Geotechnical Engineering Report

Waa Street Traffic Signals

Honolulu, O'ahu, Hawai'i

1.0 INTRODUCTION

This report provides Hart Crowser's geotechnical engineering evaluation of the Waa Street Traffic Signal project in the suburb of Wailupe, Honolulu on the island of O'ahu, Hawai'i. The project will consist of the addition of traffic signals at the intersection of Waa Street and Kalanianaole Highway. The general project area is shown on Figure 1.

Plans indicate the two traffic signal poles will be placed in the median of Kalanianaole Highway on either side of the intersection with Waa Street.

This report documents our evaluation of the site, our assessment of surface and subsurface conditions, and our recommendations for traffic signal foundation design and construction considerations.

2.0 SCOPE OF SERVICES

The purpose of our work was to assess the existing surface, soil, and groundwater conditions at the intersection and to provide geotechnical engineering parameters for design of the traffic signal foundations. Our scope of work was completed in general accordance with the scope of services detailed in our services agreement with AECOM. A summary of our scope of work is provided below.

- Reviewed relevant, readily available geologic maps and geotechnical reports that covered the site vicinity to evaluate geologic hazards, regional soil mapping, and local soil and groundwater conditions.
- Conducted field explorations, including:
  - Drilling two borings to depths of 18.5 and 25 feet below ground surface (bgs) using a truck-mounted drill rig
  - Maintaining a log of the soils encountered in the explorations and collecting soil samples for laboratory testing
- Conducted a program of laboratory testing on select soil samples.
- Prepared this report outlining our findings and recommendations, including geotechnical design recommendations related to the following:
  - Subsurface soil and groundwater conditions
  - Traffic signal pole foundations
  - Construction considerations
- Provided project management and support services, including coordinating staff and subcontractors and conducting telephone consultations and email communications with the design team.

3.0 EXISTING INFORMATION REVIEW

3.1 Geology and Geologic Hazards

The site geology is mapped by the U.S. Geological Survey (USGS) Open-File Report 2007-1089; *Geologic Map of the State of Hawai'i* (Sherrod and others 2007). The mapping shows two geologic units underlying portions of the site.

Along most of the Waa Street and Kalanianaole Highway intersection, the mapping shows calcareous reef rock and marine sediment (Pleistocene) deposits. These are described as "chiefly emerged coral reefs… consist of coral heads and coralline algae cemented by a lime matrix" (Sherrod and others 2007). Along the southern portion of the project area, the mapping shows young (Holocene) beach deposits. This is described as "sand and gravel worked by surf into unconsolidated strand-line deposits along coastline" (Sherrod and others 2007). Our investigation confirms that the subsurface conditions generally conform to the mapped geology with some exceptions detailed below.

4.0 SITE CONDITIONS

4.1 Surface Conditions

The project area is located at the intersection of Kalanianaole Highway and Waa Street near the base of the Wiliwilinui Ridge on the southeastern coast of O'ahu. Landforms at the site generally consist of a relatively level coastal plain.

The pavements along the alignment are asphalt concrete (AC), often underlain by Portland cement concrete (PCC). We observed pavements to be in generally good condition. We generally did not observe indications of wear, such as cracking, chipping, heaving, or sunken sections within the pavement.

4.2 Subsurface Conditions

4.2.1 General

We explored subsurface soil and groundwater conditions along the project alignment by advancing two borings to depths of 25 and 18.5 feet bgs. Borings HC-1 and HC-2 were completed in July 2019. The borings were advanced using a truck-mounted drill rig subcontracted with Valley Well Drilling.

The locations of the borings are shown on Figure 2. Appendix A summarizes our exploration methods and presents our exploration logs.

All borings were advanced through the existing street pavements. The borings were cored through AC and/or PCC pavement using a 10-inch-diameter carbide cutting head driven by the drill stem.

Base materials encountered below the pavement consisted of crushed coralline aggregate with sand ranging from 8 inches to 14.5 inches in borings HC-2 and HC-1, respectively.

4.2.2 Beach Deposits

Borings encountered materials we interpret as the alluvial beach deposits mapped by Sherrod and others (2007). These materials were generally encountered below the pavement section in the borings. Typically, the beach deposits consisted of medium dense to very dense silty sandy gravel and sandy silt with gravel. N-values in the beach deposits were typically over 50 blows per foot (bpf).

4.2.3 Coral Bedrock and Marine Sediments

Below the alluvial deposits in the borings, we encountered coral bedrock, which was tan, moderately to severely fractured, slight weathered, and medium hard. Based on the topography of the alignment, we anticipate that the traffic signal foundations will encounter intact coral at the planned excavation depths.

4.2.4 Groundwater

During completion of the July 2019 explorations, no groundwater was encountered in the borings. However, we anticipate that seasonal or perched water may be present in the soils below adjacent sea level, above or within the coral bedrock, or after periods of heavy precipitation.

5.0 CONCLUSIONS

Based on our explorations, testing, and analyses, it is our opinion that the site is suitable for the proposed use, provided the recommendations in this report are included in design and construction. We offer the following general summary of our conclusions.

- The near-surface materials generally consist of predominately gravelly and sandy soils. In general, we anticipate that conventional earth moving equipment will be capable of excavating the surficial soils in the project area. However, relatively shallow bedrock is present across the site.

- The foundation excavations are likely to encounter coral bedrock at both proposed traffic signal locations. Based on drilling action, the coral encountered may not be rippable with conventional means. Excavations may require the use of carbide coring bits or other rock removal methods. We do not recommend that blasting be used due to the residential location of the project.

- Bedrock excavation methods, such as pneumatic or hydraulic hammers, cause significant vibrations that could potentially damage existing structures, pavement, and utilities in the vicinity. If the contractor selects a vibration-inducing method for excavation or trenching, we recommend vibration monitoring be performed during such operations. We also recommend that the contractor be made responsible for the means and methods used such that damage to adjacent utilities and structures is avoided.

- We did not encounter groundwater during our explorations; however, due to the relatively low elevation at the site and close proximity to the Pacific Ocean, foundation excavations may encounter the water table or perched water during construction. We anticipate sump pumps would be adequate to remove such water, if encountered.

The following sections of the report present our conclusions and recommendations for geotechnical aspects of the project. Our geotechnical exploration and engineering analysis have been performed in accordance with generally accepted geotechnical practice. We have developed our conclusions and recommendations based on our current understanding of the project. If the nature or location of the project is different than we have assumed, Hart Crowser should be notified so we can confirm or modify our recommendations.

6.0 FOUNDATION RECOMMENDATIONS

Our subsurface explorations generally encountered dense to very dense gravelly and sandy soils with occasional sandy silt and coral bedrock, which we expect will provide adequate support for the proposed traffic signal foundations. All earthwork and foundation construction should be conducted in accordance with the 2005 Standard Specifications for Road and Bridge Construction for the state of Hawai'i Department of Transportation (HDOT). Specific foundation recommendations are provided in the following sections.

6.1 Excavation

Coral formations, coralline detritus, fill, and sandy and gravelly soils were encountered in the borings at the site. The contractor should be prepared to drill through these materials for the proposed traffic signal foundations. It is our opinion that conventional earthmoving equipment in proper working condition should be capable of making necessary general excavations in the soils. However, shallow coral rock was encountered in the borings and may require rock drilling methods, such as carbide coring bits. The contractor should be responsible for determining the best method to excavate the soils and rock in the field. If the contractor is using vibration-inducing equipment to excavate, vibration monitoring should be performed in order to limit potential damage to existing structures, utilities, and pavements near the project.

The contractor should be prepared to case the foundation excavations where loose soils or groundwater seepage could cause loss of ground. Fill, sand, and gravel soils can be especially prone to caving and may require casing. The actual need for casing should be determined in the field at the time of installation.

While this report describes certain approaches to excavation, the contractor is responsible for selecting and designing the specific methods; monitoring the excavations for safety; and providing adequate protection for personnel, adjacent utilities, pavement, and other structural elements.

6.2 Traffic Signal Foundations

We understand that traffic signals will be installed in the median of Kalanianaole Highway on either side of the intersection with Waa Street. The proposed traffic signal foundations are very close to existing pavements and buried utilities. We anticipate the upper 3 feet of soils at these locations would be disturbed during repairs to the existing pavement and/or utilities. As such, we do not recommend including soil resistance in the upper 3 feet during design due to the potential for future disturbance in this zone. We recommend the unfactored LRFD (ultimate) parameters in Table 1 be used for design of the traffic signal foundations. Table 2 presents the depths the soil and rock layers were observed in the borings.

Table 1 – Traffic Signal Foundation Design Parameters

Soil or Rock Layer	Ultimate Undrained Shear Strength (psf)	Friction Angle (degrees)	Unit Weight [Above/Below GWT] (pcf)
Coral / Tuff (Bedrock)	4,000	n/a	115 / 53
Sandy Silt (ML)	1,500	n/a	105 / 43
Sand & Gravel (SP/GP/GM)	n/a	34	110 / 48

Note: No factors of safety have been applied to the design parameters in Table 1.
psf = pounds per square foot • GWT = groundwater table • pcf = pounds per cubic foot

Table 2 – Traffic Signal Foundation Soil Layer Depths

Soil or Rock Layer	Depth(s) Encountered in Boring HC-1 (feet)	Depth(s) Encountered in Boring HC-2 (feet)
Coral / Tuff (Bedrock)	4.3 – 5.0	4.5 – 5.0
Sandy Silt (ML)	5.0 – 8.5	n/a
Sand & Gravel (SP/GP/GM)	3.0 – 4.3 8.5 – 25.0	3.0 – 4.5 5.0 – 18.5

The proposed traffic signals at the site are located approximately 250 feet from the coast. While no groundwater was observed in the borings during drilling, we recommend using the nearby mean sea level as the design groundwater table for the foundations.

7.0 CONSTRUCTION OBSERVATION

Satisfactory foundation and earthwork performance depends to a large degree on quality of construction. Sufficient monitoring of the contractor's activities is a key part of determining that the work is completed in accordance with the construction drawings and specifications. Subsurface conditions observed during construction should be compared with those encountered during subsurface explorations. Recognition of changed conditions often requires experience; therefore, Hart Crowser or their representative should visit the site with sufficient frequency to detect whether subsurface conditions change significantly from those anticipated.

We recommend that Hart Crowser be retained to monitor construction at the site to confirm that subsurface conditions are consistent with the site explorations and to confirm that the intent of project plans and specifications relating to earthwork and foundation construction are being met. In particular, we recommend that the subgrade preparation and placement and compaction of structural backfill, aggregate bases, and asphalt be observed and/or tested by Hart Crowser.

8.0 LIMITATIONS

We have prepared this report for the exclusive use of AECOM, the State of Hawai'i Department of Transportation, and their authorized agents for the proposed traffic signal improvement project in Honolulu, Hawai'i, in accordance with our approved scope of work. Our report is intended to provide our opinion of geotechnical parameters for design and construction of the proposed project based on exploration locations that are believed to be representative of site conditions. However, conditions can vary significantly between exploration locations and our conclusions should not be construed as a warranty or guarantee of subsurface conditions or future site performance.

Within the limitations of scope, schedule, and budget, our services have been executed in accordance with generally accepted practices in the field of geotechnical engineering in this area at the time this report was prepared. No warranty, express or implied, should be understood.

Any electronic form, facsimile, or hard copy of the original document (email, text, table, and/or figure), if provided, and any attachments are only a copy of the original document. The original document is stored by Hart Crowser and will serve as the official document of record.

9.0 REFERENCES

Sherrod, D.R., J.M. Sinton, S.E. Watkins, and K.M. Brunt 2007. Geologic Map of the State of Hawai'i: U.S. Geological Survey Open File Report 2007-1089, 85 p., 1 plate, 1:100,000 scale

State of Hawai'i Department of Transportation (HDOT) 2005. Standard Specifications for Road and Bridge Construction.

State of Hawai'i Department of Transportation (HDOT) 2002. *Pavement Design Manual*, revision March 2002.

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0 1,000 2,000 4,000 Feet

Note: Feature locations are approximate.

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Waa Street Traffic Signals
Wailupe, Hawaii

Vicinity Map

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Figure 1

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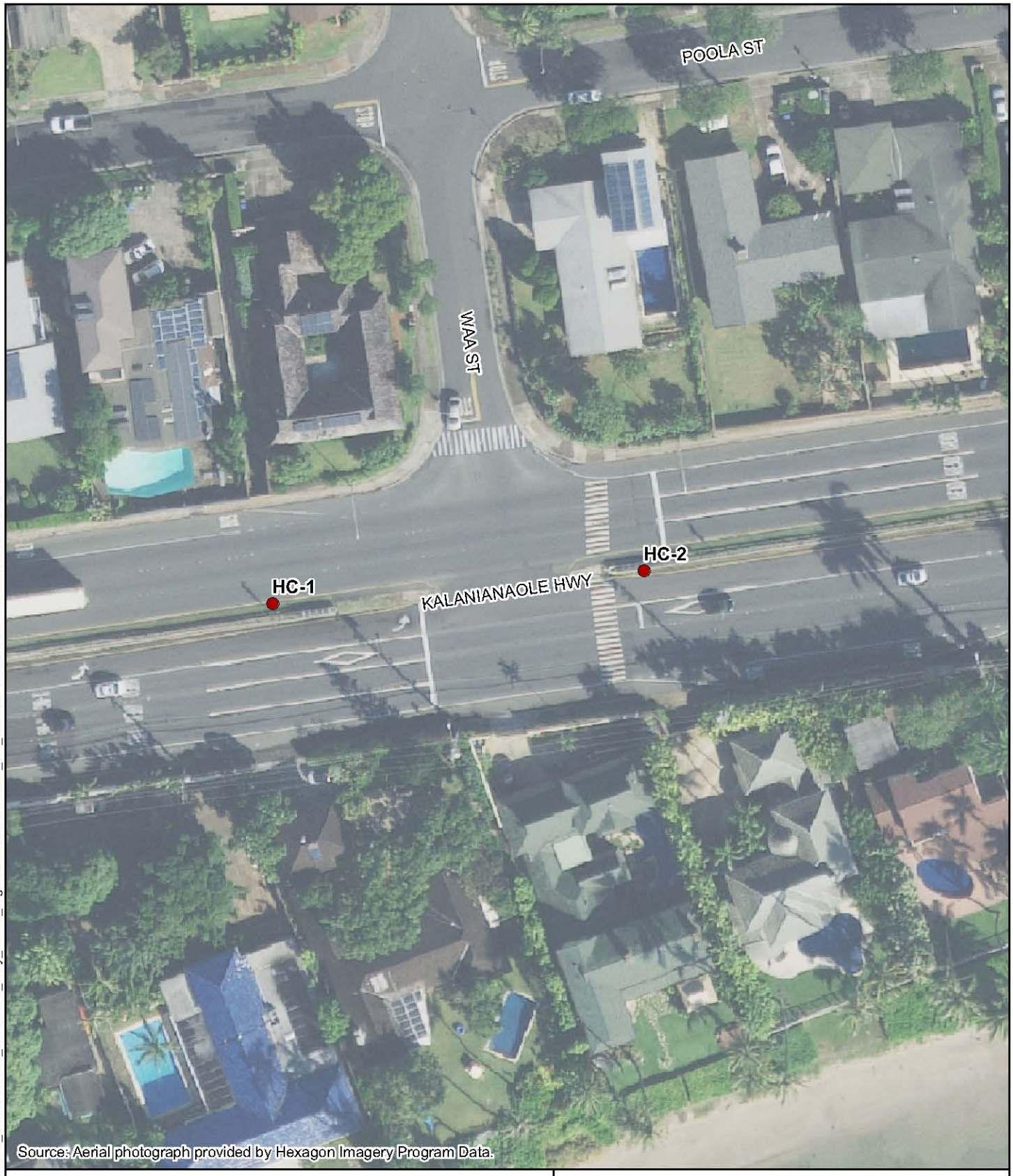

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Legend

- Boring

0 30 60 120 Feet

Note: Feature locations are approximate.

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Waa Street Traffic Signals
Wailupe, Hawaii

Site Plan

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Figure 2