GEOTECHNICAL ENGINEERING EXPLORATION
WAIAHOLE WATER SYSTEM IMPROVEMENT
KUNIA, OAHU, HAWAII

W.O. 8094-00 & 20   JANUARY 26, 2021

Prepared for

R.M. TOWILL CORPORATION

GEOLABS, INC.
Geotechnical Engineering and Drilling Services

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Prepared for

R.M. TOWILL CORPORATION

GERALD Y. SEKI
No. 5635-C

THIS WORK WAS PREPARED BY
ME OR UNDER MY SUPERVISION.

SIGNATURE

4-30-22
EXPIRATION DATE
OF THE LICENSE

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GEOLABS, INC.

Geotechnical Engineering and Drilling Services

January 26, 2021
W.O. 8094-00 & 20

Mr. Walter Chong, P.E.
R.M. Towill Corporation
2024 North King Street, Suite 200
Honolulu, HI 96819

Dear **Mr. Chong:**

Geolabs, Inc. is pleased to submit our report entitled "Geotechnical Engineering Exploration, Waiahole Water System Improvement, Kunia, Oahu, Hawaii," prepared in support of the design for the project.

Our work was performed in general accordance with the scope of services outlined in our fee proposal dated February 3, 2020.

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 recommendations for the design of the project are contained in the body of this report. If there is any point that is not clear, please contact our office.

Very truly yours,

GEOLABS, INC.

Gerald Y. Seki, P.E.
Vice President

GS:NK:lf

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SUMMARY OF FINDINGS AND RECOMMENDATIONS

Based on our borings, the project site is generally underlain by about 2 to 10 feet of surface fill, consisting of medium stiff to hard silty clay and/or clayey silt. The surface fills are underlain by alluvium, residual soil, and saprolite extending to the maximum depth explored of about 36.5 feet below the existing ground surface. In general, the alluvium and residual soil consisted of medium stiff to hard silty/sandy clay and/or clayey silt. The saprolite generally consisted of medium dense silty sand, stiff to very stiff sandy silt and hard silty clay. It should be noted that an approximately 2 to 18-inch thick layer of base material, consisting of medium dense to dense silty gravel, was encountered in the borings drilled along Plantation Road.

We did not encounter groundwater in the borings 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, groundwater seepage, perched groundwater, and other factors.

A new lined earthen reservoir about 23 feet high with slope inclination of 2.5H:1V and 4H:1V inside and outside of the reservoir, respectively, will be constructed at the project site. Prior to construction of the reservoir fill embankment, a keyway should be excavated at the toe of the reservoir embankment to provide stability for the embankment fill against sliding. The bottom of the keyway should extend at least two feet into stiff soil below the original grade at the toe of the slope and have a minimum width of 10 feet.

We understand that an impervious liner (i.e., geomembrane) will be installed within and along the sides of the reservoir to reduce water infiltration through the underlying natural material. In general, the material type, performance, installation, and protection details of the geomembrane liner should be designed in accordance with the manufacturer’s recommendations. We recommend that the geomembrane manufacturer be consulted regarding proper construction detailing and installation of the liner, with particular attention to proper anchoring of the liner at the top of the embankments. Technical representatives of the geomembrane manufacturer should be required to be on-site at all times during the installation process to assure that proper construction procedures and precautions are followed. We recommend that a geotextile underlining consisting of a heavy-duty geotextile fabric beneath the impervious liner be provided to reduce the potential for puncture of the impervious liner.

The finished subgrades of the reservoir side slopes should be proof-rolled with a smooth drum roller a minimum of 4 passes to provide a relatively smooth surface for placement of the geotextile underlining and impervious liner for the proposed reservoir.

Cobbles exposed at the finished subgrades should be removed and replaced with compacted select borrow subbase material.

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

END OF SUMMARY OF FINDINGS AND RECOMMENDATIONS

SECTION 1. GENERAL

1.1 Introduction

This report presents the results of our geotechnical engineering exploration performed for the proposed Waiahole Water System Improvement project in Kunia 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 analysis for the project. The recommendations presented herein are intended for the design of the new lined earthen reservoir, earthwork, retaining structures, access roads, manhole structures, and underground utilities only. The findings and recommendations presented herein are subject to the limitations noted at the end of this report.

1.2 Project Considerations

The project site is located west of Kunia Road and north of Plantation Road in the Kunia area on the Island of Oahu, Hawaii. The project consists of improving the existing irrigation system's efficiency and enhancing the water supply security of the Waiahole Ditch System. The project includes the following elements:

- **New Lined Earthen Reservoir:** The existing lined reservoir will be expanded to create a larger, lined earthen reservoir. Based on the information provided, the top-of-embankment and bottom-of-reservoir elevations are approximately +650 and +627 feet Mean Sea Level (MSL), respectively. The new reservoir will be lined with a high-density polyethylene or equivalent geomembrane liner. We understand that an unpaved aggregate or recycled asphalt pavement accessway will be installed along the top bank of the reservoir's perimeter to allow maintenance vehicles to be driven and parked.

- **Water Supply Well:** A new water supply well will be constructed south of the intersection of Kunia Road and Plantation Road. The new well will have a target production capacity of 2 million gallons per day. We understand that geotechnical recommendations and a boring at the well site is not required.

- **Irrigation Line “A”:** A new buried 12 to 30-inch diameter ductile iron pipeline, about 4,265 feet in length, will be installed from the existing ditch on the western end of the project limits to the new water supply well. The new line will be along Plantation Road and an existing dirt access road. The buried pipe needs to be designed to support the anticipated traffic loading above the pipe.

- **Irrigation Line “B”:** A new buried 30-inch diameter ductile iron pipeline, about 2,250 feet in length, connecting Irrigation Line “A” to the new reservoir. Irrigation Line “B” also extends beyond the new reservoir to connect to the existing ditch on the eastern end of the project site. The new line will be installed both beneath and adjacent to existing dirt access roads. Therefore, the buried pipe needs to be designed to support the anticipated traffic loading above the pipe.

- **Irrigation Line “C”:** A new buried 12-inch diameter ductile iron pipeline, about 1,060 feet in length, connecting Irrigation Line “A” to the new reservoir. The new line will be installed beneath an existing dirt access road. Therefore, the buried pipe needs to be designed to support the anticipated traffic loading above the pipe.

- **Irrigation Line “D”:** A new buried 30-inch diameter ductile iron pipeline, about 200 feet in length, connecting the existing ditch on the northern side of the project site to Irrigation Line “B”.

- **Additive Item: Closed Conduit at Hairpin Bend in System:** Replacement of two existing plastic pipes with concrete headwalls with a larger pipe at the hairpin bend. The new pipe will be about 600 linear feet.

Based on the grading plans provided, we anticipate that cuts up to about 22 feet deep and fills up to about 16 feet thick will be required to construct the new lined earthen reservoir. In addition, we understand that trench excavations up to about 11 feet below the existing ground surface will be required to install the new irrigation lines.

1.3 Purpose and Scope

The purpose of our geotechnical engineering exploration was to obtain an overview of the surface and subsurface conditions to develop a generalized soil/rock data set to formulate geotechnical engineering recommendations for the design of the Waiahole Water System Improvement project. The work was performed in general accordance with the scope of services outlined in our fee proposal dated February 3, 2020. The scope of work for this exploration included the following tasks and work efforts:

1. Perform site reconnaissance for the initial survey and condition assessment at the project site.
2. Review of available in-house soil and geologic information in the near vicinity of the project site.
3. Develop a Fieldwork Health and Safety Plan and a Simple Work Plan for our work on the project.
4. Mobilization and demobilization of trail clearing equipment to and from the project site.
5. Perform trail clearing with an excavator to provide access for our truck-mounted drill rig.
6. Boring stakeout and coordination of utility toning with the various utility companies and clearance of the proposed boring locations by our field engineer/geologist.
7. Mobilization/demobilization of a truck-mounted drill rig, water truck, and two operators to and from the project site.
8. Drilling and sampling of 18 boreholes to depths of about 11.5 to 36.5 feet below the existing ground surface for a total of about 323.4 lineal feet of exploration. The additive item consisted of drilling and sampling three boreholes to depths of about 9 to 11.5 feet below the existing ground surface for a total of about 32 lineal feet of exploration. Four bulk samples

were collected for moisture and density relationship and California Bearing Ratio (CBR) laboratory testing.

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

10. Engineering analyses of the field and laboratory data to formulate geotechnical engineering recommendations pertaining to the design of the proposed water system improvement project.

11. Preparation of this report summarizing our work on the project and presenting our findings and recommendations.

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

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

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

Detailed descriptions of our field exploration methodology and the Logs of Borings are presented in Appendix A. Results of the laboratory tests performed on selected soil samples are presented in Appendix B. The analytical corrosivity test report is presented in Appendix C.

END OF GENERAL

SECTION 2. SITE CHARACTERIZATION

2.1 Regional Geology

The Island of Oahu was built by the extrusion of basalt and 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 Koolau Volcano is estimated to be late Pliocene to early Pleistocene in age. As the volcanic activity in Waianae Volcano ceased, lava flows from Koolau Volcano banked against its eroded eastern slope forming a broad plateau, now known as the Schofield Plateau. The project site is located on the western flank of the Koolau Volcano.

In-situ weathering of the Koolau lavas on the Schofield Plateau generated a relatively thick mantle of residual soils generally consisting of reddish colored silty clays/clayey silts. These residual soils grade with depth to saprolite, i.e., soil that retains the relict structure of the parent rock, which eventually grades to basalt rock formation. In some portions of the residual soils and saprolite, remnant boulders, or “corestones” of weathering resistant rock are encountered.

Visual observations of road cuts in the area indicate that alluvial materials from the Waianae volcanic dome may form a thin mantle, about 1 to 3 feet thick, over portions of the Koolau residual soils. However, most of the site has been used for agricultural purposes for many years, and deep tilling may have resulted in mixing of this mantle with the underlying residual soils.

2.2 Existing Site Conditions

The project site is located west of Kunia Road and north of Plantation Road in the Kunia area on the Island of Oahu, Hawaii. The alignment of the proposed improvements generally begins near the access gate and agricultural buildings in the northeast corner of the project site. The alignment generally extends southwest towards the existing lined reservoir, southeast towards Plantation Road, and southwest along Plantation Road for approximately 3,300 feet. The additive item is located at the existing “hairpin bend” in the current system, located in a shallow valley near the western limit of the project site. The approximate project location is presented on the Project Location

Map, Plate 1. The general project limits and new water system alignment is presented on the Overall Site Plan, Plate 2.

In general, the proposed water system alignment traverses existing agricultural fields and runs along/below unpaved access roads. The existing lined reservoir is relatively small (approximately 500 square feet in plan dimension) and consists of a vegetated embankment with a top bench wide enough for vehicular traffic. Based on the topographic survey information provided, the existing ground surface elevation ranges from about +650 feet Mean Sea Level (MSL) near the northeastern access gate to about +550 feet MSL along Plantation Road near the center of the project limits. No elevation information was available for the hairpin bend area at the time this report was prepared.

2.3 Subsurface Conditions

We explored the subsurface conditions at the project site by drilling and sampling 21 borings, designated as Boring Nos. 1 through 21, extending to depths of 9 to 36.5 feet below the existing ground surface. In addition, four bulk samples of the near-surface soils, designated as Bulk-1 through Bulk-4, were collected for laboratory moisture/density relationships and CBR tests to evaluate the pavement support characteristics of the near-surface soils. The approximate boring and bulk sample locations are shown on the Overall Site Plan, Plate 2, and Site Plans, Plates 3.1 through 3.13.

Based on our borings, the project site is generally underlain by about 2 to 10 feet of surface fill, consisting of medium stiff to hard silty clay and/or clayey silt. The surface fills are underlain by alluvium, residual soil, and saprolite extending to the maximum depth explored of about 36.5 feet below the existing ground surface. In general, the alluvium and residual soil consisted of medium stiff to hard silty/sandy clay and/or clayey silt. The saprolite generally consisted of medium dense silty sand, stiff to very stiff sandy silt and hard silty clay. It should be noted that an approximately 2 to 18-inch thick layer of base material, consisting of medium dense to dense silty gravel, was encountered in the borings drilled along Plantation Road.

We did not encounter groundwater in the borings 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, groundwater seepage, perched groundwater, and other factors.

Detailed descriptions of our field exploration methodology and the Logs of Borings are presented in Appendix A. Descriptions and graphic representation of the material encountered in the borings are provided on the Logs of Borings in Appendix A. Results of the laboratory tests performed on selected soil samples are presented in Appendix B.

2.4 Seismic Design Parameters

Based on the International Building Code (2012 Edition), the project site may be subject to seismic activity and seismic design considerations will need to be addressed. The following subsections provide discussions on the seismicity, soil profile type for seismic design, and the potential for liquefaction at the project site.

2.4.1 Earthquakes and Seismicity

In general, earthquakes that occur throughout the world are caused solely by shifts in the tectonic plates. In contrast, earthquake activity in Hawaii is linked primarily to volcanic activity. Therefore, earthquake activity in Hawaii generally occurs before or during volcanic eruptions. In addition, earthquakes may result from the underground movement of magma that comes close to the surface but does not erupt. The Island of Hawaii experiences thousands of earthquakes each year, but most of the earthquakes are so small that they can only be detected by sensitive instruments. However, some of the earthquakes are strong enough to be felt, and a few cause minor to moderate damage.

In general, earthquakes (associated with volcanic activity) are most common on the Island of Hawaii. Earthquakes that are directly associated with the movement of magma are concentrated beneath the active Kilauea and Mauna Loa Volcanoes on the Island of Hawaii. Because the majority of the earthquakes in Hawaii (over 90 percent of earthquakes) are related to volcanic activity, the risk of high seismic activity and degree of ground shaking diminishes with increased distance from the Island of Hawaii. The Island of Hawaii has experienced numerous earthquakes greater than Magnitude 5 (M5+); however, earthquakes are not confined only to the Island of Hawaii.

To a lesser degree, the Island of Maui has experienced numerous earthquakes greater than Magnitude 5. Therefore, moderate to strong earthquakes have occurred in the County of Maui. The effects of earthquakes occurring on the Islands of Hawaii and Maui may be felt on the Island of Oahu. For example, several small landslides occurred on the Island of Oahu as a result of the Maui Earthquake of 1938 (M6.8). In addition, some houses on the Island of Oahu were reportedly damaged as a result of the Lanai Earthquake of 1871 (M7+).

Due to the relatively short period of documented earthquake monitoring in the State of Hawaii, information pertaining to earthquakes that were felt on the Island of Oahu may not be complete. In general, over the last 150 years of recorded history, we are not aware of reported earthquakes greater than Magnitude 6 occurring on the Island of Oahu. Based on available information, we understand that an earthquake of about Magnitude 5.6 occurred on June 28, 1948 in the vicinity of the Island of Oahu, possibly along the hypothesized and controversial Diamond Head Fault feature.

The Diamond Head Fault feature is believed to extend northeasterly away from the southeastern tip of the Island of Oahu. The Diamond Head Fault feature may be related to the widely documented Molokai Fracture Zone located on the sea floor in the vicinity of the Hawaiian Islands. Despite only the moderate tremor intensity, the resulting damage was reportedly widespread and included broken windows, ruptured masonry building walls, and a broken underground water main. In addition, some areas on the Island of Oahu, including the Tantalus, Iwilei, and Tripler areas, reported more intense ground shaking, severe enough to have cracked reinforced concrete.

2.4.2 Liquefaction Potential

Based on the International Building Code (2012 Edition), the project site may be subjected to seismic activity, and the potential for soil liquefaction at the project site will need to be evaluated.

Soil liquefaction is a condition where saturated cohesionless soils located near the ground surface undergo a substantial loss of strength due to the build-up of excess pore water pressures resulting from cyclic stress applications induced by earthquakes. In this process, when the loose saturated sand deposit is subjected to vibration (such as during an earthquake), the soil tends to densify and decrease in volume causing an increase in pore water pressure. If drainage is unable to occur rapidly enough to dissipate the build-up of pore water pressure, the effective stress (internal strength) of the soil is reduced. Under sustained vibrations, the pore water pressure build-up could equal the overburden pressure, essentially reducing the soil shear strength to zero and causing it to behave as a viscous fluid. During liquefaction, the soil acquires sufficient mobility to permit both horizontal and vertical movements, and if not confined, will result in significant deformations.

Soils most susceptible to liquefaction are loose, uniformly graded, fine-grained sands and loose silts with little cohesion. The major factors affecting the liquefaction characteristics of a soil deposit are as follows:

FACTORS	LIQUEFACTION SUSCEPTIBILITY
Grain Size Distribution	Fine and uniform sands and silts are more susceptible to liquefaction than coarse or well-graded sands.
Initial Relative Density	Loose sands and silts are most susceptible to liquefaction. Liquefaction potential is inversely proportional to relative density.
Magnitude and Duration of Vibration	Liquefaction potential is directly proportional to the magnitude and duration of the earthquake.

In general, the subsurface information obtained from the drilled borings indicate that the project site is underlain by relatively stiff/dense fill, alluvium, residual soil, and saprolite. Based on the subsurface conditions encountered in our field exploration, the geology in the area, and our engineering analyses, the potential for soil liquefaction at the project site is non-existent due to the presence of relatively stiff/dense fill, alluvium, residual soil, and saprolite in the absence of groundwater within the depths of our drilled borings. Therefore, the potential for liquefaction is not a design consideration at this project site.

2.4.3 Soil Profile Type for Seismic Design

Based on the subsurface materials encountered and the geologic setting of the area, we believe that the project site may be classified from a seismic analysis standpoint as being a "Stiff Soil Profile" site corresponding to a Site Class "D" soil profile based on the ASCE Standard ASCE/SEI 7-10 (Table No. 20.3-1), referenced by the International Building Code, 2012 Edition. Based on Site Class D, the following seismic design parameters were estimated and may be used for seismic analysis of the project.

SEISMIC DESIGN PARAMETERS
INTERNATIONAL BUILDING CODE
2012 EDITION

Parameter	Value
Mapped MCE Spectral Response Acceleration, S_S	0.554g
Mapped MCE Spectral Response Acceleration, S_1	0.156g
Site Class	"D"
Site Coefficient, F_a	1.357
Site Coefficient, F_v	2.178
Design Spectral Response Acceleration, S_{DS}	0.501g
Design Spectral Response Acceleration, S_{D1}	0.226g
Design Peak Bedrock Acceleration, PBA (Site Class B)	0.255g
Design Peak Ground Acceleration, PGA (Site Class D)	0.329g

END OF SITE CHARACTERIZATION

SECTION 3. DISCUSSION AND RECOMMENDATIONS

Based on our field exploration, the project site is generally underlain by about 2 to 10 feet of surface fills underlain by alluvium, residual soil, and saprolite extending to the maximum depth explored of about 36.5 feet below the existing ground surface. We did not encounter groundwater in the borings at the time of our field exploration.

Prior to construction of the reservoir fill embankment, a keyway should be excavated at the toe of the reservoir embankment to provide stability for the embankment fill against sliding. The bottom of the keyway should extend at least two feet into stiff soil below the original grade at the toe of the slope and have a minimum width of 10 feet.

We understand that an impervious liner (i.e., geomembrane) will be installed within and along the sides of the reservoir to reduce water infiltration through the underlying natural material. In general, the material type, performance, installation, and protection details of the geomembrane liner should be designed in accordance with the manufacturer's recommendations. We recommend that the geomembrane manufacturer be consulted regarding proper construction detailing and installation of the liner, with particular attention to proper anchoring of the liner at the top of the embankments. Technical representatives of the geomembrane manufacturer should be required to be on-site at all times during the installation process to assure that proper construction procedures and precautions are followed.

Detailed discussion of these items and our geotechnical engineering recommendations for design are presented in the following sections.

3.1 New Lined Earthen Reservoir

Based on the information provided, we understand the existing lined reservoir will be expanded to create a larger, lined earthen reservoir. In general, the earthen embankments will be constructed with an inside reservoir slope inclination of two and a half horizontal to one vertical (2.5H:1V) and an outside reservoir slope inclination of 4H:1V. In addition, a concrete spillway with grouted rip-rap slope protection is planned on the southwestern side of the new reservoir.

Based on the grading plan provided, we understand that excavations on the order of about 22 feet below the existing ground surface will be required to construct the proposed reservoir. Based on the subsurface conditions encountered during our field exploration program, we envision that the reservoir excavation will encounter medium stiff to hard fill, alluvium, and residual soil. It should be noted that saprolite was encountered below the planned bottom-of-reservoir excavation. However, saprolite may be encountered in localized areas of the excavation at shallower depths. Large basaltic boulders (aka core stones) may be encountered in the residual soil and/or saprolite that may require the use of hoerams and/or chipping to remove.

Prior to construction of the reservoir fill embankment, a keyway should be excavated at the toe of the reservoir embankment to provide stability for the embankment fill against sliding. The bottom of the keyway should extend at least two feet into stiff soil below the original grade at the toe of the slope and have a minimum width of 10 feet.

We understand that an impervious liner (i.e., geomembrane) will be installed within and along the sides of the reservoir to reduce water infiltration through the underlying natural material. In general, the material type, performance, installation, and protection details of the geomembrane liner should be designed in accordance with the manufacturer’s recommendations. It is critical that the liner maintains its integrity to prevent saturation and build-up of seepage water pressures within the excavation. As an added drainage measure, consideration should be given to sloping the bottom of the reservoir to a low point where a subdrain could be installed. The subdrain would aid in relieving seepage water below the impervious liner system. The subdrain should discharge to an appropriate outlet.

We recommend that the geomembrane manufacturer be consulted regarding proper construction detailing and installation of the liner, with particular attention to proper anchoring of the liner at the top of the embankments. In addition, the geomembrane liner should be textured on both sides to allow for safer installation for the laborers, and to increase the friction between the geomembrane and the embankment side slopes.

Technical representatives of the geomembrane manufacturer should be required to be on-site at all times during the installation process to assure that proper construction procedures and precautions are followed.

We recommend that a geotextile underlining consisting of a heavy-duty geotextile fabric beneath the impervious liner be provided to reduce the potential for puncture of the impervious liner. The use of geotextile fabric is recommended in-lieu of a sand cushion due to the ease of installation and the increased puncture resistance of the impervious liner when combined with a layer of geotextile underlining. In addition, a sand cushion is not recommended because of the steep side slopes of 2.5H:1V planned for the proposed reservoir.

The edges of the concrete spillway, grouted rip-rap slope protection and grouted rip-rap apron should be keyed into the reservoir embankment and/or existing ground surface (minimum 4 feet deep by 2 feet wide) to reduce the potential for erosion and undermining of these structures.

Subsequent to construction and filling of the reservoir, periodic inspections of the reservoir should be performed to evaluate the condition of the reservoir. Inspections should also be conducted following any major problems or unusual event, such as an earthquake, heavy flood, or vandalism.

3.2 Site Grading

Based on the grading plan provided, we anticipate that cuts up to about 22 feet deep and fills up to about 16 feet thick will be required to construct the proposed reservoir. In addition, trench excavations up to about 11 feet below the existing ground surface will be required to install the new irrigation lines. The following site grading items are addressed in the following subsections:

1. Site Preparation
2. Fills and Backfills
3. Fill Placement and Compaction Requirements
4. Excavations
5. Cut and Fill Slopes

Site grading operations should be observed by a Geolabs representative. It is important that a Geolabs representative be present to observe the site preparation operations to evaluate whether undesirable materials are encountered during the excavation and scarification process, and whether the exposed soil and/or rock conditions are similar to those encountered in our field exploration.

3.2.1 Site Preparation

At the on-set of earthwork, areas within the contract grading limits should be thoroughly cleared and grubbed. Vegetation, debris, deleterious materials, and other unsuitable materials should be removed and disposed of properly off-site to reduce the potential for contaminating the excavated materials.

Soft and yielding areas encountered during clearing and grubbing below areas designated to receive fill and/or future improvements should be over-excavated to expose firm natural material, and the resulting excavation should be backfilled with well-compacted fill. The excavated soft soils should not be reused as fill materials and should be properly disposed of off-site or in landscape areas (if appropriate).

In general, the over-excavated subgrades and areas designated to receive fills should be scarified to a depth of about 8 inches, moisture-conditioned to at least 2 percent above the optimum moisture content, and recompacted to a minimum of 90 percent relative compaction.

Where shrinkage cracks are observed after the subgrade compaction, we recommend preparing the subgrade soil again as recommended above. Saturation and subsequent yielding of the exposed subgrade due to inclement weather and poor drainage may require over-excavating the soft areas and replacing these areas with engineered fill.

The finished subgrades of the reservoir side slopes should be proof-rolled with a smooth drum roller a minimum of 4 passes to provide a relatively smooth surface for placement of the geotextile underlining and impervious liner for the proposed reservoir. Cobbles exposed at the finished subgrades should be removed and replaced with compacted select borrow subbase material.

3.2.2 Fills and Backfills

Based on the preliminary drawings, the excavation quantity is greater than the fill quantity. In general, the on-site fill, alluvium, residual soils, and saprolite encountered during our field exploration should be suitable for use as general fill materials, provided that the maximum particle size is less than 3 inches in largest dimension. The on-site materials generated from the excavations may be used as a source of general fill or backfill materials provided that they are screened/processed of the over-sized materials to meet the above gradation requirements (less than 3 inches in largest dimension) and deleterious material such as vegetation is removed.

Imported materials should consist of non-expansive select granular material, such as crushed coral or basalt. The select granular fill should be well-graded from coarse to fine with no particles larger than 3 inches in largest dimension. The material should have a CBR value of 20 or higher, and a swell potential of 1 percent or less when tested in accordance with ASTM D1883. The material should also contain between 10 and 30 percent particles passing the No. 200 sieve. Imported fill materials should be tested for conformance with these recommendations prior to delivery to the project site for the intended use.

3.2.3 Fill Placement and Compaction Requirements

In general, fill materials should be placed in level lifts not exceeding 8 inches in loose thickness, moisture-conditioned to at least 2 percent above the optimum moisture content and compacted to at least 90 percent relative compaction. Relative compaction refers to the in-place dry density of soil expressed as a percentage of the maximum dry density of the same soil established in accordance with ASTM D1557. Optimum moisture is the water content (percentage by weight) corresponding to the maximum dry density.

The compaction requirement for the upper 3 feet of fill below areas subjected to vehicular traffic should be increased to at least 95 percent relative compaction. Compaction should be accomplished by sheepsfoot rollers, vibratory rollers, or other types of acceptable compaction equipment. Water tamping, jetting, or ponding should not be allowed to compact the fills.

Where compaction is less than required, additional compactive effort should be applied with adjustment of moisture content as necessary to obtain the specified compaction.

3.2.4 Excavations

It is anticipated that the on-site silty/clayey fill, alluvium, residual soil, and saprolite encountered in our borings may be excavated with normal heavy excavation equipment. However, there is a potential for encountering harder, less weathered zones of volcanic rock at unpredictable depths within these soils. The contractor for the project should be cautioned that these hard, volcanic rock zones could be encountered in the excavations and may require chipping and/or the use of hoerams to excavate the materials.

The above discussions regarding the rippability of the surface materials are based on the anticipated subsurface at the project site and our experience in the project vicinity. Contractors bidding on this project should be encouraged to review and understand the geologic environment of the project site and to examine the site conditions and soil data to make their own interpretation.

3.2.5 Cut and Fill Slopes

We understand that the new reservoir slopes will be 2.5H:1V and 4H:1V inclination for the inside and outside slopes, respectively. The filling operation should start at the lowest point and continue up in level horizontal compacted layers in accordance with the above fill placement recommendations. Fill slopes should be constructed by overfilling and cutting back to the design slope ratio to obtain a well-compacted slope face. Water should be diverted away from the tops of slopes, and slope planting should be provided as soon as possible to reduce the potential for erosion of the finished slopes.

3.3 Retaining Structures

We understand that a retaining wall is required at the northeastern side of the new reservoir embankment, and concrete headwalls are required around the reservoir spillway and near the hairpin turn located at the western end of the project site. In addition, we understand that the backfill behind the embankment retaining wall will have a maximum slope inclination of 4H:1V. Based on the subsurface conditions encountered, the following general guidelines may be used for design of the retaining structures at the project site.

3.3.1 Retaining Wall Foundations

Based on the subsurface conditions anticipated at the project site, we recommend using shallow continuous strip footings bearing on the recompacted in-situ soils to support the planned retaining walls. An allowable bearing pressure of up to 3,000 pounds per square foot (psf) may be used to design shallow wall foundations bearing on the recompacted in-situ soils. This bearing value is for dead-plus-live loads and may be increased by one-third (⅓) for transient loads, such as those caused by wind or seismic forces.

Retaining structure foundations should be at least 18 inches wide and the bottom should be embedded a minimum of 24 inches below the lowest adjacent finished grades. For sloping ground conditions, the footing should extend deeper to obtain a minimum 6-foot setback distance measured horizontally from the outside edge of the footing (base of footing) to the face of the slope. Wall footings oriented parallel to the direction of the slope should be constructed in stepped footings.

Foundations next to other retaining walls, other foundations, utility trenches, or easements should be embedded below a 45-degree imaginary plane extending upward from the bottom edge of the structure or utility trench. Alternatively, footings should be extended to a depth as deep as the inverts of the utility lines or bottom of the retaining walls. This requirement is necessary to avoid surcharging adjacent below-grade structures with additional structural loads and to reduce the potential for appreciable foundation settlement.

If the foundations are designed and constructed in accordance with our recommendations, we estimate that total footing settlements may be on the order of 1 inch or less. We estimate that the differential settlements between adjacent foundations to be on the order of about 0.5 inches.

3.3.2 Static Lateral Earth Pressures

Retaining structures should be designed to resist lateral earth pressures due to the adjacent soils and surcharge effects caused by loads adjacent to the walls. The recommended lateral earth pressures for the design of the retaining structures, expressed in equivalent fluid pressures of pounds per square foot per foot of depth (pcf), are presented in the following table:

LATERAL EARTH PRESSURES
FOR DESIGN OF RETAINING STRUCTURES

Backfill Condition	**Earth Pressure Component**	**Active** (pcf)	**At-Rest** (pcf)
Level Backfill	Horizontal	40	60
	Vertical	None	None
Maximum 4H:1V Sloping Backfill	Horizontal	42	61
	Vertical	15	21

The values provided above assume that the on-site soil will be used to backfill behind the retaining structures. The backfill behind retaining structures should be compacted to between 90 and 95 percent relative compaction per ASTM D1557. Over-compaction of the retaining structure backfill should be avoided.

In general, an active condition may be used for gravity retaining walls or walls that are free to deflect by as much as 0.5 percent of the wall height. If the tops of walls are not free to deflect beyond this degree or are restrained, the walls should be designed for the at-rest condition. These lateral earth pressures do not include hydrostatic pressures that might be caused by groundwater trapped behind the walls.

Surcharge stresses due to areal surcharges, line loads, and point loads within a horizontal distance equal to the depth of the wall should be considered in the design. For uniform surcharge stresses imposed on the loaded side of the wall, a rectangular distribution with a uniform pressure equal to 36 percent of the vertical surcharge pressure acting over the entire height of the wall, which is free to deflect (cantilever), may be used in the design. For walls that are restrained, a rectangular distribution equal to 53 percent of the vertical surcharge pressure acting over the entire height of the wall may be used for design. Additional analyses during design may be needed to evaluate the surcharge effects of point loads and line loads.

3.3.3 Dynamic Lateral Earth Pressures

Dynamic lateral earth forces due to seismic loading (a = 0.329g) may be estimated by using $8.2H^2$ pounds per linear foot of wall length for level backfill conditions, where H is the height of the wall in feet. It should be noted that the dynamic lateral earth forces provided assume that the wall will be allowed to move laterally by up to about 1 inch in the event of an earthquake. For a sloping backfill condition with a maximum slope inclination of 4H:1V, the dynamic lateral earth forces due to seismic loading may be estimated by using $15.7H^2$ pounds per linear foot of wall length. The resultant force should be assumed to act through the mid-height of the wall. The dynamic lateral earth forces are in addition to the static lateral earth pressures provided above. An appropriately reduced factor of safety may be used when dynamic lateral earth forces are accounted for in the design of the retaining structures.

3.3.4 Drainage

The retaining walls should be well-drained to reduce the potential for build-up of hydrostatic pressures. A typical drainage system would consist of a 12-inch wide zone of permeable material, such as No. 3 Fine gravel (ASTM C33, No. 67 gradation), placed directly around a perforated pipe (perforations facing down) at the base of the wall discharging to an appropriate outlet or weepholes. As an alternative, a prefabricated drainage product, such as MiraDrain or EnkaDrain, may be used instead of the drainage material. The prefabricated drainage product also should be hydraulically connected to a perforated pipe at the base of the wall.

The backfill from the bottom of the wall to the bottom of the perforated pipe or weephole should consist of relatively impervious materials to reduce the potential for significant water infiltration into the subsurface. In addition, the upper 12 inches of the retaining structure backfill should consist of relatively impervious materials to reduce the potential for significant water infiltration behind the retaining structure unless covered by concrete slabs at the surface.

3.4 Access Road Design

We understand that an unpaved aggregate base course (BC) or recycled asphalt pavement (RAP) access road will be installed along the top bank of the reservoir's perimeter to allow maintenance vehicles to be driven and parked. For pavement design purposes, we have assumed the vehicle loading for the roadway would be relatively light, consisting of occasional passenger vehicles and maintenance trucks.

Based on the results of our CBR testing of the near-surface soils at the project site, a design CBR value of 15 was used to represent the compacted embankment fill material. Based on the above, the following preliminary pavement sections for the unpaved roadway on the reservoir embankment may be considered:

Reservoir Embankment Unpaved Roadway

12.0-Inch Aggregate BC or RAP (95 Percent Relative Compaction)
12.0-Inch Total Pavement Thickness over Filter Fabric (Mirafi 180N or equal) on Moist Compacted Subgrade

8.0-Inch Aggregate BC (95 Percent Relative Compaction)
8.0-Inch Total Pavement Thickness on Reinforcing Geogrid (Tensar TriAx Geogrid TX7 or equal) over Filter Fabric (Mirafi 180N or equal) on Moist Compacted Subgrade

It should be noted that there is a potential for raveling and rutting of the aggregate base course or recycled asphalt pavement layer over time. Therefore, periodic maintenance will be required for the unpaved accessway. We believe most of the maintenance will consist of periodic grading to remove ruts and depressions caused by the environment and traffic and recompacting the loose aggregate base course or RAP materials.

The gravel road should be sloped to provide adequate drainage of surface water off the gravel road.

The subgrade soils under the new pavement section should be scarified to a minimum depth of 8 inches, moisture-conditioned to at least 2 percent above the optimum moisture content and compacted to a minimum of 95 percent relative compaction. Aggregate base course and RAP materials should be moisture-conditioned to above the optimum moisture content, placed in level lifts not exceeding 8 inches in loose thickness, and compacted to a minimum of 95 percent relative compaction.

Aggregate base course should meet the material requirements for Base Course as specified in Section 31 of the Standard Specifications for Public Works Construction, City & County of Honolulu, September 1986. Geolabs should test imported fill materials for conformance with these recommendations prior to delivery to the project site for the intended use.

A Geolabs representative should monitor the pavement subgrade preparation to observe whether undesirable materials are encountered during the excavation and scarification process and to confirm whether the exposed soil conditions are similar to those encountered during our field exploration. California Bearing Ratio (CBR) tests and/or field observations should be performed on the actual subgrade soils during construction to confirm that the above design section is adequate.

3.5 Manhole Structures

Based on the information provided, manhole structures will be constructed for the new irrigation lines. Based on the borings, we anticipate that the new manhole structures will bear on relatively stiff/dense fill, alluvium, residual soil, and/or saprolite.

An allowable bearing pressure of up to 3,000 pounds per square foot (psf) may be used for the design of the manhole structures bearing on the relatively stiff/dense soils.

A minimum 6-inch gravel cushion layer should be provided between the bottom of the manhole structure and the underlying foundation soils to provide more uniform bearing support. The gravel cushion layer should consist of No. 3B Fine gravel (ASTM C33 No. 67 size).

The lateral earth pressures acting on the proposed underground manhole structure will depend on the type of backfill used, the extent of backfill, and the compactive effort on the backfill material around the structure. We recommend designing the new manhole structures to resist the lateral earth pressures (at-rest conditions) from the adjacent soils provided in the “Retaining Structures” section herein.

3.6 Underground Utility Lines

We understand that new underground irrigation lines will be installed for the water system improvement project. The methods and equipment to be used for utility trench excavations should be determined by the contractor, subject to practical limits and safety considerations. The excavations should comply with all applicable local, state, and federal safety requirements. Trench shoring design and installation should be the responsibility of the contractor. Trench shoring and bracing should conform to the appropriate health and safety requirements.

In general, for support of the utility lines, we recommend that granular bedding consisting of 6 inches of No. 3B Fine gravel (ASTM C 33, No. 67 gradation) be used under the pipes. The initial backfill up to about 1 foot above the pipes should consist of free-draining backfills, such as No. 3B Fine gravel, to reduce the potential for damaging the pipes from compaction of the backfill. It is critical that a free-draining granular material be used to reduce the potential for the formation of voids below the haunches of pipes and to provide adequate support for the sides of the pipes. The use of on-site soils as backfill immediately around utility pipes is not recommended.

The upper portion of the trench backfill from the level 1 foot above the pipes to the finished subgrade should consist of the on-site soils. The backfill material should be moisture-conditioned to at least 2 percent above the optimum moisture content, placed in level lifts not exceeding 8 inches in loose thickness, and compacted to a minimum of 90 percent relative compaction to reduce the potential for future ground subsidence. The upper 3 feet of the trench backfill below the pavement subgrade should be compacted to no less than 95 percent relative compaction. Mechanical compaction equipment should be used to compact the materials at the project site. Water tamping, jetting, or ponding should not be used to compact the backfill material.

3.7 Corrosion Potential

Four sets of laboratory corrosion tests, including pH, minimum resistivity, chloride content, and sulfate content, were performed on selected samples obtained during our field exploration to evaluate the corrosivity of the near-surface soils at the project site. The test results are summarized and presented in Appendix B. Detailed results of the Chloride Content (EPA 300.0) and Sulfate Content (EPA 300.0) tests performed by Eurofins TestAmerica Laboratories, Inc. are presented in Appendix C.

Design of metallic substructures, such as metallic piping, should consider the effects of the corrosive environment on the substructure. Resistivity is generally recognized as one of the most significant soil characteristics regarding the corrosivity of the soil to buried metallic objects. In general, the lower the resistivity, the greater the potential for corrosion of the buried metallic structure. Conversely, the higher the resistivity, the less likely the soil will contribute to the corrosion of metallic objects. Results of the resistivity testing indicate that the on-site soils have resistivity values ranging from 1,900 to 3,000 ohm-cm with pH values varying from 7.58 to 8.2. Therefore, the on-site near-surface soils may be considered very corrosive based on the Board of Water Supply, City and County of Honolulu Water System External Corrosion Control Standards dated 1991.

In addition, chloride content and sulfate content were performed by Eurofins TestAmerica Laboratories, Inc. to evaluate the corrosivity of the on-site soils encountered. Based on the chloride and sulfate content tests performed on the on-site soils, the test values are generally relatively low. It may be appropriate to consult with a professional corrosion engineer to review the test results and provide detailed recommendations for corrosion protection.

3.8 Design Review

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

3.9 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 Inspection” include the following:

- Observation of reservoir fill embankment keyway excavation
- Observation of reservoir fill embankment placement and compaction
- Observation of concrete spillway, grouted rip-rap slope protection, and grouted rip-rap apron installation
- Observation of subgrade soil preparation
- Observation of fill placement and compaction
- Observation of the trench excavation, placement of bedding materials, and trench backfill
- Observation of access road construction

A Geolabs representative should monitor the construction to observe compliance with the intent of the design concepts, specifications, or recommendations and to expedite suggestions for design changes that may be required in the event that subsurface conditions differ from those anticipated at the time this report was prepared. The recommendations provided herein are contingent upon such observations.

END OF DISCUSSION AND RECOMMENDATIONS

SECTION 4. LIMITATIONS

The analyses and recommendations submitted herein are based, in part, upon information obtained from the field borings and bulk samples. Variations of the subsurface conditions between and beyond the field borings and bulk samples may occur, and the nature and extent of these variations may not become evident until construction is underway. If the variations then appear evident, it will be necessary to re-evaluate the recommendations presented herein.

The test boring and bulk sample locations indicated herein are approximate, having been estimated using a handheld GPS device. Elevations of the borings were estimated from the profiles presented on the Site Plans created by R.M. Towill Corporation dated April 2020. The boring locations and elevations should be considered accurate only to the degree implied by the methods used.

The stratification breaks represented on the Logs of Borings depict the approximate boundaries between soil types and, as such, may denote a gradual transition. Water level data from the borings were measured at the times shown on the graphic representations and/or presented in the text of this report. These data have been reviewed and interpretations made in the formulation of this report. However, it should be noted that groundwater levels are subject to change due to rainfall, time of year, seasonal precipitation, surface water runoff, groundwater seepage, perched groundwater, and other factors.

This report has been prepared for the exclusive use of R.M. Towill Corporation for specific application to the proposed *Waiahole Water System Improvement* project in accordance with generally accepted geotechnical engineering principles and practices. No warranty is expressed or implied.

This report has been prepared solely for the purpose of assisting the engineer in the design of the proposed water system improvement project. Therefore, this report may not contain sufficient data, or the proper information, to serve as the basis for preparation of construction cost estimates. A contractor wishing to bid on this project is urged to retain a competent geotechnical engineer to assist in the interpretation of this report and/or in the performance of additional site-specific exploration for bid estimating purposes.

The owner/client should be aware that unanticipated soil/rock conditions and/or obstructions are commonly encountered. Unforeseen subsurface conditions, such as soft deposits, hard layers, cavities, or perched groundwater may occur in localized areas and may require additional probing or corrections in the field (which may result in construction delays) to attain a properly constructed project. Therefore, a sufficient contingency fund is recommended to accommodate these possible extra costs.

This geotechnical engineering exploration conducted at the project site was not intended to investigate the potential presence of hazardous materials existing at the 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

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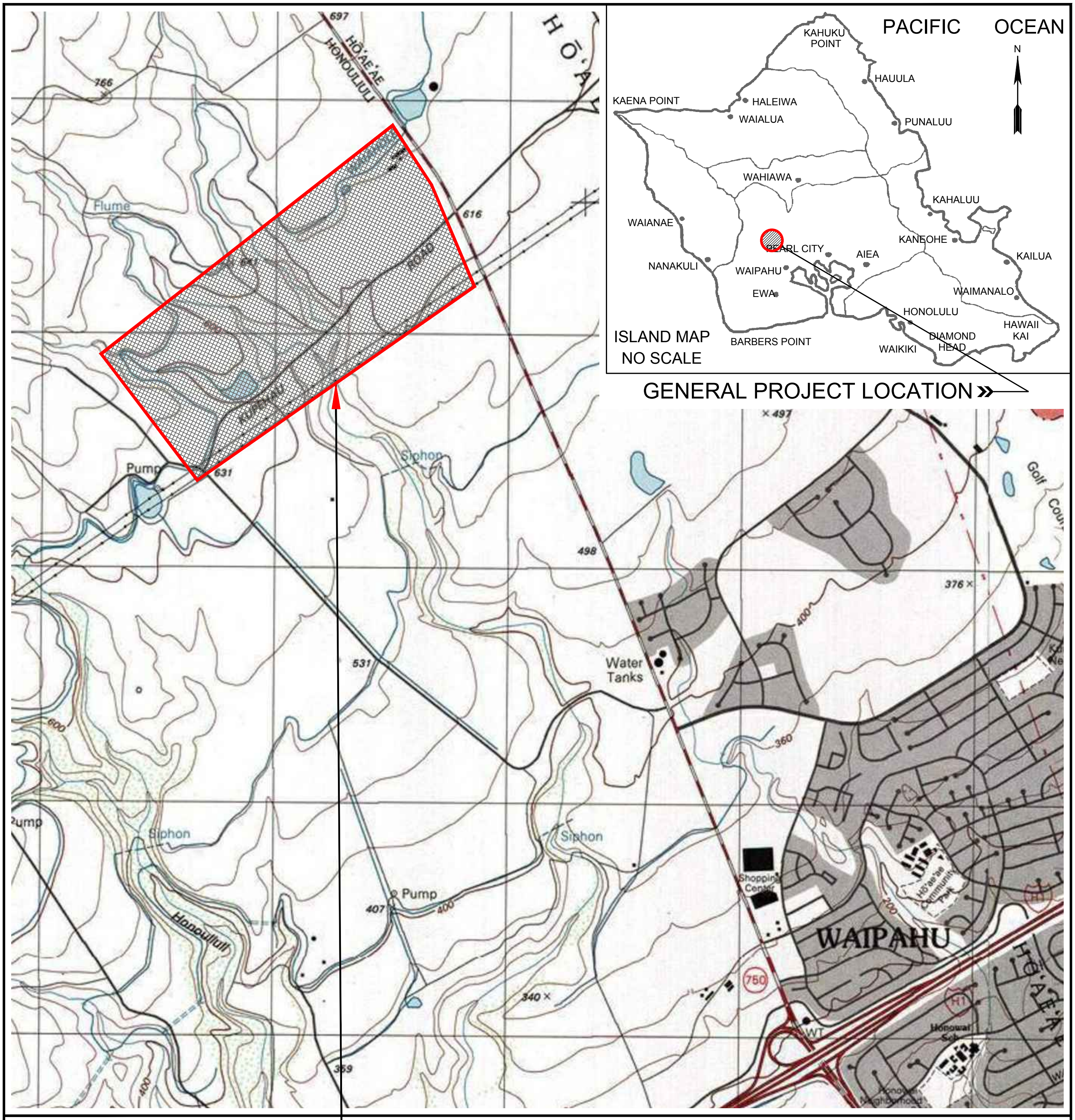
PLATES



GENERAL PROJECT LOCATION »

PROJECT LOCATION »

2000 1000 0 2000 FT.

GRAPHIC SCALE

N

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

PROJECT LOCATION MAP

WAIAHOLE WATER SYSTEM IMPROVEMENT
KUNIA, OAHU, HAWAII

GEOLABS, INC.

Geotechnical Engineering

DATE	DRAWN BY	PLATE
DECEMBER 2020	KHN	
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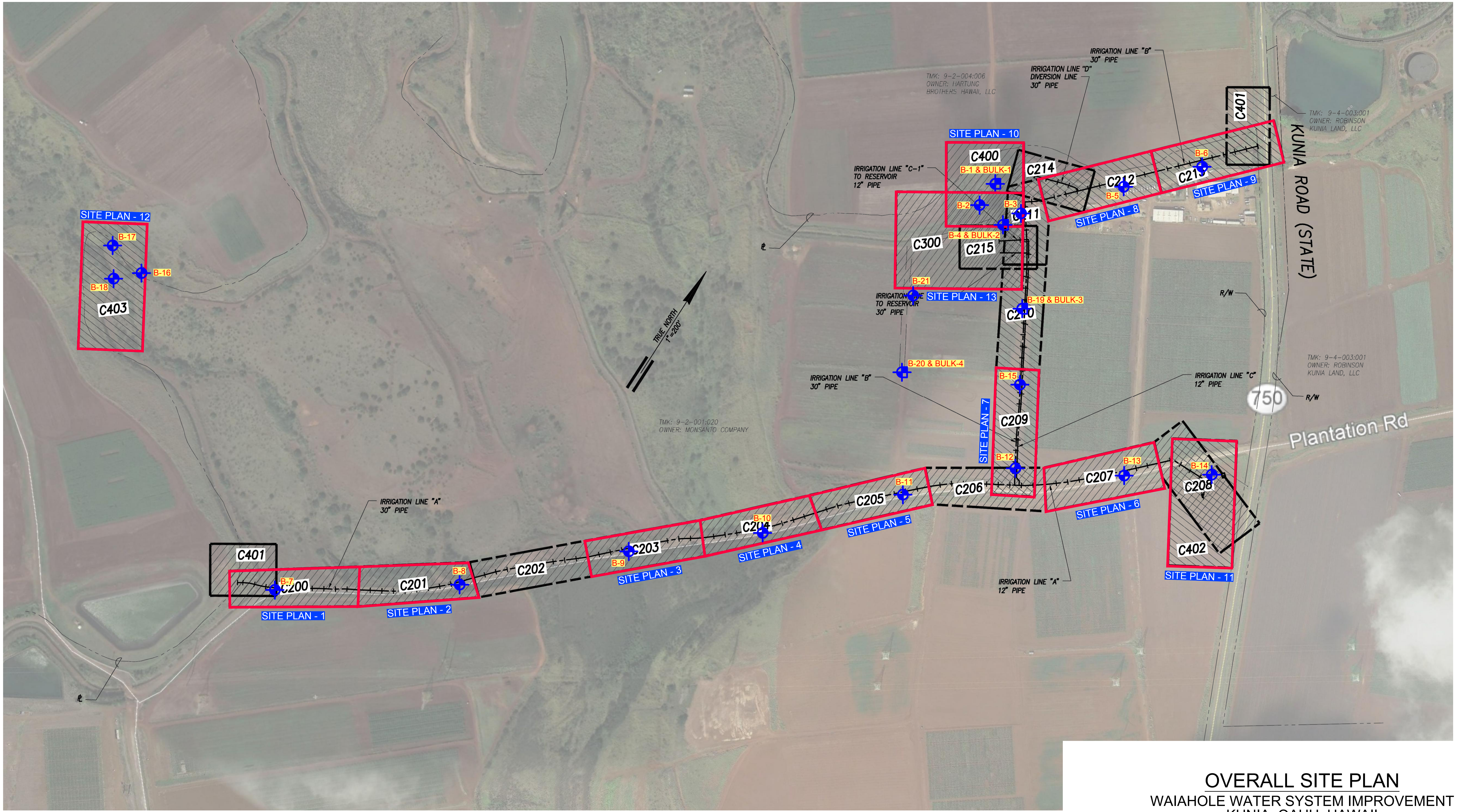

LEGEND:

- ⌖ APPROXIMATE BORING LOCATION
- ⊞ APPROXIMATE BULK SAMPLE LOCATION

REFERENCE: KEY PLAN CREATED BY R.M. TOWILL DATED APRIL 2020.

0 200 400 800 1200 FT.

GRAPHIC SCALE

N

OVERALL SITE PLAN

WAIAHOLE WATER SYSTEM IMPROVEMENT
KUNIA, OAHU, HAWAII

GEOLABS, INC.
Geotechnical Engineering

DATE	DRAWN BY	PLATE
DECEMBER 2020	KHN	
SCALE	W.O.	
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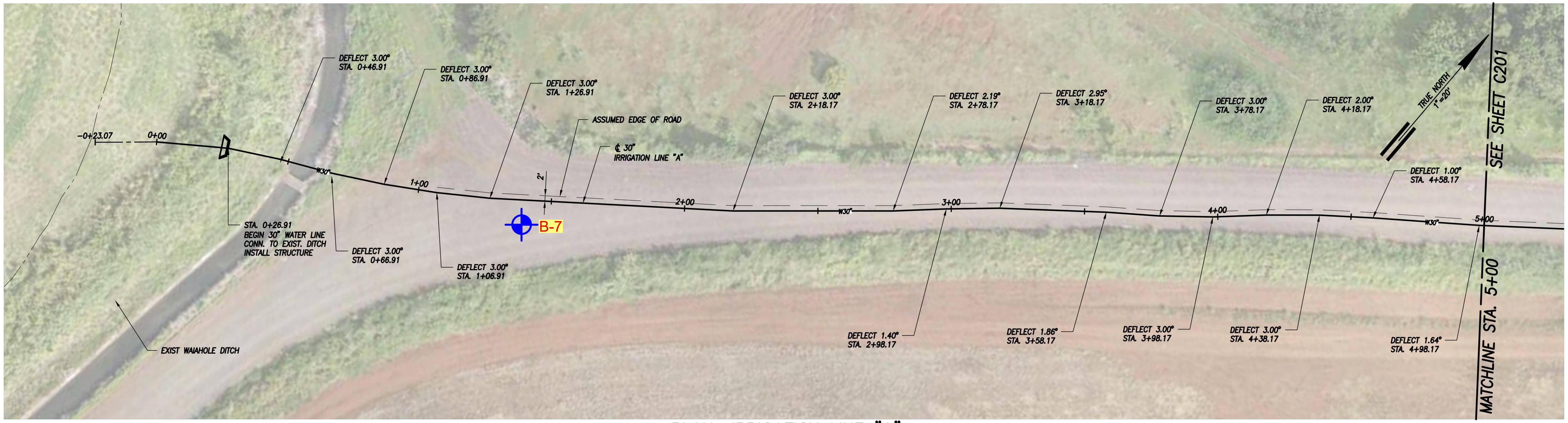

PLAN: IRRIGATION LINE "A"

LEGEND:

⊕ APPROXIMATE BORING LOCATION

REFERENCE: PLAN: IRRIGATION LINE "A" CREATED BY R.M. TOWILL DATED
APRIL 2020.

0 20 40 80 120 FT.
GRAPHIC SCALE

N

SITE PLAN - 1

WAIAHOLE WATER SYSTEM IMPROVEMENT
KUNIA, OAHU, HAWAII

GEOLABS, INC.
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DATE	DRAWN BY	PLATE
DECEMBER 2020	KHN	
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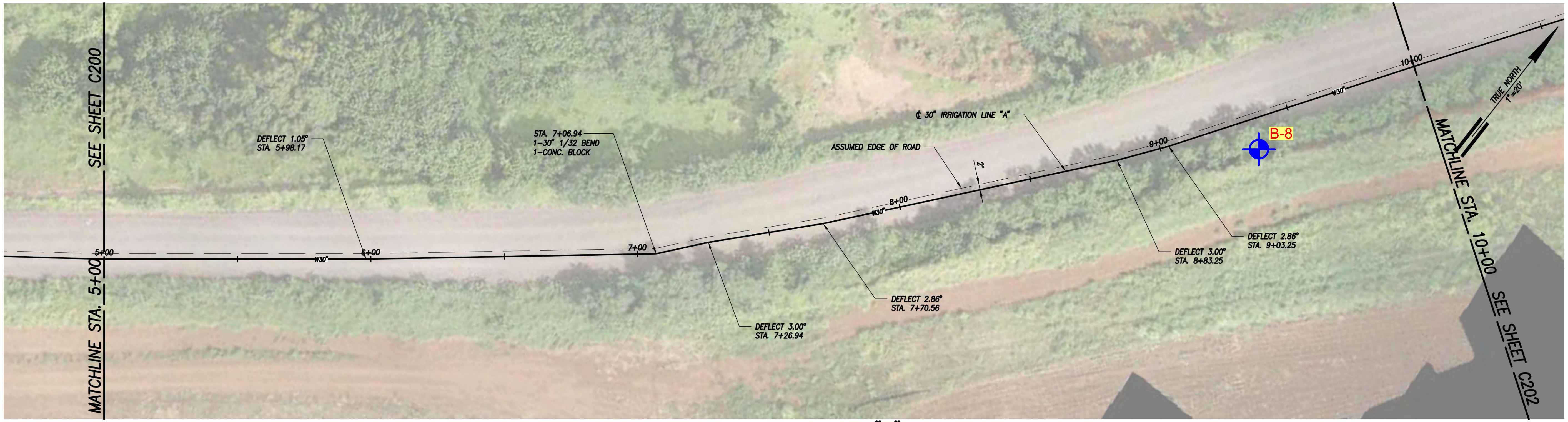

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LEGEND:

⌖ APPROXIMATE BORING LOCATION

REFERENCE: PLAN: IRRIGATION LINE "A" CREATED BY R.M. TOWILL DATED APRIL 2020.

0 20 40 80 120 FT.
GRAPHIC SCALE

N

SITE PLAN - 2
WAIAHOLE WATER SYSTEM IMPROVEMENT
KUNIA, OAHU, HAWAII

GEOLABS, INC.
Geotechnical Engineering

DATE DECEMBER 2020	DRAWN BY KHN	PLATE
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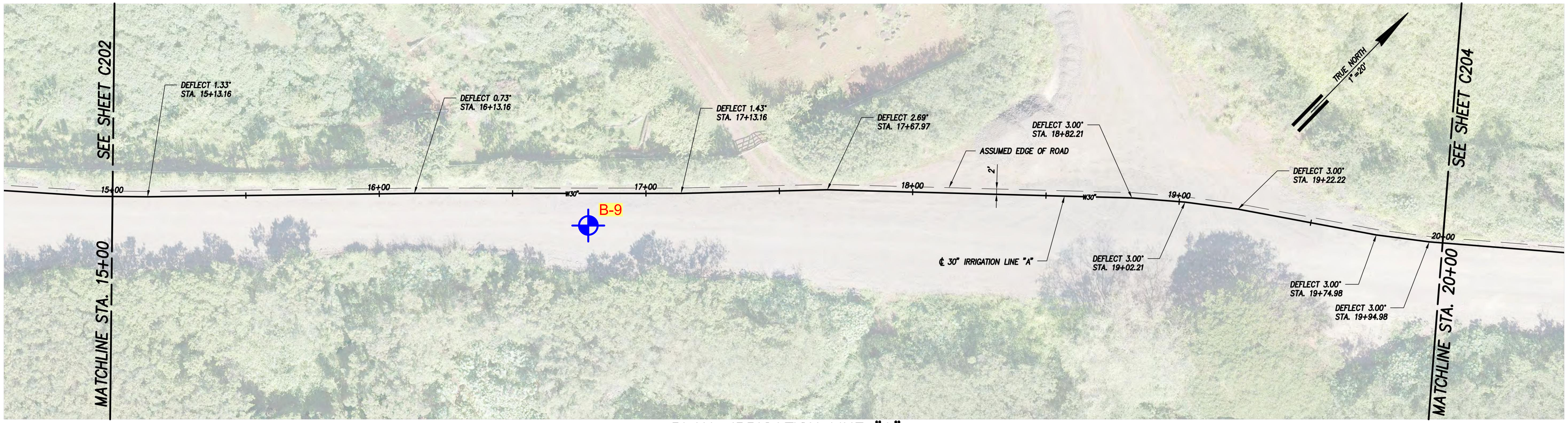

PLAN: IRRIGATION LINE "A"

LEGEND:

⊕ APPROXIMATE BORING LOCATION

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APRIL 2020.

0 20 40 80 120 FT.
GRAPHIC SCALE

N

SITE PLAN - 3

WAIAHOLE WATER SYSTEM IMPROVEMENT
KUNIA, OAHU, HAWAII

GEOLABS, INC.
Geotechnical Engineering

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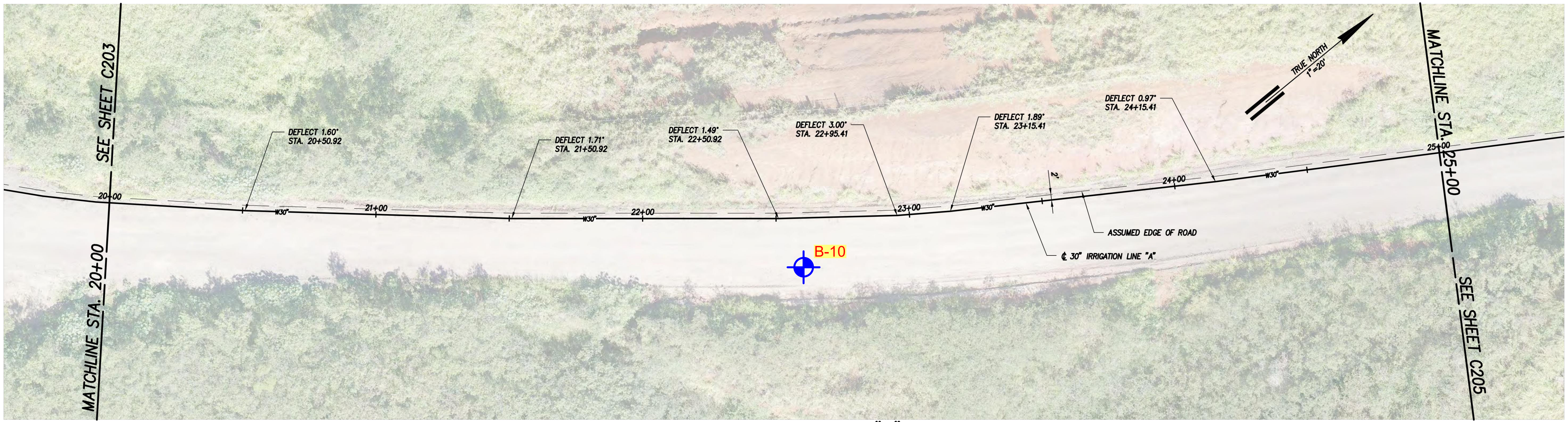

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LEGEND:

⌖	APPROXIMATE BORING LOCATION

REFERENCE: PLAN: IRRIGATION LINE "A" CREATED BY R.M. TOWILL DATED APRIL 2020.

0 20 40 80 120 FT.
GRAPHIC SCALE

N

SITE PLAN - 4

WAIAHOLE WATER SYSTEM IMPROVEMENT
KUNIA, OAHU, HAWAII

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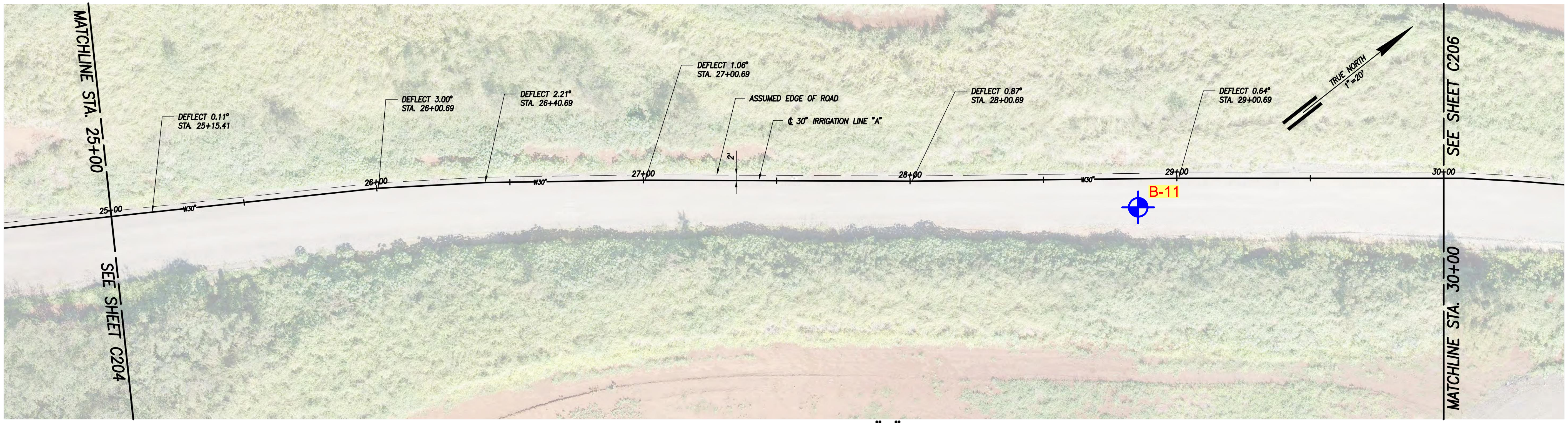

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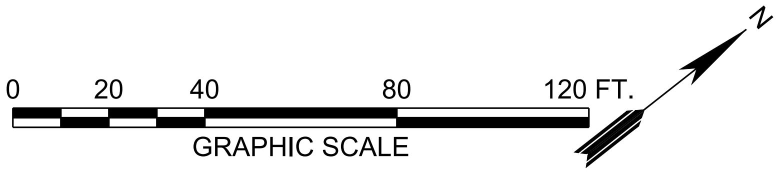

SITE PLAN - 5

WAIAHOLE WATER SYSTEM IMPROVEMENT
KUNIA, OAHU, HAWAII

GEOLABS, INC.
Geotechnical Engineering

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DECEMBER 2020	KHN	
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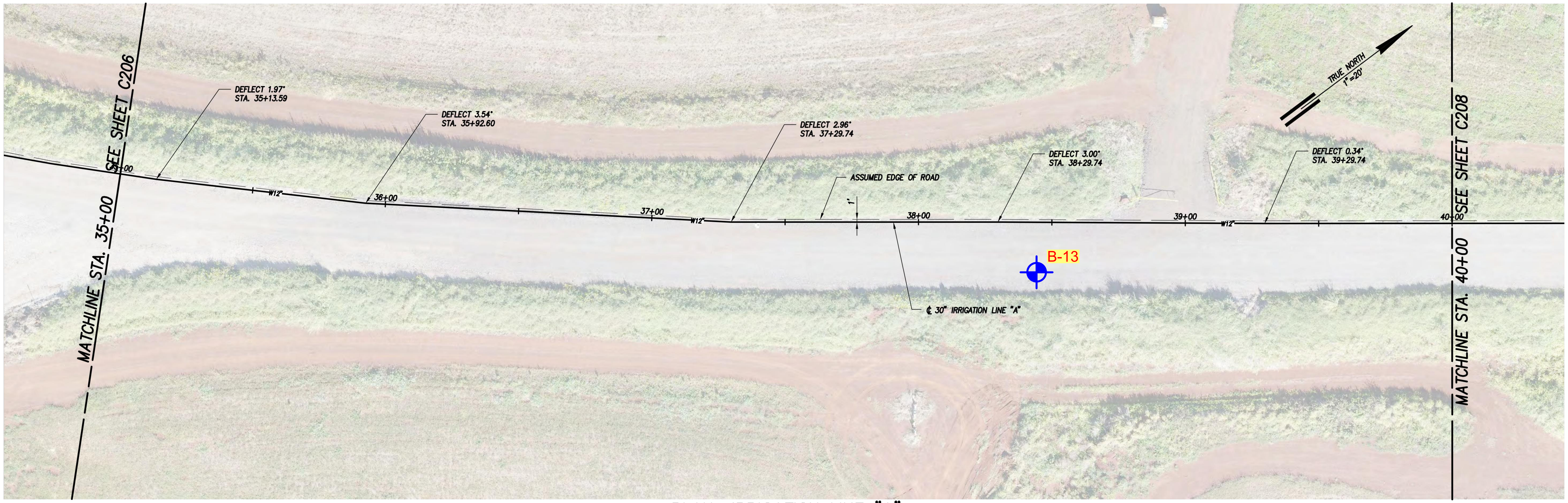

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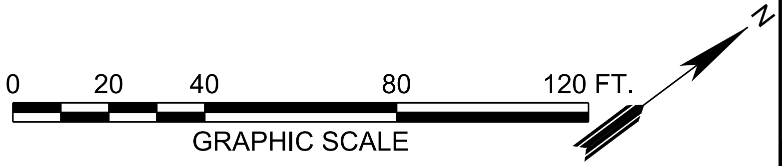

SITE PLAN - 6

WAIAHOLE WATER SYSTEM IMPROVEMENT
KUNIA, OAHU, HAWAII

GEOLABS, INC.
Geotechnical Engineering

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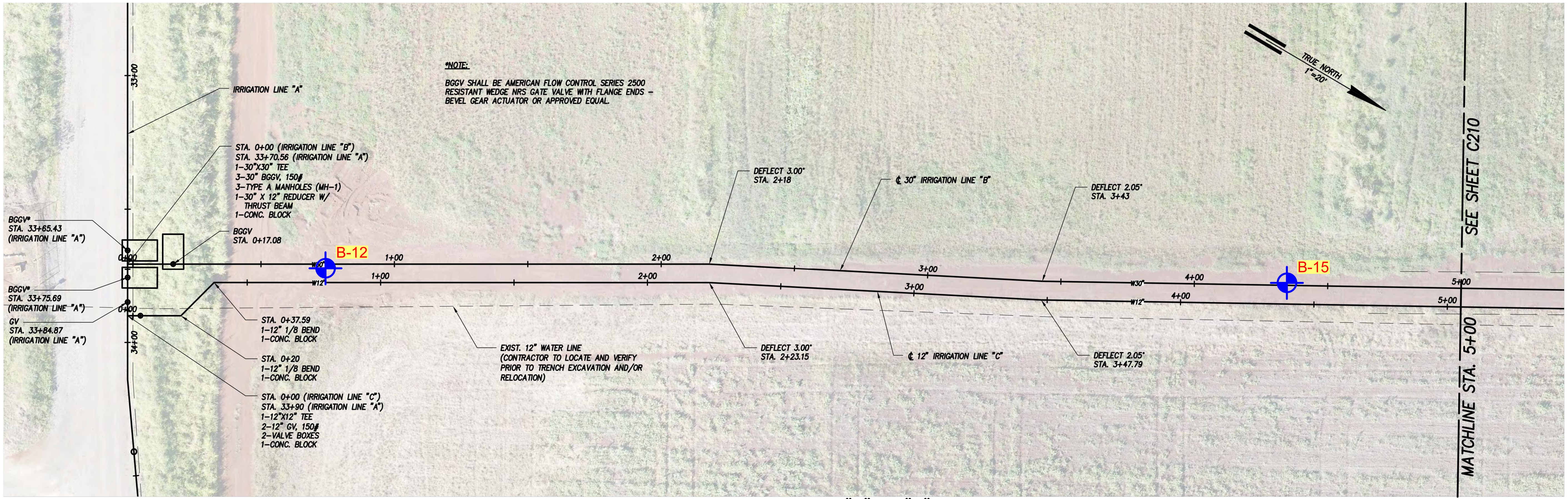

PLAN: IRRIGATION LINE "B" & "C"

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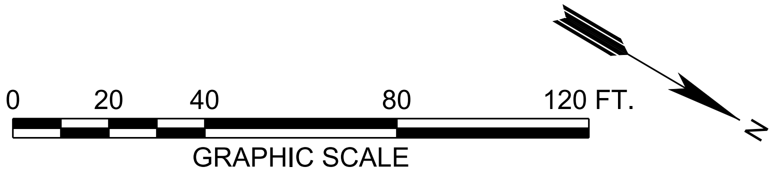
DATED APRIL 2020.



SITE PLAN - 7

WAIAHOLE WATER SYSTEM IMPROVEMENT
KUNIA, OAHU, HAWAII

GEOLABS, INC.
Geotechnical Engineering

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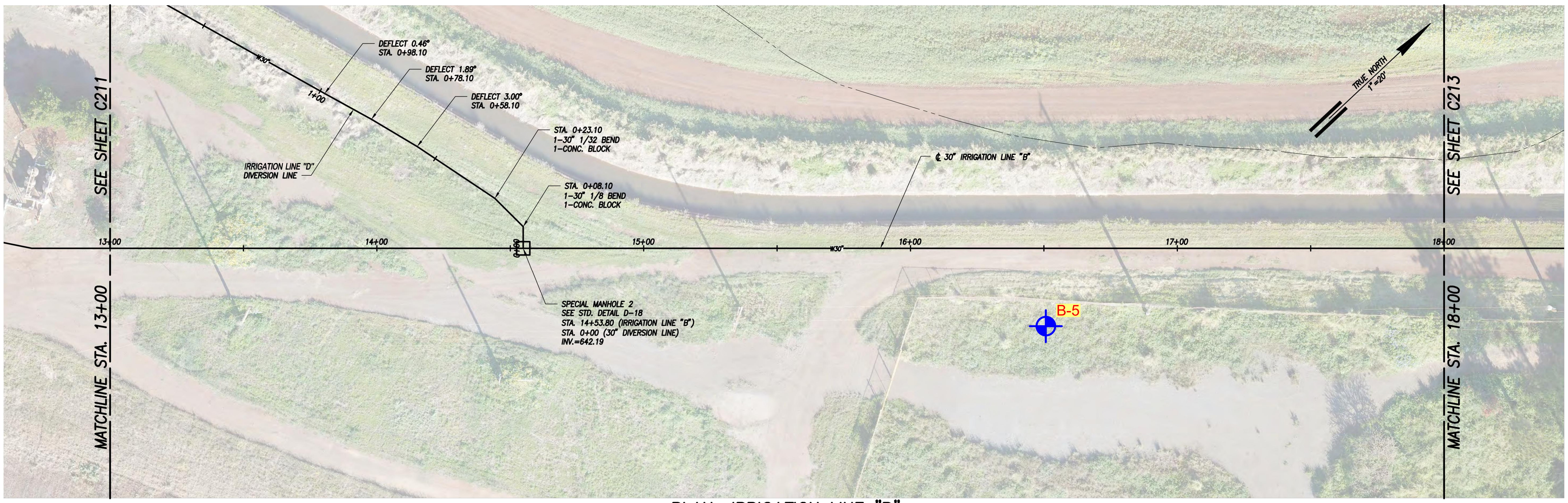

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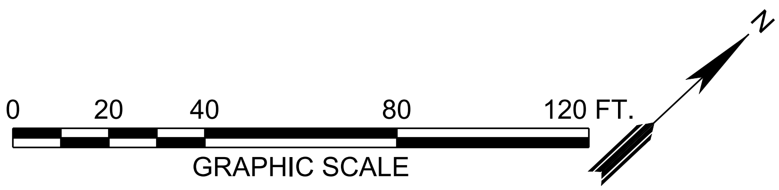

SITE PLAN - 8

WAIAHOLE WATER SYSTEM IMPROVEMENT
KUNIA, OAHU, HAWAII

GEOLABS, INC.
Geotechnical Engineering

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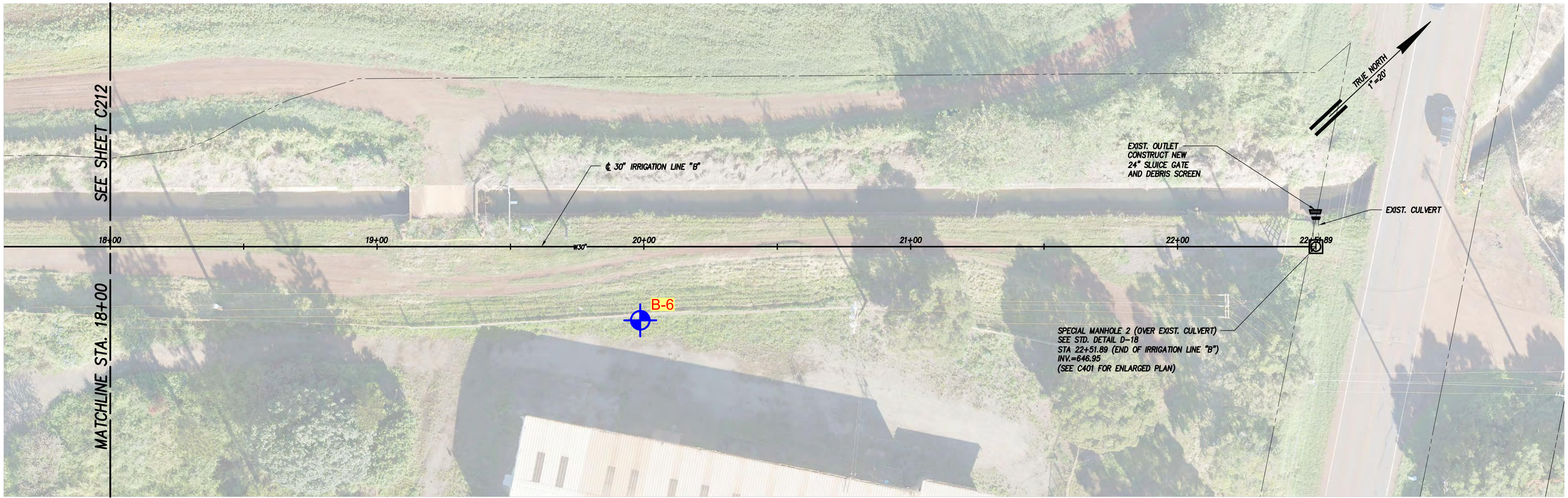
Plotter: DWG To PDF-GEO.pc3 Plotstyle: GEO-No-Dither-RBGC-HEAVY.ctb



PLAN: IRRIGATION LINE "B"

LEGEND:

⊕	APPROXIMATE BORING LOCATION

REFERENCE: PLAN: IRRIGATION LINE "B" CREATED BY R.M. TOWILL DATED APRIL 2020.

0 20 40 80 120 FT.
GRAPHIC SCALE

N

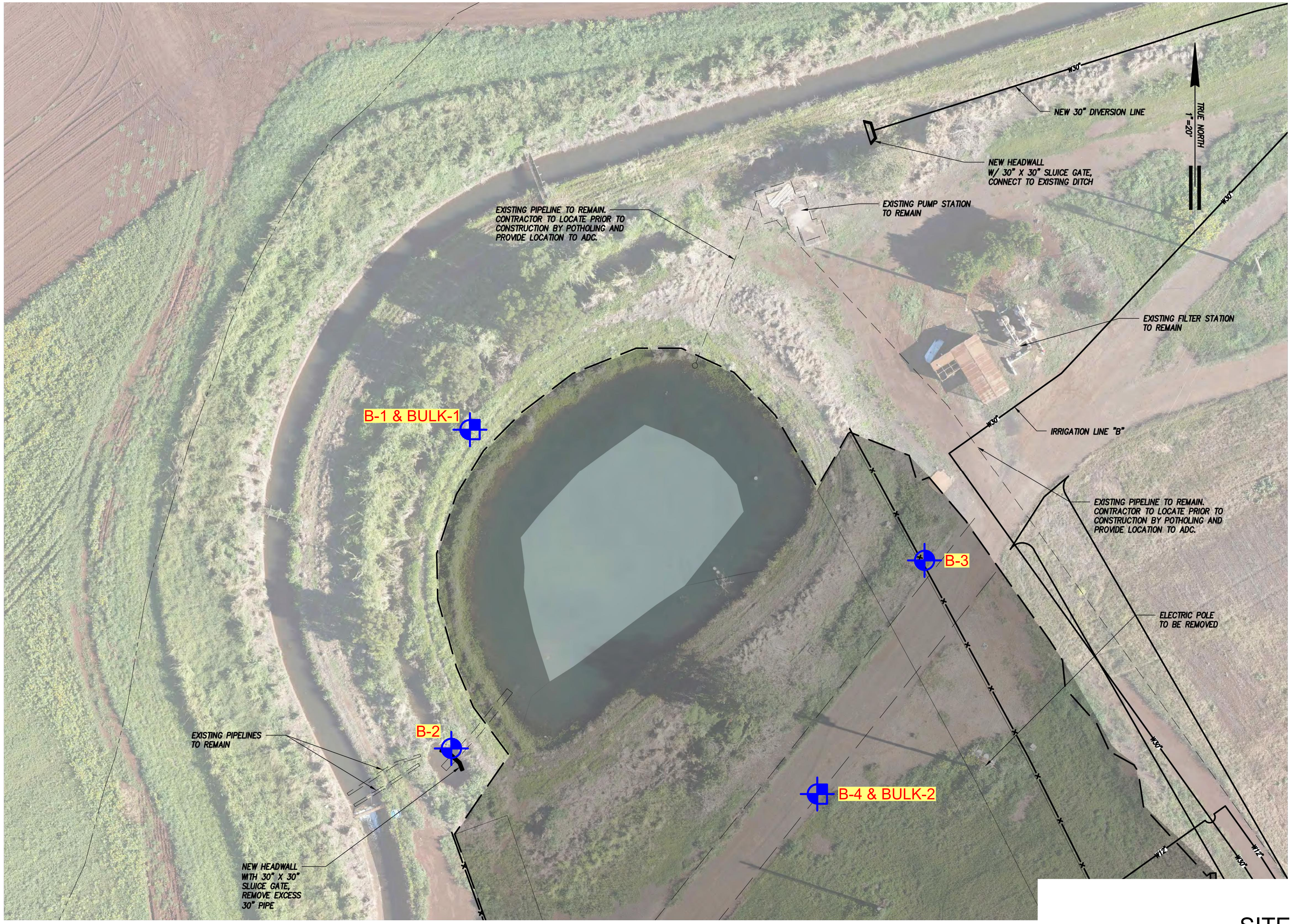
SITE PLAN - 9

WAIAHOLE WATER SYSTEM IMPROVEMENT
KUNIA, OAHU, HAWAII

GEOLABS, INC.
Geotechnical Engineering

DATE	DRAWN BY	PLATE
DECEMBER 2020	KHN	
SCALE	W.O.	
1" = 40'	8094-00&20	3.9

CAD User: KIM File Last Updated: January 04, 2021 8:37:20pm Plot Date: January 04, 2021 - 8:51:05pm
File: T:\Drafting\Working\8094-00&20_Waiahole_Water_System_Improvements\8094-00&20SitePlans.dwg\3.9
Plotter: DWG To PDF-GEO.pc3 Plotstyle: GEO-No-Dither-RBGC-HEAVY.ctb



EXISTING RESERVOIR SITE

SITE PLAN - 10

WAIAHOLE WATER SYSTEM IMPROVEMENT
KUNIA, OAHU, HAWAII

LEGEND:

⌖	APPROXIMATE BORING LOCATION
◘	APPROXIMATE BULK SAMPLE LOCATION

REFERENCE: EXISTING RESERVOIR SITE CREATED BY R.M. TOWILL DATED APRIL 2020.

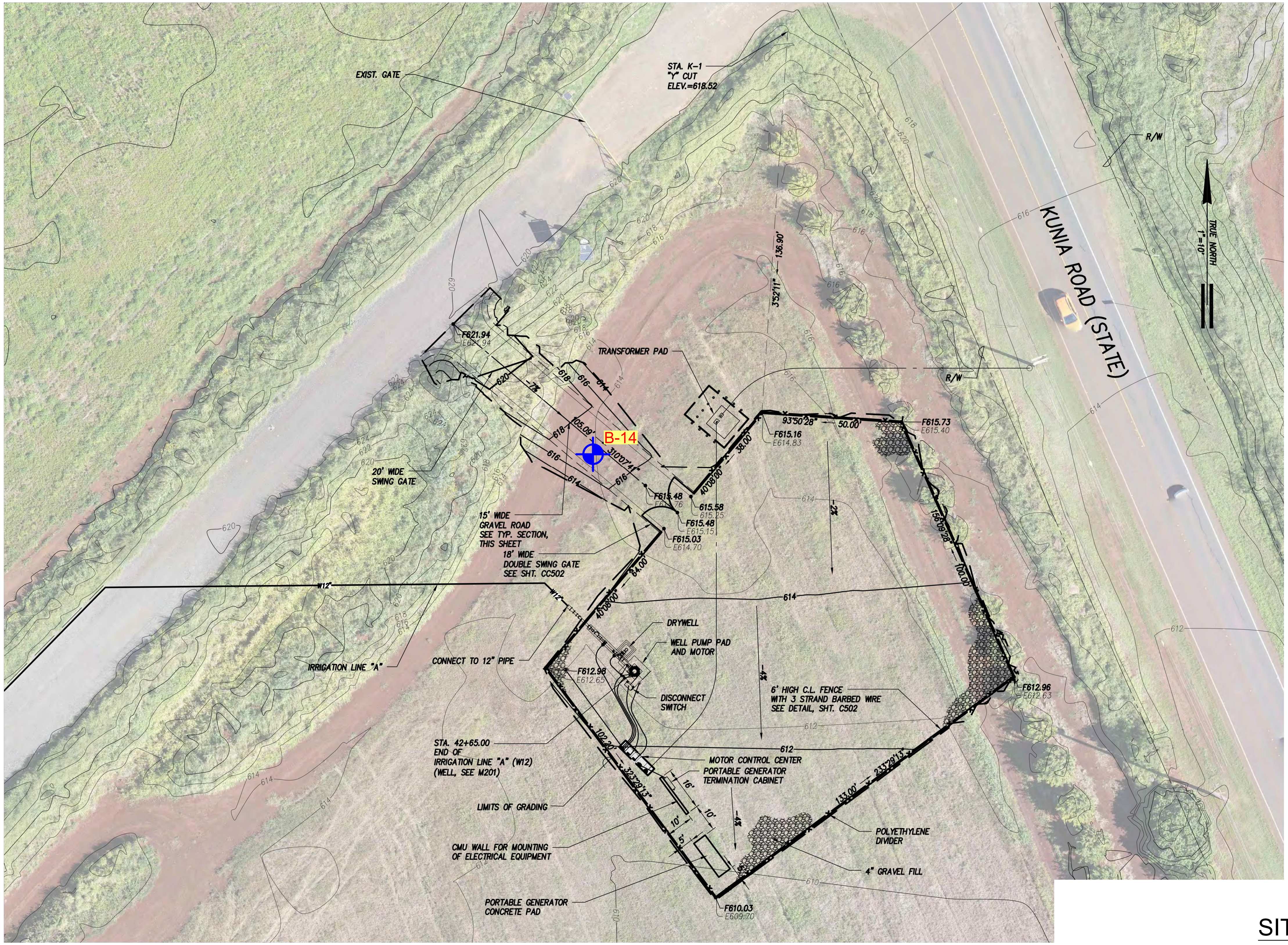
0 20 40 80 120 FT.
GRAPHIC SCALE

N

GEOLABS, INC.
Geotechnical Engineering

DATE	DRAWN BY	PLATE
DECEMBER 2020	KHN	
SCALE	W.O.	
1" = 40'	8094-00&20	3.10

CAD User: KIM File Last Updated: January 04, 2021 8:37:20pm Plot Date: January 04, 2021 - 8:53:05pm
File: T:\Drafting\Working\8094-00&20_Waiahole_Water_System_Improvements\8094-00&20SitePlans.dwg\3.10
Plotter: DWG To PDF-GEO.pc3 Plotstyle: GEO-No-Dither-RBGC-HEAVY.ctb



WELL SITE & GRADING PLAN

LEGEND:

⌖ APPROXIMATE BORING LOCATION

REFERENCE: WELL SITE & GRADING PLAN CREATED BY R.M. TOWILL DATED APRIL 2020.

0 20 40 80 120 FT.

GRAPHIC SCALE

N

SITE PLAN - 11

WAIAHOLE WATER SYSTEM IMPROVEMENT
KUNIA, OAHU, HAWAII

GEOLABS, INC.
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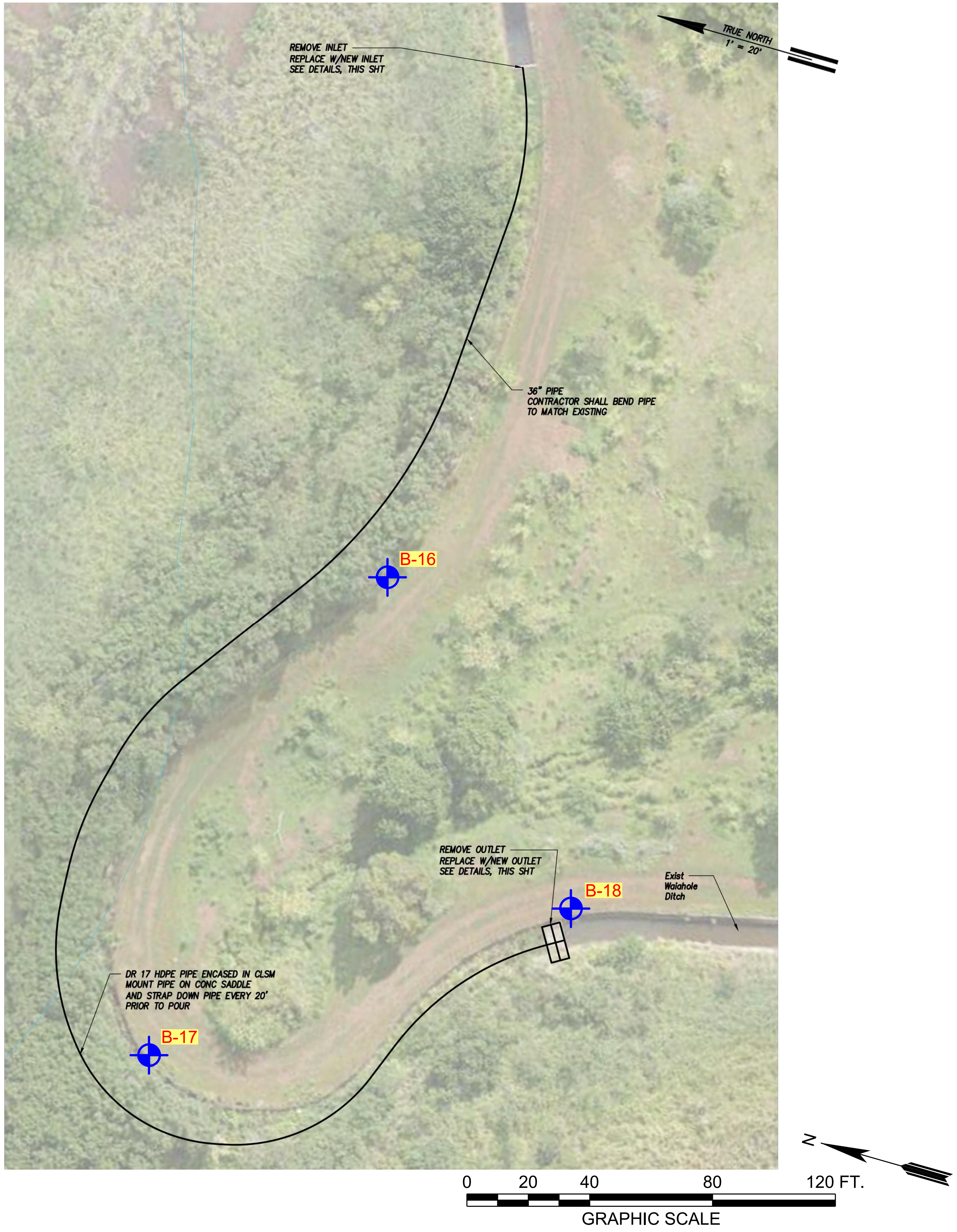
DATE	DRAWN BY	PLATE
DECEMBER 2020	KHN	
SCALE	W.O.	
1" = 40'	8094-00&20	3.11

CAD User: KIM File Last Updated: January 04, 2021 8:37:20pm Plot Date: January 04, 2021 - 8:53:49pm
File: T:\Drafting\Working\8094-00&20_Waiahole_Water_System_Improvements\8094-00&20SitePlans.dwg\3.11
Plotter: DWG To PDF-GEO.pc3 Plotstyle: GEO-No-Dither-RBGC-HEAVY.ctb



LEGEND:

⊕ APPROXIMATE BORING LOCATION

REFERENCE: HAIRPIN TURN SITE CREATED BY R.M. TOWILL DATED
APRIL 2020.

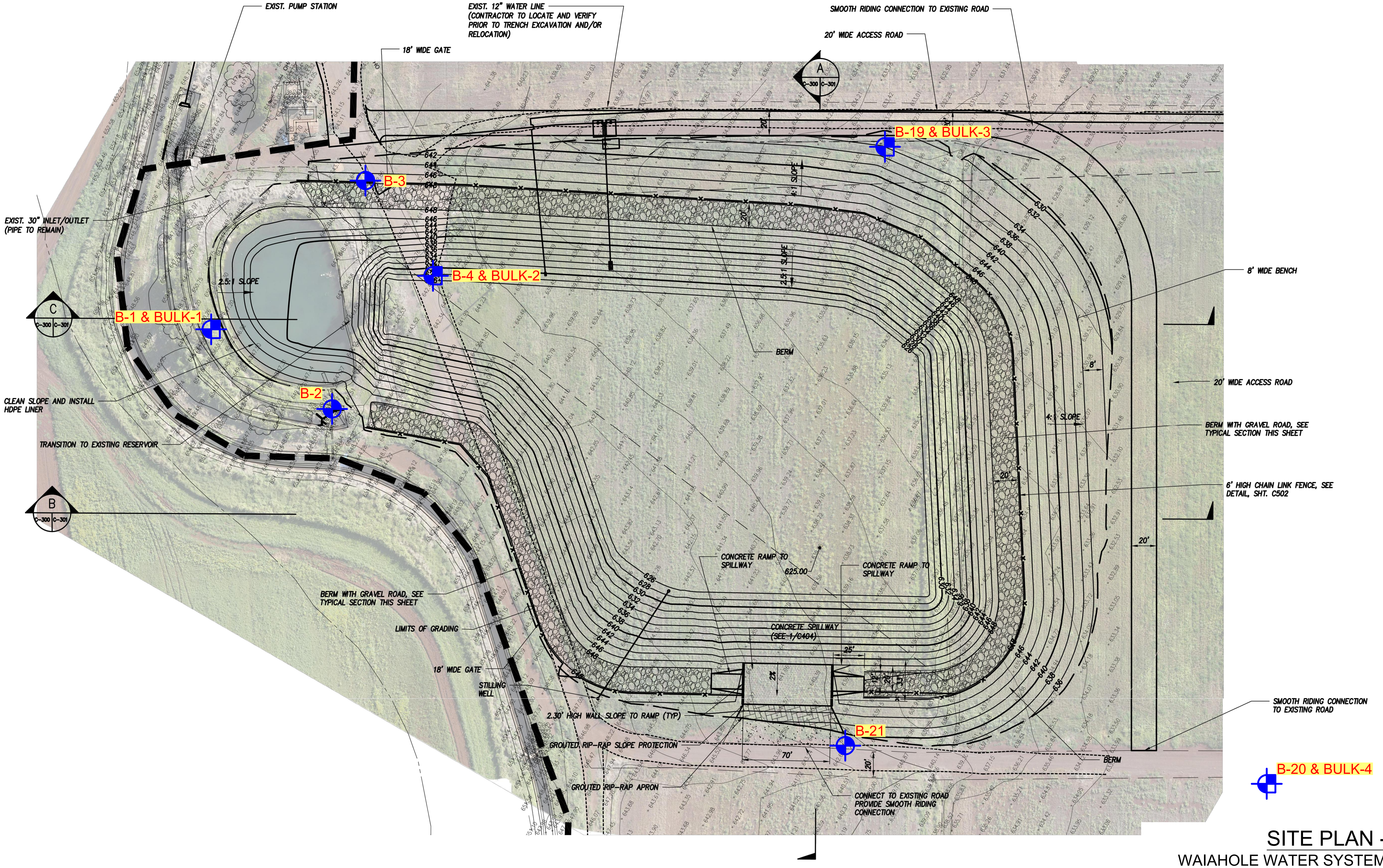
SITE PLAN - 12

WAIAHOLE WATER SYSTEM IMPROVEMENT
KUNIA, OAHU, HAWAII

GEOLABS, INC.
Geotechnical Engineering

DATE DECEMBER 2020	DRAWN BY KHN	PLATE
SCALE 1" = 40'	W.O. 8094-00&20	3.12

CAD User: KIM File Last Updated: January 04, 2021 8:37:20pm Plot Date: January 04, 2021 - 9:03:24pm
File: T:\Drafting\Working\8094-00&20_Waiahole_Water_System_Improvements\8094-00&20SitePlans.dwg\3.12
Plotter: DWG To PDF-GEO.pc3 Plotstyle: GEO-No-Dither-RBGC-HEAVY.ctb



GRAPHIC SCALE

SITE PLAN - 13

WAIAHOLE WATER SYSTEM IMPROVEMENT
KUNIA, OAHU, HAWAII

LEGEND:

⊕ APPROXIMATE BORING LOCATION

⊞ APPROXIMATE BULK SAMPLE LOCATION

REFERENCE: RESERVOIR SITE & GRADING PLAN TRANSMITTED BY R.M. TOWILL ON JANUARY 13, 2021.

GEOLABS, INC.
Geotechnical Engineering

DATE	DRAWN BY	PLATE
JANUARY 2021	KHN	
SCALE	W.O.	3.13
1" = 80'	8094-00&20	

CAD User: KIM File Last Updated: January 14, 2021 10:01:13pm Plot Date: January 20, 2021 - 6:51:50pm
File: T:\Drafting\Working\8094-00&20_Waiahole_Water_System_Improvements\8094-00&20SitePlans.dwg\3.13
Plotter: DWG To PDF-GEO.pc3 Plotstyle: GEO-No-Dither-RBGC-HEAVY.ctb

APPENDIX A

APPENDIX A

Field Exploration

We explored the subsurface conditions at the project site by drilling and sampling twenty-one borings, designated as Boring Nos. 1 through 21, extending to depths of about 9 to 36.5 feet below the existing ground surface. In addition, four bulk samples of the near-surface soils, designated as Bulk-1 through Bulk-4, were obtained to evaluate the pavement support characteristics of the near-surface soils. The approximate boring and bulk sample locations are shown on the Overall Site Plan, Plate 2, and the Site Plans, Plates 3.1 through 3.13. The borings were drilled using a truck-mounted drill rig with continuous flight augers and coring tools.

Our geologists classified the materials encountered in the borings by visual and textural examination in the field in general accordance with ASTM D2488, Standard Practice for Description and Identification of Soils, and monitored the drilling operations on a near-continuous (full-time) basis. These classifications were further reviewed visually and by testing in the laboratory. Soils were classified in general accordance with ASTM D2487, Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System), as shown on the Soil Log Legend, Plate A-0.1. Deviations made to the soil classification in accordance with ASTM D2487 are described on the Soil Classification Log Key, Plate A-0.2. Graphic representations of the materials encountered are presented on the Logs of Borings, Plates A-1 through A-21.2.

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 Logs of Borings at the appropriate sample depths. The penetration resistance shown on the Logs of Borings indicates the number of blows required for the specific sampler type used. The blow counts may need to be factored to obtain the Standard Penetration Test (SPT) blow counts.

Pocket penetrometer tests were performed on selected cohesive soil samples retrieved in the field. The pocket penetrometer test provides an indication of the unconfined compressive strength of the sample. Pocket penetrometer test results are summarized on the Logs of Borings at the appropriate sample depths.

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Soil Log Legend

UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)

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

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

LEGEND

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

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

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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).*

Plate

A-0.2

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WAIAHOLE WATER SYSTEM IMPROVEMENT
KUNIA, OAHU, HAWAII

Log of Boring

1

Approximate Ground Surface Elevation (feet MSL): 650 **

Laboratory			Field								
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS	Description
	26	73			25	3.8				MH	Reddish brown to brown **CLAYEY SILT** with a little sand, stiff, moist (fill)
	28				9						
Direct Shear	29	83			44		5				
										CL	Reddish brown **SANDY CLAY**, hard, moist (residual soil)
LL=49 PI=21	29				20/6" +27/0" Ref.		10				
UC=4.9 ksf	28	97			50/6" +50/4"		15				
	37				17		20				grades to reddish orange, very stiff, very moist locally
	36	93			51	3.3	25				grades to reddish brown with some sand
Sieve - #200 = 31.0%	52				23		30			SM	Reddish brown with some black mottling **SILTY SAND** with a little gravel, medium dense, moist (saprolite)
											Boring terminated at 31.5 feet
							35				

Date Started:	June 2, 2020	Water Level: ▼	Not Encountered
Date Completed:	June 2, 2020		
Logged By:	F. Sperberg	Drill Rig:	MOBILE B-53
Total Depth:	31.5 feet	Drilling Method:	4" Solid-Stem Auger
Work Order:	8094-00&20	Driving Energy:	140 lb. wt., 30 in. drop

Plate

A - 1.1

(Continued from previous plate)

Laboratory			Field								
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS	Description
											* Elevations estimated from Plans & Profiles created by R.M. Towill dated April 2020. ** Elevations estimated from Reservoir Site & Grading Plan transmitted by R.M. Towill on January 13, 2021. *** Elevations estimated from ©2020 GOOGLE™EARTH. Imagery dated January 15, 2018.
							40				
							45				
							50				
							55				
							60				
							65				
							70				

Date Started: June 2, 2020
Date Completed: June 2, 2020
Logged By: F. Sperberg
Total Depth: 31.5 feet
Work Order: 8094-00&20

Water Level: ▼ Not Encountered
Drill Rig: MOBILE B-53
Drilling Method: 4" Solid-Stem Auger
Driving Energy: 140 lb. wt., 30 in. drop

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WAIAHOLE WATER SYSTEM IMPROVEMENT
KUNIA, OAHU, HAWAII

Log of Boring

2

Approximate Ground Surface Elevation (feet MSL): 649 **

Laboratory			Field								
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS	Description
										ML	Reddish brown **SANDY SILT**, hard, moist (fill)
	22	98			99	>4.5					
LL=49 PI=20	23				42						
UC=0.5 ksf	33	78			23	1.0	5				grades to stiff
										MH	Reddish brown **CLAYEY SILT**, hard, moist (residual soil)
LL=50 PI=20	28				39		10				
	16	106			62/6" +10/0" Ref.		15				
	36				54		20				grades with some sand
	37	84			46/6" +60/5"		25				
										ML	Reddish brown **SANDY SILT**, stiff, moist (saprolite)
	51				9		30				
											Boring terminated at 31.5 feet
							35				

Date Started:	June 2, 2020	Water Level: ▼	Not Encountered	Plate
Date Completed:	June 2, 2020			
Logged By:	F. Sperberg	Drill Rig:	MOBILE B-53	A - 2
Total Depth:	31.5 feet	Drilling Method:	4" Solid-Stem Auger	
Work Order:	8094-00&20	Driving Energy:	140 lb. wt., 30 in. drop	

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WAIAHOLE WATER SYSTEM IMPROVEMENT
KUNIA, OAHU, HAWAII

Log of Boring

3

Approximate Ground Surface Elevation (feet MSL): 643 **

Laboratory			Field								
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS	Description
										CL	Reddish brown to brown **SILTY CLAY** with a little sand, moist (fill)
	28	99			32	>4.5				CH	Reddish brown **SILTY CLAY** with a little sand, very stiff to hard, moist (residual soil)
LL=51 PI=25	15				32						
	26	98			45		5				
	26				44		10				
											Boring terminated at 11.5 feet
							15				
							20				
							25				
							30				
							35				

Date Started:	June 1, 2020	Water Level: ⊻	Not Encountered
Date Completed:	June 1, 2020		
Logged By:	F. Sperberg	Drill Rig:	MOBILE B-53
Total Depth:	11.5 feet	Drilling Method:	4" Solid-Stem Auger
Work Order:	8094-00&20	Driving Energy:	140 lb. wt., 30 in. drop

Plate

A - 3

BORING_LOG 8094-00&20.GPJ GEOLABS.GDT 1/26/21

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WAIAHOLE WATER SYSTEM IMPROVEMENT
KUNIA, OAHU, HAWAII

Log of Boring
4

Approximate Ground Surface Elevation (feet MSL): 642 **

Laboratory			Field								
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS	Description
										CL	Reddish brown to brown **SILTY CLAY** with some sand, very stiff, moist (fill)
	26	82			49	>4.5					
	28				23	2.0					
Direct Shear	33	75			13	1.0	5				grades to medium stiff
	29				46		10			CL	Reddish brown to dark brown **SILTY CLAY** with a little sand, hard, moist (residual soil)
	29	98			65/6" +10/0" Ref.		15				
										MH	Reddish brown with orange mottling **CLAYEY SILT**, hard, moist (saprolite)
LL=55 PI=22	29				56		20				
	35	86			77		25				
	40				16		30			SM	Orange to reddish brown **SILTY SAND**, medium dense, very moist (saprolite)
											Boring terminated at 31.5 feet
							35				

Date Started:	June 3, 2020	Water Level: ▼	Not Encountered
Date Completed:	June 3, 2020	⊻	Not Encountered
Logged By:	F. Sperberg	Drill Rig:	MOBILE B-53
Total Depth:	31.5 feet	Drilling Method:	4" Solid-Stem Auger
Work Order:	8094-00&20	Driving Energy:	140 lb. wt., 30 in. drop

Plate

A - 4

GEOLABS, INC.

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WAIAHOLE WATER SYSTEM IMPROVEMENT
KUNIA, OAHU, HAWAII

Log of Boring

5

Approximate Ground Surface Elevation (feet MSL): 651.5 *

Laboratory			Field								
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS	Description
	41							G	▨	CL	Reddish brown to brown **SILTY CLAY**, very stiff, moist (residual soil)
	23							G	▨		
	25							G	▨		
	26	91			53	3.0	5		▨		
	25				39		10	▼	▨		grades to hard
											Boring terminated at 11.5 feet
							15				
							20				
							25				
							30				
							35				

Date Started:	June 1, 2020	Water Level: ▼	Not Encountered
Date Completed:	June 1, 2020		
Logged By:	F. Sperberg	Drill Rig:	MOBILE B-53
Total Depth:	11.5 feet	Drilling Method:	4" Solid-Stem Auger
Work Order:	8094-00&20	Driving Energy:	140 lb. wt., 30 in. drop

Plate

A - 5

GEOLABS, INC.

Geotechnical Engineering

WAIAHOLE WATER SYSTEM IMPROVEMENT
KUNIA, OAHU, HAWAII

Log of Boring

6

Approximate Ground Surface Elevation (feet MSL): 651 *

Laboratory			Field								
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS	Description
	22								▨	CH	Reddish brown **SILTY CLAY**, hard, moist (residual soil)
								G	▨		
	23	100			69	>4.5	5	⧗	▨		
LL=52 PI=25	27				38		10	◥	▨		
											Boring terminated at 11.5 feet
							15				
							20				
							25				
							30				
							35				

Date Started:	June 2, 2020	Water Level: ▼	Not Encountered
Date Completed:	June 2, 2020		
Logged By:	F. Sperberg	Drill Rig:	MOBILE B-53
Total Depth:	11.5 feet	Drilling Method:	4" Solid-Stem Auger
Work Order:	8094-00&20	Driving Energy:	140 lb. wt., 30 in. drop

Plate

A - 6

GEOLABS, INC.

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WAIAHOLE WATER SYSTEM IMPROVEMENT
KUNIA, OAHU, HAWAII

Log of Boring

7

Approximate Ground Surface Elevation (feet MSL): 635 *

Laboratory			Field								
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS	Description
										GM	Dark gray **SILTY GRAVEL** with some sand (basaltic), dry (fill)
	23	109			60						
										CL	Brown **SILTY CLAY** with traces of gravel, hard, moist (fill)
	23				26						
										CH	Brown **SILTY CLAY**, very stiff, moist (alluvium)
	25	94			53	4.0	5				
LL=56 PI=28	26				25		10				
											Boring terminated at 11.5 feet
							15				
							20				
							25				
							30				
							35				

Date Started:	June 4, 2020	Water Level: ▼	Not Encountered
Date Completed:	June 4, 2020		
Logged By:	F. Sperberg	Drill Rig:	MOBILE B-53
Total Depth:	11.5 feet	Drilling Method:	4" Solid-Stem Auger
Work Order:	8094-00&20	Driving Energy:	140 lb. wt., 30 in. drop

Plate

A - 7

Approximate Ground Surface Elevation (feet MSL): 586 *

Laboratory			Field								
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS	Description
										GM	Dark gray **SILTY GRAVEL** with some sand (basaltic), dry (fill)
	31	78			35			⧗		CL	Brown **SILTY CLAY** with some sand and gravel, very stiff, dry (fill)
	31				10			▼		CL	Brown with orange mottling **SILTY CLAY**, stiff, dry (residual soil)
	27	72			27		5	⧗		ML	Brown with orange, greenish gray, and black mottling **CLAYEY SILT** with some sand, stiff to very stiff, dry (saprolite)
Sieve - #200 = 21.0%	21				21		10	▼		SM	Tan with red and orange mottling **SILTY SAND** with some gravel, medium dense, dry (saprolite)
											Boring terminated at 11.5 feet
							15				
							20				
							25				
							30				
							35				

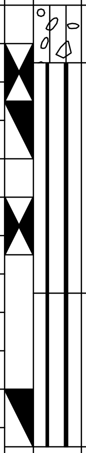
Date Started:	June 4, 2020	Water Level: ▼	Not Encountered
Date Completed:	June 4, 2020		
Logged By:	F. Sperberg	Drill Rig:	MOBILE B-53
Total Depth:	11.5 feet	Drilling Method:	4" Solid-Stem Auger
Work Order:	8094-00&20	Driving Energy:	140 lb. wt., 30 in. drop

WAIAHOLE WATER SYSTEM IMPROVEMENT
KUNIA, OAHU, HAWAII

Log of Boring

9

Approximate Ground Surface Elevation (feet MSL): 549 *



Laboratory			Field						
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	USCS	Description
								GM	Dark gray **SILTY GRAVEL** with some sand (basaltic and coralline), dry (fill)
	12	93			59	>4.5			
LL=44 PI=17	25				24			ML	Reddish brown **SANDY SILT** with some gravel (basaltic and coralline), very stiff to hard, moist (fill)
	26	89			19	3.5	5		grades to stiff
								ML	Brown **CLAYEY SILT** with some sand, very stiff, moist (residual soil)
	20				29		10		
									Boring terminated at 11.5 feet
							15		
							20		
							25		
							30		
							35		

Date Started:	June 3, 2020	Water Level: ▼	Not Encountered
Date Completed:	June 6, 2020		
Logged By:	F. Sperberg	Drill Rig:	MOBILE B-53
Total Depth:	11.5 feet	Drilling Method:	4" Solid-Stem Auger
Work Order:	8094-00&20	Driving Energy:	140 lb. wt., 30 in. drop

Plate

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Geotechnical Engineering

WAIAHOLE WATER SYSTEM IMPROVEMENT
KUNIA, OAHU, HAWAII

Log of Boring

10

Approximate Ground Surface Elevation (feet MSL): 564.5 *

Laboratory			Field								
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS	Description
								G		GM	Dark gray **SILTY GRAVEL** with some sand (basaltic and coralline), dry (fill)
	40	77			42	>4.5					
LL=71 PI=31	34				22					MH	Reddish orange with greenish gray mottling **CLAYEY SILT** with a little sand, very stiff to hard, dry to moist (saprolite)
UC=3.3 ksf	36	77			33	>4.5	5				
	42				27		10			ML	Gray with red mottling **SANDY SILT**, very stiff, moist (saprolite)
											Boring terminated at 11.5 feet
							15				
							20				
							25				
							30				
							35				

Date Started:	June 3, 2020	Water Level: ▼	Not Encountered	Plate
Date Completed:	June 3, 2020			
Logged By:	F. Sperberg	Drill Rig:	MOBILE B-53	A - 10
Total Depth:	11.5 feet	Drilling Method:	4" Solid-Stem Auger	
Work Order:	8094-00&20	Driving Energy:	140 lb. wt., 30 in. drop	

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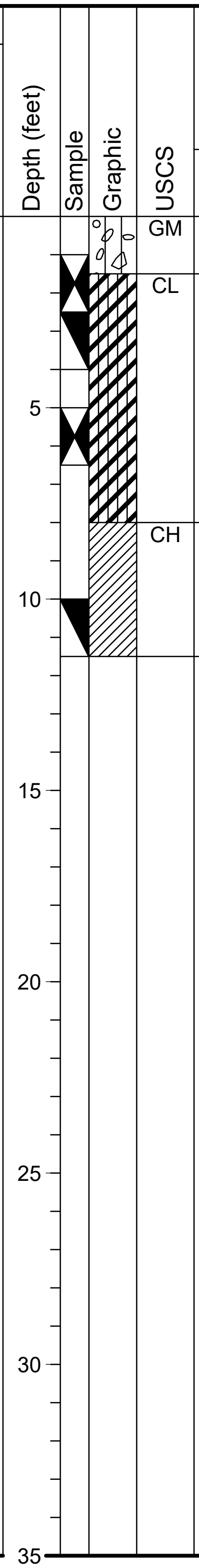
WAIAHOLE WATER SYSTEM IMPROVEMENT
KUNIA, OAHU, HAWAII

Log of Boring

11

Approximate Ground Surface Elevation (feet MSL): 607 *

Laboratory			Field					
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	USCS	Description
							GM	Dark gray to white **SILTY GRAVEL** with some sand (basaltic and coralline), dry (fill)
	12	101			73	4.0	CL	Reddish brown to brown **SANDY CLAY**, very stiff to hard, dry (alluvium)
	28				17			
	33	63			29			
LL=70 PI=42	30				33		CH	Reddish brown with black and orange mottling **SILTY CLAY** with a little sand, hard, dry (saprolite)
								Boring terminated at 11.5 feet



Date Started: June 3, 2020
Date Completed: June 3, 2020
Logged By: F. Sperberg
Total Depth: 11.5 feet
Work Order: 8094-00&20

Water Level: ▼ Not Encountered

Drill Rig: MOBILE B-53
Drilling Method: 4" Solid-Stem Auger
Driving Energy: 140 lb. wt., 30 in. drop

Plate

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GEOLABS, INC. Geotechnical Engineering	WAIAHOLE WATER SYSTEM IMPROVEMENT KUNIA, OAHU, HAWAII		**Log of Boring** 12

Laboratory			Field								
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS	Approximate Ground Surface Elevation (feet MSL): 623 * Description
										GM	Dark gray **SILTY GRAVEL** with some sand (basaltic), dry (fill)
								G		CH	Reddish brown **SILTY CLAY** with traces of sand, hard, moist (residual soil)
LL=52 PI=27	22				59						
					112		5				
	28				45		10				
											Boring terminated at 11.5 feet
							15				
							20				
							25				
							30				
							35				

Date Started:	June 3, 2020	Water Level: ▼	Not Encountered	Plate
Date Completed:	June 3, 2020			
Logged By:	F. Sperberg	Drill Rig:	MOBILE B-53	A - 12
Total Depth:	11.5 feet	Drilling Method:	4" Solid-Stem Auger	
Work Order:	8094-00&20	Driving Energy:	140 lb. wt., 30 in. drop	

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WAIAHOLE WATER SYSTEM IMPROVEMENT
KUNIA, OAHU, HAWAII

Log of Boring

13

Approximate Ground Surface Elevation (feet MSL): 621.5 *

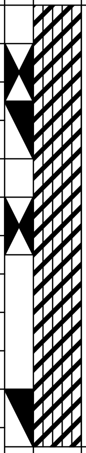
Laboratory			Field								
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS	Description
										GM	Grayish brown **SILTY GRAVEL** with some sand, dry (fill)
	25	93			35	>4.5				CL	Reddish brown to brown **SANDY CLAY**, very stiff, moist (residual soil)
	30				13						
											grades to stiff
	26	95			75	>4.5	5				grades to hard
	27				63		10				
											Boring terminated at 11.5 feet
							15				
							20				
							25				
							30				
							35				

Date Started:	June 1, 2020	Water Level: ⊻	Not Encountered
Date Completed:	June 1, 2020		
Logged By:	F. Sperberg	Drill Rig:	MOBILE B-53
Total Depth:	11.5 feet	Drilling Method:	4" Solid-Stem Auger
Work Order:	8094-00&20	Driving Energy:	140 lb. wt., 30 in. drop

Plate

A - 13

GEOLABS, INC. Geotechnical Engineering	WAIAHOLE WATER SYSTEM IMPROVEMENT KUNIA, OAHU, HAWAII	Log of Boring 14



Laboratory			Field								Approximate Ground Surface Elevation (feet MSL): 614 *
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS	Description
										CL-CH	Reddish brown **SILTY CLAY**, very stiff to hard, moist (residual soil)
LL=50 PI=25	21	71			51	4.0					
	23				52						
UC=1.7 ksf	27	89			89	>4.5	5				
	30				46		10				
											Boring terminated at 11.5 feet
							15				
							20				
							25				
							30				
							35				

Date Started:	June 1, 2020	Water Level: ⊻	Not Encountered	Plate
Date Completed:	June 1, 2020			
Logged By:	F. Sperberg	Drill Rig:	MOBILE B-53	A - 14
Total Depth:	11.5 feet	Drilling Method:	4" Solid-Stem Auger	
Work Order:	8094-00&20	Driving Energy:	140 lb. wt., 30 in. drop	

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Geotechnical Engineering

WAIAHOLE WATER SYSTEM IMPROVEMENT
KUNIA, OAHU, HAWAII

Log of Boring

15

Approximate Ground Surface Elevation (feet MSL): 628 *

Laboratory			Field								
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS	Description
	21	92			70			⧗	▨	CH	Reddish brown **SILTY CLAY**, hard, moist (residual soil)
LL=52 PI=26	23				35			▼	▨		
UC=7.5 ksf	23	101			98	>4.5	5	⧗	▨		
	26				59		10	▼	▨		
											Boring terminated at 11.5 feet
							15				
							20				
							25				
							30				
							35				

Date Started:	June 1, 2020	Water Level: ⊻	Not Encountered
Date Completed:	June 1, 2020		
Logged By:	F. Sperberg	Drill Rig:	MOBILE B-53
Total Depth:	11.5 feet	Drilling Method:	4" Solid-Stem Auger
Work Order:	8094-00&20	Driving Energy:	140 lb. wt., 30 in. drop

Plate

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GEOLABS, INC.

Geotechnical Engineering

WAIAHOLE WATER SYSTEM IMPROVEMENT
KUNIA, OAHU, HAWAII

Log of Boring
16

Approximate Ground Surface Elevation (feet MSL): 633 ***

Laboratory			Field								
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS	Description
									▨	CL	Brown **SANDY CLAY**, very stiff to hard, dry (residual soil)
Direct Shear	20	81			39				▨		
	19				52				▨		
LL=47 PI=23	18	96			50/4"		5		▨		grades with some gravel
									░	SM	Orangish brown **SILTY SAND** with some weathered gravel, medium dense, dry (saprolite)
Sieve - #200 = 18.6%	40				15		10		░		
											Boring terminated at 11.5 feet
							15				
							20				
							25				
							30				
							35				

Date Started:	June 4, 2020
Date Completed:	June 4, 2020
Logged By:	F. Sperberg
Total Depth:	11.5 feet
Work Order:	8094-00&20

Water Level: ▼	Not Encountered
Drill Rig:	MOBILE B-53
Drilling Method:	4" Solid-Stem Auger
Driving Energy:	140 lb. wt., 30 in. drop

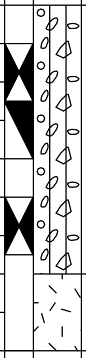
Plate

A - 16

GEOLABS, INC. Geotechnical Engineering	WAIAHOLE WATER SYSTEM IMPROVEMENT KUNIA, OAHU, HAWAII	**Log of Boring** 17

Approximate Ground Surface Elevation (feet MSL): 635 ***

Laboratory			Field								
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS	Description
										GM	Reddish brown **SILTY GRAVEL** with some sand, medium dense, dry (fill)
Sieve - #200 = 27.0%	12	69			36						
	35				23						
	20	65			18		5				
											Dark gray **BASALT**, very hard (basalt formation)
											Boring terminated at 9 feet
					50/0" Ref.		10				
							15				
							20				
							25				
							30				
							35				



Date Started:	June 4, 2020	Water Level: ▼	Not Encountered	Plate A - 17
Date Completed:	June 4, 2020			
Logged By:	F. Sperberg	Drill Rig:	MOBILE B-53	
Total Depth:	9 feet	Drilling Method:	4" Solid-Stem Auger	
Work Order:	8094-00&20	Driving Energy:	140 lb. wt., 30 in. drop	

Approximate Ground Surface Elevation (feet MSL): 628 ***

Laboratory			Field								
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS	Description
										CL	Reddish brown **SANDY CLAY**, hard, dry (saprolite)
	22	81			80	>4.5					
LL=47 PI=20	22				45						
Direct Shear	23	93			97	>4.5	5				
					23		10			ML	Brown with orange, black, and yellow mottling **CLAYEY SILT**, very stiff, dry (saprolite)
											Boring terminated at 11.5 feet
							15				
							20				
							25				
							30				
							35				

Date Started:	June 4, 2020	Water Level: ▼	Not Encountered
Date Completed:	June 4, 2020		
Logged By:	F. Sperberg	Drill Rig:	MOBILE B-53
Total Depth:	11.5 feet	Drilling Method:	4" Solid-Stem Auger
Work Order:	8094-00&20	Driving Energy:	140 lb. wt., 30 in. drop

Plate

A - 18

GEOLABS, INC. Geotechnical Engineering	WAIAHOLE WATER SYSTEM IMPROVEMENT KUNIA, OAHU, HAWAII	Log of Boring	19

Approximate Ground Surface Elevation (feet MSL): 632 **

Laboratory			Field								
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS	Description
										CL	Reddish brown **SANDY CLAY**, hard, moist (fill)
	17	67			66	>4.5					
										MH	Reddish brown **CLAYEY SILT**, very stiff, moist (alluvium)
	19				25						
	22	109			49	>4.5	5				
										CH	Brown **SILTY CLAY**, very stiff, moist (alluvium)
	22				27		10				
TXUU S_u=9.4 ksf	25	101			98	>4.5	15				grades to hard
										MH	Orangish brown **CLAYEY SILT** with a little sand, very stiff, moist (residual soil)
	28				16		20				
										ML	Gray with multi-color mottling **SANDY SILT** with traces of gravel, very stiff, moist (saprolite)
Sieve - #200 = 59.6%	30				19		25				
											grades to hard
					50/6" Ref.						Boring terminated at 27.9 feet
							30				
							35				

Date Started:	July 1, 2020	Water Level: ▼	Not Encountered 07/01/2020 1045 HRS	Plate
Date Completed:	July 1, 2020			
Logged By:	B. Aiu	Drill Rig:	CME-75DR *(Energy Transfer Ratio = 77.3%)*	
Total Depth:	27.9 feet	Drilling Method:	4" Solid-Stem Auger	A - 19
Work Order:	8094-00&20	Driving Energy:	140 lb. wt., 30 in. drop	

GEOLABS, INC. Geotechnical Engineering	WAIAHOLE WATER SYSTEM IMPROVEMENT KUNIA, OAHU, HAWAII	Log of Boring 20

Approximate Ground Surface Elevation : N/A

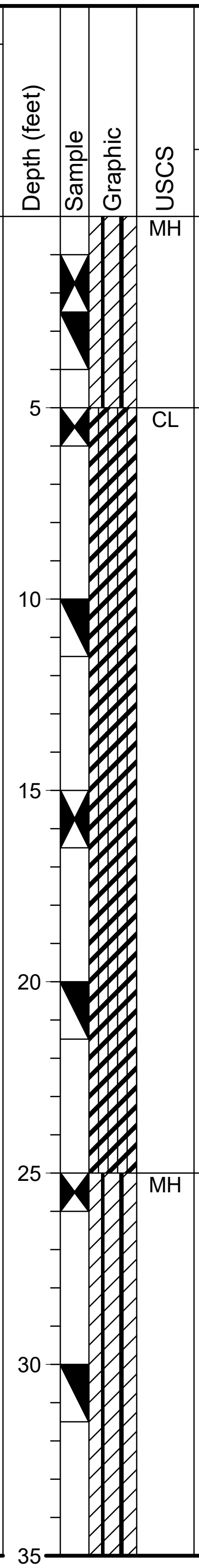
Laboratory			Field								
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS	Description
										CL	Reddish brown **SANDY CLAY**, hard, dry (fill)
	20	79			57	4.5					
	22				22						grades to very stiff
										CH	Reddish brown **SILTY CLAY**, hard, dry (residual soil)
TXUU S_u=5.9 ksf	25	95			56	4.5	5				
LL=51 PI=23	26				27		10				grades to very stiff
TXUU S_u=4.0 ksf	45	61			50	4.0	15			ML-MH	Dark grayish brown with orange mottling **CLAYEY SILT**, very stiff, moist (residual soil)
LL=50 PI=17	35				9		20				grades to orangish brown, stiff
	36	68			5	1.0	25				grades to soft
											Boring terminated at 26.5 feet
							30				
							35				

Date Started:	July 11, 2020	Water Level: ▼	Not Encountered 07/11/2020 1242 HRS	Plate
Date Completed:	July 11, 2020			
Logged By:	D. Gremminger	Drill Rig:	CME-45C TRUCK *(Energy Transfer Ratio = 78%)*	
Total Depth:	26.5 feet	Drilling Method:	4" Solid-Stem Auger	A - 20
Work Order:	8094-00&20	Driving Energy:	140 lb. wt., 30 in. drop	

GEOLABS, INC. Geotechnical Engineering	WAIAHOLE WATER SYSTEM IMPROVEMENT KUNIA, OAHU, HAWAII	**Log of Boring**	21

Approximate Ground Surface Elevation (feet MSL): 641 **

Laboratory			Field						
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	USCS	Description
								MH	Reddish brown **CLAYEY SILT** with traces of sand (coralline), very stiff, dry (fill)
	22	60			38	4.5			
	24				20				
	24	91			16/6" +10/0" Ref.	4.5	5	CL	Reddish brown **SANDY CLAY**, hard, dry (residual soil)
LL=49 PI=22	26				20		10		grades to very stiff
	45	61			85	4.5	15		grades to hard
	28				48		20		
	45	61			14/6" +15/0" Ref.	4.5	25	MH	Orangish brown with gray mottling **CLAYEY SILT** with traces of sand, hard, moist (residual soil)
LL=65 PI=28	36				21		30		grades to very stiff
							35		



Date Started:	July 11, 2020	Water Level: ▼	Not Encountered 07/11/2020 1029 HRS
Date Completed:	July 11, 2020		
Logged By:	D. Gremminger	Drill Rig:	CME-45C TRUCK *(Energy Transfer Ratio = 78%)*
Total Depth:	36.5 feet	Drilling Method:	4" Solid-Stem Auger
Work Order:	8094-00&20	Driving Energy:	140 lb. wt., 30 in. drop

Plate

A - 21.1

(Continued from previous plate)

Laboratory			Field								
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS	Description
	48				13			▼	▨	MH	grades to dark grayish brown with traces of gravel (basaltic), stiff
											Boring terminated at 36.5 feet
							40				
							45				
							50				
							55				
							60				
							65				
							70				

Date Started:	July 11, 2020	Water Level: ▼	Not Encountered 07/11/2020 1029 HRS
Date Completed:	July 11, 2020		
Logged By:	D. Gremminger	Drill Rig:	CME-45C TRUCK *(Energy Transfer Ratio = 78%)*
Total Depth:	36.5 feet	Drilling Method:	4" Solid-Stem Auger
Work Order:	8094-00&20	Driving Energy:	140 lb. wt., 30 in. drop

APPENDIX B

APPENDIX B

Laboratory Tests

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

Twenty-One Atterberg Limits tests (ASTM D4318) were performed on selected soil samples to evaluate the liquid and plastic limits. The test results are summarized on the Logs of Borings at the appropriate sample depths. Graphic presentations of the test results are provided on Plates B-1 through B-3.

Five Sieve Analysis tests (ASTM C117 & C136) were performed on selected soil samples to evaluate the gradation characteristics of the soils and to aid in soil classification. Graphic presentation of the grain size distributions is provided on Plate B-4.

To evaluate the unconfined compressive strength of the on-site clayey soils, five unconfined compression tests were performed on selected in-situ samples in accordance with ASTM D2166. Individual stress-strain curves of the unconfined compression tests are presented on Plates B-5 through B-9.

Five Unconsolidated Undrained Triaxial Compression tests (ASTM D2850) were performed on selected in-situ soil samples to evaluate the undrained shear strengths of the on-site clayey soils. The approximate in-situ effective overburden pressures were used as the applied confining pressures for both the relatively “undisturbed” soil samples and the remolded soil samples. The test results and the stress-strain curves are presented on Plates B-10 through B-14.

Four Direct Shear tests (ASTM D3080) were performed on selected samples to evaluate the shear strength characteristics of the material tested. The test results are presented on Plates B-15 through B-18.

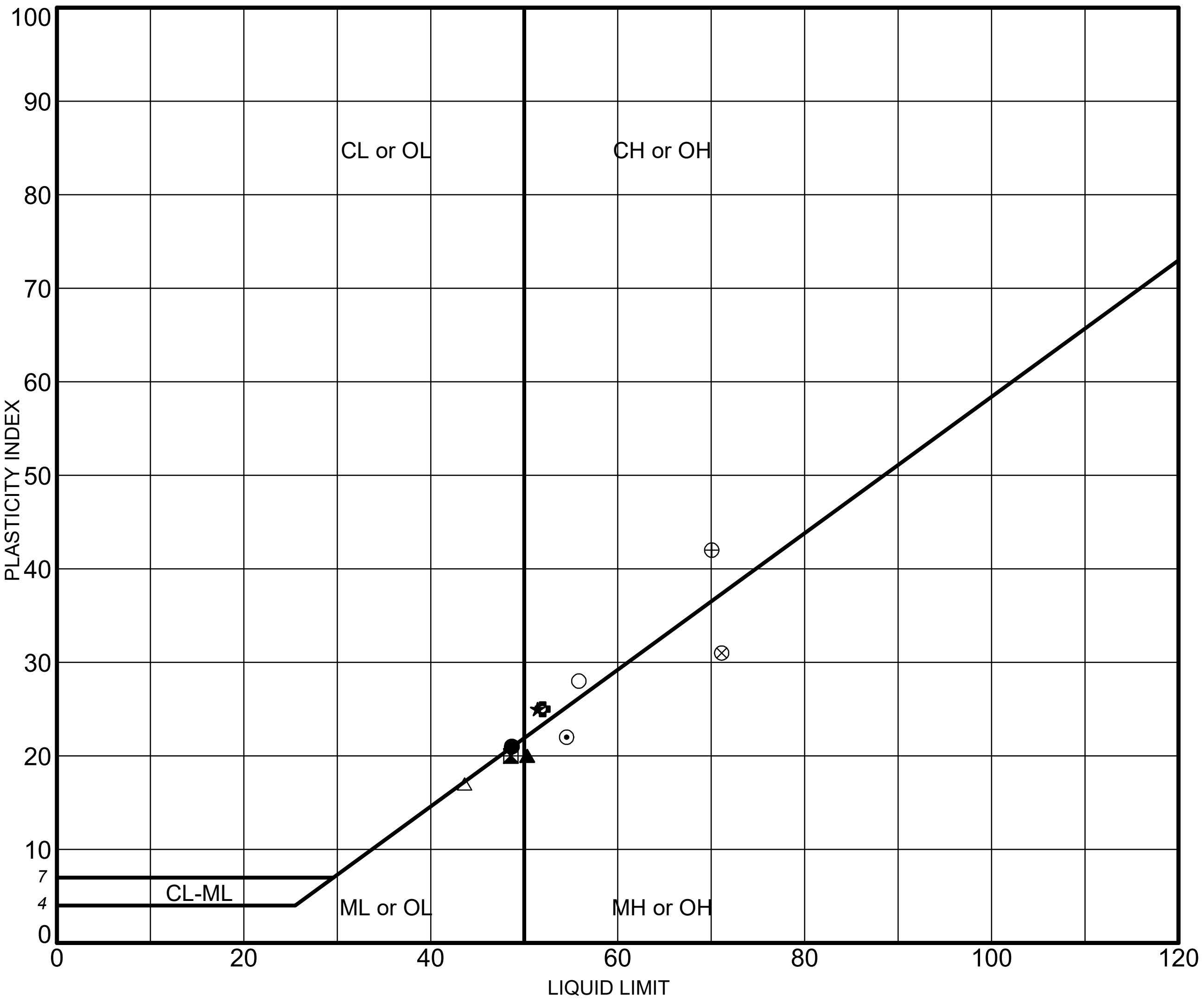
To evaluate the long-term shear strengths of the clayey soils, two Consolidated-Undrained Triaxial Compression tests were performed on selected relatively undisturbed soil samples in accordance with ASTM D4767. The test results and stress-strain curves are presented on Plates B-19 and B-20.

To evaluate the permeability of the in-situ soils, two Hydraulic Conductivity of Saturated Porous Materials by Flexible Wall Permeameter tests (ASTM D5084) were performed on relatively undisturbed samples of the on-site materials anticipated below the new line reservoir. The test results are presented on Plate B-21.

Four sets of Corrosion tests, including pH (ASTM G51), Minimum Resistivity (ASTM G57), Chloride Content (EPA 300.0), and Sulfate Content (EPA 300.0), were performed by our office and TestAmerica laboratories, Inc. on selected soil samples obtained from our field exploration. The test results are summarized on Plate B-22.

Two Modified Proctor compaction tests (ASTM D1557 A) were performed on bulk samples of the near-surface soils to evaluate the dry density and moisture content relationships. The test results are presented on Plates B-23 and B-24.

Four laboratory California Bearing Ratio tests (ASTM D1883) were performed on bulk samples of the near-surface soils to evaluate the support characteristics of the soils. The test results are presented on Plates B-25 through B-28.



	Sample	Depth (ft)	LL	PL	PI	Description
●	B-1	10.0-11.0	49	28	21	Reddish brown sandy clay (CL)
⧗	B-2	2.5-4.0	49	29	20	Reddish brown sandy silt (ML)
▲	B-2	10.0-11.5	50	30	20	Reddish brown clayey silt (MH)
★	B-3	2.5-4.0	51	26	25	Reddish brown silty clay (CH) with a little sand
⊙	B-4	20.0-21.5	55	33	22	Reddish brown with orange mottling clayey silt (MH)
✿	B-6	10.0-11.5	52	27	25	Reddish brown silty clay (CH)
○	B-7	10.0-11.5	56	28	28	Brown silty clay (CH)
△	B-9	2.5-4.0	44	27	17	Reddish brown sandy silt (ML) with some gravel
⊗	B-10	2.5-4.0	71	40	31	Reddish orange with greenish gray mottling clayey silt (MH)
⊕	B-11	10.0-11.5	70	28	42	Reddish brown w/ black & orange mott. silty clay (CH) w/ a little sand

NP = NON-PLASTIC

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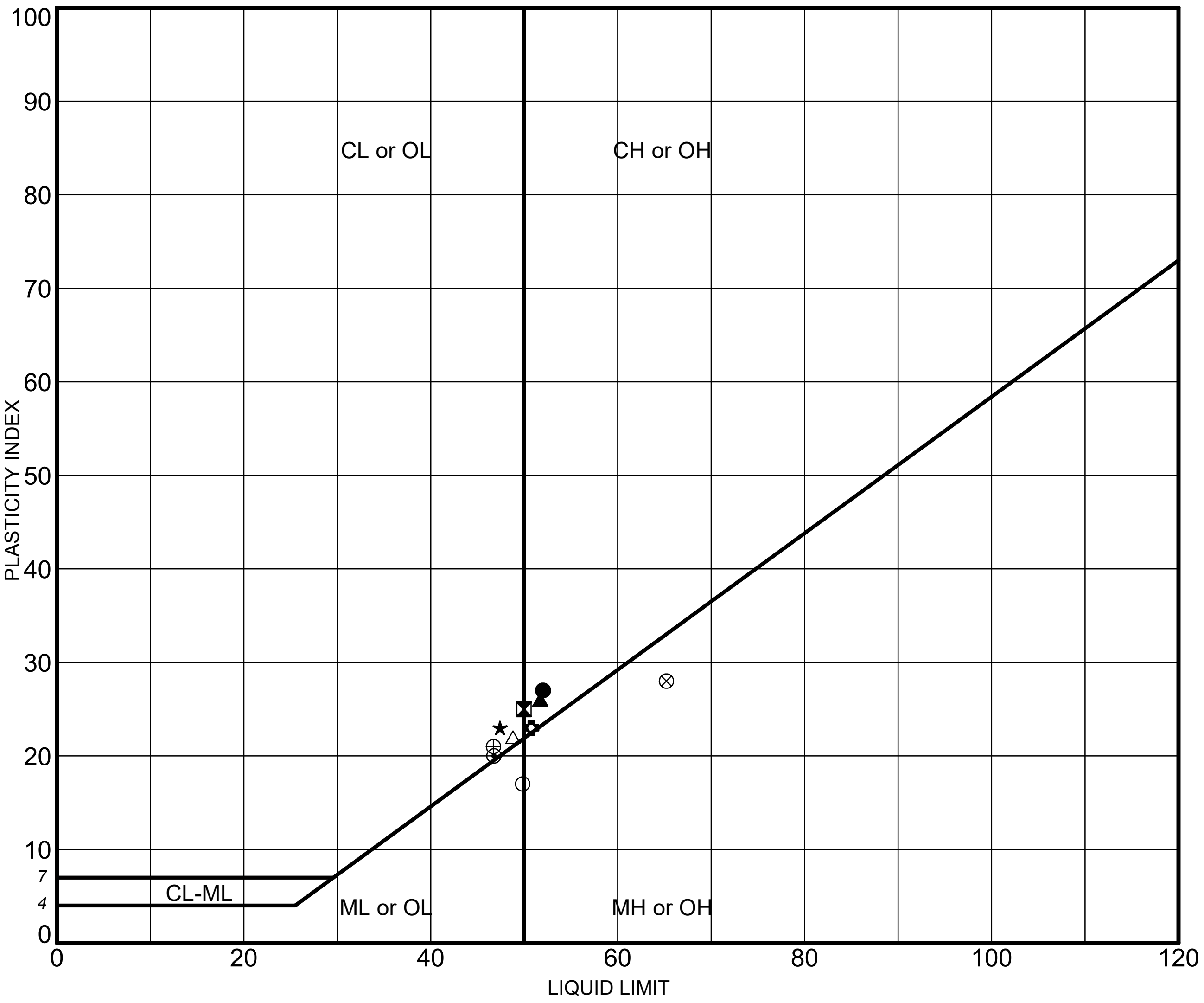
ATTERBERG LIMITS TEST RESULTS - ASTM D4318

WAIAHOLE WATER SYSTEM IMPROVEMENT
KUNIA, OAHU, HAWAII

Plate
B - 1

G ATTERBERG PI-100 LL-120 8094-00&20.GPJ GEOLABS.GDT 1/26/21



	Sample	Depth (ft)	LL	PL	PI	Description
●	B-12	3.5-5.0	52	25	27	Reddish brown silty clay (CH) with traces of sand
⧗	B-14	1.0-2.5	50	25	25	Reddish brown silty clay (CL-CH)
▲	B-15	2.5-4.0	52	26	26	Reddish brown silty clay (CH)
★	B-16	5.0-5.8	47	24	23	Brown sandy clay (CL) with some gravel
⊙	B-18	2.5-4.0	47	27	20	Reddish brown sandy clay (CL)
✿	B-20	10.0-11.5	51	28	23	Reddish brown silty clay (CH)
○	B-20	20.0-21.5	50	33	17	Orangish brown clayey silt (ML-MH)
△	B-21	10.0-11.5	49	27	22	Reddish brown sandy clay (CL)
⊗	B-21	30.0-31.5	65	37	28	Orangish brown with gray mottling clayey silt (MH) with traces of sand
⊕	BULK-3	0.0-1.0	47	26	21	Reddish brown sandy clay (CL)

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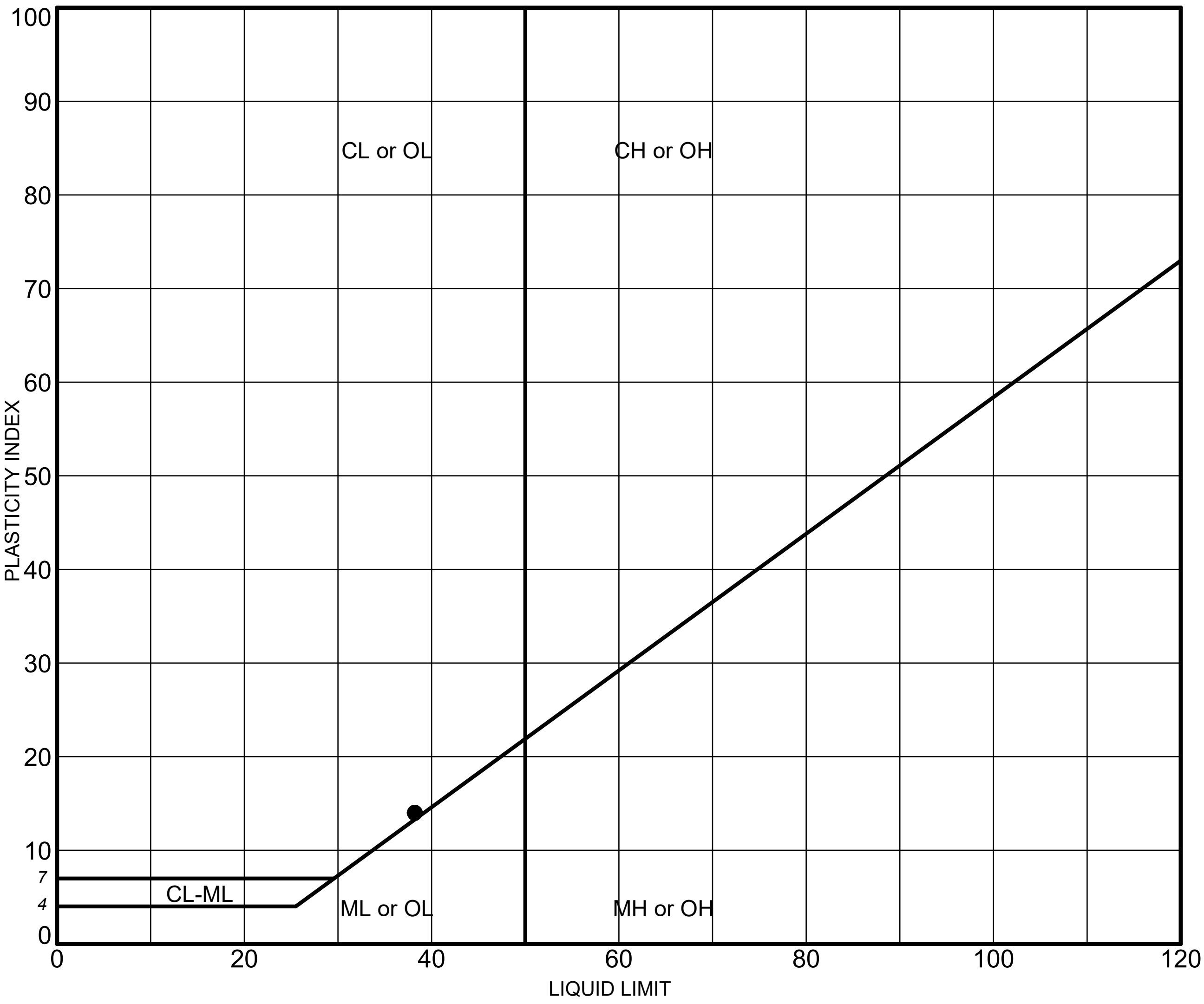
ATTERBERG LIMITS TEST RESULTS - ASTM D4318

WAIAHOLE WATER SYSTEM IMPROVEMENT
KUNIA, OAHU, HAWAII

Plate
B - 2

G ATTERBERG PI-100 LL-120 8094-00&20.GPJ GEOLABS.GDT 1/26/21



	Sample	Depth (ft)	LL	PL	PI	Description
●	BULK-4	0.0-2.0	38	24	14	Reddish brown sandy clay (CL)

NP = NON-PLASTIC

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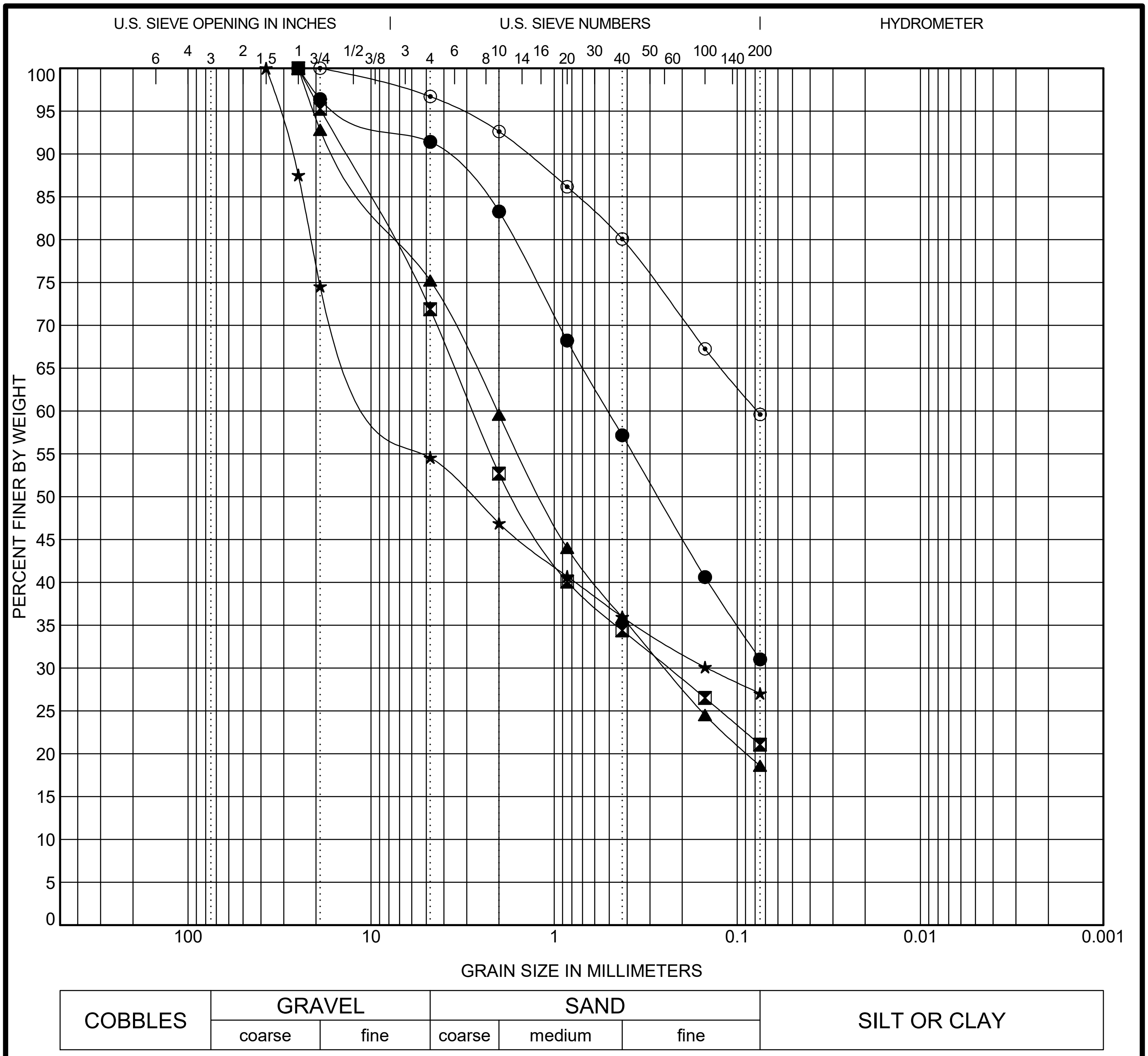
ATTERBERG LIMITS TEST RESULTS - ASTM D4318

WAIAHOLE WATER SYSTEM IMPROVEMENT
KUNIA, OAHU, HAWAII

Plate
B - 3



	Sample	Depth (ft)	Description	LL	PL	PI	Cc	Cu
●	B-1	30.0-31.5	Reddish brown w/ some black mott. silty sand (SM) w/ a little gravel					
⊠	B-8	10.0-11.5	Tan with red and orange mottling silty sand (SM) with some gravel					
▲	B-16	10.0-11.5	Orangish brown silty sand (SM) with some weathered gravel					
★	B-17	1.0-2.5	Reddish brown silty gravel (GM) with some sand					
⊙	B-19	25.0-26.5	Gray with multi-color mottling sandy silt (ML) with traces of gravel					

	Sample	Depth (ft)	D100 (mm)	D60 (mm)	D30 (mm)	D10 (mm)	%Gravel	%Sand	%Fine
●	B-1	30.0-31.5	25	0.508			8.6	60.4	31.0
⊠	B-8	10.0-11.5	25	2.781	0.238		28.1	50.8	21.0
▲	B-16	10.0-11.5	25	2.049	0.248		24.8	56.6	18.6
★	B-17	1.0-2.5	37.5	6.932	0.146		45.5	27.5	27.0
⊙	B-19	25.0-26.5	19	0.078			3.3	37.1	59.6

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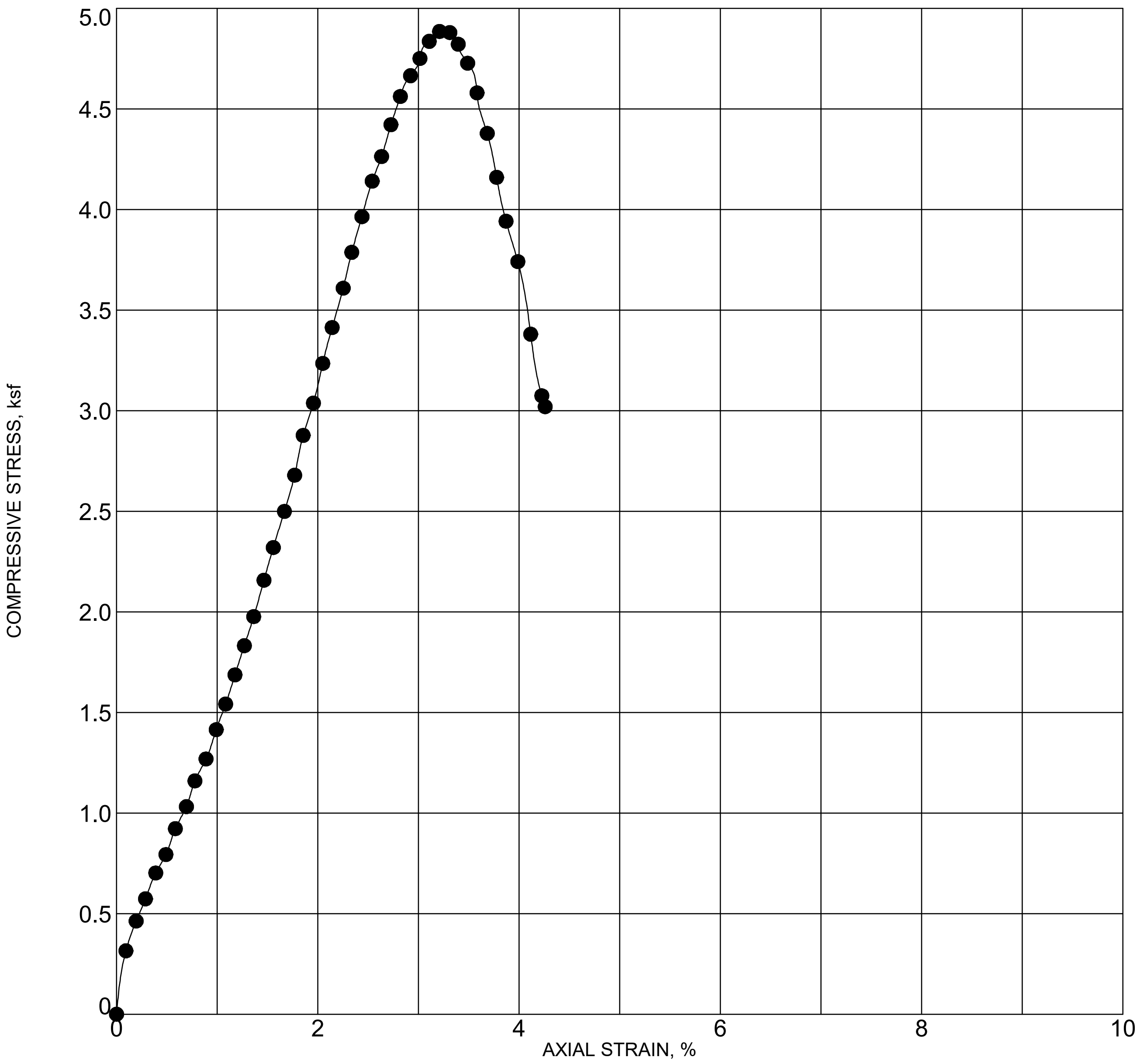
GRAIN SIZE DISTRIBUTION - ASTM C117 & C136

WAIHOLE WATER SYSTEM IMPROVEMENT
KUNIA, OAHU, HAWAII

Plate
B - 4



Unconfined Compressive Strength (ksf):	4.88
Axial Strain at Failure (%):	3.2
Strain Rate (% / minute):	0.97

Location: B-1
Depth: 15.0 - 16.5 feet
Description: Reddish brown sandy clay
Test Date: 6/29/2020

Dry Density (pcf)	96.8	Sample Diameter (inches)	2.420
Moisture (%)	28.0	Sample Height (inches)	5.200

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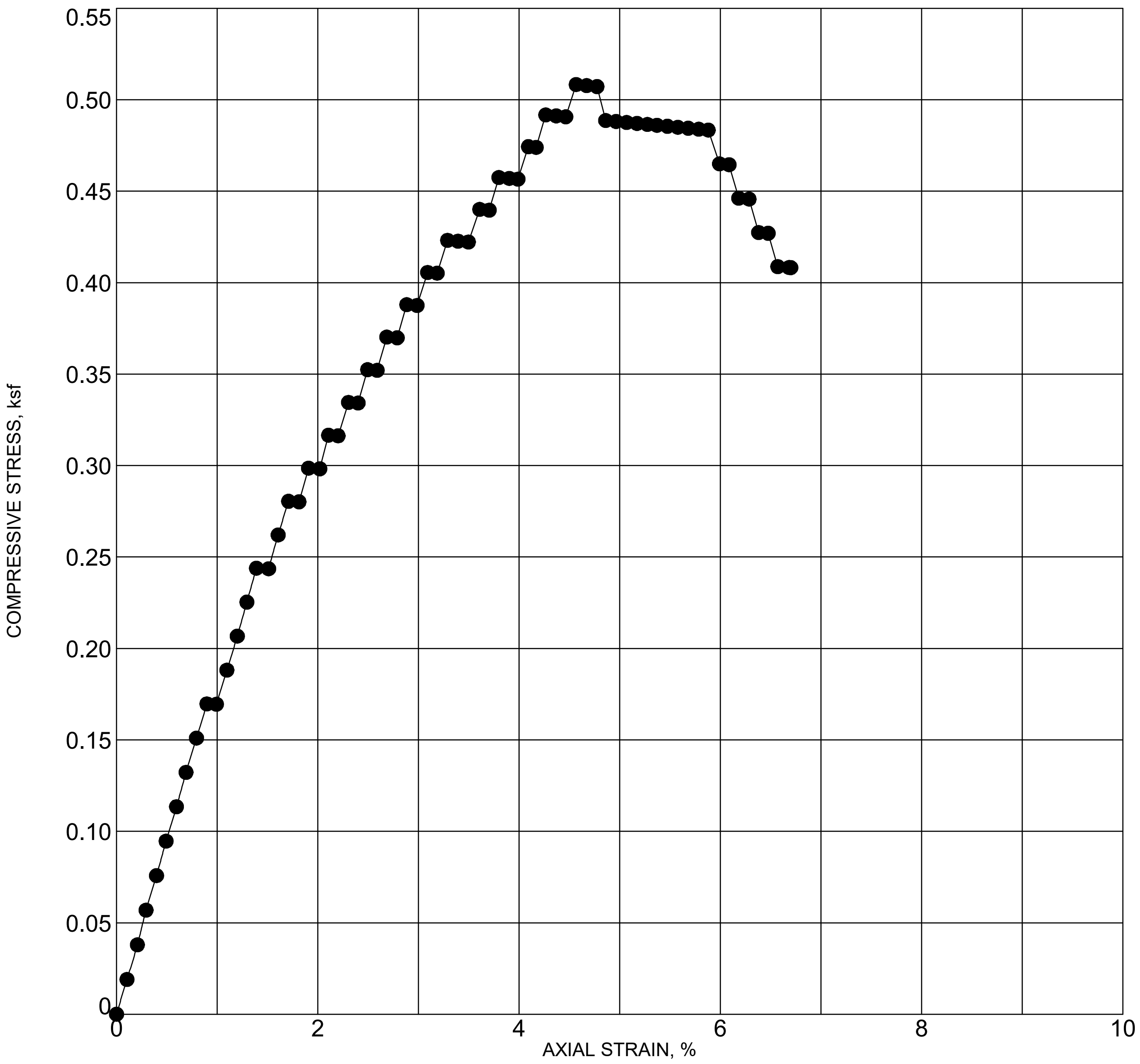
UNCONFINED COMPRESSION TEST - ASTM D2166

WAIHOLE WATER SYSTEM IMPROVEMENT
KUNIA, OAHU, HAWAII

Plate
B - 5

G_UC 8094-00&20.GPJ GEOLABS.GDT 1/26/21



Unconfined Compressive Strength (ksf):	0.51
Axial Strain at Failure (%):	4.6
Strain Rate (% / minute):	1.00

Location: B-2
Depth: 5.0 - 6.5 feet
Description: Reddish brown sandy silt (ML)
Test Date: 6/29/2020

Dry Density (pcf)	78.1	Sample Diameter (inches)	2.390
Moisture (%)	32.7	Sample Height (inches)	5.100

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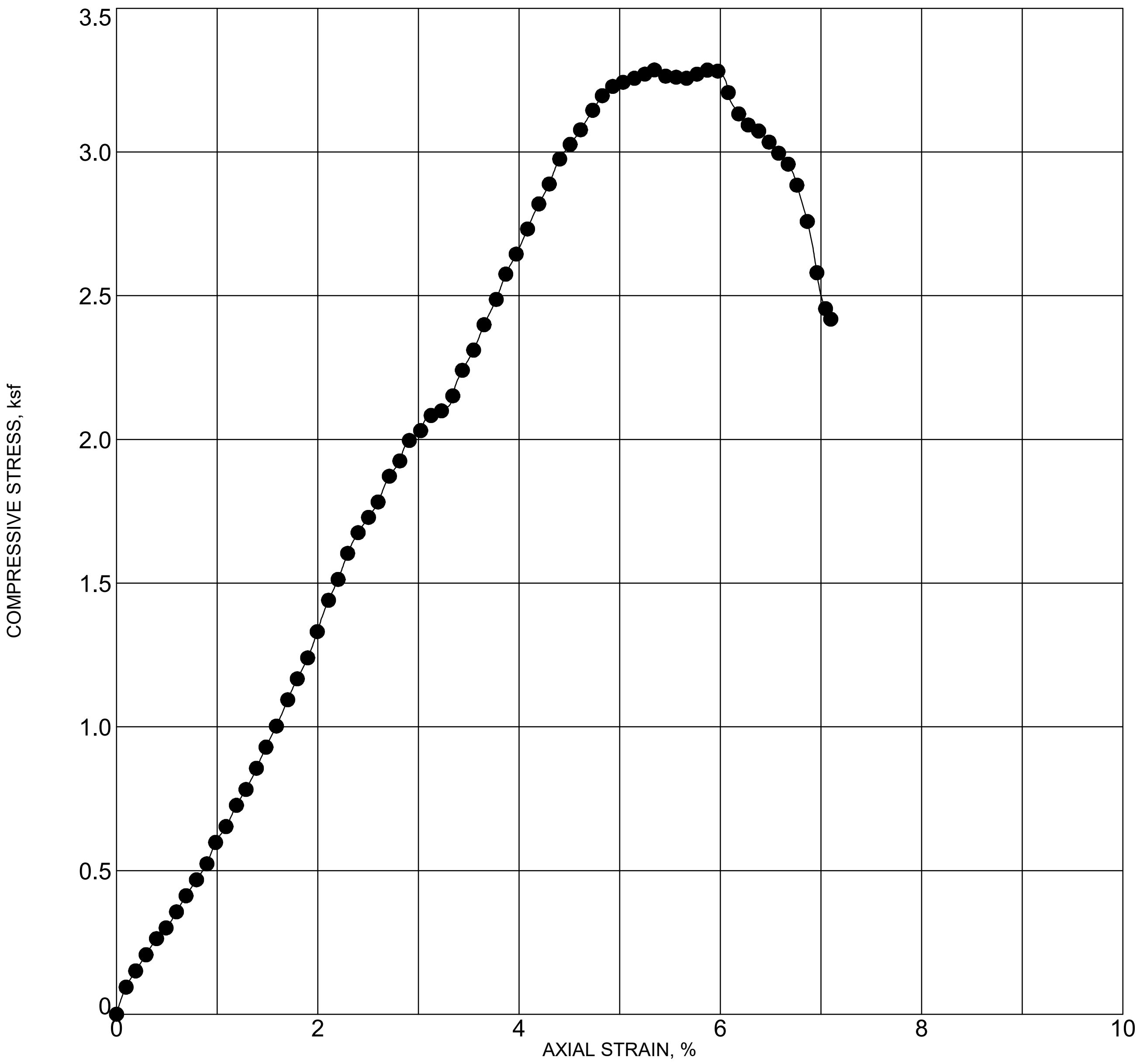
UNCONFINED COMPRESSION TEST - ASTM D2166

WAIAHOLE WATER SYSTEM IMPROVEMENT
KUNIA, OAHU, HAWAII

Plate
B - 6



Unconfined Compressive Strength (ksf):	3.29
Axial Strain at Failure (%):	5.3
Strain Rate (% / minute):	1.03

Location: B-10
Depth: 5.0 - 6.5 feet
Description: Reddish orange with greenish gray mottling clayey silt with a little sand
Test Date: 6/29/2020

Dry Density (pcf)	76.7	Sample Diameter (inches)	2.400
Moisture (%)	36.5	Sample Height (inches)	5.100

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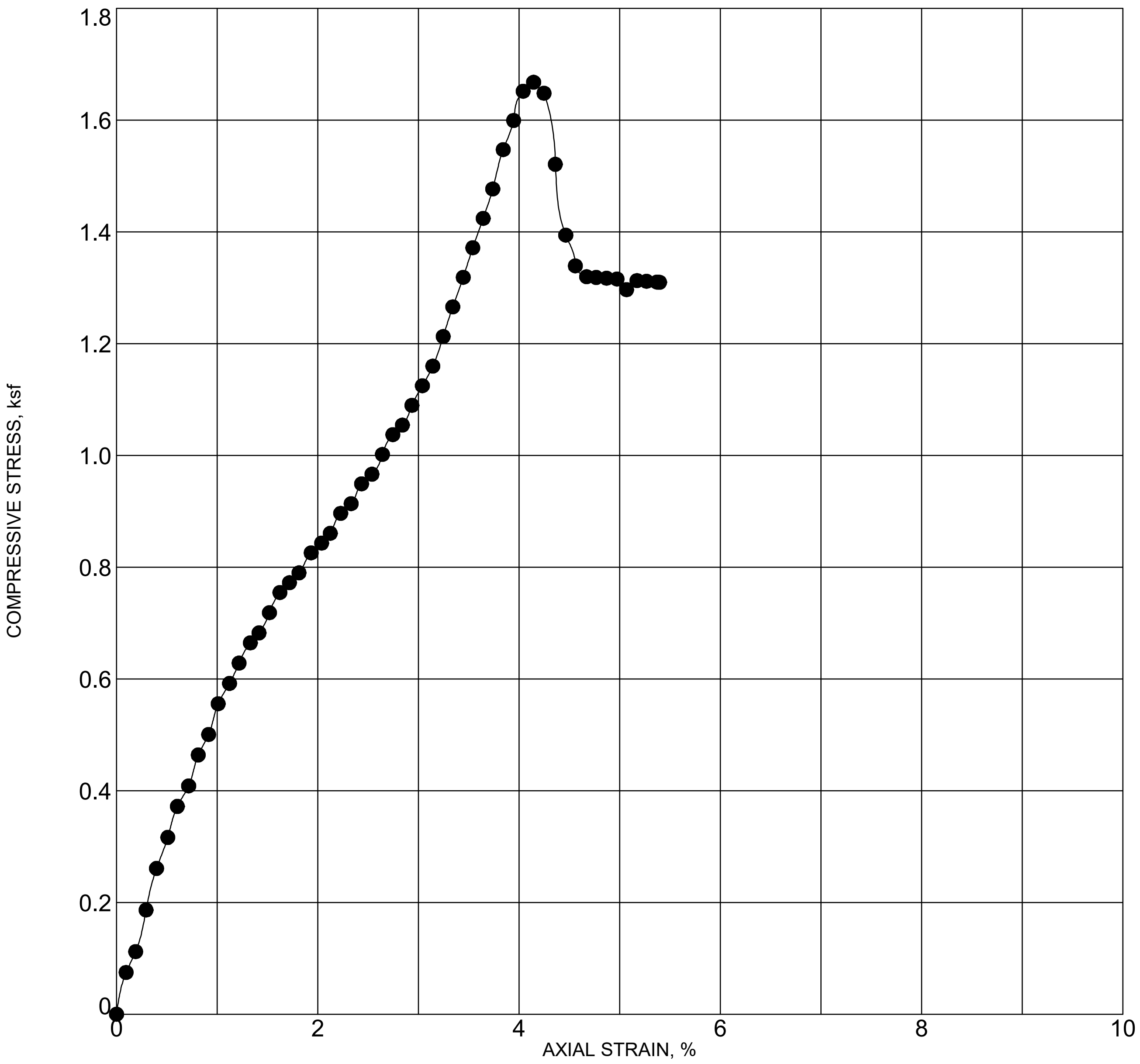
UNCONFINED COMPRESSION TEST - ASTM D2166

WAIAHOLE WATER SYSTEM IMPROVEMENT
KUNIA, OAHU, HAWAII

Plate
B - 7

G_UC 8094-00&20.GPJ GEOLABS.GDT 1/26/21



Unconfined Compressive Strength (ksf):	1.67
Axial Strain at Failure (%):	4.1
Strain Rate (% / minute):	1.01

Location: B-14
Depth: 5.0 - 6.5 feet
Description: Reddish brown silty clay
Test Date: 6/29/2020

Dry Density (pcf)	89.4	Sample Diameter (inches)	2.410
Moisture (%)	26.7	Sample Height (inches)	5.100

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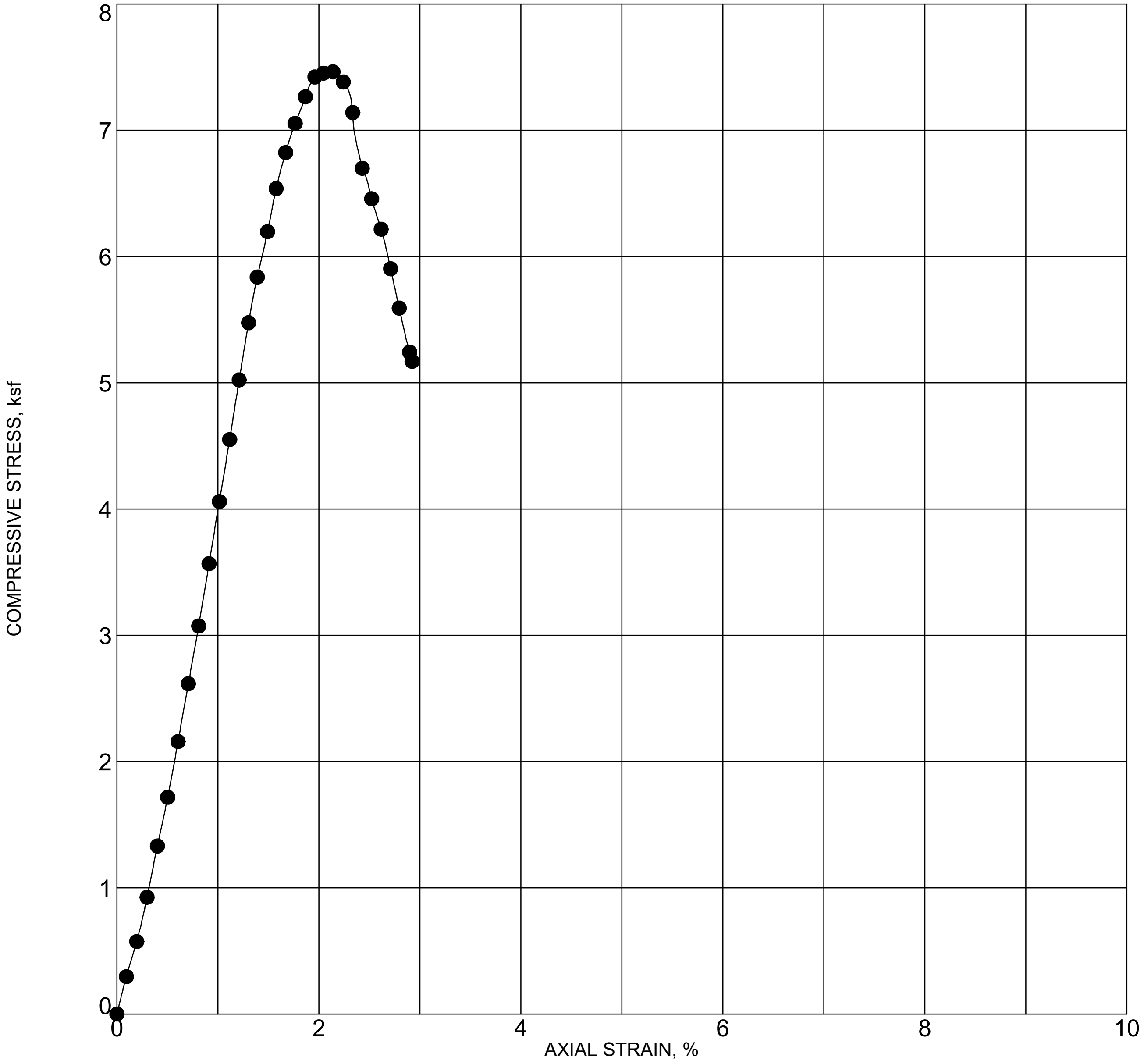
UNCONFINED COMPRESSION TEST - ASTM D2166

WAIAHOLE WATER SYSTEM IMPROVEMENT
KUNIA, OAHU, HAWAII

Plate
B - 8



Unconfined Compressive Strength (ksf):	7.46
Axial Strain at Failure (%):	2.1
Strain Rate (% / minute):	0.97

Location: B-15
Depth: 5.0 - 6.5 feet
Description: Reddish brown silty clay
Test Date: 6/22/2020

Dry Density (pcf)	98.3	Sample Diameter (inches)	2.420
Moisture (%)	24.7	Sample Height (inches)	5.167

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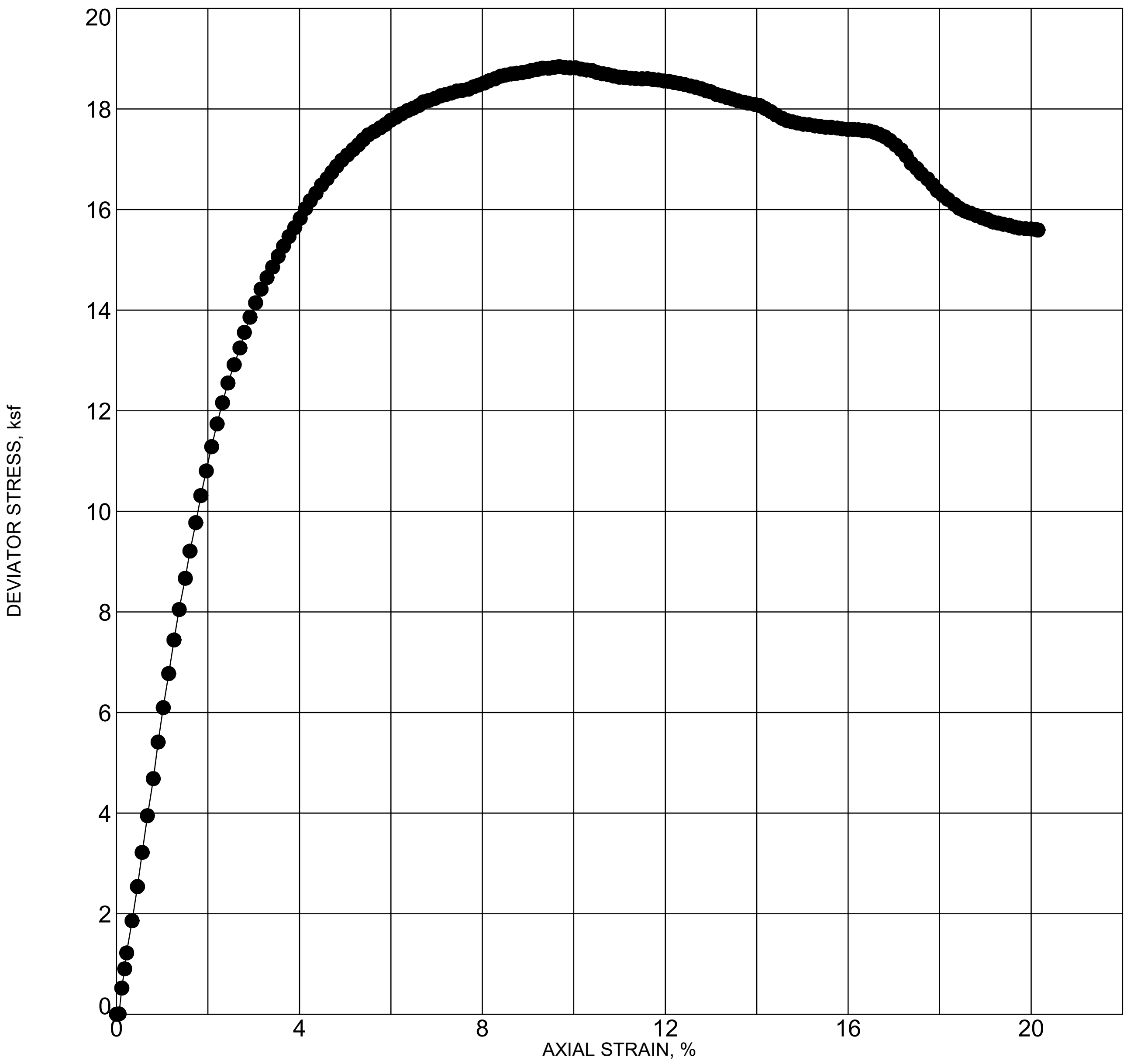
UNCONFINED COMPRESSION TEST - ASTM D2166

WAIAHOLE WATER SYSTEM IMPROVEMENT
KUNIA, OAHU, HAWAII

Plate
B - 9



Max. Deviator Stress (ksf):	18.8
Confining Stress (ksf):	1.7

Location: B-19
Depth: 15.0 - 16.5 feet
Description: Brown silty clay
Test Date: 8/13/2020

Dry Density (pcf)	102.2	Sample Diameter (inches)	2.407
Moisture (%)	25.6	Sample Height (inches)	5.067
Axial Strain at Failure (%)	9.7	Strain Rate (% / minute)	0.70

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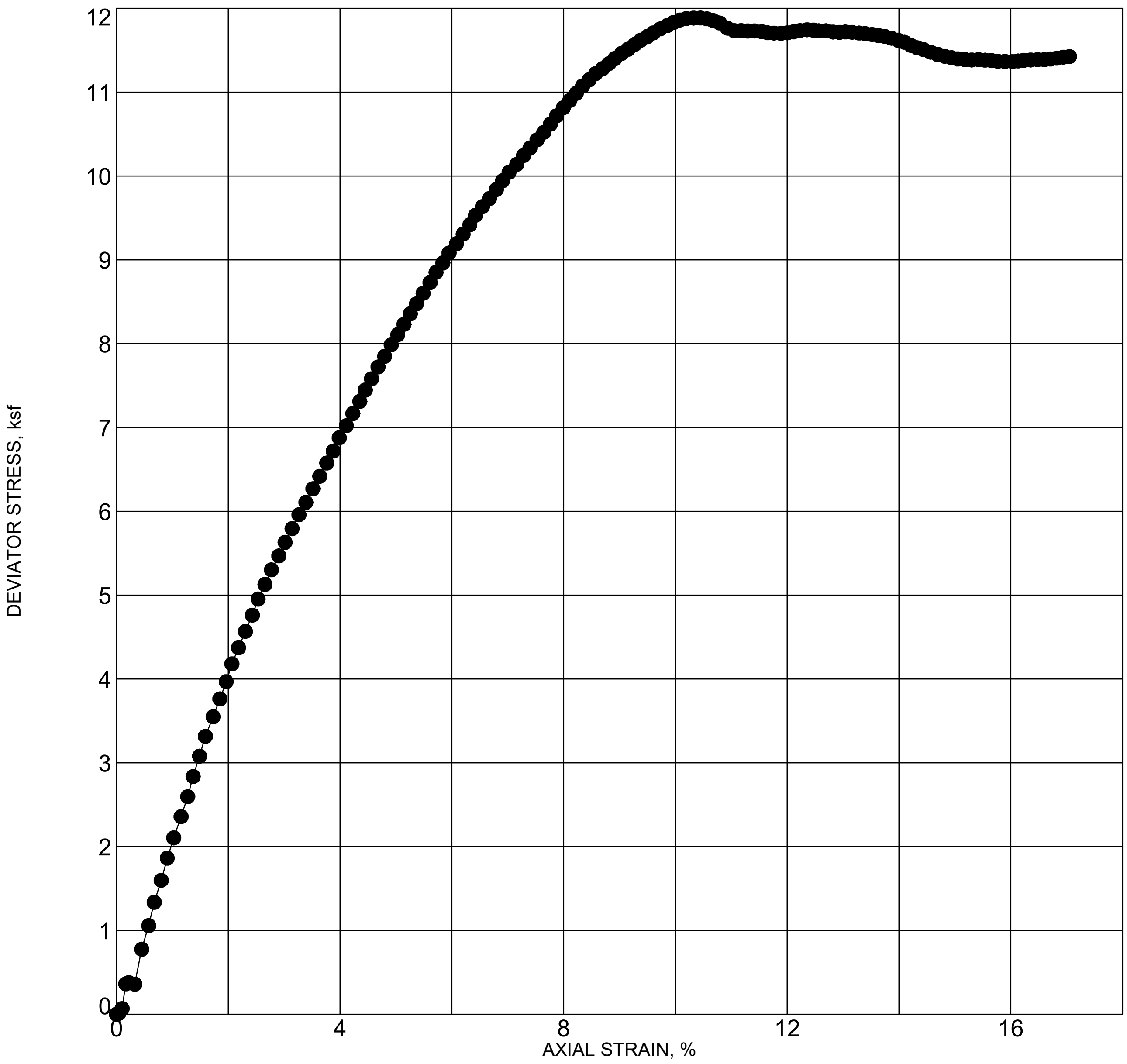
TRIAXIAL UU COMPRESSION TEST - ASTM D2850

WAIAHOLE WATER SYSTEM IMPROVEMENT
KUNIA, OAHU, HAWAII

Plate
B - 10



Max. Deviator Stress (ksf):	11.9
Confining Stress (ksf):	0.6

Location:	B-20
Depth:	5.0 - 6.5 feet
Description:	Reddish brown silty clay
Test Date:	9/11/2020

Dry Density (pcf)	95.1	Sample Diameter (inches)	2.403
Moisture (%)	24.2	Sample Height (inches)	5.033
Axial Strain at Failure (%)	10.6	Strain Rate (% / minute)	0.70

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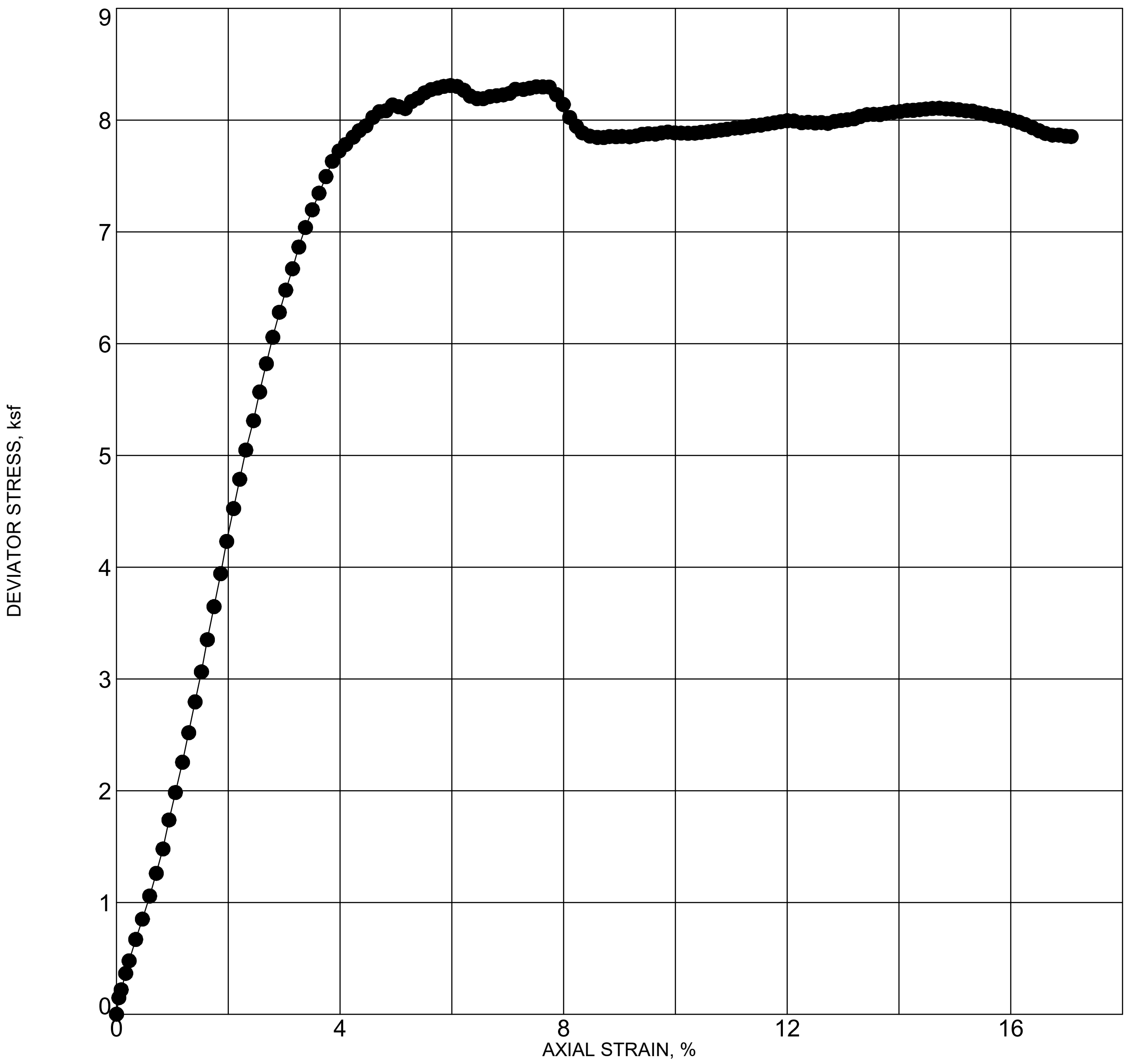
TRIAXIAL UU COMPRESSION TEST - ASTM D2850

WAIAHOLE WATER SYSTEM IMPROVEMENT
KUNIA, OAHU, HAWAII

Plate
B - 11



Max. Deviator Stress (ksf):	8.1
Confining Stress (ksf):	1.7

Location: B-20
Depth: 15.0 - 16.5 feet
Description: Dark grayish brown with orange mottling clayey silt
Test Date: 7/27/2020

Dry Density (pcf)	89.3	Sample Diameter (inches)	2.407
Moisture (%)	28.7	Sample Height (inches)	5.067
Axial Strain at Failure (%)	15.1	Strain Rate (% / minute)	0.70

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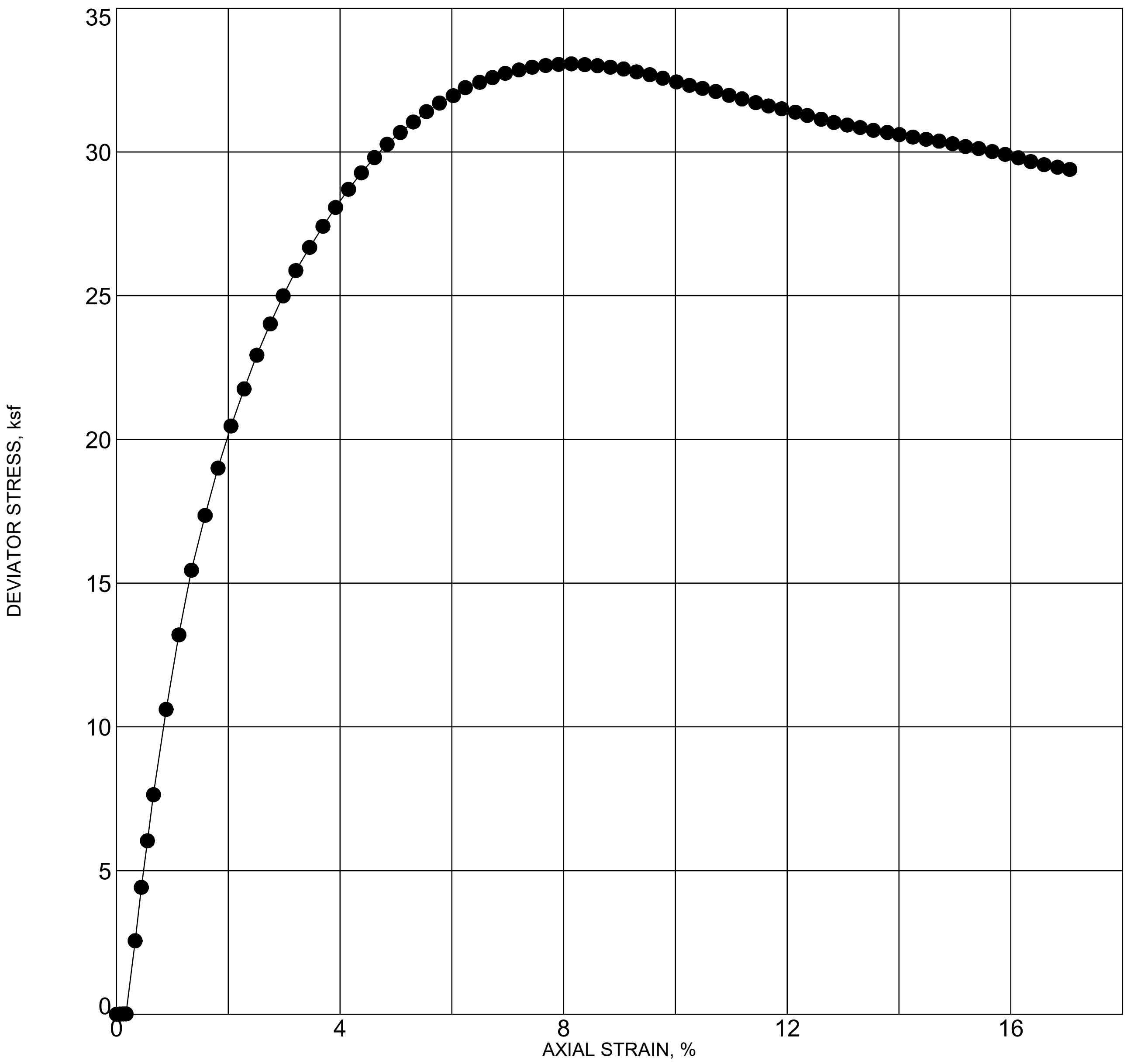
TRIAXIAL UU COMPRESSION TEST - ASTM D2850

WAIAHOLE WATER SYSTEM IMPROVEMENT
KUNIA, OAHU, HAWAII

Plate
B - 12



Max. Deviator Stress (ksf):	33.1
Confining Stress (ksf):	0.6

Location: BULK-3 (REMOLDED)
Depth: 0.0 - 1.0 feet
Description: Reddish brown sandy clay (CL)
Test Date: 1/4/2021

Dry Density (pcf)	99.4	Sample Diameter (inches)	2.407
Moisture (%)	21.2	Sample Height (inches)	5.133
Axial Strain at Failure (%)	8.1	Strain Rate (% / minute)	0.70

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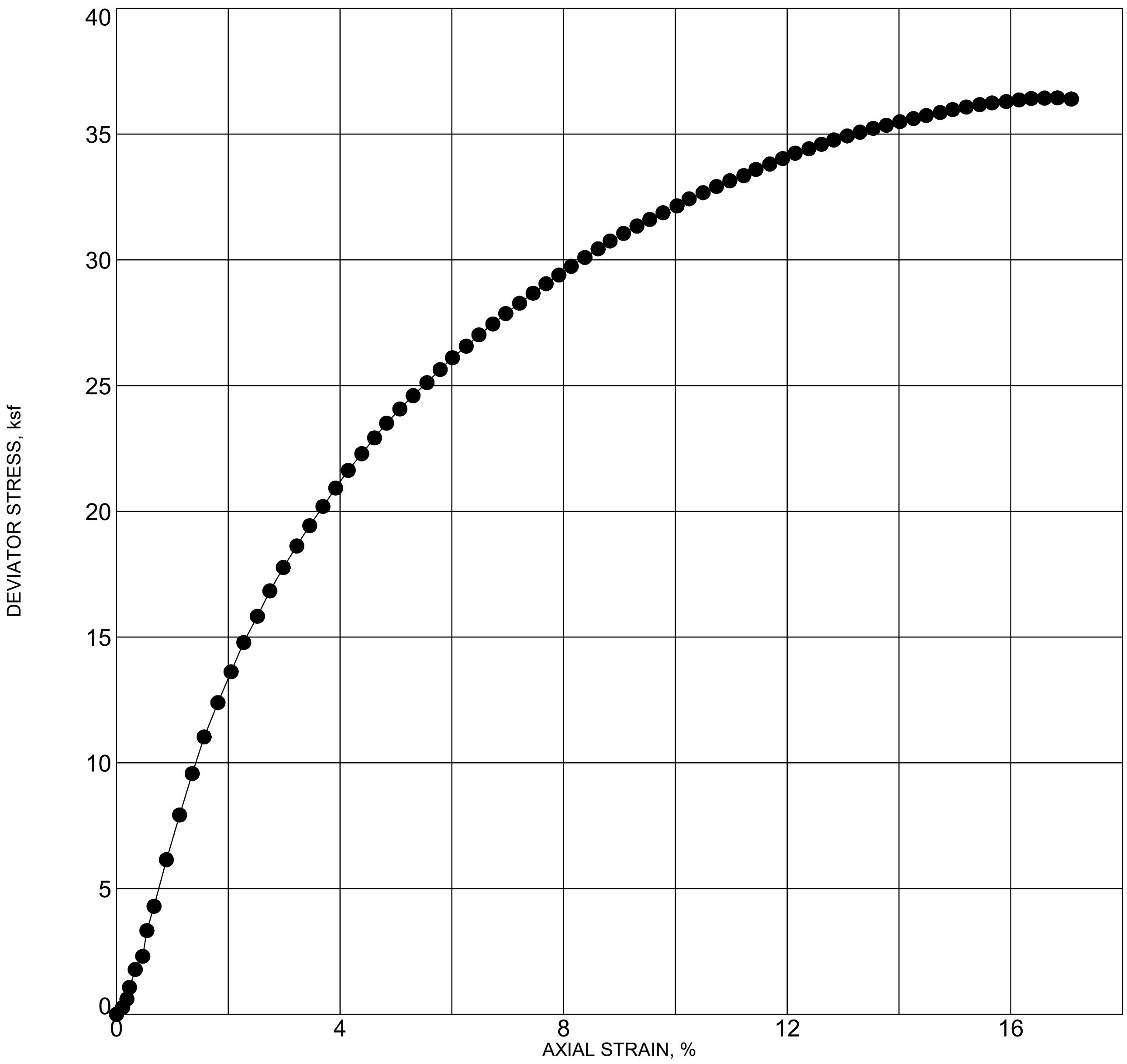
TRIAXIAL UU COMPRESSION TEST - ASTM D2850

WAIAHOLE WATER SYSTEM IMPROVEMENT
KUNIA, OAHU, HAWAII

Plate
B - 13



Max. Deviator Stress (ksf):	36.0
Confining Stress (ksf):	0.6

Location: BULK-4 (REMOLDED)
Depth: 0.0 - 2.0 feet
Description: Reddish brown sandy clay (CL)
Test Date: 1/4/2021

Dry Density (pcf)	102.9	Sample Diameter (inches)	2.407
Moisture (%)	22.2	Sample Height (inches)	5.133
Axial Strain at Failure (%)	15.0	Strain Rate (% / minute)	0.70

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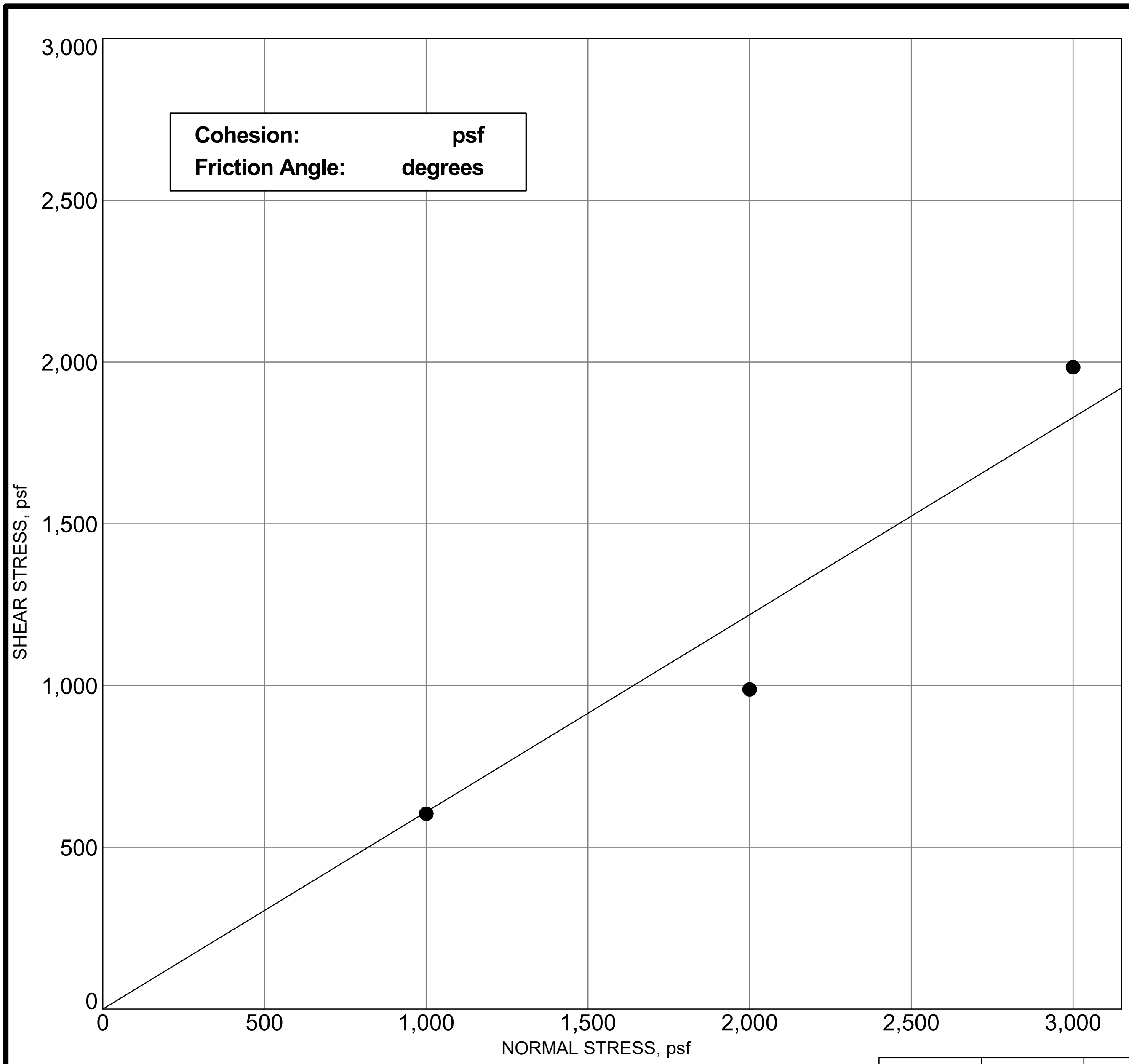
TRIAXIAL UU COMPRESSION TEST - ASTM D2850

WAIAHOLE WATER SYSTEM IMPROVEMENT
KUNIA, OAHU, HAWAII

Plate
B - 14



		Sample #1	Sample #2	Sample #3
INITIAL	Moisture Content, %	33.4	32.2	31.3
	Dry Density, pcf	84.6	89.1	92.5
	Height, inches	1.00	1.00	1.00
FINAL	Moisture Content, %	38.6	34.3	32.3
	Dry Density, pcf	81.7	91.9	96.4
	Height, inches	1.036	0.969	0.959
	Diameter, inches	2.42	2.42	2.42
	Deformation Rate, inch/minute	0.0025	0.0025	0.0022
	Normal Stress, psf	**1000**	**2000**	**3000**
	Peak Shear Stress, psf	**603**	**988**	**1984**
	Shear Displacement, inches	0.43	0.43	0.42

Sample: B-1
Depth: 5.0 - 6.5 feet
Description: Reddish brown to brown silty clay with a little sand

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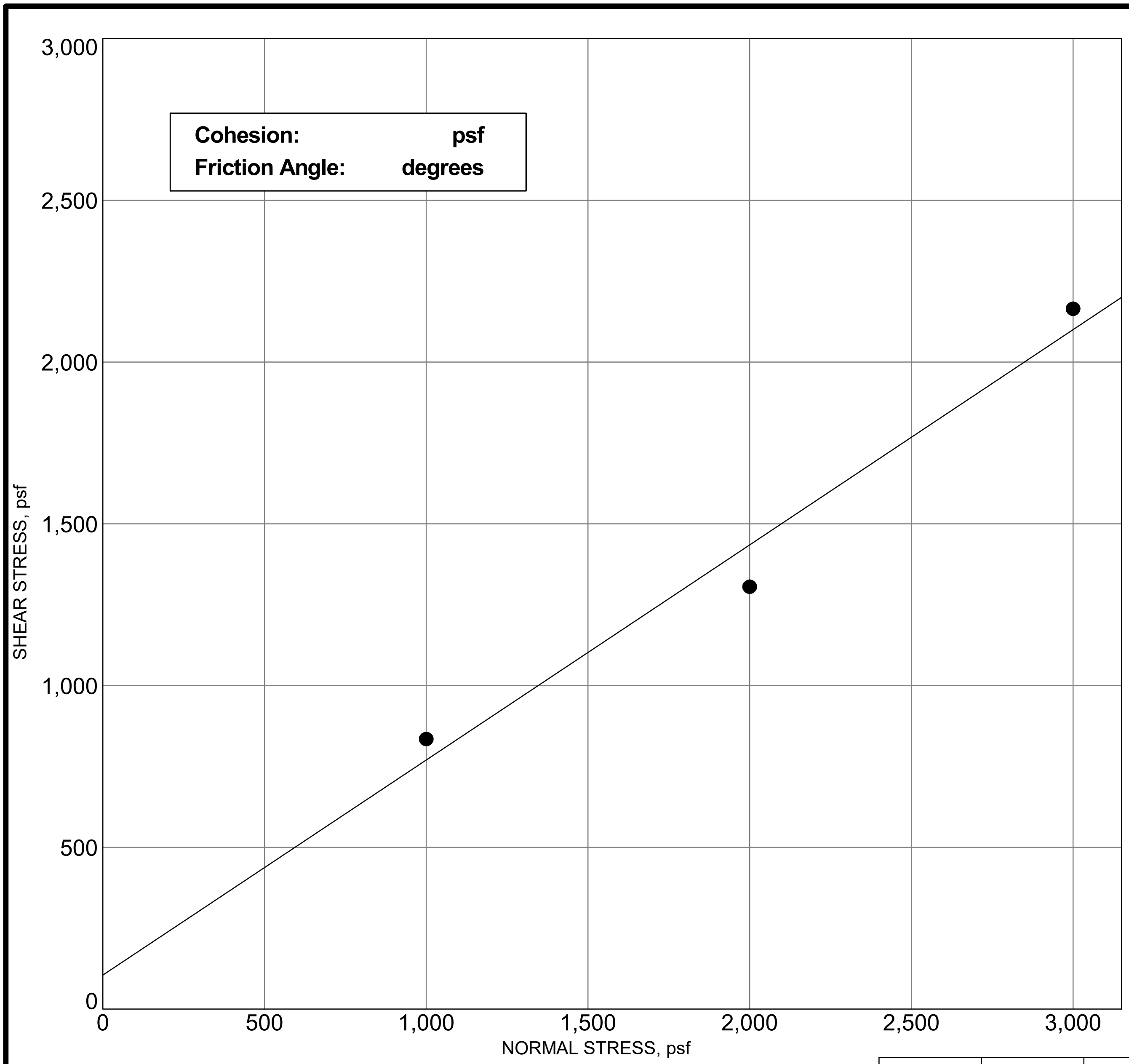
DIRECT SHEAR TEST - ASTM D3080

WAIAHOLE WATER SYSTEM IMPROVEMENT
KUNIA, OAHU, HAWAII

Plate
B - 15

G DIRECT SHEAR 8094-00&20.GPJ GEOLABS.GDT 1/26/21



		Sample #1	Sample #2	Sample #3
INITIAL	Moisture Content, %	37.5	37.6	38.8
	Dry Density, pcf	79.1	83.4	83.2
	Height, inches	1.00	1.00	1.00
FINAL	Moisture Content, %	38.9	36.2	35.2
	Dry Density, pcf	76.1	86.4	86.2
	Height, inches	1.039	0.965	0.965
	Diameter, inches	2.42	2.42	2.42
	Deformation Rate, inch/minute	0.0025	0.0022	0.0022
	Normal Stress, psf	**1000**	**2000**	**3000**
	Peak Shear Stress, psf	**835**	**1305**	**2164**
	Shear Displacement, inches	0.43	0.41	0.41

Sample: B-4
Depth: 5.0 - 6.5 feet
Description: Reddish brown to brown silty clay with some sand

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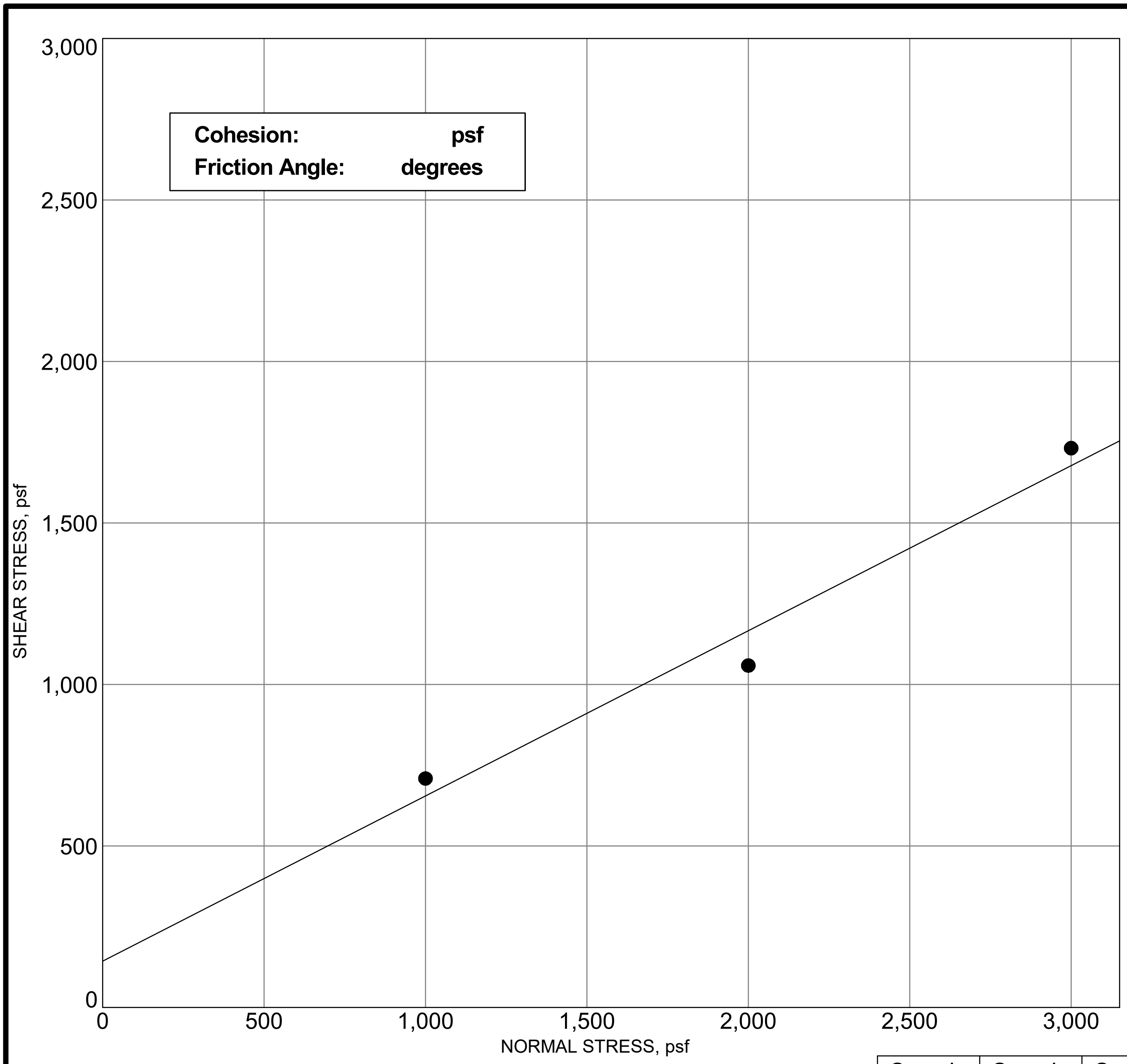
DIRECT SHEAR TEST - ASTM D3080

WAIAHOLE WATER SYSTEM IMPROVEMENT
KUNIA, OAHU, HAWAII

Plate
B - 16



		Sample #1	Sample #2	Sample #3
INITIAL	Moisture Content, %	23.1	18.3	23.3
	Dry Density, pcf	75.5	81.9	81.3
	Height, inches	1.00	1.00	1.00
FINAL	Moisture Content, %	38.0	33.1	32.2
	Dry Density, pcf	71.5	86.0	86.7
	Height, inches	1.055	0.952	0.938
	Diameter, inches	2.42	2.42	2.42
	Deformation Rate, inch/minute	0.0025	0.0024	0.0024
	Normal Stress, psf	**1000**	**2000**	**3000**
	Peak Shear Stress, psf	**709**	**1058**	**1732**
	Shear Displacement, inches	0.43	0.43	0.42

Sample: B-16
Depth: 1.0 - 2.5 feet
Description: Brown sandy clay

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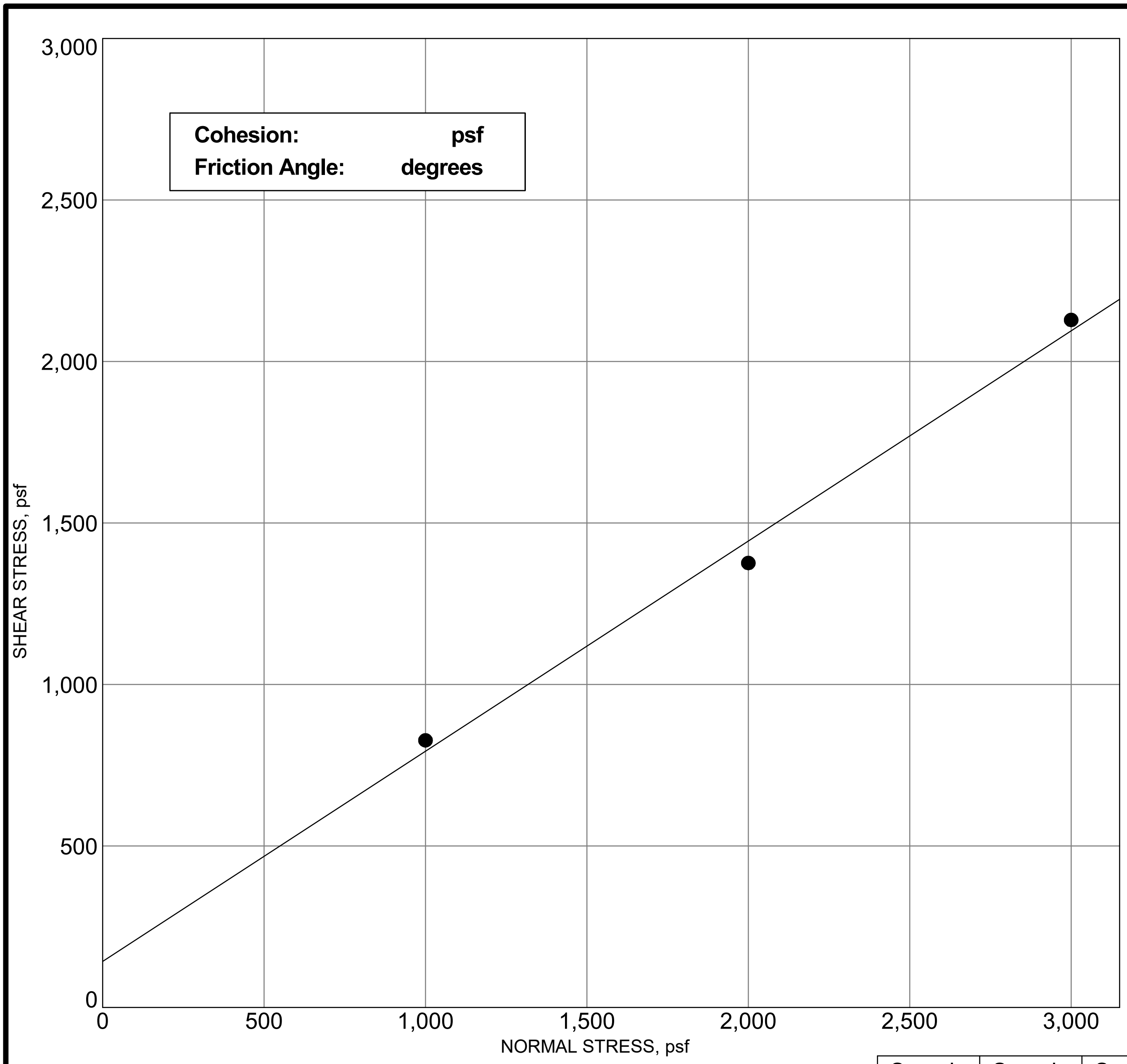
DIRECT SHEAR TEST - ASTM D3080

WAIAHOLE WATER SYSTEM IMPROVEMENT
KUNIA, OAHU, HAWAII

Plate
B - 17



		Sample #1	Sample #2	Sample #3
INITIAL	Moisture Content, %	27.1	23.1	21.9
	Dry Density, pcf	91.6	94.3	99.1
	Height, inches	1.00	1.00	1.00
FINAL	Moisture Content, %	34.9	32.9	31.2
	Dry Density, pcf	89.3	96.6	102.9
	Height, inches	1.026	0.975	0.963
	Diameter, inches	2.42	2.42	2.42
	Deformation Rate, inch/minute	0.0025	0.0022	0.0023
	Normal Stress, psf	**1000**	**2000**	**3000**
	Peak Shear Stress, psf	**827**	**1376**	**2128**
	Shear Displacement, inches	0.43	0.41	0.41

Sample: B-18
Depth: 5.0 - 6.5 feet
Description: Reddish brown sandy clay

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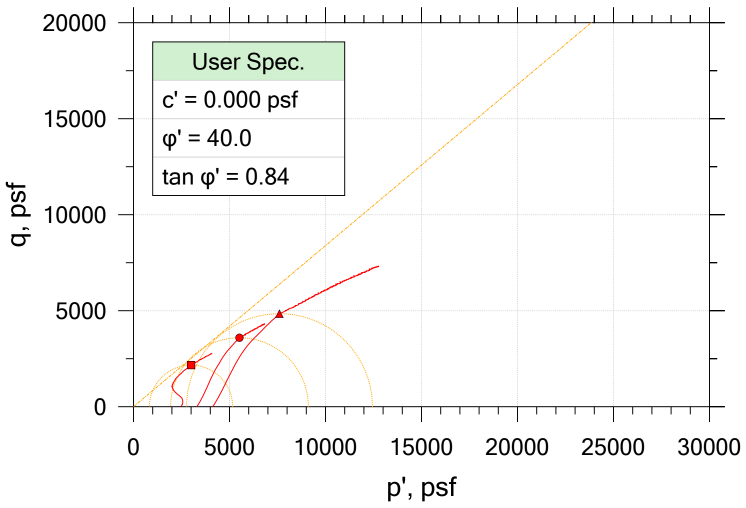
DIRECT SHEAR TEST - ASTM D3080

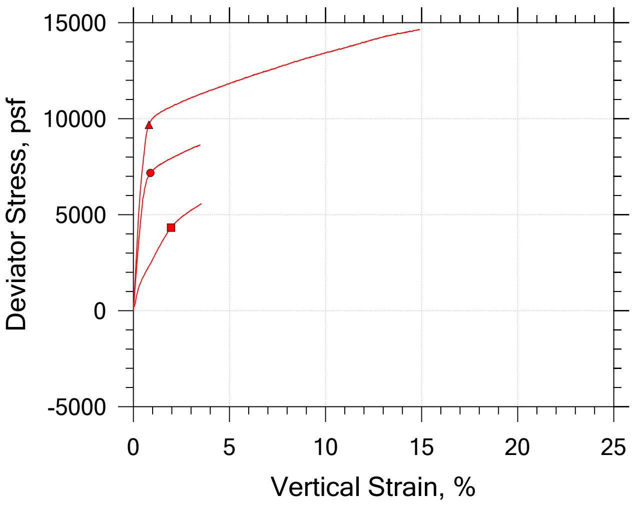
WAIAHOLE WATER SYSTEM IMPROVEMENT
KUNIA, OAHU, HAWAII

Plate
B - 18

G DIRECT SHEAR 8094-00&20.GPJ GEOLABS.GDT 1/26/21

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





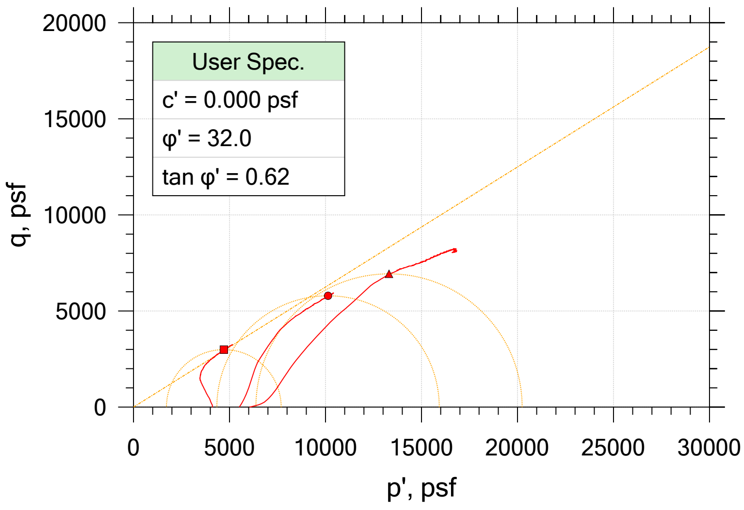
Symbol		■	●	▲	
Sample ID		RS5	RS5	RS5	
Depth, ft		15-16.5	15-16.5	15-16.5	
Test Number		17.18-psi	17.18-psi	28.65-psi	
Initial	Height, in	5.000	5.000	5.000	
	Diameter, in	2.420	2.420	2.420	
	Moisture Content (from Cuttings), %	16.3	16.3	16.3	
	Dry Density, pcf	106	106	106	
	Saturation (Wet Method), %	0.0	0.0	0.0	
	Void Ratio	0.354	0.354	0.354	
Final	Moisture Content, %	20.1	21.5	22.1	
	Dry Density, pcf	109	106	105	
	Cross-Sectional Area (Method A), in²	4.543	4.582	4.620	
	Saturation, %	100.0	100.0	100.0	
	Void Ratio	0.323	0.356	0.369	
	Back Pressure, %	1.534e+04	2.351e+04	3.016e+04	
Vertical Effective Consolidation Stress, psf		2463.	3301.	4127.	
Horizontal Effective Consolidation Stress, psf		2469.	3297.	4123.	
Vertical Strain after Consolidation, %		0.5653	-0.5231	-0.6277	
Volumetric Strain after Consolidation, %		0.7019	-0.1387	-1.078	
Time to 50% Consolidation, min		20.00	20.00	20.00	
Shear Strength, psf		2165.	3589.	4842.	
Strain at Failure, %		1.96	0.886	0.805	
Strain Rate, %/min		0.01500	0.01500	0.01500	
Deviator Stress at Failure, psf		4330.	7179.	9683.	
Effective Minor Principal Stress at Failure, psf		833.2	1928.	2761.	
Effective Major Principal Stress at Failure, psf		5163.	9107.	1.244e+04	
B-Value		0.91	---	---	

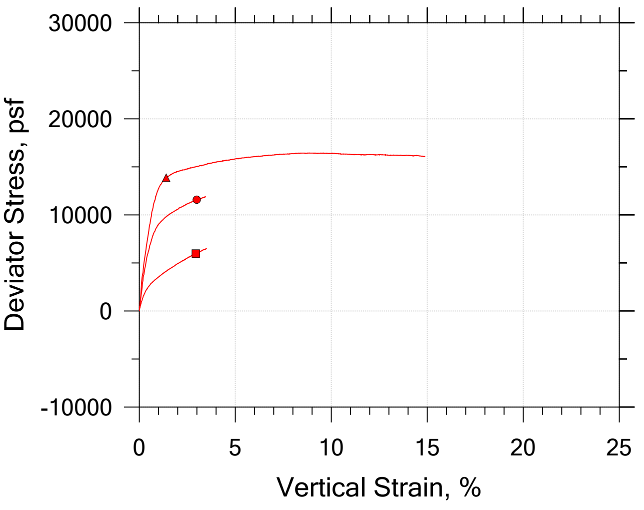
Notes:
- Before Shear Saturation set to 100% for phase calculation.
- Moisture Content determined by ASTM D2216.
- Atterberg Limits determined by ASTM D4318.
- Deviator Stress includes membrane correction.
- Values for c and φ determined from best-fit straight line for the specific test conditions. Actual strength parameters may vary and should be determined by an engineer for site conditions.

GEOLABS, INC.
Geotechnical Engineering and Drilling Services

Project: Waiahole Water	Location: Waiahole	Project No.: 8094-00&20
Boring No.: 2	Tested By: SA/JS	Checked By:
Sample No.: RS5	Test Date: 12-23-20	Depth: 15-16.5
Test No.: 17.18-psi	Sample Type:	Elevation: N/A
Description: Reddish brown clayey silt		
Remarks:		

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





Symbol		■	●	▲	
Sample ID		RS7	RS7	RS7	
Depth, ft		25-26.5	25-26.5	25-26.5	
Test Number					
Initial	Height, in	5.000	5.000	5.000	
	Diameter, in	2.500	2.500	2.500	
	Moisture Content (from Cuttings), %	36.1	36.1	36.1	
	Dry Density, pcf	82.1	82.1	82.1	
	Saturation (Wet Method), %	93.3	93.3	93.3	
	Void Ratio	1.04	1.04	1.04	
Final	Moisture Content, %	37.2	37.2	41.8	
	Dry Density, pcf	83.8	83.8	78.9	
	Cross-Sectional Area (Method A), in²	4.840	4.783	5.072	
	Saturation, %	100.0	100.0	100.0	
	Void Ratio	0.996	0.997	1.12	
	Back Pressure, %	1.404e+04	2.069e+04	3.160e+04	
Vertical Effective Consolidation Stress, psf		4110.	5516.	6037.	
Horizontal Effective Consolidation Stress, psf		4123.	5512.	6041.	
Vertical Strain after Consolidation, %		0.4134	-0.6007	-0.7447	
Volumetric Strain after Consolidation, %		1.396	1.978	-4.088	
Time to 50% Consolidation, min		16.00	16.00	16.00	
Shear Strength, psf		2990.	5792.	6935.	
Strain at Failure, %		2.94	2.99	1.40	
Strain Rate, %/min		0.01500	0.01500	0.01500	
Deviator Stress at Failure, psf		5980.	1.158e+04	1.387e+04	
Effective Minor Principal Stress at Failure, psf		1714.	4339.	6374.	
Effective Major Principal Stress at Failure, psf		7694.	1.592e+04	2.024e+04	
B-Value		0.96	---	---	

Notes:
- Before Shear Saturation set to 100% for phase calculation.
- Moisture Content determined by ASTM D2216.
- Deviator Stress includes membrane correction.
- Values for c and φ determined from best-fit straight line for the specific test conditions. Actual strength parameters may vary and should be determined by an engineer for site conditions.

GEOLABS, INC.
Geotechnical Engineering and Drilling Services

Project: Waiahole Water	Location:	Project No.: 8094-00&20
Boring No.: B2	Tested By: SA/JS	Checked By:
Sample No.: RS7	Test Date: 12-23-20	Depth: 25-26.5
Test No.:	Sample Type:	Elevation:
Description: Reddish brown clayey silt with some sand		
Remarks:		

Sample	Depth (feet)	Description	Average Permeability (cm/sec)
B-21	15 - 16.5	Reddish brown sandy clay (CL)	1.20E-7
B-21	25 - 26	Orangish brown w/ gray mott. clayey silt (MH) w/ traces of sand	3.04E-7

GEOLABS, INC.
GEOTECHNICAL ENGINEERING

W.O. 8094-00&20

SUMMARY OF PERMEABILITY TESTS - ASTM D5084

WAIAHOLE WATER SYSTEM IMPROVEMENT
KUNIA, OAHU, HAWAII

Plate
B - 21

Location	Depth (feet)	pH Value	Minimum Resistivity (ohm-cm)	Chloride Content (mg/kg)	Sulfate Content (mg/kg)
B-5	5.0 - 6.5	7.58*	2800*	78	17
B-9	5.0 - 6.5	8.2*	1900*	27	170
B-13	5.0 - 6.5	7.64*	3000*	23	39
B-15	5.0 - 6.5	7.7*	2600*	30	ND

TEST METHODS (by TestAmerica Laboratories, Inc.)

pH Value	Method 9045C
Minimum Resistivity	SM 2510B
Chloride Content	EPA 300.0
Sulfate Content	EPA 300.0

TEST METHODS (by Geolabs, Inc.)*

pH Value	ASTM G51
Minimum Resistivity	ASTM G57
Chloride Content	N/A
Sulfate Content	N/A

ND: Not Detected Within Reporting Limits

GEOLABS, INC.
GEOTECHNICAL ENGINEERING

W.O. 8094-00&20

SUMMARY OF CORROSIVITY TESTS

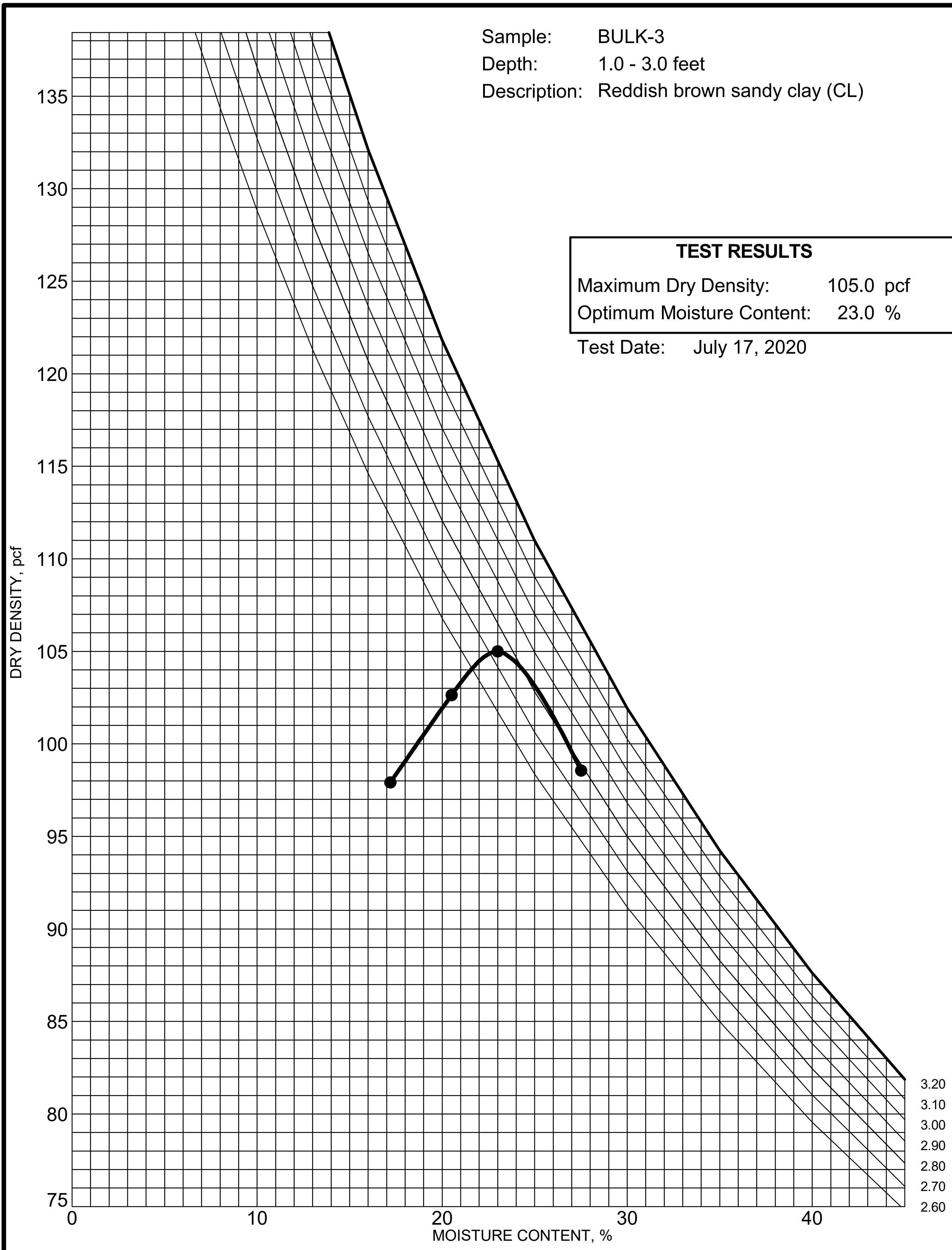
WAIAHOLE WATER SYSTEM IMPROVEMENT
KUNIA, OAHU, HAWAII

Plate
B - 22

Sample: BULK-3
Depth: 1.0 - 3.0 feet
Description: Reddish brown sandy clay (CL)

TEST RESULTS	
Maximum Dry Density:	105.0 pcf
Optimum Moisture Content:	23.0 %

Test Date: July 17, 2020



G_COMPACTION 8094-00&20.GPJ GEOLABS.GDT 1/26/21

GEOLABS, INC.
GEOTECHNICAL ENGINEERING

W.O. 8094-00&20

MOISTURE-DENSITY RELATIONSHIP - ASTM D1557 A

WAIAHOLE WATER SYSTEM IMPROVEMENT
KUNIA, OAHU, HAWAII

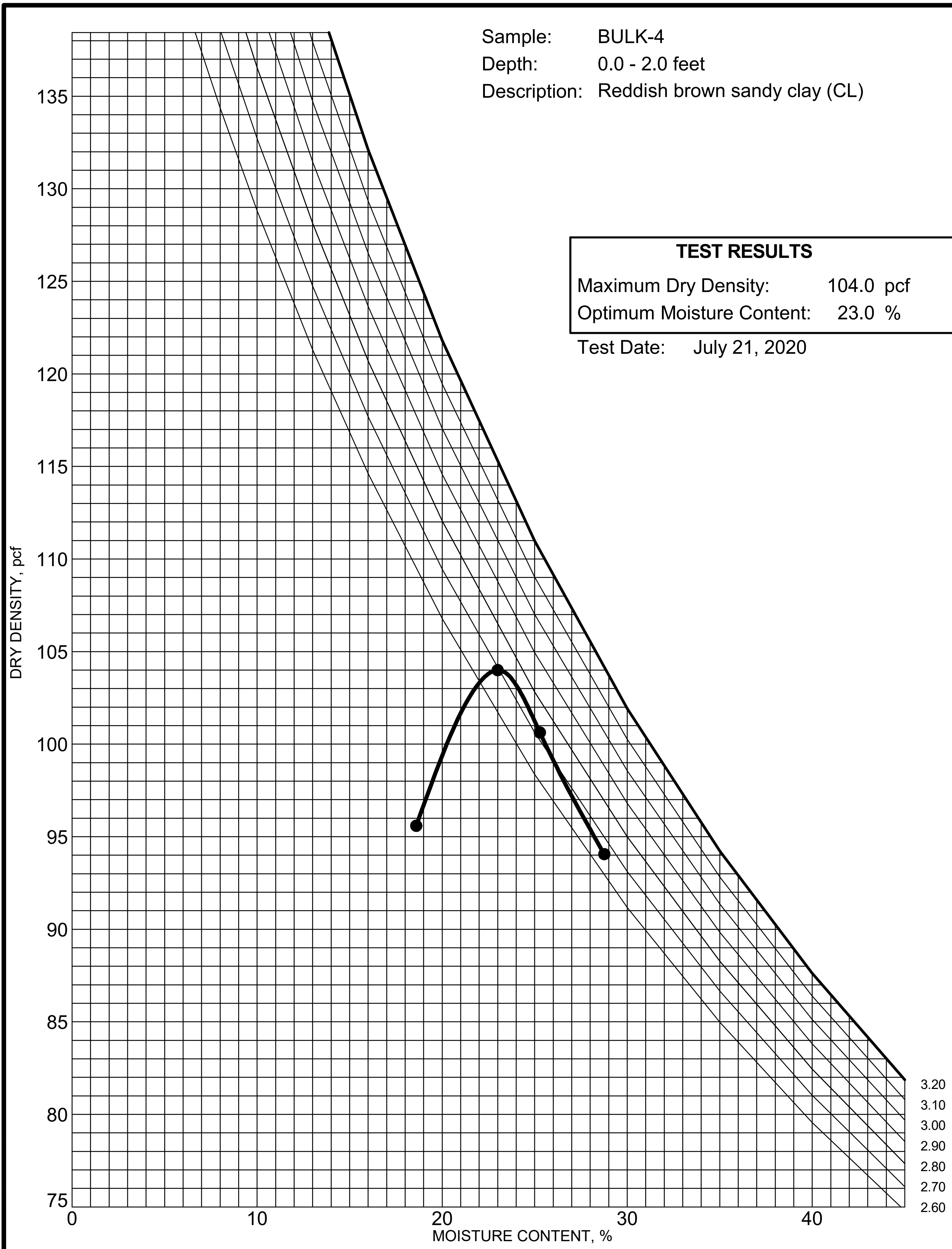
Plate
B - 23

Sample: BULK-4
Depth: 0.0 - 2.0 feet
Description: Reddish brown sandy clay (CL)

TEST RESULTS

Maximum Dry Density:	104.0	pcf
Optimum Moisture Content:	23.0	%

Test Date: July 21, 2020



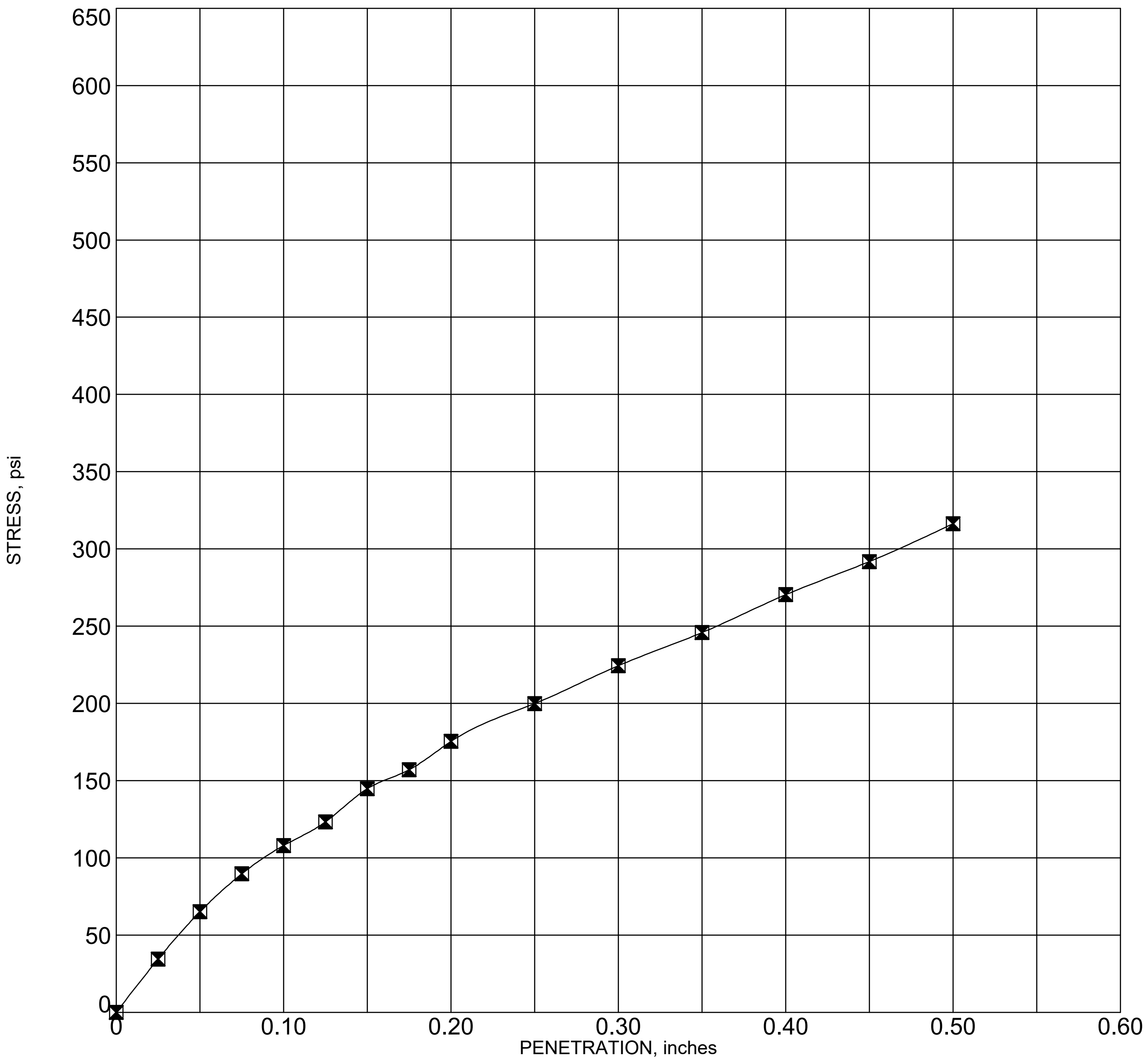
G COMPACTION 8094-00&20.GPJ GEOLABS.GDT 1/26/21

GEOLABS, INC.
GEOTECHNICAL ENGINEERING
W.O. 8094-00&20

MOISTURE-DENSITY RELATIONSHIP - ASTM D1557 A

WAIAHOLE WATER SYSTEM IMPROVEMENT
KUNIA, OAHU, HAWAII

Plate
B - 24



Corr. CBR @ 0.1"	10.8
Corr. CBR @ 0.2"	11.7
Swell (%)	0.04

Sample: BULK-1
Depth: 0.0 - 2.0 feet
Description: Reddish brown to brown clayey silt with a little sand

Molding Dry Density (pcf)	99.0	Hammer Wt. (lbs)	10
Molding Moisture (%)	28.0	Hammer Drop (inches)	18
Days Soaked	5	No. of Blows	56
Aggregate	3/4 inch minus	No. of Layers	5

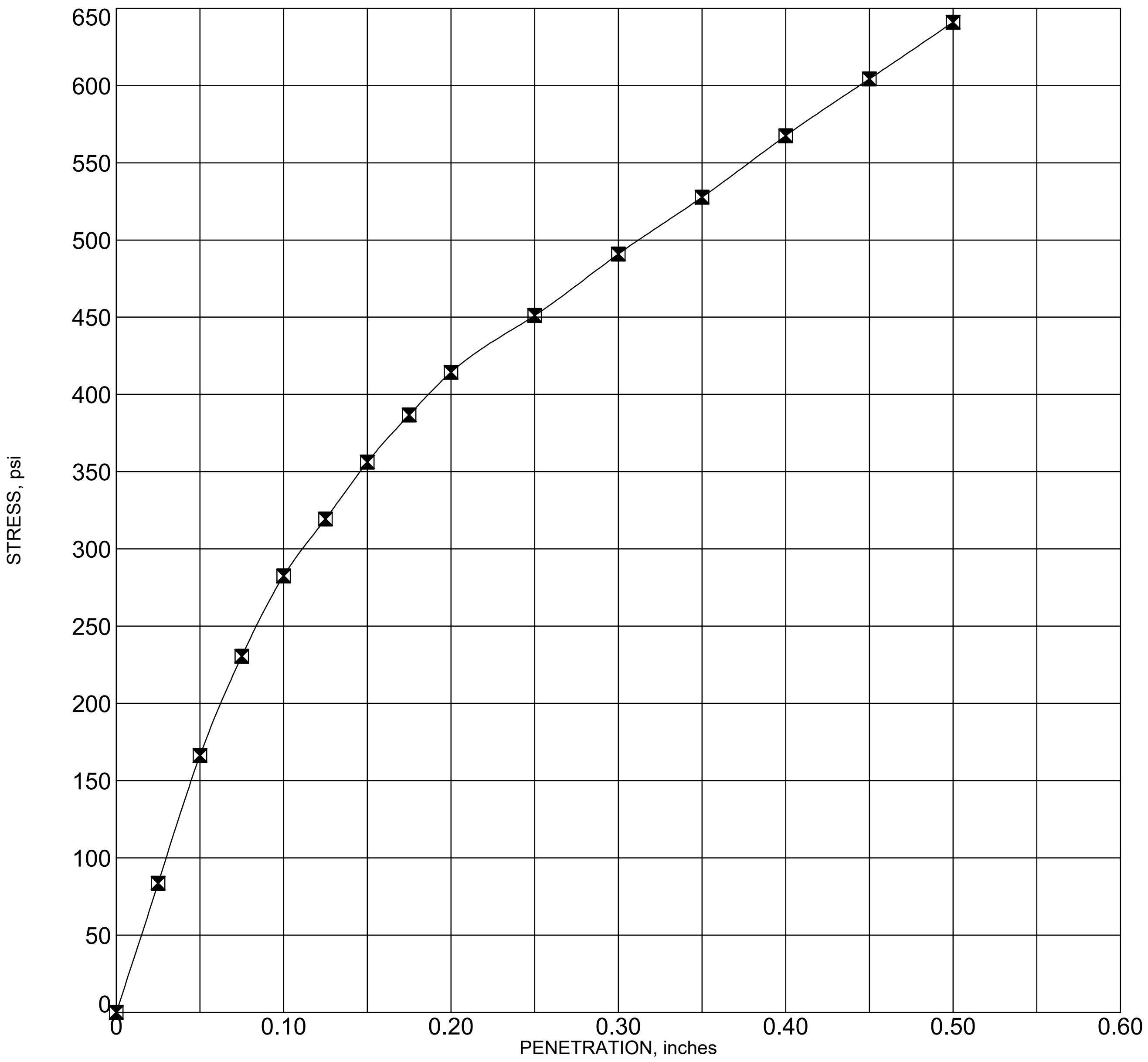
GEOLABS, INC.
GEOTECHNICAL ENGINEERING

W.O. 8094-00&20

CALIFORNIA BEARING RATIO - ASTM D1883

WAIAHOLE WATER SYSTEM IMPROVEMENT
KUNIA, OAHU, HAWAII

Plate
B - 25



Corr. CBR @ 0.1"	28.3
Corr. CBR @ 0.2"	27.6
Swell (%)	0.11

Sample: BULK-2
Depth: 0.0 - 2.0 feet
Description: Reddish brown to brown silty clay with some sand

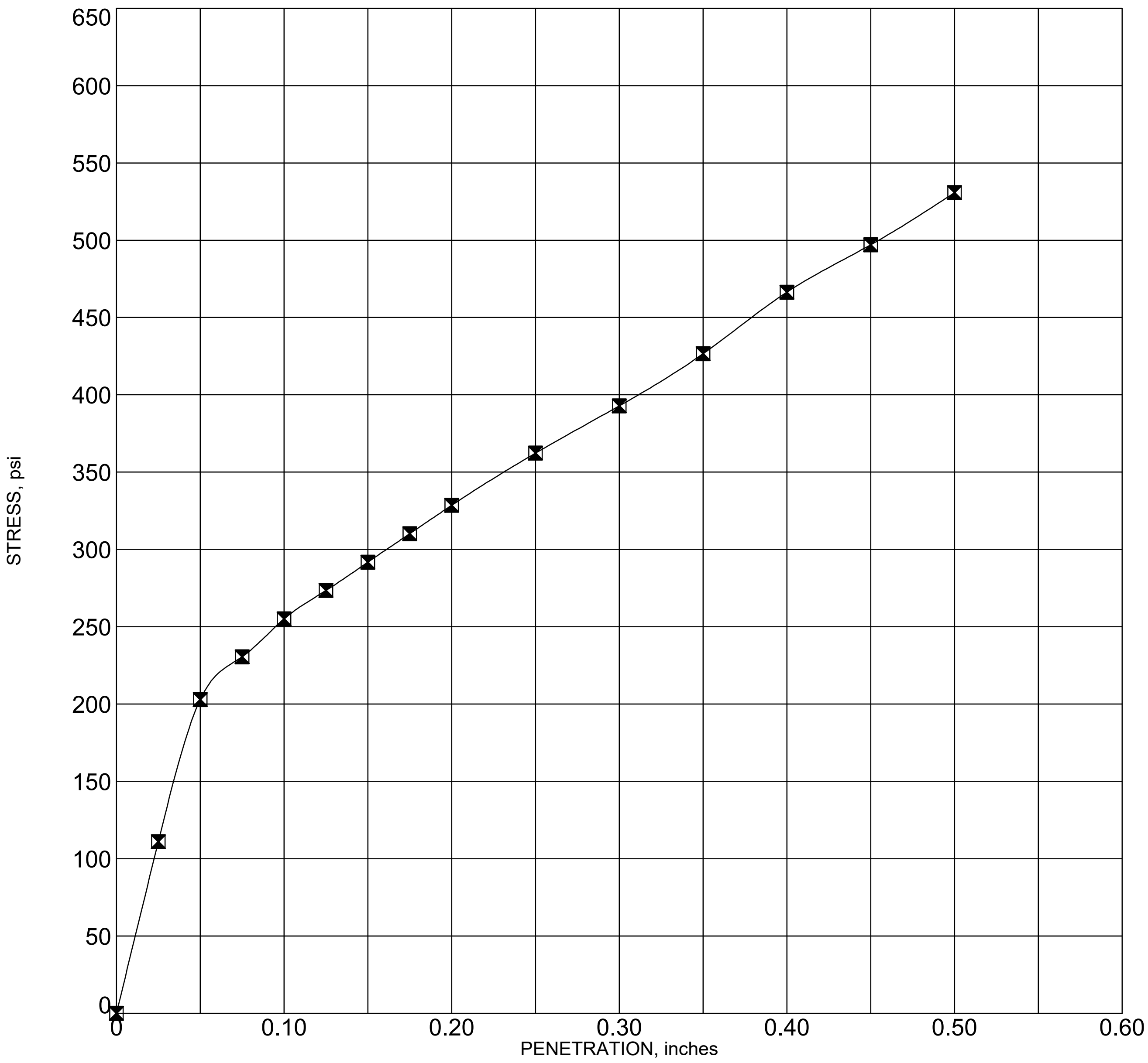
Molding Dry Density (pcf)	102.2	Hammer Wt. (lbs)	10
Molding Moisture (%)	25.8	Hammer Drop (inches)	18
Days Soaked	5	No. of Blows	56
Aggregate	3/4 inch minus	No. of Layers	5

GEOLABS, INC.
GEOTECHNICAL ENGINEERING

W.O. 8094-00&20

CALIFORNIA BEARING RATIO - ASTM D1883

WAIAHOLE WATER SYSTEM IMPROVEMENT
KUNIA, OAHU, HAWAII



Corr. CBR @ 0.1"	25.5
Corr. CBR @ 0.2"	21.9
Swell (%)	0.55

Sample: BULK-3
Depth: 1.0 - 3.0 feet
Description: Reddish brown sandy clay (CL)

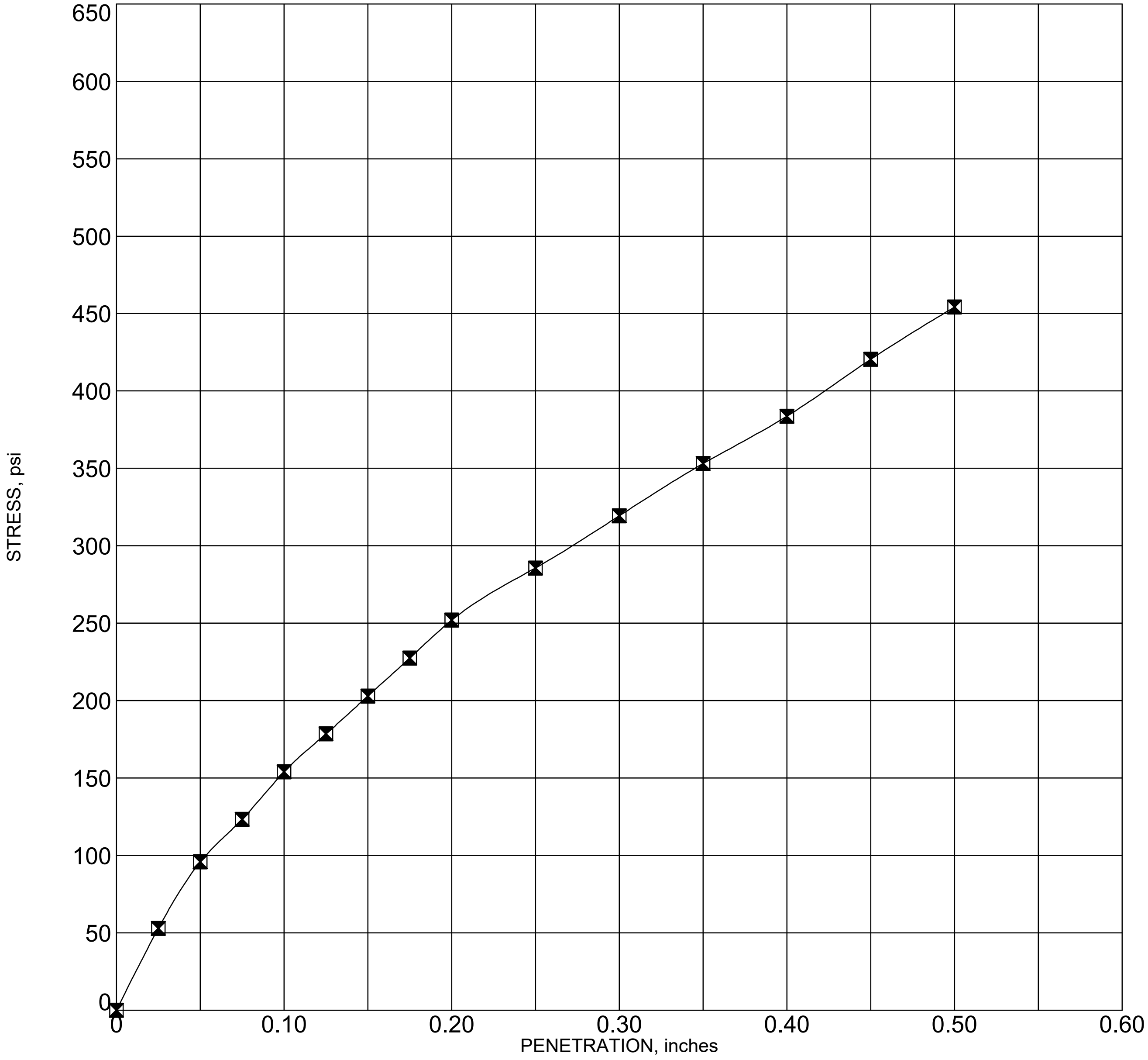
Molding Dry Density (pcf)	104.8	Hammer Wt. (lbs)	10
Molding Moisture (%)	24.1	Hammer Drop (inches)	18
Days Soaked	5	No. of Blows	56
Aggregate	3/4 inch minus	No. of Layers	5

GEOLABS, INC.
GEOTECHNICAL ENGINEERING
W.O. 8094-00&20

CALIFORNIA BEARING RATIO - ASTM D1883

WAIAHOLE WATER SYSTEM IMPROVEMENT
KUNIA, OAHU, HAWAII

Plate
B - 27



Corr. CBR @ 0.1"	15.4
Corr. CBR @ 0.2"	16.8
Swell (%)	0.63

Sample: BULK-4
Depth: 0.0 - 2.0 feet
Description: Reddish brown sandy clay (CL)

Molding Dry Density (pcf)	105.3	Hammer Wt. (lbs)	10
Molding Moisture (%)	22.2	Hammer Drop (inches)	18
Days Soaked	6	No. of Blows	56
Aggregate	3/4 inch minus	No. of Layers	5

GEOLABS, INC.
GEOTECHNICAL ENGINEERING
W.O. 8094-00&20

CALIFORNIA BEARING RATIO - ASTM D1883

WAIAHOLE WATER SYSTEM IMPROVEMENT
KUNIA, OAHU, HAWAII

Plate
B - 28

APPENDIX C

eurofins

Environment Testing
America

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ANALYTICAL REPORT

Eurofins TestAmerica, Sacramento
880 Riverside Parkway
West Sacramento, CA 95605
Tel: (916)373-5600

Laboratory Job ID: 320-61789-3
Laboratory Sample Delivery Group: 8094-00
Client Project/Site: WAIAHOLE WATER SYSTEM IMPROV.

For:
GeoLabs Inc
94-429 Koaki Street Suite 200
Waipahu, Hawaii 96797

Attn: Steven Asato

Nicole McCabe

Authorized for release by:
6/24/2020 2:25:35 PM

Nicole McCabe, Project Manager I
(916)374-4344
nicole.mccabe@testamericainc.com

LINKS

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Have a Question? Ask The Expert

Visit us at:
www.eurofinsus.com/Env

The test results in this report meet all 2003 NELAC, 2009 TNI, and 2016 TNI requirements for accredited parameters, exceptions are noted in this report. This report may not be reproduced except in full, and with written approval from the laboratory. For questions please contact the Project Manager at the e-mail address or telephone number listed on this page.

This report has been electronically signed and authorized by the signatory. Electronic signature is intended to be the legally binding equivalent of a traditionally handwritten signature.

Results relate only to the items tested and the sample(s) as received by the laboratory.

Table of Contents

Definitions/Glossary

Glossary

Abbreviation	These commonly used abbreviations may or may not be present in this report.
¤	Listed under the "D" column to designate that the result is reported on a dry weight basis
%R	Percent Recovery
CFL	Contains Free Liquid
CFU	Colony Forming Unit
CNF	Contains No Free Liquid
DER	Duplicate Error Ratio (normalized absolute difference)
Dil Fac	Dilution Factor
DL	Detection Limit (DoD/DOE)
DL, RA, RE, IN	Indicates a Dilution, Re-analysis, Re-extraction, or additional Initial metals/anion analysis of the sample
DLC	Decision Level Concentration (Radiochemistry)
EDL	Estimated Detection Limit (Dioxin)
LOD	Limit of Detection (DoD/DOE)
LOQ	Limit of Quantitation (DoD/DOE)
MCL	EPA recommended "Maximum Contaminant Level"
MDA	Minimum Detectable Activity (Radiochemistry)
MDC	Minimum Detectable Concentration (Radiochemistry)
MDL	Method Detection Limit
ML	Minimum Level (Dioxin)
MPN	Most Probable Number
MQL	Method Quantitation Limit
NC	Not Calculated
ND	Not Detected at the reporting limit (or MDL or EDL if shown)
NEG	Negative / Absent
POS	Positive / Present
PQL	Practical Quantitation Limit
PRES	Presumptive
QC	Quality Control
RER	Relative Error Ratio (Radiochemistry)
RL	Reporting Limit or Requested Limit (Radiochemistry)
RPD	Relative Percent Difference, a measure of the relative difference between two points
TEF	Toxicity Equivalent Factor (Dioxin)
TEQ	Toxicity Equivalent Quotient (Dioxin)
TNTC	Too Numerous To Count

Case Narrative

Client: GeoLabs Inc
Project/Site: WAIAHOLE WATER SYSTEM IMPROV.

Job ID: 320-61789-3
SDG: 8094-00

Job ID: 320-61789-3

Laboratory: Eurofins TestAmerica, Sacramento

Narrative

Job Narrative
320-61789-3

Comments

No additional comments.

Receipt

The samples were received on 6/15/2020 9:10 AM; the samples arrived in good condition, and where required, properly preserved and on ice. The temperature of the cooler at receipt was 3.7° C.

HPLC/IC

No analytical or quality issues were noted, other than those described in the Definitions/Glossary page.

General Chemistry

No analytical or quality issues were noted, other than those described in the Definitions/Glossary page.

Detection Summary

Client Sample ID: B5 RS4 5-6.5FT — Lab Sample ID: 320-61789-5

Analyte	Result	Qualifier	RL		Unit	Dil Fac	D	Method	Prep Type
Chloride	78		5.0		mg/Kg	1		300.0	Soluble
Sulfate	17		5.0		mg/Kg	1		300.0	Soluble

Client Sample ID: B9 RS3 5-6.5FT — Lab Sample ID: 320-61789-6

Analyte	Result	Qualifier	RL		Unit	Dil Fac	D	Method	Prep Type
Chloride	27		5.0		mg/Kg	1		300.0	Soluble
Sulfate	170		5.0		mg/Kg	1		300.0	Soluble

Client Sample ID: B13 RS3 5-6.5FT — Lab Sample ID: 320-61789-7

Analyte	Result	Qualifier	RL		Unit	Dil Fac	D	Method	Prep Type
Chloride	23		5.0		mg/Kg	1		300.0	Soluble
Sulfate	39		5.0		mg/Kg	1		300.0	Soluble

Client Sample ID: B15 RS3 5-6.5FT — Lab Sample ID: 320-61789-8

Analyte	Result	Qualifier	RL		Unit	Dil Fac	D	Method	Prep Type
Chloride	30		5.0		mg/Kg	1		300.0	Soluble

This Detection Summary does not include radiochemical test results.

Client Sample Results

1
2
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Client Sample ID: B5 RS4 5-6.5FT

Lab Sample ID: 320-61789-5

Date Collected: 06/01/20 10:00
Date Received: 06/15/20 09:10
Matrix: Solid

Method: 300.0 - Anions, Ion Chromatography - Soluble

Analyte	Result	Qualifier	RL		Unit	D	Prepared	Analyzed	Dil Fac
Chloride	**78**		5.0		mg/Kg			06/17/20 02:22	1
Sulfate	**17**		5.0		mg/Kg			06/17/20 02:22	1

Client Sample ID: B9 RS3 5-6.5FT

Lab Sample ID: 320-61789-6

Date Collected: 06/03/20 10:00
Date Received: 06/15/20 09:10
Matrix: Solid

Method: 300.0 - Anions, Ion Chromatography - Soluble

Analyte	Result	Qualifier	RL		Unit	D	Prepared	Analyzed	Dil Fac
Chloride	**27**		5.0		mg/Kg			06/17/20 02:39	1
Sulfate	**170**		5.0		mg/Kg			06/17/20 02:39	1

Client Sample ID: B13 RS3 5-6.5FT

Lab Sample ID: 320-61789-7

Date Collected: 06/01/20 10:00
Date Received: 06/15/20 09:10
Matrix: Solid

Method: 300.0 - Anions, Ion Chromatography - Soluble

Analyte	Result	Qualifier	RL		Unit	D	Prepared	Analyzed	Dil Fac
Chloride	**23**		5.0		mg/Kg			06/17/20 02:56	1
Sulfate	**39**		5.0		mg/Kg			06/17/20 02:56	1

Client Sample ID: B15 RS3 5-6.5FT

Lab Sample ID: 320-61789-8

Date Collected: 06/01/20 10:00
Date Received: 06/15/20 09:10
Matrix: Solid

Method: 300.0 - Anions, Ion Chromatography - Soluble

Analyte	Result	Qualifier	RL		Unit	D	Prepared	Analyzed	Dil Fac
Chloride	**30**		5.0		mg/Kg			06/17/20 03:13	1
Sulfate	ND		5.0		mg/Kg			06/17/20 03:13	1

QC Sample Results

Method: 300.0 - Anions, Ion Chromatography

Lab Sample ID: MB 440-612967/1-A
Matrix: Solid
Analysis Batch: 612888

Client Sample ID: Method Blank
Prep Type: Soluble

Analyte	MB Result	MB Qualifier	RL	Unit	D	Prepared	Analyzed	Dil Fac
Chloride	ND		5.0	mg/Kg			06/16/20 14:03	1
Sulfate	ND		5.0	mg/Kg			06/16/20 14:03	1

Lab Sample ID: LCS 440-612967/2-A
Matrix: Solid
Analysis Batch: 612888

Client Sample ID: Lab Control Sample
Prep Type: Soluble

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Chloride	50.0	46.8		mg/Kg		94	90 - 110
Sulfate	50.0	49.3		mg/Kg		99	90 - 110

Lab Sample ID: 320-61789-A-15-B MS
Matrix: Solid
Analysis Batch: 612888

Client Sample ID: Matrix Spike
Prep Type: Soluble

Analyte	Sample Result	Sample Qualifier	Spike Added	MS Result	MS Qualifier	Unit	D	%Rec	%Rec. Limits
Chloride	ND		49.5	45.3		mg/Kg		92	80 - 120
Sulfate	5.4		49.5	54.3		mg/Kg		99	80 - 120

Lab Sample ID: 320-61789-A-15-C MSD
Matrix: Solid
Analysis Batch: 612888

Client Sample ID: Matrix Spike Duplicate
Prep Type: Soluble

Analyte	Sample Result	Sample Qualifier	Spike Added	MSD Result	MSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Chloride	ND		49.5	44.9		mg/Kg		91	80 - 120	1	20
Sulfate	5.4		49.5	54.7		mg/Kg		100	80 - 120	1	20

QC Association Summary

Client: GeoLabs Inc
Project/Site: WAIAHOLE WATER SYSTEM IMPROV.

Job ID: 320-61789-3
SDG: 8094-00

HPLC/IC

Analysis Batch: 612888

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
320-61789-5	B5 RS4 5-6.5FT	Soluble	Solid	300.0	612967
320-61789-6	B9 RS3 5-6.5FT	Soluble	Solid	300.0	612967
320-61789-7	B13 RS3 5-6.5FT	Soluble	Solid	300.0	612967
320-61789-8	B15 RS3 5-6.5FT	Soluble	Solid	300.0	612967
MB 440-612967/1-A	Method Blank	Soluble	Solid	300.0	612967
LCS 440-612967/2-A	Lab Control Sample	Soluble	Solid	300.0	612967
320-61789-A-15-B MS	Matrix Spike	Soluble	Solid	300.0	612967
320-61789-A-15-C MSD	Matrix Spike Duplicate	Soluble	Solid	300.0	612967

Leach Batch: 612967

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
320-61789-5	B5 RS4 5-6.5FT	Soluble	Solid	DI Leach	
320-61789-6	B9 RS3 5-6.5FT	Soluble	Solid	DI Leach	
320-61789-7	B13 RS3 5-6.5FT	Soluble	Solid	DI Leach	
320-61789-8	B15 RS3 5-6.5FT	Soluble	Solid	DI Leach	
MB 440-612967/1-A	Method Blank	Soluble	Solid	DI Leach	
LCS 440-612967/2-A	Lab Control Sample	Soluble	Solid	DI Leach	
320-61789-A-15-B MS	Matrix Spike	Soluble	Solid	DI Leach	
320-61789-A-15-C MSD	Matrix Spike Duplicate	Soluble	Solid	DI Leach	

Lab Chronicle

Client: GeoLabs Inc
Project/Site: WAIAHOLE WATER SYSTEM IMPROV.

Job ID: 320-61789-3
SDG: 8094-00

Client Sample ID: B5 RS4 5-6.5FT

Lab Sample ID: 320-61789-5
Date Collected: 06/01/20 10:00
Matrix: Solid
Date Received: 06/15/20 09:10

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Soluble	Leach	DI Leach			4.00 g	40 mL	612967	06/16/20 22:49	NN	TAL IRV
Soluble	Analysis	300.0		1			612888	06/17/20 02:22	NTN	TAL IRV

Client Sample ID: B9 RS3 5-6.5FT

Lab Sample ID: 320-61789-6
Date Collected: 06/03/20 10:00
Matrix: Solid
Date Received: 06/15/20 09:10

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Soluble	Leach	DI Leach			3.99 g	40 mL	612967	06/16/20 22:49	NN	TAL IRV
Soluble	Analysis	300.0		1			612888	06/17/20 02:39	NTN	TAL IRV

Client Sample ID: B13 RS3 5-6.5FT

Lab Sample ID: 320-61789-7
Date Collected: 06/01/20 10:00
Matrix: Solid
Date Received: 06/15/20 09:10

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Soluble	Leach	DI Leach			4.00 g	40 mL	612967	06/16/20 22:49	NN	TAL IRV
Soluble	Analysis	300.0		1			612888	06/17/20 02:56	NTN	TAL IRV

Client Sample ID: B15 RS3 5-6.5FT

Lab Sample ID: 320-61789-8
Date Collected: 06/01/20 10:00
Matrix: Solid
Date Received: 06/15/20 09:10

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Soluble	Leach	DI Leach			3.97 g	40 mL	612967	06/16/20 22:49	NN	TAL IRV
Soluble	Analysis	300.0		1			612888	06/17/20 03:13	NTN	TAL IRV

Laboratory References:

TAL IRV = Eurofins Calscience Irvine, 17461 Derian Ave, Suite 100, Irvine, CA 92614-5817, TEL (949)261-1022

Accreditation/Certification Summary

Laboratory: Eurofins TestAmerica, Sacramento

All accreditations/certifications held by this laboratory are listed. Not all accreditations/certifications are applicable to this report.

Authority	Program	Identification Number	Expiration Date
Alaska (UST)	State	17-020	01-20-21
ANAB	Dept. of Defense ELAP	L2468	01-20-21
ANAB	Dept. of Energy	L2468.01	01-20-21
ANAB	ISO/IEC 17025	L2468	01-20-21
Arizona	State	AZ0708	08-11-20
Arkansas DEQ	State	19-042-0	06-17-20
California	State	2897	01-31-22
Colorado	State	CA0004	08-31-20
Connecticut	State	PH-0691	06-30-21
Florida	NELAP	E87570	07-01-21
Georgia	State	4040	01-30-21
Hawaii	State	<cert No.>	01-29-21
Illinois	NELAP	200060	03-17-21
Kansas	NELAP	E-10375	10-31-20
Louisiana	NELAP	01944	06-30-20
Maine	State	2018009	04-14-22
Michigan	State	9947	01-31-22
Nevada	State	CA000442020-1	07-31-20
New Hampshire	NELAP	2997	04-18-21
New Jersey	NELAP	CA005	06-30-21
New York	NELAP	11666	04-01-21
Oregon	NELAP	4040	01-29-21
Pennsylvania	NELAP	68-01272	03-31-21
Texas	NELAP	T104704399-19-13	06-01-21
US Fish & Wildlife	US Federal Programs	58448	07-31-20
USDA	US Federal Programs	P330-18-00239	07-31-21
Utah	NELAP	CA000442019-01	02-28-21
Vermont	State	VT-4040	04-16-21
Virginia	NELAP	460278	03-14-21
Washington	State	C581	05-05-20 *
West Virginia (DW)	State	9930C	12-31-20
Wyoming	State Program	8TMS-L	01-28-19 *

Laboratory: Eurofins Calscience Irvine

All accreditations/certifications held by this laboratory are listed. Not all accreditations/certifications are applicable to this report.

Authority	Program	Identification Number	Expiration Date
Alaska	State	CA01531	06-30-20
Arizona	State	AZ0671	10-14-20
California	Los Angeles County Sanitation Districts	10256	06-30-20
California	State	2706	06-30-20
Guam	State	20-004R	01-23-21
Hawaii	State	CA01531	01-29-21
Kansas	NELAP	E-10420	07-31-20
Nevada	State	CA015312020-9	07-31-20
Oregon	NELAP	4028 - 008	01-29-21
USDA	US Federal Programs	P330-18-00214	07-09-21
Washington	State	C900	09-03-20

* Accreditation/Certification renewal pending - accreditation/certification considered valid.

Accreditation/Certification Summary

Client: GeoLabs Inc
Project/Site: WAIAHOLE WATER SYSTEM IMPROV.

Job ID: 320-61789-3
SDG: 8094-00

Laboratory: Eurofins TestAmerica, Honolulu

All accreditations/certifications held by this laboratory are listed. Not all accreditations/certifications are applicable to this report.

Authority	Program	Identification Number	Expiration Date
Hawaii	State Program	N/A	06-28-10 *
USDA	Federal	P330-17-00296	08-30-20

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* Accreditation/Certification renewal pending - accreditation/certification considered valid.

Method Summary

Client: GeoLabs Inc
Project/Site: WAIAHOLE WATER SYSTEM IMPROV.

Job ID: 320-61789-3
SDG: 8094-00

Method	Method Description	Protocol	Laboratory
300.0	Anions, Ion Chromatography	MCAWW	TAL IRV
DI Leach	Deionized Water Leaching Procedure	ASTM	TAL IRV

Protocol References:

ASTM = ASTM International

MCAWW = "Methods For Chemical Analysis Of Water And Wastes", EPA-600/4-79-020, March 1983 And Subsequent Revisions.

Laboratory References:

TAL IRV = Eurofins Calscience Irvine, 17461 Derian Ave, Suite 100, Irvine, CA 92614-5817, TEL (949)261-1022

Sample Summary

Client: GeoLabs Inc
Project/Site: WAIAHOLE WATER SYSTEM IMPROV.

Job ID: 320-61789-3
SDG: 8094-00

Lab Sample ID	Client Sample ID	Matrix	Collected	Received	Asset ID
320-61789-5	B5 RS4 5-6.5FT	Solid	06/01/20 10:00	06/15/20 09:10	
320-61789-6	B9 RS3 5-6.5FT	Solid	06/03/20 10:00	06/15/20 09:10	
320-61789-7	B13 RS3 5-6.5FT	Solid	06/01/20 10:00	06/15/20 09:10	
320-61789-8	B15 RS3 5-6.5FT	Solid	06/01/20 10:00	06/15/20 09:10	

Eurofins TestAmerica, Irvine
17461 Derian Ave Suite 100
Irvine, CA 92614-5817
Phone (949) 261-1022 Fax (949) 260-3297

Chain of Custody Record

eurofins

Client Information

Client Contact: **Steven Asato**
Company: **GeoLabs Inc**
Address: **94-411 KOAKI ST**
City: **WAIPAHU**
State, Zip: **HI, 96797**
Phone: **808-841-5064(Tel)**
Email: Steven_a@geolabs net
Project Name: KAPOLEI HARBORSIDE ROADS A&B
Site: Kapolei

Sampler:
Phone:
Due Date Requested:
TAT Requested (days):
PO #: Purchase Order not required
8112-00
Project #:
SSOW#:

Lab PM: Fama, Sheri M
E-Mail: sheri fama@testamericainc.com

Carrier Tracking No(s): 7706 9484 1659

COC No: 370-1400-408.1
Page: Page 1 of 1
Job #:

Analysis Requested

Preservation Codes:

A - HCL
B - NaOH
C - Zn Acetate
D - Nitric Acid
E - NaHSO4
F - MeOH
G - Amchlor
H - Ascorbic Acid
I - Ice
J - DI Water
K - EDTA
L - EDA

M - Hexane
N - None
O - AsNaO2
P - Na2O4S
Q - Na2SO3
R - Na2S2O3
S - H2SO4
T - TSP Dodecahydrate
U - Acetone
V - MCAA
W - pH 4-5
Z - other (specify)

Other:

Sample Identification	Sample Date	Sample Time	Sample Type (C=comp, G=grab)	Matrix (W=water, S=solid, O=waste/oil, BT=Tissue, A=Air)	Field Filtered (Y or No)	Perform MS/MSD (Y or No)	300_ORGFM_28D - Cl, SO4	Chloride	Sulfate	Total Number of containers	Special Instructions/Note:
			Preservation Code:				N				
B1 RS1/SPT2 1-4FT	6/6/20	10 am	C					✓	✓		
B5 RS1/SPT2 1-4FT	6/6/20	10 am	C					✓	✓		

320-61789 Chain of Custody

Possible Hazard Identification
☒ *Non-Hazard* ☐ *Flammable* ☐ *Skin Irritant* ☐ *Poison B* ☐ *Unknown* ☐ *Radiological*

Deliverable Requested: I, II, III, IV, Other (specify)

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)
☐ *Return To Client* ☐ *Disposal By Lab* ☐ *Archive For* ______ *Months*

Special Instructions/QC Requirements:

Empty Kit Relinquished by: | Date: | Time: | Method of Shipment

Relinquished by	Date/Time	Company	Received by	Date/Time	Company
	6/12/20 8:00am	Geolabs		6/15/20 0910	ECMKU
Relinquished by	Date/Time	Company	Received by	Date/Time	Company
Relinquished by	Date/Time	Company	Received by	Date/Time	Company

Custody Seals Intact: Δ Yes Δ No
Custody Seal No.:
Cooler Temperature(s) °C and Other Remarks: 3.5/3.7 IR.93

Ver 01/16/2019

Eurofins TestAmerica, Irvine
17461 Derian Ave Suite 100
Irvine, CA 92614-5817
Phone (949) 261-1022 Fax (949) 260-3297

Chain of Custody Record

eurofins

Client Information
Client Contact: **Steven Asato**
Company: **GeoLabs Inc**
Address: **94-411 KOAKI ST**
City: **WAIPAHU**
State, Zip: **HI, 96797**
Phone: **808-841-5064(Tel)**
Email: Steven_a@geolabs.net
Project Name: HPHA SCHOOL STREET
Site:

Sampler:
Phone:
Due Date Requested:
TAT Requested (days):
PO #: Purchase Order not required
8042-00
Project #:
SSOW#:

Lab PM: Fama, Sheri M
E-Mail: sheri fama@testamericainc com

Carrier Tracking No(s): 7766 9484 1659

COC No: 370-1400-408 1
Page: Page 1 of 1
Job #:

Analysis Requested

Sample Identification	Sample Date	Sample Time	Sample Type (C=comp, G=grab)	Matrix (W=water, S=solid, O=waste/oil, BT=Tissue, A=Air)	Field Filtered Sample (Yes or No)	Perform MS/MSD (Yes or No)	300_ORGFM_28D - Cl, SO4	CHLORIDE	SULFATE	Total Number of containers	Special Instructions/Note:
			Preservation Code:				N				
LID-6 SPT1/SPT2	5/5/20	10 am	C					✓	✓		
BULK-1 @ B2 0-2FT	5/9/20	10 am	C					✓	✓		

Preservation Codes:

A - HCL	M - Hexane
B - NaOH	N - None
C - Zn Acetate	O - AsNaO2
D - Nitric Acid	P - Na2O4S
E - NaHSO4	Q - Na2SO3
F - MeOH	R - Na2S2O3
G - Amchlor	S - H2SO4
H - Ascorbic Acid	T - TSP Dodecahydrate
I - Ice	U - Acetone
J - DI Water	V - MCAA
K - EDTA	W - pH 4-5
L - EDA	Z - other (specify)

Other:

Possible Hazard Identification
☒ *Non-Hazard* ☐ *Flammable* ☐ *Skin Irritant* ☐ *Poison B* ☐ *Unknown* ☐ *Radiological*

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)
☐ *Return To Client* ☐ *Disposal By Lab* ☐ *Archive For* ______ *Months*

Deliverable Requested I, II, III, IV, Other (specify)
Special Instructions/QC Requirements

Empty Kit Relinquished by | Date: | Time: | Method of Shipment

Relinquished by	Date/Time	Company	Received by	Date/Time	Company
	6/12/20 8:00	Geolabs		6/15/20 0916	EC -IRV
Relinquished by	Date/Time	Company	Received by	Date/Time	Company
Relinquished by	Date/Time	Company	Received by	Date/Time	Company

Custody Seals Intact: Δ Yes [✓ No]
Custody Seal No.:
Cooler Temperature(s) °C and Other Remarks: 3.5/3.7 1R-4?

Ver 01/16/2019

Eurofins TestAmerica, Irvine
17461 Derian Ave Suite 100
Irvine, CA 92614-5817
Phone (949) 261-1022 Fax (949) 260-3297

Chain of Custody Record

eurofins

Client Information	Sampler	Lab PM Fama, Sheri M	Carrier Tracking No(s) 7706 9484 1659	COC No 370-1400-408 1
Client Contact **Steven Asato**	Phone	E-Mail sheri fama@testamericainc com		Page Page 1 of 1
Company **GeoLabs Inc**				Job #
Address **94-411 KOAKI ST**	**Due Date Requested:**			
City **WAIPAHU**	**TAT Requested (days):**			
State, Zip **HI, 96797**				
Phone **808-841-5064(Tel)**	PO # Purchase Order not required			
Email Steven a@geolabs net	8094-00			
Project Name WAIAHOLE WATER SYSTEM IMPROV.	Project #			
Site: ~~Waiah~~ WAIAHOLE	SSOW#			

Analysis Requested

Sample Identification	Sample Date	Sample Time	Sample Type (C=comp, G=grab)	Matrix (W=water, S=solid, O=waste/oil, BT=Tissue, A=Air)	Field Filtered Sample (Yes or No)	Perform MS/MSD (Yes or No)	300_ORGFM_28D - Cl, SO4	CHLORIDE	SULFATE	Total Number of containers	Special Instructions/Note:
			Preservation Code:				N				
B5 RS4 5-6.5FT	6/1/20	10 am	C					✓	✓		
B9 RS3 5-6.5FT	6/3/20	10 am	C					✓	✓		
B13 RS3 5-6.5FT	6/1/20	10 am	C					✓	✓		
B15 RS3 5-6.5FT	6/1/20	10 am	C					✓	✓		

Preservation Codes:

A - HCL	M - Hexane
B - NaOH	N - None
C - Zn Acetate	O - AsNaO2
D - Nitric Acid	P - Na2O4S
E - NaHSO4	Q - Na2SO3
F - MeOH	R - Na2S2O3
G - Amchlor	S - H2SO4
H - Ascorbic Acid	T - TSP Dodecahydrate
I - Ice	U - Acetone
J - DI Water	V - MCAA
K - EDTA	W - pH 4-5
L - EDA	Z - other (specify)

Other:

Possible Hazard Identification
☒ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown ☐ Radiological

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)
☐ Return To Client ☐ Disposal By Lab ☐ Archive For ______ Months

Deliverable Requested. I, II, III, IV, Other (specify)

Special Instructions/QC Requirements

Empty Kit Relinquished by: | Date: | Time | Method of Shipment

Relinquished by	Date/Time	Company	Received by	Date/Time	Company
	6/12/20 8:00am	Geolabs		6/15/20 0910	EC-IRV
Relinquished by	Date/Time	Company	Received by	Date/Time	Company
Relinquished by	Date/Time	Company	Received by	Date/Time	Company

Custody Seals Intact: Δ Yes [✓ Δ No]
Custody Seal No.
Cooler Temperature(s) °C and Other Remarks: 3 5/3 7
IR 93

Ver 01/16/2019

Eurofins TestAmerica, Irvine
17461 Derian Ave Suite 100
Irvine, CA 92614-5817
Phone (949) 261-1022 Fax (949) 260-3297

Chain of Custody Record

eurofins
Environment Testing
TestAmerica

Client Information	Sampler	Lab PM Fama, Sheri M	Carrier Tracking No(s) 7706 9484 1659	COC No 370-1400-408 1
Client Contact **Steven Asato**	Phone	E-Mail sheri fama@testamericainc.com		Page Page 1 of 1
Company **GeoLabs Inc**				Job #

Address **94-411 KOAKI ST**	**Due Date Requested:**
City **WAIPAHU**	**TAT Requested (days):**
State, Zip **HI, 96797**	
Phone **808-841-5064(Tel)**	PO # Purchase Order not required
Email Steven_a@geolabs net	8046-00
Project Name MANOA WATER SYSTEM IMPROV.	Project #
Site: ~~Waikiki~~ MANOA	SSOW#

Analysis Requested

Preservation Codes:

A - HCL	M - Hexane
B - NaOH	N - None
C - Zn Acetate	O - AsNaO2
D - Nitric Acid	P - Na2O4S
E - NaHSO4	Q - Na2SO3
F - MeOH	R - Na2S2O3
G - Amchlor	S - H2SO4
H - Ascorbic Acid	T - TSP Dodecahydrate
I - Ice	U - Acetone
J - DI Water	V - MCAA
K - EDTA	W - pH 4-5
L - EDA	Z - other (specify)

Other:

Sample Identification	Sample Date	Sample Time	Sample Type (C=comp, G=grab)	Matrix (W=water, S=solid, O=waste/oil, BT=Tissue, A=Air)	Field Filtered Sample (Yes or No)	Perform MS/MSD (Yes or No)	300_ORGFM_28D - Cl, SO4	CHLORIDE	SULFATE	Total Number of containers	Special Instructions/Note:
			Preservation Code:				N				
B1 RS2/RS3 3-5.83FT	6/8/20	10 am	C					✓	✓		
B2 SPT1/RS2 1.5-6.5FT	6/8/20	10 am	C					✓	✓		
B3 SPT1 1.5-3.5FT	6/8/20	10 am	C					✓	✓		
B4 SPT1/RS2 1.5-6.5FT	6/8/20	10 am	C					✓	✓		
B5 SPT1 1.5-3.3FT	6/9/20	10 am	C					✓	✓		
B6 SPT1/RS2 1.5-6.2FT	6/9/20	10 am	C					✓	✓		
B7 SPT1/RS2 1.5-6.5FT	6/9/20	10 am	C					✓	✓		

Possible Hazard Identification
☒ *Non-Hazard* ☐ *Flammable* ☐ *Skin Irritant* ☐ *Poison B* ☐ *Unknown* ☐ *Radiological*

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)
☐ *Return To Client* ☐ *Disposal By Lab* ☐ *Archive For ________ Months*

Deliverable Requested I, II, III, IV, Other (specify)

Special Instructions/QC Requirements

Empty Kit Relinquished by	Date:	Time:	Method of Shipment

Relinquished by	Date/Time	Company	Received by	Date/Time	Company
	6/12/20 8:00am	Geolabs		6/15/20 0910	EC-IRV
Relinquished by	Date/Time	Company	Received by	Date/Time	Company
Relinquished by	Date/Time	Company	Received by	Date/Time	Company

Custody Seals Intact: Δ Yes [✓ Δ No]	Custody Seal No.	Cooler Temperature(s) °C and Other Remarks: 3.5/3.7 IR-93

Ver. 01/16/2019

1 2 3 4 5 6 7 8 9 10 11 12 13 14

Login Sample Receipt Checklist

Client: GeoLabs Inc

Job Number: 320-61789-3
SDG Number: 8094-00

Login Number: 61789
List Number: 1
Creator: Kovalyov, Nikita

List Source: Eurofins TestAmerica, Sacramento

Question	Answer	Comment
Radioactivity wasn't checked or is </= background as measured by a survey meter.	N/A	
The cooler's custody seal, if present, is intact.	True	
Sample custody seals, if present, are intact.	True	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	True	
Cooler Temperature is acceptable.	True	
Cooler Temperature is recorded.	True	
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
Is the Field Sampler's name present on COC?	False	
There are no discrepancies between the containers received and the COC.	True	
Samples are received within Holding Time (excluding tests with immediate HTs)	False	Samples 3 & 4 out of holding time
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
Sample Preservation Verified.	N/A	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
Containers requiring zero headspace have no headspace or bubble is <6mm (1/4").	True	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	
Residual Chlorine Checked.	N/A	