DAVID Y. IGE
GOVERNOR OF HAWAII

BRUCE S. ANDERSON, Ph.D.
DIRECTOR OF HEALTH

STATE OF HAWAII
DEPARTMENT OF HEALTH
P. O. BOX 3378

In reply, please refer to:
File:

December 10, 2019

Yoichi Ebisu
Owner
Y. Ebisu and Associates
1126 12th Avenue, Room 305
Honolulu, Hawaii 96816

Dear Mr. Ebisu:

Enclosed is the VARIANCE (Docket No. 19-NR-VN-08) for Community Noise Control which was granted on December 9, 2019. The Decision and Order specifies the conditions and restrictions that are applicable to your project.

Non-compliance with the conditions and restrictions of the Decision and Order may bring about additional restrictions or possible suspension of the variance. Should you have any questions relative to the variance, please do not hesitate to contact me at (808) 586-4700 or at james.toma @doh.hawaii.gov.

Sincerely,

James E. Toma
Noise Section Supervisor
Indoor and Radiological Health Branch

STATE OF HAWAII
DEPARTMENT OF HEALTH

In the Matter of the Application For Variance for: Y. EBISU AND ASSOCIATES Noise – Traffic Signal Modernization – Kalanianaole Highway and Kalaniiki Street Intersection, Honolulu, Oahu	))))))))	Docket No. 19-NR-VN-08 V – 1088

DECISION AND ORDER

Pursuant to Chapter 342F, Hawaii Revised Statutes (H.R.S.), and Chapter 11-46, Hawaii Administrative Rules (H.A.R.), Community Noise Control; and based upon the application and review by the Indoor and Radiological Health Branch, the variance request from the provisions of Section 11-46-6(a), H.A.R., is hereby GRANTED with the following restrictions and conditions:

1. The variance shall be granted for traffic signal modernization within the area enclosing Kalanianaole Highway and the Kalaniiki / Wailei Street intersection, Honolulu, Oahu.

2. The variance shall be granted from June 1, 2020 to May 31, 2021 (Excluding Holidays).

3. The variance shall be granted for the following days/times:

Sunday	9:00 a.m. to 6:00 p.m.
Monday to Friday	8:00 p.m. to Midnight
Tuesday to Saturday	Midnight to 5:00 a.m.

4. The variance shall be granted with the following restriction:

   The use of the *Auger Drill-rig*, *Jackhammers and Drills* and *Concrete-saws* shall be prohibited after midnight within 500 feet of residences.

5. The applicant shall notify the Indoor and Radiological Health Branch as to the date and time of any variance hour activity as soon as the dates are confirmed, and when the project is completed.

6. The applicant shall make every effort to minimize noise emanating from the project.

7. The use of reverse signal alarms shall be prohibited from 8:00 p.m. to 7:00 a.m. Alternative methods such as utilizing a ground guide for signaling shall be employed.

8. Traffic noise from heavy vehicles travelling to and from the project site shall be minimized near residences.

9. The applicant shall have a job-site inspector to whom immediate complaints can be forwarded for prompt response, and who shall have the general responsibility of monitoring quiet work procedures.

10. Residents and businesses that may be impacted by the activity shall be given sufficient notice regarding the project. The notification for the planned nighttime activity shall contain the name and telephone number of the job-site inspector. In addition, a copy of any notifications, as well as progress reports shall be sent to the Indoor and Radiological Health Branch.

11. If the noise level is such that numerous complaints are received by the Department, the applicant shall cease operations upon receipt of an order and complete the project during hours on weekdays and weekends as directed.

12. Pursuant to Section 342F-5(d)(3), H.R.S., the applicant shall be required to perform noise sampling during the variance hours and report the results of such sampling to the Indoor and Radiological Health Branch.

13. Should the duration of the project continue beyond the expiration date, the applicant shall submit a request for extension along with an updated work schedule prior to May 31, 2021.

DATED: Honolulu, Hawaii, DEC - 9 2019.

Lynn M Nakasone

LYNN M. NAKASONE
Environmental Health Program Administrator
Environmental Health Services Division

Receipt

State of Hawaii - Dept. of Health
Indoor & Rad Health Branch
99-945 Halawa Valley Street
Aiea, HI 96701
Phone: (808) 586-4700 Fax: (808) 586-5838

Receipt Date	**1/23/2019**	**Receipt Number**	**2019-52618**

Name	Y. Ebisu and Associates	**Country**	USA
Address	1126 12th Avenue, Room 305	**Phone**	(808) 735-1634
	Honolulu HI 96816		

Check Number	15442	**Delivery method**	Walk-In

This is not proof of licensure or permit

Comments Community noise variance fee for Traffic Noise Signal Modernization at various locatioins, statewide (Kalanianaole Highway and Kalaniiki Street intersection).

Source Code	Source Code ID	Fee Amount
1117	Noise Permit and Variance Fees	$100.00
	Sum	$100.00

DAVID Y. IGE
GOVERNOR OF HAWAII

BRUCE S. ANDERSON, Ph.D.
DIRECTOR OF HEALTH

STATE OF HAWAII
DEPARTMENT OF HEALTH
P. O. BOX 3378

In reply, please refer to:
File:

January 14, 2020

Yoichi Ebisu
Owner
Y. Ebisu and Associates
1126 12th Avenue, Room 305
Honolulu, Hawaii 96816

Dear Mr. Ebisu:

Enclosed is the VARIANCE (Docket No. 19-NR-VN-09) for Community Noise Control which was granted on January 13, 2020. The Decision and Order specifies the conditions and restrictions that are applicable to your project.

Non-compliance with the conditions and restrictions of the Decision and Order may bring about additional restrictions or possible suspension of the variance. Should you have any questions relative to the variance, please do not hesitate to contact me at (808) 586-4700 or at james.toma @doh.hawaii.gov.

Sincerely,

James E. Toma
Noise Section Supervisor
Indoor and Radiological Health Branch

STATE OF HAWAII
DEPARTMENT OF HEALTH

In the Matter of the Application For Variance for: Y. EBISU AND ASSOCIATES Noise – Traffic Signal Modernization – Farrington Highway and Nanaikeola Street Intersection, Honolulu, Oahu	))))))))	Docket No. 19-NR-VN-09 V – 1089

DECISION AND ORDER

Pursuant to Chapter 342F, Hawaii Revised Statutes (H.R.S.), and Chapter 11-46, Hawaii Administrative Rules (H.A.R.), Community Noise Control; and based upon the application and review by the Indoor and Radiological Health Branch, the variance request from the provisions of Section 11-46-6(a), H.A.R., is hereby GRANTED with the following restrictions and conditions:

1. The variance shall be granted for traffic signal modernizations within the area enclosing the Farrington Highway and Nanaikeola Street intersection, Nanikuli, Oahu.

2. The variance shall be granted from May 1, 2020 to April 30, 2021 (Excluding Holidays).

3. The variance shall be granted for the following days/times:

Monday to Friday	8:00 p.m. to Midnight
Tuesday to Saturday	Midnight to 5:00 a.m.

4. The variance shall be granted with the following restriction:

   The use of the *Auger Drill-rig*, *Jackhammers and Drills* and *Concrete-saws* shall be prohibited after midnight.

5. The applicant shall notify the Indoor and Radiological Health Branch as to the date and time of any variance hour activity as soon as the dates are confirmed, and when the project is completed.

6. The applicant shall make every effort to minimize noise emanating from the project.

7. The use of reverse signal alarms shall be prohibited from 8:00 p.m. to 7:00 a.m. Alternative methods such as utilizing a ground guide for signaling shall be employed.

8. Traffic noise from heavy vehicles travelling to and from the project site shall be minimized near residences.

9. The applicant shall have a job-site inspector to whom immediate complaints can be forwarded for prompt response, and who shall have the general responsibility of monitoring quiet work procedures.

10. Residents and businesses that may be impacted by the activity shall be given sufficient notice regarding the project. The notification for the planned nighttime activity shall contain the name and telephone number of the job-site inspector. In addition, a copy of any notifications, as well as progress reports shall be sent to the Indoor and Radiological Health Branch.

11. If the noise level is such that numerous complaints are received by the Department, the applicant shall cease operations upon receipt of an order and complete the project during hours on weekdays and weekends as directed.

12. Pursuant to Section 342F-5(d)(3), H.R.S., the applicant shall be required to perform noise sampling during the variance hours and report the results of such sampling to the Indoor and Radiological Health Branch.

13. Should the duration of the project continue beyond the expiration date, the applicant shall submit a request for extension along with an updated work schedule prior to April 30, 2021.

DATED: Honolulu, Hawaii, JAN 1 3 2020.

Lynn M. Nakasone

LYNN M. NAKASONE
Environmental Health Program Administrator
Environmental Health Services Division

GEOLABS, INC.
Geotechnical Engineering and Drilling Services

September 9, 2019
W.O. 7328-00(A)(Add.)

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

Subject: Addendum
Updated 50-foot Mast Arm Traffic Signal Pole Foundation Recommendations
Traffic Signal Modernization Project
Kahuapaani Street & Ulune Street Intersection
Halawa, Oahu, Hawaii

Reference: Report by Geolabs, Inc. dated August 6, 2019
entitled "Geotechnical Engineering Exploration,
Traffic Signal Modernization Project
Kahuapaani Street & Ulune Street Intersection
Halawa, Oahu, Hawaii"

Dear **Mr. Higashionna:**

This addendum to our report entitled "Geotechnical Engineering Exploration, Traffic Signal Modernization Project, Kahuapaani Street & Ulune Street Intersection, Halawa, Oahu, Hawaii," dated August 6, 2019, provides the results of our foundation analysis based on the updated structural loads provided by Nagamine Okawa Engineers Inc. for the 50-foot mast arm traffic signal pole structure.

The findings and recommendations presented herein are subject to the limitations noted at the end of this addendum report.

50-Foot Mast Arm Traffic Signal Pole Foundation

At the time of our initial Geotechnical Engineering Exploration report, structural loading information for the 50-foot mast arm traffic signal pole was not available. Therefore, in-house structural loading information from similar projects was used to develop preliminary foundation recommendations.

Updated structural loading information for the 50-foot mast arm traffic signal pole was transmitted to Geolabs on September 5, 2019 by Nagamine Okawa Engineers Inc.

The following Load and Resistance Factor Design (LRFD) values based on Extreme Limit State I were used for the design of the 50-foot mast arm traffic signal pole foundation.

50-FOOT MAST ARM TRAFFIC SIGNAL POLE UPDATED STRUCTURAL LOADS (EXTREME LIMIT STATE I)			
Axial Load (kips)	**Shear Force** (kips)	**Resultant Bending Moment** (kip-feet)	**Torsion** (kip-feet)
3.6	12	146	219

Based on the typical dimensions of the base plate and anchor bolts, we envision that a 36-inch diameter cast-in-place concrete drilled shaft would be required for the proposed 50-foot mast arm traffic signal pole. The cast-in-place concrete drilled shaft would derive vertical support principally from skin friction between the shaft and the surrounding soils. Our updated recommendations pertaining to the drilled shaft capacities are presented in the following table.

36-INCH DIAMETER DRILLED SHAFT FOUNDATION		
Shaft Length (feet)	**Allowable Compressive Load Capacity** (kips)	**Ultimate Uplift Load Capacity** (kips)
18	340	360

The allowable compressive load capacity for the drilled shaft is to support dead-plus-live loads and may be increased by up to one-third (⅓) when considering transient loads, such as wind or seismic forces.

Uplift loads may be resisted by a combination of the dead weight of the drilled shaft and shear along the shaft surface area and adjacent soils. The uplift load capacity provided in the table above should be used only for transient loading conditions. For sustained loading conditions, the uplift load capacity should be reduced further using a factor of safety of 2.0. The project structural engineer should check the capacity of the drilled shaft in tension.

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:

- Lateral Load Resistance
- Foundation Settlements
- Drilled Shaft Construction Considerations

Lateral Load Resistance

The lateral load resistance of the drilled shaft is a function of the stiffness of the surrounding soil, the stiffness of the shaft, allowable deflection at the top of the shaft, and the induced moment in the shaft. The lateral load analyses were performed using the program LPILE 2018 for Windows, 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, results of our lateral load analyses for the concrete drilled shaft foundation are presented in the following table. The top of the shaft was assumed to be free against rotation.

SUMMARY OF LATERAL LOAD ANALYSES

Shaft Length (feet)	**Maximum Lateral Deflection** (inches)	**Maximum Shear** (kips)	**Maximum Induced Moment** (kip-feet)	**Depth to Maximum Moment** (feet)
18	0.08	28	193	5.3

NOTE: Analyses based on concrete compressive strength of 4,000 psi and a minimum of 1% longitudinal steel reinforcement.

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.

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 medium dense and stiff fill material overlying stiff residual soil, very dense saprolite, and basalt rock formation with depth. The residual and saprolitic soils encountered within the depth of the drilled shaft may contain cobbles and boulders. Therefore, some difficult drilling conditions may be encountered and should be expected in these soils. The drilled shaft contractor will need to have the appropriate equipment and tools to drill through the cobbles and boulders that may be encountered during drilled shaft installation operations.

Based on our field exploration and the estimated length of the drilled shaft, groundwater is generally not expected in the drilled hole during the shaft installation work. Due to the relatively short length of the drilled shaft, 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 hole 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 shaft 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.

Limitations

This report has been prepared for the exclusive use of Engineering Concepts, Inc. and their consultants for specific application to the Kahuapaani Street and Ulune Street 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 engineers in the project design. Therefore, this report may not contain sufficient data, or the proper information, to serve as a basis for construction cost estimates nor 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 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.

Closure

We appreciate the opportunity to be of continued service to you on this project. If you have questions or need additional information, please contact our office.

Respectfully submitted,

GEOLABS, INC.

By ______________________

Gerald Y. Seki, P.E.
Vice President

GS:NK:mj

(2 Copies to Addressee)

h:\7300Series\7328-00A.nk1.add

GERALD Y. SEKI
LICENSED PROFESSIONAL ENGINEER
No. 5635-C
HAWAII, U.S.A.

THIS WORK WAS PREPARED BY ME OR UNDER MY SUPERVISION.

SIGNATURE — 4-30-20 EXPIRATION DATE OF THE LICENSE

GEOTECHNICAL ENGINEERING EXPLORATION
TRAFFIC SIGNAL MODERNIZATION PROJECT
KAHUAPAANI STREET & ULUNE STREET INTERSECTION
HALAWA, OAHU, HAWAII

W.O. 7328-00(A)   AUGUST 6, 2019

Prepared for

ENGINEERING CONCEPTS, INC.

GEOLABS, INC.
Geotechnical Engineering and Drilling Services

GEOTECHNICAL ENGINEERING EXPLORATION
TRAFFIC SIGNAL MODERNIZATION PROJECT
KAHUAPAANI STREET & ULUNE STREET INTERSECTION
HALAWA, OAHU, HAWAII

W.O. 7328-00(A) AUGUST 6, 2019

Prepared for

ENGINEERING CONCEPTS, INC.

GERALD Y. SEKI
LICENSED PROFESSIONAL ENGINEER
No. 5635-C
HAWAII, U.S.A.

THIS WORK WAS PREPARED BY
ME OR UNDER MY SUPERVISION.

SIGNATURE 4-30-20
EXPIRATION DATE
OF THE LICENSE

GEOLABS, INC.
Geotechnical Engineering and Drilling Services
2006 Kalihi Street • Honolulu, HI 96819

Hawaii • California

GEOLABS, INC.
Geotechnical Engineering and Drilling Services

August 6, 2019
W.O. 7328-00(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, Kahuapaani Street and Ulune Street Intersection, Halawa, Oahu, Hawaii", prepared for the design of the project.

Our work was performed in general accordance with the scope of services outlined in our fee proposal dated February 19, 2016.

Please note that the soil 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:NK:lf

GEOTECHNICAL ENGINEERING EXPLORATION
TRAFFIC SIGNAL MODERNIZATION PROJECT
KAHUAPAANI STREET & ULUNE STREET INTERSECTION
HALAWA, OAHU, HAWAII
W.O. 7328-00(A) AUGUST 6, 2019

TABLE OF CONTENTS

Page

Page

APPENDIX B

APPENDIX C

GEOTECHNICAL ENGINEERING EXPLORATION
TRAFFIC SIGNAL MODERNIZATION PROJECT
KAHUAPAANI STREET & ULUNE STREET INTERSECTION
HALAWA, OAHU, HAWAII
W.O. 7328-00(A) AUGUST 6, 2019

SUMMARY OF FINDINGS AND RECOMMENDATIONS

Our field exploration generally encountered a pavement structure consisting of about 6 inches of Portland cement concrete overlying 12 inches of gravelly sand fill. Below the pavement, stiff fill material was encountered at a depth of approximately 4 feet followed by stiff to hard residual soil extending to a depth of about 15 feet below the existing ground surface. Underlying the residual soil, very dense saprolite was encountered at a depth of approximately 21.5 feet followed by medium hard to hard basalt rock formation extending to the maximum depth explored of about 28 feet below the existing ground surface. We did not encounter groundwater in the borings 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 40 feet or less, we believe the Standard Plan TE-33A.1 and 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 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.

The Type II Traffic Signal Standard does not include recommendations for traffic signal poles with mast arm lengths greater than 40 feet. Structural loading information for the 50-foot mast arm traffic signal pole was not available at the time this report was prepared. Therefore, in-house structural loading information from similar projects was used to develop preliminary foundation recommendations. It is imperative that Geolabs be forwarded the final structural loading information when it becomes available to develop final foundation recommendations for the project.

Based on the typical dimensions of the base plate and anchor bolts, we envision that a 36-inch diameter cast-in-place concrete drilled shaft with a minimum embedment length of 12 feet would be required for the proposed 50-foot mast arm traffic signal pole.

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 Kahuapaani Street and Ulune Street intersection in Halawa 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 site is located at the intersection of Kahuapaani Street and Ulune Street in Halawa on the Island of Oahu, Hawaii. The existing intersection is signalized in all four directions with both metal single pole and mast arm traffic signal poles. The project location and general vicinity are shown on the Project Location Map, Plate 1.

Based on the information provided, we understand that the mast arm lengths of the proposed traffic signal poles range from 12 to 50 feet in length. The foundations for the traffic signal poles with mast arm lengths ranging from 12 to 38 feet may be designed according to the Standard Plan TE-33A.1 and TE-33A.2, Type II Traffic Signal Standard by the State of Hawaii – Department of Transportation, Highways Division. Non-standard traffic signals, defined as traffic signal poles with mast arm lengths exceeding 40 feet, are not covered under the Standard Plans. Therefore, one exploratory soil boring was performed near the northwest corner of the intersection, where the proposed traffic signal pole with a 50-foot mast arm length is planned.

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 fee proposal dated February 19, 2016. 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 28 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 and non-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. Photograph of core samples recovered from our field exploration is 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 basalt and 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 majority of the western one-third of the island. The younger Koolau Volcano is estimated to be late Pliocene to early Pleistocene (Ice Age) in age and forms the bulk of the eastern two-thirds of the island. 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.

The project site is on the southern flank of the Koolau Volcano. The project area is generally composed of basaltic rock built by extrusion of the lavas of the Koolau 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 Koolau lava flows has occurred for the last 1 to 2 million years. The weathering process has formed 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 soils and saprolite grade to basaltic rock formation with increased depth.

2.2 Site Description

The project site is located at the intersection of Kahuapaani Street and Ulune Street in Halawa on the Island of Oahu, Hawaii. The intersection is generally bounded by residential homes to the north and the Interstate Route H-201, and Moanalua Freeway to the south.

Based on our field observations, the project site was relatively flat with a gentle slope in the southbound direction of Kahuapaani Street. Based on the provided project drawings, the existing ground surface elevations of the intersection range from about +116 to +120 feet Mean Sea Level (MSL) with a slope gradient of about 5 percent. At this intersection, Kahuapaani Street generally consists of two lanes of traffic in each direction with additional left turn only lanes onto Ulune Street in either direction. Ulune Street generally consists of two lanes in each direction with an additional left turn only lane onto Kahuapaani Street in the southbound direction.

Based on the information provided, we understand that the existing traffic signals on the four corners of the intersection will be replaced by Standard Type II Traffic Signals. The 50-foot mast arm traffic signal pole will replace both the existing single pole and mast arm traffic signals on the northwest corner of the intersection serving the westbound lanes of Ulune Street. 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 28 feet below the existing ground surface. The approximate boring location is shown on the Site Plan, Plate 2.

Our boring generally encountered a pavement structure consisting of about 6 inches of Portland cement concrete underlain by about 12 inches of gravelly sand fill. Below the pavement, fill material consisting of stiff silty clay was encountered at a depth of approximately 4 feet followed by residual soil consisting of stiff to hard silty clay extending to a depth of about 15 feet below the existing ground surface. Underlying the residual soil, saprolite was encountered at a depth of approximately 21.5 feet followed by basalt rock formation extending to the maximum depth explored of about 28 feet below the existing ground surface. The saprolite generally consisted of very dense silty sand and the basalt rock formation was moderately to highly weathered and medium hard to hard in nature.

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. Photograph of core samples recovered from our field exploration is provided in Appendix C.

END OF SITE CHARACTERIZATION

SECTION 3. DISCUSSION AND RECOMMENDATIONS

Our field exploration generally encountered a pavement structure consisting of about 6 inches of Portland cement concrete overlying 12 inches of gravelly sand fill. Below the pavement, stiff fill material was encountered at a depth of approximately 4 feet followed by stiff to hard residual soil extending to a depth of about 15 feet below the existing ground surface. Underlying the residual soil, very dense saprolite was encountered at a depth of approximately 21.5 feet followed by medium hard to hard basalt rock formation extending to the maximum depth explored of about 28 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 Plan TE-33A.1 and 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 drilled shaft foundations.

The Type II Traffic Signal Standard does not include recommendations for traffic signal poles with mast arm lengths greater than 40 feet. Structural loading information for the 50-foot mast arm traffic signal pole was not available at the time this report was prepared. Therefore, in-house structural loading information from similar projects was used to develop preliminary foundation recommendations. Geolabs should be forwarded the final structural loading information when it becomes available to develop final foundation recommendations for the project.

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 50 feet are planned to replace the existing traffic signal poles at the Kahuapaani Street and Ulune 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 Plan TE-33A.1 and 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 drilled shaft foundations.

We did not encounter groundwater at the time of our field exploration. Therefore, we recommend the following drilled shaft diameters and lengths for the proposed traffic signal pole foundations in accordance with TE-33A.2, Type II Traffic Signal Standard Drilled Shaft Foundation Schedule for a Level Ground Condition – Above Ground Water Table.

STANDARD TRAFFIC SIGNAL POLES DRILLED SHAFT FOUNDATIONS FOR LEVEL GROUND CONDITIONS		
Mast Arm Length (feet)	**Drilled Shaft Diameter** (inches)	**Drilled Shaft Length** (feet)
12	24	6
25	30	6
38	30	11

The Type II Traffic Signal System and Standard does not include recommendations for traffic signal poles with mast arm lengths greater than 40 feet. Structural loading information for the 50-foot mast arm traffic signal pole was not available at the time this report was prepared. Therefore, in-house structural loading information from similar projects was used to develop preliminary foundation recommendations. Geolabs should be forwarded the final structural loading information when it becomes available to develop final foundation recommendations for the project.

The following structural loads were utilized to design the preliminary cast-in-place concrete drilled shaft foundation for the 50-foot mast arm traffic signal pole.

50-FOOT MAST ARM TRAFFIC SIGNAL POLE PRELIMINARY STRUCTURAL LOADS			
Axial Load (kips)	**Resultant Shear Force** (kips)	**Resultant Bending Moment** (kip-feet)	**Torsion** (kip-feet)
2.5	5	100	100

Based on the typical dimensions of the base plate and anchor bolts, we envision that a 36-inch diameter cast-in-place concrete drilled shaft would be required for the proposed 50-foot mast arm traffic signal poles. The cast-in-place concrete drilled shafts would derive vertical support principally from skin friction between the shafts and the surrounding soils. Our preliminary recommendations pertaining to the drilled shaft capacities are presented in the following table.

36-INCH DIAMETER DRILLED SHAFT FOUNDATION		
Shaft Length (feet)	**Allowable Compressive Load Capacity Per Shaft** (kips)	**Ultimate Uplift Load Capacity Per Shaft** (kips)
12	226	238

The allowable compressive load capacity for the drilled shaft is to support dead-plus-live loads and may be increased by up to one-third (⅓) when considering transient loads, such as wind or seismic forces.

Uplift loads may be resisted by a combination of the dead weight of the drilled shaft and shear along the shaft surface area and adjacent soils. The uplift load capacity provided in the table above should be used only for transient loading conditions. For sustained loading conditions, the uplift load capacity should be reduced further using a factor of safety of 2.0. The project structural engineer should check the capacity of the drilled shaft in tension.

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:

- Lateral Load Resistance
- Foundation Settlements
- Drilled Shaft Construction Considerations

3.1.1 Lateral Load Resistance

The lateral load resistance of the drilled shafts is a function of the stiffness of the surrounding soil, the stiffness of the shafts, allowable deflection at the top of the shafts, and the induced moment in the shafts. The lateral load analyses were performed using the program LPILE 2018 for Windows, 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 assumed preliminary structural loads, results of our lateral load analyses for the concrete drilled shaft foundation are presented in the following table. The top of the shaft was assumed to be free against rotation.

SUMMARY OF LATERAL LOAD ANALYSES				
Shaft Length (feet)	**Maximum Lateral Deflection** (inches)	**Maximum Shear** (kips)	**Maximum Induced Moment** (kip-feet)	**Depth to Maximum Moment** (feet)
12	0.16	24.7	113.2	3.8
NOTE: Analyses based on concrete compressive strength of 4,000 psi and a minimum of 1% longitudinal steel reinforcement.				

3.1.2 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. 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.

3.1.3 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 medium dense and stiff fill material overlying stiff residual soil, very dense saprolite, and basalt rock formation with depth. The residual and saprolitic soils encountered within the depth of the drilled shaft may contain cobbles and boulders. Therefore, some difficult drilling conditions may be encountered and should be expected in these soils. The drilled shaft contractor will need to have the appropriate equipment and tools to drill through the cobbles and boulders that may be encountered during drilled shaft installation operations.

Based on our field exploration and the estimated length of the drilled shaft, groundwater is generally not expected in the drilled hole during the shaft installation work. Due to the relatively short length of the drilled shaft, 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 hole 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 shaft 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 about 2 percent 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 largest dimension and should contain between 10 and 30 percent particles passing the No. 200 sieve. The material should have a laboratory California Bearing Ration (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 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 interpolated from the contour lines and spot elevations shown on the same plan. 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 was measured at the times shown on the graphic representations and/or presented in the text of this report. The data has been reviewed and interpretation made in the formulation of this report. However, it must be noted that fluctuation may occur due to variation 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 Kahuapaani Street and Ulune Street 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 client/owner 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 nor 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:

-ΩΩΩΩΩΩΩΩΩ-

Respectfully submitted,

GEOLABS, INC.

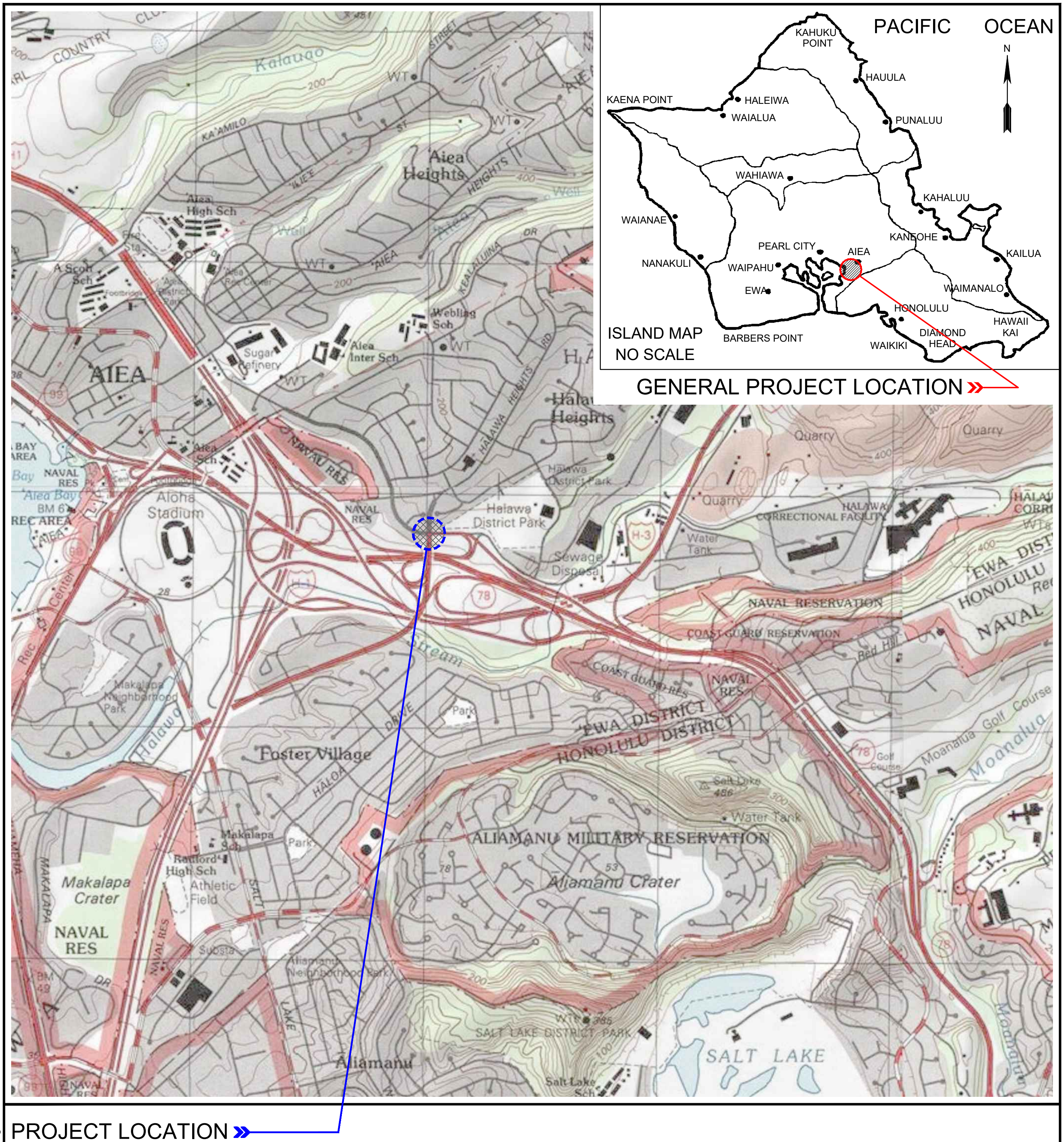
By ______________________

Gerald Y. Seki, P.E.
Vice President

GS:NK:lf

h:\7300Series\7328-00(A).nk1

PLATES



PROJECT LOCATION MAP

TRAFFIC SIGNAL MODERNIZATION PROJECT
KAHUAPAANI STREET &
ULUNE STREET INTERSECTION
HALAWA, OAHU, HAWAII

2000 1000 0 2000 FT.
GRAPHIC SCALE

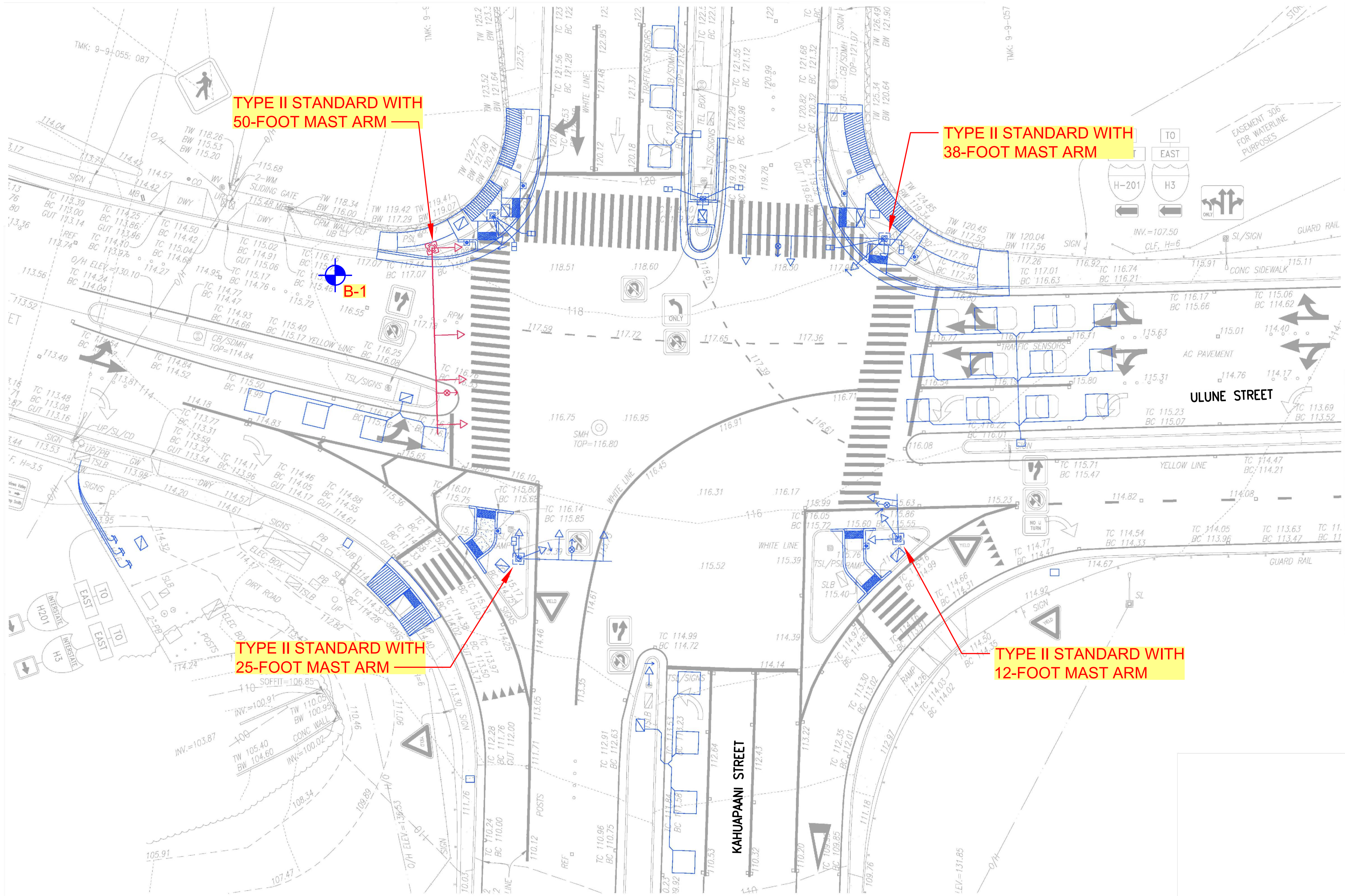
N

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

GEOLABS, INC.
Geotechnical Engineering

DATE	DRAWN BY	PLATE
JULY 2019	ASP	
SCALE	W.O.	
1" = 2,000'	7328-00(A)	1

CAD User: ASPASIONUR File Last Updated: July 30, 2019 12:42:18pm Plot Date: July 30, 2019 - 4:35:14pm
File: T:\Drafting\Working\7328-00(A)_Traffic_Signal_Modernization_Kahuapaani_&_Ulune\7328-00(A)PLM.dwg\1.0 PLM
Plotter: DWG To PDF-GEO.pc3 Plotstyle: GEO-No-Dithering.ctb



LEGEND:

APPROXIMATE BORING LOCATION

0 10 20 30 60 90 FT.

GRAPHIC SCALE

N

SITE PLAN

TRAFFIC SIGNAL MODERNIZATION PROJECT
KAHUAPAANI STREET &
ULUNE STREET INTERSECTION
HALAWA, OAHU, HAWAII

GEOLABS, INC.
Geotechnical Engineering

DATE	DRAWN BY	PLATE
JULY 2019	ASP	
SCALE	W.O.	2
1" = 30'	7328-00(A)	

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

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 28 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 representation of the materials encountered is 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.

Pocket penetrometer test was performed on a selected cohesive soil sample retrieved in the field. The pocket penetrometer test provides an indication of the unconfined compressive strength of the sample. The pocket penetrometer test result is summarized on the Log of Boring at the appropriate sample depth.

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 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.

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
- SHELBY TUBE SAMPLE
- 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

GEOLABS, INC.

Geotechnical Engineering

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).*

SOIL_CLASS_LOG_KEY 7328-00(A).GPJ GEOLABS.GDT 8/1/19

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 KAHUAPAANI STREET & ULUNE STREET INTERSECTION HALAWA, OAHU, HAWAII	Log of Boring 1

Approximate Ground Surface Elevation (feet MSL): 116 *

Laboratory: Other Tests	Laboratory: Moisture Content (%)	Laboratory: Dry Density (pcf)	Field: Core Recovery (%)	Field: RQD (%)	Field: Penetration Resistance (blows/foot)	Field: Pocket Pen. (tsf)	Depth (feet)	USCS	Description
							0		6-inch **CONCRETE**
	10	112			33			SM	Reddish brown **GRAVELLY SAND (BASALTIC)** with a little clay and silt, medium dense, moist (fill)
	31				10			CH	Brown w/ multi-color mottling **SILTY CLAY** with some sand, stiff, moist (fill)
TXUU	44	80			22	2.0	5	CH	Brownish red with multi-colored mottling **SILTY CLAY** with traces of gravel, stiff, moist (residual soil)
LL=70 PI=39	33				39		10		grades to purplish brown, hard
	29	58			65/6" Ref.		15	SM	Reddish brown **SILTY SAND** with some gravel, very dense, moist (saprolite)
	16				40/3" Ref.		20		
UC			0 97	67					Gray vesicular **BASALT**, severely to moderately fractured, moderately to highly weathered, medium hard to hard (basalt formation)
	33				20/6" +50/4"		25		
									Boring terminated at 28 feet
							30		
							35		

Date Started:	May 9, 2019	Water Level:	not encountered	Plate
Date Completed:	May 9, 2019			
Logged By:	D. Gremminger	Drill Rig:	CME-45C TRUCK	
Total Depth:	28 feet	Drilling Method:	4" Solid Stem Auger & PQ Coring	A - 1
Work Order:	7328-00(A)	Driving Energy:	140 lb. wt., 30 in. drop	

APPENDIX B

A P P E N D I X B

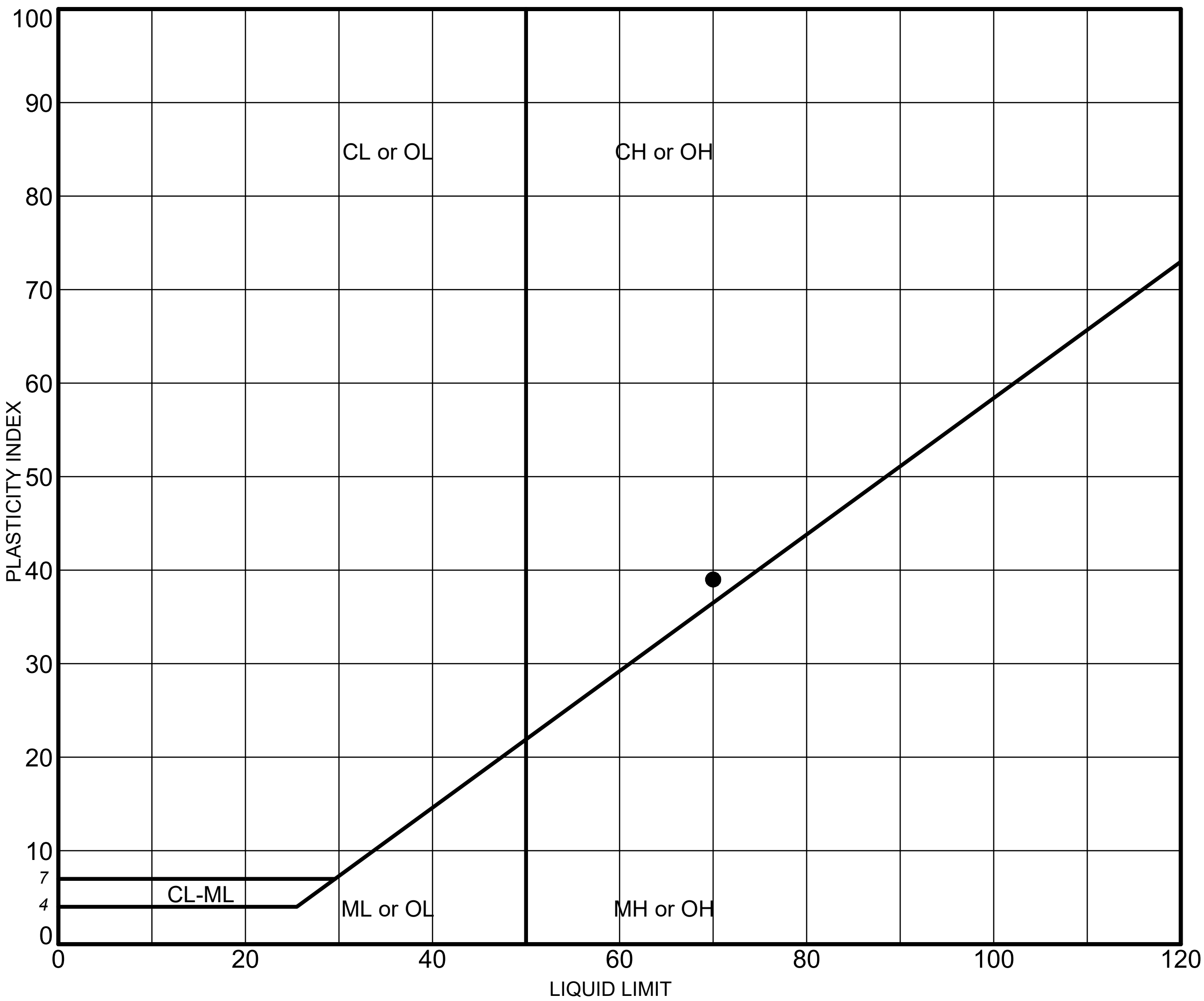
Laboratory Tests

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 Atterberg Limits test (ASTM D4318) was performed on a selected soil sample to evaluate the liquid and plastic limits and to aid in soil classification. The test results are summarized on the Log of Boring at the appropriate sample depth. Graphic presentation of the test results is provided on Plate B-1.

One Triaxial Unconsolidated Undrained Compression (TXUU) test (ASTM D2850) was performed on a selected soil sample to evaluate the undrained shear strength of the clayey soils encountered. The approximate in-situ effective overburden pressure was used as the applied confining pressure for the relatively “undisturbed” soil sample. The test results and the stress-strain curve are presented on Plate B-2.

One Unconfined Compression test (ASTM D7012 Method C) was performed on a selected rock core to evaluate the unconfined compressive strength of the rock formation encountered. Results of the unconfined compression test are presented on Plate B-3.



	Sample	Depth (ft)	LL	PL	PI	Description
●	B-1	10.0-11.5	70	31	39	Brown red w/ multi-color mottling silty clay (CH) w/ traces of gravel

NP = NON-PLASTIC

G ATTERBERG PI-100 LL-120 7328-00(A).GPJ GEOLABS.GDT 8/1/19

GEOLABS, INC.

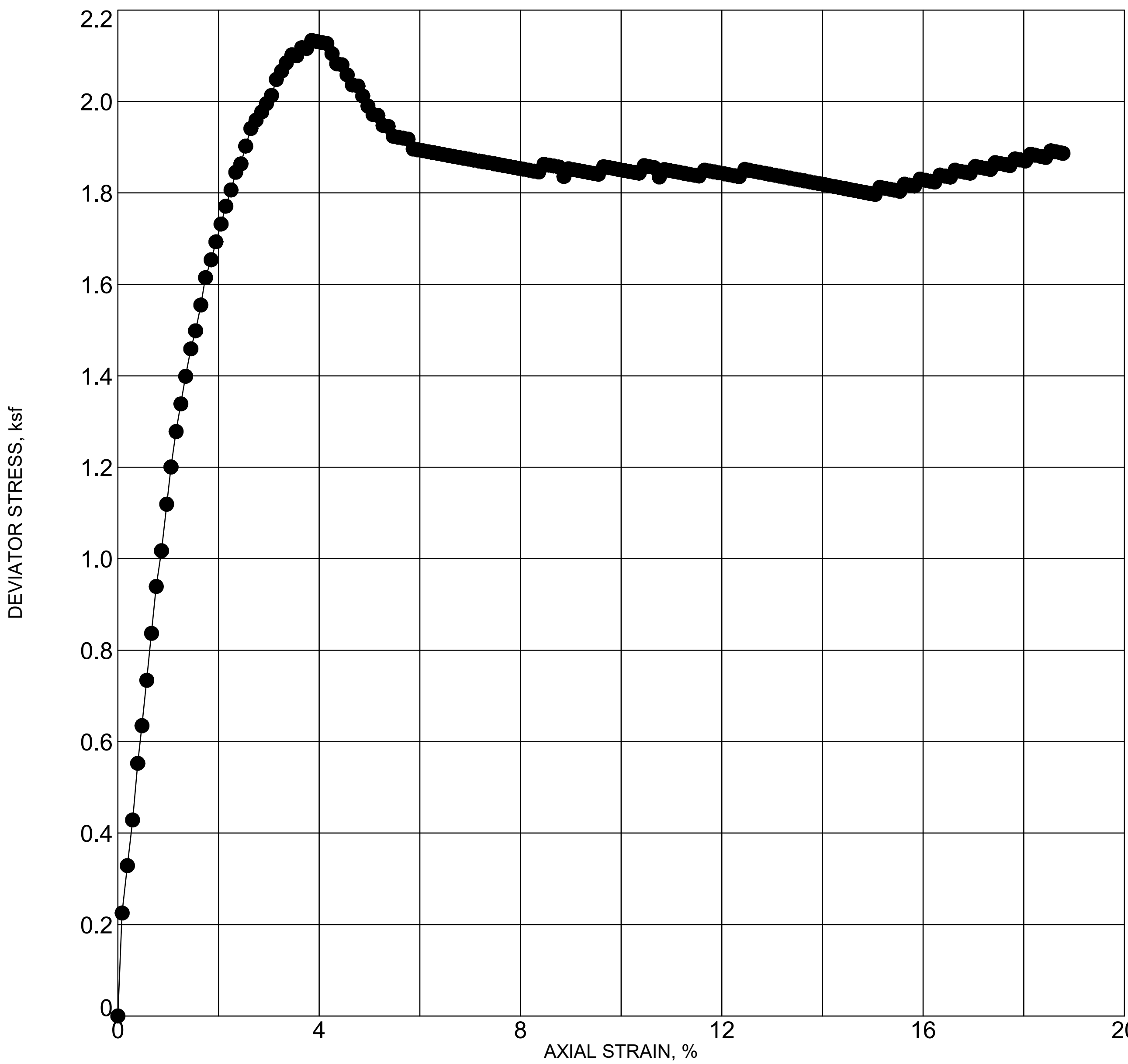
GEOTECHNICAL ENGINEERING

W.O. 7328-00(A)

ATTERBERG LIMITS TEST RESULTS - ASTM D4318

TRAFFIC SIGNAL MODERNIZATION PROJECT
KAHUAPAANI STREET &
ULUNE STREET INTERSECTION
HALAWA, OAHU, HAWAII

Plate
B - 1



Max. Deviator Stress (ksf):	1.8
Confining Stress (ksf):	0.6

Location: B-1
Depth: 5.0 - 6.5 feet
Description: Brownish red w/ multi-color mottling silty clay w/ traces of gravel
Test Date: 6/4/2019

Dry Density (pcf)	80.3	Sample Diameter (inches)	2.300
Moisture (%)	44.3	Sample Height (inches)	5.133
Axial Strain at Failure (%)	15.0	Strain Rate (% / minute)	0.99

GEOLABS, INC.
GEOTECHNICAL ENGINEERING
W.O. 7328-00(A)

TRIAXIAL UU COMPRESSION TEST - ASTM D2850

TRAFFIC SIGNAL MODERNIZATION PROJECT
KAHUAPAANI STREET &
ULUNE STREET INTERSECTION
HALAWA, OAHU, HAWAII

Plate
B - 2

G_TXUU 7328-00(A).GPJ GEOLABS.GDT 8/2/19

Location	Depth	Length	Diameter	Length/ Diameter Ratio	Density	Load	Compressive Strength
	(feet)	(inches)	(inches)		(pcf)	(lbs)	(psi)
B-1	21.5 - 26.5	6.700	3.200	2.09	159.4	82,430	10,250

ASTM D7012 (METHOD C)

APPENDIX C

B-1 21.5' TO 26.5'

21.5'

26.5'

GEOLABS, INC. MEMORANDUM

Geotechnical Engineering and Drilling Services

DATE:	June 8, 2020	**TIME:**	12:11 PM
TO:	Engineering Concepts, Inc.	**FROM:**	Gerald Seki / Nick Kam
ATTN:	Mr. Conrad Higashionna	**W.O. No.:**	7328-00(A)
SUBJECT:	Response to Questions Traffic Signal Modernization Project Kahuapaani Street & Ulune Street Intersection Halawa, Oahu, Hawaii	**NO. OF PAGES:**	1
E-MAIL:	chigashionna@ecihawaii.com		

This memorandum provides our response to questions received by email on June 5, 2020 regarding the above project. The questions and our responses are provided below.

ENGINEERING CONCEPTS QUESTIONS:

At the intersection of Kahuapaani St with Ulune St, can I use “Level Ground – Above Ground Water Table - Stiff Clays” for the recommended soil type (see Standard Plan TE-33A.1 and TE-33A.2) for sizing the drilled shaft foundation length?

I lengthened one signal standard mast arm from 12’ to 17’ long; and reduced one from 38’ to 30’ long.

GEOLABS RESPONSE:

Based on the subsurface conditions encountered at the intersection of Kahuapaani Street and Ulune Street, we recommend the following drilled shaft diameters and lengths for the proposed traffic signal pole foundations in accordance with the TE-33A.2, Type II Traffic Signal Standard Drilled Shaft Foundation Schedule for Level Ground Condition – Above Ground Water Table.

STANDARD TRAFFIC SIGNAL POLES DRILLED SHAFT FOUNDATIONS FOR LEVEL GROUND CONDITIONS		
Mast Arm Length (feet)	**Drilled Shaft Diameter** (inches)	**Drilled Shaft Length** (feet)
17	24	6
30	30	7

If you have questions or need additional information, please contact our office.

August 2, 2019
W.O. 7328-00(B)

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

TRAFFIC SIGNAL POLE FOUNDATION RECOMMENDATIONS
TRAFFIC SIGNAL MODERNIZATION PROJECT
SOUTH VINEYARD BOULEVARD & QUEEN EMMA STREET INTERSECTION
HONOLULU, OAHU, HAWAII

Dear **Mr. Higashionna:**

This letter report presents our findings and traffic signal pole foundation recommendations resulting from our desktop study and site reconnaissance of the South Vineyard Boulevard and Queen Emma Street Intersection for the Traffic Signal Modernization project.

PROJECT CONSIDERATIONS

The project site is located at the intersection of South Vineyard Boulevard and Queen Emma Street in Honolulu on the Island of Oahu, Hawaii. The existing intersection is signalized in all four directions with both single pole and mast arm traffic signal poles. The project location and general vicinity are shown on the Project Location Map, Plate 1.

Based on the information provided, we understand it is desired to replace the four existing steel mast arm traffic signal poles on each corner of the intersection with new Standard Type II Traffic Signals with mast arm lengths ranging from 25 to 38 feet. We understand the existing single pole traffic signals will remain in place. Due to budgetary constraints, our design recommendations for the Type II Traffic Signal Poles will be based on research of available geologic and subsurface information in the project vicinity. Therefore, no exploratory soil borings were drilled at the South Vineyard Boulevard and Queen Emma Street intersection.

REGIONAL GEOLOGY

The Island of Oahu was built by the extrusion of basalt and basaltic lava from two shield volcanoes, Waianae and Koolau. The older volcano, Waianae, is estimated to be middle to late Pliocene in age, and Koolau Volcano is estimated to be late Pliocene to early Pleistocene in age. The project site is situated at about the intersection of Pauoa and Nuuanu Valleys as they open onto the southeastern Oahu Coastal Plain. The coastal plain was built on the eroded flanks of the Koolau Volcano, which forms the eastern third of the Island of Oahu.

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. The Honolulu Volcanic Series, which began less than a million years ago (MacDonald and Abbott, 1970), produced numerous cinder and tuff cones and basalt flows which became inter-layered with the coastal plain deposits. The nearby Punchbowl Hill (Puowaina) is a tuff cone near the center of Honolulu built against the end of a spur of the Koolau Range. The tuff is mostly brown palagonitized vitric ash and lapilli with scattered fragments of coral limestone and Koolau basalt.

Most of the coastal plain developed during the Pleistocene Epoch when the sea level experienced fluctuations related to the glacial stages. 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 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.

The advances and retreats of the sea level produced reef deposits at varying levels during the Waimanalo Stand of the sea, first described by Stearns and Vaksvik (1935). Based on our review of the geologic map and field explorations conducted within proximity to the project site, the project site is likely underlain by surface fills overlying cinder sands and coralline detritus materials at shallow depths.

ANTICIPATED SUBSURFACE CONDITIONS

Based on the geological survey maps, the project site is located within the limits of the Honolulu Volcanics Tantalus vent deposits. We anticipate that the intersection may be underlain by near-surface fills underlain by cinder deposits and coralline detritus with depth.

The existing ground surface elevation of the South Vineyard Boulevard and Queen Emma Street intersection is about +30 feet Mean Sea Level (MSL). Therefore, we anticipate that groundwater may be encountered about 28 to 31 feet below the existing ground surface.

EXISTING SITE CONDITIONS

The project site is located at the intersection of South Vineyard Boulevard and Queen Emma Street in Honolulu on the Island of Oahu, Hawaii. The intersection is generally bordered by Kamamalu Playground to the north, The Pacific Club to the east, Island Mini Mart to the south, and Central Middle School to the west.

A reconnaissance of the project site was conducted by our engineer on May 2, 2019 to evaluate the existing site conditions. In general, the project site was observed to be relatively flat, sloping down gently on South Vineyard Boulevard in a southeasterly direction and on Queen Emma Street in a southwesterly direction. At this intersection, South Vineyard Boulevard consists of three lanes of traffic in each direction with additional left turn lanes onto Queen Emma Street in both directions. Queen Emma Street consists of two lanes of traffic in each direction with an additional right turn only lane in the mauka-bound direction. Based on the information provided, we understand that the mast arm traffic signal poles on each corner of the intersection will be replaced. The layout of the intersection and proposed traffic signal replacement locations are presented on the Site Plan, Plate 2. Photographs depicting the existing site conditions are presented on Plates 3.1 and 3.2. The approximate locations of the pictures are also included on the Site Plan.

TRAFFIC SIGNAL POLE FOUNDATIONS

Based on our research of available geologic and subsurface information in the project vicinity, we anticipate that the project site is generally underlain by sandy and gravelly near-surface fill, volcanic cinder sand, and granular coralline detritus with depth. Therefore, we recommend a “Sand & Gravel” ground condition be used in the design. Based on the anticipated subsurface soil conditions and typical loading demands of Standard Type II Traffic Signals with mast arm lengths of 25 to 38 feet, we believe the Standard Plan 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 cast-in-place concrete drilled shaft foundations to support the new traffic signal poles planned.

Based on the existing ground elevation of the South Vineyard Boulevard and Queen Emma Street intersection (about +30 feet MSL), we anticipate that groundwater will not be encountered above the design tip elevation of the cast-in-place concrete drilled shaft foundation. Therefore, we recommend the following drilled shaft diameters and lengths for the proposed traffic signal pole foundations in accordance with TE-33A.2, Type II Traffic Signal Standard Drilled Shaft Foundation Schedule for a Level Ground Condition – Above Ground Water Table.

STANDARD TRAFFIC SIGNAL POLES DRILLED SHAFT FOUNDATIONS FOR LEVEL GROUND CONDITIONS		
Mast Arm Length (feet)	**Drilled Shaft Diameter** (inches)	**Drilled Shaft Length** (feet)
25	30	7
35	30	9
38	30	10

DRILLED SHAFT CONSIDERATIONS

Drilled shafts are desirable for the traffic signal pole foundations because of the significant increase in lateral and uplift load capacities when compared to shallow foundations. However, the performance of the drilled shafts will depend significantly upon the contractor's method of construction and construction procedures.

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

We anticipate that the subsurface materials may generally consist of sandy and gravelly near-surface fills, volcanic cinder, and coralline detritus. To reduce the potential for caving in of the drilled holes, temporary casing may be required during the foundation construction work. Care should be exercised during 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 should be maintained during removal of the casing.

Based on the existing ground surface elevation of the intersection 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 length of the drilled shaft, 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 hole and concrete placement by tremie method would be required.

A low-shrink concrete mix with high slump (6 to 9 inches slump range) should be used to provide close contact between the drilled shafts and the surrounding soils. The shaft 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.

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 the placement of concrete. Therefore, it is necessary for Geolabs to observe the drilled shaft installation operations to confirm the assumed subsurface conditions.

LIMITATIONS

The geotechnical recommendations presented herein are based on research of available geologic and subsurface information in the project vicinity and the provided as-built drawings.

This report has been prepared for the exclusive use of Engineering Concepts, Inc. and their consultants, for specific application to the South Vineyard Boulevard and Queen Emma Street 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 evaluating and assisting the client/owner in selecting a suitable foundation system based on the Standard Plans by the State of Hawaii – Department of Transportation, Highways Division for the project site. Therefore, this report may not contain sufficient data, or the proper information, to serve as the basis for 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 surface and subsurface conditions are commonly encountered. Unforeseen conditions, such as perched groundwater, soft deposits, hard layers, or loose fills may occur in localized areas and may require additional exploration 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 letter report was not intended to evaluate 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.

CLOSURE

We appreciate the opportunity to provide geotechnical engineering services to you on this project. If you have questions or need additional information, please contact our office.

Respectfully submitted,

GEOLABS, INC.

By ____________________

Gerald Y. Seki P.E.
Vice President

GERALD Y. SEKI
LICENSED PROFESSIONAL ENGINEER
No. 5635-C
HAWAII, U.S.A.

THIS WORK WAS PREPARED BY ME OR UNDER MY SUPERVISION.

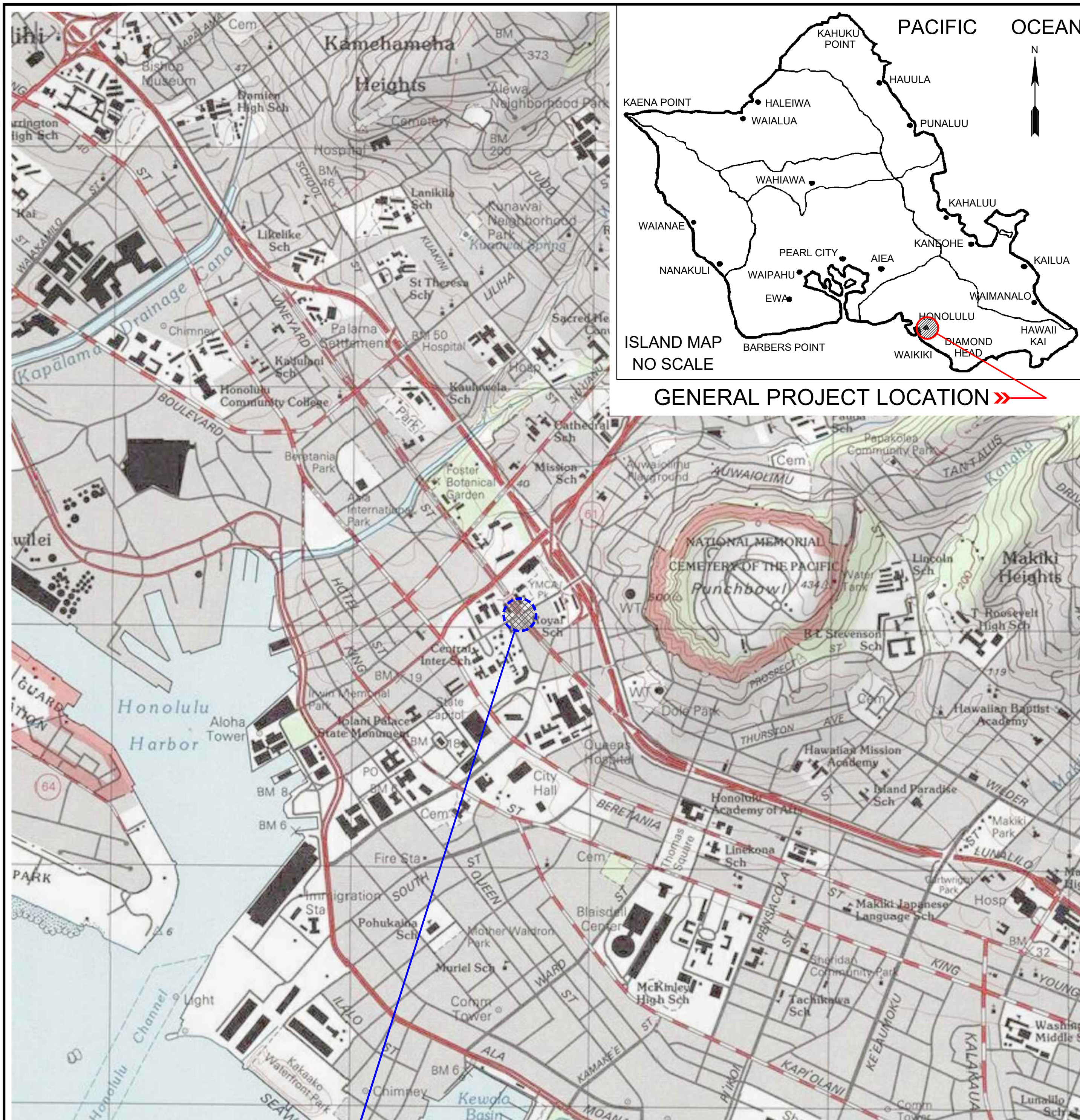
SIGNATURE
4-30-20
EXPIRATION DATE OF THE LICENSE

GS:NK:cj

Attachments: Project Location Map, Plate 1
Site Plan, Plate 2
Site Reconnaissance Photographs, Plates 3.1 and 3.2

h:\7300Series\7328-00B.nk1

PLATES



PROJECT LOCATION

PROJECT LOCATION MAP

TRAFFIC SIGNAL MODERNIZATION PROJECT
SOUTH VINEYARD BOULEVARD &
QUEEN EMMA STREET INTERSECTION
HONOLULU, OAHU, HAWAII

N

2000 1000 0 2000 FT.

GRAPHIC SCALE

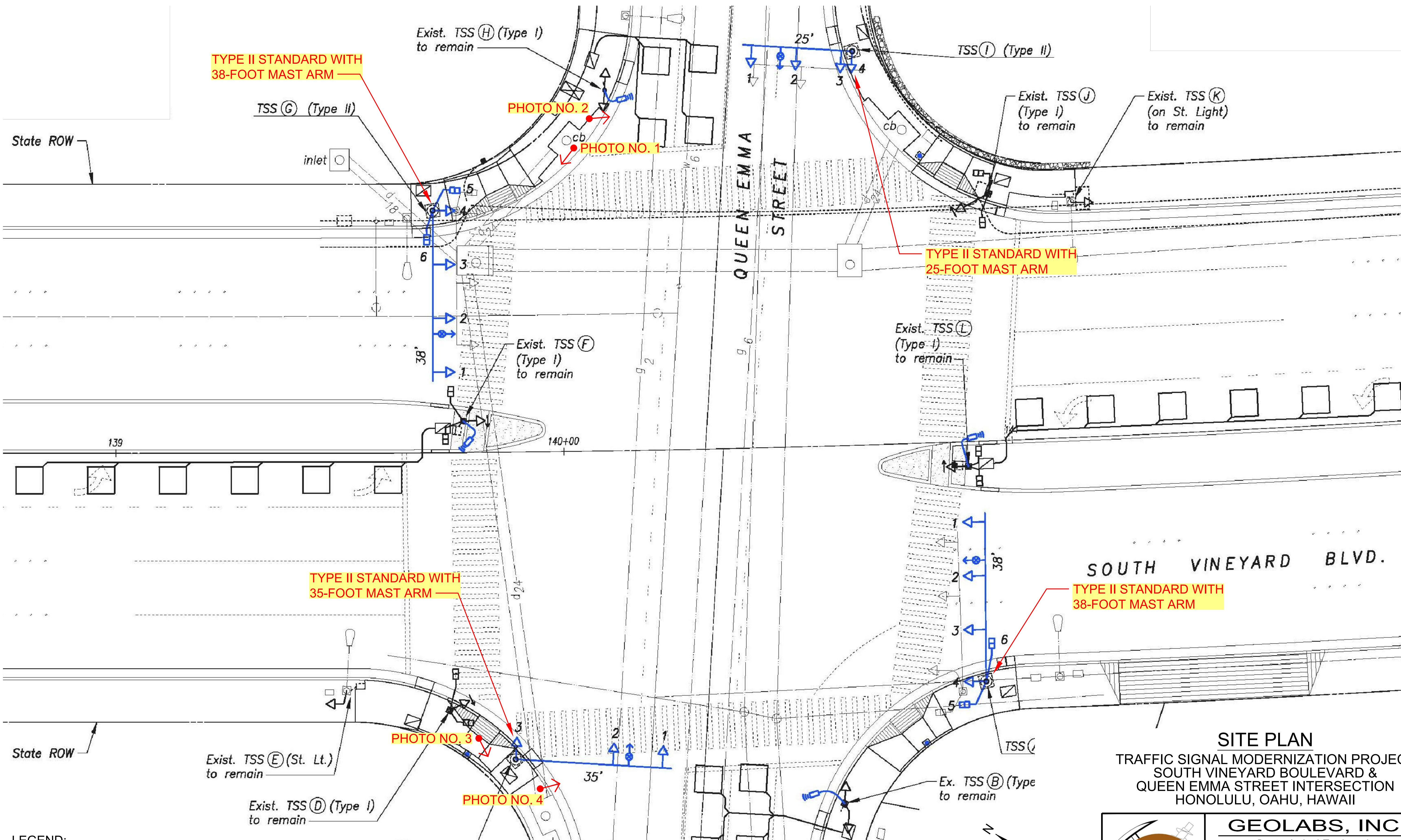
REFERENCE: MAP CREATED WITH TOPO!® ©2010 NATIONAL GEOGRAPHIC; ©2007 TELE ATLAS, REL. 1/2007.

GEOLABS, INC.

Geotechnical Engineering

DATE	DRAWN BY	PLATE
JULY 2019	ASP	
SCALE	W.O.	1
1" = 2,000'	7328-00(B)	

CAD User: ASPASIONUR File Last Updated: July 29, 2019 1:33:42pm Plot Date: July 29, 2019 - 1:56:00pm
File: T:\Drafting\Working\7328-00(B)_Traffic_Signal_Modernization_South_Vineyard_&_Queen_Emma\7328-00(B)PLM.dwg\1.0 PLM
Plotter: DWG To PDF-GEO.pc3 Plotstyle: GEO-No-Dithering.ctb



LEGEND:

APPROXIMATE LOCATION AND VIEWING DIRECTION OF SITE RECONNAISSANCE PHOTOGRAPHS

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

SITE PLAN

TRAFFIC SIGNAL MODERNIZATION PROJECT
SOUTH VINEYARD BOULEVARD &
QUEEN EMMA STREET INTERSECTION
HONOLULU, OAHU, HAWAII

GEOLABS, INC. Geotechnical Engineering		
DATE: JULY 2019	DRAWN BY: ASP	PLATE
SCALE: 1" = 20'	W.O.: 7328-00(B)	2

Photograph No. 1 – Existing traffic signal pole on the northern corner of the intersection (view facing southwest).

Photograph No. 2 – Existing traffic signal pole on the eastern corner of the intersection (view facing southeast).

TRAFFIC SIGNAL MODERNIZATION PROJECT
SOUTH VINEYARD BOULEVARD & QUEEN EMMA STREET INTERSECTION
HONOLULU, OAHU, HAWAII

Photograph No. 3 – Existing traffic signal pole on the western corner of the intersection (view facing southwest).

Photograph No. 4 – Existing traffic signal pole on the southern corner of the intersection (view facing southeast).

GEOTECHNICAL ENGINEERING EXPLORATION
TRAFFIC SIGNAL MODERNIZATION PROJECT
KALANIANAOLE HIGHWAY & KALANIIKI STREET INTERSECTION
HONOLULU, OAHU, HAWAII

W.O. 7328-00(C) AUGUST 12, 2019

Prepared for

ENGINEERING CONCEPTS INC.

GEOLABS, INC.
Geotechnical Engineering and Drilling Services

GEOTECHNICAL ENGINEERING EXPLORATION
TRAFFIC SIGNAL MODERNIZATION PROJECT
KALANIANAOLE HIGHWAY & KALANIIKI STREET INTERSECTION
HONOLULU, OAHU, HAWAII

W.O. 7328-00(C) AUGUST 12, 2019

Prepared for

ENGINEERING CONCEPTS INC.

GERALD Y. SEKI
LICENSED PROFESSIONAL ENGINEER
No. 5635-C
HAWAII, U.S.A.

THIS WORK WAS PREPARED BY
ME OR UNDER MY SUPERVISION.

4-30-20

SIGNATURE EXPIRATION DATE OF THE LICENSE

GEOLABS, INC.
Geotechnical Engineering and Drilling Services
2006 Kalihi Street • Honolulu, HI 96819

Hawaii • California

GEOLABS, INC.
Geotechnical Engineering and Drilling Services

August 12, 2019
W.O. 7328-00(C)

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, Kalanianaole Highway and Kalaniiki Street 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 fee proposal dated February 19, 2016.

Please note that the soil 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:NK:lf

GEOTECHNICAL ENGINEERING EXPLORATION
TRAFFIC SIGNAL MODERNIZATION PROJECT
KALANIANAOLE HIGHWAY & KALANIIKI STREET INTERSECTION
HONOLULU, OAHU, HAWAII
W.O. 7328-00(C) AUGUST 12, 2019

TABLE OF CONTENTS

Page

Page

GEOTECHNICAL ENGINEERING EXPLORATION
TRAFFIC SIGNAL MODERNIZATION PROJECT
KALANIANAOLE HIGHWAY & KALANIIKI STREET INTERSECTION
HONOLULU, OAHU, HAWAII
W.O. 7328-00(C) AUGUST 12, 2019

SUMMARY OF FINDINGS AND RECOMMENDATIONS

Our field exploration generally encountered a pavement structure consisting of approximately 5 inches of asphaltic concrete overlay followed by about 6 inches of Portland cement concrete. Below the pavement, fill material consisting of stiff to very stiff clay was encountered at a depth of approximately 6 feet underlain by medium hard to hard basalt rock formation extending to the maximum depth explored of about 26.7 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 40 feet or less, we believe the Standard Plan TE-33A.1 and 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.

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 Kalanianaole Highway and Kalaniiki Street intersection in the Kahala 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 five Type II traffic signal poles at the Kalanianaole Highway and Kalaniiki Street intersection in the Kahala area of Honolulu on the Island of Oahu, Hawaii. The existing intersection is signalized in all four directions with both metal single pole and mast arm traffic signal poles. The project location and general vicinity are shown on the Project Location Map, Plate 1. Based on the information provided, the mast arm lengths of the traffic signal poles range from 20 to 37 feet in length.

The foundations for the traffic signal poles with mast arm lengths ranging from 20 to 37 feet may be designed according to the Standard Plan 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 fee proposal dated February 19, 2016. 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 26.7 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. The project site is at the southwestern flank of the Koolau Mountain Range.

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 near the mouth of Kapakahi Valley, which trends roughly north to south from the Koolau Mountain Range toward the Pacific Ocean. Kapakahi Valley is essentially a deep erosional valley carved into the Koolau Shield Volcano by stream processes and mass wasting of the adjacent slopes. As a result, the project site is generally underlain by colluvial and alluvial deposits followed by Koolau basalt formation. In addition, some fills were placed at portions of the site, as a result of the original roadway construction. The fill materials are believed to resemble the native colluvial and alluvial deposits in character.

2.2 Site Description

The project site is located at the intersection of Kalanianaole Highway and Kalaniiki Street in the Kahala area of Honolulu on the Island of Oahu, Hawaii. The intersection is generally bounded by Kalani High School to the northeast and residential homes to the south and northwest.

Based on our field observations, the project site was observed to be relatively flat with a gentle slope in the eastbound direction of Kalanianaole Highway. Based on the provided project drawings, the existing ground surface elevations of the intersection range from about +16 to +19 feet Mean Sea Level (MSL) with a slope gradient of about 1 percent. At this intersection, Kalanianaole Highway generally consists of three lanes of traffic in each direction with additional left turn only lanes onto Kalaniiki Street in either direction. Kalaniiki and Waieli Streets generally consist of three lanes at the intersection.

Based on the information provided, we understand that two of the existing single pole traffic signals on Kalaniiki and Waieli Streets and two of the existing mast arm traffic signals in the Kalanianaole Highway median 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. 2, to a depth of about 26.7 feet below the existing ground surface. The approximate boring location is shown on the Site Plan, Plate 2.

Our boring generally encountered a pavement structure consisting of approximately 5 inches of asphaltic concrete overlay followed by about 6 inches of Portland cement concrete. Below the pavement, fill material consisting of stiff to very stiff clay was encountered at a depth of approximately 6 feet underlain by medium hard to hard basalt rock formation extending to the maximum depth explored of about 26.7 feet below the existing ground surface.

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 pavement structure consisting of approximately 5 inches of asphaltic concrete overlay followed by about 6 inches of Portland cement concrete. Below the pavement, fill material consisting of stiff to very stiff clay was encountered at a depth of approximately 6 feet underlain by medium hard to hard basalt rock formation extending to the maximum depth explored of about 26.7 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 Plan TE-33A.1 and 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 37 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 Plan TE-33A.1 and 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 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 in accordance with TE-33A.2, Type II Traffic Signal Standard Drilled Shaft Foundation Schedule for a Level Ground Condition – Above Ground Water Table.

STANDARD TRAFFIC SIGNAL POLES DRILLED SHAFT FOUNDATIONS FOR LEVEL GROUND CONDITIONS		
Mast Arm Length (feet)	**Drilled Shaft Diameter** (inches)	**Drilled Shaft Length** (feet)
20	24	6
26	30	7
30	30	7
35	30	8
37	30	11

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 to very stiff fill 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 depths of some 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 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 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 interpolated from the contour lines and spot elevations shown on the same plan. 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 variation 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 Kalanianaole Highway and Kalaniiki Street 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 client/owner 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 nor 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.

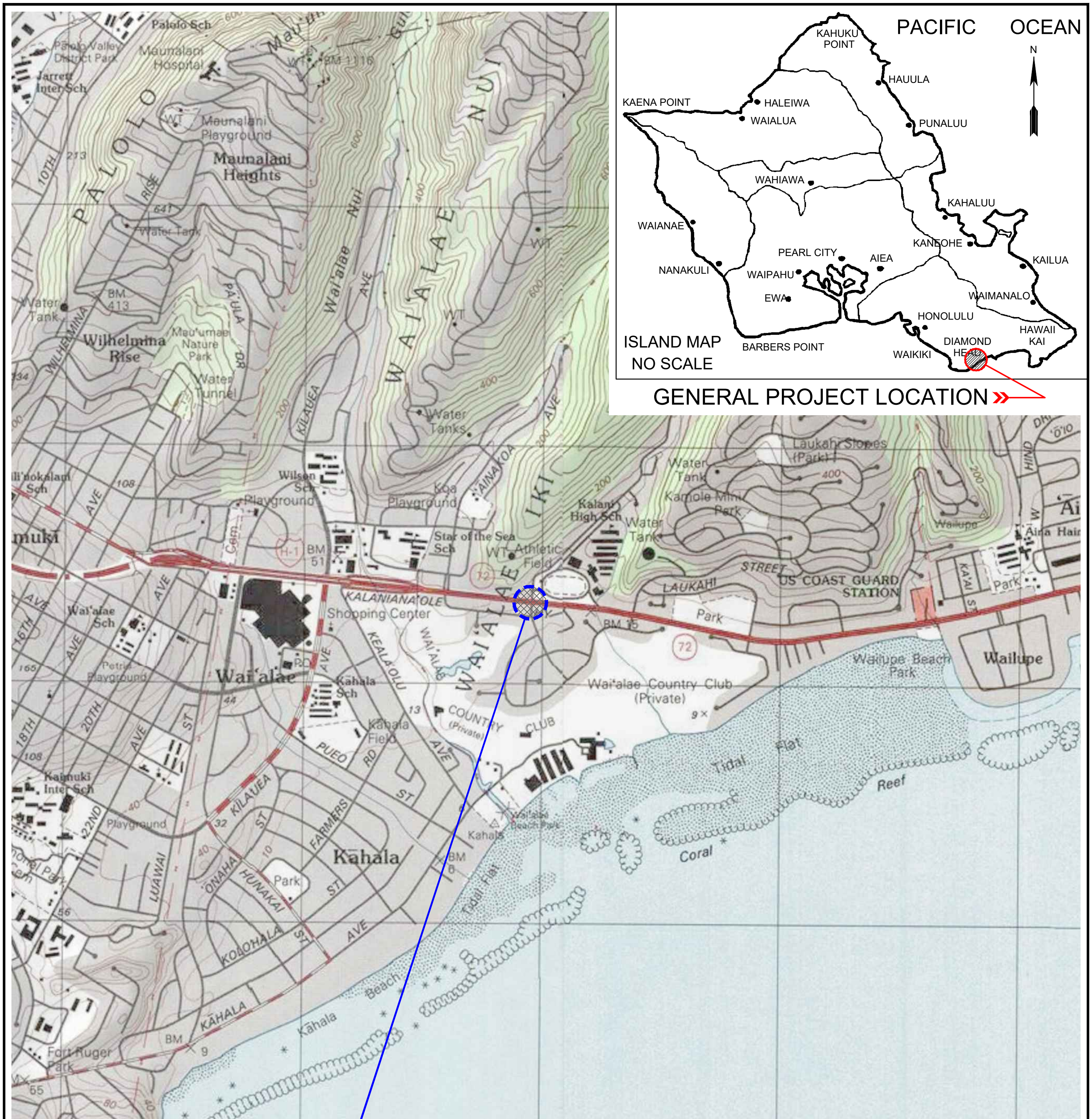
By ______________________

Gerald Y. Seki, P.E.
Vice President

GS:NK:lf

h:\7300Series\7328-00(C).nk1

PLATES



PROJECT LOCATION

PROJECT LOCATION MAP

TRAFFIC SIGNAL MODERNIZATION PROJECT
KALANIANAOLE HIGHWAY &
KALANIIKI STREET INTERSECTION
HONOLULU, OAHU, HAWAII

2000 1000 0 2000 FT.

GRAPHIC SCALE

N

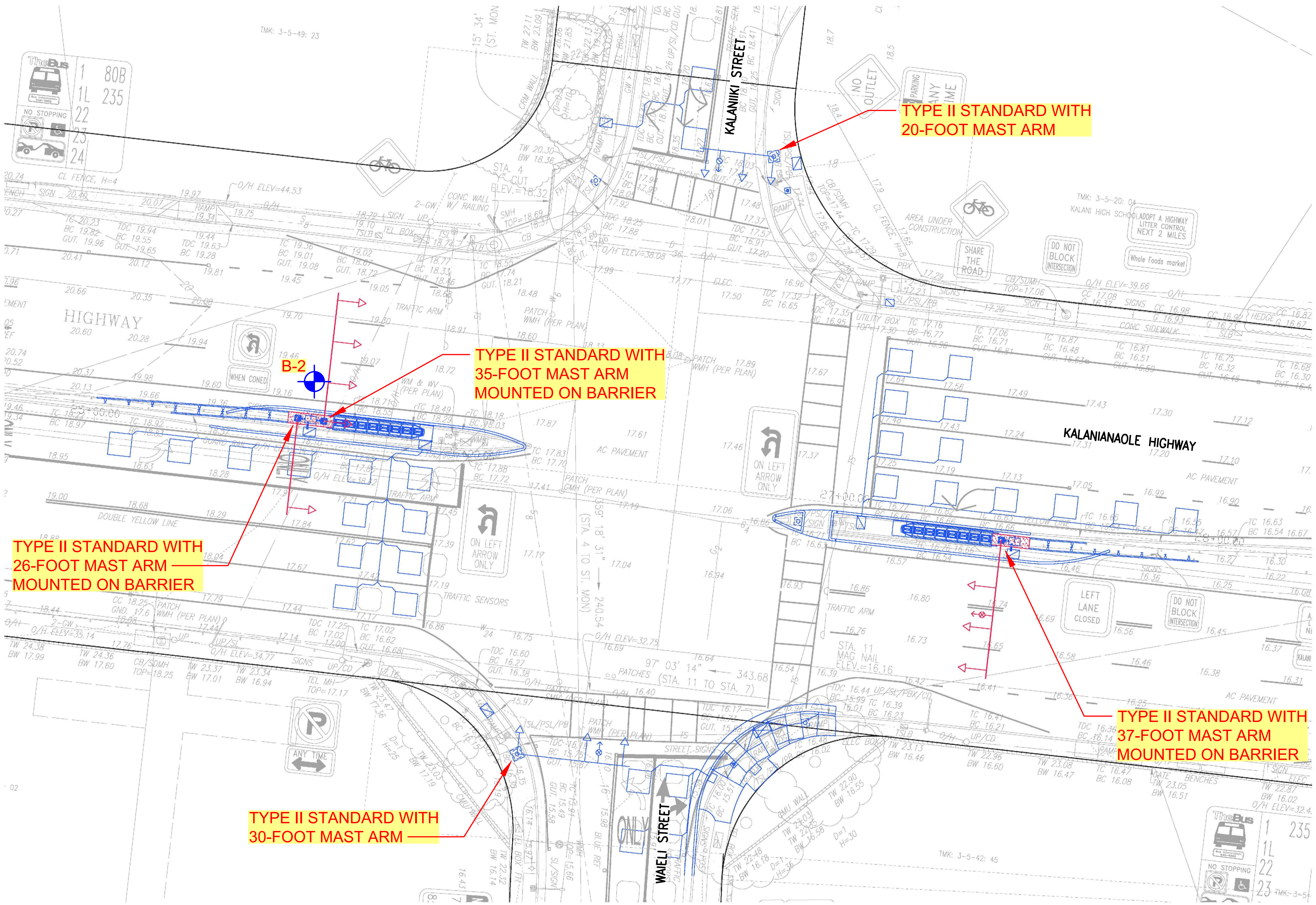
REFERENCE: MAP CREATED WITH TOPO!® ©2010 NATIONAL GEOGRAPHIC; ©2007 TELE ATLAS, REL. 1/2007.

GEOLABS, INC.

Geotechnical Engineering

DATE	DRAWN BY	PLATE
JULY 2019	ASP	
SCALE	W.O.	1
1" = 2,000'	7328-00(C)	

CAD User: ASPASIONJR File Last Updated: July 30, 2019 4:36:49pm Plot Date: July 30, 2019 - 5:08:55pm
File: C:\Users\aspasionjr\Documents\Drawing3.dwg\1.0 PLM
Plotter: DWG To PDF-GEO.pc3 Plotstyle: GEO-No-Dithering.ctb



SITE PLAN

TRAFFIC SIGNAL MODERNIZATION PROJECT
KALANIANAOLE HIGHWAY &
KALANIIKI STREET INTERSECTION
HONOLULU, OAHU, HAWAII

LEGEND:

APPROXIMATE BORING LOCATION

0 10 20 30 60 90 FT.
GRAPHIC SCALE

N

GEOLABS, INC. Geotechnical Engineering		
DATE: JULY 2019	DRAWN BY: ASP	PLATE
SCALE: 1" = 30'	W.O.: 7328-00(C)	2

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

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. 2, extending to a depth of about 26.7 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.

One pocket penetrometer test was performed on a selected cohesive soil sample retrieved in the field. The pocket penetrometer test provides an indication of the unconfined compressive strength of the sample. The pocket penetrometer test result is summarized on the Log of Boring at the appropriate sample depth.

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 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.

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
- SHELBY TUBE SAMPLE
- 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

GEOLABS, INC.

Geotechnical Engineering

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**) • **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**)	• **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

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 KALANIANAOLE HIGHWAY & KALANIIKI STREET INTERSECTION HONOLULU, OAHU, HAWAII	Log of Boring 2

Approximate Ground Surface Elevation (feet MSL): 19.5 *

Other Tests (Laboratory)	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%) (Field)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	USCS	Description
							0		5-inch **ASPHALTIC CONCRETE**
									6-inch **CONCRETE**
UC	25	87			38	4.5		CH	Brown **CLAY** with some sand and gravel, stiff to very stiff, moist (fill)
LL=66 PI=46	20				11				
	30				55/4"		5		
UC			63	63					Gray to reddish gray vesicular **BASALT**, severely to moderately fractured, moderately to highly weathered, medium hard to hard (pahoehoe basalt)
							10		
					8				grades with seams of weathered clinker
			100	43					
							15		
	28				72				
UC			100	29					
							20		
			100	52					
							25		
					30/2"				
									Boring terminated at 26.67 feet
							30		* Elevation estimated from Signal Plan transmitted by Engineering Concepts, Inc. on January 31, 2019.
							35		

Date Started:	May 10, 2019	Water Level:	not encountered	Plate
Date Completed:	May 10, 2019			
Logged By:	D. Gremminger	Drill Rig:	CME-45C TRUCK	A - 1
Total Depth:	26.67 feet	Drilling Method:	4" Solid Stem Auger & PQ Coring	
Work Order:	7328-00(C)	Driving Energy:	140 lb. wt., 30 in. drop	

APPENDIX B

A P P E N D I X B

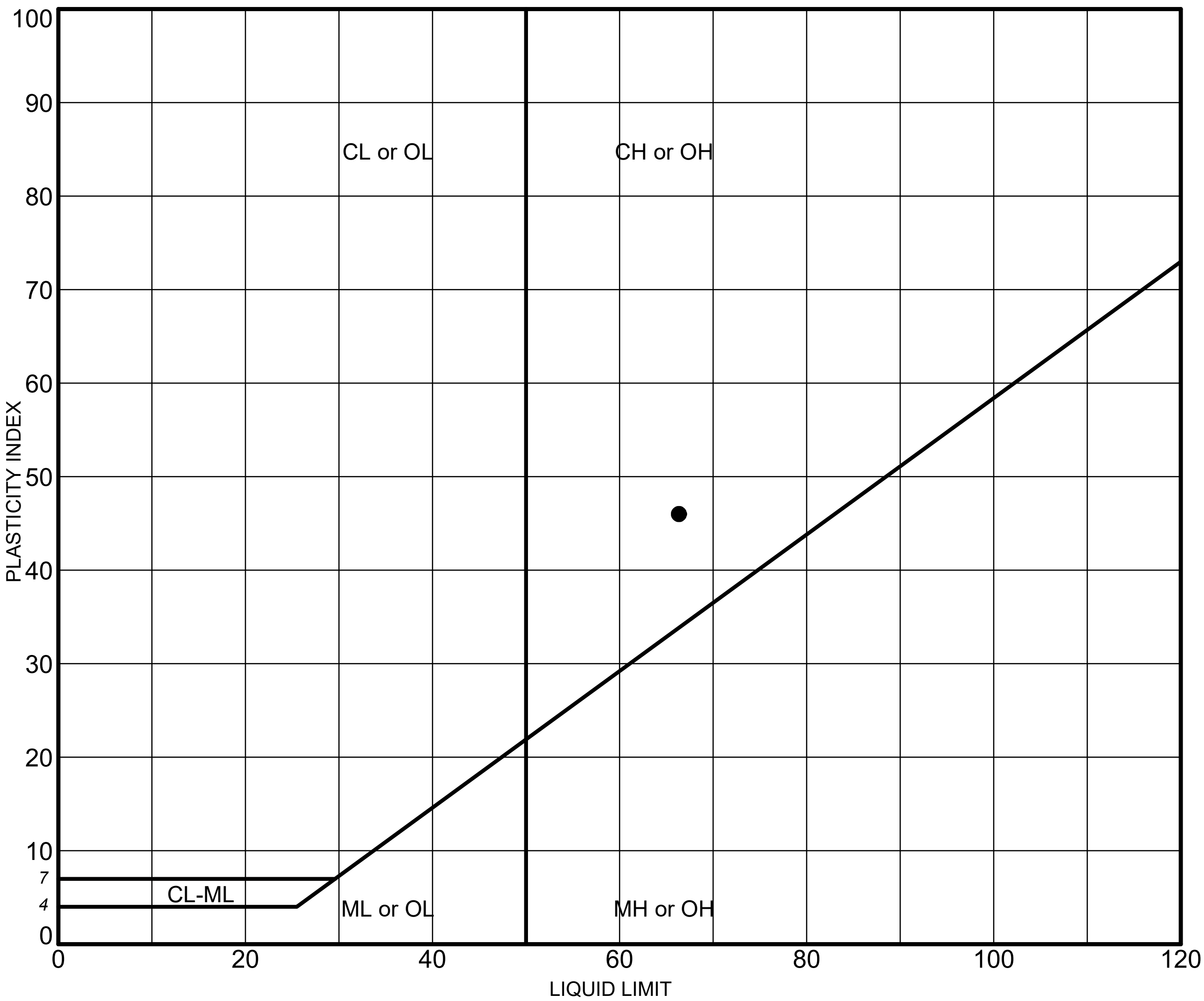
Laboratory Tests

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 Atterberg Limits test (ASTM D4318) was performed on a selected soil sample to evaluate the liquid and plastic limits and to aid in soil classification. The test results are summarized on the Log of Boring at the appropriate sample depth. Graphic presentation of the test results is provided on Plate B-1.

One Unconfined Compression test (ASTM D2166) was performed on a selected in-situ cohesive soil sample to evaluate the unconfined compressive strength of the soil. The test results are provided on Plate 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)	LL	PL	PI	Description
●	B-2	2.5-4.0	66	20	46	Brown clay (CH) with some sand and gravel

NP = NON-PLASTIC

GEOLABS, INC.
GEOTECHNICAL ENGINEERING

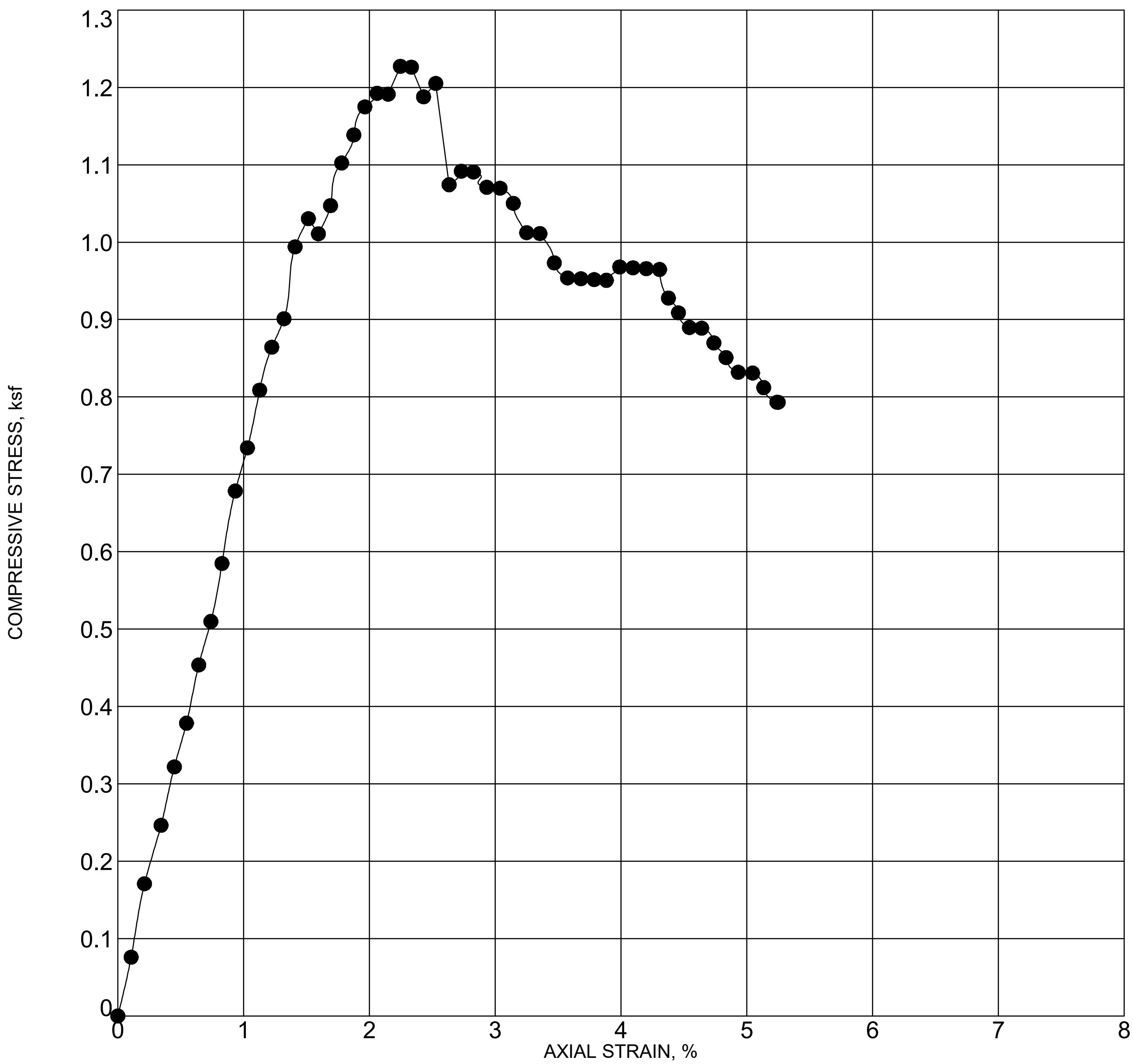
W.O. 7328-00(C)

ATTERBERG LIMITS TEST RESULTS - ASTM D4318

TRAFFIC SIGNAL MODERNIZATION PROJECT
KALANIANAOLE HIGHWAY &
KALANIIKI STREET INTERSECTION
HONOLULU, OAHU, HAWAII

Plate
B - 1

G ATTERBERG PI-100 LL-120 7328-00(C).GPJ GEOLABS.GDT 8/12/19



Unconfined Compressive Strength (ksf):	1.23
Axial Strain at Failure (%):	2.2
Strain Rate (% / minute):	0.94

Location: B-2
Depth: 1.0 - 2.5 feet
Description: Brown clay with some sand and gravel
Test Date: 6/3/2019

Dry Density (pcf)	86.7	Sample Diameter (inches)	2.390
Moisture (%)	24.9	Sample Height (inches)	5.000

G UC 7328-00(C).GPJ GEOLABS.GDT 8/12/19

GEOLABS, INC.
GEOTECHNICAL ENGINEERING
W.O. 7328-00(C)

UNCONFINED COMPRESSION TEST - ASTM D2166

TRAFFIC SIGNAL MODERNIZATION PROJECT
KALANIANAOLE HIGHWAY &
KALANIIKI STREET INTERSECTION
HONOLULU, OAHU, HAWAII

Plate
B - 2

Location	Depth	Length	Diameter	Length/ Diameter Ratio	Density	Load	Compressive Strength
	(feet)	(inches)	(inches)		(pcf)	(lbs)	(psi)
B-2	6 - 11	6.900	3.300	2.09	141.6	35,870	4,190
B-2	17.5 - 21	6.900	3.300	2.09	111.0	23,410	2,740

ASTM D7012 (METHOD C)

APPENDIX C

TRAFFIC SIGNAL MODERNIZATION PROJECT
KALANIANAOLE HIGHWAY & KALANIIKI STREET INTERSECTION
HONOLULU, OAHU, HAWAII

B-2 6.0' TO 26.0'

6.0' 12.5' 17.5' 21.0'

11.0' 16.0' 21.0' 26.0'

July 9, 2019
W.O. 7328-00(D)

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

TRAFFIC SIGNAL POLE FOUNDATION RECOMMENDATIONS
TRAFFIC SIGNAL MODERNIZATION PROJECT
FARRINGTON HIGHWAY & NANAIKEOLA STREET INTERSECTION
WAIANAE, OAHU, HAWAII

Dear **Mr. Higashionna:**

This letter report presents our findings and traffic signal pole foundation recommendations resulting from our desktop study and site reconnaissance of the Farrington Highway and Nanaikeola Street Intersection for the Traffic Signal Modernization project.

PROJECT CONSIDERATIONS

The project site is located at the intersection of Farrington Highway and Nanaikeola Street in the Nanakuli area of the Waianae District on the Island of Oahu, Hawaii. The existing intersection is signalized in all three directions with wooden and steel traffic signal poles. The project location and general vicinity are shown on the Project Location Map, Plate 1.

Based on the information provided, we understand it is desired to replace the existing wooden traffic signal pole on the northern corner of the intersection with a Standard Type II Traffic Signal with a 25-foot mast arm. Due to budgetary constraints, our design recommendations for the Type II Traffic Signal Pole will be based on research of available geologic and subsurface information in the project vicinity. Therefore, no exploratory soil borings were drilled at the Farrington Highway and Nanaikeola Street intersection.

REGIONAL GEOLOGY

The Island of Oahu was built by the extrusion of basaltic lavas from two extinct shield volcanoes, Waianae and Koolau. 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 the eastern flank of Waianae Volcano 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 Waianae Mountain Range (Waianae Volcano) is composed of layered basaltic lava flows and pyroclastic material which are grouped and classified as the Waianae Volcanic Series. The Waianae Volcanic Series is divided into the lower, middle, and upper volcanic members. The lower member is comprised of lava flows and associated pyroclastic rocks that built the main mass of the Waianae Shield Volcano. The middle member consists of rock that accumulated and gradually filled the vast volcanic caldera. The upper member is a relatively thin capping layer that covered the entire top of the shield volcano late in its history of evolution.

Once the Waianae Shield Volcano formed, a long period of deep erosion, sedimentation, and subsidence of the Island of Oahu occurred which produced the large valleys of the western side of the shield volcano. These erosional valleys were gradually filled with enormous accumulations of alluvium and colluvium deposited as a combined result of stream erosion, base level rise (sea level rise), and subsidence of the island mass.

During the Pleistocene Epoch, 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 above the present sea level.

The higher sea level stands caused the formation of deltas and fans of accumulated terrigenous sediments in the heads of old bays, accumulated reef deposits at correspondingly higher elevations, and deposited lagoonal/marine sediments in the quiet waters protected by fringing reefs. The lower sea stands caused streams to carve valleys in the sediments and reef deposits. Subaerial exposure of the sediments and calcareous materials caused consolidation of the lagoonal deposits and induration of the calcareous reef materials. The project site is located near the beach sand shoreline.

ANTICIPATED SUBSURFACE CONDITIONS

Based on the geological survey maps, the project site is located in a transition area between beach sand and recent alluvial deposits. In addition, we anticipate that a surface fill layer may be present at the project site.

The existing ground surface elevation is about +9 feet Mean Sea Level (MSL) at the new traffic signal pole location. Therefore, we anticipate that groundwater may be encountered about 7 to 10 feet below the existing ground surface.

EXISTING SITE CONDITIONS

The project site is located at the intersection of Farrington Highway and Nanaikeola Street in the Nanakuli area of the Waianae District on the Island of Oahu, Hawaii. The intersection is generally bordered by Nanakuli Super to the north, the Kaiser Permanente Nanaikeola Clinic to the east, and the Pacific Ocean to the south and west.

Site reconnaissance of the project site was conducted by our engineer on April 26, 2019 to evaluate the existing site conditions. In general, the project site was observed to be relatively flat and at a relatively low elevation (about +9 feet MSL). At this intersection, Farrington Highway consists of two lanes of traffic in each direction with an additional right turn lane onto Nanaikeola Street in the outbound direction. Nanaikeola Street consists of three lanes; two turn lanes onto Farrington Highway and one lane leading into Nanaikeola Street which terminates at a cul-de-sac. Based on the information provided, we understand that only the traffic signal pole on the northern corner of the intersection will be replaced. The layout of the intersection and proposed traffic signal replacement location are presented on the Site Plan, Plate 2. Photographs depicting the existing site conditions are presented on Plates 3.1 and 3.2. The approximate locations of the pictures are also included on the Site Plan.

The existing traffic signal at the northern corner of the intersection consists of a bitumen treated wooden pole supporting two traffic signal lights for the outbound traffic of Farrington Highway (Photograph Nos. 1 and 2). An additional Type I – Single Pole traffic signal located on the makai side of the intersection also serves to signalize the traffic in the outbound direction and supports a pedestrian crossing signal (Photograph No. 3).

TRAFFIC SIGNAL POLE FOUNDATIONS

Based on our research of available geologic and subsurface information in the project vicinity, we anticipate that the project site is generally underlain by beach and recent alluvial deposits. Therefore, we recommend a "Sand & Gravel" ground condition be used in the design. Based on the anticipated subsurface soil conditions and typical loading demands of Standard Type II Traffic Signals with 25-foot mast arms, we believe the Standard Plan 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 cast-in-place concrete drilled shaft foundations to support the new traffic signal pole planned.

Based on the existing ground elevation of the Farrington Highway and Nanaikeola Street intersection (about +9 feet MSL), we anticipate that groundwater may be encountered above the design tip elevation of the cast-in-place concrete drilled shaft foundation. Therefore, we recommend a 30-inch diameter cast-in-place concrete drilled shaft foundation with a design length of 9 feet in accordance with TE-33A.2, Type II

Traffic Signal Standard Drilled Shaft Foundation Schedule for a Level Ground Condition – Below Ground Water Table.

DRILLED SHAFT CONSIDERATIONS

Drilled shafts are desirable for the traffic signal pole foundations because of the significant increase in lateral and uplift load capacities when compared to shallow foundations. However, the performance of the drilled shafts will depend significantly upon the contractor's method of construction and construction procedures.

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

We anticipate that the subsurface materials may generally consist of coralline sand and gravel. To reduce the potential for caving in of the drilled holes, temporary casing may be required during the foundation construction work.

Care should be exercised during 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 shallow groundwater conditions should be maintained during removal of the casing. The shallow groundwater conditions at the project site may pose construction difficulties because proper observation of the sides and bottoms of the drilled shaft may not be possible.

Drilling by methods utilizing drilling fluids is not recommended. Because of the groundwater conditions anticipated within the depths of the drilled shaft excavations, concrete placement by tremie methods will be required during drilled shaft construction. 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 inches slump range) should be used to provide close contact between the drilled shafts and the surrounding soils. The shaft 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.

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 the placement of concrete. Therefore, it is necessary for Geolabs to observe the drilled shaft installation operations to confirm the assumed subsurface conditions.

LIMITATIONS

The geotechnical recommendations presented herein are based on research of available geologic and subsurface information in the project vicinity and the provided as-built drawings.

This report has been prepared for the exclusive use of Engineering Concepts, Inc. and their consultants, for specific application to the Farrington Highway and Nanaikeola Street 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 evaluating and assisting the client/owner in selecting a suitable foundation system based on the Standard Plans by the State of Hawaii – Department of Transportation, Highways Division for the project site. Therefore, this report may not contain sufficient data, or the proper information, to serve as the basis for 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 surface and subsurface conditions are commonly encountered. Unforeseen conditions, such as perched groundwater, soft deposits, hard layers, or loose fills may occur in localized areas and may require additional exploration 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 letter report was not intended to evaluate 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.

CLOSURE

We appreciate the opportunity to provide geotechnical engineering services to you on this project. If you have questions or need additional information, please contact our office.

Respectfully submitted,

GEOLABS, INC.

By ______________________

Gerald Y. Seki P.E.
Vice President

GERALD Y. SEKI
LICENSED PROFESSIONAL ENGINEER
No. 5635-C
HAWAII, U.S.A.

THIS WORK WAS PREPARED BY ME OR UNDER MY SUPERVISION.

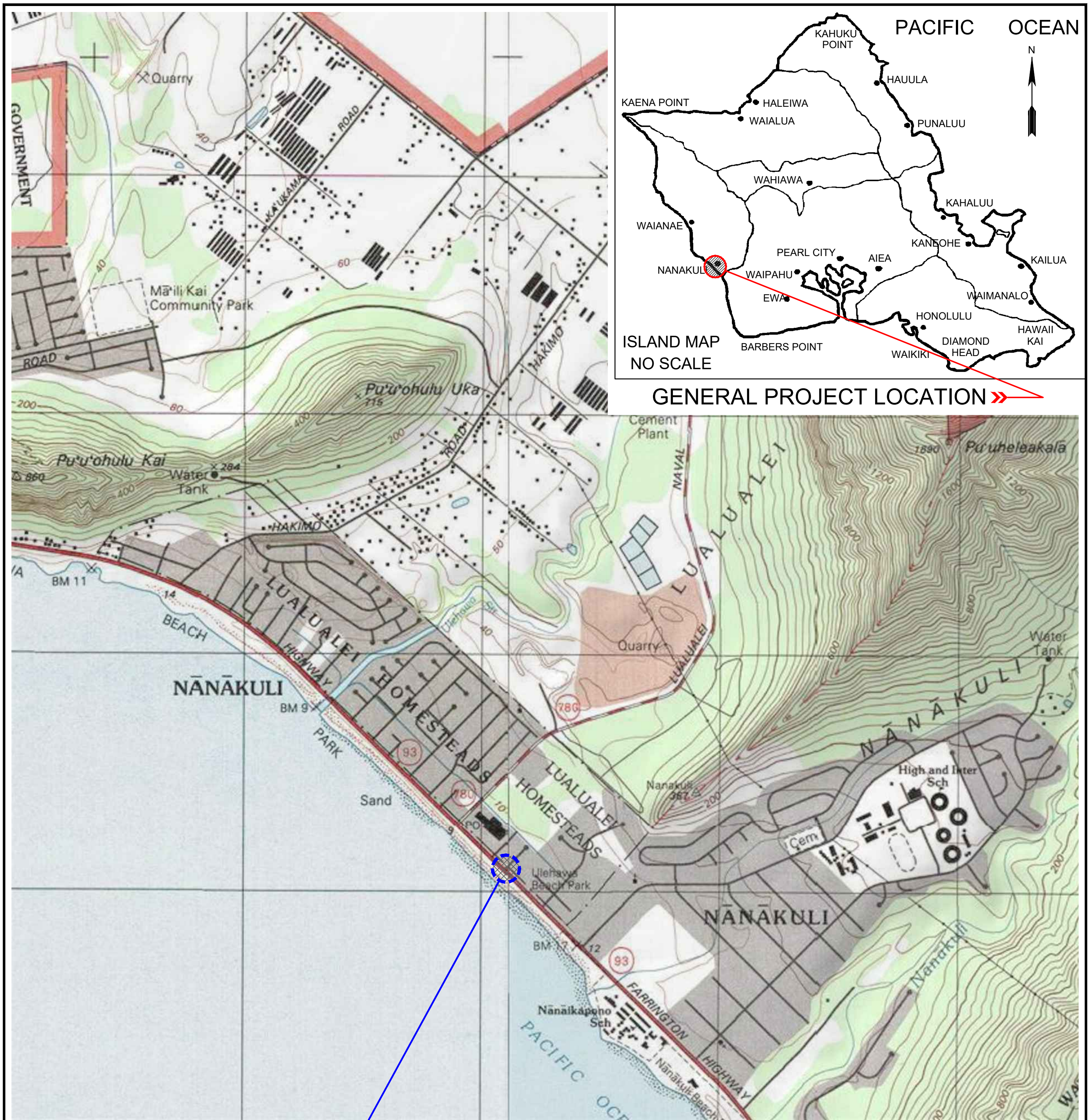
SIGNATURE ______________ 4-30-20
EXPIRATION DATE OF THE LICENSE

GS:NK:mj

Attachments: Project Location Map, Plate 1
Site Plan, Plate 2
Site Reconnaissance Photographs, Plates 3.1 and 3.2

(2 Copies to Addressee)

h:\7300Series\7328-00D.nk1



PROJECT LOCATION

PROJECT LOCATION MAP

TRAFFIC SIGNAL MODERNIZATION PROJECT
FARRINGTON HIGHWAY & NANAIKEOLA STREET INTERSECTION
WAIANAE, OAHU, HAWAII

2000 1000 0 2000 FT.

GRAPHIC SCALE

N

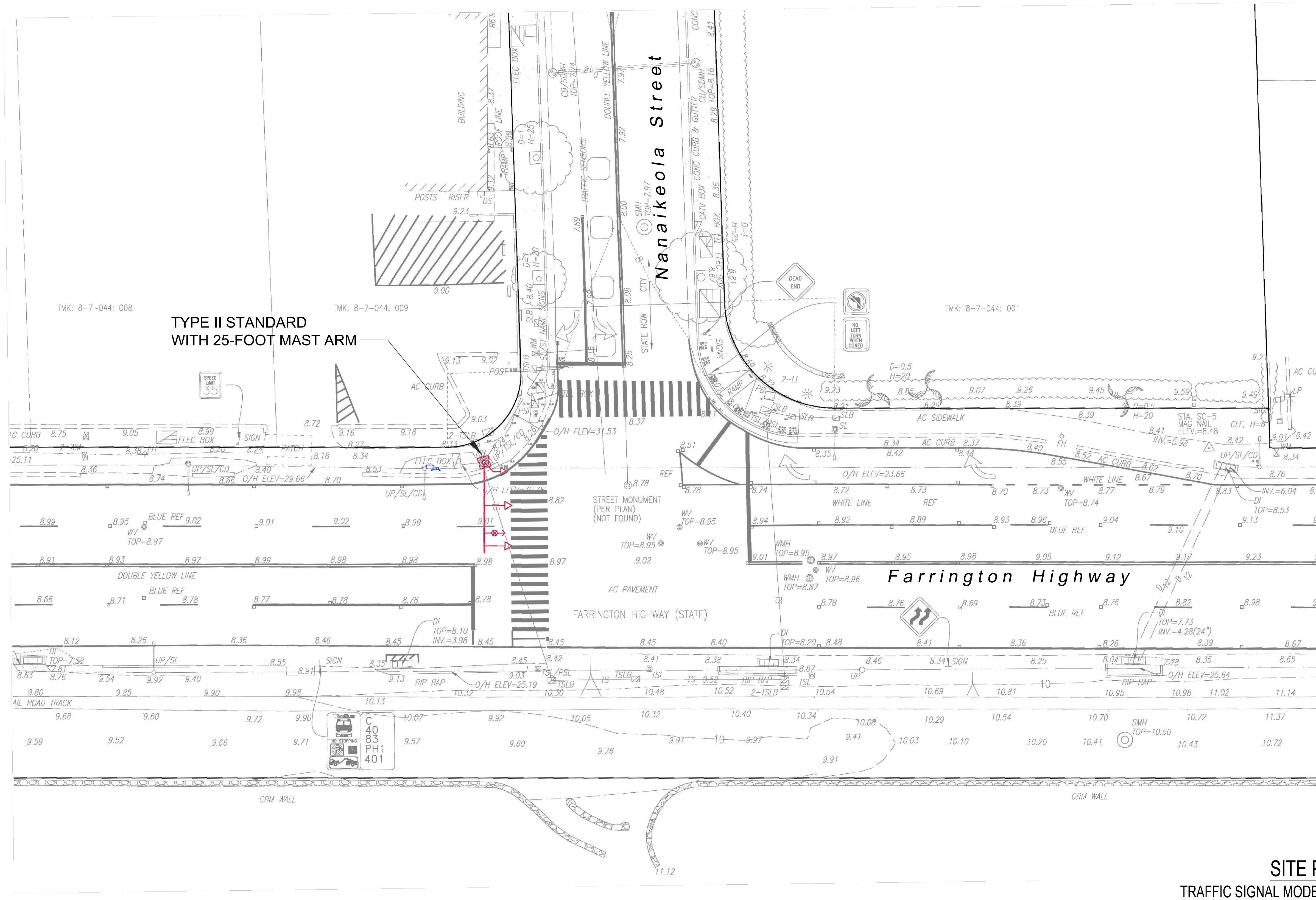
REFERENCE: MAP CREATED WITH TOPO!® ©2010 NATIONAL GEOGRAPHIC; ©2007 TELE ATLAS, REL. 1/2007.

GEOLABS, INC.

Geotechnical Engineering

DATE	DRAWN BY	PLATE
JUNE 2019	ASP	
SCALE	W.O.	
1" = 2,000'	7328-00(D)	1

CAD User: ASPASIONUR File Last Updated: June 12, 2019 4:13:48pm Plot Date: June 12, 2019 - 4:17:49pm
File: T:\Drafting\Working\7328-00(D)_Traffic_Signal_Modernization_Project_Farrington_Hwy_&_Nanaikeola_St\7328-00(D)PLM.dwg\1.0 PLM
Plotter: DWG To PDF-GEO.pc3 Plotstyle: GEO-No-Dithering.ctb



SITE PLAN

TRAFFIC SIGNAL MODERNIZATION PROJECT
FARRINGTON HIGHWAY & NANAIKEOLA STREET INTERSECTION
WAIANAE, OAHU, HAWAII

GEOLABS, INC. Geotechnical Engineering		
DATE: JUNE 2019	DRAWN BY: ASP	PLATE
SCALE: 1" = 30'	W.O. 7328-00(D)	2

CAD User: ASPASIONJR File Last Updated: June 12, 2019 4:57:38pm Plot Date: June 12, 2019 - 4:57:38pm
File: C:\Users\aspasionjr\Documents\Drawing5.dwg\2.0 SitePlan
Plotter: DWG To PDF-GEO.pc3 Plotstyle: GEO-No-Dithering-Blue-Boring.ctb

TRAFFIC SIGNAL MODERNIZATION PROJECT
FARRINGTON HIGHWAY & NANAIKEOLA STREET INTERSECTION
WAIANAE, OAHU, HAWAII

Photograph No. 1 – Existing traffic signal pole on the northern corner of the intersection (view facing southwest).

Photograph No. 2 – Existing traffic signal pole on the northern corner of the intersection (view facing).

Photograph No. 3 – Existing single pole traffic signal (left) signalizing the outbound traffic on Farrington Highway (view facing north).

August 10, 2020
W.O. 7328-00(E)

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

AMENDMENT TO GEOTECHNICAL REPORT
TRAFFIC SIGNAL POLE FOUNDATION RECOMMENDATIONS
TRAFFIC SIGNAL MODERNIZATION PROJECT
KOKO HEAD OFF-RAMP & KOKO HEAD AVENUE INTERSECTION
HONOLULU, OAHU, HAWAII

Dear **Mr. Higashionna:**

This amendment consists of incorporating changes in the mast arm lengths for the above project. Traffic signal pole foundation recommendations were previously provided in our report entitled "Traffic Signal Pole Foundation Recommendations, Traffic Signal Modernization Project, Koko Head Off-Ramp & Koko Head Avenue Intersection, Honolulu, Oahu, Hawaii," dated August 2, 2019.

TRAFFIC SIGNAL POLE FOUNDATIONS

Based on our research of available geologic and subsurface information in the project vicinity, we anticipate that the project site is generally underlain by a thin layer of fill overlying clayey residual and saprolitic soils grading to basalt formation with depth. Therefore, we recommend a "Stiff Clays" ground condition be used in the design. Based on the anticipated subsurface soil conditions and typical loading demands of Standard Type II Traffic Signals with mast arm lengths of 27 and 38 feet, we believe the Standard Plan 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 cast-in-place concrete drilled shaft foundations to support the new traffic signal poles planned.

Based on the existing ground elevation of the Koko Head Off-Ramp and Koko Head Avenue intersection (about +215 feet MSL), we anticipate that groundwater will not be encountered above the design tip elevation of the cast-in-place concrete drilled shaft foundation. Therefore, we recommend the following drilled shaft diameters and lengths for the proposed traffic signal pole foundations in accordance with TE-33A.2, Type II Traffic Signal Standard Drilled Shaft Foundation Schedule for a Level Ground Condition – Above Ground Water Table.

STANDARD TRAFFIC SIGNAL POLES DRILLED SHAFT FOUNDATIONS FOR LEVEL GROUND CONDITIONS		
Mast Arm Length (feet)	**Drilled Shaft Diameter** (inches)	**Drilled Shaft Length** (feet)
27	30	7
38	30	11

CLOSURE

We appreciate the opportunity to provide geotechnical engineering services to you on this project. If you have questions or need additional information, please contact our office.

Respectfully submitted,

GEOLABS, INC.

By ______________
Gerald Y. Seki P.E.
Vice President

GS:cjy

GERALD Y. SEKI
LICENSED PROFESSIONAL ENGINEER
No. 5635-C
HAWAII, U.S.A.

THIS WORK WAS PREPARED BY
ME OR UNDER MY SUPERVISION.

SIGNATURE
4-30-22
EXPIRATION DATE OF THE LICENSE

h:\7300Series\7328-00E.nk1.gs1