GEOTECHNICAL ENGINEERING EXPLORATION
TRAFFIC SIGNAL MODERNIZATION PROJECT
H-1 EXIT 26A & KOKO HEAD AVENUE INTERSECTION
HONOLULU, OAHU, HAWAII

W.O. 7328-20(A)   APRIL 16, 2024

Prepared for

ENGINEERING CONCEPTS INC.

GEOLABS, INC.
Geotechnical Engineering and Drilling Services

GEOTECHNICAL ENGINEERING EXPLORATION
TRAFFIC SIGNAL MODERNIZATION PROJECT
H-1 EXIT 26A & KOKO HEAD AVENUE INTERSECTION
HONOLULU, OAHU, HAWAII

W.O. 7328-20(A)   APRIL 16, 2024

Prepared for

ENGINEERING CONCEPTS INC.

GERALD Y. SEKI
LICENSED PROFESSIONAL ENGINEER
No. 5635-C

THIS WORK WAS PREPARED BY
ME OR UNDER MY SUPERVISION.

SIGNATURE
4-30-26
EXPIRATION DATE
OF THE LICENSE

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

Hawaii • California

GEOLABS, INC.

Geotechnical Engineering and Drilling Services

April 16, 2024
W.O. 7328-20(A)

Mr. Conrad Higashionna
Engineering Concepts Inc.
1150 South King Street, Suite 700
Honolulu, HI 96814

Dear **Mr. Higashionna:**

Geolabs, Inc. is pleased to submit our report entitled "Geotechnical Engineering Exploration, Traffic Signal Modernization Project, H-1 Exit 26A & Koko Head Avenue Intersection, Honolulu, Oahu, Hawaii," prepared for the design of the project.

Our work was performed in general accordance with the scope of services outlined in our revised fee proposal dated September 8, 2022.

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 unclear, please contact our office.

Very truly yours,

GEOLABS, INC.

Gerald Y. Seki, P.E.
Vice President

GS:AT:lf

94-429 Koaki Street, Suite 200 • Waipahu, Hawaii 96797
Telephone: (808) 841-5064 • E-mail: hawaii@geolabs.net

Hawaii • California

GEOTECHNICAL ENGINEERING EXPLORATION
TRAFFIC SIGNAL MODERNIZATION PROJECT
H-1 EXIT 26A & KOKO HEAD AVENUE INTERSECTION
HONOLULU, OAHU, HAWAII
W.O. 7328-20(A) APRIL 16, 2024

TABLE OF CONTENTS

Page

Page

APPENDIX B

APPENDIX C

GEOTECHNICAL ENGINEERING EXPLORATION
TRAFFIC SIGNAL MODERNIZATION PROJECT
H-1 EXIT 26A & KOKO HEAD AVENUE INTERSECTION
HONOLULU, OAHU, HAWAII
W.O. 7328-20(A) APRIL 16, 2024

SUMMARY OF FINDINGS AND RECOMMENDATIONS

Our field exploration generally encountered a surface asphaltic concrete layer approximately 9 inches thick underlain by fill material consisting of stiff sandy silt to a depth of approximately 4 feet. The fill layer was underlain by a 1.5 feet thick saprolite layer consisting of dense silty sand, followed by medium hard to hard basalt rock formation extending to the maximum depth explored of about 26.5 feet below the existing ground surface. We did not encounter groundwater in the boring drilled at the time of our field exploration. However, it should be noted that water levels may vary with seasonal rainfall, time of year, and other environmental factors.

We recommend supporting the new traffic signal poles on cast-in-place concrete drilled shaft foundations. Based on the subsurface conditions encountered for traffic signal poles with mast arm lengths of 38 feet or less, we believe the Standard Plans TE-33A.1 and TE-33A.2, Type II Traffic Signal Standard by the State of Hawaii – Department of Transportation, Highways Division may be used for the design of the proposed drilled shaft foundations. We did not encounter groundwater at the time of our field exploration. Therefore, we recommend utilizing the appropriate drilled shaft diameters and lengths in accordance with TE-33A.2, Type II Traffic Signal Standard Drilled Shaft Foundation Schedule for a Level Ground Condition – Above Ground Water Table. Additionally, we recommend a minimum embedment depth of 10 feet for the design of the drilled shaft foundations with diameters of 36 and 42 inches.

It is imperative that a Geolabs representative is present at the project site to observe the drilling and installation of the drilled shafts during construction to confirm the assumed subsurface conditions.

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

END OF SUMMARY OF FINDINGS AND RECOMMENDATIONS

SECTION 1. GENERAL

This report presents the results of our geotechnical engineering exploration conducted for the *Traffic Signal Modernization Project* at the H-1 Exit 26A and Koko Head Avenue Intersection in the Kaimuki area of 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 geotechnical recommendations resulting from our field exploration, laboratory testing, and engineering analyses for the project. These findings and geotechnical recommendations are intended for the design of traffic signal pole foundations and utilities only. The findings and recommendations presented herein are subject to the limitations noted at the end of this report.

1.1 Project Considerations

The project involves the construction of two Type II traffic signal poles at the H-1 Exit 26A and Koko Head Avenue intersection in the Kaimuki area of Honolulu on the Island of Oahu, Hawaii. The existing intersection is signalized in all directions with both metal single pole and mast arm traffic signal poles. New traffic signal structures are shown on the Site Plan, Plate 2. Based on the information provided, the mast arm lengths of the traffic signal poles range from 26 to 38 feet in length.

The foundations for the traffic signal poles with mast arm lengths ranging from 26 to 38 feet may be designed according to the Standard Plans TE-33A.1 and TE-33A.2, Type II Traffic Signal Standard by the State of Hawaii – Department of Transportation, Highways Division. In order to determine the soil type at the project site for foundation design, one exploratory soil boring was performed at the intersection to evaluate the subsurface conditions.

1.2 Purpose and Scope

The purpose of our geotechnical engineering exploration was to obtain an overview of the surface and subsurface conditions to develop an idealized soil/rock data set to formulate geotechnical engineering recommendations for the project. The work was performed in general accordance with the scope of services outlined in our revised fee proposal dated September 8, 2022. The scope of work for this exploration included the following tasks and work efforts:

1. Research and review of available in-house boring data and other subsurface information in the project vicinity.
2. Application for excavation and street usage permits from the applicable agencies and coordination of underground utility toning, site access, and traffic control by our engineer.
3. Locating and staking out of one boring location by our field engineer.
4. Mobilization and demobilization of a truck-mounted drill rig and two operators to the project site and back.
5. Drilling and sampling of one boring to a depth of approximately 26.5 feet below the existing ground surface.
6. Coordination of the field exploration and logging of the boring by our geologist.
7. Laboratory testing of selected samples obtained during the field exploration as an aid in classifying the materials and evaluating their engineering properties.
8. Analysis of the field and laboratory data to formulate geotechnical engineering recommendations for the proposed standard traffic signal pole foundations.
9. Preparation of this report summarizing our work on the project and presenting our findings and recommendations.
10. Coordination of our overall work on the project by our project engineer.
11. Quality assurance of our work and client/design team consultation by our principal engineer.
12. Miscellaneous work efforts, such as drafting, word processing, and clerical support.

Detailed descriptions of our field exploration methodology and the Log of Boring are presented in Appendix A. Results of the laboratory tests performed on selected soil samples are presented in Appendix B. Photographs of core samples recovered from our field exploration are provided 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 lava from the Waianae and Koolau shield volcanoes. The older Waianae Volcano is estimated to be middle to late Pliocene in age, and the younger Koolau Volcano is estimated to be late Pliocene to early Pleistocene in age. After a long period of volcanic inactivity, during which time 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.

During the Pleistocene Epoch (Ice Age), sea levels fluctuated in response to the cycles of continental glaciation. As the glaciers grew and advanced, less water was available to fill the oceanic basins such that sea levels fell below the present stands of the sea. When the glaciers melted and receded, an excess of water became available such that the sea levels rose to elevations above the present sea level.

The processes of erosion and deposition were affected by these glacio-eustatic sea level fluctuations. When the sea level was low, the erosional base level was correspondingly lower, and valleys were carved to depths below the present sea level. When the sea level was high, the erosional base level was raised such that sediments accumulated at higher elevations.

In the mountainous regions of Hawaii and in the heads of valleys, the erosional processes are dominated by detachment of soil and rock masses from the valley walls and are transported downslope toward the axis of a valley primarily by gravity as colluvium. Once these materials reach the stream in the central portion of a valley, alluvial processes become dominant, and the sediments are transported and deposited as alluvium.

The project site is on the southern flank of the Koolau Volcano and is composed of basaltic rock built by the extrusion of lava from the Honolulu Volcanic Series. These rocks are generally characterized by flows of jointed, dense vesicular basalt with interbedded thin clinker layers. In-situ chemical weathering of the lava flows has occurred, forming a mantle of residual and saprolitic soils. In general, saprolite is composed mainly of silty material while residual soils are more clayey. Both residual and saprolitic soils are typical of the tropical weathering of volcanic rocks. The residual and saprolitic soils grade to basaltic rock formation with increased depth. In addition, fills were placed at portions of the site as a result of the original roadway construction.

2.2 Site Description

The project site is located at the intersection of H-1 Exit 26A Off Ramp and Koko Head Avenue in the Kaimuki area of Honolulu on the Island of Oahu, Hawaii. The intersection is generally bounded by Pahoa Avenue to the south, Koko Head Avenue Over Pass to the north and residential homes to the east and west.

Based on our field observations, the project site was observed to be relatively flat with a gentle slope in the northbound direction of Koko Head Avenue. Based on our field observation and Google Earth Imagery, the existing ground surface elevations of the intersection range from about +213 to +215 feet Mean Sea Level (MSL) with a slope gradient of about 1 percent. At this intersection, Koko Head Avenue generally consists of two lanes of traffic in each direction. The H-1 Exit 26A Off Ramp consists of two traffic lanes.

Based on the information provided, we understand that the existing single pole traffic signal and the existing mast arm traffic signal will be replaced by Standard Type II Traffic Signals. The layout of the intersection and proposed traffic signal replacement location are presented on the Site Plan, Plate 2.

2.3 Subsurface Conditions

We explored the subsurface conditions at the project site by drilling and sampling one boring, designated as Boring No. 1, to a depth of about 26.5 feet below the existing ground surface. The approximate boring location is shown on the Site Plan, Plate 2.

Our boring generally encountered approximately 9 inches of asphaltic concrete at the surface. Below the asphaltic concrete pavement, fill material consisting of stiff sandy silt was encountered to a depth of approximately 4 feet underlain by a saprolite layer about 1.5 feet thick consisting of dense silty sand. The saprolite was underlain by medium hard to hard basalt rock formation extending to the maximum depth explored of about 26.5 feet below the existing ground surface. A 2-foot high void was encountered in the basalt formation at a depth of about 17.5 feet.

We did not encounter groundwater in the boring at the time of our field exploration. However, it should be noted that groundwater levels are subject to change due to rainfall, time of year, seasonal precipitation, surface water runoff, and other factors.

Detailed descriptions of the field exploration methodology are presented in Appendix A. Descriptions and graphic representations of the materials encountered in the boring are presented on the Log of Boring in Appendix A. Results of the laboratory tests performed on selected soil samples are presented in Appendix B. Photographs of core samples recovered from our field exploration are provided in Appendix C.

END OF SITE CHARACTERIZATION

SECTION 3. DISCUSSION AND RECOMMENDATIONS

Our field exploration generally encountered a surface asphaltic concrete layer about 9-inch thick. Below the asphaltic concrete, fill material consisting of stiff sandy silt was encountered extending to a depth of approximately 4 feet underlain by a thin dense saprolitic layer. The saprolite was underlain by medium hard to hard basalt rock formation extending to the maximum depth explored of about 26.5 feet below the existing ground surface. We did not encounter groundwater in the boring drilled at the time of our field exploration.

We recommend supporting the new traffic signal poles on cast-in-place concrete drilled shaft foundations. Based on the subsurface conditions encountered, for traffic signal poles with mast arm lengths of 40 feet or less, we believe the Standard Plans TE-33A.1 and TE-33A.2, Type II Traffic Signal Standard by the State of Hawaii – Department of Transportation, Highways Division may be used for the design of the proposed drilled shaft foundations.

It is imperative that a Geolabs representative is present at the project site to observe the drilling and installation of the drilled shafts during construction to confirm the assumed subsurface conditions.

Detailed discussions and recommendations for the design of foundations, utility trenches, and other geotechnical aspects of the project are presented in the following sections.

3.1 Traffic Signal Pole Foundations

Based on the information provided, we understand that new traffic signal poles with mast arm lengths of up to 38 feet are planned to replace the existing traffic signal poles at the Kalanianaole Highway and Kalaniiki Street intersection. Based on the typical loading demands and anticipated subsurface soil conditions, we recommend supporting the new traffic signal poles on single cast-in-place drilled shaft foundations.

In order to develop the required bearing and lateral load resistances, the proposed new traffic signal pole structures may be supported by a foundation system consisting of cast-in-place concrete drilled shafts. Based on the subsurface conditions encountered, for traffic signal poles with mast arm lengths of 40 feet or less, we believe the Standard Plans TE-33A.1 and TE-33A.2, Type II Traffic Signal Standard by the State of Hawaii – Department of Transportation, Highways Division may be used for the design of the proposed drilled shaft foundations. Additionally, we understand that foundation recommendations for 36-inch and 42-inch diameter drilled shafts are desired.

We did not encounter groundwater in the drilled boring at the time of our field exploration. Therefore, we recommend the following drilled shaft diameters and lengths for the proposed traffic signal pole foundations.

STANDARD TYPE II TRAFFIC SIGNAL POLES DRILLED SHAFT FOUNDATIONS FOR LEVEL GROUND CONDITIONS	
Drilled Shaft Diameter (inches)	**Drilled Shaft Length** (feet)
36	10
42	10

The load-bearing capacities of the drilled shafts will depend largely on the consistency of the soils. Because local variations in the subsurface materials likely will occur, it is imperative that our representative is present during the shaft drilling operations to confirm the subsurface conditions encountered during the drilled shaft construction and to observe the installation of the drilled shafts. In addition, contract documents should include provisions (unit prices) for additional drilling and extension of the drilled shafts during construction to account for unforeseen subsurface conditions. The subsequent subsections address the design and construction of the drilled shaft foundations, which include the following:

- Foundation Settlements
- Drilled Shaft Construction Considerations

3.1.1 Foundation Settlements

Settlement of the drilled shaft foundation will result from elastic compression of the shaft and subgrade response of the foundation embedded in the subsurface soils. The total settlement of the drilled shaft is estimated to be on the order of less than 0.5 inches. We believe that a significant portion of the settlement is elastic and should occur as the loads are applied.

3.1.2 Drilled Shaft Construction Considerations

In general, the performance of the drilled shafts will depend 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 the drilled shaft depend, to a significant extent, on the frictional resistance 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 hole and in placing concrete into the drilled hole.

The subsurface materials generally consist of stiff fill and dense saprolitic material overlying medium hard to hard basalt rock formation with depth. The fill material encountered within the depth of the drilled shafts may contain cobbles and boulders. In addition, basalt rock formation is anticipated within the design depth of the drilled shafts. Therefore, some difficult drilling conditions may be encountered and should be expected at the project site. The drilled shaft contractor will need to have the appropriate equipment and tools to drill through the cobbles, boulders, and basalt formation that may be encountered during drilled shaft installation operations.

Based on our field exploration and the estimated lengths of the drilled shafts, groundwater is generally not expected in the drilled holes during the shaft installation work. Due to the relatively short lengths of the drilled shafts, concrete placement using the free fall method should be acceptable. In the event of seasonal rainfall and/or perched groundwater, water may be encountered in the drilled holes and concrete placement by tremie method would be required.

A low-shrinkage concrete mix with a high slump (6 to 9-inch slump range) should be used to provide close contact between the drilled shafts and the surrounding soils. 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 sidewalls of the drilled hole.

It is imperative that a Geolabs representative is present at the project site to observe the drilling and installation of the drilled shafts during construction. Although the drilled shaft design is primarily based on skin friction, the bottom of the drilled hole should be relatively free of loose materials prior to placement of the concrete. Therefore, it is necessary for Geolabs to observe the drilled shaft installation operations to confirm the assumed subsurface conditions.

3.2 Utility Trench

We anticipate that underground utilities, such as new electrical lines, may be installed for the project. In general, good construction practices should be utilized for the installation and backfilling of the trenches for the new utilities. The contractor should determine the method and equipment to be used for trench excavation, subject to practical limits and safety considerations. In addition, the excavations should comply with the applicable federal, state, and local safety requirements. The contractor should be responsible for trench shoring design and installation.

In general, we recommend providing granular bedding consisting of 6 inches of open-graded gravel (ASTM C33, No. 67 gradation) under the pipes for uniform support. Free-draining granular materials, such as open-graded gravel (ASTM C33, No. 67 gradation), should also be used for the initial trench backfill up to about 12 inches above the pipes to provide adequate support around the pipes. It is critical to use this free-draining material to reduce the potential for formation of voids below the haunches of pipes and to provide adequate support for the sides of the pipes. Improper trench backfill could result in backfill settlement and pipe damage.

The upper portion of the trench backfill from the level 12 inches above the pipes to the top of the subgrade or finished grade may consist of select granular fill material. The backfill material should be moisture-conditioned to above the optimum moisture content, placed in maximum 8-inch level loose lifts, and mechanically compacted to at least 90 percent relative compaction. In areas where trenches will be in paved areas, the upper 3 feet of the trench backfill below the pavement finished grade should be compacted to no less than 95 percent relative compaction. Mechanical compaction equipment should be used to compact the backfill materials. Compaction efforts by water tamping, jetting, or ponding should not be allowed.

Select granular fill should consist of non-expansive granular material, such as crushed coralline and/or basaltic materials. The material should be well-graded from coarse to fine with particles no larger than 3 inches in the largest dimension and should contain between 10 and 30 percent particles passing the No. 200 sieve. The material should have a laboratory California Bearing Ratio (CBR) value of 20 or more and should have a maximum swell of 1 percent or less when tested in accordance with ASTM D1883.

3.3 Design Review

Preliminary and final drawings and specifications for the project should be forwarded to Geolabs for review and written comments prior to bid solicitation for construction. This review is necessary to evaluate the conformance of the plans and specifications with the intent of the foundation and utility trench recommendations provided herein. If this review is not made, Geolabs cannot be responsible for misinterpretation of our recommendations.

3.4 Post-Design Services/Services During Construction

Geolabs should be retained to provide geotechnical engineering services during construction. The critical items of construction monitoring that require "Special Inspections" include the following:

1. Observation of the drilled shaft foundation installation
2. Observation of utility trench excavation and compaction

A Geolabs representative also should monitor other aspects of earthwork construction to observe compliance with the design concepts, specifications, or recommendations and to expedite suggestions for design changes that may be required in the event subsurface conditions differ from those anticipated at the time this report was prepared. Geolabs should be accorded the opportunity to provide geotechnical engineering services during construction to confirm our assumptions in providing the recommendations presented herein.

If the actual exposed subsurface conditions encountered during construction differ from those assumed or considered herein, Geolabs should be contacted to review and/or revise the geotechnical recommendations presented herein.

END OF DISCUSSION AND RECOMMENDATIONS

SECTION 4. LIMITATIONS

The analyses and recommendations submitted herein are based, in part, upon information obtained from our test boring. Variations of the subsurface conditions beyond the test boring 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 test boring location indicated herein is approximate, having been taped from visible features shown on the Signal Plan transmitted by Engineering Concepts, Inc. on January 31, 2019. The elevation of the boring was estimated from Google Earth Pro imagery dated January 11, 2016. The field boring location and elevation should be considered accurate only to the degree implied by the methods used.

The stratification breaks represented on the Log of Boring show the approximate boundaries between soil types and, as such, may denote a gradual transition. Water level data from the boring were measured at the times shown on the graphic representations and/or presented in the text of this report. The data has been reviewed and interpretations made in the formulation of this report. However, it must be noted that fluctuation may occur due to variations in seasonal rainfall and other factors.

This report has been prepared for the exclusive use of Engineering Concepts, Inc., and their consultants for specific application to the H-1 Exit 26A and Koko Head Avenue Intersection for the Traffic Signal Modernization 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 designer in the design of the traffic signal pole foundations for the project. Therefore, this report may not contain sufficient data or the proper information to serve as the basis for construction cost estimates not for bidding purposes. 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 additional site-specific exploration for bid estimating purposes.

The owner/client should be aware that unanticipated soil conditions are commonly encountered. Unforeseen subsurface conditions, such as perched groundwater, soft deposits, or hard layers may occur in localized areas and may require additional 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 project 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 Plan	Plate 2
Field Exploration	Appendix A
Laboratory Tests	Appendix B
Photographs of Core Samples	Appendix C

-ΩΩΩΩΩΩΩΩΩ-

Respectfully submitted,

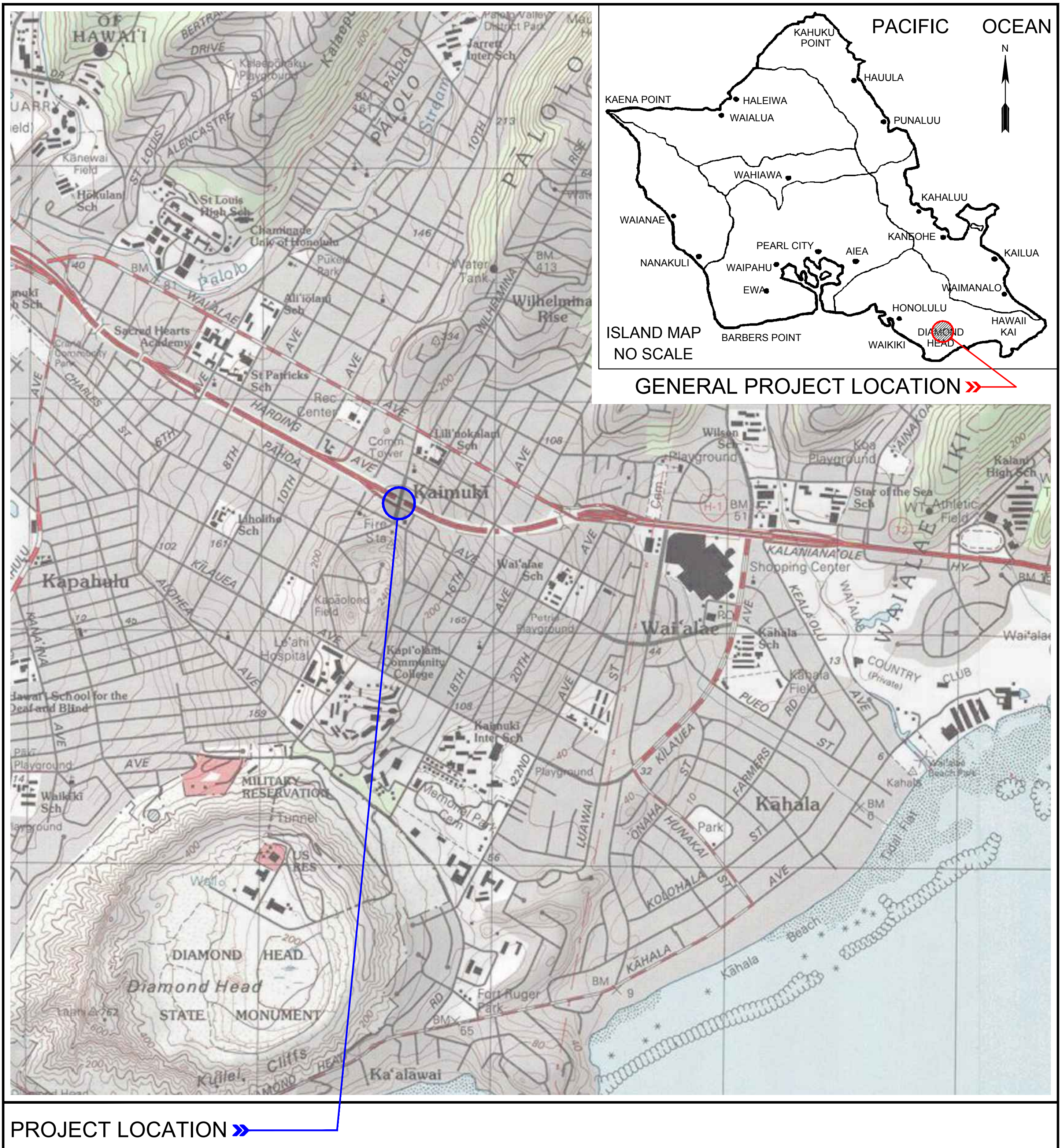
GEOLABS, INC.

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

GS:AT:lf

h:\7300Series\7328-20(A).at1

PLATES



2000 1000 0 2000 FT.

GRAPHIC SCALE

N

REFERENCE: MAP CREATED WITH TOPO!® ©2010 NATIONAL GEOGRAPHIC; ©2007 TELE ATLAS, REL. 1/2007.

PROJECT LOCATION MAP

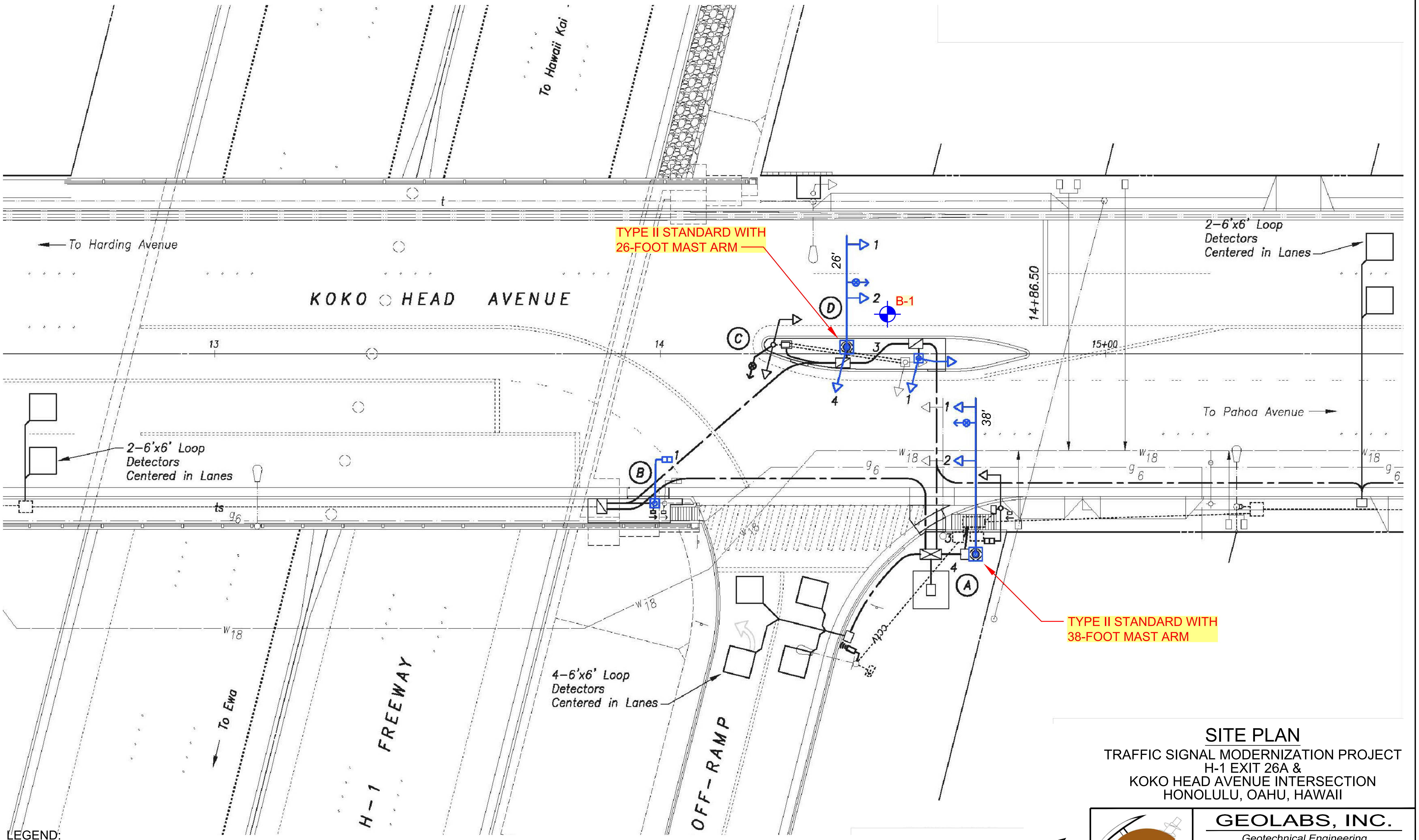
TRAFFIC SIGNAL MODERNIZATION PROJECT
H-1 EXIT 26A &
KOKO HEAD AVENUE INTERSECTION
HONOLULU, OAHU, HAWAII

GEOLABS, INC.

Geotechnical Engineering

DATE	DRAWN BY	PLATE
DECEMBER 2023	ASP / HYC	
SCALE	W.O.	
1" = 2,000'	7328-20(A)	1

CAD User: HENRY File Last Updated: December 18, 2023 - 4:48:43pm Plot Date: December 18, 2023 4:48:28pm
File: B:\Drafting\Working\7328-20(A)_Traffic_Signal_Modernization_Statewide_H-1_Exit_26A\7328-20(A)PLM.dwg\1.0 PLM
Plotter: DWG To PDF-GEO.pc3 Plotstyle: GEO-No-Dithering.ctb



LEGEND:

⌖ APPROXIMATE BORING LOCATION

0 10 20 40 60 FT.

GRAPHIC SCALE

REFERENCE: SIGNAL PLAN TRANSMITTED BY ENGINEERING CONCEPTS, INC. ON JANUARY 31, 2019.

SITE PLAN

TRAFFIC SIGNAL MODERNIZATION PROJECT
H-1 EXIT 26A &
KOKO HEAD AVENUE INTERSECTION
HONOLULU, OAHU, HAWAII

GEOLABS, INC.
Geotechnical Engineering

DATE	DRAWN BY	PLATE
DECEMBER 2023	HYC	
SCALE	W.O.	2
1" = 20'	7328-20(A)	

CAD User: ASPASIONJR File Last Updated: May 16, 2018 9:34:55am Plot Date: May 16, 2018 - 9:34:55am
File: T:\Drafting\Masters\1-LEDGERlandscape.dwg\Model
Plotter: DWG To PDF-GEO.pc3 Plotstyle: GEO-No-Dithering-Blue-Boring.ctb

APPENDIX A

APPENDIX A

Field Exploration

We explored the subsurface conditions at the project site by drilling and sampling one boring, designated as Boring No. 1, extending to a depth of about 26.5 feet below the existing ground surface. The approximate boring location is shown on the Site Plan, Plate 2. The boring was drilled using a truck-mounted drill rig equipped with continuous flight augers and rotary coring tools.

Our geologist classified the materials encountered in the boring 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. Graphic representations of the materials encountered are presented on the Log of Boring, Plate A-1.

Relatively "undisturbed" soil samples were obtained in general accordance with ASTM D3550, Ring-Lined Barrel Sampling of Soils, by driving a 3-inch OD 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 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 Log of Boring at the appropriate sample depths. The penetration resistance shown on the Log of Boring 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. 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).

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 Log of Boring 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.

GEOLABS, INC.

Geotechnical Engineering

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)

Plate

A-0.1

Soil Classification Log Key
(with deviations from ASTM D2488)

GEOLABS, INC. CLASSIFICATION*

GRANULAR SOIL (- #200 <50%)	COHESIVE 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**)	• **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. 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.	• **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 GRAVEL **with a little sand**)	• **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

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

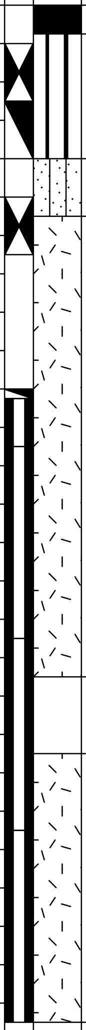
TRAFFIC SIGNAL MODERNIZATION PROJECT
H-1 EXIT 26A & KOKO HEAD AVENUE INTERSECTION
HONOLULU, OAHU, HAWAII

Log of Boring

B-1

Approximate Ground Surface Elevation (feet): 215 *

Laboratory			Field						
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	USCS	Description
							0		9-inch **ASPHALTIC CONCRETE**
Sieve - #200 = 56.1% LL=42 PI=16	22	101			22			ML	Brownish gray **SANDY SILT** with a little gravel, stiff, dry (fill)
	33				10				grades to reddish brown
								SM	Brown with orangish mottling **SILTY SAND (BASALTIC)** with some gravel (saprolitic) and a little clay, dense, moist (saprolite)
	8	140			81		5		
									Brownish gray vesicular **WEATHERED BASALT**, severely fractured, highly to moderately weathered, medium hard to hard (basalt formation)
	8		87	0	25/3"		10		
UC= 1650 psi			100	47					
							15		
			65	13					grades to severely to moderately fractured
									POSSIBLE VOID
							20		Light gray vesicular **BASALT**, moderately to severely fractured, moderately weathered, hard (basalt formation)
UC= 830 psi			100	52					
							25		
									Boring terminated at 26.5 feet
							30		* Elevation estimated from Google Earth™ Pro. ©2024 Google, Inc. Imagery dated January 11, 2016.
							35		



Date Started:	March 14, 2024	Water Level: ▼	Not Encountered	Plate
Date Completed:	December 30, 1899			
Logged By:	D. Gremminger	Drill Rig:	CME-55D *(Energy Transfer Ratio = 77.2%)*	A - 1
Total Depth:	26.5 feet	Drilling Method:	4" Solid-Stem Auger & PQ Coring	
Work Order:	7328-20A	Driving Energy:	140 lb. wt., 30 in. drop	

APPENDIX B

APPENDIX B

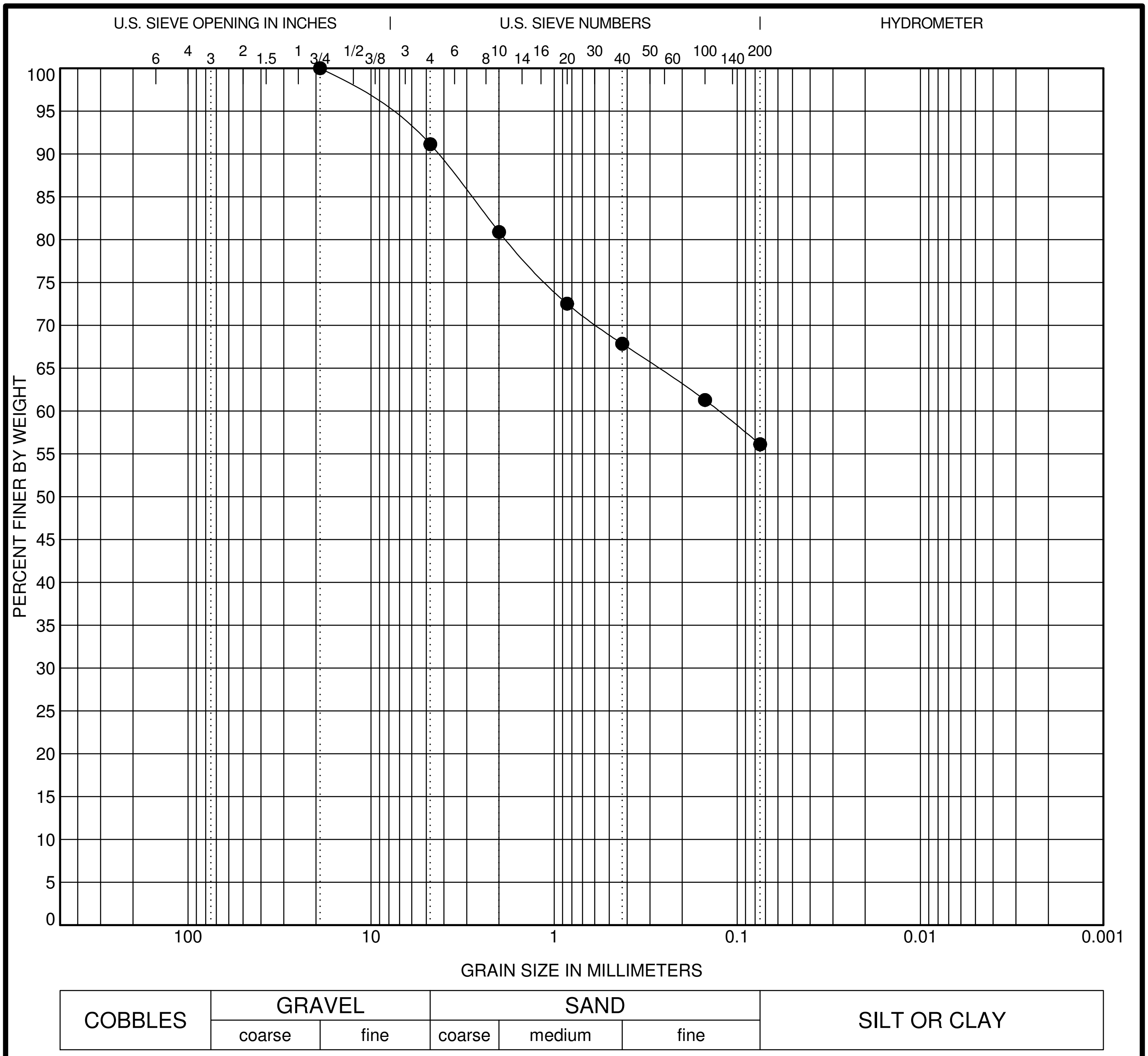
Laboratory Tests

Moisture Content (ASTM D2216) and Unit Weight (ASTM D2937) determinations were performed on selected 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.

One sieve analysis test (ASTM D6913) was performed on selected soil sample 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-1.

One one-inch Ring Swell test was performed on relatively undisturbed and remolded sample to evaluate the swelling potential of the near-surface soils under different surcharge loads. The results of these tests are summarized on Plate B-2.

Two Uniaxial Compression Strength tests (ASTM D7012 Method C) were performed on selected rock cores to evaluate the unconfined compressive strength of the rock formation encountered. Results of the uniaxial compression tests are presented on Plate B-3.



	Sample	Depth (ft)	Description	LL	PL	PI	Cc	Cu
●	B-1	1.0-2.5	Brownish gray sandy silt (ML) with a little gravel					

	Sample	Depth (ft)	D100 (mm)	D60 (mm)	D30 (mm)	D10 (mm)	%Gravel	%Sand	%Fine
●	B-1	1.0-2.5	19	0.126			8.9	35.0	56.1

GEOLABS, INC.

GEOTECHNICAL ENGINEERING

W.O. 7328-20A

GRAIN SIZE DISTRIBUTION - ASTM D6913

TRAFFIC SIGNAL MODERNIZATION H-1 EXIT 26A
HONOLULU, OAHU, HAWAII

Plate
B - 1

G_GRAIN_SIZE_MOD 7328-20A.GPJ GEOLABS.GDT 4/9/24

Location	Depth	Soil Description	Dry Density	Moisture Contents			Ring Swell
				Initial	Air-Dried	Final	
	(feet)		(pcf)	(%)	(%)	(%)	(%)
B-1**	2.5 - 4.0	Reddish brown sandy silt with a little gravel	93.2	30.9	25.3	33.6	0.9

NOTE: Samples tested were either relatively undisturbed or remolded in 2.4-inch diameter by 1-inch high rings. They were air-dried overnight and then saturated for 24 hours under a surcharge pressure of 55 psf.

* Relatively Undisturbed

** Remolded

GEOLABS, INC.

GEOTECHNICAL ENGINEERING

W.O. 7328-20A

SUMMARY OF RING SWELL TESTS

TRAFFIC SIGNAL MODERNIZATION H-1 EXIT 26A
HONOLULU, OAHU, HAWAII

Plate
B - 2

Location	Depth	Length	Diameter	Length/ Diameter Ratio	Density	Load	Compressive Strength
	(feet)	(inches)	(inches)		(pcf)	(lbs)	(psi)
B-1	11.5 - 16.5	6.935	3.229	2.15	133.4	13,510	1,650
B-1	21.5 - 26.5	6.955	3.227	2.16	113.9	6,820	830

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. 7328-20A

UNIAXIAL COMPRESSIVE STRENGTH TEST

TRAFFIC SIGNAL MODERNIZATION H-1 EXIT 26A
HONOLULU, OAHU, HAWAII

Plate
B - 3

APPENDIX C

TRAFFIC SIGNAL MODERNIZATION PROJECT
H-1 EXIT 26A & KOKO HEAD AVENUE INTERSECTION
HONOLULU, OAHU, HAWAII

B-1 10.25' TO 26.5'

10.25' **15.0'** **21.5'**

15.0' **21.5'** **26.5'**