FED. ROAD DIST. NO.	STATE	FED. AID PROJ. NO.	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
HAWAII	HAW.	STP-7310(1)	2003	7	193

SOILS ENGINEER'S NOTES

1. *Site Preparation* – Prior to the start of actual grading operations, the site should be cleared and grubbed in accordance with Section 201 of the Hawaii Standard Specifications for Road, Bridge, and Public Works Construction (Standard Specifications). All organics, rubbish and other deleterious materials are unsuitable for use as fill and should be wasted off-site.

   After the site has been cleared and grubbed, the lower areas on the western side of the road alignment, between the existing paved roadway and the slopes rising up to the west, should be overexcavated to a depth of 3 feet below the finish road grade, to remove the uncompacted fill in this area. The overexcavation of uncompacted fill will likely be required throughout the new traffic lane area from about Road Sta. 10+00 to Sta. 35+00. The excavated materials may be stockpiled for re-use as fill provided all over-sized material, organics, rubbish, and other deleterious materials are removed in accordance with the Grading recommendations.

2. *Site Grading* – Once the site has been prepared, grading operations may begin to generate the planned finished grades.

   The majority of the excavations required for the retaining wall construction can probably be accomplished with conventional earthmoving equipment. The occasional use of rock excavating equipment, such as hoerams or large, ripper-equipped dozers, should be anticipated to facilitate the removal of massive tuff near the intersection of Salt Lake Boulevard, and random seams of cemented cinders and moderately weathered tuff in the remaining areas.

   The excavated on-site soils may be used as fill or backfill provided they are placed and compacted in accordance with these recommendations. The excavated tuff may also be used as fill or backfill provided it is crushed sufficiently to conform to the gradation requirements indicated below for imported fill.

   The exposed subgrade in areas to receive fill or structural units, including the overexcavated area resulting from the removal of the uncompacted fill, should be scarified, moisture-conditioned to within 3 percent of the optimum moisture content, and uniformly compacted to at least 90 percent of the soil's maximum dry density as by Laboratory Compaction Test AASHTO T-180, for a minimum depth of 6 inches prior to any fill placement or future construction. Where the exposed subgrade is within 3 feet of the planned finish pavement level, it should be compacted to at least 95 percent relative compaction prior to any fill placement.

   Should imported fill be required, it should conform to Section 703.17 of the Standard Specifications and should have a California Bearing Ratio (CBR) greater than 25 when tested in accordance with AASHTO T-193.

   Fill and backfill should be placed in uniform lifts of no more than 8 inches in loose thickness, moisture-conditioned to within 3 percent of the optimum moisture content, and uniformly compacted to at least 95 percent relative compaction as determined by the above-referenced test.

   Temporary excavations within the cinders which will be required for the retaining wall construction should be sloped back no steeper than 1.5H:1.0V for heights of up to 25 feet, or else shored and braced by the contractor. Permanent cut slopes within the massive tuff exposed at the southwestern corner of the intersection of Puuloa Road and Salt Lake Boulevard, may be sloped as steep as 0.5H:1.0V for heights of up to 20 feet. Slopes exceeding these heights are not anticipated at this time and should be individually evaluated, should they occur.

3. *Retaining Wall* – We believe that the proposed retaining wall can be adequately supported on a continuous strip footing bearing upon properly compacted fill, the medium dense to dense cinders, or the weathered tuff where it may be designed for an allowable bearing capacity of 4,500 p.s.f. This value may be increased by one-third for short-term seismic and wind loads.

   The retaining wall footings should have a minimum base width of 5 feet and should be embedded at least 2.5 feet below the lowest adjacent compacted subgrade on level ground.

   A friction factor of 0.55 may be used at the contact surface between the bottom of the foundations and the on-site soils to resist sliding.

   Keyways cut into the on-site cinders, weathered tuff, or fill placed and compacted in accordance with the grading recommendations may be designed for a passive resistance of 375 pounds per cubic foot (p.c.f.) equivalent fluid pressure. Passive resistance should be disregarded in the top 12 inches of embedment.

   The bottom of the footing excavations should be recompacted to at least 95 percent relative compaction as determined by Laboratory Compaction test AASHTO T-180, prior to the placement of concrete and reinforcing steel. Any soft spots encountered in the foundation excavations should be removed and cleaned out to hard natural ground or compacted fill and the resulting depression backfilled in accordance with the Grading recommendations.

   Steel reinforcement of the foundations should be provided as recommended by the project structural engineer.

   The retaining wall backfill should consist of a well-graded granular fill similar to the on-site cinders. Should imported fill be used as backfill behind the retaining walls, it should conform to the requirements for Aggregate Subbase in Section 703.17 of the Standard Specifications.

   The backfill behind the wall should be placed and compacted in accordance with the Grading recommendations. The backfill should be compacted to at least 90 percent but should not exceed 95 percent relative compaction to minimize the lateral earth pressures against the wall.

   The earth pressures exerted against the wall will depend on the type and slope of the backfill behind the wall. For wall backfill consisting of the on-site cinders or imported fill conforming to the above recommendation, the estimated active earth pressures are summarized in the following table for various slope conditions.

Backfill Slope	Estimated Active Earth Pressure Horizontal (p.c.f.)	Vertical (p.c.f.)
Level	35	0
3.0H:1.0V	45	22
2.0H:1.0V	55	27

   The above earth pressures are given in terms of equivalent fluid pressures and do not include surcharge, foundation, or hydrostatic pressures which must be added, where appropriate.

   Adequate drainage, in the form of weepholes or transverse drains, should be provided behind the walls to minimize the buildup of hydrostatic pressures.

   A. Transverse drains should consist of perforated pipe surrounded by 6 inches of filter gravel, or AASHTO M43 No. 57 Gravel wrapped in non-woven filter fabric.

   B. Should weepholes be used, a continuous strip of filter gravel, or AASHTO M43 No. 57 Gravel wrapped in filter fabric, measuring at least 12 inches thick by 12 inches in height, should be placed behind the weepholes.

   C. Filter Gravel should conform to Section 703.18 of the Standard Specifications. Non-woven filter fabric should conform to Section 716.03 of the Standard Specifications.

   Estimated total settlements of 0.8 inch and estimated differential settlements exceeding 0.3 inch per 20 feet of wall length are not anticipated for foundations designed and constructed in accordance withthese recommendations. The wall and its foundations should be designed to tolerate these estimated settlements.

4. *Utilities* – Utilities should be installed in accordance with Sections 206, 603, and 604 of the Standard Specifications, and the appropriate section pertaining to each particular utility. Utility backfills should be placed and compacted utilizing the appropriate mechanical compactors above and around the pipes. Jetting and ponding of the backfill should not be allowed.

   Utility and similar site excavations should be sloped back, or shored and braced, by the contractor in accordance with DOSH or other applicable governmental regulations. The design of temporary excavations and shoring systems shall be the responsibility of the contractor.

   Groundwater was encountered at depths corresponding to about Elev. 2 and Elev. 3 in Borings 6 through 9 of this investigation. Dewatering will be required for utility trenches extending below this level. The design of the dewatering system shall be the responsibility of the contractor.

   Moderately weathered tuff and cemented cinders will likely be encountered within portions of the deeper utility trench excavations. The occasional use of rock excavating equipment should be anticipated to facilitate the removal of the tuff and cemented cinders.

   Utilities may be founded in the properly compacted fill, the medium dense to dense cinders, or the tuff. Where soft spots are encountered at the bottom of utility excavations, they should be removed down to compacted fill or the dense cinders or tuff and the resulting depression replaced with fill compacted in accordance with the grading recommendations. Should boulders or intact tuff be encountered at the pipe invert level, they should be removed in accordance with the Standard Specifications to allow placement of the required Bed Course Material. The Bed Course Material should conform to Section 703.16 of the Standard Specifications.

5. *Miscellaneous* – Positive drainage provisions should be provided to channel surface waters away from the retaining walls and pavements and preclude the ponding of water adjacent to or beneath the retaining wall, its foundations, and the road pavements. The on-site soils are highly susceptible to erosion. Erosion protection, such as seeding, hydro-mulching, or erosion mats, should be provided as soon as practical after the completion of the grading to minimize erosion within the graded slopes.

BARRY K. MURANAKA LICENSED PROFESSIONAL ENGINEER No. 8418-C HAWAII, U.S.A.

THIS WORK WAS PREPARED BY ME OR UNDER MY SUPERVISION

Expiration Date of the License: 04/30/04

STATE OF HAWAII
DEPARTMENT OF TRANSPORTATION
HIGHWAYS DIVISION

GEOTECHNICAL NOTES

PUULOA ROAD IMPROVEMENTS
Kamehameha Hwy. to Salt Lake Blvd.
Federal Aid Project No. STP-7310(1)

Scale: As shown Date: May 2003

SHEET NO. 7 OF 193 SHEETS

7

P.M.: STY
CURRENT OPR: rki
PREV. OPR:
CURRENT TIME: May 09, 2003 - 2:20pm
LAST SAVED BY:
LAST MODIFIED: Thu, 08 May 2003 - 10:06am

PREFIX: G:\DOTH9601A\ACAD\
FILE: FGE1.DWG
BEGIN: 12/01/99
SCALE: 1=1

ORIGINAL PLAN	DATE
NOTEBOOK	SURVEY PLOTTED BY
No.	DRAWN BY
	TRACED BY
	DESIGNED BY
	QUANTITIES BY
	CHECKED BY

FED. ROAD DIST. NO.	STATE	FED. AID PROJ. NO.	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
HAWAII	HAW.	STP-7310(1)	2003	8	193

F.G.E. LTD.

BORING: 1 — FILE: 1600.01
PROJECT: PUULOA ROAD WIDENING
LOCATION: MAPUNAPUNA, OAHU, HAWAII — PROJECT ENGINEER: TC
SURFACE ELEVATION: 33' ± — FIELD ENGINEER: TSK
DEPTH TO WATER: NONE ENCOUNTERED — DRAFTED BY: MD
DATE COMPLETED: 3-6-97 — DATE OF DRAWING:

LAB TEST RESULTS	MOIST CONT. %	DRY DEN. PCF	BLOWS PER FT.	SAMPLE	DEPTH	CLASSIFICATION
GRADATION: 48% GRAVEL 40% SAND 12% SILT/CLAY S.E.=62	9		53	1		REDDISH BROWN SILTY GRAVEL (GM) WITH SAND, MEDIUM DENSE, DRY (FILL)
	9	123	48	2	5	DARK GRAY SILTY SAND (SM) WITH GRAVEL, MEDIUM DENSE TO DENSE, DRY (CINDERS)
PH=8.5			55	3		
			96%REC 52%RQD	NX CORE	10	GRAYISH BROWN MODERATELY WEATHERED TUFF (WM), HARD, OCCASIONALLY BROKEN
					15	BOH @ 13.5'
					20	

F.G.E. LTD.

BORING: 2 — FILE: 1600.01
PROJECT: PUULOA ROAD WIDENING
LOCATION: MAPUNAPUNA, OAHU, HAWAII — PROJECT ENGINEER: TC
SURFACE ELEVATION: 27' ± — FIELD ENGINEER: TSK
DEPTH TO WATER: NONE ENCOUNTERED — DRAFTED BY: MD
DATE COMPLETED: 3-6-97 — DATE OF DRAWING:

LAB TEST RESULTS	MOIST CONT. %	DRY DEN. PCF	BLOWS PER FT.	SAMPLE	DEPTH	CLASSIFICATION
S.E.=14	39	72	32	1		BROWN CLAYEY SILT (MH) WITH GRAVEL, STIFF, MOIST (FILL)
GRADATION: 59% GRAVEL 30% SAND 11% SILT/CLAY	24		12	2	5	BROWN SILTY GRAVEL (GM) WITH SAND, LOOSE, MOIST (FILL)
DIRECT SHEAR: Ø=32Ø C=850 PSF 0.8% SWELL LL=49,PI=22 PH=8.1	24	97	17	3		
			23	4	10	GRAYISH BROWN CLAYEY SILT (ML-CL) WITH SAND AND GRAVEL, VERY STIFF TO HARD, DAMP
	26	93	33	5	15	(WEATHERED CINDERS)
						BOH @ 15.0'
					20	

F.G.E. LTD.

BORING: 3 — FILE: 1600.01
PROJECT: PUULOA ROAD WIDENING
LOCATION: MAPUNAPUNA, OAHU, HAWAII — PROJECT ENGINEER: TC
SURFACE ELEVATION: 25' ± — FIELD ENGINEER: TSK
DEPTH TO WATER: NONE ENCOUNTERED — DRAFTED BY: MD
DATE COMPLETED: 3-5-97 — DATE OF DRAWING:

LAB TEST RESULTS	MOIST CONT. %	DRY DEN. PCF	BLOWS PER FT.	SAMPLE	DEPTH	CLASSIFICATION
GRADATION: 25% GRAVEL 59% SAND 16% SILT/CLAY NON-PLASTIC	38		15	1		GRAYISH BROWN SILTY SAND (SM) WITH GRAVEL, LOOSE TO MEDIUM DENSE, MOIST (CINDERS)
GRADATION: 7% GRAVEL 80% SAND 13% SILT/CLAY PH=8.0	34		34	2	5	
	51	79	46	3		BROWN CLAYEY SILT (ML-CL) WITH SAND, HARD, MOIST (WEATHERED CINDERS)
			39/6"	4	10	GRAYISH BROWN HIGHLY WEATHERED TUFF (WH), SOFT
			73	5	15	BOH @ 15.0'
					20	

F.G.E. LTD.

BORING: 4 — FILE: 1600.01
PROJECT: PUULOA ROAD WIDENING
LOCATION: MAPUNAPUNA, OAHU, HAWAII — PROJECT ENGINEER: TC
SURFACE ELEVATION: 33' ± — FIELD ENGINEER: TSK
DEPTH TO WATER: NONE ENCOUNTERED — DRAFTED BY: MD
DATE COMPLETED: 3-3-97 — DATE OF DRAWING:

LAB TEST RESULTS	MOIST CONT. %	DRY DEN. PCF	BLOWS PER FT.	SAMPLE	DEPTH	CLASSIFICATION
NON-PLASTIC	17		17	1		BROWN SILTY GRAVEL (GM) WITH SAND, LOOSE, DAMP (CINDERS)
DIRECT SHEAR: Ø=36Ø C=200 PSF 0.1% SWELL	4	109	30/6" R 8%REC 5%RQD	2 NX CORE	5	
S.E.=63	24		40	3	10	GRAYISH BROWN SILTY SAND (SM) WITH GRAVEL AND OCCASIONAL COBBLES, DENSE, DRY
	27	83	50/6" R	4	15	GRADES TO MOIST
DIRECT SHEAR: Ø=45Ø C=200 PSF 2.0% SWELL	73	55	49	5	20	(CINDERS)
					25	GRAYISH BROWN CLAYEY SILT (ML-CL), HARD, MOIST (COMPLETELY WEATHERED TUFF)
						BOH @ 25.0'
					30	

LEGEND

MAJOR ROCK TYPES: BASALT; TUFF; DECOMPOSED ROCK; CORAL

MAJOR SOIL TYPES: GRAVEL; SAND; SILT; CLAY; PEAT/ORGANICS

SECONDARY CLASSIFICATION: GRAVELLY; SANDY; SILTY; CLAYEY

SAMPLING SYMBOLS: 3" O.D. UNDISTURBED SAMPLE; 3" O.D. DISTURBED SAMPLE; 2" O.D. STANDARD PENETRATION SAMPLE; NO RECOVERY; SHELBY TUBE; BAG SAMPLE; NX-CORE; WATER LEVEL

BARRY K. MURANAKA LICENSED PROFESSIONAL ENGINEER No.8418-C HAWAII, U.S.A.

THIS WORK WAS PREPARED BY ME OR UNDER MY SUPERVISION

Expiration Date of the License: 04/30/04

STATE OF HAWAII
DEPARTMENT OF TRANSPORTATION
HIGHWAYS DIVISION

BORING LOGS

PUULOA ROAD IMPROVEMENTS
Kamehameha Hwy. to Salt Lake Blvd.
Federal Aid Project No. STP-7310(1)

Scale: As shown — Date: May 2003

SHEET NO. 8 OF 193 SHEETS

8

P.M.: STY
CURRENT OPR: rki
PREV. OPR:
CURRENT TIME: May 09, 2003 - 2:21pm
LAST SAVED BY:
LAST MODIFIED: Thu, 08 May 2003 - 10:06am
PREFIX: G:\DOTH9601A\ACAD\
FILE: FGE2.DWG
BEGIN: 12/01/99
SCALE: 1=1

ORIGINAL PLAN | NOTEBOOK No. | SURVEY PLOTTED BY | DRAWN BY | TRACED BY | DESIGNED BY | QUANTITIES BY | CHECKED BY | DATE

FED. ROAD DIST. NO.	STATE	FED. AID PROJ. NO.	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
HAWAII	HAW.	STP-7310(1)	2003	9	193

F.G.E. Ltd.

Boring: 6
Project: Puuloa Road Widening
Location: Mapunapuna, Oahu, Hawaii
Surface Elevation: 14' ±
Depth to Water: 11.5'
Date Completed: 3-4-97

File: 1600.01
Project Engineer: TC
Field Engineer: TSK
Drafted by: MD
Date of Drawing:

LAB TEST RESULTS	MOIST CONT. %	DRY DEN. PCF	BLOWS PER FT.	SAMPLE	DEPTH	CLASSIFICATION
LL=54, PI=20	19	474	53	1		*Brown Clayey SILT (MH) with Gravel, hard, damp* (FILL)
Direct Shear: O=35ø C=150 psf	25	249	17	2	5	*Brown Clayey SILT (ML-CL) with Sand and Gravel, very stiff, damp* (FILL)
2.7% Swell LL=37,PI=13	12	442	10	3		
Consol.	42	314	8	4	10	*Brown Clayey SILT (ML-CL) with some Sand and Gravel, very stiff, moist* (ALLUVIUM)
			42	5	15	*Grayish Brown Clayey SILT (ML-CL), hard, saturated* (COMPLETELY WEATHERED TUFF)
					20	BOH @ 15.0'

F.G.E. Ltd.

Boring: 8
Project: Puuloa Road Widening
Location: Mapunapuna, Oahu, Hawaii
Surface Elevation: 9' ±
Depth to Water: 6.0'
Date Completed: 3-4-97

File: 1600.01
Project Engineer: TC
Field Engineer: TSK
Drafted by: MD
Date of Drawing:

LAB TEST RESULTS	MOIST CONT. %	DRY DEN. PCF	BLOWS PER FT.	SAMPLE	DEPTH	CLASSIFICATION
Gradation: 27% Gravel 26% Sand 47% Silt/Clay	31	490	41	1		*Brown Silty GRAVEL (GW-GM) with Sand, medium dense, moist* (FILL)
Gradation: 43% Gravel 41% Sand 16% Silt/Clay pH=9.2	14	650	25	2	5	*Tan Silty Coral GRAVEL (GM) with sand, medium dense, damp* (FILL)
	37		R 3 R 4			*Dark Gray Silty SAND (SM) with Gravel, very dense, saturated* (CINDERS)
			98%REC 31%RQD	NX CORE	10	*Grayish Brown Highly Weathered TUFF (WH), medium hard, broken to occasionally broken*
					15	BOH @ 14.0'
					20	

F.G.E. Ltd.

Boring: 5
Project: Puuloa Road Widening
Location: Mapunapuna, Oahu, Hawaii
Surface Elevation: 27' ±
Depth to Water: None Encountered
Date Completed: 3-3-97

File: 1600.01
Project Engineer: TC
Field Engineer: TSK
Drafted by: MD
Date of Drawing:

LAB TEST RESULTS	MOIST CONT. %	DRY DEN. PCF	BLOWS PER FT.	SAMPLE	DEPTH	CLASSIFICATION
			57/9" R	1		*Brown Silty GRAVEL (GM) with Sand* (CINDERS)
			93%REC 0%RQD	NX CORE	5	*Grayish Brown Moderately Weathered TUFF (WM), hard, broken* (CINDERS)
			83%REC 25%RQD	NX CORE		
			22%REC 0%RQD	NX CORE	10	
			48%REC 0%RQD	NX CORE	15	*Grayish Brown Silty SAND (SM) with Gravel and occasional Cobbles, dense, damp* (CINDERS)
			2%REC 0%RQD	NX CORE	20	
			60%REC 0%RQD	NX CORE	25	*Grayish Brown Clayey SILT (ML-CL) with Gravel, hard, moist* (COMPLETELY WEATHERED TUFF)
					30	BOH @ 25.0'

F.G.E. Ltd.

Boring: 7
Project: Puuloa Road Widening
Location: Mapunapuna, Oahu, Hawaii
Surface Elevation: 12' ±
Depth to Water: 9.0'
Date Completed: 3-4-97

File: 1600.01
Project Engineer: TC
Field Engineer: TSK
Drafted by: MD
Date of Drawing:

LAB TEST RESULTS	MOIST CONT. %	DRY DEN. PCF	BLOWS PER FT.	SAMPLE	DEPTH	CLASSIFICATION
S.E.=16	32	169	24	1		*Light Brown Clayey SILT (ML-CL) with Gravel, very stiff, moist* (FILL)
LL=46,PI=7			28	2	5	*Brown Silty SAND (SM) with Gravel, medium dense, moist* (FILL)
Gradation: 30% Gravel 47% Sand 23% Silt/Clay pH=8.3	21		25	3		
			15	4	10	*Grayish Brown Clayey SILT (ML-CL) with Sand, very stiff, moist* (ALLUVIUM)
pH=9.3			82	5	15	*Gray Silty SAND (SM) with Gravel, dense, saturated* (CINDERS)
						BOH @ 15.0'

F.G.E. Ltd.

Boring: 9
Project: Puuloa Road Widening
Location: Mapunapuna, Oahu, Hawaii
Surface Elevation: 8' ±
Depth to Water: 6.0'
Date Completed: 3-5-97

File: 1600.01
Project Engineer: TC
Field Engineer: TSK
Drafted by: MD
Date of Drawing:

LAB TEST RESULTS	MOIST CONT. %	DRY DEN. PCF	BLOWS PER FT.	SAMPLE	DEPTH	CLASSIFICATION
non-plastic 0.0% Swell	32	1121	38	1		*Dark Brown Clayey SILT (ML-CL) with Gravel, very stiff, damp* (FILL)
S.E.=33	8	2050	23	2	5	*Dark Brown Silty GRAVEL (GM) with Sand and Cobbles, medium dense to dense, damp* (FILL)
			65	3		
			3	4	10	*Dark Gray Silty SAND AND GRAVEL (GM-GW), very loose, saturated* (LAGOON)
pH=8.6			3	5	15	BOH @ 15.0'

BARRY K. MURANAKA
LICENSED PROFESSIONAL ENGINEER No.8418-C HAWAII, U.S.A.

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Expiration Date of the License: 04/30/04

STATE OF HAWAII
DEPARTMENT OF TRANSPORTATION
HIGHWAYS DIVISION

BORING LOGS

PUULOA ROAD IMPROVEMENTS
Kamehameha Hwy. to Salt Lake Blvd.
Federal Aid Project No. STP-7310(1)

Scale: As shown *Date: May 2003*

SHEET NO. 9 OF 193 SHEETS

9

P.M.: STY
CURRENT OPR: rki
PREV. OPR:
CURRENT TIME: May 09, 2003 - 2:23pm
LAST SAVED BY:
LAST MODIFIED: Thu, 08 May 2003 - 10:06am

PREFIX: G:\DOTH9601A\ACAD\
FILE: FGE3.DWG
BEGIN: 12/01/99
SCALE: 1=1

ORIGINAL PLAN | NOTEBOOK No. | DATE | SURVEY PLOTTED BY | DRAWN BY | TRACED BY | DESIGNED BY | QUANTITIES BY | CHECKED BY