ATTACHMENT 1
DIABLO CANYON ISFSI DATA REPORT B

FIELD BORINGS LOGS
IN THE
ISFSI STUDY AREA

Explanation

During the team core review in 2001, core was grouped by consensus in the following lithologic groups, indicated in the right-hand margin of each log.

Lithology Group	Geologic Unit	Lithology	Composition	
A	Tof_{b-1}	Dolomite	↑ Increasing dolomite	Increasing sand ↓
B	Tof_{b-1}	Very fine-grained dolomitic sandstone		
C	Tof_{b-2}	Fine-grained dolomitic sandstone		
D	Tof_{b-2}	Medium-grained sandstone		

Explanation

ROCK STRENGTH CLASSIFICATION SCALE

Term	Hardness Designator/ Grade	Field Identification	Approximate Range of Uniaxial Compressive Strength
Extremely Weak	R0	Can be indented with difficulty by thumbnail. May be friable or moldable with finger pressure.	<150 psi
Very Weak	R1	Crumbles under firm blows with point of geologic hammer. Can be peeled by a pocket knife.	150 – 725 psi
Weak	R2	Can be peeled or scraped by a pocket knife with difficulty. Cannot be scratched by fingernail. Shallow indentation made by firm blow of geologic hammer.	725 – 3,625 psi
Medium Strong	R3	Cannot be scraped or picked with a pocket knife. Specimen can be fractured with a single firm blow of a hammer/geologic pick.	3,625 – 7,250 psi
Strong	R4	More than one blow of geologic hammer required to fracture specimen.	7,250 – 14,500 psi
Very Strong	R5	Specimen requires many hard blows of hammer to fracture or chip. Hammer rebounds after impact.	14,500 – 36,250 psi
Extremely Strong	R6	Specimen can only be chipped by hammer	>36,250 psi

Modified from Brown (1981), Hoek (1996).

ROCK WEATHERING CLASSIFICATION SCALE

Designation	Symbol	Field Identification	Grade
Fresh	F	No visible sign of rock material weathering: perhaps slight discoloration on major discontinuity surfaces. Rings under hammer impact.	I
Slightly Weathered	SW	Rock mass is generally fresh with slight discoloration in rock fabric. Discontinuities are stained and may contain clay. Decomposition extends up to 1" into rock.	II
Moderately Weathered	MW	Less than 50% of rock is decomposed. Significant potion of rock shows discoloration and weathering effects. Crystals are dull and/or altered. Discontinuities are stained and may contain secondary minerals. Strength is significantly less than fresh rock.	III
Highly Weathered	HW	Rock mass is more than 50% decomposed. Rock can be broken by hand or scraped with knife or pick. All discontinuities exhibit secondary mineralization. Surface of core is friable and/or pitted due to washing out of highly altered minerals by drill water.	IV
Completely Weathered	CW	Rock mass is completely decomposed but rock fabric and structure may still be evident (saprolite). Specimen is easily crumbled or penetrated with pocket knife or geologic pick.	V
Residual Soil	RS	All rock material is decomposed to soil. Rock fabric and structure completely destroyed. There is a large change in volume, but soil has not been significantly transported.	VI

Renamed 5/23/01 for consistency w/ later hole designation JLB (98BA-1)

98BA-1/1

LOG of ROCK BORING ~~BA98-1~~

Unit calls by JLB/CMB/WAL 5/01. Friable zone calls JGH 5/01. Edited for ISFSI SAR-JLB 5/21/01

Project: PG&E DCPP - DCSF Siting Study 1998	Job Number: 1223-007	Boring Location: Borrow Area: Midway 4/25 lemon road	Total Depth: 250.5'
Type & Diameter of Boring: HQ 3.5" ID Wireline Rotary Diamond Core / Triple Tube Core Barrel		Elevation and Datum: ~~380'~~ 372'	Ground Water Depth: Not measured*	Depth to Bedrock: GP surface - 0'
Drilling Contractor and Rig: PG&E G.C. Drillers (Glen Lofing - foreman) / Mobile B-40		Length of Core Barrel and Bit: 8.5 feet JLB 5/31/01	No. of Core Boxes: 17	Date Started: 5/13/98
Casing Size and Depth: Drilled without casing; HW casing used to seam hole	Borehole Inclination: vertical	Logged By: P. Drown; Field review by J. Bachhuber 4/28/98	Date Completed: 5/21/98

Rods 185'

* drill water/mud injected during drilling

WLA

Corrbox 1

Tofb-1

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
0–1		0.51, 0.51								GRAYWACKE to ARKOSE, Calcareous (dolomitic); light brown (7.5YR6/4); Fine grained; tuffaceous; massive?	Jo, 15°, Pl, Sm, Ti, oxidized		- Mud tank placed downhill & drill water piped into tank to recirculate
1–2		0.32, 0.45, 0.50	1	5.0/5.0	100%	4.2/5.0 82%	Mod	Wi-Cl	R1-R2	(Tofb-1)	Jo, 5°, wa, Ro, Ti; shear zone, 5°, wa, Ro, Ti; shear zone, 5-15°, wa, Ro, Ti		- Began drilling @ 12:30pm; - Smooth, easy drilling; - 50-100% circulation brown return water
2–3													
3–4													
4–5										Light gray zone			
5–6		1.01				5°				GRAYWACKE to ARKOSE as above	Jo, 40, Pl, Sm, Ti; Jo, 70, Pl, Ro, Ti, oxidized		
6–7		0.48	2	4.7/5.0	94%	1.8/5.0 36%	Mod	Vc-Mo	R1-R2	Crushed, gravelly zone	Jo, 80, Pl, Ro, Ti, oxidized, locally siliceous; Jo, 50, Pl, Ro, Ti		- Very fast coring
7–8		0.18											
8–9		0.39									Jo, 0-5, Pl, Ro, Ti; Jo, 70, St, Ro, Ti, oxidized		
9–10		0.42											
10–11		0.37				10°				GRAYWACKE to ARKOSE as above	Jo, 50, Wa, Ro, Ti; Sh, 75, Pl, Ro, Ti, slightly coarser in shear zone		
11–12		0.21	3	3.1/5.0	62%	0.7/5.0 14%	Mod	Mo-Vc	R1-R2	11.2 to 11.4 clay stringers	Jo, 65, Pl, Sm, Ti, oxidized; me; Jo, 70, Pl, Sm, Ti, oxidized; Jo, 50, Pl, Sm, Ti, oxidized		- Lost circulation; - regained circulation
12–13		0.13											
13–14		0.35											
14–15		1.52				15°							

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

ROCK BORING LOG

Project	Job Number	Date	Boring No.
PG&E DCPP - DCSF Siting Study 1998	1223-007	5/13/98	BA98-1 (98BA-1)

Rods+8E
IIII-1

WLA

Core box 2

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
15–16		0:20								GRAYWACKE to ARKOSE, calcareous (dolomitic); light brown; fine grained; tuffaceous; massive?			-lost drill circulation -Very easy, "jumpy" drilling
16–17		0:14								(Tofb-1)			
17–18		0:19	4	3.2/5.0	46%	0/5.0 0%	Mw	Vc-Cl	R1-R2		Jo, 60, Pl, Ro, Ti, oxidized Jo, 80, Pl, Ro, Ti, oxidized		
18–19		0:07											
19–20		0:40				20%							
20–21		0:50								GRAYWACKE to ARKOSE as above but grading coarser with depth	Me Jo, 70, St, Ro, Ti, oxidized Me		-Smooth, easy coring
21–22		0:31	5	5.0/5.0	100%	1.6/5.0 32%					Jo, 85, wa, Ro, Ti, oxidized		Tofb-1 (B)
22–23		0:41								ARKOSE; light brown (7.5YR 6/4), medium grained; tuffaceous; massive to medium bedded?			
23–24		0:53								(Tofb-2)	Jo, 70, Pl, Ro, Ti Jo, 10, Pl, Ro, Ti		Tofb-2 (C)
24–25		1:13				25%				Arkose as above	3Me		
25–26		1:10											
26–27		0:58	6	5.2/5.2	100%	4.5/5.0 90%	Mw	Cl-wi	R2-R3		Sh, 5, wa, Ro, Ti Sh, 0-5, Pl, Ro, Op to Fi with thin clay film (<1")		
27–28		1:08									Clay film, not a clean bed JLB 3/2/01		
28–29		1:02									Me Mr		
29–30		0:55				30%							

Tofb-1

Tofb-2

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW -Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough). Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

98BA-1/3

ROCK BORING LOG

Project	Job Number	Date	Boring No.
PG&E DCPP - DCSF Siting Study 1998	1223-007	5/13/98	BA98-1 (98BA-1)

WLA

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
Curtain 3 30		2:03								ARKOSE; reddish yellow (7.5YR6/6); medium grained; subangular to rounded grains; thin to medium bedded		Bedding appears horizontal	-Smooth, easy coring -No circulation
31		0:58											
32		0:43	7	48/5	96%	28/5 56%	Mw	Cl-Wi	R2-R3	3@31.4-31.5; finer grained beds (Tofb-2)		Be, O, wa, Ro Be, O, Pl-St, Ro	
33		0:46										Ju, 80, wa, Ro, Ti, oxidized w/local siliceous coating	
34		0:39											
35		0:40				35				Arkose as above		Ju, 50, St, Ro, Ti, oxidized Me	
36		0:51										Ju, Ju, 85, wa, Ro, Ti	
37		1:14	8	5/5	100%	28/5 56%	Mw-Sw	Mo-Wi	R2-R3	3 lighter gray zone			
38		1:24											
39		0:54										Ju, 55, Pl, Ro, Ti, oxidized Ju, 70, Pl, Ro, Ti, oxidized	
40		0:55				40				ARKOSE as above		Ju, 75, Pl, Ro, Ti, oxidized Ju, 60, Pl, Ro, Ti	
41		0:35						Mo-Wi					
42		0:41	9	5/5	100%	2.2/5 44%	Mw-Sw		R2-R3				
43		0:41										Ju, 60, Pl, Ro, Ti	
44		0:46										3 Ju, 60, Pl, Ro, Ti, oxidized	
45						45						Ju, 65, St, Ro, Ti Ju, 80, Pl, Ro, Ti, oxidized	

Tofb-2

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

ROCK BORING LOG

Project	Job Number	Date	Boring No.
PG&E DCPP - DCSF Siting Study 1998	1223-007	4/13/98	BA98-1 (98BA-1)

WLA

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
Corebox 4 ↓ 45													
46	0:41									ARKOSE; reddish yellow, medium to coarse grained, local siliceous veins; thin to medium beds; tuffaceous		Jo, 70, Pl, Ro, Ti, oxidized; Jo, 45, Pl, Ro, Ti	Smooth easy drilling -No circulation
46	0:47									(Tofb-2)		Jo, 70, Pl, Ro, Ti, oxidized	
47	0:43	10	5.0/5.0	100%	22/5.0 44%	Mw-Sw	Cl-Mo	R2-R3				Jo, 60, St, Ro, Ti, oxidized	
48	0:52											Jo, 75, St, Ro, Ti, oxidized	
										Reddish brown beds		Be, 10, St, Ro	
49	0:55												
50	1:32					50°				ARKOSE, as above		Jo, 55, Pl, Ro, Ti, oxidized; Me; Jo, 60, St, Ro, Ti	-while extracting core from core barrel; air in pump caused core to be rapidly ejected; core retrieved off ground & pieced back together
51	1:18											Jo, 80, St, Ro, Ti, siliceous	
52	0:56	11	5.0/5.0	100%	14/5.0 28%	Mw-Sw	Cl-Mo	R2					
53	0:54											Jo, 60, St, Ro, Ti; Jo, 60, St, Ro, Ti; Jo, 65, St, Ro, Ti	
54	1:09											Jo, 65, St, Ro, Ti; Jo, 60, Wa, Ro, Ti	
55	0:40					55°				ARKOSE, as above		Jo, 65, St, Ro, Ti; Jo, 70, St, Ro, Ti, oxidized; Jo, 65, Pl, Ro, Ti, oxidized	
56	0:59											Jo, ~40, Wa, Ti, oxidized	
57	0:48	12	3.0/5.0	64%	0/5.0 0%	Mw-Sw	Cl	R1-R2				Jo, 80, Wa, Ro, Ti; Jo, 65, St, Ro, Ti, oxidized	
58	0:42												
59	0:54												
60						60°							

Tofb-2

Collars

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

98BA-1/5

ROCK BORING LOG

Project	Job Number	Date	Boring No.
PG&E DCPP - DCSF Siting Study 1998	1223-007	5/13/98	BA98-1 (98BA-1)

WLA

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
Corrected 5													
60										ARKOSE, siliceous; light brown (7.5YR 6/4); fine to medium grained; subangular to rounded grains, massive (Tofb-2)		Me	Smooth, easy coring - no circulation
61	1:02											Me	
62	1:23	13	3.6/5.0	72%	1.3/5.0	Mw	Vc-Mo	R2				Me	
63	1:25				24%							Jo, 80, Wa, Ro, Ti, oxidized	
64	1:18												
65	0:59					65°						Clayey joint coatings, not clay beds JLB Jo, 30, Wa, Ro, Ti 3/3/01 Jo, 75, Wa, Ro, Ti, oxidized	Belt broken Pump. Drilling stopped for ~20min. Very slow drilling - high water pressure lowdown fill
66	3:30											Jo, 10, Wa, Ro Ti Jo, 5-10, Wa, Ro, Ti	
67	2:27	14	4.8/5.0	92%	0.6/5.0	Mw	Cl-Mo	R1-R2		ARKOSE, argillaceous; light brown and light gray (5Y 4/1); fine to med. grained; very soft to low hardness - locally completely weathered to clay consistency; light gray zones appear more arkosic; no shear fabric observed		Very soft, clayey zone Not a clay bed JLB 3/3/01 Jo, 65, St, Ro, Ti, oxidized	Driller states that drill conditions like "clay"
68	1:38				12%								
69	4:18											Jo, 70, St, Ro Ti Jo, 55, St, Ro, Ti Jo, 65, St, Ro, Ti	
70	5:40					70°						Interval of clayey rock w/ thin stiff clay seams to 1/8" thick, some w/ slicks, cannot determine dip-distorted JLB 3/4/01	
71	3:00									ARKOSE (Arkosic sandstone); light brown to reddish yellow (7.5YR 6/4-6/6); fine to medium grained; subangular to rounded grains		Jo, 40, Pl, Ro, Ti Jo, 65, St, Ro, Ti JLB 3/4/01	
72	1:44	15	4.8/5.0	92%	0.9/5.0	Mu-Sw	Mo	R1-R2				Me Jo, 70, St, Ro, Ti Jo, 80-90, Wa, Ro, Ti Jo, 50, St, Sm, Ti, oxidized	
73	2:05				18%							Jo, 50, St, Ro, Ti Me	
74	1:55											Me Jo, 65, Pl, Sm, oxidized Jo, 65, Pl, Sm oxidized	
75	1:50					75°							Quit for the day

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW -Very Wide (>3'), WI-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

ROCK BORING LOG

Project	Job Number	Date	Boring No.
PG&E DCPP - DCSF Siting Study 1998	1223-007	5/14/98	BA98-1 (98BA-1)

WLA

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
75–80	core box 6	3:40, 3:30, 3:27, 3:45, 3:40	16	2ft/5ft	50%	0/5ft; 0%	MW	VC-CI	R2	ARKOSE, Calcareous; light brown to reddish yellow (7.5YR 6/4-6/6); fine to medium grained; thin to medium bedded; dolomitic; (Tofb-2)	Fr, 85-90°, Wa, Sl, clay filled, zone 1" thick; Me; Me; Jo, 70, St, Sl, oxidized; Jo, 75, Pl, Sl?, healed with silicous material; Me; Jo, 80-90, Wa, Ro, silicous material	Resumed drilling @8:00 am, 5/14; Core barrel stuck in drill string; Hole tripped + inner core barrel extracted; Pump not working properly - not enough pressure; gauges inaccurate. Caused about problem + destroyed bit; bit replaced; Mayek mud added to drill water; No circulation	
80–85	core box 7	3:35, 3:39, 4:20, 4:35, 4:28	17	2ft/5ft	50%	0.5/5ft; 10%	MW	VC-CI	R1-R2	ARKOSE, Calcareous (dolomitic); light brown (7.5YR 6/4); fine grained (crystalline?); dolomitic; thinly bedded?	Jo, 60, Pl, Sm, clay stain; Me; Jo, 75, St, Ro, Ti; Me; Me; Jo, 85-90, St, Ro, Ti; Me	Drill settings: Downfeed = 400 psi; Rot = 1000 psi; Harder drilling	
85–90	core box 8	3:30, 3:42, 2:15, 2:07, 4:02	18	2ft/5ft	48%	0.5/5ft; 10%	MW	VC-CI	R1-R2	ARKOSE as above; Dark brown + dark gray silty CLAY in shoe	Numerous healed joints dipping btwn 65-85 in rock mass; Shear zone, 75, Wa, Ro, gouge; Jo, 80-85, Wa, Ro, Ti, oxidized; Jo, 75, Wa, Ro, Ti, oxidized; fracture zone with steeply dipping joints - partially due to mechanical breaking	Joints 45° apart	

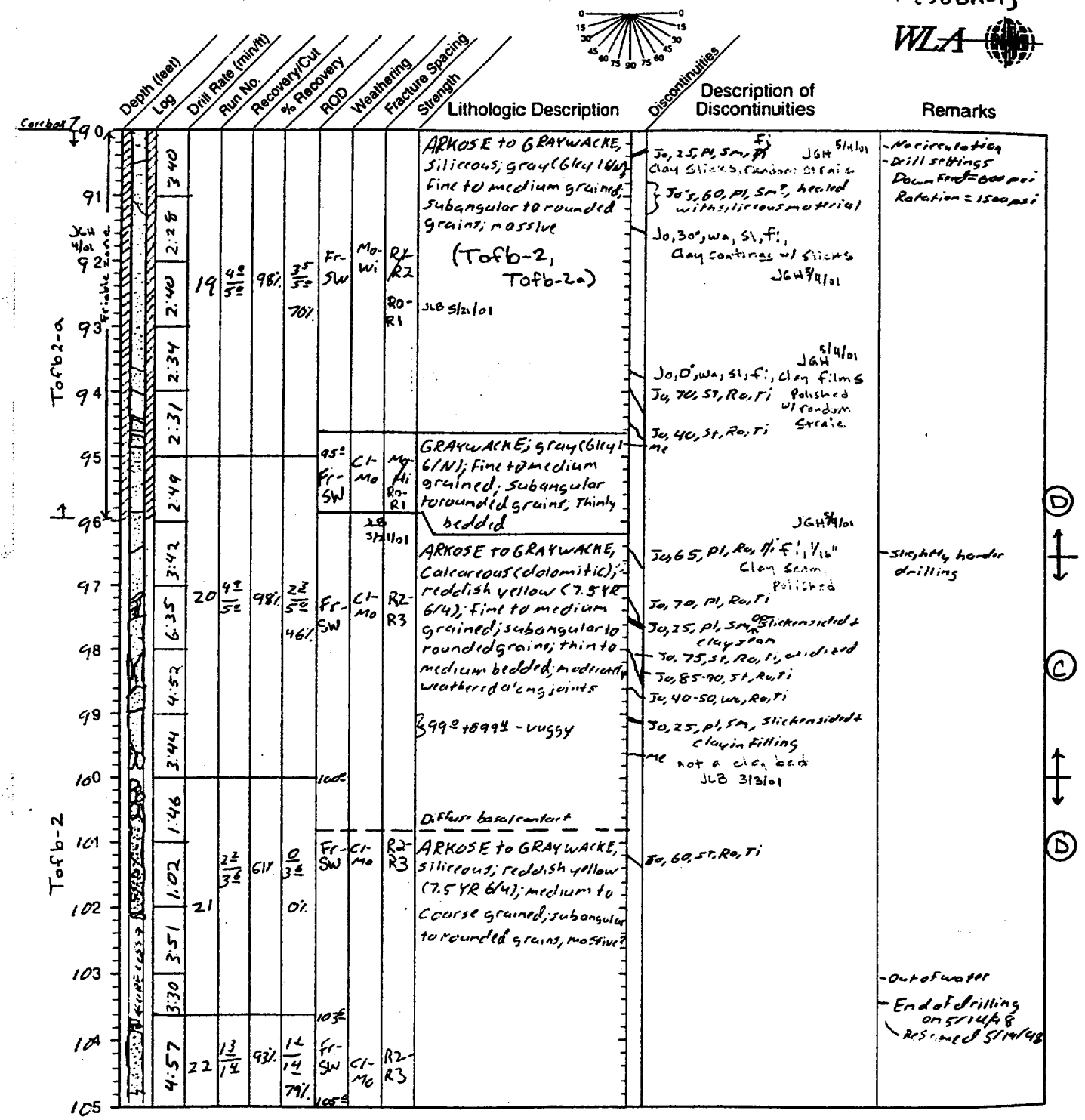
Tofb-2

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

ROCK BORING LOG

Project	Job Number	Date	Boring No.
PG&E DCPP - DCSF Siting Study 1998	1223-007	5/14/98	BA98-1 (98BA-1)

WLA



Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

98BA-1/8

ROCK BORING LOG

Project	Job Number	Date	Boring No.
PG&E DCPP - DCSF Siting Study 1998	1223-007	5/19/98	BA98-1 (98BA-1)

WLA

Rods +8E
HH HH
HH HH
11

Corebox 7

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
105										ARKOSE to GRAYWACKE, calcareous, light brown (7.5YR 6/4, cl); medium grained; siliceous; (Tofb-2, Tofb-2a)	Me		Smooth, easy coring -NO circulation
106	3:08										Jo, 70, Wa, Sm, Ti, Slickensided -Slicks dipping ~15° Polished; no clay, JGH 3/4/01		
107	2:57										Jo, 75, St, Ro, Ti, oxidized		
108	3:10	23	5°/5°	100%	2'/5° 42%	Fr-SW	Vc-Mo	R2-R3					
109	3:14										Me; Jo, 70-80, Wa, Sm, Ti, oxidized; Jo, 40, Wa, Ro, Ti		
110	2:30					110'				109'-110' Gray (Gley1 5/N) zone	Jo, 60, St, Ro, Ti; Me		Bentonite added to hole to try to regain circulation (2 bags)
111	2:02									ARKOSE to GRAYWACKE as above	Me		
112	2:11										Jo, 65, St, Ro, Ti		
113	2:41	24	5°/5°	100%	1'/5° 38%	Fr-SW	Cl-Mo	R2			Jo, 60-75, Wa, Ro, Ti; Jo, 80-90, St, Ro, He locally open, lined w/ slicks; Polished JGH 4/01; 3 open section - vug ~1/4" wide		
114	3:28										Fault, 80-90°, Wa-St, well-developed hard slicks w/ 20° rake, thin hard Be, O, Wa, Ro clay films; Jo, 75, St, Sm, locally clayey + oxidized		JLB 5/4/01
115	3:03					115'				Color and texture change			
116	2:57									GRAYWACKE, calcareous (dolomitic); gray (Gley1 6/N) to pale red (2.5YR 6/2); medium grained; subangular to rounded grains; locally light brown from 115' to 116'			
117	3:52	25	5°/5°	100%	4'/5° 96%	Fr-SW	Mo	R2-R3			Jo, 80, St, Ro, He - siliceous vein		
118	2:30										-Bedding contacts at 117', 118', 119' are horizontal		Drill strings: Downfeed - 400 psi Rot - 1200
119	2:06										Me; Mechanical breaks along bedding contacts?		
120	4:10										Me		

Corebox 8

Tofb-2

Tofb-2a friable zone JGH 4/01

all D

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW -Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

ROCK BORING LOG

Project	Job Number	Date	Boring No.
PG&E DCPP - DCSF Siting Study 1998	1223-007	5/14/98	BA98-1 (98BA-1)

WLA

Rods 185

Casing 8

Casing 9

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
120										GRAYWACKE, calcareous (dolomitic); gray (Gley1 5/N); medium to coarse grained; dolomite veins; shell hash		Be (Me?), 0-5, Wa, Ro	- Drilling string plugged. After several attempts to pull inner barrel failed, drill string pulled - 70 ft of rod pulled before inner barrel pulled - inner core barrel latching assembly broken & replaced
121	4:28												
	3:27											Be (Me?), 0-5, Wa, Ro	
122									R0				
	3:32	26	4.3/5.0	86%	3.5/5.0 70%	Fr-SW	Mo		R1-R2	JGH (Tofb-2, Tofb-2a) 5/14/01			- No circulation
123													
	4:28												
124						Fr-SW			R1/R2	- finer grained			
	5:54								R0	JGH 5/14/01			
125						125.5				GRAYWACKE as above		Jo, 80, Wa, Ro, Ti, oxidized	
	3:32												
126												Jo, 0-5, Wa, Ro, Ti, oxidized	- Drill settings Down: 350 psi Rot: 100
	2:45												
127													
	2:12	27	5.0/5.0	100	3.9/5.0 78%	Fr-SW	Mo		R1/R2	JGH 5/14/01			
128									R0				
	2:11											Jo, 65-85, Wa, Ro, Ti (avg 70)	
129													
	1:32											Jo, 45-75, Wa, Ro, Ti (Avg. 65)	
130						130.0				130½-130½ light brown zone			
	1:48												
131	JGH 4/01									light brown stringer		Fe, 70, Pl, Sm, Ti, oxidized & slickensides, tan discoloration on joint (oxidized)	
132												Me	
	2:18												
	2:21	28	5.0/5.0	100	4.4/5.0 88%								
133												Jo (Me?), 20, Wa, Ro, Ti	
	1:46												
134										GRAYWACKE BRECCIA; (dolomitic); light brown (7.5YR 6/4); medium grained with fine & coarse grains, thin to medium bedded		Jo (Me?), 10, Wa, Ro, Ti	
	2:00												
135						135.0							

Tofb-2a

Friable Zone

Tofb-2

All D

C-D

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW -Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

98BA-1/10

ROCK BORING LOG

Project	Job Number	Date	Boring No.
PG&E DCPP - DCSF Siting Study 1998	1223-007	5/19/98	BA98-1 (98BA-1)

WLA

Rods 185
Core 9

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
135	Tofb-2	2:46	gray zone							GRAYWACKE BRECCIA (dolomitic); light brown and gray; fine to medium grained; trace veins; healed shears/joints; medium bedded (Tofb-2, Tofb-2a) Sharp contact dip 50°			Smooth, easy coring Drill setting: Down 45 psi Rot: 1300 psi
136		2:47				Fr-SW	Wi	R1-R2			Shear zone, 60, St, Ro, He -		C-D
137													Tofb-2
	Tofb-1a	2:35	29	5/5 5/5	100	4/5 5/5 40%				GRAYWACKE, calcareous (dolomitic), gray (Gley 1 4/N) with light brown zones & stringers along healed joints: shears?; carbonate nodules & veins, fine to med. grained	Jo, 70, St, Ro, Ti, oxidized		Tofb-1
138	Tofb-1					Fr-SW	Wi	R1-R2					B
		2:27									Jo, 80°, Wa, St, Op polished JGH 5/4/01		Refilled water track
139	Friable Zone JGH 4/01	1:40						Ro R1		JLB 5/21/01			* Regained Circulation - Brown return
140	Core 10					140				GRAYWACKE as above	Shear fabric between 140° & 142.5°, healed, dip 50-90° Jo, 15, Va, Ro, Ti, oxidized		- lost circulation - no circulation
141		5:45											
	Tofb-1	2:49				Fr-SW	Wi	R1-R2			Jo?, 80-90, Wa, Ro, Op - with crystals formed in interstices		
142		1:54	30	5/5 5/5	100	3/5 5/5 76%					Jo, 10°, Pl, Sm, Op - 1/16" Clay, polished JGH 5/4/01		Tofb-1
143	Tofb-2a Friable Zone JGH 4/01	1:33						Ro-R1		JLB 5/21/01			Tofb-2
144		1:20											C-D
											Clayey zone, not bedding		
145		3:17				145				ARKOSE BRECCIA (dolomitic), light brown (7.5YR 6/4); fine to medium grained; vuggy; carbonate stringers along healed shears & fractures, trace carbonate nodules; no apparent bedding	Clay zone JLB 3/2/01 Jo, 50, St, Ro, Ti 5/4/01		- Smooth, easy coring
146						Fr-SW	Wi	R1-R2			Crushed zone, 0-5 Jo, 85-90, Wa, Ro, Op with gypsum? crystals		C-E
		3:32									Jo, 0-10 (Avg 0); Wa, Ro, Ti		
147			31	5/5 5/5	100	3/5 5/5 66%							
148	Tofb-2	2:17				Fr-SW	Wi	R1-R2		GRAYWACKE, calcareous (dolomitic); dark gray (Gley 1 4/N); fine to medium grained; sub-angular to rounded grains; carbonate stringers along healed joints; gypsum veins			
149		2:19									Jo, 25, Pl, Ro, Ti		
150						150					Jo, 35, St, Ro, Ti		

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW -Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

ROCK BORING LOG

Project	Job Number	Date	Boring No.
PG&E DCPP - DCSF Siting Study 1998	1223-007	5/19/98	BA98-1 (98BA-1)

WLA

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
150		2:16								GRAYWACKE, calcareous (dolomitic); dark gray (Gley1 4/N); fine to medium grained; carbonate stringers along healed fractures; thin to medium bedded (Tofb-2)	Jo, 30, St, Ro, He	Healed fracture and joints steeply dipping	-Regained circulation (10'?)
151		3:43											-lost circulation -no circulation
152		2:35	32	5'/5'	100	5'/5' 100%	Fr-SW	3'-5'	R1-R2				Drill settings Down - 600psi Rot - 1500psi
153		1:45									Me		
154		1:54											
155		1:59				155'				GRAYWACKE as above	Jo (Fo?); 80; Wa, Sm, Fi-Fi locally with clay		
156		2:16									Jo, 75, Wa, Sm, Ti		
157		2:36	33	5'/5'	100	3'/5' 66%	Fr-SW	4"-3'	R1-R2		Jo 75, pl-wa, Sm, Ti to Op (1/16") to Fi-clay (1/16" thick)		
158		2:20											Bentonite (2 bags) added to hole @ 160' on end of 5/19 to help seal hole & increase circulation
159		2:30											
160		2:30				160'				GRAYWACKE as above			End drilling on 5/19 Resume drilling on 5/20 @ 7:30 am Regained circulation
161		2:42											
162		2:37	34	5'/5'	100	4'/5' 90%	Fr-SW	4"-3'	R1-R2	162'-162.3' clayey softer rock zone	Me, Me		
163		2:15											
164		2:35									Jo, 50, Pl, Ro, Ti, Me		Lost circulation
165						165'							

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

ROCK BORING LOG

Project	Job Number	Date	Boring No.
PG&E DCPP - DCSF Siting Study 1998	1223- 007	5/20/98	BA98-1 (98BA-1)

WLA

Rods: ~~IIII~~ ~~IIII~~ ~~IIII~~ ~~IIII~~ ~~IIII~~ ~~IIII~~ IIII

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
165													No circulation
166		2:45, 2:27				Fr-SW	Mo	Mo-Hi		GRAYWACKE, calcareous (dolomitic); gray (GLY 4/N); medium grained; trace rock fragments; thin to medium bedded (Tofb-2, Tofb-2a)	Mo; Jo(Mr?), 5, Pl, Sm, Fi; clayey Polished JGH 4/01		
167		2:20	35	5e/5e	100	48/5e							
168		1:47			96%		R1			JGH 4/01			
169		2:09											
170		2:00				170°				GRAYWACKE as above but fine to medium grained	Jo(?), 35, Wa, Ro, Ti		
171		1:47					R1			JGH 4/01	Jo, 0°, Wa, Sl, Ti; clay films w/ slicks JGH 5/4/01		
172		2:41	36	5e/5e	100	38/5e	Fr-SW				Me		
173		2:59			70%						Jo(Mr?), 0, Pl, Sm, Ti; Jo, 60, Pl, Ro, Ti		
174		2:49	3 clayey zone								Jo, 5-5, Pl, Ro, Ti; Jo, 20, Pl, Ro, Ti		
175		2:28				170°	Fr-SW	VC-Mo	R1-R3		* 0.1' thick clay zone; Jo, 15, St, Ro, Ti		
176		2:50								GRAYWACKE, calcareous-dolomitic (or sandy clastic dolomite?), gray (GLY 6/N-5/N); fine to medium grained (crystalline?); thin to medium bedded; healed & clay filled vertical joints, locally fractured & brecciated zones	Jo(?Mr?), 5, St, Ro, Ti JGH 4/4/01; Jo, 60, St, Ro, Ti		
177		3:00	37	5e/5e	100	2e/5e	Fr-SW	VC-Mo	R1-R3		Fa, 85-90, Wa, Ro, Ti to Mod Fi; Brecciated zone		
178		2:56			40%						He/Fi - clayey, carbonate veins; Brecciated zone		
179		3:30									Jo, 5, St, Ro, Ti; Jo, 5, St, Ro, Ti; Jo, 10, St, Ro, Ti		
180						180°							

Tofb-2; Tofb-2a zone; Tofb-2a friable; Tofb-2

Carbonate; JGH 4/01

C-D; B-C; D

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

ROCK BORING LOG

Project	Job Number	Date	Boring No.
PG&E DCPP - DCSF Siting Study 1998	1223- 007	5/20/98	BA98-1 (98BA-1)

WLA

Core Box 12 ↓

Core Box 13 ↓

Tofb-2 / Tofb-2a / Fractable zone

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
180		3.46								GRAYWACKE, calcareous (dolomite?), gray, Fine to medium clearly crystalline?); medium bedded?, (Tofb-2a)	Jo, 80, Pl, Sm, Ti		- Smooth easy drilling - No circulation
181		3.52				Fr-SW	VC-MO	Cl-R3			Jo, 75, Wa, Ro, Ti		
											Jo, 30, 60, Pl, Ro, Ti		
											Jo, 60, Pl, Ro, Ti		
											Jo, 70, Pl, Ro, Ti		
182		3.08	38	4"/5"	80	0"/5" 10%					Jo, 80, St, Ro, Ti	Broken zone	
											Jo, 80-65, Wa, Ro, Ti w/ Dip (-45°)		
183		2.46										Me	
											Jo, 30, Pl, Ro, Ti		
184		10.52				F-SW	Cl-Wi	R2/R3 Ro-R1		GRAYWACKE, calcareous (Clastic Dolomite?); gray (Gley 1 4/N); medium grained; Thin to medium bedded, 5/21/01 JCB	Jo, 45, Pl, Ro, Ti		
185						185							
		1.55									Jo, 40, St, Ro, Ti		
186		2.03									Jo, 35, St, Ro, Ti		
											Jo, 75, St, Ro, Ti/He		
187		1.56	39	5"/5"	100	F-SW	Cl Wi	R2/R3 Ro-R1		JCB 5/21/01	Jo, 50-75 (Avg 65), St, Ro, Ti		- Smooth easy drilling - Drill settings Down: 500 psi Rot: 1500 psi
188		2.10								Brecciated zone	Jo, 15, Wa, Ro Jo, 50, St, Ro	Broken zone	
189		2.45									Jo, 15, Wa, Ro, Ti		
JGH 4/01											Jo, 70, St, Ro, Ti		
190		3.00				190				GRAYWACKE as above but medium to coarse grained	Jo, 10, Pl, Ro, Ti Jo, 10, Pl, Ro, Ti Jo, 50, St, Ro, Ti		
191		2.37									Jo, 55, St, Ro, Ti Jo, 60, Pl, Ro, Ti		
192		2.34	40	4"/5"	94%	F-SW	Cl-Wi	R2/R3 Ro-R1		JCB 5/21/01	Possible Shear zone Jo, 20, Pl, Ro, Ti, Clay film w/ many slickens JGH 5/4/01		
193		2.06											
194		2.35									JGH 4/01 Jo, 0°, Wa, Sl, Ti; clay films w/ well-developed slickens, Rake 0-5°		
195						195							

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW -Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

ROCK BORING LOG

Project	Job Number	Date	Boring No.
PG&E DCPP - DCSF Siting Study 1998	1223- 007	5/20/98	BA98-1 (98BA-1)

WLA

Rods: WT WT WT WT WT WT WT WT

Core Box 13

Depth (feet) | Log | Drill Rate (min/ft) | Run No. | Recovery/Cut | % Recovery | RQD | Weathering | Fracture Spacing | Strength | Lithologic Description | Discontinuities | Description of Discontinuities | Remarks

195, 196, 197, 198, 199, 200, 201, 202, 203, 204, 205, 206, 207, 208, 209, 210

Tofb-2a; Friable Zone; Core Box 14; Tofb-2; Tofb-2a; JLB 5/4/01; Friable Zone; Tofb-2

Drill rate: 4:00, 2:57, 2:58, 2:57, 3:18, 7:05, 2:55, 2:43, 3:17, 2:10, 3:02, 2:43, 2:35, 2:05, 3:13

Run No.: 41, 42, 43

Recovery/Cut: 5'/5', 5'/5', 5'/5', 5'/5', 5'/5'

% Recovery: 73/5' 84%, 48/5' 96%, 0/5' 16%

RQD: 100, 100, 100

Weathering: F-SW, F-SW, Fr-SW

Fracture Spacing: Wi, Wi, Wi, Wi, JLB 5/4/01 Wi

Strength: R2-R3, R1, R2-R3, R2-R3, R0-R1, R2-R3

Lithologic Description:

GRAYWACKE, calcareous (Clastic Dolomite?); gray (Gmy1 4/N); fine to medium grained; medium bedded to thick bedded with laminations along bedding (Tofb-2; Tofb-2a)

JLB 5/21/01

GRAYWACKE as above

GRAYWACKE, calcareous (Clastic Dolomite?); gray (Gmy1 5/N), medium to coarse grained; medium bedded

Discontinuities / Description of Discontinuities:

Me
Jo, 15, St, Ro, Ti
Me
Me
Jo, 35, Pl, Ro, Ti
Jo, 55, Pl, Ro, Ti - slight clay filled
Jo, 15, Pl, Ro, Ti
Be, 0-5, Pl, Ro, Ti
Be, 0-5, Pl, Ro, Me
Jo, 10, St, Ro, Me
Jo, 70, St, Ro, Me (* 1m clay films JGH 4/01)
Be, 5-10, Pl, Sm, Fi - clay stains brecciated zone ~.75" wide
Be, 5, Pl, Sm, Ti - Fi thin clay film
Jo, 40, Pl, Ro, Ti JGH 5/4/01
Jo, 45, Wa, Sm, Ti, minor steaks, Fe oxide
Jo, 60, Pl, Ro, Ti
Jo, 80-90, Wa, Ro, Ti - locally carbonate crystals
Me
Jo, 80, St, Ro, Ti
Jo, 70, St, Ro, Ti
Jo, 80-90, Wa, Ro, Ti w/ thin carbonate veins

Remarks:

Smooth, easy coring - No circulation
Drill settings: Down 500 psi Rot 1300-1500 psi
Smooth, easy coring

D, B-C, D

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

ROCK BORING LOG

Project	Job Number	Date	Boring No.
PG&E DCPP - DCSF Siting Study 1998.	1223- 007	5/20/98	BA98-1 (98BA-1)

WLA

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
Corehole 14													
210	2:50									GRAYWACKE, calcareous (Clastic Dolomite?); gray; medium to coarse grained; locally crystalline; medium bedded to massive (Tofb-2)	Jo, 75-90, Wa, Ro, Ti		-Smooth, easy coring -no circulation
211	2:32												
212	2:27	44	4ft/5ft	92%	3ft/6ft 70%	F-SW	VW	R2-R3					
213	2:36												
214	3:09												
Corehole 15													
215	2:12					215ft				GRAYWACKE as above but with carbonate nodules and cylindrical fossils?	Jo, 75-90, Wa, Ro, Ti		Drill settings Down: 300-400 psi Rot: 1500 psi
216	2:20									increasing carbonate			
217	2:14	45	5ft/5ft	100%	4ft/5ft 90%	F-SW	VW	R2-R3					
218	2:32									Dolomite? Calcareous?			
219	3:52									GRAYWACKE, calcareous (Clastic Limestone?); gray (Gley 1-4/N); fine to med. sand grains (crystalline?); carbonate nodules and thin to medium beds of medium and coarser grained material, beds appear horizontal, trace vugs; angular to rounded grains, some prismatic	Jo 80-90, St, Ro, Ti		-Slightly harder coring
220	4:06					220ft							
221	4:20												
222	3:20	46	5ft/5ft	100	4ft/5ft 80%	F-SW	VW	R2-R3					
223	3:22												
224	3:31												
225						225ft					MC		

Tofb-2

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

ROCK BORING LOG

Project	Job Number	Date	Boring No.
PG&E DCPP - DCSF Siting Study 1998	1223-007	5/20/98	BA98-1 (98BA-1)

WLA

Carbon 15

Carbon 16

Tofb-2

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
225–240	2:59, 2:58, 2:47, 2:44, 2:38, 2:27, 3:00, 3:42, 3:56, 3:50, 3:12, 3:54, 3:51, 3:36, 3:22	47	5'/5'	100	5'/5' 100%	F-SW	VW	R1-R3		GRAYWACKE, calcareous (Clastic Limestone?); gray; fine to coarse grained; thin to medium bedded; carbonate (dolomite) nodules & locally crystalline (Tofb-2)			-Smooth, easy coring
										Diffuse contact with intermixed pods of blue brown rock			
						F-SW	VW	R1-R3		GRAYWACKE, calcareous (Clastic Limestone); light brown (7.5YR 6/4); fine to coarse core; thin to medium bedded; carbonate (dolomite) nodules & zones; fossils			
						230'							
		48	5'/5'	100	5'/5' 100%	F-SW	VW	R1-R3		ARKOSE, calcareous (Limestone) light gray (10YR 7/1); fine to medium grain; diffuse zone between above/below rock		- Contact dips 30°	
										GRAYWACKE, calcareous to clastic Limestone; gray (GLEY 1 4/N); fine to coarse grain; carbonate nodules and stringers; vuggy; fossils; angular to rounded grains		contact dips 60°	
						235'				GRAYWACKE as above			
		49	5'/5'	100	5'/5' 100%	F-SW	VW	R1-R3		light gray/light brown zone			
						240'						Jo, Ta, Wa, Ro, He with dolomite vein	

D

D+

Coarse

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW -Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

ROCK BORING LOG

Project	Job Number	Date	Boring No.
PG&E DCPP - DCSF Siting Study 1998	1223-007	5/21/98	BA98-1 (98BA-1)

WLA

Rods: 𝍸 𝍸 / 𝍸 𝍸 / 𝍸 𝍸 / 𝍸 𝍸 / 𝍸 ||||

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
240 (Corebox 16)		3:08								GRAYWACKE, calcareous (Clastic Limestone?); gray (Gley 1 4/N); fine (crystalline?) to medium grained; calcite veins and nodules; thin to medium bedded (Tofo-2)			Smooth, easy coring -No circulation
241		3:13											
242		2:52	50	5.0/5.0	100	5.0/5.0 100%	F-SW	VW	R1-R3				
243		2:53											
244		3:15											
245 (Corebox 17)		3:06				245.5'							
246		2:47								GRAYWACKE, calcareous (dolomitic); unicolor zones of gray (Gley 1 4/N) and light gray (10YR 7/2); fine to medium grained sand; calcareous nodules and crystals; thin to medium bedded; cylindrical fossils			
247		2:35	51	5.0/5.0	100	4.9/5.0 98%	SW	VW	R2-R3				
248		2:56											
249		3:18									me		
250										BOH @ 250.0'		5/21/98	

Tofo-2 (240–250)

Down hole geophysics casing installed between 160' and 235'. HW-casing hung up in borehole from 0 to 160'. PVC casing (3.5" Ø OD, 3.0" Ø ID) installed and grouted in boring to 235'. Geophysics survey performed between 160' and 235'.
Boring BA98-4 drilled ~20' South west of BA98-1 in order to obtain geophysical survey of upper 150'. Boring drilled w/HW-casing and casing advancer (no coring) and 150' of PVC Schedule 40 casing (3.5" Ø OD, 3.0" Ø ID) installed and grouted.

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW -Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

Renamed 5/25/01 for consistency w/ later hole designations
JLB (98BA-2)
Unit Conversion JLB/CMB/WRL
Edited for ISFSI SAR-JLB 5/25/01

98BA-2/1

5/01 Friable zone calls JGH 5/4/01

LOG of ROCK BORING BA98-2

Page 1 of 12

Project	Job Number	Boring Location	Total Depth
PG&E DCPP - DCSF Siting Study 1998	1223-007	Borrow Area: Lower slope across from Q Road	165.0'
Type & Diameter of Boring	**Elevation and Datum**	**Ground Water Depth**	**Depth to Bedrock**
HQ 3.5" ID Wireline Rotary Diamond Core / Triple Tube Core Barrel	~~330~~ 322	Not measured *	0
Drilling Contractor and Rig	**Length of Core Barrel and Bit**	**No. of Core Boxes**	**Date Started**
PG&E G.C. Drillers (Glen Lofing - foreman) / Mobile B-40	8± Feet JLB 5/21/01	11	5/27/98
Casing Size and Depth	**Borehole Inclination**	**Logged By**	**Date Completed**
HW casing	vertical	P. Drouin	5/31/98

Rods +8.5'

* drill water injected during drilling

WLA

Core Barrel ↓

Tofb-1 / Tofb-2

Tofb-2a Zone

Friable

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
0–5	Core Loss	10:36	1	3.2/5.0	76%	0.0/5.0 0%	MW	VC-CL	R3-R4	0± Colluvium-Sandy, Clayey GRAVEL ARKOSE, calcareous (dolomitic); light brown (2.5YR 6/4) and light gray (5Y 7/N); fine to medium grained, highly jointed rock; no bedding apparent (Tofb-1/Tofb-2)	Jo, 70, Pl, Sm, Ti Jo, 75, Pl, Sm, Fi-thin clay seam Jo, 80, Pl, Ro, Ti ne Brecciated zone Jo, 70, Pl, Ro, Ti Jo, 10, Pl, Ro, He Jo?, 90, Wa, Ro, Ti Jo?, 90, Wa, Ro, Ti Jo, 30, Pl, Ro, Ti Jo, 50, Wa, Ti Jo, 85, Wa, Ti Jo, 60, Pl, Ro, Ti Jo, 70, Pl, Ro, Ti	Began coring @ 5:45 rig pitch: 23° -Mud tank down slope of boring -Good circulation: Light brown, sandy return water -Smooth easy coring -Drilling settings down: 400 psi rod: 1200 psi water: 80 psi	B-C
5						5.0							Tofb-1/Tofb-2 Tofb-2
5–10		2:06 2:04 1:45 1:19 1:43	2	5.0/5.0	100%	5.0/5.0 100%	Sw-MW	Mo-Wi	R2 RO-R1	GRAYWACKE, Argillaceous; Gray (5GY 5/N); fine to medium; primarily massively bedded with few thin beds of finer material; weak (Tofb-2a) JLB 5/21/01	Jo, 70, Wa, Ro, He, Clay seam Jo, 10, Wa, Ro, He, Clay seam Jo, 40, Pl, Sm, He, clay seam Horiz. slicks. rake 0-3° Jo, 80, Wa, Sl, He, clay seam Horiz. Slicks Rake 0-3° ne	JGH 5/4/01	C-D
10–15		1:40 1:55 0:45 1:23 1:50	3	3.4/5.0	68%	3.9/5.0 68%	Sw-MW	Mo-Wi	R2 RO-R1	GRAYWACKE as above JLB 5/21/01	Jo, 30, Pl, Sm, He, clay seam Jo?, 60, Wa, Sm, He, clay seam Jo, 30, Pl, Sm, Ti-clayey film	-Very easy coring -Harder coring	D

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW -Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type of infilling, slickensides, etc.

98BA-2/2

ROCK BORING LOG

Project	Job Number	Date	Boring No.
PG&E DCPP - DCSF Siting Study 1998	1223- 007	5/27/98	BA98-2 (98BA-2)

WLA

Core Box 2 ↓

Tofb-2

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
15										ARKOSE to GRAYWACKE, calcareous (dolomitic); reddish yellow (7.5YR 6/6), medium grained; massive; few very tight/healed joints; trace dolomitic veins (Tofb-2)	Mc		-Smooth, easy coring
16	1:25										Jo 50, Pl, Sm, Ti, oxidized; Jo 20, Sr, Ro, Ti; Mc		-Good circulation grayish brown, sandy return water
17	2:00										Jo, 85-90, Wa, Ro, Ti; Jo, 75, St, Sm, Ti; Jo 85, Wa, Ro, Ti; Jo 70, Pl, Sm, Ti		
18	3:02	4	5'/5'	100%	0'/5' 10%	MW SW	Cl	R2-R3			Jo 65, St, Ro, Ti; Jo 10-20, Wa, Ro, Ti; Jo 85-90, Wa, Sm-Ro, Ti; Brecciated Zone		-HQ drill rods full of clay/silty material due to recirculated cuttings accumulating above inner core barrel. Drill string flushed with clean water in order to extract inner core barrel.
19	2:39										Jo, 85-90, Wa, Ro, Ti		-To prevent this, only clean water used during drilling and effluence from drill allowed to drain to storm drain approximately 30' down slope on edge of road (D)
20	3:45					20%				ARKOSE to GRAYWACKE as above	Jo, 60, St, Ro, Ti - Mn? stained; Jo, 30, Wa, Ro, Ti; Jo 20, Pl, Sm, Ti; Mc; Jo, 85-90, Wa, Sm, Ti; Mc		
21	2:43										Jo, 15, Wa, Ro, Ti; Jo, 15, Pl, Sm, Ti - He w/ dolomite veins		
22	2:58	5	5'/5'	100%	0'/5' 10%	MW SW	VC-Mo	R2-R3			Jo, 30, Wa, Ro, Ti; Jo, 30, Pl, Sm, Ti - He; Jo, 60, Wa, Ro, Ti; Mc; Jo, 80, Wa, Ro, Ti, Mn? stained		-Slightly harder coring
23	3:06										Mc; Jo, 80, Wa, Ro, Ti, Mn? stained; Be?, 0-5, Wa, Ro, Ti		-Brown return water
24	5:17									24.2 to 24.5 coarse bed	Be?(Jo?), 15, Wa, Ro, Ti; Be?(Jo?), 5, Wa, Ro, Ti - He w/ dolomite; Be?(Jo?), 0, Wa, Ro, Ti - He - dolomite vein		(C-D)
25	6:05					25%				ARKOSE to GRAYWACKE as above but becoming more distinctly bedded - thin beds (<1"-2")	Jo, 30, Wa, Ro, Ti; Mc; Mc; Jo, 85-90, Wa, Ro, Ti		-Drill water allowed to recirculate - driller thinks that core out of Graywacke fines may not accumulate
26	5:58										Jo, 5, Wa, Ro, Ti; Jo, 10, Wa, Ro, Ti; Jo, 25, Wa, Ro, Ti		
27	6:36	6	5'/5'	100%	1'/5' 20%	MW SW	VC-Mo	R3			Jo, 20, St, Ro, Ti; Jo, 5, St, Ro, Ti; Jo? (Mc?), 10-80 (Avg. 40), St, Ro, Ti		
28	6:22										Jo, 5, Wa, Ro, Ti; Jo, 50, Wa, Ro, Ti; Jo, 70, Wa, Ro, Ti; Jo, 85-90, Wa, Ro, Ti; Jo, 60, St, Ro, Ti		@30' end of drilling on 5/27 - 9:00 pm
29	6:35										Mc		-HQ rod filled with circumulated fines. String flushed in order to extract core
30	4:27												

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

✓ KK 9/08/99

98BA-2/3

ROCK BORING LOG

Project	Job Number	Date	Boring No.
PG&E DCPP - DCSF Siting Study 1998	1223- 007	5/28/98	BA98-2 (98BA-2)

WLA

Corebox 3 ↓ Tofb-2

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
30		2:38								ARKOSE, calcareous (dolomitic); light brown (7.5YR 6/4) medium to fine grained, (4) dolomite veins (wide to thin) thin to medium bedded	Jo, 85-90, Wa, Ro, Ti - Me	Began coring on 5/28 at 7:30 am	
31		3:15									Jo, 10, Wa, Ro, Ti	-Smooth, easy coring	
32		4:38	7	5ft/5ft	100%	11/5ft 22%	MW	CI-MO	R3	(Tofb-2)	Jo, 10, Wa, Ro, Ti	-grayish brown return water	
33		3:28									Jo (Me?), 25, Wa, Ro, Ti; Jo, 90, Wa, Ro, Ti-Me; Jo, 15, Wa, Sl, Ti		
34		3:33								3 dolomite vein	Jo? (Me?), 15-40 (Avg 35), Wa, Ro, Ti; 3 Healed Shear/fault, 70, Pl, Ro, dolomite vein		
35		2:38				35±				ARKOSE as above	Jo, 16, Wa, Ro, Ti; Jo, 45, Wa, Sl, Ti; Jo, 85, Wa, Ro, Ti Me		
36		2:45									Jo, 55, Pl, Ro, Ti; Jo, 65, St, Ro, Ti; Jo, 85-90, Wa, Ro, Ti; Jo 50, St, Ro, Ti		
37		3:10	8	4ft/5ft	96%	1ft/5ft 20%	MW	VC-CI	R3		Jo, 15, Pl, Sm, Fi-clay film; Jo, 60, Wa, Sl, Ti, oxidized; Jo, 65, Wa, Ro, Ti/Me; Jo, 10, Pl, Sm, Ti		
38		3:27									Jo, 15, Pl, Sm, Ti		
39		2:45									Jo, 15, Pl, Sm, Fi-clay film; Jo 85-90, Wa, Pl, Ti, oxidized; Jo 35, Wa, Ro, Fi-thin clay film; Me		
40		2:40				40±							
41		2:45					MW	CI	R2	Lithic SANDSTONE, gray (Gley 1 5/N), fine to medium grained, carbonate? fragments	Jo 85-90, Wa, Sl, Ti		
42		2:37	9	3ft/5ft	60%	0.5ft/5ft 10%				ARKOSE, calcareous (dolomitic); light brown, fine to medium grained; (7.5YR 6/4, d)	Jo, 55, St, Ro, Ti; Jo, 45, Pl, Ro, Ti; Jo, 70, Pl, Sl, Ti, oxidized; Me; Me		
43		2:21										-Shear in inner core barrel came off, core run 9 lost. drill string pulled to fix core barrel and clear hole. Core pulled from outer core barrel	
44		2:20											
45													

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW -Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), CI-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

✓ KK 98 0527

98BA-2/4

ROCK BORING LOG

Project	Job Number	Date	Boring No.
PG&E DCPP - DCSF Siting Study 1998	1223- 007	5/28/98	B498-2 (98BA-2)

WLA

Core box 4

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
45–46	Tofb-2	2:03, 2:35	10	4.2/5.2	98%	SW MW	Mo Wi	R2-R3		ARKOSE, calcareous (dolomitic); light brown; fine to medium grained - grading coarser with depth (Tofb-2, Tofb-2a)			Good circulation
46–47	Tofb-2a, Friable zone, JGH 5/14/01	2:27			36%	MW	Mo Wi	R2 R1-		ARKOSE; gray (Gley 1 5N); medium to coarse, angular grains; medium bed JGH 5/14/01	Me		Return water changed from brown to gray
47–48		2:25				SW MW	Mo Wi	R1- R2-R3		ARKOSE, calcareous (dolomitic); light brown to reddish yellow (7.5YR 6/4 - 6/6); medium to coarse grained; medium bedded; some carbonate-healed joints	Jo, 30, Pl, Ro, Ti		Return water changed back to brown
48–49		2:52									Jo, 65-90, Wa, Ro, Op-0.1" to He-dolomitic; Jo, 15, St, Ro, Ti		
49–50		2:13			50%					ARKOSE as above; 50.2-50.4 Gray zone	Me; Jo, 75-90, Wa, Ro, Ti		Drilling settings Down: 3400 psi Rot: 1500 psi water: 150 psi
50–51		3:11									Jo, 80-90, Wa, Ro, Ti, oxidized; Jo, 10, Pl, St, Ti; Me		
51–52		3:47	11	4.2/5.2	94%	SW MW	VC-Mo	R2-R3		51.3-51.4 Dolomite crystals in open joint?	Me; Jo, 20, Pl, Ro, Ti; Jo, 10, St, Ro, Ti		
52–53		2:42			0%/5.4; 0%						Jo, 45, St, Ro, Ti; Jo, 5, St, Ro, Ti to Fi-thin clay		
53–54		4:37									Jo, 80, Wa, Ro, Ti; Jo's, 85, Wa, Ro, Ti; Me		
54–55		4:05			55%	SW MW	Cl	R2-R3		ARKOSE as above	Jo, 85, Wa, St, Ti, oxidized; Jo, 80-85, Wa, St, Ti		Gray return water
55–56		3:52									Jo, 80, Wa, Ro, Ti; Me; Jo, 80, Wa, St, Ti, oxid-red		
56–57	Tofb-2a, Friable zone, JGH 5/14/01	2:45	12	5.2/5.2	100					GRAYWACKE; gray (Gley 1 5/N); fine to medium grained; sub-angular grains, shell fragments?, massive JGH 5/14/01	Jo, 10, Pl, Ro?, He; Jo, 25, Pl, Ro?, He; Me		
57–58		2:14			36%	MW	Cl-Mo	R2-R3 RO			Jo, 45, Pl, Sm?, He; Jo, 30, Pl, Sm, Fi-thin clay & skeletonized Ro flake; Jo, 40, Wa, Ro, Ti		JGH 5/14/01
58–59		4:08									Jo, 5, Wa, Sm, Ti to Fi w/thin clay		
59–60					60%					Unit described on p. 5			

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

✓ KIK 9/20/99

ROCK BORING LOG

Project	Job Number	Date	Boring No.
PG&E DCPP - DCSF Siting Study 1998	1223- 007	5/28/98	BA 98-2 (98BA-2)

WLA

Corrbar 5

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
60–75		3:45, 2:48, 3:21, 2:59, 2:58, 2:39, 2:59, 3:45, 3:29, 3:34, 2:39, 2:44, 2:25, 2:19, 2:36	13, 14, 15	5'/5', 5'/5', 5'/5'	100, 100, 100	0'/5', 2'/5', 2'/5' 16%, 50%, 52%	MW, MW, SW, SW	VC-Mo, CL-Mo, Mo-Wi, Mo-Wi	R2-R3, R3, R3, R3	ARKOSE, calcareous (dolomitic), light brown to reddish yellow (7.5YR6/4-6/6), medium grained; thin to medium, horizontal beds; (Tofb-2, Tofb-2a)	Jo, 90, Wo, Sl, Ti - Slightly Op, oxidized, Mn stained	Smooth, easy coring - Light brown return water	
											Jo, 85-90, wo, Ro, Ti - tight		
											Jo, 30, St, Ro, Ti - open, broken		
											Jo, 80, wo, Sl, Ti - slightly Op, ox		
											Jo, 10, wo, Ro, Ti		
											Jo, 35, Pl, Ro, Ti		
											Jo, 45, Pl, St, Ti, carbonate coating		
											Jo, 85-90, wo, Ro, Ti, mn stained		
											Jo, 10, St, Sl, Ti - thin clay with slickensides		
											Jo, 85-90, wo, Ro, Ti, Mn stained		
											Me		
65						65°					Jo, 85-90, St, Sl, Ti, Mn stained	Gray return water	
66							MW	CL-Mo	R3 R0	JGH 5/14/01	Jo, 20, St, Sl, Ti		
											Jo, 85, wo, Ro, Ti to Me		
67							SW Mw	Mo-Wi	R2-R3 R0	GRAYWACKE, gray (GLEY1 4/N); medium grained; subangular to subrounded grains; thin to medium, sub-horizontal (2°-10°) beds; JGH 5/14/01; 67'-68'- gray and brown zone - sharp contact	Jo, 10, wo, Sl, Ti to locally clayey, Mn staining; Clay seams w/ striated slickensides JGH 5/14/01		
68											Jo, 90, Wo, Ro, Ti to slightly open		
69													
70						70°				GRAYWACKE as above			
71											Jo, 85, St, Sl, Ti		
											Jo?(Mn?), 10, wo, Ro, Ti		
72							SW	Mo-Wi	R2 R3	RO JGH 5/14/01	Jo, 80, St, Ro, Ti		
73													
74													
75											Jo, 85-90, wo, Ro, Ti		

Tofb-2, Tofb-2a, Tofb-2, Tofb-2a; Friable zone JGH 5/14/01; Friable zone JGH 5/14/01

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

ROCK BORING LOG

Project	Job Number	Date	Boring No.
PG&E DCPP - DCSF Siting Study 1998	1223- 007	5/28/98	BA98-2 (98BA-2)

WLA

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities / Description of Discontinuities	Remarks
75–80		2:54, 3:35, 2:59, 3:15, 4:29	16	5.0/5.0	100	1.3/5.0 26%	SW	Cl-Mo	R2/R3, R1+	GRAYWACKE; gray (5Y 4/1); fine to medium grained; subangular to rounded grains; thin to medium subhorizontal crossbeds (Tofb-2, Tofb-2a) JLB 5/4/01	Me; Jo, 50, Pl, Sm, Ti to Fi-clay; Jo, 5, Wa, Ro, Ti Sl. clay film, minor slicks JGH 5/4/01; Jo, 70, St, Ro, Ti; Jo, 55, St, Ro, Ti; Jo, 15, Pl, Sl, Ti; Jo, 50, St, Ro, Ti; Me; Jo, 30-45, St, Ro, Ti; Jo, 45, Pl, Sl, Ti; Jo, 85-90, Wa, Ro, Ti	Smooth, easy coring; Light gray return water; Drill Rig settings: down: 500psi, Rot: 1500psi, water: 150psi
80–85		2:41, 2:29, 2:29, 2:10, 3:02	17	4.3/5.0	86%	1.7/5.0 34%	SW	Mo	R2/R3, R1	GRAYWACKE as above (80.0) JLB 5/21/01	Jo, 40, Pl, Sm, Ti-Fi w/ thin clay; Thin clay on joints JLB 5/4/01; Jo, 45, St, Sl, Ti; Jo, 50, Pl, Sl, Ti; Jo (Be?), 5, Pl, Sl, Ti; Jo, 15, Pl, Sm, Fi-thin clay; Jo, 50, Pl, Sm, Fi w/ clay film, slicks JGH 5/4/01; Me	
85–88.3		1:52, 2:20, 2:15	18	5.0/5.0	100%	1.2/5.0 24%	SW	Cl-Mo	R2/R3, R1	GRAYWACKE as above with brown discoloring along prominent joints (85.0) JLB 5/21/01	Jo, 85, St, Ro, Ti, brown oxidized zone in fracture around joint; Jo, 15, Pl, Sl, He-carbonate; Thin clay film w/ slickensides; Me, Slickensides on subhorizontal (~15° dip); Me; Jo, 85, Wa, Ro, Ti; Me; Jo, 20, Pl, Sl, Ti	Difficult extraction of core caused multiple mechanical breaks
88.3–90		2:25, 2:52					SW	Cl-Mo	R3-R2	ARKOSE; light brown (7.5YR 4/4); medium to coarse grained; subangular to subrounded grains	Me; Jo, 85, Wa, Ro, [illegible]	

Left margin annotations: Contact; Tofb-2a Friable Zone JGH 5/4/01 (75–88.8); Tofb-2 (below 88.8). Right margin: C, D, C-D, D.

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dp, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy). Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

[illegible] above 77.5 ft in this hole.

✓ KIK 980529

ROCK BORING LOG

Project	Job Number	Date	Boring No.
PG&E DCPP - DCSF Siting Study 1998	1223- 007	5/28/98	BA98-2 (988A-2)

WLA

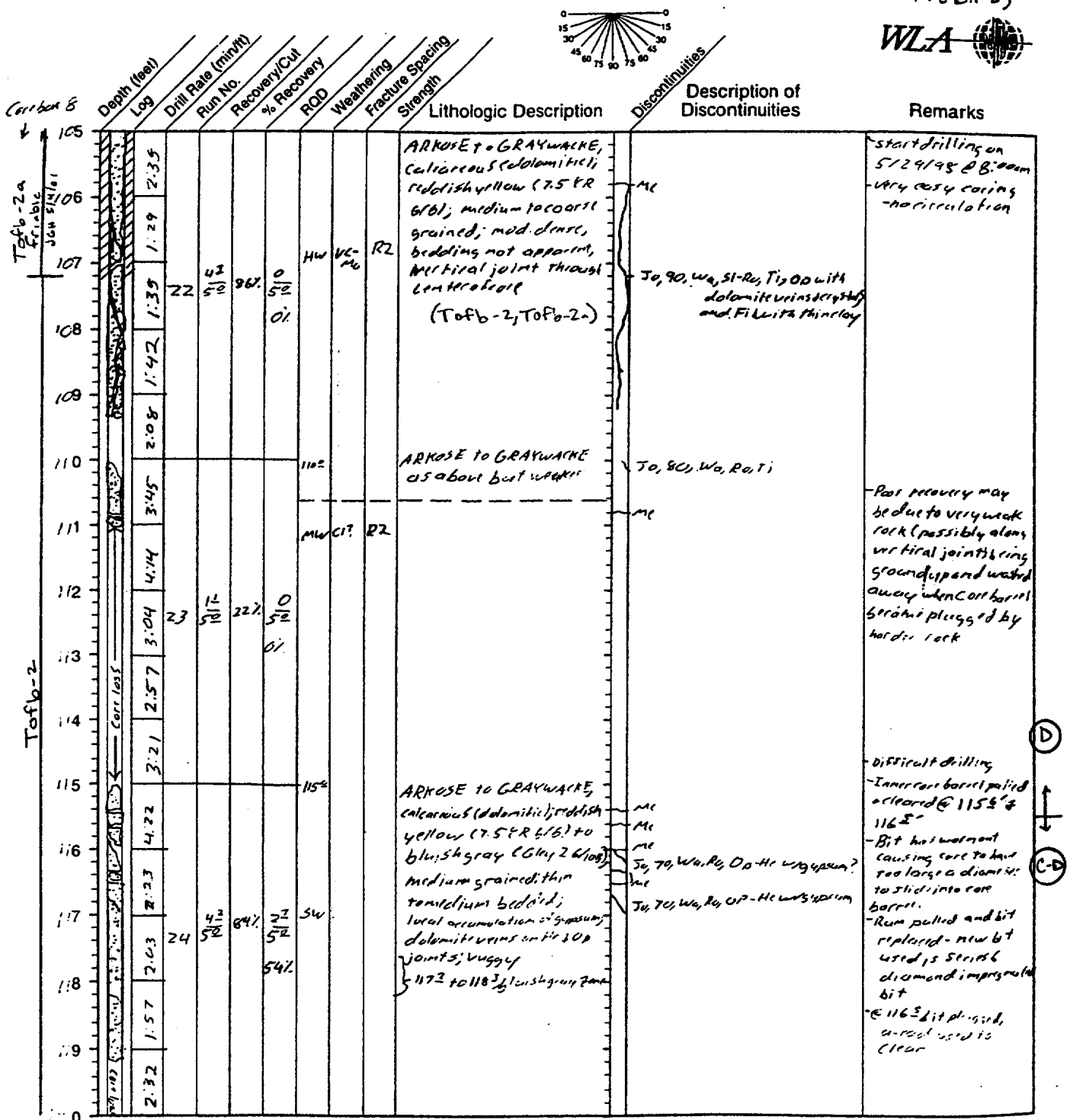
Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
Core barrel ↓ 90	Tofb-2									ARKOSE, calcareous (dolomitic); reddish yellow (7.5 YR 6/6), medium to coarse grained; subangular to rounded grains, thin to medium bedded, grading coarser with depth; vuggy (Contact dips 20°)			- Smooth, easy coring - Circulation poor
91		3:13				SW	Wi	R3					
92		2:59		5/5	100%	1/5					Mo		- Lost water pressure - Dropped to 10 psi - Lost circulation
93		3:32	19		38%					ARKOSE to GRAYWACKE; reddish yellow (7.5 YR 6/6); fine grained with medium grains less abundant, medium to thickly bedded, dolomitic	Jo, 85, Wa, Ro, Ti, Mn-stained; carbonate vein locally		- Water pressure returned to 100 psi (D)
94		2:58				SW	Cl-Mo	R3			Jo, 15, Pl, St, Ti - He-calcite Jo, 15, Pl, Ro He-calcite? Jo, 10, St, Ro, Ti Jo, 80, St, Ro, Ti, Mn-stained		
		3:32								(Tofb-2, Tofb-2a)			
95		4:42				95°				ARKOSE to GRAYWACKE as above			- Poor core drill (C)
96	Tofb-2a Friable	3:25						JGH Sh/Ph		(Contact dips 35°)	Jo, 5, Pl, Sm, Ti		
97	JGH Sh/Ph		10	5/5	100%	SW MW	Mo Wi	R0 R2-R3		GRAYWACKE, argillaceous; grey (GHy 4/N); fine to medium grained, no bedding, sparse white shell fragments (Contact dips 30°)	Jo (Me?), 5, Wa, Ro, Ti		
98					74%	SW MW	Mo Wi	R3		ARKOSE to GRAYWACKE, reddish yellow (7.5 YR 6/6); interbedded fine and medium grained beds, thin to medium bedded; dolomitic, locally green pods + lenses (1"-6")	Jo, 80, Wa, Ro, Ti Jo, 30, Pl, St, Ti; altered zone extends 2" below joint - fine grained + Fi		(D)
99		2:47								99.2 - 99.8 Gray zone	Jo, 60, St, Ro, Ti		- Water pressure shot up to 300 psi; clay blocking bit
100	Tofb-2	4:23				100%				ARKOSE to GRAYWACKE, calcareous (dolomitic), arkosic but predominantly fine grained and vuggy with dolomite crystals	Jo, 85-90, St Sl, Ox to He w/ dolomite vein		
101		3:53									Jo, 35, Pl, Sl, Ti		(C-D)
102		3:43	21	5/5	100%								
103		2:35			66%					Diffuse/Gradational contact ARKOSE to GRAYWACKE, calcareous (dolomitic); reddish yellow (7.5 YR 6/6) with trace beds of olive gray (GHy 2 6/5B); medium to coarse grained, thick dense; thin to med bedded	Jo, 5-10, Wa, Ro, Ti		
104	Tofb-2a Friable					HW	Wi	R1 R0	JGH Sh/Ph				(D)
105	JGH Sh/Ph	2:45				105°							- Stopped drilling on 5/28/98 @ 7:30 am

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

ROCK BORING LOG

Project	Job Number	Date	Boring No.
PG&E DCPP - DCSF Siting Study 1998	1223- 007	5/29/98	BA98-2 (98BA-2)

WLA



Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy). Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

98BA-2/9

ROCK BORING LOG

Project	Job Number	Date	Boring No.
PG&E DCPP - DCSF Siting Study 1998	1223-007	5/29/98	BA98-2 (98BA-2)

WLA

Core Box 9

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
120		1:03								ARKOSE to GRAYWACKE, calcareous (dolomitic); reddish yellow (7.5YR 6/6); medium grained; sub-rounded to subangular grains; wispy gypsum veins on joints; oxidized grains (Tofb-2)	30, 65, Pl, St, Op-He w/gypsum	Smooth easy drilling - No circulation	
121		1:10									70, 70, Pl, St, Op-He w/gypsum		
122		1:11	25	7.1/5.0	42%	1.0/5.0 20%	SW	Wi	R3				
123		0:49											
124		0:45										Catcher not installed on inner core barrel. Core lost. Core barrel filled in & tried backdown hole sample retrieved	C-D
125		1:32				125.0				ARKOSE to GRAYWACKE as above but reddish yellow to light gray (Clay? Zn, dry).	@ 125.2 - change in color from reddish yellow to light gray sharp irregular		
126		1:33											
127		2:51	26	5.0/5.0	100%	4.3/5.0 84%	Fr-SW	Wi	R3	light gray	10-12° JCB 5/14/01 Shear zone ~.8', 10, Pl, Rough - Finer grained material		
128		2:55									Fo, 0, Pl, St, Ti; Fo, 0, Pl, St, Ti w/ clay films & sticks JCB 5/14/01		D
129		2:40											
130		2:27				130.0				ARKOSE to GRAYWACKE as above but fine to medium grained with healed joints	Tofb-2 / Tofb-1 | Tofb-2	Stopped drilling 5:20 @ 1:54 pm. Begin reaming on 5/29 @ 11:30am	
131		2:41											
132		1:57	27	5.0/5.0	100	5.0/5.0 100%	Fr.	Wi	R3		Fo, 0, We, St, He, carbonate vein? Fo, 0, Pl, St, He, carbonate vein?		B-C
133		2:25											
134		2:35											
135													D

Tofb-2 / Tofb-1 / Tofb-2

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

ROCK BORING LOG

Project	Job Number	Date	Boring No.
PG&E DCPP - DCSF Siting Study 1998	1223-007	5/31/98	BA98-2 (98BA-2)

WLA

Corebat 10

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
135–150													
135–136		1:53								ARKOSE to GRAYWACKE, calcareous (Dolomitic); reddish-yellow with light gray zones; medium grained; thin to medium bedded; subrounded to subangular grains; oxidized; vuggy (Tofb-2, Tofb-2a)	Mc		Smooth, easy coring - No circulation - Drill Rig settings: Down: 150psi Rot: 1100psi Water: 160psi
136–137		2:20	136 to 136.5	6 inch gray pod		Fr	Wi	R3					
137–138		2:23	28	5ft/5ft	100%						Jo, 75, Pl, Sl, Ti to He w/gypsum?, locally Mn-stained		
138–139		4:40				SW	Cl-Mo	R2-R3		ARKOSE to GRAYWACKE calcareous (dolomitic)/ argillaceous; light yellowish brown (10YR 6/2); fine grained; thickly bedded; 30-40% fines; vertically jointed	Mc, Mc, Jo, 85-90, Wa, Sl, Ti to He w/ gypsum, locally Mn-stained, Mc		Polymer added to top of hole
139–140		4:03											Moderately difficult coring, @140' bit plugged by argillaceous graywacke, very dark gray. Inner barrel pulled, bit cleaned. Sample sandwiched to top of run 29
140–141		3:43				140'				GRAYWACKE, calcareous (dolomitic); gray (GY4 4/N); fine to medium grained; thickly bedded; argillaceous between 140' and 140.2'; multiple healed joints			
141–142		3:10	29	4ft/5ft	86%	FR	Wi	R3			Jo's, 65, Wa, Sl, He		
142–143		2:40			3ft/5ft 78%						Jo, 65-75, Wa, Sl, He, bifurcated; Jo, 50, St, Sl, He; Jo, 50, St, Sl, He; Jo, 45, St, Sl, He		
143–144		2:35						R1+		JGB 5/4/01	Jo, 15, St, Sl, He		
144		2:03									Mc		
145		4:24				145'				GRAYWACKE as above			
146		2:21									Jo (Mu?), 0-5, Pl, Ro, Ti; Jo (Mu?), 0-5, Pl, Ro, Ti		
147		2:16	30	5ft/5ft	100%	SW FR	Wi	R1-R3	R0-R1	JGH 5/4/01	Jo, 10, Pl, Sl, He		
148		1:58			3ft/5ft 60%								
149		2:02				MW 150'		R1-R2		dolomitic? moderately to highly weathered; Calcitic	Jo, 85-90, Wa, Ro, Ti; Friable zone around joint (~0.2'); bifurcates; Jo, 85-90, Wa, Ro, Ti continuous with joint above		

Friable zone JGH 5/4/01; Not friable, R1 JGB 5/4/01; Friable zone JGH 5/4/01

Tofb-2; Tofb-2a

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

ROCK BORING LOG

Project	Job Number	Date	Boring No.
PG&E DCPP - DCSF Siting Study 1998	1223-007	5/31/98	BA98-2 (98BA-2)

WLA

Corebox 11

Tofb-2

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
150		2.43								GRAYWACKE, calcareous (calcite); gray (Gley 1 4/N); fine to coarse grained; angular to subrounded grains; medium to thickly bedded; trace fine gravels - subangular to subrounded, lithic (Tofb-2)	Jo, 85-90, St, Ru, Ti	- Polymer added - Smooth, easy coring	D
151		2.51									Jo, 70, St, Ru, Op-He w/calcite? Jo, 90, St, Ru, Ti, Op-He w/calcite?	- No circulation	
152		2.05	31	4.2/5.2	98%	2.5/5.2 50%	FR	Mo-wi	R3		Jo, 65, St, Ru, Ti, He	- Drilling strings: Down: 300 psi Rot: 200 psi Water: 140 psi	C-A
153		1.49									Jo, 65, St, Ru, Ti Jo, 65, St, Ru, Ti		
154		2.27									Jo, 5, Pl, Ru, He Jo, 90, St, Ru, Op-He w/calcite Hard to distinguish		D
155		2.50				155±				GRAYWACKE as above with horizontal? beds 155.2 to 156.5 coarse bed	Jo, 70, St, Ru, Ti Jo, 70, St, Ru, Ti He	- Bentonite added: 150-lb bag added prior to circulating	
156		1.59									Jo or Be?, O, St, Ru, Ti w/ He w/ 0.1" calcite vein		
157		0.56	32	4.2/5.2	98%	2.5/5.2 50%	Sw FR	vl-Mo	R3		Jo, 5, St, Sl, He w/ 0.5" calcite vein Be?, O, St, Ru, Ti Be?, O, St, Ru, Ti He		
158		0.56									Jo, 60, St, Ru, Ti		
159		1.25									Jo? (He?), 10, St, Ru, Ti	- Polymer added	
160		3.19				160±				GRAYWACKE as above	Jo, 80, St, Ru, Ti He		
161		1.38											
162		1.42	33	5.2/5.2	100	2.5/5.2 80%	FR	wi	R3		Jo, 20, Wa, Sl?, He		
163		1.21								163.2-163.4 Slightly darker color (Gray Gley 1 5/N dark) zone w/ sharp, horizontal contact 163.4-163.6 - Coarse to medium grained bed - gradation contact ∴ dip of bed not apparent	Jo, 15, Wa, Sl?, He Bd?, Wi?, Sl?, Ti/He		
164		1.17									Be?, O, Pl, Sl?, Ti/He		
165													

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW -Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

98BA-2/12

ROCK BORING LOG

Project	Job Number	Date	Boring No.
PG&E DCPP - DCSF Siting Study 1998	1223-007	5/31/98	BA98-2 (98BA-2)

WLA

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
165										BOH @ 165.8' Boring terminated early due to HQ drill rod stripping at ~80'. 80' of core barrel (75') stuck in hole. Hole abandoned after attempts to free stuck rod failed. Drill rig moved ~5' northeast of BA98-2 and began drilling BA98-3. Boring backfilled with cuttings. -No PVC casing installed. Casing installed in BA98-3		5/31/98	-Very difficult coring, unable to advance core - driller thinks bit may be broken? -Hole tripped
166													
167													
168													
169													
170													
171													
172													
173													
174													
175													
176													
177													
178													
179													
180													

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW -Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

98BA-3/1

JLB (9 BBA-3) Renamed 5/25/01 for consistency of later hole designations

Unit calls JLB/CMB/WLL 5/4/01 friable rock calls JGH 5/4/01

Edited for ISFSI SAP JLB 5/25/01

LOG of ROCK BORING BA98-3

Page 1 of 4

Project	Job Number	Boring Location	Total Depth
PG&E DCPP - DCSF Siting Study 1998	1223-007	Borrow Area: 3± NE of BA98-2	220±'
Type & Diameter of Boring	**Elevation and Datum**	**Ground Water Depth**	**Depth to Bedrock**
HQ 3.5" ID Wireline Rotary Diamond Core / Triple Tube Core Barrel	~~321±'~~ 322	Not Determined	0'
Drilling Contractor and Rig	**Length of Core Barrel and Bit** JLB 5/31/01	**No. of Core Boxes**	**Date Started**
PG&E G.C. Drillers (Glen Lofing - foreman) / Mobile B-40	8± feet	4	5/31/98
Casing Size and Depth	**Borehole Inclination**	**Logged By**	**Date Completed**
HW (4½" ØOD, 3 15/16" Ø I.D.) casing to 165±/220±	vertical	P. Drown	6/3/98

* water/mud injected during drilling.

WLA

Depth (feet) | Log | Drill Rate (min/ft) | Run No. | Recovery/Cut | % Recovery | RQD | Weathering | Fracture Spacing | Strength | Lithologic Description | Discontinuities | Description of Discontinuities | Remarks

0

This boring complements BA98-2. BA98-2 terminated prior to target depth (~220±') due to mechanical failure. 0 to 165' drilled with HW casing and casing advancer, and not logged. The log of this portion of the core should be the same as BA98-2. Core logged below 165±'.

- Bentonite added through out HW drilling. HW drilling took between 1:30 and 7:00 min/ft.
- HW drilling from 0' to 165' on 5/31-6/2
- Began HQ coring on 6/2
- 3.0" PVC casing installed to 218' and grouted for downhole geophysics velocity survey. See BA98-2 for log of 0±' to 165±'

NOT LOGGED

HW-CASING SET to 165±

Cor Start

165

Depth (feet)	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
165					165±				GRAYWACKE, Calcareous (Calcitic ?; gray (GLEY1 5/N); medium to coarse grained, subangular to subrounded grains; thin to medium, horizontal beds			Began coring @ 7:10 pm. Drill Sub broken replaced.
166	3:00									Jo, 65, St, St, He; Jo, 85, St, Ro, He 100a 0.05"		
167	1:54	1	4±/5±'	94%	4±/5±' 84%	SW-FR	Wi	R3	166± to 167±' - dark gray zone			- Stopped coring @ 8:15 - No core run complete - Resumed coring on 6/3 @ 6:30 am
168	2:08								(Tofb-2, Tofb-2a)	Jo, 65, St, Ro, Ti		@ 165' - no mud/air had circulation then lost it
169	1:53											- Drill Rig pressures: Down: 300 psi; Rot: 1600 psi; Water: 1300 psi
170	2:24				170±				GRAYWACKE as above			@ 166± regained circulation - gray return water; @ 168± lost circulation; @ 169± regained circulation, "milky" gray return water
171	2:15									Jo, 85-90, St, Ro, Ti		
172	2:34	2	5±/5±'	100%	5±/5±' 50%	SW-FR	Mo-Wi	R3	172± to 175±' - dark gray zone	Jo, 65, Wa, Ro, Ti		
173	2:17									Jo, 75-90, Wa, Ro, Ti		
174	2:27											
175	3:03				175±					Jo, 80, Wa, Ro, Ti		

Tofb-2

Tofb-2a Friable Zone JGH 5/4/01

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type of infilling, slickensides, etc.

Field checked by Gary D. Simpson 6/4/98 [KDW 6/25/01]

98BA-3/1

ROCK BORING LOG

Project	Job Number	Date	Boring No.
PG&E DCPP - DCSF Siting Study 1998	1223- 007	6/3/98	BA98-3 (98BA-3)

WLA

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
175–179		2:38, 2:27, 2:29, 2:30, 2:57	3	5'/5'	100%	45/5' 90%	Sw Fr	Wi	R3-R2	GRAYWACKE, calcareous (Calcitic), gray (6164 5/N); medium to coarse grained; subangular to rounded grains; thin to medium, horizontal to subhorizontal (~10°) beds; trace fine, lithic gravel; local weak beds; distinct beds defined by changes in texture/grain size (Tofb-2)	Jo, 75, St, Ro, Ti; Be?, 0-5, Wa, Ro, Ti		-Smooth, easy coring; 50% circulation - gray return water; -Drillrig settings: Down: 300psi, Rot: 1500psi, Water: 120psi
180	Core box 2	2:10				180±				GRAYWACKE as above			8:40 am
181–183		1:33, 1:34, 1:38	4	5'/5'	96	35/5' 70%	Sw	Wi (Cl bott)	R3-R2	181½ to 182½ - coarse, weak bed	Be?, 0-5, Wa, Ro, Ti; Jo, 75, St, Ru, Op (0.05') to He; Be?(Mt?), 0-5, Wa, Ro, Ti; Be(Mt?), 0, Wa, Ro, Ti		-Milky, gray return water
184–185		1:48				185±				GRAYWACKE as above but thickly bedded and mostly coarse grained	Jo, 80, St, Sl, Ti		Drillrig settings: Down: 400psi, Rot: 1500psi, Water: 100psi
186–190		1:50, 1:43, 2:09, 2:14, 2:35	5	5'/5'	100%	43/5' 86%	Sw Fr	Wi	R3				

Tofb-2

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

98BA-3/3

ROCK BORING LOG

Project	Job Number	Date	Boring No.
PG&E DCPP - DCSF Siting Study 1998	1223- 007	6/3/98	BA98-3 (98BA-3)

WLA

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
190–193		2:30, 2:15, 2:09, 2:12	6	5'4/5'2	100%	4'3/5'2 98%	Fr	Wi	R3	GRAYWACKE, calcareous (calcitic ?); gray (Gley 1 5/N); medium to coarse grained; subangular to rounded grains; trace fine, lithic arenitic gravel; thin to medium bedded (Tofb-2)	Bd, Ro, Wa, Ro, Ti	Smooth, easy coring 60% circulation milky, gray return water. Drilling settings: Down: 400psi; Rot: 150psi; water: 100psi	10:00 am
193–195		2:15, 1:55				195'				GRAYWACKE as above but locally vuggy	Me		
195–197		1:58, 2:10	7	5'0/5'2	100%	4'8/5'2 96%	Fr	Wi	R3		Jo, So, St, Si, Ti		
197–199		2:15, 2:44											
199–200						200'				GRAYWACKE as above			Gray return water (Clear)
200–203		3:01, 2:37									Jo, 35, Pl, Si, Ti		
203–205		2:15, 2:50, 2:18	8	5'0/5'2	100%	3'8/5'2 68%	Fr	Mo Wi	R3		Jo, 20, Pl, Si, Ti; Jo, 40, St, Ro, He; Jo, 45, St, Ro, Ti; So, 65, St, Ti		Stopped for lunch @ 11:30

Tofb-2

Carbon?

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Folation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

ROCK BORING LOG

Project	Job Number	Date	Boring No.
PG&E DCPP - DCSF Siting Study 1998	1223- 007	6/3/98	BA 98-3 (8BA-3)

WLA

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
205		2:28								GRAYWACKE, calcareous (calcite)-locally argillaceous; gray (Gley1 4/N); medium to coarse grained; subangular to rounded grains, medium to thickly bedded	Jo, 50, St, Ro, Ti; Fi, w/ clay films & weak stria JGH 5/14/01	-Smooth, easy coring -70% circulation milky gray return water	
206		2:02											
207		2:35	9	5ft/5ft	100%	3ft/5ft 66%	Mw-Fr	Mo-Wi	R2-R3	206?-206? weak rock zone?/bed? that is dark gray and argillaceous (Tofb-2, Tofb-2a)	Jo?(Be?); 5-15, Wa, Ro, Ti		
208		2:17									Be?(Mc?), 0, Wa, Ro, Ti		
209		2:19								208ft to 209ft - weak rock zone?/bed? that is dark gray and argillaceous	Be?(Mc?), 0, Wa, Ro, Ti; Jo, 35, Pl, St, He; Mc?(Be?, 0, Wa, Ro, Ti)		
Contact 4 210		2:50				210?				GRAYWACKE as above with light brown (7.5YR 2/4) discoloration along prominent joints below 213ft' and locally trace vugs	Mc; Jo, 70, St, Ro, Ti		
211		2:58									Jo, 70-80, Wa, Ro, Ti; Jo, 75, St, Ro, Ti	-Momentarily lost circulation; regained it @ 70% circulation	
212		2:54	10	5ft/5ft	100%	5ft/5ft 60%	Mw-Fr	Mo-Wi	R2-R3		Jo, 70, St, Ro, He - locally Op-vuggy		
213		3:11									Jo, 80-90, St, Sl, Ti-He; Jo, 90, St, Sl, Ti - oxidized + light brown zone 0.2" thick along joint		
214		3:32									Jo 60, St, Sm, Ti - oxidized + light brown zone 0.2" thick along joint		
215		2:27				215?				GRAYWACKE as above	Jo, 80, St, Sm, Ti - oxidized + light brown zone		
216		2:35								215.6' to 216.1' light brown	Mc; Jo, 80, St, Ro, Ti; Jo, 70, St, Ro, Ti } oxidized + light brown discoloration		
217		1:59	11	4ft/5ft	80%	1ft/5ft 36%	Mo-Fr	Cl-Mo	R2-R3	216.5' to 217.5' light brown with calcareous nodules	Mc; Be?(Jo?), 5, Wa, Ro, Ti, oxidized; Jo, 90, St, Ro, Ti, oxidized; Be?, 0-10, Wa, Ro, Ti, oxidized; Jo, 45-60, Wa, Ro, Ti, oxidized	-Geophysics casing installed in borehole. Behind 40 PVC casing (3.5" OD, 3.0" ID) installed and grouted w/neat cement between 0' and 220'.	
218		3:32											
219		4:01				210?							
220										BOH @ 220.0' on 6/3/98		-Coring completed at 2:00pm	

Tofb-2a; Friable Zone; Tofb-2

all D

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

Hole drained to 149'± upon completion of drilling

LOG of ROCK BORING OOBA-1

Unit calls by JLB/CMB/WAL/EM 5/01
Edited for ISFSI SAR - JLB 5/25/01

Page 1 of 10

Project: DCPP ISFSI Borrow Area	Job Number: 1223-49	Boring Location: upper road between 500kV towers	Total Depth: 150'
Type & Diameter of Boring: HQ core double barrel core barrel		Elevation and Datum: 450'±	Ground Water Depth: N.D.'	Depth to Bedrock: 0' (surface)
Drilling Contractor and Rig: All Terrain Exploration Drilling / Failing 1500 (Ron=Driller)	Length of Core Barrel and Bit: 5.5'	No of Core Boxes: 11	Date Started: 28 Nov 2000
Casing Size and Depth: 6" casing to 4' deep	Borehole Inclination: vert	Logged By: CMB, JGH	Date Completed: 1 Dec 2000

Reviewed JLB 12/00

WLA

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
0–4										Auger to 4' to set casing		615:03 start	
4–9	Tofb-1	8:20, 7:10, 8:40, 8:00, 7:50	1	5.0/5.0	100%	3.8/5.0 76%	Sl-Mw	Mo-Cl	R1-R2	JLB 12/00 (Sandy Dolomite to Limestone) SANDSTONE, dolomitic, arkose to greywacke; to dolomite. Fe, Mn coating on some fractures; fine-grained, well sorted; occasional small fossils. Color very pale brown (10YR 7/4) occasional lithic fragments, fine, bedding not readily evident; effervesces fairly well, very well when powdered well cemented (Tofb-1)	JLB 12/00 (1/16" stiff clay coating) Jo, 10°, Pl, Sm, Op; Jo, 75°, Pl, Sm-Sl, Ti-Op, Mn coating, oxidized, clayey fill on fractures; Jo, 30°, Pl, Sl, Op; several Jo, 10-20°, Pl, Sl-Sm, Mn and oxidation; Jo, 25°, Pl, Sm-Sl, Op, slight oxidation; Jo, 35°, Pl-St, Sl-Ro, slight oxidation (dolomite veins/coating) JLB 12/00; Jo, 75°-90°, Wh-Pl, Sl, dolomite fill; Jo, 10°, Pl, Sl, Fi; Jo, 20°, Pl, Sl, dolomite fill; Jo, 30-60°, Wa, Sl, dolomite fill	15:03:00; 15:11:20; 15:18:30; Slow steady coring; 15:27:10; 15:35:10; Stop 15:43:00
9–13	Tofb-1	8:20, 7:30, 8:10, 9:20	2	4.0/4.0	100%	3.9/4.0 97%	Sl	Wi	R1-R2	Same as above; occasional thin (~2"-4") zones of more common lithic fragments, very fine grained grades to brownish yellow (10YR 6/6)	Jo, 60-70°, Pl-Sl, Sl, Ti, Mn coating; Jo, 5°, Pl, Sl, Op, Sl light Mn coating	Start 16:06:00; 16:14:30; 16:22:20; 16:30:50	
13–15	Tofb-1	7:45, 10:45	3	2.3/2.3	100%	2.3/2.3 100%	Sl	Wi-Vw	R1-R2	similar to above; grades more greywacke; more common dark lithic fragments, very fine sand size; grades darker, to yellowish brown (10YR 5/4)	Ve, 30°, Pl-Wa, Sl, Fi, Carbonate fill; Ve (Jo ±); 60-70°, Wa, Sl, Fi/Ti, Carbonate; Ve, 80°, Pl-Wh, Sl, Fi/Op, Carbonate wall; Jo, 35°, St, Sl, Ti, hairline joint Vugs	Stop 16:39:50 Slow zone; Start 16:44:15; 16:51:00 Slower; Stop 17:04:45 28 Nov	

All (A)

Weathering Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil Fracture Spacing VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak Lithologic Description Rock type, color, texture, grain size, etc Discontinuities Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein Joint descriptions Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type of infilling, slickensides, etc

ROCK BORING LOG

Project	Job Number	Date	Boring No.
DCPP ISFSI Borrow Area	1223-49	29 Nov 2000	00BA-1

WLA

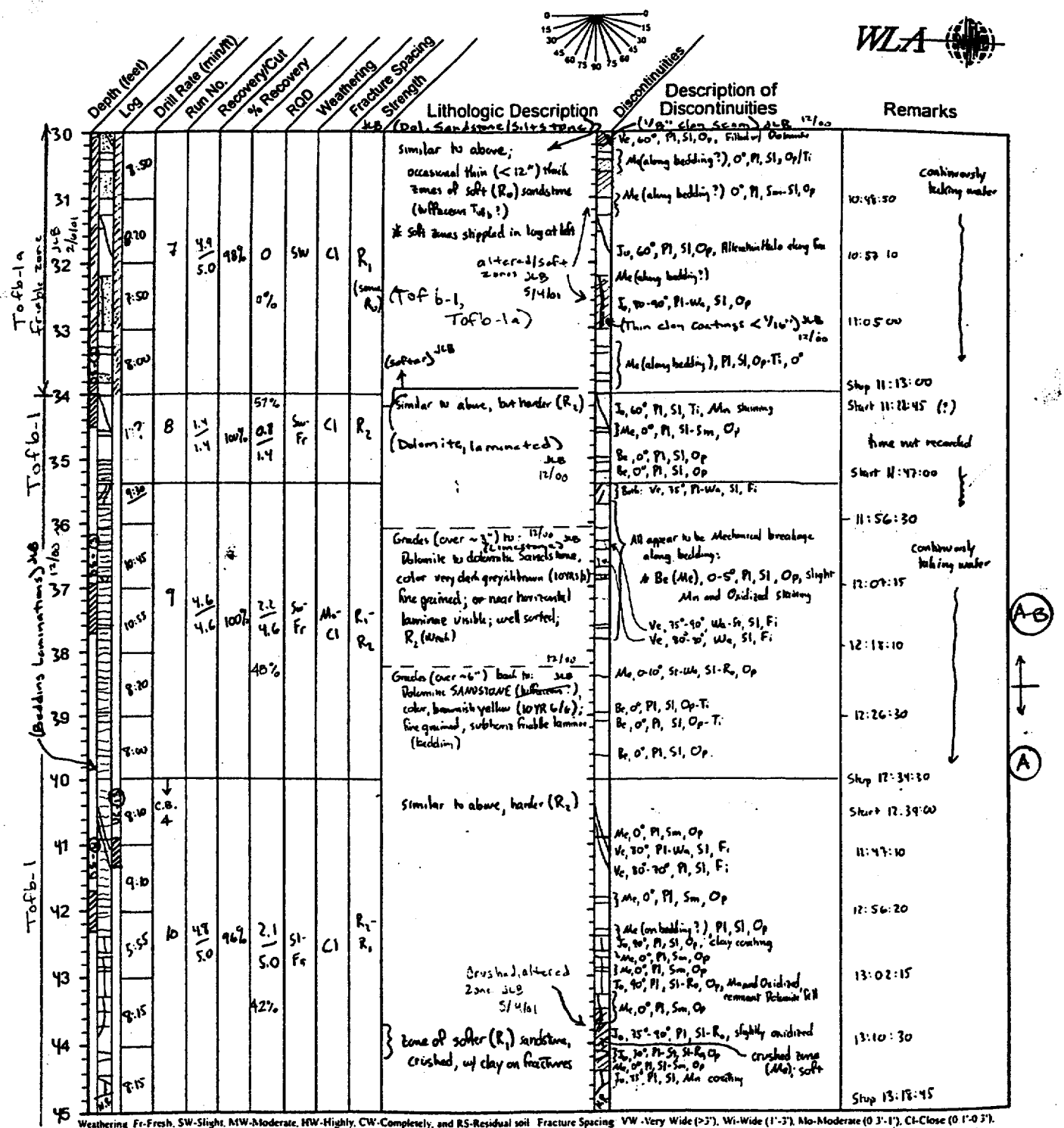
Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
15			3	2.3/2.3	100	2.3/2.3	SI	Wi-Vw	R1-R2	(Dolomite to Limestone) Similar to above: 12/00 JLB			Stop 17:04:45 28 Nov 2000
16		15:30/12 feet	c.b. 2							Dolomitic SANDSTONE to DOLOMITE, graywacke, fine grained with some fine lithic fragments, well sorted; color greyish brown (10YR5/2), with brownish yellow (10YR6/8). carbonate grains visible, fine. grades slightly coarser grained well cemented (Tofb-1; Tofb-1a)			Start 07:18 29 Nov 2000
17											Open Vug (dissolved fossil?) partially infilled with qtz (dolomite? no fizz)		07:28:30
18		15:30	4	4.7/4.7	100%	4.7/4.7 100%	Sw-Fr	Vw	R2		Jo, 30°, Pl, Sl, Op, Mn and Oxidation on Joint surface		occasional increases in pump pressure 07:44:00
19		12:15								below color boundary: grey (10YR5/1) (limestone?)	Boundary of color change, sharp, distinct boundary, 35°, Planar		07:56:15
20		11:15									Jo/Ve, 80°-90°, St-Wa, Sl, Fi/Ti		Stop 08:07:30
21		15:00								similar to above	Continuation of above fracture		Start 08:53:30 after changing to new bit
22		12:15	5	4.1/4.1	100%	3.0/4.1 73%	Sw-Fr	Wi-Cl	R1-R2	Slightly darker	Ve, 35°, Pl, Sl, Fi/Ti,		taking water 09:08:30
23		10:45								(to Dolomite) JLB 12/00	Color boundary		taking water 09:20:45
24		8:00								Dolomitic SANDSTONE, graywacke, color brownish yellow (10YR6/6); fine grained w/ fine dark lithic fragments; occasional softer ($R_0^{(-)}$ to $R_1^{(-)}$) zones; well sorted thin subhorizontal lamination (bedding) apparent in places.	Jo, 5°, Pl, Sl-Ro, Op, Mn stained (slight), Me? Me, 0°, St, Ro, Op altered zone JLB 5/4/01 Jo, 30°, Pl, Sl, Op, Mn stained; All4: Jo, 0°, Pl, Sl-Ro, Op, slight Mn stained; thin clay coating		09:31:30
											Jo, 30°, Pl, Sl, Op, Mn stained Jo, 0°, Pl, Sl-Ro, Mn stained (slight), Op Jo, (Me?), 0°, Pl-Wa, Ro, Op, Jo, 0°, Pl, Sl-Ro, Op, Sl. Mn stain		Stop 09:39:30 Start 09:49:00
25		9:15									Me, 0-10°, Wa, Ro, Op		
26		7:00									Jo, 0°, Pl, Sl, Op, Slight Oxidation, Mn Stain		09:59:15
27		5:15	6	4.9/4.9	100%	3.4/4.9 69%	Sw-Fr	Wi-Cl	R1-R2		Jo, 0°, Pl-St, Sl, Op, Slight Mn Ve, 35°, Pl-Wa, Sl, Fi, Dolomite (?) Ve, 60°, Pl, Sl, Fi, Dolomite Ve, 35°-90°, Pl-Wa, Sl, Ti/Fi (Dolomite?) Me, 0°, Pl, Sl, Op Ve, 45°, Pl, Sl, Ti/Fi		10:06:15
28		7:30									Jo, 25°, Pl-Wa, Sl, Op, slight Mn Jo, 0°, Pl, Sl, Op Jo, 0°, Pl, Sl, Op altered zone JLB 5/4/01 Jo/Ve, 35-85°, Pl, Sl, Ti/Fi Dolomite		10:11:30
29		8:00								Softer zone ($R_0^{(-)}$) 12/00 JLB	Me, 0°, Pl, Sl, Op		10:19:00
30	Tofb1a friable JLB 7/6/01	8:15	c.b. 3 7	4.9/5.0	98	0/5.0	SW	Cl	R1 (some R0)	(29.4-36.4'± thin clayey seams and pockets along solution cavities)	Jo (Ve), 80°, Pl, Sl, Op/Ti/Fi Me, 0°, Pl, Sl-Ro, Op Ve, 80°, Pl, Sl, Fi/Op, altered zone JLB 5/4/01		Stop 10:27:00 Start 10:31:45 Stop 10:40:00

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

ROCK BORING LOG

Project	Job Number	Date	Boring No.
DCPP ISFSF Borrow Area	1223-49	29 Nov 2000	00BA-1

WLA

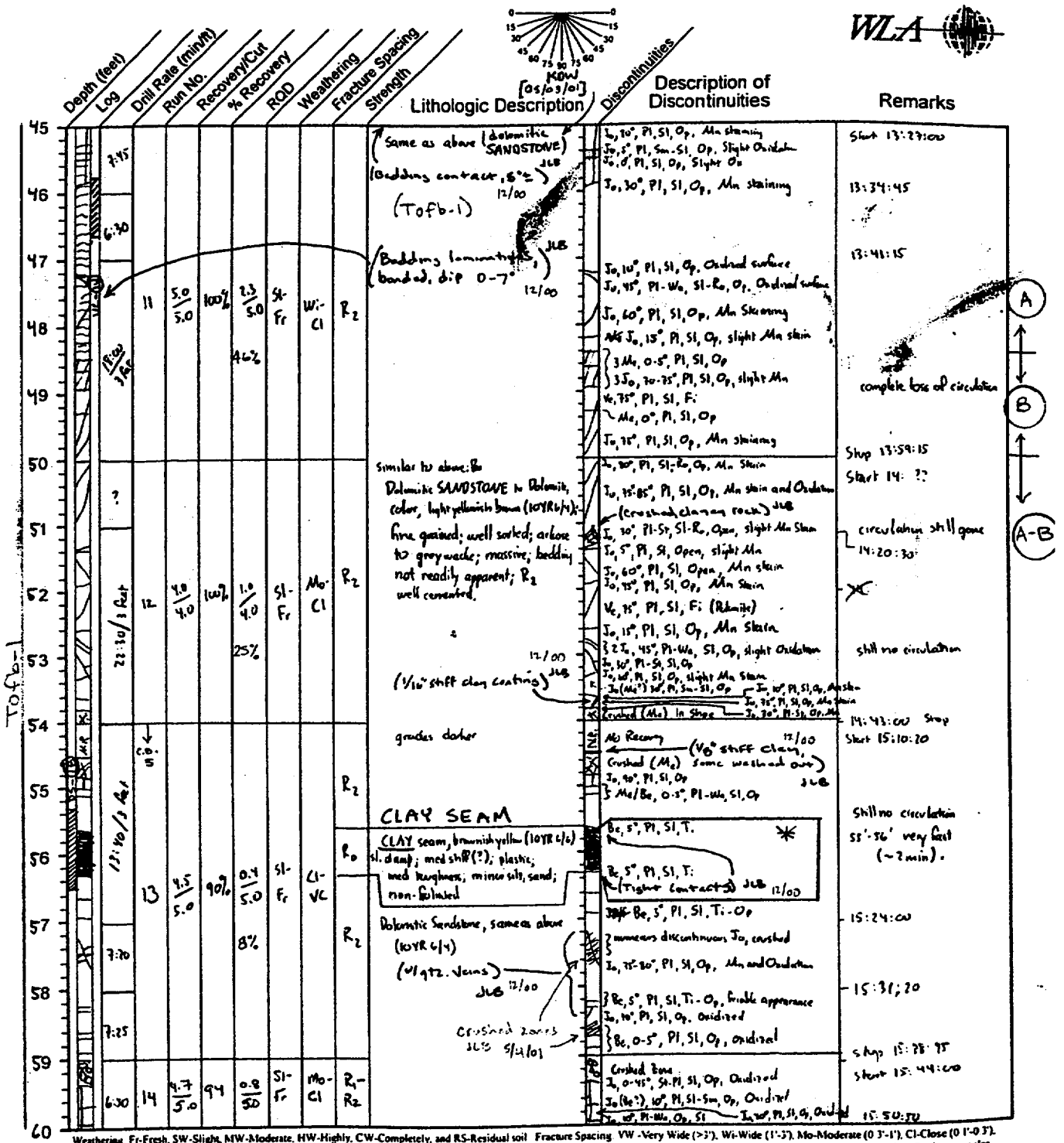


Weathering Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil Fracture Spacing VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1') Strength R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak Lithologic Description Rock type, color, texture, grain size, etc Discontinuities Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein Joint descriptions Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

ROCK BORING LOG

Project	Job Number	Date	Boring No
DCPP ISFSI Borrow Area	1223-49	29 Nov 2000	00BA-1

WLA



Weathering Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil Fracture Spacing VW -Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0 3'-1'), Cl-Close (0 1'-0 3'), and VC-Very Close (<0 1') Strength R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak Lithologic Description Rock type, color, texture, grain size, etc Discontinuities Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein Joint descriptions Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc

ROCK BORING LOG

Project	Job Number	Date	Boring No.
DCPP ISFSI Borrow Area	1223-49	29-30 Nov 2000	OOBA-1

WLA

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
60		7:25								Similar to above. Dolomitic SANDSTONE to DOLOMITE		Jo/Ve, 75°, St-Pl, Sl, Fi/Ti; Jo/Ve, 75°, Pl, Sl, Fi (Dolomite)	
61		6:35	14	4.7/5.0	94%	0.8/5.0 16%	Sl-Fr	Mo-Cl	R1-R2	Tofb-1		Jo, 15-30°, St, Sl-Ro, Op; Jo, 75°, Pl, Sl, Op, coated w/ clay; Me, 0°, Pl, Sl, Op	15:58:15 shift no circulation
62		5:35								Crushed rock JLB 5/4/01		Jo/Ve, 60-70°, Pl, Sl, Fi/Ti; Jo (Me?), 10°, Pl-St, Sl, Op; Jo (Me), 10°, Pl, Sl, Op (prominent rough vertical fracture) JLB	16:05:10
63		9:45										Jo, 70°-90°, Pl-St, Sl, Op, stained w/ Mn and oxidized; Jo (Me?), 10°, Pl, Sl, Ti-Op, downhole, friable appearance	16:10:45 Stop 16:20:30 29 Nov
64		?	15	0.6/1.0	60%	0	Sl-Fr	Cl-Vc	R2			Me, 0-10°, St, Sl, Op; Jo, 20°, St, Sl-Ro, Op; Jo, 75-90°, Pl, Sl, Op, Mn Stain; Crushed Zone (Me)	Start 07:02 30 Nov
65		?	16	0.5/1.0	50%	0	Sl-Fr	Cl-Vc	R2	Same lithology as above but very highly fractured zone (Dolomite to Fine gr. Dol. Sand Stone) JLB 12/00		Joints bounding fragments of core are stained w/ Mn and oxidized	Very difficult coring. No circulation. Hole coring between runs
66		?	17	0.4/1.0	40%	0	Sl-Fr	Cl-Vc	R2			Same as above	
67													Start 09:29:15
68	N.R.	~ 20 min/1.5'	18	1.6/2.5	64%	0	Sl-Fr	Cl-Vc	R2	Crushed/altered Zone JLB 5/4/01		No Recovery; (crushed zone (Ale or Jo)); Jo, 45°, Pl, Sl, Op, Mn stained; Jo, 90°, Pl, Sl-Ro, Op, Mn stained; Jo, 60°, Pl, Sl, Op, Mn Stained; Jo, 45-75°, Pl, Ro, Op, stained JLB 12/00	Hole collapse between runs; need to drill through rubble to get back to bottom of hole
69									Ro	12/00 (crushed rock with silt, some clay) JLB; ~~Sandy CLAY, yellowish brown (10YR 5/4)~~; slightly damp to dry; stiff (?); interbedded w/ Sand, fine; slightly plastic. Ro, (Weathered Bedrock or Clay seam?)			No circulation
70		12:15 / 1.5'	CB 6 19	1.4/1.5		0	Sl-Fr	Cl-Vc	R1-R2			No recovery; Crushed Zone (Me); Jo, 75°-90°, Sl, Ti-Op; Jo, 60°, Pl, Sl, Op, Slight Ch; Jo, 45°, Pl, Sl, Sl Op	Start 07:52:30
71										Similar to above: Dolomitic SANDSTONE, greywacke, color brownish yellow (10YR 6/6), fine grained, well sorted; massive,			Stop 08 04:45
72	N.R.	1 / 9:00	20	1.8/2.0	70%	0	Sl-Fr	Cl-Vc	R1-R2	(1/8" stiff clay cts.) JLB 12/00		No Recovery; Crushed zone (Me); Jo, 50°, Pl, Sl, Ti; Jo, 45°, Pl, Sl, Ti; Jo, 60°, Pl, Sl, Op; Jo, 50°, Pl, Sl, Op, Clay Coating; Jo, 50°, Pl, Sl, Ti; Jo, 45°, Pl-St, Sl, Op, Clay Coating (Sl-tan) JLB; Jo, 75°, Pl, Sl, Op; Jo, 60°, Pl, Sl, Op	08:46:00
73										Dolomite		Jo, 75°, Pl-St, Ro, Op, remnant dolomite fillm wall; Jo, 45°, Pl, Sl, Op, faint dip-slip slicks (?)	08:55:00 stop; Start 09:01:30
74		11:15 / 9:15	21	3.0/3.0	100%	1.8/3.0 60%	Sl-Fr	Cl-Mo	R2	altered zone JLB 5/4/01		Jo, 75°, Pl, Sl, Op, Oxidized and Mn staining; Jo, 5°, Pl, Sl, Op; Me, 0°, Pl, Sl, Op	09:15:45; 09:25:00
75													

Tofb-1

Weathering Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil Fracture Spacing VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1') Strength R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak Lithologic Description Rock type, color, texture, grain size, etc Discontinuities Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein Joint descriptions Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc

ROCK BORING LOG

Project	Job Number	Date	Boring No.
DCPP ISFSI Borrow Area	1223-49	30 Nov 2000	00BA-1

WLA

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
75–76		21	3.0/3.0	1.8/3.0	100 / 60%	Sl-Fr	Cl-Mo	R2		(Dolomite to) JCB 12/00 similar to above: Dolomitic SANDSTONE, greywacke; color brown/yellow (10YR6/6); massive, bedding indistinct; well cemented; fine grained; well sorted; pale yellow alteration halos around some joints. (Tofb-?)	Jo, 10°, Pl, Sl, Op; Jo, 60°, Pl, Sl, Op, Oxidized Surface; Jo, 60°, Pl, Sl, Op, Oxidized, Altered Halo; Jo, 90°, Pl, Sl, Op — Jo, 60°, Pl, Sl, Op, Oxidized	Stop 09:31:30; Start	
76–77		22	2.0/2.0	1.1/2.0	100% / 55%	Sl-Fr	Cl-Mo	R2			Jo, 45°, Pl, Sl, Op, Oxidized; Me (old Jo?), 0°, Pl, Sm; Jo, 80°, Pl, Sm-Sl, Op, Oxidized and Mn; Jo, 60°, Pl, Sl, Ti, Mn staining; Jo 45°, Pl, Sl, Op, some oxidation	Start 09:47:45; still no circulation some chattering of bit on rocks	B
77–78													Stop 10:13:00; Start 10:30:30
78–79										same as above (1/8" Sh FF Silty Clay Seam) 12/00 JCB	Me, 5°, Pl, Sl, Op; Jo, 65°, Pl, Sl, Op, Mn and Oxidized; Me, 5°, Pl, Sl, Op; Jo, 10°, Pl, Sl, Op, Oxidized — Jo, 75-90°, Pl-Sl, Op, Oxidized	10:30:30	A-B
79–80		23	5.0/5.0	2.5/5.0	100% / 50%	Sl-Fr	Cl-Wi	R1-R2		Fine-gr. Dolomitic Sandstone JCB; crushed zone (tectonic?); weak, altered zone JCB 5/4/01	Zone of crushed rock — Jo, 5°, Pl, Sm-Sl, Op; Jo, 75°, Wa, Sl-Ro, Op, Oxidized; Jo, 75-80°, Pl-Wa, Sl-Ro, Op	10:40:35 (fragments within crushed zone are same lithology, R2, oxidized)	B
80–81												10:47:15	
81–82										fossil casts ?			
82–83											Jo, 45-30°, Sl-Pl, Sl, Op, Slight Oxidation; Me, 75°, Pl-St, Sl, Ti/Filled Dolomite	Stop 11:07:30	
83–84		27	5.50							grades slightly more dark lithic fragments, very fine to fine grained.	rubble zone (Me from drilling); Jo, 70°, Pl-Wa, Sl-Ro, Op, Slight Oxid.	Start 11:09:00	
84–85		24	3.0/3.0	1.6/3.0	100% / 53%	Sl-Fr	Cl-Mo	R2		← possible fossil casts ? JCB 12/00	Jo, 50°, Pl, Sl, Op, Oxidation and Mn Staining	11:14:50	
85–86											Jo, 30°, Pl, Sl-Sm, Op, Slight Oxidation; Jo, 10-30°, Pl-St, Sl, Op, Slight Oxidation; Jo, 75°, Pl, Sl, Op-Ti, Mn stained, alteration halo around joint	11:22:00	A-B
86–87												Stop 11:32:30; Start 11:40:00	
87–88		25	4.5/5.0	2.0/5.0	90% / 40%	Sl-Fr	Cl-Mo	R2		similar to above	No Recovery; Me 10°, Pl, Sl, Op; Jo, 75°, Pl, Sl, Op, Mn and Oxidation — (some silty films <1/16" thick) JCB 12/00; Jo, 30°, Sl, Sl-Ro, Op, Oxidized; Jo, 75-90°, Pl, Sl, Op, Mn; Jo, 10°, Pl, Sl-Ro, Op; Jo, 85°, Pl, Sl, Mn staining; Jo, 10°, Pl, Sl, Mn; Jo, 0-5°, Pl, Sl-Ro, Mn slight	11:47:45; 11:55:45	
88–89											Jo, 60°, Pl, Sl, Ti, Alteration Halo; Jo (Be?) 20°, Pl, Sl, Op, Alteration Halo	12:05:30	
89–90												12:14:00	

Tofb-1

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

ROCK BORING LOG

Project	Job Number	Date	Boring No.
DCPP ISFSI Borrow Area	1223-49	30 Nov 2000	00BA-1

WLA

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
90–91		8:15	25	4.5/5.0	90	2.0/5.0 40%	SI-Fr	Cl-Mo	R2	(Dolomite to) JLB similar to above: Dolomite SANDSTONE, color very pale brown (10YR 7/4); fine grained; well-sorted; greywacke; massive; some portions are brownish yellow (10YR 6/6); some fine lithic fragments	Jo, 30°, Pl, Sl, Op, Alteration Halo; Jo, 35°, Pl, Sl, Op, Alteration Halo; Jo, 5°, Pl, Sl, Op; Jo, 5°, Pl, Sl-Ro, Op, Mn stain	Stop 12:22:15; Start 12:29:00	A-B
91–92		7:30	16	1.8/2.0	90%	0.5/2.0 25%	SW-Fr	Mo-Cl	R2		Jo, 30°, Pl, Sl, Ti, Oxidized; Jo, 30°, Pl, Sl, Ti, Oxidized; Jo, 35°, Pl, Sl, Op, Mn stained; Jo, 5°, Pl-Ro, Sl, Op; Jo, 35°, Pl, Sl, Op; Vn, 30°, Pl, Sl, Ti/Fi; Jo, 45°, Pl, Sl, Ti, Oxidized; Jo, 30°, Pl, Sl, Op, Mn Stained; Jo, 10-30°, Pl-St, Op, Mn Stained; Jo, 35°, Pl-St, Op, Mn and Oxidation	12:36:30	B
92–93		4:15											
93–94		4:15	27	3.0/3.0	100%	0.8/3.0 27%	Sw-Fr	Mo-Cl	R2	Similar to above	Jo, 35°, Pl, Sl, Op, dark Mn staining; Me, 0°, Pl, Sl, Op; Jo, 35°, Pl, Sl, Op, Mn staining; Jo, 35°, Pl-Wa, Sl, Ti; Jo, 35°, Pl-St, Sl, Ti; Me, 0°, Pl, Sl, Op; Jo 35°, Pl, Sl, Op, Mn and Oxidized; Jo 30°, Pl, Sl, Op, Mn and Oxidized	12:40:45 Stop; Start 13:07:00; 13:16:15	
94–95		9:15								Clay-lined JGH 5/4/01; Softer			
95–96		9:30									Jo, 0-5°, St, Sl-Ro, Op, slight Oxid.; Jo (Be?) 5°, Pl, Sl, Op; Jo/Vc, 35°-30°, Pl, Sl, Op, remnant dolomite fill	13:25:30; Stop 13:35:00	A-B
96–97	No Recovery	7:45	CBB							("punky"); similar to above: grades slightly softer (R1 in places), more closely fractured, similar color as above.		Start 13:41:00; (1/8" Salts film) JLB 12/00; 13:48:45	
97–98		9:45										13:53:30	
98–49		8:30	28	3.0/5.0	60%	0/5.0 0%	Sw	Cl-Vc	R1-R2		Jo, 90°, Pl-Wa, Sl-Ro, Op, Mn stain; Jo, 0°, Pl, Sl, Op; Jo, 30°, Pl, Sl-Ro, Op, Mn and Oxidation; Jo, 10°, Pl, Sl, Op; Jo, 10°, Pl, Sl, Op; Jo, 35°, Pl, Sl, Op; Jo 15°, Pl, Sl, Op	Still no circulation; >15000 gallons injected with no return; 14:02:00	
49–100		11:45								highly fractured / crushed zone same lithology	zone of numerous fracture breaking rock into crushed zone. Fragments are same lithology and hardness, but have been broken into fragments 0.5 - 2.0", angular	14:13:45; Stop 14:22:00	B
100–101		8:15								Broken rock zone. JLB 5/4/01	crushed zone, similar to above	Start 14: ??	
101–102										12/00 JLB		14:40:15	
102–103		10:30	29	3.0/3.0	100%	0 0%	Sw	Vc-Cl	R1-R2	(Dolomite to Dol. Sandstone) similar to above, slightly lighter color: light yellowish brown (10YR 6/4)	Jo, 35°, Pl-Wa, Sl-Ro, Op, Mn stain, dolomite coating; Jo, 35°-40°, Pl-Wa, Sl, Op, Mn Stain; Jo, 30°, Pl, Sl, Op, Mn Stain; Jo, 45°, Pl, Sl, Op, Mn stain; Jo, 35°, Pl, Sl-Sm, Op, Mn Staining; Jo, 35°, Pl, Sl-Sm, Op, Mn Stain	14:50:45	
103–104		7:30											
104–105	BB		30	1.9/2.0	95	0.4/2.0 20%	SW-Fr	Cl	R2		Crushed Zone; Jo, 60°, Pl, Sl, Op, Mn Stain; Jo, 60°, Pl, Sl, Op, Mn Stain; Jo, 60°, Pl, Sl, Ti-Op, Mn stain; Jo, 35°, Pl, Sl, Op, Mn and Oxidation	14:58:15 Stop; Start 15:08:00	

Tofb-1

Weathering Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil Fracture Spacing VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1') Strength R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak Lithologic Description Rock type, color, texture, grain size, etc Discontinuities Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc

ROCK BORING LOG

Project	Job Number	Date	Boring No.
DCPP ISFSI Borrow Area	1223-49	30 Nov - 1 Dec 2000	00BA-1

WLA

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
105–120													
105	12:00 / 2 ft	30	1.9 / 2.0	95%	0.4 / 2.0 20%	SW-Fr	Cl	R2		Stiff silty Clay seam along fr ~ ¼" thick		Jo, 35°, Pl, Sl-Sm, Op. Oxidation; Jo, 60°, Pl, Sl, Op; Jo, 15°, Pl, Sl, Clay fill ~ 0.25" thick; Jo, 10°, Pl, Sl, Op, Mn - Oxidation	Stop 15:25:00
106	7:30									Similar to above: (Dolomitic to) JLB Dolomitic SANDSTONE color brownish yellow (10YR6/6); massive; fine grained; well sorted; well cemented; greywacke; (Tofb-1)	Crushed/rubble (½-¾" thick); Jo, 30°, St, Sl-Ro, Op (3" thick clay) JLB; Be, 10°, Pl, Sl-Sm, Op, Slight Mn, minor clay		Start 15:33:30; 12/00; 15:41:00
107											Be, 10°, Pl, Sl, Op, Slight Mn; Be, 10°, Pl, Sl, Op, Slight Oxidation		
108	11:10 / 2 ft	31	5.0 / 5.0	100%	2.6 / 5.0 52%	SW-Fr	Wi-Cl	R2			Jo, 60°, Pl-Wa, Sl, Op, Slight Mn; Jo, 45°, Pl, Sl, Op, Slight Mn, Oxidation; Jo, 15°, Pl, Sl, Op, Mn and Oxidation		
109	6:35									grades Coarser	Jo, 75°, Pl, Sl-Ro, Op, Mn and Oxidation; Be, 10°, Pl, Sl, Op, Oxidation, Clay lined; Jo JGH 5/4/01	15:52:10	B
110	7:00									12/00 JLB (Dolomitic Greywacke) similar to above: grades slightly coarser grained with dark lithic fragments	Jo (Be?), 15°, Pl, Sl, Op, slight Mn	15:58:45; Stop 16:05:55	
111											Jo, 50°, Sl-Wa, Ro, Op; Jo, 30°, Pl, Sl, Op; Me, 10-45°, Pl-St, Sl, Op		Start 16: Tofb-1
112		28.9	4.0 / 4.0	100%	3.0 / 4.0 75%	Sw-Fr	Wi-Cl	R2		(Tofb-2)	Jo, 60°, Pl, Sl, Op, Slight Mn; Jo, 15°, Pl-Wa, Sl, Op; Jo (Be?) 10°, Pl, Sl, Op, Slight Oxidation; Me, 10°, Sl, Ro, Op		Tofb-2; 16:21:45
113	21:15 / 2 ft	32									Jo, 30°, Pl, Sl, Op		
114											No core JLB		Stop 16:43:00
115	5:00									(Similar to) JLB Same as above greywacke, finer-gr. Dolomitic	Crushed zone; Me, 10°, Pl, Sl, Op, oxidized; Jo, 15°, St, Sl, Op, oxidized		Start 07:17:30; 07:17:30
116	6:00		4.9 / 5.0	98	2.0 / 5.0 40%	Sw-Fr	Mo-Cl	R2		@117.15' - joint set or 0.15' Shattered Rock Zone Dips ~15°	0-15°; Jo, Wa, Sl, Op; Jo(?) Sh, 5°, Pl, Sm, Ti-He; Jo or Sh, 10°, Pl, Sm, Ti-He; Jo or Sh, 15°, Pl, Sm, Ti-He	07:23:30	
117		33									Jo, 0°, Pl, Sl, Ti; Jo, 60-90°, Wa, Ro, Op; Jo, 75-90°, St, Sl, Op; Jo, 0°, Pl, Sl, Op; Jo, 60-90°, Wa, Ro, Op; Jo, 75-90°, St, Sl, Op		Tofb-2; Tofb-1
118	11:30 / 2 ft									Crushed rock JLB 5/4/01	Jo-Me, 0°, Pl, Sl, Op, oxidized; Jo-Me, 0°, Pl-St, Sl, Op; Crushed zone; NO Recovery		
119	6:00									(Tofb-1)		07:35:00	B
120												Stop 07:41:00	

Tofb-1 / Tofb-2 / Tofb-1

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

ROCK BORING LOG

Project	Job Number	Date	Boring No
DCPP ISFSI Borrow Area	1223-49	1 Dec 2000	OOBA-1

WLA

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
120–121		34	3.5/3.5	100	0.4/3.5	Sl-Fr	Wi/Cl	R2		Same as above (Dolomitic Greywacke, Fine-grained) [KOW 05/03/01] (TOFB-1) Gabbro? over 0.3'		Jo, 75-90°, St-Wa, Sl, Op-Ti; Jo-Me, 0°, Pl, Sl, Op-Ti; Jo-Me, 0°, Pl-St, Sl, Op-Ti	Start
121–122					11%	Sl	Wi-Cl			Dolomitic Sandstone 7.5YR 7/6-Reddish Yellow Massive, v. Fine grained well sorted, well cemented Arkose.	Crushed Zone JLB 5/14/01; Jo-Me, 60-75°, St, Sl, Ti; Jo, 45°, Pl, Sl, Ti		08:02:30
122–123	17.15/1.5'					Sl-Fr	Wi/Mo	R2		Dolomite to Dolomitic Greywacke JLB 12/00	Jo, 60-75°, St, Sl, Op; crushed zone		Stop 08:19:45
123–124										Grades back to greywacke, as above.	Crushed zone; Jo, 75°, Pl, Sl, Op, Oxidation & Mn stain; Jo, 30°, Pl-St, Sl-Ro, Op; Jo, 60°, Pl, Sl, Ti, Mn stain; Jo, 60°, Pl, Ti, slight oxidation		Start 08:27:30
124–125											Jo, 60°, Pl, Ti, slight oxidation		
125–126	19.10/4.5'	35	4.5/4.5	100%	3.0/4.5 67%	Sl-Fr	Wi-Cl	R2			Jo, 75-90°, Pl, Sl, Ti, Oxidation & Mn stain; Jo, 45°, Pl, Sl, Op, Mn and Oxidation		
126–127											Jo, 50°, Pl, Sl, Op, Mn and Oxidation; Me, 15°, Sm-Wa, Ro, Op; Jo, 90°, Pl-Wa, Sl-Ro, Op, Mn and Oxidation; Jo, 80°, Pl-St, Sl-Ro, Op, Mn and Oxidation		
127–128											Jo, 75°, Pl, Sl, Op, Mn and Oxidation		Stop 09:17:00
128–129	16.10/2'	CB 10 36	3.0/3.0'	100%	0/3.0' 0%	Sl-Fr	Mo-Cl	R2		Similar to above	Crushed zone; Jo, 75°, St-Wa, Sl, Ti, Mn stained; 2 Jo, 75°, Pl, Sl, Op, Oxidation and Mn Stained; Jo, 70°, Pl, Sl, Op, Oxidized and Mn stain; Jo, 80°, Pl-Wa, Sl, Op, Oxidized and Mn Stains; Jo 60°, Pl-Wa, St, Ti-Op, Mn stain; Jo, 45°, Pl, Sl, Op, Mn stained, crushed; Jo 60°, Pl, Sl, Op, Mn stain (Slickensides); Jo 70°, Pl, Sl, Op, Mn and Oxidation; Jo, 70°, Pl, Sl, Op, slight Mn stain		Start 09:23:45; 09:40:15
129–130	10.45										Crushed Zone		Stop 09:51:00
130–131	11.15										Jo, 70-90°, Wa, Sl-Ro, Op, Oxid & Mn; Jo, 60°, Pl, Sl, Op, Slight Mn; Jo, 60°, Pl, Sl, Op, Slight Mn Stain		Start 09:57:00
131–132	7.15'										Jo, 60-75°, Pl-Wa, Sl, Op; Jo, 30°, Pl, Sl, Op, Oxidized; Jo, 75°, Pl, Sl, Op, Oxidation & Mn		10:08:15
132–133	6.45	37	5.0/5.0	100%	2.0/5.0 40%	Fr-Fr	Wi-Cl	R2			Jo, 30-60°, Wa, Sl, Op, Oxidized; Jo, 60°, St, Sl, Op, Oxidized; Jo, 60°, Pl, Sl, Op		10:15:30
133–134	7.45										Jo, 90°, Pl, Sl, Ti, Mn stain; Jo, 15°, Pl, Sl, Op; Jo, 90°, Pl-Wa, Sl, Op		10:22:15; 10:30:00
134–135													

all B

Weathering Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil Fracture Spacing VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1') Strength R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak Lithologic Description Rock type, color, texture, grain size, etc Discontinuities Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein Joint descriptions Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc

ROCK BORING LOG

Project	Job Number	Date	Boring No.
DCPP ISFSI Borrow Area	1223-49	1 Dec 2000	OO BA-1

WLA

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
135		37	5.0/5.0	100	2.0/2.0 JLB 5/31/01	Sl-Fr	Wi-Cl	R2				J_o, 15°, Sr, Sl-Ro, Op	Stop 10:35:30 Bit stuck in hole; had to trip out to get barrel and get back in. Start
136										Similar to above: Dolomitic SANDSTONE, color very pale brown (10YR 8/3); fine grained; well sorted; greywacke to arkose (?); well cemented. (ToFlo-1)	Crushed; J_o, 55°, Pl-Wa, Sl, Op, Clay coating; numerous subhorizontal fractures		
137											J_o, 15-30°, Sr, Ro, Op (vertical Joint is healed (Rounded)) in this zone JLB		
138		30	4.0/4.0	100%	0	Sl-Fr	Cl	R2			Zone of fragmented rock (<4", angular) broken during core transfer		
139											J_o, 15-20°, Pl-Wa, Sl, Op, Mn; Combination of fracture through entire core run		Stop 11:51:00
140										similar to above (Lighter weight, slightly "spongy") JLB 12/00	J_o, 60°, Pl, Sl, Op; J_o, 50°, Pl, Sl, Op; Mc, 0°, Pl, Sm, Op		Start 11:55:30
141		39	3.9/3.9	100%	2.0/3.9	Sl-Fr	Wi-Mo	R2		Dolomite, laminated, very pale brown (10YR 8/3), fine grained JLB 12/00			
142					59%						J_o, 30-60°, Pl-Wa, Sl, Op, Oxidation, Mn stain		12:16:00
143											J_o, 30°, Pl-Wa, Sl, Op, Mn, Oxidation; J_o, 30°-40°, Pl-Wa, Sl, Op-T, Mn Stained		Stop 12:25:45 Start 12:33:00
144											Broken zone, <4" angular fragments; J_o, 30°, Pl, Sl, Op & Mn, Oxidation		12:39:00
145		30	2.7/2.7	88	0.9/2.7	Sl-Fr	Cl-Mo	R2			J_o, 10°, Sr, Ro, Op; J_o, 15°, Pl, Sl, T-Op, crushed zone along joint; Broken zone, < 2" angular JLB 5/31/01 (1/4" clay coatings) JLB		12:46:15 Stop 12:53:15
146					33%					Gradational over 1', change to Dolomitic SANDSTONE, color (2.5Y 3/2) v. dark grayish brown - fine grained; well sorted; greywacke to arkose, well cemented	J_o, 60°, Pl, Sl, Op, Slight Oxidation; J_o, 70°, Pl, Sl, Op, Slight Oxidation		Start 13:00:00
147		41	4.4/4.4	100%	3.3/4.4						Mc, 0°, Pl, Sm, Op; Vc, 50°, Pl, Sl, Fi, clay; J_o, 60°, Pl, Sl, Op, Oxidized		13:18:00
148					84%					Dolomitic SANDSTONE similar to above; color dk yellowish brn (10YR 4/6) fine grained, well sorted, greywacke	Mc, 0°, Pl, Sm, Op; Mc, 0°, Pl, Sm, Op		13:28:45
149											J_o, 60°, Pl, Sl, Op, Mn and Slight Oxidation		13:37:30
150										end 13:45 1 Dec 2000			13:45:45 B.O.H.

ToFlo-1

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and Vr-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

Bottom of Hole @ 150.0'.

OOBA-2/1

LOG of ROCK BORING OOBA-2

unit calls by JLB/CNB/NAL 5/01 friable zone calls JCH/JLB 5/4/01

Edited for ISFSI SAR by JLB 5/25/01

Page 1 of 4

Project	Job Number	Boring Location	Total Depth
DCPP - ISFSI	1223-49	~10' west of T-20A+B intersection	55'

Type & Diameter of Boring	Elevation and Datum	Ground Water Depth	Depth to Bedrock
HQ core Double barrel core barrel	~~350'±~~ El. 350'± → ~~FB D-363~~	Hole drained after drilling	0', Trench Fill (0-4')

Drilling Contractor and Rig	Length of Core Barrel and Bit	No. of Core Boxes	Date Started
All Terrain / Failing 1500 Rons Driller CKDW 6/2/01 JLB 6/30/01	5.5' JLB 5/31/01	4	7 Dec. 2000

Casing Size and Depth	Borehole Inclination	Logged By	Date Completed
6" Casing to 4.5' Depth	Vert.	JCH	12-8-2000

WLA

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
0–4.5										Auger to 4.5' to set Casing.			
5–6	CSI		1	1.5/1.5	100	1.0/1.5 67%	HW	Cl-VC	R0-R1	Clayey Dolomitic Sandstone to Siltstone, 7.5YR 6/8 reddish yellow, low hardness (carbonate), sandy fine grained, highly to mod. weathered (Tofb-1a)		Start @ Me, 0°, Pl, Ro-VR, Ti; -crushed zone	Running Pitcher Barrel 5 min
6–7			2	1.2/2.0	60	0.42/1.2 28%	MW-HW	Cl	R1		NR	Jo, 40-45°, St, Sl, Ti	4 min
7–8										grading more comp. w/ localized harder zones			
8–9			3	2.0/2.0	100	1.2/2.0 60%	MW-HW	Cl	R1			Me, top of Run; Jo, 70°, Wa, Sl-Ro, Ti; Jo-Me, 0-20°, Wa, Ro, op; Jo-Me, 0-15°, Wa, Ro, op; Me, 0°, Pl, Sl, Ti; Me, 0°, Pl, Sl, Ti	5 min
9–10													
10–11			4	2.2/3.0	73	0.52/2.2 24%	MW	Cl	R1	(Block-in-Matrix Jns)	NR	Jo-Me, 0-10°, Wa, Sl, Ti, Ox; Jo-Me, 0°, Wa, Sl, Ti, Sl ox; Jo, 30-90°, Wa, Ti, Sl ox; -crushed zone	Switched to Core Barrel @ 8:08 AM; 8:25 AM
11–12													
12–13													
13–14			5	4.0/4.0	100	1.95/4.0 49%	MW	Cl	R1			Me, 0°, St, Ti; Jo; Me, 0°, Pl, Ti; Crushed zone	8:30 AM
14–15							SW	Cl-Mo	R1	Dolomitic Sandstone. Next Page		Me, 0°, Pl, Ti; Jo, 60-75°, Wa, Ti; Me, 0°, Pl, Ti	8:48 AM

Friable Zone Tofb-1a JLB 5/4/01

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type of infilling, slickensides, etc.

ROCK BORING LOG

Project	Job Number	Date	Boring No.
DCPP - IFSFI	1223-49	7 Dec 2000	00BA-2

WLA

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
15–16		5	4.0/4.0	100	1.95/4.0 49%	SW	Cl	RI		Dolomitic Sandstone. 7.5YR 6/6 reddish yellow. Mod. Hardness - Fine grained Sand 2.5Y 7/2, l. grey fresh. slight 8.72 w/ HCl (Tofb-1a)	-Me, 0°, Pl, Ti; Me, 0°, Pl, Ti		8:48 AM Stop
17–19	CB 2	6	3.1/5.0	62	0.45/3.1 14%	SW	Cl-Mo	RI		Same as above. Subhorizontal faint laminations near top of run.	-crushed zone; -Me, 0°, Pl, Sl, Ti; Me, 0°, Pl, Sl, Ti; Jo, 30-45°, Wa, Sl, Ti; Me, 0°, Pl, Sl, Ti; -Jo-Me, 60-75°, St, Sl, Ti; -crushed zone.		8:53 Start; 9:11 Stop
19–22								Ro-Ri	Ro-Ri				
22–24		7	3.0/3.0	100	0.8/3.0 27%	SW	Cl	RI		Same as above; grading harder w/ depth	crushed zone; -Me, 0°, Pl, Sl, Ti; -Jo, 75°-90°, Pl, Sl, Ti; -Me, 0°, Pl, Sl, Ti; -Me, 0°, Pl, Sl, Ti; -Jo, 30-45°, St, Sl, Ti, Ox, Mn0		9:17; 9:27 Stop
24–27		8	2.5/3.0	83	0.75/2.5 30%	SW	Mo-Cl	RI		Same as above	-Jo, 90, Wa, Sl, Ti, Ox, Mn0; -Me, 0°, Pl, Sl, Ti; -Jo, 30°, Pl, Sl-Sm, Fi, CaCO3; -Me, 0°, Pl, Sl, Ti; -Jo, 0-75°, St, Sl, Ti; crushed zone.		9:33; 9:45
27–28						SW	Cl	RI		Dolomitic Sandstone Moderate hardness, Fine grained, well sorted, well oxidized Sand. 2.5YR 6/6 reddish yellow			
28–30		9	2.0/2.0	100	0/2.0 0%	SW	Cl	RI			-Me, 0°, Pl, Sl, Ti; -Me, 0°, Pl, Sl, Ti; -Jo, 90°, Wa, Sl, Ti; crushed zone		9:49; 9:58

Fractures Zone 24.8 5/4/01; Tofb-1a; Ro-Ri 26.6 5/4/01

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

ROCK BORING LOG

Project	Job Number	Date	Boring No.
DCPP - ISFSI	1223-49	7 Dec. 2000	00BA-2

WLA

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
30–31	CB 3	10	2.0/2.0	100	0	SW	CI	Ro-R1 Br R3		Dolomitic Sandstone as above (Tofb-1) JLB 5/4/01		Me,0°, Pl, Sl, Ti; Me,0°, Pl, Sl, Ti; Crushed zone JGH 5/4/01	10:08
31–32						SW	MO	R3		Ro-R1 .2' Gradational; Sandstone to Dolomitic Sandstone Moderate hardness - Medium grained mod. sorted sand. Color 7.5YR 6/4 L. Brown-Ox 2.5Y 7/1 L. gray - fresh. (Tofb-2)		Fi, 1mm clay no slicks; Jo, 60-75°, Wa, Sl, Ti; Jo, 60-75°, Wa, Sl, Ti; Me,0°, Pl, Sl, Ti; Me,0°, Pl, Sl, Ti;	10:18 Stop Tofb-1
32–33		11	2.0/2.0	100	1.5/2.0 75%	SW	MO	R2-R3					10:20 Start Tofb-2; 10:30 Stop
34–35		12	1.6/2.0	80	0.65/1.6 41%	SW	MO	R2-R3		Same as above		Me,0°, Pl, Sl, Ti; Me,0°, Pl, Sl, Ti; Jo, 75°, Pl, Sl, Ti; Jo-Me, 0°, Wa, Sl, Ti;	10:54; 10:48
36–37		13	4.9/5.0	98	2.3/4.9 47%	SW	MO	R2		Sandstone to Dolomitic Sandstone Same as above		Me,0°, Pl, Sl, Ti; Me,0°, Pl, Sl, Ti	10:52
38						SW	CI	Ro/R2		38.0 Faulted Contact Clay Gouge .05' Thick; Dolomitic Sandstone Moderate hardness - Fine grained well sorted sand. 7.5YR 6/6 reddish yellow JGH 5/4/01 (Tofb-1) (Tofb-1a)	38.5	Fa, 60°, Pl, Sl-Sm, Fi	Tofb-2
39–40								Ro-R1				Crushed zone; Jo-Me, 0°, Wa, Ro, Ti; Jo, 80-90°, Wa, Ro, Ti	Tofb-1; 11:28
41–42	CB 4	14	5.0/5.0	100	2.55/5.0 51%	SW	CI	R1-R2		Dolomitic Sandstone as above; Sand grades to medium grained mod. sorted (Tofb-2) (Tofb-2a) Contact 0.25 x 10° mm core		Jo, 60°, Wa, Pl, Ti, Fi, 1-2mm clay crushed zone; Jo, 80-90°, Wa, Sl, Ti; crushed zone no slicks; Jo, 70°, Wa, Sl, Ti	11:37 Tofb-2
43–44						SW	MO	Br R2		Sandstone to Dolomitic (Graywacke) Sandstone, Moderate hardness, medium grained mod. sorted sand. Color 2.5Y 5/1 gray. JGH 5/4/01		Me, 0°, Pl, Sl, Ti; Jo-Me, 45°, Wa, Ro, Ti	

Tofb-1a Friable Zone JLB 5/4/01; Tofb-2 Friable Zone JGH 5/4/01

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), CI-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

ROCK BORING LOG

Project	Job Number	Date	Boring No.
DCPP ISFSI	1223-49	7 Dec. 2000	00 BA-2

WLA

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
4 5			14	5.0/5.0	100	2.55/5.0 51%	SW	MO	R1-R2	Sandstone to Dolomitic Sandstone as above		Me, 0°, Pl, Sl, Ti	12:07
4 6													12:13
4 7			15	4.0/4.0	100	2.6/4.0	SW	MO	R1-R2	Same as above (Tofb-2, Tofb-2a)		3-Me, 0°, Pl, Sl, Ti;	
4 8					65%	SW	CI-MO	R2		Dolomitic Sandstone (Greywacke) 7.5YR 5/6 Reddish yellow Moderate hardness, Medium grained, Moderately Sorted well oxidized sand. well cemented 2.5Y 5/1 Fresh (Lg grey)		Me, 0°, Pl, Sl, Ti; Ja, 75°, St, Sl, Ti;	
4 9												Me, 0°, Pl, Sl, Ti; Me, 0°, Pl, Sl, Ti; crushed zone ✓ JLB 5/4/01	12:44
5 0			16	4.8/5.0	96	2.15/4.8 45%	SW	CI-MO	R2	Same as above		Ja, 30°, Pl, Sl, Ti; CaCo, lined.	12:49
5 1												Me, 0°, St, Sl, Ti;	
5 2												Me, 0°, St, Sl, Ti; JGH 5/4/01; Me-Ja 30°, St, Sl, Ti/Fi; Me-Ja, 0°, St, Sl, Ti 1mm clay	
5 3												Ja, 30°, St, Sl, Ti; Ja, 45°, St, Sl, Ti minor Stepic.	
5 4												Ja, 90°, St, Sl, Ti;	
5 5												Ja, 75-90°, Wa, Sl, Ti;	1:20
5 6												TD 55' @ 1:20 PM Finished on 7 Dec 2000	
5 7													
5 8													
5 9													
6 0													

Tofb-2a Friable zone JGH 5/4/01

Tofb-2

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

LOG of ROCK BORING 00BA-3

Unit calls by JLB/CMB/WAL 5/01 Friable zone calls JGH/JLB 5/4/01
Edited for ISFSI SAR by JLB 5/25/01

Project	Job Number	Boring Location	Total Depth
DCPP - ISFSI	1223-49	NW end of lot near H_2O treatment	30.0'

Type & Diameter of Boring	Elevation and Datum	Ground Water Depth	Depth to Bedrock
HQ core Double barrel core barrel	~~FBD~~	Not determined *	1.5'

Drilling Contractor and Rig	Length of Core Barrel and Bit	No. of Core Boxes	Date Started
All Terrain / Failing 1500 (Kevin Drillers) [KW 6/21/01]	5.5' 306'	3	8. Dec. 2000

Casing Size and Depth	Borehole Inclination	Logged By	Date Completed
6" casing to 4.0' Depth	90°	JGH	8 Dec. 2000

* water from rock added during drilling

WLA

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
0		CB 1								Augered to 1.0' depth to set casing			Start @ 8:00 AM.
1	NR		1	0.9/1.0	90	0	HW / SW	/ C1	/ R1-	Clayey Fill - Dark Brown, Sandy with angular gravel. BR - Sandstone to Dolomitic Sandstone - as below	NA		Pitcher Barrel
2										Reamed out hole to 3.5' to run rock core barrel, too hard for Pitcher Tube			
4	R2		2	2.0/2.5	80	1.1/2.0 55%	SW	MO	R2- to R0	Sandstone to Dolomitic Sandstone-Greywacke Moderate hardness - Medium grained moderate sorted sand 7.5YR 5/6 - Reddish Yellow JGH-JLB 5/4/01 (Tofb-2, Tofb-2a)	R Rubble Zone	Jo, 30°, Pl, Sl, He; Me, 0°, Pl, Sl, Ti; Me, 0°, Pl, Sl, Ti; Me, 0°, Pl, Sl, Ti	Started Core barrel 8:45 AM
6										Same as above		Me, 0°, Pl, Sl, Ti	9:03 Stop; 9:10
7			3	3.0/3.0	100	2.6/3.0 87%	SW	MO	R2-			Me, 0°, Pl, Sl, Ti; Me, 0°, Pl, Sl, Ti; Jo, 60°, Wa, Ro, Op; Jo, 0-45°, St, Ro, Ti	
9	NR	CB2									NR		9:32 Stop; 9:45
10			4	3.6/3.8	95	3.25/3.6 90%	SW	MO	R2 to R1+	29.8' Grades to Coarse Sand Same unit JLB 5/4/01 Clayey SS interval but not clay bed JLB 3/3/01		Me, 0°, Pl, Sl, Ti; Me, 0°, Pl, Sl, Ti; Me, 0°, Pl, Ro, Ti; Me, 0°, Pl, Ro, Op; Jo, 30°, St, Ro, Ti	10:13 Stop
12							MW	C1	R1-/Rot	Weathered out Sandstone Sand, CLAY - Medium stiff Slightly Dense, Angular S.S. Fragments 7.5YR 7/6 Reddish Yellow		Me, 0°, Pl, Sl, Ti; Jo?, 45°, Pl, Ro, Ti - He	10:18 Start
13			5	22/22	100	0.95/2.2 43%	SW	C1-MO	R1+	Sandstone to Dolomitic Sandstone. - Greywacke Moderate hardness Medium to fine grained Moderately sorted well oxidized sand w/ angular Lithic Fragments. 7.5YR 7/6 Reddish Yellow		Jo, 15-30°, St, Ro, Ti; Jo, 60°, St-Wa, Sl, Ti; Jo, 30-60°, Wa, Sl, Ti; Jo, 60-90°, Wa, Sl, Ti; Jo-Mo, 10-15°, Pl, Sl, Ti; Mo	10:30
15													

Tofb-2; Tofb-2a Friable zone JLB 5/4/01; Tofb-2; Tofb-2a Friable zone JLB 5/4/01; Tofb-2

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type of infilling, slickensides, etc.

ROCK BORING LOG

Project	Job Number	Date	Boring No.
DCPP IFSFI	1223-49	8 Dec 2000	00 BA-3

WLA

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
15–20	NR	6	4.9/5.0	98	3.75/4.9 76%	SW	Mo to Wi	R1+ to R2-		Sandstone - Same as above to dolomitic SANDSTONE [KOW 05/03/00] unit grades from more to less resistant 3x.	NR	Me,0°, Pl, Sl, T; Me,0°, Pl, Sl, T; Jo, 60°-90°, Wa, Sl, He, silica Lined; Jo, 60°, St, Sl, T; Me, 0°, Pl, Sl, T; Me-Jo, 0°, Wa, Sl, T;	10.43 Start; 11:30 Stop; 11:38
20–22	CB 3	7	5.0/5.0	100	2.3/5.0 46%	SW	MO	R2-		Same as above		Me, 0°, Pl, Sl, T; Me-Jo, 0°, Wa, Sl, T; Me, 0°, Pl, Sl, T; Jo, 30°, Pl, Sl, F: - clay films, Polished, no slick JGH 5/4/01	
22–23								R1+		JLB 5/23/01		Jo, 45°, Pl, Sl, T; Jo, 60°, Wa, Sl, T; Jo-Me, 0°, Wa, Sl, T; Me, 0°, Pl, Sl, T; Me, 0°, Pl, Sl, T;	12.28 / 12.35
23–25													
25–26		8	5.0/5.0	100	3.7/5.0	SW	MO	R2		Same as above		Me, 0°, Pl, Sl, T; Jo, 60°, Wa, Sl, T/; F: 1/16" clay, no slicks JGH 5/4/01	
26–27					74%	SW	Mo	R1+		Sandstone to Dolomitic Sandstone - Greywacke Medium Grained well sorted Sand, moderate hardness 2.54 g/cc L. Gray.	Crushed Zone	Jo, 0°, Pl, Sm, OP - 4/16" clay - slicked & polished JGH 5/4/01	
27–30												Me, 0°, Pl, Sl, T; Me, 0°, Pl, Sl, T; Jo, 45°-60°, Wa, Sl, T; Me-Jo, 0°, St, Sl, T; Me, 0°, Pl, Sl, T;	105 Stop

Tofb-2; Tofb-2a Fribble zone JLB 5/4/01; Tofb-2

all D

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

ROCK BORING LOG

Project	Job Number	Date	Boring No.
DCPP - ISFSI	1223-49	8 Dec 2000	00BA-3

WLA

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
30										end hole @ 30' @ 1:05 PM			
31										Started Cleanup			
32										Grouted hole to ground surface			
33													
34													
35													
6													
7													
8													
9													
0													
1													
2													
3													
4													
5													

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

LOG of ROCK BORING 01CTF-A

Unit calls by JLB/CMB/WRL 5/01
Edited for ISFSI SAR by JLB 5/25/01

Project: ~~CTF~~ DCPP ISFSI	Job Number: 12234-1	Boring Location: CTF Facility	Total Depth: 58.6'
Type & Diameter of Boring: Triple HQ Core, ~~Double~~ Barrel Core Barrel (JLB 5/31/01)	Elevation and Datum: ~~307'~~ 306.1' (JLB 5/31/01)	Ground Water Depth: Not recorded	Depth to Bedrock: 2.0'
Drilling Contractor and Rig: Shannon + James [JKW 4/21/01] Cascade Drilling CME-~~75~~ 95	Length of Core Barrel and Bit: 8'-7" (JLB 5/31/01)	No. of Core Boxes: 5	Date Started: 4/18/01
Casing Size and Depth: 8" hollow stem auger set to 3'	Borehole Inclination: vertical	Logged By: RDK	Date Completed: 4/19/01

WLA

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
0–3										Hole was hand-excavated to 3.0' to clear for utilities (CMB 19 April 2001)		*colors added by CMB 19 April 2001	Begin drilling 8:40 PM cleaning hole for Auger; check depth of test hole in AM; driller reports debris in hole
3–4	CB1		1	0.8/8.4 *	100	0.8/0.8 *							check length of run from initial test pit *
4–5					100%								
5–6	Tofb-2											slop/debris	
6–7						SW	RQ-JLH 5/14/01	R1		above 6.2 ft. debris/slop; Gray coarse grained Sandstone @6.4 color change to light yellowish brown coarse grained sandstone; individual sand grains 1mm diam. some grains oxidized; slightly weathered; very weak; (Tofb-2, Tofc-2a)		no discontinuities; color 2.5Y 6/4 (CMB 19 April 01); no discontinuities	solid core w/no discontinuities from 6.2 ft – 7 ft.
7–8		4:32											9:15 PM drillers deal w/ 1½" pump; 9:25 PM run 2 starts
8–9	Tofb-2a Friable Zone JLH 5/14/01	5:17											
9–10		5:26	2	5/5	100%	MW		RQ		8.5' grey sandstone, very fine-fine grained; Extremely weak; mod. weathered; color Grey 5/N	Jo, 20° He; Jo, ¼ across core He		
10–11		5:14			3.9/5 78%	SW		RQ-R1		coarse grained yellow brn sandstone; very weak; slightly weathered; color 2.5Y 6/4	Jo, 60°, Pl, Sl, oP, ox; Me, 0°, Pl, Sl, oP, ox		
11–12		3:35				SW-Fr		R1-R2		2.5Y 7/4; harder and finer than above dolo. Sandstone, fine grained very weak to weak; Slightly weathered to fresh whitish brown, very slight fizz; @12' friable zone 0.5 ft. coarse-med grained sandstone; becomes less friable to 12.2'	Me, 0°, Sl, OP; Jo, vertical, Sl, oP, ox; Me, 10° Pl, Sl, oP, ox; Me, 0° Pl, Sl, oP, ox; Jo, 80° Pl, Sl, oP, Mn o.f. ox; ← end of run		Driller reports bit not advancing may have material left from run!
12–13	Tofb-2	3:20	3	1/1	100%	SW		R1		Coarse grained sf.	Jo, 58°, He; Jo, ¼ a, He; Jo, 70° Pl, He, End of run		10:10 PM did 1 ft. run to get broken piece; lost 30 gallons of water into formation ?
13–14		4:14	4	4.8/5	96					Coarse grained yellow brn, very weak, slightly weathered sandstone 2.5Y 6/4	Me, 5°, Pl, Sm-Sl, oP, ox		
14–15		5:14			1/1 100% 2.5/5 50%								

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type of infilling, slickensides, etc.

Check CMB 19 April 2001 CMB WRL

ROCK BORING LOG

Project	Job Number	Date	Boring No.
DCPP ISFSI/CTF	1223a-1	4/18/01 – 4/19/01	01CTF-A

WLA

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
15		CB 2				SW			R1	coarse grained sandstone same as above			
16	Tofb-2	4:08										Me,0°,Pl,Sm, Me 10°,Ro,St	
17		4:31	4	4.8/5	96	SW-Fr		R2-R3		med grained sandy dolomite, fizzes w/HCL; Dolomitic Sandstone (CMB 19 April 2001)		Jo,80°,Pl,Sl,OP,MNO & ox; Me,St,Sl; Ve,10°,Pl,He,quartz?	11:05PM
		4:44			2.5/5 50%							Me,0°,Pl, end of run	
18		4:20										Me,vertical,Wa,Ro, (Jo?; CMB 19 April 2001)	
19		6:13	5	5/5	100%	MW		R0-R1		med. grained sandstone softer than above; Extremely weak to very weak; moderately weathered; color 10YR 7/2 - yellow		Jo,60°,Pl,Sl,OP,ox; Clay along Jo (CMB 19 April 2001)	
20		5:14			2.5/5 50%							Me,0°,Pl,Sm,OP; Jo,70°,Pl,Sl,OP,ox	11:35PM
21	Tofb-2a Friable Zone 5/14/01	5:36								CaCO3 matrix slight fiz to HCL dolomitic matrix		Jo,40°,Pl,Sl,OP,MNO & ox	
22		5:20										Me,80°,Wa,Sl,OP,MNO & ox; Jo,15°,Pl,Sm,OP,ox	11:55PM
23		3:32								from 23 to 25.4 coarser grained than above		Jo,~30°,Pl,Sl,OP - clay films; Polished, random slicks; Jo,50°,Pl,He,Ti,	
24		5:22										Jo,50°,Pl,Ti, not all the way thru core; Jo,15°,Pl,Sl,OP	12:19AM
25		4:38	6	4.7/5	94	SW		R1-R2		fine grained dolomitic sandstone fizzes with HCL; Slightly weathered; very weak to weak		Jo,30°,Sl,OP,MNO & ox	
26		4:59			4.3/5 86%							Jo,30°,Sl,OP,MNO,ox; Ve,Pl,Fi,quartz? } some healed microfractures	
27		5:48								color 7.5Y 7/6 yellow			12:33AM
28												Me,Wa,Ro,OP,MNO & ox; end of run; Jo,15°,Pl,Ti,	dinner break; 1:20 AM begin drilling again
29		3:15	7	5/5	100%					grades to 2.5Y 6/6 olive yellow		Jo,60°,Pl,Ti; Jo,60°,Pl,Ti;	
30		4:30			3.3/5 66%							Jo,80°,Pl-wa,Sl,OP,MNO & ox	W/ clay - no slicks not polished

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

Check: CMB 19 April 2001 CMB MBL

ROCK BORING LOG

Project	Job Number	Date	Boring No.
DCPP ISFSI CTF	12236-1	4/19/01	01CTF-A

WLA

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
30													
31	4:59	7	5/5	100%	3.3/5	SW		R1-R2		fine grained sandstone slightly weathered very weak to weak (Tofb-2, Tofb-2a)		Jo,80° Pl-Un,oP,Sl,MNO & ox; Jo,20°,Pl,Ti; fracture or Jo,60°,St,Ro,oP,ox; Jo,50°,Pl,Sl,oP,ox	1:45 AM
32	4:25; 4:53				66%	HW		R0		very soft clayey silt		Be?,30°,Pl,Ti	2:05 AM soft clayey sand from 32.4-32.6 ft.
33	5:30	8	5/5	100%	1.4/5	SW		R1-R2		fine grained sandstone to end of run; color 2.5Y 7/3 pale yellow; fine sandstone, fine grained, well cemented, slightly weathered (CMB 19 April 2001)		MNO stain sub vertical; Jo,40°,Pl,Sl,oP,MNO & ox; Ve,St,subvertical,Ti,fi,CaCO3; Jo,He,Ti	
34	3:40											Broken pieces; Jo; Jo,Pl,60°,Sl,oP; Me,80°,Wa,Sl,oP,no ox; Jo,Pl,Sl,oP,MNO & ox	
35	5:47				28%							broken and crumbly	
36	6:40											Jo,20°,Pl,SM,oP,MNO & ox	2:45 AM
37	6:23											Jo,40°,Pl,Sl,oP,MNO & ox	
38	3:30					MW/1		R0		@37.6 turns gray color med grained ss soften than above med. weathered extremely weak color: Gley 4/10Y dark greenish gray		Jo,30°,Pl,Sl,oP; Jo,20°,Pl,Sl,oP,1/16" clay - polished & slicked, no striae; Jo,20°,Pl,Ti; end of run ← clay on fracture surface at end of core run (CMB 19 April 2001)	3:05 AM
39	5:34	9	5/5	100%	2.4/5	SW-F		R0 R1/R2		very fine to fine sandstone @39.3 back to H. brown color		Jo,Pl,Sl; Jo,30°,Pl,Sl; Jo,70°,Pl,He	
40	5:16	CB4			48%					color 2.5Y 7/6 yellow		Jo,40°,Pl,Ti-slightly open; Jo,Wa,Sl,He; Jo,Pl,Sl,40°,oP,MNO & ox	200 lbs downhole press. 160 RPM's
41	4:20											Jo,30°,Pl,Sl,oP,MNO & ox	
42	4:48									med grained ss		Ve,subvertical,Wa,Ro,oP	3:35 AM
43										well cemented, fine to medium grained (CMB 19 April)		Jo,45°; end of run	
44	2:45	10	5/5	100	3.2/5	SW-Fr		R1-R2				Jo,St,Ti	
45					64%								

Tofb-2; Tofb-2a Friable zone; Tofb-2; Tofb-2a Friable zone; Tofb-2

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

Check CMB 19 April 2001 CMB

ROCK BORING LOG

Project	Job Number	Date	Boring No.
DCPP ISFSI/CTF	12239-1	4/19	01CTF-A

WLA

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
45	5:06						SW-Fr		R1-R2	(Tofb-2, Tofb-2a) very fine sandstone. Slightly weathered to Fresh; very weak to weak dolomitic matrix	Ve, subvertical, Wa, Ti,	raining	
46	4:02										Ve, subvert. Calcite filled? Wa, ne		C-D
47	4:02	10	5/5	100	3.2/5 64%	MW			R0	Coarse sandstone individual grains 0.5-1mm moderately weathered extremely weak	Jo, 50°, Sm, Pl, OP, MNe, ox; Jo, 45°, Sl, Pl, OP, MNo, OX		
48	6:04									color 10YR6/8 brownish yellow	Crumbly broken into many pieces	clay within broken zone, 60° dip? (CMB April 01)	D
49	5:11										end of run	4:40AM	
50	16:15		3.8/3.8	100%	2/3.8 53%					@50.5' silty clay fine layer 0.1ft thick	Jo, 40°, Pl, Wa, OP, ox; Me, Pl, OP, cracked by handling; Be?, 10°, Pl, OP ← clayey rock	stop to mix mud ≈ 10 min; 5AM	
51	5:15	11								returns to coarse sandstone individual grains up to 1mm brown color	Jo, Pl, Sl, OP, ox, 80° zone - not bedding clay		
52	3:74									color 10YR6/8	Jo, 10°, Pl, Sl, OP; end of run	5:20AM; JGH 5/4/01	
53		12	0.7/1.7	41	0.6/1.7 35%	MW		RQ-R1 JGH 5/4/01	RQ		Jo, 45°, Pl, Sl, OP, OX; end of run	5:50AM	
54	6:52	CB 5								@53.7 becomes grey Gley 4/10Y; @54.4 turns brown color	Jo, Pl, Sl, Ti; Jo, 50°, Pl, OP, OX; Jo, 20°, Wa, RO, OP; Me, 0°, Pl, Sl, OP	6:05AM; 6:25 water run w/PG&E truck	
55	6:26									coarse grained sandstone same as above	broken pieces		
56	5:45		5/5	100%	4.2/5 84%						Jo, 40°, Pl-St, OP		
57	4:56						SW		R1	@57.4 becomes grey color Gley 4/10Y	break handling core		
58										BOH 58.6'		7:10AM finish coring	
59													
60													

Tofb-2; Tofb-2a JGH 5/4/01; Friable Zone

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

Check CMB 19 April 2001 CMB RL

LOG of ROCK BORING 01-A

Unit calls by JLB/CMB/JWL 5/01 Friable zone calls JGH/JLB 5/4/01
Edited for ISFSI SAR by JLB 5/24/01

Project: DCPP - ISFSI	Job Number: 1223-A-1	Boring Location: Station 140 NW Corner of Dry Cask Pad	Total Depth: 71.8'
Type & Diameter of Boring: Triple HQ core ~~Double~~ Barrel Core Barrel		Elevation and Datum: 305.71'	Ground Water Depth: not recorded; Depth to Bedrock: 4.8'
Drilling Contractor and Rig: Cascade Drilling, CME 75 95 Kirk Julio JLB 5/31/01		Length of Core Barrel and Bit: see 01-D 8'7"	No. of Core Boxes: 5; Date Started: 4/19/01
Casing Size and Depth: 8" Auger Set To 4' Depth	Borehole Inclination: 90°	Logged By: JGH + RDK	Date Completed: 4/20/01

WLA

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
0–3										Back filled test pit & Set Auger/Casing to 3.5' Depth.			Started boring in 3' Deep Test pit. Pit was excavated for utility location. Started on 4/19/01 - Repaired H_2O pump - Cleaned up on B-RTF - Setup on B-01-A - From 7:30 AM to 10:45 AM
10:59	NR	2:39	CB1 1	28/3.0	93	0.45/5.0	SW	R1		Stuff from Test pit Consists of Sub-angular Sandstone Fragments.	NR	Crushed zone, Slff, Me	- Start Run #1 @ 10: AM
4–5		5:48			15%					-SANDSTONE, Dolomitic greywacke, 7.5YR 5/6, Medium-grained, Well-Sorted, Well-Oxidized Sand, Massive, moderate hardness. (Tofo-2, Same as above Tofo-2)	-Jo, 40°, wa, Sl, op, ox		
5–6		5:48					SW	R1			-Jo, 0°, wa, Sl, T; -Jo, 0°, wa, Sl, op -Crushed zone -Jo, 0-70°, wa, Sl, op -Jo, 45°, wa, Sl, op -Jo, ~0°, wa, Sl, op		
12:29		4:00									-Jo, 0°, St, Sl, op, ox -Jo, 90°, wa, Sl, T; -Jo, 70°, wa, Sl, T; -Jo, 60°, wa, Sl, T; -Jo, 0°, wa, Sl, op -Jo, 0°, wa, Sl, T; -Jo, 0°, wa, Sl, T;		@11:30 - Fixing Spindle because it is spraying everyone. - also Filling H_2O Truck. - Driller reports spindle is bocoming.
7–8		3:38		48/5.0	96	0.7/5.0	SW	R1-R2					
8–9		2:20	2		14%						-Jo, 0°, St, Sl, op -Jo, 75°, wa, Sl, T; -Jo, 45°, wa, Sl, T; -Jo, ~0°, wa, Sl, op -Jo, 30°, Pl, Sl, op -Jo, 30°, Pl, Sl, op		
9–10		3:57											
10–11		3:20									-Jo, 90°, wa, Sl, He, $CaCO_3$		
12:47													
4:35													
11–12		4:20								Same as above @11.5-13.1 Common $CaCO_3$ veining, up to 1cm thick. Lining most Fractures	-Crushed, Me, w/$CaCO_3$ -Jo, 0°, wa, Sl, op, ox -Jo, 0°, wa, Sl, op, ox -Jo, 90°, wa, VR, op, w/$CaCO_3$ -Crushed, Me, w/$CaCO_3$		@12:54 - Shutdown to try to Fix Spindel. Rig back online @ 4:30 PM. Waited ~2 hr for PG+E welders
12–13		4:42	3	5.0/5.0	100	.95/5.0	SW	R1-R2			-Jo, 80°, wa, Sl, op, Fi, $CaCO_3$ -Jo, 30°, wa, Sl, op, ox		
					19%						-Jo, 70-90°, wa, Sl, He, $CaCO_3$		
13–14		3:39								@14'- Micro Cavum ~1cm x 2cm. lined with $CaCO_3$	-Jo, ~90°, wa, Sl, op		
14–15		5:19											

all C-D

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type of infilling, slickensides, etc.

ROCK BORING LOG

Project	Job Number	Date	Boring No.
DCPP ISFSI/CTF	1223a-1	4/19/01	01A

6949.

WLA

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
15–16	5:14, 7:16	3	5/5	100	0.35/5 19%	SW		R1-R2		@15.2'- clay filled fracture ~1cm thick - flat lying across core (Tofb-2, Tofb-2a)		-Jo, 0°, wa, sl, Ti; ~Jo, 0-10°, wa, sl, Fi, 1cm Clay; -Jo, 0-30°, wa, sl, Ti; ~Jo, 0°, wa, sl, Op & OX	25-30° JUB 5/4/01
16–17	7:56	CB2	4.7/5.0	94	1.15/5.0 23%	SW		R1		Same as above		Crushed zone, Me; -Jo, 0°, wa, sl, Op; -Jo, 90°, wa, sl, Op; -Jo, 50°, wa, sl, Op; ~Jo, 70°, wa, sl, He, CaCO3-veinlet; -Jo, 90°, wa, sl, He, CaCO3-veinlet; -Jo, 75°, wa, sl, He, CaCO3 veinlet	@100 PSI
17–18	7:01	4											
18–19	4:27					SW		R2		@18.5'- unit grades to hard; @19.3'- unit grades back to moderately hard			
19–20	6:06					SW		R1				-Jo, ~90°, wa, sl, Op; -Jo, ~10°, pl, sl, Op; -Jo, ~10°, Pl, sl, Op; -Crushed zone; -Jo, 35°, wa, sl, Op	
20–21	7:18											-Crushed zone	@5:35 - Water truck rental broke. water valve cracked.
21–22	7:42		4.35/5.0	87	2.35/5.0 47%					Same as above; Top 0.4' of run is possible stuff. Bored.		-Jo, 0°, Pl, sl, Ti	
22–23	6:53	5				SW		R1					
23–24	6:02											-Jo, 0°, Pl, sl, Ti; Jo, 70, wa, sl, Op; Jo, ~0°, wa, sl, Op	@100 PSI; @24.5' complete loss of circ. 0%
24–25	7:38											-Jo, Me(?) 0°, Pl, sl, Op	
25–26	3:18									Similar to above Well sorted, med grained sandstone, massive oxidized, slightly less hard than above		-Crushed zone	@26.5 lost all water in the hole.
26–27	6:03					SW		Ro-R1					
27–28		6	2.5/4	63	.4/4 10%					vertical vein at 28 ft. has 0.5 cm, white material		crushed zone; Jo, 70°-80°, Wa, Ro, Op; Jo, 30°, Pl, sl, Op; Jo, 30°, Pl, sl, Op; Jo, Pl, sl, Op	
28–29	25:01									below last discontinuity @29.9 clay layer H. brown		Jo, 70°, Pl, sl, Op; Jo, 70°, Pl, sl, Op	clay layer is .05 ft. thick
29–30													

Tofb-2; Tofb-2a friable zone; JUB 5/4/01; ROK out sit; 9/11 C-D

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

ROCK BORING LOG

Project	Job Number	Date	Boring No.
DCPP · ISFSI/CTF	1223a-1	4/19/01 - 4/20/01	01-A

WLA

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
30–45	Tofb-2; Tofb-2a friable zone; JCB 5/14/01	6; 7; 8; 9; 10; 11	2.4/4; 1.3/1.3; 4.9/5; 1.5/2; 3/3; 4.2/5	63; 100; 98; 75; 100; 84	0.4/4; 1.1/1.3 (85%); 2.4/5 (48%); 1/2 (50%); 1/3 (33%); 1.3/5 (26%)	MW; SW; MW; SW-MW; SW-Fr; SW-MW; SW	R0; R1-R2; R1; R0; R1; R2; R1; R1-R2; R2	JCB 5/14/01		med-coarse grained sandstone; fine grained sandstone dolomitic matrix, sand grains dominantly fine grained (1.25-.5mm) occasional coarse grains and med grains. very weak to weak slightly weathered (Tofb-2, Tofb-2a); brown coarse grained sandstone slightly oxidized; @34.4 becomes grey color to end of run; much softer than above and below; medium to coarse grained grey sandstone; many white colored grains; @37.1 turns brown color med grained sandstone dolomitic matrix heavy 6:22 w/ white on matrix; heavy dolomitic cement; very fine to fine grained sandstone slightly weathered to fresh, hard, weak rock strength, many joints trending different directions filled w/calcite up to 1.5mm diameter; between 40.6 and 40.8 med-coarse grained sandstone layer, soft; coarse grained sandstone hard, oxidized grains grains subrounded to rounded dolomitic matrix; grades downward to fine to very fine sandstone	Me,0°,Pl,Sm,OP } Both could be bedding?; Me,0°,Pl,Sm,OP; Jo,50°,Pl,He,Ti; Jo,50°,Pl,He,Ti,MNO filled; Jo,50°,Pl,Sl,OP,MNO ox, MNO stain directly below; Jo,70°,Pl,He,Ti; Jo,St,He,Ti,MNO filled <1mm; Me,shear break,0°,Sl,OP; Jo,Pl,80°,Sl,OP,MNO & ox; Jo,70°,Pl,Ro,OP,MNO & ox; Jo,70°Pl,Ro,OP,MNO & ox; Jo,Pl,Sl,OP; Jo,Pl,Sl,OP; Jo,St,Sl,OP; Jo,70-80°,Wa,Sl,OP; Jo,40°,Pl,Sl,OP; Jo,70°,Pl,Sl,OP; Me,shear break; Jo,Pl,Sl,OP,-Ti; Jo,20°,Pl,Sm,OP,1mm clay,ox; Jo,30°,Pl,Sm,OP,1mm clay,ox & MNO; Jo,30°Pl,Sl,OP,ox; Me,shear break; Jo,10°,Pl,Sm,OP,ox; Me,shear break; Jo,Wa,45-70°,Sl,OP,ox,MNO; Jo,Pl,10°,Sm,OP,ox; Jo,60°,Pl,Sl,OP,ox; Jo,80°,Pl,Sl,OP,MNO & ox; Jo,60°,Pl,Sl,OP,MNO & ox; crumbled/broken pieces; crushed zone JCB 5/14/01; Jo,10°,Pl,Sl,OP; Jo,10°,Pl,Ti; Jo,30°,Pl,Sm,OP; Jo,60°,Pl,Ti; Jo,45°,Pl,Sm,OP,ox; Broken; Jo,Wa,Ro,OP; Jo,Bo,Pl,Ti; Jo,45,Pl,Sl,MNO,Ti; Jo,WA,75-80,Ti,filled w/<1mm MNO; Jo,<1cm,OP,MNO & ox; Jo,WA,80,Ti; Jo,45,Pl,Sl,OP; Broken	harder sandstone above and below unit; 8:15 to 9:10 PM drillers have rig problems with mud pump; 9:30 PM resume coring overhead lights have short turning on and off; 10:00 PM; 10:15 PM; 11:20 PM; @≈38.5 driller reports extremely hard drilling (slow) ≈20min at same depth; 11:50 PM; 12:05 PM; 12:30 PM; 12:45 PM; 1:00 Am 4/20/01 driller reports soft ≈45 sec.	C-D; C; D; C; D

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

ROCK BORING LOG

Project	Job Number	Date	Boring No.
DCPP ISFSI/CTF	1223a-1	4/20/01	01-A

WLA

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
45–60	Tofb-2; Tofb-2a (Fracture Zone); Tofb-2	2:34; 2:37; 1:45; 1:45; 1:45; 8:25; 14:46; 4:32; 4:28; 3:58; 7:10; 6:07; 3:15; 4:44; 4:35	11; 12; 13; 14	4.2/5; 4.8/5; 4.8/5; 5/5	84; 96; 96; 100	26%; 1.3/5; 2.6/5; 52%; 2.2/5; 44%; 3.3/5; 66%	SW; HW; MW-SW; SW; HW; SW; MW; SW	R2; Ro; Ro-R1; R1-R2; Ro; R1-R2; Ro; R1-R2		Fine to very fine sandstone (Tofb-2, Tofb-2a); sandy clay w/gravel gravel clasts up to 0.25cm occasionally 1cm in diameter; coarse grained sandstone grey color; @48.2 thin clay layer ≈1m thick hard to see layer boundaries; @48.8 color changes to brown coarse grained sandstone; fine grained dolomitic sandstone, slightly weathered, hard; @54.95 1in thick vein silty clay w/sand and gravel; fine grained dolomitic sandstone slightly weathered, hard dolomitic matrix; @58.9 1cm thick grey clay layer; very fine sandstone w/some clay, very soft; fine grained dolomitic sandstone	JO,80°,Pl,Sm,OP,MNO ½ox; JO,80-90°,WA,Ti; JO,Pl30°,Sm,Ti; JO,70°,Pl,Rough OP; Me,shear break; silty/sandy breccia zone; Fa.?,80°,Pl,Sm,OP fault,60°; JO,0°,Pl,Sm,OP; JO,0°,Wa,Sl,OP; Broken; JO,0°,Pl,Ti,He; JO(Me?),St,Sm,OP,0°; JO,20°,Pl,Ti,He,MNO; JO,WA,Ro,OP MNO ½ox; JO,WA60-90°,He,Ti; JO,Ti,Pl,Sl,OP; JO,Ti,Pl,Sl,OP,MNO ½ox; JO,Pl,Ti,He; Me,Pl,0°,Sm,OP(JO?); JO,10°,Sm,Pl,OP,MNO ½ox; Broken; JO,0°,Sm,Pl,OP,ox; JO,80°,Wa,Sl,OP,ox; JO,20°,Pl,Sl,OP,ox; JO,60°,Pl,He,Ti,MNO; JO,0°,Pl,Sl,OP,ox; JO,70-80 WA,Sl,OP,ox; JO,30°,Pl,Sm,OP,ox crushed JCB 5/4/01; Broken; Be,20°,Pl,Sm silty, sandy clay possibly beds?; JO,0°,WA,Ti JCB 4/4/01; JO,60°,Pl,Sl,OP,MNO ½ox; JO,20°,Pl,Ti JCB 5/4/01; 20° faults, thin slickensided clay surfaces w/ well-developed; JO,45°,Pl,Sm,Ti,He,MNO millions; Broken; JO,45°,Pl,Sm,OP,MNO ½ox; JO,60°,Pl,Sl,Ti; JO,10°,Wa,Ti,MNO; JO,30°,Pl,Sm,OP,MNO ½ox; JO,30°,Pl,Sl,OP,ox; JO,70°,Pl,Sl,ox,OP; JO,40°,Pl,He; Be(JO?),20°,Pl,Sm,OP,1cm clay; JO,40,Pl,He; JO,40,Pl,He	high angle joint may be a fault. Sandstone often changes color along and clay contact is also along a high angle contact; 2:10PM driller dinner break; 3:AM mixing mud.; drillers H_2O tub drained twice w/no return (into formation) for ½ hour lost water into formation @ 3:35 AM start getting return water; 3:50 AM; 4:45AM water true fill; 5:05 AM resume drilling; 5:20AM	D; high angle fault; D; C-D

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW -Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy). Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

ROCK BORING LOG

Project	Job Number	Date	Boring No.
DCPP ISFSI/CTF	1223a-1	4/20/01	01-A

WLA

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
60–61	4:11, 5:47	14	5/5	100	66%, 3.3/5	SW		R1–R2		Fine grained dolomitic sandstone		Jo,45°,Pl,Sl,oP,MNO & ox; Jo,40°,Pl,Sm,oP,MNO & ox	6:10AM
61–62	4:36	↓ CB5											
62–63	4:20					SW–Fr		R2				Jo,0°,Pl,Sl,oP,MNO	
63–64	5:23	15	4.7/5	94	2.8/5, 56%							Jo,Pl,like possible bedding; Jo,30°,Pl,Sl; Jo,45°,Pl,Sl,oP,MNO & ox; Jo,10°,Pl,ti	
64–65	4:14											Jo,0°,Pl,He,ti,MNO; Jo,70°,Pl,Sl,oP	
65–66	4:20											Jo,0°,Pl,Sm,oP; Jo,50°,Pl,Ti; Jo,80°,Wa,Sl,oP,MNO & ox	
66–67	3:13					SW–Fr		R2				Jo,80°,WA,Sl,oP,MNO & ox; Jo,50°,Pl,Sm,oP MNO & ox; Jo,30°,Pl,Sm,oP,MNO & ox	6:25AM
67–68	3:59											Jo,30°,Pl,Sm,oP,ox; Jo,30°,Pl,Sm,oP,MNO	
68–69	3:09	16	4.8/5	96	0.8/5, 16%							Jo,70°,Pl,Sl,oP,MNO & ox; Broken; Jo,70°,Pl,Sl,oP; Jo,70°,Pl,Sm,oP,ox,CaCO3	6:35AM
69–70	5:09						JGH	R1–		@70.2 turns grey color		Jo,60°,Pl,Sm,ti; Jo,70°,Pl,Sm,oP	
70–71	4:44											Jo,70°,Pl,Sm,oP; Jo,50°,Pl,Sm,oP; Jo,50°,Pl,Sm,oP	many other cracks in rock
71–72										B.O.H. 71.8ft.			
72–75													

To fb-2; To fb-2a Friable Zone JGH

C-D; D

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

LOG of ROCK BORING 01-B

Unit calls by JLB/CAB/WAL 5/01 friable zone calls JLB/JLB 5/31/01 Edited for ISFSI SAR by JLB 5/25/01

01-B/1

Project: DCPP-ISFSI	Job Number: 1223-A-1	Boring Location: NW of Center of ISFSI pad ~~NW Corner of Dry Cask Pad~~ JLB 5/31/01	Total Depth: 72.0
Type & Diameter of Boring: HQ core - Triple barrel core barrel		Elevation and Datum: 318.9 JLB 5/31/01	Ground Water Depth: not recorded
Drilling Contractor and Rig: Cascade - CME ~~85~~ 95 - Kirk & Julio JLB 5/31/01		Length of Core Barrel and Bit: ~~See B-01-6~~ 8'7"	No. of Core Boxes: 4
Casing Size and Depth: 8" Hollow Stem Auger - to 4.0'	Borehole Inclination: 90	Logged By: JGH	Date Started: 4/21/01
			Date Completed: 4/21/01

WLA

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
0										Set Auger/Casing to 4.0' depth.			Driller reported 1' of stuff in auger before starting.
1													
2													
3		2:23					Slough?			Cored Sandstone		Gray Coarse Sand-silt w/clay and bentonite clay surface coating	
4										Stuff			1.4' @ Run 1 - Stuff
7:23 AM										Brown silty clay, soft		(Tofb-2)	@170 PSI
5		5:12	CB1	3.5/4.0	88	1.3/4.0	SW	R1/R0		SANDSTONE - dolomitic greywacke, 7.5YR 6/6, Medium-grained, well-sorted sand, well oxidized. Moderately hard. Subrounded grains.	-Jo,0°,St,Sl,op -Jo,65°,wa,Sl,Slop		100% circ.
6		3:26	1			32%		R3		JLB 5/31/01 Vein well cemented, strongly dolomitized JLB 5/31/01	-Jo,0°,wa,Sl,op -Jo,90°,wa,Sl,op, clayey infill -Jo,0°,St,Sl,op		1/16" thick
7		2:26								Same as above	-Jo,80°,wa,VR,op		
8		4:20		5.0/5.0	100	2.3/5.0	SW	R1 R2		alternating medium grained and medium to coarse-grained layers w/ gradational texture changes (JLB 4/21/01)	-Jo,40°,wa,Sl,op -Jo,25°,wa,Sl,op -Jo,0°,wa,Sl,T; -Jo,0°,wa,Sl,op		
9		7:55	2			46%					-Jo,90°,wa,Sl,op -Me,0°,Pl,Sl,T;		
10		4:03									-Jo,0°,wa,Sl,op -Jo,60°,wa,Sl,op		
11		2:50											@11'- 90° circ. @170 PSI
8:10 / 8:16											-Jo,30°,45°,Sl,wa,op		
12		3:05								Same as above	-Jo,90°,Pl,Sl,op		@12' 70° circ 170 PSI
13		4:26	3	5.0/5.0	100	2.4/5.0		R3		JLB 5/31/01 grey lamination 10° dip	-Jo,60-90°,wa,Sl,T;-healed		@12.5'-50° circ.
14						48%					-Jo,0°,Pl,Sl,op		
		3:20									-Jo,0°,Pl,Sl,T;		
15													

Tofb-2

Sandstone correlates w/ unit Tofb-2 JLB 4/21/01

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW -Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or We-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type of infilling, slickensides, etc.

Checked JLB 4/21/01

ROCK BORING LOG

Project	Job Number	Date	Boring No.
DCPP ISFSI	1223a-1	4/21/01	01-B

WLA

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
15–16	3:43	3	5/5	100	2.4/5 48%	SW		R2		(Tof b-2)		-Jo, 0-20°, wa, Sl, He, OX Jo, 0°, Pl, Sl, T., OX -Jo, 0°, wa, Sl, op	
16–17	3:37											Jo, 0°, Pl, Sl, op, OX Jo, 0°, Pl, Sl, op, OX Jo, 0°, Pl, Sl, op, OX NR	
17–18	2:28		4.9/5.0	98	2.45/5.0	SW		R2		Same as above Possible Bedding		-Jo, 90°, wa, Sl, op, Ox & MnO Jo, 0°, wa, Sl, op, MnO -Mz?, 0°, Pl, Sl, op Polished Surface JLB 4/4/01	@17.5' Spindal Packing burst. Drillers re-packed fittings. -No Down Time-
18–19	7:13	4			49%					19.5 - gradational wavy contact lighter colored bed more resistant. 19.9' flat lying, wavy contact		Jo, 0-90°, wa, Sl, op, OX -Jo, 0°, Pl, Sl, T., MnO	
19–20	5:23					SW		R3		SANDSTONE, Dolomitic greywacke, 10YR 7/3, medium-grained, well-sorted well oxidized sand. massive w/ few Dolomite filled micro fractures.		-Be, 0°, wa, SM, T. Be, 0°, wa, SM, T.	
20–21	5:28					SW		R2				Jo, 0°, wa, Sl, op, OX Jo, 0°, wa, Sl, op, V.OX -Jo, 90°, wa, Sl, op, OX -Jo, 0°, wa, Sl, op, OX	@20' 50% Circ 150 PSI
21–22	4:57											-Jo, 20°, Pl, Sl, op, OX Jo, 0-20°, Pl, Sl, op + Fi-CaCO3 -Jo, 0°, wa, Sl, 1/2 op - vug	
22–23	?	CB2								Same as above		-Jo, 0°, St, VR, op, OX & MnO -Jo, 30°, wa, Sl, T., OX	@
23–24	5:42	5	5.0/5.0	100	3.2/5.0 64%	SW		R2		Some thin Calcite/dolomite veins and small (1/8"±) angular weathered shale/claystone clasts (weathered to clay) JLB 4/4/01		-Jo, 10-50°, wa, Sl, T., OX -Jo, 30°, Pl, Sl, T., OX -Jo, 0°, St, Sl, op, OX	
24–25	3:57											-Jo, 10°, wa, Sl, Slop, OX -Jo, ~90°, wa, Sl, op	@25.5' 50% Circ @95 PSI
25–26	4:53											-Jo, 20°, wa-St, Sl, op -Mz, 0°, Pl, Sl, T.	
26–27	5:20											-Jo, 20°, wa, Sl, T.	
27–28	2:48	6	5.0/5.0	100	2.0/5.0 40%	SW		R2		Same as above		-Jo, 60-90°, wa, VR, op -Me, 0°, Pl, Sl, T. -Jo, 90°, wa, Sl, op	@29' 40% Circ @90 PSI
28–29	3:02									Small vugs		-Jo, 20°, Pl, Sl, op -Jo, 0°, wa, Sl, op - vug	
29–30	2:50											-Jo, 70°, wa, Sl, op	@29.5' Driller reports softer drilling.

8:35 8:40 9:15 10:55

Tof b-2

Correlative w/ Tof b-2 JLB 4/4/01

all D

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

checked JLB 4/21/01

ROCK BORING LOG

Project	Job Number	Date	Boring No.
DCPP ISFSI/CTF	12234-1	4/21/01	01-B

WLA

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
30–31	4:55, 2:57	6	5/5	100	2/5 40%	SW		R2		Medium grained dolomitic SANDSTONE, well-(greywacke) mod. sorted, well cemented; disseminated weathered shale-claystone angular clasts (1/8"±), oxidized streaks, joints, laminations	Jo-0°, Pl, Sl, Op; Jo, 90°, wa, Sl, Op, Ox; 3-Jo, 0°, Pl, Sl, Op; Jo, 60°, wa, Sl, Op		
11:17 / 11:27													
32–33	3:18, 3:57	7	5.0/5.0	100	3.4/5.0 68%	SW		R2		Same as above (Tofb-2, Tofb-2a)	Pl, 0°, Pl, Sl, Pl-O; Jo, 75°, Pl, Sl, He, Ox; Jo, 20°, Pl, Sl, He, Ox; Jo, 0°, Pl, Sl, Op-Ox; 3-Jo, 0°, wa, Sl, Op; Jo, 80°, Pl, Sl, He, Ox	@32'- 30% Circ @95 PSI	
34–35	5:34, 5:10										3-Jo, 45°, Pl, Sl, Op, Ox; Jo, 45°, Pl, Sl, He, Ox		
36–37	4:33, 6:00										Jo, 90°, Pl, Sl, He, Ox; Jo, 90°, St, Sl, Op, Ox; Crushed zone		
11:49 / 12:14													
37–38		8	5.0/5.0	100	2.0/5.0 40%	SW		R2		Same as above; Gradational Contact	Jo, 60°, Pl, Sl, Op; Jo, ~90°, wa, Sl, Ti; Jo, 70°, wa, Sl, Op, Ox; Jo, 0°, St, Sl, Op, Ox	@38' 20-30° Circ @~100 PSI	
38–39	5:56, 3:29					SW		R1		SANDSTONE - greywacke 7.5YR 6/2, Coarse-grained, poorly sorted, w/small gravel (slate + Qtz), Massive, Slightly hard, Slightly oxidized, mod. well cemented	Jo, ~0°, wa, Sl, Ti, Ox; Jo, 70°, Pl-wa, Sl, Ti; Jo, ~0°, wa, Sl, Ti; Jo, 30°, wa, Sl, Sl-Op; Jo-Fa, ~60°, wa, Sl, Fi ~	Clay + rock Frags 1.5 cm thick,	
40–41	5:35, 3:53					SW		R2		Gradational Contact SANDSTONE, Dolomitic, greywacke, 7.5YR 7/2, Med.-grained, well-sorted, well-oxidized sand. Massive. Moderately hard.	Me, ~0°, wa, Sl, Op; crushed zone; Jo, ~90°, wa-St, Sl, Op, Ox; Jo, 40°, Pl, Sl, Slop, Fi-1/16" clay, slicks; Jo-~90°, wa, Sl, Ox	JGH 5/4/01 @12:40-refusal	
12:40 / 12:55													
42–43	1:20	9	5.0/5.0	100	1.7/5 34%						Jo, 80°, wa, St; Jo, 40°, Pl, Sl, Op, trace clay; Jo, Pl, 30°, Sl, Op, Ox - Polished surfaces take on 100; Jo, 40°, Pl, Sl, Op, Ox; Jo, 70°, wa, Sl, Op; Jo, 0°, Pl, Sm-Op, some clay; Jo, 0°, Pl, Sm, Op, trace clay; Jo, 0°, Pl, Sl, Op, Ox, trace clay; Jo, wa, Sl, He, Ti; Jo, 70°, Pl, Ti; Jo Pl-St, Sl, Op, Ox	JGH 5/4/01 @42'. 40° Circ. @100 PSI	
43–44												@43.2' Lost all H_2O 0° Circ	
44–45						SW		R2		grades into fine grained Sandstone, massive 10YR 7/3 very pale brown	Broken, Jo, 70°, wa, Sl, Op	@45.8'-Lost all Circ. again 0°	

Correlative w/ Tofb-2 Sandstone JGB 4/21/01

JGHL

@2:50 RDKL

all D 100 PSI

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

Checked JGB 4/21/01

@45'- Lost 4 tubs of H_2O. 0° Circ.

ROCK BORING LOG

Project	Job Number	Date	Boring No.
DCPP ISFSI/CTF	1223a-1	4/21/01	01-B

WLA

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
45										fine grained sandstone (Tofb-2, Tofb-2a)			@45.5 - gained back ~20° circ.
46		2:59, 4:48	9	5/5	100%	SW		R2		@46-46.4 interbed of med. grained SS. grades back into fine grained sandstone, massive; @46.8 clay seam 0.5-1cm thick		Jo, 70°, wa, Sl, op, MNO & ox; Jo, 70°, Pl, Sl, op; Jo, 70°, Pl, Sm, op, immclay, ox; Jo, 60°, Pl-St, Sm, op 0.5-1cm clay 35-40°, crushed rock w/ clay	
47					39%					fine grained sandstone massive, hard, 10YR 8/2 very pale brown		Jo, 80°, wa, Sl, op, MNO & ox; Jo, 0°, Pl, Sm, op; Jo, wa, 20°, Sl, op; Jo, 70°, R, Sl, op, ox; Jo, 20°, Pl, Sm, op	Sand JCB 5/4/01
48		5:26, 6:23	10	5.0/5.0	100%	SW		R2				Jo, 80°, wa, Ro, MNO, ox, op, trace clay; Jo, 40°, Pl, Sl, Ti; Jo, 30°, Pl, Sm, op, ox, trace clay	@49' - Still no circ. ~15 gal circ @ 100 psi +2,000 ROM
49					28%			R2 R1 R2		@48.7° slightly softer		Jo, vert, wa, He, Ti; Jo, wa, 80°, Sl; Jo, 40°, Pl, Sl, op, ox	
50		3:25, ?										Jo, 70°, Pl, Sl, op, ox; Broken Rock	
51		3:20										Jo, 35°, Pl, Sm, op, ox; Jo, wa, 80°, Ro, op, MNO & ox; Jo, 60°, Pl, Sl, op, ANO & ox	
52		2:58	11	4.7/5.0	94							Broken; Jo, 80°, wa, Sl, clay coating <1/16"	
53		5:09			62%							fa; Jo, 80°, Pl, He, Ti, Fi, 1-2mm clay, stiff, wall polished, slicks	Gain 5/4/01
54		6:53				SW		R2		gradual contact into pale brown coarse grained sandstone		Jo, 20°, Pl, He, Ti; gradational, irregular bonded contact	
55		3:35				MW		R1-R0		@54.6 turns gray sandstone, mod. altered, friable, softer than above; clay 7/10Y-6/10Y to greenish gray-greenish gray		Jo, 60°, Pl, Sm, op, Fi, 1mm clay; Jo, 70°, Pl, Sm, op, Fi, 1mm clay, w/ slicks; fa Be(?), bonded, 12-18° dip ?	@55.0' - 20-30° circ. Color change reported by driller to gray.
56		5:49				SW		R2 Ro-Fi		@55.6 back to pale brown med-coarse grained sandstone sharp contact, massive 10YR 7/3-7/4 very pale brown hard		Jo, 45°, Pl, Sm, op, ox; Jo, 20°, wa, He, Ti; Jo, 70°, wa, He, Ti, Fi, 1/32" clay, polished w/ slicks	@56.0' Driller reported color change back to orange.
57		5:27	12	4.7/5	94			F2				← healed microfractures; Jo, 70°, wa, Sl, op, MNO & ox	
58		11:12			49%							Jo, 75°, Pl, Sl, op, ox; Jo, 0°, Pl, Sl, op; Jo, 40°, wa, Sl, op; Jo, 10°, Pl, He, Ti; Jo, 10°, Sl, op; Jo, 10°, Pl, Sm, op; Jo, 60°, wa, Sl, op, MNO & ox		loss of circulation all water from tub gone between 58 & 59'
59		2:47				SW		R2		clear contact into very fine grained dolomitic sandstone to fine grained sandy dolomite, massive hard, dolomite/calcite veins		Jo, 60°, Pl, Sm, op; Jo, 50°, Pl-Wa, Sl, op	
60													

Tofb-2; Tofb-2a friable zone; Tofb-2b

1:35 1:50 2:14 2:20 2:40

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

Checked JCB 4/26/01

ROCK BORING LOG

Project	Job Number	Date	Boring No.
DCPP ISFSI/CTF	1223a-1	4/21/01	01-B

WLA

Depth (feet)	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Remarks
60–62	2:15, 4:28	12	4.7/5.0	94	2.4/5 48%	SW		R2	very fine to fine grained dolomitic sandstone 10YR 7/2 very pale brown (Tofb-2)	@61' lost all circulation 0.0% circulation
62–67	1:22 (>20+), 1:52, 2:37, 2:08, 1:38	13	4.8/5.0	96	2.8/5.0 56%	SW		R3 (JLB 5/4/01), R2	Same as above	most Me (30°?) discontinuities in run 13 are probably Me. driller reports chattering. Driller not using mud. This might be the reason for the Me. breaks; 5:45 PM; ø return on circulation water
67–72	3:01, 4:47, 2:08, 2:12	14	5.0/5.0	100	2.4/5.0 48%	SW		R2	Same as above; @70.8 Same rock as above but grey color gley 1 7/10y light greenish grey; B.O.H. 72'	6:00 PM

Description of Discontinuities (top to bottom):

- J0,0°,Pl,Sl,Op
- J0,0°,Pl,Sl,Op
- healed micro fracture
- J0,0°,Pl,Sl,Op
- Me, shear break
- Broken
- Me(30°?),Pl,Sl,Op
- J0,70°,Pl,Sl,Op,ox
- Me(30°?),0°,Pl,Sl,Op
- Me(30°?),Wa,Sl,Op
- J0,0°,Wa,Sl,Op
- Me(30°?),Wa,Sl,Op,0°
- Me(30°?),0°,Wa,Sl,Op
- Me(30°?),0°,Wa,Sl,Op
- J0,80°,Wa,Sl,Op MnO ± ox
- Me(30°?),Wa,Sl,Op
- Me(30°?),0°,Wa,Sl,Op
- J0,80°,Wa,Sl,Op
- Me(30°?),0°,Sl,Op
- Me(30°?),0°,Sl,Op
- J0,80°,Wa,He,Ti
- J0,70°,Pl,He,Ti
- Me(30°?),0°,Pl,Sm,Op
- Me(30°?),0°,Wa,Sl,Op
- J0,40°,Wa,Sl,Op
- Me(30°?),0°,Wa,Sl,Op
- Me, shear break
- Broken
- Me J0,80°,Pl,Sl,Op,
- Me
- Me
- J0,80°-90°,Wa,He,Ti,Fi, ox sand
- J0,60°,Pl,He,Ti
- Me
- Me J0,70°,Wa,Sl,Op,ox
- Me J0,60°,Pl,Sl,Op,MnO ± ox
- Me
- J0,70-90°,Wa,Sl,Op,MnO ± ox
- Me (×11)
- J0,20°,Wa,Sl,Op
- Me
- Me
- Me

Tofb-2

D; C-D; D

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy). Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

01-C/1

LOG of ROCK BORING 01-C

Unit Cols by JLB/CMB/DRL 5/01 Friable zone Cols JGH/JLB 5/4/01
Edited for ISFSI SAR by JLB 5/25/01

Project: DCPP-ISFSI	Job Number: 1223-A-1	Boring Location: Center of ISFSI Pad JGH ~~Central Northern Edge of Pad~~ 5/31/01	Total Depth: 67.0
Type & Diameter of Boring: HQ Core, Triple Barrel Core Barrel		Elevation and Datum: 323'± (Survey Pts. #138)	Ground Water Depth: not measured
Drilling Contractor and Rig: Cascade CME 95, Kurt > Day Crew, Julio JLB 5/31/01		Length of Core Barrel and Bit: ~~See Old D~~ 8'7" JLB 5/31/01	No. of Core Boxes: 3
Casing Size and Depth: 8" Hollow Stem Auger	Borehole Inclination: 90	Logged By: JGH	Date Started: 4/22/01
			Date Completed: 4/23/01

WLA

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
0–7										Augered down to 9.5' (into Bedrock) to set Casing. - Mud expanded up auger to 7.0'			- Arrived on Site at 7:00AM. Drillers Setting up on hole
7–9.5	NR SIFF	4:20, 2:00	CB1 1	4.6/5.0	92	0/5.0 0%				Interlayered bentonite, friable sandstone, harder sandstone, soil	NR SIFF		- Started Coring @ 7:30AM @ 7.0'
9.5–11		5:29	1				HW			"altered" Sandstone JLB 4/26/01 SANDSTONE, greywacke, 2.5YR 5/1, Coarse-grained moderately sorted, Petro-rich(?) Sand. Massive. Soft, friable. Abrupt-Smooth Contact		(Tofb-2, Tofb-2a) -Jo, 70°, Pl, Sl, Slop -Jo, 0°, Pl, Sl, op, ox	
11–14		2:45, 3:13, 3:43	2	5.0/5.0	100	2.1/5.0 42%	HW, MW/SW		RO, RO, R1-R2	SANDSTONE, dolomitic, greywacke, 7.5YR 7/6, Medium-grained, Moderately sorted, well oxidized Sand, Massive, Slightly hard, friable. grades finer-grained (fine-med. grained JLB 4/26/01) Run-2 Same as above increase in hardness decrease in weathering Dolomitic fine-grained SANDSTONE to Dolomite(?) JLB 4/22/01		-Jo, 60°, Pl, Sl, Slop, ox -Me, 0°, Pl, Sl, Ti -Jo, 40°, Pl, Sl, op, Fi-Clay Film -Be(?), 25°, Pl, Sl, Ti-with ?, front bent JLB -Me, 0°, Pl, Sl, Ti -Jo, 0°, wa, Sl, op -Me, 0°, wo, Sl, op, grooves -Jo, 60°, wa, Sl, op, ox -Jo, 0°, wa, Sl, op -Jo, 0°, St, Sl, op -Jo, 0°, St, Sl, op -Jo, 90°, wa, Sl, op, Mn0+0X -Me, 0°, Pl, Sl, Ti, grooves -Me, 0°, Pl, Sl, Ti, grooves -Jo, 0°, St, Sl, op, ox	5°-12° 4/26/01 JLB 4/26/01 Sandstone grades more-cemented, less weathered @ 12' - 100% Core. @ 105 psi

Tofb-2 / Tofb-2a Friable Zone JGH 5/4/01 / Tofb-2

8:30AM; 8:4; 7:1

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type of infilling, slickensides, etc

Checked JLB 4/22/01

ROCK BORING LOG

Project	Job Number	Date	Boring No.
DCPP ISFSI	1223a-1	4/22/01	01-C

WLA

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
15	3:50	2	5/5	100	21/5	SW		R2		SANDSTONE, Dolomitic fine-medium, well-sorted well oxidized Sand. Few Lithic Grains, Massive, Moderately Hard 7.5YR 7/3, well-cemented, highly weathered Shale-claystone clasts to 1/4"		-Me, 0°, wa, Sl, op, grooved -Jo, 0-30°, wa, Sl, Slop Jo, 90°, wa, Sl, Ti	
16	5:48				42%							-Jo, 0°, wa, Sl, T; -Jo, 15°, wa, Sl, Fi, Clay Film	
9:31 / 9:49 17	2:57									Same as above (Tofb-2)		-Jo, 30°, Pl, Sl, op, MnO + OX	@17'- 80° circ.
18	5:22	3	5.0/5.0	100	.75/5.0	SW		R2				-Jo, 75°, wa, Sl, op, OX -Jo, ~65°, wa, Sl, op, OX -Me, 0°, Pl, Sl, T;, grooved	
19	4:57				15%							>Me, 0°, Pl, Sl, T; -Jo, 60°, wa, Sl, T; -Me, 0°, Pl, Sl, T;	
20	4:36									gradational contact Fine-grained Dolomitic SANDSTONE to DOLOMITE, well-cemented JLB 4/22/01		-Jo, ~0°, wa, Sl, op -Jo, 50°, wa, Sl, op, OX -crushed zone	@20'-22' Driller reports softer drilling
21	7:10											-Jo, 60-70°, wa, Sl, op -Jo, 0°, wa, Sl, op -Jo, 90°, wa, Sl, op	
10:14 / 10:21 22	2:45									gradational contact Medium grained Dolomitic SANDSTONE, well-cemented, (graywacke) JLB 4/22/01		-Jo, 80°, wA, VR, op, OX -Jo, 90°, wa, Sl, op, OX, MnO	
23	2:47	4	5.0/5.0	100	1.5/5.0	SW		R2				-Jo, 80°, wa, Sl, op, MnO -crushed zone -Me, 0°, Pl, Sl, op -Jo, 5°, wa, Sl, op, OX *	D
24	3:58				30%							-Jo, 5°, wa, Sl, op, OX	@23.5' 70° circ
25	3:44									~25' grades to Fine grained. Fine-grained Dolomitic SANDSTONE to DOLOMITE JLB 4/22/01		-Me, 0°, Pl, Sl, op, OX -Jo, 90°, wa, Sl, Ti, OX -Jo, 75°, wa, Sl, T;, OX -Jo, 5°, wa, Sl, op, OX -Jo, 80°, wa, Sl, op, OX -crushed -Jo, 60°, wa, Sl, op, OX + MnO	@24.5' Fracture Zone Repeated 60° circ. Lost all pump pressure. C
26	3:36											-Jo, 0°, wa, Sl, op, OX >Jo, 5°, wa, Sl, op, OX + MnO -Jo, 0-90°, St, Sl, Ti, -Jo, 0°, wa, Sl, op -Jo, 60°, wa, Sl, op, MnO	@25.5 - 40° circ.
10:39 / 10:5 27	3:37	CB 2	4.6/5.0	92	0/5.0	SW		R2		Same as above Fine-grained, well-sorted dolomitic, SANDSTONE		-Jo, 80°, wa, Sl, op, MnO + OX -Jo, ~0°, wa, Sl, op, MnO	
28	4:02	5			0%							-Jo, 30°-60°, wa, Sl, op, MnO +	Crystalline Dolomite
29	3:10											-Jo, 30-90°, wa, Sl, Slop, MnO -Jo, 30°, Pl, Sl, Slop, OX -Jo, 0°, wa, Sl, Slop, OX -Jo, ~90°, wa, Sl, op, OX, MnO -Jo, 0°, wa, Sl, op, MnO + OX -crushed zone	@29'- 0° circ.
30													

Tofb-2

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

checked JLB 4/22/01

ROCK BORING LOG

Project	Job Number	Date	Boring No.
DCPP ISFSI 2001	12239-1	4/23/01	01-C

WLA

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
30–32	4:07, 5:05	5	4.6/5	92	0/5.0, 0%	SW		R2		(Tofo-2, Tofo-2a)		-Jo-70°, wa, Sl, op-ox -Jo, ~0°, St, Sl, op, ox -Jo, 65°, wa, Sl, Ti-He, Ox+MnO -Jo, 30°, Pl, Sl, Slop, ox -Jo, 60°, Pl, Sl, Slop, ox -Fr-sealed -Jo, 5°-Pl, Sl, Slop, ox -Jo, ~90°, Sl, op, ox+MnO	@32'- @11:30 AM Cross-over weld broke. Rig Down Need welder
11:11 4/23/01 @1128													
32–35	4:21, 6:58, 5:53, 5:42	6	5.0/5.0	100	1.7/5.0, 34%	SW		R2		SANDSTONE, greywacke 7.5YR 7/6, Medium-grained, Moderately Sorted, well oxidized sand, Massive, Moderately hard. Sparce/few clay stone fragments in sandy Matrix.		-Jo-80°, wa, Sl, Ti-He, Ox+MnO -Jo, 0°, wa, Sl, Ti, ox -Jo, 60-90°, wa, Sl, op, ox -Jo, 15°, St, Sl, Slop, ox -Jo, 90°, wa, Sl, He, CaCo3 -Me, 0°, Pl, Sl, Ti -Jo, 15°, Pl, Sl, Slop -Jo, 80°, wa, Sl, op -Jo, 60°, wa, Sl, Ti JSH 5/4/01	4/23/01 -Drillers arrived on site @ 10:30AM -Put rig together Covering by 11:30 @32' 0.5° circ. 105 PSI	C
35–36						SW		R2		SANDSTONE-altered grey zone		-Jo, 60, Pl, Sl, op, w/ clay 2mm bonded color changes, Subhorizontal JLO 4/24/01	C-D
36	5:34					SW		R2		SANDSTONE-unaltered, as above.			@34.5 ~10.5° circ
36–37										SANDSTONE, dolomitic, greywacke, 7.5YR 7/3, fine-grained, well-sorted, well oxidized sand, Massive, Moderately hard to hard, Common crystalline Dolomite lining fractures, + few clay stone fragments.		-Jo, 0°, wa, Sl, op, MnO >Jo, 60-80°, wa, Sl, op, MnO -Jo, 35°, wa, Sl, op, ox -Jo, 5°, wa, Sl, op, ox -Jo, 90°, wa, Sl, Ti, ox	
11:58 12:12													
37–38	11:16	7										-Jo, 0°, wa, Sl, op	@37'-20.5° circ. @105 PSI
38–39	7:52		5.2/5.0	104	0.6/5.0, 12%							-Jo, 40°, wa, Sl, op -Crushed zone -Jo, 40°, wa, Sl, op -Jo, 90°, wa, Sl, op+Fi, CaCo3, ox	
39–40	7:43									Nomens irregular w/ thin, lithic fragments above color change JLO 4/24/01 40.1'-gradational		-Jo, 0°, wa, Sl, op, ox -Jo, 90°, wa, Sl, op, ox, MnO	
40–41	3:23				40.6 color change		brown-grey	R3-R1		SANDSTONE, greywacke, medium-grained, Moderately Sorted, altered sand, grey, petro rich (?), Massive 41.5' gradational		-Jo, 75°, wa, Sl, op, ox, MnO -Jo, 0°, wa, Sl, Ti, ox -Jo, 60°, wa, Sl, He, Clay -Jo, 30°, Pl, Sl, op+Fi, clay film	@40.5' Driller reports color change to gray + softer Drilling. @~41.0'-back to orange + harder Drilling.
41–42	6:58											-Fa, 20°, St, Sl, Ti+Fi-clay film -Fa, 40°, Pl, Sl, Ti+He, slicks -Jo, 0°, Pl, Sl, op, ox+MnO	
12:50 12:58													
42–43	5:46	8	4.0/4.3	93	0.55/4.3, 13%	SW		R1		SANDSTONE, greywacke, medium-grained, Moderately Sorted, well oxidized sand, Massive, v. few clay stone fragments, moderately hard.		-Jo, 30°, wa, Sl, op, MnO -Jo, 90°, wa, Sl, He, CaCo3 -Jo, 0°, wa, Sl, Ti -Jo, 45°, wa, Sl, op, MnO	@42'~30.5° circ @100 PSI Calcite/dolomite veins
43–44	7:25											-Jo, 0-5°, wa, Sl, op, crushed w/ clay 42cm thick, along bedding? -Jo, 35°, Pl, Sl, Ti crushed zone	
44–45	4:20											-Jo, 90°, wa, Sl, op	

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

Checked JLO 4/24/01

ROCK BORING LOG

Project	Job Number	Date	Boring No.
DCPP ISFSI	1223a-1	23 April 2001	01-C

WLA

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
45										See above (Tofo-2)		-Jo, 0-30°, Wa, SI PP	@45' down to 20.5° circ. @120 PSI
46		8	40/4.3	93	0.55/4.3 13%	SW			R1	- Run #9 slipped out of core barrel. No Recovery		-Jo, 80°, Wa, SI, op, ox + Mn O	@46.35' - Weld broke. Shut down @1:30 PM. Rig up + running @4:44 PM.
4:44 PM 47	No Recovery	5:23	9									- Crushed Zone	
5:08 PM		3:37	10							Same as above		- Mc, 0°, Pl, Sh, op, grooves	
48		3:36		5.0/5.0	104	SW			R2			- Jo, ~80°, Wa, SI, Step-Ti	@47' - 20.5° circ 150 PSI 1800 RPM's
					0.35/5.0							- Jo, ~0°, Wa, SI, Ti	
												- Jo, 30°, Wa, SI, op, ox	
												- Jo, 0°, St, SI, op	
49		4:13			7%					49.2' - gradational		- Jo, 0-30°, Wa, SI, op	
										SANDSTONE, dolomitic, greywacke, fine-grained, well-sorted, slightly oxidized sand. Massive. Moderately hard. 7.5YR 7/3;		- crushed	
												Jo, ~0°+60°, Wa, SI, op	
												- Jo, 70°, Wa, SI, op, CaCO3	
50		5:01				SW			R2			- Jo, 0°, Wa-Pl, SI, op	
												- Jo, 90°, Wa, SI, op, ox, calc	
												- crushed zone	
51		6:20										- Jo, 30°, Wa, SI, op, ox + Mn O calc	@52' lost all circ. @52.5 back to ~15.5°
5:31 5:47 52	No Recovery	4:58										- Jo, ~90°, Wa, SI, op, ox, calc	
53		11:16								contact not recovered	No Recovery		@53' - Driller reports harder drilling. Circ up to 25.5°
54		7:03	11	3.2/5.0	64	SW	Cl-Mo		R2	SANDSTONE, fine-grained to medium grained, greywacke, well sorted, well cemented with dolomitic cement.		Jo, 5-30°, Wa-St, op, ox; Jo, 30°, Pl-St, SI, op, ox and Mn; Jo, 0°, Pl, Wa, SI, op; Jo, 0-30°, St-Wa, Ro, op, ox; Jo, 15-30°, St, SI-Ro, op	@54.5 - Driller reports softer drilling + color change. Running @15.5° circ 80 PSI
55		11:53		1.35/5.0	27%							Jo, 50°, Pl, Ti-op, SI; Ve, 80°, Pl, SI, Fe, dolomite fill; Jo (Be?), Wa-St, Ro, op, 5°	
56		13:23				MW	Vc		R1	SANDSTONE, med. grained, some clay, well sorted		Jo, 5°, Wa, SI-Ro, op; Jo (Be?) 5°, Wa, Ro, op	@55' - Driller reports color back to orange. Hard. @55.5 - Back to grey - Soft
57		4:10								SANDSTONE, fine to medium grained, well sorted, well cemented, greywacke. Open vugs along fractures common.		Jo, 60°, Pl-St, SI, op, ox, Mn	
58		4:36	12	4.9/5.0	98	SW	Cl-Mo		R2			Ve, 60-75°, Wa-Pl, SI, Ti, dolomite fill; Ve, 60°, Pl, SI, Ti-op, dolomite fill; Jo, 50°, Pl-Wa, SI, op; several Ve, 70°, Pl-Wa, SI, Ti/Fi to op; Jo, 15°, St-Wa, SI, op, ox; Jo, 60°, Pl, SI, op, ox	
59		4:21			3.1/5.0 62%							Jo, 30°, Pl-St, op, SI, remnant fill on surface; Jo, 40°, Pl, op, SI	
						SW	Cl-Mo		R2	SANDSTONE, med. grained, well sorted, well cemented,		Ve, 30-90°, Wa, SI, Ti/Fi; Jo, 30°, Pl-Wa, op, SI	
60													

Tofo-2

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Mc-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

ROCK BORING LOG

Project	Job Number	Date	Boring No.
DCPP ISFSI	1223a-1	23 April 2001	01-C

WLA

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
60													
61		N.R 5:12	12	4.9/5.0	98	3.1/5.0 62%	S_w	Cl-M_o	R_2	See Above: SANDSTONE, greywacke, med. grained, well sorted, well cemented. (Tofb-2)		J_o, 60°, Pl, Sm-Sl, Op, Thin Clay along surface Numerous Ve, anastomosing, filled w/ dolomite J_o (Be?) 0°, Pl-St, Sl, Op	Driller reports soft.
62		4:03										J_o, 75°, Pl, Sl, Op, remnant Clay on surface, Crushed Zone (Me) w/ 1mm clay w/ slicks J_o, 60°, Pl-Wa, Sl, Op, Ox/Mn J_o, 0-5°, St, Ro, Op	BOH 5/4/01 50% circulation
63		5:10										J_o, 30°, Pl, Sl, Op J_o, 10°, Pl, Sl, Op, Mn/Ox J_o (Sh?) 60°, Pl, Sl, Ti, Clay and breccia along surface	
64		4:55	13	5.0/5.0	100%	0.5/5.0				highly fractured zone		J_o, 70°, Pl-Wa, Sl, Op Me J_o, 90°, Wa, Sl, Ti-Op J_o, 50°, Wa, Sl, Op	
65		4:30				10%				similar to above, but Grey return to brown sandstone		several J_o, 45°, Pl-Wa, Sl, Op J_o, 70°, Pl-Wa, Sl, Op J_o, 5°, Pl, Sl, Op, soft with 0.25" clay *	
66		5:15					S_w	Cl	R_2			J_o, 10°, St-Wa, Sl, Ti-Op J_o, 60°, St-Wa, Sl, Op J_o, 5°, Pl-St, Sl, Op J_o, 75°, Pl-Wa, Sl, Op, Mn and Ox several Jo in crushed zone	all C-D
67												BOH 67.0' 22:00 23 April 2001	
68													
69													
70													
71													
72													
73													
74													
75													

Tofb-2

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

LOG of ROCK BORING 01-D

Unit calls JGH/CMB/WRK 5/01 Friable Zone calls JGH/JLB 5/4/01

Edited for ISFSI SAR by JLB 5/22/01

Project: DCPP - ISFSI	Job Number: 1223-A-1	Boring Location: Center of ISFSI Pad ~~NW Corner of Pad~~	Total Depth: 68.5'
Type & Diameter of Boring: Triple HQ core ~~Double~~ Barrel Core Barrel (JLB 5/31/01)		Elevation and Datum: ~326' 325.2	Ground Water Depth: N.D.
Drilling Contractor and Rig: Cascade CME 75 - Drillers - Day, Kirk, Shannon; Helpers - Day, Tullio, James	Length of Core Barrel and Bit: 8'-7" (JLB 5/31/01)	No. of Core Boxes: 3	Depth to Bedrock: 0'
Casing Size and Depth: 6" Hollow Stem Auger - Set to 4'	Borehole Inclination: 90°	Logged By: JGH & RDK	Date Started: 17 April 2001
			Date Completed: 18 April 2001

WLA

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
0–4										Augered to 4.0' to Set Casing			
2:18 PM	NR	11:42	CB 1	1.3/3.0	43	0	SW/MW	CI	R1	Sandy DOLOMITE Dolomitic Sandstone: 7.5YR 5/2 reddish yellow low hardness, v.fine-grained MnO coating vertical fractures. Massive, Moderately weathered. (Tofb-1)	NR	Crushed zone (Me); Jo, 40°, St, Sl, Ti; Me, 0°, Pl, Sm, Ti; Me, 0°, Pl, Sl, Ti; Me; Jo, ~90°, Pl, Sl, Ti w/MnO; Me, 0°, Pl, Sm, Ti; Me, 0°, Wa, Sl, Ti; Crushed zone (Me)	2:18PM - Start ~250 psi
		2:25	1										
2:53 PM		5:34											* 3:40 PM to 2:47 water leaking up around auger/casing. Shutdown Rig and Packed Cement around Auger/Casing.
3:35 PM	NR	8:48								Same as above healed @8.6' to ~12' Common Microfractures. - Microfractures are randomly orientated Discontinuous and wavy. None are through entire core. 7.3'-8.5', 9.5'-10.3' slightly coarser grained than above (fine grained) and higher sand content CMB 19 April	NR	Crushed zone (Me); Jo, 30°, Wa, Sl, Slop, Ox; Jo, 20°-30°, Wa, Sl, Ti; Jo, 0-30°, St, Op, VR; Jo°, 0-45°, Wa, Sl, Slop, Ox; Me, 0°, Wa, Sl, Ti, grooves; 3-Zone of Discontinuous Microfractures; Jo, 90°, Wa, Sl, Slop, Ox; Jo, 0°, Wa, Sl, Slop	Run 2 Down feed = 200 PSI
		4:42	2	4.4/5.0 ↓ wet 2.3 *	BB	1.2/5.0 24%	SW	MD	R1				Run 2 * Core slipped out grabbed 2nd 1/3 of Core when re-occupied
		6:40											
		8:02											
		7:23											
4:13 PM													
5:01 PM	NR	10:11	3	0/3	0	X/3 0%				Lost Run #3 Sample Sample Pulled out or Sample was pulverized or Drilled through Sand Stone?	NR	Jo, 30°, Wa, Sl, Ti, Ox; Jo, ~20°, St, VR, Slop, Ox; Jo, 30-60°, Wa-St, VR, Ti, Ox; Jo, 20-45°, St, VR, Slop, Ox; Crushed zone (Me)	- Run 3 - Core slipped out of barrel. NR. We will try to recover Sample.
		7:40											
5.20 PM													- Run 4 - Sampler reoccupied to bottom May have lost Run 3
5:35 PM	NR	?	4	1.65/2.5	66	0	MW		Ro-R1	9'14.85' - SANDSTONE (lense) 0.7' thick - See next Page	NR	Crushed zone, Me	
14–15													

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW -Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type of infilling, slickensides, etc.

RQD = over 4"

Checked JLB 9/17/01

CMB 9/19/01

all B

ROCK BORING LOG

Project	Job Number	Date	Boring No.
DCPP - ISFSI	1223-A-1	18 April 2001	01-D

WLA

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
15		4			0	↑			↑	@14.85-15.55- Sandstone Greywacke, 7.5YR 3/4 low-mod hardness fine-grained well-sorted sand well oxidized sand grains		-Crushed zone, Me -Jo, 30°, St, Sl, Ti, Ox -Jo, 20-30°, St-Wa, Sl, Ti	
16		1:65	1	1.65/2.5	66	0	SW		R1			-Jo, 45-90°, Wa, Sl, Ti -Jo, 0°, Wa, Sl, Ti	
17		11:00	2	1.9/2.0	95	0.35/2.0				@15.55- Sandy Dolomite to Dolomitic Sandstone 7.5YR 5/6, low hardness V. fine-grained, Massive, Moderately weathered.		-Jo, 0-30°, Wa, Sl, Ti -Jo, 90°, Wa, Sl, Ti	@17'- end of run 4 lost Circulation @6:10 PM- added more mud - regained circ
18		6:39	5		17%					(Tofb-1)		-Jo, 0°, St, VR, Ti Jo, 0°, Pl, Sl, Ti, Ox Jo, 0°, Wa, Sl, Ti, Ox -Jo, 70°, Wa-St, Ox + MnO Me, 0°, Wa-Pl, Sl, Ti	@19'- lost circ. end run @21'
19		6:10	6	0.9/3.0	30	0	SW		R1	Slightly weathered dolomite, finer grained than above, very fine grained faint, sub horizontal laminae micro fractures (discontinuous) in bottom 0.3ft.			
20		3:44										Jo, 15°, Sm-Sl, Op, MnO & ox Jo, 45°, St, Sl, Op, MnO	8:17pm
21		5:00											
22		2:54								Sandstone, medium grained much coarser than above massive, sand grains oxidized, Subrounded & well sorted, 7.5YR 7/6 (Tofb-2, Tofb-2a)			Contact Top of Sandstone CMB 19 April 2001
23		2:02	7	1.4/2.5	56	0.4/2.5	MW		RO	Similar to above but below 23.8ft less weathered than above, massive, harder than above.		Me, 70°, Pl, Sl, Op, MnO & ox Jo, 50°, Pl, Sl, He, slight filling Iron clay MnO & ox Jo, 50°, Pl, Sl, He, slight filling Iron clay Jo/MnO & ox	175 down drop pressure 200 psi
24		2:16			16%		SW						
							SW		R1	Sandstone - as above - well Cemented zone + Fractured		crumbly	
25		1:57					SW		RO-R1	Sandstone, less weathered than above, medium grained massive, possibly medium bedded mottled grey & orange (rusty) well sorted, sugary texture 7.5YR 5/4		Jo, 30°, St, VR, Op, MnO & ox Jo, 10°, St, RO, He few healed microfractures	200 downward pressure 200-250 psi
26		3:39	8	2.2/2.5	88	1.1/2.5						Jo, 20°, Pl, Sl, Op, MnO & ox Jo, 0-10°, St, He Jo, 30°, Pl, Sl, Op, MnO & ox	review in AM for bedding
					44%								
27		1:33					SW		R1	Sandstone - as above - well cemented zone - V. Fractured possibly from drilling action		Jo, 30°, St, RO, Op, MnO & ox crumbly	10:05PM, mechanical difficulties w/drilling. Sprocket on pump drive train worn to much chain skipping. Stop for night 10:30 PM.
28		4:46	9	1.5/2.5	62	0.7/2.5	MW		RO	SANDSTONE Greywacke 7.5YR 7/6, medium-grained well sorted sand, well oxidized grains, low hardness, massive. Top 0.7' of run is moderately weathered - grades to slightly weathered at bottom.		-Jo, 35°, Wa-St, Sl, Op -Crushed zone, Me -Jo, 10°, Wa, Sl, Op -Jo, ~10°, Wa, Sl, Op -Me, 0°, Pl, Sl, Ti	4/18/01 Started up at 8:52AM. Re occupied at 27'. Lost no water overnight. Running @ 205 PSI
29		5:04			20%		SW						
30		2:49	10	1.6/2.5	64	0.45/2.5	10%					-Jo, 40°, Pl, Sm, Ti Sheared pieces - crushed No clay - clear fracture surfaces	

Tofb-1 7:01 PM 5:31 PM; 6:52 PM 7:14 PM; 7:21 7:30 PM; Tofb-2a Friable zone; 8:52 AM 4/18/01; 9:04 AM; 9:27 AM; Tofb-2

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

Check CMB 19 April 2001 CM M. RL

ROCK BORING LOG

Project	Job Number	Date	Boring No.
DCPP - ISFSI	1223-A-1	17 April 2001	01-D

WLA

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
30–31	RZ	4:00	10	16/2.5	64	45/25 18%	SW		R1	Same as above Moderate hardness Ro Jsh s/4/0 (Tofo-2, Tofo-2a) @31.2' - Small Calcite Veinlets, ~5mm thick, wavy + discontinuous	-Jo, 0°, Pl, Sl, op -Me(?), 0°, Pl, Sl, Ti -Jo, 0-20°, Wa, Sl, Ti -Jo, 0-90°, Wa, Sl, Ti -Jo, 10°, Wa, Sl, Ti -Me(?) 0°, Pl, Sl, Ti		
31–32		4:37											Run 11 - Trying a 5' run
32–33		4:49	CB2 11	5.0/5.0 + Shoe	100	1.25/5.0 25%	SW		R1	Same as above Ro Jsh s/4/0 well cemented (CMB 19 April 2001)	-Jo, 0°, Wa, Sl, Slop -Me, 0°, Pl, Sl, Ti -Jo, 0°, Wa, Sl, Slop -Jo, 0°, Pl, Sl, op		
33–34		6:04									-Jo, 0°, Wa, Sl, Ti -Jo, 65°, Wa, Sl, Ti-Slop		
34–35		5:18								@34.9 - Calcite Veinlet ~1mm thick, flat lying & continuous across core.	-Jo, 40°, Pl, Sl, Ti -Jo, 10°, Wa, Sl, Ti -Me, 0°, Pl, Sl, Ti -Jo, 30°, Wa, Sl, Ti		
35–36		5:34									-Jo, 80°, Pl, Sl, Ti -Jo, 70°, Wa, Sl, op -Jo, 0°, Wa, Sl, op -Jo, 10°, Wa, Sl, Ti -Jo, 70°, Wa, Sl, op -Crushed zone		
36–37		11:17									-Jo, 80°, Wa, Sl, Ti -Jo, 60°, Wa, Sl, Ti -Crushed zone		@37' - complete loss of circ.
37–38	RZ	4:38		4.0/4.5	88	0.4/4.5 9%	SW		R1	Same as above Massive fine to medium grained, well cemented (CMB 19 April 2001)	-Me, 0°, Wa, Sl, Ti, Rounded top -Jo, 0°, Pl, Sl, Ti -Jo, 20°, Wa, Sl, Ti -Me, 0°, Pl, Sl, Ti, rounded top		Gradual loss of Circ. reported from 100.1° to 50.1° over 5'
38–39		5:35									-Me, 0°, Pl, Sl, Ti, grooves -Jo, 0°, Pl, Sl, Slop -Jo, 30°, Wa, Sl, Ti -Jo, 0°, Pl, Sl, op		
39–40		5:36									-Jo, 0°, Sh, Sl, op -Jo, 45°, Wa, Sl, op -Jo, 80°, Wa, Sl, Slop		
40–41		4:40									-Jo, 45°, Wa, Sl, op -Jo, 0°, Wa, Sl, op -Jo, 0-90°, Wa, Sl, Slop		11:23 AM @~41.5' - Mud hose broke open. Helper went to fill water tank
41–42	RZ	2:50											
42–43	RZ	4:57	13	0.4/1.5	26	0	SW		R1	- Sample slipped out of barrel. Only 0.4' recovered No Joint Survey	-Crushed zone, Me		
43–44	RZ	8:00	14	0/1.0	0.0	0	—		—				@12:33 PM @44' - complete loss of circ.
44–45	RZ	5:00	15	3.7/4	93	0.5/4 12%	SW		R1	Same as above.	-Jo, 90°, Pl, Sl, op -crushed zone, Me		

9:34 AM
10:06 AM
10:44 AM
10:57 AM
11:23 AM
12:05 PM
12:12
12:29
12:31 PM
12:50 PM

Tofo-2a
Tofo-2

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW -Very Wide (>3'), W-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

Check CMB 19 April 2001 CMB

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ROCK BORING LOG

Project	Job Number	Date	Boring No.
DCPP- ISFSI	1223-A-1	18 April 2001	01-D

WLA

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Remarks
45–46		13.25	15	3.7/4.0	93	0.5/4.0 12%	SW		R1	SANDSTONE - as above. Fine grained, well cemented (CMB, 19 April 2001) (Tofb-1/2)	Jo,45°,Wa,Sl,SIOP; Jo,0°,Pl,Sl,OP; Crushed zone; Jo,0°,Wa,Sl,OP; Jo,90°,Pl,Sl,OP, MnO coating; Jo,0°,Wa,Sl,OP	Good Circ. (100%)
46–47											Jo,0-70°,Wa,Sl,Ti; Jo,0-30°,Wa,Sl,OP; Jo,50°,Pl,Sl,OP; Crushed zone; Jo,90°,St,Sl,OP	
47–48											Jo,80°,Wa,Sl,Ti	@48.2' - Weathered out Pebbel in S.S. Matrix.
48–49		3:09	16	4.7/5.0	94	0.75/5.0 15%	SW		R1	SANDSTONE, greywacke. Same as above 7.5YR 7/6, Fine-grained, well sorted Sand, well-oxidized grains, Moderate hardness, Massive. @48.7'-50' Zone of microfractures - Discontinuous - Wavy to Welded - Not through-going core	Jo,50°,Pl,Sl,Fi, 1mm clay Seam; Jo,60°,Wa,Sl,OP; Jo,0°,Wa,VR,OP; Jo,75°,Wa,Sl,OP; Jo,0°,Wa,Sl,OP; Jo,0°,St,VR,OP; Crushed Zone	B-C
49–50		4:43										
50–51		3:20										
51–52		3:05										
52–53		3:35								(Tofb-2)	Jo,40°,Wa,Sl,OP; Jo,45°,St,Sl,OP; Jo,20°,Wa,Sl,OP	
53–54		3:01	CB3	5.0/5.0	100	0.45/5.0 9%	MW		Ro-R1	SANDSTONE - greywacke ~10YR 4/4, Med.-coarse-grained well-sorted Sand, slightly oxidized grains, low hardness, massive "Dirty S.S." @54.5' - ~1mm thick Clay lined Fracture. Dip ~60°	Jo,-20°,Pl,Sl,OP; Jo,0°,Wa,Sl,OP; Jo,0°,St,VR,SIOP; Jo,60°,Wa,Sl,SIOP; Jo,90°,Wa,Sl,Fi,clay film; Jo,0°,Pl,Sl,Ti; Jo,60°,Pl,Sl,Fi,Clay film; Crushed zone w/ clay	Sheared, crushed zone (known-up Joints exist on clay films at 55' Random Orientation) 55'-56' - medium to coarse grained sandstone (CMB 19 April 2001) C
54–55		3:02	17							Crushed-weak zone; Sic Sinks	Jo,0°,Pl,Sl,OP; Jo,30°,Pl,Sl,Ti; Jo,60°,Pl,Sl,Ti;	
55–56		2:29								Flat lying Contact		
56–57		4:46					SW		R1	SANDSTONE, greywacke 7.5YR 6/6, Fine-grained well sorted Sand, well-oxidized Sand grains, Moderate hardness, Massive. (Tofb-1)	Jo,0°,Pl,Sl,Ti; Jo,0°,Wa,Sl,OP; Jo,90°,St,Sl,OP; Me,0°,Wa,Sl,Ti; grooves; Crushed zone; Jo,0-30°,St,Sl,OP; Jo,60°,Wa,Sl,Ti	@56.5' have ~70% circ. B
57–58		4:25										
58–59		2:50	18	3.6/4.0	90	0.1/4.0 20%	SW		R1+	Same as above (Tofb-1/Tofb-2)	Jo,10°,Pl,SM,Ti,OX	
59–60											Jo,0-30°,Wa,Sl,Ti,OX; Jo,0°,St,Sl,Ti,OX	@~60' lost all circ. B-C

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R8-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

Check: CMB 19 April 2001 CLM RL

ROCK BORING LOG

Project	Job Number	Date	Boring No.
DCPP - ISFSI	1223-A-1	18 April 2001	01-D

WLA

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
60													
61	6:54	18	3.6/4	90	0.8/4 20%	SW			R1+	@60.1'-~1cm thick clay seam * - Dip ~35° * (Tofb-1/Tofb-2) fine grained to medium grained sandstone (CMB 19 April 2001)	Jo, 60°, Wa, Sl, Op, Ox CaCO3 Jo, 0°, Wa, Sl, op, Ox Jo, 60°, Wa, Sl, Fi, Clay 1cm. Jo, 0°, Wa, Sl, op, ox Jo, 0°, Wa, Sl, op, ox Jo, 90°, St, Wr, op	@61.0-62.0' Lost 100% circ. Pumped in 175 gal. end of run 18	B-c
62	7:53										Jo, 70°, Wa, Sl, op Jo, 60°, Wa, Sl, op Jo, 90°, Wa, Sl, op, ox		
63	4:26	19	3.4/3.5	97	1.0/3.5 28%	SW			R1	Same as above @63'- Microfracture healed w/MnO (Tofb-2, Tofb-2a)	NR Crushed zone, Me Jo, 65°, Pl, Sl, He, MnO Jo-Me, 0°, Pl, Sl, Ti, grooves Crushed Zone	No water in rod. @63.5' Lost all circ.	C
64	6:02										Jo, 80°, Wa, Sl, He, MnO Jo, 0°, Wa, Sl, op, ox Jo, 90°, Wa, Sl, op, Ox, MnO Jo, 0°, Wa, Sl, op Jo, 0°, Wa, Sl, op	@65' Lost all circ.	
65	2:40												
66	2:53	20	1.8/3.0	60	0.45/3.0 15%	SW			R1		NR		
67	2:45										Jo, 60°, Pl, Sm, Ti, Ox Crushed zone, Me		
68	5:17									@68.3'- goes to low hardness + Moderately weathered	Jo, 60-90°, Wa, Sl, Ti Jo, 0°, Wa, Sl, Ti		
69												End Boring at 68.5' @ 4:15PM - Drillers will Flush out hole for 1 hours. and will start cleanup. I will catchup on my log.	
70													
71													
72													
73													
74													
75													

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

Check CMB 19 April 2001 CMB

01-E/1

Friable zones by JGW/JLB 5/14/01

LOG of ROCK BORING 01-E

Unit calls by JLB/CMB/WRL 5/01
Edited for ISFSI SAR by JLB 5/28/01

Page 1 of 6

Project	Job Number	Boring Location	Total Depth
DCPP ISFSI	12236-1	~~ISFSI Pad NE~~ SE corner of ISFSI Pad JGW 5/31/01	81.0

Type & Diameter of Boring	Elevation and Datum	Ground Water Depth	Depth to Bedrock
HQ Double Barrel Core Barrel	~~339'~~ 337.6'	not measured*	0'

Drilling Contractor and Rig	Length of Core Barrel and Bit	No. of Core Boxes	Date Started
All Terrain Drilling [KOW 06/20/01] Failing 1500 Rig Ron + Chris	5.51 JLB 5/31/01	6	04/19/01

Casing Size and Depth	Borehole Inclination	Logged By	Date Completed
Auger to 3.5', Set casing 6"	90°	KDW	4/20/01

* water and mud injected during drilling.

WLA

Rdg: 3/3 2/3 1/3

Depth (feet) | Log | Drill Rate (min/ft) | Run No. | Recovery/Cut | % Recovery | RQD | Weathering | Fracture Spacing | Strength | Lithologic Description | Discontinuities | Description of Discontinuities | Remarks

Augered to 5.0'

(Tofb-1, Tofb-1a)

Sm-Sh → strong Rock added to run

SANDSTONE well cemented, m-grained dolomitic, good frac

Zone of broken rock

Jo, subhor, Wa, Sl, Ti, no stain

Jo, 40°, St, Sl, Ti, Fe stain

SANDSTONE, highly weathered, banded (color) @ 60°, Fe stained 10YR 5-6/4 to 10YR 4-5/6 dolomitic, good frac

color banding = parallel to underlying theme

SANDSTONE, hard, fine-grained, well cemented, 10YR 6/4 (light brownish yellow), similar to 5.0-10.0' dolomitic, good frac

Some dolomite veining @ 7.7' (to sandy Dolomite, JLB 4/20)

Jo, hor., Wa, Sl, Ti, little to no Fe stain

Jo, 40° to 70°, Sl, Wa, Ti, no stain

faint clay films, no slicks JGW 5/14/01

recovery section 0.7'

As Above, w/ highly weathered zones around some fracture zones

Jo, 10°, Wa, Sl, Ti, no stain

small horizontal breaks

Jo, 60°, Wa, Sl, Ti, Mn stain

@ 12.85' orange clay layer w/ 0.01' thick

Jo, 60°, Wa, Sl, Ti, no stain

fractured zone

between 2.0' and 3.0' grades to gray fg-grained dolomite SANDSTONE 10YR 4/3 (brown

Jo, 50°, zone of broken rock, St, Sl, Ti

Zone of Jo, Ht, 50° no Fe or Mn stain

Jo, 50°, St, Ro, no Fe or Mn stain

Jo, subhor, Wa, Sl, Ti, minor Fe stain

Jo, subvert, Wi, Sl, Ti, Mn stain

Jo, hor. to 10°, St, Sl, Ti, no stain

Jo, 40° to 50°, Wa, Sl, Ti, Fe stain

thin clay coating w/ slicks, JLB 4/20/01

Is a thick Shear zone

1/8" clay streak, 65° (JLB 4/20/01)

Jo, 55°, Wa, Sl, Ti, no stain

Shear zone, many blocks

Jo, 70°, Wa, Sl, Ti, Fe stain

Jo, 50°, wa, Sl, Ti, no stain

Jo, 60°, Wa, Sl, Ti, Fe stain, minor Mn

Jo, vert, Wa, Sl, Ti, Fe stain, minor Mn

Jo, 30°, Wa, Sl, Ti, Fe stain

many breaks / this section came out jumbled

Jo, 10°, Wa, Sl, Ti, no stain

Jo, 10°, Wa, Sl, Ti minor Mn stain

Jo, 70°, Wa, Sl, Ti, Fe + Mn stain

Jo, 10°, Wa, Sl, Ti, little to no Fe stain

Jo, 80°, Wa, Sl, Ti, little Mn stain

Jo, 70°, Wa, Sl, Ti, little staining

Jo, 70°, Wa, Sl, Ti, little Fe stain + Mn, two

Jo x 2, 10°, w/ friable zone between along clay layer; Wa, Sl, Ti, Fe stain

Jo, 70°, Wa, Sl, Ti, Fe + Mn stain

Jo, 10°, Wa, Sl, Ti, Fe stain

Jo x 3, 70°, Wa, Sl, Ti, little to no stain

Jo x 2, subhor, Wa, Sl, Ti, no stain

Jo, 70°, Wa, Sl, Ti, no stain

Jo, subhor., Wa, Sl, Ti, no stain

0.7' worth of sludge (one large rock) fell into hole

Shear zone w/ faint (clay) films, Sl. polished JGW 5/8/01

190 psi

200 psi

100% return

faint clay films, Sl. polished JGW 5/8/01

160 psi

180 psi

220 psi

250 psi

Tofb-1a

Friable Zone JLB 5/14/01

Tofb-1

Friable Zone

Jgw 5/14/01

(color banding)

Blocky-in-matrix filtered dolomite JLB 4/20

Coarse-grained Tofb-1 Dolomite JLB 4/20/01

Fine-grained Tofb-1 Dolomite JLB 4/20/01

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough). Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type of infilling, slickensides, etc.

Checked JLB 4/20/01

.OCK BORING LOG

Project	Job Number	Date	Boring No.
DCPP ISFSI	12223a-1	04/20/01	01-E

WLA

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
15–16		3	4.9/5	98	28% 1.4/5	SW	Wi	R2	S2	SANDSTONE, brown(gray) 1hy2 4/3 fgrained, well cemented, dolomitic (to sandy Dolomite, sub wheb) (Tofb-1)	Jo, lk, 70° x3		
16–17		CB 2								As above Jo, subvert, stver/chip, wa, Sl, Ti no staining; Jo, crstor, St, Sl, Ti, Mn+Fe stain; Jo, lk, 60°; Jo, lk, calcite coating, 80°; Jo, lk, stator., Ti to Op, weath.; Jo, lk, 30° x2; Jo, 40°, Sl, wa, Ti, Mn+Fe staining; Jo, lk, 30°; Jo, lk, 70°	Jo, 80°, wa, Sl, Ti, Fe+Mn stain; Jo, hor, St, Sl, Ti, no stain; Jo, 60°, wa, Sl, Ti, no stain; rebroken up zone; Jo, lk, subhor, Ti to Op, weathered; Jo, lk, stator, Ti to Op, weathered; Jo, lk, 30°, Ti to Op, weathered; Jo, subvert, wa, Sl, Ti, Mn+Fe staining; Jo, lk, 30°; Jo, 70°, wa, Sl, Ti, Mn+Fe stain	200psi	
17–18		4	5/5	100	1.7/5 34%	SW	Mo	R2	S2				A
18–19											Jo, lk, 70°; Jo, 30°, wa, Sl, Ti, Mn+Fe staining; clayey shear above; Jo, lk, 60°; Jo, lk, 30°; Jo, 70°, wa, Sl, Ti, very little Fe stain; Jo, 80°, wa, Sl, Ti, no stain; Jo, 30°, wa, Sl, Ti, Fe stain, thin clay gouge		180psi w/ 90% return	
19–20													
20–21													
21–22										As above but becoming more weathered w/2 very altered zones @21.9' zone ~0.01' thick, clayey silty shear zone, highly altered Fe stained, white to orange, 40°; Jo, lk, 45°; Jo, 40°, lk x2	Jo, 30°, wa, Sl, Ti, Fe+Mn stained; Jo, 40°, St, Sl, Ti, no stain; Jo, 70°, wa, Sl, Ti, Fe stain; Jo, lk, 70°; Jo, 30°, St, Sl, Ti no stain; Jo, 30° lk / Jo, 40°, lk, Fe stain, altered; Jo, 40°, wa, Sl, Ti, no stain; 1/16" clay seam, 45°; Jo, 40°, weak zone — lk Jo?	Clay 1/16" thick Jo w 5/4/01	B
22–23	Altered, Soft Zones	5	4.8/5	96	1.8/5 36%	Sw-Mw	Mo	R1-Ro	S1-S0	Jo, 70°, wa, Sl, Ti, lt lk Fe stain fnc. zone @ bottom ~ 0.03' thick; @22.4 zone ~0.5' thick, clayey silty shear zone, highly altered, sheared, Fe stained, brown to orange bands, 40°; @3.0', ~hor. Jo, St, Sl, Ti, Mn stain; Jo, 60°, wa, Sl, Ti, no stain; Jo, 70°, wa, Sl, Ti, Fe stain; Jo, 70°, lk + rebroke, wa, Sl, Ti; highly fractured 22.7' to 25.7'	Jo, lk, wa, Ti, Sl, no stain; Jo, hor, frac zone on top, wa, Sl, Ti, no stain; Jo, 50°, wa, Sl, Ti, Fe + Mn stained x3; Jo, 50°, wa, Sl, Ti, Fe + Mn staining; Jo, 40°, wa, Sl, Ti, Fe+Mn staining; Jo, 30°, wa, Sl, Ti, no stain; Jo, lk, 70°, rebroke; 1/8" clayey seam, 40°	zone of clay-coated joints, polished @24'	110psi; 120psi w/ 90% return; 180psi	Altered Dolomite Blocky Matrix ?
23–24													
24–25													
25–26											Jo, sub hor, wa, Sl, Ti, no stain		
26–27		6	5/5	100	1.6/5 32%	MW	Mo-Cl	R1	S1	Same as above and very fractured; Jo, 40°, wa, Sl, Ti, no stain; Zone of lk Jo, 70°, fill (calcite?) is weathering out; many lk Jo, most @70°, rebreaking; Jo lk, 70°, fill weathering out; Jo, 40°, wa, Sl, Ti, no stain @ 28.3'-5' discontinuous calcite veins healed fracs?	Jo, 50°, wa, Sl, Ti no stain; Jo, 40°, wa, Sl, Ti, no Fe, Mn staining x2; Jo, 70°, wa, Sl, Ti, Fe stain, minor Mn; Jo, 20°, wa, Sl, Ti, no stain; Jo, 80°, wa, Sl, Ti, rebroke lk Jo; crushed zone sub 5/4/01; Jo, 50°, wa, Sl, Ti, no stain; Jo, 60°, wa, Sl, Ti, major Mn+Fe staining; Jo, 60°, wa, Sl, Ti no stain; Jo, rebreaked, wa, Sl, Ti, Fe stain; Jo, 60°, wa, Sl, Ti, Fe stain	@29'	160psi; 170psi ~90% Return; 170psi; 180psi	A-B; A
27–28													
28–29													
29–30													

Correlative w/ Tofb-1 dolomite, sub wheb.

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW -Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

checked JLB 4/20/01

01-E 13

ROCK BORING LOG

Project	Job Number	Date	Boring No.
DCPP ISFSI	12234-1	04/30/01	01-E

WLA

Columns: Depth (feet) | Log | Drill Rate (min/ft) | Run No. | Recovery/Cut | % Recovery | RQD | Weathering | Fracture Spacing | Strength | Lithologic Description | Discontinuities | Description of Discontinuities | Remarks

Depth (ft)	Drill Rate	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength
30–31	NA	6	5/5	100	32% 1.6/5	MW	Mo-Cl	R1 S1
31–32	NA	CB 3						
32–35.5	NA	7	4/4.5	88	0.5/4.5 11%			
35.5–41		8	5/5.5	91	2.5/5.5 45%			
41–45		9	4.9/5	98	0.8/5 16%	HW / MW / HW / MW	Mo	R0 S0 / S1+ / S0 / S1+

Log column times: 16:12, 16:36, 17:35, 18:10, 21:43, 21:16(?), 23:30, 5:49, 12:50, 23:50, 29:26

Lithologic Description:

SANDSTONE, fg, well to mod. cemented brown gray, highly fractured dolomitic (to Sandy Dolomite, JLB, 4/30/01)

As above — Jo, He, arti

(Tofb-1, Tofb-1a)

@32.1' change to more weathered sandstone; more fractured dolomitic.

Jo, 70°, Wa, Sl, Ti, Fe + Mn stain

Jo, 40°, Wa, Sl, Ti, Fe + Mn stain →

Jo, 30°, Wa, Sl, Ti, Fe + Mn Stains →

Jo, 70°, He →

many Jo, He, 70° becoming Re broken, highly weathered Zone

Same as above
last 1/2' Crushed zone JLB 5/4/01

@36.9–37.5' much Mn stain parallel to fractures

Jo, He, subvert →

@37.3 + 37.6' ~20° brown bands Mn stains

@38.3 to 38.52 – soft, altered zone in SANDSTONE, reducing zone / gray streaking; He Jo @ ~40°

Fe band @ 39.1'

Calcite in veins ~70° banding (Fe Stains) more weathered zone

(clayey BIM matrix JLB 4/30)

Back into block in matrix but includes weathered zone to 41.5' 41.5 to 41.8' dolom. SANDSTONE competent, fgrained
41.8' to 42.4' matrix again – highly weathered fg dolomitic SANDSTONE (clayey BIM matrix) JLB 4/30/01

SANDSTONE, dolomitic, fg, well cemented

Jo, 70°, He →

Description of Discontinuities:

Jo, vert, Wa, Sl, Ti, Fe Stain

Jo, 50°, Wa, Sl, Ti, Fe stained

Jo, He, subvert to 70°, discontinuous calcite veins

Jo, 40° to 30°, Wa, Sl, Ti no stain

Jo, He, 60°

Jo, 60°, Wa, Sl, Ti, Mn stain

Jo, 50°, Wa, Sl, Ti, Mn stain

Jo, 60°, Wa, Sl, Ti, no stain

Jo, 40, Wa, Sl, Ti, no stain x 2

Jo, 30°, Closed (col) Sm surfaces

Jo, subvert, Wa, Sl, Ti, Mn + Fe stains

Jo, 70°, Wa, Sl, Ti, Mn stains

Jo, 70° Wa, Sl, Ti, Mn + Fe Stains

Jo, subvert,

Jo, 70°, Wa, Sl, Ti, no stain

Jo, 60°, Wa, Sl, Ti, no Mn stain, Fe stain

Jo, 30° Wa, Sl, Ti, no staining

Jo, 80°, Op, Absw / silt in places,

Jo, 70°, Fract zone

Me

Zone of slight shearing (DM 5/01) or intense wthg., minor clay films, no slicks; weakly polished surfaces JGH 5/4/01

Zone of many Jo and Jo, He most around 70°, appears Drilling rebroke these He Jo

crushed, altered rock JLB 5/4/01

crushed zone @ block/mtx contact

Jo, 80°, He

Jo, He, 60°

Jo, vert, Wa, Sl, Ti Mn stain

Jo, 40°, Wa, Sl, Ti, Mn + Fe stain

Jo, 60° Wa, Sl, Ti, Mn + Fe stain

Jo, 40°, Wa, Sl, Ti, some Mn

Jo, vert, closed

Jo, 90°, Wa, Sl, Ti, Mn + Fe stained

Jo, 70°, Wa, Sl, Ti, Mn + Fe stained

Jo, 70°, Wa, Sl, Ti, Mn + Fe stained

Remarks:

Tofb-1 (30–39.4'); Tofb-1a (friable) altered zone JLB 5/4/01 (39.4–43'); Tofb-1 (43–45')

Sandstone, dolomitic w/ (clay); Sandstone, dol. Breccia; JLB 4/30/01; Tofb-1, dolomitic; Tofb-1 (JLB 4/30/01); Tofb-1 dolomitic (JLB 4/30/01)

A — 200 psi

35.5'

Refusal / lost circulation @ 36.5' 50-60% return

B — 350 psi; 140 psi

210 psi

5.5' run but only 5' core fits in sleeve

A — 150 psi; 80% recovery

200 psi; 150 psi; 200 psi

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

mtx = matrix
fg = fine grained

Checked JLB 4/30/01

ROCK BORING LOG

Project	Job Number	Date	Boring No.
DCPP ISFSI	1223-1	04/20/01	01-E

WLA

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
45–60		9, 10, 11, 12	4.4/5, 5/5, 5/5, 5/5	98, 100, 100, 100	16%, 0.3/5, 4.7/5, 3.3/5, 3.8/5; 84%, 66%, 76%	MW, MW, SW to MW, MW-Wi, Wi-Mo	Mo, Mo, Wi, Mo, Wi-Mo	R1 S1, R2 S2, R2 S2, R1 S1, R2 S2		dolomitic SANDSTONE fg, well cemented 2.5Y 6/3 (Sandy Dolomite to dolomitic fine grained sstone); SANDSTONE, as above; horizontal to subhor. lams. color bands on bedding? (Tofb-1); @ 49.3 vertical calcite veins; Fe stained bands; As above; V. competent SANDSTONE; @ 54.4 - 55.0' increase in density of ~70° calcite veins; As above to 56.2; @56.2' SANDSTONE becomes more altered, soft, weathered to 57.0'; CB4; CB5	Jo, Hk, 60°; Jo, hor., Wa, Sl, Ti, Mn stained; Jo, 70°, Wa, Sl, Ti, Mn + Fe stained; Jo, vert, Wa, Sl, Ti, Mn + Fe stained; Jo, hor., clean, Me?; Jo, 80°, Wa, Sl, Ti, Mn stain, Me; Jo, 60°, Wa, Sl, Ti, Fe + Mn stained; Jo, subvert, Sl, Wa, Ti, no stain; Jo, horizontal x2, Wa, Sl, Ti, no stain; Jo, He, 40, calcite vein; Jo, He, subvert, parallel to calcite veins (x2); Jo, 70 subvert, Wa, Sl, Ti, rebroken He Jo (parallel to veins); Jo, 50°, Wa, Sl, Ti, Mn stains; brown laminations, subhoriz. Me; Jo, 70°, Wa, Sl, Ti, Fe + Mn stains; Jo, 50°, Wa, Sl, Ti, Fe + Mn stains; Jo, hor., St, Sl, Ti, no stain, fresh; Jo, 80°, Wa, Sl, Ti, Mn + Fe stains; Jo, 10°, He? fresh; Jo, 70°, He + now breaking; Jo, hor., fresh; Jo, 70°, He, calcite veining; Jo, 60°, Wa, Sl, Ti, minor Fe stains; Jo, 70°, He; Jo, He, 70°; Jo, 80°, Wa, Sl, Ti, Fe + Mn stained, base of weathered zone; Jo, He, 45, Fe stained; Jo, 65°, Wa, Sl, Ti, Mn stained; Jo, 10°, Wa, Sl, Ti, not stained; Jo, 10°, St, Sl, Ti, fresh; Jo, 60°, Wa, Sl, Ti, Mn + Fe stained; Jo, 10°, Wa, Sl, Ti, fresh; Jo, partially healed/rebroken, 90-80°, Wa, Sl, Ti, Mn + Fe stained; Jo, He, 50°; Jo, He, 75°	Correlative to Tofb-1 "Dolomitic" Sandstone (Jo & Hole)	180 psi; 180 psi; 200 psi; 200psi; 200psi; 200psi; 150psi; 120psi; 60psi; 180psi	A; A-B; B

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

Checked by JLB 4/26/01

ROCK BORING LOG

Project	Job Number	Date	Boring No.
DCPP ISFSI	1233a-1	04/20/01	01-E

WLA

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
60–75		12; 13; 14; 15	5/5; 5/5; 4.7/5; 4.7/5	100; 100; 94; 98	3.8/5 76%; 4.0/5 80%; 4.5/5 90%; 4.5/5 90%	SI-MW; MW; SW; SW; MW	Mo; Vi; Mo; Mo-Vi; Vi	S2; R1-R2; R2; R2; R1; R1	R6	SANDSTONE, well cemented dolomitic, fg, 10YR 5/4 (yellowish brown) (Tofb-1, Tofb-1a) @61.2' color change from 10YR5/4 to 2.5Y 4/2 (dark grayish brown) @61.8 to 62.2' 10YR5/4 zone No text. changes across the contacts Jo, tk, 30°, Mn stain fine gr. (Dolomitic Sandstone JLB 4/20/01) @63.6' 10° color change to 10YR6/4 (light yellowish brown) @63.7 2 10° to hor. laminar bedding? Pebble zone around Jo, 60° (Dolomite to Dolomitic fine gr. Sandstone; JLB 4/20/01) is Above (Tofb-1, Tofb-1a) (JLB 4/20/01) Tan-brown dolomitic fine gr. SANDSTONE to DOLOMITE Med-grained sand SANDSTONE @70.2 (weakly cemented) to med to cgrained sandstone, more friable, lt. gray brown (like color above) Wa, Sl, Ti, more 2 As/base Coarse-grained SANDSTONE, gray, silty @71.7' darker gray silty nodule - possible burrowed (Tofb-2a)	Jo, Hc, 50°; Jo, 70°, Wa, Sl, Ti, Fe + Mn stain; Jo, 70°, tk; Jo, 10°, Wa, Sl, Ti, no staining, fresh; Jo, subhor, Wa, Sl, Ti, ", fresh; Jo, subhor, tk, Mn stain; Jo, 60°, Wa, Sl, Ti, Fe staining; Jo, 50°, Wa, Sl, Ti, Fe/Mn stain; Jo, 60°, Wa, Sl, Ti, Fe/Mn stain; Jo, tk, subvert, varies, calcite vein; Jo, 50°, Wa, Sl, Ti, Fe + Mn stains; Jo, 60°, Wa, Sl, Ti, Fe + Mn stains (zone 3 pure [illegible] Jo); Jo, 40°, Fe, calcite vein; Jo, tk 70°; Jo, jagged, Sl, Cl, Ti, Mn/Fe stained; Jo, tk, 80° zone, calcite vein; Jo, tk, 70° zone; Jo, 50°, Wa; Jo [illegible] Wa, Sl, Ti [illegible]; Jo, hor., Wa, Cl, Ti, [illegible] stained; (Tofb-1, Tofb-1a); (Tofb-2a); Jo, 70°, Wa, Cl, Ti, no stain; JLB 4/4/01; Jo 30, Wa, Sl, Op, clay films; Jo, tk, 60° Possible striations @ 20°; Jo, 30°, Wa, Cl, Ti, clay films possible striations @ 20°; Jo, 80°, Wa, Cl, Ti, w/ thin clay films, horiz. slicks; Jo, 80°, Wa, Cl, Ti, w/ clean hor. slicks; Jo, 70°, Wa, Cl, Ti, w/ some clay films	Tofb-1 "Dolomite" and fine gr. dol. ss.; Top of Transition Zone (?) JLB 4/20/01; Transition Zone JLB 4/20/01; @66; @69'; Bottom of Transition Zone (?) in 20% return JLB 4/20/01; Tofb-2 Sandstone	200 psi; 100 psi; 100 psi; 180 psi; 180 psi; 180 psi; 270 psi; 270 psi; 180°; 180°; 180 psi; B; D

Tofb-1; Tofb-1a; Tofb-2a; Friable Zone JLB 4/4/01

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW -Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

checked JLB 4/20/01

01-E 16

ROCK BORING LOG

Project	Job Number	Date	Boring No.
DCPP ISFSI	1223a-1	04/20/01	01-E

WLA

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
75		15	4.4/5	98	4.4/5 88%		Wi		R1	gray cg SANDSTONE (Tofb-2a) As Above		Jo, 70°, Wa, Cl, Ti, no skin, minor clay; Jo, 60°, He; Jo, 70°, He	Tofb-2 Sandstone; 150 psi
76												Jo, He, 60°, thin clay seam 1/16"; Jo, He, 70°; Jo, 70°, St, Sl, Fi, clay filled; Jo, He, 60°; Jo, Hor., Me; Jo, He, 80°	
77													
78		16	4.7/5	99	4.4/5 88%	MW	Wi		R1				
79													150
80										@80.5' bedding sub hor. missing 0.3'		Jo, 70°, Wa, Cl, Ti, clay films w/ subhor. slickenlines; Jo, 30°, Wa, Cl, Ti, no clay, no skin; Jo, 70°, Wa, Cl, Calcite crystals on surface, Me	150
81													TD 81'
82													
83													
84													
85													
86													
87													
88													
89													
90													

Tofb-2a friable zone JGW 9/4/01

Tofb-2a

all D

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

04/20/01

Checked JCB 4/20/01

01-F/1

Fracture zone calls by JGH/JLB 5/2/01

LOG of ROCK BORING 01-F

Unit calls by JLB/CMB/WAL 5/01

Edited for ISFSI SAR by JLB 5/28/01

Project: DCPP ISFSI	Job Number: 1223x-1	Boring Location: ~~Borrow Pit~~ South of ISFSI Pad JGH 4/31/01	Total Depth: 130.5
Type & Diameter of Boring: HQ core double barrel core barrel		Elevation and Datum: ~~39.5'~~ ft	Ground Water Depth: ~~6.5'~~ N.D.	Depth to Bedrock: 0'
Drilling Contractor and Rig: All Terrain Drilling Failing 1500 Rig (Ron + Chris (new 05/20/01))		Length of Core Barrel and Bit: 5.5' 390.6 JLB 4/31/01	No. of Core Boxes: 9	Date Started: 04/21/01
Casing Size and Depth: 2' casing to 6"	Borehole Inclination: 90°	Logged By: KOW		Date Completed: 4/23/01

WLA

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
0–4										Augered to 4'		(to South Dolomite 4'-7'±; fine-gr. dol. substrate below 7'± JLB 4/30/01)	Note: 7:30 AM On 4/23/01 driller noted artesian water flowing from hole to surface. It had rained during the night. Also observed by WD Page @ 7:45 AM. as about 4 gpm that ceased by about 8 AM
4–5.5		0 / 9:15 / 9:53	CB 1 / 1	1.3/1.5	86	0.0/1.5 0%	SW	Mo	R2 S2	dolomitic SANDSTONE, 10YR 6/4, (light yellowish brown) fine grained, well cemented, well sorted Jo, Wa, Sl, Ti, minor Mn stain; highly fractured zone 5.5 to 6.5' Same as above w/ bedding / laminae low to 10° dip Jo, St, Ro, Fe stains Jo, vert, Ro, Ti, no Fe stains	Jo, 70°, Wa, Sl, Ti, very little Fe stain Jo, wavy, Me Me Jo, 55°, Wa, Sl, Ti, Mn stain Jo, undul, Wa, Sl, Ti, Fe stain, water Jo, hor, R2, Wa, Sl, Ti, no stains, some Mn stain ← fractured zone Jo, 40°, Wa, Sl, Ti, Mn & Fe stains (< 1/16") Jo, 40°, Wa, Sl, Ti, Mn & Fe stains Jo, hor, Wa, Sl, Ti, Mn & Fe stains Jo, 20-30°, Wa, Sl, Ti, no stains Jo, Me, Wa, Sl, Ti, no stains, 1/16" clay film Jo, 15°, 55°	Refusal @ 5.5' @ ~6.5' Ground water (perched zone?) out of H2O / Poured @ ~10:30 am 120 psi	220 psi A
5.5–7.5		M	2	4.9/5.3	92	1.8/5.3 34%	SW	Mo to Cl	R2 S2	(Tofb-1)	Jo, 30°, Wa, Sl, Ti, Mn & Fe stain Jo, 40°, Wa, Sl, Ti, Mn & Fe stain Jo, 40°, Wa, Sl, Ti, no stain Jo, 40°, Wa, Sl, Ti, no stain Jo, 60°, Wa, Sl, Ti, no stain Jo, 60°, Wa, Sl, Ti, Mn & Fe stain		losing H_2O @ 7' 140 psi A-B
7.5–10										Clayey (JLB 4/30/01) @ 10.1' SANDSTONE is more weathered & softer, altered	Jo, very irregular, Sl, Ro, Ti, no stain Jo, 20°, Wa, Sl, Ti, no stain	(Correlation to Tofb-1 JLB 4/30/01)	L
10–11							HW HW		R1 S1	missing 0.7' section	← sandy, clayey zone JLB 5/4/01		
11–12.5		M	3	2.6/3.3	79	0/3.3 0%	SW	Cl	R2 S2	well cemented dolomitic SANDSTONE (as @ 4-5'), fine grained, clayey zones, @ 12.2 to 13.0' graded to moderately weathered SANDSTONE	Jo, 70-80°, Wa, Sl, < 1/16" clay film Me Me Rubble zone, few discernable surfaces		
12.5–13.5							HW		R1 S1	very highly fractured zone, Jo do not come apart as separate surfaces	Jo, 10° Jo, 40°, Pl, Sm, 1/16" clay film Jo, 10° Jo, 10° ← crushed zone JLB 5/4/01 < 1/16" clay film		Mo-highly weath., clayey, silty rock zone w/ harder rock fragments
13.5–15		NA	4	2.3/3	77	0.0/3 0%	HW SW	Cl	R0-R2 S1-S2	As above Jo, 50-80°, Wa, Cl, Ti, Fe + Mn stained	Jo, 60°, Wa, Ro, Ti?, no stains Jo, 60°, Wa, Cl, Ti, no stain Jo, 60°, Wa, Cl, Ti, no stain Jo, 30°, Ile		

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3') and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type of infilling, slickensides, etc.

Checked JLB 4/4/01

ROCK BORING LOG

Project	Job Number	Date	Boring No.
DCPP ISFSI	1223a-1	04/21/01 - 04/22/01	01-f

WLA

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
15–22 (Tofb-1)													
15–16	NA	4	2.3/3	77	0.0/3 0%	mw-SW	CI	R1-R2		highly fractured dolomitic SANDSTONE, block are well cemented but are weathering along their edges. V well fractured areas are more heavily weathered. Zone of highly fractured and weathered rock.		highly fractured + weathered zone; Jo, 30°, Wa, Sl, Ti, no stain; Jo, 60°, Wa, Sl, Ti, no stain; Jo, 80°, Wa, Sl, Ti, no stain; Jo, 60°, Wa, Sl, Ti, no stain; Jo, 20°, Wa, Sl, Ti, no stain; fractured clayey zone	A-B; JLB 4
16–17	CB 2 NA	5	0.8/1	90	0.0/1 0%	SW	VC?	R1		cavied, blocky SANDSTONE as above. No intact core		no distinct surface to log	
17–18	NA	6	1.1/2	55	0.0/2 0%	SW	VC?	R2		as above, blocky, little intact core / lost 0.9' of core (Tofb-1)		? (from 0.2' long 1/2 core piece) Jo, 70°, Wa, Sl, can't determine Ti, Mn and Fe staining; ? Jo, 80°, Wa, Sl, can't determine Ti, Mn and Fe stained	A
18–19	12:17 12:22	7	0.2/1	20	0.0/1 0%	SW	VC?	R2		blocks of SANDSTONE as above / repeated angles could not be READ as reamed. Jo, 30°, Wa, Sl, Fe + Mn stained		Jo locations unknown; Jo, 70°, Wa, Cl, Fe + Mn stained; Jo, 10°, Wa, Cl, Fe + Mn stained; Jo, 10°, Smooth, Cl, Fe + Mn stained	
19–20	NA	8	>1/1	100	0.0/1 0%	SW	VC?	R2		blocks of SANDSTONE, as above. Jo, Vert, Sl, Ro, Fe + Mn stained; Jo, 10°, Wa, Ro, Fe + Mn stained; Jo, Vert, Wa, Sl, Fe + Mn stained		Jo, Vert, Wa, Cl, Mn stained; Jo, 50°, Wa, Cl, Mn stained; Jo, 30°, Wa, Cl, Mn and Fe stained; Jo, 10°, Wa, Cl, Mn and Fe stained	No Return 80 psi; Hole keeps caving; having difficult time advancing; adding bentonite to try to plug hole / will flush later. 2pm - Rods still going through blocky zone
20–21										No Recovery			
21–22	NA	8								No Recovery		Repeatedly lost hole during drilling with complete water loss and occassional bit blockage. Decided to grout hole through this zone and recore the following day. JLB 4/22/01	
22–23										No Recovery			
23–24										No Recovery			
24–25										No Recovery			
25–26										No Recovery			
26–27										No Recovery			
27–28	NA									No Recovery			
28–29	8:32									No Recovery		JLB 4/22/01 Clayey crushed rock mixed w/ harder rock frags.	@27.0' @ 2:30pm all previous runs after 22.0' came up empty. 100 Gal. cement used to grout hole. - Drilled through it 4/22/01 @22.0' we lost all circulation - probably into blocks Rod couldn't get out yesterday.
29–30	NA	9	0.5'/2	25	0.0/2 0%	SW	C?	R2		SANDSTONE, fine grained, well cemented, dolomitic 2.5Y 7/4 (pale yellow)		last 1.5' of 2' - some joints hold but location unknown; Jo, red, Wa, Sl, Ti, Mn + Fe stains; Jo, 80°, Wa, Sl, Ti, Mn + Fe stains; Jo, 0°, Wa, Sl, Ti, Mn + Fe stains	A-B; @28.0' @ 8:30a 1 psi; @29.0' 1 psi

Correlative with Tofb-1 Jo 4/1/01

← Thin runs may all be slough →

Gap w/ no recov.

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

Checked JLB 4/22/01

ROCK BORING LOG

Project	Job Number	Date	Boring No.
DCPP - ISFSI	1223a-1	04/22/01	01f

WLA

Depth (feet) | Log | Drill Rate (min/ft) | Run No. | Recovery/Cut | % Recovery | RQD | Weathering | Fracture Spacing | Strength | Lithologic Description | Discontinuities | Description of Discontinuities | Remarks

30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45

Tofb-1 | Tofb-1a friable (clay zone) | Tofb-1 | Tofb-1a friable | Tofb-1 | Tofb-1a friable (clay zone)

Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength
9	0.5/2	25	0.0/1 0%	SW	C1?	R1-R2
10	3.8/3.5	109	0.0/3.5 0%	SW-MW	C1	R1-R2
11	2.4/3.5	69	0.0/3.5 0%	MW	VC	R1-R2
CB3 12	3.0/3	100	0.0/3 0%	SW	C1-VC	R2
13	4.8/5	96	1.4/5 28%	SW	Mo	R2
				Hw	C1	R1-R0
				SW	Mo	R2

Lithologic Description:

SANDSTONE, fine grained, well cemented, dolomitic, 2.5Y 7/4 (pale yellow) (to sandy, clayey Dolomite: JLB 4/22/01)

as above w/ Fe oxide staining

Jo, 20°, wk, Sl, Ti, no stain

(Tofb-1, Tofb-1a)

Jo, 60°, wk, Sl, Ti, no stain

Jo, 60°, Wa, Sl, Ti, no stain — clayey zone — grades after, clayier (JLB 4/22/01)

Jo, 40-60°, Wa, Sl, Ti, no stain

as above — lost 0.6' Section

Dolomitic fine-grained

@35.5' SANDSTONE has pockets + zones of higher alteration along fracture zone S, clayey

Jo, subvert, Wa, Sl, Ti, little Fe stain

very fractured black, soft

grade weather

clayey zone

fine grained, well sorted, well cemented SANDSTONE, highly fractured but not very altered

Jo, partially He, vert., Ti, Sl, Wa, Fe + Mn stain

Jo, subvert, He x 2

Dolomitic fine-grained SANDSTONE as above

Jo, He, 30°

Jo, He 80° x 2

Jo, He 30° to vert. x 2

@42.8' thin dark layer w/ some clay bedding? subhorizontal (Probable not bedding, JLB 4/22/01)

@43.8 - 44.35' highly fractured, highly altered zone with clay and Fe staining

clayey zone

Discontinuities:

Jo, vert, Wa, Sl, Ti, Mn + Fe stains

Jo, 80°, Wa, Sl, Ti, Mn + Fe stains

Jo, 40°, Wa, Sl, Ti, Mn + Fe stains

locations unknown

Jo, 60°, Wa, Sl, Ti, Fe stains

Jo, vert, Wa, Sl, Ti, Fe + Mn stains

Jo, 70°, Wa, Sl, Ti, Fe + Mn stains

Jo, 60°, Wa, Sl, Ti, slightly Fe stained

Jo, 60°, Wa, Sl, Ti, Fe + Mn stained

Jo, 70°, Wa, Ro, Ti, little Fe stain, zone ~0.05' wide

Jo, 70°, Wa, Sl, Ti, no stain

Jo, 20°, Wa, Sl, Ti, minor Fe

Jo, 70°, Wa, Sl, Ti, Fe stains

Jo, 50°, Wa, Sl, Ti, minor Fe stains

Jo, 50°, Wa, Sl, Ti, minor Fe stains

Me x 2 — Rubbly zone

Jo, 40°, Wa, Sl, Ti, Fe stained

Jo, 60°, Wa, Sl, Ti, Fe stained

Jo, 70°, Wa, Sl, Ti, Fe stained

Zone hor. Jo, Fe stain

Jo, 30°, Wa, Sl, Ti, little Fe stain

Jo, vert, Jo, Ro, Ti, no stain

Jo, 70°, Wa, Sl, Ti, little Fe stain

Jo, 50°, Wa, Sl, Ti, no stain

blocky, rubble zone, little staining

Jo, 30°, Wa, Sl, Ti, slightly Mn + Fe stained

Jo, 70°, Wa, Sl, Ti, Mn + Fe stained

Jo, 40°, Wa, Sl, Ti, no stain

Jo, 40°, Wa, Sl, Ti, no stain

Jo, 40°, Wa, Sl, Ti, little Mn stain

Jo, 60°, Wa, Sl, Ti, no stain

Jo, 60°, Wa, Sl, Ti, Fe stain

Jo, 40°, Wa, Sl, Ti, Mn + Fe stained, top of highly fractured zone

Jo, hor, Wa, Sl, Ti, no stain, bottom of frac. zone

Jo, hor, Wa, Sl, Op to Ti, no stain

Jo, 30°, Wa, Sl, Op to Ti, no stain

Me

Jo, 30 to 70°, Wa, Sl, Ti, Mn stain

Jo, Pl to Wa, Sl, Ti, Mn stain

Jo, Wa, Sl, Ti, no stain

Jo, hor, Wa, Sl, Ti, no stain x2

Jo, non-per, Wa, Sl, Ti, Mn stain

clayey frac. zone

Jo, vert, Wa, Sl, Ti, Fe + Mn stain

Jo, 80, Wa, Sl, Ti, Fe + Mn stained

Remarks:

Angles could be (90 - x) where x is reported on the left

No Return of H_2O

@32' 100 psi

@33' 120 psi

@34' 120 psi

Refusal @ 34.5'

@35.5' 120 psi

@36.5' 120 psi

@37.5' 120 psi

Refusal @ 37.5'

120 psi

120 psi

150 psi

Refusal @ 41.0'

120 psi

120 psi

@44' 120 psi

120 psi

all A-B

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

Checked JLB 4/22/01

.035
1'
26'

ROCK BORING LOG

Project	Job Number	Date	Boring No.
DCPP ISFSI	12234-1	04/22/01	01-F

WLA

Depth (feet) | Log | Drill Rate (min/ft) | Run No. | Recovery/Cut | % Recovery | RQD | Weathering | Fracture Spacing | Strength | (Tofb-1, Tofb-1a) Lithologic Description | Discontinuities | Description of Discontinuities | Remarks

Tofb-1 friable (alt.) zone JLB 5/4/01

Tofb-1a

color bands

Tofb-1

Tofb-2

Tofb-2a friable zone JLB 5/4/01

No Recovery

CB4

Lithologic Description (excerpts):

SANDSTONE, olive-brn, fg, well cemented 2.5Y 7/4 (pale yellow) (Fine gr. Dolomitic SANDSTONE to Sandy Dolomite, JLB 4/24/01) clayey missing 0.1'

Same as above

@46.6' - zone of highly altered material, clay in fracture zone

crushed rock zones

highly fractured rock w/ rocky 46.8 - 47.7'

@47.7' bedding ? Fe-stained to ends ~10°

highly fractured zone (rocky) @48.0 to 48.6'

(Tofb-1, Tofb-1a)

fine grained Dolomitic SANDSTONE as above

fine gr. Dolomitic SANDSTONE as above

fract. zone 51.8 - 52.4

@~52.3 coarsening to fine to medium grained sands, well cemented

Fe stains along lk fractures

grading coarser-grained

Last 2.2' core

dolomitic SANDSTONE, as above fine to medium grained, well cemented

(Tofb-2, Tofb-2a) possible

@57.5' clayey zone 'bedding' 5-15° to 59.7'

possibly bedding (subhorizontal) JLB 5/4/01

clayier lense

possibly bedding

@59.9 2 Fe stains 5°+10° to not look like HeJo

Discontinuities (excerpts):

Jo, 80°, Wa, Sl, Ti, Fe + Mn stains

Jo, 45°, Pl lowk, Sl, Ti, Fe + Mn stains

Jo, 60°, Wa, Sl, Mn stains

Jo, hor x2, Wa, Sl, Ti, band clayey fracture zone

Jo, 70°, Wa, Sl, Ti, Fe + Mn stain

Jo, 70°, Wa, Sl, Ti, Mn stain + Fe

Jo, 30°, Wa, Sl, Ti, Mn + Fe stain

Jo, 40°, Wa, Sl, Ti, Mn + Fe stained fractured zone

Jo, 60° Wa, Sl, Ti, Mn + Fe stains

Jo, 50°, Wa

Jo, 60°, Wa, Sl, Ti, Fe stained, minor Mn

Jo, 20°, Wa, Sl, Ti, Fe + Mn stained

Jo, 70°, Wa, Sl, Ti, no stain

Jo, 30°, Wa, Sl, Ti, no stain

Jo, 40°, Wa, Sl, Ti, Fe stain, loo

Jo, 50°, Wa, Sl, Ti, no stain, bottom of fract. zone

Jo, Subvert, Wa, Sl Ti, no stain

Jo, 40°, Wa, Sl, Ti, Mn + Fe stains

Jo, 70°, Wa, Sl, Ti, Mn + Fe stains

Jo, 30°, Wa, Sl, Ti, Fe stain

Jo, 60°, Wa, Sl, Ti, Fe + Mn stain

Jo, irreg, subhor, Sl, Ro, op to Ti no stain

Jo, He, 30°

Jo, He, sub hor.

Jo, He, 30°

Jo, He, 40-10°

Jo, He, 40°

Jo, Wa, Sl, 30° Fe stained, bottom of core run

Jo, 30°, Wa, Sl, Ti, no Fe stains

Jo, hor, Wa, Sl, Ti, no stain

Same

Be(?) 5-15°, fissile seam

Jo, <10°, Wa, Sl, Ti, no stain

Jo, He, 20° Fe stained

Jo, He, subvert. Clay films

Jo, Sl, Ro, Ti, Fe stains w/ slicks

Jo, 10°, Wa, Sl, Ti, some Fe stain on lowest two Jo

Jo, He, subvert

Jo, 70°, Wa, Sl, Ti, no stain

Remarks:

@47' 100 psi

150

@49' 150 psi

Jo, 85-90°, Wa, Sl, op

@50' 220 psi

@51' 220 psi

@52 140 psi

@53' 180

@54' 200 psi

@55' 200 psi

@56' 200 psi

Tofb-1

Tofb-2

@57' 180 psi

@58' 180 psi

@59' 160 psi JLB 5/4/01

@60' 160 psi

A-B, B, C

~15' possible top of transition zone

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW -Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

Checked JLB 4/22/01

ROCK BORING LOG

Project	Job Number	Date	Boring No.
DCPP ISFSI	12230-1	04/27/01	01-F

WLA

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
60–66	Tofb-2	16	4.9/5	98	68/5 36%	SW	Mo	S2		dolomitic SANDSTONE, fine to medium grained, well cemented 2.5Y 6/4 (light yellow brown)	Jo, vert, Sl, Ro, no stain; Jo, 30°, Wa, Sl, Ti, Fe stain	gradational contact. Med.-grained Dolomitic SANDSTONE	
61–66		17	5.0/5	100	2.3/5 46%	SW	Cl	S2		dolomitic SANDSTONE, medium grained, well cemented; between 66.7 and 63' faint bands (bedding) come out as core dries (Tofb-1)	Jo, 80°, Wa, Sl, Fe + Mn stained; Jo, subhor, Wa, Sl, little Fe stain; Jo, 60°, Wa, Sl, Ti, Fe + Mn stained; Jo, 40°, Wa, Sl, Ti, Fe stained; Jo, He, 70°, calcite veined; Jo, vert, Wa, Cl, Ti, Mn stained; Jo, 10°-80°, Wa, Cl, Ti, little Fe; Jo, He, 70°-80°, calcite + Mn lined; Jo, 70°, Wa, Sl, Ti, Fe stained, clay films JGH 4/4/01; Jo, 50 to 70°, He; Jo, 50°, Wa, Sl, Ti, Fe + Mn stained, clay films JGH 4/4/01	bedding? thin subvertic. laminations JGB 4/30/01	80 psi; @63' 80 psi; 4/4/01 @64' 60 psi; @65' 80 psi
66–67			CBS							fine grained Dolomitic SANDSTONE to Dolomite, well cemented, few lithics, calcite veining; dolomitic SANDSTONE, fine to medium grained as directly above	Jo, 70°, Wa, Sl, Ti, Mn + Fe stained; Jo, vert., Wa, Sl, Mn stained; Jo (x2), 70°, Wa, Sl, Ti, Mn + Fe stained; Jo, 60°, Wa, Sl, Ti, Fe + Mn stained; Jo (x2), He, subvert, calcite veined	Closely fractured JGB 4/30/01	@67' 80 psi
67–72	Tofb-1	18	5/5	100	0.3/5 10%	SW	Cl to VC	S2		highly fractured zones (Tofb-2); highly fractured zone; fractured (Jo w/ calcite veining); many fractures	Jo, hor, Wa, Sl, Ti, fresh stain; Jo, vert, Wa, Sl, Ti, Mn and Fe stained; Jo, 60°, Wa, Sl, Ti, Mn + Fe stained; Jo, 50 + 60°, Wa, Sl, Ti, Mn + Fe stained; Jo, 30°, Wa, Sl, Ti, Mn + Fe stained x2; Jo, 70°, Wa, Cl, Ti, Mn + Fe stained; Jo, 30°, Wa, Cl, Ti, Mn + Fe stained; Jo, 60°, Wa, Cl, Ti, Mn + Fe stained; Jo, hor, Wa, Cl, Ti, no stain, fresh; Jo, 70°, Wa, Cl, Ti, Mn + Fe stains; Jo, 40°, Wa, Cl, Ti, Fe stains, calcite crystals; Jo, hor, Wa, Cl, Ti, no stain; Jo, 80° (weathered), Wa, Cl, Ti, Fe + Mn stain; Jo, 60°, Wa, Cl, Ti, Mn stain	Decrease in Drill Rate; @68' 180 psi; @69' 100 psi; @70' 140 psi; @71' 160 psi; @72' 100 psi	
72–75	Tofb-2	19	4.4/5	BB	1.3/5 26%	SW	Mo	S2		gradational contact; Dolomitic fine to medium grained SANDSTONE, well sorted, soft weathered shale-claystone clasts (graywacke), well cemented; many fractures	Jo, 80° (weathered), Wa, Cl, Ti, Fe + Mn stain; Jo, 60°, Wa, Cl, Ti, Mn stain; Jo, 80° vert, Wa, Cl, Ti, little Mn stain; Jo, hor, St, Ro, Ti, no stain; Jo, 60°, Wa, Sl, Ti, little Fe + Mn stain; Jo, 40°, Wa, Sl, Ti, no staining; Jo, 20°, Wa, Cl, Ti, no staining; Jo, 30°, Wa, Cl, Ti, Fe staining; Jo, 60°, Wa, Cl, Ti, little Fe stain; Jo, 30°, Wa, Cl, Ti, little Fe + Mn stain; Jo, 70°-80°, Wa, Cl, Ti, little Fe stain	@72' 100 psi; @73' 140 psi; @74' 140 psi; @75' 140	

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

Checked JGB 4/30/01

ROCK BORING LOG

Project	Job Number	Date	Boring No.
DCPP ISFSI	12234-1	04/22/01	01-F

WLA

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
75–76		19	4.1/5	88	4.3/5 26%	SW	CI	S2		dolomitic SANDSTONE, fine to medium-grained, well cemented 10YR6/6 (brownish yellow)		Jo, 20°, Wa, Sl, Ti, no stain, fresh; Jo, 50°, Wa, Sl, little Fe stain	
76–77										as above; zone of intense fracturing; grades finer-grained		Jo, 40°, St, Sl, Ti, little Fe; Jo, 85°, Wa, Sl, Ti, little Fe; Jo, 70°, Wa, Sl, Ti, little Fe, Mn stain	@77' 150psi
77–78												Jo, 40°, Wa, Sl, Ti, no staining; Jo, vert, Wa, Sl, Ti, little Fe	@78' 110psi
78–79		20	5/5	100	4.9/5 38%	SW	Mo	S2		gradational contact; fine grained Dolomitic SANDSTONE to DOLOMITE, well cemented JLB 4/22/01; coarsening		crushed joint JLB 5/4/01; Jo, He, 70°	@79' 180psi
79–80												Jo, 50°, Wa, Sl, Ti, Fe + Mn staining; Jo, vert, Wa, Sl, Ti, Fe + Mn staining; Jo, 20°, Wa, Sl, Ti, Fe + Mn staining	
80–81		ND								@80.8' brown banding in horizontal Bedding?		Jo, He, 60°; Jo, 10-20°, Wa, Sl, Ti, little Fe stain; Jo, 56°, Wa, Sl, Ti, Mn + Fe staining	
81–82		ND	COC							as above, but with more calcite veining and more fracturing		Jo, 50°, Wa, Sl, Ti, little Fe stain	@82' 160psi
82–83		1:15	21	5.0/5.0	100	0.0/4.6 0%	SW	CI-VC	S2	fracture zone		Jo, 55°, Wa, Sl, Ti, Fe stain; Jo, 50°, He, calcite veins; Jo, vert to 70°, Wa, Sl, Ti, Fe + Mn stains	@83' 160psi
83–84										Riedel fractures		Jo, 70°, Wa, Sl, Ti, Fe + Mn stains; Jo, 70°, Wa, Sl, Ti, Fe + Mn stains crushed bond JLB 5/4/01	@84' 160psi
84–85												Jo, 40°, Wa, Sl, Ti, Fe + Mn stains; Jo, 10°, Wa, Sl, Ti, little Fe staining; Jo, 80°, Wa, Sl, Ti, Fe + Mn staining	@85' 180psi
85–86		ND								No stratigraphic boundary JLB 4/22/01; fine to medium-grained dolomitic SANDSTONE well cemented (hard) Same color as above		Jo, 55°, Wa, Sl, Ti, Fe staining; Jo, 70°, Wa, Sl, Fe + Mn staining; Jo, rusher, Wa, Sl, Fe + Mn staining	Dolomite-filled fractures JLB 4/22/01
86–87		6:12 pm										Jo, 80°, Wa, Sl, Fe + Mn staining; Jo, 60°, Wa, Sl, Fe + Mn staining; Jo, 60°, Wa, Sl, calcite crystals	
87–88		6:22 pm	4.8/5	96	4.4/5 8%	SW	CI-VC	S2		Fine gr. Dolomitic SANDSTONE to DOLOMITE, well cemented, numerous dolomite-filled fractures JLB 4/22/01		Jo, 70, Wa, Ra, Op, large calcite XTLs; Jo, subvert, Wa, Sl, Ti, Mn stain; Jo, 60°, Wa, Sl, Ti, Mn + Fe stain; Jo, He, 60°	@88.0' 220psi
88–89		6:32 pm	22									Jo, 10°, Wa, Sl, Ti, no stain; Jo, 30°, Wa, Sl, Ti, Mn stain	@89' 150psi
89–90		9:20								same as above		Jo, 20°, Wa, Sl, Ti; Jo, 70°, Wa, Sl, Ti, Mn + Fe stain	

Toft6-2 / Toft6-1 / Toft6-2

Transition zone unit Toft6-1 (?) JLB 4/22/01

C / B / C

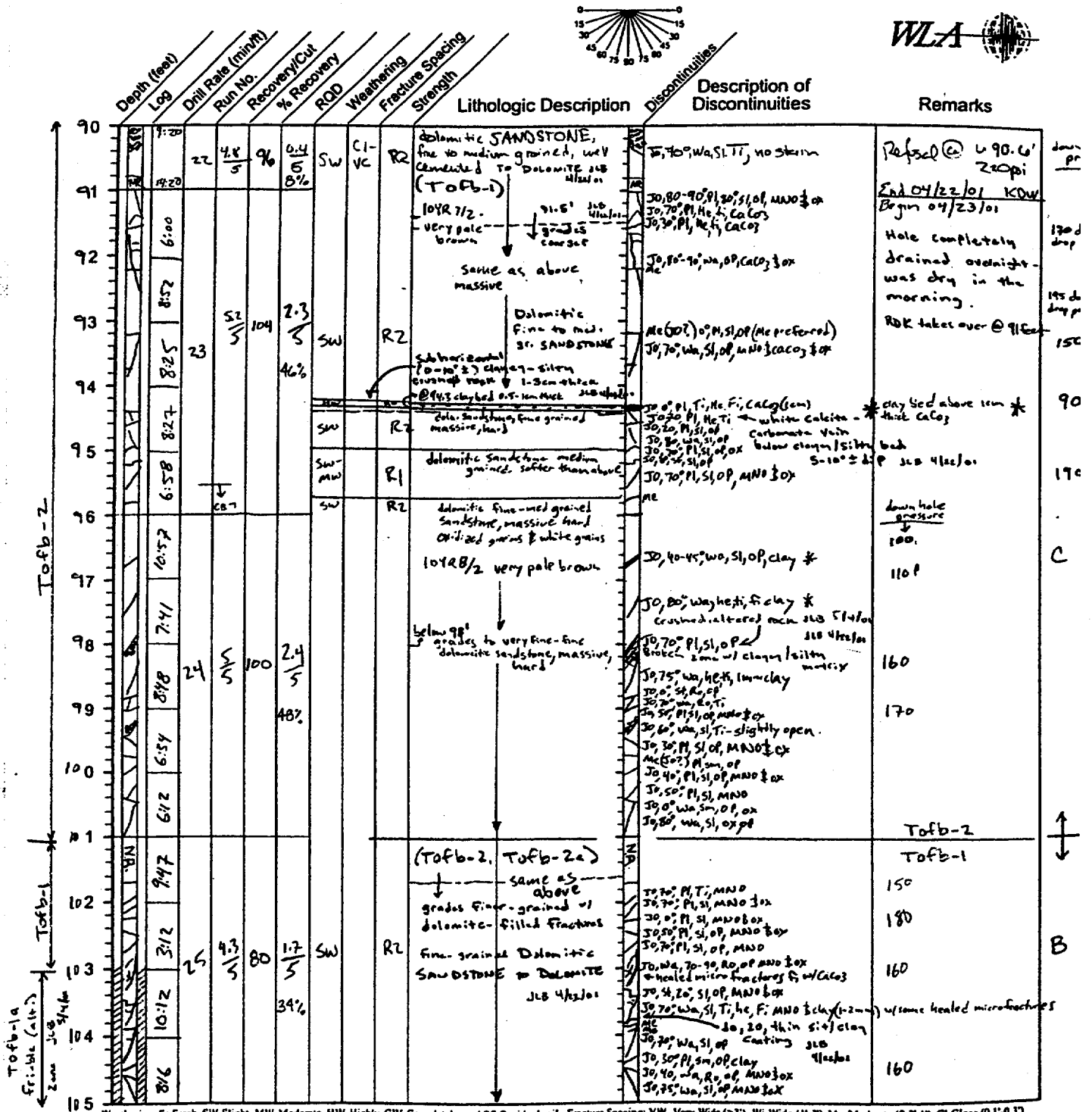
Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), CI-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

Checked JLB 4/22/01

ROCK BORING LOG

Project	Job Number	Date	Boring No.
DCPP ISFSI	12234-1	04/22/01	01-F

WLA



Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Mc-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

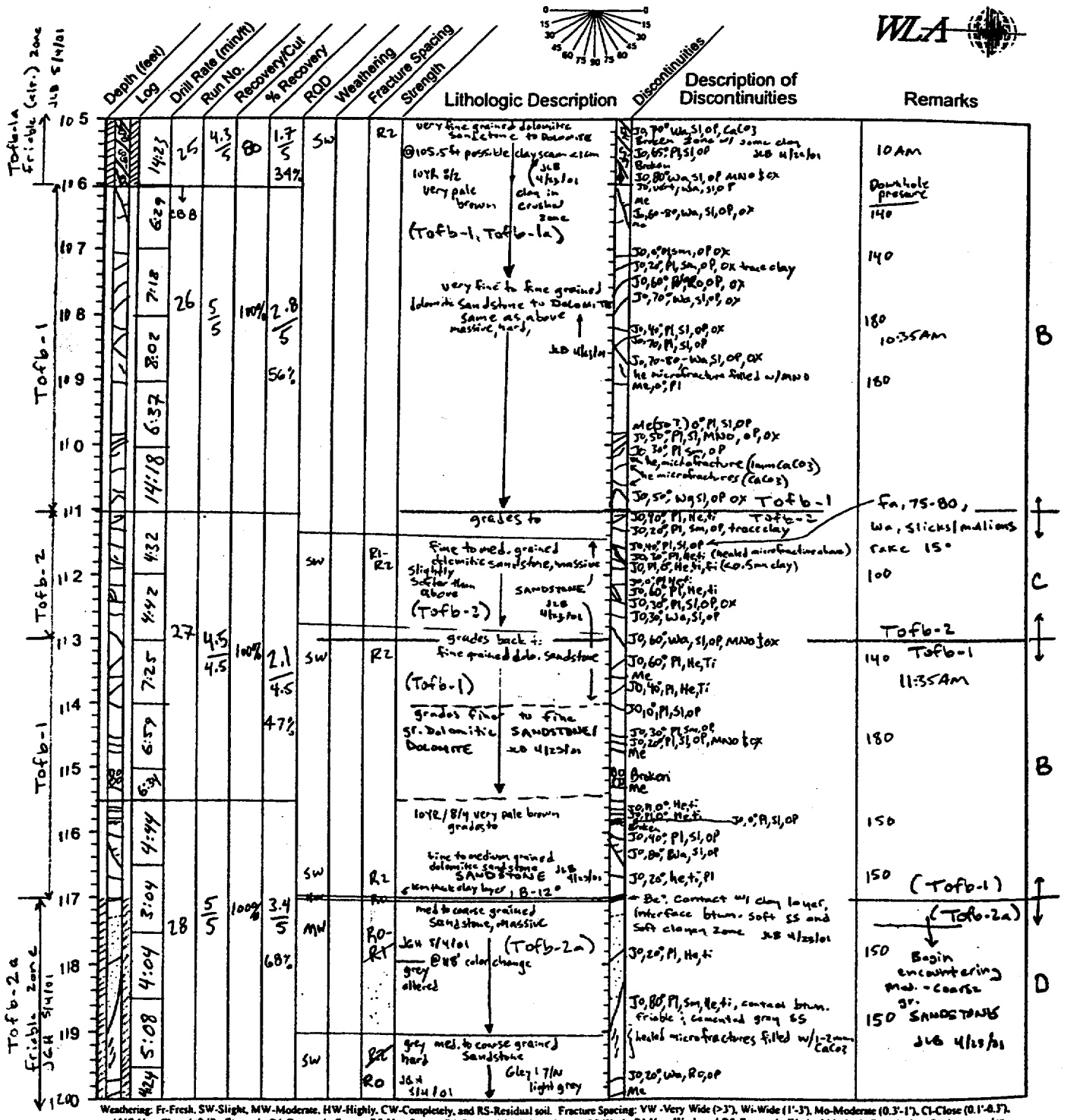
Check CMB 4/23/01 CLM M. Bl

ROCK BORING LOG

Project	Job Number	Date	Boring No.
DCPP ISFSI/CTF	1223-A-1	4/23/01	01-F

Logged by: RDK

WLA



Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

Checked JLB 4/23/01

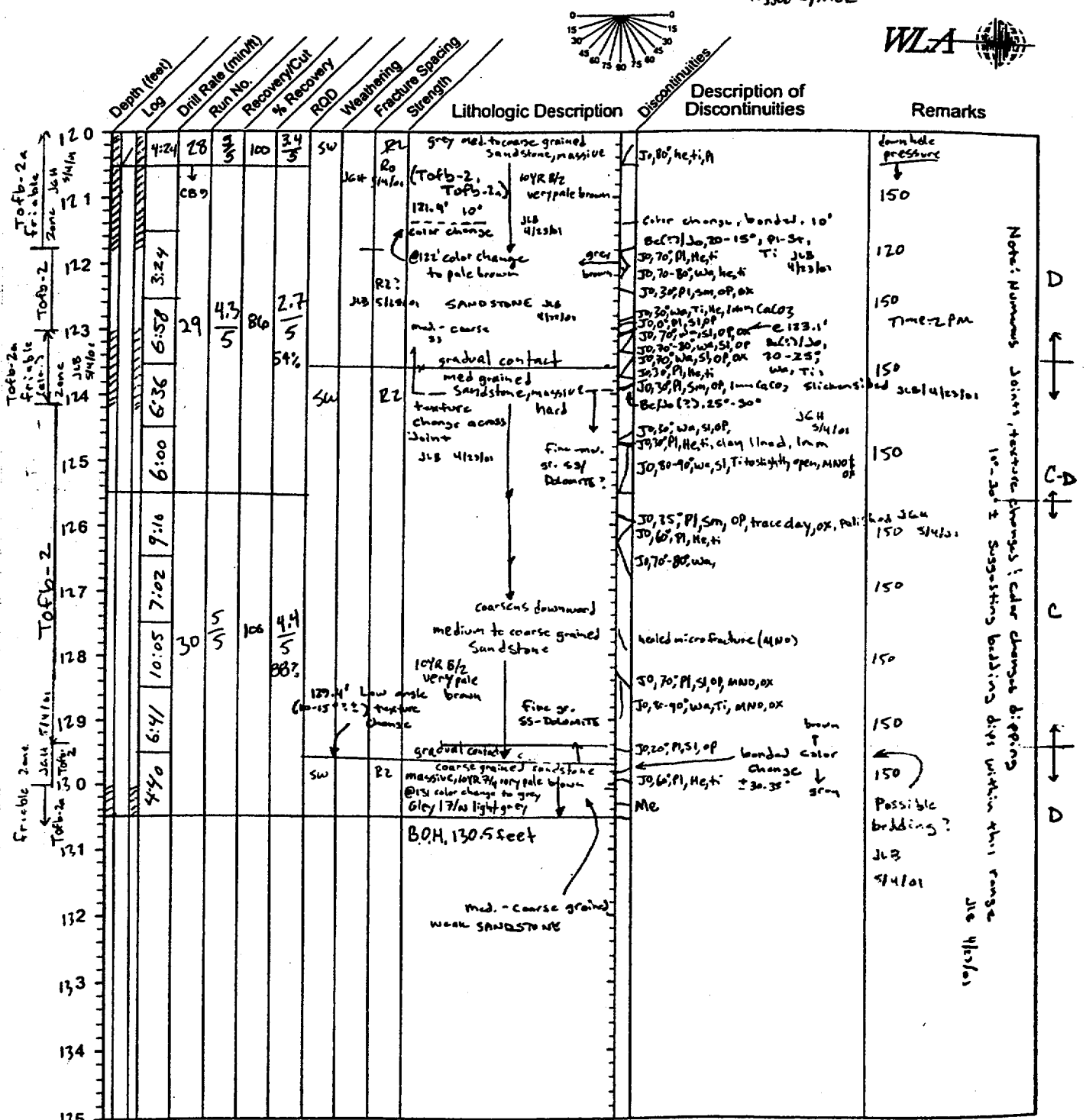
01-F/9

ROCK BORING LOG

Project	Job Number	Date	Boring No.
DCPP ISFSI/CTF	1223-A-1	4/23/01	01-F

logged by: RDK

WLA



Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy). Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

checked JLB 4/23/01

Ron-drill
01-G/1, Chris-Asst

Friable zone calls by JGH/JLB 5/4/01
units calls by JLB/CMB/WAL 5/01
Edited for ISFSI SAR by JB 5/28/01

LOG of ROCK BORING D1-G

Page 1 of Co

Project	Job Number	Boring Location	Total Depth
DCPP ISFSI	1223-A-1	NE Corner of Dry Cask Pad	76.0'

Type & Diameter of Boring	Elevation and Datum	Ground Water Depth	Depth to Bedrock
HQ Double Barrel Core Barrel	~315' Sealevel	NA	<2'

Drilling Contractor and Rig	Length of Core Barrel and Bit	No. of Core Boxes	Date Started
All Terrain Exploration Drilling, Failing 1500 Rig	5.5' 316.8' JB 5/31/01	5	17 April 2001

Casing Size and Depth	Borehole Inclination	Logged By	Date Completed
6" Casing to 4' Deep	90°	JLB, JGH, CMB, KDW	04/18/01

Steel Inventory
130' HQ Rods
1 lead barrel
8' rods
5' 10'

* Not determined, drill water mud injected during drilling.

WLA

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
0–4			CB1							Auger to 4' to set Casing			~10:00AM
4–5		25 min.	1	1.55/2.0	78	100	SI	Wi	R1-R2	DOLOMITE, fine-grained, pale yellow to light yellow-brown (2.5Y, 6/3-7/3); well cemented; strong HCl effervescense; manganese staining (occasional dark little "frags")	gray banding, 35-45°		10:37 Running @ 170psi minimum fluid loss A
5–6											Jo, 85, Wa, SI, sl. Fe. crushed rock JLB 5/4/01		200 psi 10:53
6–7							SI-Mo		R1	weak zone w/ clay	Me Jo, 10°, Fe stained, Wa, SI		downfeed 80 psi
7–8		25 minutes	2	2.2/3.0	73	0.45/30 15%	SI	Mo	R1-R2	Dolomite (same rock, becoming more weathered)	Me Jo 75°, Fe stained, Wa, SI, SIOp		B
8–9							SI-Mo		R1-	weak zone w/ clay	me crushed rock JLB 5/4/01 Jo, 75°, Wa, SI, Mn		downfeed 100psi
9–10		31 minutes	3	2.5*/2	125	2.2/2 100%	SI	Mo	R1-R2	Same rock, becoming less weathered, [illegible] HCl effervescence 10YR 7/3 v. pale brown	Jo, 65°, Wa, SI, Ti JI Mn + Ox; healed joint, 65°		downfeed 120psi downfeed 180psi no significant H_2O loss
10–11											Jo, 50°, Wa, Mn; Jo, 70°, Wa, He; Jo, 55°, Wa, SI, Ti Fe+Mn	Came out of run 3; are part of in 2.5' long zone of highly frac'd dolomite	
11–12	Tofb-1a friable zone JLB 5/4/01						SI-MW		R1	DOLOMITE - Sandy dolo. to dolomitic ss? few thin calcite veins - irregularly shaped (not planar) (wavy) 2.5Y 6/3 (light yellowish brown); strong HCl effervescence, disseminated dark minerals + rock frags.	Jo, 10°, Wa, SI, Ti Fe staining		downfeed 120psi no sig. H_2O loss A-B
12–13	Tofb-1		4	5/5	100	3.25/5 65%	SI	Mo	R1-R2		Jo, 40°, Wa, Ti, SI Mn+Fe staining; Jo, 30°, Wa, Ti, SI Mn staining only; Jo, 15°, Wa, Ti, SI Mn staining only		no sig. H_2O loss downfd 200psi
13–14											Jo, 30° (0.6" zone) Wa surfaces, Ti (individual surfaces) Calcite staining	clay lined JGH 5/4/01	downfd 225psi no sig. H_2O loss
14–15											Jo, 60°, Wa, Ti, Fe + Mn staining		

Calcite veins

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Mc-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type of infilling, slickensides, etc.

* Run 3 incl. a [illegible]

Check 4/19/01 JLB

ROCK BORING LOG

Project	Job Number	Date	Boring No.
DCPP ISFSI	1223a-1	04/17/01	01-G

WLA

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
15–16		4	5/5	100	65% 3.25/5	S1	Mo	R1-R2		See pg. 1		Jo, 15°, Wa, Ti, Ro Ox+Mn Staining	dwnfd 180 psi
16–17	12:47, 12:59	CB2								Dolomitic-Calcareous SANDSTONE; fine-grained, dense; 5Y5/2 (darker than previous dolomites, strong HCl fizz; (reddish gray)			
17–18	12:07					S1	Wi	R2		More strongly weathered below broken rock zone @ 18.65'; sub-hor. laminations (bedding)			
18–19	1:15	5	5/5	100	3.1/5							w/ 1" thick zone of broken rock; 1/16" thick clay seam above; ~1/2-3/4" thick clay seam. Both occur on low angle joint planes; both stiff. plastic, silty clay, 10YR 4-5/6	
19–20	1:26				62%	S1-MW	Mo	R1-R2		Jo, 70°, Wa, Ti, Si, Fe staining; Jo, horizontal, Wa, Ti, Si, Fe+Mn Staining; Jo, 80°, Wa, Ti, Si, Mn staining; Jo, Horiz., Wa, Ti, Si, Mn staining; Jo, Horiz., Wa, Ti, Ro; Jo filled w/ calcite ~0.05" thick 70°. Wa. Ti, Si, Fe+Mn stain		bedding? top: horizontal bottom: 0-5°	dwnfd 145 psi
20–21	1:36											Jo, sub-hor., Wa, Ti, Si, no staining	
21–22	1:45, 1:49									(break @ 1 ft done w/ hammer) Similar to above; increase in # healed fractures + veining Fe stained zones with irreg. boundaries; 5Y6/3 (light reddish brown) Strong effervescence with HCl			dwnfd 200 psi
22–23	2:00							R2					
23–24	2:10	6	5/5	100	4.3/5	S1	Mo			Color change to grayer sandstone @ ~2.6-2.7' in run (13.6') 5Y6/1 (gray) Strong effervescence with HCl		Jo, 40°, Wa, Si, Ti, Mn + Fe stained	
24–25	2:21				84%							Jo, horizontal, Wa, Si, Ti, Fe stain	
25–26	2:29							R1 R1-R2		JGH 5/4/01		Jo, horizontal, Wa, Si, Ti, no stain	
26–27	2:39, 2:45					S1-MW	Mo					Jo zone w/ thin (<0.05") bry coatings; fractures merge to one Jo @ ~4.3' in run surfaces - Wa, Ti, Ro, Fe+Mn stains; Jo, 70°, Wa, Ti, Si, Fe+Mn stain	no sig. H_2O loss
27–28	no track									Same as above / Fe stain in old burrows? Jo, 60°, Wa, Ti, Si, Fe+Mn stained		Jo, 35°, rock above Jo is highly fracd/broken up (below = competent) Wa, Ti, Ro; Fe stained; Jo, 60°, He	dwnfd 220 psi
28–29	3:04	7	5/5	100	4.35/5	S1-MW	Mo	R2		below 1.5+2.5' in run several Fe stained laminae (bedding?) oriented hor. to 5°		Jo, 60°, Wa, Ti, Si, Fe+Mn stain; Rock above Jo fractured	dwnfd 230 psi
29–30	3:14, 3:18				87%							Jo, hor., Wa, Ti, Si, Fe+Mn stain v. thin clay film; Jo, 80°, Wa, Ti, Si, no staining (may have broken during coring)	

Tofb-1; Tofb-1 Friable 5/4/01; Tofb-1 Friable Zone; Tofb-1; Tofb-1 Friable Zone; Tofb-1

thin, wh. Calcite Vein; thin (dark?) calcite veins; healed; color change; JGH 5/4/01; healed; zone of broken; frac. zone; zone of fractures; healed frac

A-e; A

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), WI-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. (Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein.) Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

Check 18 April 2001 CMB

ROCK BORING LOG

Project	Job Number	Date	Boring No.
DCPP ISFSI	1723 a - 1	04/17/01	01-6

WLA

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
30		7 (min)	5/5	100	87% 4.35/5	SI-MW	Mo	R2		Dolomitic-Calcareous SANDSTONE; fine-grained, dense, 5Y 5/2 (olive gray) Strong HCl fizz; sub-hor. lam. (bedding?)		no joints, fracs, etc in 30-31' section	
31	3:33 3:37	CB3								Similar to above - dolomitic SANDSTONE, fine-grained, few lithics; 10YR7/4 (v. pale brown) Fe staining along healed fracs. + in oil kerfs (?) Few calcite veins continuing gradational coarsening downward		Jo, 80°, Wa, Ti, Sl, Fe+Mn stained; Jo, 30°, He (2 He fracs); He, hor., Wa, Ti, Sl no stain (might have broken during coring - parallel to bedding?)	downfeed 240psi
32	3:49											He, 30°, Wa, Ti, Sl, no stain/fresh (broken during coring?)	
33	3:58	8	5/5	100	3.9/5 78%	SI-MW	Mo	R2				Jo, 50°, He; Jo, 70°, He; Jo, 40°, He	downfeed 220psi
34	4:09												
35	4:20									Zone of Jo, He, 70° beginning; color change @ 35.5' to greyer dolomitic SANDSTONE / Strong HCl fizz 5Y 6/2 light olive (color contact is vertical)		Jo, 45° to hor (probably fresh break during coring along previously He joint)	
36	4:28 4:32											Jo, 40°, He Zone anastomozing Jo together	
37	4:45					SI-MW	Wi	R2		Continuation of above with continued increase in grain size		Jo, 30°, He; Jo, 70°, He - Zone of healed fracs.; Jo, 55°, He; Jo, vertical, He, bounded by He fracs.	A-
38	4:53	9	5/5	100	3.9/5 78%							Jo, 70-75° zone, He; Jo, 45°, Wa, Sl, Ti, Fe+Mn stained v. thin clay coating, w/ slicks	Jan 5/4/01
39	5:04									Jo, 60°, He zone of 2 fracs Riedel shears w/ other zone		Jo, 60°, He Zone of 4 anastomozing He fracs.	
40	5:11									Faint lamina @ 39.4-39.6' bedding? 40° dip; Calcite vein ± @ 39.8-40.1'		Jo, He, 80°, Wa - irregular/not planar; Jo, hor. to 20°, very Wa, Ti, Ro, Fe stain; He, hor, Wa, Ti, Sl no stain	
						MW	Mo	R1-R2				Jo, 80°, Wa, Ti, Sl, Fe stain; He, hor, Wa, Ti, Sl, no stain (3 fracs); Jo, 65°, Wa, Ti, Sl, Fe stain	
41	4:20									Dolomitic/calcareous SANDSTONE; incr. sand w/ depth 10YR6/6 (brownish yellow)		Fa, 70°, Sm (slickensides, rake = hor.) Pl, Ti; Jo, 80°, He	Began using stopwatch for each run (min:sec)
42	6:11					MW	Mo	R1-R2				Jo, 90°, Wa, Sl, Ti, Fe+Mn staining; He breaks 41.6 to 42' - hor.	
43	14:40	10	5/5	100	4.15/5 83%	SI-MW	Wi	R2		2.5Y 7/4 (pale yellow) same material as above		Jo, He, 45°; Jo, He, 45°, is actually several strands en echelon; Jo, He 80°	downfd 200psi
44	24:20											Jo(s?) merge, He, 70-90°	A-
45	33:35											Jo, hor, He; Jo, 50°, He; Jo, He, 50° (2 strands); Jo, He, hor to 10°	

Calcite Vein; Calcite Veins; color contact; calcite veins

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'); Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

Check: CMB 18 April 2001 CMB

ROCK BORING LOG

Project	Job Number	Date	Boring No.
DCPP ISFSI	1223a-1	04/18/01	01-G

WLA

Depth (feet)	Log	Drill Rate (min/in)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
45		10	5/5	100	83% 4.15/5	SW-MW	Wi		R2	Calcarious SANDSTONE 2.5Y 7/4 pale yellow		Jo, 25-55° zone, He; Jo, 60°, He; Jo, He, 85°	dwnfd 230 psi; coring really fast; darker color in H_2O
46	38:30	↓ 0.4 no recovery				MW	Mo		S1	10YR 6/8 (brownish yellow) missing 0.6' core			
47	2:40					SW	Mo		S2	Calcarious SANDSTONE as above		Fo, 70°, Sm, Ti; Jo, boundary, hor., Wa, Ro, Ti	
48	16:00	11	4.6/5	92	0.33 1.38/5 7%	MW SW	Mo		S1-S2	pore weathered SS 10YR to 2.5Y 6/6 brownish yellow		Jo, 60°, He; Jo, 90, Polished, no clay; Jo, 80°, Wa, Sl, Ti, Fe + Mn staining	JCH Sl 4/10
49	25:00									Fo, vert to 70°, S+ to Wa, Sl, Ti Fe + Mn staining		He	downf 150 psi
50	41:19					MW SW	Cl			10YR 6/6 in highly frac zone		Jo, 40°, Wa, Ti, Sl, Fe + Mn staining; Zone of highly fractured rock; Jo 5/4 10; Zone of silty clay; Jo, 60, Wa, Sl, Ti, lower boundary of fract. zone	@50' took H_2O Circulation taking in 2x more H_2O
51	2:39									SANDSTONE, friable in powder, fine-grained, dense, well-sorted, few lithic frags., 5Y 7/1 (clean break - light gray) grading to 5Y 6/4 (light yellowish brown) by bottom of run		Jo, 50-80, Wa, Ti, Sl, no clay, mod. Fe + Mn stain; Jo, He 70°; Jo, 80°, Wa, Ti, Sl, Mn stain; He, - along bedding?	Walk fell in wind - lost the time
52	7:08												Wed. Morning lost all fluid over night (in 10' left in hole in morning used Rens unlatch for time)
53	7:15	12	5/6	100	1/5	MW	Mo		R2-R2+ (hard to scrap)			Jo, 60°, Wa, Ti, Sl, Mn staining; Jo, vert, Wa, Ti, Sl, Mn staining; Jo, irreg. but mostly horizontal, Wa, Ti, Sl Fe + Mn staining	downfd 160 psi
54	7:22				20%					Frac. zone coincident w/ laminae or. ~20°, Fe + Mn stained; clayey		Frac zone, 2 min orientations 60-70°, Wa, Ti, Sl, minor Fe + Mn staining; Zone of He fracs, vert	
55	7:29						Cl					Jo, 70°, Wa, Ti, Sl, no stain top of frac zone; Jo/frac. zone hor to 30°, Wa, Ti, Sl no Fe + Mn stain	
56	7:34					MW				Me @ v. top of run - hammer blows; Same as above; laminae @ 56-56.4' Fe stain clayey, ~ 0-10°		Jo, vertical, Wa, Ti, Sl, no Fe + Mn stain; Jo/frac. zone, 0-10°, parallel to laminae	Begin using stopwatch
57	3:40					SW SW-MW	Cl		R1-R2	Jo, ~vert, Wa, Sl, Fe + Mn stain frac. zone on outside of core		Me x2 along bedding?; Jo, He, calcite veining; Me along bedding?, hor.	
58	10:00	13	5/5	100	1.5/5 30%					Jo, ~Vert, Wa, Sl, Fe + Mn stain		Jo, He, 60°; Jo, 70-80°, Wa, Sl, Ti, little to no Fe + Mn stain	lost all return - no H_2O coming up; 50% return @ [illegible]; return comes & goes (none to 50% return) drilling is fairly easy good progress; downfd @ 58' 110 psi
59	18:50						Mo						
60	26:30												

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

Check: CMB 18 April 2001

ROCK BORING LOG

Project	Job Number	Date	Boring No.
DCPP	1223a-1	04/18/01	01-G

WLA

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
60													
61		13	5/5	100	30% 1.5/5	SW	Mo	R1-R2		Zone of gray dolomitic SANDSTONE - alteration band ~5Y 5/2		No Jo or fracs	120 psi ~10% return
62		14	3.5/3.5	100	2.35/3.5 47%	SW-SM	Cl Mo	R1		2.5Y 5/3 on either side of gray band (also dol. SANDSTONE as above w/ slight increase in lithic frags + more alteration banding Jo vert, Wa, Sl, Ti, Fe+Mn stain in 65.6-66.7' alt. bands - sub-hor. to 50° (previously described as laminae)		Zone of Jo, Wa, Sl, Ti, Fe+Mn stain mostly vert + hor. Jo, 60°, Wa, Sl, Ti, Fe+Mn stain Jo, 65°, Wa, Sl, Ti, Fe + Mn stain Mc, 10°	150 psi ~50% return @ 62' 170 psi 10% return @ 63'
63										2.5Y 6/3 Calcite vein - 80° to vert		Jo, 10-20°, Wa, Sl, Ti, no stain, partially along alt. bands	@ 64' 110 psi 30% Return A-B
64										(Tofb-1) end of sub-run - refusal		Jo, 55°, Wa, Ti, Sl, v. little Mn stain Jo, 60, polished	@ 64.5' refusal 250 psi 50% return no recovery 0.4'
65		14	1.3/2.5	52	0.5/2.5 20%	SW-SM				as above		zone of Jo/fract., Fe+Mn stain Jo vert, Wa, Ti, Sl, Mn+Fe stain Jo, 70°, base of fray zone, Wa, Ti, Sl Fe + Mn stain	B
66										Jo - clay lining, 45°, Wa, Sl, Ti		Jo, 45°, Wa, Sl, Ti, Fe + Mn stain Mc	150 psi Tofb-1 50% return
67		15	5/5	100	3.3/5 66%	MW SW-MW SW	Mo Mo Wi	R1-R2 R2 R0		Broken chunks, rounded pieces, no sharp Jo bounding SANDSTONE 2.5Y 6/4 f-m grained, softer than above; minor clay/silt clay laminae becomes harder (51-52 as above @ 66.7' orange clast (0.04' diam) above color change from reddish to gray 5Y 5/1 below color contact Gray clast (0.03' diam) below contact clasts = clay & silt Gray clast @ Mc (0.05' diam) Gray clast @ 4.1' above color Δ @ 4.2 color change back to Orange-red sand No texture changes across color boundaries (Tofb-2, Tofb-2a)		Jo, Ht, 45° crushed zone, 1 hor, Mc Jo, 70°, Wa, Sl, Ti no stain Jo, 45°, Wa, Sl, Ti, Fe stain Vert Jo, Wa, Sl, Ti, Fe stain Hor. Jo (many) Wa, Sl, Ti, Fe stain crushed zone; bounded on bottom by Jo, 30°, Wa, Sl, Ti, little to no stain Jo, 55°, Wa, Ti, Sl, no stain Thin shale lamina (gray) (Bedding?) CMB 4/18/01	Tofb-2 110 psi 50% return D gray return water 110 psi 60% return 110 psi 60% return
71										Zone of harder more cemented SANDSTONE 71' to 72.2' @ Jo, Ht, 30 Jo, 40-70°, Wa, Ti, Sl, Fe+Mn stain Jo, hor. to 30°, Wa, Ti, Sl, Fe+Mn stain Jo, 70°, Wa, Ti, Sl, Fe+Mn stain		Jo, 20° Wa, Ti, Sl Mn+Fe stain Jo zone, 80° main Jo, Wa, Ti, Sl, Fe+Mn stain Jo, 10° base of zone, Wa, Ti, Sl, Fe+Mn st. Jo, 30°, Wa, Ti, Sl, no stain Jo, 60°, Wa, Ti, Sl, no stain fract. zone Jo, 40-80° Wa, Ti, Sl, Fe+Mn stain Jo, Wa, Ti, Sl, Fe stain	lost all circulation Circulation back to 72' 150° PSI 50% return
73		16	5/5	100	1.5/5 30%	SW-MW	R"Changes to Jan 5/4/01	R1-R0		Color change @ 73.1-73.4' orange above, gray below Irreg. alteration boundary			to 73' 150 PSI 60% return
74								R0		Jo, vert to hor., Wa, Ti, Sl, no stain (zone of Jo)		Jo, 40°, thin clay coating, Wa, Sl, Ti, no stain	to 74' 100 PSI 60% return
75										@ Fe+Mn stain in SANDSTONE		Jo, 10°, Wa, Sl, Ti no stain Jo, 10°, Wa, Sl, Ti no stain Jo, 80°-vert, Wa, Sl, Ti no stain	675' 100 PSI 70% return

Tofb-1 Tofb-2a Zone Jan 5/4/01 Friable

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

Check: CMB 18 April 2001

ROCK BORING LOG

Project	Job Number	Date	Boring No.
DCPP ISFSI	1223a-1	04/18/01	01-G

WLA

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
75.0		16	5/5	100	1.5/5 30%	Sev-Mod	C1	R1-R2		SANDSTONE fine grained, few lithic fragments (olive yellow) 2.5Y 6/4 (Tofb-2) Jo zone, 30-40°, Wa, Ti, Sl no stain, thin clay film	Jo, hor, Wa, Sl, Ti; Fe Stain, minor Jo, hor. to 10°, Wa, Sl, Ti, Fe stain Jo, 70°-vert, Wa, Sl, Ti, no stain Me, horiz., Jo, 40°, Wa, Sl, Ti, no stain	Slicks Jc 14 Sl 4 lat	120 psi 70% return
76.0													End of Hole @ 76.0' 11:00am 04/18/01
2													
3													
4													
5													
6													
7													
8													
9													
0													
1													
2													
3													
4													
5													

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy). Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

Check: CMB 11 April 2001

LOG of ROCK BORING 01-H

friable zone calls by JGH/JLB 5/1/01
units calls by JLB/CMB/WAL 5/01
Edited for ISFSI SAR by JLB 5/30/01

Project	Job Number	Boring Location		Total Depth
DCPP ISFSI	1223a-1	DCPP ISFSI		101'
Type & Diameter of Boring		**Elevation and Datum**	**Ground Water Depth**	**Depth to Bedrock**
HQ double barrel core barrel		346.6' → JLB 5/31/01 ~~346~~ (Sea Level)	NA *	0
Drilling Contractor and Rig		**Length of Core Barrel and Bit**	**No. of Core Boxes**	**Date Started**
All Terrain Drilling Failing 1500 Rig [KDW 04/20/01] Ron + Chris		5.51	7	04/18/01
Casing Size and Depth	**Borehole Inclination**	**Logged By**		**Date Completed**
Auger to 4'; set casing to 6"	90°	KDW + JGH		04/19/01

*Not determined, water and mud injected during drilling

WLA

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
0–3										Auger to 3.5'			
4	7:24	CB1	1	4.5/4.5	100	2.9/4.5 64%	SW	Mo	R1-R2	SANDSTONE, dolomitic (slight fizz of powder), fgrained, hard; well cemented, lithic fragments, E+Mn stain 10YR 6/6 (brownish yellow) (Tofb-1)	Jo, 20°, St, Ti, Sl, E+Mn stain	Began coring @ 12:45pm	
4							MW	Cl	R1		Jo, sub hor., Wa, Sl, Ti, no stain (several)	dumfeed 180psi	
5	13:00										Jo, 50°, Wa, Sl, Ti, no stain		
											Jo, 30°, Wa, Sl, Ti, no stain		
										Jo, He, 30°	Jo, 40°, Wa, Sl, Ti, no stain	@ ~5' taking H_2O ~50% return	
											Jo, 55°, Wa, Sl, Ti, Mn stain clay films JGH 5/4/01		A
6							SW	Mo	R1-R2	Jo, vert, Wa, Ti, Sl, Mn stain			
	24:00									Jo, hor, Wa, Ti, Sl no stain	Jo, 30°, Wa, Sl, Ti, Mn stain		
										More pervasive Mn stain betw. 6 and 6.4'	Jo, 30°, Wa, Sl, Ti, Mn stain (minor)		
7										Jo, He, 20°, zone of alt. around it	Jo, He, 70°, alteration to gray along it (α zone)	dumfd 150psi ~70% return	
Alt. Zone	34:17									Altered zone - gray coloring	Jo, 40° ~~40°~~ (sic) Wa, Sl, Ti, no stains, but bounds altered zone		
8	39:26										Jo, 60°, Wa, Sl, Ti; Fe + Mn stained He	dumfd 170psi	
										Same as above	Jo, 30°, Wa, Ro, Ti, no staining, zone > Jo, 20° to hor., Wa, Rl, Ti no stain altered.	120psi	
9	44:35								R1-R2		Jo, 20°, Wa, Rl, Ti, Mn stain		
Alteration Band	48:18						SW-MW	Mo		Alteration bands @ 9.2 + 2.0	Jo, 50°, Wa, Sl, Ti, no stain broken up zone	110psi ~60% return	B
10			2	5/5	100	3.4/5 68%				Jo, ~30, wa, Sl, op, clay films JGH	Jo, 35°, Wa, Sl, Ti no stain		
										Calcite veins, vert., betw. 5/1/01 10.7 and 11'	Jo, 30°, Wa, Sl, Ti, no stain, v. fresh	120psi ~60% return	
11	52:50										Jo, 70°, Wa, Sl, Ti; Mn + Fe staining		
											Jo, 25°, Wa, Sl, Ti, Mn + Fe staining		
Tofb-2												Tofb-1	
Tofb-2 friable (weak) zone JLB 5/1/01										(Tofb-2, Tofb-2a)	Jo, He, 30°	Tofb-2	
12	70:00										Jo, 30°, Wa, Sl, Ti, no stain	@ 12' 120 psi 50% return	
											- Jo, 90, wa, Sl, op, clay (1mm) JGH 5/1/01	@ 13' 120psi 60% return	
							MW		R1	Jo, 30°, Ti, Sl, Wa no stain	Jo, 75°, Wa, Ti, Rl, Fe + Mn stain, zone		C
13	51:00										Jo, He, 70°, Fe stain		
										SANDSTONE, v. Sl dolomitic becoming coarser 2.5Y 6-5/6 (olive yel to light olive yellow), less well cemented than above	Jo, 50°, Wa, Sl, Ti, no stain, looks fresh	into H' @ ~1/min 100psi / No Return	
14	13:45		3	3/3	100	1.3/3 43%	MW	Mo	R1		Jo, He? 30° to 30° (sic) fresh, Wa, Ti, Sl, no stain	@ ~10min ~10% return	
											Jo, 30°, Wa, Sl, Ti no stain, fresh	@ 14' 110 psi / 10% return	
											Jo, 70°, Wa, Sl, Ti no stain, fresh	150psi	
15	24:00												

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW -Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type of infilling, slickensides, etc.

ROCK BORING LOG

Project	Job Number	Date	Boring No.
DCPP ISFSI	R223a-1	04/18/01	01-H

Pad Grade = 310'
> 50' below grade

WLA

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
15		3	3/3	100	1.3/3 43%	MW	Mo	R1		SANDSTONE, r. Sl dolomitic lithic frags Jo, hor., Wa, Sl, Ti (Tofb-2, Tofb-2a) no stain	Jo, 80°, Wa, Ti, Rl no stain		120 psi 50% return
										Fe stain on SANDSTONE	Jo, 80°, Wa, Ti, Rl no stain; Jo, 40°, Wa, Ti, Sl-Ro, no stain; Jo, 30°, Wa, Ti, Sl, Fe stain		
16	35:00 0										missing section		
missing section weathered zone		CB2				SW		R2		As above, med grained (continued coarsening) lithic frags. (few to many)	Jo, 50°, Wa, Sl, no stain; Jo, hor. Wa, Sl, no stain		120 psi 50% return
17	4:10						MW	R1		weathered zone @ 16.7-16.9' color contact @ 17.2' ~35° 2.5Y 6/4 (light yellowish brown) over 5Y 5/1 (olive gray)	Me, hor.		
Color contacts						SW	Mo				Me, hor		150 psi
18	4:20							R2		color contact (gray over brown) 60° @ 18.0'			
Tofb-2	26:00	4	4.7/5	94	4.6/5							No apparent Jo or Me Jo	
19							Ww			@ 19.6 Mn? stains ~50° zone Alteration; not planar "lotspy" + irregular			
Mn stains					92%								
20	36:39									total missing section this run = 0.4'. Arbitrarily divided between top + bottom of run	Jo, Vk, 50°		120 psi
21	24:42 0									SANDSTONE, dolomitic, same grain size as above well cemented	Jo, Subhor., Wa, Sl, Ti, Mn + Fe staining; Jo, 60°, Wa, Sl, Ti, Mn + Fe staining is bottom of small mable zone		
22	0:45					SW		R2		10YR 5/6 (yellowish brown)	Me - hammer blow; Jo, 80°, Wa, Ti, Sl, no stain, friable edges; Jo, 60°, Wa, Ti, Sl, Fe stain	@22'	180 psi 30% return
Fri.-Wk (altered) Zone 2-8 5/4/01													
23	25:22						Mo				Jo, varied, accurate along length of core, Wa, Ti, Sl, Mn + Fe stained	@23'	190 psi 50% return
altered zone		5	5/5	100	4.0/5								
24	26:43				80%	HW		Ro		@ 23.7 to 24.0' altered, weak SANDSTONE, friable, highly sheared	Jo, subhor., Wa, Ti, Sl, no stain 23.7 to 24.0 contains many blocks w/ no stain on their surfaces; Jo, subhor., Wa, Sl, Ti, Fe + Mn stains; Jo, 70°, Wa, Sl, Ti, Fe + Mn stain	@ 26:00 hit soft zone	150 psi Ran out of H_2O @ 26 min Resumed 5 min later 190 psi
Tofb-2a						SW		R2		10YR 6/6 (brownish yellow)	Me - from hammer blow		190 psi 30% return
25	16:30												
26	26:45 0									SANDSTONE, hard, well cemented, med grained 10YR 6/6 (brownish yellow)			150 psi
Tofb-2 Color change													
27	8:32					SW	Wi	R2		color Δ to 5Y 4/1 (dark gray) @ 26.4 to 26.8'	Me - hammer blow		
28	19:00	6	4.9/5	98	4.85/5					color Δ @ 27.6 to 28.0 back to brownish yellow			190% psi 30% return
					97%								
29	27:00									color Δ @ 29.1-29.3 to gray @ 29.6' texture change to friable SANDSTONE	Jo, 60°, Wa, Sl, Ti, Fe + Mn stain; Jo, hor., Wa, Sl, Ti, no stain - fresh		190% psi
color Δ													
30	36:00							R1			Jo, hor (bedding?) Wa, Sl, Ti, no stain is the contact to more friable SANDSTONE		200 psi

Tofb-2a Friable zone Jo, Vk 5/4/01

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

ROCK BORING LOG

Project	Job Number	Date	Boring No.
DCPD ISFSI	12239-1	04/18/01	01-H

WLA

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
30		6	4.9/5	98	4.85/5 97%	SW	Wi	RI		friable SANDSTONE, med-grained 5Y 4/1 (dark gray)		No Jo, etc	
31		CB3				MW		RI		Same as above			
32						SW				between 31.9' and 33 textural gradually changes to SANDSTONE, well cemented + hard, fine-med. grained @ 32.15 color change from gray to 10YR 5/4 (yellowish brown)		Me, all hor. + rounded	200psi
33		7	4.7/5	94	1.9/5 38%		Mo	R2				Jo, 10°, Wa, Ti, Si, Fe+Mn stained; Jo, sub.hor., Wa, Si, Ti, no stain (3)	200psi
34										Jo, vert., Wa, Si, Ti, Fe+Mn stained		Jo, Wa, Ti, Si, no staining - broken on one side of vert. fracr but tite on other side	190psi 20% return
35										total 0.3' missing section arbitrarily split 2" @ Top 1" @ Bottom		Jo, 60°, Wa, Si, Ti, Mn+Fe staining; Jo, 30°, Wa, Si, Ti, little Mn staining; Jo, 30°, Wa, Si, Ti, little Mn, much Fe staining	200psi
36										As above		Jo, subhor., Wa, Si, Ti, Fe + little Mn staining; Jo, sub vert., He, calcite-lined; Jo, 80°, Wa, Si, Ti, no stain; Jo, 50°, Wa, Si, Ti, little Mn stain	ended 4 the day Began @ 7:00am
37								R2		Jo, Wa, Si, Ti, Mn stain, vert.		Jo, 75°, Wa, Si, Ti, Mn+Fe stain; Jo (many) Subhor. to 70°, Wa, Si, Ti, Fe staining	200psi 10% return
38			5/5	100	4.0/5 80%	SW	Mo					Jo, 50°, Wa, Si, Ti, little Mn+Fe stain; Jo, He, vert. to 80°	210psi <10% return
39						MW-HW		R1-R2		@ 39.35' two very thin clay layers between fracture blocks		Jo, 40°, Wa, Si, Ti, Fe+Mn stain; Jo, 10°, Wa, Si, Ti, no stain; appears to be along a clay layer; Jo, 40°, Wa, Si, Ti, no stain, clay layer, fractured zone no.06' thick; Jo/Be, 13, Pl, thin clay	130psi 10% return
40						SW		R2		Jo, He, 30°; Jo x2, Subhor., bounding crushed, weak, powdery zone (like to no clay) ~0.01 to 0.5' thick Wa, Si, Ti, no staining		Jo, 20°, Pl, Sm to Si, no slickensides, Ti, Fe + Mn stain; clay lining; Jo, 10°, Pl to Wa, Si, Ti, Fe+Mn stain	Jie 5/4/01 Coring @ 7:38 Saw run out of H2O in chase truck @ 7:45 we have H2O again 130psi @40' = 150 psi 180 psi ~15% return
41						SW	Mo	R2		dolomite SANDSTONE as above, w/ increasing $CaCO_3$ in system @42' Mn stendrels		Jo, 30°, Wa, Si, Ti, Fe+Mn staining; Jo, hor. to 30°, Si, Ti, Wa, Fe+Mn stain; Jo, He, 60° frac. zone @ base	
42										Jo, He, 30°; Jo, 30°, Wa, Si, Ti, Fe+Mn stain		Jo, He zone with Mn above surface doesn't dry out fast; Jo, 60° to vert, Wa, Si, Ti, Mn stain; Jo, 35°, Wa, Si, Ti, Mn+Fe stain	@42' 200psi
43		9	5.1/5	102	4.5/5 90%	SW	Mo	R2+		Sandstone has been weathered out next to calcite vein @ 43.4'; Jo, He, Mn stain; Jo, 15°, Wa, Si, Ti, Fe stain		Jo, 20°, Wa, Si, Ti, Fe+Mn stain; Jo, 30° He with calcite vein in/weathering out Jo; zone Jo, He, Mn stain, dry and sticky; Jo, 80°, Wa, Si, Ti, Mn+Fe stain	@43' 220psi 10-20% return over 2' (varies)
44										vugs @ 43.6' where rock weathered out; tag @ 44.7' + along fractures		Jo, 40°, Wa, Si, Ti, Mn+Fe stain; Jo, 80°, Wa, Si, Ti, Mn stain	@44' 160psi; @45' 160psi
45													

Friable zone; JLB 5/4/01 Tofb-2a; color contact; weak fracture zones; Mn staining; calcite vein; Tofb-2; D; C

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

ROCK BORING LOG

Project	Job Number	Date	Boring No.
DCPP ISFSI	1223a-1	04/19/01	01-H

WLA

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
45	5:20	9	5.0/5	100	90% 4.5/5	SW	Mo	R2+		dolomitic SANDSTONE, very hard, well cemented, increase in carbonate with depth 2.5Y 5-6/4 (light yellowish to light olive brown)	Jo, 80°, Sl, Wa, Ti; Mn stain		10% Return
	1 hr. 0										Jo, subhor., Sl, wa, Ti, Fe stain (x3)		
46		CB4								Same as above	Jo, 30°, Sl, Wi, Ti, Fe + Mn stain		
										@ 46.3' vugs (dissolution)	Jo, vert, wa, Sl, Ti, Fe stained		
											Jo, hor., Wa, Sl, Ti, Fe stain		
											Jo, He, 30° } both with calcite		
47	8:40										Jo, He, 10° } veins		
											Jo, 40°, Wa, Sl, Ti, no stain, fresh		
											Jo, subvert, He but partially re-opened; calcite veining		
48	15:40										Jo, 70°, Wa, Sl, Ti, minor Fe + Mn		
											Jo, 40°, Wa, Sl, Ti, Fe + Mn stain		150 psi
		10	5.0/5	100	3.8/5	SW	Mo	R2		Zone of gray alteration 2	Jo, He, 40°, alt. to gray along it		
											Jo, He, 70°, " " " " (Zone)	@49'	160 psi
49	24:25				76%						Jo, 30°, Wa, Sl, Ti, Fe + minor Mn stain		
											Jo, He, vert to 70°, alt. along it, beginning to re-break	@50'	160 psi
50	32:20									@50.5' clay "clast" ~3/4" long + 1/4" high, long axis ~hor. bedding parallel?			
clay											Jo, 80° + 30°, Wa, Sl, Ti, Mn + Fe stain	@51'	160 psi
											He - hammer blow		30% return
51	41:20									Same as above	Jo, 50°, Wa, Ti, Sl, Mn stain		C
										10YR 6/6 (yellow) Crushed zone JLB 5/4/01	Jo, He + rebreaking in places Wa, Sl, Ti, vert + very irregular Mn staining		
52	13:36										Jo, subhor, He, " "		180 psi
													50% Return
								R2		@54.3' to 55' very gradually becomes less hard / more weathered with depth	Jo, He, 30°		
53	23:10	11	5/5	100	4.1/5	SW	Mo				Jo, subhor to 40°, top of fragmented zone		210 psi
					82%					@53.6' Mn stain - tendrol, Jo, He, vert	Jo, 80°, two Jo bounding fragmented zone, Wa, Sl, Fi b Op, calcite vein along bo Rum		200 psi
54	32:45									54.3 to 55.5' - 2.5Y 6/2 (gray) color transition zone	Jo, 30°, Wa, Sl, Ti, Mn stain		
											Jo, 70°, Wa, Sl, Ti, no stain		
color transition zone										← gradational			200 psi ~10% return
55	39:00					SW-MW		R1		below 55.5' 6Y 3/1 (dark mineral color - other minerals = white) more friable			
											Jo, 35°, Wa, Sl, Ti, no stain (only gray)		
56	45:00										Jo, subhor., Wa, Sl Ti, no stain		
							R1 to R0			gradational		@56'	~70% Return
57	9:35					SW-MW		R1-		Same as above, becoming more friable with depth JGH 5/4/01	Jo, 10°, Wa, Sl, Ti, no stain	@57'	160 psi
color change							Mo			@57.8' gradational color change from gray to 10YR 5/6 (yellowish brown)			D
58	18:29	12	5/5	100	4.1/5					[KDW 5/30/01] ~0.01'		@58'	160 psi
					82%	SW				@59.9' clay layer ~~[illegible]~~	Jo, 30°, Wa, Sl, Ti, Mn + Fe staining; Jo, 10°, Wa, Sl, Ti, Mn + Fe stained		50% Return
59	30:35										Jo, 10°, Wa, Sl, Ti, Mn + Fe stain; Jo, He, 70° vert.	@59'	200 psi
										Jo, He, 70°	Jo (zone of shearing) 10°, Wa, Sl, Ti, no stain (both surfaces)		
										@59.9' transition to more friable SANDSTONE		@60'	220 psi 50% return
60	41:35					SW-MW		R1					

Tofb-2 (45–51); Tofb-2a (51–56); Tofb-2 (56–60); Color transition zone; Friable zone; JGH 5/4/01

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW -Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

ROCK BORING LOG

Project	Job Number	Date	Boring No.
DCPP ISFSI	12223a-1	04/19/01	01-H

WLA

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
60	61:35	12	5/5	100	82% 9.1/5	SW-MW	Mo	R1		10YR 4-5/3 (yellowish brown) friable SANDSTONE, med. grained mod. weathered 60.05-60.3 Gray zone 5Y 3/1 below 60.3' 10YR 4-5/3	Jo, subhor., Wa, Sl, Ti, no stain; Jo, subhor., not parallel to color change Wa, Sl, Ti, no stain		220 psi
61	52:23	285								SANDSTONE, well cemented medium-grained 10YR 5/4 (yellowish brown)	Jo, 45°, Wa, Sl, Ti, minor Mn stain; Jo, subvert, Wa, Sl, Ti, Mn & Fe stain; Jo, subhor., Wa, Sl, Ti, no stain	50-70% Return (varies)	200 psi
62	14:46						Mo	R2			Jo, Hk, 80°; Jo, 30°, Wa, Sl, Ti, minor Fe stain		
63	24:25	13	5/5	100	4.8/5 96%	SW	Wi			@2.7 to 3' .002" clasts orange clay	Jo, 80°, Wa, Sl, Ti, Mn & Fe stain		220 psi; 220 psi
64	35:10												220 psi
65	44:49										Jo, hor. to 40°, Wa, Sl, Ti, no stain fresh; Jo, 50°, Wa, Sl, Ti, Mn stain		
66	52:40									Same as above	Jo, 80°, Wa, Sl, Mn stain (X2; Jo, 50°, Wa, Sl, Ti, Fe stain		
67	5:45						Mo			[KDW 5/30/01]; @67.2' clay layer ~~0.01" thick~~ 0.01" thick orange clay; @67.4' 30° dip sand kind of clay 30° dip, ~~0.01"~~ 0.01'	Jo, subhor, Wa, Sl, Ti, no stain; Jo, 70°, Wa, Sl, Ti, Fe stain; Jo, hor., Wa, Sl, Ti, no stain	50% Return	220 psi
68	12:35	14	5/5	100	4/5 80%	SW	Wi	R2		[KDW 5/30/01]			240 psi
69	19:26										Jo, subhor, Wa, Sl, Ti, no stain; Jo, ~10, Wa, Sl, op, clay Film w/ discontinuous sticks	JGW 5/14/01	220 psi
70	25:00										Jo, 50°, Wa, Sl, Ti, Fe stain, minor Mn; Jo, 60°, Wa, Sl, Ti, no stain; Jo, hor., Wa, Sl, Ti, little Fe stain		220 psi
71	32:30	No Data								Same as above	Jo, Hk, 30°; Jo, 30°, Wa, Sl, Ti, Fe stain; Jo, subhor., Wa, Sl, Ti, no stain		200 psi
72										[KDW 5/30/01]; @72.8' clay layer ~~0.01" thick~~ 0.01' thick JB 6/6/01	Jo, 70°, Wa, Sl, Ti, Fe stain; Jo, Hk, 80°; Jo, Hk, 80°; Jo, ~30, Wa, Sl, Fi, 1mm clay; Jo, Hk, 40° JGW 5/14/01	50% +/-	220 psi
73	6:33	15	5/5	100	3.45/5 69%	SW	Mo	R2			Jo, 60°, Wa, Sl, Ti, Fe stain		240 psi
74	11:38									Crushed zone JLB 5/14/01; Jo, Hk, Mn stained 10°	Jo, 65° Wa, Sl, Fe stain, Ti; Zone of crushed rock; Jo, 10°, Wa, Sl, Ti, Fe & Mn stained		220 psi
75	17:31												

Tofb-2 Color Change; Tofb-2a Friable Zone JLB 5/14/01; Tofb-2; D; C; D; C

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy). Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

ROCK BORING LOG

Project	Job Number	Date	Boring No.
DCPP ISFSI	12236-1	04/19/01	01-H

WLA

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
75	Tofb-2	21:50	15	5/5	100	69% 3.4/5	SW	Mo	R2	SANDSTONE, well cemented 10YR 5/4 med-coarse grained massive, moderately hard	Jo, 30°, Wa, Sl, Ti, Fe (minor) staining		C
76	Tofb-1	CB6								Well-oxidized sand grains	Jo, 70°, Wa, Sl, Ti, fresh, no stain; Jo, 90°, Wa, Sl, Op, Sl ox; Jo, 0°, Wa-St, Sl, Op	220 psi; Tofb-2; Tofb-1	
77	Tofb-1	4:45								Run 16 - Same as above	Jo, 60°, Pl, Sl, Ti	200 psi; @5:50 we lost circulation	B
78	Tofb-2	10:45	16	5/5	100	3.2/5 64%	SW		R1-R2		Jo, 0°, Wa, Sl, Ti; Jo, 0°, Wa-St, Sl, Ti; Jo, ~60°, Wa, Sl, Ti	Tofb-1; @14:40 circ. back to 10-20%	
79		15:55								@79.3-79.6 zone of friable rock. Well oxidized with clay lined fracture Dip ~ 60°, Clay ≈ 1-5mm thick	Jo, ~60°, Pl, Sl, Ti; Jo, ~60°, Wa, Sl, Fi, ~0.5cm Clay; Jo, 60°, Pl, Sl, Fi, ~1cm Clay; Jo, ~60°, Wa, Sl, Fi, mixed clay + S.S. Frags.	Tofb-2; 220 psi	
80		8:45									Jo, 0°, Pl, Sl, Ti	220 psi	C
81	Tofb-2a Friable Zone JGH 5/14/01	24:48 0					SW		R1-R2	Same as above			
82		8:12	17	4.8/5.0	96	3.2/5.0 64%	SW	Mo	R1-	SANDSTONE, altered, organic rich - Medium grained well sorted, massive	Jo, 10°, Wa, Sl, Ti no stain; Jo, 10°, Wa, Sl, Ti, no stain		
83	Tofb-2	3:00					SW		R1-	SANDSTONE, dolomitic graywacke, med grained, well sorted, well oxidized sand massive JGH 5/14/01	Jo, 0, Wa, Sl, Fi - clay seam 0.05' thick JGH 5/14/01; Jo, hor., Wa, Sl, Ti, no stain; Jo, 65°, Wa, Sl, Ti, Fe stain fractured zone, minor Fe + Mn; Jo, 60°, Wa, Sl, Ti, Fe stain	200 psi 0-10% Return; Tofb-2; @11 min lost circulation @83 → 200 psi	
84		13:52								Jo, hor., Wa, Sl, Ti, Fe stain; Jo, vert, Wa, Sl, Ti Fe stained	Jo, 30°, Wa, Sl, Ti, Fe stain; Jo, 20°, Wa, Sl, Ti, Fe stain; Jo, 30°, Wa, Sl, Ti, Fe stain	Tofb-1; @84' gained back 50% of circ Running at 220 psi	
85	Tofb-1	6:18									Jo, 50°, Wa, Sl, Ti, no staining		B
86		4:50								Same texture	Jo, 50°, Wa, Sl, Ti, Fe + minor Mn		
87	Tofb-2	5:29	18	2.9/5	58	2.9/5 58%	SW	Mo	R1		Me	Tofb-1; Tofb-2	
88		6:32								@88.3' alt. zone / color change to gray (as above) to 88.6' texture as above	No other Jo; Me		C
89	Tofb-2a Friable Zone JGH 5/14/01	8:38	CB7				SW	Mo	R1	As above to 89.2' Then softer + more fractured			
90		3:34	19	2/2	100	0.5/2 25%	MW	Cl	R1-R0	Crushed	All surfaces Mn stained, various orientations, small pieces, Jo, 30°, Wa, Sl, Ti, Fe + Mn stains	@90' - 220 PSI	

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

ROCK BORING LOG

Project	Job Number	Date	Boring No.
DCPP ISFSI	1223a-1	04/19/01	01-H

WLA

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
90		19	2/2	100	0.5/2 25%	MW	CI	RI-RO		SANDSTONE, weathered, friable in blocks, med to coarse-grained (Tofb-2, Tofb-2a)		Jo, 80°, Wa, Sl, Ti, no stain Jo, 70°, Wa, Sl, Ti, no stain Jo, subhor., Wa, Sl, Ti no stain	
91	4:30									Run 20 - lost 0.5' core - arbitrary 0.25' on each end		highly fract'd zone, various orint. little to no Fe stain	@91'- 80 PSI
92	4:30		4.5/5	90	1.1/5		CI	RI		SANDSTONE, not very weathered, hard, m-c grained, Fe stained		Fo, 20°, Wa, Sl, Ti, little Fe stain	C
93	4:47	20			22%	SW				Fe stain ← fract'd zones various orientations		Fo, 30°, Wa, Sl, Ti, little Fe stain	@93'- 150psi
94	6:19									Fe, near vert., Sa, Sl Ti, Fe stain @94.3' color Δ to dark gray 5Y 4/2		Fo, 70°, Wa, Sl, Ti, little Fe stain Fo, 60°, Wa, Sl, Ti, little Fe stain Fo, 60°, Wa, Sl, Ti, no stain Fo, 40°, Wa, Sl, Ti, Fe stain (little)	@94'-220 PSI
95	6:25						Mo	RI		@94.5' layer of dark gray clay w 0.02' width		Fo, 30°, Wa, Sl, Ti, no stain Fo, 10°, He Fo, He, 50° Fo, He, 50°	@95' 250psi
96	No DATA									← 0.25' missing Gray SANDSTONE as above to 96.25' / @96.25' yellow brown SANDSTONE, hard, med grained, altered moderately			D
97	7:00											Fo, 40°, Sl, Wa, Ti, clay film, Sl clean Fe stains Fo, vert, @~80° → Sl, Wa, Ti, no stains highly fractured rock, all orientations little Fe + Mn staining	@97' 250psi
98	11:45		5/5	100	0.4/5 8%	SW-MW	CI	RI-		highly fractured		Jo, 80°, Wa, Sl, Ti, Fe staining Jo, 90°, Wa, Sl, Ti, Fe staining Jo, 80°, Wa, Sl, Ti, Fe staining	250psi 250psi
99	14:50									@99.85' silty, soft zone above gray SANDSTONE		Jo, 80°, Wa, Sl, Ti Jo, 70°, Wa, Sl, Ti, no stain	C 250psi
100	31:35									@99.9' color change back to dark gray		Jo, 40°, Sl, Wa, Ti, no stain Jo, 40°+60°, Wa, Ti, Sl, no stain Jo, 30°, Wa, Ti, Sl, no stain	250psi D
101	40:00												End of Boring TD. 101' 5:20pm 04/19/01
102													
3													
4													
5													

Friable (altered, weak) zone 30B 5Y4/1 Tofb-2a

Color Change → Clay →

Color Change → Color Change →

Tofb-2

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

LOG of ROCK BORING 01-I

friable zone calls by JGH/JLB 5/4/01
unit calls by JLB/CMB/WRL 5/01
Edited for ISFSI SAR by JLB 5/28/01

Project: DCPP ISFSI/CTF	Job Number: 1223a-1	Boring Location: near top of hill	Total Depth: 321 ft
Type & Diameter of Boring: HQ Double core barrel	Elevation and Datum: ~~575~~ 566.9' JLB 5/31/01	Ground Water Depth: not measured*	Depth to Bedrock: 4.0'
Drilling Contractor and Rig: All Terrain Drilling, Failing 1500 Rig; Drillers: Ron & Chris (PM)	Length of Core Barrel and Bit: 5.51	No. of Core Boxes: 22	Date Started: 4/24/01
Casing Size and Depth: Casing set to 4 feet.	Borehole Inclination: 90°	Logged By: RDK, JGH	Date Completed: 4/27/01

* water - mud injected during drilling.

WLA

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
0–4										Casing setting			PSI
4–5		6:46	CB1				SW		R2	very fine to fine grained Sandstone (TOfb-1) massive, hard, slightly weathered, 10YR 7/4 very pale brown	JO, 30°, Pl, Sl, op		210
5–6		7:30		5/5	100%	2.7/5				to DOLOMITE: JLB 4/27/01; * crushed rock w/ sh-mottled clay seam JLB 4/27/01; @6.5 1cm thick clay seam	JO, 60°, Pl, Sm, Gl, MNO & ox; healed microfracture (MNO)		100; 106
6–7		6:00	1			54%				very fine to fine grained Sandstone massive hard, 10YR 7/4 very pale brown	JO, 60°, Pl, he, ti, MNO, thin clay coating 1/8"; Crushed Zone JLB; JO, 20°, Pl, he, ti 5/4/01 JLB 4/27/01		150
7–8		7:00					SW		R2	to DOLOMITE: JLB 4/27/01; silty * crushed zone, not clay JLB 4/27/01; @7.7' 1cm thick clay seam	JO, 70° Pl, Sl, op MNO & ox; JO, 70°, Pl, Sl, op, MNO & ox; JO (ma?) 20°, Pl, Sl, op; JO, 30°, Pl, Sl, op, MNO		110
8–9		7:00					SW		R2	very fine to fine grained Sandstone, massive, hard; needs handlens to see most grains; slightly weathered; same color as above	JO, 30°, Pl, Sl, op; JO, 30°, Pl, Sl, op; Crushed Zone JLB 5/4/01; healed microfracture, Pl, MNO; JO, 30°, Pl, Sl, op, MNO		110
9–10		6:00											110
10–11		6:00	2	5/5	100%	1.5/5					JO, 50° Pl, Sl, op, MNO; healed microfractures, MNO; JO, 30°, Pl, Sl, op, MNO & ox; JO, 0°, Pl, Sl, op		
11–12		9:00				30%				Dolomitic JLB 4/27/01; crushed altered rock JLB 5/4/01	JO, 60°, Wa, Sl, op; JO, 60°, Wa, Sl, op, MNO & ox; JO, 80°, Wa, Sl, op, MNO, 1cm clay along joint		100; Start getting 50% return on fluid
12–13		6:42									Broken		
13–14		8:54									JO, 70°, Pl, Sl, op, MNO; JO, 80°, Pl, Sl, op, MNO & ox; JO, 20°, Pl, Sm, op, MNO & ox; silty crushed zone JLB 4/27/01		110
14–15		8:31	3	5/5	100	1.2/5	SW		R2		JO, 90°, Wa, Sl, op, MNO; JO, 20°, Wa, Sl, op, MNO; JO, 70°, Wa, Sl, op, MNO & ox & clay (oxing)		80

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type of infilling, slickensides, etc.

ROCK BORING LOG

Project	Job Number	Date	Boring No.
DCPP ISFSI/CTF	12239-1	4/24/01	01-I

logged by: RDK

WLA

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks	Time
15–16	8:05, 8:45	3	5/5	100%	1.2/5	SW		R2		very fine grained Sandstone, massive, hard some oxidized grains many white colored grains (Tofb-1)	Jo,10°,Pl,Sm,OP (Me?) Jo,75°,Pl,Sl,OP,OX Jo,10°,Pl,Ti,(0.5-1cm clay) Jo,45°,Pl,Ti,dry Jo,60°,wa,Sl,OP,OX Jo,30°,Pl,Sl,OP,MNO & OX	PSI 80	80% H_2O return	
16–17										Dolomite JLB 4/27/01 occasional fine grave (CMB 4/25/01)	Me Jo,10°,Pl,Sm,OP,OX,MNO Jo,15°,Pl,Sl,OP,MNO healed microfractures (MNO)	90	loss of all circulation	
17–18	7:57				24%						healed microfracture, MNO Jo,10°,Pl,Sm,OP Me Jo,80-90,wa,Sl,OP,MNO Jo,30-90 wa Sl,OP MNO & OX Jo,(Me?),10°,Pl,Sm,OP Jo,30-90,wa,Sl,OP,MNO & OX	100	add polymer mud start getting some tetted water	9:1
18–19	9:17										Jo,0°,Pl,Sm,OP,OX,clay (1mm)		Shut down to pump H_2O up the hill 11:00 AM return to drilling	9:30
19–20	6:00									Same as above slaty & crushed rock, silt/clay/sand for a few feet JLB 4/27/01	Me Be,wa,OP,Ti,OX Jo(Me?),Pl,Sl,OP Slaty fabric 10°-20° dip JLB 4/27/01	180	10% return on H_2O	1015
20										20.5-24 clay layers JLB 4/27/01				
20–21	7:44	4	4/4	100%	4/4	MW		R1		very fine grained sandstone softer than above	Jo,70°,wa,Sl,OP,MNO,clay	190		
21–22	9:24					SW		R2		very fine grained Sandstone, massive hard, handlense needed to see most grains	Jo,0°,Pl,Sl,OP,OX Jo,Pl,Sl,OP,MNO Broken Jo,Pl,0°,Sm,OP Jo,0°,Pl,Sm,OP healed micro fracture ($CaCO_3$ & MNO)	120	clay along fracture Broken areas may be clay along fracture when breaks up coring	
22–23	11:57									altered, crushed rock JLB 5/4/01	Broken Jo,80-90,wa,Sl,OP,MNO,clay (1cm approx) Jo,60°,Pl,Sm,OP MNO & OX clay on fracture, Jo,70°,Pl,Sl,OP	150	11:35AM stop to fill H_2O	
23–24	8:00, 10:00	CB2 5	3/3	100%	2.8/3					Dolomite JLB 4/27/01 Same as above	Jo,70°,wa,Sl,OP,OX Jo,60°,Pl,Sl,OP,MNO & OX healed microfractures (he?) Ja,15°,Pl,Sm,OP	110	12:05PM	
24–25	11:00				93%						Jo,30°,he,ti Jo,10°,Pl,Sm,OP Jo,60°,Pl,he,ti	110		
25–26	7:00									Same as above	Jo,80°,wa,he,ti,MNO & OX	100	50% return H_2O	DS lamin ?
26–27	4:42					SW		R2			he?,wa,ti,he he?,wa,ti,he layers of darker sand Jo,20°,Pl,ti,he Jo(he?),he,ti,Pl Jo,Pl,20°,he,ti	100	many darker layers ≈1-2mm could be bedding	
27–28	8:09	6	4.7/5	94	/5					numerous slightly wavy, thin, darker laminations (healed fr) CMB 4/25/01 10-20° dip JLB 4/27/01	he?,Pl,he,ti slightly darker sand Jo,Pl,10°,Sm,OP	100	Also many healed microfractures	
28–29	12:55										ve,wa,90,Ti(CaCO3) Jo,70°,wa,Ro, Jo,90°,wa,Sl,OP MNO & OX	110		all A
29–30														

Tofb-1

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

Checked CMB 4/25/01

LOG of ROCK BORING 01-I

1223a-1 4/24/01 Page #3 of 22

Project	Job Number	Boring Location		Total Depth
Type & Diameter of Boring		Elevation and Datum	Ground Water Depth	Depth to Bedrock
Drilling Contractor and Rig		Length of Core Barrel and Bit	No. of Core Boxes	Date Started
Casing Size and Depth		Borehole Inclination	Logged By	Date Completed

WLA

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
30–39	Tofb-1, Tofb-1a, Friable zone	10:02, 9:47, 9:37, 8:52, 12:20, 15:16, 4:48, 7:17, 15:15, 9:47	6, 7, 8, 9	4.7/5, 5/5, 3/3.8, 5.2/5.2	60%, 100%, 62%, 79%, 10%, 100%, 61%	3/5, 3.1/5, 0.4/3.8, 3.2/5.2	SW, SW, SW, SW	R2, R1-R2, R2	Same as above very fine grained sandstone; Dolomitic JLB 4/27/01; @33.6 becomes slightly darker color same rock as above; JLB 5/4/01 slightly darker color (CMB 4/25/01); v. fine to fine grained massive (CMB 4/25/01)	10YR 8/2 very pale brown (Tofb-1, Tofb-1a); 10YR 7/2 light grey; Same as above; Same as above	Jo,0°,Pl,Sm,oP; Jo,90,Wa,Sl,oP,MNO & ox; Jo,90,Wa,ti,MNO; Jo,40°,Pl,He,ti; many healed microfractures and some very small darker bands. ?bedding? ~15°; Jo,20°,Pl,Sl,oP,MNO; Jo,80-90,Wa,Sl,oP,OX; Jo,10,Pl,Sm,oP,clay; Jo,40°,Pl,Sl,oP,MNO & ox; Jo,20°,St,Ro,oP; Healed microfractures (MNO); Jo,40°,Pl,Sl,oP,ox; Jo,50,Pl,Sm,oP; Jo,10°,Pl,Sm,oP; Broken; Bu(?); Jo,10-15°, fissile zone along laminations, Pl,ti; JLB 4/27/01; Jo,80°-90°,Wa,Sl,oP,MNO,clay; Jo,70°,Pl,Sl,oP,MNO,ox; Jo,50°,Pl,Sl,oP,MNO; Broken disturbed; Crushed zone w/ silt on along films on fragments JLB 4/27/01; Jo,Wa,80°-90°,Sl,oP,clay (1mm); Ve,70,Wa,he,ti,MNO JLB 4/27/01; Jo,20°,St,Sl,oP, irregular oxidized clay lin's; Jo,Pl-St,Sl,oP healed micro fracture (MNO); Jo,70,Pl,Sm,oP; Jo,70°,Pl,Sl,oP,MNO & ox clay (8.5cm); Jo,80°,Pl,Sl,oP,MNO & ox; Jo,70°,Pl,Sl,oP,MNO; * Subhorizontal lamination, 10°-15° bedding JLB 4/27/01	PSI; 120; 120; 2:30 PM; Film 1/16" thick; 180; 120; 100; 3:40 PM; 150; 140; 150; 160; 110; ← clay along fr * (CMB 4/25/01); 120; all A	

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Ti-Tilled, He-Healed, Op-Open and Ti-Tight), type of infilling, slickensides, etc.

Check CMB 4/25/01

ROCK BORING LOG

Project	Job Number	Date	Boring No.
DCPP ISFSI/CTF	12239-1	4/24/01 - 4/25/01	01-I

logged by: RDK/WLA

WLA

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
45		7:52				SW		R2		very fine grained sandstone, clay along bedding		Jo, Pl, Ro, op, ox, MNO; clay bed (2cm thick) *	PSI 100
46		6:28				SW		R2		@ 45.6ft. clay bed returns to very fine grained sandstone, massive, hard (Tofb-1) Dolomitic JCB 4/27/01 10YR 7/2 very pale brown		Jo, 20°, Pl, Sm, op, MNO; Stiff silty clay bed w/ tight 10°-15° contact w/ rock JCB 4/27/01	TIME 6:00 PM
47		7:05	10	5/5	100%					15-20° clay and carbonate seam, silty, stiff JCB 4/27/01		Jo, 70°, wa, Ro, op, ox; Jo, 80°-90°, wa, Sl, op, MNO; Jo, 30°, Pl, Sl, op, ox; Jo, 50°, Pl, Sl, op, ox	100
48		7:36			3.2/5 61%							clay along Jo, Pl, Sl, op; Jo, 45°, Pl, Sl, op	100
49		7:44				SW		R2		@ 48.1 clay seam along joint (cm-thick) very fine grained sandstone to fine grained (CMB 4/25/01) Dolomitic JCB 4/27/01 Same as sandstone above clay		Jo, 70°, wa, Sl, op, MNO; ox	100
50		7:22	CB 4									Me; Jo, 80°-90°, T, He, MNO; Jo, 70°, Pl, Sl, op; Jo, 80°-90°, wa, Sl, op, MNO; ox; Me	100
51		8:24								Same as above		Jo, 80°, Pl, Sm, op, MNO; ox; Me	70% circulation loss; No return on water
52		6:47	11	5/5	100%							Jo, 80°, Pl, Sl, MNO, ox, CaCO3	110 6:35 PM; 100
53		11:10			2.75/5 55%							Jo, 30°, Pl, Sm, op, ox healed microfracture (MNO); Jo, 70°, wa, ti; Jo, 30°, Pl, Sm, op, ox	10% return on H_2O; 150
54		8:55										Jo, 10°, Pl, Sl, op; Me	
55		8:28				R2				SANDSTONE, Dolomitic, 7.5YR 5/4 (m), Massive, V. fine-grained, v. well sorted, moderately oxidized sand, hard, slightly weathered.	NR		Started drilling on 4/25 @ 7:21 AM @ 56'-' 75 psi - No Return on H2O yet 0% circ.
56		10:23	12	4.55/5.0	91	SW		R2				Me, 0°, Pl, Sl, T; Tofb-2 JCB 4/27/01	
57		8:02			2.9/5.0 58%					occasional fine grained clasts disseminated throughout (CMB 4/25/01) (Tofb-1)		Me, 0°, Sl, Ti; crushed zone - Clay/grey sandy	
58		6:09										Jo, wa, 0°, Sl, T; Jo, 0°, wa, Sl, op, ox; Jo, 70°, Pl, Sl, op, ox	
59		7:52										Jo, 0-30°, wa, Sl, op, ox; Me, wa, Sl, Ti; Crushed zone.	

Tofb-1 (45–50); Tofb-2 (55–56); Tofb-1 (56–59)

7:21 4/25; 8:09 6/4

10°-15° bedding laminations JCB 4/27/01

RDK J A A-B

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

Check CMB 4/25/01 CMB M. RL

ROCK BORING LOG

Project	Job Number	Date	Boring No.
DCCP/ISFSI	12236-1	4/25/01	01-I

WLA

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
8:08													
60													
61		8.02				SW			R2	Same as above (Tofb-1, Tofb-1a) crushed rock zone w/ some clay, not a bdg. seam JLB 4/27/01		Jo, 90°, Pl, Sl, HE, MnO -Jo, 15°, Wa, Sl, OP, OX -Jo, 0°, Wa, Sl, OP, OX	
80psi		5:50	13	4.7/5.0	94	HW			R0	Clay Seam w/ common rock frags.		-Crushed zone w/ clay	@61' - 80 psi 0.5° circ
62		6:51			1.05/5.0 21%	SW			R2	SANDSTONE - as above.		-Jo, 80°, Wa, Sl, OP, CX -Me, 0°, Pl, Sl, Ti, OX	
										crushed rock zone w/ silt & clay, not a bedding seam JLB 4/27/01		-Jo, 80°, Wa, Sl, OP, MnO	
63		13:07				HW			R0	Clay zone w/ common rock		-Crushed Zone	@63.5' Driller reports harder drilling.
64		11:25				SW			R2	SANDSTONE as above very fine to fine grained		-Jo, ~90°, Wa, Sl, OP, OX -Jo, 0°, Wa, OP, OX + MnO	@64' - 140 psi
100		1:51											
8:57									R1(-) to R2(-) JLB 4/27/01	Same as above			
65		10:57	↓CB 5	4.3/5.0	86	SW			R2	@~66' - large claystone rip up clast			
66		10:19	14									-Me, 0°, Pl, Sl, OP,	@67' - 80 psi 0.5° circ
67		9:39			3.95/5.0 79%							Me, 0°, Pl, Sl, Ti -Jo, 90°, Wa, Sl, He, OX Jo's, 30°, Pl, Sl, OP	
68		1:29											@68' - V. Soft Drilling
69		12:57				HW			R0	Clay Zone w/ common rock fragments		-crushed zone w/ silt & clayey Not a bdg. clay seam JLB 4/27/01	
										SANDSTONE - as above		-Me, 0°, Pl, Sl, Ti	
9:45 7:45													
70		12:39										-Crushed Zone, Friable	@71' 100 PSI 0.5° Circ
71		10:12	15	4.7/5.0	94	SW			R2			-Jo, 0°, Pl, Sl, OP, OX -Crushed Zone w/ Clay -Me, 0°, Pl, Sl, OP, OX -Me, 0°, Pl, Sl, Ti, grooves	
72		11:33			0.95/5.0 19%							-Jo, 20°, Wa, Sl, Sl OP, OX	@73' - 110 PSI 0.5° circ.
73		8:02										-Me, 0°, Pl, Sl, Ti -Jo, 90°, Wa, Sl, OP, OX + MnO	
74		8:16										. Subhorizontal laminations JLB 4/27/01	@74' - 130 psi
12:33													
75													

Tofb-1 (Crushed rock zone) Friable zones JLB 5/4/01 Tofb-1 Tofb-1a Friable (crushed rock) zone JLB 5/4/01 Tofb-1 Tofb-1 Tofb-1

A-B

A

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy). Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

Checked JLB 4/27/01

ROCK BORING LOG

Project	Job Number	Date	Boring No.
DCPP ISFSI	1223a-1	4/25/01	

WLA

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
0:46 / 150PM; 5–6	12:39					SW		R2		SANDSTONE - as above (Tofb-1) Gradational Contact		-Jo, 10°, Pl, Si, op	@75'-150 psi
6–7	9:03	16	5.0/5.0	100	3.95/5.0	SW		R2		SANDSTONE - Dolomitic & Petrolithic, 10YR 4/1 (m), fine-Medium-grained, well Sorted, organic rich Sand. Massive, Moderately hard, petro odor on fresh surface. Primarily fine grained (CMB 27 April 2001)		- Me, 0°, Pl, Si, op, ox	
7–8	9:28				79%							-Jo, 0°, Wa, Si, op, V.ox; -Jo, 60°, wa, Si, op, V.ox.	
8–9	8:38												
9–10	9:19											Me, 0°, Pl, Si, Ti, ox	
11:35 / 1:41; 10–11	10:27	CB 6			4.35	SW		R2		Same as above. Contact gradational over 0.5' (CMB)		-Be, Pl, 0°, Ti	
11–12	9:00	17	5.0/5.0	100	5.0 / 87%	SW		R2		SANDSTONE, Dolomitic, greywacke?, 10YR 5/4, v. fine-grained, well Sorted, Moderately oxidized Sand, Massive, Moderately hard, common Dark colored blotches & laminations that decrease w/ Depth.		Jo, 20°, Pl, Si, op, slox	JH ↑ RDK ↓
12–13	10:58											-Me, 0°, Pl, Si, T.	
13–14	10:23												
14–15	9:03											-Me, 0°, Pl, Si, T.; -Me, 0°, Pl, Si, T.	
2:31 / 12:42; 15–16	9:04									to DOLOMITE JLB 4/27/01		Jo, 90°, wa, Si, op, MNO & ox; Jo, 50°, Pl, Si, op, MNO; Broken; Jo, 20°, Pl, Sm, op trace clay; Jo, 20°, Pl, Sm, op; Jo, Wa, ti, he, fi (CaCO3 (0.5cm); Ve, wa, he, ti, fi, CaCO3 (0.25mm)	@85'-100 psi OJ Circ.
16–17	7:32									Well-defined bed-parallel laminations (CMB 27 April 2001) Laminations dip 12-20° JLB 4/27/01			
17–18	9:03	18	5.0/5.0	100%	3.2/5.0 / 64%	SW		R2		Same as above		Ve, 50°, Pl, Sm, He, (CMB 27 April 2001); Jo, 20°, Pl, Sm, op remnant vein fill on joint (CMB 27 April 2001)	
18–19	9:58											Be; Jo, 80°, Pl, Si, op, MNO & ox; Jo, 70°, Wa, Si, op, MNO, & ox; Jo, 20°, Pl, Sm, op; Jo, Pl, 20°, Sm, op	
19–20	11:07											Me	all A ↑
1:29													

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Si-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

/ Check CMB 27 April 2001

ROCK BORING LOG

Project	Job Number	Date	Boring No.
DCPP / ISFSI	1223a-1	4/25/01	01-I

WLA

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
90		6:25				SW		R2		Same as above		Jo, 20°, Pl, Sl, OP, clay (0.25-0.5cm)	
91		5:50				SW		R2		Dolomitic JLB 4/27/01 fine-grained sandstone, darker than above, massive, well sorted, oxidized sand, occasional clasts up to 1cm (lava), some organic layers, can see grains w/out hand lens		Broken; Jo, 70°, Pl, Sl, OP, MNO, ox, clay films JLB 5/4/01; Jo, 70°, wa, Sl, OP	
92		5:15	19	5.0/5.0	100%					(Tofb-1)		Jo, 20°, Sl, OP; Jo, 70°, Pl, Sl, OP-ti, CaCO3 remnant vein fill on joint (CMB 27 April 2001)	No Return
93		6:30			2.6/5 52%					0.4" elongated rounded clast (CMB 27 April 2001)		Jo, 30°, St, Sl, OP, trace clay; Jo, 30°, Pl, Sl, OP, MNO, ox, clay; Jo, 30°, Pl, Sl, OP, ox, trace clay	
94		7:02				SW		R2		gradual contact: very fine grained sandstone need hand lense to see grains well sorted, massive		Jo, 60°, Pl, Sl, OP, MNO & ox	2:04 PM
95		8:00	CB7			SW		R2		very fine to fine grained sandstone, a slightly coarser than above, massive, well sorted		Jo, 70°, Pl, Sl, OP, mpdo, ox; Jo, 20°, St, Sm, OP	A
96		4:22										Jo, 20°, Pl, Sl, OP; Jo, 60°, wa, Sl, OP, MNO; Jo, 80-90°, wa, Sl, OP, MNO, ox	
97		4:58	20	4.7/5.0	94					grades finer (CMB 27 April 2001)		numerous bedding surfaces oxpermanganate dry (CMB 27 April 2001); Jo, 80°, 90°, wa, Sl, OP, ox	PSI 80 A-B
98		6:47			1.0/5.0 20%	SW		R2		very fine grained sandstone massive, well sorted 10YR 7/4 very pale brown		Jo, 20°, Pl, Sm, OP, ox; Jo, 10°, Pl, Sl, OP; Jo, 70°, Pl, Sl, OP, MNO, ox	2:35 PM
99		8:32								Dolomitic JLB 4/27/01		me; Jo, 80-90°, wa, OP, MNO & ox; me; me; Jo, 80-90°, wa, Sl, OP, MNO, ox; me	100; 150; core has lot of mechanic fractures a is broken up
100		9:12				SW		R2		very fine to fine grained sandstone varies between very fine and fine grained, massive, well sorted, hard 10YR 6/4 lt. yellowish brown; well-cemented (CMB)		Jo, 20°, Pl, Sm, OP, trace clay; Jo, 20°, St, Sl, OP; Jo, 20°, Pl, Sm, OP, trace clay	90
101		9:35										Jo, 70-80, wa, Sl, OP, grey discoloration (0.5cm); Jo, 0°, Pl, Sm, OP	80
102		22:06	21	5.0/5.0	100							Jo, 80-90°, wa, Sl, OP, MNO, ox; Jo, 50°, Pl, ke, ti; Jo, 50°, Pl, Sl, OP; subhorizontal (10-15°) bdg. laminations JLB 4/27/01	0.1" alteration/bleaching of rock along fractures (CMB 27 April 2001)
103					0.6/5.0 12%					well-defined bedding-parallel lamination (CMB 27 April 2001)		Jo, 90, wa, Sl, OP, MNO, ox; Jo, 50°, wa, Sl, OP, MNO, ox; Jo, 50°-90°, wa, Sl, OP; Jo, 20°, Pl, Sl, MNO	150
104		8:14								Dolomitic JLB 4/27/01		Jo, 20°, Pl, ke, ti; Jo, 30°, Pl, Sl, OP, MNO; me; me	No H_2O return
105													

Tofb-1

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

✓ check CMB 27 April 2001

ROCK BORING LOG

Project	Job Number	Date	Boring No.
DSPP/ISFSI	1223a-1	4/25/01	01-I

WLA

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
105	NR	8:27				SW		R2		fine grained sandstone, massive moderately hard, slightly weathered 10YR 6/4-6/6 (Tofb-1, Tofb-1a)		Stiff clayey, silty Sand Seam, 10-12° along bedding JLB 4/27/01	PSI 60
106		7:49								@ 106.6 clayseam oxidized (2cm)		clay seam (with fine-med. grained sand) CMB 27 April 2001	60
107		6:42	22	4.2/5.0	84	SW		R2		fine grained sandstone massive, hard 10YR 6/4-6/6 lt. yellowish brown to brownish yellow		Me	60
108		6:20			2.2/5.0 44%							Me; J0,20°,Wa,Sl,OP,ox; J0,80°-90°,Wa,Sl,OP,CaCO3,MNO,ox; J0,20°,Pl,Sm,OP	60
109		6:37								well-defined bedding laminations, darker. (CMB 27 April 2001) 18-20° ± JLB 4/27/01		J0,80°,Wa,Sl,OP,MNO,ox, trace clay; Broken clay along joints	100
110	NR	5:34	CB 8			SW of MW zones	JLB 4/27/01	R1-R2(-)		(CMB 27 April 2001) Sandy Clay ?		J0,80°-90°,Wa,Sl,OP,CaCO3,MNO,ox; Broken clay along joints 1cm clay at bottom of run.	
111		3:22								finely bedded (10°) becomes more weathered with depth, still fine grained		possible slough (?) JLB 4/27/01	140
112		3:45	23	2.9/5.0	58							J0,Wa,Sl,OP,ox JLB 4/27/01	40
113		7:32			0/5.0 0%	MW		R1				J0,80°,Wa,Sl,OP,ox,clay 1/8" thick; J0,80°,Wa,Sl,OP,MNO,ox,clay	60
114		5:46				HW		RO		very fine grained altered sandstone, with clay highly weathered		J0(Be?),Pl,OP,Sl,ox; J0(Be?),Pl,Sm,OP,ox; Broken, highly weathered	100
115		6:42				SW		R2		fine grained sandstone, finely bedded, moderately hard. 10YR 6/6 yellowish brown		Broken, Planar Me	5:35pm
116		5:10				HW		RO		high clay content same rock (weathering; not clay bed) CMB 27 April 2001		J0,80°,Wa,Sl,OP,MNO	100
117		8:10	24	4.8/5.0	96	SW-MW		R2				J0,0°,Pl,he,ti; J0,we,10°-30°,ti,he,CaCO3(1mm); J0,Pl,80°,Sl,OP,MNO,ox; J0,we,ti,CaCO3; J0,20°,Pl,Sl,OP	100
118		4:36			2.2/5.0 44%					combined well defined bedding laminations (CMB 27 April 2001)		Be,20°,he,ti; Be,20°,Pl,Sm,OP; J0,60°,Pl,ti,he,MNO,ox; J0(Be?),Pl,OP; J0,70°,Wa,Sl,OP,ox; Be,10°,Pl,OP	100
119		4:01										J0,Pl,80°,Sl,OP,MNO,ox,CaCO3 crushed JLB 5/1/01	100
120													

Tofb-1; Tofb-1a; friable (crushed/altered) zone JLB 5/4/01; Tofb-1

all A-P

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

✓ Check CMB 27 April 2001 CMB JLB

ROCK BORING LOG

Project	Job Number	Date	Boring No.
DCPP ISFSI	1223a-1	4/25/01	01-I

WLA

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
120	NR	2:34				SW		R2		fine grained sandstone same as above well sorted (Tofb-1)			PSI 100
121	NR	2:12											100
122	NR	4:11	25	3.1/5.0	62	0.4/5.0 8%				occasional med-grained mafics (MB 27 April 2001)		Crushed, altered rock JLB 5/1/01	100
123		4:08										Broken; Jo,20°,Pl,oP-ti,0.5cm clay; Jo,70°; Jo,70°,Pl,Sl,oP,ox	140
124		6:56				HW		RO		fine clayey sand 10YR7/3 yellow		Clayey sandstone, bed, 10-20° dip JLB 4/27/01; Jo,80°-90°,wa,Sl,oP,MNO; Jo,20°,wa,Sl,oP; Jo,70°,Pl,Sl,oP,MNO; Ve,wa,ti,he,CaCO3 (0.25cm)	
125	NR	2:14	CB9			SW		R2		0.1ft coarse sandstone; fine to med. grained sandstone darker than above, massive hard, 10YR 6/3 pale brown well sorted, moderately hard, thin bedding, dark laminations, occasional coarse lithic clasts, subangular dark			50
126		3:23		1.8/3.0	60	0	HW	RO				← Crushed silty (sand) zone JLB 4/27/01 0.1' thick, low angle - med. angle dip? (10-30°±)	
127		5:19	26			3.0	SW	R2		sand grains (0.25-0.5mm) ← @26.2 more weathered than surrounding rock		← Laminations 60-85° JLB; Jo,75-85°,wa-St,Sl,oP JLB 4/27/01	B
128	NR	6:03					HW	RO		JLB 4/27/01 grades coarser JLB 4/27/01		ME ← 0.1' thick crushed/clayey * Zone, med. angle (20-35°) JLB 4/27/01; Jo,70°,Pl,Sl; ← Thin clay film on joint JLB 4/27/01	Begin Drilling 10/26/01 7:00am; line out casing and put back in to unclog
129		9:27	27	1.4/2.0	70	0.4/2.0 20%				med. grained Dolomitic SANDSTONE		Jo,St,RO,oP,MNO; Jo,50°,Pl,Sm,oP,OX; Jo°,80°,90°,wa,Ro,oP,ox,MNO	80
130		10:18										← Slough	120
										same as above			8:45am resume drilling * DS
131		4:42		4.0/4.0	100%	SW est. by JLB 6/1/01		R2		@130.5 clay seam (1cm thick) w/med-fine-grained sand back into fine-med. grained sandstone same as above clay seam		← * 1/2-1cm stiff CLAY SEAM 10°, Pl, along bedding JLB; Jo,20°,Sm,oP,clay,ox; Jo,80°-90°,wa,Sl,oP,MNO,ox	80
132		6:15	28			.9/4.0 22%				10YR 6/6 brownish yellow; fine grained Dolomitic SANDSTONE JLB 4/27/01		Jo,70°,wa,Sl,oP crushed, altered rock JLB; Jo,wa,80°,oP,Sl,MNO,ox 5/1/01; Jo,20°,St,Sl,oP	40 0.4 ft. of debris in top of core
133		5:49					MW	R1		same rock, more weathered softer		Broken; Jo,70°,wa-St,oP,ox; Jo,20-40°,wa-St,oP,ox; Me; Ve,he,ti,facO3	80
134	NR	6:28	29	3.9/5.0	78	1.6/5.0 32%	SW	R2		gradual contact grades to fine grained sandstone, hard finely bedded (dark laminations) occasional coarse grains			80
135													

Tofb-1

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

Checked JLB 4/27/01

ROCK BORING LOG

Project	Job Number	Date	Boring No.
DCPP / ISFSI	1223a-1	4/26/01	01-I

WLA

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
135–150	7:08, 5:39, 6:05, 7:57, 6:27, 5:55, 4:48, 6:02, 2:59, 4:52, 9:02, 10:19, 8:46, 5:30	29, 30, 31, 32	3.9/5.0, 5.0/5.0, 0.6/2.0, 5.0/5.0	78, 100, 30, 100%	4.6/5.0, 2.6/5.0, 0/2.0, 1.8/5.0	SW, HW, SW, SW-Fr, MW	JLB 4/27/01	R1-R2, Ro, R1-R2, R2, R1		fine grained sandstone, Same as above many healed microfractures 10YR 7/6 yellow well sorted, occasional coarse grains (dark) (To fb-1); Crushed rock JLB 5/4/01; Becomes massive w/depth; between 141.7 and 141.9 softer RO (along a Joint) JLB 4/27/01; Same as above; very fine grained dolomitic sandstone, finely laminated, dark organic layers, hard, well sorted, $CaCO_3$ cement, 10YR 8/2 very pale brown TO DOLOMITE; Crushed altered rock JLB 5/4/01; fine grained sandstone, well sorted, coarser than above 10YR 6/6 brownish yellow	Me; Me; Me; Ve, he, ti, wa, $CaCO_3$; Me; Me; Me; Jo, 70°, wa, Sl, op, ox; Jo, 70°, Pl, Sl, op, ox; Jo, 40°, Pl, Sm, he, ti, MNO, ox; Jo, 70°, Pl, Sl, op, ox; Jo, 50°, Pl, Sm, op, ox; Jo, 60°, wa, Sl, op; Jo, 80-90°, wa, Ro, op; Ve, healed, ti, $CaCO_3$; Me; Jo, 70°, Pl, Sl, op, 0.5cm clay; Jo, 90°, wa, he, ti, MNO; Jo, 80°-90°, wa, Sl, op, ox; Me; Jo, 70°, wa, he, ti; Ve, he, ti, $CaCO_3$; Jo, 70°, wa, Sl, op; Jo, 70°, wa, Sm, op, clay; Broken; Jo, 70°, Pl, Sl, op, clay, ox; Jo, 20°, Pl, Sl, op (3-4mm clay) or drilling clay? JLB 4/27/01; Jo, 20°, Pl, Sl, op; Jo, 20°, Pl, Sm, op, MNO, ox; Jo, 90°, wa, Sl, op, MNO, ox; Jo, 15°, Pl, Sl, op, MNO, ox; Me; Jo, 20°, St, Sl, op, MNO; Jo, 10°, Pl, Sl, op, ox; clay along Joints; shattered broken	Crushed zone JLB 4/27/01; Bedding laminations 10°± JLB 4/27/01; JLB 4/27/01; Broken zone w/ thin stiff clay ← Coatings on Joints (smear)	PSI; 30 PSI; 80; 80; 100; 80; 80; 60; 80; 75; 60; 80; 100; 100; 100	11:30AM; B; A; B

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

Checked JLB 4/27/01

ROCK BORING LOG

Project	Job Number	Date	Boring No.
DCPP/ISFSI	1223a-1	4/26/01	01-I

WLA

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
150–151	6:55	32	5.0/5.0	100%	1.8/5.0 36%		MW		R1-R2	same as above; fine grained SANDSTONE JLB (Tofb-1, Tofb-1a) 4/27/01		shattered broken; Jo, wa, 75-80°, si, op	12:15 PM down for repairs overshot spring bed; 1:30 PM start drilling again; B
151–152	3:15	CBH					HW		R0	very fine sand to silt w/clay highly weathered. Entire mass is weathered, soft		Silty crushed, clayey zone, Part slough (?) JLB 4/27/01	
152–153	20:53	33	5.0/5.0	100%	3.0/5.0 60%		SW		R2	very fine to fine grained dolomitic sandstone, massive, some laminations 10YR 8/2 very pale brown		Be?, 0°, Pl, * Bdg. laminations ±10° JLB 4/27/01; Jo, Be?, 0°, Pl, op; Jo(Be?) 10°, Pl, Sl, op; Jo, 70°, wa, Sl, op, MNO, ox	core slipped out of shoe retrieving run 33 was ~ recovered during run 54. Both runs considered 5 feet run together
153–154	8:53											Jo(Be?) wa, Sl, op; Jo, 70, wa, Sl, op, 0.5cm clay on joint; Jo, 0°, Pl, Sm, op, MNO	140 PSI
154–155	9:52	34					SW		R2	grey, very fine to fine grained sandstone, massive, Gley 1 6/10Y greenish grey		Jo, ti, he, MNO, ox; Jo, 90, mullions & polished surfaces JLB 5/4/01; Fault w/ horiz. movement. JLB 5/4/01; * Med.-coarse grained SANDSTONE JLB 4/27/01	150 PSI; 2:30 pm; A-B
155–156							MW-HW		R0-R1	med to coarse grained sandstone Gley 1 7/10Y ~~light~~ greenish grey.		Jo, 20°, Pl, Sm, op (slicks?)	
156–157	10:20						SW	as CLENO	R1? R2	very fine grained sandstone, massive, many healed microfractures, Gley 1 7/10Y to 6/10Y H. greenish grey to greenish grey, well sorted, some thin darker laminations. Some clasts of fine sand. petrolithic		* Bedding Contact 15°-18°, and 1/4" shaley seam w/ Slickensided (faint) Joint surface; Jo, wa, 80°, he, ti	100 PSI
157–158	9:52	35	5.0/5.0	100%	4.2/5.0 84%				R2?		JLB 5/2/01	we, he, ti, CaCO3, MNO; Jo, wa, 80°, he, ti; me	100 PSI; 100 PSI; B
158–159	10:26									Dark Petrolithic Calcareous Fine-grained Dolomitic SANDSTONE JLB 4/27/01		faint bedding laminations 10-15° JLB 4/27/01; Jo, 80°, wa, he, ti, fi, CaCO3; healed microfracture; Be(?) Jo, 15, wa-Pl, Sl; healed microfractures	100 PSI
159–160	10:06											Jo, 30°, wa, Sm, op; we, he, ti, fi CaCO3; Jo, 20°, wa, Rough	100 PSI; DS TEST 1
160–161	9:31									same as above			
161–162	13:33	CEH										Be?, 0°, Pl, dark brown; Jo, 70°, Pl-wa, Sl, op, CaCO3	120 PSI
162–163	13:05	36	5.0/5.0	100%	3.5/5.0 70%							Jo(Be?) 10°, Pl, Sl, op; Faint Subhorizontal laminations JLB 4/27/01	160 PSI
163–164	9:09									below 164.2 ft. rock becomes darker; Gley 1 5/10Y greenish grey		Jo(Be?) 15°, Pl, Sl, op	150 PSI; DS TES
164–165	8:13											Jo, 10°, Pl, Sl, op; Jo, Be?, 10°, Pl, Sl, op	150

Tofb-1; Tofb-1a (Grube) JLB 5/4/01

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

Checked JLB 4/27/01

ROCK BORING LOG

Project	Job Number	Date	Boring No.
DCPP/ISFSI	1223a-1	4/26/01	01-I

WLA

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	PSI	Remarks
165	11:45	36	5.0/5.0	100%	3.5/5 70%	SW		R2		Same as above. Dark Petrolithic fine-gr. SANDSTONE (Tofb-1)		{Jo, (Be?) 10°, Pl, Sl, Ti, -, Op	110 PSI HEP	
166												Jo, 10°, St, Sl, Op		
167	15:52					SW-MW		R1-R2		Very fine to fine grained Sandstone, thin laminations, some beds slightly weathered others mod. weathered, well sorted 10YR 6/6 brownish yellow		Jo, 20°, Pl, Sl, Op, ox; Jo, 80°, Pl, Ti, he; Jo (Be?), Pl, Sl, Op	150; 150	5:30 PM
										@167.48' clay seam		Jo (Be?), Sl, Sl, Op; Jo (Be?), Pl, Sl, Op; Zone of multiple clay seams 1/8-1/4" thick along 10° bdg. laminations		
168	8:43	37	5.0/5.0	100%	2.8/5.0 56%	SW		R1-R2		Same as sandstone above clay layer		Jo, 20°, Pl, Sl, Op, ox	140	DS? clay
169	6:18											healed microfractures (CaCO3 1-2mm)	150	B
170	6:22											Jo, 80-90°, Wa, Sl, Op, CaCO3, Ox		
										Slough(?) JLB 4/27/01		Jo (Be?), 20°, St, Sl, Op; Jo (Be?), 0°, Pl, Sl, Op; Me		
171 RDK JCH 7:00 PM	10:00					HW		RO		Clay seam w/Rock fragments; Possible Vertical Fabric — to axis of cave.		Crushed zone w/Clay - Vert. Fab.; Jo, 10°, 1/8" silty clay infill, Planar	80 PSI	Possible slough(?) JLB 4/27/01
172	10:00	38	5.0/5.0	100%	3.2/5.0 64%	SW		R2		@171.2' - SANDSTONE, dolomitic, common to many fine laminations of darker bands, very fine to fine-grained, well sorted, slightly oxidized sand, moderately hard. Laminations dip 10-12°.		Jo, 90°, Wa, Sl, He, Ox + CaCO3	80 PSI	
173												Me, 0°, Pl, Sl, Ti;		A-B
174	26:00									-174.6' - Thick lamination; -174.7' Possible bedding; -174.9' - Thick lamination; -175.0' - Possible bedding		Me, 0°, Pl, Sl, Ti; Jo, 0°, St, Sl, Op, Ox; >Be, ~10°, Pl, Sl, Ti; 3-Be, ~10°, Pl, Sl, Ti;	100	DS bdds?
175	8:03									Fine-med. grained, Dolomitic, Laminated SANDSTONE JLB		>Me, 0°, Pl, Sl, Ti;	100; @176' - 80 PSI	
176 7:19 PM										-Same as above. 4/27/01		Me, 0°, Pl, Sl, Ti, Ox		
	10:51	CB 13										Jo, ~0°, St, Sl, Op, Ox		
177	7:42	39	5.0/5.0	100	2.1/5.0 42%	SW		R2				Me, ~0°, Pl, Sl, Ti		
178	8:59											Jo, 90°, Wa, Sl, Op; 3-Crushed zone		
179	7:15											Jo, 90°, Wa, Sl, Op, MnO		
8:03 PM 180												Jo, 0-10°, Wa, Sl, Op, MnO		

Tofb-1

* Well-developed bedding laminations, thin (1/4"-2") shale lamination, and clay seams, dip 10°+ JLB 4/27/01

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, Sl-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

checked JLB 4/27/01

NITE CREW

ROCK BORING LOG

Project	Job Number	Date	Boring No.
DCPP ISFSI	1223a-1	4/26/01	01-I

WLA

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
180	7:30	39	5/5	100	2.1/5 42%	SW		R2		@180' grades to few to common fine laminations. SANDSTONE- Same as above, but goes to Massive. No laminations. (Tofb-1)		-Jo, ~30°, wa, Sl, op, ox	
181	9:33											-Jo, 80°, wa, Sl, op, v.ox, MnO -Crushed zone, ox	@181' 80 PSI
182	13:42		4.9/5.0	98	1.7/5.0 24%	SW		R2				>Jo, ~0°, wa, Sl, He, ox, CaCO3 -Jo, ~10°, wa, Sl, He, pro CaCO3	@183'-100 PSI 0.8° Circ
183	9:57	40										-Me, 0°, Pl, Sl, Ti -Jo, 40°, Pl, Sl, op, -CaCO3 -Be, ~0°, Pl, Sl, Ti	@184'-120 PSI
184	9:20					SW		R2		SANDSTONE, dolomitic, Petrolithic, grey, V. fine to fine grained, well sorted organic rich Sand, Massive, 184.9 Moderately hard.		-Me, 0°, Pl, Sl, Ti -Jo, 70-80°, wa, Sl, op, ox	
185	8:13					HW		Ro		Clay Seam, Oxidized, Many Slicks		*Crushed zone w/Clay & Slicks -Be, ~0°, Pl, Sl, Ti	2 clay beds 185.0-185.25 -2cm 185.2-185.25-1cm Stiff clay. Upper bed 10-20°, Partly warped into joint. Lower bed 10-15° w/ tight, lower contact
186	7:39					SW		R2		185.3 SANDSTONE, dolomitic, greywacke(?), yellowbrown, V. fine to fine grained, well sorted, well oxidized Sand, with few to common fine laminations, Moderately hard. few claystone rip up clasts in Sandy Matrix.		-Jo, 70-90°, wa, Sl, op, ox -Jo, 90°, wa, Sl, op, ox + MnO -Jo, 10°, wa, Sl, op, ox -Jo, 10°, wa, Sl, op, ox -Jo, 60-70°, St, Sl, Fi, Clay Seam, Friable	Jus 4/27/01 @187 100 PSI
187	8:13	41	5.0/5.0	100	2.9/5.0 58%							-Me, 0°, Pl, Sl, op -Jo, 80°, wa, Sl, Slop, ox -Me, 0°, Pl, Sl, Ti -Jo, 10°, wa, Sl, Clay Film (1/16") Jus 4/27/01	against rock, and polished surface 4/27/01
188													
189	11:47									Gradational Contact over 0.5'		Be, 0°, Pl, Sl, Ti	
190	5:21					SW		R2-R1		SANDSTONE, dolomitic, Petrolithic, grey, Medium grained, well sorted organic rich Sand, Massive. Moderately hard w/ few Claystone rip up clasts in Sandy Matrix.			
191	5:33	CB 14										NR -Jo, 0°, wa, Sl, He -Jo, 10-15°, wa, Sl, op	
192	6:56	42	4.8/5.0	96	2.75/5.0							-Jo, 0°, St, Sl, Ti	100 PSI
										Gradational Contact over 0.5'		-Be, 0°, Pl, Sl, Ti, grades	
193	6:21				59%					SANDSTONE, dolomitic, greywacke(?), yellowbrown, fine-grained, well sorted, well oxidized Sand, with few random fine laminations Moderately hard.		-Jo, ~0°, wa, Sl, op, ox	
194	7:10					SW		R2				-Jo, 30°, Pl, Sl, Slop, ox >Jo, 0°, wa, Sl, op, ox + MnO -Jo, 90°, wa, Sl, op, ox + MnO -Crushed zone	
195												-Jo, 0°, Pl, Sl, Slop, ox + MnO	

Tofb-1

8:43 8:18 PM — 9:07 PM 9:25 — 10:02 10:14

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

ROCK BORING LOG

Project	Job Number	Date	Boring No.
DCPP ISFSI	1223a-1	4/27/01	01-I

WLA

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
195	5:23	42	4.8/5	96	2.95/5	SW		R2		Same as above (Tofb-1)		SOLID	
196	4:42				59%					Same as above @196.7 - Possible internal bedding contact. Abrupt		-Me, 0°, Pl, Sl, Slop, grooves; 3-Me, 0°, Pl, Sl, Slop; -Be(?), 5°, Pl, Sl, Ti; -Jo, 0°, Pl, Sl, Ti, Clay Films	@196'.80 PSI Softer drilling; B
197	5:57		5.0/5.0	100	2.8/5.0	SW		R2				-Me, 0°, Pl, Sl, op; -Me, ~0°, Pl, Sl, Ti	
198	8:36	43			56%					Few to common fine laminations indicate bedding - lams dip ~5-12° across core.			A-B
199	9:36											-Jo, 12°, Wa, Sl, Slop; -Jo, 0°, Wa, Sl, Slop; -Jo, ~5°, Wa, Sl, Slop; -Jo, 0°, Wa, Sl, Slop } Friable	
200	4:05											-Crushed Zone	
201	5:46					SW		R2			NR		@202' - 100PSI; B
202	9:45	44	4.1/5.0	82	3.1/5.0					SANDSTONE, dolomitic, Petrolithic, grey, fine-medium-grained, well-sorted, organic rich, sand, massive, mod. hardness.		-Be, ~25°, Pl, Sl, Ti	
203	10:25				62%	SW		R2				-Jo, 70°, Pl, Sl, He-Ti, $CaCO_3$	
204	9:12												
205	10:23											Jo, 0-5°, Pl, Sl, Slop; -Jo, 70°, Pl, Sl, He, $CaCO_3$	
206	6:35	CB 15								Sharp Abrupt Contact		Not bedding SLB 4/20/01; -Be, 60°, Pl, Sl, Ti	
207	7:45	45	5.0/5.0	100	1.55/5.0	SW		R2		SANDSTONE, dolomitic, greywacke, yellow brown, fine-medium-grained, well-sorted, oxidized sand, massive, moderately hard.		-Jo, ~80°, Wa, Sl, Op, OX; -Me, 0°, Wa, Sl, Op, OX	@207'-80PSI
208	9:35				31%							-Me, 0°, Wa, Sl, Slop, OX; -Jo, 80°, Wa, Sl, Op	@209'-100PSI
209	4:28											-Jo, 80°, Pl, Sl, Op; -Jo, 0°, Pl, Sl, Op, OX	
210													

Tofb-1

10:17 / 11:01 — 11:35 PM / 11:50 — 4/26 / 4/27 — 1:07 AM

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

NITE CREW RULES

ROCK BORING LOG

Project	Job Number	Date	Boring No.
DCPP / ISFSI	1223a-1	4/27/01	01-I

WLA

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
210												← clayey, sandy zone crushed	
1:40 AM	6:20	45	5/5	100	1.25/5 31%	SW			R2	Same as above (Tofb-1)		Crushed Zone	
211 / 2:27 AM	6:13									Same as above		-Jo, 60°, wa, Sl, op, ox	@212'- 80PSI
212	6:11		5.0/5.0	100	- 1.2/5.0 24%	SW	1.0/50		R2			-Jo, 60°, wa, Sl, op, ox	
213	5:46	46								estimated from log/photo by JAH 6/1/01		-Jo, 0°, wa, Sl, op, ox -Jo, 90°, wa, Sl, op, ox, Mo	
214	6:17											-Crushed Zone	
215	10:14											-Be, 0°, Pl, Sl, Ti; +10° -Be?, 0°, Pl, Sl, op?	
2:41 AM / 216						SW HW			R2 R0	SANDSTONE - Petrolithic Clay Seam w/ Slicks.		crushed zone w/ Clay	
3:17 AM	5:00					SW			R2	SANDSTONE - Same as top of run 46 Almost - warm Contact		AK -Jo, 80°, wa, Sl, slop, ox	
217	7:23		3.9/4.0	98	3.5/4.0					SANDSTONE, Dolomitic, Petrolithic, fine-grained, well sorted, Organic rich Sand, Massive, Moderately Hard.		-Be, 60-80°, wa, Sl, Ti; Not bedding JLB 4/28/01	217'- 80PSI
218		47			87%	SW			R2				
Tofb-1													
219	10:03												
3:50 / 220													
1:09	8:49		CB 16							Same as above grades to fine to medium grained, well sorted sand			
221													@221' - 100PSI
222	8:11		5.0/5.0	100	4.3/5.0 86%	SW			R2				
223	9:43	48										-Jo, 0°, wa, Sl, He, Clay film? -Jo, 40°, wa, Sl, He, Clay film?	
	11:18									223.6			
224	11:40					MW			R1	Same as above. -Material becomes friable, Slightly hard & Fine-grained well sorted		-Jo, ~15°, wa, Sl, op -Jo, 0°, wa, Sl, op	
5:01 / 225												-crushed zone	

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

CREW OF KNIGHTS

ROCK BORING LOG

Project	Job Number	Date	Boring No.
DCPP / ISFSI	1223a-1	4/27/01	01-I

WLA

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Description of Discontinuities	Remarks
5:31 AM Burnt; 22 5	7:32									Same as above @255 - unit contains pockets of unaltered (non-Petrolithic) matrix, (Tofb-1)	-Jo, 0-10°, St, Sl, Op-	
22 6	7:21	49	50/50	100	0.45/50 9%	SW		R1			-Jo, 90°, St, Sl, Op -Jo, 0°, Wa, Sl, Op	@226 - 100 PSI
22 7	6:46										-Me, 0°, Pl, Sl, Op -Me, 0°, Pl, Sl, Op -Jo, 80°, Wa, Sl, Op	
22 8	9:07									Abrupt Wavy Contact	-Jo, ~80°, St, Sl, Op, MnO -Jo, ~80°, St, Sl, Op, MnO -Be, 15-20°, Wa, Sl, Ti	@228 - 100 PSI Water Started to return 1.1 circ.
22 9	9:02					SW		R2		SANDSTONE, dolomitic, greywacke, fine-medium, well sorted, slightly oxidized sand, massive, moderately hard, with common dolomite veining.	-irregular 50-70° Joints, St-Wa, St. -Crushed zone w/ common dolomite veinlets clay films to 1/16" on steep joints JLB 4/26/01	
5:03 AM Burley; 23 0	7:07									Same as above Pickup in faint laminations - bedding ~6°	-Jo, 50°, Wa, Sl, Op, Ox -Jo, 0°, Wa, Sl, Op, Ox -Clay Seam; irregular, 1cm, 5-15° thick, soft slent clay bed(?) - disturbed by drilling	
23 1	6:06		5.0/50	100	1.5/5.0 30%	SW		R2		@230.5 to 230.7 Clay Seam - 0.2' thick No slicks observed.	-Jo, 60°, Wa, Sl, Slop, Ox	@231' - 100 PSI
23 2	6:54	50									-Jo, 80°, Wa, Sl, Slop, Ox -Jo, 0°, Pl, Sl, Slop, Ox	
23 3	3:16										-Jo, 90°, Wa, Sl, Slop, Ox -Me, 0°, Pl, Sl, Slop -Me, 0°, Pl, Sl, Slop	@233' - Softer Pocket
23 4	9:24										-Jo, 0°, Pl, Sl, Slop. -Jo, 20°, Wa, Sl, Slop, Ox	
6:59 AM 7:09 AM; 23 5	5:01		CB 17								Jo, 50°, Pl, Sl, Op, Mn Ox	JGH RDK
23 6	9:50									@236.3 clay seam 3 (1cm)	Jo, 20, Pl, Sl, Op, MnO Jo, 50°, Pl, Sl, Op, MnO, Ox	@236 - 40 PSI * DS
23 7	8:02	51	5.0/5.0	100%	3.1/5.0 62%					Same as above clay thin bedding	Be CLAY, 15° 36, tight (bottom) planar surface, soft, silty 1cm JLB 4/26/01 Ve, he, ti, CaCO3 Jo, 20°, Pl, he, ti, CaCO3	@238 - 80 PSI
23 8	6:52											
23 9	4:20										Jo, 70°, Wa, Ro, Ox, Op Jo, 20°, Pl, Sl, Op, Ox	all B
7:45; 24 0											Me	

Tofb-1

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

N/C / DC

ROCK BORING LOG

Project	Job Number	Date	Boring No.
DCPP ISFSI	1223a-1	4/27/01	01-I

WLA

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	PSI	Remarks
24 0	8:44					SW		R2		Same as above fine to med grained dolomitic sandstone. (fine dominates) 10YR 6/4 lt. yellowish brown			80	
241	5:41											Jo(me?),0°,Sl,OP	80	
242		52	5.0/5.0	100%	4.6/5.0					(Tofb-1)		Jo,0°,wa,Sl,op	80	8:20AM
243	7:38				92%							Jo,30°,Pl,he,ti; Jo,20°,wa,Sl,op	80	
244	6:09												80	
245	6:25											Me; Jo,30°,Pl,Sl,op,MNO & ox; Jo,0°,Pl,Sl,op,clay ican; Jo,Me?,0°,Pl,Sl,op		
246	6:32					SW		R2		Similar to above slightly coarser. fine to med grained sandstone massive, hard, slightly weathered 10YR 6/3 lt pale → brown well sorted		Jo,10°,Pl,Sl,op; Jo,10°,Pl,Ro,op	80	
247	4:52											Jo(Be?),Pl,Sl,op,MNO; Jo(Be?),10°,Pl,Sl,op		
248	5:11	53	5.0/5.0	100%	4.1/5.0							Jo,(Be?),0°,Pl,Sl,op; Jo,70°,wa,Sl,op,MNO & ox; Jo,80°,Pl,he,ti; Jo,80°,wa,he,ti,MNO & ox	80	
249	4:40				82%					grades to fine grained		Jo,75-80°,wa,he,ti,MNO & ox; Jo,75-80°,wa,he,ti,MNO,ox		9:30AM
250	6:12									@249.8' changes color to Gley1 4/5GY dark greenish grey finely laminated		Me	40	
251	6:52		CB 18										80	
252	10:04	54	5.0/5.0	100	4.6/5.0	SW		R2		(Tofb-2) gradual contact med to coarse grained sandstone grey Gley1 4/10GY dark greenish grey		Be,10°,Pl,Sl,op Good Contact	100	B
253	8:39				92%	SW		R2		clear contact, fine sandstone well sorted, massive, hard Gley1 5/10Y greenish grey (Tofb-1)		Be,10°,Pl,Sl,op * checked dip WDPI JLB 10°-11° 4/27/01; Me; Bedding Laminations 10° WDP 4/27/01	Tofb-2 / 80	D / B
254	14:17									@254 changes color 10YR 7/2 light grey		Me; Me		
255	8:19											Me	90	

Tofb-1 (0–249); Tofb-2 (249–254); Tofb-1 (254–255)

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

ROCK BORING LOG

Project	Job Number	Date	Boring No.
DCPP/ISFSI	1223a-1	4/27/01	01-I

WLA

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
255													PSI 50
256	13:21					SW		R2		Same as above @255.2 color changes to 10YR 6/4-5/4 H, yellowish brown to yellowish brown	Me		
	5:32	55								very fine-grained Dolomitic SANDSTONE JLB 4/26/01 massive, wellsorted, hard	Jo, 0-15°, wa, he, ti, ox	10°± Subhorizontal bedding laminations w/ pebbles	
257	7:00		4.5/4.5	100%	3.9/4.5						Jo, 60-70°, wa, Sl, op, MNO, ox		11:00 AM
					87%					(Tofb-1)	Jo, 70°, wa, ti, he, ox		Stop to fill H_2O
258	5:00										Me		rod weight for pull down
											Jo, wa, he, ti, MNO		
259	6:52										Jo, 70°, Pl, Sl, op, altered grey sand		
											Me		
											Broken Jo, 50°, Pl, Sl, op, ox		
260	4:09					SW		R2		Same as above	Jo 80-90°, wa, Sl, op, MNO, ox		Rod weight is the only downhole pressure
											Jo, 40°, he, ti, MNO		A-B
											Jo, 40°, Pl, he, ti		
261	7:59	56	4.5/4.5	100	3.9/4.5						Jo, 70-90°, wa he, ti MNO, $CaCO_3$		12:00 PM
											Me		
											Me		
262	6:06				87%						Jo, 70°, Pl, Sl, op		≈½ of core sliped out of barrel but was recovered in run 57, described as a 5' run followed by a 3ft. run
263	5:39					SW		R2		gradual contact into very fine to fine grained sandstone, some darker laminations @263 color change to 6Gley1 7/10Y light greenish grey			B
	3:19									(Some zones fine grained but dominantly very fine)			
264	7:06	30	3.0/3.0	100	2.8/3.0							No obvious discontinuities	
265					83%					@265.2ft. color change to 10YR 8/2 very pale brown Same rock	Jo, Be?, 10°, wa, he, ti, $CaCO_3$		
	7:28	57								dark laminations			
266	8:37												1:00 PM A-B
267											Ve, ti, he, $CaCO_3$ (1-2mm)		
	6:40									Color change Sharp, 65° contact, bonded JLB 4/26/01	Jo, 70°, wa, Sl, op, MNO, ox, 0.5cm clay	10°± Subhorizontal laminations JLB 4/28/01	
268											Jo, 50°, Pl, he, ti		
	8:22	58	5.0/5.0	100	4.7/5.0	SW		R2		@268.3 color change to 6Gley1 7/10Y H. greenish grey & Same rock as above	Ve, he, ti, $CaCO_3$ (<1mm)		
269					94%								
	7:54									color sharp contact, 20-30°, bonded			
270										@269.7' color change to 10YR 7/2 H. grey JLB 4/28/01			

Tofb-1

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

Checked JLB 4/28/01

ROCK BORING LOG

Project	Job Number	Date	Boring No.
DCPP/ISFSI	1223a-1	4/27/01.	01-I

WLA

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
270	8:32	58	5.0/5.0	100	4.7/5.0	SW		R2		Same as above	Jo,(Be?),Pl,Si,op		4:15PM Burley. Hikin' rods up the hill.
271	8:23				94%					@270.9 color change to 10YR 7/2 H. grey (Tofb-1)			
272	4:27										Me		
273	10:14	59	4.0/4.0	100	3.8/4.0					@272.8 color change to 10YR 8/2 very pale brown	Jo(Me?),0°,St,Si,op; Jo,0-15°, subparallel to bedding laminations JLB 4/20/01	Subhorizontal bedding laminations 5°-12° JLB 4/20/01	A-B
274	8:58									from 274.5 to 275 10YR 7/2 H. grey	Jo,0°,St,op,Si; Ve,he,ti; $CaCO_3$ (2mm)		2:30PM
275	5:50				95%					back to pale brown			B
276	3:14	CB 20								Continues to be very fine grained sandstone with occasional thin lenses of fine sandstone. Color varies between zones of pale brown and zones of lt. grey. Coloration is parallel to bedding sometimes and other places crosses bedding. Many stepped healed micro-fractures, massive, w/some laminations.			
277	4:20					SW		R2					
278	3:52	60	5.0/5.0	100	5.0/5.0						Me(Be?),St,Si,op 15°: dip, break along bedding laminations JLB 4/20/01		
279	6:25				100%						Me(Be?),Pl,Si,op		
280	7:32										Me(Be?),Pl,Si,op; Me(Be?),Pl,Si,op		4:45
281	5:53									color turns to light grey for entire run. Very fine grained sandstone massive w/occasional laminations. Well sorted	Be(Jo?),wavy,he,ti		
282	6:56	61	5.0/5.0	100	5.0/5.0						three hairline joints, ti, he, 80°, Pl		
283	8:00				100%						Be(Jo?),he,ti,wavy; Be(Jo?),he,ti,wavy; Be(Jo?),he,ti,wavy		
284	8:00												
285													

Tofb-1

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

Checked JLB 4/20/01

ROCK BORING LOG

Project	Job Number	Date	Boring No.
DCPP/ISFSI	1223a-1	4/27/01	01-I

WLA

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
285–286	5:46	61	5.0/5.0	100%	5.0/5.0 100%	SW		R2		very fine grained sandstone (Tofb-1)	me		
286–287	9:09									Tenture run 10YR 7/4 to 10YR 6/4 very pale brown to lt. yellowish brown massive w/some laminations slightly weathered hard.	Be,0°,Pl,He,ti,MNO		
287–288	5:23	62	5.0/5.0	100%	1.6/5.0 32%						Jo,70°,Pl,St,ox; Jo,80°-90°,wa,Ro,op,ox,MNO; me; me; ve,ti,he,1mm CaCO3		
288–289	8:03										Jo,80°,Wa,St,op,ox,MNO; ve,vn,ti,he,MNO		
289–290	5:36									10-15° CLAY seam/bed ½-1cm JLB 4/20/01	Jo,60°,wa,Pl,St,op,ox; Jo,10°-0°,St,St,op; Jo,80,wa,Ro,op,ox,MNO	many healed microfractures	
290						RU		RO		clayey silt to silty CLAY	Jo,80?,Wa,15°,St,op		
290–291	6:25					SW		R2		very fine grained sandstone same as above clayey silt layer	ve,ti,he,80°-90°,wa (1mm CaCO3); me		
291–292	7:27	CB 21								very fine to fine grained sandstone color is mottled pale brown and lt. greenish grey. (similar colors to above) massive, well sorted, hard	Be(Jo?),0°,he,ti(CaCO3)		6:20PM
292–293	8:12	63									Me: handling core; Jo,15°,wa,he,ti,CaCO3		
293–294	7:56		5.0/5.0	100%	5.0/5.0 100%					many healed microfractures	Jo,he,ti,70°; Jo,70°,he,ti	JLB 4/20/01 well-cemented laminated rock w/ few joints	
294–295											Jo,wa,80-90°,ti,he		
295–296											Jo,50°,Pl,he,ti		
296–297	3:59									many healed microfractures throughout run 64			CMB takes over logging
297–298	7:31	64	5.0/5.0	100%	4.9/5.0 98%	SW		R2					6:45PM
298–299	7:52									throughout run alternating v. fine and fine grained lenses	Me; numerous short discontinuous veins; Jo,he,ti; MNO, Planar		
299–300	7:00										me		

Tofb-1

grading darker JLB 4/20/01

subhorizontal bedding laminations 5-15° JLB 4/20/01

all B

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW -Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

Checked 4/20/01 JLB

~~Crew: damaged, blown out, keeplosion Bachhuber, Jones (Kidney Stone)~~

ROCK BORING LOG

Project	Job Number	Date	Boring No.
DCPP/ISFSI	1223a-1	4/27/01	01-I

WLA

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
300	7:14	64	5.0/5.0	100	4.7/5.0 95%	Ja+ 6/1/01	SW		R2	(Tofb-1)	Me, Be?, 0°, Pl, Sl, oP		
301	4:00									Same as above: SANDSTONE, very fine to fine grained, well cemented, hard; mottled greys to greenish grey; well-defined bed parallel thin laminae of very fine and fine grained clasts	Me		
302	8:20										Jo, 45-60°, Pl-St, Op, Sl.		
303	M.R.	65	5.0/5.0	100%	4.0/5.0		Sw		R2	bedding laminations 5-15°?, JLB 4/26/01 well-cemented w/ few joints.	Be, 10°, Pl, Sm-Sl, Op Jo, 75°, Pl, Sl, Ti (hairline)		
304	8:25												
305	8:00										Jo, 60°, Pl-Wa, Sl, Ti-Fi, 1mm vein fill Jo, 60°, Pl-Wa, Sl, Op Jo, 60-45°, Pl-Wa, Sl, Op Jo, 60°-0°, Pl-Wa, Sl, Op Jo, 75°, 0°, Wa-Pl, Sl, Op		
306	4:55	CB 22								Same as above, with thin (<1") laminations of brown fine grained sandstone throughout run	several small (<0.5") subvertical veins		
307	6:35	66	5.0/5.0	100%	5.0/5.0 100%		Sw		R2				
308	7:00												
309	7:30										Ve, 50°, Pl-Wa, Ti/Fi Jo, 30°, Pl-St, Sl, Op		
310	6:00												
311	6:10									SANDSTONE, very fine grained, to SILTSTONE; grey grading to brown, well defined bed parallel laminations, darker grey; well cemented, hard.			
312	6:40										bedding laminations 8-12° JLB 4/28/01		
313	8:25	67	5.0/5.0	100%	4.7/5.0 94%		Sw		R2			21:30	
314	7:00										Jo, 80-90°, Pl, Ti, Sl		
315													

Tofb-1

Orientation: 0, 15, 30, 45, 60, 75, 90, 75, 60, 45, 30, 15, 0

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

checked JLB 4/28/01

an B

ROCK BORING LOG

Project	Job Number	Date	Boring No.
DCPP/ ISFSI	1223a-1	27 Apr. 2001	01-I

WLA

Depth (feet)	Log	Drill Rate (min/ft)	Run No.	Recovery/Cut	% Recovery	RQD	Weathering	Fracture Spacing	Strength	Lithologic Description	Discontinuities	Description of Discontinuities	Remarks
315										(Tofb-1) similar to above: Very fine grained SANDSTONE, grey and brown, well cemented, darker laminations up to 0.5" thick			
6	6:00											J_o, 60°-90°, Pl-Wa, Op, Sl; M_e	
7	4:40									Slightly softer zone (R_2-)		J_o, 60-30°, Pl-Wa, Sl, Op	
8	6:50	68	5.0/5.0	100%	5.0/5.0	Sw		R_2				J_o, 60°, Pl-Sl, Sl, Op	
9	7:45				100%					grades slightly coarser (to fine grained)		J_o, 30°, Pl-Sl, Sl, Op, Mn stained	
0	8:05											X_o (M_e?), 0°, St, Ro, Op	all B
321										321' B.O.H. 23:10 27 Apr 2001			
2													
3													
4													
5													
6													
7													
8													
9													
0													

Tofb-1

Weathering: Fr-Fresh, SW-Slight, MW-Moderate, HW-Highly, CW-Completely, and RS-Residual soil. Fracture Spacing: VW-Very Wide (>3'), Wi-Wide (1'-3'), Mo-Moderate (0.3'-1'), Cl-Close (0.1'-0.3'), and VC-Very Close (<0.1'). Strength: R6-Extremely Strong, R5-Very Strong, R4-Strong, R3-Medium Strong, R2-Weak, R1-Very Weak, and R0-Extremely Weak. Lithologic Description: Rock type, color, texture, grain size, etc. Discontinuities: Be-Bedding, Fa-Fault, Fo-Foliation, Jo-Joint, Me-Mechanical break, Sh-Shear, and Ve-Vein. Joint descriptions: Dip, Surface shape (Pl-Planar, St-Stepped, or Wa-Wavy), Roughness (Sm-Smooth, Sl-Slightly Rough, Ro-Rough, and VR-Very Rough), Aperture (Fi-Filled, He-Healed, Op-Open and Ti-Tight), type and amount of infilling, slickensides, etc.

checked JLB 4/20/01

ATTACHMENT 2

DIABLO CANYON ISFSI DATA REPORT B

GROUNDWATER LEVEL MEASUREMENTS

Memorandum

Date: October 19, 2001 **File #: 72.10.05**

To: Robert K. White

From: Richard L. Klimczak, Project Engineer

Subject: Diablo Canyon Units 1 and 2
Transmittal of January 2001 Ground Water Level Measurements at the ISFSI Site

Pacific Gas and Electric Company

Dear Rob,

Attached is a copy of the one page TES Report No. 420DC-01.70 as revised on 10/16/01 to add ground water level measurements performed by TES, on January 23, 2001. A report of measurements taken October 4, 2001were previously transmitted to you on October 10, 2001.

The water levels were measured inside boreholes 98BA-1 and 98BA-3 at the ISFSI site.

The record of January 2001 measurements was requested in AR A0541736.

This transmittal is per requirements of DCPP Procedure CF3.ID17.

Please let me, or A. Tafoya, know if you have any questions.

Richard L. Klimczak
Project Engineer
Diablo Canyon Used Fuel Storage Project

cc:	LJStrickland	SLO B3
	BHPatton	SLO BB
	AFTafoya	SLO B10
	CEHartz	SLO B0
	WPage	245 Market N4C, 422B
	JISun	245 Market N4C, 422A
	JYoung	245 Market N4C, 413C
	DCPP Chronological File	
	DCPP RMS	DCPP 119/1
	DCPP File No. 72.10.05	

Report issued: October 8, 2001
Report Revised: October 16, 2001

Report 420DC-01.70

Pacific Gas and Electric Company
Laboratory Test Report
Technical and Ecological Services
3400 Crow Canyon Road
San Ramon, CA 94583

SUBJECT: **DIABLO CANYON POWER PLANT – ISFSI Water Level Readings**

On October 4, 2001 water level readings were taken at the ISFSI site and the Lot 7 site. A Solinst Model 101-300 P3 Serial # 20436 water level indicator was used for all readings and is in good working order. The water level indicator is graduated in hundredths of a foot. All piezometer caps were in place before readings and replaced after readings. All water level readings are from the top of the standpipe. The readings are as follows:

Bore Hole #	Water Level
ISFSI Site	
98 BA-1	235.60'
98 BA-3	217.76'
Lot 7 Site	
DCSF 96-1(WLA-1)	18.22'(Bottom at 32.00')
DCSF 96-6(WLA-6)	Dry(Bottom at 23.68')

Read on January 23, 2001

ISFSI Site	
98 BA-1	205.90'
98 BA-3	199.76'

All readings were performed with the same water level indicator. The January 23, 2001 readings were the first set of readings for the ISFSI site by TES. The first readings for the Lot #7 site by TES was October 4, 2001.

Distribution: Steve Flaten
Al Tafoya
Jon Schletz
Robert White

Date: 10/16/01

Tested By: Douglass S. Watson

Approved By: Anton Pirtz

DATA REPORT C

1998 GEOPHYSICAL INVESTIGATIONS AT THE ISFSI STUDY AREA

(Agbabian Associates and GeoVision)

DIABLO CANYON ISFSI

PREPARED BY		DATE	12/17/01
	Jeff L. Bachhuber		William Lettis & Associates, Inc.
	Printed Name		Organization
VERIFIED BY		DATE	12/17/01
	Scott C. Lindvall		William Lettis & Associates, Inc.
	Printed Name		Organization
APPROVED BY		DATE	12/17/01
	William D. Page		PG&E Geosciences Dept.
	Printed Name		Organization

REGISTERED GEOLOGIST
JEFF BACHHUBER
EG 1534
CERTIFIED ENGINEERING GEOLOGIST
STATE OF CALIFORNIA

DATA REPORT C

1998 Geophysical Investigations at the ISFSI Study Area

(Agbabian Associates and GeoVision)

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2.0	Methodology	C-4
3.0	Results	C-5
4.0	References	C-6

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Figure C-1 Locations of Seismic Refraction Lines and Borings for Downhole Velocity Surveys, ISFSI Study Area

List of Attachments

Attachment 1 Agbabian Associates Report titled "Geophysical Investigations for the DCPP HLW-Dry Cask Storage Facility at the Diablo Canyon Power Plant" dated July 31, 1998 and revised September 25, 1998

DATA REPORT C
1998 GEOPHYSICAL INVESTIGATIONS AT THE ISFSI STUDY AREA
(Agbabian Associates and GeoVision)

1.0 INTRODUCTION

GeoVision Geophysical Services, under subcontract to Agbabian Associates, conducted surface seismic refraction and subsurface borehole seismic velocity surveys in the ISFSI site area in 1998 to characterize the seismic velocity properties of bedrock at the ISFSI site. Their report titled "Geophysical Investigations for the DCPP HLW-Dry Cask storage facility at the Diablo Canyon Power Plant" dated July 31, 1998, is included as Attachment 1. The relevant surveys in this report are referred to as the "Borrow Area HLW-Dry Cask Site". The GeoVision report also includes results from refraction surveys at the "Water Tank" site, located near a wooden water tank on the north side of Diablo Canyon between the 230kV and 500kV switchyards. The Water Tank site surveys are not relevant to the ISFSI site and are not discussed except in the GeoVision report. The borehole geophysics program was performed under the direction of William D. Page of PG&E's Geosciences Department. Jeff L. Bachhuber of William Lettis & Associates, Inc. (WLA) performed intermittent observation and review of the field data acquisition.

The preparation of this data report was performed under the 2000 WLA Work Plan (William Lettis & Associates, Inc., Work Plan, 2000). The geophysical measurements were made during the investigations performed in 1998. These data have been accepted by the Diablo Canyon ISFSI Project by C.E. Hartz (EDMS Item #993500012), 10 CFR 50, Appendix B, Criterion III).

2.0 METHODOLOGY

Surface Refraction Survey

GeoVision performed four compressional (P) and shear (S) wave refraction surveys along two transverse surface lines BA-1 and BA-2, shown on Figure 2 in the attached report. The refraction lines were located in the ISFSI study area (Figure C-1). Three seismic sources were used: a 40-pound sledgehammer, a Betsy Downhole Percussion Firing Rod and a Hasbrouck Golf Shoe S-wave seismic source. Each survey was performed using a 10-foot geophone spacing. S-wave refraction data were processed using FIRSTPIX™ by Interpex Limited. Arrival times were used to plot time versus distance graphs, which were then used to calculate the S-wave velocities of the different subsurface rock layers. The time versus distance plots are included in the GeoVision report.

The seismic refraction survey was completed between April 17 and May 1, 1998 by Antony Martin, Alexander Jack, and Richard Funk of GeoVision, with Robert Nigbor of Agbabian Associates as Project Manager.

Borehole Velocity Surveys

Suspension velocity measurements were performed in three cased boreholes designated 98BA-1, 98BA-3 and 98BA-4, to measure shear wave velocities and compressional wave velocities as a function of depth (Figure C-1). Suspension compressional (P) and horizontal shear (S_H) wave velocity measurements were collected to a maximum depth of 227 ft. An OYO Model 170 Suspension Logging Recorder and Suspension Logging Probe measured horizontal shear and compressional wave velocities at 1.64 ft (0.5 m) intervals. Data acquisition was performed on June 5 (98BA-1) and June 8 and 9 (98BA-3 and 98BA-4), 1998.

Collected data was processed in two different ways: (1) difference in travel times between two receivers (R1-R2) that are spaced 3.28 ft. apart and, (2) difference in travel time between the source and receiver (S-R1) that are spaced 10.3 feet apart. The travel time plots for the R1-R2 and S-R1 were compared for quality assurance.

The borehole velocity survey was completed between June 5, 1998 and June 9, 1998 by John Diehl and Rob Steller of GeoVision under subcontract to Agbabian Associates. Dr. Robert Nigbor of Agbabian Associates was Project Manager.

3.0 RESULTS

Surface Refraction Survey

A simple P-wave velocity model was constructed for the rocks in the ISFSI site area using the acquired refraction data. The subsurface geology is modeled using three layers: a thin 1- to 4-foot thick layer of soil and disturbed rock on the surface of the old borrow area cutslope (V_p = 1075-1730 ft/sec), a 5- to 25-foot thick layer of "weathered rock" (V_p = 2723-4124 ft/sec), and underlying layer of "less weathered rock" (V_p = 4061-6485 ft/sec). Each layer exhibits highly variable velocities, as is expected of fractured and weathered rock. The refraction plots, travel time curves, and velocity interpretations are in the GeoVision report.

Borehole Velocity Surveys

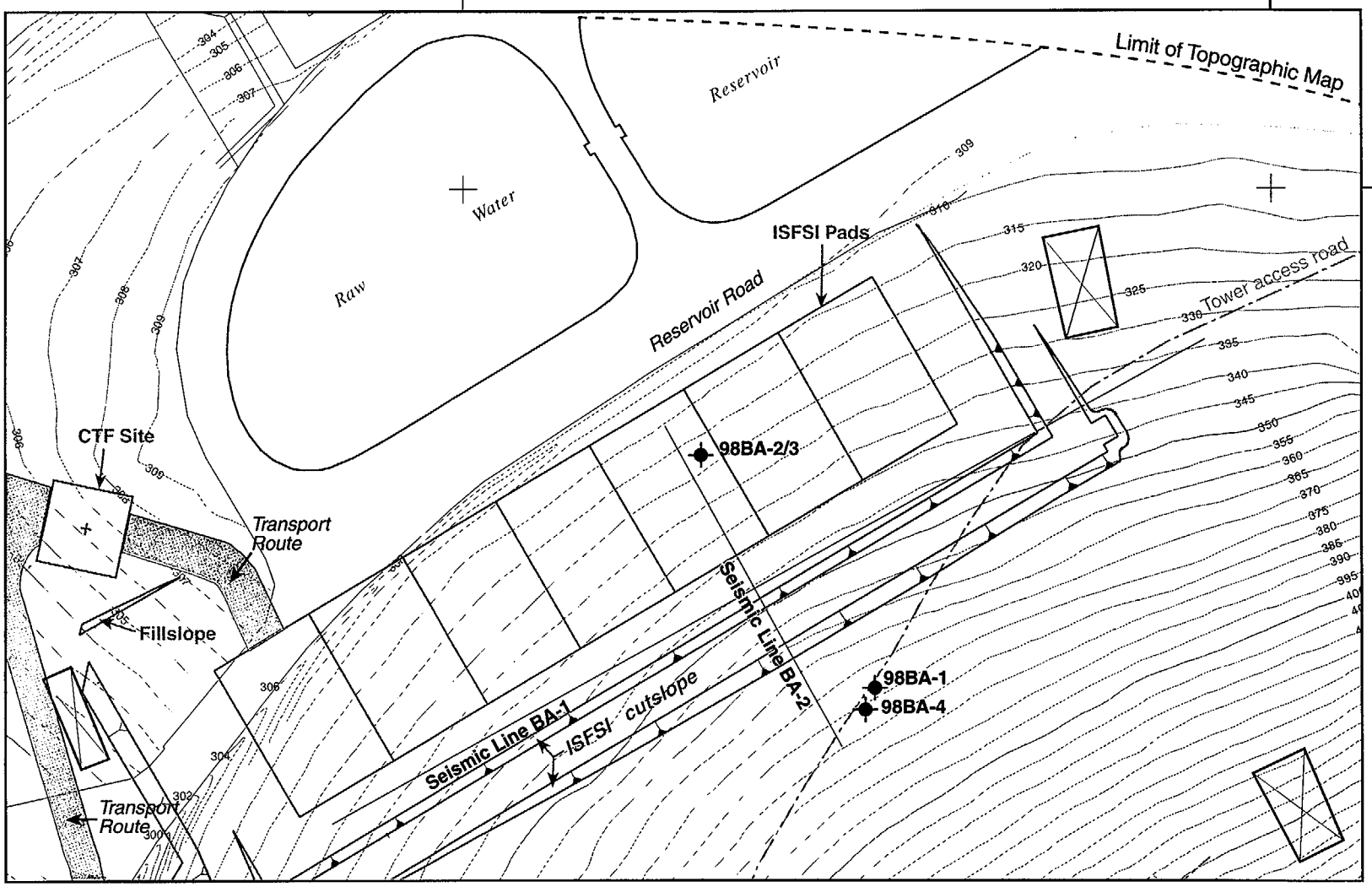
Suspension compressional and shear wave velocity profiles for the surveyed boreholes are in the GeoVision report. The profiles show good correlation between the receiver-to-receiver and source-to-receiver data, provided verification of data quality. Measured P-wave velocities range between about 2,395 and 12,917 feet per second (fps), and S_H-wave velocities range between 1,305 and 6,871 fps. Velocity profiles show a general, progressive velocity increase with depth, with localized velocity variations across distances of several feet that may reflect lithology or rock mass variations. Geologic rock conditions in the borings are described in William Lettis & Associates, Inc. (2001) Diablo Canyon ISFSI Data Report B.

4.0 REFERENCES

Hartz, C.E., no date, ISFSI Site Investigation DCPP, EDMS Item #993500012, 10 CFR 50 Appendix B, Criterion III, 12 p.

William Lettis & Associates, Inc., Work Plan, 2000, Additional Geologic Mapping, Exploratory Drilling, and Completion of Kinematic Analyses for the Diablo Canyon Power Plant, Independent Spent Fuel Storage Installation Site, Rev. 2, November 28, 2000.

William Lettis & Associates, Inc., Diablo Canyon ISFSI Data Report B, Rev. 1, Borings in ISFSI Study Area.



EXPLANATION

Footprint of 500 kV tower

Outline of ISFSI Pads

O1-I Boring for ISFSI, number indicated (initial number is year drilled)

Proposed ISFSI Pads cut slope

N

0 50 100 150 200

Contour interval = 5 feet

DIABLO CANYON ISFSI

FIGURE C-1
LOCATIONS OF SEISMIC REFRACTION LINES AND BORINGS FOR DOWNHOLE VELOCITY SURVEYS, ISFSI STUDY AREA

ATTACHMENT 1

DATA REPORT C

AGBABIAN ASSOCIATES REPORT

Geophysical Investigations for the DCPP HLW-Dry Cask Storage Facility at Diablo Canyon Power Plant

July 31, 1998,

Revised September 25, 1998

AGBABIAN ASSOCIATES
engineers and consultants

GEOPHYSICAL INVESTIGATIONS

for the

DCPP HLW-DRY CASK STORAGE FACILITY

at the

DIABLO CANYON POWER PLANT

Report prepared for the

Pacific Gas and Electric Company

Report R9730-6676

July 31, 1998

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GEOPHYSICAL INVESTIGATIONS

for the

DCPP HLW-DRY CASK STORAGE FACILITY

at the

DIABLO CANYON POWER PLANT

Prepared for

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Report R9730-6676

July 31, 1998

Revised September 25, 1998

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APPENDIX B: Procedure for Seismic Refraction Method, DCPP HLW-Dry Cask Storage Facility

APPENDIX C: Geophone Elevations and First Arrival Data

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SUMMARY

Geophysical investigations at two sites, the Water Tank and Borrow Area sites, were performed for the proposed DCPP HLW-Dry Cask Storage Facility between April and June of 1998. These investigations consisted of P- and S-wave seismic refraction and P- and S-wave velocity borehole logging. The investigations focused on the preferred Borrow Area Site (Figure 1). The purpose of the seismic refraction survey was to map the P and S-wave velocity structure along two survey lines at each site. The purpose of the borehole logging was to provide a detailed measurement of the P and S-wave velocity structure surrounding two boreholes located at the Borrow Area site.

SEISMIC REFRACTION PROCEDURE

INTRODUCTION

GeoVision performed compressional (P) and shear (S) wave refraction surveys at the Borrow Area and Water Tank sites (proposed locations for the DCPP HLW-Dry Cask Storage Facility), Diablo Canyon Power Plant (DCPP), from April 17 to May 1, 1998, to assess shallow velocity structure. This report presents the results of the refraction survey at the Borrow Area. Only preliminary processing was completed for data collected at the Water Tank site. Because it is a secondary site, this information was not needed by PG&E at this time. A site map showing the location of the Borrow Area and Water Tank sites is presented as Figure 1.

The work was conducted by Antony Martin, Alexander Jack, and Richard Funk of GEOVision Geophysical Services under subcontract to Agbabian Associates. Dr. Robert Nigbor was Project Manager, and Mr. Rob White was the liason for Pacific Gas and Electric.

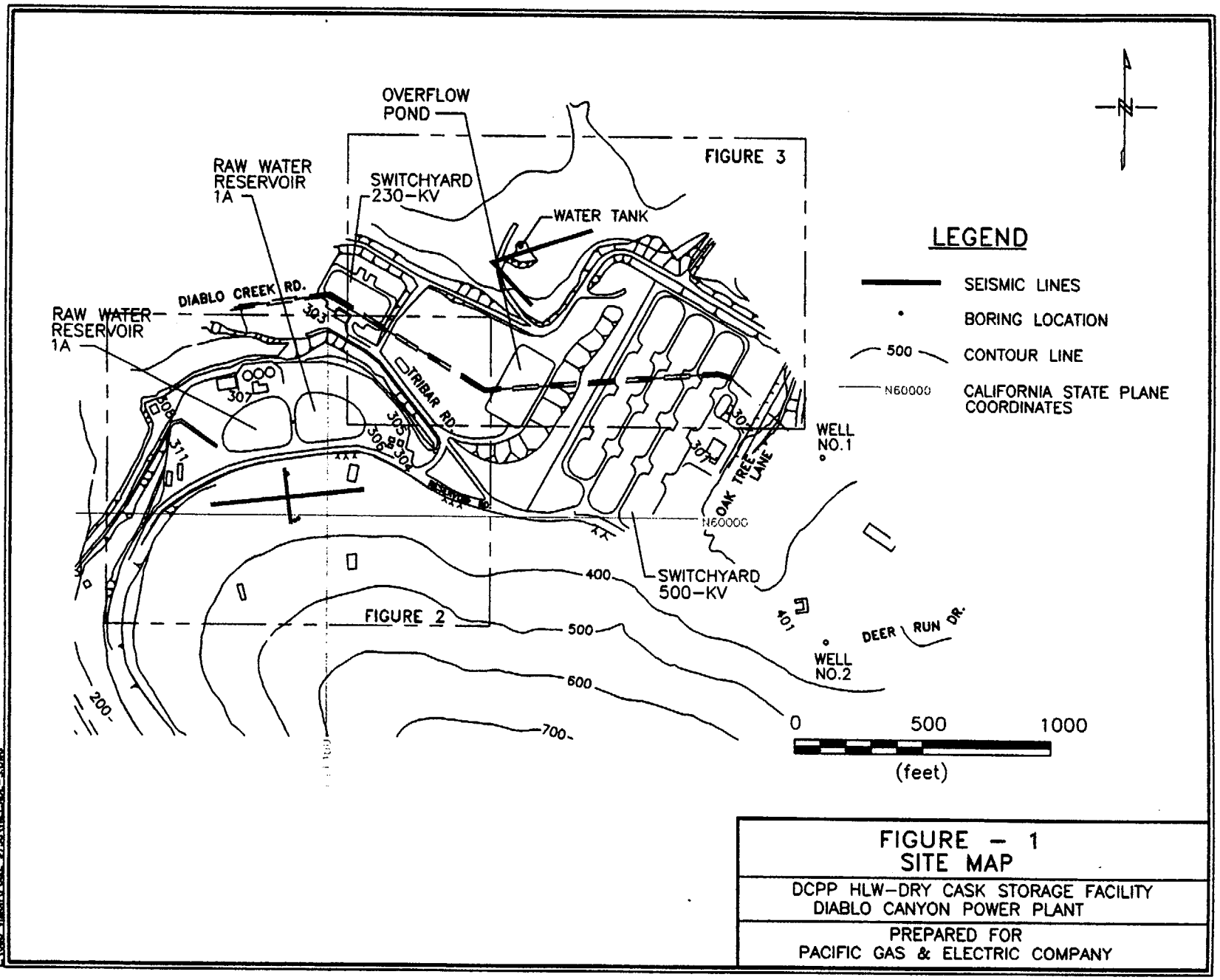
Two refraction lines were completed at the Borrow Area (Lines BA-1 and BA-2) and two lines were completed at the Water Tank Site (Lines WTS-1 and WTS-2) as shown on Figures 2 and 3, respectively.

All seismic refraction investigations were conducted in accordance with the Workplan and Procedure approved by PGE and attached in Appendices A and B. The specific energy sources, seismographs, geophones, and survey methods used are described below.

EQUIPMENT AND FIELD PROCEDURES

Seismic refraction equipment used during this investigation consisted of a 24-channel Geometrics Strataview R24 signal enhancement seismograph, Geospace 8-hertz (Hz) vertical geophones, Mark Products 10-Hz horizontal geophones, geophone cables, a 20-lb sledge hammer and aluminum plate, a Betsy Downhole Percussion Firing Rod (DFR) with 500 or 400-grain black powder charges, and a Hasbrouck Golf Shoe S-wave seismic source (Golf Shoe).

A geophone spacing of 10 feet was used for both the P- and S-wave refraction surveys. Line BA-1 consisted of three overlapping spreads of 24 geophones with 40 feet of overlap and a total length of 610 feet. Lines BA-2 and WTS-2 consisted of a single spread of 24


OVERFLOW POND
RAW WATER RESERVOIR 1A
SWITCHYARD 230-KV
WATER TANK
FIGURE 3
DIABLO CREEK RD.
RAW WATER RESERVOIR 1A
TRIBAR RD.
OAK TREE LANE
WELL NO.1
N60000
SWITCHYARD 500-KV
FIGURE 2
DEER RUN DR.
WELL NO.2
400
500
600
700
200
0
500
1000
(feet)
LEGEND
SEISMIC LINES
BORING LOCATION
500 CONTOUR LINE
N60000 CALIFORNIA STATE PLANE COORDINATES
FIGURE – 1
SITE MAP
DCPP HLW–DRY CASK STORAGE FACILITY
DIABLO CANYON POWER PLANT
PREPARED FOR
PACIFIC GAS & ELECTRIC COMPANY

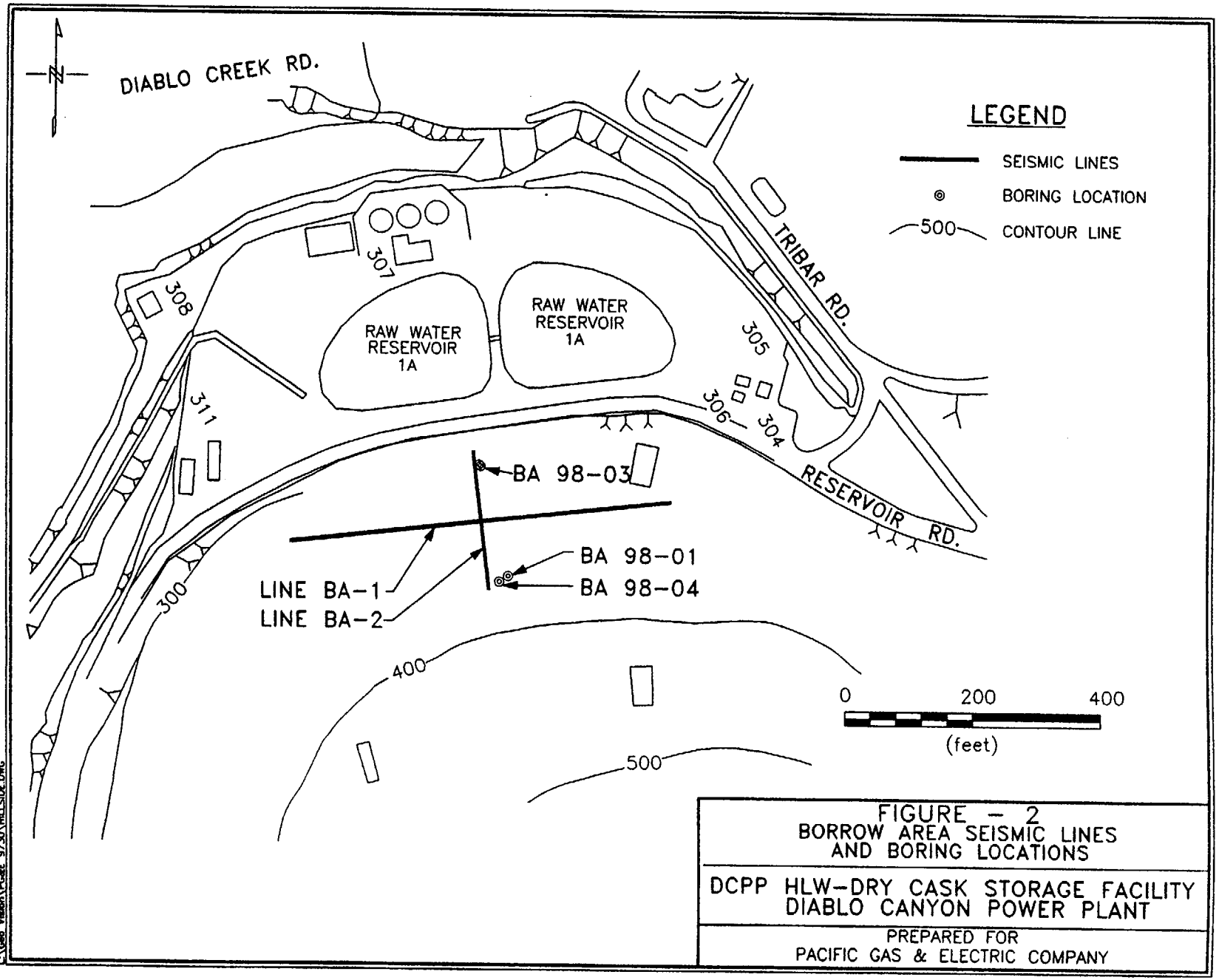


FIGURE – 2
BORROW AREA SEISMIC LINES AND BORING LOCATIONS

DCPP HLW–DRY CASK STORAGE FACILITY
DIABLO CANYON POWER PLANT

PREPARED FOR
PACIFIC GAS & ELECTRIC COMPANY

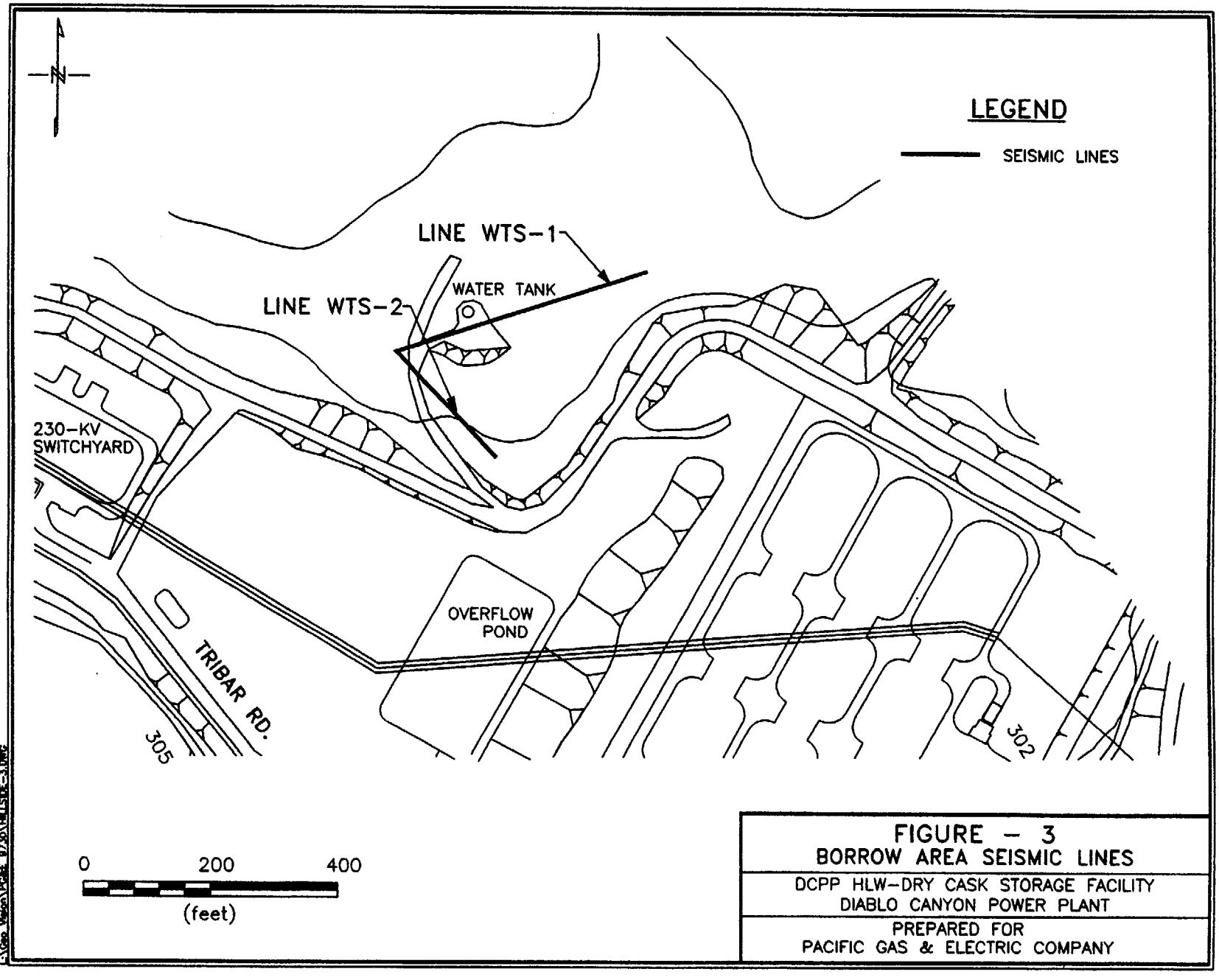


FIGURE – 3
BORROW AREA SEISMIC LINES

DCPP HLW–DRY CASK STORAGE FACILITY
DIABLO CANYON POWER PLANT

PREPARED FOR
PACIFIC GAS & ELECTRIC COMPANY

JULY 1999
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geophones (230-feet long). Line WTS-1 consisted of two overlapping 24-channel spreads with 40 feet of overlap and a total length of 420 feet. All geophone and shotpoint locations were measured using a 300-foot tape measure. Relative elevations of each geophone location were surveyed using a Nikon AP-7 automatic level. The end points of each seismic line were staked and later surveyed by a licensed surveyor to provide horizontal and vertical control.

The first spread of each seismic line was labeled spread 1 and the first geophone of each spread was labeled geophone 1. A minimum of five P-wave shot points were occupied per spread: a center shot between geophones 12 and 13, end shots at geophones 1 and 24, and far-offset shots between 70 and 150 feet off the end of each spread. Where possible, far-offset shots were located at a distance far enough from the end of the spread so that all first arrivals originated from the target refractor (bedrock surface). Occasionally, additional P-wave shot points were occupied between geophones 6 and 7 and 18 and 19 and at additional off-end locations to better define subsurface velocity structure. Typically, three S-wave shot points were occupied per spread: a center shot between geophones 12 and 13 and end shots at geophones 1 and 24. The geometry of lines BA-1 and BA-2 are presented in Figure 4 and the geometry of lines WTS-1 and WTS-2 are presented as Figure 5.

The 20-lb sledgehammer was generally used as the P-wave energy source for shot points inside and at the ends of each spread. The DFR was used as the energy source for end and far-offset shots because the travel path was greater and a stronger source was necessary. Shallow shot holes were drilled to a depth of between 1 and 2 feet for DFR shots using either a hand auger, motorized auger, or rotary-hammer drill. The 20-lb sledge striking each end of the Golf Shoe was used as the S-wave energy source. Separate seismic records were saved for positive polarity (striking one end of the source) and reverse polarity (striking the other end of the source) shots.

The final seismic record at each shot location was the result of stacking multiple shots to increase the signal to noise ratio. Five to 15 stacks were generally sufficient for hammer P- and S-wave shots, whereas 1 or 2 stacks were sufficient when using the DFR.

Paper copies of all seismic records were printed in the field, and data were also stored on floppy disk. Data files were named with the sequential line, spread, and shot number and a ".dat" extension. The names and locations of all shot points were recorded in field notes.

There were several sources of seismic noise (ground vibrations) at the site resulting from plant operations. The primary source of noise where overhead high-voltage powerlines. Figure 6 demonstrates the 60-Hz signal picked up by the seismic cable and geophones from the powerlines over the Borrow Area. The presence of the powerlines necessitated the use of a 60-Hz notch acquisition filter during data recording. The use of the filter only reduced the effects of the 60-Hz noise but did not eliminate it. Other noise sources included wind, nearby generators, vehicle traffic and aircraft. To minimize noise from vehicles and aircraft, shots were generally not fired until the vehicle/aircraft was out of hearing range.

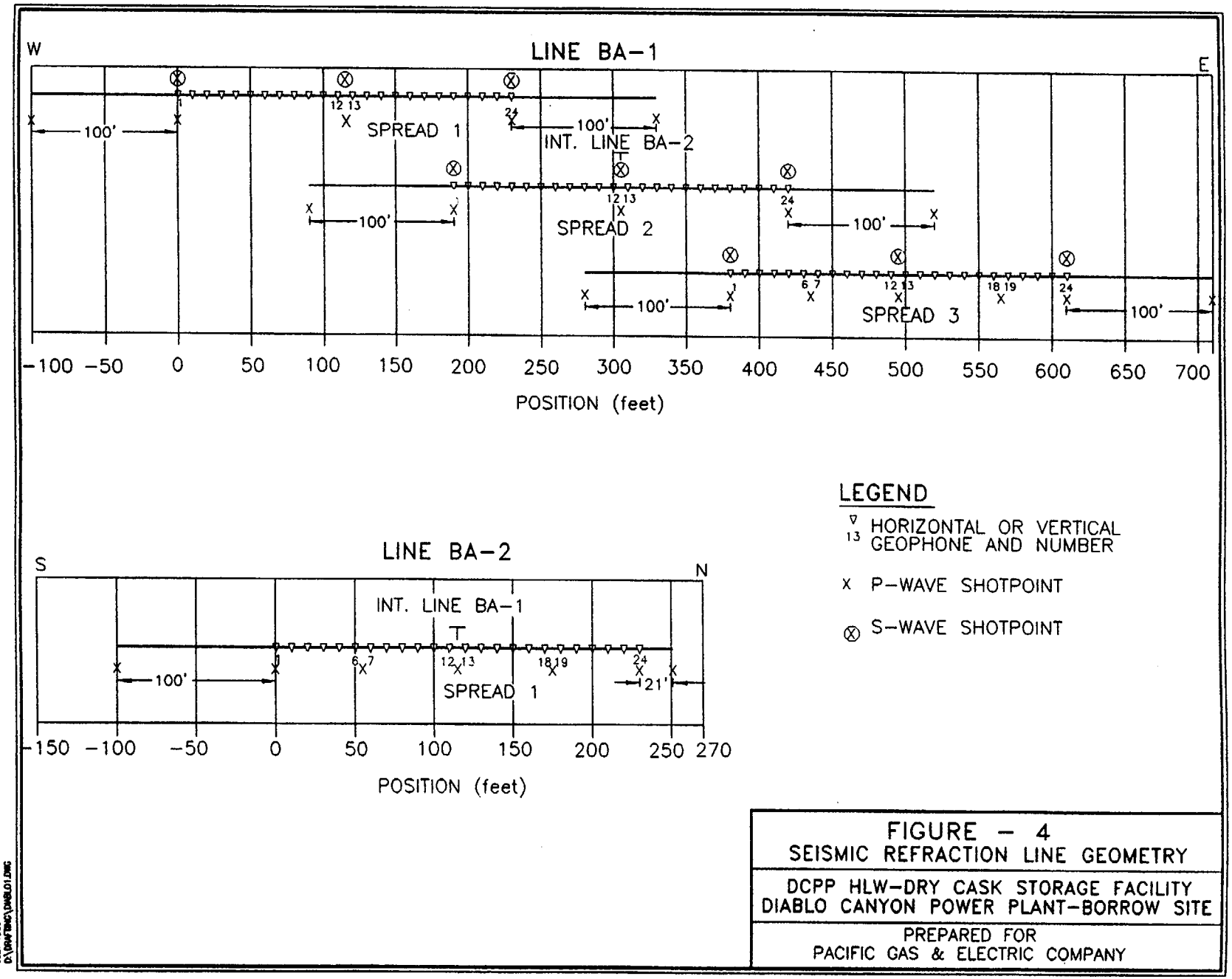

FIGURE - 4
SEISMIC REFRACTION LINE GEOMETRY

DCPP HLW-DRY CASK STORAGE FACILITY
DIABLO CANYON POWER PLANT-BORROW SITE

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PACIFIC GAS & ELECTRIC COMPANY

JULY 1998
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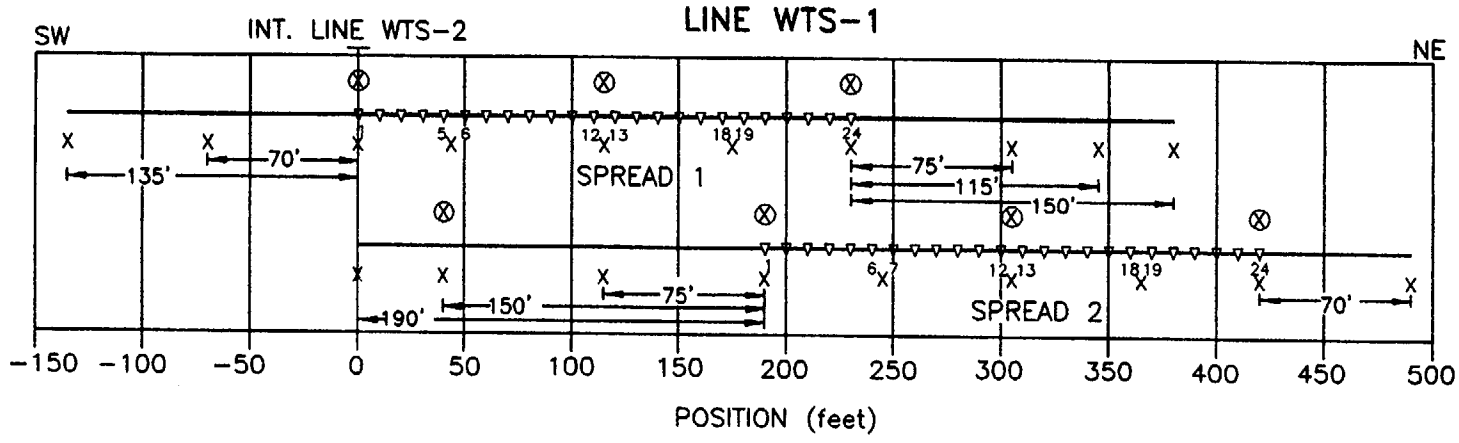
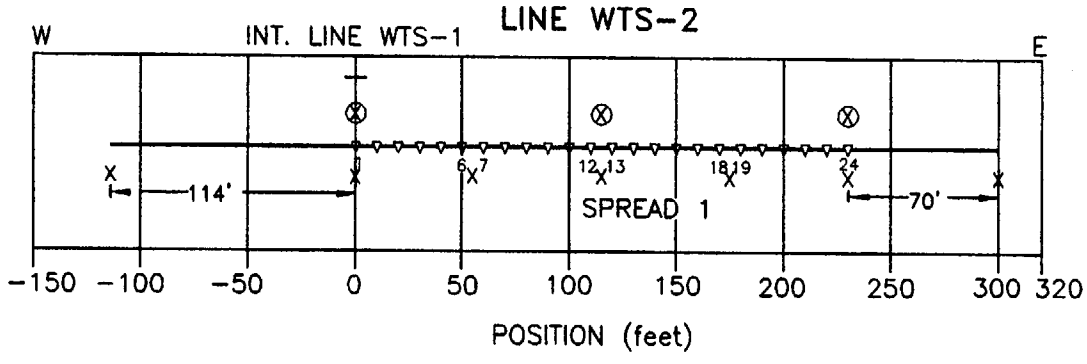




LEGEND

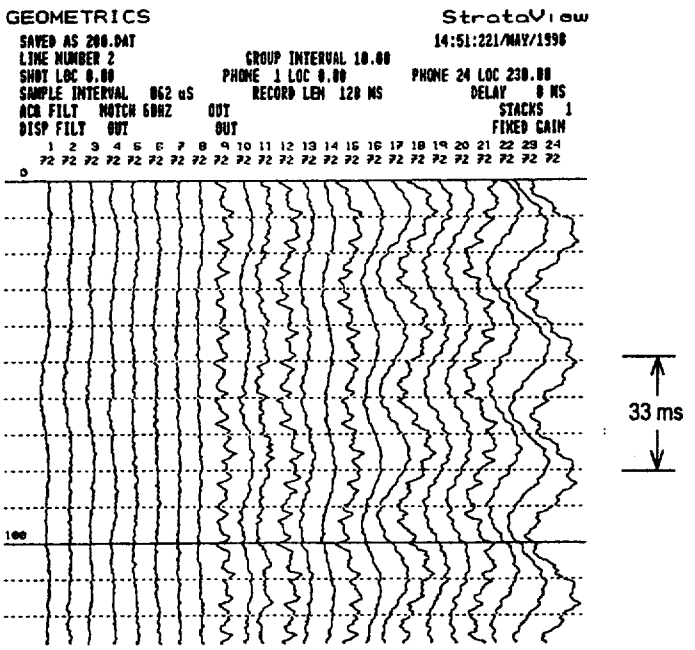
- ▽ 13 HORIZONTAL OR VERTICAL GEOPHONE AND NUMBER
- x P-WAVE SHOTPOINT
- ⊗ S-WAVE SHOTPOINT

FIGURE - 5
SEISMIC REFRACTION LINE GEOMETRY

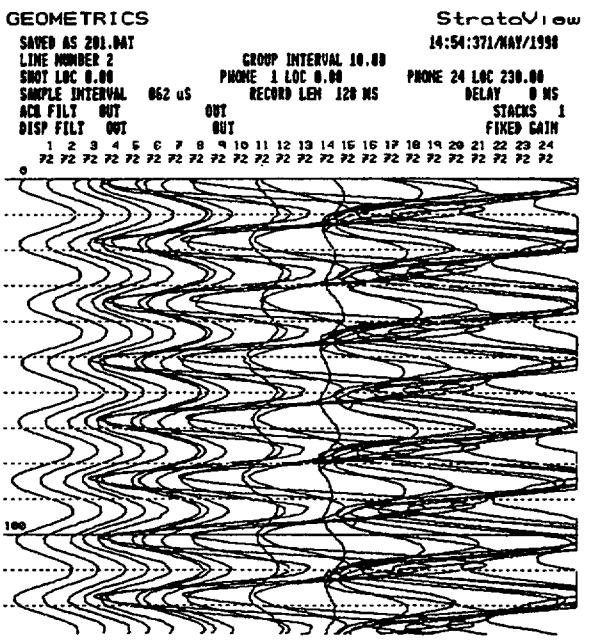
DCPP HLW-DRY CASK STORAGE FACILITY
DIABLO CANYON POWER PLANT-WATER TANK SITE

PREPARED FOR
PACIFIC GAS & ELECTRIC COMPANY

JULY 1993
D:\DRAFTING\DWG\FIG02.DWG



Example of 60 Hz filtered ambient noise, showing 30 Hz artifact



Example of unfiltered ambient noise

Figure 6 EXAMPLE OF FILTERED AND UNFILTERED SEISMIC SIGNALS

DATA PROCESSING

P-Wave Refraction Data

P-wave seismic-refraction data collected at the Borrow Area were modeled using the generalized reciprocal method (GRM), as outlined in Palmer (1980 and 1981), Lankston and Lankston (1986) and Lankston (1988).

GRM is a seismic-refraction interpretation method designed to accurately map undulating refractor surfaces from in-line refraction data using both forward and reverse shots. The method is related the Hales (1958) method and the reciprocal method (Hawkins, 1961) of seismic-refraction interpretation.

The first step in data processing consisted of picking the arrival time of the first energy received at each geophones (first break) for each shot. The first break arrivals on each seismic record are either a direct arrival from a compressional wave (P-wave) traveling in the surface layer, or a refracted arrival from a subsurface interface where there is a velocity increase. The first break picks for each shot were made in the program FIRSTPIX™ by Interpex Limited. The arrival times for each shot point were saved as ASCII files and, for ease of use, assigned names equivalent to the field file but with a ".pic" extension.

Relative elevations for each geophone location were calculated from the leveling data using Microsoft Excel and were converted to true elevation using the elevation data provided for the ends of each line (PG&E Drawing, see reference). Geophone elevations and first arrival data for each line are summarized in Appendix C.

The seismic refraction data were processed using the GRM program VIEWSEIS by Viewlog Systems. For each seismic line the first arrival and elevation data files were entered into the program and time-distance plots for the forward and reverse shots were generated. Forward shots are shot points where energy is traveling from geophone 1 to 24. Energy travels in the opposite direction for reverse shots and shots inside each spread (mid-shots) have both forward and reverse components. The first arrival data for each shot point was then assigned to the layer from which it was refracted. Three layers were apparent in the seismic refraction data acquired at this site and consisted of a low velocity sediment/decomposed rock layer, an intermediate velocity weathered rock layer and a higher velocity rock layer. The refracted data for each layer were then phantomed (shifted in time) to line up with the travel-time data for the zero-offset end shot to form a single travel-time curve for each refractor along the line. This method was employed for both forward and reverse shots according to the procedures outlined in Lankston and Lankston (1986).

Two important parameters used in GRM processing are the reciprocal time and the XY spacing. Reciprocal time for a given refractor is defined as the time required for a ray to travel the refracted path from the end shot at one end of the line to the corresponding shot at the opposite end of the line. The reciprocal time for the forward shot should be equal to that for the reverse shot because theoretically, the same travel path is taken. The XY spacing for a given refractor is defined as the distance at the surface between forward and reverse rays emerging from the same point on the target refractor.

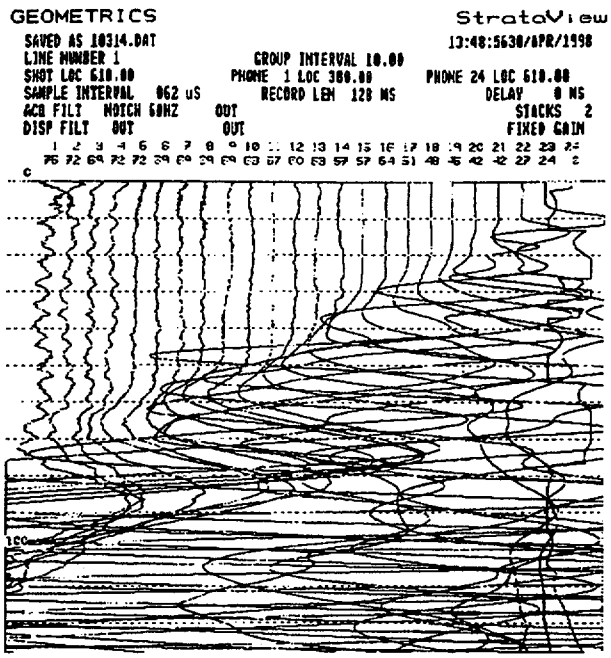
After phantoming was completed, GRM processing was conducted. First, velocity analysis functions were calculated for various XY spacings to establish layer velocity and lateral velocity variations within each layer. These functions are determined by the forward and reverse phantomed travel times, the reciprocal time, and the XY spacing; calculations were made according to the equations presented in Palmer (1980) and Lankston (1988). Time-depth functions (Palmer, 1980; Lankston, 1988) were also calculated for each refractor at various XY distances. The velocity analysis and time-depth functions for each refractor were then viewed to determine the optimum XY spacing. The velocity analysis function corresponding to the optimum XY spacing is such that the least detail is observed and the time-depth function corresponding to the optimum XY is the one showing the most detail (Palmer, 1980).

On each of the seismic lines the optimum XY spacing for the bedrock refractor could not be determined graphically from the velocity analysis and time-depth functions because the depth to bedrock was too small relative to the geophone spacing. Therefore, the refraction data collected during this investigation were first processed using an XY spacing of zero which is the reciprocal method (Hawkins, 1961). An average XY spacing for each layer was then determined from the resulting model and the data reprocessed with these XY spacings to obtain a more accurate depth section. This method of interpretation works very well providing no velocity inversions or hidden layers occur in subsurface geologic materials. A velocity inversion is a geologic layer with a lower seismic velocity than an overlying layer. Critical refractions do not occur along the top of this layer because velocity has to increase with depth for refractions to occur. This layer is, therefore, not modeled and depths to underlying layers are overestimated. A hidden layer is a layer of intermediate velocity between two other layers, but of sufficiently small thickness so that refracted arrivals do not arrive at the geophones before arrivals from the deeper, higher velocity layers. Because the seismic refraction method only involves the interpretation of first arrivals, a hidden layer is not modeled and depths to underlying layers are underestimated.

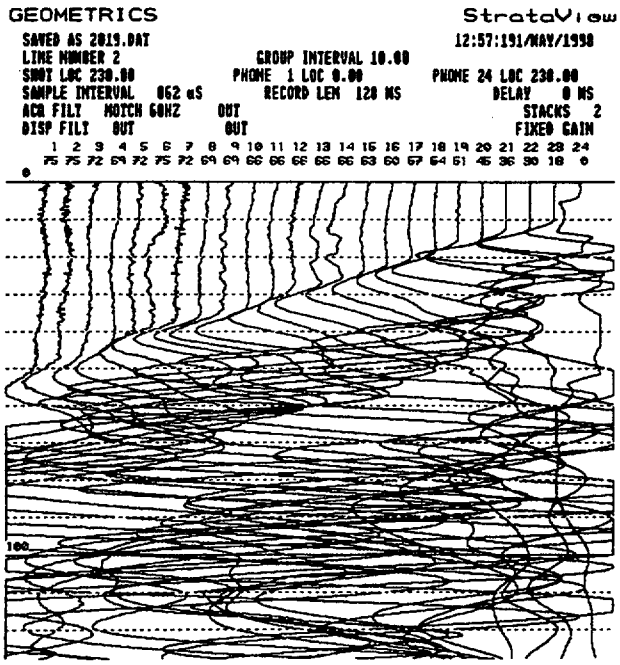
Another possible source of error in estimating depth to bedrock may occur if there is a thick weathered layer. There is generally not an abrupt contact between weathered and competent bedrock, but rather a transition zone where bedrock becomes more competent with depth. In this situation it is difficult to predict which portion of the bedrock the seismic refraction method is imaging.

Finally, due to the location of the BA-1 & -2 lines beneath high-voltage powerlines, a notch filter was required at 60 Hz to reduce the level of ambient induced electrical noise. First arrival seismic signals observed in the recorded data exhibited frequencies near 50 Hz. The notch filter may have affected the amplitude level of these signals, particularly affecting weak arrivals at far geophones. Faster arriving waves might be masked entirely, although this is unlikely.

Figure 7 presents two examples of waveform data from the seismic refraction survey. The first is from Line BA-1, and the second is from Line BA-2. Note that there is much less



Line BA-1, Spread 3, Shot @ 610 Ft, DFR 500 grain, 2 Stacks



Line BA-2, Spread 1, Shot @ 230 Ft, DFR 400 grain, 2 Stacks

Figure 7 EXAMPLE SEISMIC REFRACTION WAVEFORMS

noise in the travel time data for Line BA-2 which was oriented perpendicular to the high voltage powerlines.

Travel time data and interpreted depth sections for lines BA-1 and BA-2 are presented in Figures 8 and 9. Different symbols in the travel time data represent the different geologic layers interpreted in the models below.

S-Wave Refraction Data

S-wave refraction data was acquired only to determine approximate S-wave velocities of shallow rock and, therefore, only a simple analysis was conducted. First-arrival times were picked using the program FIRSTPIX™ by Interpex Limited. The positive and reverse polarity records were subtracted in order to enhance S-wave arrivals and attenuate P-wave arrivals. On many of the seismic records identification of S-wave arrivals was difficult due to noise and weak signals, and it is possible that slower surface wave arrivals were occasionally picked as S-waves. The arrival times for each shot point were saved as ASCII files. Plots of time versus distance were generated for each line and linear fits made to portions of the travel time curves using linear regression. The velocity of each of the segments on the travel-time curves is calculated as the inverse of the slope of the segment and are valid providing subsurface interfaces are horizontal or parallel surface topography.

Figure 10 presents the travel time data and average shear wave velocities for Line BA-1, Spreads 1, 2, and 3. Shear wave arrivals were not picked from the Line BA-2 data due to noise and weak signals. No shear wave analysis was done for Lines WTS-1 or -2.

RESULTS

Borrow Area Site

For the Borrow Area, the P-wave data were modeled using 3 layers: a very thin 1 to 4-foot thick layer of soil and decomposed rock, a 5 to 25-foot thick layer of weathered sandstone, and below that a layer of less weathered sandstone. The velocities of each layer are highly variable as would be expected for fractured and variably weathered rock. The P-wave velocity of the thin upper layer varies from about 1075 to 1730 feet/second. The upper weathered layer has P-wave velocities ranging from about 2723 to 4124 feet/second and the lower weathered layer has velocities ranging from 4061 to 6485 feet/second. The average P-wave velocity of the lower weathered sandstone layer is about 5500 feet/second.

There is about a 5-foot discrepancy in the interpretation of the depth to the lower weathered sandstone layer at the intersection of the two lines that most likely results from the variable subsurface velocities and the higher noise levels in Line BA-1. P-wave noise levels were much lower in Line BA-2 and, therefore, results from this line appear to be more reliable. Given the noise levels in the data, interpreting a layer with P-wave velocity of higher than 7,500 feet/second and depth greater than about 50 feet is not possible.

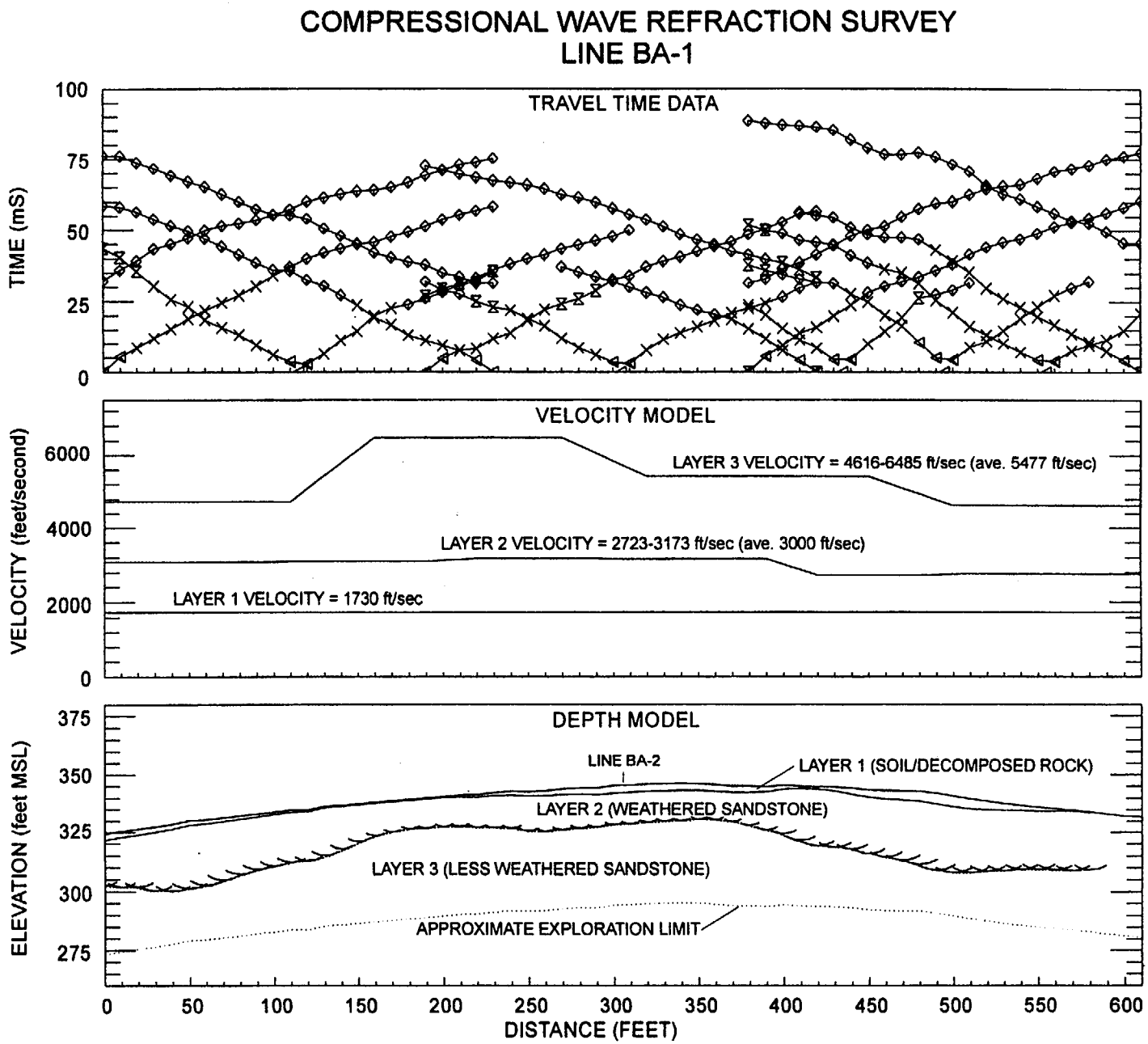
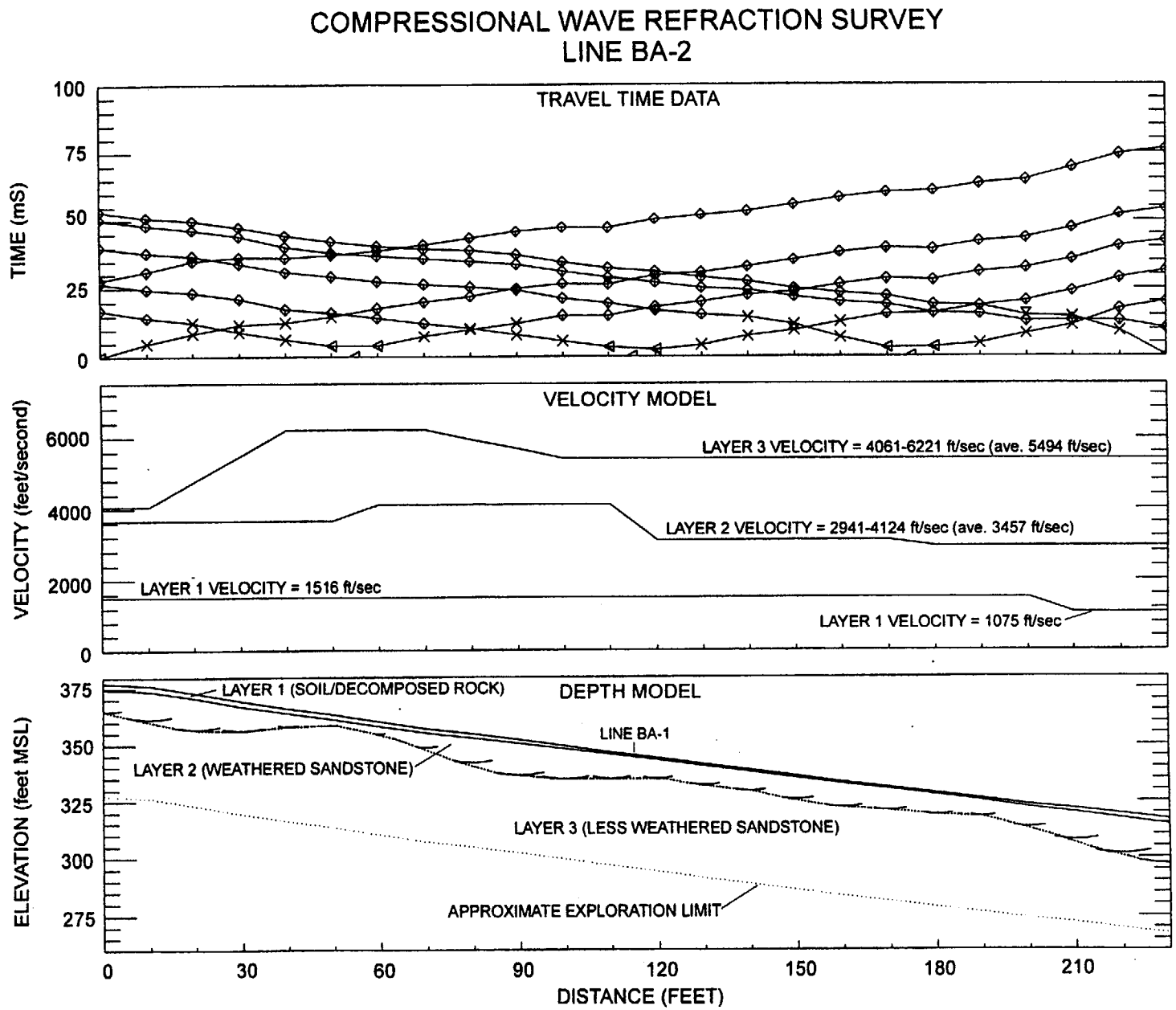


Figure 818P-WAVE REFRACTION INTERPRETATION – LINE BA-1



F igure 9 P-WAVE REFRACTION INTERPRETATION – LINE BA-2

19

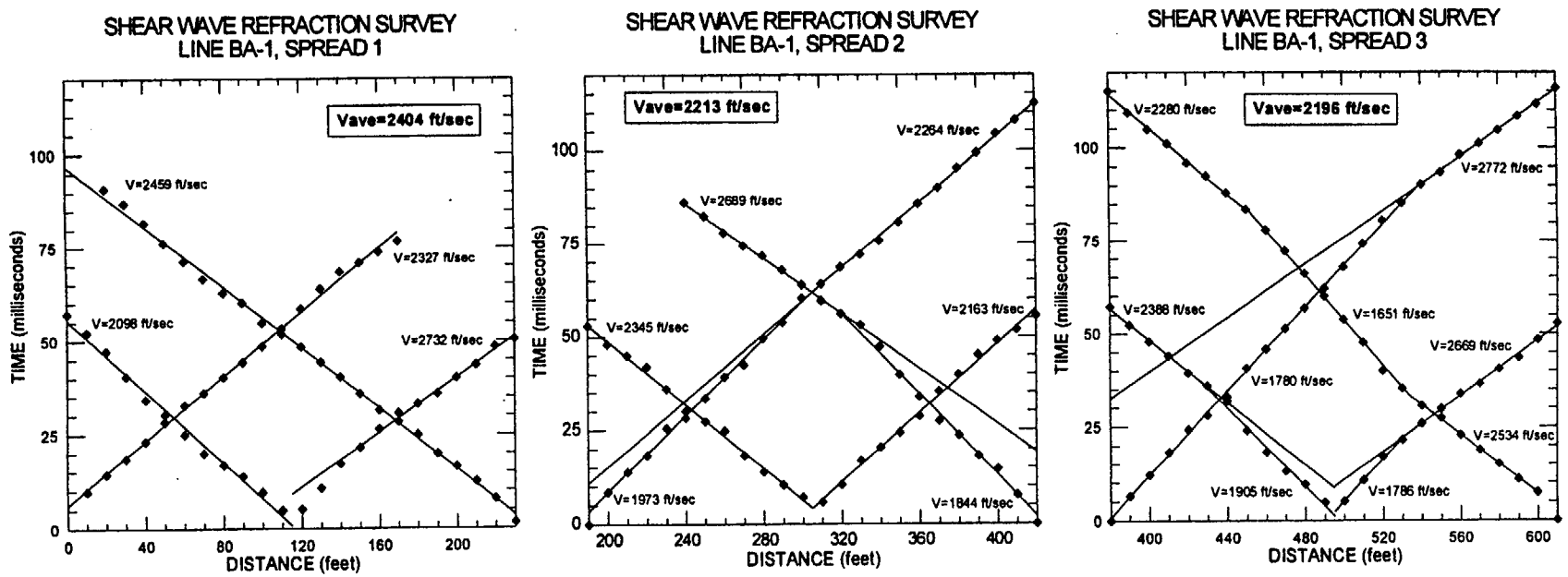


Figure 10 TRAVEL TIME DATA AND AVERAGE SHEAR WAVE VELOCITIES FOR LINE BA-1, SPREADS 1, 2, AND 3

Only very simple modeling of S-wave data was attempted. Assuming that subsurface layers are horizontal relative to topography (i.e. parallel to surface topography) then the velocity of each layer is the inverse of the slope of the portion of the travel time curve with arrivals from that layer. Generally, it was not possible to distinguish between S-wave arrivals from the weathered zone and the lower weathered sandstone layer. In fact, it appears that refracted S-waves from the lower layer are masked by the noise levels in the data. The dominant waveforms in the seismic records appear to be surface waves (probably Love waves propagating through the weathered layer). Interpreted S-wave velocities vary from about 1651 to 2772 feet/second and average about 2300 feet/second. These velocities are somewhat low relative to the P-wave velocities in the lower sandstone unit, so the S-wave velocities are probably indicative of the properties in the upper weathered layer.

Water Tank Site

The data for the Water Tank Site were stored and not analyzed at this time because this site is not the preferred site.

BOREHOLE VELOCITY LOGGING

INTRODUCTION

Suspension velocity measurements were performed in three cased boreholes designated BA 98-1, 98-3 and 98-4, located in the Borrow Area Site to measure shear wave velocities and compressional wave velocities as a function of depth. Suspension P- and S_H-wave velocity measurements were collected to a maximum depth of 227ft. Data acquisition was performed on June 5 (98-1), and June 8 and 9 (98-3 and 98-4), 1998. The work was conducted by John Diehl and Rob Steller of GEOVision under subcontract to Agbabian Associates. Dr. Robert Nigbor was Project Manager, and Mr. Rob White was the liaison for Pacific Gas & Electric Company.

The locations of the boreholes logged using the PS Suspension logging system are shown in Figures 1 and 2, and detailed below.

BOREHOLE	LOCATION	SURVEY LOCATION *	REF. ELEV.
BA 98-1	South end of BA-2	44	372.2
BA 98-4	South end of BA-2	43	374.8
BA 98-3	North end of BA-2	79	322.8

* reference PG&E drawing "Locations of Exploratory Boreholes, Geophysical Test Runs, and Reference Elevations for Spent Fuel Dry Cask Storage Facility, DCPP"

All borehole velocity measurements were conducted in accordance with the Workplan and Procedure approved by PG&E and attached in Appendices D and E respectively. The specific details of the method as it applied to this site are described below.

EQUIPMENT AND FIELD PROCEDURES

The OYO Model 170 Suspension Logging Recorder and Suspension Logging Probe were used to obtain in-situ horizontal shear and compressional wave velocity measurements at 1.64 ft (.5 m) intervals. The acquired data was analyzed and a profile of velocity versus depth was produced for both compressional and horizontally polarized shear waves in accordance with the procedure (Appendix E).

All boreholes were logged as 3-inch diameter PVC cased boreholes filled with clear water. At the start of each measurement sequence, the suspension probe was positioned with the mid-point of the receiver spacing at ground level, and mechanical and electronic depth counters were set to zero. The probe was then lowered to the bottom of each borehole, then returned to the surface, stopping at 1.64 ft intervals to collect data. The depth range to 144 ft in BA 98-1 was not available for logging due to abandoned steel casing in the borehole. This required the installation of borehole BA 98-4 at nearly the same location (within approximately 25 ft) which was logged to the entire depth. Measurement intervals and dates of data collection are summarized below.

BOREHOLE	DATE LOGGED	DEPTH RANGE (ft)	DEPTH AS DRILLED (ft)	SAMPLE INTERVAL (ft)	ISOLATION TUBE (ft)
BA 98-1	6-5 and 6-9-98	144.4 – 219.8	240	1.64	6.56
BA 98-4	6-8-98	3.3 – 132.2	150	1.64	6.56
BA 98-3	6-8-98	3.3 – 200.8	220	1.64	6.56

Upon completion of the measurements, the probe zero depth indication at ground level was verified prior to removal from the casing.

DATA PROCESSING

The recorded digital records were analyzed to locate the first minima on the vertical axis records, indicating the arrival of P-wave energy. The difference in travel time between receiver 1 and receiver 2 (R1-R2) arrivals was used to calculate the P-wave velocity for that 3.28 ft (1 m) interval. When observable, P-wave arrivals on the horizontal axis records were used to verify the velocities determined from the vertical axis data.

This receiver-to-receiver analysis was augmented and checked by performing source-to-receiver analysis. The P-wave velocity calculated from the travel time over the 10.3 ft interval from source to receiver 1 (S-R1) was calculated and plotted for quality assurance of the velocity derived from the travel time between receivers. In this analysis, the depth values as recorded were increased by 6.8 ft to correspond to the mid-point of the 10.3 ft S-R1 interval. Travel times were obtained by picking the first break of the P-wave signal at the near receiver and subtracting 3.9 milliseconds, the calculated and experimentally verified delay for this acquisition system from source trigger pulse (beginning of record) to source impact. This delay corresponds to the duration of acceleration of the solenoid before impact.

The recorded digital records were studied to establish the presence of clear S_H-wave pulses, as indicated by the presence of opposite polarity pulses on each pair of horizontal records. Ideally, the S_H-wave signals from the 'normal' and 'reverse' source pulses are very nearly inverted images of each other. Digital FFT - IFFT lowpass filtering was used to remove the higher frequency P-wave signal from the S_H-wave signal. Different filter cutoffs were used to separate P- and S_H-waves at different depths, ranging from 800 Hz in the slowest zones to 2500 Hz in the regions of highest velocity.

Generally, the first maximum was picked for the 'normal' signals and the first minimum for the 'reverse' signals, although other points on the waveform were used if the first pulse was distorted. The absolute arrival time of the 'normal' and 'reverse' signals may vary by +/- 0.2 milliseconds, due to differences in the actuation time of the solenoid source caused by constant mechanical bias in the source or by borehole inclination. This variation does not affect the R1-R2 velocity determinations, as the differential time is measured between

arrivals of waves created by the same source actuation. The final velocity value is the average of the values obtained from the 'normal' and 'reverse' source actuations.

As with the P-wave data, S_H-wave velocity calculated from the travel time over the 10.3 ft interval from source to first receiver was calculated and plotted for verification of the velocity derived from the travel time between receivers. In this analysis, the depth values were increased by 6.8 ft to correspond to the mid-point of the 10.3 ft S-R1 interval. Travel times were obtained by picking the first break of the S_H-wave signal at the near receiver and subtracting 3.9 milliseconds, the calculated and experimentally verified delay from the beginning of the record at the source trigger pulse to source impact.

Figure 11 shows an example of R1-R2 measurements on the filtered record for a depth of 64 ft in borehole BA 98-4. In Figure 12, the time difference over the 3.28 ft (1 m) interval of 1.41 (7.06-5.65) millisecond is equivalent to a S_H-wave velocity of 4,755 ft/sec. Whenever possible, time differences were determined from several phase points on the S_H-waveform records to verify the data obtained from the first arrival of the S_H-wave pulse. Figure 12 displays the same record before filtering with an 2,200 Hz FFT - IFFT digital lowpass filter.

RESULTS

Suspension R1-R2 P- and S_H-wave velocity data for BA 98-3 are plotted in Figures 13. Data from BA 98-1 and 98-4 are combined on the same plot in Figure 14. The S_H-wave velocity data are presented at an expanded scale in Figures 15 and 16. The suspension velocity data presented in these Figures are presented in Tables 1 through 3.

Suspension S-R1 results are presented in Appendix F. P- and S_H-wave velocity data from R1-R2 analysis and quality assurance analysis of S-R1 data are plotted together in Figures 17 and 18 to aid in visual comparison. The R1-R2 data is an average velocity over a 3.3 ft segment of the soil column; the S-R1 data is an average over 10.3 ft, and shows a significant smoothing relative to the R1-R2 plots. S-R1 data are presented in tabular format in Appendix F Tables F-1 to F-4. Good correspondence between the shape of the P- and S_H-wave velocity curves is observed for all data sets. The velocities derived from S-R1 and R1-R2 data are in good agreement, providing verification of the higher resolution R1-R2 data.

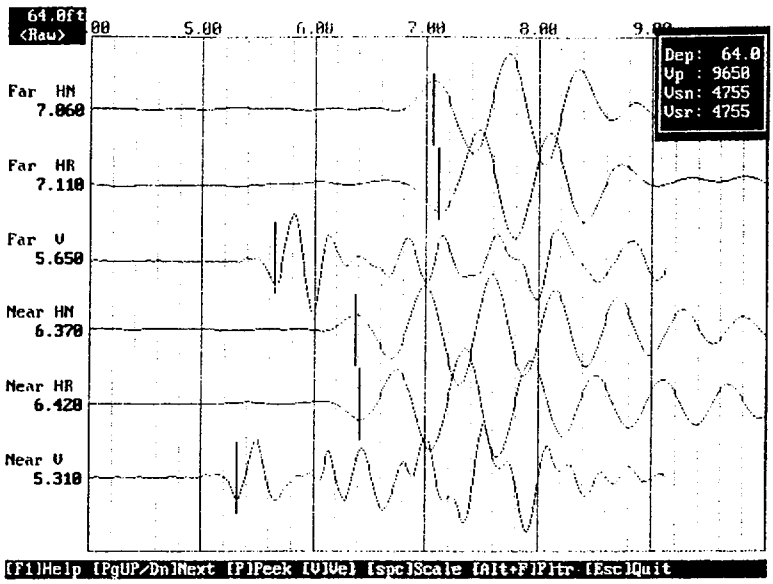


Figure 11 EXAMPLE R1-R2 WAVEFORM FILTERED AND TRUNCATED, BORING BA-98-4

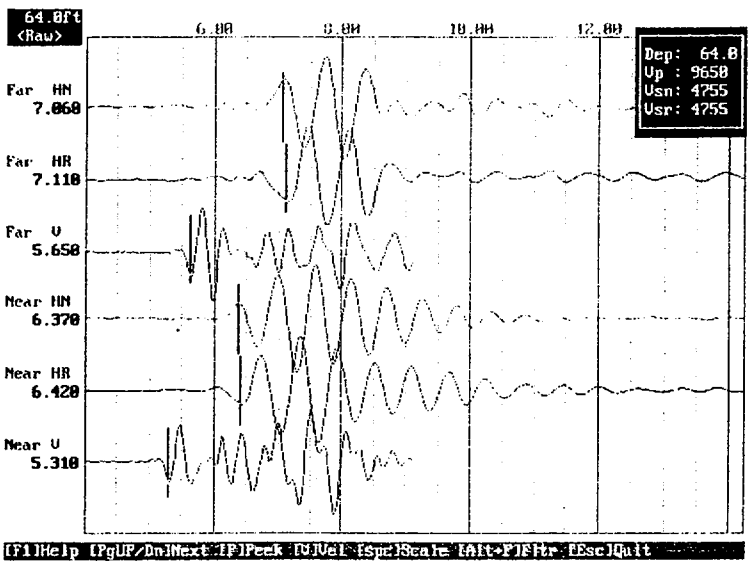


Figure 12 EXAMPLE R1-R2 WAVEFORM UNFILTERED, BORING BA-98-4

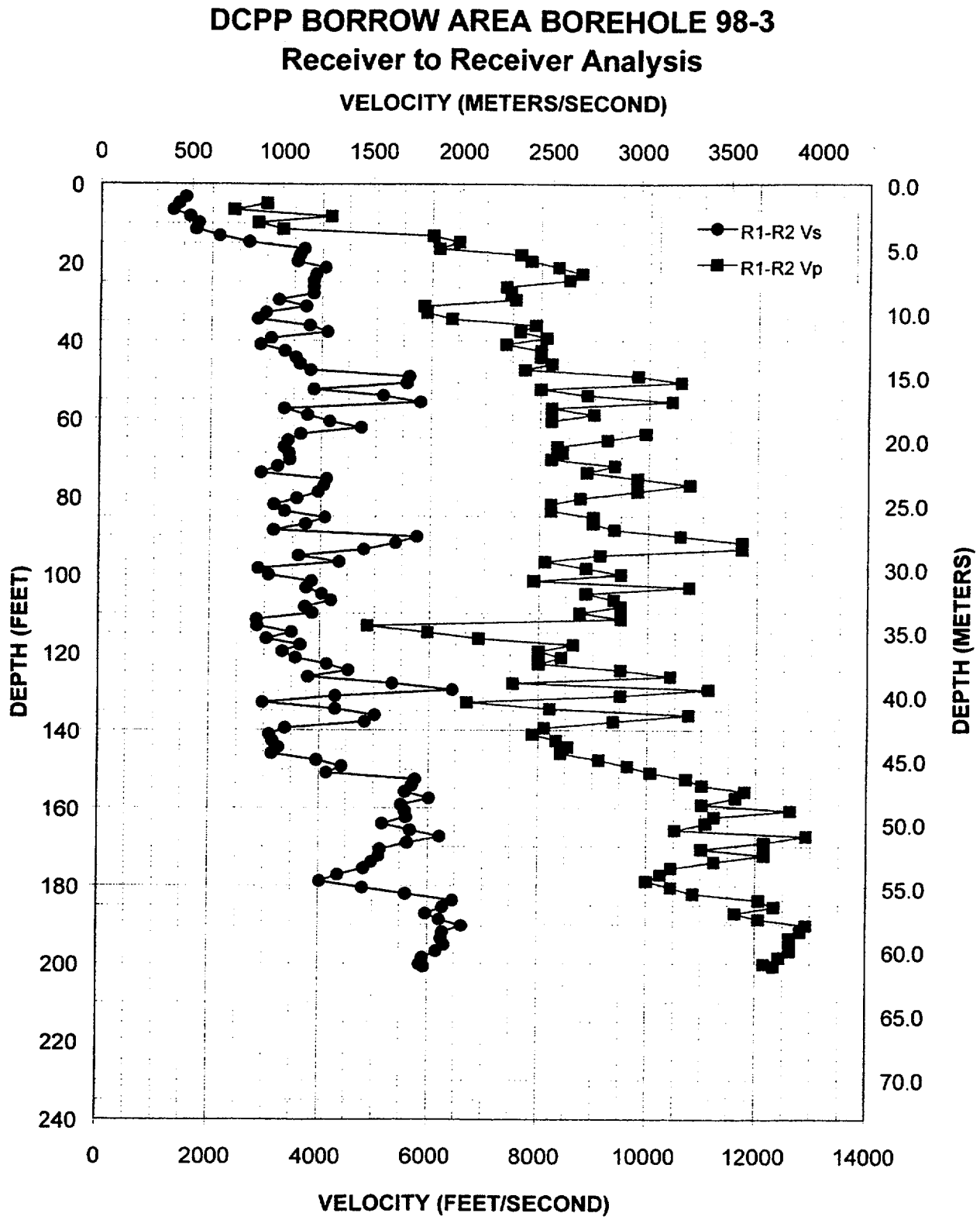


Figure 13 BA 98-3 R1-R2 P- AND S_H-WAVE RESULTS

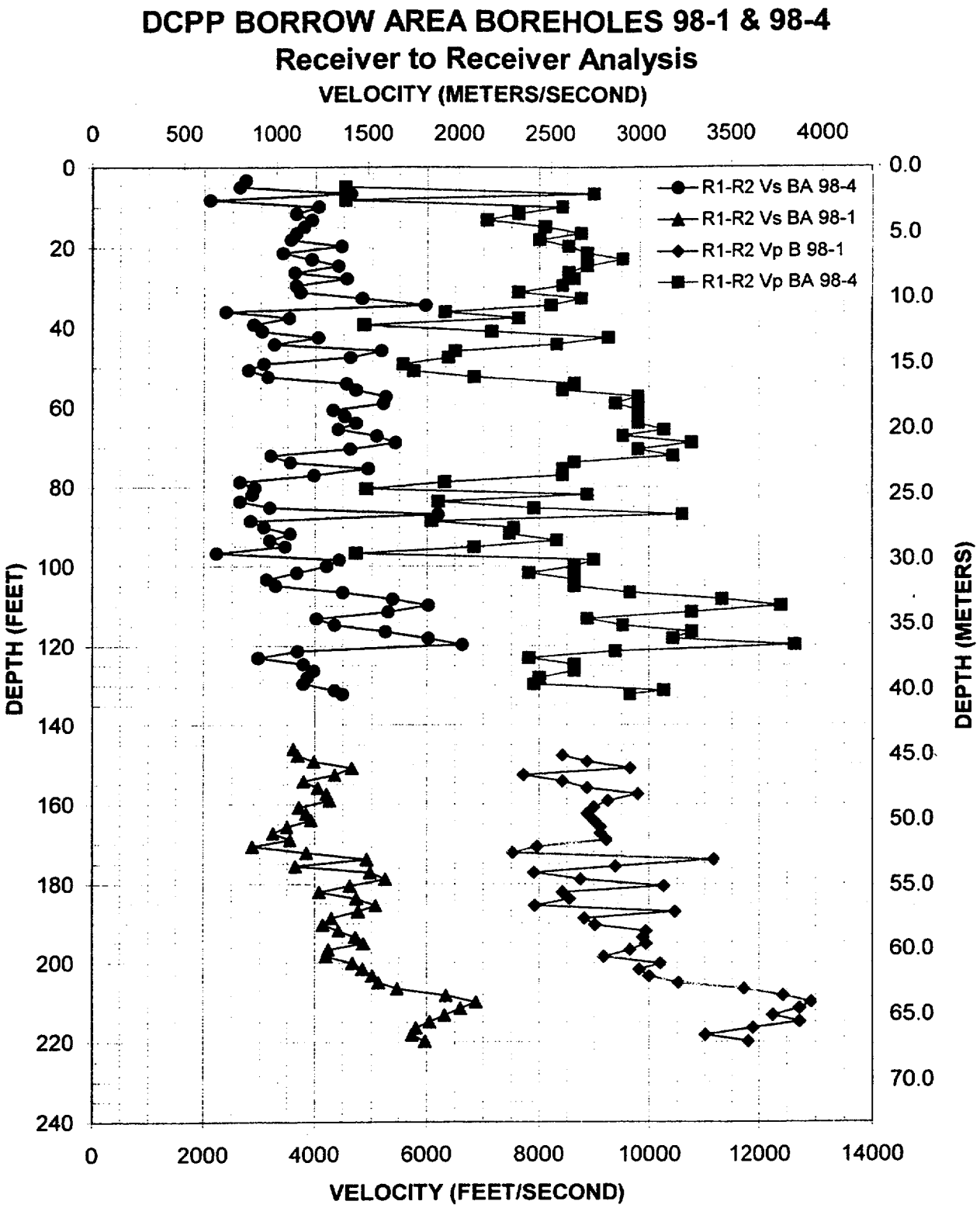


Figure 14 BA 98-1 and BA 98-4 R1-R2 P- AND S_H-WAVE RESULTS

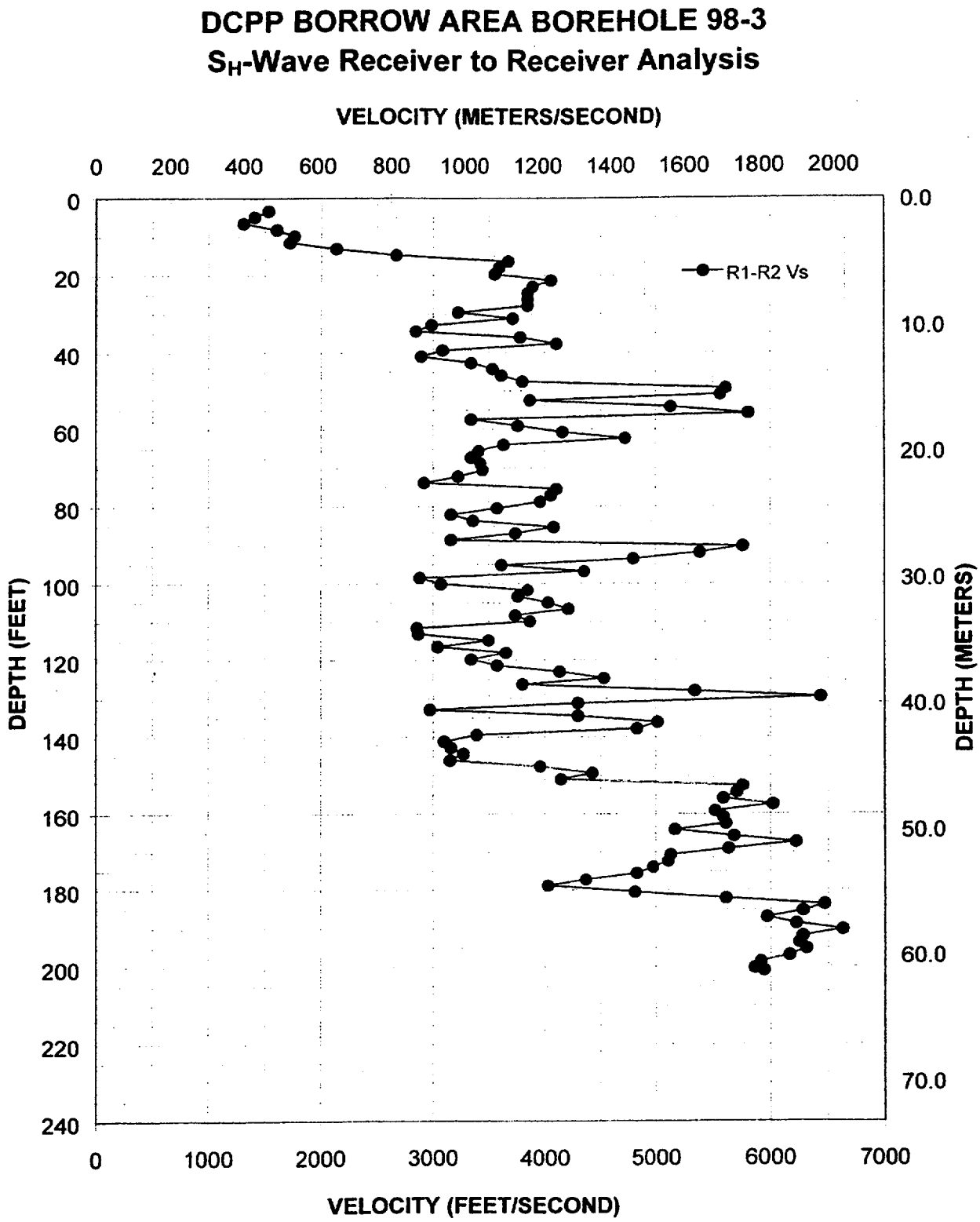


Figure 15 BA 98-3 R1-R2 S_H-WAVE RESULTS

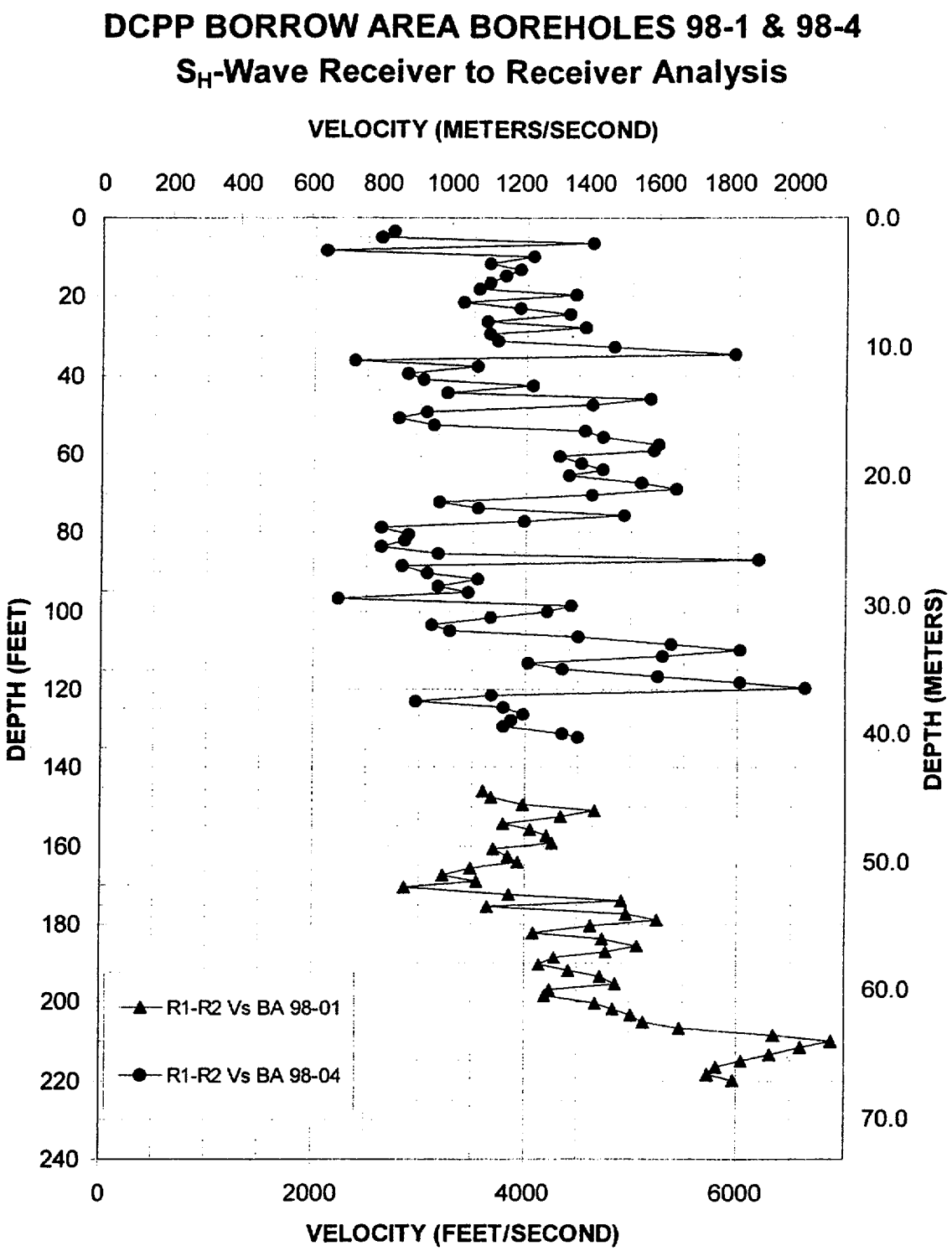


Figure 16 BA 98-1/04 R1-R2 S_H-WAVE RESULTS

DEPTH (FT)	Vs (FT/S)	Vp (FT/S)		DEPTH (FT)	Vs (FT/S)	Vp (FT/S)
3.3	1526	0		103.4	3750	10757
4.9	1402	2983		105.0	4026	8867
6.6	1305	2395		106.6	4206	9374
8.2	1600	4153		108.3	3728	9510
9.8	1754	2828		109.9	3860	8749
11.5	1715	3281		111.6	2853	9510
13.1	2130	6020		113.2	2865	4861
14.8	2667	6497		114.8	3490	5965
16.4	3666	6132		116.5	3038	6907
18.0	3586	7630		118.1	3645	8634
19.7	3547	7812		119.8	3331	8002
21.3	4050	8306		121.4	3566	8412
23.0	3883	8749		123.0	4127	8002
24.6	3837	8522		124.7	4525	9510
26.3	3837	7373		126.3	3793	10415
27.9	3837	7456		128.0	5335	7542
29.5	3217	7542		129.6	6433	11121
31.2	3707	5859		131.2	4289	9510
32.8	2983	5911		132.9	2969	6696
34.5	2841	6371		134.5	4289	8202
36.1	3771	7906		136.2	5009	10757
37.7	4101	7630		137.8	4825	9374
39.4	3081	8101		139.4	3382	8101
41.0	2891	7373		141.1	3095	7906
42.7	3331	8002		142.7	3155	8327
44.3	3528	8002		144.4	3265	8544
45.9	3605	8202		146.0	3147	8412
47.6	3793	7720		147.6	3953	9113
49.2	5608	9794		149.3	4419	9650
50.9	5561	10583		150.9	4140	10064
52.5	3860	8002		152.6	5756	10722
54.1	5126	8867		154.2	5706	11010
55.8	5807	10415		155.8	5584	11802
57.4	3331	8202		157.5	6020	11634
59.1	3750	8989		159.1	5514	11010
60.7	4153	8202		160.8	5584	12619
62.3	4721	0		162.4	5608	11236
64.0	3625	9942		164.0	5167	11084
65.6	3400	9242		165.7	5681	10516
67.3	3331	8306		167.3	6220	12917
68.9	3418	8412		169.0	5632	12151
70.5	3435	8202		170.6	5126	11010
72.2	3217	9374		172.2	5106	12151
73.8	2916	8867		173.9	4971	11236
75.5	4101	9794		175.5	4825	10449
77.1	4050	10757		177.2	4360	10253
78.7	3953	9794		178.8	4026	10003
80.4	3566	8749		180.5	4807	10449
82.0	3155	8202		182.1	5608	10864
83.7	3348	8202		183.7	6465	12062
85.3	4076	8989		185.4	6279	12334
86.9	3728	8989		187.0	5965	11634
88.6	3155	9374		188.7	6220	12062
90.2	5756	10583		190.3	6628	12917
91.9	5378	11717		191.9	6279	12816
93.5	4790	11717		193.6	6249	12619
95.1	3605	9113		195.2	6309	12619
96.8	4345	8101		196.9	6161	12619
98.4	2878	8867		198.5	5911	12427
100.1	3066	9510		200.1	5859	12151
101.7	3837	7906		200.8	5938	12334

Table 1 P-S LOG DATA FOR BA 98-3

R1-R2 ANALYSIS		
DEPTH (FT)	Vs (FT/S)	Vp (FT/S)
144.4		
146.0	3605	
147.6	3686	8412
149.3	3977	8867
150.9	4654	9650
152.6	4345	7720
154.2	3793	8412
155.8	4050	8867
157.5	4206	9794
159.1	4261	9242
160.8	3707	8989
162.4	3837	8867
164.0	3929	8989
165.7	3490	9113
167.3	3232	9113
169.0	3547	9216
170.6	2859	7963
172.2	3848	7525
173.9	4915	11159
175.5	3645	9374
177.2	4971	7906
178.8	5249	8749
180.5	4621	10253
182.1	4076	8412
183.7	4738	8544
185.4	5067	7925
187.0	4772	10449
188.7	4289	8819
190.3	4140	9013
191.9	4419	9942
193.6	4721	9882
195.2	4861	9942
196.9	4233	9650
198.5	4193	9164
200.1	4670	10189
201.8	4843	9823
203.4	5009	10002
205.1	5126	10516
206.7	5468	11717
208.3	6340	12427
210.0	6871	12917
211.6	6595	12716
213.3	6309	12242
214.9	6048	12716
216.5	5807	11887
218.2	5731	11010
219.8	5965	11802

Table 2 P-S LOG DATA FOR BA 98-1

R1-R2 ANALYSIS					
DEPTH (FT)	Vs (FT/S)	Vp (FT/S)	DEPTH (FT)	Vs (FT/S)	Vp (FT/S)
3.3	2734	0	68.9	5423	10757
4.9	2625	4525	70.5	4621	9794
6.6	4621	8989	72.2	3185	10415
8.2	2103	4525	73.8	3547	8634
9.8	4050	8412	75.5	4934	8412
11.5	3645	7630	77.1	3977	8412
13.1	3929	7056	78.7	2635	6309
14.8	3793	8101	80.4	2891	4897
16.4	3645	8749	82.0	2853	8867
18.0	3547	8002	83.7	2635	6190
19.7	4464	8522	85.3	3170	7906
21.3	3400	8867	86.9	6190	10583
23.0	3929	9510	88.6	2828	6076
24.6	4404	8867	90.2	3066	7542
26.3	3625	8522	91.9	3547	7456
27.9	4557	8634	93.5	3170	8306
29.5	3645	8412	95.1	3454	6835
31.2	3728	7630	96.8	2224	4721
32.8	4825	8749	98.4	4434	8989
34.5	5965	8202	100.1	4206	8634
36.1	2377	6309	101.7	3666	7812
37.7	3528	7630	103.4	3110	8634
39.4	2878	4861	105.0	3281	8634
41.0	3024	7132	106.6	4494	9650
42.7	4050	9242	108.3	5378	11313
44.3	3248	8306	109.9	6020	12381
45.9	5167	6497	111.6	5292	10757
47.6	4621	6371	113.2	4026	8867
49.2	3052	5561	114.8	4345	9510
50.9	2792	5756	116.5	5249	10757
52.5	3125	6835	118.1	6020	10415
54.1	4557	8634	119.8	6628	12619
55.8	4721	8412	121.4	3686	9374
57.4	5249	9794	123.0	2969	7812
59.1	5208	9374	124.7	3793	8634
60.7	4317	9794	126.3	3977	8634
62.3	4525	9794	128.0	3860	8002
64.0	4721	9794	129.6	3793	7906
65.6	4404	10253	131.2	4345	10253
67.3	5087	9510	132.2	4494	9650

Table 3 P-S LOG DATA FOR BA 98-4

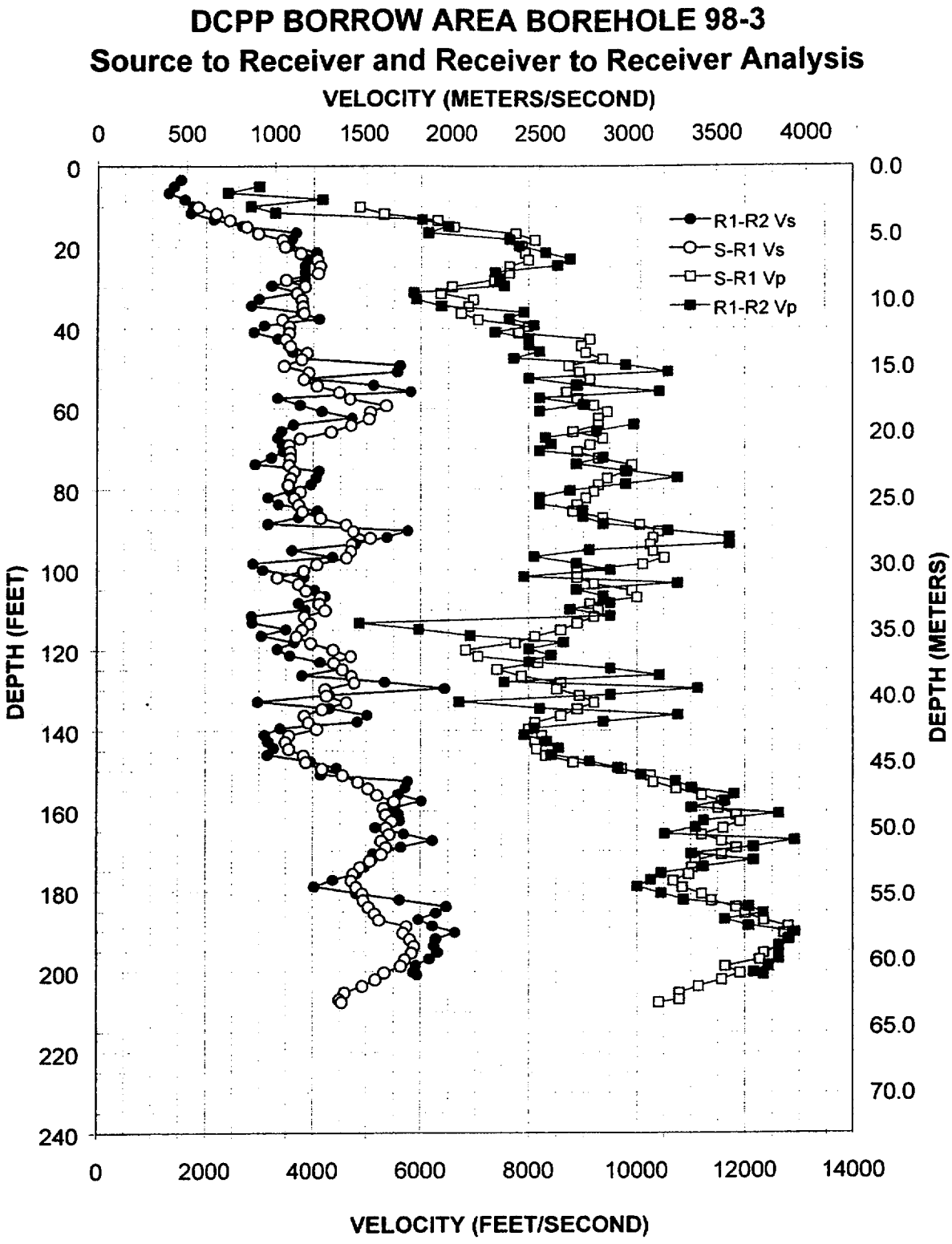


Figure 17 BA 98-3 S-R1 AND R1-R2 P- AND S''-WAVE SOURCE TO RECEIVER AND RECEIVER TO RECEIVER ANALYSIS RESULTS

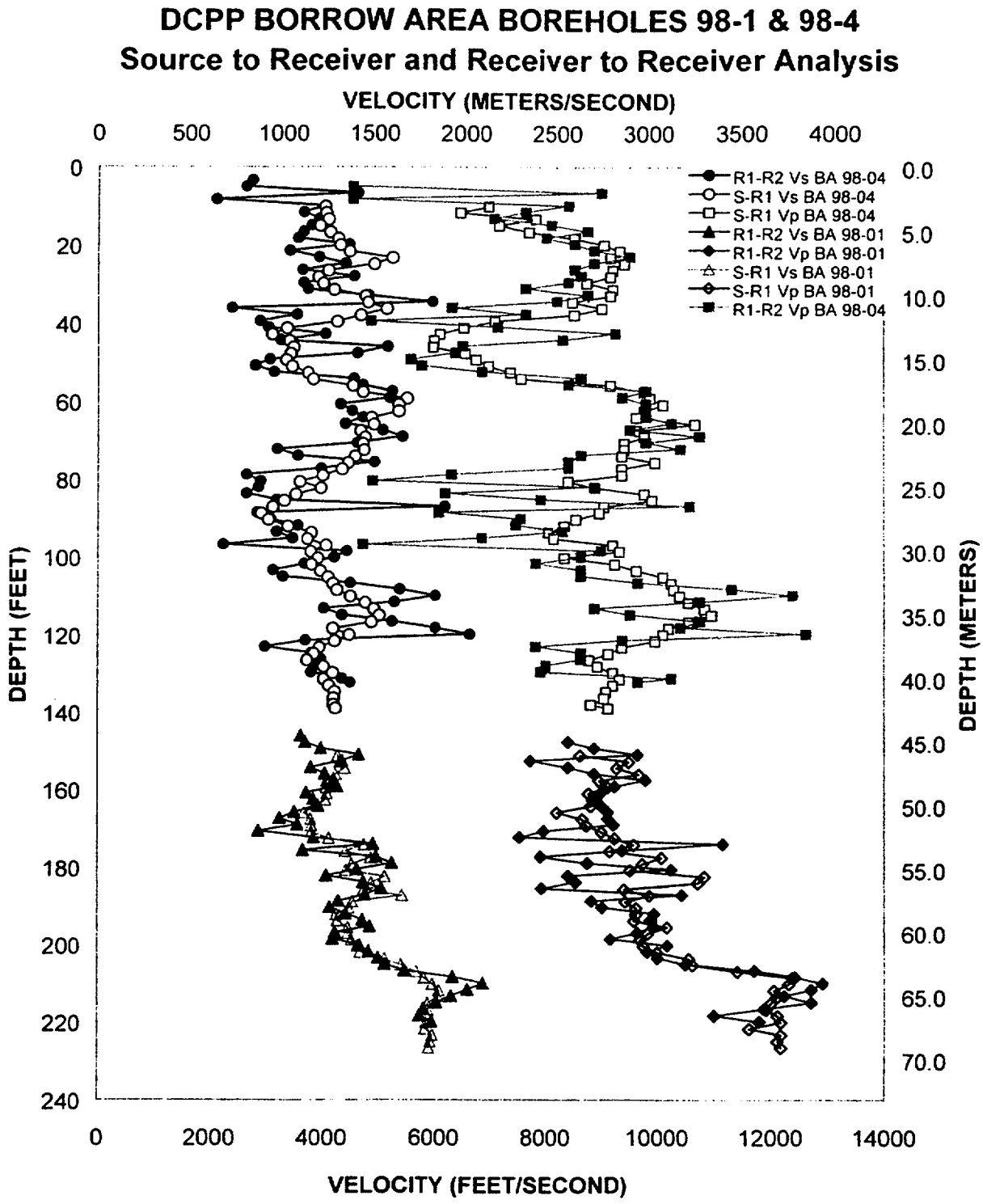


Figure 18 BA 98-1/04 S-R1 AND R1-R2 P- AND S_H-WAVE SOURCE TO RECEIVER AND RECEIVER TO RECEIVER ANALYSIS RESULTS

The results in BA 98-3, which is at the north end of Line BA-2, exhibit a weathered zone down to a depth of about 20 ft, with S_H-wave velocities increasing from 1,800 fps to 4,000 fps. Similarly P-wave velocities increase from 3,000 fps to 8,000 fps. From 20 ft to about 145 ft these velocities remain relatively constant. From 145 ft to 155 ft the rock S_H-wave velocities increase to about 5,500 fps where they remain (with some variation) to total depth. Similarly, P-wave velocities increase in the same region to about 11,500 fps.

The results in BA 98-1/04, which is at the south end of Line BA-2, exhibit a weathered zone from 5-10 ft. Generally the characteristics are very similar with the 4,000 fps S_H-wave velocities from 10 ft to 200 ft, increasing to 6,000 fps below 210 ft. The P-wave velocities are slightly higher at 8,500 fps from 10 ft to 200 ft, increasing to 12,000 fps below 210 ft.

SUMMARY

COMPARISON OF RESULTS

The range of velocities measured in the upper fifty feet of rock at the Borrow Site using the two different geophysical techniques show some differences. In all cases, velocities measured using the surface refraction technique are lower than velocities measured using the borehole suspension technique. A thorough review of the data quality and methods of analysis used confirmed that field procedures and analyses fully complied with applicable Quality Assurance procedures described in the Appendices.

Further evaluation of relationships between geologic characteristics observed at the site, such as orientation and weathering of joint sets and bedding, and velocity differences described herein is to be performed by others.

QUALITY ASSURANCE

These geophysical investigations conducted at the proposed DCPP HLW-Dry Cask Storage Facility at the Water Tank and Borrow Area Sites of the Diablo Canyon Power Plant were performed by professional staff of GEOVision Geophysical Services under the supervision of Antony J. Martin, R.GP., and quality assurance of Mr. John G. Diehl, P.E. and Mr. Rob Steller, and project management by Dr. Robert L. Nigbor. Industry-standard or better methods and levels of care were employed for both measurements and analyses. All work was performed under Agbabian Associates quality assurance procedures, which include:

- Use of NIST-traceable calibrations, where applicable, for field and laboratory instrumentation Use of standard field data logs

- Where applicable, use of independent verification of data (for example, comparison of receiver-to-receiver and source-to-receiver velocities for the suspension velocity measurements, see Appendix F)
- Independent review of calculations and results by a registered professional engineer, geologist, or geophysicist.

REGISTERED GEOPHYSICIST
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California Registered Geophysicist GP989
GEO*Vision* Geophysical Services

9/25/98
Date

QC REVIEWED
BY
DATE 9-25-98

REFERENCES

Guidelines for Determining Design Basis Ground Motions, Report TR-102293, Electric Power Research Institute, Palo Alto, California, November 1993, Sections 7 and 8.

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Procedure for Seismic Refraction Method, DCPP HLW-Dry Cask Storage Facility (Appendix B)

Procedure for OYO P-S Suspension Seismic Velocity Logging Method, DCPP HLW-Dry Cask Storage Facility (Appendix E)

Workplan: Borrow and Water Tank Site Refraction Studies, DCPP HLW-Dry Cask Storage Facility (Appendix A)

Workplan: Phase 2 Borehole Logging, DCPP HLW-Dry Cask Storage Facility (Appendix D)

APPENDIX A

GEOPHYSICAL INVESTIGATIONS FOR THE DCPP HLW-DRY CASK STORAGE FACILITY WORKPLAN: BORROW AND WATER TANK SITE REFRACTION STUDIES

Geophysical Investigations for the DCPP HLW-Dry Cask Storage Facility
Borrow and Water Tank Site Refraction Studies
Proposed CWA #3 and 4 for Contract 4600006633

Workplan

Purpose
The purpose of the seismic refraction survey is to map the P and S-wave velocity structure at each site. Depending on the results, the survey may only provide the average P- and S-wave velocity of various rock units, or may indicate the thickness of the weathered zone and depth to competent rock.

Scope of Work

Borrow Site and Water Tank Sites
Acquire P- and S-wave refraction data along 3 profiles at each site averaging 230-feet in length to estimate the thickness of the weathered zone and average P- and S-wave velocity of weathered and competent rock.

Data Collection

Equipment
The following seismic equipment will be used during this investigation:

- Geometrics Strataview R24 24-channel, 24-bit seismic recording system
- 8-14 Hz vertical geophones for P-wave measurements
- 4.5-14 Hz horizontal geophones for S-wave measurements
- 8-14 Hz 3-component geophones for P- and S-wave measurements in lieu of above
- 2, 12-channel refraction cables with 10 to 30-foot takeouts
- Betsy downhole percussion firing rod with 250-500-grain 12 gauge blanks
- Sledge hammer and aluminum plate
- Traction plank S-wave source
- Hasbrouck golf shoe S-wave source

Other miscellaneous equipment will include:
- Hand auger or motorized auger
- Shovel
- Nikon automatic level and rod
- 300-foot tape measures
- Laptop computer
- Diskettes

Field Procedures

Please refer to GEOVision's "Procedure for Seismic Refraction Method" (Attachment 1) for general procedures. In the case of deviations or conflicts between the two, this Work Plan shall have precedence.

Borrow Site and Water Tank Sites
Each seismic line will consist of single or multiple overlapping 24-channel spreads of geophones spaced 10-feet apart for a total spread length of 230-feet (Figure 2). Vertical and horizontal geophones or 3-component geophones will be used for P-wave and S-wave measurements. The P-wave seismic source will consist of a sledgehammer striking an aluminum plate or Betsy downhole percussion firing rod. The S-wave source will consist of a sledgehammer striking the side of a traction plank weighted by a vehicle, a heavy weight on the surface, or in a plate in a shallow hole.

All geophone and shot-point locations will be measured using a 300-foot tape measure. A Nikon automatic level will be used to survey the relative elevation of each geophone and shot location. A licensed surveyor will survey the endpoints of each seismic line using control points or coordinates provided by PG&E.

A minimum of five P-wave shot points (center shot, forward and reverse end shots and far-offset shots) and three S-wave shot points (center shot, forward and reverse end shots) will be occupied per line. Stacking of multiple shots will be conducted as necessary to improve the signal to noise ratio. At each shotpoint, both normal and reverse polarity S-wave records will be obtained to facilitate recognition of S-waves on the seismic records. The layout of each seismic line (orientation, geophone spacing, shot point locations, number stacks, filenames, etc.) and comments on noise sources, etc. will be accurately documented in field notes. Paper copies of all seismic records will be printed in the field and signed by the field geophysicist. Data will also be stored on floppy disk.

Data Processing

Borrow Site and Water Tank Site
P-wave refraction data will be modeled using the generalized reciprocal method (GRM). GRM is a seismic refraction interpretation method designed to accurately map undulating refractor surfaces from in-line refraction data using both forward and reverse shots. The first step in data processing will consist of picking first arrivals using the program FIRSTPIX by Interpex, Ltd. The GRM will be implemented using the program VIEWSEIS by Viewlog Systems. For each seismic line the first arrival and geophone elevation data will be entered into the program and Time-Distance plots generated. First arrival data will then be interactively assigned to various geologic layers (i.e. soil, weathered rock, and competent rock) and the GRM implemented to model the depth to competent rock along the line and velocities of each layer.

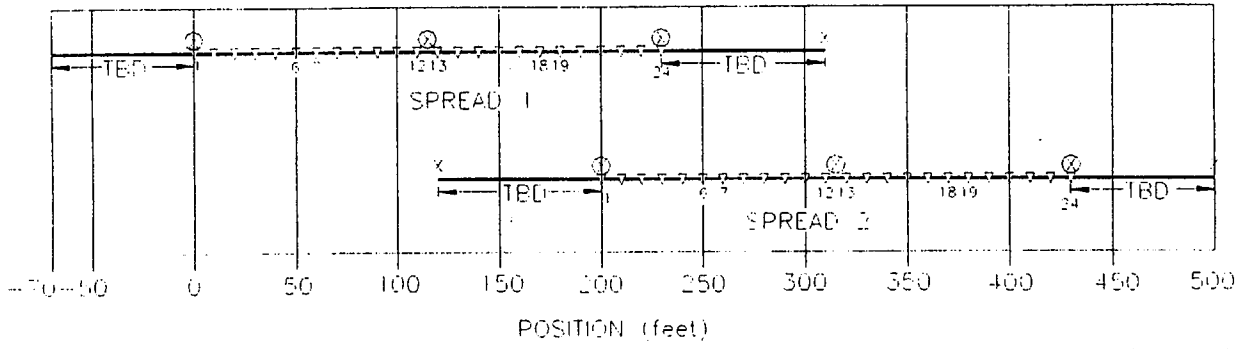
S-wave refraction data will be modeled slope-intercept method to assess the approximate velocities of subsurface geologic units. If the S-wave refraction data is of good enough quality (generating strong shear waves is very difficult), processing with GRM will be considered.

Quality Control
Quality control measures will include the following:

- Abide by **GEO***Vision* Seismic Refraction Procedure approved by PG&E
- The investigation will be supervised by California Registered Geophysicist
- Equipment will be calibrated and tested as necessary
- Field activities will be clearly documented
- All hand or spreadsheet calculations will be checked and verified
- Abide by **GEO***Vision* QA/QC Program
- Abide by PG&E QA/QC Program

Report
The report will include data tabulations, QA/QC information and a discussion of field procedures, data processing, interpretation, and the results of the survey. Interpreted depth-sections will be provided for seismic refraction lines at the Borrow and Water Tank Sites. The report will be independently reviewed and approved by a California registered geophysicist.

Registered Geophysicist	QA Review
Name: Antony J. Martin	Name: John G. Diehl
Title: Technical Director	Title: Vice President/QA Manager
Signature: Antony J Martin	Signature:
Date: 4/15/98	Date: 4/15/98



LEGEND

- GEOPHONE AND NUMBER
- P SHOTPOINT (MINIMAL CONFIGURATION)
- S SHOTPOINT (MINIMAL CONFIGURATION)

FIGURE 1

PROPOSED GEOMETRY OF SEISMIC REFRACTION LINES
BORROW AND WATER TANK SITES
DCPP HLW-DRY CASK STORAGE FACILITY

Prepared for
PG&E Corporation

GEOVISION GEOPHYSICAL SERVICES

APPENDIX B

PROCEDURE FOR SEISMIC REFRACTION METHOD,

DCPP HLW-DRY CASK STORAGE FACILITY

ATTACHMENT 1

PROCEDURE FOR SEISMIC REFRACTION METHOD

DCPP HLW-Dry Cask Storage Facility

Background

This procedure describes a method for measuring shear and compressional wave velocities in soil and rock. The Seismic Refraction Method is applied by generating compressional waves (*P*) (and sometimes shear (S_H)) on the land surface and measuring the travel time of the corresponding waves from the source to one or more geophones. These measurements are used to interpret subsurface conditions and materials. This travel time, along with distance between source and geophone(s), can also be interpreted to yield depth to refracting layer(s). The calculated seismic velocities can often be used to characterize some of the properties of natural and man-made subsurface materials.

This is a general procedure and does not address all the details and components of a seismic refraction survey. Please refer to the references provided for additional information.

Objective

The specific objective varies depending on the project. It can be simply to reconnoiter subsurface conditions, or to provide detailed subsurface information. For example, rippability studies require very few geophones and a very simple analysis. On the other hand, detailed studies require very careful design of geophone spacing, source energy and location, accurate measurement of geophone elevations, and so on. In general, the basic outcome is a measurement of seismic wave velocities. Detailed studies will also provide a profile of the depth to refractors.

Equipment

1. Seismic energy source. Four types of sources used by GEOVision include:

   1.1. Sledge hammers of various weights

   1.2. Mechanical or accelerated weight drop or impact devices, such as the Bison EWG-1 or Geometrics Dynasource

1.3. Projectile (gun) sources, such as the Betsy Seisgun, Betsy downhole percussion firing rod

1.4. Explosives

2. Multichannel seismograph, such as Geometrics Strataview R24, OYO DAS-1, or equivalent. GEOVision uses 24 to 48 channel systems for detailed refraction surveys. Seismographs must provide for digital recording, and for signal enhancement (energy) stacking. Single - 12 channel systems are acceptable for simple surveys such as rippability studies.

3. 4 - 14 Hertz geophones (vertical for P-wave refraction studies, horizontal for S-wave studies), connected to the seismograph by cable. Geophone and take-out (electrical connection) spacing is determined by the depth of exploration and the resolution required

4. Trigger cable or radio link, to provide a timing signal to the seismograph at the time of source impact

5. Batteries to operate refraction system

Figure 1 is a sketch of the field layout for a typical refraction survey.

Environmental Conditions

Seismic refraction data are affected by ground vibrations from a variety of sources. These include ambient sources such wind, water movement (such as waves breaking on a nearby beach), natural seismic activity, and rainfall on the geophones. They also include cultural sources such as vehicular traffic, construction equipment, nearby motors, aircraft, or blasting. Frozen ground can contribute a high-velocity near-surface path that will obscure the contribution of deeper layers.

Such sources should be minimized as much as possible. Where possible, refraction data should not be collected during high winds or rain, or while vehicles are passing.

Calibration

Calibration of the multichannel seismograph is required. Calibration is limited to the timing accuracy of the recorder. GEOVision's Seismograph Calibration Procedure or equivalent should be used. Calibration must be performed on an annual basis.

Measurement Procedure

The specific procedure varies according to the objective for the survey, the design of the survey, and the method used to define the planar refractors. These are described in more detail in other references (1 - 6).

The most important considerations are:

1. Location of seismic refraction lines
2. Length and orientation of lines
3. Geophone spacing
4. Location of shots (sources)
5. Approach or interpretation method. These can include:

   5.1. Intercept-time or crossover method

   5.2. Delay-time methods and variations thereof

   5.3. Reciprocal methods, including:

      5.3.1. Common Reciprocal Method

      5.3.2. Generalized Reciprocal Method

   5.4. Ray-tracing methods

   5.5. Tomographic methods

Of these approaches, the method most often used by GEOVision for detailed refraction surveys is the Generalized Reciprocal Method. This method is acknowledged superior to many other methods for modeling irregular dipping refractors and lateral velocity changes.

The general field procedures are as follows:

1. Check for adequate space to lay out a straight line in accordance with the survey design
2. Locate and position first geophone according to design and such that the location can be repeated or identified independently (the line should be referenced to absolute fiducials at several locations).

3. Accurately mark geophone locations. Locations must be surveyed to within a few percent of the geophone interval, including elevation

4. Lay out geophone cable

5. Place geophones at marked locations. Geophones must be vertical and well coupled to the ground using the spike provided. Where rock is exposed the spike may be replaced with a tripod base.

6. Test geophones and cables for shorts or open circuits.

7. Set up source(s) at design locations. Shot locations must also be surveyed to within a few percent of the geophone interval.

8. Place trigger cable

9. Test seismic source and trigger cable

10. Input survey geometry into seismograph

11. Test noise level and set gains and filters

12. Proceed with refraction measurements

Required Field Records

1) Field log for each refraction measurement describing:

   a) Location of each geophone

   b) Date and time of test

   c) Tester or data recorder

   d) Description of source (location, amplitude, number of stacks)

   e) Any gain or filtering by channel during recording

   f) Any deviations from test plan and action taken as a result

   g) File name as recorded on disk

   h) QA Review

Much of the above information will be automatically recorded in the seismograph header at the time of recording (gains, filtering, and survey geometry) and need not be recorded on the paper log.

2) Diskettes or tapes with backup copies of data on hard disk, labeled with line and measurement designation, record ID numbers, date, and tester name.

Analysis and Interpretation

Following completion of field work, the recorded digital records are processed by computer and interactively analyzed by an experienced geophysicist to produce plots and tables of P and S_H wave velocity versus depth.

Again, the specific procedure varies according to the objective for the survey, the design of the survey, and the method used to define the planar refractors.

In general, GEOVision refraction data is processed using the Generalized Reciprocal Method (GRM), one of the most advanced modeling methods currently available for seismic refraction data. Processing steps consist of loading field records into a computer, picking the travel times of first arrivals, entering shot and spread geometry, phantoming data from all shots on a line to obtain one set of forward and reverse travel time curves for each refractor, and applying the GRM to obtain a depth section (model showing different geologic units and their velocities).

Preliminary interpretations are carefully verified using available geologic and drilling data. If at all possible, GEOVision recommends performing OYO P-S Suspension Logging or Downhole velocity survey in at least one borehole for a high-resolution constraint of the model. If such data is not available, the report will so mention.

Report

The final report will include the objective and scope of the survey, discussion of the geologic setting, any limitations of the survey, and any assumptions made. The field approach will be described including a description of equipment, procedures, and data acquisition parameters. The location of the seismic refraction line will be described along with a site map and the shot-point/geophone layout. Any corrections made to the field data will be discussed, including justification. The results of field measurements will be described including samples of raw data, and time-distance plots.

The methodology for picking first arrivals, and for interpreting the results will be described along with any software program used. The interpreted results based on these methods will be presented along with any qualifications and alternate interpretations. These will include depth sections and seismic velocities.

Appropriate references for any supporting data will be provided.

The report will be signed by the California Registered Geophysicist responsible for the refraction survey and data interpretation, and QA Reviewed in accordance with GEOVision QA Procedures.

Registered Geophysicist	QA Review
Name: Antony J. Martin	Name: John G. Diehl
Title: Technical Director	Title: Vice President/QA Manager
Signature: Antony Martin	Signature:
Date: 4/15/98	Date: 4-15-98

References:

1. ASTM Standard D 5777-95 "Standard Guide for Using the Seismic Refraction Method for Subsurface Investigation"

2. Redpath, Bruce B. "Seismic Refraction Exploration for Engineering Site Investigations", Explosive Excavation Research Laboratory, Livermore, CA, distributed by NTIS, US Dept. of Commerce, Springfield, VA

3. "Geophysical Exploration for Engineering and Environmental Investigations", Technical Engineering and Design Guides as adapted from the US Army Corps of Engineers, No.23, published by ASCE Press, Reston, VA

4. Dobrin, M.B. 1960 *Introduction to Geophysical Prospecting*. 2nd Edition. McGraw-Hill Book Co. Inc, New York

5. Telford, W.M., et al, 1976 *Applied Geophysics* Cambridge University Press

6. Milsom, J. 1989 *Field Geophysics* Open University Press, Milton Keynes

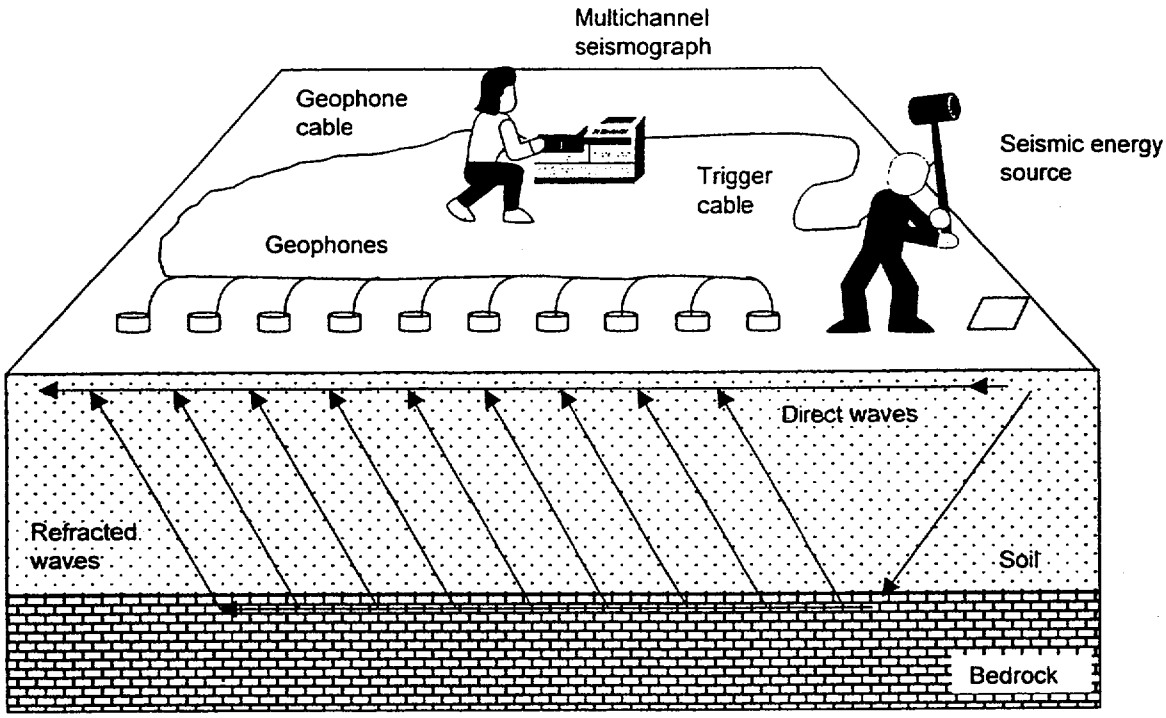


Figure 1 FIELD LAYOUT OF A MULTICHANNEL SEISMIGRAPH SHOWING WAVE PATHS

APPENDIX C

GEOPHONE ELEVATIONS AND FIRST ARRIVAL DATA

BORROW AREA LINE BA-1, SPREAD 1 P-WAVE DATA, Data Collected April 1998						
Position (feet)	Elevation (feet above MSL)	First Arrival Time (milliseconds) File Name/Shot Position (feet)				
		1018.dat/0	1019.dat/-100	10110.dat/115	10112.dat/230	10113.dat/330
0	324.2	0.0	32.3	43.6	58.8	76.3
10	325.5	5.4	36.0	40.5	58.3	76.0
20	326.5	8.6	39.3	35.6	56.5	73.8
30	327.5	12.0	43.4	30.4	53.9	71.6
40	328.7	15.4	45.1	25.8	51.6	69.1
50	330.2	19.0	47.3	23.3	49.8	67.0
60	330.6	21.9	49.9	18.6	47.0	65.3
70	331.5	24.6	51.5	15.9	44.3	62.8
80	332.2	27.3	52.4	13.3	41.4	60.1
90	333.1	30.4	53.6	9.5	38.6	57.5
100	333.8	34.1	55.4	6.0	36.1	55.6
110	334.8	37.1	57.4	3.6	35.9	55.4
120	335.6	40.0	60.3	2.8	32.6	54.1
130	336.4	42.1	61.5	6.4	30.5	50.6
140	336.9	43.5	62.8	11.3	27.3	48.0
150	337.5	45.0	63.8	14.5	23.8	45.3
160	338.2	45.8	64.0	20.0	19.4	42.1
170	338.9	47.8	65.1	22.8	16.9	40.4
180	339.4	49.4	66.8	24.0	13.1	38.9
190	340.0	51.4	69.1	26.1	11.3	37.9
200	340.7	53.9	71.0	28.4	9.4	35.1
210	341.3	55.5	73.0	30.8	7.6	33.8
220	341.5	57.0	73.9	32.1	4.1	31.4
230	342.3	58.5	75.3	35.8	0.0	31.5

BORROW AREA LINE BA-1, SPREAD 2 P-WAVE DATA, Data Collected April 1998						
Position (feet)	Elevation (feet above MSL)	First Arrival Times (milliseconds)				
		File Name/Shot Position (feet)				
		10212.dat/305	10214.dat/190	10215.dat/90	10216.dat/520	10217.dat/420
190	340.0	32	0	27	72.8	
200	340.7	29	4.8	29.5	71.1	
210	341.3	27.8	7.8	31.1	69.8	
220	341.5	25.1	8.3	33.3	68.5	
230	342.3	23.1	11.9	36	67.4	
240	342.9	22	13.9	38.3	66.8	
250	342.7	19	18.4	40	65.9	
260	343.1	16.5	22.3	41.4	64.5	
270	343.9	12	24.3	43.5	62.6	37.3
280	344.2	8.5	26	44.9	61.6	35.4
290	344.3	6.1	28.9	46.4	60	33.8
300	345.2	3.5	32.8	47.9	57.9	32.1
310	345.5	3	34.1	50.1	55.8	30.1
320	345.8	7.8	37.3		53.9	28.3
330	346.1	11.6	39.3		51.4	26.6
340	346.2	14	40.8		48.6	23.9
350	346.1	16.3	42.6		46.8	22.1
360	345.6	18.4	44.4		45.1	20.6
370	345.1	21.1	46.1		42.6	18.9
380	345.0	22.8	48.6		41.5	15.5
390	344.8	24.5	50.6		39.9	11.9
400	345.4	26.8	53		38.8	7.6
410	345.0	29.9	56		36.4	4.1
420	344.8	31.8	56.9		33.6	0

BORROW AREA LINE BA-1, SPREAD 3 P-WAVE DATA, Data Collected April 1998								
Position (feet)	Elevation (feet above MSL	First Arrival Times (milliseconds)						
		File Name/Shot Position (feet)						
		10311.dat/380	10312.dat/280	10313.dat/495	10314.dat/610	10316.dat/710	10318.dat/555	10319.dat/435
380	345.0	0.0	31.6	37.9		88.5	51.9	23.9
390	344.8	5.5	33.0	36.0		87.6	50.1	20.4
400	345.4	9.4	36.6	34.6		87.0	49.0	15.6
410	345.0	13.9	38.8	33.0	56.6	86.8	46.6	11.4
420	344.8	16.0	41.5	31.9	55.4	86.3	45.9	8.5
430	344.7	20.0	44.6	31.5	54.8	85.3	45.1	4.4
440	344.2	23.9	48.1	27.8	51.1	81.9	41.3	4.4
450	343.5	28.3	50.3	25.0	48.6	79.0	38.8	10.0
460	343.2	30.5	51.6	20.3	47.6	76.8	36.5	14.5
470	343.1	32.1	54.9	16.5	47.6	76.6	35.3	19.4
480	342.9	33.8	57.8	10.5	46.9	77.4	31.4	26.4
490	342.0	36.0	59.6	5.0	43.1	75.9	25.5	27.6
500	340.8	38.3	60.3	4.3	39.3	73.1	21.3	29.1
510	339.6	41.6	62.6	8.8	35.4	70.6	16.3	31.8
520	338.7	44.1	64.5	10.9	29.8	65.6	13.3	
530	337.6	45.9	65.5	14.8	26.1	62.9	10.1	
540	336.8	47.0	66.1	19.0	23.1	61.1	7.0	
550	336.0	49.0	68.3	23.3	19.8	58.6	4.3	
560	335.5	51.4	70.6	27.3	16.9	56.3	3.8	
570	334.9	52.9	71.6	29.9	13.8	53.6	7.5	
580	334.0	54.6	72.9	32.3	10.8	52.6	9.6	
590	333.0	56.4	75.0		7.4	49.6	11.6	
600	332.3	58.4	76.1		4.1	45.8	14.9	
610	331.8	60.6	77.5		0.0	45.6	21.0	

BORROW AREA LINE BA-2 P-WAVE DATA, Data Collected April 1998								
Position (feet)	Elevation (feet above MSL)	First Arrival Times (milliseconds)						
		File Name/Shot Position (feet)						
		2019.dat/230	20111.dat/251	20112.dat/175	20113.dat/115	20114.dat/55	20115.dat/0	20117.dat/-100
0	377.6	53.4	50.5	40.1	26.9	17.1	0.0	27.9
10	376.4	51.2	48.3	38.1	24.6	14.4	4.8	31.1
20	373.1	49.9	46.5	37.0	23.4	12.6	8.5	35.1
30	369.3	47.5	44.1	34.1	21.1	9.0	11.8	36.4
40	366.1	44.4	40.3	30.9	17.4	6.3	12.6	36.3
50	363.2	42.2	38.1	29.3	16.1	4.0	14.8	37.3
60	360.0	40.5	37.0	27.5	14.3	4.0	17.6	38.8
70	356.9	39.4	36.0	26.5	12.3	7.4	19.9	41.0
80	354.6	38.9	34.9	25.5	10.4	9.9	22.0	43.5
90	352.0	37.4	33.8	24.3	7.9	12.3	24.9	45.9
100	349.3	34.7	31.1	21.3	5.6	15.1	26.7	47.4
110	346.5	32.5	28.9	19.4	3.4	15.1	26.5	47.3
120	344.0	31.2	27.1	16.9	2.5	18.1	29.7	50.5
130	341.0	29.0	25.1	15.4	4.1	20.0	30.8	52.0
140	338.5	27.5	24.3	14.4	7.4	22.4	32.9	53.4
150	335.8	24.9	21.8	11.8	9.6	23.6	35.4	55.9
160	333.2	23.3	20.0	6.9	12.8	26.5	38.2	58.5
170	330.9	22.1	18.9	3.1	15.6	28.5	39.8	60.5
180	328.4	19.0	15.9	3.3	16.0	27.9	39.3	61.0
190	326.1	18.5	15.6	4.6	18.4	31.0	42.2	63.5
200	323.5	15.1	12.9	8.3	20.3	32.5	43.4	64.8
210	321.6	14.5	13.3	11.4	23.9	35.6	47.2	69.4
220	319.2	9.3	13.1	17.3	28.6	40.4	52.2	74.3
230	316.8	0.0	10.3	19.8	31.3	42.5	54.2	76.1

APPENDIX D

GEOPHYSICAL INVESTIGATIONS FOR THE DCPP HLW-DRY CASK STORAGE FACILITY WORKPLAN: PHASE 2

(*BOREHOLE LOGGING*)

Geophysical Investigations for the DCPP HLW-Dry Cask Storage Facility
Phase 2 Work Plan
Proposed CWA #5 for Contract 4600006633

Workplan

Purpose
The purpose of the borehole logging is to provide a detailed measurement of the P and S-wave velocity structure surrounding up to three boreholes located at the borrow area hillside site.

Scope of Work
The following tasks will be performed in three boreholes located at the borrow area hillside site.

Task 1: Perform borehole logging using the P-S Suspension method (reference GEOVision's "Procedure for OYO P-S Suspension Seismic Velocity Logging Method")

Task 2: If the results of the P-S suspension logging indicate questionable or inconsistent data, perform borehole logging using the Downhole Seismic Method (reference GEOVision's "Procedure for Downhole Seismic Velocity Logging").

Data Collection
Equipment
The following seismic equipment will be used during this investigation:

Task 1
- OYO P-S 170 Digital Logging Recorder
- OYO P-S Suspension Logger probe, including two sets horizontal and vertical geophones, seismic source, and power supply for source and receivers
- Winch and winch controller, with logging cable
- Batteries to operate OYO 170 and winch, or generator for the winch

Task 2
- OYO Model 170 Digital Logging Recorder or equivalent
- Downhole probe, including horizontal and vertical geophones, fluxgate compass for orientation downhole, and system for locking probe against the side of the borehole
- Downhole source, either traction plank per procedure or Hasbrouck Golf Shoe
- 16 and 20-pound sledge hammers with impulse switches to trigger recording
- Geophone for surface recording to check trigger time
- OPTIONAL: Winch and winch controller, with logging cable (may not be used)
- Batteries to operate OYO 170 and controls for downhole probe

Other miscellaneous equipment will include:
- Laptop computer
- Diskettes
- Various cables

Equipment Calibration

The OYO P-S 170 recorder shall be calibrated within 12 months prior to use in the field and labeled in accordance with the Agbabian Associates Quality Assurance Program and the GEOVision "Calibration Procedure for **GEO***Vision*'s Seismic Recorder/Logger". The 12-month calibration interval was instituted in the Agbabian Associates Quality Assurance Program Section 12.1 (Revised Sept 25, 1997) in recognition of the consistent accuracy demonstrated over many years of by-yearly calibration checks. Instrumentation within the probes (geophones, fluxgate compass, seismic source) does not require calibration for this procedure.

Field Procedures

Please refer to GEOVision's "Procedure for OYO P-S Suspension Seismic Velocity Logging Method" and "Procedure for Downhole Seismic Velocity Logging". In case of deviations or conflicts between the two, this Work Plan shall have precedence.

Up to three boreholes will be drilled and cased by others. The depths and locations of the boreholes will be determined following preliminary evaluation of the results from the Refraction Survey performed previously at the site. The depths should be at least 5 meters greater than the desired measurement depth in order to accommodate the length of the P-S Suspension probe. Logging will be performed in uncased boreholes if the boreholes can be maintained in the uncased condition. Otherwise, upon completion of drilling, the boreholes will be cased with 3" ID PVC, and grouted according to the method recommended in ASTM D 4428/D 4428M-91. Disturbance to the borehole walls will be minimized.

P-S Suspension measurements will be performed in the boreholes at 1 meter intervals or less. Downhole measurements will be performed at 1.5 meter intervals. Prior to performing downhole measurements, each borehole will be emptied of fluid. Paper copies of all seismic records will be printed in the field and signed by the field geophysicist. Data will also be stored on floppy disk.

Data Processing

Data processing and analysis will be accomplished according to the referenced procedures.

The results will be compared between the P-S Suspension logging, Downhole logging, and the refraction survey conducted previously at the site.

Quality Control

Quality control measures will include the following:

- Abide by **GEO***Vision*'s "Procedure for OYO P-S Suspension Seismic Velocity Logging Method", and
- ASTM D 4428/D 4428M-91 "Standard Test Methods for Crosshole Seismic Testing" approved by PG&E (for grouting methods only)
- Abide by **GEO***Vision*'s "Procedure for Downhole Seismic Velocity Logging".
- The investigation will be supervised by California Registered Geophysicist
- Equipment will be calibrated and tested as necessary
- Field activities will be clearly documented

- All hand or spreadsheet calculations will be checked and verified
- Abide by **Agbabian Associates** QA/QC Program
- Abide by PG&E QA/QC Program

Report

The report will include data tabulations, QA/QC information and a discussion of field procedures, data processing, interpretation, and the results of the survey. Interpreted velocity profiles will be provided for each borehole. The report will be independently reviewed and approved by a California registered geophysicist.

Registered Geophysicist	QA Review
Name: Antony J. Martin	Name: John G. Diehl
Title: Technical Director	Title: Vice President/QA Manager
Signature:	Signature:
Date: 6/3/98	Date: 6/3/98

APPENDIX E

PROCEDURE FOR OYO P-S SUSPENSION SEISMIC VELOCITY LOGGING METHOD

PROCEDURE FOR

OYO P-S SUSPENSION SEISMIC VELOCITY LOGGING METHOD

Reviewed 3/10/1998

Background

This procedure describes a method for measuring shear and compressional wave velocities in soil and rock. The OYO P-S Suspension Method is applied by generating shear and compressional waves in a borehole using the OYO P-S Suspension Logger borehole tool and measuring the travel time between two receiver geophones or hydrophones located in the same tool.

Objective

The outcome of this procedure is a plot and table of P and S_H wave velocity versus depth for each borehole. Standard analysis is performed on receiver to receiver data. Data is presented in report format, with ASCII data files and digital records transmitted on diskette.

Instrumentation

1. OYO Model 170 Digital Logging Recorder or equivalent
2. OYO P-S Suspension Logger probe, including two sets horizontal and vertical geophones, seismic source, and power supply for the source and receivers
3. Winch and winch controller, with logging cable
4. Batteries to operate OYO 170 and winch

The Model 170 Suspension P-S Logging system, manufactured by OYO Corporation, is currently the only commercially available suspension system. As shown in Figure 1, the System consists of a borehole probe suspended by a cable and a recording/control electronics package on the surface.

The suspension system probe consists of a combined reversible polarity solenoid horizontal shear-wave generator (S_H) and compressional-wave generator (P), joined to two biaxial geophones by a flexible isolation cylinder. The separation of the two geophones is one meter, allowing average wave velocity in the region between the

geophones to be determined by inversion of the wave travel time between the two geophones. The total length of the probe is approximately 7 meters; the center point of the geophones is approximately 5 meters above the bottom end of the probe.

The probe receives control signals from, and sends the amplified geophone signals to, the instrumentation package on the surface via an armored 7 conductor cable. The cable is wound onto the drum of a winch and is used to support the probe. Cable travel is measured by a rotary encoder to provide probe depth data.

The entire probe is suspended by the cable and centered in the borehole by nylon "whiskers." Therefore, source motion is not coupled directly to the borehole walls; rather, the source motion creates a horizontally propagating pressure wave in the fluid filling the borehole and surrounding the source. This pressure wave produces a horizontal displacement of the soil forming the wall of the borehole. This displacement propagates up and down the borehole wall, in turn causing a pressure wave to be generated in the fluid surrounding the geophones as the soil displacement wave passes their location.

Environmental Conditions

The OYO P-S Suspension Logging Method can be used in either cased or uncased boreholes. For best results, the borehole must be between 10 and 20 cm in diameter, or 4 to 8 inches.

Uncased boreholes are preferred because the effects of the casing and grouting are removed. It is recommended that the borehole be drilled using the rotary mud method. This method does little damage to the borehole wall, and the drilling fluid coats and seals the borehole wall reducing fluid loss and wall collapse. The borehole fluid must be well circulated prior to logging.

If the borehole must be cased, the casing must be PVC and properly installed and grouted. The best method is using a tremie tube to pump grout from the bottom. Any voids in the grout will cause problems with the data. Likewise, large grout bulbs used to fill cavities will also cause problems. The grout must be set before testing. This means the grouting must take place at least 48 hours before testing.

Calibration

Calibration of the Model 170 digital recorder is required. Calibration is limited to the timing accuracy of the recorder. GEOVision's Seismograph Calibration Procedure or equivalent should be used. Calibration must be performed on an annual basis.

Measurement Procedure

The entire probe is lowered into the borehole to a specific measurement depth by the winch. A measurement sequence is then initiated by the operator from the instrumentation package control panel. No further operator intervention is then needed to complete the measurement sequence described below.

The system electronics activates the SH-wave source in one direction and records the output of the two horizontally oriented geophone axes which are situated parallel to the axis of motion of the source. The source is then activated in the opposite direction, and the horizontal output signals are again recorded, producing a SH-wave record of polarity opposite to the previous record. The source is finally actuated in the first direction again, and the responses of the vertical geophone axes to the resultant P-wave are recorded during this sampling.

The data from each geophone during each source activation is recorded as a different channel on the recording system. The Model 170 has six channels (two simultaneous recording channels), each with a 12 bit 1024 sample record. The recorded data is displayed on a CRT display and on paper tape output as six channels with a common time scale. Data is stored on 3.5-inch floppy diskettes for further processing. Up to 8 sampling sequences can be stacked (averaged) to improve the signal to noise ration of the signals.

Review of the displayed data on the CRT or paper tape allows the operator to set the gains, filters, delay time, pulse length (energy), sample rate, and stacking number in order to optimize the quality of the data before recording.

Typical depth spacing for measurements is 1.0 meters, or 3.3 feet. Alternative spacing is 0.5 meter, or 1.6 feet.

Required Field Records

1) Field log for each borehole showing

   a) Borehole identification

   b) Date of test

   c) Tester or data recorder

   d) Description of measurement

   e) Any deviations from test plan and action taken as a result

   f) QA Review

2) Paper output records for each measurement as backup showing depth and ID number

3) List of record ID numbers (for data on diskette) and corresponding depth

4) Diskettes with backup copies of data on hard disk, labeled with borehole designation, record ID numbers, date, and tester name.

An example Field Log is attached to this procedure.

Analysis

Following completion of field work, the recorded digital records are processed by computer using the OYO Corporation software program PSLOG and interactively analyzed by an experienced geophysicist to produce plots and tables of P and S_H wave velocity versus depth.

The digital time series records from each depth are transferred to a personal computer for analysis. Figure 2 shows a sample of the data from a single depth. These digital records are analyzed to locate the first minima on the vertical axis records, indicating the arrival of P-wave energy. The difference in travel time between these arrivals is used to calculate the P-wave velocity for that 1-meter interval. When observable, P-wave arrivals on the horizontal axis records are used to verify the velocities determined from the vertical axis data. In addition, the soil velocity calculated from the travel time from source to first receiver is compared to the velocity derived from the travel time between receivers.

The digital records are studied to establish the presence of clear SH-wave pulses, as indicated by the presence of opposite polarity pulses on each pair of horizontal records. Ideally, the SH-wave signals from the 'normal' and 'reverse' source pulses are very nearly inverted images of each other. Digital FFT – IFFT lowpass filtering are used to remove the higher frequency P-wave signal from the SH-wave signal.

The first maxima are picked for the 'normal' signals and the first minima are picked for the 'reverse' signals. The absolute arrival time of the 'normal' and 'reverse' signals may vary by +/- 0.2 milliseconds, due to differences in actuation time of the solenoid source caused by constant mechanical bias in the source or by borehole inclination. This variation does not affect the velocity determinations, as the differential time is measured between arrivals of waves created by the same source actuation. The final velocity value is the average of the values obtained from the 'normal' and 'reverse' source actuations.

In Figure 2, the time difference over the 1-meter interval of 1.70 millisecond is equivalent to a SH-wave velocity of 588 m/sec. Whenever possible, time differences are determined from several phase points on the S_H -wave pulse trains to verify the data obtained from the first arrival of the S_H -wave pulse. In addition, the soil velocity

calculated from the travel time from source to first receiver is compared to the velocity derived from the travel time between receivers.

Figure 3 is a sample composite plot of the far normal horizontal geophone records for a range of depths. This plot shows the waveforms at each depth, clearly showing the S-wave arrivals. This display format is used during analysis to observe trends in velocity with changing depth.

Once the proper picks are entered, PSLOG automatically calculates both V_s and V_p for each depth. The program allows spreadsheet output for presentation in either charts are tables or both.

Standard analysis is performed on receiver 1 to receiver 2 data, with separate analysis performed on source to receiver data as a quality assurance procedure.

Registered Geophysicist _____ Date 3/10/98

QA Review _____ Date 3/10/98

References:

1. Guidelines for Determining Design Basis Ground Motions, Report TR-102293, Electric Power Research Institute, Palo Alto, California, November 1993, Sections 7 and 8.

2. The P-S Velocity Logging Method, R.L. Nigbor and T. Imai, XIII ICSMFE, 1994, New Delhi, India / XIII CIMSTF, 1994, New Delhi, India

OYO SUSPENSION P-S VELOCITY LOGGING SETUP

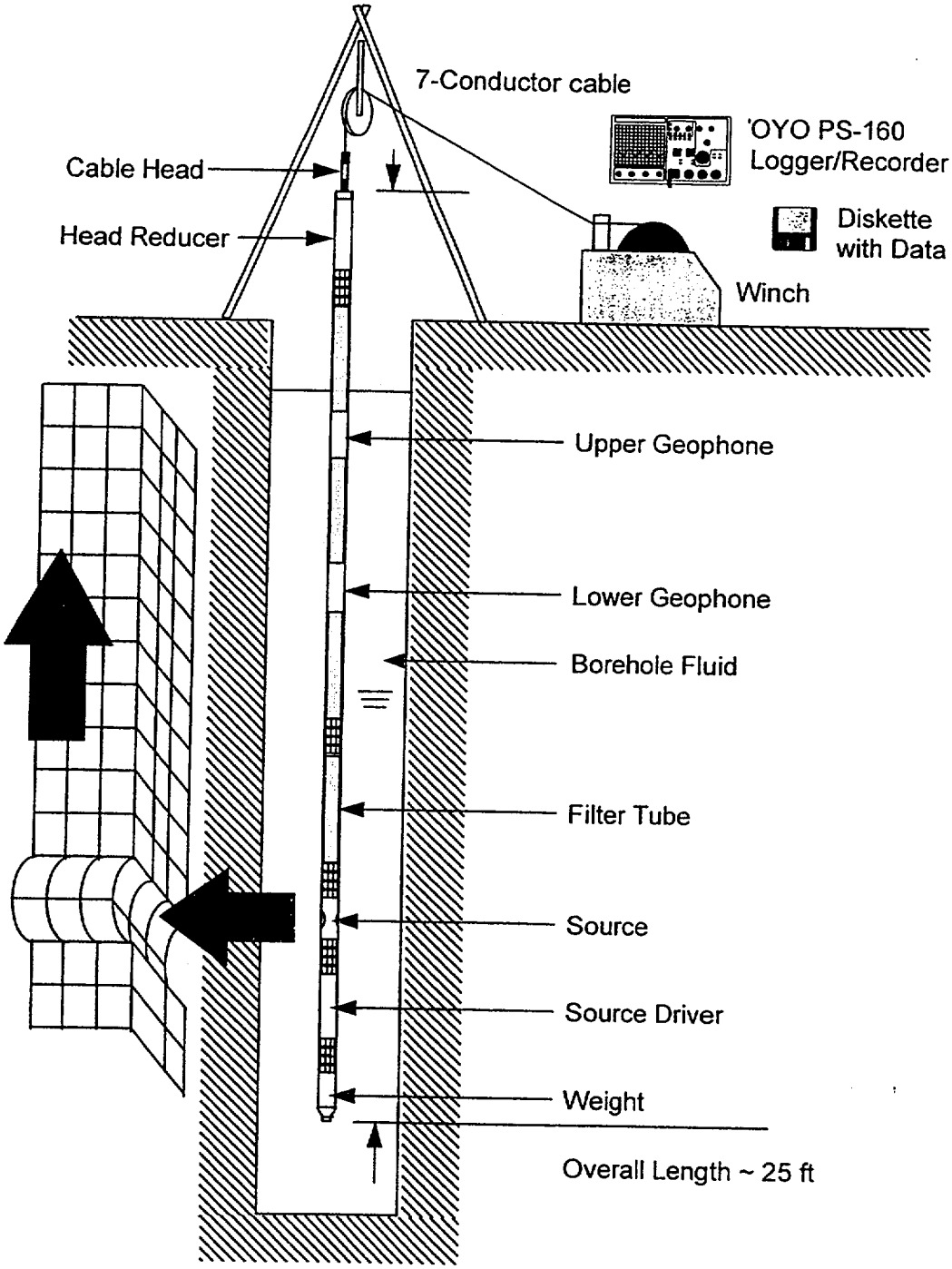


Figure 1. Suspension PS logging method setup

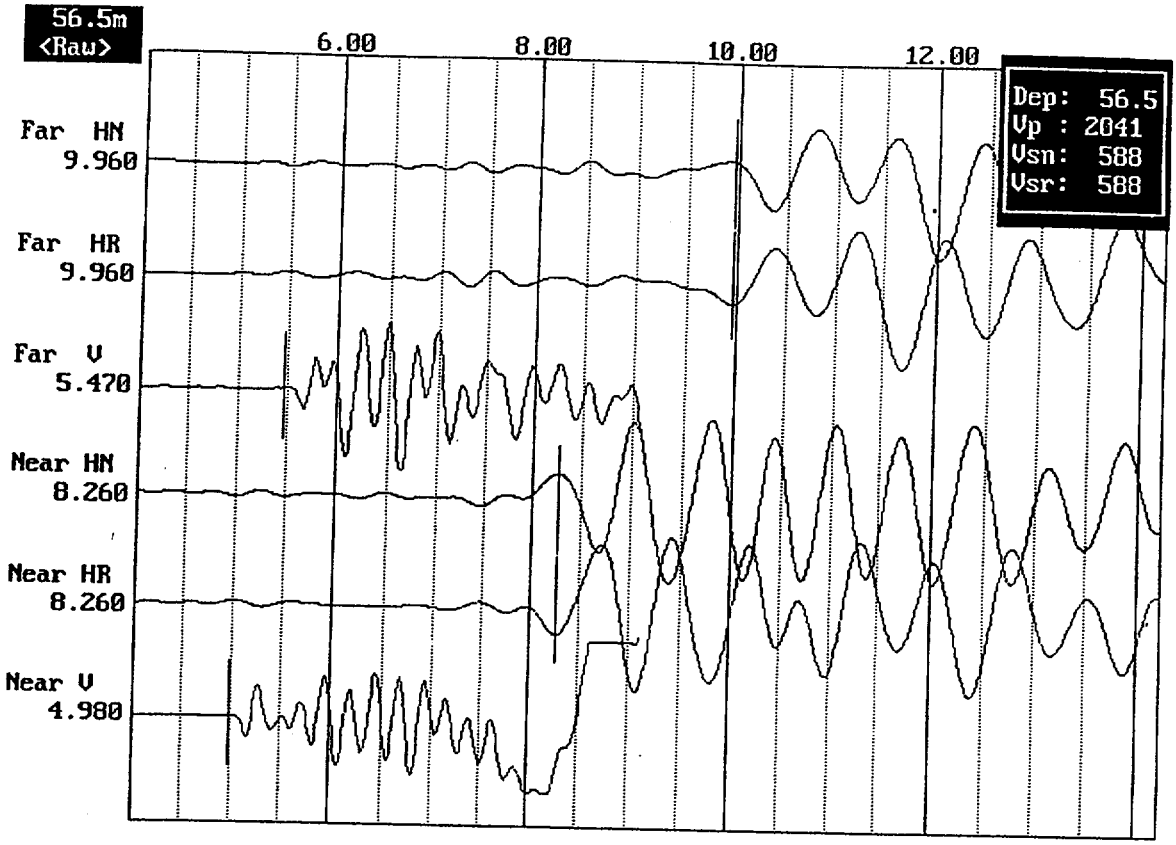


Figure 2. Sample suspension method waveform data showing horizontal normal and reversed (HR and HN), and vertical (V) waveforms received at the near (bottom 3 channels) and far (top 3 channels) geophones. The arrivals in milliseconds for each pick are shown on the left. The box in the upper right corner shows the depth in the borehole and the velocities calculated based on the picks.

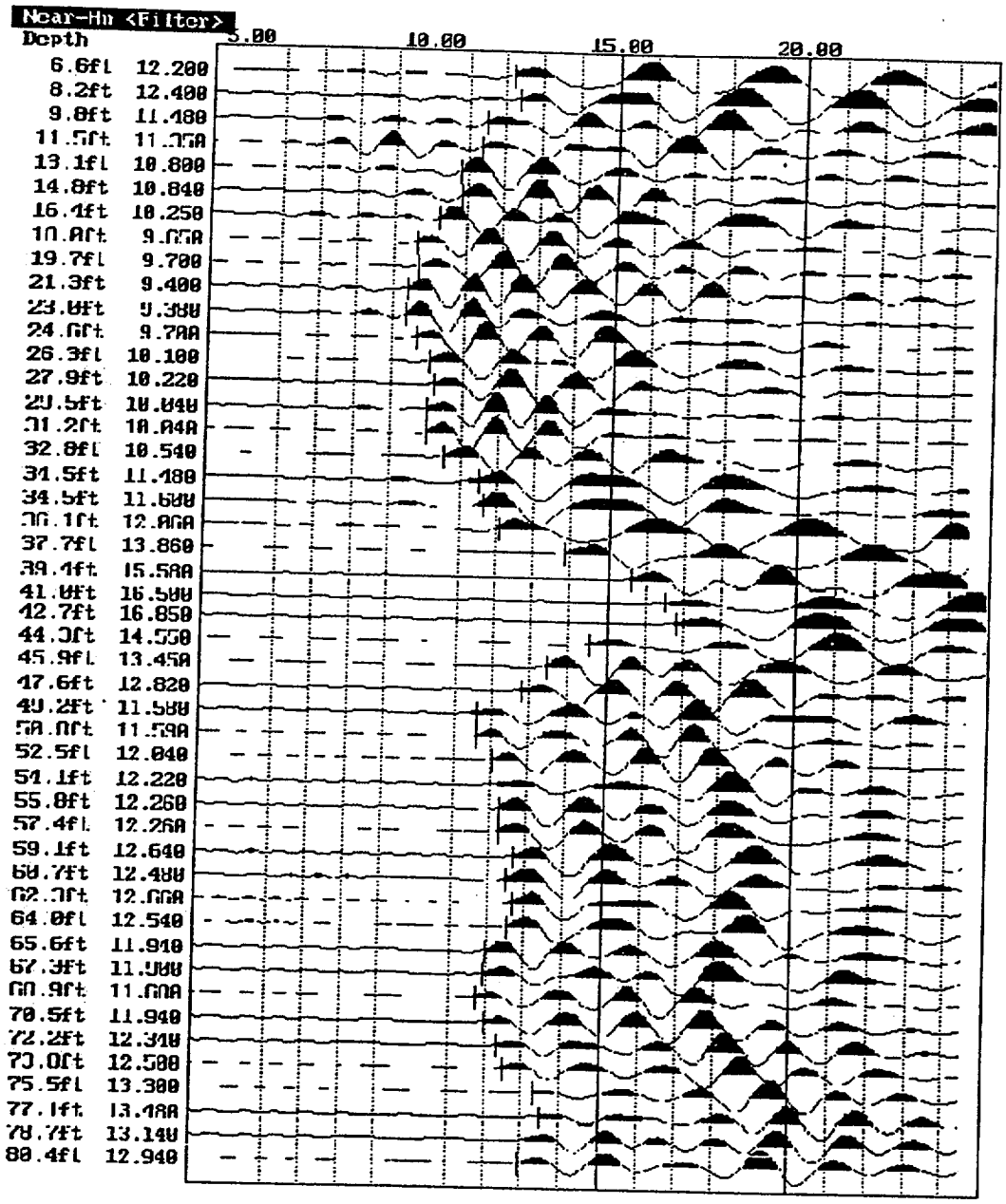


Figure 3. Sample composite waveform plot for normal shear waves received at the near geophone in a single borehole

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P-S SUSPENSION VELOCITY FIELD LOG

SITE:_____ DATE:_____
CLIENT:_____ JOB:_____
AUTHOR:_____ PAGE 1 OF _____

CONTACT:_____ _OFFICE_ PHONE:_____
_____ PHONE:_____
CONTACT:_____ _OFFICE_ PHONE:_____
_____ PHONE:_____
CONTACT:_____ _____ PHONE:_____
_____ PHONE:_____
CONTACT:_____ _____ PHONE:_____
_____ PHONE:_____
DRILLER:_____ _____ PHONE:_____
COMPANY:_____ _____ PHONE:_____

DIRECTIONS TO SITE:_____
_____
_____
_____
_____

GENERAL SITE CONDITIONS/LOCATION:_____
_____

EA#:_____
BOREHOLE DESIGNATION:_____LOCATION:_____
_____
COUNTY:_____RANGE:_____TOWNSHIP:_____SECTION:_____
BOREHOLE CONSTRUCTION: CASED_____ UNCASED_____
DIAMETERS AND DEPTH RANGES: _____ 0 TO _____ ; _____, _____ TO _____
BOREHOLE TOTAL DEPTH AS DRILLED:_____
CONDUCTOR CASING?: YES____ DEPTH TO BOTTOM OF CASING_____; NO____
DEPTH TO BEDROCK:_____ DEPTH TO WATER TABLE:_____
BOREHOLE FLUID: WATER_____; FRESH WATER MUD_____; SALT WATER MUD _____;
OTHER:_____
DEPTH TO BOREHOLE FLUID:_____ TIME SINCE LAST CIRCULATION:_____

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SITE:_____ DATE:_____
CLIENT:_____ JOB:_____
AUTHOR:_____ PAGE 2 OF _____

LOGGING CREW:_____
VEHICLE(S) USED AND MILEAGE: RED_____; BLUE_____;WHITE_____
MOBILIZED FROM:_____ DEPARTURE TIME:_____
ARRIVED ON SITE:_____
STANDBY TIME:_____ CAUSE:_____
LOGGING STARTED:_____ LOGGING COMPLETED:_____
STANDBY TIME:_____ CAUSE:_____
LOGGING STARTED:_____ LOGGING COMPLETED:_____
DEMOBILIZED TO:_____ ARRIVAL TIME:_____
ADDITIONAL DEMOB TIME:_____ REASON:_____

BATTERIES CHANGED BEFORE LOGGING: YES_____; NO____; STORED WITH NEW_____
WINCH COMPROBE_____ HAND_____ WHITE TRK_____
INSTRUMENT 12004_____ 15014_____
GEOPHONE _____

MAINTENANCE PERFORMED ON SITE:_____

EQUIPMENT PROBLEMS OR FAILURES:_____

SUGGESTIONS, ADDITIONS, CHANGES:_____

COMMENTS:_____

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GEOVISION SUSPENSION LOGGING FIELD NOTES

SITE: _____ DATE: _____

CLIENT: _____ JOB: _____

AUTHOR: _____ PAGE _____ OF _____

DEPTH METERS	DEPTH FEET	UNFILTERED FILE NO.	FILTERED FILE NO.	COMMENTS CASING, WATER, ROCK, ETC
0.5	1.64			
1.0	3.28			
1.5	4.92			
2.0	6.56			
2.5	8.20			
3.0	9.84			
3.5	11.48			
4.0	13.12			
4.5	14.76			
5.0	16.40			
5.5	18.04			
6.0	19.69			
6.5	21.33			
7.0	22.97			
7.5	24.61			
8.0	26.25			
8.5	27.89			
9.0	29.53			
9.5	31.17			
10.0	32.81			
10.5	34.45			
11.0	36.09			
11.5	37.73			
12.0	39.37			
12.5	41.01			
13.0	42.65			
13.5	44.29			
14.0	45.93			
14.5	47.57			
15.0	49.21			
15.5	50.85			
16.0	52.49			
16.5	54.13			
17.0	55.77			
17.5	57.41			
18.0	59.06			
18.5	60.70			

GEOVISION SUSPENSION LOGGING FIELD NOTES

SITE:_____ DATE:_____

CLIENT:_____ JOB:_____

AUTHOR:_____ PAGE_____OF_____

DEPTH METERS	DEPTH FEET	UNFILTERED FILE NO.	FILTERED FILE NO.	COMMENTS CASING, WATER, ROCK, ETC
19.0	62.34			
19.5	63.98			
20.0	65.62			
20.5	67.26			
21.0	68.90			
21.5	70.54			
22.0	72.18			
22.5	73.82			
23.0	75.46			
23.5	77.10			
24.0	78.74			
24.5	80.38			
25.0	82.02			
25.5	83.66			
26.0	85.30			
26.5	86.94			
27.0	88.58			
27.5	90.22			
28.0	91.86			
28.5	93.50			
29.0	95.14			
29.5	96.78			
30.0	98.43			
30.5	100.07			
31.0	101.71			
31.5	103.35			
32.0	104.99			
32.5	106.63			
33.0	108.27			
33.5	109.91			
34.0	111.55			
34.5	113.19			
35.0	114.83			
35.5	116.47			
36.0	118.11			
36.5	119.75			
37.0	121.39			

GEOVISION SUSPENSION LOGGING FIELD NOTES

SITE: _____ DATE: _____

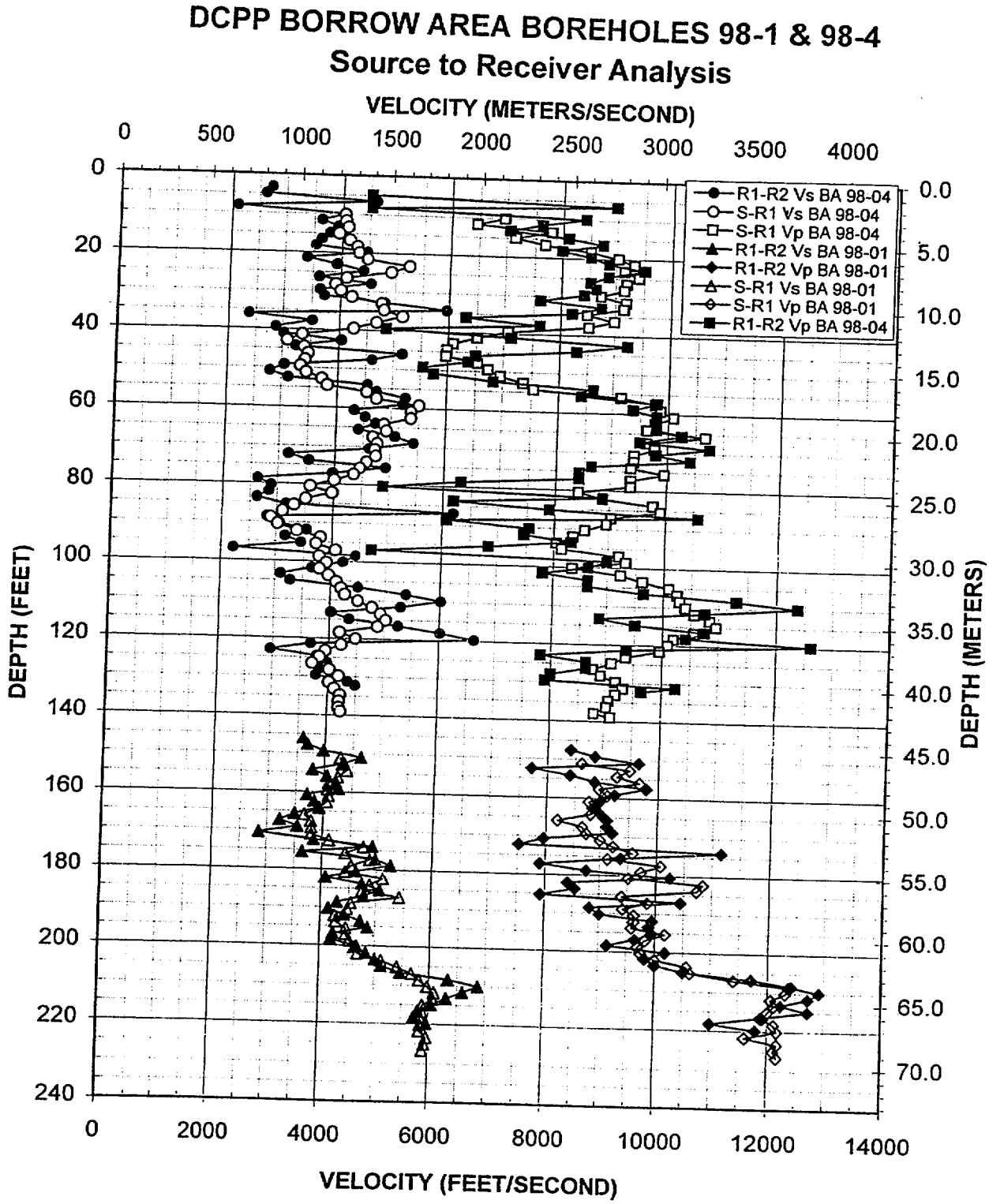
CLIENT: _____ JOB: _____

AUTHOR: _____ PAGE _____ OF _____

DEPTH METERS	DEPTH FEET	UNFILTERED FILE NO.	FILTERED FILE NO.	COMMENTS CASING, WATER, ROCK, ETC
37.5	123.03			
38.0	124.67			
38.5	126.31			
39.0	127.95			
39.5	129.59			
40.0	131.23			
40.5	132.87			
41.0	134.51			
41.5	136.15			
42.0	137.80			
42.5	139.44			
43.0	141.08			
43.5	142.72			
44.0	144.36			
44.5	146.00			
45.0	147.64			
45.5	149.28			
46.0	150.92			
46.5	152.56			
47.0	154.20			
47.5	155.84			
48.0	157.48			
48.5	159.12			
49.0	160.76			
49.5	162.40			
50.0	164.04			
50.5	165.68			
51.0	167.32			
51.5	168.96			
52.0	170.60			
52.5	172.24			
53.0	173.88			
53.5	175.52			
54.0	177.17			
54.5	178.81			
55.0	180.45			
55.5	182.09			

APPENDIX F

SOURCE-TO-RECEIVER (S-R1) ANALYSIS OF OYO P-S SUSPENSION LOG DATA


DCPP BORROW AREA BOREHOLES 98-1 & 98-4
Source to Receiver Analysis
VELOCITY (METERS/SECOND)
0
500
1000
1500
2000
2500
3000
3500
4000
DEPTH (FEET)
0
20
40
60
80
100
120
140
160
180
200
220
240
DEPTH (METERS)
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
45.0
50.0
55.0
60.0
65.0
70.0
R1-R2 Vs BA 98-04
S-R1 Vs BA 98-04
S-R1 Vp BA 98-04
R1-R2 Vs BA 98-01
R1-R2 Vp BA 98-01
S-R1 Vs BA 98-01
S-R1 Vp BA 98-01
R1-R2 Vp BA 98-04
0
2000
4000
6000
8000
10000
12000
14000
VELOCITY (FEET/SECOND)

DCPP DRY CASK SITING PROJECT
BORROW SITE BOREHOLE BA 98-1
VELOCITY DATA ACQUIRED 6/9/98
Table F-1

R1-R2 ANALYSIS			S-R1 ANALYSIS		
DEPTH (FT)	Vs (FT/S)	Vp (FT/S)	AVG DEPTH (FT)	Vs (FT/S)	Vp (FT/S)
198.5	4193	9164	198.72	4527	9699
200.1	4670	10189	200.36	4629	9754
201.8	4843	9823	202	4682	10000
203.4	5009	10002	203.64	5124	10575
205.1	5126	10516	205.28	5407	10640
206.7	5468	11717	206.92	5675	11419
208.3	6340	12427	208.56	5819	12380
210.0	6871	12917	210.2	5971	12321
211.6	6595	12716	211.84	6095	12061
213.3	6309	12242	213.48	6077	12118
214.9	6048	12716	215.12	5886	12005
216.5	5807	11887	216.76	5886	11921
218.2	5731	11010	218.4	5852	12118
219.8	5965	11802	220.04	5852	12175
			221.69	5836	11625
			223.33	5971	12175
			224.97	5937	12118
			226.61	5903	12175

DCPP DRY CASK SITING PROJECT
BORROW SITE BA 98-4
VELOCITY DATA ACQUIRED 6/8/98
Table F-4

R1-R2 ANALYSIS			S-R1 ANALYSIS		
DEPTH (FT)	Vs (FT/S)	Vp (FT/S)	AVG DEPTH (FT)	Vs (FT/S)	Vp (FT/S)
3.3	2734	0			
4.9	2625	4525			
6.6	4621	8989			
8.2	2103	4525			
9.8	4050	8412	10.07	4039	6959
11.5	3645	7630	11.71	4055	6458
13.1	3929	7056	13.35	4104	7803
14.8	3793	8101	14.99	3946	7153
16.4	3645	8749	16.63	4137	7687
18.0	3547	8002	18.27	4274	8512
19.7	4464	8522	19.91	4310	9035
21.3	3400	8867	21.55	4478	9321
23.0	3929	9510	23.19	5255	9156
24.6	4404	8867	24.83	4928	9406
26.3	3625	8522	26.48	4104	9196
27.9	4557	8634	28.12	3916	9156
29.5	3645	8412	29.76	4008	8729
31.2	3728	7630	31.4	4204	9196
32.8	4825	8749	33.04	4769	9156
34.5	5965	8202	34.68	4813	8477
36.1	2377	6309	36.32	5150	8996
37.7	3528	7630	37.96	4682	8512
39.4	2878	4861	39.6	4256	7079
41.0	3024	7132	41.24	3355	6519
42.7	4050	9242	42.88	3093	6095
44.3	3248	8306	44.52	3399	5988
45.9	5167	6497	46.16	3468	5971
47.6	4621	6371	47.8	3422	6540
49.2	3052	5561	49.44	3344	6732
50.9	2792	5756	51.08	3445	6959
52.5	3125	6835	52.72	3732	7357
54.1	4557	8634	54.36	3829	7546
55.8	4721	8412	56	4537	9156
57.4	5249	9794	57.64	4725	9763

DCPP DRY CASK SITING PROJECT
BORROW SITE BA 98-4
VELOCITY DATA ACQUIRED 6/8/98
Table F-4

R1-R2 ANALYSIS			S-R1 ANALYSIS		
DEPTH (FT)	Vs (FT/S)	Vp (FT/S)	AVG DEPTH (FT)	Vs (FT/S)	Vp (FT/S)
59.1	5208	9374	59.28	5508	9856
60.7	4317	9794	60.92	5365	10098
62.3	4525	9794	62.56	5365	9763
64.0	4721	9794	64.2	4882	9626
65.6	4404	10253	65.85	4928	10674
67.3	5087	9510	67.49	4682	9626
68.9	5423	10757	69.13	4769	9763
70.5	4621	9794	70.77	4725	9406
72.2	3185	10415	72.41	4747	9406
73.8	3547	8634	74.05	4578	9364
75.5	4934	8412	75.69	4459	9952
77.1	3977	8412	77.33	4346	9364
78.7	2635	6309	78.97	4008	9364
80.4	2891	4897	80.61	3589	8408
82.0	2853	8867	82.25	3977	8879
83.7	2635	6190	83.89	3515	9763
85.3	3170	7906	85.53	3312	9904
86.9	6190	10583	87.17	3112	9035
88.6	2828	6076	88.81	2901	8957
90.2	3066	7542	90.45	3029	8548
91.9	3547	7456	92.09	3377	8340
93.5	3170	8306	93.73	3801	8047
95.1	3454	6835	95.37	3725	8142
96.8	2224	4721	97.01	4071	9196
98.4	4434	8989	98.65	3787	9321
100.1	4206	8634	100.29	3916	8340
101.7	3666	7812	101.93	3801	9238
103.4	3110	8634	103.57	3962	9626
105.0	3281	8634	105.22	4104	10098
106.6	4494	9650	106.86	4187	10249
108.3	5378	11313	108.5	4256	10300
109.9	6020	12381	110.14	4498	10404
111.6	5292	10757	111.78	4769	10564
113.2	4026	8867	113.42	4928	10842

DCPP DRY CASK SITING PROJECT
BORROW SITE BA 98-4
VELOCITY DATA ACQUIRED 6/8/98
Table F-4

R1-R2 ANALYSIS			S-R1 ANALYSIS		
DEPTH (FT)	Vs (FT/S)	Vp (FT/S)	AVG DEPTH (FT)	Vs (FT/S)	Vp (FT/S)
114.8	4345	9510	115.06	5024	10957
116.5	5249	10757	116.7	4882	10564
118.1	6020	10415	118.34	4187	10198
119.8	6628	12619	119.98	4478	10098
121.4	3686	9374	121.62	4221	9952
123.0	2969	7812	123.26	3946	9364
124.7	3793	8634	124.9	3843	9115
126.3	3977	8634	126.54	3718	8766
128.0	3860	8002	128.18	4023	8918
129.6	3793	7906	129.82	4187	9196
131.2	4345	10253	131.46	4023	9321
132.2	4494	9650	133.1	4120	9196
			134.74	4221	9075
			136.38	4204	9035
			138.02	4204	8803
			139.01	4239	9115

Table F-4 Page 3 of 3

DCPP DRY CASK SITING PROJECT
BORROW AREA HILLSIDE SITE BOREHOLE BA 98-3
VELOCITY DATA ACQUIRED 6/8/98

RECEIVER TO RECEIVER (R1-R2) ANALYSIS			SOURCE TO RECEIVER (S-R1) ANALYSIS		
DEPTH (FT)	Vs (FT/S)	Vp (FT/S)	AVG DEPTH (FT)	Vs (FT/S)	Vp (FT/S)
55.8	5807	10415	56	4478	8692
57.4	3331	8202	57.64	4682	8879
59.1	3750	8989	59.28	5365	9196
60.7	4153	8202	60.92	5074	9450
62.3	4721	0	62.56	5049	9279
64.0	3625	9942	64.2	4703	9279
65.6	3400	9242	65.85	4328	8803
67.3	3331	8306	67.49	3759	9364
68.9	3418	8412	69.13	3552	9115
70.5	3435	8202	70.77	3576	8879
72.2	3217	9374	72.41	3576	9279
73.8	2916	8867	74.05	3552	9904
75.5	4101	9794	75.69	3652	9810
77.1	4050	10757	77.33	3589	9450
78.7	3953	9794	78.97	3540	9279
80.4	3566	8749	80.61	3759	9196
82.0	3155	8202	82.25	3652	9035
83.7	3348	8202	83.89	3732	8879
85.3	4076	8989	85.53	3801	8803
86.9	3728	8989	87.17	4137	9364
88.6	3155	9374	88.81	4609	10049
90.2	5756	10583	90.45	4747	10404
91.9	5378	11717	92.09	5074	10300
93.5	4790	11717	93.73	4714	10249
95.1	3605	9113	95.37	4703	10300
96.8	4345	8101	97.01	4619	10510
98.4	2878	8867	98.65	4071	10098
100.1	3066	9510	100.29	3829	8879
101.7	3837	7906	101.93	3333	8879
103.4	3750	10757	103.57	3732	9196
105.0	4026	8867	105.22	3872	9904
106.6	4206	9374	106.86	4137	10000

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DCPP DRY CASK SITING PROJECT
BORROW AREA HILLSIDE SITE BOREHOLE BA 98-3
VELOCITY DATA ACQUIRED 6/8/98

RECEIVER TO RECEIVER (R1-R2) ANALYSIS			SOURCE TO RECEIVER (S-R1) ANALYSIS		
DEPTH (FT)	Vs (FT/S)	Vp (FT/S)	AVG DEPTH (FT)	Vs (FT/S)	Vp (FT/S)
108.3	3728	9510	108.5	4120	9115
109.9	3860	8749	110.14	4221	9279
111.6	2853	9510	111.78	3843	9196
113.2	2865	4861	113.42	3946	8879
114.8	3490	5965	115.06	3801	8583
116.5	3038	6907	116.7	3692	8110
118.1	3645	8634	118.34	3962	7744
119.8	3331	8002	119.98	4364	6821
121.4	3566	8412	121.62	4703	7055
123.0	4127	8002	123.26	4383	8175
124.7	4525	9510	124.9	4537	7410
126.3	3793	10415	126.54	4714	7863
128.0	5335	7542	128.18	4769	8583
129.6	6433	11121	129.82	4221	8512
131.2	4289	9510	131.46	4247	8918
132.9	2969	6696	133.1	4619	9196
134.5	4289	8202	134.74	4170	8879
136.2	5009	10757	136.38	3843	8583
137.8	4825	9374	138.02	3916	8110
139.4	3382	8101	139.66	4071	7984
141.1	3095	7906	141.3	3552	8240
142.7	3155	8327	142.94	3492	8110
144.4	3265	8544	144.59	3552	8142
146.0	3147	8412	146.23	3829	8306
147.6	3953	9113	147.87	3872	8803
149.3	4419	9650	149.51	4170	9717
150.9	4140	10064	151.15	4547	10249
152.6	5756	10722	152.79	4847	10300
154.2	5706	11010	154.43	5037	10729
155.8	5584	11802	156.07	5202	11196
157.5	6020	11634	157.71	5508	11573
159.1	5514	11010	159.35	5323	11508

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DCPP DRY CASK SITING PROJECT
BORROW AREA HILLSIDE SITE BOREHOLE BA 98-3
VELOCITY DATA ACQUIRED 6/8/98

RECEIVER TO RECEIVER (R1-R2) ANALYSIS			SOURCE TO RECEIVER (S-R1) ANALYSIS		
DEPTH (FT)	Vs (FT/S)	Vp (FT/S)	AVG DEPTH (FT)	Vs (FT/S)	Vp (FT/S)
160.8	5584	12619	160.99	5365	11839
162.4	5608	11236	162.63	5464	11908
164.0	5167	11084	164.27	5370	11599
165.7	5681	10516	165.91	5421	11196
167.3	6220	12917	167.55	5282	11573
169.0	5632	12151	169.19	5365	11839
170.6	5126	11010	170.83	5282	11573
172.2	5106	12151	172.47	5074	11075
173.9	4971	11236	174.11	4882	11016
175.5	4825	10449	175.75	4747	10957
177.2	4360	10253	177.39	4714	10674
178.8	4026	10003	179.03	4813	10842
180.5	4807	10449	180.67	4928	11196
182.1	5608	10864	182.31	4952	11381
183.7	6465	12062	183.96	5049	11839
185.4	6279	12334	185.6	5163	12005
187.0	5965	11634	187.24	5242	12335
188.7	6220	12062	188.88	5738	12795
190.3	6628	12917	190.52	5675	12716
191.9	6279	12816	192.16	5803	12795
193.6	6249	12619	193.8	5886	12623
195.2	6309	12619	195.44	5836	12335
196.9	6161	12619	197.08	5706	12262
198.5	5911	12427	198.72	5628	11638
200.1	5859	12151	200.36	5337	11908
200.8	5938	12334	202	5176	11573
			203.64	4928	11135
			205.28	4588	10785
			206.92	4488	10785
			207.58	4527	10404

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DCPP DRY CASK SITING PROJECT
BORROW AREA HILLSIDE SITE BOREHOLE BA 98-3
VELOCITY DATA ACQUIRED 6/8/98

RECEIVER TO RECEIVER (R1-R2) ANALYSIS			SOURCE TO RECEIVER (S-R1) ANALYSIS		
DEPTH (FT)	Vs (FT/S)	Vp (FT/S)	AVG DEPTH (FT)	Vs (FT/S)	Vp (FT/S)
3.3	1526	0			
4.9	1402	2983			
6.6	1305	2395			
8.2	1600	4153			
9.8	1754	2828	10.07	1853	4858
11.5	1715	3281	11.71	2182	5309
13.1	2130	6020	13.35	2438	6300
14.8	2667	6497	14.99	2754	6603
16.4	3666	6132	16.63	2977	7744
18.0	3586	7630	18.27	3422	8110
19.7	3547	7812	19.91	3468	7863
21.3	4050	8306	21.55	3759	7923
23.0	3883	8749	23.19	4071	7984
24.6	3837	8522	24.83	4120	7630
26.3	3837	7373	26.48	4087	7630
27.9	3837	7456	28.12	3492	7357
29.5	3217	7542	29.76	3843	6561
31.2	3707	5859	31.4	3692	6358
32.8	2983	5911	33.04	3787	6959
34.5	2841	6371	34.68	3801	6867
36.1	3771	7906	36.32	3829	6732
37.7	4101	7630	37.96	3422	7055
39.4	3081	8101	39.6	3552	7984
41.0	2891	7373	41.24	3552	7803
42.7	3331	8002	42.88	3492	9115
44.3	3528	8002	44.52	3576	8957
45.9	3605	8202	46.16	3887	9035
47.6	3793	7720	47.8	3787	9364
49.2	5608	9794	49.44	3456	8729
50.9	5561	10583	51.08	3916	8918
52.5	3860	8002	52.72	3829	9115
54.1	5126	8867	54.36	4071	8879

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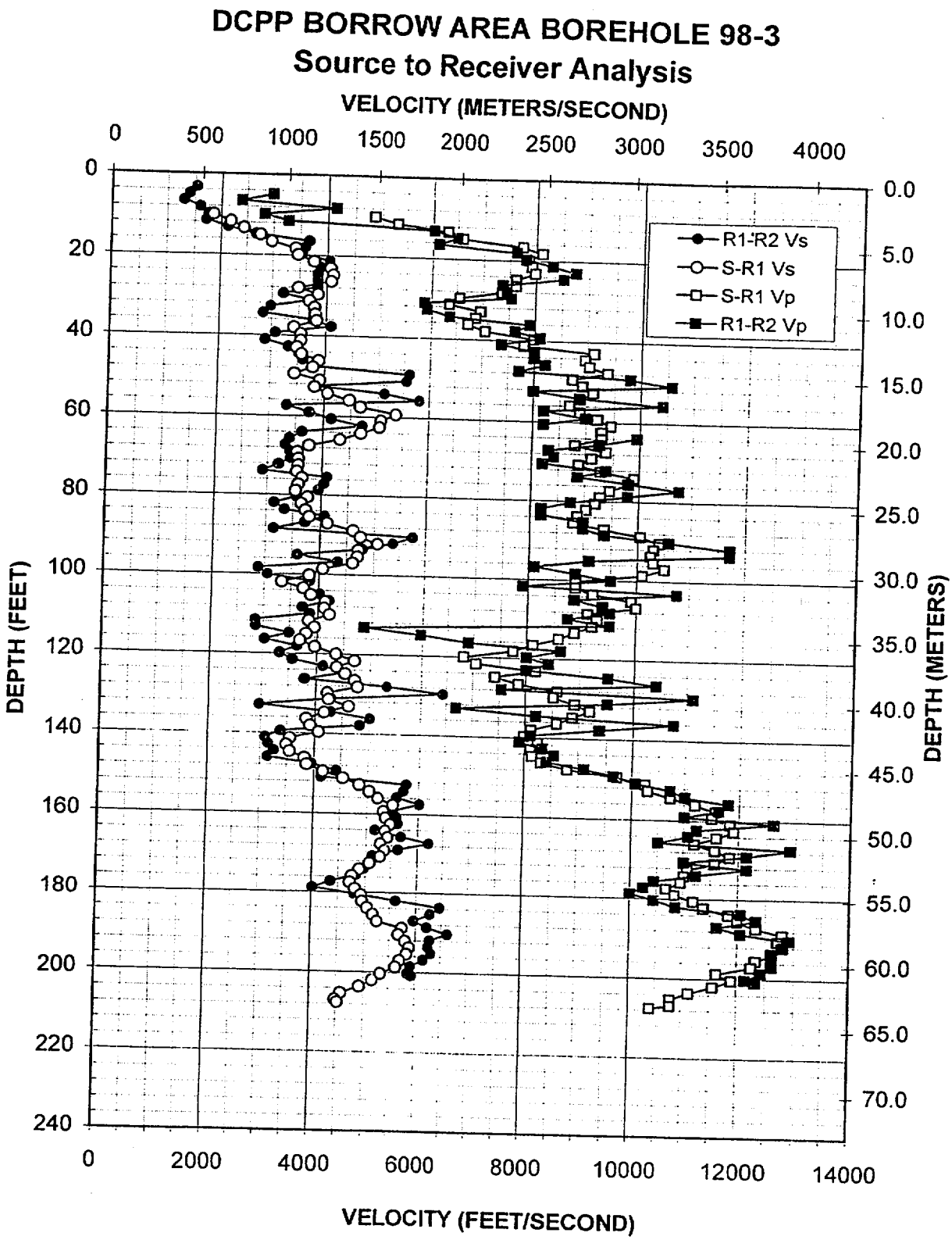
DCPP BORROW AREA BOREHOLE 98-3
Source to Receiver Analysis
VELOCITY (METERS/SECOND)
0
500
1000
1500
2000
2500
3000
3500
4000
DEPTH (FEET)
0
20
40
60
80
100
120
140
160
180
200
220
240
DEPTH (METERS)
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
45.0
50.0
55.0
60.0
65.0
70.0
R1-R2 Vs
S-R1 Vs
S-R1 Vp
R1-R2 Vp
0
2000
4000
6000
8000
10000
12000
14000
VELOCITY (FEET/SECOND)