SOILS INVESTIGATION
LA'I'OPUA VILLAGE 4
KEALAKEHE, NORTH KONA, HAWAII
TMK: 7-4-21: 10 AND 12

for

SATO & ASSOCIATES, INC.

HIRATA & ASSOCIATES, INC.
W.O. 04-4001
December 9, 2005

Hirata & Associates

Geotechnical
Engineering

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December 9, 2005
W.O. 04-4001

Mr. Jason Kage
Sato & Associates, Inc.
2046 South King Street
Honolulu, Hawaii 96826

Dear Mr. Kage:

Our report, "Soils Investigation, La'i'opua Village 4, Kealakehe, North Kona, Hawaii, TMK: 7-4-21: 10 and 12," dated December 9, 2005, our Work Order 04-4001 is enclosed. This investigation was conducted in general conformance with the scope of work presented in our proposal dated July 12, 2004.

Hard, gray basalt was encountered throughout the project site at shallow depths of about 6 to 12 inches below ground surface. The basalt was slightly weathered and varied from a slight to highly fractured condition down to the maximum depths drilled. Numerous clinker pockets were encountered within the basalt stratum, usually varying from about 6 inches to 5 feet in thickness. Overlying the basalt was a thin layer of clayey silt (volcanic ash), gravel, and cobbles. Basalt outcrops and boulders were also observed at ground surface throughout the site. Neither groundwater nor seepage water was encountered in the borings.

From a geotechnical viewpoint, it is our opinion that the project site can generally be developed as planned. Although not encountered in our borings, lave tubes, cavities, and voids are commonly encountered in basalt formation. As a result, proofrolling is recommended prior to fill placement in fill areas and prior to construction of improvements in cut areas. Yielding areas or cavities disclosed during the proofrolling operations should be exposed and properly backfilled with compacted fill or controlled low strength material (CLSM).

Geotechnical recommendations for development of the project site, including recommendations for site grading, design of building foundations, retaining walls, light pole foundations, pipe support, trench excavations and backfill, flexible roadway pavement, and playcourt pavement are presented in this report.

We appreciate this opportunity to be of service. Should you have any questions concerning this report, please feel free to call on us.

Very truly yours,

HIRATA & ASSOCIATES, INC.

Paul S Morimoto

Paul S. Morimoto Vice President

PSM:CCT

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SOILS INVESTIGATION
LA'I'OPUA VILLAGE 4
KEALAKEHE, NORTH KONA, HAWAII
TMK: 7-4-21: 10 AND 12

INTRODUCTION

This report presents the results of our soils investigation performed for the proposed La'i'opua Village 4 in Kealakehe, North Kona, Hawaii. Our scope of services for this study included the following:

- A visual reconnaissance of the site and its vicinity to observe existing conditions which may affect the project. The general location of the project site is shown on the enclosed Location Map, Plate A2.1.
- A review of available in-house soils information pertinent to the site and the proposed project.
- Drilling and sampling 18 exploratory borings to depths of about 20 feet. A description of our field investigation is summarized on Plates A1.1 and A1.2. The soils encountered are described on the Boring Logs, Plates A4.1 through A4.18. The approximate exploratory boring locations are shown on the enclosed Boring Location Plan, Plate A2.2.
- Performing percolation tests in 5 of the test borings. Test results are presented on Department of Health Site Evaluation/Percolation Test Forms, Plates A5.1 through A5.5.
- Laboratory testing of selected soil samples. Testing procedures are presented in Appendix B, Description of Laboratory Testing, Plates B1.1 through B1.3. Test results are presented on the Boring Logs (Plates A4.1 through A4.18), Modified Proctor Test report (Plate B2.1) and California Bearing Ratio Test reports (Plates B3.1 and B3.2).
- Engineering analyses of the field and laboratory data.

- Preparation of this report presenting geotechnical recommendations for the site grading, design of foundations, slabs-on-grade, resistance to lateral pressures, retaining walls, light pole foundations, pipe support, trench excavations and backfill, flexible pavement, and playcourt pavement, as well as percolation test results.

PROJECT CONSIDERATIONS

The proposed La'i'opua Village 4 project will consist of developing approximately 236 residential lots on about 55 acres of land.

The residences will be one to two stories in height. We assume that the structures will be using wood or light gauge steel frame construction, with concrete slabs-on-grade. Although not available at the time of this report, the final building loads are expected to be relatively light.

Grading for the project will include both cutting and filling. Based on preliminary grading plans, maximum cuts and fills will be on the order of 20 feet. In addition to slopes, retaining walls will be used to accommodate grade changes.

The project will also include new roads and driveways, as well as infrastructure servicing the proposed development. In addition, the project also include grading and grassing for a 5-acre neighborhood park located adjacent to Village 4.

SITE CONDITIONS

The project site encompasses approximately 60 acres of land located approximately 3/4 miles east of Queen Kaahumanu Highway in the Kealakehe area of North Kona. The site is bordered by La'i'opua Village 3 and Uhi Uhi Reserve on the north, Manawalea Street on the east, and Keanalehu Drive on the west and south. Beyond Keanalehu Drive, Kealakehe High School is located further west.

The site generally slopes downward in a northwesterly direction. Total relief over the property is on the order of 190 feet, with elevations ranging from about +590 at the northeast corner of the site to about +490 at the south corner and +400 in the northwestern portion. The site is presently vacant of structures and covered with a moderate growth of vegetation. Basalt outcrops were observed throughout the site.

At the time of our fieldwork, a boulder crushing operation occupied the northwestern portion of the site, in the area downhill of the proposed park. Numerous stockpiles of boulder and processed/crushed material were located throughout the area.

SOIL CONDITIONS

The project site was generally covered by about 6 to 12 inches of silt, gravel, and cobbles at ground surface. The clayey silt appeared to be material derived from volcanic ash. Volcanic ash is oftentimes characterized by poor workability and a collapsing type structure with the introduction of water.

Underlying the silt, gravel, and cobble layer was gray basalt extending down to the maximum depths drilled. The basalt was hard, only slightly weathered, and varied from a slight to highly fractured condition. Numerous clinker pockets were encountered within the basalt stratum. Clinker layers usually varied from about 6 inches to 5 feet in thickness.

Neither groundwater nor seepage was encountered in our borings down to the maximum depths drilled.

CONCLUSIONS AND RECOMMENDATIONS

Based on our exploratory fieldwork and laboratory testing, we believe that from a geotechnical viewpoint, the site can generally be developed as planned.

Hard basalt was encountered at ground surface or at shallow depths throughout the project site. We believe that pneumatic equipment will be required for excavations into the basalt. Due to the close proximity of the project site to the Kealakehe High School and the existing La'i'opua Village 3, the use of blasting to facilitate excavation may be precluded. In addition, our previous experience indicates that blasting may shatter the basalt to a highly fragmented condition, resulting in a potential loss of bearing strength for foundations in its vicinity.

The excavated basalt is expected to consist of predominantly boulder-size rock fragments. The material will be acceptable for reuse in compacted structural fills provided the excavated basalt is crushed to a well-graded consistency with rock fragments larger than 6 inches removed before compaction.

Although not encountered in our borings, lava tubes, cavities, and voids are commonly encountered in basalt formation. Our previous borings drilled at the adjacent Kealakehe High School encountered voids ranging from 3 to 30 inches within the basalt stratum. We therefore recommend that the site be proofrolled prior to fill placement in fill areas and prior to construction of improvements in cut areas. The proofrolling should be performed using large vibratory drum roller with minimum static weight of 20 tons. Yielding areas or cavities disclosed during the proofrolling operations should be exposed and properly backfilled with compacted fill or controlled low strength material (CLSM).

Conventional shallow foundations may be used to support the proposed structures. Footings may be founded on either new compacted fill or undisturbed hard basalt.

To reduce the potential for differential settlement, all foundations supporting a structure should be founded on the same material and designed for the same allowable bearing value. Based on the preliminary grading plans, many of the residential lots will be located in transition areas between cut and fill. Although the building locations were not available, foundation excavations at those lots are expected to expose both new compacted fill and hard basalt at the bottom of footing elevations. In order to provide more uniform support and minimize the potential for differential settlement, alternatives for those buildings include (1) extending all footing excavations through the compacted fill layer and founding all footings on basalt, and (2) overexcavating footing excavations in cut areas to a depth at least 12 inches below the bottom of footings, replacing the excavated basalt with the same structural fill used throughout the remainder of the building site, and founding all footings on compacted fill.

Site Grading

Site Preparation - The project site should be cleared of all vegetation, large tree roots, boulders, and other deleterious material. In gully areas and natural drainage ways, all deposits of loose and eroded material should be removed down to firm, undisturbed soils or basalt prior to placement of fill. Subdrains should be installed prior to placing fill in gullies and natural drainage ways.

Due to its unusual and poor workability, the clayey silt/volcanic ash, if encountered, should be stripped for use as top soil.

Existing boulder stockpiles located in the northwestern area of the site should be also removed. The boulders may be reused in the boulder fill or crushed/processed to well-graded granular fill material.

Cavities and voids are common in the basalt stratum and should be expected. If encountered during site preparation, the cavities and voids should be exposed and properly backfilled with compacted fill or controlled low strength material (CLSM).

Proofrolling - In order to detect and collapse potential near surface cavities in the basalt stratum, proofrolling should be performed prior to (1) placement of fill in fill areas and (2) construction of improvements in cut areas after the site has been graded to approximate finish subgrade. The proofrooling should be performed using a large vibratory drum roller with a minimum static weight of 20 tons or a heavy bulldozer for a minimum of eight passes. Yielding areas or cavities disclosed during the proofrolling operations should be exposed and properly backfilled with compacted fill or controlled low strength material (CLSM).

Onsite Fill Material - The onsite clinker and gravel will be acceptable for reuse in compacted fills and backfill, provided all rock fragments larger than 6 inches in maximum dimension are removed.

The excavated basalt and boulders may be reused in structural fills provided the material is crushed to a well-graded consistency, and all rock fragments larger than six inches in maximum dimension are removed.

Imported Fill Material - If needed, imported fill should be well-graded, non-expansive granular material. Specifications for imported structural fill should indicate a maximum particle size of 3 inches, and state that between 8 and 20 percent of soil by weight shall pass the #200 sieve. In addition, the plasticity index (P.I.) of that portion of the soil passing the #40 sieve shall not be greater than 10. Imported fill should also have a minimum CBR value of 20 and a CBR expansion potential no greater than 1.0 percent when tested in accordance with ASTM D 1883.

Boulder Fill - Boulder disposal may be permitted in deeper fill areas where no structures or improvements are planned. Boulders should not be placed within 5 feet of finish grade nor within 10 feet of slope faces, measured horizontally. Boulder fill should also not be placed in anticipated utility line alignments nor within the depths of the anticipated utility lines.

The size of the boulders should be limited to approximately 24 inches in diameter. Boulders larger than 24 inches in maximum dimension should not be used unless reduced in size. The boulders should be placed in relatively level areas and in a manner that reduces the potential for the formation of voids. Voids between boulders should be filled using sand and gravel material water jetted into place. Each boulder layer should be limited to 24 inches in thickness.

A 12-inch thick choke layer, consisting of 6-inch minus material, should be placed over each boulder layer. The choke layers should be compacted in lifts to the recommended minimum standard as indicated in the *Compaction* section below.

Compaction - We anticipate that most of the fill material for this project will be granular in nature. Granular fill should be placed in horizontal lifts restricted to eight inches in loose thickness and compacted to a minimum 95 percent compaction as determined by ASTM D 1557.

Compaction testing of the boulder layer is generally not practical. The boulder layer should be compacted to a dense, non-yielding condition with a Caterpillar D-9 bulldozer, or similar sized heavy construction equipment. The choke layer placed over the boulder layer should be compacted in horizontal lifts to a minimum 95 percent compaction as determined by ASTM D 1557.

Rippability - Excavations into the surface clayey silt can be accomplished using conventional earth moving equipment. However, excavations into the hard basalt stratum will generally require pneumatic equipment.

Slope Gradients - Fill slopes and cut slopes exposing surface soil should be stable at gradients of 2:1 (horizontal to vertical) or flatter. Fill slopes exceeding 25 feet in height should include benches at least 8 feet in width. The benches should be constructed at intervals not exceeding 25 feet in vertical height.

Fill placed in areas which slope steeper than 5:1 (horizontal to vertical), should be continually benched as the fill is brought up in lifts. Fill slopes should be constructed by overfilling and cutting back to the design slope gradient to obtain a well-compacted slope face.

Cut slopes exposing hard basalt should be stable at gradients of 1:1 (horizontal to vertical) or flatter.

Where applicable, all slopes should be planted as soon as practical upon completion of grading to reduce the effects of erosion and weathering.

Foundations

Conventional shallow foundations, such as spread footings or thickened slabs, founded on basalt or at least 12 inches of granular structural fill may be used to support the proposed structures. To provide more uniform support and to reduce the potential for differential movements, all footings supporting a structure should be founded on the same material.

Although the final building locations and finish grades were not available, we anticipate that many residences will be located in transition areas between cut and fill, exposing both basalt and compacted fill. To provide more uniform support and to reduce the potential for differential movements, all footings supporting a structure should be founded on the same material. Alternatives for structures located in transition areas between cut and fill are (1) extending all footings through the compacted fill layer and founding all footings on basalt, and (2) overexcavating cut areas to a depth at least 12 inches below the bottom of footings, replacing the excavated basalt with the same fill material used throughout the remainder of the building, and founding all footings on compacted fill.

Footings founded directly on basalt may be designed for an allowable bearing value of 5,000 pounds per square foot, while footings founded on compacted granular fill may be designed for an allowable bearing value of 2,500 pounds per square foot. The allowable bearing values are for the total of dead and frequently applied live loads, and may be increased by one-third for short duration loading which includes the effect of wind and seismic forces.

Spread footings should be a minimum of 16 inches in width; thickened slab foundations should be at least 12 inches wide. Footings and thickened slabs should be embedded at least 12 and 18 inches below finish adjacent grade for one and two-story structures, respectively.

The bottom of all footing excavations should be cleaned of loose material and thoroughly tamped prior to placement of reinforcing steel and concrete. Footings located on, or near the top of slopes, should be embedded such that a minimum horizontal distance of 5 feet is maintained between the bottom edge of footing and slope face.

Building foundations adjacent to retaining walls should be embedded below an imaginary plane extending upward from the bottom of wall at a 45° angle from the horizontal. The intent of this recommendation is to reduce the additional lateral stresses imposed on the wall by the foundations.

Seismic Design

Based on the 1997 Uniform Building Code, the site is located within Seismic Zone 4. Within this zone, a seismic zone factor (Z) equal to 0.4 is recommended (97 UBC Table 16-I) for calculation of shear and lateral load imparted on structures during an earthquake. Based on our borings advanced for this study and our knowledge of the deep soil conditions in the area, the subsurface soils can be characterized as a rock profile. Therefore, soil profile type S_A is recommended for this site. In addition, near source seismic factors N_a of 1.0 and N_v of 1.0 are also recommended for use in seismic design.

Lateral Design

Resistance to lateral loading may be provided by friction acting at the base of foundations and by passive earth pressure acting on the buried portions of foundations.

Allowable coefficients of friction of 0.4 and 0.5 may be used with the dead load forces for compacted fill and basalt, respectively. Passive earth pressure may be computed as an equivalent fluid having densities of 300 and 500 pounds per cubic foot for compacted fill and basalt, respectively. Unless covered by pavement or concrete slabs, the upper 12 inches of soil or basalt should not be considered in computing lateral resistance.

Retaining Walls

Retaining wall foundations may be designed using the recommendations presented in the *Foundations, Seismic Design,* and *Lateral Design* sections of this report.

For active earth pressure considerations, the following equivalent fluid pressures may be used.

Soil Type	Level Backfill Condition	Sloping Backfill Condition	Restrained/ At-rest Condition
Onsite Silty gravel	40 pcf	50 pcf	55 pcf
Compacted Fill	40 pcf	50 pcf	55 pcf
Basalt	25 pcf	35 pcf	40 pcf

To prevent buildup of hydrostatic pressures, weepholes or subdrains should be included in the design of retaining structures.

Foundation Settlement

Although structural loads were not available at the time of this report, excessive settlement is not anticipated as the final building loads are expected to be relatively light. The final structural loads should be forwarded to our office, when available, for review.

Slabs-on-Grade

To provide uniform support, all building slabs-on-grade should be underlain by a 4-inch cushion of clean gravel, such as #3 Fine (ASTM C33, Size No. 67). Building slabs should also be protected by a vapor barrier.

Slabs-on-grade which will receive floor covering, especially "hard" floor covering such as slate or marble, should include control joints saw-cut into the concrete slab. The purpose of this is to help reduce the potential for reflective cracking of the floor covering due to shrinkage cracks in the concrete slab. Proper curing of the concrete slab will help reduce shrinkage cracking.

Slabs-on-grade subjected to vehicle loadings should be underlain by 6 inches of base course. The base course layer is in lieu of the gravel cushion and should be compacted to a minimum 95 percent compaction as determined by ASTM D 1557.

Concrete walkways and sidewalks should be underlain by a minimum 6 inches of granular base material such as select borrow or base course. The granular base should be compacted to a minimum 95 percent compaction as determined by ASTM D 1557.

Light Pole Foundations

Either spread footings or drilled pier foundations may be used to support the proposed light poles. The spread footings and drilled pier foundations may be designed using recommendations presented in the *Foundations, Seismic Design,* and *Lateral Design* sections of this report.

In addition, frictional resistance between the concrete shaft of drilled pier foundations and the surrounding soils or basalt may be considered in design of drilled pier foundations, provided the concrete is poured neat against the drilled hole. An adhesion value of 1000 pounds per square foot may be used in determining the additional load capacity due to friction. However, the upper 2 feet of embedded drilled pier foundation should not be considered in determining the load bearing capacity due to friction.

Utility Pipe Support

Conventional crushed rock cradles may be used to support the utility lines. The thickness of crushed rock cradle and pipe cushion material should conform to specifications presented in the "Standard Specifications for Public Works Construction" and the "Water System Standards for the State of Hawaii". Pipe bedding material should also be placed along the sides of the pipe and up to a minimum 12 inches above the pipe.

Trench Excavation and Backfill

Based on our exploratory borings, we believe that trench excavations into the hard basalt will require pneumatic equipment. Excavation sidewalls exposing hard basalt should stand at a near vertical gradient for temporary conditions. Excavation sidewalls exposing compacted granular fill are expected to stand for temporary conditions at slopes of 1:1 (horizontal to vertical) or flatter. It should be the Contractor's responsibility to conform to all OSHA safety standards for excavations.

The excavated basalt may be used as backfill above the pipe bedding material (12 inches above the pipe), provided the material is crushed to a relatively well-graded consistency, and all rock fragments larger than six inches in maximum dimension are removed. This backfill section should be compacted in lifts to a minimum 90 percent compaction as determined by ASTM D 1557. If necessary, trench backfill may also consist of imported granular structural fill.

Unless covered by concrete slabs or AC pavement, the upper 12 inches of trench backfill should consist of low impermeability material, such as non-expansive clayey silt or silty clay, compacted to a minimum 90 percent compaction as determined by ASTM D 1557. The intent of this recommendation is to reduce the potential for surface water infiltration into the trench backfill material.

In building, roadway, and concrete walkway areas, the upper 24 inches of trench backfill below the slabs and pavement section should be compacted to a minimum 95 percent compaction as determined by ASTM D 1557.

Pavement Design

Flexible pavement for roadway and driveway areas may be designed based on the following section. The recommended section assumes that the pavement will only be subjected to light to medium traffic with only occasional heavy vehicle loadings.

2.0"	Asphaltic Concrete
6.0"	Aggregate Base Course (minimum CBR of 85)
8.0"	Total Thickness

The above recommended pavement section assumed that either silty gravel or basalt will be exposed at subgrade elevation. In the event clayey silt/volcanic ash is exposed at the pavement subgrade elevation, the clayey silt/volcanic ash should be completely removed and replaced with compacted granular fill.

Playcourt Pavement Design

In addition to the manufacturer's specifications for the court surface, all playcourts should also be underlain by at least 6 inches of base course.

For asphaltic concrete playcourts, the following pavement section may be used.

2.0"	Asphaltic Concrete
6.0"	Aggregate Base Course (minimum CBR of 85)
8.0"	Total Thickness

The surface clayey silt/volcanic ash should be completely removed from playcourt areas and replaced with compacted granular structural fill. The base course should be compacted to a minimum 95 percent compaction as determined by ASTM D 1557.

If the playcourt is located within a cut and fill area exposing both basalt and new compacted fill, an additional 6-inch layer of select borrow below the base course layer is recommended.

ADDITIONAL SERVICES

We recommend that we perform a general review of the final design plans and specifications. This will allow us to verify that the foundation design and earthwork recommendations have been properly interpreted and implemented in the design plans and construction specifications.

For continuity, we recommend that we be retained during construction to (1) observe mass grading operations and fill placement, including boulder fills, and perform compaction testing, (2) observe footing excavations prior to placement of granular structural fill, reinforcing steel and concrete, (3) review and/or perform laboratory testing on import borrow to determine its acceptability for use in compacted fills, and (4) provide geotechnical consultation as required. Our services during construction will allow us to verify that our recommendations are properly interpreted and included in construction, and if necessary, to make modifications to those recommendations, thereby reducing construction delays in the event subsurface conditions differ from those anticipated.

LIMITATIONS

The boring logs indicate the approximate subsurface soil conditions encountered only at those times and locations where our borings were made, and may not represent conditions at other times and locations.

This report was prepared specifically for Sato & Associates, Inc. and their sub-consultants for design of the proposed La'i'opua Village 4 in Kealakehe, North Kona, Hawaii. The boring logs, laboratory test results, and recommendations presented in this report are for design purposes only, and are not intended for use in developing cost estimates by the contractor.

During construction, should subsurface conditions differ from those encountered in our borings, we should be advised immediately in order to re-evaluate our recommendations, and to revise or verify them in writing before proceeding with construction.

Our recommendations and conclusions are based upon the site materials observed, the preliminary design information made available, the data obtained from our site exploration, our engineering analyses, and our experience and engineering judgement. The conclusions and recommendations are professional opinions which we have strived to develop in a manner consistent with that level of care, skill, and competence ordinarily exercised by members of the profession in good standing, currently practicing under similar conditions. We will be responsible for those recommendations and conclusions, but will not be responsible for the interpretation by others of the information developed. No warranty is made regarding the services performed under this agreement, either express or implied.

Respectfully submitted,

HIRATA & ASSOCIATES, INC.

Con C. Truong, P.E.

Paul Morimoto

Paul S. Morimoto, Project Manager

PAUL S. MORIMOTO
No. 5299-C

This work was prepared by
me or under my supervision
Expiration Date of License:
April 30, 2006

APPENDIX A

FIELD INVESTIGATION

DESCRIPTION OF FIELD INVESTIGATION

GENERAL

The site was explored between November 2 and 22, 2004, by performing a visual site reconnaissance and drilling 18 exploratory test borings to depths of about 20 feet with a CME-55 truck mounted drill rig. In addition, percolation tests were performed in five of the test borings.

A bulldozer was used to provide access to boring sites for our drill rig and support trucks. While clearing access paths and work areas, some of the surface soils were removed at the boring locations.

During drilling operations, the soils were continuously logged by our field engineer and classified by visual examination in accordance with the Unified Soil Classification System. The boring logs indicate the depths at which the soils or their characteristics change, although the change could actually be gradual. If the change occurred between sample locations, the depth was interpreted based on field observations. Classifications and sampling intervals are shown on the boring logs. A Boring Log Legend is presented on Plate A3.1; the Unified Soil Classification and Rock Weathering Classification Systems are shown on Plates A3.2 and A3.3, respectively. The soils encountered are logged on Plates A4.1 through A4.18.

Boring locations were located in the field by measuring/taping offsets from existing site features shown on the site plans. The boring locations shown on Plate A2.2 are therefore approximate, in accordance with the field methods used. Ground surface elevations at boring locations were estimated using a topographic survey map prepared by Controlpoint Surveying, Inc., dated April 6, 2005.

SOIL SAMPLING

Representative soil samples and core samples of basalt were recovered from the borings for selected laboratory testing and analyses. Representative samples were recovered by driving a 3-inch O.D. split tube sampler a total of 18 inches with a 140-pound hammer dropped from a height of 30 inches. The number of blows required to drive the sampler the final 12 inches are recorded at the appropriate depths on the boring logs, unless noted otherwise. Due to the shallow depths to basalt encountered throughout the site, only a few representative soil samples were recovered from one of the borings.

Core samples were obtained by drilling with an NX core barrel having an inside diameter of 2.1 inches. The depths and recovery percentages for each core run are shown on the enclosed Boring Logs. The rock quality designation (RQD) for each core run is also shown on the Boring Logs. This is a modified core recovery percentage which takes into account the number of fractures observed in the core samples. Only pieces of core 4 inches in length or longer, as measured along the centerline, were included in the determination of this modified core recovery percentage. Fractures caused by drilling or handling were ignored.

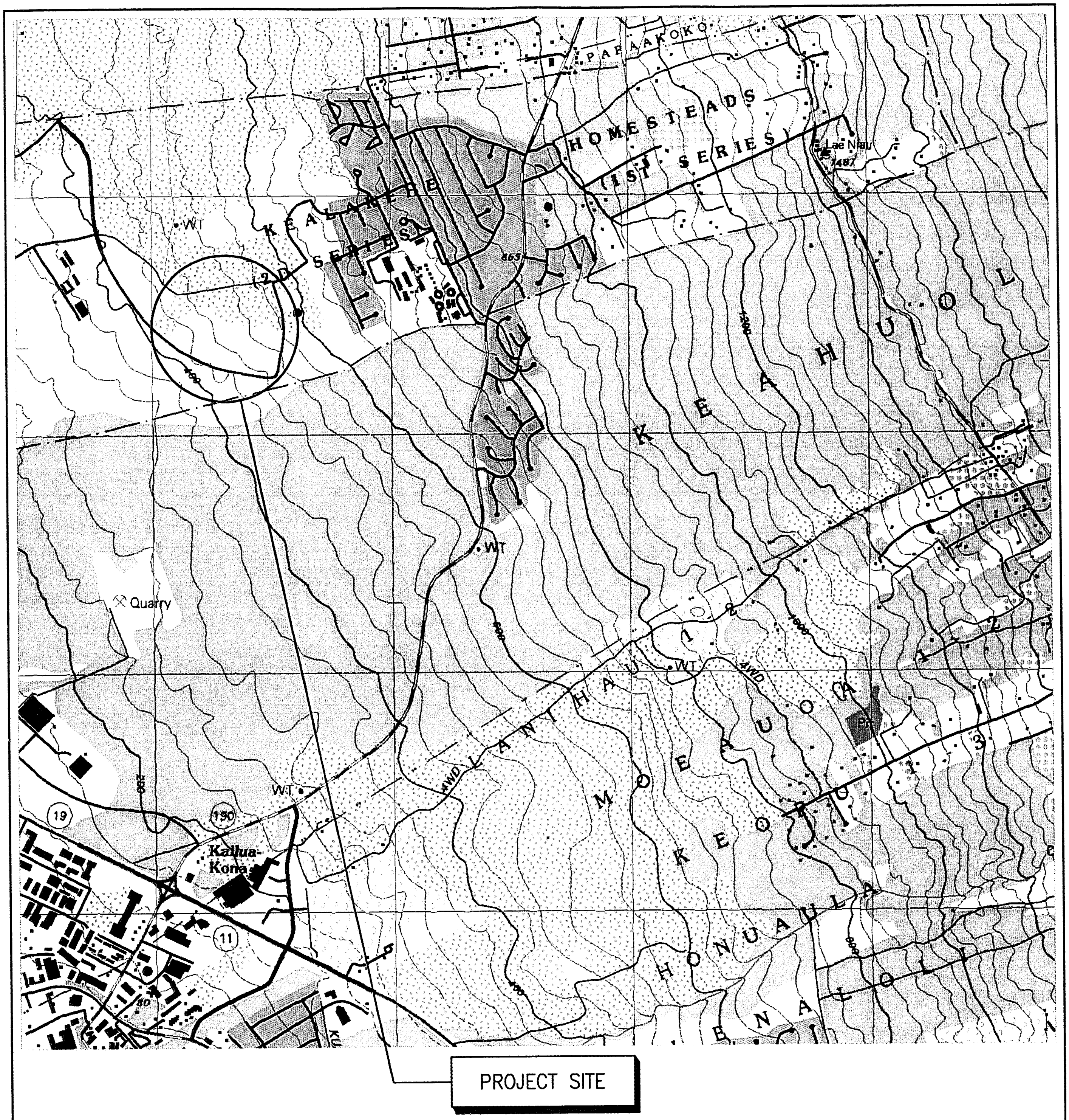
The following is a general correlation between RQD percentages and rock quality.

RQD (%)	Description of Rock Quality
0 - 25	Very Poor
25 - 50	Poor
50 - 75	Fair
75 - 90	Good
90 - 100	Excellent

Reference: Tunnel Engineering Handbook, Second Edition,
edited by J.O. Bickel, T.R. Kuesel, and E.H. King, 1996.

PERCOLATION TESTING

Percolation tests were performed in five of the test borings. Test results are presented on Plates A5.1 through A5.5, Site Evaluation/Percolation Test Forms.



Reference: Topographic quadrangle map prepared by the United States
Department of the Interior Geologic Survey
Kailua Quadrangle, Hawaii County, Hawaii. 1996.

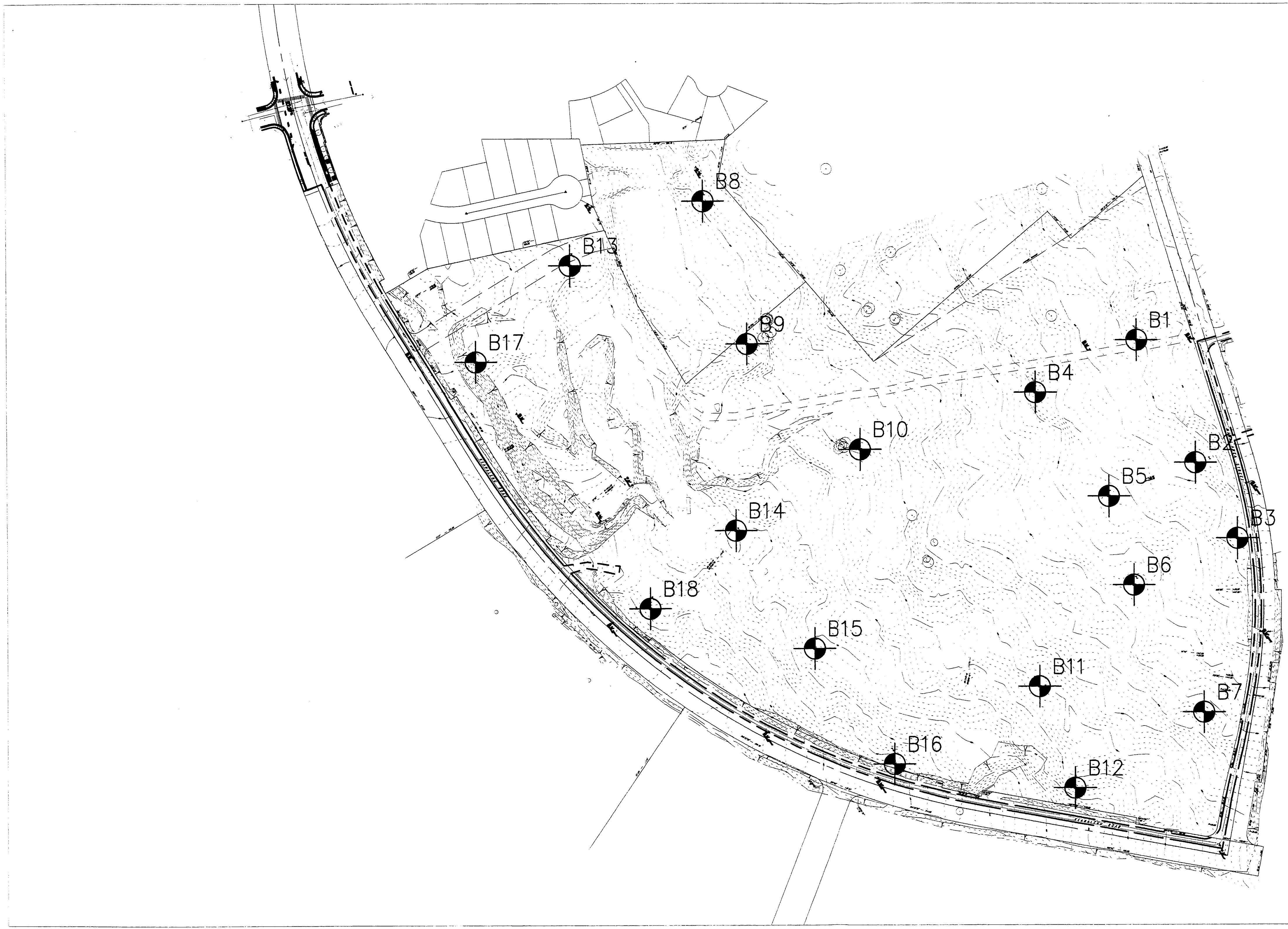
W.O. 04-4001

Laiopua Village 4, Kealakehe, North Kona

Ernest K. Hirata
& Associates, Inc.

LOCATION MAP

Plate A2.1



LEGEND:

⊕ Approximate location of borings and percolation test holes

GRAPHIC SCALE:
0 300 600FT.
1" = 300'

Reference: Topographic Survey Map prepared by Controlpoint Surveying, Inc., dated 4/6/05.

W.O. 04-4001	Laiopua Village 4, Kealakehe, North Kona
Hirata & Associates, Inc.	BORING LOCATION PLAN Plate A2.2

MAJOR DIVISIONS			GROUP SYMBOLS		TYPICAL NAMES
COARSE GRAINED SOILS (More than 50% of the material is LARGER than No. 200 sieve size.)	GRAVELS (More than 50% of coarse fraction is LARGER than the No. 4 sieve size.)	CLEAN GRAVELS (Little or no fines.)	▨	GW	Well graded gravels, gravel-sand mixtures, little or no fines.
			▨	GP	Poorly graded gravels or gravel-sand mixtures, little or no fines.
		GRAVELS WITH FINES (Appreciable amt. of fines.)	▨	GM	Silty gravels, gravel-sand-silt mixtures.
			▨	GC	Clayey gravels, gravel-sand-clay mixtures.
	SANDS (More than 50% of coarse fraction is SMALLER than the No. 4 sieve size.)	CLEAN SANDS (Little or no fines.)	▨	SW	Well graded sands, gravelly sands, little or no fines.
			▨	SP	Poorly graded sands or gravelly sands, little or no fines.
		SANDS WITH FINES (Appreciable amt. of fines.)	▨	SM	Silty sands, sand-silt mixtures.
			▨	SC	Clayey sands, sand-clay mixtures.
FINE GRAINED SOILS (More than 50% of the material is SMALLER than No. 200 sieve size.)	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 GREATER than 50.)		▨	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
			▨	CH	Inorganic clays of high plasticity, fat clays.
			▨	OH	Organic clays of medium to high plasticity, organic silts.
HIGHLY ORGANIC SOILS			▨	PT	Peat and other highly organic soils.
			▨	FRESH TO MODERATELY WEATHERED BASALT	
			▨	VOLCANIC TUFF / HIGHLY TO COMPLETELY WEATHERED BASALT	
			▨	CORAL	

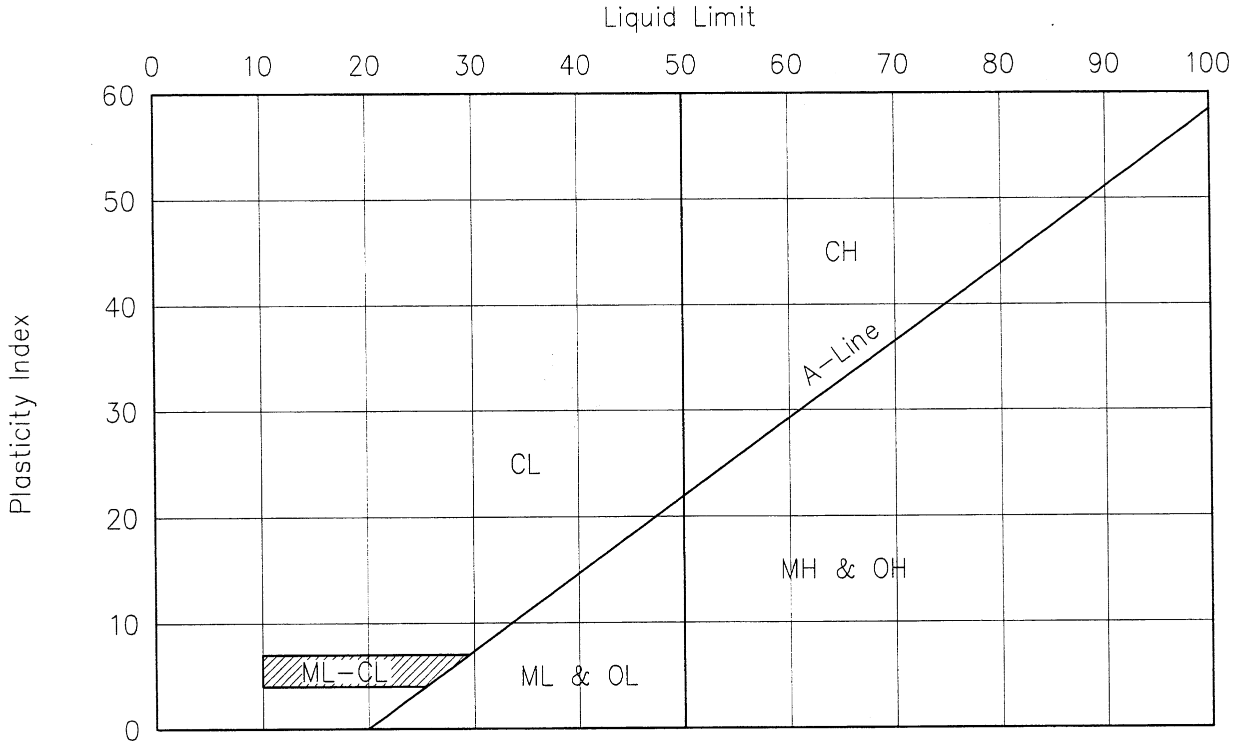
SAMPLE DEFINITION

⧓ 2" O.D. Standard Split Spoon Sampler	☒ Shelby Tube	RQD Rock Quality Designation
☐ 3" O.D. Split Tube Sampler	▮ NX / 4" Coring	▽ Water Level

W.O. 04-4001	Laiopua Village 4, Kealakehe, North Kona
Hirata & Associates, Inc.	**BORING LOG LEGEND**

Plate A3.1

PLASTICITY CHART



GRADATION CHART

COMPONENT DEFINITIONS BY GRADATION

COMPONENT	SIZE RANGE
Boulders	Above 12 in.
Cobbles	3 in. to 12 in.
Gravel	3 in. to No. 4 (4.76 mm)
Coarse gravel	3 in. to 3/4 in.
Fine gravel	3/4 in. to No. 4 (4.76 mm)
Sand	No. 4 (4.76 mm) to No. 200 (0.074 mm)
Coarse sand	No. 4 (4.76 mm) to No. 10 (2.0 mm)
Medium sand	No. 10 (2.0 mm) to No. 40 (0.42 mm)
Fine sand	No. 40 (0.42 mm) to No. 200 (0.074 mm)
Silt and clay	Smaller than No. 200 (0.074 mm)

W.O. 04-4001

Laiopua Village 4, Kealakehe, North Kona

Hirata & Associates, Inc.

UNIFIED SOIL CLASSIFICATION SYSTEM

Plate A3.2

Grade	Symbol	Description
Fresh	F	No visible signs of decomposition or discoloration. Rings under hammer impact.
Slightly Weathered	WS	Slight discoloration inwards from open fractures, otherwise similar to F.
Moderately Weathered	WM	Discoloration throughout. Weaker minerals such as feldspar decomposed. Strength somewhat less than fresh rock but cores cannot be broken by hand or scraped by knife. Texture preserved.
Highly Weathered	WH	Most minerals somewhat decomposed. Specimens can be broken by hand with effort or shaved with knife. Core stones present in rock mass. Texture becoming indistinct but fabric preserved.
Completely Weathered	WC	Minerals decomposed to soil but fabric and structure preserved (Saprolite). Specimens easily crumbled or penetrated.
Residual Soil	RS	Advanced state of decomposition resulting in plastic soils. Rock fabric and structure completely destroyed. Large volume change.

Reference: Soils Mechanics, NAVFAC DM-7.1, Department of the Navy, Naval Facilities Engineering Command, September, 1986.

W.O. 04-4001

Laiopua Village 4, Kealakehe, North Kona

Hirata & Associates, Inc.

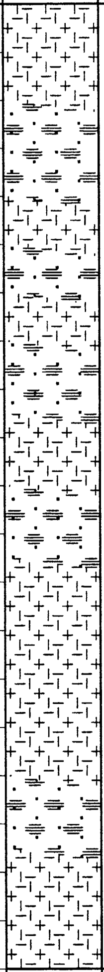
ROCK WEATHERING CLASSIFICATION SYSTEM

HIRATA & ASSOCIATES, INC.

BORING LOG

W.O. 04-4001

BORING NO. B1 DRIVING WT. 140 lb. START DATE 11/8/04
SURFACE ELEV. 560±* DROP 30 in. END DATE 11/8/04

DEPTH	GRAPH	SAMPLE	BLOWS PER FOOT	DRY DENSITY (PCF)	MOIST. CONT. (%)	DESCRIPTION
0						BASALT (WS) – Gray, hard, vesicular, slightly weathered. Covered by a thin layer of silt and gravel. Begin NX coring at 0 feet. 57% Recovery from 0 to 5 feet. RQD = 38% Clinker from 2 to 4 feet.
5						87% Recovery from 5 to 10 feet. RQD = 47% Clinker from 5 to 6 feet. Clinker from 7 to 8.5 feet.
10						70% Recovery from 10 to 15 feet. RQD = 30% Clinker from 10 to 10.5 feet. Clinker from 11 to 11.5 feet.
15						95% Recovery from 15 to 20 feet. RQD = 68% Clinker from 16 to 17.5 feet.
20						End boring at 20 feet. Neither groundwater nor seepage water encountered.
25						* Elevations based on Topographic Survey Map prepared by ControlPoint Surveying, Inc., dated 4/6/05.
30						

HIRATA & ASSOCIATES, INC.

BORING LOG

W.O. 04-4001

BORING NO. B2
DRIVING WT. 140 lb.
START DATE 11/9/04
SURFACE ELEV. 553.3±
DROP 30 in.
END DATE 11/10/04

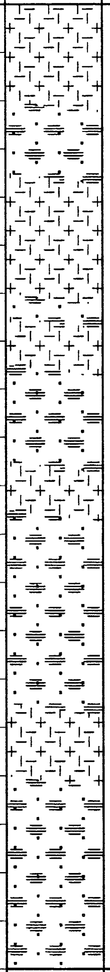
DEPTH	GRAPH	SAMPLE	BLOWS PER FOOT	DRY DENSITY (PCF)	MOIST. CONT. (%)	DESCRIPTION
0						BASALT (WS) – Gray, hard, vesicular, slightly weathered. Covered by a thin layer of silt, gravel, and cobbles. Begin NX coring at 0 feet. 90% Recovery from 0 to 5 feet. RQD = 80% Clinker from 1 to 2 feet.
5						98% Recovery from 5 to 10 feet. RQD = 85% Clinker from 7 to 8 feet.
10						60% Recovery from 10 to 15 feet. RQD = 52% Clinker from 10 to 10.5 feet. Clinker from 12 to 13 feet. Clinker from 14 to 14.5 feet.
15						35% Recovery from 15 to 20 feet. RQD = 0% Highly fractured, hard.
20						End boring at 20 feet. Neither groundwater nor seepage water encountered.
25						
30						

Plate A4.2

BORING LOG

W.O. 04-4001

BORING NO. B3 DRIVING WT. 140 lb. START DATE 11/9/04
SURFACE ELEV. 553.5± DROP 30 in. END DATE 11/9/04



DEPTH	GRAPH	SAMPLE	BLOWS PER FOOT	DRY DENSITY (PCF)	MOIST. CONT. (%)	DESCRIPTION
0						BASALT (WS) – Gray, hard, vesicular, slightly weathered. Covered by a thin layer of silt, gravel, and cobbles. Begin NX coring at 0 feet. 80% Recovery from 0 to 5 feet. RQD = 35% Clinker from 2 to 3.5 feet.
5						85% Recovery from 5 to 10 feet. RQD = 45% Clinker from 6 to 6.5 feet. Clinker from 7.5 to 9.5 feet.
10						40% Recovery from 10 to 15 feet. RQD = 12% Clinker from 10.5 to 14.5 feet, dense.
15						40% Recovery from 15 to 20 feet. RQD = 20% Clinker from 16 to 20 feet, dense.
20						End boring at 20 feet. Neither groundwater nor seepage water encountered.
25						
30						

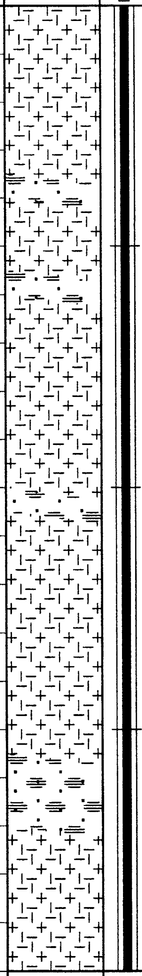
Plate A4.3

HIRATA & ASSOCIATES, INC.

BORING LOG

W.O. 04-4001

BORING NO. B4
DRIVING WT. 140 lb.
START DATE 11/9/04
SURFACE ELEV. 533±
DROP 30 in.
END DATE 11/9/04



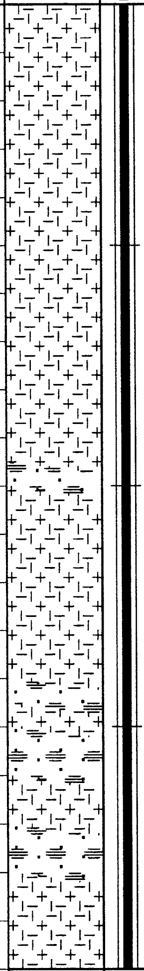
DEPTH	GRAPH	SAMPLE	BLOWS PER FOOT	DRY DENSITY (PCF)	MOIST. CONT. (%)	DESCRIPTION
0						BASALT (WS) – Gray, hard, vesicular, slightly weathered. Covered by a thin layer of silt, gravel, and cobbles. Begin NX coring at 0 feet. 98% Recovery from 0 to 5 feet. RQD = 92% Clinker from 3.5 to 4 feet.
5						98% Recovery from 5 to 10 feet. RQD = 86% Clinker from 5.5 to 6 feet.
10						96% Recovery from 10 to 15 feet. RQD = 90% Clinker from 10 to 10.5 feet.
15						79% Recovery from 15 to 20 feet. RQD = 53% Clinker from 15.5 to 17 feet.
20						End boring at 20 feet. Neither groundwater nor seepage water encountered.
25						
30						

Plate A4.4

BORING LOG

W.O. 04-4001

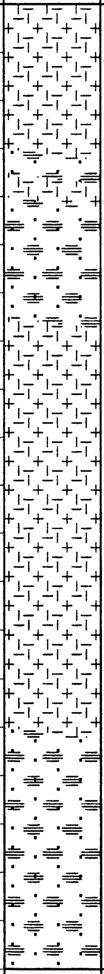
BORING NO. B5
DRIVING WT. 140 lb.
START DATE 11/10/04
SURFACE ELEV. 537.2±
DROP 30 in.
END DATE 11/10/04

DEPTH	GRAPH	SAMPLE	BLOWS PER FOOT	DRY DENSITY (PCF)	MOIST. CONT. (%)	DESCRIPTION
0 5 10 15						BASALT (WS) – Gray, hard, vesicular, slightly weathered. Covered by a thin layer of silt, gravel, and cobbles. Begin NX coring at 0 feet. 98% Recovery from 0 to 5 feet. RQD = 92% 95% Recovery from 5 to 10 feet. RQD = 80% Clinker from 9.5 to 10 feet. 100% Recovery from 10 to 15 feet. RQD = 92% Clinker from 14 to 14.5 feet. 80% Recovery from 15 to 20 feet. RQD = 5% Clinker from 15 to 16 feet. Clinker from 17 to 18 feet.
20 25 30						End boring at 20 feet. Neither groundwater nor seepage water encountered.

BORING LOG

W.O. 04-4001

BORING NO. B6
DRIVING WT. 140 lb.
START DATE 11/11/04
SURFACE ELEV. 524.1±
DROP 30 in.
END DATE 11/11/04

DEPTH	GRAPH	SAMPLE	BLOWS PER FOOT	DRY DENSITY (PCF)	MOIST. CONT. (%)	DESCRIPTION
0						BASALT (WS) – Gray, hard, vesicular, slightly weathered. Covered by a thin layer of silt, gravel, and cobbles. Begin NX coring at 0 feet. 90% Recovery from 0 to 5 feet. RQD = 32% Clinker from 3 to 3.5 feet. Clinker from 4 to 6.5 feet. 85% Recovery from 5 to 10 feet. RQD = 60%
5						
10						98% Recovery from 10 to 15 feet. RQD = 90%
15						30% Recovery from 15 to 20 feet. RQD = 0% Clinker from 15 to 20 feet.
20						End boring at 20 feet. Neither groundwater nor seepage water encountered.
25						
30						

HIRATA & ASSOCIATES, INC.

BORING LOG

W.O. 04-4001

BORING NO. B7
DRIVING WT. 140 lb.
START DATE 11/3/04
SURFACE ELEV. 516.9±
DROP 30 in.
END DATE 11/3/04

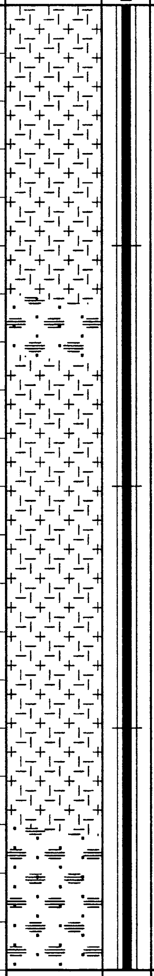
DEPTH	GRAPH	SAMPLE	BLOWS PER FOOT	DRY DENSITY (PCF)	MOIST. CONT. (%)	DESCRIPTION
0						BASALT (WS) – Gray, hard, vesicular, slightly weathered. Covered by a thin layer of silt, gravel, and cobbles. Begin NX coring at 0 feet. 95% Recovery from 0 to 5 feet. RQD = 85%
5						67% Recovery from 5 to 10 feet. RQD = 27% Clinker from 6 to 7.5 feet.
10						70% Recovery from 10 to 15 feet. RQD = 65%
15						30% Recovery from 15 to 20 feet. RQD = 0% Clinker from 17 to 20 feet.
20						End boring at 20 feet. Neither groundwater nor seepage water encountered.
25						
30						

Plate A4.7

BORING LOG

W.O. 04-4001

BORING NO. B8
DRIVING WT. 140 lb.
START DATE 11/3/04
SURFACE ELEV. 482.7±
DROP 30 in.
END DATE 11/3/04

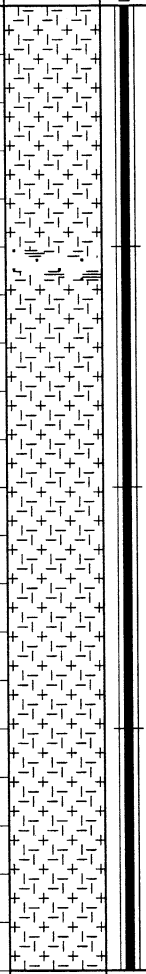
DEPTH	GRAPH	SAMPLE	BLOWS PER FOOT	DRY DENSITY (PCF)	MOIST. CONT. (%)	DESCRIPTION
0						BASALT (WS) – Gray, hard, vesicular, slightly weathered. Covered by a thin layer of silt, gravel, and cobbles. Begin NX coring at 0 feet. 92% Recovery from 0 to 5 feet. RQD = 72%
5						72% Recovery from 5 to 10 feet. RQD = 47% Clinker from 5 to 5.5 feet.
10						93% Recovery from 10 to 15 feet. RQD = 63%
15						93% Recovery from 15 to 20 feet. RQD = 85%
20						End boring at 20 feet. Neither groundwater nor seepage water encountered.
25						
30						

Plate A4.8

BORING LOG

W.O. 04-4001

BORING NO. B9
DRIVING WT. 140 lb.
START DATE 11/3/04
SURFACE ELEV. 471.6±
DROP 30 in.
END DATE 11/3/04

DEPTH	GRAPH	SAMPLE	BLOWS PER FOOT	DRY DENSITY (PCF)	MOIST. CONT. (%)	DESCRIPTION
0						BASALT (WS) – Gray, hard, vesicular, slightly weathered. Covered by a thin layer of silt, gravel, and cobbles. Begin NX coring at 0 feet. 80% Recovery from 0 to 5 feet. RQD = 67% Clinker from 4 to 5 feet.
5						87% Recovery from 5 to 10 feet. RQD = 67% Clinker from 8 to 9 feet.
10						100% Recovery from 10 to 15 feet. RQD = 73% Highly fractured from 12 to 13 feet. Clinker from 14 to 14.5 feet.
15						87% Recovery from 15 to 20 feet. RQD = 80%
20						End boring at 20 feet. Neither groundwater nor seepage water encountered.
25						
30						

BORING LOG

W.O. 04-4001

BORING NO. B10

DRIVING WT. 140 lb.

START DATE 11/9/04

SURFACE ELEV. 482±

DROP 30 in.

END DATE 11/9/04

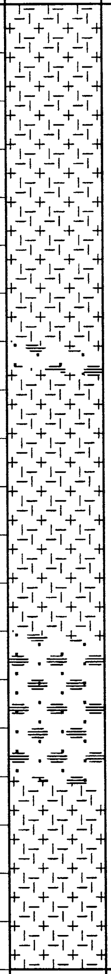
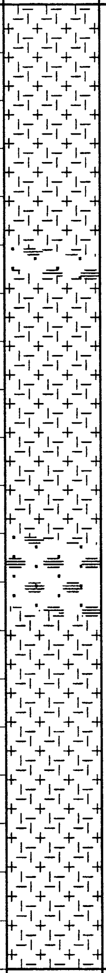
DEPTH	GRAPH	SAMPLE	BLOWS PER FOOT	DRY DENSITY (PCF)	MOIST. CONT. (%)	DESCRIPTION
0						BASALT (WS) – Gray, hard, vesicular, slightly weathered. Covered by a thin layer of silt, gravel, and cobbles. Begin NX coring at 0 feet. 98% Recovery from 0 to 5 feet. RQD = 92%
5						98% Recovery from 5 to 10 feet. RQD = 85% Clinker from 7 to 7.5 feet.
10						70% Recovery from 10 to 15 feet. RQD = 41% Fractured from 10 to 11 feet. Clinker from 13 to 16 feet.
15						88% Recovery from 15 to 20 feet. RQD = 77%
20						End boring at 20 feet. Neither groundwater nor seepage water encountered.
25						
30						

Plate A4.10

BORING LOG

W.O. 04-4001

BORING NO. B11
DRIVING WT. 140 lb.
START DATE 11/22/04
SURFACE ELEV. 488.9±
DROP 30 in.
END DATE 11/22/04

DEPTH	GRAPH	SAMPLE	BLOWS PER FOOT	DRY DENSITY (PCF)	MOIST. CONT. (%)	DESCRIPTION
0 5 10 15						BASALT (WS) – Gray, hard, vesicular, slightly weathered. Covered by a thin layer of silt, gravel, and cobbles. Begin NX coring at 0 feet. 82% Recovery from 0 to 5 feet. RQD = 74% 81% Recovery from 5 to 10 feet. RQD = 70% Clinker from 5 to 5.5 feet. Clinker from 9.5 to 10 feet. 50% Recovery from 10 to 15 feet. RQD = 33% Clinker 11 to 12.5 feet. 51% Recovery from 15 to 20 feet. RQD = 33%
20 25 30						End boring at 20 feet. Neither groundwater nor seepage water encountered.

BORING LOG

W.O. 04-4001

BORING NO. B12 DRIVING WT. 140 lb. START DATE 11/4/04
SURFACE ELEV. 474.5± DROP 30 in. END DATE 11/4/04

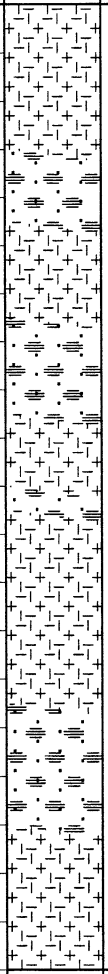
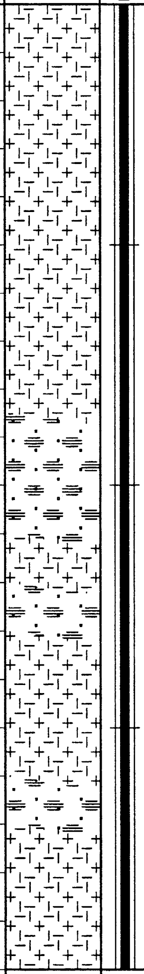
DEPTH	GRAPH	SAMPLE	BLOWS PER FOOT	DRY DENSITY (PCF)	MOIST. CONT. (%)	DESCRIPTION
0 5 10 15						BASALT (WS) – Gray, hard, vesicular, slightly weathered. Covered by a thin layer of silt, gravel, and cobbles. Begin NX coring at 0 feet. 80% Recovery from 0 to 5 feet. RQD = 47% Clinker from 3 to 4.5 feet. 67% Recovery from 5 to 10 feet. RQD = 47% Clinker from 6.5 to 8.5 feet. 87% Recovery from 10 to 15 feet. RQD = 77% Clinker from 10 to 10.5 feet. Clinker from 14.5 to 17 feet. 67% Recovery from 15 to 20 feet. RQD = 45%
20 25 30						End boring at 20 feet. Neither groundwater nor seepage water encountered.

Plate A4.12

BORING LOG

W.O. 04-4001

BORING NO. B13
DRIVING WT. 140 lb.
START DATE 11/2/04
SURFACE ELEV. 438.3±
DROP 30 in.
END DATE 11/2/04

DEPTH	GRAPH	SAMPLE	BLOWS PER FOOT	DRY DENSITY (PCF)	MOIST. CONT. (%)	DESCRIPTION
0						BASALT (WS) – Gray, hard, vesicular, slightly weathered. Covered by a thin layer of silt and gravel. Begin NX coring at 0 feet. 100% Recovery from 0 to 5 feet. RQD = 93%
5						67% Recovery from 5 to 10 feet. RQD = 35% Clinker from 8.5 to 11 feet.
10						97% Recovery from 10 to 15 feet. RQD = 35% Clinker from 12 to 13 feet.
15						97% Recovery from 15 to 20 feet. RQD = 72% Clinker from 16 to 17 feet.
20						End boring at 20 feet. Neither groundwater nor seepage water encountered.
25						
30						

BORING LOG

W.O. 04-4001

BORING NO. B14
DRIVING WT. 140 lb.
START DATE 11/5/04
SURFACE ELEV. 450.8±
DROP 30 in.
END DATE 11/5/04

DEPTH	GRAPH	SAMPLE	BLOWS PER FOOT	DRY DENSITY (PCF)	MOIST. CONT. (%)	DESCRIPTION
0						BASALT (WS) – Gray, hard, vesicular, slightly weathered. Covered by a thin layer of silt and gravel. Begin NX coring at 0 feet. 100% Recovery from 0 to 5 feet. RQD = 87%
5						70% Recovery from 5 to 10 feet. RQD = 30% Clinker from 5 to 6 feet. Clinker from 8.5 to 10 feet.
10						90% Recovery from 10 to 15 feet. RQD = 55% Highly fractured from 10 to 12.5 feet.
15						97% Recovery from 15 to 20 feet. RQD = 85%
20						End boring at 20 feet. Neither groundwater nor seepage water encountered.
25						
30						

Plate A4.14

HIRATA & ASSOCIATES, INC.

BORING LOG

W.O. 04-4001

BORING NO. B15
SURFACE ELEV. 456.5±
DRIVING WT. 140 lb.
DROP 30 in.
START DATE 11/8/04
END DATE 11/8/04

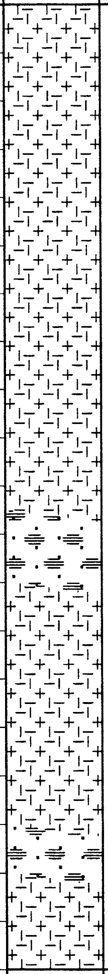
DEPTH	GRAPH	SAMPLE	BLOWS PER FOOT	DRY DENSITY (PCF)	MOIST. CONT. (%)	DESCRIPTION
0						BASALT (WS) – Gray, hard, vesicular, slightly weathered. Covered by a thin layer of silt, gravel, and cobbles. Begin NX coring at 0 feet. 98% Recovery from 0 to 5 feet. RQD = 93% Clinker from 2 to 2.5 feet.
5						88% Recovery from 5 to 10 feet. RQD = 65% Clinker from 7 to 8 feet.
10						80% Recovery from 10 to 15 feet. RQD = 72% Clinker from 13 to 13.5 feet.
15						80% Recovery from 15 to 20 feet. RQD = 50% Clinker from 15 to 16 feet. Clinker from 19 to 19.5 feet.
20						End boring at 20 feet. Neither groundwater nor seepage water encountered.
25						
30						

Plate A4.15

BORING LOG

W.O. 04-4001

BORING NO. B16
DRIVING WT. 140 lb.
START DATE 11/10/04
SURFACE ELEV. 439.2±
DROP 30 in.
END DATE 11/10/04

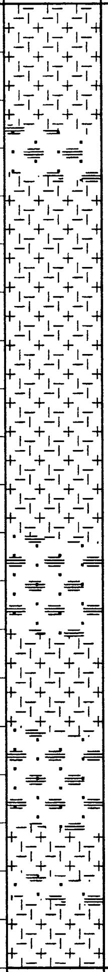
DEPTH	GRAPH	SAMPLE	BLOWS PER FOOT	DRY DENSITY (PCF)	MOIST. CONT. (%)	DESCRIPTION
0						BASALT (WS) – Gray, hard, vesicular, slightly weathered. Covered by a thin layer of silt and gravel. Begin NX coring at 0 feet. 100% Recovery from 0 to 5 feet. RQD = 95%
5						97% Recovery from 5 to 10 feet. RQD = 48% Highly fractured from 5.5 to 7.5 feet.
10						85% Recovery from 10 to 15 feet. RQD = 70% Clinker from 10.5 to 12 feet.
15						80% Recovery from 15 to 20 feet. RQD = 70% Clinker from 17 to 18 feet.
20						End boring at 20 feet. Neither groundwater nor seepage water encountered.
25						
30						

HIRATA & ASSOCIATES, INC.

BORING LOG

W.O. 04-4001

BORING NO. B17
DRIVING WT. 140 lb.
START DATE 11/2/04
SURFACE ELEV. 429.6±
DROP 30 in.
END DATE 11/2/04

DEPTH	GRAPH	SAMPLE	BLOWS PER FOOT	DRY DENSITY (PCF)	MOIST. CONT. (%)	DESCRIPTION
0						BASALT (WS) – Gray, hard, vesicular, slightly weathered. Covered by a thin layer of silt and gravel. Begin NX coring at 0 feet. 97% Recovery from 0 to 5 feet. RQD = 30% Clinker from 2.5 to 3.5 feet.
5						100% Recovery from 5 to 10 feet. RQD = 97%
10						90% Recovery from 10 to 15 feet. RQD = 63% Clinker from 11 to 13 feet.
15						97% Recovery from 15 to 20 feet. RQD = 27% Clinker from 15 to 17 feet. Clinker from 18 to 18.5 feet.
20						End boring at 20 feet. Neither groundwater nor seepage water encountered.
25						
30						

HIRATA & ASSOCIATES, INC.

BORING LOG

W.O. 04-4001

BORING NO. B18
DRIVING WT. 140 lb.
START DATE 11/2/04
SURFACE ELEV. 431.3±
DROP 30 in.
END DATE 11/2/04

DEPTH	GRAPH	SAMPLE	BLOWS PER FOOT	DRY DENSITY (PCF)	MOIST. CONT. (%)	DESCRIPTION
0						GRAVEL (GW) – Dark gray, slightly moist, dense, with sand and cobbles.
		☐	46	86	12	
		☐	43	82	6	
5						BASALT (WS) – Gray, hard, vesicular, slightly weathered. Begin NX coring at 5 feet. 100% Recovery from 5 to 10 feet. RQD = 68%
10						97% Recovery from 10 to 15 feet. RQD = 82%
15						93% Recovery from 15 to 20 feet. RQD = 63% Highly fractured from 16 to 17 feet.
20						End boring at 20 feet. Neither groundwater nor seepage water encountered.
25						
30						

Plate A4.18

SITE EVALUATION / PERCOLATION TEST

Date/Time: November 12, 2004/ 11:00 a.m.
Test performed by: Hirata & Associates, Inc.
Owner: Department of Hawaiian Home Lands
Tax Map Key: (3) 7-4-21: 10 and 12
Test Number: Boring B2

Elevation: 553.3 ± ft.
Depth to Groundwater Table: >20 ft. below grade
Depth to Bedrock (if observed): 0. ft. below grade
Diameter of Hole: 3 in.
Depth to Hole Bottom: 20 ft. below grade

Depth, below grade (feet)	**Soil Profile** (Color, texture, other)
0-20	BASALT - Gray, hard, vesicular, slightly weathered, fractured, with clinker pockets.

PERCOLATION READINGS

Time 12 inches of water to seep away: <1 minutes
Time 12 inches of water to seep away: <1 minutes

____ For percolation tests in sandy soils, record time intervals and water drops every 10 minutes for at least 1 hour.

____ For percolation tests in non-sandy soils, presoak the test hole for at least 4 hours. Record time intervals and water drops at least every 10 minutes for 1 hour; or if the time for the first 6 inches to seep away is greater than 30 minutes, record time intervals and water drops at least every 30 minutes for 4 hours or until 2 successive drops do not vary by more than 1/16 inch.

Time interval	Drop in inches	Time interval	Drop in inches
	* See note below		

* Unable to fill hole with water. Maximum flow rate of water introduced was about 12.5 gallons per minute.

Percolation Rate (time/final water level drop): NA min/in

As the engineer responsible for gathering and providing site information and percolation test results, I attest to the fact that above site information is accurate and that the site evaluation was conducted in accordance with the provisions of Chapter 11-62, "Wastewater Systems" and the results were acceptable.

CON C. TRUONG
LICENSED PROFESSIONAL ENGINEER
No. 9019-C

Engineer's Signature/Stamp

Plate A5.1

SITE EVALUATION / PERCOLATION TEST

Date/Time: November 12, 2004/ 11:20 a.m.
Test performed by: Hirata & Associates, Inc.
Owner: Department of Hawaiian Home Lands
Tax Map Key: (3) 7-4-21: 10 and 12
Test Number: Boring B9

Elevation: 471.6 ± ft.
Depth to Groundwater Table: >20 ft. below grade
Depth to Bedrock (if observed): 0. ft. below grade
Diameter of Hole: 3 in.
Depth to Hole Bottom: 20 ft. below grade

Depth, below grade (feet)	**Soil Profile** (Color, texture, other)
0-20	BASALT - Gray, hard, vesicular, slightly weathered, fractured, with clinker pockets.

PERCOLATION READINGS

Time 12 inches of water to seep away: <1 minutes
Time 12 inches of water to seep away: <1 minutes

____ For percolation tests in sandy soils, record time intervals and water drops every 10 minutes for at least 1 hour.

____ For percolation tests in non-sandy soils, presoak the test hole for at least 4 hours. Record time intervals and water drops at least every 10 minutes for 1 hour; or if the time for the first 6 inches to seep away is greater than 30 minutes, record time intervals and water drops at least every 30 minutes for 4 hours or until 2 successive drops do not vary by more than 1/16 inch.

Time interval	Drop in inches	Time interval	Drop in inches
	* See note below		

* Unable to fill hole with water. Maximum flow rate of water introduced was about 13 gallons per minute.

Percolation Rate (time/final water level drop): NA min/in

As the engineer responsible for gathering and providing site information and percolation test results, I attest to the fact that above site information is accurate and that the site evaluation was conducted in accordance with the provisions of Chapter 11-62, "Wastewater Systems" and the results were acceptable.

CON C. TRUONG
No. 9019-C

Engineer's Signature/Stamp

Plate A5.2

SITE EVALUATION / PERCOLATION TEST

Date/Time: November 11, 2004/ 12:30 p.m.
Test performed by: Hirata & Associates, Inc.
Owner: Department of Hawaiian Home Lands
Tax Map Key: (3) 7-4-21: 10 and 12
Test Number: Boring B12

Elevation: 474.5 ± ft.
Depth to Groundwater Table: >20 ft. below grade
Depth to Bedrock (if observed): 0. ft. below grade
Diameter of Hole: 3 in.
Depth to Hole Bottom: 20 ft. below grade

Depth, below grade (feet)	**Soil Profile** (Color, texture, other)
0-20	BASALT - Gray, hard, vesicular, slightly weathered, fractured, with clinker pockets.

PERCOLATION READINGS

Time 12 inches of water to seep away: <1 minutes
Time 12 inches of water to seep away: <1 minutes

____ For percolation tests in sandy soils, record time intervals and water drops every 10 minutes for at least 1 hour.

____ For percolation tests in non-sandy soils, presoak the test hole for at least 4 hours. Record time intervals and water drops at least every 10 minutes for 1 hour; or if the time for the first 6 inches to seep away is greater than 30 minutes, record time intervals and water drops at least every 30 minutes for 4 hours or until 2 successive drops do not vary by more than 1/16 inch.

Time interval	Drop in inches	Time interval	Drop in inches
	* See note below		

* Unable to fill hole with water. Maximum flow rate of water introduced was about 9 gallons per minute.

Percolation Rate (time/final water level drop): NA min/in

As the engineer responsible for gathering and providing site information and percolation test results, I attest to the fact that above site information is accurate and that the site evaluation was conducted in accordance with the provisions of Chapter 11-62, "Wastewater Systems" and the results were acceptable.

CON C. TRUONG
LICENSED PROFESSIONAL ENGINEER
No. 9019-C

Engineer's Signature/Stamp

Plate A5.3

SITE EVALUATION / PERCOLATION TEST

Date/Time: November 12, 2004/ 12:40 p.m.
Test performed by: Hirata & Associates, Inc.
Owner: Department of Hawaiian Home Lands
Tax Map Key: (3) 7-4-21: 10 and 12
Test Number: Boring B14

Elevation: 450.8 ± ft.
Depth to Groundwater Table: >20 ft. below grade
Depth to Bedrock (if observed): 0. ft. below grade
Diameter of Hole: 3 in.
Depth to Hole Bottom: 20 ft. below grade

Depth, below grade (feet)	**Soil Profile** (Color, texture, other)
0-20	BASALT - Gray, hard, vesicular, slightly weathered, fractured, with clinker pockets.

PERCOLATION READINGS

Time 12 inches of water to seep away: <1 minutes
Time 12 inches of water to seep away: <1 minutes

____ For percolation tests in sandy soils, record time intervals and water drops every 10 minutes for at least 1 hour.

____ For percolation tests in non-sandy soils, presoak the test hole for at least 4 hours. Record time intervals and water drops at least every 10 minutes for 1 hour; or if the time for the first 6 inches to seep away is greater than 30 minutes, record time intervals and water drops at least every 30 minutes for 4 hours or until 2 successive drops do not vary by more than 1/16 inch.

Time interval	Drop in inches	Time interval	Drop in inches
	* See note below		

* Unable to fill hole with water. Maximum flow rate of water introduced was about 14 gallons per minute.

Percolation Rate (time/final water level drop): NA min/in

As the engineer responsible for gathering and providing site information and percolation test results, I attest to the fact that above site information is accurate and that the site evaluation was conducted in accordance with the provisions of Chapter 11-62, "Wastewater Systems" and the results were acceptable.

CON C. TRUONG
No. 9019-C

Engineer's Signature/Stamp

SITE EVALUATION / PERCOLATION TEST

Date/Time: November 12, 2004/ 1:15 p.m.
Test performed by: Hirata & Associates, Inc.
Owner: Department of Hawaiian Home Lands
Tax Map Key: (3) 7-4-21: 10 and 12
Test Number: Boring B17

Elevation: 429.6 ± ft.
Depth to Groundwater Table: >20 ft. below grade
Depth to Bedrock (if observed): 0. ft. below grade
Diameter of Hole: 3 in.
Depth to Hole Bottom: 20 ft. below grade

Depth, below grade (feet)	**Soil Profile** (Color, texture, other)
0-20	BASALT - Gray, hard, vesicular, slightly weathered, fractured, with clinker pockets.

PERCOLATION READINGS

Time 12 inches of water to seep away: <1 minutes
Time 12 inches of water to seep away: <1 minutes

____ For percolation tests in sandy soils, record time intervals and water drops every 10 minutes for at least 1 hour.

____ For percolation tests in non-sandy soils, presoak the test hole for at least 4 hours. Record time intervals and water drops at least every 10 minutes for 1 hour; or if the time for the first 6 inches to seep away is greater than 30 minutes, record time intervals and water drops at least every 30 minutes for 4 hours or until 2 successive drops do not vary by more than 1/16 inch.

Time interval	Drop in inches	Time interval	Drop in inches
	* See note below		

* Unable to fill hole with water. Maximum flow rate of water introduced was about 14 gallons per minute.

Percolation Rate (time/final water level drop): NA min/in

As the engineer responsible for gathering and providing site information and percolation test results, I attest to the fact that above site information is accurate and that the site evaluation was conducted in accordance with the provisions of Chapter 11-62, "Wastewater Systems" and the results were acceptable.

CON C. TRUONG
No. 9019-C

Engineer's Signature/Stamp

Plate A5.5

APPENDIX B

LABORATORY TESTING

DESCRIPTION OF LABORATORY TESTING

CLASSIFICATION

Field classification was verified in the laboratory in accordance with the Unified Soil Classification System. Laboratory classification was determined by visual examination. The final classifications are shown at the appropriate locations on the Boring Logs, Plates A4.1through A4.18.

MOISTURE-DENSITY

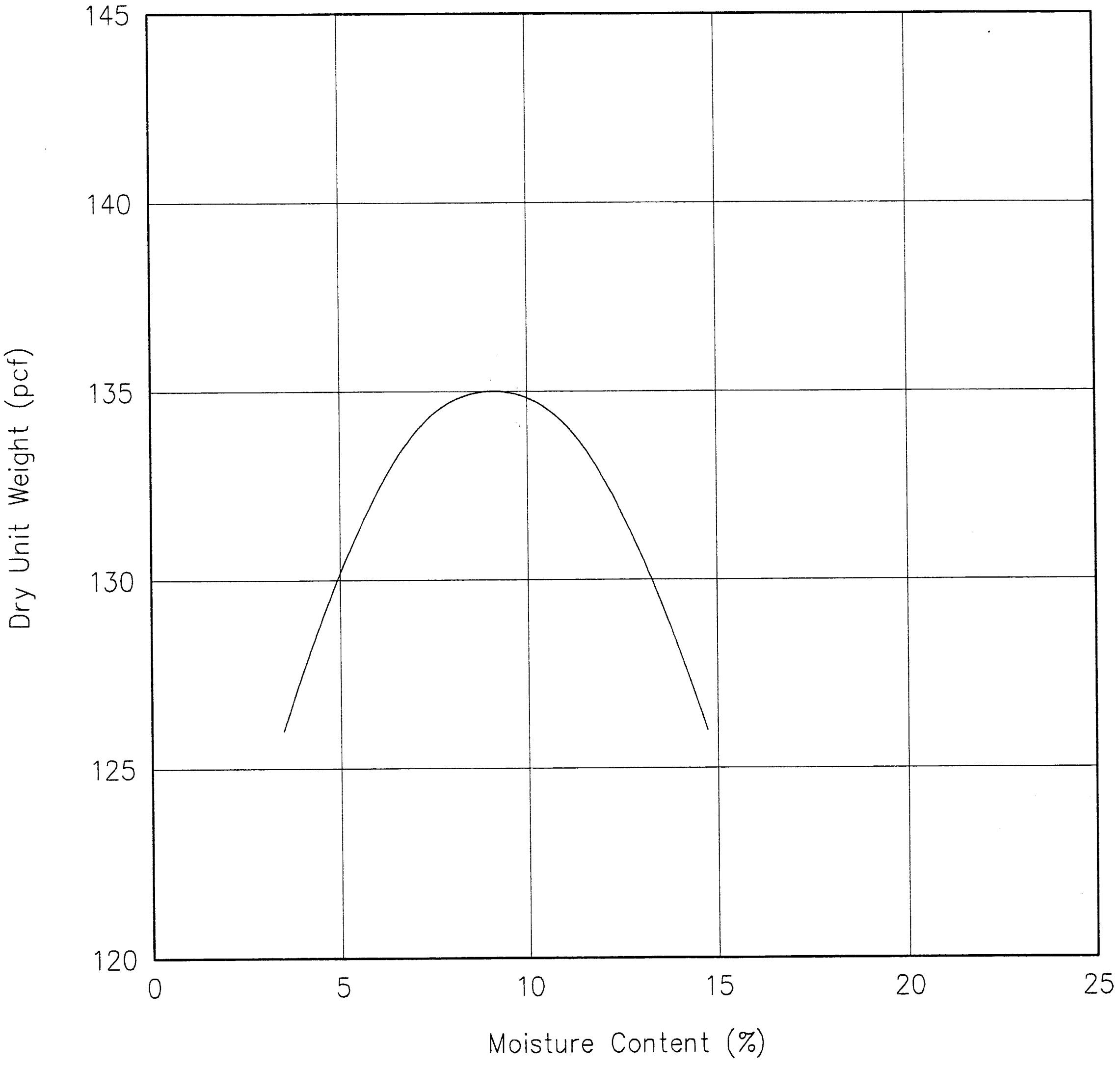
Representative samples were tested for insitu moisture content and dry unit weight. The dry unit weight was determined in pounds per cubic foot while the moisture content was determined as a percentage of dry weight. Samples were obtained using a 3-inch O.D. split tube sampler. Test results are shown at the appropriate depths on the Boring Logs, Plates A4.1 through A4.18.

PROCTOR TESTS

A Modified Proctor test was performed on a bag sample of near surface soil obtained from boring B9. The tests were performed in general accordance with ASTM D 1557 and results are shown on Plate B2.1

CALIFORNIA BEARING RATIO TESTS

CBR tests were performed on bag samples of near surface soil obtained from borings B9 and B11. The tests were performed in general accordance with ASTM D 1883, and results are shown on Plates B3.1 and B3.2.



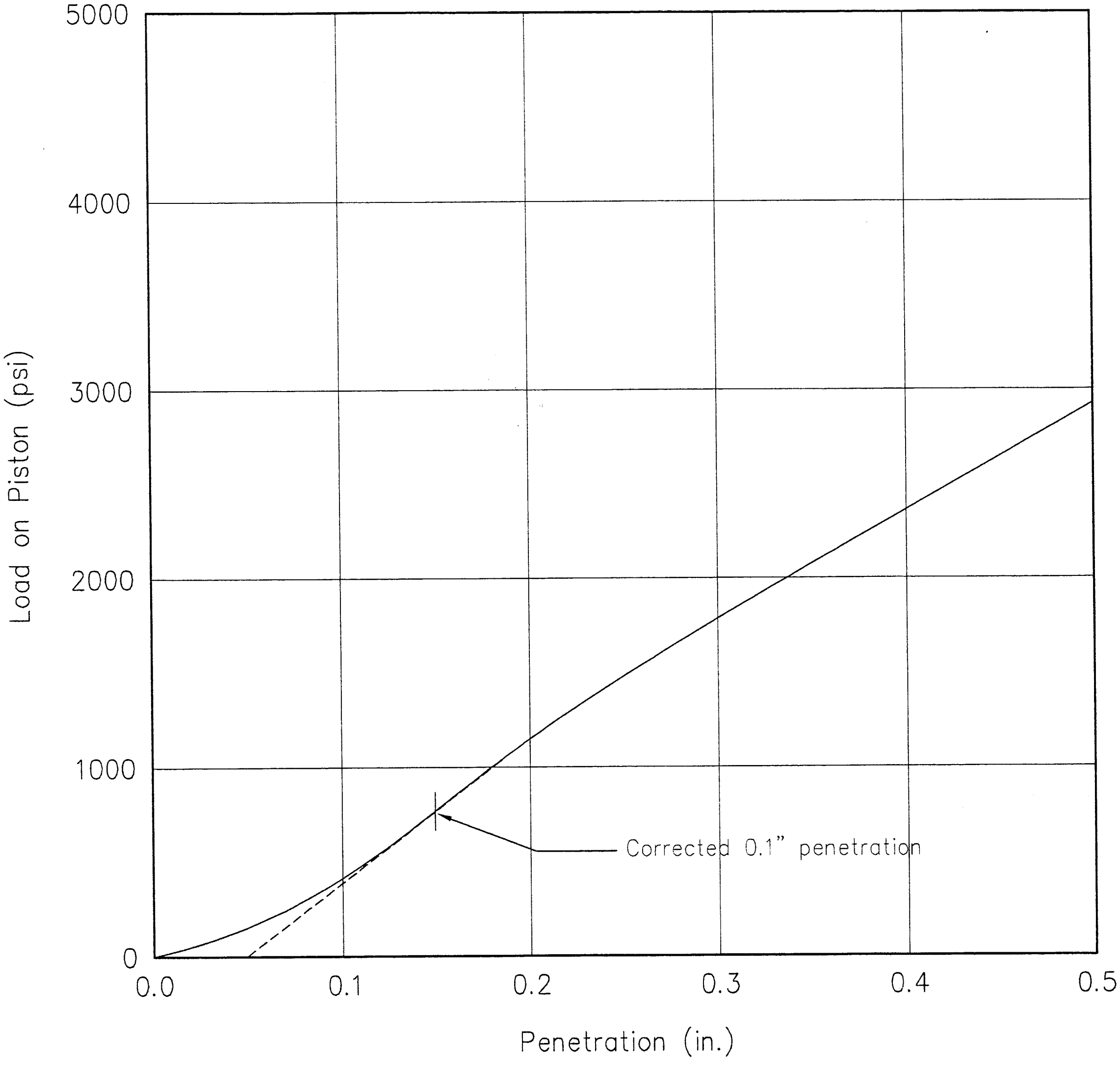
Soil Data

Location: Boring B9 at surface
Description: Gray sandy gravel with silt

Test Results

Maximum Dry Density: 135 pcf
Optimum Moisture Content: 9%

W.O. 04-4001	Laiopua Village 4, Kealakehe, North Kona
Hirata & Associates, Inc.	MODIFIED PROCTOR CURVE Plate B2.1



Soil Data

Location: Boring B9 at surface

Description: Gray sandy gravel with silt

Sample Dry Density: 133 pcf

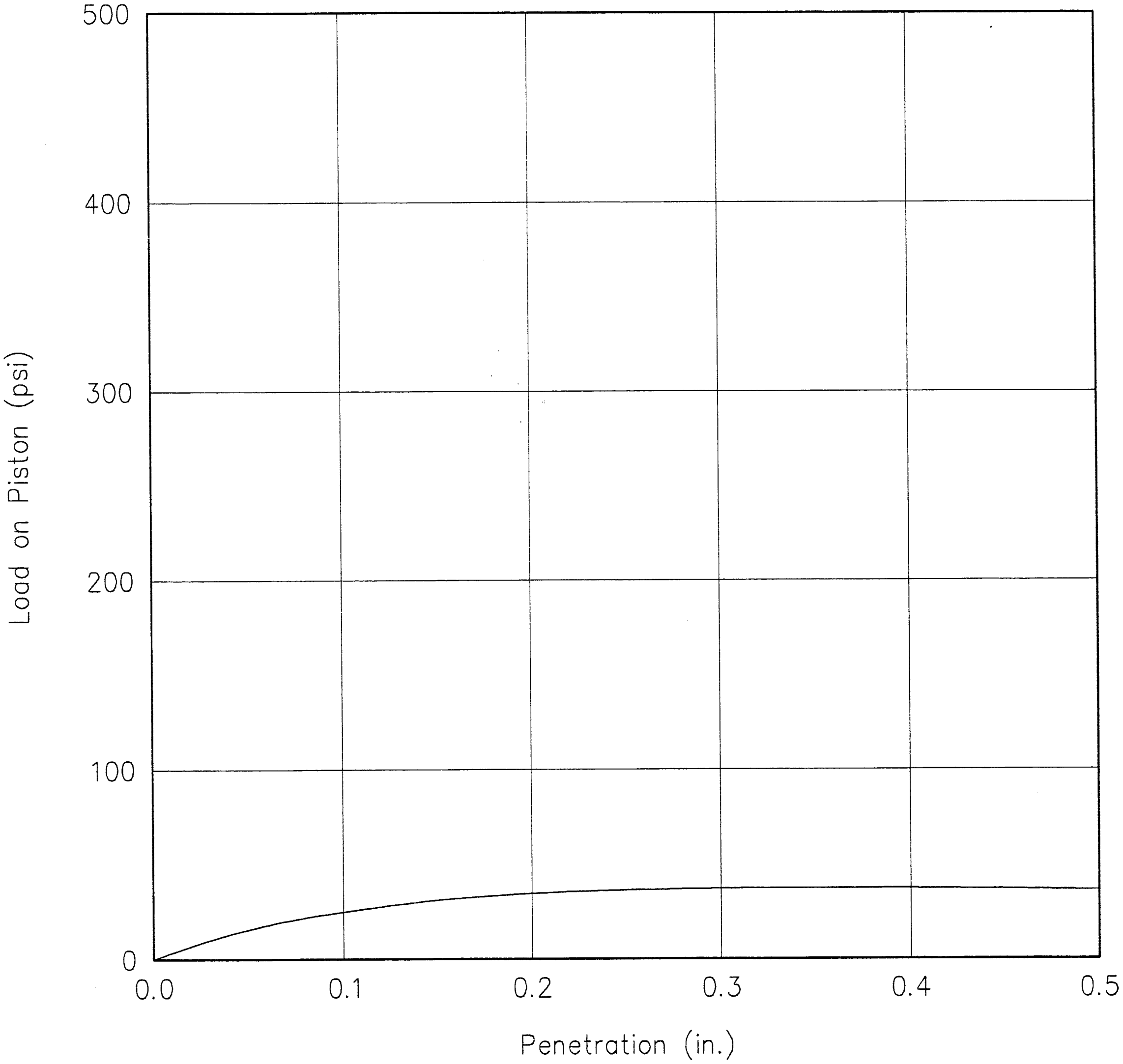
Sample Moisture Content: 11%

Test Results

CBR Value: 76%

Expansion: 0%

W.O. 04-4001	Laiopua Village 4, Kealakehe, North Kona
Hirata & Associates, Inc.	CBR STRESS PENETRATION CURVE Plate B3.1



Soil Data

Location:	Boring B11 at surface
Description:	Grayish brown clayey silt (volcanic ash)
Sample Dry Density:	71 pcf
Sample Moisture Content:	69%

Test Results

CBR Value:	2.5%
Expansion:	2.5%

W.O. 04-4001	Laiopua Village 4, Kealakehe, North Kona
Hirata & Associates, Inc.	CBR STRESS PENETRATION CURVE Plate B3.2

SECTION 01340 - DRAWINGS TO BE FURNISHED BY CONTRACTOR

The following shall supplement the General Conditions.

1.01 Shop drawings and submittals shall be made in accordance with Section 5.5 - Shop Drawings and Other Submittals of the General Conditions.

1.02 All submittals, RFIs, change requests and other documentation shall be submitted electronically via Newforma.

1.03 The Contractor's stamp and verification of drawings shall consist of the following format:

LAIOPUA VILLAGE 4 SUBDIVISION, PHASE 2 - HEMA
DHHL CONTRACT NO. IFB-21-HHL-007

(Contractor's Name) ______________________________

(Signature) ______________________________ (Date) ______________

This submittal has been checked and verified in accordance with the requirements of the contract documents and any equipment submitted herewith can be installed in the allocated spaces.

Submittal No. ______________________________

Specification Section No. ______________________________

Paragraph No. ______________________________

Contract Drawing Ref. ______________________________

Subcontractor ______________________________

Supplier ______________________________

Manufacturer ______________________________

Exceptions Taken: Yes ______________ No ______________

Details of Exception ______________________________

____

____

1.04 The person signing the Contractor's submittal stamp shall be the one designated under the contract agreement with the DHHL. The signature shall be in original ink. Stamped signature will not be acceptable. Submittal forms shall be completely filled out, signed and dated.

1.05 All changes made to the submittal drawings by the Contractor in the form of written or typewritten markings shall be initialed and dated by the Contractor.

1.06 When the Contractor takes any exception to the submittal drawings, such exception shall be brought to the attention of the Engineer. The exception shall be submitted with the shop drawings together with sufficient details and justifications.

1.07 Within 30 days after receipt of notice to proceed, the Contractor shall submit to the Engineer in duplicate, a schedule, listing all items that will be submitted for review and approval action by the DHHL, the State Department of Transportation, or the County of Hawaii. The schedule shall include, among other things, a list of shop drawings and manufacturer's literature, certificates of compliance, material samples, and guarantees. The schedule shall indicate the type of item, contract requirement reference; the Contractor's scheduled date for submitting the above items and projected needs for approval answers and procurement dates. In preparing the schedule, adequate time (minimum of 15 days) shall be allowed for review and approval; additional time shall be allowed to provide for possible resubmittal. Also, the scheduling shall be coordinated with the approved progress schedule.

1.08 The Contractor shall maintain at the job site two sets of full size contract drawings, marking them in red to show all variations between the construction actually provided and that indicated or specified in the contract documents, including buried or concealed herein, or where variations in scope or character of work from that of the original contract are authorized, the drawings shall be marked to define the construction actually provided. Where equipment installation is involved, the size, manufacturer's name, model number and power input or output characteristics are applicable shall be shown on the as-built drawings. The representations of such changes shall conform to standard and detail as necessary to clearly portray the as-built construction. The drawings shall be maintained and updated on a daily basis.

Monthly and final payments of the Contactor shall be subject to prior approval of the drawings.

On completion of the work, both sets of marked-up drawings shall be delivered to the Engineer, and shall be subject to his approval before acceptance.

END OF SECTION