FOUNDATION INVESTIGATION
SADDLE ROAD MAINTENANCE BASEYARD
VICINITY OF MAUNA KEA STATE PARK
HAMAKUA DISTRICT, HAWAII
TMK: 4-4-016: 003

for

ANBE, ARUGA & ISHIZU, ARCHITECTS, INC.

HIRATA & ASSOCIATES, INC.
W.O. 13-5490
July 8, 2013

Hirata & Associates
Geotechnical Engineering
Hirata & Associates, Inc.
99-1433 Koaha Pl
Aiea, HI 96701
tel 808.486.0787
fax 808.486.0870

July 8, 2013
W.O. 13-5490

Mr. Clarence Izuo
Anbe, Aruga and Ishizu, Architects, Inc.
1441 Kapiolani Boulevard, Suite 206
Honolulu, Hawaii 96814

Dear Mr. Izuo:

Our report, "Foundation Investigation, Saddle Road Maintenance Baseyard, Vicinity of Mauna Kea State Park, Hamakua District, Hawaii, TMK: 4-4-016: 003," dated July 8, 2013, our Work Order 13-5490 is enclosed. This investigation was conducted in general conformance with the scope of work presented in our proposal dated June 28, 2010.

Grayish brown sand with silt and gravel in a medium dense to dense condition was encountered in all our borings. The sand extended to depths of about 4.5 and 5.5 feet in borings B6 and B7, drilled in the area of the proposed culvert, and to the maximum depths drilled in the remaining borings. The silt content of the near surface soils appears to be derived from volcanic ash which is oftentimes characterized by poor workability. Numerous cobbles and boulders were encountered in the sand stratum. In the area of the proposed culvert, the sand was underlain by slightly weathered basalt in a hard condition, extending to the maximum depths drilled. Neither groundwater nor seepage water was encountered in our borings.

Conventional shallow foundations may be used to support the proposed shop building and fuel canopy. However, as a precautionary measure due to the poor workability characteristics of the silt/volcanic ash content in the near surface soils, we recommend that all footings and concrete slabs-on-grade be underlain by a minimum 12 inches of imported granular fill. The standard 4-inch gravel cushion and vapor barrier below slabs-on-grade may be considered part of the granular fill section. The remainder of the fill section should consist of well-graded imported granular structural fill.

The following is a summary of our geotechnical recommendations. This summary is not intended to be a substitute for our report which includes more detailed explanations of our recommendations, as well as additional requirements.

- Allowable bearing value = 2,000 psf
- Coefficient of friction = 0.4
- Passive earth pressure = 300 pcf

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 President

PSM:JGH

TABLE OF CONTENTS

APPENDICES

APPENDIX A

APPENDIX B

FOUNDATION INVESTIGATION
SADDLE ROAD MAINTENANCE BASEYARD
VICINITY OF MAUNA KEA STATE PARK
HAMAKUA DISTRICT, HAWAII
TMK: 4-4-016: 003

INTRODUCTION

This report presents the results of our foundation investigation performed for the proposed Saddle Road Maintenance Baseyard in Hamakua, Hawaii. Our scope of services for this study included the following:

- A visual reconnaissance of the site 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 seven exploratory borings to depths ranging from approximately 5.5 to 15.5 feet, and two probe holes to depths of about 5 feet. A description of our field investigation is summarized on Plates A1.1 and A1.2. The approximate exploratory boring and probe hole locations are shown on the enclosed Boring Location Plan, Plate A2.2, and the soils encountered in the borings and probe holes are described on the Boring Logs, Plates A4.1 through A4.9.

- Drilling two percolation test holes to depths of approximately 6 feet. The approximate test hole locations are shown on Plate A2.2. Falling head percolation tests were performed in the test holes and results are presented on the Department of Health Site Evaluation/Percolation Test forms, Plates A5.1 and A5.2.

- Laboratory testing of selected soil samples. Testing procedures are presented in the Description of Laboratory Testing, Plates B1.1 and B1.2. Test results are presented in the Description of Laboratory Testing, and on the Boring Logs (Plates A4.1 through A4.7), Consolidation Test reports (Plates B2.1 through

B2.4), Direct Shear Test reports (Plates B3.1 through B3.3), Modified Proctor Test reports (Plates B4.1 and B4.2), CBR Test reports (Plates B5.1 and B5.2), and Gradation Test report (Plates B6.1).

- Engineering analyses of the field and laboratory data.
- Preparation of this report presenting geotechnical recommendations for the design of foundations, including seismic considerations, slabs-on-grade, resistance to lateral pressures, flexible and rigid pavement, and site grading.

PROJECT CONSIDERATIONS

The proposed Saddle Road Maintenance Baseyard will support crews maintaining the new Saddle Road. The facility will include a shop building, storage area, fueling station with canopy, equipment wash area, aggregate storage bins, parking area, and leach field. The shop building will be a two-story metal structure with plan dimensions of approximately 125 by 36 feet.

Structural loads were not available at the time of this report, however, we assume that building loads will be relatively light.

Finish floor elevations for the shop building were also unavailable at the time of this report. However, based on the relatively level topography of the site, we expect that the finish elevations will generally match that of the existing elevations, and only minor site grading work is anticipated.

The project will also include asphaltic concrete (AC) paved parking and driveway areas, and an access road. The access road will be approximately 0.3 miles in length and we understand that a culvert will be required along the access road.

SITE CONDITIONS

The project site is located on the north side of Saddle Road in the southwestern portion of Mauna Kea State Park, located in the Hamakua District of Hawaii. The

project site is bordered by undeveloped land covered with light to moderate vegetation. A single-story CMU structure with a concrete slab-on-grade was observed to the east of the project site.

The area of the proposed fuel station is occupied by a single-story wooden building with a tool shed to the east. The northwestern portion of the project site is occupied by several animal pens. The remainder of the site is vacant of structures and covered with sparse grass and trees. Cobbles and boulders were observed at ground surface throughout the site.

The site is sloped such that drainage generally flows in a westerly direction. Total relief over the site is approximately 15 feet with elevations ranging from about +6509 on the west to +6524 on the east.

SOIL CONDITIONS

Probe hole PH2, drilled at the southern end of the access road, encountered pavement consisting of approximately 1.5 inches of asphaltic concrete. Underlying the pavement in probe hole PH2, and at the surface in the remaining borings was grayish brown sand with silt and gravel. Cobbles and boulders were also encountered within the sand stratum. The sand was generally in a medium dense to dense condition and extended to the maximum depths drilled, except in the area of the culvert where the sand extended to depths of about 4.5 and 5.5 feet below grade. Sampling resulted in blow counts ranging from 12 to 71 blows per foot of penetration. In sections with numerous cobbles and boulders, sampling resulted in refusal prior to 12 inches of penetration.

The silt portion of the soil appears to be derived from volcanic ash which is oftentimes characterized by poor workability and a collapsing type structure with the introduction of water. However, the soil predominantly consists of sand and gravel,

and laboratory testing did not indicate a collapsing type structure with the introduction of water.

In the area of the culvert, the sand stratum was underlain by slightly weathered basalt in a hard condition. The basalt extended to the maximum depths drilled.

Groundwater: Neither groundwater nor seepage water was encountered in the exploratory borings and probe holes down to the maximum depths drilled.

CONCLUSIONS AND RECOMMENDATIONS

Conventional shallow foundations may be used to support the proposed structures. However, although the near surface soils predominantly consist of sand and gravel, as a precautionary measure due to the silt/volcanic ash content of the near surface soils, additional site preparation work is recommended for footings and slabs-on-grade. The additional site work will consist of placing a minimum 12 inches of granular structural fill below footings and slabs-on-grade.

Foundations

Conventional shallow foundations, such as spread footings or thickened slab foundations, underlain by a minimum 12 inches of imported granular structural fill may be used to support the proposed structures. The imported granular structural fill should conform to and be placed in accordance with specifications in the *Site Grading* section of this report. The granular structural fill section should also extend laterally a minimum of 12 inches beyond the edge of foundations.

Conventional shallow foundations may also be used to support the culvert structure. However, based on our exploratory borings, we anticipate that basalt may be encountered at the bottom of foundation excavations. Foundations bearing directly on the slightly weathered basalt may be used to support the culvert structure.

Foundations may be designed for the following allowable bearing values. 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 effects of wind and seismic forces.

Foundation Subgrade	Allowable Bearing Value
Imported Granular Fill	2,000 psf
Basalt	5,000 psf

Spread footings should be a minimum 16 inches in width; thickened edge slab foundations should be a minimum 12 inches wide. Foundations bearing on imported granular structural fill should be embedded at least 12 inches below finish adjacent grade. The bottom of footing excavations should be thoroughly tamped and cleaned of loose material prior to placement of reinforcing steel and concrete. Culvert foundations bearing on the hard basalt should be embedded a minimum 6 inches into the basalt.

Seismic Design

Based on the borings drilled as part of this study and our knowledge of the deep soil conditions in the area, it is our opinion that the subsurface soils can be characterized as a very dense and soft rock profile. Therefore, based on the 2006 International Building Code, Site Class C is recommended for this site and the following site coefficients and spectral accelerations may be used in design:

$F_a = 1.0$	$S_s = 1.50$
$F_v = 1.3$	$S_1 = 0.60$

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.

A coefficient of friction of 0.4 may be used with the dead load forces. For passive earth pressure considerations, the following equivalent fluid pressures may be used. Unless covered by pavement or concrete slabs, the upper 12 inches of soil should not be considered in computing lateral resistance.

Soil Type	Passive Earth Pressure	Maximum Passive Earth Pressure
Insitu Sand/Imported Granular Fill	300 pcf	3,000 pcf
Basalt	400 pcf	4,000 pcf

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
Insitu Sand/Imported Granular Fill	35 pcf	45 pcf	50 pcf
Basalt	25 pcf	35 pcf	40 pcf

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

Foundation Settlement

Structural loads were not available at the time of this report. However, structural loads are expected to be relatively light, and differential settlement is not expected to exceed 1/4 inch for foundations bearing on compacted granular structural fill. The final building loads should be forwarded to our office, when available, for review.

Settlement of foundations founded on the hard basalt is expected to be negligible.

Slabs-on-Grade

All building slabs-on-grade should be underlain by a minimum 12 inches of imported granular fill. To provide uniform support, the upper 4 inches of the granular fill should consist of a cushion of clean gravel, such as #3 Fine (ASTM C33, Size No.

67). The remainder of the fill section should consist of well-graded granular structural fill. All building slabs should also be protected by a vapor barrier placed over the cushion material.

Prior to placement of the imported granular structural fill, the exposed subgrade should be scarified to a minimum depth of about 6 inches, moisture conditioned as necessary to about 2 percent above the optimum moisture content, and recompacted to a minimum 95 percent compaction as determined by ASTM D 1557. The overlying imported granular structural fill should be compacted to a minimum 95 percent compaction as determined by ASTM D 1557. The gravel cushion should be compacted to a level surface using a vibratory compactor.

Floor slabs subjected to vehicular or forklift loading should be underlain by a minimum 6 inches of base course in lieu of the 4-inch gravel cushion. The base course may be considered part of the 12-inch imported granular section recommended under all building slabs.

Exterior slabs-on-grade and concrete walkways should be underlain by a minimum 12 inches of imported granular structural fill with the upper 4 inches consisting of base course. The granular structural fill and base course should be compacted to a minimum 95 percent compaction as determined by ASTM D 1557.

Pavement Design

Flexible and rigid pavement for parking areas, driveways, and the access road may be designed based on the following sections:

Flexible Pavement

3.0"	Asphaltic Concrete
6.0"	Base Course (minimum CBR = 85)
9.0"	Total Thickness

Rigid Pavement

6.0" Portland Cement Concrete
6.0" Base Course (minimum CBR = 85)
12.0" Total Thickness

Prior to placement of the base course, the exposed subgrade should be scarified to a minimum depth of 6 inches, moisture conditioned to about 2 percent above the optimum moisture content, and compacted to a minimum 95 percent compaction as determined by ASTM D 1557. The base course should also be compacted to a minimum 95 percent compaction as determined by ASTM D 1557.

Site Grading

Site Preparation - The project site should be cleared of all vegetation, debris and other deleterious material.

Excavations into the onsite soils may encounter boulders. Should portions of boulders extend into the granular fill section recommended below footings, slabs-on-grade, or the pavement section, the boulders should be removed and replaced with granular structural fill. In areas requiring fill placement, the subgrade soils should be scarified to a minimum depth of 6 inches, moistened if necessary to about 2 percent above the optimum moisture content, and compacted to a minimum 95 percent compaction as determined by ASTM D 1557. Where basalt is encountered or exposed, scarification may be terminated prior to the minimum 6 inch depth.

Onsite Fill Material - The onsite sand may be reused in compacted fills or backfills, except in the imported granular structural fill sections recommended below all footings and slab-on-grade, provided all rock fragments larger than 3 inches in maximum dimension are removed prior to reuse.

Reuse of excavated basalt will require crushing to a well-graded consistency, with a maximum particle size of 3 inches.

Imported Fill Material - Imported structural fill should be well-graded, non-expansive granular material. Specifications for imported granular 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 structural fill should have a CBR expansion value of less than 1.0 percent and a minimum CBR value of 12 percent, when tested in accordance with ASTM D 1883.

Compaction - Imported granular structural fill should be placed in horizontal lifts restricted to 8 inches in loose thickness and compacted to a minimum 95 percent compaction as determined by ASTM D 1557. Fill placed in areas which slope steeper than 5H:1V should be continually benched as the fill is brought up in lifts.

Structural Excavations - Based on our exploratory borings, excavations into the onsite sand can generally be accomplished using conventional excavation equipment. However, confined excavations into the underlying basalt or near surface boulders will require pneumatic equipment.

Temporary shallow cuts into the onsite soils should be stable at slope gradients of 1H:1V or flatter. However, the contractor should be responsible for conforming to OSHA safety standards for excavations.

Boring B4, drilled near the proposed fueling station, encountered medium dense to dense sand with silt and gravel which extended to the maximum depth drilled. Although it is our geotechnical opinion that excavations into the sand for installation

of the fuel tank can be accomplished using conventional excavating equipment, confined excavations into sections with numerous cobbles and boulders may require pneumatic equipment.

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) check footing excavations prior to placement of imported granular fill, reinforcing steel, and concrete, (2) review and/or perform laboratory testing on import borrow to determine its acceptability for use in compacted fills, (3) observe structural fill placement and perform compaction testing, 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 and probe holes were made, and may not represent conditions at other times and locations.

This report was prepared specifically for Anbe, Aruga and Ishizu, Architects, Inc. and their sub-consultants for design of the proposed Saddle Road Maintenance Baseyard. 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 in this report 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 in the same locality. 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, either express or implied.

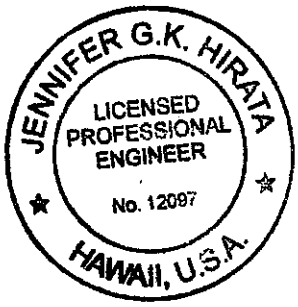
Respectfully submitted,

HIRATA & ASSOCIATES, INC.

Jennifer G. Hirata, P.E.

Rick I.K. Yoshida, Project Manager

RIKY:JGH



This work was prepared by me or under my supervision
Expiration Date of License:
April 30, 2014

APPENDIX A

FIELD INVESTIGATION

DESCRIPTION OF FIELD INVESTIGATION

GENERAL

The site was explored from April 30 to May 2, 2013, by performing a visual reconnaissance of the site, drilling 7 test borings to depths ranging from about 5.5 to 15.5 feet, and drilling two probe holes to depths of about 5 feet. The borings and probe holes were drilled with a CME-55 truck-mounted drill rig. In addition, two percolation test holes were drilled to depths of about 6 feet and tested in accordance with Department of Health guidelines.

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, while 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 A4.9.

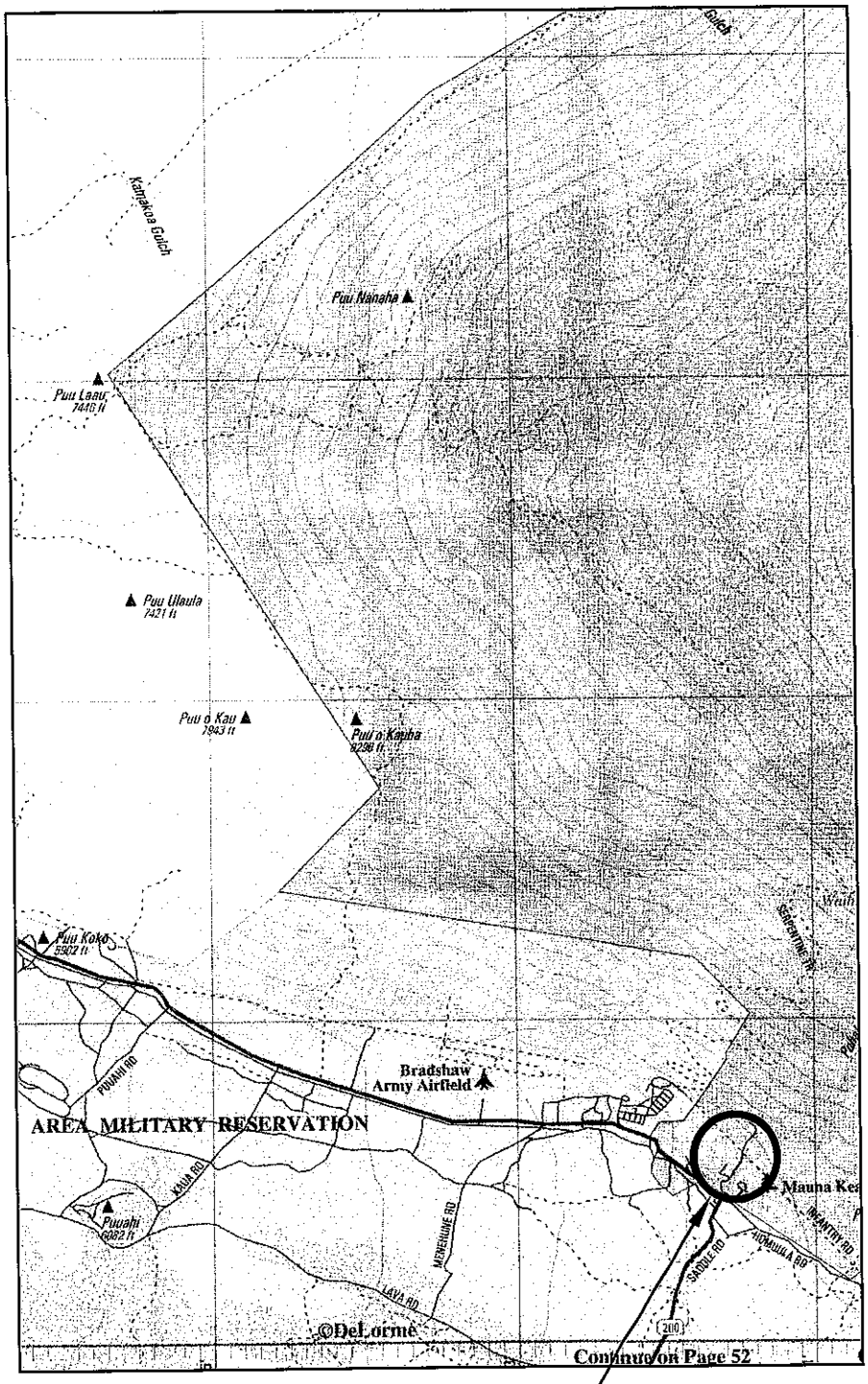
The borings, probes, and percolation tests were located in the field by measuring/taping offsets from existing site features shown on the plans. Surface elevations at these locations were estimated based on the Site Plan provided by Anbe, Aruga & Ishizu, Architects, Inc. on April 22, 2013. The accuracy of the locations shown on Plate A2.2, and the elevations shown on Plates A4.1 through A4.9, A5.1, and A5.2 are therefore approximate, in accordance with the field methods used.

SOIL SAMPLING

Representative and bulk soil samples 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. Bulk soil samples were recovered from near borings B4 and B7, at depths of about 1 foot below ground surface.

FIELD TESTING

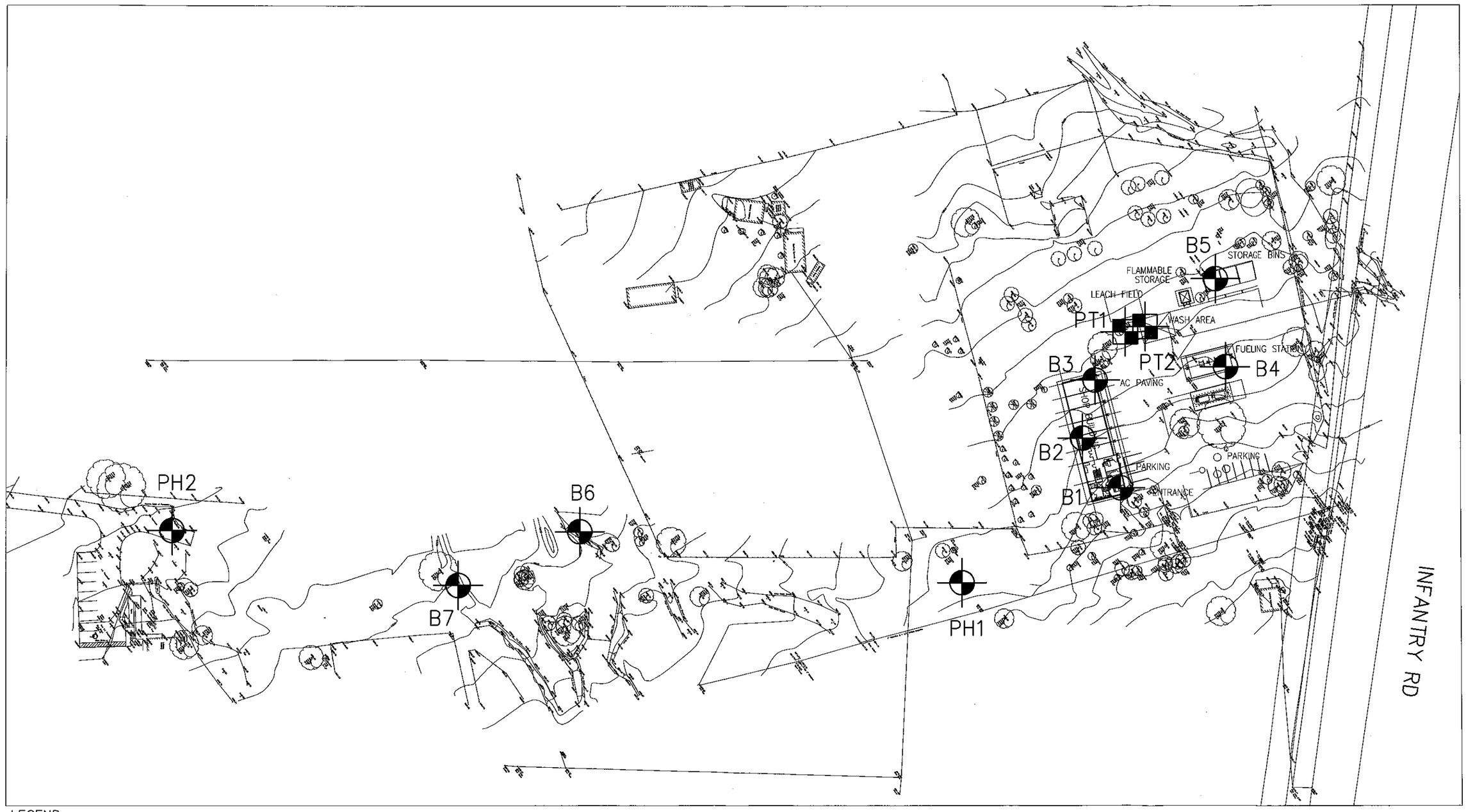
Two percolation test holes were drilled to depths of about 6 feet in the proposed leach field area in the western portion of the site. Falling head percolation tests were performed in general accordance with Department of Health guidelines. The approximate test hole locations are shown on Plate A2.2, and test results are shown on Plates A5.1 and A5.2.



Reference: Hawaii Atlas & Gazetteer, Topo Maps of the Entire State by DeLorme (1999)

NOT TO SCALE

W.O. 13-5490	Saddle Road Maintenance Baseyard
Hirata & Associates, Inc.	LOCATION MAP Plate A2.1



LEGEND:

Approximate location of borings and probe holes

Approximate location of percolation tests

GRAPHIC SCALE:

0 50 100 200 FT.

1" = 100'

Reference: Site Plan provided by Anbe, Aruga & Ishizu, Architects, Inc. on April 22, 2013.

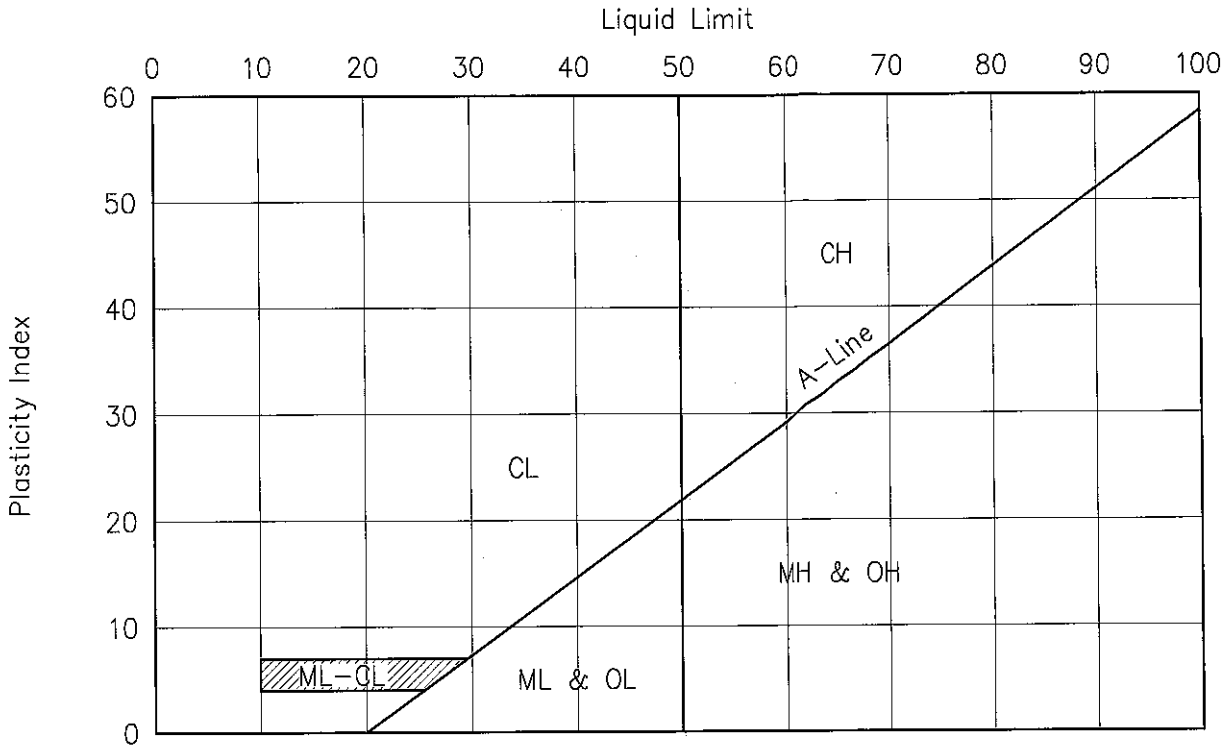
W.O. 13-5490	Saddle Road Maintenance Baseyard
Hirata & Associates, Inc.	BORING LOCATION PLAN Plate A2.2

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. 13–5490	Saddle Road Maintenance Baseyard
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 Coarse gravel Fine gravel	3 in. to No. 4 (4.76 mm) 3 in. to 3/4 in. 3/4 in. to No. 4 (4.76 mm)
Sand Coarse sand Medium sand Fine sand	No. 4 (4.76 mm) to No. 200 (0.074 mm) No. 4 (4.76 mm) to No. 10 (2.0 mm) No. 10 (2.0 mm) to No. 40 (0.42 mm) No. 40 (0.42 mm) to No. 200 (0.074 mm)
Silt and clay	Smaller than No. 200 (0.074 mm)

W.O. 13-5490	Saddle Road Maintenance Baseyard
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. 13-5490	Saddle Road Maintenance Baseyard
Hirata & Associates, Inc.	ROCK WEATHERING CLASSIFICATION SYSTEM Plate A3.3

HIRATA & ASSOCIATES, INC.

BORING LOG

W.O. 13-5490

BORING NO. B1 DRIVING WT. 140 lb. START DATE 5/1/13
SURFACE ELEV. 6519±* DROP 30 in. END DATE 5/1/13

DEPTH	GRAPH	SAMPLE	BLOWS PER FOOT	DRY DENSITY (PCF)	MOIST. CONT. (%)	DESCRIPTION
0						SAND (SP–SM) – Grayish brown, dry, medium dense to dense, with silt and gravel.
			23/9"	74	5	
						Cobble at 2.5 feet.
			25	95	4	
5			22/9"	102	6	
						Cobble at 6.5 feet.
			26/6"	112	12	
10						Boulder at 10 feet.
			50/11"	102	8	
15						End boring at 15.5 feet.
						Neither groundwater nor seepage water encountered.
20						
						* Elevations based on Site Plan provided by Anbe, Aruga & Ishizu, Architects, Inc. on April 22, 2013.
25						
30						Plate A4.1

HIRATA & ASSOCIATES, INC.

BORING LOG

W.O. 13-5490

BORING NO. B2 DRIVING WT. 140 lb. START DATE 5/1/13
SURFACE ELEV. 6515.5± DROP 30 in. END DATE 5/1/13

DEPTH	GRAPH	SAMPLE	BLOWS PER FOOT	DRY DENSITY (PCF)	MOIST. CONT. (%)	DESCRIPTION
0						SAND (SP-SM) – Grayish brown, dry, medium dense to dense, with silt and gravel.
		□	12	86	6	
		□	37/9"	105	5	
5						Boulder at 5 feet.
						Cobble at 7 feet.
		□	45	125	13	
10						
		□	35	112	7	
15						End boring at 14.5 feet.
20						Neither groundwater nor seepage water encountered.
25						
30						

Plate A4.2

HIRATA & ASSOCIATES, INC.

BORING LOG

W.O. 13-5490

BORING NO. B3 DRIVING WT. 140 lb. START DATE 4/30/13
SURFACE ELEV. 6513± DROP 30 in. END DATE 4/30/13

DEPTH	GRAPH	SAMPLE	BLOWS PER FOOT	DRY DENSITY (PCF)	MOIST. CONT. (%)	DESCRIPTION
0						SAND (SP-SM) – Grayish brown, dry, medium dense to dense, with silt and gravel.
			16	96	4	
			35	106	3	
5			13/3"	No Recovery		Cobble at 5.5 feet.
			39	123	11	
10						
			22/2"	112	5	
15						End boring at 15 feet.
						Neither groundwater nor seepage water encountered.
20						
25						
30						

Plate A4.3

HIRATA & ASSOCIATES, INC.

BORING LOG

W.O. 13-5490

BORING NO. B4 DRIVING WT. 140 lb. START DATE 5/1/13

SURFACE ELEV. 6514.5± DROP 30 in. END DATE 5/1/13

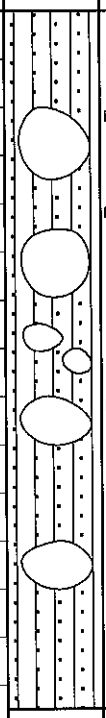
DEPTH	GRAPH	SAMPLE	BLOWS PER FOOT	DRY DENSITY (PCF)	MOIST. CONT. (%)	DESCRIPTION
0						SAND (SP–SM) – Grayish brown, dry, medium dense to dense, with silt and gravel.
			10/No	Penetration		Boulder at 2 feet.
			20/2"	89	6	
5						Boulder at 4.5 feet.
						Cobbles from 6.5 to 7 feet.
			10/No	Penetration		Boulder at 8 feet.
10						Boulder at 11 feet.
			28	98	13	
15						End boring at 14.5 feet.
20						Neither groundwater nor seepage water encountered.
25						
30						

Plate A4.4

HIRATA & ASSOCIATES, INC.

BORING LOG

W.O. 13-5490

BORING NO. B5 DRIVING WT. 140 lb. START DATE 5/1/13
SURFACE ELEV. 6511± DROP 30 in. END DATE 5/1/13

DEPTH	GRAPH	SAMPLE	BLOWS PER FOOT	DRY DENSITY (PCF)	MOIST. CONT. (%)	DESCRIPTION
0						SAND (SP-SM) – Grayish brown, dry, medium dense to dense, with silt and gravel.
			16	99	2	
			19	90	6	
5			34	118	2	
						Cobble at 7 feet.
			44	105	4	
10						Cobble at 11 feet.
			81/9"	131	6	
15						End boring at 15.5 feet.
20						Neither groundwater nor seepage water encountered.
25						
30						

Plate A4.5

HIRATA & ASSOCIATES, INC.

BORING LOG

W.O. 13-5490

BORING NO. B6 DRIVING WT. 140 lb. START DATE 5/2/13
SURFACE ELEV. 6502± DROP 30 in. END DATE 5/2/13

DEPTH	GRAPH	SAMPLE	BLOWS PER FOOT	DRY DENSITY (PCF)	MOIST. CONT. (%)	DESCRIPTION
0						SAND (SP-SM) – Grayish brown, dry, dense, with silt and gravel.
			71	100	5	
			12/6"	97	5	
						Cobble at 4 feet.
5			26/6"	107	11	
						BASALT (WS) – Gray, hard, slightly weathered.
						End boring at 8 feet.
10						
15						
20						Neither groundwater nor seepage water encountered.
25						
30						

Plate A4.6

HIRATA & ASSOCIATES, INC.

BORING LOG

W.O. 13-5490

BORING NO. B7 DRIVING WT. 140 lb. START DATE 5/2/13

SURFACE ELEV. 6500± DROP 30 in. END DATE 5/2/13

DEPTH	GRAPH	SAMPLE	BLOWS PER FOOT	DRY DENSITY (PCF)	MOIST. CONT. (%)	DESCRIPTION
0						SAND (SP–SM) – Grayish brown, dry, dense, with silt and gravel.
			30	108	3	
			8/3"	95	8	
5						BASALT (WS) – Gray, hard, slightly weathered.
						End boring at 5.5 feet.
10						
15						
20						Neither groundwater nor seepage water encountered.
25						
30						

Plate A4.7

HIRATA & ASSOCIATES, INC.

BORING LOG

W.O. 13-5490

BORING NO. Probe Hole 1 (PH1) DRIVING WT. 140 lb. START DATE 5/2/13
SURFACE ELEV. 6517.5± DROP 30 in. END DATE 5/2/13

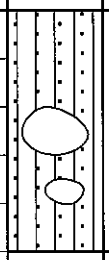
DEPTH	GRAPH	SAMPLE	BLOWS PER FOOT	DRY DENSITY (PCF)	MOIST. CONT. (%)	DESCRIPTION
0						SAND (SP–SM) – Grayish brown, dry, medium dense to dense, with silt and gravel. Boulder at 2 feet. Cobble at 3.5 feet.
5						End boring at 5 feet. Neither groundwater nor seepage water encountered.
10						
15						
20						
25						
30						

Plate A4.8

HIRATA & ASSOCIATES, INC.

BORING LOG

W.O. 13-5490

BORING NO. Probe Hole 2 (PH2) DRIVING WT. 140 lb. START DATE 5/2/13
SURFACE ELEV. 6493± DROP 30 in. END DATE 5/2/13

DEPTH	GRAPH	SAMPLE	BLOWS PER FOOT	DRY DENSITY (PCF)	MOIST. CONT. (%)	DESCRIPTION
0						SAND (SP–SM) – Grayish brown, dry, medium dense to dense, with silt and gravel.
5						End boring at 5 feet.
10						
15						
20						Neither groundwater nor seepage water encountered.
25						
30						

Plate A4.9

SITE EVALUATION/PERCOLATION TEST

Date/Time: April 30, 2013
Test performed by: Hirata & Associates, Inc.
Owner:
Tax Map Key: 4-4-016: 003
Test Number: PT1

Elevation: 6511± ft.
Depth to Groundwater Table: >5 ft. below grade (Based on nearby boring B3)
Depth to Bedrock (if observed): >5 ft. below grade (Based on nearby boring B3)
Diameter of Hole: 4 in.
Depth to Hole Bottom: 6 ft. below grade

Depth (inches)	Soil Profile (Color, texture, other)
0 - 72	Grayish brown sand with silt, gravel, and cobbles.

PERCOLATION READINGS

Time 12 inches of water to seep away: <30 min.
Time 12 inches of water to seep away: <30 min.

√ 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
10 min.	3-1/3		
10 min.	3-1/8		
10 min.	2-5/16		
10 min.	2		
10 min.	1-15/16		
10 min.	1-7/8		

Percolation Rate (time/final water level drop): 5.3 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.

RICK I.K. YOSHIDA
LICENSED PROFESSIONAL ENGINEER
No. 11118-C
HAWAII, U.S.A.

Rick I K Yoshida
Engineer's Signature/Stamp

Plate A5.1

SITE EVALUATION/PERCOLATION TEST

Date/Time: April 30, 2013
Test performed by: Hirata & Associates, Inc.
Owner:
Tax Map Key: 4-4-016: 003
Test Number: PT2

Elevation: 6511.5± ft.
Depth to Groundwater Table: >5 ft. below grade (Based on nearby boring B5)
Depth to Bedrock (if observed): >5 ft. below grade (Based on nearby boring B5)
Diameter of Hole: 4 in.
Depth to Hole Bottom: 6 ft. below grade

Depth (inches)	Soil Profile (Color, texture, other)
0 - 72	Grayish brown sand with silt, gravel, and cobbles.

PERCOLATION READINGS

Time 12 inches of water to seep away: >30 min.
Time 12 inches of water to seep away: >30 min.

√ 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
30 min.	3-7/8	30 min.	2-3/4
30 min.	3-11/16	30 min.	2-3/8
30 min.	3-5/8		
30 min.	3-5/16		
30 min.	3-3/16		
30 min.	3-1/16		

Percolation Rate (time/final water level drop): 12.6 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.

RICK I.K. YOSHIDA
LICENSED PROFESSIONAL ENGINEER
No. 11118-C
HAWAII, U.S.A.

Rick I K Yoshida
Engineer's Signature/Stamp

Plate A5.2

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 both visual examination and sieve analysis testing performed in general accordance with ASTM D 422. Sieve analysis results are shown on Plate B6.1. The final classifications are shown at the appropriate locations on the Boring Logs, Plates A4.1 through A4.9.

MOISTURE-DENSITY

Representative samples were tested for field 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 A4.9.

CONSOLIDATION

Selected representative samples were tested for their consolidation characteristics. Test samples were 2.42 inches in diameter and 1 inch high. Porous stones were placed in contact with the top and bottom of test samples to permit addition and release of pore fluid. Loads were then applied in several increments in a geometric progression, and the resulting deformations recorded at selected time intervals. Test results are plotted on the Consolidation Test Reports, Plates B2.1 through B2.4.

SHEAR TESTS

Shear tests were performed in the Direct Shear Machine which is of the strain control type. Each sample was sheared under varying confining loads in order to determine the Coulomb shear strength parameters, cohesion and angle of internal friction. Test results are presented on Plates B3.1 through B3.3.

PROCTOR TESTS

Modified Proctor tests were performed in general accordance with ASTM D 1557 on bulk samples obtained from near borings B4 and B7 at depths of about 1 foot below grade. The test is used to determine the optimum moisture content at which the soil compacts to 100 percent density. Results are shown on Plates B4.1 and B4.2.

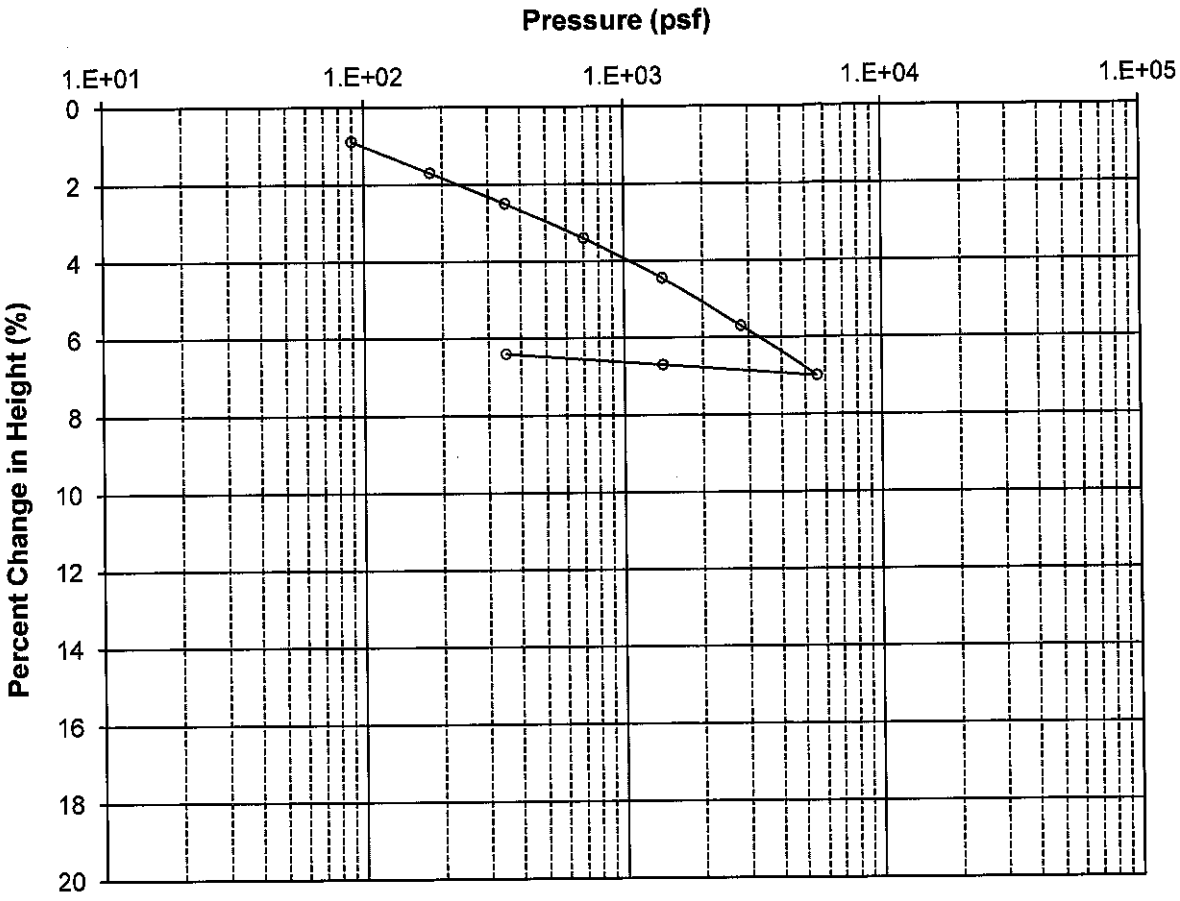
CALIFORNIA BEARING RATIO TESTS

CBR tests were performed in general accordance with ASTM D 1883 on bulk samples obtained from near borings B4 and B7 at depths of about 1 foot below grade. The test is used to evaluate the relative quality of subgrade soils to be used in the design of flexible and rigid pavements. Results are shown on Plates B5.1 and B5.2.

SIEVE ANALYSIS

A sieve analysis test was conducted in general accordance with ASTM D 422 on a bulk sample obtained from near boring B7 at a depth of about 1 foot below grade. The test is used to determine the grain size distribution. Test results are presented on Plate B6.1.

Consolidation Test Results



Sample Description

Boring No.: B1 Depth (ft): 5

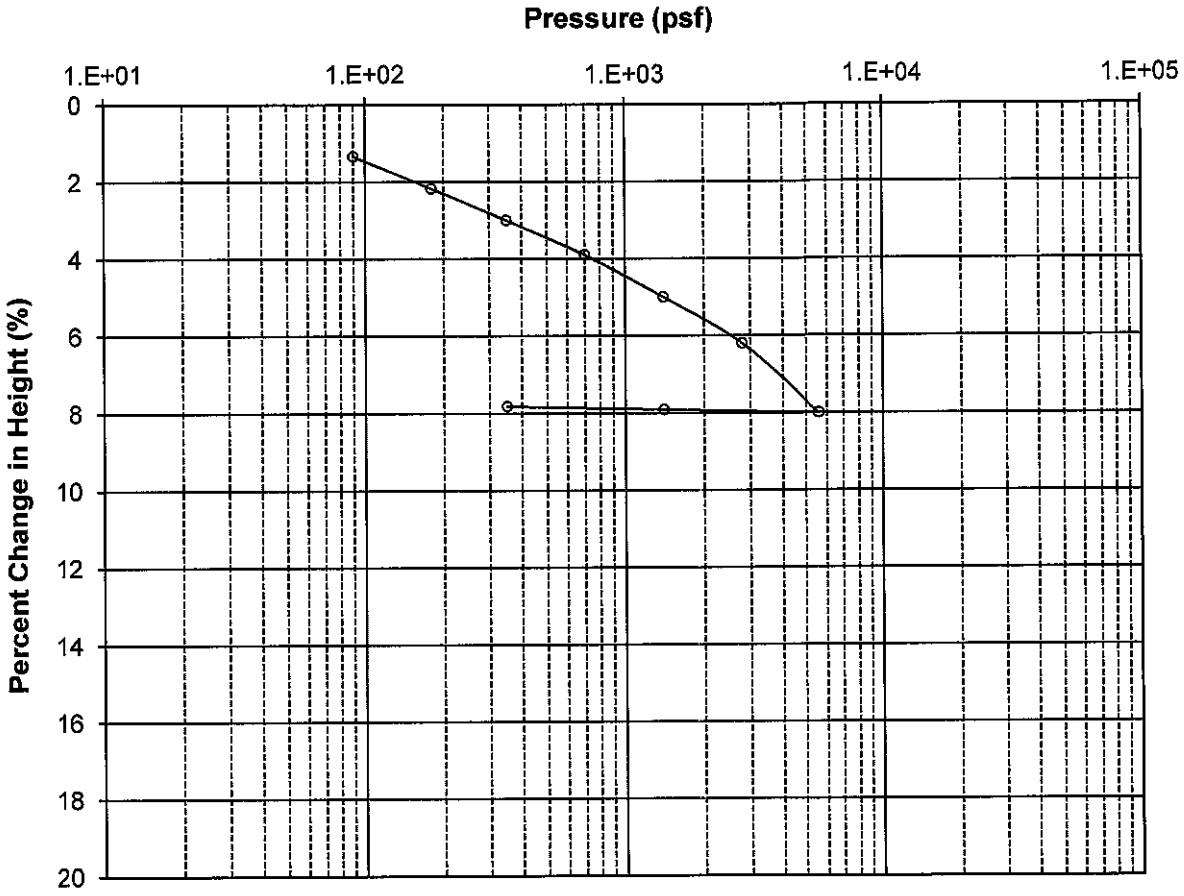
Soil Description: Grayish brown sand with silt and gravel

	Moisture Content (%)	Dry Density (pcf)
Initial	5.9	101.7
Final	18.9	108.6

Remark: Water added at 700 psf

W.O. 13-5490	Saddle Road Maintenance Baseyard
Hirata & Associates, Inc.	CONSOLIDATION TEST Plate B2.1

Consolidation Test Results



Sample Description

Boring No.: B2 Depth (ft): 4

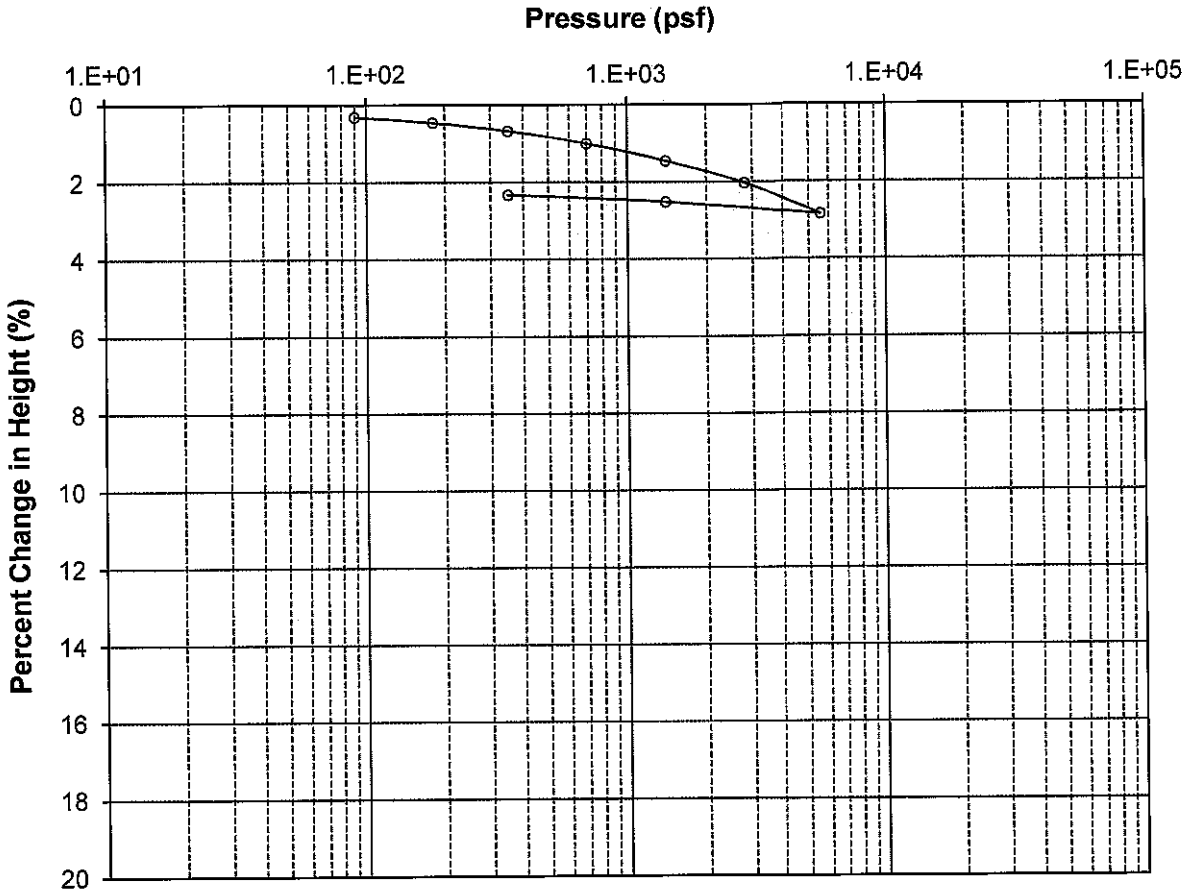
Soil Description: Grayish brown sand with silt and gravel

	Moisture Content (%)	Dry Density (pcf)
Initial	4.8	104.6
Final	18.9	113.4

Remark: water added at 700 psf

W.O. 13-5490	Saddle Road Maintenance Baseyard
Hirata & Associates, Inc.	CONSOLIDATION TEST Plate B2.2

Consolidation Test Results



Sample Description

Boring No.: B5 Depth (ft): 5

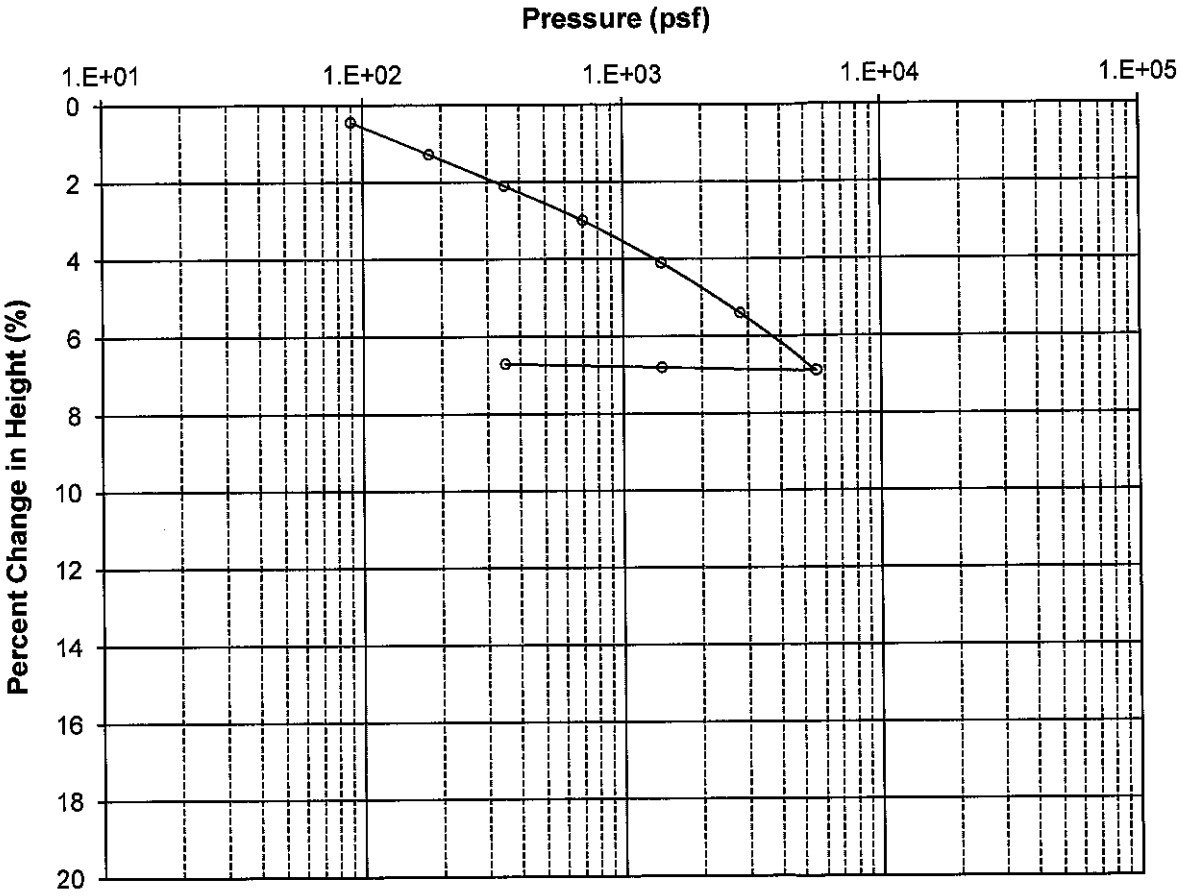
Soil Description: Grayish brown sand with silt and gravel

	Moisture Content (%)	Dry Density (pcf)
Initial	2.4	118.2
Final	12.4	121.1

Remark:

W.O. 13-5490	Saddle Road Maintenance Baseyard
Hirata & Associates, Inc.	CONSOLIDATION TEST Plate B2.3

Consolidation Test Results



Sample Description

Boring No.: B7 Depth (ft): 4

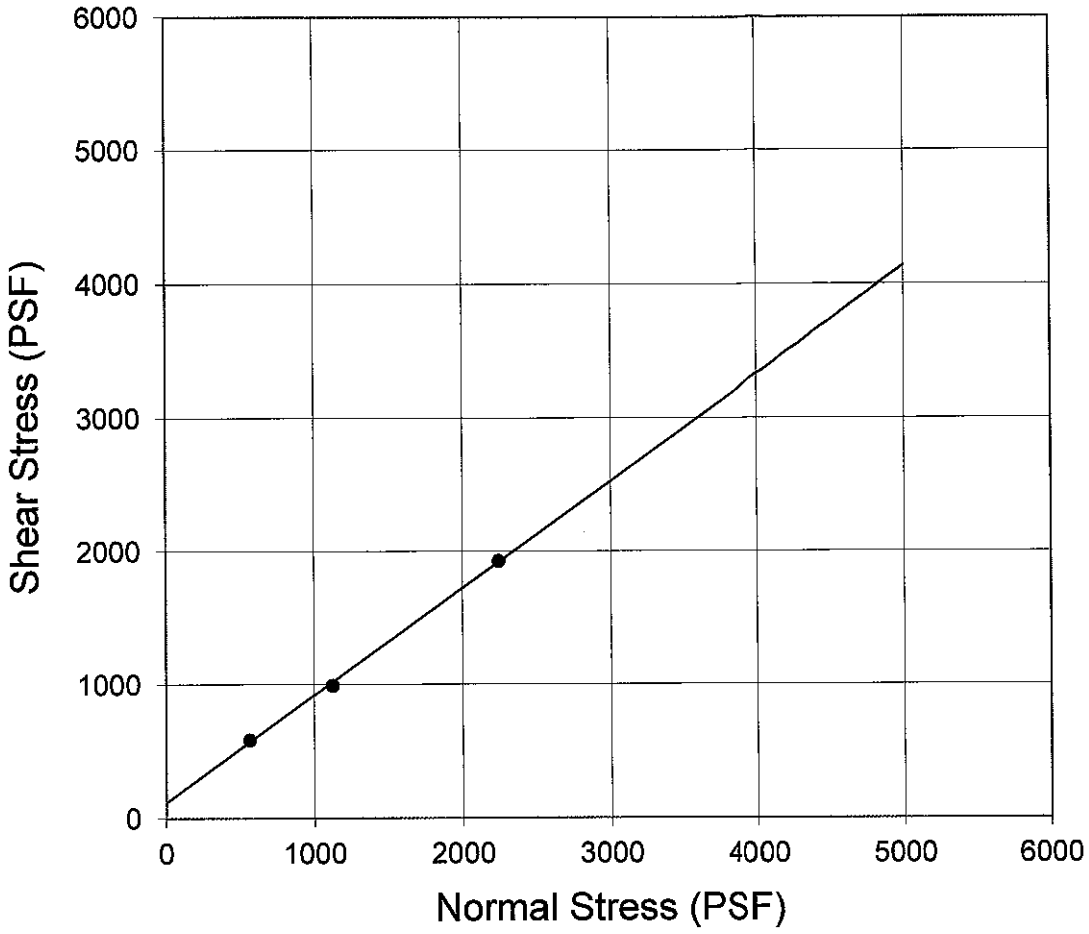
Soil Description: Grayish brown sand with silt and gravel

	Moisture Content (%)	Dry Density (pcf)
Initial	7.8	94.6
Final	20.7	101.4

Remark: water added at 700 psf

W.O. 13-5490	Saddle Road Maintenance Baseyard
Hirata & Associates, Inc.	CONSOLIDATION TEST Plate B2.4

Direct Shear Test Results



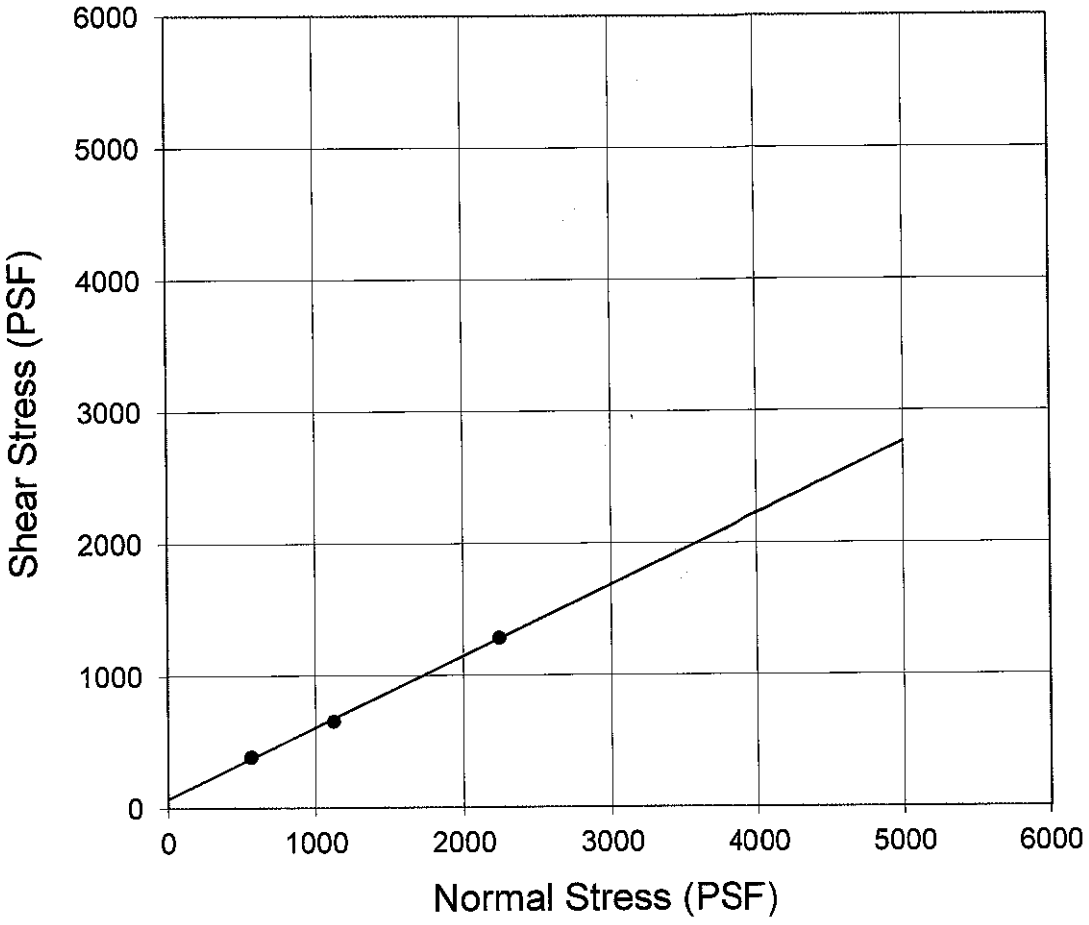
Sample Description

Boring No.: B2 Depth (ft): 2
Soil Description: Grayish brown sand with silt and gravel
Strength Intercept (C): 119.6 PSF (Peak Strength)
Friction Angle (ϕ): 38.8 DEG (Peak Strength)

Remark:

W.O. 13-5490	Saddle Road Maintenance Baseyard
Hirata & Associates, Inc.	DIRECT SHEAR TEST Plate B3.1

Direct Shear Test Results



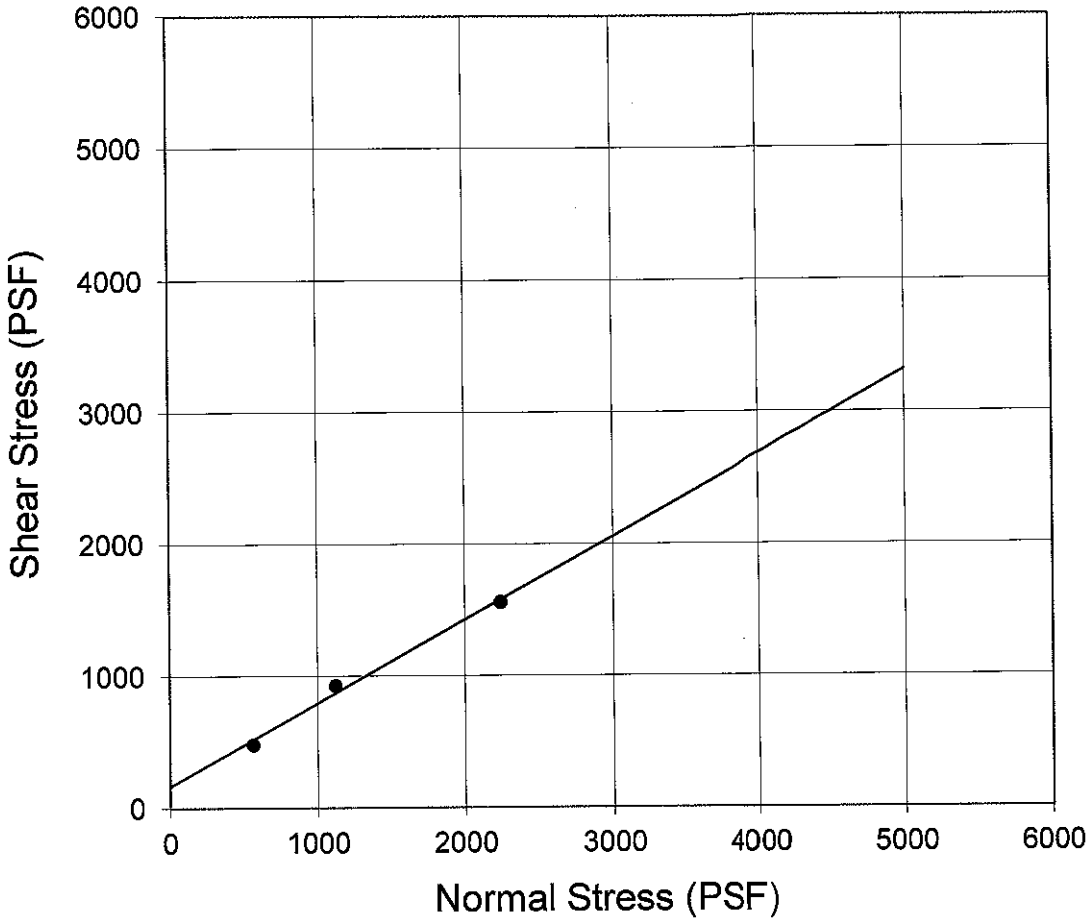
Sample Description

Boring No.: B3 Depth (ft): 1
Soil Description: Grayish brown sand with silt and gravel
Strength Intercept (C): 73.4 PSF (Peak Strength)
Friction Angle (ϕ): 28.3 DEG (Peak Strength)

Remark:

W.O. 13-5490	Saddle Road Maintenance Baseyard
Hirata & Associates, Inc.	DIRECT SHEAR TEST Plate B3.2

Direct Shear Test Results

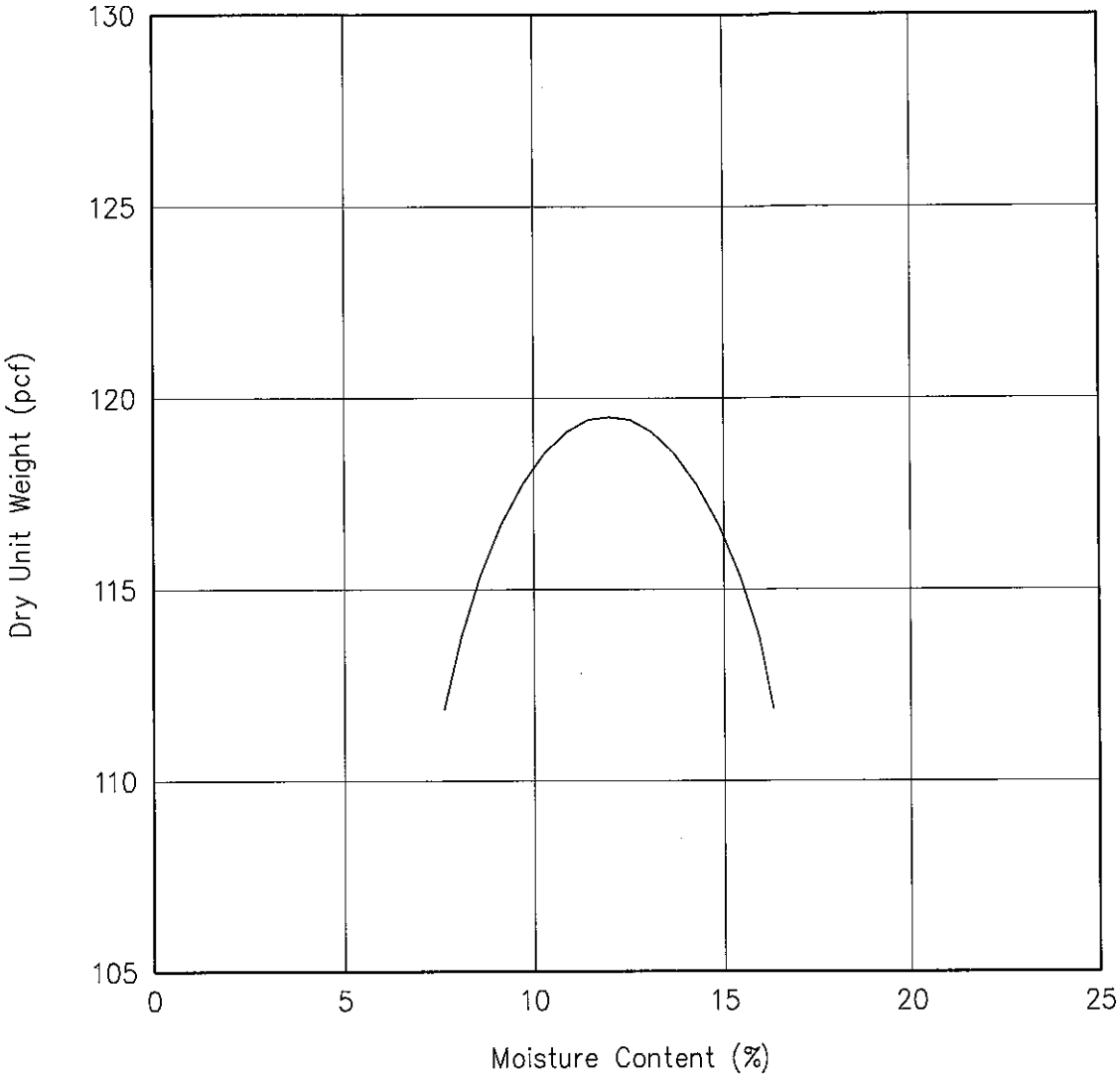


Sample Description

Boring No.: B7 Depth (ft): 2
Soil Description: Grayish brown sand with silt and gravel
Strength Intercept (C): 166.6 PSF (Peak Strength)
Friction Angle (ϕ): 32.2 DEG (Peak Strength)

Remark:

W.O. 13-5490	Saddle Road Maintenance Baseyard
Hirata & Associates, Inc.	DIRECT SHEAR TEST Plate B3.3



Soil Data

Location: Near boring B4 at a depth of about 1 foot

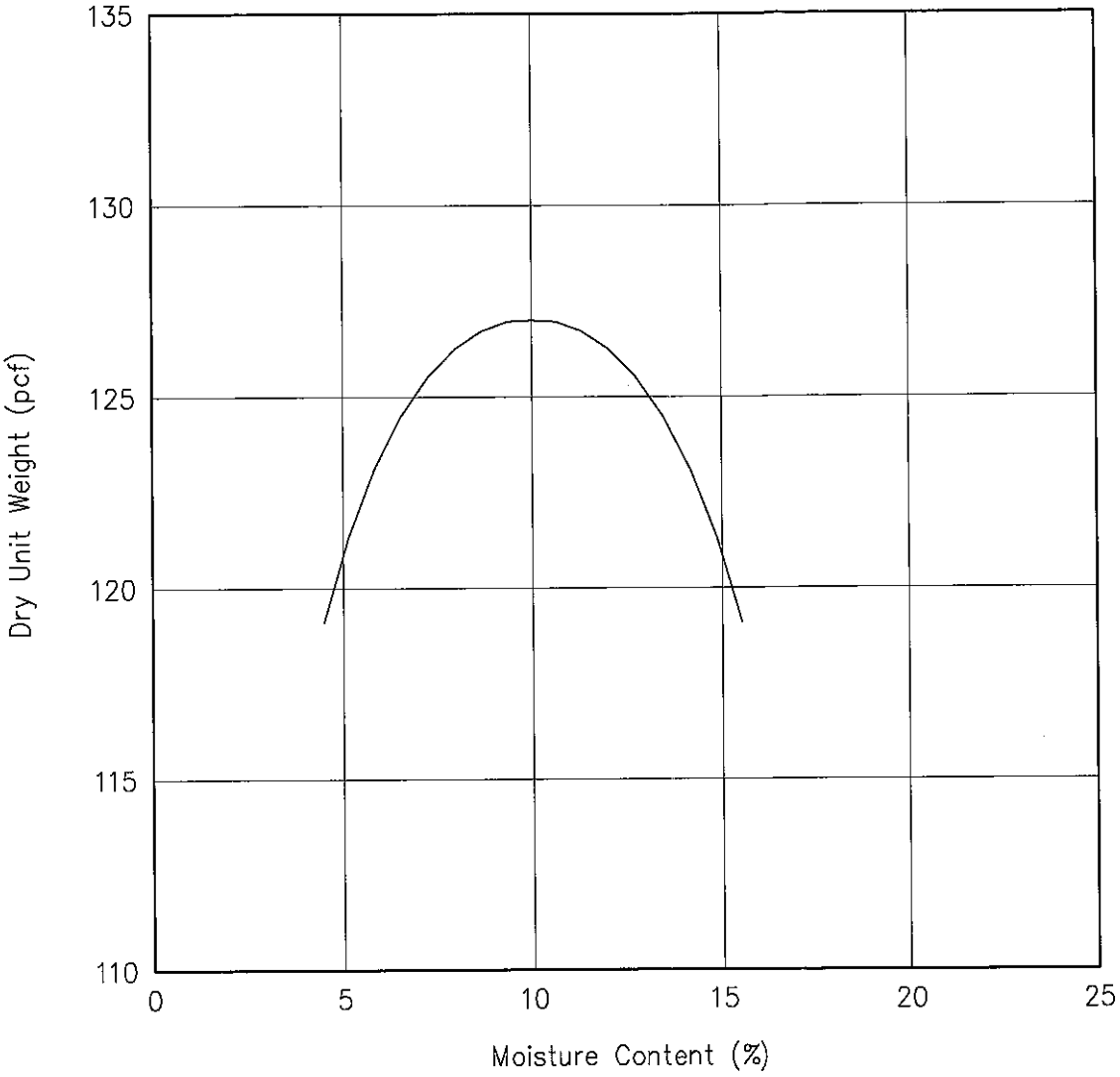
Description: Grayish brown sand with silt and gravel

Test Results

Maximum Dry Density: 119.5 pcf

Optimum Moisture Content: 12%

W.O. 13-5490	Saddle Road Maintenance Baseyard
Hirata & Associates, Inc.	MODIFIED PROCTOR CURVE Plate B4.1



Soil Data

Location: Near boring B7 at a depth of about 1 foot

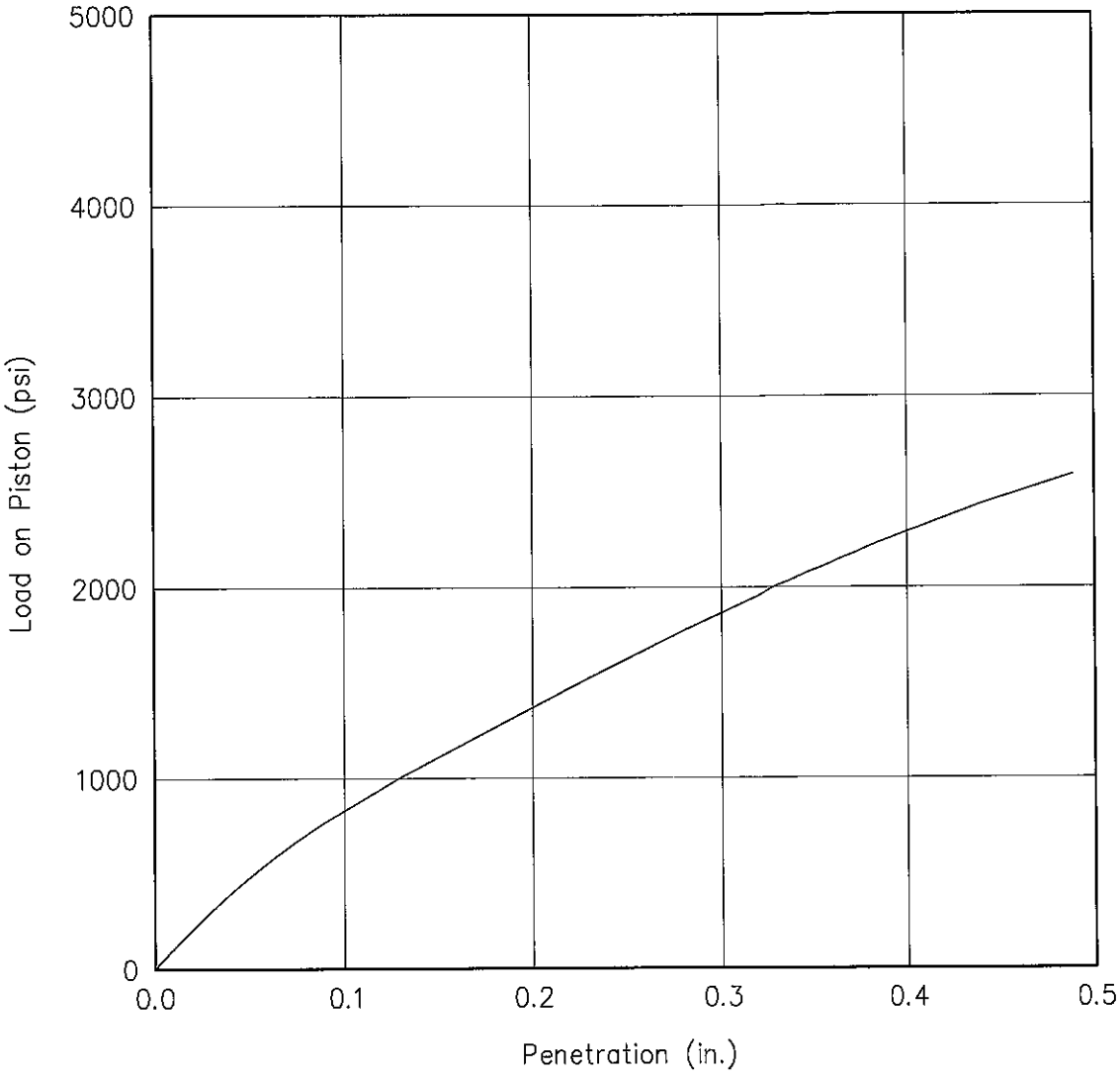
Description: Grayish brown sand with silt and gravel

Test Results

Maximum Dry Density: 127 pcf

Optimum Moisture Content: 10%

W.O. 13-5490	Saddle Road Maintenance Baseyard
Hirata & Associates, Inc.	MODIFIED PROCTOR CURVE Plate B4.2



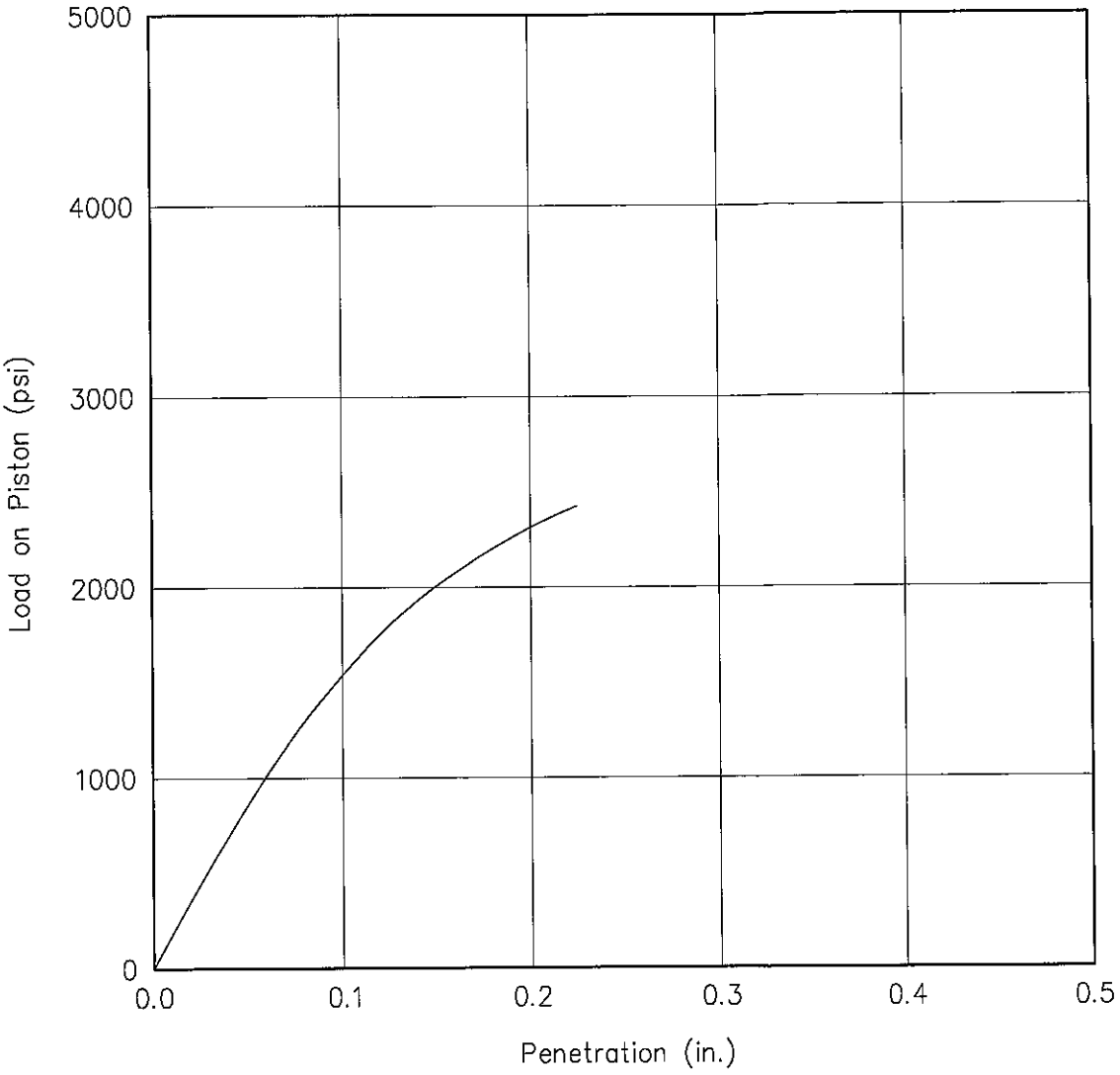
Soil Data

Location:	Near boring B4 at 1 foot
Description:	Grayish brown sand with silt and gravel
Sample Dry Density:	119 pcf
Sample Moisture Content:	12%

Test Results

CBR Value:	83%
Expansion:	0%

W.O. 13-5490	Saddle Road Maintenance Baseyard
Hirata & Associates, Inc.	CBR STRESS PENETRATION CURVE Plate B5.1



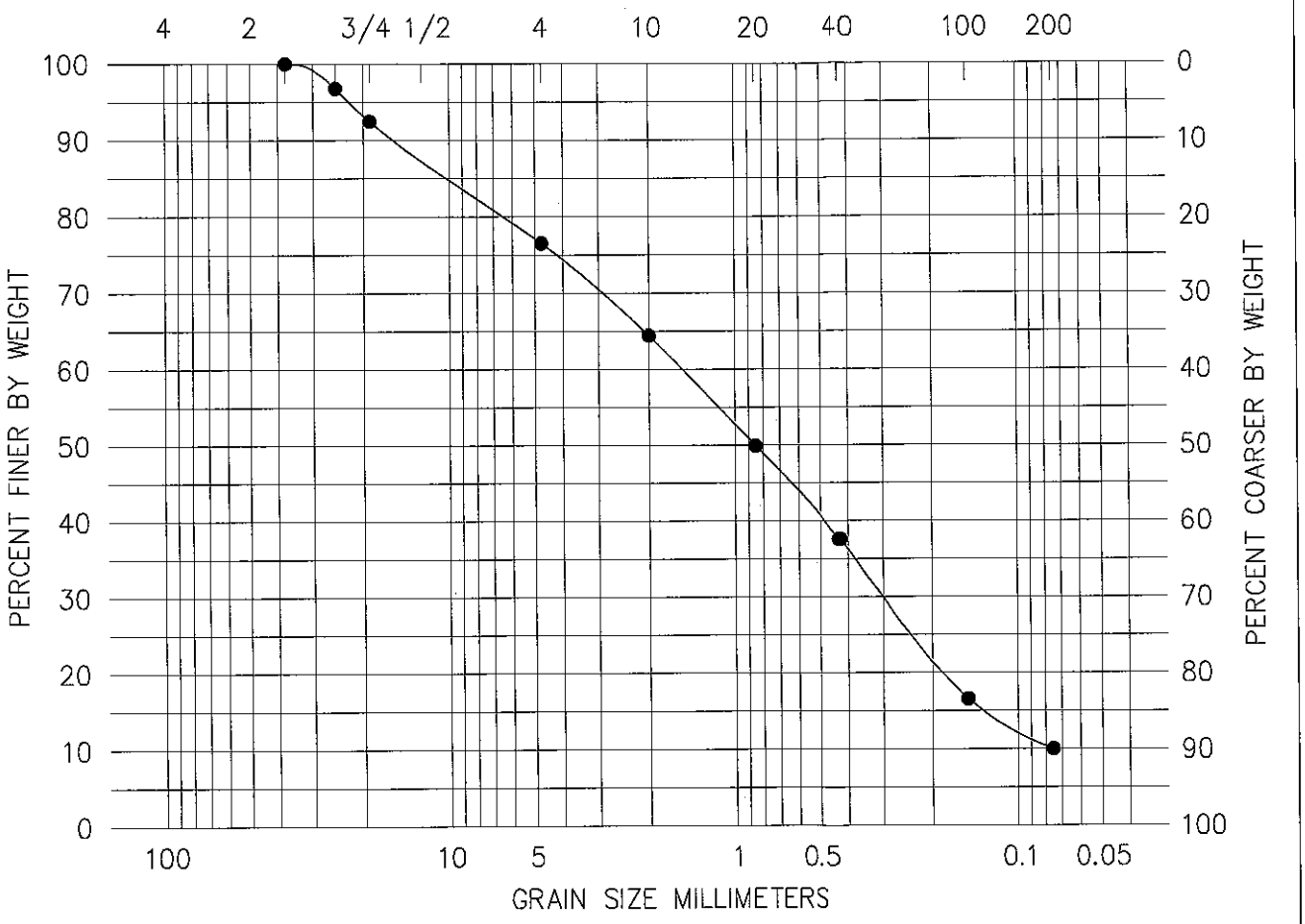
Soil Data

Location:	Near boring B7 at a depth of about 1 foot
Description:	Grayish brown sand with silt and gravel
Sample Dry Density:	127 pcf
Sample Moisture Content:	10%

Test Results

CBR Value:	155%
Expansion:	0%

W.O. 13-5490	Saddle Road Maintenance Baseyard
Hirata & Associates, Inc.	CBR STRESS PENETRATION CURVE Plate B5.2



COBBLES	GRAVEL		SAND			SILT or CLAY
	Coarse	Fine	Coarse	Medium	Fine	

● Sample #1	Location:	Near boring B7 from a depth of about 1 foot
	Description:	Grayish brown sand with silt and gravel

W.O. 13-5490	Saddle Road Maintenance Baseyard
Hirata & Associates, Inc.	SIEVE ANALYSIS TEST Plate B6.1