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## **APPENDIX A**

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## **APPENDIX A**

### **Field Exploration**

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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).

<b><u>Rock Quality</u></b>	<b><u>RQD</u> (%)</b>
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.



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## Soil Log Legend

### UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)

MAJOR DIVISIONS			USCS		TYPICAL DESCRIPTIONS		
COARSE-GRAINED SOILS	GRAVELS	CLEAN GRAVELS		GW	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES		
		LESS THAN 5% FINES		GP	POORLY-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES		
		GRAVELS WITH FINES		GM	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES		
		MORE THAN 12% FINES		GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES		
	SANDS	CLEAN SANDS		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES		
		LESS THAN 5% FINES		SP	POORLY-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES		
		SANDS WITH FINES		SM	SILTY SANDS, SAND-SILT MIXTURES		
		MORE THAN 12% FINES		SC	CLAYEY SANDS, SAND-CLAY MIXTURES		
FINE-GRAINED SOILS	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



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## Soil Classification Log Key

(with deviations from ASTM D2488)

### GEOLABS, INC. CLASSIFICATION\*

#### GRANULAR SOIL (- #200 <50%)

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

#### COHESIVE SOIL (- #200 ≥ 50%)

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

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

### RELATIVE DENSITY / CONSISTENCY

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

### MOISTURE CONTENT DEFINITIONS

Dry: Absence of moisture, dry to the touch  
Moist: Damp but no visible water  
Wet: Visible free water

### 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)

Plate

A-0.2

\*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).



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## Rock Log Legend

### ROCK DESCRIPTIONS

	<b>BASALT</b>		<b>CONGLOMERATE</b>
	<b>BOULDERS</b>		<b>LIMESTONE</b>
	<b>BRECCIA</b>		<b>SANDSTONE</b>
	<b>CLINKER</b>		<b>SILTSTONE</b>
	<b>COBBLES</b>		<b>TUFF</b>
	<b>CORAL</b>		<b>VOID/CAVITY</b>

### ROCK DESCRIPTION SYSTEM

#### ROCK FRACTURE CHARACTERISTICS

*The following terms describe general fracture spacing of a rock:*

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

#### DEGREE OF WEATHERING

*The following terms describe the chemical weathering of a rock:*

<b>Unweathered:</b>	Rock shows no sign of discoloration or loss of strength.
<b>Slightly Weathered:</b>	Slight discoloration inwards from open fractures.
<b>Moderately Weathered:</b>	Discoloration throughout and noticeably weakened though not able to break by hand.
<b>Highly Weathered:</b>	Most minerals decomposed with some corestones present in residual soil mass. Can be broken by hand.
<b>Extremely Weathered:</b>	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:*

<b>Very Hard:</b>	Specimen breaks with difficulty after several "pinging" hammer blows. Example: Dense, fine grain volcanic rock
<b>Hard:</b>	Specimen breaks with some difficulty after several hammer blows. Example: Vesicular, vugular, coarse-grained rock
<b>Medium Hard:</b>	Specimen can be broke 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
<b>Soft:</b>	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
<b>Very Soft:</b>	Crumbles under hammer blow. Can be peeled and carved by knife. Can be indented by finger pressure. Example: Saprolite

Plate

A-0.3



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

Log of  
Boring

1

Laboratory			Field				Depth (feet)	Sample	Graphic	USCS	Approximate Ground Surface Elevation (feet MSL): 116 *
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)					Description
TXUU	10	112			33					SM	6-inch <b>CONCRETE</b>
	31				10					CH	Reddish brown <b>GRAVELLY SAND (BASALTIC)</b> with a little clay and silt, medium dense, moist (fill)
	44	80			22	2.0	5			CH	Brown w/ multi-color mottling <b>SILTY CLAY</b> with some sand, stiff, moist (fill) Brownish red with multi-colored mottling <b>SILTY CLAY</b> 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 <b>SILTY SAND</b> with some gravel, very dense, moist (saprolite)
UC	16		0 97	67	40/3" Ref.		20				Gray vesicular <b>BASALT</b> , 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

Date Completed: May 9, 2019

Logged By: D. Gremminger

Total Depth: 28 feet

Work Order: 7328-00(A)

Water Level:  not encountered

Drill Rig: CME-45C TRUCK

Drilling Method: 4" Solid Stem Auger & PQ Coring

Driving Energy: 140 lb. wt., 30 in. drop

Plate

A - 1