PAVEMENT JUSTIFICATION REPORT
KAMEHAMEHA V HIGHWAY (ROUTE 450)
KAWELA BRIDGE REPLACEMENT
ISLAND OF MOLOKAI, HAWAII

W.O. 5909-00(B) OCTOBER 5, 2010

Prepared for

KAI HAWAII, INC.

ROBIN M. LIM
LICENSED PROFESSIONAL ENGINEER
No. 8436-C
HAWAII, U.S.A.

THIS WORK WAS PREPARED BY
ME OR UNDER MY SUPERVISION.

4-30-12

SIGNATURE 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 5, 2010
W.O. 5909-00(B)

Mr. Michael Hunnemann
KAI Hawaii, Inc.
31 North Pauahi Street, Second Floor
Honolulu, HI 96817

Dear **Mr. Hunnemann:**

Geolabs, Inc. is pleased to submit our report entitled "Pavement Justification Report, Kamehameha V Highway (Route 450), Kawela Bridge Replacement, Island of Molokai, Hawaii" prepared specifically for the design of pavements.

Our work was performed in general accordance with the scope of services outlined in our revised fee proposal dated September 13, 2005.

Detailed discussion and specific design recommendations for the pavements 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.

Robin M. Lim, P.E.
Vice President

RML:RP:as

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Hawaii • California

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PAVEMENT JUSTIFICATION REPORT

KAMEHAMEHA V HIGHWAY (ROUTE 450)

KAWELA BRIDGE REPLACEMENT

ISLAND OF MOLOKAI, HAWAII

W.O. 5909-00(B) OCTOBER 5, 2010

SUMMARY OF FINDINGS AND RECOMMENDATIONS

New pavements will be constructed as part of the bridge replacement project to transition from the existing pavements to the new bridge structure. Based on our field exploration, we anticipate that majority of the pavement subgrade soils will likely consist of silty sand. Typically, new DOT pavements include a drainage layer to facilitate drainage and increase the pavement life. However, the existing road does not have a drainage layer or a drainage system to collect and discharge subsurface water. Incorporating a drainage layer below the two short sections of new pavements would not be feasible. In addition, if a drainage layer is included in the new pavement section, the build-up of subsurface water within the permeable base layer may result in saturated soil conditions, which could increase the potential for slope instability. Therefore, we have considered only pavement structural sections without a permeable drainage layer in our analyses.

Based on the traffic data provided and the R-value of the subgrade soils (R-value=48), we recommend using a flexible pavement structural section consisting of 3 inches of AC on 4 inches ACB over 6 inches of ASB for the new pavement. In addition, for the temporary detour road, we recommend using a flexible pavement structural section consisting of 2.5 inches AC over 6 inches of AB.

One of the primary distress mechanisms in pavement structures is pumping due to saturation of the base, subbase, and/or subgrade soils. Therefore, the pavement surface should be sloped, and drainage gradients should be maintained to carry surface water off the pavement to appropriate drainage structures. The text of this pavement justification report should be referred to for detailed discussion and specific pavement design recommendations for the replacement bridge project.

END OF SUMMARY OF FINDINGS AND RECOMMENDATIONS

SECTION 1. GENERAL

1.1 Introduction

This pavement justification report presents the results of our analyses performed for the design of new pavements for the *Kawela Bridge Replacement* project on the Island of Molokai, Hawaii. The project location and general vicinity are shown on the Project Location Map, Plate 1.

This report summarizes the findings from our field exploration and presents our geotechnical recommendations derived from our analyses for the design of pavements only. The findings and recommendations presented herein are subject to the limitations noted at the end of this report.

1.2 Project Considerations

The project site is along Kamehameha V Highway (Route 450) at Milepost(MP) 5.110 to MP 5.118 on the Island of Molokai, Hawaii. Based on the information provided, the existing Kawela Bridge was built in 1940. The existing bridge, measuring 46 feet long by 26 feet wide, serves both the inbound and outbound traffic on Kamehameha V Highway. The existing bridge is supported by two abutments and one intermediate pier in relatively good condition.

Based on field observations, Kawela Stream was relatively active with fast flowing shallow water. The bridge appears to be low, and the opening from the bottom of the bridge to the water surface was about 2 feet at the time of our site visit. We understand that the stream overflows and floods the bridge and surrounding area during the rainy season. Both upstream and downstream banks are heavily vegetated and numerous cobbles and boulders were observed on the streambed. We understand that the existing bridge is hydraulically inadequate and does not conform to current State of Hawaii, Department of Transportation (HDOT) and Federal Highway Administration (FHWA) design and seismic standards.

We understand the current design concept involves demolishing the existing bridge and replacing it with an 80-foot long by 40-foot wide new single-span concrete bridge with a bikeway/pedestrian walkway that will meet current HDOT and FHWA standards. In addition, a detour road using pipe culverts at the stream crossing will be installed to allow traffic to traverse around the bridge construction area.

As part of the project, a portion of the roadway pavement will be reconstructed to transition from the existing roadway to the new bridge structure. Therefore, this pavement justification report was prepared for the design of new pavements.

END OF GENERAL

SECTION 2. SITE CHARACTERIZATION

2.1 Regional Geology

The Island of Molokai was built by the extrusion of basaltic lava flows from two shield volcanoes during the early to middle Pleistocene Epoch. The two shield volcanoes comprising the Island of Molokai are known as East Molokai Mountain and West Molokai Mountain. The new bridge project site is located on the southeastern flank of the East Molokai Mountain.

The East Molokai Mountain was originally a typical elongated basaltic/andesitic shield-shaped dome. It was built over the northwest and east-trending rifts, with a steep slope on the north side where the lava flows plunged into deep water, and a gentle slope on the west side where the lava flows banked against the West Molokai dome.

During the Pleistocene Epoch (Ice Age), many sea level changes occurred as a result of widespread glaciation in the continental areas of the world. As the great continental glaciers advanced and accumulated, the level of the ocean fell due to a lower quantity of water available to fill the oceanic basins. Conversely, as the glaciers receded, or melted, global sea levels rose because of the increase in available water. The land mass of the Island of Molokai remained essentially stable during these changes, and the fluctuations were eustatic in nature. These glacio-eustatic fluctuations resulted in stands of the sea that were both higher and lower relative to the present sea level on Molokai.

The processes of erosion and deposition were affected by these glacio-eustatic sea level fluctuations. When the sea level was low, the erosional base level was correspondingly lower, and valleys were carved to depths below the present sea level. When the sea level was high, the erosional base level was raised such that sediments accumulated at higher elevations.

In the mountainous regions of the Island of Molokai, the erosional processes are dominated by detachment of soil and rock masses from the valley walls that are transported down slope toward the axis of a valley primarily by gravity as colluvium. Once these materials reach the stream in the central portion of a valley, alluvial processes become dominant, and the sediments are transported and deposited as alluvium.

In general, stream flows are intermittent and flashy, such that the stream flows transmit large volumes of water for very short duration. Because of this, 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 material. Chemical processes also cause induration, or cementation, of the coarse-grained portion of the sediment resulting in 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 materials, which are transported down slope, 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.

2.2 Site Description

The project site is at Kamehameha V Highway (Route 450) between MP 5.110 to MP 5.118 on the Island of Molokai, Hawaii. The existing bridge, which spans across Kawela Stream, is a two-lane, two-span concrete structure supported by two abutments and one intermediate pier. The bridge measures 46 feet long by 26 feet wide. The bridge center pier, abutments and wing walls are of cement rubble masonry (CRM) and concrete construction.

Based on the topographic survey, the existing bridge deck elevations range from about +6 to +7 feet Mean Sea Level (MSL). At the time of our field exploration, we observed relatively fast following shallow water in the stream. The opening between the bottom of the bridge to the water surface was approximately 2 feet.

2.3 Subsurface Conditions

Our field exploration program consisted of drilling and sampling four borings, designated as Boring Nos. 1 through 4, near the proposed bridge location extending to depths of about 72 and 77 feet below the existing ground surface. The approximate boring locations are shown on the Site Plan, Plate 2.

In general, the borings encountered a layer of surface fill that primarily consisted of very dense silty sand extending to depths of about 5 feet below the existing grade. The surface fill was underlain by lagoonal deposit. The lagoonal deposit consists of very loose to loose sand and gravel extending to about 55 feet below the existing ground surface. Below the lagoonal deposit, our borings encountered very dense alluvial deposits consisting of cobbles and boulders. The alluvial deposit extended to the maximum depths drilled of approximately 77 feet below the existing ground surface.

We encountered groundwater in our borings at depths of about 5 feet below the existing ground surface at the time of our field exploration. It should be noted that groundwater levels are expected to fluctuate depending on tides, seasonal rainfall, time of year, surface runoff, and other factors. Considering that the bridge is adjacent to a stream, the groundwater level will vary in response to the water level in the stream.

END OF SITE CHARACTERIZATION

SECTION 3. DISCUSSION AND RECOMMENDATIONS

As part of the bridge replacement project, new pavements will be constructed to transition from the existing roadway to the new bridge structure. Typically, new DOT pavements include a drainage layer to facilitate drainage and increase the pavement life. However, the existing road does not have a drainage layer or a drainage system to collect and discharge subsurface water. Incorporating a drainage layer below the two short sections of new pavements would not be feasible. Also, if a drainage layer is included in the new pavement section, the build-up of subsurface water within the permeable base layer may result in saturated soil conditions, which could increase the potential for slope instability. Therefore, we have considered only pavement structural sections without a permeable drainage layer in our analyses.

3.1 Methodology of Pavement Design

Two types of pavement structural sections (flexible and rigid pavements) were considered in the pavement analyses for this project. The flexible pavement sections presented herein were generally determined based on the methodology described in Chapter 3 of the revised Pavement Design Manual dated March 2002. The Pavement Design Manual was prepared by the State of Hawaii - Department of Transportation, Highways Division, Material Testing and Research Branch. The pavement design methodology is based on the Hveem Stabilometer method developed and used by the California Department of Transportation (Caltrans).

The design procedures for the rigid pavement sections are generally based on the design procedures described in the Portland Cement Association “Thickness Design for Concrete Highway and Street Pavements” in addition to the revised Pavement Design Manual mentioned above.

3.2 Design Traffic Loading Conditions/Traffic Index

Based on the design guidelines from the revised Pavement Design Manual dated March 2002, portions of Kamehameha V Highway (Route 450) within the project area may be classified as a “Low Volume Paved” roadway. Therefore, pavements will need to be designed for a pavement life of 20 years. Design traffic parameters were provided by the State of Hawaii - Department of Transportation, Highways Division. A copy of the design traffic parameters provided for use in our pavement analyses is presented as Plate B-1 in Appendix B. The following table summarizes the design traffic parameters used in our pavement analyses.

DESIGN TRAFFIC PARAMETERS	
Design Period	20 Years
Average Daily Traffic (ADT) Year 2008 Year 2028	Vehicles per day per direction 1,850 2,600
24-Hour Truck Traffic	3.5%
Type of Axle	Truck Traffic Distribution
2-axle	78.19%
3-axle	8.59%
4-axle	8.59%
5-axle	4.63%
6-axle	0%
7-axle	0%

Based on a design period of 20 years, the provided traffic volume, and the assumed truck distribution, a Traffic Index (TI) of 7.5 has been determined for portions of Kamehameha V Highway (Route 450) within the project area. Detailed analyses on the Traffic Index Determination are presented on Plate B-2.

3.3 Design Subgrade Conditions

Based on our field exploration, we anticipate that majority of the pavement subgrade soils will generally consist of dense silty sand. Laboratory Resistance (R) Value test was conducted on the near-surface soil, and obtained a value of 48.

We performed our pavement designs based on an R-value of 48 for the pavement subgrade soils in our pavement design analyses. If site grading exposes soils other than those assumed in the pavement design, additional tests should be performed to confirm and/or revise the recommended pavement section for actual field conditions.

3.4 Design Pavement Section

Based on the information provided, we understand that a drainage system (catch basins, inlets, pipes, swales, etc.) does not exist at or near the project site. In addition, a drainage layer is not present below the existing pavement section. The revised Pavement Design Manual requires a highly permeable drainage layer below the pavements unless the site has a very low annual rainfall or the site consists of pavement subgrades that are free-draining (permeability greater than 100 feet per day). The project site is not in a low rainfall environment and the pavement subgrade soils are not free-draining; therefore, according to the design manual, a drainage layer should be incorporated into the pavement section.

Since an existing drainage system is not present at or near the project site and a drainage layer is not present below the existing pavements, daylighting subsurface water from the drainage layer below the new pavements is infeasible. To daylight the subsurface water, we envision that additional infrastructure work will be required to incorporate a drainage layer into the new pavements. We believe that it is not feasible to incorporate a drainage layer into two very short sections of the highway. In addition, a drainage layer included in the new pavement section would result in a build-up of subsurface water within the drainage layer. The subsurface water would likely cause saturated soil conditions that could increase the potential for instability of the adjacent slopes; therefore, the new pavements with a drainage layer were not included in our pavement analyses.

Due to the high rainfall in the area, asphalt concrete base (ACB) should be used as the base material to facilitate the performance of pavement construction work in a timely manner. Detailed analyses and calculations for the three pavement design options are presented on Plates B-3 through B-5 in Appendix B.

OPTION 1

Flexible Pavement

3.0-Inch Asphaltic Concrete
4.0-Inch Asphalt Concrete Base (92 Percent Relative Compaction)
6.0-Inch Aggregate Subbase (95 Percent Relative Compaction)
13.0-Inch Total Pavement Thickness on Compacted Subgrade

OPTION 2

Flexible Pavement

3.0-Inch Asphaltic Concrete
5.5-Inch Asphalt Concrete Base (92 Percent Relative Compaction)
8.5-Inch Total Pavement Thickness on Compacted Subgrade

OPTION 3

Rigid Pavement

7.5-Inch Portland Cement Concrete
6.0-Inch Aggregate Subbase (95 Percent Relative Compaction)
13.5-Inch Total Pavement Thickness on Compacted Subgrade

An economic analysis was performed on the above three pavement structural sections presented above to evaluate the initial construction cost and life cycle cost of the pavement sections presented. Based on our cost comparisons of the pavement design options, Option 1 is the most economical solution for the Kawela Bridge Replacement project. Therefore, we recommend using the Option 1 pavement section for the new Kawela Bridge pavement design. Detailed economic analyses for the three pavement design options are presented on Plates B-6 through B-8.

Based on the current design concept, we understand that a temporary detour road will be provided prior to the construction of the new Kawela Bridge Replacement. We assumed that a design period of approximately 1 year with similar subgrade soil conditions will be used to design the temporary detour road pavement section. The following pavement section design may be used for the temporary detour road.

Temporary Detour Road

Flexible Pavement

2.5-Inch Asphaltic Concrete
6.0-Inch Asphalt Base Course (95 Percent Relative Compaction)
8.5-Inch Total Pavement Thickness on Compacted Subgrade

The subgrade soils below the pavement areas should be moisture-conditioned to above the optimum moisture and compacted to at least 95 percent relative compaction. CBR and density tests should be performed on the actual subgrades soils encountered during construction to confirm the adequacy of the above sections.

3.5 Subgrade Preparation Below Pavement Section

We anticipate that majority of the new pavements will be constructed generally in a cut condition. In general, the area within the contract grading limits should be cleared and grubbed thoroughly at the on-set of earthwork. To reduce the potential for contaminating the excavated materials, vegetation, debris, deleterious material and other unsuitable materials should be removed and disposed properly off-site or in a designated area.

Soft and yielding areas encountered during clearing and grubbing below areas designated to receive fill or future improvements should be over-excavated to expose stiff and/or dense materials. The resulting excavation should be backfilled with aggregate subbase materials. The excavated soft and/or organic soils should be properly disposed off-site.

After clearing and grubbing, the future pavement areas should be excavated, where necessary, to the pavement subgrade level (i.e., bottom of the aggregate subbase course layer). The pavement subgrade soils should be scarified to a depth of about 8 inches, moisture-conditioned to above the optimum moisture content, and compacted to no less than 95 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 AASHTO T 180 (ASTM D 1557). Optimum moisture is the water content (percentage by dry weight) corresponding to the maximum dry density.

If the subgrade soils are pumping during subgrade preparation, the pumping subgrade conditions may be stabilized by using cement treatment. As a guide, stabilization by cement treatment may consist of one sack of cement for approximately 25 square feet of subgrade area. Geolabs should be contacted to evaluate the pumping subgrade conditions and to evaluate whether the pavement sections need to be revised and/or modified based on the exposed subgrade conditions.

Where shrinkage cracks are observed after compaction of the subgrade, we recommend scarifying the soils and preparing again as recommended above.

Saturation and subsequent yielding of the exposed subgrade due to inclement weather and poor drainage may require over-excavation of the soft areas and replacement with well-compacted fill. Contract documents should include additive and deductive unit prices for over-excavation and compacted fill placement to account for variations in the over-excavation quantities.

3.6 Fill Materials

In general, the excavated on-site materials may be re-used as a source of general fill material. Imported fill materials, if required, should consist of non-expansive select granular material, such as crushed coralline or basaltic materials. The materials should be well graded from coarse to fine with particles no larger than 3 inches in largest dimension and should contain between 10 and 30 percent particles passing the No. 200 sieve. The materials should have a laboratory CBR value of 20 or more and should have a maximum swell of 1 percent or less. Imported fill materials should be tested for conformance with these recommendations prior to delivery to the project site for the intended use.

3.7 Compaction Requirements

In general, fill and backfill materials should be moisture-conditioned to above the optimum moisture content, placed in level lifts not exceeding 8 inches in loose thickness, and compacted to a minimum of 95 percent relative compaction. Aggregate subbase materials required for the new pavements should conform to the requirements stipulated in Subsection 703.17 of the State of Hawaii, Standard Specifications for Road and Bridge Construction (HSS). The aggregate subbase should be moisture-conditioned to above the optimum moisture content, placed in 8-inch level loose lifts, and compacted to no less than 95 percent of the maximum dry density according to AASHTO T 180.

Asphalt concrete base (ACB) material should consist of asphalt-treated basaltic aggregates, placed in a layer not to exceed 6 inches in compacted thickness, and compacted to at least 92 percent of the maximum theoretical specific gravity in accordance with AASHTO T 209 (ASTM D 2041).

Asphaltic concrete (AC) material should be constructed in general accordance with Section 401 – Hot Mix Asphalt Pavement of the State of Hawaii, Standard Specifications for Road and Bridge Construction (2005) and subsequent amendments.

Field density tests should be performed on the compacted fills and backfills in general accordance with ASTM D 1556. In general, field density tests should be performed at the frequencies presented in the following table.

Material	Location of Material	Test Frequency
Treated Base	Pavements & Shoulders	One test per 100 lineal feet of roadway per lift.
Aggregate Subbase	Pavements & Shoulders	One test per 100 lineal feet of roadway per lift.
Subgrade (Silty Clays/Sands)	Pavements & Shoulders	One test per 100 lineal feet of roadway per lift.
Trench Backfill	Utility Trenches	One test per 200 lineal feet of trench per lift of backfill.

3.8 Pavement Drainage

One of the primary distress mechanisms in pavement structures is pumping due to saturation of the base, subbase, and/or subgrade soils. Therefore, special attention should be given to the surface drainage of the pavements.

As mentioned above, no existing drainage system and drainage layer below the existing pavements is present at the site. The Pavement Design Manual requires the incorporation of a drainage layer into new pavements. Additional infrastructure work (such as new drain lines and inlets) would be necessary to incorporate a drainage layer into two short sections of new pavements. We believe this would not be feasible and that it would result in a build-up of subsurface water within the drainage layer. The subsurface water would likely cause saturated soil conditions, which could increase the potential for instability of the adjacent slopes.

Therefore, it is essential to slope the pavement surface and to maintain the drainage gradients so that surface water may be carried off the pavement to appropriate drainage structures. 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 proposed construction should be forwarded to Geolabs for review and written comments prior to bid advertisement. This review is necessary to evaluate general conformance of the plans and specifications with the intent of the pavement design recommendations provided herein. If this review is not made, Geolabs cannot be responsible for misinterpretation of our recommendations.

3.10 Construction Monitoring

It is recommended to retain Geolabs for geotechnical engineering services during construction. The critical items of construction monitoring that require "Special Inspection" include observation of the subgrade preparation. This is 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. The recommendations provided herein are contingent upon such observations.

If the actual exposed subsurface conditions encountered during construction are different from those assumed or considered in this report, then appropriate design modifications should be made.

END OF DISCUSSION AND RECOMMENDATIONS

SECTION 4. LIMITATIONS

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

The boring locations are approximate, having been estimated by taping from reference points and visible features shown the Site Plan transmitted by Austin, Tsutsumi & Associates, Inc. on June 25, 2008. Elevations of the borings were interpolated between the spot elevations shown on the site plan. The physical locations of the field borings should be considered accurate only to the degree implied by the methods used.

The stratification lines shown on the graphic representations of the borings depict the approximate boundaries between soil/rock types and, as such, may denote a gradual transition. Water level data from the borings were measured at the times shown on the graphic representations and/or presented in the text herein. These data have been reviewed and interpretations made in the formulation of this report. However, it must be noted that fluctuation may occur due to variation in tides, rainfall, temperature, and other factors.

This report has been prepared for the exclusive use of KAI Hawaii, Inc. for specific application to the *Kawela Bridge Replacement* project on the Island of Molokai 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 preparation of the design drawings related to the pavements only. Therefore, this report may not contain sufficient data, or the proper information for use in forming a basis for the preparation of construction cost estimates or contract bidding. 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 subsurface conditions are commonly encountered. Unforeseen subsurface conditions, such as perched groundwater, soft deposits, hard layers, or cavities, 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.

END OF LIMITATIONS

CLOSURE

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

-ΩΩΩΩΩΩΩΩΩ-

Respectfully submitted,

GEOLABS, INC.

By ______________________

Robin M. Lim, P.E.
Vice President

RML:RP:as

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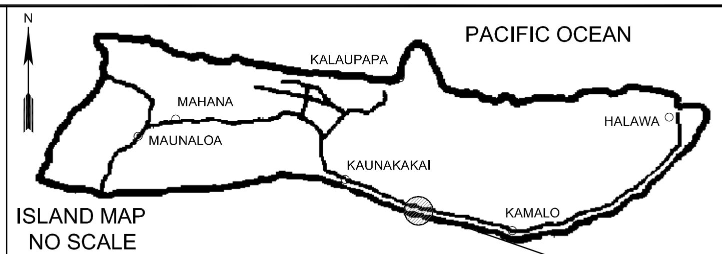
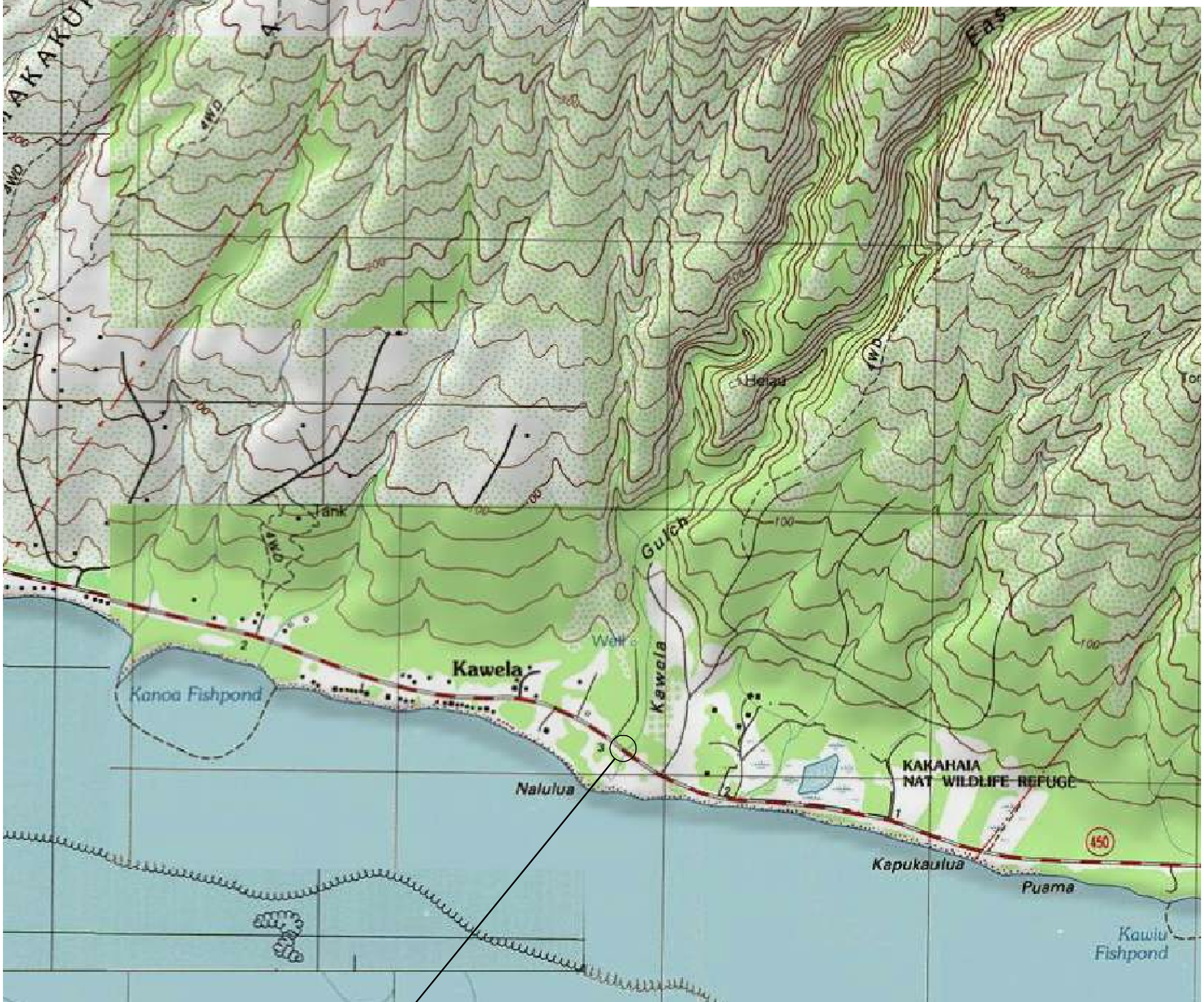
PLATES



GENERAL PROJECT LOCATION »



PROJECT LOCATION »

PROJECT LOCATION MAP

KAMEHAMEHA V HIGHWAY
KAWELA BRIDGE REPLACEMENT
MP 5.110 TO MP 5.118
ISLAND OF MOLOKAI, HAWAII

.5 0 1 km

GRAPHIC SCALE

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REFERENCE: MAP CREATED WITH TOPO!® ©2001 NATIONAL GEOGRAPHIC (WWW.NATIONALGEOGRAPHIC.COM/TOPO).

GEOLABS, INC.

Geotechnical Engineering

DATE	DRAWN BY	PLATE
OCTOBER 2008	HYC	
SCALE	W.O.	
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User: JLP File Created: August 26, 2008 File Last Updated: October 16, 2008 11:54:52am
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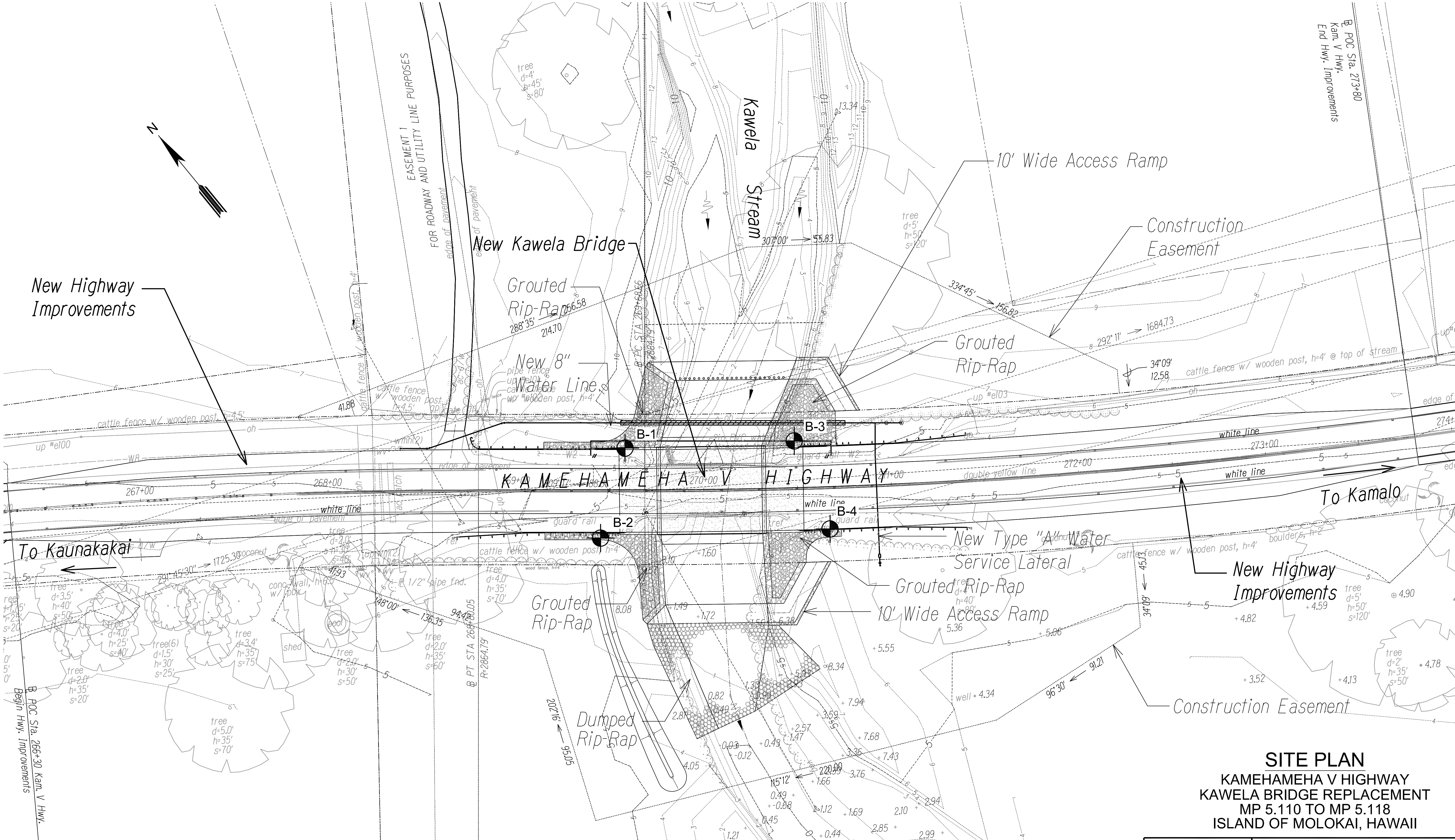

SITE PLAN

KAMEHAMEHA V HIGHWAY
KAWELA BRIDGE REPLACEMENT
MP 5.110 TO MP 5.118
ISLAND OF MOLOKAI, HAWAII

LEGEND:

APPROXIMATE BORING LOCATION

0 10 20 30 40 50 100 150 FT.

GRAPHIC SCALE

REFERENCE: GENERAL PLAN TRANSMITTED BY AUSTIN, TSUTSUMI & ASSOCIATES, INC. ON JUNE 25, 2008.

GEOLABS, INC.
Geotechnical Engineering

DATE	DRAWN BY	PLATE
OCTOBER 2008	JRP	2
SCALE	W.O.	
1" = 50'	5909-00(B)	

CAD User: JJP File Last Updated: October 16, 2008 1:35:47pm Plot Date: October 17, 2008 - 9:22:08am
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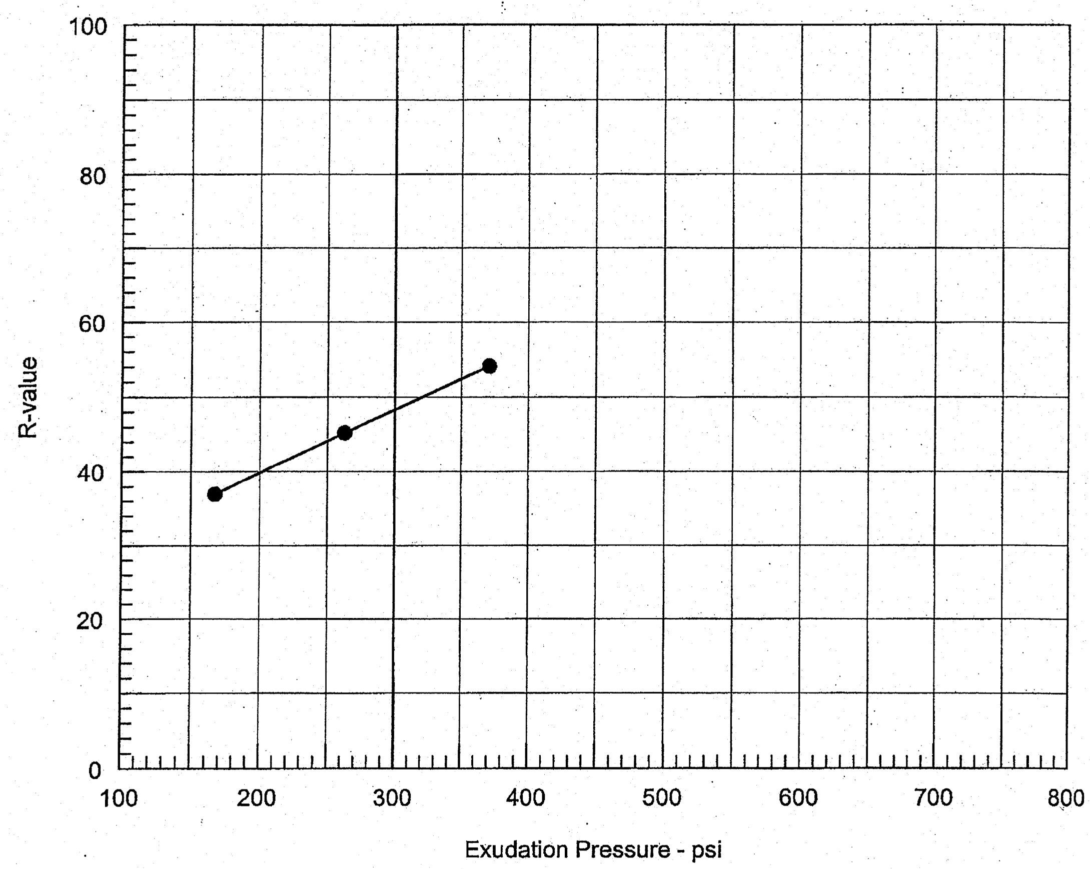
APPENDIX A

APPENDIX A

Laboratory Tests

One laboratory Resistance (R) Value test (ASTM D 2844) was performed by Signet Testing Labs on a selected bulk sample of the near-surface soils to evaluate the pavement support characteristics of the soils. The test result is presented on Plate A.

R-VALUE TEST REPORT



Resistance R-Value and Expansion Pressure - ASTM D 2844

No.	Compact. Pressure psi	Density pcf	Moist. %	Expansion Pressure psi	Horizontal Press. psi @ 160 psi	Sample Height in.	Exud. Pressure psi	R Value	R Value Corr.
1	215	100.9	22.1	0.85	48	2.53	371	54	54
2	105	99.4	23.9	0.39	70	2.47	167	37	37
3	160	100.0	23.0	0.61	60	2.51	263	45	45

Test Results	Material Description
R-value at 300 psi exudation pressure = 48	Reddish brown silt, Sample-1, sample received 5/28/2008

Project No.: 0007653

Project:

Location: Kamehameha V Hwy Kawela Bridge Replacement MP5.110 to MP5.118

Sample Number: L11916

Date: 6/4/2008

R-VALUE TEST REPORT

SIGNET TESTING LABS, INC.

Tested by: DTN

Checked by: LKL

Remarks:

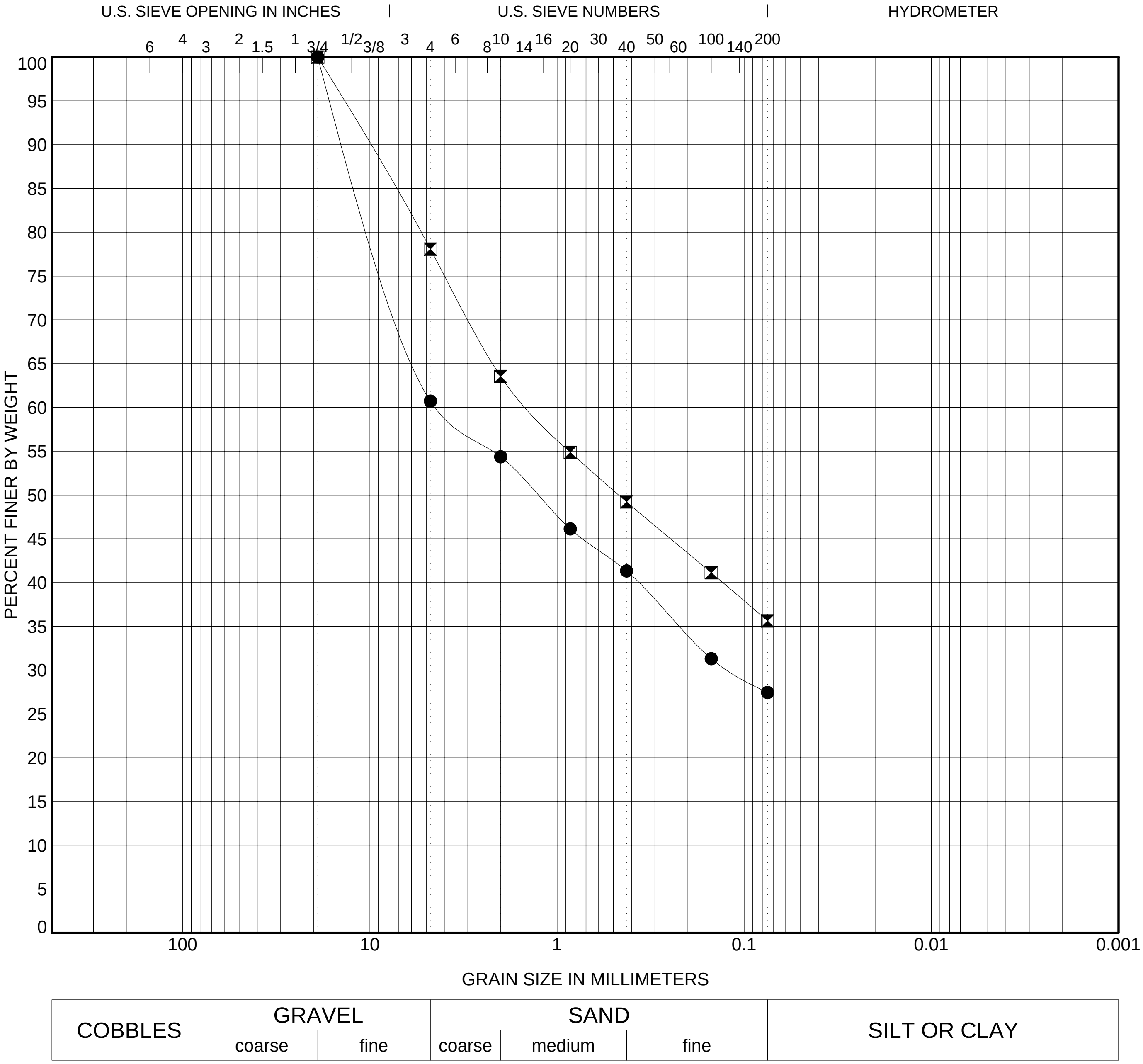
Sample-1

#5909-00

W.O. 5909-00(B)

PLATE A

APPENDIX B



	Sample	Depth (ft)	Description	LL	PL	PI	Cc	Cu
●	B-1	22.0-23.5	Gray silty gravel (GM) with some sand					
⧗	B-3	27.0-28.5	Gray silty sand (SM) with gravel					

	Sample	Depth (ft)	D100 (mm)	D60 (mm)	D30 (mm)	D10 (mm)	%Gravel	%Sand	%Fine
●	B-1	22.0-23.5	19	4.315	0.119		39.3	33.3	27.4
⧗	B-3	27.0-28.5	19	1.412			21.9	42.5	35.6

G_GRAIN SIZE 5909-00.GPJ GEOLABS.GDT 10/17/08

GEOLABS, INC.

GEOTECHNICAL ENGINEERING

W.O. 5909-00(B)

GRAIN SIZE DISTRIBUTION - ASTM C 136

KAMEHAMEHA V HIGHWAY
KAWELA BRIDGE REPLACEMENT
MP 5.110 TO MP 5.118
ISLAND OF MOLOKAI, HAWAII

Plate
B - 1

TRAFFIC INDEX DETERMINATION

Project: Kawela Bridge Replacement
Molokai, Hawaii

Street Name: Kamehameha V Highway

(1)	Design Period (years)	20
(2)	Current Average Daily Traffic (ADT) Per Direction	925
(3)	Future Average Daily Traffic (ADT) Per Direction	1300
(4)	Average ADT Per Direction Over Design Period	1112.5
(5)	Design Lane Factor	1

Number of Lanes In One Direction	Design Lane Factor
1	1
2	1
3	0.8
4	0.75

(6) 24-Hour Truck Traffic, T_{24} (%) 3.5

Truck Traffic Distribution :

2-axle	=	78.19%
3-axle	=	8.59%
4-axle	=	8.59%
5-axle	=	4.63%
6-axle	=	0.00%
7-axle	=	0.00%

(7) Average Daily Truck Traffic Per Direction, ADTT 39

(8) Equivalent 18-kip Single Axle Loads, ESAL

2-axle : % of 2-axle trucks x No. trucks x 65	=	1979
3-axle : % of 3-axle trucks x No. trucks x 525	=	1756
4-axle : % of 4-axle trucks x No. trucks x 1162	=	3887
5-axle : % of 5-axle trucks x No. trucks x 1462	=	2636
6-axle : % of 6-axle trucks x No. trucks x 968	=	0
Annual ESAL :	=	10257
Total ESAL For Design Period	=	205144
TRAFFIC INDEX (TI) = 9 (ESAL/1,000,000)EXP(0.119)		7.45
	SAY	7.5

Project: Kawela Bridge Replacement
Molokai, Hawaii

Street: Kamehameha V Highway

Design Parameters

Traffic Index	7.5
R value of ACB	90
R value of ASB	60
R value of Subgrade	48

Pavement Section using Asphalt Concrete Base and Aggregate Subbase

Trial Thickness of AC + ACB 7 Inches

(1) **Asphalt Concrete (AC)**

GE required						0.240		
GE with Tolerance =	0.240	+	0.240	=		0.480		
Gf of AC						2.140		
GE/Gf	=	2.69			SAY	3.000	Inches	
					USE	3.000	Inches	(min. 2.5")

(2) **Asphalt Concrete Base (ACB)**

GE required	=			0.960		
GE of AC	=			0.295		
GE required of ACB	=			0.665		
Gf of ACB				2.033		
GE/Gf	=	3.93	SAY	4.00	Inches	
			USE	4.00	Inches	(min. 4")

(3) **Calculate New Gf of AC**

Thickness of AC + Thickness of ACB	0.583
New Gf of AC	2.140

(4) **Aggregate Subbase (ASB)**

GE required	=			1.248		
GE of AC	=			0.295		
GE of ACB	=			0.678		
GE required of ASB	=			0.276		
GE less tolerance	=			0.036		
Gf of ASB	=			1.000		
GE/Gf	=	0.43	SAY	6.00	Inches	
			USE	6.00	Inches	(min. 6")

Design Pavement Section

3.0	**Inches**	**AC**
4.0	**Inches**	**ACB**
6.0	**Inches**	**ASB**
13.0	**Inches**	**Total Thickness**

Project: Kawela Bridge Replacement
Molokai, Hawaii

Street: Kamehameha V Highway

Design Parameters

Traffic Index	7.5
R value of ACB	90
R value of Subgrade	48

Pavement Section using Asphalt Concrete Base

Trial Thickness of AC + ACB 8.5 Inches

(1)	**Asphalt Concrete (AC)**							
	GE required					0.240		
	GE with Tolerance =	0.240	+	0.240	=	0.480		
	Gf of AC					2.281		
	GE/Gf	=	2.53		SAY	3.00	Inches	
					USE	3.00	Inches	(min. 2.5")
(2)	**Asphalt Concrete Base (ACB)**							
	GE required	=				1.248		
	GE of AC	=				0.330		
	GE required of ACB	=				0.918		
	Gf of ACB					2.167		
	GE/Gf	=	5.08		SAY	5.50	Inches	
					USE	5.50	Inches	(min. 4")
(3)	**Calculate New Gf of AC**							
	Thickness of AC + Thickness of ACB					0.708		
	New Gf of AC					2.281		

Design Pavement Section

3.0	**Inches**	**AC**
5.5	**Inches**	**ACB**
8.5	**Inches**	**Total Thickness**

Project: Kawela Bridge Replacement
Molokai, Hawaii
Street: Kamehameha V Highway

Rigid Pavement Design

Design Period = 20 years (One-Way Traffic)

	2 Axles		3 Axles		4 Axles		5 Axles		6 Axles		TOTAL		Axle/1000
Single Axle	ADTT=	30	ADTT=	3	ADTT=	3	ADTT=	2	ADTT=	0	ADTT=	39	
Loads (kips)	Factors	Repetition	Factors	Repetition	Factors	Repetition	Factors	Repetition	Factors	Repetition	REPETITIONS		
20-22	69	2101	123	410	709	2372	1515	2732	1289	0		7615	26.789
22-24	48	1464	18	60	893	2987	431	777	2309	0		5288	18.604
24-26	35	1059	8	25	606	2028	34	61	434	0		3174	11.166
26-28	7	204	6	19	230	770	6	11				1003	3.529
28-30	7	204	5	18	229	767	6	11				999	3.516
30-32			5	16	43	143						160	0.561
32-34			5	16	42	140						157	0.552
34-36			5	16	42	140						157	0.552
Tandem Axle Loads (kips)													
30-32			507	1697	406	1358	182	328	434	0		3383	11.903
32-34			370	1239	293	981	208	375				2595	
34-36			105	350	374	1251	133	240				1841	15.606
36-38			105	350	125	419	186	335				1104	
38-40			67	223	84	281	75	136				640	6.136
40-42			30	99	56	187	40	72				358	
42-44					56	187	26	46				233	2.078
44-46					27	91	33	60				151	
46-48			4	13			25	45				58	0.733
48-50			4	13			25	45				58	0.203

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ECONOMIC ANALYSIS OPTION 1

Project: Kawela Bridge Replacement
Molokai, Hawaii

Street: Kamehameha V Highway

OPTION 1: 3" AC Pavement Section with 4" ACB and 6" ASB

New Pavement Section: 3" AC over 4" ACB and 6" ASB (13.0" Roadway Excavation)

Initial Cost

Items	Thickness (inches)	Quantity (cy/sy)	Unit Price	Cost Per Square Yard
AC	3	0.08	$ 300.00	$ 51.75
ACB	4	0.11	$ 300.00	$ 70.67
ATPB	0	0.00	$ 350.00	$ -
CTPB	0	0.00	$ 150.00	$ -
UTPB	0	0.00	$ 60.00	$ -
AB	0	0.00	$ 50.00	$ -
ASB	6	0.17	$ 40.00	$ 6.67
Roadway Excavation	13	0.36	$ 50.00	$ 18.06
			Total Initial Cost	$ 147.14

Maintenance Cost

Year	Items	Thickness (inches)	Quantity (cy/sy)	Present Unit Price	Inflated Unit Price	Inflated Cost Per Sq. Yd.	Present Cost Per Sq. Yd.
10	Cold-Planing	2.0	0.06	$ 72.00	$ 128.94	$ 7.16	$ 4.00
	AC Overlay	2.0	0.06	$ 300.00	$ 537.25	$ 61.78	$ 34.50

Number of Overlay = 1	**Total Maint. Cost**	$	38.50
OPTION 1:	**TOTAL COST**	**$**	**185.64**

ECONOMIC ANALYSIS OPTION 2

Project: Kawela Bridge Replacement
Molokai, Hawaii

Street: Kamehameha V Highway

OPTION 2: **3" AC Pavement Section with 5.5" ACB**

New Pavement Section: 3" AC over 5.5" ACB (8.5" Roadway Excavation)

Initial Cost

Items	Thickness (inches)	Quantity (cy/sy)	Unit Price	Cost Per Square Yard
AC	3	0.08	$ 300.00	$ 51.75
ACB	5.5	0.15	$ 300.00	$ 97.17
ATPB	0	0.00	$ 350.00	$ -
CTPB	0	0.00	$ 150.00	$ -
UTPB	0	0.00	$ 60.00	$ -
AB	0	0.00	$ 50.00	$ -
ASB	0	0.00	$ 40.00	$ -
Roadway Excavation	8.5	0.24	$ 50.00	$ 11.81
			Total Initial Cost	$ 160.72

Maintenance Cost

Year	Items	Thickness (inches)	Quantity (cy/sy)	Present Unit Price	Inflated Unit Price	Inflated Cost Per Sq. Yd.	Present Cost Per Sq. Yd.
10	Cold-Planing	2.0	0.06	$ 72.00	$ 128.94	$ 7.16	$ 4.00
	AC Overlay	2.0	0.06	$ 300.00	$ 537.25	$ 61.78	$ 34.50

Number of Overlay =	1	**Total Maint. Cost**	$ 38.50
OPTION 2:		**TOTAL COST**	**$ 199.22**

ECONOMIC ANALYSIS OPTION 3

Project: Kawela Bridge Replacement
Molokai, Hawaii

Street: Kamehameha V Highway

OPTION 3: 7.5" PCC and 6" ASB

New Pavement Section: 7.5" PCC and 6" ASB (13.5" Roadway Excavation)

Initial Cost

Items	Thickness (inches)	Quantity (cy/sy)	Unit Price	Cost Per Square Yard
PCC	7.5	0.21	$ 400.00	$ 172.50
ACB	0	0.00	$ 300.00	$ -
ATPB	0	0.00	$ 350.00	$ -
CTPB	0	0.00	$ 150.00	$ -
UTPB	0	0.00	$ 60.00	$ -
AB	0	0.00	$ 50.00	$ -
ASB	6	0.17	$ 40.00	$ 6.67
Roadway Excavation	13.5	0.38	$ 50.00	$ 18.75
			Total Initial Cost	$ 197.92

OPTION 3: **TOTAL COST** **$ 197.92**