ELOG FIELD LOG REV 1.1a

GEOVision
geophysical services

B-710GDH cc 3/18/08
~~B-710124~~

ELOG FIELD LOG

Borehole*

SITE*: Turkey Point NPP DATE*: 3/18/08
CLIENT*: MACTEC JOB*: 8083
AUTHOR*: C. Carter PAGE: 1 OF 2

CONTACT: _____ PHONE: Off _____ Cell _____

CONTACT: _____ PHONE: Off _____ Cell _____

CONTACT: _____ PHONE: Off _____ Cell _____

CONTACT: _____ PHONE: Off _____ Cell _____
COMPANY: _____

GENERAL SITE CONDITIONS/LOCATION: _____

COUNTY: Miami-Dade RANGE: _____ TOWNSHIP: _____ SECTION: _____
BOREHOLE CONSTRUCTION: CASED _____ UNCASED _____
DIAMETERS AND DEPTH RANGES: 6" 0 TO 19.5'; 4" 19.5' TO 273'

BOREHOLE TOTAL DEPTH AS DRILLED*: 273

SURFACE CASING?: YES X DEPTH TO BOTTOM OF CASING 115 ft; NO ___
DEPTH TO BEDROCK: ~ 34 ft DEPTH TO WATER TABLE: 6
BOREHOLE FLUID: WATER ___; FRESH WATER MUD X; SALT WATER MUD ___;
OTHER: _____
DEPTH TO BOREHOLE FLUID: ~10' TIME SINCE LAST CIRCULATION: 9am

LOGGING CREW: C. Carter
VEHICLE(S) USED AND MILEAGE: _____
MOBILIZED FROM: Florida City, FL DEPARTURE TIME: 8:30am
ARRIVED ON SITE: 8:45 am
STANDBY TIME: _____ CAUSE: _____

*ITEMS WITH * MUST BE COMPLETED. OTHER INFORMATION IS OPTIONAL*

GEOVision Geophysical Services 1151 Pomona Road, Unit P, Corona, CA 92882 Ph (951) 549-1234 Fx (951) 549-1236

ELOG FIELD LOG REV 1.1a

GEOVision
geophysical services

B-710GDH cc 3/18/08
~~B-710DH~~ ELOG FIELD LOG
Borehole*

SITE*:	Turkey Point NPP	DATE*:	3/18/08
CLIENT*:	MACTEC	JOB*:	8083
AUTHOR*:	C. Carter	PAGE:	PAGE 2 OF 2

WINCH: COMPROBE [ ] SILVER [X] OYO [ ] RG [ ] OTHER [ ]
MICROLOGGER* 5310 [ ] 5772 [X] OTHER
ELOG PROBE* 5490 [X] OTHER
SHEAVE* COMPROBE [ ] OYO 101 [ ] 102 [X] 103 [ ] RG [ ]

PROBE LENGTH	2.50M(8.20 FT)	
PLUS YOKE 10.0M (32.8 FT)*	~~+32.8~~ cc 3/18/08	
MINUS CASING STICK-UP*	- 1.08	REF TO GROUND SURFACE
DEPTH REF. OFFSET AT START*	39.92	
DEPTH REF. OFFSET AT END*	39.95	
AFTER SURVEY DEPTH ERROR*	.03	

LOG NAME*	START DEPTH*	START TIME	END DEPTH*	END TIME
cc 3/18/08 ~~B710DHTEST01~~		10:04		10:05am
B710DHELOGTEST01		10:04		10:05am
CC 3/19/08 B710DHELOGUP02	270.6 ft	10:29	94.8 ft	10:49
B710GDHELOG TEST02		10:04am		10:05am
B710GDHELOG UP02	270.6 ft	10:29am	94.8 ft	10:49am

MAINTENANCE PERFORMED ON SITE*: N/A (N/A if none)

EQUIPMENT PROBLEMS OR FAILURES*: N/A (N/A if none)

SUGGESTIONS, ADDITIONS, CHANGES: cc 3/18/08 Very Low ~~High~~ resistivity above 200'.

*ITEMS WITH * MUST BE COMPLETED. OTHER INFORMATION IS OPTIONAL.*

GEOVision Geophysical Services *1151 Pomona Road, Unit P, Corona, CA 92882* *Ph (951) 549-1234 Fx (951) 549-1236*

P-S FIELD LOG REV V1.31a

GEOVision
geophysical services

B-710GDH cc 3/18/08
~~B-710DH~~
Borehole

P-S SUSPENSION VELOCITY FIELD LOG REV 1.31a

SITE*: Turkey Point NPP DATE*: 3/18/08
CLIENT*: MACTEC JOB*: 8083
AUTHOR*: C. Carter PAGE 1 OF * 5

CONTACT: _____ PHONE: Off Cell _____

CONTACT: _____ PHONE: Off Cell _____

CONTACT: _____ PHONE: Off Cell _____

CONTACT: _____ PHONE: Off Cell _____

DIRECTIONS TO SITE: _____

GENERAL SITE CONDITIONS/LOCATION: _____

COUNTY: Miami-Dade RANGE: _____ TOWNSHIP: _____ SECTION: _____
BOREHOLE CONSTRUCTION*: CASED _____ UNCASED X
DIAMETERS AND DEPTH RANGES*: 6" 0 TO 19.5' ; 4" 19.5 TO 273 ft
BOREHOLE TOTAL DEPTH AS DRILLED*: 273 ft
SURFACE CASING?: X DEPTH TO BOTTOM OF CASING 113 ft; NO _____
DEPTH TO BEDROCK: ~3 ft DEPTH TO WATER TABLE: 0
BOREHOLE FLUID: WATER ____; FRESH WATER MUD X ; SALT WATER MUD: _____
OTHER: _____
DEPTH TO BOREHOLE FLUID*: ~10 ft TIME SINCE LAST CIRCULATION: 9am

*ITEMS WITH * MUST BE COMPLETED, OTHER INFORMATION IS OPTIONAL*

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P-S FIELD LOG REV V1.31a

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geophysical services

B-710DH cc 3/18/08 P-S SUSPENSION VELOCITY FIELD LOG REV 1.31a

Borehole*

SITE*: Turkey Point NPP DATE*: 3/18/08
CLIENT*: MACTEC JOB*: 8083
AUTHOR*: C. Carter PAGE 2 OF * 5

LOGGING CREW*: C. Carter
MOBILIZED FROM: Florida City, FL DEPARTURE TIME: 8:30 am
ARRIVED ON SITE: 8:45 am
STANDBY TIME: CAUSE:
LOGGING STARTED: 12:19 pm LOGGING COMPLETED: 1:02 pm

BATTERIES CHANGED BEFORE LOGGING: YES ; NO X ; STORED WITH NEW

WINCH	COMPROBE ☐		GREY ☒	OYO ☐	RG ☐	OTH			
INSTRUMENT*	OYO 12004 ☐	15014 ☐	19029 ☐		RG 160023 ☒	160024 ☐			
RECEIVER S/N*	12008 ☐	20042 ☐	26066 ☐	11001 ☐	23053 ☐	30086 ☒			
ISOLATION TUBE S/N*	300083 ☐	24053 ☐	28068 ☐	28072 ☒	2M				
SHEAVE*	COMPROBE ☐	OYO 101 ☐	102 ☒	103 ☐	RG ☐				
MICROLOGGER*	5310 ☐	5772 ☒	NOT APPLICABLE (OYO) ☐						
PROBE OFFSET*	OYO 2.0M ☐	RG 2.5M ☒							

MINUS CASING STICK-UP* .33
DEPTH REF. OFFSET AT START* 2.17
DEPTH REF. OFFSET AT END* 2.14
AFTER SURVEY DEPTH ERROR* .03
} REF TO GROUND SURFACE

LOG NAME*	START DEPTH*	START TIME	END DEPTH *	END TIME
~~B710DH5USPDOWN02~~	~~121.4 ft~~	~~12:19 pm~~	~~252.6~~	~~1:02 pm~~
cc 1/9/08				
~~B710DH~~				
B710GDH5USPDOWN02	121.4 ft	12:19 pm	252.6 ft	1:02 pm

MAINTENANCE PERFORMED ON SITE*: N/A (N/A if none)

EQUIPMENT PROBLEMS OR FAILURES*: N/A (N/A if none)

SUGGESTIONS, ADDITIONS, CHANGES:
COMMENTS:

*ITEMS WITH * MUST BE COMPLETED. OTHER INFORMATION IS OPTIONAL*

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B-710GDH cc 3/18/08

P-S FIELD LOG REV V1.31a

GEOVISION SUSPENSION LOGGING FIELD NOTES

SITE*: Turkey Point NPP — DATE*: 3/11/08, 3/18/08
CLIENT*: MACTEC — JOB*: 8083 cc 3/18/08
AUTHOR*: C. Carter — PAGE* 3 OF 5

*ITEMS WITH * MUST BE COMPLETED. OTHER INFORMATION IS OPTIONAL.*

DEPTH METERS	DEPTH FEET	UNFILTERED FILE NO*.	FILTERED FILE NO*. (if any)	COMMENTS CASING, WATER, ROCK, ETC
21.0	68.90	30		
21.5	70.54	31		
22.0	72.18	32		
22.5	73.82	33		
23.0	75.46	34		
23.5	77.10	35		
24.0	78.74	36		
24.5	80.38	37		
25.0	82.02	38		
25.5	83.66	39		
26.0	85.30	40		
26.5	86.94	41		
27.0	88.58	42		
27.5	90.22	43		
28.0	91.86	44		
28.5	93.50	45		
29.0	95.14	46		
29.5	96.78	47		
30.0	98.43	48		
30.5	100.07	49		
31.0	101.71	50		
31.5	103.35	51		
32.0	104.99	52		
32.5	106.63	53		
33.0	108.27	54		
33.5	109.91	55		
34.0	111.55	56		
34.5	113.19	57		
35.0	114.83	58		
35.5	116.47	59		
36.0	118.11	60		
36.5	119.75	61		
37.0	121.39	62 67		12:19 pm (3/18)
37.5	123.03	63 68		
38.0	124.67	64 69		
38.5	126.31	65 70		
39.0	127.95	66 71		2:05 (3/11)
39.5	129.59	72		
40.0	131.23	73		
40.5	132.87	74		
41.0	134.51	75		

B-710GDH 3/18/08
~~B-710DH~~

P-S FIELD LOG REV V1.31a

GEOVISION SUSPENSION LOGGING FIELD NOTES

SITE*: Turkey Point NPP DATE*: 3/18/08

CLIENT*: MACTEC JOB*: 8083

AUTHOR*: C. Carter PAGE* 7 OF 5

*ITEMS WITH * MUST BE COMPLETED. OTHER INFORMATION IS OPTIONAL*

DEPTH METERS	DEPTH FEET	UNFILTERED FILE NO*.	FILTERED FILE NO*. (if any)	COMMENTS CASING, WATER, ROCK, ETC
41.5	136.15	76		
42.0	137.80	77		
42.5	139.44	78		
43.0	141.08	79		
43.5	142.72	80		
44.0	144.36	81		
44.5	146.00	82		
45.0	147.64	83		
45.5	149.28	84		
46.0	150.92	85		
46.5	152.56	86		
47.0	154.20	87		
47.5	155.84	88		
48.0	157.48	89		
48.5	159.12	90		
49.0	160.76	91		
49.5	162.40	92		
50.0	164.04	93		
50.5	165.68	94		
51.0	167.32	95		
51.5	168.96	96		
52.0	170.60	97		
52.5	172.24	98		
53.0	173.88	99		
53.5	175.52	100		
54.0	177.17	101		
54.5	178.81	102		
55.0	180.45	103		
55.5	182.09	104		
56.0	183.73	105		
56.5	185.37	106		
57.0	187.01	107		
57.5	188.65	108		
58.0	190.29	109		
58.5	191.93	110		
59.0	193.57	111		
59.5	195.21	112		
60.0	196.85	113		
60.5	198.49	114		
61.0	200.13	115		
61.5	201.77	116		

B-710GDH cc 3/18/08
B-710DH

P-S FIELD LOG REV V1.31a

GEOVISION SUSPENSION LOGGING FIELD NOTES

SITE*: Turkey Point NPP DATE*: 3/18/08

CLIENT*: MACTEC JOB*: 8083

AUTHOR*: C. Carter PAGE* 5 OF 5

*ITEMS WITH * MUST BE COMPLETED. OTHER INFORMATION IS OPTIONAL.*

DEPTH METERS	DEPTH FEET	UNFILTERED FILE NO*.	FILTERED FILE NO*. (if any)	COMMENTS CASING, WATER, ROCK, ETC
62.0	203.41	117		
62.5	205.05	118		
63.0	206.69	119		
63.5	208.33	120		
64.0	209.97	121		
64.5	211.61	122		
65.0	213.25	123		
65.5	214.90	124		
66.0	216.54	125		
66.5	218.18	126		
67.0	219.82	127		
67.5	221.46	128		
68.0	223.10	129		
68.5	224.74	130		
69.0	226.38	131		
69.5	228.02	132		
70.0	229.66	133		
70.5	231.30	134		
71.0	232.94	135		
71.5	234.58	136		
72.0	236.22	137		
72.5	237.86	138		
73.0	239.50	139		
73.5	241.14	140		
74.0	242.78	141		
74.5	244.42	142		
75.0	246.06	143		
75.5	247.70	144		
76.0	249.34	145		
76.5	250.98	146		
77.0	252.62	147		1:02pm
77.5	254.27			
78.0	255.91			
78.5	257.55			
79.0	259.19			
79.5	260.83			
80.0	262.47			
80.5	264.11			
81.0	265.75			
81.5	267.39			
82.0	269.03			

ACOUSTIC TELEVIEWER LOG COVER 1.0a.pdf

GEOVision
geophysical services

B-7106DH ACOUSTIC TELEVIEWER FIELD LOG Rev 1.0a

Borehole*

SITE*: Turkey Point NPP DATE*: 3/18/08
CLIENT*: MACTEC JOB*: 8083
AUTHOR*: C. Carter PAGE 1 OF 2

CONTACT: _____ PHONE: Off _____ Cell _____

CONTACT: _____ PHONE: Off _____ Cell _____

CONTACT: _____ PHONE: Off _____ Cell _____

DRILLER _____ PHONE: Off _____ Cell _____
COMPANY: _____

GENERAL SITE CONDITIONS/LOCATION: _____

COUNTY: Miami-Dade RANGE: _____ TOWNSHIP: _____ SECTION: _____
BOREHOLE CONSTRUCTION: CASED _____ UNCASED _____
DIAMETERS AND DEPTH RANGES: 6" 0 TO 19.5' ; 4" 17.5 TO 273'

BOREHOLE TOTAL DEPTH AS DRILLED*: 273 ft

SURFACE CASING?: YES X DEPTH TO BOTTOM OF CASING 115' ; NO _____
DEPTH TO BEDROCK: ~3 ft DEPTH TO WATER TABLE: ~0
BOREHOLE FLUID: WATER _____ ; FRESH WATER MUD X ; SALT WATER MUD _____ ;
OTHER: _____
DEPTH TO BOREHOLE FLUID: ~10 ft TIME SINCE LAST CIRCULATION: 9am

LOGGING CREW: C. Carter
VEHICLE(S) USED AND MILEAGE: _____
MOBILIZED FROM: Florida City DEPARTURE TIME: 8:30 am
ARRIVED ON SITE: 8:45 am
STANDBY TIME: _____ CAUSE: _____

*ITEMS WITH * MUST BE COMPLETED. OTHER INFORMATION IS OPTIONAL*

GEOVision Geophysical Services *1151 Pomona Road, Unit P, Corona, CA 92882* *Ph (951) 549-1234 Fx (951) 549-1236*

ACOUSTIC TELEVIEWER LOG COVER 1.0a.pdf

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B-710GDH ACOUSTIC TELEVIEWER FIELD LOG Rev 1.0a
Borehole*

SITE*: Turkey Point NPP DATE*: 3/18/08
CLIENT*: MACTEC JOB*: 8083
AUTHOR*: C. Carter PAGE 2 OF 2

WINCH: COMPROBE____ SILVER✓ OYO____ OTHER____
MICROLOGGER* 5310___ 5772 ✓
TELEVIEWER* ACOUSTIC #5174 X OTHER____
SHEAVE* COMPROBE____ OYO 101___ 102 ✓ 103___ RG____

1 PROBE TILT TEST* 34.04 BRUNTON TILT* 34
2 PROBE TILT TEST* 86.06 BRUNTON TILT* 86
3 PROBE TILT TEST* 19.8 BRUNTON TILT* 20 AFTER LOG* yes
1 PROBE AZIMUTH TEST* 183.6 BRUNTON AZIMUTH* 187
2 PROBE AZIMUTH TEST* 295.5 BRUNTON AZIMUTH* 300
3 PROBE AZIMUTH TEST* 244.0 BRUNTON AZIMUTH* 247 AFTER LOG* yes

PROBE OFFSET*	1.44M(4.72FT)	
MINUS CASING STICK-UP*	-1.08	REF TO GROUND SURFACE
DEPTH REF. OFFSET AT START*	3.64	
DEPTH REF. OFFSET AT END*	3.57	
AFTER SURVEY DEPTH ERROR*	.07	

LOG NAME*	START DEPTH*	START TIME	END DEPTH *	END TIME
B710GDHAUUP02	253.7 ft	2:08pm	102.2 ft	2:16

MAINTENANCE PERFORMED ON SITE*: N/A (N/A if none)

EQUIPMENT PROBLEMS OR FAILURES*: N/A (N/A if none)

SUGGESTIONS, ADDITIONS, CHANGES:

*ITEMS WITH * MUST BE COMPLETED. OTHER INFORMATION IS OPTIONAL*

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CALIPER FIELD LOG REV 1.1a.PDF

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B-710GDH
Borehole*

CALIPER FIELD LOG

SITE*: Turkey Point NPP DATE*: 3/18/08
CLIENT*: MACTEC JOB*: 8083
AUTHOR*: C. Carter PAGE: 1 OF 2

CONTACT: _____ PHONE: Off _____ Cell _____

CONTACT: _____ PHONE: Off _____ Cell _____

CONTACT: _____ PHONE: Off _____ Cell _____

DRILLER _____ PHONE: Off _____ Cell _____
COMPANY: _____

GENERAL SITE CONDITIONS/LOCATION: _____

COUNTY: _____ RANGE: _____ TOWNSHIP: _____ SECTION: _____
BOREHOLE CONSTRUCTION: CASED _____ UNCASED X
DIAMETERS AND DEPTH RANGES: 6" 0 TO 19.5 ft ; 4" 19.5' TO 273 ft

BOREHOLE TOTAL DEPTH AS DRILLED*: 273 ft

SURFACE CASING?: YES Y DEPTH TO BOTTOM OF CASING 115 ft ; NO ____
DEPTH TO BEDROCK: ~3 ft DEPTH TO WATER TABLE: 0
BOREHOLE FLUID: WATER ____ ; FRESH WATER MUD X ; SALT WATER MUD ____ ;
OTHER: _____
DEPTH TO BOREHOLE FLUID: ~10 ft TIME SINCE LAST CIRCULATION: 9am

LOGGING CREW: C. Carter
VEHICLE(S) USED AND MILEAGE: _____
MOBILIZED FROM: Florida City, FL DEPARTURE TIME: 8:30am
ARRIVED ON SITE: 8:45 am
STANDBY TIME: _____ CAUSE: _____

*ITEMS WITH * MUST BE COMPLETED. OTHER INFORMATION IS OPTIONAL*

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CALIPER FIELD LOG REV 1.1a.PDF

GEOVision geophysical services

B-7106DH (Borehole*) CALIPER FIELD LOG

SITE*: Turkey Point NPP DATE*: 3/18/08
CLIENT*: MACTEC JOB*: 8083
AUTHOR*: C. Carter PAGE: PAGE 2 OF 2

WINCH: COMPROBE ___ SILVER X OYO ___ RG ___ OTHER ___
MICROLOGGER* 5310 ☐ 5772 ☒ OTHER ___
CALIPER PROBE* 5368 ☑ OTHER ___
SHEAVE* COMPROBE ☐ OYO 101 ☐ 102 ☒ 103 ☐ RG ☐

PROBE OFFSET	2.08M(6.82 FT)	12 IN MAX
MINUS CASING STICK-UP*	1.08	REF TO GROUND SURFACE
DEPTH REF. OFFSET AT START*	5.74	
DEPTH REF. OFFSET AT END*	5.65	
AFTER SURVEY DEPTH ERROR*	.09	

LOG NAME*	START DEPTH*	START TIME*	END DEPTH*	END TIME*
B7106DHCALTEST03		2:40		2:42 pm
B7106DHCALUP02	257.95	2:59 pm	108.6	3:15 pm
B7106DHCALTEST04		3:29 pm		3:31 pm

CALIBRATION PLATE S/N 201

		AS BUILT			PVC FITTING
		1.968 IN	3.937 IN	8.000 IN	~~4.507 IN~~ 4.510
	FILE NAME	(50 MM)	(100 MM)	(203.2 MM)	(114.3 MM)
AS MEAS.*	B7106DHCALTEST03	1.971	3.971	7.998	4.543
AS MEAS.*	B7106DHCALTEST04	1.999	3.986	8.09	4.517
AS MEAS.					
AS MEAS.					
AS MEAS.					
AS MEAS.					

cc 3/18/08

MAINTENANCE PERFORMED ON SITE*: N/A (N/A if none)

EQUIPMENT PROBLEMS OR FAILURES*: N/A (N/A if none)

SUGGESTIONS, ADDITIONS, CHANGES: ___

*ITEMS WITH * MUST BE COMPLETED. OTHER INFORMATION IS OPTIONAL*

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GEVision
geophysical services

B-720GDH BORING GEOPHYSICS FIELD LOG SUMMARY

Borehole*

SITE*:Turkey Point NPP DATE*: 3/20/08
CLIENT*:MACTEC JOB*:8083
AUTHOR*:C. Carter PAGE*: 1 OF 1

CONTACT: PHONE:

BOREHOLE CONSTRUCTION: CASED UNCASED X
DIAMETERS AND DEPTH RANGES: 4" 0 TO 73 ft ; 3 7/8 73 TO 220 ft
BOREHOLE TOTAL DEPTH AS DRILLED*: 220 ft
CONDUCTOR CASING?: YES X DEPTH TO BOTTOM OF CASING 73/20.5 ; NO
DEPTH TO BEDROCK: ~3 ft
BOREHOLE FLUID: WATER ; FRESH WATER MUD X ; SALT WATER MUD ;

LOGGING CREW: C. Carter

LOG TYPE*	FILE NAME*	DEPTH RANGE*	DATE*	TIMES*
ELOG	B720GDHELOGTEST01		3/20/08	11:07 - 11:08 am
ELOG	B720GDHELOG UP01	219.4 - 69.7 ft	3/20/08	11:37 - 11:54 am
P-S velocity	B720GDHSUSPDOWN01	23.0m - 61.0m	3/20/08	12:44 - 1:29 pm
Deviation	B720GDHAUUP01	200.4 - 7 ft	3/20/08	2:37 - 2:47
Caliper	B720GDHCALTEST01		3/20/08	3:15 - 3:16
Caliper	B720GDHCALUP01	202.5 - 59.55 ft	3/20/08	3:33 - 3:47
Caliper	B720GDHCALTEST02		3/20/08	4:00 - 4:01
ELOG	B720GDHELOGUP02	131.15 - 30.95 ft	3/20/08	5:00 - 5:11 pm
P-S velocity	P720GDHSUSPDOWN02	8.0m - 37.0m	3/20/08	5:34 - 6:07 pm
ATV	B720GDHAUUP02	120.4 - 19.7 ft	3/20/08	6:53 - 7:22 pm
Caliper	B720GDHCALTEST03		3/20/08	7:41 - 7:42 pm
Caliper	B720GDHCALUP02	82.1 - 16.3 ft	3/20/08	7:53 - 8:00 pm
Caliper	B720GDHCALTEST04		3/20/08	8:07 - 8:08 pm

ITEMS WITH * MUST BE COMPLETED. OTHER INFORMATION IS OPTIONAL

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ELOG FIELD LOG REV 1.1a

GEOVision
geophysical services

B-720GDH
Borehole*

ELOG FIELD LOG

SITE*: Turkey Point NPP
CLIENT*: MACTEC
AUTHOR*: C. Carter
DATE*: 3/20/08
JOB*: 8083
PAGE: 1 OF 2

CONTACT: _____ PHONE: Off _____ Cell _____

CONTACT: _____ PHONE: Off _____ Cell _____

CONTACT: _____ PHONE: Off _____ Cell _____

CONTACT: _____ PHONE: Off _____ Cell _____
COMPANY: _____

GENERAL SITE CONDITIONS/LOCATION: _____

COUNTY: Miami-Dade RANGE: _____ TOWNSHIP: _____ SECTION: _____
BOREHOLE CONSTRUCTION: CASED _____ UNCASED X
DIAMETERS AND DEPTH RANGES: 4" 0 TO 73' ; 3 7/8 73 TO 220'

BOREHOLE TOTAL DEPTH AS DRILLED*: 220 ft

SURFACE CASING?: YES X DEPTH TO BOTTOM OF CASING 73 1/2 5' ; NO ____
DEPTH TO BEDROCK: ~3 ft DEPTH TO WATER TABLE: 0
BOREHOLE FLUID: WATER ____ ; FRESH WATER MUD ____ ; SALT WATER MUD ____ ;
OTHER: _____
DEPTH TO BOREHOLE FLUID: ~0 TIME SINCE LAST CIRCULATION: 10:30 am

LOGGING CREW: C. Carter
VEHICLE(S) USED AND MILEAGE: _____
MOBILIZED FROM: Florida City, FL DEPARTURE TIME: 7:15
ARRIVED ON SITE: 7:30
STANDBY TIME: 8-5 3/4 CAUSE: _____

*ITEMS WITH * MUST BE COMPLETED. OTHER INFORMATION IS OPTIONAL*

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ELOG FIELD LOG REV 1.1a

GEOVision
geophysical services

B-7206DH ELOG FIELD LOG
Borehole*

SITE*: Turkey Point NPP DATE*: 3/20/08
CLIENT*: MACTEC JOB*: 8083
AUTHOR*: C. Carter PAGE: PAGE 2 OF 2

WINCH: COMPROBE [ ] SILVER [X] OYO [ ] RG [ ] OTHER [ ]
MICROLOGGER* 5310 [ ] 5772 [X] OTHER
ELOG PROBE* 5490 [X] OTHER
SHEAVE* COMPROBE [X] OYO 101 [ ] 102 [X] 103 [ ] RG [ ]

PROBE LENGTH	2.50M(8.20 FT)	
PLUS YOKE 10.0M (32.8 FT)*	32.8	32.8
MINUS CASING STICK-UP*	8.08	10.08
DEPTH REF. OFFSET AT START*	32.92	30.92 REF TO GROUND SURFACE
DEPTH REF. OFFSET AT END*	32.35	30.90
AFTER SURVEY DEPTH ERROR*	.37	.02

LOG NAME*	START DEPTH*	START TIME	END DEPTH*	END TIME
B7206DHELOGTEST01		11:07am		11:08am
B7206DHELOGUP01	219.4 ft	11:37am	69.7 ft	11:54am
B7206DHELOGUP02	131.15 ft	5:00pm	30.95 ft	5:11pm

MAINTENANCE PERFORMED ON SITE*: N/A (N/A if none)

EQUIPMENT PROBLEMS OR FAILURES*: N/A (N/A if none)

SUGGESTIONS, ADDITIONS, CHANGES: "Tiger salt" was added to high yield bentonite drilling mud from 0-73 ft. Resistivity is very low above 200 ft.

cc 3/20/08

*ITEMS WITH * MUST BE COMPLETED. OTHER INFORMATION IS OPTIONAL.*

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P-S FIELD LOG REV V1.31a

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B-720GDH

P-S SUSPENSION VELOCITY FIELD LOG REV 1.31a

Borehole

SITE*: Turkey Point NPP DATE*: 3/20/08

CLIENT*: MACTEC JOB*: 8083

AUTHOR*: C. Carter PAGE 1 OF* 5

CONTACT: _____ PHONE: Off Cell _____

CONTACT: _____ PHONE: Off Cell _____

CONTACT: _____ PHONE: Off Cell _____

CONTACT: _____ PHONE: Off Cell _____

DIRECTIONS TO SITE: _____

GENERAL SITE CONDITIONS/LOCATION: _____

COUNTY: Miami-Dade RANGE: _____ TOWNSHIP: _____ SECTION: _____

BOREHOLE CONSTRUCTION*: CASED _____ UNCASED X

DIAMETERS AND DEPTH RANGES*: 4" 0 TO 73'; 3 7/8", 73 TO 220 ft

BOREHOLE TOTAL DEPTH AS DRILLED*: 220 ft /225 ft

SURFACE CASING?: X DEPTH TO BOTTOM OF CASING 73 ft; NO _____

DEPTH TO BEDROCK: ~3 ft DEPTH TO WATER TABLE: 0

BOREHOLE FLUID: WATER _____; FRESH WATER MUD X; SALT WATER MUD; _____

OTHER: _____

DEPTH TO BOREHOLE FLUID*: ~0 TIME SINCE LAST CIRCULATION: 10:30 am

*ITEMS WITH * MUST BE COMPLETED. OTHER INFORMATION IS OPTIONAL*

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P-S FIELD LOG REV V1.31a

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B-7206DH P-S SUSPENSION VELOCITY FIELD LOG REV 1.31a

Borehole*

SITE*: Turkey Point NPP DATE*: 3/20/08
CLIENT*: MACTEC JOB*: 8083
AUTHOR*: C. Carter PAGE 2 OF * 45 cc 3/20/08

LOGGING CREW*: C. Carter
MOBILIZED FROM: Florida City, FL DEPARTURE TIME: 8:15 am
ARRIVED ON SITE: 7:30 am
STANDBY TIME: 8-5 3/19 " CAUSE:
LOGGING STARTED: 12:44 LOGGING COMPLETED: 1:29 pm

BATTERIES CHANGED BEFORE LOGGING: YES ____; NO X; STORED WITH NEW ____

WINCH	COMPROBE [ ]		GREY [X]	OYO [ ]	RG [ ]	OTH ____		
INSTRUMENT* OYO	12004 [ ]	15014 [ ]	19029 [ ]		RG	160023 [X]	160024 [ ]	
RECEIVER S/N*	12008 [ ]	20042 [ ]	26066 [ ]	11001 [ ]		23053 [ ]	30086 [X]	
ISOLATION TUBE S/N*	300083 [ ]	24053 [ ]	28068 [ ]	28072 [X]	2M ____			
SHEAVE* COMPROBE [ ]	OYO 101 [ ]	102 [X]	103 [ ]		RG [ ]			
MICROLOGGER*	5310 [ ]	5772 [X]	NOT APPLICABLE (OYO) [ ]					
PROBE OFFSET*	OYO 2.0M [X] cc 3/20/08		RG 2.5M [X]					

MINUS CASING STICK-UP*	2.46 m	3.08 m	REF TO GROUND SURFACE
DEPTH REF. OFFSET AT START*	.04 m	-.58	
DEPTH REF. OFFSET AT END*	.28	-.57	
AFTER SURVEY DEPTH ERROR*	.24	.01	

LOG NAME*	START DEPTH*	START TIME	END DEPTH *	END TIME
B7206DHSUSPDOWN01	23.0m	12:44pm	61.0m	1:29pm
B7206DHSUSPDOWN02	8.0m	5:34pm	37.0m	6:07pm

MAINTENANCE PERFORMED ON SITE*: N/A (N/A if none)

EQUIPMENT PROBLEMS OR FAILURES*: Run1: Wireline on drill rig pulled down (N/A if none)
2m when probe came out of borehole fluid. Depth read -2.19m @ Ref pt.
SUGGESTIONS, ADDITIONS, CHANGES: After running the ATV I realized the
COMMENTS: casing was set @ 20.5ft. I was told it was set at 25ft

*ITEMS WITH * MUST BE COMPLETED. OTHER INFORMATION IS OPTIONAL*

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P-S FIELD LOG REV V1.31a

B-720604 GEOVISION SUSPENSION LOGGING FIELD NOTES

SITE*: Turkey Point NPP DATE*: 3/20/08

CLIENT*: MACTEC JOB*: 8083

AUTHOR*: C. Carter PAGE* 3 OF 5

*ITEMS WITH * MUST BE COMPLETED. OTHER INFORMATION IS OPTIONAL*

DEPTH METERS	DEPTH FEET	UNFILTERED FILE NO*.	FILTERED FILE NO*. (if any)	COMMENTS CASING, WATER, ROCK, ETC
0.5	1.64			
1.0	3.28			
1.5	4.92			
2.0	6.56			
2.5	8.20			
3.0	9.84			
3.5	11.48			
4.0	13.12			
4.5	14.76			
5.0	16.40			
5.5	18.04			
6.0	19.69			
6.5	21.33			
7.0	22.97			
7.5	24.61			
8.0	26.25	78		5:34
8.5	27.89	79		
9.0	29.53	80		
9.5	31.17	81		
10.0	32.81	82		
10.5	34.45	83		
11.0	36.09	84		
11.5	37.73	85		
12.0	39.37	86		
12.5	41.01	87		
13.0	42.65	88		
13.5	44.29	89		
14.0	45.93	90		
14.5	47.57	91		
15.0	49.21	92		
15.5	50.85	93		
16.0	52.49	94		
16.5	54.13	95		
17.0	55.77	96		
17.5	57.41	97		
18.0	59.06	98		
18.5	60.70	99		
19.0	62.34	100		
19.5	63.98	101		
20.0	65.62	102		
20.5	67.26	103		

P-S FIELD LOG REV V1.31a

B-720 GDH

GEOVISION SUSPENSION LOGGING FIELD NOTES

SITE*:Turkey Point NPP DATE*: 3/20/08

CLIENT*: MACTEC JOB*: 8083

AUTHOR*: C. Carter PAGE* 3 4 cc 3/20/08 OF 4 5

*ITEMS WITH * MUST BE COMPLETED. OTHER INFORMATION IS OPTIONAL.*

DEPTH METERS	DEPTH FEET	UNFILTERED FILE NO*.	FILTERED FILE NO*. (if any)	COMMENTS CASING, WATER, ROCK, ETC
21.0	68.90	104		
21.5	70.54	105		
22.0	72.18	106		
22.5	73.82	107		
23.0	75.46	001 108		12:44
23.5	77.10	2 109		
24.0	78.74	3 110		
24.5	80.38	4 111		
25.0	82.02	5 112		
25.5	83.66	6 113		
26.0	85.30	7 114		
26.5	86.94	8 115		
27.0	88.58	9 116		
27.5	90.22	10 117		
28.0	91.86	11 118		
28.5	93.50	12 119		
29.0	95.14	13 120		
29.5	96.78	14 121		
30.0	98.43	15 122		
30.5	100.07	16 123		
31.0	101.71	17 124		
31.5	103.35	18 125		
32.0	104.99	19 126		
32.5	106.63	20 127		
33.0	108.27	21 128		
33.5	109.91	22 129		
34.0	111.55	23 130		
34.5	113.19	24 131		
35.0	114.83	25 132		
35.5	116.47	26 133		
36.0	118.11	27 134		
36.5	119.75	28 135		
37.0	121.39	29 136		6:07
37.5	123.03	30		
38.0	124.67	31		
38.5	126.31	32		
39.0	127.95	33		
39.5	129.59	34		
40.0	131.23	35		
40.5	132.87	36		
41.0	134.51	37		

P-S FIELD LOG REV V1.31a

B-7206H GEOVISION SUSPENSION LOGGING FIELD NOTES

SITE*:Turkey Point NPP DATE*: 3/20/08

CLIENT*: MACTEC JOB*: 8083

AUTHOR*: C. Carter PAGE* 4 5 OF 4 5 ~~3/20/08~~

*ITEMS WITH * MUST BE COMPLETED. OTHER INFORMATION IS OPTIONAL.*

DEPTH METERS	DEPTH FEET	UNFILTERED FILE NO*.	FILTERED FILE NO*. (if any)	COMMENTS CASING, WATER, ROCK, ETC
41.5	136.15	38		
42.0	137.80	39		
42.5	139.44	40		
43.0	141.08	41		
43.5	142.72	42		
44.0	144.36	43		
44.5	146.00	44		
45.0	147.64	45		
45.5	149.28	46		
46.0	150.92	47		
46.5	152.56	48		
47.0	154.20	49		
47.5	155.84	50		
48.0	157.48	51		
48.5	159.12	52		
49.0	160.76	53		
49.5	162.40	54		
50.0	164.04	55		
50.5	165.68	56		
51.0	167.32	57		
51.5	168.96	58		
52.0	170.60	59		
52.5	172.24	60		
53.0	173.88	61		
53.5	175.52	62		
54.0	177.17	63		
54.5	178.81	64		
55.0	180.45	65		
55.5	182.09	66		
56.0	183.73	67		
56.5	185.37	68		
57.0	187.01	69		
57.5	188.65	70		
58.0	190.29	71		
58.5	191.93	72		
59.0	193.57	73		
59.5	195.21	74		
60.0	196.85	75		
60.5	198.49	76		
61.0	200.13	77		1:29
61.5	201.77			

ACOUSTIC TELEVIEWER LOG COVER 1.0a.pdf

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B-720GDH ACOUSTIC TELEVIEWER FIELD LOG Rev 1.0a

Borehole*

SITE*: Turkey Point NPP DATE*: 3/20/08
CLIENT*: MACTEC JOB*: 8083
AUTHOR*: C. Carter PAGE 1 OF 2

CONTACT: PHONE: Off Cell

CONTACT: PHONE: Off Cell

CONTACT: PHONE: Off Cell

DRILLER Phillip PHONE: Off Cell
COMPANY: MACTEC

GENERAL SITE CONDITIONS/LOCATION:

COUNTY: Miami-Dade RANGE: TOWNSHIP: SECTION:
BOREHOLE CONSTRUCTION: CASED UNCASED X
DIAMETERS AND DEPTH RANGES: 4" 0 TO 73 ft ; 3 7/8 , 73 TO 220 ft

BOREHOLE TOTAL DEPTH AS DRILLED*: 220 ft

SURFACE CASING?: YES X DEPTH TO BOTTOM OF CASING 73 ft ; NO
DEPTH TO BEDROCK: ~34 DEPTH TO WATER TABLE: Ø
BOREHOLE FLUID: WATER ; FRESH WATER MUD X ; SALT WATER MUD ;
OTHER:
DEPTH TO BOREHOLE FLUID: ~ Ø TIME SINCE LAST CIRCULATION: 10:30 am

LOGGING CREW: C. Carter
VEHICLE(S) USED AND MILEAGE:
MOBILIZED FROM: Florida City DEPARTURE TIME: 7:15 am
ARRIVED ON SITE: 7:30 am
STANDBY TIME: CAUSE:

*ITEMS WITH * MUST BE COMPLETED. OTHER INFORMATION IS OPTIONAL*

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B-7206DH ACOUSTIC TELEVIEWER FIELD LOG Rev 1.0a
Borehole*

SITE*: Turkey Point NPP DATE*: 3/25/08
CLIENT*: MACTEC JOB*: 8083
AUTHOR*: C. Carter PAGE 2 OF 2

WINCH: COMPROBE____ SILVER X OYO____ OTHER____
MICROLOGGER* 5310___ 5772 X
TELEVIEWER* ACOUSTIC #5174 X OTHER____
SHEAVE* COMPROBE____ OYO 101___ 102 X 103___ RG____

1 PROBE TILT TEST* 96.22 BRUNTON TILT* 90
2 PROBE TILT TEST* 10.16 BRUNTON TILT* 10
3 PROBE TILT TEST* 19.24 BRUNTON TILT* 19 AFTER LOG* yes
1 PROBE AZIMUTH TEST* 33.6 BRUNTON AZIMUTH* 36
2 PROBE AZIMUTH TEST* 72.10 BRUNTON AZIMUTH* 74
3 PROBE AZIMUTH TEST* 115.5 BRUNTON AZIMUTH* 119 AFTER LOG* yes

PROBE OFFSET*	1.44M(4.72FT)	
MINUS CASING STICK-UP*	8.08	REF TO GROUND SURFACE
DEPTH REF. OFFSET AT START*	-3.36	
DEPTH REF. OFFSET AT END*	-3.36	
AFTER SURVEY DEPTH ERROR*	0	

LOG NAME*	START DEPTH*	START TIME	END DEPTH *	END TIME
B7206DHAUDP01	200.4 ft	2:37 pm	~7 ft	2:47 pm

MAINTENANCE PERFORMED ON SITE*: N/A (N/A if none)

EQUIPMENT PROBLEMS OR FAILURES*: N/A (N/A if none)

SUGGESTIONS, ADDITIONS, CHANGES:

*ITEMS WITH * MUST BE COMPLETED. OTHER INFORMATION IS OPTIONAL*

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B-7206

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B-7206DH ACOUSTIC TELEVIEWER FIELD LOG Rev 1.0a

Borehole*

SITE*: Turkey Point NPP DATE*: 3/20/08
CLIENT*: MACTEC JOB*: 8083
AUTHOR*: C. Carter PAGE 1 OF 2

CONTACT: _____ PHONE: Off _____ Cell _____

CONTACT: _____ PHONE: Off _____ Cell _____

CONTACT: _____ PHONE: Off _____ Cell _____

DRILLER _____ PHONE: Off _____ Cell _____
COMPANY: _____

GENERAL SITE CONDITIONS/LOCATION: _____

COUNTY: Miami-Dade RANGE: _____ TOWNSHIP: _____ SECTION: _____
BOREHOLE CONSTRUCTION: CASED _____ UNCASED X
DIAMETERS AND DEPTH RANGES: 4" 0 TO 73'; 3 7/8" 73 TO 220'

BOREHOLE TOTAL DEPTH AS DRILLED*: 220

SURFACE CASING?: YES X DEPTH TO BOTTOM OF CASING 21'; NO _____
DEPTH TO BEDROCK: ~34' DEPTH TO WATER TABLE: ~0
BOREHOLE FLUID: WATER _____; FRESH WATER MUD X; SALT WATER MUD _____;
OTHER: _____
DEPTH TO BOREHOLE FLUID: ~0 TIME SINCE LAST CIRCULATION: 10:30 am

LOGGING CREW: C. Carter
VEHICLE(S) USED AND MILEAGE: _____
MOBILIZED FROM: Florida City DEPARTURE TIME: 7:15 am
ARRIVED ON SITE: 7:30 am
STANDBY TIME: _____ CAUSE: _____

*ITEMS WITH * MUST BE COMPLETED. OTHER INFORMATION IS OPTIONAL*

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ACOUSTIC TELEVIEWER LOG COVER 1.0a.pdf

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B-720GDH ACOUSTIC TELEVIEWER FIELD LOG Rev 1.0a

Borehole*

SITE*: Turkey Point NPP DATE*: 3/20/08
CLIENT*: MACTEC JOB*: 8083
AUTHOR*: C. Carter PAGE 2 OF 2

WINCH: COMPROBE____ SILVER X OYO____ OTHER____
MICROLOGGER* 5310___ 5772 X
TELEVIEWER* ACOUSTIC #5174 X OTHER____
SHEAVE* COMPROBE____ OYO 101____ 102 X 103____ RG____

1 PROBE TILT TEST* 19.01 BRUNTON TILT* 19
2 PROBE TILT TEST* 90.43 BRUNTON TILT* 90
3 PROBE TILT TEST* 10.88 BRUNTON TILT* 11 AFTER LOG* yes
1 PROBE AZIMUTH TEST* 19.3 BRUNTON AZIMUTH* 21
2 PROBE AZIMUTH TEST* 70.3 BRUNTON AZIMUTH* 74
3 PROBE AZIMUTH TEST* 144.6 BRUNTON AZIMUTH* 146 AFTER LOG* yes

PROBE OFFSET*	1.44M(4.72FT)	
MINUS CASING STICK-UP*	-10.08	REF TO GROUND SURFACE
DEPTH REF. OFFSET AT START*	-5.36	
DEPTH REF. OFFSET AT END*	-5.34	
AFTER SURVEY DEPTH ERROR*	.02	

LOG NAME*	START DEPTH*	START TIME	END DEPTH *	END TIME
B720GDHAUVP02	120.45ft	6:53	19.7 ft	7:22pm

MAINTENANCE PERFORMED ON SITE*: N/A (N/A if none)

EQUIPMENT PROBLEMS OR FAILURES*: N/A (N/A if none)

SUGGESTIONS, ADDITIONS, CHANGES:

*ITEMS WITH * MUST BE COMPLETED. OTHER INFORMATION IS OPTIONAL*

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CALIPER FIELD LOG REV 1.1a.PDF

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B-7206DH
Borehole*

CALIPER FIELD LOG

SITE*: Turkey Point NPP
CLIENT*: MACTEC
AUTHOR*: C. Carter
DATE*: 3/20/08
JOB*: 8083
PAGE: 1 OF 2

CONTACT: _____ PHONE: Off _____ Cell _____

CONTACT: _____ PHONE: Off _____ Cell _____

CONTACT: _____ PHONE: Off _____ Cell _____

DRILLER _____ PHONE: Off _____ Cell _____
COMPANY: _____

GENERAL SITE CONDITIONS/LOCATION: _____

COUNTY: _____ RANGE: _____ TOWNSHIP: _____ SECTION: _____
BOREHOLE CONSTRUCTION: CASED _____ UNCASED X
DIAMETERS AND DEPTH RANGES: 4" 0 TO 73 ft ; 3 7/8 73 TO 220 ft

BOREHOLE TOTAL DEPTH AS DRILLED*: 220 ft

SURFACE CASING?: YES X DEPTH TO BOTTOM OF CASING 73 ft/20.5' ; NO _____
DEPTH TO BEDROCK: ~3 ft DEPTH TO WATER TABLE: 0
BOREHOLE FLUID: WATER _____ ; FRESH WATER MUD X ; SALT WATER MUD _____ ;
OTHER: _____
DEPTH TO BOREHOLE FLUID: ~0 TIME SINCE LAST CIRCULATION: 10:30am

LOGGING CREW: C. Carter
VEHICLE(S) USED AND MILEAGE: _____
MOBILIZED FROM: Florida City, FL DEPARTURE TIME: 7:45 am
ARRIVED ON SITE: 7:30 am
STANDBY TIME: 6-5 3/19 CAUSE: _____

*ITEMS WITH * MUST BE COMPLETED. OTHER INFORMATION IS OPTIONAL*

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CALIPER FIELD LOG REV 1.1a.PDF

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B-7206DH
Borehole*
CALIPER FIELD LOG

SITE*: Turkey Point NPP
CLIENT*: MACTEC
AUTHOR*: C. Carter

DATE*: 3/20/08
JOB*: 8083
PAGE: PAGE 2 OF 2

cc 3/20/08

WINCH: COMPROBE [ ] SILVER [X] OYO [ ] RG [ ] OTHER [ ]
MICROLOGGER* 5310 [ ] 5772 [X] OTHER
CALIPER PROBE* 5368 [X] OTHER
SHEAVE* COMPROBE [ ] OYO 101 [ ] 102 [X] 101 [ ] RG [ ]

PROBE OFFSET	2.08M(6.82 FT)		12 IN MAX
MINUS CASING STICK-UP*	8.08	10.08	
DEPTH REF. OFFSET AT START*	-1.23	-3.26	REF TO GROUND SURFACE
DEPTH REF. OFFSET AT END*	-1.25	-3.20	
AFTER SURVEY DEPTH ERROR*	.02	.06	

LOG NAME*	START DEPTH*	START TIME*	END DEPTH*	END TIME*
B7206DHCALTEST01		3:15		3:16
B7206DHCALUP01	202.5 ft	3:33	59.55 ft	3:47
B7206DHCALTEST02		4:00		4:01
B7206DHCALTEST03		7:41		7:42
B7206DHCALTEST04		8:07		8:08
B7206DHCALUP02	82.1 ft	7:53	16.3 ft	8:00

CALIBRATION PLATE S/N 201

		AS BUILT			PVC FITTING
		1.968 IN	3.937 IN	8.000 IN	4.507 IN
	FILE NAME	(50 MM)	(100 MM)	(203.2 MM)	(114.3 MM)
AS MEAS.*	B7206DHCALTEST01	1.968	3.978	8.02	4.530
AS MEAS.*	B7206DHCALTEST02	1.942	3.927	7.999	4.504
AS MEAS.	B7206DHCALTEST03	1.977	3.953	8.05	4.513
AS MEAS.	B7206DHCALTEST04	1.977	3.986	8.02	4.50
AS MEAS.					
AS MEAS.					

4.510 cc 3/20/08

MAINTENANCE PERFORMED ON SITE*: N/A (N/A if none)

EQUIPMENT PROBLEMS OR FAILURES*: N/A (N/A if none)

SUGGESTIONS, ADDITIONS, CHANGES:

*ITEMS WITH * MUST BE COMPLETED. OTHER INFORMATION IS OPTIONAL*

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DH FIELD LOG REV 1.1a.pdf

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B740 (DH) **DOWNHOLE VELOCITY FIELD LOG REV 1.1a**

Borehole*

SITE*: Turkey Pt N?
CLIENT*: Mactec
AUTHOR*: A. Martin

DATE*: 6/24/08 & 6/25/08
JOB*: 8083
PAGE 1 OF * 3

CONTACT: Matt Cooke PHONE: Off (Cell) 303-241-5792

CONTACT: _____ PHONE: Off Cell _____

CONTACT: _____ PHONE: Off Cell _____

CONTACT: _____ PHONE: Off Cell _____

CONTACT: _____ PHONE: Off Cell _____

DIRECTIONS TO SITE: _____

GENERAL SITE CONDITIONS/LOCATION: _____

COUNTY: — RANGE: — TOWNSHIP: — SECTION: —
BOREHOLE CONSTRUCTION: CASED ✓2" TIME SINCE GROUT 3+ weeks
DIAMETERS AND DEPTH RANGES: 6" 0 TO 150' ; _____ TO

BOREHOLE TOTAL DEPTH AS DRILLED*: 150'

DEPTH TO BEDROCK: ≈3' DEPTH TO WATER TABLE: ≈1'

WATER PUMPED FROM BOREHOLE*? YES ✓ NO - then what DEPTH TO WATER water pumped to 110'

*ITEMS WITH * MUST BE COMPLETED. OTHER INFORMATION IS OPTIONAL*

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DH FIELD LOG REV 1.1a.pdf

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B740 (DH5) **DOWNHOLE VELOCITY FIELD LOG**
Borehole*

SITE*: Turkey Point nP
CLIENT*: Mactec
AUTHOR*: A. Morton

DATE*: 6/24/08 & 6/25/08
JOB*: 8083
PAGE 1 OF 2 * 3

LOGGING CREW*: A. Morton / N. Baldwin
MOBILIZED FROM: Florida City
DEPARTURE TIME: 0715am
ARRIVED ON SITE: 0745hrs
STANDBY TIME:
CAUSE:
LOGGING STARTED: 1145hrs / 0800hrs (6/24/08 / 6/25/08)
LOGGING COMPLETED: 1640 / 1100hrs 1115hrs (6/24/08 / 6/25/08) on 6/24/08

WINCH	HAND ✓		OTHER	
INSTRUMENT*	Geode 3458	✓	3459 ☐	Other
GEOPHONES*	BHG3 9501	☐	Other BHG3 s/n B3079	

Plank Orientation*: N82W (MN) Sh Source Offset* 9'11" P Source Offset* 11'
Surface geophones - If any-Offset Sh 16'8" P Offset 17'8"

P SOURCE Triple accelerated weight drop
Sh SOURCE "

CHANNEL ASSIGNMENTS 1 = borehole V, 2 = borehole Htl, 3 = borehole Htr
4 = surface V, 5 = surface Htl, 6 = surface Htr

SAMPLE RATES:
Depth range 5'-148' Sh-wave 20.833/ms 5R/0.1755 RL P-wave 20.833/ms 5R/0.0755 RL
Depth range Sh-wave P-wave
Depth range Sh-wave P-wave

MAINTENANCE PERFORMED ON SITE*: NA CP 7/24/08

EQUIPMENT PROBLEMS OR FAILURES*: Difficulty with contact closure triggers on highly conductive ground — no impact on data quality.

SUGGESTIONS, ADDITIONS, CHANGES:

COMMENTS:

*ITEMS WITH * MUST BE COMPLETED. OTHER INFORMATION IS OPTIONAL.*

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DH FIELD LOG REV 1.1a.pdf

B740 (DH) **DOWNHOLE VELOCITY FIELD LOG**
Borehole*

SITE*: Turkey Point NP DATE*: 6/24/08 & 6/25/08 on 6/24/08
CLIENT*: MACTEC JOB*: 8083
AUTHOR*: A. Martin PAGE* 3 OF 3

*ITEMS WITH * MUST BE COMPLETED. OTHER INFORMATION IS OPTIONAL*

DEPTH* (Feet)	Sh CHANNEL NUMBERS*		# OF STACKS	SH FILE NUMBER*		P CHANNEL NUMBER*	# OF STACKS	P FILE NUMBER*
	HL*	HT		RED*	GRN*			
5	2	3	8	59	60	1	5	107
10			8	57	58		5	102
15			8	55	56		5	101
20			8	53	54		5	100
25			8	51	52		1/5	98/99
30			8	49/71	50/72		2	97
35			8	47	48		5	96
40			8	45	46		5	95
45			8	43	44		5	94
50			9	41	42		5	93
55			8	39	40		7	92
60			8	37	38		5	91
65			10	35	36		6	90
70			10	33	34		6	89
75			10	31	32		6	88
80			10	29	30		5	87
85			10	27	28		5	86
90			10	25/63	26/64		6	85
95			12	23	24		5	84
100			10	21	22		5	83
105			10	19	20		6	82
110			10	17	18		6	81
115			10	15	16		6	80
120			12	13	14		6	79
126			12	11	12		6	78
130			12	9	10		6	77
135			10	7	8		8	76
140			10	5	6		8	75
141			10	3	4		8	74
142 *	2	3	10	1/61	2/62	1	5	73
90'	Noise		65 - 70					
			End of log		cgh — 6/25/08			
Note: File 99 - 103			with 16lb sledge hammer					

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* edit depth

APPENDIX G

BORING GEOPHYSICAL LOGGING FIELD MEASUREMENT PROCEDURES

PROCEDURE FOR

OYO P-S SUSPENSION SEISMIC VELOCITY LOGGING

Background

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

Objective

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

Instrumentation

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

The Suspension P-S Logger system, manufactured by OYO Corporation, or the Robertson Digital P-S Suspension Probe with the Robertson Micrologger2 are currently the only commercially available suspension logging systems. As shown in Figure 1, these systems consists of a borehole probe suspended by a cable and a recording/control electronics package on the surface.

The suspension system probe consists of a combined reversible polarity solenoid horizontal shear-wave generator (S_H) and compressional-wave generator (P), joined to

two biaxial geophones by a flexible isolation cylinder. The separation of the two geophones is one meter, allowing average wave velocity in the region between the geophones to be determined by inversion of the wave travel time between the two geophones. The total length of the probe is approximately 7 meters; the center point of the geophones is approximately 4 meters above the bottom end of the probe.

The probe receives control signals from, and sends the amplified geophone signals to, the instrumentation package on the surface via an armored 4 or 7 conductor cable. The cable is wound onto the drum of a winch and is used to support the probe. Cable travel is measured by a rotary encoder to provide probe depth data.

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

Environmental Conditions

The OYO P-S Suspension Logging Method can be used in either cased or uncased boreholes. For best results, the uncased borehole must be between 10 and 20 cm in diameter, or 4 to 8 inches. A cased borehole may be as small as 3 inches, if properly grouted (see below) and the grout annulus does not exceed 1 inch.

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

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

For borehole casing, applicable preparation procedures are presented in ASTM Standard D4428/D4428M-91 Section 4.1 (see ASTM website for copy).

Calibration

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

Measurement Procedure

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

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

The data from each geophone during each source activation is recorded as a different channel on the recording system. The seismograph has at least six channels (two simultaneous recording channels), each with at least a 12 bit 1024 sample record. Newer seismographs may have longer record lengths. The recorded data is displayed on a CRT or LCD display and possibly on paper tape output as six channels with a common time scale. Data is stored on digital media for further processing. Up to 8 sampling sequences can be stacked (averaged) to improve the signal to noise ratio of the signals.

Review of the data on the display or paper tape allows the operator to set the gains, filters, delay time, pulse length (energy), sample rate, and stacking number in order to optimize the quality of the data before recording. In the case of the Model 170, printed data is verified by the operator prior to moving the probe. In the case of the Robertson Micrologger2, storage on the hard disk should be verified from time-to-time, certainly before exiting the borehole.

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

Required Field Records

1) Field log for each borehole showing

   a) Borehole identification

   b) Date of test

   c) Tester or data recorder

d) Description of measurement

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

f) QA Review

2) Paper output records are no longer required, since the Micrologger2 cannot generate them. However, data must be stored in at least 2 places prior to leaving the site

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

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

An example Field Log is attached to this procedure.

Analysis

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

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

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

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

value is the average of the values obtained from the 'normal' and 'reverse' source actuations.

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

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

Once the proper picks are entered in PSLOG, the picks are transferred to an Excel spreadsheet where Vs and Vp are calculated. The spreadsheet allows output for presentation in charts and tables.

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

Registered Geophysicist Antony Martin Date 9/11/06

QA Review [signature] Date 9/11/06

References:

1. "In Situ P and S Wave Velocity Measurement", Ohya, S. 1986. Proceedings of In-Situ '86, *Use of In-Situ Tests In Geotechnical Engineering*, an ASCE Specialty Conference sponsored by the Geotechnical Engineering Division of ASCE and co-sponsored by the Civil Engineering Dept of Virginia Tech.

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

3. "Standard test Methods for Crosshole Seismic Testing", ASTM Standard D4428/D4428M-91, July 1991, Philadelphia, PA

OYO SUSPENSION P-S VELOCITY LOGGING SETUP

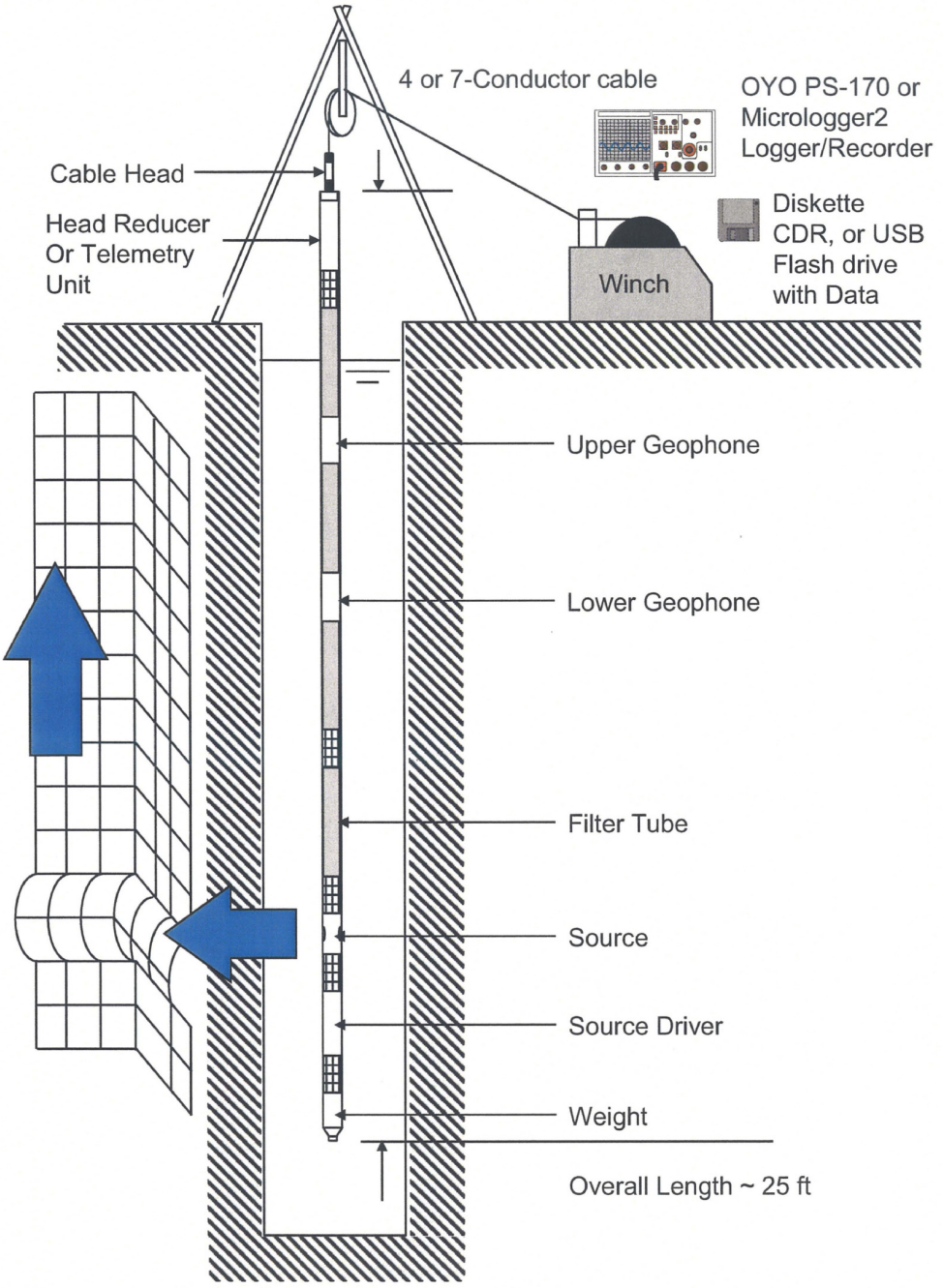

Figure 1. Suspension PS logging method setup

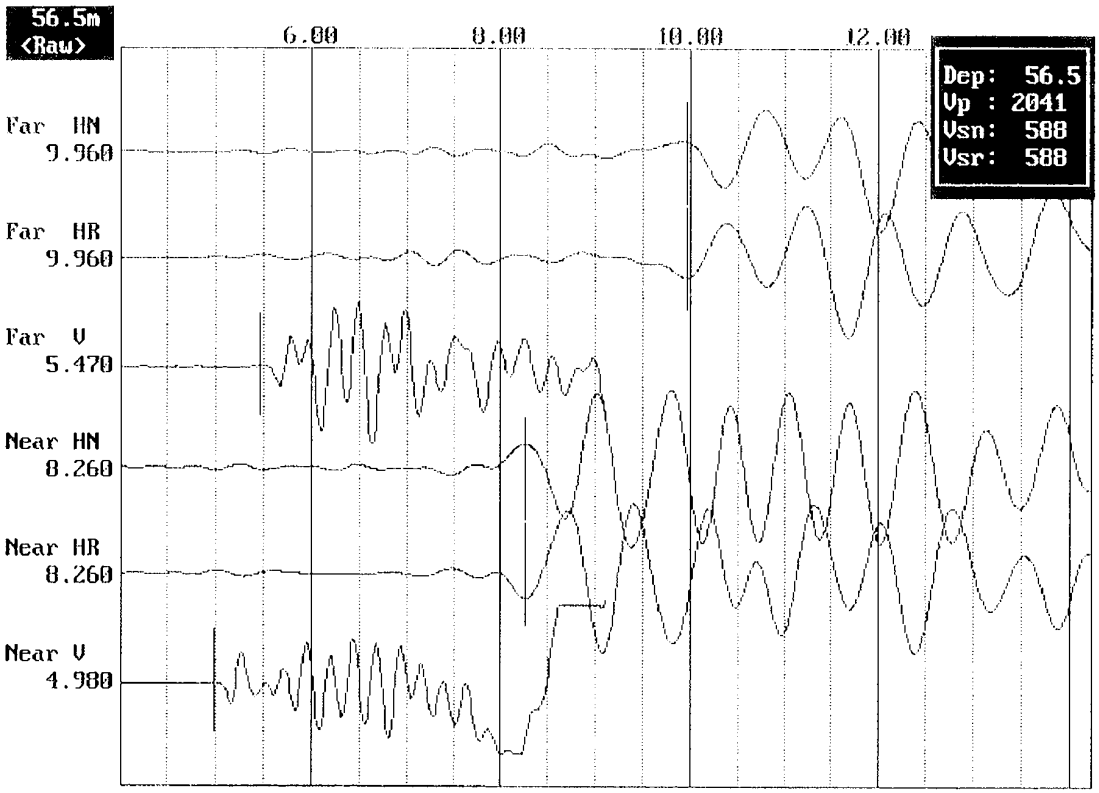

Figure 2. Sample suspension method waveform data showing horizontal normal and reversed (HR and HN), and vertical (V) waveforms received at the near (bottom 3 channels) and far (top 3 channels) geophones. The arrivals in milliseconds for each pick are shown on the left. The box in the upper right corner shows the depth in the borehole and the velocities calculated based on the picks.

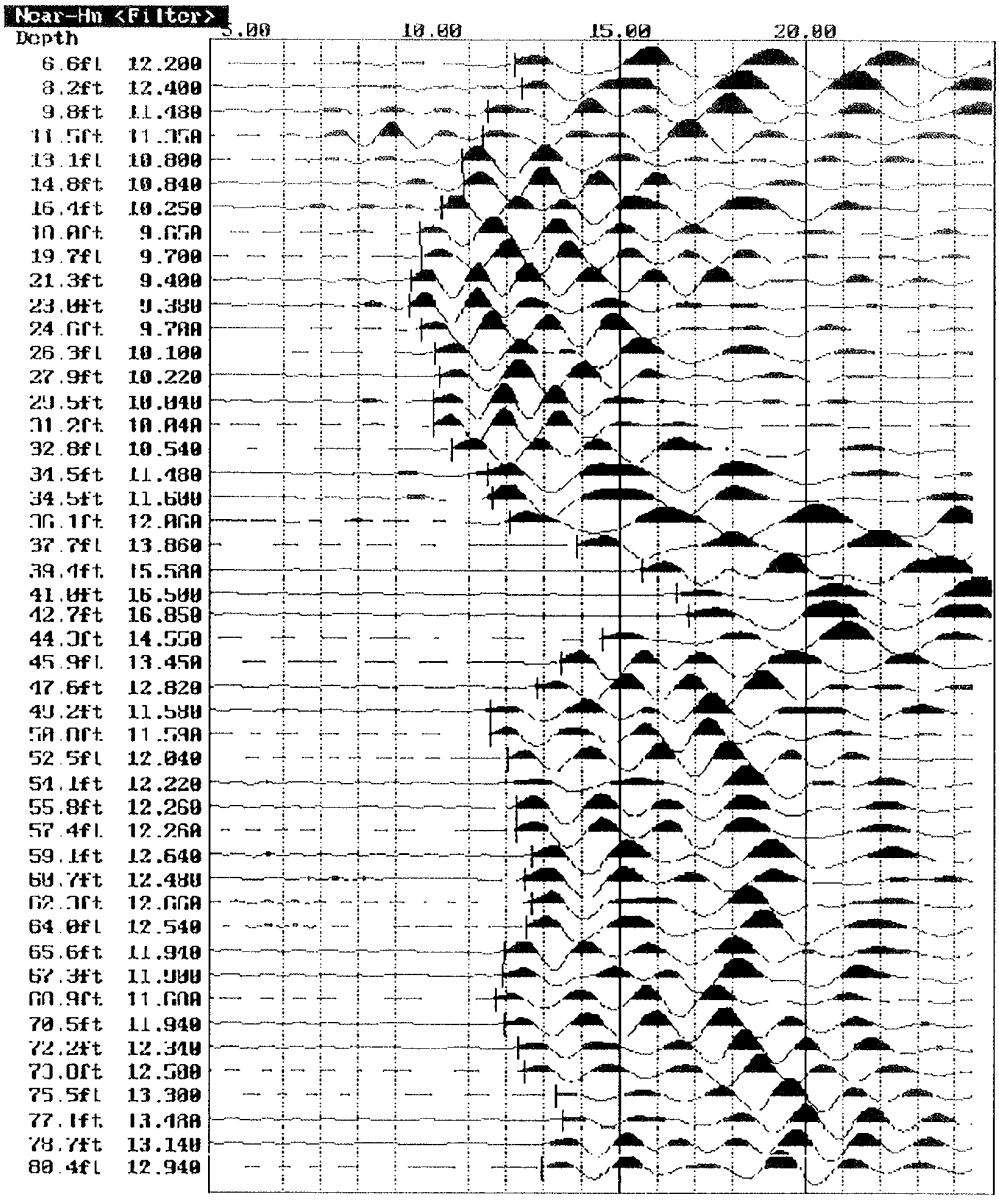

Figure 3. Sample composite waveform plot for normal shear waves received at the near geophone in a single borehole

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P-S SUSPENSION VELOCITY FIELD LOG

SITE:_____ DATE:_____
CLIENT:_____ JOB:_____
AUTHOR:_____ PAGE 1 OF _____

CONTACT:_____ _OFFICE_ PHONE:_____
_____ PHONE:_____
CONTACT:_____ _OFFICE_ PHONE:_____
_____ PHONE:_____
CONTACT:_____ _____ PHONE:_____
_____ PHONE:_____
CONTACT:_____ _____ PHONE:_____
_____ PHONE:_____
DRILLER:_____ _____ PHONE:_____
COMPANY:_____ _____ PHONE:_____

DIRECTIONS TO SITE:_____
_____
_____
_____
_____

GENERAL SITE CONDITIONS/LOCATION:_____
_____

EA#:_____
BOREHOLE DESIGNATION:_____LOCATION:_____
_____
COUNTY:_____RANGE:_____TOWNSHIP:_____SECTION:_____
BOREHOLE CONSTRUCTION: CASED_____ UNCASED_____
DIAMETERS AND DEPTH RANGES: _____ 0 TO _____ ; _____, _____ TO _____
BOREHOLE TOTAL DEPTH AS DRILLED:_____
CONDUCTOR CASING?: YES____ DEPTH TO BOTTOM OF CASING_____; NO____
DEPTH TO BEDROCK:_____ DEPTH TO WATER TABLE:_____
BOREHOLE FLUID: WATER_____; FRESH WATER MUD_____; SALT WATER MUD _____;
OTHER:_____
DEPTH TO BOREHOLE FLUID:_____ TIME SINCE LAST CIRCULATION:_____

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SITE:_____ DATE:_____
CLIENT:_____ JOB:_____
AUTHOR:_____ PAGE 2 OF _____

LOGGING CREW:_____
VEHICLE(S) USED AND MILEAGE: _____
MOBILIZED FROM:_____ DEPARTURE TIME:_____
ARRIVED ON SITE:_____
STANDBY TIME:_____ CAUSE:_____
LOGGING STARTED:_____ LOGGING COMPLETED:_____
STANDBY TIME:_____ CAUSE:_____
LOGGING STARTED:_____ LOGGING COMPLETED:_____
DEMOBILIZED TO:_____ ARRIVAL TIME:_____
ADDITIONAL DEMOB TIME:_____ REASON:_____

BATTERIES CHANGED BEFORE LOGGING: YES_____; NO_____; STORED WITH NEW_____

WINCH	COMPROBE ☐		GREY ☐	OYO ☐	RG ☐	OTH ☐		
INSTRUMENT	OYO 12004 ☐	15014 ☐	19029 ☐		RG 160023 ☐	160024 ☐		
RECEIVER S/N	12008 ☐	20042 ☐	26066 ☐	11001 ☐	23053 ☐			

MAINTENANCE PERFORMED ON SITE:_____
_____
_____
_____

EQUIPMENT PROBLEMS OR FAILURES:_____
_____
_____

SUGGESTIONS, ADDITIONS, CHANGES:_____
_____
_____

COMMENTS:_____
_____
_____
_____
_____
_____

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GEOVISION SUSPENSION LOGGING FIELD NOTES

SITE: _____ DATE: _____

CLIENT: _____ JOB: _____

AUTHOR: _____ PAGE _____ OF _____

DEPTH METERS	DEPTH FEET	UNFILTERED FILE NO.	FILTERED FILE NO.	COMMENTS CASING, WATER, ROCK, ETC
0.5	1.64			
1.0	3.28			
1.5	4.92			
2.0	6.56			
2.5	8.20			
3.0	9.84			
3.5	11.48			
4.0	13.12			
4.5	14.76			
5.0	16.40			
5.5	18.04			
6.0	19.69			
6.5	21.33			
7.0	22.97			
7.5	24.61			
8.0	26.25			
8.5	27.89			
9.0	29.53			
9.5	31.17			
10.0	32.81			
10.5	34.45			
11.0	36.09			
11.5	37.73			
12.0	39.37			
12.5	41.01			
13.0	42.65			
13.5	44.29			
14.0	45.93			
14.5	47.57			
15.0	49.21			
15.5	50.85			
16.0	52.49			
16.5	54.13			
17.0	55.77			
17.5	57.41			
18.0	59.06			

GEOVISION SUSPENSION LOGGING FIELD NOTES

SITE: _____ DATE: _____

CLIENT: _____ JOB: _____

AUTHOR: _____ PAGE _____ OF

DEPTH METERS	DEPTH FEET	UNFILTERED FILE NO.	FILTERED FILE NO.	COMMENTS CASING, WATER, ROCK, ETC
18.5	60.70			
19.0	62.34			
19.5	63.98			
20.0	65.62			
20.5	67.26			
21.0	68.90			
21.5	70.54			
22.0	72.18			
22.5	73.82			
23.0	75.46			
23.5	77.10			
24.0	78.74			
24.5	80.38			
25.0	82.02			
25.5	83.66			
26.0	85.30			
26.5	86.94			
27.0	88.58			
27.5	90.22			
28.0	91.86			
28.5	93.50			
29.0	95.14			
29.5	96.78			
30.0	98.43			
30.5	100.07			
31.0	101.71			
31.5	103.35			
32.0	104.99			
32.5	106.63			
33.0	108.27			
33.5	109.91			
34.0	111.55			
34.5	113.19			
35.0	114.83			
35.5	116.47			
36.0	118.11			

PROCEDURE FOR

DOWNHOLE SEISMIC VELOCITY LOGGING

Background

This procedure describes a method for measuring shear and compressional wave velocities in soil and rock. The Downhole Method is applied by generating shear and compressional waves at the surface and measuring the travel time between the surface and the borehole.

Objective

The outcome of this procedure is a plot and table of P and S_H wave velocity versus depth for each borehole. Alternatively or additionally, travel time plots may also be produced. Data is presented in report format, with ASCII data files and digital records transmitted on disk.

Instrumentation

1. OYO Model 170 Digital Seismograph, Geometrics Strataview or equivalent
2. Downhole probe, including horizontal and vertical geophones, fluxgate compass for orientation downhole, and system for locking probe against the side of the borehole
3. Sledge hammer with impulse switch to trigger recording
4. Winch and logging cable
5. Batteries to operate seismograph and controls for downhole probe
6. Various cables

Downhole soil velocities are measured using a variable azimuth downhole geophone and a seismograph. This system orients the downhole geophones parallel to the axis of excitation at the surface, insuring that signals received at the downhole geophones are of maximum amplitude, and are not subject to errors in travel time caused by incorrect phase of first arrival picks, as found with non-orientable downhole probes.

The downhole probe consists of a horizontal and vertical geophone mounted on a rotatable structure with a fluxgate magnetometer compass sensor. The compass/geophone assembly is mounted with preamplifiers and compass drive circuitry inside a 2.5 inch diameter case approximately 30 inches in length. The compass/geophone assembly can be rotated from the surface control module to match the azimuth of the horizontal geophone axis with the azimuth of the surface shear wave source. The probe receives control signals from, and sends the amplified geophone signals to, instrumentation on the surface via a 4- or 7-conductor cable. Cable travel is measured to provide probe depth data. The probe is locked into the borehole by inflation of an external rubber bladder or motor-driven spring clamp that runs the length of the probe.

Sledge hammer blows against the ends of a steel capped traction plank are used as an S_H-wave energy source. The traction plank is weighted by placing under the wheel or wheels of a truck. Sledge hammer blows against a striker plate on the surface are used as a P-wave energy source. System triggering is performed by a hammer switch mounted on the sledgehammer handle.

In operation, the S_H-wave produced by swinging the hammer in one direction produces an output at the downhole horizontal geophones which is digitized and recorded. The hammer is then swung in the opposite direction, and the horizontal output signals are again recorded, producing a shear-wave record of polarity opposite to the previous record. A vertical hammer blow is executed, and the response of the vertical geophone to the resultant P-wave is recorded.

The signal from each geophone generated by each hammer blow is recorded as a different channel on the recording system. The recorded data is displayed on the seismograph display. Data and all system parameters are stored on disk for further processing. Multiple hammer blows can be summed to improve the signal-to-noise ratio of the signals.

Review of the displayed data on the display allows the operator to set the gains, filters, sample rate, and summing number in order to optimize the quality of the data before recording to disk.

Environmental Conditions

For best results, the borehole should be between 7.5 and 17 cm in diamater, or 3 to 6 inches.

The locking method requires that soil boreholes be cased with PVC for best results. Casing is not required in hard rock boreholes. If installed, the casing must be properly installed and grouted. The best method is using a tremie tube to pump grout from the bottom. Any voids in the grout will cause problems with the data. Likewise, large grout bulbs used to fill cavities will also cause problems. The grout must be set before testing. This means the grouting must take place at least 48 hours before testing.

For borehole casing, applicable preparation procedures are presented in ASTM Standard D4428/D4428M-91 Section 4.1 (see ASTM website for copy).

The seismograph must be protected from rain. The downhole probe may or may not be submersible (depending on type). The procedure below provides for emptying the borehole of water.

Calibration

Calibration of the seismograph is required.

Downhole Measurement Procedure

Prior to performing downhole measurements each borehole casing may be emptied using a submersible pump or bailer. The downhole probe compass azimuth is checked at the surface, and compared to the azimuth of the traction plank S_H-wave source. The mechanical or electronic depth encoders are set to zero with the geophones located at ground level. The probe is then lowered to the bottom of the borehole at the desired intervals. At each desired depth, the probe is locked in place. The compass/geophone assembly is then rotated to match the azimuth of the surface S_H-source. At each sampling depth a minimum of two opposite horizontal records and one vertical record is acquired, and the gains adjusted as necessary to get good signal to noise ratio. The waveform data from each depth is checked on the display, and recorded before moving to the next depth. Upon removal of the probe from the borehole, depth indications are re-checked with the geophones located at ground level.

Typical depth spacing for measurements is 1.5 meters, or 5 feet. Alternative spacing is 1 meter, or 3 feet.

Deviations From Above Written Methods And Procedures

It is permissible for on-site personnel to deviate from this procedure with respect to the size and number of sledge hammers, the size of the traction plank, the weight of the truck, removing water from the borehole (not needed for submersible geophone packages), or the use of a winch (manual lowering is acceptable for shallow depths), and sequence of horizontal and vertical records, provided adequate waveforms are obtained.

Required Field Records

1) Field log for each borehole showing
   a) Borehole identification
   b) Date of test
   c) Tester or data recorder
   d) Description of measurement
   e) Offset of centerpoint of plank and P-wave striker plate from the borehole collar
   f) Any deviations from test plan and action taken as a result
   g) Field check of data validity, performed by tester during data collection
   h) List of record ID numbers (for data on disk) and corresponding depth
2) Data on hard disk with backup copies of data on removable media, labeled with borehole designation, record ID numbers, date, and tester name.

Downhole Analysis

Records are analyzed to locate the first arrival of energy on each downhole geophone record. The horizontal records are studied to verify the presence of clear S_H-wave pulses, as indicated by the presence of opposite polarity pulses on each pair of horizontal records. Ideally, the shear-wave signals from the 'normal' and 'reverse' hammer blows are very nearly inverted images of each other. Digital low-pass filtering may be used to remove the higher frequency converted P-wave signal and cultural noise from the S_H-wave signal.

Total travel time is corrected for changes in path length due to offset of the source from the borehole collar, and then plotted versus depth.

Results are further presented in the form of velocity profiles with depth for both P- and S_H-wave velocities.

QA Review

This procedure has been reviewed and approved by the undersigned.

Registered Geophysicist Anthony Martin Date 04/12/06

QA Review [signature] Date 04/12/06

References:

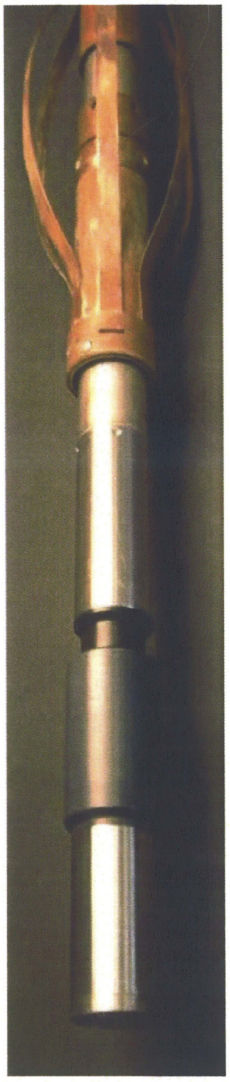
1. "Standard test Methods for Crosshole Seismic Testing", ASTM Standard D4428/D4428M-91, July 1991, Philadelphia, PA

PROCEDURE FOR USING THE ROBERTSON GEOLOGGING HI-RESOLUTION ACOUSTIC TELEVIEWER (HiRAT)

Reviewed 2/13/06

Background

The acoustic televiewer is a device for producing a qualitative image of the wall of a borehole. Because it uses ultrasound rather than visible light it is able to work in dirty or opaque borehole fluids, although heavy drilling mud will cause excessive dispersion of the acoustic beam. The picture below shows the sonde's lower nylon section, and one of the bowspring attachments which are used to centralize the sonde in the borehole.



Pulses of ultrasound (0.5 - 1.5MHz) are generated by a piezo-electric resonator. The pulses are transmitted through the oil in which the resonator is immersed, through the wall of the acoustic housing, then propagate through the borehole fluid and are reflected from the wall of the borehole. The reflected energy is picked up by the same transducer, from which is recorded both the ***amplitude*** of the returned pulse and the ***travel-time*** which have elapsed. Blanking must be applied to prevent the transducer from registering reflections from the inside surface of the acoustic housing. The material of the housing is chosen so that its acoustic properties are similar to the oil which fills it. The housing is not designed to withstand borehole fluid pressures, but has a piston device to allow equalization between inside and outside pressure.

The ***amplitude*** of the returned pulse is a function of the acoustic reflectivity of the borehole wall. If the beam strikes a hard borehole wall normally to the surface the energy will be returned to the transducer and a strong return will be recorded. If the formation is softer, then less energy will be reflected. Also, if the surface of the borehole is rough, or effectively missing because of the presence of a fracture or other structure, then energy will be dispersed and a poor return will be recorded.

The ***travel-time*** is a simple function of the diameter of the borehole and the velocity of sound in the borehole fluid (typically 1.5Km/sec). An A/D converter monitors the output from the transducer once the blanking period has expired and a comparator is used to detect the peak amplitude during the sampling window.

The coaxially-mounted transducer has a planar radiating surface, but the vibration characteristics are such that the acoustic pulse is emitted as a 'pencil' beam. The emitted beam is deflected by a planar mirror so that it leaves the acoustic housing at right angles to the sonde axis. The mirror is rotated to scan the borehole wall. The ultrasound pulses are synchronized with rotation of the mirror so that up to 360 pulses are emitted in every revolution. Because of the time which must elapse for the two-way transit of the borehole fluid, there is an upper limit upon the number of radial samples that may be acquired from a borehole of a particular radius. In larger boreholes, therefore, it may be necessary to reduce the number of radial samples. The sonde is able to operate at 90, 180 or 360 samples per revolution.

An image of the borehole wall is produced by moving the sonde along the borehole axis while it is scanning radially. By the same logic as shown above, it can be seen that any horizontal point will be imaged by more than one sweep of the acoustic beam so long as the axial movement of the sonde during one complete sweep is no greater than the beam diameter. An upper limit is therefore imposed upon the logging speed which will be a function of the rotational speed of the transducer, the radial sampling interval and borehole diameter.

Objective

The objective of this procedure is to provide a pseudo "core" of the borehole, and map the orientation and angles of cracks and voids in rock boreholes.

Instrumentation

This procedure is written specifically for the Robertson Geologging High-Resolution Acoustic Televiewer (HiRAT). The required equipment includes:

1. The Robertson High-Resolution Acoustic Televiewer (HiRAT) sonde with centralizers
2. A 4-conductor wire-line winch with cable at least 30m (100ft) longer than the depth of the borehole (RG Smart Winch or equivalent. GEOVision has adapted all our 4-conductor winches)
3. A sheave with depth encoder with minimum 500 pulse/revolution
4. A Robertson Geologging Micrologger II
5. A laptop with Winlogger installed and the following minimum system requirements:
   - Windows 98SE or above
   - 64M System memory
   - 800x600x24 SVGA Display with DirectX 8.0
   - 500Mhz CPU
   - USB 2.0 connection
6. Battery power supply with cables

Environmental Conditions

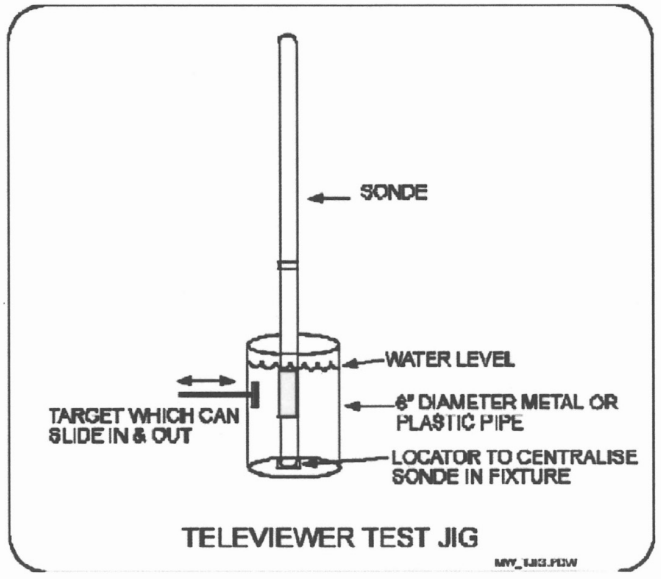
This tool is designed for fluid-filled boreholes between 67 and 150mm (3-6in) in rock. Since fine cracks are usually not visible in the walls of soil borings, the televiewers add very little information from a soil boring than a simple video. Now if the boring has soil AND rock, televiewer visuals in the soil may still be useful.

Calibration

The acoustic televiewer uses the variability in reflectance and the travel time to make an image of the borehole wall, mostly resulting from relative differences of materials and the physical characteristics of the wall. Since these are relative measurements, no field calibration of the sonde is required. However, it is important that the same location in the borehole be checked at the start and finish of the logging to make sure that the response or functionality haven't changed during the measurement.

A test fixture may be used to check function of the acoustic televiewer prior to use. This test fixture should comprise a plastic pipe, with a known internal diameter between 3 and 6 inches. This should be filled with water and the sonde stood upright in the fixture. A target made of metal or metal foil is glued on the inside of the container, or optionally on a seal and shaft so that it can be moved in and out on a line radial to the center-line of the pipe. A representation of this is shown in the figure below.

The purpose of this test fixture is to check the ability of the sonde to differentiate between materials of different acoustic reflectances, and different travel times, and to check the calibration of the caliper function of the sensor using the measured diameter of the pipe. However, if calibrated caliper measurements are required, it is recommended that a mechanical 3-arm caliper tool be used for this purpose because it can be calibrated in the field prior to use. The HiRAT will give very accurate results but this procedure does not cover calibration.



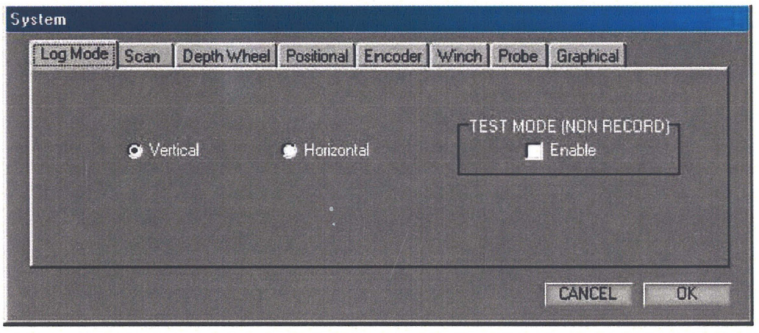
TELEVIEWER TEST JIG

Hi-RAT Field Procedure

Because the logging software is a standalone module, there are a number of settings which must be initialized independently of the WinLogger software. These include the depth measurement subsystem and sonde operating modes. Click on 'System' on the menu bar to show the following dialog boxes:

1.0 Log Mode

The sonde can operate in three distinct modes:



- Vertical mode is used for boreholes which are drilled from the surface and are deviated at less than 70 degrees from the vertical. Most exploration boreholes will fall into this class. In this mode the image is orientated according to compass directions (magnetic co-ordinates).

- Horizontal mode is used for boreholes which are sub-horizontal so their inclination will probably exceed 70 degrees from the vertical. Boreholes in this class would normally be drilled as part of ground investigations for tunneling and mining, drilling ahead of a drive to determine the nature and extent of fracturing. In this mode the image is orientated according to gravitational coordinates (up/down) since there is no unique point of the image circle which can be orientated to North with any precision.

- Test mode is used to exercise all sonde functions without creating a log. The image will scroll on the screen in the normal fashion, and orientation readouts will be refreshed continuously.

2.0 Scan Parameters

The scan parameters control the radial sampling of the borehole. The values will be retained between logging sessions, so the sonde will be initialized correctly at power-on. There are three parameters in the dialog: