GEOTECHNICAL ENGINEERING EXPLORATION
INTERSTATE ROUTE H-1 AND H-201
DESTINATION SIGN UPGRADE/REPLACEMENT, PHASE 3
FEDERAL-AID PROJECT NO. NH-0300(144)
ISLAND OF OAHU, HAWAII

W.O. 7341-00   FEBRUARY 3, 2022

Prepared for

KSF, INC.

GEOLABS, INC.
Geotechnical Engineering and Drilling Services

GEOTECHNICAL ENGINEERING EXPLORATION
INTERSTATE ROUTE H-1 AND H-201
DESTINATION SIGN UPGRADE/REPLACEMENT, PHASE 3
FEDERAL-AID PROJECT NO. NH-0300(144)
ISLAND OF OAHU, HAWAII

W.O. 7341-00 FEBRUARY 3, 2022

Prepared for

KSF, INC.

GERALD Y. SEKI
No. 5635-C

THIS WORK WAS PREPARED BY
ME OR UNDER MY SUPERVISION.

SIGNATURE

4-30-22
EXPIRATION DATE
OF THE LICENSE

GEOLABS, INC.
Geotechnical Engineering and Drilling Services
94-429 Koaki Street, Suite 200 • Waipahu, HI 96797

Hawaii • California

GEOLABS, INC.
Geotechnical Engineering and Drilling Services

February 3, 2022
W.O. 7341-00

Mr. Calvin Miyahara
KSF, Inc.
615 Piikoi Street, Suite 300
Honolulu, HI 96814

Dear **Mr. Miyahara:**

Geolabs, Inc. is pleased to submit our report entitled "Geotechnical Engineering Exploration, Interstate Route H-1 and H-201 Destination Sign Upgrade/Replacement, Phase 3, Federal Aid Project No. NH-0300(144), Island of Oahu, Hawaii," prepared for the design of the proposed project.

Our work for the project was performed in general accordance with the scope of services outlined in our revised fee proposal dated November 14, 2016, and additional fee proposal dated December 12, 2018.

Please note that the soil and rock samples recovered during our field exploration (remaining after testing) will be stored for a period of two months from the date of this report. The samples will be discarded after that date unless arrangements are made for a longer sample storage period. Please contact our office for alternative sample storage requirements, if appropriate.

Detailed discussion and specific design recommendations 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.

Gerald Y. Seki, P.E.
Vice President

GS:HC:lf

GEOTECHNICAL ENGINEERING EXPLORATION
INTERSTATE ROUTE H-1 AND H-201
DESTINATION SIGN UPGRADE/REPLACEMENT, PHASE 3
FEDERAL-AID PROJECT NO. NH-0300(144)
ISLAND OF OAHU, HAWAII

W.O. 7341-00 FEBRUARY 3, 2022

TABLE OF CONTENTS

GEOTECHNICAL ENGINEERING EXPLORATION
INTERSTATE ROUTE H-1 AND H-201
DESTINATION SIGN UPGRADE/REPLACEMENT, PHASE 3
FEDERAL-AID PROJECT NO. NH-0300(144)
ISLAND OF OAHU, HAWAII
W.O. 7341-00 FEBRUARY 3, 2022

SUMMARY OF FINDINGS AND RECOMMENDATIONS

Based on our field exploration and research of available geologic information, the geologic units that comprise the sign replacement sites include lava flows of the Koolau and Honolulu Volcanic Series, tuff and tuff cone deposits of the Honolulu Volcanic Series, and Quaternary alluvium. We encountered groundwater at Signs H1EBR-253, H1EB-305, H1WB-421 and H2NBR-722 sites at depths ranging from about 11 to 23 feet below the existing ground surface. It should be noted that groundwater levels encountered in the drilled borings are subject to change due to rainfall, time of year, seasonal precipitation, surface water runoff, and other factors.

In order to develop the required bearing and lateral load resistances for the new sign structures, we recommend supporting the sign structures on drilled shaft foundations having a minimum diameter of 48, 60, or 72 inches. Based on the anticipated structural loads and the subsoil conditions encountered at each site, the recommended shaft embedment lengths of the drilled shafts supporting the sign structures range between 14 and 30 feet.

The performance of the drilled shafts depends significantly upon the contractor's method of construction, construction procedures, and workmanship. Therefore, the contractor should review the recommendations and general guidelines presented in this report during the drilled shaft foundation construction.

Basalt rock and volcanic tuff formations were encountered at Signs H1EBR-253, 78WB-853, H1WB-421 and H1EB-104 sites. Cobbles and boulders were encountered at the Sign H2NBR-722 site. The drilled shaft subcontractor should have the appropriate equipment and tools to drill through the basalt rock, volcanic tuff, boulders, and cobbles, where encountered.

Alluvial deposits consisting of loose to medium dense silty gravel and silty sand were encountered at the Signs H1EB-305 and H2NBR-722 sites. These loose soils may likely cave-in and/or slough off during the drilling operations; therefore, the temporary casing may be required during the drilled shaft installation and/or the use of polymer drilling fluids (if accepted by Geolabs) may be necessary to maintain the integrity of the drilled hole during drilled shaft installation. The text of this report should be referred to for detailed discussion and recommendations.

END OF SUMMARY OF FINDINGS AND RECOMMENDATIONS

SECTION 1. GENERAL

1.1 Introduction

This report presents the results of our geotechnical engineering exploration performed for the "*Interstate Route H-1 and H-201 Destination Sign Upgrade/Replacement, Phase 3, Island of Oahu, Hawaii"* project from Ewa to Honolulu on the Island of Oahu, Hawaii. The project location and general vicinity are shown on the Project Location Map, Plate 1.

This report summarizes the findings and presents our geotechnical engineering recommendations derived from our field exploration, laboratory testing, and engineering analyses. These recommendations are only intended for the foundation design of the replacement destination sign structures. The findings and recommendations presented herein are subject to the limitations noted at the end of this report.

1.2 Project Considerations

The project involves the upgrade and replacement of 11 destination sign structures on the Island of Oahu. We understand that amongst the 11 destination sign structures, four of the destination sign structures, including signs H1EBR-253, H1WB-421, H1EB-305 and 78WB-853, will be replaced. The four destination sign structures to be replaced are located at various areas on the Island of Oahu along Interstate Route H-1 and Moanalua Freeway. We understand that two additional destination signs structures, H2NBR-722 along Kamehameha Highway and H1EB-104 along Interstate Route H-1 Freeway, are subsequently included for replacement. Therefore, a total of six destination sign structures will be replaced with new foundations.

The following structural load information acting at the top of the foundation was provided by the project structural engineer for our analysis of the new sign structure foundation design.

FOUNDATION LOADING FOR REPLACEMENT DESTINATION SIGNS					
EXTREME EVENT I LIMIT STATE					
Destination Sign Identification	H1EBR-253 & 78WB-853	H1WB-421	H1EB-305	H2NBR-722	H1EB-104
Vertical Load (kips)	49.2	60.5	48	42.2	52.6
Shear Parallel to Sign (kips)	4.4	10.7	6.6	4.4	10.7
Shear Perpendicular to Sign (kips)	59.5	70.1	46	46	58.7
Moment Parallel to Sign (ft.-kips)	68	1,313	403	68	845
Moment Perpendicular to Sign (ft.-kips)	1,429	1,603	1,045	1,080	1,409
Torsion (ft.-kips)	63	1,828	250	49	1,134

1.3 Purpose and Scope

The purpose of our exploration was to obtain an overview of the subsurface conditions to develop an idealized soil/rock data set to formulate geotechnical engineering recommendations for the design of the proposed project. The work was performed in general accordance with our revised fee proposal dated November 14, 2016, and additional fee proposal dated December 12, 2018. The scope of work for this exploration included the following tasks and work efforts:

1. Research and review of available in-house geologic and soils information along the highway alignment under this project.
2. Application of necessary excavation permits from the State of Hawaii – Department of Transportation, Highways Division.
3. Staking out of the boring locations and utility toning and clearance with various utility companies.
4. Provisions of police officers and safety devices for traffic control and lane closures at the boring locations during our field exploration program.
5. Mobilization and demobilization of a truck-mounted drill rig and two operators to the project sites and back.

6. Drilling and sampling of nine borings extending to depths of about 26.5 to 45.6 feet below the existing ground surface.

7. Coordination of the field exploration and logging of the borings by our geologist.

8. Laboratory testing of selected soil and rock core samples obtained during the field exploration as an aid in classifying the materials and evaluating their engineering properties.

9. Engineering analyses of the field and laboratory data to formulate geotechnical engineering recommendations pertaining to the foundation design of the replacement destination sign structures.

10. Preparation of this report summarizing our work on the project and presenting our findings and geotechnical engineering recommendations.

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

12. Quality assurance of our work and client/design team consultation by our principal engineer.

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

Detailed descriptions of our field exploration and the Logs of Borings are provided in Appendix A. Results of the laboratory tests are presented in Appendix B. Photographs of core samples are presented in Appendix C.

END OF GENERAL

SECTION 2. SITE CHARACTERIZATION

2.1 Regional Geology

The Island of Oahu was built by the extrusion of basaltic lavas from the Waianae and Koolau shield volcanoes. The older 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 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. Waianae Volcano became extinct while Koolau Volcano was still active, and its eastern flank was partially buried below Koolau lavas banking against its eastern flank. These banked or ponded lavas formed a broad plateau referred to as the Schofield Plateau.

The Schofield Plateau was formed when lavas from the Koolau Volcano ponded against the already eroded slopes of the Waianae Volcano in the late Pleistocene Epoch. The dips of the lava beds are generally near horizontal (between 3 to 5 degrees from horizontal). The lava flows on the plateau have undergone in-situ weathering extending to depths of 50 to 100 feet and are characterized by the red colors of the soil.

As the main shield building on the Island of Oahu drew to a close during the Pleistocene Epoch, sea levels fluctuated in response to continental glaciation. As the sea levels fluctuated, fringing coral/algal reefs began to grow on the seaward margins of the island. After a long period of volcanic activity, during which erosion incised deep valleys into the Koolau shield, volcanic activity returned with a series of lava flows followed by cinder and tuff cone formations. These series are referred to as the Honolulu Volcanic Series. Subsequently, a thick sedimentary wedge, known as the Honolulu Coastal Plain, started to accumulate along the southern shores of Oahu. The Honolulu Coastal Plain is composed of intercalated coral/algal reef deposits, terrigenous and marine sediments and volcanics of the Honolulu Volcanic Series.

In general, the project sites are located on the southerly side of the Koolau Volcano and Schofield Plateau. The geologic units include lava flows, tuff, and tuff cone deposits of the Honolulu Volcanic Series and Quaternary alluvium.

2.2 Existing Site Conditions

The project sites are along Interstate Routes H-1 and H-201 and along Kamehameha Highway at various locations on the Island of Oahu, Hawaii. The project locations and general vicinity are shown on the Project Location Map, Plate 1. The approximate locations of each site are shown on the Site Plans, Plates 2.1 through 2.6. The following provides a brief description of the existing conditions at each destination sign site.

2.2.1 Sign H1EBR-253 Site

This site is generally located east of the main gates of Joint Base Pearl Harbor-Hickam along the eastbound direction of Nimitz Highway between O'Malley Boulevard and Valkenburgh Street. Based on the drawings provided, we understand that the existing two-post sign structure will be replaced with another two-post sign structure about 10 feet west from the existing sign structure.

2.2.2 Sign H1WB-421 Site

The site is located along the westbound direction of Interstate Route H-1 between Gulick Avenue and Kalihi Street overpasses. Based on the drawings provided, we understand that the existing two-post sign structure will be replaced with a one-post, cantilever sign structure about 10 feet east from the existing sign structure.

2.2.3 Sign H1EB-305 Site

The site is located along the eastbound direction of Interstate Route H-1 near Vineyard Boulevard Exit 20B. Based on the drawings provided, we understand that the existing one-post, double cantilever sign structure will be replaced with another one-post, double cantilever sign structure about 10 feet southeast from the existing sign structure.

2.2.4 Sign 78WB-853 Site

The site is generally located along the westbound direction of Moanalua Freeway between Ala Kapuna Street overpass and Interstate Route H3 Exit 1D. Based on the drawings provided, we understand that the existing two-post sign structure will be replaced with another two-post sign structure about 10 feet west from the existing sign structure.

2.2.5 Sign H2NBR-722 Site

The site is generally located near the fork along the westbound direction of Kamehameha Highway by Sam’s Club in Pearl City. Based on the drawings provided, we understand that the existing two-post sign structure will be replaced with another two-post sign structure about 10 feet west from the existing sign structure.

2.2.6 Sign H1EB-104 Site

The site is located at about 0.5 miles west of the Fort Weaver Road exit along Interstate Route H-1 in the eastbound direction. Based on the drawings provided, we understand that the existing one-post cantilever sign structure will be replaced with another one-post cantilever sign structure about 10 feet east from the existing sign structure.

2.3 Subsurface Conditions

Our field exploration consisted of drilling and sampling nine borings, designated as Boring Nos. 1 through 9, extending to depths of about 26.5 to 45.6 feet below the existing ground surface. The approximate boring locations are shown on the Site Plans, Plates 2.1 through 2.6. The subsurface conditions at each sign location are presented in the following subsections.

2.3.1 Sign H1EBR-253 Site

The subsurface condition near the existing Sign H1EBR-253 structure was explored by drilling and sampling two borings, designated as Boring Nos. 1 and 2, on Nimitz Highway extending to a depth of about 31 feet below the existing pavement surface.

Our field exploration indicates that the project site is generally covered with about 4-inch thick asphaltic concrete pavement underlain by surficial fills and volcanic tuff formation extending to the maximum depth explored of about 31 feet below the pavement surface. In general, our borings encountered surficial fills consisting of silty gravel and sandy silt extending to depths of about 4 and 4.5 feet below the pavement surface. The surficial fill was generally underlain by medium hard to soft volcanic tuff formation extending to the maximum depth explored of about 31 feet below the pavement surface. It should be noted that within Boring No. 1, weathered volcanic tuff consisting of very stiff sandy silt was encountered within the volcanic tuff formation between depths of about 9 and 11 feet below the pavement surface. Groundwater was encountered in the borings at about 11 and 11.5 feet below the pavement surface at the time of our field exploration.

2.3.2 Sign H1WB-421 Site

The subsurface condition near the existing Sign H1WB-421 structure was explored by drilling and sampling one boring, designated as Boring No. 6, on Interstate Route H-1 Freeway extending to a depth of about 26.5 feet below the existing pavement surface.

Our field exploration indicates that the project site is generally covered with about 12-inch thick asphaltic concrete pavement underlain by surficial fills, residual soil and saprolite with basalt formation at a greater depth. In general, our boring encountered surficial fills consisting of medium dense to dense sandy gravel, and very stiff clayey silt extending to a depth of about 4 feet below the pavement surface. The surficial fill was generally underlain by residual soil consisting of stiff to very stiff silty clay extending to a depth of about 9.5 feet below the pavement surface. Beneath the residual soil, saprolite consisting of dense to very dense silty sand was encountered between the depths of about 9.5 and 11.5 feet below the pavement surface. Underlying the saprolite, our boring encountered hard basalt formation extending to the maximum depth explored of about 26.5 feet below the pavement surface. Groundwater was encountered in the boring at about 9.6 feet below the pavement surface at the time of our field exploration.

2.3.3 Sign H1EB-305 Site

The subsurface condition near the existing Sign H1EB-305 structure was explored by drilling and sampling one boring, designated as Boring No. 3, on Interstate

Route H-1 Freeway extending to a depth of about 38 feet below the existing pavement surface.

Our field exploration indicates that the project site is generally covered with about 7-inch thick asphaltic concrete pavement underlain by surficial fills and alluvial deposits extending to the maximum depth explored of about 38 feet below the pavement surface. In general, our boring encountered surficial fills consisting of dense to medium dense sands and gravels, and stiff to very stiff silty clay extending to a depth of about 6 feet below the pavement surface. The surficial fill was generally underlain by alluvial deposits consisting of medium stiff to very stiff silty clay and clayey silt extending to the maximum depth explored of about 38 feet below the pavement surface. It should be noted that a loose silty gravel layer was encountered within the alluvial deposits between depths of about 15 and 20 feet below the pavement surface. Groundwater was encountered in the boring at about 15 feet below the pavement surface at the time of our field exploration.

2.3.4 Sign 78WB-853 Site

The subsurface condition near the existing Sign 78WB-853 structure was explored by drilling and sampling two borings, designated as Boring Nos. 4 and 5, on Moanalua Freeway extending to depths of about 31.5 feet below the existing pavement surface.

Our field exploration indicates that the project site is generally covered with asphaltic concrete pavement of about 6 to 12 inches thickness underlain by fills, residual soils, weathered clinker and saprolite with basalt formation at greater depths. In general, our borings encountered fills consisting of dense to loose sandy gravel and gravelly sand extending to depths of about 11 and 2.5 feet below the pavement surface for Boring Nos. 4 and 5, respectively. The fill was generally underlain by residual soils, weathered clinker and saprolite consisting of very stiff to hard silty clay and clayey silt extending to depths of about 19.5 and 24.5 feet below the pavement surface. Underlying the residual soils, weathered clinker and saprolite, our borings encountered hard basalt formation extending to the maximum depths explored of about 31.5 feet below the pavement surface. We did not encounter groundwater in the drilled borings at the time of our field exploration.

2.3.5 Sign H2NBR-722 Site

The subsurface condition near the existing Sign H2NBR-722 structure was explored by drilling and sampling two borings, designated as Boring Nos. 7 and 8, on Kamehameha Highway extending to depths of about 30.1 and 45.6 feet below the existing pavement surface.

Our field exploration indicates that the project site is generally covered with about 8 to 9 inches thick asphaltic concrete pavement underlain by surficial fills and alluvium extending to the maximum depth explored of about 45.6 feet below the pavement surface. In general, our borings encountered surficial fills consisting of gravelly sand and silty gravel extending to depths of about 2 to 3 feet below the pavement surface. The surficial fill was generally underlain by alluvium consisted of hard sandy silt with some gravel to medium dense silty sand and sandy gravel with cobbles and boulders extending to the maximum depth explored of about 45.6 feet below the pavement surface. Dense cobbles and boulders were encountered at various depths of about 25 to 45.6 feet below the pavement surface. Groundwater was encountered in the borings at about 22.7 and 23.3 feet below the pavement surface at the time of our field exploration.

2.3.6 Sign H1EB-104 Site

The subsurface condition near the existing Sign H1EB-104 structure was explored by drilling and sampling one boring, designated as Boring No. 9, on Interstate Route H-1 Freeway extending to a depth of about 31 feet below the existing pavement surface.

Our field exploration indicates that the project site is generally covered with about 3-inch thick asphaltic concrete pavement underlain by surficial fills, residual soil and saprolite with basalt formation at a greater depth. In general, our boring encountered surficial fills consisting of medium dense sandy gravel and clayey sand extending to a depth of about 3 feet below the pavement surface. The surficial fill was generally underlain by residual soil consisting of medium stiff sandy silt extending to a depth of about 4.5 feet below the pavement surface. Beneath the residual soil, saprolite consisting of very dense silty sand with some gravel was encountered between the depths of about 4.5 and 12.5 feet below the pavement surface. Underlying the saprolite, hard basalt formation was encountered extending to the maximum depth explored of about 31 feet below the pavement surface. We did not encounter groundwater in the drilled boring at the time of our field exploration.

It should be noted that groundwater levels encountered in the drilled borings are subject to change due to rainfall, time of year, seasonal precipitation, surface water runoff, and other factors.

Detailed descriptions of the materials encountered from our field exploration are presented on the Logs of Borings in Appendix A. Results of the laboratory tests performed on selected soil samples are presented in Appendix B. Photographs of core samples are presented in Appendix C.

END OF SITE CHARACTERIZATION

SECTION 3. DISCUSSION AND RECOMMENDATIONS

In order to develop the required bearing and lateral load resistances for the new sign structures, we recommend supporting the sign structures on drilled shaft foundations. The sign structures should be supported on drilled shafts having a minimum diameter of 60 or 72 inches. Based on the anticipated structural loads and the subsoil conditions encountered at each site, the recommended shaft lengths for the 60-inch and 72-inch diameter drilled shafts supporting the sign structures range between 14 and 30 feet.

The drilled shaft subcontractor should have the appropriate equipment and tools to drill through the basalt rock, volcanic tuff, boulders, and cobbles encountered at the sign structure sites. The performance of the drilled shafts depends significantly upon the contractor's method of construction, construction procedures, and workmanship. Therefore, the contractor should review the recommendations and general guidelines presented in the “Drilled Shaft Construction Considerations” subsection of this report. Detailed discussion of these items and our geotechnical engineering design recommendations are presented in the following sections.

3.1 Drilled Shaft Foundations

Based on the structural loading information provided, the sign structure foundations will be subjected to relatively high ground line moments. In order to develop the required bearing and lateral load resistances, the proposed new sign structures may be supported by a foundation system consisting of cast-in-place concrete drilled shafts. Our recommendations for the drilled shaft foundations at each sign site are presented in the following table.

DRILLED SHAFT FOUNDATION DESIGNS			
Destination Sign I.D.	**Number of Post Supports**	**Minimum Shaft Diameter** (inches)	**Minimum Shaft Embedment Length** (feet)
H1EBR-253	2	60	14
H1WB-421	1	72	16
H1EB-305	1	60	30
78WB-853	2	60	28
H1NBR-722	2	60	28
H1EB-104	1	72	18

The cast-in-place concrete drilled shafts would derive vertical support principally from skin friction between the shafts and the surrounding soils. The end bearing component of the drilled shafts has been discounted in our analysis.

3.1.1 Lateral Load Resistance

The lateral load resistance of each drilled shaft is a function of the stiffness of the surrounding soil, the stiffness of the drilled shaft, allowable deflection at the top of the drilled shaft, and the induced moment in the drilled shaft. The lateral load analyses were performed using the program LPILE for Windows, which is a microcomputer adaptation of a finite difference, laterally loaded deep foundation program originally developed at the University of Texas at Austin. The program solves for deflection and bending moment along a deep foundation under lateral loads as a function of depth. The analysis was carried out with the use of non-linear “p-y” curves to represent soil moduli. The lateral deflection was then computed using the appropriate soil moduli at various depths.

Based on the provided structural loads and the subsurface soil conditions at each destination sign location, the results of our analyses are summarized in the following table. The project structural engineer should verify the drilled shaft structural capacity for the calculated induced stresses.

LATERAL DEFLECTION AND MAXIMUM INDUCED MOMENT & SHEAR IN THE DRILLED SHAFTS					
Destination Sign I.D.	**Limit State**	**Lateral Head Deflection** (inches)	**Maximum Induced Shear** (kips)	**Maximum Induced Moment** (kip-feet)	**Depth to Maximum Moment** (feet)
H1EBR-253	Extreme Event I	0.2	299.7	1,717	5.0
H1WB-421	Extreme Event I	0.4	780.0	2,308	5.5
H1EB-305	Extreme Event I	0.7	94.8	1,358	7.0
78WB-853	Extreme Event I	0.7	156.4	1,758	7.5
H1NBR-722	Extreme Event I	0.9	119.3	1,325	8.0
H1EB-104	Extreme Event I	0.4	499.5	2,000	7.0

For the analysis of the drilled shaft foundations, we have assumed that a minimum concrete compressive strength of 4,500 pounds per square inch (psi) will be specified and a nominal longitudinal reinforcing steel of about 1 percent of the cross-sectional area of the drilled shaft will be used.

In general, drilled shaft foundations are constructed by drilling a hole down into the bearing strata, placing reinforcing steel, and then pumping high slump concrete to fill up the hole. The result is a cast-in-place concrete drilled shaft for foundation support. Based on the subsurface conditions encountered at each project site, we envision the drilled shaft foundations would derive vertical support primarily from skin friction between the drilled shaft and the surrounding materials. The end bearing component of the drilled shafts has been discounted in our analysis since the relatively small vertical loading will be resisted mainly by skin friction before reaching the shaft tip.

3.1.2 Torsional Resistance

In general, the sign structures may be subjected to torsional moments resulting in torsion on the drilled shaft foundations. Torsion may be resisted by the side shear along the drilled shaft surface and adjacent soils. Based on our analyses, we believe that the recommended diameter of drilled shafts extending to the depths recommended should be capable of resisting the torsional moment without significant movement of the foundations. It is our understanding that frequency analyses for modeling the foundation along with the structure for the two large cantilever signs structures under high torsional loads will be performed for Signs H1WB-421 and H1EB104. For the required analyses, “p-y” curves for the pile cap and the drilled shaft were estimated using the LPILE program for a composite pile with an upper pile section consisting of 7.5 feet by 7.5 feet by 5 feet thick with the top of the pile at 6 inches above the finish ground surface. The second pile section from the 5 feet below the top of the pile to the design bottom consists of a 72-inch diameter drilled shaft. Results of the generated non-linear “p-y” curves are summarized and present on Plates 3.1 through 4.2.

3.1.3 Foundation Settlement

Settlement of the drilled shaft foundation will result from elastic compression of the shaft and subgrade response of the foundation embedded in the soils encountered at the site. We anticipate that the total settlements of the drilled shafts are estimated to be less than 0.5 inches. We believe that a significant portion of the settlement will be elastic and should occur as the loads are applied.

3.1.4 Drilled Shaft Construction Considerations

In general, the performance of drilled shafts depends significantly upon the contractor's method of installation and construction procedures. The following conditions would have a significant effect on the effectiveness and cost of the drilled shaft foundations.

The load-bearing capacities of drilled shafts depend, to a significant extent, on the friction between the shaft and the surrounding soils. Therefore, proper construction techniques, especially during the drilling operations, are important. The contractor should exercise care in drilling the shaft holes and in placing concrete into the drilled holes.

Basalt rock and volcanic tuff formations were encountered at the Signs H1EBR-253, 78WB-853, H1WB-421 and H1EB-104 sites. In addition, cobbles and boulders were encountered at the Sign H2NBR-722 site. The drilled shaft subcontractor will need to have the appropriate equipment and tools to drill through the basalt rock, volcanic tuff, boulders, and cobbles, where encountered.

Based on our field exploration, alluvial deposits consisting of loose to medium dense silty gravel and silty sand were encountered at the Signs H1EB-305 and H2NBR-722 sites. These loose soils may likely cave-in and/or slough off during the drilling operations. To reduce the potential for caving-in of the drilled holes, the temporary casing may be required during the drilled shaft installation and/or the use of drilling fluids (polymer slurry) may be necessary to maintain the integrity of the drilled hole during drilled shaft installation. Drilling by methods utilizing drilling fluids may have a significant effect on the supporting capacity of the drilled shaft; therefore, use of drilling fluids would require prior evaluation and acceptance by Geolabs.

Care should be exercised during the removal of the temporary casing to reduce the potential for "necking" of the drilled shaft. Therefore, a minimum 5-foot head of concrete above the bottom of the casing or adequate concrete head to counter the hydrostatic pressures due to the groundwater conditions, where encountered, should be maintained during the removal of the casing.

The groundwater conditions may pose construction difficulties because proper observation of the sides and bottoms of the drilled shaft may not be possible. Groundwater conditions are anticipated within the depths of the drilled shaft excavations at Signs H1EBR-253, H1EB-305, H1WB-421 and H2NBR-722 sites. Concrete placement by tremie methods will be required during drilled shaft construction where groundwater is encountered in the drilled holes. The concrete should be placed in a suitable manner by displacing the water in an upward fashion from the bottom of the drilled hole. A low-shrink concrete mix with high slump (7 to 9-inch slump range) should be used to provide close contact between the drilled shafts and the surrounding soils. The concrete should be placed in a suitable manner to reduce the potential for segregation of the aggregates from the concrete mix. In addition, the concrete should be placed promptly after drilling (within 24 hours after drilling of the holes) to reduce the potential for softening of the sides of the drilled holes.

A Geolabs representative should be present to observe the drilling and installation of drilled shafts during construction. Although the drilled shafts are designed based primarily on skin friction, the bottom of the drilled hole should be relatively free of loose materials prior to the placement of concrete. Therefore, Geolabs' observation of the drilled shaft installation operations is necessary to confirm the assumed subsurface conditions and should be designated a “Special Inspection” item.

3.2 Design Review

Drawings and specifications for the proposed construction should be forwarded to Geolabs for review and written comments prior to bid advertisement. This review is necessary to evaluate the conformance of the plans and specifications with the intent of the foundation and earthwork recommendations provided herein. If this review is not made, Geolabs cannot assume responsibility for misinterpretation of the recommendations presented.

3.3 Construction Observation

Geolabs should be retained to provide geotechnical engineering services during construction of the proposed project. The critical item of construction monitoring that requires "Special Inspection" includes observation of the drilled shaft construction.

A Geolabs representative should monitor other aspects of earthwork construction to observe compliance with the intent of 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 herein 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. LIMITATIONS

The analyses and recommendations submitted herein are based in part upon information obtained from the field borings. Variations of conditions between and beyond the field 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 herein.

The field boring locations are approximate, having been estimated by using a hand-held Global Positioning System (GPS) device and shown on the roadway plans provided by WSP USA Inc. on December 12, 2018. Elevations of three borings were estimated based on spot elevations shown on the available topographic survey maps prepared by Controlpoint Surveying, Inc. for some of the sign locations. The physical locations and elevations of the borings should be considered accurate only to the degree implied by the methods used.

The stratification breaks shown on 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 seasonal rainfall, surface runoff and other factors. These data have been reviewed and interpretations made in the formulation of this report.

This report has been prepared for the exclusive use of KSF, Inc. for specific application to the *Interstate Route H-1 and H-201 Destination Sign Upgrade/Replacement, Phase 3, Federal Aid Project No. NH-0300(144), Island of Oahu, Hawaii* 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 engineer in the design of the proposed project. Therefore, this report may not contain sufficient data, or the proper information, to serve as the basis for preparation of construction cost estimates. A contractor wishing to bid on this project is urged to retain a competent geotechnical engineer to assist in the interpretation of this report and/or in the performance of additional site-specific exploration for bid estimating purposes.

The owner/client should be aware that unanticipated soil conditions are commonly encountered. Unforeseen soil 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.

This geotechnical engineering exploration conducted at the project site was not intended to investigate the potential presence of hazardous materials existing at the site. It should be noted that the equipment, techniques, and personnel used to conduct a geo-environmental exploration differ substantially from those applied in geotechnical engineering.

END OF LIMITATIONS

CLOSURE

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

Project Location Map	Plate 1
Site Plans	Plates 2.1 thru 2.6
P-Y Curves	Plates 3.1 thru 4.2
Field Exploration	Appendix A
Laboratory Tests	Appendix B
Photographs of Core Samples	Appendix C

* * *

Respectfully submitted,

GEOLABS, INC.

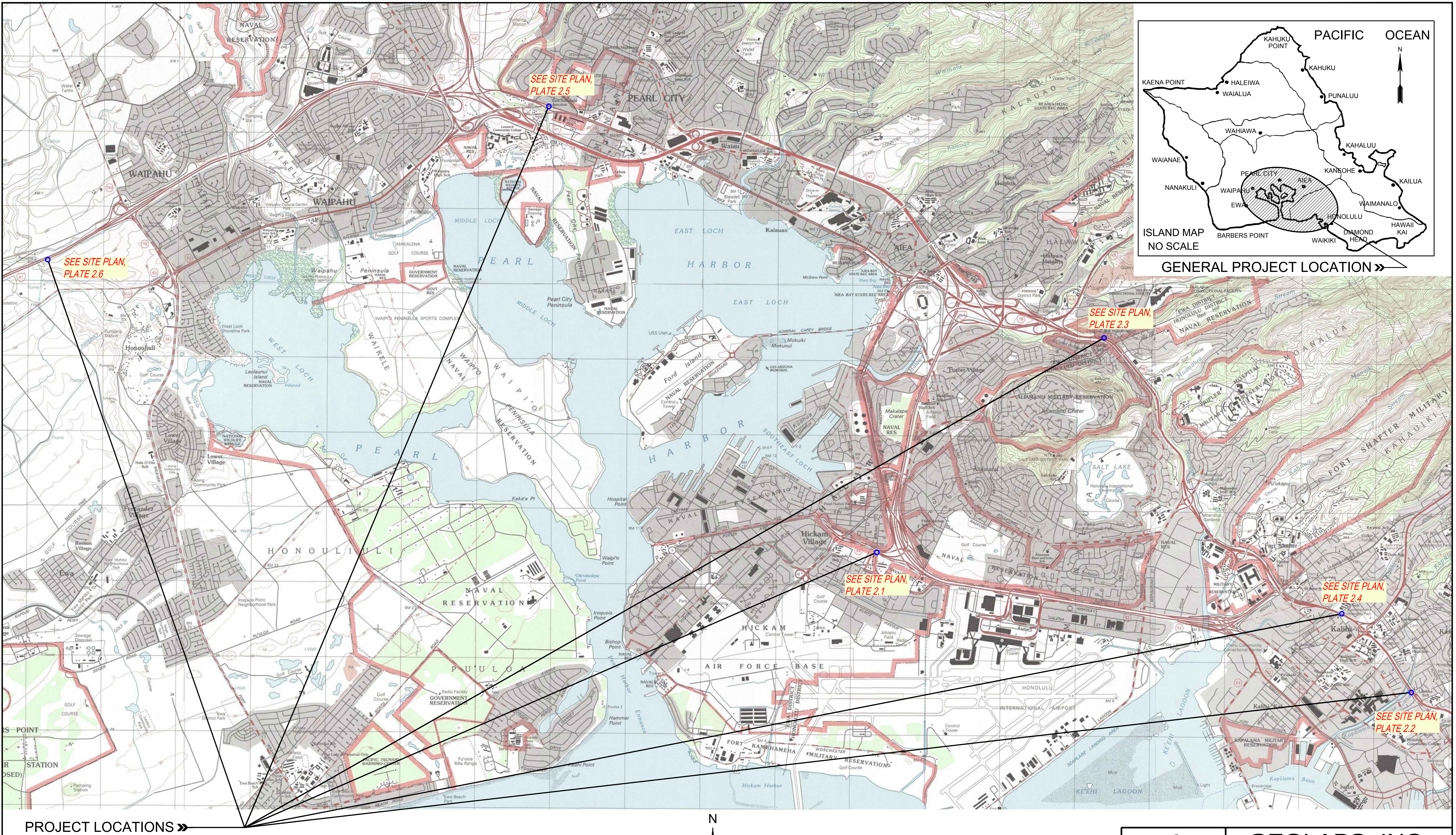
By ______________________
Herbert Y.F. Chu, P.E.
Associates/Senior Project Engineer

By ______________________
Gerald Y. Seki, P.E.
Vice President

GS:HC:lf

h:\7300Series\7341-00.hc1

PLATES



N

4000 2000 0 4000 FT.

GRAPHIC SCALE

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

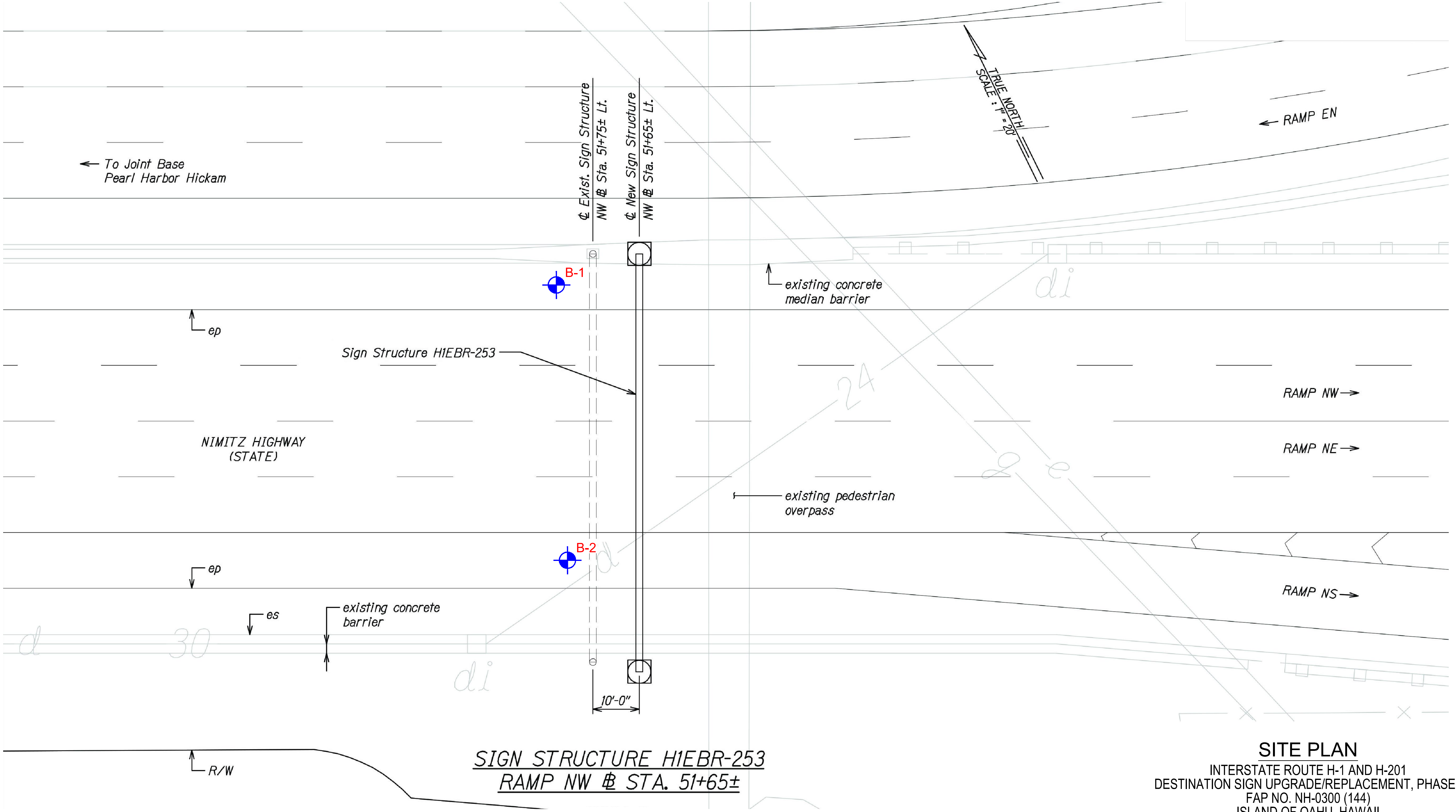
PROJECT LOCATION MAP

INTERSTATE ROUTE H-1 AND H-201
DESTINATION SIGN UPGRADE/REPLACEMENT, PHASE 3
FAP NO. NH-0300 (144)
ISLAND OF OAHU, HAWAII

GEOLABS, INC.
Geotechnical Engineering

DATE	DRAWN BY	PLATE
JANUARY 2022	HYC	
SCALE	W.O.	
1" = 4,000'	7341-00	1

CAD User: HENRY File Last Updated: December 14, 2018 2:02:50pm Plot Date: January 19, 2022 - 12:23:22pm
File: A:\Drafting\Drafting\Working\7341-00_Interstate_Route_H-1_&_H201_Sign_Upgrade\7341-00PLM.dwg\PLM
Plotter: DWG To PDF-GEO.pc3 Plotstyle: GEO-No-Dithering-Blue-Boring.ctb



SIGN STRUCTURE H1EBR-253
RAMP NW ℄ STA. 51+65±

SITE PLAN
INTERSTATE ROUTE H-1 AND H-201
DESTINATION SIGN UPGRADE/REPLACEMENT, PHASE3
FAP NO. NH-0300 (144)
ISLAND OF OAHU, HAWAII

LEGEND:

⌖ APPROXIMATE BORING LOCATION

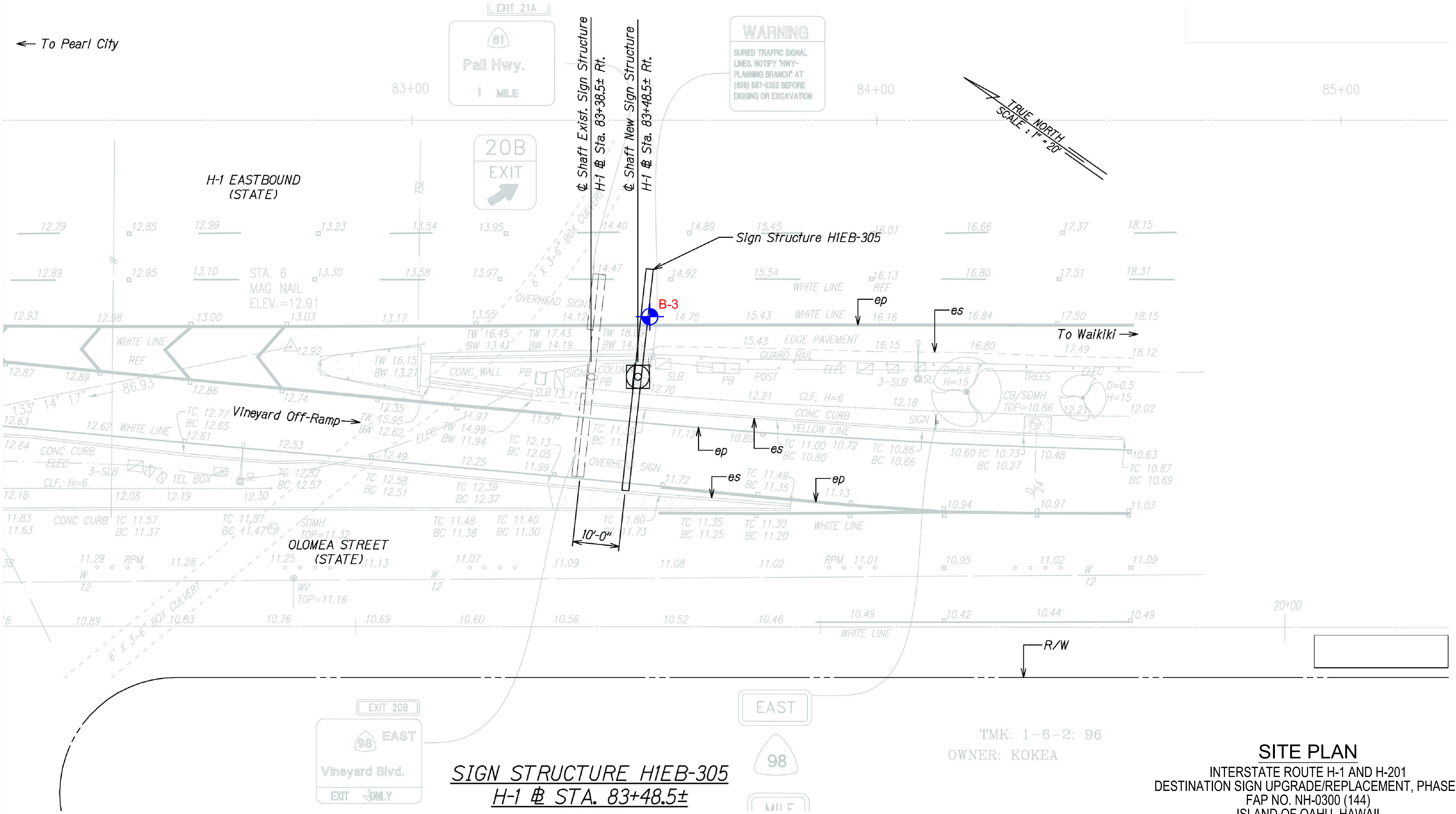
REFERENCE: ROADWAY CONSTRUCTION PLAN SIGN H1EBR-253
DATED DECEMBER 2018 FROM PROJECT DRAWINGS.

0 10 20 40 60 FT.
GRAPHIC SCALE

GEOLABS, INC.
Geotechnical Engineering

DATE	DRAWN BY	PLATE
DECEMBER 2018	HYC	
SCALE	W.O.	
1" = 20'	7341-00	2.1

CAD User: HENRY File Last Updated: December 19, 2018 9:03:23am Plot Date: December 19, 2018 - 9:03:48am
File: T:\Drafting\Working\7341-00Interstate_Route_H-1_&_H201_Sign_Upgrade\7341-00SitePlan.dwg\2.1
Plotter: DWG To PDF-GEO.pc3 Plotstyle: PLOT HP_Half.ctb



SIGN STRUCTURE H1EB-305
H-1 Ⓑ STA. 83+48.5±

LEGEND:

⊕ APPROXIMATE BORING LOCATION

REFERENCE: ROADWAY CONSTRUCTION PLAN SIGN H1EB-305
DATED DECEMBER 2018 FROM PROJECT DRAWINGS.

0 10 20 40 60 FT.
GRAPHIC SCALE

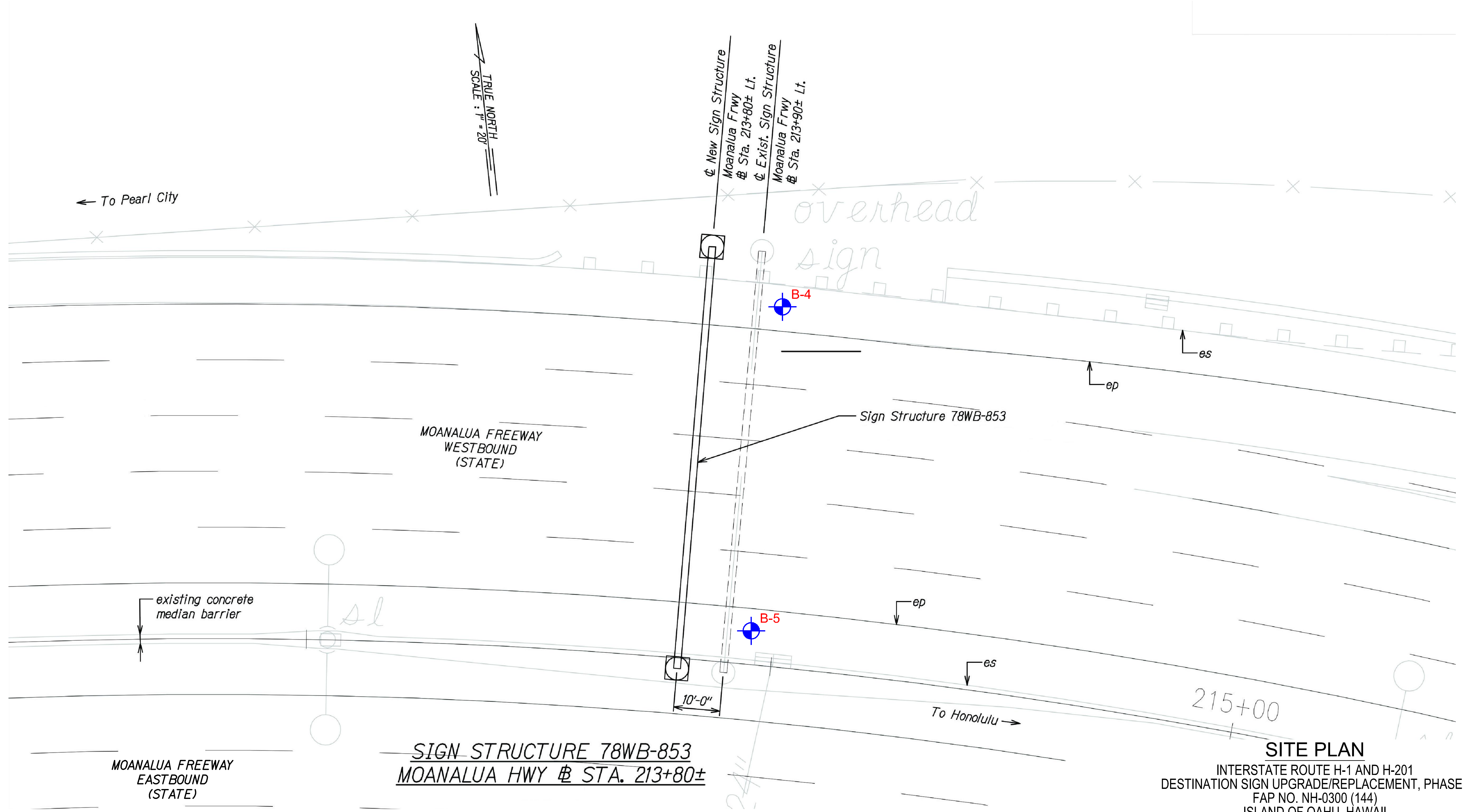
SITE PLAN

INTERSTATE ROUTE H-1 AND H-201
DESTINATION SIGN UPGRADE/REPLACEMENT, PHASE3
FAP NO. NH-0300 (144)
ISLAND OF OAHU, HAWAII

GEOLABS, INC.
Geotechnical Engineering

DATE	DRAWN BY	PLATE
DECEMBER 2018	HYC	
SCALE	W.O.	2.2
1" = 20'	7341-00	

CAD User: HENRY File Last Updated: December 19, 2018 9:03:23am Plot Date: December 19, 2018 - 9:04:04am
File: T:\Drafting\Working\7341-00Interstate_Route_H-1_&_H201_Sign_Upgrade\7341-00SitePlan.dwg\2.2
Plotter: DWG To PDF-GEO.pc3 Plotstyle: PLOT HP_Half.ctb



SIGN STRUCTURE 78WB-853
MOANALUA HWY Ⓑ STA. 213+80±

SITE PLAN

INTERSTATE ROUTE H-1 AND H-201
DESTINATION SIGN UPGRADE/REPLACEMENT, PHASE3
FAP NO. NH-0300 (144)
ISLAND OF OAHU, HAWAII

LEGEND:

⌖ APPROXIMATE BORING LOCATION

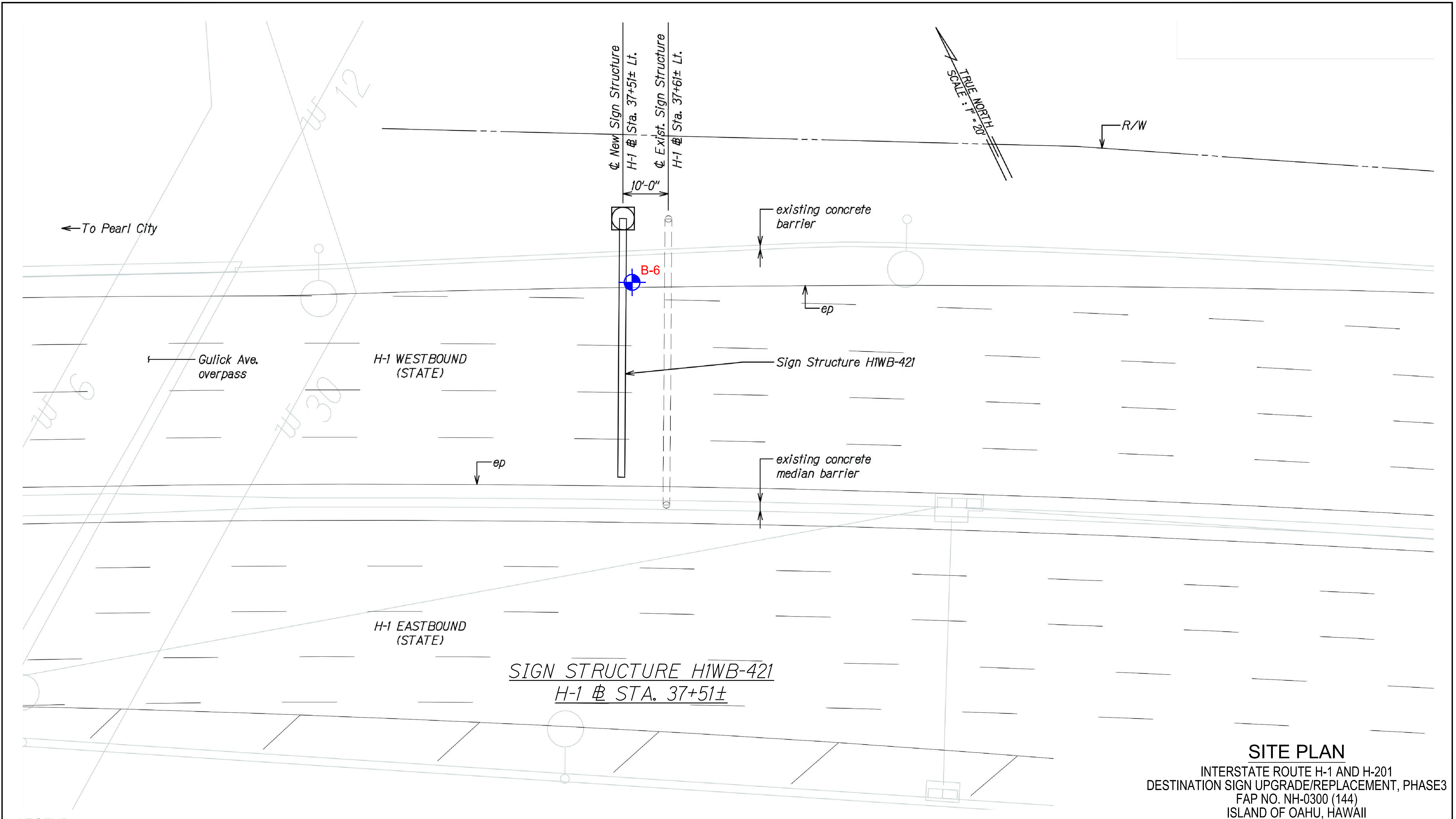
0 10 20 40 60 FT.
GRAPHIC SCALE

REFERENCE: ROADWAY CONSTRUCTION PLAN SIGN 78WB-853
DATED DECEMBER 2018 FROM PROJECT DRAWINGS.

GEOLABS, INC.
Geotechnical Engineering

DATE	DRAWN BY	PLATE
DECEMBER 2018	HYC	
SCALE	W.O.	2.3
1" = 20'	7341-00	

CAD User: HENRY File Last Updated: December 19, 2018 9:03:23am Plot Date: December 19, 2018 - 9:04:20am
File: T:\Drafting\Working\7341-00Interstate_Route_H-1_&_H201_Sign_Upgrade\7341-00SitePlan.dwg\2.3
Plotter: DWG To PDF-GEO.pc3 Plotstyle: PLOT HP_Half.ctb



SIGN STRUCTURE H1WB-421
H-1 ℄ STA. 37+51±

LEGEND:

⌖ APPROXIMATE BORING LOCATION

0 10 20 40 60 FT.

GRAPHIC SCALE

REFERENCE: ROADWAY CONSTRUCTION PLAN SIGN H1WB-421
DATED DECEMBER 2018 FROM PROJECT DRAWINGS.

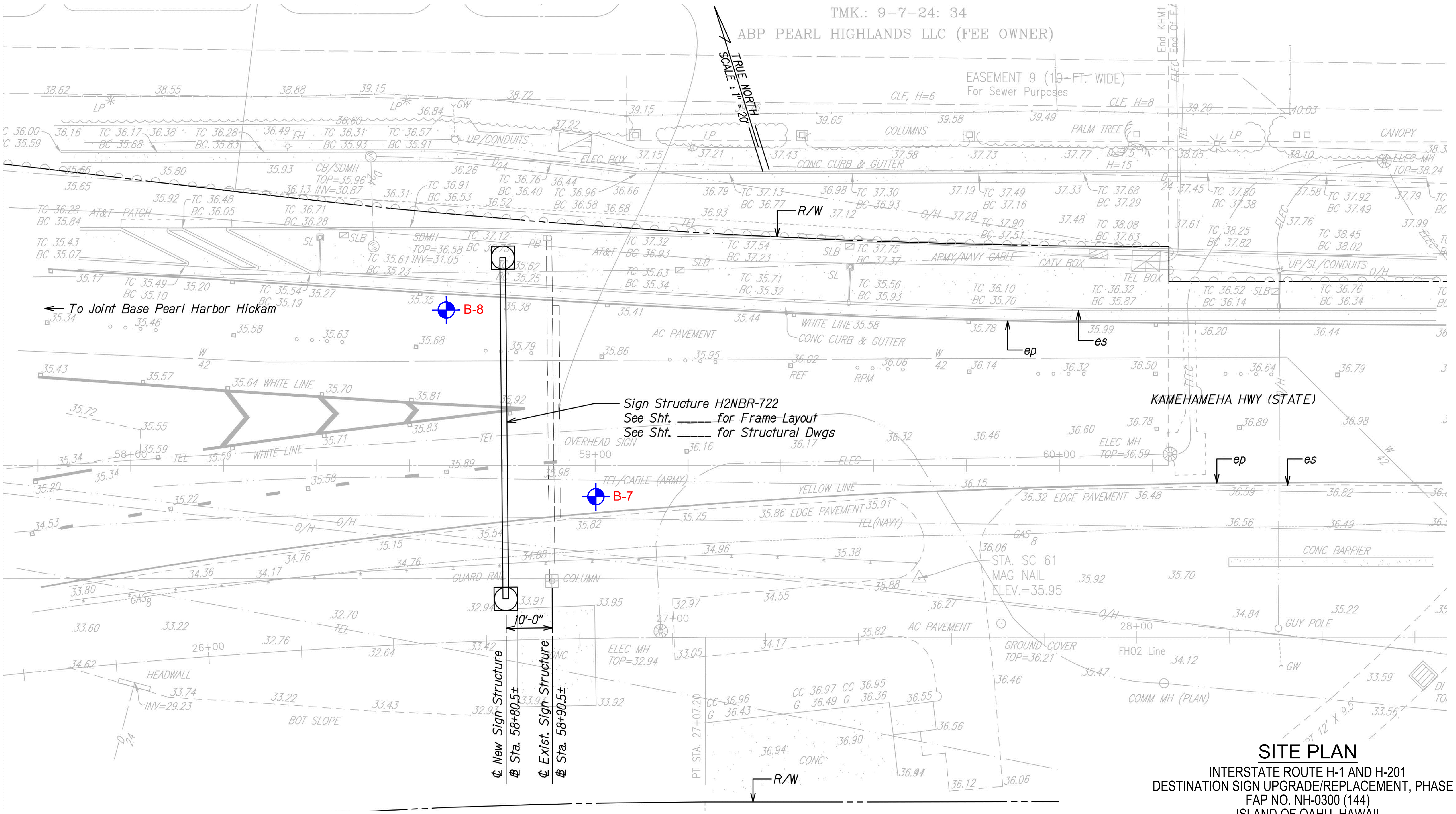
SITE PLAN

INTERSTATE ROUTE H-1 AND H-201
DESTINATION SIGN UPGRADE/REPLACEMENT, PHASE3
FAP NO. NH-0300 (144)
ISLAND OF OAHU, HAWAII

GEOLABS, INC.
Geotechnical Engineering

DATE	DRAWN BY	PLATE
DECEMBER 2018	HYC	
SCALE	W.O.	2.4
1" = 20'	7341-00	

CAD User: HENRY File Last Updated: December 19, 2018 9:03:23am Plot Date: December 19, 2018 - 9:04:33am
File: T:\Drafting\Working\7341-00Interstate_Route_H-1_&_H201_Sign_Upgrade\7341-00SitePlan.dwg\2.4
Plotter: DWG To PDF-GEO.pc3 Plotstyle: PLOT HP_Half.ctb



SIGN STRUCTURE H2NBR-722
KAMEHAMEHA HWY ℔ STA. 58+80.5±

LEGEND:

⊕ APPROXIMATE BORING LOCATION

REFERENCE: ROADWAY CONSTRUCTION PLAN SIGN H2NBR-722
DATED DECEMBER 2018 FROM PROJECT DRAWINGS.

0 10 20 40 60 FT.
GRAPHIC SCALE

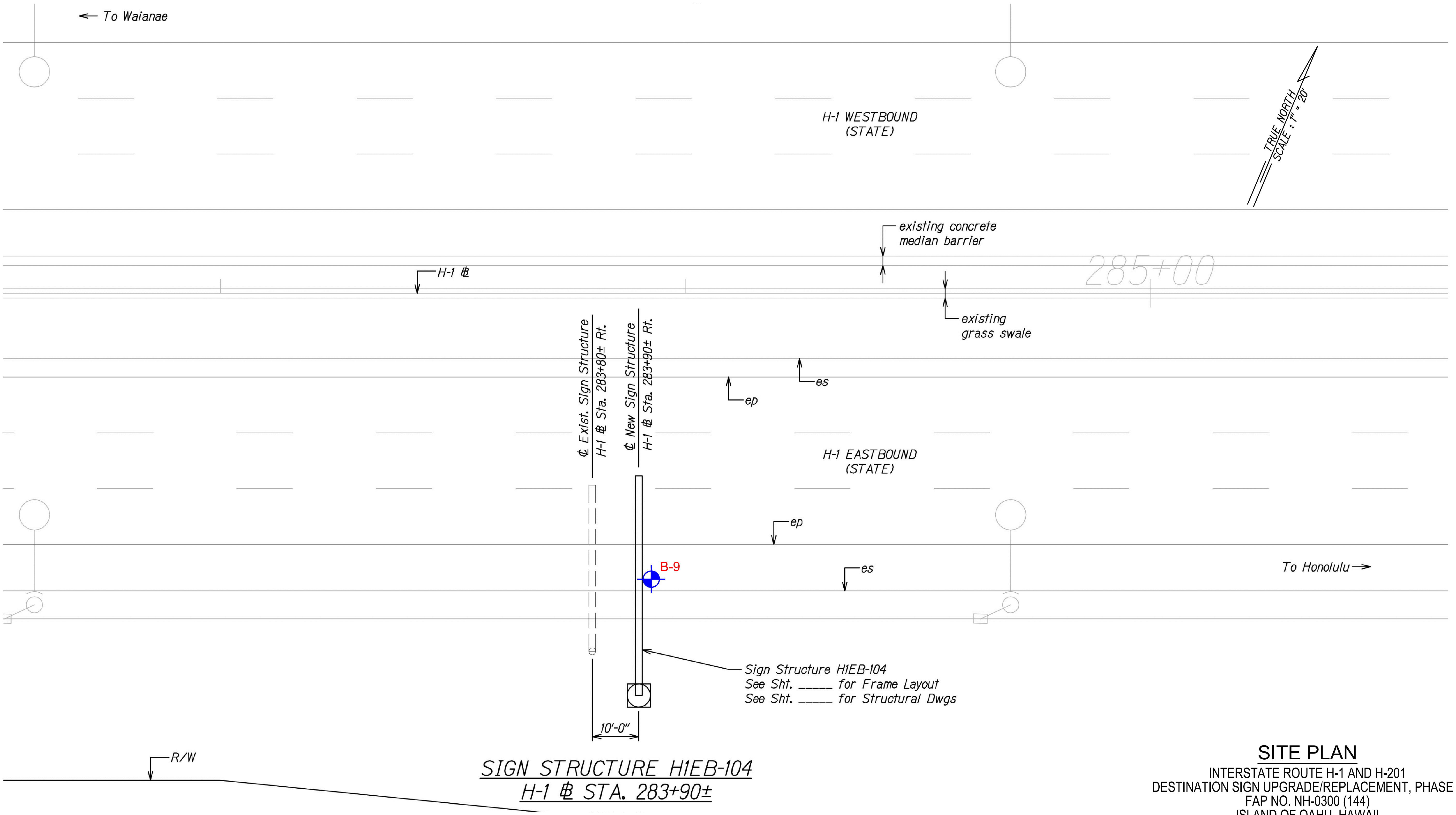
SITE PLAN

INTERSTATE ROUTE H-1 AND H-201
DESTINATION SIGN UPGRADE/REPLACEMENT, PHASE 3
FAP NO. NH-0300 (144)
ISLAND OF OAHU, HAWAII

GEOLABS, INC.
Geotechnical Engineering

DATE	DRAWN BY	PLATE
JANUARY 2022	HYC	2.5
SCALE	W.O.	
1" = 20'	7341-00	

CAD User: HENRY File Last Updated: December 19, 2018 9:54:01am Plot Date: January 19, 2022 - 4:06:13pm
File: A:\Drafting\Drafting\Working\7341-00_Interstate_Route_H-1_&_H201_Sign_Upgrade\7341-00SitePlan.dwg\2.5
Plotter: DWG To PDF-GEO.pc3 Plotstyle: PLOT HP_Half.ctb



SIGN STRUCTURE H1EB-104
H-1 ℄ STA. 283+90±

LEGEND:

⊕ APPROXIMATE BORING LOCATION

GRAPHIC SCALE

REFERENCE: ROADWAY CONSTRUCTION PLAN SIGN H1EB-104
DATED DECEMBER 2018 FROM PROJECT DRAWINGS.

SITE PLAN
INTERSTATE ROUTE H-1 AND H-201
DESTINATION SIGN UPGRADE/REPLACEMENT, PHASE 3
FAP NO. NH-0300 (144)
ISLAND OF OAHU, HAWAII

GEOLABS, INC.
Geotechnical Engineering

DATE	DRAWN BY	PLATE
JANUARY 2022	HYC	
SCALE	W.O.	2.6
1" = 20'	7341-00	

CAD User: HENRY File Last Updated: December 19, 2018 9:54:01am Plot Date: January 19, 2022 - 4:06:30pm
File: A:\Drafting\Drafting\Working\7341-00_Interstate_Route_H-1_&_H201_Sign_Upgrade\7341-00SitePlan.dwg\2.6
Plotter: DWG To PDF-GEO.pc3 Plotstyle: PLOT HP_Half.ctb

SIGN H1WB-421 LATERAL LOAD ANALYSIS
Interstate Route H-1 and H-201
Destination Sign Upgrade/Replacement, Phase 3
Island of Oahu, Hawaii

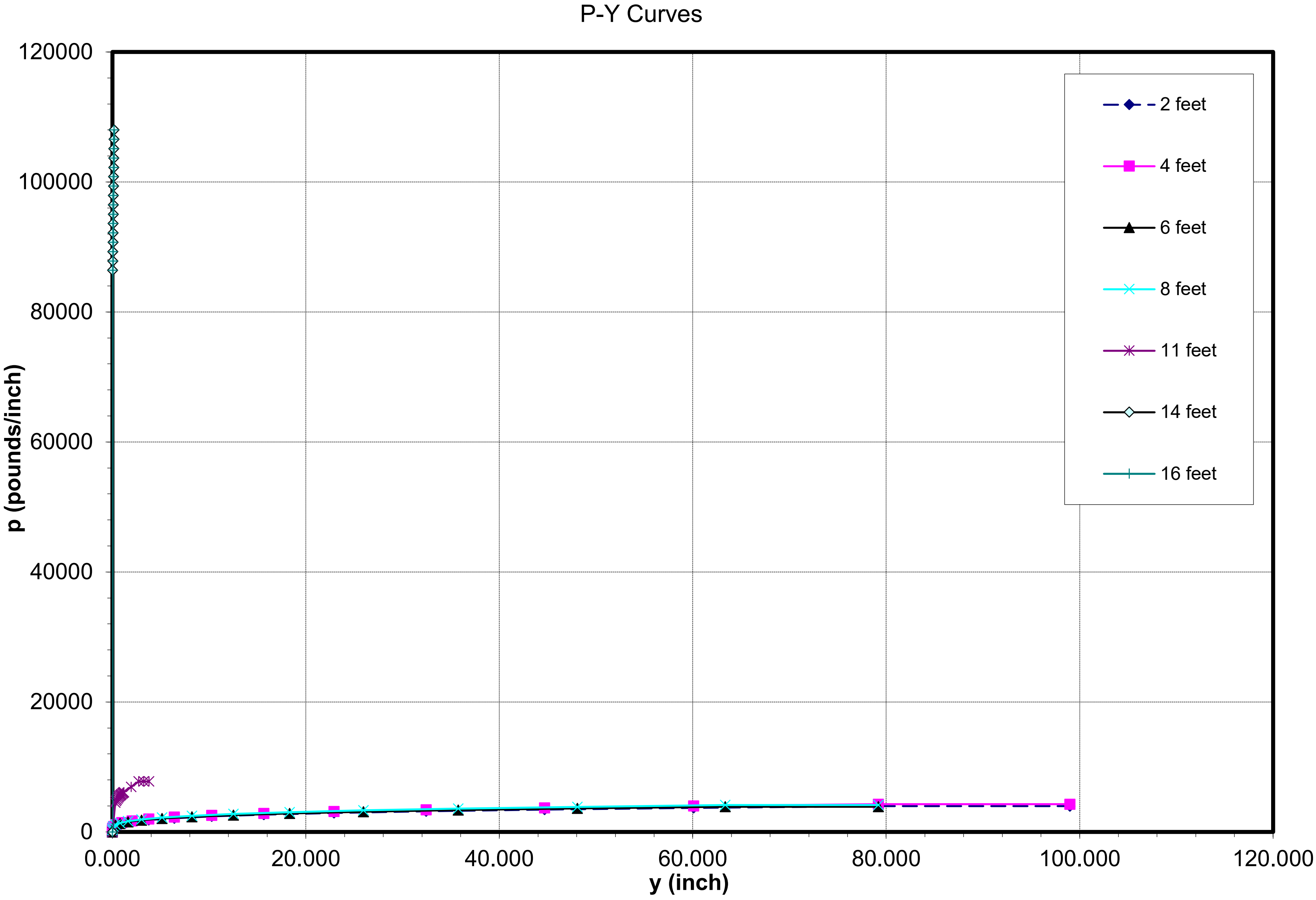
2 feet		4 feet		6 feet		8 feet		11 feet	
y	p	y	p	y	p	y	p	y	p
(inch)	(pounds/inch)	(inch)	(pounds/inch)	(inch)	(pounds/inch)	(inch)	(pounds/inch)	(inch)	(pounds/inch)
0.000	0.0	0.000	0.0	0.000	0.0	0.000	0.000	0.000	0.000
0.002	264.9	0.002	284.8	0.001	258.2	0.001	275.967	0.286	4512.033
0.025	529.8	0.025	569.5	0.020	516.5	0.020	551.934	0.370	4764.266
0.127	794.7	0.127	854.3	0.101	774.7	0.101	827.901	0.453	4975.191
0.401	1059.6	0.401	1139.0	0.320	1032.9	0.320	1103.868	0.536	5157.567
0.978	1324.5	0.978	1423.8	0.782	1291.1	0.782	1379.835	0.619	5318.899
2.028	1589.4	2.028	1708.5	1.622	1549.4	1.622	1655.802	0.702	5464.005
3.756	1854.3	3.756	1993.3	3.005	1807.6	3.005	1931.769	0.785	5596.177
6.408	2119.2	6.408	2278.1	5.126	2065.8	5.126	2207.736	0.868	5717.769
10.264	2384.1	10.264	2562.8	8.211	2324.0	8.211	2483.703	0.951	5830.529
15.644	2649.0	15.644	2847.6	12.516	2582.3	12.516	2759.670	1.034	5935.793
22.905	2913.9	22.905	3132.3	18.324	2840.5	18.324	3035.637	1.117	6034.604
32.440	3178.8	32.440	3417.1	25.952	3098.7	25.952	3311.603	1.200	6127.797
44.682	3443.6	44.682	3701.8	35.746	3357.0	35.746	3587.570	1.950	6946.188
60.100	3708.5	60.100	3986.6	48.080	3615.2	48.080	3863.537	2.700	7764.580
79.200	3973.4	79.200	4271.4	63.360	3873.4	63.360	4139.504	3.240	7764.580
99.000	3973.4	99.000	4271.4	79.200	3873.4	79.200	4139.504	3.780	7764.580

14 feet		16 feet	
y	p	y	p
(inch)	(pounds/inch)	(inch)	(pounds/inch)
0.000	0.0	0.000	0.0
0.029	86400.0	0.029	86400.0
0.038	87840.0	0.038	87840.0
0.048	89280.0	0.048	89280.0
0.058	90720.0	0.058	90720.0
0.067	92160.0	0.067	92160.0
0.077	93600.0	0.077	93600.0
0.086	95040.0	0.086	95040.0
0.096	96480.0	0.096	96480.0
0.106	97920.0	0.106	97920.0
0.115	99360.0	0.115	99360.0
0.125	100800.0	0.125	100800.0
0.134	102240.0	0.134	102240.0
0.144	103680.0	0.144	103680.0
0.154	105120.0	0.154	105120.0
0.163	106560.0	0.163	106560.0
0.173	108000.0	0.173	108000.0

Soil Profile at Sign H1WB-421 (B-6)

Fill	0-5 feet
Residual Soil	5-10 feet
Saprolite	10-12 feet
Basalt Formation	12-26 feet

SIGN H1WB-421 LATERAL LOAD ANALYSIS
Interstate Route H-1 and H-201
Destination Sign Upgrade/Replacement, Phase 3
Island of Oahu, Hawaii



W.O. 7341-00

GEOLABS, INC.
Hawaii • California

PLATE 3.2

SIGN H1EB-104 LATERAL LOAD ANALYSIS
Interstate Route H-1 and H-201
Destination Sign Upgrade/Replacement, Phase 3
Island of Oahu, Hawaii

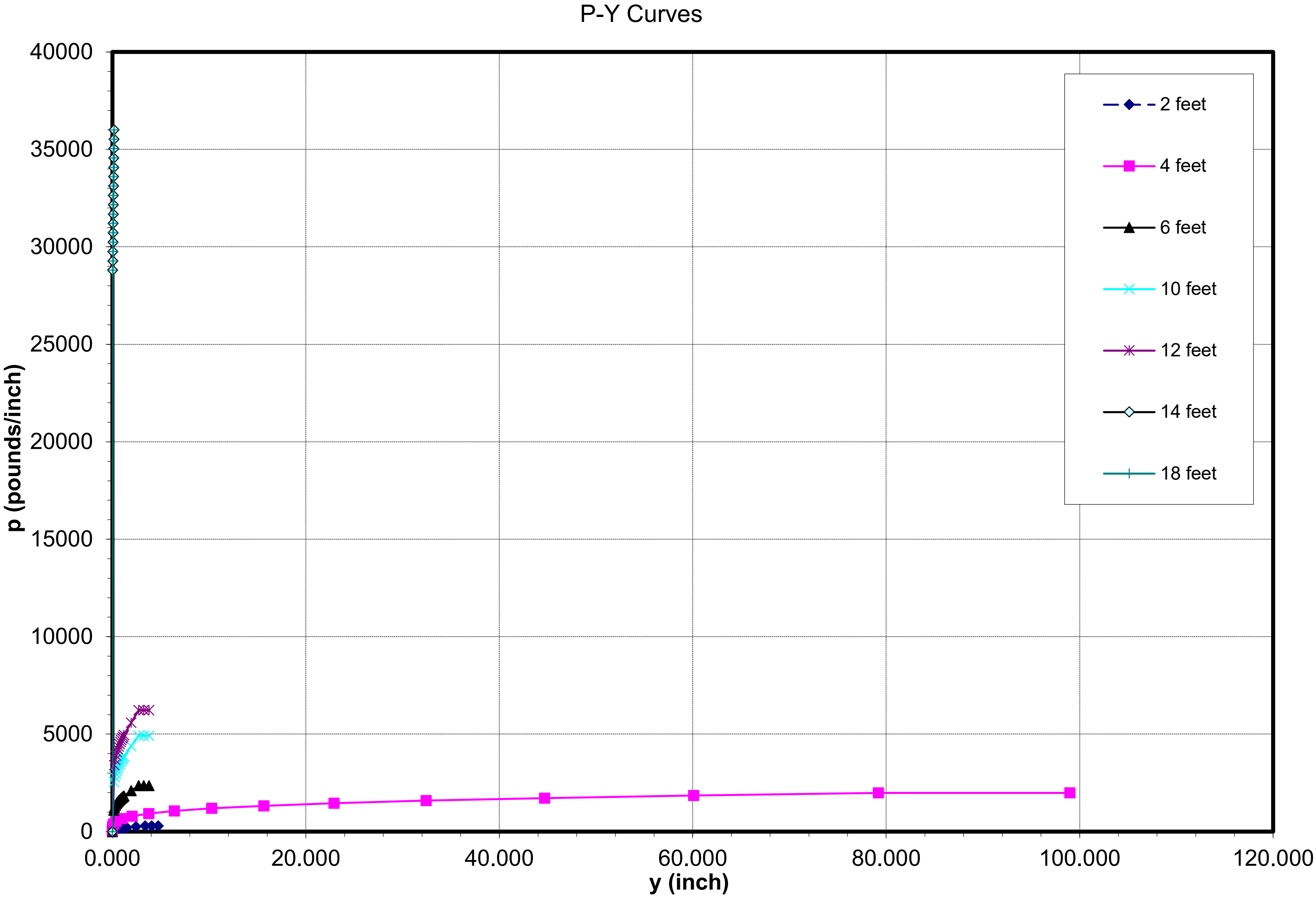
2 feet		4 feet		6 feet		10 feet		12 feet	
y	p	y	p	y	p	y	p	y	p
(inch)	(pounds/inch)	(inch)	(pounds/inch)	(inch)	(pounds/inch)	(inch)	(pounds/inch)	(inch)	(pounds/inch)
0.000	0.0	0.000	0.0	0.000	0.0	0.000	0.000	0.000	0.000
0.050	80.5	0.002	132.3	0.133	1100.0	0.178	2541.529	0.198	3410.370
0.182	116.5	0.025	264.5	0.230	1248.4	0.271	2786.487	0.289	3688.413
0.313	136.1	0.127	396.8	0.327	1354.2	0.364	2972.552	0.380	3903.579
0.445	150.4	0.401	529.1	0.424	1438.1	0.457	3124.554	0.471	4081.005
0.577	162.0	0.978	661.3	0.521	1508.3	0.550	3254.060	0.562	4232.987
0.709	171.8	2.028	793.6	0.618	1569.0	0.643	3367.469	0.653	4366.525
0.841	180.3	3.756	925.9	0.715	1622.9	0.736	3468.726	0.744	4486.017
0.973	188.0	6.408	1058.1	0.812	1671.4	0.828	3560.448	0.836	4594.416
1.104	194.9	10.264	1190.4	0.909	1715.6	0.921	3644.463	0.927	4693.808
1.236	201.3	15.644	1322.6	1.006	1756.3	1.014	3722.108	1.018	4785.726
1.368	207.2	22.905	1454.9	1.103	1794.1	1.107	3794.387	1.109	4871.331
1.500	212.7	32.440	1587.2	1.200	1829.5	1.200	3862.077	1.200	4951.526
2.438	250.6	44.682	1719.4	1.950	2094.2	1.950	4391.910	1.950	5591.425
3.375	288.5	60.100	1851.7	2.700	2358.9	2.700	4921.744	2.700	6231.323
4.050	288.5	79.200	1984.0	3.240	2358.9	3.240	4921.744	3.240	6231.323
4.725	288.5	99.000	1984.0	3.780	2358.9	3.780	4921.744	3.780	6231.323

14 feet		18 feet	
y	p	y	p
(inch)	(pounds/inch)	(inch)	(pounds/inch)
0.000	0.0	0.000	0.0
0.029	28800.0	0.029	28800.0
0.038	29280.0	0.038	29280.0
0.048	29760.0	0.048	29760.0
0.058	30240.0	0.058	30240.0
0.067	30720.0	0.067	30720.0
0.077	31200.0	0.077	31200.0
0.086	31680.0	0.086	31680.0
0.096	32160.0	0.096	32160.0
0.106	32640.0	0.106	32640.0
0.115	33120.0	0.115	33120.0
0.125	33600.0	0.125	33600.0
0.134	34080.0	0.134	34080.0
0.144	34560.0	0.144	34560.0
0.154	35040.0	0.154	35040.0
0.163	35520.0	0.163	35520.0
0.173	36000.0	0.173	36000.0

Soil Profile at Sign H1EB-104 (B-9)

Fill	0-3 feet
Residual Soil	3-5 feet
Saprolite	5-13 feet
Basalt Formation	13-31 feet

SIGN H1EB-104 LATERAL LOAD ANALYSIS
Interstate Route H-1 and H-201
Destination Sign Upgrade/Replacement, Phase 3
Island of Oahu, Hawaii



W.O. 7341-00

GEOLABS, INC.
Hawaii • California

PLATE 4.2

APPENDIX A

APPENDIX A

Field Exploration

We explored the subsurface conditions at the project site by drilling and sampling nine borings, designated as Boring Nos. 1 through 9, extending to depths ranging from about 26.5 to 45.6 feet below the existing pavement surface. The approximate boring locations are shown on the Site Plans, Plates 2.1 through 2.6. The borings were drilled using a truck-mounted drill rig equipped with continuous flight augers and coring tools.

Our geologist classified the materials encountered in the borings by visual and textural examination in the field in general accordance with ASTM D2488, Standard Practice for Description and Identification of Soils, and monitored the drilling operations on a near-continuous (full-time) basis. These classifications were further reviewed visually and by testing in the laboratory. Soils were classified in general accordance with ASTM D2487, Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System), as shown on the Soil Log Legend, Plate A-0.1. Deviations made to the soil classification in accordance with ASTM D2487 are described on the Soil Classification Log Key, Plate A-0.2. Rock cores were described in general accordance with the Rock Description System, as shown on the Rock Log Legend, Plate A-0.3. The Rock Description System is based on the publication “Suggested Methods for the Quantitative Description of Discontinuities in Rock Masses” by the International Society for Rock Mechanics (March 1977). Graphic representations of the materials encountered are presented on the Logs of Borings, Plates A-1 through A-9.

Relatively “undisturbed” soil samples were obtained in general accordance with ASTM D3550, Ring-Lined Barrel Sampling of Soils, by driving a 3-inch O.D. Modified California sampler with a 140-pound hammer falling 30 inches. In addition, some samples were obtained from the drilled borings in general accordance with ASTM D1586, Penetration Test and Split-Barrel Sampling of Soils, by driving a 2-inch O.D. 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 Borings at the appropriate sample depths. The penetration resistance shown on the Logs of Borings indicates the number of blows required for the specific sampler type used. The blow counts may need to be factored to obtain the Standard Penetration Test (SPT) blow counts.

Core samples of the rock materials encountered at the project site were obtained by using diamond core drilling techniques in general accordance with ASTM D2113, 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 rock material left in the hollow core of the bit is mechanically recovered for examination and description.

Recovery (REC) may be used as a subjective guide to the interpretation of the relative quality of rock masses, where appropriate. 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 in rock that is sound material in excess of 4 inches in length without any discontinuities, discounting any drilling, mechanical, and handling induced fractures or breaks. If 2.5 feet of sound material is recovered from a 5.0-foot core run in rock, 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" by Robert S. Carmichael (1989).

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

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

Soil Log Legend

UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)

MAJOR DIVISIONS			USCS	TYPICAL DESCRIPTIONS
COARSE-GRAINED SOILS MORE THAN 50% OF MATERIAL RETAINED ON NO. 200 SIEVE	GRAVELS MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN GRAVELS LESS THAN 5% FINES	**GW**	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
			GP	POORLY-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
		GRAVELS WITH FINES MORE THAN 12% FINES	**GM**	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES
			GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES
	SANDS 50% OR MORE OF COARSE FRACTION PASSING THROUGH NO. 4 SIEVE	CLEAN SANDS LESS THAN 5% FINES	**SW**	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
			SP	POORLY-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
		SANDS WITH FINES MORE THAN 12% FINES	**SM**	SILTY SANDS, SAND-SILT MIXTURES
			SC	CLAYEY SANDS, SAND-CLAY MIXTURES
FINE-GRAINED SOILS 50% OR MORE OF MATERIAL PASSING THROUGH NO. 200 SIEVE	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50	**ML**	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
			CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
			OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS	LIQUID LIMIT 50 OR MORE	**MH**	INORGANIC SILT, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
			CH	INORGANIC CLAYS OF HIGH PLASTICITY
			OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS			**PT**	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

LEGEND

◪	(2-INCH) O.D. STANDARD PENETRATION TEST
⧗	(3-INCH) O.D. MODIFIED CALIFORNIA SAMPLE
S	SHELBY TUBE SAMPLE
G	GRAB SAMPLE
▮	CORE SAMPLE
▽	WATER LEVEL OBSERVED IN BORING AT TIME OF DRILLING
▼	WATER LEVEL OBSERVED IN BORING AFTER DRILLING
▼	WATER LEVEL OBSERVED IN BORING OVERNIGHT

LL	LIQUID LIMIT (NP=NON-PLASTIC)
PI	PLASTICITY INDEX (NP=NON-PLASTIC)
TV	TORVANE SHEAR (tsf)
UC	UNCONFINED COMPRESSION OR UNIAXIAL COMPRESSIVE STRENGTH
TXUU	UNCONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION (ksf)

GEOLABS, INC.

Geotechnical Engineering

Soil Classification Log Key

(with deviations from ASTM D2488)

GEOLABS, INC. CLASSIFICATION*

GRANULAR SOIL (- #200 <50%)

- **PRIMARY** constituents are composed of the largest percent of the soil mass. Primary constituents are capitalized and bold (i.e., **GRAVEL, SAND**)
- **SECONDARY** constituents are composed of a percentage less than the primary constituent. If the soil mass consists of 12 percent or more fines content, a cohesive constituent is used (**SILTY** or **CLAYEY**); otherwise, a granular constituent is used (**GRAVELLY** or **SANDY**) provided that the secondary constituent consists of 20 percent or more of the soil mass. Secondary constituents are capitalized and bold (i.e., **SANDY** GRAVEL, **CLAYEY** SAND) and precede the primary constituent.
- **accessory descriptions** compose of the following:
  with some: >12%
  with a little: 5 - 12%
  with traces of: <5%
  accessory descriptions are lower cased and follow the Primary and Secondary Constituents
  (i.e., SILTY GRAVEL **with a little sand**)

COHESIVE SOIL (- #200 ≥50%)

- **PRIMARY** constituents are based on plasticity. Primary constituents are capitalized and bold (i.e., **CLAY, SILT**)
- **SECONDARY** constituents are composed of a percentage less than the primary constituent, but more than 20 percent of the soil mass. Secondary constituents are capitalized and bold (i.e., **SANDY** CLAY, **SILTY** CLAY, **CLAYEY** SILT) and precede the primary constituent.
- **accessory descriptions** compose of the following:
  with some: >12%
  with a little: 5 - 12%
  with traces of: <5%
  accessory descriptions are lower cased and follow the Primary and Secondary Constituents
  (i.e., SILTY CLAY **with some sand**)

EXAMPLE: Soil Containing 60% Gravel, 25% Sand, 15% Fines. Described as: **SILTY GRAVEL** with some sand

RELATIVE DENSITY / CONSISTENCY

Granular Soils			Cohesive Soils			
N-Value (Blows/Foot)		Relative Density	N-Value (Blows/Foot)		PP Readings (tsf)	Consistency
SPT	MCS		SPT	MCS		
0 - 4	0 - 7	Very Loose	0 - 2	0 - 4		Very Soft
4 - 10	7 - 18	Loose	2 - 4	4 - 7	< 0.5	Soft
10 - 30	18 - 55	Medium Dense	4 - 8	7 - 15	0.5 - 1.0	Medium Stiff
30 - 50	55 - 91	Dense	8 - 15	15 - 27	1.0 - 2.0	Stiff
> 50	> 91	Very Dense	15 - 30	27 - 55	2.0 - 4.0	Very Stiff
			> 30	> 55	> 4.0	Hard

MOISTURE CONTENT DEFINITIONS

Dry: Absence of moisture, dry to the touch

Moist: Damp but no visible water

Wet: Visible free water, usually soil is below water table

ABBREVIATIONS

WOH: Weight of Hammer

WOR: Weight of Drill Rods

SPT: Standard Penetration Test Split-Spoon Sampler

MCS: Modified California Sampler

PP: Pocket Penetrometer

GRAIN SIZE DEFINITION

Description	Sieve Number and / or Size
Boulders	> 12 inches (305-mm)
Cobbles	3 to 12 inches (75-mm to 305-mm)
Gravel	3-inch to #4 (75-mm to 4.75-mm)
Coarse Gravel	3-inch to 3/4-inch (75-mm to 19-mm)
Fine Gravel	3/4-inch to #4 (19-mm to 4.75-mm)
Sand	#4 to #200 (4.75-mm to 0.075-mm)
Coarse Sand	#4 to #10 (4.75-mm to 2-mm)
Medium Sand	#10 to #40 (2-mm to 0.425-mm)
Fine Sand	#40 to #200 (0.425-mm to 0.075-mm)

**Soil descriptions are based on ASTM D2488-09a, Visual-Manual Procedure, with the above modifications by Geolabs, Inc. to the Unified Soil Classification System (USCS).*

GEOLABS, INC.

Geotechnical Engineering

Rock Log Legend

ROCK DESCRIPTIONS

⁄	**BASALT**	⁘	**CONGLOMERATE**
○	**BOULDERS**	▤	**LIMESTONE**
△	**BRECCIA**	∴	**SANDSTONE**
×	**CLINKER**	×	**SILTSTONE**
⬠	**COBBLES**	▩	**TUFF**
☼	**CORAL**		**VOID/CAVITY**

ROCK DESCRIPTION SYSTEM

ROCK FRACTURE CHARACTERISTICS

The following terms describe general fracture spacing of a rock:

Massive:	Greater than 24 inches apart
Slightly Fractured:	12 to 24 inches apart
Moderately Fractured:	6 to 12 inches apart
Closely Fractured:	3 to 6 inches apart
Severely Fractured:	Less than 3 inches apart

DEGREE OF WEATHERING

The following terms describe the chemical weathering of a rock:

Unweathered:	Rock shows no sign of discoloration or loss of strength.
Slightly Weathered:	Slight discoloration inwards from open fractures.
Moderately Weathered:	Discoloration throughout and noticeably weakened though not able to break by hand.
Highly Weathered:	Most minerals decomposed with some corestones present in residual soil mass. Can be broken by hand.
Extremely Weathered:	Saprolite. Mineral residue completely decomposed to soil but fabric and structure preserved.

HARDNESS

The following terms describe the resistance of a rock to indentation or scratching:

Very Hard:	Specimen breaks with difficulty after several "pinging" hammer blows. Example: Dense, fine grain volcanic rock
Hard:	Specimen breaks with some difficulty after several hammer blows. Example: Vesicular, vugular, coarse-grained rock
Medium Hard:	Specimen can be broked by one hammer blow. Cannot be scraped by knife. SPT may penetrate by ~25 blows per inch with bounce. Example: Porous rock such as clinker, cinder, and coral reef
Soft:	Can be indented by one hammer blow. Can be scraped or peeled by knife. SPT can penetrate by ~100 blows per foot. Example: Weathered rock, chalk-like coral reef
Very Soft:	Crumbles under hammer blow. Can be peeled and carved by knife. Can be indented by finger pressure. Example: Saprolite

GEOLABS, INC.

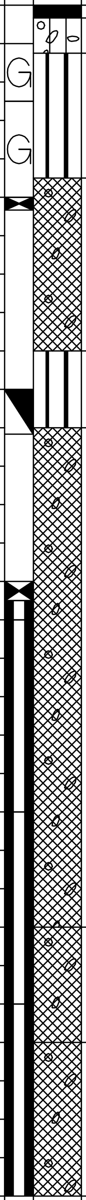
Geotechnical Engineering

INTERSTATE ROUTE H-1 AND H-201
DESTINATION SIGN UPGRADE/
REPLACEMENT, PHASE 3
FAP NO. NH-0300 (144)
ISLAND OF OAHU, HAWAII

Log of Boring

1

Approximate Ground Surface Elevation : N/A



Laboratory			Field						
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	USCS	Description
									4-inch **ASPHALTIC CONCRETE**
	9							GM	Gray **SILTY GRAVEL (BASALTIC)** with some sand (basaltic), moist (fill)
	16							ML	Brown **SANDY SILT** with some gravel (basaltic) (fill)
	26	70			53/4"		5		Grayish brown **TUFF**, medium hard (volcanic tuff)
	38				22/6" +50/2"		10	ML	Brown **SANDY SILT** with a little gravel, very stiff, moist (weathered volcanic tuff)
						▼			Grayish brown **TUFF**, moderately to closely fractured, slightly weathered, medium hard (volcanic tuff)
UC= 2460 psi			100 92	100 77			15		
							20		grades to slightly fractured
UC= 1810 psi			100	48					
							25		Grayish brown **TUFF**, severely fractured, highly weathered, soft (volcanic tuff)
			92	35					
							30		Grayish brown **TUFF**, closely fractured, slightly weathered, medium hard (volcanic tuff)
									Boring terminated at 31 feet
							35		

Date Started:	March 27, 2018	Water Level: ▼	11.5 ft. 03/27/2018 1303 HRS	Plate
Date Completed:	March 27, 2018			
Logged By:	N. Vaiana	Drill Rig:	CME-75DG2	A - 1
Total Depth:	31 feet	Drilling Method:	4" Solid Stem Auger & PQ Coring	
Work Order:	7341-00	Driving Energy:	140 lb. wt., 30 in. drop	

GEOLABS, INC. Geotechnical Engineering	INTERSTATE ROUTE H-1 AND H-201 DESTINATION SIGN UPGRADE/ REPLACEMENT, PHASE 3 FAP NO. NH-0300 (144) ISLAND OF OAHU, HAWAII	**Log of Boring** 2

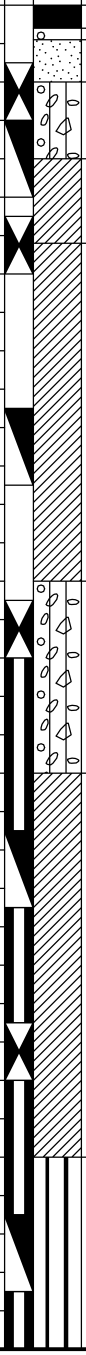
Approximate Ground Surface Elevation : N/A

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
											4-inch **ASPHALTIC CONCRETE**
	12							G		GM	Brownish gray **SILTY GRAVEL (BASALTIC)** with some sand (basaltic), moist (fill)
	14							G		GM	Brown **SILTY GRAVEL (BASALTIC)** with some sand (basaltic), moist (fill)
	31				10/0" Ref.		5				Grayish brown **TUFF**, severely to closely fractured, slightly weathered, medium hard (volcanic tuff)
UC= 1090 psi			100	20							
							10				
			100	60			▼				grades to moderately fractured
							15				
UC= 1410 psi			100	48							grades to closely fractured
							20				
			100	5							
							25				
			100	5							
							30				Boring terminated at 31 feet
							35				

Date Started:	March 28, 2018	Water Level: ▼	11.0 ft. 03/28/2018 1300 HRS	Plate
Date Completed:	March 28, 2018			
Logged By:	N. Vaiana	Drill Rig:	CME-75DG2	A - 2
Total Depth:	31 feet	Drilling Method:	4" Solid Stem Auger & PQ Coring	
Work Order:	7341-00	Driving Energy:	140 lb. wt., 30 in. drop	

GEOLABS, INC. Geotechnical Engineering	INTERSTATE ROUTE H-1 AND H-201 DESTINATION SIGN UPGRADE/ REPLACEMENT, PHASE 3 FAP NO. NH-0300 (144) ISLAND OF OAHU, HAWAII	**Log of Boring** 3

Approximate Ground Surface Elevation (feet): 14.5 *



Laboratory			Field						
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	USCS	Description
									7-inch **ASPHALTIC CONCRETE**
	14	110			48			GP- GM	Gray **SANDY GRAVEL (BASALTIC)** with a little silt, dense, moist (fill)
	24				17			SP GM	Gray **GRAVELLY SAND (BASALTIC)**, medium dense, moist (fill)
								CH	Gray with brown mottling **SILTY GRAVEL (BASALTIC)**, medium dense, moist (fill)
TXUU S_u=1.6 ksf	32	86			41	2.5	5	CH	Gray **SILTY CLAY** with some gravel (basaltic) and a little cobbles, stiff to very stiff, moist (fill)
									Dark brown **SILTY CLAY**, very stiff, wet (alluvium)
							10		
	62				5				grades to medium stiff
	23	105			10		▽ 15	GM	Dark gray **SILTY GRAVEL (BASALTIC)** with some sand, loose, wet (alluvium)
			19						
									grades with silty clay pockets locally
							20	CH	Gray with tan mottling **SILTY CLAY** with a little gravel (coralline), medium stiff (alluvium w/ coral debris)
	47				6				
			100						
							25		
LL=110 PI=78 TXUU S_u=1.5 ksf	67	61			17	3.3			grades to very stiff
			52						
							30	ML	Gray with brown mottling **CLAYEY SILT** with some sand, stiff (alluvium)
	56				10				
			64						
							35		

Date Started:	April 18, 2018	Water Level: ▽	15.0 ft. 04/18/2018 2240 HRS	Plate A - 3.1
Date Completed:	April 19, 2018			
Logged By:	S. Latronic	Drill Rig:	CME-45C TRUCK	
Total Depth:	38 feet	Drilling Method:	4" Solid Stem Auger & PQ Coring	
Work Order:	7341-00	Driving Energy:	140 lb. wt., 30 in. drop	

GEOLABS, INC. Geotechnical Engineering	INTERSTATE ROUTE H-1 AND H-201 DESTINATION SIGN UPGRADE/ REPLACEMENT, PHASE 3 FAP NO. NH-0300 (144) ISLAND OF OAHU, HAWAII	**Log of Boring** 3

(Continued from previous plate)

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
	55	67			14	2.0				ML	
							40				Boring terminated at 38 feet * Elevations estimated from Topographic Survey Map prepared by Controlpoint Surveying, Inc. dated February 15, 2018.
							45				
							50				
							55				
							60				
							65				
							70				

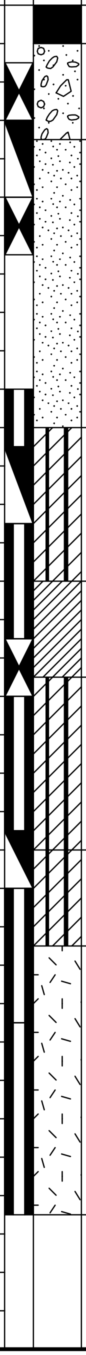
Date Started:	April 18, 2018	Water Level: ⊻	15.0 ft. 04/18/2018 2240 HRS	Plate A - 3.2
Date Completed:	April 19, 2018			
Logged By:	S. Latronic	Drill Rig:	CME-45C TRUCK	
Total Depth:	38 feet	Drilling Method:	4" Solid Stem Auger & PQ Coring	
Work Order:	7341-00	Driving Energy:	140 lb. wt., 30 in. drop	

INTERSTATE ROUTE H-1 AND H-201
DESTINATION SIGN UPGRADE/
REPLACEMENT, PHASE 3
FAP NO. NH-0300 (144)
ISLAND OF OAHU, HAWAII

Log of Boring

4

Approximate Ground Surface
Elevation : N/A



Laboratory			Field						
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	USCS	Description
									12-inch **ASPHALTIC CONCRETE**
	4	116			61			GW	Gray angular **SANDY GRAVEL (BASALTIC)** with traces of clayey silt, dense, moist (fill)
	6				12				
								SP-SM	Brownish gray **GRAVELLY SAND (BASALTIC)** with a little silt, medium dense, moist (fill)
Sieve - #200 = 11.9%	7	74			14		5		grades to loose
									grades to sandy gravel locally
			50				10		
								MH	Reddish brown **CLAYEY SILT** with a little gravel (basaltic), very stiff, moist (residual soil)
	27				23				
			28						
							15	CH	Reddish brown **SILTY CLAY**, very stiff to hard, moist (residual soil)
TXUU S_u=5.8 ksf	35	172			82	>4.5			
								MH	Dark brown **SILTY CLAY** with some decomposed gravel, hard, moist (weathered clinker)
			100						
							20		
	37				74				
								MH	Gray **CLAYEY SILT** with remnant rock structure, hard, moist (saprolite)
			88	0					
							25		Gray vugular **BASALT**, severely to closely fractured, slightly weathered, hard (basalt formation)
			98	40					
									grades to moderately fractured
							30		
									Boring terminated at 31.5 feet
							35		

Date Started: April 15, 2018
Date Completed: April 16, 2018
Logged By: S. Latronic
Total Depth: 31.5 feet
Work Order: 7341-00

Water Level: ▼ Not Encountered
Drill Rig: CME-45C TRUCK
Drilling Method: 4" Solid Stem Auger & PQ Coring
Driving Energy: 140 lb. wt., 30 in. drop

Plate

A - 4

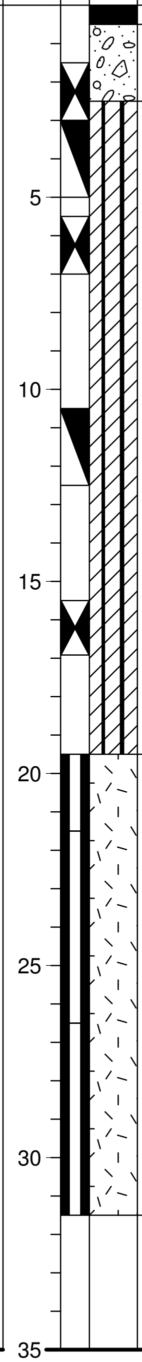
GEOLABS, INC.

Geotechnical Engineering

INTERSTATE ROUTE H-1 AND H-201
DESTINATION SIGN UPGRADE/
REPLACEMENT, PHASE 3
FAP NO. NH-0300 (144)
ISLAND OF OAHU, HAWAII

Log of Boring 5

Approximate Ground Surface Elevation : N/A



Laboratory			Field						
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	USCS	Description
									6-inch **ASPHALTIC CONCRETE**
	19	99			37			GW	Gray angular **SANDY GRAVEL (BASALTIC)**, dense, moist (fill)
	32				48			MH	Reddish brown **CLAYEY SILT** with some decomposed gravel, hard, moist (residual soil)
LL=52 PI=14	58	64			84		5		
	42				30		10		
									grades with remnant rock structure
	29	95			31/6" +50/5"	>4.5	15		
			79	29			20		Gray vugular **BASALT**, closely fractured, slightly weathered, hard (basalt formation)
UC= 7270 psi			100	17					
							25		
			100	72					
									grades to moderately fractured
							30		
									Boring terminated at 31.5 feet
							35		

Date Started:	April 16, 2018	Water Level: ▼	Not Encountered
Date Completed:	April 17, 2018		
Logged By:	S. Latronic	Drill Rig:	CME-45C TRUCK
Total Depth:	31.5 feet	Drilling Method:	4" Solid Stem Auger & PQ Coring
Work Order:	7341-00	Driving Energy:	140 lb. wt., 30 in. drop

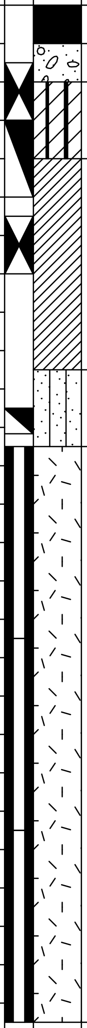
Plate

A - 5

BORING_LOG 7341-00.GPJ GEOLABS.GDT 1/24/22

GEOLABS, INC. Geotechnical Engineering	INTERSTATE ROUTE H-1 AND H-201 DESTINATION SIGN UPGRADE/ REPLACEMENT, PHASE 3 FAP NO. NH-0300 (144) ISLAND OF OAHU, HAWAII	**Log of Boring** 6

Approximate Ground Surface
Elevation : N/A



Laboratory			Field						
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	USCS	Description
									12-inch **ASPHALTIC CONCRETE**
	16	91			50	>4.5		GW	Gray **SANDY GRAVEL (BASALTIC)**, medium dense to dense, moist (fill)
	30				19			MH	Brown with gray mottling **CLAYEY SILT** with some gravel (basaltic) and a little sand, very stiff, moist (fill)
LL=82 PI=46	42	68			17	>4.5	5	CH	Brown **SILTY CLAY** with some sand and gravel, stiff to very stiff, moist (residual soil)
	30				50/2"		∇ 10	SM	Brownish gray **SILTY SAND (BASALTIC)** with some gravel, dense to very dense, wet (saprolite)
UC= 24170 psi			100	72					Gray **BASALT**, slightly to moderately fractured, unweathered to slightly weathered, very hard (basalt formation)
							15		
			93	15					grades with clayey seams locally, closely fractured
							20		
UC= 19190 psi			100	70					
							25		
									Boring terminated at 26.5 feet
							30		
							35		

Date Started: April 17, 2018
Date Completed: April 18, 2018
Logged By: S. Latronic
Total Depth: 26.5 feet
Work Order: 7341-00

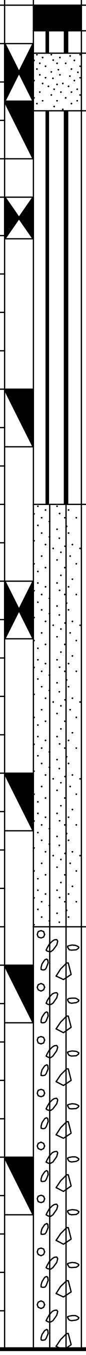
Water Level: ∇ 9.6 ft. 04/17/2018 2220 HRS
Drill Rig: CME-45C TRUCK
Drilling Method: 4" Solid Stem Auger & PQ Coring
Driving Energy: 140 lb. wt., 30 in. drop

Plate

A - 6

GEOLABS, INC. Geotechnical Engineering	INTERSTATE ROUTE H-1 AND H-201 DESTINATION SIGN UPGRADE/ REPLACEMENT, PHASE 3 FAP NO. NH-0300 (144) ISLAND OF OAHU, HAWAII	**Log of Boring** 7

Approximate Ground Surface Elevation (feet): 36 *



Laboratory			Field						
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	USCS	Description
									8-inch **ASPHALTIC CONCRETE**
								ML	Light brown with multi-color mottling **SANDY SILT** with a little gravel, very stiff to hard, moist (fill)
	11	77			56			SP	Tan **GRAVELLY SAND (CORALLINE)**, medium dense to dense, moist (fill)
	36				20			ML	Brown **SANDY SILT** with some gravel, hard, moist (alluvium)
LL=33 PI=1 TXUU S_u=6.0 ksf					77/6" +25/1"		5		
	36				36		10		
								SM	Brown with multi-color mottling rounded **SILTY SAND** with some gravel (basaltic), medium dense, moist (alluvium)
Sieve - #200 = 12.4%	27	77			37		15		
	40				10		20		
							▼		
								GM	Brown **SILTY GRAVEL** with some sand (basaltic), medium dense (alluvium) grades with some cobbles
Sieve - #200 = 16.5%	27	104			19		25		
	42				18		30		
							35		

Date Started:	January 4, 2022	Water Level: ▼	23.3 ft. 01/04/2022 1115 HRS	Plate
Date Completed:	January 4, 2022			
Logged By:	B. Aiu	Drill Rig:	CME-75DG2	A - 7.1
Total Depth:	45.6 feet	Drilling Method:	4" Solid-Stem Auger & PQ Coring	
Work Order:	7341-00	Driving Energy:	140 lb. wt., 30 in. drop	

GEOLABS, INC.

Geotechnical Engineering

INTERSTATE ROUTE H-1 AND H-201
DESTINATION SIGN UPGRADE/
REPLACEMENT, PHASE 3
FAP NO. NH-0300 (144)
ISLAND OF OAHU, HAWAII

Log of Boring

7

(Continued from previous plate)

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
	48	82			28					GM	grades with a little clay
	42				16/6" +25/1"		40				grades with boulders
	32	85			25/1"		45				
											Boring terminated at 45.6 feet * Elevations estimated from Topographic Survey Map prepared by Controlpoint Surveying, Inc. dated February 20, 2018.
							50				
							55				
							60				
							65				
							70				

Date Started:	January 4, 2022	Water Level: ▼	23.3 ft. 01/04/2022 1115 HRS
Date Completed:	January 4, 2022		
Logged By:	B. Aiu	Drill Rig:	CME-75DG2
Total Depth:	45.6 feet	Drilling Method:	4" Solid-Stem Auger & PQ Coring
Work Order:	7341-00	Driving Energy:	140 lb. wt., 30 in. drop

Plate

A - 7.2

GEOLABS, INC. Geotechnical Engineering	INTERSTATE ROUTE H-1 AND H-201 DESTINATION SIGN UPGRADE/ REPLACEMENT, PHASE 3 FAP NO. NH-0300 (144) ISLAND OF OAHU, HAWAII	Log of Boring 8

Approximate Ground Surface Elevation (feet): 35.5 *

Laboratory			Field							
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	USCS	Description
									9-inch **ASPHALTIC CONCRETE**
	11	123			99			GM	Reddish brown with gray angular **SILTY GRAVEL (BASALTIC)** with some sand, very dense, moist (fill)
	40				51			ML	Brown **SANDY SILT**, hard, moist (alluvium)
LL=NP PI=NP TXUU S_u=4.8 ksf	18	82			121		5		
	38				34		10		
								GW-GM	Brown with multi-color mottling **SANDY GRAVEL** with a little silt, medium dense, moist (alluvium)
Sieve - #200 = 10.1%	19	95			25		15		
Sieve - #200 = 14.3%	27				28		20		grades with more silt
	38	91			33		25		
									grades with cobbles and boulders
	16				25/1"		30		Boring terminated at 30.1 feet
							35		

* Elevations estimated from Topographic Survey Map prepared by Controlpoint Surveying, Inc. dated February 20, 2018.

Date Started:	January 3, 2022	Water Level: ▼	22.7 ft. 01/03/2022 1035 HRS	Plate
Date Completed:	January 3, 2022			
Logged By:	B. Aiu	Drill Rig:	CME-75DG2	
Total Depth:	30.1 feet	Drilling Method:	4" Solid-Stem Auger & PQ Coring	A - 8
Work Order:	7341-00	Driving Energy:	140 lb. wt., 30 in. drop	

GEOLABS, INC.

Geotechnical Engineering

INTERSTATE ROUTE H-1 AND H-201
DESTINATION SIGN UPGRADE/
REPLACEMENT, PHASE 3
FAP NO. NH-0300 (144)
ISLAND OF OAHU, HAWAII

Log of Boring
9

Approximate Ground Surface Elevation : N/A

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
											3-inch **ASPHALTIC CONCRETE**
										GP	Brownish gray **SANDY GRAVEL (BASALTIC)**, moist (fill)
LL=38 PI=16	25	92			18						
Sieve - #200 = 37.7%	11				109					SC	Reddish brown **CLAYEY SAND** with some angular gravel, dense, moist (fill)
										ML	Reddish brown **SANDY SILT** with a little clay, medium stiff, moist (residual soil)
	28	83					5				
										SM	Reddish brown and gray **SILTY SAND (BASALTIC)** with some gravel (basaltic), very dense, moist (saprolite)
Sieve - #200 = 22.1%	27				34/6" +50/4"		10				
											Brownish gray vugular **BASALT**, severely fractured, moderately weathered, hard (basalt formation)
			100	21							
							15				
			100	47							
											grades to slightly fractured
UC= 4340 psi											
											grades to gray grades to closely to severely fractured
							20				
			97	10							
							25				
			100	63							grades to moderately fractured
UC= 2910 psi											
							30				
											Boring terminated at 31 feet
							35				

Date Started:	January 5, 2022	Water Level: ▼	Not Encountered
Date Completed:	January 6, 2022		
Logged By:	B. Aiu	Drill Rig:	CME-75DG2
Total Depth:	31 feet	Drilling Method:	4" Solid-Stem Auger & PQ Coring
Work Order:	7341-00	Driving Energy:	140 lb. wt., 30 in. drop

Plate

A - 9

APPENDIX B

APPENDIX B

Laboratory Tests

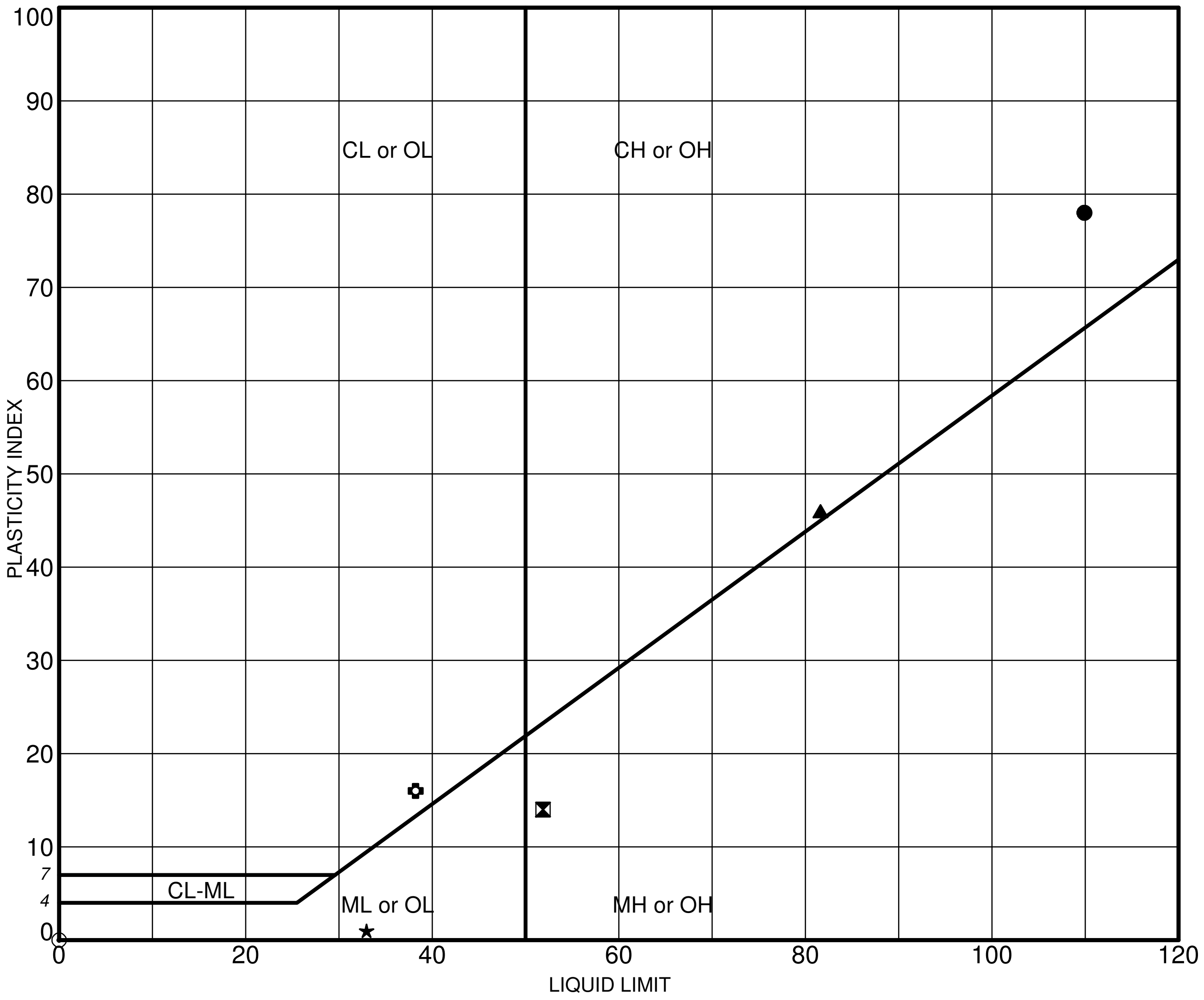
Moisture Content (ASTM D2216) and Unit Weight determinations (ASTM D2937) were performed on selected soil samples as an aid in the classification and evaluation of soil properties. The test results are presented on the Logs of Borings at the appropriate sample depths.

Six Atterberg Limits tests (ASTM D4318) were performed on selected soil samples to evaluate the liquid and plastic limits and to aid in soil classification. Test results are summarized on the Logs of Borings at the appropriate sample depths. The test results are provided on Plate B-1.

Seven Sieve Analysis tests (ASTM D6913) were performed on selected soil samples to evaluate the gradation characteristics of the soils and to aid in soil classification. Graphic presentations of the grain size distributions are provided on Plates B-2 and B-3.

Nine Unconfined Compression tests (ASTM D7012) were performed on selected core samples to evaluate the unconfined compressive strength of the rock formation encountered. Unconfined compression test results are presented on Plate B-4.

Five Unconsolidated Undrained Triaxial Compression tests (ASTM D2850) were performed on selected soil samples to evaluate the undrained shear strength of the soils. The undrained shear strength test results along with the shear stress-strain curves are presented on Plates B-5 through B-9.



	Sample	Depth (ft)	LL	PL	PI	Description
●	B-3	26.5-28.0	110	32	78	Gray with tan mottling silty clay (CH) with a little gravel
⧗	B-5	5.5-7.0	52	38	14	Reddish brown clayey silt (MH) with some decomposed gravel
▲	B-6	5.5-7.0	82	36	46	Brown silty clay (CH) with some sand and gravel
★	B-7	5.0-6.5	33	32	1	Brown sandy silt (ML) with some gravel
⊙	B-8	5.0-6.5	NP	NP	NP	Brown sandy silt
✿	B-9	1.0-2.5	38	22	16	Reddish brown clayey sand (SC) with some gravel

NP = NON-PLASTIC

GEOLABS, INC.

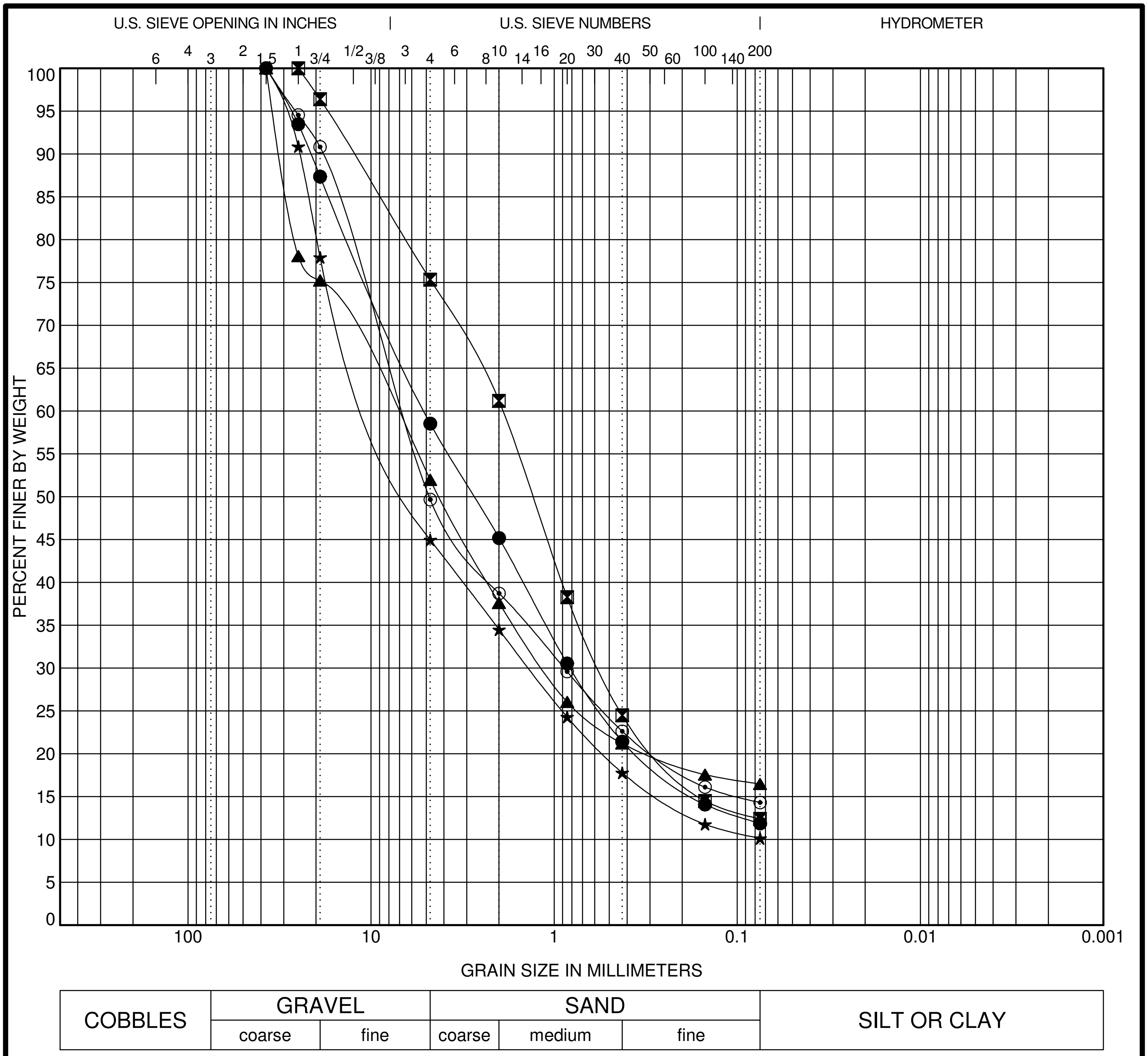
GEOTECHNICAL ENGINEERING

W.O. 7341-00

ATTERBERG LIMITS TEST RESULTS - ASTM D4318

INTERSTATE ROUTE H-1 AND H-201
DESTINATION SIGN UPGRADE/
REPLACEMENT, PHASE 3
FAP NO. NH-0300 (144)
ISLAND OF OAHU, HAWAII

Plate
B - 1



	Sample	Depth (ft)	Description	LL	PL	PI	Cc	Cu
●	B-4	5.0-6.5	Brownish gray gravelly sand (SP-SM) with a little silt				3.1	122.2
⊠	B-7	15.0-16.5	Brown with multi-color mottling silty sand (SM) with some gravel				4.8	56.2
▲	B-7	25.0-26.5	Brown silty gravel (GM) with some sand					
★	B-8	15.0-16.5	Brown w/ multi-color mottling sandy gravel (GW-GM) w/ a little silt				3.0	125.4
⊙	B-8	20.0-21.5	Brown silty gravel (GM) with some sand					

	Sample	Depth (ft)	D100 (mm)	D60 (mm)	D30 (mm)	D10 (mm)	%Gravel	%Sand	%Fine
●	B-4	5.0-6.5	37.5	5.1	0.816		41.5	46.7	11.9
⊠	B-7	15.0-16.5	25	1.915	0.561		24.7	62.9	12.4
▲	B-7	25.0-26.5	37.5	7.664	1.139		48.0	35.5	16.5
★	B-8	15.0-16.5	37.5	8.943	1.374		55.1	34.8	10.1
⊙	B-8	20.0-21.5	37.5	6.729	0.883		50.3	35.4	14.3

GEOLABS, INC.
GEOTECHNICAL ENGINEERING

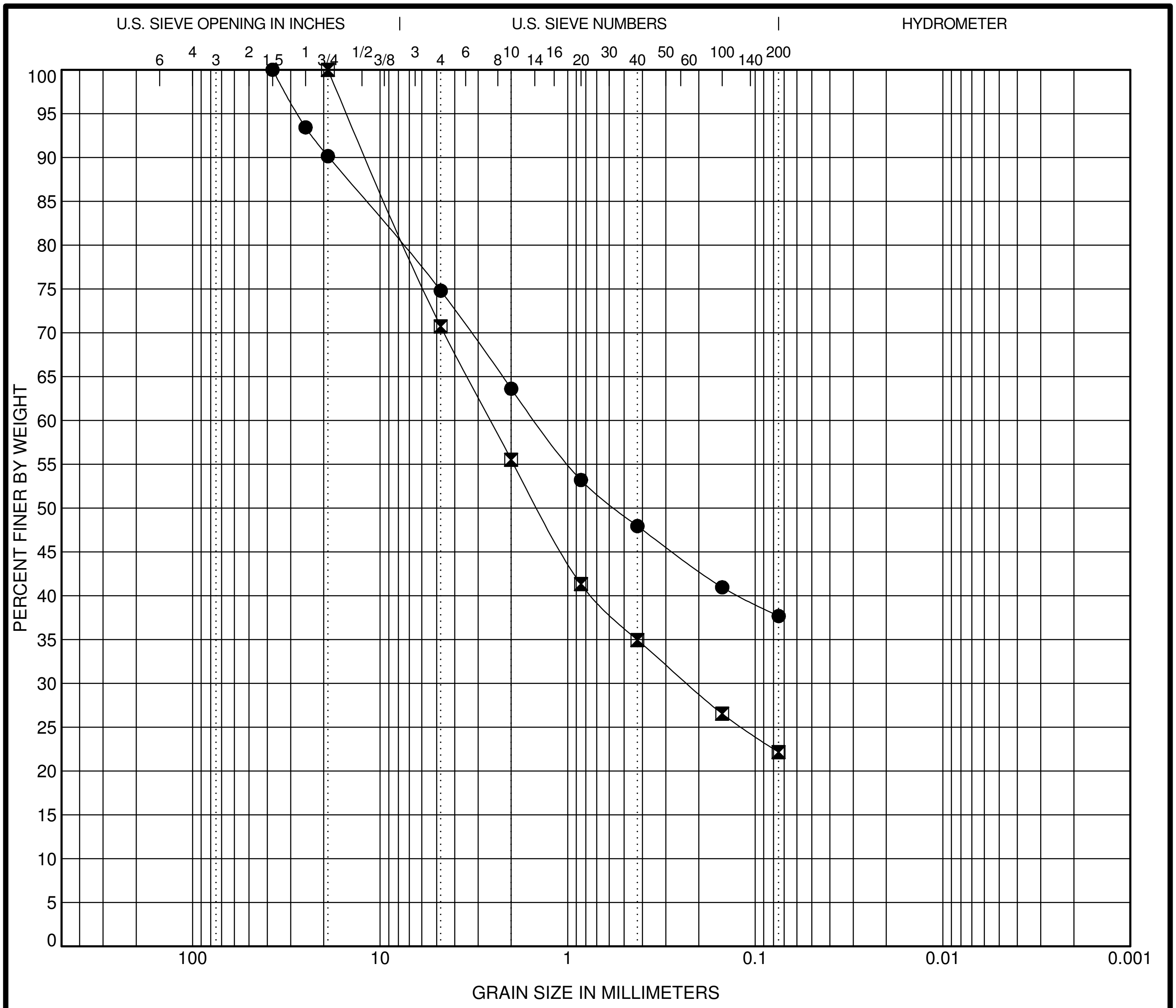
W.O. 7341-00

GRAIN SIZE DISTRIBUTION - ASTM D6913

INTERSTATE ROUTE H-1 AND H-201
DESTINATION SIGN UPGRADE/
REPLACEMENT, PHASE 3
FAP NO. NH-0300 (144)
ISLAND OF OAHU, HAWAII

Plate
B - 2

G_GRAIN_SIZE_MOD 7341-00.GPJ GEOLABS.GDT 1/24/22



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Sample	Depth (ft)	Description	LL	PL	PI	Cc	Cu
●	B-9	1.0-2.5	Reddish brown clayey sand (SC) with some gravel	38	22	16		
☒	B-9	10.0-11.3	Reddish brown and gray silty sand (SM) with some gravel					

	Sample	Depth (ft)	D100 (mm)	D60 (mm)	D30 (mm)	D10 (mm)	%Gravel	%Sand	%Fine
●	B-9	1.0-2.5	37.5	1.487			25.2	37.1	37.7
☒	B-9	10.0-11.3	19	2.584	0.23		29.3	48.6	22.1

GEOLABS, INC.

GEOTECHNICAL ENGINEERING

W.O. 7341-00

GRAIN SIZE DISTRIBUTION - ASTM D6913

INTERSTATE ROUTE H-1 AND H-201
DESTINATION SIGN UPGRADE/
REPLACEMENT, PHASE 3
FAP NO. NH-0300 (144)
ISLAND OF OAHU, HAWAII

Plate
B - 3

G GRAIN SIZE MOD 7341-00.GPJ GEOLABS.GDT 1/24/22

Location	Depth	Length	Diameter	Length/ Diameter Ratio	Density	Load	Compressive Strength
	(feet)	(inches)	(inches)		(pcf)	(lbs)	(psi)
B-1	15.5 - 16	6.743	3.189	2.11	133.6	19,610	2,460
B-1	21 - 26	6.710	3.185	2.11	125.1	14,390	1,810
B-2	6 - 11	6.721	3.230	2.08	117.1	8,920	1,090
B-2	16 - 21	6.681	3.239	2.06	117.9	11,610	1,410
B-5	21.5 - 26.5	6.950	3.250	2.14	153.7	60,330	7,270
B-6	11.5 - 16.5	7.020	3.250	2.16	185.0	200,540	24,170
B-6	21.5 - 26.5	6.840	3.240	2.11	185.4	158,200	19,190
B-9	17 - 17.5	6.500	3.200	2.03	120.7	34,900	4,340
B-9	28.5 - 29	6.500	3.250	2.00	134.8	24,140	2,910

ASTM D7012 (METHOD C)

Note: Samples were not prepared in accordance with ASTM D4543. Therefore, results reported may differ from results obtained from a test speciment that meets the requirements of Practice D4543

GEOLABS, INC.

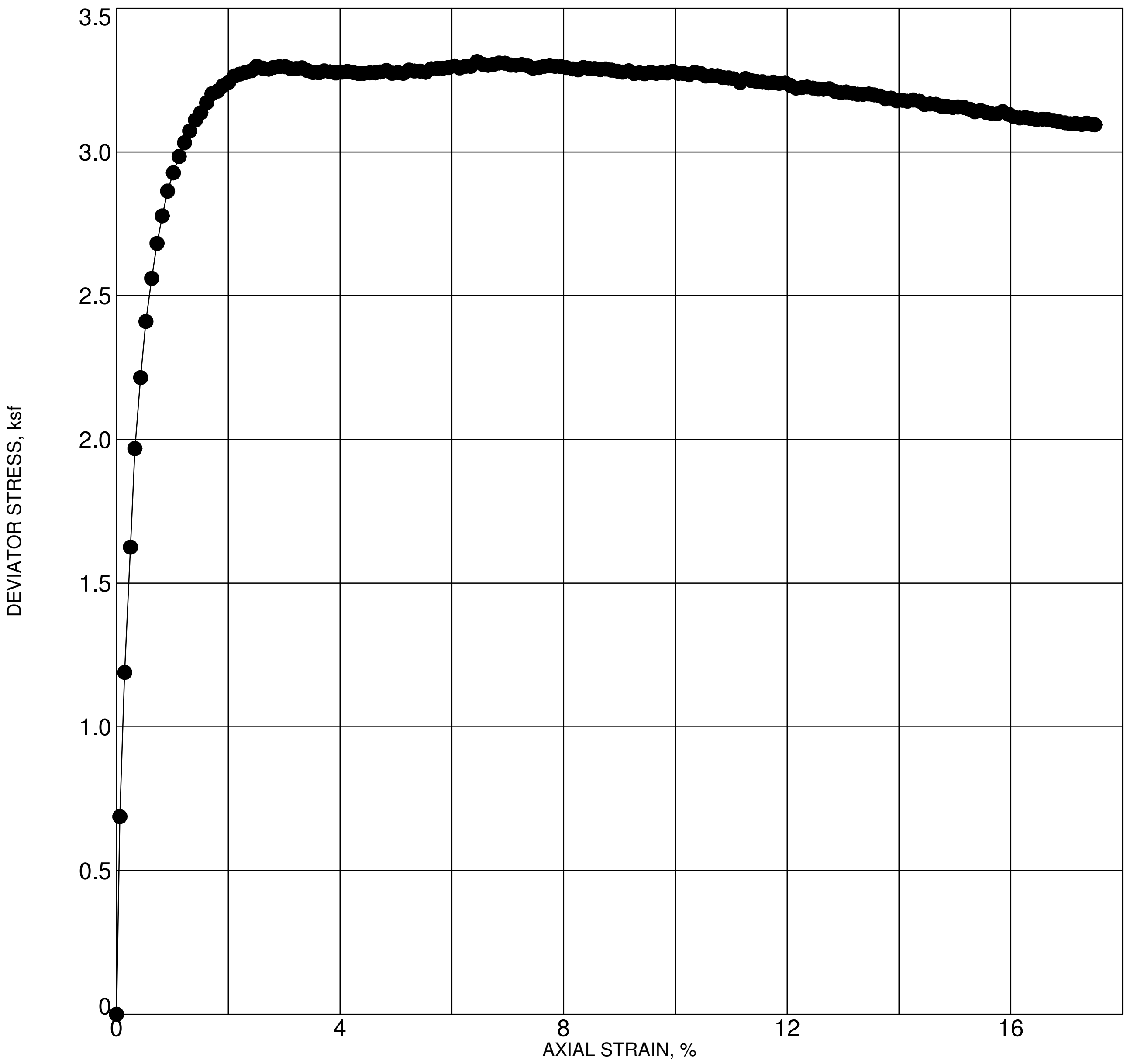
GEOTECHNICAL ENGINEERING

W.O. 7341-00

UNIAXIAL COMPRESSIVE STRENGTH TEST

INTERSTATE ROUTE H-1 AND H-201
DESTINATION SIGN UPGRADE/
REPLACEMENT, PHASE 3
FAP NO. NH-0300 (144)
ISLAND OF OAHU, HAWAII

Plate
B - 4



Max. Deviator Stress (ksf):	3.2
Confining Stress (ksf):	0.6

Location: B-3
Depth: 5.5 - 7.0 feet
Description: Dark brown silty clay
Test Date: 5/25/2018

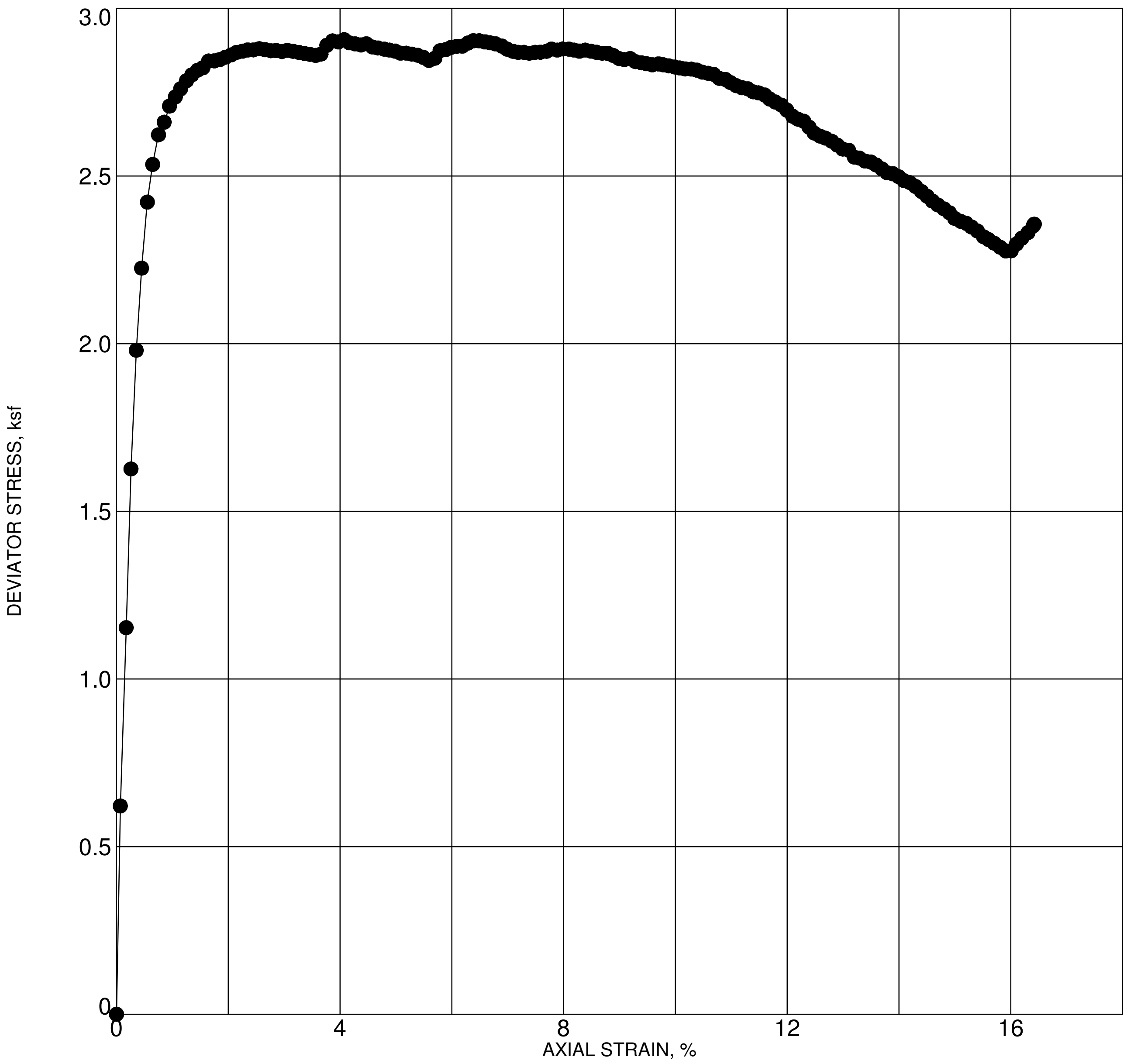
Dry Density (pcf)	85.9	Sample Diameter (inches)	2.393
Moisture (%)	32.2	Sample Height (inches)	5.107
Axial Strain at Failure (%)	15.0	Strain Rate (% / minute)	0.99

GEOLABS, INC.
GEOTECHNICAL ENGINEERING
W.O. 7341-00

TRIAXIAL UU COMPRESSION TEST - ASTM D2850

INTERSTATE ROUTE H-1 AND H-201
DESTINATION SIGN UPGRADE/
REPLACEMENT, PHASE 3
FAP NO. NH-0300 (144)
ISLAND OF OAHU, HAWAII

Plate
B - 5



Max. Deviator Stress (ksf):	2.9
Confining Stress (ksf):	2.5

Location:	B-3
Depth:	26.5 - 28.0 feet
Description:	Gray with tan mottling silty clay (CH) with a little gravel
Test Date:	5/25/2018

Dry Density (pcf)	60.9	Sample Diameter (inches)	2.323
Moisture (%)	67.2	Sample Height (inches)	5.103
Axial Strain at Failure (%)	4.0	Strain Rate (% / minute)	1.01

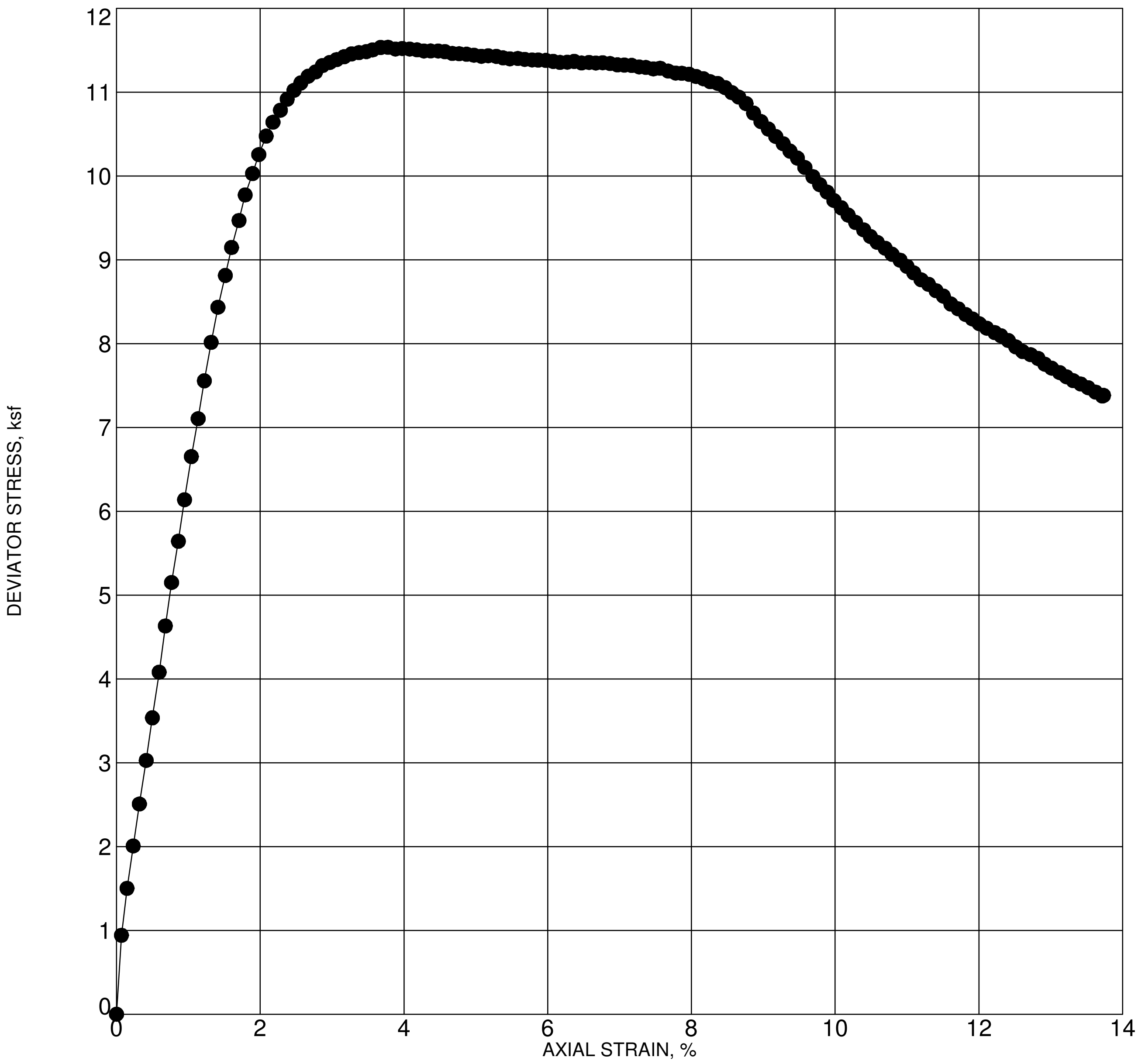
GEOLABS, INC.
GEOTECHNICAL ENGINEERING

W.O. 7341-00

TRIAXIAL UU COMPRESSION TEST - ASTM D2850

INTERSTATE ROUTE H-1 AND H-201
DESTINATION SIGN UPGRADE/
REPLACEMENT, PHASE 3
FAP NO. NH-0300 (144)
ISLAND OF OAHU, HAWAII

Plate
B - 6



Max. Deviator Stress (ksf):	11.5
Confining Stress (ksf):	2.0

Location: B-4
Depth: 16.5 - 18.0 feet
Description: Dark brown silty clay with some decompose gravel
Test Date: 5/25/2018

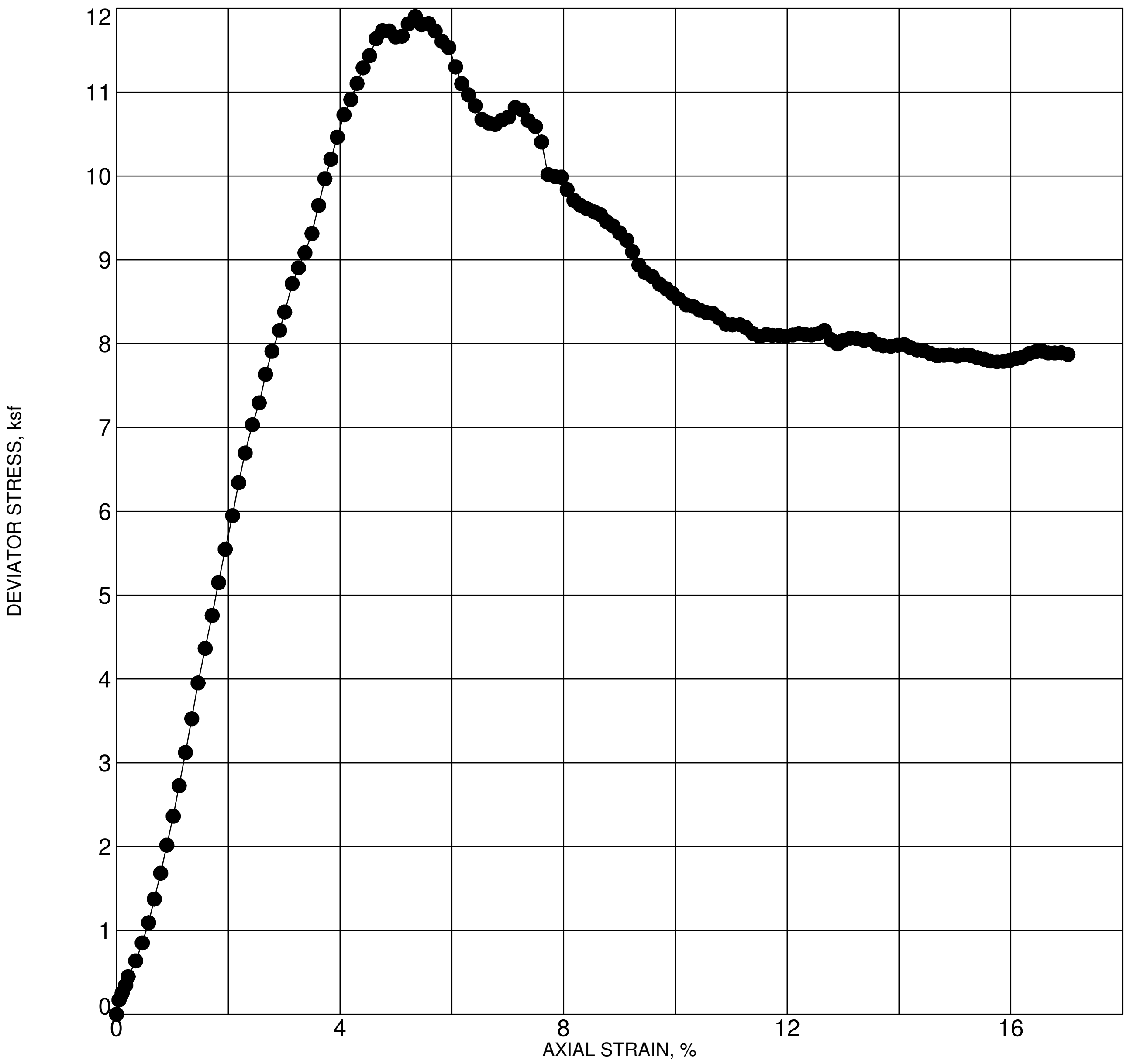
Dry Density (pcf)	84.2	Sample Diameter (inches)	2.407
Moisture (%)	35.4	Sample Height (inches)	5.107
Axial Strain at Failure (%)	3.8	Strain Rate (% / minute)	1.01

GEOLABS, INC.
GEOTECHNICAL ENGINEERING
W.O. 7341-00

TRIAXIAL UU COMPRESSION TEST - ASTM D2850

INTERSTATE ROUTE H-1 AND H-201
DESTINATION SIGN UPGRADE/
REPLACEMENT, PHASE 3
FAP NO. NH-0300 (144)
ISLAND OF OAHU, HAWAII

Plate
B - 7



Max. Deviator Stress (ksf):	11.9
Confining Stress (ksf):	0.5

Location: B-7
Depth: 5.0 - 6.5 feet
Description: Brown sandy silt (ML) with some gravel
Test Date: 1/18/2022

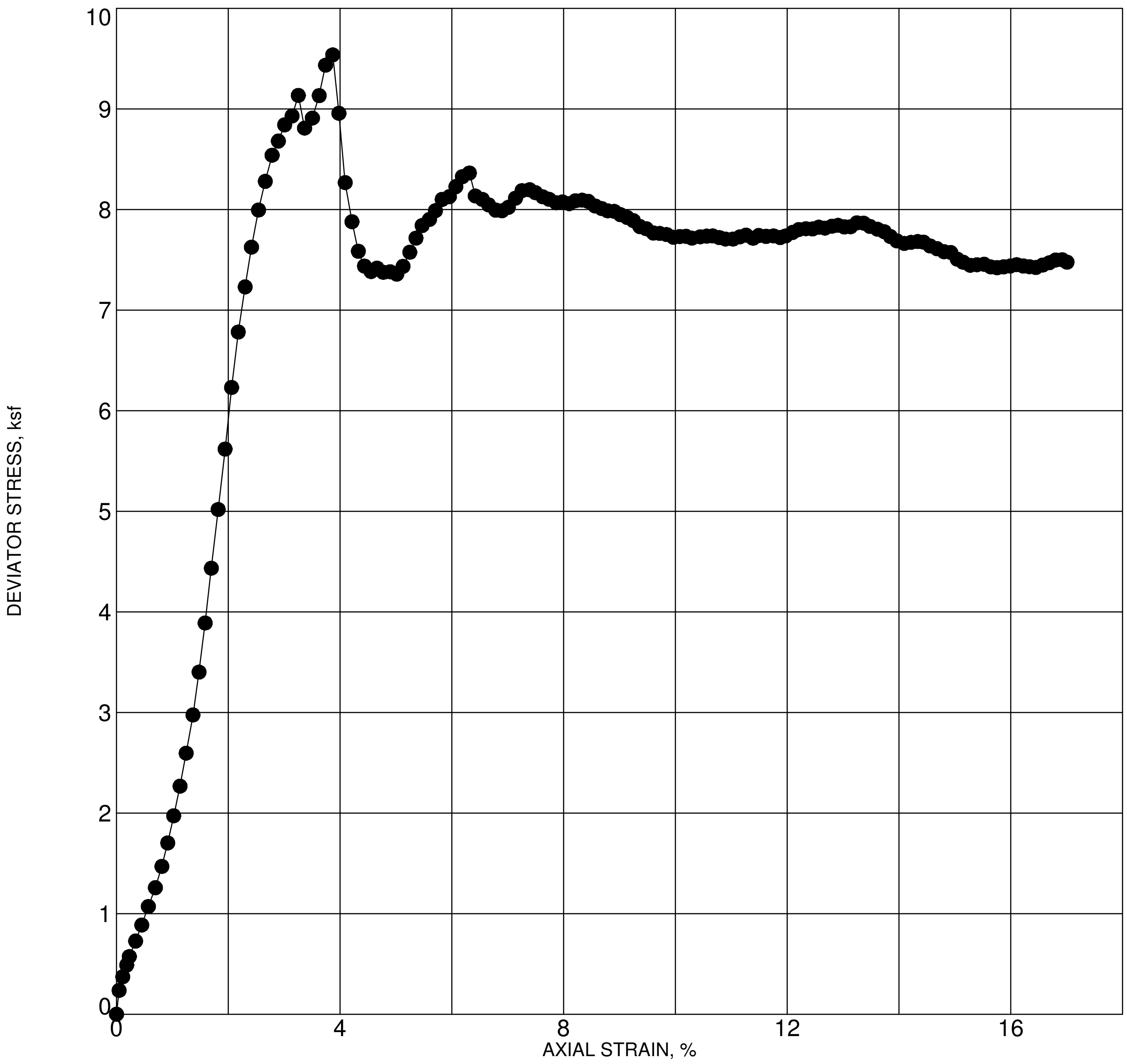
Dry Density (pcf)	72.9	Sample Diameter (inches)	2.413
Moisture (%)	32.1	Sample Height (inches)	5.100
Axial Strain at Failure (%)	5.3	Strain Rate (% / minute)	0.70

GEOLABS, INC.
GEOTECHNICAL ENGINEERING
W.O. 7341-00

TRIAXIAL UU COMPRESSION TEST - ASTM D2850

INTERSTATE ROUTE H-1 AND H-201
DESTINATION SIGN UPGRADE/
REPLACEMENT, PHASE 3
FAP NO. NH-0300 (144)
ISLAND OF OAHU, HAWAII

Plate
B - 8



Max. Deviator Stress (ksf):	9.5
Confining Stress (ksf):	0.5

Location: B-8
Depth: 5.0 - 6.5 feet
Description: Brown sandy silt
Test Date: 1/19/2022

Dry Density (pcf)	76.7	Sample Diameter (inches)	2.413
Moisture (%)	27.2	Sample Height (inches)	5.100
Axial Strain at Failure (%)	3.9	Strain Rate (% / minute)	0.70

G_TXUU 7341-00.GPJ GEOLABS.GDT 1/24/22

GEOLABS, INC.
GEOTECHNICAL ENGINEERING
W.O. 7341-00

TRIAXIAL UU COMPRESSION TEST - ASTM D2850

INTERSTATE ROUTE H-1 AND H-201
DESTINATION SIGN UPGRADE/
REPLACEMENT, PHASE 3
FAP NO. NH-0300 (144)
ISLAND OF OAHU, HAWAII

Plate
B - 9

APPENDIX C

B-1 15.5’ TO 31.0’

15.5’ 19.0’ 24.0’ 28.5’

19.0’ 24.0’ 28.5’ 31.0’

INTERSTATE ROUTE H-1 AND H-201 DESTINATION SIGN UPGRADE/REPLACEMENT, PHASE 3
FEDERAL-AID PROJECT NO. NH-0300(144)
ISLAND OF OAHU, HAWAII

B-2 6.0’ TO 31.0’

B-3 17.0’ TO 36.5’

17.0’ 28.0’

26.5’ 36.5’

INTERSTATE ROUTE H-1 AND H-201 DESTINATION SIGN UPGRADE/REPLACEMENT, PHASE 3
FEDERAL-AID PROJECT NO. NH-0300(144)
ISLAND OF OAHU, HAWAII

B-4 10.0’ TO 31.5’

INTERSTATE ROUTE H-1 AND H-201 DESTINATION SIGN UPGRADE/REPLACEMENT, PHASE 3
FEDERAL-AID PROJECT NO. NH-0300(144)
ISLAND OF OAHU, HAWAII

B-5 19.5’ TO 31.5’

B-6 11.5’ TO 26.5’

11.5’ **16.5’** **21.5’**

16.5’ **21.5’** **26.5’**

B-9 14.0’ TO 31.0’

14.0’ 16.0’ 21.0’ 26.0’

16.0’ 21.0’ 26.0’ 31.0’