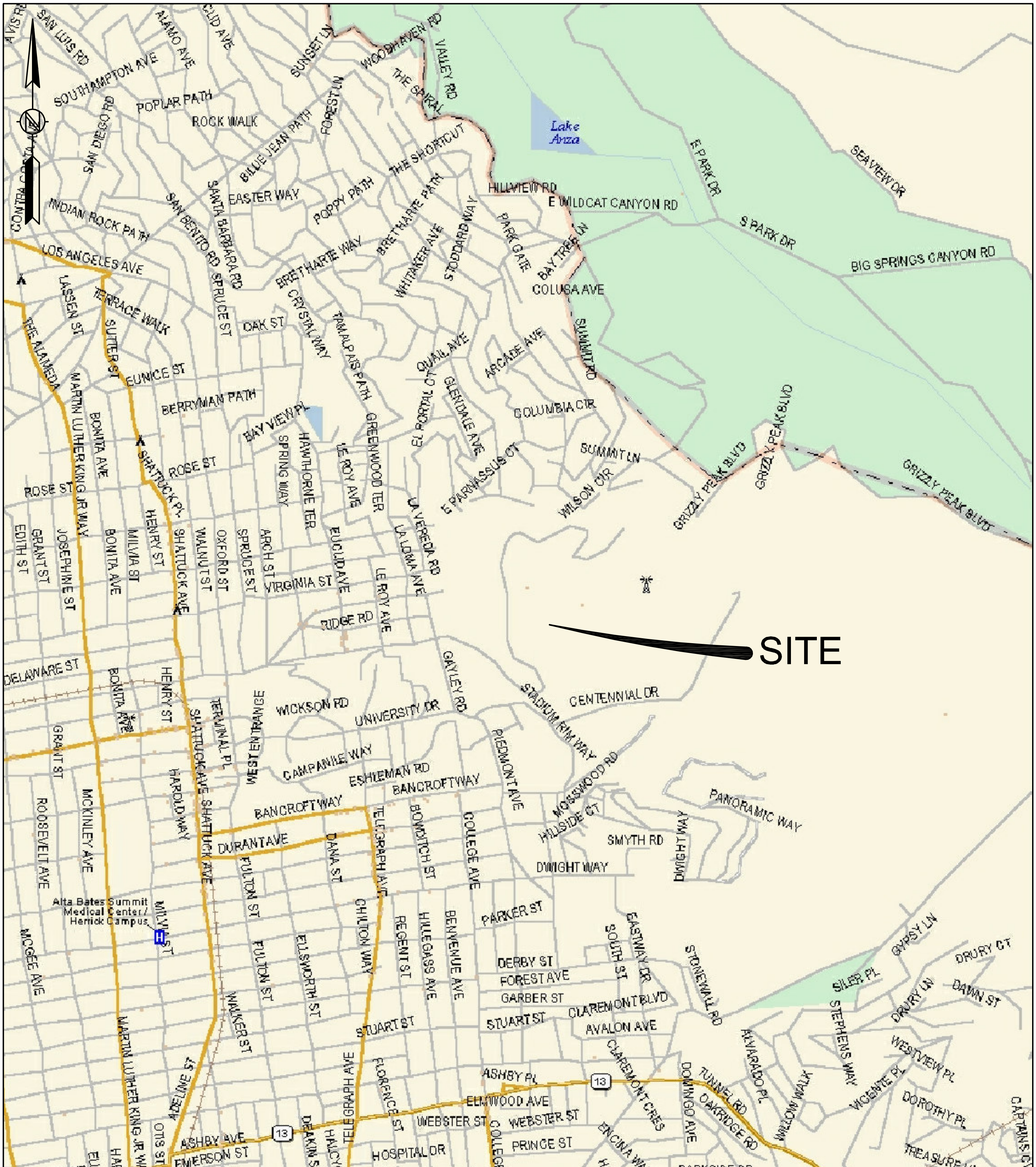
PLATES



2000 1000 0 2000

scale feet

Base: Delorme.

KLEINFELDER

SITE LOCATION

CRT Building

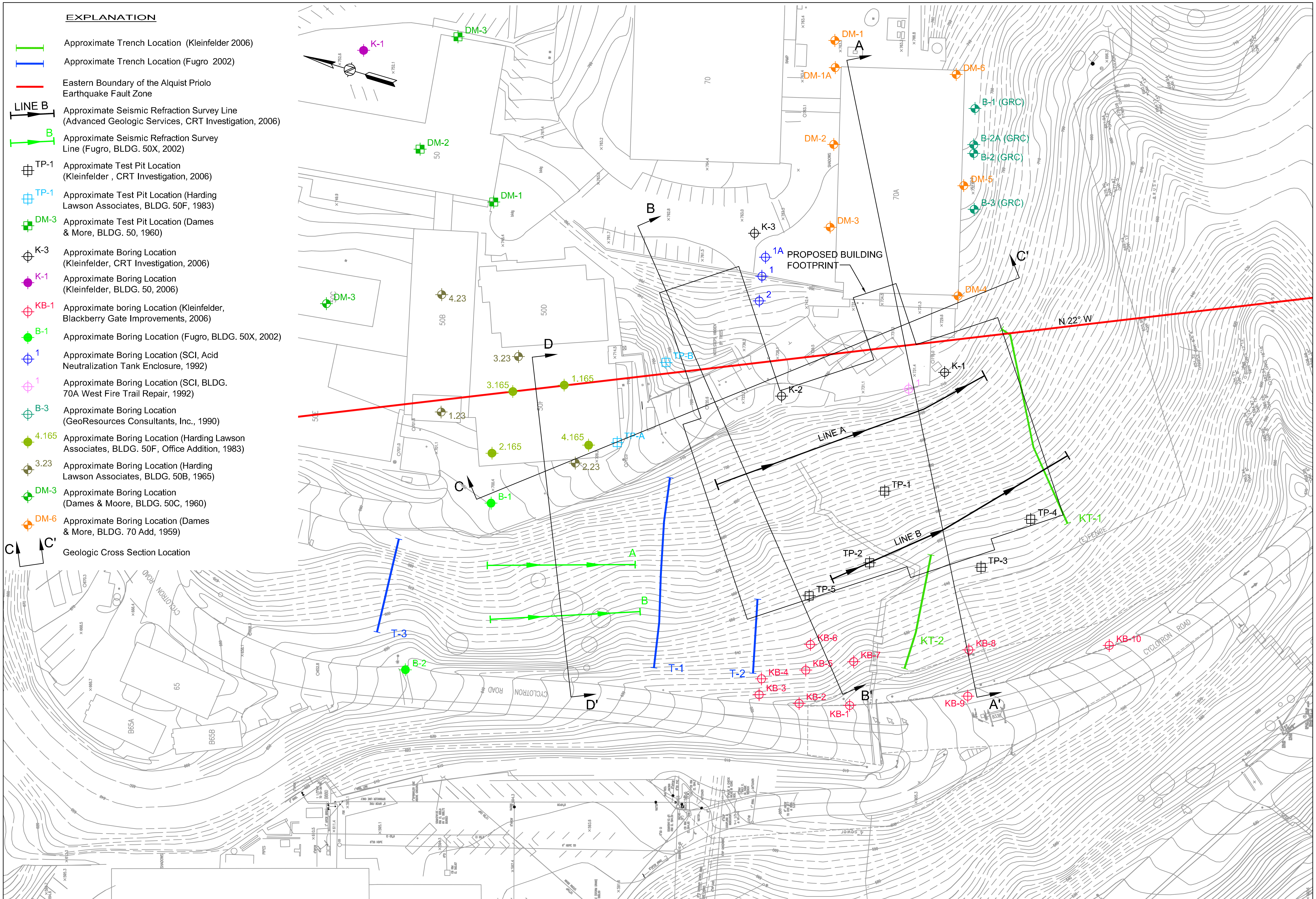
Lawrence Berkeley National Laboratory

Berkeley, California

PLATE

1

PROJECT NO. 74911 DATE JUNE 2007



EXPLANATION

- Approximate Trench Location (Kleinfelder 2006)
- Approximate Trench Location (Fugro 2002)
- Eastern Boundary of the Alquist Priolo Earthquake Fault Zone
- LINE B — Approximate Seismic Refraction Survey Line (Advanced Geologic Services, CRT Investigation, 2006)
- B — Approximate Seismic Refraction Survey Line (Fugro, BLDG. 50X, 2002)
- TP-1 — Approximate Test Pit Location (Kleinfelder , CRT Investigation, 2006)
- TP-1 — Approximate Test Pit Location (Harding Lawson Associates, BLDG. 50F, 1983)
- DM-3 — Approximate Test Pit Location (Dames & More, BLDG. 50, 1960)
- K-3 — Approximate Boring Location (Kleinfelder, CRT Investigation, 2006)
- K-1 — Approximate Boring Location (Kleinfelder, BLDG. 50, 2006)
- KB-1 — Approximate boring Location (Kleinfelder, Blackberry Gate Improvements, 2006)
- B-1 — Approximate Boring Location (Fugro, BLDG. 50X, 2002)
- 1 — Approximate Boring Location (SCI, Acid Neutralization Tank Enclosure, 1992)
- 1 — Approximate Boring Location (SCI, BLDG. 70A West Fire Trail Repair, 1992)
- B-3 — Approximate Boring Location (GeoResources Consultants, Inc., 1990)
- 4.165 — Approximate Boring Location (Harding Lawson Associates, BLDG. 50F, Office Addition, 1983)
- 3.23 — Approximate Boring Location (Harding Lawson Associates, BLDG. 50B, 1965)
- DM-3 — Approximate Boring Location (Dames & Moore, BLDG. 50C, 1960)
- DM-6 — Approximate Boring Location (Dames & More, BLDG. 70 Add, 1959)
- C C' — Geologic Cross Section Location

Base: Lawrence Berkeley National Laboratory, 2006

scale: 50 25 0 50 feet

KLEINFELDER

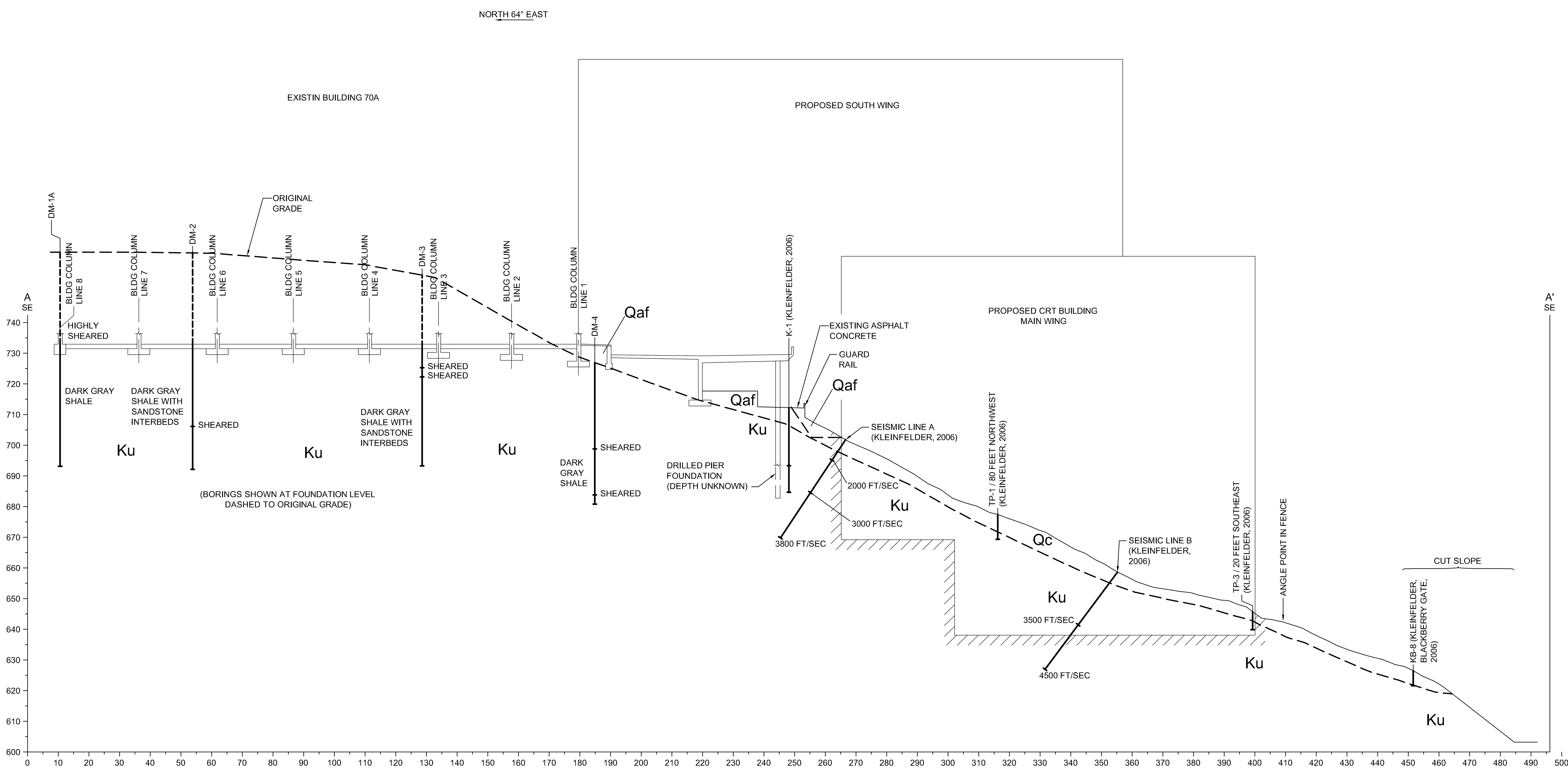
PROJECT NO. 74911 DATE JUNE 2007

SITE PLAN

Geotechnical Investigation
CRT Building
Lawrence Berkeley National Laboratory
Berkeley, California

PLATE 2

U:\GEOTECH_PROJECTS\Projects\Active\74911 CRT Building\CAD\74911-2.dwg, Layout1, 7/12/2007 4:11:36 PM



EXPLANATION

Qaf Artificial Fill

Qc Colluvium

Ku Cretaceous Undifferentiated (Sandstone, Siltstone, Shale)

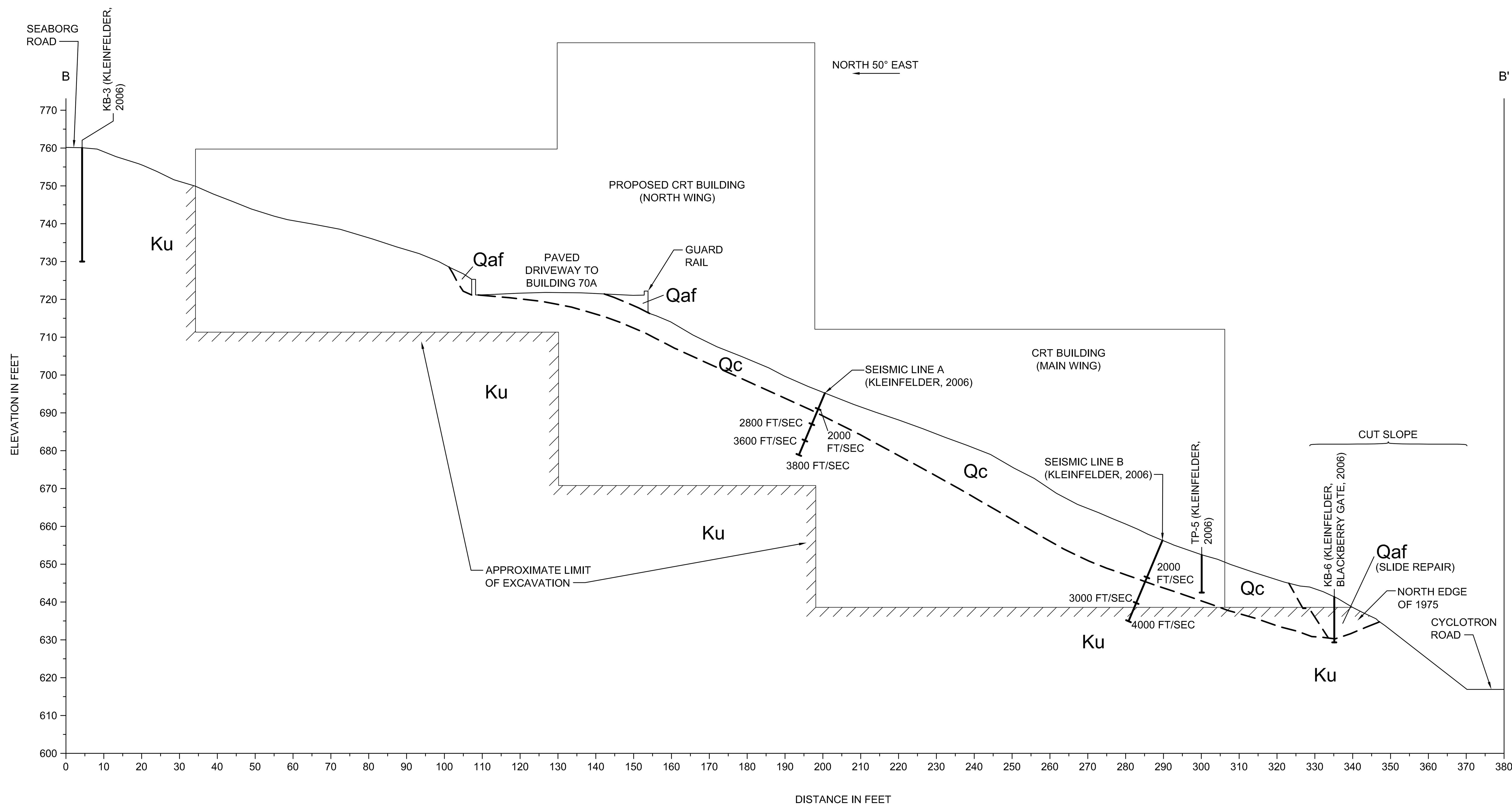
20 10 0 20
scale feet

KLEINFELDER

PROJECT NO. 74911 DATE JUNE 2007

GEOLOGIC SECTION A - A'
CRT BUILDING
LAWRENCE BERKELEY NATIONAL LABORATORY
Berkeley, California

PLATE 3



EXPLANATION

Qaf	Artificial Fill
Qc	Colluvium
Ku	Cretaceous Undifferentiated (Sandstone, Siltstone, Shale)

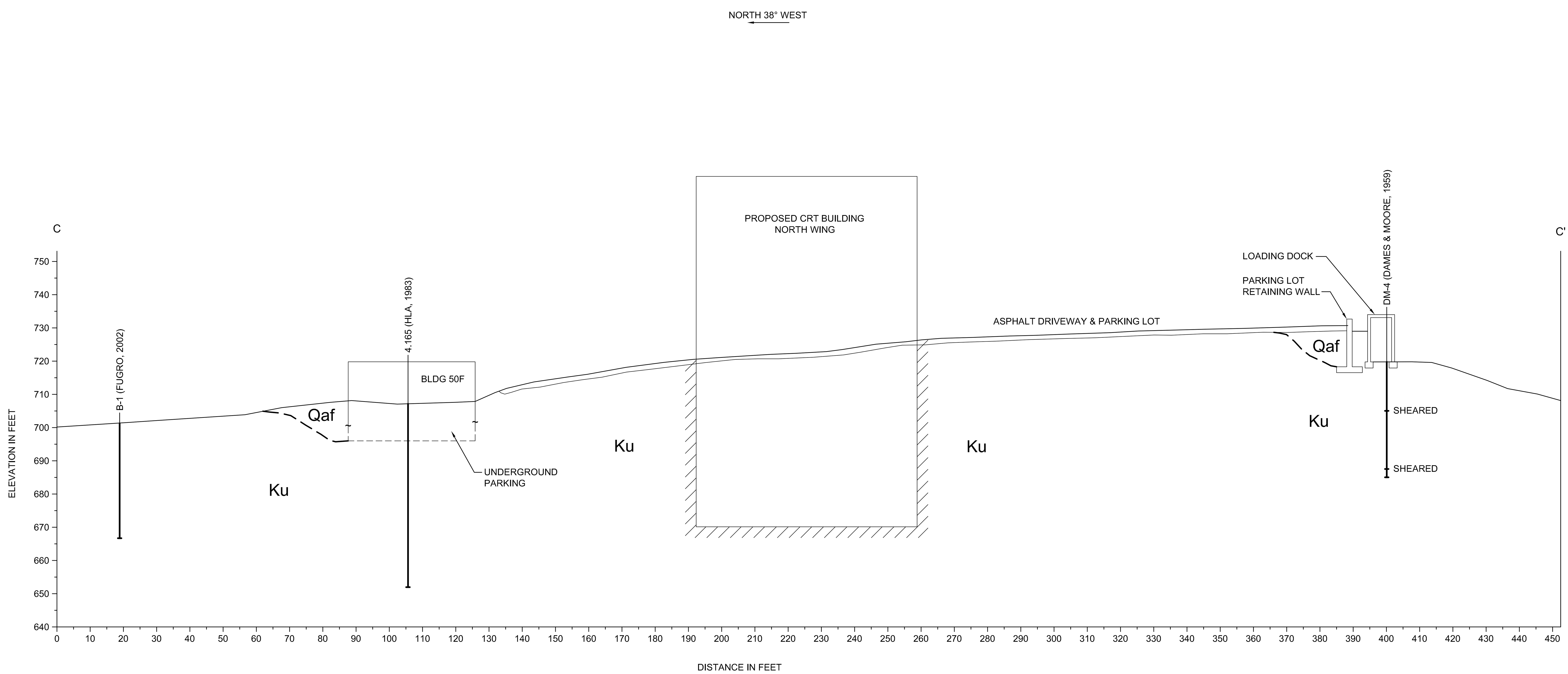
20 10 0 20
scale feet

KLEINFELDER

PROJECT NO. 74911 DATE JUNE 2007

GEOLOGIC SECTION B - B'
CRT BUILDING
LAWRENCE BERKELEY NATIONAL LABORATORY
Berkeley, California

PLATE 4



EXPLANATION

Qaf Artificial Fill

Qc Colluvium

Ku Cretaceous Undifferentiated (Sandstone, Siltstone, Shale)

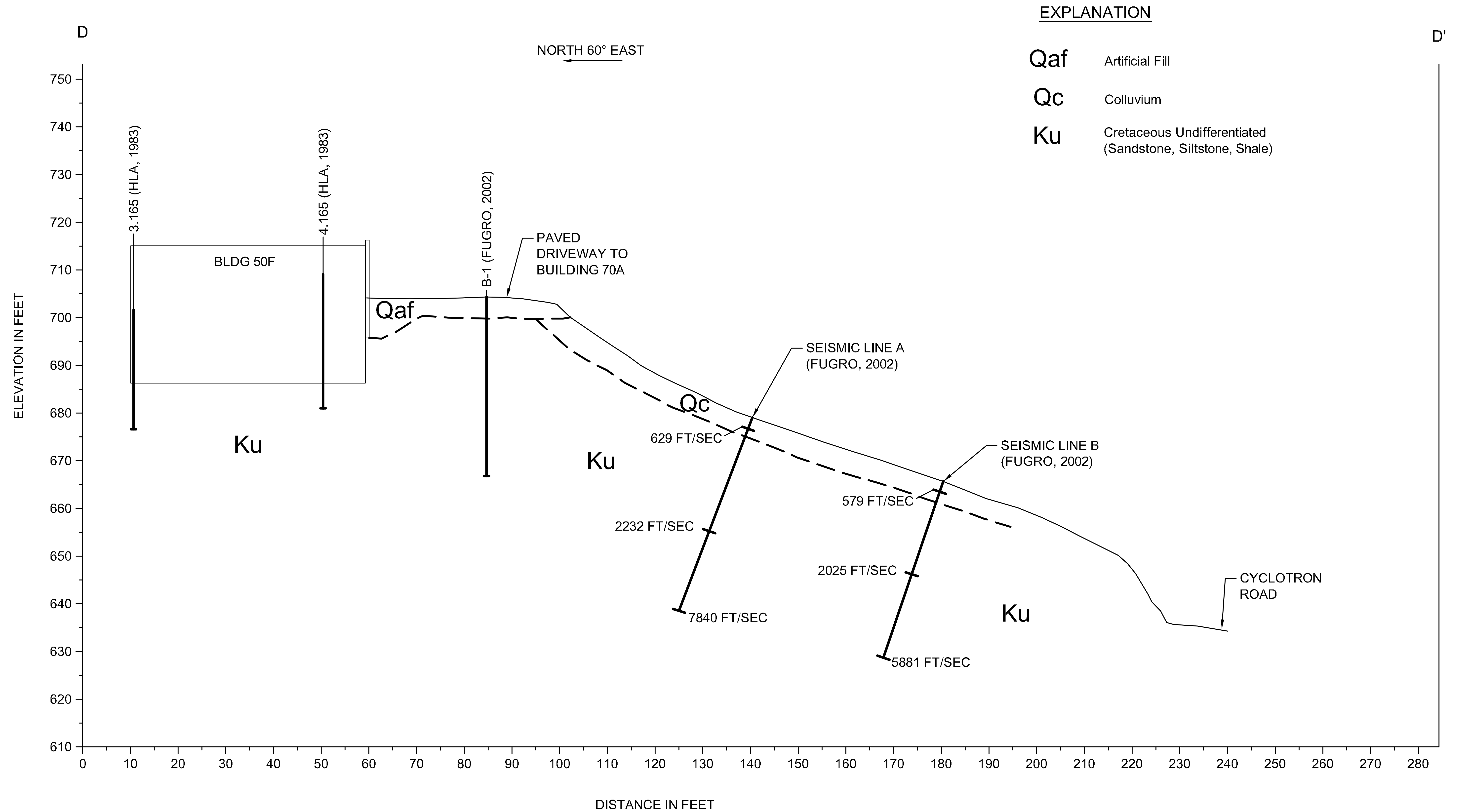
20 10 0 20
scale feet

KLEINFELDER

PROJECT NO. 74911 DATE JUNE 2007

GEOLOGIC SECTION C - C'
CRT BUILDING
LAWRENCE BERKELEY NATIONAL LABORATORY
Berkeley, California

PLATE 5



KLEINFELDER

PROJECT NO. 74911 DATE JUNE 2007

GEOLOGIC SECTION D - D'
CRT BUILDING
LAWRENCE BERKELEY NATIONAL LABORATORY
Berkeley, California

PLATE 6

APPENDIX A

UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS				DESCRIPTIVE NAMES
COARSE GRAINED SOILS More than Half > #200 sieve	**GRAVELS** MORE THAN HALF COARSE FRACTION IS LARGER THAN NO. 4 SIEVE	CLEAN GRAVELS WITH LITTLE OR NO FINES	GW	WELL GRADED GRAVELS, GRAVEL-SAND MIXTURES
			GP	POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES
		GRAVELS WITH OVER 15% FINES	GM	SILTY GRAVELS, POORLY GRADED GRAVEL-SAND-SILT MIXTURES
			GC	CLAYEY GRAVELS, POORLY GRADED GRAVEL-SAND-CLAY MIXTURES
	SANDS MORE THAN HALF COARSE FRACTION IS SMALLER THAN NO. 4 SIEVE	CLEAN SANDS WITH LITTLE OR NO FINES	SW	WELL GRADED SANDS, GRAVELLY SANDS
			SP	POORLY GRADED SANDS, GRAVELLY SANDS
		SANDS WITH OVER 15% FINES	SM	SILTY SANDS, POORLY GRADED SAND-SILT MIXTURES
			SC	CLAYEY SANDS, POORLY GRADED SAND-CLAY MIXTURES
FINE GRAINED SOILS More than Half < #200 sieve	**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 CLAYS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SANDY OR SILTY SOILS, ELASTIC SILTS
			CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
			OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS			Pt	PEAT AND OTHER HIGHLY ORGANIC SOILS

FIELD SAMPLING

- CALIFORNIA SAMPLE 2.5" I.D.
- MODIFIED CALIFORNIA SAMPLE 2" I.D.
- DISTURBED, BAG OR BULK SAMPLE
- STANDARD PENETRATION TEST
- SHELBY TUBE SAMPLE
- 3-1/2" I.D. CONTINUOUS CORE SAMPLE
- UNRETAINED PORTION OF SAMPLE
- ▼ WATER LEVEL OBSERVED IN BORING (at given post-drilling time)
- ▽ WATER LEVEL OBSERVED IN BORING (at time of drilling)

LABORATORY TESTS

LL	LIQUID LIMIT
PI	PLASTICITY INDEX
SA	SIEVE ANALYSIS
#200	PERCENT PASSING #200 SIEVE
RV	RESISTANCE VALUE
EI	EXPANSION INDEX
DS	DIRECT SHEAR
Tx/UU	TRIAXIAL SHEAR-UNCONSOLIDATED UNDRAINED
UC	UNCONFINED COMPRESSION
SG	SPECIFIC GRAVITY
PP	POCKET PENETROMETER SHEAR STRENGTH (tsf)

NOTES:

The lines separating strata on the logs represent approximate boundaries only. The actual transition may be gradual. No warranty is provided as to the continuity of soil strata between borings. Logs represent the soil strata and groundwater observed at the boring location on the date of drilling only.

KLEINFELDER

PROJECT NUMBER **74911** DATE **Jun 2007**

BORING LOG LEGEND

CRT Building
Lawrence Berkeley National Laboratory
Berkeley, California

PLATE **A-1**

GRAPHIC ROCK SYMBOLS

SHALE OR CLAYSTONE	CHERT	SERPENTINITE
SILTSTONE	PYROCLASTIC	METAMORPHIC ROCKS
SANDSTONE	VOLCANIC FLOWS	ALTERED ROCKS
CONGLOMERATE	PLUTONIC	SHEARED ROCKS

WEATHERING INDEX

W1 - FRESH - No visible sign of rock material weathering; perhaps slight discoloration on major discontinuity surfaces.

W2 - SLIGHTLY WEATHERED - Discoloration indicates weathering of rock material and discontinuity surfaces. All the rock material may be discolored by weathering and may be somewhat weaker than in its fresh condition.

W3 - MODERATELY WEATHERED - Less than half of the rock material is decomposed and/or disintegrated to a soil. Fresh of discolored rock is present either as a discontinuous framework or as corestones.

W4 - HIGHLY WEATHERED - More than half of the rock material is decomposed and/or disintegrated to a soil. Fresh or discolored rock is present either as a discontinuous framework or as corestones.

W5 - COMPLETELY WEATHERED - All rock material is decomposed and/or disintegrated to a soil. The original mass structure is still largely intact.

STRENGTH INDEX

R0 - EXTREMELY WEAK - Indented by thumbnail

R1 - VERY WEAK - Crumbles under firm blows with a point of geological hammer, can be peeled by pocket knife

R2 - WEAK - Can be peeled by a knife with difficulty, shallow indentations made by firm blow with point of geological hammer.

R3 - MEDIUM STRONG - Cannot be scraped or peeled with a pocket knife, specimen can be fractured with a single firm blow of geological hammer.

R4 - STRONG - Specimen requires more than one blow of geological hammer to fracture it.

R5 - VERY STRONG - Specimen withstands several blows of geological hammer without breaking.

R6 - EXTREMELY STRONG - Specimen can only be chipped with a geological hammer.

FRACTURE SPACING

VERY LITTLE FRACTURED	Greater than 4.0 feet
OCCASIONALLY FRACTURED	1.0 to 4.0 feet
MODERATELY FRACTURED	0.5 to 1.0 feet
CLOSELY FRACTURED	0.1 to 0.5 foot
INTENSELY FRACTURED	0.05 to 0.1 foot
CRUSHED	Less than 0.05 foot

BEDDING OR LAYERING

VERY THICK OR MASSIVE	Greater than 4.0 feet
THICK	2.0 to 4.0 feet
THIN	0.2 to 2.0 feet
VERY THIN	0.05 to 0.2 foot
LAMINATED	0.01 to 0.05 foot
THINLY LAMINATED	Less than 0.01 foot

KLEINFELDER

ROCK DESCRIPTION CRITERIA

CRT Building
Lawrence Berkeley National Laboratory
Berkeley, California

PLATE **A-2**

PROJECT NUMBER **74911** DATE **Jun 2007**

LABORATORY				FIELD					
Dry Density (pcf)	Moisture Content (%)	Shear Strength (ksf)	Other Tests	Blows/foot *	Sample	Depth (feet)	Lithology Symbol	U.S.C.S. Designation	SOIL DESCRIPTION
						0–1			**ASPHALT CONCRETE** = 7 inches
						1		GM/GC	**AGGREGATE BASE** = 12 inches
						2			**GRAVELLY SANDY CLAY**- dark yellow brown, moist, very stiff, subangular gravels up to 1" (fill)
				18		3			
						4		CL	
115	12.8			25		5			
						6			
						7			**SILTSTONE**- dark yellow brown, completely weathered, very closely fractured, very weak
						8			
						9			
116	8.8			35		10			
						11			
						12			
						13			
111	13.5					14			
				55		15			
						16			
						17			
						18			**SHALE**- gray, highly weathered, very closely fractured, weak, thinly bedded
				55		19			
						20			
						21			
						22			
						23			
						24			very difficult drilling
						25			**SANDSTONE**- yellow brown, highly weathered, very closely fractured, weak
						26			
				70/3"		27			
						28			BOTTOM OF BORING K-1 @ 27 FEET No Free Water Encountered
						29–35			

* The blow counts have been converted to standard N-value blow counts.
** LBNL Datum

SURFACE ELEVATION: **712' ****
TOTAL DEPTH: **27.0 feet**
GROUND WATER DEPTH: ∇ **feet at time of drilling**
▼ **feet**

LOGGED BY: **R. Padgett**
EQUIPMENT: **Mobile B-53**
DIAMETER of BORING: **6**
DATE DRILLED: **9-18-06**

KLEINFELDER

LOG OF EXPLORATION
BORING K-1
CRT Building
Lawrence Berkeley National Laboratory
Berkeley, California

PLATE **A-3**

PROJECT NUMBER **74911** DATE **Jun 2007**

LABORATORY				FIELD					
Dry Density (pcf)	Moisture Content (%)	Shear Strength (ksf)	Other Tests	Blows/foot *	Sample	Depth (feet)	Lithology Symbol	U.S.C.S. Designation	SOIL DESCRIPTION
						0			**ASPHALT CONCRETE** = 5 inches
								GM/GC	**AGGREGATE BASE** = 9 inches
						1			
								GC	**CLAYEY SANDY GRAVEL**- light brown, dry, medium dense, fine to coarse grained sand, fine rounded gravel to 1/2" angular gravel (fill)
						2			
						3			
						4			
				18		5			Encountered Concrete Duct Bank Boring Terminated
						6			BOTTOM OF BORING K-2 @ 5.5 FEET No Free Water Encountered
						7			
						8			
						9			
						10			

* The blow counts have been converted to standard N-value blow counts.
** LBNL Datum

SURFACE ELEVATION: **719' ****
TOTAL DEPTH: **5.5 feet**
GROUND WATER DEPTH: ▽ **feet at time of drilling**
▼ **feet**

LOGGED BY: **R. Padgett**
EQUIPMENT: **Mobile B-53**
DIAMETER of BORING: **6**
DATE DRILLED: **9-18-06**

KLEINFELDER

PROJECT NUMBER **74911** DATE **Jun 2007**

LOG OF EXPLORATION
BORING K-2
CRT Building
Lawrence Berkeley National Laboratory
Berkeley, California

PLATE
A-4

LABORATORY				FIELD					
Dry Density (pcf)	Moisture Content (%)	Shear Strength (ksf)	Other Tests	Blows/foot *	Sample	Depth (feet)	Lithology Symbol	U.S.C.S. Designation	SOIL DESCRIPTION
						0–1		GM/GC	**ASPHALT CONCRETE** = 4 inches **AGGREGATE BASE** = 12 inches
117	14.2			42		2–3			**SILTSTONE**- yellow brown with blue/gray clay seams, highly weathered, very closely fractured, very weak
124	11.6			54		4–5			
						8			stiffer drilling
				53/8"		9–10			
						10			**SANDSTONE**- yellow brown to brown, highly to completely weathered, very closely fractured, very weak
						13			**SILTSTONE**- yellow brown with blue/gray clay seams, highly weathered, very closely fractured, very weak
118	13.4			42		14–15			
				50/3" 50/3"		17–18			**SANDSTONE**- yellowish brown to reddish brown, moderately weathered, very closely fractured, friable
				34		27–28			**SHALE**- blue gray, highly to completely weathered, very closely fractured, very weak, highly sheared with strong, rounded corestones
				72/7"		29–30			
						30			BOTTOM OF BORING K-3 @ 30 FEET. Groundwater Encountered at 27 FEET

* The blow counts have been converted to standard N-value blow counts.
** LBNL Datum

SURFACE ELEVATION: **762' ****
TOTAL DEPTH: **30.0 feet**
GROUND WATER DEPTH: ▽ **27.0 feet at time of drilling**
▼ **feet**

LOGGED BY: **R. Padgett**
EQUIPMENT: **Mobile B-53**
DIAMETER of BORING: **6**
DATE DRILLED: **9-18-06**

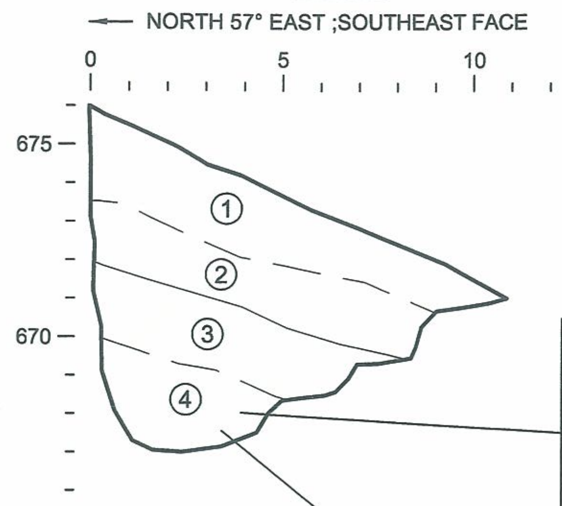
KLEINFELDER

PROJECT NUMBER **74911** DATE **Jun 2007**

LOG OF EXPLORATION
BORING K-3
CRT Building
Lawrence Berkeley National Laboratory
Berkeley, California

PLATE **A-5**

TP-1

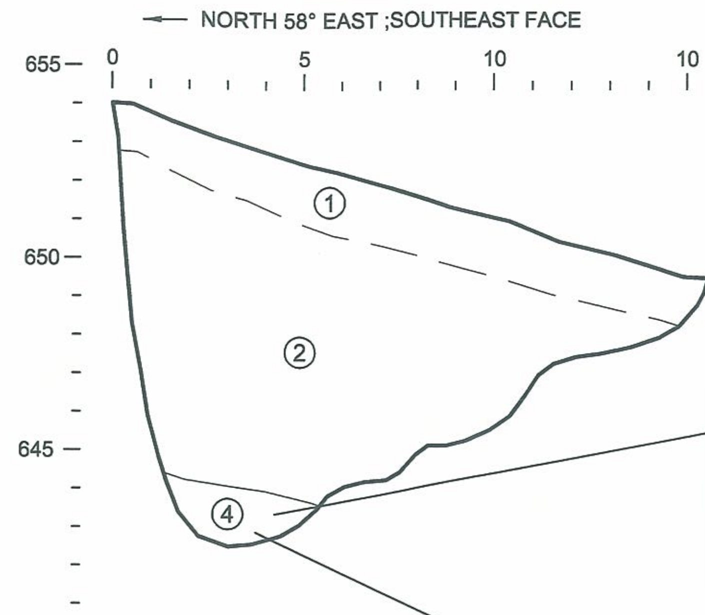


Depth (feet)	P.P. (tsf)
0.5	3.5
1.0	4.5
2.5	4.5+
3.0	4.5+

Fracture or Bedding Orientation in Unit 4	
Dip Direction	DIP
289°	64°
145°	60°
345°	76°
185°	29°

Fracture per Foot in Unit 4	
Direction	Number of Fractures
X	6
Y	7
Z	6 TO 9

TP-2

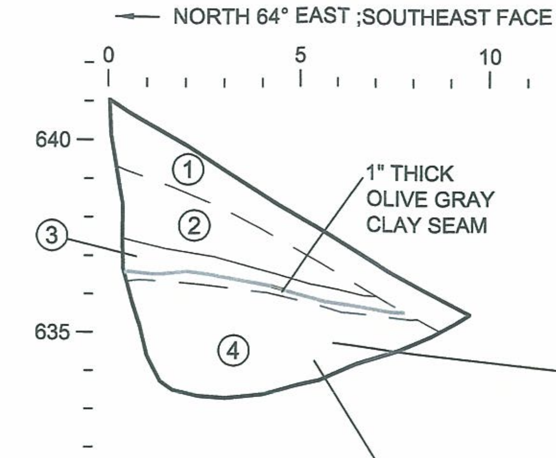


Depth (feet)	P.P. (tsf)
0.5	4.0
2.0	4.5+
4.5	4.5+
6	4.5+

Fracture or Bedding Orientation in Unit 4	
Dip Direction	DIP
206°	39°
210°	60°
41°	72°
212°	50°
40°	90°
228°	40°

Fracture per Foot in Unit 4	
Direction	Number of Fractures
X	9
Y	5
Z	8 TO 11

TP-3

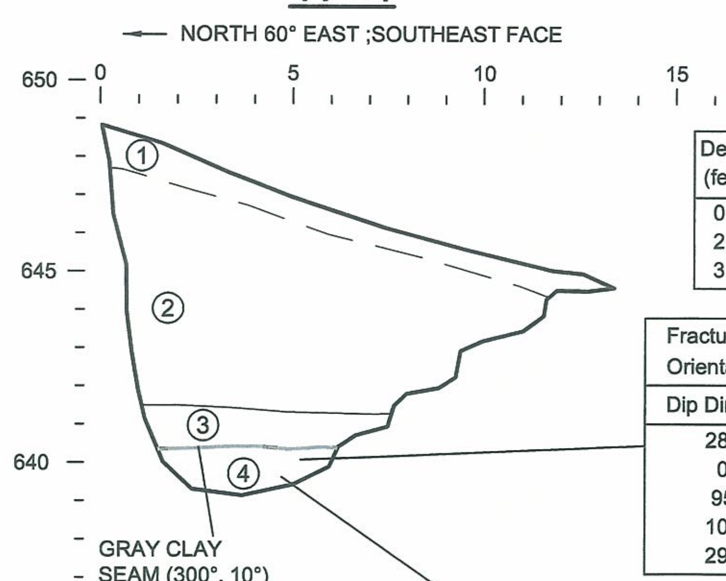


Depth (feet)	P.P. (tsf)
0.5	3.0
2.0	4.5+

Fracture or Bedding Orientation in Unit 4	
Dip Direction	DIP
282°	88°
85°	66°
302°	56°
223°	50°
250°	68°
16°	30°
249°	64°

Fracture per Foot in Unit 4	
Direction	Number of Fractures
X	6
Y	8
Z	6

TP-4

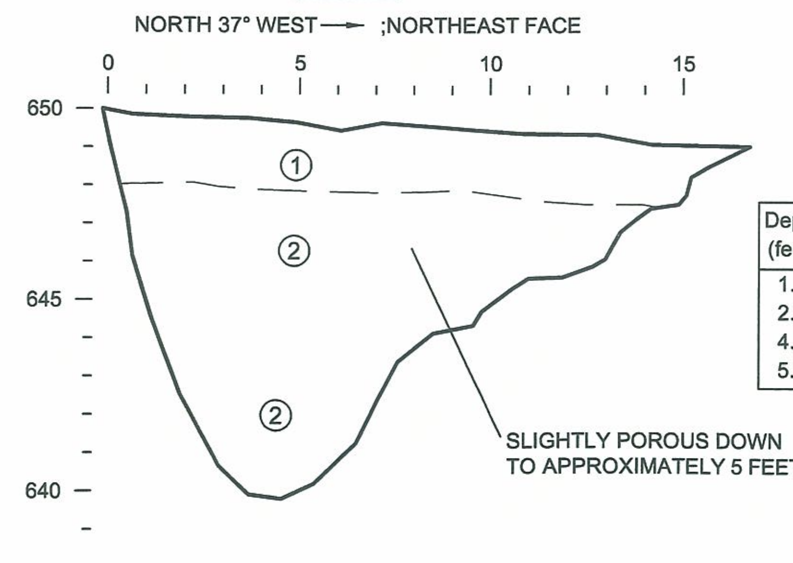


Depth (feet)	P.P. (tsf)
0.5	3.0
2.0	4.5+
3.5	4.5+

Fracture or Bedding Orientation in Unit 4	
Dip Direction	DIP
281°	80°
0°	90°
95°	6°
105°	88°
295°	28°

Fracture per Foot in Unit 4	
Direction	Number of Fractures
X	5
Y	6
Z	8

TP-5

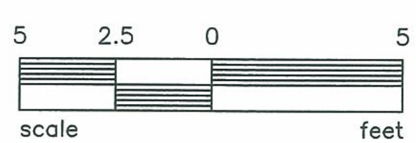


Depth (feet)	P.P. (tsf)
1.0	4.5
2.0	4.5+
4.0	4.5+
5.0	4.5+

1. SANDY SILT WITH GRAVEL (ML) - Dark brown, dry, very stiff to hard (3.0 to >4.5 tsf) sub-angular gravels up to 1-inch diameter, moderate rootlets, slightly porous.
2. GRAVELLY SANDY CLAY (CL) - Dark yellow brown, moist, hard (>4.5 tsf), sub-angular gravels up to 2.5-inch diameter (colluvium).
3. SILTSTONE - Dark, yellow brown, completely weathered, extremely weak rock, no visible bedding and relic fractures. Very close, very tight aperture - JRL 6-8
4. SILTSTONE - Dark, yellow brown, completely weathered, very weak to weak rock. Bedding close spacing. Fractures very close.

EXPLANATION

(symbol)	Seepage
DD	Dry Density (pounds per square foot)
MC	Moisture Content (%)
▮	Tube Sample
P.P.	Pocket Penetrometer
tsf	Tons per square foot
∇	Groundwater



KLEINFELDER

PROJECT NO. 74911 DATE JUNE 2007

LOG OF TEST PITS TP-1 THROUGH TP-5
CRT BUILDING
LAWRENCE BERKELEY NATIONAL LABORATORY
Berkeley, California

PLATE A-6

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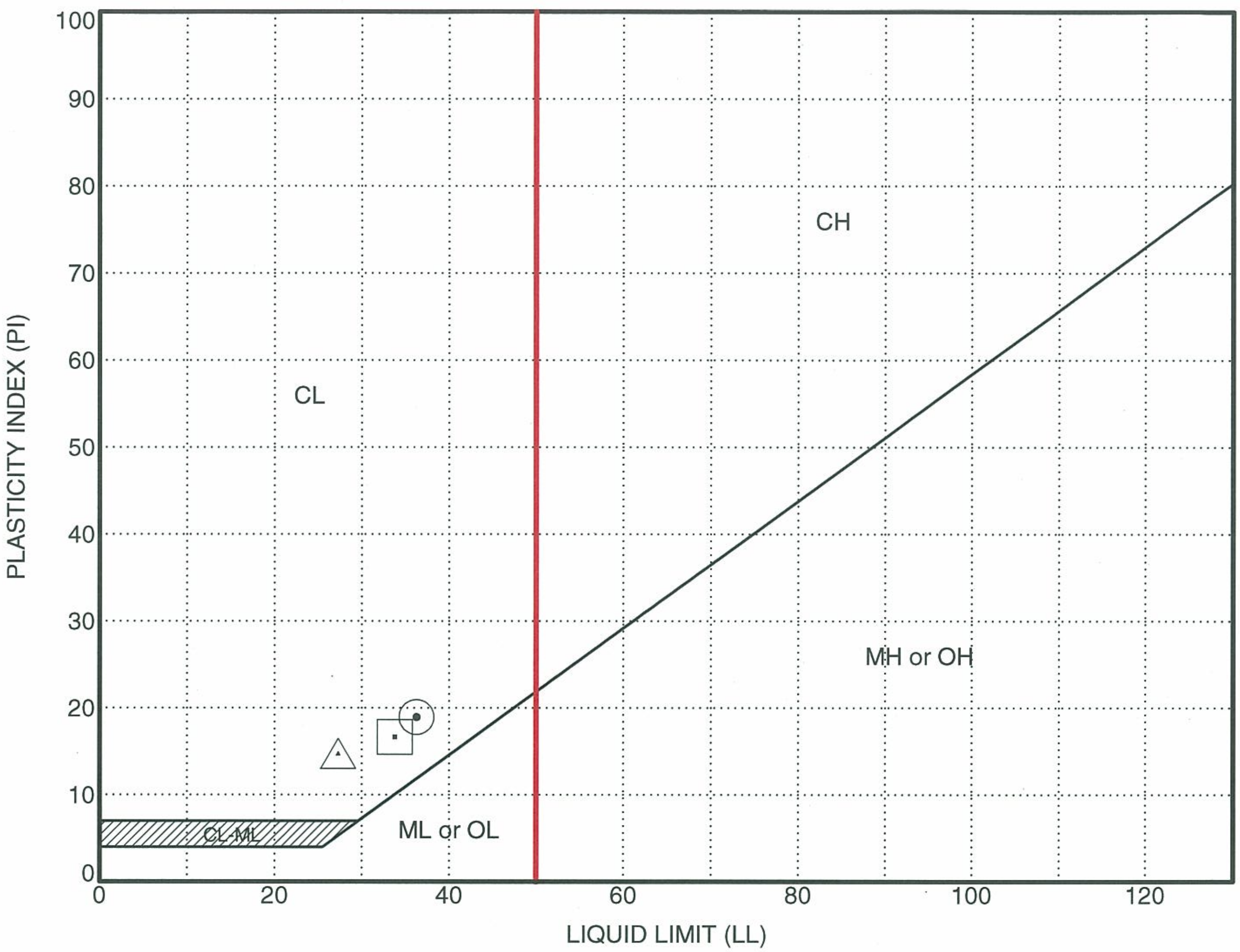
APPENDIX B



SAMPLE SOURCE	CLASSIFICATION	LIQUID LIMIT (%)	PLASTIC LIMIT (%)	PLASTICITY INDEX (%)	% PASSING #200 SIEVE
⊙ K-1 @ 10.0'	Siltstone	36	17	19	
⊡ K-3 @ 14.5'	Siltstone	34	17	17	
△ K-3 @ 28.0' - 29.5'	Shale	27	13	14	

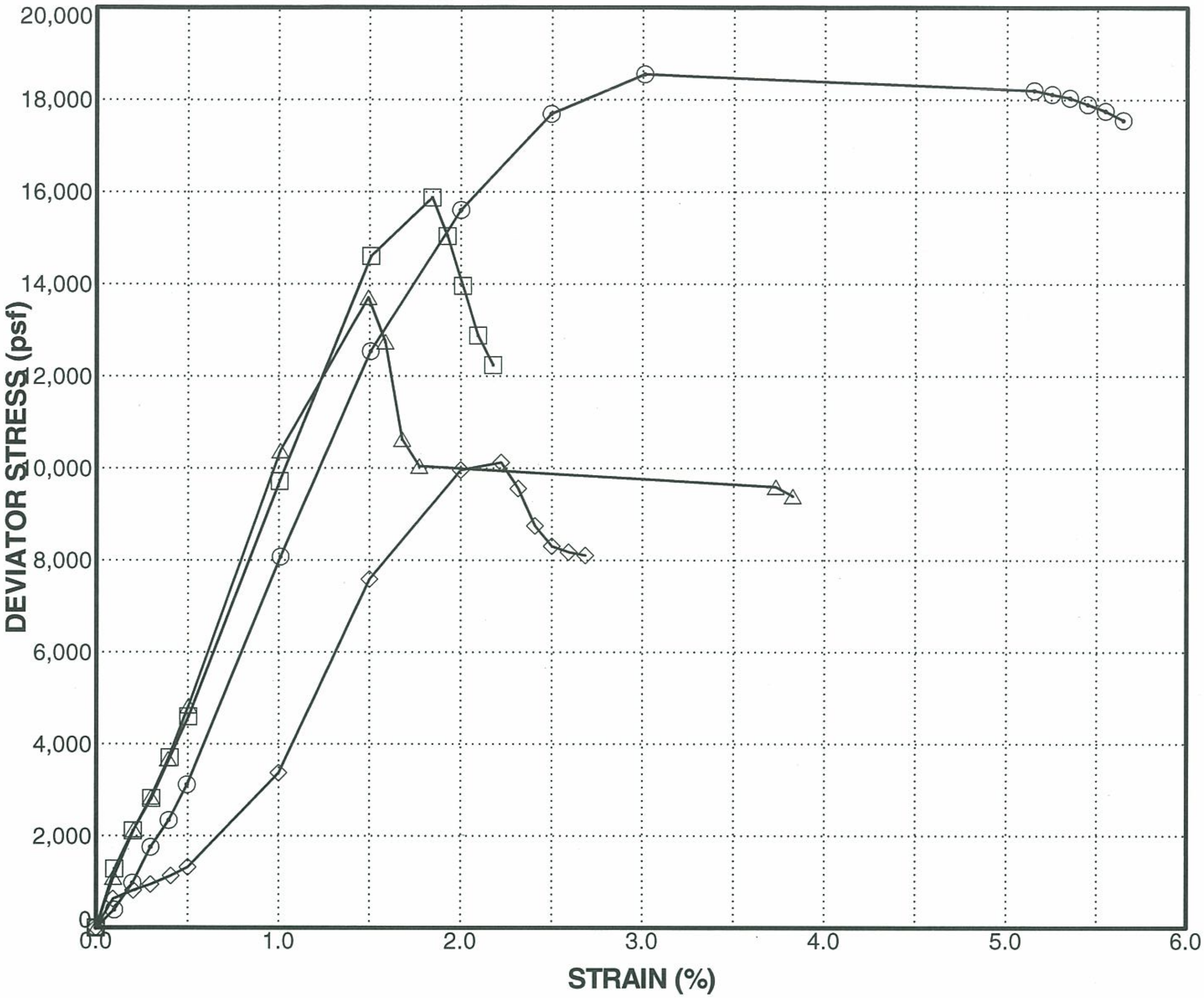
KLEINFELDER

PROJECT NUMBER **74911** DATE **Jun 2007**

PLASTICITY CHART

CRT Building
Lawrence Berkeley National Laboratory
Berkeley, California

PLATE **B-1**



Sample Source	Classification	Type of Test	Confinement Pressure (psf)	Shear Strength (psf)	Strain (%)	Dry Density (pcf)	Moisture Content (%)
⊙ K-1 @ 5.0'	Gravelly Sandy Clay	TXUU	1440	9276	3	115	12.8
⊡ K-3 @ 3.0'	Siltstone	TXUU	374	7939	2	117	14.2
△ K-3 @ 4.5'	Siltstone	TXUU	720	6856	1	124	11.6
◇ K-3 @ 14.5'	Siltstone	TXUU	2592	5063	2	118	13.4

UC = Unconfined Compression

TX/UU = Unconsolidated Undrained Triaxial

KLEINFELDER

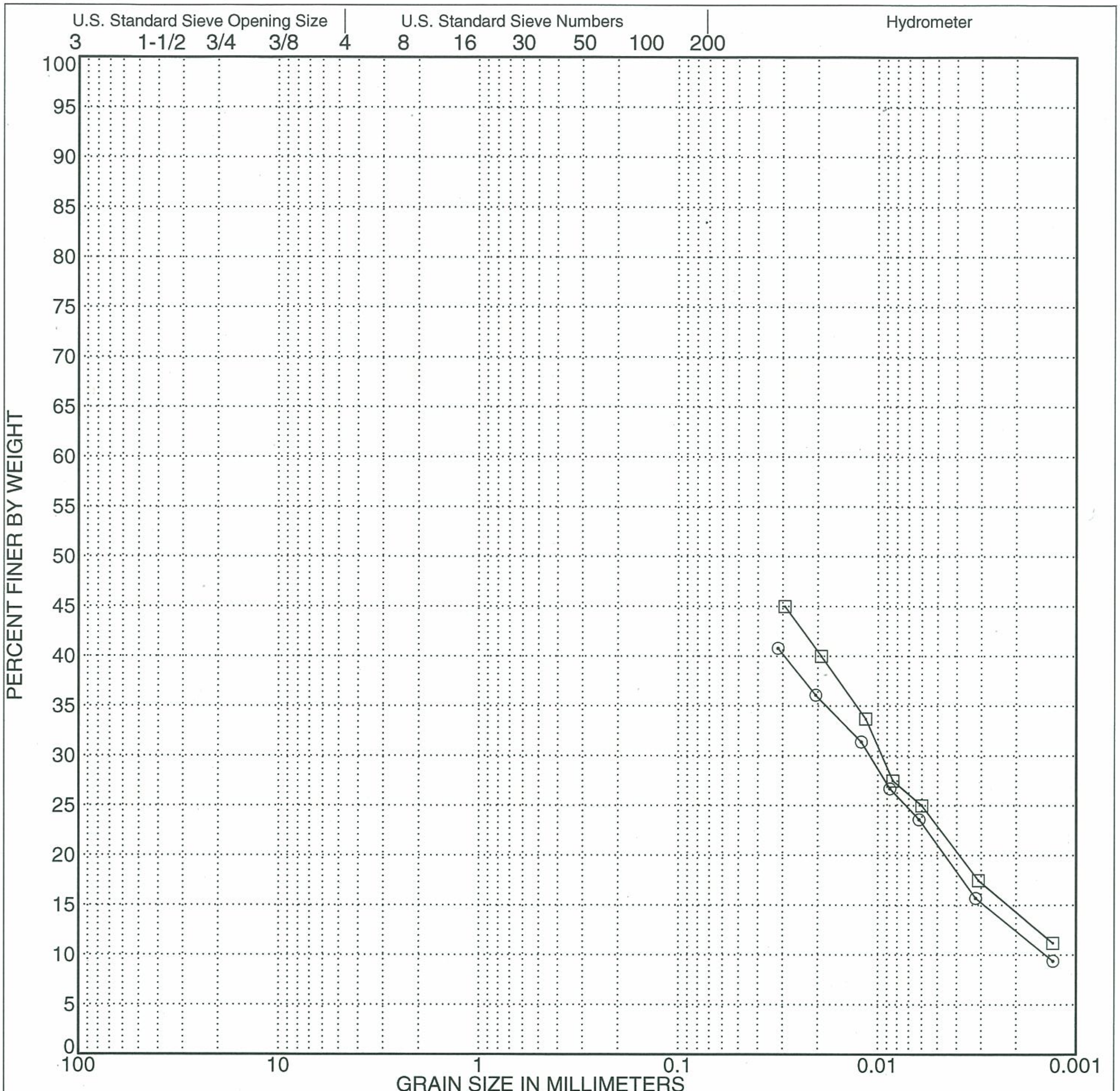
PROJECT NUMBER **74911** DATE **Jun 2007**

STRENGTH TEST DATA

CRT Building
Lawrence Berkeley National Laboratory
Berkeley, California

PLATE

B-2



Cobbles	GRAVEL		SAND			SILT	CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE		

SYMBOL	SAMPLE SOURCE	CLASSIFICATION
⊙	K-1 @ 10.0'	Siltstone
⊡	K-3 @ 28.0' - 29.5'	Shale

KLEINFELDER

PARTICLE SIZE ANALYSIS

CRT Building
Lawrence Berkeley National Laboratory
Berkeley, California

PLATE **B-3**

PROJECT NUMBER **74911** DATE **Jun 2007**

APPENDIX C

ADVANCED GEOLOGICAL SERVICES
800 SFD Blvd, Ste. E
San Anselmo, CA 94960
(415) 453-2800 (ph.)

September 19, 2006
Reference: 06-148-1CA

Mr. Jared Pratt
Kleinfelder, Inc.
2240 Northpoint Parkway
Santa Rosa, CA 95407

Subject: Seismic Refraction Survey
CRT Building, LBNL
Berkeley, California

Dear Mr. Pratt:

Advanced Geological Services, Inc. (AGS) presents this letter report to Kleinfelder, Inc. describing the results of a seismic refraction (SR) survey completed by geophysicist Dan Jones and field technician Steve Ward on August 31, 2006 at the subject site in Berkeley, California. Background information and site orientation were provided by Kleinfelder representatives.

SITE DESCRIPTION

The project site is located on a sloping hillside between Cyclotron Road and Building 70A at Lawrence Berkeley National Laboratory (LBNL). In general, the grassy ground surface is steeply sloping to the south in this area, with scattered eucalyptus trees. There is a sidewalk crossing the hillside toward the north-central portion of the site. A site map showing the seismic refraction survey location, overlain on a topographic map provided by Kleinfelder, is included as Figure 1. Locations of geotechnical borings and test pits were unavailable at the time this map was completed. Test pit information provided by Kleinfelder indicates approximately two feet of topsoil overlying colluvium, that in turn overlies an undifferentiated Cretaceous mixed sandstone-siltstone bedrock.

PURPOSE

Site information indicates that a new building is planned for the project site, with the approximate footprint as shown on Figure 1. It is AGS's understanding that this installation may involve maximum cuts to depths of 30 to 40 feet bgs. The purpose of the seismic refraction survey was to measure the (compressional or p-wave) velocity of subsurface seismic layers. AGS understands that this information will be used in conjunction with the boring and test pit results to evaluate the subsurface conditions, specifically the excavation characteristics, or rippability, of bedrock for pre-construction planning.

SEISMIC REFRACTION (SR) METHOD

The seismic refraction method provides information regarding the seismic velocity structure of the subsurface. The method is based upon the generation and propagation of an elastic wave (compressional P-wave) into the subsurface. The P-wave propagates through the ground and is refracted along interfaces that mark an increase in velocity. Part of the P-wave energy is refracted back to the ground surface and is subsequently monitored by a series of co-linear, vibration-sensitive devices called geophones that are placed at the ground surface. The resulting seismic waveforms are recorded on a seismograph and analyzed to determine the depth and velocities of subsurface seismic layers.

The physical properties of earth materials (fill, sediment, rock) such as compaction, density, hardness, and induration dictate the corresponding seismic velocity of the material. Additionally, other factors such as bedding, fracturing, weathering, and saturation can also affect seismic velocity. In general, low velocities are typically indicative of loose soil, poorly compacted fill material, poorly to semi-consolidated sediments, deeply weathered, and highly fractured rock. Conversely, high velocities are indicative of competent rock or dense and highly compacted sediments and fill. The highest velocities are measured in unweathered and little fractured rock.

There are certain limitations associated with the SR method as applied for this investigation. These limitations are primarily based on assumptions that are made by the data analysis routine. The data analysis routine assumes that the velocity of subsurface materials typically increase with depth. Therefore, if a layer exhibits velocities that are slower than those of the material above it, the slower layer may not be resolved. Also, a velocity interval may simply be too thin to be detected, for instance the upper weathered portion of the bedrock surface, if only a few feet thick.

The quality of the field data is critical to the construction of an accurate depth and velocity profile. Strong, clear "first-break" information from refracted interfaces will make the data processing, analysis, and interpretation much more accurate and meaningful. Vibrational noise or poor subsurface conditions can decrease the ability to accurately locate and pick seismic waves from the interfaces.

Due to these and other limitations inherent to the seismic refraction method, resultant velocity cross-sections should be considered only as approximations of the subsurface conditions. The actual conditions may vary locally. The actual conditions may vary locally and could warrant follow-up intrusive work for verification.

SEISMIC REFRACTION FIELD SURVEY

AGS obtained seismic refraction data along two (2) lines as shown on the Site Map (Figure 1). These lines are labeled A and B and are oriented roughly parallel to the topographic contours. Line A is located approximately 10-35 feet west of the head of the slope. Line B occurs further downslope by 85 to 100 feet. The approximate positions of these lines were chosen by

Kleinfelder to provide information in the desired locations and adjusted in the field based on accessibility. The approximate final position of each line was recorded on a topographic map supplied by Kleinfelder. The lines were each 225 feet in length (from end-shot to end-shot) to provide the desired depth of investigation (30-40 feet bgs). They were each comprised of one seismic spread consisting of 24 geophones and five shot points. The geophones were coupled to the ground surface in collinear arrays at 9 foot intervals. Shot points were located at the each end of each line and then every 54 to 58.5 feet along the lines. AGS used the supplied topographic map and some on-site hand-leveling to assign elevations to each geophone and shotpoint.

AGS produced P-waves through multiple impacts with a 16-lb sledge hammer against a metal plate placed on the ground surface. An accelerometer-switch attached to the hammer transmits a triggering pulse to the seismograph each time it strikes the plate. AGS detected the P-waves produced by the hammer impacts using 10-Hz high output geophones. The detected seismic signals were digitized and recorded using a DAQ Link II Seismograph. The data were recorded on an internal hard drive for later analysis.

DATA ANALYSIS

AGS downloaded the seismic data to a computer and processed it using the program SeisOpt Picker by *Optim, Inc.* to determine the shot point to geophone travel times. These travel times represent the first arrival of the P-wave energy to each geophone along the 24 channel spread. For each line, all first arrivals were determined in this fashion and combined to plot travel time versus geophone distance graphs, or "TD" graphs. These values, the travel times, and the location and relative elevation of each shot point and geophone were then entered into the computer program SeisOpt@2D (also by *Optim, Inc.*). The computer program uses a tomographic method, "discretizing" the subsurface below the line into grid cells of an appropriate size and assigns a velocity to each cell. Forward modeling is performed, generating test velocity models, through which travel times are calculated. These calculated travel times are compared with the observed data. The program then uses the generalized simulated annealing technique to perform a nonlinear optimization. It iteratively adjusts the velocities of each cell, recalculates the travel times, and reduces the error between the calculated and observed travel times. The optimal solution is the velocity model with the minimum acceptable travel-time error.

The final results of the seismic velocity tomographic modeling are presented as velocity cross sections of the subsurface. Each cross section contains a grid of seismic velocities as a function of horizontal distance and depth (or elevation). The grid is color contoured using SURFER (by *Golden Software*) to show an areal distribution of seismic velocity along each line, as opposed to a simple layered model. The same velocity contour scale is used for each line to allow for side-by-side comparison of the profiles.

The tomographic method, unlike traditional refraction processing techniques that employ either the generalized reciprocal method (GRM) or variations of the time-delay method, images velocity gradients in the subsurface. As is often the case in reality, the tomographic method reveals subsurface velocities as gradients and not solid layers. An appropriate gradient is introduced between horizons defined by discrete velocities. The interface between layers is the depth at which the gradient change is the steepest. In general, this will be shallower than the actual depth at which the layer velocity is encountered in the resulting velocity contour cross-section. For example, the interface between layers that have average velocities of 500 ft/s and 2000 ft/s, will not be at the 2000 ft/s contour line, but rather shallower where velocities are about 1,250-1,500 ft/s (i.e. typically where the contours are most closely spaced). Aside from increased resolution of velocities with depth, an additional benefit of the tomographic method includes the ability to incorporate lateral changes in seismic velocities across a bedrock refractor.

RESULTS AND DISCUSSION

The results of the seismic refraction survey along Lines A and B are represented by the seismic velocity cross-sectional profiles shown on Figures 2 and 3, respectively. The velocity cross-sectional profiles are presented as contoured results, with south to the left in each figure. This presentation is meant to show increased resolution of the velocities along each line, as opposed to a standard two or three layer earth model. Small contour closures, or very erratic contour lines along the edges of the cross sections may be attributable to processing artifacts. The overall cross-sections from this type of presentation, however, may be more representative of true subsurface conditions, particularly in the near-surface where gradational weathering may be experienced.

The cross-sections on Figures 2 and 3 indicate subsurface velocities ranging from 1,000 to 7,000 feet per second (ft/s). The estimated depth of investigation is approximated at 20 to 35 feet for Line A and 40 to 50 feet for Line B. The shallower depth of investigation for Line A may be attributable to refractor geometry or other unknown subsurface conditions toward the top of the slope. Along Line A, at depths below ground surface greater than 10-to-15 feet, the velocity ranges from 3,000 to 3,800 feet per second. Along Line B, higher velocity material is observed at depth, ranging up to 7,000 feet per second. The maximum velocity observed within forty feet of the ground surface (proposed maximum cut depth) along Line B is approximately 5,800 feet per second. The highest velocity material along Line B appears to be slightly deeper toward the middle of the profile than at the north and south ends of the line.

EXCAVATION CHARACTERISTICS (RIPPABILITY)

Seismic velocity charts relating seismic velocity and excavation characteristics have been developed from field tests by others. These charts list the seismic velocity of various types of bedrock materials and their relative ease of excavation using different types of rippers. Caterpillar Tractor Company publishes a performance manual that lists ripper performance charts for various size tractors and types of rippers. A review of a ripper performance chart from the Caterpillar Performance Handbook (October, 1997) indicates that with a D8R, sedimentary rock is rippable up to 6,300 ft/s and marginally rippable to 8,500 ft/s. Similarly, with a D11R, sedimentary rock is rippable up to 9,700 ft/s and marginally rippable to 12,000 ft/s.

This information should only be used as a general guide, however, as many other factors should also be considered. These factors include the rock jointing and fracture patterns, the experience of the equipment operator, and the equipment and excavation methods selected. This information should be combined with a complete and thorough analysis of test pit information, the geotechnical boring data, as well as local ripping experience (if available) to make a final assessment.

DATA QUALITY AND ADDITIONAL DISCUSSION

Overall, the seismic refraction data quality for this project was good. This estimation was determined based on the strength and relative obviousness of the refraction arrivals from the multiple velocity interfaces. AGS made a considerable effort to increase the signal-to-noise ratio where the data appeared of lesser quality by stacking additional impacts of the sledgehammer beyond what was necessary under normal conditions. Frequency filters were applied to the collected seismic data to attempt to minimize the effects of the observed noise.

CLOSING

All geophysical data and field notes collected as a part of this investigation will be archived at the AGS office. The data collection and interpretation methods used in this investigation are consistent with standard practices applied to similar geophysical investigations. The correlation of geophysical responses with probable subsurface features is based on the past results of similar surveys although it is possible that some variation could exist at this site. Due to the nature of geophysical data, no guarantees can be made or implied regarding the targets identified or the presence or absence of additional objects or targets.

It was a pleasure working with you on this project and we look forward to being able to provide you with geophysical services in the future.

Respectfully,

Advanced Geological Services, Inc.

Daniel P. Jones
Senior Geophysicist, PGp

Enclosure: Figures 1: Seismic Refraction Site Map
Figures 2-3: Seismic Refraction Profiles

ADVANCED GEOLOGICAL SERVICES

SEISMIC REFRACTION SURVEY
SITE MAP
CRT BUILDING – LBNL

LOCATION: BERKELEY, CALIFORNIA

CLIENT: KLEINFELDER, INC.

ADVANCED GEOLOGICAL SERVICES, INC.

PROJECT #: 06-148-1CA

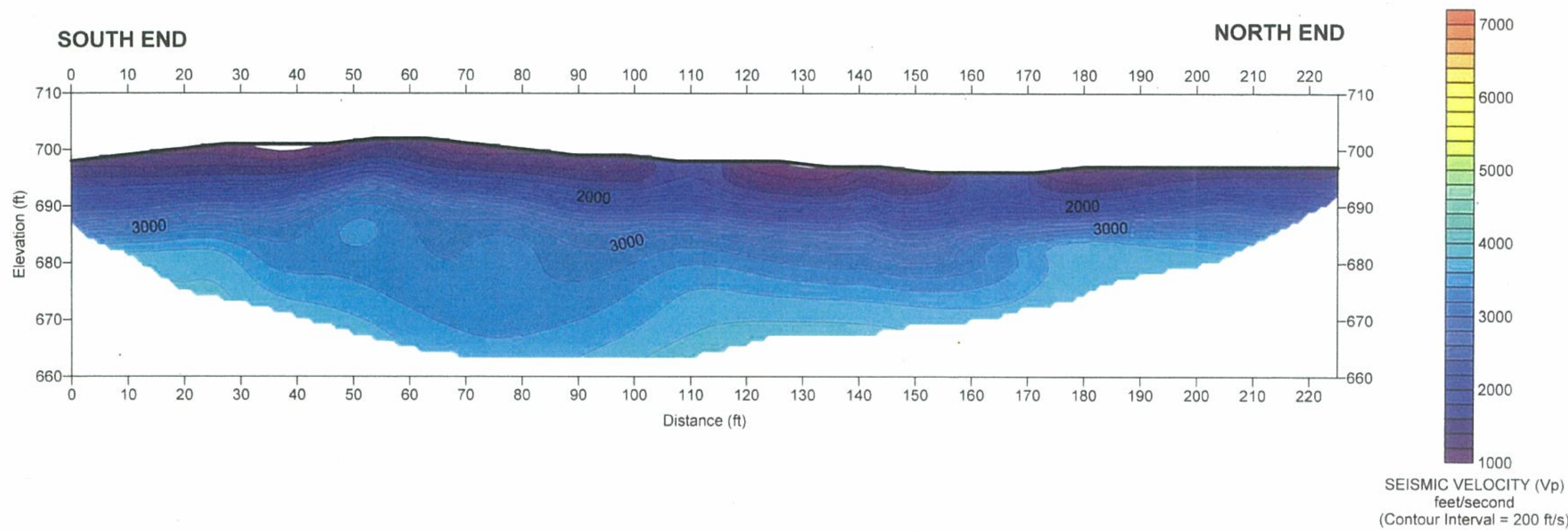
DATE: SEPTEMBER 2006

DRAWN BY: D. JONES

APPROVED BY: D. JONES

FIGURE 1

SEISMIC REFRACTION PROFILE - LINE A



NOTE:
1) Data were acquired with a 24 Channel DAQ Link II Seismograph coupled with 10 Hz geophones at 9 feet intervals. Data collection involved performing five shotpoints per line spaced every 54-58.5 feet.
2) Surface elevations are approximate.
3) Data were processed with SeisOpt@2D refraction interpretation software by Optim, Inc. Due to the limitations inherent to the seismic refraction method the velocity cross-section, although very detailed, should be considered an approximation of subsurface conditions.

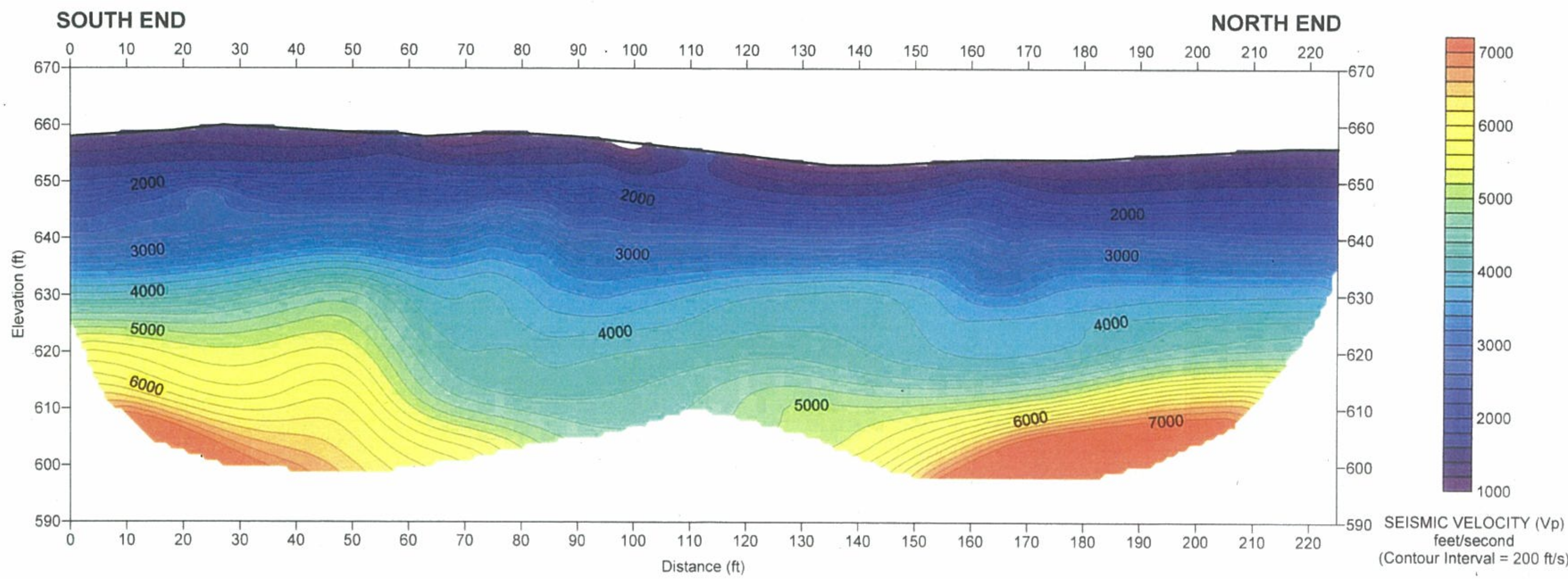
SCALE

0 10 20 40

(1 inch = 20 feet)

ADVANCED GEOLOGICAL SERVICES	SEISMIC PROFILE - LINE A CRT BUILDING - LBNL	
	LOCATION: BERKELEY, CALIFORNIA	
	CLIENT: KLEINFELDER, INC.	FIGURE
PROJECT #: 06-148-1CA	ADVANCED GEOLOGICAL SERVICES, INC.	2
DATE: SEPTEMBER 2006	DRAWN BY: D. JONES / APPROVED BY: D. JONES	

SEISMIC REFRACTION PROFILE - LINE B



NOTE:
1) Data were acquired with a 24 Channel DAQ Link II Seismograph coupled with 10 Hz geophones at 9 feet intervals. Data collection involved performing five shotpoints per line spaced every 54-58.5 feet.
2) Surface elevations are approximate.
3) Data were processed with SeisOpt@2D refraction interpretation software by Optim, Inc. Due to the limitations inherent to the seismic refraction method the velocity cross-section, although very detailed, should be considered an approximation of subsurface conditions.

SCALE

0 10 20 40

(1 inch = 20 feet)

ADVANCED GEOLOGICAL SERVICES

SEISMIC PROFILE - LINE B CRT BUILDING - LBNL		
LOCATION: BERKELEY, CALIFORNIA		
CLIENT: KLEINFELDER, INC.		FIGURE 3
PROJECT #: 06-148-1CA	ADVANCED GEOLOGICAL SERVICES, INC.	
DATE: SEPTEMBER 2006	DRAWN BY: D. JONES	APPROVED BY: D. JONES

APPENDIX D

KLEINFELDER
2405 140th Avenue NE Suite A101 Bellevue, WA 98005 (425) 562-4200 (425) 562-4201 fax

TECHNICAL MEMORANDUM (APPENDIX D)

TO:	Mark Stanley, GE	DATE:	09/21/06
FM:	Chad Lukkarila CEG, Brendan Fisher, PE, PG	PROJECT	74911: Task 1
RE:	LBNL CRT Building Cut Slope Preliminary Design Summary Berkeley, California		

As requested, we have completed preliminary estimates of the wall pressure, extent of bolting to support the vertical cuts on the back and side cuts, and foundation bearing pressure for spread footing foundations.

Stereonets

For the first part of our analysis, we plotted the orientations of the discontinuities mapped on stereonets using the computer programs Dips Version 5.0 by Rocscience and ROCKPACK III by C. F. Watts (2001) and preformed a Markland Analysis (Plate D-1). Where the stability of a rock cut is controlled by the structure of the rock mass, a Markland analysis is a well documented and widely accepted design tool even though the analysis does not provide a safety factor relating shear stresses to shear strength (Hoek and Bray, 1981; FHWA, 1998). The information required to perform the analysis are the design slope dip and dip direction, the orientation of the discontinuities within the rock mass, and the friction angle of the lithologies represented in the rock cut. Stereonets provide a two-dimensional representation of the three-dimensional discontinuity data. We plotted both poles and dip vectors. The poles tend to accentuate the orientation of steeply dipping discontinuities while the dip vectors lend themselves to performing Markland analyses.

The Markland analysis does not consider a cohesion intercept when modeling the strength of discontinuities. This method also assumes that the discontinuities are continuous and through-going with no "bridging" within the discontinuity. The effect of "bridging" would allow a tensional component (or cohesion intercept) of discontinuity strength. The factor of safety of the slope is estimated by dividing the tangent of the friction angle by the tangent of the dip of the discontinuity or the plunge of the line of intersection of two discontinuities. Therefore, when the dip of a discontinuity or the plunge of the line of intersection is greater than friction angle, the factor of safety is less that 1.0. When the dip of a discontinuity or the plunge of the line of

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intersection is less than the friction angle, the factor of safety is greater than 1.0. In either case, the structure will not daylight the slope if the dip or plunge is greater than the dip of the slope face.

We assumed friction angles of 30 degrees based on the detailed geomechanical information that we collected in the field, experience with similar rock types, and guidance from the Rock Slopes Reference Manual (FHWA, 1998). Vertical cut slopes are planned for the back wall and sidewall of the excavation. By inspection of the stereonets, we concluded that the proposed slope inclinations have the potential for wedge-, planar-, and toppling-type failures from the back wall and sidewall (Plate D-2).

Geomechanical Classifications

For the second part of our analysis, we completed geomechanical rock mass classifications. These classifications are accomplished using the field data and therefore are more of a design tool than actual field data collection. Two of the more widely accepted classifications systems are the Rock Mass Rating System (RMR) by Bieniawski (1989) and the Geological Strength Index (GSI) from Hoek (1997).

The RMR, also referred to as the geomechanics classification system, is based on the algebraic sum of six rock mass property ratings, namely:

- Strength of intact rock material (uniaxial compressive strength)
- Rock quality designation (RQD)
- Spacing of discontinuities
- Condition of discontinuities
- Groundwater conditions
- Orientation of discontinuities relative to the excavation or rock slope

To estimate the RMR, we compared field data to published tables by Bieniawski (1989). Values for RMR can range from 0 to 100. From the ratings, rock class and corresponding descriptions and engineering properties are assigned to the overall rock mass. Bieniawski's RMR classification can be related to Hoek's (1997) Geological Strength Index (GSI). If the 1989 version of Bieniawski's RMR classification is used, the $GSI = RMR_{89}' - 5$ where RMR_{89}' has the "Groundwater" rating set to 15 and "Adjustment for Joint Orientation" set to zero. For example, assume a RMR is calculated to be 30 with the groundwater rating set to 15 and the joint orientation adjustment set to –5 for favorable joint orientations. Correcting the RMR as stated above, it would equal 35 (groundwater set to 15 and joint orientation adjustment set to zero). The calculated GSI would then be calculated as RMR – 5, or 30. The GSI rating can also be estimated directly from the information that we collected during our field mapping.

The rock mass information collected at site indicates a siltstone with rock strength of 0.25 to 1 MPa (36 to 145 psi), or extremely weak rock. The RQD was estimated to be 5, which indicates a highly fractured rock mass. The RMR and GSI were estimated to be approximately 40 +/- 5, which indicated a very blocky to disturbed, fair quality rock mass with fair quality, moderately weathered discontinuity surfaces.

Slope Stability and Wall Pressure

For the third part of our analysis, we completed slope stability analyses for the potential wedge and planar-type failures along with a global stability analysis for failure through the rock mass. We utilized the computer programs, Rocplane V. 2.0 and Swedge V.4.0 by Rocscience® to complete the stability analyses on the potential wedge and planar-type failures. We assumed cohesion of zero and a friction angle of 30 degrees. We assumed a slope height of 43 feet based on the cross-section of the excavation. Plates D-3 and D-4 display the wedge and planar-type failures that are possible from the back wall and sidewall.

The geometry of each potential failure outlined in Plates D-3 and D-4 were analyzed using the computer programs discussed above to estimate the factor of safety. If the factor of safety was less than 1.0, we estimated a wall pressure to achieve a factor of safety greater than 1.0. Table 1 summarizes the failure geometries and the required wall pressures. Additionally, we estimated an equivalent earth pressure distribution for the design of a retention system during construction based on the "Plane 1" block geometry of the cut slope back wall listed below. Based on our calculations, the equivalent fluid pressure (safety factor of 1.0) is 50H (PCF).

Table 1. Summary of Potential Wedge and Planar Type Failures

Failure Geometry	Factor of Safety	Pressure Required for Factor of Safety >1.0 – rectangular distribution (tsf)	Width of Wedge on Upper Slope Surface (ft)
Cut Slope Back Wall			
Plane 1	0.4	0.50	29
Wedge 1	0.3	0.25	16
Wedge 2	1.1	NA	21
Wedge 3	1.0	NA	30
Wedge 4	0.4	0.35	29
Wedge 5	1.5	NA	45
Wedge 6	0.4	0.35	29
Wedge 7	0.2	0.22	11
Cut Slope Sidewall			
Plane 1	0.2	0.50	12
Wedge 1	2.0	NA	35
Wedge 2	0.3	0.25	14
Wedge 3	0.2	0.25	11
Wedge 4	0.2	0.19	8
Wedge 5	1.7	NA	18

We utilized the computer program Slide V. 5.0 by Rocscience® to complete the global stability analysis of the proposed cut slope. The proposed slope is stepped with a 43-foot high upper wall and a 30-foot high lower wall separated by a 45-foot wide horizontal bench. We estimated the Hoek-Brown strengths using the geomechanical data that we collected in the field. The following list presents specific design data for the cut slope.

- Siltstone
  - Rock Strength = 0.7 MPa (102 psi)
  - GSI = 40

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Figure 5 displays the stability analysis of the proposed slope and the estimated wall pressure required for a factor of safety greater than 1.0. The model indicates a rectangular pressure distribution over the height of the upper cut slope (43 feet) of 1,200 psf. We also estimated the pressure based on a standard triangular pressure distribution. Based on our calculations, the equivalent fluid pressure is 50H (PCF).

Foundation Bearing Pressure

The bearing pressure of footings on rock depends on the presence of discontinuities, weathering and the quality of the rock mass. The Caltrans Bridge Design Specifications dated April 2000 provides presumptive bearing pressure values for preliminary design of simple structures on good quality rock masses (Caltrans Table 4.11-4.1.4-1). In his book, Foundations on Rock (1999), Dr. Duncan Wylie provides estimates for bearing pressures based on rock strength and rock quality designation (RQD). Dr. Wylie states that bearing pressure estimates should be reduced for fractured rock based on the RQD. He states that for a RQD less than 50, the bearing pressure estimate should be reduced by a factor of 0.25 to 0.1. We estimated a RQD of 5 for the siltstone. Table 2 summarizes the pressure ranges based on Caltrans and the RQD adjusted ranges possible for the siltstone present at the site. We assumed a bearing pressure adjustment of 0.25 for the RQD.

Table 2. Summary of Allowable Bearing Pressures (Based on Caltrans, 2000)

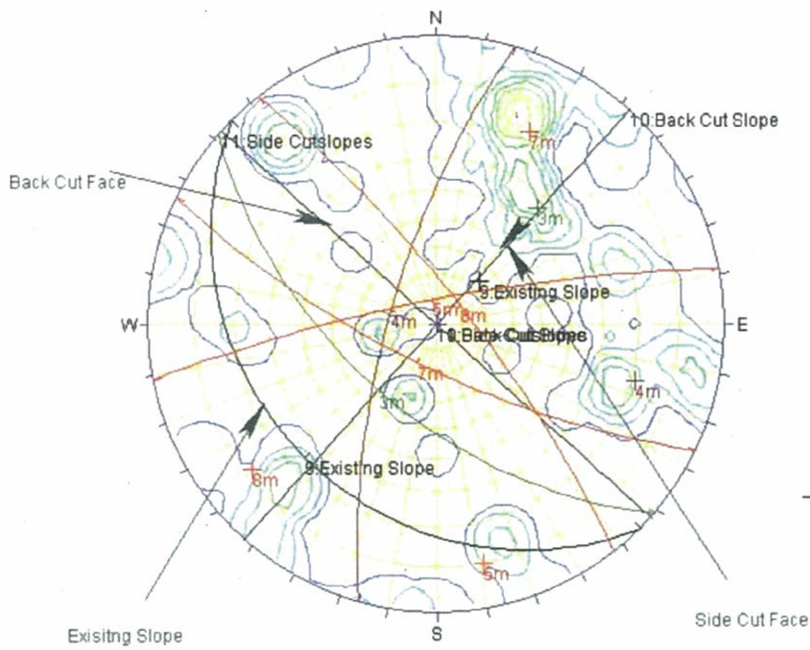
Type of Material	Consistency in Place	Ordinary Range (tsf)	RQD Adjusted Range (tsf)	Recommended Value (tsf)
Sedimentary Rock: Siltstone	Hard Sound Rock	15 to 25	3.75 to 6.25	5
Weathered or Broken Bedrock	Medium Hard Rock	8 to 12	2 to 3	2.5

We also calculated the ultimate bearing pressure of the rock using methods in Wyllie, 1999 based on the Hoek-Brown Failure Criterion for the rock mass. We estimated an ultimate bearing capacity ranging from 1.5 to 3 tsf.

Additionally, we completed an estimate of the bearing capacity based on bearing capacity theory (for soil). We assumed a friction angle of 35 degrees and cohesion of zero. Based on our calculations, the ultimate bearing capacity is approximately 12.0 tsf.

It appears reasonable to use a value of 10 tsf for the ultimate rock bearing capacity. The ultimate bearing capacity in sheared rock should be limited to 2.5 tsf.

One important consideration is that the values above are for "flat" ground where the distance of the footing from the top of a cut slope is greater than six times the width of the footing. If the distance is less, the ultimate bearing capacity would be lowered based on the slope geometry and distance. Alternatively, drilled piers can be used to support these foundations.



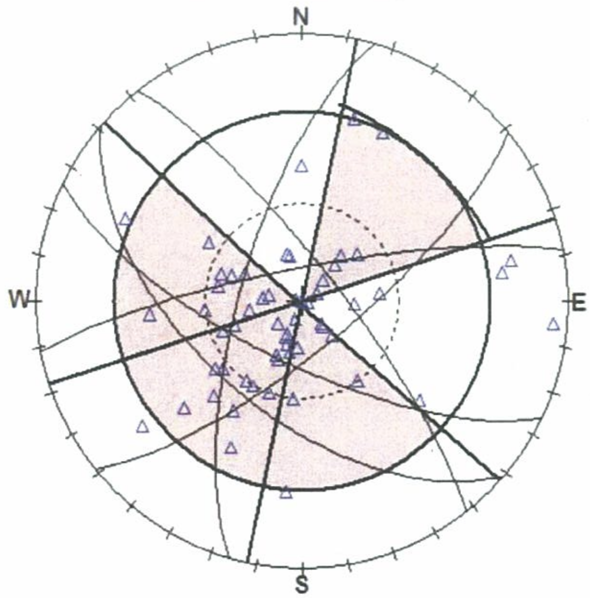
Orientations

ID		Dip / Direction
9		24 / 225
10		90 / 222
11		90 / 132
3	m	56 / 221
4	m	71 / 286
5	m	80 / 349
7	m	73 / 206
8	m	78 / 052

Equal Angle
Lower Hemisphere
62 Poles
62 Entries

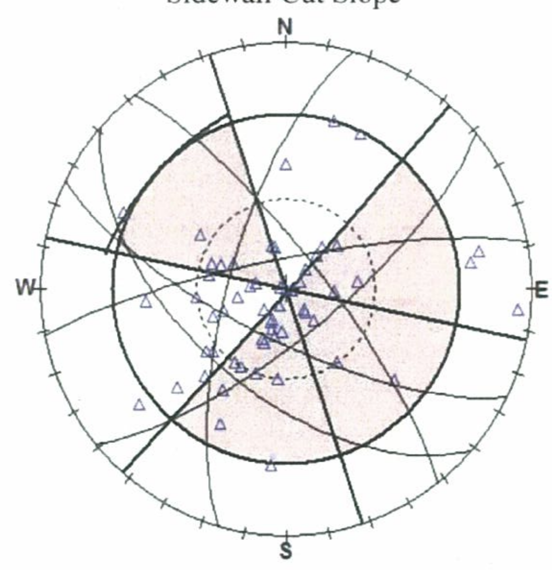
KLEINFELDER	**Stereonet**	**PLATE**
PROJECT NO. 74911 September 2006	CRT Building Lawrence Berkeley National Lab Berkeley, California	***D-1***

Backwall Cut Slope



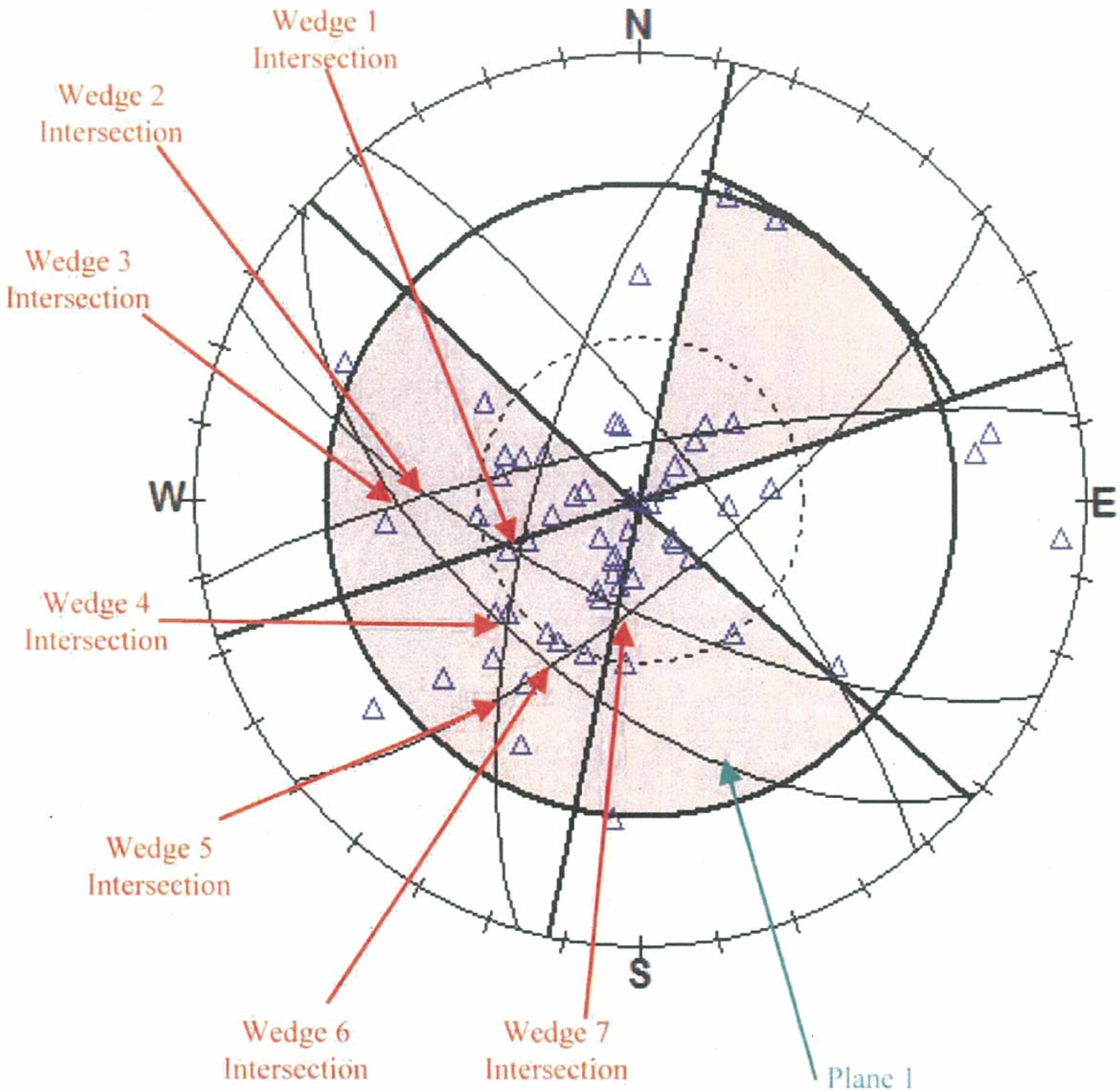
Dip = 90°
Direction = 222°
Friction = 30°

Sidewall Cut Slope



Dip = 90°
Direction = 132°
Friction = 30°

KLEINFELDER	**Markland Analyses** CRT Building Lawrence Berkeley National Lab Berkeley, California	**PLATE** ***D-2***
PROJECT NO. 74991 September 2006		



KLEINFELDER

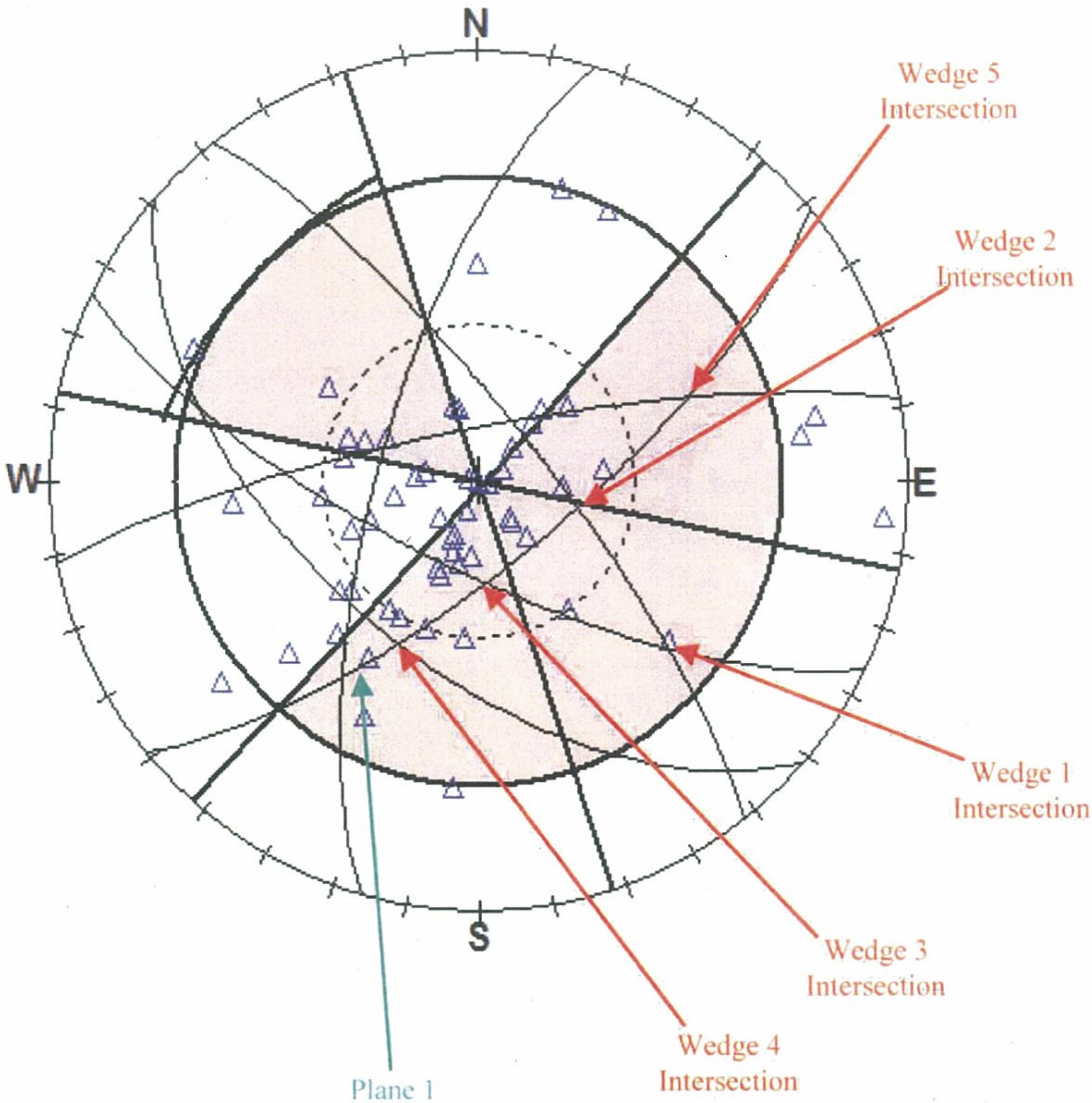
PROJECT NO. 74911 September 2006

Back Wall Failure Potential

CRT Building
Lawrence Berkeley National Lab
Berkeley, California

PLATE

D-3



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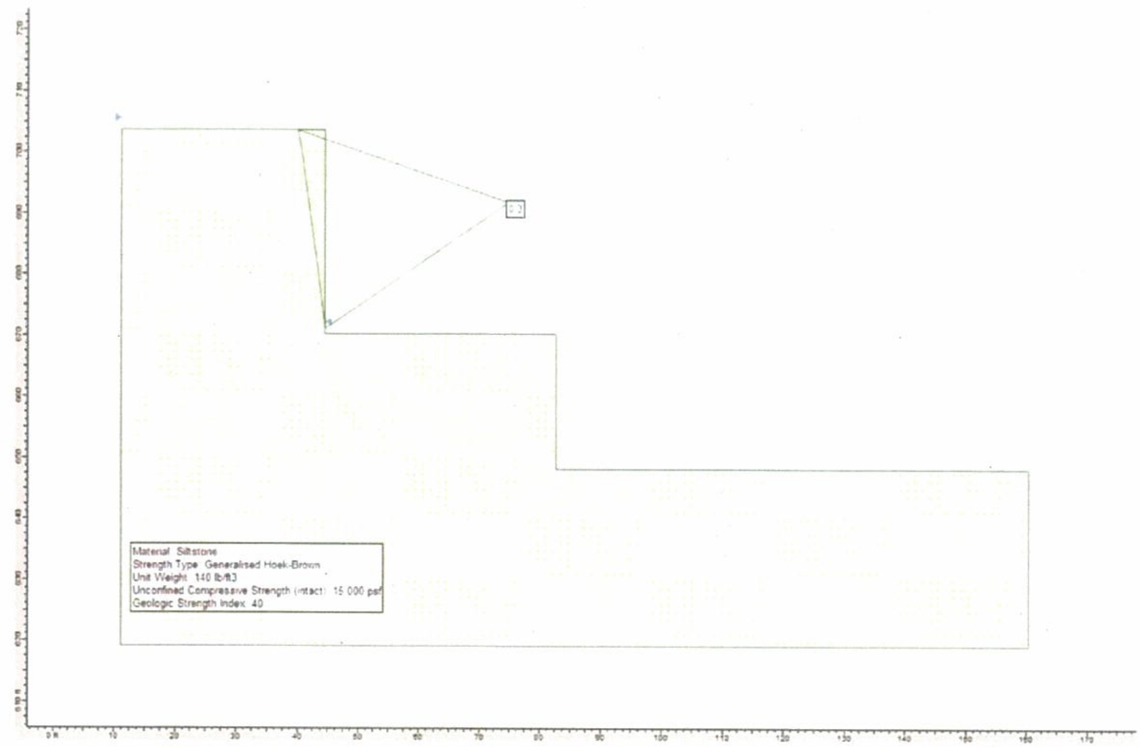
PROJECT NO. 74911 September 2006

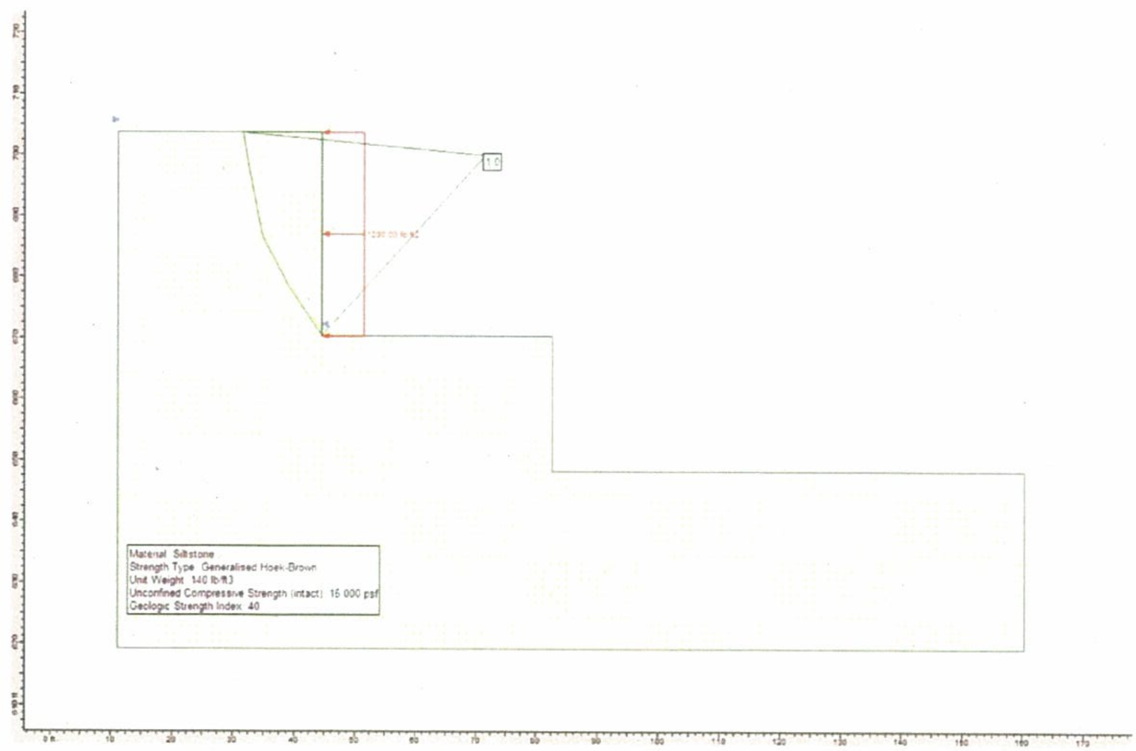
Sidewall Failure Potential

CRT Building
Lawrence Berkeley National Lab
Berkeley, California

PLATE

D-4





KLEINFELDER

PROJECT NO. 74911 September 2006

Global Stability Analysis

CRT Building
Lawrence Berkeley National Lab
Berkeley, California

PLATE

D-5

APPENDIX E

ETS

Environmental Technical Services

1343 Redwood Way
Petaluma, CA 94954
(707) 795-9605 / FAX 795-9384

-Soil, Water & Air Testing & Monitoring
-Analytical Labs
-Technical Support

Serving people and the environment so that both benefit.

COMPANY: Kleinfelder Associates, 2240 Northpoint Parkway, Santa Rosa, CA 95407			ANALYST(S)	SUPERVISOR
ATTN: Mark H. Stanley		DATE of	D. Salinas	D. Jacobson
JOB SITE: CRT Bldg, LBNL, Berkeley, California	DATE RECEIVED	COMPLETION	S. Santos	LAB DIRECTOR
FILE #: 74911-1	9/22/2006	10/2/2006		G.S. Conrad PhD

LAB SAMPLE NUMBER	SAMPLE ID	DESCRIPTION of SOIL and/or SEDIMENT	SOIL pH -log[H+]	NOMINAL RESISTIVITY ohm-cm	ELECTRICAL CONDUCTIVITY µmhos/cm	SULFATE SO4 ppm	CHLORIDE Cl ppm
02207-1	CRT1/LBNL	K-3 @ 15'	**6.45**	**2,440**	**[410]**	**84**	**40**
Method	Detection	Limits —>	---	1	0.1	1	1

LAB SAMPLE NUMBER	SAMPLE ID	DESCRIPTION of SOIL and/or SEDIMENT	SALINITY ECe mmhos/cm	SOLUBLE SULFIDES (S=) ppm	SOLUBLE CYANIDES (CN=) ppm	REDOX mV	PERCENT MOISTURE %
02207-1	CRT1/LBNL	K-3 @ 15'				**+328.9**	
Method	Detection	Limits —>	—	0.1	0.1	1	0.1

COMMENTS

Resistivity is nearly 2,500 ohm-cm which is fair, but soil reaction (i.e., pH) is mildly acidic which does not help; both sulfate and chloride are quite low; and redox is very mild. The Cal Trans times to perforation for this soil are as follows; 18 ga steel the time to perforation is nearly 17 yrs, and for 12 ga it goes up to about 37 yrs. Also, the average pitting rate determination for ductile iron and mild steel in this soil material is approximately at 0.130 mm/yr, thus pitting to a depth of 2 mm would be about 15 yrs; and to a 4 mm depth it would be 30 yrs. Chloride is low enough that it should not have any significant corrosion impact on concrete steel reinforcement; and sulfates are low enough that there should not be any adverse impact on concrete, mortar, grout or cement. The redox value indicates the soil is only very mildly reduced, thus there should be no significant adverse impact here either. As concerns buried metals, this soil would benefit greatly from alkaline treatment in that pushing its pH up to the 7.5-8.5 range would increase the 18 ga time to perforation to ≈36 yrs which is more than double the native soil time. Other than alkaline treatment, to increase metals longevity any more in this soil would require further upgrading (i.e., heavier gauge or more resistant steel); and/or that other actions be taken (e.g. special engineering fill, coating steel, cathodic protection, etc.). Last, standard concrete mixes (and related materials) do not appear to be at risk in this soil based on these results.

\\\\NOTES: Methods are from following sources: extractions by Cal Trans protocols as per Cal Test 417 (SO4), 422 (Cl), and 532/643 (pH & resistivity); &/or by ASTM Vol. 4.08 & ASTM Vol. 11.01 (=EPA Methods of Chemical Analysis, or Standard Methods); pH - ASTM G 51; Spec. Cond. - ASTM D 1125; resistivity - ASTM G 57; redox - Pt probe/ISE; sulfate - extraction Title 22, detection ASTM D 516 (=EPA 375.4); chloride - extraction Title 22, detection ASTM D 512 (=EPA 325.3); sulfides - extraction by Title 22, and detection EPA 376.2 (= SMEWW 4500-S D); cyanides - extraction by Title 22, and detection by ASTM D 4374 (=EPA 335.2).

APPENDIX F

Kleinfelder, 2006
Test Boring K-1

REFERENCE:

Kleinfelder, Inc., *Geotechnical Evaluation, Building 50 Seismic Retrofit, Lawrence Berkeley National Laboratory, Berkeley, California* (KA 75173) bound report dated September 29, 2006

SYMBOL	ROCK TYPE	SYMBOL	ROCK TYPE	SYMBOL	ROCK TYPE
	BRECCIA		SILTSTONE		PHYLLITE
	CLAYSTONE		MUDSTONE		SANDSTONE
	CONGLOMERATE		SHALE		GREENSTONE
	GRANITE		BEDROCK		VOLCANIC

WEATHERING

Fresh - No visible sign of rock material weathering; perhaps slight discoloration on major discontinuity surfaces. **Weathering Grade I.**

Slightly Weathered - Discoloration indicates weathering of rock material and discontinuity surfaces. All the rock material may be discolored by weathering and may be somewhat weaker externally than in its fresh condition. **Weathering Grade II.**

Moderately Weathered - Less than half of the rock material is decomposed and/or disintegrated to a soil. Fresh or discolored rock is present either as a continuous framework or corestones. **Weathering Grade III.**

Highly Weathered - More than half of the rock material is decomposed and/or disintegrated to a soil. Fresh or discolored rock is present either as a discontinuous framework or as corestones. **Weathering Grade IV.**

Completely Weathered - All rock material is decomposed and/or disintegrated to a soil. The original mass structure is still largely intact. **Weathering Grade V.**

Residual Soil - All rock material is converted to a soil. The mass structure and material fabric are destroyed. There is a large change in volume, but the soil has not been significantly transported. **Weathering Grade VI.**

STRENGTH (OF INTACT ROCK PIECES

Grade	Description	Field Identification	Approx. UCS (Mpa)	Approx. UCS (psi)
R0	Extremely Weak Rock	Idented by thumbnail	0.25 - 1.0	50 - 150
R1	Very Weak Rock	Crumbles under firm blows with point of geological hammer	1.0 - 5.0	150 - 750
R2	Weak Rock	Can be peeled by a pocket knife, specimen can be fractured with single firm blow of geological hammer	5.0 - 25	750 - 3,500
R3	Moderately Strong Rock	Cannot be scraped or peeled with pocket knife, specimen can be fractured with single firm blow of geological hammer	25 - 50	3,500 - 7,500
R4	Strong Rock	Specimen requires more than one blow of geological hammer to fracture it	50 - 100	7,500 - 15,000
R5	Very Strong Rock	Specimen requires many blows of geological hammer to fracture it	100 - 250	15,000 - 35,000
R6	Extremely Strong Rock	Specimen can only be chipped with geological hammer	>250	>35,000

DISCONTINUITY SPACING

	English	Metric
1. Extremely close	<1.0 in.	(<20 mm)
2. Very close	1.0 - 2.5 in.	(20 - 60 mm)
3. Close	2.5 - 8.0 in.	(60 - 200 mm)
4. Moderately	8.0 in - 2.0 ft.	(200 - 600 mm)
5. Wide	2.0 - 6.5 ft.	(600 - 2,000 mm)
6. Very wide	6.5 - 20.0 ft.	(2 - 6 m)
7. Ext. wide	>20.0 ft.	(>6 m)

APERTURE WIDTH

Very tight	<1.0 mm
Tight	0.1 - 0.25 mm
Partly open	0.25 - 0.5 mm
Open	0.5 - 2.5 mm
Moderately wide	2.5 - 10 mm
Wide	10 mm - 1 cm
Very wide	1 - 10 cm
Extremely wide	10 - 100 cm
Cavernous	>1 m

ROCK QUALITY DESIGNATION

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

$$RQD = \frac{\text{Sum of Intact Pieces >4 inches (100 mm)}}{\text{Total Core Run Length}}$$

KLEINFELDER

ROCK DESCRIPTION CRITERIA
Building 50 Seismic Retrofit
Lawrence Berkeley National Laboratory
Berkeley, California

PLATE

A-1

Drafted By: R. Padgett
Date: 09/29/06
Project No.: 75173
File Number: 75173

ROCK KEY BORING.GPJ 10/9/06

Date Completed: 9/25/2006 Logged By: R. Padgett

Boring Location: N37.87697 W122.25183

Driller: Pitcher Drilling Drilling Method/Size: Pitcher Barrel (2 7/8" diameter), Diamond Core (3" diameter)

Elev. Top of Hole: Approximately 752.6 ft. Total Depth: 61 feet Groundwater Depth: I NA / F NA

Elevation (ft., msl)	Depth (feet)	Time/Core Run Length	Recovery (in.)	Recovery (%)	RQD (%)	Fractures per foot	I. / F.	Graphic Log	ROCK DESCRIPTION/NOTES	DISCONTINUITIES
									AGGREGATE BASE-	
									SILTSTONE- olive gray & redbrown, very fine grained, slightly to moderately weathered, extremely weak, very closly fractured (Augered to 4-feet)	4.5 tsf (pocket penetrometer)
750										
	5		31	100	50	5			**SILTSTONE-** olive gray & redbrown, very fine grained, slightly to moderately weathered, closely fractured, weak, iron and manganese staining on fracture faces	Joint, 60 degrees to axis, closely spaced, smooth, undulating (JRC 4-6), thin clay infill, iron staining on joint faces, dry Joint, 60 degrees to axis, moderately spaced, slightly rough, undulating (JRC 8-10), dry Pitcher core advanced at 400 psi
745			30	100	76	>10			**SHALE-** red brown & olive gray, moderately weathered, extremely weak, highly sheared, sandstone corestones up to 2.5" diamter **CLAYEY SILTSTONE-** red brown, yellow brown and gray, moderately weathered, extremely weak, moist, blocky	Shear zone, highly sheared, moist, zone extends from 6.5 to 7 feet bgs, moist Joint, 50 degrees to axis, 2.0 tsf, moist Joint, 60 degrees to axis Joint, 50 degrees to axis, closely spaced, slightly rough to smooth, undulating (JRC 6-8), no infill, partly open to open, iron and manganese staining on joint faces Pitcher core advanced at 700 psi
	10		24	80	33	>10				Fracture, 60 degrees to axis, extremely closely spaced, smooth, undulating (JRC 4-6), thin clay infill, dry to moist Pitcher core advanced at 700 psi Very closely spaced fractures
740			24	100	33	>10				Joint, 60 degrees to axis, slightly rough to rough, undulating (JRC 8-10), no infill, dry
	15		24	80	72	5				Pitcher core advanced at 700 psi
735			30	100	26	>10			**SHALE-** dark gray, moderately weathered, closely fractured, weak	Fracture, 180 degrees to axis, very closely spaced, rough, undulating (JRC 8-10), tight, iron and manganese staining on fracture faces Shear zone, extremely closely spaced, zone extends from 17 to 18 feet bgs Joint, 60 degrees to axis, smooth, undulating (JRC 2-4), no infill Pitcher core advanced advanced at 800 psi Joint, 30 degrees to axis, closely spaced, smooth, undulating (JRC 6-8), no infill, iron
	20									

KLEINFELDER

Drafted By: R. Padgett Project No.: 75173
Date: 10/6/2006 File Number: 75173

LOG OF BORING K-1
Building 50 Seismic Retrofit
Lawrence Berkeley National Laboratory
Berkeley, California

PLATE 1 of 3

A-2

Elevation (ft., msl)	Depth (feet)	Time/Core Run Length	Recovery (in.)	Recovery (%)	RQD (%)	Fractures per foot	F.	Graphic Log	ROCK DESCRIPTION/NOTES	DISCONTINUITIES
			24	100	23	>10				staining on joint surfaces
									SHALE- dark gray, moderately weathered, very closely fractured, extremely weak, pressure facets present	Pitcher core practical refusal, switched to NQ Diamond core at 21 feet bgs Core rate 4 min/ft Fracture, 20 and 50 degrees to axis, very closely spaced, smooth to slickenside (JRC 2-4), tight, clay infill, iron and manganese staining Core rate 4 min/ft Core rate 4 min/ft
			60	100	48	>10				
725	25								**SHALE-** dark gray, slightly weathered, very weak to weak, closely fractured	Core rate 3 min/ft Joint, 60 degrees to axis, closely spaced, slightly rough to smooth, undulating (JRC 8-10), tight, no infill, iron staining on joint faces Core rate 3 min/ft Core rate 4 min/ft at 400 psi Joint, 60 degrees to axis, closely spaced, rough to very rough (JRC 18-20) Core rate 3 min/ft
			60	100	63	>10			**SHALE-** dark gray, moderately to highly weathered, extremely weak, closely fractured	Core rate 4 min/ft Core rate 3 min/ft
720	30									Core rate 4 min/ft Joint, 60 degrees to axis, smooth (JRC 2-4), no infill Shear zone, 30 to 50 degrees to axis, extremely closely spaced, smooth to slickensides (JRC 2-4), thin clay infill, iron staining and pressure facets on shears, shear zone extends from 31 to 36 feet bgs Core rate 3 min/ft Core rate 4 min/ft Core rate 4 min/ft
			60	100	21	>10				
715	35									Core rate 4 min/ft Core rate 4 min/ft Joint, 50 degrees to axis, closely spaced, smooth (JRC 2-4)
			60	100	0	>10				
710	40									Core rate 4 min/ft Core rate 5 min/ft
									SHALE- dark gray, highly weathered, extremely weak, extremely closely sheared	Shear Zone, extremely closely spaced, slickensides, wet, shear zone extends from 41 to 43 feet bgs Core rate 5 min/ft Core rate 5 min/ft

Elevation (ft., msl)	Depth (feet)	Time/Core Run Length	Recovery (in.)	Recovery (%)	RQD (%)	Fractures per foot	Graphic Log	ROCK DESCRIPTION/NOTES	DISCONTINUITIES
705	45		60	100	6	>10		**SHALE-** dark gray, moderately weathered, weak, closely fractured	Joint, 50 degrees to axis, closely spaced, smooth, undulating (JRC 4-6), tight, no infill, dry Core rate 4 min/ft Core rate 5 min/ft Joint, 40 degrees to axis, closely spaced, smooth (JRC 4-6) Core rate 5 min/ft
								SHALE- dark gray, highly weathered, extremely weak, pervasively sheared	Shear Zone, extremely closely spaced, slickensides, moist, zone extends from 46 to 49 feet bgs Core rate 6 min/ft Core rate 2 min/ft
			60	100	30	>10			
700	50							**SANDSTONE-** light gray, slightly weathered, moderately strong, closely fractured	Joint, 15 degrees to axis, rough, undulating (JRC 10-12), no infill, dry Core rate 3 min/ft Core rate 2 min/ft
								SHALE- dark gray, moderately weathered, extremely weak, extremely closely sheared	Shear zone, extremely closely spaced, slickensides, shear zone extends from 51 to 52.5 feet bgs Core rate 1 min/ft Joint, 40 degrees to axis, closely spaced, slightly rough (JRC 10-12) Core rate 2 min/ft
			60	100	18	>10			
695	55							**SANDSTONE-** gray, highly to completely weathered, very closely fractured, extremely weak	Core rate 2 min/ft Shear zone, extremely closely spaced, slickensides, shear zone extends from 56.5 to 58 feet bgs Core rate 2 min/ft Core rate 2 min/ft
			60	100	10	>10			
690	60							**SANDSTONE-** light gray, slightly to moderately weathered, very weak, closely fractured	Shear, 30 degrees to axis, very closely spaced, rough, undulating (JRC 10-12), clay infill, slickensides on shear faces Core rate 2 min/ft
								Boring completed at a depth of approximately 61 feet below existing site grade.	
685	65								

KLEINFELDER

Drafted By: R. Padgett
Date: 10/6/2006
Project No.: 75173
File Number: 75173

LOG OF BORING K-1
Building 50 Seismic Retrofit
Lawrence Berkeley National Laboratory
Berkeley, California

PLATE
3 of 3
A-2

CORING LOG BORING.GPJ 10/6/06

Fugro, 2002
Test Boring B-1 and B-2

REFERENCE:

Fugro West, Inc., *Geotechnical Investigation, Proposed Building 50X, Lawrence Berkeley National Laboratory, Berkeley, California* (FW 658.052) bound report dated August 5, 2002

UNIFIED SOIL CLASSIFICATION SYSTEM (ASTM D2487-93)

MAJOR DIVISIONS			GROUP NAMES	
COARSE-GRAINED SOILS More than 50% retained on the No. 200 sieve	GRAVELS MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	Clean gravels less than 5% fines	GW	Well-graded gravel, Well-graded gravel with sand
			GP	Poorly graded gravel, Poorly graded gravel with sand
		Gravels with more than 12% fines	GM	Silty gravel, Silty gravel with sand
			GC	Clayey gravel, Clayey gravel with sand
	SANDS MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE	Clean sand less than 5% fines	SW	Well-graded sand, Well-graded sand with gravel
			SP	Poorly graded sand, Poorly graded sand with gravel
		Sands with more than 12% fines	SM	Silty sand, Silty sand with gravel
			SC	Clayey sand, Clayey sand with gravel
FINE-GRAINED SOILS 50% or more passes the No. 200 sieve	SILTS AND CLAYS Liquid Limit Less than 50%		ML	Silt, Silt with sand or gravel, Sandy or gravelly silt, Sandy or gravelly silt with gravel or sand
			CL	Lean clay, Lean clay with sand or gravel, Sandy or gravelly lean clay, Sandy or gravelly lean clay with gravel or sand
			OL	Organic silt or clay, Organic silt or clay with sand or gravel, Sandy or gravelly organic silt or clay, Sandy or gravelly organic silt or clay with gravel or sand
	SILTS AND CLAYS Liquid Limit Greater than 50%		MH	Elastic silt, Elastic silt with sand or gravel, Sandy or gravelly elastic silt, Sandy or gravelly elastic silt with gravel or sand
			CH	Fat clay, Fat clay with sand or gravel, Sandy or gravelly fat clay, Sandy or gravelly fat clay with gravel or sand
			OH	Organic silt or clay, Organic silt or clay with sand or gravel, Sandy or gravelly organic silt or clay, Sandy or gravelly organic silt or clay with gravel or sand
HIGHLY ORGANIC SOILS			PT	Peat

For definition of dual and borderline symbols, see ASTM D2487-93.

KEY TO TEST DATA AND SYMBOLS

Perm	-	Permeability
Consol	-	Consolidation
LL	-	Liquid Limit
PI	-	Plasticity Index
Gs	-	Specific Gravity
MA	-	Particle Size Analysis
-200	-	Percent Passing No. 200 Sieve
ND	-	Not Detected
■	-	Tube Sample
⊠	-	Bag or Bulk Sample
◫	-	Lost Sample
∇	-	First Groundwater
▼	-	Stabilized Groundwater

	Shear Strength (psf)	Confining Pressure (psf)	
TxUU	3200	(2600)	Unconsolidated-Undrained Triaxial Shear
TxCU	3200	(2600)	Consolidated-Undrained Triaxial Shear
TxCD	3200	(2600)	Consolidated-Drained Triaxial Shear
SSCU	3200	(2600)	Consolidated-Undrained Simple Shear
SSCD	3200	(2600)	Consolidated-Drained Simple Shear
DSCD	2700	(2000)	Consolidated-Drained Direct Shear
UC	470		Unconfined Compression
LVS	700		Laboratory Vane Shear
FV	300		Field Vane Shear
RFV	300		
TV	800		Torvane Shear
PP	400		Pocket Penetrometer *(actual reading divided by 2)*

FUGRO SOIL CLASSIFICATION 658-052.GPJ SCI_CORP.GDT 5/15/02

FUGRO
FUGRO WEST, INC.
1000 Broadway, Suite 200, Oakland, California 94607
Tel: (510) 268-0461, Fax: (510) 268-0137

Building 50X Berkeley, California			PLATE
JOB NUMBER	DATE	APPROVED	A1
658.052	5/02		

BEDDING OF SEDIMENTARY ROCKS

Bed thickness in feet:

Very thick-bedded	Greater than 4.0
Thick-bedded	2.0 to 4.0
Thin-bedded	0.2 to 2.0
Very thin-bedded	0.05 to 0.2
Laminated	0.01 to 0.05
Thinly laminated	less than 0.01

FRACTURING

Size of pieces in feet:

Very little fractured	Greater than 4.0
Occasionally fractured	1.0 to 4.0
Moderately fractured	0.5 to 1.0
Closely fractured	0.1 to 0.5
Intensely fractured	0.05 to 0.1
Crushed	less than 0.05

HARDNESS

Soft . . . . reserved for plastic material alone.

Low hardness . . . . . can be gouged deeply or carved easily with a knife blade.

Moderately hard . . . . can be readily scratched by a knife blade; scratch leaves a heavy trace of dust and is readily visible after the powder has been blown away.

Hard . . . . can be scratched with difficulty; scratch produces little powder and is often faintly visible.

Very hard . . . . cannot be scratched with knife blade; leaves a metallic streak.

STRENGTH

Plastic . . . . very low strength.

Friable . . . . crumbles easily by rubbing with fingers.

Weak . . . . an unfractured specimen of such material will crumble under light hammer blows.

Moderately strong . . specimen will withstand a few heavy hammer blows before breaking.

Strong . . . . specimen will withstand a few heavy ringing hammer blows and will yield with difficulty only dust and small flying fragments.

Very strong . . . . specimen will resist heavy ringing hammer blows and will yield with difficulty only dust and small flying fragments.

WEATHERING

Deep . . . . moderate to complete mineral decomposition, extensive disintegration, deep and thorough discoloration, many fractures, all extensively coated or filled with oxides, carbonates and/or clay or silt.

Moderate . . . . slight change or partial decomposition of minerals, little disintegration; cementation little to unaffected. Moderate to occasionally intense discoloration. Moderately coated fractures.

Little . . . . no megascopic decomposition of minerals; little or no effect on normal cementation. Slight and intermittent, or localized discoloration. Few stains on fracture surfaces.

Fresh . . . . unaffected by weathering agents. No disintegration or discoloration. Fractures usually less numerous than joints.

ROCK CLASSIFICATION CRITERIA

FUGRO
FUGRO WEST, INC.
1000 Broadway Suite 200, Oakland, California 94607
Tel: (510) 268-0461, Fax: (510) 268-0137

Building 50X
Berkeley, California

JOB NUMBER 658.052

DATE 5/02

PLATE A2

LOG OF BORING

Project Name & Location: Building 50X, Berkeley, California	Ground Surface Elevation: 700 feet
	Elevation Datum: LBL Project Datum
Drilling Coordinates:	Start: Date 4/27/02, Time 08:00; Finish: Date 4/27/02, Time 10:45
Drilling Company & Driller: Gregg Jason/Lou	
Rig Type & Drilling Method: Mobile 61, Hollow Stem Auger	Drilling Fluid: NA; Hole Diameter: 6.5"
Sampler Type(s): A) Modified California (3" O.D., 2.5" I.D.); B) SPT (2" O.D., 1.4" I.D.)	Logged By: AF
Sampling Method(s): A) 140 lb hammer with 30" drop (Wireline); B) 140 lb hammer with 30" drop (Wireline)	Backfill Method: Cement Grout; Date: 4/27/02

Depth (feet)	Sampler Type	Blows/6 inches or pressure	Blows/12 inches	SOIL DESCRIPTIONS: GROUP NAME (GROUP SYMBOL) color, consistency/density, moisture condition, other descriptions (Local Name or Material Type)	Moisture Content (%)	Dry Density (pcf)	Other
0				**ASPHALTIC CONCRETE 3 - INCHES THICK**			
				GRAVELLY LEAN CLAY (CL) Dark brown, soft, moist (fill)			
	A	2 2 2	4		13.9	92	
5	A	12 17 25	42	**GRAVELLY LEAN CLAY (CL)** Brown, stiff to very stiff, moist. With rock fragments at 5.0'	15.1	102	
	A	8 7 8	15		18.3	102	
10				With reddish brown sand pockets			
	A	12 17 25	42				
15				**SANDSTONE** Brown, intensely to moderately fractured, low to moderately hard, friable, moderate to deep weathering			
	A	18 35 40	75		21.6	102	TxUU = 2830 psf PP = 3250 psf
20							
	A	16 23 28	51		18.8	108	PP = 3750 psf
25				Trace reddish brown sandstone fragments Gray clay filled seams			
	B	7 11 15	26	Color change to brownish gray at 29.0'			
30				Hard drilling at 32.0'			
	B	50/4"	50/4"	Refusal at 33.0'			
35				Bottom of boring at 33.4 feet below ground surface.			
				Notes Groundwater not encountered during drilling			
40							

FUGRO WEST, INC.
1000 Broadway, Suite 200, Oakland, California 94607
Tel: (510) 268-0461, Fax: (510) 268-0137

Building 50X
Berkeley, California

JOB NUMBER 658.052 | DATE 6/02 | BORING B-1

LOG OF BORING

Project Name & Location: Building 50X Berkeley, California	Ground Surface Elevation: 646 feet Elevation Datum: LBL Project Datum
Drilling Coordinates:	Start: Date 4/27/02 Time 11:30 — Finish: Date 4/27/02 Time 13:30
Drilling Company & Driller: Gregg Jason/Lou	Drilling Fluid: NA — Hole Diameter: 6.5"
Rig Type & Drilling Method: Mobile 61, Hollow Stem Auger	
Sampler Type(s): A) Modified California (3" O.D., 2.5" I.D.) B) SPT (2" O.D., 1.4" I.D.)	Logged By: AF
Sampling Method(s): A) 140 lb hammer with 30" drop (Wireline) B) 140 lb hammer with 30" drop (Wireline)	Backfill Method: Cement Grout — Date: 4/27/02

Depth (feet)	Sampler Type	Blows/6 inches or pressure	Blows/12 inches	Soil Descriptions: GROUP NAME (GROUP SYMBOL) color, consistency/density, moisture condition, other descriptions (Local Name or Material Type)	Moisture Content (%)	Dry Density (pcf)	Other
0				**ASPHALTIC CONCRETE 4 - INCHES THICK** **SANDY LEAN CLAY WITH GRAVEL (CL)** Dark brown, stiff, moist, with siltstone at 3 feet (fill)			
	A	8 11 16	27		13.3	111	
5	A	6 8 13	21	**SANDY LEAN CLAY WITH GRAVEL (CL)** Brown, stiff, moist	16.7	110	
10	A	9 11 30	41		18.4	104	TxUU = 1740 psf
				SANDSTONE Brown, intensely to moderately fractured, low to moderately hard, friable to weak, moderate weathering			
	A	50/6"	50/6"		10.5	111	PP = 2000 psf
15	B	17 18 22	40		18.4	99	
20	B	20 30 50	80		7	121	
	B	50/4"	50/4"				
25				Bottom of boring at 24 feet below ground surface. Notes Groundwater not encountered during drilling			
30							
35							
40							

FUGRO
FUGRO WEST, INC.
1000 Broadway, Suite 200, Oakland, California 94607
Tel: (510) 268-0461, Fax: (510) 268-0137

Building 50X
Berkeley, California

JOB NUMBER 658.052 — DATE 6/02

BORING **B-2**

SCI, 1992
Test Boring B-1

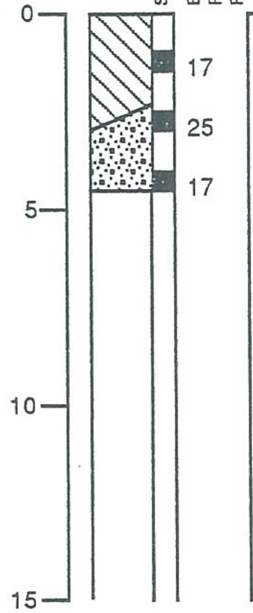
REFERENCE:

Subsurface Consultants, Inc., *Geotechnical Investigation, Acid Neutralization Tank Enclosure, Building 70a, Lawrence Berkeley Laboratory, Berkeley, California* (SCI 658.007) letter report dated March 30, 1992

LOG OF TEST BORING 1

EQUIPMENT 3" Minuteman
DATE DRILLED 3/12/92
ELEVATION - -

LABORATORY TESTS	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	OVM (PPM)	DEPTH (FEET)	SAMPLE	BLOWS PER FOOT



ORANGE BROWN CLAYEY SILT (CL-ML)
stiff, moist, some gravel

DRAIN ROCK

hole abandoned because of caving

UC = Unconfined Compressive
Shear Strength (psf)

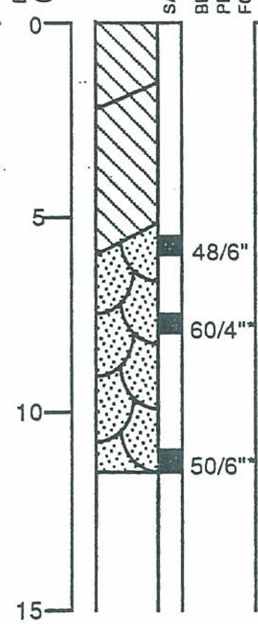
SAMPLER TYPES:
CALIFORNIA DRIVE
I.D.: 2.5 inches
O.D.: 2.0 inches
*STANDARD PENETRATION TEST
O.D.: 2.0 inches
I.D.: 1.4 inches

HAMMER WEIGHT: 70 pounds
HAMMER DROP: 30 inches

LOG OF TEST BORING 1A

EQUIPMENT 3" Minuteman
DATE DRILLED 3/12/92
ELEVATION - -

LABORATORY TESTS	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	OVM (PPM)	DEPTH (FEET)	SAMPLE	BLOWS PER FOOT



DARK BROWN SILTY CLAY (CL)
medium stiff, moist
LIGHT BROWN SANDY CLAY (CL)
stiff, moist

GRAY BROWN SANDSTONE
fractured, fine grained, weathered, soft, friable

auger refusal at 11 feet

Subsurface Consultants

LBL ACID TANK ENCLOSURE - BERKELEY, CA

JOB NUMBER	DATE	APPROVED	PLATE
658.007	3/30/92	SL	2

GENERAL SOIL CATEGORIES			SYMBOLS	TYPICAL SOIL TYPES
COARSE GRAINED SOILS More than half is larger than No. 200 sieve	GRAVEL More than half coarse fraction is larger than No. 4 sieve size	Clean Gravel with little or no fines	GW	Well Graded Gravel, Gravel-Sand Mixtures
			GP	Poorly Graded Gravel, Gravel-Sand Mixtures
		Gravel with more than 12% fines	GM	Silty Gravel, Poorly Graded Gravel-Sand-Silt Mixtures
			GC	Clayey Gravel, Poorly Graded Gravel-Sand-Clay Mixtures
	SAND More than half coarse fraction is smaller than No. 4 sieve size	Clean sand with little or no fines	SW	Well Graded Sand, Gravelly Sand
			SP	Poorly Graded Sand, Gravelly Sand
		Sand with more than 12% fines	SM	Silty Sand, Poorly Graded Sand-Silt Mixtures
			SC	Clayey Sand, Poorly Graded Sand-Clay Mixtures
FINE GRAINED SOILS More than half is smaller than No. 200 sieve	SILT AND CLAY Liquid Limit Less than 50%		ML	Inorganic Silt and Very Fine Sand, Rock Flour, Silty or Clayey Fine Sand, or Clayey Silt with Slight Plasticity
			CL	Inorganic Clay of Low to Medium Plasticity, Gravelly Clay, Sandy Clay, Silty Clay, Lean Clay
			OL	Organic Clay and Organic Silty Clay of Low Plasticity
	SILT AND CLAY Liquid Limit Greater than 50%		MH	Inorganic Silt, Micaceous or Diatomaceous Fine Sandy or Silty Soils, Elastic Silt
			CH	Inorganic Clay of High Plasticity, Fat Clay
			OH	Organic Clay of Medium to High Plasticity, Organic Silt
HIGHLY ORGANIC SOILS			PT	Peat and Other Highly Organic Soils

UNIFIED SOIL CLASSIFICATION SYSTEM

Subsurface Consultants

LBL ACID TANK ENCLOSURE – BERKELEY, CA

JOB NUMBER	DATE	APPROVED	PLATE
658.007	3/30/92	SL	4

10

BEDDING OF SEDIMENTARY ROCKS

Very thick-bedded	Greater than 4.0	Bed thickness in feet
Thick-bedded	2.0 to 4.0	
Thin-bedded	0.2 to 2.0	
Very thin-bedded	0.05 to 0.2	
Laminated	0.01 to 0.05	
Thinly laminated	less than 0.01	

FRACTURING

Very little fractured	Greater than 4.0	Size of pieces in feet
Occasionally fractured	1.0 to 4.0	
Moderately fractured	0.5 to 1.0	
Closely fractured	0.1 to 0.5	
Intensely fractured	0.05 to 0.1	
Crushed	less than 0.05	

HARDNESS

Soft .... reserved for plastic material alone.

Low hardness .... can be gouged deeply or carved easily with a knife blade.

Moderately hard .... can be readily scratched by a knife blade; scratch leaves a heavy trace of dust and is readily visible after the powder has been blown away.

Hard .... can be scratched with difficulty; scratch produces little powder and is often faintly visible.

Very hard .... cannot be scratched with knife blade; leaves a metallic streak.

STRENGTH

Plastic .... very low strength.

Friable .... crumbles easily by rubbing with fingers.

Weak .... an unfractured specimen of such material will crumble under light hammer blows.

Moderately strong ... specimen will withstand a few heavy hammer blows before breaking.

Strong .... specimen will withstand a few heavy ringing hammer blows and will yield with difficulty only dust and small flying fragments.

Very strong .... specimen will resist heavy ringing hammer blows and will yield with difficulty only dust and small flying fragments.

WEATHERING

Deep .... moderate to complete mineral decomposition, extensive disintegration, deep and thorough discoloration, many fractures, all extensively coated or filled with oxides, carbonates and/or clay or silt.

Moderate .... slight change or partial decomposition of minerals, little disintegration; cementation little to unaffected. Moderate to occasionally intense discoloration. Moderately coated fractures.

Little .... no megascopic decomposition of minerals; little or no effect on normal cementation. Slight and intermittent, or localized discoloration. Few stains on fracture surfaces.

Fresh .... unaffected by weathering agents. No disintegration or discoloration. Fractures usually less numerous than joints.

ROCK CLASSIFICATION CRITERIA

Subsurface Consultants

LBL ACID TANK ENCLOSURE – BERKELEY, CA

JOB NUMBER	DATE	APPROVED	PLATE
658.007	3/30/92	SL	5

GRC, 1990
Test Borings B-1 through B-3

REFERENCE:

Geo/Resource Consultants, Inc., *Proposed Air Handling Units (AHU), South of Building 70A, Lawrence Berkeley Laboratory, Berkeley, California* (GRC 1574-00-0) bound report dated May 22, 1990

LOG OF BORING B-1

Equipment: Solid Flight Auger

Elevation: ~ 730 ft. Date: 4/5/90

Laboratory Analyses	Blows/ft.	Moisture Content (%)	Dry density (pcf)	Depth (ft.)	Description
Qu/2 = 4979 psf	50	12.2	115.0	0	BROWN SANDY CLAY (CL) hard, with sandstone fragments, shale fragments, iron staining
	50/6"			5	BROWN SILTSTONE soft, friable, severely weathered, intensely fractured
	35/6"			10	
					grades to moderately weathered @ 14 ft.
DS/CU = 4342 psf @ 1 ksf = 3413 psf @ 2 ksf = 4361 psf @ 4 ksf	35/6"			15	
	40/6"			20	grades to moderately hard, moderately strong, moderately weathered, intensely fractured to crushed
	35/4"			25	GRAY SHALE soft, weak, slightly weathered, crushed; contains slickensides
					Boring Terminated @ 26 ft. No groundwater was encountered during drilling
				30	
				35	
				40	

Blowcount is penetration resistance of California Modified Sampler driven by a 140 lbs hammer falling 30 inches.

Geo/Resource Consultants, Inc.
Geologists / Engineers / Environmental Scientists

Job No. 1574-000-0 Appr: JY Date 4/10/90

LOG OF BORING B-1

LBL ADDITION A.H.U.
LAWRENCE BERKELEY LABORATORY
BERKELEY, CALIFORNIA

FIGURE 3

LOG OF BORING B-2

Equipment: Solid Flight Auger

Elevation: ~ 730 ft. Date: 4/5/90

Laboratory Analyses	Blows/ft.	Moisture Content (%)	Dry density (pcf)	Depth (ft.)	Description
PL = 21 LL = 31 PI = 10 Qu/2 =3400 psf	22	12.5	105	0–4	BROWN SANDY CLAY (CL) moist, very stiff, with sandstone fragments occasional shale fragments, iron staining
	44			4–7	BROWN SILTSTONE moderately hard, moderately strong, moderately weathered, closely fractured
				7	Refusal @ 7 ft. Boring Terminated @ 7 ft. No groundwater was encountered during drilling

Blowcount is penetration resistance of California Modified Sampler driven by a 140 lbs hammer falling 30 inches.

Geo/Resource Consultants, Inc.
Geologists / Engineers / Environmental Scientists

Job No. 1574-000-0 Appr: JT Date 4/10/90

LOG OF BORING B-2

LBL ADDITION A.H.U.
LAWRENCE BERKELEY LABORATORY
BERKELEY, CALIFORNIA

FIGURE 4

LOG OF BORING B-2A

Equipment: Solid Flight Auger

Elevation: ~730 ft. Date: 4/5/90

Laboratory Analyses	Blows/ft.	Moisture Content (%)	Dry density (pcf)	Depth (ft.)	Description
				0	**BROWN SANDY CLAY (CL)** very stiff, with sandstone fragments, occasional shale fragments
	58			5	grades to very hard @ 5 ft.
					GRAY SILTSTONE soft, weak, moderately weathered, intensely fractured
	40/2"			10	hit boulder @ 9 ft - 9.5 ft.
	50			15	grades very soft, friable, severely weathered
	25/2"			20	**GRAY SHALE** soft, weak, moderately weathered crushed
	40/2"			25	
					Boring Terminated @ 26 ft. No groundwater was encountered during drilling
				30	
				35	
				40	

Blowcount is penetration resistance of California Modified Sampler driven by a 140 lbs hammer falling 30 inches.

Geo/Resource Consultants, Inc.
Geologists / Engineers / Environmental Scientists

Job No. 1574-000-0 Appr: SY Date 4/10/90

LOG OF BORING B-2A

LBL ADDITION A.H.U.
LAWRENCE BERKELEY LABORATORY
BERKELEY, CALIFORNIA

FIGURE 5

LOG OF BORING B-3

Equipment: Solid Flight Auger

Elevation: ~ 730 ft. Date: 4/5/90

Laboratory Analyses	Blows/ft.	Moisture Content (%)	Dry density (pcf)	Depth (ft.)	Description
PL = 24 LL = 40 PI = 16	16			0	BROWN SANDY CLAY (CL) moist, stiff, contains siltstone fragments
				5	grades to very stiff @ 5 ft.
Qu/2 = 4392 psf	30	12.3	106		grades to hard @ 8.5 ft.
	45/6"			10	BROWN SILTSTONE soft, weak to moderately strong, moderately weathered, intensely fractured
	55/6"			15	becomes gray, moderately hard, moderately strong, slightly weathered
	60/6"			20	grades to gray shalestone @ 19 ft.
					Boring Terminated @ 21 ft. No groundwater was encountered during drilling
				25	
				30	
				35	
Blowcount was obtained by 140 lbs. hammer, falling 30 inches, and S & H Sampler.				40	

Geo/Resource Consultants, Inc.
Geologists / Engineers / Environmental Scientists

Job No. 1574-000-0 Appr: JT Date 4/10/90

LOG OF BORING B-3

LBL ADDITION A.H.U.
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BERKELEY, CALIFORNIA

FIGURE 6

UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS				SOIL DESCRIPTION
COARSE GRAINED SOILS over 50% coarser than #200 sieve	GRAVELS over half of coarse fraction larger than No. 4 sieve	clean gravels with little or no fines	GW	Well Graded Gravels, Gravel - Sand Mixtures
			GP	Poorly Graded Gravels, Gravel - Sand Mixtures
		gravels with over 12% fines	GM	Silty Gravels, Poorly Graded Gravel - Sand - Silt Mixtures
			GC	Clayey Gravels, Poorly Graded Gravel-Sand-Clay Mixtures
	SANDS over half of coarse fraction finer than No. 4 sieve	clean sands with little or no fines	SW	Well Graded Sands, Gravelly Sands
			SP	Poorly Graded Sands, Gravelly Sands
		sands with over 12% fines	SM	Silty Sands, Poorly Graded Sand - Silt Mixtures
			SC	Clayey Sands, Poorly Graded Sand - Clay Mixtures
FINE GRAINED SOILS over 50% is finer than #200 sieve	SILTS AND CLAYS liquid limit less than 50		ML	Silts, Very Fine Sands, Silty or Clayey Fine Sands
			CL	Low Plasticity Clays, Sandy or Silty Clays
			OL	Low Plasticity Organic Silts and Clays
	SILTS AND CLAYS liquid limit greater than 50		MH	Micaceous or Diatomaceous Silts, Volcanic Ash, Elastic Silts
			CH	High Plasticity Clays - Fat Clays
			OH	High Plasticity Organic Silts and Clays
	HIGHLY ORGANIC SOILS		Pt	Peat and Other Fibrous Organic Soils

KEY TO SAMPLES

- "Undisturbed" 2.5" sample
- Disturbed Sample
- Indicates depth of sampling with no recovery
- Indicates depth and location of coring run
- Indicates depth of Standard Penetration Test and 2" sample

KEY TO TEST DATA

Shear Strength, psf
Confining Pressure or Normal Load, psf

TxUU	750	(2600)	Unconsolidated Undrained Triaxial
TxCU	540	(2600)	Conslidated Undrained Triaxial
TxCD	800	(2600)	Consolidated Drained Triaxial
DS	500	(2000)	Direct Shear
UC	400		Unconfined Compression
FVS	470		Field Vane Shear
FP	500		Field Penetrometer

PI = Plasticity Index
C = Consolidation Test

Geo/Resource Consultants, Inc.
Consulting Engineers, Geologists, Geophysicists

Job No. 1574-00-0 Appr: JY Date 4/18/90

SOIL CLASSIFICATION CHART AND KEY TO TEST DATA

FIGURE 7

HLA, 1983
Test Borings 1.165 through 4.165

REFERENCE:

Harding Lawson Associates, *Geotechnical Investigation, Building 50F, Office Addition, Lawrence Berkeley Laboratory, Berkeley, California,* (HLA 2000,165.01) bound report dated March 1, 1983

Equipment 6" Flight Auger

Elevation 702 Feet Date 11/1/82

Laboratory Tests	Blows/foot	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	Cored Interval	Depth (ft)	Description
						0	2" ASPHALT, 6" BASE
		11.6	123				GRAY SHALE intensely fractured, soft, weak moderately weathered, sheared with abundant clay fracture fillings
TXUU = 1800 psf @ 720 psf		5.4	130			5	
						10	
						15	
							change to moderately hard, moderately strong
						20	
							auger refusal at 24'
						25	
							(water level not stabilized prior to backfilling)
						30	
						35	
						40	

Harding Lawson Associates
Engineers, Geologists
& Geophysicists

Log of Boring 1.165
Building 50F
Lawrence Berkeley Laboratory
Berkeley, California

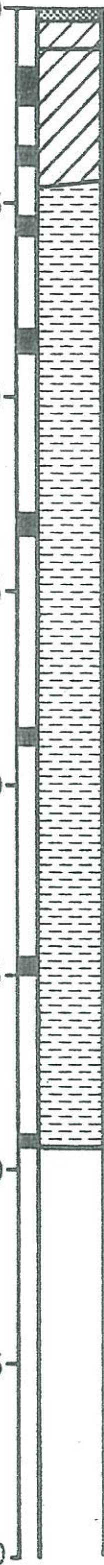
PLATE **2**

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
J. Weitzel	2000,165.01	LEL	1/83		

Equipment 6" Flight Auger

Elevation 701 Feet Date 11/1/82

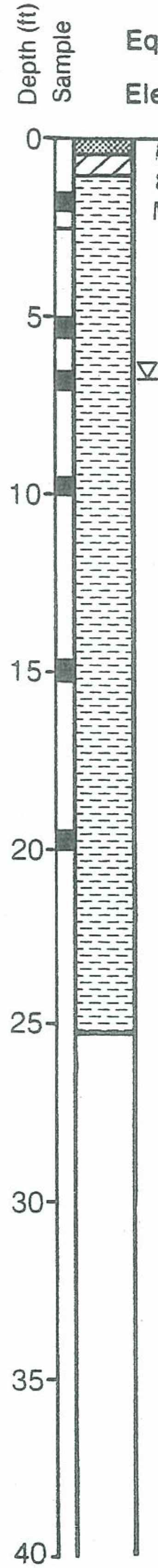
Laboratory Tests	Blows/foot	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	Cored Interval	Depth (ft)	Sample	Description
						0		4" ASPHALT
								8" SANDY CLAY SUBBASE
								DARK BROWN CLAY (CL) very stiff, moist, (weathered rock)
TXUU = 3120 psf @ 720 psf		11.4	114					
						5		BROWN SHALE intensely fractured, low hardness, weak, highly weathered
						10		color change to gray
								change to moderately hard, moderately strong, little weathered
						15		
						20		change to low hardness, weak between 23' and 26'
						25		
		6.9	131					auger refusal at 29.5'
						30		(no free water encountered)
						35		
						40		



Laboratory Tests	Blows/foot	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	Cored Interval
TXUU = 3420 psf @ 720 psf		8.5	127		
TXUU = 4150 psf @ 720 psf		10.5	130		

Equipment 6" Flight Auger

Elevation 701.5 Feet Date 11/1/82



4" ASPHALT

8" BROWN SANDY CLAY FILL

MOTTLED GRAY-BROWN SHALE
intensely fractured, soft, weak, little weathered with clay-filled fractures

water level 11/1/82

change to gray, low hardness, little weathered

change to moderately fractured, moderately hard, moderately strong, dry

auger refusal at 25.3'

Harding Lawson Associates
Engineers, Geologists & Geophysicists

Log of Boring 3.165
Building 50F
Lawrence Berkeley Laboratory
Berkeley, California

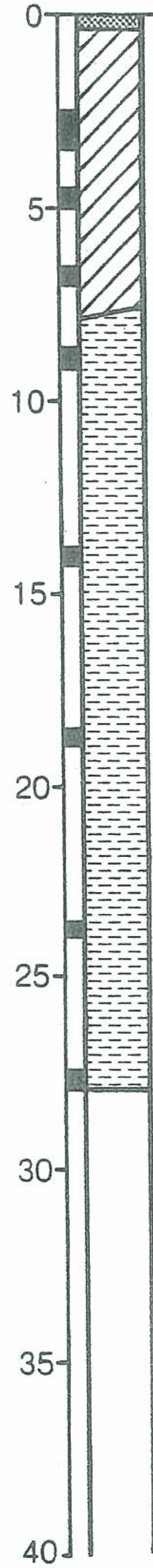
PLATE **4**

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
J. Weitzel	2000,165.01	LEL	1/83		

Equipment 6" Flight Auger

Elevation 709 Feet   Date 11/1/82

Laboratory Tests	Blows/foot	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	Cored Interval	Depth (ft)
		13.6	116			
TXUU = 8250 psf @ 720 psf		11.7	116			
		10.4	122			
		10.3	126			



4" ASPHALT

BROWN CLAY (CL)
very stiff, dry, with abundant weathered rock fragments

BROWN SHALE
intensely fractured, low hardness, weak, highly weathered

change to moderately hard, moderately strong, little weathered

color change to gray

auger refusal at 28'

(no free water encountered)

Harding Lawson Associates
Engineers, Geologists & Geophysicists

Log of Boring 4.165
Building 50F
Lawrence Berkeley Laboratory
Berkeley, California

PLATE
5

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
J. Weitzel	2000,165.01	LEL	1/83		

MAJOR DIVISIONS					TYPICAL NAMES
COARSE GRAINED SOILS (MORE THAN HALF IS LARGER THAN NO. 200 SIEVE)	GRAVELS (MORE THAN HALF COARSE FRACTION IS LARGER THAN No. 4 SIEVE SIZE)	CLEAN GRAVELS WITH LITTLE OR NO FINES	GW		WELL GRADED GRAVELS, GRAVEL-SAND MIXTURES
			GP		POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES
		GRAVELS WITH OVER 12% FINES	GM		SILTY GRAVELS, POORLY GRADED GRAVEL-SAND - SILT MIXTURES
			GC		CLAYEY GRAVELS, POORLY GRADED GRAVEL - SAND - CLAY MIXTURES
	SANDS (MORE THAN HALF COARSE FRACTION IS SMALLER THAN NO. 4 SIEVE SIZE)	CLEAN SANDS WITH LITTLE OR NO FINES	SW		WELL GRADED SANDS, GRAVELLY SANDS
			SP		POORLY GRADED SANDS, GRAVELLY SANDS
		SANDS WITH OVER 12% FINES	SM		SILTY SANDS, POORLY GRADED SAND - SILT MIXTURES
			SC		CLAYEY SANDS, POORLY GRADED SAND - CLAY MIXTURES
FINE GRAINED SOILS (MORE THAN HALF IS SMALLER THAN NO. 200 SIEVE)	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 CLAYS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS (LIQUID LIMIT GREATER THAN 50)		MH		INORGANIC SILTS, MICACEOUS OR DIATOMACIOUS FINE SANDY OR SILTY SOILS, ELASTIC SILTS
			CH		INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
			OH		ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS			Pt		PEAT AND OTHER HIGHLY ORGANIC SOILS

UNIFIED SOIL CLASSIFICATION SYSTEM

Consol — Consolidation
LL — Liquid Limit (in %)
PL — Plastic Limit (in %)
G_S — Specific Gravity
SA — Sieve Analysis
■ — "Undisturbed" Sample
⊠ — Bulk Sample

Shear Strength, psf		Confining Pressure, psf	
*Tx	320	(2600)	— Unconsolidated Undrained Triaxial
TxCU	320	(2600)	— Consolidated Undrained Triaxial
DS	2750	(2000)	— Consolidated Drained Direct Shear
FVS	470		— Field Vane Shear
*UC	2000		— Unconfined Compression
LVS	700		— Laboratory Vane Shear

KEY TO TEST DATA

Harding Lawson Associates
Engineers, Geologists
& Geophysicists

Soil Classification Chart and Key to Test Data
Building 50F
Lawrence Berkeley Laboratory
Berkeley, California

PLATE 6

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
J. Weitzel	2000,165.01	LE	1/83		

I **CONSOLIDATION OF SEDIMENTARY ROCKS;** usually determined from unweathered samples. Largely dependent on cementation.

U = unconsolidated
P = poorly consolidated
M = moderately consolidated
W = well consolidated

II **BEDDING OF SEDIMENTARY ROCKS**

Splitting Property	Thickness	Stratification
Massive	Greater than 4.0 ft.	very thick bedded
Blocky	2.0 to 4.0 ft.	thick-bedded
Slabby	0.2 to 2.0 ft.	thin-bedded
Flaggy	0.05 to 0.2 ft.	very thin-bedded
Shaly or platy	0.01 to 0.05 ft.	laminated
Papery	less than 0.01 ft.	thinly laminated

III **FRACTURING**

Intensity	Size of Pieces in Feet
Very little fractured	Greater than 4.0
Occasionally fractured	1.0 to 4.0
Moderately fractured	0.5 to 1.0
Closely fractured	0.1 to 0.5
Intensely fractured	0.05 to 0.1
Crushed	Less than 0.05

IV **HARDNESS**

1. **Soft** — Reserved for plastic material alone
2. **Low hardness** — can be gouged deeply or carved easily with a knife blade
3. **Moderately hard** — can be readily scratched by a knife blade; scratch leaves a heavy trace of dust and is readily visible after the powder has been blown away.
4. **Hard** — can be scratched with difficulty; scratch produces little powder and is often faintly visible.
5. **Very hard** — cannot be scratched with knife blade; leaves a metallic streak.

V **STRENGTH**

1. **Plastic** or very low strength
2. **Friable** — crumbles easily by rubbing with fingers
3. **Weak** — An unfractured specimen of such material will crumble under light hammer blows.
4. **Moderately strong** — Specimen will withstand a few heavy hammer blows before breaking.
5. **Strong** — Specimen will withstand a few heavy ringing hammer blows and will yield with difficulty only dust and small flying fragments.
6. **Very strong** — Specimen will resist heavy ringing hammer blows and will yield with difficulty only dust and small flying fragments.

VI **WEATHERING** — The physical and chemical disintigration and decomposition of rocks and minerals by natural processes such as oxidation, reduction, hydration, solution, carbonation, and freezing and thawing.

D. **Deep** — Moderate to complete mineral decomposition; extensive disintegration; deep and thorough discoloration; many fractures, all extensively coated or filled with oxides, carbonates and/or clay or silt.
M. **Moderate** -- Slight change or partial decomposition of minerals; little disintegration; cementation little to unaffected. Moderate to occasionally intense discoloration. Moderately coated fractures.
L. **Little** — No megascopic decomposition of minerals; little or no effect on normal cementation. Slight and intermittent, or localized discoloration. Few stains on fracture surfaces.
F. **Fresh** — Unaffected by weathering agents. No disintegration or discoloration. Fractures usually less numerous than joints.

Harding Lawson Associates
Engineers, Geologists
& Geophysicists

Physical Properties Criteria for Rock Descriptions
Building 50F
Lawrence Berkeley Laboratory
Berkeley, California

PLATE **7**

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
	2000,165.01	LEL	1/83		

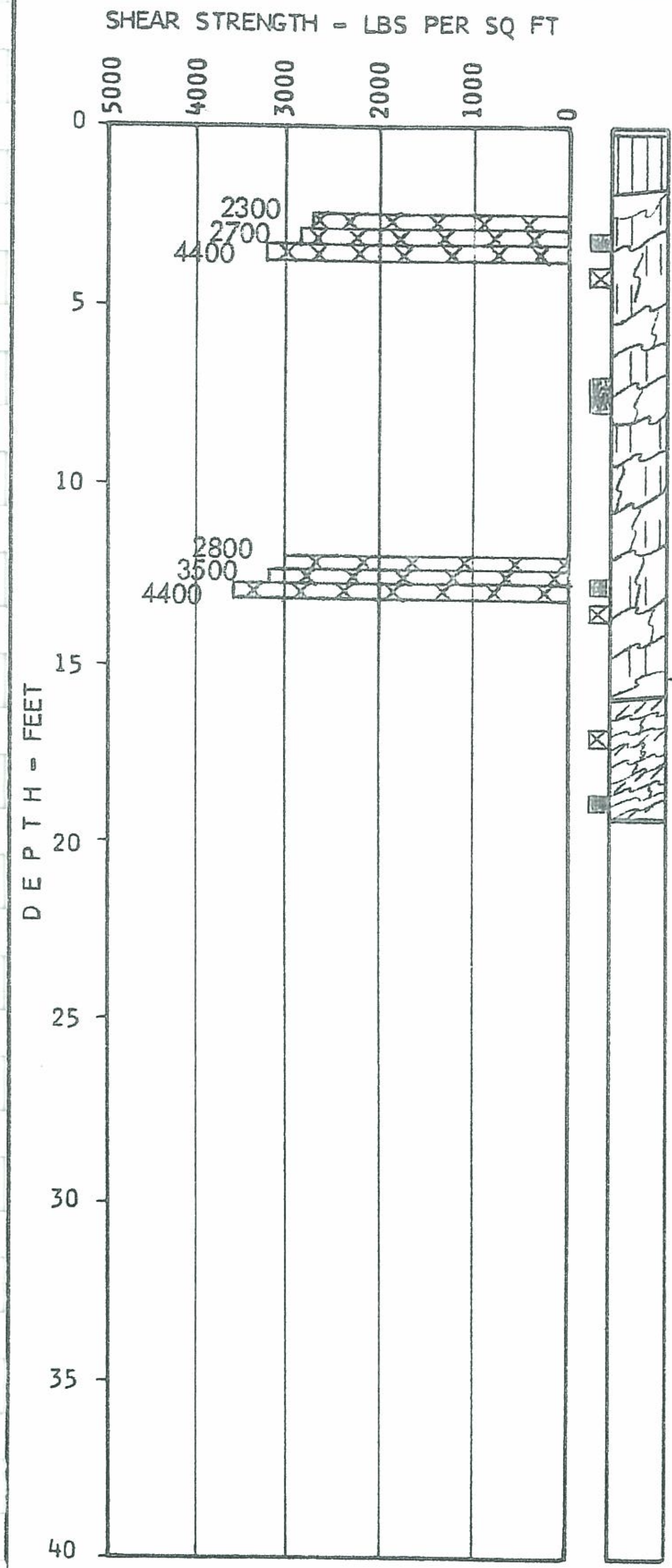
Hardin Associates, 1965
Test Borings 1 through 4

REFERENCE:

Harding Associates, Planned Building 50-B, Lawrence Radiation Laboratory, Berkeley, California (HA 2000.23) plates, cross sections and boring logs dated January 20, 1965.

JOB L.R.L. BLDG. 50 ADDITION NO 2000.23 BY TR/mo DATE 9-16-64

BORING 1



MOISTURE CONTENT - %

DRY DENSITY - LBS PER CU FT

ELEVATION 701

2" ASPHALT CONCRETE

BROWN SILTY SAND (SM - SW)
firm, moist, with rock fragments (Fill)

8.3 124 GRAY BROWN SILTSTONE
fractured and highly decomposed
firm, moist
grading, gray, partially decomposed, moderately hard
grading, very hard

with some clay seams

9.7 131

water level, 8-31-64

DARK GRAY SHALE
sheared, with clay seams, moist to wet

5.0 140

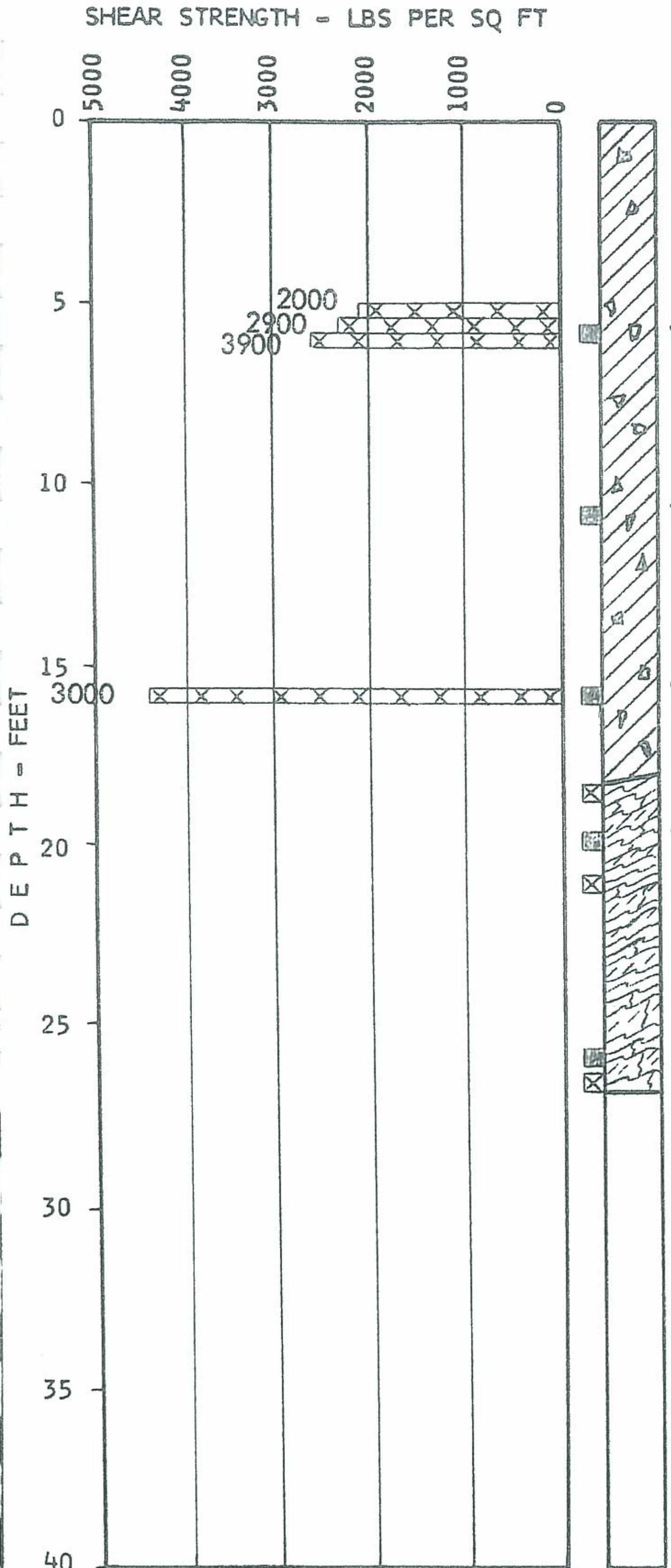
HARDING ASSOCIATES
SOIL MECHANICS ENGINEERS

LOG OF BORING

EQUIPMENT 16" Bucket Auger DRILLED 8-28-64

JOB L.R.L. BLDG. 50 ADDITION NO 2000.23 BY TR/mo DATE 9-16-64

BORING 2



MOISTURE CONTENT - %

DRY DENSITY - LBS PER CU FT

ELEVATION 710

Moisture Content (%)	Dry Density (lbs/cu ft)	Description
		BROWN SILTY CLAY (CL) firm, damp, with some highly decomposed siltstone fragments
14.1	116	grading, gray brown, with increasing siltstone fragments
14.6	118	
10.3	123	
		water seepage at 17.5'
10.9	124	GRAY SHALE sheared and decomposed, with abundant clay seams, firm, moist
		with some hard zones, damp
7.2	133	

HARDING ASSOCIATES

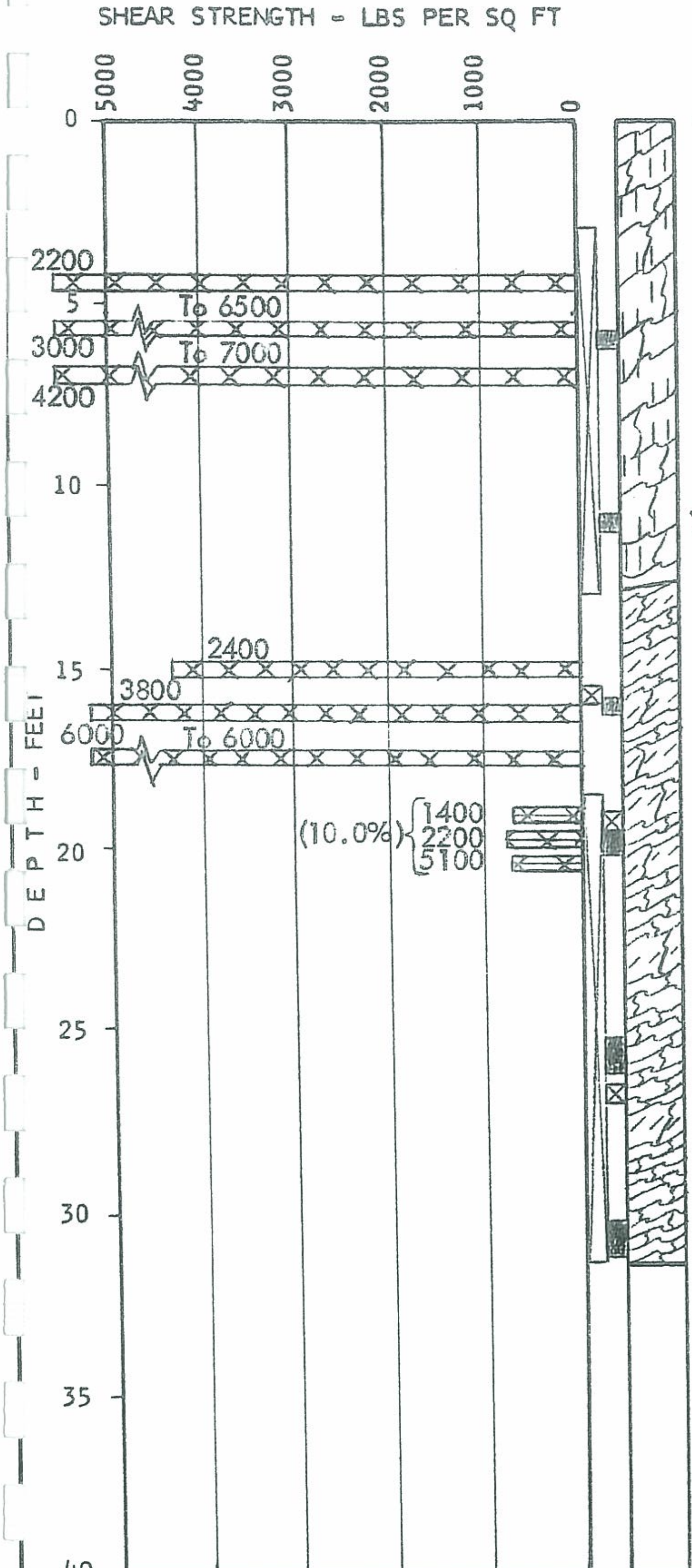
SOIL MECHANICS ENGINEERS

LOG OF BORING

EQUIPMENT 16" Bucket Auger DRILLED 8-31-64

JOB L.R.L. BLDG. 50 ADDITION NO 2000.23 BY TR/mo DATE 9-16-64

BORING 3



MOISTURE CONTENT - %

DRY DENSITY - LBS PER CU FT

ELEVATION 726

Moisture Content (%)	Dry Density (lbs per cu ft)
8.7	131
10.6	120
8.5	133
7.6	141
6.5	135
6.2	139

BROWN SANDSTONE & SILTSTONE
thin-bedded, fractured and partially decomposed, firm, dry to damp

with layers of brown decomposed shale

GRAY SHALE
fractured, with clay seams, firm, damp

grading, gray blue, highly sheared with abundant clay seams
less sheared, decreasing clay
saturated

grading, hard, with calcite veinlets
water seepage at 26'

sheared, with clay seams at 28'

HARDING ASSOCIATES
SOIL MECHANICS ENGINEERS

LOG OF BORING

EQUIPMENT 16" Bucket Auger DRILLED 8-31-64

JOB L.R.L. BLDG. 50 ADDITION NO 2000.23 BY TR/mo DATE 9-16-64

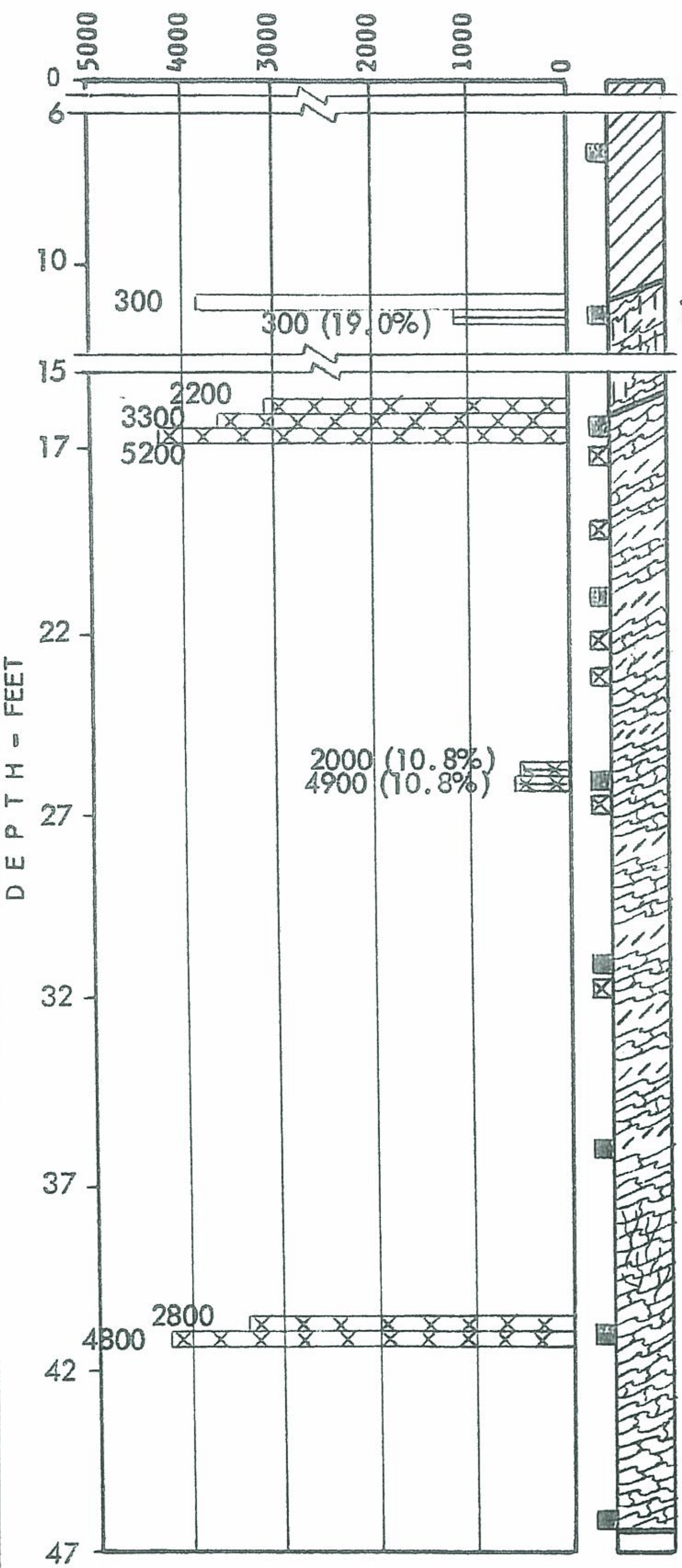
BORING 4

SHEAR STRENGTH – LBS PER SQ FT

MOISTURE CONTENT – %

DRY DENSITY – LBS PER CU FT

ELEVATION 739



Moisture content (%)	Dry density (lbs per cu ft)	Description
		MOTTLED BROWN SILTY CLAY (CL) firm, damp
		grading, moist
		grading, with sand and siltstone rock fragments
15.8	116	BROWN SHALE & SILTSTONE highly decomposed and fractured, with some brown clay seams, moist
8.7	130	GRAY SHALE--fractured, with brown clay seams, moist
		water seepage at 18'
		grading, hard at 20'
6.9	131	
		grading, very hard
		grading, softer, with clay seams
9.1	133	
8.6	133	grading, hard; water seepage at 31'
6.0	135	
		grading, blue gray, highly sheared, with clay seams, wet
5.9	137	
		grading, very hard, with calcite veinlets
6.0	135	

HARDING ASSOCIATES
SOIL MECHANICS ENGINEERS

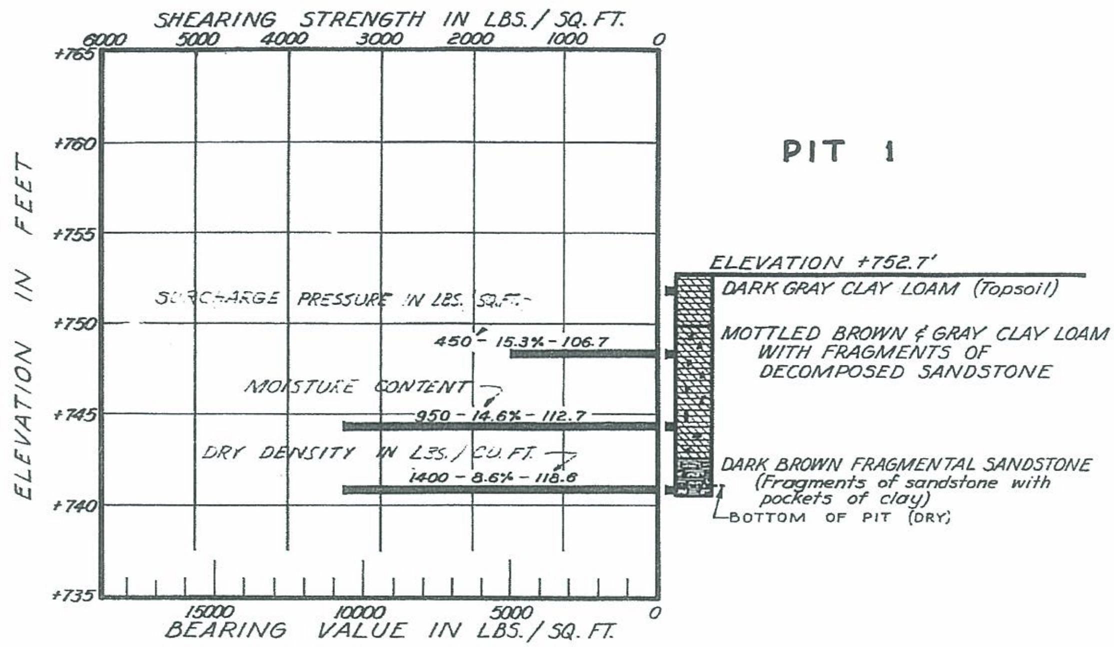
LOG OF BORING

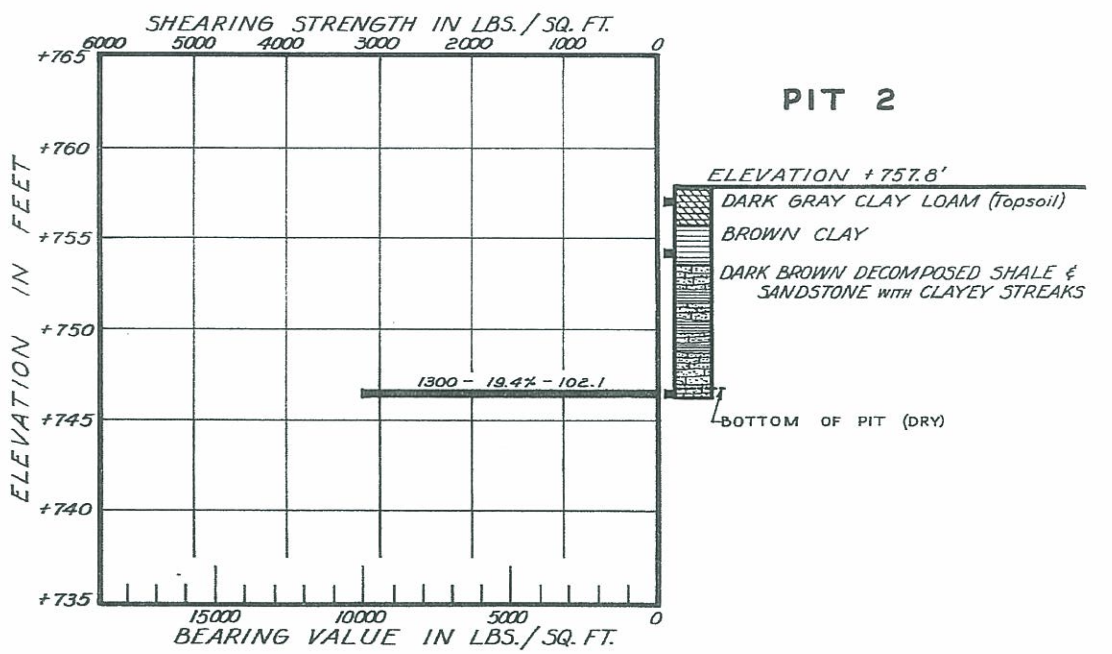
EQUIPMENT 16" Bucket Auger DRILLED 9-2-64

D&M 1960
Test Borings 2 through 4

REFERENCE:

Dames & Moore, *Earth Pressure Recommendations, Proposed Retaining Wall, Proposed Addition to Building 50, Lawrence Radiation Laboratory, Berkeley, California* (no reference number), Report dated August 19, 1960



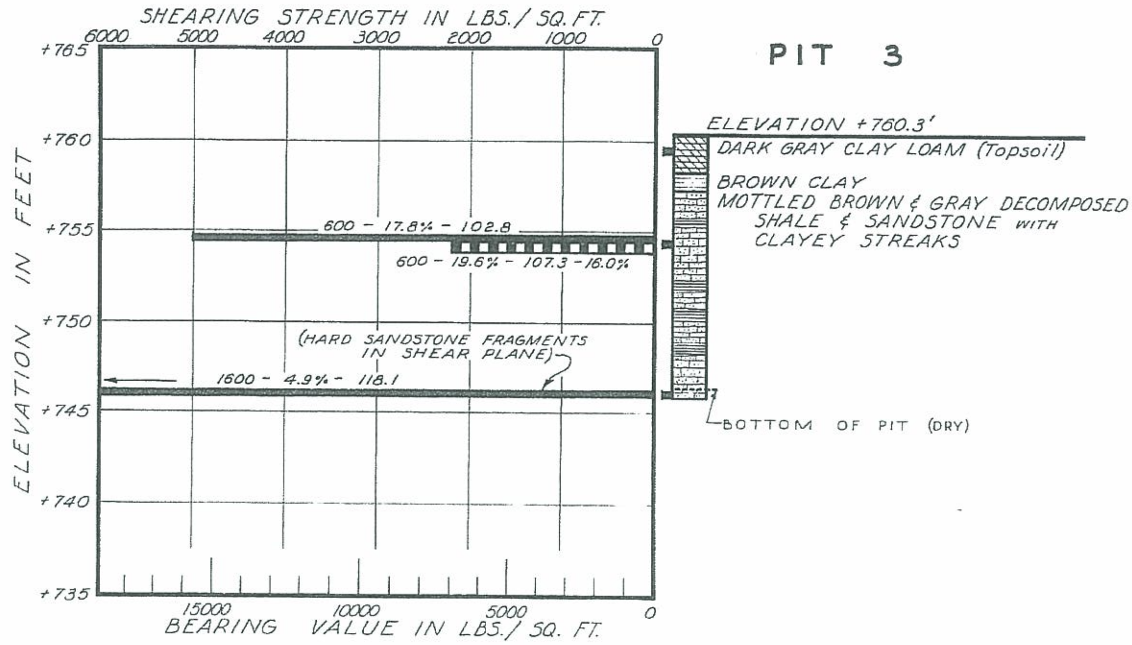


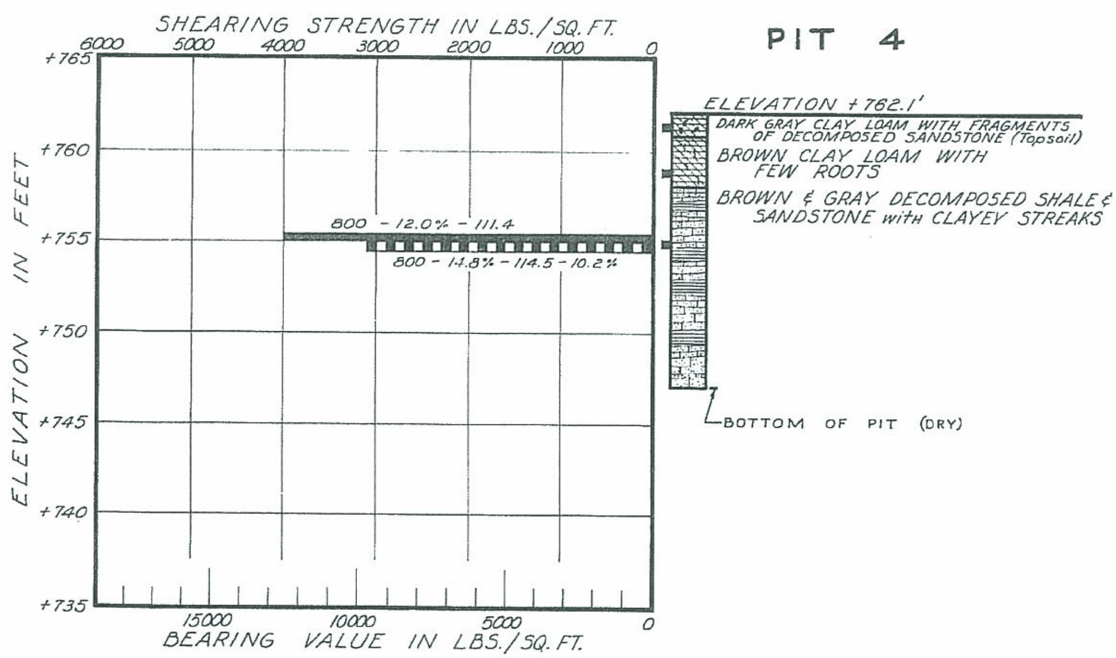
LOG OF PITS

DAMES & MOORE
FOUNDATION ENGINEERS

PLATE 2A

DAMES & MOORE
JOB No ___
THIS DRAWING IS ONE OF A SERIES OF ___ DRAWINGS
JOB TITLE ___
LOCATION ___
CLIENT ___
DATE JOB STARTED ___ DATE PRINTED ___
DRAWN BY ___ DATE 7/28/48
DATA CHECK BY ___ DATE ___
DRAFTING CHECK BY ___ DATE ___
REPORT DICTATED BY ___ DATE ___





LOG OF PITS

DAMES & MOORE
FOUNDATION ENGINEERS

JOB NO ____ LOCATION ____
THIS DRAWING IS ONE OF A SERIES OF ____ DRAWINGS
CLIENT ____
DATE JOB STARTED ____ DATE PRINTED ____
DATA CHECK BY ____ DATE ____
DRAFTING CHECK BY ____ DATE ____
REPORT DICTATED BY ____ DATE ____

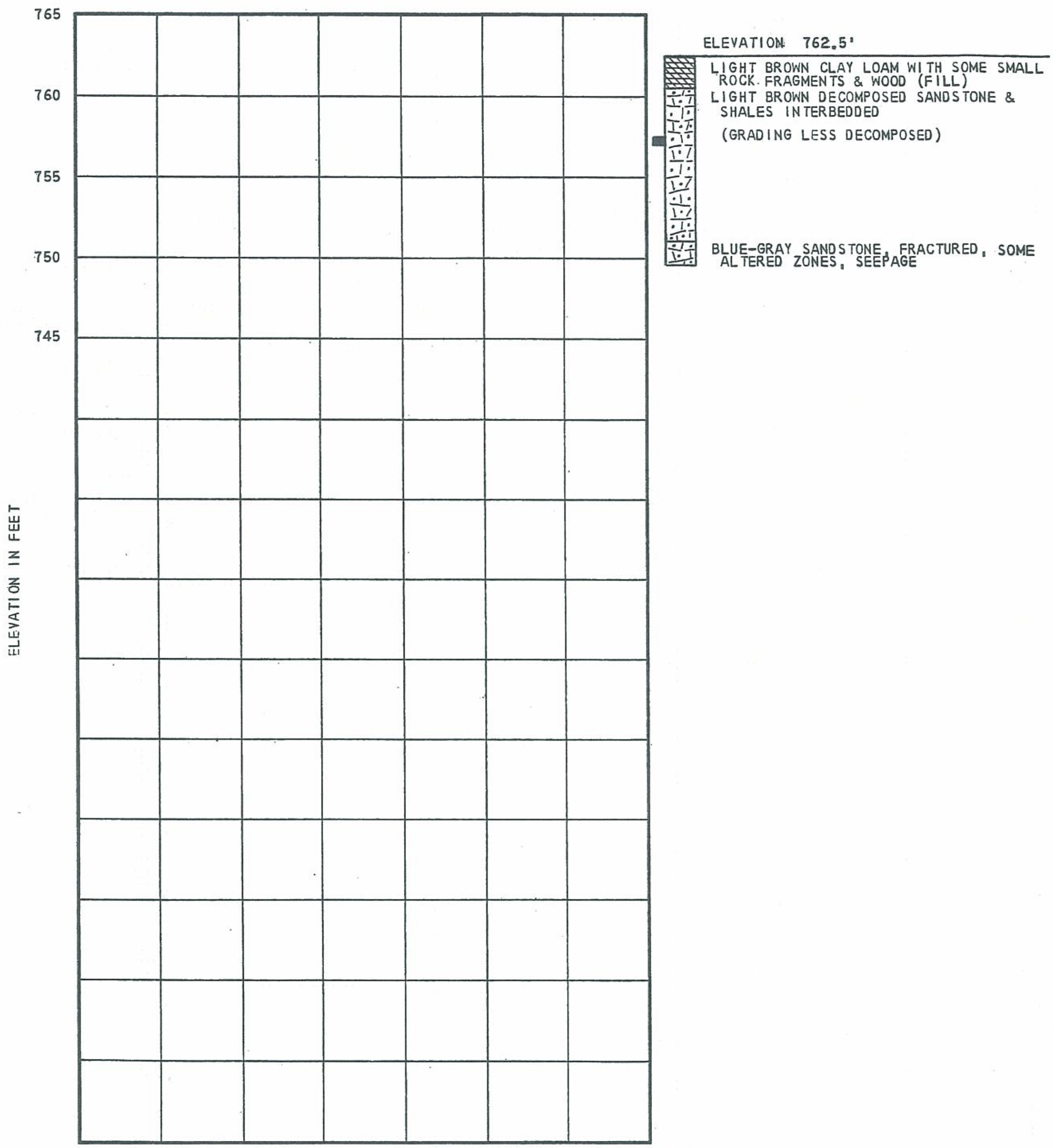
D&M 1959
Test Borings 1a through 6

REFERENCE:

Dames & Moore, Foundation Investigation, Proposed Building 70 Addition, Lawrence Radiation Laboratory, Berkeley, California (no reference number), Report dated April 2, 1959

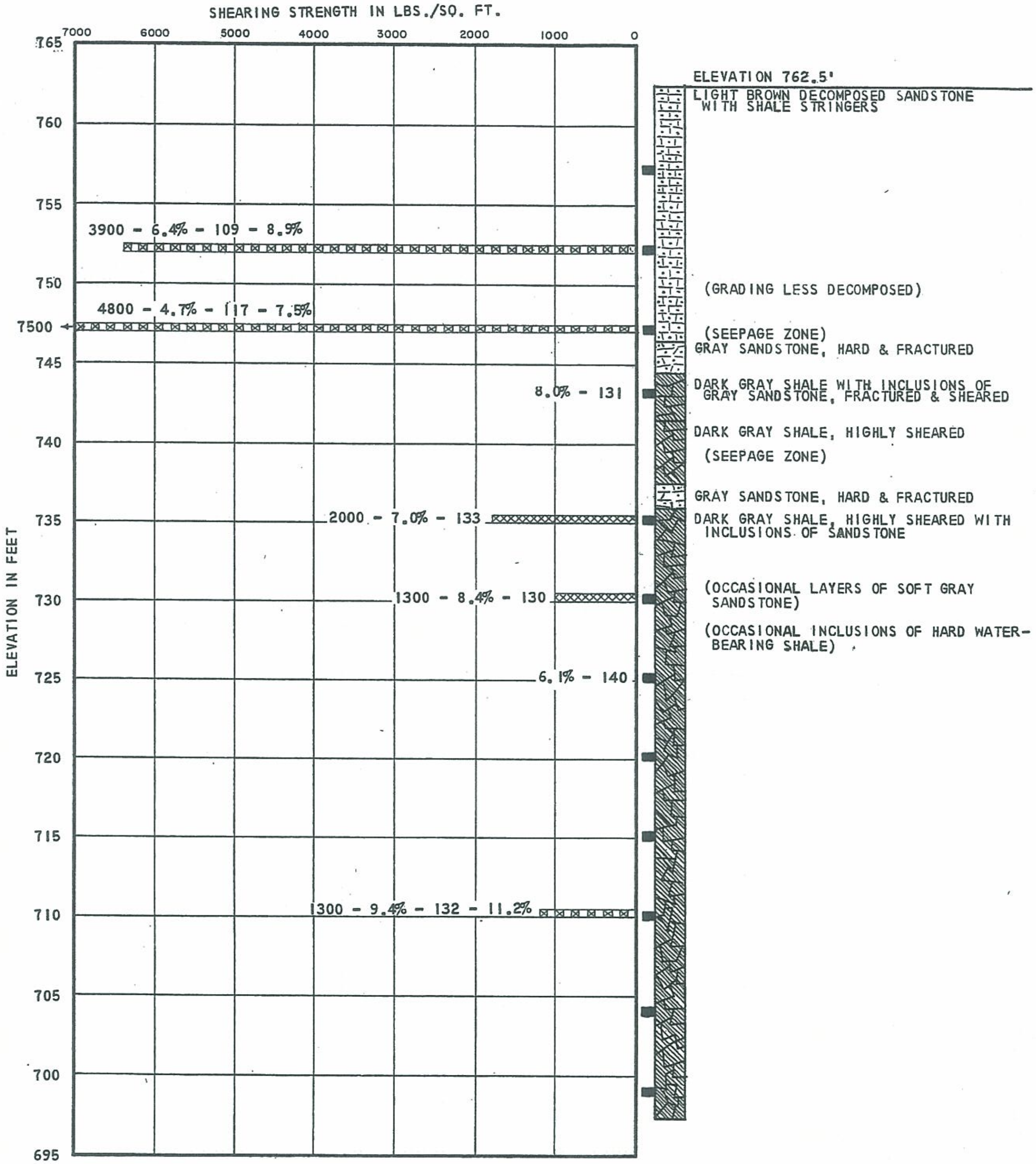
BORING 1

DRILLED 3-6-59



LOG OF BORING

BORING I-A
DRILLED 3-11-59



LOG OF BORING

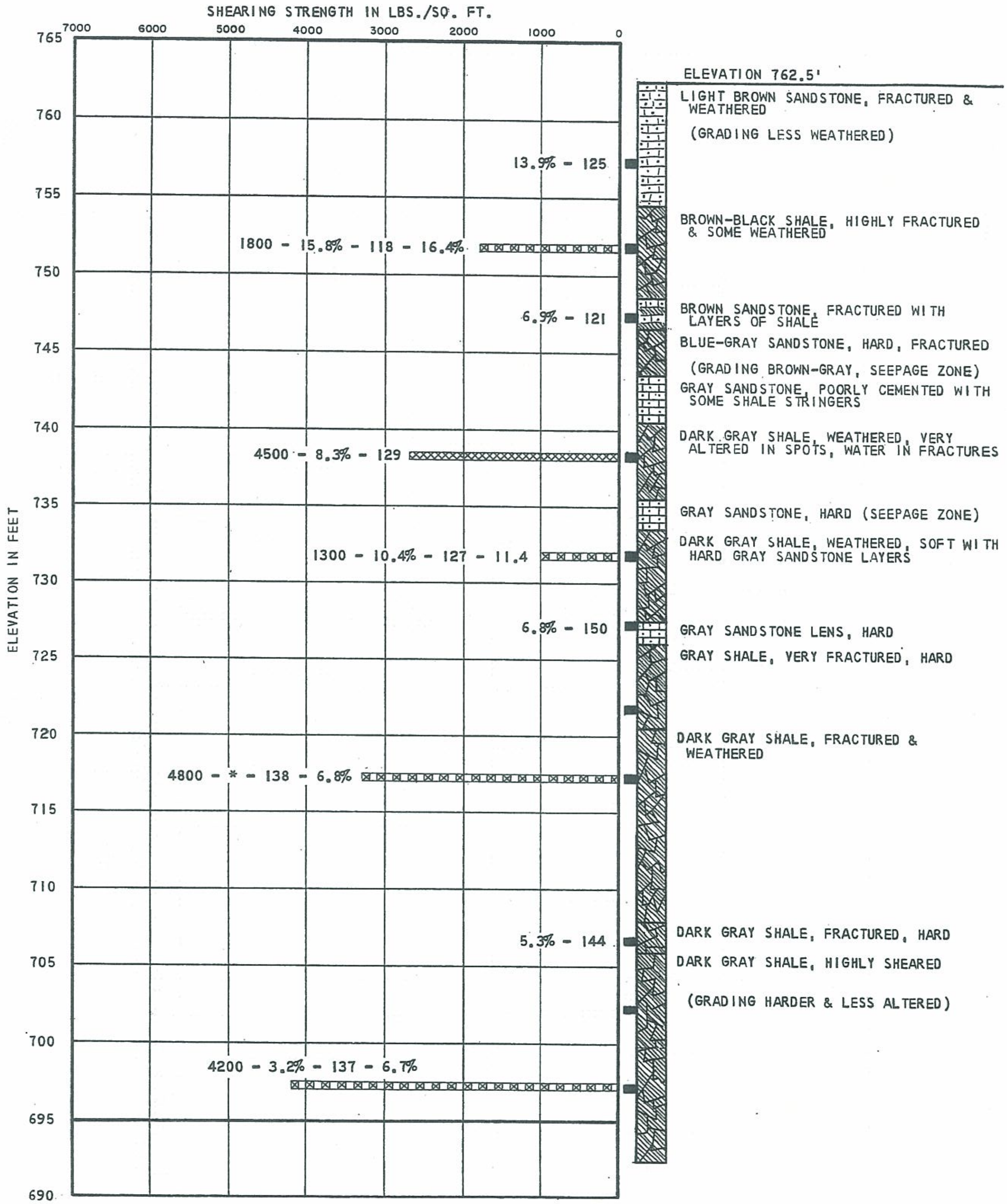
BY RG DATE
CHECKED BY [illegible] DATE 4/1/59

DAMES & MOORE
SOIL MECHANICS ENGINEERS

PLATE A10

BORING 2

DRILLED 3-6-59 & 3-9-59



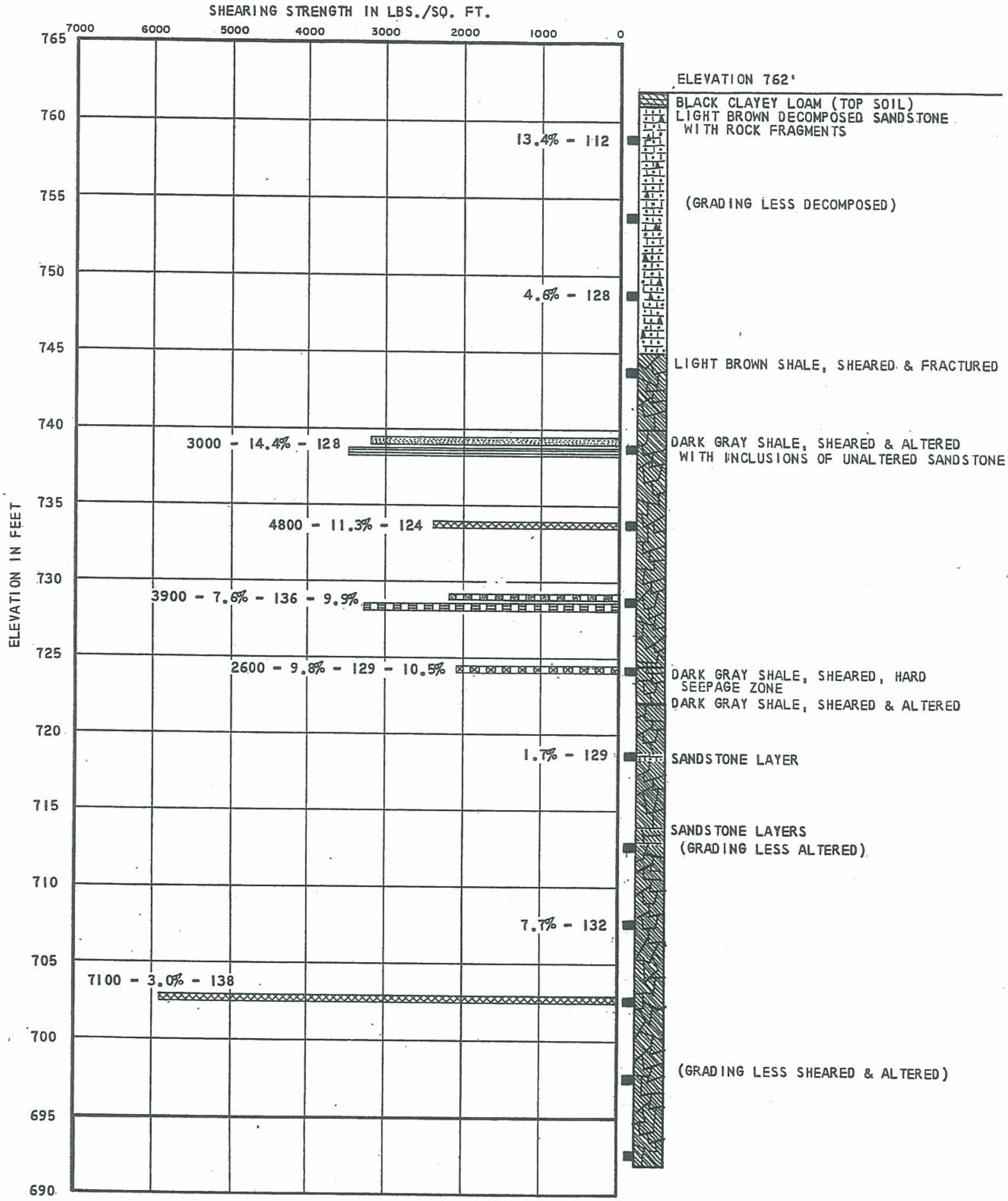
LOG OF BORING

BY ____ DATE ____
BY ____ DATE ____
PLATE ____ OF ____

BY RC DATE ____
CHECKED BY [illegible] DATE 4/1/59

DAMES & MOORE
SOIL MECHANICS ENGINEERS

BORING 3
DRILLED 3-10-59



LOG OF BORING

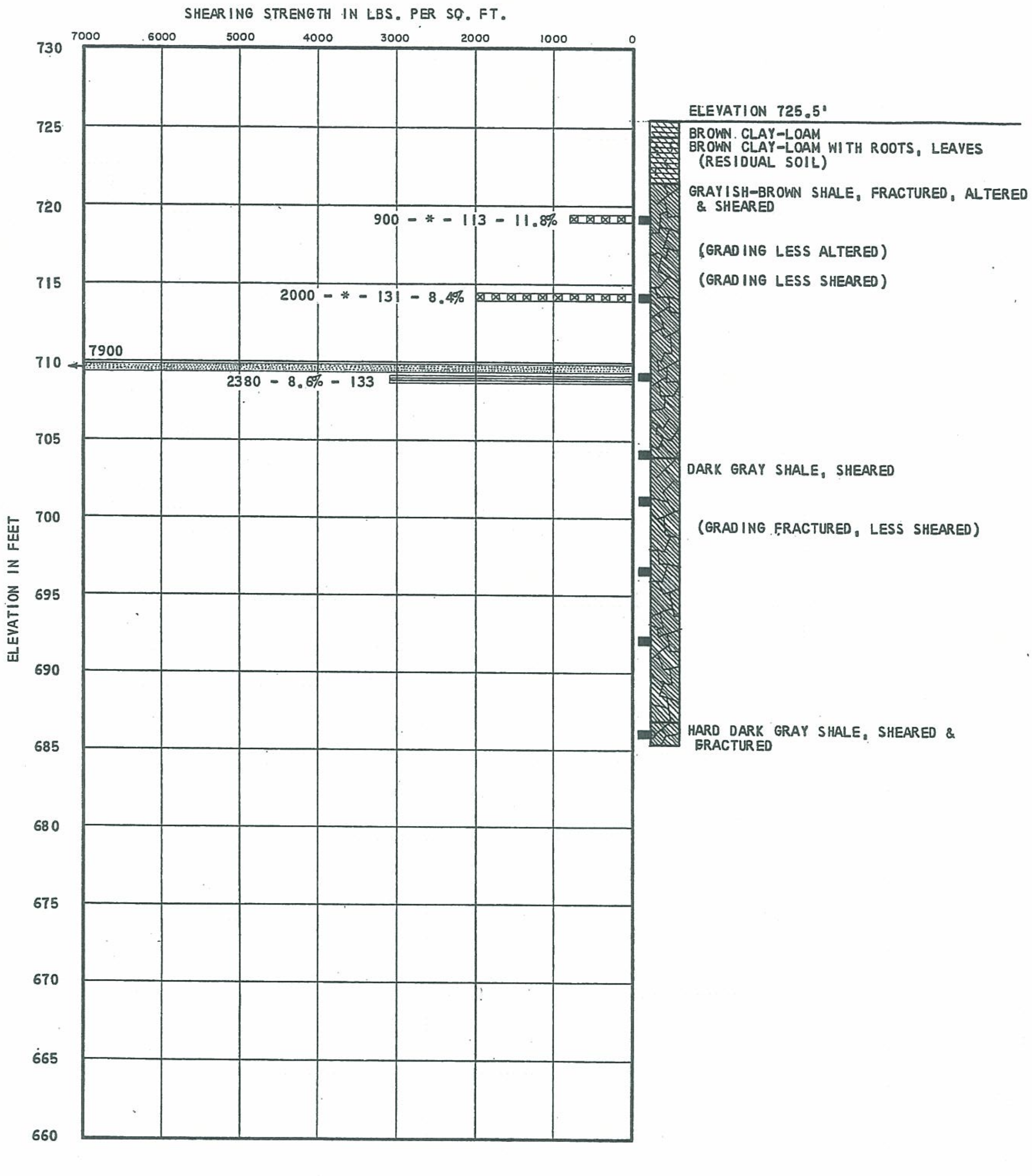
DAMES & MOORE
SOIL MECHANICS ENGINEERS

BY ____ DATE ____
BY ____ DATE ____
PLATE ____ OF ____

BY BG DATE ____
CHECKED BY [illegible] DATE 4/1/59

BORING 4

DRILLED 3-12-59



LOG OF BORING

DAMES & MOORE

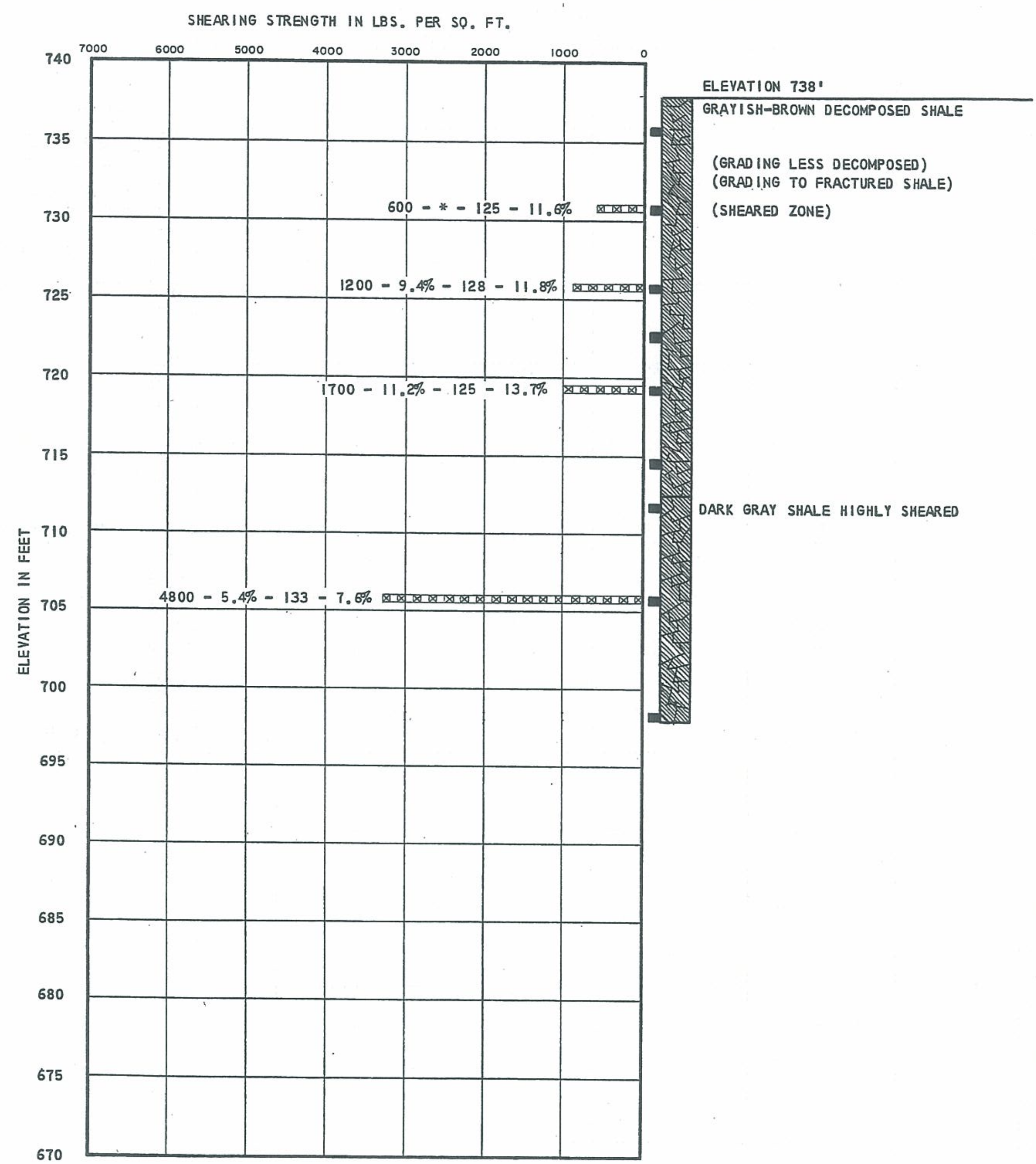
SOIL MECHANICS ENGINEERS

BY___ DATE___
BY___ DATE___
PLATE___ OF___

Univ. of Calif. - Berkeley
BY kl DATE 3-19-59
CHECKED BY [illegible] DATE 4/1/59

BORING 5

DRILLED 3-12-59

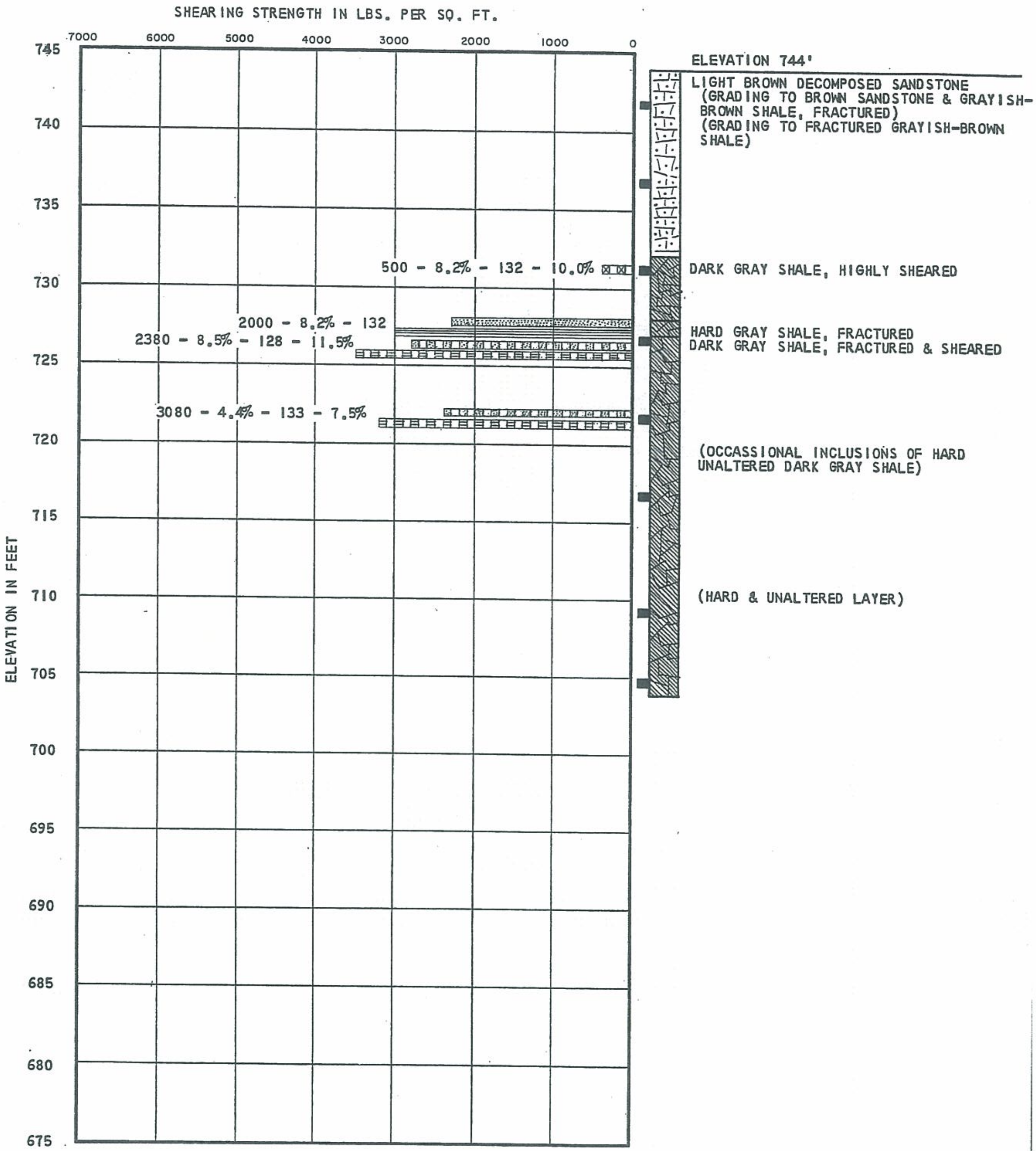


LOG OF BORING

BY ki DATE 3-19-59
CHECKED BY DATE 4/1/59

DAMES & MOORE
SOIL MECHANICS ENGINEERS

BORING 6
DRILLED 3-13-59

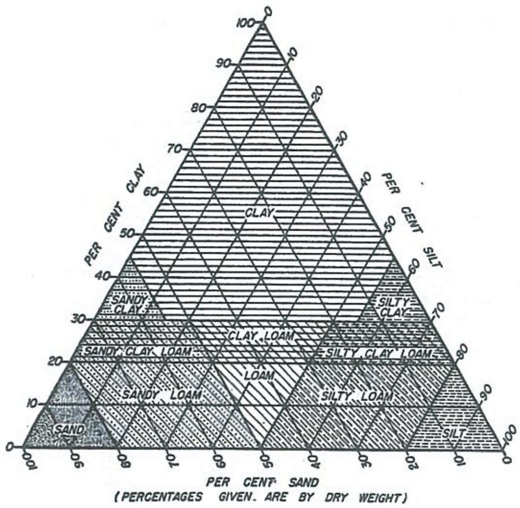


LOG OF BORING

Univ. of Calif. - Berkeley
BY ki DATE 3-19-59
CHECKED BY DATE

BY DATE
BY DATE
PLATE OF

DAMES & MOORE
SOIL MECHANICS ENGINEERS



SOIL FRACTION	PARTICLE SIZE			
	LOWER LIMIT MM.	LOWER LIMIT INCHES	UPPER LIMIT MM.	UPPER LIMIT INCHES
CLAY	·		.005	.0002
SILT	.005	.0002	.05	.002
SAND				
FINE	.05	.002	.25	.01
MEDIUM	.25	.01	.5	.02
COARSE	.5	.02	2.0	.08
ROCK FRACTION	THESE FRACTIONS ARE NOT CONSIDERED IN DETERMINING SOIL CLASSIFICATION.			
GRAVEL	2.0	.08	64.	2.5
COBBLES	64.	2.5	256.	10.
BOULDERS	256.	10.		

■ INDICATES DEPTH AT WHICH UNDISTURBED SAMPLE WAS EXTRACTED

TESTS AT FIELD MOISTURE

TESTS AT ARTIFICIALLY CHANGED MOISTURE

TEST SURCHARGE PRESSURE IN POUNDS PER SQUARE FOOT.
PER CENT FIELD MOISTURE EXPRESSED AS A PERCENTAGE OF THE DRY WEIGHT OF SOIL
DRY DENSITY EXPRESSED IN POUNDS PER CUBIC FOOT
PER CENT MOISTURE WHEN TESTED EXPRESSED AS A PERCENTAGE OF THE DRY WEIGHT OF SOIL

DIRECT SHEAR – STRAIN CONTROL

2500—20.4%—104.2

25.4%—104.2—20.4%

YIELD POINT SHEARING STRENGTH IN LBS. PER SQ. FT.

ULTIMATE SHEARING STRENGTH IN LBS. PER SQ. FT.

TRIAXIAL TESTS

2500 20.4% 104.2

25.4% -104.2-20.4%

MAXIMUM SHEARING STRENGTH IN LBS. PER SQ. FT.

SOIL CLASSIFICATION CHART AND KEY TO TEST DATA

REVISIONS
BY ______ DATE ______
BY ______ DATE ______
PLATE ______ OF ______

FILE 234-AE
UNIV OF CALIF - BERKELEY
BY AJT DATE 1-2-59
CHECKED BY ______ DATE ______

466.10 (REV.)

DAMES & MOORE
SOIL MECHANICS ENGINEERS

D&M 1948
Test Pits 1 through 4

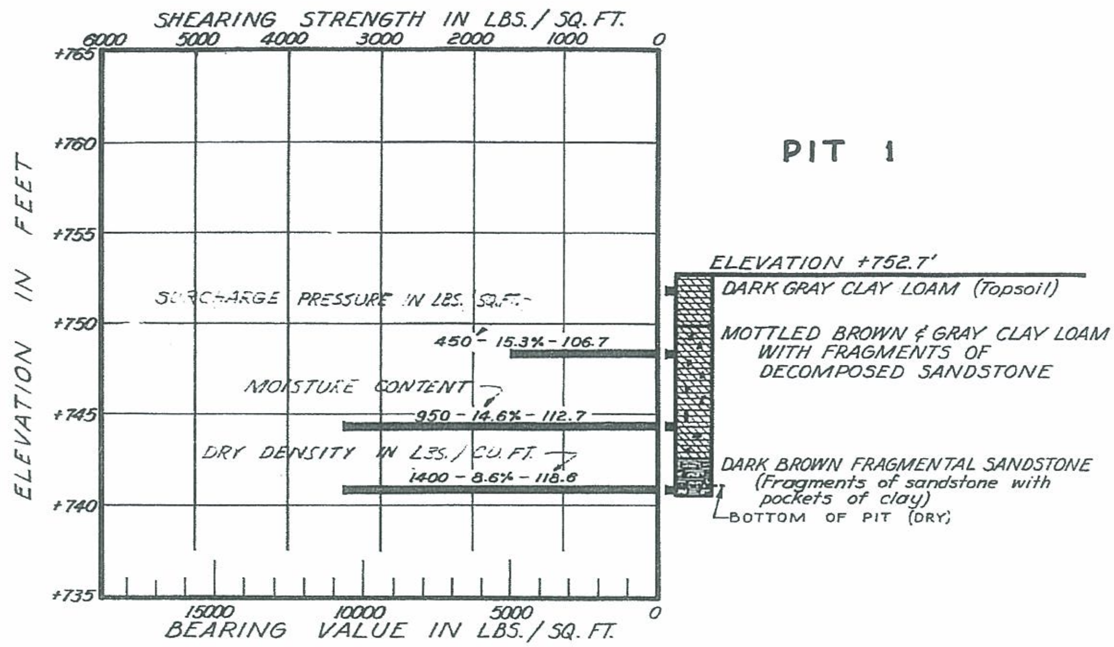
REFERENCE:

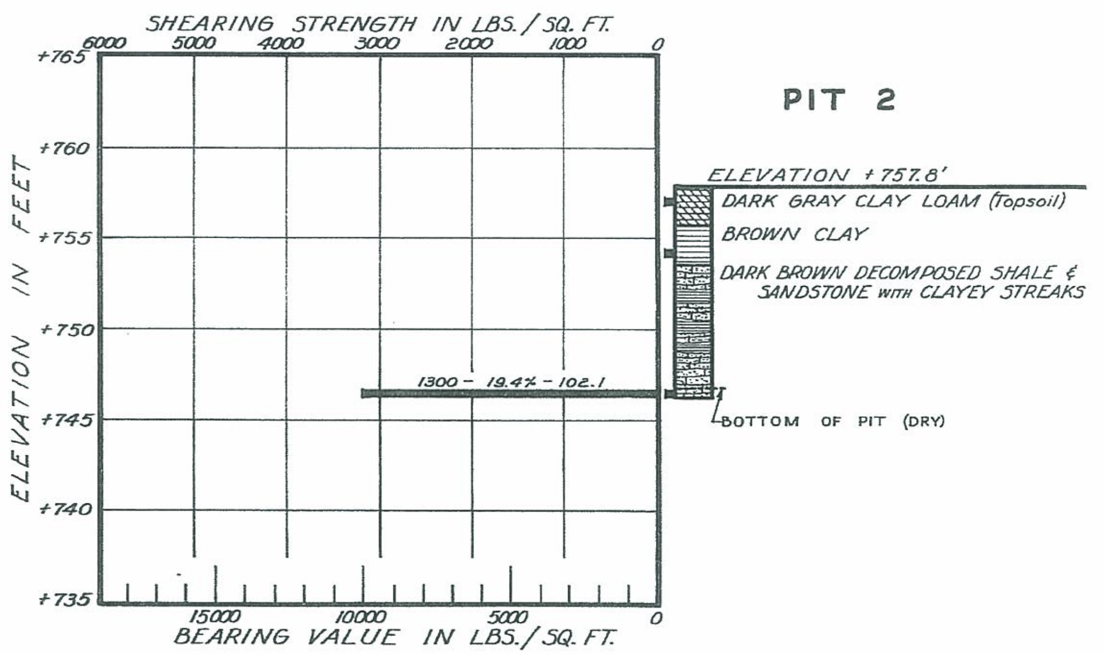
Dames & Moore, Site Plan and Test Pit Logs Building 50, dated July 28, 1948

DAMES & MOORE
JOB No ______
THIS DRAWING IS ONE OF A SERIES OF ______ DRAWINGS

JOB TITLE ______
LOCATION ______
CLIENT ______
DATE JOB STARTED ______ DATE PRINTED ______

DRAWN BY ______ DATE ______
DATA CHECK BY ______ DATE ______
DRAFTING CHECK BY ______ DATE ______
REPORT DICTATED BY ______ DATE ______

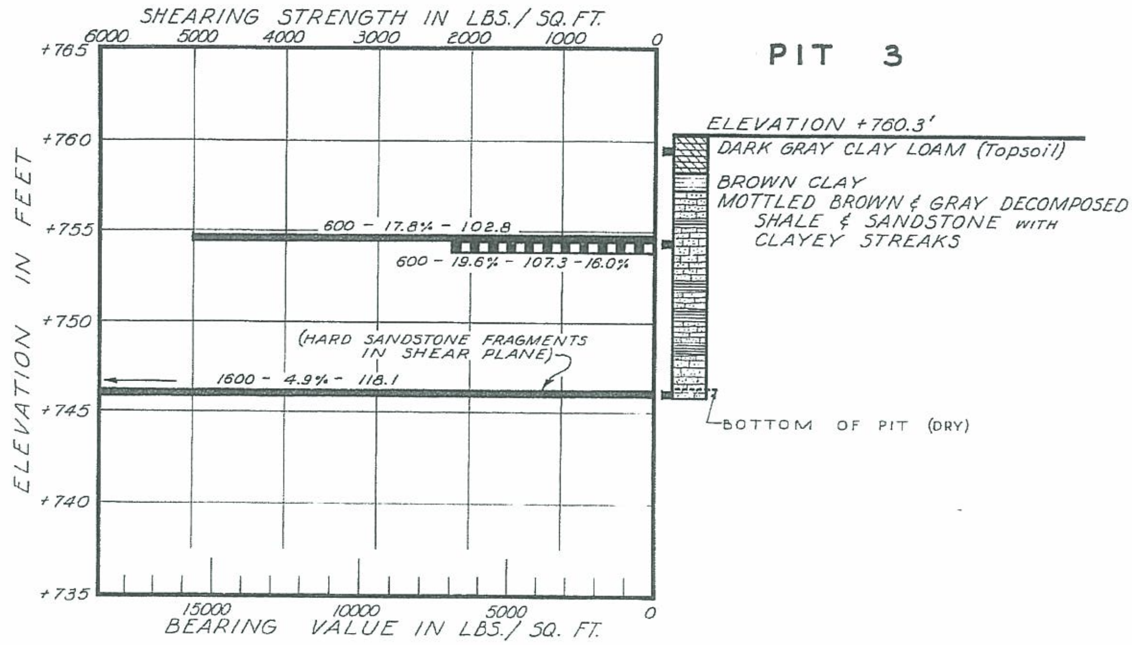


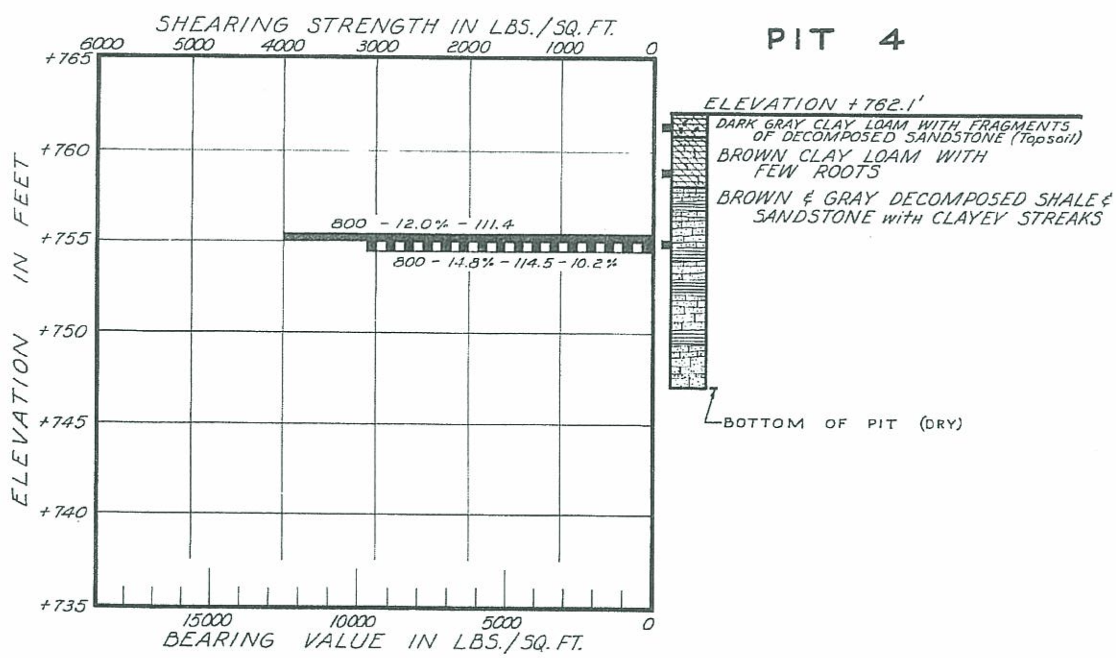


LOG OF PITS

DAMES & MOORE
FOUNDATION ENGINEERS

PLATE 2A





LOG OF PITS

DAMES & MOORE
FOUNDATION ENGINEERS

JOB NO. ____ THIS DRAWING IS ONE OF A SERIES OF ____ DRAWINGS
LOCATION ____ CLIENT ____ DATE JOB STARTED ____ DATE PRINTED ____
DRAWN BY ____ DATA CHECK BY ____ DRAFTING CHECK BY ____ REPORT DICTATED BY ____
DATE ____ DATE ____ DATE ____ DATE ____