts:

1. Research and review of available in-house soil and geologic information related to the project site.

2. Review of available as-built plans and boring logs provided by the State of Hawaii – Department of Transportation, Highways Division (HDOT).

3. Reconnaissance and observation of the surface conditions of the PCC areas and shoulder conditions to identify pavement areas requiring reconstruction and/or rehabilitation.

4. Coordination with the State to obtain the necessary excavation permit and with the various utility companies for toning clearance of the boring locations by an engineer/geologist from our firm.

5. Mobilization and demobilization of truck-mounted drill equipment and operators to and from the project site.

6. Drilling and sampling of twenty-six borings at selected locations along the highway rehabilitation project extending to depths ranging from about 1 to 123 feet below the existing ground surface. Eight of the borings were drilled to evaluate the thickness of the existing asphaltic concrete (AC) topping and/or Portland Cement Concrete (PCC).

7. Performance of Cone Penetration Testing (CPT) at one select location to evaluate the compressive characteristics of soft natural alluvium deposits.

8. Coordination of the field exploration and logging of the borings by a engineer/geologist from our firm.

9. Analyses of the field data for the formulation of geotechnical engineering recommendations pertaining to the design of the pavement reconstruction/rehabilitation for the project.

10. Preparation of this report summarizing our work on the project and presenting our findings and pavement reconstruction and/or rehabilitation design recommendations.

11. Coordination of our overall work on the project by a project engineer from our firm.

12. Quality assurance of our work on the project and client/design team consultation by a principal engineer from our firm.

13. Miscellaneous work efforts such as drafting, word processing, and clerical support.

Detailed descriptions of our field exploration methodology and the logs of borings are presented in Appendix A of this report. Results of the laboratory tests performed on selected soil samples are presented in Appendix B. Pavement design calculation is presented in Appendix C.

END OF GENERAL

SECTION 2.0 - SITE CHARACTERIZATION

2.1 Regional Geology

The Island of Oahu was built by the extrusion of basaltic lavas from two main shield volcanoes, Waianae and Koolau. The older shield volcano (Waianae Volcano) is estimated to be middle to late Pliocene in age and forms the bulk of the western third of the island. The younger shield volcano (Koolau Volcano) is estimated to be late Pliocene to early Pleistocene (Ice Age) in age and forms the majority of the eastern two-thirds of the island. The Waianae Volcano became extinct while the Koolau Volcano remained active. Therefore, the older Waianae Volcano's eastern flank was partially buried below the younger Koolau Volcano lavas that banked against the Waianae's eastern flank. These banked and ponded lava flows formed a broad upland plateau referred to as the Schofield Plateau of Central Oahu.

During the evolutionary history of the Island of Oahu, fluctuation of the ocean sea level occurred as a result of the worldwide advance and retreat of the great continental glaciers. These sea-level changes occurred more substantially during the Pleistocene Epoch and had some effect on the geologic evolution of the Island of Oahu. The changes in worldwide sea levels affected the erosional baseline of terrestrial streams and caused local submergence and emergence of the coastal island landforms with respect to the level of the sea.

The project site is located along the distal southern flank of the Koolau Volcano as shown on the Project Location Map, Plate 1. The project site traverses a localized portion of an extensive region of multiple southwest trending streams that drain from the Koolau summit. Widened areas of stream confluence, including Punanani Gulch, Waimalu Stream, Kalauao Stream and Aiea Stream, are located at Waimalu Gulch, Pearl Country Club and Aiea Heights Industrial areas, which is traversed by the existing Interstate Route H-1 Highway. The stream confluence located in the widened areas drains into the East Loch of Pearl Harbor (located about 0.75 miles toward the south of the project site).

2.2 Existing Site/Pavement Conditions

The Interstate Route H-1 Highway is a major thoroughfare extending from about the Kahala area in the east to about the Kapolei area in the west on the Island of Oahu, Hawaii. The approximate limits for this rehabilitation project generally consist of six areas as shown on the General Site Plan, Plate 2 and Site Plans, Plates 3.1 through 3.6.

In general, the Interstate Route H-1 Highway within the project limits generally consists of five to six outbound travel lanes and five inbound travel lanes separated by a concrete median barrier. Both metal guardrails and concrete barriers, depending on the location, bound the outside shoulders of the highway.

Area 1 (Sta. 62+73 to 63+40) is located within the approach slab of the eastern abutment of the Waiau Interchange structure adjacent to the Pearl City Off-Ramp. The original approach slab was previously overlaid with asphalt concrete to maintain a smooth transition between the interchange structure and the approach slab caused by continuous settlement.

Area 2 (Sta. 102+30 to 111+10) is located on the western side of the existing Waimalu Viaduct structure. A concrete culvert consisting of three 162-inch diameter pipes traverse below the embankment of the Interstate Route H-1 Highway. Based on a review of the available plans, we understand that some localized surcharge fills and sand drains were constructed during the original incremental construction phasing of the Interstate Route H-1 Highway. The embankment fills and surcharge fills placed were on the order of about 40 to 50 feet in vertical height. Following construction of the Interstate Route H-1 Highway at Waimalu, some ground settlement of the embankments occurred that caused distress to the highway pavements. It is believed that some additional settlement is occurring at the site evidenced by continued pavement distress. Several layers of asphaltic concrete overlays (as much as 10.5 inches or more) have been placed over the PCC pavements of the highway in this area in an effort to restore the grades of the highway pavements.

Area 3 (Sta. 144+66 to 149+75) and Area 4 (Sta. 162+50 to 168+94) are located between Kaonohi Street and Kaamilo Street Overpass near the Pearl Country Club. The embankment fills placed over the gullies traversing under the highway during the original construction were on the order of about 40 to 55 feet in vertical height. One 108-inch and two 180-inch diameter sectional pipe culverts in Areas 3 and 4, respectively, traverse below the embankment of the Interstate Route H-1 Highway.

Area 5 (Sta. 183+40 to 185+00) is situated between Kaamilo Street overpass and Aiea Heights Drive overpass. A 126-inch diameter pipe culvert was constructed below the embankment of the Interstate Route H-1 Highway to drain water from the Aiea Heights residential area to the open concrete drainage channel located on the makai side of the highway.

Area 6 (Sta. 193+94 to 194+75) is situated between Aiea Heights Drive overpass and the Aiea Heights exit. A double 15 feet by 12 feet concrete box culvert was constructed below the embankment of the Interstate Route H-1 Highway to drain water from the Aiea Heights residential area to the existing Aiea Stream.

As mentioned previously, a pavement condition survey was conducted with the assistance of a GPS system provided by Control Point Surveying within the entire project limit. Details of the pavement survey results are described in a separate report.

2.3 Subsurface Conditions

Our field exploration program consisted of drilling and sampling eighteen borings, designated as Boring Nos. 1 through 18, at selected locations along the highway rehabilitation project extending to depths ranging from about 20 to 123 feet below the existing pavement surface. One cone penetration test (CPT) was conducted in Area 2 to a depth of 80 feet below the existing pavement surface. The approximate locations of the borings drilled and CPT are shown on the Site Plans, Plates 3.1 through 3.6 and summarized in the following table.

Areas	Approx. Stations		Nos. of Boring Drilled	Depths of Boring Drilled
	From	To		
1	62+73	63+40	2	50'
2	102+30	111+10	1 (CPT)	80'
3	144+66	149+75	4	64' – 77'
4	162+50	168+90	5	21' – 123'
5	183+40	185+00	3	45' – 61'
6	193+94	194+75	4	20'

In addition, eight additional borings, designated as Boring Nos. 101 through 108, were drilled extending to depths of approximately 1 to 3 feet below the ground surface in Areas 3, 4, and 6 to examine the existing pavement sections.

In general, Area 1 is underlain by 26 to 28 feet of medium to very stiff embankment fill overlying 14 to 16 feet of residual material and weathered basalt rock formation extending to the depth drilled of approximately 50 feet below the existing ground surface.

Area 2 subsurface conditions were explored by performing a Cone Penetration Test (CPT) to supplement our previous boring information drilled in the area. The subsurface conditions are highly variable and very complex. In general, Area 2 is underlain by embankment fill placed over soft recent alluvium and weathered basalt formation. The maximum thickness of soft soils encountered in the borings is about 44 feet. This soft recent alluvium has been determined to be under-consolidated material and it is estimated that only 60 to 80 percent (average 70 percent) of the total primary consolidation settlement has occurred at the present time.

Area 3 and Area 4 are located over old drainageways extending from the existing Pearl Country Club and Kalauao Stream towards Pearl Harbor, respectively. The subsurface conditions are highly variable and very complex. In general, Area 3 is underlain by 17 to 45 feet of fills overlying alluvium and weathered basalt rock formation extending to the depth of about 70 feet below the existing ground surface. Area 4 is

underlain by 47 to 56 feet of embankment fills over alluvium, river deposits and weathered basalt rock formation extending to the maximum depth drilled of 123 feet below the existing ground surface. It should be noted that basalt formation was not encountered in Boring No. 4 of Area 3 and Boring No. 8 of Area 4.

Area 5 is located over an old drainageway crossing from mauka towards makai of the Aiea Heights area. The subsurface conditions generally consist of 7 to 10 feet of embankment fill over 12 to 15 of feet old fill and weathered basalt rock formation extending to the depth drilled of 61 feet below the existing ground surface.

Area 6 is located over the existing double 15 feet by 12 feet concrete box culvert crossing from mauka towards makai of the Aiea Heights area extending into the Aiea Stream. The subsurface conditions generally consist of 4 to 14 feet of embankment fill over alluvium delta deposits to the depth drilled of about 20 feet below the existing ground surface. A void about 2.5 feet deep was encountered in Boring No. 17 at the depth of about 17 feet below the existing ground surface.

Generally, static groundwater level was not encountered in the borings drilled in Area 1, and Areas 3 through 6. However, seepage water was intercepted in Boring No. 4 of Area 3 at the depth of about 57.5 feet, Boring No. 9 of Area 4 at the depth of about 65 feet, and Boring No. 15 of Area 6 at the depth of about 15 feet below the existing ground surface. In Area 2, groundwater was encountered at the depth of 41.5 feet below the existing ground surface. However, it should be noted that groundwater levels are subject to change due to rainfall, the time of year, and other factors.

For illustration purposes, generalized subsurface profiles depicting the interpreted subsurface conditions in the six areas are provided on Plates 4 through 9.

The thickness of the existing pavement sections was measured during our drilling operation and is summarized in the following table.

Areas	Location	Pavement Thickness (inches)	
		AC	PCC
1	Traffic Lanes	1.5	7.0
	Shoulder Lane	4.0	N/A
2	Traffic Lanes	3.0 – 10.5	9.0 – 9.5
	Shoulder Lane	20.0	N/A
3	Far Left Traffic Lane	14.0 – 17.0	N/A
	Other Traffic Lanes	10.5 – 13.0	9.0 – 12.0
	Shoulder Lane	11.5 – 13.0	N/A
4	Far Left Traffic Lane	10.5 – 18.0	N/A
	Other Traffic Lanes	3.0 – 4.0	9.0 – 9.5
	Shoulder Lane	5.5 – 12.0	N/A
5	Far Left Traffic Lane	N/A	10.0
	Other Traffic Lanes	1.0	10.0 – 11.0
6	Northern Portion	1.0	9.0 – 12.0
	Southern Portion	9.0 – 10.5	N/A

Based on our borings and the as-built drawings provided, there are two types of pavement configurations in Areas 2, 3 and 4. In general, pavement configuration 1, located in the far left traffic lane about 10 feet wide next to the concrete median barrier and shoulder lane, consists of asphalt concrete over aggregate base and subbase courses on the compacted subgrade. Pavement configuration 2, located in the remaining traffic lanes, consists of asphalt concrete overlay on Portland Cement Concrete over aggregate subbase on the compacted subgrade.

Our borings drilled in Area 6 (Borings Nos. 16 and 18) indicated that the southern portion of Area 6 is underlain by asphalt concrete pavement section with multiple overlays only. The interface of the AC overlaying the PCC and the AC pavement sections may be parallel and adjacent to the southern edge of the existing concrete box culvert.

Detailed descriptions of the field exploration methodology are presented in Appendix A of this report. Descriptions and graphic representations of the materials encountered in the borings are presented on the Logs of Borings, Plates A-1.1 through

A-26 of Appendix A. Results of the CPT conducted are plotted in terms of measurements of cone resistance, friction ratio, local friction and pore pressure on Plate A-27 of Appendix A. Results of the laboratory tests performed on selected soil samples are presented in Appendix B of this report.

END OF SITE CHARACTERIZATION

SECTION 3.0 - DISCUSSION AND RECOMMENDATIONS

Our field exploration program indicates that the project site is generally underlain by embankment fill ranging from 10 to 56 feet thick. Soft to stiff alluvium, river deposits and weathered basalt rock formation were encountered in our borings underlying the embankment fill to the maximum depth drilled of 123 feet below the existing ground surface.

In general, the settlement in the six areas was initially caused by the embankment filling conducted during the original highway construction. The sources of settlement consist of the fill compression by its own weight, consolidation of natural soft to medium stiff alluvium, and fill hydro-compression saturation after completion of fill placement. Based on results of our field exploration and laboratory testing on the soil samples and geotechnical engineering analysis, we believe that the settlement in the six areas was caused primarily by one or more of the sources above. Additional on-going settlement, estimated up to 12 inches, may occur over a long period of time in the future.

The new concrete approach slab may be constructed to replace the existing concrete approach slab in Area 1, next to the eastern side abutment wall of the Waiau Interchange structure. The new approach slab may be supported on a micropile foundation system. The micropile foundation consist of drilling 7-inch diameter holes reinforced by epoxy coated rebar grouted in place in the pattern of 5 feet by 5 feet center-to-center.

Two pavement configurations were encountered in our borings in each of Areas 2, 3, and 4. Configuration 1, consisting of asphalt concrete over aggregate base and subbase courses on the compacted subgrade, about 10 feed wide, was encountered in the far left traffic lane next to the concrete median barrier and shoulder lane. Configuration 2, consisting of asphalt concrete overlay and Portland Cement Concrete over aggregate subbase course on the compacted subgrade, was encountered in the remaining traffic lanes.

Pavement reconstruction was recommended for the existing pavement Configuration 1. The existing pavement section requiring reconstruction should be completely removed to expose the underlying subgrade soils and be replaced with a new pavement section. Pavement rehabilitation may be conducted for the existing remaining traffic lanes for pavement Configuration 2. It will require cold-planing up to 7 inches of the existing pavement and overlay with new AC pavement sections to restore the highway to the required grade.

We also recommend that a program should be established after construction to monitor the on-going settlement in Areas 2 and 3.

Due to the relatively small settlement, up to 1 to 2 inches, observed in Areas 5 and 6, we believe that the existing pavement may be cold-planed by 2 inches and overlaid by new AC pavement sections to restore the highway to the required grade.

3.1 Ground Settlements

We understand that six areas within the project limits have experienced continuous settlement problems. In these areas, asphalt concrete resurfacing has been placed over the original PCC pavement sections in order to maintain the highway grade. It is desired to study the causes and sources of settlement, to estimate possible additional settlement in the future, and to provide cost effective repair solutions.

In general, the settlement in the six areas was initially caused by the embankment filling conducted during the original highway construction. The sources of settlement consist of the following:

1. Fill compression by its own weight;
2. Consolidation of natural soft to medium stiff alluvium;
3. Fill hydro-compression saturation after completion of fill placement.

The settlement caused by fill compression under its own weight usually would be completed in a relatively short period if the fills were placed (compacted) properly. The settlement caused by consolidation from natural soft to medium stiff alluvium material

underlying the fill embankment is highly dependent on the soil compressibility characteristics and geometry of the embankment, such as over-consolidation ratio, settlement time factor, compression and recompression ratios, thickness of compressible layer, and thickness of the fill above.

The settlement caused by hydro-compression usually occurs in thicker fine grain cohesive fills when the compacted fills are wetted after construction. The wetting process may be initiated by rainfall, irrigation, or infiltration of ground water into the fill from the underlying natural formations. Improper placement of fills increases the potential and severity of the settlements. The improper placement of fills includes insufficient compaction, and low moisture content during initial fill placement. Research has shown that saturation could cause fill collapsing if the fill was placed initially in a relatively dry condition (Thomas L. Brandon. et al, 1990).

Our geotechnical evaluation focused on the compressibility and hydro-compression saturation of fill, and consolidation of the alluvial deposits. Saturation of the fill was evaluated by measuring in-situ fill indexes. Consolidation characteristics were also measured to evaluate the settlement contributed from primary consolidation of the soft natural alluvial deposits.

Based on results of our field exploration and laboratory testing on the soil samples and geotechnical engineering analysis, we believe that the settlement in the six areas was caused primarily by one of more of the above. Details of our analysis, findings and recommendations are summarized in the following table and discussed in the following section.

Area	Thickness of Pavement (inches)		Estimated Potential Additional Settlement (inches)		
	AC	PCC	Fill Compression	Consolidation	Fill Hydro-compression
1	1.5	7	<2.0	<0.5	<0.5
2	3-11	9-10	<1.0	12	<0.5
3	10-13	9-12	<1.0	3-5	<0.5

Area	Thickness of Pavement (inches)		Estimated Additional Settlement (inches)		
	AC	PCC	Fill Compression	Consolidation	Fill Hydro-compression
4	3-4	9-10	<1.0	<0.5	8-12
5	1	10-11	<1.0	0	<2.5
6	1	9-12	<1.0	<0.5	<2.0

Area 1 (Sta. 62+73 to 63+40)

As mentioned previously, Area 1 is located in the approach slab area of the Waiau Interchange structure eastern abutment. Our boring information indicated that the subsurface conditions consist of about 28 feet of medium stiff to very stiff clayey and silty fill material and 13 feet of stiff to hard residual and/or saprolite over weathered basalt formation at greater depth, as shown on the Soil Profile in Area 1, Plate 4. The moisture content of the fill material ranged from 27 to 48 percent. Based on results of our laboratory tests and engineering analysis, saturation of the fill material is about 90 to 100 percent.

Based on the above results of testing and analysis, we believe that settlement experienced in Area 1 may be caused primarily by fill compression and hydro-compression. Fill hydro-compression may be nearly completed based on the estimated saturation in the fill. However, completion of saturation may cause additional settlement in the future. We estimate the potential additional settlement to be on the order of 1 to 2 inches.

Based on the as-built plans provided, we understand that the existing approach slab is supported on the 6-inch wide corbel, which was structurally connected to the abutment wall. It is likely that the concrete slab has experienced settlement on the order of 1.5 inches. Therefore, the integrity of the concrete corbel is suspect. We recommend that a new concrete approach slab supported on a new foundation system be constructed to replace the existing approach slab.

Area 1 is located next to the eastern abutment wall of the Waiau Interchange adjacent to the Pearl City Off-Ramp. Extremely high traffic volume and demand of lane usage require the repair solution to result in minimum lane closure. With consideration of the length of the construction period, the type of approach slab structure, and the cost, we recommend that a micropile foundation system be installed to support the new approach slab. Details of micropile foundation is discussed in the "Micropile Foundation" section.

Area 2 (Sta. 102+30 to 111+10)

Subsurface conditions were based on borings drilled for the previous project (H-1 Waimalu Viaduct Widening) and geological background in the vicinity and a supplemental Cone Penetration Test (CPT). In general, Area 2 is underlain by 15 to 20 feet of embankment fill placed over soft to medium stiff recent alluvium and weathered basalt formation at greater depth, as shown on the Soil Profile in Area 2, Plate 5. The thickness of the soft to medium stiff alluvium is up to about 44 feet.

The stiff to very stiff fill materials have moisture content of about 26 to 35 percent. Laboratory tests conducted for the previous project indicated that higher saturation has been achieved in the fill layer. CPT results confirm the previous findings that the alluvium is under-consolidated with excess pore pressure present in the alluvium. Therefore, we believe that the settlements experienced in Area 2 may be a result of all three sources mentioned above. However, settlement from fill compression and hydro-compression seems to be nearly completed. Additional settlement in the future will be primarily from on-going consolidation of soft to medium stiff alluvium under the weight of the embankment fill.

Based on our analysis, the alluvium layer appears to have achieved about 60 to 80 percent consolidation. Continuous consolidation settlements on the order of about 12 inches may be expected over a long period of time in the future.

To stabilize the on-going settlements of the under-consolidated alluvium and to reduce the potential for significant ground settlement in the future, permanent solutions such as jet-grouting methods may be used to stabilize the under-consolidated recent alluvium below the highway embankment. In general, the tips of the jet-grouted columns should be extended until the stiff/dense materials are encountered at each jet-grouted column location.

Considering the high cost of mitigation and slow rate of settlements, we believe that pavement rehabilitation and reconstruction may be adopted to restore the original highway grade as temporary to moderate term solution with a program to monitor on-going settlement after completion of the construction. Details of pavement rehabilitation and reconstruction is discussed in the "Pavement Design" section.

Area 3 (Sta. 144+66 to 149+75)

Our field exploration indicated that Area 3 is underlain by 17 to 45 feet of fills overlying alluvium deposit and weathered basalt rock formation. The pavement sections in the majority of the traffic lanes consist of about 10 to 12 inches of AC over 9 to 12 inches of PCC, except for a portion of the far left lane, approximately 10 feet wide, next to the concrete median barrier which consists of 14 to 17 inches of AC without concrete pavement below. The embankment fill consists of medium stiff to very stiff silty clay material. In-situ moisture of the fill material is in the range of 24 to 35 percent with estimated percent saturation of about 75 to 95 percent.

We believe that the settlement in Area 3 may have been caused by the combination of insufficient compaction of the embankment fill during the original construction and consolidation of the medium stiff recent alluvium. In addition, the pavement distress in the far left traffic lane consisting of alligator cracking, spalling, separation between AC and PCC pavement section, is caused mainly by inadequate pavement strength.

Based on our analyses, we believe that the primary consolidation settlement in the recent alluvium layer may be completed or nearly completed. However, the consolidation and saturation in the embankment fill layer may not be completed yet. The total future settlement from the fill consolidation and saturation is estimated on the order of 3 to 5 inches.

Possible long-term solutions including grouting and jet grouting were evaluated but deemed ineffective and very costly. Therefore, we recommend that flexible pavement section be adopted as moderate term repair to restore the original design highway grade. Pavement reconstruction and rehabilitation are recommended. We also recommend that a program be established after construction to monitor the on-going settlement. Details of pavement rehabilitation and reconstruction is discussed in the "Pavement Design" section.

Area 4 (Sta. 162+50 to 168+94)

Area 4 is underlain by 47 to 56 feet of embankment fills over alluvium, river deposits and weathered basalt rock formation. The embankment fill consists of very stiff to hard silty and clayey material with some gravel and boulders. The pavement sections in the majority of the traffic lanes consist of about 3 to 4 inches of AC over 9 to 10 of inches PCC, except for a portion of the far left lane, approximately 10 feet wide, next to the concrete median barrier which consists of 10 to 18 inches of AC without concrete pavement below. In-situ moisture content of the fill material is in the range of 15 to 30 percent with estimated saturation of about 50 to 80 percent.

We believe that the settlement in Area 4 may be caused mainly by the compression/consolidation of the alluvium deposits below the embankment fill placed during the original construction. The pavement distress in the far left traffic lane consisting of alligator cracking, spalling, separation between AC and PCC pavement section, is caused mainly by the inadequate pavement strength.

Based on the boring information and length of time that the fill has been in place, we believe that primary consolidation in the alluvium layer may be nearly completed. However, our laboratory tests indicated that the in-situ fill material is relatively dry and has potential for additional settlement on the order of 8 to 12 inches if saturated.

Possible long-term solutions including grouting and jet grouting were evaluated but deemed ineffective and very costly. Since the embankment fill has been in place for over 30 years, it is our opinion that the possibility of fill saturation is small. Therefore, we recommend that the pavement reconstruction and rehabilitation may be conducted to restore the original design grade.

Area 5 (Sta. 183+40 to 185+00)

The subsurface conditions in Area 5 generally consist of 7 to 10 feet of embankment fill over 12 to 15 feet of old fill and weathered basalt rock formation. The pavement sections in the traffic lanes consist of about 1 inch of AC over 10 to 11 inches of PCC. In-situ moisture content of the fill material is in the range of about 22 to 30 percent with estimated saturation to be approximately 65 to 80 percent.

We believe that the settlement in Area 5 may be caused mainly by the compression of the old fill below the embankment fill placed during the original construction. Based on the boring information and length of time that the fill has been in place, we believe that primary consolidation within the fill layer may be completed. The results of our laboratory tests indicated that the fill material has potential for additional settlement on the order of 2.5 inches, if saturated.

Based on the relatively thin AC overlay constructed previously, it is likely that settlement on the order of 1 to 2 inches has occurred in Area 5. Therefore, the existing PCC underlain by AC overlay is likely in fair to good condition. Because of potential additional settlement due to saturation, we recommend to cold-plane

2 inches of the existing pavement and to overlay with new AC pavement sections to restore the highway to the required grade.

Area 6 (Sta. 193+94 to 194+75)

The subsurface conditions in Area 6 generally consist of 4 to 14 feet of embankment fill over alluvium delta deposits. The pavement sections in the northern two-third of Area 6 consist of about 1 inch of AC over 9 to 12 inches of PCC. The pavement sections in the southern one-third of Area 6 consist of 9 to 10.5 inches of AC. In-situ moisture content of the fill material is in the range of about 16 to 34 percent.

We believe that the settlement in Area 6 may be caused mainly by the consolidation of the soft alluvium delta deposits below the embankment fill. Based on the boring information and length of time that the fill has been in place, we believe that primary consolidation within the soft alluvium delta deposits may be completed. However, we believe that the fill material has potential for additional settlement on the order of 2 inches if saturated.

Based on the relatively thin AC overlay constructed previously, it is likely that settlement on the order of 1 to 2 inches has occurred in Area 6. Therefore, the existing PCC underlain by AC overlay is likely in fair to good condition. Because of potential additional settlement due to the saturation, we recommend to cold-plane 2 inches of the existing pavement and to overlay with new AC pavement sections to restore the highway to the required grade.

3.2 Pavement Design in Areas 2, 3, and 4

In general, the type and severity of the distresses exhibited in the pavement areas would determine whether rehabilitation or reconstruction of the existing pavements should be performed from an engineering point-of-view. Based on the as-built plans provided, the pavement sections in the project limits originally consisted of 9 to 9.5 inches of Portland Cement Concrete (PCC) over 12 inches of aggregate subbase course. Over the past 30 years since original construction, multiple asphalt

concrete overlays were placed on the PCC pavements in the six settlement areas in order to maintain the required highway grade. Details of the existing pavement sections thickness are summarized in the previous "Subsurface Conditions" section.

As mentioned previously, two pavement configurations were encountered in our borings in each of Areas 2, 3, and 4. In general, the shoulder lane and far left traffic lane, about 10 feet wide next, to the existing concrete medial barrier were underlain only by asphalt concrete pavement over aggregate base and subbase courses on the compacted subgrade (Configuration 1). The remaining traffic lanes were underlain by both asphalt concrete and Portland Cement Concrete pavements over aggregate subbase course on the compacted subgrade (Configuration 2).

Based on our coring samples of the existing pavement sections, it appears that multiple resurfacing operations were previously conducted in the project areas. However, the bonding between the multiple resurfacing layers is generally in fair to good condition. Based on our pavement survey, the majority of the PCC pavements are in fair to good condition with localized distress observed. With the higher strength of PCC anticipated, we assume that the PCC sections under the asphalt concrete overlays to be in fair to good conditions without major failure.

In addition, we recognize that complete removal of the existing PCC pavement section would significantly increase the construction time and cost and may not be feasible nor practical due to the extremely high traffic volumes and usage demand of the highway at these locations.

With the above reasons, we provide the following recommendations. It should be noted that the existing PCC sections under the AC overlays are assumed to be in fair and good conditions. However, possible localized failure zones in the PCC section are unknown until the AC overlay is completely removed. Therefore, a contingency fund should be allocated in the construction budget for these possible extra costs.

1. Pavement reconstruction should be performed for the existing pavement Configuration 1 including the 10-foot wide far left traffic lane next to the concrete median barrier and shoulder lane. The existing pavement section

requiring reconstruction should be completely removed to expose the underlying subgrade soils and be replaced with a new pavement section.

2. Pavement rehabilitation should be conducted for the existing pavement Configuration 2 consisting of AC over PCC. It will require cold-planing up to 7 inches of the existing pavement or to the underlying PCC and overlay with new asphalt concrete to restore the highway to the required grade.

The above recommendations are presented on the Sketch of Pavement Reconstruction and Rehabilitation, Plate 10. Detailed discussion of these items and our geotechnical engineering design recommendations are presented in the following sub-sections of this report.

3.2.1 Methodology of Pavement Design

It is assumed that the existing PCC sections are in fair to good condition and capable to support the current traffic loading. Therefore, the rehabilitation of the pavement section Configuration 2 will only require restoring the original design highway grade by cold-planing up to 7 inches of the existing overlying pavement and placing new AC overlays to the grade. The existing flexible pavement section Configuration 1 will require reconstruction.

In general, the procedures used in determining the new pavement section follow those described in Chapter 3 of the "Pavement Design Manual" dated March 2002. The pavement design manual was prepared by the State of Hawaii - Department of Transportation, Highways Division, Material Testing and Research Branch. The design procedures for flexible pavements are based on the Hveem Stabilometer method developed by the California Department of Transportation (Caltrans).

3.2.2 Design Traffic Loading Conditions/Traffic Index

Based on the instructions provided by the State of Hawaii - Department of Transportation, Highways Division, Material Testing and Research Branch, reconstruction of the severely distressed or failed pavement areas should be designed for a pavement life of 10 years. Our pavement analyses also included a pavement life of 50 years for comparison. Design traffic loading conditions, including 24-hour truck traffic, were based on the information provided by the

Department of Transportation, Highways Division, and are summarized as follows. A copy of the design traffic parameters is presented on Plate C-1 of Appendix C. It should be noted that the average daily traffic (ADT) values in Years 2004, 2014 and 2054 for H-1 highway eastbound were extrapolated based on the values in Years 2002 and 2022 provided.

DESIGN TRAFFIC PARAMETERS	
Design Period	10 / 50 Years
Average Daily Traffic (ADT)	Vehicles per day per direction
Year 2004	118,674
Year 2014	126,870
Year 2054	165,714
24-Hour Truck Traffic	3.0 %
Truck Traffic Distribution	
2-axle	65.51%
3-axle	11.82%
4-axle	2.09%
5-axle	19.17%
6-axle	1.29%
7-axle	0.12%

It should be noted that truck traffic distribution in the shoulder lane was assumed 100 percent from 2-axle vehicle such as pick-up truck in our analysis.

Based on the design period, traffic volume, and truck traffic distribution information above, the Traffic Index (TI) has been determined for the project. Results of the Traffic Index Determination are summarized in the following table.

TRAFFIC INDEX (TI) DETERMINATION	
Location /Design Life	Traffic Index (TI)
Far Left Lane 10-Year Design Life	12.0
Shoulder Lane 10-Year Design Life	9.5
Far Left Lane 50-Year Design Life	15.0
Shoulder Lane 50-Year Design Life	12.0

3.2.3 Design Subgrade Conditions

Based on our field exploration conducted within the pavement areas requiring reconstruction, our borings generally encountered clayey subgrade soils at shallow depths below the existing pavement section. Laboratory CBR tests performed on the near-surface clayey soils obtained from our field exploration indicated that the material exhibited CBR values of about 4.3 to 8.3. The test results are presented on Plates B-6.1 through B-6.4 of Appendix B. As a result, R-value of about 9 was adopted in our pavement analyses by using correlation between R-value and CBR.

3.2.4 Pavement Reconstruction

As mentioned previously, pavement reconstruction should be performed for the existing pavement section Configuration 1 including the 10-foot wide far left traffic lane next to the concrete median barrier and shoulder lane. The existing pavement section requiring reconstruction should be completely removed to expose the underlying subgrade soils and be replaced by a new pavement section.

Based on the instructions provided by the State of Hawaii - Department of Transportation, Highways Division, Material Testing and Research Branch, reconstruction of the severely distressed or failed pavement areas should be designed for a pavement life of 10 years. As a comparison, 50-year pavement life is also used in our analysis.

We understand that the shoulder lane is only used during rush hours for passenger vehicle. Therefore, we assume that truck traffic distribution in the shoulder lane is 100 percent from 2-axle vehicle such as pick-up truck in our analysis. Based on the

above assumptions and our pavement analysis, the following pavement sections may be considered for the pavement reconstruction in Areas 2, 3 and 4. In addition, economic analyses were also performed on the following design pavement sections to evaluate the initial construction cost and necessary life cycle cost of the pavement sections. Detailed calculations and analyses are presented on Plates C-2.1 through C-6.5 of Appendix C.

Far Left Traffic Lane with 10-Year Design Life
4.0 Inches Asphaltic Concrete
10.0 Inches Asphalt Concrete Base (91 Percent Relative Specific Gravity)
10.0 Inches Aggregate Subbase (95 Percent Relative Compaction)
24.0 Inches Total Pavement Thickness on Compacted Subgrade

Far Left Traffic Lane with 50-Year Design Life
4.5 Inches Asphaltic Concrete
13.0 Inches Asphalt Concrete Base (91 Percent Relative Specific Gravity)
15.0 Inches Aggregate Subbase (95 Percent Relative Compaction)
32.5 Inches Total Pavement Thickness on Compacted Subgrade

Shoulder Lane with 10-Year Design Life
4.0 Inches Asphaltic Concrete
7.0 Inches Asphalt Concrete Base (91 Percent Relative Specific Gravity)
7.0 Inches Aggregate Subbase (95 Percent Relative Compaction)
18.0 Inches Total Pavement Thickness on Compacted Subgrade

Shoulder Lane with 50-Year Design Life
4.0 Inches Asphaltic Concrete
10.0 Inches Asphalt Concrete Base (91 Percent Relative Specific Gravity)
10.0 Inches Aggregate Subbase (95 Percent Relative Compaction)
24.0 Inches Total Pavement Thickness on Compacted Subgrade

We recommend that the existing pavement be removed and replaced with the new pavement section as shown above. The existing AC and underlying base and subbase materials within the reconstruction areas should be completely removed to expose the underlying subgrade materials. In areas where the new pavement design is thicker than the existing pavement section, additional over-excavation into the subgrade materials will be necessary in order to provide the required AC and asphalt concrete base thicknesses.

The exposed subgrade materials should be scarified to a depth of about 8 inches, moisture-conditioned to above the optimum moisture content, and recompacted to a minimum of 95 percent relative compaction. Relative compaction refers to the in-place dry density of soil expressed as a percentage of the maximum dry density of the same soil established in accordance with ASTM D 1557 or AASHTO T-180 test procedures. Optimum moisture is the water content (percentage by dry weight) corresponding to the maximum dry density. If pumping conditions are encountered during compaction of the subgrade soils, the subgrade soils may be stabilized by cement treatment to reduce the potential for pumping subgrade conditions. As a guide, one sack of cement may be used for 50 square feet of subgrade area.

The asphalt concrete base material should consist of asphalt treated basalt aggregate compacted to a density of at least 91 percent of the maximum theoretical specific gravity determined in accordance with ASTM D 2041 or AASHTO T 209. The aggregate base course and subbase materials should be compacted to a density of at least 95 percent of the maximum dry density and the maximum compacted thickness of each layer should not exceed 6 inches.

3.2.5 Rehabilitation of Existing Pavements

Based on our field exploration results, the majority of the traffic lanes, except the far left lane about 10 feet wide next to the median and shoulder lane, were underlain by both asphalt concrete and PCC pavement sections over aggregate subbase course on the compacted subgrade (Configuration 2). Based on our coring samples of the existing pavement sections, it appears that multiple resurfacing operations were previously conducted in the project areas. However, the bonding between the multiple resurfacing layers is generally in fair to good condition.

Based on our pavement survey, the majority of the PCC pavements are in fair to good condition with localized distress observed. With higher strength of PCC anticipated, we assume the PCC sections under the asphalt concrete overlays to be in fair to good condition without failure. We believe that the existing PCC pavement section is adequate to support the current high traffic loading. In

addition, we recognize that complete removal of the existing PCC pavement sections would significantly increase the construction time and cost and may not be feasible nor practical due to the extremely high traffic volumes and usage demand of the highway at these locations.

Therefore, we recommend that pavement rehabilitation be conducted for the pavement section Configuration 2 consisting of AC over PCC. With consideration for cost and constructability, we recommend that the AC overlay be removed down to the concrete pavement or a maximum of 7 inches of existing pavement and overlaid with new AC pavement sections to restore the highway to the required grade.

It should be noted that the thickness of AC overlay varies in Areas 2, 3 and 4. When the thickness of AC overlay is less than 7 inches, rehabilitation will require removal of the existing AC overlay completely and replacement of new AC pavement section to the required highway grade.

We also recommend that a minimum of 4 inches of cold-plane may be extended 5 feet beyond the settlement areas into the PCC pavement sections for better bonding. We believe that the 5 feet of overlapping will minimize the potential AC overlay from peeling-off.

For cost estimate purposes, we provide the following estimated existing AC overlay profiles overlying the existing PCC in the Areas 2, 3 and 4. It should be noted that the following estimated existing AC overlay profiles are primarily based on our boring information. The actual thickness of the overlay will vary.

Areas	Approx. Stations		Thickness of AC Overlay (inches)	
	From	To	Min.	Max.
2	102+30	105+50	3.0	7.5
	105+50	108+00	7.5	10.5
	108+00	111+10	3.0	10.5
3	144+66	146+40	3.0	13.0
	146+40	148+55	12.0	13.0
	148+55	149+75	3.0	12.0
4	162+50	168+94	3.0	4.0

It should be noted that the existing PCC sections under the AC overlays are assumed to be in fair and good condition. However, possible localized failure zones will not be evident until the AC overlay is completely removed. If present, localized failed PCC zones may require removal and replacement or strengthening with geotextile. Therefore, a contingency fund should be allocated in the construction budget for these possible extra costs.

3.2.6 Surface Drainage

One of the primary distress mechanisms in pavement structures is pumping due to saturation of the subbase and base course and/or subgrade soils. In addition, one of the settlement sources is saturation of the embankment fill under the existing pavement sections. Therefore, the pavement surface should be sloped to drain and drainage gradients should be maintained to carry surface water off the pavement to appropriate drainage structures. Surface water ponding should not be allowed after construction. Development of good shoulder drainage along with a program to prevent obstructions in the drainage structures is strongly recommended to reduce the potential for pavement deterioration or premature failure of the pavements.

3.3 Rehabilitation of Existing Pavements in Areas 5 and 6

Our field exploration indicated that Areas 5 and 6 are underlain by relatively thin AC overlay on the order of 1 to 2 inches over PCC pavement sections. Our coring samples of the existing pavement sections show that PCC pavement sections in Areas

5 and 6 are in fair or good conditions. Based on our laboratory tests and analyses, we believe that primary consolidation within the fill material and alluvium delta deposit may be completed. However, the fill material may have potential for additional settlement on the order of 2 to 2.5 inches, if saturated.

The URETEK concrete lifting technique was initially considered to raise the existing PCC pavement section and restore to the required highway grade. This method uses a high-density polyurethane material injected below the PCC pavement section to provide an expansive force that lifts the PCC slab. However, field observations indicated that the surface of the concrete pavement was deeply scored, apparently to aid in the bonding of the thin overlay to the concrete surface. Therefore, the concrete pavement surface may not be suitable for traffic.

Therefore, we believe that pavement rehabilitation may be an effective solution to meet the original design intent. We recommend to cold-plane 2 inches of the existing pavement and overlay with new AC pavement section to the required highway grade. The cold-plane will require removing the existing AC overlay and extending into the existing PCC pavement. Similar to the rehabilitation in Areas 2, 3 and 4, we also recommend that the 2 inches of cold-plane may be extended 5 feet beyond the settlement areas into PCC pavement sections, except at the southern end of Area 6. We believe that the 5 feet of overlapping will effectively minimize the thin AC overlay from peeling-off that was observed in conjunction with the existing AC overlay.

Due to the relatively small settlements, we anticipate that the existing PCC sections under AC overlays are in fair and good conditions. However, possible localized failure zones will not be evident until the AC overlay is completely removed. If present, localized failed PCC zones will require removal and replacement or strengthening with geotextile. Therefore, a contingency fund should be allocated in the construction budget for these possible extra costs.

As mentioned previously, the pavement surface should be sloped to drain and drainage gradients should be maintained to carry surface water off the pavement to

appropriate drainage structures. This requirement is primarily to prevent or reduce distress mechanisms in pavement structures caused by saturation of the subbase and base course and/or subgrade soils. It is also a provision to reduce additional settlement caused by saturation of the embankment fill under the existing pavement sections.

3.4 Micropile Foundation in Area 1

Our field exploration indicated that Area 1 is underlain by 26 to 28 feet of medium to very stiff and very moist to wet embankment fill overlying 14 to 16 feet of residual material and weathered basalt rock formation.

Based on our laboratory tests and our analyses, we believe that primary settlement from the three sources mentioned previously was completed. Less than 1 to 2 inches of settlement was estimated to occur in the future. Therefore, we recommend that the new concrete approach slab may be constructed to replace the existing approach slab. The new concrete approach slab is recommend to be supported on the micropile foundation system.

Based on the current design concepts, we understand a 7-inch diameter drilled hole is desired to provide adequate grout cover around the reinforcing rebar. The micropile may be placed in a 5 feet by 5 feet center-to-center pattern. In general, the micropile would derive vertical support primarily from skin friction. The end-bearing component of the micropile has been discounted due to difficulties associated with obtaining a clean bottom during construction.

We envision that the micropiles may be installed during off-peak hours with lane closures and temporary sealing of the tops of the holes. After completion of all of the micropiles, the existing approach slab may be removed and replaced. This phase of work will probably require complete closure of the highway.

Based on the boring information, we provided the following micropile capacities for three different lengths.

Length of Micropile (feet below bottom of the cap)	Ultimate Capacity of Micropile (kips)
15	20
20	30
25	40

In general, the performance of the micropiles will depend significantly upon the contractor's method of installation and construction procedures. The load bearing capacities of micropiles depend on the friction resistance between the pile and the surrounding soils. Therefore, the contractor should exercise care when drilling and placing concrete grout into the holes.

Boulders may be encountered within the embankment fill during drilling for micropile. Difficult drilling conditions should be expected. The contractor will need to have the appropriate equipment and tools to drill through these types of obstructions, where encountered, in the subsurface. Appropriate measures will also be needed to avoid dislodging boulders into the drilled hole during the drilling and installation process.

The reinforcing rebar should be placed in the center of the drilled hole using spacers to ensure that sufficient concrete grout is placed around the rebar.

Due to the relatively small size of the drilled hole, we envision that concrete grout placement may be conducted by tremie methods from bottom up. Appropriate quality control of the concrete grout placement should be established to ensure good quality grout appearing on the top of the micropile. The concrete grout should be placed in a suitable manner to reduce the potential for segregation of the aggregates from the concrete grout mix. In addition, the concrete should be placed promptly after drilling to reduce the potential for softening of the sides of the drilled holes.

It is imperative that a representative from Geolabs be present at the site to observe the drilling and installation of micropiles during construction. Although the micropiles are designed based primarily on skin friction, the bottom of the drilled hole should be relatively free of loose materials prior to placement of concrete grout.

Therefore, observation of the micropile installation operations by Geolabs is necessary to confirm the assumed subsurface conditions and should be designated a "Special Inspection" item.

3.5 Design Review

Drawings and specifications for the Interstate Route H-1 Rehabilitation, Eastbound Lanes, Waiau Interchange to Kaimakani Street project should be forwarded to Geolabs for review and written comments prior to advertisement for bids. This review is necessary to evaluate conformance of the plans and specifications to the intent of the pavement rehabilitation/reconstruction, micropile foundations and earthwork recommendations provided herein. If this review is not made, Geolabs cannot be responsible for misinterpretation of the recommendations presented.

3.6 Construction Monitoring

It is recommended that Geolabs be retained to provide geotechnical engineering services during construction of the project. The items of construction monitoring that are critical include observation of the excavation of the pavement reconstruction areas, subgrade preparation, drilling and installation of micropile foundation, and other earthwork. This is to observe compliance with the design concepts, specifications, or recommendations and to expedite suggestions for design changes that may be required in the event that subsurface conditions differ from those anticipated at the time this report was prepared. The recommendations provided in this report are contingent upon such observations. If the actual exposed subsurface conditions encountered during construction are different from those assumed or considered in this report, then appropriate modifications to the design should be made.

END OF DISCUSSION AND RECOMMENDATIONS

SECTION 4.0 - LIMITATIONS

The analyses and recommendations submitted in this report are based, in part, upon information obtained from the test borings, laboratory test data and as-built drawings provided. Variations of subsurface conditions between and beyond the test borings may occur, and the nature and extent of these variations may not become evident until construction is underway. If variations then appear evident, it will be necessary to re-evaluate the recommendations presented in this report.

The locations of the test borings are approximate, having been estimated by taping from reference points and visible features shown on the Site Plan transmitted by Parsons Brinckerhoff on June 13, 2005. Elevations of the borings were interpolated between the spot elevations and contour lines shown on the same plan. The locations and elevations of the test borings should be considered accurate only to the degree implied by the methods used.

The stratification breaks shown on the graphic representations of the borings depict the approximate boundaries between soil/rock types and, as such, may denote a gradual transition. Water level data from the borings were measured at the times shown on the graphic representations and/or presented in the text of this report. These data have been reviewed and interpretations made in the formulation of this report. However, it must be noted that fluctuation may occur due to variation in rainfall, tides, temperature, and other factors.

This report has been prepared for the exclusive use of Parsons Brinckerhoff, and their client, State of Hawaii – Department of Transportation, Highways Division, for specific application to the Interstate Route H-1 Rehabilitation, Eastbound Lanes, Waiau Interchange to Kaimakani Street project in accordance with generally accepted geotechnical engineering principles and practices. No warranty is expressed or implied.

This report has been prepared solely for the purpose of assisting the design engineer in the preparation of design drawings related to the pavements rehabilitation/reconstruction and micropile foundations for the project only. Therefore,

this report may not contain sufficient data, or the proper information, for use to form the basis for preparation of construction cost estimates or contract bidding. A contractor wishing to bid on this project should retain a competent geotechnical engineer to assist in the interpretation of this report and/or in the performance of site-specific exploration for bid estimating purposes.

The owner/client should be aware that unanticipated subsurface conditions are commonly encountered. Unforeseen subsurface conditions, such as perched groundwater, soft deposits, hard layers, or cavities, may occur in localized areas and may require additional probing or corrections in the field (which may result in construction delays) to attain a properly constructed project. Therefore, a sufficient contingency fund is recommended to accommodate these possible extra costs.

END OF LIMITATIONS

CLOSURE

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

Plate 1	-	Project Location Map
Plate 2	-	General Site Plan
Plates 3.1 thru 3.6	-	Site Plans
Plates 4 thru 9	-	Soil Profiles
Plate 10	-	Sketch of Pavement Reconstruction and Rehabilitation
Appendix A	-	Field Exploration
Plate A	-	Boring Log Legend
Plates A-1 thru A-26	-	Logs of Borings
Plate A-27	-	Data Plot CPT
Appendix B	-	Laboratory Testing
Plates B-1 thru B-8	-	Laboratory Test Data

Appendix C	-	Pavement Design
Plates C-1 thru C-6.5	-	Pavement Calculations and Economic Analyses

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Respectfully submitted,

GEOLABS, INC.

By _____
John Y.L. Chen, P.E.
Project Engineer

By _____
Clayton S. Mimura, P.E.
President

CSM:JC:cj

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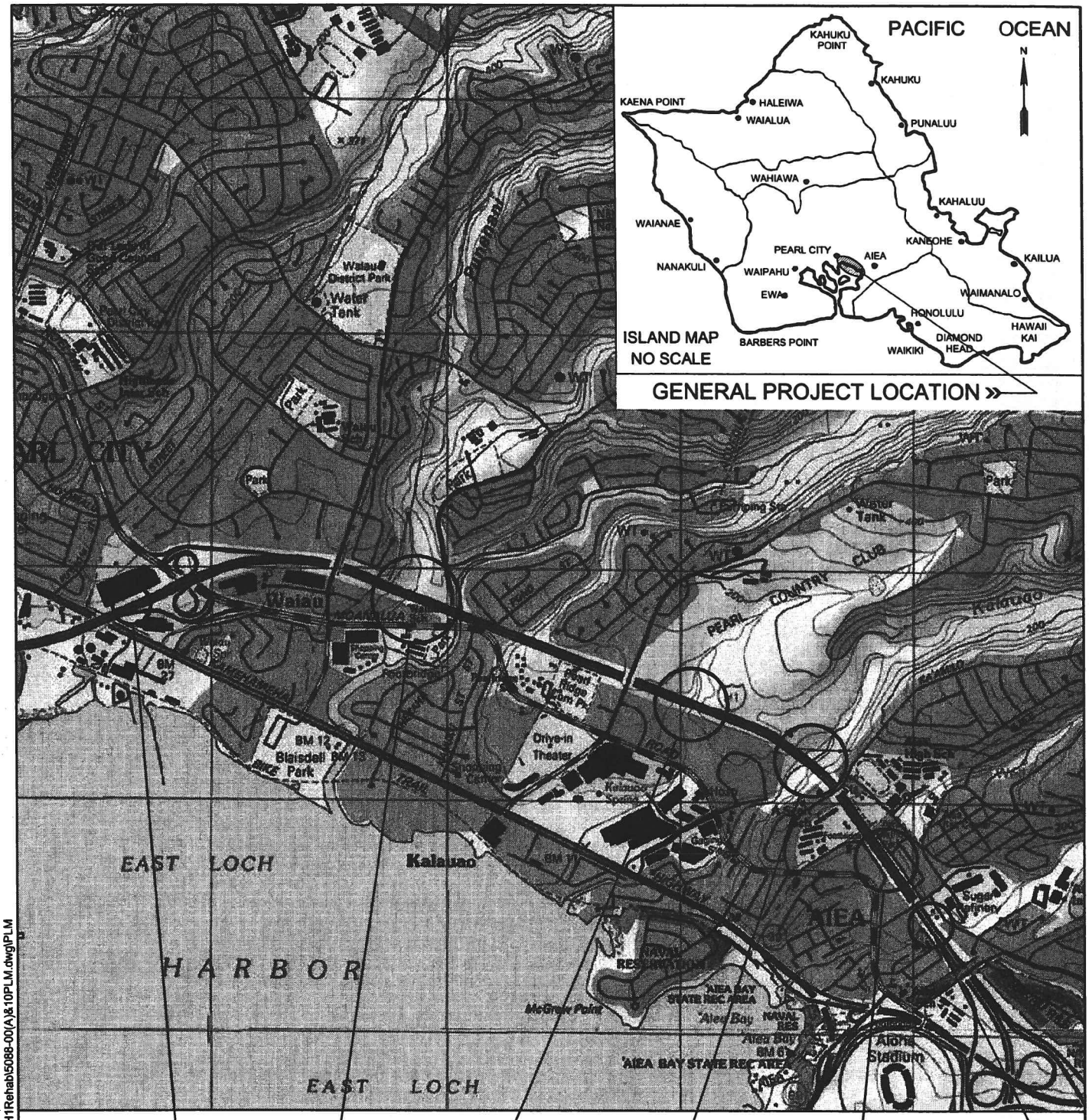
PLATES



PROJECT LOCATION MAP

INTERSTATE ROUTE H-1 REHAB., EB LANES
WAIAU INTERCHANGE TO KAIMAKANI STREET
EWA, OAHU, HAWAII

2000 1000 0 2000 FT.

GRAPHIC SCALE

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REFERENCE: MAP CREATED WITH TOPO!® ©2001 NATIONAL GEOGRAPHIC (WWW.NATIONALGEOGRAPHIC.COM/TOPO).

GEOLABS, INC.		
Geotechnical Engineering		
DATE: JUNE 2005	DRAWN BY: JRP	PLATE: 1
SCALE: 1" = 2,000'	W.O.: 5088-00(A) & 5088-10	

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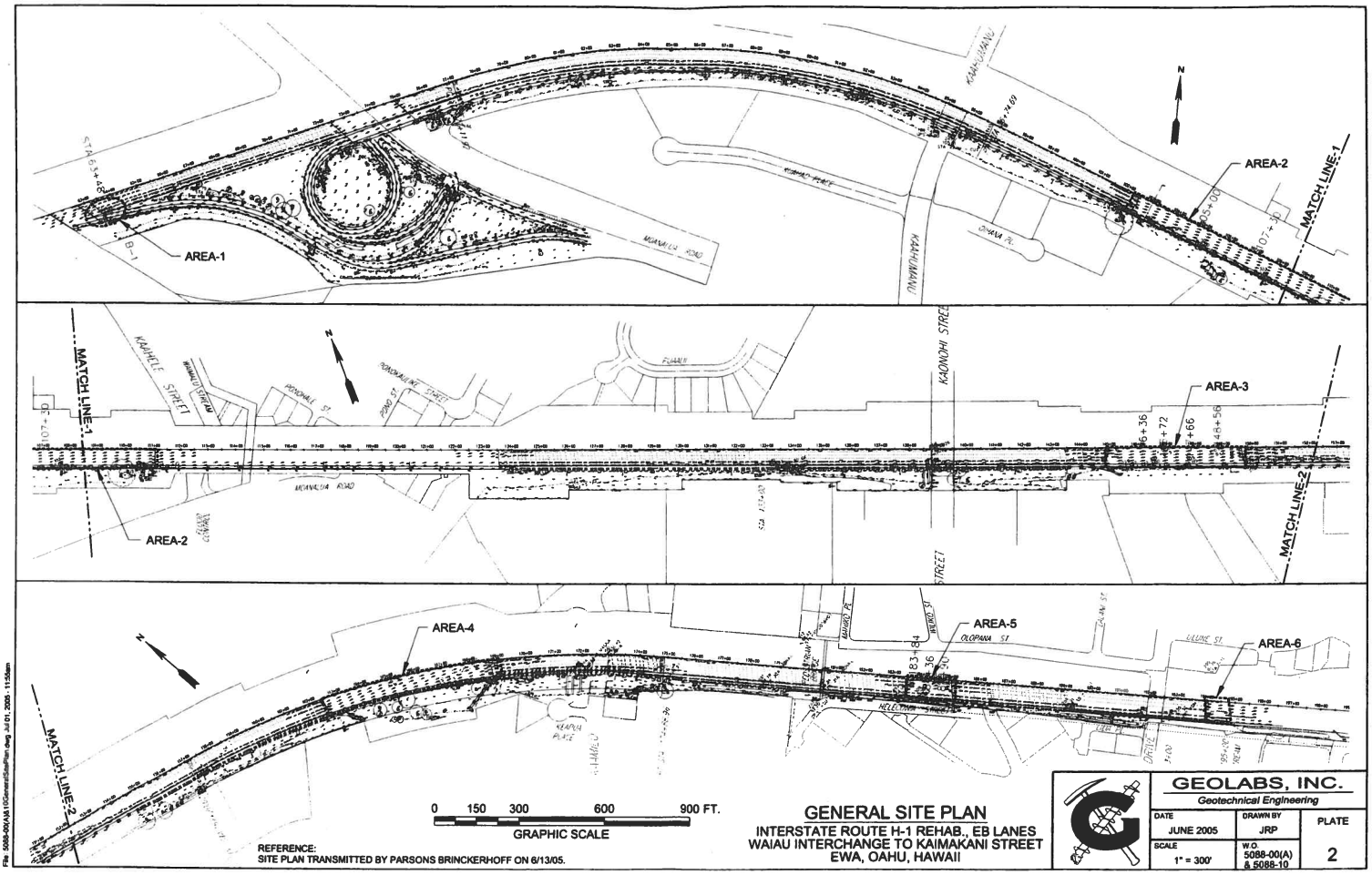

GENERAL SITE PLAN
INTERSTATE ROUTE H-1 REHAB., EB LANES
WAIAU INTERCHANGE TO KAIMAKANI STREET
EWA, OAHU, HAWAII

REFERENCE:
SITE PLAN TRANSMITTED BY PARSONS BRINCKERHOFF ON 6/13/05.

GEOLABS, INC. Geotechnical Engineering		
DATE: JUNE 2005	DRAWN BY: JRP	PLATE: 2
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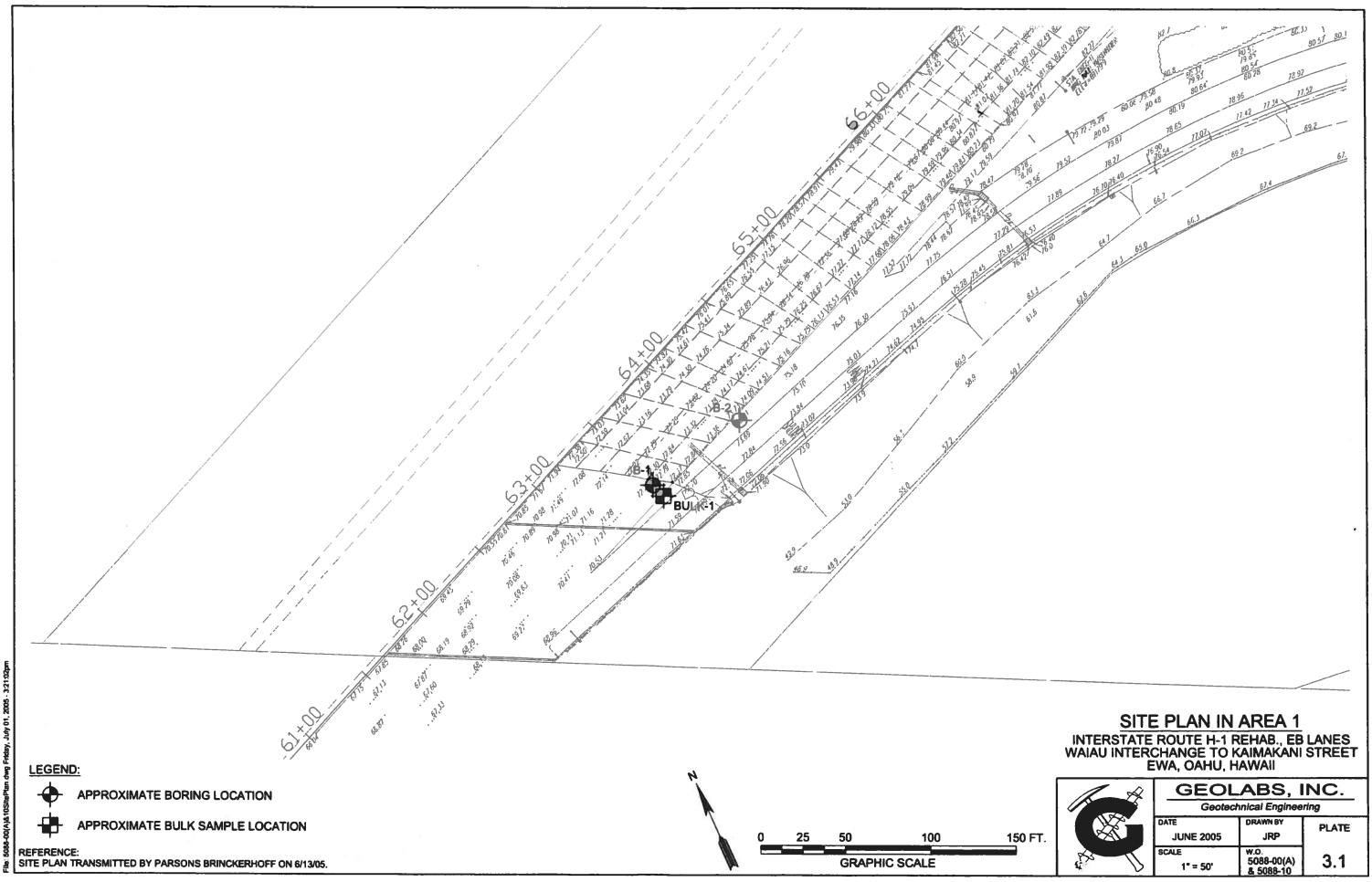


SITE PLAN IN AREA 1

INTERSTATE ROUTE H-1 REHAB., EB LANES
WAIAU INTERCHANGE TO KAIMAKANI STREET
EWA, OAHU, HAWAII

LEGEND:

- APPROXIMATE BORING LOCATION
- APPROXIMATE BULK SAMPLE LOCATION

REFERENCE:
SITE PLAN TRANSMITTED BY PARSONS BRINCKERHOFF ON 6/13/05.

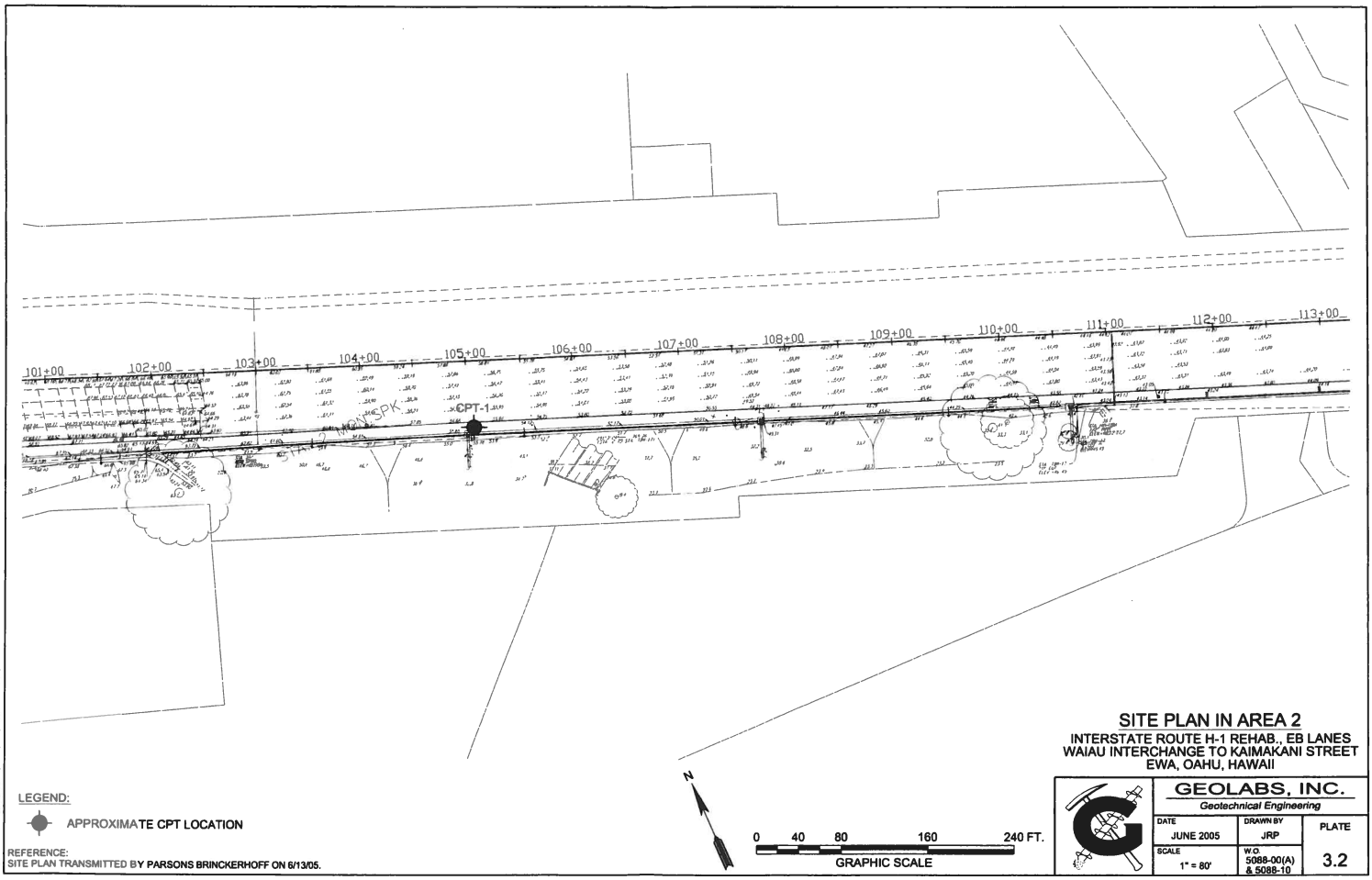
N

0 25 50 100 150 FT.
GRAPHIC SCALE

GEOLABS, INC.
Geotechnical Engineering

DATE	DRAWN BY	PLATE
JUNE 2005	JRP	3.1
SCALE: 1" = 50'	W.O.: 5088-00(A) & 5088-10	

File: 5088-00(A)\GS\Plan.dwg Friday, July 01, 2005 - 3:21:02pm



SITE PLAN IN AREA 2

INTERSTATE ROUTE H-1 REHAB., EB LANES
WAIAU INTERCHANGE TO KAIMAKANI STREET
EWA, OAHU, HAWAII

LEGEND:

APPROXIMATE CPT LOCATION

REFERENCE:
SITE PLAN TRANSMITTED BY PARSONS BRINCKERHOFF ON 6/13/05.

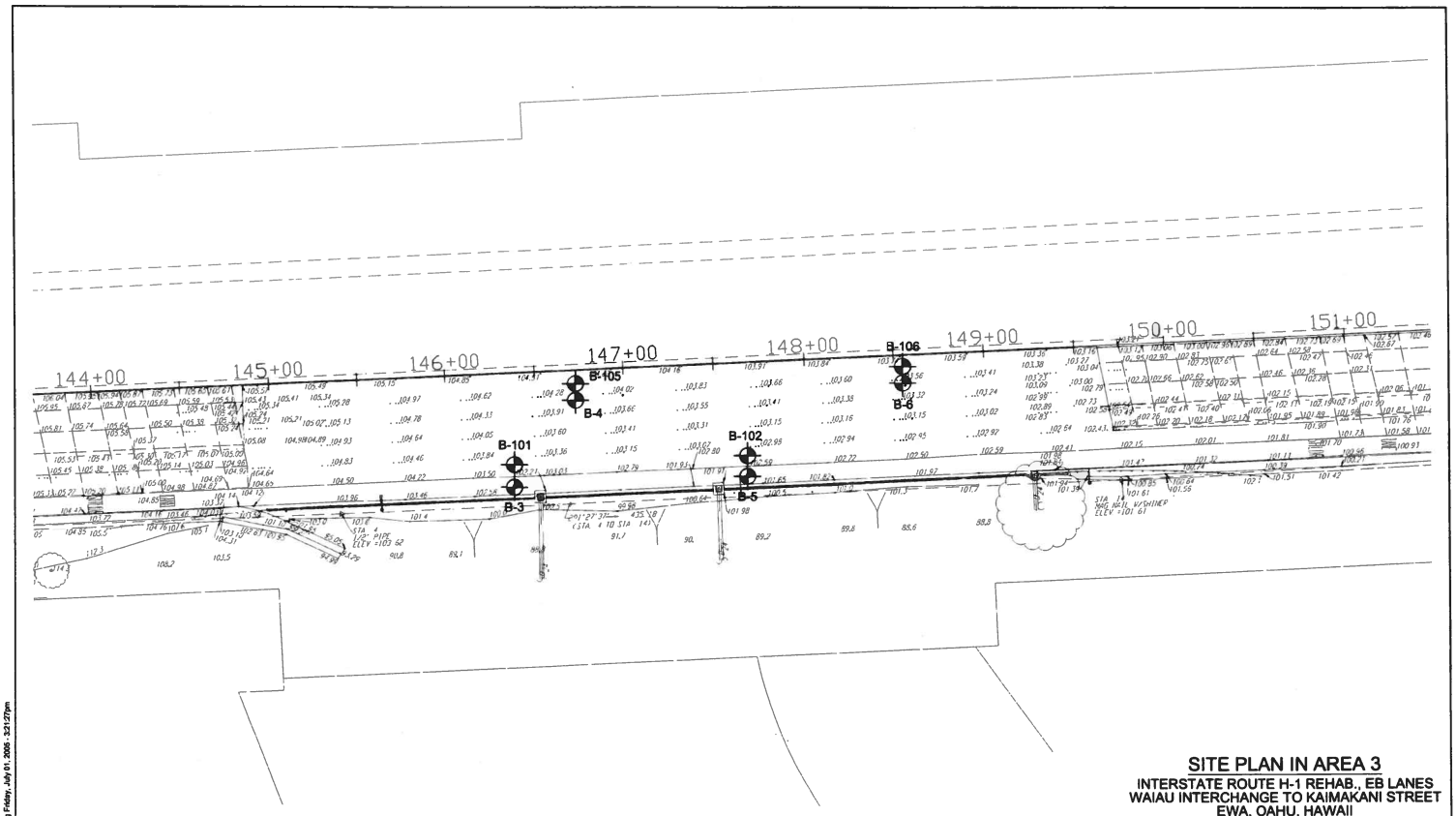
N

0 40 80 160 240 FT.
GRAPHIC SCALE

GEOLABS, INC.
Geotechnical Engineering

DATE	DRAWN BY	PLATE
JUNE 2005	JRP	3.2
SCALE: 1" = 80'	W.O. 5088-00(A) & 5088-10	

File: 5088-00(A)&10SitePlan.dwg Friday, July 01, 2005 - 3:21:14pm



SITE PLAN IN AREA 3

INTERSTATE ROUTE H-1 REHAB., EB LANES
WAIAU INTERCHANGE TO KAIMAKANI STREET
EWA, OAHU, HAWAII

LEGEND:

APPROXIMATE BORING LOCATION

REFERENCE:
SITE PLAN TRANSMITTED BY PARSONS BRINCKERHOFF ON 6/13/05.

N

0 25 50 100 150 FT.
GRAPHIC SCALE

GEOLABS, INC.		
Geotechnical Engineering		
DATE: JUNE 2005	DRAWN BY: JRP	PLATE: 3.3
SCALE: 1" = 50'	W.O. 5088-00(A) & 5088-10	

File: 5088-00(A)&10SitePlan.dwg Friday, July 01, 2005 - 3:21:27pm

SITE PLAN IN AREA 5

INTERSTATE ROUTE H-1 REHAB., EB LANES
WAIAU INTERCHANGE TO KAIMAKANI STREET
EWA, OAHU, HAWAII

LEGEND:

APPROXIMATE BORING LOCATION

REFERENCE:
SITE PLAN TRANSMITTED BY PARSONS BRINCKERHOFF ON 6/13/05.

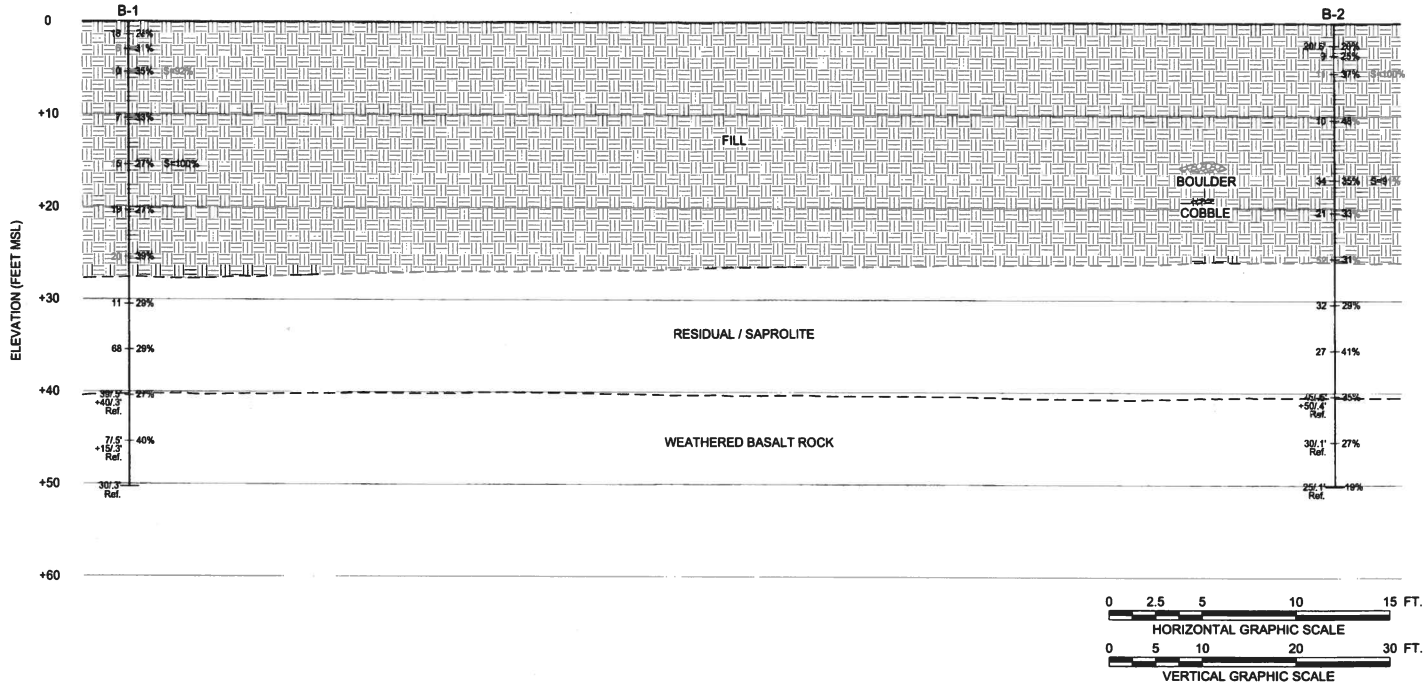
N

0 25 50 100 150 FT.
GRAPHIC SCALE

GEOLABS, INC.
Geotechnical Engineering

DATE	DRAWN BY	PLATE
JUNE 2005	JRP	3.6
SCALE	W.O.	
1" = 50'	5088-00(A) & 5088-10	

File: 5088-00(A)&10SitePlan.dwg Friday, July 01, 2005 - 3:38:30pm



LEGEND:

18 — 35% S=90% — APPROXIMATE DEGREE OF SATURATION

BLOW COUNTS — MOISTURE CONTENTS

NOTE:
THE CONDITIONS ILLUSTRATED ARE BASED ON OUR BORINGS, AS-BUILT DRAWINGS AND GEOLOGICAL INTERPRETATIONS. WHILE THESE ARE BELIEVED TO BE GENERALLY CORRECT, THE CONDITIONS MAY VARY LOCALLY FROM THOSE INDICATED.

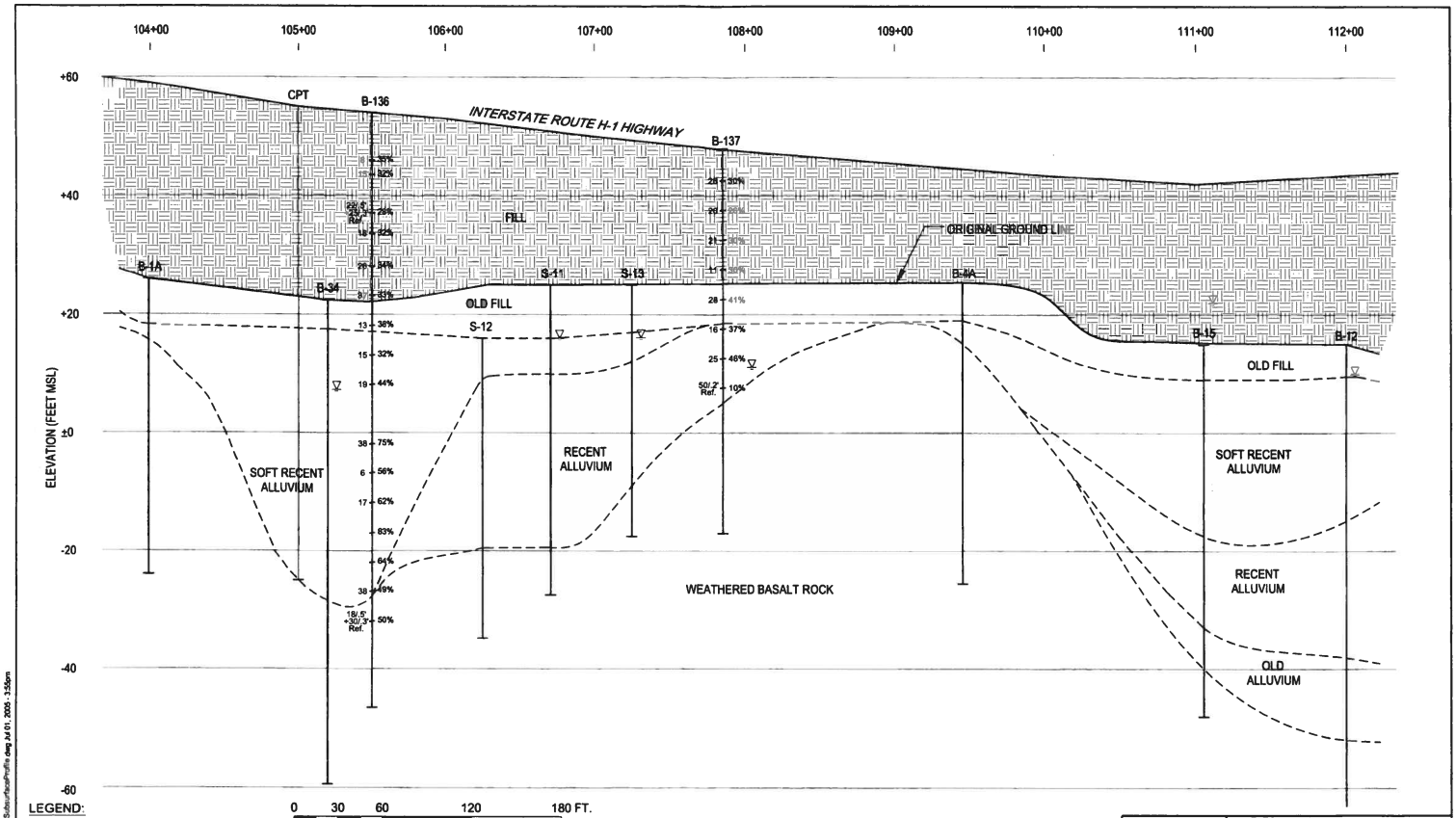
SOIL PROFILE IN AREA 1

INTERSTATE ROUTE H-1 REHAB., EB LANES
WAIAU INTERCHANGE TO KAIMAKANI STREET
EWA, OAHU, HAWAII

GEOLABS, INC.
Geotechnical Engineering

DATE	DRAWN BY	PLATE
JUNE 2005	JRP	4
SCALE: HORIZ: 1" = 5' VERT: 1" = 10'	W.O. 5088-00(A) & 5088-10	

File: 5088-00SoilProfileInArea_1-2-3-4-5.dwg Friday, July 01, 2005 - 3:41pm



LEGEND:

18 — 35%
BLOW COUNTS — MOISTURE CONTENTS

0 30 60 120 180 FT.
GRAPHIC SCALE (HORIZONTAL)

0 15 30 45 FT.
GRAPHIC SCALE (VERTICAL)

NOTE: THE CONDITIONS ILLUSTRATED ARE BASED ON OUR BORINGS, AS-BUILT DRAWINGS AND GEOLOGICAL INTERPRETATIONS. WHILE THESE ARE BELIEVED TO BE GENERALLY CORRECT, THE CONDITIONS MAY VARY LOCALLY FROM THOSE INDICATED.

SOIL PROFILE IN AREA 2

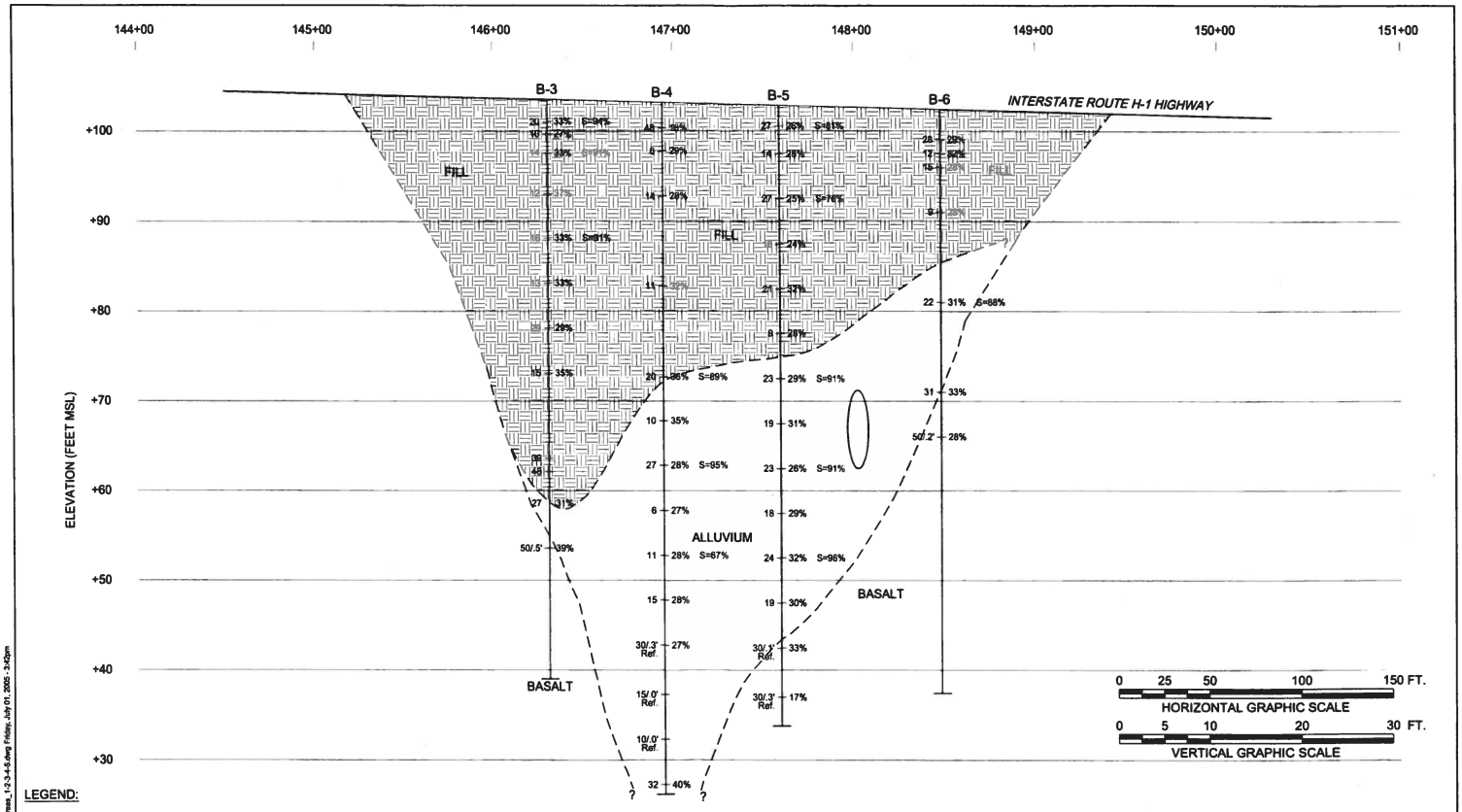
INTERSTATE ROUTE H-1 REHAB., EB LANES
WAIAU INTERCHANGE TO KAIMAKANI STREET
EWA, OAHU, HAWAII

GEOLABS, INC.
Geotechnical Engineering

DATE	DRAWN BY	PLATE
JUNE 2005	JRP	5

SCALE: HORIZ: 1" = 60' VERT: 1" = 15'
W.O. 5088-00(A) & 5088-10

File: 5088-00(A)&10\Illustrator\Soil Profile.dwg Jul 01, 2005 - 3:35pm



LEGEND:

18 — 35% S=90% — APPROXIMATE DEGREE OF SATURATION

BLOW COUNTS — MOISTURE CONTENTS

NOTE:
THE CONDITIONS ILLUSTRATED ARE BASED ON OUR BORINGS, AS-BUILT DRAWINGS AND GEOLOGICAL INTERPRETATIONS. WHILE THESE ARE BELIEVED TO BE GENERALLY CORRECT, THE CONDITIONS MAY VARY LOCALLY FROM THOSE INDICATED.

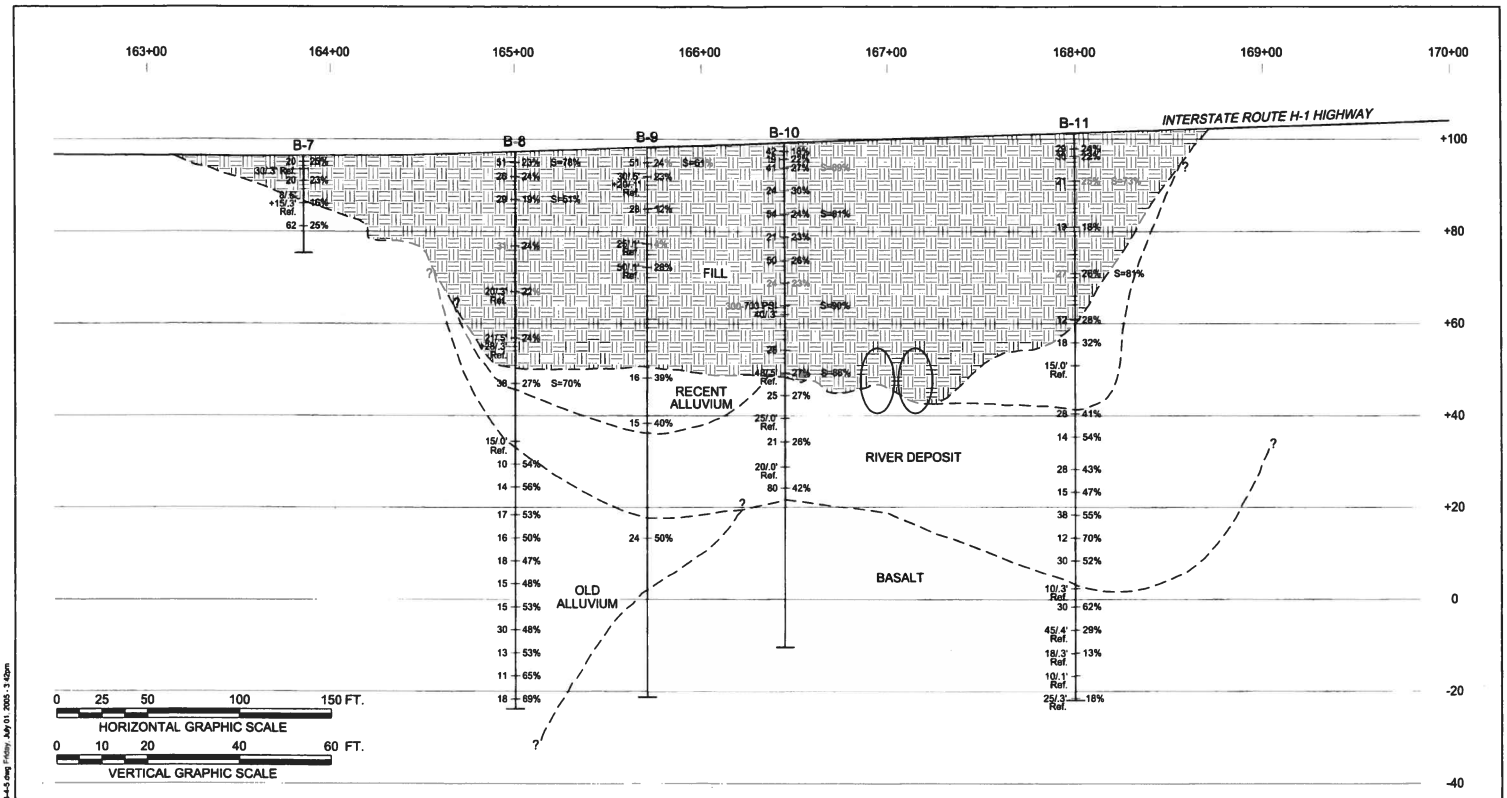
SOIL PROFILE IN AREA 3

INTERSTATE ROUTE H-1 REHAB., EB LANES
WAIAU INTERCHANGE TO KAIMAKANI STREET
EWA, OAHU, HAWAII

GEOLABS, INC.
Geotechnical Engineering

DATE	DRAWN BY	PLATE
JUNE 2005	JRP	6
SCALE: HORIZ: 1" = 50' VERT: 1" = 10'	W.O. 5088-00(A) & 5088-10	

File: 5088-00(A)&10SoilProfileInAreas_1-2-3-4-5.dwg Friday, July 01, 2005 - 3:42pm



LEGEND:

18 — 35% S=90% — APPROXIMATE DEGREE OF SATURATION

BLOW COUNTS — MOISTURE CONTENTS

NOTE:
THE CONDITIONS ILLUSTRATED ARE BASED ON OUR BORINGS, AS-BUILT DRAWINGS AND GEOLOGICAL INTERPRETATIONS. WHILE THESE ARE BELIEVED TO BE GENERALLY CORRECT, THE CONDITIONS MAY VARY LOCALLY FROM THOSE INDICATED.

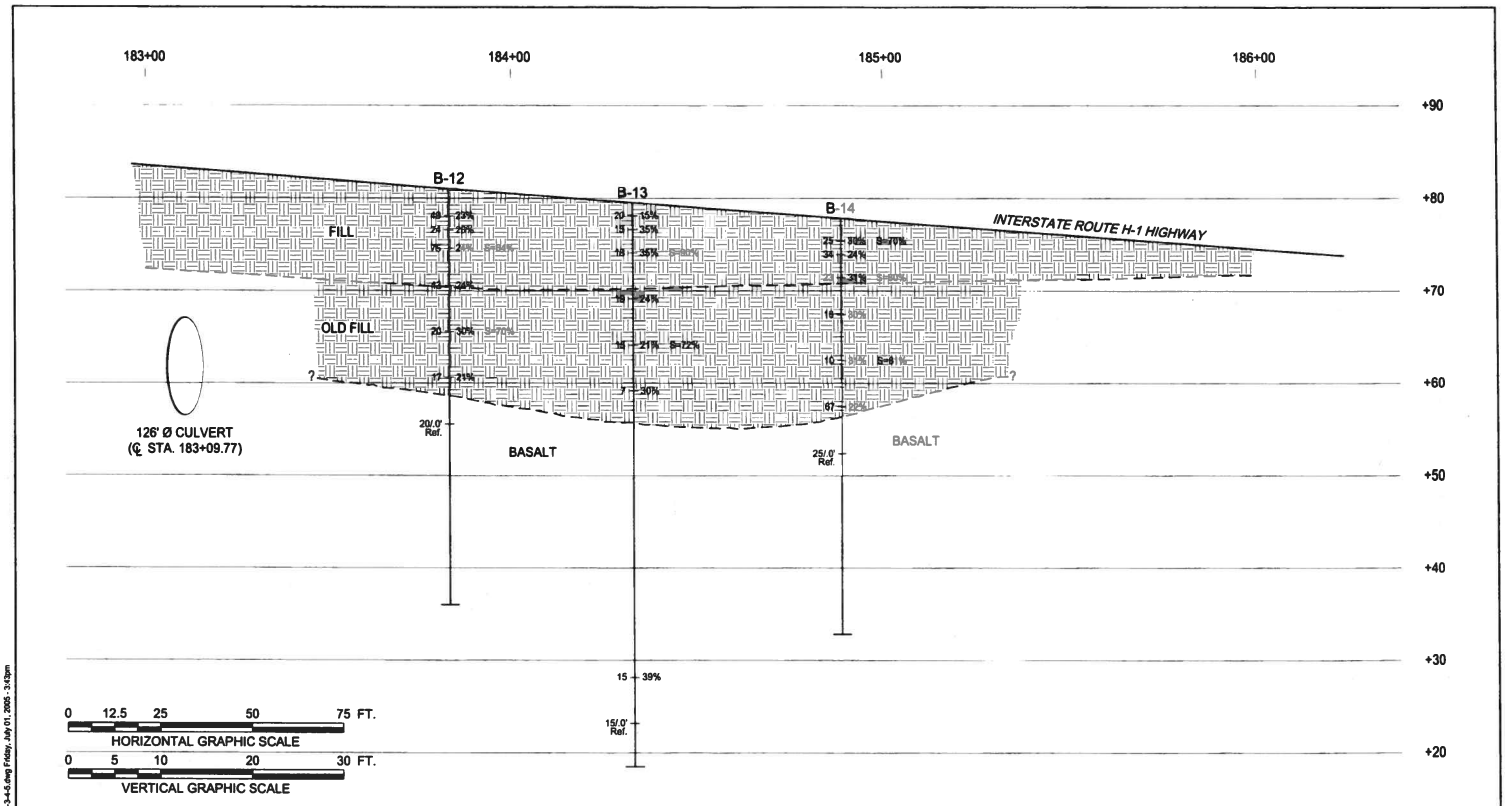
SOIL PROFILE IN AREA 4

INTERSTATE ROUTE H-1 REHAB., EB LANES
WAIAU INTERCHANGE TO KAIMAKANI STREET
EWA, OAHU, HAWAII

GEOLABS, INC.
Geotechnical Engineering

DATE	DRAWN BY	PLATE
JUNE 2005	JRP	7
SCALE: HORIZ. 1" = 50' VERT. 1" = 20'	W.O. 5088-00(A) & 5088-10	

File: 5088-00(A)&10\Soil Profile\Areas_1,2-3-4-5.dwg Friday, July 01, 2005 - 3:42pm



LEGEND:

18 — BLOW COUNTS
35% — MOISTURE CONTENTS
S=90% — APPROXIMATE DEGREE OF SATURATION

NOTE:
THE CONDITIONS ILLUSTRATED ARE BASED ON OUR BORINGS, AS-BUILT DRAWINGS AND GEOLOGICAL INTERPRETATIONS. WHILE THESE ARE BELIEVED TO BE GENERALLY CORRECT, THE CONDITIONS MAY VARY LOCALLY FROM THOSE INDICATED.

SOIL PROFILE IN AREA 5

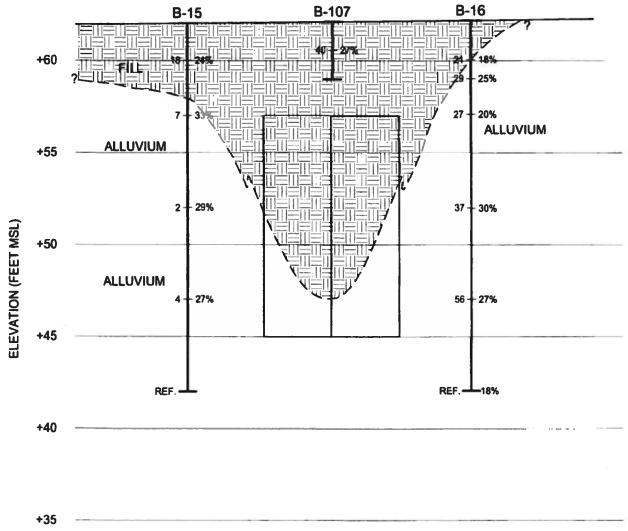
INTERSTATE ROUTE H-1 REHAB., EB LANES
WAIAU INTERCHANGE TO KAIMAKANI STREET
EWA, OAHU, HAWAII

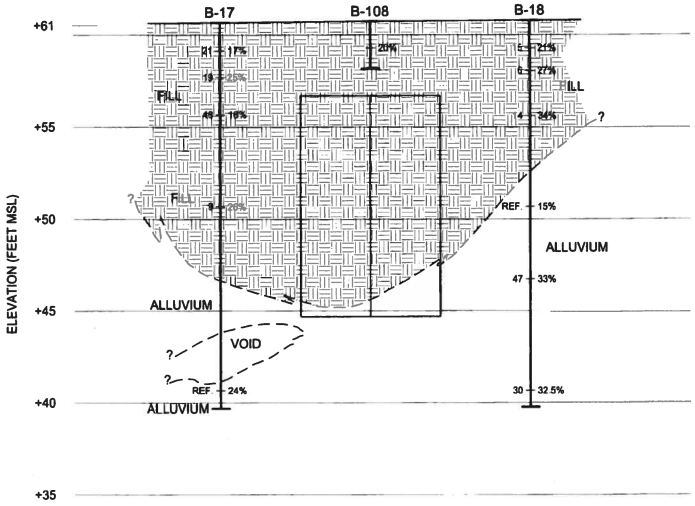
GEOLABS, INC.
Geotechnical Engineering

DATE	DRAWN BY	PLATE
JUNE 2005	JRP	8

SCALE: HORIZ. 1" = 25' VERT. 1" = 10'
W.O. 5088-00(A) & 5088-10

File: 5088-00(A)&10SoilProfileInArea_1-2-3-4-5.dwg Friday, July 01, 2005 - 3:43pm





0 2.5 5 10 15 FT.
HORIZONTAL GRAPHIC SCALE

0 5 10 20 30 FT.
VERTICAL GRAPHIC SCALE

LEGEND:

18 — 35%
BLOW COUNTS — MOISTURE CONTENTS

NOTE:
THE CONDITIONS ILLUSTRATED ARE BASED ON OUR BORINGS, AS-BUILT DRAWINGS AND GEOLOGICAL INTERPRETATIONS. WHILE THESE ARE BELIEVED TO BE GENERALLY CORRECT, THE CONDITIONS MAY VARY LOCALLY FROM THOSE INDICATED.

SOIL PROFILE IN AREA 6

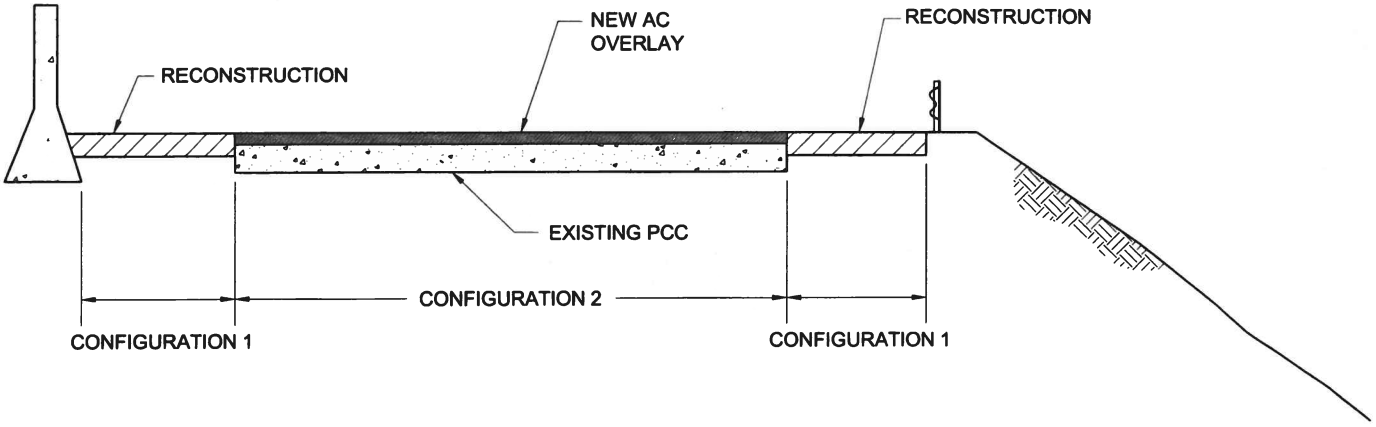
INTERSTATE ROUTE H-1 REHAB., EB LANES
WAIAU INTERCHANGE TO KAIMAKANI STREET
EWA, OAHU, HAWAII

GEOLABS, INC.
Geotechnical Engineering

DATE	DRAWN BY	PLATE
JUNE 2005	JRP	9
SCALE: HORIZ: 1" = 5' VERT: 1" = 10'	W.O. 5088-00(A) & 5088-10	

File: 5088-00SoilProfileArea-6.dwg Friday, July 08, 2005 - 1:52pm

File: 5088-00A)&10PavementReconstructionAndRehab.dwg Jul 27, 2005 - 2:41pm



SKETCH OF PAVEMENT RECONSTRUCTION AND REHABILITATION

INTERSTATE ROUTE H-1 REHAB., EB LANES
WAIAU INTERCHANGE TO KAIMAKANI STREET
EWA, OAHU, HAWAII

GEOLABS, INC.
Geotechnical Engineering

DATE	DRAWN BY	PLATE
JUNE 2005	JRP	
SCALE	W.O.	
NOT TO SCALE	5088-00(A) & 5088-10	10

APPENDIX A

Field Exploration

APPENDIX A

Field Exploration

The subsurface conditions along the Interstate Route H-1 Rehabilitation project were explored by drilling and sampling twenty-six borings, designated as Boring Nos. 1 through 18 and Nos. 101 through 108, extending to depths of about 1 to 123 feet below the existing pavement surface. In addition, one CPT test was performed to a depth of about 80 feet below the existing pavement surface. The approximate locations of the test borings and CPT are shown on the Site Plans, Plates 3.1 through 3.6. The borings were drilled using a truck-mounted drill rig equipped with continuous solid-stem augers and coring tools.

The materials encountered in the borings were classified by visual and textural examination in the field by an engineer or a geologist, who monitored the drilling operations on a near-continuous basis. These classifications were further reviewed visually and by testing in the laboratory. Soils were classified in general conformance with the Unified Soil Classification System, as shown on Plate A. Graphic representations of the materials encountered are provided on the Logs of Borings, Plates A-1.1 through A-26.

Relatively "undisturbed" soil samples were obtained from the borings drilled in general accordance with ASTM Test Designation D 3550, Ring-Lined Barrel Sampling of Soils, by driving a 3-inch OD Modified California sampler with a 140-pound hammer falling 30 inches. Some samples were obtained from the drilled borings in general accordance with ASTM Test Designation D 1586, Penetration Test and Split-Barrel Sampling of Soils, by driving a 2-inch OD standard penetration sampler using the same hammer and drop. The blow counts needed to drive the sampler the second and third 6 inches of an 18-inch drive are shown as the "Penetration Resistance" on the Logs of Boring at the appropriate sample depths.

Pocket penetrometer tests were performed on selected cohesive soil samples retrieved in the field. The pocket penetrometer test provides an indication of the unconfined compressive strength of the soil sample. Results of the pocket penetrometer tests are presented on the Logs of Borings at the appropriate sample depths.

Core samples of the rock formations encountered at the site were obtained using diamond core drilling techniques in general accordance with ASTM Standard Practice D 2113, Diamond Core Drilling for Site Investigation. Core drilling is a rotary drilling method that uses a hollow bit to cut into the rock formation. The material left in the hollow core of the bit is mechanically recovered for examination and description.

Recovery (REC) is used as a subjective guide to the interpretation of the relative quality of rock masses. Recovery is defined as the actual length of material recovered from a coring attempt versus the length of the core attempt. For example, if 3.7 feet of material is recovered from a 5.0-foot core run, the recovery would be 74 percent and would be shown on the Logs of Borings as REC = 74%.

The Rock Quality Designation (RQD) is also a subjective guide to the relative quality of rock masses. RQD is defined as the percentage of the core run that is sound material in excess of 4 inches in length without discontinuities, discounting drilling induced fractures or breaks. If 2.5 feet of sound material is recovered from a 5.0-foot core run, the RQD would be 50 percent and would be shown on the Logs of Borings as RQD = 50%. Generally, the following is used to describe the relative quality of the rock, based on the "Practical Handbook of Physical Properties of Rocks and Minerals."

Rock Quality	**RQD** (%)
Very Poor	0 – 25
Poor	25 – 50
Fair	50 – 75
Good	75 – 90
Excellent	90 – 100

The rippability of a rock mass is a function of the relative hardness of the rock, its relative quality, brittleness, and fissile characteristics. A dense basalt formation with a high RQD values would be very difficult to rip and would probably require more arduous methods of excavation.

[h:\5000 Series\5088-00(A) & 5088-10.jc1 – p.46]

GEOLABS, INC.	INTERSTATE ROUTE H-1 REHAB., EB LANES WAIAU INTERCHANGE TO KAIMAKANI STREET EWA, OAHU, HAWAII	Log of Boring 1
Geotechnical Engineering		

Laboratory			Field							Approximate Ground Surface Elevation (feet MSL): 72 *
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	USCS		Description
							0			1.5-inch **ASPHALTIC CONCRETE**
	28	92			18	2.0		GW		7-inch **CONCRETE**
								CH		12-inch **BASE COURSE**
LL=59 PI=36	31				6	3.0				Brown with multi-color mottling **SILTY CLAY** with sand and gravel, medium stiff, moist (fill)
	35	82			10	1.0	5			grades with less gravel
	33				7	0.5	10			grades to dark brown, moist to wet
	27	83			15	<0.5	15			grades to brown, stiff, wet
	27				19	3.5	20			grades to very stiff
	39	77			20	3.5	25			
								CH		Brown **SILTY CLAY** with some roots/rootlets, stiff, moist (saprolite)
LL=56 PI=34	29				11	3.5	30			
							35			

Date Started:	October 26, 2003	Water Level: ▽ Not Encountered	Plate
Date Completed:	October 26, 2003		
Logged By:	Y. Chiba	Drill Rig: CME-75	
Total Depth:	50.3 feet	Drilling Method: 4" Auger	A - 1.1
Work Order:	5088-00(A) & 5088-10	Driving Energy: 140 lb. wt., 30 in. drop	

BORING_LOG 5088-00(A).GPJ GEOLABS.GDT 7/8/05

GEOLABS, INC. Geotechnical Engineering	INTERSTATE ROUTE H-1 REHAB., EB LANES WAIAU INTERCHANGE TO KAIMAKANI STREET EWA, OAHU, HAWAII	Log of Boring 1

Laboratory			Field				Depth (feet)	Sample	Graphic	USCS	(Continued from previous plate) Description
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)					
	29	84			68	>4.5				CH	grades with red mottling, hard
						>4.5					
	27				39/.5' +40/.3' Ref.		40				grades to reddish brown
											Gray **BASALT**, completely fractured, extremely weathered, soft (basalt formation)
	40				7/.5' +15/.3' Ref.		45				
											grades to vesicular, moderately weathered, medium hard
	14				30/.3' Ref.		50				Boring terminated at 50.3 feet * Elevations estimated from Site Plan transmitted by Parsons Brinckerhoff on 4/9/04.
							55				
							60				
							65				
							70				

Date Started:	October 26, 2003	Water Level: ▽ Not Encountered	Plate
Date Completed:	October 26, 2003		
Logged By:	Y. Chiba	Drill Rig: CME-75	
Total Depth:	50.3 feet	Drilling Method: 4" Auger	A - 1.2
Work Order:	5088-00(A) & 5088-10	Driving Energy: 140 lb. wt., 30 in. drop	

BORING LOG 5088-00(A).GPJ GEOLABS.GDT 7/8/05

GEOLABS, INC.

Geotechnical Engineering

INTERSTATE ROUTE H-1 REHAB., EB LANES
WAIAU INTERCHANGE TO KAIMAKANI STREET
EWA, OAHU, HAWAII

Log of Boring **2**

Laboratory			Field							Approximate Ground Surface Elevation (feet MSL): 74 *
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	USCS	Description
							0		GW	4-inch **ASPHALTIC CONCRETE**
										14-inch **BASE COURSE**
	20	91			20/.5'				CH	Brown **SILTY CLAY** with gravel, stiff, damp (fill)
	25				9	1.5				grades to medium stiff, moist
	37	80			11		5			grades to wet
LL=56 PI=27	48				10	1.0	10			
	35	83			34	0.5	15			
	33				21	1.0	20			
LL=64 PI=31	31	88			52	2.0	25		MH	Brown with black mottling **CLAYEY SILT**, very stiff, moist (residual soil)
	29				32	>4.5	30			grades with remnant rock structure
							35			

Date Started:	October 26, 2003	Water Level: ▽ Not Encountered	Plate
Date Completed:	October 27, 2003		
Logged By:	Y. Chiba	Drill Rig: CME-75	
Total Depth:	50.1 feet	Drilling Method: 4" Auger	A - 2.1
Work Order:	5088-00(A) & 5088-10	Driving Energy: 140 lb. wt., 30 in. drop	

BORING_LOG 5088-00(A).GPJ GEOLABS.GDT 7/8/05

GEOLABS, INC. Geotechnical Engineering	INTERSTATE ROUTE H-1 REHAB., EB LANES WAIAU INTERCHANGE TO KAIMAKANI STREET EWA, OAHU, HAWAII	Log of Boring 2

Laboratory			Field							
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS
	41	75			27					MH
	35				45/.5' +50/.4'		40			
	38				30/.1' Ref.		45			
	19				25/.1' Ref.		50			
							55			
							60			
							65			
							70			

(Continued from previous plate)

Description

grades with gray mottling

Brown and gray **BASALT**, completely fractured, extremely to highly weathered, soft (basalt formation)

grades to medium hard

Boring terminated at 50.1 feet

Date Started:	October 26, 2003	Water Level: ▽ Not Encountered	Plate
Date Completed:	October 27, 2003		
Logged By:	Y. Chiba	Drill Rig: CME-75	
Total Depth:	50.1 feet	Drilling Method: 4" Auger	A - 2.2
Work Order:	5088-00(A) & 5088-10	Driving Energy: 140 lb. wt., 30 in. drop	

BORING_LOG 5088-00(A).GPJ GEOLABS.GDT 7/8/05

GEOLABS, INC.	INTERSTATE ROUTE H-1 REHAB., EB LANES	Log of Boring
Geotechnical Engineering	WAIAU INTERCHANGE TO KAIMAKANI STREET EWA, OAHU, HAWAII	3

Laboratory			Field							Approximate Ground Surface Elevation (feet MSL): 102.5 *
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	USCS	Description
							0			13-inch **ASPHALTIC CONCRETE**
									GW	11-inch **BASE COURSE**
	32	92			22	1.5			CH	Brown **SILTY CLAY,** stiff, moist (fill)
LL=65 PI=36	27				10					
	33	80			14		5			grades with some sand and gravel
	37				12	0.8	10			grades to wet
	37	81			16		15			
	32				13	1.0	20			grades with traces of gravel, moist
					29	1.5	25			grades to stiff to very stiff
	35				15		30			**COBBLE**
			50							grades with gravel, cobbles and metallic debris, stiff
							35			

Date Started:	October 20, 2003	Water Level: ▽ Not Encountered	Plate
Date Completed:	October 21, 2003		
Logged By:	S. Latronic	Drill Rig: CME-75	
Total Depth:	64.5 feet	Drilling Method: 4" Auger & PQ Coring	A - 3.1
Work Order:	5088-00(A) & 5088-10	Driving Energy: 140 lb. wt., 30 in. drop	

BORING_LOG 5088-00(A).GPJ GEOLABS.GDT 7/8/05

GEOLABS, INC.

Geotechnical Engineering

INTERSTATE ROUTE H-1 REHAB., EB LANES
WAIAU INTERCHANGE TO KAIMAKANI STREET
EWA, OAHU, HAWAII

Log of Boring 3

Laboratory			Field							
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS	(Continued from previous plate) Description
			40			2.5					grades to very stiff
					39		40				
					48						
			75								
LL=52 PI=25	31				27		45			CH	Brown **SILTY CLAY,** very stiff, moist (alluvium)
			52								
	39	80			50/.2'		50				Brown **BASALT**, severely fractured, highly weathered, soft to medium hard (basalt formation)
			100	87							grades to reddish brown to gray dense with welded clinker, slightly fractured, slightly weathered, very hard at 51 feet
			100	68			55				grades to massive
			100	100			60				
							65				Boring terminated at 64.5 feet
							70				

Date Started:	October 20, 2003	Water Level: ▽ Not Encountered	Plate
Date Completed:	October 21, 2003		
Logged By:	S. Latronic	Drill Rig: CME-75	
Total Depth:	64.5 feet	Drilling Method: 4" Auger & PQ Coring	A - 3.2
Work Order:	5088-00(A) & 5088-10	Driving Energy: 140 lb. wt., 30 in. drop	

BORING_LOG 5088-00(A).GPJ GEOLABS.GDT 7/8/05

GEOLABS, INC. Geotechnical Engineering	INTERSTATE ROUTE H-1 REHAB., EB LANES WAIAU INTERCHANGE TO KAIMAKANI STREET EWA, OAHU, HAWAII	Log of Boring 4

Laboratory			Field								Approximate Ground Surface Elevation (feet MSL): 104 *
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS	Description
							0				12-inch **ASPHALTIC CONCRETE**
											12-inch **CONCRETE**
	18	101			48	4.0					12-inch **BASE COURSE**
										CH	Orangish red **SILTY CLAY** with sand and some gravel, hard, damp (fill)
	29				6	3.0	5				grades to grayish brown with multi-color mottling, very stiff, moist
LL=60 PI=33	28	88			14	2.5	10				grades to orangish brown with gray mottling
							15				
	32				11	2.0	20				grades to brown with multi-color mottling, moist to wet
							25				
						1.5					
											grades to medium stiff to stiff, wet
	36	83			20	1.5	30				
										CH	Brown with multi-color mottling **SILTY CLAY** with sand and rounded cobbles and gravel, medium stiff, wet (alluvium)
							35				

Date Started:	October 27, 2003	Water Level: ▽ 57.5 ft. 10/29/03 2200 HRS		Plate
Date Completed:	October 29, 2003			
Logged By:	Y. Chiba	Drill Rig:	CME-75	
Total Depth:	77 feet	Drilling Method:	4" Auger & PQ Coring	A - 4.1
Work Order:	5088-00(A) & 5088-10	Driving Energy:	140 lb. wt., 30 in. drop	

BORING_LOG 5088-00(A).GPJ GEOLABS.GDT 7/11/05

GEOLABS, INC. Geotechnical Engineering	INTERSTATE ROUTE H-1 REHAB., EB LANES WAIAU INTERCHANGE TO KAIMAKANI STREET EWA, OAHU, HAWAII	Log of Boring 4

Laboratory			Field							
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS	(Continued from previous plate) Description
	35				10	2.0				CH	grades to grayish brown with multi-color mottling, stiff
	28	83			27	2.0	40				grades to dark brown with some orange, moist
	27				6	3.0	45				grades to orange-brown, very stiff
	28	65			11	1.0	50				grades with black mottling with some roots/rootlets, medium stiff
	28				15	4.0	55				grades to hard
	27	87	54	0	30/.3' Ref.		60			SM	Reddish brown with yellow and tan mottling **SILTY SAND** with gravel, medium dense, wet (alluvium)
										CH	Gray with brownish orange mottling **SILTY CLAY** in a sand and gravel matrix, hard, wet (alluvium)
			53	0	15/.0' Ref.		65				
							70				

Date Started:	October 27, 2003	Water Level: ▽ 57.5 ft. 10/29/03 2200 HRS		Plate
Date Completed:	October 29, 2003			
Logged By:	Y. Chiba	Drill Rig:	CME-75	
Total Depth:	77 feet	Drilling Method:	4" Auger & PQ Coring	A - 4.2
Work Order:	5088-00(A) & 5088-10	Driving Energy:	140 lb. wt., 30 in. drop	

BORING_LOG 5088-00(A).GPJ GEOLABS.GDT 7/11/05

GEOLABS, INC. Geotechnical Engineering	INTERSTATE ROUTE H-1 REHAB., EB LANES WAIAU INTERCHANGE TO KAIMAKANI STREET EWA, OAHU, HAWAII	Log of Boring 4

Laboratory			Field							
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS
			60	0	10/.0' Ref.		75			CH
	40				32					

(Continued from previous plate)

Description

grades to tannish gray with multi-color mottling with rounded cobbles and boulders

Boring terminated at 77 feet

80 85 90 95 100 105

Date Started:	October 27, 2003	Water Level: ▽ 57.5 ft. 10/29/03 2200 HRS	Plate
Date Completed:	October 29, 2003		
Logged By:	Y. Chiba	Drill Rig: CME-75	
Total Depth:	77 feet	Drilling Method: 4" Auger & PQ Coring	A - 4.3
Work Order:	5088-00(A) & 5088-10	Driving Energy: 140 lb. wt., 30 in. drop	

BORING_LOG 5088-00(A).GPJ GEOLABS.GDT 7/11/05

GEOLABS, INC.

Geotechnical Engineering

INTERSTATE ROUTE H-1 REHAB., EB LANES
WAIAU INTERCHANGE TO KAIMAKANI STREET
EWA, OAHU, HAWAII

Log of Boring **5**

Laboratory			Field								
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS	Approximate Ground Surface Elevation (feet MSL): 102 * **Description**
											11.5-inch **ASPHALTIC CONCRETE**
											21.5-inch **BASE COURSE**
	25	83			27	4.0				CH	Brownish red with multi-color mottling **SILTY CLAY** with some gravel and sand, very stiff, damp (fill)
	28				14	>4.5	5				grades to brown with multi-color mottling, stiff
	24	93			27	>4.5	10				grades to dark reddish brown with multi-color mottling, very stiff
LL=57 PI=29	24				18	>4.5	15				grades to dark reddish brown
LL=62 PI=29	32	80			21	>4.5	20			MH	Brownish red with multi-color mottling **CLAYEY SILT** with sand and some gravel, very stiff, moist to wet (fill)
	28				9	4.0	25			CH	Dark reddish brown **SILTY CLAY** with some sand, stiff, moist (fill)
	31	81			23	3.0	30			CH	Grayish brown with multi-color mottling **SILTY CLAY** with sand, rounded gravel, pebbles and some cobbles, very stiff, moist to wet (alluvium)
							35				

Date Started:	October 21, 2003	Water Level: ▽ Not Encountered	Plate
Date Completed:	October 22, 2003		
Logged By:	Y. Chiba	Drill Rig: CME-75	
Total Depth:	70.5 feet	Drilling Method: 4" Auger & PQ Coring	A - 5.1
Work Order:	5088-00(A) & 5088-10	Driving Energy: 140 lb. wt., 30 in. drop	

BORING_LOG 5088-00(A).GPJ GEOLABS.GDT 7/8/05

GEOLABS, INC. Geotechnical Engineering	INTERSTATE ROUTE H-1 REHAB., EB LANES WAIAU INTERCHANGE TO KAIMAKANI STREET EWA, OAHU, HAWAII	Log of Boring 5

Laboratory			Field								
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS	(Continued from previous plate) Description
	31				19	1.5				CH	
	27	95			23	>4.5	40				grades to dark reddish brown with some subrounded pebbles and roots/rootlets
	29				18	0.5	45				grades with some sand, stiff to very stiff
	30	92			24	2.0	50				grades to very stiff
LL=65 PI=38	30				19	4.0	55				grades to reddish brown with gray mottling
	10		92	0	30/.1' Ref.		60				Orangish red with gray mottling **CLINKER**, severely fractured, extremely weathered, hard (basalt formation)
	17		100	26	30/.3' Ref.		65				Gray with dark brown mottling dense to vesicular **BASALT**, closely fractured, highly to moderately weathered, hard to medium hard (basalt formation)
							70				

Date Started:	October 21, 2003	Water Level: ▽ Not Encountered	Plate
Date Completed:	October 22, 2003		
Logged By:	Y. Chiba	Drill Rig: CME-75	
Total Depth:	70.5 feet	Drilling Method: 4" Auger & PQ Coring	A - 5.2
Work Order:	5088-00(A) & 5088-10	Driving Energy: 140 lb. wt., 30 in. drop	

BORING LOG 5088-00(A).GPJ GEOLABS.GDT 7/8/05

GEOLABS, INC. Geotechnical Engineering	INTERSTATE ROUTE H-1 REHAB., EB LANES WAIAU INTERCHANGE TO KAIMAKANI STREET EWA, OAHU, HAWAII	Log of Boring 5

Laboratory			Field							
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS

(Continued from previous plate)

Description

grades to severely fractured with some red silty clay seams on fractured surfaces, medium hard at 69.3 feet

Boring terminated at 70.5 feet

75
80
85
90
95
100
105

Date Started:	October 21, 2003	Water Level: ▽ Not Encountered	Plate
Date Completed:	October 22, 2003		
Logged By:	Y. Chiba	Drill Rig: CME-75	
Total Depth:	70.5 feet	Drilling Method: 4" Auger & PQ Coring	A - 5.3
Work Order:	5088-00(A) & 5088-10	Driving Energy: 140 lb. wt., 30 in. drop	

BORING_LOG 5088-00(A).GPJ GEOLABS.GDT 7/8/05

GEOLABS, INC. Geotechnical Engineering	INTERSTATE ROUTE H-1 REHAB., EB LANES WAIAU INTERCHANGE TO KAIMAKANI STREET EWA, OAHU, HAWAII	Log of Boring 6

Laboratory			Field								
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS	Approximate Ground Surface Elevation (feet MSL): 103.5 * Description
											12-inch **ASPHALTIC CONCRETE**
											12-inch **CONCRETE**
											12-inch **BASE COURSE**
	29	86			28					CH	Brown **SILTY CLAY** with gravel, stiff to very stiff, moist (fill)
	32				12	2.0	5				
	28	82			15	2.5					
							10				
LL=51 PI=25	28				9	1.5					grades to stiff
							15				
										CH	Brown **SILTY CLAY** with sand, very stiff, moist to wet (alluvium)
							20				
	31	90			22	2.0					
							25				
							30				
	33				31						Brownish gray **BASALT**, completely fractured, extremely weathered, soft (basalt formation)
							35				

Date Started:	October 27, 2003	Water Level: ▽ Not Encountered	Plate
Date Completed:	October 27, 2003		
Logged By:	Y. Chiba	Drill Rig: CME-75	
Total Depth:	65 feet	Drilling Method: 4" Auger & PQ Coring	A - 6.1
Work Order:	5088-00(A) & 5088-10	Driving Energy: 140 lb. wt., 30 in. drop	

BORING_LOG 5088-00(A).GPJ GEOLABS.GDT 7/8/05

GEOLABS, INC.	INTERSTATE ROUTE H-1 REHAB., EB LANES	Log of Boring
Geotechnical Engineering	WAIAU INTERCHANGE TO KAIMAKANI STREET EWA, OAHU, HAWAII	6

Laboratory			Field							
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS

(Continued from previous plate)

Description

	28	74			50/.2'						grades to gray, moderately weathered, medium hard
			50	50							
			100	87			40				grades to dense, slightly fractured to massive, slightly weathered, very hard
			95	33			45				
			73	0			50				Reddish gray **CLINKER**, severely fractured, moderately weathered, medium hard (basalt formation)
			100	0			55				grades to highly weathered, soft
			90	15			60				
							65				Gray dense **BASALT**, moderately fractured, slightly weathered, hard (basalt formation)
											Boring terminated at 65 feet
							70				

Date Started:	October 27, 2003	Water Level: ▽ Not Encountered	Plate
Date Completed:	October 27, 2003		
Logged By:	Y. Chiba	Drill Rig: CME-75	
Total Depth:	65 feet	Drilling Method: 4" Auger & PQ Coring	A - 6.2
Work Order:	5088-00(A) & 5088-10	Driving Energy: 140 lb. wt., 30 in. drop	

BORING LOG 5088-00(A).GPJ GEOLABS.GDT 7/8/05

GEOLABS, INC.	INTERSTATE ROUTE H-1 REHAB., EB LANES WAIAU INTERCHANGE TO KAIMAKANI STREET EWA, OAHU, HAWAII	Log of Boring 7
Geotechnical Engineering		

Laboratory			Field							Approximate Ground Surface Elevation (feet MSL): 92 *
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS	Description
											5.5-inch **ASPHALTIC CONCRETE**
	25	95			20/.5' +30/.3' Ref. 15/.1' Ref.	>4.5				CL	15.5-inch **BASE COURSE** Orangish brown with multi-color mottling **SANDY CLAY** with gravel and silt, hard, damp (fill) grades with cobbles at 2.5 feet
	23				20	>4.5	5			CH	Brown **SILTY CLAY** with gravel and sand, very stiff, damp (alluvium)
										SC	Brown **CLAYEY SAND** with silt and gravel, stiff to very stiff, damp (alluvium)
	16				8/.5' +15/.3' Ref.		10				grades with some cobbles
										CH	Reddish brown with multi-color mottling **SILTY CLAY** with some sand and gravel, hard, damp (alluvium)
LL=64 PI=38	25	92			62	>4.5	15				
			28	0							grades with rock fragments
							20				
											Boring terminated at 21 feet
							25				
							30				
							35				

Date Started:	October 15, 2003	Water Level: ▽ Not Encountered		Plate
Date Completed:	October 15, 2003			
Logged By:	Y. Chiba	Drill Rig:	CME-75	A - 7
Total Depth:	21 feet	Drilling Method:	4" Auger & PQ Coring	
Work Order:	5088-00(A) & 5088-10	Driving Energy:	140 lb. wt., 30 in. drop	

BORING_LOG 5088-00(A).GPJ GEOLABS.GDT 7/8/05

GEOLABS, INC.	INTERSTATE ROUTE H-1 REHAB., EB LANES	Log of Boring
Geotechnical Engineering	WAIAU INTERCHANGE TO KAIMAKANI STREET EWA, OAHU, HAWAII	8

Laboratory			Field							Approximate Ground Surface Elevation (feet MSL): 93 *
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	USCS		Description
							0			12-inch **ASPHALTIC CONCRETE**
										15-inch **BASE COURSE**
	23	84			51	>4.5		CH		Reddish brown with multi-color mottling **SILTY CLAY** with some sand and gravel, hard, damp (fill)
LL=66 PI=43	24				26	>4.5	5			grades to very stiff
	24	85			29	>4.5	10			grades with some cobbles
						>4.5	15			
	24				31	>4.5	20			grades to hard
							25			
	22	64			20/.3' Ref.	>4.5	30			grades to dark reddish brown with roots/rootlets and cobbles/boulders
							35			

Date Started:	October 16, 2003	Water Level: ▽ Not Encountered	Plate
Date Completed:	October 20, 2003		
Logged By:	Y. Chiba	Drill Rig: CME-75	
Total Depth:	120 feet	Drilling Method: 4" Auger & HQ Coring	A - 8.1
Work Order:	5088-00(A) & 5088-10	Driving Energy: 140 lb. wt., 30 in. drop	

BORING_LOG 5088-00(A).GPJ GEOLABS.GDT 7/8/05

GEOLABS, INC.	INTERSTATE ROUTE H-1 REHAB., EB LANES	Log of Boring
Geotechnical Engineering	WAIAU INTERCHANGE TO KAIMAKANI STREET EWA, OAHU, HAWAII	8

Laboratory			Field							
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS	(Continued from previous plate) Description
							40			CH	
	24				21/.5' +28/.3' Ref.	3.0					
							45				
						3.5				CH	Dark grayish brown with blue and brown mottling **SILTY CLAY** with fine sand and subrounded gravel and pebbles, hard, damp (recent alluvium)
LL=63 PI=34	25	92			38	4.0	50				
			83				55			CL	Dark brown **SANDY CLAY** with silt and cobbles and boulders, very stiff, moist (river deposit)
			25								
							60				
			100	0	15/.0' Ref.						
							65			MH	Brown with multi-color mottling **CLAYEY SILT** with rounded pebbles and some gravel, stiff, moist (old alluvium)
						1.5					
LL=56 PI=21	54				10						grades to wet
			100	0			70				

Date Started:	October 16, 2003	Water Level: ▽ Not Encountered	Plate
Date Completed:	October 20, 2003		
Logged By:	Y. Chiba	Drill Rig: CME-75	
Total Depth:	120 feet	Drilling Method: 4" Auger & HQ Coring	A - 8.2
Work Order:	5088-00(A) & 5088-10	Driving Energy: 140 lb. wt., 30 in. drop	

GEOLABS, INC. Geotechnical Engineering	INTERSTATE ROUTE H-1 REHAB., EB LANES WAIAU INTERCHANGE TO KAIMAKANI STREET EWA, OAHU, HAWAII	Log of Boring 8

Laboratory			Field								
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS	(Continued from previous plate) Description
						0.5				MH	
	56				14	0.5					
			100	0			75				grades with some cobbles
						0.5					grades with friable sand, stiff to very stiff
LL=57 PI=21	53				17	0.5					
			100	0			80				grades with well-rounded coarse sand and pebbles, medium stiff
LL=62 PI=26	50				16	0.5					
			100	0			85				
	47				18	0.5					
			100	0			90				
LL=75 PI=38	48				15						grades to dark brown with multi-color mottling, stiff to very stiff
			52	0		3.5	95				
	53				15	2.5					grades to medium stiff
			100	0			100				
						0.5					grades to brown with extremely weathered friable subrounded to rounded gravel and cobbles, very stiff to hard
	48				30	2.0	105				

Date Started:	October 16, 2003	Water Level: ▽ Not Encountered	Plate
Date Completed:	October 20, 2003		
Logged By:	Y. Chiba	Drill Rig: CME-75	
Total Depth:	120 feet	Drilling Method: 4" Auger & HQ Coring	A - 8.3
Work Order:	5088-00(A) & 5088-10	Driving Energy: 140 lb. wt., 30 in. drop	

BORING_LOG 5088-00(A).GPJ GEOLABS.GDT 7/8/05

GEOLABS, INC.	INTERSTATE ROUTE H-1 REHAB., EB LANES	Log of Boring
Geotechnical Engineering	WAIAU INTERCHANGE TO KAIMAKANI STREET EWA, OAHU, HAWAII	8

Laboratory			Field								
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS	(Continued from previous plate) Description
			100	0						MH	
	53				13	2.0					grades to orangish brown with fine sand, stiff
			100	0			110				
	65				21	2.0					grades to dark brown with sand
			100	0			115				
	69				18	1.5					grades to brownish red with friable sand, very stiff
							120				Boring terminated at 120 feet
							125				
							130				
							135				
							140				

Date Started:	October 16, 2003	Water Level: ▽ Not Encountered	Plate
Date Completed:	October 20, 2003		
Logged By:	Y. Chiba	Drill Rig: CME-75	
Total Depth:	120 feet	Drilling Method: 4" Auger & HQ Coring	A - 8.4
Work Order:	5088-00(A) & 5088-10	Driving Energy: 140 lb. wt., 30 in. drop	

BORING_LOG 5088-00(A).GPJ GEOLABS.GDT 7/8/05

GEOLABS, INC.	INTERSTATE ROUTE H-1 REHAB., EB LANES	Log of Boring
Geotechnical Engineering	WAIAU INTERCHANGE TO KAIMAKANI STREET EWA, OAHU, HAWAII	9

Laboratory			Field							Approximate Ground Surface Elevation (feet MSL): 97.5 *
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	USCS	Description
										18-inch **ASPHALTIC CONCRETE**
										12-inch **BASE COURSE**
	24	81			51				CH	Brown **SILTY CLAY** with gravel, very stiff, damp (fill)
	23				30/.5' +20/.1' Ref.	4.5	5		GP	Gray **BOULDERS AND COBBLES** with sand, dense (fill)
	12				28		10		CH	Brown **SILTY CLAY** with gravel, very stiff (fill)
	4				25/.1' Ref.		15			grades with cobbles and boulders
	28		100		50/.1' Ref.	4.0	20			
			65				25			
							30		GP	Gray **BOULDERS AND COBBLES** in a silty clay matrix, very dense, damp (fill)
							35			

Date Started:	October 26, 2003	Water Level: ▽ 64 ft. 11/2/03 2145 HRS		Plate
Date Completed:	November 3, 2003			
Logged By:	S. Latronic	Drill Rig:	CME-75	
Total Depth:	119.5 feet	Drilling Method:	4" Auger & PQ Coring	A - 9.1
Work Order:	5088-00(A) & 5088-10	Driving Energy:	140 lb. wt., 30 in. drop	

BORING_LOG 5088-00(A).GPJ GEOLABS.GDT 7/11/05

GEOLABS, INC.

Geotechnical Engineering

INTERSTATE ROUTE H-1 REHAB., EB LANES
WAIAU INTERCHANGE TO KAIMAKANI STREET
EWA, OAHU, HAWAII

Log of Boring **9**

Laboratory			Field							
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS

(Continued from previous plate)

Description

Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	USCS	Description
			100				40	GP	
			95						
			45				45		
LL=63 PI=41	39				16	1.0	50	CH	Brownish gray **SILTY CLAY** with gravel, stiff to very stiff, moist to wet (recent alluvium)
			100			2.5			
			40			3.0	55		
	40				15		60		
			100					SM	Brown and black **SILTY SAND** with cobbles and boulders, medium dense to dense, moist to wet (river deposit)
			57				65		
							70		

Date Started:	October 26, 2003	Water Level: ▽ 64 ft. 11/2/03 2145 HRS	Plate
Date Completed:	November 3, 2003		
Logged By:	S. Latronic	Drill Rig: CME-75	
Total Depth:	119.5 feet	Drilling Method: 4" Auger & PQ Coring	A - 9.2
Work Order:	5088-00(A) & 5088-10	Driving Energy: 140 lb. wt., 30 in. drop	

BORING_LOG 5088-00(A).GPJ GEOLABS.GDT 7/11/05

GEOLABS, INC.	INTERSTATE ROUTE H-1 REHAB., EB LANES	Log of Boring
Geotechnical Engineering	WAIAU INTERCHANGE TO KAIMAKANI STREET EWA, OAHU, HAWAII	9

Laboratory			Field								
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS	(Continued from previous plate) Description
			80							SM	
			50				75				
			20				80				
										MH	Grayish brown **CLAYEY SILT,** very stiff, moist to wet (old alluvium)
	50				24		85				
			100								
			100				90				
			100	0			95				Dark gray **BASALT**, severely fractured, highly weathered, soft to medium hard (basalt formation)
			95	0			100				
							105				

Date Started:	October 26, 2003	Water Level: ▽ 64 ft. 11/2/03 2145 HRS	Plate
Date Completed:	November 3, 2003		
Logged By:	S. Latronic	Drill Rig: CME-75	
Total Depth:	119.5 feet	Drilling Method: 4" Auger & PQ Coring	A - 9.3
Work Order:	5088-00(A) & 5088-10	Driving Energy: 140 lb. wt., 30 in. drop	

BORING_LOG 5088-00(A).GPJ GEOLABS.GDT 7/11/05

GEOLABS, INC. Geotechnical Engineering	INTERSTATE ROUTE H-1 REHAB., EB LANES WAIAU INTERCHANGE TO KAIMAKANI STREET EWA, OAHU, HAWAII	Log of Boring 9

Laboratory			Field								
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS	(Continued from previous plate) Description
			93	0							
			95	20			110				
			100	0			115				grades to medium hard
							120				Boring terminated at 119.5 feet
							125				
							130				
							135				
							140				

Date Started:	October 26, 2003	Water Level: ▽	64 ft. 11/2/03 2145 HRS	Plate
Date Completed:	November 3, 2003			
Logged By:	S. Latronic	Drill Rig:	CME-75	
Total Depth:	119.5 feet	Drilling Method:	4" Auger & PQ Coring	A - 9.4
Work Order:	5088-00(A) & 5088-10	Driving Energy:	140 lb. wt., 30 in. drop	

BORING_LOG 5088-00(A).GPJ GEOLABS.GDT 7/11/05

GEOLABS, INC.

Geotechnical Engineering

INTERSTATE ROUTE H-1 REHAB., EB LANES
WAIAU INTERCHANGE TO KAIMAKANI STREET
EWA, OAHU, HAWAII

Log of Boring **10**

Laboratory			Field								
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS	Approximate Ground Surface Elevation (feet MSL): 95 * **Description**
											8-inch **ASPHALTIC CONCRETE**
											22-inch **BASE COURSE**
	18	92			42						
	22				19	>4.5				CH	Reddish brown with multi-color mottling **SILTY CLAY** with some gravel and sand, stiff to very stiff, damp (fill)
	27	91			41	>4.5	5				grades to very stiff to hard, moist
LL=56 PI=30	30				24		10				grades to very stiff
											grades with some cobbles
	24	83			54	>4.5	15				grades to hard, damp
	23				21		20				grades to very stiff, moist
	26	95			50	>4.5	25				grades to hard
	23				24		30			MH	Brown with red mottling **CLAYEY SILT** with some gravel, very stiff, damp (fill)
							35				

Date Started:	October 15, 2003	Water Level: ▽ Not Encountered	Plate
Date Completed:	October 17, 2003		
Logged By:	E. Shinsato	Drill Rig: CME-75	
Total Depth:	109.5 feet	Drilling Method: 4" Auger & PQ Coring	A - 10.1
Work Order:	5088-00(A) & 5088-10	Driving Energy: 140 lb. wt., 30 in. drop	

BORING_LOG 5088-00(A).GPJ GEOLABS.GDT 7/8/05

GEOLABS, INC. Geotechnical Engineering	INTERSTATE ROUTE H-1 REHAB., EB LANES WAIAU INTERCHANGE TO KAIMAKANI STREET EWA, OAHU, HAWAII	Log of Boring 10

Laboratory			Field							
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS	(Continued from previous plate) Description
	27	93			300-700 psi					MH	
	14	85	85		40/.3' Ref.					GM	Grayish brown with multi-color mottling **SILTY GRAVEL** with sand and some cobbles, very dense, damp
			83				40			CH	Reddish brown with multi-color mottling **SILTY CLAY** with basaltic gravel, stiff (fill)
	36				25		45				
			100								
	27	88	54		48/.5' Ref.		50				
										CH	Reddish brown with multi-color mottling **SILTY CLAY** with cobbles and gravel, hard (river deposit)
	27				25		55				
			90								grades with some organic odor
			20		25/.0' Ref.		60			GM	Grayish brown **SILTY GRAVEL** with some cobbles and sand, medium dense to dense (river deposit)
	26				21		65				
			57								grades with some basaltic boulders
					20/.0' Ref.		70				

Date Started:	October 15, 2003	Water Level: ▽ Not Encountered	Plate
Date Completed:	October 17, 2003		
Logged By:	E. Shinsato	Drill Rig: CME-75	
Total Depth:	109.5 feet	Drilling Method: 4" Auger & PQ Coring	A - 10.2
Work Order:	5088-00(A) & 5088-10	Driving Energy: 140 lb. wt., 30 in. drop	

BORING_LOG 5088-00(A).GPJ GEOLABS.GDT 7/8/05

GEOLABS, INC. Geotechnical Engineering	INTERSTATE ROUTE H-1 REHAB., EB LANES WAIAU INTERCHANGE TO KAIMAKANI STREET EWA, OAHU, HAWAII	Log of Boring 10

Laboratory			Field							
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS	(Continued from previous plate) Description
			37							GM	
	42				80		75			SM	Brownish gray **SILTY SAND,** very dense (river deposit)
			100	0							Grayish brown **BASALT**, severely fractured, moderately to highly weathered, soft to medium hard (basalt formation)
			100	0			80				
			97	48			85				Reddish gray **CLINKER** with red clay seams, severely fractured, highly weathered, medium hard (basalt formation)
			100	40			90				Reddish brown vesicular **BASALT**, closely fractured, moderately weathered, medium hard (basalt formation) grades to grayish brown, soft to medium hard at 87 feet grades to gray at 88.5 feet grades to dark gray
			50	0			95				grades to brown
			90	13			100				Reddish gray **CLINKER**, severely fractured, moderately to highly weathered, soft (basalt formation)
											Gray vugular **BASALT**, severely fractured, moderately weathered, medium hard (basalt formation)
											Reddish gray **CLINKER**, severely fractured, highly weathered, soft (basalt formation)
							105				

Date Started:	October 15, 2003	Water Level: ▽ Not Encountered	Plate
Date Completed:	October 17, 2003		
Logged By:	E. Shinsato	Drill Rig: CME-75	
Total Depth:	109.5 feet	Drilling Method: 4" Auger & PQ Coring	A - 10.3
Work Order:	5088-00(A) & 5088-10	Driving Energy: 140 lb. wt., 30 in. drop	

BORING_LOG 5088-00(A).GPJ GEOLABS.GDT 7/8/05

GEOLABS, INC. Geotechnical Engineering	INTERSTATE ROUTE H-1 REHAB., EB LANES WAIAU INTERCHANGE TO KAIMAKANI STREET EWA, OAHU, HAWAII	Log of Boring 10

Laboratory			Field								
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS	(Continued from previous plate) Description
			73	48							Reddish gray-brown with tan vesicular **BASALT**, closely to moderately fractured, moderately weathered, medium hard (basalt formation)
							110				Boring terminated at 109.5 feet
							115				
							120				
							125				
							130				
							135				
							140				

Date Started:	October 15, 2003	Water Level: ▽ Not Encountered	Plate
Date Completed:	October 17, 2003		
Logged By:	E. Shinsato	Drill Rig: CME-75	
Total Depth:	109.5 feet	Drilling Method: 4" Auger & PQ Coring	A - 10.4
Work Order:	5088-00(A) & 5088-10	Driving Energy: 140 lb. wt., 30 in. drop	

BORING_LOG 5088-00(A).GPJ GEOLABS.GDT 7/8/05

GEOLABS, INC. Geotechnical Engineering	INTERSTATE ROUTE H-1 REHAB., EB LANES WAIAU INTERCHANGE TO KAIMAKANI STREET EWA, OAHU, HAWAII	Log of Boring 11

Laboratory			Field							Approximate Ground Surface Elevation (feet MSL): 100 *
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	USCS	Description
										10.75-inch **ASPHALTIC CONCRETE**
										13.25-inch **BASE COURSE**
	24	93			29	>4.5			CH	Orangish red **SILTY CLAY** with sand and some gravel, hard, damp (fill)
	22				30	>4.5	5			grades with multi-color mottling
	25	82			21	>4.5	10			grades to very stiff
	18				19	4.0	20			grades to reddish brown
LL=55 PI=31	26	91			27	>4.5	30			grades to orangish brown with multi-color mottling, hard

Date Started:	October 29, 2003	Water Level: ▽ Not Encountered	Plate
Date Completed:	November 3, 2003		
Logged By:	Y. Chiba	Drill Rig: CME-75	
Total Depth:	123.3 feet	Drilling Method: 4" Auger & PQ Coring	A - 11.1
Work Order:	5088-00(A) & 5088-10	Driving Energy: 140 lb. wt., 30 in. drop	

BORING_LOG 5088-00(A).GPJ GEOLABS.GDT 7/8/05

GEOLABS, INC. Geotechnical Engineering	INTERSTATE ROUTE H-1 REHAB., EB LANES WAIAU INTERCHANGE TO KAIMAKANI STREET EWA, OAHU, HAWAII	Log of Boring 11

Laboratory			Field							
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS	(Continued from previous plate) Description
										CH	grades to dark brown with multi-color mottling, very stiff
	28				12	3.0	40				
										CL	Dark brown **SANDY SILT** with gravel, very stiff, moist to wet (alluvium)
	32	83			18	2.5	45				
										CH	Dark grayish brown **SILTY CLAY** with sand, subrounded pebbles and gravel, very stiff, wet (alluvium)
			55	0	15/.0' Ref.		50				
			58	0		3.0	55				
							60			SC	Brownish orange with multi-color mottling **CLAYEY SAND** with rounded pebbles and some gravel, hard, wet (river deposit)
	41	78			28	3.5					
			0	0						SM	Brown with multi-color mottling **SILTY SAND** with rounded pebbles and gravel, stiff, wet (river deposit)
							65				
	54				14	2.0					
			83	0						MH	Reddish brown **CLAYEY SILT** with sand, subrounded cobbles and pebbles, medium stiff, wet (river deposit)
							70				

Date Started:	October 29, 2003	Water Level: ▽ Not Encountered	Plate
Date Completed:	November 3, 2003		
Logged By:	Y. Chiba	Drill Rig: CME-75	
Total Depth:	123.3 feet	Drilling Method: 4" Auger & PQ Coring	A - 11.2
Work Order:	5088-00(A) & 5088-10	Driving Energy: 140 lb. wt., 30 in. drop	

BORING_LOG 5088-00(A).GPJ GEOLABS.GDT 7/8/05

GEOLABS, INC.	INTERSTATE ROUTE H-1 REHAB., EB LANES	Log of Boring
Geotechnical Engineering	WAIAU INTERCHANGE TO KAIMAKANI STREET EWA, OAHU, HAWAII	11

Laboratory			Field							
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS	(Continued from previous plate) Description
	43	78	100	0	28		75			MH	grades to brownish gray with multi-color mottling, very stiff
LL=82 PI=40	47		100	0	15		80				grades to stiff
	55	65	76	0	38	2.0	85				grades to stiff to very stiff
	70		0	0	12		90			SM	Orange **SILTY SAND** with gravel, medium dense, wet (river deposit)
	52	64	100	0	30	2.0	95				grades to brown with pebbles
			100	33	10/.3' Ref.	2.0	100				Gray with dark brown mottling dense to vesicular **BASALT**, moderately fractured, highly weathered, medium hard (basalt formation)
	62	56	100	0	30		105				grades to severely fractured, extremely weathered, soft

Date Started:	October 29, 2003	Water Level: ▽ Not Encountered	Plate
Date Completed:	November 3, 2003		
Logged By:	Y. Chiba	Drill Rig: CME-75	
Total Depth:	123.3 feet	Drilling Method: 4" Auger & PQ Coring	A - 11.3
Work Order:	5088-00(A) & 5088-10	Driving Energy: 140 lb. wt., 30 in. drop	

BORING_LOG 5088-00(A).GPJ GEOLABS.GDT 7/8/05

GEOLABS, INC.	INTERSTATE ROUTE H-1 REHAB., EB LANES	Log of Boring
Geotechnical Engineering	WAIAU INTERCHANGE TO KAIMAKANI STREET EWA, OAHU, HAWAII	11

Laboratory			Field								
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS	Description
											(Continued from previous plate)
	29		100	0	45/.4' Ref.		110				grades to dark brown with multi-color mottling, extremely to highly weathered
	13		35	0	18/.3' Ref.						grades to vesicular to scoriaceous
			100	14	10/.1' Ref.		115				grades to extremely weathered
	18				25/.3' Ref.		120				grades to dark gray scoriaceous to dense, moderately fractured, highly to moderately weathered, hard
							125				Boring terminated at 123.3 feet
							130				
							135				
							140				

Date Started:	October 29, 2003	Water Level: ▽ Not Encountered	Plate
Date Completed:	November 3, 2003		
Logged By:	Y. Chiba	Drill Rig: CME-75	
Total Depth:	123.3 feet	Drilling Method: 4" Auger & PQ Coring	A - 11.4
Work Order:	5088-00(A) & 5088-10	Driving Energy: 140 lb. wt., 30 in. drop	

BORING_LOG 5088-00(A).GPJ GEOLABS.GDT 7/8/05

GEOLABS, INC. Geotechnical Engineering	INTERSTATE ROUTE H-1 REHAB., EB LANES WAIAU INTERCHANGE TO KAIMAKANI STREET EWA, OAHU, HAWAII	Log of Boring 12

Laboratory			Field				Depth (feet)	Sample	Graphic	USCS	Approximate Ground Surface Elevation (feet MSL): 80 *
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)					Description
											1-inch **ASPHALTIC CONCRETE**
											10-inch **CONCRETE**
										MH	7-inch **BASE COURSE**
	23	89			49						Brown **CLAYEY SILT** with sand and gravel, hard, damp (fill)
	26				24	3.5				CH	Brown **SILTY CLAY** with sand and gravel, very stiff, damp (fill)
	24	86			75		5				grades to very hard
											COBBLE
LL=57 PI=29	24				43	3.5	10				
											COBBLE grades with subrounded gravel
	30	84			20	1.5	15				grades to very stiff, moist
	21				27		20				
			100	85	20/.0' Ref.		25				Gray dense **BASALT**, widely fractured, slightly weathered, hard to very hard (basalt formation)
											grades to vugular
			90	70			30				
							35				

Date Started:	October 23, 2003	Water Level: ▽ Not Encountered	Plate
Date Completed:	October 23, 2003		
Logged By:	S. Latronic	Drill Rig: CME-75	
Total Depth:	45 feet	Drilling Method: 4" Auger & PQ Coring	A - 12.1
Work Order:	5088-00(A) & 5088-10	Driving Energy: 140 lb. wt., 30 in. drop	

BORING_LOG 5088-00(A).GPJ GEOLABS.GDT 7/8/05

GEOLABS, INC.	INTERSTATE ROUTE H-1 REHAB., EB LANES WAIAU INTERCHANGE TO KAIMAKANI STREET EWA, OAHU, HAWAII	Log of Boring 12
Geotechnical Engineering		

Laboratory			Field							
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS

(Continued from previous plate)

Description

Core Recovery (%)	RQD (%)	Depth (feet)	Description
80	33		Reddish gray **CLINKER**, severely fractured, highly weathered, soft (basalt formation)
		40	Gray dense vugular **BASALT**, moderately fractured, slightly weathered, hard to very hard (basalt formation)
68	0		Reddish gray **CLINKER**, severely fractured, moderately weathered, medium hard (basalt formation)
		45	Boring terminated at 45 feet
		50	
		55	
		60	
		65	
		70	

Date Started:	October 23, 2003	Water Level: ▽ Not Encountered	Plate
Date Completed:	October 23, 2003		
Logged By:	S. Latronic	Drill Rig: CME-75	
Total Depth:	45 feet	Drilling Method: 4" Auger & PQ Coring	A - 12.2
Work Order:	5088-00(A) & 5088-10	Driving Energy: 140 lb. wt., 30 in. drop	

BORING_LOG 5088-00(A).GPJ GEOLABS.GDT 7/8/05

GEOLABS, INC.

Geotechnical Engineering

INTERSTATE ROUTE H-1 REHAB., EB LANES
WAIAU INTERCHANGE TO KAIMAKANI STREET
EWA, OAHU, HAWAII

Log of Boring **13**

Laboratory			Field							
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS

Approximate Ground Surface Elevation (feet MSL): 80 *

Description

Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	USCS	Description
								10-inch **CONCRETE**
	15	102			20			14-inch **BASE COURSE**
	35				15	4.0	CH	Brown **SILTY CLAY** with sand and gravel, very stiff to stiff, moist to wet (new fill)
	35	81			18	1.5		
							CH	Brown **SILTY CLAY** with sand and some gravel, stiff to very stiff, damp (old fill)
	24				19	1.5		
	21	83			15	1.5		grades to dark brown with multi-color mottling, with some cobbles and concrete fragments
LL=56 PI=32	30				7	1.5		grades to medium stiff, moist
			94	71				Gray dense **BASALT**, moderately fractured, moderately weathered, hard (basalt formation)
								grades to vesicular, slightly weathered, very hard
			87	73				grades to brown with gray mottling scoriaceous, medium dense
								grades to gray dense, moderately to slightly weathered, very hard

Date Started:	November 3, 2003	Water Level: ▽ Not Encountered	Plate
Date Completed:	November 4, 2003		
Logged By:	Y. Chiba	Drill Rig: CME-75	
Total Depth:	61 feet	Drilling Method: 4" Auger & PQ Coring	A - 13.1
Work Order:	5088-00(A) & 5088-10	Driving Energy: 140 lb. wt., 30 in. drop	

BORING_LOG 5088-00(A).GPJ GEOLABS.GDT 7/8/05

GEOLABS, INC. Geotechnical Engineering	INTERSTATE ROUTE H-1 REHAB., EB LANES WAIAU INTERCHANGE TO KAIMAKANI STREET EWA, OAHU, HAWAII	Log of Boring 13

Laboratory			Field							
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS

(Continued from previous plate)

Description

Core Recovery (%)	RQD (%)	Moisture Content (%)	Penetration Resistance (blows/foot)	Depth (feet)	Description
42	12				Brownish gray with multi-color mottling **CLINKER**, moderately fractured, extremely weathered, medium hard (basalt formation)
100	100			40	Gray vesicular **BASALT**, slightly fractured, slightly weathered, very hard (basalt formation)
38	8			45	Brown with multi-color mottling **CLINKER**, severely fractured, extremely to highly weathered, medium hard (basalt formation)
		39	15	50	
100	29				
100	95		15/.0' Ref.	55	Gray vesicular **BASALT**, moderately fractured, moderately weathered, very hard (basalt formation)
				60	Boring terminated at 61 feet
				65	
				70	

Date Started:	November 3, 2003	Water Level: ▽ Not Encountered	Plate
Date Completed:	November 4, 2003		
Logged By:	Y. Chiba	Drill Rig: CME-75	
Total Depth:	61 feet	Drilling Method: 4" Auger & PQ Coring	A - 13.2
Work Order:	5088-00(A) & 5088-10	Driving Energy: 140 lb. wt., 30 in. drop	

BORING_LOG 5088-00(A).GPJ GEOLABS.GDT 7/8/05

GEOLABS, INC.	INTERSTATE ROUTE H-1 REHAB., EB LANES WAIAU INTERCHANGE TO KAIMAKANI STREET EWA, OAHU, HAWAII	Log of Boring 14

Geotechnical Engineering

Laboratory			Field				Depth (feet)	Sample	Graphic	USCS	Approximate Ground Surface Elevation (feet MSL): 77.5 *
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)					**Description**
							0				1-inch **ASPHALTIC CONCRETE**
											11-inch **CONCRETE**
	30	83			25					CH	6-inch **BASE COURSE**
											Brown **SILTY CLAY** with gravel, very stiff, moist (fill)
	24				34	2.5					grades to hard, damp
							5				
	31	84			23	1.0					**COBBLE**
											grades to very stiff, moist
	30				16		10				
	31	88			10	1.5	15				grades to grayish brown, stiff
	22				67		20				grades to brown with sand, very hard
											Brownish gray vesicular **BASALT**, severely fractured, moderately weathered, hard (basalt formation)
			100	30	25/.0' Ref.		25				grades to gray dense, moderately fractured, slightly weathered, hard to very hard
			95	58			30				Grayish brown **CLINKER**, severely fractured, completely weathered, soft (basalt formation)
											Gray vesicular **BASALT**, widely fractured, slightly to moderately weathered, hard (basalt formation)
							35				

Date Started:	October 22, 2003	Water Level: ▽ Not Encountered	Plate
Date Completed:	October 22, 2003		
Logged By:	S. Latronic	Drill Rig: CME-75	
Total Depth:	45 feet	Drilling Method: 4" Auger & PQ Coring	A - 14.1
Work Order:	5088-00(A) & 5088-10	Driving Energy: 140 lb. wt., 30 in. drop	

BORING_LOG 5088-00(A).GPJ GEOLABS.GDT 7/8/05

GEOLABS, INC.	INTERSTATE ROUTE H-1 REHAB., EB LANES WAIAU INTERCHANGE TO KAIMAKANI STREET EWA, OAHU, HAWAII	Log of Boring 14
Geotechnical Engineering		

Laboratory			Field							
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS

(Continued from previous plate)

Description

60	30	Reddish gray **CLINKER**, severely fractured, highly weathered, soft (basalt formation)
55	50	Gray dense to vugular **BASALT**, moderately fractured, slightly weathered, hard to very hard (basalt formation)
		Reddish gray **CLINKER**, severely fractured, highly weathered, soft (basalt formation)
		Boring terminated at 45 feet

40 45 50 55 60 65 70

Date Started:	October 22, 2003	Water Level: ▽ Not Encountered	Plate
Date Completed:	October 22, 2003		
Logged By:	S. Latronic	Drill Rig: CME-75	
Total Depth:	45 feet	Drilling Method: 4" Auger & PQ Coring	A - 14.2
Work Order:	5088-00(A) & 5088-10	Driving Energy: 140 lb. wt., 30 in. drop	

BORING_LOG 5088-00(A).GPJ GEOLABS.GDT 7/8/05

GEOLABS, INC.

Geotechnical Engineering

INTERSTATE ROUTE H-1 REHAB., EB LANES
WAIAU INTERCHANGE TO KAIMAKANI STREET
EWA, OAHU, HAWAII

Log of Boring **15**

Approximate Ground Surface Elevation (feet MSL): 62.1 *

Laboratory: Other Tests	Laboratory: Moisture Content (%)	Laboratory: Dry Density (pcf)	Field: Core Recovery (%)	Field: RQD (%)	Field: Penetration Resistance (blows/foot)	Field: Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS	Description
											1-inch **ASPHALTIC CONCRETE** overlay
											12-inch **CONCRETE**
					7	0.5				GW / CH	Grayish brown **SANDY BASALTIC GRAVEL** in a silt matrix, medium dense, damp (base course)
										CH	Brown **SILTY CLAY** with sand and some organic fragments, very soft, moist (fill)
					7	<0.5	5				Brown with multi-color mottling **SILTY CLAY** with rounded coarse sand and gravel, very soft, moist (alluvium)
					2	1.0	10				grades to medium stiff
										CL	Brown **SANDY CLAY** with rounded gravel and some silt, very soft
					4	<0.5	15				
											grades with debris
					30/.3' Ref.		20				Boring terminated at 20.3 feet
											Boring was backfilled by bentonite capped with black top.
							25				*Elevations estimated from Topographic Map transmitted by Parsons Brinckerhoff on June 13, 2005.
							30				
							35				

Date Started:	May 19, 2005	Water Level: ▽ 14.8 ft. 5/19/05 1405 HRS	Plate
Date Completed:	May 19, 2005		
Logged By:	Y. Chiba	Drill Rig: CME-75	
Total Depth:	20.3 feet	Drilling Method: 4" Concrete Core & 4" Auger	A - 15
Work Order:	5088-00(A) & 5088-10	Driving Energy: 140 lb. wt., 30 in. drop	

BORING_LOG 5088-10.GPJ GEOLABS.GDT 7/8/05

GEOLABS, INC.	INTERSTATE ROUTE H-1 REHAB., EB LANES WAIAU INTERCHANGE TO KAIMAKANI STREET EWA, OAHU, HAWAII	Log of Boring 16
Geotechnical Engineering		

Laboratory			Field				Depth (feet)	Sample	Graphic	USCS	Approximate Ground Surface Elevation (feet MSL): 62.2 *
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)					**Description**
											4.75-inch **ASPHALTIC CONCRETE** overlay
											4.5-inch **ASPHALTIC CONCRETE**
					21					GM	4-inch **PERMEABLE BASE**
					29	0.5				CL	Grayish dark brown **SILTY BASALTIC GRAVEL AND SAND,** medium dense (base course)
					27		5			GW	Brown with multi-color mottling **SANDY CLAY** with well-rounded coarse sand and gravel, medium stiff, damp (alluvium)
											Brown with multi-color mottling well-rounded **SANDY BASALTIC GRAVEL** in a silty clay matrix with some cobbles, medium dense, moist
											grades with boulders and cobbles at 7.6 feet
					37	>4.5	10			CH	Brown with multi-color mottling **SILTY CLAY** with some coarse sand, very hard, damp (alluvium)
											grades to brown with black and gray mottling
					56	>4.5	15				
										ML	Brown with multi-color mottling **SANDY SILT** with clay and highly weathered basaltic gravel and cobbles, very stiff, damp (alluvium)
					48/.3' Ref.		20				Boring terminated at 20.8 feet
											Boring was backfilled by bentonite capped with black top.
							25				
							30				
							35				

Date Started:	May 19, 2005	Water Level: ▽ Not Encountered	Plate
Date Completed:	May 19, 2005		
Logged By:	Y. Chiba	Drill Rig: CME-75	
Total Depth:	20.8 feet	Drilling Method: 4" Concrete Core & 4" Auger	A - 16
Work Order:	5088-00(A) & 5088-10	Driving Energy: 140 lb. wt., 30 in. drop	

BORING_LOG 5088-10.GPJ GEOLABS.GDT 7/8/05

GEOLABS, INC.	INTERSTATE ROUTE H-1 REHAB., EB LANES WAIAU INTERCHANGE TO KAIMAKANI STREET EWA, OAHU, HAWAII	Log of Boring 17
Geotechnical Engineering		

Laboratory			Field				Depth (feet)	Sample	Graphic	USCS	Approximate Ground Surface Elevation (feet MSL): 61.1 *
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)					**Description**
											1-inch **ASPHALTIC CONCRETE** overlay
											10-inch **CONCRETE**
					21					GW	4.5-inch **PERMEABLE BASE**
					19	1.5				CL	Grayish brown **BASALTIC SANDY GRAVEL** in a silt matrix, medium dense, damp (base course)
					46	4.0	5				Brown with multi-color mottling fine friable **SANDY CLAY** with basaltic gravel and some cobbles, very stiff, damp (fill)
											grades to hard at 5.2 feet
										CH	Brown with multi-color mottling **SILTY CLAY** with basaltic gravel, hard, damp (fill)
					9	3.5	10				
					9	<0.5	15			CL	Dark brown with multi-color mottling fine **SANDY CLAY** with some basaltic gravel, soft, moist (alluvium)
											VOID
					60/.5' +20/.3' Ref.		20			GW	Orangish brown with multi-color mottling **SANDY ROUNDED HIGHLY WEATHERED BASALTIC GRAVEL AND COBBLES** in a silt matrix, very dense, wet (alluvium)
											Boring terminated at 21.3 feet
							25				Boring was backfilled by bentonite capped with black top.
							30				
							35				

Date Started:	May 20, 2005	Water Level: ▽ Not Encountered		Plate
Date Completed:	May 20, 2005			
Logged By:	Y. Chiba	Drill Rig:	CME-75	
Total Depth:	21.3 feet	Drilling Method:	4" Concrete Core & 4" Auger	A - 17
Work Order:	5088-00(A) & 5088-10	Driving Energy:	140 lb. wt., 30 in. drop	

BORING_LOG 5088-10.GPJ GEOLABS.GDT 7/8/05

GEOLABS, INC.	INTERSTATE ROUTE H-1 REHAB., EB LANES	Log of Boring
Geotechnical Engineering	WAIAU INTERCHANGE TO KAIMAKANI STREET EWA, OAHU, HAWAII	18

Laboratory			Field								
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS	Description
											Approximate Ground Surface Elevation (feet MSL): 61.2 *
											Description
					15	1.5				GW	3-inch **ASPHALTIC CONCRETE** overlay 3.25-inch **ASPHALTIC CONCRETE** overlay
					6					CH	4-inch **ASPHALTIC CONCRETE** Gray **BASALTIC SANDY GRAVEL,** medium dense, damp (base course)
					14	0.5	5				Brown **SILTY CLAY** with sand, medium stiff, moist (fill) grades to soft at 3 feet grades with some subrounded basaltic gravel at 4.7 feet
										CL	Orangish brown with multi-color mottling highly weathered **BASALTIC GRAVELLY CLAY AND SAND,** very stiff, damp (alluvium)
					20/.3' Ref.		10				
										CL	Brownish orange with multi-color mottling **SANDY CLAY** with rounded highly weathered basaltic coarse sand and gravel with some boulders, very stiff, moist (alluvium)
					47	2.0	15				
					30	2.0	20				
											Boring terminated at 21.5 feet Boring was backfilled by bentonite capped with black top.
							25				
							30				
							35				

Date Started:	May 20, 2005	Water Level: ▽ Not Encountered	Plate
Date Completed:	May 20, 2005		
Logged By:	Y. Chiba	Drill Rig: CME-75	
Total Depth:	21.5 feet	Drilling Method: 4" Concrete Core & 4" Auger	A - 18
Work Order:	5088-00(A) & 5088-10	Driving Energy: 140 lb. wt., 30 in. drop	

BORING_LOG 5088-10.GPJ GEOLABS.GDT 7/8/05

GEOLABS, INC.	INTERSTATE ROUTE H-1 REHAB., EB LANES WAIAU INTERCHANGE TO KAIMAKANI STREET EWA, OAHU, HAWAII	Log of Boring 101
Geotechnical Engineering		

Laboratory			Field				Depth (feet)	Sample	Graphic	USCS	Approximate Ground Surface Elevation (feet MSL): 103.3 *
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)					**Description**
											12.75-inch **ASPHALTIC CONCRETE**
											9.75-inch **CONCRETE**
										GW	Gray with brown mottling densely cemented **SANDY GRAVEL** with silt, dense
											Boring terminated at 2.2 feet
							5				
							10				

Date Started:	October 24, 2003	Water Level: ▽ Not Encountered		Plate
Date Completed:	October 24, 2003			
Logged By:	Y. Chiba	Drill Rig:	CME-75	A - 19
Total Depth:	2.2 feet	Drilling Method:	5" Concrete Core	
Work Order:	5088-00(A) & 5088-10	Driving Energy:	140 lb. wt., 30 in. drop	

BORING_LOG 5088-00(A).GPJ GEOLABS.GDT 7/8/05

GEOLABS, INC. Geotechnical Engineering	INTERSTATE ROUTE H-1 REHAB., EB LANES WAIAU INTERCHANGE TO KAIMAKANI STREET EWA, OAHU, HAWAII	Log of Boring 102

Laboratory			Field								
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS	Approximate Ground Surface Elevation (feet MSL): 102.6 * Description
											10.63-inch **ASPHALTIC CONCRETE**
											9.38-inch **CONCRETE**
											Boring terminated at 1.7 feet
							5				
							10				

Date Started:	October 24, 2003	Water Level: ▽ Not Encountered		Plate
Date Completed:	October 24, 2003			
Logged By:	Y. Chiba	Drill Rig:	CME-75	
Total Depth:	1.7 feet	Drilling Method:	5" Concrete Core	A - 20
Work Order:	5088-00(A) & 5088-10	Driving Energy:	140 lb. wt., 30 in. drop	

BORING_LOG 5088-00(A).GPJ GEOLABS.GDT 7/8/05

GEOLABS, INC. Geotechnical Engineering	INTERSTATE ROUTE H-1 REHAB., EB LANES WAIAU INTERCHANGE TO KAIMAKANI STREET EWA, OAHU, HAWAII	Log of Boring 103

Laboratory			Field							
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS

Approximate Ground Surface Elevation (feet MSL): 93.9 *

Description

4-inch **ASPHALTIC CONCRETE**

9.25-inch **CONCRETE**

Boring terminated at 1.1 feet

5

10

Date Started:	October 23, 2003	Water Level: ▽ Not Encountered	Plate
Date Completed:	October 23, 2003		
Logged By:	Y. Chiba	Drill Rig: CME-75	A - 21
Total Depth:	1.1 feet	Drilling Method: 5" Concrete Core	
Work Order:	5088-00(A) & 5088-10	Driving Energy: 140 lb. wt., 30 in. drop	

BORING_LOG 5088-00(A).GPJ GEOLABS.GDT 7/8/05

GEOLABS, INC.	INTERSTATE ROUTE H-1 REHAB., EB LANES	Log of Boring
Geotechnical Engineering	WAIAU INTERCHANGE TO KAIMAKANI STREET EWA, OAHU, HAWAII	104

Laboratory			Field								Approximate Ground Surface Elevation (feet MSL): 96 *
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS	Description
											3-inch **ASPHALTIC CONCRETE**
											9.13-inch **CONCRETE**
											Boring terminated at 1 feet
							5				
							10				

Date Started:	October 23, 2003	Water Level: ▽ Not Encountered	Plate
Date Completed:	October 23, 2003		
Logged By:	Y. Chiba	Drill Rig: CME-75	A - 22
Total Depth:	1 feet	Drilling Method: 5" Concrete Core	
Work Order:	5088-00(A) & 5088-10	Driving Energy: 140 lb. wt., 30 in. drop	

BORING_LOG 5088-00(A).GPJ GEOLABS.GDT 7/8/05

GEOLABS, INC. Geotechnical Engineering	INTERSTATE ROUTE H-1 REHAB., EB LANES WAIAU INTERCHANGE TO KAIMAKANI STREET EWA, OAHU, HAWAII	Log of Boring 105

Laboratory			Field				Depth (feet)	Sample	Graphic	USCS	Approximate Ground Surface Elevation (feet MSL): 104.2 *
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)					**Description**
											17-inch **ASPHALTIC CONCRETE**
										GW	**BASE COURSE**
											Boring terminated at 1.8 feet
							5				
							10				

Date Started:	November 3, 2003	Water Level: ▽ Not Encountered	Plate
Date Completed:	November 3, 2003		
Logged By:	S. Latronic	Drill Rig: CME-75	A - 23
Total Depth:	1.8 feet	Drilling Method: 4.5" Concrete Core	
Work Order:	5088-00(A) & 5088-10	Driving Energy: 140 lb. wt., 30 in. drop	

BORING_LOG 5088-00(A).GPJ GEOLABS.GDT 7/8/05

GEOLABS, INC.	INTERSTATE ROUTE H-1 REHAB., EB LANES WAIAU INTERCHANGE TO KAIMAKANI STREET EWA, OAHU, HAWAII	Log of Boring 106
Geotechnical Engineering		

Laboratory			Field								Approximate Ground Surface Elevation (feet MSL): 103.7 *
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS	Description
											14-inch **ASPHALTIC CONCRETE**
										GW	**BASE COURSE**
											Boring terminated at 1.5 feet
							5				
							10				

Date Started:	November 3, 2003	Water Level: ▽ Not Encountered		Plate
Date Completed:	November 3, 2003			
Logged By:	S. Latronic	Drill Rig:	CME-75	A - 24
Total Depth:	1.5 feet	Drilling Method:	4.5" Concrete Core	
Work Order:	5088-00(A) & 5088-10	Driving Energy:	140 lb. wt., 30 in. drop	

BORING_LOG 5088-00(A).GPJ GEOLABS.GDT 7/8/05

GEOLABS, INC. Geotechnical Engineering	INTERSTATE ROUTE H-1 REHAB., EB LANES WAIAU INTERCHANGE TO KAIMAKANI STREET EWA, OAHU, HAWAII	Log of Boring 107

Laboratory			Field								
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS	Approximate Ground Surface Elevation (feet MSL): 62.1 * Description
											1.75-inch **ASPHALTIC CONCRETE** overlay
											9.25-inch **CONCRETE**
											6-inch **PERMEABLE BASE**
					40					GW	Dark grayish brown with multi-color mottling **SANDY BASALTIC GRAVEL** in a silty clay matrix with friable gravel, dense (base course)
							5				Boring terminated at 3 feet Boring was backfilled by bentonite capped with black top.
							10				

Date Started:	May 19, 2005	Water Level: ▽ Not Encountered	Plate
Date Completed:	May 19, 2005		
Logged By:	Y. Chiba	Drill Rig: CME-75	
Total Depth:	3 feet	Drilling Method: 4" Concrete Core	A - 25
Work Order:	5088-00(A) & 5088-10	Driving Energy: 140 lb. wt., 30 in. drop	

BORING_LOG 5088-10.GPJ GEOLABS.GDT 7/8/05

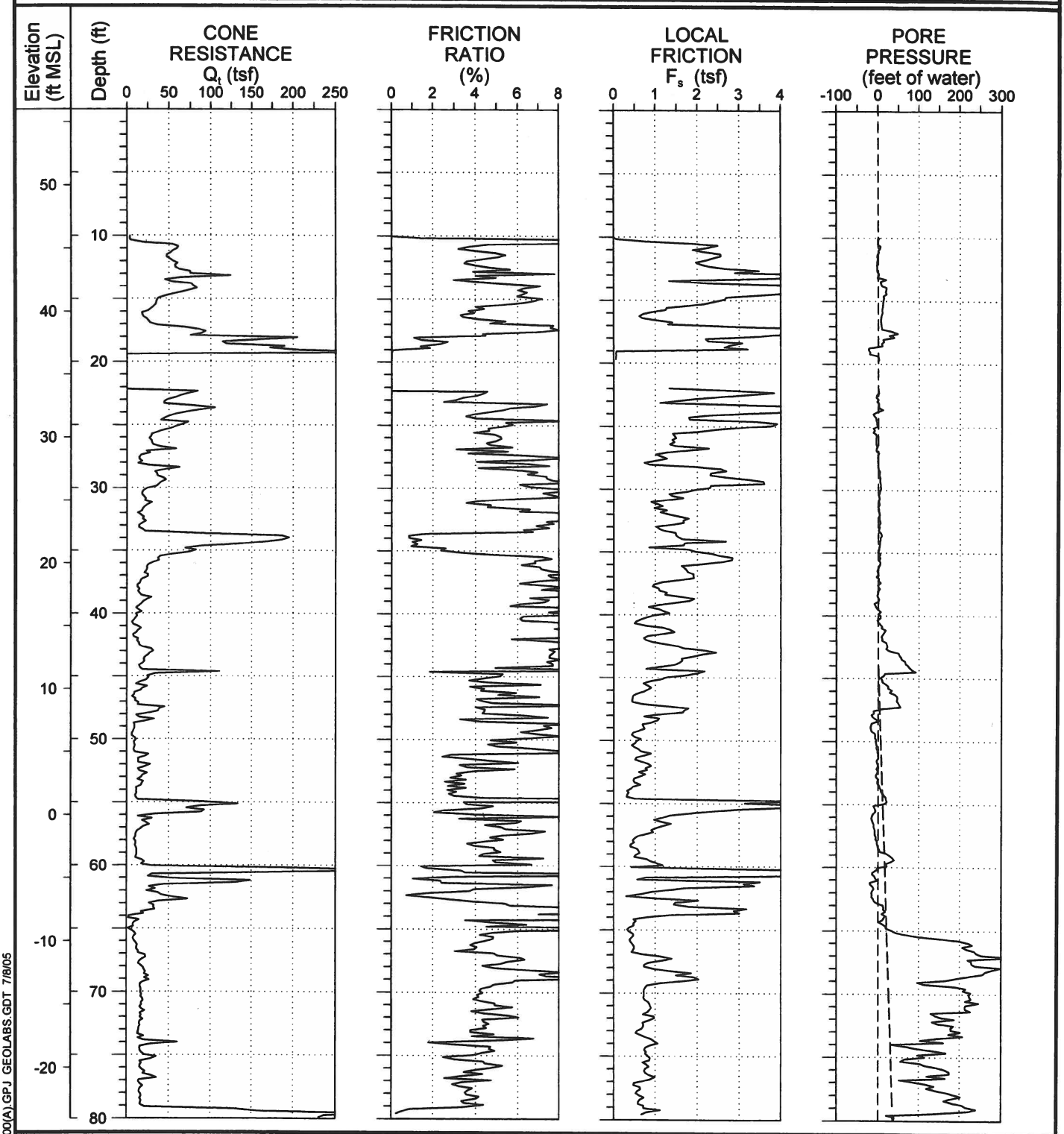
GEOLABS, INC.	INTERSTATE ROUTE H-1 REHAB., EB LANES	Log of Boring
Geotechnical Engineering	WAIAU INTERCHANGE TO KAIMAKANI STREET EWA, OAHU, HAWAII	108

Laboratory			Field								Approximate Ground Surface Elevation (feet MSL): 61.2 *
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS	Description
											1-inch **ASPHALTIC CONCRETE** overlay 9.25-inch **CONCRETE**
											5-inch **PERMEABLE BASE**
					20/.4' Ref.					GW	Brownish gray **SANDY BASALTIC GRAVEL** in a silt matrix, dense, damp (base course)
						2.0				CH	Brown with gray mottling **SILTY CLAY** with basaltic gravel, very stiff, damp
											Boring terminated at 2.4 feet
											Boring was backfilled by bentonite capped with black top.
							5				
							10				

Date Started:	May 20, 2005	Water Level: ▽ Not Encountered	Plate
Date Completed:	May 20, 2005		
Logged By:	Y. Chiba	Drill Rig: CME-75	
Total Depth:	2.4 feet	Drilling Method: 4" Concrete Core	A - 26
Work Order:	5088-00(A) & 5088-10	Driving Energy: 140 lb. wt., 30 in. drop	

BORING_LOG 5088-10.GPJ GEOLABS.GDT 7/8/05

GEOLABS, INC.	INTERSTATE ROUTE H-1 REHAB., EB LANES	DATA PLOT
Geotechnical Engineering	WAIAU INTERCHANGE TO KAIMAKANI STREET	CPT
	EWA, OAHU, HAWAII	



Date Started:	October 24, 2003	Water Level: 44 ft. HRS	PLATE
Date Completed:	October 24, 2003		
Logged By:	B. Chang	Drill Rig: MOBILE B-90	
Total Depth:	79.89 feet	Drilling Method: 4" Auger & CPT	A - 27
Work Order:	5088-00(A) & 5088-10	Approx. Ground Surface Elevation: 56 feet MSL	

CPT LOG LETTER 5088-00(A).GPJ GEOLABS.GDT 7/8/05

APPENDIX B

Laboratory Testing

APPENDIX B

Laboratory Testing

Moisture Content (ASTM D 2216) and Unit Weight (ASTM D 2937) determinations were performed on selected soil samples as an aid in the classification and evaluation of soil properties. The results of these tests are presented on the Logs of Borings at the appropriate sample depths.

Twenty-five Atterberg Limits tests (ASTM D 4318) were performed on selected samples of the soils to evaluate the liquid and plastic limits and to aid in soil classification. Results of the tests are summarized on the Logs of Borings at the appropriate sample depths. Graphic presentations of the test results are provided on Plates B-1.1 through B-1.3.

Seven Consolidation tests (ASTM Test Designation D 2435) were performed on selected silty and clayey soil samples to evaluate the compressibility characteristics of the on-site compressible soils. The test results are presented on Plates B-2.1 through B-2.7.

The Conventional Consolidation tests were modified to evaluate the compressibility characteristics of the in-situ soil samples under surcharge load equal to approximate over-burden earth pressures. The soil sample is allowed to settle until it has stabilized under a surcharge load. Water is then added to the soil sample to evaluate its collapse or swell potential in a saturated condition. Nineteen modified consolidation tests were performed, and the test results are presented on Plates B-3.1 through 3.4.

One Unconsolidated Undrained Triaxial Compression (TXUU) test (ASTM Test Designation D 2850) was performed on a selected soil sample to evaluate the undrained shear strength of the silty and clayey soils encountered. The approximate in-situ effective overburden pressure was used as the applied confining pressure for the relatively "undisturbed" soil sample. The test results and the stress-strain curve are presented on Plate B-4.

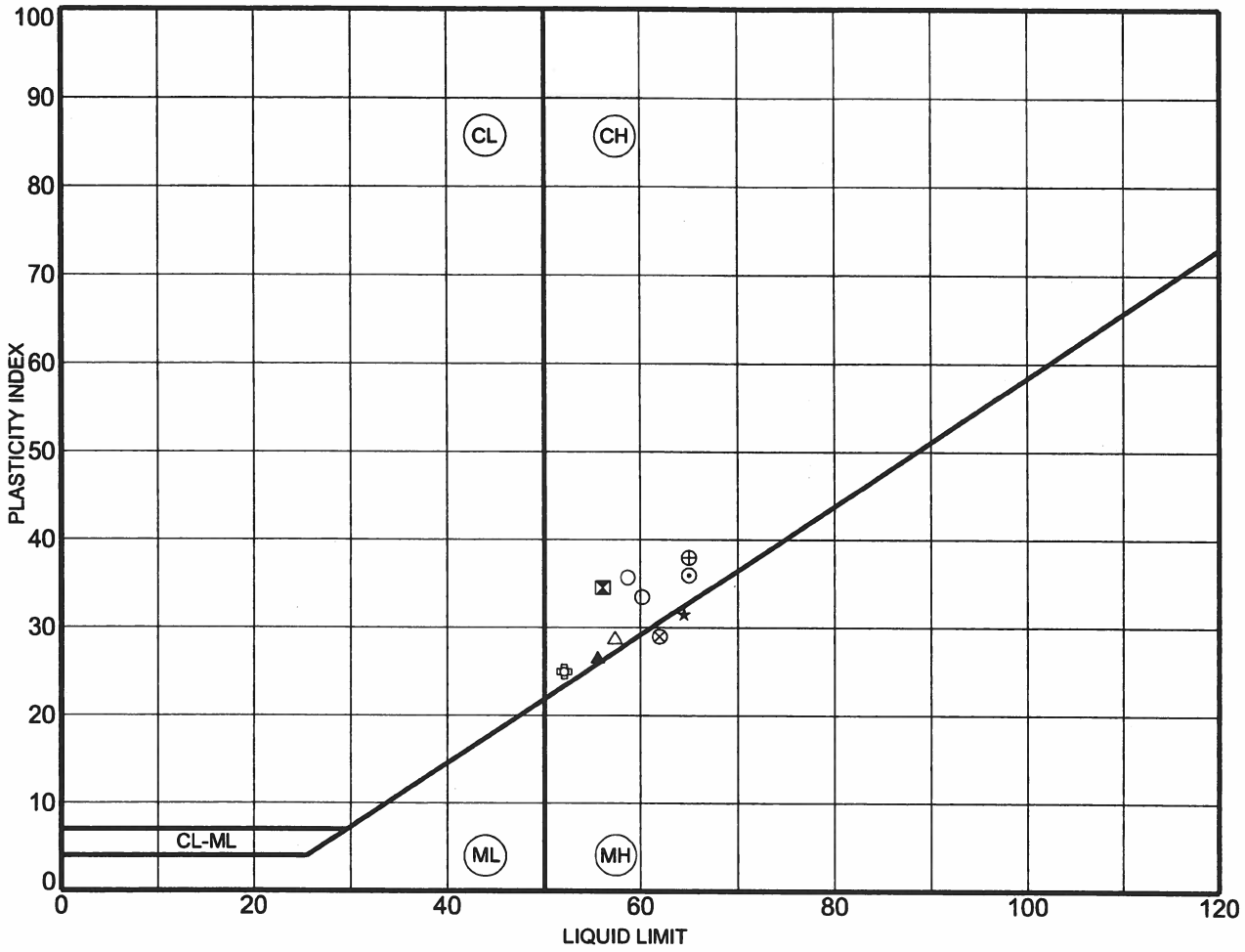
Three Sieve Analysis Tests (ASTM C 117 & C 136) were performed on selected soil samples to evaluate the gradation characteristics of the soils and to aid in soil classification. Graphic presentation of the grain size distribution is provided on Plate B-5.

Four California Bearing Ratio (CBR) tests (ASTM D 1883) were performed on the bulk samples to evaluate the strength characteristics for pavement subgrade support. Results of the CBR test are presented on Plates B-6.1 through B-6.4.

Three Modified Proctor tests (ASTM D 1557) were performed on bulk samples to evaluate the relationship between the moisture content and the dry density of the soil. Results of the test are presented on Plates B-7.1 through B-7.3.

Twenty-nine Specific Gravity tests (ASTM D 854) were performed on selected soil samples to determine the specific gravity of soil solids that pass the 4.75-mm (No. 4) sieve, by means of a water pycnometer. The specific gravity of soil solids is the ratio of the mass of a unit volume of a soil solid to the mass of the same volume of gas-free distilled water at 20°C. Results of the tests are summarized on Plate B-8.

[h:\5000 Series\5088-00(A) & 5088-10.jc1 – p.49]



	Sample	Depth (ft)	LL	PL	PI	Description
●	B-1	2.5 - 4.0	59	23	36	Brown w/ multi-color mottling SILTY CLAY (CH) w/ sand & gravel
⊠	B-1	30.0 - 31.5	56	22	34	Brown SILTY CLAY (CH) sith some roots/rootlets
▲	B-2	10.0 - 11.5	56	29	27	Brown SILTY CLAY (CH) with gravel
★	B-2	25.0 - 26.5	64	33	31	Brown with black mottling CLAYEY SILT (MH)
⊙	B-3	3.5 - 5.0	65	29	36	Brown SILTY CLAY (CH)
⊕	B-3	44.5 - 46.0	52	27	25	Brown SILTY CLAY (CH)
○	B-4	10.0 - 11.5	60	27	33	Orangish brown w/ gray mottling SILTY CLAY (CH) w/ sand & some gravel
△	B-5	15.0 - 16.5	57	28	29	Dark reddish brown SILTY CLAY (CH) w/ some gravel & sand
⊗	B-5	20.0 - 21.5	62	33	29	Brownish red w/ mutli-color mottling CLAYEY SILT (MH) w/ sand & some gravel
⊕	B-5	55.0 - 56.5	65	27	38	Reddish brown SILTY CLAY (CH) w/ some sand

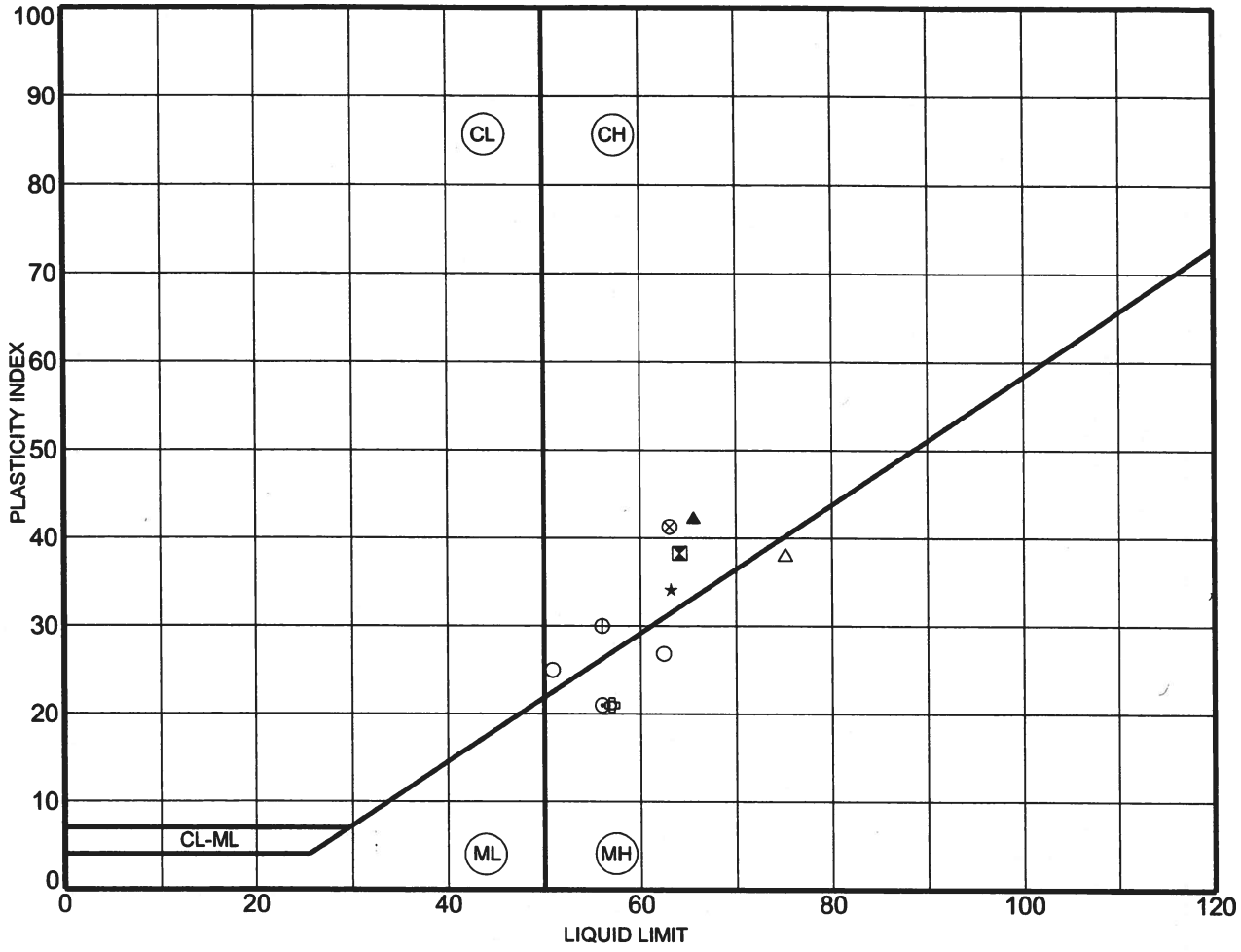
GEOLABS, INC.
GEOTECHNICAL ENGINEERING
W.O. 5088-00(A) & 5088-10

ATTERBERG LIMITS TEST RESULTS - ASTM D 4318

INTERSTATE ROUTE H-1 REHAB., EB LANES
WAIAU INTERCHANGE TO KAIMAKANI STREET
EWA, OAHU, HAWAII

Plate
B - 1.1

G ATTERBERG 5088-00.GPJ GEOLABS.GDT 4/19/04



	Sample	Depth (ft)	LL	PL	PI	Description
●	B-6	11.0 - 12.5	51	26	25	Brown SILTY CLAY (CH) w/ gravel
⊠	B-7	15.0 - 16.5	64	26	38	Reddish brown w/ multi-color mottling SILTY CLAY (CH) w/ some sand & gravel
▲	B-8	5.0 - 6.5	66	23	43	Reddish brown w/ multi-color mottling SILTY CLAY (CH) w/ some sand & gravel
★	B-8	50.0 - 51.5	63	29	34	Dark grayish brown w/ blue & brown mottling SILTY CLAY (CH) with fine sand & sub-rounded gravel & pebbles
⊙	B-8	67.5 - 69.0	56	35	21	Brown w/ multi-color mottling CLAYEY SILT (MH) w/ rounded pebbles & some gravel
⊕	B-8	78.5 - 80.0	57	36	21	Brown w/ multi-color mottling CLAYEY SILT (MH) w/ sand
○	B-8	83.5 - 85.0	62	36	26	Brown CLAYEY SILT (MH) w/ well rounded coarse sand & pebbles
△	B-8	93.5 - 95.0	75	37	38	Dark brown w/ multi-color mottling CLAYEY SILTY (MH)
⊗	B-9	49.5 - 51.0	63	22	41	Brownish gray SILTY CLAY (CH) w/ gravel
⊕	B-10	10.0 - 11.5	56	26	30	Reddish brown w/ multi-color mottling SILTY CLAY (CH) w/ some gravel & sand

G ATTERBERG 5088-00.GPJ GEOLABS.GDT 4/19/04

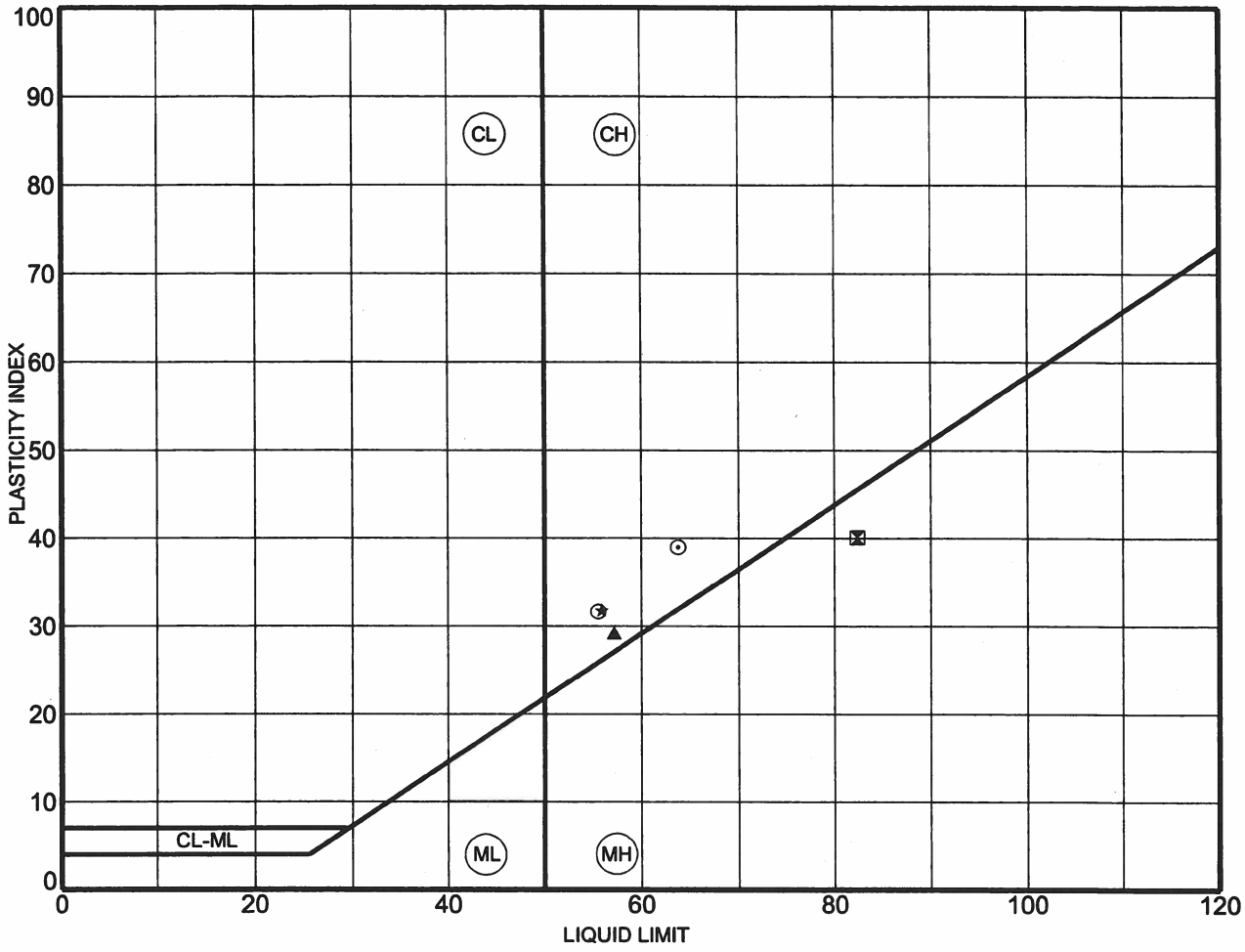
GEOLABS, INC.
GEOTECHNICAL ENGINEERING

W.O. 5088-00(A) & 5088-10

ATTERBERG LIMITS TEST RESULTS - ASTM D 4318

INTERSTATE ROUTE H-1 REHAB., EB LANES
WAIAU INTERCHANGE TO KAIMAKANI STREET
EWA, OAHU, HAWAII

Plate
B - 1.2



	Sample	Depth (ft)	LL	PL	PI	Description
●	B-11	30.0 - 31.5	55	24	31	Orangish brown w/ multi-color mottling SILTY CLAY (CH) w/ sand & some gravel
⊠	B-11	77.5 - 79.0	82	42	40	Brownish gray CLAYEY SILTY (MH) w/ sand
▲	B-12	10.0 - 11.5	57	28	29	Brown SILTY CLAY (CH) w/ sand & gravel
★	B-13	20.0 - 21.5	56	24	32	Dark brown w/ multi-color mottling SILTY CLAY (CH) w/ some cobbles
⊙	B-15	10.0 - 11.5	64	25	39	Brown SILTY CLAY (CH) with some sand & gravel

GEOLABS, INC.
GEOTECHNICAL ENGINEERING

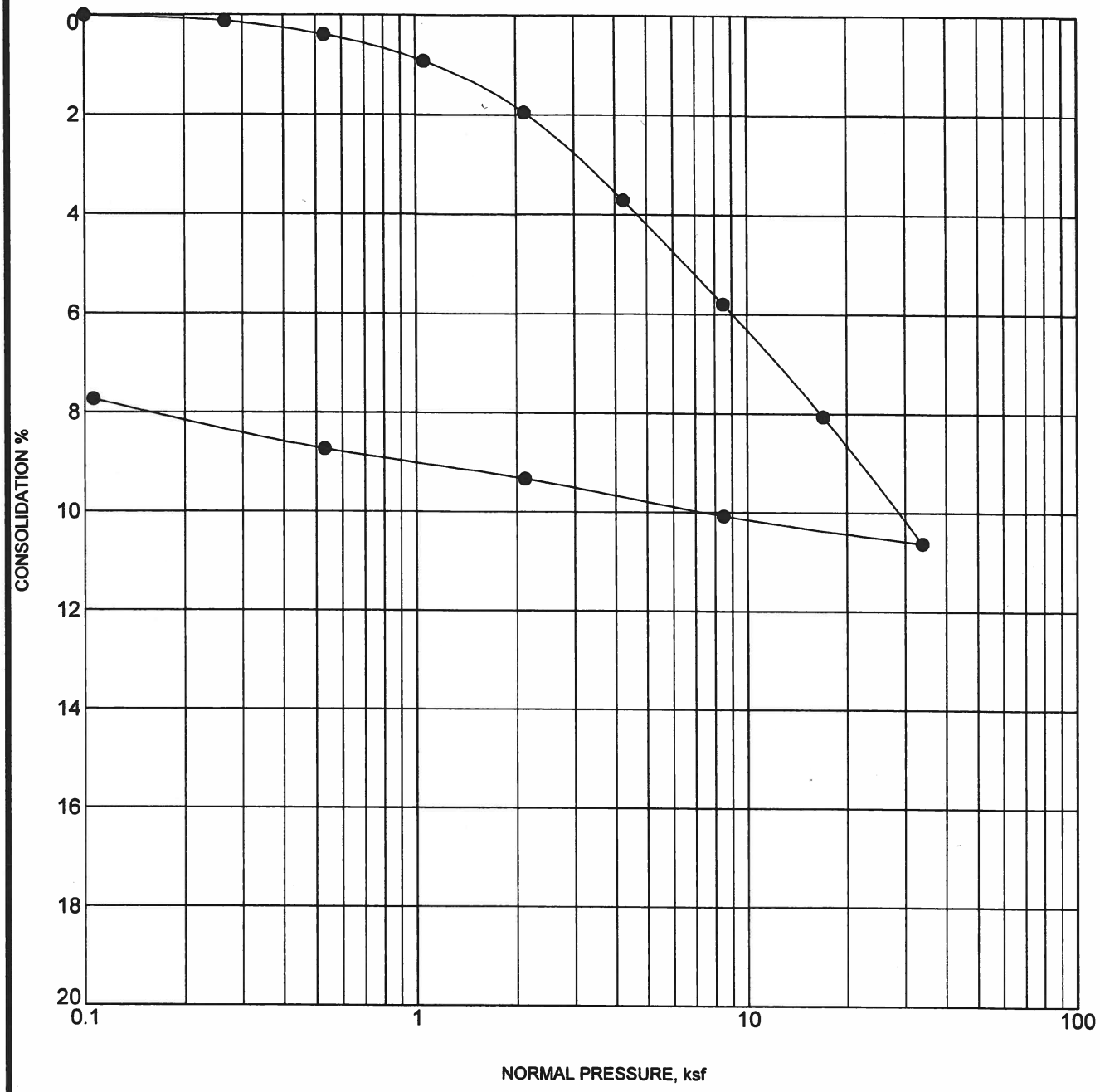
W.O. 5088-00(A) & 5088-10

ATTERBERG LIMITS TEST RESULTS - ASTM D 4318

INTERSTATE ROUTE H-1 REHAB., EB LANES
WAIAU INTERCHANGE TO KAIMAKANI STREET
EWA, OAHU, HAWAII

Plate
B - 1.3

G ATTERBERG 5088-00.GPJ GEOLABS.GDT 4/19/04



	Initial	Final
water content, %:	39.2	38.0
dry density, pcf:	77.8	84.3

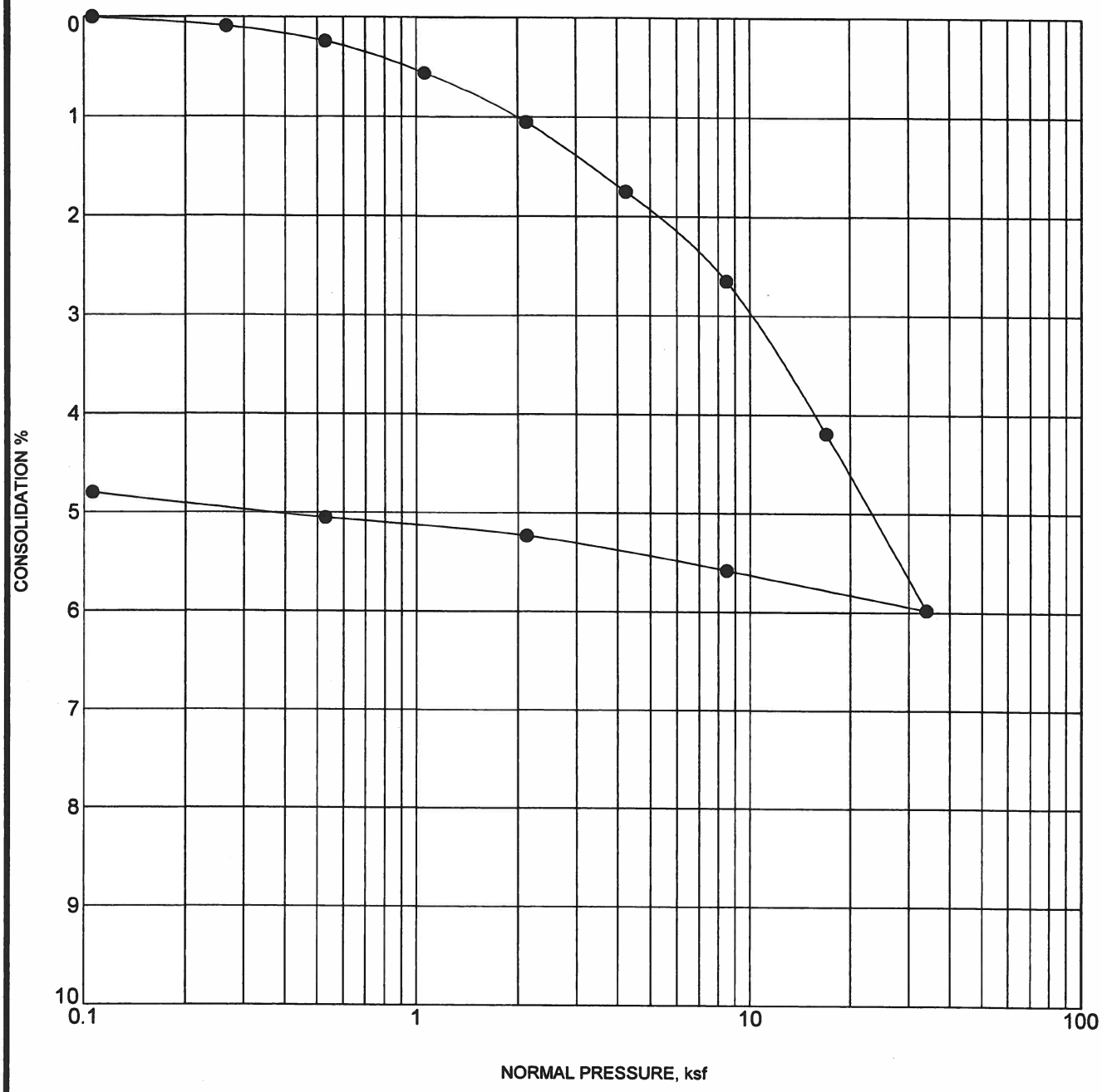
Sample: B-4
Depth: 30.0 - 31.5 feet
Description: Brown w/ multi-color mottling SILTY CLAY w/ sand & rounded cobbles & gravel

G_CONSOL_5088-00(A).GPJ GEOLABS.GDT 7/8/05

GEOLABS, INC.
GEOTECHNICAL ENGINEERING
W.O. 5088-00(A) & 5088-10

CONSOLIDATION TEST - ASTM D 2435
INTERSTATE ROUTE H-1 REHAB., EB LANES
WAIAU INTERCHANGE TO KAIMAKANI STREET
EWA, OAHU, HAWAII

Plate
B - 2.1



	Initial	Final
water content, %:	29.1	27.4
dry density, pcf:	93.1	97.8

Sample: B-4

Depth: 40.0 - 41.5 feet

Description: Dark brown w/ orange mottling SILTY CLAY w/ sand & rounded cobbles & gravel

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CONSOLIDATION TEST - ASTM D 2435

INTERSTATE ROUTE H-1 REHAB., EB LANES

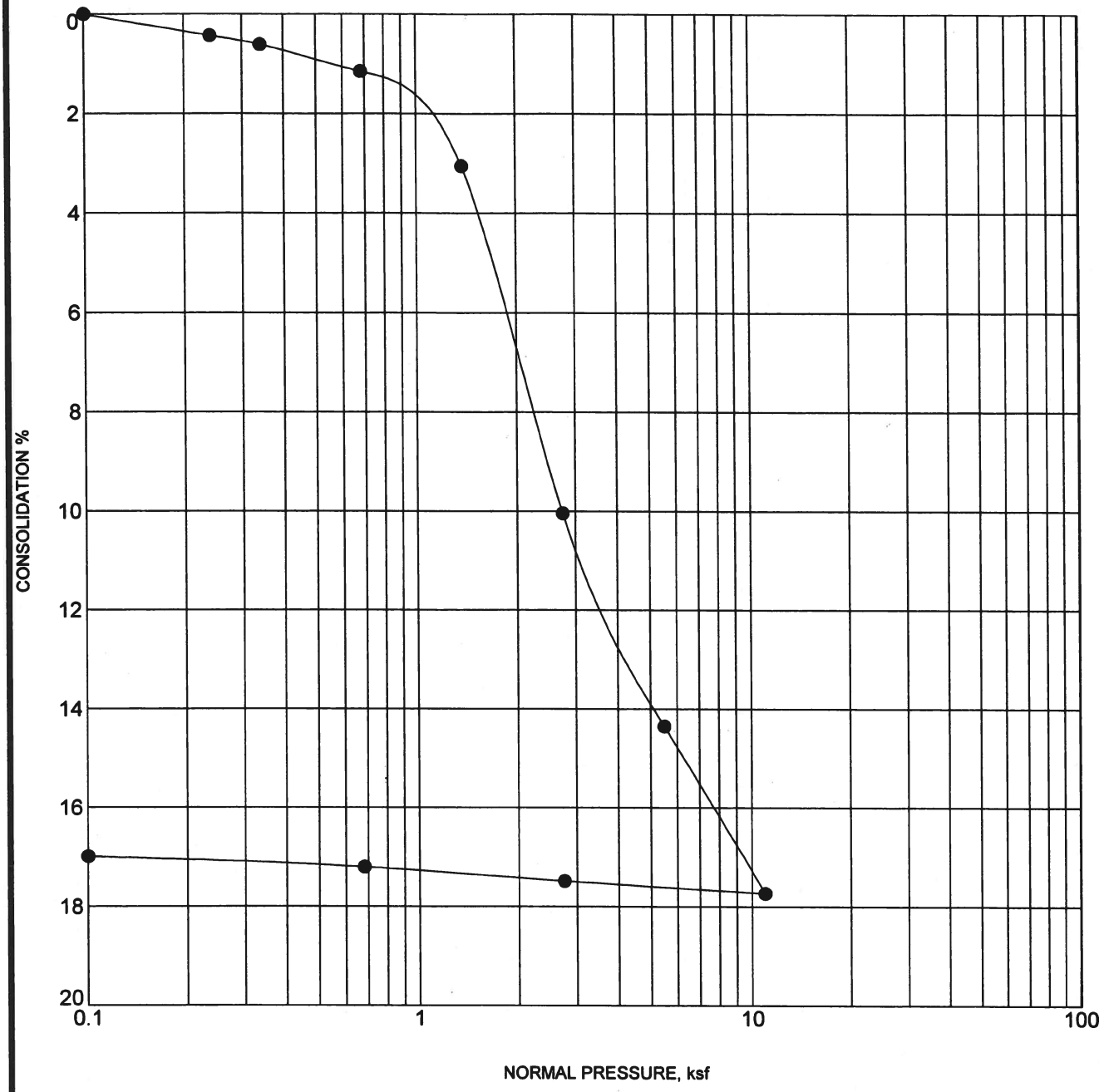
WAIAU INTERCHANGE TO KAIMAKANI STREET

EWA, OAHU, HAWAII

Plate

B - 2.2

G CONSOL 5088-00(A).GPJ GEOLABS.GDT 7/8/05



	Initial	Final
water content, %:	28.8	29.9
dry density, pcf:	80.2	96.6

Sample: B-4
Depth: 50.0 - 51.5 feet
Description: Orange brown w/ black mottling SILTY CLAY w/ some roots/rootlets

G CONSOL 5088-00(A).GPJ GEOLABS.GDT 7/8/05

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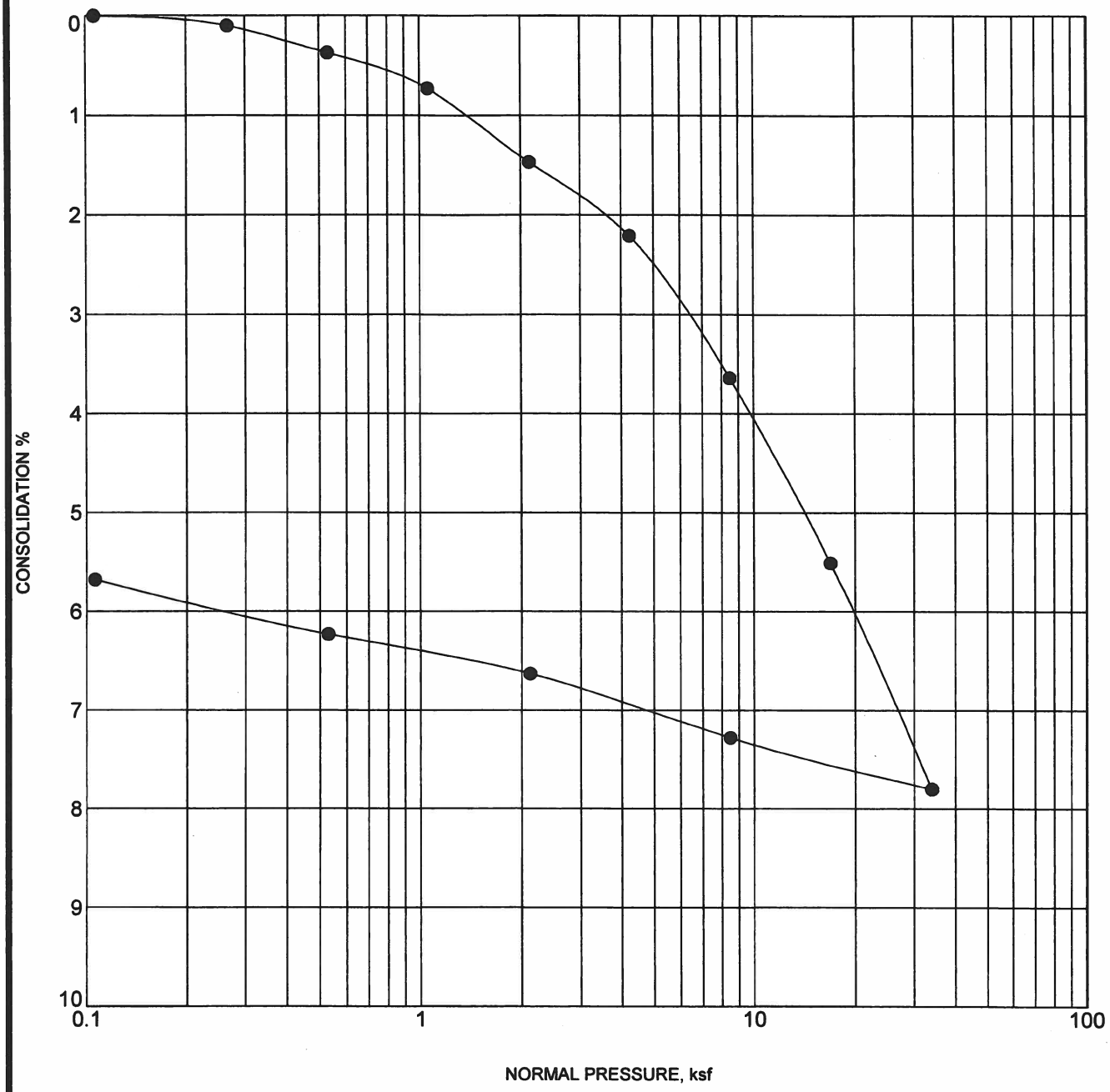
CONSOLIDATION TEST - ASTM D 2435

INTERSTATE ROUTE H-1 REHAB., EB LANES
WAIAU INTERCHANGE TO KAIMAKANI STREET
EWA, OAHU, HAWAII

Plate
B - 2.3



	Initial	Final
water content, %:	31.0	31.3
dry density, pcf:	88.4	93.7

Sample: B-6
Depth: 21.0 - 22.5 feet
Description: Brown SILTY CLAY with sand

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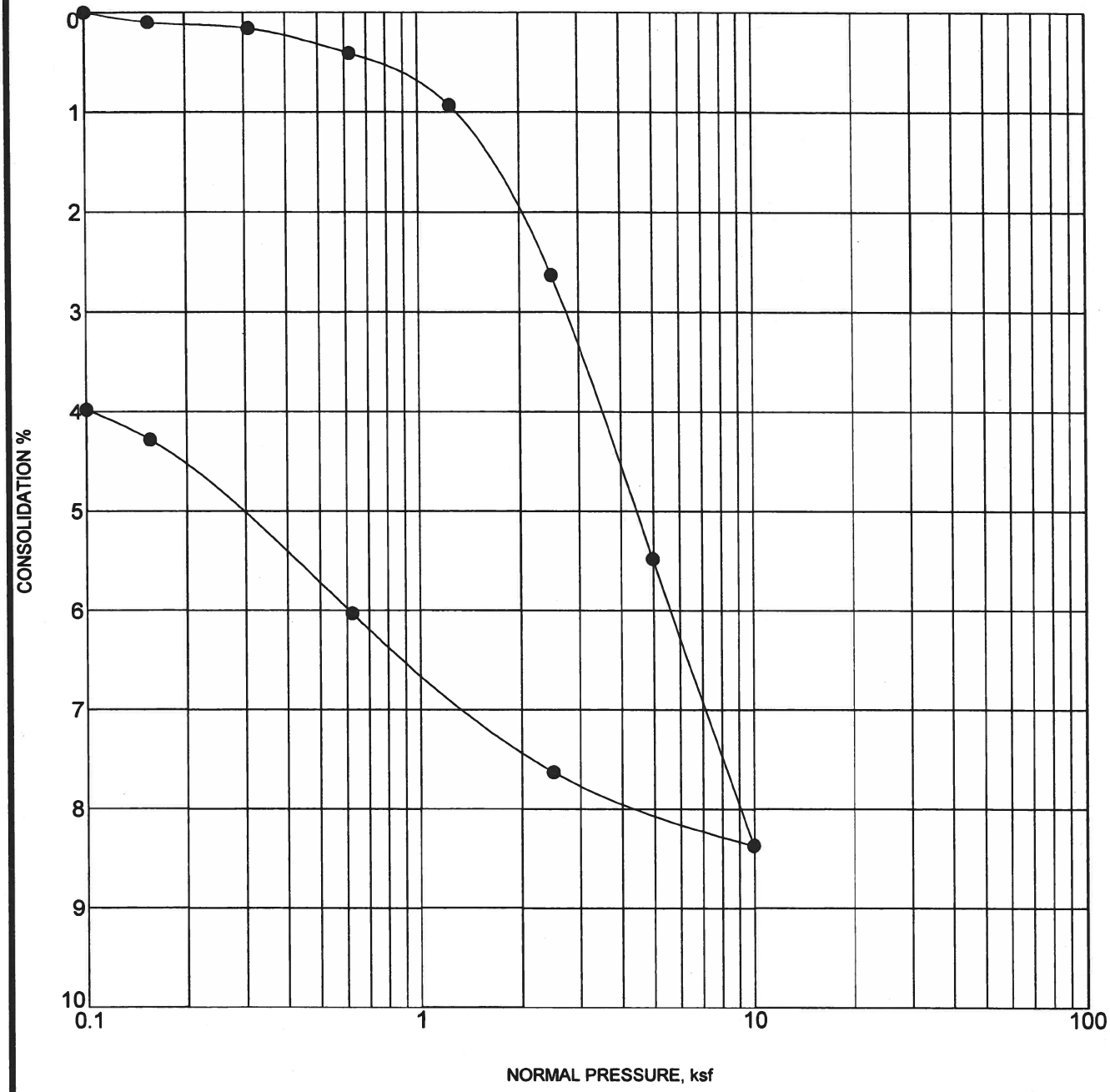
CONSOLIDATION TEST - ASTM D 2435

INTERSTATE ROUTE H-1 REHAB., EB LANES
WAIAU INTERCHANGE TO KAIMAKANI STREET
EWA, OAHU, HAWAII

Plate
B - 2.4

G CONSOL 5088-00(A).GPJ GEOLABS.GDT 7/8/05



	Initial	Final
water content, %:	28.4	36.2
dry density, pcf:	89.3	93.0

Sample: B-11
Depth: 10.0 - 11.5 feet
Description: Orangish red w/ multi-color mottling SILTY CLAY w/ sand & some gravel

G CONSOL 5088-00(A).GPJ GEOLABS.GDT 7/8/05

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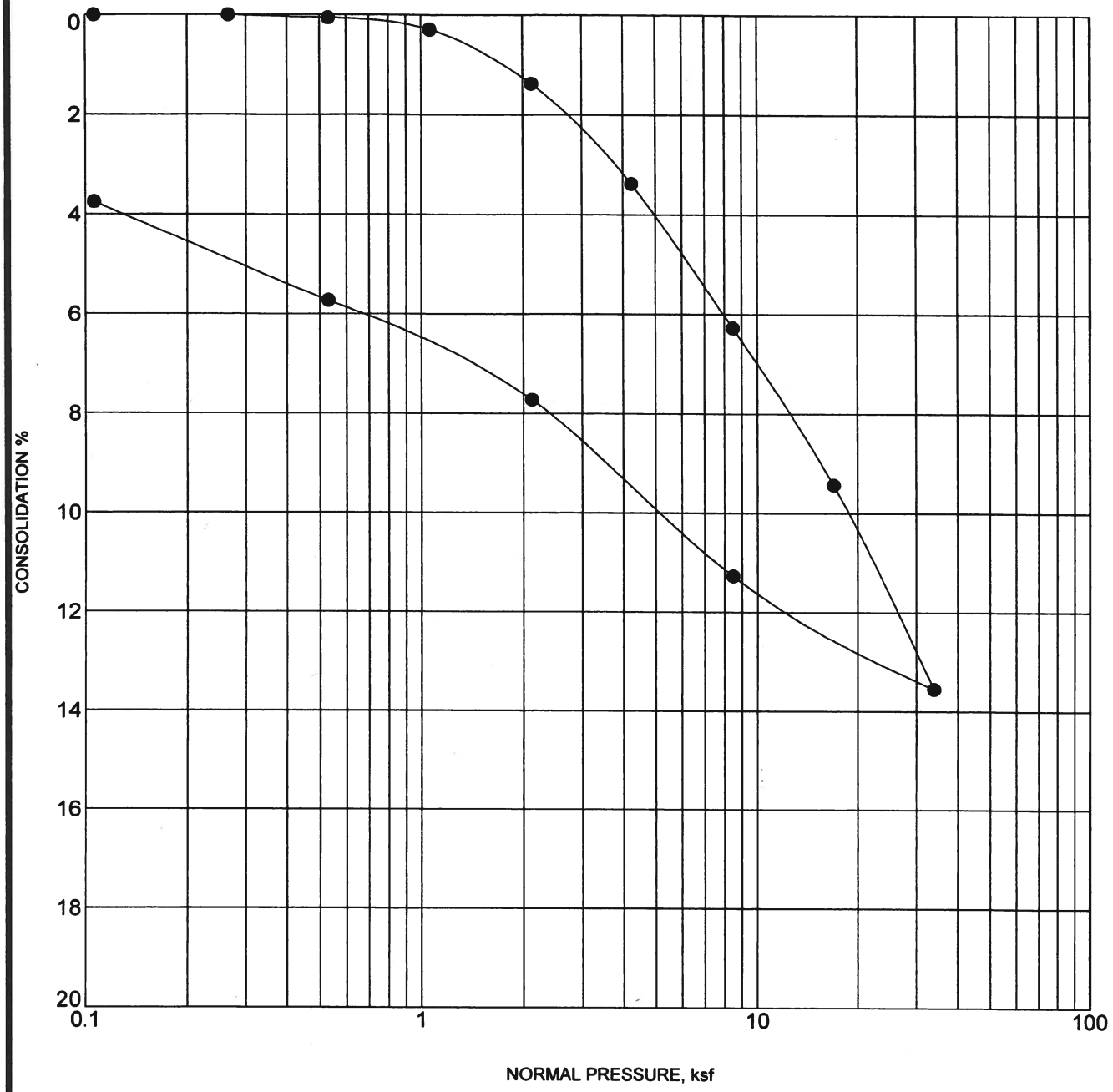
W.O. 5088-00(A) & 5088-10

CONSOLIDATION TEST - ASTM D 2435

INTERSTATE ROUTE H-1 REHAB., EB LANES
WAIAU INTERCHANGE TO KAIMAKANI STREET
EWA, OAHU, HAWAII

Plate
B - 2.5



	Initial	Final
water content, %:	37.4	38.7
dry density, pcf:	82.5	85.8

Sample: B-13
Depth: 5.0 - 6.5 feet
Description: Brown SILTY CLAY w/ sand & gravel

GEOLABS, INC.
GEOTECHNICAL ENGINEERING

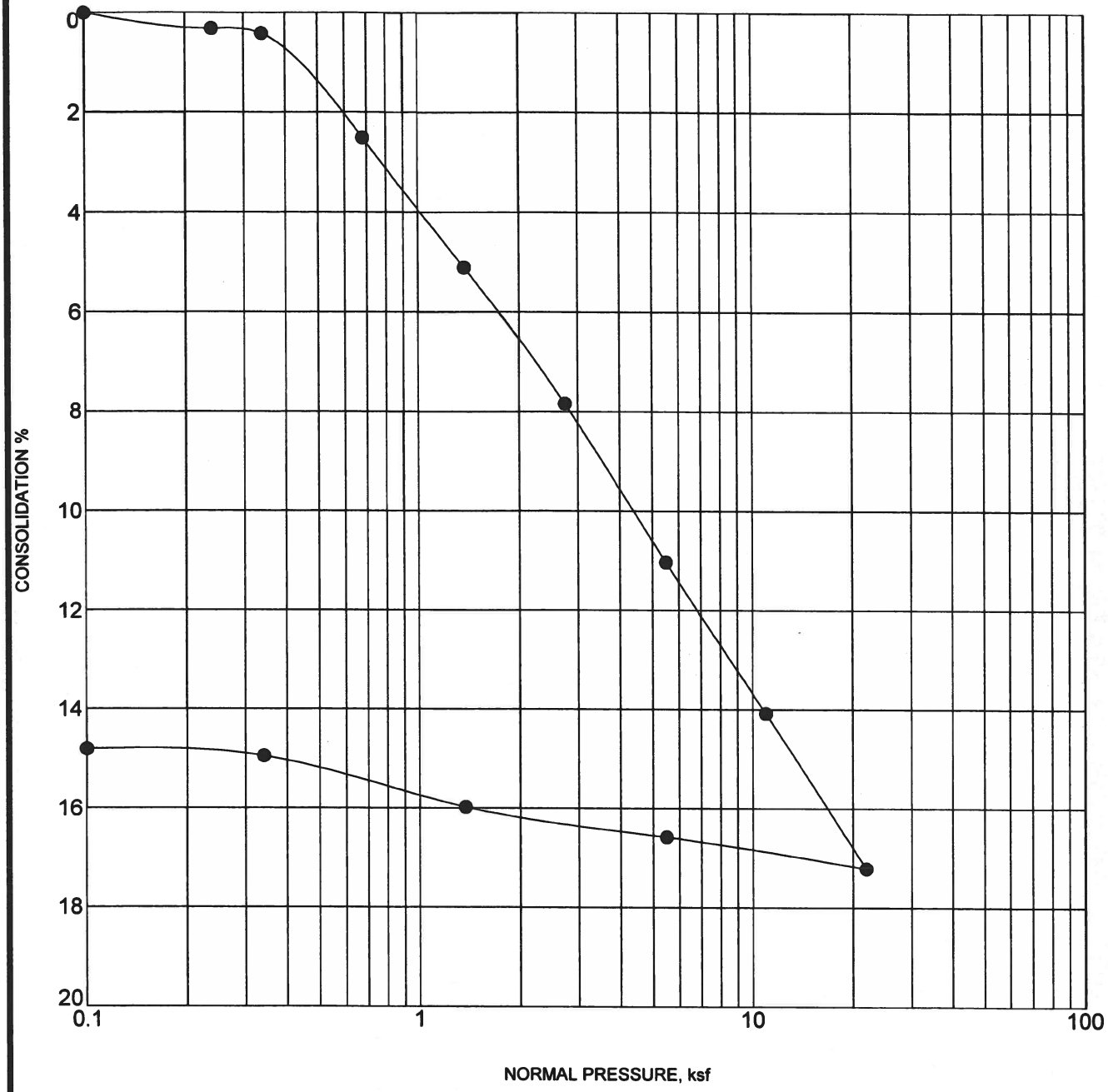
W.O. 5088-00(A) & 5088-10

CONSOLIDATION TEST - ASTM D 2435

INTERSTATE ROUTE H-1 REHAB., EB LANES
WAIAU INTERCHANGE TO KAIMAKANI STREET
EWA, OAHU, HAWAII

Plate
B - 2.6

G_CONSOL 5088-00(A).GPJ GEOLABS.GDT 7/8/05



	Initial	Final
water content, %:	30.1	30.4
dry density, pcf:	80.0	93.9

Sample: B-13

Depth: 15.0 - 16.5 feet

Description: Dark brown w/ multi-color mottling SILTY CLAY w/ some cobbles

G CONSOL 5088-00(A).GPJ GEOLABS.GDT 7/8/05

GEOLABS, INC.

GEOTECHNICAL ENGINEERING

W.O. 5088-00(A) & 5088-10

CONSOLIDATION TEST - ASTM D 2435

INTERSTATE ROUTE H-1 REHAB., EB LANES

WAIAU INTERCHANGE TO KAIMAKANI STREET

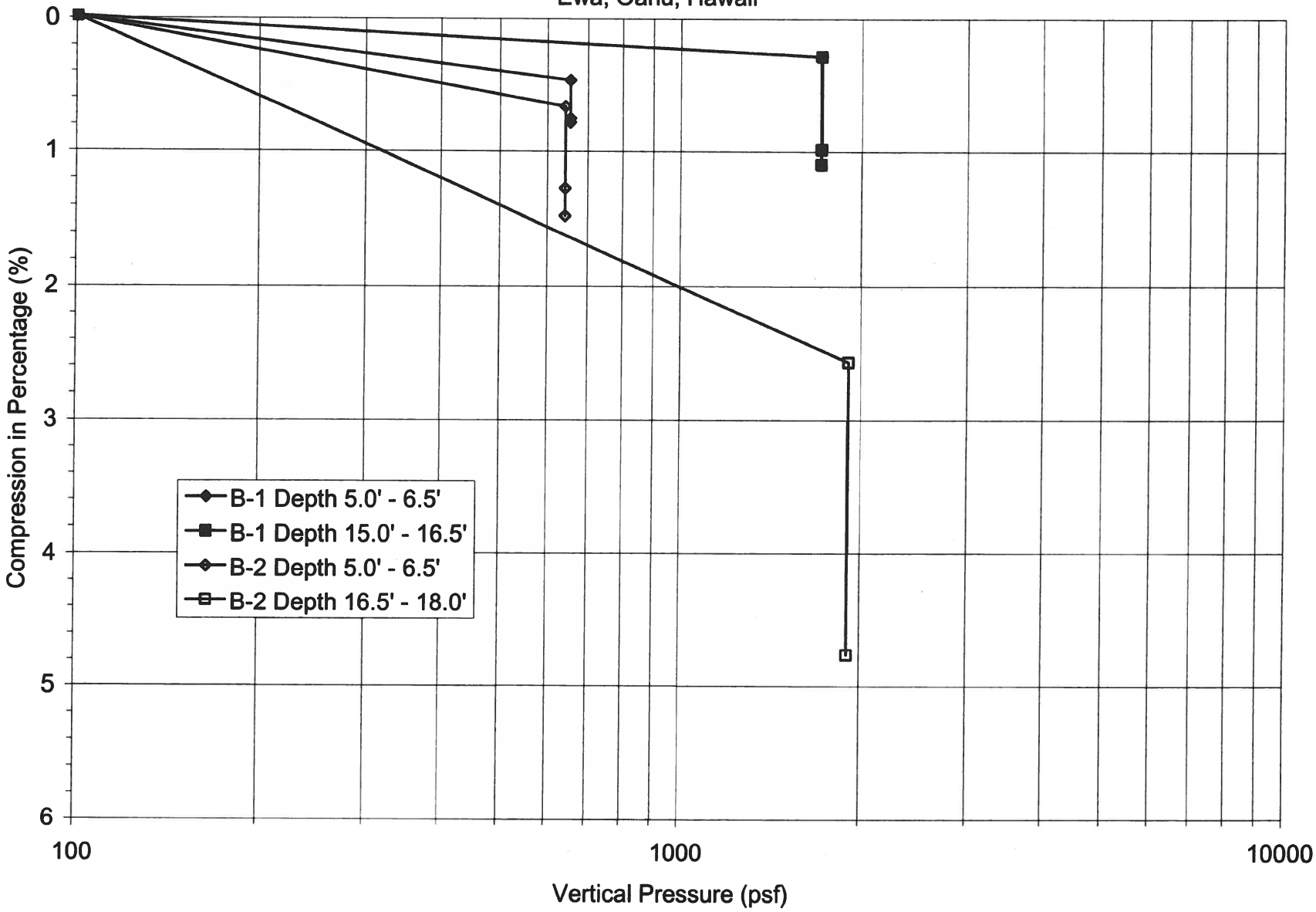
EWA, OAHU, HAWAII

Plate

B - 2.7

MODIFIED CONSOLIDATION TEST

Interstate Route H-1 Rehabilitation, Eastbound Lanes
Waiau Interchange to Kaimakani Street
Ewa, Oahu, Hawaii



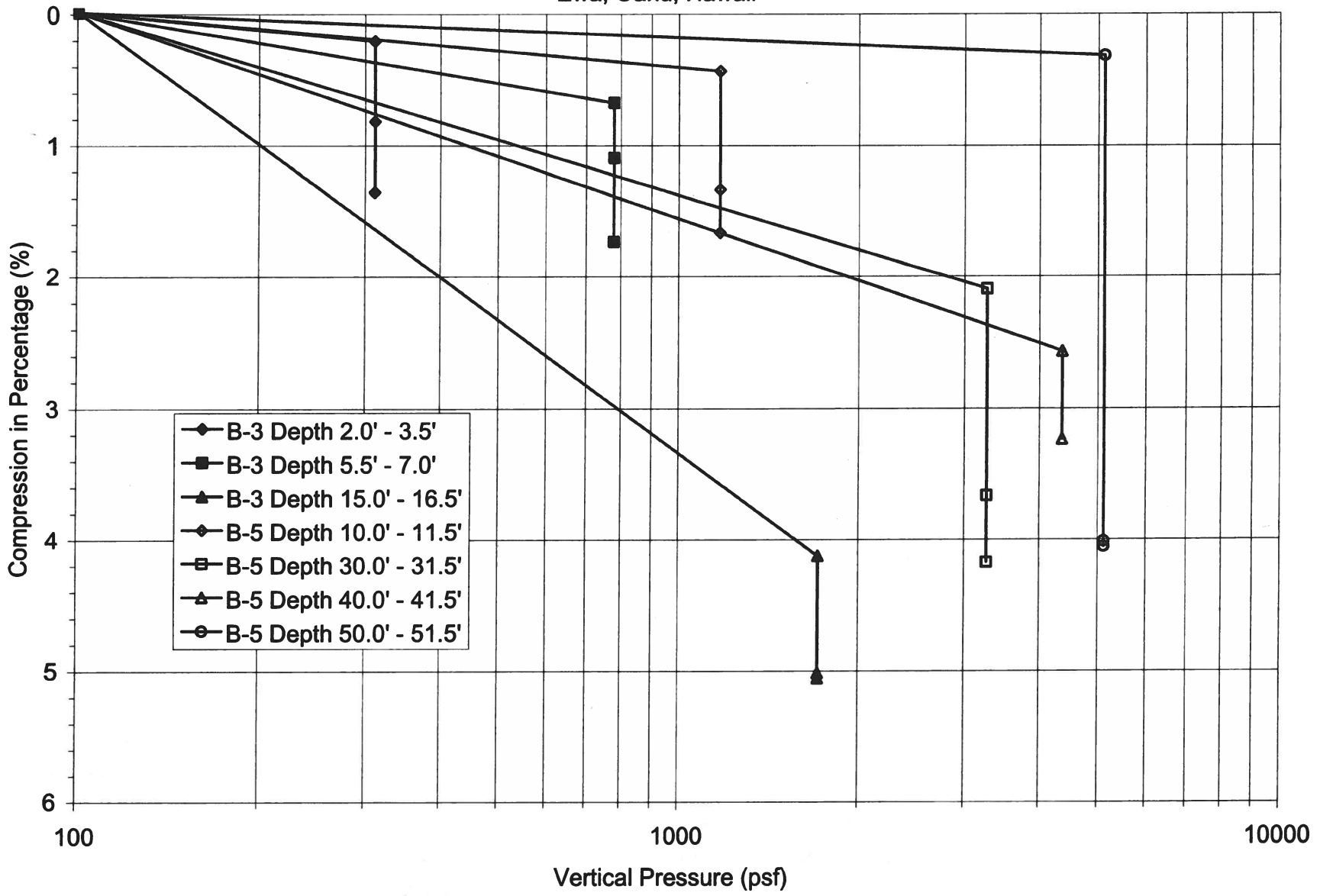
W.O. 5088-00(A) 5088-10

GEOLABS, INC.

PLATE B-3.1

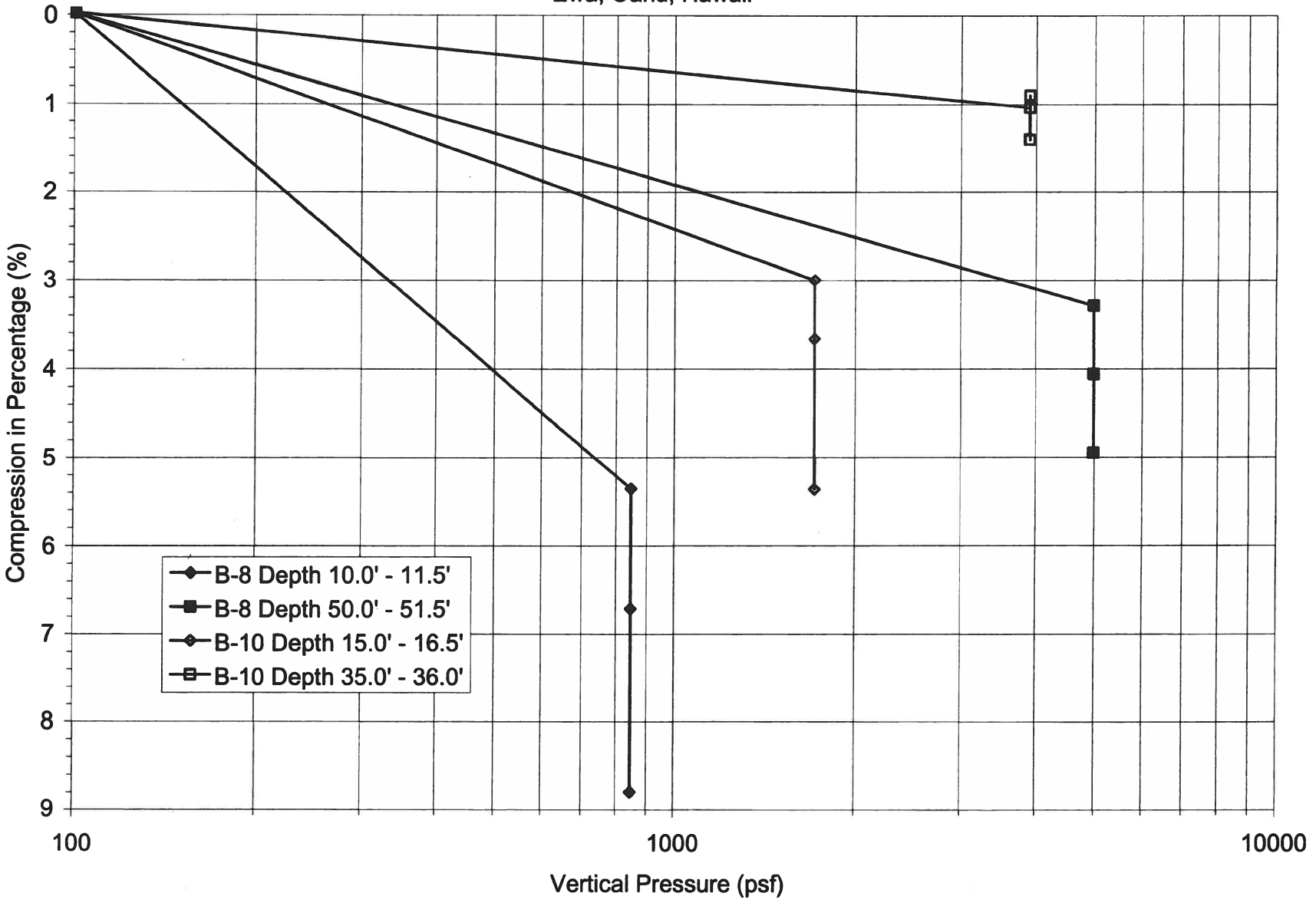
MODIFIED CONSOLIDATION TEST

Interstate Route H-1 Rehabilitation, Eastbound Lanes
Waiau Interchange to Kaimakani Street
Ewa, Oahu, Hawaii



MODIFIED CONSOLIDATION TEST

Interstate Route H-1 Rehabilitation, Eastbound Lanes
Waiau Interchange to Kaimakani Street
Ewa, Oahu, Hawaii



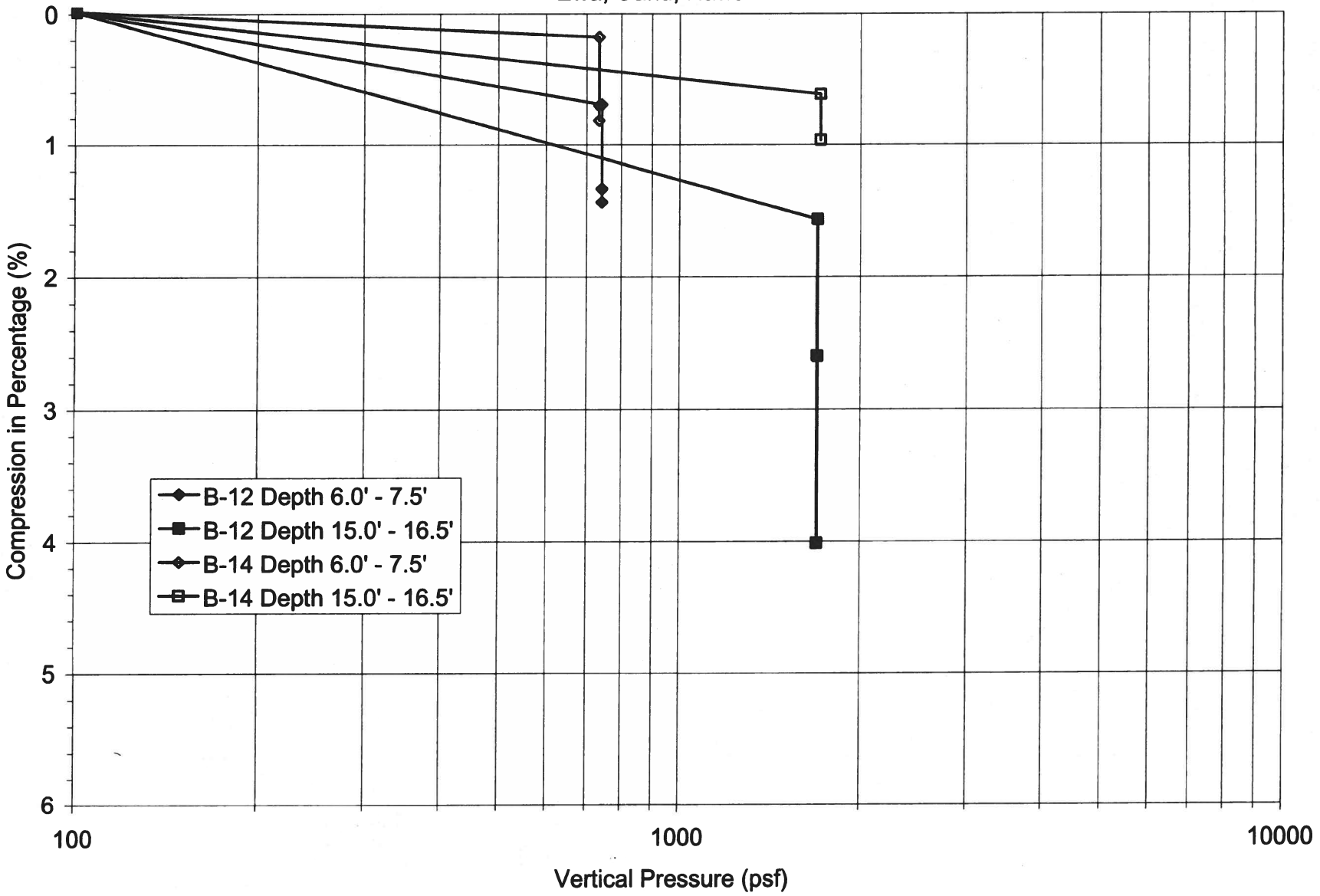
W.O. 5088-00(A) 5088-10

GEOLABS, INC.

PLATE B-3.3

MODIFIED CONSOLIDATION TEST

Interstate Route H-1 Rehabilitation, Eastbound Lanes
Waiau Interchange to Kaimakani Street
Ewa, Oahu, Hawaii



W.O. 5088-00(A) 5088-10

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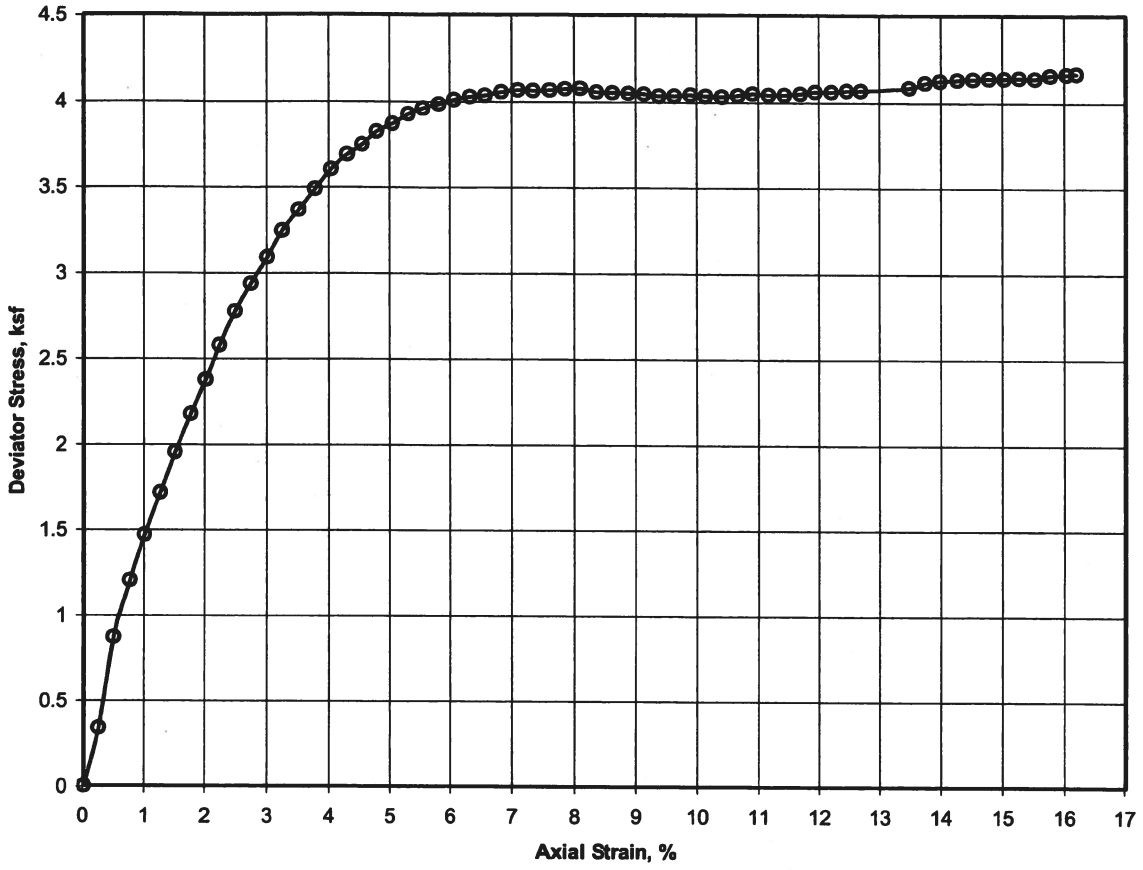
PLATE B-3.4

UNCONSOLIDATED UNDRAINED COMPRESSIVE STRENGTH OF COHESIVE SOILS IN TRIAXIAL COMPRESSION - ASTM D 2850



LOCATION: B - 3
DEPTH : 25 - 26.5 feet

DESCRIPTION: Brown with multi-color mottling **SILTY CLAY (CH)** with sand and some gravel

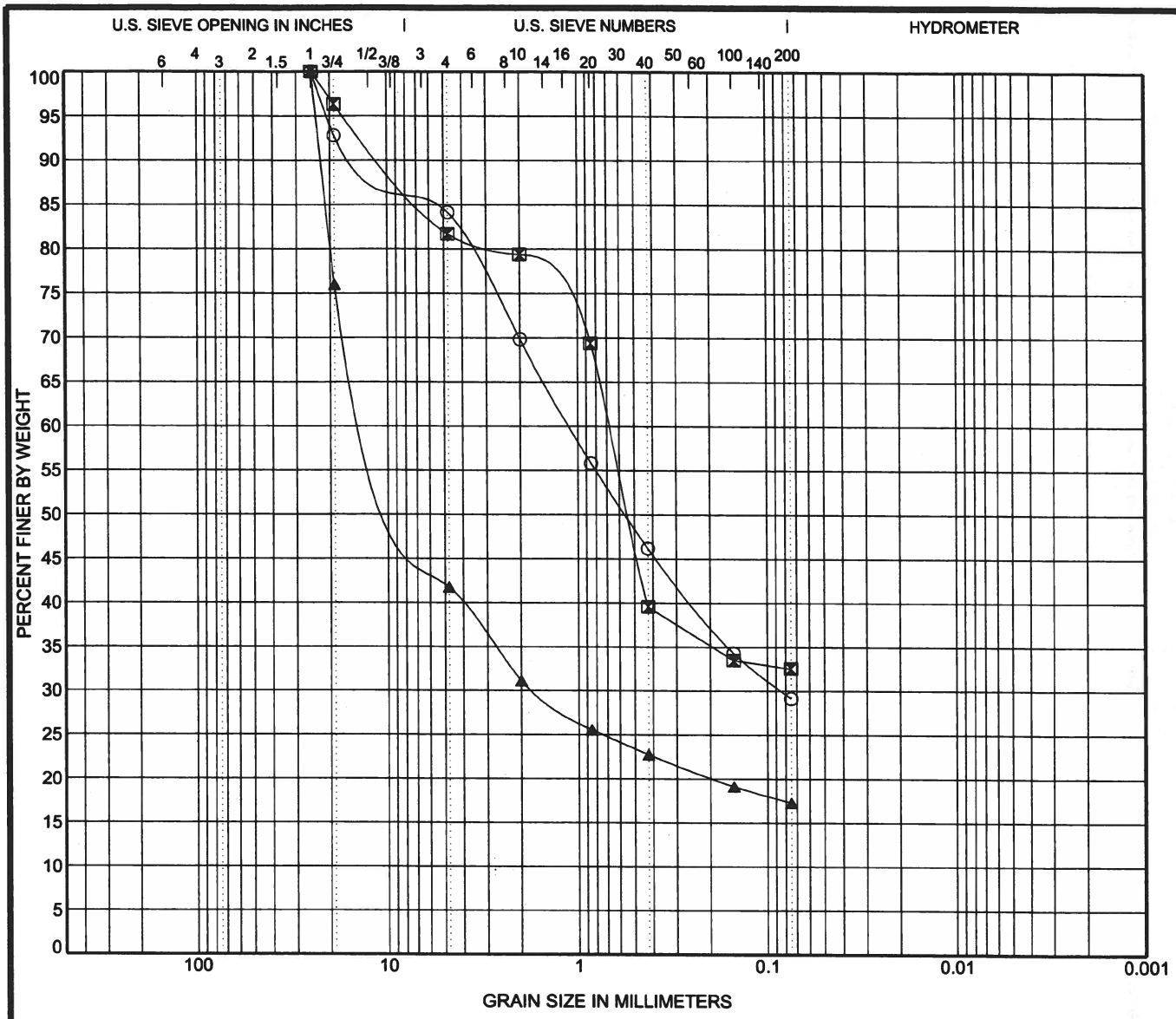
DRY DENSITY:	90.5 pcf	SAMPLE DIAMETER:	2.374 inches
MOISTURE CONTENT:	29.0 %	SAMPLE HEIGHT:	5.829 inches

AT FAILURE

STRAIN RATE =	1.02 %/min.		
CONFINING PRESSURE =	2.74 ksf		
MAX. DEVIATOR STRESS =	4.13 ksf @	15.0	% STRAIN

PROJECT:
INTERSTATE ROUTE H-1 REHAB., EB LANES
WAIAU INTERCHANGE TO KAIMAKANI STREET
EWA, OAHU, HAWAII

UNCONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST	
GEOLABS, INC. *Geotechnical Engineering*	
DATE Jul 05	W.O. 5088-00



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Sample	Depth (ft)	Description	LL	PL	PI	Cc	Cu
○	B-10	74.5 - 76.0	Brownish gray SILTY SAND (SM)					
⊠	B-11	65.5 - 67.0	Brown w/ multi-color mottling SILTY SAND (SM) w/					
			w/ rounded pebbles & gravel					
▲	B-16	5.0 - 6.5	Brown w/ tan mottle CLAYEY GRAVEL (GC) w/ sand					

	Sample	Depth (ft)	D100 (mm)	D60 (mm)	D30 (mm)	D10 (mm)	%Gravel	%Sand	%Fine
○	B-10	74.5 - 76.0	25	1.098	0.084		15.8	55.0	29.2
⊠	B-11	65.5 - 67.0	25	0.684			18.3	49.1	32.5
▲	B-16	5.0 - 6.5	25	9.945	1.683		58.2	24.5	17.3

GEOLABS, INC.
GEOTECHNICAL ENGINEERING

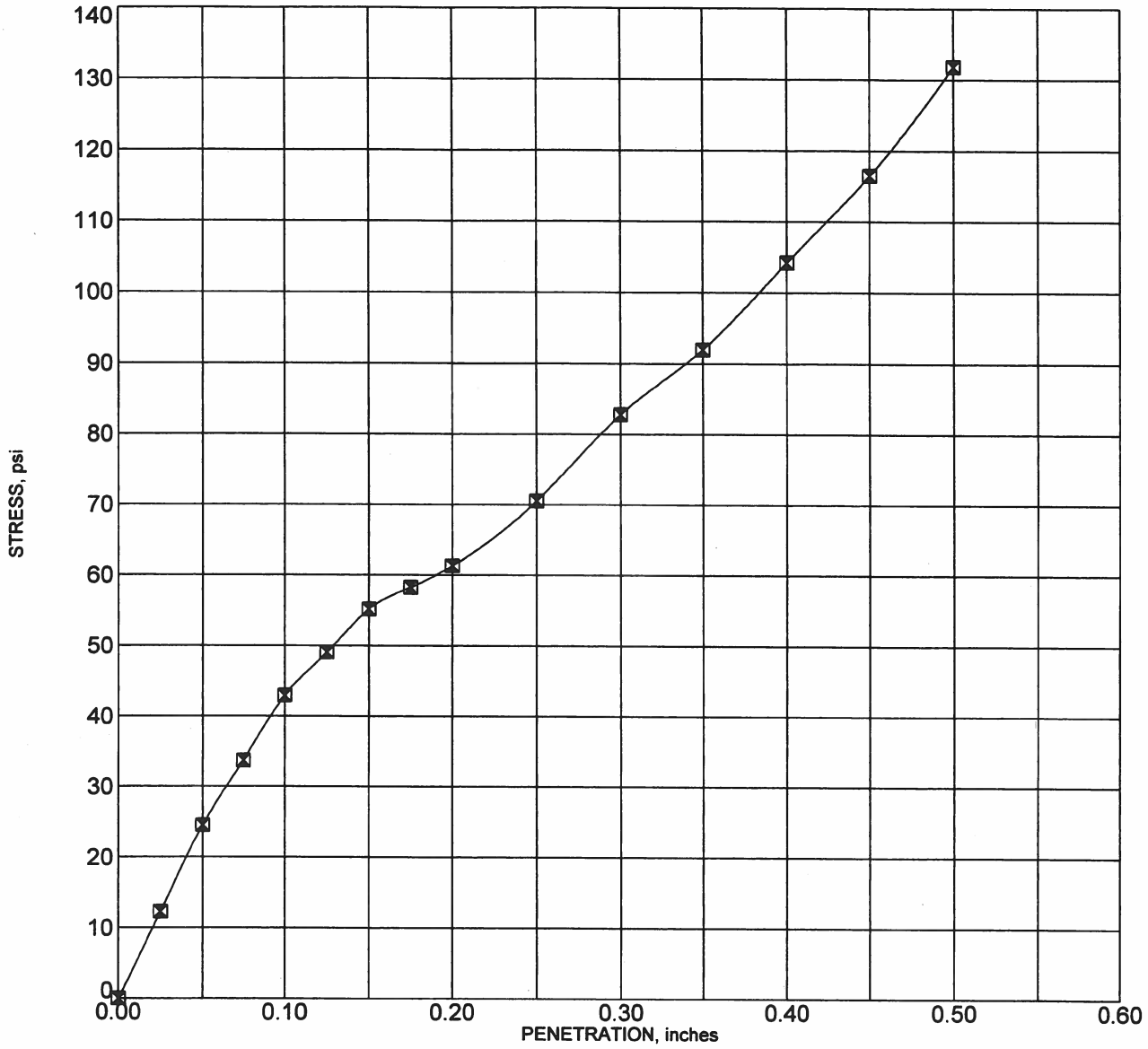
W.O. 5088-00(A) & 5088-10

GRAIN SIZE DISTRIBUTION - ASTM C 117 & C 136

INTERSTATE ROUTE H-1 REHAB., EB LANES
WAIAU INTERCHANGE TO KAIMAKANI STREET
EWA, OAHU, HAWAII

Plate
B - 5

G GRAIN SIZE 5088-00(A).GPJ GEOLABS.GDT 7/8/05



Corr. CBR @ 0.1"	4.3
Swell (%)	3.10

Sample: Bulk-1
Depth: 2.0 - 10.0 feet
Description: Tannish brown SILTY CLAY with some decomposed rock

Molding Dry Density (pcf)	97.0	Hammer Wt. (lbs)	10
Molding Moisture (%)	25.7	Hammer Drop (inches)	18
Days Soaked	4	No. of Blows	56
Aggregate	3/4 inch minus	No. of Layers	5

GEOLABS, INC.
GEOTECHNICAL ENGINEERING

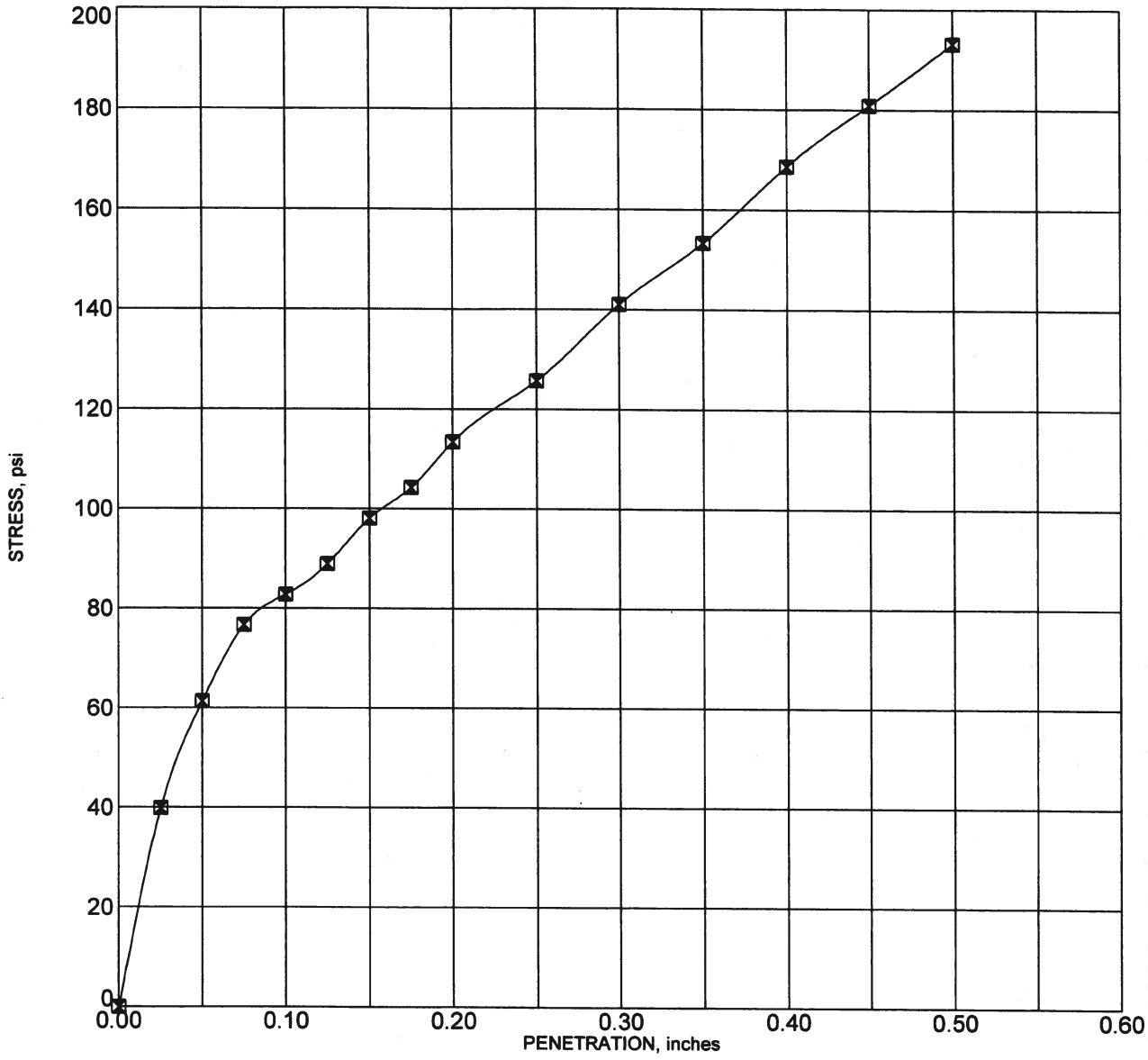
W.O. 5088-00(A) & 5088-10

CALIFORNIA BEARING RATIO - ASTM D 1883

INTERSTATE ROUTE H-1 REHAB., EB LANES
WAIAU INTERCHANGE TO KAIMAKANI STREET
EWA, OAHU, HAWAII

Plate
B - 6.1

G_CBR_5088-00(A).GPJ GEOLABS.GDT 7/8/05



Corr. CBR @ 0.1"	8.3
Swell (%)	1.80

Sample: Bulk-2
Depth: 3.0 - 30.0 feet
Description: Reddish brown SILTY CLAY with some basalt gravel

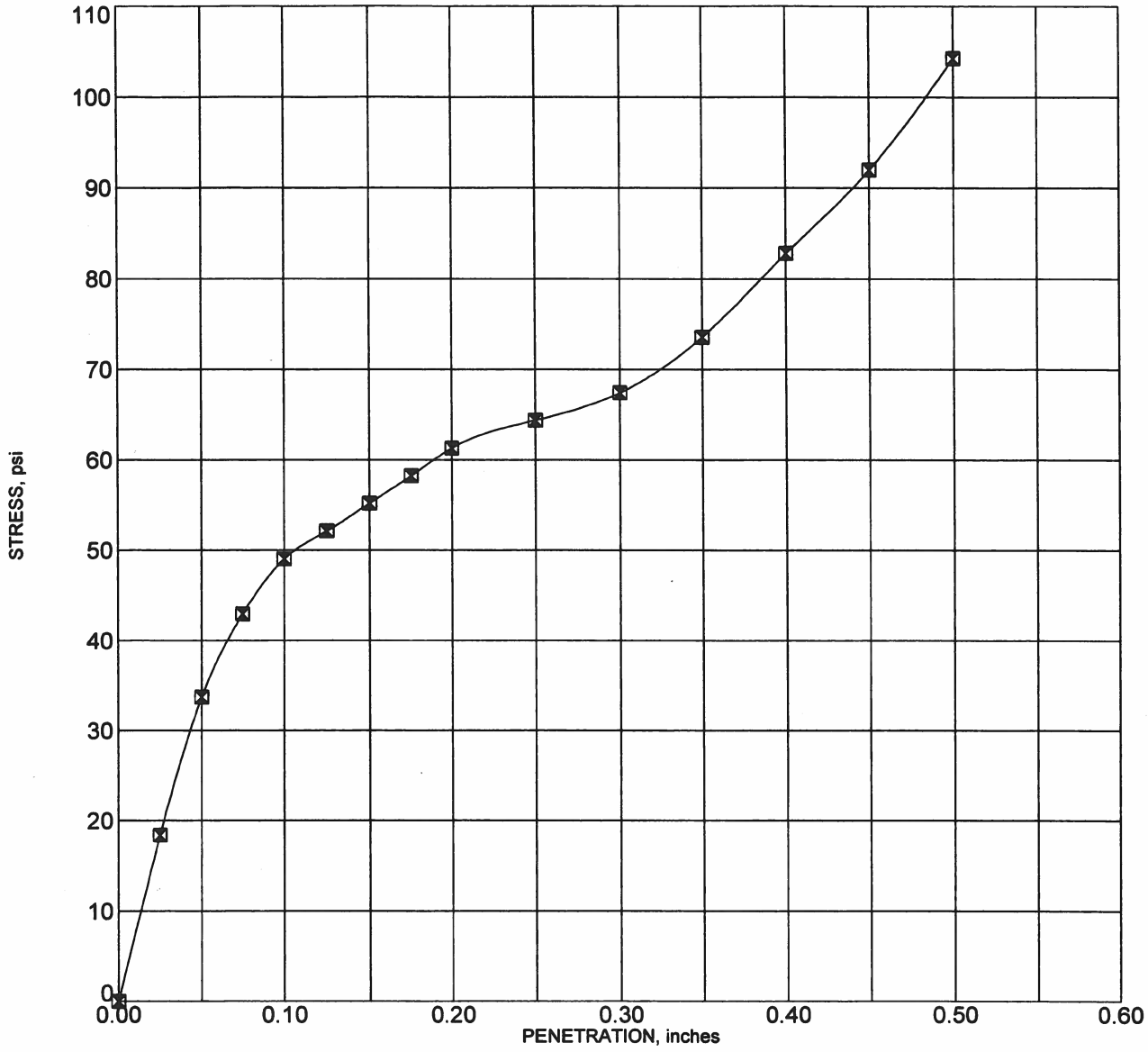
Molding Dry Density (pcf)	99.6	Hammer Wt. (lbs)	10
Molding Moisture (%)	23.0	Hammer Drop (inches)	18
Days Soaked	4	No. of Blows	56
Aggregate	3/4 inch minus	No. of Layers	5

GEOLABS, INC.
GEOTECHNICAL ENGINEERING
W.O. 5088-00(A) & 5088-10

CALIFORNIA BEARING RATIO - ASTM D 1883
INTERSTATE ROUTE H-1 REHAB., EB LANES
WAIAU INTERCHANGE TO KAIMAKANI STREET
EWA, OAHU, HAWAII

Plate
B - 6.2

G CBR 5088-00(A).GPJ GEOLABS.GDT 7/8/05



Corr. CBR @ 0.1"	4.9
Swell (%)	2.60

Sample: Bulk-3
Depth: 5.0 - 20.0 feet
Description: Gray brown SILTY CLAY with gravel

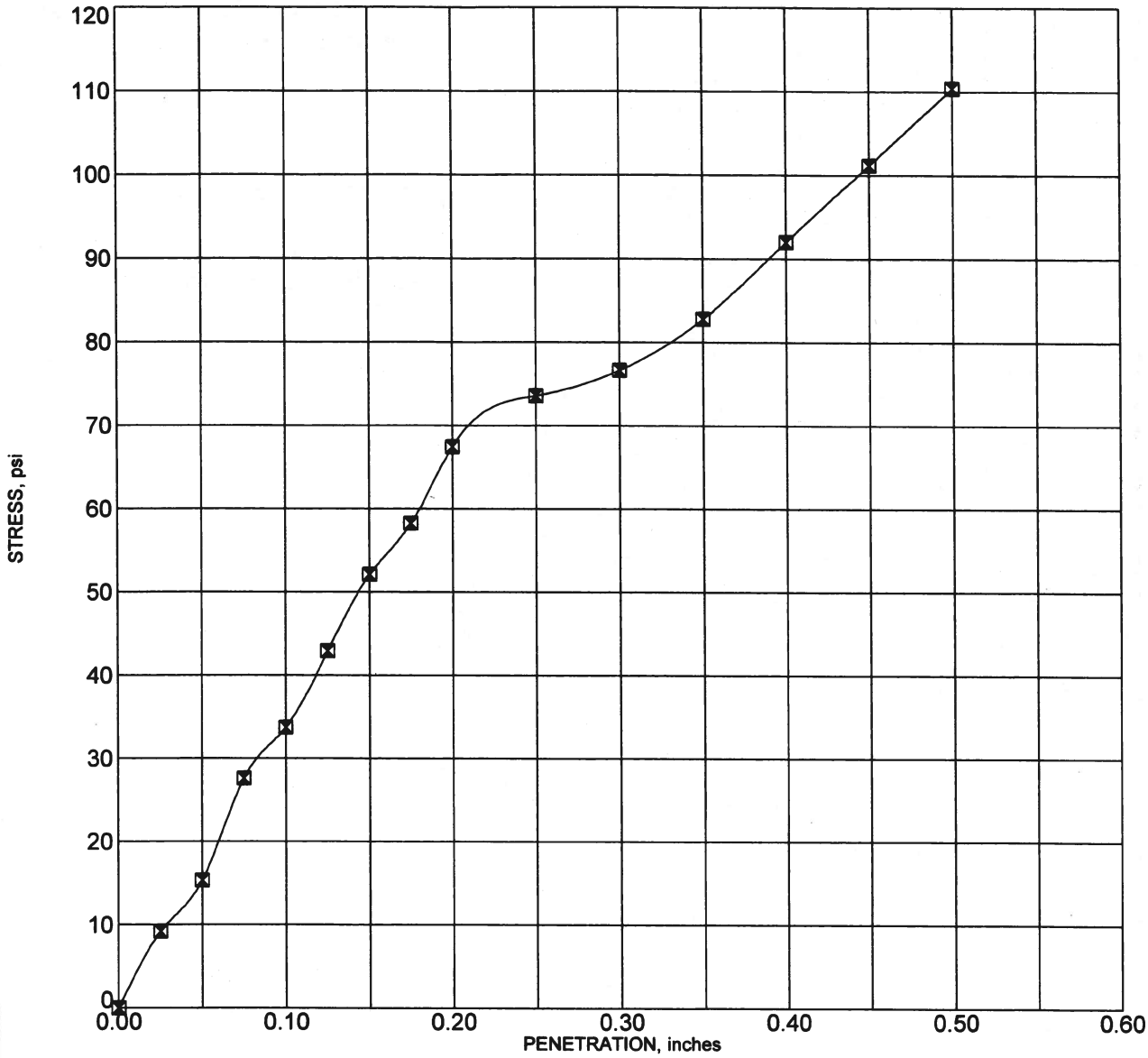
Molding Dry Density (pcf)	98.9	Hammer Wt. (lbs)	10
Molding Moisture (%)	23.6	Hammer Drop (inches)	18
Days Soaked	4	No. of Blows	56
Aggregate	3/4 inch minus	No. of Layers	5

GEOLABS, INC.
GEOTECHNICAL ENGINEERING
W.O. 5088-00(A) & 5088-10

CALIFORNIA BEARING RATIO - ASTM D 1883
INTERSTATE ROUTE H-1 REHAB., EB LANES
WAIAU INTERCHANGE TO KAIMAKANI STREET
EWA, OAHU, HAWAII

Plate
B - 6.3

G_CBR_5088-00(A).GPJ GEOLABS.GDT 7/8/05



Corr. CBR @ 0.1"	3.4
Swell (%)	4.00

Sample: Mix Samples from B-15 through 18, 107 and 108
Depth: 2.0 - 3.0 feet
Description: Brown CLAYEY SAND with gravel

Molding Dry Density (pcf)	109.2	Hammer Wt. (lbs)	10
Molding Moisture (%)	17.9	Hammer Drop (inches)	18
Days Soaked	2	No. of Blows	56
Aggregate	3/4 inch minus	No. of Layers	5

GEOLABS, INC.
GEOTECHNICAL ENGINEERING
W.O. 5088-00(A) & 5088-10

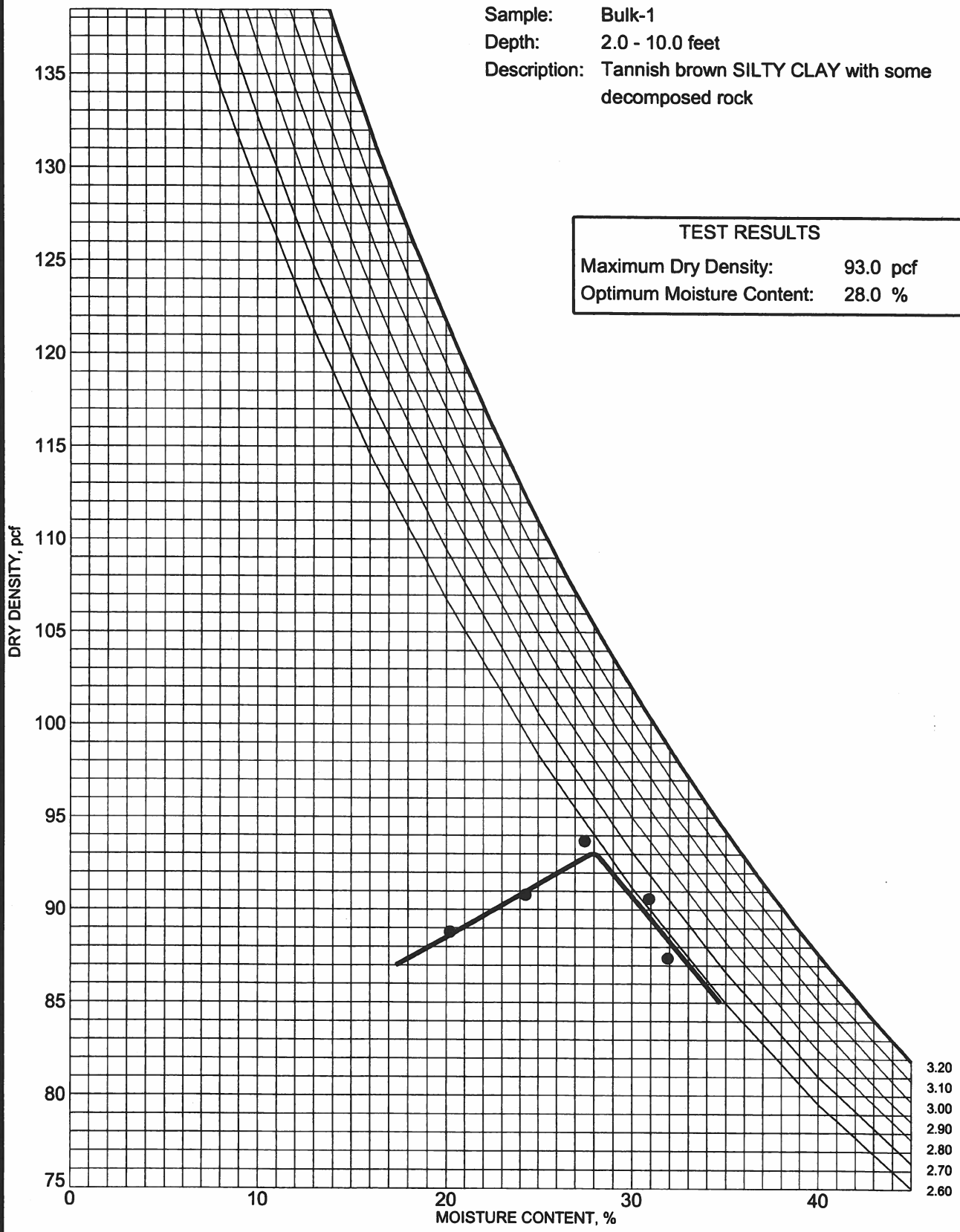
CALIFORNIA BEARING RATIO - ASTM D 1883
INTERSTATE ROUTE H-1 REHAB., EB LANES
WAIAU INTERCHANGE TO KAIMAKANI STREET
EWA, OAHU, HAWAII

Plate
B - 6.4

G_CBR_5088-10.GPJ GEOLABS.GDT 7/12/05

Sample: Bulk-1
Depth: 2.0 - 10.0 feet
Description: Tannish brown SILTY CLAY with some decomposed rock

TEST RESULTS	
Maximum Dry Density:	93.0 pcf
Optimum Moisture Content:	28.0 %



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GEOTECHNICAL ENGINEERING

W.O. 5088-00(A) & 5088-10

MOISTURE-DENSITY RELATIONSHIP - ASTM D 1557 A

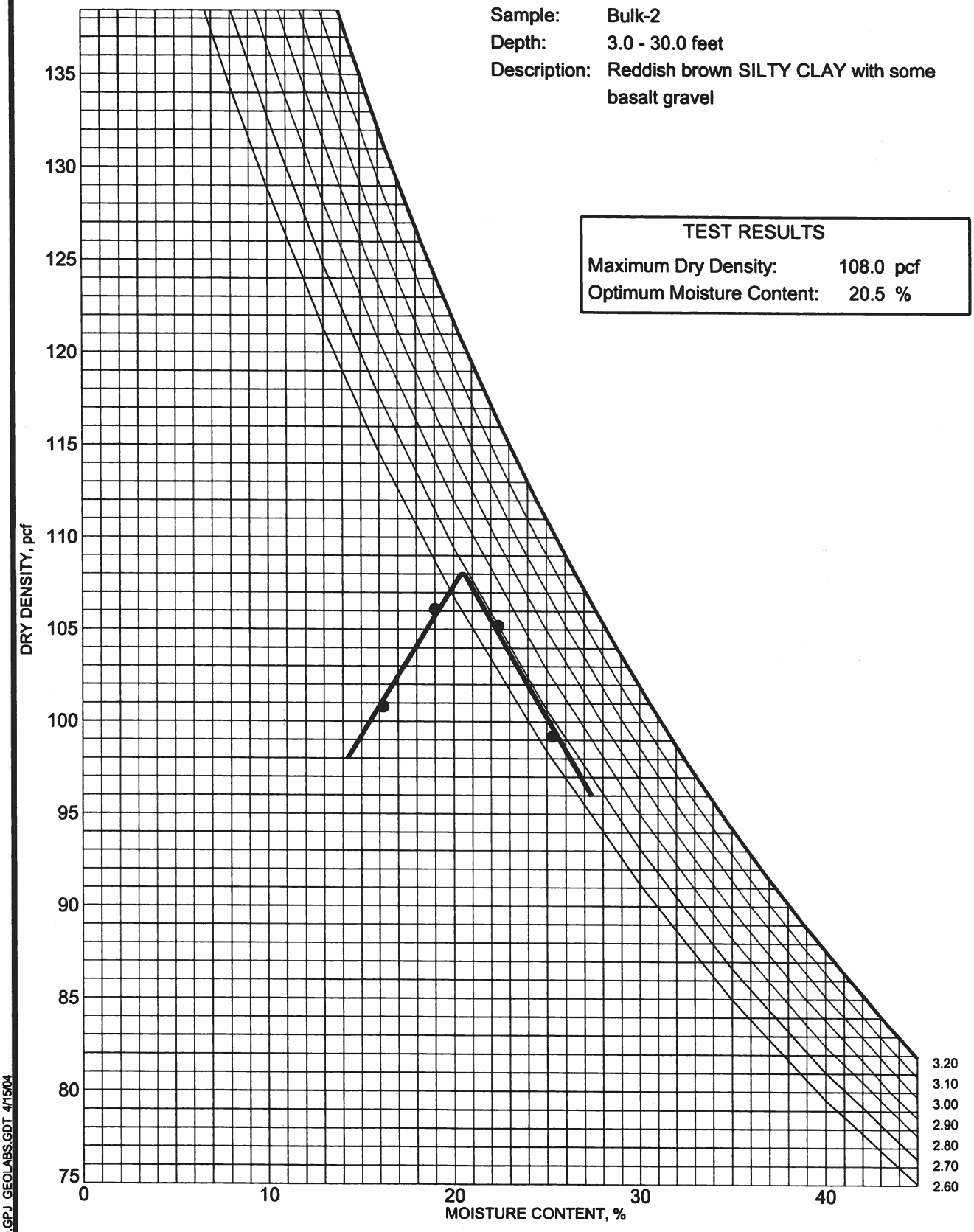
INTERSTATE ROUTE H-1 REHAB., EB LANES
WAIAU INTERCHANGE TO KAIMAKANI STREET
EWA, OAHU, HAWAII

Plate
B - 7.1

G_COMPACTION_5088-00.GPJ GEOLABS.GDT 4/15/04

Sample: Bulk-2
Depth: 3.0 - 30.0 feet
Description: Reddish brown SILTY CLAY with some basalt gravel

TEST RESULTS	
Maximum Dry Density:	108.0 pcf
Optimum Moisture Content:	20.5 %



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W.O. 5088-00(A) & 5088-10

MOISTURE-DENSITY RELATIONSHIP - ASTM D 1557 A

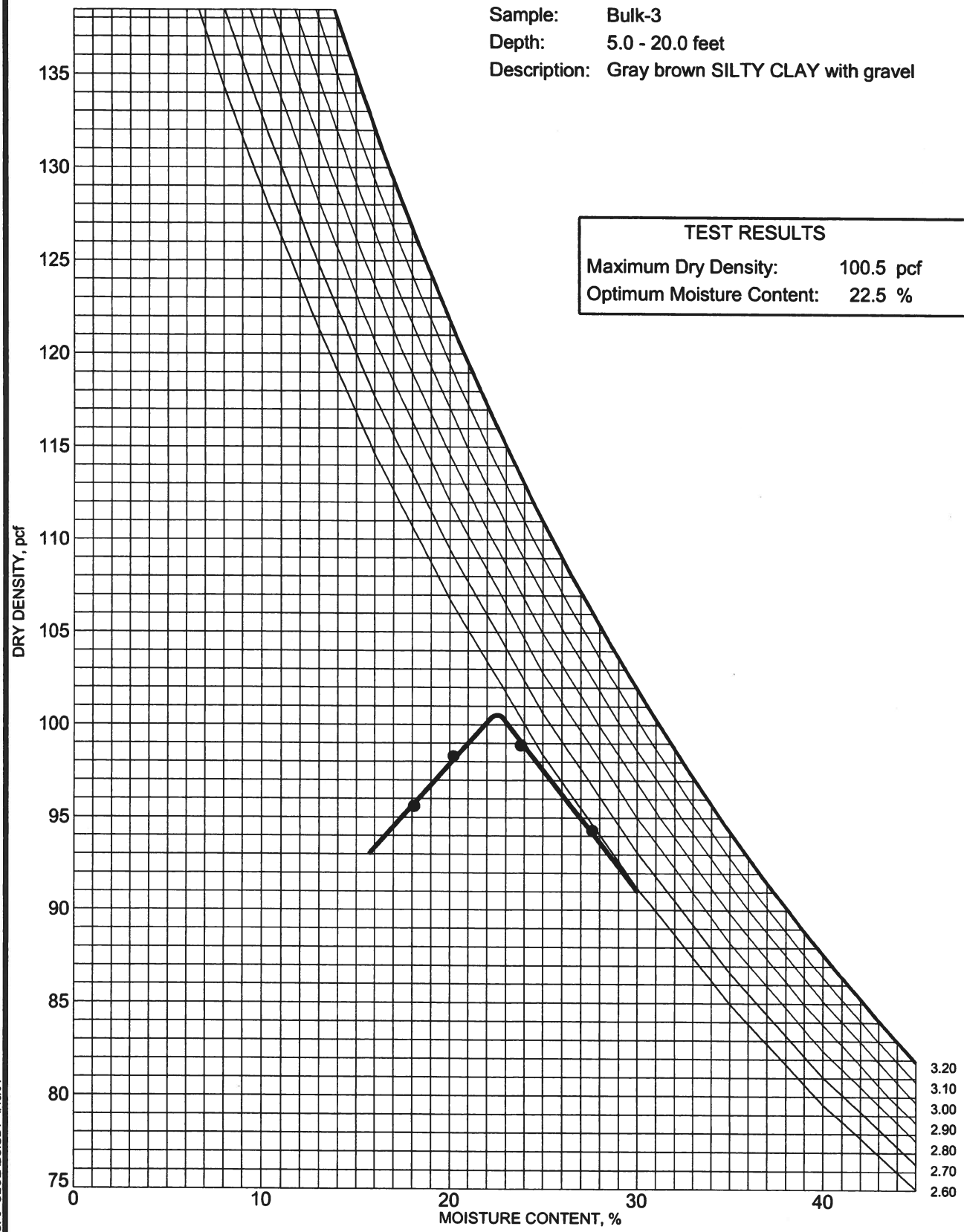
INTERSTATE ROUTE H-1 REHAB., EB LANES
WAIAU INTERCHANGE TO KAIMAKANI STREET
EWA, OAHU, HAWAII

Plate
B - 7.2

G_COMPACTION_5088-00.GPJ_GEOLABS.GDT_4/15/04

Sample: Bulk-3
Depth: 5.0 - 20.0 feet
Description: Gray brown SILTY CLAY with gravel

TEST RESULTS	
Maximum Dry Density:	100.5 pcf
Optimum Moisture Content:	22.5 %



G COMPACTION 5088-00.GPJ GEOLABS.GDT 4/15/04

GEOLABS, INC.
GEOTECHNICAL ENGINEERING

W.O. 5088-00(A) & 5088-10

MOISTURE-DENSITY RELATIONSHIP - ASTM D 1557 B

INTERSTATE ROUTE H-1 REHAB., EB LANES
WAIAU INTERCHANGE TO KAIMAKANI STREET
EWA, OAHU, HAWAII

Plate
B - 7.3

SUMMARY OF SPECIFIC GRAVITY TEST RESULTS

Interstate Route H-1 Rehabilitation, Eastbound Lanes
Waiau Interchange to Kaimakani Street
Ewa, Oahu, Hawaii

Sample No.	Depth (feet)	Specific Gravity
B-1 RS-3	5.0 – 6.5	2.74
B-1 RS-5	15.0 – 16.5	2.59
B-2 RS-3	5.0 – 6.5	2.75
B-2 RS-5	16.5 – 18.0	2.71
B-3 SS-4	10.0 – 11.5	2.66
B-3 SS-6	20.0 – 21.5	2.58
B-3 SS-8	30.0 – 30.5	2.68
B-5 SS-2	5.0 – 6.5	2.61
B-5 SS-4	15.0 – 16.5	2.72
B-5 SS-6	25.0 – 26.5	2.80
B-5 SS-8	35.0 – 36.5	2.61
B-5 SS-10	45.0 – 46.5	2.67
B-7 SS-3	5.0 – 6.5	2.67
B-8 RS-1	2.0 – 3.5	2.75
B-8 RS-3	10.0 – 11.5	2.76
B-8 SS-11	78.5 – 80.0	2.67
B-9 RS-1	3.0 – 4.5	2.68
B-10 SS-2	3.0 – 4.5	2.73
B-10 RS-3	5.0 – 6.5	2.64
B-10 RS-5	15.0 – 16.5	2.49
B-10 SS-9	35.0 – 36.5	2.84
B-10 SS-11	44.5 – 46.0	2.52
B-10 RS-12	49.5 – 50.5	2.48
B-12 RS-1	2.5 – 4.0	2.51
B-12 RS-3	6.0 – 7.5	2.44
B-12 RS-5	15.0 – 16.5	2.40
B-14 RS-1	2.0 – 3.5	2.47
B-14 RS-3	6.0 – 7.5	2.39
B-14 RS-5	15.0 – 16.5	2.45

TEST METHOD:
ASTM D 854 - Specific Gravity

APPENDIX C

Pavement Design

December 13, 2002
Date

MEMORANDUM

TO: HWY-DD

ATTN: R. Sun

FROM: HWY-PH

The following data are submitted for your information:

NAME OF PROJECT: Interstate Route H-1 Rehabilitation,

SECTION: Eastbound Lanes, Waiau Interchange to Kaimakani Street

PROJECT NO.:

TRAFFIC DATA:

2002 ADT	117,100
2022 ADT	133,800
DHV	15,400
Design K	11.5
Design D	100/0
Design T	1.5
T24	3.0

	24-HOUR TRUCK COMPOSITION
CLASSIFICATION	PERCENT
BUS	9.52
2D	55.99
3X	11.82
4X	0.35
2S1, 3S1, 2S2	1.74
3S2, 3-2, 2-3	19.12
6/6+X S-TLR	1.23
5X M-TLR	0.05
6X M-TLR	0.06
7X M-TLR	0.12

REF. NO. TA 02-22

TRAFFIC INDEX DETERMINATION

Project: Interstate Route H-1 Rehabilitation, Eastbound Lanes
Waiau Interchange to Kaimakani Street

Street Name: H-1 Eastbound Lanes (Far Left Traffic Lane with 10 years Design Life)

(1) Design Period (years) — 10

(2) Current Average Daily Traffic (ADT) Per Direction — 118674

(3) Future Average Daily Traffic (ADT) Per Direction — 126870

(4) Average ADT Per Direction Over Design Period — 122772

(5) Design Lane Factor — 0.75

Number of Lanes In One Direction	Design Lane Factor
1	1
2	1
3	0.8
4	0.75

(6) 24-Hour Truck Traffic, T_{24} (%) — 3

Truck Traffic Distribution :

2-axle	=	65.51%
3-axle	=	11.82%
4-axle	=	2.09%
5-axle	=	19.17%
6-axle	=	1.29%
7-axle	=	0.12%

(7) Average Daily Truck Traffic Per Direction, ADTT — 2762

(8) Equivalent 18-kip Single Axle Loads, ESAL

2-axle : % of 2-axle trucks x No. trucks x 65	=	117626
3-axle : % of 3-axle trucks x No. trucks x 525	=	171419
4-axle : % of 4-axle trucks x No. trucks x 1162	=	67086
5-axle : % of 5-axle trucks x No. trucks x 1462	=	774197
6-axle : % of 6-axle trucks x No. trucks x 968	=	37703
Annual ESAL :	=	1168031
Total ESAL For Design Period	=	11680309
TRAFFIC INDEX (TI) = 9 (ESAL/1,000,000)EXP(0.119)		12.06
	SAY	12.0

Project: Interstate Route H-1 Rehabilitation, Eastbound Lanes
Waiau Interchange to Kaimakani Street

Street: H-1 Eastbound Lanes (Far Left Traffic Lane with 10 years Design Life)

Design Parameters

Traffic Index	12.0
R value of ACB	90
R value of ASB	60
R value of Subgrade	9

Pavement Section using Asphalt Concrete Base and Aggregate Subbase

Trial Thickness of AC + ACB 14

(1) **Asphalt Concrete (AC)**

GE required					0.384		
GE with Tolerance =	0.384	+	0.240	=	0.624		
Gf of AC					**2.126**		
GE/Gf	=	3.52		SAY	4.00	Inches	(min. 2.5")

(2) **Asphalt Concrete Base (ACB)**

GE required	=				1.536		
GE of AC	=				0.709		
GE required of ACB	=				0.827		
Gf of ACB					2.020		
GE/Gf	=	4.91		SAY	5.00	Inches	(min. 4")
				USE	10.00		

(3) **Calculate New Gf of AC**

Thickness of AC + Thickness of ACB					1.167		
New Gf of AC					**2.126**		

(4) **Aggregate Subbase (ASB)**

GE required	=				3.494		
GE of AC	=				0.709		
GE of ACB	=				1.683		
GE required of ASB	=				1.102		
GE less tolerance	=				0.862		
Gf of ASB	=				1.000		
GE/Gf	=	10.35		SAY	10.00	Inches	(min. 6")

Design Pavement Section

4.0	**Inches**	**AC**
10.0	**Inches**	**ACB**
10.0	**Inches**	**ASB**
24.0	**Inches**	**Total Thickness**

TRAFFIC INDEX DETERMINATION

Project: Interstate Route H-1 Rehabilitation, Eastbound Lanes
Waiau Interchange to Kaimakani Street

Street Name: H-1 Eastbound Lanes (Shoulder Lane with 10 years Design Life)

(1)	Design Period (years)			10
(2)	Current Average Daily Traffic (ADT) Per Direction			118674
(3)	Future Average Daily Traffic (ADT) Per Direction			126870
(4)	Average ADT Per Direction Over Design Period			122772
(5)	Design Lane Factor			0.75

Number of Lanes In One Direction	Design Lane Factor
1	1
2	1
3	0.8
4	0.75

(6)	24-Hour Truck Traffic, T_{24} (%)			3
	Truck Traffic Distribution :	2-axle =	100.00%	
		3-axle =	0.00%	
		4-axle =	0.00%	
		5-axle =	0.00%	
		6-axle =	0.00%	
		7-axle =	0.00%	
(7)	Average Daily Truck Traffic Per Direction, ADTT			2762
(8)	Equivalent 18-kip Single Axle Loads, ESAL			
	2-axle : % of 2-axle trucks x No. trucks x 65		=	179554
	3-axle : % of 3-axle trucks x No. trucks x 525		=	0
	4-axle : % of 4-axle trucks x No. trucks x 1162		=	0
	5-axle : % of 5-axle trucks x No. trucks x 1462		=	0
	6-axle : % of 6-axle trucks x No. trucks x 968		=	0
	Annual ESAL :		=	179554
	Total ESAL For Design Period		=	1795541
	TRAFFIC INDEX (TI) = 9 (ESAL/1,000,000)EXP(0.119)			9.65
			SAY	9.5

Project: Interstate Route H-1 Rehabilitation, Eastbound Lanes
Waiau Interchange to Kaimakani Street

Street: H-1 Eastbound Lanes (Shoulder Lane with 10 years Design Life)

Design Parameters

Traffic Index	9.5
R value of ACB	90
R value of ASB	60
R value of Subgrade	9

Pavement Section using Asphalt Concrete Base and Aggregate Subbase

Trial Thickness of AC + ACB 11

(1) **Asphalt Concrete (AC)**

GE required					0.304		
GE with Tolerance =	0.304	+	0.240	=	0.544		
Gf of AC					**2.207**		
GE/Gf	=	2.96		SAY	4.00	Inches	(min. 2.5")

(2) **Asphalt Concrete Base (ACB)**

GE required	=				1.216		
GE of AC	=				0.736		
GE required of ACB	=				0.480		
Gf of ACB					2.096		
GE/Gf	=	2.75		SAY	3.00	Inches	(min. 4")
				USE	7.00		

(3) **Calculate New Gf of AC**

Thickness of AC + Thickness of ACB					0.917		
New Gf of AC					**2.207**		

(4) **Aggregate Subbase (ASB)**

GE required	=				2.766		
GE of AC	=				0.736		
GE of ACB	=				1.223		
GE required of ASB	=				0.808		
GE less tolerance	=				0.568		
Gf of ASB	=				1.000		
GE/Gf	=	6.81		SAY	7.00	Inches	(min. 6")

Design Pavement Section

4.0	**Inches**	**AC**
7.0	**Inches**	**ACB**
7.0	**Inches**	**ASB**
18.0	**Inches**	**Total Thickness**

TRAFFIC INDEX DETERMINATION

Project: Interstate Route H-1 Rehabilitation, Eastbound Lanes
Waiau Interchange to Kaimakani Street

Street Name: H-1 Eastbound Lanes (Far Left Traffic Lane with 50 years Design Life)

(1)	Design Period (years)	50
(2)	Current Average Daily Traffic (ADT) Per Direction	118674
(3)	Future Average Daily Traffic (ADT) Per Direction	165714
(4)	Average ADT Per Direction Over Design Period	142194
(5)	Design Lane Factor	0.75

Number of Lanes In One Direction	Design Lane Factor
1	1
2	1
3	0.8
4	0.75

(6) 24-Hour Truck Traffic, T_{24} (%) 3

Truck Traffic Distribution :

2-axle	=	65.51%
3-axle	=	11.82%
4-axle	=	2.09%
5-axle	=	19.17%
6-axle	=	1.29%
7-axle	=	0.12%

(7) Average Daily Truck Traffic Per Direction, ADTT 3199

(8) Equivalent 18-kip Single Axle Loads, ESAL

2-axle : % of 2-axle trucks x No. trucks x 65	=	136234
3-axle : % of 3-axle trucks x No. trucks x 525	=	198537
4-axle : % of 4-axle trucks x No. trucks x 1162	=	77699
5-axle : % of 5-axle trucks x No. trucks x 1462	=	896671
6-axle : % of 6-axle trucks x No. trucks x 968	=	43667
Annual ESAL :	=	1352808
Total ESAL For Design Period	=	67640415
TRAFFIC INDEX (TI) = 9 (ESAL/1,000,000)EXP(0.119)		14.86
	SAY	15.0

Project: Interstate Route H-1 Rehabilitation, Eastbound Lanes
Waiau Interchange to Kaimakani Street

Street: H-1 Eastbound Lanes (Far Left Traffic Lane with 50 years Design Life)

Design Parameters

Traffic Index	15.0
R value of ACB	90
R value of ASB	60
R value of Subgrade	9

Pavement Section using Asphalt Concrete Base and Aggregate Subbase

Trial Thickness of AC + ACB 17.5

(1) **Asphalt Concrete (AC)**

GE required					0.480		
GE with Tolerance =	0.480	+	0.240	=	0.720		
Gf of AC					**2.047**		
GE/Gf	=	4.22		SAY	4.50	Inches	(min. 2.5")

(2) **Asphalt Concrete Base (ACB)**

GE required	=				1.920		
GE of AC	=				0.768		
GE required of ACB	=				1.152		
Gf of ACB					1.945		
GE/Gf	=	7.11		SAY	7.50	Inches	(min. 4")
				USE	13.00		

(3) **Calculate New Gf of AC**

Thickness of AC + Thickness of ACB					1.458		
New Gf of AC					**2.047**		

(4) **Aggregate Subbase (ASB)**

GE required	=				4.368		
GE of AC	=				0.768		
GE of ACB	=				2.107		
GE required of ASB	=				1.494		
GE less tolerance	=				1.254		
Gf of ASB	=				1.000		
GE/Gf	=	15.04		SAY	15.00	Inches	(min. 6")

Design Pavement Section

4.5	**Inches**	**AC**
13.0	**Inches**	**ACB**
15.0	**Inches**	**ASB**
32.5	**Inches**	**Total Thickness**

TRAFFIC INDEX DETERMINATION

Project: Interstate Route H-1 Rehabilitation, Eastbound Lanes
Waiau Interchange to Kaimakani Street

Street Name: H-1 Eastbound Lanes (Shoulder Lane with 50 years Design Life)

(1)	Design Period (years)			50
(2)	Current Average Daily Traffic (ADT) Per Direction			118674
(3)	Future Average Daily Traffic (ADT) Per Direction			165714
(4)	Average ADT Per Direction Over Design Period			142194
(5)	Design Lane Factor			0.75

Number of Lanes In One Direction	Design Lane Factor
1	1
2	1
3	0.8
4	0.75

(6)	24-Hour Truck Traffic, T_{24} (%)			3
	Truck Traffic Distribution :	2-axle =	100.00%	
		3-axle =	0.00%	
		4-axle =	0.00%	
		5-axle =	0.00%	
		6-axle =	0.00%	
		7-axle =	0.00%	
(7)	Average Daily Truck Traffic Per Direction, ADTT			3199
(8)	Equivalent 18-kip Single Axle Loads, ESAL			
	2-axle : % of 2-axle trucks x No. trucks x 65		=	207959
	3-axle : % of 3-axle trucks x No. trucks x 525		=	0
	4-axle : % of 4-axle trucks x No. trucks x 1162		=	0
	5-axle : % of 5-axle trucks x No. trucks x 1462		=	0
	6-axle : % of 6-axle trucks x No. trucks x 968		=	0
	Annual ESAL :		=	207959
	Total ESAL For Design Period		=	10397936
	TRAFFIC INDEX (TI) = 9 (ESAL/1,000,000)EXP(0.119)			11.89
			SAY	12.0

Project: Interstate Route H-1 Rehabilitation, Eastbound Lanes
Waiau Interchange to Kaimakani Street

Street: H-1 Eastbound Lanes (Shoulder Lane with 50 years Design Life)

Design Parameters

Traffic Index	12.0
R value of ACB	90
R value of ASB	60
R value of Subgrade	9

Pavement Section using Asphalt Concrete Base and Aggregate Subbase

Trial Thickness of AC + ACB 14

(1) **Asphalt Concrete (AC)**

GE required					0.384		
GE with Tolerance =	0.384	+	0.240	=	0.624		
Gf of AC					**2.126**		
GE/Gf	=	3.52		SAY	4.00	Inches	(min. 2.5")

(2) **Asphalt Concrete Base (ACB)**

GE required	=				1.536		
GE of AC	=				0.709		
GE required of ACB	=				0.827		
Gf of ACB					2.020		
GE/Gf	=	4.91		SAY	5.00	Inches	(min. 4")
				USE	10.00		

(3) **Calculate New Gf of AC**

Thickness of AC + Thickness of ACB					1.167		
New Gf of AC					**2.126**		

(4) **Aggregate Subbase (ASB)**

GE required	=				3.494		
GE of AC	=				0.709		
GE of ACB	=				1.683		
GE required of ASB	=				1.102		
GE less tolerance	=				0.862		
Gf of ASB	=				1.000		
GE/Gf	=	10.35		SAY	10.00	Inches	(min. 6")

Design Pavement Section

4.0	**Inches**	**AC**
10.0	**Inches**	**ACB**
10.0	**Inches**	**ASB**
24.0	**Inches**	**Total Thickness**

ECONOMIC JUSTIFICATION

PROJECT: Interstate Route H-1 Rehabilitation, Eastbound Lanes
Waiau Interchange to Kaimakani Street
Ewa, Oahu, Hawaii

	Unit Prices:	**In-Place Costs**
1	Asphalt Concrete Pavement (AC) - per ton	$ 110.00
2	Asphalt Concrete Base (ACB) - per ton	$ 105.00
3	Asphalt Treated Permeable Base (ATPB) - per ton	$ 125.00
4	Cement Treated Permeable Base (CTPB) - per cubic yard	$ 130.00
5	Untreated Permeable Base (UTPB) - per cubic yard	$ 60.00
6	Aggregate Base (AB) - per cubic yard	$ 50.00
7	Aggregate Subbase (ASB) - per cubic yard	$ 40.00
8	Portland Cement Concrete Pavement (PCC) - per cubic yard	$ 400.00
9	Roadway Excavation - per cubic yard	$ 50.00
10	Cold Planing of Existing AC - per cubic yard	$ 72.00
11	AC Overlay - per ton	$ 110.00
12	Retexturing of Concrete Pavement - per square yard	$ 30.00

Assumptions/Limitations:

1. The new pavement sections are based on the current HDOT design guidelines

2. HDOT Conversion Factors:

Asphalt Concrete Pavement (Mix IV):	2.07 Tons/cubic yard
Asphalt Concrete Base:	2.12 Tons/cubic yard
Asphalt Treated Permeable Base:	2.19 Tons/cubic yard

3. Assume cold-plane and overlay 2.0 inches of AC every 7 to 8 years for AC pavement with untreated bases
   Assume cold-plane and overlay 2.0 inches of AC every 10 to 12 years for AC pavement with treated bases

4. Economic analysis based on excavated pavement sections.

5. Assume rate of inflation at 6 percent per year.

6. Assume rate of discount at 6 percent per year.

A. Far Left Lane 10-Year Design Life

Pavement Section (in):	4.0	10.0	10.0	24.0
	AC	ACB	ASB	Roadway Excavation

Initial Cost

Items	Thickness (inches)	Quantity (cy/sy)	Unit Price	Cost Per Square Yard
AC	4.0	0.11	$ 110.00	$ 25.30
ACB	10.0	0.28	$ 105.00	$ 61.83
ATPB	0	0.00	$ 125.00	$ -
CTPB	0	0.00	$ 130.00	$ -
UTPB	0	0.00	$ 60.00	$ -
AB	0	0.00	$ 50.00	$ -
ASB	10.0	0.28	$ 40.00	$ 11.11
Roadway Excavation	24.0	0.67	$ 50.00	$ 33.33
			Total Initial Cost	$ 131.58

Maintenance Cost

Year	Items	Thickness (inches)	Quantity (cy/sy)	Present Unit Price	Inflated Unit Price	Inflated Cost Per Sq. Yd.	Present Cost Per Sq. Yd.
Number of Overlay =	0		**Total Maint. Cost**				$ -
OPTION A:			**TOTAL COST**				**$ 131.58**

PAVEMENT COST COMPARISON

OPTION	DESIGN LIFE	TOTAL COST
A	Far Left Lane 10-Year Design Life	$ 131.58
B	Shoulder Lane 10-Year Design Life	$ 101.36
C	Far Left Lane 50-Year Design Life	$ 237.25
D	Shoulder Lane 50-Year Design Life	$ 198.18

B. Shoulder Lane 10-Year Design Life

Pavement Section (in):	4.0 AC	7.0 ACB	7.0 ASB	18.0 Roadway Excavation

Initial Cost

Items	Thickness (inches)	Quantity (cy/sy)	Unit Price	Cost Per Square Yard
AC	4.0	0.11	$ 110.00	$ 25.30
ACB	7.0	0.19	$ 105.00	$ 43.28
ATPB	0	0.00	$ 125.00	$ -
CTPB	0	0.00	$ 130.00	$ -
UTPB	0	0.00	$ 60.00	$ -
AB	0	0.00	$ 50.00	$ -
ASB	7.0	0.19	$ 40.00	$ 7.78
Roadway Excavation	18	0.50	$ 50.00	$ 25.00
			Total Initial Cost	$ 101.36

Maintenance Cost

Year	Items	Thickness (inches)	Quantity (cy/sy)	Present Unit Price	Inflated Unit Price	Inflated Cost Per Sq. Yd.	Present Cost Per Sq. Yd.
Number of Overlay =	0		**Total Maint. Cost**				$ -
OPTION B:			**TOTAL COST**				**$ 101.36**

C. Far Left Lane 50-Year Design Life

Pavement Section (in):	4.5	13.0	15.0	32.5
	AC	ACB	ASB	Roadway Excavation

Initial Cost

Items	Thickness (inches)	Quantity (cy/sy)	Unit Price	Cost Per Square Yard
AC	4.5	0.13	$ 110.00	$ 28.46
ACB	13.0	0.36	$ 105.00	$ 80.38
ATPB	0	0.00	$ 125.00	$ -
CTPB	0	0.00	$ 130.00	$ -
UTPB	0	0.00	$ 60.00	$ -
AB	0	0.00	$ 50.00	$ -
ASB	15.0	0.42	$ 40.00	$ 16.67
Roadway Excavation	32.5	0.90	$ 50.00	$ 45.14
			Total Initial Cost	$ 170.65

Maintenance Cost

Year	Items	Thickness (inches)	Quantity (cy/sy)	Present Unit Price	Inflated Unit Price	Inflated Cost Per Sq. Yd.	Present Cost Per Sq. Yd.
10	Cold-Planing	2.0	0.06	$ 72.00	$ 128.94	$ 7.16	$ 4.00
	AC Overlay	2.0	0.06	$ 110.00	$ 196.99	$ 22.65	$ 12.65
20	Cold-Planing	2.0	0.06	$ 72.00	$ 230.91	$ 12.83	$ 4.00
	AC Overlay	2.0	0.06	$ 110.00	$ 352.78	$ 40.57	$ 12.65
30	Cold-Planing	2.0	0.06	$ 72.00	$ 413.53	$ 22.97	$ 4.00
	AC Overlay	2.0	0.06	$ 110.00	$ 631.78	$ 72.66	$ 12.65
40	Cold-Planing	2.0	0.06	$ 72.00	$ 740.57	$ 41.14	$ 4.00
	AC Overlay	2.0	0.06	$ 110.00	$1,131.43	$ 130.11	$ 12.65
Number of Overlay =	4		**Total Maint. Cost**				$ 66.60

OPTION C: **TOTAL COST** **$ 237.25**

D. Shoulder Lane 50-Year Design Life

Pavement Section (in):	4.0 AC	10.0 ACB	10.0 ASB	24.0 Roadway Excavation

Initial Cost

Items	Thickness (inches)	Quantity (cy/sy)	Unit Price	Cost Per Square Yard
AC	4.0	0.11	$ 110.00	$ 25.30
ACB	10.0	0.28	$ 105.00	$ 61.83
ATPB	0	0.00	$ 125.00	$ -
CTPB	0	0.00	$ 130.00	$ -
UTPB	0	0.00	$ 60.00	$ -
AB	0	0.00	$ 50.00	$ -
ASB	10.0	0.28	$ 40.00	$ 11.11
Roadway Excavation	24	0.67	$ 50.00	$ 33.33
			Total Initial Cost	$ 131.58

Maintenance Cost

Year	Items	Thickness (inches)	Quantity (cy/sy)	Present Unit Price	Inflated Unit Price	Inflated Cost Per Sq. Yd.	Present Cost Per Sq. Yd.
10	Cold-Planing	2.0	0.06	$ 72.00	$ 128.94	$ 7.16	$ 4.00
	AC Overlay	2.0	0.06	$ 110.00	$ 196.99	$ 22.65	$ 12.65
20	Cold-Planing	2.0	0.06	$ 72.00	$ 230.91	$ 12.83	$ 4.00
	AC Overlay	2.0	0.06	$ 110.00	$ 352.78	$ 40.57	$ 12.65
30	Cold-Planing	2.0	0.06	$ 72.00	$ 413.53	$ 22.97	$ 4.00
	AC Overlay	2.0	0.06	$ 110.00	$ 631.78	$ 72.66	$ 12.65
40	Cold-Planing	2.0	0.06	$ 72.00	$ 740.57	$ 41.14	$ 4.00
	AC Overlay	2.0	0.06	$ 110.00	$1,131.43	$ 130.11	$ 12.65
Number of Overlay =	4		**Total Maint. Cost**				$ 66.60

OPTION D: **TOTAL COST** **$ 198.18**