

ATTACHMENT I
LOGS OF BOREHOLES RF#14 TO RF#29

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LOGS OF BOREHOLES RF#14 TO RF#29

As mentioned in Section 6.2.2, an exploratory program that included fifteen boreholes was undertaken to gain an understanding of the subsurface geologic conditions at the WHB Area and to provide access for downhole and suspension seismic geophysical methods. Drilling of the exploratory boreholes began in June 2000 and concluded in November 2000. The boreholes were located as shown on Figure 2 in the main text and as tabulated in Table I-1. Four of the fifteen boreholes were continuously cored from the surface with PQ (3.35 inch) and HQ (2.5 inch) coring systems. The remaining eleven boreholes were conventional mud rotary holes, although an interval at the bottom of borehole RF#22 was cored. The cored boreholes were logged based on the core, while the mud rotary holes were logged based on the drill cuttings.

Table I-1 Borehole Locations, Total Depth and Drilling Method

Designation	Northing	Easting	Elevation (ft.)	Total Depth (ft.)	Drilling Method
RF#14	N765,309	E571,065	3651.5	550.0	Core
RF#15	N765,774	E570,225	3681.0	330.0	Core
RF#16	N765,056	E570,473	3672.0	452.8	Core
RF#17	N766,076	E571,042	3672.4	667.8	Core
RF#18	N764,522	E570,627	3640.3	493.6	Mud Rotary
RF#19	N765,880	E571,384	3661.8	645.2	Mud Rotary
RF#20	N765,637	E570,797	3671.3	160.0	Mud Rotary
RF#21	N765,899	E570,739	3673.0	192.2	Mud Rotary
RF#22	N766,206	E570,793	3679.2	540.6	Mud Rotary/core
RF#23	N765,311	E570,465	3674.0	159.1	Mud Rotary
RF#24	N766,344	E570,542	3684.5	268.0	Mud Rotary
RF#25	N765,968	E570,626	3676.5	159.0	Mud Rotary
RF#26	N765,248	E570,580	3670.8	264.9	Mud Rotary
RF#28	N765,510	E570,105	3680.6	99.8	Mud Rotary
RF#29	N766,018	E570,836	3672.7	430.0	Mud Rotary

DTN: GS020383114233.003

Note: DTN: GS020383114233.003 has some minor internal inconsistencies, as follows: RF#24: Log page 1 says at the top that total depth is 268.0 feet and at the bottom that total depth is 267.9 feet. RF#26: Log page 1 says at top that total depth is 264.9 feet and at bottom that total depth is 265.0 feet. RF#28: log page 1 says at the top that total depth is 100.0 feet and at the bottom that total depth is 99.8 feet. The values used herein are based on a review of the data.

The borehole logs were initiated in the field and finalized based on examination in the Sample Management Facility. The final logs are presented in alphanumeric order beginning on the second page following this page. The final logs may also be found in DTN: GS020383114233.003.

GEOLOGIC LOG OF DRILL HOLE NO. UE-25 RF#14

SHEET 1 OF 11

FEATURE: Waste Handling Building
 LOCATION: ESF North Portal Pad
 BEGUN: 9/13/2000 FINISHED: 9/27/2000
 DEPTH TO WATER: Not Encountered

PROJECT: Yucca Mountain Project
 COORDINATES: N 765,308.73 E 571,065.44
 TOTAL DEPTH: 550.0 ft.
 DEPTH TO BEDROCK: 101.8 ft.

STATE: Nevada
 GROUND ELEVATION: 3651.52
 ANGLE FROM HORIZONTAL: -90
 HOLE LOGGED BY: USBR/SMF
 REVIEWED BY: Mark McKeown

NOTES	DEPTH	ENGINEERING INDEXES					% CORE RECOVERY	% ROD	GEOLOGIC UNIT [USCS]	GRAPHIC	CLASSIFICATION AND PHYSICAL CONDITION										
		SHEAR WAVE VELOCITY <i>v_s</i>																			
		1000	2000	3000	4000	5000	6000	7000	8000	9000											
							HARDNESS	WELDING	FRACTURE DENSITY												
<p>Purpose of Hole: Develop geologic design data required for Waste Handling Building foundation parameters and seismic hazard analysis.</p> <p>Drill Equipment: Schramm T685 Drill Rig, UDR 1000 Drill Rig</p> <p>Drillers: D. Harrison, R. McKay; Dynatec Drilling Inc.; Salt Lake City, Utah.</p> <p>Drilling Method: Used 12" hammer to 5.02. Cement 10.75 O.D. casing with 1.29 stickup. Re-enter hole on 9/13/2000 with PQ coring system. Cored with PQ to 116.06. Used PQ rods as casing and installed HQ coring system. Cored with HQ to the total depth of 549.99.</p> <p>Drilling Conditions: 0.00 to 443.06: Replaced 2 bits.</p> <p>Drilling Fluid: 0.00 to 5.02: Non-potable water. 5.02 to 290.09: Non-potable water, Quick Gel mud with EZ-Mud. 290.09 to 294.15: non-potable water, Quik Gel mud with EZ-Mud and LCM to re-establish circulation. 294.15 to 549.99: Non-potable water, Quick Gel mud with EZ-Mud.</p> <p>Loss Intervals: 290.09 to 294.15</p> <p>Casing Record: 0.00 to 4.72: 10.75 O.D. casing. 0.00 to 116.06: PQ casing. 116.06 to 549.99: No casing</p> <p>Hole Completion: Ream hole from 5.00 to 550.15 with 8.5 Tricone Bit. Set and cement 512.22 of 4.5" PVC casing.</p>	5						100		0		Qal	[Symbol]	0.0 to 101.8 ft. QUATERNARY ALLUVIUM (Qal)								
	10						50		50		Qal (GP-GM)s	[Symbol]	0.0 to 5.0: No Recovery								
	15						100		59		Qal (GP)s	[Symbol]	5.0 - 9.1: POORLY GRADED GRAVEL WITH SAND AND SILT (GP-GM)s; About 50% fine to coarse, hard, subrounded to subangular gravel; about 40% predominately fine, hard, subrounded to subangular sand; about 10% nonplastic fines, no dry strength, rapid dilatancy, low toughness; maximum size 65mm, dry, light brown; strong reaction with HCl; firm, weakly cemented.								
	20						100		59		Qal GW	[Symbol]	9.1 - 11.5: POORLY GRADED GRAVEL WITH SAND (GP)s; About 60% fine to coarse, hard subrounded to subangular gravel; about 35% fine to coarse, subrounded to subangular sand; about 5% nonplastic fines, no dry strength, rapid dilatancy, low toughness; maximum size 75mm, dry, light brown; strong reaction with HCl; firm, weak to strongly cemented.								
	25						100		63		Qal (GP)s	[Symbol]	11.5 - 14.9: WELL GRADED GRAVEL (GW); About 100% fine to coarse, hard, subrounded to angular gravel; maximum size 75mm, light brown; 10% of gravel is partially coated with up to 1mm white caliche.								
	30						100		73		Qal (GP)sc	[Symbol]	14.9 - 18.1: POORLY GRADED GRAVEL WITH SAND (GP)s; About 70% fine to predominately coarse, hard, subrounded to subangular gravel; about 25% predominately fine sand; about 5% nonplastic fines, no dry strength, rapid dilatancy, low toughness; trace of cobbles; maximum size 95mm, dry, light brown; weak reaction with HCl; firm, weakly cemented.								
	35						100		39		Qal GW	[Symbol]	18.1 - 23.2: POORLY GRADED GRAVEL WITH SAND AND COBBLES (GP)sc; About 65% fine to coarse, hard, subangular to angular gravel; about 30% predominately fine sand; about 5% nonplastic fines, no dry strength, rapid dilatancy, low toughness; trace of cobbles; maximum size 215mm, dry, light brown; weak to strong reaction with HCl; firm, weak to moderately cemented.								
	40						100		77		Qal (SM)g	[Symbol]	23.2 - 26.8: WELL GRADED GRAVEL (GW); About 100% fine to coarse, hard, subrounded to angular gravel; maximum size 75mm, light brown; 10% of gravel is partially coated with up to 1mm white caliche.								
	45						100		23		Qal (GP)s	[Symbol]	26.8 - 30.6: SILTY SAND WITH GRAVEL (SM)g; About 55% predominately fine sand; about 30% predominately fine to coarse, hard, subrounded to subangular gravel; about 15% nonplastic fines, no dry strength, rapid dilatancy, low toughness; maximum size 60mm, dry; weak reaction with HCl; firm, weakly cemented.								
							100		70		Qal (GP)s	[Symbol]	30.6 - 44.6: POORLY GRADED GRAVEL WITH SAND (GP)s; About 60% predominately fine to coarse, hard, subangular gravel; about 35% predominately fine to medium sand; about 5% nonplastic fines, no dry strength, rapid dilatancy, low toughness; maximum size 170mm, dry, light brown; weak reaction with HCl; firm, weakly cemented.								
							100		70		Qal (GP)s	[Symbol]	44.6 - 47.8: POORLY GRADED SAND WITH GRAVEL (SP)g; About 60% predominately fine to medium sand; about 35% fine to coarse, hard, subrounded to subangular gravel; about 5% nonplastic fines, no dry strength, rapid dilatancy, low toughness; maximum size 160mm, dry, light brown; weak reaction with HCl; firm, weakly cemented.								
							100		91		Qal (SP)g	[Symbol]	47.8 - 52.5: NO RECOVERY								
							100		0		NR	[Symbol]	52.5 - 55.6: WELL GRADED GRAVEL (GW); About 95% fine to coarse, hard, subrounded to subangular gravel; about 5% fine to coarse, subrounded to subangular sand; maximum size 190mm, moist; no reaction with HCl; approximately 30% of gravel is caliche coated.								

- COMMENTS:
- All measurements are in feet unless noted otherwise.
 - LCM (Lost Circulation Material) consists of cellophane cuttings.
 - USCS classifications were determined in the field, with limited access to samples to keep samples intact for future tests.
 - Shear Wave Velocity data from GeoVision suspension logging. Data acquired from downhole survey conducted after PVC casing installed.
 - USCS soil classifications are based on USBR Earth Manual procedure 5005 - Determining Unified Soil Classification (Visual Method)

WHB_LOG_WHB.GPJ_WHB.GDT_6/13/02

GEOLOGIC LOG OF DRILL HOLE NO. UE-25 RF#14

SHEET 2 OF 11

FEATURE: Waste Handling Building
 LOCATION: ESF North Portal Pad
 BEGUN: 9/13/2000 FINISHED: 9/27/2000
 DEPTH TO WATER: Not Encountered

PROJECT: Yucca Mountain Project
 COORDINATES: N 765,308.73 E 571,065.44
 TOTAL DEPTH: 550.0 ft.
 DEPTH TO BEDROCK: 101.8 ft.

STATE: Nevada
 GROUND ELEVATION: 3651.52
 ANGLE FROM HORIZONTAL: -90
 HOLE LOGGED BY: USBR/SMF
 REVIEWED BY: Mark McKeown

NOTES	DEPTH	SHEAR WAVE VELOCITY ft/s	ENGINEERING INDEXES				% CORE RECOVERY	% ROD	GEOLOGIC UNIT (USCS)	GRAPHIC	CLASSIFICATION AND PHYSICAL CONDITION																																							
			HARDNESS	WELDING	FRACTURE DENSITY	% CORE RECOVERY																																												
	55					0		NR		55.6 - 60.5: WELL GRADED GRAVEL WITH SAND (GW)s; About 85% fine to coarse, hard, subrounded to subangular gravel; about 15% predominately fine sand; trace of fines; maximum size 120mm, dry, light brown; weak reaction with HCl; soft weakly cemented.																																								
						71		Qal GW		60.5 - 69.3: POORLY GRADED GRAVEL WITH SAND (GP)s; About 80% fine to coarse, hard, subrounded to subangular gravel; about 15% fine to coarse, subrounded to subangular sand; about 5% nonplastic fines, no dry strength, rapid dilatancy, low toughness; maximum size 170mm, dry; weak reaction with HCl; soft, weakly cemented.																																								
						43		Qal (GW)s		69.3 - 78.1: POORLY GRADED GRAVEL (GP); About 100% fine to coarse, hard, subrounded to subangular gravel; maximum size 120mm, moist; no to strong reaction with HCl.																																								
						64		Qal (GP)s		78.1 - 80.3: POORLY GRADED GRAVEL WITH COBBLES (GP)c; About 50% coarse, hard, subangular gravel; about 50% cobbles; moist; cobbles have caliche coating.																																								
						58		Qal (GP)s		80.3 - 84.8: POORLY GRADED GRAVEL WITH COBBLES (GP)c; About 80% coarse, subrounded to subangular gravel; about 20% cobbles; moist.																																								
						35		Qal GP		101.8 to 192.5 ft. COMB PEAK IGNIMBRITE - TUFF "X" (Tpxi): Pyroclastic flow, nonwelded, moderately indurated light to medium gray tuff with 10 to 15 percent, light greenish-gray, pumice clasts, up to 20 percent grayish-red volcanic lithic clasts and 2 to 3 percent phenocrysts of sanidine and plagioclase. Generally the tuff is slightly weathered (W4), moderately soft (H5) to soft (H6), and very slightly fractured (FD1). Both upper and lower contacts are unconformable.																																								
						47		Qal (GP)c		Discontinuity Measurements: <table border="1" style="font-size: small;"> <thead> <tr> <th>Depth</th> <th>Angle*</th> <th>Roughness</th> <th>Infilling</th> </tr> </thead> <tbody> <tr><td>102.3</td><td>75</td><td>R2</td><td>5mm clay</td></tr> <tr><td>115.8</td><td>05</td><td>R2</td><td><1mm light brown stain</td></tr> <tr><td>140.4</td><td>15</td><td>R2</td><td>clean</td></tr> <tr><td>172.5</td><td>25</td><td>R2</td><td>trace clay</td></tr> <tr><td>172.2</td><td>25</td><td>R2</td><td>trace clay</td></tr> <tr><td>188.0</td><td>20</td><td>R3 to 1</td><td>sand</td></tr> <tr><td>189.9</td><td>30</td><td>R3</td><td>trace clay</td></tr> <tr><td>190.2</td><td>35</td><td>R3</td><td>3mm altered tuff</td></tr> <tr><td>190.9</td><td>30</td><td>R2</td><td>clean</td></tr> </tbody> </table>	Depth	Angle*	Roughness	Infilling	102.3	75	R2	5mm clay	115.8	05	R2	<1mm light brown stain	140.4	15	R2	clean	172.5	25	R2	trace clay	172.2	25	R2	trace clay	188.0	20	R3 to 1	sand	189.9	30	R3	trace clay	190.2	35	R3	3mm altered tuff	190.9	30	R2	clean
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						49		Qal (GP)c		192.5 to 203.4 ft. POST TIVA CANYON BEDDED TUFFS (Tpxt5): Nonwelded, devitrified, reworked (?) fallout tephra and pyroclastic flows separated by distinct paleosols. Bedded tuffs are very pale orange with 20 to 30 percent pumice clasts and less than 1 percent, pale red, volcanic lithic clasts. The tuff has up to 1 percent quartz, sanidine and lesser plagioclase, with less than 1 percent biotite and manganese oxides. Generally the bedded tuffs are very soft (H7), moderately weathered (W6), and slightly to very slightly fractured (FD2). The lower contact is unconformable.																																								
						88		Qal		Discontinuity Measurements: <table border="1" style="font-size: small;"> <thead> <tr> <th>Depth</th> <th>Angle*</th> <th>Roughness</th> <th>Infilling</th> </tr> </thead> <tbody> <tr><td>197.3</td><td>20</td><td>R3</td><td>clean</td></tr> <tr><td>201.8</td><td>45</td><td>R3</td><td>clean</td></tr> </tbody> </table>	Depth	Angle*	Roughness	Infilling	197.3	20	R3	clean	201.8	45	R3	clean																												
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197.3	20	R3	clean																																															
201.8	45	R3	clean																																															
						93		NR		203.4 to 275.0 ft. TIVA CANYON TUFF CRYSTAL RICH NON-LITHOPHYSAL ZONE (Tpxn) Pyroclastic flow, moderately to mostly densely welded, devitrified, pale red to grayish red, with up to 15 percent phenocrysts. Phenocrysts are mostly sanidine and plagioclase with some quartz and rare biotite. Rare pumice from 212.5 to 222.8 ft. and up to 15 percent pumice clasts from 222.8 to 269.0 ft. From 276.7 to 288.0 ft. the tuff has up to 2 percent pumice clasts and 5 to 8 percent phenocrysts of sanidine and plagioclase with rare biotite. Generally the tuff is moderately soft (H5) to mostly moderately hard (H4), moderately to slightly weathered (W4), and intensely to moderately fracture (FD6). The lower contact is conformable.																																								
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WHB_LOG_WHB.GPJ_WHB.GDT 6/13/02

GEOLOGIC LOG OF DRILL HOLE NO. UE-25 RF#14

SHEET 3 OF 11

FEATURE: Waste Handling Building

PROJECT: Yucca Mountain Project

STATE: Nevada

LOCATION: ESF North Portal Pad

COORDINATES: N 765,308.73 E 571,065.44

GROUND ELEVATION: 3651.52

BEGUN: 9/13/2000 FINISHED: 9/27/2000

TOTAL DEPTH: 550.0 ft.

ANGLE FROM HORIZONTAL: -90

DEPTH TO WATER: Not Encountered

DEPTH TO BEDROCK: 101.8 ft.

HOLE LOGGED BY: USBR/SMF

REVIEWED BY: Mark McKeown

NOTES	DEPTH	SHEAR WAVE VELOCITY Vs	ENGINEERING INDEXES			% CORE RECOVERY	% ROD	GEOLOGIC UNIT [USCS]	GRAPHIC	CLASSIFICATION AND PHYSICAL CONDITION																																																																																																								
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	110					98	96			206.5 40 R3 trace white mineral 206.9 20 R3 trace white mineral 208.0 10-20 R3 4mm white mineral 208.6 30 R2 0-5mm white mineral 213.6 35 R2 clean 214.7 10 R2 clean 215.8 10 R3 clean 218.1 30 R3 clean 223.5 25 R3 clean 223.7 50 R3 clean 224.7 40 R2 clean 225.3 20 R2 clean 227.8 15 R3 clean 228.4 25 R2 sand 230.0 05 R3 clean 234.7 40 R2 clean 238.4 30 R2 trace white mineral 240.1 55 R2 clean 243.3 65 R2 clean 250.1 05 R2 10mm tan clay; polished; slickensided 253.2 40 R2 sand; gravel 253.9 30 R3 clean 256.3 45 R2 sand 256.7 15 to 40 R2 sand 257.3 60 R2 1mm white mineral 267.4 10 R3 clean 267.7 60 R2 2mm silica 268.0 0 R3 clean 268.4 0 R3 sand 268.8 20 R3 clean 268.9 25 R3 clean 269.3 30 R3 clean 270.5 10 R2 trace white mineral 270.7 20 R2 trace white mineral 273.4 15 R3 clean 274.3 15 R3 clean																																																																																																								
	115					100	100																																																																																																											
	120					96	88																																																																																																											
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	140			H6	FD1			Tpki		275.0 to 395.0 ft. TIVA CANYON TUFF CRYSTAL POOR UPPER LITHOPHYSAL ZONE (Tpcpu) Pyroclastic flow, densely welded, grayish orange to pale red, with 2 to 5 percent lithophysal cavities, up to 20 by 40 mm in size. Lithophysae increase to 15 percent at 310.0 ft and up to 25 percent at 320 ft., with up to 50 percent cavities partially filled with silica. Phenocrysts compose less than 1 percent of the tuff mostly sanidine and plagioclase with minor biotite. Also up to 3 percent pumice clasts as large as 40 by 10 mm. Zones of nonwelded, fracture fill(?) from 334 to 359 ft., and 369 to 395 ft. composed of reworked and variously bedded clay/silt sized, tuffaceous material. Generally the tuff is moderately soft (H5) to mostly moderately hard (H4), slightly (W3) to moderately weathered (W5), and intensely to moderately fractured (FD6). Lower contact is conformable. Discontinuity Measurements: <table border="1" style="font-size: small; margin-left: 20px;"> <thead> <tr> <th>Depth</th> <th>Angle*</th> <th>Roughness</th> <th>Infilling</th> </tr> </thead> <tbody> <tr><td>275.9</td><td>20</td><td>R2</td><td>clean</td></tr> <tr><td>276.0</td><td>25</td><td>R2</td><td>clean</td></tr> <tr><td>278.7-279.4</td><td>30</td><td>R2</td><td>0.6' breccia; sand & gravel; cemented</td></tr> <tr><td>279.6-280.0</td><td>60</td><td>R3</td><td>0.4' breccia; sand & gravel; cemented</td></tr> <tr><td>280.1</td><td>35</td><td>R3</td><td>10mm breccia</td></tr> <tr><td>282.0</td><td>30</td><td>R3</td><td>trace white mineral</td></tr> <tr><td>280.9-281.2</td><td>50-80</td><td></td><td>rotated; breccia</td></tr> <tr><td>281.4</td><td>55</td><td>R3</td><td>breccia</td></tr> <tr><td>284.0</td><td>20</td><td>R2</td><td>1-2mm silica</td></tr> <tr><td>283.1-284.9</td><td>0-20</td><td>R3</td><td>clean</td></tr> <tr><td>285.0</td><td>10</td><td>R3</td><td>1mm silica</td></tr> <tr><td>285.3</td><td>25</td><td>R2</td><td>clean</td></tr> <tr><td>286.0</td><td>35</td><td>R3</td><td>trace silica</td></tr> <tr><td>287.0</td><td>25</td><td>R2</td><td>3mm silica</td></tr> <tr><td>287.6</td><td>25</td><td>R3</td><td>1mm silica</td></tr> <tr><td>288.4</td><td>60</td><td>R3</td><td>clean</td></tr> <tr><td>288.9</td><td>35</td><td>R3</td><td>clean</td></tr> <tr><td>289.0</td><td>70</td><td>R3</td><td>clean</td></tr> <tr><td>289.3</td><td>15</td><td>R2</td><td>clean</td></tr> <tr><td>289.4</td><td>65</td><td>R3</td><td>clean</td></tr> <tr><td>289.8</td><td>10</td><td>R3</td><td>2mm silica</td></tr> <tr><td>290.7</td><td>25</td><td>R2</td><td>trace white mineral</td></tr> <tr><td>291.4-291.6</td><td>35</td><td>R3</td><td>40mm clay, sand, gravel</td></tr> <tr><td>292.2</td><td>35</td><td>R3</td><td>gravel</td></tr> <tr><td>291.9</td><td>75</td><td>R3</td><td>2mm silica</td></tr> </tbody> </table>	Depth	Angle*	Roughness	Infilling	275.9	20	R2	clean	276.0	25	R2	clean	278.7-279.4	30	R2	0.6' breccia; sand & gravel; cemented	279.6-280.0	60	R3	0.4' breccia; sand & gravel; cemented	280.1	35	R3	10mm breccia	282.0	30	R3	trace white mineral	280.9-281.2	50-80		rotated; breccia	281.4	55	R3	breccia	284.0	20	R2	1-2mm silica	283.1-284.9	0-20	R3	clean	285.0	10	R3	1mm silica	285.3	25	R2	clean	286.0	35	R3	trace silica	287.0	25	R2	3mm silica	287.6	25	R3	1mm silica	288.4	60	R3	clean	288.9	35	R3	clean	289.0	70	R3	clean	289.3	15	R2	clean	289.4	65	R3	clean	289.8	10	R3	2mm silica	290.7	25	R2	trace white mineral	291.4-291.6	35	R3	40mm clay, sand, gravel	292.2	35	R3	gravel	291.9	75	R3	2mm silica
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WHB LOG WHB.GPJ WHB.GDT 6/13/02

GEOLOGIC LOG OF DRILL HOLE NO. UE-25 RF#14

SHEET 4 OF 11

FEATURE: Waste Handling Building
 LOCATION: ESF North Portal Pad
 BEGUN: 9/13/2000 FINISHED: 9/27/2000
 DEPTH TO WATER: Not Encountered

PROJECT: Yucca Mountain Project
 COORDINATES: N 765,308.73 E 571,065.44
 TOTAL DEPTH: 550.0 ft.
 DEPTH TO BEDROCK: 101.8 ft.

STATE: Nevada
 GROUND ELEVATION: 3651.52
 ANGLE FROM HORIZONTAL: -90
 HOLE LOGGED BY: USBR/SMF
 REVIEWED BY: Mark McKeown

NOTES	DEPTH	SHEAR WAVE VELOCITY ft/s	ENGINEERING INDEXES				GEOLOGIC UNIT (USCS)	GRAPHIC	CLASSIFICATION AND PHYSICAL CONDITION
			HARDNESS	WELDING	FRACTURE DENSITY	% CORE RECOVERY			
	170					100	100		292.3 80 R3 clean
									294.9 45 R3 clay, sand
									295.1-295.5 30 R3 breccia, sand, gravel, tr. clay
									295.8-296.0 50 R3 breccia, sand, gravel, tr. clay
									298.6 30 R3 <1 mm silica
									299.2 65 R3 clean
									299.8 25 R3 clean
									299.7 20 R3 clean
									304.2-306.0 70 R2 clay, sand, gravel
									306.8 30 R3 1mm silica
									307.2 35 R3 1mm silica
									308.9 60 R3 20mm silica
									308.4 25 R3 2mm silica
									310.4 35 R2 1mm quartz
									310.6 30 R3 none
									311.3 55 R3 none
									311.8 55 R3 none
									312.0 45 R3 sand, trace quartz
									312.2-313.3 45 R2 breccia; sand & gravel
									313.8 05 R3 1mm vapor phase minerals
									314.5 35 R3 sand
									315.2-316.1 45 R2 breccia; sand, gravel, clay
									317.0-320.3 20 R2 sand, gravel, clay
									322.5 65 R2 none
									322.8 05 R2 trace white mineral
									322.9 70 R2 none
									323.4 50 R3 none
									321.0 60 R3 8mm vapor phase alteration
									326.3 10 R3 1.2" clay, sand, gravel
									327.3 50 R3 clean
									329.2 05 to 35 R2 15mm clay
									344.8 5 to 15 R4 1mm clay
									349.0 05 R3 <1mm white mineral & clay
									351.7 35 R3 <1mm clay(?) & MnO(?)
									358.0-358.9 85 R2 clay, sand, gravel breccia
									359.2 40 R3 1mm clay
									359.9 25 R2 3mm sand, gravel, clay
									360.4 30 R2 clean
									361.6 25 R3 clean
									362.2-362.4 65 R2 sand, gravel, clay, MnO
									363.4 70 R3 trace white mineral
									364.0 35 R3 clean
									364.6 55 R3 trace white mineral
									364.8 20 R2 MnO coating
									366.8-367.5 40 R3 clay, sand, gravel
									395.0 to 443.7 ft. TIVA CANYON TUFF CRYSTAL POOR
									MIDDLE NON-LITHOPHYSAL ZONE (Tpcpmn)
									Pyroclastic flow, densely welded, devitrified, pale red, tuff with less than 1 percent lithophysae up to 50 by 10 mm. Less than 1 percent phenocrysts of sanidine, plagioclase, and biotite. The tuff has 1 to 2 percent very light gray pumice clasts and pink spherulites, and up to 10 percent volcanic lithic fragments. Zones of nonwelded, fracture fill(?) from 402.7 to 431.7 ft., 434.0 to 435.8 ft., and 442.4 to 443.7 ft. composed of reworked and variously bedded clay/silt sized, tuffaceous material. Generally the tuff is moderately soft (H5), moderately to slightly weathered (W4), with fracture densities ranging from slightly fractured (FD3) to very intensely fractured (FD8). Lower contact is conformable.
									Discontinuity Measurements:
									Depth Angle* Roughness Infilling
									367.9 60 R3 2mm clay
									368.9 05 R2 clay, sand, gravel
									370.0 30 R3 MnO stain & 5mm clay
									373.7 15 R4 contact between clayey infilling material at Tpc
									373.9 60 R2 2mm silica
									374.3 35 R2
									374.3 55 R2
									374.8 60 R2 trace of clay
									375.1 quartz filled lithophysal cav. 25mm thick
									375.4 50 R3 trace of clay
									375.6 60 R4
									378.6 45 R3 trace of clay
									378.8 35 R3
									378.8 60 R3
									379.0 0 R4 1mm silica
									379.6 15 R4 trace silica
									379.8 20 R3
									380.0 75 R3 1mm silica
									380.2 65 R3 trace silica
									380.7 05 R3

WHB LOG WHB.GPJ WHB.GDT 6/13/02

GEOLOGIC LOG OF DRILL HOLE NO. UE-25 RF#14

SHEET 6 OF 11

FEATURE: Waste Handling Building
 LOCATION: ESF North Portal Pad
 BEGUN: 9/13/2000 FINISHED: 9/27/2000
 DEPTH TO WATER: Not Encountered

PROJECT: Yucca Mountain Project
 COORDINATES: N 765,308.73 E 571,065.44
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trace silica</td></tr> <tr><td>477.3</td><td>75</td><td>R1</td><td>trace white mineral</td></tr> <tr><td>478.4</td><td>85</td><td>R1</td><td>vapor phase alteration-2mm</td></tr> <tr><td>478.5</td><td>55</td><td>R3</td><td>trace white mineral</td></tr> <tr><td>479.0</td><td>60</td><td>R1</td><td>trace white mineral</td></tr> <tr><td>480.3</td><td>70</td><td>R1</td><td>2mm vapor phase minerals</td></tr> <tr><td>(healed)</td><td></td><td></td><td></td></tr> <tr><td>480.9</td><td>75</td><td>R1</td><td>2mm vapor phase minerals</td></tr> <tr><td>(healed)</td><td></td><td></td><td></td></tr> <tr><td>482.4</td><td>55</td><td>R1</td><td>2mm vapor phase minerals</td></tr> <tr><td>(healed)</td><td></td><td></td><td></td></tr> <tr><td>483.1</td><td>45</td><td>R4</td><td>trace white minerals</td></tr> <tr><td>484.4</td><td>65</td><td>R4</td><td>clean</td></tr> <tr><td>484.6</td><td>60</td><td>R4</td><td>clean</td></tr> <tr><td>485.4</td><td>80</td><td>R2</td><td>trace white mineral</td></tr> <tr><td>485.6</td><td>75</td><td>R4</td><td>clean</td></tr> <tr><td>485.9</td><td>50</td><td>R4</td><td>trace white mineral</td></tr> </tbody> </table>	Depth	Angle*	Roughness	Infilling	455.7	40	R3	clean	456.4	20	R3	0 to 1mm silica	458.0	45	R3	clean	458.1	35	R3	3mm silica	460.2	60	R2	trace white mineral	460.0	30	R3	trace white mineral	460.4	70	R2	clean	460.9	65	R3	trace white mineral	461.1	85	R3	trace white mineral	461.3	35	R4	MnO & trace white mineral	461.8	60	R3	clean	462.1	60	R4	clean	462.7	30	R3	clean	463.1	25	R4	trace white mineral	463.9	75	R4	clean	464.1	55	R3	trace white mineral	464.8	35	R3	trace white mineral	465.0	55	R4	clean	465.5	65	R4	clean	465.9	70	R4	trace white mineral	466.3	65	R4	trace white mineral	467.0	20	R3	trace white mineral	467.1	75	R2	trace white mineral	467.3	50	R2	4mm sand & silica	467.7	50	R3	trace white mineral	468.0	80	R4	trace white mineral	468.2	55	R4	clean	468.4	80	R4	clean	468.5	35	R4	trace white mineral	468.7	60	R4	clean	469.0	70	R4	clean	469.4	45	R4	trace white mineral	470.0	60	R2	trace white mineral	471.2	80	R2	trace white mineral	472.4	80	R3	trace white mineral	472.8	80	R2	trace white mineral	473.1	75	R3	trace white mineral	474.5	10	R2	trace white mineral	476.8	80	R2	trace white mineral	476.2	80	R1	trace white mineral; trace silica	477.3	75	R1	trace white mineral	478.4	85	R1	vapor phase alteration-2mm	478.5	55	R3	trace white mineral	479.0	60	R1	trace white mineral	480.3	70	R1	2mm vapor phase minerals	(healed)				480.9	75	R1	2mm vapor phase minerals	(healed)				482.4	55	R1	2mm vapor phase minerals	(healed)				483.1	45	R4	trace white minerals	484.4	65	R4	clean	484.6	60	R4	clean	485.4	80	R2	trace white mineral	485.6	75	R4	clean	485.9	50	R4	trace white mineral
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WHB LOG WHB.GPJ WHB.GDT 8/13/02

GEOLOGIC LOG OF DRILL HOLE NO. UE-25 RF#14

SHEET 7 OF 11

FEATURE: Waste Handling Building
 LOCATION: ESF North Portal Pad
 BEGUN: 9/13/2000 FINISHED: 9/27/2000
 DEPTH TO WATER: Not Encountered

PROJECT: Yucca Mountain Project
 COORDINATES: N 765,308.73 E 571,065.44
 TOTAL DEPTH: 550.0 ft.
 DEPTH TO BEDROCK: 101.8 ft.

STATE: Nevada
 GROUND ELEVATION: 3651.52
 ANGLE FROM HORIZONTAL: -90
 HOLE LOGGED BY: USBR/SMP
 REVIEWED BY: Mark McKeown

NOTES	DEPTH	SHEAR WAVE VELOCITY m/s	ENGINEERING INDEXES				GEOLOGIC UNIT (USCS)	GRAPHIC	CLASSIFICATION AND PHYSICAL CONDITION					
			HARDNESS	WELDING	FRACTURE DENSITY	% CORE RECOVERY			% ROD					
	350		H7		FD5	89	67	(Fracture Fill)		486.2	70	R4	clean	
											487.3	85	R3	trace white mineral
											487.0	80	R2	clean
											488.2	60	R3	trace white mineral
											489.1	60	R3	trace white mineral
											489.7	30	R3	trace white mineral
											490.0	60	R4	trace white mineral
											490.0	50	R4	trace white mineral
											494.0	0	R2	MnO stain
											493.8	30	R3	trace white mineral
	355		H4		FD6	84	32	Tpcpul		493.4	35	R3	MnO stain; trace white mineral	
											492.8	20	R2	clean
											491.9	40	R3	clean
											491.8	80	R3	trace white mineral
											491.6	30	R3	clean
											491.2	10	R3	clean
						FD4	86		17		495.0	05	R2	trace MnO & white mineral
											495.3	80	R3	clean
											495.9	75	R3	clean
	360			H6						(Fracture Fill)		497.4	80	R3
											498.0	65	R3	clean
											498.6	80	R3	clean
											498.9	60	R3	trace white mineral
											499.2	70	R3	clean
						FD6					499.4	80	R3	clean
											499.6	80	R3	clean
											499.8	05	R3	clean
											504.0	10	R3	trace MnO & white mineral
											503.4	85	R3	trace MnO & white mineral
	370		H3		FD3			Tpcpmn		504.5	15	R3	trace MnO & white mineral	
											506.8	80	R3	trace white mineral
											507.5	35	R3	clean
											508.4	65	R2	trace white mineral
											500.6	70	R3	trace white mineral
											500.7	70	R3	trace white mineral
											501.6	75	R3	clean
											501.7	70	R3	trace white mineral
											502.1	75	R3	trace white mineral
											502.3	70	R3	trace white mineral
	375		H3		FD7			(Fracture Fill)		502.6	65	R3	trace white mineral	
											502.7	75	R3	trace white mineral
											502.8	15	R3	trace white mineral
											503.2	85	R3	trace white mineral
											512.1	65	R3	trace white mineral
											512.9	80	R3	trace white mineral
											513.0	70	R2	3mm vapor phase mineral
											514.0	25	R2	trace white mineral
											514.2	75	R2	trace white mineral
											514.3	10	R2	trace white mineral
	380		H3		FD6			(Fracture Fill)		515.6	15	R3	clean	
											516.4	15	R2	trace MnO
											517.8	10	R1	trace clay
											517.9	15	R2	1mm clay; sand
											520.4	70	R2	MnO, white mineral stain
											520.6	75	R2	MnO stain
											520.9	80	R2	clean
											520.5	80	R3	clean
											521.2	85	R3	MnO stain
											522.0	10	R3	clean
	385		H3					(Fracture Fill)		522.6	15	R3	clean	
											523.3	80	R2	15-40mm sand
											523.8	80	R2	gravel fragments
											524.0	25	R3	healed
											526.0	25	R2	0.4ft. Sand, gravel, & clay breccia
											528.4	75	R3	trace white mineral
											528.9	60	R2	clean; slickensides
											529.3	65	R2	clean; slickensides
											529.4	70	R2	clean; slickensides
											530.4	25	R2	3 to 8mm clay; slickensides;
	390		H3					(Fracture Fill)		530.8	55	R2	polished; hard	
											531.2	40	R2	clean
											531.7	80	R2	trace MnO
											531.5	10	R3	MnO stain
											532.0	50	R3	MnO stain
											532.1	15	R3	MnO stain
											532.5	55	R2	sand
											532.7	40	R2	trace clay; sand
											532.8	50	R3	sand
											533.0	70	R2	sand & gravel
	395		H6					(Fracture Fill)		533.1	75	R2	sand & gravel	
											533.2	70	R3	clean
	400		H4					(Fracture Fill)						
	405													

WHB LOG WHB.GPJ WHB.GDT 8/13/02

GEOLOGIC LOG OF DRILL HOLE NO. UE-25 RF#14

SHEET 9 OF 11

FEATURE: Waste Handling Building
 LOCATION: ESF North Portal Pad
 BEGUN: 9/13/2000 FINISHED: 9/27/2000
 DEPTH TO WATER: Not Encountered

PROJECT: Yucca Mountain Project
 COORDINATES: N 765,308.73 E 571,065.44
 TOTAL DEPTH: 550.0 ft.
 DEPTH TO BEDROCK: 101.8 ft.

STATE: Nevada
 GROUND ELEVATION: 3651.52
 ANGLE FROM HORIZONTAL: -90
 HOLE LOGGED BY: USBR/SMF
 REVIEWED BY: Mark McKeown

NOTES	DEPTH	SHEAR WAVE VELOCITY ft/s	ENGINEERING INDEXES			GEOLOGIC UNIT [USCS]	GRAPHIC	CLASSIFICATION AND PHYSICAL CONDITION
			HARDNESS	WELDING	FRACTURE DENSITY			
	470				FD5	100	39	
	475				FD4	100	69	
	480							
	485				FD3	98	76	
	490							
	495					100	55	
	500			H4	FD4			Tpccpin
	505					100	45	
	510							
	515				FD3	100	88	
	520							
	525				FD4	99	54	

WHB LOG WHB.GPJ WHB.GDT 6/13/02

GEOLOGIC LOG OF DRILL HOLE NO. UE-25 RF#14

SHEET 10 OF 11

FEATURE: Waste Handling Building
 LOCATION: ESF North Portal Pad
 BEGUN: 9/13/2000 FINISHED: 9/27/2000
 DEPTH TO WATER: Not Encountered

PROJECT: Yucca Mountain Project
 COORDINATES: N 765,308.73 E 571,065.44
 TOTAL DEPTH: 550.0 ft.
 DEPTH TO BEDROCK: 101.8 ft.

STATE: Nevada
 GROUND ELEVATION: 3651.52
 ANGLE FROM HORIZONTAL: -90
 HOLE LOGGED BY: USBR/SMF
 REVIEWED BY: Mark McKeown

NOTES	DEPTH	SHEAR WAVE VELOCITY m/s	ENGINEERING INDEXES					GEOLOGIC UNIT (USCS)	GRAPHIC	CLASSIFICATION AND PHYSICAL CONDITION
			HARDNESS	WELDING	FRACTURE DENSITY	% CORE RECOVERY	% ROD			
	530		H4		FD4	99	54			
	535		H6		FD6	100	18	Tpepin		
	540									
	545		H4		FD5	100	36			
	550		BOTTOM OF HOLE							

WHB_LOG.WHB.GPJ.WHB.GDT 6/13/02

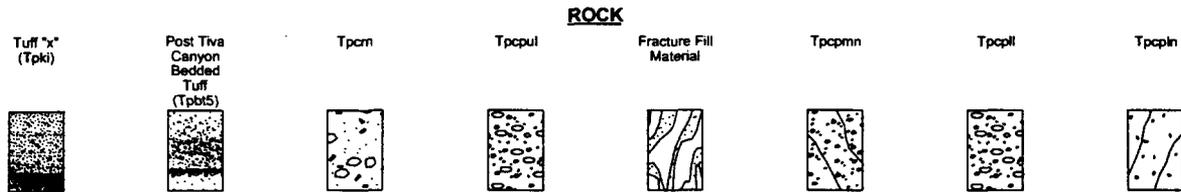
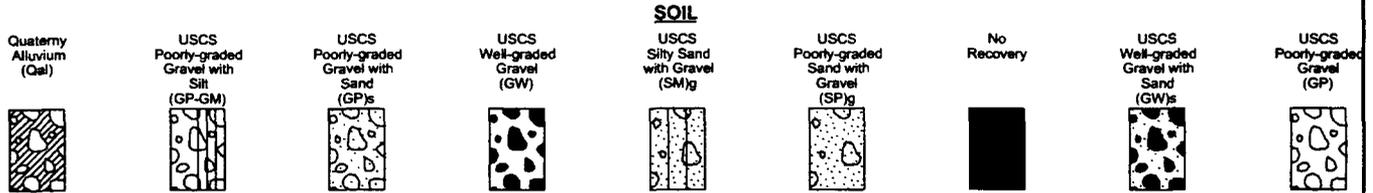
GEOLOGIC LOG OF DRILL HOLE NO. UE-25 RF#14

SHEET 11 OF 11

FEATURE: Waste Handling Building
 LOCATION: ESF North Portal Pad
 BEGUN: 9/13/2000 FINISHED: 9/27/2000
 DEPTH TO WATER: Not Encountered

PROJECT: Yucca Mountain Project
 COORDINATES: N 765,308.73 E 571,065.44
 TOTAL DEPTH: 550.0 ft.
 DEPTH TO BEDROCK: 101.8 ft.

STATE: Nevada
 GROUND ELEVATION: 3651.52
 ANGLE FROM HORIZONTAL: -90°
 HOLE LOGGED BY: USBR/SMF
 REVIEWED BY: Mark McKeown



	<u>HARDNESS</u>		<u>WEATHERING</u>	
Alpha-numeric descriptor	Descriptor	Criteria	Alpha-numeric descriptor	Descriptor
H1	Extremely	Core, fragment, or exposure cannot be scratched with knife or sharp pick; can only be chipped with repeated heavy hammer blows.	W1	Fresh
H2	Very Hard	Cannot be scratched with knife or sharp pick. Core or fragment breaks with repeated heavy hammer blows.	W2	Slightly weathered to fresh
H3	Hard	Can be scratched with knife or sharp pick with difficulty (heavy pressure). Heavy hammer blow required to break specimen.	W3	Slightly weathered
H4	Moderately Hard	Can be scratched with knife or sharp pick with light pressure. Core or fragment breaks with moderate hammer blow.	W4	Moderately to slightly weathered
H5	Moderately Soft	Can be grooved 1/16 inch (2mm) deep by sharp pick with moderate or heavy pressure. Core or fragment breaks with light hammer blow or heavy manual pressure.	W5	Moderately weathered
H6	Soft	Can be grooved or gouged easily by knife or sharp pick with light pressure. Can be scratched with fingernail. Breaks with light to moderate manual pressure.	W6	Intensely to moderately weathered
H7	Very Soft	Can be readily indented, grooved or gouged with fingernail, or carved with a knife. Breaks with light manual pressure.	W7	Intensely weathered
			W8	Very intensely weathered
			W9	Decomposed

General characteristics (strength, excavation, etc.)

Hammer rings when crystalline rocks are struck. Almost always rock excavation except for naturally weak or weakly cemented rocks such as siltstones or shales.

Hammer rings when crystalline rocks are struck. Body of rock not weakened. With few exceptions, such as siltstones or shales, classified as rock excavation.

Hammer does not ring when rock is struck. Body of rock is slightly weakened. Depending on fracturing, usually is rock excavation, except in naturally weak rocks such as siltstones or shales.

Dull sound when struck with hammer, usually can be broken with moderate to heavy manual pressure or by light hammer blow without reference to planes of weakness such as incipient or hairline fractures, or veinlets. Rock is significantly weakened. Usually common excavation.

Can be granulated by hand. Always common excavation. Resistant minerals such as quartz may be present as "stringers" or "dikes".

FRACTURE DENSITY

Alpha-numeric descriptor	Descriptor	Criteria (Excludes mechanical breaks)
FD0	Unfractured	No observed fractures.
FD1	Very slightly fractured	Core recovered mostly in lengths greater than 3 feet (1 m).
FD2	Slightly to very slightly fractured	
FD3	Slightly fractured	Core recovered mostly in lengths from 1 to 3 feet (300 to 1,000 mm) with few scattered lengths less than 1 foot (300 mm) or greater than 3 feet (1,000 mm).
FD4	Moderately to slightly fractured	
FD5	Moderately fractured	Core recovered mostly in lengths from 0.33 to 1.0 foot (100 to 300 mm) with most lengths about 0.67 foot (200 mm).
FD6	Moderately to intensely fractured	
FD7	Intensely fractured	Lengths average from 0.1 to 0.33 foot (30 to 100 mm) with fragmented intervals. Core recovered mostly in lengths less than 0.33 foot (100 mm).
FD8	Very intensely to intensely fractured	
FD9	Very intensely fractured	Core recovered mostly as chips and fragments with a few scattered short core lengths.

RF14 KEY WHB.GPJ WHB.GDT 6/14/02

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GEOLOGIC LOG OF DRILL HOLE NO. UE-25 RF#15

SHEET 1 OF 7

FEATURE: Waste Handling Building

PROJECT: Yucca Mountain Project

STATE: Nevada

LOCATION: ESF North Portal Pad

COORDINATES: N 765,773.64 E 570,224.85

GROUND ELEVATION: 3680.98

BEGUN: 8/30/2000 FINISHED: 9/11/2000

TOTAL DEPTH: 330.0 ft.

ANGLE FROM HORIZONTAL: -90

DEPTH TO WATER: Not Encountered

DEPTH TO BEDROCK: 5.0 ft.

HOLE LOGGED BY: USBR/SMF

REV-EWED BY: Mark McKeown

NOTES	DEPTH	SHEAR WAVE VELOCITY Vs	ENGINEERING INDEXES				% CORE RECOVERY	% ROD	GEOLOGIC UNIT [USCS]	GRAPHIC	CLASSIFICATION AND PHYSICAL CONDITION																																																																																																																																																																																																											
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<p>Purpose of Hole: Preliminary, conceptual-level geotechnical foundation investigations for the design of the Waste Handling Building (WHB).</p> <p>Drill Equipment: Schramm T685 Drill Rig, UDR 1000 Drill Rig</p> <p>Drillers: D. Harrison, R. McKay, D. Fyffe; Dynatec Drilling Inc.; Salt Lake City, Utah.</p> <p>Drilling Method: Install 12" hammer. Hammer to 5.03. Cement 10.75 O.D. casing with 1.38 stickup. Re-enter hole on 8/30/2000 with PQ coring system. Cored with PQ to 77.16. Used PQ rods as casing and installed HQ coring system. Cored with HQ to the total depth of 330.00.</p> <p>Drilling Conditions: 77.16 to 289.26 replace bit.</p> <p>Drilling Fluid: 0.00 to 5.03: Non-potable water. 5.03 to 330.00: Quick Gel mud with EZ-Mud and LCM to re-establish circulation.</p> <p>Loss Intervals: Lost circulation from 51.00 to 330.00.</p> <p>Casing Record: 0.00 to 4.63: 10.75 O.D. casing. 0.00 to 77.16: PQ casing. 77.16 to 330.00: No casing</p> <p>Hole Completion: Ream hole from 5.03 to 330.0. Set and cement 4.5" PVC casing.</p>	1000 2000 3000 4000 5000 6000 7000 8000 9000									<p>0.0 to 6.5 ft. PAD FILL (Fill) 0.0 - 5.0: POORLY GRADED GRAVEL (GP) Predominately fine to coarse, hard, subangular gravel with a trace of nonplastic fines on gravel surfaces; derived from moderately to densely welded Tuff.</p> <p>6.5 to 78.0 ft. TIVA CANYON TUFF CRYSTAL RICH NON-LITHOPHYSAL ZONE (Tpcm) Pyroclastic flow, densely welded, devitrified, light gray to pale red tuff with 15 to 20 percent phenocrysts of plagioclase, sanidine, and minor (less than 1 percent) biotite. Pumice clasts compose up to 10 percent of the tuff, pumice clasts increase to up to 25 to 30 percent at a depth of 67.4 feet. Generally the tuff is moderately hard (H4), moderately to slightly weathered (W4), and intensely to moderately fractured (FD6). Upper contact is unconformable (erosional), lower contact is conformable.</p> <p>Discontinuity Measurements:</p> <table border="1" style="font-size: small;"> <thead> <tr> <th>Depth</th> <th>Angle*</th> <th>Roughness</th> <th>Infilling</th> </tr> </thead> <tbody> <tr><td>5.2</td><td>30</td><td>R3</td><td>0.5" calcite</td></tr> <tr><td>6.8</td><td>65</td><td>R2</td><td>1.0" Calcite</td></tr> <tr><td>7.1</td><td>80</td><td>R2</td><td>0.25" Calcite</td></tr> <tr><td>8.7</td><td>30</td><td>R3</td><td>Clean</td></tr> <tr><td>9.2</td><td>25</td><td>R2</td><td>0.1" Calcite</td></tr> <tr><td>9.2</td><td>70</td><td>R2</td><td>0.25" Calcite</td></tr> <tr><td>11.2</td><td>30</td><td>R2</td><td>0.25" Calcite</td></tr> <tr><td>13.7</td><td>40</td><td></td><td>0.1" Clay & Sand</td></tr> <tr><td>14.8</td><td>10</td><td>R3</td><td>Trace Clay</td></tr> <tr><td>18.0</td><td>10</td><td>R3</td><td>0.3" Calcite & Clay</td></tr> <tr><td>16.8</td><td>40</td><td>R3</td><td>Clean</td></tr> <tr><td>17.8</td><td>70</td><td>R2</td><td>Clean</td></tr> <tr><td>18.5</td><td>65</td><td>R2</td><td>Clean</td></tr> <tr><td>19.0</td><td>35</td><td>R2</td><td>Clean</td></tr> <tr><td>20.0</td><td>05</td><td>R2</td><td>0.75" Calcite</td></tr> <tr><td>22.4</td><td>55</td><td>R3</td><td>Clean</td></tr> <tr><td>24.5</td><td>30</td><td>R2</td><td>0.25" Clay</td></tr> <tr><td>24.8</td><td>50</td><td>R3</td><td><0.1" gray non-crystalline</td></tr> <tr><td>25.1</td><td>60</td><td>R2</td><td><0.1" gray non-crystalline</td></tr> <tr><td>26.6</td><td>70</td><td>R3</td><td>Clean</td></tr> <tr><td>27.1</td><td>60</td><td>R3</td><td>Trace Fe</td></tr> <tr><td>28.4</td><td>25</td><td>R3</td><td>Quartz & Clay</td></tr> <tr><td>29.0</td><td>40</td><td>R3</td><td>Clay</td></tr> <tr><td>29.3</td><td>30-90</td><td>R3</td><td>Calcite? & Clay</td></tr> <tr><td>32.6 - 32.8</td><td>15</td><td>R3</td><td>Quartz & Clay</td></tr> <tr><td>34.5 - 35.3</td><td>20</td><td>R3</td><td>Clay & Pumice</td></tr> <tr><td>34.4</td><td>90</td><td>R3</td><td>Clean</td></tr> <tr><td>34.9</td><td>90</td><td>R3</td><td>Clay & Pumice</td></tr> <tr><td>38.5</td><td>45</td><td>R2</td><td>Clean</td></tr> <tr><td>43.4 - 43.8</td><td>10</td><td>R3</td><td>Clean</td></tr> <tr><td>49.3 - 49.5</td><td>45</td><td>R2</td><td>Trace Clay</td></tr> <tr><td>49.6 - 50.3</td><td>5-10</td><td>R3</td><td>Trace Clay</td></tr> <tr><td>49.6 - 49.9</td><td>10</td><td>R3</td><td>Clean</td></tr> <tr><td>53.1</td><td>45</td><td>R3</td><td>Trace Clay</td></tr> <tr><td>55.1 - 57.8</td><td>0-5</td><td>R4</td><td>White mineral, Clay</td></tr> <tr><td>59.6 - 59.7</td><td>5 0</td><td>R3</td><td>Clay</td></tr> <tr><td>61.7 - 62.1</td><td>10</td><td>R3</td><td>Trace Clay</td></tr> <tr><td>65.6 - 66.7</td><td>10</td><td>R3</td><td>Breccia zone</td></tr> <tr><td>65.3</td><td>65</td><td>R3</td><td>Sand</td></tr> <tr><td>67.7</td><td>65</td><td>R3</td><td>0.1" Vapor-phase coating</td></tr> <tr><td>68.8</td><td>70</td><td>R2</td><td>0.1" Vapor-phase coating, sand</td></tr> <tr><td>69.8</td><td>30</td><td>R3</td><td>0.1" Quartz, Sand</td></tr> <tr><td>70.5</td><td>30</td><td>R2</td><td>Sand</td></tr> <tr><td>69.4</td><td>80</td><td>R1</td><td>Sand</td></tr> <tr><td>71.4</td><td>60</td><td>R2</td><td>Vapor-phase parting</td></tr> <tr><td>71.7</td><td>60</td><td>R3</td><td>0.1" Vapor-phase</td></tr> <tr><td>72.2</td><td>85</td><td>R3</td><td>0.1" Vapor-phase</td></tr> <tr><td>72.8</td><td>50</td><td>R4</td><td>Paper thin white mineral</td></tr> <tr><td>73.2</td><td>55</td><td>R3</td><td>Clean</td></tr> <tr><td>74.1 - 74.4</td><td>40</td><td>R3</td><td>0.2" Breccia - clay, sand.</td></tr> </tbody> </table>	Depth	Angle*	Roughness	Infilling	5.2	30	R3	0.5" calcite	6.8	65	R2	1.0" Calcite	7.1	80	R2	0.25" Calcite	8.7	30	R3	Clean	9.2	25	R2	0.1" Calcite	9.2	70	R2	0.25" Calcite	11.2	30	R2	0.25" Calcite	13.7	40		0.1" Clay & Sand	14.8	10	R3	Trace Clay	18.0	10	R3	0.3" Calcite & Clay	16.8	40	R3	Clean	17.8	70	R2	Clean	18.5	65	R2	Clean	19.0	35	R2	Clean	20.0	05	R2	0.75" Calcite	22.4	55	R3	Clean	24.5	30	R2	0.25" Clay	24.8	50	R3	<0.1" gray non-crystalline	25.1	60	R2	<0.1" gray non-crystalline	26.6	70	R3	Clean	27.1	60	R3	Trace Fe	28.4	25	R3	Quartz & Clay	29.0	40	R3	Clay	29.3	30-90	R3	Calcite? & Clay	32.6 - 32.8	15	R3	Quartz & Clay	34.5 - 35.3	20	R3	Clay & Pumice	34.4	90	R3	Clean	34.9	90	R3	Clay & Pumice	38.5	45	R2	Clean	43.4 - 43.8	10	R3	Clean	49.3 - 49.5	45	R2	Trace Clay	49.6 - 50.3	5-10	R3	Trace Clay	49.6 - 49.9	10	R3	Clean	53.1	45	R3	Trace Clay	55.1 - 57.8	0-5	R4	White mineral, Clay	59.6 - 59.7	5 0	R3	Clay	61.7 - 62.1	10	R3	Trace Clay	65.6 - 66.7	10	R3	Breccia zone	65.3	65	R3	Sand	67.7	65	R3	0.1" Vapor-phase coating	68.8	70	R2	0.1" Vapor-phase coating, sand	69.8	30	R3	0.1" Quartz, Sand	70.5	30	R2	Sand	69.4	80	R1	Sand	71.4	60	R2	Vapor-phase parting	71.7	60	R3	0.1" Vapor-phase	72.2	85	R3	0.1" Vapor-phase	72.8	50	R4	Paper thin white mineral	73.2	55	R3	Clean	74.1 - 74.4	40	R3	0.2" Breccia - clay, sand.
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- COMMENTS:
- All measurements are in feet unless noted otherwise.
 - No attempts to re-establish circulation were made below 278 ft.
 - LCM (Lost Circulation Material) consists cellophane cuttings.
 - USCS classifications were determined in the field, with limited access to samples to keep samples intact for future tests.
 - Shear Wave Velocity data from GeoVision suspension logging. Data acquired from downhole survey conducted after PVC casing installed.
 - USCS soil classifications are based on USBR Earth Manual procedure 5005 - Determining Unified Soil Classification (Visual Method)

WHB_LOG_WHNB.GPJ WHB.GDT 8/13/02

GEOLOGIC LOG OF DRILL HOLE NO. UE-25 RF#15

SHEET 4 OF 7

FEATURE: Waste Handling Building
 LOCATION: ESF North Portal Pad
 BEGUN: 8/30/2000 FINISHED: 9/11/2000
 DEPTH TO WATER: Not Encountered

PROJECT: Yucca Mountain Project
 COORDINATES: N 765,773.64 E 570,224.85
 TOTAL DEPTH: 330.0 ft.
 DEPTH TO BEDROCK: 5.0 ft.

STATE: Nevada
 GROUND ELEVATION: 3680.98
 ANGLE FROM HORIZONTAL: -90
 HOLE LOGGED BY: USBR/SMF
 REVIEWED BY: Mark McKeown

NOTES	DEPTH	SHEAR WAVE VELOCITY ft/s	ENGINEERING INDEXES			% CORE RECOVERY	% RQD	GEOLOGIC UNIT (USGS)	GRAPHIC	CLASSIFICATION AND PHYSICAL CONDITION
			HARDNESS	WELDING	FRACTURE DENSITY					
	170									234.7 10 R3 2mm white mineral, trace MnO(?)
	175				96	55				235.4 25 R3 Trace white mineral, trace FeO
										235.7 20 R3 1" white mineral, 1mm MnO
										236.8 40 R2 Clean
										237.1 20 R3 2mm white mineral
										239.1 30 R2 1mm white mineral
										239.8 30 R3 2mm white mineral
										240.6 40 R3 10mm white mineral, 1mm MnO
										241.9 85 R2 Sand, gravel
	180				FD4			Tcpul		242.4 to 256.6 ft. TIVA CANYON TUFF CRYSTAL POOR LOWER LITHOPHYCAL ZONE (Tpcpl) Pyroclastic flow, densely welded, devitrified, moderate orange pink tuff with rare light gray pumice. Phenocrysts of sanidine and rare biotite compose less than 1 percent of the rock by volume. Lithophysal cavities compose 15 to 20 percent of the rock by volume with some larger than core diameter. Lithophysae are filled and coated with vapor phase minerals to varying degrees. Generally the tuff is hard (H3), slightly weathered (W3), and slightly to very slightly fractured (FD2). Lower contact is conformable.
	185									Discontinuity Measurements:
	190				FD7	73	0			Depth Angle* Roughness Infilling
										243.2 60 R2 2mm white mineral
										244.9 15 R3 2mm white mineral
										244.8 75 R2 5mm vapor-phase alteration
										249.6 80 R2 1mm gray mineral
										250.3 80 R3
										250.6 85 R3
										256.5 10 R3 Trace white mineral
	195				FD4	96	66			256.6 to 330.0 ft. TIVA CANYON TUFF CRYSTAL POOR LOWER NON-LITHOPHYCAL ZONE (Tpcpln) Pyroclastic flow, densely welded, devitrified, pale red tuff with less than 1 percent light gray pumice clasts. Phenocrysts of sanidine and plagioclase compose less than 1 percent of the rock by volume. Medium gray lithic clasts compose less 1 percent of the rock by volume. Clast supported breccia from 276.2 to 280.3 ft. Generally the tuff is moderately hard (H4), slightly weathered (W3), with fracture densities mostly moderately fractured (FD4) to some intensely fractured (FD7) zones. Lower contact undetermined, bottom of borehole at 330.0 ft.
	200									Discontinuity Measurements:
	205				FD5	95	49			Depth Angle* Roughness Infilling
										259.7 10 R1 Trace white mineral
										260.7 10 R2 Trace white mineral
										261.7 70 R3 Trace white mineral, MnO
										263.1 35 R2 Trace white mineral
										264.4 85 R2 Trace white mineral
										264.5 60 R2 Trace white mineral
										267.2 10 R3 Trace white mineral
										266.5 40 R3 Trace white mineral
										267.4 25 R2 Trace white mineral
										269.5 30 R2 Trace white mineral
										270.7 65 R3 Trace white mineral
										271.1 60 R2 Trace white mineral
										271.3 70 R3 Trace white mineral
										271.6 60 R3 Trace white mineral
										272.3 85 R2 Trace white mineral
										272.8 80 R3 1mm white mineral
										274.1 85 R3 Trace white mineral
										274.9 85 R3 Trace white mineral
										275.3 30 R3 Trace white mineral
										276.0 40 R2 Trace white mineral
										276.1 25 R2 Trace white mineral
										280.3 85 R4
										280.6 10 R3 Trace MnO & vapor-phase mineral
										280.9 80 R3 Trace MnO
										283.7 65 R3 Trace vapor-phase mineral
										284.2 25 R3
										285.1 55 R3
										285.8 75 R3
										286.2 60 R3 Vapor-phase minerals
										286.3 30 R3
										286.8 25 R3 Trace vapor-phase minerals
										287.1 55 R3
	220				FD6		0			
	225				FD4	100	69			

WHB LOG WHB.GPJ WHB.GDT 6/13/02

GEOLOGIC LOG OF DRILL HOLE NO. UE-25 RF#15

SHEET 6 OF 7

FEATURE: Waste Handling Building
 LOCATION: ESF North Portal Pad
 BEGUN: 8/30/2000 FINISHED: 9/11/2000
 DEPTH TO WATER: Not Encountered

PROJECT: Yucca Mountain Project
 COORDINATES: N 765,773.64 E 570,224.85
 TOTAL DEPTH: 330.0 ft.
 DEPTH TO BEDROCK: 5.0 ft.

STATE: Nevada
 GROUND ELEVATION: 3680.98
 ANGLE FROM HORIZONTAL: -90
 HOLE LOGGED BY: USBR/SMF
 REVIEWED BY: Mark McKeown

NOTES	DEPTH	SHEAR WAVE VELOCITY Vs	ENGINEERING INDEXES			% CORE RECOVERY	% ROD	GEOLOGIC UNIT (USCS)	GRAPHIC	CLASSIFICATION AND PHYSICAL CONDITION
			HARDNESS	WELDING	FRACTURE DENSITY					
	290				FD7	99	84			
	295				FD4	96	93			
	300									
	305				FD3		97			
	310			H3				Tppin		
	315				FD4	100	88			
	320									
	325				FD3		100			
	330				FD4					
	BOTTOM OF HOLE									

WHB_LOG WHB.GPJ WHB.GDT 6/13/02

GEOLOGIC LOG OF DRILL HOLE NO. UE-25 RF#15

SHEET 7 OF 7

FEATURE: Waste Handling Building
 LOCATION: ESF North Portal Pad
 BEGUN: 8/30/2000 FINISHED: 9/11/2000
 DEPTH TO WATER: Not Encountered

PROJECT: Yucca Mountain Project
 COORDINATES: N 765,773.64 E 570,224.85
 TOTAL DEPTH: 330.0 ft.
 DEPTH TO BEDROCK: 5.0 ft.

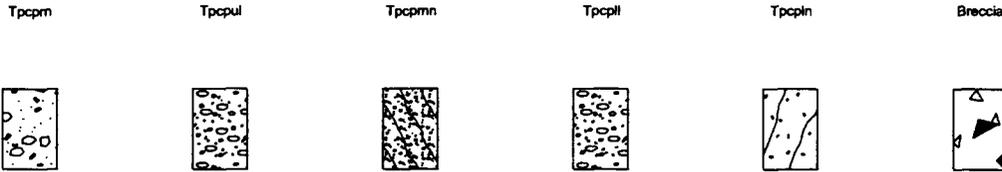
STATE: Nevada
 GROUND ELEVATION: 3680.98
 ANGLE FROM HORIZONTAL: -90°
 HOLE LOGGED BY: USBR/SMF
 REVIEWED BY: Mark McKeown

SOIL

Fill
(made ground)



ROCK



WELDING

Densely Welded



HARDNESS

Alpha-numeric descriptor	Descriptor	Criteria
H1	Extremely	Core, fragment, or exposure cannot be scratched with knife or sharp pick; can only be chipped with repeated heavy hammer blows.
H2	Very Hard	Cannot be scratched with knife or sharp pick. Core or fragment breaks with repeated heavy hammer blows.
H3	Hard	Can be scratched with knife or sharp pick with difficulty (heavy pressure). Heavy hammer blow required to break specimen.
H4	Moderately Hard	Can be scratched with knife or sharp pick with light pressure. Core or fragment breaks with moderate hammer blow.
H5	Moderately Soft	Can be grooved 1/16 inch (2mm) deep by sharp pick with moderate or heavy pressure. Core or fragment breaks with light hammer blow or heavy manual pressure.
H6	Soft	Can be grooved or gouged easily by knife or sharp pick with light pressure, can be scratched with fingernail. Breaks with light to moderate manual pressure.
H7	Very Soft	Can be readily indented, grooved or gouged with fingernail, or carved with a knife. Breaks with light manual pressure.

WEATHERING

Alpha-numeric descriptor	Descriptor	General characteristics (strength, excavation, etc.)
W1	Fresh	Hammer rings when crystalline rocks are struck. Almost always rock excavation except for naturally weak or weakly cemented rocks such as siltstones or shales.
W2	Slightly weathered to fresh	
W3	Slightly weathered	Hammer rings when crystalline rocks are struck. Body of rock not weakened. With few exceptions, such as siltstones or shales, classified as rock excavation.
W4	Moderately to slightly weathered	
W5	Moderately weathered	Hammer does not ring when rock is struck. Body of rock is slightly weakened. Depending on fracturing, usually is rock excavation except in naturally weak rocks such as siltstones or shales.
W6	Intensely to moderately weathered	
W7	Intensely weathered	Dull sound when struck with hammer, usually can be broken with moderate to heavy manual pressure or by light hammer blow without reference to planes of weakness such as incipient or hairline fractures, or veins etc. Rock is significantly weakened. Usually common excavation.
W8	Very intensely weathered	
W9	Decomposed	Can be granulated by hand. Always common excavation. Resistant minerals such as quartz may be present as "stringers" or "dikes".

FRACTURE DENSITY

Alpha-numeric descriptor	Descriptor	Criteria (Excludes mechanical breaks)
FD0	Unfractured	No observed fractures.
FD1	Very slightly fractured	Core recovered mostly in lengths greater than 3 feet (1 m).
FD2	Slightly to very slightly fractured	
FD3	Slightly fractured	Core recovered mostly in lengths from 1 to 3 feet (300 to 1,000 mm) with few scattered lengths less than 1 foot (300 mm) or greater than 3 feet (1,000 mm).
FD4	Moderately to slightly fractured	
FD5	Moderately fractured	Core recovered mostly in lengths from 0.33 to 1.0 foot (100 to 300 mm) with most lengths about 0.67 foot (200 mm).
FD6	Moderately to intensely fractured	
FD7	Intensely fractured	Lengths average from 0.1 to 0.33 foot (30 to 100 mm) with fragmented intervals. Core recovered mostly in lengths less than 0.33 foot (100 mm).
FD8	Very intensely to intensely fractured	
FD9	Very intensely fractured	Core recovered mostly as chips and fragments with a few scattered short core lengths.

RF15 KEY WHB.GPJ WHB.GDT 6/14/02

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GEOLOGIC LOG OF DRILL HOLE NO. UE-25 RF#16

SHEET 1 OF 9

FEATURE: Waste Handling Building
 LOCATION: ESF North Portal Pad
 BEGUN: 6/26/2000 FINISHED: 8/7/2000
 DEPTH TO WATER: Not Encountered

PROJECT: Yucca Mountain Project
 COORDINATES: N 765,055.54 E 570,472.65
 TOTAL DEPTH: 452.8 ft.
 DEPTH TO BEDROCK: 75.7 ft.

STATE: Nevada
 GROUND ELEVATION: 3672.03
 ANGLE FROM HORIZONTAL: -90
 HOLE LOGGED BY: USBR/SMF
 REVIEWED BY: Mark McKeown

NOTES	DEPTH	SHEAR WAVE VELOCITY Vs					ENGINEERING INDEXES				% CORE RECOVERY	% ROD	GEOLOGIC UNIT (USCS)	GRAPHIC	CLASSIFICATION AND PHYSICAL CONDITION	
		1000	2000	3000	4000	5000	HARDNESS	WELDING	FRACTURE DENSITY							
<p>PURPOSE OF HOLE: Develop geologic design data required for Waste Handling Building foundation parameters and seismic hazard analysis.</p> <p>DRILL EQUIPMENT: Schramm T685 Drill Rig, UDR 1000 Drill Rig</p> <p>DRILLER: G. Fox, M. Fyffe, D. Harrison; Dynatec Drilling, Inc., Salt Lake City, Utah</p> <p>DRILLING METHOD: Augered to approximately 3.5' where boulder was encountered. Pulled auger bit and installed 13.75" hammer bit. Continued with hammer to 4.9'. Cemented casing with 1.11' stickup. Re-entered hole with PQ coring system. Cored with PQ to 97.6'. Used PQ rods as casing and installed HQ coring system. Cored with HQ to the total depth of 452.8'.</p> <p>DRILLING CONDITIONS: 0.0 to 3.5: Hard, difficult drilling with augers in coarse material. 3.5 to 4.9: No problems reported. 4.9 to 66.0: Difficult drilling characterized by short runs, blocking off and often tripping out. 66.0 to 223.6: Easier drilling, less blocking off, longer runs. 223.6 to 452.8: Difficult drilling characterized by loss of circulation, blocking off, and short runs.</p> <p>DRILLING FLUID: 0 to 3.5: none 3.5 to 4.9: non-potable water 4.9 to 452.8: non-potable water, Hydrogel mud with EZ-Mud and LCM to re-establish circulation.</p> <p>DRILL FLUID LOSS INTERVALS: 11 ft. 51 ft. 164.6 ft. 166 ft. 227.5 ft. 233 ft. 237 ft. 245 ft. 250.4 ft. 252.5 ft. 277 ft. 278 ft.*</p> <p>* Remaining hole drilled without circulation</p>	5									0		Fill GP		<p>0.0 to 22.4 ft. PAD FILL (Fill)</p> <p>0.0 - 22.4: POORLY GRADED GRAVEL (GP) Predominately fine to coarse, hard, subangular gravel with a trace of nonplastic fines on gravel surfaces; derived from moderately to densely welded Tuff; approximately 50% have a spotty very light gray vapor phase coating; noncrystalline less than 2mm in thickness; maximum size recovered, 75mm.</p> <p>22.4 to 75.7 ft. QUATERNARY ALLUVIUM (Qal)</p> <p>22.4 - 25.9: POORLY GRADED SAND WITH SILT AND GRAVEL (SP-SM)g About 60% coarse to fine sand; about 30% coarse to fine, angular to subangular gravel of welded tuff and felsic phenocrysts, up to 30 x 30mm; about 10% silty fines; maximum size recovered, 50mm; brown with white caliche stringers; hard consistency; weakly cemented with caliche; weak reaction with HCl.</p> <p>25.9 - 33.8: POORLY GRADED GRAVEL WITH COBBLES (GP)c About 90% coarse to fine, hard, angular to subangular gravel of welded tuff, approximately 70% with spotty caliche coatings; about 10% fine to medium sand; several fine-grained caliche fragments; loosely cemented. Total interval (by volume) approximately 30% cobbles; maximum size recovered, 120mm.</p> <p>33.8 - 35.2: No Recovery</p> <p>35.2 - 38.1: SILTY SAND WITH GRAVEL AND COBBLES (SM)gc About 45% predominately fine to coarse, angular to subangular sand; about 35% fine to coarse, angular to subangular gravel of welded tuff; about 20% silty fines with no dry strength and low plasticity; brown; moist; strong reaction with HCl. Total interval (by volume) approximately 35% cobbles; maximum size recovered, 230mm.</p> <p>38.1 - 49.8: POORLY GRADED GRAVEL WITH SILT, SAND AND COBBLES (GP-GM)sc About 60% fine to coarse, angular to subangular gravel of welded tuff; about 30% fine to coarse, angular sand; about 10% silty fines with no to low dry strength; light brown; moist; no to strong reaction with HCl. Total interval (by volume) approximately 5% cobbles; maximum size recovered, 90mm.</p> <p>49.8 - 53.3: SILTY SAND WITH GRAVEL (SM)g About 45% fine to medium sand; about 40% fine to coarse, angular to subangular gravel of welded tuff; about 15% silty fines with low plasticity and low dry strength; maximum size recovered, 60mm; light brown; moist; weak to strong reaction with HCl.</p> <p>53.3 - 56.0: SILTY GRAVEL WITH SAND (GM)s About 55% fine to coarse, angular to subangular gravel of welded tuff; about 30% fine to coarse, angular sand; about 15% silty, nonplastic fines with low dry strength; maximum size recovered, 50mm; light brown; moist; strong reaction with HCl.</p> <p>56.0 - 60.4: SILTY SAND WITH GRAVEL (SM)g About 50% predominately fine to coarse, angular to subangular sand; about 35% fine to coarse, subangular gravel of Tiva Canyon Tuff clasts; about 15% silty fines with no to low plasticity and low dry strength; maximum size recovered, 70mm; light brown, white caliche bed from 58.7-59.0; moist; weak to strong reaction with HCl.</p> <p>60.4 - 66.0: SILTY GRAVEL WITH SAND (GM)s About 50% coarse to fine, angular to subangular gravel of Tiva Canyon Tuff clasts; about 35% predominately fine sand; about 15% silty fines with low plasticity and low dry strength; maximum size recovered, 75mm; strongly cemented with caliche, breaks</p>		
	10										10					
	15										18					
	20										0					
	25										0					
	30										100				Qal (SP-SM)g	
	35										31					
	40										0					
	45										0				Qal (GP)c	
	50										26					
	55										0					
	60										100				Qal (SM)gc	
	65										100					
70										58		Qal (GP-GM)sc				
75										35						
80										0						
85										91						
90										100						

- COMMENTS:
- All measurements are in feet unless noted otherwise.
 - No attempts to re-establish circulation were made below 278 ft.
 - LCM (Lost Circulation Material) consists of cellophane cuttings.
 - USCS classifications were determined in the field, where limited classification methods were available in order to keep samples intact for future tests.
 - Shear Wave Velocity data from GeoVision suspension logging. Data acquired from downhole survey conducted after PVC casing installed.
 - USCS soil classifications are based on USBR Earth Manual procedure 5005 - Determining Unified Soil Classification (Visual Method)

WHB LOG WHB.GPJ WHB.GDT 6/13/02

GEOLOGIC LOG OF DRILL HOLE NO. UE-25 RF#16

SHEET 2 OF 9

FEATURE: Waste Handling Building
 LOCATION: ESF North Portal Pad
 BEGUN: 6/26/2000 FINISHED: 8/7/2000
 DEPTH TO WATER: Not Encountered

PROJECT: Yucca Mountain Project
 COORDINATES: N 765,055.54 E 570,472.65
 TOTAL DEPTH: 452.8 ft.
 DEPTH TO BEDROCK: 75.7 ft.

STATE: Nevada
 GROUND ELEVATION: 3672.03
 ANGLE FROM HORIZONTAL: -90
 HOLE LOGGED BY: USBR/SMF
 REVIEWED BY: Mark McKeown

NOTES	DEPTH	SHEAR WAVE VELOCITY ft/s	ENGINEERING INDEXES			% CORE RECOVERY	% ROD	GEOLOGIC UNIT (USCS)	GRAPHIC	CLASSIFICATION AND PHYSICAL CONDITION																																																															
			HARDNESS	WELDING	FRACTURE DENSITY																																																																				
<p>CASING RECORD: 0 to 4.9: 10.75" O.D. casing 0 to 97.6: PQ casing 97.6 to 452.8: No casing</p> <p>HOLE COMPLETION: Pulled all casing and left open for future geophysical studies.</p>	0					70			only with hammer blow; light brown to pale orange; moist; strong reaction with HCl.																																																																
	55					87	Qal (SM)g		66.0 - 75.7: SILTY SAND WITH GRAVEL (SM)g About 45% predominately fine sand; about 35% coarse to fine, angular to subangular gravel of welded Tiva Canyon Tuff and Tuff X; about 20% silty fines; maximum size recovered, 60mm; strongly cemented with caliche, breaks only with hammer blow; light brown to pale orange; moist; strong reaction with HCl.																																																																
	60					100	Qal (GM)s		75.7 to 133.2 ft. COMBS PEAK IGNIMBRITE - TUFF X (Tpki): Nonwelded flow, moderately indurated, argillized and partially zeolitized, very pale orange with grayish-orange mottling. The tuff has approximately 20-25% pumice, up to 35x30mm in size, with about 10-15% volcanic lithic clasts, up to 25x25mm. Rare phenocrysts of sanidine, biotite (bronze), magnetite (?), and manganese oxides. Generally the tuff is moderately hard (H4) to soft (H6), slightly (W3) to moderately (W5) weathered, and unfractured (FD0) to slightly fractured (FD2). Lower contact is unconformable.																																																																
	65					83	Qal (SM)g																																																																		
	70					100	Qal (GM)s		133.2 to 137.8 ft. POST TIVA CANYON BEDDED TUFFS (Tpbt5): Nonwelded, possibly reworked fallout tephra and pyroclastic flows separated by distinct paleosols. The tuff is moderately indurated, devitrified, pale yellowish-brown with 10 to 15 percent pumice clasts (up to 10x7mm), and less than 10 percent volcanic lithic clasts (up to 4x5 mm). The bedded tuffs have about 2 percent phenocrysts of feldspar, quartz, and biotite. Generally the tuff is moderately hard (H4) to soft (H6), slightly (W3) to moderately (W6) weathered, and unfractured (FD0) to slightly fractured (FD3). Lower contact is unconformable.																																																																
	75					100	Qal (SM)g																																																																		
	80						73		137.8 to 222.0 ft. TIVA CANYON TUFF CRYSTAL RICH NON-LITHOPHYSAL ZONE (Tpcrn) Pyroclastic flow, densely welded, devitrified, pale red to grayish-red, with 10 to 15 percent phenocrysts. Phenocrysts are mostly feldspar and biotite with lesser quartz and pyroxene. Rare pumice clasts from 145.9 to 157.1 feet, and up to 20 percent pumice clasts from 157.1 to 192.0 feet. The tuff has up to 15 percent lithophysal cavities from 192.0 to 208.0 feet. Generally the tuff is moderately hard (H4), slightly (W3) weathered, and slightly fractured (FD3) to moderately fractured (FD5). The lower contact is conformable.																																																																
	85					100	Qal (GM)s																																																																		
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WHB LOG WHB.GPJ WHB.GDT 6/13/02

GEOLOGIC LOG OF DRILL HOLE NO. UE-25 RF#16

SHEET 3 OF 9

FEATURE: Waste Handling Building
 LOCATION: ESF North Portal Pad
 BEGUN: 6/26/2000 FINISHED: 8/7/2000
 DEPTH TO WATER: Not Encountered

PROJECT: Yucca Mountain Project
 COORDINATES: N 765,055.54 E 570,472.65
 TOTAL DEPTH: 452.8 ft.
 DEPTH TO BEDROCK: 75.7 ft.

STATE: Nevada
 GROUND ELEVATION: 3672.03
 ANGLE FROM HORIZONTAL: -9D
 HOLE LOGGED BY: USBR/SMF
 REVIEWED BY: Mark McKeown

NOTES	DEPTH	SHEAR WAVE VELOCITY ft/s	ENGINEERING INDEXES			% CORE RECOVERY	% ROD	GEOLOGIC UNIT (USCS)	GRAPHIC	CLASSIFICATION AND PHYSICAL CONDITION			
			HARDNESS	WELDING	FRACTURE DENSITY					R3	R4	clay	trace clay
	110									169.7	80	R3	clay
										169.8	60	R3	clay
										170.1	60	R3	clay, sand
										170.6	90	R3	clay, sand
										171.2	15	R3	sand
										171.0-174.6		FRACTURE ZONE	
										174.6	55	R4	trace clay
										175.1	60	R4	none
										176.0	15	R4	sand
										176.8	50	R3	healed
										177.8	20	R3	clay, sand
										179.3	30	R4	clay, sand
										179.4	80	R4	sand
										179.7	55	R4	trace clay, sand
										180.9	20	R2	clay, sand
										185.2	40	R3	trace clay
										185.6	40	R3	sand, trace clay
										187.4	30	R3	trace clay
										187.9	60	R3	trace sand
										188.1	55	R3	sand
										188.5	20	R3	sand, trace clay
										189.0	55	R3	sand
										190.6	65	R3	vapor phase alteration
										191.2	65	R3	none
										191.8	40	R3	none
										192.0	35	R3	none
										193.3	45	R4	none
										193.9	45	R4	trace sand
										197.3	30	R4	none
										197.4	30	R3	none
										197.6	25	R3	clay
										198.1	60	R3	clay
										198.9	25	R4	clay
										199.4	55	R4	none
										203.4	50	R3	sand
										203.8	50	R3	none
										204.0	40	R3	none
										204.7	35	R3	trace sand
										204.9	30	R3	trace sand
										203.4-203.6	25	R3	none
										203.6	90	R2	none
										204.1	90	R3	none
										204.2	90	R3	none
										204.6	50	R2	none
										204.7-204.9	30	R2	none
										205.7	45	R3	none
										206.8	45	R3	none
										206.8-207.3		FRACTURE ZONE	
										208.2-208.9		FRACTURE ZONE	
										209.3	irreg.	R2	none
										210.3	70	R2	none
										210.5-210.7	10	R3	none
										212.1-212.2	30	R2	none
										213.7	45	R3	quartz crystals
										216.1	75	R3	quartz crystals
										221.0-221.3	25	R4	trace Calcite
										221.1-221.3	35	R2	none
										222.0 to 360.0 ft. TIVA CANYON TUFF CRYSTAL POOR UPPER LITHOPHYSAL ZONE (Tpcpu)			
										Pyroclastic flow, densely welded, moderate orange-pink with light gray mottling, and about 3-5% lithophysae (up to 50x50mm) with light gray crystal coating. Tuff has approximately 5 percent pumice clasts (up to 10x4mm). There are less than 5 percent phenocrysts of plagioclase and sanadine, with less than 1 percent biotite and manganese oxide. At 247.0 the phenocrysts content decreases to less than 1 percent. Lithophysae, both filled and unfilled, content increases to 20 percent at 301.0 feet. Generally the tuff is moderately hard (H4), slightly (W4) to moderately weathered (W6), and slightly fractured (FD3) to very intensely fractured (FD9). The lower contact is conformable.			
										Discontinuity Measurements:			
										Depth	Angle*	Roughness	Infilling
										221.8-224.9		FRACTURE ZONE	
										225.4	55	R4	trace Calcite
										225.4-225.8		FRACTURE ZONE	
										225.8-226.0	10	R4	trace Calcite
										226.1	70	R3	none
										226.1-226.7		FRACTURE ZONE	
										226.7-226.8	40	R3	none
										226.9-227.0		FRACTURE ZONE	
										227.0-227.2	40	R3	none
										227.3	80	R2	none

WHB LOG WHB.GPJ WHB.GDT 6/13/02

GEOLOGIC LOG OF DRILL HOLE NO. UE-25 RF#16

SHEET 4 OF 9

FEATURE: Waste Handling Building
 LOCATION: ESF North Portal Pad
 BEGUN: 6/26/2000 FINISHED: 8/7/2000
 DEPTH TO WATER: Not Encountered

PROJECT: Yucca Mountain Project
 COORDINATES: N 765,055.54 E 570,472.65
 TOTAL DEPTH: 452.8 ft.
 DEPTH TO BEDROCK: 75.7 ft.

STATE: Nevada
 GROUND ELEVATION: 3672.03
 ANGLE FROM HORIZONTAL: -90
 HOLE LOGGED BY: USBR/SMF
 REVIEWED BY: Mark McKeown

NOTES	DEPTH	SHEAR WAVE VELOCITY ft/s	ENGINEERING INDEXES			GEOLOGIC UNIT (USCS)	GRAPHIC	CLASSIFICATION AND PHYSICAL CONDITION					
			HARDNESS	WELDING	FRACTURE DENSITY			% CORE RECOVERY	% ROD				
	170				FD4			227.7-227.8	90	R3	white mineral		
								228.0-228.6	15	R3	none		
								229.2	60	R3	none		
					97	44		229.2-229.6	20	R3	none		
								230.7-230.9	55	R2	none		
								231.1	90	R2	none		
								231.1-231.5		FRACTURE ZONE			
								231.8	45	R2	trace quartz crystals		
								231.8-232.3		FRACTURE ZONE			
								232.3	60	R3	trace quartz crystals		
								233.0-233.2	45	R3	quartz crystals		
								235.0-235.1	45	R3	trace Calcite		
					100	58		235.8	50	R2	none		
								235.7-236.3	15	R3	none		
								235.9-236.3	25	R3	trace Calcite		
								236.1-236.3	25	R3	none		
								237.9	45	R2	none		
								238.7-238.9	15-20	R2	quartz crystals		
								239.2	70	R2	quartz crystals		
								239.8	60	R2	quartz crystals		
								240.0	60	R3	none		
								240.2	50	R2	trace iron oxide		
								240.4	70	R3	none		
					100	74		240.4-241.1	10-15	R3	none		
								241.2-241.7	15	R3	none		
								241.8-243.8		FRACTURE ZONE			
								244.5-244.7	20	R2	trace Calcite		
								246.8	15	R2	none		
								248.6	20	R3	trace white mineral		
								248.9	25	R3	trace white mineral		
								249.7	30	R3	none		
								251.8	5	R3	none		
								252.5	10	R3	none		
								255.4	10	R2	none		
								255.8	15	R2	none		
								256.4	75	R2	lithophysal		
								257.5	40	R3	trace sand		
								259.5	30	R2	none		
								261.1	50	R3	none		
								263.5	80	R3	none		
								264.5	20	R2	none		
								265.9	15	R3	sand, trace clay		
								266.4	60	R3	none		
								266.9	30	R3	clay		
								269.0	20	R3	sandy breccia		
								272.9-277.3		FRACTURE ZONE			
								277.4	0	R4	none		
								278.6	10	R3	none		
								279.1	50	R4	none		
								279.2	40	R4	none		
								279.5	25	R3	none		
								280.6-284.4		FRACTURE ZONE			
								284.4-284.6	20	R3	none		
								284.6-284.8	45	R2	none		
								286.3-286.6	35	R3	quartz crystals		
								287.7	55	R4	clay, quartz crystals		
								289.3-290.0	0	R3	none		
								291.8	35	R3	clayey breccia		
								292.8	90	R3	clayey breccia		
								293.0	30	R3	clay		
								294.7	90	R2	clayey breccia		
								294.9	60	R2	clayey breccia		
								297.3-297.8	15	R3	trace Calcite		
								297.6	70	R3	none		
								298.0	60	R2	clayey breccia		
								298.2	80	R3	none		
								298.9-302.5		FRACTURE ZONE			
								301.5	45	R3	quartz crystals		
								303.1	35	R3	trace clay		
								305.0-313.7		FRACTURE ZONE			
								308.6-309.1	15	R3	none		
								310.4-310.7	20	R2	clayey breccia		
								310.2-310.5	30	R2	clayey breccia		
								312.4-312.6	30	R4	trace clay		
								314.4-314.8	20	R3	none		
								315.2	45	R4	none		
								315.6-316.0	25	R3	none		
								318.4	50	R2	quartz crystals		
								322.0-322.2	20	R2	none		
								323.4-324.0	30	R2	clayey breccia		
								324.3-325.1	10	R3	clayey breccia		
								324.7-325.3	25	R3	clayey breccia		
								324.9-325.6	0	R3	clayey breccia		
								325.2-325.9	20	R2	clayey breccia		
								326.1-327.3		FRACTURE ZONE			

WHB LOG WHB.GPJ WHB.GDT 6/13/02

GEOLOGIC LOG OF DRILL HOLE NO. UE-25 RF#16

SHEET 5 OF 9

FEATURE: Waste Handling Building
 LOCATION: ESF North Portal Pad
 BEGUN: 6/26/2000 FINISHED: 8/7/2000
 DEPTH TO WATER: Not Encountered

PROJECT: Yucca Mountain Project
 COORDINATES: N 765,055.54 E 570,472.65
 TOTAL DEPTH: 452.8 ft.
 DEPTH TO BEDROCK: 75.7 ft.

STATE: Nevada
 GROUND ELEVATION: 3672.03
 ANGLE FROM HORIZONTAL: -90
 HOLE LOGGED BY: USBR/SMF
 REVIEWED BY: Mark McKeown

NOTES	DEPTH	SHEAR WAVE VELOCITY ft/s		ENGINEERING INDEXES			GEOLOGIC UNIT [USCS]	GRAPHIC	CLASSIFICATION AND PHYSICAL CONDITION
		1000	2000	HARDNESS	WELDING	FRACTURE DENSITY			
	230					FD6	84	26	327.3 35 R2 none
						FD7	86	32	330.8-332.0 CLAYEY BRECCIA ZONE
									333.6 50 R3 none
									332.7-333.3 20 R3 quartz, Calcite
									332.9 50 R3 none
									334.7-335.9 0 R2 quartz crystals
									335.1 50 R3 trace clay
									335.5 75 R3 none
									335.6 55 R3 none
						FD5	100	48	336.1-337.3 FRACTURE ZONE
									337.9 40 R2 clayey breccia
									338.0-338.4 CLAYEY BRECCIA ZONE
									338.4 40 R3 none
									338.5-338.7 30 R3 none
									338.6 45 R3 none
									339.5-340.8 FRACTURE ZONE
						FD6	100	32	341.7-345.3 FRACTURE ZONE
									346.0 60 R2 trace quartz
									346.2-347.0 10 R3 none
						FD8	92	0	346.4-346.8 0 R4 none
									346.5-346.9 10 R4 none
									346.8 80 R3 none
						FD5	89	61	347.3-348.6 FRACTURE ZONE
									348.3-348.7 20 R3 clayey breccia
									348.7 40 R3 none
									349.2-349.7 15 R3 none
									349.0-349.4 20 R3 none
						FD8	93	0	350.9 30 R3 none
									351.0 60 R3 trace Calcite
									351.1-351.2 0 R3 clay
									351.6-352.8 FRACTURE ZONE
									354.3-356.1 FRACTURE ZONE
						FD6	95	0	356.4 50 R3 trace Calcite
									356.5 85 R3 none
									356.5-356.7 30 R3 trace Calcite
						FD8	76	16	356.8-357.3 0 R3 none
									358.4 60 R2 clay, Calcite
									358.5 60 R2 Calcite
									358.7-359.0 20 R4 clay, quartz, Calcite
									358.9 80 R3 quartz, Calcite
						FD5	94	63	359.6 70 R3 iron oxide, Calcite
	260								360.0 to 403.0 ft. TIVA CANYON TUFF MIDDLE
									NON-LITHOPHYSAL ZONE (Tpcpmn)
									Pyroclastic flow, densely welded, predominately pale red tuff with less than 5% flattened pumice, and less than 1% lithophysae. The tuff has less than 1 percent phenocrysts of plagioclase, sanidine, and rare manganese oxide. Volcanic lithic content increases with depth with poorly developed anastomosing vapor phase partings. Generally the tuff is moderately hard (H4) to moderately soft (H5) in isolated zones, slightly (W3) to moderately weathered (W5), and slightly fractured (FD3) to intensely fractured (FD8).
									Discontinuity Measurements:
									Depth Angle* Roughness Infilling
									360.1-360.4 40 R3 iron oxide, Calcite
									360.5 85 R2 breccia, Calcite
									360.6-360.9 40 R3 Calcite
									360.7 65 R3 clay, Calcite
									361.2 85 R2 quartz, Calcite
									362.0 30 R4 Calcite
									362.2-362.5 25 R4 none
									363.1 90 R3 none
									364.0 70 R2 none
									364.9-365.2 30 R4 trace Calcite
									365.5 80 R4 none
									367.2 85 R2 none
									372.9 70 R3 clay, quartz
									373.1 90 R2 clay, quartz, Calcite
									373.2-373.7 25 R3 quartz, Calcite
									375.3 60 R3 trace quartz
									375.8 60 R3 clay
									376.5-376.9 20 R4 none
									377.0-377.3 25 R3 none
									377.4-377.7 30 R3 none
									379.7-381.2 0 R4 none
									380.8 20 R3 quartz, Calcite
									381.2 90 R3 trace quartz
									381.4-381.6 30 R3 trace quartz, Calcite
									382.8-383.2 20 R4 none
									383.3-383.7 CLAYEY BRECCIA ZONE
									383.8-384.2 20 R4 none
									384.3 50 R3 trace quartz

WHB LOG WHB.GPJ WHB.GDT 6/13/02

GEOLOGIC LOG OF DRILL HOLE NO. UE-25 RF#16

SHEET 6 OF 9

FEATURE: Waste Handling Building
 LOCATION: ESF North Portal Pad
 BEGUN: 6/26/2000 FINISHED: 8/7/2000
 DEPTH TO WATER: Not Encountered

PROJECT: Yucca Mountain Project
 COORDINATES: N 765,055.54 E 570,472.65
 TOTAL DEPTH: 452.8 ft.
 DEPTH TO BEDROCK: 75.7 ft.

STATE: Nevada
 GROUND ELEVATION: 3672.03
 ANGLE FROM HORIZONTAL: -90
 HOLE LOGGED BY: USBR/SMF
 REVIEWED BY: Mark McKeown

NOTES	DEPTH	SHEAR WAVE VELOCITY ft/s	ENGINEERING INDEXES			GEOLOGIC UNIT (USCS)	GRAPHIC	CLASSIFICATION AND PHYSICAL CONDITION
			HARDNESS	WELDING	FRACTURE DENSITY			
	290				FD3	100	52	385.2-385.4 30 R3 clay, trace quartz
								385.5-386.5 FRACTURE ZONE
					FD4	97	59	386.5-386.9 10 R3 trace quartz, trace Calcite
								388.4-389.5 CLAYEY BRECCIA ZONE
								393.1 55 R3 quartz, Calcite
								393.8 45 R4 quartz, Calcite
								394.3 30 R3 clay, quartz, Calcite
								395.0-395.5 30 R3 trace quartz, Calcite
								395.8 70 R3 quartz, trace Calcite
					FD9	87	0	396.2-396.4 30 R3 quartz, Calcite
								397.2 45 R3 clay
								397.7-398.1 25 R2 none
								398.2-398.6 40 R3 none
					FD7	92	0	398.6 40 R3 clayey breccia
								398.7 60 R2 trace Calcite
								399.3 60 R3 trace Calcite
								399.7-399.9 30 R3 none
					FD8	33	0	400.2 85 R3 trace quartz, Calcite
								401.0 40 R3 breccia, quartz, Calcite
								402.3 50 R4 quartz, Calcite
								402.7 90 R2 none
					FD3	100	48	403.0 to 422.5 ft. TIVA CANYON TUFF CRYSTAL POOR LOWER LITHOPHYSAL ZONE (Tpcpl)
								Pyroclastic flow, densely welded, devitrified, moderate orange pink tuff with rare light gray pumice, phenocrysts of sanidine and rare biotite compose less than 1 percent of the rock by volume. Lithophysal cavities compose up to 10 percent of the rock by volume with vapor phase mineral coatings, additionally 10 percent of the rock contains light gray vapor phase mineral spots up to 30 by 48 mm in size. Generally the tuff is hard (H3), slightly weathered (W3), and slightly to very slightly fractured (FD2). Lower contact is conformable.
								Discontinuity Measurements:
								Depth Angle° Roughness Infilling
								403.0-403.4 30 R2 quartz, Calcite
								404.0 70 R3 quartz, Calcite
								404.3-406.0 5 R2 quartz, Calcite
								404.6 80 R2 none
								405.9-406.2 35 R3 quartz, Calcite
								406.4-406.7 25 R3 none
								406.4-407.6 5 R2 none
								408.3 60 R3 trace quartz
								409.2 60 R3 none
								409.5-409.8 25 R3 trace quartz, Calcite
								410.2-410.6 5 R3 clay, quartz, Calcite
								410.6-411.7 FRACTURE ZONE
								415.7 55 R2 clay, quartz, Calcite
								416.0-416.5 15 R2 clayey breccia, quartz
								418.8-419.7 FRACTURE ZONE
								422.5 to 452.8 ft. TIVA CANYON TUFF CRYSTAL POOR LOWER NON-LITHOPHYSAL ZONE (Tpcpln)
								Pyroclastic flow, densely welded, devitrified, pale red tuff with less than 1 percent light gray pumice clasts. Phenocrysts of sanidine and plagioclase compose less than 1 percent of the rock by volume. Medium gray lithic clasts compose less 1 percent of the rock by volume. Generally the tuff is moderately hard (H4), slightly weathered (W3), with fracture densities mostly moderately fractured (FD5) to intensely fractured (FD7) zones. Lower contact undetermined, bottom of borehole at 452.8 ft.
								Discontinuity Measurements:
								Depth Angle° Roughness Infilling
								422.9-423.6 5 R3 clayey breccia, quartz, iron oxide, Calcite
								424.3-424.6 20 R4 quartz, Calcite
								424.6-424.9 10 R3 quartz, Calcite
								424.7-425.1 40 R4 quartz, Calcite
								425.5-425.8 30 R4 Calcite, trace iron oxide
								426.2-429.2 FRACTURE ZONE
								429.8 30 R4 trace Calcite, trace iron oxide
								430.1-430.8 10 R3 trace Calcite
								430.6-431.3 20 R3 quartz, Calcite
								430.8 45 R4 Calcite, trace iron oxide
								431.0-431.6 0-25 R2 quartz, Calcite
								431.5-441.7 FRACTURE ZONE
								435.5-435.8 20 R4 trace Calcite, trace iron oxide
								435.4 60 R3 trace Calcite
								436.3 45 R4 Calcite, trace iron oxide

WHB LOG WHB.GPJ WHB.GDT 6/13/02

GEOLOGIC LOG OF DRILL HOLE NO. UE-25 RF#16

SHEET 7 OF 9

FEATURE: Waste Handling Building
 LOCATION: ESF North Portal Pad
 BEGUN: 6/26/2000 FINISHED: 8/7/2000
 DEPTH TO WATER: Not Encountered

PROJECT: Yucca Mountain Project
 COORDINATES: N 765,055.54 E 570,472.65
 TOTAL DEPTH: 452.8 ft.
 DEPTH TO BEDROCK: 75.7 ft.

STATE: Nevada
 GROUND ELEVATION: 3672.03
 ANGLE FROM HORIZONTAL: -90
 HOLE LOGGED BY: USBR/SMF
 REVIEWED BY: Mark McKeown

NOTES	DEPTH	SHEAR WAVE VELOCITY Vs		ENGINEERING INDEXES			GEOLOGIC UNIT [USCS]	GRAPHIC	CLASSIFICATION AND PHYSICAL CONDITION	
				HARDNESS	WELDING	FRACTURE DENSITY				% CORE RECOVERY
	350					FD7	85	0	Tpcpul	437.8-438.1 25 R4 trace Calcite, trace iron oxide
						FD6	85	0		438.1 45 R3 trace quartz, trace Calcite,
						FD7	80	0		trace iron oxide
						FD8	83	0		438.1-438.3 20 R3 trace Calcite
						FD5	73	47		438.9 90 R3 Calcite
						FD9	56	0		441.3-441.5 25 R3 clayey breccia
										441.8 60 R3 Calcite
										442.0-442.3 40 R3 none
										443.1 35 R2 none
										443.3-443.7 20 R3 quartz, Calcite, trace iron oxide
										443.7-443.9 FRACTURE ZONE
						FD7	95	0		446.4 45 R3 none
										449.4-450.0 5-30 R3 trace quartz, Calcite, trace iron oxide
										449.9 80 R3 clayey breccia
										449.9-452.8 CLAYEY BRECCIA ZONE
						FD6	100	25		
						FD5	100	67		
				H4		FD4	100	89		
						FD3	100	55		
						FD5				
						FD4	94	56	Tpcpmn	
						FD6	89	0		
				H5		FD7	100	0		
						FD3	100	78		
						FD5	100	63		
							90	0		
						FD6	100	0	Tpcpl	

* Angles are measured from core axis and are plus or minus 5 degrees.

WHB_LOG_WHB.GPJ_WHB.GDT_6/13/02

GEOLOGIC LOG OF DRILL HOLE NO. UE-25 RF#16

SHEET 8 OF 9

FEATURE: Waste Handling Building
 LOCATION: ESF North Portal Pad
 BEGUN: 6/26/2000 FINISHED: 8/7/2000
 DEPTH TO WATER: Not Encountered

PROJECT: Yucca Mountain Project
 COORDINATES: N 765,055.54 E 570,472.65
 TOTAL DEPTH: 452.8 ft.
 DEPTH TO BEDROCK: 75.7 ft.

STATE: Nevada
 GROUND ELEVATION: 3672.03
 ANGLE FROM HORIZONTAL: -90
 HOLE LOGGED BY: USBR/SMF
 REVIEWED BY: Mark McKeown

NOTES	DEPTH	SHEAR WAVE VELOCITY ft/s	ENGINEERING INDEXES			GEOLOGIC UNIT [USCS]	GRAPHIC	CLASSIFICATION AND PHYSICAL CONDITION
			HARDNESS	WELDING	FRACTURE DENSITY			
	410				FD6			
					FD7	100	24	
	415				FD3	95	81	Tpcpl
						100	56	
	420				FD9	100	0	
					FD3	90	43	
	425				FD5	98	41	
						58	0	
	430				FD8	100	0	
						70	0	
					FD7	100	50	
					FD5			
					FD7	89	0	
	435					80	0	
						100	0	
					FD8	92	0	Tpcpln
						100	0	
						92	0	
	440				FD9	100	0	
					FD6	100	31	
	445							
					FD3	96	59	
	450				FD7			
						90	0	
BOTTOM OF HOLE								

WHB_LOG_WHBS.GPJ WHB.GDT 6/13/02

GEOLOGIC LOG OF DRILL HOLE NO. UE-25 RF#16

SHEET 9 OF 9

FEATURE: Waste Handling Building
 LOCATION: ESF North Portal Pad
 BEGUN: 6/26/2000 FINISHED: 8/7/2000
 DEPTH TO WATER: Not Encountered

PROJECT: Yucca Mountain Project
 COORDINATES: N 765,055.54 E 570,472.65
 TOTAL DEPTH: 452.8 ft.
 DEPTH TO BEDROCK: 75.7 ft.

STATE: Nevada
 GROUND ELEVATION: 3672.03
 ANGLE FROM HORIZONTAL: -90°
 HOLE LOGGED BY: USBR/SMF
 REVIEWED BY: Mark McKeown

USCS
Poorly-graded
Gravel
(GP)



USCS
Poorly-graded
Sand with
Silt
(SP-SM)



SOIL

USCS
Silty Sand
(SM)



USCS
Poorly-graded
Gravel with
Silt
(GP-GM)



USCS
Silty Gravel
(GM)



ROCK

Tuff "x"
(Tpki)



Post Tiva
Canyon
Bedded
Tuff
(Tpbt5)



Tpcpm



Tpcpul



Tpcpmn



Tpcpll



Tpcph



WELDING

Non-Welded



Densely Welded



HARDNESS

Alpha-numeric descriptor	Descriptor	Criteria
H1	Extremely	Core, fragment, or exposure cannot be scratched with knife or sharp pick; can only be chipped with repeated heavy hammer blows.
H2	Very Hard	Cannot be scratched with knife or sharp pick. Core or fragment breaks with repeated heavy hammer blows.
H3	Hard	Can be scratched with knife or sharp pick with difficulty (heavy pressure). Heavy hammer blow required to break specimen.
H4	Moderately Hard	Can be scratched with knife or sharp pick with light pressure. Core or fragment breaks with moderate hammer blow.
H5	Moderately Soft	Can be grooved 1/16 inch (2mm) deep by sharp pick with moderate or heavy pressure. Core or fragment breaks with light hammer blow or heavy manual pressure.
H6	Soft	Can be grooved or gouged easily by knife or sharp pick with light pressure, can be scratched with fingernail. Breaks with light to moderate manual pressure.
H7	Very Soft	Can be readily indented, grooved or gouged with fingernail, or carved with a knife. Breaks with light manual pressure.

WEATHERING

Alpha-numeric descriptor	Descriptor	General characteristics (strength, excavation, etc.)
W1	Fresh	Hammer rings when crystalline rocks are struck. Almost always rock excavation except for naturally weak or weakly cemented rocks such as siltstones or shales.
W2	Slightly weathered to fresh	
W3	Slightly weathered	Hammer rings when crystalline rocks are struck. Body of rock not weakened. With few exceptions, such as siltstones or shales, classified as rock excavation.
W4	Moderately to slightly weathered	
W5	Moderately weathered	Hammer does not ring when rock is struck. Body of rock is slightly weakened. Depending on fracturing, usually is rock excavation except in naturally weak rocks such as siltstones or shales.
W6	Intensely to moderately weathered	
W7	Intensely weathered	Dull sound when struck with hammer, usually can be broken with moderate to heavy manual pressure or by light hammer blow without reference to planes of weakness such as incipient or hairline fractures, or veinlets. Rock is significantly weakened. Usually common excavation.
W8	Very intensely weathered	
W9	Decomposed	Can be granulated by hand. Always common excavation. Resistant minerals such as quartz may be present as "stringers" or "dikes".

FRACTURE DENSITY

Alpha-numeric descriptor	Descriptor	Criteria (Excludes mechanical breaks)
FD0	Unfractured	No observed fractures.
FD1	Very slightly fractured	Core recovered mostly in lengths greater than 3 feet (1 m).
FD2	Slightly to very slightly fractured	
FD3	Slightly fractured	Core recovered mostly in lengths from 1 to 3 feet (300 to 1,000 mm) with few scattered lengths less than 1 foot (300 mm) or greater than 3 feet (1,000 mm).
FD4	Moderately to slightly fractured	
FD5	Moderately fractured	Core recovered mostly in lengths from 0.33 to 1.0 foot (100 to 300 mm) with most lengths about 0.67 foot (200 mm).
FD6	Moderately to intensely fractured	
FD7	Intensely fractured	Lengths average from 0.1 to 0.33 foot (30 to 100 mm) with fragmented intervals. Core recovered mostly in lengths less than 0.33 foot (100 mm).
FD8	Very intensely to intensely fractured	
FD9	Very intensely fractured	Core recovered mostly as chips and fragments with a few scattered short core lengths.

RF16 KEY WHB.GPJ WHB.GDT 6/14/02

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GEOLOGIC LOG OF DRILL HOLE NO. UE-25 RF#17

SHEET 1 OF 13

FEATURE: Waste Handling Building
 LOCATION: ESF North Portal Pad
 BEGUN: 6/27/2000 FINISHED: 8/29/2000
 DEPTH TO WATER: Not Encountered

PROJECT: Yucca Mountain Project
 COORDINATES: N 766,075.86 E 571,041.88
 TOTAL DEPTH: 667.8 ft.
 DEPTH TO BEDROCK: 96.1 ft.

STATE: Nevada
 GROUND ELEVATION: 3672.38
 ANGLE FROM HORIZONTAL: -90
 HOLE LOGGED BY: USBR/SMF
 REVIEWED BY: Mark McKeown

NOTES	DEPTH	ENGINEERING INDEXES			% CORE RECOVERY	% ROD	GEOLOGIC UNIT [USCS]	GRAPHIC	CLASSIFICATION AND PHYSICAL CONDITION
		SHEAR WAVE VELOCITY V_s	HARDNESS	WELDING					
<p>PURPOSE OF HOLE: Acquire geologic design data required to develop Waste Handling Building foundation parameters and seismic hazard analysis.</p> <p>DRILL EQUIPMENT: Schramm T885 Drill Rig, UDR 1000 Drill Rig</p> <p>DRILLER: G. Fox, D. Harrison; Dynatec Drilling, Inc.; Salt Lake City, Utah.</p> <p>DRILLING METHOD: Installed 12" hammer. Hammered to 4.9'. Cemented casing with 1.1' stickup. Re-entered hole on 8/7/2000 with PQ coring system. Cored with PQ to 195.3'. Used PQ rods as casing and installed HQ coring system. Cored with HQ to the total depth of 667.8'.</p> <p>DRILLING CONDITIONS: 0.0 to 187.8: Replaced 3 bits, lost circulation at 47.8' and 175.3'. 187.8 to 667.8: No circulation, hard, smooth drilling.</p> <p>DRILLING FLUID: 0.0 to 4.9: non-potable water 4.9 to 667.8: non-potable water, Quik Gel mud with EZ-Mud and LCM to re-establish circulation.</p> <p>LOSS INTERVALS: 47.8 ft. 175.3 ft. 187.5 ft.*</p> <p>* Remaining hole drilled without circulation</p> <p>CASING RECORD: 0.0 to 4.9: 10.75 O.D. casing 0.0 to 195.3: PQ casing 195.3 to 667.8: No casing</p> <p>HOLE COMPLETION: Pulled all casing and left open for future geophysical studies.</p>	1000 2000 3000 4000 5000 6000 7000 8000 9000							<p>0.0 to 96.1 ft. QUATERNARY ALLUVIUM (Qal)</p> <p>0.0 - 5.0: No Recovery</p> <p>5.0 - 7.1: POORLY GRADED GRAVEL WITH SAND (GP)_s About 75% coarse to fine, angular gravel; about 20% predominately fine to medium sand; about 5% silty fines; maximum size recovered, 65mm; slightly to moderately cemented with caliche; light brown; moist; strong reaction with HCl.</p> <p>7.1 - 14.2: POORLY GRADED GRAVEL WITH SILT AND SAND (GP-GM)_s About 60% gap graded fine and coarse, angular to subangular gravel; about 30% coarse to fine sand; 10% fines with low plasticity; maximum size recovered, 70mm; non-cemented to moderately cemented with caliche; light brown; moist; weak to strong reaction with HCl.</p> <p>14.2 - 22.2: POORLY GRADED GRAVEL WITH COBBLES (GP)_c About 85% predominately coarse and fine, angular to subangular gravel of densely welded tuff with some caliche coating; about 10% predominately fine sand; about 5% fines with low plasticity; non-cemented to slightly cemented with caliche; light brown, maroon and gray; moist; strong reaction with HCl. Total interval (by volume) approximately 10% cobbles; maximum size recovered, 120mm.</p> <p>22.2 - 25.5: POORLY GRADED GRAVEL WITH SILT AND SAND (GP-GM)_s About 60% coarse to fine, angular gravel; about 30% fine to coarse, predominately angular sand; about 10% fines with low plasticity; maximum size recovered, 65mm; non-cemented to slightly cemented with caliche; light brown to gray; moist; strong reaction with HCl.</p> <p>25.5 - 28.4: WELL GRADED GRAVEL (GW) Almost entirely coarse to fine, angular to subangular, well graded gravel; trace of sand and fines that appear to be washed out; maximum size recovered, 65mm; non-cemented; light brown, gray, white and maroon; moist.</p> <p>28.4 - 32.9: POORLY GRADED GRAVEL WITH COBBLES (GP)_c About 85% coarse to fine, angular to subangular, poorly graded gravel; about 10% predominately coarse to fine, angular sand; about 5% silty fines; non-cemented; brown to gray; moist; strong reaction with HCl. Total interval (by volume) approximately 15% cobbles; maximum size recovered, 130mm.</p> <p>32.9 - 34.3: SILTY GRAVEL WITH SAND (GM)_s About 45% coarse to fine, angular to subangular gravel with a trace of caliche coating some surfaces; about 40% fine to coarse, angular sand; about 15% silty fines; maximum size recovered, 45mm; non-cemented to slightly cemented; light brown; moist; strong reaction with HCl.</p> <p>34.3 - 36.8: POORLY GRADED GRAVEL WITH SILT, SAND AND COBBLES (GP-GM)_{sc} About 65% predominately fine to coarse, angular to subangular gravel; about 25% fine to coarse, predominately medium sand; about 10% silty fines, non-cemented; light brown; moist; strong reaction with HCl. Total interval (by volume) approximately 5% cobbles; maximum size recovered, 95mm.</p> <p>36.8 - 44.0: POORLY GRADED GRAVEL WITH COBBLES (GP)_c About 85% coarse to fine, angular to subangular gravel; about 10% predominately fine sand; about 5% fines with low plasticity; slightly to moderately cemented with caliche; light brown; moist;</p>	
	5				0		Qal (GP) _s		
	10				100		Qal (GP-GM) _s		
	15				59		Qal (GP-GM) _s		
	20				69		Qal (GP) _c		
	25				49		Qal (GP) _c		
	30				84		Qal (GP) _c		
	35				67		Qal (GP-GM) _s		
	40				48		Qal GW		
	45				100		Qal (GP) _c		
					66		Qal (GM) _s		
					100		Qal (GP-GM) _{sc}		
					76		Qal (GP) _c		
				100		Qal (GP-GM) _s			
				93		Qal (GP) _c			
				69		Qal (GP) _c			
				61		Qal (GW-GM) _s			
				67		Qal (GW-GM) _s			

- COMMENTS:
- All measurements are in feet unless noted otherwise.
 - No attempts to re-establish circulation were made below 187.5 ft.
 - LCM (Lost Circulation Material) consists cellophane cuttings or cotton seed hulls.
 - USCS classifications were determined in the field, where limited classification methods were available due to the desire to keep samples intact for future tests.
 - Shear Wave Velocity data from GeoVision suspension logging. Data acquired from downhole survey conducted after PVC casing installed.
 - USCS soil classifications are based on USBR Earth Manual procedure 5005 - Determining Unified Soil Classification (Visual Method)

WHB_LOG_WHB.GPJ_WHB.GDT 6/13/02

GEOLOGIC LOG OF DRILL HOLE NO. UE-25 RF#17

SHEET 2 OF 13

FEATURE: Waste Handling Building
 LOCATION: ESF North Portal Pad
 BEGUN: 8/27/2000 FINISHED: 8/29/2000
 DEPTH TO WATER: Not Encountered

PROJECT: Yucca Mountain Project
 COORDINATES: N 766,075.86 E 571,041.88
 TOTAL DEPTH: 667.8 ft.
 DEPTH TO BEDROCK: 96.1 ft.

STATE: Nevada
 GROUND ELEVATION: 3672.38
 ANGLE FROM HORIZONTAL: -90
 HOLE LOGGED BY: USBR/SMF
 REVIEWED BY: Mark McKeown

NOTES	DEPTH	SHEAR WAVE VELOCITY ft/s		ENGINEERING INDEXES			% CORE RECOVERY	% ROD	GEOLOGIC UNIT [USCS]	GRAPHIC	CLASSIFICATION AND PHYSICAL CONDITION																																																				
		1000	2000	HARDNESS	WELDING	FRACTURE DENSITY																																																									
							67				strong reaction with HCl. Total interval (by volume) approximately 15% cobbles of welded tuff; maximum size recovered, 190mm.																																																				
							56				44.0 - 50.8: WELL GRADED GRAVEL WITH SILT AND COBBLES (GW-GM)c About 80% fine to coarse, angular to subangular, well graded gravel; about 10% fine to coarse, angular sand; about 10% silty fines; non-cemented; light brown to gray; moist; weak to strong reaction with HCl. Total interval (by volume) approximately 5% cobbles; maximum size recovered, 110mm.																																																				
							100																																																								
							57		Qal (GP)c		50.8 - 65.4: POORLY GRADED GRAVEL WITH COBBLES (GP)c About 90% coarse to fine, angular to subangular, poorly graded gravel; about 5% fine to coarse, angular sand; about 5% silty fines; non-cemented to moderately cemented with caliche; light brown to gray; moist; strong reaction with HCl. Total interval (by volume) approximately 15% cobbles (greater near bottom of interval); maximum size recovered, 135mm.																																																				
							83																																																								
							71																																																								
							100																																																								
							100		Qal SM		65.4 - 66.3: SILTY SAND (SM) About 80% predominately fine sand; about 20% silty fines; trace of fine gravel; maximum size recovered, 5mm; non-cemented; light brown; moist; strong reaction with HCl.																																																				
							100		Qal (GM)s		66.3 - 69.3: SILTY GRAVEL WITH SAND (GM)s About 55% coarse to fine, angular to subangular, poorly graded gravel; about 30% predominately fine to coarse, angular sand; about 15% silty fines; maximum size recovered, 75mm; non-cemented; light brown to gray; moist; weak reaction with HCl.																																																				
							93																																																								
							65		Qal (GP-GM)s																																																						
							6				69.3 - 71.9: POORLY GRADED GRAVEL WITH SILT, SAND AND COBBLES (GP-GM)sc About 70% predominately coarse to fine, angular to subangular, poorly graded gravel; about 20% coarse to fine, angular to subangular sand; about 10% silty fines; non-cemented to moderately cemented with caliche; light brown to gray; moist; no to weak reaction with HCl. Total interval (by volume) approximately 30% cobbles; maximum size recovered, 100mm.																																																				
							65																																																								
							53		Qal (GP)c		71.9 - 85.3: POORLY GRADED GRAVEL WITH COBBLES (GP)c About 85% predominately coarse to fine, angular to subangular, poorly graded gravel; about 10% coarse to fine, angular sand; about 5% fines with no to low plasticity; non-cemented; some caliche coating on gravel and cobbles; brown to gray; moist; no to strong reaction with HCl. Total interval (by volume) approximately 30% cobbles of welded tuff; maximum size, 150mm.																																																				
							81																																																								
							57																																																								
							100																																																								
							97																																																								
							100		Qal (SM)gc		85.3 - 92.4: SILTY SAND WITH GRAVEL AND COBBLES (SM)gc About 45% coarse to fine, angular to subangular sand; about 40% coarse to fine, angular to subangular gravel; about 15% fines with no to low plasticity; non-cemented to strongly cemented with caliche at 87.7; light brown, gray, beige; moist; weak to strong reaction with HCl. Total interval (by volume) approximately 5% cobbles; maximum size recovered, 100mm.																																																				
							98	98			92.4 to 287.2 ft. BEDDED TUFF (Tmbt1) Nonwelded pyroclastic flows with paleosols and reworked tuffaceous sediments. Medium grained (1 to 5 mm), very pale gray and generally massively bedded. Strongly caliche cemented from 92.4 to 96.1 ft. Tuff is moderately to slightly weathered (W4-5), some isolated intensely weathered (W7) zones; ranges from moderately hard (H4) to soft (H6), most moderately soft (H4); mostly unfractured (FD0) to slightly fractured (FD3) with some small zones of up to intensely fractured (FD7). Lower contact is unconformable.																																																				
							FD0	100	100																																																						
							100	100																																																							
							FD1	100	100																																																						
							63	63		Tmbt1																																																					
							FD0	100	100																																																						
											Discontinuity Measurements:																																																				
											<table border="1"> <thead> <tr> <th>Depth</th> <th>Angle*</th> <th>Roughness</th> <th>Infilling</th> </tr> </thead> <tbody> <tr><td>102.0</td><td>70</td><td>R3</td><td>clay</td></tr> <tr><td>104.4</td><td>65</td><td>R3</td><td>clay, calcite calcite</td></tr> <tr><td>115.3</td><td>35</td><td>R4</td><td>none</td></tr> <tr><td>120.0</td><td>30</td><td>R4</td><td>none</td></tr> <tr><td>138.8</td><td>90</td><td>R2</td><td>none</td></tr> <tr><td>141.4</td><td>45</td><td>R3</td><td>none</td></tr> <tr><td>141.8</td><td>45</td><td>R3</td><td>none</td></tr> <tr><td>158.7</td><td>30</td><td>R3</td><td>none</td></tr> <tr><td>171.0-172.3</td><td>0-5</td><td>R2</td><td>none</td></tr> <tr><td>176.8</td><td>65</td><td>R3</td><td>trace clay</td></tr> <tr><td>175.8</td><td>60</td><td>R3</td><td>none</td></tr> <tr><td>183.6</td><td>60</td><td>R3</td><td>none</td></tr> </tbody> </table>	Depth	Angle*	Roughness	Infilling	102.0	70	R3	clay	104.4	65	R3	clay, calcite calcite	115.3	35	R4	none	120.0	30	R4	none	138.8	90	R2	none	141.4	45	R3	none	141.8	45	R3	none	158.7	30	R3	none	171.0-172.3	0-5	R2	none	176.8	65	R3	trace clay	175.8	60	R3	none	183.6	60	R3	none
Depth	Angle*	Roughness	Infilling																																																												
102.0	70	R3	clay																																																												
104.4	65	R3	clay, calcite calcite																																																												
115.3	35	R4	none																																																												
120.0	30	R4	none																																																												
138.8	90	R2	none																																																												
141.4	45	R3	none																																																												
141.8	45	R3	none																																																												
158.7	30	R3	none																																																												
171.0-172.3	0-5	R2	none																																																												
176.8	65	R3	trace clay																																																												
175.8	60	R3	none																																																												
183.6	60	R3	none																																																												

WHB LOG WHB.GPJ WHB.GDT 8/13/02

GEOLOGIC LOG OF DRILL HOLE NO. UE-25 RF#17

SHEET 3 OF 13

FEATURE: Waste Handling Building
 LOCATION: ESF North Portal Pad
 BEGUN: 6/27/2000 FINISHED: 8/29/2000
 DEPTH TO WATER: Not Encountered

PROJECT: Yucca Mountain Project
 COORDINATES: N 766,075.86 E 571,041.88
 TOTAL DEPTH: 667.8 ft.
 DEPTH TO BEDROCK: 96.1 ft.

STATE: Nevada
 GROUND ELEVATION: 3672.38
 ANGLE FROM HORIZONTAL: -90
 HOLE LOGGED BY: USBR/SMP
 REVIEWED BY: Mark McKeown

NOTES	DEPTH	SHEAR WAVE VELOCITY ft/s	ENGINEERING INDEXES			GEOLOGIC UNIT (USCS)	GRAPHIC	CLASSIFICATION AND PHYSICAL CONDITION
			HARDNESS	WELDING	FRACTURE DENSITY			
	110							186.0 40 R3 trace clay 188.0 40 R3 clay 188.6 80 R4 none 188.6 85 R3 none 189.1 90 R3 trace black mineral 192.5 30 R2 clayey breccia 199.3 35 R3 none 199.6 90 R2 none 201.0 80 R4 trace clay 214.3 90 R3 none 231.4-243.9 R2 CLAYEY BRECCIA ZONE 244.6 25 clay, iron oxide 247.6-247.8 R2 FRACTURE ZONE 248.0 90 R3 clay 249.1-249.4 15 R3 clay 250.2 60 R3 none 251.3-251.9 20 R2 none 253.8 85 R3 trace clay 254.9 85 R4 none 270.7 80 R3 none 283.2 90 R2 trace clay 291.6 80 R3 clay 300.3-300.7 30 R3 none 300.8 90 R3 none 301.6 80 R2 trace clay 305.6 65 R4 trace clay
	115							
	120							
	125							
	130							
	135							
	140							
	145							
	150							
	155							
	160							
	165							

287.2 to 348.4 ft. COMB PEAK IGIMBRITE - TUFF X (Tpk1):
 Nonwelded pyroclastic flow, moderately indurated, approximately 20-25% pumice (up to 35x30mm), about 10-15% volcanic lithic fragments (up to 25x25mm). Tuff is medium gray with rare phenocrysts of sanidine, biotite, magnetite, and manganese oxides. Generally the tuff is moderately soft (H5), moderately to slightly weathered (W4), and unfractured (FD0) to very slightly fractured (FD1).

Discontinuity Measurements:

Depth	Angle*	Roughness	Infilling
347.5-348.0	15	R2	trace clay

348.4 to 368.9 ft. POST TIVA CANYON BEDDED TUFFS (Tpb15):
 Nonwelded, possibly reworked fallout tephra and pyroclastic flows separated by distinct paleosols. The tuff is devitrified, pale yellowish-brown, moderately indurated, with 10 to 15 percent pumice, (up to 10x7mm), and less than 10 percent volcanic lithic fragments generally less than 1 mm. The bedded tuffs have about 1 percent feldspar, quartz phenocrysts, and approximately 2% biotite. Generally the bedded tuffs are moderately soft (H5), slightly (W4) to moderately (W6) weathered, mostly unfractured (FD0) to moderately fractured (FD4) with one zone of intensely fractured (FD7) rock.

Discontinuity Measurements:

Depth	Angle*	Roughness	Infilling
364.2-364.8	20	R3	none
366.6	50	R2	none
374.3-376.2			CLAYEY BRECCIA ZONE
376.1	35	R2	trace clay
381.2-381.6	25	R2	none

368.9 to 478.0 ft. TIVA CANYON TUFF CRYSTAL RICH NON-LITHOPHYSAL ZONE (Tpcrn)
 Pyroclastic flow, moderately to mostly densely welded, devitrified, pale red to grayish red, with 10 to 15 percent phenocrysts. Phenocrysts mostly feldspar and some quartz, with rare biotite and pyroxene. Rare pumice from 392.0 to 404.6 feet and up to 20 percent pumice from 404.6 to 457.2 feet. Up to 15 percent lithophysal cavities from 457.2 to 471.4 feet. Generally the rock is soft to mostly moderately hard (H4), moderately to slightly weathered (W4), slightly (FD4) to intensely fractured (FD8).

Discontinuity Measurements:

Depth	Angle*	Roughness	Infilling
381.3-382.3	10	R2	none
383.8	75	R3	none
383.8-384.3	10	R3	none
384.3-385.1	0	R3	none
385.8-386.0	25	R3	calcite
386.4-387.2	10	R2	breccia
387.0-388.5	5	R3	calcite
387.1-387.5	25	R3	none

WHB LOG WHB.GPJ WHB.GDT 6/13/02

GEOLOGIC LOG OF DRILL HOLE NO. UE-25 RF#17

SHEET 5 OF 13

FEATURE: Waste Handling Building
 LOCATION: ESF North Portal Pad
 BEGUN: 6/27/2000 FINISHED: 8/29/2000
 DEPTH TO WATER: Not Encountered

PROJECT: Yucca Mountain Project
 COORDINATES: N 766,075.86 E 571,041.88
 TOTAL DEPTH: 667.8 ft.
 DEPTH TO BEDROCK: 96.1 ft.

STATE: Nevada
 GROUND ELEVATION: 3672.38
 ANGLE FROM HORIZONTAL: -90
 HOLE LOGGED BY: USBR/SMF
 REVIEWED BY: Mark McKeown

NOTES	DEPTH	SHEAR WAVE VELOCITY ft/s		ENGINEERING INDEXES		FRACTURE DENSITY	% CORE RECOVERY	% ROD	GEOLOGIC UNIT [USCS]	GRAPHIC	CLASSIFICATION AND PHYSICAL CONDITION																																																																															
		HARDNESS	WELDING	HARDNESS	WELDING						R1	R2	R3	R4																																																																												
	230					FD3	44	39	Tmbt1		479.7	65	R5	trace calcite																																																																												
											479.8	45	R4	none																																																																												
							46	0			479.8	15	R3	none																																																																												
											480.0	50	R4	none																																																																												
											480.1	45	R4	none																																																																												
											480.2	50	R4	none																																																																												
											480.3	60	R4	none																																																																												
											480.3	85	R4	none																																																																												
											480.9	30	R3	breccia																																																																												
											481.3	40	R3	clayey breccia																																																																												
											481.7	70	R4	none																																																																												
						FD7	46	0	(Clayey Breccia)		485.4	40	R3	none																																																																												
											488.7	50	R3	sandy, pumiceous breccia																																																																												
											489.8	55	R3	trace manganese oxide																																																																												
											491.1	55	R4	sandy, pumiceous breccia																																																																												
											493.6	60	R4	none																																																																												
											493.6	35	R4	none																																																																												
											493.8	25	R4	none																																																																												
											496.3	40	R6	clay																																																																												
											496.7	45	R4	none																																																																												
							95	0			496.9	35	R4	none																																																																												
							100	0			496.9	60	R4	none																																																																												
											497.1	55	R4	none																																																																												
						FD3	100	94			497.6-499.2		BRECCIA ZONE	trace iron oxide																																																																												
											500.1	40	R2	breccia																																																																												
											500.3	20	R3	none																																																																												
											500.5	20	R3	none																																																																												
											502.8	80	R5	none																																																																												
											506.8	45	R3	breccia																																																																												
											509.6	15	R3	none																																																																												
											518.9	45	R2	none																																																																												
											522.4	15	R2	trace iron oxide																																																																												
											522.6	65	R3	none																																																																												
											523.2	65	R3	none																																																																												
											545.0	10	R3	none																																																																												
											551.2	25	R2	none																																																																												
						FD4					551.4	30	R4	clay, gravel																																																																												
							100	51			552.6	5	R3	none																																																																												
											554.1	5	R3	none																																																																												
											555.8	30	R3	none																																																																												
											557.5	5	R3	clay, sand, gravel																																																																												
											559.0	5	R3	clay, sand, gravel																																																																												
											559.2	30	R4	sand, gravel																																																																												
											561.2	10	R3	none																																																																												
											564.9	35	R3	quartz																																																																												
											565.4	30	R4	clay																																																																												
											565.9	40	R3	none																																																																												
											566.9	20	R3	none																																																																												
											567.4	15	R2	none																																																																												
											568.2	35	R3	none																																																																												
											568.9	20	R3	quartz																																																																												
											569.7	10	R3	quartz																																																																												
						FD3	100	100	Tmbt1		571.1	60	R3	none																																																																												
											587.3 to 637.6 ft. TIVA CANYON TUFF CRYSTAL POOR MIDDLE NON-LITHOPHYSAL ZONE (Tpcpmn) Pyroclastic flow; densely welded; predominately pale red with mottled dark grayish red and scattered pink spots; mottling becomes fine-grained and merges with rock fabric with depth; mineralization in fractures only; less than 5% flattened and altered pumice; less than 1% lithophysal; lithics increase with depth. Moderately hard (H4); slightly to moderately weathered (W4); very slightly fractured (FD1) to moderately fractured (FD6). Discontinuity Measurements: <table border="1" style="font-size: small;"> <thead> <tr> <th>Depth</th> <th>Angle*</th> <th>Roughness</th> <th>Infilling</th> </tr> </thead> <tbody> <tr><td>580.4</td><td>35</td><td>R3</td><td>none</td></tr> <tr><td>580.8</td><td>70</td><td>R3</td><td>none</td></tr> <tr><td>581.2</td><td>30</td><td>R3</td><td>none</td></tr> <tr><td>582.8</td><td>15</td><td>R3</td><td>trace clay</td></tr> <tr><td>583.3</td><td>15</td><td>R3</td><td>trace clay</td></tr> <tr><td>588.8</td><td>10</td><td>R3</td><td>quartz, sand</td></tr> <tr><td>590.0</td><td>15</td><td>R3</td><td>trace quartz</td></tr> <tr><td>591.5</td><td>65</td><td>R3</td><td>none</td></tr> <tr><td>592.1</td><td>40</td><td>R3</td><td>none</td></tr> <tr><td>594.4</td><td>15</td><td>R3</td><td>sand</td></tr> <tr><td>595.3</td><td>15</td><td>R3</td><td>none</td></tr> <tr><td>596.0</td><td>20</td><td>R3</td><td>quartz</td></tr> <tr><td>597.5</td><td>10</td><td>R3</td><td>quartz</td></tr> <tr><td>599.1</td><td>20</td><td>R3</td><td>trace quartz</td></tr> <tr><td>610.8</td><td>30</td><td>R4</td><td>trace clay</td></tr> <tr><td>611.2</td><td>55</td><td>R3</td><td>none</td></tr> <tr><td>611.4</td><td>50</td><td>R3</td><td>none</td></tr> <tr><td>612.1</td><td>30</td><td>R3</td><td>clay</td></tr> </tbody> </table>				Depth	Angle*	Roughness	Infilling	580.4	35	R3	none	580.8	70	R3	none	581.2	30	R3	none	582.8	15	R3	trace clay	583.3	15	R3	trace clay	588.8	10	R3	quartz, sand	590.0	15	R3	trace quartz	591.5	65	R3	none	592.1	40	R3	none	594.4	15	R3	sand	595.3	15	R3	none	596.0	20	R3	quartz	597.5	10	R3	quartz	599.1	20	R3	trace quartz	610.8	30	R4	trace clay	611.2	55	R3	none	611.4	50	R3	none	612.1	30	R3	clay
Depth	Angle*	Roughness	Infilling																																																																																							
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WHB LOG WHB.GPJ WHB.GDT 6/13/02

GEOLOGIC LOG OF DRILL HOLE NO. UE-25 RF#17

SHEET 6 OF 13

FEATURE: Waste Handling Building
 LOCATION: ESF North Portal Pad
 BEGUN: 6/27/2000 FINISHED: 8/29/2000
 DEPTH TO WATER: Not Encountered

PROJECT: Yucca Mountain Project
 COORDINATES: N 766,075.86 E 571,041.88
 TOTAL DEPTH: 667.8 ft.
 DEPTH TO BEDROCK: 96.1 ft.

STATE: Nevada
 GROUND ELEVATION: 3672.38
 ANGLE FROM HORIZONTAL: -90
 HOLE LOGGED BY: USBR/SMF
 REVIEWED BY: Mark McKeown

NOTES	DEPTH	SHEAR WAVE VELOCITY ft/s	ENGINEERING INDEXES			% CORE RECOVERY	% ROD	GEOLOGIC UNIT {USGS}	GRAPHIC	CLASSIFICATION AND PHYSICAL CONDITION			
			HARDNESS	WELDING	FRACTURE DENSITY					R4	R2	none	
	290		H5			100	100			615.4	20	R4	none
										619.2	35	R2	none
			H4							621.1	15	R3	none
										622.4	30	R3	none
										624.0	15	R2	calcite
										624.6	80	R2	none
										625.7	40	R3	none
										626.4	85	R2	none
										628.1	35	R3	quartz
										628.4	60	R2	none
										630.2	15	R3	quartz
										631.0	30	R3	sand, gravel
										632.3	50	R3	none
			H5		FD1					633.7	40	R2	manganese oxide
										634.0	15	R3	clay, sand
										634.9	40	R3	clay, sand
										635.4	30	R3	none
										635.9	75	R2	none
										636.3	5	R3	none
										636.7	25	R3	none
										637.4	15	R2	none
	305		H4			88	88			637.6 to 653.2 ft. TIVA CANYON TUFF CRYSTAL POOR LOWER LITHOPHYSAL ZONE (Tpcpl) Pyroclastic flow, densely welded, devitrified, moderate orange pink tuff with rare light gray pumice. Phenocrysts of sanidine and rare biotite compose less than 1 percent of the rock by volume. Lithophysal cavities compose up to 10 percent of the rock by volume, up to 5 by 15 mm in size. Generally the tuff is moderately hard (H4), slightly weathered (W3), and moderately to intensely fractured (FD6). Lower contact is conformable.			
	310									Discontinuity Measurements:			
										Depth	Angle*	Roughness	Infilling
										637.8	20	R3	clay, sand, gravel
										638.7	65	R3	pumice
										639.0	75	R4	manganese oxide
						99	99			640.1	60	R3	none
										640.5	35	R3	none
										641.0	35	R2	none
										642.1	85	R2	none
										644.0	65	R3	clay, sand
										645.2	75	R2	none
										646.4	70	R2	none
										646.6	30	R2	trace white mineral
										646.8-647.0	40	R2	clay, sand, gravel
										648.0-648.7	20	R2	clay, sand, gravel
										650.3	30	R3	sand
										650.4	30	R3	sand
										651.9	25	R3	sand
	320									653.2 to 667.8 ft. TIVA CANYON TUFF CRYSTAL POOR LOWER NON-LITHOPHYSAL ZONE (Tpcpln) Pyroclastic flow, densely welded, devitrified, pale red tuff with less than 1 percent light gray pumice clasts. Phenocrysts of sanidine and plagioclase compose less than 1 percent of the rock by volume. Medium gray lithic clasts compose less 1 percent of the rock by volume. Generally the tuff is moderately hard (H4), slightly weathered (W3), with fracture densities mostly moderately to intensely fractured (FD7). Lower contact undetermined, bottom of borehole at 667.8 ft.			
	325		H5		FD0	100	100			Discontinuity Measurements:			
										Depth	Angle*	Roughness	Infilling
										653.5-657.4	5-15	R2	lapilli tuff
										657.4	40	R2	clay, sand
										658.5-658.7	25	R3	clay, sand
										661.0-662.0	0-10	R4	none
										661.1-661.3	30	R3	none
										662.4	60	R4	none
										663.0	65	R3	none
										663.0-663.3	25	R4	none
										663.4	55	R3	none
										663.9-664.1	30	R4	quartz
										664.2	65	R2	trace quartz
										665.3	30	R4	none
										665.7	35	R4	none
										666.3	45	R3	trace calcite
					FD1	93	93			666.3-666.6	30	R4	none
										666.5-667.1	0-10	R3	quartz, calcite
										667.2	45	R2	clayey breccia

WHB LOG WHB.GPJ WHB.GDT 6/13/02

GEOLOGIC LOG OF DRILL HOLE NO. UE-25 RF#17

SHEET 7 OF 13

FEATURE: Waste Handling Building
 LOCATION: ESF North Portal Pad
 BEGUN: 6/27/2000 FINISHED: 8/29/2000
 DEPTH TO WATER: Not Encountered

PROJECT: Yucca Mountain Project
 COORDINATES: N 766,075.86 E 571,041.88
 TOTAL DEPTH: 667.8 ft.
 DEPTH TO BEDROCK: 96.1 ft.

STATE: Nevada
 GROUND ELEVATION: 3672.38
 ANGLE FROM HORIZONTAL: -90
 HOLE LOGGED BY: USBR/SMF
 REVIEWED BY: Mark McKeown

NOTES	DEPTH	SHEAR WAVE VELOCITY Vs	ENGINEERING INDEXES			% CORE RECOVERY	% ROD	GEOLOGIC UNIT [USCS]	GRAPHIC	CLASSIFICATION AND PHYSICAL CONDITION
			HARDNESS	WELDING	FRACTURE DENSITY					
	350				FD1	93	93			* Angles are measured from core axis and are plus or minus 5 degrees.
	355				FD0	77	77		Tpbt5	
	360									
	365		H5			84	47			
	370				FD2	81	81		Tpcm	
	375				FD7	100	77	(Clayey Breccia)		
	380				FD4					
	385				FD5	100	59			
	390		H4		FD4	79	46		Tpcm	
	395				FD5					
	400				FD8	100	48			
	405				FD4					
			H7							
			H4							
			H7		FD5	100	28			
			H4		FD3	96	65			

WHB_LOG WHB.GPJ WHB.GDT 6/13/02

GEOLOGIC LOG OF DRILL HOLE NO. UE-25 RF#17

SHEET 8 OF 13

FEATURE: Waste Handling Building
 LOCATION: ESF North Portal Pad
 BEGUN: 6/27/2000 FINISHED: 8/29/2000
 DEPTH TO WATER: Not Encountered

PROJECT: Yucca Mountain Project
 COORDINATES: N 766,075.86 E 571,041.88
 TOTAL DEPTH: 667.8 ft.
 DEPTH TO BEDROCK: 96.1 ft.

STATE: Nevada
 GROUND ELEVATION: 3672.38
 ANGLE FROM HORIZONTAL: -90
 HOLE LOGGED BY: USBR/SMF
 REVIEWED BY: Mark McKeown

NOTES	DEPTH	SHEAR WAVE VELOCITY ft/s	ENGINEERING INDEXES		FRACTURE DENSITY	% CORE RECOVERY	% ROD	GEOLOGIC UNIT [USCS]	GRAPHIC	CLASSIFICATION AND PHYSICAL CONDITION
			HARDNESS	WELDING						
	410		H4		FD3	96	65			
	415		H6		FD7					
	420		H4		FD5	97	47			
	425		H6		FD4					
	430		H4		FD4					
	435		H6		FD4	97	56			
	440		H4		FD7					
	445		H4		FD5					
	450		H4		FD8					
	455		H6		FD4	100	57			
	460		H4		FD7					
	465		H4		FD5	100	38	(Breccia)		
			H6		FD7			Tpcm		
			H4		FD3	75	55	(Fracture Fill)		
			H4		FD7	100	0			
			H4		FD8	78	0			
			H4		FD8	69	0			
			H6		FD7	79	38			
			H6		FD8	0	NR			

WHB LOG WHB.GPJ WHB.GDT 6/13/02

GEOLOGIC LOG OF DRILL HOLE NO. UE-25 RF#17

SHEET 9 OF 13

FEATURE: Waste Handling Building
 LOCATION: ESF North Portal Pad
 BEGUN: 6/27/2000 FINISHED: 8/29/2000
 DEPTH TO WATER: Not Encountered

PROJECT: Yucca Mountain Project
 COORDINATES: N 766,075.86 E 571,041.88
 TOTAL DEPTH: 667.8 ft.
 DEPTH TO BEDROCK: 96.1 ft.

STATE: Nevada
 GROUND ELEVATION: 3672.38
 ANGLE FROM HORIZONTAL: -90
 HOLE LOGGED BY: USBR/SMF
 REVIEWED BY: Mark McKeown

NOTES	DEPTH	SHEAR WAVE VELOCITY ft/s	ENGINEERING INDEXES					GEOLOGIC UNIT [USCS]	GRAPHIC	CLASSIFICATION AND PHYSICAL CONDITION
			HARDNESS	WELDING	FRACTURE DENSITY	% CORE RECOVERY	% ROD			
	470		H6		FD8	82	41			
			H5		FD7	89	56	Tpcm		
			H4		FD6	83	83			
	475		H6		FD5	93	93	(Fracture Fill)		
					FD4	87	78			
	480		H4		FD6	100	52	Tpcpul		
			H6		FD8	100	0			
	485		H4		FD7	80	46	(Fracture Fill)		
					FD4	89	74			
	490		H6		FD8	69	21	(Fracture Fill)		
			H3		FD7	54	0	Tpcpul		
	495					89	43	(Fracture Fill)		
					FD9			Tpcpul		
	500					100	0	(Breccia)		
					FD8	77	0			
	505					89	64			
					FD5					
	510		H4			100	39			
					FD7	64	0	Tpcpul		
					FD8	100	0			
	515				FD7	75	0			
					FD8	91	0			
					FD6	81	0			
	520				FD8	60	0			
	525				FD3	100	86			

WHB_LOG WHB.GPJ WHB.GDT 6/13/02

GEOLOGIC LOG OF DRILL HOLE NO. UE-25 RF#17

SHEET 10 OF 13

FEATURE: Waste Handling Building
 LOCATION: ESF North Portal Pad
 BEGUN: 6/27/2000 FINISHED: 8/29/2000
 DEPTH TO WATER: Not Encountered

PROJECT: Yucca Mountain Project
 COORDINATES: N 766,075.86 E 571,041.88
 TOTAL DEPTH: 667.8 ft.
 DEPTH TO BEDROCK: 96.1 ft.

STATE: Nevada
 GROUND ELEVATION: 3672.38
 ANGLE FROM HORIZONTAL: -90
 HOLE LOGGED BY: USBR/SMF
 REVIEWED BY: Mark McKeown

NOTES	DEPTH	SHEAR WAVE VELOCITY ft/s	ENGINEERING INDEXES				GEOLOGIC UNIT [USCS]	GRAPHIC	CLASSIFICATION AND PHYSICAL CONDITION
			HARDNESS	WELDING	FRACTURE DENSITY	% CORE RECOVERY			
	530				FD3	100	86		
	535					94	90		
	540				FD2				
	545					100	97		
	550								
	555				FD5	96	29		
	560			H4	FD7	100	0	Tpcpul	
	565				FD6	94	0		
	570				FD3	91	57		
	575				FD5	97	27		
	580								
	585				FD3	98	87		
						100	63		

WHB_LOG WHB.GPJ WHB.GDT 6/13/02

GEOLOGIC LOG OF DRILL HOLE NO. UE-25 RF#17

SHEET 11 OF 13

FEATURE: Waste Handling Building
 LOCATION: ESF North Portal Pad
 BEGUN: 6/27/2000 FINISHED: 8/29/2000
 DEPTH TO WATER: Not Encountered

PROJECT: Yucca Mountain Project
 COORDINATES: N 766,075.86 E 571,041.88
 TOTAL DEPTH: 667.8 ft.
 DEPTH TO BEDROCK: 96.1 ft.

STATE: Nevada
 GROUND ELEVATION: 3672.38
 ANGLE FROM HORIZONTAL: -90
 HOLE LOGGED BY: USBR/SMF
 REVIEWED BY: Mark McKeown

NOTES	DEPTH	SHEAR WAVE VELOCITY ft/s	ENGINEERING INDEXES			% CORE RECOVERY	% RQD	GEOLOGIC UNIT [USCS]	GRAPHIC	CLASSIFICATION AND PHYSICAL CONDITION
			HARDNESS	WELDING	FRACTURE DENSITY					
	590				FD3	100	63	Tpcpul		
	595				FD4	100	88			
	600									
	605				FD1	100	97			
	610									
	615			H4		100	77	Tpcpmn		
	620				FD2					
	625					100	97			
	630									
	635				FD3	100	62			
	640				FD6	100	0	Tpcpl (Fracture Fill)		
	645				FD4	99	75	Tpcpl		

WHB LOG WHB.GPJ WHB.GDT 6/13/02

GEOLOGIC LOG OF DRILL HOLE NO. UE-25 RF#17

SHEET 12 OF 13

FEATURE: Waste Handling Building
 LOCATION: ESF North Portal Pad
 BEGUN: 6/27/2000 FINISHED: 8/29/2000
 DEPTH TO WATER: Not Encountered

PROJECT: Yucca Mountain Project
 COORDINATES: N 766,075.86 E 571,041.88
 TOTAL DEPTH: 667.8 ft.
 DEPTH TO BEDROCK: 96.1 ft.

STATE: Nevada
 GROUND ELEVATION: 3672.38
 ANGLE FROM HORIZONTAL: -90
 HOLE LOGGED BY: USBR/SMF
 REVIEWED BY: Mark McKeown

NOTES	DEPTH	SHEAR WAVE VELOCITY ft/s	ENGINEERING INDEXES			% CORE RECOVERY	% ROD	GEOLOGIC UNIT [USCS]	GRAPHIC	CLASSIFICATION AND PHYSICAL CONDITION
			HARDNESS	WELDING	FRACTURE DENSITY					
	650				99	75		Tpcpll		
	655				100	80				
	660		H4		FD4			Tpcpin		
	665				FD6	92	19			
	BOTTOM OF HOLE									

WHB_LOG WHB.GPJ WHB.GDT 6/13/02

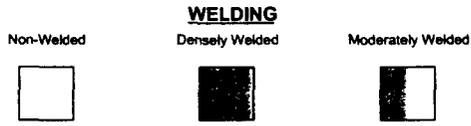
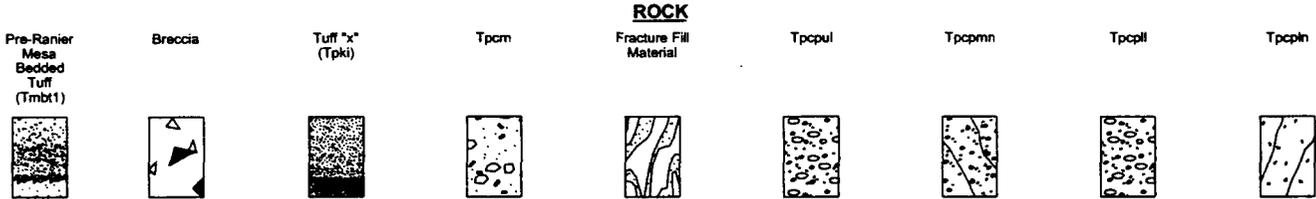
GEOLOGIC LOG OF DRILL HOLE NO. UE-25 RF#17

SHEET 13 OF 13

FEATURE: Waste Handling Building
 LOCATION: ESF North Portal Pad
 BEGUN: 6/27/2000 FINISHED: 8/29/2000
 DEPTH TO WATER: Not Encountered

PROJECT: Yucca Mountain Project
 COORDINATES: N 766.075.86 E 571.041.88
 TOTAL DEPTH: 667.8 ft.
 DEPTH TO BEDROCK: 96.1 ft.

STATE: Nevada
 GROUND ELEVATION: 3672.38
 ANGLE FROM HORIZONTAL: -90°
 HOLE LOGGED BY: USBR/SMF
 REVIEWED BY: Mark McKeown



HARDNESS			WEATHERING		
Alpha-numeric descriptor	Descriptor	Criteria	Alpha-numeric descriptor	Descriptor	General characteristics (strength, excavation, etc.)
H1	Extremely	Core, fragment, or exposure cannot be scratched with knife or sharp pick; can only be chipped with repeated heavy hammer blows.	W1	Fresh	Hammer rings when crystalline rocks are struck. Almost always rock excavation except for naturally weak or weakly cemented rocks such as siltstones or shales.
H2	Very Hard	Cannot be scratched with knife or sharp pick. Core or fragment breaks with repeated heavy hammer blows.	W2	Slightly weathered to fresh	
H3	Hard	Can be scratched with knife or sharp pick with difficulty (heavy pressure). Heavy hammer blow required to break specimen.	W3	Slightly weathered	Hammer rings when crystalline rocks are struck. Body of rock not weakened. With few exceptions, such as siltstones or shales, classified as rock excavation.
H4	Moderately Hard	Can be scratched with knife or sharp pick with light pressure. Core or fragment breaks with moderate hammer blow.	W4	Moderately to slightly weathered	
H5	Moderately Soft	Can be grooved 1/16 inch (2mm) deep by sharp pick with moderate or heavy pressure. Core or fragment breaks with light hammer blow or heavy manual pressure.	W5	Moderately weathered	Hammer does not ring when rock is struck. Body of rock is slightly weakened. Depending on fracturing, usually is rock excavation except in naturally weak rocks such as siltstones or shales.
H6	Soft	Can be grooved or gouged easily by knife or sharp pick with light pressure, can be scratched with fingernail. Breaks with light to moderate manual pressure.	W6	Intensely to moderately weathered	
H7	Very Soft	Can be readily indented, grooved or gouged with fingernail, or carved with a knife. Breaks with light manual pressure.	W7	Intensely weathered	Dull sound when struck with hammer, usually can be broken with moderate to heavy manual pressure or by light hammer blow without reference to planes of weakness such as incipient or hairline fractures, or veins. Rock is significantly weakened. Usually common excavation.
			W8	Very intensely weathered	
			W9	Decomposed	Can be granulated by hand. Always common excavation. Resistant minerals such as quartz may be present as "stringers" or "dikes".

FRACTURE DENSITY		
Alpha-numeric descriptor	Descriptor	Criteria (Excludes mechanical breaks)
FD0	Unfractured	No observed fractures.
FD1	Very slightly fractured	Core recovered mostly in lengths greater than 3 feet (1 m).
FD2	Slightly to very slightly fractured	
FD3	Slightly fractured	Core recovered mostly in lengths from 1 to 3 feet (300 to 1,000 mm) with few scattered lengths less than 1 foot (300 mm) or greater than 3 feet (1,000 mm).
FD4	Moderately to slightly fractured	
FD5	Moderately fractured	Core recovered mostly in lengths from 0.33 to 1.0 foot (100 to 300 mm) with most lengths about 0.67 foot (200 mm).
FD6	Moderately to intensely fractured	
FD7	Intensely fractured	Lengths average from 0.1 to 0.33 foot (30 to 100 mm) with fragmented intervals. Core recovered mostly in lengths less than 0.33 foot (100 mm).
FD8	Very intensely to intensely fractured	
FD9	Very intensely fractured	Core recovered mostly as chips and fragments with a few scattered short core lengths.

RF17 KEY WHB.GPJ WHB.GDT 6/14/02

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GEOLOGIC LOG OF DRILL HOLE NO. UE-25 RF#18

SHEET 1 OF 6

FEATURE: Waste Handling Building
 LOCATION: ESF North Portal Pad
 BEGUN: 9/5/2000 FINISHED: 9/21/2000
 DEPTH TO WATER: Not Encountered

PROJECT: Yucca Mountain Project
 COORDINATES: N 764,522.34 E 570,626.93
 TOTAL DEPTH: 493.6 ft.
 DEPTH TO BEDROCK: 65.0 ft.

STATE: Nevada
 GROUND ELEVATION: 3640.34
 ANGLE FROM HORIZONTAL: -90
 HOLE LOGGED BY: USBR/SMF
 REVIEWED BY: Mark McKeown

NOTES	DEPTH	ENGINEERING INDEXES					GEOLOGIC UNIT [USCS]	GRAPHIC	CLASSIFICATION AND PHYSICAL CONDITION
		SHEAR WAVE VELOCITY V_s	HARDNESS	WELDING	FRACTURE DENSITY	% CORE RECOVERY			
<p>Purpose of Hole: Preliminary, conceptual-level geotechnical foundation investigations for the design of the Waste Handling Building (WHB).</p> <p>Drill Equipment: Schramm T685 Drill Rig</p> <p>Drillers: G. Fox, V. Mora, M. Fyffe; Dynatec Drilling Inc.; Salt Lake City, Utah.</p> <p>Drilling Method: Install 12" hammer. Hammer to 6.01. Cement 10.75 O.D. casing with 1.29 stickup. Re-enter hole on 9/15/2000 with 8.50 Tricone bit. Drill from 6.01 to total depth of 493.56.</p> <p>Drilling Conditions: Lost circulation from 240.00 to 250.00.</p> <p>Drilling Fluid: 0.00 to 5.00: Non-potable water. 5.00 to 493.56: Quick Gel mud with EZ-Mud and LCM to re-establish circulation.</p> <p>Loss Intervals: 240.00 to 250.00</p> <p>Casing Record: 0.00 to 6.01 : 10.75 O.D. casing. 6.01 to 493.56: No casing</p> <p>Hole Completion: Set and cement 492.41 of 4.50 schedule 80 PVC casing.</p>	1000							0.0 to 60.0 ft. QUATERNARY ALLUVIUM (Qal) Tuffaceous alluvium consisting of a mixture of pale red and light gray densely welded ignimbrite with minor fragments of white non-welded tuff. Up to 15 percent of the densely welded material has white to light gray caliche coatings.	
	2000							60.0 to 65.0 ft. BEDDED TUFF (Tmbt1) Bedded tuff, nonwelded, crystallized, very pale-orange with 10 to 12 percent pumice clasts. Tuff contains less than 1 percent pale to moderate red volcanic lithic clasts. Quartz and feldspar phenocrysts range from 10 to 15 percent of the tuff by volume, and biotite and manganese less than 1 percent.	
	3000							65.0 to 204.0 ft. COMB PEAK IGNIMBRITE - TUFF X (Tpki) Pyroclastic flow, nonwelded, crystallized, with up to 20 percent pumice clasts. Tuff contains 2 to 3 percent sanidine, plagioclase, quartz, and less than 1 percent biotite and hornblende phenocrysts. Up to 20 percent moderate red to medium dark gray, volcanic lithic clasts.	
	4000							204.0 to 292.0 ft. TIVA CANYON TUFF CRYSTAL RICH NON-LITHOPHYSAL ZONE (Tpcrn) Pyroclastic flow, moderately to densely welded, crystallized, with 8 to 10 percent sanidine and plagioclase phenocrysts, and less than 1 percent biotite phenocrysts. From 207.0 to 211.0 ft. moderately welded tuff has up to 8 percent, light gray pumice clasts. From 211.0 to 217 ft. densely welded tuff has up to 10 percent dark gray pumice. From 217.0 to 223.0 ft. grayish-brown pumice content decreases to 3 to 5 percent. Tuff is pumice poor (less than 1 percent) from 223.0 to 248.0. From 248.0 to 267.0 ft. the tuff has 10 to 15 percent very light gray to medium light gray pumice clasts.	
	5000							292.0 to 425.0 ft. TIVA CANYON TUFF CRYSTAL POOR UPPER LITHOPHYSAL ZONE (Tpcpu) Pyroclastic flow, densely welded, crystallized, vapor phase altered, light gray, with 2 to 3 percent sanidine and plagioclase, and less than 1 percent biotite phenocrysts. Tuff has up to 5 percent, very light gray, pumice clasts. Lithophysae are distinguished by vapor phase altered chips, indicating the edges of voids in the tuff.	
	6000							425.0 to 470.0 ft. TIVA CANYON TUFF CRYSTAL POOR MIDDLE NON-LITHOPHYSAL ZONE (Tpcpm) Pyroclastic flow, densely welded, crystallized, pale red, with less than 1 percent sanidine, plagioclase, and biotite phenocrysts. Tuff has up to 1 percent pumice clasts and less than 1 percent volcanic lithic clasts. Vapor phase altered chips indicate some lithophysae from 360.0 to 367.0 ft.	
	7000							470.0 to 493.6 ft. TIVA CANYON TUFF CRYSTAL POOR LOWER LITHOPHYSAL ZONE (Tpcpl) Pyroclastic flow, densely welded, crystallized, pale reddish-brown with minor vapor phase alteration. Less than 5 percent, very light gray, pumice clasts and less than 1 percent medium gray volcanic lithic clasts. Tuff contains less than 1 percent sanidine, plagioclase, biotite, and manganese phenocrysts.	
	8000								
	9000								
	9500								

COMMENTS: 1. Hole logged from cuttings
 2. Shear Wave Velocity data from GeoVision suspension logging. Data acquired from downhole survey conducted after PVC casing installed.

WHB LOG WHB.GPJ WHB.GDT 6/14/02

GEOLOGIC LOG OF DRILL HOLE NO. UE-25 RF#18

SHEET 2 OF 6

FEATURE: Waste Handling Building
 LOCATION: ESF North Portal Pad
 BEGUN: 9/5/2000 FINISHED: 9/21/2000
 DEPTH TO WATER: Not Encountered

PROJECT: Yucca Mountain Project
 COORDINATES: N 764,522.34 E 570,626.93
 TOTAL DEPTH: 493.6 ft.
 DEPTH TO BEDROCK: 65.0 ft.

STATE: Nevada
 GROUND ELEVATION: 3640.34
 ANGLE FROM HORIZONTAL: -90
 HOLE LOGGED BY: USBR/SMF
 REVIEWED BY: Mark McKeown

NOTES	DEPTH	SHEAR WAVE VELOCITY [ft/s]	ENGINEERING INDEXES				% CORE RECOVERY	% ROD	GEOLOGIC UNIT [USCS]	GRAPHIC	CLASSIFICATION AND PHYSICAL CONDITION
			HARDNESS	WELDING	FRACTURE DENSITY	% CORE RECOVERY					
	105 110 115 120 125 130 135 140 145 150 155 160 165 170 175 180 185 190 195 200 205 210 215							Tpk1			
								Tpcm			

WHB LOG WHB.GPJ WHB.GDT 6/14/02

GEOLOGIC LOG OF DRILL HOLE NO. UE-25 RF#18

SHEET 5 OF 6

FEATURE: Waste Handling Building
 LOCATION: ESF North Portal Pad
 BEGUN: 9/5/2000 FINISHED: 9/21/2000
 DEPTH TO WATER: Not Encountered

PROJECT: Yucca Mountain Project
 COORDINATES: N 764,522.34 E 570,626.93
 TOTAL DEPTH: 493.6 ft.
 DEPTH TO BEDROCK: 65.0 ft.

STATE: Nevada
 GROUND ELEVATION: 3640.34
 ANGLE FROM HORIZONTAL: -90
 HOLE LOGGED BY: USBR/SMF
 REVIEWED BY: Mark McKeown

NOTES	DEPTH	SHEAR WAVE VELOCITY m/s	ENGINEERING INDEXES				GEOLOGIC UNIT (USCS)	GRAPHIC	CLASSIFICATION AND PHYSICAL CONDITION
			HARDNESS	WELDING	FRACTURE DENSITY	% CORE RECOVERY			
	460						T _{pcpm}	[Symbol]	
	465							[Symbol]	
	470							[Symbol]	
	475							[Symbol]	
	480							[Symbol]	
	485							[Symbol]	
	490							[Symbol]	
	BOTTOM OF HOLE								

WHB_LOG_WHB.GPJ_WHB.GDT 6/14/02

GEOLOGIC LOG OF DRILL HOLE NO. UE-25 RF#18

SHEET 6 OF 6

FEATURE: Waste Handling Building
LOCATION: ESF North Portal Pad
BEGUN: 9/5/2000 FINISHED: 9/21/2000
DEPTH TO WATER: Not Encountered

PROJECT: Yucca Mountain Project
COORDINATES: N 764,522.34 E 570,626.93
TOTAL DEPTH: 493.6 ft.
DEPTH TO BEDROCK: 65.0 ft.

STATE: Nevada
GROUND ELEVATION: 3640.34
ANGLE FROM HORIZONTAL: -90°
HOLE LOGGED BY: USBR/SMF
REVIEWED BY: Mark McKeown

SOIL

Quaternary
Alluvium
(Qal)



ROCK

Pre-Ranier
Mesa
Bedded
Tuff
(Tmbt1)



Tuff "x"
(Tpk)



Tpcpm



Tpcpul



Tpcpnn



Tpcpll



WELDING

Non-Welded



Densely Welded



Moderately Welded



RF18_KEY.WHB.GPJ.WHB.GDT 6/14/02

GEOLOGIC LOG OF DRILL HOLE NO. UE-25 RF#19

SHEET 1 OF 7

FEATURE: Waste Handling Building
 LOCATION: ESF North Portal Pad
 BEGUN: 10/12/2000 FINISHED: 10/23/2000
 DEPTH TO WATER: Not Encountered

PROJECT: Yucca Mountain Project
 COORDINATES: N 765,880.41 E 571,383.73
 TOTAL DEPTH: 645.2 ft.
 DEPTH TO BEDROCK: 127.0 ft.

STATE: Nevada
 GROUND ELEVATION: 3661.81
 ANGLE FROM HORIZONTAL: -90
 HOLE LOGGED BY: USBR/SMF
 REVIEWED BY: Mark McKeown

NOTES	DEPTH	SHEAR WAVE VELOCITY ft/s	ENGINEERING INDEXES			% CORE RECOVERY	% ROD	GEOLOGIC UNIT (USCS)	GRAPHIC	CLASSIFICATION AND PHYSICAL CONDITION
			HARDNESS	WELDING	FRACTURE DENSITY					
<p>Purpose of Hole: Preliminary, conceptual-level geotechnical foundation investigations for the design of the Waste Handling Building (WHB).</p> <p>Drill Equipment: Schramm T685 Drill Rig</p> <p>Drillers: G. Fox, V. Mora, M. Fyffe; Dynatec Drilling Inc., Salt Lake City, Utah.</p> <p>Drilling Method: Install 12" hammer. Hammer to 4.87. Cement 10.75 O.D. casing with 1.25 stickup. Re-enter hole on 10/13/2000 with 8.50 Tricone bit. Drill from 4.87 to total depth of 645.15.</p> <p>Drilling Conditions: Lost circulation at 285.00, 300.00, 320.00, 572.73 and 585.00.</p> <p>Drilling Fluid: 0.00 to 4.87: Non-potable water. 4.87 to 645.15: Quick Gel mud with EZ-Mud and LCM to re-establish circulation.</p> <p>Loss Intervals: 285.00, 300.00, 320.00, 572.73 and 585.00.</p> <p>Casing Record: 0.00 to 4.87: 10.75 O.D. casing. 4.87 to 645.15: No casing</p> <p>Hole Completion: Set and cement 645.70 of 4.50 schedule 80 PVC casing. Note: Hole was initially drilled to 645.15. Driller advanced at least .58 while conditioning hole on completion of drilling.</p>									<p>0.0 to 120.0 ft. QUATERNARY ALLUVIUM (Qal) Tuffaceous alluvium consisting of a mixture of pale red and light gray densely welded ignimbrite with minor fragments of white non-welded tuff. Up to 15 percent of the densely welded material have white to light gray caliche coatings.</p> <p>120.0 to 280.0 ft. BEDDED TUFF (Tmbt1) Pre-Rainier Mesa Bedded Tuff composed of bedded and reworked tuff. Bedded tuff is nonwelded, argillic, with up to 10 percent quartz, plagioclase, and sanidine phenocrysts. Bedded tuff contains up to 15 percent argillically altered pumice clasts. Some beds have up to 4 percent volcanic lithic clasts. Tuff is predominately grayish-orange pink and drill cuttings returns are sand to silt sized.</p> <p>280.0 to 410.0 ft. COMB PEAK IGNIMBRITE - TUFF X (Tpk1): Pyroclastic flow, nonwelded, crystalized, with up to 20 percent pumice clasts. Tuff contains 2 to 3 percent sanidine, plagioclase, quartz, and less than 1 percent biotite and hornblende phenocrysts. Up to 8 percent moderate red to medium dark gray, volcanic lithic clasts. Tuff is predominately grayish-orange pink with possible minor silicification.</p> <p>410.0 to 420.0 ft. POST TIVA CANYON BEDDED TUFFS (Tpbts): Bedded tuff, nonwelded, argillic with 1 to 2 percent quartz and sanidine phenocrysts. Pumice clasts compose up to 15 percent pumice clasts and 5 percent volcanic lithic clasts. Tuff is predominately very pale orange and white.</p> <p>420.0 to 510.0 ft. TIVA CANYON TUFF CRYSTAL RICH NON-LITHOPHYSAL ZONE (Tpcrn) Pyroclastic flow, moderately to densely welded, crystalized, with 8 to 10 percent sanidine and plagioclase phenocrysts, and less than 1 percent biotite phenocrysts. From 425 to 436 ft. the tuff has up to 10 percent dark gray pumice clasts. From 436 to 457 ft. the tuff is crystal poor with only 3 percent clasts content. From 457 to 483 ft. the tuff has a mix of light brownish-gray and very light gray pumice clasts, composing up 15 percent of rock.</p> <p>510.0 to 635.0 ft. TIVA CANYON TUFF CRYSTAL POOR UPPER LITHOPHYSAL ZONE (Tpcpul) Pyroclastic flow, densely welded, crystalized, vapor-phase altered, light gray, with 2 to 3 percent sanidine and plagioclase, and less than 1 percent biotite phenocrysts. Tuff has up to 15 percent, very light gray, pumice clasts. Lithophysae are distinguished by vapor-phase altered chips, indicating the edges of voids in the tuff.</p> <p>635.0 to 645.2 ft. TIVA CANYON TUFF CRYSTAL POOR MIDDLE NON-LITHOPHYSAL ZONE (Tpcpmn) Pyroclastic flow, densely welded, crystalized, pale red, with less than 1 percent sanidine, plagioclase, and biotite phenocrysts. Tuff has up to 1 percent pumice clasts and less than 1 percent volcanic lithic clasts. Vapor-phase altered chips indicate some lithophysae from 560.0 to 570.0 ft.</p>	

COMMENTS: 1. Hole logged from cuttings
 2. Shear Wave Velocity data from GeoVision suspension logging. Data acquired from downhole survey conducted after PVC casing installed.

WHB LOG WHB.GPJ WHB.GDT 8/14/02

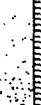
GEOLOGIC LOG OF DRILL HOLE NO. UE-25 RF#19

SHEET 2 OF 7

FEATURE: Waste Handling Building
 LOCATION: ESF North Portal Pad
 BEGUN: 10/12/2000 FINISHED: 10/23/2000
 DEPTH TO WATER: Not Encountered

PROJECT: Yucca Mountain Project
 COORDINATES: N 765,880.41 E 571,383.73
 TOTAL DEPTH: 645.2 ft.
 DEPTH TO BEDROCK: 127.0 ft.

STATE: Nevada
 GROUND ELEVATION: 3661.81
 ANGLE FROM HORIZONTAL: -90
 HOLE LOGGED BY: USBR/SMF
 REVIEWED BY: Mark McKeown

NOTES	DEPTH	SHEAR WAVE VELOCITY ft/s	ENGINEERING INDEXES				% CORE RECOVERY	% RQD	GEOLOGIC UNIT [USCS]	GRAPHIC	CLASSIFICATION AND PHYSICAL CONDITION
			HARDNESS	WELDING	FRACTURE DENSITY						
	105							Qal			
	110										
	115										
	120										
	125										
	130										
	135										
	140										
	145										
	150										
	155										
	160										
	165										
	170							Tmbt1			
	175										
	180										
	185										
	190										
	195										
	200										
	205										
	210										
	215										

WHB_LOG WHB.GPJ WHB.GDT 6/14/02

GEOLOGIC LOG OF DRILL HOLE NO. UE-25 RF#19

SHEET 3 OF 7

FEATURE: Waste Handling Building

PROJECT: Yucca Mountain Project

STATE: Nevada

LOCATION: ESF North Portal Pad

COORDINATES: N 765,880.41 E 571,383.73

GROUND ELEVATION: 3661.81

BEGUN: 10/12/2000 FINISHED: 10/23/2000

TOTAL DEPTH: 645.2 ft.

ANGLE FROM HORIZONTAL: -90

DEPTH TO WATER: Not Encountered

DEPTH TO BEDROCK: 127.0 ft.

HOLE LOGGED BY: USBR/SMF

REVIEWED BY: Mark McKeown

NOTES	DEPTH	SHEAR WAVE VELOCITY ft/s	ENGINEERING INDEXES				GEOLOGIC UNIT [USCS]	GRAPHIC	CLASSIFICATION AND PHYSICAL CONDITION
			HARDNESS	WELDING	FRACTURE DENSITY	% CORE RECOVERY			
	220	~2500							
	225	~2500							
	230	~2500							
	235	~2500							
	240	~2500							
	245	~2500							
	250	~2500							
	255	~2500							
	260	~2500							
	265	~2500							
	270	~2500							
	275	~2500							
	280	~2500							
	285	~2500							
	290	~2500							
	295	~2500							
	300	~2500							
	305	~2500							
	310	~2500							
	315	~2500							
	320	~2500							
	325	~2500							
	330	~2500							
	335	~2500							

WHB_LOG WHB.GPJ WHB.GDT 8/14/02

GEOLOGIC LOG OF DRILL HOLE NO. UE-25 RF#19

SHEET 4 OF 7

FEATURE: Waste Handling Building

PROJECT: Yucca Mountain Project

STATE: Nevada

LOCATION: ESF North Portal Pad

COORDINATES: N 765,880.41 E 571,383.73

GROUND ELEVATION: 3661.81

BEGUN: 10/12/2000 FINISHED: 10/23/2000

TOTAL DEPTH: 645.2 ft.

ANGLE FROM HORIZONTAL: -90

DEPTH TO WATER: Not Encountered

DEPTH TO BEDROCK: 127.0 ft.

HOLE LOGGED BY: USBR/SMF

REVIEWED BY: Mark McKeown

NOTES	DEPTH	SHEAR WAVE VELOCITY ft/s	ENGINEERING INDEXES				GEOLOGIC UNIT (USCS)	GRAPHIC	CLASSIFICATION AND PHYSICAL CONDITION
			HARDNESS	WELDING	FRACTURE DENSITY	% CORE RECOVERY			
	1000 2000 3000 4000 5000 6000 7000 8000 9000								
	340 345 350 355 360 365 370 375 380 385 390 395 400 405 410 415 420 425 430 435 440 445 450 455								
						Tpk1			
						Tpb15			
						Tpcm			

WHB LOG WHB.GPJ WHB.GDT 6/14/02

GEOLOGIC LOG OF DRILL HOLE NO. UE-25 RF#19

SHEET 6 OF 7

FEATURE: Waste Handling Building
 LOCATION: ESF North Portal Pad
 BEGUN: 10/12/2000 FINISHED: 10/23/2000
 DEPTH TO WATER: Not Encountered

PROJECT: Yucca Mountain Project
 COORDINATES: N 765,880.41 E 571,383.73
 TOTAL DEPTH: 645.2 ft.
 DEPTH TO BEDROCK: 127.0 ft.

STATE: Nevada
 GROUND ELEVATION: 3661.81
 ANGLE FROM HORIZONTAL: -90
 HOLE LOGGED BY: USBR/SMF
 REVIEWED BY: Mark McKeown

NOTES	DEPTH	SHEAR WAVE VELOCITY ft/s	ENGINEERING INDEXES				GEOLOGIC UNIT (USCS)	GRAPHIC	CLASSIFICATION AND PHYSICAL CONDITION
			HARDNESS	WELDING	FRACTURE DENSITY	% CORE RECOVERY			
	1000 2000 3000 4000 5000 6000 7000 8000 9000								
	580 585 590 595 600 605 610 615 620 625 630 635 640 645								
			BOTTOM OF HOLE				Tpcpul		
							Tpcpmn		

WHB_LOG_WHB.GPJ WHB.GDT 6/14/02

GEOLOGIC LOG OF DRILL HOLE NO. UE-25 RF#19

SHEET 7 OF 7

FEATURE: Waste Handling Building
 LOCATION: ESF North Portal Pad
 BEGUN: 10/12/2000 FINISHED: 10/23/2000
 DEPTH TO WATER: Not Encountered

PROJECT: Yucca Mountain Project
 COORDINATES: N 765,880.41 E 571,383.73
 TOTAL DEPTH: 645.2 ft.
 DEPTH TO BEDROCK: 127.0 ft.

STATE: Nevada
 GROUND ELEVATION: 3661.81
 ANGLE FROM HORIZONTAL: -90°
 HOLE LOGGED BY: USBR/SMF
 REVIEWED BY: Mark McKeown

SOIL

Quaternary
 Alluvium
 (Qal)



ROCK

Pre-Ranier
 Mesa
 Bedded
 Tuff
 (Tmbt1)



Tuff 'x'
 (Tpk1)



Post Tiva
 Canyon
 Bedded
 Tuff
 (Tpkt5)



Tpcpm



Tpcpl



Tpcpmn



WELDING

Non-Welded



Densely Welded



Moderately Welded



RF19_KEY_WHB.GPJ_WHB.GDT 6/14/02

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GEOLOGIC LOG OF DRILL HOLE NO. UE-25 RF#20

SHEET 2 OF 3

FEATURE: Waste Handling Building
 LOCATION: ESF North Portal Pad
 BEGUN: 9/5/2000 FINISHED: 9/8/2000
 DEPTH TO WATER: Not Encountered

PROJECT: Yucca Mountain Project
 COORDINATES: N 765,637.36 E 570,796.82
 TOTAL DEPTH: 160.0 ft.
 DEPTH TO BEDROCK: 98.0 ft.

STATE: Nevada
 GROUND ELEVATION: 3671.26
 ANGLE FROM HORIZONTAL: -90
 HOLE LOGGED BY: USBR/SMF
 REVIEWED BY: Mark McKeown

NOTES	DEPTH	SHEAR WAVE VELOCITY ft/s	ENGINEERING INDEXES				GEOLOGIC UNIT (USCS)	GRAPHIC	CLASSIFICATION AND PHYSICAL CONDITION
			HARDNESS	WELDING	FRACTURE DENSITY	% CORE RECOVERY			
	105						Tpbt5		
	110								
	115						Tpcm		
	120								
	125								
	130								
	135								
	140								
	145						Tpcpul		
	150								
	155								
	160								BOTTOM OF HOLE

WHB LOG WHB.GPJ WHB.GDT 6/14/02

GEOLOGIC LOG OF DRILL HOLE NO. UE-25 RF#20

SHEET 3 OF 3

FEATURE: Waste Handling Building
 LOCATION: ESF North Portal Pad
 BEGUN: 9/5/2000 FINISHED: 9/8/2000
 DEPTH TO WATER: Not Encountered

PROJECT: Yucca Mountain Project
 COORDINATES: N 765,637.36 E 570,796.82
 TOTAL DEPTH: 160.0 ft.
 DEPTH TO BEDROCK: 98.0 ft.

STATE: Nevada
 GROUND ELEVATION: 3671.26
 ANGLE FROM HORIZONTAL: -90°
 HOLE LOGGED BY: USBR/SMF
 REVIEWED BY: Man. McKeown

SOIL

Fill
(made
ground)



Quaternary
Alluvium
(Qal)



ROCK

Post Tiva
Canyon
Bedded
Tuff
(Tpbts)



Tpcpm



Tpcpl



WELDING

Non-Welded



Densely Welded



Moderately Welded



RF20 KEY WHB.GPJ WHB.GDT 6/14/02

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GEOLOGIC LOG OF DRILL HOLE NO. UE-25 RF#21

SHEET 1 OF 3

FEATURE: Waste Handling Building
 LOCATION: ESF North Portal Pad
 BEGUN: 9/6/2000 FINISHED: 9/7/2000
 DEPTH TO WATER: Not Encountered

PROJECT: Yucca Mountain Project
 COORDINATES: N 765,898.81 E 570,739.18
 TOTAL DEPTH: 192.2 ft.
 DEPTH TO BEDROCK: 115.0 ft.

STATE: Nevada
 GROUND ELEVATION: 3673.02
 ANGLE FROM HORIZONTAL: -90
 HOLE LOGGED BY: USBR/SMF
 REVIEWED BY: Mark McKeown

NOTES	DEPTH	ENGINEERING INDEXES					GEOLOGIC UNIT [USCS]	GRAPHIC	CLASSIFICATION AND PHYSICAL CONDITION
		SHEAR WAVE VELOCITY ft/s	HARDNESS	WELDING	FRACTURE DENSITY	% CORE RECOVERY			
<p>Purpose of Hole: Preliminary, conceptual-level geotechnical foundation investigations for the design of the Waste Handling Building (WHB).</p> <p>Drill Equipment: Schramm T685 Drill Rig</p> <p>Drillers: G. Fox, V. Mora, M. Fyffe; Dynatec Drilling Inc.; Salt Lake City, Utah.</p> <p>Drilling Method: Install 12" hammer. Hammer to 5.01. Cement 10.75 O.D. casing with 1.00 slickup. Re-enter hole on 9/6/2000 with 8.50 Tricone bit. Drill from 5.01 to total depth of 192.23.</p> <p>Drilling Conditions: Lost circulation at 125.00 and 190.00</p> <p>Drilling Fluid: 0.00 to 5.01: Non-potable water. 5.01 to 125.00: Quick Gel mud with EZ-Mud. 125.00 to 192.23: Quick Gel with EZ-Mud and LCM to re-establish circulation.</p> <p>Loss Intervals: 125.00 and 190.00</p> <p>Casing Record: 0.00 to 5.01: 10.75 O.D. casing. 5.01 to 192.23: No casing</p> <p>Hole Completion: Set and cement 192.04 of 4.50 schedule 80 PVC casing.</p>	1000						Fill	<p>0.0 to 5.0 ft. PAD FILL (Fill) Predominately fine to coarse, hard, subangular gravel with a trace of nonplastic fines on gravel surfaces; derived from moderately to densely welded Tuff.</p>	
	2000							<p>5.0 to 115.0 ft. QUATERNARY ALLUVIUM (Qal) Tuffaceous alluvium consisting of a mixture of pale red and light gray densely welded ignimbrite with minor fragments of white non-welded tuff. Up to 15 percent of the densely welded material has white to light gray caliche coatings.</p>	
	3000							<p>115.0 to 165.0 ft. TIVA CANYON TUFF CRYSTAL RICH NON-LITHOPHYSAL ZONE (Tpcrm) Pyroclastic flow, moderately to densely welded, crystallized, with 8 to 10 percent sanidine and plagioclase phenocrysts, and less than 1 percent biotite phenocrysts. From 102 to 110 ft. the tuff has up to 7 percent dark gray pumice clasts. From 110 to 123 ft. the tuff is crystal poor with only 1 percent clast content. From 123 to 127 ft. the tuff has a mix of light brownish-gray and very light gray pumice clasts, composing up 10 percent of rock.</p>	
	4000							<p>165.0 to 192.2 ft. TIVA CANYON TUFF CRYSTAL POOR UPPER LITHOPHYSAL ZONE (Tpcpul) Pyroclastic flow, densely welded, crystallized, vapor-phase altered, light gray, with 2 to 3 percent sanidine and plagioclase, and less than 1 percent biotite phenocrysts. Tuff has up to 15 percent, very light gray, pumice clasts. Lithophysae are distinguished by vapor-phase altered chips, indicating the edges of voids in the tuff.</p>	
	5000							<p>Qal</p>	
	6000								
	7000								
	8000								
	9000								
	10000								
	11000								
	12000								
	13000								
	14000								
	15000								
	16000								
	17000								
	18000								
	19000								

COMMENTS:

1. Hole logged from cuttings
2. LCM (Lost Circulation Material) consists of cellophane cuttings or cotton seed hulls.
3. Shear Wave Velocity data from GeoVision suspension logging. Data acquired from downhole survey conducted after PVC casing installed.

WHB LOG WHB.GPJ WHB.GDT 6/14/02

GEOLOGIC LOG OF DRILL HOLE NO. UE-25 RF#21

SHEET 2 OF 3

FEATURE: Waste Handling Building
 LOCATION: ESF North Portal Pad
 BEGUN: 9/6/2000 FINISHED: 9/7/2000
 DEPTH TO WATER: Not Encountered

PROJECT: Yucca Mountain Project
 COORDINATES: N 765,898.81 E 570,739.18
 TOTAL DEPTH: 192.2 ft.
 DEPTH TO BEDROCK: 115.0 ft.

STATE: Nevada
 GROUND ELEVATION: 3673.02
 ANGLE FROM HORIZONTAL: -90
 HOLE LOGGED BY: USBR/SMF
 REVIEWED BY: Mark McKeown

NOTES	DEPTH	SHEAR WAVE VELOCITY ft/s	ENGINEERING INDEXES			% CORE RECOVERY	% ROD	GEOLOGIC UNIT (USCS)	GRAPHIC	CLASSIFICATION AND PHYSICAL CONDITION
			HARDNESS	WELDING	FRACTURE DENSITY					
	105							Qal	[Hatched Pattern]	
	110									
	115									
	120								[Dotted Pattern]	
	125									
	130									
	135									
	140									
	145									
	150									
	155									
	160									
	165									
	170									
	175									
	180									
	185									
	190									
BOTTOM OF HOLE										

WHB LOG WHB.GPJ WHB.GDT 6/14/02

GEOLOGIC LOG OF DRILL HOLE NO. UE-25 RF#21

SHEET 3 OF 3

FEATURE: Waste Handling Building
LOCATION: ESF North Portal Pad
BEGUN: 9/6/2000 FINISHED: 9/7/2000
DEPTH TO WATER: Not Encountered

PROJECT: Yucca Mountain Project
COORDINATES: N 765,898.81 E 570,739.18
TOTAL DEPTH: 192.2 ft.
DEPTH TO BEDROCK: 115.0 ft.

STATE: Nevada
GROUND ELEVATION: 3673.02
ANGLE FROM HORIZONTAL: -90°
HOLE LOGGED BY: USBR/SMF
REVIEWED BY: Mark McKeown

SOIL

Fill
(made
ground)



Quaternary
Alluvium



ROCK

Tpcpm



Tpcpl



WELDING

Moderately Welded



Densely Welded



RF21_KEY WHB.GPJ WHB.GDT 6/14/02

INTENTIONALLY LEFT BLANK

GEOLOGIC LOG OF DRILL HOLE NO. UE-25 RF#22

SHEET 1 OF 6

FEATURE: Waste Handling Building
 LOCATION: ESF North Portal Pad
 BEGUN: 7/25/2000 FINISHED: 8/15/2000
 DEPTH TO WATER: Not Encountered

PROJECT: Yucca Mountain Project
 COORDINATES: N 766,206.2 E 570,793.48
 TOTAL DEPTH: 540.6 ft.
 DEPTH TO BEDROCK: 90.0 ft.

STATE: Nevada
 GROUND ELEVATION: 3679.17
 ANGLE FROM HORIZONTAL: -90
 HOLE LOGGED BY: USBR/SMF
 REVIEWED BY: Mark McKeown

NOTES	DEPTH	ENGINEERING INDEXES						GEOLOGIC UNIT (USCS)	GRAPHIC	CLASSIFICATION AND PHYSICAL CONDITION					
		SHEAR WAVE VELOCITY (ft/s)													
		1000	2000	3000	4000	5000	6000	HARDNESS	WELDING	FRACTURE DENSITY	% CORE RECOVERY	% RCD			
<p>Purpose of Hole: Develop geologic design data required to develop Waste Handling Building foundation parameters and seismic hazard analysis.</p> <p>Drill Equipment: Schramm T685 Drill Rig, UDR 1000 Drill Rig.</p> <p>Drillers: George Fox, D Harrison, R Mckay, Dynatec Drilling Inc., Salt Lake City, Utah.</p> <p>Drilling Method: Install 12" hammer. Hammer to 5.00. Cement 10.75 O.D. casing with 1.02 stickup. Drill to depth of 511.47 with 8.50 Tricone bit. Install PQ rods to serve as temporary casing. Install HQ core system. Core with HQ to total depth of 540.56.</p> <p>Drilling Conditions:</p> <p>Drilling Fluid: 0.00 to 5.00: Non-potable water. 5.00 to 540.56: Non-potable water, Quick Gel Mud with EZ-Mud and LCM to re-establish circulation.</p> <p>Loss Intervals: 443.00 to 490.00: circulation was re-established in some intervals.</p> <p>Casing Record: 0.00 to 5.00: 10.75 O.D. casing. 5.00 to 511.47: No casing. 511.47 to 540.56: PQ casing (?)</p> <p>Hole Completion: PVC casing set and cemented to total depth of 511.38.</p>	5												Gal	<p>0.0 to 80.0 ft. QUATERNARY ALLUVIUM (Gal) Tuffaceous alluvium consisting of a mixture of pale red and light gray densely welded ignimbrite with minor fragments of white non-welded tuff. Up to 15 percent of the densely welded material have white to light gray caliche coatings.</p> <p>80.0 to 318.0 ft. BEDDED TUFF (Tmbt1) Pre-Rainier Mesa Bedded Tuff composed of bedded and reworked tuff. Bedded tuff is nonwelded, argillic, with up to 10 percent quartz, plagioclase, and sanidine phenocrysts. Bedded tuff contains up to 15 percent argillically altered pumice clasts. Some beds have up to 4 percent volcanic lithic clasts. Tuff is predominately grayish-orange pink and drill cuttings returns are sand to silt sized.</p> <p>318.0 to 415.0 ft. COMB PEAK IGNIMBRITE - TUFF X (Tpkj): Pyroclastic flow, nonwelded, crystallized, with up to 15 percent pumice clasts. Tuff contains 2 to 3 percent sanidine, plagioclase, quartz, and less than 1 percent biotite and hornblende phenocrysts. Up to 3 percent moderate red to medium dark gray, volcanic lithic clasts. Tuff is predominately grayish-orange pink with possible minor silicification.</p> <p>415.0 to 438.0 ft. POST TIVA CANYON BEDDED TUFFS (Tpbt5): Bedded tuff, nonwelded, argillic with 1 to 2 percent quartz and sanidine phenocrysts. Pumice clasts compose up to 15 percent pumice clasts and 5 percent volcanic lithic clasts. Tuff is predominately very pale orange and white.</p> <p>438.0 to 530.5 ft. TIVA CANYON TUFF CRYSTAL RICH NON-LITHOPHYSAL ZONE (Tpcrn) From 438.0 to 511.5 ft. borehole was mud-rotary drilled, the following is a description of drill chips. Pyroclastic flow, moderately to densely welded, crystallized, with 8 to 10 percent sanidine and plagioclase phenocrysts, and less than 1 percent biotite phenocrysts. From 455 to 485 ft. the tuff has a mix of light brownish-gray and very light gray pumice clasts, composing up to 10 percent of rock. No recovery from 485 to 505.4 ft. Borehole cored from 511.5 to 540.56 ft., the following is a description of drill core. Pyroclastic flow, densely welded, crystallized with vapor phase alteration. Tuff has 10 to 15 percent, brownish-gray pumice clasts up to 20 by 5 mm in size. Up to 10 percent sanidine and plagioclase phenocrysts with less than 1 percent biotite phenocrysts. Generally the rock is soft to mostly moderately hard (H4), moderately to slightly weathered (W4), slightly (FD4) to moderately fractured (FD5).</p>	
		10													
		15													
		20													
		25													
		30													
		35													
		40													
		45													
		50													
		55													
		60													
		65													
		70													
		75													
		80													
		85													
		90												Tmbt1	
		95													

Discontinuity Measurements:

Depth	Angle*	Roughness	Infilling
511.7	90		R3
512.0	90		R3
512.1	90		R3
512.15	90		R2
512.4 - 513.0	Fracture Zone		Vapor Phase
513.1	20		R2
514.1	90		R3
514.15	50		R3
516.35	90		R3
518.3	90		R3
518.4	90		R3
519.9	60		R3
521.5	60		R3
522.4 - 522.6	90		R2
522.8	73		R4
525.0	90		R3
525.5	47		R4
526.4 - 527.1	90		R3 Fracture Zone
528.0	40		R3

COMMENTS: 1. Hole logged from cuttings to 511.47 and core from 511.47 to 540.56.
 2. Shear Wave Velocity data from GeoVision suspension logging. Data acquired from downhole survey conducted after PVC casing installed.
 3. No usable velocity data acquired above 229 feet.

WHB_LOG WHB.GPJ WHB.GDT 6/14/02

GEOLOGIC LOG OF DRILL HOLE NO. UE-25 RF#22

SHEET 2 OF 6

FEATURE: Waste Handling Building
 LOCATION: ESF North Portal Pad
 BEGUN: 7/25/2000 FINISHED: 8/15/2000
 DEPTH TO WATER: Not Encountered

PROJECT: Yucca Mountain Project
 COORDINATES: N 766,206.2 E 570,793.48
 TOTAL DEPTH: 540.6 ft.
 DEPTH TO BEDROCK: 90.0 ft.

STATE: Nevada
 GROUND ELEVATION: 3679.17
 ANGLE FROM HORIZONTAL: -90
 HOLE LOGGED BY: USBR/SMF
 REVIEWED BY: Mark McKeown

NOTES	DEPTH	SHEAR WAVE VELOCITY ft/s	ENGINEERING INDEXES			% CORE RECOVERY	% ROD	GEOLOGIC UNIT (USCS)	GRAPHIC	CLASSIFICATION AND PHYSICAL CONDITION																																																											
			HARDNESS	WELDING	FRACTURE DENSITY																																																																
	105								530.0 90 R3																																																												
	110								<p>530.0 to 540.6 ft. TIVA CANYON TUFF CRYSTAL POOR UPPER LITHOPHYSAL ZONE (Tpcpu) Pyroclastic flow, densely welded, crystallized, medium gray with less than 5 percent pumice clasts up to 35 by 5 mm. No lithophysae are present in this core run, however contact is distinguished by the decrease in phenocrysts to 2 to 3 percent sanidine and plagioclase with less than 1 percent biotite. Tuff has less than 1 percent dark-yellowish brown and light gray volcanic lithic fragments. Generally the rock is moderately hard (H4), moderately (W4) weathered, and moderately fractured (FD5).</p> <p>Discontinuity Measurements:</p> <table border="1"> <thead> <tr> <th>Depth</th> <th>Angle*</th> <th>Roughness</th> <th>Infilling</th> </tr> </thead> <tbody> <tr><td>530.9</td><td>30</td><td>R4</td><td></td></tr> <tr><td>531.7</td><td>55</td><td>R4</td><td></td></tr> <tr><td>532.6</td><td>15</td><td>R3</td><td></td></tr> <tr><td>533.1</td><td>70</td><td>R4</td><td>Vapor Phase</td></tr> <tr><td>534.4</td><td>75</td><td>R4</td><td>Vapor Phase</td></tr> <tr><td>535.0</td><td>50</td><td>R4</td><td></td></tr> <tr><td>535.4</td><td>90</td><td>R4</td><td>Vapor Phase</td></tr> <tr><td>535.6</td><td>85</td><td>R4</td><td>Vapor Phase & calcite</td></tr> <tr><td>536.2</td><td>60</td><td>R3</td><td></td></tr> <tr><td>537.0</td><td>60</td><td>R2</td><td>Rubble</td></tr> <tr><td>537.5</td><td>52</td><td>R4</td><td></td></tr> <tr><td>537.7</td><td>48</td><td>R3</td><td>Vapor Phase</td></tr> <tr><td>538.5</td><td>60</td><td>R3</td><td>Vapor Phase</td></tr> <tr><td>538.9 - 540.6</td><td></td><td></td><td>Breccia Zone</td></tr> </tbody> </table> <p>* Angles are measured from core axis and are plus or minus 5 degrees.</p>	Depth	Angle*	Roughness	Infilling	530.9	30	R4		531.7	55	R4		532.6	15	R3		533.1	70	R4	Vapor Phase	534.4	75	R4	Vapor Phase	535.0	50	R4		535.4	90	R4	Vapor Phase	535.6	85	R4	Vapor Phase & calcite	536.2	60	R3		537.0	60	R2	Rubble	537.5	52	R4		537.7	48	R3	Vapor Phase	538.5	60	R3	Vapor Phase	538.9 - 540.6			Breccia Zone
Depth	Angle*	Roughness	Infilling																																																																		
530.9	30	R4																																																																			
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	210																																																																				
	215																																																																				

WHB LOG WHB.GPJ WHB.GDT 6/14/02

GEOLOGIC LOG OF DRILL HOLE NO. UE-25 RF#22

SHEET 3 OF 6

FEATURE: Waste Handling Building
 LOCATION: ESF North Portal Pad
 BEGUN: 7/25/2000 FINISHED: 8/15/2000
 DEPTH TO WATER: Not Encountered

PROJECT: Yucca Mountain Project
 COORDINATES: N 766,206.2 E 570,793.48
 TOTAL DEPTH: 540.6 ft.
 DEPTH TO BEDROCK: 90.0 ft.

STATE: Nevada
 GROUND ELEVATION: 3679.17
 ANGLE FROM HORIZONTAL: -90
 HOLE LOGGED BY: USBR/SMF
 REVIEWED BY: Mark McKeown

NOTES	DEPTH	SHEAR WAVE VELOCITY m/s	ENGINEERING INDEXES				% CORE RECOVERY	% ROD	GEOLOGIC UNIT (USCS)	GRAPHIC	CLASSIFICATION AND PHYSICAL CONDITION
			HARDNESS	WELDING	FRACTURE DENSITY	% CORE RECOVERY					
	220 225 230 235 240 245 250 255 260 265 270 275 280 285 290 295 300 305 310 315 320 325 330 335							Tmb1			
								Tpki			

WHB_LOG WHB.GPJ WHB.GDT 6/14/02

GEOLOGIC LOG OF DRILL HOLE NO. UE-25 RF#22

SHEET 4 OF 6

FEATURE: Waste Handling Building
 LOCATION: ESF North Portal Pad
 BEGUN: 7/25/2000 FINISHED: 8/15/2000
 DEPTH TO WATER: Not Encountered

PROJECT: Yucca Mountain Project
 COORDINATES: N 766,206.2 E 570,793.48
 TOTAL DEPTH: 540.6 ft.
 DEPTH TO BEDROCK: 90.0 ft.

STATE: Nevada
 GROUND ELEVATION: 3679.17
 ANGLE FROM HORIZONTAL: -90
 HOLE LOGGED BY: USBR/SMF
 REVIEWED BY: Mark McKeown

NOTES	DEPTH	SHEAR WAVE VELOCITY [Vs]	ENGINEERING INDEXES					% CORE RECOVERY	% ROD	GEOLOGIC UNIT [USCS]	GRAPHIC	CLASSIFICATION AND PHYSICAL CONDITION
			HARDNESS	WELDING	FRACTURE DENSITY	% CORE RECOVERY	% ROD					
	1000 2000 3000 4000 5000 6000 7000 8000 9000											
	340											
	345											
	350											
	355											
	360											
	365											
	370											
	375											
	380											
	385											
	390											
	395											
	400											
	405											
	410											
	415											
	420											
	425											
	430											
	435											
	440											
	445											
	450											
	455											

WHB_LOG WHB.GPJ WHB.GDT 8/14/02

GEOLOGIC LOG OF DRILL HOLE NO. UE-25 RF#22

SHEET 5 OF 6

FEATURE: Waste Handling Building
 LOCATION: ESF North Portal Pad
 BEGUN: 7/25/2000 FINISHED: 8/15/2000
 DEPTH TO WATER: Not Encountered

PROJECT: Yucca Mountain Project
 COORDINATES: N 766,206.2 E 570,793.48
 TOTAL DEPTH: 540.6 ft.
 DEPTH TO BEDROCK: 90.0 ft.

STATE: Nevada
 GROUND ELEVATION: 3679.17
 ANGLE FROM HORIZONTAL: -90
 HOLE LOGGED BY: USBR/SMF
 REVIEWED BY: Mark McKeown

NOTES	DEPTH	SHEAR WAVE VELOCITY m/s	ENGINEERING INDEXES			% CORE RECOVERY	% ROD	GEOLOGIC UNIT [USCS]	GRAPHIC	CLASSIFICATION AND PHYSICAL CONDITION
			HARDNESS	WELDING	FRACTURE DENSITY					
	460									
	465									
	470									
	475									
	480									
	485									
	490									
	495									
	500									
	505									
	510									
	515					97	54			
	520				FD4	94	77			
	525									
	530			H4	FD5	99	71			
	535					93	86			
	540				FD4	98	59			
	BOTTOM OF HOLE									

Tpcm

Begin core drilling at 511.5

Tpcpul

WHB_LOG_WHB.GPJ.WHB.GDT 6/14/02

GEOLOGIC LOG OF DRILL HOLE NO. UE-25 RF#22

SHEET 6 OF 6

FEATURE: Waste Handling Building
 LOCATION: ESF North Portal Pad
 BEGUN: 7/25/2000 FINISHED: 8/15/2000
 DEPTH TO WATER: Not Encountered

PROJECT: Yucca Mountain Project
 COORDINATES: N 766,206.2 E 570,793.48
 TOTAL DEPTH: 540.6 ft.
 DEPTH TO BEDROCK: 90.0 ft.

STATE: Nevada
 GROUND ELEVATION: 3679.17
 ANGLE FROM HORIZONTAL: -90°
 HOLE LOGGED BY: USBR/SMF
 REVIEWED BY: Mark McKeown

SOIL

Quaternary
Alluvium
(Qal)



ROCK

Pre-Rainier
Mesa
Bedded
Tuff
(Tmbt1)



Tuff "x"
(Tpk1)



Post Tiva
Canyon
Bedded
Tuff
(Tpbt5)



Tpcpm



Tpcpl



WELDING

Non-Welded



Densely Welded



HARDNESS

Alpha-numeric descriptor	Descriptor	Criteria
H1	Extremely	Core, fragment, or exposure cannot be scratched with knife or sharp pick; can only be chipped with repeated heavy hammer blows.
H2	Very Hard	Cannot be scratched with knife or sharp pick. Core or fragment breaks with repeated heavy hammer blows.
H3	Hard	Can be scratched with knife or sharp pick with difficulty (heavy pressure). Heavy hammer blow required to break specimen.
H4	Moderately Hard	Can be scratched with knife or sharp pick with light pressure. Core or fragment breaks with moderate hammer blow.
H5	Moderately Soft	Can be grooved 1/16 inch (2mm) deep by sharp pick with moderate or heavy pressure. Core or fragment breaks with light hammer blow or heavy manual pressure.
H6	Soft	Can be grooved or gouged easily by knife or sharp pick with light pressure, can be scratched with fingernail. Breaks with light to moderate manual pressure.
H7	Very Soft	Can be readily indented, grooved or gouged with fingernail, or carved with a knife. Breaks with light manual pressure.

WEATHERING

Alpha-numeric descriptor	Descriptor	Criteria	General characteristics (strength, excavation, etc.)
W1	Fresh		Hammer rings when crystalline rocks are struck. Almost always rock excavation except for naturally weak or weakly cemented rocks such as siltstones or shales.
W2	Slightly weathered to fresh		
W3	Slightly weathered		Hammer rings when crystalline rocks are struck. Body of rock not weakened. With few exceptions, such as siltstones or shales, classified as rock excavation.
W4	Moderately to slightly weathered		
W5	Moderately weathered		Hammer does not ring when rock is struck. Body of rock is slightly weakened. Depending on fracturing, usually is rock excavation except in naturally weak rocks such as siltstones or shales.
W6	Intensely to moderately weathered		
W7	Intensely weathered		Dull sound when struck with hammer, usually can be broken with moderate to heavy manual pressure or by light hammer blow without reference to planes of weakness such as incipient or hairline fractures, or vein-ets. Rock is significantly weakened. Usually common excavation.
W8	Very intensely weathered		
W9	Decomposed		Can be granulated by hand. Always common excavation. Resistant minerals such as quartz may be present as "stringers" or "dikes".

FRACTURE DENSITY

Alpha-numeric descriptor	Descriptor	Criteria (Excludes mechanical breaks)
FD0	Unfractured	No observed fractures.
FD1	Very slightly fractured	Core recovered mostly in lengths greater than 3 feet (1 m).
FD2	Slightly to very slightly fractured	
FD3	Slightly fractured	Core recovered mostly in lengths from 1 to 3 feet (300 to 1,000 mm) with few scattered lengths less than 1 foot (300 mm) or greater than 3 feet (1,000 mm).
FD4	Moderately to slightly fractured	
FD5	Moderately fractured	Core recovered mostly in lengths from 0.33 to 1.0 foot (100 to 300 mm) with most lengths about 0.67 foot (200 mm).
FD6	Moderately to intensely fractured	
FD7	Intensely fractured	Lengths average from 0.1 to 0.33 foot (30 to 100 mm) with fragmented intervals. Core recovered mostly in lengths less than 0.33 foot (100 mm).
FD8	Very intensely to intensely fractured	
FD9	Very intensely fractured	Core recovered mostly as chips and fragments with a few scattered short core lengths.

RF22_KEY WHB.GPJ WHB.GDT 6/14/02

GEOLOGIC LOG OF DRILL HOLE NO. UE-25 RF#23

SHEET 1 OF 3

FEATURE: Waste Handling Building
 LOCATION: ESF North Portal Pad
 BEGUN: 9/25/2000 FINISHED: 9/27/2000
 DEPTH TO WATER: Not Encountered

PROJECT: Yucca Mountain Project
 COORDINATES: N 765,311.43 E 570,465.03
 TOTAL DEPTH: 159.1 ft.
 DEPTH TO BEDROCK: 76.0 ft.

STATE: Nevada
 GROUND ELEVATION: 3673.98
 ANGLE FROM HORIZONTAL: -90
 HOLE LOGGED BY: USBR/SMF
 REVIEWED BY: Mark McKeown

NOTES	DEPTH	SHEAR WAVE VELOCITY ft/s	ENGINEERING INDEXES			% CORE RECOVERY	% ROD	GEOLOGIC UNIT [USCS]	GRAPHIC	CLASSIFICATION AND PHYSICAL CONDITION
			HARDNESS	WELDING	FRACTURE DENSITY					
<p>Purpose of Hole: Preliminary, conceptual-level geotechnical foundation investigations for the design of the Waste Handling Building (WHB).</p> <p>Drill Equipment: Schramm T685 Drill Rig</p> <p>Drillers: G. Fox, V. Mora, M. Fyffe; Dynatec Drilling Inc.; Salt Lake City, Utah.</p> <p>Drilling Method: Install 12" hammer. Hammer to 5.00. Cement 10.75 O.D. casing with 1.03 stickup. Re-enter hole on 9/26/2000 with 8.50 Tricone bit. Drill from 5.00 to total depth of 159.10.</p> <p>Drilling Conditions: 1 new bit. Circulation weak from 119.71 to 139.40</p> <p>Drilling Fluid: 0.00 to 5.00: Non-potable water. 5.00 to 119.71: Quick Gel mud with EZ-Mud. 119.71.00 to 159.10: Quick Gel with EZ-Mud and LCM to improve circulation.</p> <p>Loss Intervals: 119.71.00 to 139.40: Circulation weak</p> <p>Casing Record: 0.00 to 5.00 : 10.75 O.D. casing. 5.00 to 159.10: No casing</p> <p>Hole Completion: Set and cement 158.96 of 4.50 schedule 80 PVC casing.</p>								<p>0.0 to 12.0 ft. PAD FILL (Fill) Predominately fine to coarse, hard, subangular gravel with a trace of nonplastic fines on gravel surfaces; derived from moderately to densely welded Tuff.</p> <p>12.0 to 76.0 ft. QUATERNARY ALLUVIUM (Gal) Tuffaceous alluvium consisting of a mixture of pale red and light gray densely welded ignimbrite with minor fragments of white non-welded tuff. Up to 15 percent of the densely welded material has white to light gray caliche coatings.</p> <p>76.0 to 92.0 ft. COMB PEAK IGIMBRITE - TUFF X (Tpki): Pyroclastic flow, nonwelded, crystallized, with up to 15 percent pumice clasts. Tuff contains 2 to 3 percent sanidine, plagioclase, quartz, and less than 1 percent biotite and hornblende phenocrysts. Up to 20 percent moderate red to medium dark gray, volcanic lithic clasts. Tuff is predominately grayish-orange pink with possible minor silicification.</p> <p>92.0 to 95.0 ft. POST TIVA CANYON BEDDED TUFFS (Tpbts): Bedded tuff, nonwelded, argillic with 1 to 2 percent quartz and sanidine phenocrysts. Up to 15 percent pumice clasts and 5 percent volcanic lithic clasts. Tuff is predominately very pale orange and white.</p> <p>95.0 to 159.1 ft. TIVA CANYON TUFF CRYSTAL RICH NON-LITHOPHYSAL ZONE (Tpcm) Pyroclastic flow, moderately to densely welded, crystallized, with 8 to 10 percent sanidine and plagioclase phenocrysts, and less than 1 percent biotite phenocrysts. From 108.0 to 115.0 ft. the tuff has up to 10 percent dark gray pumice clasts. From 115.0 to 135.0 ft. the tuff is crystal poor with only 3 percent Clasts content. From 135.0 to 159.1 ft. the tuff has a mix of light brownish-gray and very light gray pumice clasts, composing up 15 percent of rock.</p>		

COMMENTS: 1. Hole logged from cuttings
 2. Shear Wave Velocity data from GeoVision suspension logging. Data acquired from downhole survey conducted after PVC casing installed.

WHB LOG, WHB.GPJ, WHB.GDT, 8/14/02

GEOLOGIC LOG OF DRILL HOLE NO. UE-25 RF#23

SHEET 2 OF 3

FEATURE: Waste Handling Building
 LOCATION: ESF North Portal Pad
 BEGUN: 9/25/2000 FINISHED: 9/27/2000
 DEPTH TO WATER: Not Encountered

PROJECT: Yucca Mountain Project
 COORDINATES: N 765,311.43 E 570,465.03
 TOTAL DEPTH: 159.1 ft.
 DEPTH TO BEDROCK: 76.0 ft.

STATE: Nevada
 GROUND ELEVATION: 3673.98
 ANGLE FROM HORIZONTAL: -90
 HOLE LOGGED BY: USBR/SMF
 REVIEWED BY: Mark McKeown

NOTES	DEPTH	SHEAR WAVE VELOCITY ft/s	ENGINEERING INDEXES				% CORE RECOVERY	% ROD	GEOLOGIC UNIT (USCS)	GRAPHIC	CLASSIFICATION AND PHYSICAL CONDITION	
			HARDNESS	WELDING	FRACTURE DENSITY							
	105 110 115 120 125 130 135 140 145 150 155										Tpcm	
			BOTTOM OF HOLE									

WHB LOG WHB.GPJ WHB.GDT 8/14/02

GEOLOGIC LOG OF DRILL HOLE NO. UE-25 RF#23

SHEET 3 OF 3

FEATURE: Waste Handling Building
LOCATION: ESF North Portal Pad
BEGUN: 9/25/2000 FINISHED: 9/27/2000
DEPTH TO WATER: Not Encountered

PROJECT: Yucca Mountain Project
COORDINATES: N 765,311.43 E 570,465.03
TOTAL DEPTH: 159.1 ft.
DEPTH TO BEDROCK: 76.0 ft.

STATE: Nevada
GROUND ELEVATION: 3673.98
ANGLE FROM HORIZONTAL: -90°
HOLE LOGGED BY: USBR/SMF
REVIEWED BY: Mark McKeown

SOIL

Fill
(made
ground)



Quaternary
Alluvium
(Qal)



ROCK

Tuff "x"
(Tpk)



Post Tiva
Canyon
Bedded
Tuff
(Tpb5)



Tpcpn



WELDING

Non-Welded



Densely Welded



RF23_KEY WHB.GPJ WHB.GDT 6/14/02

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GEOLOGIC LOG OF DRILL HOLE NO. UE-25 RF#24

SHEET 1 OF 4

FEATURE: Waste Handling Building
 LOCATION: ESF North Portal Pad
 BEGUN: 8/15/2000 FINISHED: 8/23/2000
 DEPTH TO WATER: Not Encountered

PROJECT: Yucca Mountain Project
 COORDINATES: N 766,344.31 E 570,542.26
 TOTAL DEPTH: 268.0 ft.
 DEPTH TO BEDROCK: 45.0 ft.

STATE: Nevada
 GROUND ELEVATION: 3684.48
 ANGLE FROM HORIZONTAL: -90
 HOLE LOGGED BY: USBR/SMF
 REVIEWED BY: Mark McKeown

NOTES	DEPTH	SHEAR WAVE VELOCITY ft/s	ENGINEERING INDEXES				% CORE RECOVERY	% ROD	GEOLOGIC UNIT [USGS]	GRAPHIC	CLASSIFICATION AND PHYSICAL CONDITION
			HARDNESS	WELDING	FRACTURE DENSITY	% CORE RECOVERY					
<p>Purpose of Hole: Preliminary, conceptual-level geotechnical foundation investigations for the design of the Waste Handling Building (WHB).</p> <p>Drill Equipment: Schramm T685 Drill Rig</p> <p>Drillers: G. Fox, V. Mora, M. Fyffe; Dynatec Drilling Inc.; Salt Lake City, Utah.</p> <p>Drilling Method: Install 12" hammer. Hammer to 5.06. Cement 10.75 O.D. casing with 1.07 slickup. Re-enter hole on 8/17/2000 with 8.50 Tricone bit. Drill from 5.06 to total depth of 267.96.</p> <p>Drilling Conditions: Lost circulation to weak circulation from 100.00 to 267.96. 233.00 to 236.00 very soft drilling. Smooth to rough drilling in some intervals.</p> <p>Drilling Fluid: 0.00 to 5.06: Non-potable water. 5.06 to 100.00: Quick Gel mud with EZ-Mud. 100.00 to 267.96: Quick Gel with EZ-Mud and LCM to re-establish circulation.</p> <p>Loss Intervals: 100.00 to 267.96: Lost circulation to weak circulation.</p> <p>Casing Record: 0.00 to 5.06 : 10.75 O.D. casing. 5.06 to 267.96: No casing</p> <p>Hole Completion: Set and cement 266.05 of 4.50 schedule 80 PVC casing.</p>							<p>0.0 to 10.0 ft. PAD FILL (Fill) Predominately fine to coarse, hard, subangular gravel with a trace of nonplastic fines on gravel surfaces; derived from moderately to densely welded Tuff.</p> <p>10.0 to 30.0 ft. QUATERNARY ALLUVIUM (Qal) Tuffaceous alluvium consisting of a mixture of pale red and light gray densely welded ignimbrite with minor fragments of white non-welded tuff. Up to 15 percent of the densely welded material has white to light gray caliche coatings.</p> <p>30.0 to 110.0 ft. TIVA CANYON TUFF CRYSTAL RICH NON-LITHOPHYSAL ZONE (Tpcr) Pyroclastic flow, moderately to densely welded, crystalized, with 8 to 10 percent sanidine and plagioclase phenocrysts, and less than 1 percent biotite phenocrysts. From 44.0 to 57.0 ft. the tuff is pumice poor with less than 1 percent clast content. From 57.0 to 93.0 ft. the tuff has a mix of light brownish-gray and very light gray pumice clasts, composing up 15 percent of rock. Based on the occurrence of vapor phase mineralization fragments in the chips, there is a lithophysal bearing zone from 93.0 to 104.0 ft. Phenocryst content begins to decrease at 104.0 ft.</p> <p>110.0 to 230.0 ft. TIVA CANYON TUFF CRYSTAL POOR UPPER LITHOPHYSAL ZONE (Tpcup) Pyroclastic flow, densely welded, crystalized, vapor phase altered, light gray, with less than 1 percent sanidine, plagioclase, and biotite phenocrysts. Tuff has less than 1 percent, very light gray, pumice clasts and volcanic lithic fragments. Lithophysae are distinguished by vapor phase altered chips, indicating the edges of voids in the tuff.</p> <p>230.0 to 267.9 ft. TIVA CANYON TUFF CRYSTAL POOR MIDDLE NON-LITHOPHYSAL ZONE (Tpcpm) Pyroclastic flow, densely welded, crystalized, pale red, with less than 1 percent sanidine, plagioclase, and biotite phenocrysts. Tuff has up to 1 percent pumice clasts and less than 1 percent volcanic lithic clasts. Vapor phase altered chips indicate some lithophysae from 360.0 to 367.0 ft.</p>				

COMMENTS: 1. Hole logged from cuttings
 2. Shear Wave Velocity data from GeoVision suspension logging. Data acquired from downhole survey conducted after PVC casing installed.

WHB LOG WHB.GPJ WHB.GDT 6/14/02

GEOLOGIC LOG OF DRILL HOLE NO. UE-25 RF#24

SHEET 2 OF 4

FEATURE: Waste Handling Building
 LOCATION: ESF North Portal Pad
 BEGUN: 8/15/2000 FINISHED: 8/23/2000
 DEPTH TO WATER: Not Encountered

PROJECT: Yucca Mountain Project
 COORDINATES: N 766,344.31 E 570,542.26
 TOTAL DEPTH: 268.0 ft.
 DEPTH TO BEDROCK: 45.0 ft.

STATE: Nevada
 GROUND ELEVATION: 3684.48
 ANGLE FROM HORIZONTAL: -90
 HOLE LOGGED BY: USBR/SMF
 REVIEWED BY: Mark McKeown

NOTES	DEPTH	SHEAR WAVE VELOCITY ft/s	ENGINEERING INDEXES				% CORE RECOVERY	% ROD	GEOLOGIC UNIT (USCS)	GRAPHIC	CLASSIFICATION AND PHYSICAL CONDITION
			HARDNESS	WELDING	FRACTURE DENSITY	% CORE RECOVERY					
	105							Tpcm			
	110										
	115										
	120										
	125										
	130										
	135										
	140										
	145										
	150										
	155										
	160										
	165							Tpcpul			
	170										
	175										
	180										
	185										
	190										
	195										
	200										
	205										
	210										
	215										

WHB LOG WHB GPT WHB GDT 8/14/02

GEOLOGIC LOG OF DRILL HOLE NO. UE-25 RF#24

SHEET 3 OF 4

FEATURE: Waste Handling Building
 LOCATION: ESF North Portal Pad
 BEGUN: 8/15/2000 FINISHED: 8/23/2000
 DEPTH TO WATER: Not Encountered

PROJECT: Yucca Mountain Project
 COORDINATES: N 766,344.31 E 570,542.26
 TOTAL DEPTH: 268.0 ft.
 DEPTH TO BEDROCK: 45.0 ft.

STATE: Nevada
 GROUND ELEVATION: 3684.48
 ANGLE FROM HORIZONTAL: -90
 HOLE LOGGED BY: USBR/SMF
 REVIEWED BY: Mark McKeown

NOTES	DEPTH	SHEAR WAVE VELOCITY ft/s	ENGINEERING INDEXES				GEOLOGIC UNIT (USCS)	GRAPHIC	CLASSIFICATION AND PHYSICAL CONDITION
			HARDNESS	WELDING	FRACTURE DENSITY	% CORE RECOVERY			
	220								
	225					T _{pcpul}			
	230								
	235								
	240								
	245								
	250					T _{pcpmn}			
	255								
	260								
	265								
	BOTTOM OF HOLE								

WHB_LOG WHB.GPJ WHB.GDT 8/14/02

GEOLOGIC LOG OF DRILL HOLE NO. UE-25 RF#24

SHEET 4 OF 4

FEATURE: Waste Handling Building
LOCATION: ESF North Portal Pad
BEGUN: 8/15/2000 FINISHED: 8/23/2000
DEPTH TO WATER: Not Encountered

PROJECT: Yucca Mountain Project
COORDINATES: N 786,344.31 E 570,542.26
TOTAL DEPTH: 268.0 ft.
DEPTH TO BEDROCK: 45.0 ft.

STATE: Nevada
GROUND ELEVATION: 3684.48
ANGLE FROM HORIZONTAL: -90°
HOLE LOGGED BY: USBR/SMF
REVIEWED BY: Mark McKeown

SOIL

Fill
(made
ground)



Quaternary
Alluvium
(Qal)



ROCK

Tpcpm



Tpcpul



Tpcpmn



WELDING

Moderately Welded



Densely Welded



RF24 KEY WHB.GPJ WHB.GDT 6/14/02

GEOLOGIC LOG OF DRILL HOLE NO. UE-25 RF#25

SHEET 1 OF 3

FEATURE: Waste Handling Building
 LOCATION: ESF North Portal Pad
 BEGUN: 9/21/2000 FINISHED: 9/22/2000
 DEPTH TO WATER: Not Encountered

PROJECT: Yucca Mountain Project
 COORDINATES: N 765,968.15 E 570,626.38
 TOTAL DEPTH: 159.0 ft.
 DEPTH TO BEDROCK: 70.0 ft.

STATE: Nevada
 GROUND ELEVATION: 3676.54
 ANGLE FROM HORIZONTAL: -90
 HOLE LOGGED BY: USBR/SMF
 REVIEWED BY: Mark McKeown

NOTES	DEPTH	SHEAR WAVE VELOCITY fts	ENGINEERING INDEXES			% CORE RECOVERY	% ROD	GEOLOGIC UNIT {USCS}	GRAPHIC	CLASSIFICATION AND PHYSICAL CONDITION
			HARDNESS	WELDING	FRACTURE DENSITY					
<p>Purpose of Hole: Preliminary, conceptual-level geotechnical foundation investigations for the design of the Waste Handling Building (WHB).</p> <p>Drill Equipment: Schramm T685 Drill Rig</p> <p>Drillers: G. Fox, V. Mora, M. Fyffe; Dynatec Drilling Inc., Salt Lake City, Utah.</p> <p>Drilling Method: Install 12" hammer. Hammer to 5.00. Cement 10.75 O.D. casing with 1.12 stickup. Re-enter hole on 9/22/2000 with 8.50 Tricone bit. Drill from 5.00 to total depth of 158.97.</p> <p>Drilling Conditions: 1 new bit.</p> <p>Drilling Fluid: 0.00 to 5.00: Non-potable water. 5.00 to 158.97: Quick Gel mud with EZ-Mud.</p> <p>Loss Intervals: None</p> <p>Casing Record: 0.00 to 5.00 : 10.75 O.D. casing. 5.00 to 158.97: No casing</p> <p>Hole Completion: Set and cement 158.50 of 4.50 schedule 80 PVC casing.</p>	5						Fill	<p>0.0 to 10.0 ft. PAD FILL (Fw) Predominately fine to coarse, hard, subangular gravel with a trace of nonplastic fines on gravel surfaces; derived from moderately to densely welded Tuff.</p>		
	10								<p>10.0 to 70.0 ft. QUATERNARY ALLUVIUM (Gal) Tuffaceous alluvium consisting of a mixture of pale red and light gray densely welded ignimbrite with minor fragments of white non-welded tuff. Up to 15 percent of the densely welded material has white to light gray caliche coatings.</p>	
	15									<p>70.0 to 125.0 ft. TIVA CANYON TUFF CRYSTAL RICH NON-LITHOPHYSAL ZONE (Tpcm) Pyroclastic flow, moderately to densely welded, crystallized, with 8 to 10 percent sanidine and plagioclase phenocrysts, and less than 1 percent biotite phenocrysts. From 70.0 to 87.0 ft. the tuff is pumice poor with less than 1 percent clast content. From 87.0 to 115.0 ft. the tuff has a mix of light brownish-gray and very light gray pumice clasts, composing up 10 percent of rock. Based on the occurrence of vapor phase mineralization fragments in the chips, there is a lithophysal bearing zone from 115.0 to 125.0 ft.</p>
	20									<p>125.0 to 159.0 ft. TIVA CANYON TUFF CRYSTAL POOR UPPER LITHOPHYSAL ZONE (Tpcpu) Pyroclastic flow, densely welded, crystallized, vapor phase altered, light gray, with less than 1 percent sanidine, plagioclase, and biotite phenocrysts. Tuff has less than 1 percent, very light gray, pumice clasts and volcanic lithic fragments. Lithophysae are distinguished by vapor phase altered chips, indicating the edges of voids in the tuff.</p>
	25									
	30									
	35									
	40									
	45									
	50									
	55									
	60									
	65									
	70									
	75									
80										
85										
90										
95										

COMMENTS: 1. Hole logged from cuttings
 2. Shear Wave Velocity data from GeoVision suspension logging. Data acquired from downhole survey conducted after PVC casing installed.

WHB_LOG_WHB.GPJ WHB.GDT 8/14/02

GEOLOGIC LOG OF DRILL HOLE NO. UE-25 RF#25

SHEET 2 OF 3

FEATURE: Waste Handling Building

PROJECT: Yucca Mountain Project

STATE: Nevada

LOCATION: ESF North Portal Pad

COORDINATES: N 765,968.15 E 570,626.38

GROUND ELEVATION: 3676.54

BEGUN: 9/21/2000 FINISHED: 9/22/2000

TOTAL DEPTH: 159.0 ft.

ANGLE FROM HORIZONTAL: -90

DEPTH TO WATER: Not Encountered

DEPTH TO BEDROCK: 70.0 ft.

HOLE LOGGED BY: USBR/SMF

REVIEWED BY: Mark McKeown

NOTES	DEPTH	SHEAR WAVE VELOCITY ft/s	ENGINEERING INDEXES				GEOLOGIC UNIT [USCS]	GRAPHIC	CLASSIFICATION AND PHYSICAL CONDITION
			HARDNESS	WELDING	FRACTURE DENSITY	% CORE RECOVERY			
	<div style="display: flex; flex-direction: column; align-items: center;"> <div style="margin-bottom: 5px;">100</div> <div style="margin-bottom: 5px;">105</div> <div style="margin-bottom: 5px;">110</div> <div style="margin-bottom: 5px;">115</div> <div style="margin-bottom: 5px;">120</div> <div style="margin-bottom: 5px;">125</div> <div style="margin-bottom: 5px;">130</div> <div style="margin-bottom: 5px;">135</div> <div style="margin-bottom: 5px;">140</div> <div style="margin-bottom: 5px;">145</div> <div style="margin-bottom: 5px;">150</div> <div style="margin-bottom: 5px;">155</div> </div>						<div style="margin-bottom: 20px;">Tpcm</div> <div>Tcpul</div>		
			BOTTOM OF HOLE						

WHB LOG WHB.GPJ WHB.GDT 6/14/02

GEOLOGIC LOG OF DRILL HOLE NO. UE-25 RF#25

SHEET 3 OF 3

FEATURE: Waste Handling Building
LOCATION: ESF North Portal Pad
BEGUN: 9/21/2000 FINISHED: 9/22/2000
DEPTH TO WATER: Not Encountered

PROJECT: Yucca Mountain Project
COORDINATES: N 765,968.15 E 570,626.38
TOTAL DEPTH: 159.0 ft.
DEPTH TO BEDROCK: 70.0 ft.

STATE: Nevada
GROUND ELEVATION: 3676.54
ANGLE FROM HORIZONTAL: -90°
HOLE LOGGED BY: USBR/SMF
REVIEWED BY: Mark McKeown

SOIL

Fill
(made
ground)



Quaternary
Alluvium
(Qal)



ROCK

Tpcpm



Tpcpul



WELDING

Densely Welded



RF25_KEY WHB.GPJ WHB.GDT 6/14/02

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GEOLOGIC LOG OF DRILL HOLE NO. UE-25 RF#26

SHEET 3 OF 4

FEATURE: Waste Handling Building
 LOCATION: ESF North Portal Pad
 BEGUN: 6/26/2000 FINISHED: 7/25/2000
 DEPTH TO WATER: Not Encountered

PROJECT: Yucca Mountain Project
 COORDINATES: N 785,247.95 E 570,579.71
 TOTAL DEPTH: 264.9 ft.
 DEPTH TO BEDROCK: 85.0 ft.

STATE: Nevada
 GROUND ELEVATION: 3670.79
 ANGLE FROM HORIZONTAL: -90
 HOLE LOGGED BY: USBR/SMF
 REVIEWED BY: Mark McKeown

NOTES	DEPTH	SHEAR WAVE VELOCITY ft/s	ENGINEERING INDEXES				% CORE RECOVERY	% ROD	GEOLOGIC UNIT {USCS}	GRAPHIC	CLASSIFICATION AND PHYSICAL CONDITION
			HARDNESS	WELDING	FRACTURE DENSITY	% CORE RECOVERY					
	220										
	225										
	230										
	235										
	240										
	245								Tpcm		
	250										
	255										
	260										
	BOTTOM OF HOLE										

WHB LOG WHB.GPJ WHB.GDT 6/14/02

GEOLOGIC LOG OF DRILL HOLE NO. UE-25 RF#26

SHEET 4 OF 4

FEATURE: Waste Handling Building
LOCATION: ESF North Portal Pad
BEGUN: 6/26/2000 FINISHED: 7/25/2000
DEPTH TO WATER: Not Encountered

PROJECT: Yucca Mountain Project
COORDINATES: N 765,247.95 E 570,579.71
TOTAL DEPTH: 264.9 ft.
DEPTH TO BEDROCK: 85.0 ft.

STATE: Nevada
GROUND ELEVATION: 3670.79
ANGLE FROM HORIZONTAL: -90°
HOLE LOGGED BY: USBR/SMF
REVIEWED BY: Mark McKeown

SOIL

Fill
(made
ground)



Quaternary
Alluvium
(Qal)



ROCK

Tuff "x"
(Tpk1)



Post Tiva
Canyon
Bedded
Tuff
(Tpb15)



Tpcpm



WELDING

Non-Welded



Densely Welded



RF26_KEY_WHB.GPJ_WHB.GDT 6/14/02

GEOLOGIC LOG OF DRILL HOLE NO. UE-25 RF#28

SHEET 1 OF 2

FEATURE: Waste Handling Building
 LOCATION: ESF North Portal Pad
 BEGUN: 8/24/2000 FINISHED: 8/25/2000
 DEPTH TO WATER: Not Encountered

PROJECT: Yucca Mountain Project
 COORDINATES: N 765,510.21 E 570,104.87
 TOTAL DEPTH: 100.0 ft.
 DEPTH TO BEDROCK: 15.0 ft.

STATE: Nevada
 GROUND ELEVATION: 3680.63
 ANGLE FROM HORIZONTAL: -90
 HOLE LOGGED BY: USBR/SMF
 REVIEWED BY: Mark McKeown

NOTES	DEPTH	SHEAR WAVE VELOCITY N/s	ENGINEERING INDEXES				% CORE RECOVERY	% ROD	GEOLOGIC UNIT (USCS)	GRAPHIC	CLASSIFICATION AND PHYSICAL CONDITION	
			HARDNESS	WELDING	FRACTURE DENSITY							
<p>Purpose of Hole: Preliminary, conceptual-level geotechnical foundation investigations for the design of the Waste Handling Building (WHB).</p> <p>Drill Equipment: Schramm T685 Drill Rig</p> <p>Drillers: G. Fox, V. Mora, M. Fyffe; Dynatec Drilling Inc.; Salt Lake City, Utah.</p> <p>Drilling Method: Install 12" hammer. Hammer to 4.96. Cement 10.75 O.D. casing with 1.16 slickup. Re-enter hole on 8/25/2000 with 8.50 Tricone bit. Drill from 4.96 to total depth of 99.75.</p> <p>Drilling Conditions: Smooth soft drilling to total depth of hole.</p> <p>Drilling Fluid: 0.00 to 4.96: Non-potable water. 4.96 to total depth of 99.75: Quick Gel mud with EZ-Mud.</p> <p>Loss Intervals: NA</p> <p>Casing Record: 0.00 to 4.96: 10.75 O.D. casing. 4.96 to 99.75: No casing.</p> <p>Hole Completion: Set and cement 97.98 of 4.50 schedule 80 PVC casing.</p>	5							Fill		<p>0.0 to 5.0 ft. PAD FILL (Fill) Predominately fine to coarse, hard, subangular gravel with a trace of nonplastic fines on gravel surfaces; derived from moderately to densely welded Tuff.</p>		
	10								Qal		<p>5.0 to 15.0 ft. QUATERNARY ALLUVIUM (Qal) Tuffaceous alluvium consisting of a mixture of pale red and light gray densely welded ignimbrite with minor fragments of white non-welded tuff. Up to 15 percent of the densely welded material has white to light gray caliche coatings.</p>	
	15											<p>15.0 to 70.0 ft. TIVA CANYON TUFF CRYSTAL RICH NON-LITHOPHYSAL ZONE (Tpcm) Pyroclastic flow, moderately to densely welded, crystallized, with 8 to 10 percent sanidine and plagioclase phenocrysts, and less than 1 percent biotite phenocrysts. From 15.0 to 30.0 ft. the tuff has a mix of light brownish-gray and very light gray pumice clasts, composing up 10 percent of rock. From 30.0 to 47.0 ft. the presence of vapor phase mineral coatings on the chips indicate the presence lithophysal cavities. Phenocrysts content begins to decrease at 47.0 ft.</p>
	20											
	25											
	30											
	35											
	40											
	45											
	50											
55												
60												
65												
70												
75												
80												
85												
90												
95												
100											BOTTOM OF HOLE	

COMMENTS: 1. Hole logged from cuttings
 2. Shear Wave Velocity data from GeoVision suspension logging. Data acquired from downhole survey conducted after PVC casing installed.

WHB LOG WHB.GPJ WHB.GDT 8/14/02

GEOLOGIC LOG OF DRILL HOLE NO. UE-25 RF#28

SHEET 2 OF 2

FEATURE: Waste Handling Building
LOCATION: ESF North Portal Pad
BEGUN: 8/24/2000 FINISHED: 8/25/2000
DEPTH TO WATER: Not Encountered

PROJECT: Yucca Mountain Project
COORDINATES: N 765,510.21 E 570,104.87
TOTAL DEPTH: 100.0 ft.
DEPTH TO BEDROCK: 15.0 ft.

STATE: Nevada
GROUND ELEVATION: 3680.63
ANGLE FROM HORIZONTAL: -90°
HOLE LOGGED BY: USBR/SMF
REVIEWED BY: Mark McKeown

SOIL

Fill
(made
ground)



Quaternary
Alluvium
(Qal)



ROCK

Tpcpm



Tpcpul



WELDING

Densely Welded



RF28_KEY WHB.GPJ WHB.GDT 6/14/02

GEOLOGIC LOG OF DRILL HOLE NO. UE-25 RF#29

SHEET 2 OF 5

FEATURE: Waste Handling Building
 LOCATION: ESF North Portal Pad
 BEGUN: 10/26/2000 FINISHED: 11/1/2000
 DEPTH TO WATER: Not Encountered

PROJECT: Yucca Mountain Project
 COORDINATES: N 766,018.46 E 570,836.04
 TOTAL DEPTH: 430.0 ft.
 DEPTH TO BEDROCK: 85.0 ft.

STATE: Nevada
 GROUND ELEVATION: 3672.71
 ANGLE FROM HORIZONTAL: -90
 HOLE LOGGED BY: USBR/SMF
 REVIEWED BY: Mark McKeown

NOTES	DEPTH	SHEAR WAVE VELOCITY ft/s	ENGINEERING INDEXES				% CORE RECOVERY	% ROD	GEOLOGIC UNIT [USCS]	GRAPHIC	CLASSIFICATION AND PHYSICAL CONDITION
			HARDNESS	WELDING	FRACTURE DENSITY	% CORE RECOVERY					
	105	1000									
	110	2000									
	115	3000									
	120	4000									
	125	5000									
	130	6000									
	135	7000									
	140	8000									
	145	9000									
	150										
	155										
	160										
	165										
	170										
	175										
	180										
	185										
	190										
	195										
	200										
	205										
	210										
	215										

WHB LOG WHB.GPJ WHB.GDT 6/14/02

GEOLOGIC LOG OF DRILL HOLE NO. UE-25 RF#29

SHEET 4 OF 5

FEATURE: Waste Handling Building

PROJECT: Yucca Mountain Project

STATE: Nevada

LOCATION: ESF North Portal Pad

COORDINATES: N 766,018.46 E 570,836.04

GROUND ELEVATION: 3672.71

BEGUN: 10/26/2000 FINISHED: 11/1/2000

TOTAL DEPTH: 430.0 ft.

ANGLE FROM HORIZONTAL: -90

DEPTH TO WATER: Not Encountered

DEPTH TO BEDROCK: 85.0 ft.

HOLE LOGGED BY: USBR/SMF

REVISED BY: Mark McKeown

NOTES	DEPTH	SHEAR WAVE VELOCITY ft/s	ENGINEERING INDEXES				% CORE RECOVERY	% ROD	GEOLOGIC UNIT (USCS)	GRAPHIC	CLASSIFICATION AND PHYSICAL CONDITION
			HARDNESS	WELDING	FRACTURE DENSITY	% CORE RECOVERY					
	340	4000									
	345	4000									
	350	4000									
	355	4000							Tpki	[Symbol]	
	360	4000									
	365	4000									
	370	4000									
	375	4000							Tpbt5	[Symbol]	
	380	4000									
	385	4000									
	390	4000									
	395	4000									
	400	4000									
	405	4000							Tpcm	[Symbol]	
	410	4000									
	415	4000									
	420	4000									
	425	4000									
	430	4000									BOTTOM OF HOLE

WHB LOG WHB.GPJ WHB.GDT 6/14/02

GEOLOGIC LOG OF DRILL HOLE NO. UE-25 RF#29

SHEET 5 OF 5

FEATURE: Waste Handling Building
LOCATION: ESF North Portal Pad
BEGUN: 10/26/2000 FINISHED: 11/1/2000
DEPTH TO WATER: Not Encountered

PROJECT: Yucca Mountain Project
COORDINATES: N 766,018.46 E 570,836.04
TOTAL DEPTH: 430.0 ft.
DEPTH TO BEDROCK: 85.0 ft.

STATE: Nevada
GROUND ELEVATION: 3672.71
ANGLE FROM HORIZONTAL: -90°
HOLE LOGGED BY: USBR/SMF
REVIEWED BY: Mark McKeown

SOIL

Quaternary
Alluvium
(Qal)



ROCK

Pre-Ranier
Mesa
Bedded
Tuff
(Tmbt1)



Tuff "x"
(Tpx)



Post Tiva
Canyon
Bedded
Tuff
(Tpbts)



Tpcm



WELDING

Non-Welded



Densely Welded



Moderately Welded



RF29_KEY_WHB.GPJ WHB.GDT 6/14/02

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ATTACHMENT II
REVISED LOG OF BOREHOLE RF#13

ATTACHMENT II

REVISED LOG OF BOREHOLE RF#13

As mentioned in Section 6.2.3, borehole RF#13 was originally drilled in 1998 at the location shown on Figure 2 in the main text. Its log was revised for this program in order to show engineering properties and shear wave velocity on the log. During the process of creating final SMF geologic logs for the current program (RF#14 to 29), the RF#13 core was reexamined. Initially, the borehole was logged with a normal fault that repeated the Tpcpmn at the bottom of the hole (CRWMS M&O 1999b, Appendix L). With further drilling it is now accepted that instead of the Tpcpmn the zone in question is the Tpcpln, which is confirmed in all the cored boreholes in the current program (DTN: GS020383114233.003). The revised log of RF#13 (DTN: GS020383114233.003) is included in this attachment. The revised log may also be found in DTN: GS020383114233.003.

GEOLOGIC LOG OF DRILL HOLE NO. UE-25 RF#13

SHEET 2 OF 8

FEATURE: Waste Handling Building
 LOCATION: ESF North Portal Pad
 BEGUN: 10/6/1998 FINISHED: 12/7/1998
 DEPTH TO WATER: Not Encountered

PROJECT: Yucca Mountain Project
 COORDINATES: N 765,500.04 E 570,720.12
 TOTAL DEPTH: 350.1 ft.
 DEPTH TO BEDROCK: 98.0 ft.

STATE: Nevada
 GROUND ELEVATION: 3671.03
 ANGLE FROM HORIZONTAL: -90°
 HOLE LOGGED BY: URS/SMF/USBR
 REVIEWED BY: M. Luebbers/M. McKeown

NOTES	DEPTH	ENGINEERING PROPERTIES			SHEAR WAVE VELOCITY ft/s	GEOLOGIC UNIT	CLASSIFICATION	LITHOLOGY	% CORE RECOVERY	% ROD	CLASSIFICATION AND PHYSICAL CONDITION
		SPT	FRACTURE DENSITY	HARDNESS							
	91 6"										Laboratory Classification: 97.8 - 98.1'
	106 8"						SP				98.0 to 164.4': COMB PEAK IGNIMBRITE - Tuff "X" (Tpkt) 98.0 to 98.5': Very light grey; well indurated (silicified) matrix showing oriented pumice; approximately 40% pumice; 5 - 7% lithic fragments, subrounded to angular, 1 - 2% phenocrysts of quartz(?), felsics, and mafics (biotite(?)). 98.5 to 98.7': Thin bed; white; very fine grained; partly silicified; no distinct pumice. 98.7 to 160.0': White; non-welded; devitrified; 25 - 30% pumice; 1 - 2% phenocrysts of feldspar, quartz, rare mafics including biotite(?); approximately 5% lithic fragments. 160.0 to 162.2': White; non-welded; devitrified; 20 - 30% pumice; 2% phenocrysts; 1% lithic fragments. 162.4 to 162.6': Pinkish gray; very fine grained; 1 - 2% small (<1mm) phenocrysts and 2% very fine grained lithic fragments. 162.6 to 164.4': White; non-welded; devitrified; approximately 25 up to 50% pumice at base; 2% phenocrysts; 2% lithic fragments. Intensely fractured from 98.0 - 100.5'; unfractured from 100.5 - 102.5'; intensely fractured from 102.5 - 105.8'; slightly fractured from 105.8 - 108.1'; intensely to moderately fractured from 108.1 - 115.8'; very intensely to intensely fractured from 115.8 - 121.1'; moderately fractured from 121.1 - 122.8'; intensely to moderately fractured from 122.8 - 145.3'; slightly fractured from 145.3 - 161.8'; and intensely to moderately fractured from 161.8 - 164.4'. Discontinuity Measurements: Incination from Depth (ft.) Core Axis (o) Rough Infilling 99.5 40 R2-R3 trace to paper thin light brown coating 102.9 20 R3 trace to paper thin light brown coating 104.6 60 R2 trace to paper thin light brown coating 109.0 35 R2 trace to paper thin light brown coating 120.9 30 R3 trace to paper thin light brown coating 121.7 50 R2 trace to paper thin light brown coating 125.8 40 R2 trace to paper thin light brown coating 126.0 40 R2 trace to paper thin light brown coating 136.0 45 R3 clean 145.0 30 R2-R3 clean 152.6 40 R1 paper thin light brown coating 154.9 55 R2 trace to paper thin light brown coating
	113 8"						SP-SM				
	119 5"										
	167 10"						Qal				
	100 6"										
	66 3"						SM				
	88 3"										
	125 5"						SM				
	73 4"										
	FD7										
	FD0	H4	W2				Tuff "x" (Tpkt)	100	43		
	FD7							100	68		
								100	65		164.4 - 169.3 TIVA CANYON ASHFALL TUFF (nonwelded) Tpbtt5 Fallout tephra (?); grayish-orange pink to pale brown; argillic alteration (core damp, sticky, surface smeared by core catcher); approximately 10% white pumice; 10% variably colored, altered lithic fragments; a thin (16 mm) layer of pale to moderate red, very well sorted fallout tephra occurs at 166.8'; moderate red to moderate reddish orange and grayish-orange pink, heavily altered from 166.8 - 169.3'; moderately soft from 164.4 - 166.8'; moderately weathered from 164.4 - 166.8'; intensely to moderately fractured from 164.4 - 166.8'; contact with underlying unit (Tpcrn4d) dips 30o below horizontal and is distinct and separated. Discontinuity Measurements: No discontinuities

COMMENTS:

WHB13 LOG WHB13.GPJ WHB13.GDT 6/13/02

GEOLOGIC LOG OF DRILL HOLE NO. UE-25 RF#13

SHEET 3 OF 8

FEATURE: Waste Handling Building
 LOCATION: ESF North Portal Pad
 BEGUN: 10/6/1998 FINISHED: 12/7/1998
 DEPTH TO WATER: Not Encountered

PROJECT: Yucca Mountain Project
 COORDINATES: N 765,500.04 E 570,720.12
 TOTAL DEPTH: 350.1 ft.
 DEPTH TO BEDROCK: 98.0 ft.

STATE: Nevada
 GROUND ELEVATION: 3671.03
 ANGLE FROM HORIZONTAL: -90°
 HOLE LOGGED BY: URS/SMF/USBR
 REVIEWED BY: M. Liebbers, M. McKeown

NOTES	DEPTH	ENGINEERING PROPERTIES			SHEAR WAVE VELOCITY Vs	GEOLOGIC UNIT	CLASSIFICATION	LITHOLOGY	% CORE RECOVERY	% ROD	CLASSIFICATION AND PHYSICAL CONDITION
		SPT	FRACTURE DENSITY	HARDNESS							
	105		FD7					100	65	169.3 - 175.9	TIVA CANYON CRYSTAL RICH NONLITHOPHYSAL TUFF (moderately to strongly welded tuff) Tpcm4d Pale red; moderately welded, devitrified; 7 - 10% vesicular pumice; 7% phenocrysts of feldspar, rare quartz, altered biotite and other mafics; lithic fragments rare to absent; moderately hard; moderately to slightly weathered; very intensely fractured; contact with underlying unit (Tpcm3) is gradational and broken, with significant change in alteration.
	110		FD3					100	42	169.3-170.2	Inclination from Depth (ft.) Core Axis (o) Rough Infilling 85 R2 trace to paper thin light tan coating
	115		FD6					98	52	175.0-176.0	intersecting R3 trace to paper thin white non-crystalline coating 75-85
	120		FD8	W2				72	32	175.9 - 186.6	TIVA CANYON CRYSTAL RICH NONLITHOPHYSAL TUFF (moderately to strongly welded tuff) Tpcm3 Pale red; matrix is highly porous; 10% phenocrysts; pumice and lithic fragments absent; clay-altered, soft, greenish fragments, not aligned, waxy textured, approximately 1 cm; large (2 cm) vesiculated pumice mixed with small flattened cavities (eroded out pumice?); moderately hard; slightly weathered to fresh; very intensely fractured; contact with underlying unit (Tpcm2) is gradational and broken.
	125		FD5					94	30	179.1	Inclination from Depth (ft.) Core Axis (o) Rough Infilling 70 R4 trace light brown 181.2 70 R4 healed with sand-size fragments; 0-1mm white mineral
	130		H4			Tuff "x" (Tpk)		16	0	182.0	intersecting R4 clean 70 and 85 186.5 70 R2-R3 trace white mineral
	135		FD6					68	42	186.6 - 202.0	TIVA CANYON CRYSTAL RICH NONLITHOPHYSAL TUFF (moderately to strongly welded tuff) Tpcm2 Pale red; same as overlying unit except at 191.5' alteration becomes intense, pumice very soft, matrix rough; matrix waxy, friable, plastic, and sticky from 195.5 - 196.5' with splotches of blue/white mineral (opal?); 10 - 12% phenocrysts at 200.3'; moderately hard; slightly weathered to fresh 186.6 - 191.4'; slightly weathered 191.4 - 202.0'; very intensely fractured; contact with underlying unit (Tpcm1) is gradational and broken.
	140			W3				100	43	187.4	Inclination from Depth (ft.) Core Axis (o) Rough Infilling 30 R3 clean 188.0 50 R3 bluish drusy quartz and white noncrystalline coating
	145							96	38	191.5	30 R3 trace white noncrystalline material 192.4 40 R2 trace white noncrystalline material
	150		FD3	W1				100	24	194.2	30 R3 local brown stain 195.2 35 R4 caliche cemented breccia 196.9 25 R3 patches of white mineral 198.3 30 R2 - R3 patches of white mineral 198.8 40 R2 - R3 patches of white mineral 200.6 45 R2 patches of white mineral
	155							100	34	202.0 - 219.1	TIVA CANYON CRYSTAL RICH NONLITHOPHYSAL TUFF (strongly welded tuff) Tpcm1 Light brownish gray, moderately welded, devitrified; 10 - 15% pumice, up to 25 - 35% locally, moderately to highly flattened, up to core diameter; 10% phenocrysts of feldspar and rare quartz(?); some vapor phase

COMMENTS:

WHB13_LOG_WHB13.GPJ_WHB13.GDT 8/13/02

GEOLOGIC LOG OF DRILL HOLE NO. UE-25 RF#13

SHEET 4 OF 8

FEATURE: Waste Handling Building
 LOCATION: ESF North Portal Pad
 BEGUN: 10/6/1998 FINISHED: 12/7/1998
 DEPTH TO WATER: Not Encountered

PROJECT: Yucca Mountain Project
 COORDINATES: N 765,500.04 E 570,720.12
 TOTAL DEPTH: 350.1 ft.
 DEPTH TO BEDROCK: 98.0 ft.

STATE: Nevada
 GROUND ELEVATION: 3671.03
 ANGLE FROM HORIZONTAL: -90°
 HOLE LOGGED BY: URS/SMF/USBR
 REVIEWED BY: M. Luebbers/M. McKeown

NOTES	DEPTH	ENGINEERING PROPERTIES			SHEAR WAVE VELOCITY Vs	GEOLOGIC UNIT	CLASSIFICATION	LITHOLOGY	% CORE RECOVERY	% ROD	CLASSIFICATION AND PHYSICAL CONDITION	
		SPT	FRACTURE DENSITY	HARDNESS								WEATHERING
	160		FD3	H4	W1		Tuff "x" (Tпки)	100	34	alteration of matrix; moderately hard; slightly weathered from 202.0 - 204.7', slightly weathered to fresh from 204.7 - 219.1'; contact with underlying unit (Tpcpul) is a possible fault(?) contact, broken; material from 215.4 to 219.1 feet not recovered.		
	165		FD6	H5	W5		Tpbt5	100	82	Discontinuity Measurements: Inclination from Depth (ft.) Core Axis (o) Rough Infilling 207.1 40 R3 trace light brown stain 212.8 80 R3 trace white mineral 212.8 50 R3 clean		
	170		NR	NR	NR		Tpcm4	100	73	219.1 - 231.5 TIVA CANYON CRYSTAL POOR UPPER LITHOPHYSAL TUFF (strongly welded tuff) Tpcpul Densely welded; pale reddish-brown to grayish-orange pink; 2% pumice; 2 - 3% phenocrysts of feldspar, rare mafics; lithic fragments absent; 1% or less oblate lithophysal cavities with vapor phase minerals and light gray alteration rims, flattened and approximately 20 degrees to near-perpendicular to core axis; at 231.0' first concentration of well developed spherulites; moderately hard from 219.1 - 225.6', hard from 225.6 - 231.5'; slightly weathered to fresh; very intensely fractured; contact with underlying unit (Tpcpmn) is distinct; broken.		
	175				W4			0	NR	Discontinuity Measurements: Inclination from Depth (ft.) Core Axis (o) Rough Infilling 220-223 multiple R3 trace to paper thin white and light brown coating 224.8 15 R5 clean 229.0 30 R3 trace tan and light brown stain		
	180						Tpcm3	70	0	231.5 - 286.7 TIVA CANYON MIDDLE NONLITHOPHYSAL TUFF (densely welded) Tpcpmn Pale reddish-brown; densely welded; devitrified; less than 1% pumice, vapor phase altered and eroded out, up to greater than core diameter, locally occur in swarms up to 50%; approximately 5% pumice below 260'; 2 - 3% phenocrysts of feldspar, hornblende (?); hard from 231.5 - 271.0', moderately hard from 271.0 - 271.5', very hard from 271.5 - 286.7'; fresh from 231.5 - 271.0', slightly weathered from 271.0 - 271.5', slightly weathered to fresh from 271.5 - 286.7'; very intensely fractured from 231.5 - 231.7', slightly to very slightly fractured from 231.7 - 270.5', intensely to moderately fractured from 270.5 - 286.7'; contact with underlying unit (Tpcpmn2) is gradational.		
	185				W2			82	0			
	190		FD9	H4			Tpcm2	72	0	Discontinuity Measurements: Inclination from Depth (ft.) Core Axis (o) Rough Infilling 233.8 70 R2 trace tan and light brown stain 236.0 80 R4 clean 237.0 35 R4 trace tan, light brown, and white stain 237.5 40 R3 paper thin tan, light brown, and white coating 237.7 45 R3 paper thin tan, light brown, and white coating 239.0 45 R2 paper thin tan coating 241.9 20 R2 paper thin tan and white coating 242.1 40 R3 trace white mineral 242.4 40 R3 trace tan and white mineral 249.6 50 R3 trace tan and white mineral 250.5-250.7 20 R4 4 to 6cm yellowish-orange crystalline infilling 251.6 30 R5 white crystalline infilling 256.4 15 R3 paper thin tan and white coating 257.2 70 R3 paper thin tan and white coating 261.7 30 R4 clean		
	195				W3			91	0			
	200							66	0			
	205				W2		Tpcm1	77	0			
								82	0			

COMMENTS:

WHB13_LOG_WHB13.GPJ WHB13.GDT_8/13/02

GEOLOGIC LOG OF DRILL HOLE NO. UE-25 RF#13

SHEET 6 OF 8

FEATURE: Waste Handling Building
 LOCATION: ESF North Portal Pad
 BEGUN: 10/6/1998 FINISHED: 12/7/1998
 DEPTH TO WATER: Not Encountered

PROJECT: Yucca Mountain Project
 COORDINATES: N 765,500.04 E 570,720.12
 TOTAL DEPTH: 350.1 ft.
 DEPTH TO BEDROCK: 98.0 ft.

STATE: Nevada
 GROUND ELEVATION: 3671.03
 ANGLE FROM HORIZONTAL: -9°
 HOLE LOGGED BY: URS/SMF/USBR
 REVIEWED BY: M. Luebbers/M. McKeown

NOTES	DEPTH	ENGINEERING PROPERTIES			SHEAR WAVE VELOCITY ft/s	GEOLOGIC UNIT	CLASSIFICATION		CLASSIFICATION AND PHYSICAL CONDITION
		FRACTURE DENSITY	HARDNESS	WEATHERING			LITHOLOGY	% CORE RECOVERY	
	265	FD2	H3	W1			100	82	302.6 10 R5 healed with paper thin white mineral 303.1 45 R5 paper thin white mineral 303.4 70 R3 paper thin white mineral 303.7 20 R4 clean 305.3 25 R2 1 mm white mineral 306.5 15 R3 1 mm white mineral 307.2 40 R2 1 mm white mineral 307.7 05 R4 1 mm white mineral 308.7 30 R5 partially healed with trace white mineral
	270		H4	W3		Tpcpmm	94	34	309.3 30 R4 clean 309.5 25 R4 trace tan mineral 310.1 35 R5 clean 311.2 50 R3 paper thin white mineral 311.3 50 R4 patches of white mineral 311.5 40 R3 trace of white mineral 312.1 35 R4 paper thin white mineral 314.3 70 R2 healed with 3mm white to grey mineral (vapor phase mineral?)
	275						94	45	314.9 35 R4 paper thin white mineral 315.3 25 R3 clean 315.7 45 R3 paper thin white mineral 316-319 20 R2 paper thin white mineral 319.3 25 R2 paper thin white mineral 320.0 30 R3 paper thin white mineral 320.9 65 R2 1mm white mineral 325.8 60 R3 clean 326.5 40 R4 clean 327.6 60 R3 1 - 2mm white mineral 328.3 30 R3 healed with a trace of white mineral
	280	FD6					100	62	329.6 30 R2 3mm cemented sand and tan and white mineral 330.2 35 R3 1mm white mineral 330.9 20 R4 paper thin white mineral 330.95 65 R4 paper thin white mineral 331.9 70 R4 paper thin white mineral 332.2 35 R4 clean 332.5 25 R4 paper thin white mineral 332.9 45 R4 4mm white mineral 334.6 40 R4 paper thin white mineral 335.3 60 R4 paper thin white mineral 335.6 60 R2 paper thin white mineral 336.2 25 R4 tight; clean 337.0 70 R4 paper thin white mineral 337.1 40 R4 clean 337.7 45 R4 trace white mineral 337.8 50 R4 patches of white mineral 338.0 40 R4 patches of white mineral 338.4 60 R3 patches of white mineral 339.8 40 R2 patches of white mineral 340.3 45 R3 trace white mineral 340.8 35 R4 patches of white mineral 340.9 30 R4 patches of white mineral 341.5 50 R4 paper thin white mineral 342.3 20 R3 healed; 2mm grey mineral 343.5 30 R4 patches of white mineral 343.6 25 R4 patches of white mineral 343.8 60 R2 patches of white mineral 344.1 30 R3 patches of white mineral 345.3 30 R4 1mm white mineral 345.5 25 R4 1mm white mineral 349.3 65 R3 1mm white mineral
	285								
	290		H2	W2			96	61	
	295	FD9				Tpcpll	96	32	
	300						33	0	
	305	FD5		W3			94	71	
	310			W1		Tpcpln	100	46	
							100	34	

COMMENTS:

WHB13.LOG WHB13.GPJ WHB13.GDT 6/13/02

GEOLOGIC LOG OF DRILL HOLE NO. UE-25 RF#13

SHEET 7 OF 8

FEATURE: Waste Handling Building
 LOCATION: ESF North Portal Pad
 BEGUN: 10/6/1998 FINISHED: 12/7/1998
 DEPTH TO WATER: Not Encountered

PROJECT: Yucca Mountain Project
 COORDINATES: N 765,500.04 E 570,720.12
 TOTAL DEPTH: 350.1 ft.
 DEPTH TO BEDROCK: 98.0 ft.

STATE: Nevada
 GROUND ELEVATION: 3671.03
 ANGLE FROM HORIZONTAL: -90°
 HOLE LOGGED BY: URS/SMF/USBR
 REVIEWED BY: M. Luebers/M. McKeown

NOTES	DEPTH	ENGINEERING PROPERTIES			SHEAR WAVE VELOCITY ft/s	GEOLOGIC UNIT	CLASSIFICATION		CLASSIFICATION AND PHYSICAL CONDITION
		SPT	FRACTURE DENSITY	HARDNESS			WEATHERING	LITHOLOGY	
	315			W1	~6000			100 34	
	320			W3	~5000			88 26	
	325				~5500			100 60	
	330	FD5	H2		~6500	Tppln		92 63	
	335			W1	~5500			88 30	
	340				~5000			68 27 96 63 100 72	
	345				~5500				
	350				~5000			100 70	
BOTTOM OF HOLE									

COMMENTS:

WHB13_LOG_WHB13.GPJ WHB13.GDT 6/13/02

GEOLOGIC LOG OF DRILL HOLE NO. UE-25 RF#13

SHEET 8 OF 8

FEATURE: Waste Handling Building
 LOCATION: ESF North Portal Pad
 BEGUN: 10/6/1998 FINISHED: 12/7/1998
 DEPTH TO WATER: Not Encountered

PROJECT: Yucca Mountain Project
 COORDINATES: N 765,500.04 E 570,720.12
 TOTAL DEPTH: 350.1 ft.
 DEPTH TO BEDROCK: 98.0 ft.

STATE: Nevada
 GROUND ELEVATION: 3671.03
 ANGLE FROM HORIZONTAL: -90°
 HOLE LOGGED BY: URS/SMF/USBR
 REVIEWED BY: M Luebbers/M. McKeown

<u>HARDNESS</u>			<u>WEATHERING</u>		
Alpha-numeric descriptor	Descriptor	Criteria	Alpha-numeric descriptor	Descriptor	General characteristics (strength, excavation, etc.)
H1	Extremely	Core, fragment, or exposure cannot be scratched with knife or sharp pick; can only be chipped with repeated heavy hammer blows.	W1	Fresh	Hammer rings when crystalline rocks are struck. Almost always rock excavation except for naturally weak or weakly cemented rocks such as siltstones or shales.
H2	Very Hard	Cannot be scratched with knife or sharp pick. Core or fragment breaks with repeated heavy hammer blows.	W2	Slightly weathered to fresh	
H3	Hard	Can be scratched with knife or sharp pick with difficulty (heavy pressure). Heavy hammer blow required to break specimen.	W3	Slightly weathered	Hammer rings when crystalline rocks are struck. Body of rock not weakened. With few exceptions, such as siltstones or shales, classified as rock excavation.
H4	Moderately Hard	Can be scratched with knife or sharp pick with light pressure. Core or fragment breaks with moderate hammer blow.	W4	Moderately to slightly weathered	
H5	Moderately Soft	Can be grooved 1/16 inch (2mm) deep by sharp pick with moderate or heavy pressure. Core or fragment breaks with light hammer blow or heavy manual pressure.	W5	Moderately weathered	Hammer does not ring when rock is struck. Body of rock is slightly weakened. Depending on fracturing, usually is rock excavation except in naturally weak rocks such as siltstones or shales.
H6	Soft	Can be grooved or gouged easily by knife or sharp pick with light pressure, can be scratched with fingernail. Breaks with light to moderate manual pressure.	W6	Intensely to moderately weathered	
H7	Very Soft	Can be readily indented, grooved or gouged with fingernail, or carved with a knife. Breaks with light manual pressure.	W7	Intensely weathered	Dull sound when struck with hammer, usually can be broken with moderate to heavy manual pressure or by light hammer blow without reference to planes of weakness such as incipient or hairline fractures, or veins etc. Rock is significantly weakened. Usually common excavation.
			W8	Very intensely weathered	
			W9	Decomposed	Can be granulated by hand. Always common excavation. Resistant minerals such as quartz may be present as "stringers" or "dikes".

FRACTURE DENSITY

Alpha-numeric descriptor	Descriptor	Criteria (Excludes mechanical breaks)
FD0	Unfractured	No observed fractures.
FD1	Very slightly fractured	Core recovered mostly in lengths greater than 3 feet (1 m).
FD2	Slightly to very slightly fractured	
FD3	Slightly fractured	Core recovered mostly in lengths from 1 to 3 feet (300 to 1,000 mm) with few scattered lengths less than 1 foot (300 mm) or greater than 3 feet (1,000 mm).
FD4	Moderately to slightly fractured	
FD5	Moderately fractured	Core recovered mostly in lengths from 0.33 to 1.0 foot (100 to 300 mm) with most lengths about 0.67 foot (200 mm).
FD6	Moderately to intensely fractured	
FD7	Intensely fractured	Lengths average from 0.1 to 0.33 foot (30 to 100 mm) with fragmented intervals. Core recovered mostly in lengths less than 0.33 foot (100 mm).
FD8	Very intensely to intensely fractured	
FD9	Very intensely fractured	Core recovered mostly as chips and fragments with a few scattered short core lengths.

RF13 KEY WHB13.GPJ WHB.GDT 6/14/02

ATTACHMENT III

LOGS OF TEST PITS TP-WHB-1 TO TP-WHB-4

As mentioned in Section 6.2.4, this attachment presents the geologic logs (DTN: GS020383114233.001) of the four test pits, TP-WHB-1 to -4, that were excavated in the WHB Area. See Attachment IV for Photomosaic Maps of the test pits.

7-1336-A (1-86) Bureau of Reclamation		LOG OF TEST PIT OR AUGER HOLE		SHEET 1 OF 3 HOLE NO. TP-WHB-1	
FEATURE: Waste Handling Building		PROJECT: Yucca Mountain Project			
LOCATION: TP-WHB-1		GROUND ELEVATION: 3682.0			
COORDINATES: N 766,304 E 570,772		METHOD OF EXPLORATION: John Deere 992 D-LC track hoe			
APPROXIMATE DIMENSIONS: approx. 70 x 70 ft. x 21 ft. deep		HOLE LOGGED BY: Russell Schreiner, 8/28/00			
TOTAL DEPTH: 21.0 ft. DEPTH TO WATER: N/A		DATE EXCAVATED: 07/13/2000 to 07/27/2000			
CLASSIFICATION GROUP SYMBOL	CLASSIFICATION AND DESCRIPTION OF MATERIAL				
(GP-GM)scb	<p>0.0-9.0 ft. POORLY GRADED GRAVEL WITH SILT AND SAND, COBBLES AND BOULDERS - SU1 - (GP-GM)scb: About 60% fine to coarse, hard, subrounded to subangular gravel; about 30% fine to coarse, hard, subrounded to subangular sand; about 10% nonplastic fines with no dry strength and rapid dilatancy; strong reaction with HCl.</p> <p>TOTAL SAMPLE (BY VOLUME): About 15% hard, subrounded to subangular cobbles; about 5% hard, subrounded to subangular boulders; remainder minus 75 mm; max. dimension 600 mm.</p> <p>IN-PLACE CONDITION: Moderate to strong caliche cementation (breaks through rock, not cementation), has thin lens (4 to 6 ") of fine gravel and sand, heavy white calcium carbonate caliche coating on gravel, cobbles, and boulders, dry, pinkish gray to pale yellowish brown to light brown.</p>				
(GP-GM)s	<p>3.0-4.0 ft. POORLY GRADED GRAVEL WITH SILT AND SAND - SU2 - (GP-GM)s: About 70% predominantly fine, hard, subrounded to subangular gravel; about 20% fine to coarse, hard, subrounded to subangular sand; about 10% nonplastic fines with no dry strength, rapid dilatancy; max. size 20 mm; strong reaction with HCl.</p> <p>IN-PLACE CONDITION: Weak to moderate caliche cementation, dry, pale yellowish brown.</p>				
(GP)sc	<p>8.0 to 10.0 ft. POORLY GRADED GRAVEL WITH SAND AND COBBLES - SU3 - (GP)sc: About 80% predominantly fine, hard, subrounded to subangular gravel; about 15% fine to coarse, hard, subrounded to subangular sand; about 5% nonplastic fines with no dry strength, rapid dilatancy; strong reaction with HCl.</p> <p>TOTAL SAMPLE (BY VOLUME): Less than 5% hard, subrounded to subangular cobbles; remainder minus 75 mm; max. dimension 170 mm.</p> <p>IN-PLACE CONDITION: Weak to moderate caliche cementation, dry, pale yellowish brown.</p>				
<p>REMARKS: Test pits excavated using John Deere 992 D-LC track hoe with 2 cubic yard bucket and Caterpillar 966 front end loader. Site prepared using Fiat Allis dozer with a single tooth ripper. Stopped excavation at 21 ft. target depth. Depths may overlap. All 3 exposed walls of the test pit were mapped, and they vary one from the other, i.e., soil units are not continuous across the entire pit. The purpose of soil unit (SU) designations is to label specific soil units within each test pit, and not to correspond to soil units in the other test pits.</p>					

TEST PIT LOG YMWHTP.GPJ WHB-TP.GDT 7/23/02

LOG OF TEST PIT OR AUGER HOLE

FEATURE: <u>Waste Handling Building</u>	PROJECT: <u>Yucca Mountain Project</u>
LOCATION: <u>TP-WHB-1</u>	GROUND ELEVATION: <u>3682.0</u>
COORDINATES: <u>N 766,304</u> <u>E 570,772</u>	METHOD OF EXPLORATION: <u>John Deere 992 D-LC track hoe</u>
APPROXIMATE DIMENSIONS: <u>approx. 70 x 70 ft. x 21 ft. deep</u>	HOLE LOGGED BY: <u>Russell Schreiner, 8/28/00</u>
TOTAL DEPTH: <u>21.0 ft.</u> DEPTH TO WATER: <u>N/A</u>	DATE EXCAVATED: <u>07/13/2000 to 07/27/2000</u>

CLASSIFICATION GROUP SYMBOL	CLASSIFICATION AND DESCRIPTION OF MATERIAL
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(GP-GM)scb	<p>4.0 to 15.5 ft. POORLY GRADED GRAVEL WITH SILT, SAND, COBBLES, AND BOULDERS - SU4 - (GP-GM)scb: About 70% fine to coarse, hard, subrounded to subangular gravel; about 20% fine to coarse, hard, subrounded to subangular sand; about 10% nonplastic fines with no dry strength, rapid dilatancy; strong reaction with HCl.</p> <p>TOTAL SAMPLE (BY VOLUME): About 20% hard, subrounded to subangular cobbles; less than 5% hard, subrounded to subangular boulders, remainder minus 75 mm, max. dimension 600 mm.</p> <p>IN-PLACE CONDITION: Moderate to strong caliche cementation (breaks through rocks, not cementation), heavy white calcium carbonate caliche coating on gravel, cobbles, and boulders, dry, pinkish gray to light brown.</p>
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(GP-GM)sc	<p>13.0 to 16.0 ft. POORLY GRADED GRAVEL WITH SILT, SAND AND COBBLES - SU6 - (GP-GM)sc: About 60% predominantly fine to medium, hard, subrounded to subangular gravel; about 30% fine to coarse, hard, subrounded to subangular sand; about 10% nonplastic fines with no dry strength, rapid dilatancy; strong reaction with HCl.</p> <p>TOTAL SAMPLE (BY VOLUME): Less than 5% hard, subrounded to subangular cobbles; remainder minus 75 mm; max. dimension 230 mm</p> <p>IN-PLACE CONDITION: Moderate to strong caliche cementation (breaks through rocks, not cementation), lensed material with lenses of fine gravels to 4 inches thick, lenses of heavy white caliche cementation, and pockets of fine gravel and sand, heavy white calcium carbonate caliche coating on gravel, and cobbles, dry, pale yellowish brown.</p>
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REMARKS:
 Test pits excavated using John Deere 992 D-LC track hoe with 2 cubic yard bucket and Caterpillar 966 front end loader. Site prepared using Fiat Allis dozer with a single tooth ripper. Stopped excavation at 21 ft. target depth. Depths may overlap. All 3 exposed walls of the test pit were mapped, and they vary one from the other, i.e., soil units are not continuous across the entire pit. The purpose of soil unit (SU) designations is to label specific soil units within each test pit, and not to correspond to soil units in the other test pits.

TEST PIT LOG YMWHTP.GPJ WHB-TP.GDT 7/23/02

LOG OF TEST PIT OR AUGER HOLE

FEATURE: <u>Waste Handling Building</u>	PROJECT: <u>Yucca Mountain Project</u>
LOCATION: <u>TP-WHB-1</u>	GROUND ELEVATION: <u>3682.0</u>
COORDINATES: <u>N 766,304</u> <u>E 570,772</u>	METHOD OF EXPLORATION: <u>John Deere 992 D-LC track hoe</u>
APPROXIMATE DIMENSIONS: <u>approx. 70 x 70 ft. x 21 ft. deep</u>	HOLE LOGGED BY: <u>Russell Schreiner, 8/28/00</u>
TOTAL DEPTH: <u>21.0 ft.</u> DEPTH TO WATER: <u>N/A</u>	DATE EXCAVATED: <u>07/13/2000 to 07/27/2000</u>

CLASSIFICATION GROUP SYMBOL	CLASSIFICATION AND DESCRIPTION OF MATERIAL
(GM)scb	<p>15.5 to 17.0 ft. SILTY GRAVEL WITH SAND, COBBLES, AND BOULDERS - SU7 - (GM)scb: About 50% fine to coarse, hard, subrounded to subangular gravel; about 30% predominantly fine, hard, subrounded to subangular sand; about 20% nonplastic fines with no dry strength, rapid dilatancy; weak to strong reaction with HCl.</p> <p>TOTAL SAMPLE (BY VOLUME): About 10% hard, subrounded to subangular, cobbles; about 10% hard, subrounded to subangular boulders; remainder minus 75 mm; max. dimension 370 mm.</p> <p>IN-PLACE CONDITION: Moderate to strong caliche cementation, layers of medium to fine gravel up to 6 inches thick; fine gravel lens had weak reaction with HCl, heavy white calcium carbonate caliche coating on gravel, cobbles, and boulders, dry, pinkish gray to light brown.</p>
(GP)scb	<p>17.0 to 21.0 ft. POORLY GRADED GRAVEL WITH SAND, COBBLES, AND BOULDERS - SU8 - (GP)scb: About 70% fine to coarse, hard, subrounded to subangular gravel; about 25% fine to coarse, hard, subrounded to subangular sand; about 5% nonplastic fines with no dry strength, rapid dilatancy; strong reaction with HCl.</p> <p>TOTAL SAMPLE (BY VOLUME): About 15% hard, subrounded to subangular cobbles; about 25% hard, subrounded to subangular boulders, max. dimension 350 mm.</p> <p>IN-PLACE CONDITION: Moderate to strong caliche cementation, stratification near floor of pit consists of a few fine to medium (<0.5 mm) grained sand and coarse gravel/cobble (> 20 mm) lenses up to 4 ft long and 0.5 ft wide, heavy white calcium carbonate caliche coating on gravel, cobbles, and boulders, dry, pale yellowish brown.</p>

REMARKS:
 Test pits excavated using John Deere 992 D-LC track hoe with 2 cubic yard bucket and Caterpillar 966 front end loader. Site prepared using Fiat Allis dozer with a single tooth ripper. Stopped excavation at 21 ft. target depth. Depths may overlap. All 3 exposed walls of the test pit were mapped, and they vary one from the other, i.e., soil units are not continuous across the entire pit. The purpose of soil unit (SU) designations is to label specific soil units within each test pit, and not to correspond to soil units in the other test pits.

TEST PIT LOG YMHBTB-GP-J WHB-TP-GDT 7/23/02

LOG OF TEST PIT OR AUGER HOLE

FEATURE: <u>Waste Handling Building</u>	PROJECT: <u>Yucca Mountain Project</u>
LOCATION: <u>TP-WHB-2</u>	GROUND ELEVATION: <u>3658.0</u>
COORDINATES: <u>N 756,595</u> <u>E 571,106</u>	METHOD OF EXPLORATION: <u>John Deere 992 D-LC track hoe</u>
APPROXIMATE DIMENSIONS: <u>approx. 70 x 70 ft. x 19 ft. deep</u>	HOLE LOGGED BY: <u>Russell Schreiner, 9/5/00</u>
TOTAL DEPTH: <u>19.0 ft.</u> DEPTH TO WATER: <u>N/A</u>	DATE EXCAVATED: <u>07/31/2000 to 08/23/2000</u>

CLASSIFICATION GROUP SYMBOL	CLASSIFICATION AND DESCRIPTION OF MATERIAL
(GP-GM)scb	<p>0.0 to 16.0 ft. POORLY GRADED GRAVEL WITH SILT, SAND, COBBLES, AND BOULDERS - SU1 - (GP-GM)scb: About 65% predominantly medium to coarse, subrounded to subangular gravel; about 25% predominantly fine to medium, hard, subrounded to subangular sand; about 10% nonplastic fines with no dry strength, rapid dilatancy; strong reaction with HCl.</p> <p>TOTAL SAMPLE (BY VOLUME): About 15% hard, subrounded to subangular cobbles; about 5% hard, subrounded to subangular boulders, max. dimension 900 mm.</p> <p>IN-PLACE CONDITION: Predominantly strong caliche cementation on the west side of the test pit, pockets of strongly cemented coarse gravels to 4 inches thick, pinkish gray to pale yellowish brown, to light brown.</p>
(GP-GM)scb	<p>0.0 to 14.0 ft. POORLY GRADED GRAVEL WITH SILT, SAND, COBBLES, AND BOULDERS - SU4 - (GP-GM)scb: About 60% predominantly fine to coarse, hard, subrounded to subangular gravel; about 30% predominantly fine to medium, hard, subrounded to subangular sand; about 10% nonplastic fines with no dry strength, rapid dilatancy; strong reaction with HCl.</p> <p>TOTAL SAMPLE (BY VOLUME): About 15% hard, subrounded to subangular cobbles; about 5% hard, subrounded to subangular boulders; remainder minus 75 mm; max. dimension 900 mm.</p> <p>IN-PLACE CONDITION: Predominantly weak to moderate caliche cementation on the east side of the test pit, caliche coatings on gravels, lenses of fine gravel to 4 inches thick, dry, pale yellowish brown to light brown.</p>
(GP-GM)sc	<p>4.0 to 6.0 ft. POORLY GRADED GRAVEL WITH SILT, SAND, AND COBBLES - SU5 - (GP-GM)sc: About 70% predominantly fine, to medium, subrounded to subangular gravel; about 20% predominantly medium to</p>

REMARKS:
 Test pits excavated using John Deere 992 D-LC track hoe with 2 cubic yard bucket and Caterpillar 966 front end loader. Site prepared using Fiat Allis dozer with a single tooth ripper. Stopped excavation at 19 ft. target depth. Depths may overlap. All 3 exposed walls of the test pit were mapped, and they vary one from the other, i.e., soil units are not continuous across the entire pit. The purpose of soil unit (SU) designations is to label specific soil units within each test pit, and not to correspond to soil units in the other test pits.

TEST PIT LOG YMWHBTP.GPJ WHB-TP.GDT 7/23/02

LOG OF TEST PIT OR AUGER HOLE

FEATURE: <u>Waste Handling Building</u>	PROJECT: <u>Yucca Mountain Project</u>
LOCATION: <u>TP-WHB-2</u>	GROUND ELEVATION: <u>3658.0</u>
COORDINATES: <u>N 756,595</u> <u>E 571,106</u>	METHOD OF EXPLORATION: <u>John Deere 992 D-LC track hoe</u>
APPROXIMATE DIMENSIONS: <u>approx. 70 x 70 ft. x 19 ft. deep</u>	HOLE LOGGED BY: <u>Russell Schreiner, 9/5/00</u>
TOTAL DEPTH: <u>19.0 ft.</u> DEPTH TO WATER: <u>N/A</u>	DATE EXCAVATED: <u>07/31/2000 to 08/23/2000</u>

CLASSIFICATION GROUP SYMBOL	CLASSIFICATION AND DESCRIPTION OF MATERIAL
	<p>coarse, subrounded to subangular sand; about 10% nonplastic fines with no dry strength, rapid dilatancy; strong reaction with HCl.</p> <p>TOTAL SAMPLE (BY VOLUME): About 10% hard subrounded to subangular cobbles; less than 5% hard, subrounded to subangular boulders; remainder minus 75 mm, max. dimension 450 mm.</p> <p>IN-PLACE CONDITION: Weak to moderate caliche cementation, thin lenses of fine gravels to 4 inches thick, pockets of sand to 6 inches thick, thin lenses of caliche coated fine gravels to 2 inches thick, dry, pale yellowish brown to pinkish gray where caliche cementation is moderate.</p>
(GM)scb	<p>6.0 to 12.0 ft. SILTY GRAVEL WITH SAND, COBBLES AND BOULDERS - SU3 - (GM)scb: About 70% fine to medium, hard, subrounded to angular gravel; about 15% fine to medium, hard, subrounded to subangular sand; about 15% nonplastic fines with no dry strength, rapid dilatancy.</p> <p>TOTAL SAMPLE (BY VOLUME): About 5 to 10% hard, subrounded to subangular cobbles; less than 5% hard, subrounded to subangular boulders; remainder minus 75 mm; max. dimension 150 mm.</p> <p>IN-PLACE CONDITIONS: Moderate to strong caliche cementation, dry, pinkish gray to pale yellowish brown.</p>
(GP-GM)s	<p>9.0 to 19.0 ft. POORLY GRADED GRAVEL WITH SILT AND SAND - SU2 - (GP-GM)s: About 70% predominantly fine, hard, subrounded to subangular gravel; about 20% predominantly medium to coarse, hard, subrounded to subangular sand; about 10% nonplastic fines with no dry strength, rapid dilatancy; strong reaction with HCl.</p> <p>TOTAL SAMPLE (BY VOLUME): About 5% hard, subrounded to subangular cobbles; less than 5% hard, subrounded to subangular boulders; remainder minus 75 mm; max. dimension 900 mm.</p>

REMARKS:
 Test pits excavated using John Deere 992 D-LC track hoe with 2 cubic yard bucket and Caterpillar 966 front end loader. Site prepared using Fiat Allis dozer with a single tooth ripper. Stopped excavation at 19 ft. target depth. Depths may overlap. All 3 exposed walls of the test pit were mapped, and they vary one from the other, i.e., soil units are not continuous across the entire pit. The purpose of soil unit (SU) designations is to label specific soil units within each test pit, and not to correspond to soil units in the other test pits.

TEST PIT LOG YMWHTP.GPJ WHB-TP.GDT 7/23/02

LOG OF TEST PIT OR AUGER HOLE

FEATURE: <u>Waste Handling Building</u>	PROJECT: <u>Yucca Mountain Project</u>
LOCATION: <u>TP-WHB-2</u>	GROUND ELEVATION: <u>3658.0</u>
COORDINATES: <u>N 756,595</u> <u>E 571,106</u>	METHOD OF EXPLORATION: <u>John Deere 992 D-LC track hoe</u>
APPROXIMATE DIMENSIONS: <u>approx. 70 x 70 ft. x 19 ft. deep</u>	HOLE LOGGED BY: <u>Russell Schreiner, 9/5/00</u>
TOTAL DEPTH: <u>19.0 ft.</u> DEPTH TO WATER: <u>N/A</u>	DATE EXCAVATED: <u>07/31/2000 to 08/23/2000</u>

CLASSIFICATION GROUP SYMBOL	CLASSIFICATION AND DESCRIPTION OF MATERIAL
	<p>IN-PLACE CONDITION: Weak to moderate caliche cementation, lenses of fine gravel to 2 inches thick, pockets of fine sand and gravel to 4 inches thick, dry, pale yellowish brown, to pinkish gray where caliche cementation is moderate.</p>

REMARKS:
Test pits excavated using John Deere 992 D-LC track hoe with 2 cubic yard bucket and Caterpillar 966 front end loader. Site prepared using Fiat Allis dozer with a single tooth ripper. Stopped excavation at 19 ft. target depth. Depths may overlap. All 3 exposed walls of the test pit were mapped, and they vary one from the other, i.e., soil units are not continuous across the entire pit. The purpose of soil unit (SU) designations is to label specific soil units within each test pit, and not to correspond to soil units in the other test pits.

TEST PIT LOG YMWHTP.GPJ WHB-TP.GDT 7/23/02

LOG OF TEST PIT OR AUGER HOLE

FEATURE: <u>Waste Handling Building</u>	PROJECT: <u>Yucca Mountain Project</u>
LOCATION: <u>TP-WHB-3</u>	GROUND ELEVATION: <u>3650.0</u>
COORDINATES: <u>N 765,306</u> <u>E 571,161</u>	METHOD OF EXPLORATION: <u>John Deere 992 D-LC track hoe</u>
APPROXIMATE DIMENSIONS: <u>approx. 70 x 70 ft. x 20 ft. deep</u>	HOLE LOGGED BY: <u>Russell Schreiner, 9/5/00</u>
TOTAL DEPTH: <u>20.0 ft.</u> DEPTH TO WATER: <u>N/A</u>	DATE EXCAVATED: <u>08/01/2000 to 08/23/2000</u>

CLASSIFICATION GROUP SYMBOL	CLASSIFICATION AND DESCRIPTION OF MATERIAL
(GP)scb	<p>0.0 to 18.0 ft. POORLY GRADED GRAVEL WITH SILT, SAND, COBBLES, AND BOULDERS - SU3 - (GP)scb: About 65% predominantly fine to medium, hard, subrounded to subangular gravel; about 25% fine to coarse, hard, subrounded to subangular sand; about 10% nonplastic fines with no dry strength, rapid dilatancy; strong reaction with HCl.</p> <p>TOTAL SAMPLE (BY VOLUME): About 10% hard, subrounded to subangular cobbles; about 5% hard, subrounded to subangular boulders; remainder minus 75 mm; max. dimension 900 mm.</p> <p>IN-PLACE CONDITION: Weak to moderate caliche cementation, thin lenses of fine clean gravels and 4 to 6 inch pockets of fine sand, pockets of coarse gravels to 8 inches thick, dry, pale yellowish brown.</p>
(GP-GM)scb	<p>0.0 to 4.0 ft. POORLY GRADED GRAVEL WITH SILT, SAND, COBBLES, AND BOULDERS - SU1 - (GP-GM)scb: About 70% predominantly coarse, hard, subrounded to subangular gravel; about 20% predominantly fine, hard, subrounded to subangular sand; about 10% nonplastic fines with no dry strength, rapid dilatancy; strong reaction with HCl.</p> <p>TOTAL SAMPLE (BY VOLUME): About 20% hard, subrounded to subangular cobbles; about 5% hard, subrounded to subangular boulders; remainder 75 mm; max. dimension 600 mm.</p> <p>IN-PLACE CONDITION: Weak to strong caliche cementation, 2 to 4 inch thick pockets of fine sand, whitish coatings on gravel, dry, pale yellowish brown.</p>
(GP-GM)scb	<p>4.0 to 15.0 ft. POORLY GRADED GRAVEL WITH SILT, SAND, COBBLES AND BOULDERS - SU5 - (GP-GM)scb: About 55% predominantly fine, hard, subrounded to subangular gravel; about 35% fine to coarse, hard, subrounded to subangular sand; about 10% nonplastic fines with no dry strength, rapid dilatancy; strong reaction with HCl</p>

REMARKS:
 Test pits excavated using John Deere 992 D-LC track hoe with 2 cubic yard bucket and Caterpillar 966 front end loader. Site prepared using Fiat Allis dozer with a single tooth ripper. Stopped excavation at 19 ft. target depth. Depths may overlap. All 3 exposed walls of the test pit were mapped, and they vary one from the other, i.e., soil units are not continuous across the entire pit. The purpose of soil unit (SU) designations is to label specific soil units within each test pit, and not to correspond to soil units in the other test pits.

TEST PIT LOG YMWHTP.GPJ WHB-TP.GDT 7/23/02

LOG OF TEST PIT OR AUGER HOLE

FEATURE: <u>Waste Handling Building</u>	PROJECT: <u>Yucca Mountain Project</u>
LOCATION: <u>TP-WHB-3</u>	GROUND ELEVATION: <u>3650.0</u>
COORDINATES: <u>N 765,306</u> <u>E 571,161</u>	METHOD OF EXPLORATION: <u>John Deere 992 D-LC track hoe</u>
APPROXIMATE DIMENSIONS: <u>approx. 70 x 70 ft. x 20 ft. deep</u>	HOLE LOGGED BY: <u>Russell Schreiner, 9/5/00</u>
TOTAL DEPTH: <u>20.0 ft.</u> DEPTH TO WATER: <u>N/A</u>	DATE EXCAVATED: <u>08/01/2000 to 08/23/2000</u>

CLASSIFICATION GROUP SYMBOL	CLASSIFICATION AND DESCRIPTION OF MATERIAL
	<p>TOTAL SAMPLE (BY VOLUME): About 5% hard subrounded to subangular cobbles; less than 5% hard, subrounded to subangular boulders; remainder minus 75 mm; max. dimension 300 mm.</p> <p>IN-PLACE CONDITION: Weak to moderate caliche cementation, thin layers of fine clean gravels to 6 inches thick, thin layers of heavily cemented gravels to 4 inches thick, pockets of coarse caliche cemented gravels, occasional pockets of fine silty sand to 4 inches thick, dry, pale yellowish brown.</p>
(GP-GM)sc	<p>3.0 to 9.5 ft. POORLY GRADED GRAVEL WITH SILT, SAND, AND COBBLES - SU2 - (GP-GM)sc: About 50% predominantly fine, hard, subrounded to subangular gravel; about 40% fine to coarse, hard, subrounded to subangular sand; about 10% nonplastic fines with no dry strength, rapid dilatancy; weak to strong reaction with HCl</p> <p>TOTAL SAMPLE (BY VOLUME): About 5% hard subrounded to subangular cobbles; remainder minus 75-mm.</p> <p>IN-PLACE CONDITION: Weak to moderate caliche cementation, thin layers of fine clean gravels to 6 inches thick, thin layers of heavily cemented gravels to 4 inches thick, pockets of coarse caliche cemented gravels, occasional pockets of fine silty sand to 4 inches thick, dry, pale yellowish brown.</p>
(GP)scb	<p>6.0 to 12.0 ft. POORLY GRADED GRAVEL WITH SAND, COBBLES, AND BOULDERS - SU4 - (GP)scb: About 80% predominantly coarse, hard, subrounded to subangular gravel; about 15% predominantly fine, hard, subrounded to subangular sand; about 5% nonplastic fines with no dry strength, rapid dilatancy; strong reaction with HCl.</p> <p>TOTAL SAMPLE (BY VOLUME): About 25% hard subrounded to subangular cobbles; less than 5% hard, subrounded to subangular boulders; remainder minus 75 mm; max. dimension 300 mm.</p>

REMARKS:
 Test pits excavated using John Deere 992 D-LC track hoe with 2 cubic yard bucket and Caterpillar 966 front end loader. Site prepared using Fiat Allis dozer with a single tooth ripper. Stopped excavation at 19 ft. target depth. Depths may overlap. All 3 exposed walls of the test pit were mapped, and they vary one from the other, i.e., soil units are not continuous across the entire pit. The purpose of soil unit (SU) designations is to label specific soil units within each test pit, and not to correspond to soil units in the other test pits.

TEST PIT LOG YMWHTP.GPJ WHB.TP.GDT 7/23/02

LOG OF TEST PIT OR AUGER HOLE

FEATURE: <u>Waste Handling Building</u>	PROJECT: <u>Yucca Mountain Project</u>
LOCATION: <u>TP-WHB-3</u>	GROUND ELEVATION: <u>3650.0</u>
COORDINATES: <u>N 765,306</u> <u>E 571,161</u>	METHOD OF EXPLORATION: <u>John Deere 992 D-LC track hoe</u>
APPROXIMATE DIMENSIONS: <u>approx. 70 x 70 ft. x 20 ft. deep</u>	HOLE LOGGED BY: <u>Russell Schreiner, 9/5/00</u>
TOTAL DEPTH: <u>20.0 ft.</u> DEPTH TO WATER: <u>N/A</u>	DATE EXCAVATED: <u>08/01/2000 to 08/23/2000</u>

CLASSIFICATION GROUP SYMBOL	CLASSIFICATION AND DESCRIPTION OF MATERIAL
	<p>IN-PLACE CONDITON: Weak to moderate caliche cementation, thin layers of fine clean gravels to 6 inches thick, thin layers of heavily cemented gravels to 4 inches thick, pockets of coarse caliche cemented gravels, ocasional pockets of fine silty sand to 4 inches thick, dry, pale yellowish brown.</p>
(GP-GM)scb	<p>16.0 to 20.0 ft. POORLY GRADED GRAVEL WITH SILT, SAND, COBBLES, AND BOULDERS - SU6 - (GP-GM)scb: About 70% predominantly coarse, hard, subrounded to subangular gravel; about 20% predominantly fine, hard subrounded to subangular sand; about 10% nonplastic fines with no dry strength, rapid dilatancy; no reaction with HCl.</p> <p>TOTAL SAMPLE (BY VOLUME): About 15% hard, subrounded to subangular cobbles; remainder minus 75 mm; max. dimension 250 mm.</p> <p>IN-PLACE CONDITION: Strong caliche cementation, dry, pale yellowish brown.</p>
(GM)sc	<p>18.0 to 20.0 ft. SILTY GRAVEL WITH SAND, AND COBBLES - SU7 - (GM)sc: About 60% predominantly fine, hard subrounded to subangular gravel; about 25% predominantly fine, hard, subrounded to subangular sand; about 15% nonplastic fines with no dry strength, rapid dilatancy; strong reaction with HCl</p> <p>TOTAL SAMPLE (BY VOLUME): About 5% hard, subrounded to subangular cobbles; remainder 75 mm; max. dimension 90 mm.</p> <p>IN-PLACE CONDITION: Moderate to strong caliche cementation, dry, pale yellowish brown.</p>

REMARKS:
 Test pits excavated using John Deere 992 D-LC track hoe with 2 cubic yard bucket and Caterpillar 966 front end loader. Site prepared using Fiat Allis dozer with a single tooth ripper. Stopped excavation at 19 ft. target depth. Depths may overlap. All 3 exposed walls of the test pit were mapped, and they vary one from the other, i.e., soil units are not continuous across the entire pit. The purpose of soil unit (SU) designations is to label specific soil units within each test pit, and not to correspond to soil units in the other test pits.

TEST PIT LOG YMWHTP.GPJ WHB-TP.GDT 7/23/02

FEATURE: Waste Handling Building PROJECT: Yucca Mountain Project
 LOCATION: TP-WHB-4 GROUND ELEVATION: 3664.7
 COORDINATES: N 765,950 E 571,453 METHOD OF EXPLORATION: John Deere 992 D-LC track hoe
 APPROXIMATE DIMENSIONS: approx. 70 x 70 ft. x 16 ft. deep HOLE LOGGED BY: Russell Schreiner, 9/14/00
 TOTAL DEPTH: 16.0 ft. DEPTH TO WATER: N/A DATE EXCAVATED: 08/28/2000 to 09/06/2000

CLASSIFICATION GROUP SYMBOL	CLASSIFICATION AND DESCRIPTION OF MATERIAL
(GP-GM)scb	<p>0.0 to 16.0 ft. POORLY GRADED GRAVEL WITH SILT, SAND, COBBLES, AND BOULDERS - SU2 - (GP-GM)scb: About 65% predominantly fine to coarse, hard, subrounded to subangular gravel; about 25% predominantly fine, subrounded to subangular sand; about 10% low plasticity fines with high dry strength, rapid dilatancy; strong reaction with HCl.</p> <p>TOTAL SAMPLE (BY VOLUME): About 15% hard, subrounded to subangular cobbles; about 5% hard, subrounded to subangular boulders; remainder minus 75 mm; max. dimension 900 mm.</p> <p>IN-PLACE CONDITION: Strong caliche cementation, stratified, pockets of cemented fine gravels and sands, dry, very pale orange.</p>
(SM)gc	<p>0.0 to 2.0 ft. SILTY SAND WITH GRAVEL AND COBBLES - SU7 - (SM)gc: About 40% predominantly fine, hard, subrounded to subangular gravel; about 40% predominantly fine subrounded sand; about 20% low plasticity fines with low toughness, none to low dry strength, rapid dilatancy; strong reaction with HCl.</p> <p>TOTAL SAMPLE (BY VOLUME): About 5 to 10% hard subrounded to subangular cobbles; remainder minus 75 mm; max. dimension 200 mm.</p> <p>IN-PLACE CONDITION: Weak to strong caliche cementation, surficial layer with abundant roots and some organic material, dry, pale yellowish brown to light brown.</p>
(GP-GM)scb	<p>2.0 to 8.0 ft., 12 to 16 ft. POORLY GRADED GRAVEL WITH SILT, SAND, COBBLES, AND BOULDERS - SU1 - (GP-GM)scb: About 70% predominantly fine to medium, subrounded to subangular gravel; about 20% predominantly fine to coarse subrounded to subangular sand; about 10% low plasticity fines with low dry strength, rapid dilatancy; strong reaction with HCl.</p> <p>TOTAL SAMPLE (BY VOLUME): About 10% hard, subrounded to</p>

REMARKS:

Test pits excavated using John Deere 992 D-LC track hoe with 2 cubic yard bucket and Caterpillar 966 front end loader. Site prepared using Fiat Allis dozer with a single tooth ripper. Stopped excavation at 16 ft. target depth. Depths may overlap. All 3 exposed walls of the test pit were mapped, and they vary one from the other, i.e., soil units are not continuous across the entire pit. The purpose of soil unit (SU) designations is to label specific soil units within each test pit, and not to correspond to soil units in the other test pits.

TEST PIT LOG YMWHP-TP-GPJ WHB-TP-GDT 7/23/02

LOG OF TEST PIT OR AUGER HOLE

FEATURE: <u>Waste Handling Building</u>	PROJECT: <u>Yucca Mountain Project</u>
LOCATION: <u>TP-WHB-4</u>	GROUND ELEVATION: <u>3664.7</u>
COORDINATES: <u>N 765,950</u> <u>E 571,453</u>	METHOD OF EXPLORATION: <u>John Deere 992 D-LC track hoe</u>
APPROXIMATE DIMENSIONS: <u>approx. 70 x 70 ft. x 16 ft. deep</u>	HOLE LOGGED BY: <u>Russell Schreiner, 9/14/00</u>
TOTAL DEPTH: <u>16.0 ft.</u> DEPTH TO WATER: <u>N/A</u>	DATE EXCAVATED: <u>08/28/2000 to 09/06/2000</u>

CLASSIFICATION GROUP SYMBOL	CLASSIFICATION AND DESCRIPTION OF MATERIAL
	<p>subangular cobbles; about 5% subrounded to subangular boulders; remainder minus 75 mm; max. dimension 450 mm.</p> <p>IN-PLACE CONDITION: Moderate to strong caliche cementation, irregularly and weakly stratified with a few coarse gravel/cobble lenses, roots present, dry, pale yellowish brown to light brown.</p>
(GP-GM)scb	<p>2.0 to 4.0 ft., 6.0 to 12.0 ft. POORLY GRADED GRAVEL WITH SILT, SAND, COBBLES, AND BOULDERS - SU3 - (GP-GM)scb: About 80% predominantly coarse, hard, subrounded to subangular gravel; about 10% predominantly fine, hard, sand; about 10% low plasticity fines with low dry strength, rapid dilatancy; strong reaction with HCl.</p> <p>TOTAL SAMPLE (BY VOLUME): About 30% hard, subrounded to subangular cobbles; less than 5% hard, subrounded to subangular boulders; remainder minus 75 mm; max. dimension 350 mm.</p> <p>IN-PLACE CONDITION: Moderate to strong caliche cementation, stratified, pockets of cemented fine gravels and sands, dry, pinkish gray to very pale orange.</p>
(GP-GM)sc	<p>14.0 to 16.0 ft. POORLY GRADED GRAVEL WITH SILT, SAND, AND COBBLES - SU6 - (GP-GM)sc: About 55% predominantly fine, hard, subrounded to subangular gravel; about 35% predominantly fine, hard, subrounded to subangular sand; about 10% low plasticity fines with low toughness and low dry strength, rapid dilatancy; strong reaction with HCl.</p> <p>TOTAL SAMPLE (BY VOLUME): About 5% hard, subrounded to subangular cobbles; remainder minus 75 mm; max. dimension 100 mm.</p> <p>IN-PLACE CONDITION: Moderate to strong caliche cementation, stratified, laminated, lensed, pockets of silty, cemented sands to 4 inches thick, dry, pinkish gray to pale yellowish brown.</p>

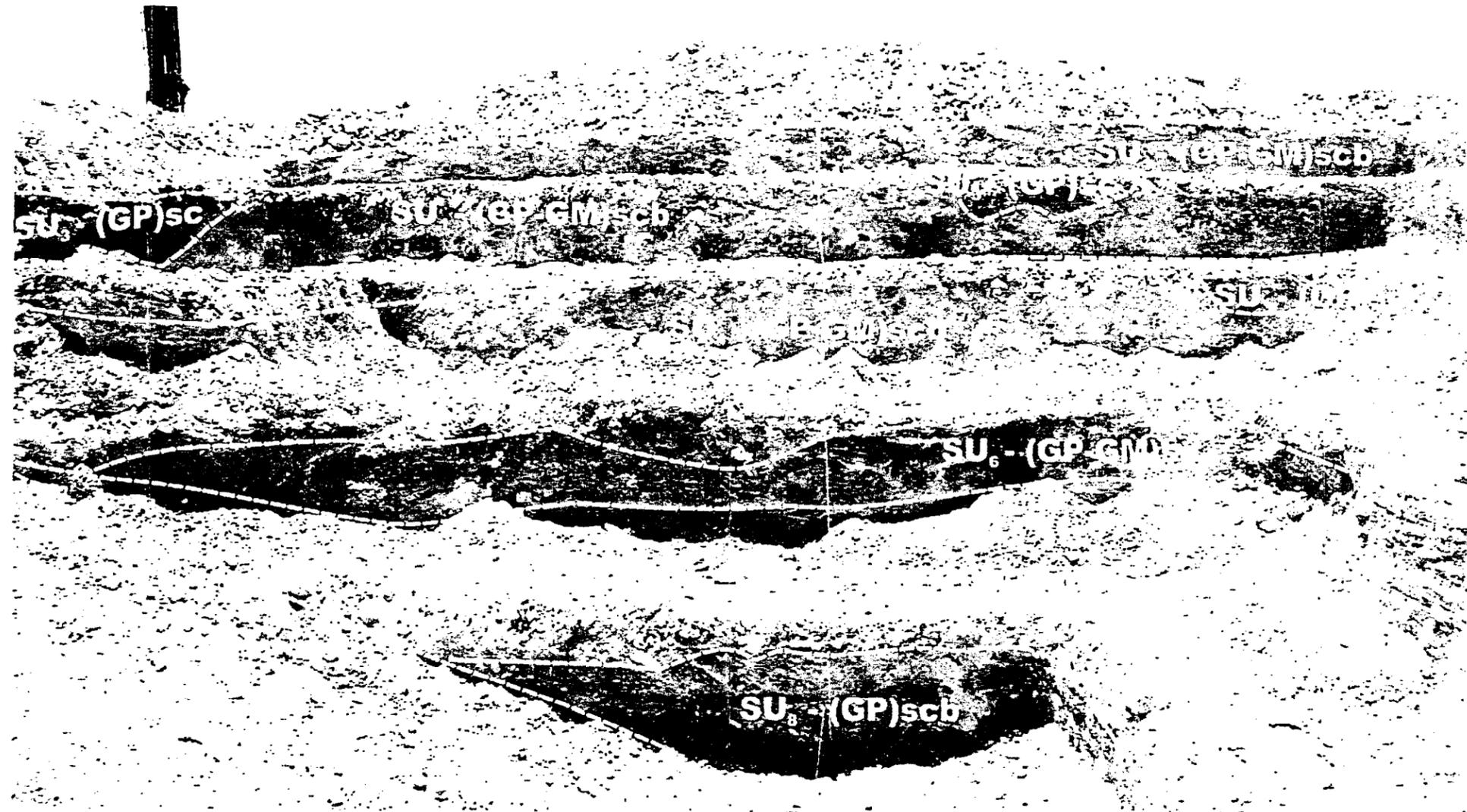
REMARKS:
 Test pits excavated using John Deere 992 D-LC track hoe with 2 cubic yard bucket and Caterpillar 966 front end loader. Site prepared using Fiat Allis dozer with a single tooth ripper. Stopped excavation at 16 ft. target depth. Depths may overlap. All 3 exposed walls of the test pit were mapped, and they vary one from the other, i.e., soil units are not continuous across the entire pit. The purpose of soil unit (SU) designations is to label specific soil units within each test pit, and not to correspond to soil units in the other test pits.

TEST PIT LOG YMWHTP.GPJ WHB-TP.GDT 7/23/02

ATTACHMENT IV
PHOTOMOSAIC MAPS OF TEST PITS TP-WHB-1 TO TP-WHB-4

ATTACHMENT IV
PHOTOMOSAIC MAPS OF TEST PITS TP-WHB-1 TO TP-WHB-4

As mentioned in Section 6.2.4, this attachment presents a series of three geologic maps for each of the four test pits excavated in the WHB Area (DTN: GS020383114233.001). The geologic mapping is superimposed on a photomosaic of the test pits. Each figure covers one of the side slopes of the test pit (mapping was not performed on the bottom of the pit or on the access ramp into the pit, which occupied the fourth side of each pit).



Note: Soil Units (SU) are specific to test pit and do not correspond to other pits.

Source: DTN GS020383114233.001

Figure IV-1. Test Pit TP-WHB-1 South Wall



Note: Soil Units (SU) are specific to test pit and do not correspond to other pits.

Source: DTN GS020383114233.001

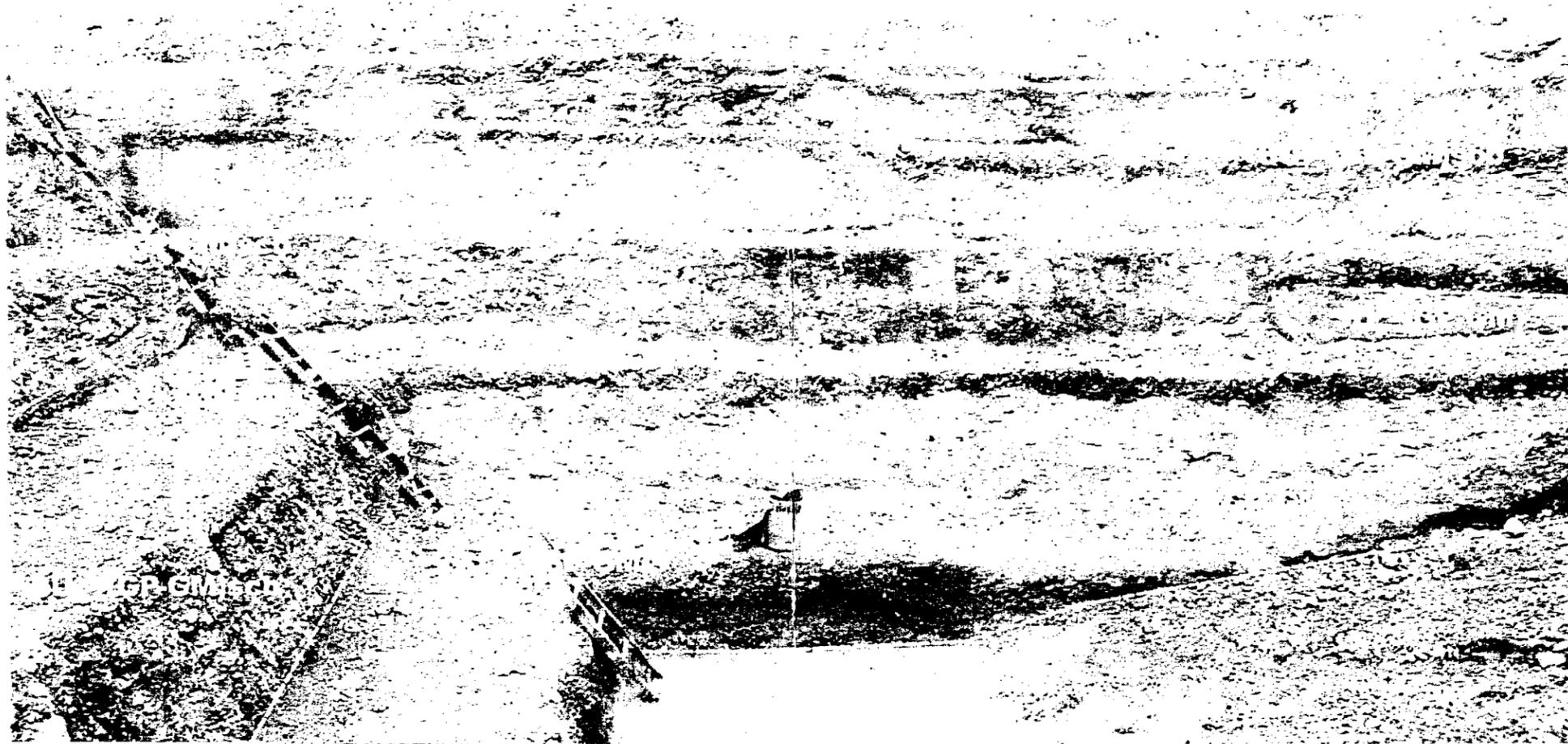
Figure IV-2. Test Pit TP-WHB-1 North Wall



Note: Soil Units (SU) are specific to test pit and do not correspond to other pits.

Source: DTN GS020383114233.001

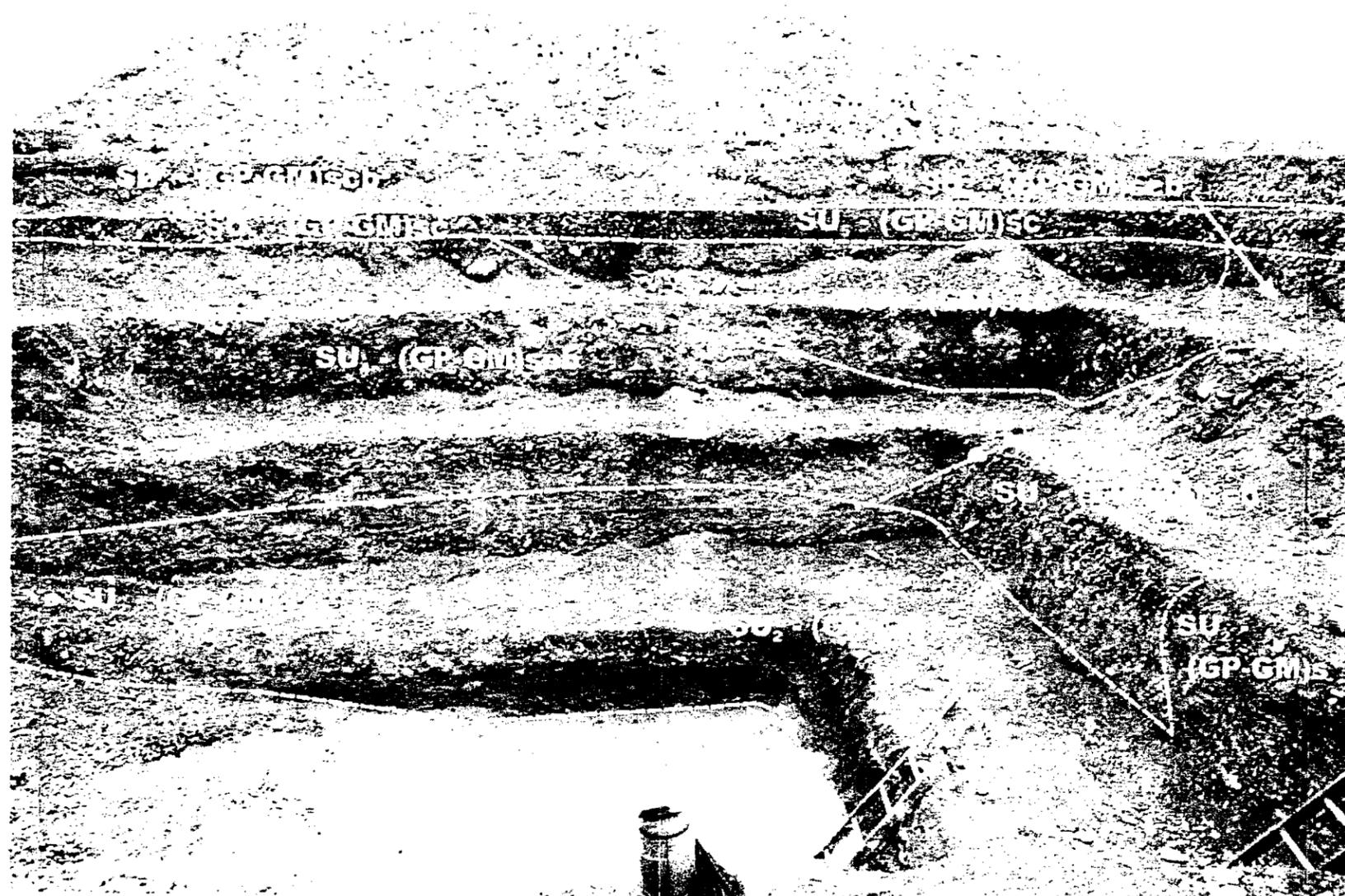
Figure IV-3. Test Pit TP-WHB-1 West Wall



Note: Soil Units (SU) are specific to test pit and do not correspond to other pits.

Source: DTN GS020383114233.001

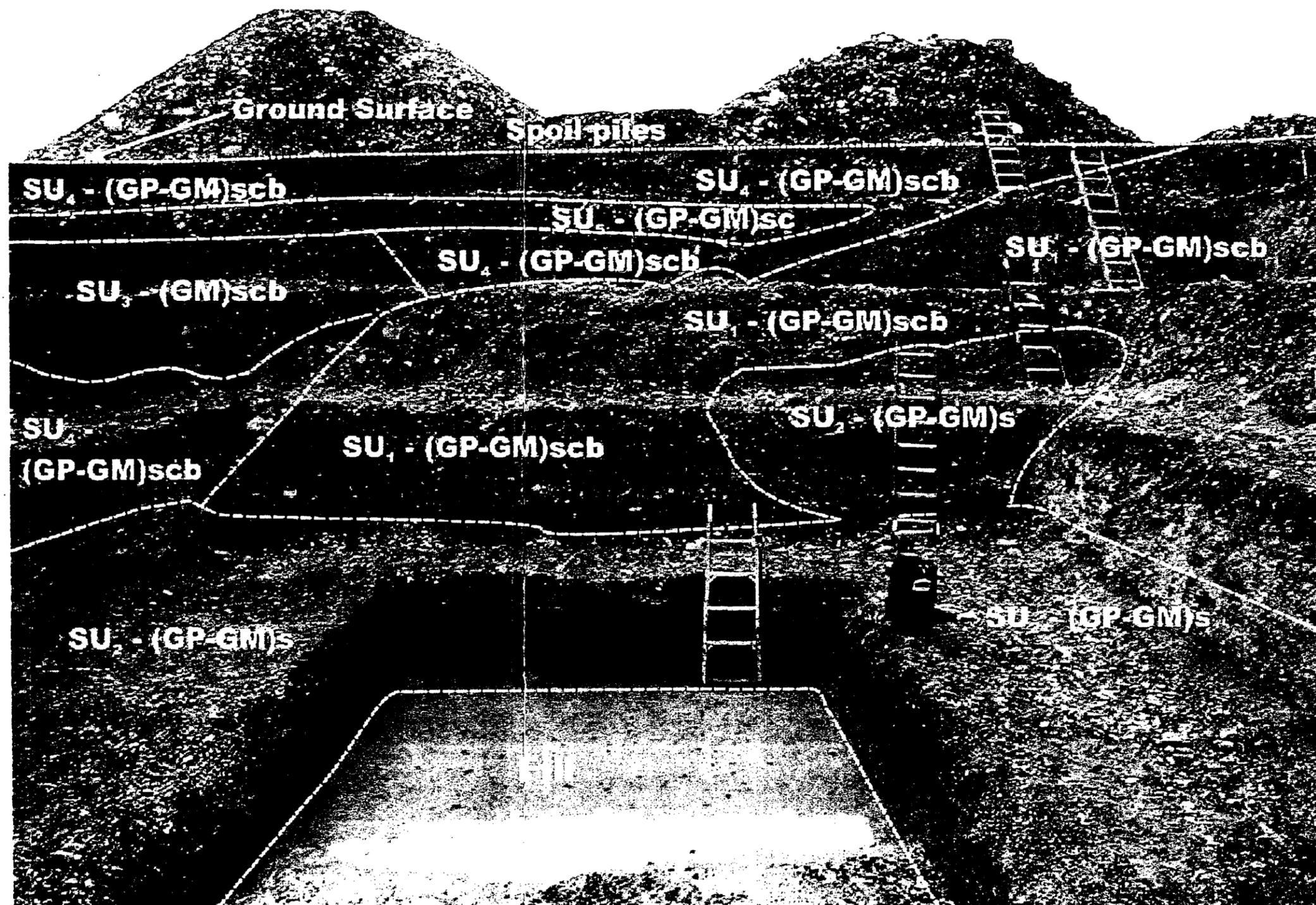
Figure IV-4. Test Pit TP-WHB-2 West Wall



Note: Soil Units (SU) are specific to test pit and do not correspond to other pits.

Source: DTN GS020383114233.001

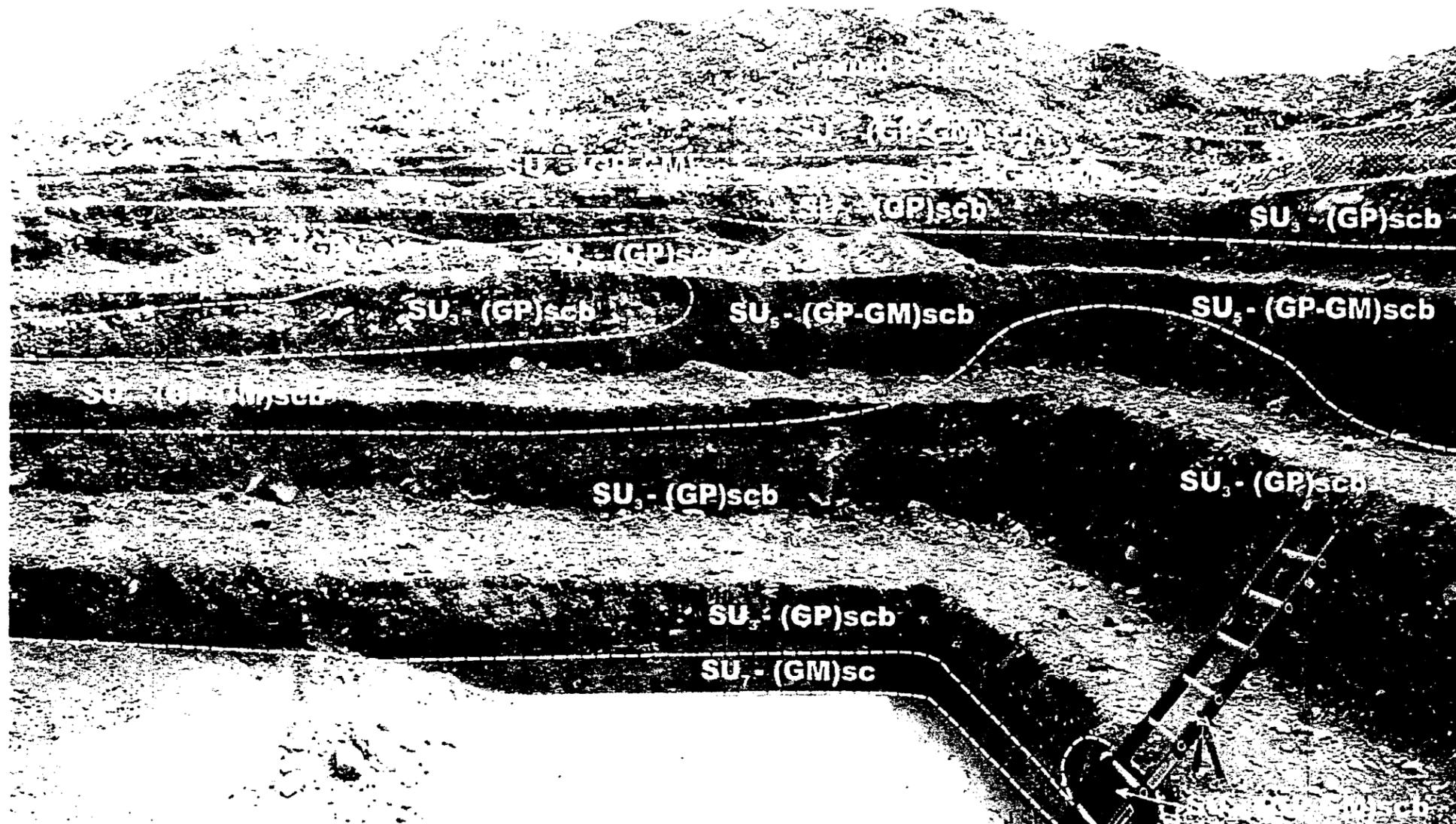
Figure IV-5. Test Pit TP-WHB-2 East Wall



Note: Soil Units (SU) are specific to test pit and do not correspond to other pits.

Source: DTN GS020383114233.001

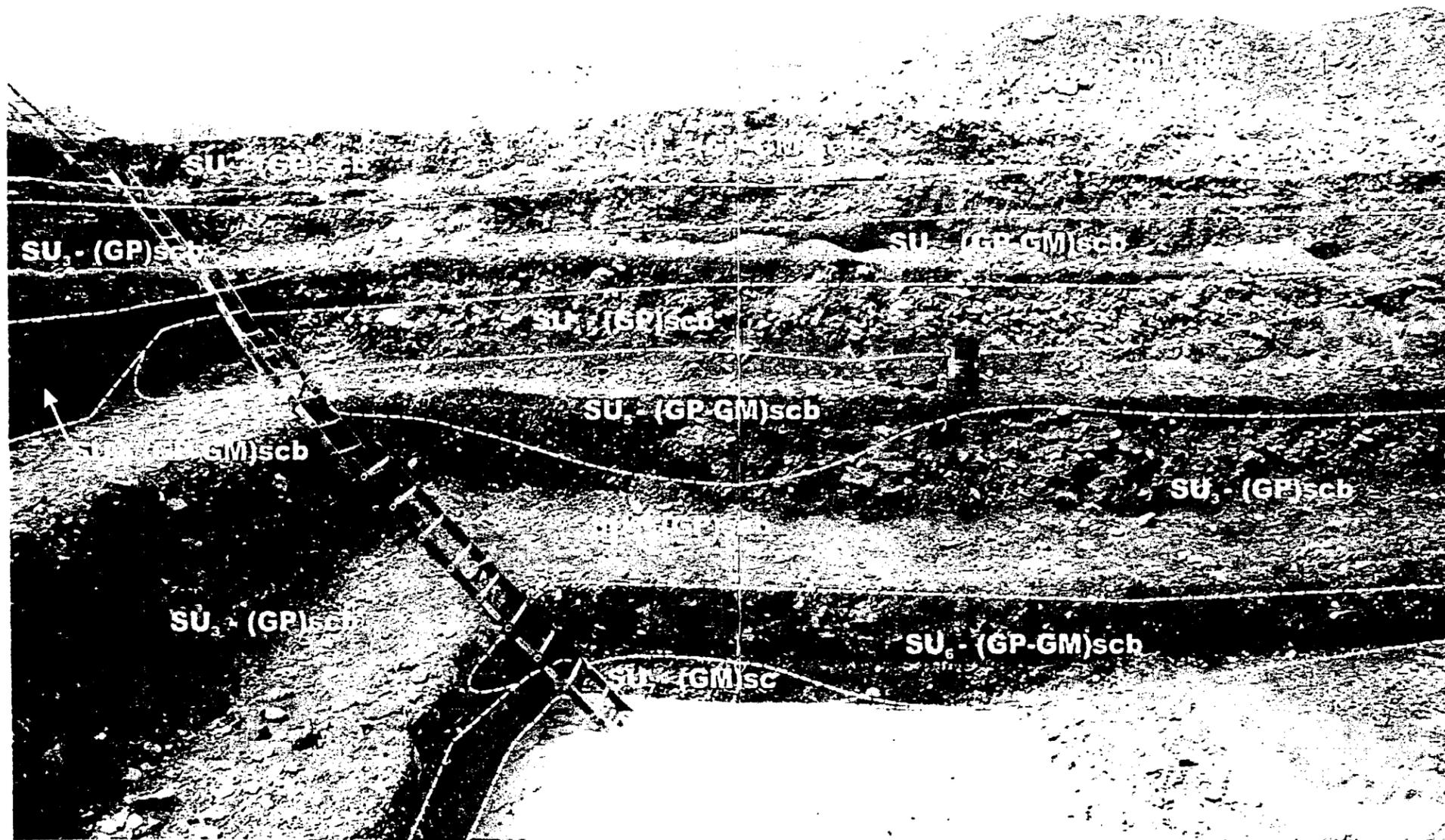
Figure IV-6. Test Pit TP-WHB-2 South Wall



Note: Soil Units (SU) are specific to test pit and do not correspond to other pits.

Source: DTN GS020383114233.001

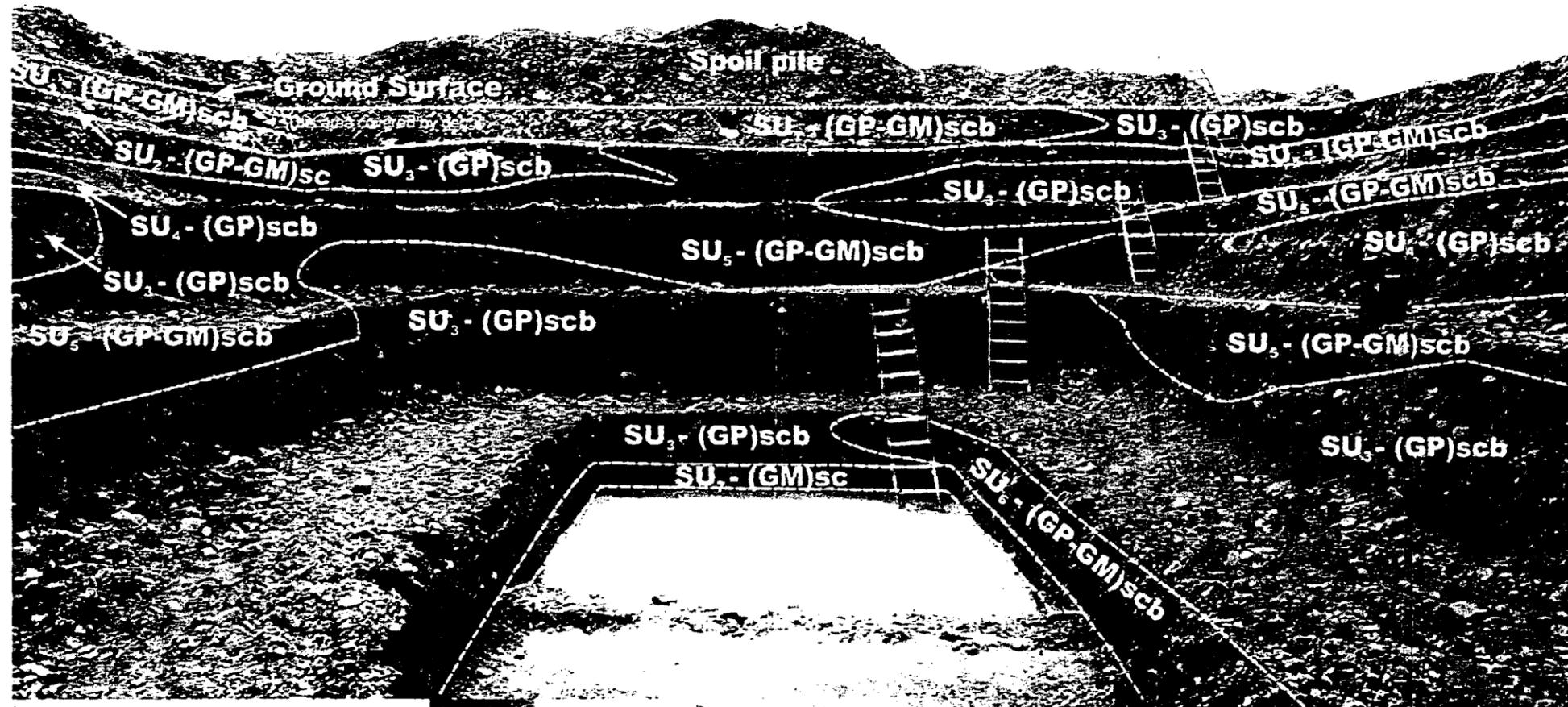
Figure IV-7. Test Pit TP-WHB-3 East Wall



Note: Soil Units (SU) are specific to test pit and do not correspond to other pits.

Source: DTN GS020383114233.001

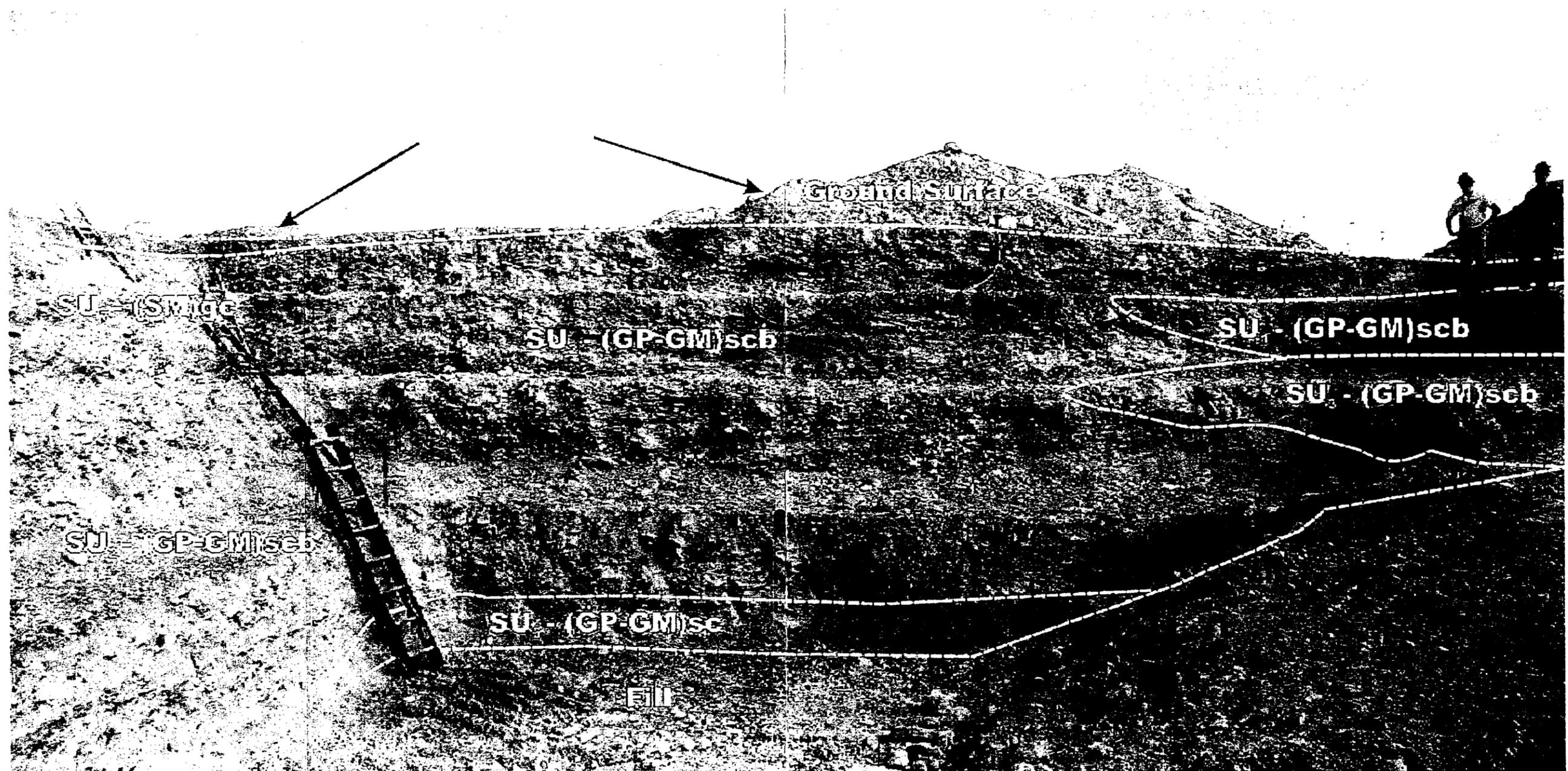
Figure IV-8. Test Pit TP-WHB-3 West Wall



Note: Soil Units (SU) are specific to test pit and do not correspond to other pits.

Source: DTN GS020383114233.001

Figure IV-9. Test Pit TP-WHB-3 South Wall



Note: Soil Units (SU) are specific to test pit and do not correspond to other pits.

Source: DTN GS020383114233.001

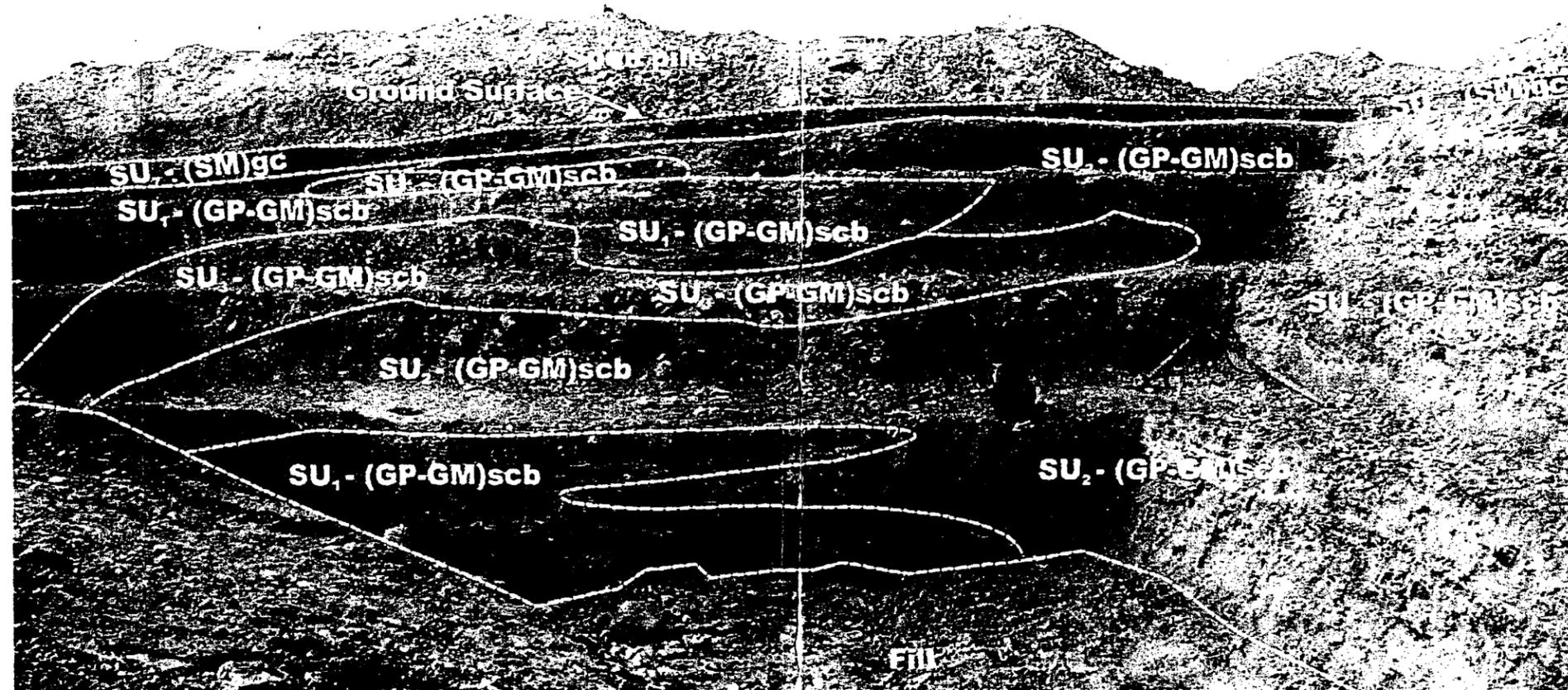
Figure IV-10. Test Pit TP-WHB-4 East Wall



Note: Soil Units (SU) are specific to test pit and do not correspond to other pits.

Source: DTN GS020383114233.001

Figure IV-11. Test Pit TP-WHB-4 North Wall



Note: Soil Units (SU) are specific to test pit and do not correspond to other pits.

Source: DTN GS020383114233.001

Figure IV-12. Test Pit TP-WHB-4 Wes Wall