GEOTECHNICAL ENGINEERING EXPLORATION
CENTRAL MAUI REGIONAL PARK
WAIKAPU, MAUI, HAWAII
W.O. 6802-00 OCTOBER 1, 2013

Prepared for

R.M. TOWILL CORPORATION

DAYTON E. FRAIM
LICENSED PROFESSIONAL ENGINEER
No. 7572-C
HAWAII, U.S.A.

THIS WORK WAS PREPARED BY
ME OR UNDER MY SUPERVISION.

SIGNATURE 4-30-14
EXPIRATION DATE OF THE LICENSE

GEOLABS, INC.
Geotechnical Engineering and Drilling Services
2006 Kalihi Street • Honolulu, HI 96819

Hawaii • California

GEOLABS, INC.
Geotechnical Engineering and Drilling Services

October 1, 2013
W.O. 6802-00

Mr. Gordon Ring
R.M. Towill Corporation
2024 North King Street, Suite 200
Honolulu, HI 96819

Dear **Mr. Ring:**

Geolabs, Inc. is pleased to submit our report entitled "*Geotechnical Engineering Exploration, Central Maui Regional Park, Waikapu, Maui, Hawaii*" for the design of the proposed grading and drainage project.

Our work was performed in general accordance with the scope of services outlined in our fee proposal dated April 25, 2012.

Please note that the soil samples recovered during our field exploration (remaining after testing) will be stored for a period of two months from the date of this report. The samples will be discarded after that date unless arrangements are made for a longer sample storage period. Please contact our office for alternative sample storage requirements, if appropriate.

Detailed discussions and recommendations are contained in the body of this report. If there is any point that is not clear, please contact our office.

Very truly yours,

GEOLABS, INC.

Clayton S. Mimura, P.E.
President

CSM:DEF:mj

2006 Kalihi Street • Honolulu, Hawaii 96819
Phone: (808) 841-5064 • Facsimile: (808) 847-1749 • E-mail: hawaii@geolabs.net

Hawaii • California

GEOTECHNICAL ENGINEERING EXPLORATION

CENTRAL MAUI REGIONAL PARK

WAIKAPU, MAUI, HAWAII

W.O. 6802-00 OCTOBER 1, 2013

TABLE OF CONTENTS

Page

GEOTECHNICAL ENGINEERING EXPLORATION

CENTRAL MAUI REGIONAL PARK

WAIKAPU, MAUI, HAWAII

W.O. 6802-00 OCTOBER 1, 2013

SUMMARY OF FINDINGS AND RECOMMENDATIONS

Our exploration indicates that, over most of the site, there is a thin surface layer of man-made fill generally consisting of medium dense silty sand overlying the native dune sands. The dune sands at the site form a relatively thin veneer over older alluvial materials. The alluvial materials are generally very stiff to hard clayey silts with interbeds of gravel, cobbles and boulders.

We did not encounter groundwater in the excavated test pits at the time of our field exploration. It should be noted that groundwater levels are subject to change due to rainfall, time of year, seasonal precipitation, surface water runoff, and other factors. However, the existing ground elevations at the project site are at an elevation several tens of feet above the highest basal groundwater in the area. Therefore, we believe that the natural groundwater at the site should not have a significant impact on the earthwork for the project.

It is anticipated that site grading for this project will consist of cuts and fills on the order of about 5 feet in depth or thickness to create level playing fields along with excavation of up to 22 feet in depth to create detention/infiltration basins.

Fills and backfills may consist of excavated soil, less than 3 inches in size, that is not contaminated with organic matter or other deleterious materials. Imported fill and backfill material, if required, should consist of soil and rock materials less than 3 inches in size with a CBR value of 8 or more and with a maximum swell of less than 2 percent when tested in accordance with ASTM D 1883.

Based on the subsurface soil conditions encountered at the site, we believe that shallow foundations may be used to support new structures associated with the park development. An allowable bearing pressure of up to 2,500 psf may be used for design of the foundations bearing on recompacted in-situ sandy soils; or, bearing on fill soils placed and compacted in accordance with the recommendations presented herein.

Our double-ring infiltrometer tests indicate surface infiltration rates ranging from 3.1 to in excess of 150 centimeters per hour.

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

END OF SUMMARY OF FINDINGS AND RECOMMENDATIONS

SECTION 1. GENERAL

1.1 Introduction

This report presents the results of our geotechnical engineering exploration performed for the Central Maui Regional Park project in the Waikapu area on the Island of Maui, Hawaii. The project location and general vicinity are shown on the Project Location Map, Plate 1.

This report summarizes the findings and geotechnical engineering recommendations derived from our field exploration, infiltration testing, and engineering analyses for the site grading and storm water runoff drainage project. The recommendations presented herein are intended for the design of site grading; and, for the design of a detention and infiltration system for the subsurface disposal of storm water runoff. The findings and recommendations presented herein are subject to the limitations noted at the end of this report.

1.2 Project Considerations

The project site is located in the northeastern portion of the Waiale master planned development in the Waikapu area of Wailuku, Maui. The project encompasses about 65 acres and will provide recreational facilities including baseball fields, softball fields, soccer fields and related facilities, such as parking and comfort stations. In addition, the site will be graded to provide detention and infiltration for regional drainage.

In order to provide information for the design of the site improvements, we conducted a geotechnical engineering exploration consisting of excavating and sampling ten test pits at selected locations within the park area along with the performance of five double-ring infiltrometer tests in selected test pits.

1.3 Purpose and Scope

The purpose of our geotechnical engineering exploration is to obtain information for the subsurface conditions to formulate a summary of the soil conditions for the design of the proposed detention/infiltration structures. In order to accomplish this, we performed an exploration program consisting of the following tasks and work efforts:

1. Review of available soils and geologic information in the project vicinity.

2. Filing of application for permits to excavate, staking of test pit locations, and toning for utilities.

3. Mobilization and demobilization of a Komatsu PC 160 track excavator and operator to and from the project site.

4. Excavating and sampling ten test pits to depths ranging between approximately 8.5 and 24.0 feet below the existing ground surface.

5. Performance of five double-ring infiltrometer tests to evaluate the infiltration characteristics of the shallow subsurface soils.

6. Coordination of the field exploration, logging of the test pits and performance of the field testing by our field engineer/geologist.

7. Laboratory testing of selected samples obtained during the field exploration as an aid to classifying the materials and evaluating their engineering properties.

8. Analyses of the field and laboratory data to formulate geotechnical engineering recommendations for the proposed project.

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

10. Coordination of our work on the project by our project manager.

11. Quality assurance of our overall work on the project and client/design team consultation by our principal engineer.

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

END OF GENERAL

SECTION 2. SITE CHARACTERIZATION

2.1 Regional Geology

The Island of Maui was built by two major volcanoes, the older West Maui (Tertiary Epoch) and the more recent East Maui, also known as Haleakala (Pleistocene Epoch). The Isthmus of Maui is a narrow, gently sloping plain located between these two volcanoes. The project site is in the western area of this gently sloping plain.

The Isthmus of Maui was created by lava flows from East Maui (Haleakala) banking against the older flank of West Maui. Stratigraphy in the isthmus is complicated due to the multitude of erosional and depositional forces that have played roles in its creation. Much of the eastern and western sides of the isthmus are comprised of alluvium washed from the slopes of West Maui and Haleakala. The erosional processes in the slopes above the isthmus are dominated by the detachment of soil and rock masses from the mountain walls, and the soil materials are transported downslope toward the Isthmus primarily by gravity as colluvium.

Once these materials reach the stream or other natural drainage course, the alluvial process becomes dominant, and the sediments are transported and deposited as alluvium. In general, stream flows in Hawaii are intermittent and flashy (i.e., the stream flows transmit large volumes of water for very short durations). Because of this, the transport of sediments is intermittent, and the bulk of the stream's hydraulic load consists of a poorly sorted mixture of boulders, cobbles, gravel, sands, and fines. When the erosional base levels change, these sediment loads are left as deposits.

When deposits are left in-place for long periods of time, chemical processes begin to alter the materials, simultaneously causing a breakdown or weathering of the materials. Chemical processes also cause induration, or cementation, of the coarse-grained portion of the sediment into a poorly consolidated sedimentary rock or conglomerate. Simultaneously, erosion continues in the areas above the valley floors and upstream in headwaters. This continued erosion generates material, which is transported downslope covering the older alluvial deposits. Depending on the local base level and rate of transport, these newer sediments are generally transient in terms of geologic time. In addition, their consistency and density are generally less than those of the older, partially consolidated deposits.

Underlying the alluvial deposits are overlapping lavas from the West Maui and East Maui volcanoes. The bulk of the Haleakala shield was built during the late Pliocene and early Pleistocene Epoch by thinly bedded basaltic lava flows of the Honomanu Volcanic Series. During the Pleistocene Epoch, the characteristics of the lavas changed to very hard, thickly bedded flows of andesitic composition. These lavas have been grouped as the Kula Volcanic Series.

Further complicating the stratigraphy of the isthmus was the development of broad fringing reefs in the bay formed at the juncture between West Maui and East Maui; and, glacio-eustatic sea level changes that occurred during the Pleistocene Epoch in response to the advance and retreat cycles of continental glaciation. During the glacial advances, water was bound into the wide spread glaciers as ice on a year round basis and less water was available to fill the ocean basins. As a consequence, global sea levels fell below the current sea level. During the retreats, more water was available and sea levels rose.

When the sea levels fell, the fringing reefs, with their complement of calcium carbonate sand derived from both detrital and bioclastic sources, were exposed to the prevailing tradewinds which blew in about the same direction as the current tradewinds but were estimated to have an average velocity of about 60 miles per hour. These winds, transporting the loose sand from the reef areas, resulted in a strip of sand dunes that extended from the present Wailuku-Kahului area to as far as the south coast of the Maui Isthmus, blanketing the volcanic and alluvial deposits on the floor of the isthmus.

Our field exploration at the site indicates that the near-surface sand is fine-grained and appears to be wind blown dune sands.

2.2 Site Description

The project site is within the northeastern portion of the Waiale planned community development in the Waikapu area of the Island of Maui, Hawaii as shown on the Site Plan, Plate 2. The site is about 65 acres of predominately agricultural land which is used mainly as pasture. The western end of the site is densely vegetated with keawe and other dryland vegetation.

The ground surface generally slopes gently down towards the northeast with elevations ranging from about 180 feet Mean Sea Level (MSL) at the western end of the site down to about 150 feet MSL at the eastern boundary.

2.3 Subsurface Conditions

We explored the subsurface conditions by excavation and sampling ten test pits, designated as Test Pit Nos. 1 through 10, inclusive, extending to depths ranging between 8.5 and 24.0 feet below the existing ground surface. Double-ring infiltrometer tests were performed at selected depths in Test Pit Nos. 1, 2, 3, 4 and 8 to determine the subsurface permeability characteristics at the site.

Based on our field exploration, over most of the site, there is a thin surface layer of man-made fill generally consisting of medium dense silty sand overlying the native dune sands. The dune sands at the site form a relatively thin veneer over older alluvial materials. The alluvial materials are generally very stiff to hard clayey silts with interbeds of gravel, cobbles and boulders appearing to reflect a depositional environment similar to an outwash plain from intermittent streams. A generalized summary of the subsurface conditions encountered in the test pits is presented in the following table:

SIMPLIFIED SUMMARY OF SUBSURFACE CONDITIONS
(All depths in feet below ground surface)

MATERIAL	TP-1	TP-2	TP-3	TP-4	TP-5	TP-6	TP-7	TP-8	TP-9	TP-10
Fill	0 to 2.5	0 to 1.0	0 to 3.0	0 to 1.5		0 to 0.5	0 to 0.5	0 to 0.5		
Dune Sand			3.0 to 6.5	1.5 to 3.0	0 to 4.0	0.5 to 4.0	0.5 to 1.5	0.5 to 7.0	0 to 6.0	0 to 6.0
Clayey Silt with Gravel (Alluvium)	2.5 to 9.5	1.0 to 15.0	6.5 to 11.5	3.0 to 19.0	4.0 to 7.0	4.0 to 10.5			6.0 to 9.0	6.0 to 8.5
Gravel and Cobbles (Alluvium)	9.5 to 18.0	15.0 to 18.5	11.5 to 13.5	19.0 to 24.0	7.0 to 12.0	10.5 to 11.5	1.5 to 9.0	7.0 to 9.0		
Clayey Silt with Gravel (Alluvium)								9.0 to 10.5		

SIMPLIFIED SUMMARY OF SUBSURFACE CONDITIONS (All depths in feet below ground surface)										
MATERIAL	**TP-1**	**TP-2**	**TP-3**	**TP-4**	**TP-5**	**TP-6**	**TP-7**	**TP-8**	**TP-9**	**TP-10**
Gravel and Cobbles (Alluvium)								10.5 to 14.0		
Boulders and Cobbles			13.5 to 20.5							
Groundwater Depth	NE*	NE	NE	NE	NE	NE	NE	NE	NE	NE
End Depth	18.0	18.5	20.5	24.0	12.0	11.5	9.0	14.0	9.0	8.5

*Not encountered at time of field exploration

It should be noted that the sand encountered at the site is fine grained and poorly graded, having almost uniform grain sizes. We also encountered some areas with a high degree of cementation to the sand.

We did not encounter groundwater in the excavated test pits at the time of our field exploration. It should be noted that groundwater levels are subject to change due to rainfall, time of year, seasonal precipitation, surface water runoff, and other factors. However, the existing ground elevations at the project site are at an elevation several tens of feet above the highest basal groundwater in the area. Therefore, we believe that the natural groundwater at the site should not have a significant impact on the earthwork.

Detailed descriptions of our field exploration methodology and the Logs of Test Pits are presented on Plates A-1 through A-10, inclusive, of Appendix A. Results of the laboratory tests performed on selected soil samples are presented in Appendix B. The results of the infiltrometer tests are presented in Appendix C.

END OF SITE CHARACTERIZATION

SECTION 3. DISCUSSION AND RECOMMENDATIONS

Our exploration indicates that, over most of the site, there is a thin surface layer of man-made fill generally consisting of medium dense silty sand overlying the native dune sands. The dune sands at the site form a relatively thin veneer over older alluvial materials. The alluvial materials are generally very stiff to hard clayey silts with interbeds of gravel, cobbles and boulders.

We did not encounter groundwater in the excavated test pits at the time of our field exploration. It should be noted that groundwater levels are subject to change due to rainfall, time of year, seasonal precipitation, surface water runoff, and other factors. However, the existing ground elevations at the project site are at an elevation several tens of feet above the highest basal groundwater in the area. Therefore, we believe that the natural groundwater at the site should not have a significant impact on the earthwork.

It is anticipated that site grading for this project will consist of cuts and fills on the order of about 5 feet in depth or thickness to create level playing fields along with excavations of up to 22 feet in depth to create detention/infiltration basins.

Fills and backfills may consist of excavated soil, less than 3 inches in size, that is not contaminated with organic matter or other deleterious materials. Imported fill and backfill material, if required, should consist of soil and rock materials less than 3 inches in size with a CBR value of 8 or more and with a maximum swell of less than 2 percent when tested in accordance with ASTM D 1883.

Based on the subsurface soil conditions encountered at the site, we believe that shallow foundations may be used to support new structures associated with the park development. An allowable bearing pressure of up to 2,500 psf may be used for design of the foundations bearing on recompacted in-situ sandy soils; or, bearing on fill soils placed and compacted in accordance with the recommendations presented herein.

Our double-ring infiltrometer tests indicate surface infiltration rates ranging from 3.1 to in excess of 150 centimeters per hour.

Detailed discussions and recommendations for design of the site grading, infiltration systems and other geotechnical aspects of the project are presented in the following sections.

3.1 Site Grading

It is anticipated that site grading for this project will consist of cuts and fills on the order of about 5 feet in depth or thickness to create level playing fields along with excavations of up to 22 feet in depth to create detention/infiltration basins. Items of grading that are addressed in the following subsections include: (1) Site Preparation, (2) Fills and Backfills, (3) Fill Placement and Compaction Requirements, (4) Excavation, and (5) Cut and Fill Slopes.

A Geolabs representative should monitor site preparation, grading and infiltration trench installation operations to observe whether undesirable materials are encountered during the excavation process and to confirm whether the exposed soil/rock conditions are similar to those encountered in our field exploration.

3.1.1 Site Preparation

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

Soft and yielding areas encountered during clearing and grubbing work should be over-excavated to expose firm natural material, and the resulting excavation should be backfilled with well-compacted engineered fill. The excavated soil may be used as fill, provided that it meets the requirements for fill material.

3.1.2 Fills and Backfills

Fills and backfills may consist of excavated on-site soil, less than 3 inches in size, that is not contaminated with organic matter; or, contaminated with other deleterious materials. Imported fill and backfill material, if required, should consist of soil and rock materials less than 3 inches in size with a CBR value of 8 or more and with a maximum swell of less than 2 percent when tested in accordance with ASTM D 1883. Geolabs, Inc. should observe and or test imported fill materials for suitability prior to being transported to the site for the intended use.

3.1.3 Fill Placement and Compaction Requirements

Fills and backfills should be moisture-conditioned to about 2 percent above the optimum moisture, placed in level lifts not exceeding 8 inches in loose thickness, and compacted to at least 90 percent relative compaction. Relative compaction refers to the in-place dry density of soil expressed as a percentage of the maximum dry density of the same soil established in accordance with ASTM D 1557. Optimum moisture is the water content (percentage by weight) corresponding to the maximum dry density. We wish to emphasize that moisture conditioning of the fill materials is an integral part of the fill placement recommendations provided herein. Compaction should be accomplished by sheepsfoot rollers, vibratory rollers, or other types of acceptable compaction equipment.

Because moisture-conditioning and compaction are critical elements of earthwork, Geolabs should perform observations and soil density tests during site grading to assist the contractor in obtaining the required degree of compaction and the proper moisture content. Where compaction is less than required, additional compactive effort should be applied with adjustment of moisture content as necessary, to obtain the specified compaction.

3.1.4 Excavation

It is anticipated that the on-site soils may be excavated with normal heavy excavation and earthmoving equipment. This discussion regarding the rippability of the subsurface materials is based on field data obtained from the test pits excavated at the project site. We recommend encouraging contractors bidding on this project to examine the site conditions and soil data to make their own interpretation.

3.1.5 Cut and Fill Slopes

Based on the subsurface conditions that our work at the site has encountered, it appears that cut slopes required for the project would expose sandy soils. In general, we believe that cut slopes into the soil material may be cut at an inclination of two horizontal to one vertical (2H:1V) or flatter. However, considering the cohesionless nature of the sand and the use of the site as a public park, it is suggested that flatter slopes, such as 3H or 4H:1V be incorporated into the project design, where feasible.

Fill slopes should be designed with a slope inclination of 2H:1V or flatter with the same caveat suggested above.

3.2 Foundations

It is anticipated that some new structures will be required for the park development, such as comfort stations, baseball dugouts and similar buildings. Based on the subsurface conditions encountered at the project site, we believe that shallow spread and/or continuous footings may be used to support the new structures. An allowable bearing pressure of up to 2,500 psf may be used to design the shallow foundations bearing on recompacted on-site soils; or, bearing on new fills placed and compacted as recommended herein. This bearing value is for dead-plus-live loads and may be increased by one-third (1/3) for transient loads, such as those caused by wind or seismic forces.

In general, the bottom of the footings should be embedded a minimum of 24 inches below the lowest adjacent finished grade. Foundations next to utility trenches or easements should be embedded below a 45-degree imaginary plane extending upward from the bottom edge of the utility trench or the footings should be embedded to a depth as deep as the inverts of the utility lines. This requirement is necessary to avoid surcharging adjacent below-grade structures with additional structural loads and to reduce the potential for appreciable foundation settlement.

If foundations are designed and constructed in strict accordance with the recommendations presented herein, we estimate total settlements of the foundations to be less than 1 inch. Differential settlements between adjacent footings supported on similar materials may be on the order of about 0.5 inch or less.

Lateral loads acting on the structures may be resisted by friction between the base of the foundation and the bearing materials and by passive earth pressure developed against the near-vertical faces of the embedded portion of foundations. A coefficient of friction of 0.4 may be used for footings bearing on the recompacted sandy soils or new compacted fills. Resistance due to passive earth pressure may be estimated using an equivalent fluid pressure of 300 pounds per square foot per foot of depth (pcf) assuming that the soils around the footings are well compacted. Unless covered by pavements or slabs, the passive pressure resistance in the upper 12 inches below the finished grade should be neglected.

A Geolabs representative should observe the foundation excavations during foundation construction to evaluate the competency of the bearing materials and the embedment depths of the foundations. If unsuitable materials are encountered in the foundation excavations, these materials should be over-excavated to expose the underlying stiff material and replaced with non-expansive structural fill material compacted to a minimum of 95 percent relative compaction.

3.3 Walkways

It is anticipated that sidewalks and other concrete walkways will be installed as part of the park development. The near-surface soils encountered at the site consist of clayey silts, which exhibit a low expansion potential when subjected to moisture fluctuations. To reduce the potential for structural distress to lightly loaded slabs resulting from minor expansion or saturation and softening of the subgrade by accumulation of water, the subgrades for slabs-on-grades should be scarified to a depth of at least 8 inches, moisture-conditioned to at least 2 percent above the optimum moisture, and compacted to not less than 90 percent relative compaction. Relative compaction refers to the in-place dry density of soil expressed as a percentage of the maximum dry density of the same soil determined in accordance with ASTM D 1557. Optimum moisture is the water content (percentage by dry weight) corresponding to the maximum dry density.

We recommend a minimum 4-inch thick slab with 4 inches of aggregate subbase cushion below the walkways. Control joints should be provided at intervals equal to the width of the walkways and at right angle intersections. It should be emphasized that the areas adjacent to the slabs should be backfilled tightly against the edges of the slabs with low expansion, relatively impervious soils. These areas should also be graded to divert water away from the slabs and to reduce the potential for water ponding around the slabs and foundations

3.4 Utility Trenches

We anticipate that the utilities for the new park facility will primarily consist of water, sewer, drain, and electrical lines. In general, good construction practices should be utilized for the installation and backfilling of the trenches for the new utilities. The contractor should determine the method and equipment to be used for trench excavation, subject to practical limits and safety considerations. In addition, the excavations should comply with the applicable federal, state, and local safety requirements. The contractor should be responsible for trench shoring design and installation.

In general, we recommend providing granular bedding consisting of 6 inches of No. 3B Fine gravel (ASTM C 33, No. 67 gradation) under the pipes for uniform support. Free-draining granular materials, such as No. 3B Fine gravel (ASTM C 33, No. 67 gradation), also should be used for the initial trench backfill up to about 12 inches above the pipes or groundwater level to provide adequate support around the pipes. It is critical to use this free-draining material to reduce the potential for formation of voids below the haunches of pipes and to provide adequate support for the sides of the pipes. Improper trench backfill could result in backfill settlement and pipe damage.

The upper portion of the trench backfill from the level 12 inches above the pipes or groundwater level to the top of the subgrade or finished grade may consist of on-site granular soils (with a maximum particle size of 3 inches) or select granular fill material. The backfill should be placed in maximum 8-inch level loose lifts and mechanically compacted to no less than 90 percent relative compaction to reduce the potential for appreciable future ground subsidence. Where trenches are below pavement areas, the upper 3 feet of the trench backfill below the pavement finished grade should be compacted to a minimum of 95 percent relative compaction.

Based on our field exploration, the project site is underlain by sandy soils at relatively shallow depths. It is anticipated that the sandy soils may be excavated with normal heavy excavation equipment, such as large backhoe excavators. However, the dune formations typically contain localized hard and crystallized zones. Additionally, cobbles and boulders were encountered at deeper depths. Therefore, we anticipate that some difficult excavation conditions may arise in localized areas during construction. It may be necessary to excavate the trenches in some areas by using hoe-rams or by chipping.

The above discussions regarding the rippability of the materials are based on our visual observation of the existing site and field data from the exploration performed at the project site.

3.5 Retaining Structures

We anticipate that low retaining structures for grade separations may be required. Based on the subsurface conditions encountered and grading concept, the following general guidelines may be used for design of the retaining structures.

3.5.1 Wall Foundations

In general, we believe that retaining wall foundations may be designed in accordance with the recommendations and parameters presented in the "Foundations" section herein. In addition, retaining wall foundations should be at least 18 inches wide and should be embedded a minimum of 24 inches below the lowest adjacent finished grades. For sloping ground conditions, the footing should extend deeper to obtain a minimum 6-foot setback distance measured horizontally from the outside edge of the footing to the face of the slope. Wall footings oriented parallel to the direction of the slope should be constructed in stepped footings.

3.5.2 Lateral Earth Pressures

Retaining structures should be designed to resist the lateral earth pressures due to the adjacent soils and surcharge effects caused by loads adjacent to the walls. The following lateral earth pressures, expressed in equivalent fluid pressures of pounds per square foot per foot of depth (pcf), may be used in the design of retaining structures planned at the project site.

LATERAL EARTH PRESSURES FOR DESIGN OF RETAINING STRUCTURES			
Backfill Condition	**Earth Pressure Component**	**Active** (pcf)	**At-Rest** (pcf)
Level Backfill	Horizontal	40	60
	Vertical	None	None
Maximum 2H:1V Sloping Backfill	Horizontal	58	76
	Vertical	29	38

The values provided above assume that granular soils with a maximum particle size of 3 inches or less may be used to backfill behind the retaining structures. It is assumed that the backfill behind retaining structures will be compacted to between 90 and 95 percent relative compaction. Over-compaction of the retaining structure backfill should be avoided.

In general, the at-rest condition should be used for retaining structures where the top of the structure is restrained from movement prior to backfilling of the wall. The active condition should be used only for gravity retaining walls and retaining structures that are free to deflect by as much as 0.5 percent of the wall height.

Surcharge stresses due to areal surcharges, line loads, and point loads within a horizontal distance equal to the depth of the retaining structures should be considered in the design. For uniform surcharge stresses imposed on the loaded side of the structures, a rectangular distribution with uniform pressure equal to 43 percent of the vertical surcharge pressure acting on the entire height of the structure, which is restrained, may be used in design. For retaining structures that are free to deflect (cantilever), a rectangular pressure distribution equal to 27 percent of the vertical surcharge pressure acting over the entire height of the structure may be used for design. Additional analyses during design may be needed to evaluate the surcharge effects of point loads and line loads.

3.5.3 Drainage

Retaining walls should be well drained to reduce the build-up of hydrostatic pressures. A typical drainage system would consist of a 12-inch wide zone of permeable material, such as No. 3B Fine gravel (ASTM C 33, No. 67 gradation), placed directly around a perforated pipe (perforations facing down) at the base of the wall discharging to an appropriate outlet or weepholes. As an alternative, a prefabricated drainage product, such as MiraDrain or EnkaDrain, may be used instead of the drainage material. The prefabricated drainage product also should be hydraulically connected to a perforated pipe at the base of the wall.

Backfill behind the permeable drainage zone may consist of compacted on-site materials or free-draining compacted fills, where specified by the designer. Unless covered by concrete slabs, the upper 12 inches of backfill should consist of low-expansion, relatively impervious materials to reduce the potential for excessive water infiltration behind the walls.

3.6 Surface and Subsurface Permeability

In order to provide information on surface and subsurface permeability at the project site, we conducted five double-ring infiltrometer tests at selected depths in test pits excavated at the site. These tests indicated that the subsurface soils at the site have a very wide range of infiltration rates. Our field test values indicated a low of about 3 centimeters per hour (cm/hr) to a high in excess of 150 cm/hr. Infiltrometer Test No. 5, which was conducted in Test Pit No. 8 at a depth of about 5.5 feet below the existing ground surface, took water so rapidly that readings could not be obtained from the infiltrometer apparatus. The following table summarizes the results of the infiltrometer tests.

SUMMARY OF INFILTROMETER TESTS				
Test No.	**Location**	**Depth** (ft bgs)	**Material Tested**	**Approximate Infiltration Rate** (cm/hr)
1	Test Pit 1	5.0	Clayey Silt	10
2	Test Pit 2	4.3	Clayey Silt	12
3	Test Pit 3	4.0	Sand	150
4	Test Pit 4	4.5	Clayey Silt	3
5	Test Pit 8	5.5	Sand	Too rapid to measure

3.7 Detention/Infiltration System Design

Although our infiltration testing indicates that the on-site soils generally have good infiltration rates, it should be realized that the tests were conducted on bare soil and were conducted on a short term basis. As such, the tests may not necessarily reflect the long term performance of the detention and infiltration.

The effects of clogging by sediments, turf and thatching under the turf will generally reduce the long term capacity of an infiltration system. These should be considered in the design and operations and maintenance of the system.

3.8 Pavements

We anticipate that flexible asphaltic concrete pavements will be used for this project. We anticipate that the traffic will be limited to use by passenger vehicles and light trucks. Based on the above assumption, we recommend using the following flexible pavement section for preliminary design purposes:

Flexible Pavement

2.0-Inch Asphaltic Concrete
6.0-Inch Aggregate Base Course (95 Percent Relative Compaction)
6.0-Inch Select Borrow Subase (95 Percent Relative Compaction)
14.0-Inch Total Pavement Thickness on Compacted Subgrade

Pavement subgrades should be moisture-conditioned to above the optimum moisture and compacted to a minimum of 95 percent relative compaction. The aggregate base course materials should consist of crushed basaltic aggregates compacted to no less than 95 percent relative compaction. CBR and field density tests should be performed on the actual subgrade soils encountered during construction to confirm the adequacy of the above section.

In general, paved areas should be sloped, and drainage gradients should be maintained to carry surface water off the site. Surface water ponding should not be allowed on-site during or after construction.

3.9 Design Review

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

3.10 Post-Design Services/Services During Construction

We recommend retaining Geolabs to provide geotechnical engineering services during construction. The critical items of construction monitoring that require "Special Inspection" include the following:

- Observation and testing of site preparation, grading, excavation and compaction

A Geolabs representative should monitor other aspects of earthwork construction to observe compliance with the design concepts, specifications, or recommendations and to expedite suggestions for design changes that may be required in the event that subsurface conditions differ from those anticipated at the time this report was prepared. Geolabs should be accorded the opportunity to provide construction observation services to confirm our assumptions in providing the recommendations presented herein.

If the actual exposed subsurface conditions encountered during construction differ from those assumed or considered in this report, Geolabs should be contacted to review and/or revise the geotechnical engineering recommendations presented herein.

END OF DISCUSSION AND RECOMMENDATIONS

SECTION 4. LIMITATIONS

The analyses and recommendations submitted herein are based, in part, upon information obtained from test pits and in-situ permeability/infiltration tests. Variations of subsurface soil conditions may occur, between and beyond the field exploration points and the nature and extent of these variations may not become evident until construction is underway. If variations then appear evident, it will be necessary to re-evaluate the recommendations provided herein.

This report has been prepared for the exclusive use of R.M. Towill Corporation, their client and their project consultants for specific application to the Central Maui Regional Park project in accordance with generally accepted geotechnical engineering principles and practices. No warranty is expressed or implied.

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

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

This geotechnical engineering exploration conducted at the project site was not intended to investigate the potential presence of hazardous materials existing at the site. It should be noted that the equipment, techniques, and personnel used to conduct a geo-environmental exploration differ substantially from those applied in geotechnical engineering.

END OF LIMITATIONS

CLOSURE

The following plates and appendices are attached and complete this report:

-ΩΩΩΩΩΩΩΩΩ-

Respectfully submitted,

GEOLABS, INC.

By ______________________

Dayton E. Fraim, P.E., P.G.
Project Engineer/Geologist

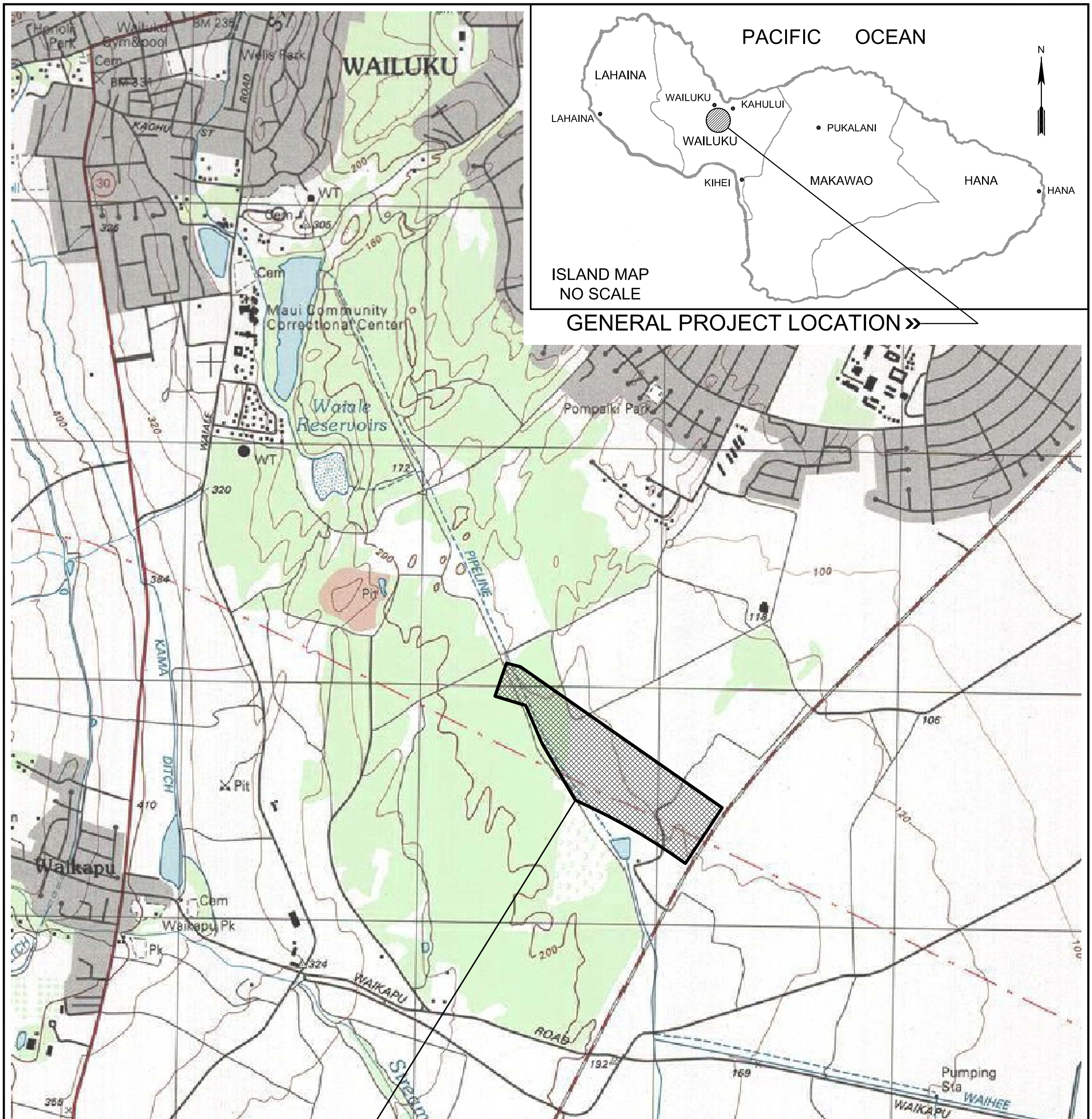
By ______________________

Clayton S. Mimura, P.E.
President

CSM:DEF:mj

h:\6800Series\6802-00.def1

PLATES



2000 1000 0 2000 FT.

GRAPHIC SCALE

N

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

PROJECT LOCATION MAP

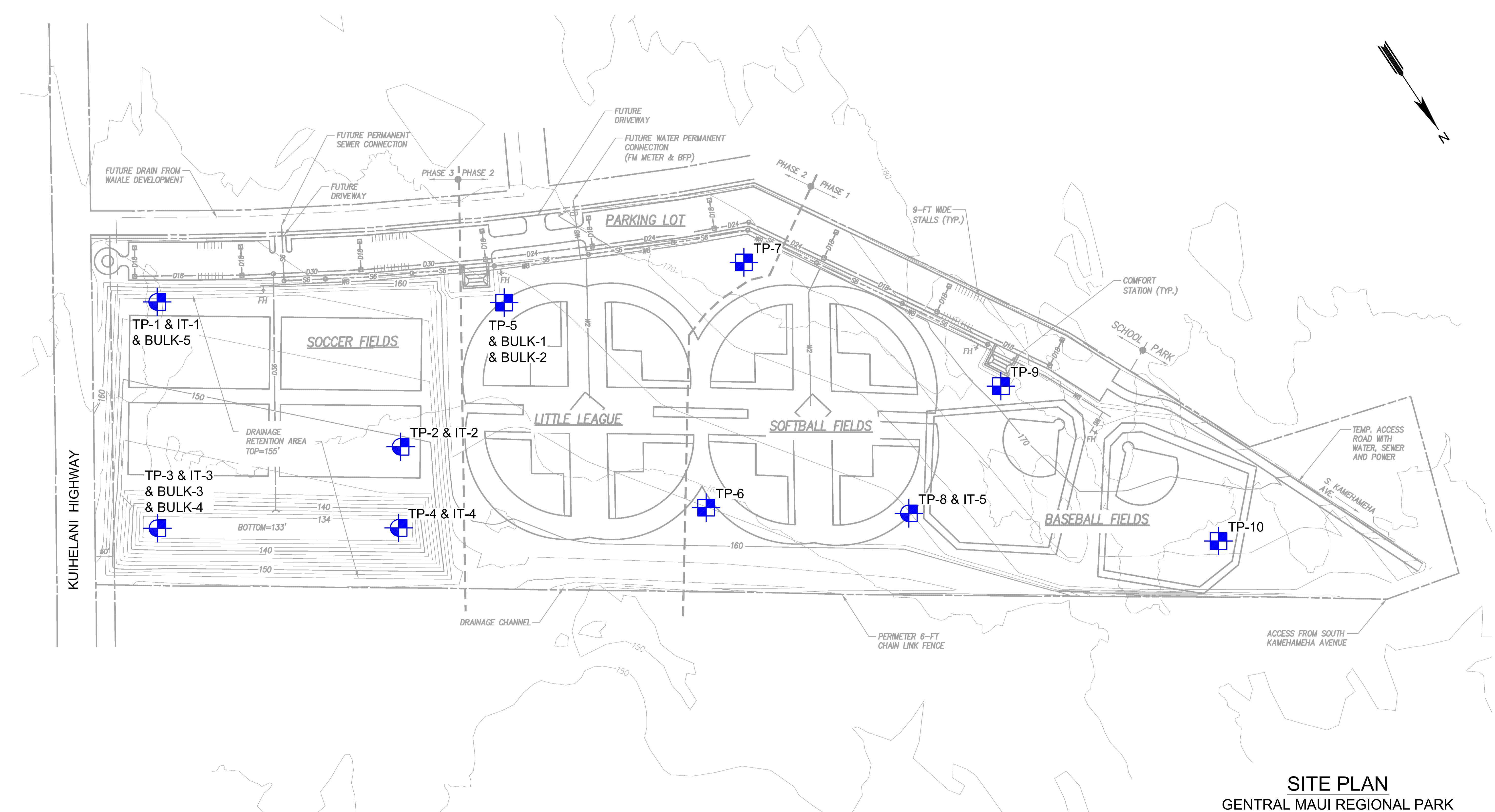
CENTRAL MAUI REGIONAL PARK
WAIKAPU, MAUI, HAWAII

GEOLABS, INC.

Geotechnical Engineering

DATE	DRAWN BY	PLATE
MARCH 2013	KHN	
SCALE	W.O.	1
1" = 2,000'	6802-00	

CAD User: KIM File Last Updated: March 25, 2013 9:52:10am Plot Date: March 25, 2013 - 9:54:34am
File: T:\Drafting-9904\Working\6802-00CentralMauiRegionalPark\6802-00PLM.dwg\PLM
Plotter: Adobe PDF Plotstyle: GEO-No-Dithering.ctb



SITE PLAN

GENTRAL MAUI REGIONAL PARK
WAIKAPU, MAUI, HAWAII

LEGEND:

- APPROXIMATE TEST PIT LOCATION (BULK SAMPLES TAKEN AS NOTED)
- APPROXIMATE INFILTRATION TEST LOCATION

REFERENCE: GENERAL SITE PLAN TRANSMITTED BY R. M. TOWILL CORPORATION ON NOVEMBER 21, 2012.

0 125 250 500 750 FT.
GRAPHIC SCALE

GEOLABS, INC.
Geotechnical Engineering

DATE	DRAWN BY	PLATE
MARCH 2013	KHN	
SCALE	W.O.	2
1" = 250'	6802-00	

CAD User: KIM File Last Updated: March 25, 2013 10:08:10am Plot Date: March 25, 2013 - 10:08:26am
File: T:\Drafting-9904\Working\6802-00CentralMauiRegionalPark\6802-00SitePlan.dwg\SP
Plotter: Adobe PDF Plotstyle: GEO-No-Dithering-Blue-Boring.ctb

APPENDIX A

<u>APPENDIX A</u>

Field Exploration

The subsurface conditions at the site were explored by excavating and sampling ten test pits, designated as Test Pit Nos. 1 through 10, inclusive, extending to depths ranging between 8.5 and 24.0 feet below the existing ground surface. The test pits were excavated using a Komatsu PC 160 track excavator provided by our subcontractor, G.J. Gomes. The approximate test pit locations are shown on the Site Plan, Plate 2.

The materials encountered in the test pits were classified by visual and textural examination in the field by our geologist, who observed the field exploration operations on a near-continuous basis. These classifications were further reviewed by visual observation and testing in the laboratory. Soils were classified in general conformance with the Unified Soil Classification System as shown on the Soil Log Legend, Plate A. Logs of the materials encountered are presented on the Logs of Test Pits, Plates A-1 through A-10.

GEOLABS, INC.

Geotechnical Engineering

Soil Log Legend

UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)

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

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

LEGEND

- (2-INCH) O.D. STANDARD PENETRATION TEST
- (3-INCH) O.D. MODIFIED CALIFORNIA SAMPLE
- SHELBY TUBE SAMPLE
- GRAB SAMPLE
- CORE SAMPLE
- WATER LEVEL OBSERVED IN BORING AT TIME OF DRILLING
- WATER LEVEL OBSERVED IN BORING AFTER DRILLING

LL	LIQUID LIMIT (NP=NON-PLASTIC)
PI	PLASTICITY INDEX (NP=NON-PLASTIC)
TV	TORVANE SHEAR (tsf)
PEN	POCKET PENETROMETER (tsf)
UC	UNCONFINED COMPRESSION (psi)
UU	UNCONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION (ksf)

Plate

A-0.1

GEOLABS, INC. Geotechnical Engineering	Rock Log Legend

ROCK DESCRIPTIONS

BASALT	FINGER CORAL
BOULDERS	LIMESTONE
BRECCIA	SANDSTONE
CLINKER	SILTSTONE
COBBLES	TUFF
CORAL	VOID/CAVITY

ROCK DESCRIPTION SYSTEM

ROCK FRACTURE CHARACTERISTICS

The following terms describe general fracture spacing of a rock:

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

DEGREE OF WEATHERING

The following terms describe the chemical weathering of a rock:

Unweathered:	Rock shows no sign of discoloration or loss of strength.
Slightly Weathered:	Slight discoloration inwards from open fractures.
Moderately Weathered:	Discoloration throughout and noticeably weakened though not able to break by hand.
Highly Weathered:	Most minerals decomposed with some corestones present in residual soil mass. Can be broken by hand.
Extremely Weathered:	Saprolite. Mineral residue completely decomposed to soil but fabric and structure preserved.

HARDNESS

The following terms describe the resistance of a rock to indentation or scratching:

Very Hard:	Specimen breaks with difficulty after several "pinging" hammer blows. Example: Dense, fine grain volcanic rock
Hard:	Specimen breaks with some difficulty after several hammer blows. Example: Vesicular, vugular, coarse-grained rock
Medium Hard:	Specimen can be broked by one hammer blow. Cannot be scraped by knife. SPT may penetrate by ~25 blows per inch with bounce. Example: Porous rock such as clinker, cinder, and coral reef
Soft:	Can be indented by one hammer blow. Can be scraped or peeled by knife. SPT can penetrate by ~100 blows per foot. Example: Weathered rock, chalk-like coral reef
Very Soft:	Crumbles under hammer blow. Can be peeled and carved by knife. Can be indented by finger pressure. Example: Saprolite

GEOLABS, INC. Geotechnical Engineering	CENTRAL MAUI REGIONAL PARK WAIKAPU, MAUI, HAWAII	Log of Test Pit **TP-1**

Laboratory			Field								
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS	Approximate Ground Surface Elevation (feet): 160 * — Description
							0–1.5			SM	Tannish brown **SILTY SAND** with a little organic matter, medium dense, damp (fill)
Sieve - #200 = 2.1%							1.5–9.5	G		ML	Brown **CLAYEY SILT** with seams of sand and gravel, very stiff to hard, damp (alluvium)
							9.5–18				Brownish gray **GRAVELLY COBBLES** with a little sand and traces of silt, very dense, damp (alluvium)
							18				Test Pit terminated at 18 feet * Elevations estimated from General Site Plan transmitted by R. M. Towill Corporation on November 21, 2012 and 2013 Google Earth ©.

Depth scale: 5, 10, 15, 20, 25, 30

Date Started:	January 11, 2013	Water Level:	Not Encountered	Plate
Date Completed:	January 11, 2013			
Logged By:	S. Latronic	Drill Rig:	KOMATSU PC160	A - 1
Total Depth:	18 feet	Drilling Method:	N/A	
Work Order:	6802-00	Driving Energy:	N/A	

GEOLABS, INC. Geotechnical Engineering	CENTRAL MAUI REGIONAL PARK WAIKAPU, MAUI, HAWAII	Log of Test Pit TP-2

Approximate Ground Surface Elevation (feet): 160 *

Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS	Description
							0			SM	Tannish brown **SILTY SAND** with traces of clay and organic matter, medium dense, damp (fill)
										GW	Tannish white rounded **SANDY GRAVEL** with a little silt, medium dense, dry to damp (alluvium)
										ML	Brown **CLAYEY SILT** with a little fine sand, very stiff, damp (alluvium)
							5				
							10				
							15				Brownish gray rounded **GRAVELLY COBBLES** with a little sand and traces of silt, dense, damp (alluvium)
							18.5				Test Pit terminated at 18.5 feet
							20				
							25				
							30				

Date Started:	January 10, 2013	Water Level:	Not Encountered	Plate A - 2
Date Completed:	January 10, 2013			
Logged By:	S. Latronic	Drill Rig:	KOMATSU PC160	
Total Depth:	18.5 feet	Drilling Method:	N/A	
Work Order:	6802-00	Driving Energy:	N/A	

GEOLABS, INC.

Geotechnical Engineering

CENTRAL MAUI REGIONAL PARK
WAIKAPU, MAUI, HAWAII

Log of Test Pit TP-3

Approximate Ground Surface Elevation (feet): 154 *

Other Tests (Laboratory)	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	USCS	Description
							0	G	MH	Brown **CLAYEY SILT** with a little sand and traces of gravel, stiff, damp (fill)
							3		SP	Tan poorly graded fine **SAND**, loose to medium dense, dry to damp (dune sand)
							6.5		ML	Brown **CLAYEY SILT** with a little fine sand, very stiff to hard, damp (alluvium)
							11.5			Brownish gray rounded **GRAVELLY COBBLES** with a little sand and traces of silt, dense, damp (alluvium)
Sieve - #200 = 23.8%							13.5	G	ML	Brown **CLAYEY SILT** with a little fine sand, very stiff to hard, damp (alluvium)
							16			Brownish gray subrounded **COBBLY BOULDERS** with some gravel and a little sand, dense, damp (alluvium)
							20.5			Test Pit terminated at 20.5 feet

Depth scale: 5, 10, 15, 20, 25, 30

Date Started:	January 11, 2013	Water Level:	Not Encountered
Date Completed:	January 11, 2013		
Logged By:	S. Latronic	Drill Rig:	KOMATSU PC160
Total Depth:	20.5 feet	Drilling Method:	N/A
Work Order:	6802-00	Driving Energy:	N/A

Plate A - 3

GEOLABS, INC. Geotechnical Engineering	CENTRAL MAUI REGIONAL PARK WAIKAPU, MAUI, HAWAII	Log of Test Pit **TP-4**

Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS	Description (Approximate Ground Surface Elevation (feet): 154 *)
							0			SM	Tannish brown **SILTY SAND** with traces of organic matter, loose to medium dense, damp (fill)
							1.5			SP	Light tan poorly graded fine to medium **SAND**, medium dense, damp (dune sand)
							3			ML	Brown **CLAYEY SILT** with a little fine sand, very stiff to very stiff, damp (alluvium)
							19				Brownish gray rounded **GRAVELLY COBBLES** with a little silt, dense, damp (alluvium)
							24				Test Pit terminated at 24 feet

Date Started: January 10, 2013	Water Level: Not Encountered		Plate A - 4
Date Completed: January 10, 2013			
Logged By: S. Latronic	Drill Rig: KOMATSU PC160		
Total Depth: 24 feet	Drilling Method: N/A		
Work Order: 6802-00	Driving Energy: N/A		

GEOLABS, INC.

Geotechnical Engineering

CENTRAL MAUI REGIONAL PARK
WAIKAPU, MAUI, HAWAII

Log of Test Pit

TP-5

Approximate Ground Surface Elevation (feet): 166 *

Other Tests	Depth (feet)	Sample	USCS	Description
	0		SP	Light tan poorly graded fine **SAND** with traces of silt, loose, dry (dune sand)
Sieve - #200 = 5.5%	2	G		Light tannish white **CALCAREOUS SANDSTONE**, closely fractured, moderately weathered, soft (cemented dune sand)
Sieve - #200 = 38.1%	4	G	ML	Brown **CLAYEY SILT** with a little fine sand, very stiff to hard, damp (alluvium)
	7			Brownish gray rounded **GRAVELLY COBBLES** with a little sand and traces of silt, dense, damp (alluvium)
	12			Test Pit terminated at 12 feet

Columns: Laboratory (Other Tests; Moisture Content (%); Dry Density (pcf)), Field (Core Recovery (%); RQD (%); Penetration Resistance (blows/foot); Pocket Pen. (tsf)), Depth (feet), Sample, Graphic, USCS, Description. Depth scale: 5, 10, 15, 20, 25, 30.

Date Started:	January 9, 2013	Water Level:	Not Encountered
Date Completed:	January 9, 2013		
Logged By:	S. Latronic	Drill Rig:	KOMATSU PC160
Total Depth:	12 feet	Drilling Method:	N/A
Work Order:	6802-00	Driving Energy:	N/A

Plate

A - 5

GEOLABS, INC. Geotechnical Engineering	CENTRAL MAUI REGIONAL PARK WAIKAPU, MAUI, HAWAII	Log of Test Pit **TP-6**

Approximate Ground Surface Elevation (feet): 160 *

Laboratory: Other Tests	Laboratory: Moisture Content (%)	Laboratory: Dry Density (pcf)	Field: Core Recovery (%)	Field: RQD (%)	Field: Penetration Resistance (blows/foot)	Field: Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS	Description
										SM	Tannish brown fine **SILTY SAND** with traces of organic matter, loose, dry (fill)
										SP	Light tan poorly graded fine **SAND** with traces of silt, loose to medium dense, dry (dune sand)
											Light tannish white **CALCAREOUS SANDSTONE**, closely fractured, moderately weathered, soft (cemented dune sand)
							5			ML	Brown **CLAYEY SILT** with a little fine sand, very stiff to hard, damp (alluvium)
							10				Brownish gray rounded **GRAVELLY COBBLES** with some boulders, dense, damp (alluvium)
											Test Pit terminated at 12 feet
							15				
							20				
							25				
							30				

Date Started:	January 9, 2013	Water Level:	Not Encountered	Plate A - 6
Date Completed:	January 9, 2013			
Logged By:	S. Latronic	Drill Rig:	KOMATSU PC160	
Total Depth:	12 feet	Drilling Method:	N/A	
Work Order:	6802-00	Driving Energy:	N/A	

GEOLABS, INC. Geotechnical Engineering	CENTRAL MAUI REGIONAL PARK WAIKAPU, MAUI, HAWAII	Log of Test Pit **TP-7**

Approximate Ground Surface Elevation (feet): 177 *

Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS	Description
							0			SM	Tannish brown **SILTY SAND** with traces of organic matter, loose, damp (fill)
										SP	Light tan poorly graded fine **SAND** with traces of silt, loose, dry (dune sand)
										ML	Brown **CLAYEY SILT** with a little fine sand and gravel, very stiff, damp (alluvium)
							14				Test Pit terminated at 14 feet

Depth scale (feet): 5, 10, 15, 20, 25, 30

Date Started:	January 10, 2013	Water Level:	Not Encountered
Date Completed:	January 10, 2013		
Logged By:	S. Latronic	Drill Rig:	KOMATSU PC160
Total Depth:	14 feet	Drilling Method:	N/A
Work Order:	6802-00	Driving Energy:	N/A

Plate A - 7

GEOLABS, INC.

Geotechnical Engineering

CENTRAL MAUI REGIONAL PARK
WAIKAPU, MAUI, HAWAII

Log of Test Pit

TP-8

Approximate Ground Surface Elevation (feet): 171 *

Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	USCS	Description
							0 – 0.7		SM	Tannish brown fine **SILTY SAND** with traces of organic matter, loose, dry (fill)
							0.7 – 2.5		SP	Tan poorly graded fine **SAND** with a little silt, loose, dry (dune sand)
							2.5 – 7		SP-SM	Tan poorly graded fine to medium **SILTY SAND**, medium dense, damp (dune sand)
							7 – 9			Brownish gray rounded **GRAVELLY COBBLES** with a little sand and traces of silt, dense, damp (alluvium)
							9 – 10.5		ML	Brown **CLAYEY SILT** with a little fine sand, very stiff to hard, damp (alluvium)
							10.5 – 14			Brownish gray rounded **GRAVELLY COBBLES** with some boulders, dense, damp (alluvium)
							14			Test Pit terminated at 14 feet

Depth scale: 5, 10, 15, 20, 25, 30

Date Started:	January 9, 2013	Water Level:	Not Encountered
Date Completed:	January 9, 2013		
Logged By:	S. Latronic	Drill Rig:	KOMATSU PC160
Total Depth:	14 feet	Drilling Method:	N/A
Work Order:	6802-00	Driving Energy:	N/A

Plate

A - 8

GEOLABS, INC. Geotechnical Engineering	CENTRAL MAUI REGIONAL PARK WAIKAPU, MAUI, HAWAII	Log of Test Pit TP-9

Approximate Ground Surface Elevation (feet): 180 *

Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS	Description
							0–3			SP	Light tan poorly graded fine to medium **SAND** with traces of silt, loose to medium dense, dry (dune sand)
							3–6				Light tannish white cemented **CALCAREOUS SANDSTONE**, closely fractured, slightly weathered, soft to medium hard (cemented dune sand)
							6–9			MH	Brown **CLAYEY SILT** with a little fine sand and gravel, very stiff, damp (alluvium)
							9				Test Pit terminated at 9 feet

Depth scale: 5, 10, 15, 20, 25, 30

Date Started:	December 27, 2012	Water Level:	Not Encountered
Date Completed:	December 27, 2012		
Logged By:	S. Latronic	Drill Rig:	KOMATSU PC160
Total Depth:	9 feet	Drilling Method:	N/A
Work Order:	6802-00	Driving Energy:	N/A

Plate A - 9

GEOLABS, INC. Geotechnical Engineering	CENTRAL MAUI REGIONAL PARK WAIKAPU, MAUI, HAWAII	Log of Test Pit TP-10

Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS	Description (Approximate Ground Surface Elevation (feet): 163 *)
										SP	Light tan poorly graded fine to medium **SAND** with traces of silt, loose, dry (dune sand)
											Light tannish white cemented **CALCAREOUS SANDSTONE**, moderately fractured, slightly weathered, soft to medium hard (cemented dune sand)
							5			GM	Brown with gray subrounded **SILTY GRAVEL** with a little sand, dense, damp (alluvium)
										MH	Brown **CLAYEY SILT** with a little fine sand, very stiff, damp (alluvium)
											Test Pit terminated at 8.5 feet
							10				
							15				
							20				
							25				
							30				

Date Started:	December 27, 2012	Water Level:	Not Encountered	Plate
Date Completed:	December 27, 2012			
Logged By:	S. Latronic	Drill Rig:	KOMATSU PC160	A - 10
Total Depth:	8.5 feet	Drilling Method:	N/A	
Work Order:	6802-00	Driving Energy:	N/A	

APPENDIX B

APPENDIX B

Laboratory Tests

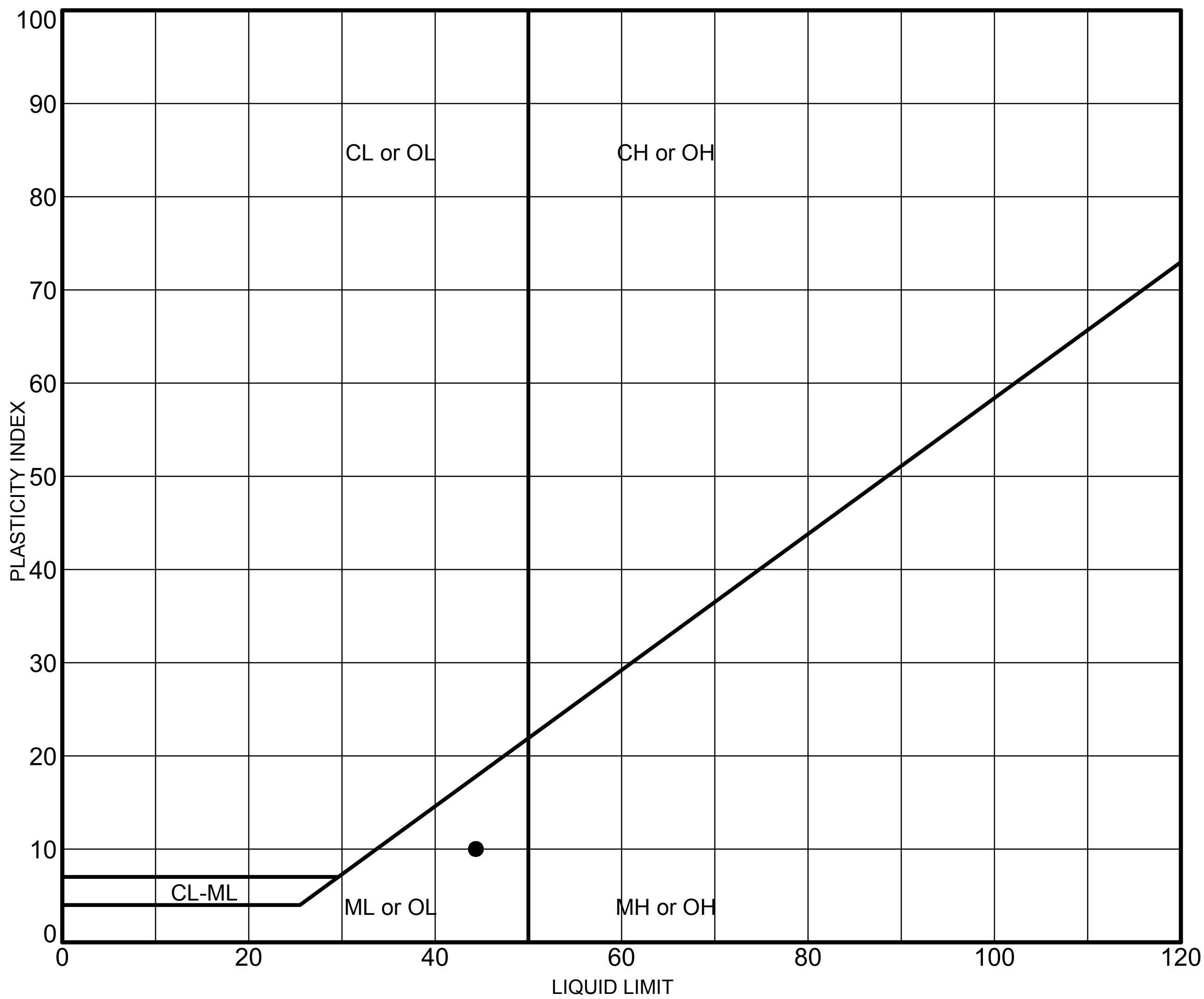
Moisture Content (ASTM D 2216) and Unit Weight determinations (ASTM D 2937) were performed on selected soil samples as an aid in the classification and evaluation of soil properties. The test results are presented on the Logs of Test Pits at the appropriate sample depths.

One Atterberg Limits test (ASTM D 4318) was performed on a selected soil sample to evaluate the liquid and plastic limits. The test results are summarized on the Logs of Test Pits at the appropriate sample depths. Graphic presentations of the test results are provided on Plate 1.

Five Sieve Analysis tests (ASTM C 117 & C 136) were performed on selected soil samples to evaluate the gradation characteristics of the soils and to aid in soil classification. Graphic presentations of the grain size distribution are provided on Plate B-2.

One Modified Proctor compaction test (ASTM D 1557 C) was performed on selected bulk sample of the near-surface soils to evaluate the dry density and moisture content relationships. The test results are presented on Plate B-3.

Four laboratory California Bearing Ratio tests (ASTM D 1883) were performed on selected bulk samples to evaluate the pavement support characteristics of the soils. The test results are presented on Plates B-4 thru B-7.



	Sample	Depth (ft)	LL	PL	PI	Description
●	BULK-4	13.5-14.5	44	34	10	Red-brown sandy silt (ML)

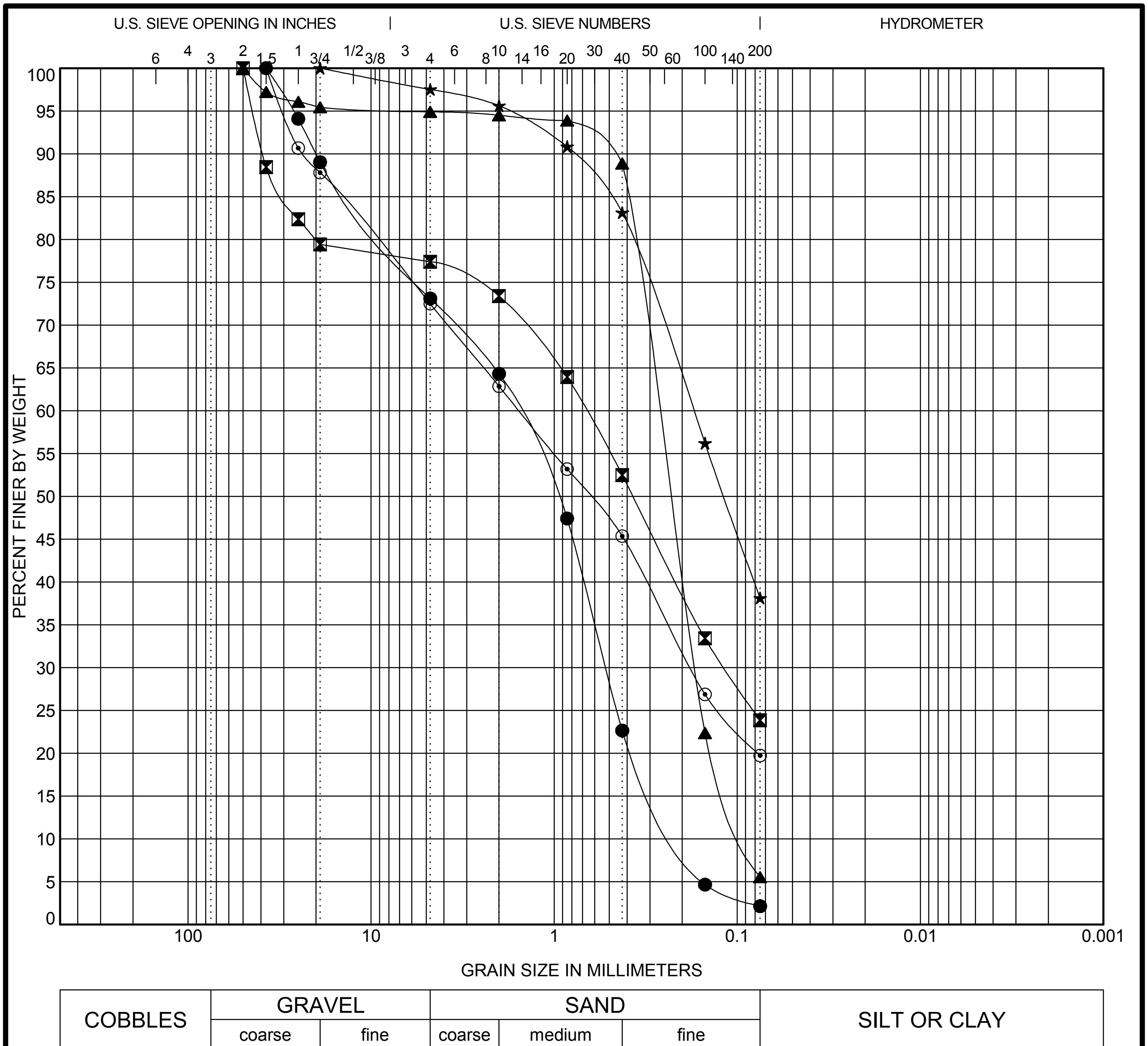
GEOLABS, INC.
GEOTECHNICAL ENGINEERING

W.O. 6802-00

ATTERBERG LIMITS TEST RESULTS - ASTM D 4318

CENTRAL MAUI REGIONAL PARK
WAIKAPU, MAUI, HAWAII

Plate
B - 1



	Sample	Depth (ft)	Description	LL	PL	PI	Cc	Cu
●	TP-1	2.5-3.5	Gray-tan sand (SP) with some gravel and traces of silt				0.8	7.9
⧗	TP-3	13.5-14.5	Red-brown sand (SM) with some silt and gravel					
▲	TP-5	1.5-3.0	Brown sand (SP-SM) with a little silt and gravel				1.2	3.0
★	TP-5	5.0-6.5	Tan-brown sand (SM) with some silt and traces of gravel					
⊙	BULK-3	5.0-6.5	Brown sand (SM) with some gravel and silt					

	Sample	Depth (ft)	D100 (mm)	D60 (mm)	D30 (mm)	D10 (mm)	%Gravel	%Sand	%Fine
●	TP-1	2.5-3.5	37.5	1.608	0.522	0.204	26.9	71.0	2.1
⧗	TP-3	13.5-14.5	50	0.67	0.117		22.6	53.6	23.8
▲	TP-5	1.5-3.0	50	0.27	0.169	0.09	5.1	89.4	5.5
★	TP-5	5.0-6.5	19	0.174			2.5	59.4	38.1
⊙	BULK-3	5.0-6.5	37.5	1.555	0.179		27.5	52.8	19.7

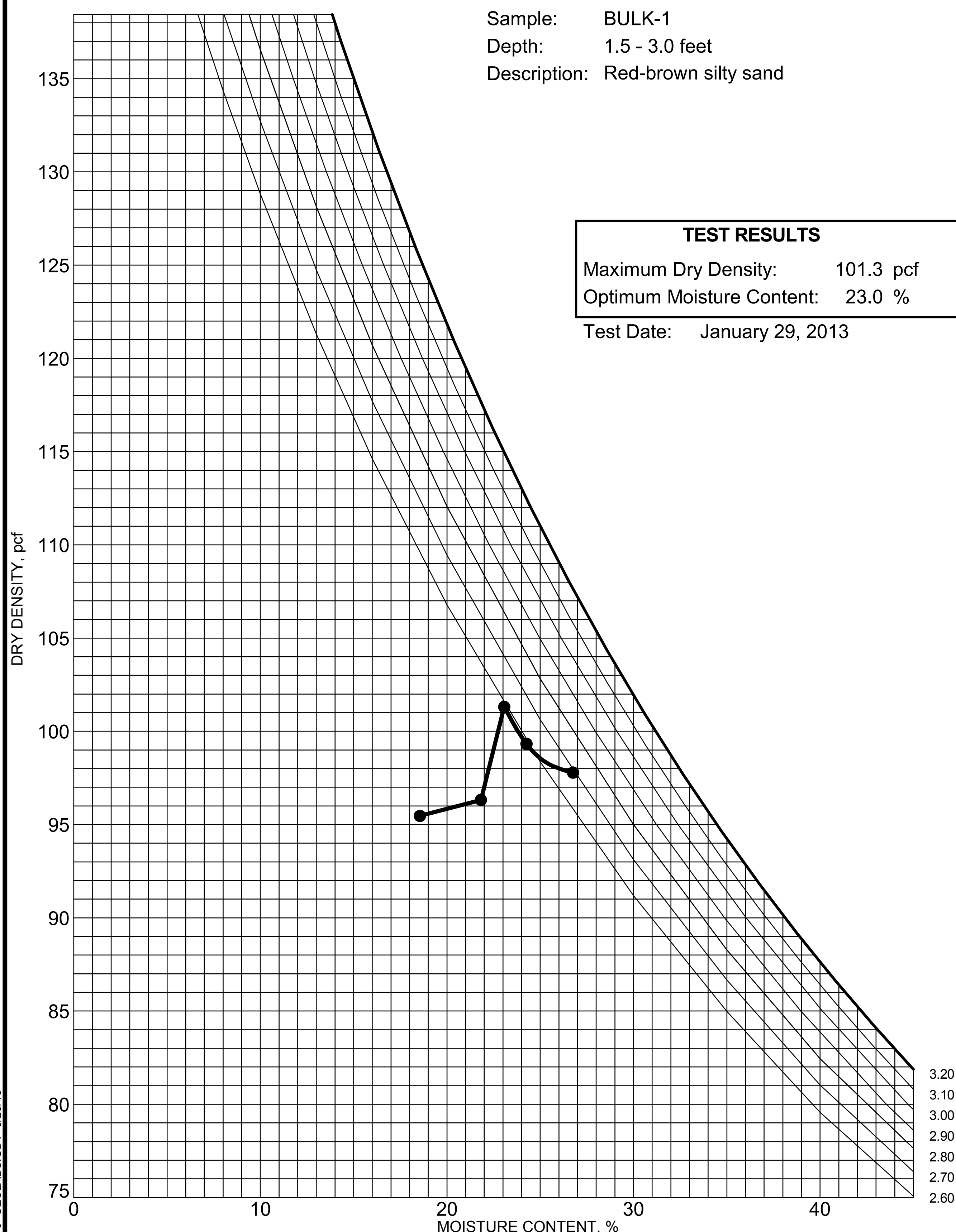
GEOLABS, INC.
GEOTECHNICAL ENGINEERING
W.O. 6802-00

GRAIN SIZE DISTRIBUTION - ASTM C 117 & C 136

CENTRAL MAUI REGIONAL PARK
WAIKAPU, MAUI, HAWAII

Plate
B - 2

G_GRAIN_SIZE 6802-00.GPJ GEOLABS.GDT 3/25/13



Sample: BULK-1

Depth: 1.5 - 3.0 feet

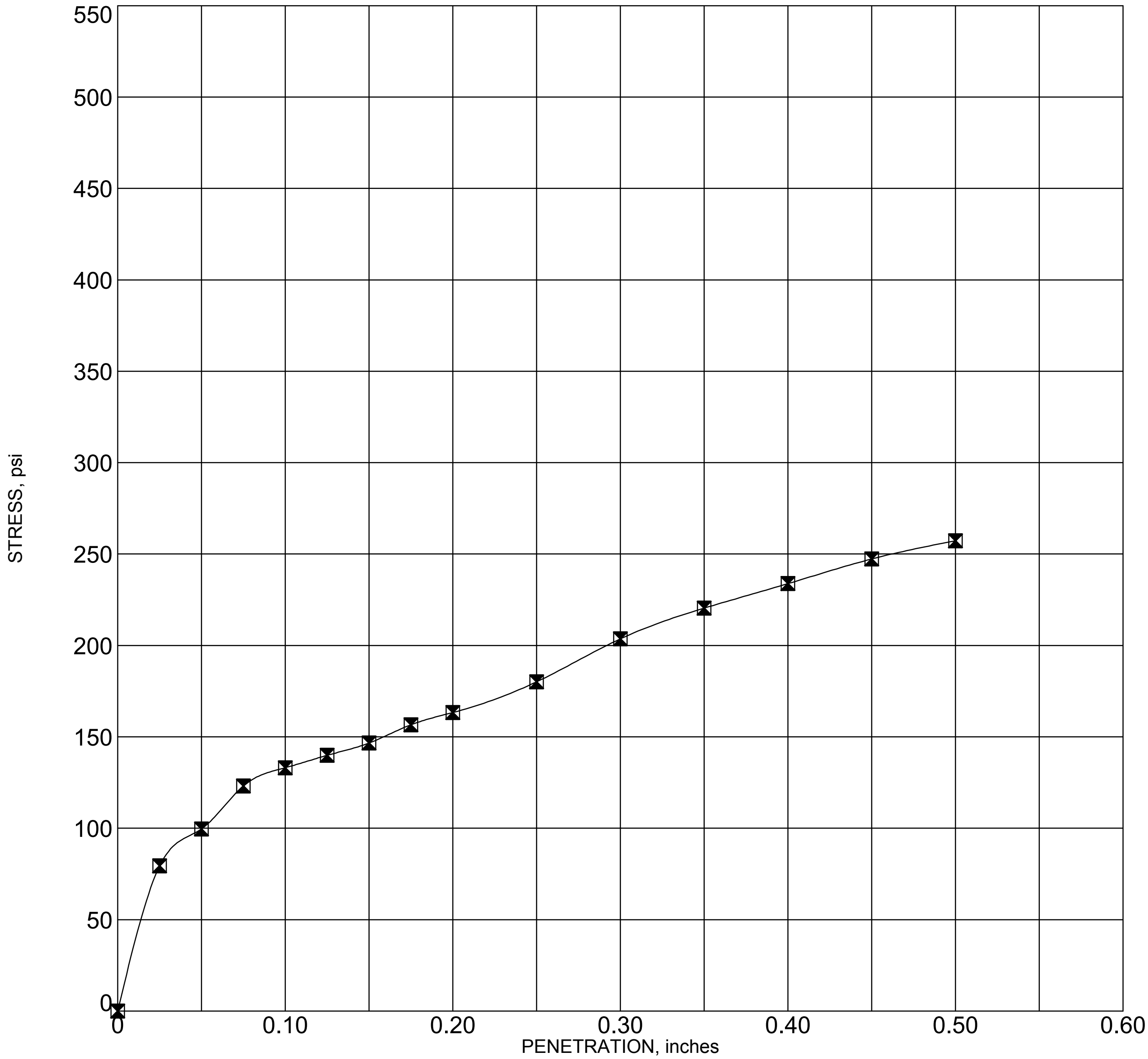
Description: Red-brown silty sand

TEST RESULTS	
Maximum Dry Density:	101.3 pcf
Optimum Moisture Content:	23.0 %

Test Date: January 29, 2013

G_COMPACTION 6802-00.GPJ GEOLABS.GDT 3/25/13

GEOLABS, INC. GEOTECHNICAL ENGINEERING	MOISTURE-DENSITY RELATIONSHIP - ASTM D 1557/698	
W.O. 6802-00	CENTRAL MAUI REGIONAL PARK WAIKAPU, MAUI, HAWAII	Plate B - 3



Corr. CBR @ 0.1"	13.3
Corr. CBR @ 0.2"	10.9
Swell (%)	1.05

Sample: BULK-1
Depth: 1.5 - 3.0 feet
Description: Red-brown silty sand

Molding Dry Density (pcf)	96.7	Hammer Wt. (lbs)	10
Molding Moisture (%)	24.1	Hammer Drop (inches)	18
Days Soaked	4	No. of Blows	56
Aggregate	3/4 inch minus	No. of Layers	5

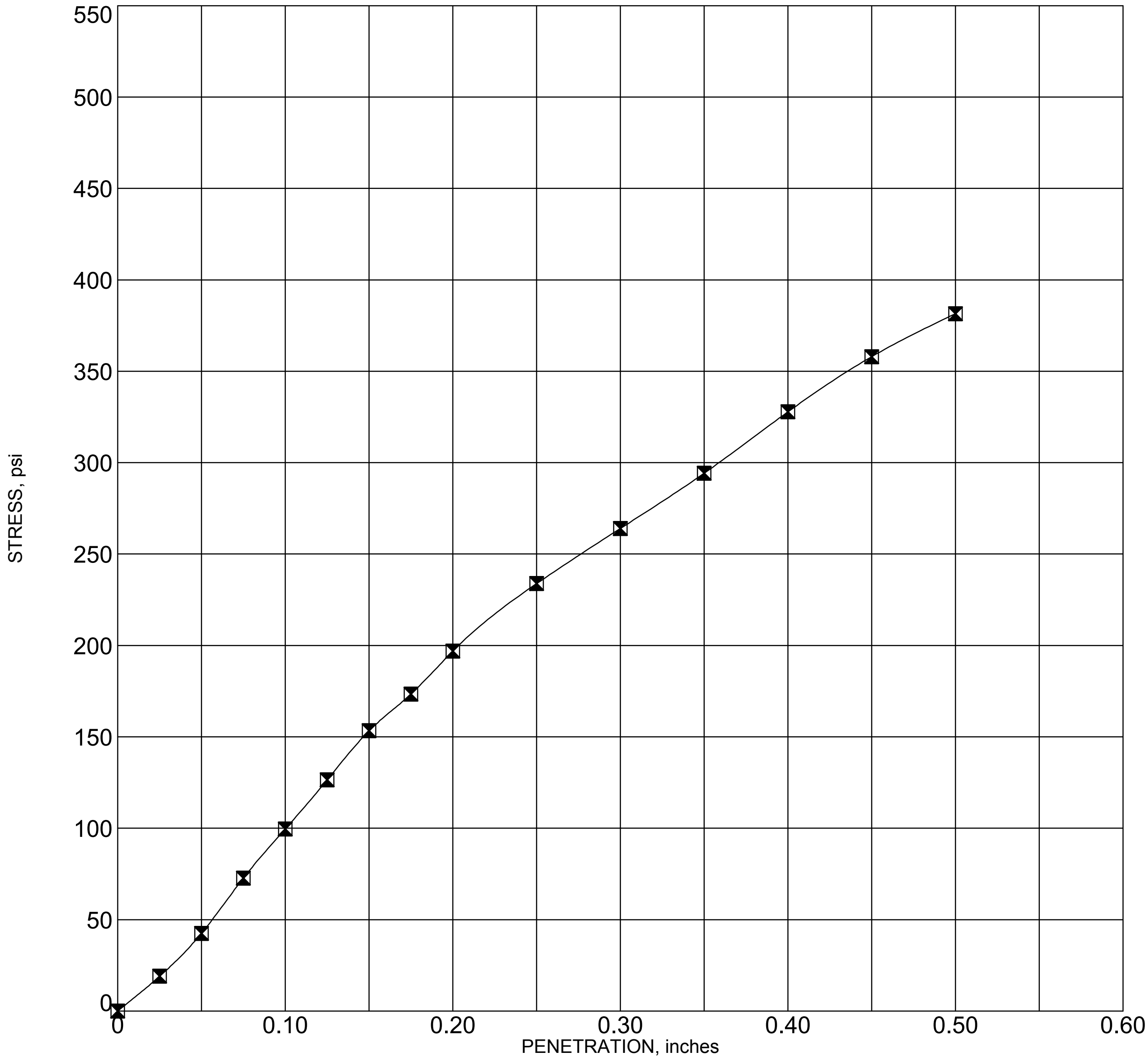
GEOLABS, INC.
GEOTECHNICAL ENGINEERING
W.O. 6802-00

CALIFORNIA BEARING RATIO - ASTM D 1883

CENTRAL MAUI REGIONAL PARK
WAIKAPU, MAUI, HAWAII

Plate
B - 4

G_CBR 6802-00.GPJ GEOLABS.GDT 3/25/13



Corr. CBR @ 0.1"	11.0
Corr. CBR @ 0.2"	13.6
Swell (%)	0.00

Sample: BULK-2
Depth: 5.0 - 6.5 feet
Description: Tan-brown silty sand (coralline) with traces of gravel

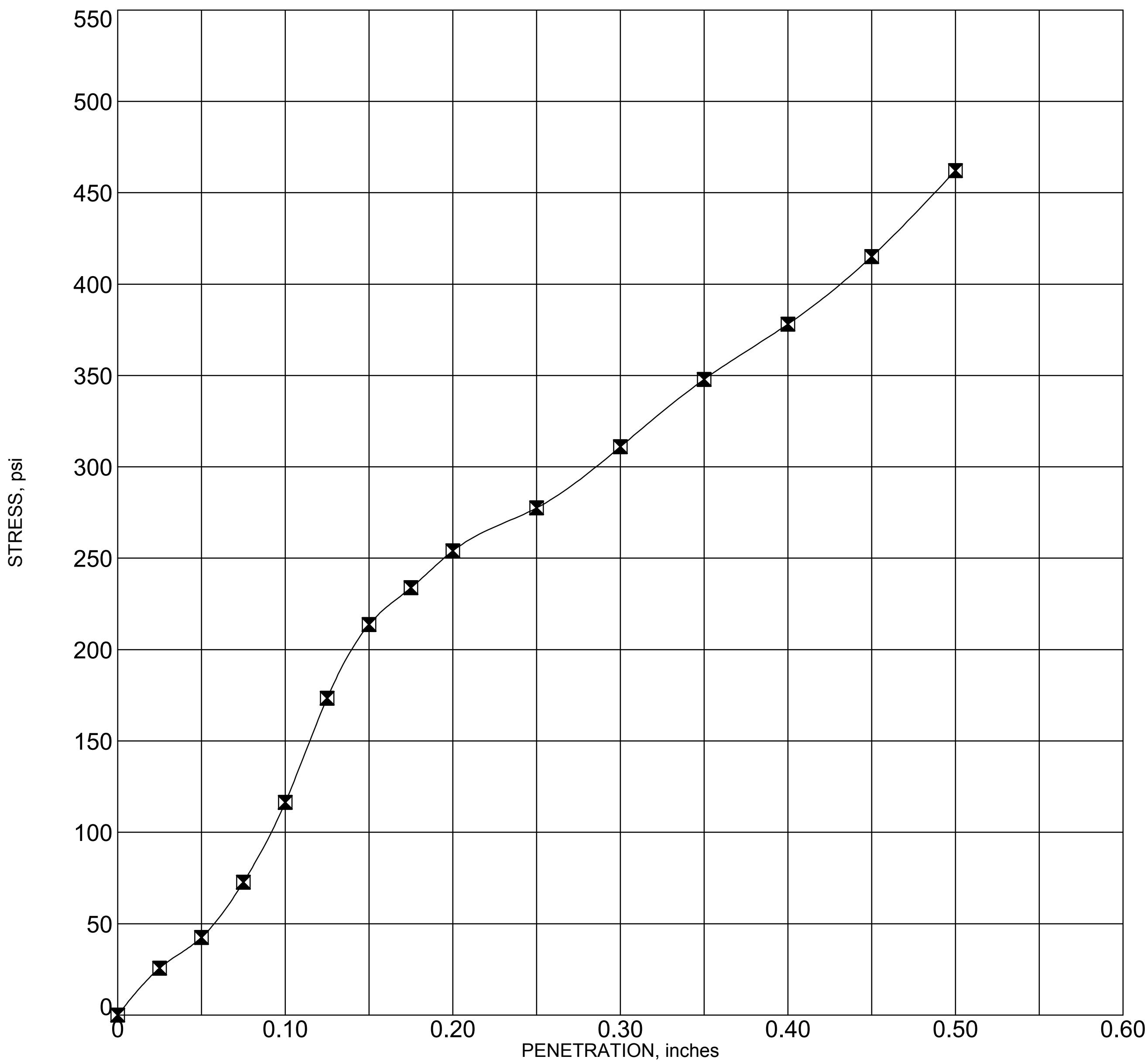
Molding Dry Density (pcf)	100.0	Hammer Wt. (lbs)	10
Molding Moisture (%)	15.6	Hammer Drop (inches)	18
Days Soaked	4	No. of Blows	56
Aggregate	3/4 inch minus	No. of Layers	5

GEOLABS, INC.
GEOTECHNICAL ENGINEERING
W.O. 6802-00

CALIFORNIA BEARING RATIO - ASTM D 1883

CENTRAL MAUI REGIONAL PARK
WAIKAPU, MAUI, HAWAII

Plate
B - 5



Corr. CBR @ 0.1"	20.8
Corr. CBR @ 0.2"	18.3
Swell (%)	0.28

Sample: BULK-3
Depth: 1.0 - 2.0 feet
Description: Brown silt with some sand

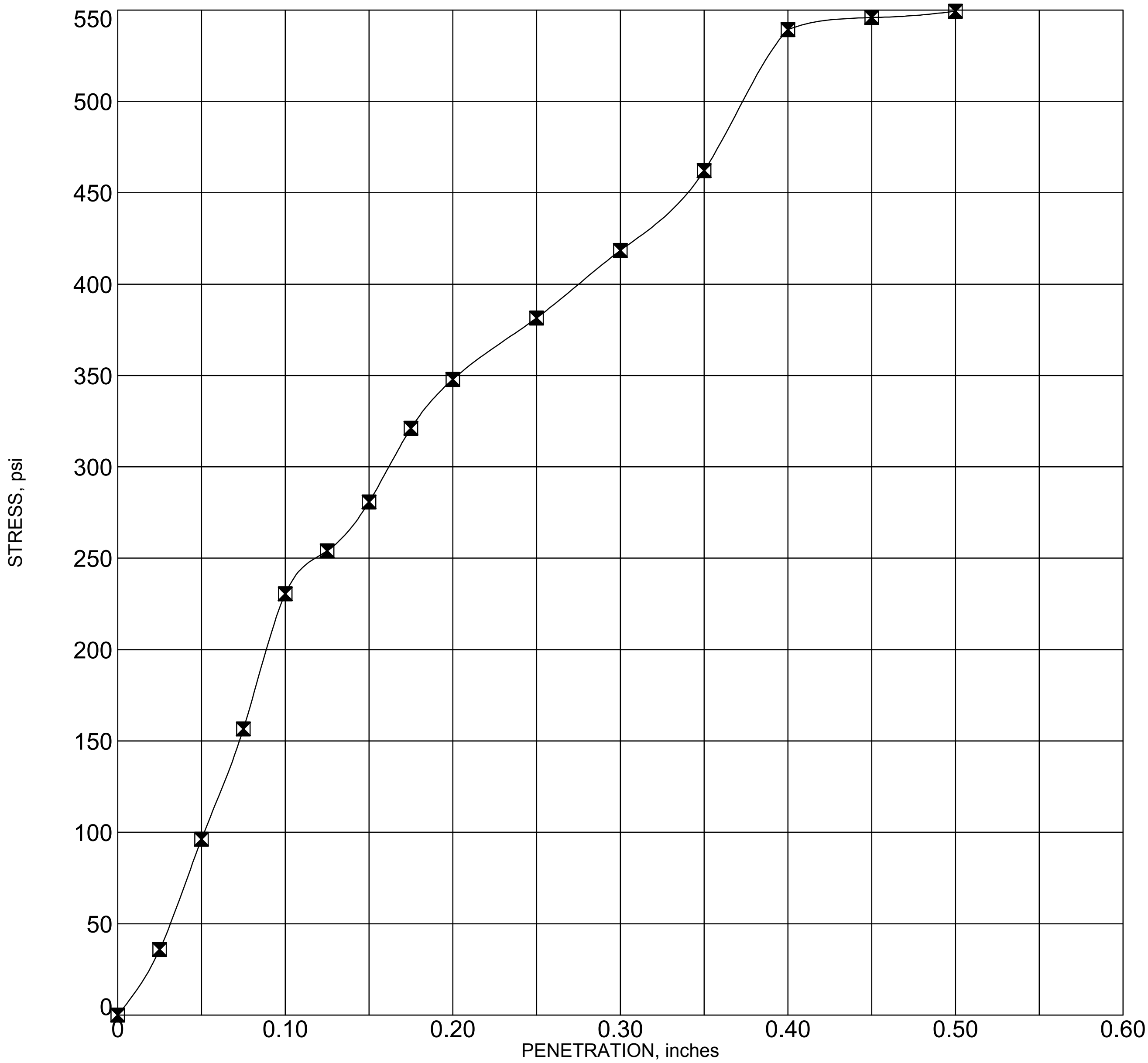
Molding Dry Density (pcf)	100.1	Hammer Wt. (lbs)	10
Molding Moisture (%)	23.4	Hammer Drop (inches)	18
Days Soaked	4	No. of Blows	56
Aggregate	3/4 inch minus	No. of Layers	5

GEOLABS, INC.
GEOTECHNICAL ENGINEERING
W.O. 6802-00

CALIFORNIA BEARING RATIO - ASTM D 1883

CENTRAL MAUI REGIONAL PARK
WAIKAPU, MAUI, HAWAII

Plate
B - 6



Corr. CBR @ 0.1"	23.5
Corr. CBR @ 0.2"	23.5
Swell (%)	0.00

Sample: BULK-5
Depth: 2.5 - 3.0 feet
Description: Gray sand with gravel

Molding Dry Density (pcf)	112.7	Hammer Wt. (lbs)	10
Molding Moisture (%)	11.1	Hammer Drop (inches)	18
Days Soaked	4	No. of Blows	56
Aggregate	3/4 inch minus	No. of Layers	5

GEOLABS, INC.
GEOTECHNICAL ENGINEERING
W.O. 6802-00

CALIFORNIA BEARING RATIO - ASTM D 1883

CENTRAL MAUI REGIONAL PARK
WAIKAPU, MAUI, HAWAII

Plate
B - 7

G_CBR 6802-00.GPJ GEOLABS.GDT 3/25/13

APPENDIX C

APPENDIX C

Infiltration Tests

In order to provide information on the surface infiltration rates of the on-site soils, we conducted five double-ring infiltrometer tests at selected locations on the site. These tests were performed in general accordance with ASTM D 3385. Infiltrometer Test No. 5, which was conducted in Test Pit 8 at a depth of about 5.5 feet below the existing ground surface, took water so rapidly that readings could not be obtained from the infiltrometer apparatus. Therefore, the data from that test were not plotted. The results from the remaining tests are presented on Plates C-1 through C-4.

DOUBLE RING INFILTROMETER --- ASTM D3385-09

Project Name: Maui Central Regional Park

W.O.: 6802-00 Test Date: 12/27/12

Tested By: SL/JS Liquid: Water

Water Table Depth (feet):

Inner Ring Penetration (in): 2

Outer Ring Penetration (in): 3.0

	Area (cm^2)	Liquid depth (in)	Liquid depth (cm)	Theoretical liquid volume (gal)	Initial liq vol (gal)
Inner Ring	707.0	11.0	27.9	5.2	2
Annular Space	2106.0	11.0	27.9	15.5	11

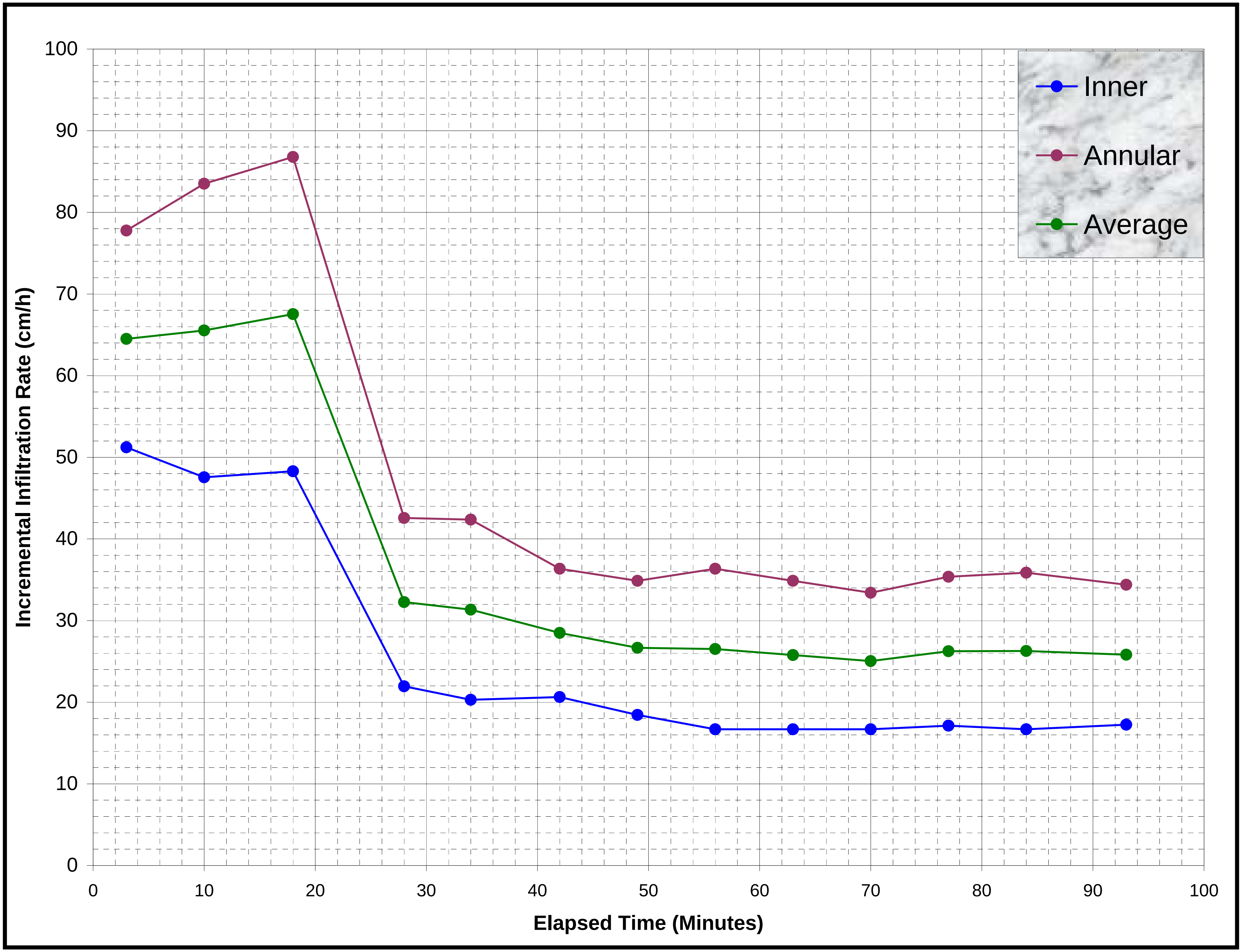
Liquid level maintained by: □ Flow Valve; □ Float Valve; ■ Mariotte Tube

(Test Pit - 1: 5.0' depth) Material: Brown Clayey Silt

Infiltration Test Number	1		Elapsed Time per Test	Total Elapsed Time	Flow Readings								Infiltration Rate			Remarks
					Inner (Tube 1)				Annular (Tube 2)				Inner	Annular	Average	
No.	Start or End	Time hr:min	(min)	(min)	height (in)	height (cm)	Marriote (cm)	flow (cm^3)	height (in)	height (cm)	Marriote (cm)	flow, (cm^3)	(cm/h)	(cm/h)	(cm/h)	Weather conditions, etc...
1	Start	11:35	3	3	9.250	4.4	23.0	1810.3	9.250	4.4	10.5	8189.7	51.2	77.8	64.5	
	End	11:38														
2	Start	11:42	3	10	10.250	1.9	25.5	1681.0	10.100	2.3	7.0	8793.1	47.6	83.5	65.5	
	End	11:45														
3	Start	11:50	3	18	10.250	1.9	25.0	1706.9	9.750	3.2	5.0	9137.9	48.3	86.8	67.5	
	End	11:53														
4	Start	12:00	3	28	10.750	0.6	43.0	775.9	10.500	1.3	32.0	4482.8	21.9	42.6	32.3	
	End	12:03														
5	Start	12:05	4	34	10.600	1.0	39.5	956.9	10.300	1.8	23.5	5948.3	20.3	42.4	31.3	
	End	12:09														
6	Start	12:12	5	42	10.500	1.3	34.5	1215.5	10.250	1.9	21.0	6379.3	20.6	36.3	28.5	
	End	12:17														
7	Start	12:19	5	49	10.500	1.3	37.0	1086.2	10.300	1.8	22.5	6120.7	18.4	34.9	26.7	
	End	12:24														
8	Start	12:26	5	56	10.600	1.0	39.0	982.8	10.300	1.8	21.0	6379.3	16.7	36.3	26.5	
	End	12:31														
9	Start	12:33	5	63	10.600	1.0	39.0	982.8	10.250	1.9	22.5	6120.7	16.7	34.9	25.8	
	End	12:38														
10	Start	12:40	5	70	10.600	1.0	39.0	982.8	10.300	1.8	24.0	5862.1	16.7	33.4	25.0	
	End	12:45														
11	Start	12:47	5	77	10.600	1.0	38.5	1008.6	10.250	1.9	22.0	6206.9	17.1	35.4	26.2	
	End	12:52														
12	Start	12:54	5	84	10.600	1.0	39.0	982.8	10.250	1.9	21.5	6293.1	16.7	35.9	26.3	
	End	12:59														
13	Start	13:01	7	93	10.250	1.9	30.5	1422.4	9.900	2.8	9.0	8448.3	17.2	34.4	25.8	
	End	13:08														
14	Start															
	End															
15	Start															
	End															
16	Start															
	End															

Remarks:

1. Inner Infiltration Rate: $V_{IR} = \Delta V_{IR} / (A_{IR} * \Delta t)$ Annular space infiltration rate: $V_A = \Delta V_A / (A_A * \Delta t)$
2. Applicable to relatively UNIFORM FINE-GRAINED SOIL, with low to moderate ring penetration, and without fat clay and gravel-size particles.
3. Test should be conducted ABOVE ground water level.
4. NOT for very pervious or impervious soil (k should be within 10^{-6} to 10^{-2} cm/s). NOT for dry or stiff soil that fractures easily.
5. NOT able to determine coefficient of permeability *k* directly.


Inner
Annular
Average
Incremental Infiltration Rate (cm/h)
Elapsed Time (Minutes)
0
10
20
30
40
50
60
70
80
90
100

DOUBLE RING INFILTROMETER --- ASTM D3385-09

Project Name: Maui Central Regional Park

W.O. 6802-00 Test Date: 1/10/13

Tested By SL/JS Liquid: Water

Water Table Depth (feet)

Inner Ring Penetration (in) 2

Outer Ring Penetration (in) 3.0

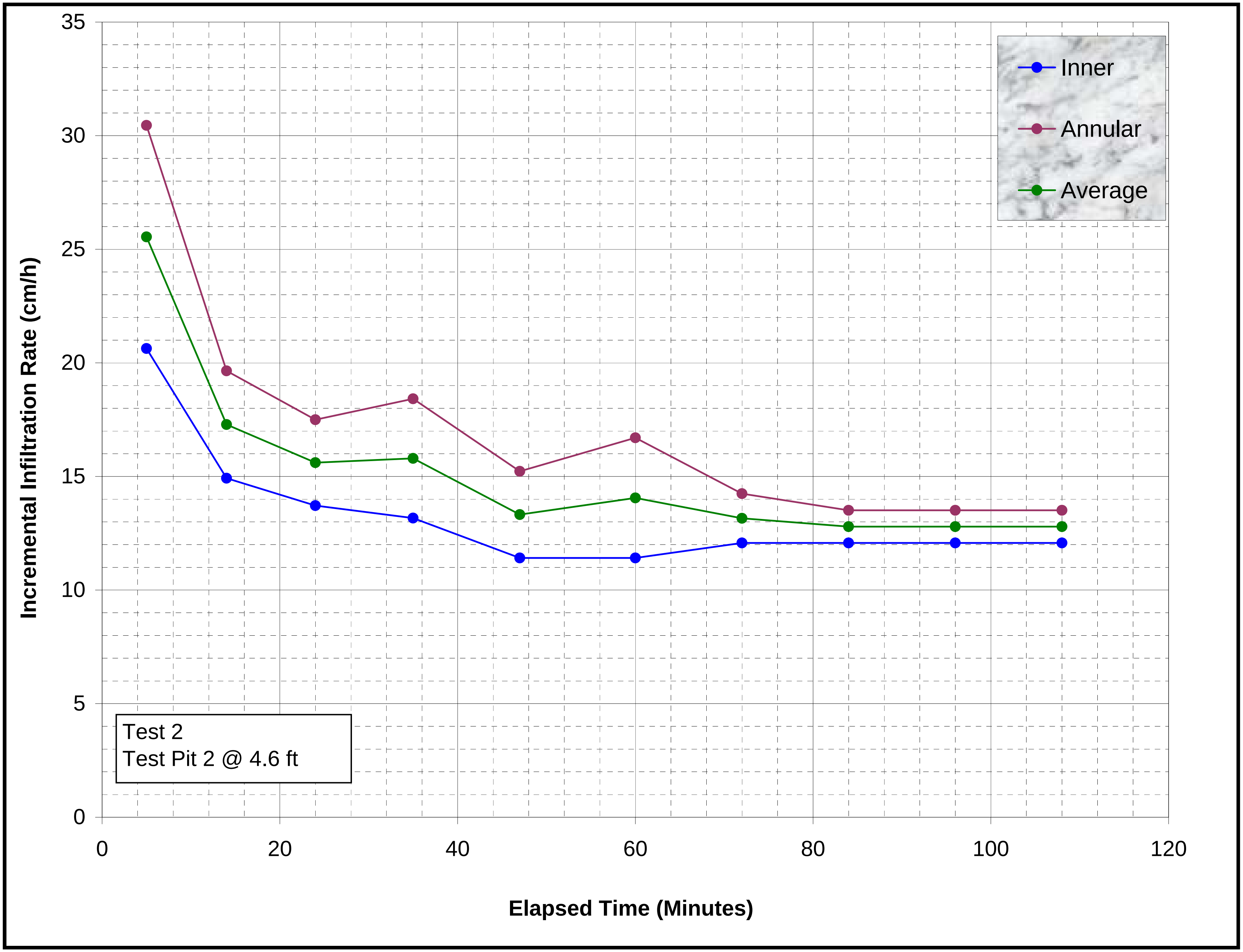
	Area (cm^2)	Liquid depth (in)	Liquid depth (cm)	Theoretical liquid volume (gal)	Initial liq vol (gal)
Inner Ring	707.0	12.0	30.5	5.7	5.7
Annular Space	2106.0	12.0	30.5	17.0	17

Liquid level maintained by: □ Flow Valve; □ Float Valve; ■ Mariotte Tube

(Test Pit - 2: 4.25' depth) Material: Brown Clayey Silt

Infiltration Test Number		2	Elapsed Time per Test	Total Elapsed Time	Flow Readings								Infiltration Rate			Remarks
					Inner (Tube 1)				Annular (Tube 2)				Inner	Annular	Average	
No.	Start or End	Time hr:min	(min)	(min)	height (in)	height (cm)	Marriote (cm)	flow (cm^3)	height (in)	height (cm)	Marriote (cm)	flow, (cm^3)	(cm/h)	(cm/h)	(cm/h)	Weather conditions, etc...
1	Start	10:50	5	5	11.400	1.5	34.5	1215.5	11.300	1.8	27.0	5344.8	20.6	30.5	25.5	
	End	10:55														
2	Start	10:59	5	14	11.600	1.0	41.0	879.3	11.500	1.3	38.0	3448.3	14.9	19.6	17.3	
	End	11:04														
3	Start	11:06	8	24	11.400	1.5	33.0	1293.1	11.300	1.8	29.5	4913.8	13.7	17.5	15.6	
	End	11:14														
4	Start	11:17	8	35	11.400	1.5	34.0	1241.4	11.250	1.9	28.0	5172.4	13.2	18.4	15.8	
	End	11:25														
5	Start	11:27	10	47	11.300	1.8	32.0	1344.8	11.200	2.0	27.0	5344.8	11.4	15.2	13.3	
	End	11:37														
6	Start	11:40	10	60	11.300	1.8	32.0	1344.8	11.200	2.0	24.0	5862.1	11.4	16.7	14.1	
	End	11:50														
7	Start	11:52	10	72	11.300	1.8	30.5	1422.4	11.300	1.8	29.0	5000.0	12.1	14.2	13.2	
	End	12:02														
8	Start	12:04	10	84	11.300	1.8	30.5	1422.4	11.300	1.8	30.5	4741.4	12.1	13.5	12.8	
	End	12:14														
9	Start	12:16	10	96	11.300	1.8	30.5	1422.4	11.300	1.8	30.5	4741.4	12.1	13.5	12.8	
	End	12:26														
10	Start	12:28	10	108	11.300	1.8	30.5	1422.4	11.300	1.8	30.5	4741.4	12.1	13.5	12.8	
	End	12:38														
11	Start															
	End															
12	Start															
	End															
13	Start															
	End															
14	Start															
	End															
15	Start															
	End															
16	Start															
	End															

Remarks:
1. Inner Infiltration Rate: $V_{IR} = \Delta V_{IR} / (A_{IR} * \Delta t)$ Annular space infiltration rate: $V_A = \Delta V_A / (A_A * \Delta t)$
2. Applicable to relatively UNIFORM FINE-GRAINED SOIL, with low to moderate ring penetration, and without fat clay and gravel-size particles.
3. Test should be conducted ABOVE ground water level.
4. NOT for very pervious or impervious soil (k should be within 10^{-6} to 10^{-2} cm/s). NOT for dry or stiff soil that fractures easily.
5. NOT able to determine coefficient of permeability *k* directly.



W.O. 6802-00

GEOLABS, INC.
Hawaii • California

PLATE C-2.2

DOUBLE RING INFILTROMETER --- ASTM D3385-09

Project Name Maui Central Regional Park
W.O. 6802-00 Test Date: 1/11/13
Tested By SL/JS Liquid: Water
Water Table Depth (feet)
Inner Ring Penetration (in) 2
Outer Ring Penetration (in) 3.0

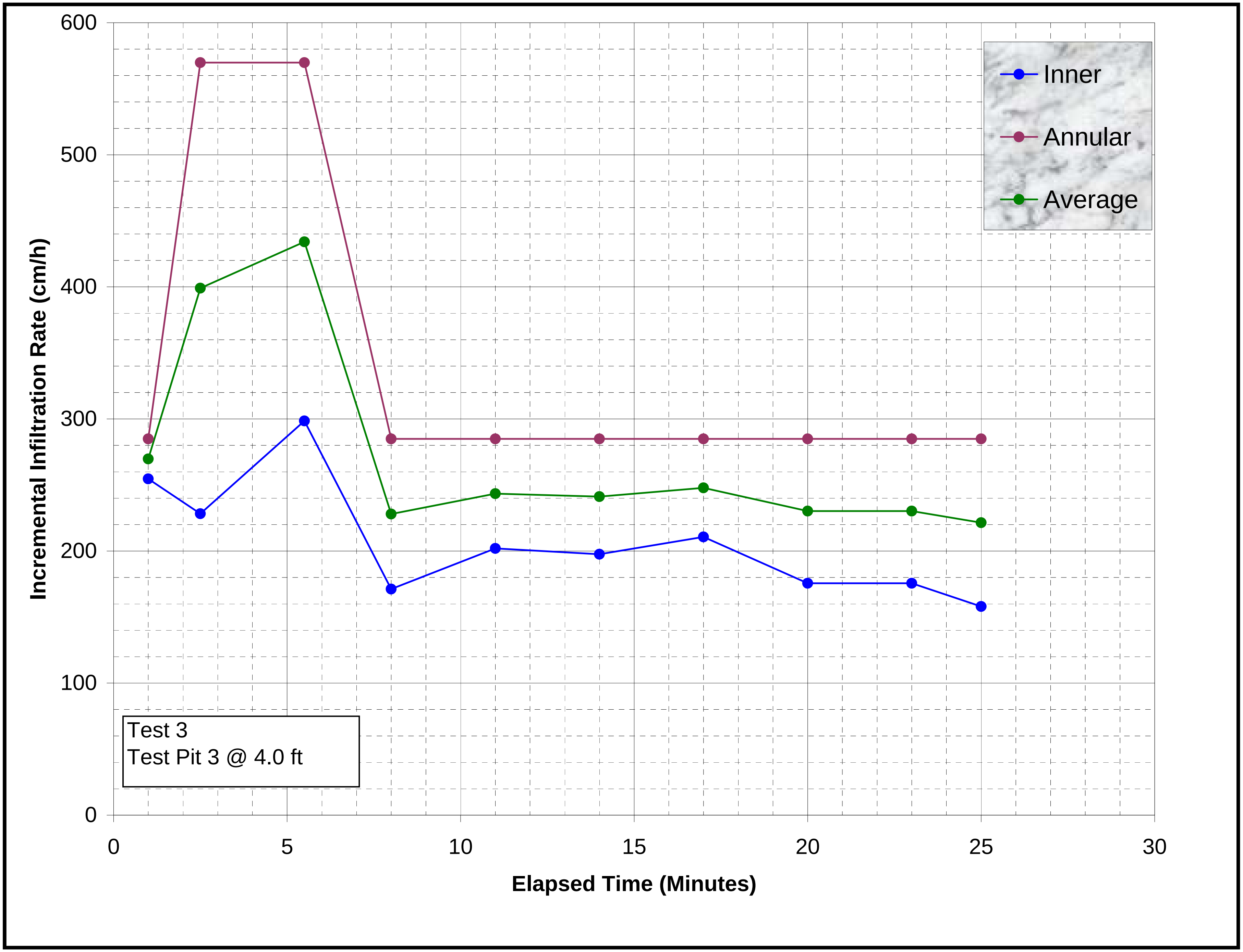
	Area (cm^2)	Liquid depth (in)	Liquid depth (cm)	Theoretical liquid volume (gal)	Initial liq vol (gal)
Inner Ring	707.0	12.0	30.5	5.7	5.7
Annular Space	2106.0	12.0	30.5	17.0	17

Liquid level maintained by: □ Flow Valve; □ Float Valve; ■ Mariotte Tube

(Test Pit - 3: 4.0' depth) Material: Tan Poorly Graded Sand

Infiltration Test Number	3	Elapsed Time per Test	Total Elapsed Time	Flow Readings								Infiltration Rate			Remarks
				Inner (Tube 1)				Annular (Tube 2)				Inner	Annular	Average	
No.	Start or End	Time hr:min	(min)	(min)	height (in)	height (cm)	Marriote (cm)	flow (cm^3)	height (in)	height (cm)	Marriote (cm)	flow, (cm^3)	(cm/h)	(cm/h)	(cm/h)	Weather conditions, etc...
1	Start	8:29	1	1	11.400	1.5	0.0	3000.0	11.300	1.8	0.0	10000.0	254.6	284.9	269.7	
	End	8:30														
2	Start	8:31	0.5	2.5	11.700	0.8	32.0	1344.8	11.750	0.6	0.0	10000.0	228.3	569.8	399.0	
	End	8:31														
3	Start	8:34	0.5	5.5	11.500	1.3	24.0	1758.6	11.700	0.8	0.0	10000.0	298.5	569.8	434.1	
	End	8:34														
4	Start	8:36	1	8	11.300	1.8	19.0	2017.2	11.500	1.3	0.0	10000.0	171.2	284.9	228.0	
	End	8:37														
5	Start	8:39	1	11	11.300	1.8	12.0	2379.3	11.400	1.5	0.0	10000.0	201.9	284.9	243.4	
	End	8:40														
6	Start	8:42	1	14	11.300	1.8	13.0	2327.6	11.300	1.8	0.0	10000.0	197.5	284.9	241.2	
	End	8:43														
7	Start	8:45	1	17	11.200	2.0	10.0	2482.8	11.250	1.9	0.0	10000.0	210.7	284.9	247.8	
	End	8:46														
8	Start	8:48	1	20	11.300	1.8	18.0	2069.0	11.400	1.5	0.0	10000.0	175.6	284.9	230.2	
	End	8:49														
9	Start	8:51	1	23	11.300	1.8	18.0	2069.0	11.500	1.3	0.0	10000.0	175.6	284.9	230.2	
	End	8:52														
10	Start	8:53	1	25	11.300	1.8	22.0	1862.1	11.400	1.5	0.0	10000.0	158.0	284.9	221.5	
	End	8:54														
11	Start															
	End															
12	Start															
	End															
13	Start															
	End															
14	Start															
	End															
15	Start															
	End															
16	Start															
	End															

Remarks:
1. Inner Infiltration Rate: $V_{IR} = \Delta V_{IR} / (A_{IR} * \Delta t)$ Annular space infiltration rate: $V_A = \Delta V_A / (A_A * \Delta t)$
2. Applicable to relatively UNIFORM FINE-GRAINED SOIL, with low to moderate ring penetration, and without fat clay and gravel-size particles.
3. Test should be conducted ABOVE ground water level.
4. NOT for very pervious or impervious soil (k should be within 10^{-6} to 10^{-2} cm/s). NOT for dry or stiff soil that fractures easily.
5. NOT able to determine coefficient of permeability *k* directly.



W.O. 6802-00

GEOLABS, INC.
Hawaii • California

PLATE C-3.2

DOUBLE RING INFILTROMETER --- ASTM D3385-09

Project Name: Maui Central Regional Park
W.O.: 6802-00 Test Date: 1/11/13
Tested By: SL/JS Liquid: Water
Water Table Depth (feet):
Inner Ring Penetration (in): 2
Outer Ring Penetration (in): 3.0

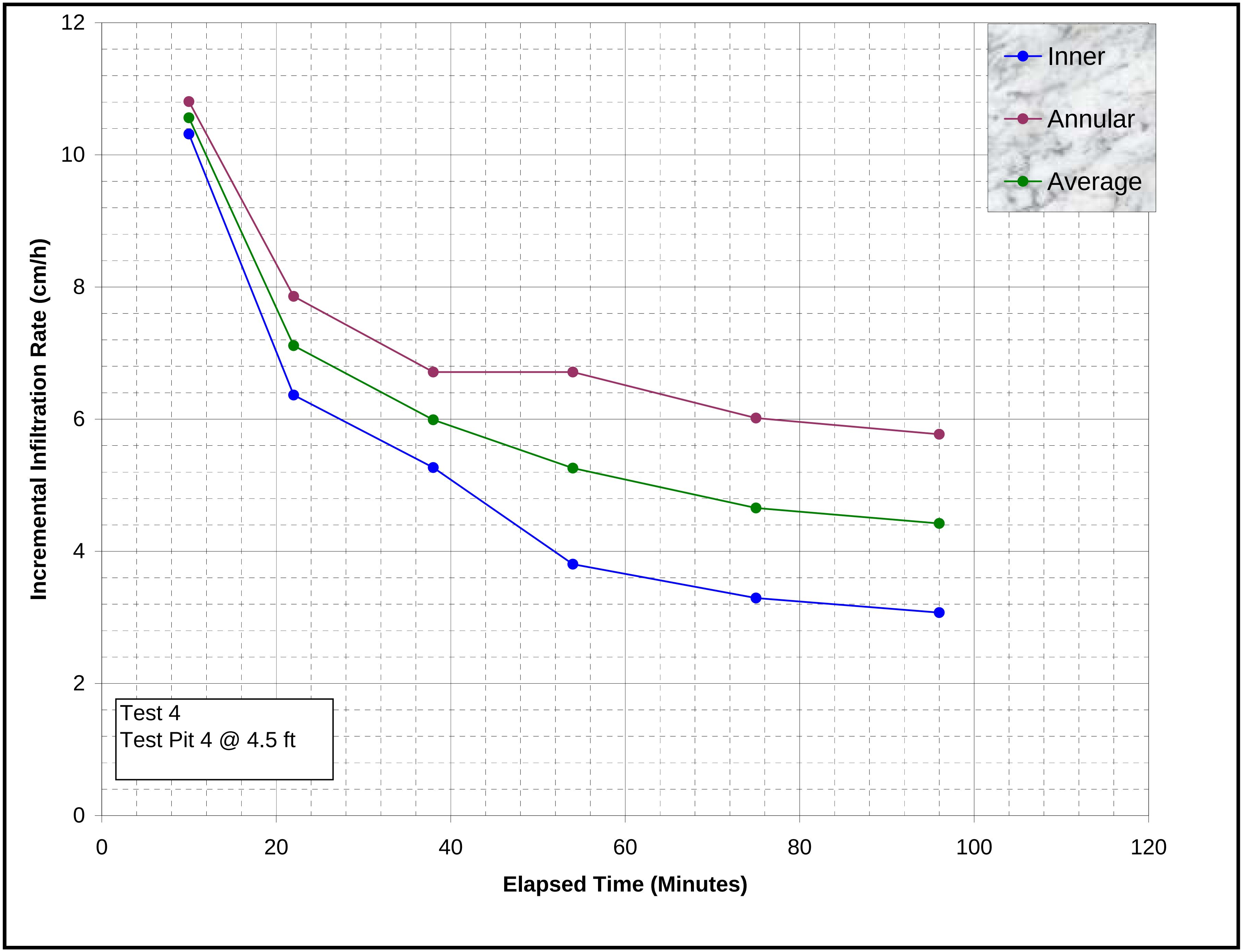
	Area (cm^2)	Liquid depth (in)	Liquid depth (cm)	Theoretical liquid volume (gal)	Initial liq vol (gal)
Inner Ring	707.0	14.0	35.6	6.6	6.6
Annular Space	2106.0	14.0	35.6	19.8	19.8

Liquid level maintained by: □ Flow Valve; □ Float Valve; ■ Mariotte Tube

(Test Pit - 4: 4.5' depth) Material: Brown Clayey Silt

Infiltration Test Number		4	Elapsed Time per Test	Total Elapsed Time	Flow Readings								Infiltration Rate			Remarks
					Inner (Tube 1)				Annular (Tube 2)				Inner	Annular	Average	
No.	Start or End	Time hr:min	(min)	(min)	height (in)	height (cm)	Marriote (cm)	flow (cm^3)	height (in)	height (cm)	Marriote (cm)	flow, (cm^3)	(cm/h)	(cm/h)	(cm/h)	Weather conditions, etc...
1	Start	14:00	10	10	13.400	1.5	34.5	1215.5	13.500	1.3	36.0	3793.1	10.3	10.8	10.6	
	End	14:10														
2	Start	14:12	10	22	13.700	0.8	43.5	750.0	13.600	1.0	42.0	2758.6	6.4	7.9	7.1	
	End	14:22														
3	Start	14:23	15	38	13.600	1.0	40.0	931.0	13.500	1.3	37.5	3534.5	5.3	6.7	6.0	
	End	14:38														
4	Start	14:39	15	54	13.700	0.8	45.0	672.4	13.500	1.3	37.5	3534.5	3.8	6.7	5.3	
	End	14:54														
5	Start	14:55	20	75	13.600	1.0	43.0	775.9	13.300	1.8	33.5	4224.1	3.3	6.0	4.7	
	End	15:15														
6	Start	15:16	20	96	13.700	0.8	44.0	724.1	13.400	1.5	34.5	4051.7	3.1	5.8	4.4	
	End	15:36														
7	Start															
	End															
8	Start															
	End															
9	Start															
	End															
10	Start															
	End															
11	Start															
	End															
12	Start															
	End															
13	Start															
	End															
14	Start															
	End															
15	Start															
	End															
16	Start															
	End															

Remarks:
1. Inner Infiltration Rate: $V_{IR} = \Delta V_{IR} / (A_{IR} * \Delta t)$ Annular space infiltration rate: $V_A = \Delta V_A / (A_A * \Delta t)$
2. Applicable to relatively UNIFORM FINE-GRAINED SOIL, with low to moderate ring penetration, and without fat clay and gravel-size particles.
3. Test should be conducted ABOVE ground water level.
4. NOT for very pervious or impervious soil (k should be within 10^{-6} to 10^{-2} cm/s). NOT for dry or stiff soil that fractures easily.
5. NOT able to determine coefficient of permeability *k* directly.



Incremental Infiltration Rate (cm/h)
Elapsed Time (Minutes)
0
2
4
6
8
10
12
0
20
40
60
80
100
120
Inner
Annular
Average
Test 4
Test Pit 4 @ 4.5 ft