ATTACHMENT C

Observation Well Logs

Development Records

Slug Test Data

Observation Well Construction Logs

Volume 1 of 1

ATTACHMENT C

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1.0 OBSERVATION WELLS

1.1 Geotechnical Borings to Plan Well Installation

Geotechnical borings were drilled near each of the proposed observation well (OW) cluster locations to obtain the information necessary for Bechtel to determine the depth(s) and locations for the OW installation. The logs for these geotechnical borings, which have comparable numbers to the corresponding observation wells, are found in Attachment B of the report.

Following Bechtel's review of the geotechnical borings, the observation wells were installed approximately 5 to 20 feet from the geotechnical boring with a deeper screen interval on one side of the boring and the shallow screen interval on the opposite side. The observation wells were installed using either hollow stem auger or mud rotary drilling methods in accordance with the Specification and following Bechtel's directions for depth and other details. Diagrams of the wells are provided in Appendices C-1 and C-4 of this attachment. The wells consist of PVC screen and riser pipe, sand filter pack, bentonite chips or pellets, and cement bentonite grout. Protective steel well stick-up covers were placed around the above ground surface stick-up well and concrete pads were placed at the surface as noted in the Specification.

1.2 Well Installation

Twenty-eight observation wells of the thirty proposed observation wells were installed throughout the site as part of this project. Proposed wells OW-420L and OW-931L were not installed per Bechtel direction in the field, as a result of lower sands not being present. The observation wells were installed per Section 6.0 of the Specification. One replacement observation well (OW-332La) was installed after it was discovered that the original well (OW-332L) had collapsed at a depth of approximately six feet. Observation well OW-332L was abandoned on February 7, 2007, prior to the installation of well OW-332La. The well was abandoned in general accordance with Texas Administrative Code Title 16, Part 4 Chapter 76 Rule 1004 (16 TAC 76.1004). Well OW-332L was grouted by pumping a specified grout mix through a 1-inch PVC tremie pipe which was lowered to the bottom of the observation well. The tremie pipe was pulled toward the surface during grouting to assure a consistent application of grout throughout the well length. The well location was grouted to the existing surface elevation.

Soil borings for installation of all observation wells were advanced using either hollow stem auger or mud rotary drilling to make a nominal eight-inch borehole diameter. The borings were advanced to depths specified by Bechtel's field representative.

As discussed in Section 1.1, the observation wells were installed in separate borings near the geotechnical borings as instructed by Bechtel. The lithology shown on the Observation Well Logs is based on a description of material obtained from cuttings. Due to the method of obtaining the sample for classification, there may be some differences in lithology from the nearby soil boring. Well screen placement was based on the hydrogeologic condition observed in each geotechnical boring at the time of installation.

The designated depth was reached at each boring location to allow the installation of a two-inch well. The well installation included a sump, 0.20-inch slotted PVC screen and riser casing, which were connected together and placed in the open soil boring. A sand filter pack was placed around the sump and screen to at least two feet above the top of the screened interval. A two- to three-foot bentonite seal was placed above the sand filter pack. The annulus was then grouted from the top of the bentonite seal to the ground surface at each boring to assure no surface water or rain could directly penetrate into the observation well. The grout-mix specified in Section 5.12 of the Specification was used.

The depth of the screened interval, length of the screen and general well configuration were designated in the field for each well by a Bechtel's field representative. Since the ground surface elevations at the well sites were not determined until after the well pads were placed, the top of the PVC casing elevation less the casing stickup above ground surface as measured at the time of installation was used to back-calculate the ground surface elevations shown on the observation well logs. All water depth measurements are referenced to the top of the PVC casing. The elevation of the top of the casing was also used along with measurements of the well sections to calculate OW elevations for the well monitoring intervals. Well construction details for all 28 wells are included in Appendices C-1 and C-4 herein.

The wells were capped with a lockable steel well cover extending approximately two feet above grade. A concrete pad, two feet square and six inches thick, was placed around each well cover according to the Specification, and installation was observed by a hydrogeologist.

1.3 Well Development

Upon installation, each observation well was developed by air lifting and bailing. The development procedure approved by Bechtel was first to bail until the water shows minimal sediment, then air lift to remove at least a minimum of five standing well volumes of water, cycling through the pump on and off to create a surging effect. A well was considered developed when the removed water was reasonably clear of suspended sediment and relatively clear to sight. Ground water level and total depth of the OW were measured before and after water development.

The wells were developed satisfactorily using the planned procedure. Well development records are included in Appendix C-2 herein according to ASTM D 5092-04e1, South Texas COL geotechnical work plan, and Bechtel's Engineering Specifications for Subsurface Investigation.

2.0 FIELD PERMEABILITY TESTS

2.1 Slug Tests

Field permeability testing was conducted in each observation well (except OW-332La) using procedures described in Section 8 of ASTM D 4044-96(2002). This procedure is commonly termed the "slug test" method. Slug testing involves establishing a static ground water level, lowering a solid weighted cylinder into the well to cause an increase of ground water level in the well and monitoring the time rate for the well ground water level to return to the pre-test static level. This method is commonly called the "slug-in" method. After stabilization, the slug is rapidly removed to create a lowering of the water level in the well, and the time rate for water to recover to the pre-test ground water static level is recorded. This method is commonly called the "slug-out" method. Electronic transducers and data loggers are used for measuring the ground water levels and times during the test.

Results of the slug testing are presented in Table C-2, Slug Test Data Summary. Charts (graphs) of the water surface versus time during the slug tests are in Appendix C-3. The slug test data is presented as required in Section 9 of ASTM D 4044-96(2002). The rising head and falling head solutions are presented in three different methods – Butler, KGS, and Bouwer-Rice.

2.1.1 Butler Solution Model

The Butler solution predicts the theoretical change in ground water level in the test well. Butler (1998) extended the Hvorslev (1951) solution for a single-well slug test in a homogeneous, anisotropic confined aquifer to include inertial effects in the test well. The solution accounts for oscillatory ground water level response sometimes observed in aquifers of high hydraulic conductivity. Butler (2002) amended the method to incorporate frictional loss in small-diameter wells.

Assumptions :

- aquifer has infinite areal extent,
- aquifer is homogeneous and of uniform thickness,
- test well is partially penetrating,
- aquifer is confined,
- flow is quasi-steady state, and
- volume of water, V, is injected into or discharged from the well instantaneously.

2.1.2 KGS Model

The KGS Model analyzes data from multiwell slug tests assuming no wellbore storage in observation wells. The solution simulates water-level response at the test and observation wells and includes a skin zone of finite thickness enveloping the test well. For fully penetrating wells in a confined aquifer, the KGS Model is equivalent to the Cooper et al. (1967) solution. For partially penetrating wells in a confined aquifer without wellbore skin, the KGS Model and the Dougherty-Babu (1984) solution are identical.

Assumptions :

- aquifer has infinite areal extent,
- aquifer is homogeneous and of uniform thickness,
- aquifer potentiometric surface is initially horizontal,
- test and observation wells are fully or partially penetrating,
- aquifer is confined,
- flow is unsteady,
- water is released instantaneously from storage with decline of hydraulic head, and
- volume of water, V, is injected into or discharged from the well instantaneously.

2.1.3 Bouwer-Rice Model

The Bouwer-Rice solution method employs a quasi-steady state model that ignores elastic storage in the aquifer. If the test well is screened across the water table, one may apply an optional correction for the effective porosity of the filter pack. When the test well is fully submerged (i.e., screened below the ground water table) or the aquifer is confined, the correction is unnecessary.

Assumptions

- aquifer has infinite areal extent,
- aquifer is homogeneous and of uniform thickness,
- test well is fully or partially penetrating,
- aquifer is unconfined,
- flow to well is quasi-steady-state (storage is negligible), and
- volume of water, V, is injected into or discharged from the well instantaneously.

2.2 Slug Test Results Discussion

Results for the slug tests performed were obtained using AQTESOLV Pro version 4.02. Each rising and falling slug test was evaluated using three separate slug test methodologies. These solutions may vary in applicability depending on the lithology at the particular well location. Each solution was obtained using the automated best fit provided by the AQTESOLV program. However, several solutions were modified from the best fit using the visual curve match function to provide a more reasonable curve match.

Variability of K values at individual wells is evident between different methods; however, considering the variability of the site lithology, thickness of the aquifer and well constructions (potential skin effects) it appears that the test results are relatively consistent with each other (within an order of magnitude).

3.0 WATER LEVEL MEASUREMENTS

A MACTEC representative collected water level measurements from each installed observation well on December 28, 2006. Wells were opened and ground water was allowed to equilibrate to the atmosphere prior to water levels being collected. Observation well OW-332La was not monitored as part of this effort as this well was not installed until February 9, 2007. Measurements were made using an electric water level meter and referenced to the notched top of the casing. Water levels recorded are in Table C-3, included in Attachment C, herein.

Appendix C-4

Well Construction Logs

TABLE C-1
OBSERVATION WELL CONSTRUCTION DETAILS SUMMARY
STP COL PROJECT
MACTEC ENGINEERING AND CONSULTING, INC.
PROJECT # 5050-06-0496

WELL ID	Well Diameter (inches)	Drilling Method	Boring Diameter (inches)	Concrete Pad Elevation (feet, msl)	Top of Notch Elevation (feet, msl)	Top of Bentonite Seal (feet, bgs)	Top of Sand (feet, bgs)	Screened Interval (feet, bgs)	Screen Length (feet)	Sump Length (feet)	Total Well Depth (feet, bgs)
OW-308L	2	MR	8	29.87	31.78	78	82	86-96	10	1.1	97.1
OW-308U	2	MR	8	29.88	31.80	28	32	36-46	10	1.1	47.1
OW-332L[1]	2	MR	8	30.24	31.85	84	88	92.1-102.1	10	1.1	103.2
OW-332La	2	MR	8	30.01	32.08	84	87	92-102	10	1.1	103.1
OW-332U	2	MR	8	30.24	32.10	27	31	35-45	10	1.1	46.1
OW-348L	2	MR	8	30.08	31.86	60	64	68.2-78.2	10	0.9	79.1
OW-348U	2	MR	8	30.51	32.28	21	24	28-38	10	1.1	39.1
OW-349L	2	MR	8	29.41	31.03	61	65	70-80	10	1.1	81.1
OW-349U	2	MR	8	29.40	31.29	27	31	35-45	10	1.1	46.1
OW-408L	2	MR/RC	8	31.73	33.76	62	66	70.2-80.2	10	1.1	81.3
OW-408U	2	HSA	8	31.50	33.57	24.1	28	32-42	10	1.1	43.1
OW-420U	2	MR	8	32.28	33.79	31	34	38-48	10	1.1	49.1
OW-438L	2	MR	8	30.11	31.57	85	89	93-103	10	1.1	104.1
OW-438U	2	MR	8	30.53	32.18	23	26	30-40	10	1.0	41.0
OW-910L	2	MR	8	30.75	32.48	74	77	81-91	10	1.1	92.1
OW-910U	2	MR	8	30.69	32.32	18	21	25-35	10	1.1	36.1
OW-928L	2	MR	8	29.81	31.66	103	106	110-120	10	1.1	121.1
OW-928U	2	MR	8	30.02	31.69	21.5	24.5	28.5-38.5	10	1.1	39.6
OW-929L	2	MR	8	38.93	38.63	79.6	83	87-97	10	1.1	98.1
OW-929U	2	MR	8	36.91	38.71	42	45	49-59	10	1.1	60.1
OW-930L	2	MR	8	26.21	27.96	88	91	95-105	10	1.5	106.5
OW-930U	2	MR	8	25.62	27.33	18	21	26-36	10	1.1	38.1
OW-931U	2	MR	7	30.63	32.10	18	21	25-35	10	1.0	36.0
OW-932L	2	MR	8	31.09	32.79	61.5	64.6	68.5-78.5	10	1.1	79.6
OW-932U	2	MR	8	31.35	32.83	21.5	24.5	28.5-38.5	10	1.1	39.6
OW-933L	2	MR	8	28.74	30.45	68	72	76-86	10	1.1	87.1
OW-933U	2	MR	8	28.87	30.62	20	23	26-36	10	1.1	37.1
OW-934L	2	MR	7	29.04	30.94	82	85	89-99	10	1.0	100.0
OW-934U	2	MR	8	28.54	30.39	22	26	30-40	10	1.1	41.1

NOTES:
(1) Well was found to be collapsed. Replacement well, OW-332La, was drilled to replace OW-332L.
HSA Hollow stem auger
MR Mud rotary drilling
RC Rock core bit
bgs Below ground surface
msl Mean sea level
Sump length includes sump and plug length

Prepared By/Date MJD 4/3/07
Checked By/Date KAW 4/3/07

TABLE C-2
SLUG TEST DATA SUMMARY
STP COL PROJECT
MACTEC ENGINEERING AND CONSULTING, INC.
PROJECT # 5050-06-0496

WELL ID	Monitoring Well Dimension Data											Aquifer Data			Slug Test Type			Slug Test Solution (feet/day)					
																		Rising Head			Falling Head		
	Well Diameter (inches)	Drilling Method	Boring Diameter (inches)	Concrete Pad Elevation (feet, msl)	Top of Notch Elevation (feet, msl)	Top of Bentonite Seal (feet, bgs)	Top of Sand (feet, bgs)	Screened Interval (feet, bgs)	Screen Length (feet)	Sump Length (feet)	Total Well Depth (feet, bgs)	Static Water Level (feet, bgs)	Well Penetration Depth (feet, bgs)	Saturated Thickness (feet, bgs)	Test Type	Rising Head Initial Displacement (feet)	Falling Head Initial Displacement (feet)	Butler	KGS	Bouwer-Rice	Butler	KGS	Bouwer-Rice
OW-308L	2	MR	8	29.87	31.78	78	82	86-96	10	1.1	97.1	16.07	27	31	B, R, F	8.87	13.13	64.12	68.69	65	72	72.93	55.84
OW-308U	2	MR	8	29.88	31.80	28	32	36-46	10	1.1	47.1	8.36	28	28	B, R, F	9.778	6.791	70.09	63.93	62.63	63.97	61.54	68.28
OW-332L	2	MR	8	30.24	31.85	84	88	92.1-102.1	10	1.1	103.2	16.15	18.5	35	B, R, F	8.847	11.47	52.96	54.23	33.28	49.41	49.41	55.2
OW-332U	2	MR	8	30.24	32.10	27	31	35-45	10	1.1	46.1	8.69	16.5	20.5	B, R, F	5.767	5.748	37.32	36.26	26.95	19.3	18.33	11.29
OW-348L	2	MR	8	30.08	31.86	60	64	68.2-78.2	10	0.9	79.1	16.15	13	23	B, R, F	5.755	8.578	59.12	45.62	43.94	75.94	60.64	39.45
OW-348U	2	MR	8	30.51	32.28	21	24	28-38	10	1.1	39.1	8.84	19	25	B, R, F	5.889	8.016	118.6	83.03	67.67	68.06	71.42	64.94
OW-349L	2	MR	8	29.41	31.03	61	65	70-80	10	1.1	81.1	15.22	13	15	B, R, F	14.9	7.603	63.25	50.56	35.12	42.81	40.47	52.4
OW-349U	2	MR	8	29.40	31.29	27	31	35-45	10	1.1	46.1	8.03	28.7	30.7	B, R. F	5.488	6.212	30.74	60.24	42.98	71.38	55.58	52.82
OW-408L	2	MR/RC	8	31.73	33.76	62	66	70.2-80.2	10	1.1	81.3	18.11	11.5	15	B, R, F	10.84	7.342	47.98	72.51	37.54	70.31	67.68	50.37
OW-408U	2	HSA	8	31.50	33.57	24.1	28	32-42	10	1.1	43.1	10.18	13.5	15.5	B, R, F	9.342	9.499	16.86	11.06	10.94	22.4	31.48	28.44
OW-420U	2	MR	8	32.25	33.79	31	34	38-48	10	1.1	49.1	10.43	48	25	B, R	6.37	ND	23.15	32.9	44.74	ND	ND	ND
OW-438L	2	MR	8	30.11	31.57	85	89	93-103	10	1.1	104.1	16.82	11	17	B, R, F	5.526	8.968	17.11	27.13	9.849	15.1	27.47	13.77
OW-438U	2	MR	8	30.63	32.18	23	26	30-40	10	1	41	8.85	18	19.5	B, R, F	8.457	5.488	37.95	39.4	26.1	64.66	53.06	24.12
OW-910L	2	MR	8	30.75	32.48	74	77	81-91	10	1.1	92.1	16.71	11.5	5	B, R, F	7.792	9.991	2.552	0.3244	0.5645	2.156	0.9391	0.4684
OW-910U	2	MR	8	30.69	32.32	18	21	25-35	10	1.1	36.1	9.18	16.5	25	B, R, F	8.539	8.502	25.94	28.91	20.82	63.52	47.41	48.28
OW-928L	2	MR	8	29.81	31.56	103	108	110-120	10	1.1	121	16.05	11.5	15	B, R, F	10.71	11.92	18.69	11.2	7.444	30.23	23.6	20.64
OW-928U	2	MR	8	30.02	31.69	21.5	24.5	28.5-38.5	10	1.1	39.6	8.63	15	20	B, R, F	8.001	7.679	18.85	31.5	8.268	19.02	15.91	16.01
OW-929L	2	MR	8	36.93	38.63	79.5	83	87-97	10	1.1	98.1	23.47	13.5	45	B, R, F	11.97	8.292	55.91	53.85	29.05	58.93	72.56	88.98
OW-929U	2	MR	8	36.91	38.71	42	45	49-59	10	1.1	60.1	12.92	10	5	B, R, F	12.44	11.85	14.31	3.224	3.648	16.07	11.6	2.423
OW-930L	2	MR	8	26.21	27.98	88	91	95-105	10	1.5	106.5	15.15	27	40	B, R, F	10.66	6.697	40.45	38.58	28.82	24.3	15.09	18.92
OW-930U	2	MR	8	25.62	27.33	18	21	25-35	10	1.1	36.1	8.82	16	23.9	B, R, F	8.47	8.612	64.63	22.71	31.73	79.61	47.12	47.71
OW-931U	2	MR	7	30.53	32.10	18	21	25-35	10	1	36	10.20	16	28.5	B, R, F	4.668	5.216	34.39	23.45	19.99	68.08	71.64	48.58
OW-932L	2	MR	8	31.09	32.79	61.5	64.5	68.5-78.5	10	1.1	79.6	7.23	14.2	14.5	B, R, F	5.11	9.546	24.34	23.25	17.73	22.25	22.25	24.89
OW-932U	2	MR	8	31.35	32.83	21.5	24.5	28.5-38.5	10	1.1	39.6	9.16	20	21.2	B, R, F	9.407	8.981	20.74	12.8	13.57	32.48	15.65	22.12
OW-933L	2	MR	8	28.74	30.45	68	72	76-86	10	1.1	87.1	14.60	5	5	B, R, F	17.68	8.602	214.3	50.89	63.29	191.2	214.3	64.3
OW-933U	2	MR	8	28.87	30.62	20	23	26-36	10	1.1	37.1	7.08	14	19.5	B, R, F	18.99	9.413	64.32	9.58	3.104	8.335	5.276	2.763
OW-934L	2	MR	7	29.04	30.94	82	85	89-99	10	1	100	17.21	32	32.8	B, R, F	3.283	7.671	77.6	131.3	34.97	126.6	128.6	31.72
OW-934U	2	MR	8	28.54	30.39	22	26	30-40	10	1.1	41.1	10.65	15.5	17.5	B, R, F	12.1	9.958	51.93	31.62	32.87	48.76	98.64	40.28

NOTES: Static water levels recorded prior to running the slug test.
Displacement values have been corrected to reflect total displacement (from time 0).
Slug was composed of two separate slugs tied together;
Dimension of Slug A: 9.09 pounds, diameter = 1.6 inches, length = 6.5 feet
Dimension of Slug B: 6.41 pounds, diameter = 1.6 inches, length = 6.5 feet
Well Penetration Depth is the depth of screened interval from the top of the aquifer

- ND — No data available, data not recovered from datalogger
- NA — Not applicable, no slug test conducted
- MR — Mud rotary drilling
- RC — Rock core bit
- bgs — Below ground surface
- msl — Mean sea level
- B — Background Test
- R — Rising Head Test
- F — Falling Head Test

Prepared By/Date MJD 4/3/07
Checked By/Date KAW 4/3/07

TABLE C-3
WATER LEVEL DATA SUMMARY SHEET
STP COL PROJECT
MACTEC ENGINEERING AND CONSULTING, INC.
PROJECT # 5050-06-0496

WELL ID	Concrete Pad Elevation (feet, msl)	Top of Notch Elevation (feet, msl)	Depth to Water, 12/28/06 (feet, btoc)	Groundwater Elevation (feet, msl)	Water Level Meter Make and Model	Water Level Meter Serial No.
OW-308L	29.87	31.78	16.08	15.70	Solinst Model 101	41882
OW-308U	29.88	31.80	7.78	24.02	Solinst Model 101	41882
OW-332L (1)	30.24	31.85	15.22	16.63	Solinst Model 101	41882
OW-332La	30.01	32.08	NA	NA	NA	NA
OW-332U	30.24	32.10	8.01	24.09	Solinst Model 101	41882
OW-348L	30.08	31.86	16.16	15.70	Solinst Model 101	41882
OW-348U	30.51	32.28	8.09	24.19	Solinst Model 101	41882
OW-349L	29.41	31.03	15.22	15.81	Solinst Model 101	41882
OW-349U	29.40	31.29	7.28	24.01	Solinst Model 101	41882
OW-408L	31.73	33.76	18.05	15.71	Solinst Model 101	41882
OW-408U	31.50	33.57	9.71	23.86	Solinst Model 101	41882
OW-420U	32.25	33.79	9.98	23.81	Solinst Model 101	41882
OW-438L	30.11	31.57	15.85	15.72	Solinst Model 101	41882
OW-438U	30.53	32.18	8.45	23.73	Solinst Model 101	41882
OW-910L	30.75	32.48	16.62	15.86	Solinst Model 101	41882
OW-910U	30.69	32.32	9.11	23.21	Solinst Model 101	41882
OW-928L	29.81	31.56	15.75	15.81	Solinst Model 101	41882
OW-928U	30.02	31.69	8.18	23.51	Solinst Model 101	41882
OW-929L	36.93	38.63	23.47	15.16	Solinst Model 101	41882
OW-929U	36.91	38.71	12.92	25.79	Solinst Model 101	41882
OW-930L	26.21	27.98	14.90	13.08	Solinst Model 101	41882
OW-930U	25.62	27.33	7.92	19.41	Solinst Model 101	41882
OW-931U	30.53	32.10	9.82	22.28	Solinst Model 101	41882
OW-932L	31.09	32.78	17.23	14.87	Solinst Model 101	41882
OW-932U	31.35	32.83	8.52	24.27	Solinst Model 101	41882
OW-933L	28.74	30.45	14.60	18.23	Solinst Model 101	41882
OW-933U	28.87	30.62	6.44	24.01	Solinst Model 101	41882
OW-934L	29.04	30.94	17.07	13.55	Solinst Model 101	41882
OW-934U	28.54	30.39	10.22	20.72	Solinst Model 101	41882

NOTES:
(1) Well was found to be collapsed. Replacement well, OW-332La, was drilled to replace OW-332L.
bgs Below ground surface
DTW Depth to Water
btoc Below Top of Casing
msl Mean sea level
NA Not Applicable

Prepared By/Date MOD 4/3/07

Checked By/Date KAW 4/3/07

Appendix C-1

Observation Well Logs

Project Name : Job Number STP COL : 5050-06-0496	MACTEC	WELL LOG SOIL - Well No. OW-308-L	
Type and Diameter of Boring Wash Rotary / 8 inch	Boring Location Unit 3 - Reactor Building N 363196.43 E 2943374.36		Total Depth 99 feet
Drilling Contractor and Rig BEST / Failing 1500	Elevation at Boring 29.87 feet	Ground Water Depth 16.08 feet	Depth to Bedrock
Sampling Method No sampling	Elevation at Well 31.78 feet	No. of Samples 0	Date Started 11/13/06
	Borehole Inclination 0	Logged by M. H. Niemann	Date Completed 11/22/06

Reviewed by / Date MHD 4/3/07

Reviewed by / Date KAW 4/3/07

Depth (feet)	Sample	Sample Type & No.	Uncorrected Blows/6 Inches	Recovery (Inches)	Water Content	Grain Size	Atterberg Limits	Lithology	Soil Type (USCS)	Lithology	Remarks	WELL
0–20									CH	Cuttings appear to be CLAY (CH) Cuttings appear to be reddish brown; CLAY (CH); some fine calcareous nodules	Descriptions based on observations of Rotary Wash cuttings; rig geologist and driller's observations Screen placements based on information from geotechnical boring 12/28/06: Water level measured after development	
20–30									SM	Cuttings appear to be reddish brown; silt; SAND (SM)		
30–40									SP	Cuttings appear to be reddish brown; SAND (SP); fine		

Depth scale: 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40

Project Name : Job Number STP COL : 5050-06-0496	MACTEC	WELL LOG SOIL - Well No. OW-308-L

Depth (feet)	Sample	Sample Type & No.	Uncorrected Blows/6 Inches	Recovery (Inches)	Water Content	Grain Size	Atterberg Limits	Lithology	Soil Type (USCS)	Lithology	Remarks	WELL
40									SP	Cuttings appear to be reddish brown; SAND (SP); fine		
50										Cuttings appear to be reddish brown; SAND (SP); fine		
60									CL-ML	Cuttings appear to be gray transistioning into reddish brown; clay; SILT (CL-ML); some clay		
70									CH	Cuttings appear to be reddish brown; sand; CLAY (CH); some sand		
80												

Project Name : Job Number

STP COL : 5050-06-0496

MACTEC

WELL LOG SOIL - Well No. OW-308-L

Depth (feet)	Sample	Sample Type & No.	Uncorrected Blows/6 inches	Recovery (inches)	Water Content	Grain Size	Atterberg Limits	Lithology	Soil Type (USCS)	Lithology	Remarks	WELL
80									SP	Cuttings appear to be reddish brown; SAND (SP); fine to coarse sand		
90									SP	Cuttings appear to be reddish brown; clay; gravel; SAND (SP); coarse sand		
99										Boring Terminated at 99-feet	Wash hole and ream to 8 inch diameter	

Depth scale: 80–120 feet

Project Name : Job Number STP COL : 5050-06-0496	MACTEC	WELL LOG SOIL - Well No. OW-308-U	
Type and Diameter of Boring Wash Rotary / 8 inch	Boring Location Unit 3 - Reactor Building N 363196.64 E 2943354.04		Total Depth 49 feet
Drilling Contractor and Rig BEST / Failing 1500	Elevation at Boring 29.88 feet	Ground Water Depth 4.5 feet	Depth to Bedrock
Sampling Method No sampling	Elevation at Well 31.8 feet	No. of Samples 0	Date Started 11/14/06
	Borehole Inclination 0	Logged by M. H. Niemann	Date Completed 11/27/06

Reviewed by / Date MJD 4/3/07
Reviewed by / Date KAW 4/3/07

Depth (feet)	Sample	Sample Type & No.	Uncorrected Blows/6 Inches	Recovery (Inches)	Water Content	Grain Size	Atterberg Limits	Lithology	Soil Type (USCS)	Lithology	Remarks	WELL
0–10									SP	Cuttings appear to be SAND (SP). Grades into dark gray; CLAY (CH)	Descriptions based on observations of Rotary Wash cuttings; rig geologist and driller's observations 12/28/06: Water level measured after development Screen placements based on information from geotechnical boring	
10–20									CH	Cuttings appear to be dark gray transistioning into reddish brown; CLAY (CH)		
20–30									SC	Cuttings appear to be reddish brown; clay; SAND (SC); some calcareous nodules. Increase sand with depth.		
30–40									SP	Cuttings appear to be brown to reddish brown; SAND (SP)		

Project Name : Job Number STP COL : 5050-06-0496	MACTEC	WELL LOG SOIL - Well No. OW-308-U

Depth (feet)	Sample	Sample Type & No.	Uncorrected Blows/6 inches	Recovery (inches)	Water Content	Grain Size	Atterberg Limits	Lithology	Soil Type (USCS)	Lithology	Remarks	WELL
40									SP	Cuttings appear to be brown; SAND (SP); fine		
49										Boring Terminated at 49-feet	Wash hole and ream to 8 inch diameter	

Project Name : Job Number

MACTEC

STP COL ; 5050-06-0496

SOIL LOG - Boring No. OW-332-L

Type and Diameter of Boring	Boring Location		Total Depth
Wash Rotary / 6 inch	Proposed Power Block N 363739.87 E 2943610.91		105 feet
Drilling Contractor and Rig	**Elevation at boring**	**Ground Water Depth**	**Depth to Bedrock**
BEST / Failing 1500	30.24 feet		
Sampling Method	**Sample Driving Hammer/Drop**	**No. of Samples**	**Date Started**
No sampling	140 lbs / 30 inches	0	11/21/06
	Borehole Inclination	**Logged by**	**Date Completed**
	0	M. Freychineaud	12/1/06

Reviewed by / Date HLC 5/4/07

Reviewed by / Date KAW 4/27/07

Depth (feet)	Sample	Sample Type & No.	Uncorrected Blows/6 Inches	Recovery (inches)	Water Content	Grain Size	Atterberg Limits	Lithology	Soil Type (USCS)	Lithology	Remarks	Instrument
0									CH	Cuttings appear to be CLAY (CH)	***OW-332L COLLAPSED. PLEASE SEE REPLACEMENT WELL OW-332La*** OW-332L was drilled to 105 feet on 12/01/06 and found collapsed 2/2007. OW-332L was abandoned 2/7/2007. Descriptions based on observations of Rotary Wash cuttings; rig geologist and driller's observations Screen placements based on information from geotechnical boring	
10										Cuttings appear to be CLAY (CH)		
20										Cuttings appear to be CLAY (CH)		
30									SP	Cuttings appear to be SAND (SP)		
40												

Project Name : Job Number MACTEC STP COL : 5050-06-0496	SOIL LOG - Boring No. OW-332-L

Depth (feet)	Sample	Sample Type & No.	Uncorrected Blows/6 Inches	Recovery (Inches)	Water Content	Grain Size	Atterberg Limits	Lithology	Soil Type (USCS)	Lithology	Remarks	Instrument
40									SP	Cuttings appear to be SAND (SP)		
50									CH	Cuttings appear to be CLAY (CH)		
60									SC	Cuttings appear to be clay; SAND(SC)		
70									SM	Cuttings appear to be silt; SAND (SM)		
80												

Project Name : Job Number

MACTEC

STP COL : 5050-06-0496

SOIL LOG - Boring No. OW-332-L

Depth (feet)	Sample	Sample Type & No.	Uncorrected Blow/6 Inches	Recovery (Inches)	Water Content	Grain Size	Atterberg Limits	Lithology	Soil Type (USCS)	Lithology	Remarks	Instrument
80									SP	Cuttings appear to be SAND (SP)		
81												
82												
83												
84												
85												
86												
87												
88												
89												
90										Cuttings appear to be SAND (SP)		
91												
92												
93												
94												
95												
96												
97												
98												
99												
100										Cuttings appear to be SAND (SP)		
101												
102												
103												
104												
105										Boring Terminated at 105-feet	Wash hole and ream to 8 inch diameter	
106												
107												
108												
109												
110												
111												
112												
113												
114												
115												
116												
117												
118												
119												
120												

STP SOIL STP COL WELLS.GPJ WLA.GDT 4/30/07

Project Name : Job Number MACTEC STP-COL : 5050-06-0496	SOIL LOG - Boring No. OW-332-La		
Type and Diameter of Boring Wash Rotary / 8 inch	Boring Location Proposed Power Block N 363739.87 E 2943610.91		Total Depth 105 feet
Drilling Contractor and Rig BEST / Failing 1500	Elevation at boring 30.01 feet	Ground Water Depth	Depth to Bedrock
Sampling Method No sampling	Sample Driving Hammer/Drop NA / NA	No. of Samples 0	Date Started 2/7/07
	Borehole Inclination 0	Logged by M. H. Niemann	Date Completed 2/9/07

Reviewed by / Date HC 5/4/07

Reviewed by / Date KAW 4/27/07

Depth (feet)	Sample	Sample Type & No.	Uncorrected Blows/6 inches	Recovery (inches)	Water Content	Grain Size	Atterberg Limits	Lithology	Soil Type (USCS)	Lithology	Remarks	Instrument
0									CH	Cuttings appear to be CLAY (CH)	***REPLACEMENT FOR OW-332L*** OW-332L was drilled to 105 feet on 12/01/06 and found collapsed 2/2007. OW-332L was abandoned 2/7/2007.	
6											Descriptions based on observations of Rotary Wash cuttings; rig geologist and driller's observations. Screen placements based on information from geotechnical boring.	
10										Cuttings appear to be CLAY (CH)		
15											12/28/06: Water level measured after development	
20										Cuttings appear to be CLAY (CH)		
30									SP	Cuttings appear to be SAND (SP)		
40												

Project Name : Job Number MACTEC STP COL. : 5050-06-0496	SOIL LOG - Boring No. OW-332-La

Depth (feet)	Sample	Sample Type & No.	Uncorrected Blows/6 Inches	Recovery (Inches)	Water Content	Grain Size	Atterberg Limits	Lithology	Soil Type (USCS)	Lithology	Remarks	Instrument
40–50									SP	Cuttings appear to be SAND (SP)		
50–60									CH	Cuttings appear to be CLAY (CH)		
60–70									SC	Cuttings appear to be clay, SAND(SC)		
70–80									SM	Cuttings appear to be silt, SAND (SM)		

Project Name : Job Number MACTEC STP COL ; 5050-06-0496	SOIL LOG - Boring No. OW-332-La

Depth (feet)	Sample	Sample Type & No.	Uncorrected Blows/6 Inches	Recovery (inches)	Water Content	Grain Size	Atterberg Limits	Lithology	Soil Type (USCS)	Lithology	Remarks	Instrument
80									SP	Cuttings appear to be SAND (SP).		
81												
82												
83												
84												
85												
86												
87												
88												
89												
90										Cuttings appear to be SAND (SP)		
91												
92												
93												
94												
95												
96												
97												
98												
99												
100										Cuttings appear to be SAND (SP)		
101												
102												
103												
104												
105										Boring Terminated at 105-feet	Wash hole and ream to 8 inch diameter	
106												
107												
108												
109												
110												
111												
112												
113												
114												
115												
116												
117												
118												
119												
120												

Project Name : Job Number STP COL : 5050-06-0496	MACTEC	WELL LOG SOIL - Well No. OW-332-U

Type and Diameter of Boring	Boring Location		Total Depth
Wash Rotary / 8 inch	Proposed Power Block N 363739.21 E 2943591.02		48 feet
Drilling Contractor and Rig BEST / Failing 1500	Elevation at Boring 30.24 feet	Ground Water Depth 8.01 feet	Depth to Bedrock
Sampling Method No sampling	Elevation at Well 32.1 feet	No. of Samples 0	Date Started 11/3/06
	Borehole Inclination 0	Logged by R. Clark	Date Completed 11/21/06

Reviewed by / Date MJD 4/3/07

Reviewed by / Date KAW 4/3/07

Depth (feet)	Sample	Sample Type & No.	Uncorrected Blows/6 inches	Recovery (inches)	Water Content	Grain Size	Atterberg Limits	Lithology	Soil Type (USCS)	Lithology	Remarks	WELL
0									CH	Cuttings appear to be CLAY (CH)		
5											Screen placements based on information from geotechnical boring	
8									∇		12/28/06: Water level measured after development	
10										Cuttings appear to be CLAY (CH)		
20									SP	Cuttings appear to change to SAND (SP)		
30										Cuttings appear to be SAND (SP)		
40												

Project Name : Job Number STP COL : 5050-06-0496	MACTEC	WELL LOG SOIL - Well No. OW-332-U

Depth (feet)	Sample	Sample Type & No.	Uncorrected Blows/6 Inches	Recovery (Inches)	Water Content	Grain Size	Atterberg Limits	Lithology	Soil Type (USCS)	Lithology	Remarks	WELL
40–48									SP	Cuttings appear to be SAND (SP)		
48										Boring Teminated at 48-feet	Wash hole and ream to 8 inch diameter	

Project Name : Job Number STP COL : 5050-06-0496	MACTEC	WELL LOG SOIL - Well No. OW-348-L	
Type and Diameter of Boring: Wash Rotary / 8 inch	Boring Location: Fire Water Tank N 362685.92 E 2943014.48		Total Depth: 81 feet
Drilling Contractor and Rig: BEST / Failing 1500	Elevation at Boring: 30.08 feet	Ground Water Depth: 16.16 feet	Depth to Bedrock: -
Sampling Method: No sampling	Elevation at Well: 31.86 feet	No. of Samples: 0	Date Started: 11/2/06
	Borehole Inclination: 0	Logged by: R. Clark	Date Completed: 11/21/06

Reviewed by / Date MJD 4/5/07

Reviewed by / Date KAW 4/3/07

Depth (feet)	Sample	Sample Type & No.	Uncorrected Blows/6 inches	Recovery (inches)	Water Content	Grain Size	Atterberg Limits	Lithology	Soil Type (USCS)	Lithology	Remarks	WELL
0–5									CH	Cuttings appear to be CLAY (CH); Wood material observed in first 5-feet of cuttings (possible Fill).	Descriptions based on observations of Rotary Wash cuttings; rig geologist and driller's observations	
5–27									CH	Cuttings appear to be CLAY (CH) Cuttings appear to be CLAY (CH) Cuttings appear to be CLAY (CH)	Screen placements based on information from geotechnical boring	
27–40									SP	Cuttings appear to change to SAND (SP) Cuttings appear to be SAND (SP)		

Project Name : Job Number STP COL : 5050-06-0496	MACTEC	WELL LOG SOIL - Well No. OW-348-L

Depth (feet)	Sample	Sample Type & No.	Uncorrected Blows/6 Inches	Recovery (Inches)	Water Content	Grain Size	Atterberg Limits	Lithology	Soil Type (USCS)	Lithology	Remarks	WELL
40									SP	Cuttings appear to be SAND (SP)		
50										Cuttings appear to be SAND (SP)		
64									CH	Cuttings appear to change to CLAY (CH)		
70										Cuttings appear to be CLAY (CH)		
80												

Project Name : Job Number STP COL : 5050-06-0496	MACTEC	WELL LOG SOIL - Well No. OW-348-L

Depth (feet)	Sample	Sample Type & No.	Uncorrected Blows/6 inches	Recovery (inches)	Water Content	Grain Size	Atterberg Limits	Lithology	Soil Type (USCS)	Lithology	Remarks	WELL
80									CH			
81										Boring Terminated at 81-feet		
82												
83												
84												
85												
86												
87												
88												
89												
90												
91												
92												
93												
94												
95												
96												
97												
98												
99												
100												
101												
102												
103												
104												
105												
106												
107												
108												
109												
110												
111												
112												
113												
114												
115												
116												
117												
118												
119												
120												

Project Name : Job Number STP COL : 5050-06-0496	MACTEC	WELL LOG SOIL - Well No. OW-348-U	
Type and Diameter of Boring Wash Rotary / 8 inch	Boring Location Fire Water Tank N 362685.23 E 2942994.44		Total Depth 42 feet
Drilling Contractor and Rig BEST / Falling 1500	Elevation at Boring 30.51 feet	Ground Water Depth 8.09 feet	Depth to Bedrock
Sampling Method No sampling	Elevation at Well 32.28 feet	No. of Samples 0	Date Started 11/2/06
	Borehole Inclination 0	Logged by R. Clark	Date Completed 11/21/06

Reviewed by / Date MJD 4/5/07

Reviewed by / Date KAW 4/3/07

Depth (feet)	Sample	Sample Type & No.	Uncorrected Blows/6 Inches	Recovery (Inches)	Water Content	Grain Size	Atterberg Limits	Lithology	Soil Type (USCS)	Lithology	Remarks	WELL
0									CH	Cuttings appear to be CLAY (CH)	Descriptions based on observations of Rotary Wash cuttings; rig geologist and driller's observations	
5											Screen placements based on information from geotechnical boring	
8									▽		12/28/06: Water level measured after development	
10										Cuttings appear to be CLAY (CH)		
20										Cuttings appear to be CLAY (CH)		
24									SP	Cuttings appear to be SAND (SP)		
30										Cuttings appear to be SAND (SP)		
40												

STP WELL STP COL WELLS.GPJ WLA.GDT 4/3/07

Project Name : Job Number STP COL : 5050-06-0496	MACTEC	WELL LOG SOIL - Well No. OW-348-U

Depth (feet)	Sample	Sample Type & No.	Uncorrected Blows/6 Inches	Recovery (Inches)	Water Content	Grain Size	Atterberg Limits	Lithology	Soil Type (USCS)	Lithology	Remarks	WELL
40–42									SP			
42										Boring Terminated at 42-feet	Wash hole and ream to 8 inch diameter	

Project Name : Job Number STP COL : 5050-06-0496	MACTEC	WELL LOG SOIL - Well No. OW-349-L

Type and Diameter of Boring Rotary Wash / 8 inch	Boring Location Heavy Haul Road N 362901.84 E 2943602.97		Total Depth 83 feet
Drilling Contractor and Rig BEST / Failing 1500	Elevation at Boring 29.41 feet	Ground Water Depth 15.22 feet	Depth to Bedrock
Sampling Method No Sampling	Elevation at Well 31.03 feet	No. of Samples 0	Date Started 11/4/06
	Borehole Inclination 0	Logged by R. Clark	Date Completed 11/4/06

Reviewed by / Date MD 4/3/07

Reviewed by / Date KAW 4/3/07

Depth (feet)	Sample	Sample Type & No.	Uncorrected Blows/6 inches	Recovery (inches)	Water Content	Grain Size	Atterberg Limits	Lithology	Soil Type (USCS)	Lithology	Remarks	WELL
0									CH	Cuttings appear to be a CLAY (CH)	Descriptions based on observations of Rotary Wash cuttings; rig geologist and driller's observations	
5											Screen placements based on information from geotechnical boring	
10										Cuttings appear to be a CLAY (CH)		
15									▽		12/28/06: Water level measured after development	
20										Cuttings appear to be a CLAY (CH)		
24									SP			
30										Cuttings appear to be a SAND (SP)		
40												

Project Name : Job Number STP COL : 5050-06-0496	MACTEC	WELL LOG SOIL - Well No. OW-349-L

Depth (feet)	Sample	Sample Type & No.	Uncorrected Blows/6 Inches	Recovery (Inches)	Water Content	Grain Size	Atterberg Limits	Lithology	Soil Type (USCS)	Lithology	Remarks	WELL
40										Cuttings appear to be a SAND (SP)		
41												
42												
43												
44												
45												
46												
47												
48												
49												
50										Cuttings appear to be a SAND (SP)		
51												
52												
53												
54												
55												
56												
57												
58												
59												
60										Cuttings appear to be a SAND (SP)		
61												
62												
63												
64												
65												
66												
67												
68												
69												
70										Cuttings appear to be a SAND (SP)		
71												
72												
73												
74												
75												
76												
77												
78												
79												
80												

Project Name : Job Number STP COL : 5050-06-0496	MACTEC	WELL LOG SOIL - Well No. OW-349-L

Depth (feet)	Sample	Sample Type & No.	Uncorrected Blows/6 Inches	Recovery (Inches)	Water Content	Grain Size	Atterberg Limits	Lithology	Soil Type (USCS)	Lithology	Remarks	WELL
80–83									SP	Cuttings appear to be a SAND (SP)		
83										Boring Terminated at 83-feet	Wash hole and ream to 8 inch diameter	

Project Name : Job Number STP COL : 5050-06-0496	MACTEC	WELL LOG SOIL - Well No. OW-349-U

Type and Diameter of Boring Rotary Wash / 8 inch	Boring Location Heavy Haul Road N 362902.4 E 2943582.28	Total Depth 48 feet
Drilling Contractor and Rig BEST / Failing 1500	Elevation at Boring 29.4 feet / Ground Water Depth 7.28 feet	Depth to Bedrock
Sampling Method No Sampling	Elevation at Well 31.29 feet / No. of Samples 0	Date Started 11/7/06
	Borehole Inclination 0 / Logged by R. Clark	Date Completed 11/27/06

Reviewed by / Date MSD 4/3/07

Reviewed by / Date KAW 4/3/07

Depth (feet)	Sample	Sample Type & No.	Uncorrected Blows/6 Inches	Recovery (Inches)	Water Content	Grain Size	Atterberg Limits	Lithology	Soil Type (USCS)	Lithology	Remarks	WELL
0									CH	Cuttings appear to be a CLAY (CH)	Descriptions based on observations of Rotary Wash cuttings; rig geologist and driller's observations	
5											Screen placements based on information from geotechnical boring	
7									▽		12/28/06: Water level measured after development	
10										Cuttings appear to be a CLAY (CH)		
20										Cuttings appear to be a CLAY (CH)		
30									SP	Cuttings appear to be a SAND (SP)		
40												

Project Name : Job Number

STP COL : 5050-06-0496

MACTEC

WELL LOG SOIL - Well No. OW-349-U

Depth (feet)	Sample	Sample Type & No.	Uncorrected Blows/6 inches	Recovery (inches)	Water Content	Grain Size	Atterberg Limits	Lithology	Soil Type (USCS)	Lithology	Remarks	WELL
40–48									SP	Cuttings appear to be a SAND (SP)		
48–80										Boring Termintated at 48-feet	Wash hole and ream to 8 inch diameter	

Depth scale: 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80

Project Name : Job Number STP COL : 5050-06-0496	MACTEC	WELL LOG SOIL - Well No. OW-408-L	

Type and Diameter of Boring Wash Rotary / 6.5 inch	Boring Location Unit 4 - Reactor Building N 363196.18 E 2942472.54		Total Depth 82 feet
Drilling Contractor and Rig BEST / Failing 1500	Elevation at Boring 31.73 feet	Ground Water Depth 18.05 feet	Depth to Bedrock
Sampling Method No sampling	Elevation at Well 33.76 feet	No. of Samples 0	Date Started 10/31/06
	Borehole Inclination 0	Logged by R. Clark	Date Completed 11/20/06

Reviewed by / Date MDD 4/3/07
Reviewed by / Date KAW 4/3/07

Depth (feet)	Sample	Sample Type & No.	Uncorrected Blows/6 inches	Recovery (inches)	Water Content	Grain Size	Atterberg Limits	Lithology	Soil Type (USCS)	Lithology	Remarks	WELL
0									CH	Cuttings appear to be dark red; CLAY (CH)	Descriptions based on observations of Rotary Wash cuttings; rig geologist and driller's observations	
5											Screen placements based on information from geotechnical boring	
10										Cuttings appear to be red-brown; CLAY (CH)		
18									▽		12/28/06: Water level measured after development	
24									SP	Cuttings appear to be SAND (SP)		
35										Cuttings appear to be SAND (SP); fine-grained		
40												

Project Name : Job Number STP COL : 5050-06-0496	MACTEC	WELL LOG SOIL - Well No. OW-408-L

Depth (feet)	Sample	Sample Type & No.	Uncorrected Blows/6 Inches	Recovery (Inches)	Water Content	Grain Size	Atterberg Limits	Lithology	Soil Type (USCS)	Lithology	Remarks	WELL
40									SP	Cuttings appear to be SAND (SP); fine-grained		
41												
42												
43												
44												
45												
46												
47												
48												
49												
50												
51												
52												
53												
54												
55												
56												
57												
58												
59												
60												
61												
62												
63												
64												
65												
66												
67												
68												
69												
70												
71												
72												
73												
74												
75												
76												
77												
78												
79												
80												

Project Name : Job Number STP COL : 5050-06-0496	MACTEC	WELL LOG SOIL - Well No. OW-408-L

Depth (feet)	Sample	Sample Type & No.	Uncorrected Blows/6 inches	Recovery (inches)	Water Content	Grain Size	Atterberg Limits	Lithology	Soil Type (USCS)	Lithology	Remarks	WELL
80–82									SP			
82										Boring Terminated at 82-feet	Wash hole and ream to 8 inch diameter	

Project Name : Job Number STP COL : 5050-06-0496	MACTEC	WELL LOG SOIL - Well No. OW-408-U	
Type and Diameter of Boring Hollow Stem Auger / 8 inch	Boring Location Unit 4 - Reactor Building N 363194.01 E 2942456.01		Total Depth 43.5 feet
Drilling Contractor and Rig BEST / CME 45	Elevation at Boring 31.5 feet	Ground Water Depth 9.71 feet	Depth to Bedrock
Sampling Method No sampling	Elevation at Well 33.57 feet	No. of Samples 0	Date Started 11/1/06
	Borehole Inclination 0	Logged by R. Clark	Date Completed 11/20/06

Reviewed by / Date MJD 4/3/07

Reviewed by / Date KAW 4/3/07

Depth (feet)	Sample	Sample Type & No.	Uncorrected Blows/6 Inches	Recovery (Inches)	Water Content	Grain Size	Atterberg Limits	Lithology	Soil Type (USCS)	Lithology	Remarks	WELL
0									CH	Cuttings appear to be CLAY (CH); high plasticity	Descriptions based on observations of Rotary Wash cuttings; rig geologist and driller's observations	
5											Screen placements based on information from geotechnical boring	
10										Cuttings appear to be CLAY (CH); high plasticity	12/28/06: Water level measured after development	
20										Cuttings appear to be silt; CLAY (CH)		
25										Cuttings appear to be silt; CLAY (CH)		
37										Cuttings are CLAY (CH)		
38									SP	Cuttings appear to be SAND (SP)		
40												

Project Name : Job Number STP COL : 5050-06-0498	MACTEC	WELL LOG SOIL - Well No. OW-408-U

Depth (feet)	Sample	Sample Type & No.	Uncorrected Blows/6 Inches	Recovery (Inches)	Water Content	Grain Size	Atterberg Limits	Lithology	Soil Type (USCS)	Lithology	Remarks	WELL
40–43.5									SP			
43.5										Boring Terminated at 43.5-feet	Wash hole and ream to 8 inch diameter	

Project Name : Job Number STP COL : 5050-06-0496	MACTEC	WELL LOG SOIL - Well No. OW-420-U

Type and Diameter of Boring	Boring Location	Total Depth
Rotary Wash / 8 inch	Heavy Haul Road N 362902.15 E 2942016.94	51 feet

Drilling Contractor and Rig	Elevation at Boring	Ground Water Depth	Depth to Bedrock
BEST / Falling 1500	32.25 feet	9.98 feet	

Sampling Method	Elevation at Well	No. of Samples	Date Started
No Sampling	33.79 feet	0	11/7/06

Borehole Inclination	Logged by	Date Completed
0	R. Clark	11/20/06

Reviewed by / Date MOD 4/3/07
Reviewed by / Date KAW 4/3/07

Depth (feet)	Sample	Sample Type & No.	Uncorrected Blows/6 inches	Recovery (inches)	Water Content	Grain Size	Atterberg Limits	Lithology	Soil Type (USCS)	Lithology	Remarks
0									CH	Cuttings appear to be a CLAY (CH)	Descriptions based on observations of Rotary Wash cuttings; rig geologist and driller's observations
5											Screen placements based on information from geotechnical boring
10									∇	Cuttings appear to be a CLAY (CH)	12/28/06: Water level measured after development
20										Cuttings appear to be a CLAY (CH)	
30									SP	Cuttings appear to be a SAND (SP)	
40											

STP WELL STP COL WELLS.GPJ WLA.GDT 4/3/07

Project Name : Job Number STP COL : 5050-06-0496	MACTEC	WELL LOG SOIL - Well No. OW-420-U

Depth (feet)	Sample	Sample Type & No.	Uncorrected Blows/6 inches	Recovery (inches)	Water Content	Grain Size	Atterberg Limits	Lithology	Soil Type (USCS)	Lithology	Remarks	WELL
40									SP	Cuttings appear to be a SAND (SP)		
50										Cuttings appear to be a SAND (SP)		
51										Boring Terminated at 51-feet	Wash hole and ream to 8 inch diameter	
80												

Project Name : Job Number STP COL : 5050-06-0496	MACTEC	WELL LOG SOIL - Well No. OW-438-L

Type and Diameter of Boring Wash Rotary / 8 inch	Boring Location Maintenance Shop N 363790.77 E 2942045.09		Total Depth 105 feet
Drilling Contractor and Rig BEST / Failing 1500	Elevation at Boring 30.11 feet	Ground Water Depth 15.85 feet	Depth to Bedrock
Sampling Method No sampling	Elevation at Well 31.57 feet	No. of Samples 0	Date Started 11/21/06
	Borehole Inclination 0	Logged by M. H. Niemann	Date Completed 12/1/06

Reviewed by / Date MTD 4/3/07
Reviewed by / Date KAW 4/3/07

Depth (feet)	Sample	Sample Type & No.	Uncorrected Blows/6 inches	Recovery (inches)	Water Content	Grain Size	Atterberg Limits	Lithology	Soil Type (USCS)	Lithology	Remarks	WELL
0									CH	Cuttings appear to be dark gray; CLAY (CH)	Descriptions based on observations of Rotary Wash cuttings; rig geologist and driller's observations	
5											Screen placements based on information from geotechnical boring	
10										Cuttings appear to be reddish brown; CLAY (CH)		
16									▽		12/28/06: Water level measured after development	
20									SP	Cuttings appear to be reddish brown; silt; SAND (SP)		
30										Cuttings appear to be brown; silt; SAND (SP); fine sand		
40												

Project Name : Job Number STP COL : 5050-06-0496	MACTEC	WELL LOG SOIL - Well No. OW-438-L

Depth (feet)	Sample	Sample Type & No.	Uncorrected Blows/6 Inches	Recovery (inches)	Water Content	Grain Size	Atterberg Limits	Lithology	Soil Type (USCS)	Lithology	Remarks	WELL
40									SP	Cuttings appear to be brown; silt; SAND (SP); fine sand		
50										Cuttings appear to be brown; silt; SAND (SP); fine sand. Grades into reddish brown; gravel; CLAY (CH); some gravel		
60									CH	Cuttings appear to be reddish gray; CLAY (CH); calcareous nodules observed		
70										Cuttings appear to be reddish gray; CLAY (CH); calcareous nodules observed		
80												

Project Name ; Job Number STP COL : 5050-06-0496	MACTEC	WELL LOG SOIL - Well No. OW-438-L

Depth (feet)	Sample	Sample Type & No.	Uncorrected Blows/6 Inches	Recovery (inches)	Water Content	Grain Size	Atterberg Limits	Lithology	Soil Type (USCS)	Lithology	Remarks	WELL
80									SP	Cuttings appear to be brown; SAND (SP); little to no silt; fine to coarse sand		
90										Cuttings appear to be brown; SAND (SP); fine to coarse sand		
100										Cuttings appear to be brown; SAND (SP); fine to coarse sand		
105										Boring Terminated at 105-feet	Wash hole and ream to 8 inch diameter	

Project Name : Job Number STP COL : 5050-06-0496	MACTEC	WELL LOG SOIL - Well No. OW-438-U	
Type and Diameter of Boring Wash Rotary / 8 inch	Boring Location Maintenance Shop N 363792.04 E 2942025.17		Total Depth 42 feet
Drilling Contractor and Rig BEST / Failing 1500	Elevation at Boring 30.53 feet	Ground Water Depth 8.45 feet	Depth to Bedrock
Sampling Method No sampling	Elevation at Well 32.18 feet	No. of Samples 0	Date Started 11/20/06
	Borehole Inclination 0	Logged by A. Osorio	Date Completed 12/1/06

Reviewed by / Date MJD 4/3/07
Reviewed by / Date KAW 4/3/07

Depth (feet)	Sample	Sample Type & No.	Uncorrected Blows/6 Inches	Recovery (Inches)	Water Content	Grain Size	Atterberg Limits	Lithology	Soil Type (USCS)	Lithology	Remarks	WELL
0									CH	Surface Grass (Approximately 4 inches)	Descriptions based on observations of Rotary Wash cuttings; rig geologist and driller's observations	
1										Cuttings appear to be black to gray; CLAY (CH)		
5											Screen placements based on information from geotechnical boring	
8									▽	Color changes to brown		
9											12/28/06: Water level measured after development	
10										Cuttings appear to be brown; silt; CLAY (CH)		
20										Cuttings appear to be brown; CLAY (CH)		
28									SP			
30										Cuttings appear to be brown; SAND (SP)		
40												

Project Name : Job Number STP COL : 5050-06-0496	MACTEC	WELL LOG SOIL - Well No. OW-438-U

Depth (feet)	Sample	Sample Type & No.	Uncorrected Blows/6 Inches	Recovery (Inches)	Water Content	Grain Size	Atterberg Limits	Lithology	Soil Type (USCS)	Lithology	Remarks	WELL
40–42									SP	Cuttings appear to be brown; SAND (SP)		
42										Boring Terminated at 42-feet	Wash hole and ream to 8 inch diameter	

Project Name : Job Number STP COL : 5050-06-0496	MACTEC	WELL LOG SOIL - Well No. OW-910-L	
Type and Diameter of Boring Wash Rotary / 8 inch	Boring Location UHS Basin N 363363.45 E 2941266.45		Total Depth 94 feet
Drilling Contractor and Rig BEST / Failing 1500	Elevation at Boring 30.75 feet	Ground Water Depth 16.62 feet	Depth to Bedrock
Sampling Method No sampling	Elevation at Well 32.48 feet	No. of Samples 0	Date Started 12/18/06
	Borehole Inclination 0	Logged by M. H. Niemann	Date Completed 12/20/06

Reviewed by / Date MTD 4/3/07

Reviewed by / Date KAW 4/3/07

Depth (feet)	Sample	Sample Type & No.	Uncorrected Blows/6 inches	Recovery (inches)	Water Content	Grain Size	Atterberg Limits	Lithology	Soil Type (USCS)	Lithology	Remarks	WELL
0									CH	Cuttings appear to be dark gray; CLAY (CH) to 5-feet; grades to gray to light gray; CLAY (CH)	Descriptions based on observations of Rotary Wash cuttings; rig geologist and driller's observations	
5											Screen placements based on information from geotechnical boring	
10										Cuttings appear to be gray; CLAY (CH) to 11-feet; changes to reddish brown; silt; CLAY (CH)		
16.62									▽		12/28/06: Water level measured after development	
20										Cuttings appear to be reddish brown; silt; CLAY (CH)		
22									SP	Cuttings appear to change to brown; silt; SAND (SP); fine grained		
30										Cuttings appear to be brown; silt; SAND (SP); fine grained		
40												

Project Name : Job Number STP COL : 5050-06-0496	MACTEC	WELL LOG SOIL - Well No. OW-910-L

Depth (feet)	Sample	Sample Type & No.	Uncorrected Blows/6 Inches	Recovery (inches)	Water Content	Grain Size	Atterberg Limits	Lithology	Soil Type (USCS)	Lithology	Remarks	WELL
40									SP	Cuttings appear to be brown; silt; SAND (SP); fine grained		
47									CH	Cuttings appear to change to CLAY (CH)		
50										Cuttings appear to be CLAY (CH)		
60										Cuttings appear to be greenish gray to gray; CLAY (CH)		
70										Cuttings appear to be greenish gray; CLAY (CH); calcareous nodules		
80												

Project Name : Job Number STP COL : 5050-06-0496	MACTEC	WELL LOG SOIL - Well No. OW-910-L

Depth (feet)	Sample	Sample Type & No.	Uncorrected Blows/6 Inches	Recovery (Inches)	Water Content	Grain Size	Atterberg Limits	Lithology	Soil Type (USCS)	Lithology	Remarks	WELL
80									CH	Cuttings appear to be greenish gray; CLAY (CH); calcareous nodules		
82									SP	Cuttings appear to change to silt; SAND (SP); fine grained		
90										Cuttings appear to change to silt; SAND (SP); fine grained		
91									CH	Cuttings appear to change to CLAY (CH)		
94										Boring Terminated at 94-feet	Wash hole and ream to 8 inch diameter	

Depth scale: 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120

STP WELL STP COL WELLS.GPJ WLA.GDT 4/3/07

Project Name : Job Number STP COL : 5050-06-0496	MACTEC	WELL LOG SOIL - Well No. OW-910-U

Type and Diameter of Boring Wash Rotary / 8 inch	Boring Location UHS Basin N 363362.02 E 2941246.57		Total Depth 38 feet
Drilling Contractor and Rig BEST / Failing 1500	Elevation at Boring 30.89 feet	Ground Water Depth 9.11 feet	Depth to Bedrock
Sampling Method No sampling	Elevation at Well 32.32 feet	No. of Samples 0	Date Started 12/16/06
	Borehole Inclination 0	Logged by M. H. Niemann	Date Completed 12/20/06

Reviewed by / Date MTD 4/4/07

Reviewed by / Date KAW 4/3/07

Depth (feet)	Sample	Sample Type & No.	Uncorrected Blows/6 Inches	Recovery (Inches)	Water Content	Grain Size	Atterberg Limits	Lithology	Soil Type (USCS)	Lithology	Remarks	WELL
0									CH	Cuttings appear to be dark gray; CLAY (CH) to 8-feet. Grades to light gray and reddish brown; CLAY (CH) and silt; CLAY (CH); some calcareous nodules	Descriptions based on observations of Rotary Wash cuttings; rig geologist and driller's observations	
5											Screen placements based on information from geotechnical boring	
9									▽		12/28/06: Water level measured after development	
10										Cuttings appear to be reddish brown; silt; CLAY (CH); calcareous nodules		
20										Cuttings appear to be reddish brown; silt; CLAY (CH)		
22									SP	Cuttings appear to change to brown; silt; SAND (SP); fine grained		
30										Cuttings appear to be brown; silt; SAND (SP); fine grained		
38										Boring Terminated at 38-feet	Wash hole and ream to 8 inch diameter	

Project Name : Job Number STP COL : 5050-06-0496	MACTEC	WELL LOG SOIL - Well No. OW-928-L	
Type and Diameter of Boring Wash Rotary / 8 inch	Boring Location Northwest of Power Block N 364932.3 E 2940376.21		Total Depth 123 feet
Drilling Contractor and Rig BEST / Failing 1500	Elevation at Boring 29.81 feet	Ground Water Depth 15.75 feet	Depth to Bedrock
Sampling Method No sampling	Elevation at Well 31.56 feet	No. of Samples 0	Date Started 12/15/06
	Borehole Inclination 0	Logged by M. H. Niemann	Date Completed 12/19/06

Reviewed by / Date MTD 4/3/07

Reviewed by / Date KAW 4/3/07

Depth (feet)	Sample	Sample Type & No.	Uncorrected Blows/6 Inches	Recovery (inches)	Water Content	Grain Size	Atterberg Limits	Lithology	Soil Type (USCS)	Lithology	Remarks	WELL
0									CH	Cuttings appear to be gray to yellowish brown; gravel; CLAY (CH); fine gravel/calcareous nodules. Grades to yellowish gray to reddish brown; silt; CLAY (CH)	Descriptions based on observations of Rotary Wash cuttings; rig geologist and driller's observations	
5											Screen placements based on information from geotechnical boring	
10										Cuttings appear to be reddish brown; silt; CLAY (CH)		
16									▽		12/28/06: Water level measured after development	
20										Cuttings appear to be reddish brown; silt; CLAY (CH)		
27									SP	Cuttings appear to change to reddish brown; SAND (SP); silt; fine grained		
30										Cuttings appear to be reddish brown; silt; SAND (SP); fine grained		
40												

Project Name : Job Number STP COL : 5050-06-0496	MACTEC	WELL LOG SOIL - Well No. OW-928-L

Depth (feet)	Sample	Sample Type & No.	Uncorrected Blows/6 inches	Recovery (inches)	Water Content	Grain Size	Atterberg Limits	Lithology	Soil Type (USCS)	Lithology	Remarks	WELL
40–42									SP	Cuttings appear to be reddish brown; silt; SAND (SP); fine grained.		
42									CH	Cuttings appear to change to reddish brown; silt; CLAY (CH); few fine calcareous nodules		
50										Cuttings appear to be reddish brown; silt; CLAY (CH)		
60										Cuttings appear to be reddish brown; silt; CLAY (CH)		
70										Cuttings appear to be reddish brown mottling with gray; silt; CLAY (CH)		
80												

Project Name : Job Number STP COL : 5050-06-0496	MACTEC	WELL LOG SOIL - Well No. OW-928-L

Depth (feet)	Sample	Sample Type & No.	Uncorrected Blows/6 inches	Recovery (inches)	Water Content	Grain Size	Atterberg Limits	Lithology	Soil Type (USCS)	Lithology	Remarks	WELL
80									CH	Cuttings appear to be reddish brown; silt; CLAY (CH)		
83									SP	Cuttings appear to be silt; SAND (SP)		
90										Cuttings appear to be silt; SAND (SP)		
94									CH	Cuttings appear to be CLAY (CH)		
99									SP	Cuttings appear to change to silt; SAND (SP)		
110										Cuttings appear to be silt; SAND (SP)		
120												

Project Name : Job Number STP COL : 5050-06-0496	MACTEC	WELL LOG SOIL - Well No. OW-928-L

Depth (feet)	Sample	Sample Type & No.	Uncorrected Blows/6 inches	Recovery (inches)	Water Content	Grain Size	Atterberg Limits	Lithology	Soil Type (USCS)	Lithology	Remarks	WELL
120–123									SP	Cuttings appear to be silt; SAND (SP)		
123										Boring Terminated at 123-feet	Wash hole and ream to 8 inch diameter	

Project Name : Job Number STP COL : 5050-06-0496	MACTEC	WELL LOG SOIL - Well No. OW-928-U

Type and Diameter of Boring: Wash Rotary / 8 inch	Boring Location: Northwest of Power Block N 384933.86 E 2940356.48	Total Depth: 41.5 feet
Drilling Contractor and Rig: BEST / Failing 1500	Elevation at Boring: 30.02 feet / Ground Water Depth: 8.18 feet	Depth to Bedrock:
Sampling Method: No sampling	Elevation at Well: 31.69 feet / No. of Samples: 0	Date Started: 12/16/06
	Borehole Inclination: 0 / Logged by: M. H. Niemann	Date Completed: 12/19/06

Reviewed by / Date MJD 4/3/07

Reviewed by / Date KAW 4/3/07

Depth (feet)	Soil Type (USCS)	Lithology	Remarks
0	CH	Cuttings appear to be dark gray; CLAY (CH) grading to a gray and reddish brown; silt; CLAY (CH)	Descriptions based on observations of Rotary Wash cuttings; rig geologist and driller's observations
5			Screen placements based on information from geotechnical boring
8	∇		12/28/06: Water level measured after development
10		Cuttings appear to be reddish brown; silt; CLAY (CH)	
20		Cuttings appear to be reddish brown; silt; CLAY (CH)	
23	SP	Cuttings appear to be brown; silt; SAND (SP)	

Columns (empty): Sample, Sample Type & No., Uncorrected Blows/6 Inches, Recovery (inches), Water Content, Grain Size, Atterberg Limits, WELL

Project Name : Job Number STP COL : 5050-06-0496	MACTEC	WELL LOG SOIL - Well No. OW-928-U

Depth (feet)	Sample	Sample Type & No.	Uncorrected Blows/6 Inches	Recovery (inches)	Water Content	Grain Size	Atterberg Limits	Lithology	Soil Type (USCS)	Lithology	Remarks	WELL
40–41.5									SP	Cuttings appear to be brown; silt; SAND (SP)		
41.5										Boring Terminated at 41.5-feet	Wash hole and ream to 8 inch diameter	

STP WELL STP COL WELLS.GPJ WLA.GDT 4/3/07

Project Name : Job Number STP COL : 5050-06-0496	MACTEC	WELL LOG SOIL - Well No. OW-929-L	
Type and Diameter of Boring Wash Rotary / 8 inch	Boring Location Northeast of Power Block N 364671.5 E 2945497.78		Total Depth 100 feet
Drilling Contractor and Rig BEST / Failing 1500	Elevation at Boring 36.93 feet	Ground Water Depth 23.47 feet	Depth to Bedrock
Sampling Method No sampling	Elevation at Well 38.63 feet	No. of Samples 0	Date Started 12/12/06
	Borehole Inclination 0	Logged by M. H. Niemann	Date Completed 12/30/06

Reviewed by / Date MJD 4/3/07

Reviewed by / Date KAW 4/3/07

Depth (feet)	Sample	Sample Type & No.	Uncorrected Blows/6 Inches	Recovery (Inches)	Water Content	Grain Size	Atterberg Limits	Lithology	Soil Type (USCS)	Lithology	Remarks	WELL
0									CH	Cuttings appear to be reddish brown; sand; CLAY (CH); some sand	Descriptions based on observations of Rotary Wash cuttings; rig geologist and driller's observations	
5											Screen placements based on information from geotechnical boring	
10										Cuttings appear to be reddish brown; CLAY (CH) grading to dark gray; CLAY (CH)		
20										Cuttings appear to be reddish brown; CLAY (CH)		
23									▽			
24											12/28/06: Water level measured after development	
30										Cuttings appear to be reddish brown and gray; CLAY (CH)		
40												

Project Name : Job Number

STP COL : 5050-06-0496

MACTEC

WELL LOG SOIL - Well No. OW-929-L

Depth (feet)	Sample	Sample Type & No.	Uncorrected Blows/6 Inches	Recovery (Inches)	Water Content	Grain Size	Atterberg Limits	Lithology	Soil Type (USCS)	Lithology	Remarks	WELL
40									CH	Cuttings appear to be reddish brown and gray; sand; CLAY (CH); some sand		
50										Cuttings appear to be reddish brown and gray; sand; CLAY (CH); some sand		
53									SP	Cuttings appear to change to silt; SAND (SP)		
60									CH	Cuttings appear to change to CLAY (CH)		
70										Cuttings appear to be reddish brown; CLAY (CH)		
80												

Project Name : Job Number STP COL : 5050-06-0496	MACTEC	WELL LOG SOIL - Well No. OW-929-L

Depth (feet)	Sample	Sample Type & No.	Uncorrected Blows/6 Inches	Recovery (inches)	Water Content	Grain Size	Atterberg Limits	Lithology	Soil Type (USCS)	Lithology	Remarks	WELL
80									CH	Cuttings appear to be reddish brown; CLAY (CH)		
82									SP	Cuttings appear to change to reddish brown; silt; SAND (SP)		
90										Cuttings appear to change to reddish brown; silt; SAND (SP)		
99									CH	Cuttings appear to change to reddish brown; CLAY (CH)		
100										Boring Terminated at 100-feet	Wash hole and ream to 8 inch diameter	

Project Name : Job Number STP COL : 5050-06-0496	MACTEC	WELL LOG SOIL - Well No. OW-929-U	
Type and Diameter of Boring: Wash Rotary / 8 inch	Boring Location: Northeast of Power Block, N 364672.34 E 2945477.58		Total Depth: 62 feet
Drilling Contractor and Rig: BEST / Failing 1500	Elevation at Boring: 36.91 feet	Ground Water Depth: 12.92 feet	Depth to Bedrock
Sampling Method: No sampling	Elevation at Well: 38.71 feet	No. of Samples: 0	Date Started: 12/13/06
	Borehole Inclination: 0	Logged by: M. H. Niemann	Date Completed: 12/15/06

Reviewed by / Date MJD 4/3/07

Reviewed by / Date KAW 4/3/07

Depth (feet)	Sample	Sample Type & No.	Uncorrected Blows/6 inches	Recovery (inches)	Water Content	Grain Size	Atterberg Limits	Lithology	Soil Type (USCS)	Lithology	Remarks	WELL
0									CH	Cuttings appear to be grayish green to gray; sand; CLAY (CH); some sand	Descriptions based on observations of Rotary Wash cuttings; rig geologist and driller's observations	
5											Screen placements based on information from geotechnical boring	
10										Cuttings appear to be gray and reddish brown; CLAY (CH) transitioning into dark gray; CLAY (CH) and reddish brown; CLAY (CH)		
13									▽		12/28/06: Water level measured after development	
20										Cuttings appear to be reddish brown and gray; CLAY (CH); calcareous nodules		
30										Cuttings appear to be reddish brown and gray; CLAY (CH)		
40												

Project Name : Job Number STP COL : 5050-06-0496	MACTEC	WELL LOG SOIL - Well No. OW-929-U

Depth (feet)	Sample	Sample Type & No.	Uncorrected Blows/6 Inches	Recovery (Inches)	Water Content	Grain Size	Atterberg Limits	Lithology	Soil Type (USCS)	Lithology	Remarks	WELL
40–52									CH	Cuttings appear to be reddish brown and gray; CLAY (CH) Cuttings appear to be reddish brown and gray; CLAY (CH)		
52–59									SP	Cuttings appear to change to SAND (SP)		
59–62									CH	Cuttings appear to change to reddish brown; CLAY (CH)		
62–80										Boring Terminated at 62-feet	Wash hole and ream to 8 inch diameter	

Depth scale: 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80

Project Name : Job Number STP COL : 5050-06-0496	MACTEC	WELL LOG SOIL - Well No. OW-930-L	
Type and Diameter of Boring Wash Rotary / 8 inch	Boring Location Southeast of Unit 1 & 2 ECR/UHS N 360214.45 E 2949525.96		Total Depth 108 feet
Drilling Contractor and Rig BEST / Failing 1500	Elevation at Boring 26.21 feet	Ground Water Depth 14.9 feet	Depth to Bedrock
Sampling Method No sampling	Elevation at Well 27.98 feet	No. of Samples 0	Date Started 12/11/06
	Borehole Inclination 0	Logged by C. Bruce	Date Completed 12/18/06

Reviewed by / Date MD 4/3/07

Reviewed by / Date KAW 4/3/07

Depth (feet)	Sample	Sample Type & No.	Uncorrected Blows/6 inches	Recovery (inches)	Water Content	Grain Size	Atterberg Limits	Lithology	Soil Type (USCS)	Lithology	Remarks	WELL
0									CH	Cuttings appear to be very dark greenish gray (GLEY 1 3/5GY); silt; CLAY (CH)	Descriptions based on observations of Rotary Wash cuttings; rig geologist and driller's observations	
5											Screen placements based on information from geotechnical boring	
15									▽	Cuttings appear to be yellowish red (5YR 5/8); silt; CLAY (CH)	12/28/06: Water level measured after development	
18									SM	Cuttings appear to be yellowish red (5YR 5/8); silt; SAND (SM)		
30										Cuttings appear to be strong brown (7.5YR 4/6); silt; SAND (SM)		
40												

Project Name : Job Number STP COL : 5050-06-0496	MACTEC	WELL LOG SOIL - Well No. OW-930-L

Depth (feet)	Sample	Sample Type & No.	Uncorrected Blows/6 Inches	Recovery (Inches)	Water Content	Grain Size	Atterberg Limits	Lithology	Soil Type (USCS)	Lithology	Remarks	WELL
40									SM	Cuttings appear to be strong brown (7.5YR 4/6); silt; SAND (SM)		
46									CH	Cuttings appear to be strong brown (7.5YR 5/8); silt; CLAY (CH)		
55										Cuttings appear to be strong brown (7.5YR 5/8); silt; CLAY (CH); trace of angular calcium carbonate fragments		
64									SM	Cuttings appear to be strong brown (7.5YR 5/8); silt; SAND (SM)		
70										Cuttings appear to be strong brown (7.5YR 5/8); silt; SAND (SM)		
80												

Project Name : Job Number STP COL : 5050-06-0496	MACTEC	WELL LOG SOIL - Well No. OW-930-L

Depth (feet)	Sample	Sample Type & No.	Uncorrected Blows/6 Inches	Recovery (Inches)	Water Content	Grain Size	Atterberg Limits	Lithology	Soil Type (USCS)	Lithology	Remarks	WELL
80									SM	Cuttings appear to be strong brown (7.5YR 5/6); silt; SAND (SM); sand is coarsening with depth		
90										Cuttings appear to be strong brown (7.5YR 5/6); silt; SAND (SM); sand is coarsening with depth		
100										Cuttings appear to be dark yellowish brown; silt; gravel; SAND (SM); trace of gravel and coarse sand		
107										Cuttings appear to be dark yellowish brown; silt; gravel; SAND (SM); trace of gravel and coarse sand		
108										Boring Terminated at 108-feet	Wash hole and ream to 8 inch diameter	

Depth scale: 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120

Project Name : Job Number STP COL : 5050-06-0496	MACTEC	WELL LOG SOIL - Well No. OW-930-U	
Type and Diameter of Boring Wash Rotary / 8 inch		Boring Location Southeast of Unit 1 & 2 ECR/UHS N 360209.72 E 2949506.58	Total Depth 38 feet
Drilling Contractor and Rig BEST / Failing 1500	Elevation at Boring 25.62 feet	Ground Water Depth 7.92 feet	Depth to Bedrock
Sampling Method No sampling	Elevation at Well 27.33 feet	No. of Samples 0	Date Started 12/11/06
	Borehole Inclination 0	Logged by M. H. Niemann	Date Completed 12/18/06

Reviewed by / Date MOD 4/3/07
Reviewed by / Date KAW 4/13/07

Depth (feet)	Sample	Sample Type & No.	Uncorrected Blows/6 inches	Recovery (inches)	Water Content	Grain Size	Atterberg Limits	Lithology	Soil Type (USCS)	Lithology	Remarks	WELL
0									CH	Cuttings appear to be dark gray; CLAY (CH)	Descriptions based on observations of Rotary Wash cuttings; rig geologist and driller's observations	
5											Screen placements based on information from geotechnical boring	
8									▽		12/28/06: Water level measured after development	
10										Cuttings appear to be dark gray; CLAY (CH) to 15-feet; transitioning into reddish brown; CLAY (CH) to 18-feet		
18									SM	Cuttings appear to change to brown; silt; SAND (SM); fine grained		
20										Cuttings appear to be brown; silt; SAND (SM); fine grained		
30										Cuttings appear to be brown; silt; SAND (SM); fine grained		
38										Boring Terminated at 38-feet	Wash hole and ream to 8 inch diameter	

Project Name : Job Number STP COL : 5050-06-0496	MACTEC	WELL LOG SOIL - Well No. OW-931-U	
Type and Diameter of Boring Wash Rotary / 7 Inch	Boring Location Southwest of Power Block N 361979.42 E 2939520.36		Total Depth 38 feet
Drilling Contractor and Rig BEST / Holemaster 1500	Elevation at Boring 30.53 feet	Ground Water Depth 9.82 feet	Depth to Bedrock
Sampling Method No sampling	Elevation at Well 32.1 feet	No. of Samples 0	Date Started 12/8/06
	Borehole Inclination 0	Logged by D. Heslep	Date Completed 12/15/06

Reviewed by / Date MJD 4/3/07

Reviewed by / Date KAW 4/3/07

Depth (feet)	Soil Type (USCS)	Lithology	Remarks
0–5	CH	Cuttings appear to be dark gray; silt; CLAY (CH)	Descriptions based on observations of Rotary Wash cuttings; rig geologist and driller's observations
5–10		Cuttings appear to be reddish orange; silt; sand; CLAY (CH); some sand	Screen placements based on information from geotechnical boring
10–20		Cuttings appear to be reddish orange; silt; sand; CLAY (CH); some sand	12/28/06: Water level measured after development
20–30	SP	Cuttings appear to change to reddish orange; SAND (SP)	
30–38		Cuttings appear to change to reddish orange; SAND (SP)	
38–40		Boring Terminated at 38-feet	Wash hole and ream to 8 inch diameter

Column headings: Depth (feet), Sample, Sample Type & No., Uncorrected Blows/6 Inches, Recovery (inches), Water Content, Grain Size, Atterberg Limits, Lithology, Soil Type (USCS), Lithology, Remarks, WELL

Project Name : Job Number STP COL : 5050-06-0496	MACTEC	WELL LOG SOIL - Well No. OW-932-L

Type and Diameter of Boring: Wash Rotary / 8 inch	Boring Location: South of Power Block, N 361899.37 E 2942115.9		Total Depth: 81.5 feet
Drilling Contractor and Rig: BEST / Failing 1500	Elevation at Boring: 31.09 feet	Ground Water Depth: 17.23 feet	Depth to Bedrock
Sampling Method: No sampling	Elevation at Well: 32.79 feet	No. of Samples: 0	Date Started: 12/14/06
	Borehole Inclination: 0	Logged by: M. H. Niemann	Date Completed: 12/19/06

Reviewed by / Date MJD 4/3/07

Reviewed by / Date KAW 4/3/07

Depth (feet)	Soil Type (USCS)	Lithology	Remarks
0	CH	Cuttings appear to be dark gray; CLAY (CH); grading into light gray and reddish brown; CLAY (CH)	Descriptions based on observations of Rotary Wash cuttings; rig geologist and driller's observations
5			Screen placements based on information from geotechnical boring
10		Cuttings appear to be reddish brown; CLAY (CH); few fine calcareous nodules	
17	▽		12/28/06: Water level measured after development
25	SP	Cuttings appear to change to; silt; SAND (SP); fine grained	
30		Cuttings appear to be brown; silt; SAND (SP); fine grained	

Columns: Depth (feet), Sample, Sample Type & No., Uncorrected Blows/6 Inches, Recovery (Inches), Water Content, Grain Size, Atterberg Limits, Lithology, Soil Type (USCS), Lithology, Remarks, WELL. Depth scale 0–40.

Project Name : Job Number STP COL : 5050-06-0496	MACTEC	WELL LOG SOIL - Well No. OW-932-L

Depth (feet)	Sample	Sample Type & No.	Uncorrected Blows/6 Inches	Recovery (Inches)	Water Content	Grain Size	Atterberg Limits	Lithology	Soil Type (USCS)	Lithology	Remarks	WELL
40									SP	Cuttings appear to be brown; silt; SAND (SP); fine grained		
50										Cuttings appear to be brown; silt; SAND (SP); fine grained		
55									CH	Cuttings appear to change to reddish brown; CLAY (CH) grading to gray; CLAY (CH) below 58-feet		
60										Cuttings appear to be gray; CLAY (CH)		
67									SP	Cuttings appear to change to silt; SAND (SP); fine grained		
70										Cuttings appear to be a silty SAND (SP); fine grained		
80												

Project Name : Job Number STP COL : 5050-06-0496	MACTEC	WELL LOG SOIL - Well No. OW-932-L

Depth (feet)	Sample	Sample Type & No.	Uncorrected Blows/6 Inches	Recovery (Inches)	Water Content	Grain Size	Atterberg Limits	Lithology	Soil Type (USCS)	Lithology	Remarks	WELL
80–81.5									SP			
81.5										Boring Terminated at 81.5-feet	Wash hole and ream to 8 inch diameter	

Depth scale: 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120

Project Name : Job Number STP COL : 5050-06-0496	MACTEC	WELL LOG SOIL - Well No. OW-932-U	
Type and Diameter of Boring Wash Rotary / 8 inch	Boring Location South of Power Block N 361898.53 E 2942097.29		Total Depth 41.5 feet
Drilling Contractor and Rig BEST / Failing 1500	Elevation at Boring 31.95 feet	Ground Water Depth 8.52 feet	Depth to Bedrock
Sampling Method No sampling	Elevation at Well 32.83 feet	No. of Samples 0	Date Started 12/14/06
	Borehole Inclination 0	Logged by M. H. Niemann	Date Completed 12/19/06

Reviewed by / Date MTD 4/3/07

Reviewed by / Date KAW 4/3/07

Depth (feet)	Sample	Sample Type & No.	Uncorrected Blows/6 inches	Recovery (inches)	Water Content	Grain Size	Atterberg Limits	Soil Type (USCS)	Lithology	Remarks
0								CH	Cuttings appear to be dark gray; CLAY (CH)	Descriptions based on observations of Rotary Wash cuttings; rig geologist and driller's observations
5										Screen placements based on information from geotechnical boring
8.5								▽		12/28/06: Water level measured after development
10									Cuttings appear to be reddish brown; CLAY (CH)	
20									Cuttings appear to be reddish brown; CLAY (CH)	
26								SP	Cuttings appear to change to silt; SAND (SP); fine grained	
30									Cuttings appear to be silt; SAND (SP); fine grained	

Project Name : Job Number STP COL : 5050-06-0496	MACTEC	WELL LOG SOIL - Well No. OW-932-U

Depth (feet)	Sample	Sample Type & No.	Uncorrected Blows/6 inches	Recovery (inches)	Water Content	Grain Size	Atterberg Limits	Lithology	Soil Type (USCS)	Lithology	Remarks	WELL
40–41.5									SP			
41.5										Boring Terminated at 41.5-feet	Wash hole and ream to 8 inch diameter	

Depth scale: 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80

Project Name : Job Number STP COL : 5050-06-0496	MACTEC	WELL LOG SOIL - Well No. OW-933-L	
Type and Diameter of Boring Mud Rotary / 8 inch	Boring Location South of Power Block N 361898.05 E 2943516.01		Total Depth 88 feet
Drilling Contractor and Rig BEST / Failing 1500	Elevation at Boring 28.74 feet	Ground Water Depth 14.6 feet	Depth to Bedrock
Sampling Method No sampling	Elevation at Well 30.45 feet	No. of Samples 0	Date Started 11/8/06
	Borehole Inclination 0	Logged by R. Clark	Date Completed 11/28/06

Reviewed by / Date MD 4/3/07

Reviewed by / Date KAW 4/3/07

Depth (feet)	Sample	Sample Type & No.	Uncorrected Blows/6 Inches	Recovery (Inches)	Water Content	Grain Size	Atterberg Limits	Lithology	Soil Type (USCS)	Lithology	Remarks	WELL
0									CH	Cuttings from appear to be CLAY (CH)	Descriptions based on observations of Rotary Wash cuttings; rig geologist and driller's observations	
5											Screen placements based on information from geotechnical boring	
10										Cuttings from appear to be CLAY (CH)		
15									∇		12/28/06: Water level measured after development	
20									CL-ML	Cuttings from appear to be silt; CLAY (CL-ML)		
30									SP	Cuttings from appear to be SAND (SP)		
40												

Project Name : Job Number STP COL : 5050-06-0496	MACTEC	WELL LOG SOIL - Well No. OW-933-L

Depth (feet)	Sample	Sample Type & No.	Uncorrected Blows/6 inches	Recovery (inches)	Water Content	Grain Size	Atterberg Limits	Lithology	Soil Type (USCS)	Lithology	Remarks	WELL
40									SP	Cuttings from appear to be SAND (SP)		
50										Cuttings from appear to be SAND (SP)		
60										Cuttings from appear to be SAND (SP)		
70										Cuttings from appear to be SAND (SP)		
80												

Project Name : Job Number STP COL : 5050-06-0496	MACTEC	WELL LOG SOIL - Well No. OW-933-L

Depth (feet)	Sample	Sample Type & No.	Uncorrected Blows/6 Inches	Recovery (inches)	Water Content	Grain Size	Atterberg Limits	Lithology	Soil Type (USCS)	Lithology	Remarks	WELL
80–88									SP	Cuttings from appear to be SAND (SP)		
88–120										Boring Terminated at 88-feet	Wash hole and ream to 8 inch diameter	

Project Name : Job Number STP COL : 5050-06-0496	MACTEC	WELL LOG SOIL - Well No. OW-933-U

Type and Diameter of Boring Mud Rotary / 8 inch	Boring Location South of Power Block N 361897.65 E 2943494.66		Total Depth 38 feet
Drilling Contractor and Rig BEST / Failing 1500	Elevation at Boring 28.87 feet	Ground Water Depth 6.44 feet	Depth to Bedrock
Sampling Method No sampling	Elevation at Well 30.62 feet	No. of Samples 0	Date Started 11/13/06
	Borehole Inclination 0	Logged by R. Clark	Date Completed 11/28/06

Reviewed by / Date MJD 4/3/07

Reviewed by / Date KAW 4/3/07

Depth (feet)	Sample	Sample Type & No.	Uncorrected Blows/6 Inches	Recovery (Inches)	Water Content	Grain Size	Atterberg Limits	Lithology	Soil Type (USCS)	Lithology	Remarks	WELL
0									CH	Cuttings from appear to be CLAY (CH)	Descriptions based on observations of Rotary Wash cuttings; rig geologist and driller's observations	
5											Screen placements based on information from geotechnical boring	
6									▽		12/28/06: Water level measured after development	
10										Cuttings from appear to be CLAY (CH)		
20										Cuttings from appear to be CLAY (CH)		
26									SP	Cuttings from appear to be SAND (SP)		
38										Boring Terminated at 38-feet	Wash hole and ream to 8 inch diameter	

Project Name : Job Number STP COL : 5050-06-0496	MACTEC	WELL LOG SOIL - Well No. OW-934-L	
Type and Diameter of Boring: Wash Rotary / 7 Inch	Boring Location: Northeast of Unit 1 & 2 ECR/UHS N 362082.08 E 2948254.12		Total Depth: 102 feet
Drilling Contractor and Rig: BEST / Holemaster 1500	Elevation at Boring: 29.04 feet	Ground Water Depth: 17.07 feet	Depth to Bedrock:
Sampling Method: No sampling	Elevation at Well: 30.94 feet	No. of Samples: 0	Date Started: 12/9/06
	Borehole inclination: 0	Logged by: D. Heslep	Date Completed: 12/15/06

Reviewed by / Date MD 4/5/07

Reviewed by / Date KAW 4/13/07

Depth (feet)	Sample	Sample Type & No.	Uncorrected Blows/6 Inches	Recovery (Inches)	Water Content	Grain Size	Atterberg Limits	Lithology	Soil Type (USCS)	Lithology	Remarks	WELL
0									CH	Cuttings appear to be dark gray to reddish brown; silt; sand; CLAY (CH); some sand; calcareous nodules	Descriptions based on observations of Rotary Wash cuttings; rig geologist and driller's observations	
5										Cuttings appear to be reddish brown; silt; sand; CLAY (CH); some sand; calcareous nodules	Screen placements based on information from geotechnical boring	
10										Cuttings appear to be reddish dark gray; silt; sand; CLAY (CH); some sand; calcareous nodules		
17									▽		12/28/06: Water level measured after development	
20										Cuttings appear to be reddish dark gray; silt; sand; CLAY (CH); some sand; calcareous nodules		
22									SP	Cuttings appear to change to reddish brown; silt; clay; SAND (SP); some silt; some clay; fine to very fine grained		
30										Cuttings appear to be reddish brown; silt; clay; SAND (SP); some silt; some clay; fine to very fine grained		
40												

Project Name : Job Number STP COL : 5050-06-0496	MACTEC	WELL LOG SOIL - Well No. OW-934-L

Depth (feet)	Sample	Sample Type & No.	Uncorrected Blows/6 Inches	Recovery (Inches)	Water Content	Grain Size	Atterberg Limits	Lithology	Soil Type (USCS)	Lithology	Remarks	WELL
40									SP	Cuttings appear to be reddish brown; silt; clay; SAND (SP); some silt; some clay; fine to very fine grained		
49									CH	Cuttings appear to change to reddish brown to tan and light gray; silt; sand; CLAY (CH); some sand		
51										Cuttings appear to be tan to light gray; silt; sand; CLAY (CH); some sand; very fine grained		
60										Cuttings appear to be tan to light gray; silt; sand; CLAY (CH); some sand; very fine grained		
62									SP	Cuttings appear to change to reddish tan; SAND (SP); very fine grained		
70										Cuttings appear to be reddish tan; SAND (SP); very fine grained		
75									CH	Cuttings appear to change to tan; sand; silt; CLAY (CH); very fine grained; some silt		
80												

Project Name : Job Number STP COL : 5050-06-0496	MACTEC	WELL LOG SOIL - Well No. OW-934-L

Depth (feet)	Sample	Sample Type & No.	Uncorrected Blows/6 Inches	Recovery (Inches)	Water Content	Grain Size	Atterberg Limits	Lithology	Soil Type (USCS)	Lithology	Remarks	WELL
80									CH	Cuttings appear to be tan; sand; silt; CLAY (CH); very fine grained; some silt		
90										Cuttings appear to be tan; sand; silt; CLAY (CH); very fine grained; some silt		
92									SP	Cuttings appear to change to tan; silt; SAND (SP); very fine grained; some silt		
100										Cuttings appear to be tan; silt; SAND (SP); very fine grained; some silt		
102										Boring Terminated at 102-feet	Wash hole and ream to 8 inch diameter	

STP WELL STP COL WELLS.GPJ WLA.GDT 4/3/07

Project Name : Job Number STP COL : 5050-06-0496	MACTEC	WELL LOG SOIL - Well No. OW-934-U	
Type and Diameter of Boring Mud Rotary / 8 inch	Boring Location NE of Unit 1 & 2 ECR/UHS N 362079.87 E 2948234.2		Total Depth 43 feet
Drilling Contractor and Rig BEST / Failing 1500	Elevation at Boring 28.54 feet	Ground Water Depth 10.22 feet	Depth to Bedrock
Sampling Method No sampling	Elevation at Well 30.39 feet	No. of Samples 0	Date Started 11/21/06
	Borehole Inclination 0	Logged by M. Fraychineaud	Date Completed 12/1/06

Reviewed by / Date MSD 4/3/07

Reviewed by / Date KAW 4/3/07

Depth (feet)	Sample	Sample Type & No.	Uncorrected Blows/6 Inches	Recovery (Inches)	Water Content	Grain Size	Atterberg Limits	Lithology	Soil Type (USCS)	Lithology	Remarks	WELL
0									CH	Cuttings appear to be black (Gley1 25/N); silt; CLAY (CH); moist; little silt; high plasticity	Descriptions based on observations of Rotary Wash cuttings; rig geologist and driller's observations	
5											Screen placements based on information from geotechnical boring	
10									∇		12/28/06: Water level measured after development	
13										Cuttings appear to be yellowish red (5YR 5/6); silt; CLAY (CH); moist; little silt; high plasticity; some pebbles and calcareous nodules		
26									SP	Cuttings appear to be reddish yellow (5YR 6/6); silt; SAND (SP); fine; some silt; trace mafic minerals		

Depth scale: 0–40 feet

Project Name : Job Number STP COL : 5050-06-0496	MACTEC	WELL LOG SOIL - Well No. OW-934-U

Depth (feet)	Sample	Sample Type & No.	Uncorrected Blows/6 Inches	Recovery (Inches)	Water Content	Grain Size	Atterberg Limits	Lithology	Soil Type (USCS)	Lithology	Remarks	WELL
40–43									SP	Cuttings appear to be reddish yellow (5YR 6/6); silt; SAND (SP); fine; some silt; trace mafic minerals		
43										Boring Terminated at 43-feet	Wash hole and ream to 8 inch diameter	

Depth scale: 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80

Appendix C-2

Well Development Records

MACTEC

WELL DEVLOPMENT

Project Name: **STP COL Subsurface Investigation**
MACTEC Project Number: 5050-06-0496

Well Number:	OW-332-U	Developed by:	ML/Niemann
Date Developed:	11-21-06	Development start time:	2:20p
Date Drilled:	11-3-06	Development stop time:	3:50p
Casing Diameter:	2 in	Water Level (start)(b):	8.35 ft
Length of Screened Interval:	10' ft	Water Level (end):	8.50 ft
Top of Screened Interval:	35.0 logs ft	Calculated well volume (0.163 gal/ft*)(~~b-a~~):	6.22 gal
Well depth from construction log(a):	Total 46.0 / 45.0 logs ft	Minimum volume to be removed:	31.1 gal
Well Depth (start)(a):	46.51 ft (1.72' Stickup)	Actual volume removed:	190 gal
Well Depth (end):	47.55 ft	Disposal method of removed water:	infiltrate surrounding ground

* for 2 inch well casing = [(((2inch)/(12inch/ft))^2)*3.14]/4 * 7.46 gal/ft^3=0.163 gal/ft

Description of equipment used: Ingersoll Rand 185 Air Compressor w/ 3/8" OD flexible hose, and 1" OD tremie pipe
1.75' surge block to attach to tremie pipe

Description of appearance of water at start:
brown to reddish brown color (sediment filled)
after surging, dk reddish brown

Description of appearance of water at end:
pale brown to clear
bottom runs clear out of hose

MJS 1-5-07

MACTEC

WELL DEVLOPMENT

Project Name: **STP COL Subsurface Investigation**
MACTEC Project Number: 5050-06-0496

Well Number: OW-348-U
Date Developed: 11-21-06
Date Drilled: 11-2-06
Casing Diameter: 2 in
Length of Screened Interval: 10' ft
Top of Screened Interval: 28.0 bgs ft
Well depth from construction log(a): 38.0 bgs ft
Checked twice to make sure 41.71 1.7 stick up
Well Depth (start): ~~40.71~~ -SU ft
Well Depth (end): 41.95-S.U. ft

Developed by: Best / H H Newman
Development start time: 8:10 am
Development stop time: 9:45 AM
Water Level (start)(b): 8.7 -S.U. ft
Water Level (end): ~~24~~ 8.09 ft
Calculated well volume (0.163 gal/ft*)(b-a): 4.98 gal
Minimum volume to be removed: 24 gal
Actual volume removed: 160 gal
Disposal method of removed water: infiltration

* for 2 inch well casing = $[(((2inch)/(12inch/ft))^2)*3.14]/4 * 7.46\ gal/ft^3 = 0.163\ gal/ft$

Description of equipment used: Ingersoll Rand 185 air compressor 3/8" flex hose for air flow - 1" OD tremie pipe w/ hose clamped on top for water flow

Description of appearance of water at start: start development @ 32' mid screen. surged after 70 gallons - brown, no sand in bucket

Description of appearance of water at end: significantly more clear than after 20 gal. removed. Opaque, very light brown in white bucket but mostly clear in cupped hands.

MACTEC

WELL DEVLOPMENT

Project Name: **STP COL Subsurface Investigation**
MACTEC Project Number: 5050-06-0496

Well Number:	OW-348-L	Developed by:	Matt F.
Date Developed:	11.21.06	Development start time:	10:28AM
Date Drilled:	11.2.06	Development stop time:	11:35AM
Casing Diameter:	2 in	Water Level (start)(b):	16.4 - s.u.[1] ft
Length of Screened Interval:	10 ft	Water Level (end):	16.13 - s.u.[1] ft
Top of Screened Interval:	68.3 bgs ft	Calculated well volume (0.163 gal/ft*)(a-b):	10.4 gal
Well depth from construction log(a):	78.3 bgs ft (Bottom of screen)	Minimum volume to be removed:	52 gal
Well Depth (start):	81.35 - s.u.[1] ft	Actual volume removed:	115 gal
Well Depth (end):	81.3 - s.u.[1] ft	Disposal method of removed water:	Ground Surface

* for 2 inch well casing = [(((2inch)/(12inch/ft))^2)*3.14]/4 * 7.46 gal/ft^3 =0.163 gal/ft

[1] s.u. = stick up of PVC casing from ground surface = ~1.9 feet

Description of equipment used: Ingersoll-Rand 185 air compressor; 3/8" flex hose for air flow; 1" O.D. PVC tremie pipe w/hose attachment for discharge water.

Description of appearance of water at start: Start development @ 45' bgs. Removed 30 gal and then surged well. Installed tremie to approx. 78' bgs. Water was (for approx 16 mins).

Description of appearance of water at end: Slightly opaque but generally clear.

VS 1.5.07

MACTEC

WELL DEVLOPMENT

Project Name: STP COL Subsurface Investigation

MACTEC Project Number: 5050-06-0496

Well Number:	OW-408U	Developed by:	M H Wierman & Best
Date Developed:	11/20/06	Development start time:	1:45 pm
Date Drilled:	11.1.06	Development stop time:	2:55 pm
Casing Diameter:	2 in	Water Level (start)(b):	~~17.85~~ 10.09' ft
Length of Screened Interval:	10' ft	Water Level (end):	10.26
Top of Screened Interval:	32' bgs ft	Calculated well volume (0.163 gal/ft*)(~~b-a~~):	4.03/5.20 gal
~~Well depth from construction log(a)~~:	42' bgs ft	Minimum volume to be removed:	20.17/26 gal
Well Depth (start)(a):	34.85 ~~83.16~~ ft	Actual volume removed:	~~184~~ 70 gal
Well Depth (end):	44.29-1.8ft	Disposal method of removed water:	infiltrate - pour on ground

* for 2 inch well casing = $[(((2inch)/(12inch/ft))^2)*3.14]/4 * 7.46 gal/ft^3 = 0.163 gal/ft$

Description of equipment used: Ingersoll-Rand 185 air compressor
1" OD Tremie pipe + 3/8" flexible tubing (for air flow)

Description of appearance of water at start: Couple cups of sand in bottom of first bucket can fill it in ... removed water - will surge well after ... removed.

Description of appearance of water at end: Water was very cloudy w/ sediment after surging - cleared up after several buckets (5 gallons each).

1.5.07

Ano 12/30/06

35
45

MACTEC

WELL DEVLOPMENT

Project Name: **STP COL Subsurface Investigation**

MACTEC Project Number: 5050-06-0496

Well Number:	OW-408 L	Developed by:	MH Niemann
Date Developed:	11·20·06	Development start time:	3:10 pm
Date Drilled:	10·31·06	Development stop time:	4:40
Casing Diameter:	2" in	Water Level (start)(b):	17.85 ft
Length of Screened Interval:	10' ft	Water Level (end):	18.46 - stickup
Top of Screened Interval:	70.2 bgs ft	Calculated well volume (0.163 gal/ft*)(b-a):	10.65 gal
Well depth from construction log(a):	80.2 bgs ft bottom of screen	Minimum volume to be removed:	53.23 gal
Well Depth (start):	83.16 ft stickup 1.82'	Actual volume removed:	85 gal
Well Depth (end):	83.16 ft	Disposal method of removed water:	infiltration on ground

* for 2 inch well casing = $[(((2inch)/(12inch/ft))^2)*3.14]/4 * 7.46\ gal/ft^3 = 0.163\ gal/ft$

Description of equipment used: Ingersoll Rand 185 air compressor
1" OD tremie pipe w/ hose clamped to top for extra airflow
3/8" flexible pipe/tubing (for airflow)

Description of appearance of water at start: cloudy, brown - having them clear after 35 gallons removed

Description of appearance of water at end:
clear

VH 8.15.07

75
85

MACTEC

WELL DEVLOPMENT
Project Name: **STP COL Subsurface Investigation**
MACTEC Project Number: 5050-06-0496

Well Number:	OW-420-U	Developed by:	M.H. Niemann Bek +
Date Developed:	11.20.06	Development start time:	10:22
Date Drilled:	11.7.06	Development stop time:	11:30
Casing Diameter:	2" in	Water Level (start)(b):	10.21 ft
Length of Screened Interval:	10' ft	Water Level (end):	10.37 ft
Top of Screened Interval:	38' bgs ft	Calculated well volume (0.163 gal/ft*)(b-a):	6.36 gal
~~Well depth from construction log~~(a):	48' bottom of screened interval ft	Minimum volume to be removed:	33 gal
Well Depth (start):	50.51 w/ stickup 49 ft	Actual volume removed:	~~75~~ 70 MN 11/20/06 gal
Well Depth (end):	50.51 ft	Disposal method of removed water:	on ground to infiltrate naturally

* for 2 inch well casing = $[(((2inch)/(12inch/ft))^2)*3.14]/4 * 7.46\ gal/ft^3 = 0.163\ gal/ft$

Description of equipment used: 1.24 ~~3/4~~" OD tremie pipe
Ingersoll-Rand air compressor 185
3/4" flexible polyhose

Description of appearance of water at start: Sediment filled (brown not clear) after ~ 20 g, start to clean up (lt brown)

Description of appearance of water at end: Clear - no visible sediment in water coming from hose

VJJ 1.5.07

MACTEC

WELL DEVLOPMENT

Project Name: **STP COL Subsurface Investigation**

MACTEC Project Number: 5050-06-0496

Well Number:	OW - 308 - U	Developed by:	A. Osario
Date Developed:	11/27/06	Development start time:	10:00 AM
Date Drilled:	11/14/2006	Development stop time:	11:10 AM
Casing Diameter:	2" in	Water Level (start)(b):	8.29 ft
Length of Screened Interval:	10 ft	Water Level (end):	8.53 ft
Top of Screened Interval:	36 ft	Calculated well volume (0.163 gal/ft*)(b-a):	6.15 gal
Well depth from construction log(a):	46 ft	Minimum volume to be removed:	30.7 gal
Well Depth (start):	48.91 ft	Actual volume removed:	135 gal
Well Depth (end):	48.90 ft	Disposal method of removed water:	Infiltration

* for 2 inch well casing = $[(((2inch)/(12inch/ft))^2)*3.14]/4 * 7.46\ gal/ft^3 = 0.163\ gal/ft$

Description of equipment used:

Ingersoll-Rand 185 Compressor with
3/4" of PVC
1" of PVC & water level meter

Description of appearance of water at start:

cloudy, dark brown color

Description of appearance of water at end:

clear; no trace of fines

[illegible] 1-5-07

MACTEC

WELL DEVLOPMENT

Project Name: **STP COL Subsurface Investigation**

MACTEC Project Number: 5050-06-0496

Well Number:	OW-308-L	Developed by:	MH Nieman
Date Developed:	11/22/06	Development start time:	10:10a
Date Drilled:	11/13/06	Development stop time:	11:30a
Casing Diameter:	2 in	Water Level (start)(b):	17.31 ft
Length of Screened Interval:	10 ft	Water Level (end):	meas 11/22/06 ~~13~~ 15.9 ft measured 11/28/06
Top of Screened Interval:	86 ft	Calculated well volume (0.163 gal/ft*)(~~b-a~~):	13.0 gal
Well depth from construction log(a):	97.12 ft w/ stickup = 99.05	Minimum volume to be removed:	65.0 gal
Well Depth (start):	93.92 ft stickup = 1.93'	Actual volume removed:	190 gal
Well Depth (end):	97.78 ft measured 11/28/06	Disposal method of removed water:	infiltrate into surrounding ground

* for 2 inch well casing = $[(((2inch)/(12inch/ft))^2)*3.14]/4 * 7.46\ gal/ft^3 = 0.163\ gal/ft$

Description of equipment used: Ingersoll Rand 185 (air compressor) 3/8" OD flexible hose, + 1" OD tremie pipe

Description of appearance of water at start: dk reddish brown, sediment filled water

after surging – dk brown, reddish sediment filled

Description of appearance of water at end: turbid but no fines – running clear

WJ 1.5.07

15.33

MACTEC

WELL DEVLOPMENT

Project Name: STP COL Subsurface Investigation
MACTEC Project Number: 5050-06-0496

Well Number:	OW-332-L	Developed by:	MH Niemann
Date Developed:	11/22/06	Development start time:	7:50a
Date Drilled:	11/3/06	Development stop time:	9:25a
Casing Diameter:	2 in	Water Level (start)(b):	17.15 ft
Length of Screened Interval:	10 ft	Water Level (end):	16.61 ft
Top of Screened Interval:	92.1 ft	Calculated well volume (0.163 gal/ft *)(a-b):	13.86 gal
Well depth from construction log(a):	103.25 ft Stickup 1.45'	Minimum volume to be removed:	69.32 gal
Well Depth (start)(a):	102.02 ft	Actual volume removed:	150.0 gal
Well Depth (end):	104.6 ft	Disposal method of removed water:	infiltrate surrounding ground

* for 2 inch well casing = $[(((2inch)/(12inch/ft))^2)*3.14]/4 * 7.46 gal/ft^3 = 0.163 gal/ft$

Description of equipment used: Ingersoll Rand 185 air compressor, 3/8" OD flexible hose + 1" OD tremie pipe 1.75" surge block + tremie pipe for surging

Description of appearance of water at start: dark reddish brown, sediment-filled
After surging - back to dark brown, sediment-filled

Description of appearance of water at end: Clear running, v. pale brown tint (no fines)

1.5.07

MACTEC

WELL DEVLOPMENT
Project Name: **STP COL Subsurface Investigation**
MACTEC Project Number: 5050-06-0496

Well Number: OW-349-U
Developed by: A. Osorio

Date Developed: 11-27-06
Development start time: 12:43 pm

Date Drilled: 11-7-06
Development stop time:

Casing Diameter: 2" in
Water Level (start)(b): 7.86 ft

Length of Screened Interval: 10 ft
Water Level (end): 7.98 ft

Top of Screened Interval: 35 ft
Calculated well volume (0.163 gal/ft*)(~~b-a~~): 6.05 gal

Well depth from construction log(a): 45 ft
Minimum volume to be removed: 30.27 gal

Well Depth (start): 47.93 ft (including 2' stickup)
Actual volume removed: 185 gal

Well Depth (end): 47.90 ft (including 2' stickup)
Disposal method of removed water: Infiltration

* for 2 inch well casing = [(((2inch)/(12inch/ft))^2)*3.14]/4 * 7.46 gal/ft^3 =0.163 gal/ft

Description of equipment used:
Ingersoll - Rand 185 Compressor with 3/4" of PVC for purging of well
1" of PVC for surging of well
Water level meter

Description of appearance of water at start:
Cloudy, dark brown, trace of fines

Description of appearance of water at end:
turbid, no fines traces.

UJ 1.5.07

MACTEC

WELL DEVLOPMENT
Project Name: **STP COL Subsurface Investigation**
MACTEC Project Number: 5050-06-0496

Well Number:	OW-349-L	Developed by:	M H Nieman
Date Developed:	11.27.06-11/28/06	Development start time:	3:10p
Date Drilled:	11.4.06	Development stop time:	9:53p
Casing Diameter:	2 in	Water Level (start)(b):	15.18 ft
Length of Screened Interval:	10 ft	Water Level (end):	15.49 ft
Top of Screened Interval:	70 ft	Calculated well volume = (0.163 gal/ft*)(b-a):	10.73 gal
Well depth from construction log(a):	80 ft 81.03 w/ sump + stickup 82.67 stickup = 1.64'	Minimum volume to be removed:	53.67 gal
Well Depth (start):	78.3 ft	Actual volume removed:	200 gal
Well Depth (end):	81.67 ft	Disposal method of removed water:	Infiltration of surrounding ground

* for 2 inch well casing = $[(((2inch)/(12inch/ft))^2)*3.14]/4 * 7.46\ gal/ft^3 = 0.163\ gal/ft$

Description of equipment used: 185 Ingersoll Rand air compressor, 3/8" OD flexible hose, 1" OD tremie pipe + 1.75" surge block + tremie pipe (for surging well)

Description of appearance of water at start: mod-dk brown-reddish brown, full of sand
after surging - same appearance, dk brown

Description of appearance of water at end: running clear - slight tint of water but no fines

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1.5.07

MACTEC

WELL DEVLOPMENT

Project Name: **STP COL Subsurface Investigation**
MACTEC Project Number: 5050-06-0496

Well Number:	OW-438U	Developed by:	MH Wiemann
Date Developed:	12/1/06	Development start time:	9:10
			initial Development 11/28/06 + surging
Date Drilled:	11/20/06	Development stop time:	10:30
Casing Diameter:	2 in	Water Level (start)(b):	8.81 ft
Length of Screened Interval:	10 ft	Water Level (end):	8.65 ft
Top of Screened Interval:	30 ft	Calculated well volume (0.163 gal/ft*)(~~b-a~~):	5.64 gal
Well depth from construction log(a):	41.12 ft w/ stickup = 42.82, stickup = 1.7'	Minimum volume to be removed:	28.18 gal
Well Depth (start):	(a) 43.39 ft	Actual volume removed:	125 gal
Well Depth (end):	43.48 ft	Disposal method of removed water:	infiltrate surrounding ground

* for 2 inch well casing = $[(((2inch)/(12inch/ft))^2)*3.14]/4 * 7.46\ gal/ft^3 = 0.163\ gal/ft$

Description of equipment used: 185 Ingersoll Rand air compressor, 3/8" OD flexible air hose, 1" OD tremie pipe + 1.75" surge block and tremie pipe (for well surging)

Description of appearance of water at start: Mud - dk brown, full of fines and sediment

Description of appearance of water at end: pale tinted/cloudy, no fines, mostly clear

NOTE: 25 gallons initially removed on 11/28/06
100 gallons removed on 12/1/06

MACTEC

WELL DEVLOPMENT
Project Name: STP COL Subsurface Investigation
MACTEC Project Number: 5050-06-0496

Well Number:	OW-438L	Developed by:	M/Wiemann
Date Developed:	12/1/06	Development start time:	10:33a
Date Drilled:	11/21/06	Development stop time:	1:20p
Casing Diameter:	2 in	Water Level (start)(b):	16.95 ft
Length of Screened Interval:	10 ft	Water Level (end):	15.91 ft
Top of Screened Interval:	93 ft	Calculated well volume* (0.163 gal/ft*)(b-a):	~~16.97~~ 14.2 gal
Well depth from construction log(a):	104.12 ft w/ stickup = 105.72 stickup = 1.6"	Minimum volume to be removed:	~~84.8~~ 71.0 gal
Well Depth (start):	103.52 ft	Actual volume removed:	200 gal
Well Depth (end):	104.62 ft	Disposal method of removed water:	infiltrate surrounding

* for 2 inch well casing = [(((2inch)/(12inch/ft))^2)*3.14]/4 * 7.46 gal/ft^3 =0.163 gal/ft

Description of equipment used: 185 Ingersol Rand air compressor, 3/8" OD flexible air hose, 1" OD tremie pipe + 1.75" surge block and tremie pipe (for well surging)

Description of appearance of water at start: dk brown, full of sediment
after surging, same appearance as development start

Description of appearance of water at end: pale tinted water, no fines, surging clears

UJf 1.5.07

MACTEC

WELL DEVLOPMENT

Project Name: **STP COL Subsurface Investigation**
MACTEC Project Number: 5050-06-0496

Well Number:	OW-910U	Developed by:	M+/ Niemann
Date Developed:	12/20/06	Development start time:	9:40
Date Drilled:	12/16/06	Development stop time:	11:05
Casing Diameter:	2 in	Water Level (start)(b):	9.5 ft
Length of Screened Interval:	10 ft	Water Level (end):	9.62 ft
Top of Screened Interval:	25 ft	Calculated well volume (0.163 gal/ft*)(~~b-a~~) (a-b) 1.5.07:	~~4.66~~ 4.34 gal 1.5.07
Well depth from construction log(a):	36.12 ft	Minimum volume to be removed:	~~23.32~~ 21.7 gal 1.5.07
Well Depth (start):	34.7 ft Stickup = ~2'	Actual volume removed:	160 gal
Well Depth (end):	35.95 ft	Disposal method of removed water:	infiltration in surrounding ground

* for 2 inch well casing = $[(((2inch)/(12inch/ft))^2)*3.14]/4 * 7.46\ gal/ft^3 = 0.163\ gal/ft$

Description of equipment used: Ingersoll Rand 185 air compressor, 3/8" air hose, 1" tremie pipe, Grout 1.25" surge block & tremie pipe

Description of appearance of water at start: brown & full of sediment & fines

Description of appearance of water at end: pale black & no fines

1.5.07

MACTEC

WELL DEVLOPMENT
Project Name: **STP COL Subsurface Investigation**
MACTEC Project Number: 5050-06-0496

Well Number: OW-910L
Developed by: Matt Wiemann
Date Developed: 12/20/06
Development start time: 7:48
Date Drilled: 12/18/06
Development stop time: 9:34
Casing Diameter: 2 in
Water Level (start)(b): 21.75 ft
Length of Screened Interval: 10 ft
Water Level (end): 21.7 ft
Top of Screened Interval: 81 ft
Calculated well volume (0.163 gal/ft *)(~~b-a~~): 11.79 gal
Well depth from construction log(a): 92.12 ft +2=94.12 Stickup ≅2'
Minimum volume to be removed: 58.98 gal
Well Depth (start): 91.45 ft
Actual volume removed: 110 gal
Well Depth (end): 92.5 ft
Disposal method of removed water: infiltration on the Secondary fixed

* for 2 inch well casing = $[((2inch)/(12inch/ft))^2)*3.14]/4 * 7.46\ gal/ft^3 = 0.163\ gal/ft$

Description of equipment used: Ingersoll Rand 185 air compressor 3/8" air hose 1" tremie pipe and 1.25" Sing. tremie Pipe

Description of appearance of water at start: brown + full of sediment + fines

Description of appearance of water at end: pale tint, no fines

Uff 1-5-07

MACTEC

WELL DEVLOPMENT

Project Name: **STP COL Subsurface Investigation**

MACTEC Project Number: 5050-06-0496

Well Number:	OW-928U	Developed by:	MH Niemann
Date Developed:	12/19/06	Development start time:	9:46
Date Drilled:	12/14/06	Development stop time:	10:50
Casing Diameter:	2" in	Water Level (start)(b):	8.61 ft
Length of Screened Interval:	10' ft	Water Level (end):	8.61 ft
Top of Screened Interval:	28.5 ft	Calculated well volume (0.163 gal/ft*)(b-a):	5.36 gal
Well depth from construction log(a):	39.62 ft +1.9 = 41.52 Stickup = 1.9	Minimum volume to be removed:	26.8 gal
Well Depth (start):	40.6 ft	Actual volume removed:	100 gal
Well Depth (end):	41.12 ft	Disposal method of removed water:	infiltration of surrounding gravel

* for 2 inch well casing = $[(((2inch)/(12inch/ft))^2)*3.14]/4 * 7.46\ gal/ft^3 = 0.163\ gal/ft$

Description of equipment used: Ingersoll Rand 185 air compressor, 3/8" air hose, 1" tremie pipe and 1.25" surge block & tremie pipe

Description of appearance of water at start: brown + full of sediment + fines

Description of appearance of water at end: Slightly tinted + no fines

Uff 1.5.07

MACTEC

WELL DEVLOPMENT
Project Name: **STP COL Subsurface Investigation**
MACTEC Project Number: 5050-06-0496

Well Number:	OW-928 L	Developed by:	MH Niemann
Date Developed:	12/19/06	Development start time:	8:00
Date Drilled:	12/15/06	Development stop time:	9:35
Casing Diameter:	2" in	Water Level (start)(b):	16.0 ft
Length of Screened Interval:	10' ft	Water Level (end):	16.12 ft
Top of Screened Interval:	110 ft	Calculated well volume (0.163 gal/ft*)(b-a):	17.44 gal
Well depth from construction log(a):	121.12 ft + 1.9 = 123.02 stickup = 1.9	Minimum volume to be removed:	87.22 gal
Well Depth (start):	122.61 ft	Actual volume removed:	170 gal
Well Depth (end):	129.0 ft	Disposal method of removed water:	infiltration of surrounding ground

* for 2 inch well casing = $[(((2inch)/(12inch/ft))^2)*3.14]/4 * 7.46\ gal/ft^3 = 0.163\ gal/ft$

Description of equipment used: Ingersoll Rand 185 air compressor, 3/8" air hose, 1" tremie pipe and 1.25" surge block + tremie pipe

Description of appearance of water at start: brown + full of sediment + fines

Description of appearance of water at end: slightly tinted, no fines

1.5.07

MACTEC

WELL DEVLOPMENT

Project Name: **STP COL Subsurface Investigation**

MACTEC Project Number: 5050-06-0496

Well Number:	OW-929U	Developed by:	Best/C Fruce
Date Developed:	12/15/06	Development start time:	10:30
Date Drilled:	12/13/06	Development stop time:	12:15
Casing Diameter:	2 in	Water Level (start)(b):	14.65 ft
Length of Screened Interval:	10 ft	Water Level (end):	14.66 ft
Top of Screened Interval:	49 ft	Calculated well volume (0.163 gal/ft*)(b-a):	7.74 gal
Well depth from construction log(a):	60.12 ft (+2 stickup)	Minimum volume to be removed:	38.68 gal
Well Depth (start):	61.10 ft	Actual volume removed:	135 gal
Well Depth (end):	61.10 ft	Disposal method of removed water:	Ground

* for 2 inch well casing = $[(((2inch)/(12inch/ft))^2)*3.14]/4 * 7.46\ gal/ft^3 = 0.163\ gal/ft$

Description of equipment used:

Surge Block / Air lift / 1 inch pipe

Description of appearance of water at start:

Very Turbid Some fine sand

Description of appearance of water at end:

Cloudy Trace of silt

1.5.07

MACTEC

WELL DEVLOPMENT

Project Name: STP COL Subsurfaca Investigation
MACTEC Project Number: 5050-06-0496

Well Number:	OW-929L	Developed by:	Best / C. Bruce
Date Developed:	12/15/06	Development start time:	0913
Date Drilled:	12/12/06	Development stop time:	10:22
Casing Diameter:	2 in	Water Level (start)(b):	23.47 ft (TOC)
Length of Screened Interval:	10 ft	Water Level (end):	23.48 ft
Top of Screened Interval:	87 ft	Calculated well volume (0.163 gal/ft*)(b-a):	12.50 ~~62.4~~ gal
Well depth from construction log(a):	98.12 (1.7' stickup) ft (bgs)	Minimum volume to be removed:	62.51 gal
Well Depth (start):	99.92 ft (TOC)	Actual volume removed:	100 gal
Well Depth (end):	99.93 ft	Disposal method of removed water:	ground

* for 2 inch well casing = $[(((2inch)/(12inch/ft))^2)*3.14]/4 * 7.48\ gal/ft^3 = 0.163\ gal/ft$

Description of equipment used:
Air lift / 1 inch pipe Surge Block (2")

Description of appearance of water at start:
Start: Slightly cloudy, no sand or silt, after 15 gallons very turbid

Description of appearance of water at end:
100 gallons: Slightly cloudy, no traces of sand

1.5.07

MACTEC

WELL DEVLOPMENT
Project Name: **STP COL Subsurface Investigation**
MACTEC Project Number: 5050-06-0496

Well Number:	OW-930 U	Developed by:	Best/C.Bruce
Date Developed:	12/18/06	Development start time:	13:45
Date Drilled:	12/11/06	Development stop time:	15:30
Casing Diameter:	2" in	Water Level (start)(b):	8.80 ft
Length of Screened Interval:	10 ft	Water Level (end):	8.85 ft
Top of Screened Interval:	25 ft	Calculated well volume (0.163 gal/ft*)(a-b):	4.78 gal
Well depth from construction log(a):	36.12 (+ 2' stick up)	Minimum volume to be removed:	23.90 gal
Well Depth (start):	37.70 ft	Actual volume removed:	200 gal
Well Depth (end):	34.70 ft	Disposal method of removed water:	ground

* for 2 inch well casing = $[(((2inch)/(12inch/ft))^2)*3.14]/4 * 7.46\ gal/ft^3 = 0.163\ gal/ft$

Description of equipment used:
Airlift pump system / Surge Block

Description of appearance of water at start: Very Turbid with Sand and Silt

Description of appearance of water at end: Cloudy, Trace of silt

1.5.07

MACTEC

WELL DEVLOPMENT

Project Name: STP COL Subsurfaca Investigation

MACTEC Project Number: 5050-06-0496

Well Number:	OW-930L	Developed by:	[illegible]
Date Developed:	12/18/06	Development start time:	~~09:45~~ 12:30 CWB 12/18/06
Date Drilled:	12/11/06	Development stop time:	13:30
Casing Diameter:	2 in	Water Level (start)(b):	15.90 ft
Length of Screened Interval:	10 ft	Water Level (end):	15.32 ft
Top of Screened Interval:	95 ft	Calculated well volume (0.163 gal/ft*)(a-b):	15.05 gal
Well depth from construction log(a):	106.5 (bgs) (+1.7) ft	Minimum volume to be removed:	75.22 gal
Well Depth (start):	97.4 ft	Actual volume removed:	150 gal
Well Depth (end):	104.6 (TOC) ft	Disposal method of removed water:	[illegible]

* for 2 inch well casing = $[(((2inch)/(12inch/ft))^2)*3.14]/4 * 7.46\ gal/ft^3 = 0.163\ gal/ft$

Description of equipment used:
Airlift pump system / surge block

Description of appearance of water at start: Very turbid with sand and silt

Description of appearance of water at end: Clearing with a trace of silt

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1.5.07

MACTEC

WELL DEVLOPMENT

Project Name: **STP COL Subsurface Investigation**
MACTEC Project Number: 5050-06-0496

Well Number: OBS - 931 U
Developed by: Best / E Bruce
Date Developed: 12/15/06
Development start time: 13:35
Date Drilled: 12/8/06
Development stop time: 15:30
Casing Diameter: 2 in
Water Level (start)(b): 10.25 ft
Length of Screened Interval: 10 ft
Water Level (end): 10.26 ft
Top of Screened Interval: 25 ft
Calculated well volume (0.163 gal/ft*)(b-a): ~~4.47~~ 4.52 gal
Well depth from construction log(a): 36 (+2' stickup) ft
Minimum volume to be removed: ~~22.3~~ 22.6 gal
Well Depth (start): 37.65 ft
Actual volume removed: 150 gal
Well Depth (end): 38.00 ft
Disposal method of removed water: ground

* for 2 inch well casing = $[(((2inch)/(12inch/ft))^2)*3.14]/4 * 7.46\ gal/ft^3 = 0.163\ gal/ft$

Description of equipment used:
Air lift / 1" pipe surg Block

Description of appearance of water at start:
Very Turbid with Sand and silt

Description of appearance of water at end:
Cloudy Trace of silt

1-5-07

MACTEC

WELL DEVLOPMENT
Project Name: STP COL Subsurface Investigation
MACTEC Project Number: 5050-06-0496

Well Number:	OW-932U	Developed by:	M H Nieman
Date Developed:	12/19/06	Development start time:	1:55
Date Drilled:	12/14/06	Development stop time:	3:05
Casing Diameter:	2 in	Water Level (start)(b):	9.22 ft
Length of Screened Interval:	10 ft	Water Level (end):	9.21 ft
Top of Screened Interval:	28.5 ft	Calculated well volume (0.163 gal/ft*)(~~b-a~~):	5.26 gal
Well depth from construction log(a):	39.62 ft + 1.9 = 41.52	Minimum volume to be removed:	26.3 gal
Well Depth (start):	39.2 ft Stickup = 1.9'	Actual volume removed:	100 gal
Well Depth (end):	40.4 ft	Disposal method of removed water:	Infiltration of surrounding ground

* for 2 inch well casing = $[(((2inch)/(12inch/ft))^2)*3.14]/4 * 7.46 gal/ft^3 = 0.163 gal/ft$

Description of equipment used: Ingersoll Rand 185 air compressor, 3/8" air hose, 1" tremie pipe + 1.25" surge block and tremie pipe

Description of appearance of water at start: brown + full of sediment + fines

Description of appearance of water at end: pale hazy + no fines

MHN 1-5-07

MACTEC

WELL DEVLOPMENT

Project Name: **STP COL Subsurface Investigation**

MACTEC Project Number: 5050-06-0496

Well Number:	OW-932 L	Developed by:	MHWamamarr MW 12/14/06
Date Developed:	12/19/06	Development start time:	11:30
Date Drilled:	12/14/06 MW 12/14/06	Development stop time:	1:50
Casing Diameter:	2 in	Water Level (start)(b):	18.75 ft
Length of Screened Interval:	10' ft	Water Level (end):	17.59 ft
Top of Screened Interval:	68.5 ft	Calculated well volume (0.163 gal/ft*)(a-b):	10.25 gal
Well depth from construction log(a):	79.62 ft + 2.0 = 81.62 Stickup = 2.0	Minimum volume to be removed:	51.2 gal
Well Depth (start):	78.0 ft	Actual volume removed:	130 gal
Well Depth (end):	80.22 ft	Disposal method of removed water:	infiltration of surrounding ground

* for 2 inch well casing = $[(((2inch)/(12inch/ft))^2)*3.14]/4 * 7.46\ gal/ft^3 = 0.163\ gal/ft$

Description of equipment used: Ingersoll Rand 185 air compressor, 3/4" air hose, 1" black pipe and 1.25" surge block + tremie pipe

Description of appearance of water at start: brown + lots of sediment + fines

Description of appearance of water at end: pale tint + no fines

MACTEC

WELL DEVLOPMENT

Project Name: **STP COL Subsurface Investigation**

MACTEC Project Number: 5050-06-0496

Well Number:	DW-933-U	Developed by:	M. Hiemann
Date Developed:	11/28/06	Development start time:	1:50p
Date Drilled:	11/13/06	Development stop time:	3:55p
Casing Diameter:	2 in	Water Level (start)(b):	6.92 ft
Length of Screened Interval:	10 ft	Water Level (end):	7.28 ft
Top of Screened Interval:	26 ft	Calculated well volume (0.163 gal/ft*)(a-b):	4.92 gal
Well depth from construction log(a):	37.12 ft 38.84 w/stickup	Minimum volume to be removed:	24.6 gal
Well Depth (start):	36.5 ft (stickup = 1.72')	Actual volume removed:	135 gal
Well Depth (end):	38.75 ft	Disposal method of removed water:	infiltrate surrounding ground

* for 2 inch well casing = [(((2inch)/(12inch/ft))^2)*3.14]/4 * 7.46 gal/ft^3 =0.163 gal/ft

Description of equipment used: 185 Ingersoll Rand Air Compressor 3/8" OD flexible air hose, 1" OD tremie pipe + 1.75" surge block + tremie pipe.

Description of appearance of water at start: dark brown to medium brown, filled w/ sediment + fines; after surging, water appears as it did in the beginning

Description of appearance of water at end: v. sl. silt tinted, no fines, no odors

1-5-07

MACTEC

WELL DEVLOPMENT

Project Name: STP COL Subsurface Investigation

MACTEC Project Number: 5050-06-0496

Well Number:	OW-933-L	Developed by:	MH Viemann
Date Developed:	11/28/06	Development start time:	10:25a
Date Drilled:	11/8/06	Development stop time:	1:40p
Casing Diameter:	2 in	Water Level (start)(b):	15.33 ft
Length of Screened Interval:	10 ft	Water Level (end):	14.8 ft
Top of Screened Interval:	76 ft	Calculated well volume (0.163 gal/ft* (a-b)):	11.7 gal
Well depth from construction log(a):	86 (87.12 total) ft ~~88.83~~ w/stickup	Minimum volume to be removed:	58.5 gal
Well Depth (start):	83.75 ft 1.71' stickup	Actual volume removed:	180 gal
Well Depth (end):	88.8 ft mw 11/4/06	Disposal method of removed water:	infiltrate to surrounding ground

* for 2 inch well casing = $[(((2inch)/(12inch/ft))^2)*3.14]/4 * 7.46 gal/ft^3 = 0.163 gal/ft$

Description of equipment used: 185 Ingersoll Rand air Compressor, 3/8" OD flexible air hose, 1" OD tremie pipe + 1.75" surge block + tremie pipe

Description of appearance of water at start: cloudy to medium reddish brown, full of sediment – starts to clear in 5 to 10 on 25 gal of surging, water resembles water at start

Description of appearance of water at end: V. slightly tinted, no fines, nearly clear

WL 15.03

MACTEC

WELL DEVLOPMENT

Project Name: STP COL Subsurface Investigation
MACTEC Project Number: 5050-06-0496

Well Number:	OW-934U	Developed by:	MH Niemann
Date Developed:	12/1/06	Development start time:	2:15p
Date Drilled:	11/21/06	Development stop time:	3:55p
Casing Diameter:	2 in	Water Level (start)(b):	10.69 ft
Length of Screened Interval:	10 ft	Water Level (end):	10.91 ft
Top of Screened Interval:	30 ft	Calculated well volume (0.163 gal/ft*)(b-a):	5.22 gal
Well depth from construction log(a):	41.15 ft w/ stickup = 42.75' stickup: 1.6	Minimum volume to be removed:	26.13 gal
Well Depth (start):	40.75 ft	Actual volume removed:	115 gal
Well Depth (end):	42.43 ft	Disposal method of removed water:	infiltrate ground surface around well

* for 2 inch well casing = $[(((2inch)/(12inch/ft))^2)*3.14]/4 * 7.46\ gal/ft^3 = 0.163\ gal/ft$

Description of equipment used: 185 Ingersoll Rand Air Compressor, 3/8" OD flexible air hose, 1" OD tremie pipe + 1.75" surge block and tremie pipe

Description of appearance of water at start: dark brown, full of sediment after surging, same appearance

Description of appearance of water at end: nearly clear, v. pale tint, no fines

[illegible] 1.5.07

MACTEC

WELL DEVLOPMENT
Project Name: **STP COL Subsurface Investigation**
MACTEC Project Number: 5050-06-0496

Well Number:	OW-934L	Developed by:	Best / C. Brock
Date Developed:	12/15/06	Development start time:	~~15:56 12/15/06~~ 17:00 12/15/06 0820 12/18/06
Date Drilled:	12/09/06	Development stop time:	0920 12/18/06
Casing Diameter:	2 in	Water Level (start)(b):	23.06 ft
Length of Screened Interval:	10 ft	Water Level (end):	17.24 ft
Top of Screened Interval:	89 ft	Calculated well volume (0.163 gal/ft* (b-a)):	12.70 gal
Well depth from construction log(a):	99 (+2' tailpipe) ft	Minimum volume to be removed:	63.49 gal
Well Depth (start):	98.75 ft	Actual volume removed:	160 gal
Well Depth (end):	100.30 ft	Disposal method of removed water:	ground

* for 2 inch well casing = $[(((2inch)/(12inch/ft))^2)*3.14]/4 * 7.46\ gal/ft^3 = 0.163\ gal/ft$

Description of equipment used:
Surg Block / Air lift (1 inch pipe)

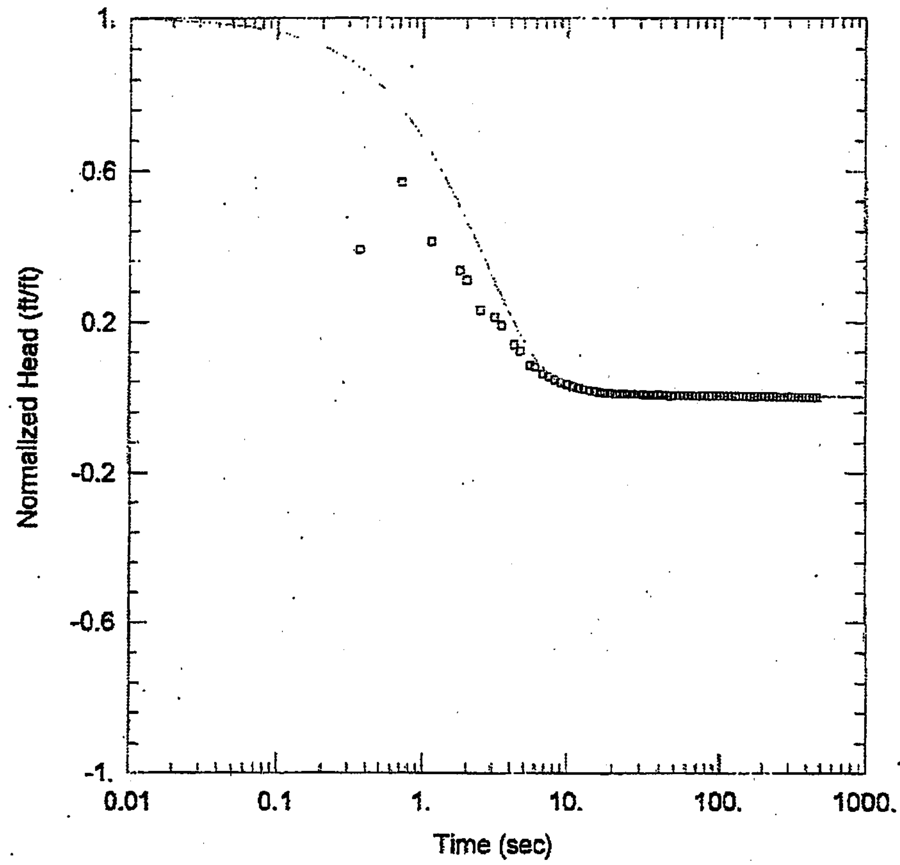
Description of appearance of water at start:
Very Turbid Sand, Silt

Description of appearance of water at end: Cloudy Trace of Silt

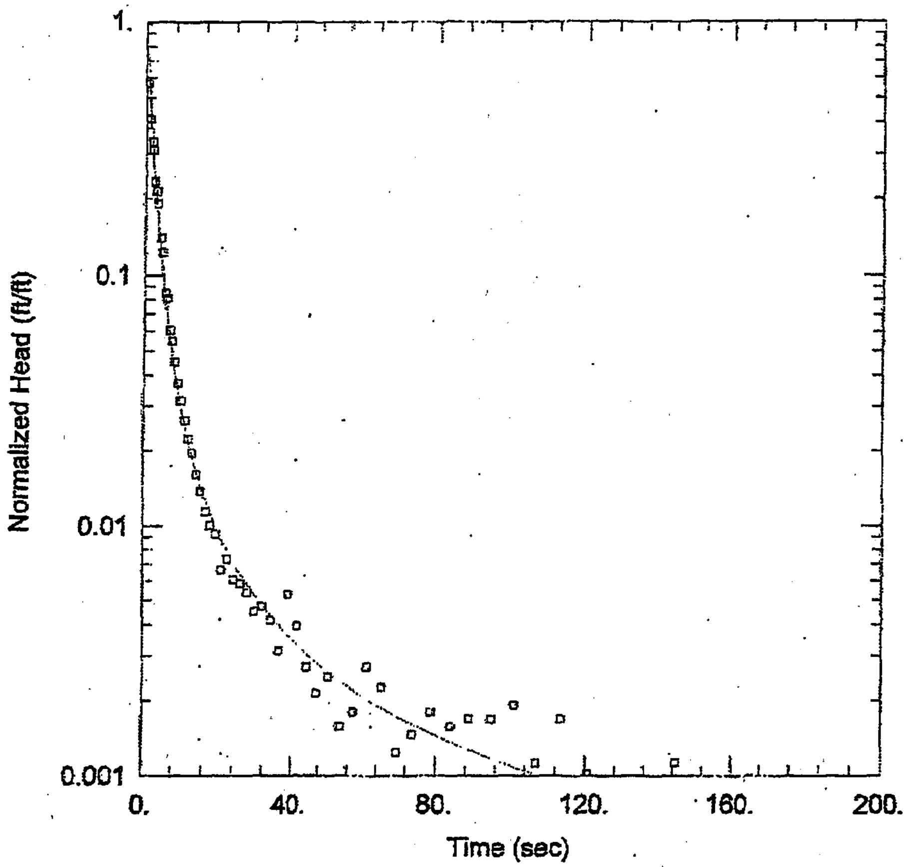
1.5.07

Appendix C-3

Slug Test Charts



OW-308 L RISING HEAD TEST	
AQUIFER DATA	
Saturated Thickness: 31. ft	Anisotropy Ratio (Kz/Kr): 0.01479
WELL DATA (OW-308 L)	
Initial Displacement: 8.87 ft	Static Water Column Height: 80.58 ft
Total Well Penetration Depth: 27. ft	Screen Length: 10. ft
Casing Radius: 0.08333 ft	Well Radius: 0.3333 ft
SOLUTION	
Aquifer Model: Confined	Solution Method: Butler
K = 64.12 ft/day	Le = 0.1 ft



OW-308 L RISING HEAD TEST

AQUIFER DATA

Saturated Thickness: 31. ft

WELL DATA (OW-308 L)

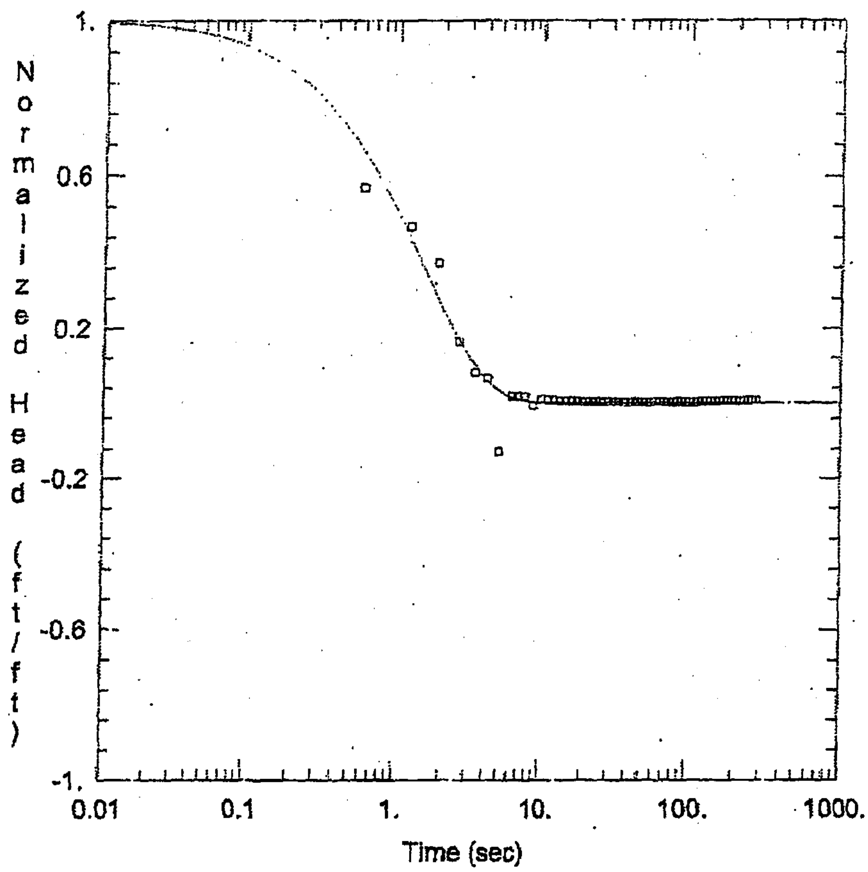
Initial Displacement: 8.87 ft
Total Well Penetration Depth: 27. ft
Casing Radius: 0.08333 ft

Static Water Column Height: 80.58 ft
Screen Length: 10. ft
Well Radius: 0.3333 ft

SOLUTION

Aquifer Model: Confined
K_r = 66.69 ft/day
K_z/K_r = 0.01479

Solution Method: KGS Model
S_s = 2.081E-5 ft^{-1}



OW-308 L FALLING HEAD TEST

AQUIFER DATA

Saturated Thickness: 31. ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (OW-308 L)

Initial Displacement: 13.13 ft

Total Well Penetration Depth: 27. ft

Casing Radius: 0.08333 ft

Static Water Column Height: 80.58 ft

Screen Length: 10. ft

Well Radius: 0.3333 ft

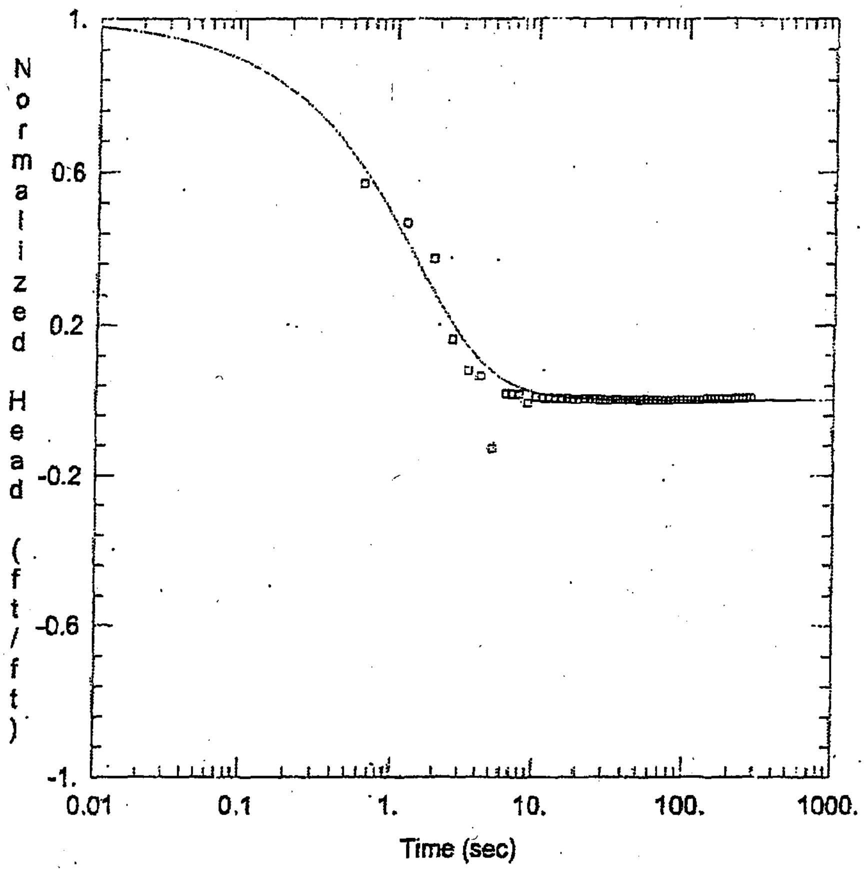
SOLUTION

Aquifer Model: Confined

K = 72. ft/day

Solution Method: Butler

Le = 0.1 ft



OW-308 L FALLING HEAD TEST

AQUIFER DATA

Saturated Thickness: 31. ft

WELL DATA (OW-308 L)

Initial Displacement: 13.13 ft
Total Well Penetration Depth: 27. ft
Casing Radius: 0.08333 ft

Static Water Column Height: 80.58 ft
Screen Length: 10. ft
Well Radius: 0.3333 ft

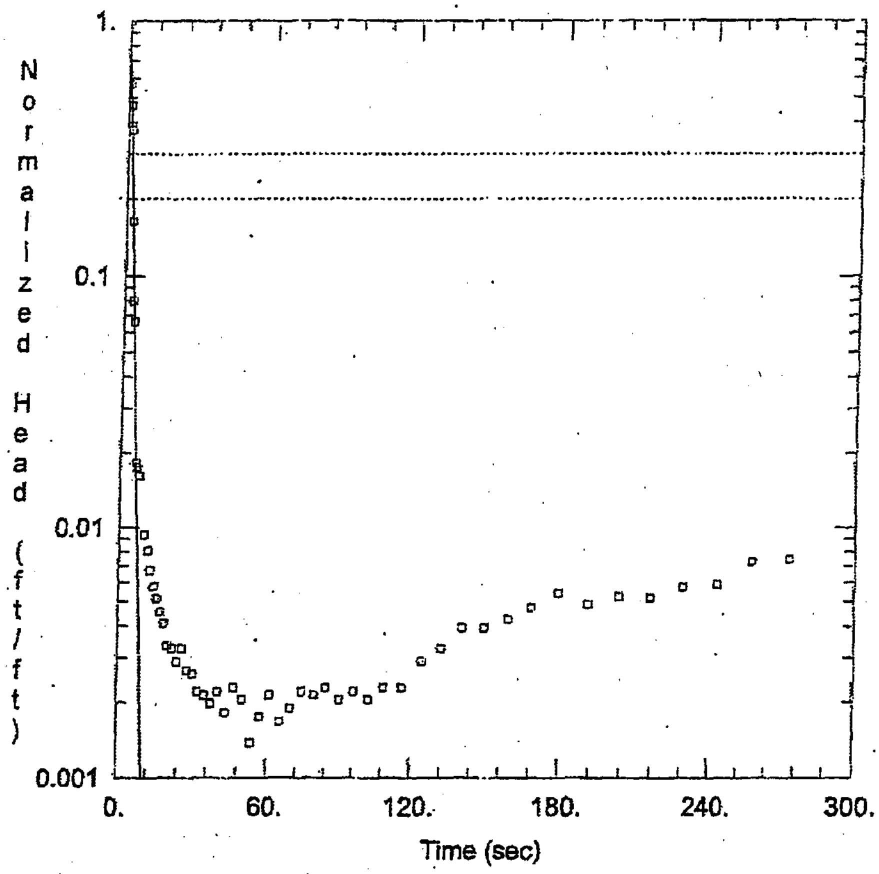
SOLUTION

Aquifer Model: Confined

Kr = 72.93 ft/day
Kz/Kr = 0.03162

Solution Method: KGS Model

Ss = 1.474E-5 ft^{-1}



OW-308 L FALLING HEAD TEST

AQUIFER DATA

Saturated Thickness: 31. ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (OW-308 L)

Initial Displacement: 13.13 ft
Total Well Penetration Depth: 27. ft
Casing Radius: 0.08333 ft

Static Water Column Height: 80.58 ft
Screen Length: 10. ft
Well Radius: 0.3333 ft

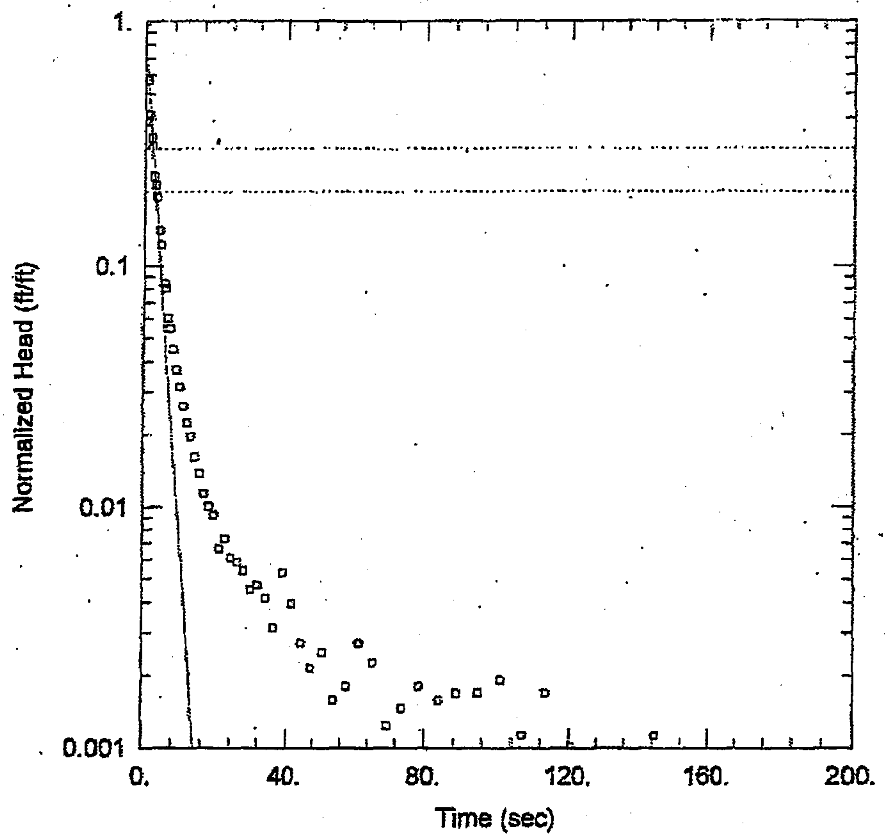
SOLUTION

Aquifer Model: Confined

K = 55.64 ft/day

Solution Method: Bouwer-Rice

y0 = 12.85 ft



OW-308 L RISING HEAD TEST

AQUIFER DATA

Saturated Thickness: 31. ft — Anisotropy Ratio (Kz/Kr): 0.01479

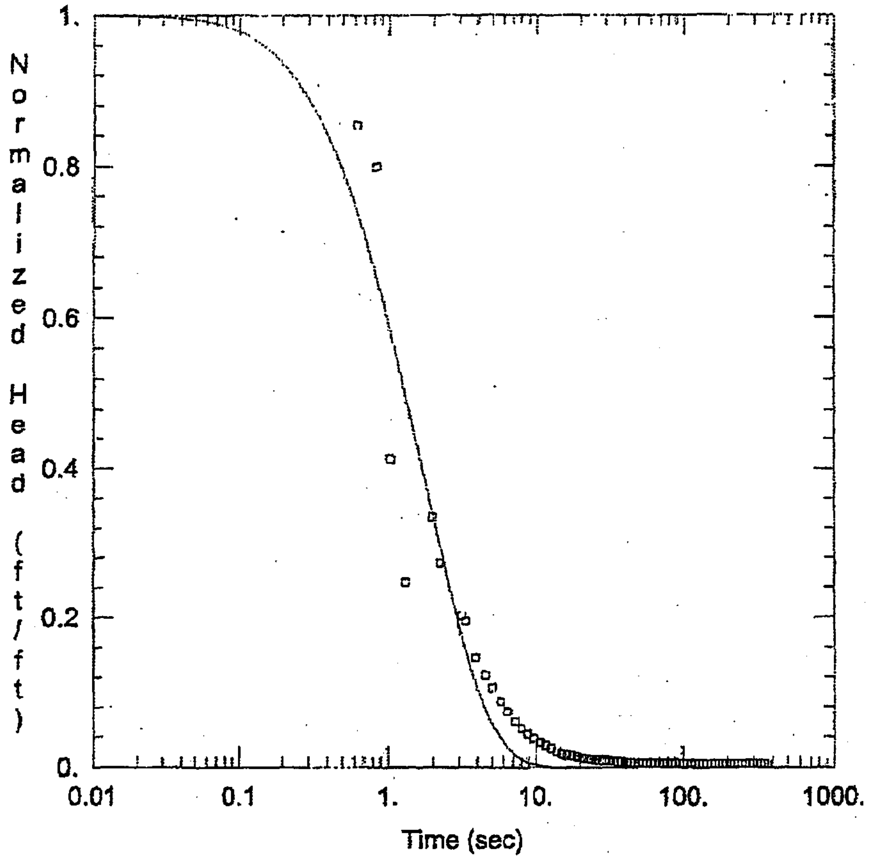
WELL DATA (OW-308 L)

Initial Displacement: 8.87 ft — Static Water Column Height: 80.58 ft
Total Well Penetration Depth: 27. ft — Screen Length: 10. ft
Casing Radius: 0.08333 ft — Well Radius: 0.3333 ft

SOLUTION

Aquifer Model: Confined — Solution Method: Bouwer-Rice

K = 65. ft/day — y0 = 7.189 ft



OW-308 U RISING HEAD TEST

Data Set: C:\...\OW-308 U RISING HEAD TEST.aqt
Date: 04/03/07 Time: 08:33:56

AQUIFER DATA

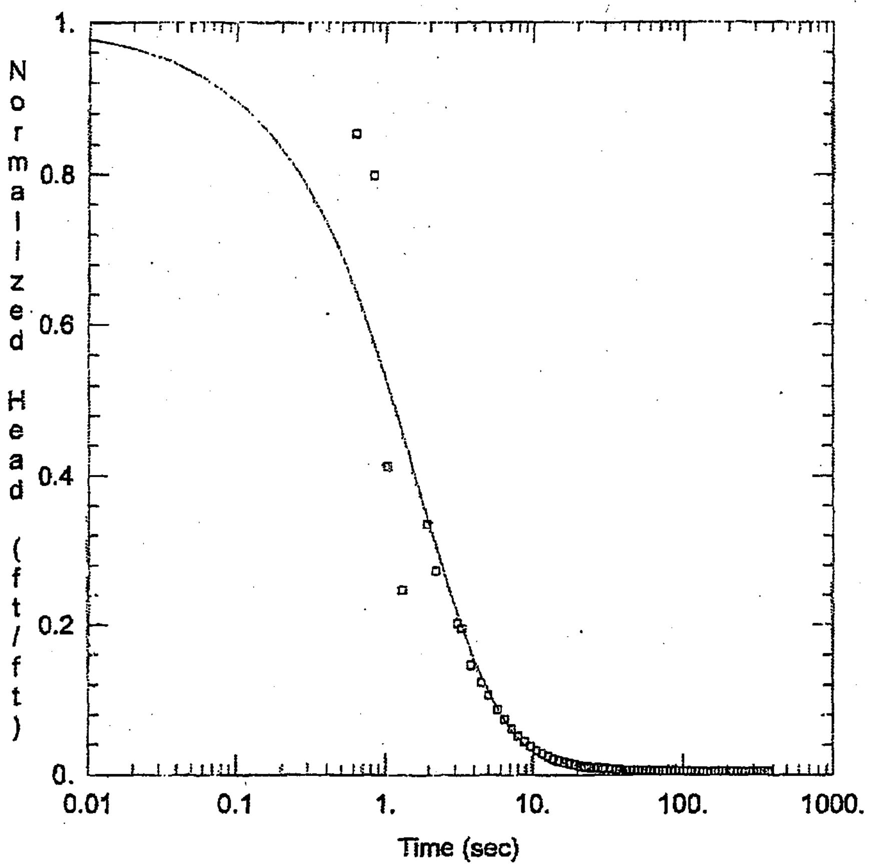
Saturated Thickness: 26. ft Anisotropy Ratio (Kz/Kr): 0.8128

WELL DATA (OW-308 U)

Initial Displacement: 9.778 ft Static Water Column Height: 40.54 ft
Total Well Penetration Depth: 28. ft Screen Length: 10. ft
Casing Radius: 0.08333 ft Well Radius: 0.3333 ft

SOLUTION

Aquifer Model: Confined Solution Method: Butler
K = 70.09 ft/day Le = 5.428 ft



OW-308 U RISING HEAD TEST

Data Set: C:\...\OW-308 U RISING HEAD TEST.aqt
Date: 04/03/07 Time: 08:33:16

AQUIFER DATA

Saturated Thickness: 26. ft

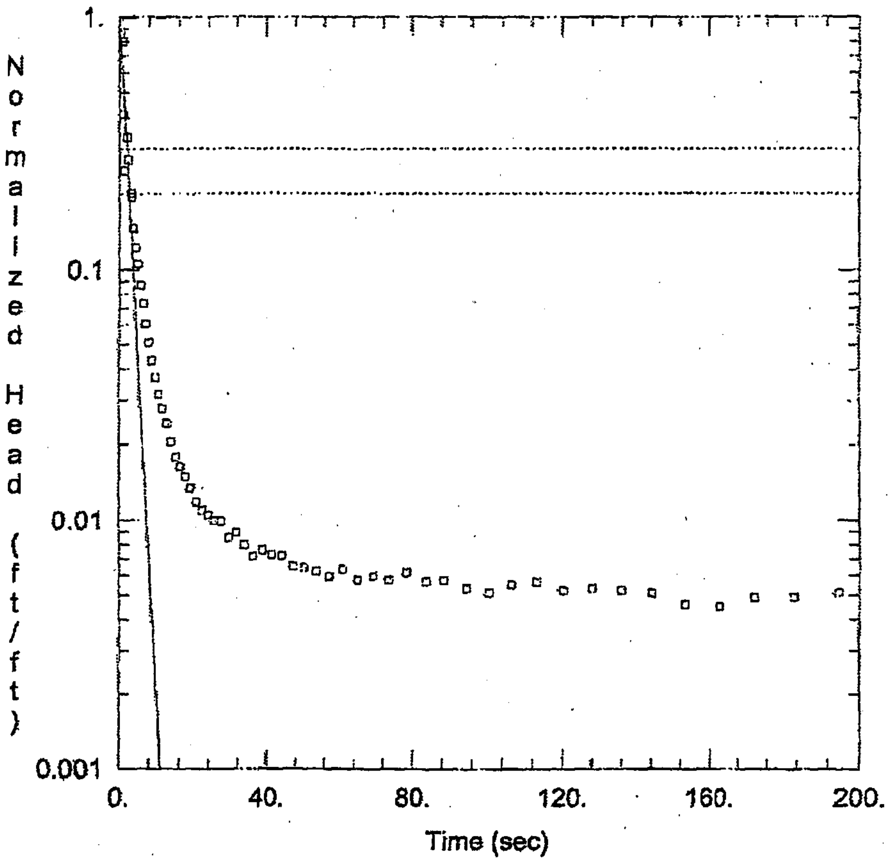
WELL DATA (OW-308 U)

Initial Displacement: 9.778 ft
Total Well Penetration Depth: 28. ft
Casing Radius: 0.08333 ft
Static Water Column Height: 40.54 ft
Screen Length: 10. ft
Well Radius: 0.3333 ft

SOLUTION

Aquifer Model: Confined
Solution Method: KGS Model

K_r = 63.93 ft/day
K_z/K_r = 0.8128
S_s = 5.821E-5 ft^{-1}



OW-308 U RISING HEAD TEST

Data Set: C:\...\OW-308 U RISING HEAD TEST.aqt
Date: 04/03/07 Time: 08:32:10

AQUIFER DATA

Saturated Thickness: 26. ft Anisotropy Ratio (Kz/Kr): 0.8128

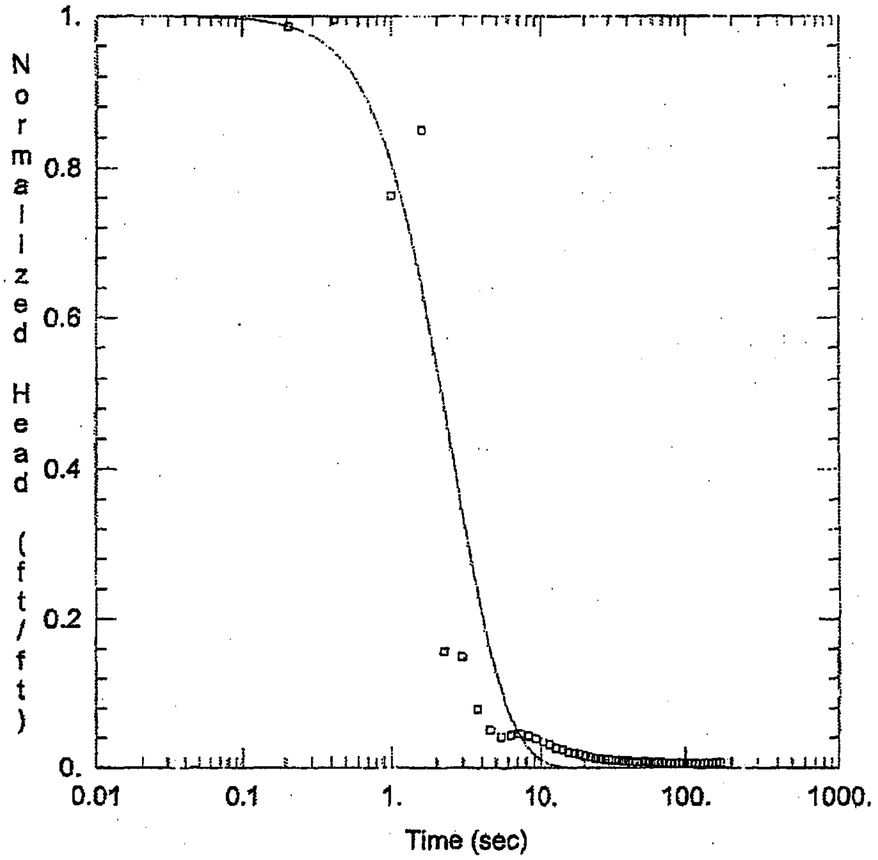
WELL DATA (OW-308 U)

Initial Displacement: 9.778 ft
Total Well Penetration Depth: 28. ft
Casing Radius: 0.08333 ft
Static Water Column Height: 40.54 ft
Screen Length: 10. ft
Well Radius: 0.3333 ft

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 62.63 ft/day y0 = 10.51 ft



OW-308 U FALLING HEAD TEST

Data Set: C:\...\OW-308 U FALLING HEAD TEST.aqt
Date: 04/03/07 Time: 08:29:58

AQUIFER DATA

Saturated Thickness: 26. ft Anisotropy Ratio (Kz/Kr): 0.03758

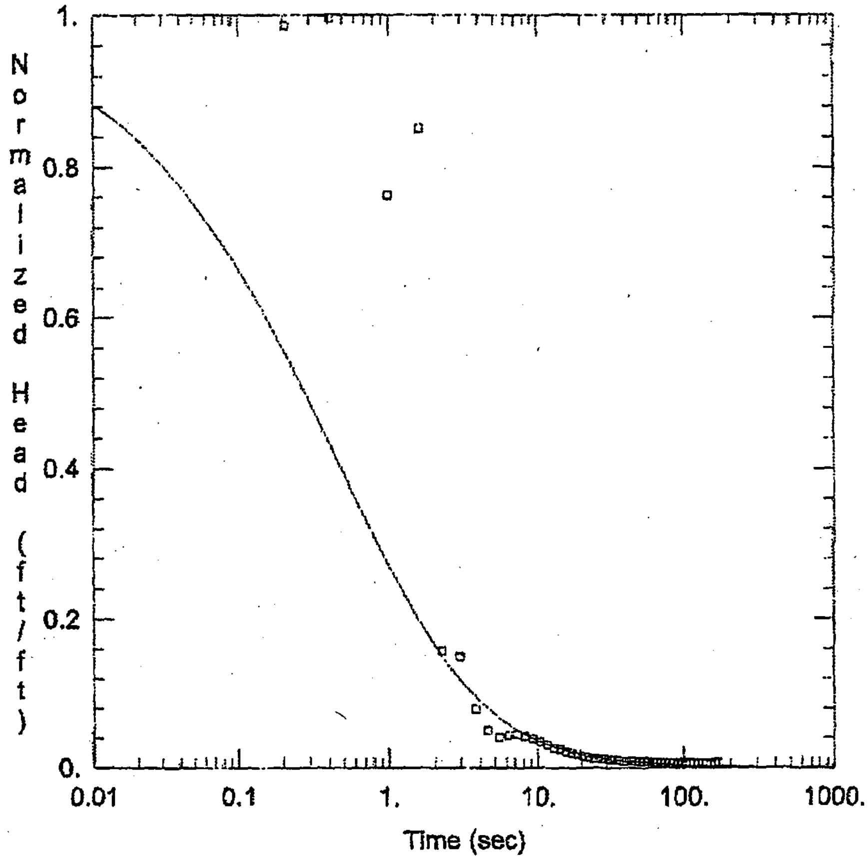
WELL DATA (OW-308 U)

Initial Displacement: 6.791 ft
Total Well Penetration Depth: 28. ft
Casing Radius: 0.08333 ft
Static Water Column Height: 40.54 ft
Screen Length: 10. ft
Well Radius: 0.3333 ft

SOLUTION

Aquifer Model: Confined Solution Method: Butler

K = 63.97 ft/day Le = 45.58 ft



OW-308 U FALLING HEAD TEST

Data Set: C:\...\OW-308 U FALLING HEAD TEST.aqt
Date: 04/03/07 Time: 08:29:16

AQUIFER DATA

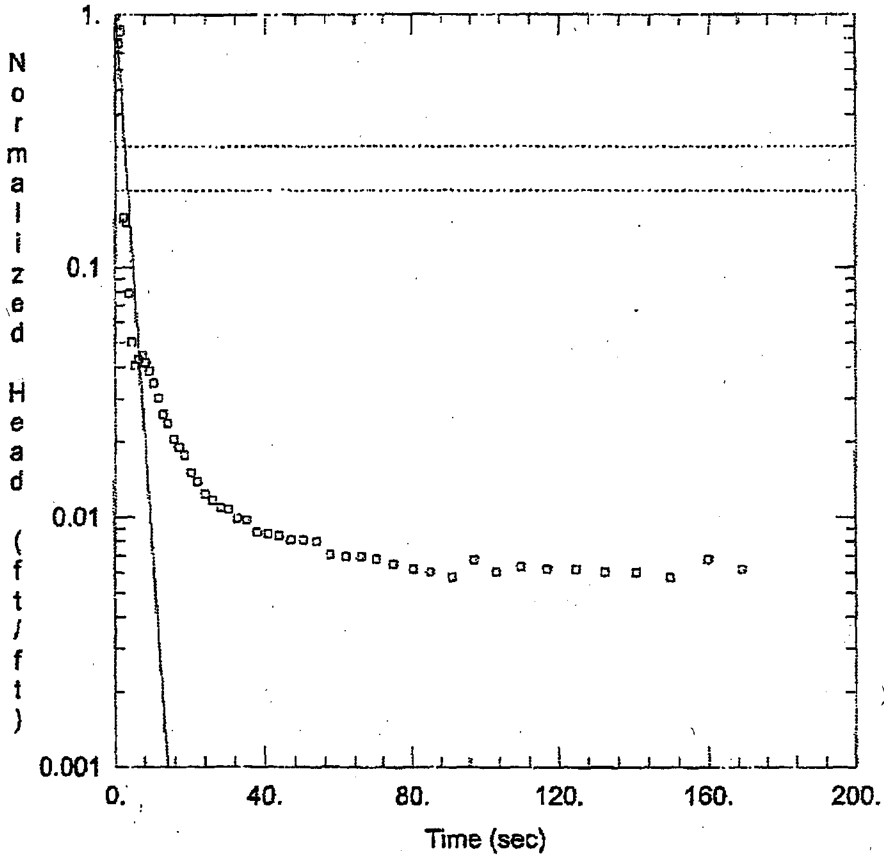
Saturated Thickness: 26. ft

WELL DATA (OW-308 U)

Initial Displacement: 6.791 ft
Total Well Penetration Depth: 28. ft
Casing Radius: 0.08333 ft
Static Water Column Height: 40.54 ft
Screen Length: 10. ft
Well Radius: 0.3333 ft

SOLUTION

Aquifer Model: Confined
Kr = 61.54 ft/day
Kz/Kr = 0.03758
Solution Method: KGS Model
Ss = 0.003463 ft^{-1}



OW-308 U FALLING HEAD TEST

Data Set: C:\...\OW-308 U FALLING HEAD TEST.aqt
Date: 04/03/07 Time: 08:25:09

AQUIFER DATA

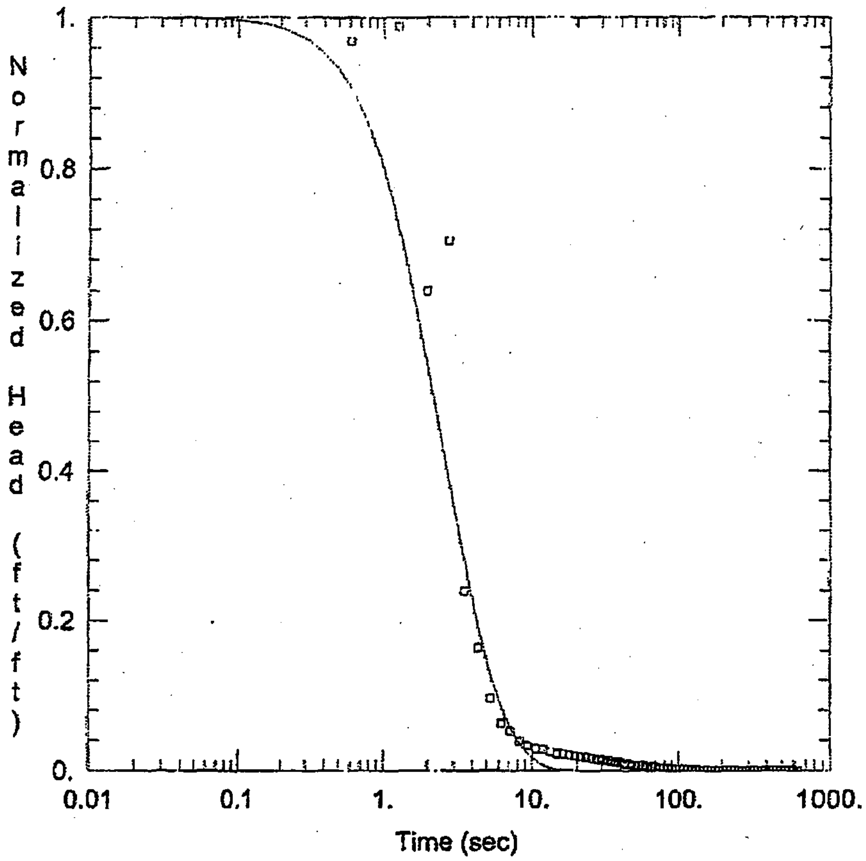
Saturated Thickness: 26. ft Anisotropy Ratio (Kz/Kr): 0.03758

WELL DATA (OW-308 U)

Initial Displacement: 6.791 ft
Total Well Penetration Depth: 28. ft
Casing Radius: 0.08333 ft
Static Water Column Height: 40.54 ft
Screen Length: 10. ft
Well Radius: 0.3333 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice
K = 68.26 ft/day
y0 = 7.641 ft



OW-332 L RISING HEAD TEST

AQUIFER DATA

Saturated Thickness: 35. ft

Anisotropy Ratio (Kz/Kr): 0.04786

WELL DATA (New Well)

Initial Displacement: 8.847 ft

Total Well Penetration Depth: 18.5 ft

Casing Radius: 0.0833 ft

Static Water Column Height: 87.75 ft

Screen Length: 10. ft

Well Radius: 0.3333 ft

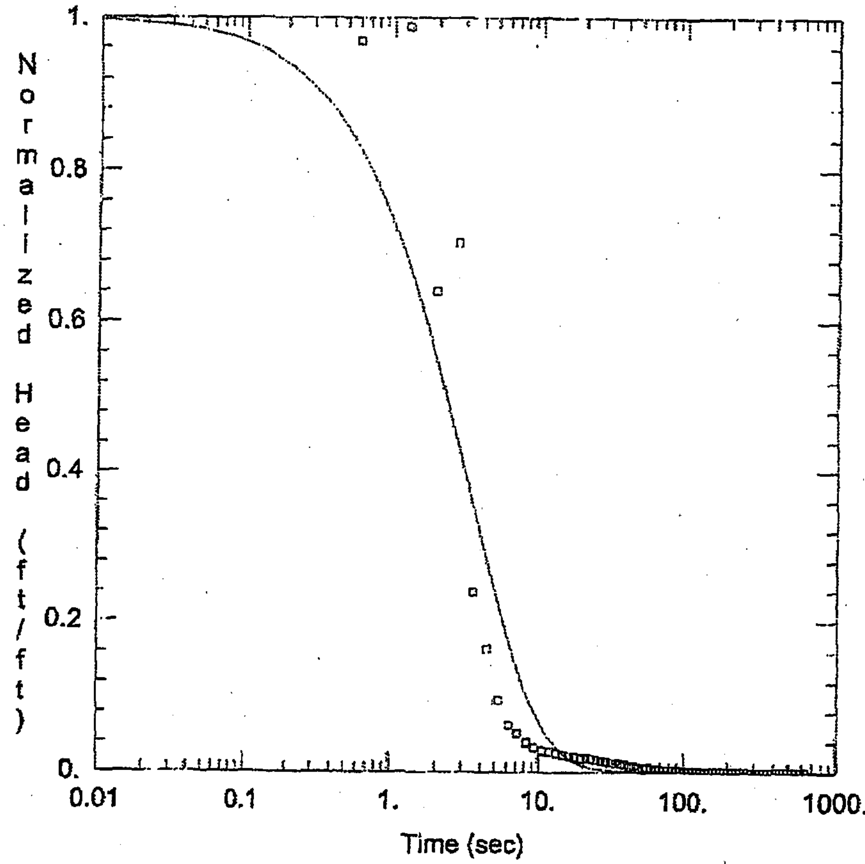
SOLUTION

Aquifer Model: Confined

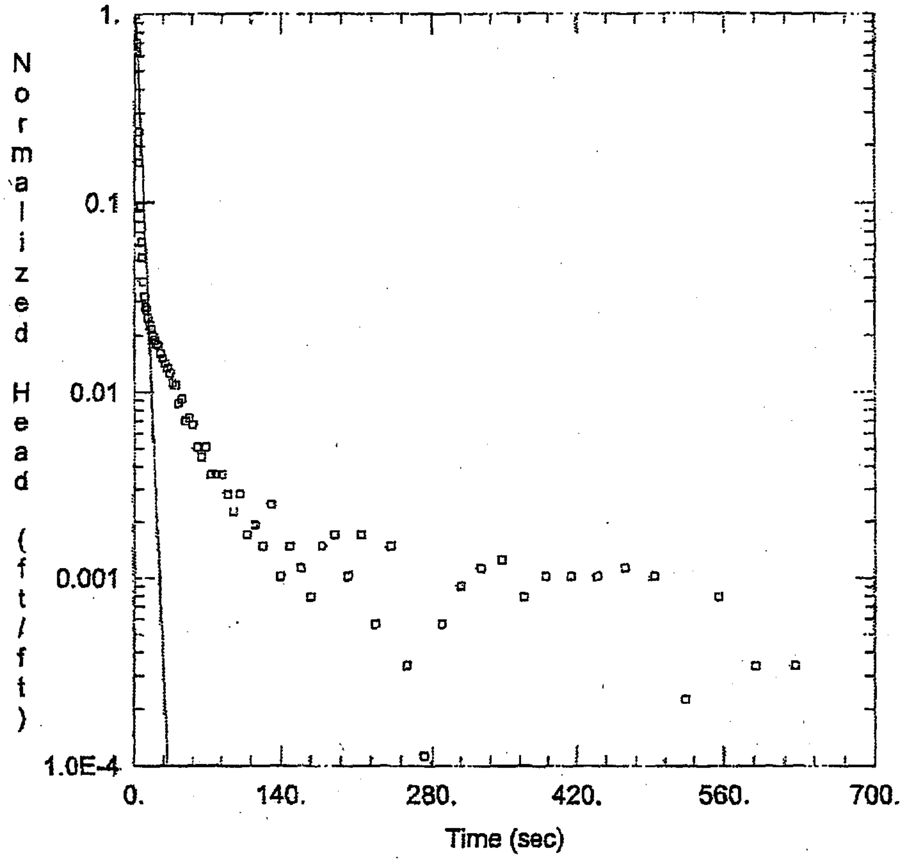
Solution Method: Butler

K = 52.96 ft/day

Le = 40.28 ft



OW-332 L RISING HEAD TEST	
AQUIFER DATA	
Saturated Thickness: 35. ft	
WELL DATA (New Well)	
Initial Displacement: 8.847 ft Total Well Penetration Depth: 18.5 ft Casing Radius: 0.0833 ft	Static Water Column Height: 87.75 ft Screen Length: 10. ft Well Radius: 0.3333 ft
SOLUTION	
Aquifer Model: Confined	Solution Method: KGS Model
Kr = 54.23 ft/day Kz/Kr = 0.04786	Ss = 3.169E-12 ft^{-1}



OW-332 L RISING HEAD TEST

AQUIFER DATA

Saturated Thickness: 35. ft

Anisotropy Ratio (Kz/Kr): 0.04786

WELL DATA (New Well)

Initial Displacement: 8.847 ft
Total Well Penetration Depth: 18.5 ft
Casing Radius: 0.0833 ft

Static Water Column Height: 87.75 ft
Screen Length: 10. ft
Well Radius: 0.3333 ft

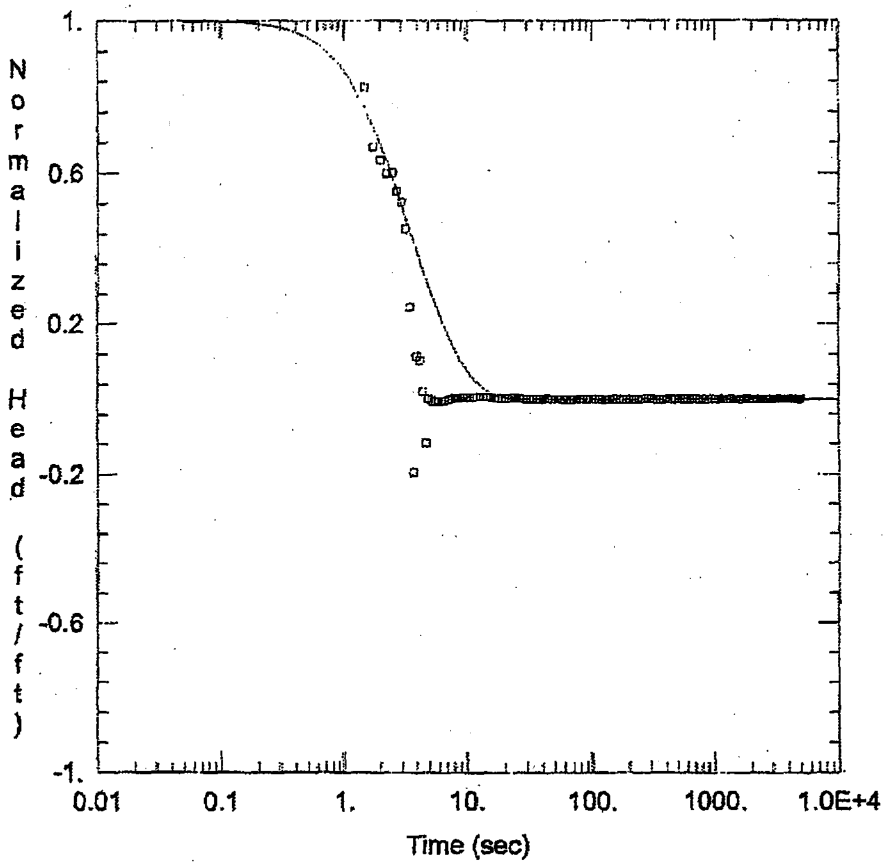
SOLUTION

Aquifer Model: Confined

K = 33.28 ft/day

Solution Method: Bouwer-Rice

y0 = 12.5 ft



OW-332 L FALLING HEAD TEST

AQUIFER DATA

Saturated Thickness: 35. ft

Anisotropy Ratio (Kz/Kr): 0.001035

WELL DATA (OW-322 L)

Initial Displacement: 11.47 ft

Total Well Penetration Depth: 18.5 ft

Casing Radius: 0.08333 ft

Static Water Column Height: 87.75 ft

Screen Length: 10. ft

Well Radius: 0.3333 ft

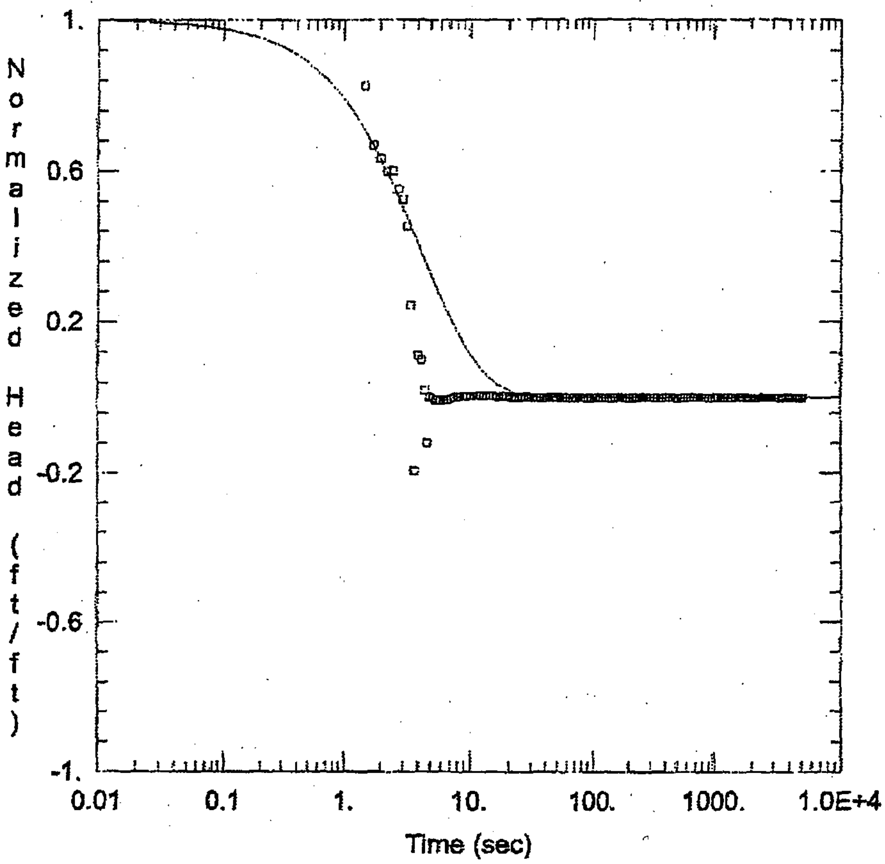
SOLUTION

Aquifer Model: Confined

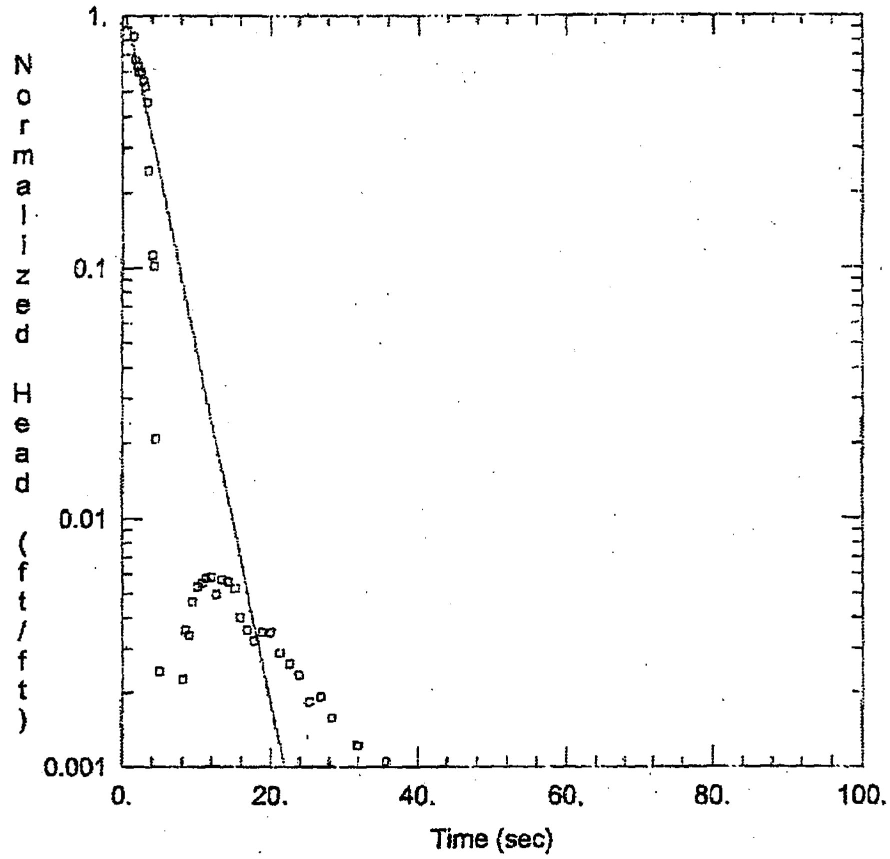
Solution Method: Butler

K = 49.41 ft/day

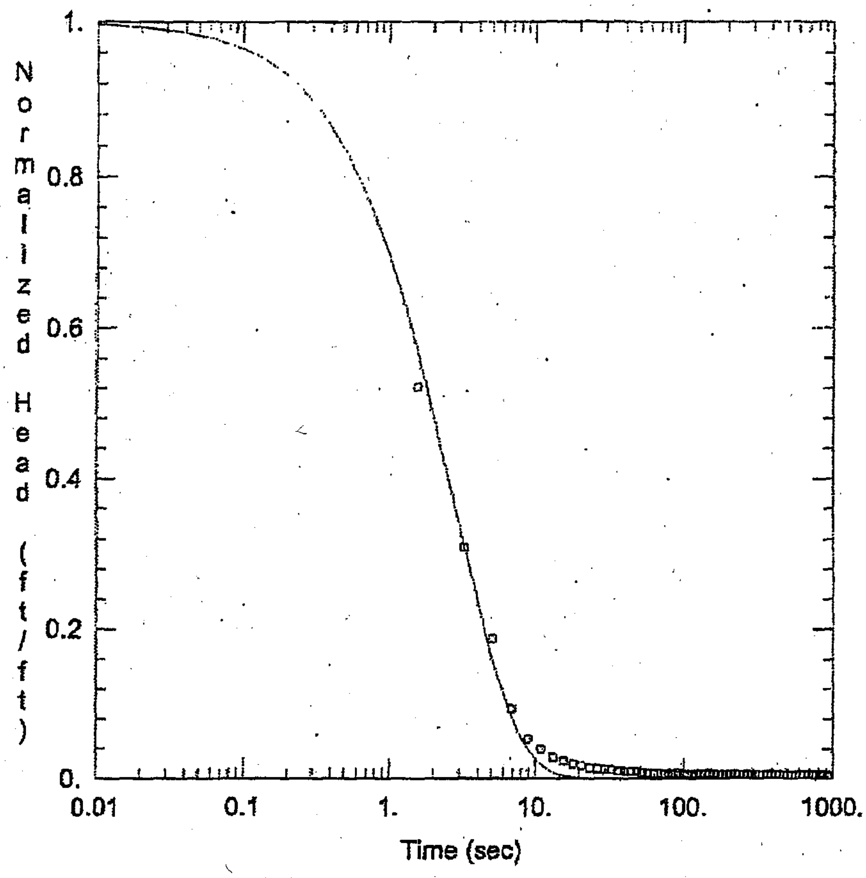
Le = 63.67 ft



OW-332 L FALLING HEAD TEST	
AQUIFER DATA	
Saturated Thickness: 35. ft	
WELL DATA (OW-322 L)	
Initial Displacement: 11.47 ft	Static Water Column Height: 87.75 ft
Total Well Penetration Depth: 18.5 ft	Screen Length: 10. ft
Casing Radius: 0.08333 ft	Well Radius: 0.3333 ft
SOLUTION	
Aquifer Model: Confined	Solution Method: KGS Model
Kr = 49.41 ft/day	Ss = 1.131E-11 ft^{-1}
Kz/Kr = 0.001035	



OW-332 L FALLING HEAD TEST	
AQUIFER DATA	
Saturated Thickness: 35. ft	Anisotropy Ratio (Kz/Kr): 0.001035
WELL DATA (OW-322 L)	
Initial Displacement: 11.47 ft	Static Water Column Height: 87.75 ft
Total Well Penetration Depth: 18.5 ft	Screen Length: 10. ft
Casing Radius: 0.08333 ft	Well Radius: 0.3333 ft
SOLUTION	
Aquifer Model: Confined	Solution Method: Bouwer-Rice
K = 55.2 ft/day	y0 = 13.38 ft



OW-332 U RISING HEAD TEST

AQUIFER DATA

Saturated Thickness: 20.5 ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (OW-322 U)

Initial Displacement: 5.767 ft

Total Well Penetration Depth: 16.5 ft

Casing Radius: 0.0833 ft

Static Water Column Height: 38.73 ft

Screen Length: 10. ft

Well Radius: 0.3333 ft

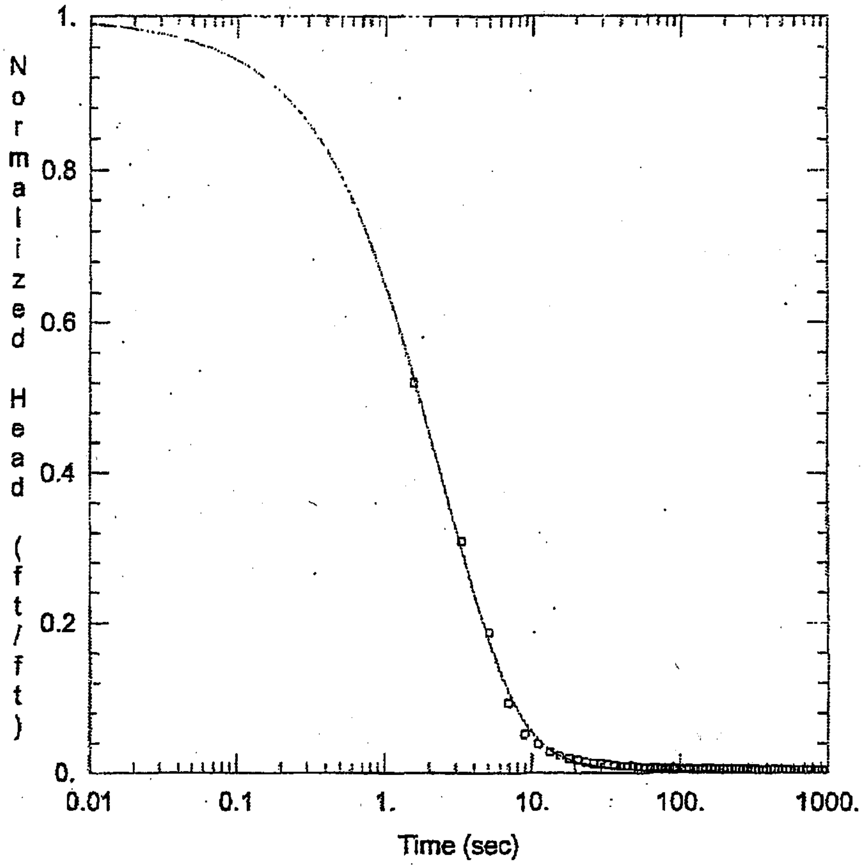
SOLUTION

Aquifer Model: Confined

K = 37.32 ft/day

Solution Method: Butler

Le = 0.1 ft



OW-332 U RISING HEAD TEST

AQUIFER DATA

Saturated Thickness: 20.5 ft

WELL DATA (OW-322 U)

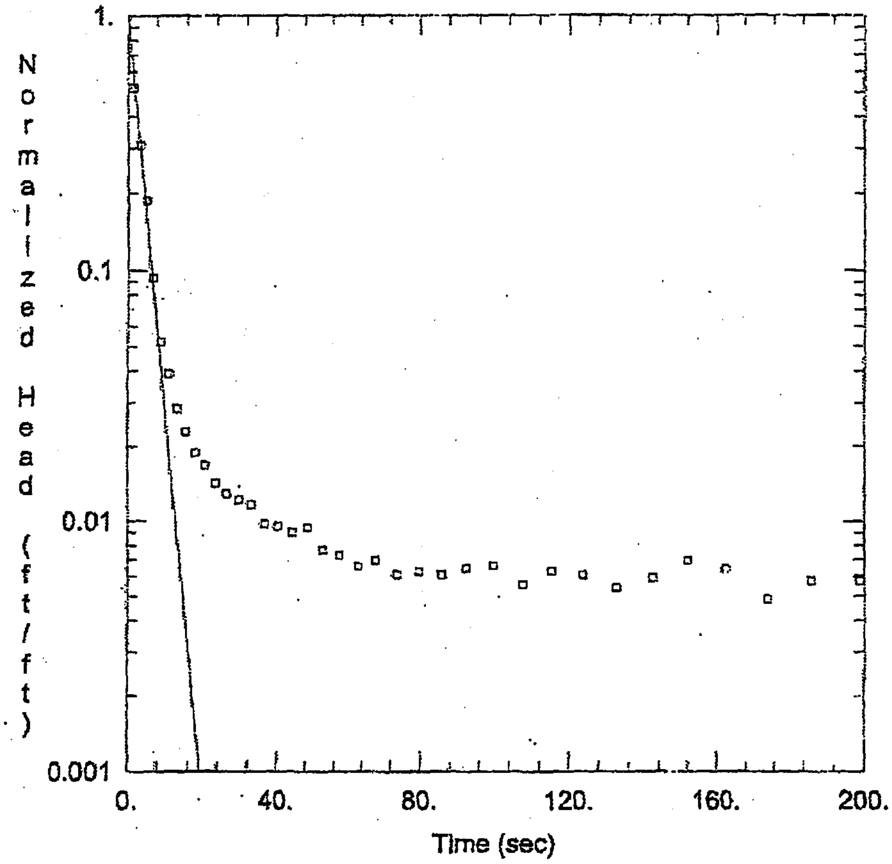
Initial Displacement: 5.767 ft
Total Well Penetration Depth: 16.5 ft
Casing Radius: 0.0833 ft

Static Water Column Height: 38.73 ft
Screen Length: 10. ft
Well Radius: 0.3333 ft

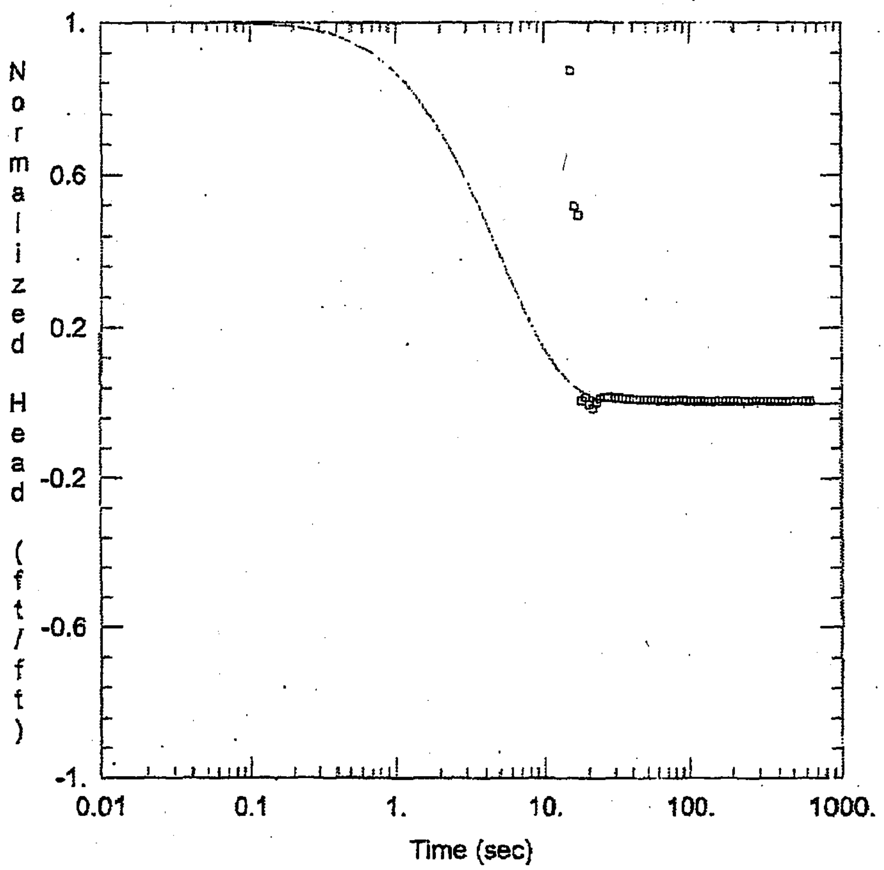
SOLUTION

Aquifer Model: Confined
K_r = 36.26 ft/day
K_z/K_r = 1.

Solution Method: KGS Model
S_s = 4.444E-6 ft^{-1}



OW-332 U RISING HEAD TEST	
AQUIFER DATA	
Saturated Thickness: 20.5 ft	Anisotropy Ratio (Kz/Kr): 1.
WELL DATA (OW-322 U)	
Initial Displacement: 5.767 ft	Static Water Column Height: 38.73 ft
Total Well Penetration Depth: 16.5 ft	Screen Length: 10. ft
Casing Radius: 0.0833 ft	Well Radius: 0.3333 ft
SOLUTION	
Aquifer Model: Confined	Solution Method: Bouwer-Rice
K = 26.95 ft/day	y0 = 5.654 ft



OW-332 U FALLING HEAD TEST

AQUIFER DATA

Saturated Thickness: 20.5 ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (OW-322 U)

Initial Displacement: 5.748 ft
Total Well Penetration Depth: 16.5 ft
Casing Radius: 0.08333 ft

Static Water Column Height: 38.73 ft
Screen Length: 10. ft
Well Radius: 0.3333 ft

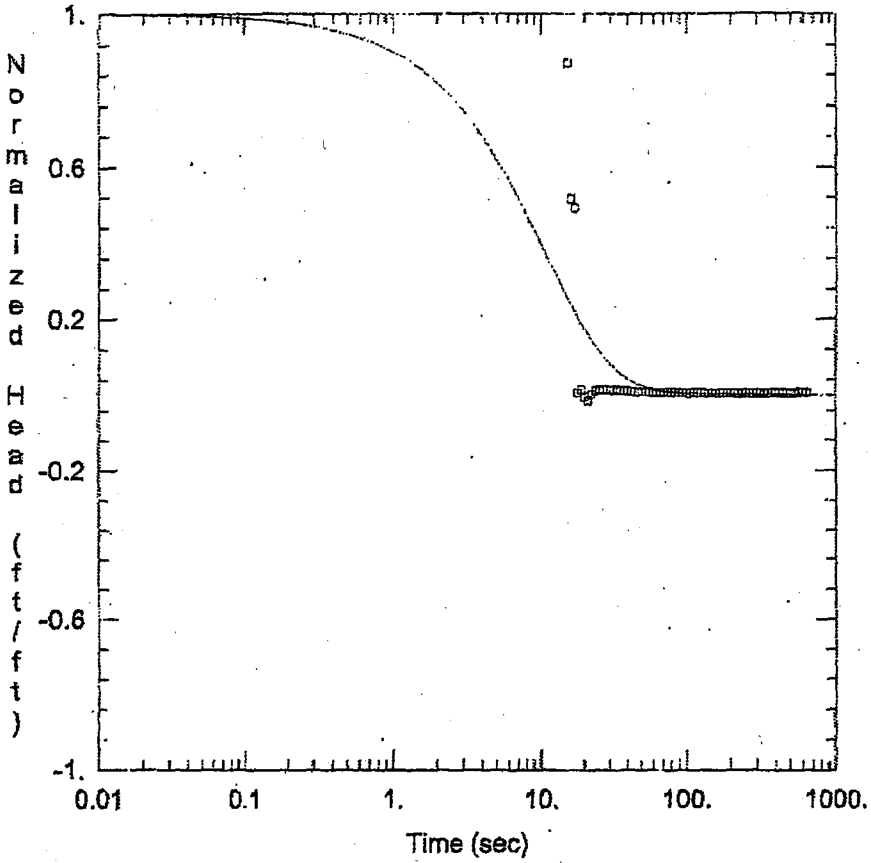
SOLUTION

Aquifer Model: Confined

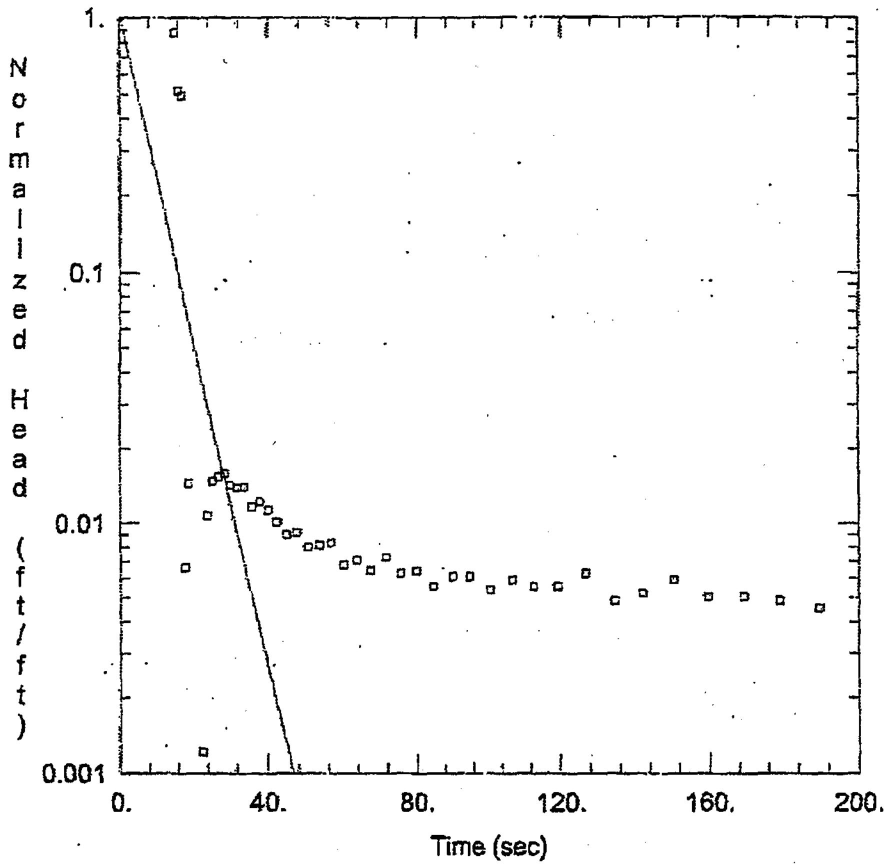
Solution Method: Butler

K = 19.3 ft/day

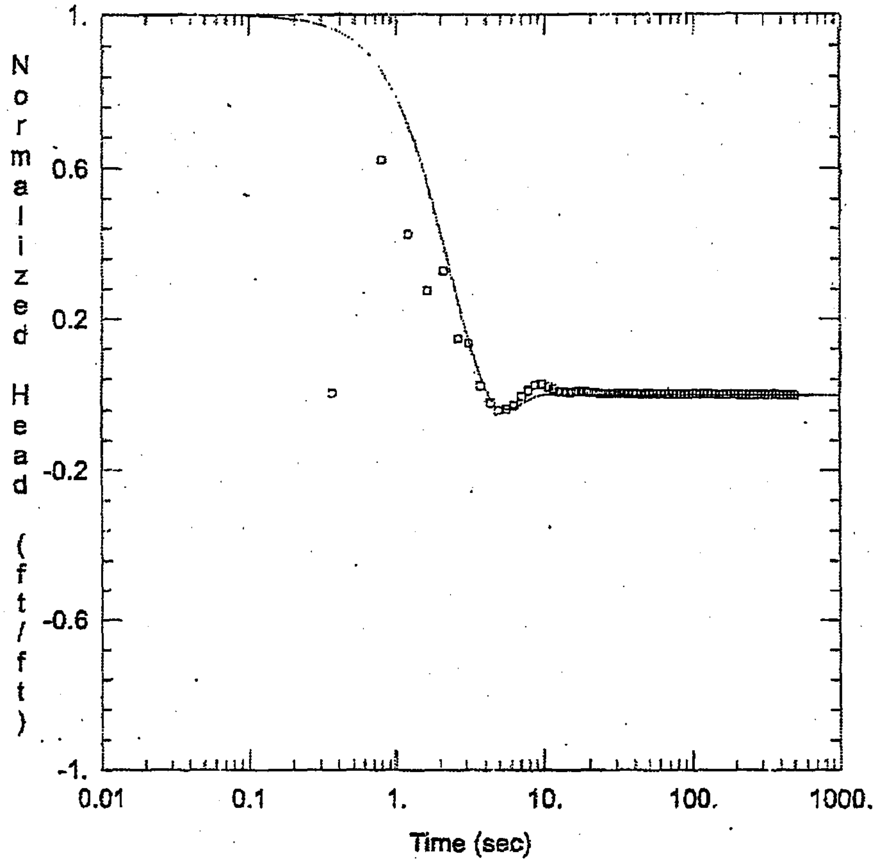
Le = 48. ft



OW-332 U FALLING HEAD TEST	
AQUIFER DATA	
Saturated Thickness: 20.5 ft	
WELL DATA (OW-322 U)	
Initial Displacement: 5.748 ft	Static Water Column Height: 38.73 ft
Total Well Penetration Depth: 16.5 ft	Screen Length: 10. ft
Casing Radius: 0.08333 ft	Well Radius: 0.3333 ft
SOLUTION	
Aquifer Model: Confined	Solution Method: KGS Model
Kr = 18.33 ft/day	Ss = 4.878E-12 ft^{-1}
Kz/Kr = 1.	



OW-332 U FALLING HEAD TEST	
AQUIFER DATA	
Saturated Thickness: 20.5 ft	Anisotropy Ratio (Kz/Kr): 1.
WELL DATA (OW-322 U)	
Initial Displacement: 5.748 ft	Static Water Column Height: 38.73 ft
Total Well Penetration Depth: 16.5 ft	Screen Length: 10. ft
Casing Radius: 0.08333 ft	Well Radius: 0.3333 ft
SOLUTION	
Aquifer Model: Confined	Solution Method: Bouwer-Rice
K = 11.29 ft/day	y0 = 6.077 ft



OW-348 L RISING HEAD TEST

AQUIFER DATA

Saturated Thickness: 23. ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (OW-348 L)

Initial Displacement: 5.755 ft
Total Well Penetration Depth: 13. ft
Casing Radius: 0.08333 ft

Static Water Column Height: 65. ft
Screen Length: 10. ft
Well Radius: 0.3333 ft

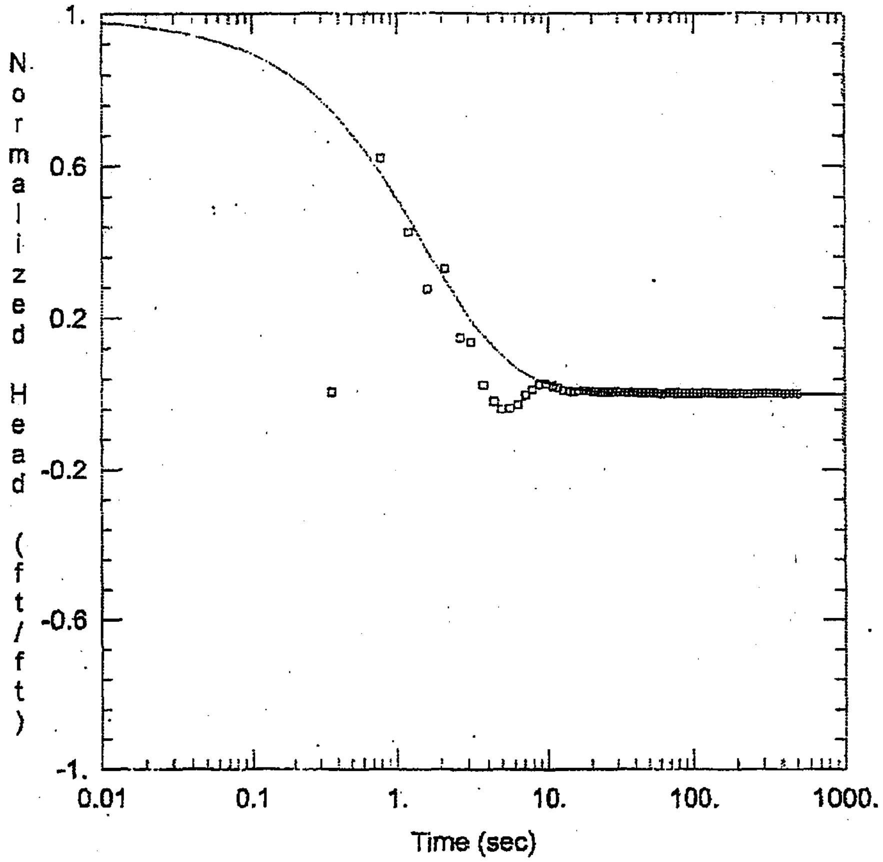
SOLUTION

Aquifer Model: Confined

Solution Method: Butler

K = 58.12 ft/day

Le = 49.29 ft



OW-348 L RISING HEAD TEST

AQUIFER DATA

Saturated Thickness: 23. ft

WELL DATA (OW-348 L)

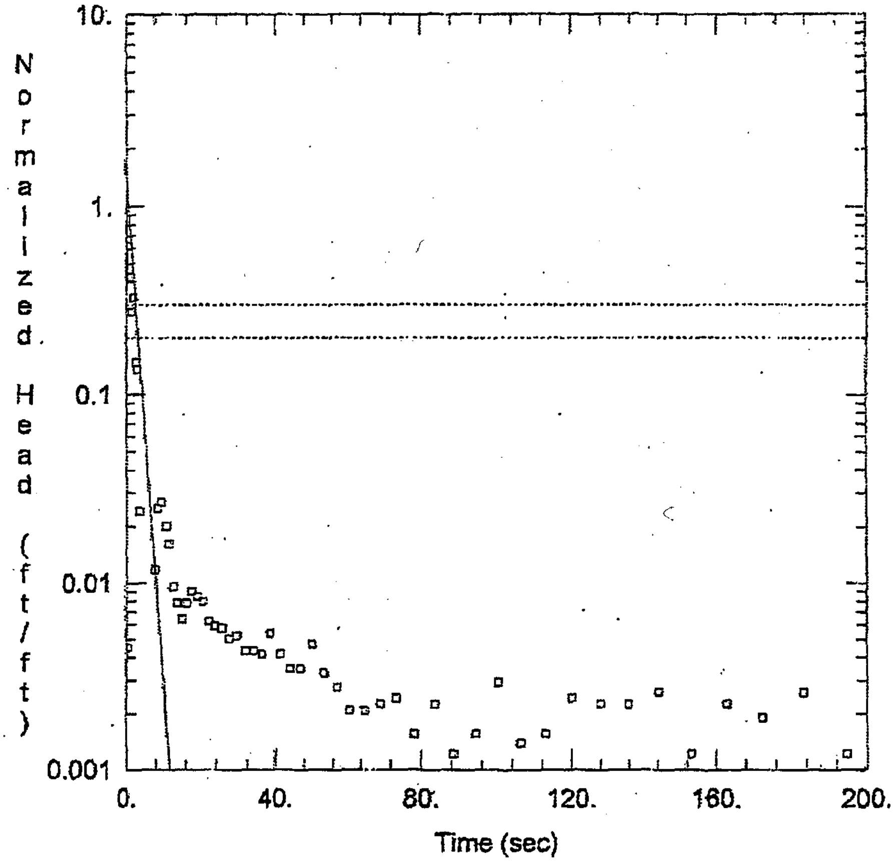
Initial Displacement: 5.755 ft
Total Well Penetration Depth: 13. ft
Casing Radius: 0.08333 ft

Static Water Column Height: 65. ft
Screen Length: 10. ft
Well Radius: 0.3333 ft

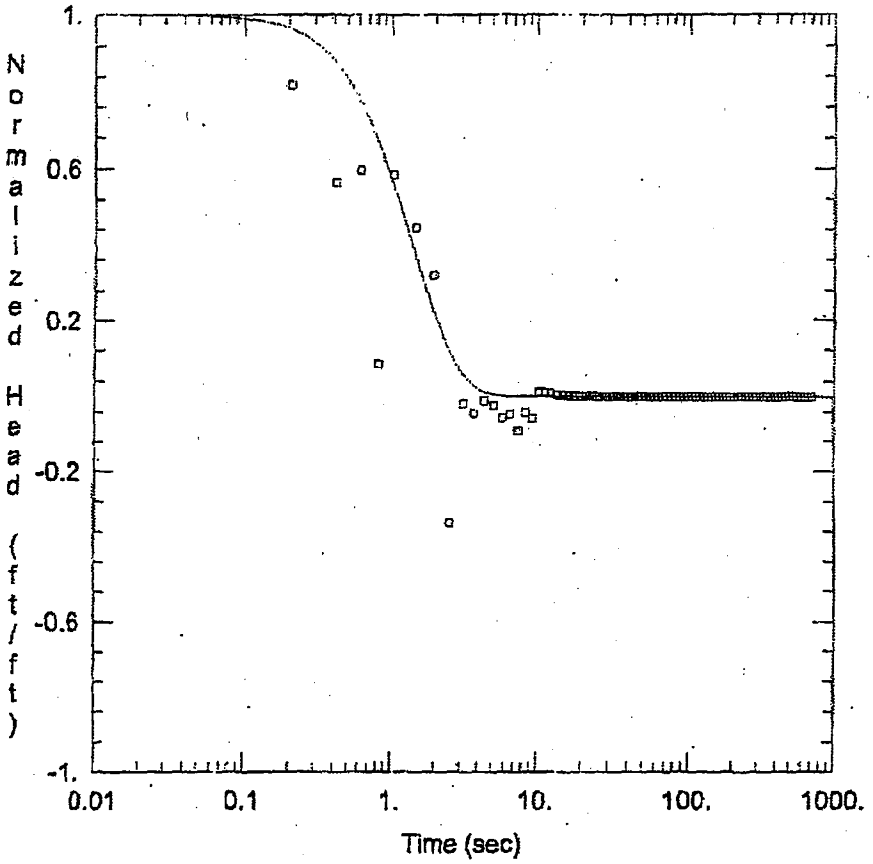
SOLUTION

Aquifer Model: Confined
Kr = 45.62 ft/day
Kz/Kr = 1.

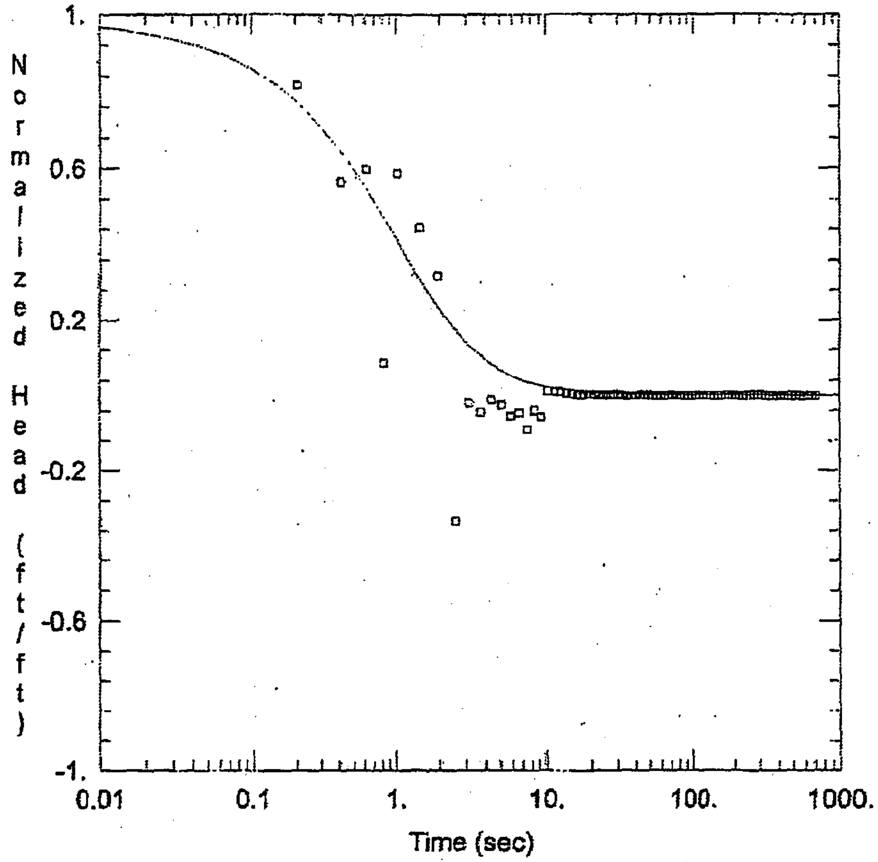
Solution Method: KGS Model
Ss = 4.348E-5 ft^{-1}



OW-348 L RISING HEAD TEST	
AQUIFER DATA	
Saturated Thickness: 23. ft	Anisotropy Ratio (Kz/Kr): 1.
WELL DATA (OW-348 L)	
Initial Displacement: 5.755 ft	Static Water Column Height: 65. ft
Total Well Penetration Depth: 13. ft	Screen Length: 10. ft
Casing Radius: 0.08333 ft	Well Radius: 0.3333 ft
SOLUTION	
Aquifer Model: Confined	Solution Method: Bouwer-Rice
K = 43.94 ft/day	y0 = 8.844 ft



OW-348 L FALLING HEAD TEST	
AQUIFER DATA	
Saturated Thickness: 15. ft	Anisotropy Ratio (Kz/Kr): 1.
WELL DATA (OW-348 L)	
Initial Displacement: 8.578 ft	Static Water Column Height: 65. ft
Total Well Penetration Depth: 13. ft	Screen Length: 10. ft
Casing Radius: 0.08333 ft	Well Radius: 0.3333 ft
SOLUTION	
Aquifer Model: Confined	Solution Method: Butler
K = 75.94 ft/day	Le = 15.1 ft



OW-348 L FALLING HEAD TEST

AQUIFER DATA

Saturated Thickness: 15. ft

WELL DATA (OW-348 L)

Initial Displacement: 8.578 ft
Total Well Penetration Depth: 13. ft
Casing Radius: 0.08333 ft

Static Water Column Height: 65. ft
Screen Length: 10. ft
Well Radius: 0.3333 ft

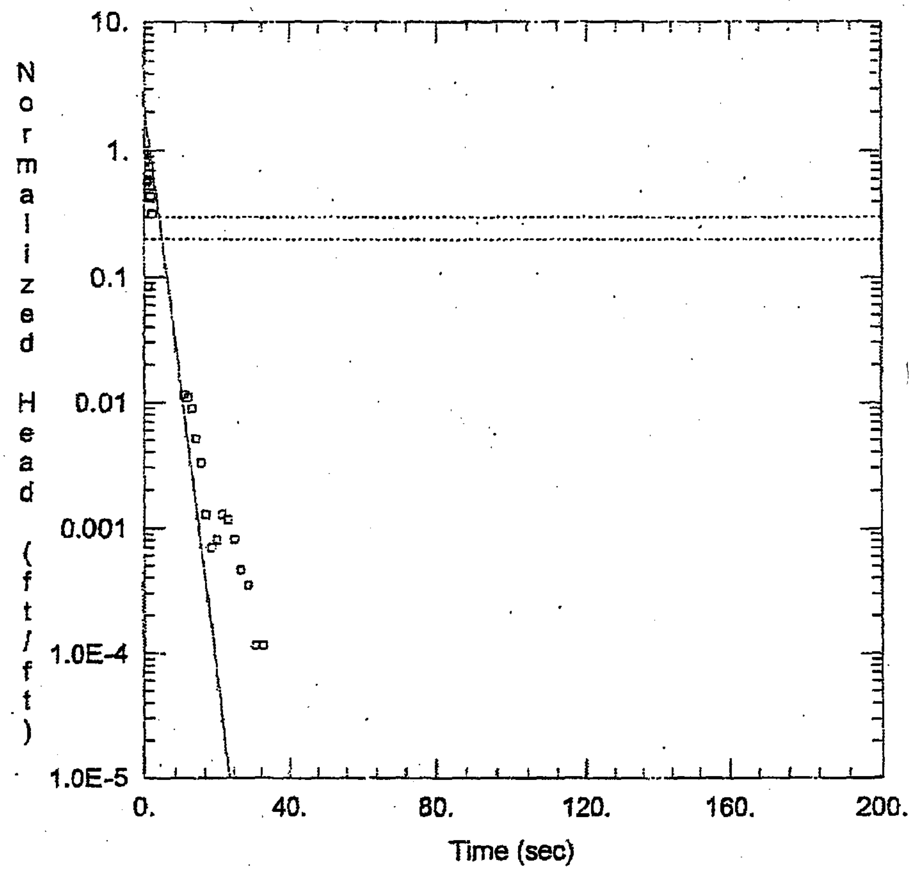
SOLUTION

Aquifer Model: Confined

Kr = 60.64 ft/day
Kz/Kr = 1.

Solution Method: KGS Model

Ss = 6.667E-5 ft^{-1}



OW-348 L FALLING HEAD TEST

AQUIFER DATA

Saturated Thickness: 15. ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (OW-348 L)

Initial Displacement: 8.578 ft
Total Well Penetration Depth: 13. ft
Casing Radius: 0.08333 ft

Static Water Column Height: 65. ft
Screen Length: 10. ft
Well Radius: 0.3333 ft

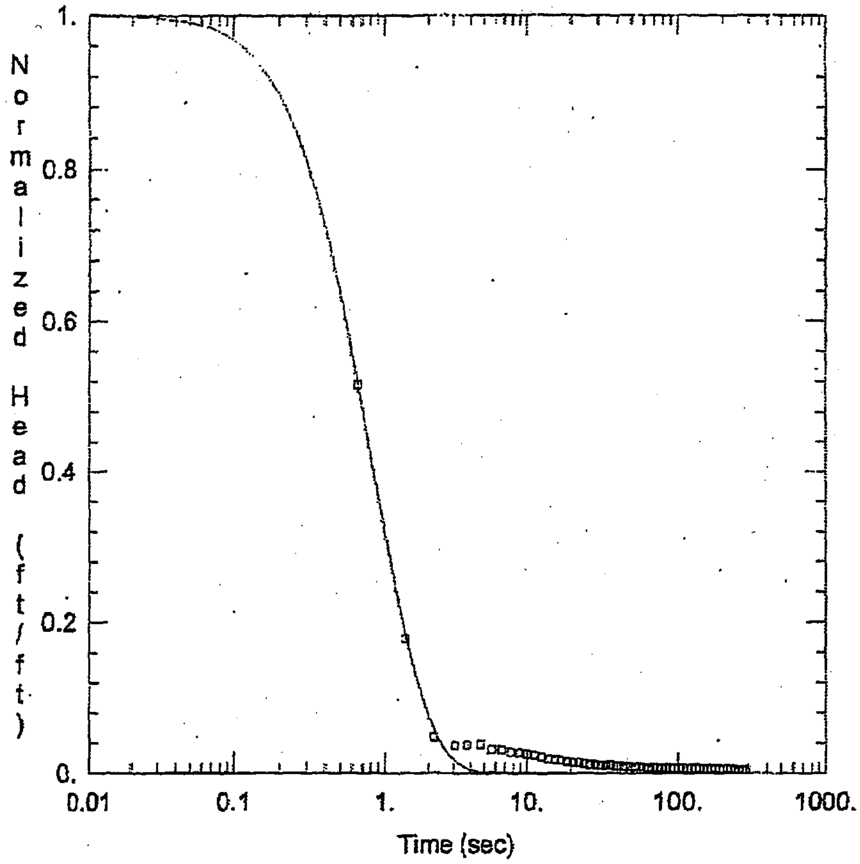
SOLUTION

Aquifer Model: Confined

Solution Method: Bouwer-Rice

K = 39.45 ft/day

y0 = 18.08 ft



OW-348 U RISING HEAD TEST

AQUIFER DATA

Saturated Thickness: 25. ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (OW-348 U)

Initial Displacement: 5.889 ft
Total Well Penetration Depth: 19. ft
Casing Radius: 0.08333 ft

Static Water Column Height: 32.68 ft
Screen Length: 10. ft
Well Radius: 0.3333 ft

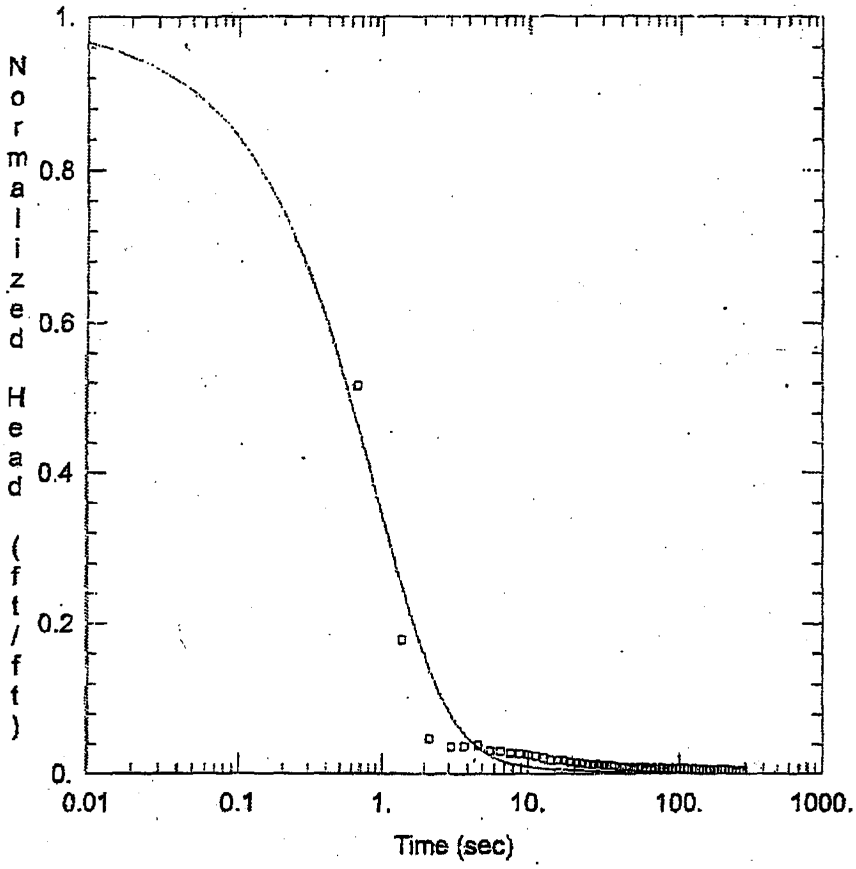
SOLUTION

Aquifer Model: Confined

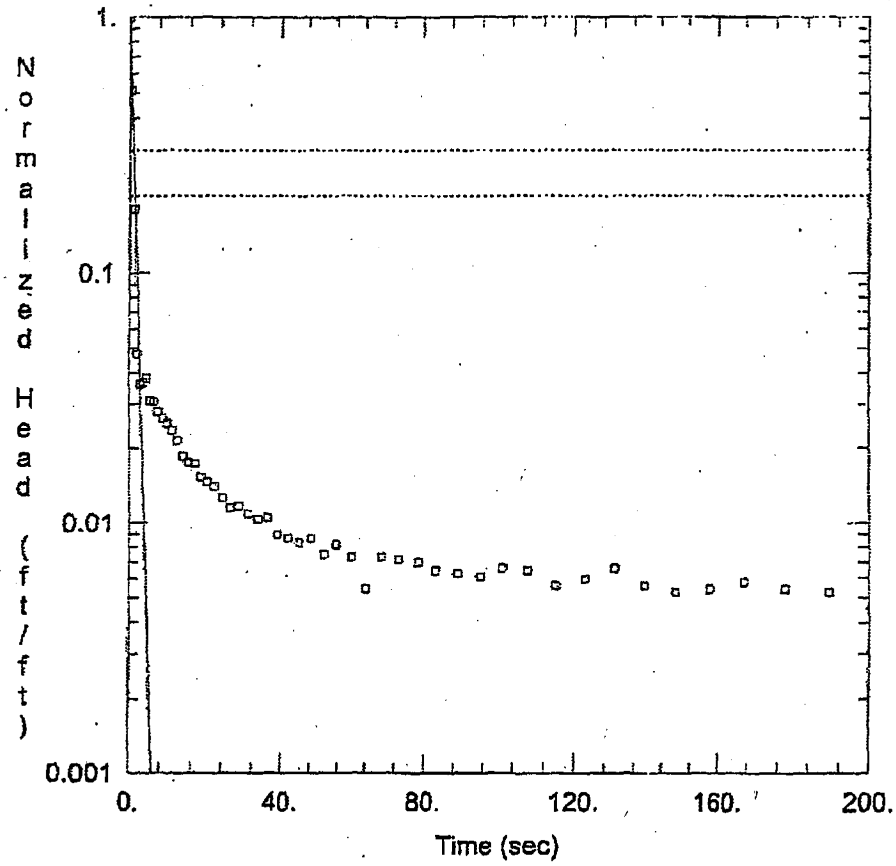
K = 118.6 ft/day

Solution Method: Butler

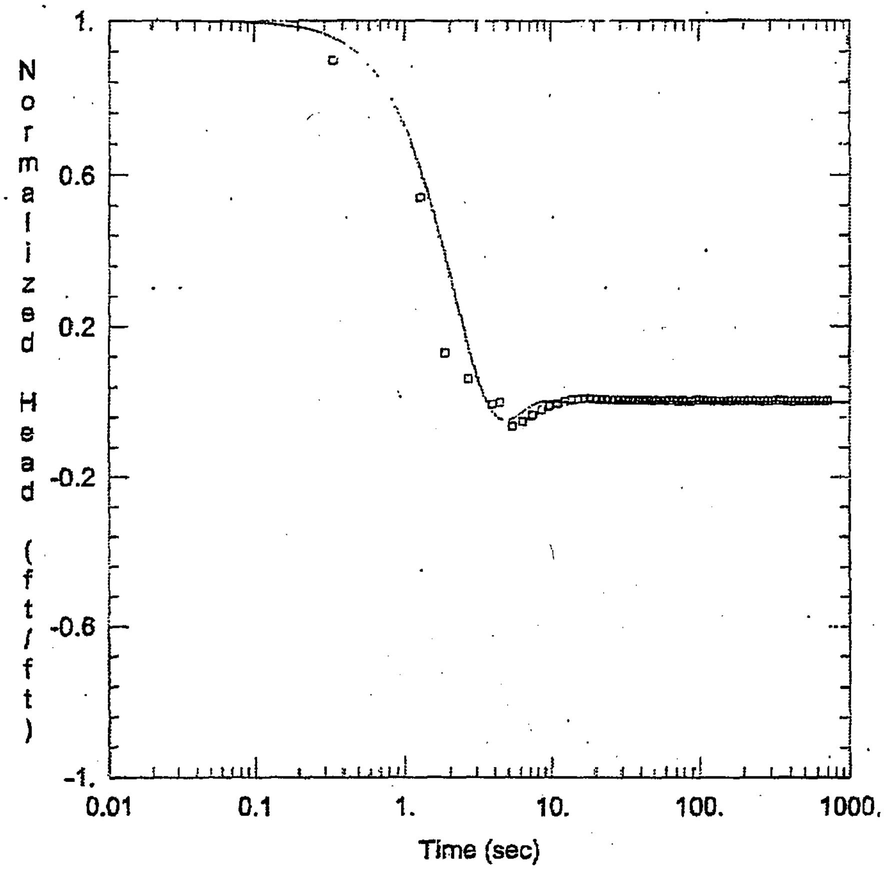
Le = 4.062 ft



OW-348 U RISING HEAD TEST	
AQUIFER DATA	
Saturated Thickness: 25. ft	
WELL DATA (OW-348 U)	
Initial Displacement: 5.889 ft	Static Water Column Height: 32.68 ft
Total Well Penetration Depth: 19. ft	Screen Length: 10. ft
Casing Radius: 0.08333 ft	Well Radius: 0.3333 ft
SOLUTION	
Aquifer Model: Confined	Solution Method: KGS Model
Kr = 83.03 ft/day	Ss = 4.0E-5 ft^{-1}
Kz/Kr = 1.	



OW-348 U RISING HEAD TEST	
AQUIFER DATA	
Saturated Thickness: 25. ft	Anisotropy Ratio (Kz/Kr): 1.
WELL DATA (OW-348 U)	
Initial Displacement: 5.889 ft	Static Water Column Height: 32.68 ft
Total Well Penetration Depth: 19. ft	Screen Length: 10. ft
Casing Radius: 0.08333 ft	Well Radius: 0.3333 ft
SOLUTION	
Aquifer Model: Confined	Solution Method: Bouwer-Rice
K = 87.67 ft/day	y0 = 5.951 ft



OW-348 U FALLING HEAD TEST

AQUIFER DATA

Saturated Thickness: 25. ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (OW-348 U)

Initial Displacement: 8.016 ft
Total Well Penetration Depth: 19. ft
Casing Radius: 0.08333 ft

Static Water Column Height: 32.68 ft
Screen Length: 10. ft
Well Radius: 0.3333 ft

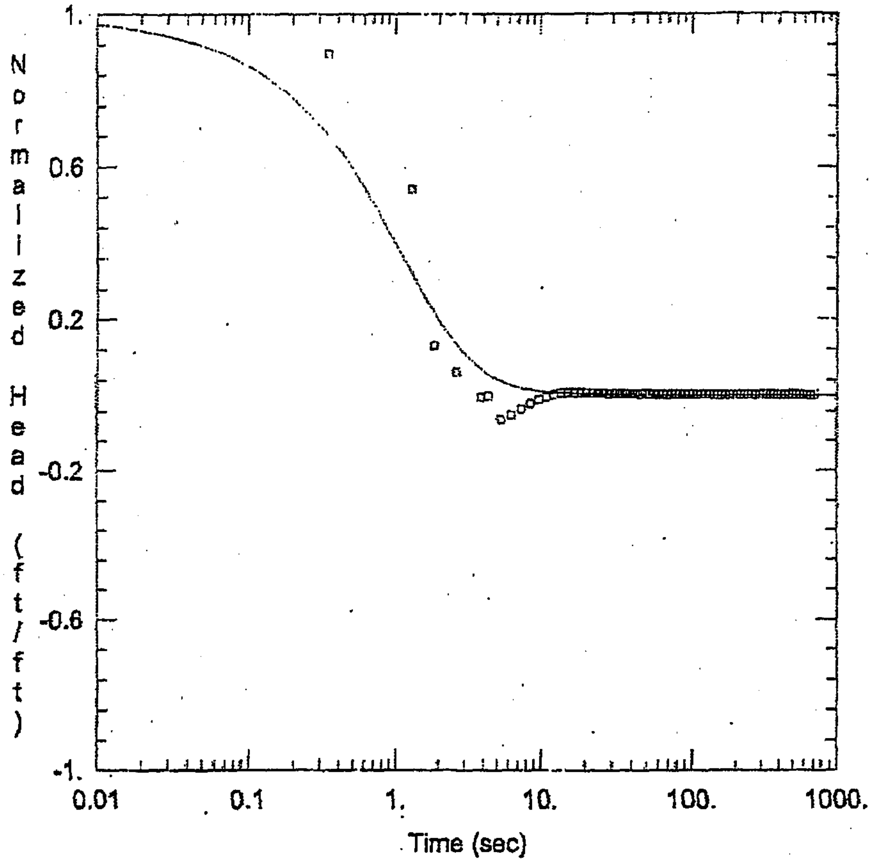
SOLUTION

Aquifer Model: Confined

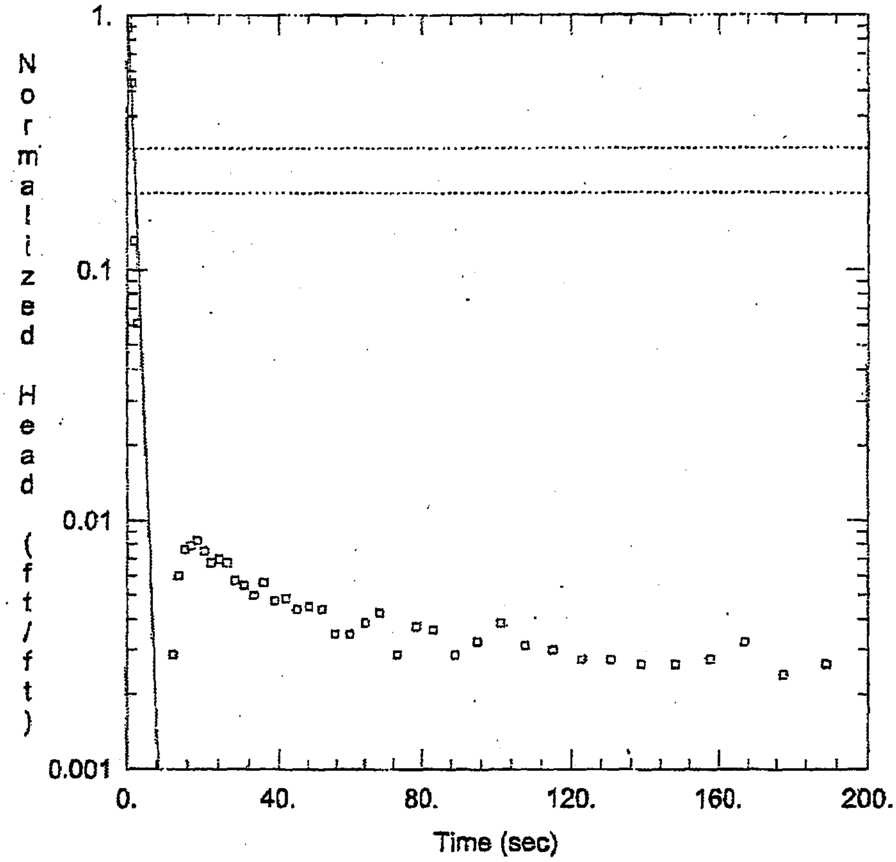
Solution Method: Butler

K = 68.06 ft/day

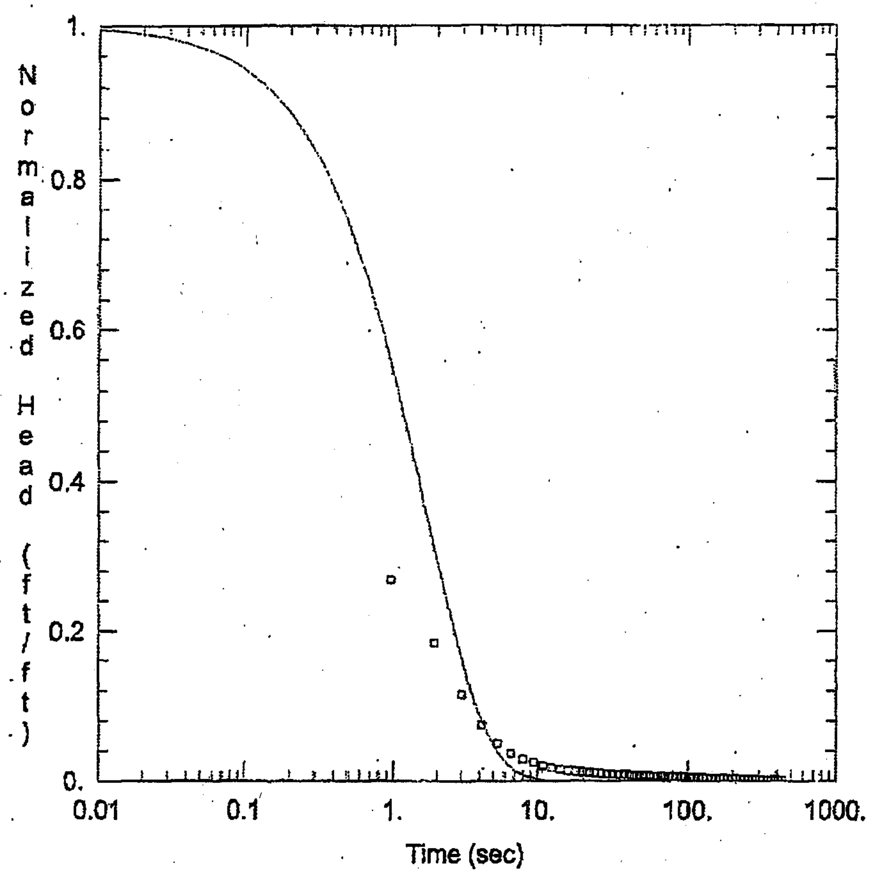
Le = 38.2 ft



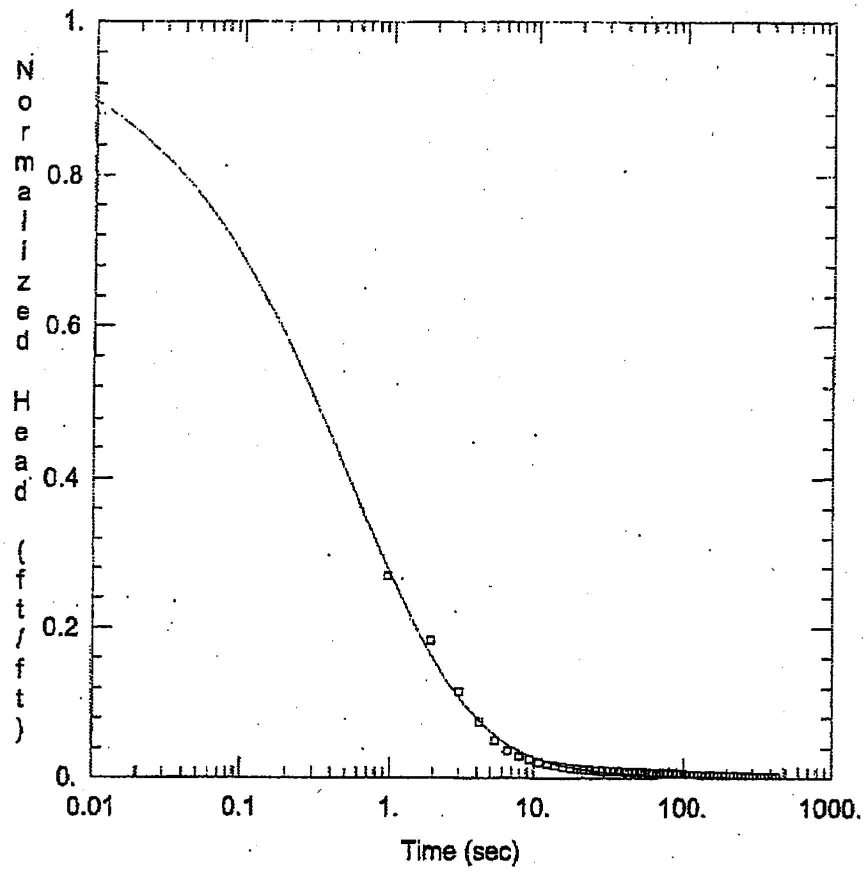
OW-348 U FALLING HEAD TEST	
AQUIFER DATA	
Saturated Thickness: 25. ft	
WELL DATA (OW-348 U)	
Initial Displacement: 8.016 ft	Static Water Column Height: 32.68 ft
Total Well Penetration Depth: 19. ft	Screen Length: 10. ft
Casing Radius: 0.08333 ft	Well Radius: 0.3333 ft
SOLUTION	
Aquifer Model: Confined	Solution Method: KGS Model
Kr = 71.42 ft/day	Ss = 3.069E-5 ft^{-1}
Kz/Kr = 1.	



OW-348 U FALLING HEAD TEST	
AQUIFER DATA	
Saturated Thickness: 25. ft	Anisotropy Ratio (Kz/Kr): 1.
WELL DATA (OW-348 U)	
Initial Displacement: 8.016 ft	Static Water Column Height: 32.68 ft
Total Well Penetration Depth: 19. ft	Screen Length: 10. ft
Casing Radius: 0.08333 ft	Well Radius: 0.3333 ft
SOLUTION	
Aquifer Model: Confined	Solution Method: Bouwer-Rice
K = 64.94 ft/day	y0 = 10.1 ft



OW-349 L RISING HEAD TEST	
AQUIFER DATA	
Saturated Thickness: 15. ft	Anisotropy Ratio (Kz/Kr): 1.
WELL DATA (OW-349 L)	
Initial Displacement: 14.9 ft	Static Water Column Height: 66.33 ft
Total Well Penetration Depth: 13. ft	Screen Length: 10. ft
Casing Radius: 0.08333 ft	Well Radius: 0.3333 ft
SOLUTION	
Aquifer Model: Confined	Solution Method: Butler
K = 63.25 ft/day	Le = 0.1 ft



OW-349 L RISING HEAD TEST

AQUIFER DATA

Saturated Thickness: 15. ft

WELL DATA (OW-349 L)

Initial Displacement: 14.9 ft
Total Well Penetration Depth: 13. ft
Casing Radius: 0.08333 ft

Static Water Column Height: 66.33 ft
Screen Length: 10. ft
Well Radius: 0.3333 ft

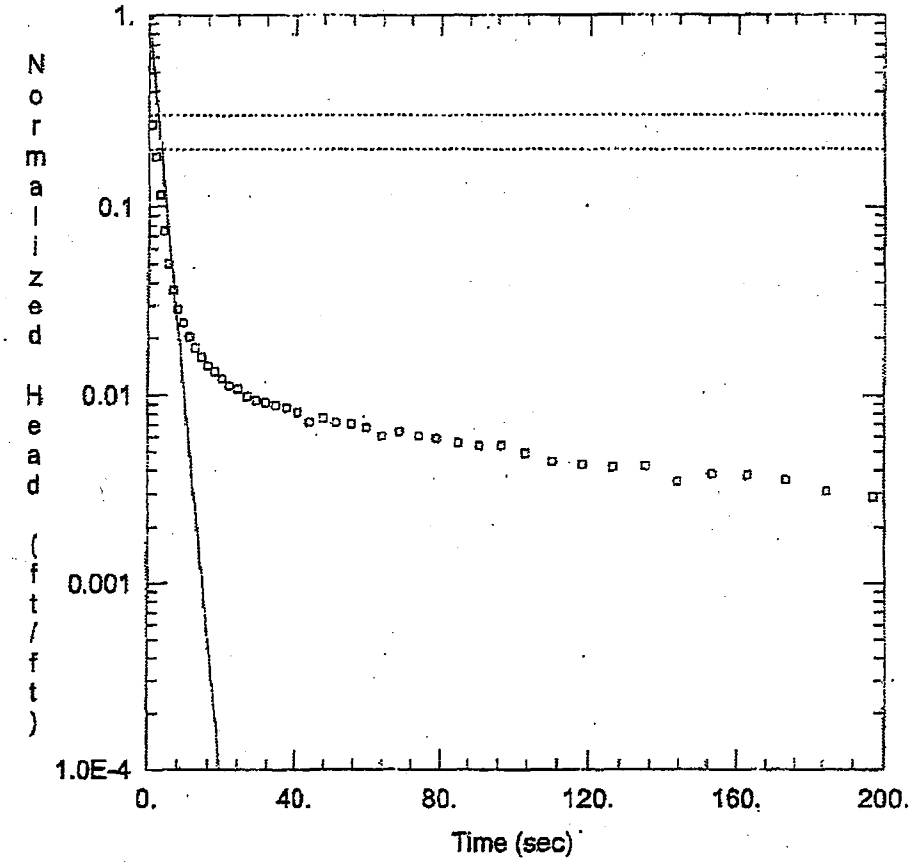
SOLUTION

Aquifer Model: Confined

Solution Method: KGS Model

Kr = 50.56 ft/day
Kz/Kr = 1.

Ss = 0.001543 ft^{-1}



OW-349 L RISING HEAD TEST

AQUIFER DATA

Saturated Thickness: 15. ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (OW-349 L)

Initial Displacement: 14.9 ft

Total Well Penetration Depth: 13. ft

Casing Radius: 0.08333 ft

Static Water Column Height: 66.33 ft

Screen Length: 10. ft

Well Radius: 0.3333 ft

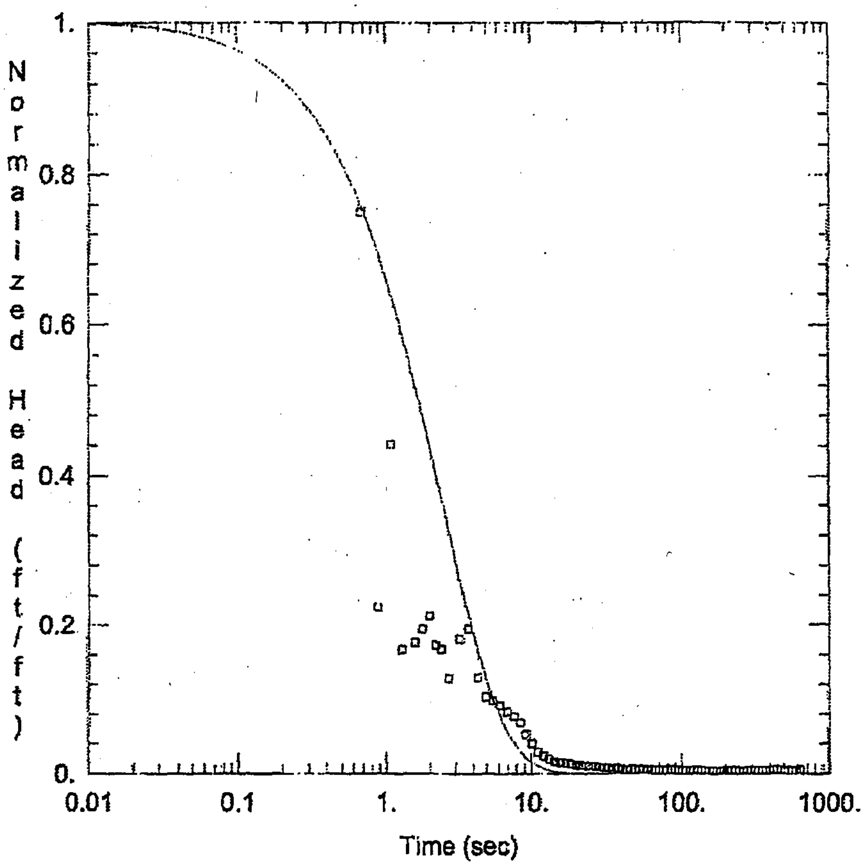
SOLUTION

Aquifer Model: Confined

K = 35.12 ft/day

Solution Method: Bouwer-Rice

y0 = 14.24 ft



OW-349 L FALLING HEAD TEST

AQUIFER DATA

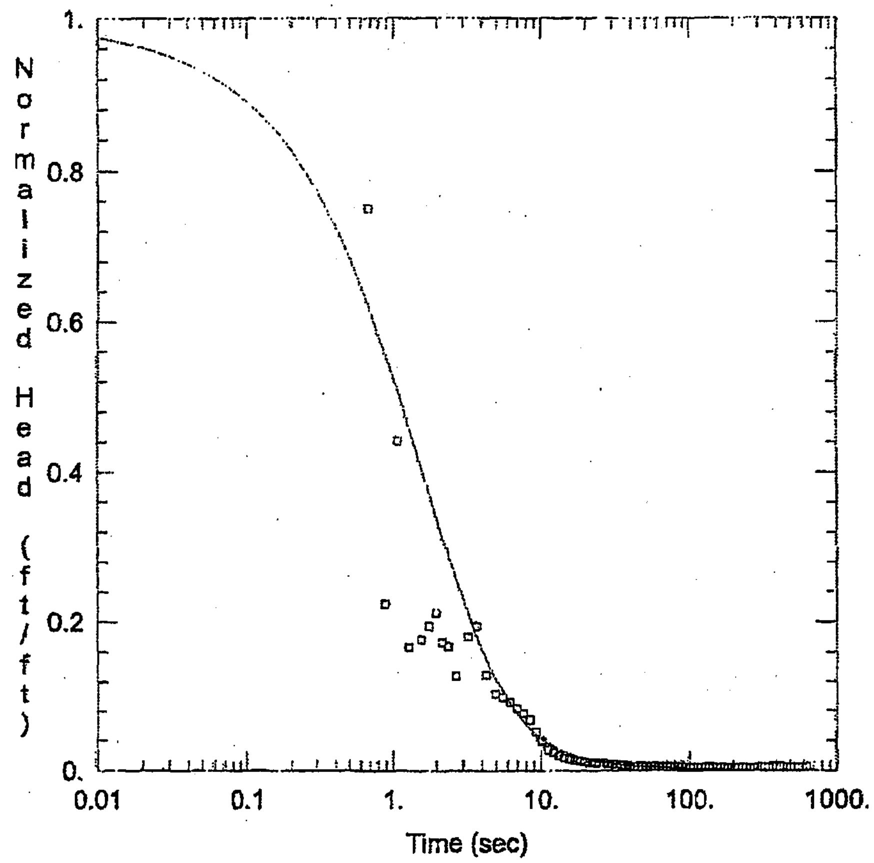
Saturated Thickness: 15. ft   Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (OW-349 L)

Initial Displacement: 7.603 ft   Static Water Column Height: 66.33 ft
Total Well Penetration Depth: 13. ft   Screen Length: 10. ft
Casing Radius: 0.08333 ft   Well Radius: 0.3333 ft

SOLUTION

Aquifer Model: Confined   Solution Method: Butler
K = 42.81 ft/day   Le = 1. ft



OW-349 L FALLING HEAD TEST

AQUIFER DATA

Saturated Thickness: 15. ft

WELL DATA (OW-349 L)

Initial Displacement: 7.603 ft
Total Well Penetration Depth: 13. ft
Casing Radius: 0.08333 ft

Static Water Column Height: 66.33 ft
Screen Length: 10. ft
Well Radius: 0.3333 ft

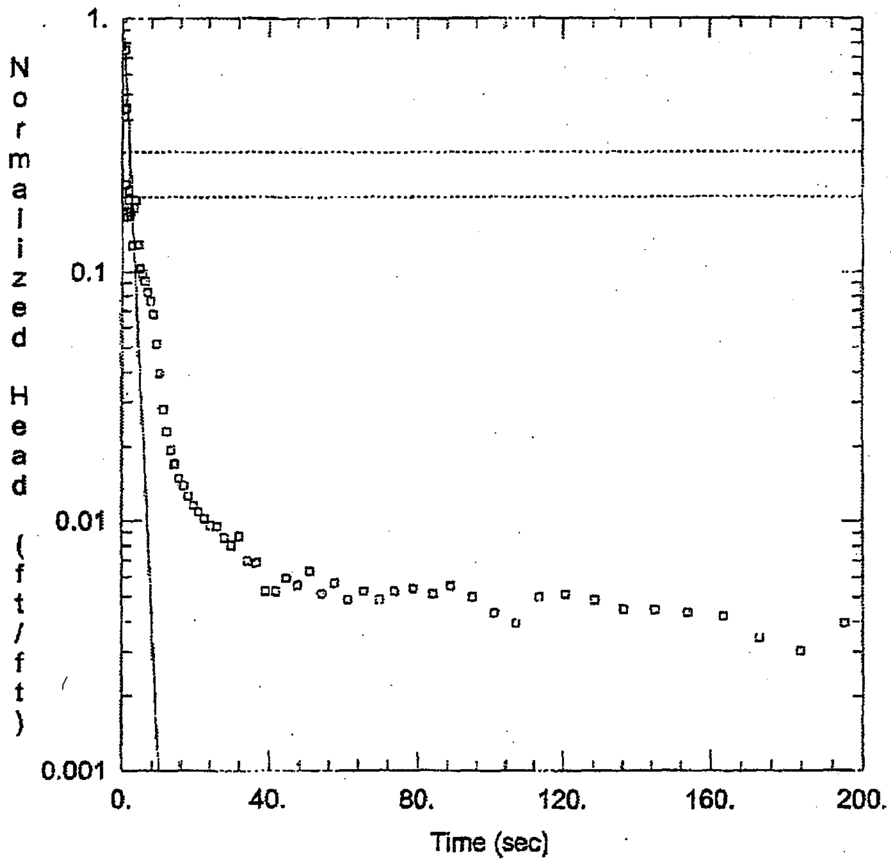
SOLUTION

Aquifer Model: Confined

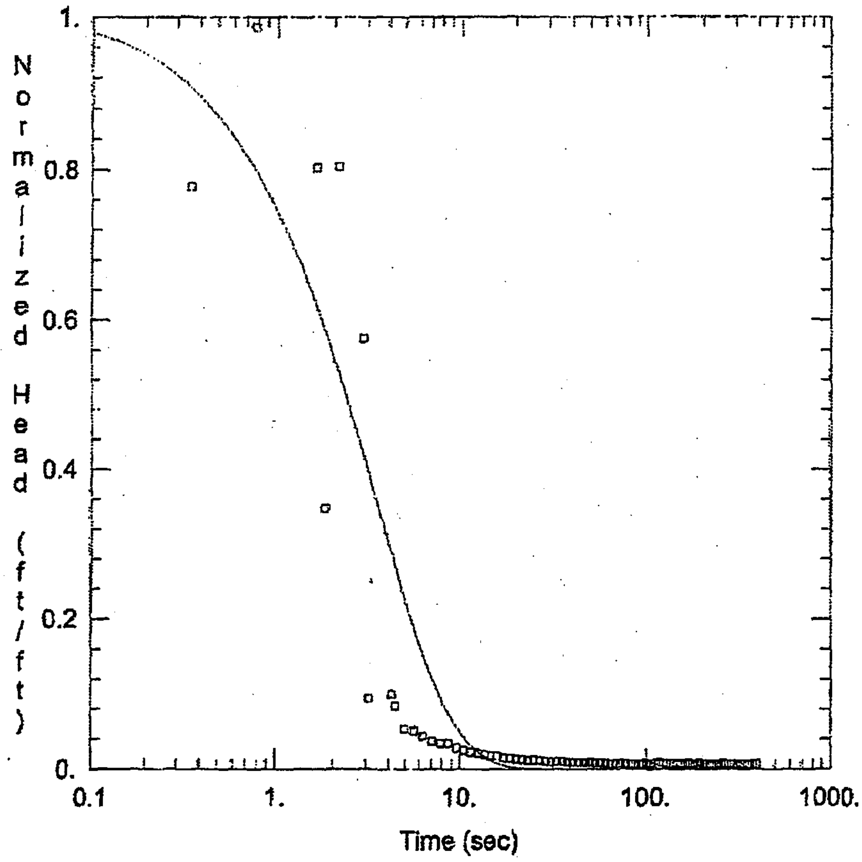
Kr = 40.47 ft/day
Kz/Kr = 1.

Solution Method: KGS Model

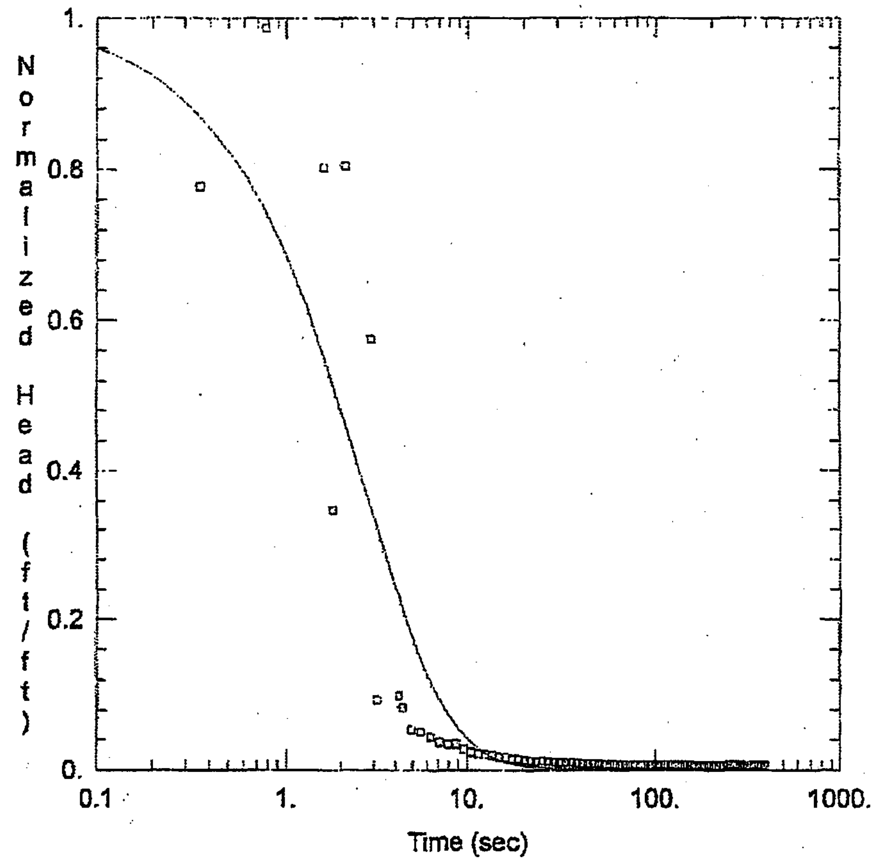
Ss = 6.667E-5 ft^{-1}



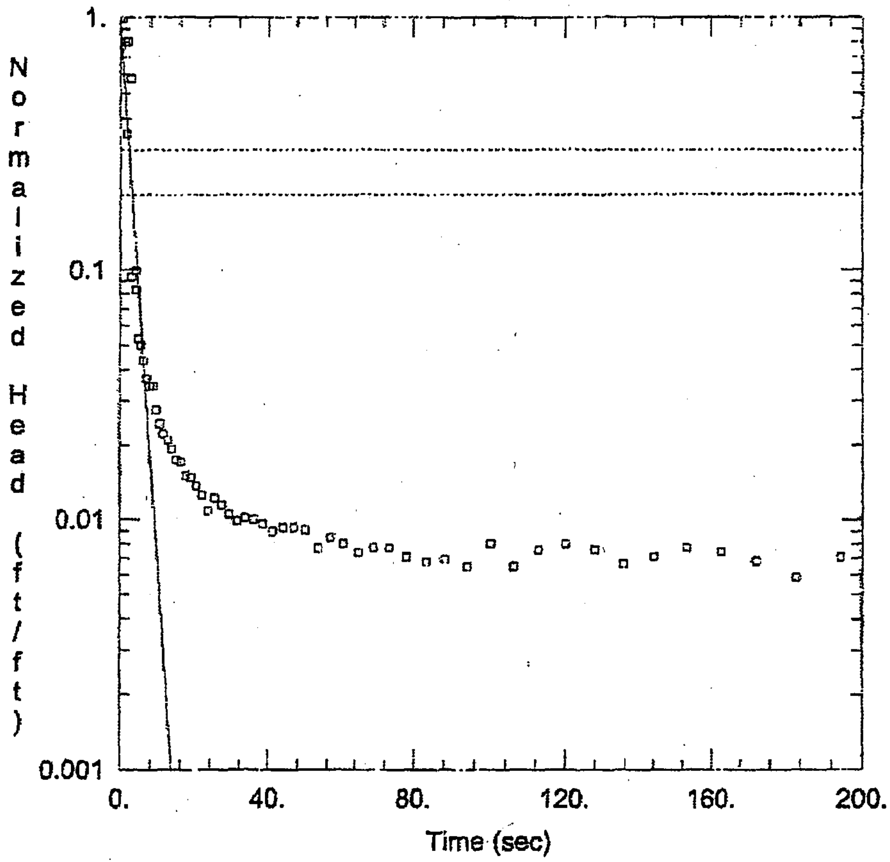
OW-349 L FALLING HEAD TEST	
AQUIFER DATA	
Saturated Thickness: 15. ft	Anisotropy Ratio (Kz/Kr): 1.
WELL DATA (OW-349 L)	
Initial Displacement: 7.603 ft	Static Water Column Height: 66.33 ft
Total Well Penetration Depth: 13. ft	Screen Length: 10. ft
Casing Radius: 0.08333 ft	Well Radius: 0.3333 ft
SOLUTION	
Aquifer Model: Confined	Solution Method: Bouwer-Rice
K = 52.4 ft/day	y0 = 9.103 ft



OW-349 U RISING HEAD TEST	
AQUIFER DATA	
Saturated Thickness: 30.7 ft	Anisotropy Ratio (Kz/Kr): 1.
WELL DATA (OW-349 U)	
Initial Displacement: 6.488 ft	Static Water Column Height: 39.97 ft
Total Well Penetration Depth: 28.7 ft	Screen Length: 10. ft
Casing Radius: 0.08333 ft	Well Radius: 0.3333 ft
SOLUTION	
Aquifer Model: Confined	Solution Method: Butler
K = 30.74 ft/day	Le = 3.53 ft



OW-349 U RISING HEAD TEST	
AQUIFER DATA	
Saturated Thickness: 30.7 ft	
WELL DATA (OW-349 U)	
Initial Displacement: 6.488 ft	Static Water Column Height: 39.97 ft
Total Well Penetration Depth: 28.7 ft	Screen Length: 10. ft
Casing Radius: 0.08333 ft	Well Radius: 0.3333 ft
SOLUTION	
Aquifer Model: Confined	Solution Method: KGS Model
Kr = 60.24 ft/day	Ss = 3.257E-12 ft^{-1}
Kz/Kr = 1.	



OW-349 U RISING HEAD TEST

AQUIFER DATA

Saturated Thickness: 30.7 ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (OW-349 U)

Initial Displacement: 6.488 ft

Total Well Penetration Depth: 28.7 ft

Casing Radius: 0.08333 ft

Static Water Column Height: 39.97 ft

Screen Length: 10. ft

Well Radius: 0.3333 ft

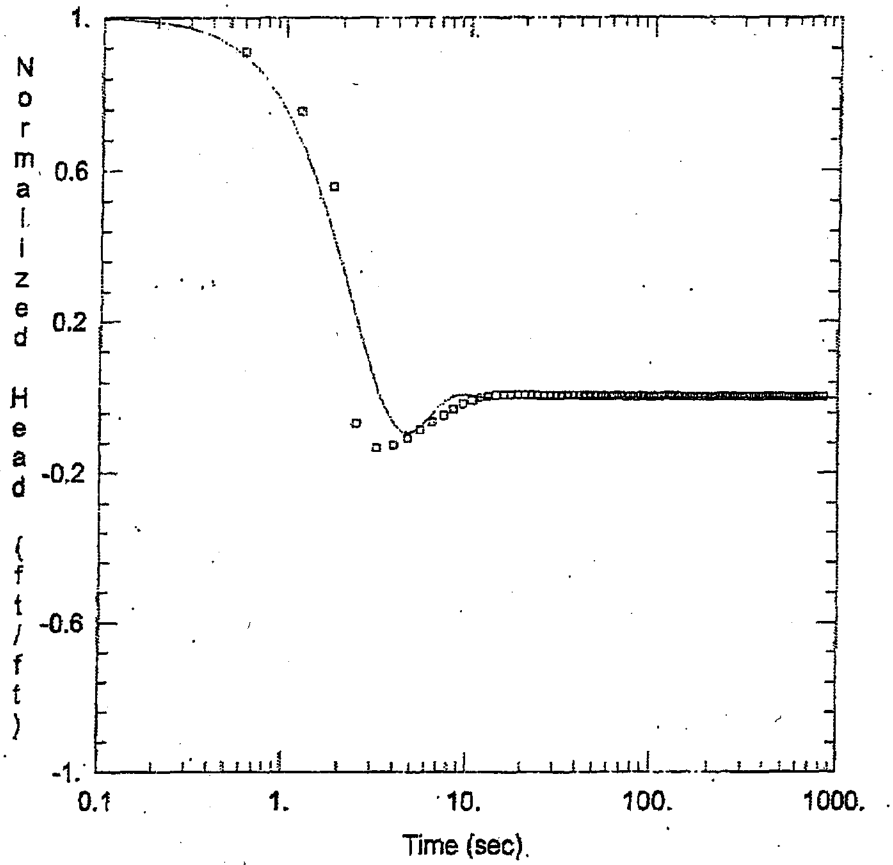
SOLUTION

Aquifer Model: Confined

Solution Method: Bouwer-Rice

K = 42.98 ft/day

y0 = 6.488 ft



OW-349 U FALLING HEAD TEST

AQUIFER DATA

Saturated Thickness: 33.7 ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (OW-349 U)

Initial Displacement: 6.212 ft

Total Well Penetration Depth: 28.7 ft

Casing Radius: 0.08333 ft

Static Water Column Height: 39.97 ft

Screen Length: 10. ft

Well Radius: 0.3333 ft

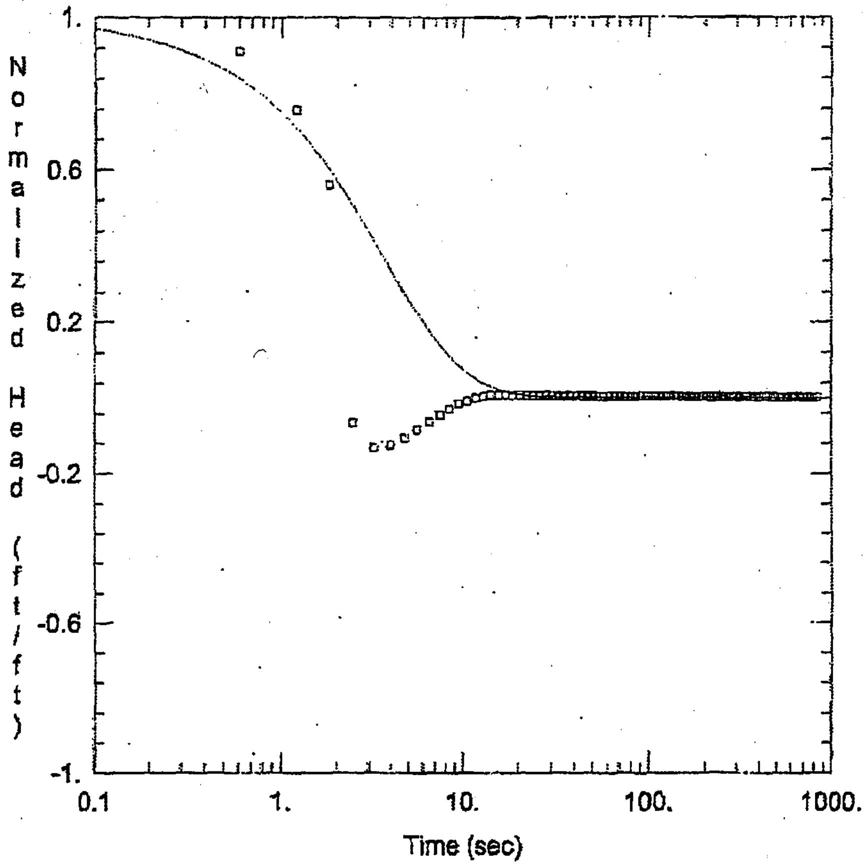
SOLUTION

Aquifer Model: Confined

K = 71.38 ft/day

Solution Method: Butler

Le = 46.23 ft



OW-349 U FALLING HEAD TEST

AQUIFER DATA

Saturated Thickness: 33.7 ft

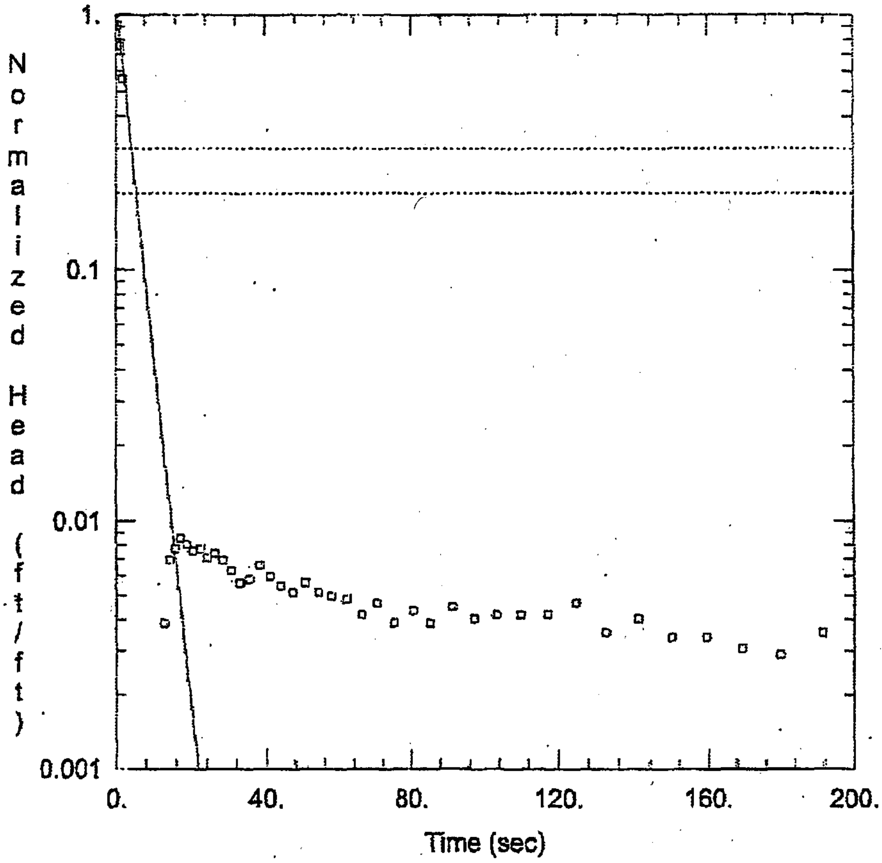
WELL DATA (OW-349 U)

Initial Displacement: 6.212 ft
Total Well Penetration Depth: 28.7 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 39.97 ft
Screen Length: 10. ft
Well Radius: 0.3333 ft

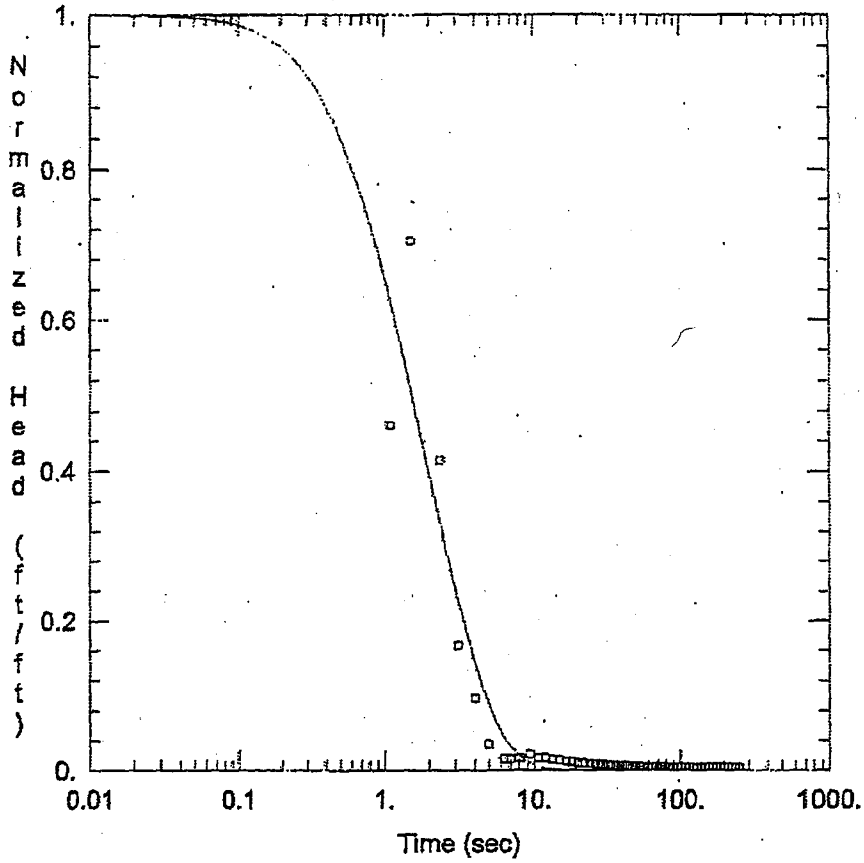
SOLUTION

Aquifer Model: Confined
Solution Method: KGS Model

Kr = 55.58 ft/day
Kz/Kr = 0.002371
Ss = 2.384E-10 ft^{-1}



OW-349 U FALLING HEAD TEST	
AQUIFER DATA	
Saturated Thickness: 33.7 ft	Anisotropy Ratio (Kz/Kr): 0.002371
WELL DATA (OW-349 U)	
Initial Displacement: 6.212 ft	Static Water Column Height: 39.97 ft
Total Well Penetration Depth: 28.7 ft	Screen Length: 10. ft
Casing Radius: 0.08333 ft	Well Radius: 0.3333 ft
SOLUTION	
Aquifer Model: Confined	Solution Method: Bouwer-Rice
K = 52.82 ft/day	y0 = 7.374 ft



OW-408 L RISING HEAD TEST

AQUIFER DATA

Saturated Thickness: 15. ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (OW-408 L)

Initial Displacement: 10.84 ft
Total Well Penetration Depth: 11.5 ft
Casing Radius: 0.08333 ft

Static Water Column Height: 64.95 ft
Screen Length: 10. ft
Well Radius: 0.3333 ft

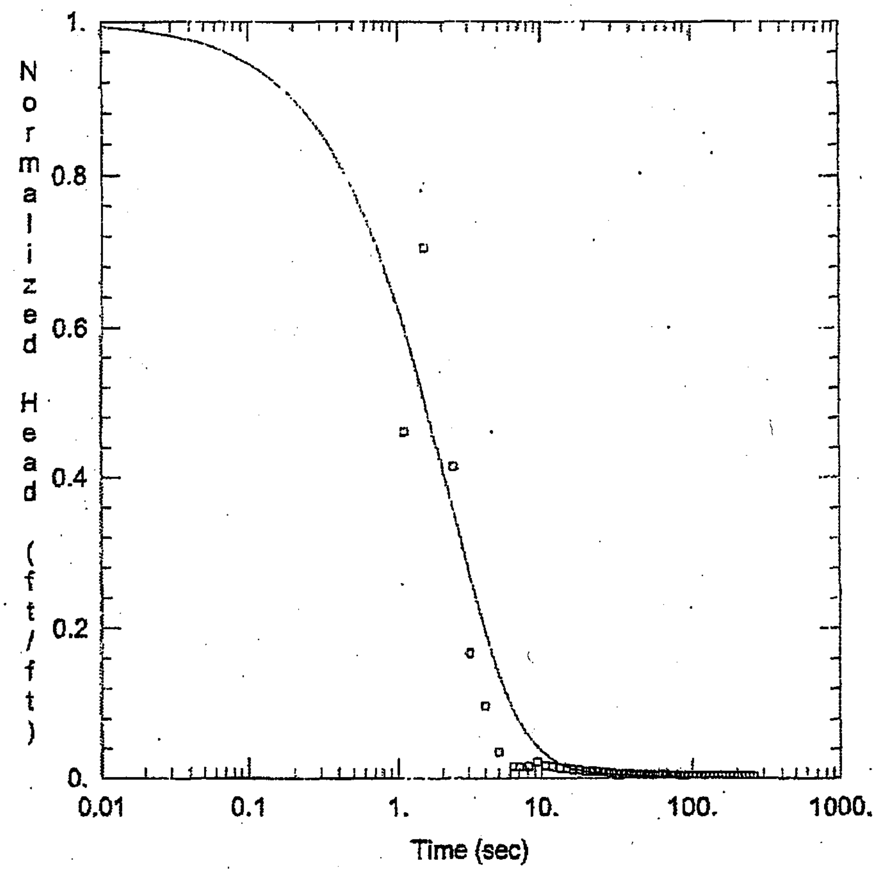
SOLUTION

Aquifer Model: Confined

K = 47.96 ft/day

Solution Method: Butler

Le = 10.08 ft



OW-408 L RISING HEAD TEST

AQUIFER DATA

Saturated Thickness: 15. ft

WELL DATA (OW-408 L)

Initial Displacement: 10.84 ft
Total Well Penetration Depth: 11.5 ft
Casing Radius: 0.08333 ft

Static Water Column Height: 64.95 ft
Screen Length: 10. ft
Well Radius: 0.3333 ft

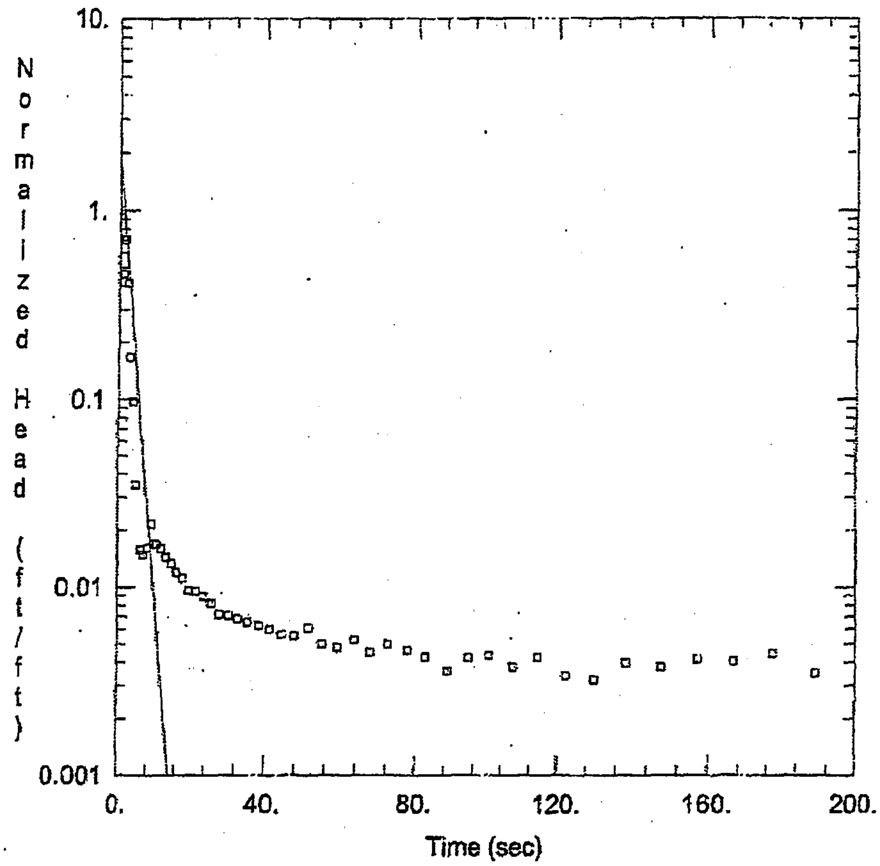
SOLUTION

Aquifer Model: Confined

Kr = 72.51 ft/day
Kz/Kr = 0.09886

Solution Method: KGS Model

Ss = 3.265E-8 ft^{-1}



OW-408 L RISING HEAD TEST

AQUIFER DATA

Saturated Thickness: 15. ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (OW-408 L)

Initial Displacement: 10.84 ft
Total Well Penetration Depth: 11.5 ft
Casing Radius: 0.08333 ft

Static Water Column Height: 64.95 ft
Screen Length: 10. ft
Well Radius: 0.3333 ft

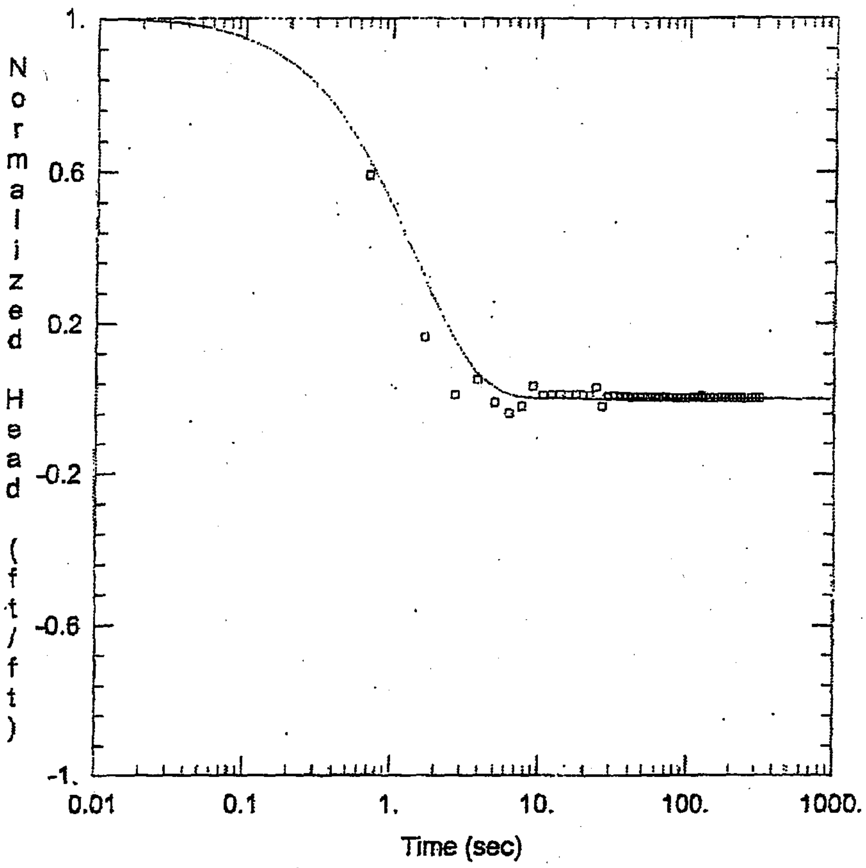
SOLUTION

Aquifer Model: Confined

K = 37.54 ft/day

Solution Method: Bouwer-Rice

y0 = 20.36 ft



OW-408 L FALLING HEAD TEST

AQUIFER DATA

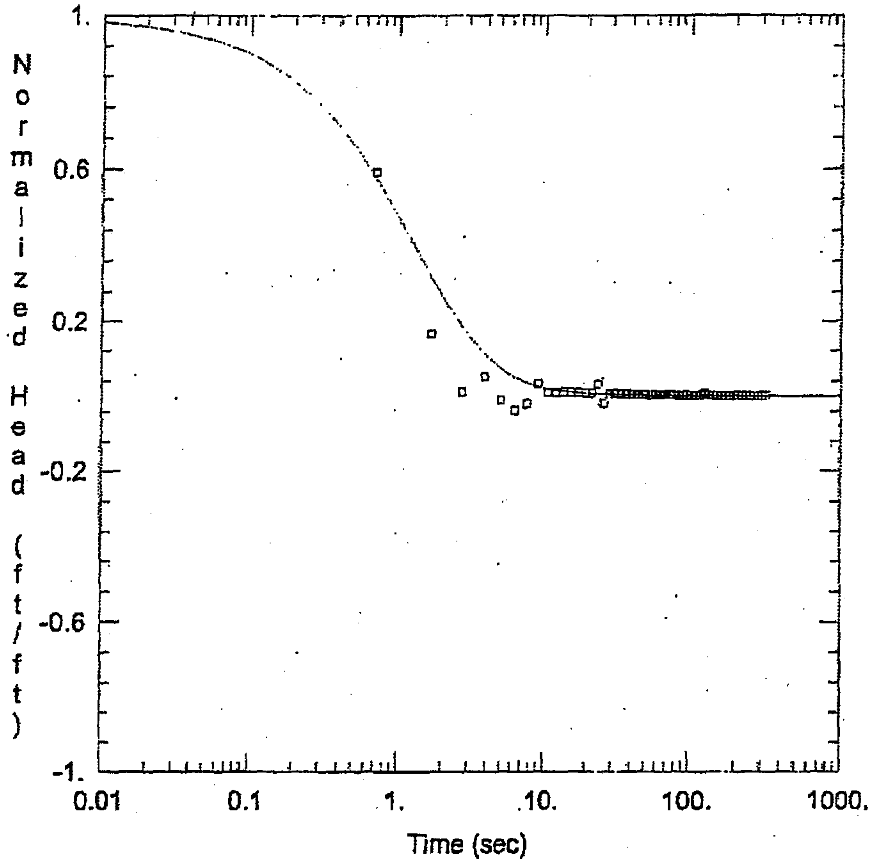
Saturated Thickness: 15. ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (OW-408 L)

Initial Displacement: 7.342 ft Static Water Column Height: 64.95 ft
Total Well Penetration Depth: 11.5 ft Screen Length: 10. ft
Casing Radius: 0.08333 ft Well Radius: 0.3333 ft

SOLUTION

Aquifer Model: Confined Solution Method: Butler
K = 70.31 ft/day Le = 1. ft



OW-408 L FALLING HEAD TEST

AQUIFER DATA

Saturated Thickness: 15. ft

WELL DATA (OW-408 L)

Initial Displacement: 7.342 ft
Total Well Penetration Depth: 11.5 ft
Casing Radius: 0.08333 ft

Static Water Column Height: 64.95 ft
Screen Length: 10. ft
Well Radius: 0.3333 ft

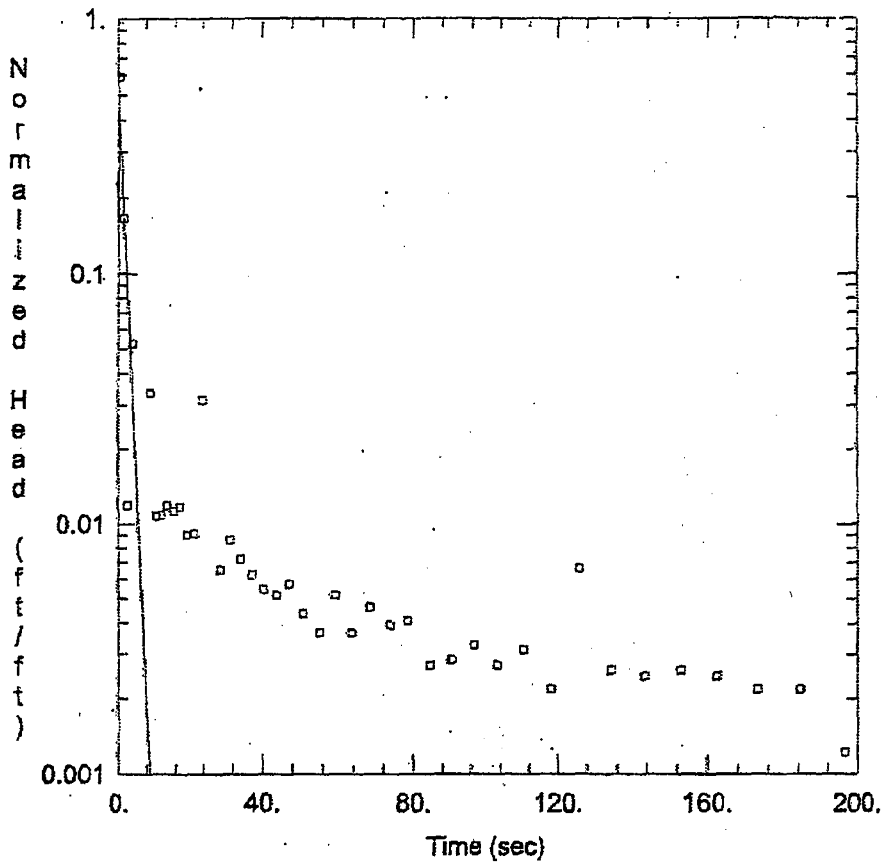
SOLUTION

Aquifer Model: Confined

Kr = 67.66 ft/day
Kz/Kr = 1.

Solution Method: KGS Model

Ss = 8.393E-6 ft^{-1}



OW-408 L FALLING HEAD TEST

AQUIFER DATA

Saturated Thickness: 15. ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (OW-408 L)

Initial Displacement: 7.342 ft
Total Well Penetration Depth: 11.5 ft
Casing Radius: 0.08333 ft

Static Water Column Height: 64.95 ft
Screen Length: 10. ft
Well Radius: 0.3333 ft

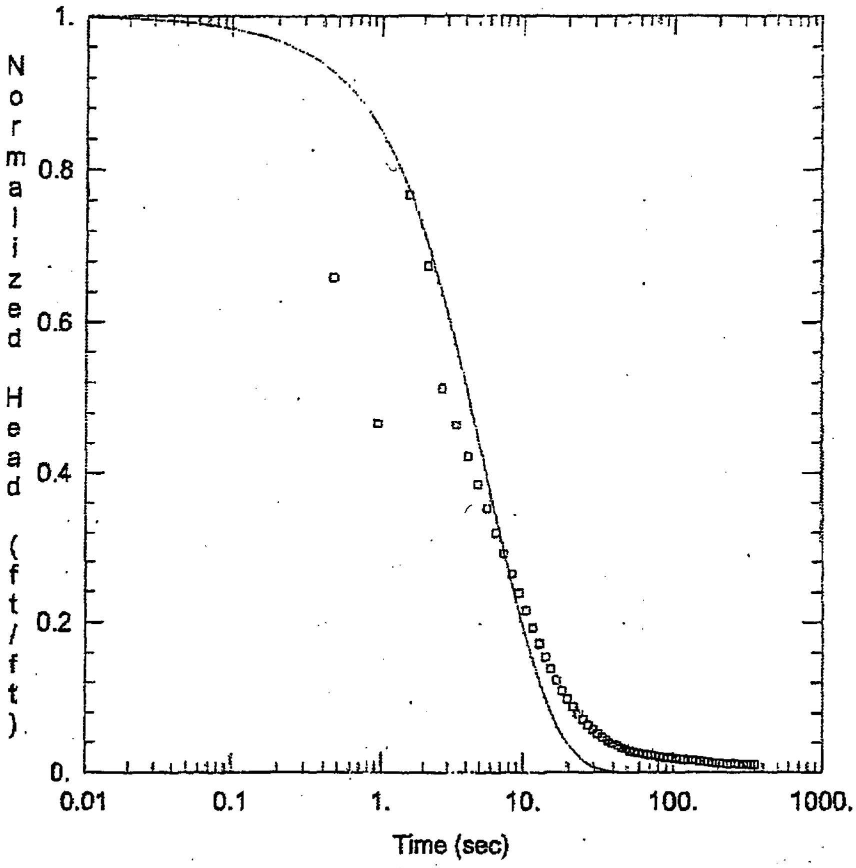
SOLUTION

Aquifer Model: Confined

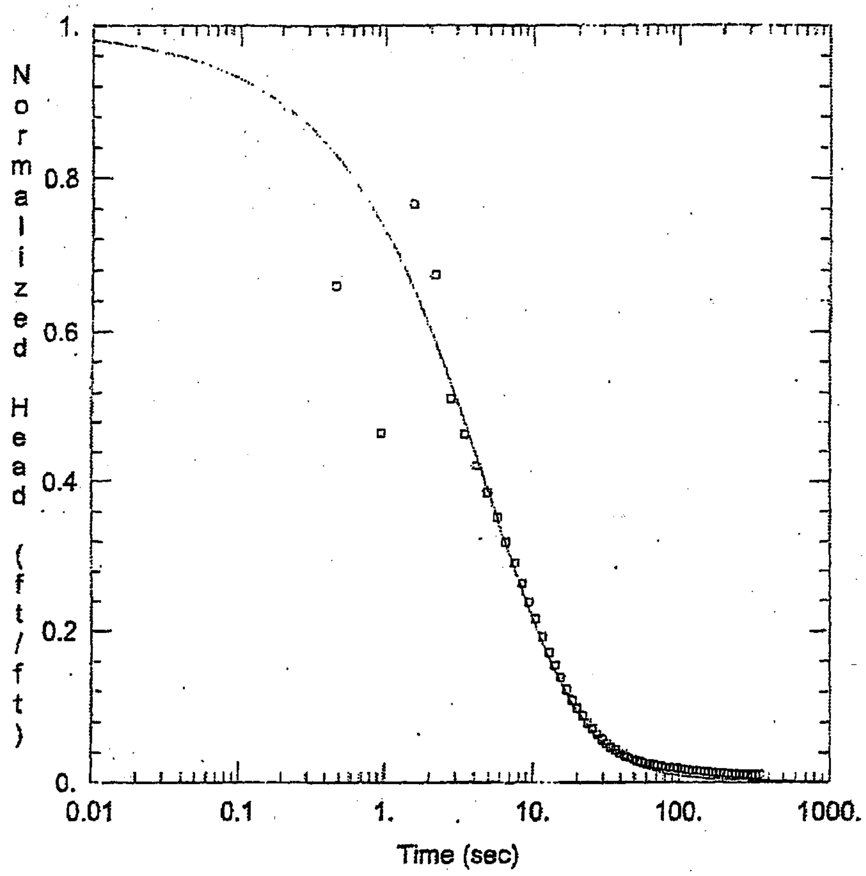
Solution Method: Bouwer-Rice

K = 50.37 ft/day

y0 = 3.948 ft



OW-408 U RISING HEAD TEST	
AQUIFER DATA	
Saturated Thickness: 15.5 ft	Anisotropy Ratio (Kz/Kr): 1.
WELL DATA (OW-408 U)	
Initial Displacement: 9.342 ft	Static Water Column Height: 34.17 ft
Total Well Penetration Depth: 13.5 ft	Screen Length: 10. ft
Casing Radius: 0.0833 ft	Well Radius: 0.3333 ft
SOLUTION	
Aquifer Model: Confined	Solution Method: Butler
K = 16.86 ft/day	Le = 0.1 ft



OW-408 U RISING HEAD TEST

AQUIFER DATA

Saturated Thickness: 15.5 ft

WELL DATA (OW-408 U)

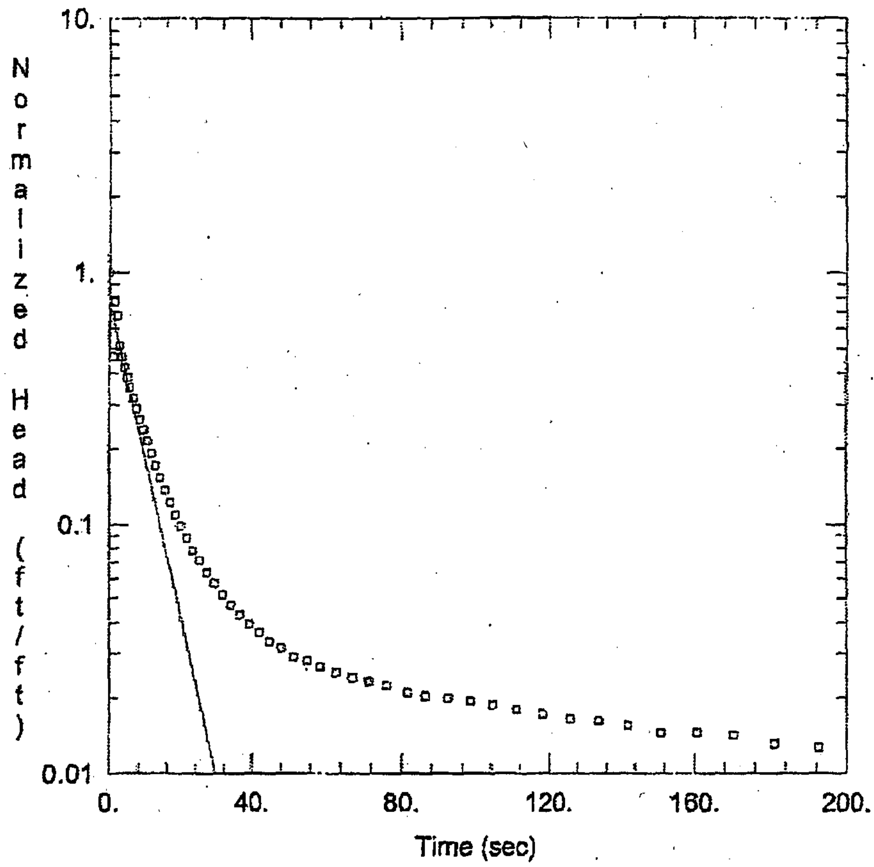
Initial Displacement: 9.342 ft
Total Well Penetration Depth: 13.5 ft
Casing Radius: 0.0833 ft

Static Water Column Height: 34.17 ft
Screen Length: 10. ft
Well Radius: 0.3333 ft

SOLUTION

Aquifer Model: Confined
Kr = 11.06 ft/day
Kz/Kr = 1.

Solution Method: KGS Model
Ss = 0.0002017 ft^{-1}



OW-408 U RISING HEAD TEST

AQUIFER DATA

Saturated Thickness: 15.5 ft   Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (OW-408 U)

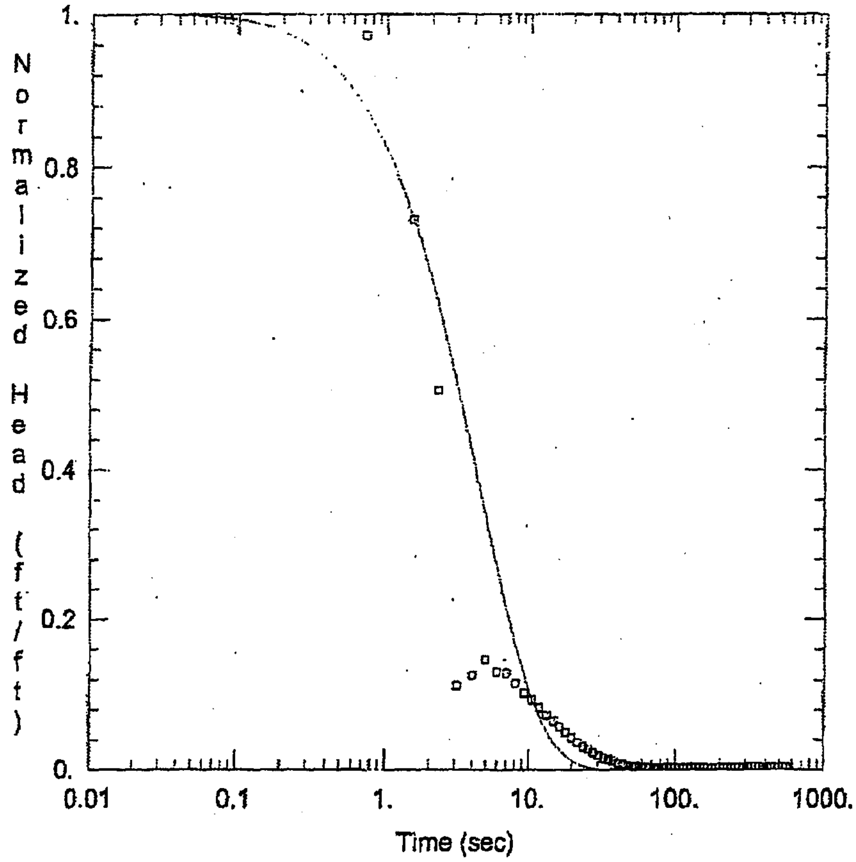
Initial Displacement: 9.342 ft
Total Well Penetration Depth: 13.5 ft
Casing Radius: 0.0833 ft

Static Water Column Height: 34.17 ft
Screen Length: 10. ft
Well Radius: 0.3333 ft

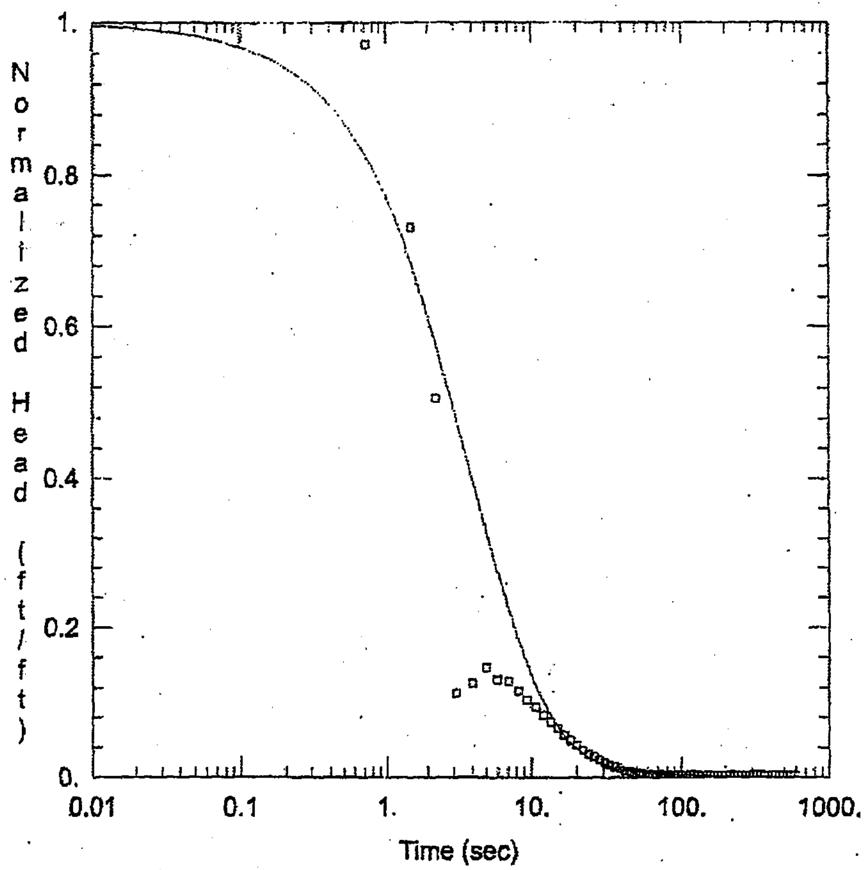
SOLUTION

Aquifer Model: Confined   Solution Method: Bouwer-Rice

K = 10.94 ft/day   y0 = 7.185 ft



OW-408 U FALLING HEAD TEST	
AQUIFER DATA	
Saturated Thickness: 15.5 ft	Anisotropy Ratio (Kz/Kr): 1.
WELL DATA (OW-408 U)	
Initial Displacement: 9.499 ft	Static Water Column Height: 34.17 ft
Total Well Penetration Depth: 13.5 ft	Screen Length: 10. ft
Casing Radius: 0.0833 ft	Well Radius: 0.3333 ft
SOLUTION	
Aquifer Model: Confined	Solution Method: Butler
K = 22.4 ft/day	Le = 17.38 ft



OW-408 U FALLING HEAD TEST

AQUIFER DATA

Saturated Thickness: 15.5 ft

WELL DATA (OW-408 U)

Initial Displacement: 9.499 ft
Total Well Penetration Depth: 13.5 ft
Casing Radius: 0.0833 ft

Static Water Column Height: 34.17 ft
Screen Length: 10. ft
Well Radius: 0.3333 ft

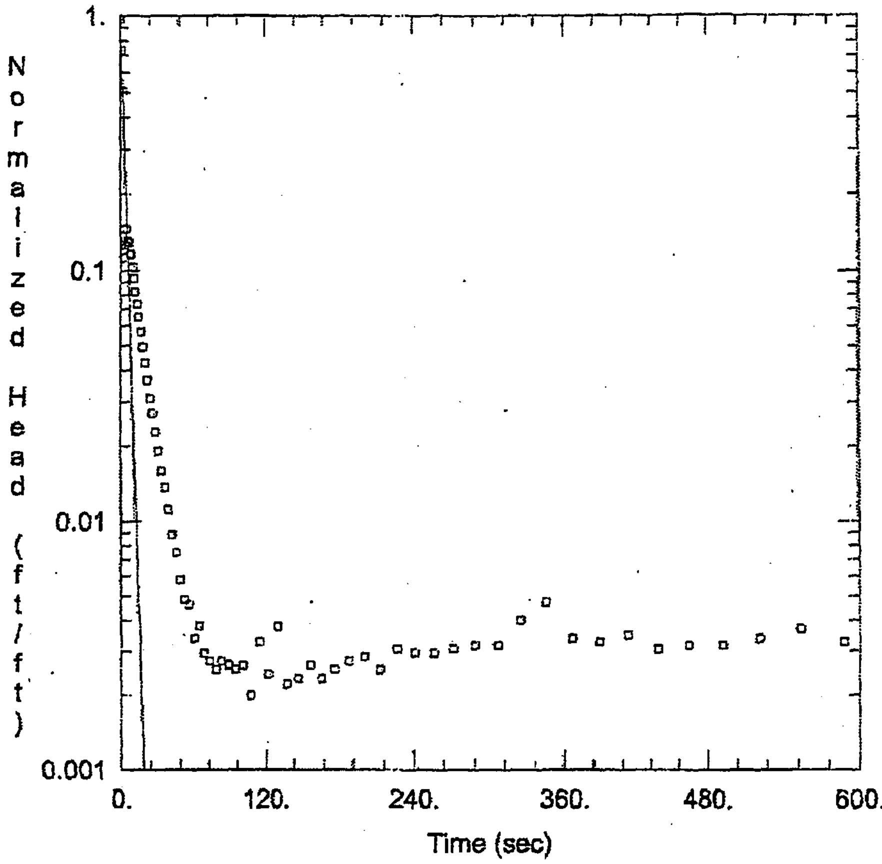
SOLUTION

Aquifer Model: Confined

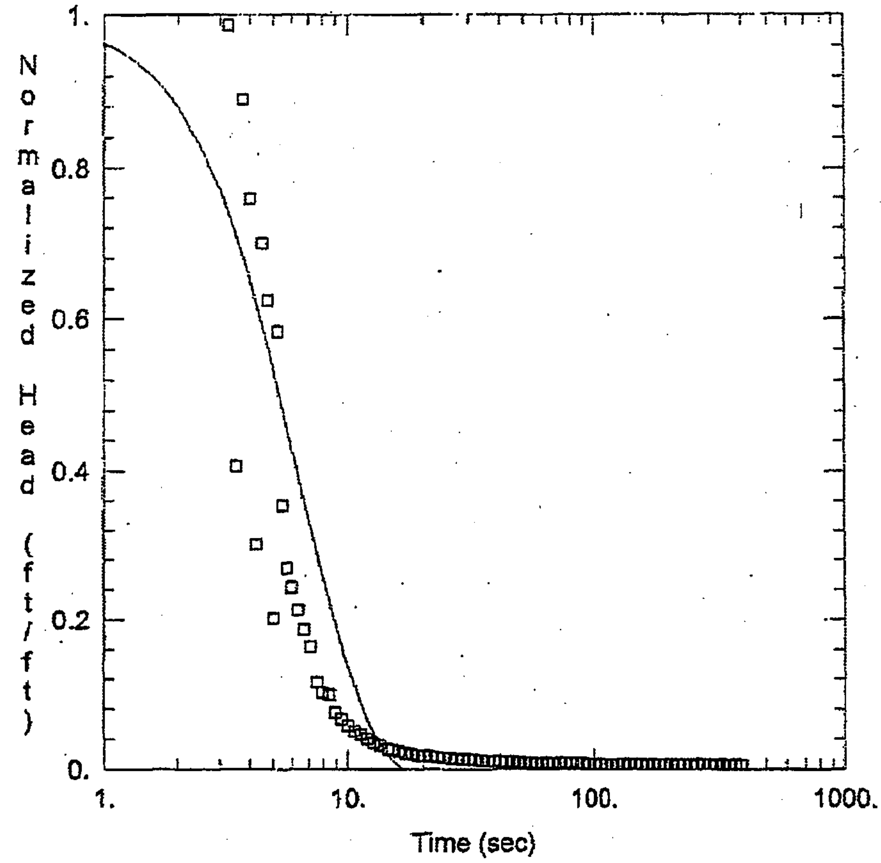
Kr = 31.48 ft/day
Kz/Kr = 1.

Solution Method: KGS Model

Ss = 1.106E-7 ft^{-1}



OW-408 U FALLING HEAD TEST	
AQUIFER DATA	
Saturated Thickness: 15.5 ft	Anisotropy Ratio (Kz/Kr): 1.
WELL DATA (OW-408 U)	
Initial Displacement: 9.499 ft	Static Water Column Height: 34.17 ft
Total Well Penetration Depth: 13.5 ft	Screen Length: 10. ft
Casing Radius: 0.0833 ft	Well Radius: 0.3333 ft
SOLUTION	
Aquifer Model: Confined	Solution Method: Bouwer-Rice
K = 28.44 ft/day	y0 = 10.46 ft



OW-420 U RISING HEAD

AQUIFER DATA

Saturated Thickness: 25.2 ft

Anisotropy Ratio (Kz/Kr): 0.4519

WELL DATA (OW-420 U)

Initial Displacement: 6.37 ft
Total Well Penetration Depth: 48. ft
Casing Radius: 0.08333 ft

Static Water Column Height: 39.88 ft
Screen Length: 10. ft
Well Radius: 0.3333 ft

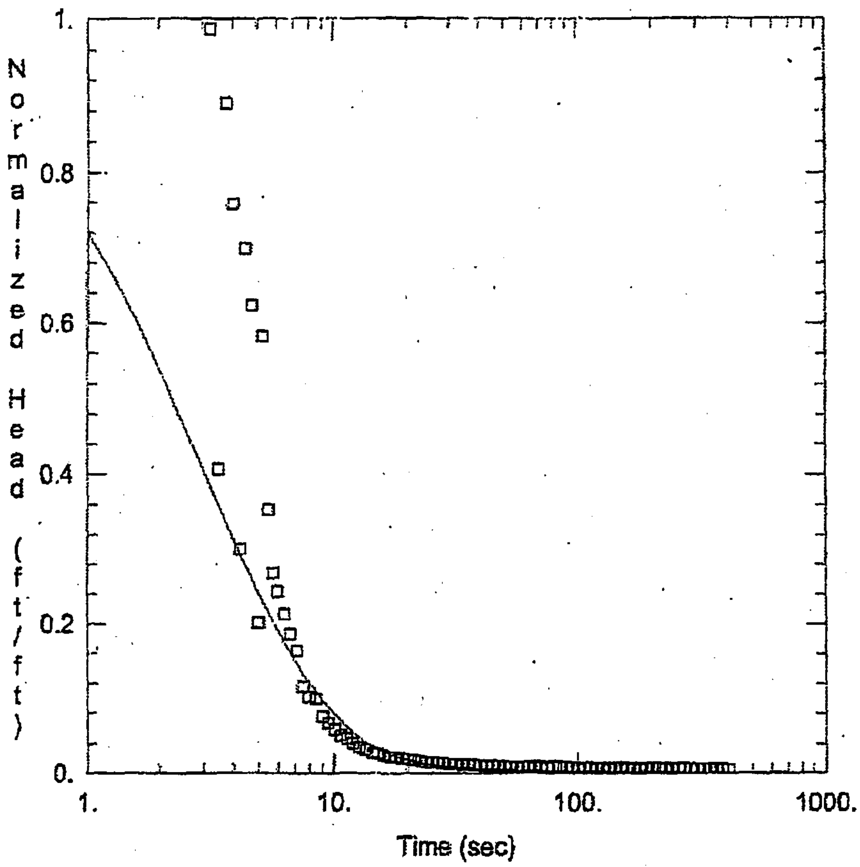
SOLUTION

Aquifer Model: Confined

Solution Method: Butler

K = 23.15 ft/day

Le = 381.2 ft



OW-420 U RISING HEAD

AQUIFER DATA

Saturated Thickness: 25.2 ft

WELL DATA (OW-420 U)

Initial Displacement: 6.37 ft
Total Well Penetration Depth: 48. ft
Casing Radius: 0.08333 ft

Static Water Column Height: 39.88 ft
Screen Length: 10. ft
Well Radius: 0.3333 ft

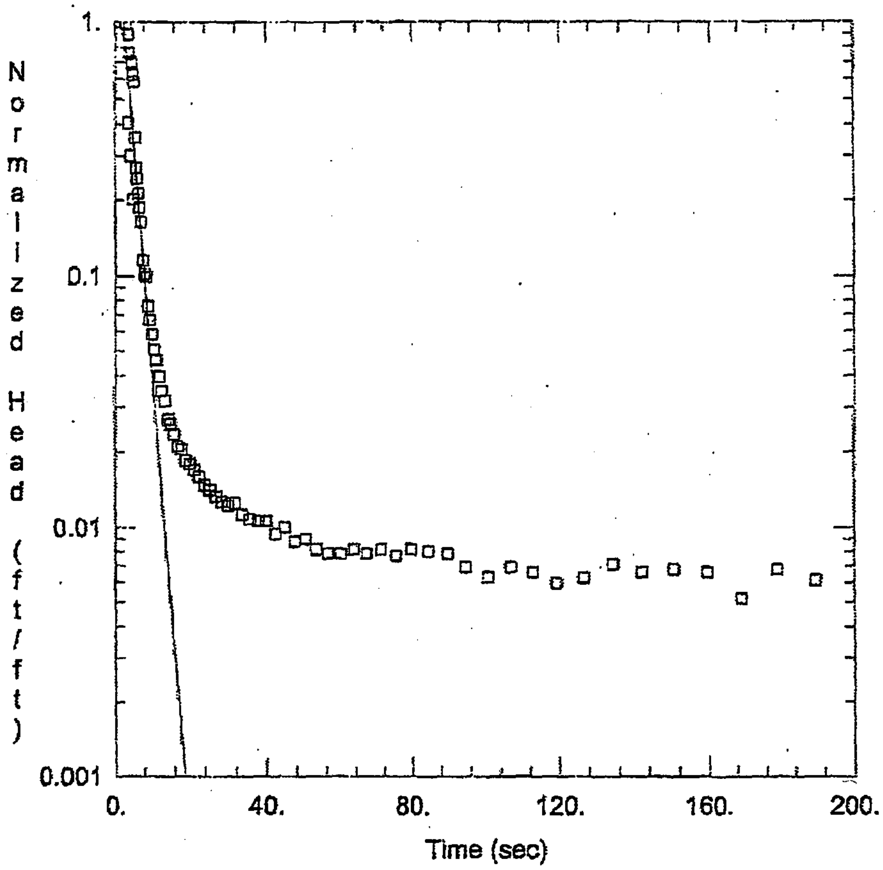
SOLUTION

Aquifer Model: Confined

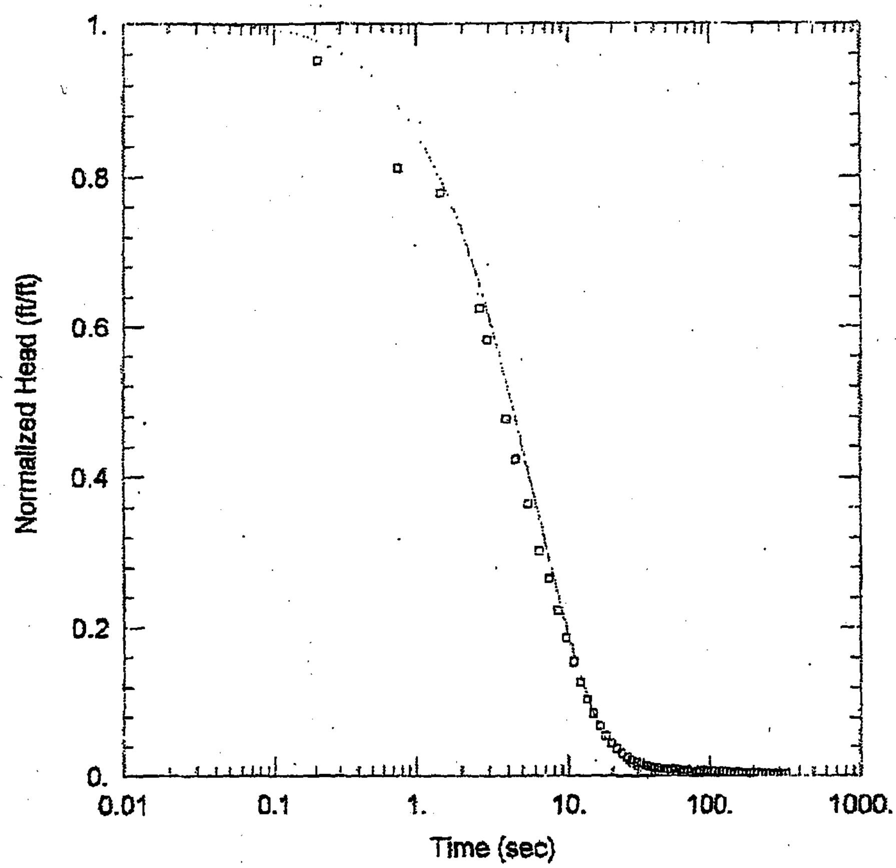
Kr = 32.9 ft/day
Kz/Kr = 0.4519

Solution Method: KGS Model

Ss = 8.987E-7 ft^{-1}



OW-420 U RISING HEAD	
AQUIFER DATA	
Saturated Thickness: 25. ft	Anisotropy Ratio (Kz/Kr): 1.
WELL DATA (OW-420 U)	
Initial Displacement: 6.37 ft	Static Water Column Height: 39.88 ft
Total Well Penetration Depth: 48. ft	Screen Length: 10. ft
Casing Radius: 0.08333 ft	Well Radius: 0.3333 ft
SOLUTION	
Aquifer Model: Confined	Solution Method: Bouwer-Rice
K = 44.74 ft/day	y0 = 18.78 ft



OW-438 L RISING HEAD TEST

AQUIFER DATA

Saturated Thickness: 17. ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (OW-438 L)

Initial Displacement: 5.526 ft
Total Well Penetration Depth: 11. ft
Casing Radius: 0.08333 ft

Static Water Column Height: 88.49 ft
Screen Length: 10. ft
Well Radius: 0.3333 ft

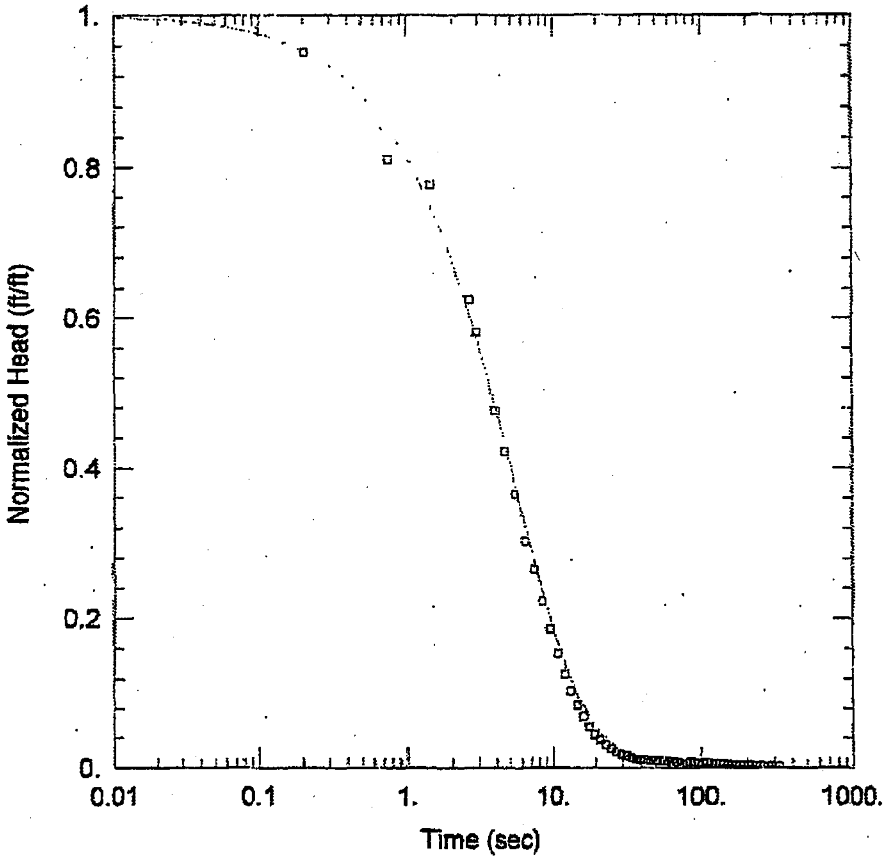
SOLUTION

Aquifer Model: Confined

Solution Method: Butler

K = 17.11 ft/day

Le = 13.8 ft



OW-438 L RISING HEAD TEST

AQUIFER DATA

Saturated Thickness: 17. ft

WELL DATA (OW-438 L)

Initial Displacement: 5.526 ft
Total Well Penetration Depth: 11. ft
Casing Radius: 0.08333 ft

Static Water Column Height: 88.49 ft
Screen Length: 10. ft
Well Radius: 0.3333 ft

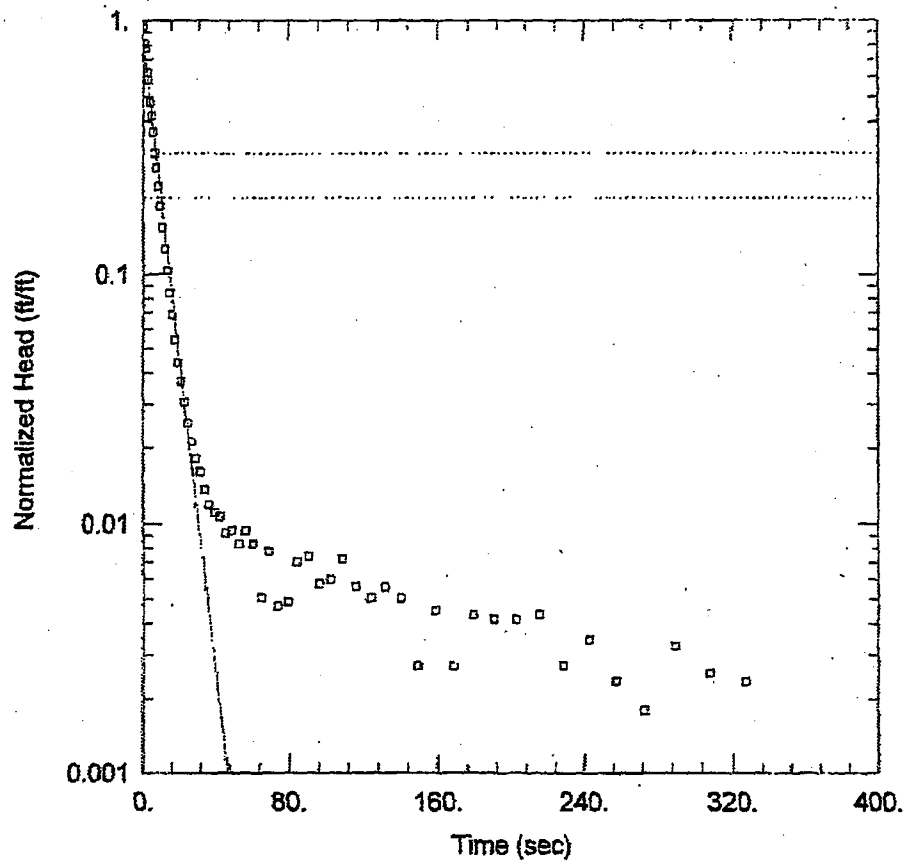
SOLUTION

Aquifer Model: Confined

Kr = 27.13 ft/day
Kz/Kr = 1.

Solution Method: KGS Model

Ss = 2.481E-8 ft^{-1}



OW-438 L RISING HEAD TEST

AQUIFER DATA

Saturated Thickness: 17. ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (OW-438 L)

Initial Displacement: 5.526 ft
Total Well Penetration Depth: 11. ft
Casing Radius: 0.08333 ft

Static Water Column Height: 88.49 ft
Screen Length: 10. ft
Well Radius: 0.3333 ft

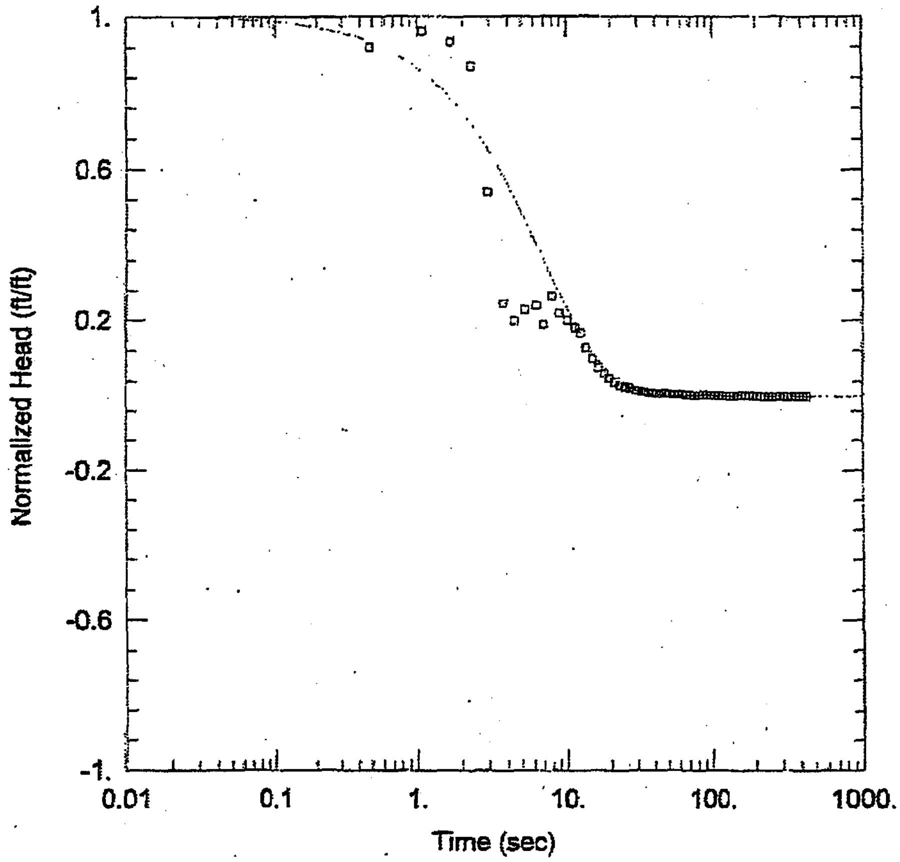
SOLUTION

Aquifer Model: Confined

Solution Method: Bouwer-Rice

K = 9.849 ft/day

y0 = 4.555 ft



OW-438 L FALLING HEAD TEST

AQUIFER DATA

Saturated Thickness: 17. ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (OW-438 L)

Initial Displacement: 8.968 ft
Total Well Penetration Depth: 11. ft
Casing Radius: 0.08333 ft

Static Water Column Height: 88.49 ft
Screen Length: 10. ft
Well Radius: 0.3333 ft

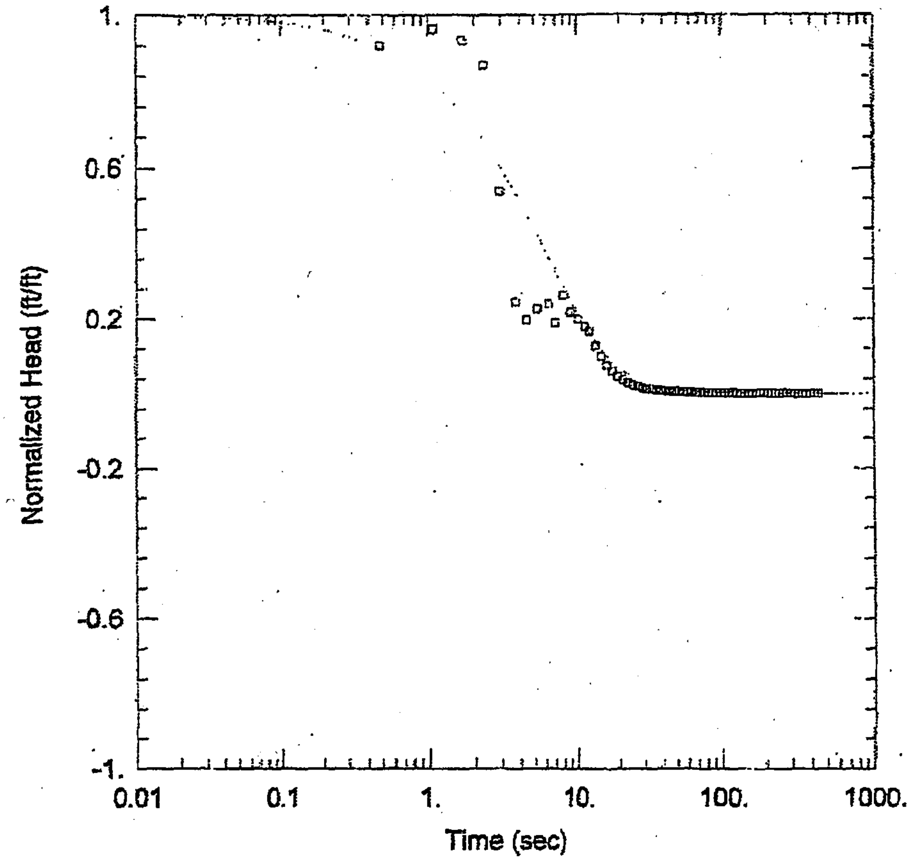
SOLUTION

Aquifer Model: Confined

Solution Method: Butler

K = 15.1 ft/day

Le = 1. ft



OW-438 L FALLING HEAD TEST

AQUIFER DATA

Saturated Thickness: 17. ft

WELL DATA (OW-438 L)

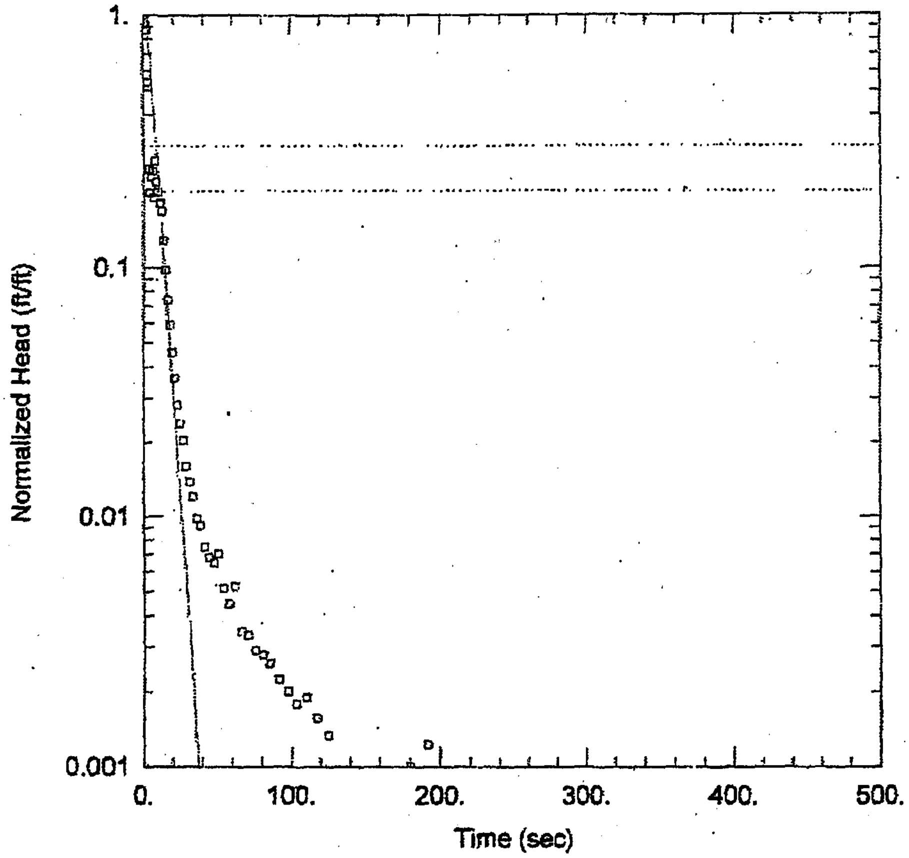
Initial Displacement: 8.968 ft
Total Well Penetration Depth: 11. ft
Casing Radius: 0.08333 ft

Static Water Column Height: 88.49 ft
Screen Length: 10. ft
Well Radius: 0.3333 ft

SOLUTION

Aquifer Model: Confined
Kr = 27.47 ft/day
Kz/Kr = 1.

Solution Method: KGS Model
Ss = 3.123E-9 ft^{-1}



OW-438 L FALLING HEAD TEST

AQUIFER DATA

Saturated Thickness: 17. ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (OW-438 L)

Initial Displacement: 8.968 ft
Total Well Penetration Depth: 11. ft
Casing Radius: 0.08333 ft

Static Water Column Height: 88.49 ft
Screen Length: 10. ft
Well Radius: 0.3333 ft

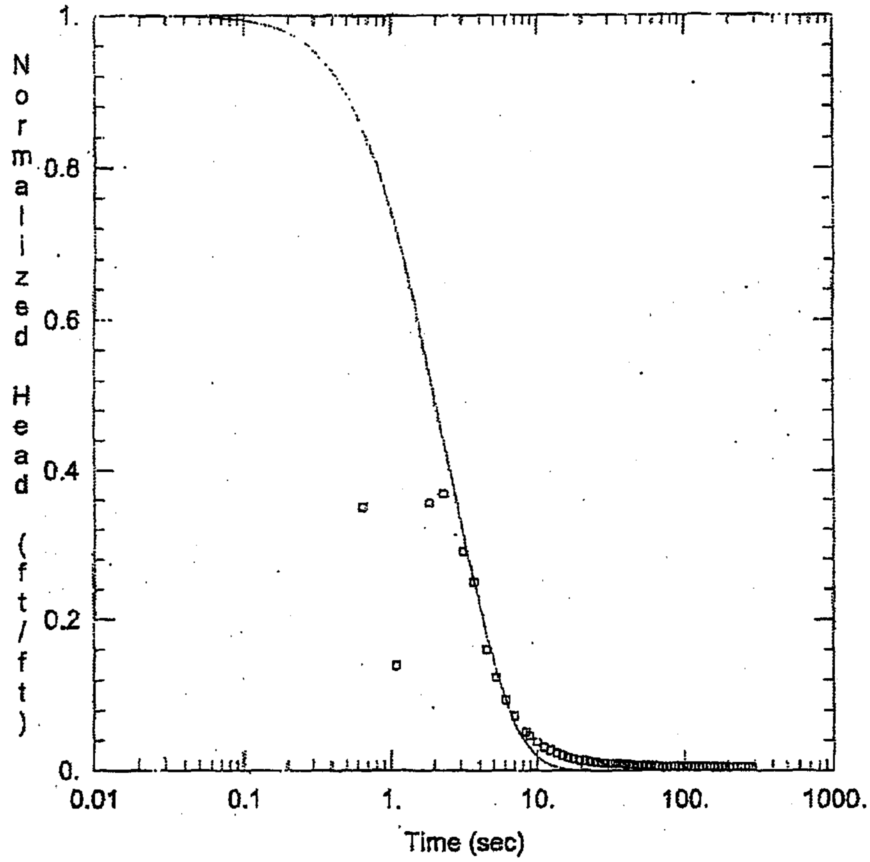
SOLUTION

Aquifer Model: Confined

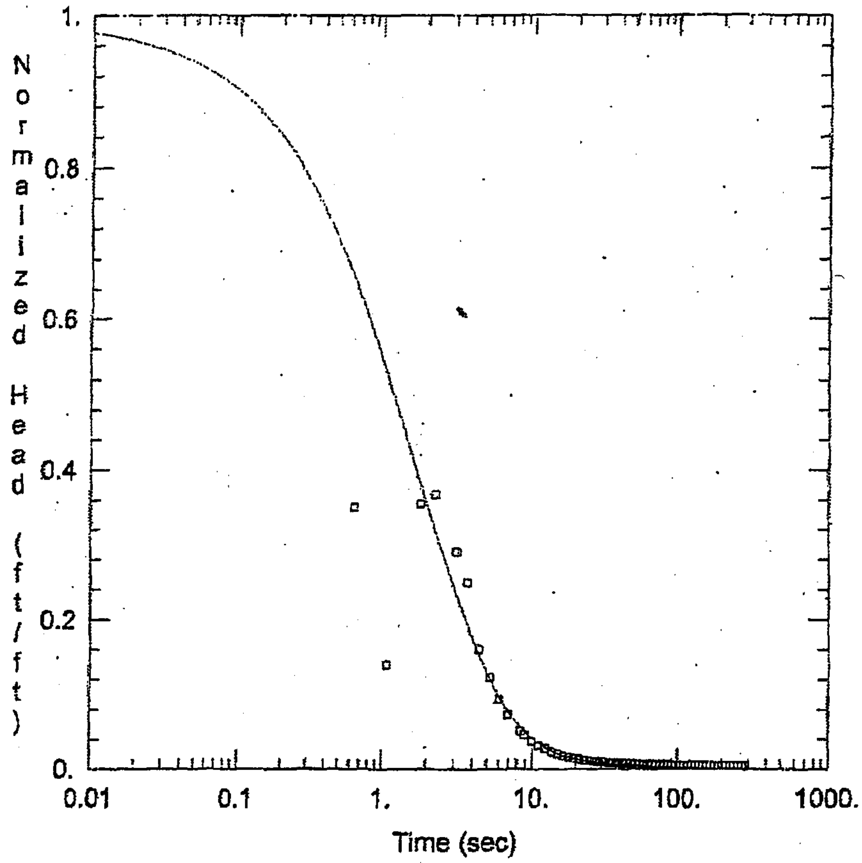
Solution Method: Bouwer-Rice

K = 13.77 ft/day

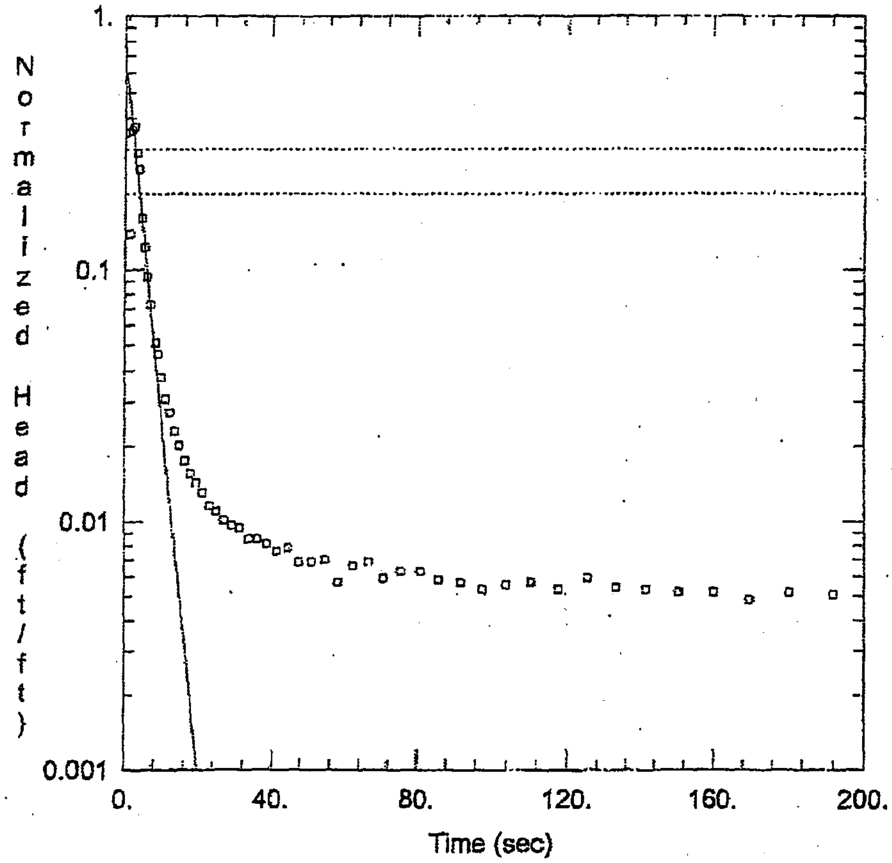
y0 = 15.09 ft



OW-438 U RISING HEAD TEST	
AQUIFER DATA	
Saturated Thickness: 19.5 ft	Anisotropy Ratio (Kz/Kr): 1.
WELL DATA (OW-438 U)	
Initial Displacement: 8.457 ft	Static Water Column Height: 34.58 ft
Total Well Penetration Depth: 18. ft	Screen Length: 10. ft
Casing Radius: 0.08333 ft	Well Radius: 0.3333 ft
SOLUTION	
Aquifer Model: Confined	Solution Method: Butler
K = 37.95 ft/day	Le = 20.89 ft



OW-438 U RISING HEAD TEST	
AQUIFER DATA	
Saturated Thickness: 19.5 ft	
WELL DATA (OW-438 U)	
Initial Displacement: 8.457 ft	Static Water Column Height: 34.58 ft
Total Well Penetration Depth: 18. ft	Screen Length: 10. ft
Casing Radius: 0.08333 ft	Well Radius: 0.3333 ft
SOLUTION	
Aquifer Model: Confined	Solution Method: KGS Model
Kr = 39.4 ft/day	Ss = 5.128E-5 ft^{-1}
Kz/Kr = 1.	



OW-438 U RISING HEAD TEST

AQUIFER DATA

Saturated Thickness: 19.5 ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (OW-438 U)

Initial Displacement: 8.457 ft

Total Well Penetration Depth: 18. ft

Casing Radius: 0.08333 ft

Static Water Column Height: 34.58 ft

Screen Length: 10. ft

Well Radius: 0.3333 ft

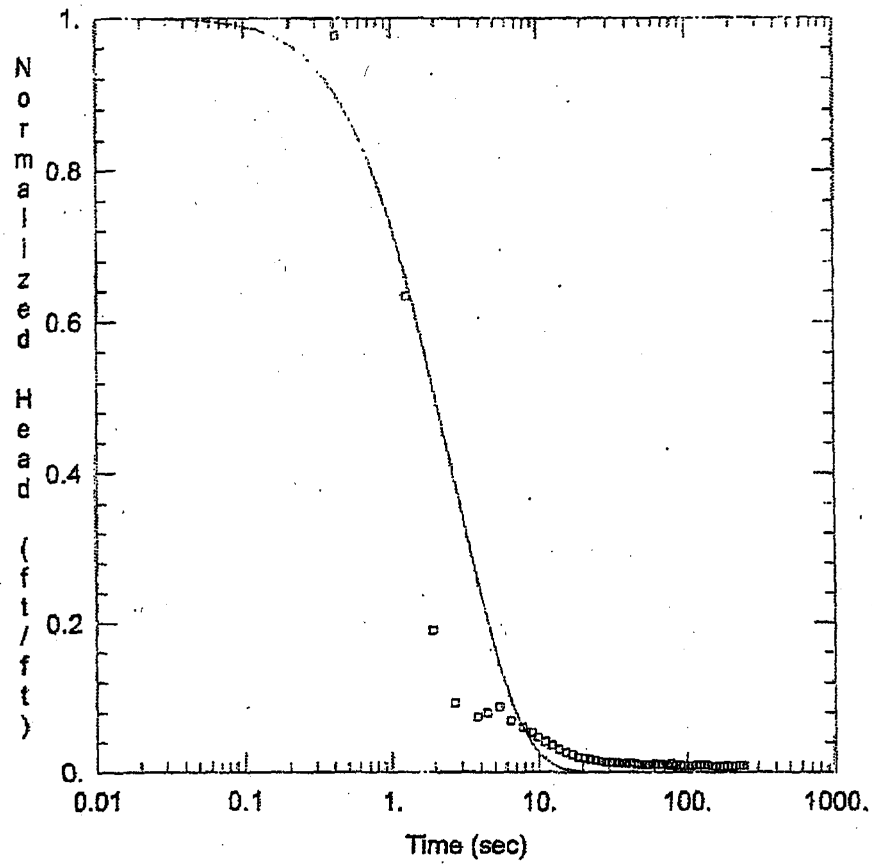
SOLUTION

Aquifer Model: Confined

K = 26.1 ft/day

Solution Method: Bouwer-Rice

y0 = 5.672 ft



OW-438 U FALLING HEAD TEST

AQUIFER DATA

Saturated Thickness: 19.5 ft

Anisotropy Ratio (Kz/Kr): 0.004571

WELL DATA (OW-438 U)

Initial Displacement: 5.486 ft
Total Well Penetration Depth: 18. ft
Casing Radius: 0.08333 ft

Static Water Column Height: 34.58 ft
Screen Length: 10. ft
Well Radius: 0.3333 ft

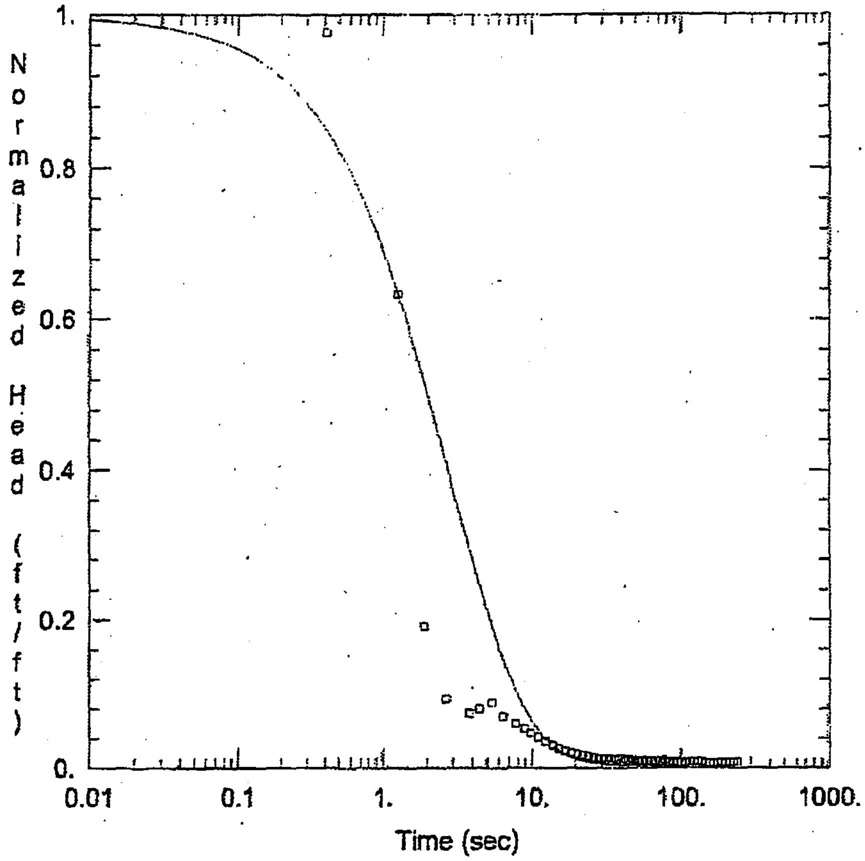
SOLUTION

Aquifer Model: Confined

Solution Method: Butler

K = 64.66 ft/day

Le = 11. ft



OW-438 U FALLING HEAD TEST

AQUIFER DATA

Saturated Thickness: 19.5 ft

WELL DATA (OW-438 U)

Initial Displacement: 5.486 ft
Total Well Penetration Depth: 18. ft
Casing Radius: 0.08333 ft

Static Water Column Height: 34.58 ft
Screen Length: 10. ft
Well Radius: 0.3333 ft

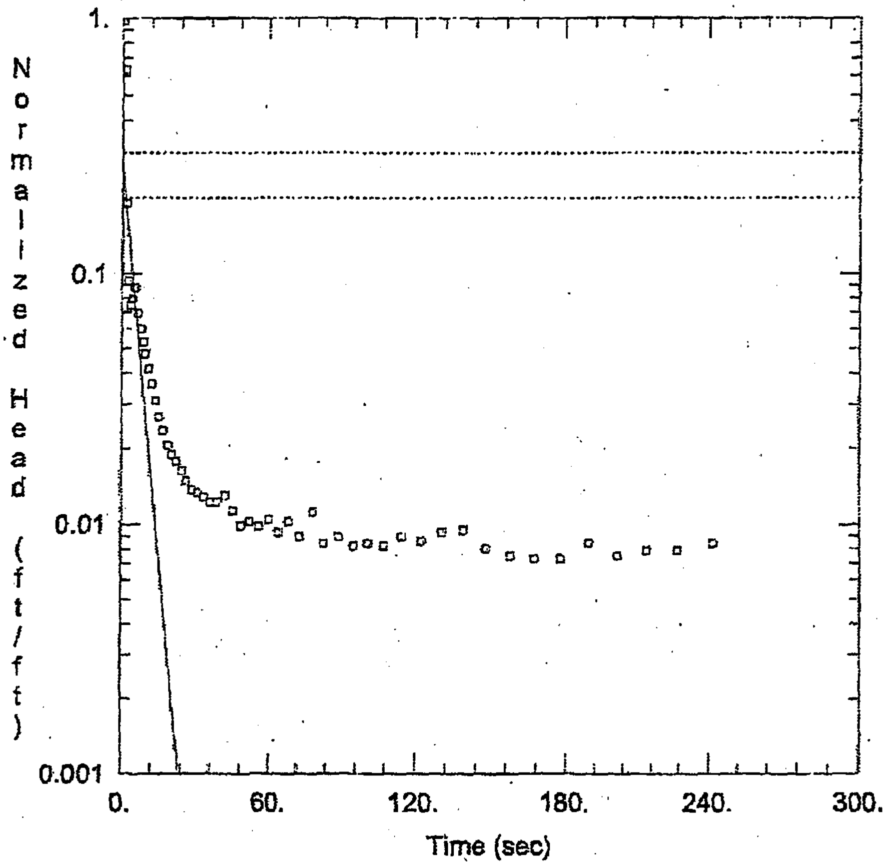
SOLUTION

Aquifer Model: Confined

Kr = 53.06 ft/day
Kz/Kr = 0.004571

Solution Method: KGS Model

Ss = $2.283E\text{-}7\ ft^{-1}$



OW-438 U FALLING HEAD TEST

AQUIFER DATA

Saturated Thickness: 19.5 ft

Anisotropy Ratio (Kz/Kr): 0.1905

WELL DATA (OW-438 U)

Initial Displacement: 5.486 ft
Total Well Penetration Depth: 18. ft
Casing Radius: 0.08333 ft

Static Water Column Height: 34.58 ft
Screen Length: 10. ft
Well Radius: 0.3333 ft

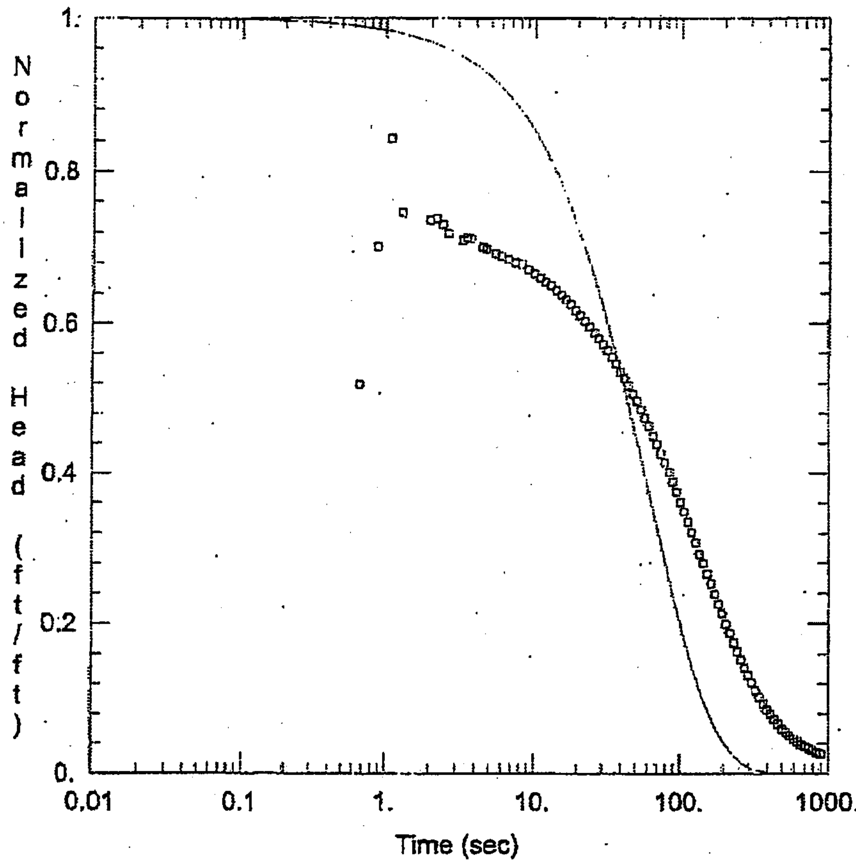
SOLUTION

Aquifer Model: Confined

Solution Method: Bouwer-Rice

K = 24.12 ft/day

y0 = 1.513 ft



OW-910 L RISING HEAD TEST

AQUIFER DATA

Saturated Thickness: 5. ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (OW-910 L)

Initial Displacement: 7.792 ft

Total Well Penetration Depth: 11.5 ft

Casing Radius: 0.0833 ft

Static Water Column Height: 74.8 ft

Screen Length: 10. ft

Well Radius: 0.3333 ft

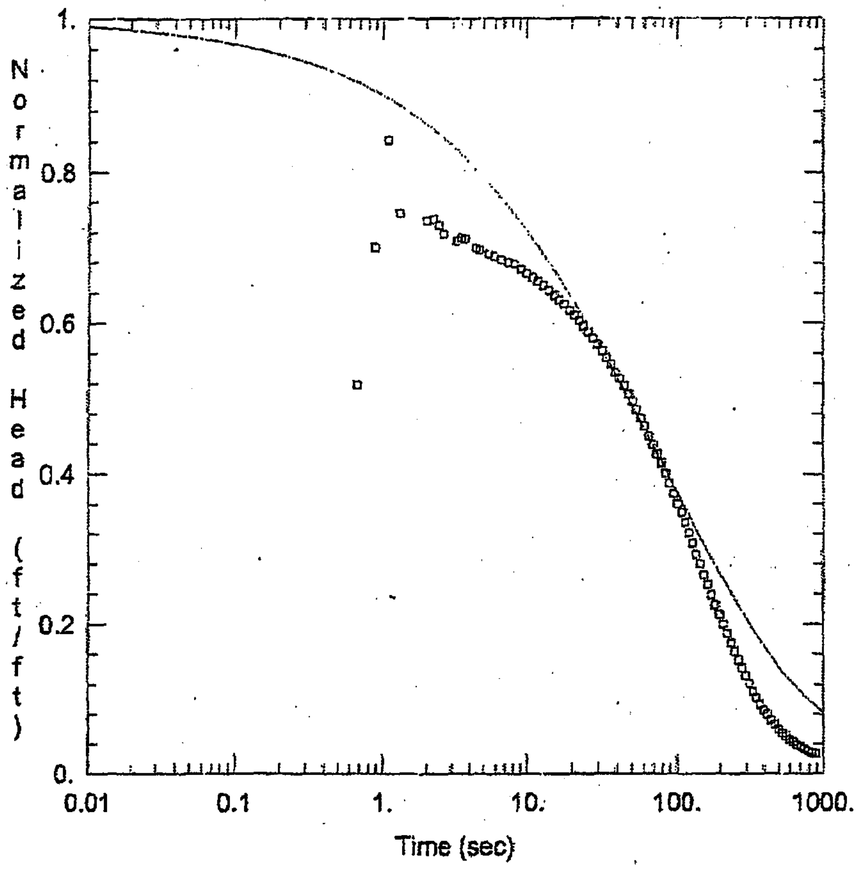
SOLUTION

Aquifer Model: Confined

Solution Method: Butler

K = 2.552 ft/day

Le = 10.96 ft



OW-910 L RISING HEAD TEST

AQUIFER DATA

Saturated Thickness: 5. ft

WELL DATA (OW-910 L)

Initial Displacement: 7.792 ft
Total Well Penetration Depth: 11.5 ft
Casing Radius: 0.0833 ft

Static Water Column Height: 74.8 ft
Screen Length: 10. ft
Well Radius: 0.3333 ft

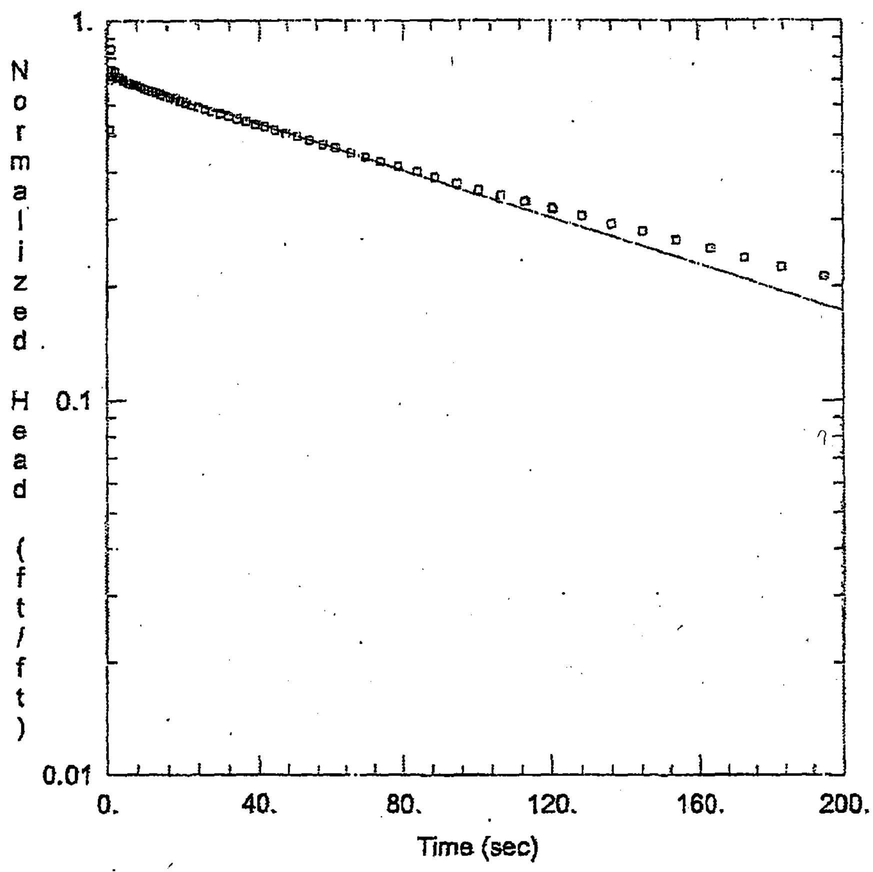
SOLUTION

Aquifer Model: Confined

Kr = 0.3244 ft/day
Kz/Kr = 1.

Solution Method: KGS Model

Ss = 0.009989 ft^{-1}



OW-910 L RISING HEAD TEST

AQUIFER DATA

Saturated Thickness: 5. ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (OW-910 L)

Initial Displacement: 7.792 ft

Total Well Penetration Depth: 11.5 ft

Casing Radius: 0.0833 ft

Static Water Column Height: 74.8 ft

Screen Length: 10. ft

Well Radius: 0.3333 ft

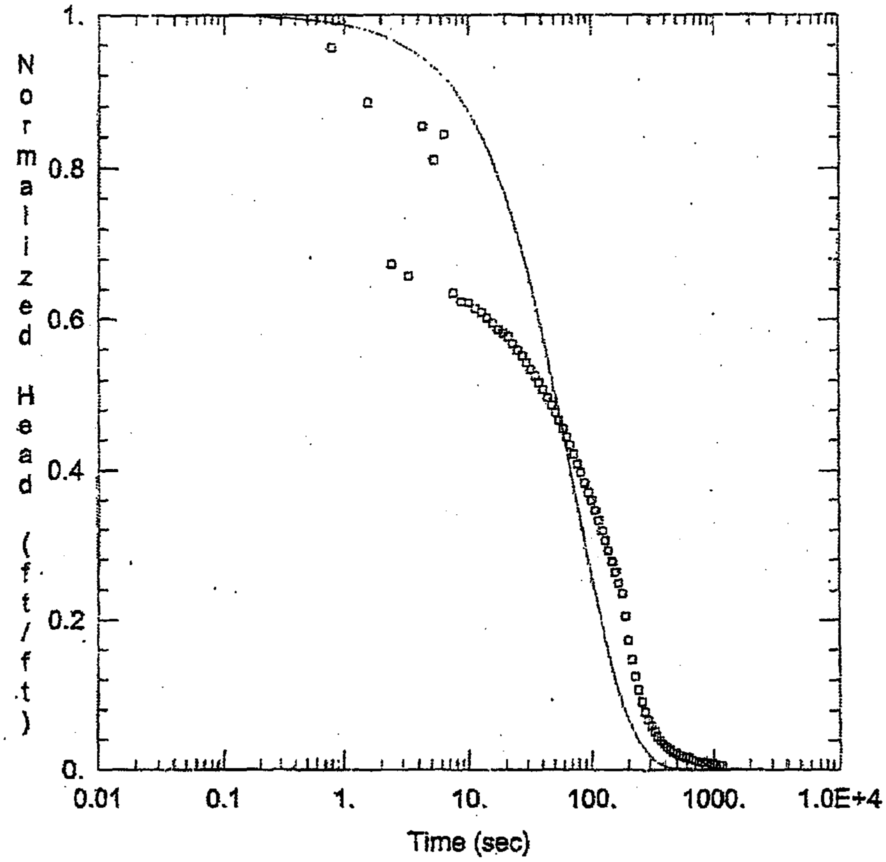
SOLUTION

Aquifer Model: Confined

Solution Method: Bouwer-Rice

K = 0.5645 ft/day

y0 = 5.55 ft



OW-910 L FALLING HEAD TEST

AQUIFER DATA

Saturated Thickness: 5. ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (OW-910 L)

Initial Displacement: 9.991 ft
Total Well Penetration Depth: 11.5 ft
Casing Radius: 0.0833 ft

Static Water Column Height: 74.8 ft
Screen Length: 10. ft
Well Radius: 0.3333 ft

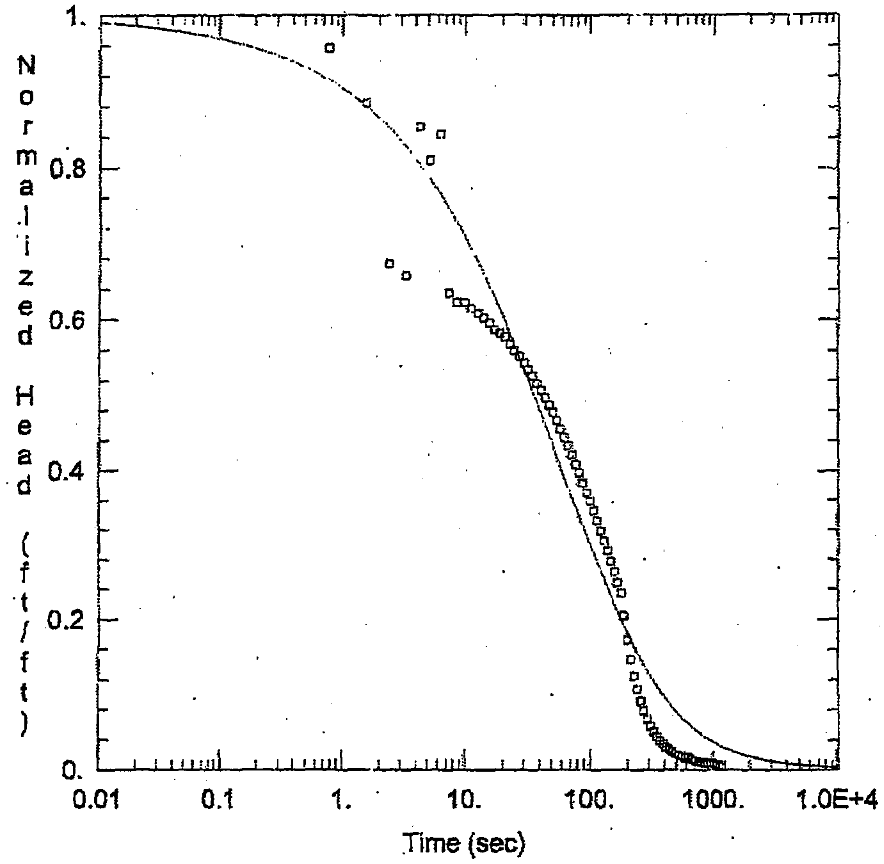
SOLUTION

Aquifer Model: Confined

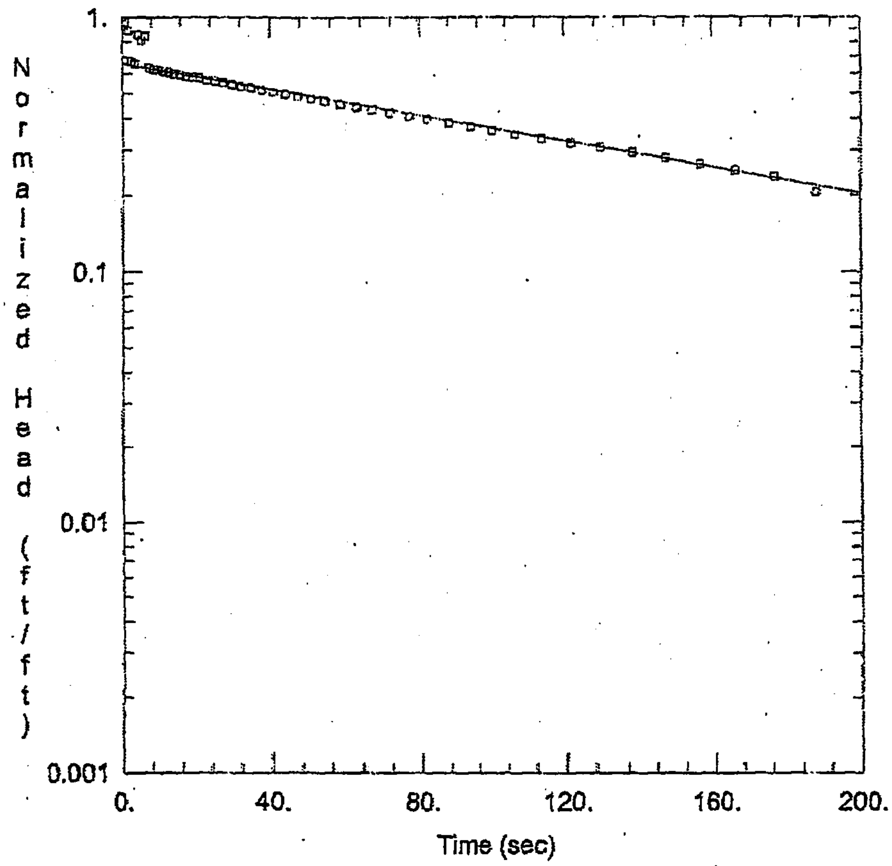
Solution Method: Butler

K = 2.156 ft/day

Le = 0.1 ft



OW-910 L FALLING HEAD TEST	
AQUIFER DATA	
Saturated Thickness: 5. ft	
WELL DATA (OW-910 L)	
Initial Displacement: 9.991 ft	Static Water Column Height: 74.8 ft
Total Well Penetration Depth: 11.5 ft	Screen Length: 10. ft
Casing Radius: 0.0833 ft	Well Radius: 0.3333 ft
SOLUTION	
Aquifer Model: Confined	Solution Method: KGS Model
Kr = 0.9391 ft/day	Ss = 0.00287 ft^{-1}
Kz/Kr = 1.	



OW-910 L FALLING HEAD TEST

AQUIFER DATA

Saturated Thickness: 5. ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (OW-910 L)

Initial Displacement: 9.991 ft

Total Well Penetration Depth: 11.5 ft

Casing Radius: 0.0833 ft

Static Water Column Height: 74.8 ft

Screen Length: 10. ft

Well Radius: 0.3333 ft

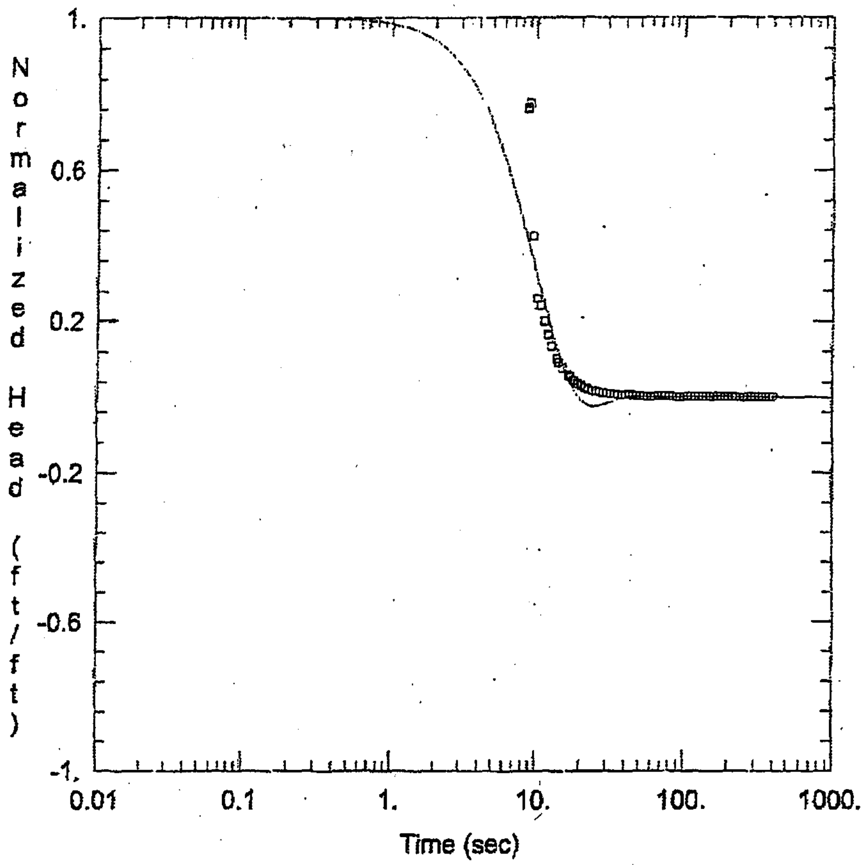
SOLUTION

Aquifer Model: Confined

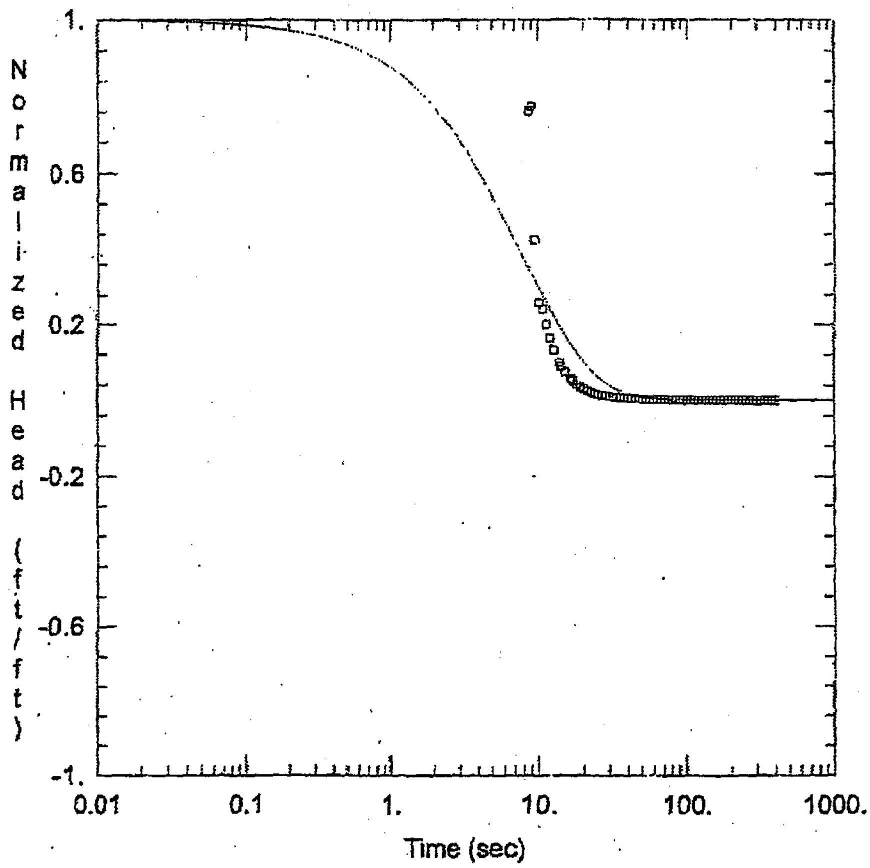
Solution Method: Bouwer-Rice

K = 0.4684 ft/day

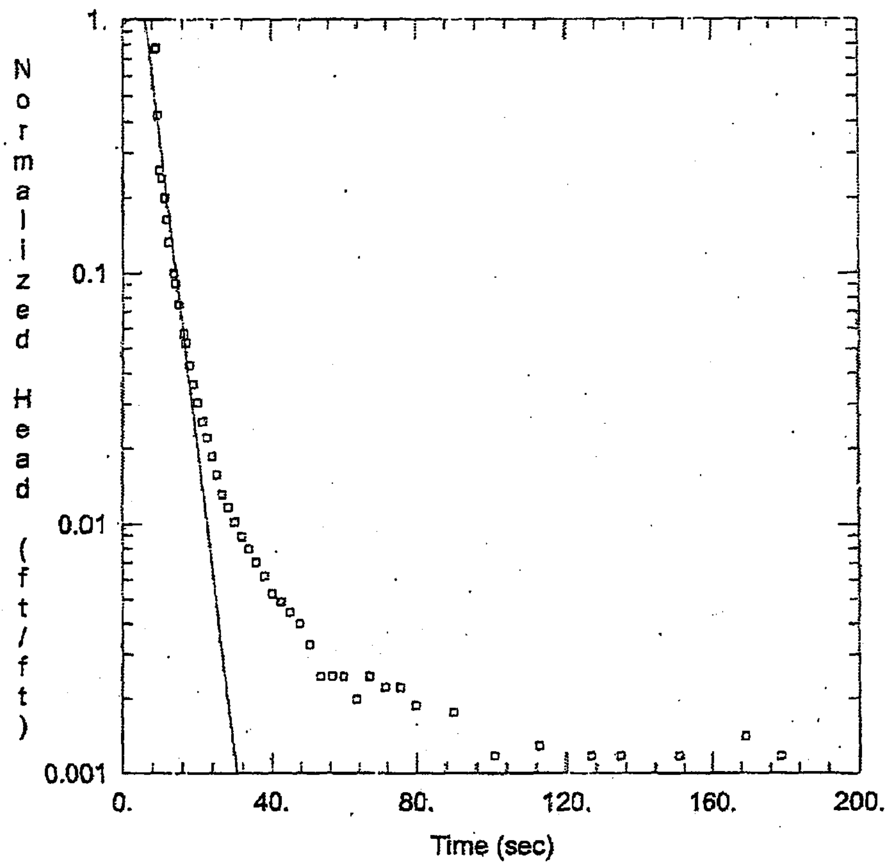
y0 = 6.589 ft



OW-910 U RISING HEAD TEST	
AQUIFER DATA	
Saturated Thickness: 25. ft	Anisotropy Ratio (Kz/Kr): 0.001189
WELL DATA (OW-910 U)	
Initial Displacement: 8.539 ft	Static Water Column Height: 26.75 ft
Total Well Penetration Depth: 16.5 ft	Screen Length: 10. ft
Casing Radius: 0.0833 ft	Well Radius: 0.3333 ft
SOLUTION	
Aquifer Model: Confined	Solution Method: Butler
K = 25.94 ft/day	Le = 861.6 ft



OW-910 U RISING HEAD TEST	
AQUIFER DATA	
Saturated Thickness: 25. ft	
WELL DATA (OW-910 U)	
Initial Displacement: 8.539 ft	Static Water Column Height: 26.75 ft
Total Well Penetration Depth: 16.5 ft	Screen Length: 10. ft
Casing Radius: 0.0833 ft	Well Radius: 0.3333 ft
SOLUTION	
Aquifer Model: Confined	Solution Method: KGS Model
Kr = 28.91 ft/day	Ss = 4.0E-12 ft^{-1}
Kz/Kr = 0.001189	



OW-910 U RISING HEAD TEST

AQUIFER DATA

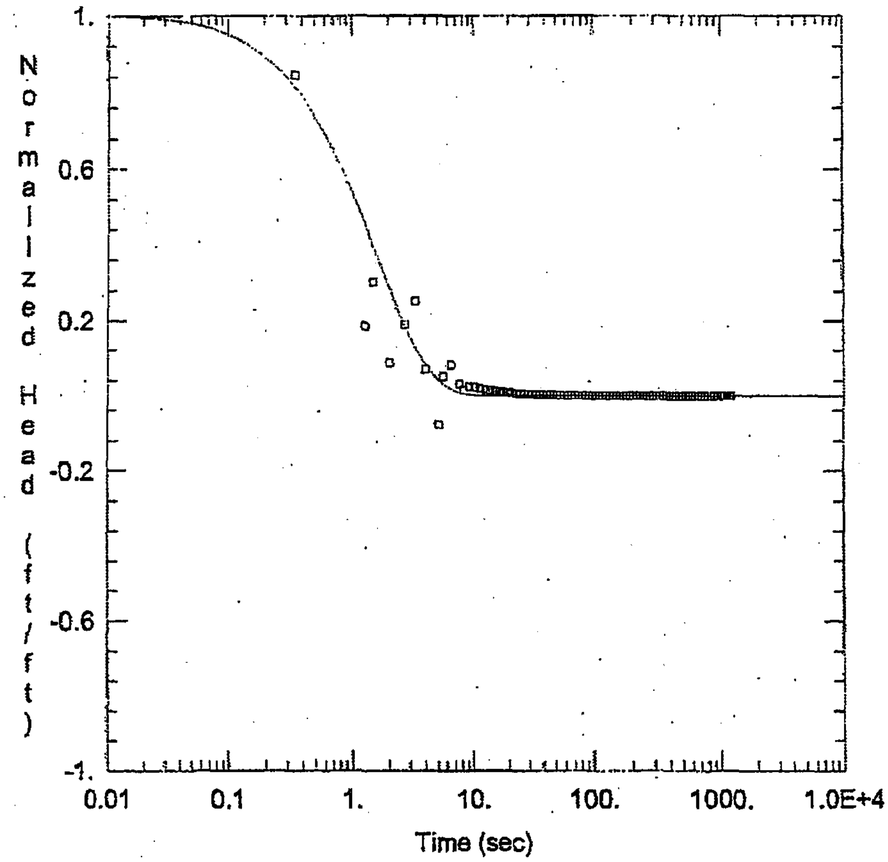
Saturated Thickness: 25. ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (OW-910 U)

Initial Displacement: 8.539 ft
Total Well Penetration Depth: 16.5 ft
Casing Radius: 0.0833 ft
Static Water Column Height: 26.75 ft
Screen Length: 10. ft
Well Radius: 0.3333 ft

SOLUTION

Aquifer Model: Confined
K = 20.82 ft/day
Solution Method: Bouwer-Rice
y0 = 48.65 ft



OW-910 U FALLING HEAD TEST

AQUIFER DATA

Saturated Thickness: 25. ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (OW-910 U)

Initial Displacement: 8.502 ft
Total Well Penetration Depth: 16.5 ft
Casing Radius: 0.0833 ft

Static Water Column Height: 26.75 ft
Screen Length: 10. ft
Well Radius: 0.3333 ft

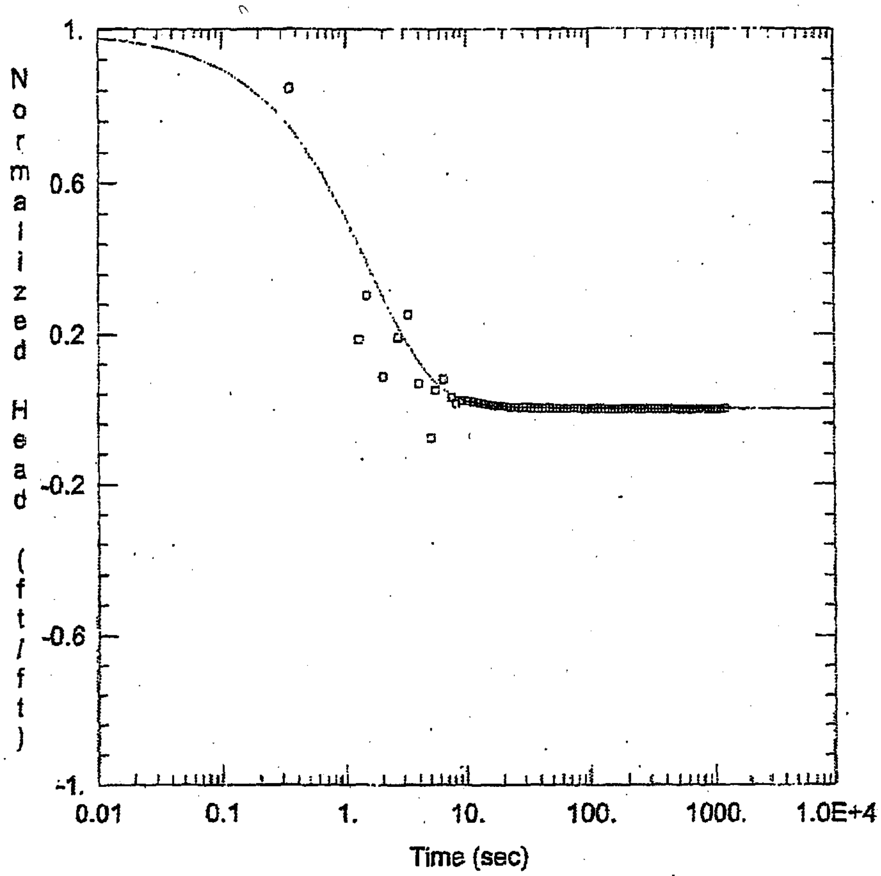
SOLUTION

Aquifer Model: Confined

K = 63.52 ft/day

Solution Method: Butler

Le = 1. ft



OW-910 U FALLING HEAD TEST

AQUIFER DATA

Saturated Thickness: 25. ft

WELL DATA (OW-910 U)

Initial Displacement: 8.502 ft
Total Well Penetration Depth: 16.5 ft
Casing Radius: 0.0833 ft

Static Water Column Height: 26.75 ft
Screen Length: 10. ft
Well Radius: 0.3333 ft

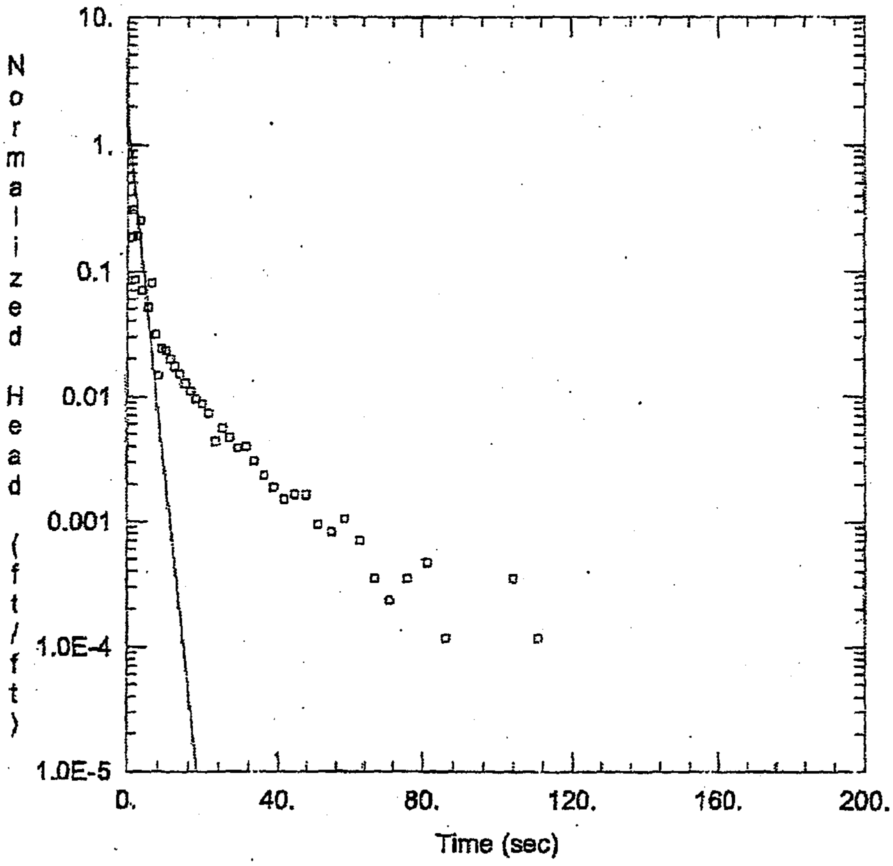
SOLUTION

Aquifer Model: Confined

Kr = 47.41 ft/day
Kz/Kr = 1.

Solution Method: KGS Model

Ss = 4.0E-5 ft^{-1}



OW-910 U FALLING HEAD TEST

AQUIFER DATA

Saturated Thickness: 25. ft　　Anisotropy Ratio (Kz/Kr): 1.

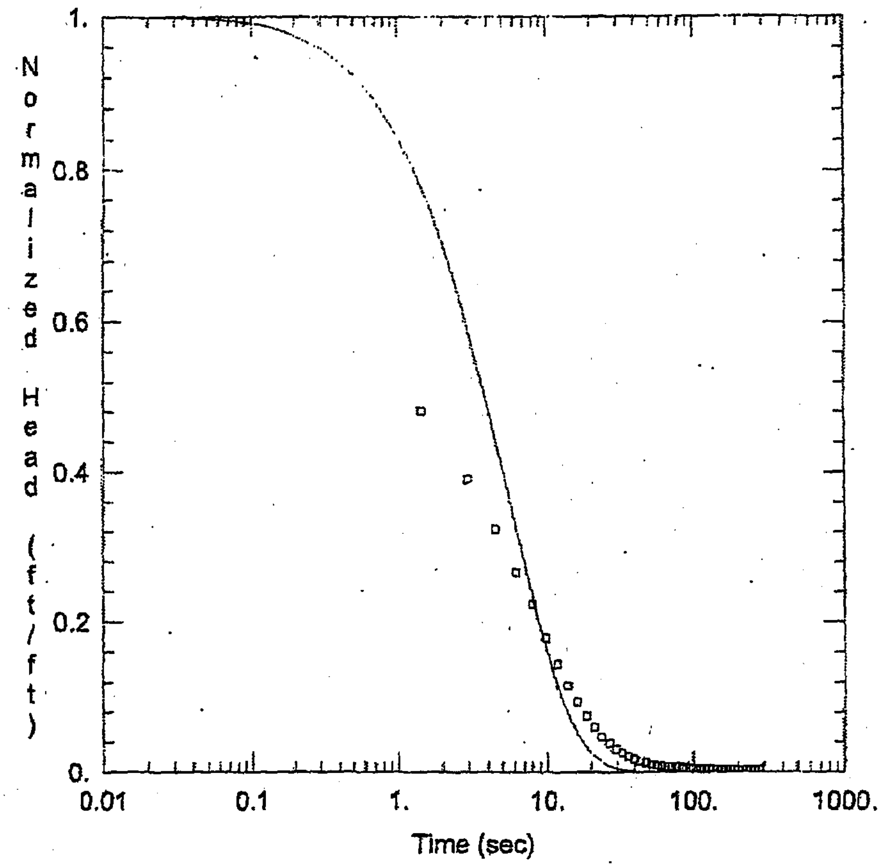
WELL DATA (OW-910 U)

Initial Displacement: 8.502 ft　　Static Water Column Height: 26.75 ft
Total Well Penetration Depth: 16.5 ft　　Screen Length: 10. ft
Casing Radius: 0.0833 ft　　Well Radius: 0.3333 ft

SOLUTION

Aquifer Model: Confined　　Solution Method: Bouwer-Rice

K = 48.26 ft/day　　y0 = 13.41 ft



OW-928 L RISING HEAD TEST

AQUIFER DATA

Saturated Thickness: 15. ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (OW-928 L)

Initial Displacement: 10.71 ft

Total Well Penetration Depth: 11.5 ft

Casing Radius: 0.08333 ft

Static Water Column Height: 106.8 ft

Screen Length: 10. ft

Well Radius: 0.3333 ft

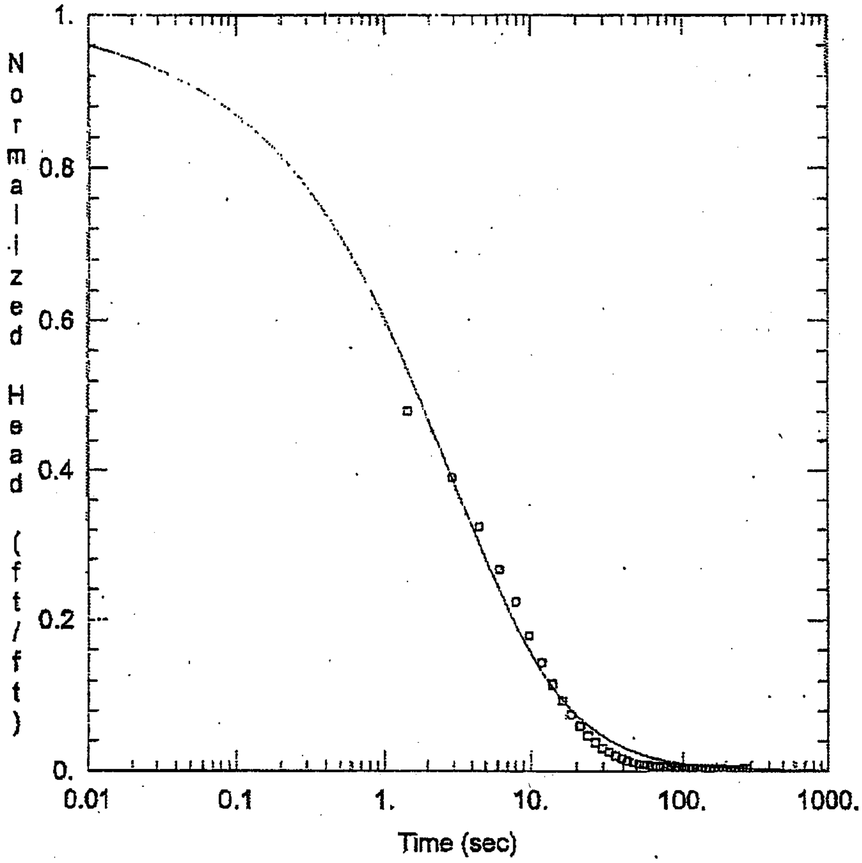
SOLUTION

Aquifer Model: Confined

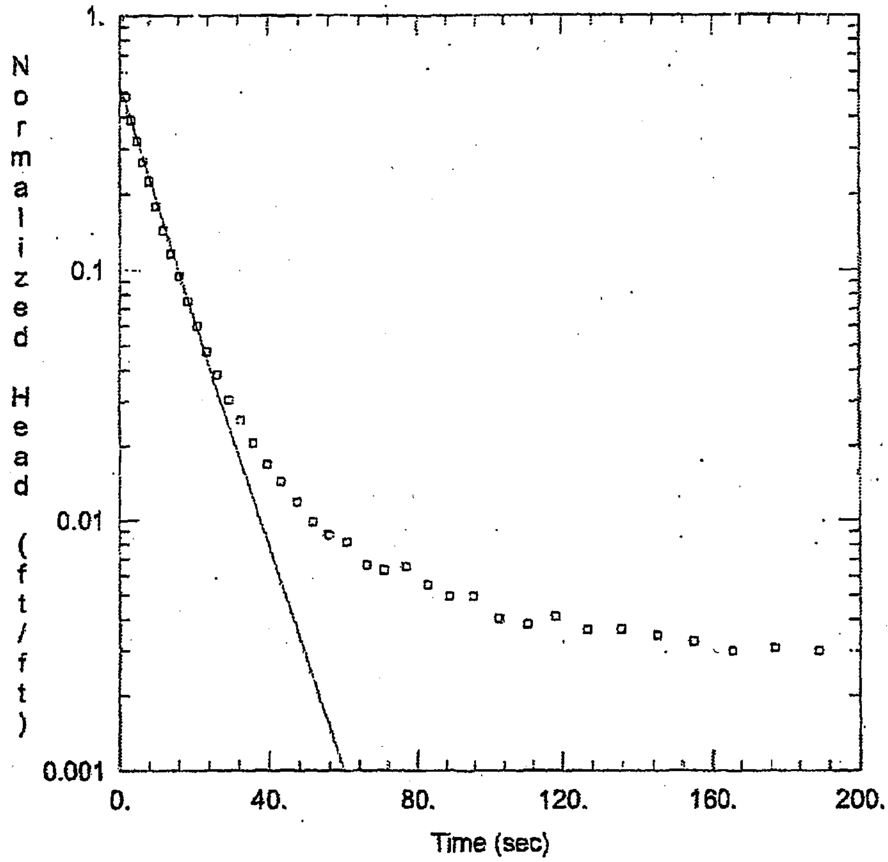
K = 18.69 ft/day

Solution Method: Butler

Le = 11.48 ft



OW-928 L RISING HEAD TEST	
AQUIFER DATA	
Saturated Thickness: 15. ft	
WELL DATA (OW-928 L)	
Initial Displacement: 10.71 ft	Static Water Column Height: 106.8 ft
Total Well Penetration Depth: 11.5 ft	Screen Length: 10. ft
Casing Radius: 0.08333 ft	Well Radius: 0.3333 ft
SOLUTION	
Aquifer Model: Confined	Solution Method: KGS Model
Kr = 11.2 ft/day	Ss = 0.00104 ft^{-1}
Kz/Kr = 1.	



OW-928 L RISING HEAD TEST

AQUIFER DATA

Saturated Thickness: 15. ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (OW-928 L)

Initial Displacement: 10.71 ft

Total Well Penetration Depth: 11.5 ft

Casing Radius: 0.08333 ft

Static Water Column Height: 106.8 ft

Screen Length: 10. ft

Well Radius: 0.3333 ft

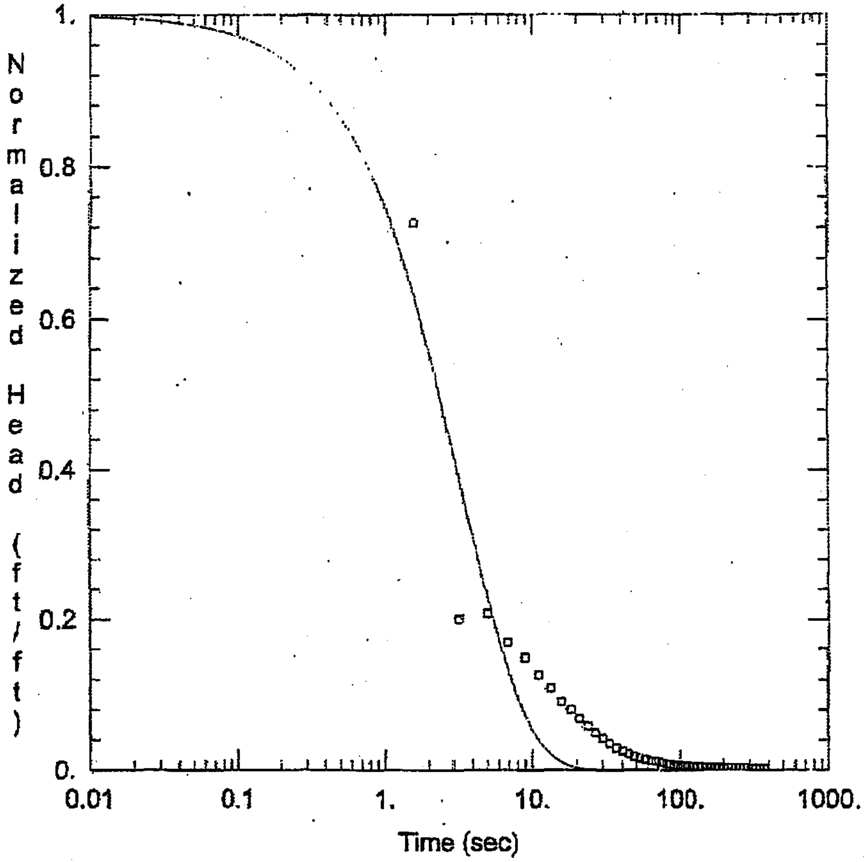
SOLUTION

Aquifer Model: Confined

K = 7.444 ft/day

Solution Method: Bouwer-Rice

y0 = 5.71 ft



OW-928 L FALLING HEAD TEST

AQUIFER DATA

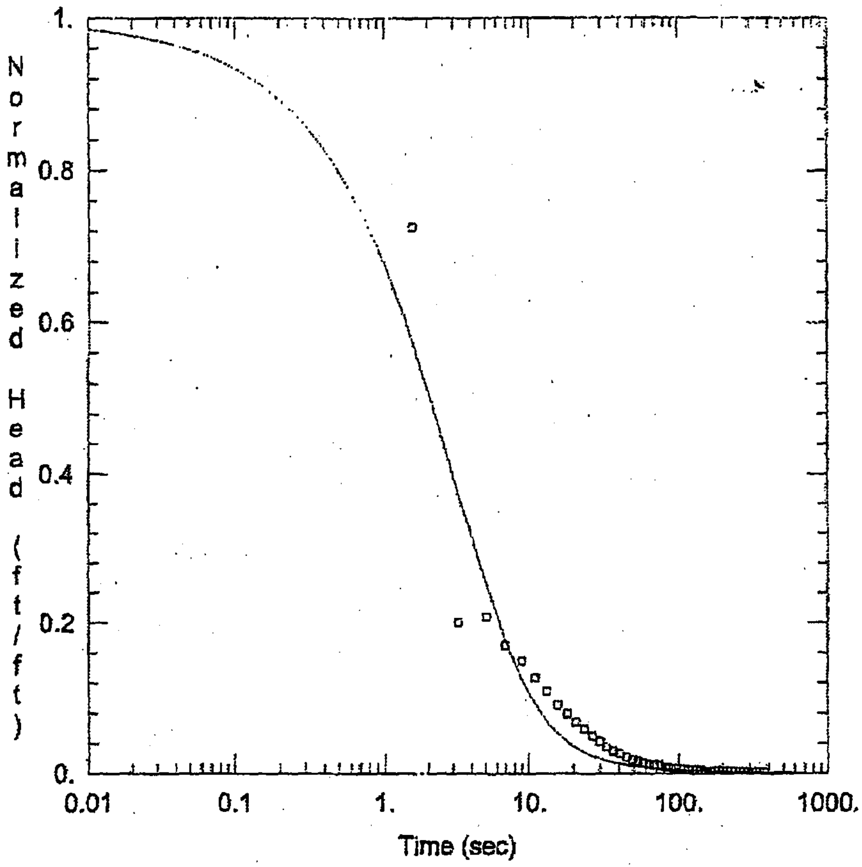
Saturated Thickness: 15. ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (New Well)

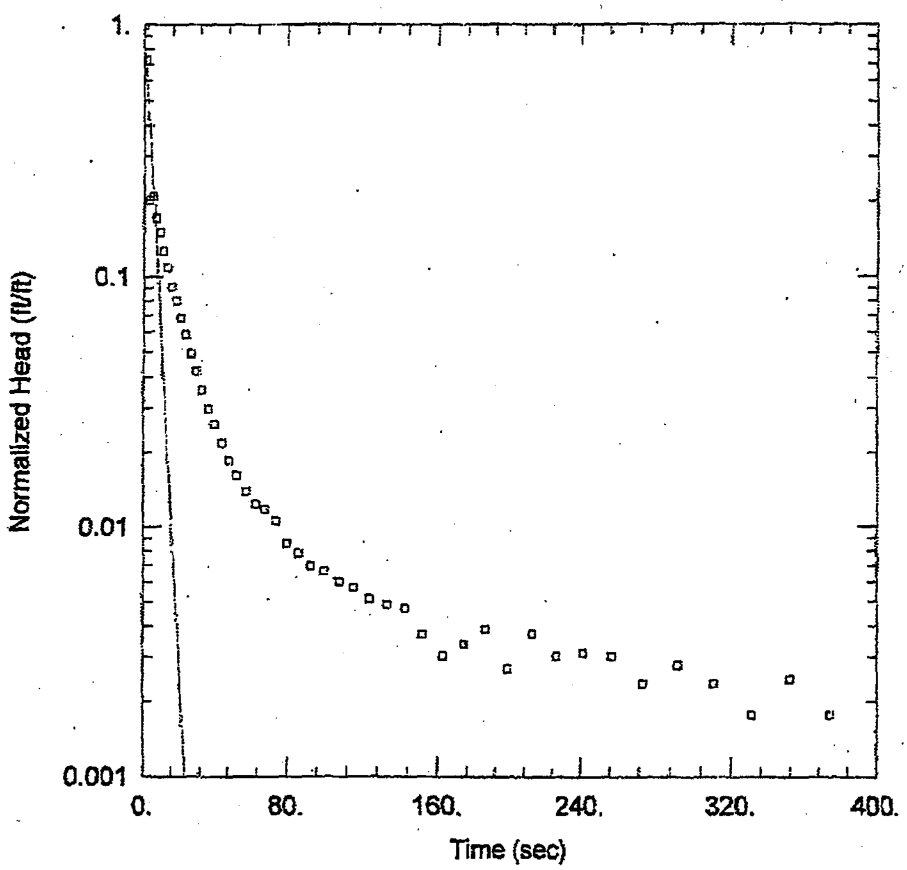
Initial Displacement: 11.92 ft
Total Well Penetration Depth: 11.5 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 106.8 ft
Screen Length: 10. ft
Well Radius: 0.3333 ft

SOLUTION

Aquifer Model: Confined
K = 30.23 ft/day
Solution Method: Butler
Le = 0.1 ft



OW-928 L FALLING HEAD TEST	
AQUIFER DATA	
Saturated Thickness: 15. ft	
WELL DATA (New Well)	
Initial Displacement: 11.92 ft	Static Water Column Height: 106.8 ft
Total Well Penetration Depth: 11.5 ft	Screen Length: 10. ft
Casing Radius: 0.08333 ft	Well Radius: 0.3333 ft
SOLUTION	
Aquifer Model: Confined	Solution Method: KGS Model
Kr = 23.6 ft/day	Ss = 4.055E-5 ft^{-1}
Kz/Kr = 1.	



OW-928 L FALLING HEAD TEST

AQUIFER DATA

Saturated Thickness: 15. ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (New Well)

Initial Displacement: 11.92 ft

Total Well Penetration Depth: 11.5 ft

Casing Radius: 0.08333 ft

Static Water Column Height: 106.8 ft

Screen Length: 10. ft

Well Radius: 0.3333 ft

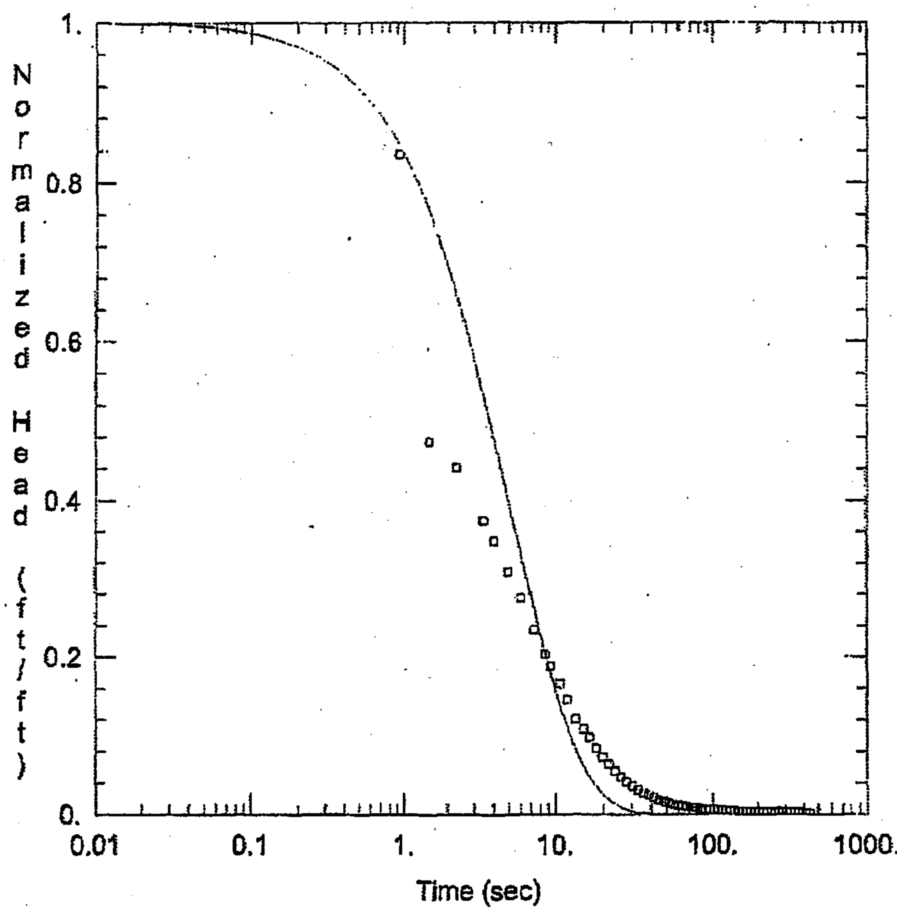
SOLUTION

Aquifer Model: Confined

Solution Method: Bouwer-Rice

K = 20.64 ft/day

y0 = 11.89 ft



OW-928 U RISING HEAD TEST

AQUIFER DATA

Saturated Thickness: 20. ft   Anisotropy Ratio (Kz/Kr): 1.

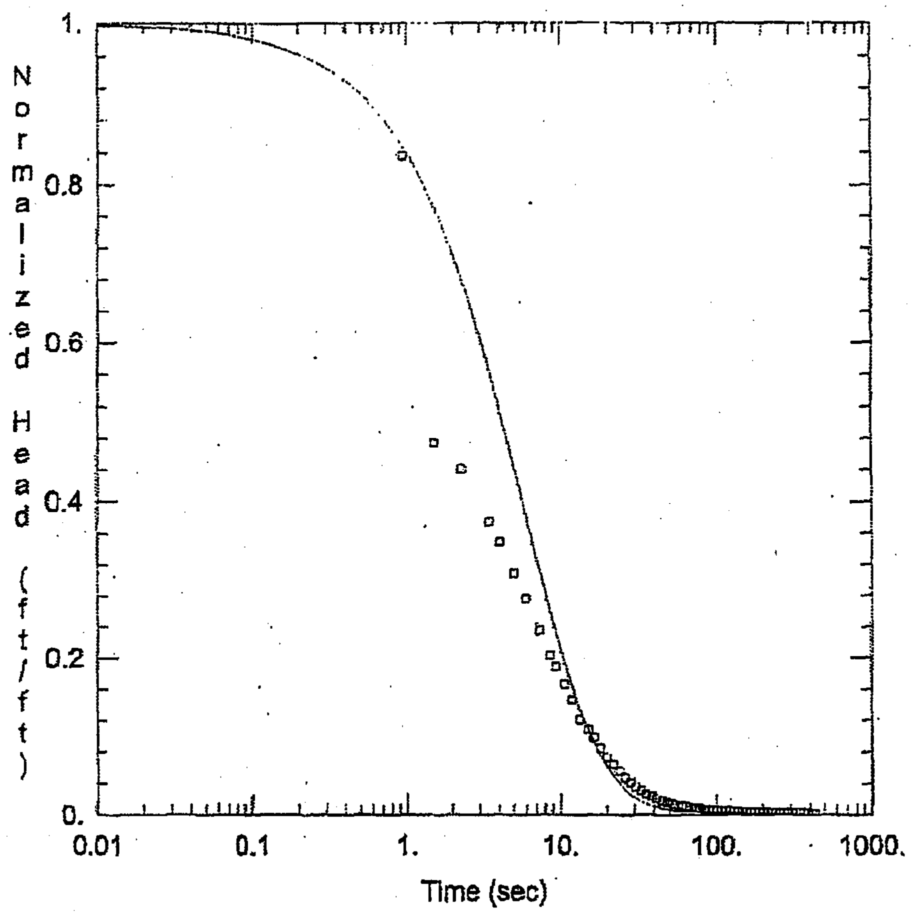
WELL DATA (OW-928 U)

Initial Displacement: 8.001 ft   Static Water Column Height: 32.08 ft
Total Well Penetration Depth: 15. ft   Screen Length: 10. ft
Casing Radius: 0.0833 ft   Well Radius: 0.3333 ft

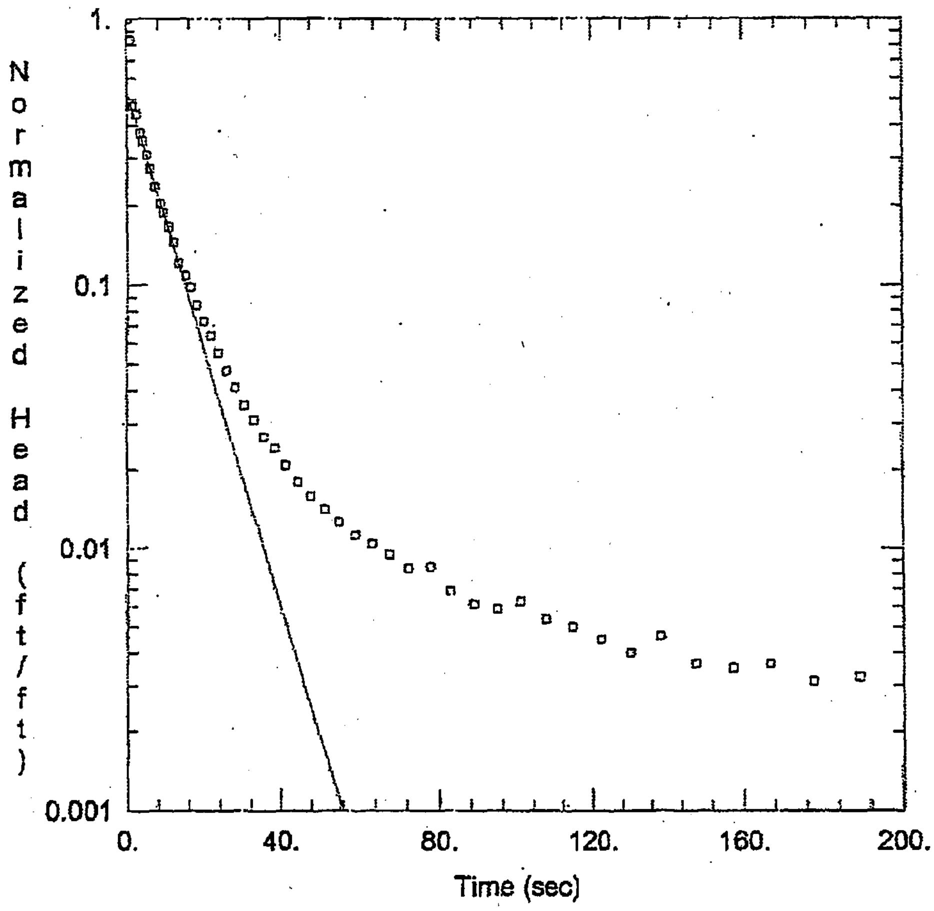
SOLUTION

Aquifer Model: Confined   Solution Method: Butler

K = 18.85 ft/day   Le = 5.495 ft



OW-928 U RISING HEAD TEST	
AQUIFER DATA	
Saturated Thickness: 20. ft	
WELL DATA (OW-928 U)	
Initial Displacement: 8.001 ft	Static Water Column Height: 32.08 ft
Total Well Penetration Depth: 15. ft	Screen Length: 10. ft
Casing Radius: 0.0833 ft	Well Radius: 0.3333 ft
SOLUTION	
Aquifer Model: Confined	Solution Method: KGS Model
Kr = 31.5 ft/day	Ss = 1.094E-11 ft^{-1}
Kz/Kr = 1.	



OW-928 U RISING HEAD TEST

AQUIFER DATA

Saturated Thickness: 20. ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (OW-928 U)

Initial Displacement: 8.001 ft
Total Well Penetration Depth: 15. ft
Casing Radius: 0.0833 ft

Static Water Column Height: 32.08 ft
Screen Length: 10. ft
Well Radius: 0.3333 ft

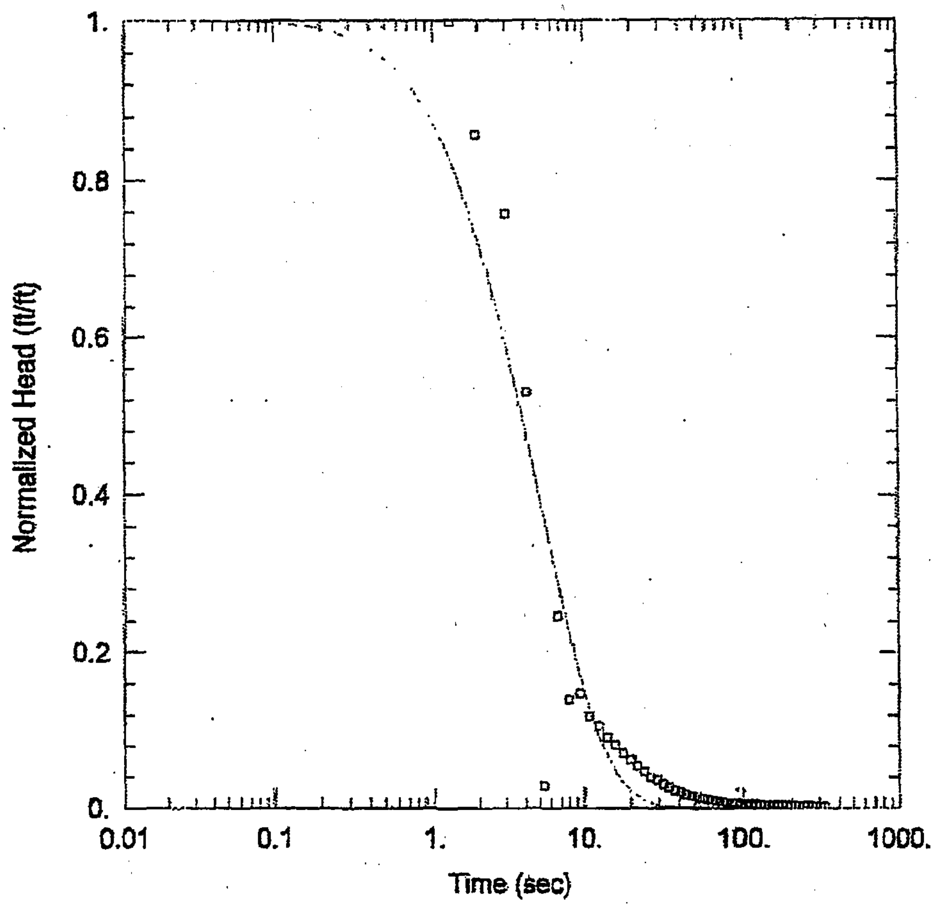
SOLUTION

Aquifer Model: Confined

K = 8.268 ft/day

Solution Method: Bouwer-Rice

y0 = 4.286 ft



OW-928 U FALLING HEAD TEST

AQUIFER DATA

Saturated Thickness: 20. ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (OW-928 U)

Initial Displacement: 7.679 ft

Total Well Penetration Depth: 15. ft

Casing Radius: 0.0833 ft

Static Water Column Height: 32.08 ft

Screen Length: 10. ft

Well Radius: 0.3333 ft

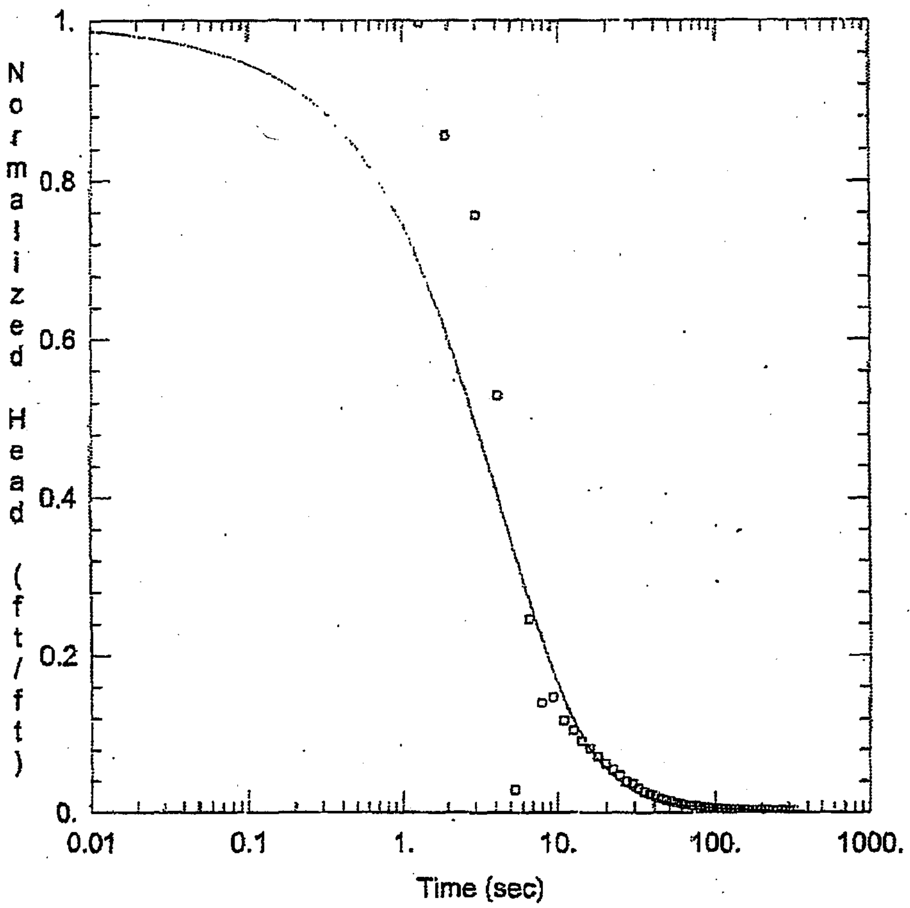
SOLUTION

Aquifer Model: Confined

Solution Method: Butler

K = 19.02 ft/day

Le = 47.86 ft



OW-928 U FALLING HEAD TEST

AQUIFER DATA

Saturated Thickness: 20. ft

WELL DATA (OW-928 U)

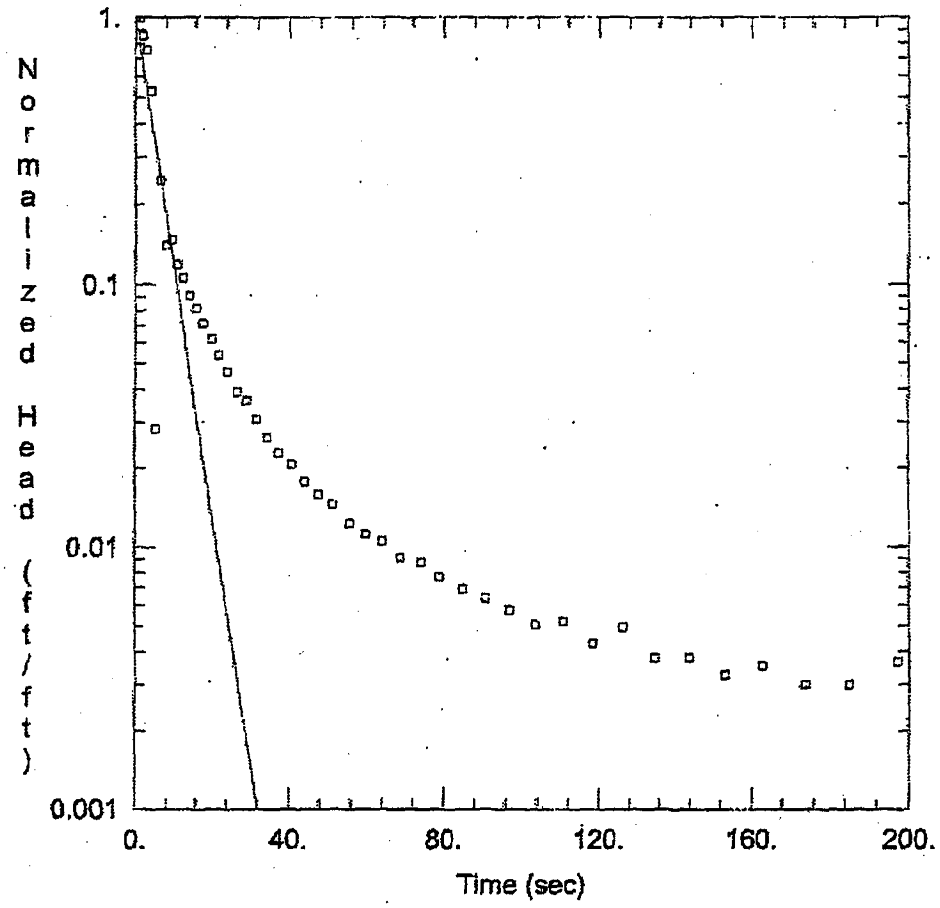
Initial Displacement: 7.679 ft
Total Well Penetration Depth: 15. ft
Casing Radius: 0.0833 ft

Static Water Column Height: 32.08 ft
Screen Length: 10. ft
Well Radius: 0.3333 ft

SOLUTION

Aquifer Model: Confined
Kr = 15.91 ft/day
Kz/Kr = 1.

Solution Method: KGS Model
Ss = 5.0E-5 ft^{-1}



OW-928 U FALLING HEAD TEST

AQUIFER DATA

Saturated Thickness: 20. ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (OW-928 U)

Initial Displacement: 7.679 ft

Total Well Penetration Depth: 15. ft

Casing Radius: 0.0833 ft

Static Water Column Height: 32.08 ft

Screen Length: 10. ft

Well Radius: 0.3333 ft

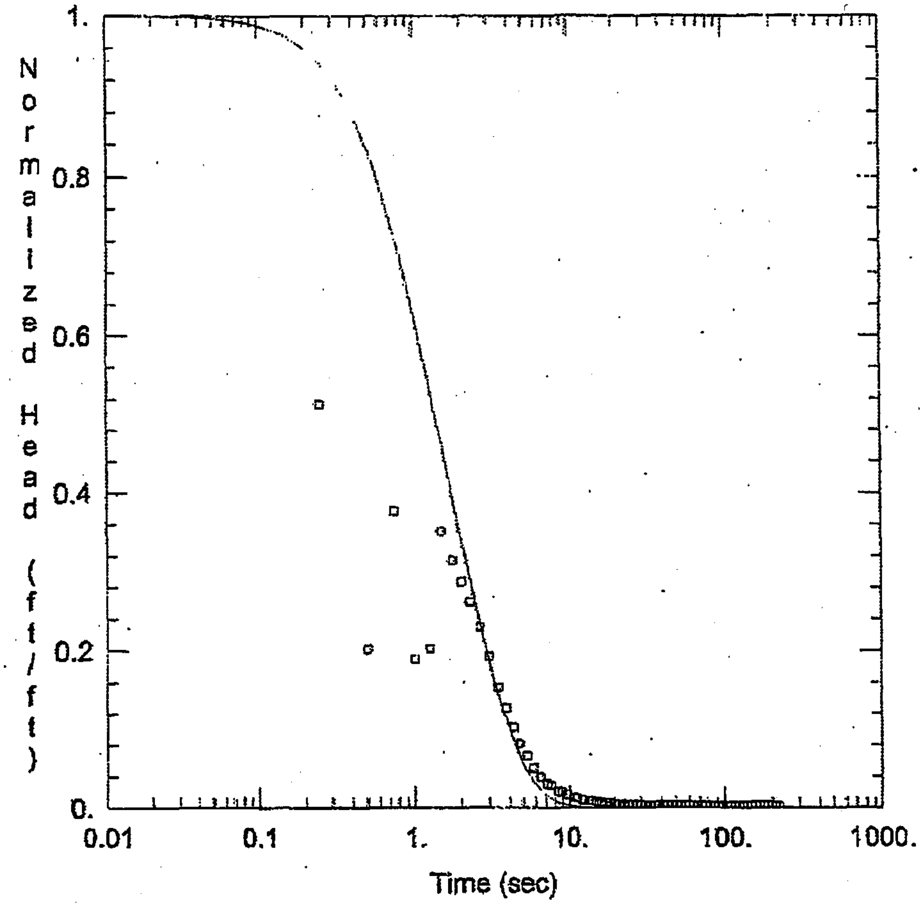
SOLUTION

Aquifer Model: Confined

K = 16.01 ft/day

Solution Method: Bouwer-Rice

y0 = 7.815 ft



OW-929 L RISING HEAD TEST

AQUIFER DATA

Saturated Thickness: 45. ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (OW-929 L)

Initial Displacement: 11.97 ft
Total Well Penetration Depth: 13.5 ft
Casing Radius: 0.0833 ft

Static Water Column Height: 76.46 ft
Screen Length: 10. ft
Well Radius: 0.3333 ft

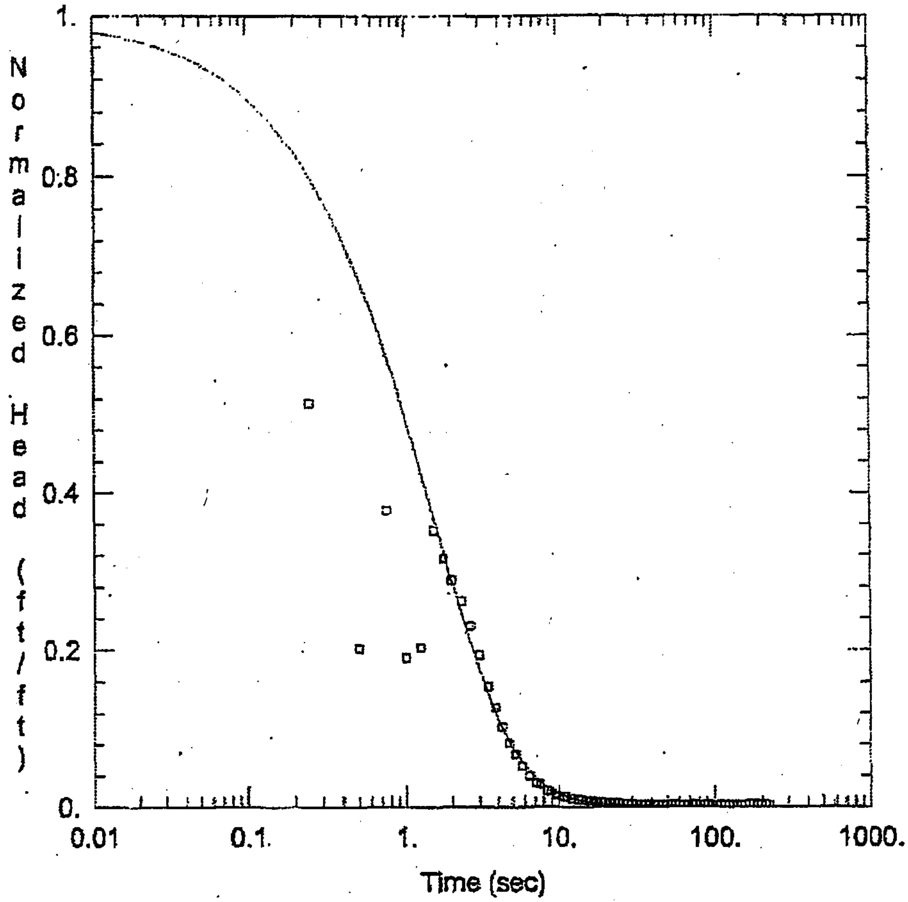
SOLUTION

Aquifer Model: Confined

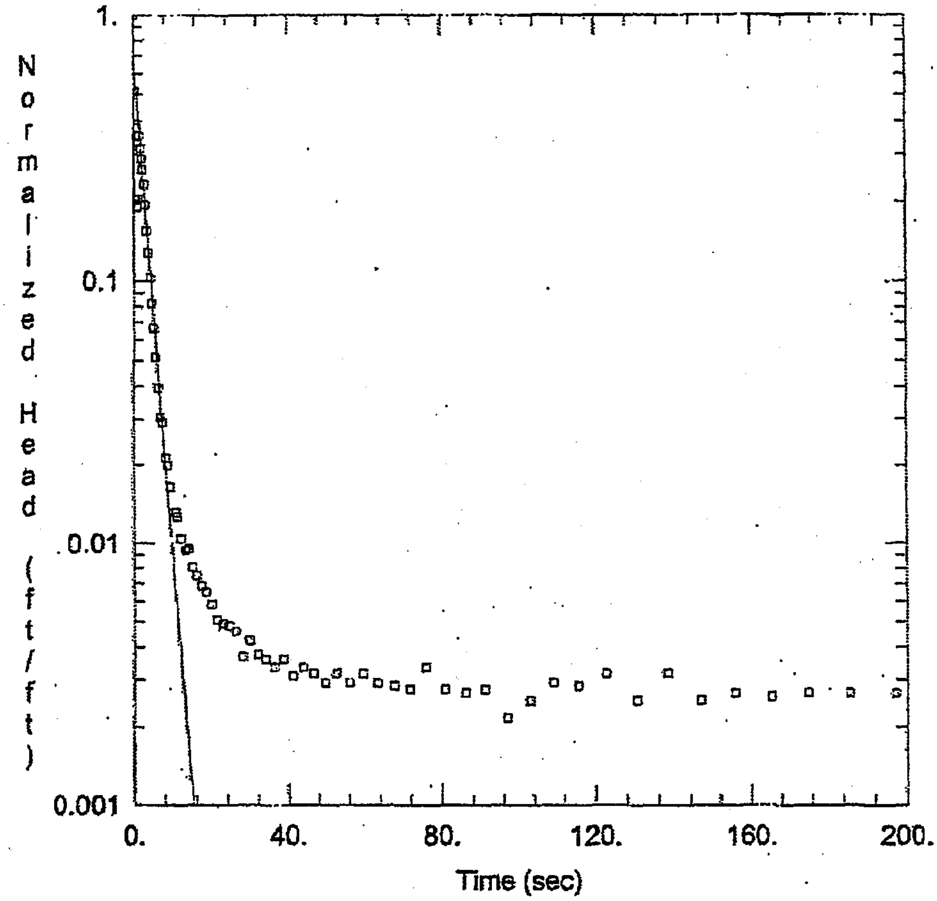
Solution Method: Butler

K = 55.91 ft/day

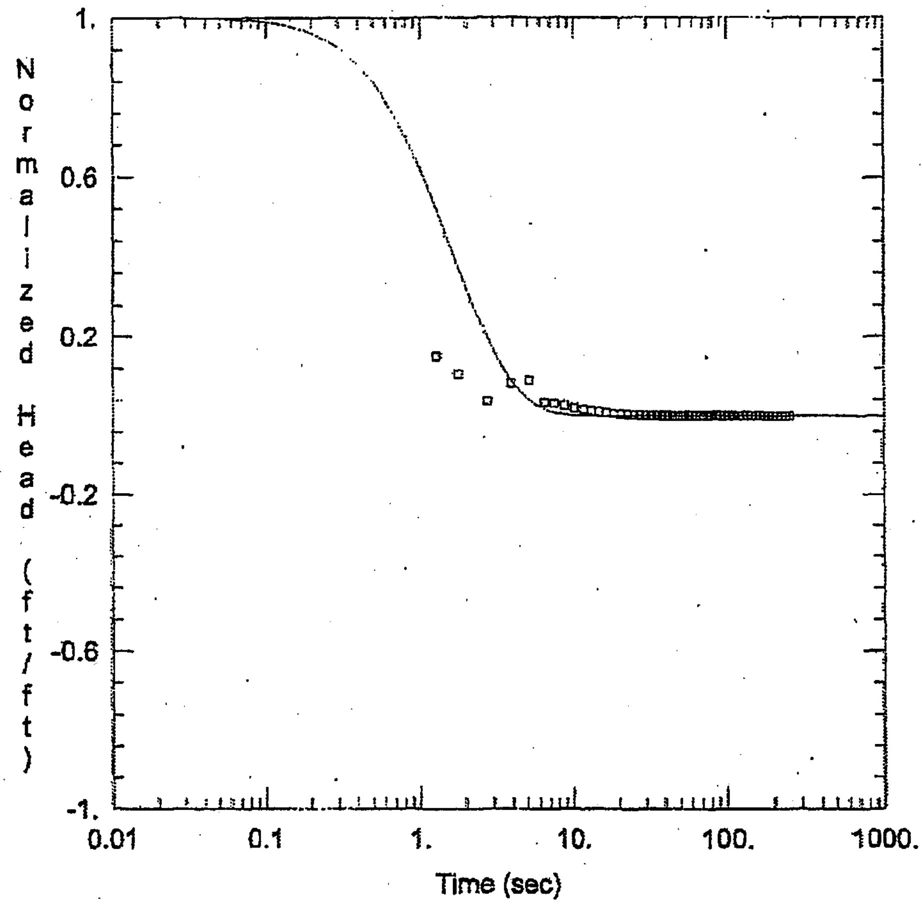
Le = 11.73 ft



OW-929 L RISING HEAD TEST	
AQUIFER DATA	
Saturated Thickness: 45. ft	
WELL DATA (OW-929 L)	
Initial Displacement: 11.97 ft	Static Water Column Height: 76.46 ft
Total Well Penetration Depth: 13.5 ft	Screen Length: 10. ft
Casing Radius: 0.0833 ft	Well Radius: 0.3333 ft
SOLUTION	
Aquifer Model: Confined	Solution Method: KGS Model
Kr = 53.85 ft/day	Ss = 2.222E-5 ft^{-1}
Kz/Kr = 1.	



OW-929 L RISING HEAD TEST	
AQUIFER DATA	
Saturated Thickness: 45. ft	Anisotropy Ratio (Kz/Kr): 1.
WELL DATA (OW-929 L)	
Initial Displacement: 11.97 ft	Static Water Column Height: 76.46 ft
Total Well Penetration Depth: 13.5 ft	Screen Length: 10. ft
Casing Radius: 0.0833 ft	Well Radius: 0.3333 ft
SOLUTION	
Aquifer Model: Confined	Solution Method: Bouwer-Rice
K = 29.05 ft/day	y0 = 8.095 ft



OW-929 L FALLING HEAD TEST

AQUIFER DATA

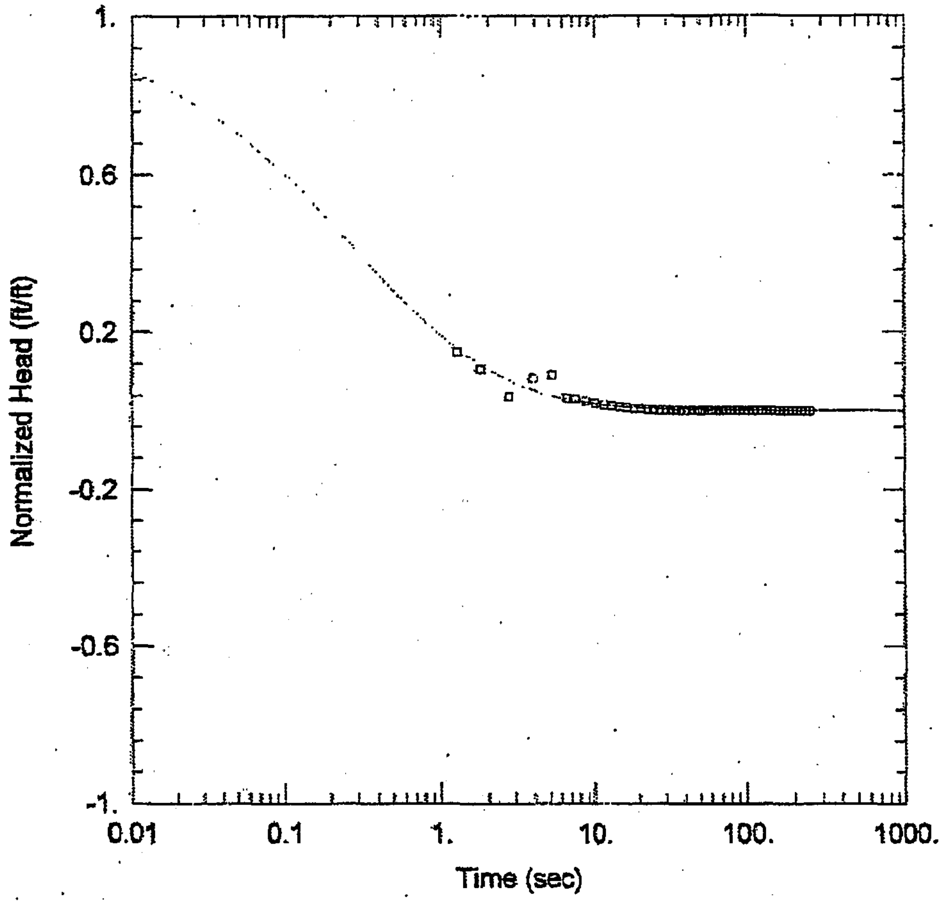
Saturated Thickness: 45. ft   Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (OW-929 L)

Initial Displacement: 8.292 ft   Static Water Column Height: 76.46 ft
Total Well Penetration Depth: 13.5 ft   Screen Length: 10. ft
Casing Radius: 0.0833 ft   Well Radius: 0.3333 ft

SOLUTION

Aquifer Model: Confined   Solution Method: Butler
K = 58.93 ft/day   Le = 12.71 ft



OW-929 L FALLING HEAD TEST

AQUIFER DATA

Saturated Thickness: 45. ft

WELL DATA (OW-929 L)

Initial Displacement: 8.292 ft
Total Well Penetration Depth: 13.5 ft
Casing Radius: 0.0833 ft

Static Water Column Height: 76.46 ft
Screen Length: 10. ft
Well Radius: 0.3333 ft

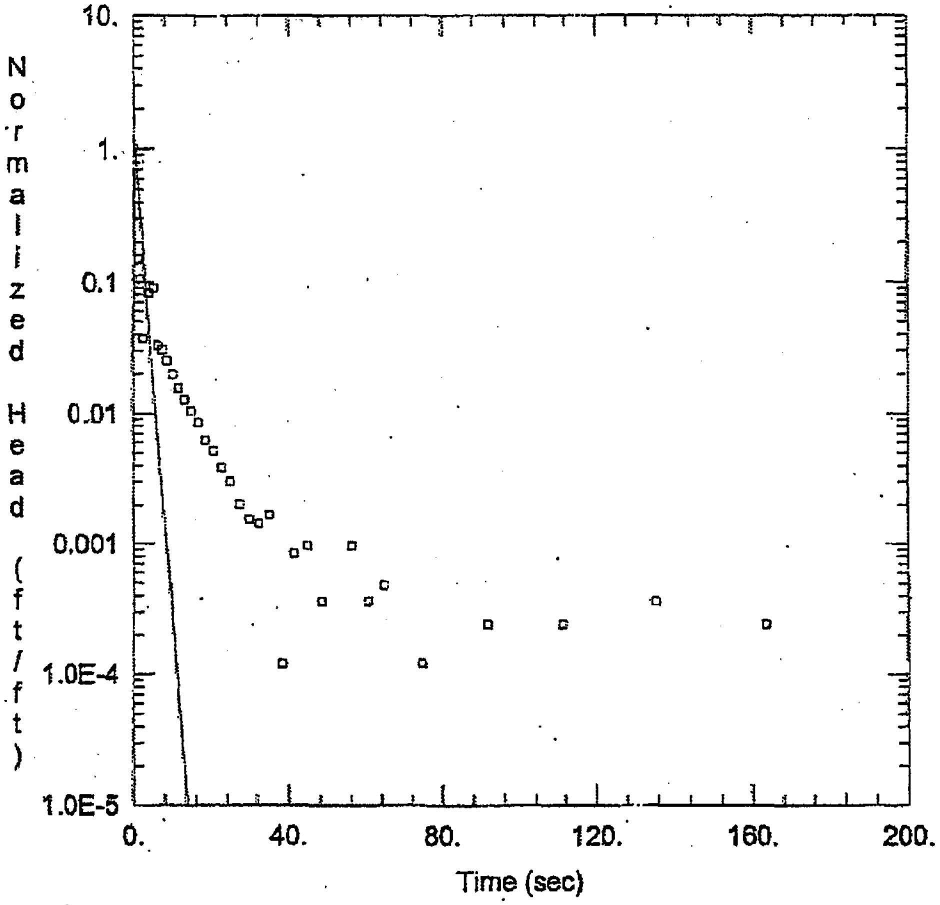
SOLUTION

Aquifer Model: Confined

Kr = 72.56 ft/day
Kz/Kr = 1.

Solution Method: KGS Model

Ss = 0.002222 ft^{-1}



OW-929 L FALLING HEAD TEST

AQUIFER DATA

Saturated Thickness: 45. ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (OW-929 L)

Initial Displacement: 8.292 ft

Total Well Penetration Depth: 13.5 ft

Casing Radius: 0.0833 ft

Static Water Column Height: 76.46 ft

Screen Length: 10. ft

Well Radius: 0.3333 ft

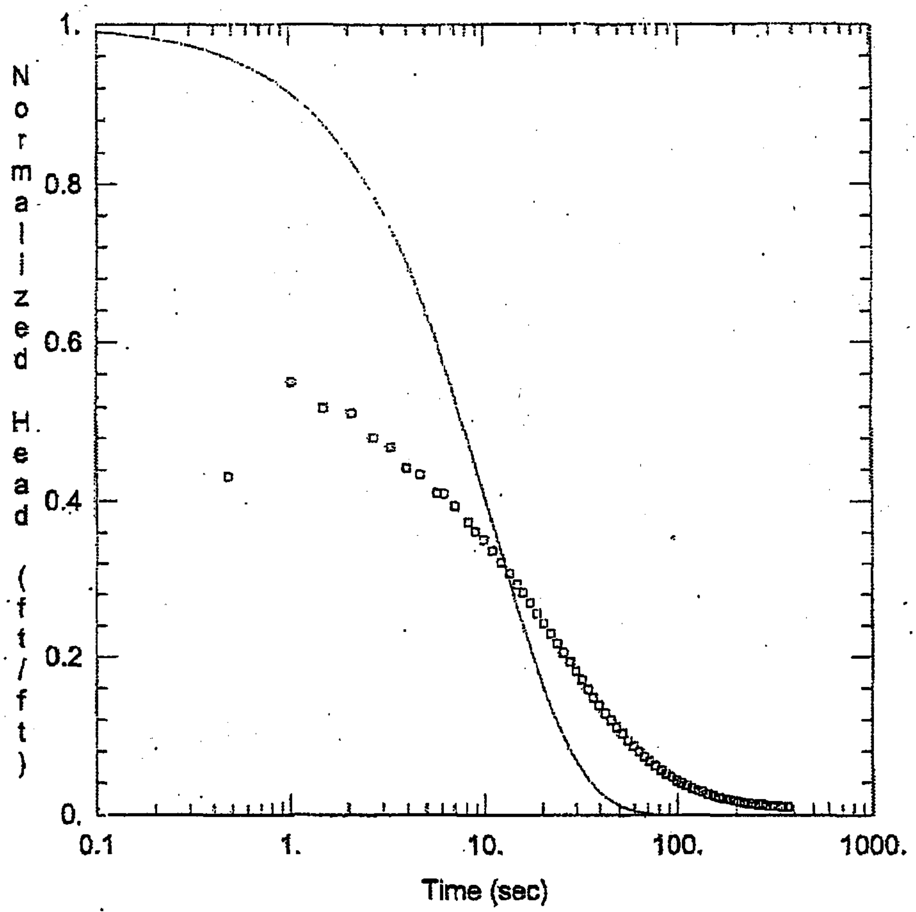
SOLUTION

Aquifer Model: Confined

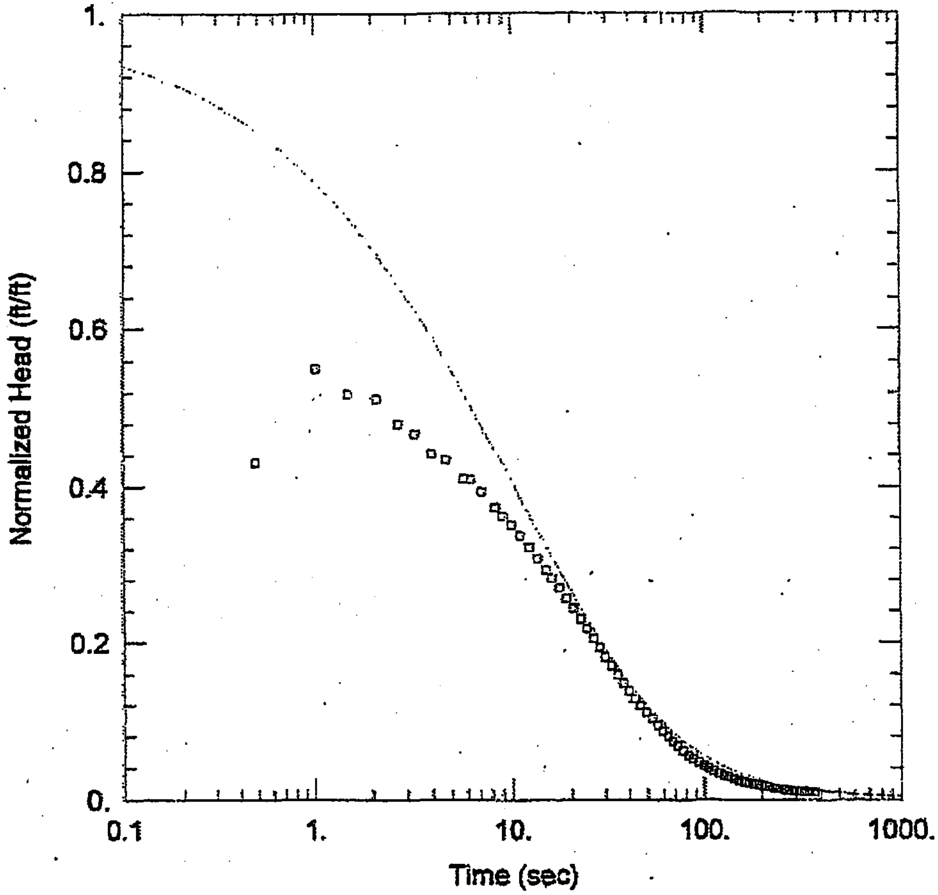
K = 58.98 ft/day

Solution Method: Bouwer-Rice

y0 = 11.84 ft



OW-929 U RISING HEAD TEST	
AQUIFER DATA	
Saturated Thickness: 5. ft	Anisotropy Ratio (Kz/Kr): 1.
WELL DATA (OW-929 U)	
Initial Displacement: 12.44 ft	Static Water Column Height: 48.18 ft
Total Well Penetration Depth: 10. ft	Screen Length: 10. ft
Casing Radius: 0.0833 ft	Well Radius: 0.3333 ft
SOLUTION	
Aquifer Model: Confined	Solution Method: Butler
K = 14.31 ft/day	Le = 0.1 ft



OW-929 U RISING HEAD TEST

AQUIFER DATA

Saturated Thickness: 11.85 ft

WELL DATA (OW-929 U)

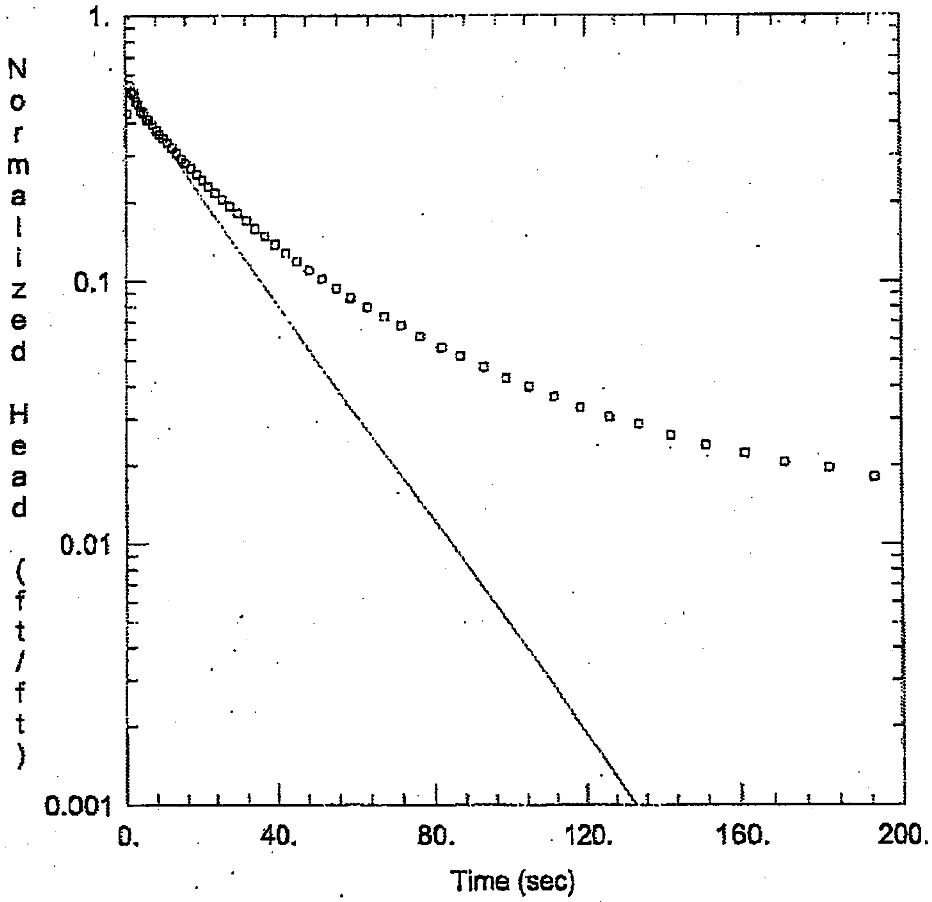
Initial Displacement: 12.44 ft
Total Well Penetration Depth: 10. ft
Casing Radius: 0.0833 ft

Static Water Column Height: 48.18 ft
Screen Length: 10. ft
Well Radius: 0.3333 ft

SOLUTION

Aquifer Model: Confined
Kr = 3.224 ft/day
Kz/Kr = 1.

Solution Method: KGS Model
Ss = 0.0009578 ft^{-1}



OW-929 U RISING HEAD TEST

AQUIFER DATA

Saturated Thickness: 5. ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (OW-929 U)

Initial Displacement: 12.44 ft

Static Water Column Height: 48.18 ft

Total Well Penetration Depth: 10. ft

Screen Length: 10. ft

Casing Radius: 0.0833 ft

Well Radius: 0.3333 ft

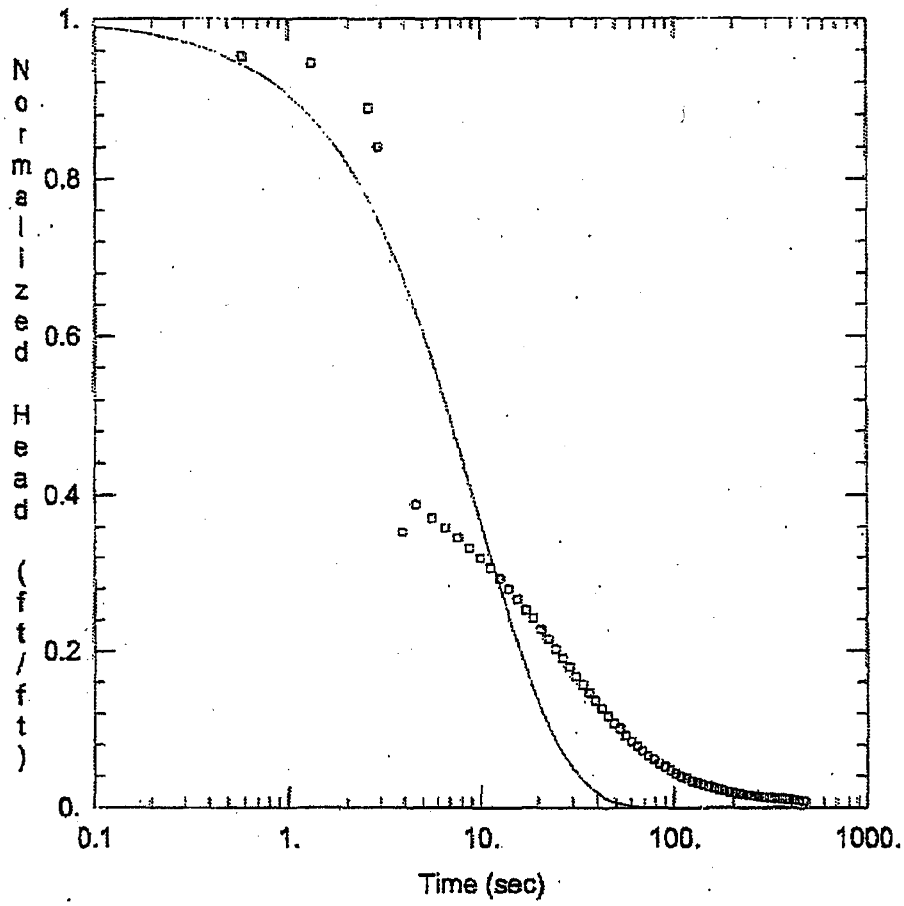
SOLUTION

Aquifer Model: Confined

Solution Method: Bouwer-Rice

K = 3.648 ft/day

y0 = 6.787 ft



OW-929 U FALLING HEAD TEST

AQUIFER DATA

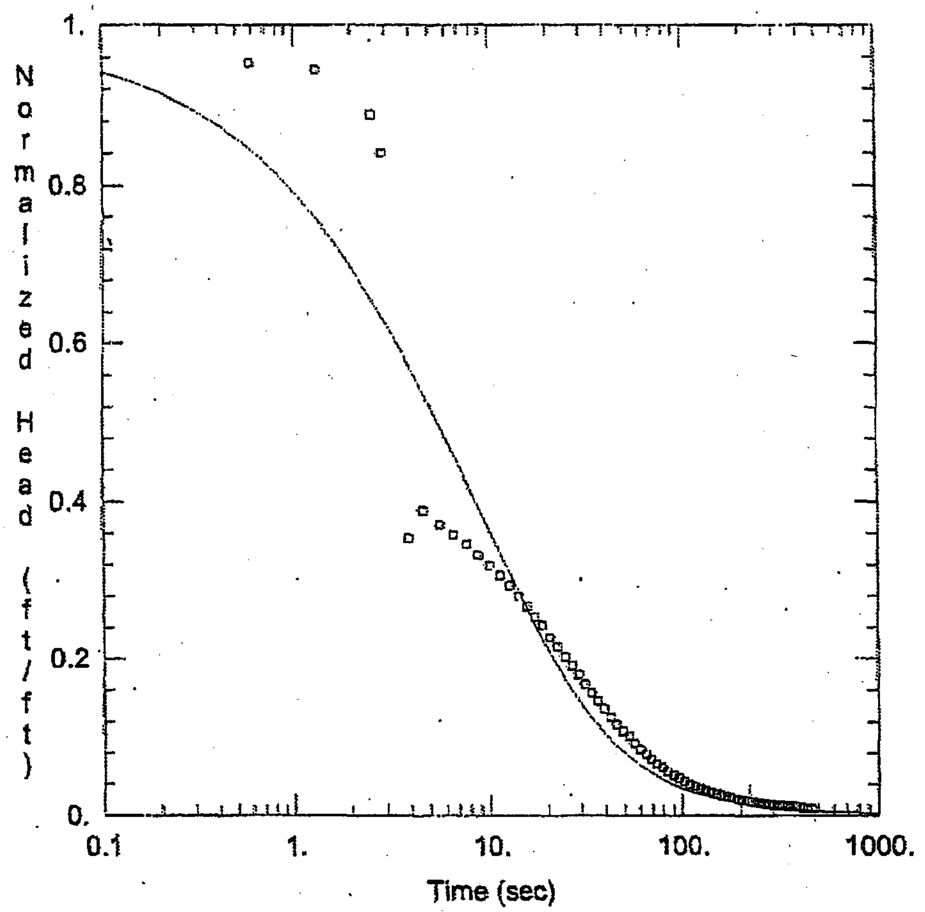
Saturated Thickness: 5. ft   Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (OW-929 U)

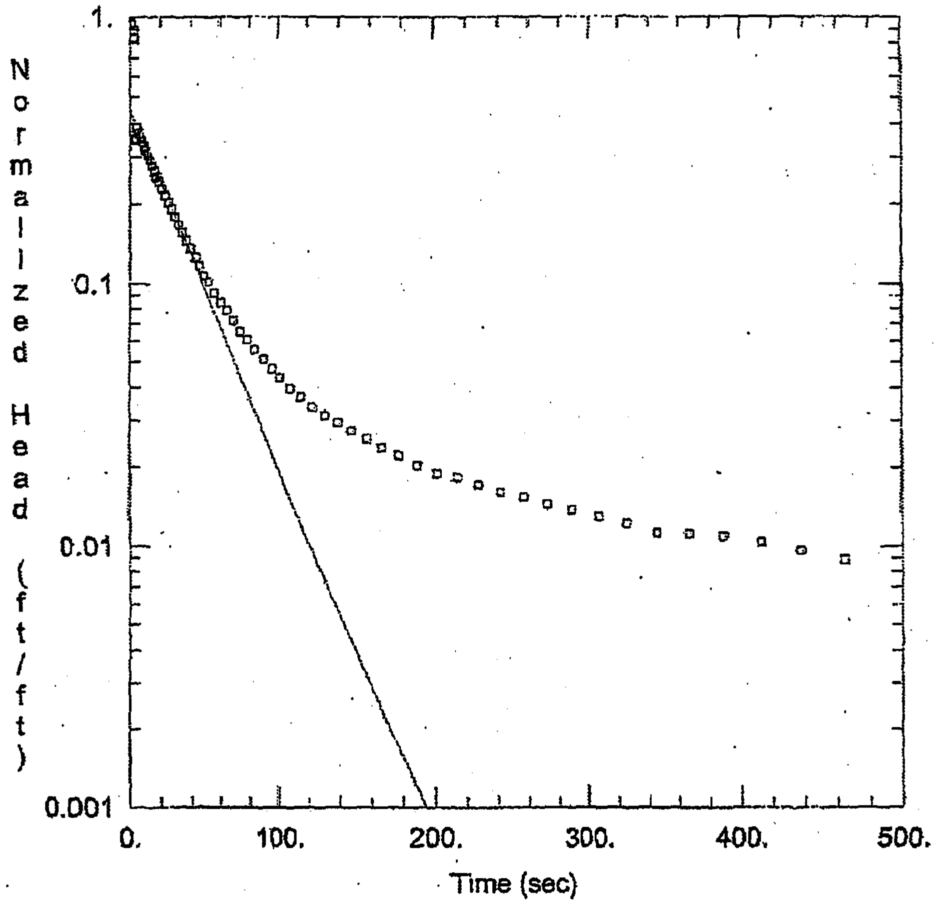
Initial Displacement: 11.85 ft   Static Water Column Height: 48.18 ft
Total Well Penetration Depth: 10. ft   Screen Length: 10. ft
Casing Radius: 0.08333 ft   Well Radius: 0.3333 ft

SOLUTION

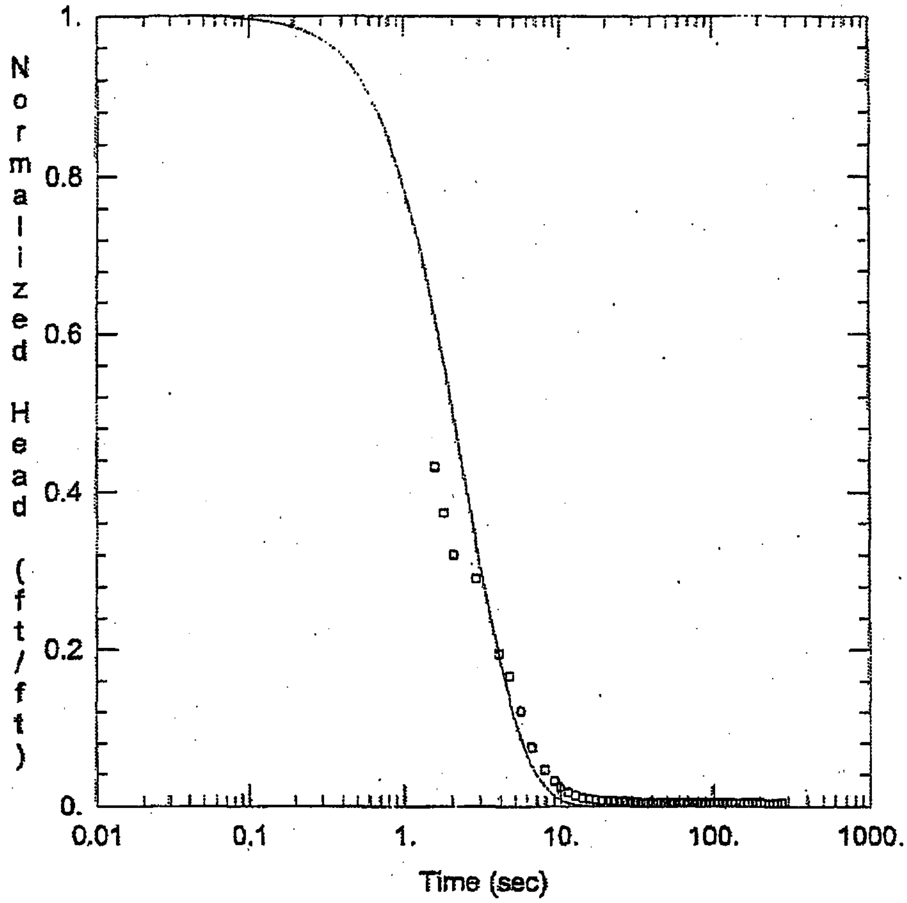
Aquifer Model: Confined   Solution Method: Butler
K = 16.07 ft/day   Le = 0.1 ft



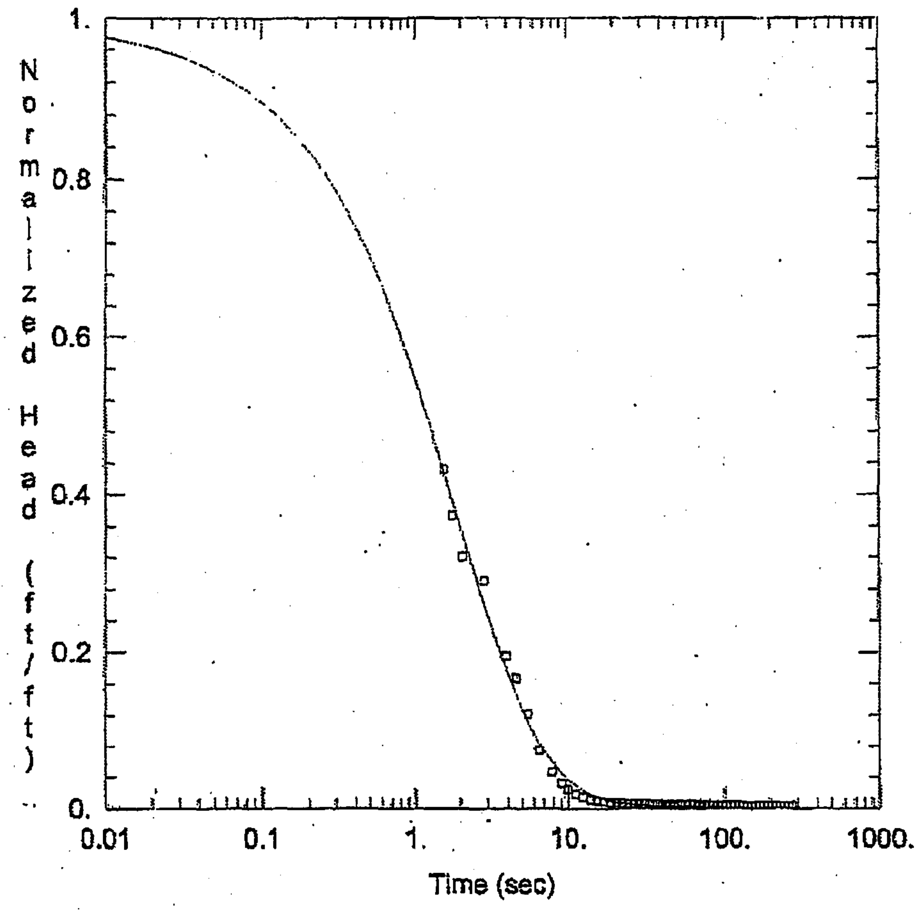
OW-929 U FALLING HEAD TEST	
AQUIFER DATA	
Saturated Thickness: 5. ft	
WELL DATA (OW-929 U)	
Initial Displacement: 11.85 ft	Static Water Column Height: 48.18 ft
Total Well Penetration Depth: 10. ft	Screen Length: 10. ft
Casing Radius: 0.08333 ft	Well Radius: 0.3333 ft
SOLUTION	
Aquifer Model: Confined	Solution Method: KGS Model
Kr = 11.5 ft/day	Ss = 0.000698 ft^{-1}
Kz/Kr = 1.	



OW-929 U FALLING HEAD TEST	
AQUIFER DATA	
Saturated Thickness: 5. ft	Anisotropy Ratio (Kz/Kr): 1.
WELL DATA (OW-929 U)	
Initial Displacement: 11.85 ft	Static Water Column Height: 48.18 ft
Total Well Penetration Depth: 10. ft	Screen Length: 10. ft
Casing Radius: 0.08333 ft	Well Radius: 0.3333 ft
SOLUTION	
Aquifer Model: Confined	Solution Method: Bouwer-Rice
K = 2.423 ft/day	y0 = 5.303 ft



OW-930 L RISING HEAD TEST	
AQUIFER DATA	
Saturated Thickness: 40. ft	Anisotropy Ratio (Kz/Kr): 1.
WELL DATA (OW-930 L)	
Initial Displacement: 10.66 ft	Static Water Column Height: 89.35 ft
Total Well Penetration Depth: 27. ft	Screen Length: 10. ft
Casing Radius: 0.08333 ft	Well Radius: 0.3333 ft
SOLUTION	
Aquifer Model: Confined	Solution Method: Butler
K = 40.45 ft/day	Le = 39.81 ft



OW-930 L RISING HEAD TEST

AQUIFER DATA

Saturated Thickness: 40. ft

WELL DATA (OW-930 L)

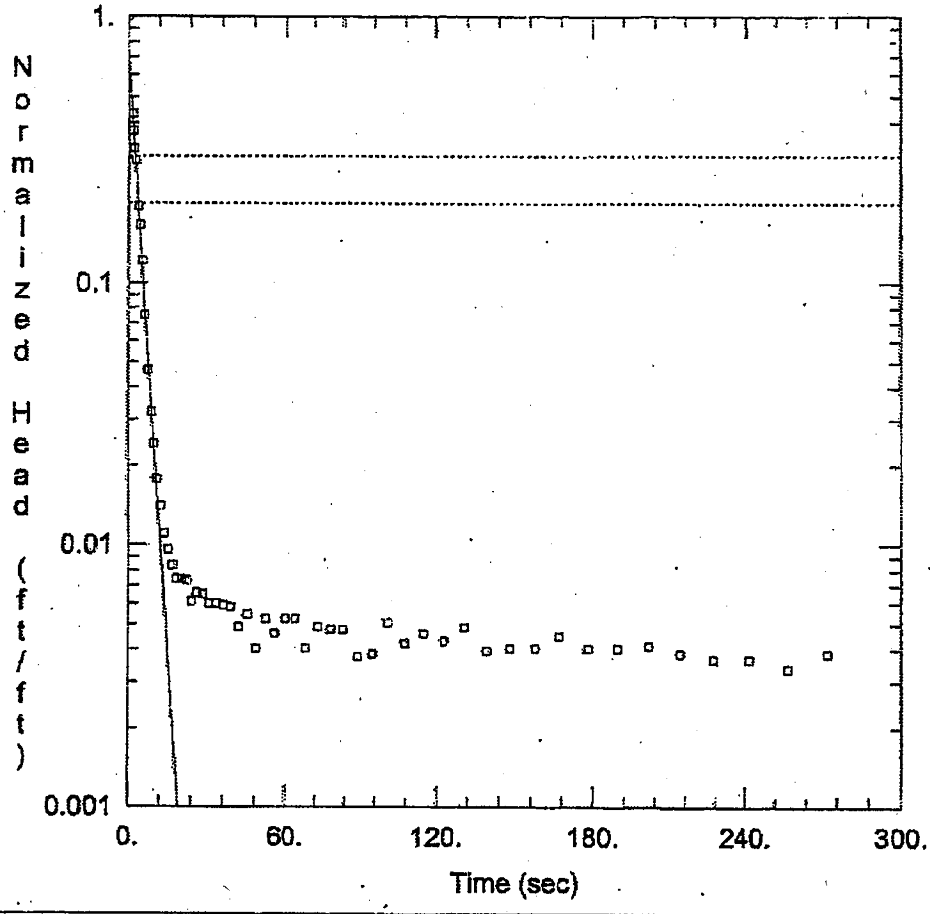
Initial Displacement: 10.66 ft
Total Well Penetration Depth: 27. ft
Casing Radius: 0.08333 ft

Static Water Column Height: 89.35 ft
Screen Length: 10. ft
Well Radius: 0.3333 ft

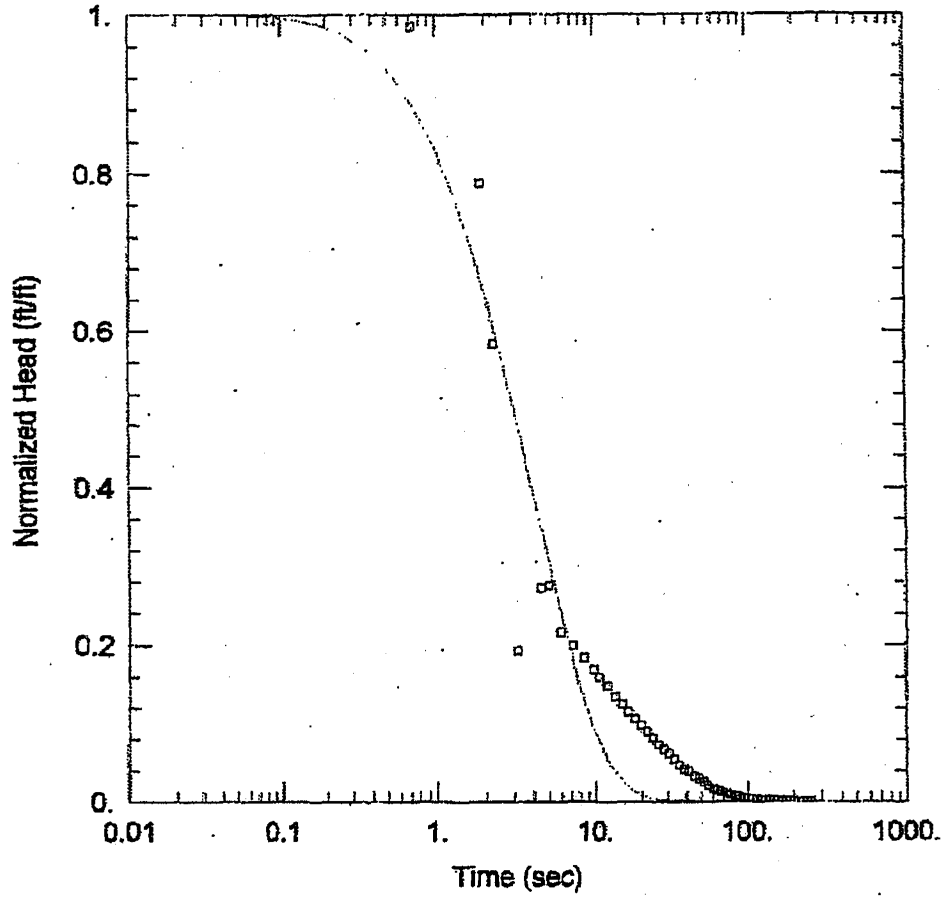
SOLUTION

Aquifer Model: Confined
Kr = 36.58 ft/day
Kz/Kr = 1.

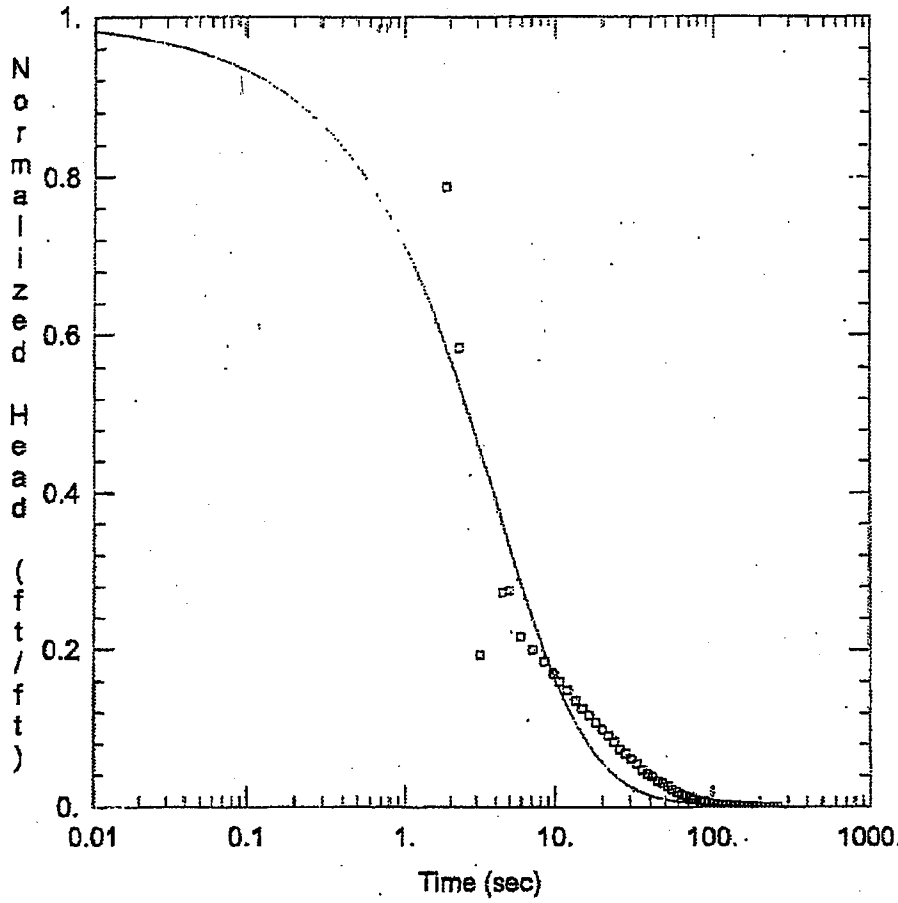
Solution Method: KGS Model
Ss = 7.267E-5 ft^{-1}



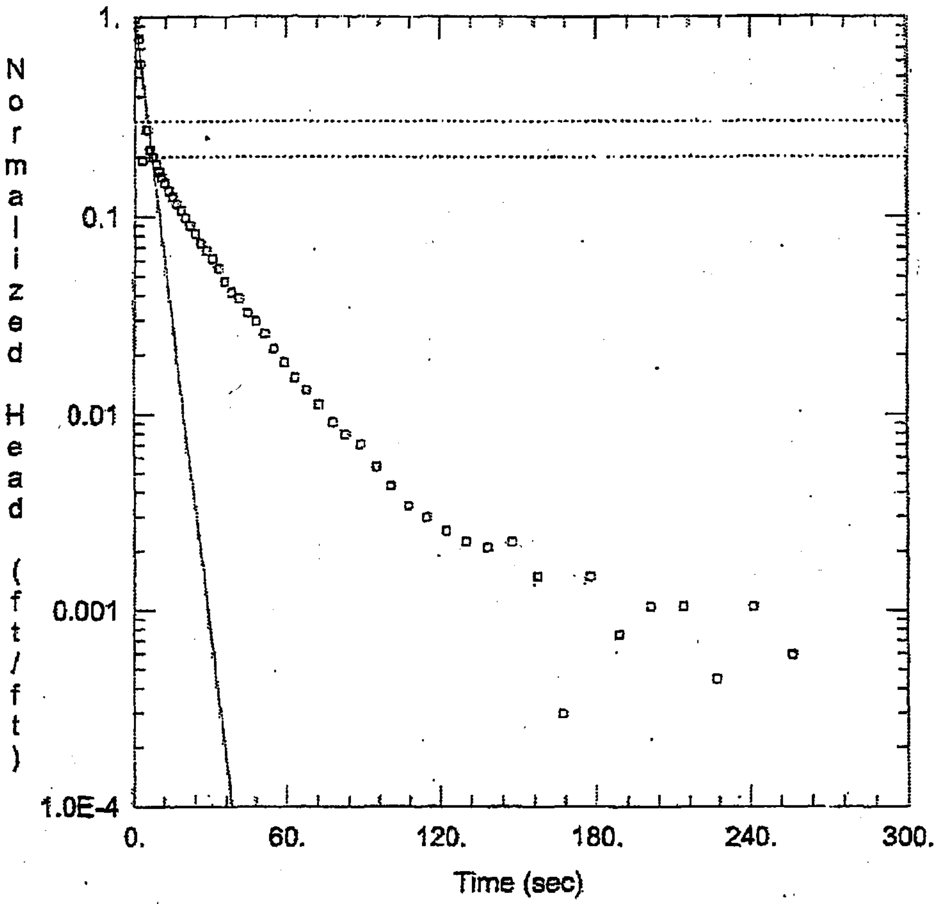
OW-930 L RISING HEAD TEST	
AQUIFER DATA	
Saturated Thickness: 40. ft	Anisotropy Ratio (Kz/Kr): 1.
WELL DATA (OW-930 L)	
Initial Displacement: 10.66 ft	Static Water Column Height: 89.35 ft
Total Well Penetration Depth: 27. ft	Screen Length: 10. ft
Casing Radius: 0.08333 ft	Well Radius: 0.3333 ft
SOLUTION	
Aquifer Model: Confined	Solution Method: Bouwer-Rice
K = 26.92 ft/day	y0 = 7.557 ft



OW-930 L FALLING HEAD TEST	
AQUIFER DATA	
Saturated Thickness: 40. ft	Anisotropy Ratio (Kz/Kr): 1.
WELL DATA (OW-930 L)	
Initial Displacement: 6.697 ft	Static Water Column Height: 89.35 ft
Total Well Penetration Depth: 27. ft	Screen Length: 10. ft
Casing Radius: 0.08333 ft	Well Radius: 0.3333 ft
SOLUTION	
Aquifer Model: Confined	Solution Method: Butler
K = 24.3 ft/day	Le = 30.24 ft



OW-930 L FALLING HEAD TEST	
AQUIFER DATA	
Saturated Thickness: 40. ft	
WELL DATA (OW-930 L)	
Initial Displacement: 6.697 ft	Static Water Column Height: 89.35 ft
Total Well Penetration Depth: 27. ft	Screen Length: 10. ft
Casing Radius: 0.08333 ft	Well Radius: 0.3333 ft
SOLUTION	
Aquifer Model: Confined	Solution Method: KGS Model
Kr = 15.09 ft/day	Ss = 0.0001143 ft^{-1}
Kz/Kr = 1.	



OW-930 L FALLING HEAD TEST

AQUIFER DATA

Saturated Thickness: 40. ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (OW-930 L)

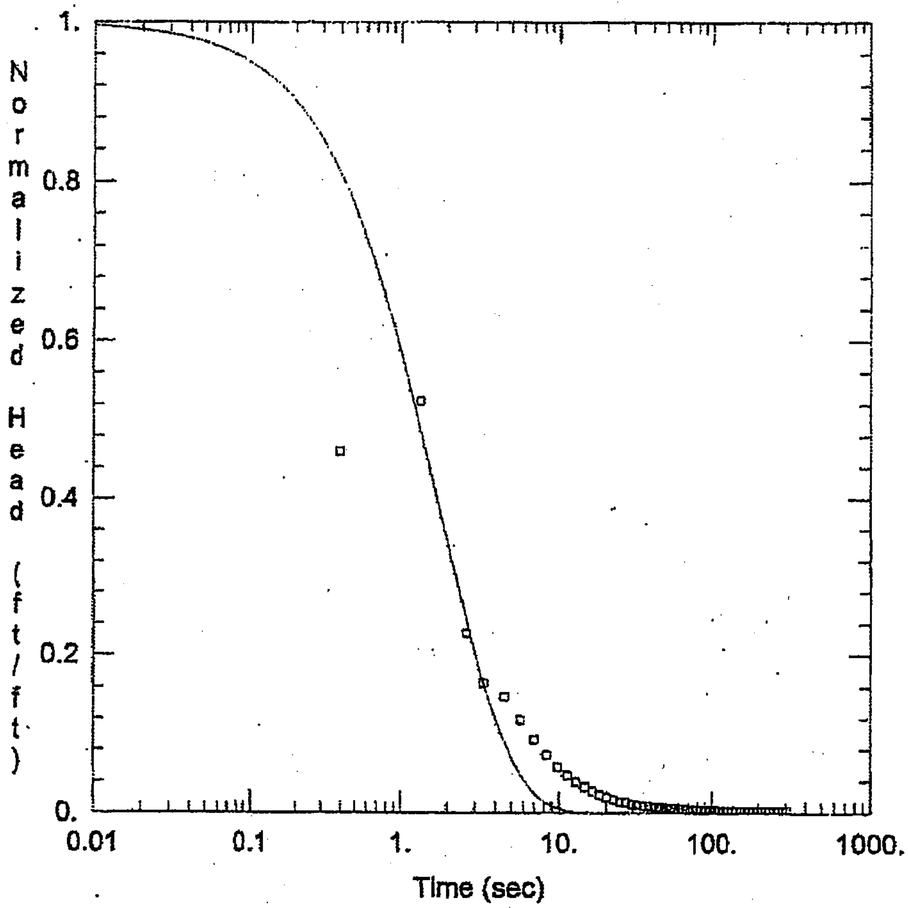
Initial Displacement: 6.697 ft
Total Well Penetration Depth: 27. ft
Casing Radius: 0.08333 ft

Static Water Column Height: 89.35 ft
Screen Length: 10. ft
Well Radius: 0.3333 ft

SOLUTION

Aquifer Model: Confined
K = 18.92 ft/day

Solution Method: Bouwer-Rice
y0 = 6.904 ft



OW-930 U RISING HEAD TEST

AQUIFER DATA

Saturated Thickness: 23.9 ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (OW-930 U)

Initial Displacement: 8.47 ft

Total Well Penetration Depth: 16. ft

Casing Radius: 0.08333 ft

Static Water Column Height: 25.83 ft

Screen Length: 10. ft

Well Radius: 0.3333 ft

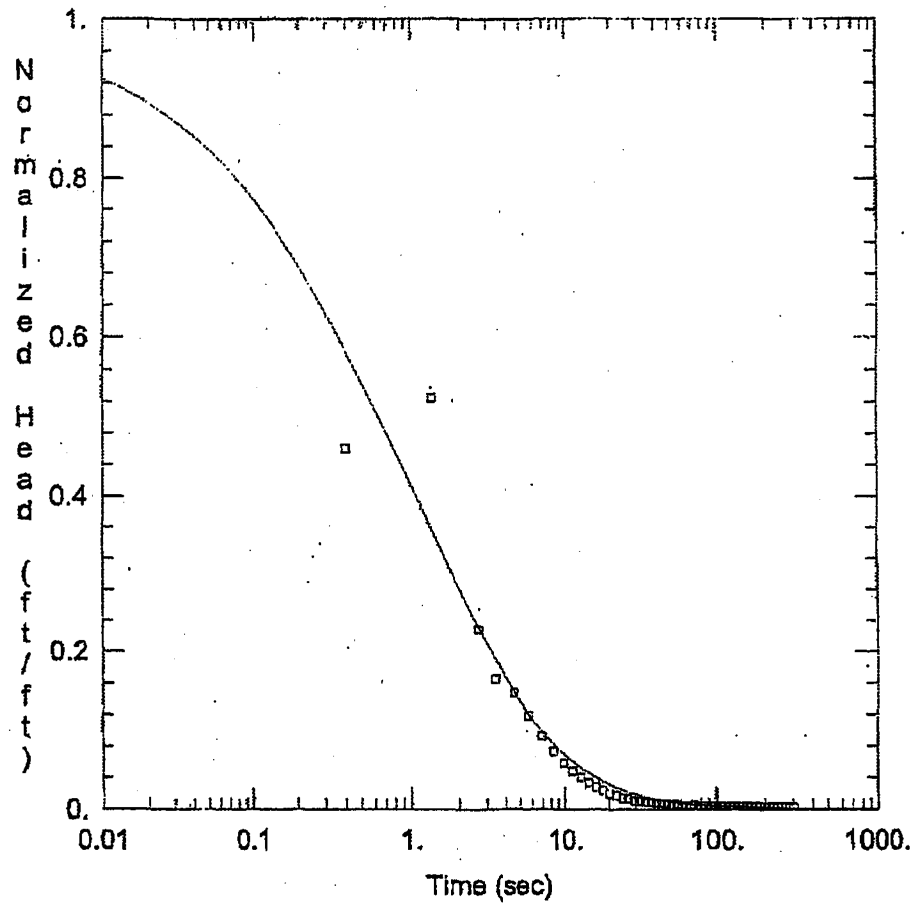
SOLUTION

Aquifer Model: Confined

Solution Method: Butler

K = 54.63 ft/day

Le = 0.1 ft



OW-930 U RISING HEAD TEST

AQUIFER DATA

Saturated Thickness: 23.9 ft

WELL DATA (OW-930 U)

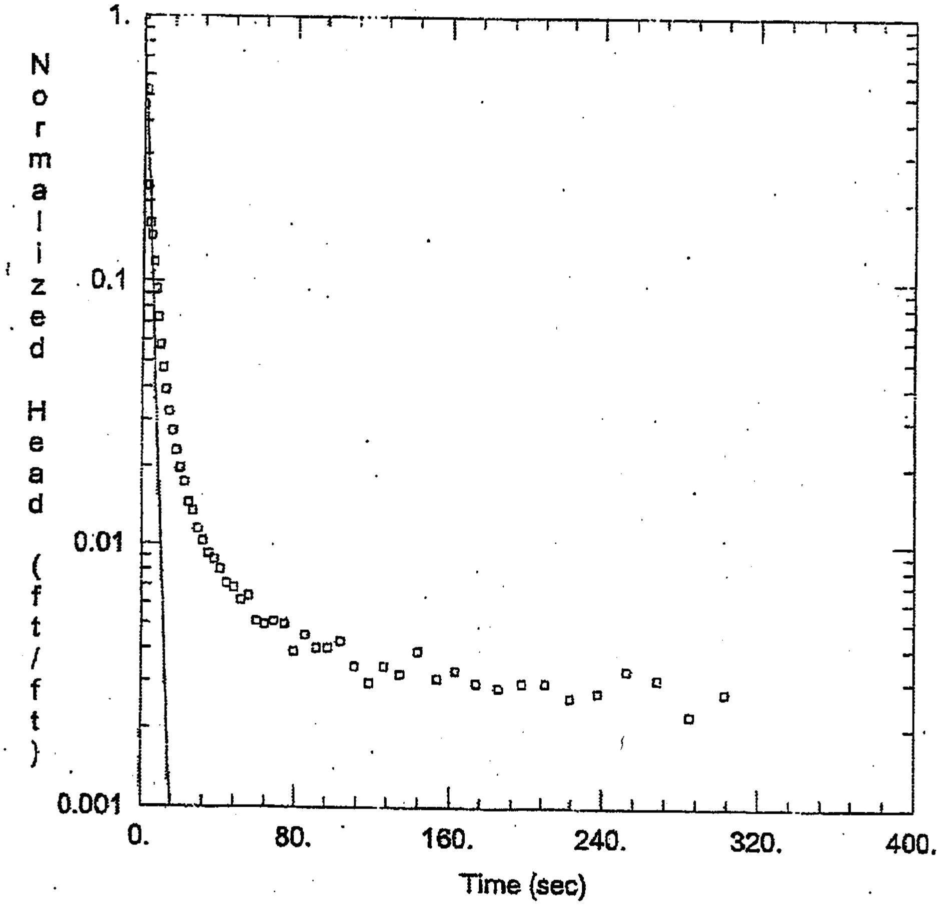
Initial Displacement: 8.47 ft
Total Well Penetration Depth: 16. ft
Casing Radius: 0.08333 ft

Static Water Column Height: 25.83 ft
Screen Length: 10. ft
Well Radius: 0.3333 ft

SOLUTION

Aquifer Model: Confined
Kr = 22.71 ft/day
Kz/Kr = 1.

Solution Method: KGS Model
Ss = 0.001841 ft^{-1}



OW-930 U RISING HEAD TEST

AQUIFER DATA

Saturated Thickness: 23.9 ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (OW-930 U)

Initial Displacement: 8.47 ft
Total Well Penetration Depth: 16. ft
Casing Radius: 0.08333 ft

Static Water Column Height: 25.83 ft
Screen Length: 10. ft
Well Radius: 0.3333 ft

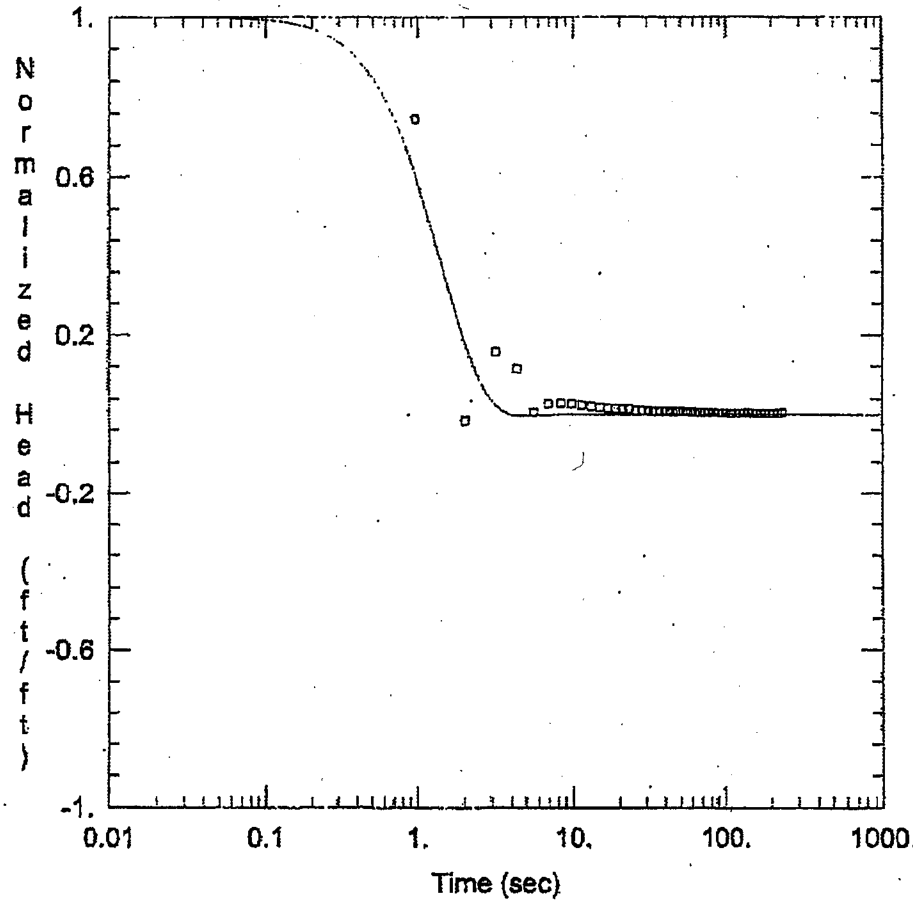
SOLUTION

Aquifer Model: Confined

K = 31.73 ft/day

Solution Method: Bouwer-Rice

y0 = 7.021 ft



OW-930 U FALLING HEAD TEST

AQUIFER DATA

Saturated Thickness: 23.9 ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (OW-930 U)

Initial Displacement: 8.612 ft

Total Well Penetration Depth: 16. ft

Casing Radius: 0.08333 ft

Static Water Column Height: 25.83 ft

Screen Length: 10. ft

Well Radius: 0.3333 ft

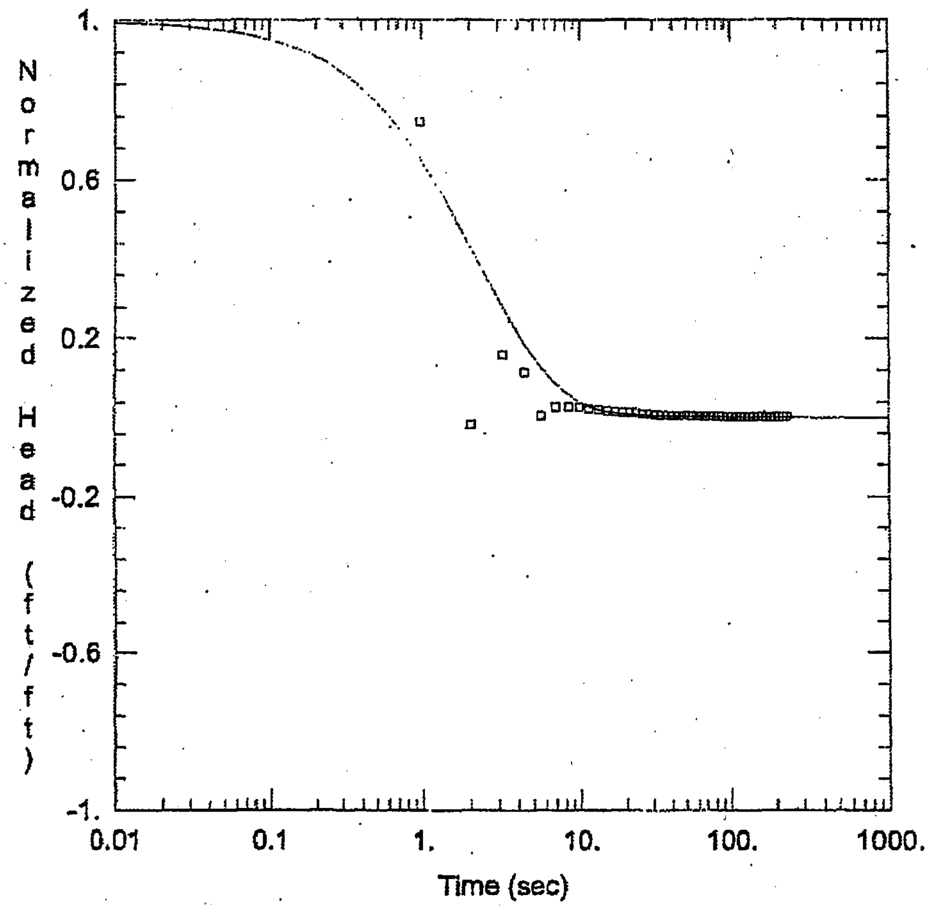
SOLUTION

Aquifer Model: Confined

Solution Method: Butler

K = 79.61 ft/day

Le = 17.83 ft



<u>OW-930 U FALLING HEAD TEST</u>

<u>AQUIFER DATA</u>

Saturated Thickness: <u>23.9</u> ft

<u>WELL DATA (OW-930 U)</u>

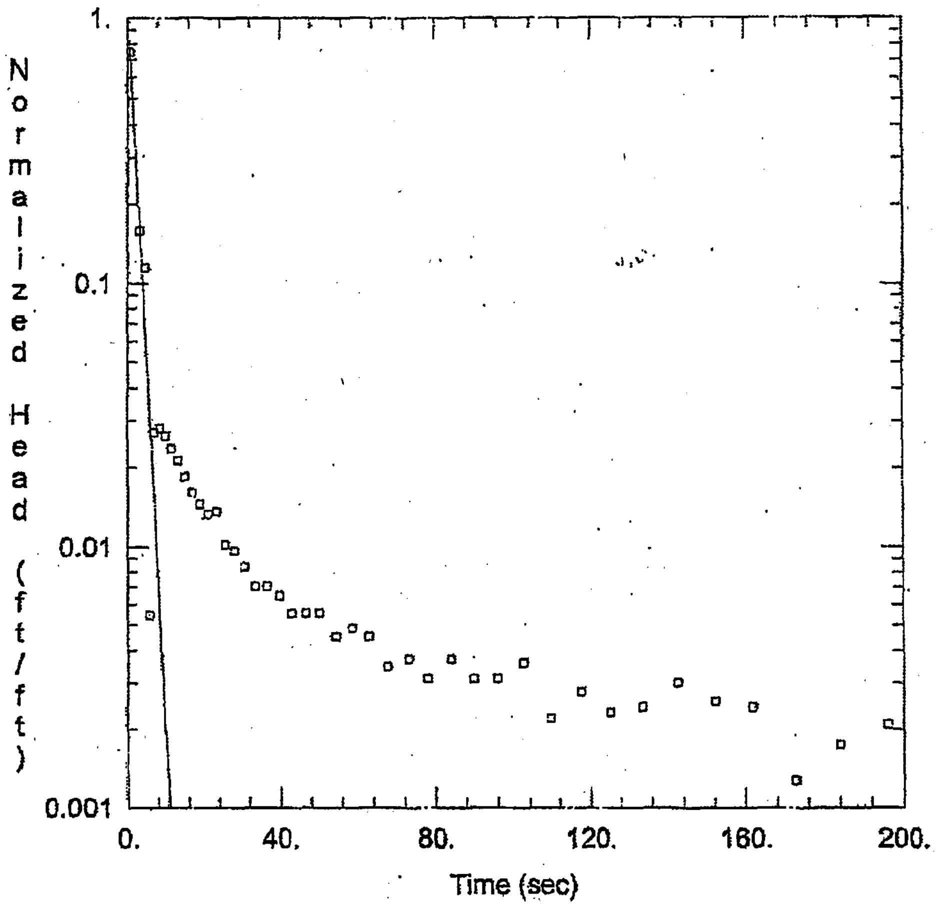
Initial Displacement: <u>8.612</u> ft
Total Well Penetration Depth: <u>16.</u> ft
Casing Radius: <u>0.08333</u> ft

Static Water Column Height: <u>25.83</u> ft
Screen Length: <u>10.</u> ft
Well Radius: <u>0.3333</u> ft

<u>SOLUTION</u>

Aquifer Model: <u>Confined</u>
K_r = <u>47.12</u> ft/day
K_z/K_r = <u>1.</u>

Solution Method: <u>KGS Model</u>
S_s = <u>1.468E-7</u> ft^{-1}



OW-930 U FALLING HEAD TEST

AQUIFER DATA

Saturated Thickness: 23.9 ft   Anisotropy Ratio (Kz/Kr): 1.

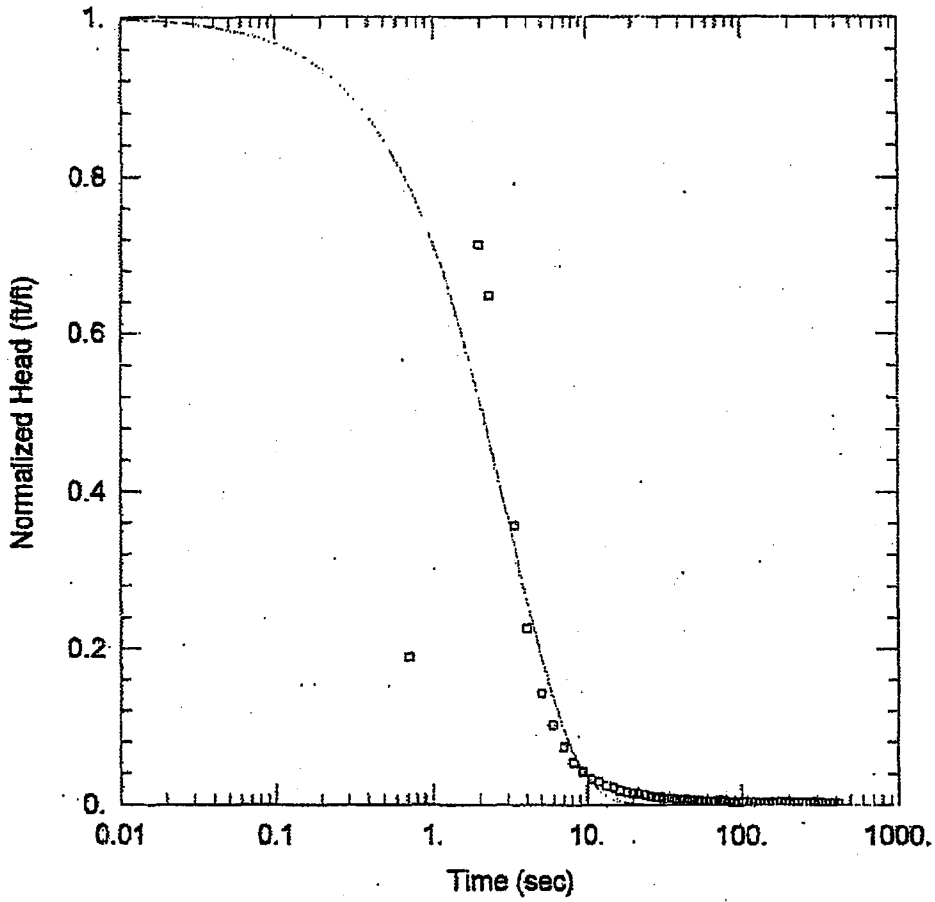
WELL DATA (OW-930 U)

Initial Displacement: 8.612 ft   Static Water Column Height: 25.83 ft
Total Well Penetration Depth: 16. ft   Screen Length: 10. ft
Casing Radius: 0.08333 ft   Well Radius: 0.3333 ft

SOLUTION

Aquifer Model: Confined   Solution Method: Bouwer-Rice

K = 47.71 ft/day   y0 = 10.64 ft



OW-931 U RISING HEAD TEST

AQUIFER DATA

Saturated Thickness: 29.5 ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (OW-931 U)

Initial Displacement: 4.668 ft

Total Well Penetration Depth: 16. ft

Casing Radius: 0.08333 ft

Static Water Column Height: 27.82 ft

Screen Length: 10. ft

Well Radius: 0.3333 ft

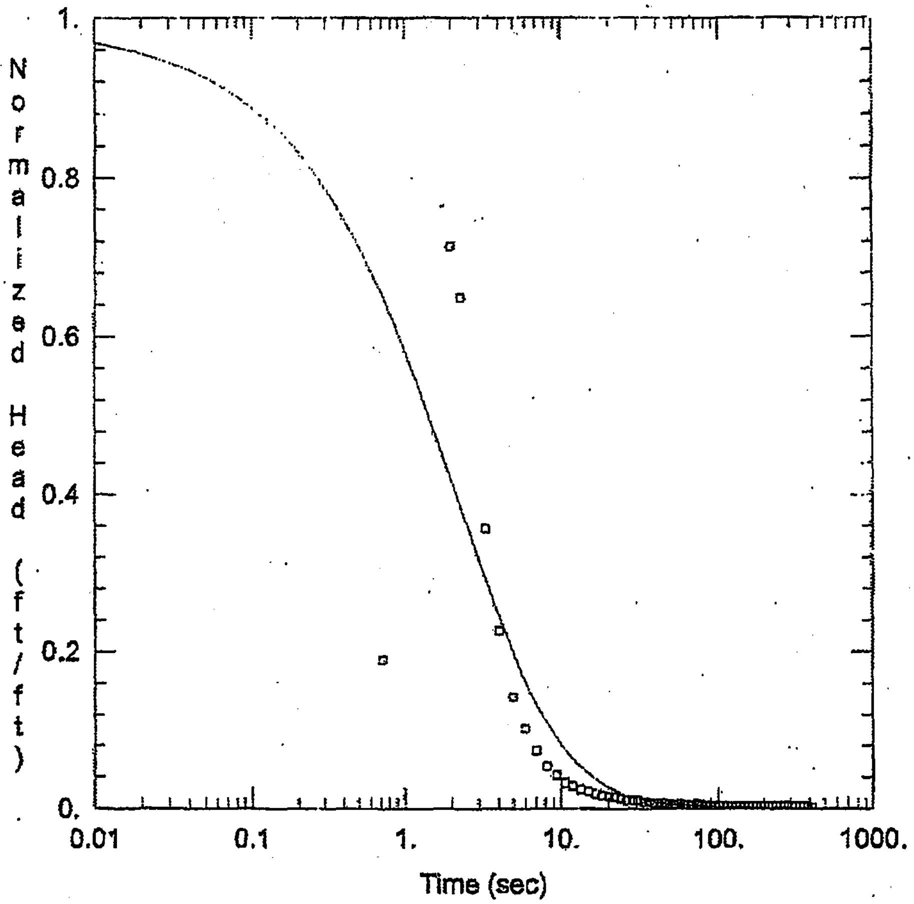
SOLUTION

Aquifer Model: Confined

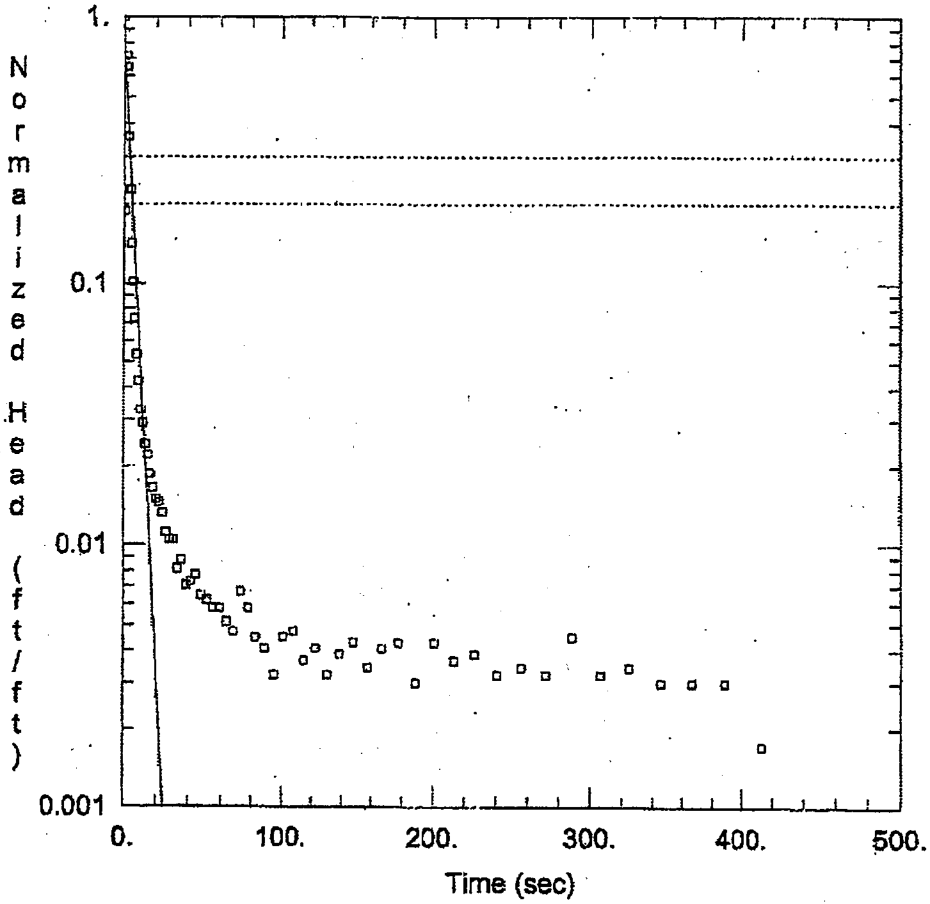
K = 34.39 ft/day

Solution Method: Butler

Le = 0.1 ft



OW-931 U RISING HEAD TEST	
AQUIFER DATA	
Saturated Thickness: 29.5 ft	
WELL DATA (OW-931 U)	
Initial Displacement: 4.668 ft	Static Water Column Height: 27.82 ft
Total Well Penetration Depth: 16. ft	Screen Length: 10. ft
Casing Radius: 0.08333 ft	Well Radius: 0.3333 ft
SOLUTION	
Aquifer Model: Confined	Solution Method: KGS Model
Kr = 23.45 ft/day	Ss = 0.0002309 ft^{-1}
Kz/Kr = 1.	



OW-931 U RISING HEAD TEST

AQUIFER DATA

Saturated Thickness: 29.5 ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (OW-931 U)

Initial Displacement: 4.668 ft
Total Well Penetration Depth: 16. ft
Casing Radius: 0.08333 ft

Static Water Column Height: 27.82 ft
Screen Length: 10. ft
Well Radius: 0.3333 ft

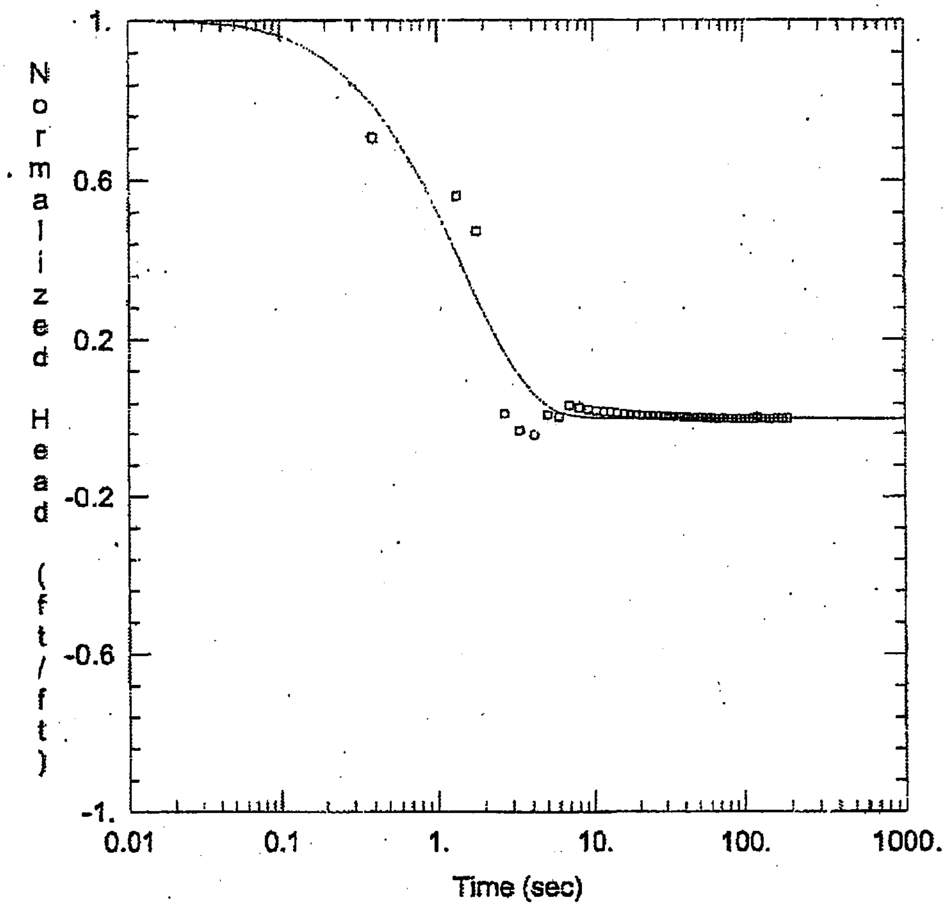
SOLUTION

Aquifer Model: Confined

K = 19.99 ft/day

Solution Method: Bouwer-Rice

y0 = 3.815 ft



OW-931 U FALLING HEAD TEST

AQUIFER DATA

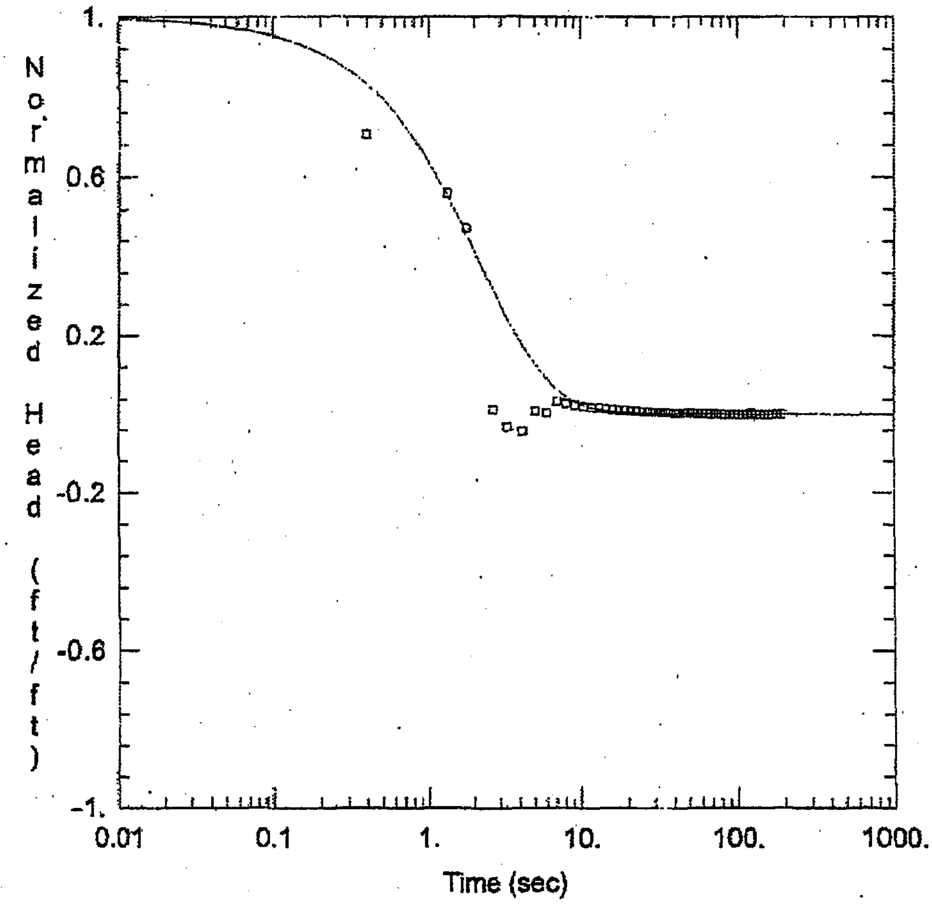
Saturated Thickness: 29.5 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (OW-931 U)

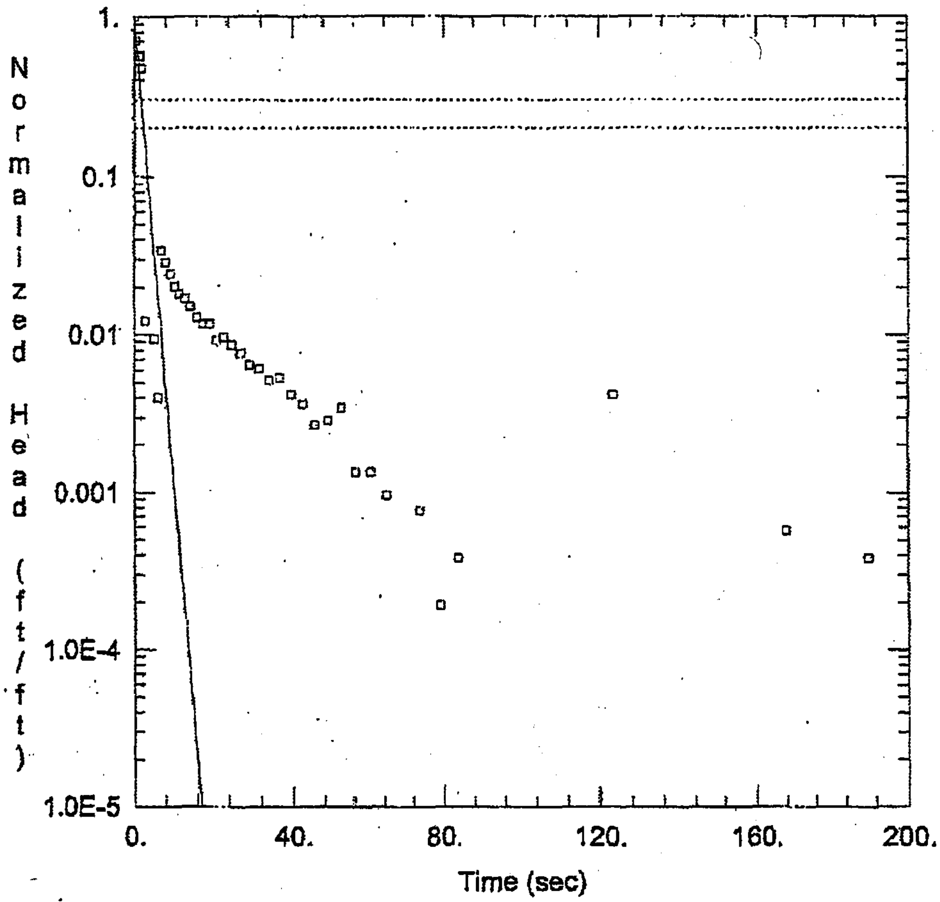
Initial Displacement: 5.216 ft
Total Well Penetration Depth: 16. ft
Casing Radius: 0.08333 ft
Static Water Column Height: 27.82 ft
Screen Length: 10. ft
Well Radius: 0.3333 ft

SOLUTION

Aquifer Model: Confined
K = 68.08 ft/day
Solution Method: Butler
Le = 2.125 ft



OW-931 U FALLING HEAD TEST	
AQUIFER DATA	
Saturated Thickness: 29.5 ft	
WELL DATA (OW-931 U)	
Initial Displacement: 5.216 ft	Static Water Column Height: 27.82 ft
Total Well Penetration Depth: 16. ft	Screen Length: 10. ft
Casing Radius: 0.08333 ft	Well Radius: 0.3333 ft
SOLUTION	
Aquifer Model: Confined	Solution Method: KGS Model
Kr = 71.64 ft/day	Ss = 3.39E-12 ft^{-1}
Kz/Kr = 1.	



OW-931 U FALLING HEAD TEST

AQUIFER DATA

Saturated Thickness: 29.5 ft　　Anisotropy Ratio (Kz/Kr): 1.

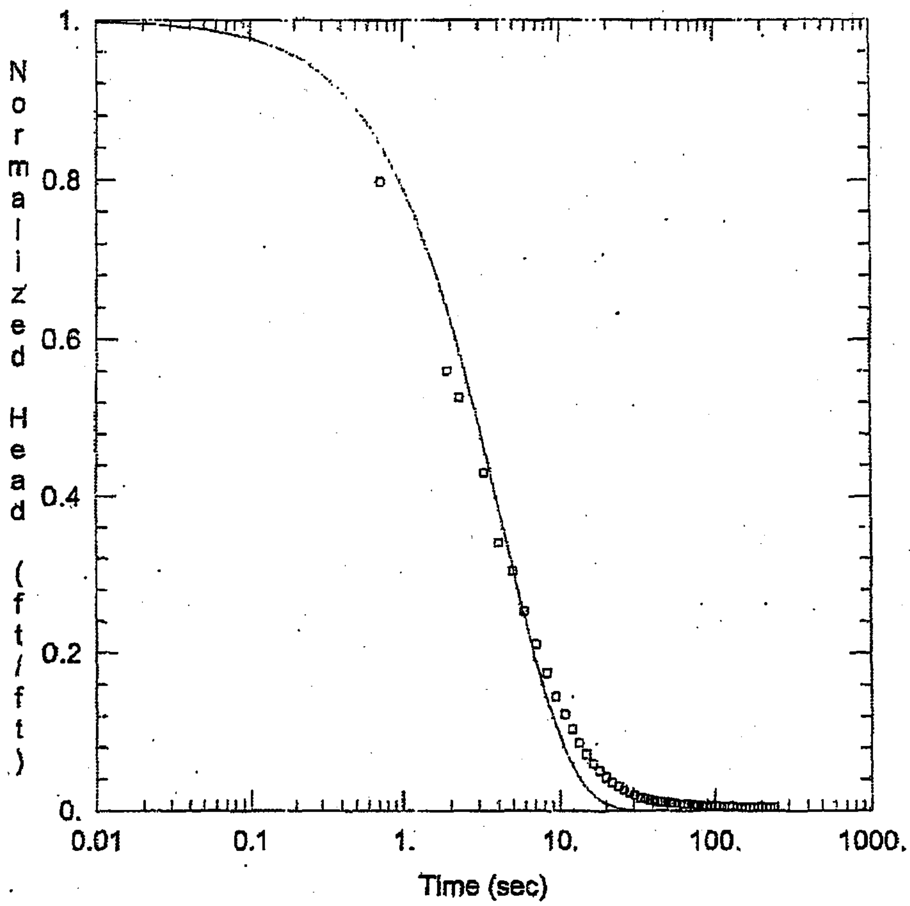
WELL DATA (OW-931 U)

Initial Displacement: 5.216 ft　　Static Water Column Height: 27.82 ft
Total Well Penetration Depth: 16. ft　　Screen Length: 10. ft
Casing Radius: 0.08333 ft　　Well Radius: 0.3333 ft

SOLUTION

Aquifer Model: Confined　　Solution Method: Bouwer-Rice

K = 48.58 ft/day　　y0 = 5.267 ft



OW-932 L RISING HEAD TEST

AQUIFER DATA

Saturated Thickness: 14.5 ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (OW-932 L)

Initial Displacement: 5.11 ft
Total Well Penetration Depth: 14.2 ft
Casing Radius: 0.0833 ft

Static Water Column Height: 62.32 ft
Screen Length: 10. ft
Well Radius: 0.3333 ft

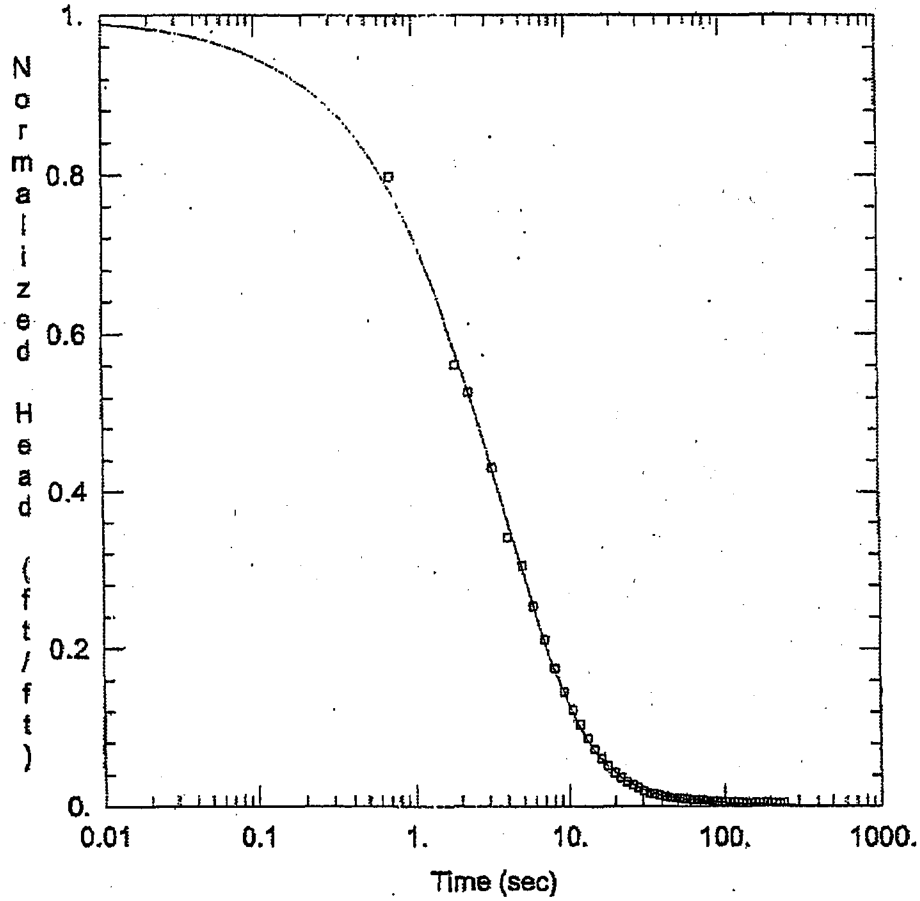
SOLUTION

Aquifer Model: Confined

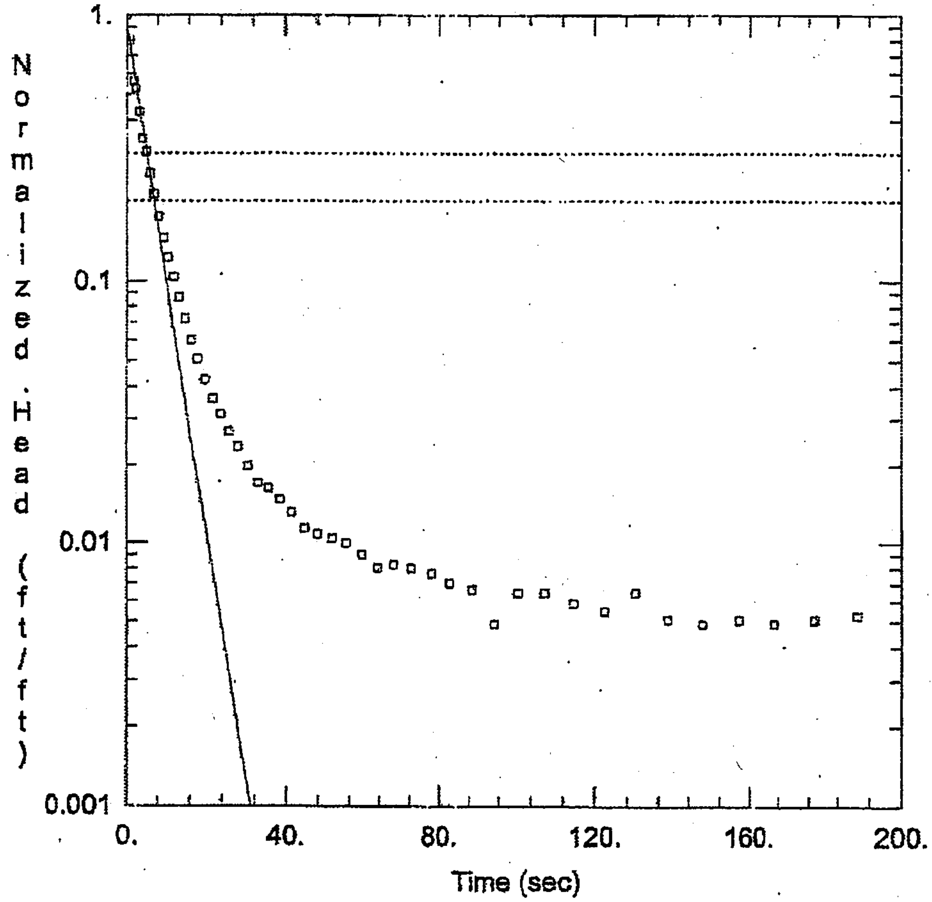
Solution Method: Butler

K = 24.34 ft/day

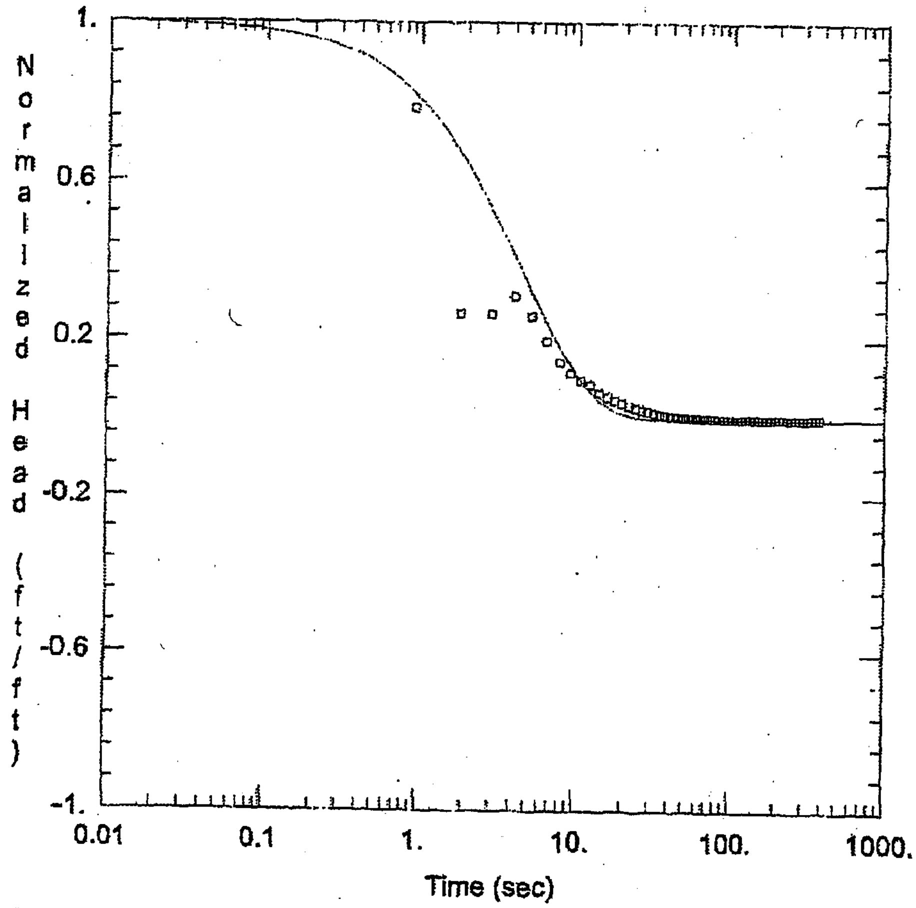
Le = 0.1 ft



OW-932 L RISING HEAD TEST	
AQUIFER DATA	
Saturated Thickness: 14.5 ft	
WELL DATA (OW-932 L)	
Initial Displacement: 5.11 ft	Static Water Column Height: 62.32 ft
Total Well Penetration Depth: 14.2 ft	Screen Length: 10. ft
Casing Radius: 0.0833 ft	Well Radius: 0.3333 ft
SOLUTION	
Aquifer Model: Confined	Solution Method: KGS Model
Kr = 23.25 ft/day	Ss = 1.74E-5 ft^{-1}
Kz/Kr = 1.	



OW-932 L RISING HEAD TEST	
AQUIFER DATA	
Saturated Thickness: 14.5 ft	Anisotropy Ratio (Kz/Kr): 1.
WELL DATA (OW-932 L)	
Initial Displacement: 5.11 ft	Static Water Column Height: 62.32 ft
Total Well Penetration Depth: 14.2 ft	Screen Length: 10. ft
Casing Radius: 0.0833 ft	Well Radius: 0.3333 ft
SOLUTION	
Aquifer Model: Confined	Solution Method: Bouwer-Rice
K = 17.73 ft/day	y0 = 4.767 ft



OW-932 L FALLING HEAD TEST

AQUIFER DATA

Saturated Thickness: 14.5 ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (OW-932 L)

Initial Displacement: 9.546 ft
Total Well Penetration Depth: 14.2 ft
Casing Radius: 0.0833 ft

Static Water Column Height: 62.32 ft
Screen Length: 10. ft
Well Radius: 0.3333 ft

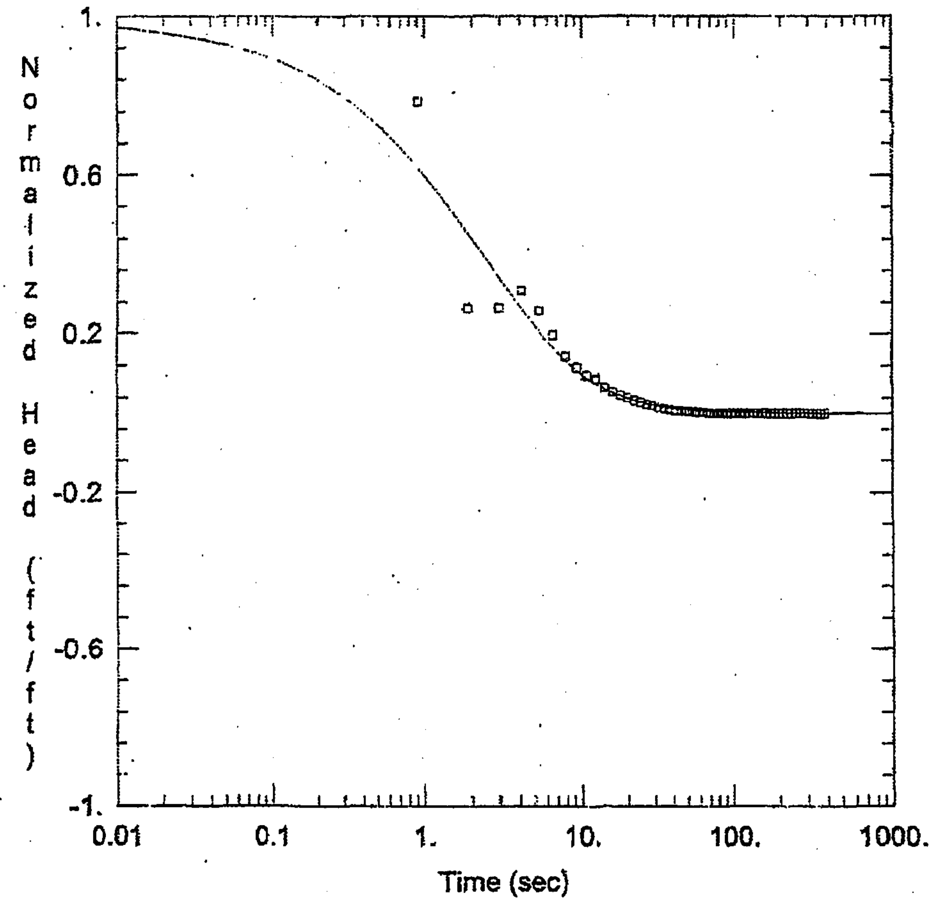
SOLUTION

Aquifer Model: Confined

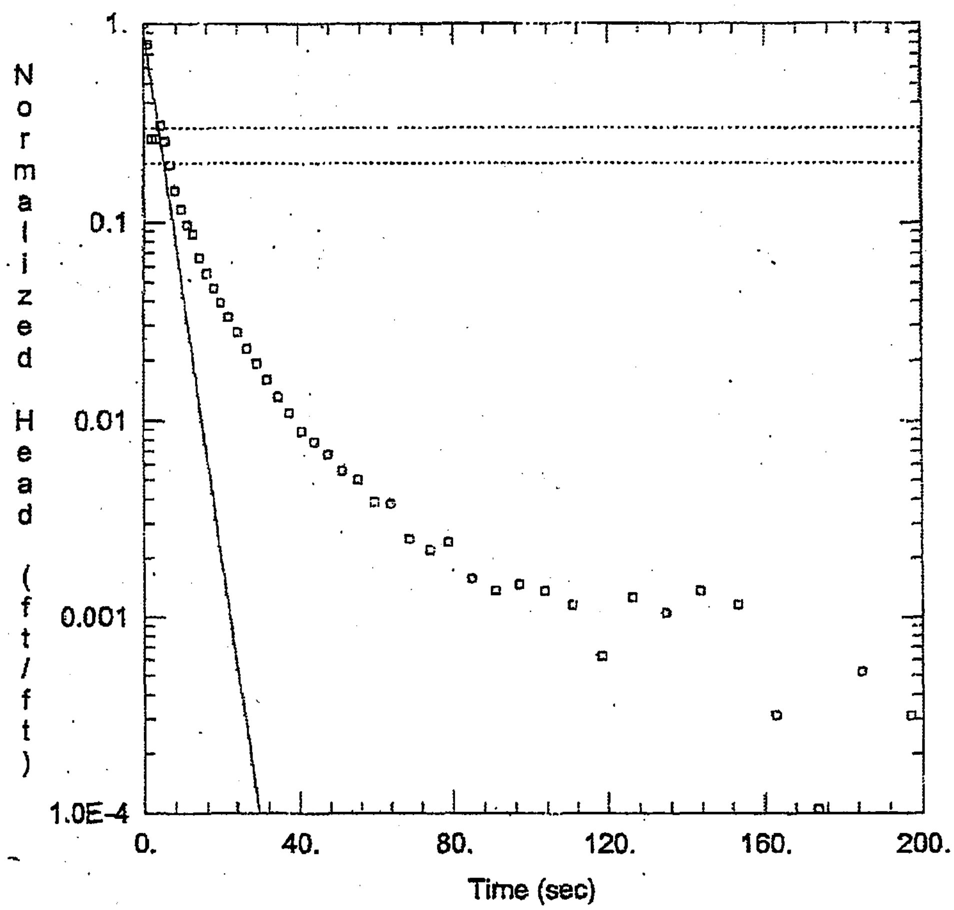
K = 22.25 ft/day

Solution Method: Butler

Le = 0.1 ft



OW-932 L FALLING HEAD TEST	
AQUIFER DATA	
Saturated Thickness: 14.5 ft	
WELL DATA (OW-932 L)	
Initial Displacement: 9.546 ft	Static Water Column Height: 62.32 ft
Total Well Penetration Depth: 14.2 ft	Screen Length: 10. ft
Casing Radius: 0.0833 ft	Well Radius: 0.3333 ft
SOLUTION	
Aquifer Model: Confined	Solution Method: KGS Model
Kr = 22.25 ft/day	Ss = 0.000219 ft^{-1}
Kz/Kr = 1.	



OW-932 L FALLING HEAD TEST

AQUIFER DATA

Saturated Thickness: 14.5 ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (OW-932 L)

Initial Displacement: 9.546 ft
Total Well Penetration Depth: 14.2 ft
Casing Radius: 0.0833 ft

Static Water Column Height: 62.32 ft
Screen Length: 10. ft
Well Radius: 0.3333 ft

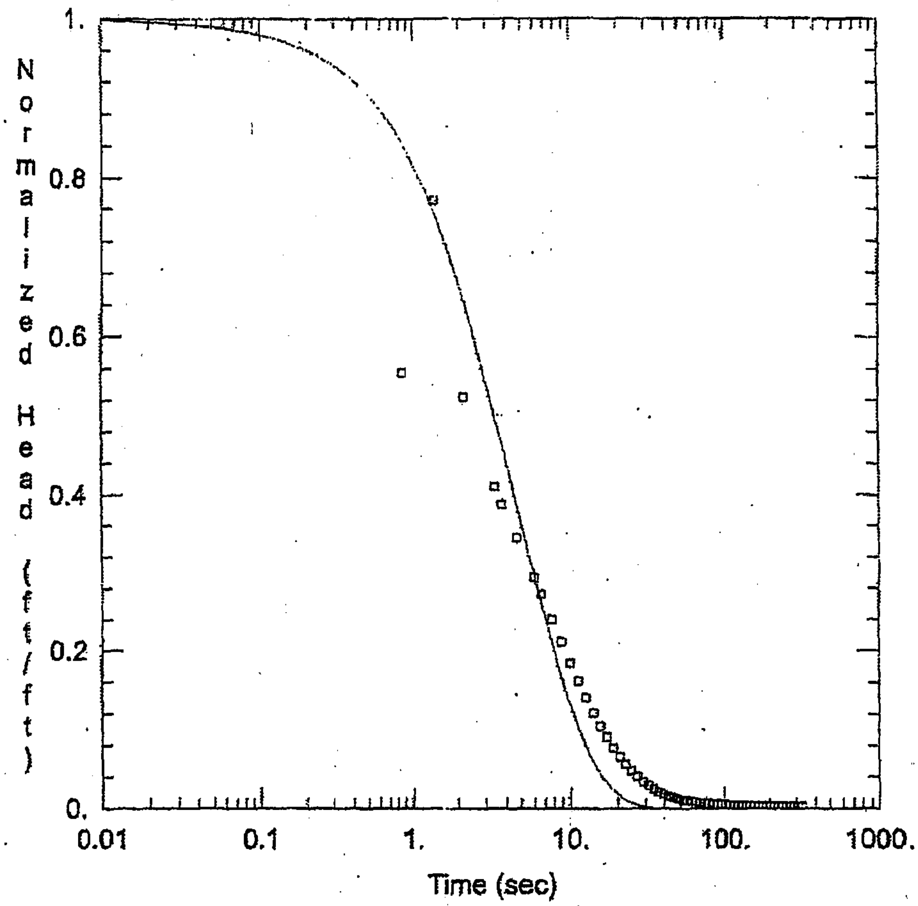
SOLUTION

Aquifer Model: Confined

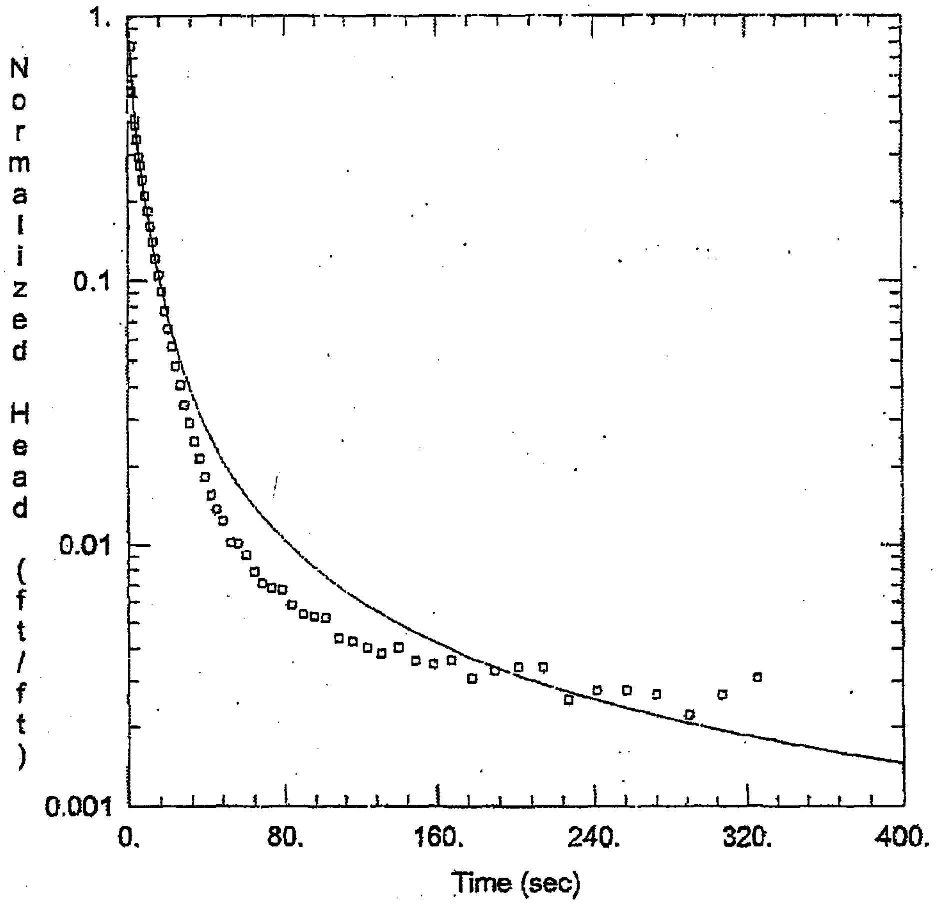
K = 24.89 ft/day

Solution Method: Bouwer-Rice

y0 = 8.883 ft



OW-932 U RISING HEAD TEST	
AQUIFER DATA	
Saturated Thickness: 21.2 ft	Anisotropy Ratio (Kz/Kr): 1.
WELL DATA (OW-932 U)	
Initial Displacement: 9.407 ft	Static Water Column Height: 30.93 ft
Total Well Penetration Depth: 20. ft	Screen Length: 10. ft
Casing Radius: 0.08333 ft	Well Radius: 0.3333 ft
SOLUTION	
Aquifer Model: Confined	Solution Method: Butler
K = 20.74 ft/day	Le = 0.1 ft



OW-932 U RISING HEAD TEST

AQUIFER DATA

Saturated Thickness: 21.2 ft

WELL DATA (OW-932 U)

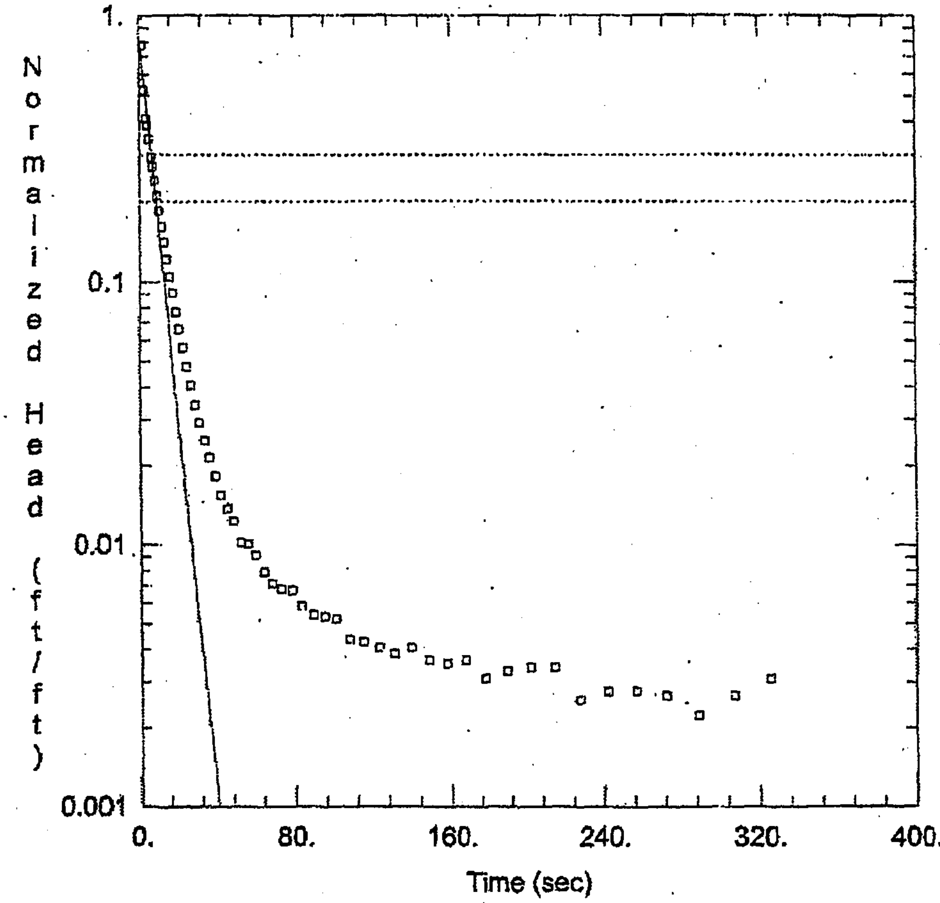
Initial Displacement: 9.407 ft
Total Well Penetration Depth: 20. ft
Casing Radius: 0.08333 ft

Static Water Column Height: 30.93 ft
Screen Length: 10. ft
Well Radius: 0.3333 ft

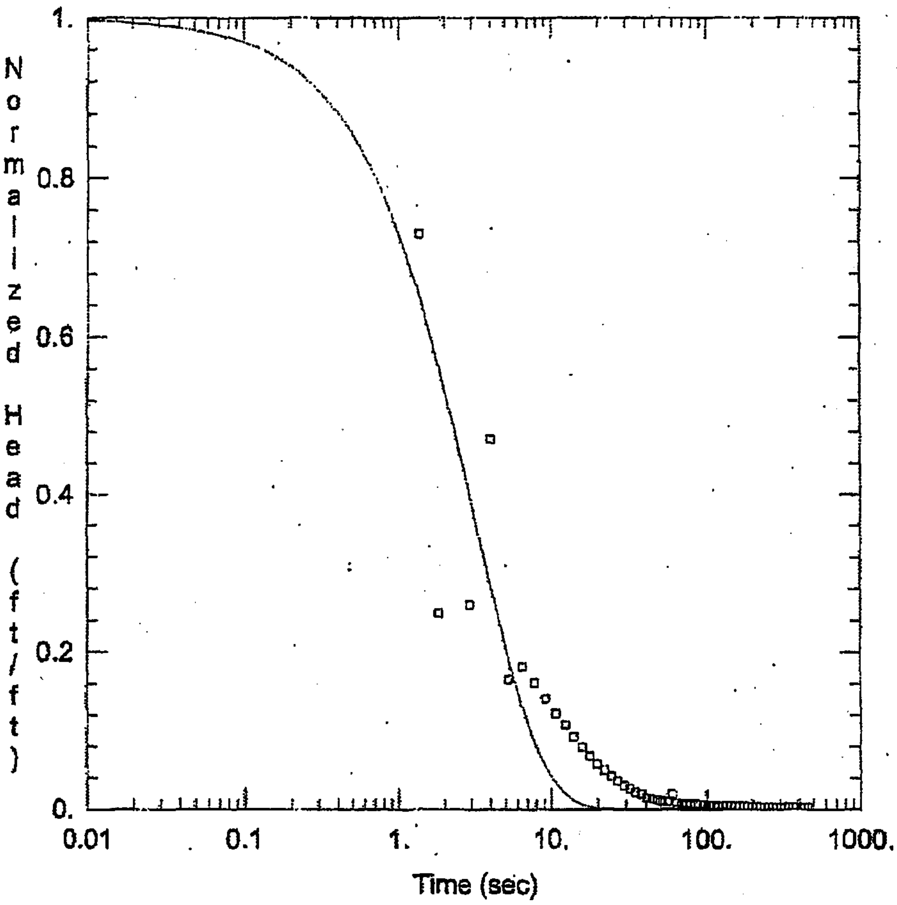
SOLUTION

Aquifer Model: Confined
Kr = 12.8 ft/day
Kz/Kr = 1.

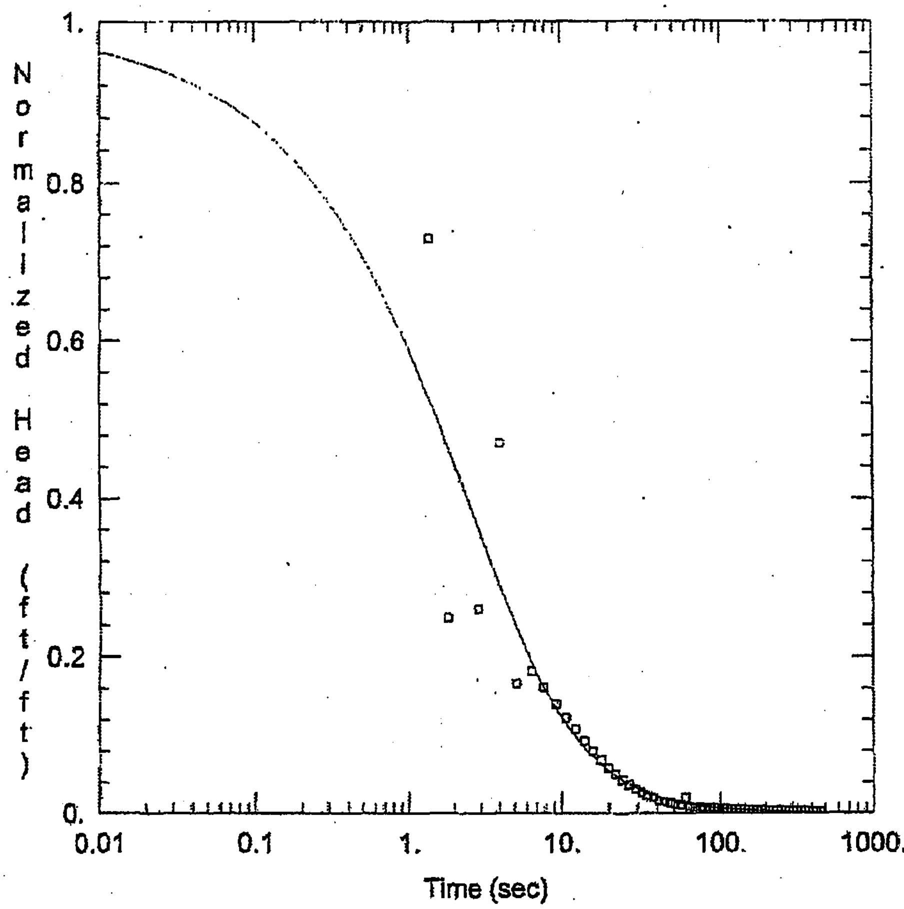
Solution Method: KGS Model
Ss = 0.0002813 ft^{-1}



OW-932 U RISING HEAD TEST	
AQUIFER DATA	
Saturated Thickness: 21.2 ft	Anisotropy Ratio (Kz/Kr): 1.
WELL DATA (OW-932 U)	
Initial Displacement: 9.407 ft	Static Water Column Height: 30.93 ft
Total Well Penetration Depth: 20. ft	Screen Length: 10. ft
Casing Radius: 0.08333 ft	Well Radius: 0.3333 ft
SOLUTION	
Aquifer Model: Confined	Solution Method: Bouwer-Rice
K = 13.57 ft/day	y0 = 7.865 ft



OW-932 U FALLING HEAD TEST	
AQUIFER DATA	
Saturated Thickness: 21.2 ft	Anisotropy Ratio (Kz/Kr): 1.
WELL DATA (OW-932 U)	
Initial Displacement: 8.981 ft	Static Water Column Height: 30.93 ft
Total Well Penetration Depth: 20. ft	Screen Length: 10. ft
Casing Radius: 0.08333 ft	Well Radius: 0.3333 ft
SOLUTION	
Aquifer Model: Confined	Solution Method: Butler
K = 32.48 ft/day	Le = 0.1 ft



OW-932 U FALLING HEAD TEST

AQUIFER DATA

Saturated Thickness: 21.2 ft

WELL DATA (OW-932 U)

Initial Displacement: 8.981 ft
Total Well Penetration Depth: 20. ft
Casing Radius: 0.08333 ft

Static Water Column Height: 30.93 ft
Screen Length: 10. ft
Well Radius: 0.3333 ft

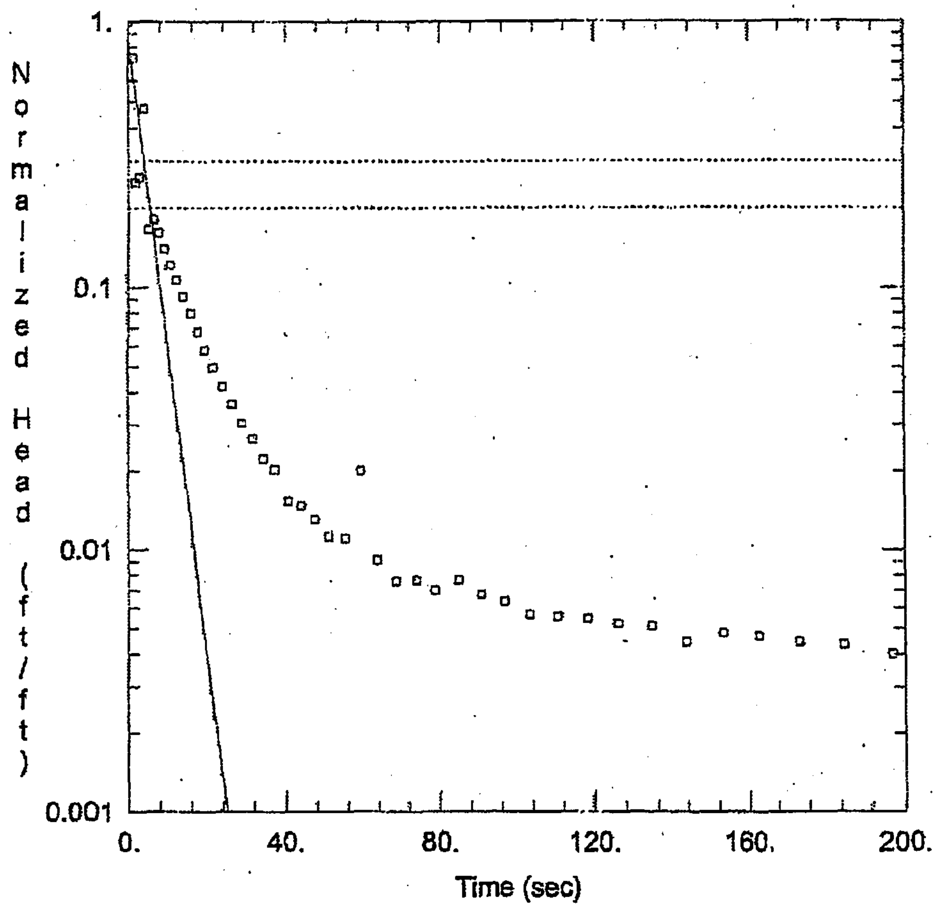
SOLUTION

Aquifer Model: Confined

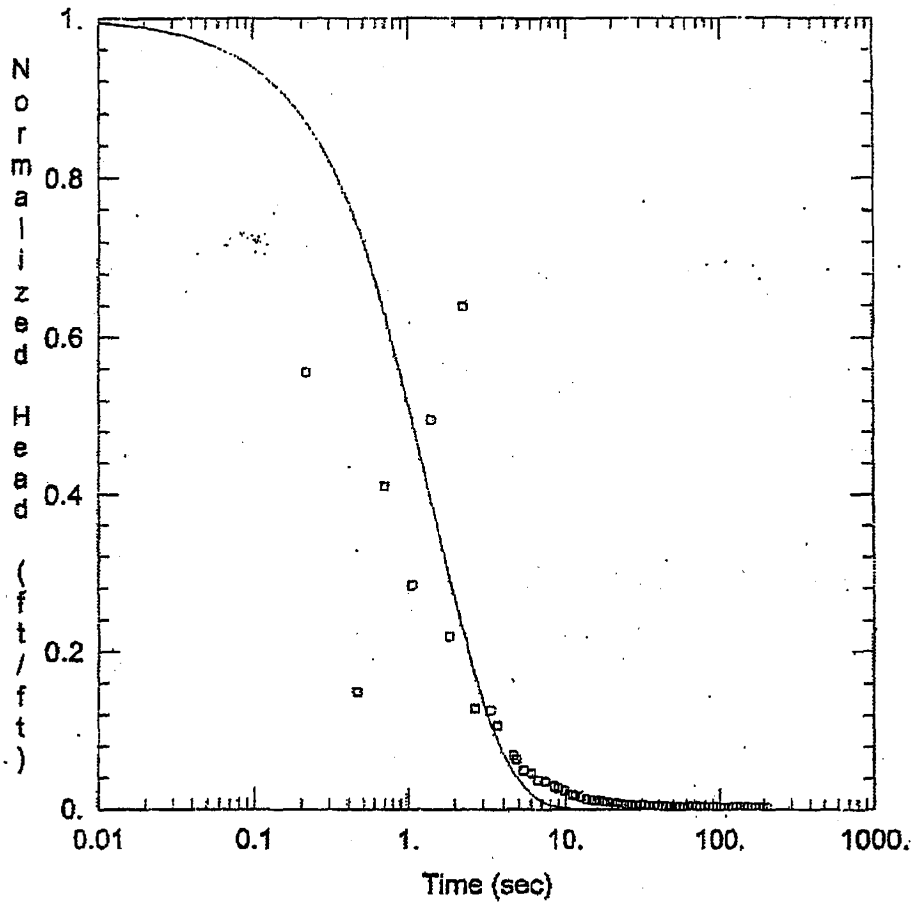
Solution Method: KGS Model

Kr = 15.65 ft/day
Kz/Kr = 1.

Ss = 0.0006107 ft^{-1}



OW-932 U FALLING HEAD TEST	
AQUIFER DATA	
Saturated Thickness: 21.2 ft	Anisotropy Ratio (Kz/Kr): 1.
WELL DATA (OW-932 U)	
Initial Displacement: 8.981 ft	Static Water Column Height: 30.93 ft
Total Well Penetration Depth: 20. ft	Screen Length: 10. ft
Casing Radius: 0.08333 ft	Well Radius: 0.3333 ft
SOLUTION	
Aquifer Model: Confined	Solution Method: Bouwer-Rice
K = 22.12 ft/day	y0 = 8.036 ft



OW-933 L RISING HEAD TEST

AQUIFER DATA

Saturated Thickness: 5. ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (OW-933 L)

Initial Displacement: 17.68 ft

Total Well Penetration Depth: 5. ft

Casing Radius: 0.08333 ft

Static Water Column Height: 74.2 ft

Screen Length: 5. ft

Well Radius: 0.3333 ft

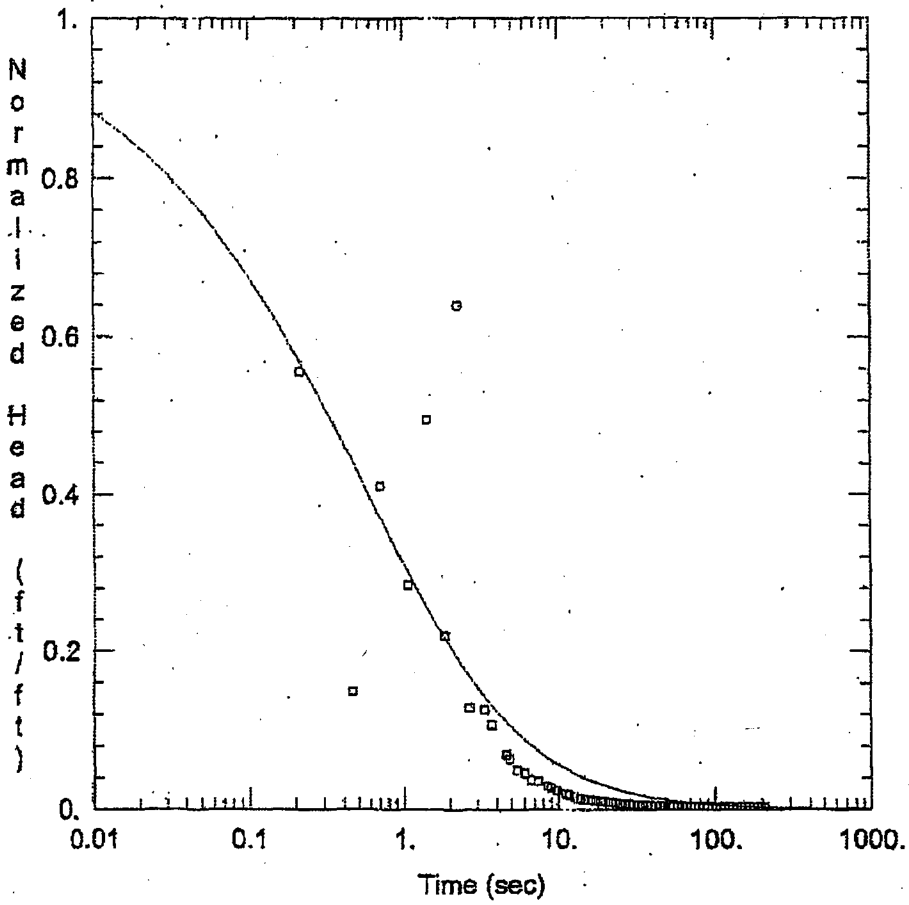
SOLUTION

Aquifer Model: Confined

Solution Method: Butler

K = 214.3 ft/day

Le = 0.1 ft



OW-933 L RISING HEAD TEST

AQUIFER DATA

Saturated Thickness: 5. ft

WELL DATA (OW-933 L)

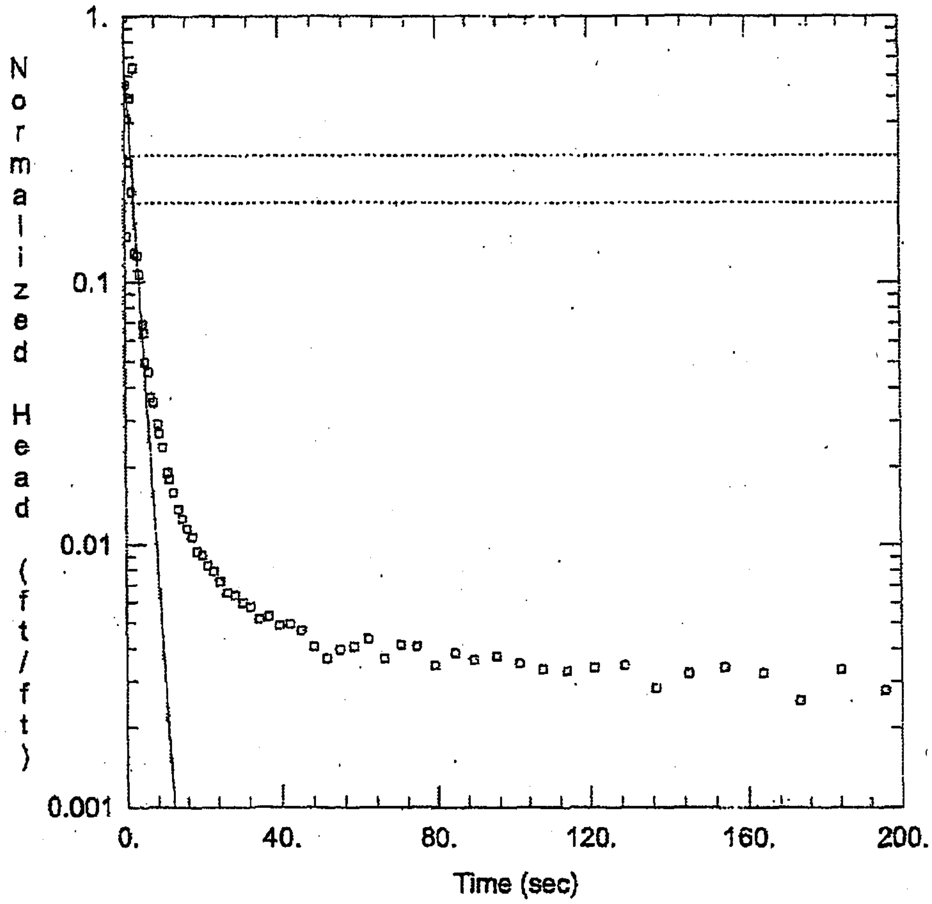
Initial Displacement: 17.68 ft
Total Well Penetration Depth: 5. ft
Casing Radius: 0.08333 ft

Static Water Column Height: 74.2 ft
Screen Length: 5. ft
Well Radius: 0.3333 ft

SOLUTION

Aquifer Model: Confined
Kr = 50.89 ft/day
Kz/Kr = 1.

Solution Method: KGS Model
Ss = 0.009086 ft^{-1}



OW-933 L RISING HEAD TEST

AQUIFER DATA

Saturated Thickness: 5. ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (OW-933 L)

Initial Displacement: 17.68 ft
Total Well Penetration Depth: 5. ft
Casing Radius: 0.08333 ft

Static Water Column Height: 74.2 ft
Screen Length: 5. ft
Well Radius: 0.3333 ft

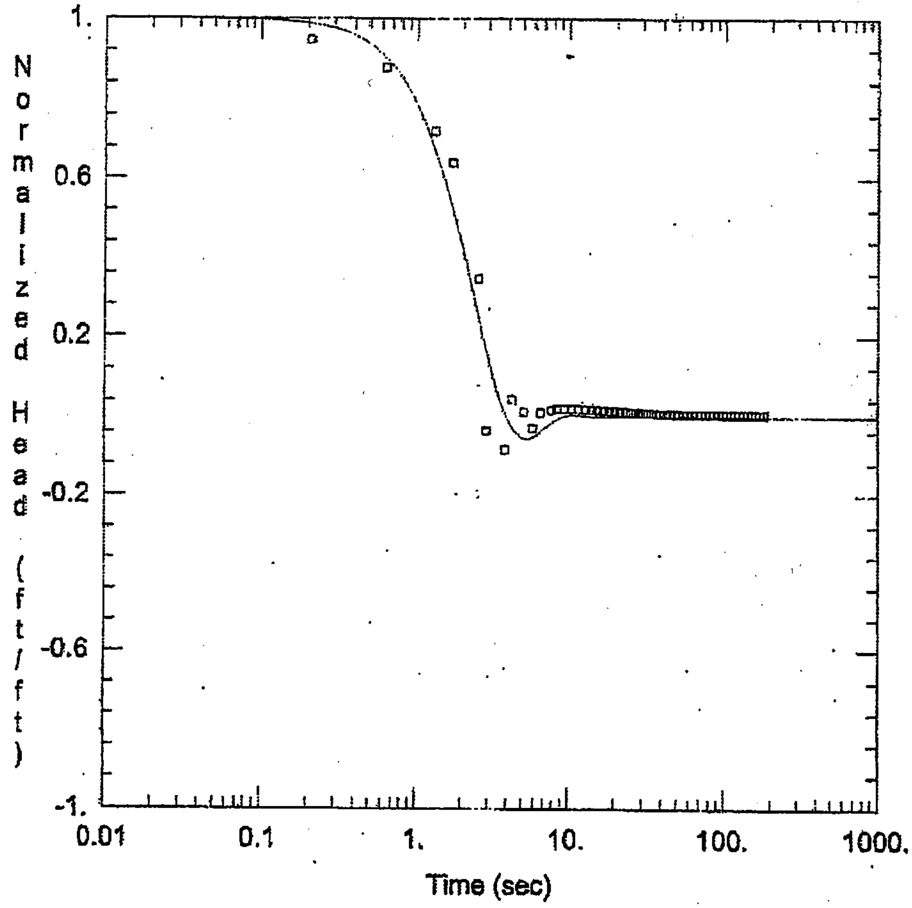
SOLUTION

Aquifer Model: Confined

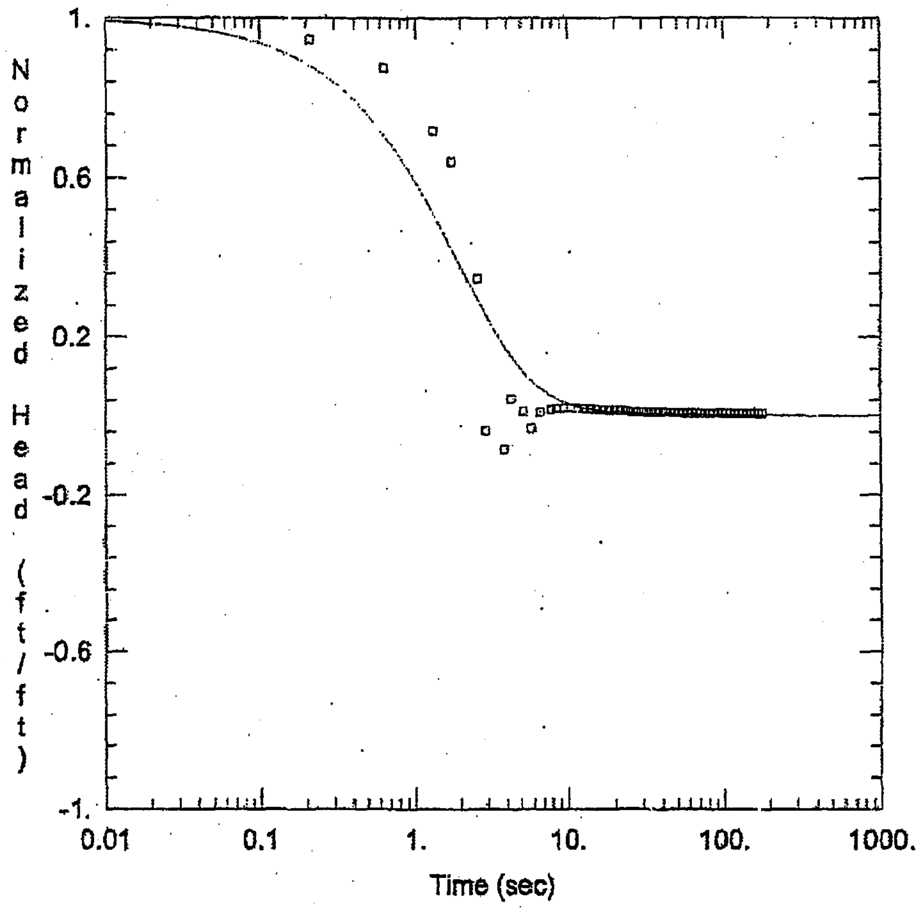
Solution Method: Bouwer-Rice

K = 63.29 ft/day

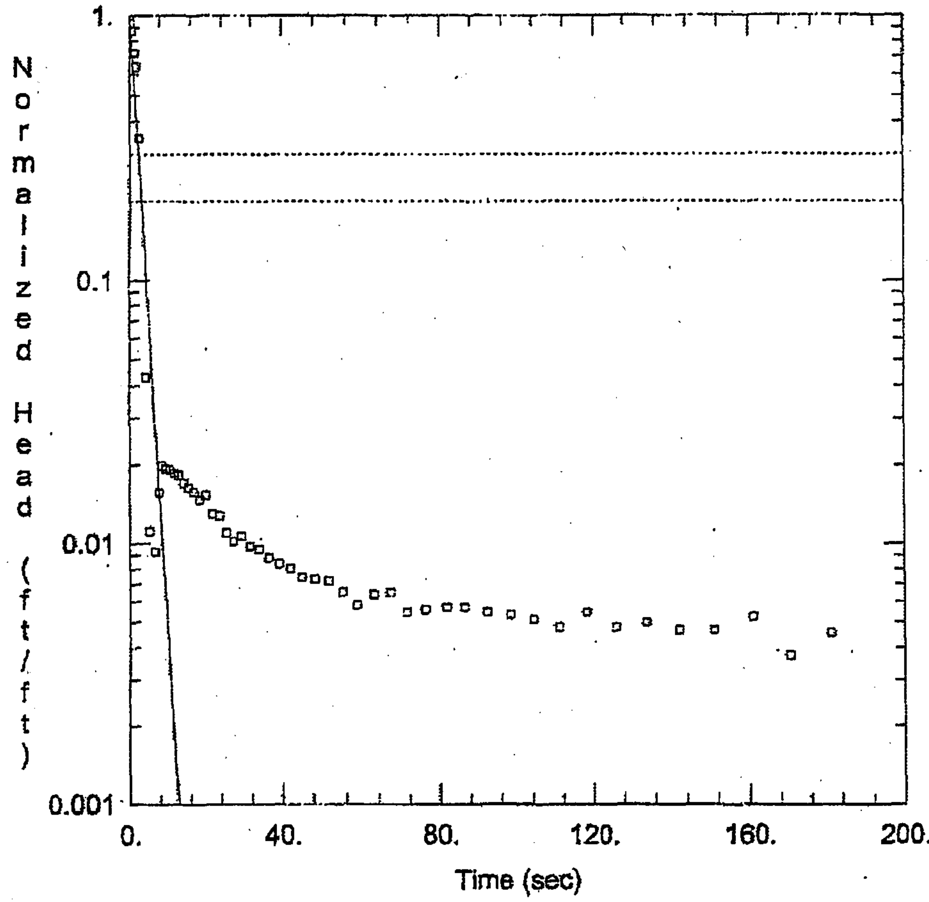
y0 = 12.52 ft



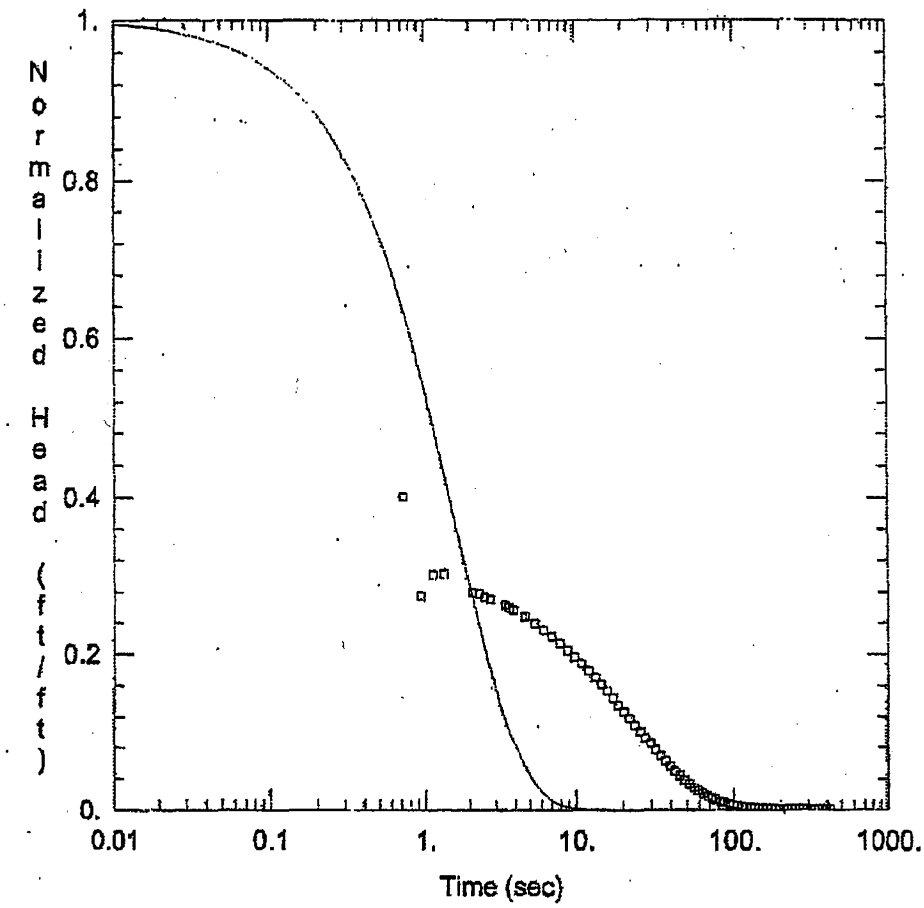
OW-933 L FALLING HEAD TEST	
AQUIFER DATA	
Saturated Thickness: 5. ft	Anisotropy Ratio (Kz/Kr): 1.
WELL DATA (OW-933 L)	
Initial Displacement: 8.602 ft	Static Water Column Height: 74.2 ft
Total Well Penetration Depth: 5. ft	Screen Length: 5. ft
Casing Radius: 0.08333 ft	Well Radius: 0.3333 ft
SOLUTION	
Aquifer Model: Confined	Solution Method: Butler
K = 191.2 ft/day	Le = 51.43 ft



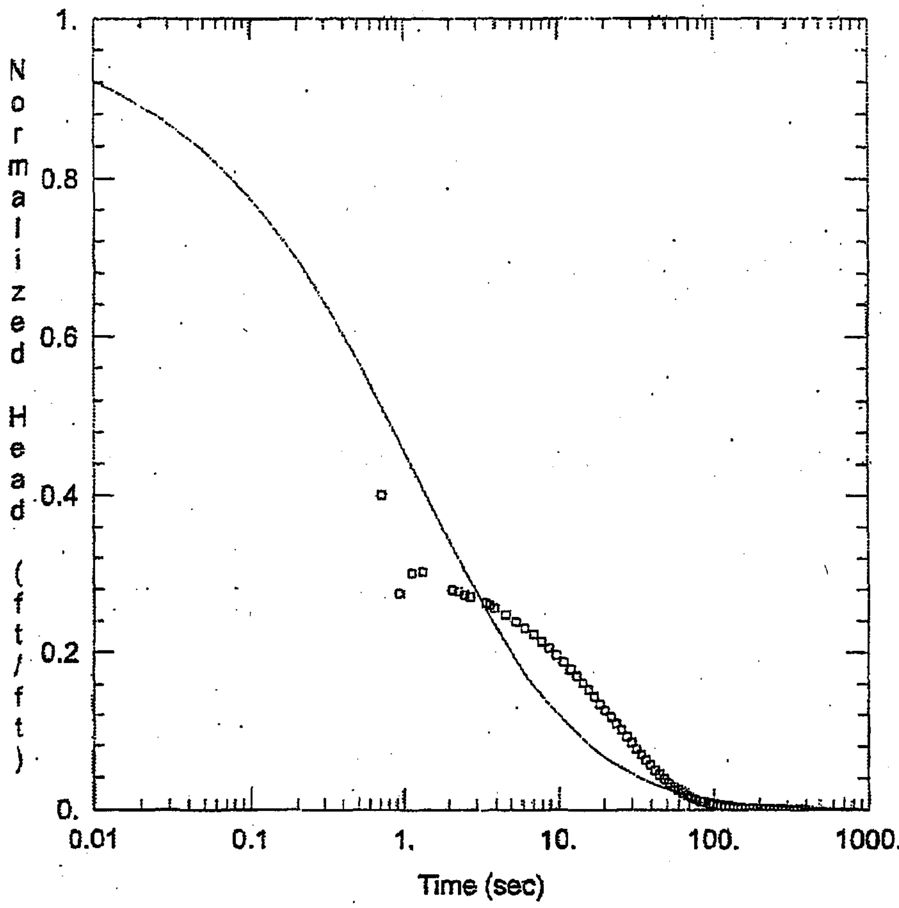
OW-933 L FALLING HEAD TEST	
AQUIFER DATA	
Saturated Thickness: 5. ft	
WELL DATA (OW-933 L)	
Initial Displacement: 8.602 ft	Static Water Column Height: 74.2 ft
Total Well Penetration Depth: 5. ft	Screen Length: 5. ft
Casing Radius: 0.08333 ft	Well Radius: 0.3333 ft
SOLUTION	
Aquifer Model: Confined	Solution Method: KGS Model
Kr = 214.3 ft/day	Ss = 3.554E-8 ft^{-1}
Kz/Kr = 1.	



OW-933 L FALLING HEAD TEST	
AQUIFER DATA	
Saturated Thickness: 5. ft	Anisotropy Ratio (Kz/Kr): 1.
WELL DATA (OW-933 L)	
Initial Displacement: 8.602 ft	Static Water Column Height: 74.2 ft
Total Well Penetration Depth: 5. ft	Screen Length: 5. ft
Casing Radius: 0.08333 ft	Well Radius: 0.3333 ft
SOLUTION	
Aquifer Model: Confined	Solution Method: Bouwer-Rice
K = 64.3 ft/day	y0 = 9.039 ft



OW-933 U RISING HEAD TEST	
AQUIFER DATA	
Saturated Thickness: 19.5 ft	Anisotropy Ratio (Kz/Kr): 1.
WELL DATA (OW-933 U)	
Initial Displacement: 18.99 ft	Static Water Column Height: 31.67 ft
Total Well Penetration Depth: 14. ft	Screen Length: 10. ft
Casing Radius: 0.0833 ft	Well Radius: 0.3333 ft
SOLUTION	
Aquifer Model: Confined	Solution Method: Butler
K = 64.32 ft/day	Le = 0.1 ft



OW-933 U RISING HEAD TEST

AQUIFER DATA

Saturated Thickness: 19.5 ft

WELL DATA (OW-933 U)

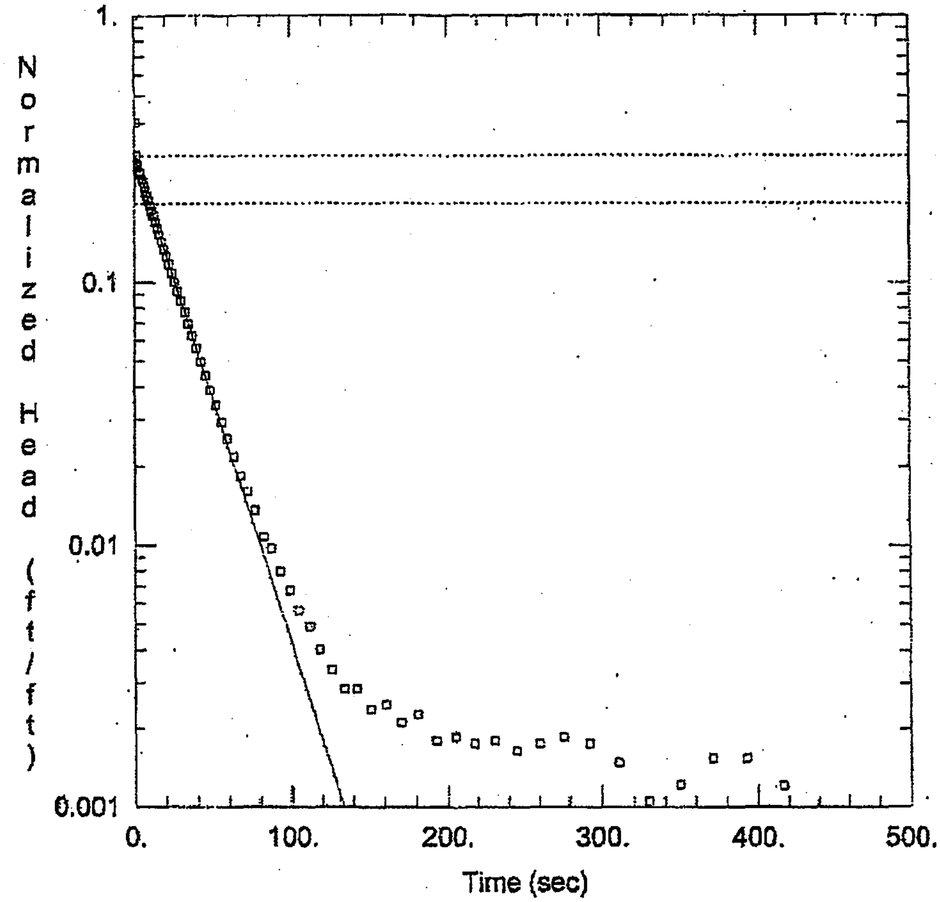
Initial Displacement: 18.99 ft
Total Well Penetration Depth: 14. ft
Casing Radius: 0.0833 ft

Static Water Column Height: 31.67 ft
Screen Length: 10. ft
Well Radius: 0.3333 ft

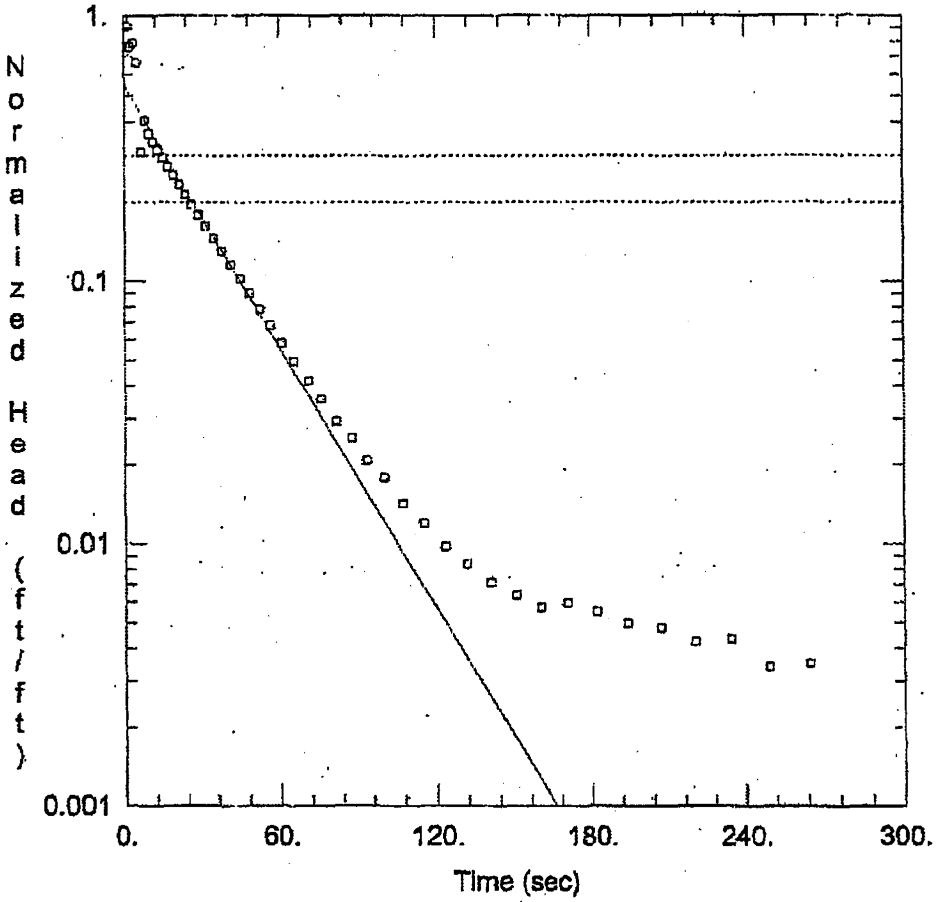
SOLUTION

Aquifer Model: Confined
Kr = 9.58 ft/day
Kz/Kr = 1.

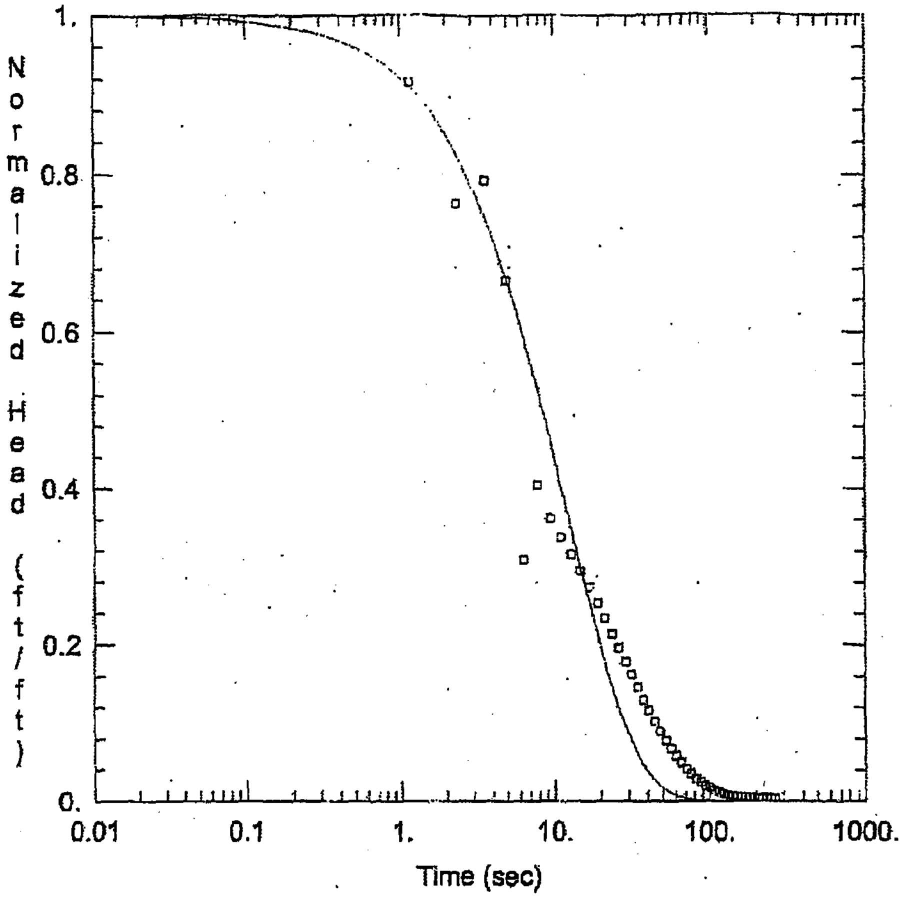
Solution Method: KGS Model
Ss = 0.005128 ft^{-1}



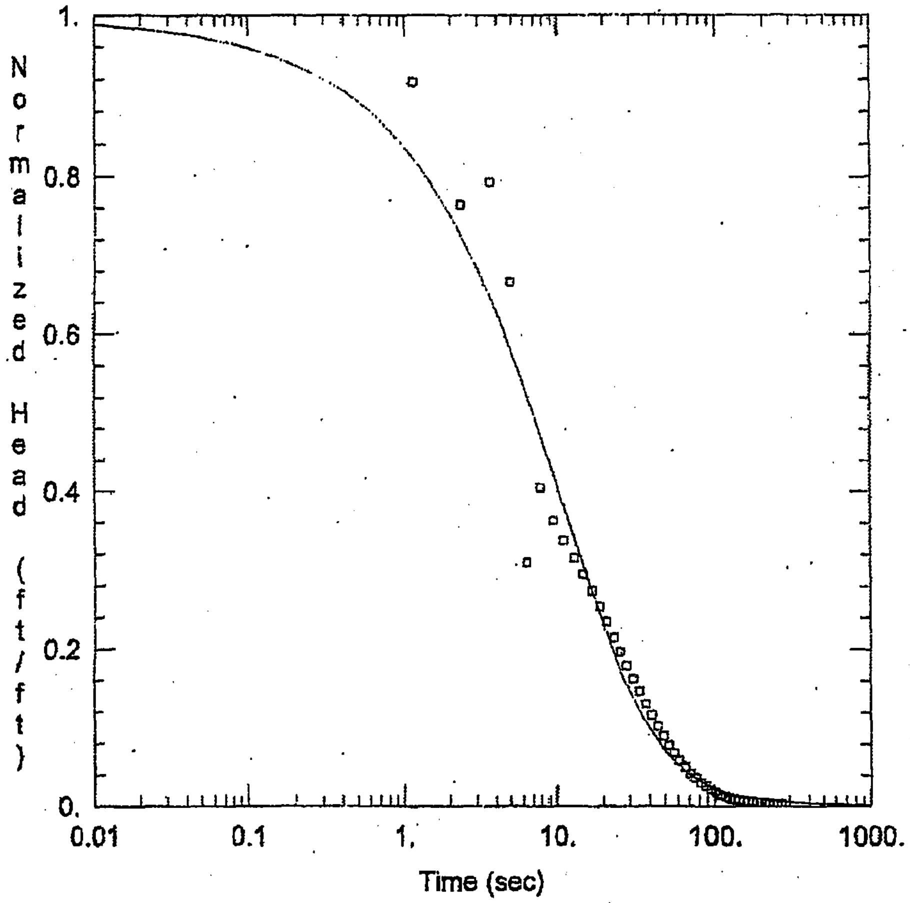
OW-933 U RISING HEAD TEST	
AQUIFER DATA	
Saturated Thickness: 19.5 ft	Anisotropy Ratio (Kz/Kr): 1.
WELL DATA (OW-933 U)	
Initial Displacement: 18.99 ft	Static Water Column Height: 31.67 ft
Total Well Penetration Depth: 14. ft	Screen Length: 10. ft
Casing Radius: 0.0833 ft	Well Radius: 0.3333 ft
SOLUTION	
Aquifer Model: Confined	Solution Method: Bouwer-Rice
K = 3.104 ft/day	y0 = 5.768 ft



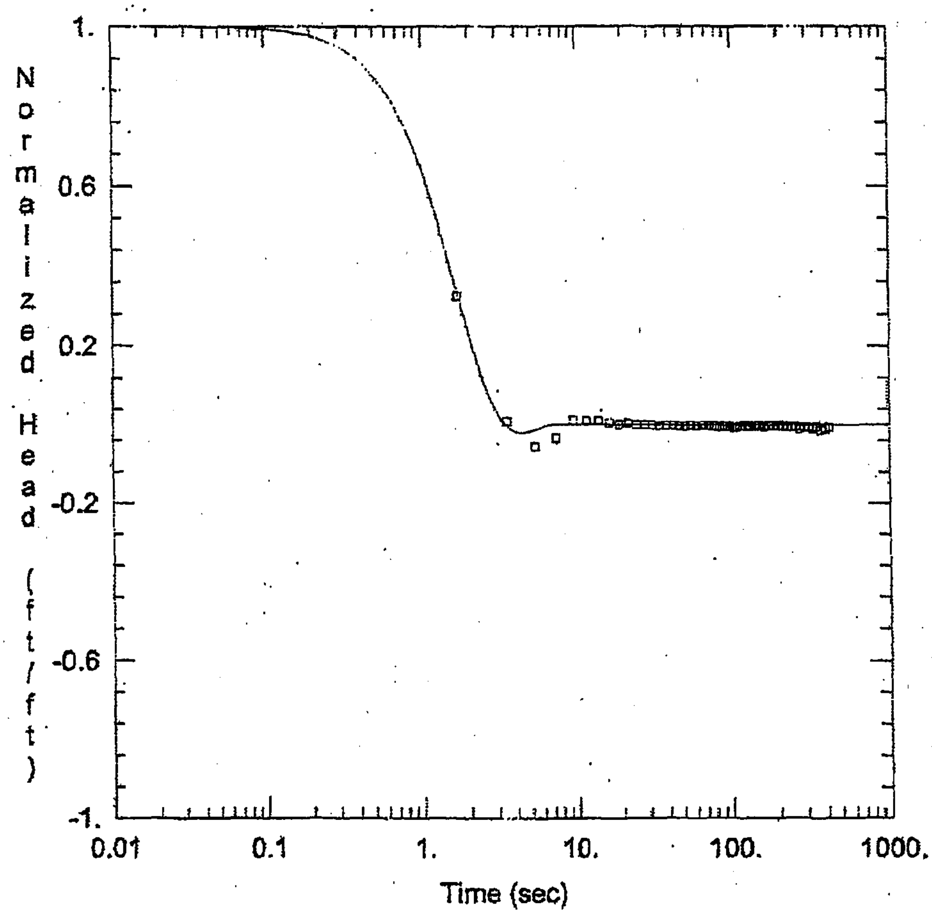
OW-933 U FALLING HEAD TEST	
AQUIFER DATA	
Saturated Thickness: 19.5 ft	Anisotropy Ratio (Kz/Kr): 1.
WELL DATA (OW-933 U)	
Initial Displacement: 9.413 ft	Static Water Column Height: 31.67 ft
Total Well Penetration Depth: 14. ft	Screen Length: 10. ft
Casing Radius: 0.0833 ft	Well Radius: 0.3333 ft
SOLUTION	
Aquifer Model: Confined	Solution Method: Bouwer-Rice
K = 2.763 ft/day	y0 = 5.158 ft



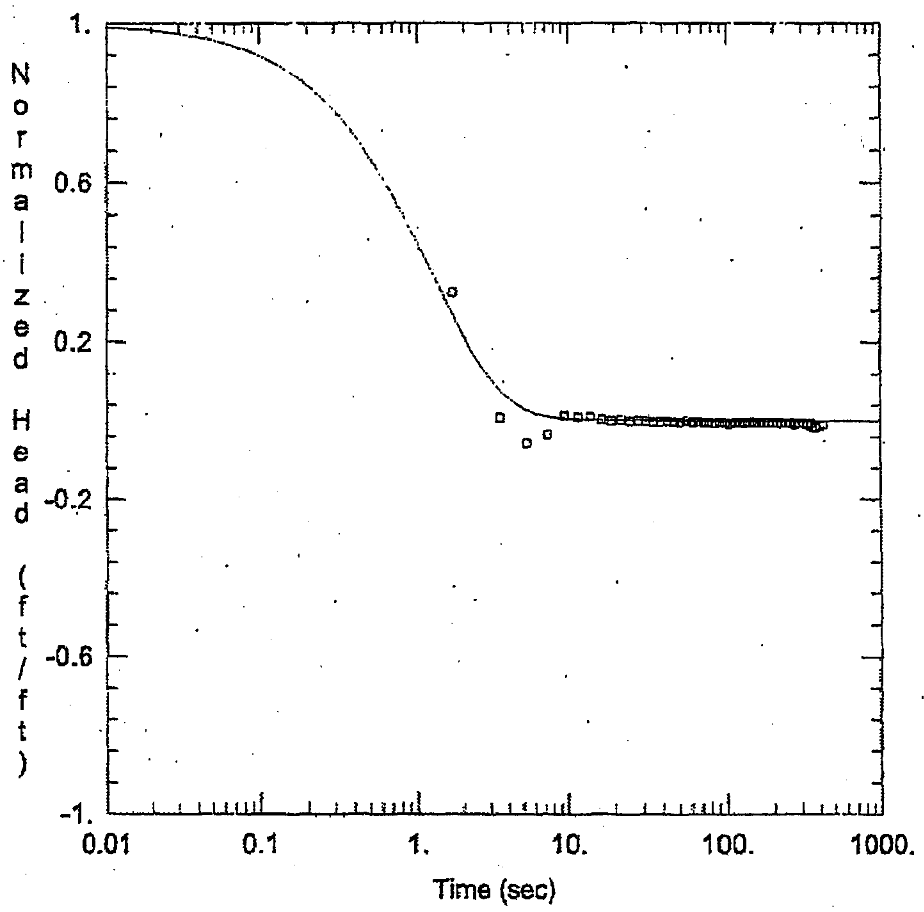
OW-933 U FALLING HEAD TEST	
AQUIFER DATA	
Saturated Thickness: 19.5 ft	Anisotropy Ratio (Kz/Kr): 1.
WELL DATA (OW-933 U)	
Initial Displacement: 9.413 ft	Static Water Column Height: 31.67 ft
Total Well Penetration Depth: 14. ft	Screen Length: 10. ft
Casing Radius: 0.0833 ft	Well Radius: 0.3333 ft
SOLUTION	
Aquifer Model: Confined	Solution Method: Butler
K = 8.335 ft/day	Le = 0.1 ft



OW-933 U FALLING HEAD TEST	
AQUIFER DATA	
Saturated Thickness: 19.5 ft	
WELL DATA (OW-933 U)	
Initial Displacement: 9.413 ft	Static Water Column Height: 31.67 ft
Total Well Penetration Depth: 14. ft	Screen Length: 10. ft
Casing Radius: 0.0833 ft	Well Radius: 0.3333 ft
SOLUTION	
Aquifer Model: Confined	Solution Method: KGS Model
Kr = 5.276 ft/day	Ss = 0.0001649 ft^{-1}
Kz/Kr = 1.	



OW-934 L RISING HEAD TEST	
AQUIFER DATA	
Saturated Thickness: 32.8 ft	Anisotropy Ratio (Kz/Kr): 1.
WELL DATA (New Well)	
Initial Displacement: 3.263 ft	Static Water Column Height: 82.6 ft
Total Well Penetration Depth: 32. ft	Screen Length: 10. ft
Casing Radius: 0.0833 ft	Well Radius: 0.3333 ft
SOLUTION	
Aquifer Model: Confined	Solution Method: Butler
K = 77.6 ft/day	Le = 24.28 ft



OW-934 L RISING HEAD TEST

AQUIFER DATA

Saturated Thickness: 32.8 ft

WELL DATA (New Well)

Initial Displacement: 3.263 ft
Total Well Penetration Depth: 32. ft
Casing Radius: 0.0833 ft

Static Water Column Height: 82.6 ft
Screen Length: 10. ft
Well Radius: 0.3333 ft

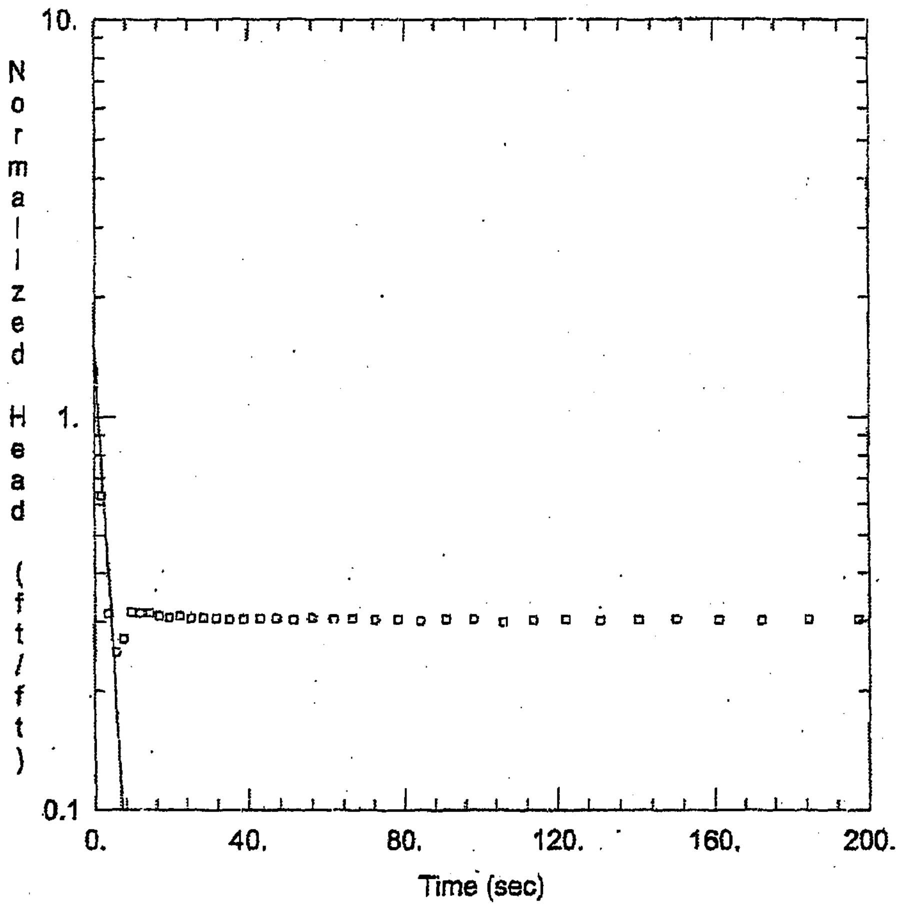
SOLUTION

Aquifer Model: Confined

Solution Method: KGS Model

Kr = 131.3 ft/day
Kz/Kr = 1.

Ss = 3.049E-12 ft^{-1}



OW-934 L RISING HEAD TEST

AQUIFER DATA

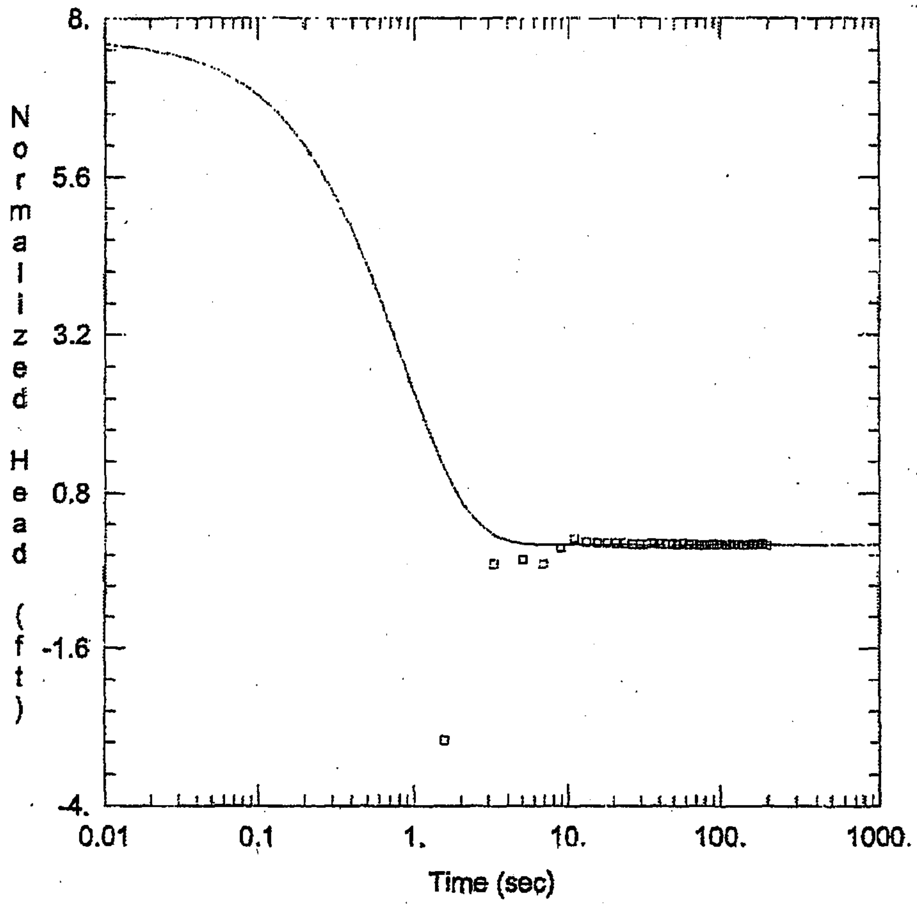
Saturated Thickness: 32.8 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (New Well)

Initial Displacement: 3.263 ft
Total Well Penetration Depth: 32. ft
Casing Radius: 0.0833 ft
Static Water Column Height: 82.6 ft
Screen Length: 10. ft
Well Radius: 0.3333 ft

SOLUTION

Aquifer Model: Confined
K = 34.97 ft/day
Solution Method: Bouwer-Rice
y0 = 4.926 ft



OW-934 L FALLING HEAD TEST

AQUIFER DATA

Saturated Thickness: 32.8 ft   Anisotropy Ratio (Kz/Kr): 1.

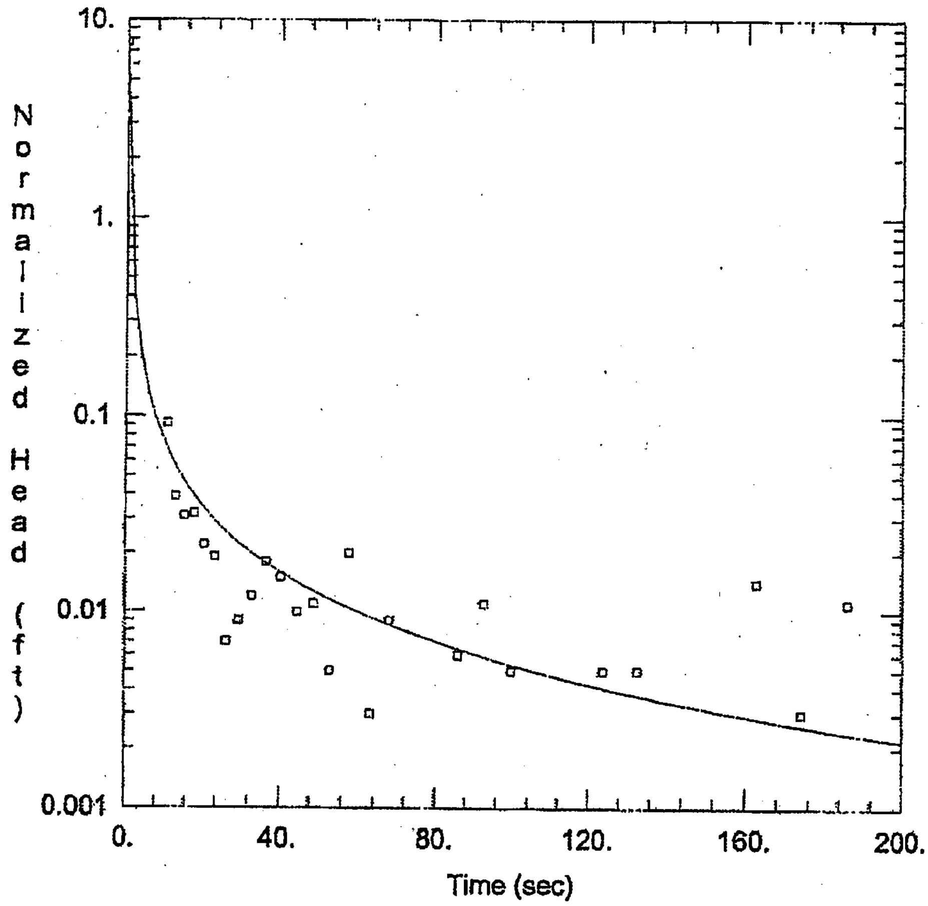
WELL DATA (OW-934 L)

Initial Displacement: 7.671 ft   Static Water Column Height: 82.6 ft
Total Well Penetration Depth: 32. ft   Screen Length: 10. ft
Casing Radius: 0.0833 ft   Well Radius: 0.3333 ft

SOLUTION

Aquifer Model: Confined   Solution Method: Butler

K = 126.6 ft/day   Le = 0.1 ft



OW-934 L FALLING HEAD TEST

AQUIFER DATA

Saturated Thickness: 32.8 ft

WELL DATA (OW-934 L)

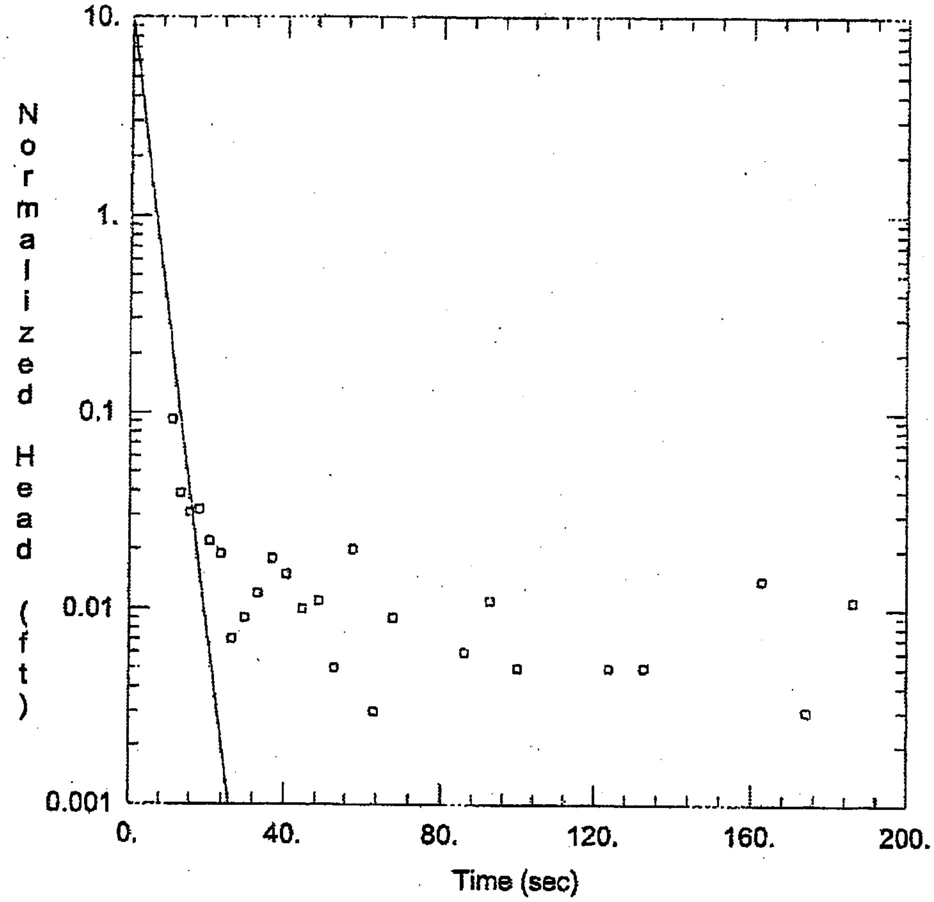
Initial Displacement: 7.671 ft
Total Well Penetration Depth: 32. ft
Casing Radius: 0.0833 ft

Static Water Column Height: 82.6 ft
Screen Length: 10. ft
Well Radius: 0.3333 ft

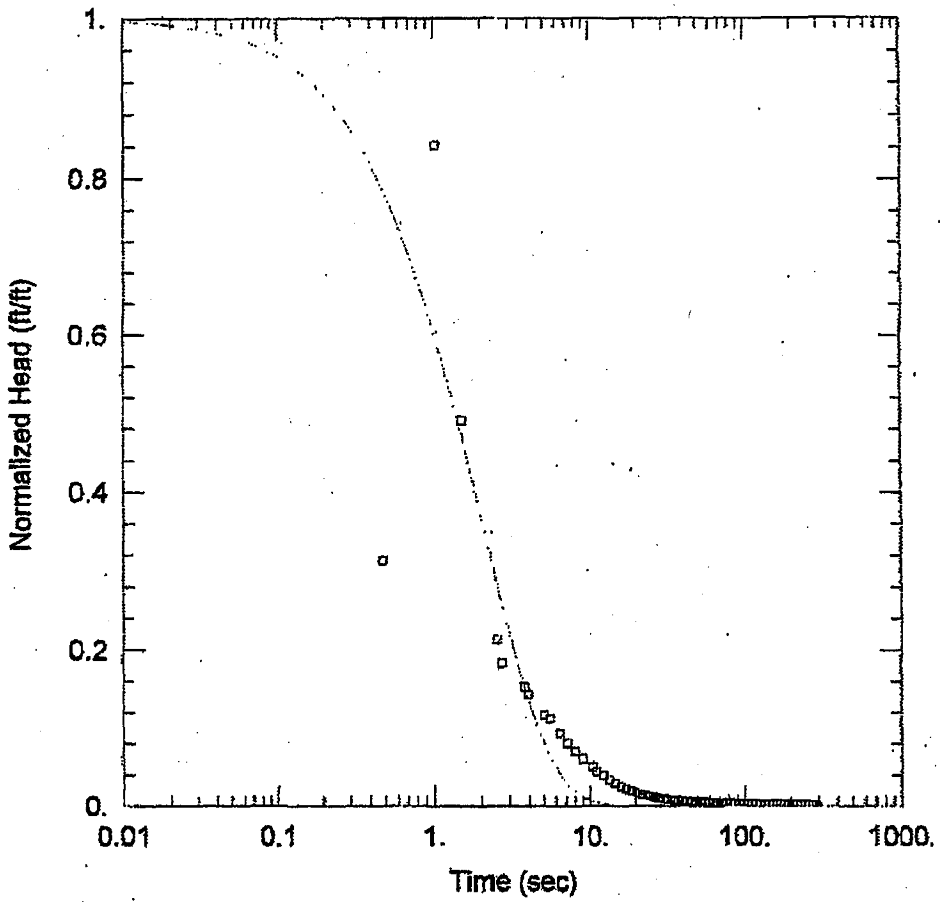
SOLUTION

Aquifer Model: Confined
Kr = 126.6 ft/day
Kz/Kr = 1.

Solution Method: KGS Model
Ss = 0.003049 ft^{-1}



OW-934 L FALLING HEAD TEST	
AQUIFER DATA	
Saturated Thickness: 32.8 ft	Anisotropy Ratio (Kz/Kr): 1.
WELL DATA (OW-934 L)	
Initial Displacement: 7.671 ft	Static Water Column Height: 82.6 ft
Total Well Penetration Depth: 32. ft	Screen Length: 10. ft
Casing Radius: 0.0833 ft	Well Radius: 0.3333 ft
SOLUTION	
Aquifer Model: Confined	Solution Method: Bouwer-Rice
K = 31.72 ft/day	y0 = 9.903 ft



OW-934 U RISING HEAD

AQUIFER DATA

Saturated Thickness: 17.5 ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (OW-934 U)

Initial Displacement: 12.1 ft
Total Well Penetration Depth: 15.5 ft
Casing Radius: 0.0833 ft

Static Water Column Height: 31.56 ft
Screen Length: 10. ft
Well Radius: 0.3333 ft

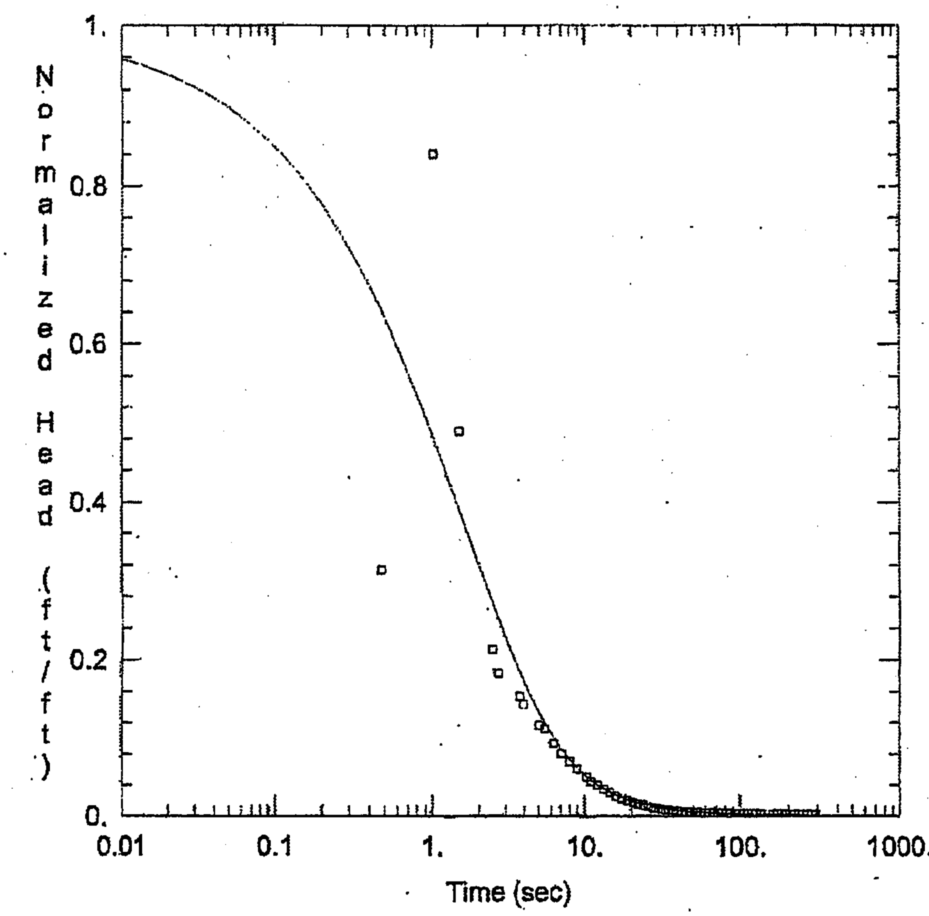
SOLUTION

Aquifer Model: Confined

K = 51.93 ft/day

Solution Method: Butler

Le = 0.1 ft



OW-934 U RISING HEAD

AQUIFER DATA

Saturated Thickness: 17.5 ft

WELL DATA (OW-934 U)

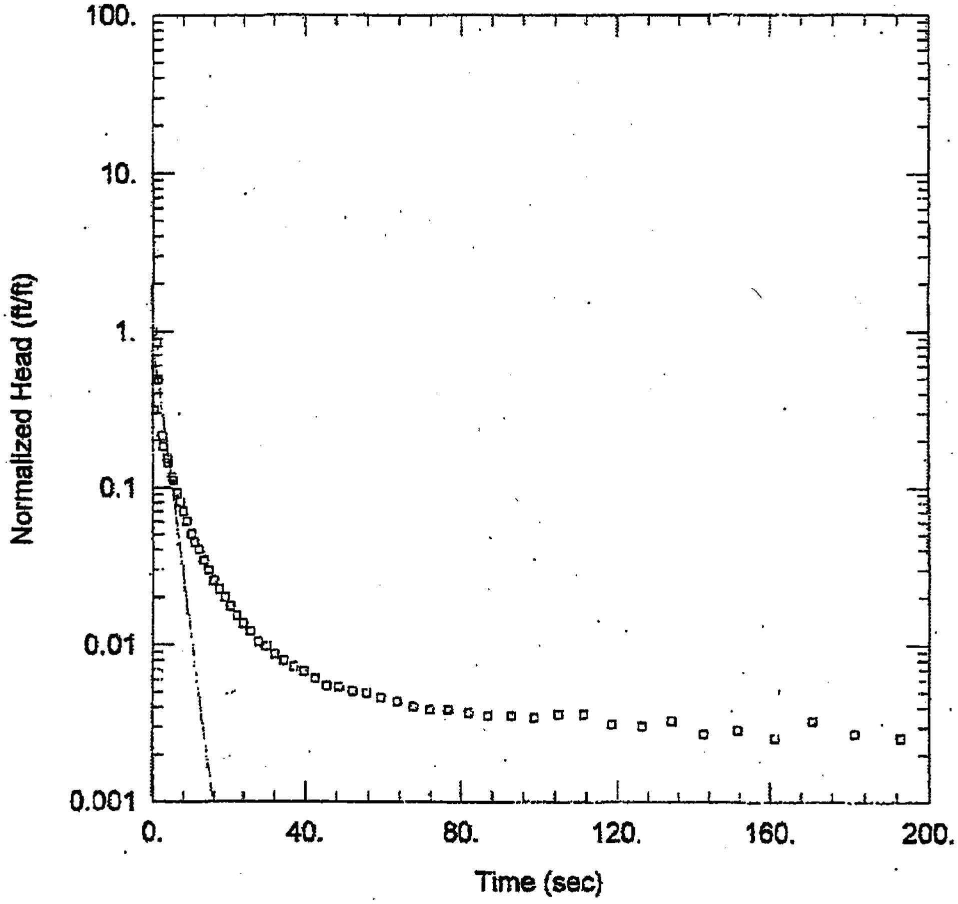
Initial Displacement: 12.1 ft
Total Well Penetration Depth: 15.5 ft
Casing Radius: 0.0833 ft

Static Water Column Height: 31.55 ft
Screen Length: 10. ft
Well Radius: 0.3333 ft

SOLUTION

Aquifer Model: Confined
Solution Method: KGS Model

Kr = 31.62 ft/day
Ss = 0.0003359 ft^{-1}
Kz/Kr = 1.



OW-934 U RISING HEAD

AQUIFER DATA

Saturated Thickness: 17.5 ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (OW-934 U)

Initial Displacement: 12.1 ft
Total Well Penetration Depth: 15.5 ft
Casing Radius: 0.0833 ft

Static Water Column Height: 31.55 ft
Screen Length: 10. ft
Well Radius: 0.3333 ft

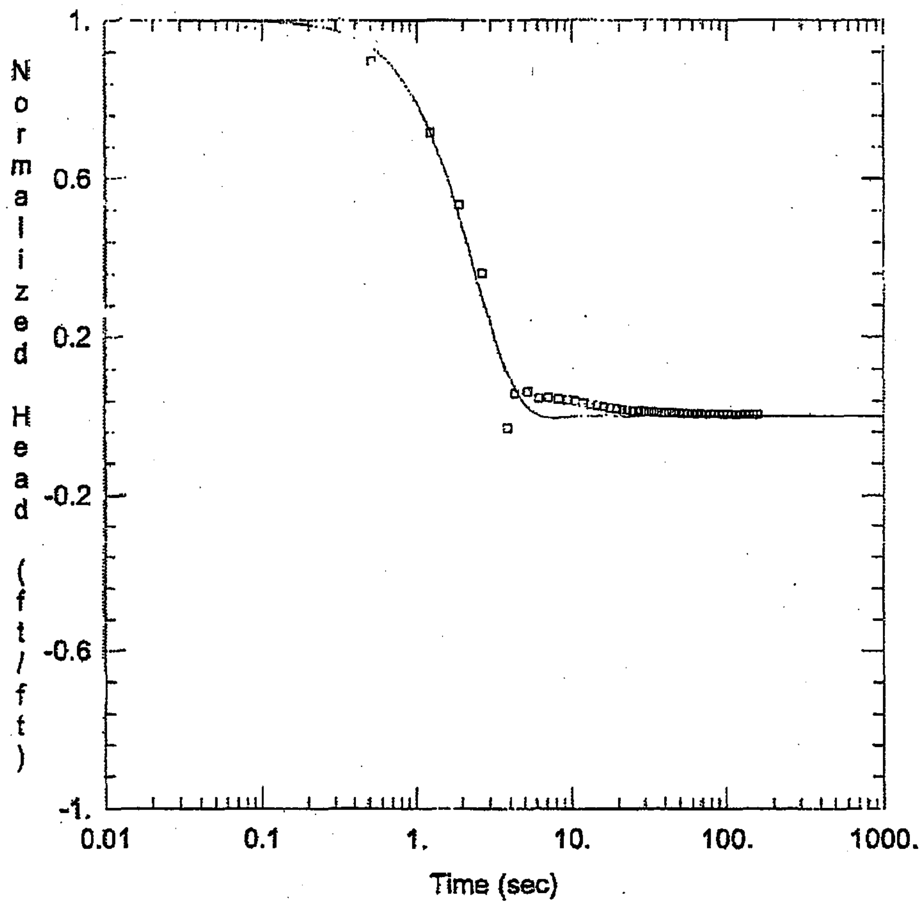
SOLUTION

Aquifer Model: Confined

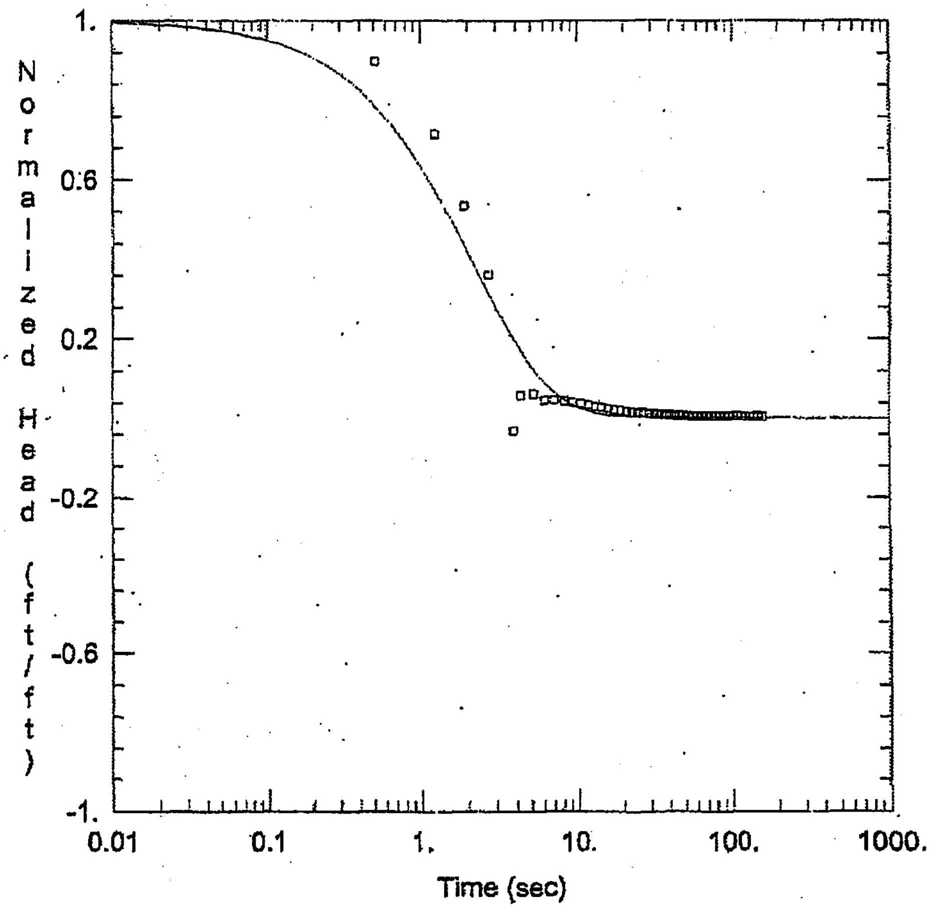
Solution Method: Bouwer-Rice

K = 32.87 ft/day

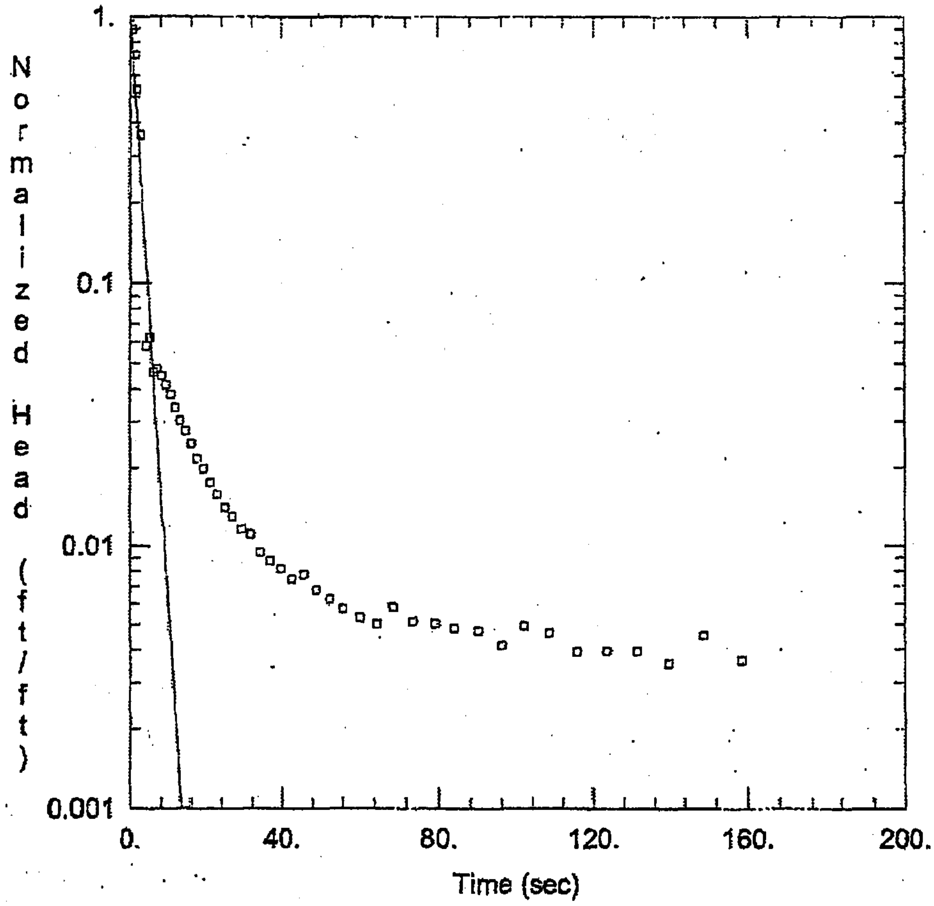
y0 = 10.32 ft



OW-934 U FALLING HEAD	
AQUIFER DATA	
Saturated Thickness: 17.5 ft	Anisotropy Ratio (Kz/Kr): 1.
WELL DATA (New Well)	
Initial Displacement: 9.956 ft	Static Water Column Height: 31.55 ft
Total Well Penetration Depth: 15.5 ft	Screen Length: 10. ft
Casing Radius: 0.0833 ft	Well Radius: 0.3333 ft
SOLUTION	
Aquifer Model: Confined	Solution Method: Butler
K = 48.76 ft/day	Le = 47.81 ft



OW-934 U FALLING HEAD	
AQUIFER DATA	
Saturated Thickness: 17.5 ft	
WELL DATA (New Well)	
Initial Displacement: 9.956 ft	Static Water Column Height: 31.55 ft
Total Well Penetration Depth: 15.5 ft	Screen Length: 10. ft
Casing Radius: 0.0833 ft	Well Radius: 0.3333 ft
SOLUTION	
Aquifer Model: Confined	Solution Method: KGS Model
Kr = 96.64 ft/day	Ss = 5.714E-12 ft^{-1}
Kz/Kr = 1.	



OW-934 U FALLING HEAD	
AQUIFER DATA	
Saturated Thickness: 17.5 ft	Anisotropy Ratio (Kz/Kr): 1.
WELL DATA (New Well)	
Initial Displacement: 9.956 ft	Static Water Column Height: 31.55 ft
Total Well Penetration Depth: 15.5 ft	Screen Length: 10. ft
Casing Radius: 0.0833 ft	Well Radius: 0.3333 ft
SOLUTION	
Aquifer Model: Confined	Solution Method: Bouwer-Rice
K = 40.28 ft/day	y0 = 10.59 ft

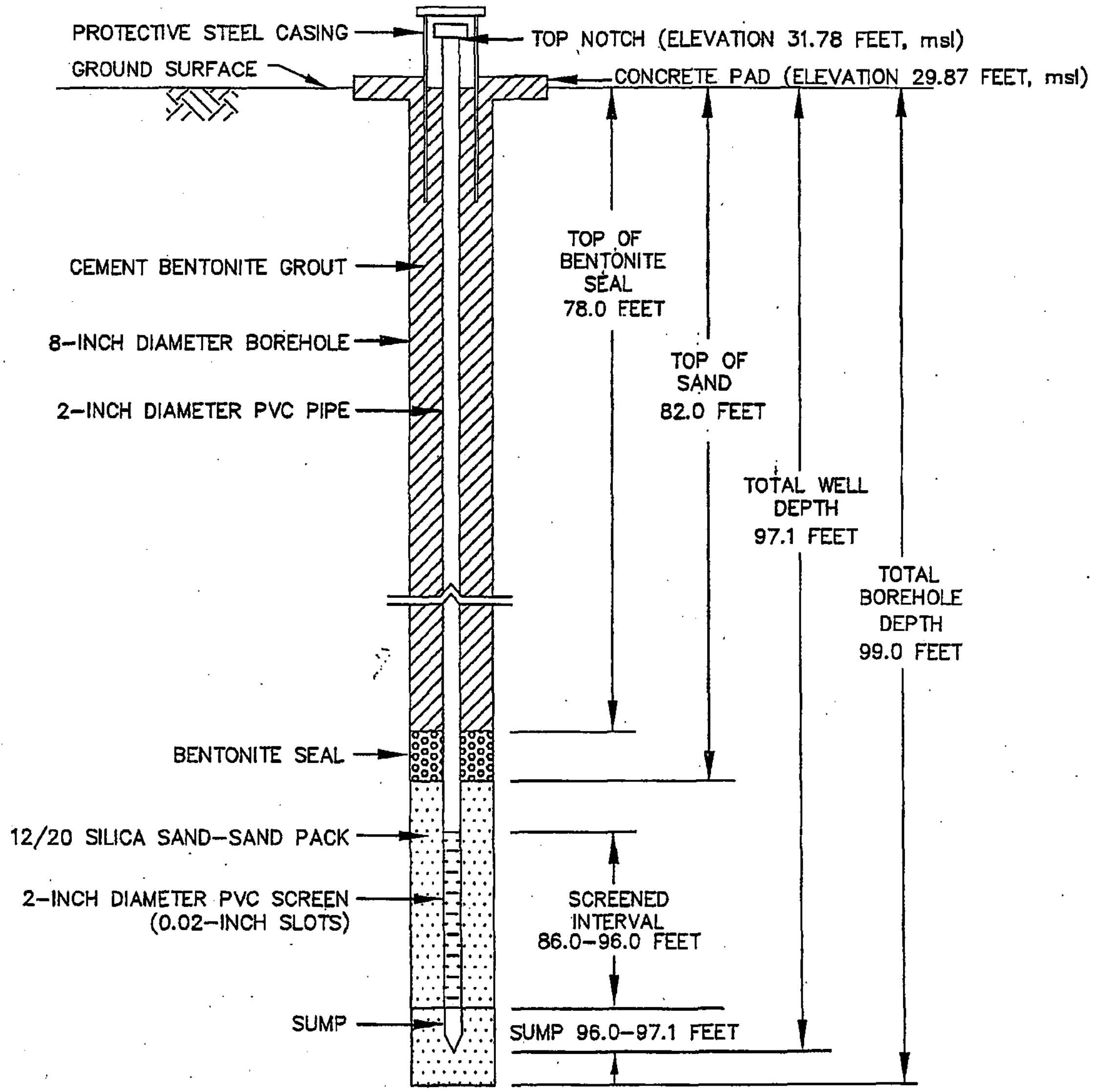
Appendix C-4

Observation Well Construction Logs

Project Name: STP COL PROJECT Project Number: 6234-08-4632 MACTEC	WELL CONSTRUCTION LOG: OW-308-L
Type of Boring: WASH ROTARY	Boring Location: UNIT 3-REACTOR BUILDING N 363196.43 E 2943374.36
	DATE COMPLETED: 11/22/06

Prepared by MJ Harvey 5-25-08

Checked by KAW 5.28.08

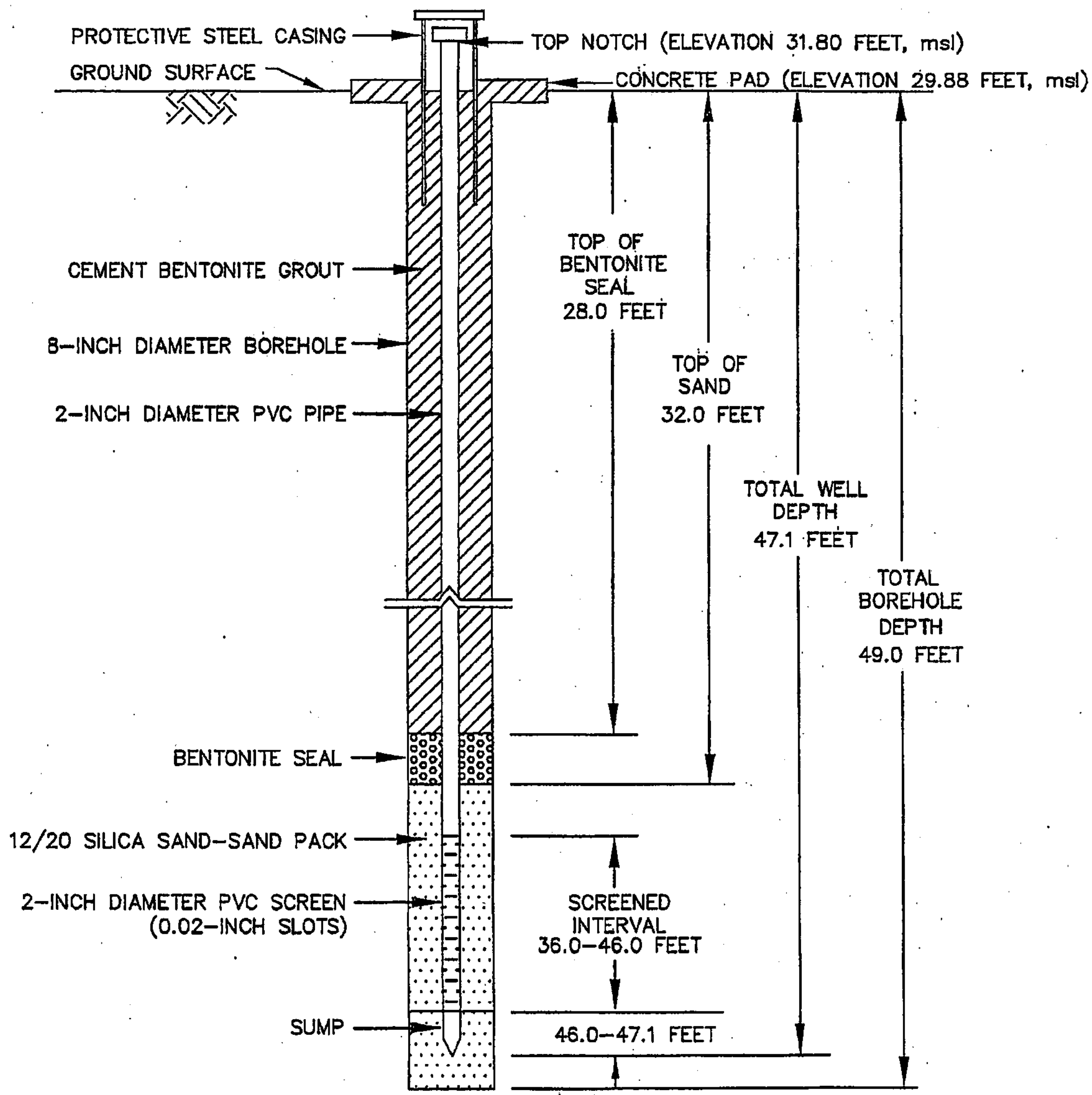


NOTE: 1.) BORING B-308 WAS USED TO DESIGN OW-308-L.
2.) DRAWING NOT TO SCALE.

P:\AutoCAD Drawings Only\Geotechnical\2008\6234-08-4632 STP COL Project\OW.308.L.dwg Thu, 24 Apr 2008 - 8:38am mharriso

Project Name: STP COL PROJECT Project Number: 6234-08-4632	MACTEC	WELL CONSTRUCTION LOG: OW-308-U
Type of Boring: WASH ROTARY		Boring Location: UNIT 3-REACTOR BUILDING N 363195.64 E 2943354.04
		DATE COMPLETED: 11/27/06

Prepared by MJH 5-25-08
Checked by KAW 5·28·08

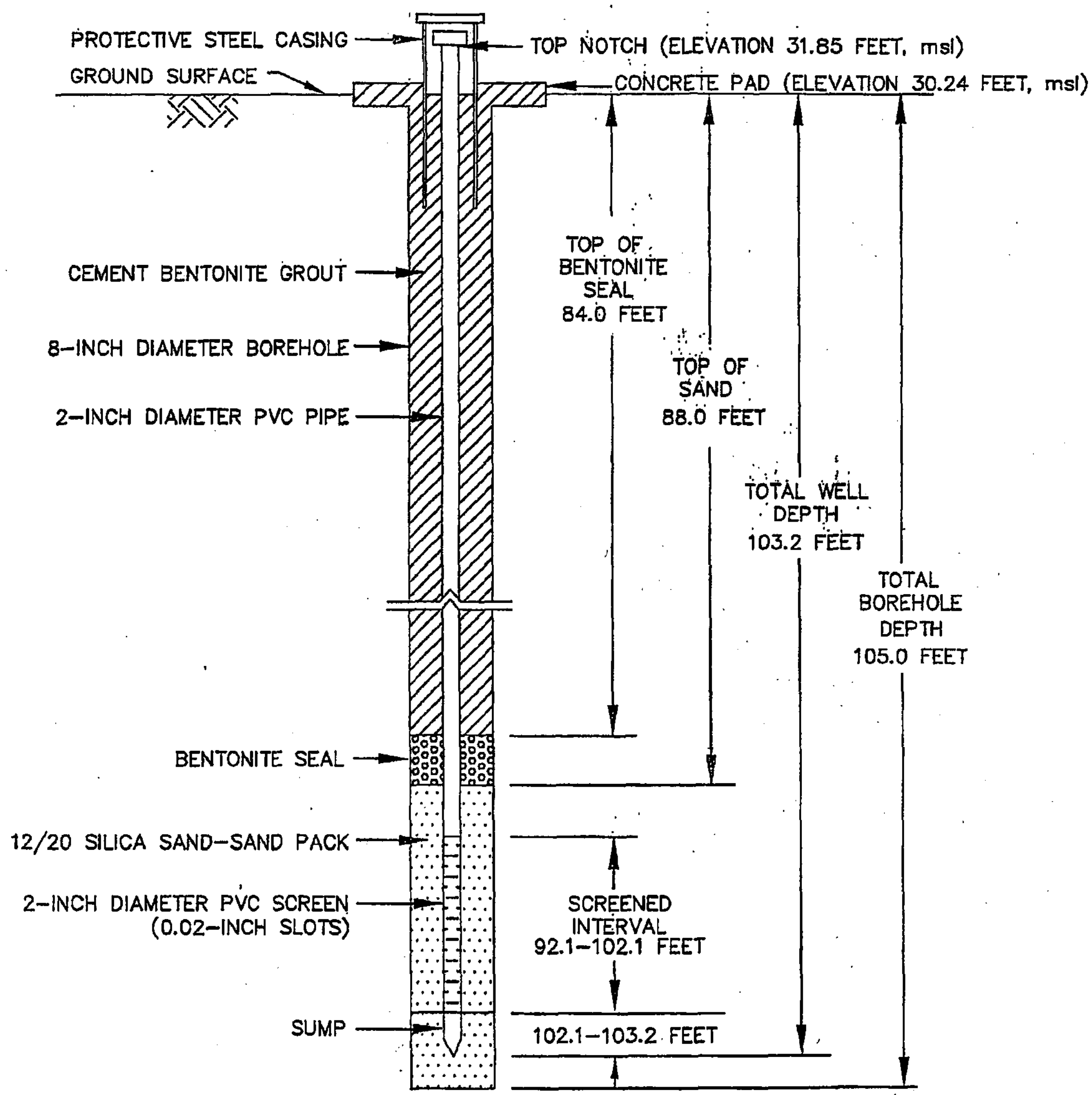


NOTE: 1.) BORING B-308 WAS USED TO DESIGN OW-308-U.
2.) DRAWING NOT TO SCALE.

Project Name: STP COL PROJECT Project Number: 6234-08-4632	MACTEC	WELL CONSTRUCTION LOG: OW-332-L
Type of Boring: WASH ROTARY		Boring Location: PROPOSED POWER BLOCK N 363739.87 E 2943610.91
		DATE COMPLETED: 12/01/06

Prepared by MJH 5-25-08

Checked by KAW 5.28.08



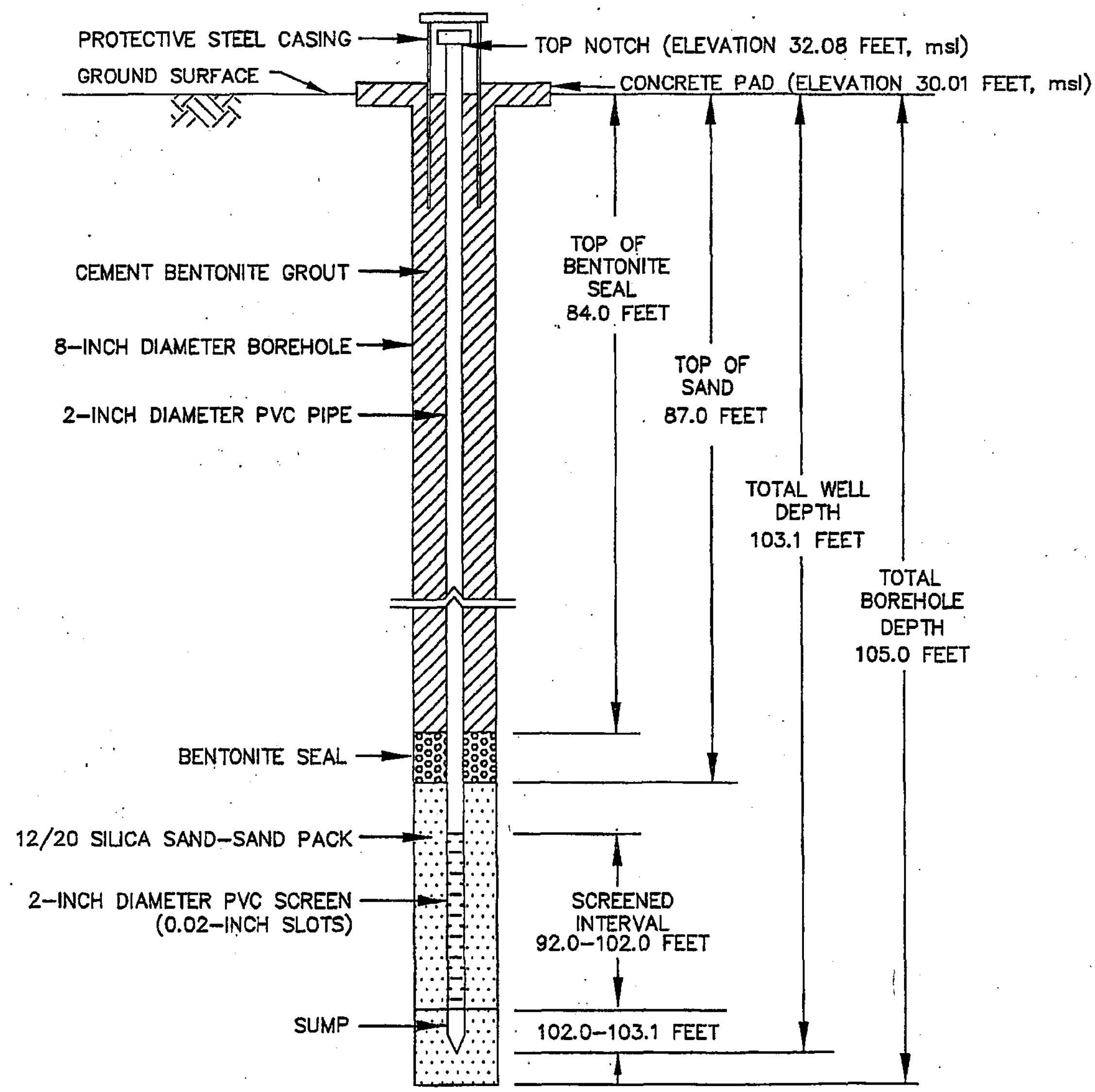
NOTE: 1.) BORING B-332 WAS USED TO DESIGN OW-332-L.
2.) DRAWING NOT TO SCALE.

P:\AutoCAD Drawings Only\Geotechnical\2008\6234-08-4632 STP COL Project\OW.332L.dwg Thu, 24 Apr 2008 - 8:43am mharriso

Project Name: STP COL PROJECT Project Number: 6234-08-4632	MACTEC	WELL CONSTRUCTION LOG: OW-332-La
Type of Boring: WASH ROTARY		Boring Location: PROPOSED POWER BLOCK N 363739.87 E 2943610.91
		DATE COMPLETED: 02/09/07

Prepared by MJH 5-25-08

Checked by KAW 5.28.08

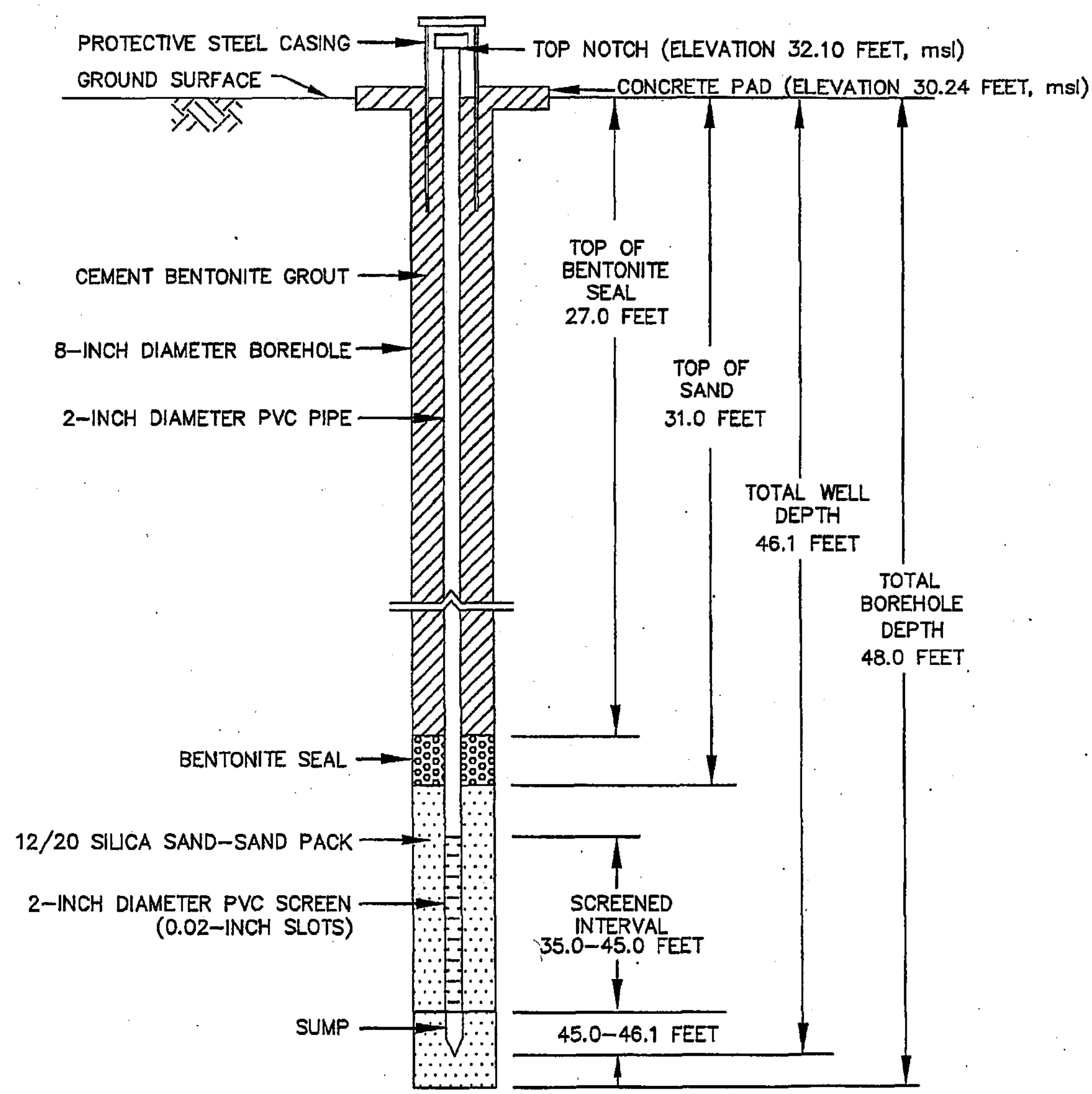


NOTE: 1.) BORING B-332 WAS USED TO DESIGN OW-332-La.
2.) DRAWING NOT TO SCALE.

P:\AutoCAD Drawings Only\Geotechnical\2008\6234-08-4632 STP COL Project\OW.332La.dwg Thu, 24 Apr 2008 - 8:44am mharriso

Project Name: STP COL PROJECT Project Number: 6234-08-4632	MACTEC	WELL CONSTRUCTION LOG: OW-332-U
Type of Boring: WASH ROTARY		Boring Location: PROPOSED POWER BLOCK N 363739.21 E 2943591.02
		DATE COMPLETED: 11/21/06

Prepared by 5-25-08 MJH
Checked by KAW 5.28.08

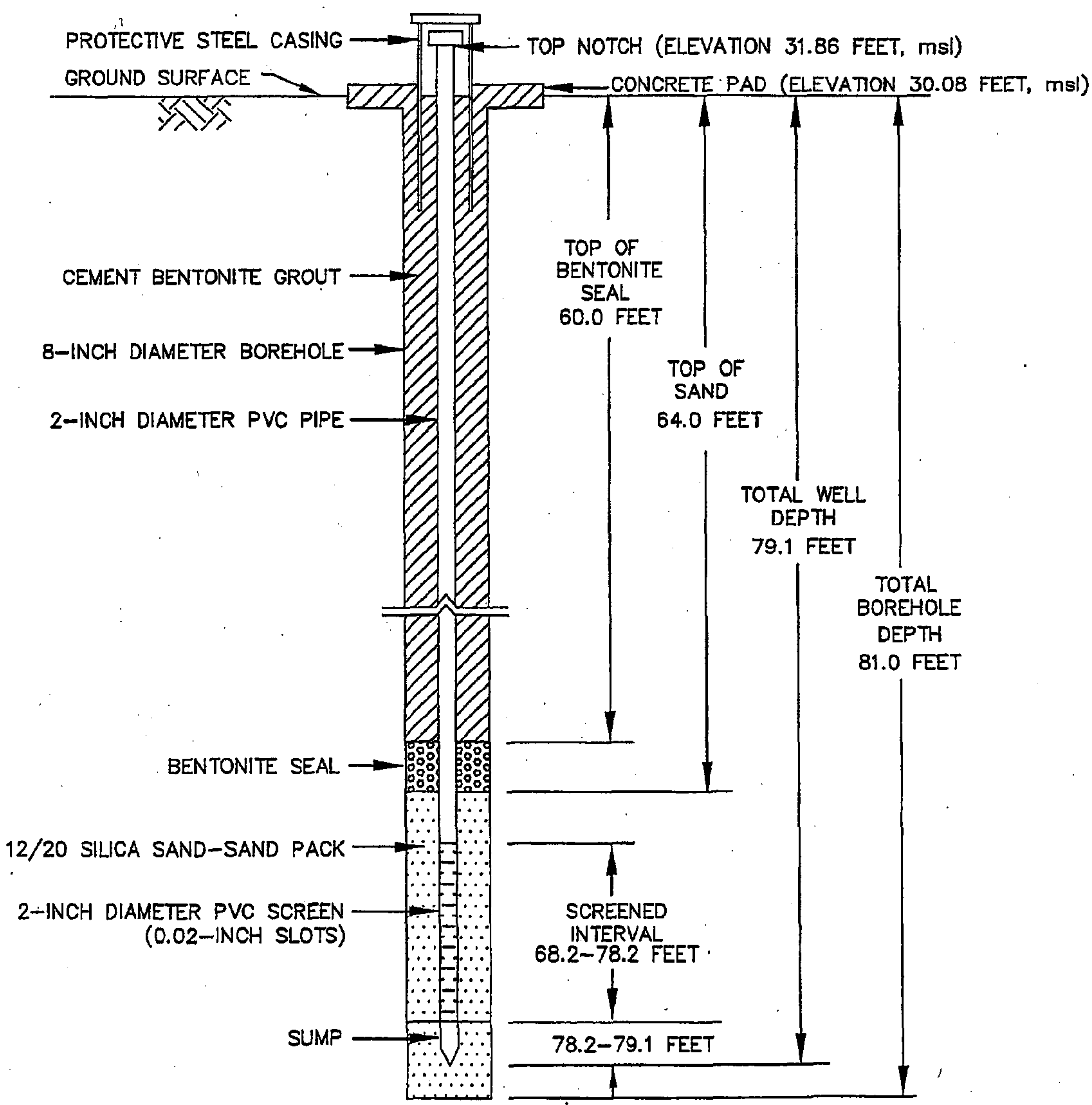


NOTE: 1.) BORING B-332 WAS USED TO DESIGN OW-332-U.
2.) DRAWING NOT TO SCALE.

P:\AutoCAD Drawings Only\Geotechnical\2008\6234-08-4632 STP COL Project\OW.332U.dwg Thu, 24 Apr 2008 - 8:45am mharriso

Project Name: STP COL PROJECT Project Number: 6234-08-4632	MACTEC	WELL CONSTRUCTION LOG: OW-348-L
Type of Boring: WASH ROTARY		Boring Location: FIRE WATER TANK N 362685.92 E 2943014.48
		DATE COMPLETED: 11/21/06

Prepared by MJH 5-25-08
Checked by KAW 5.28.08



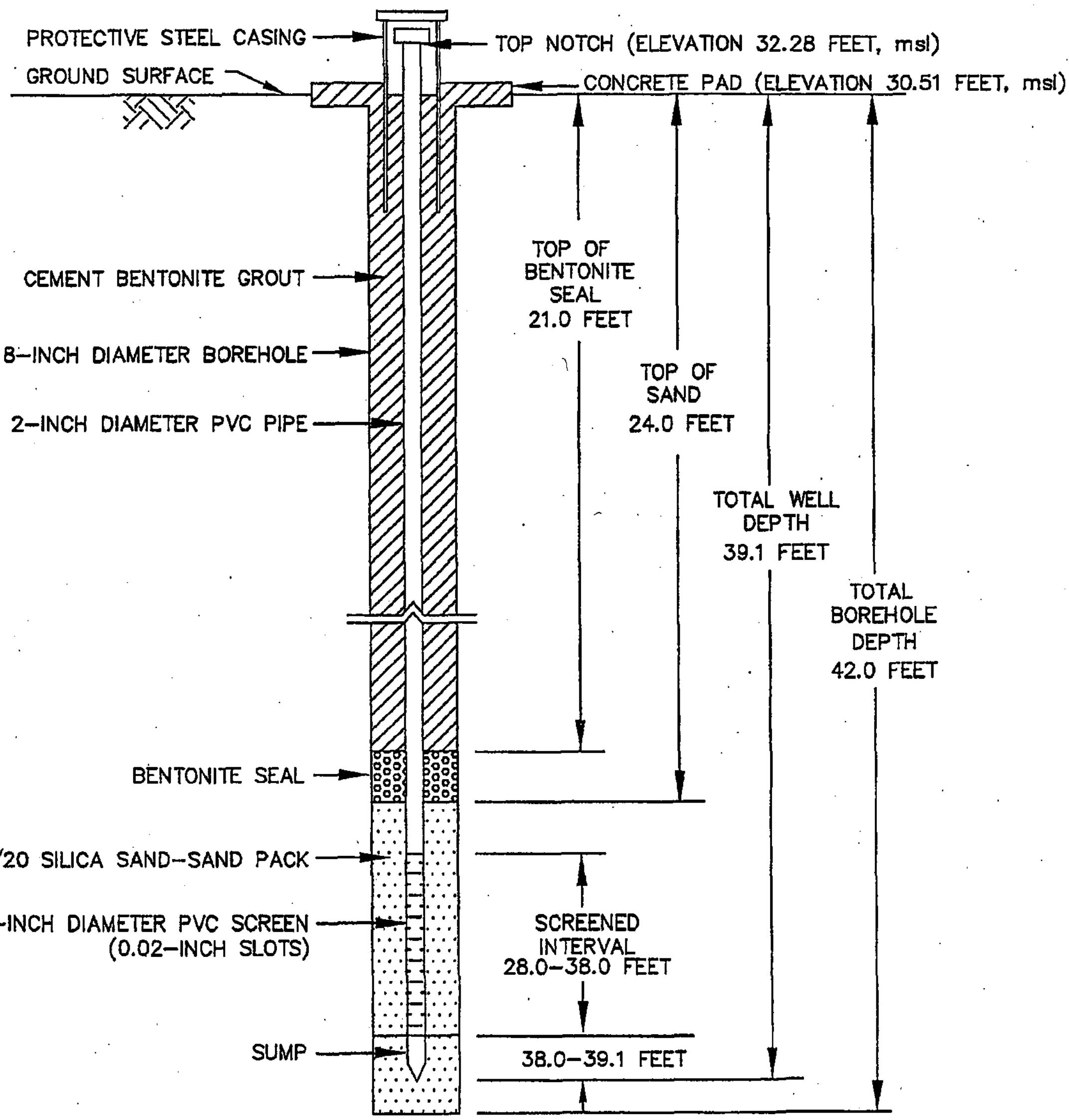
NOTE: 1.) BORING B-348 WAS USED TO DESIGN OW-348-L.
2.) DRAWING NOT TO SCALE.

P:\AutoCAD Drawings Only\Geotechnical\2008\6234-08-4632 STP COL Project\OW.348L.dwg Thu, 24 Apr 2008 - 8:46am mharriso

Project Name: STP COL PROJECT Project Number: 6234-08-4632	MACTEC	WELL CONSTRUCTION LOG: OW-348-U
Type of Boring: WASH ROTARY		Boring Location: FIRE WATER TANK N 362685.23 E 2942994.44
		DATE COMPLETED: 11/21/06

Prepared by 5-25-08 MJH

Checked by KAW 5.28.08



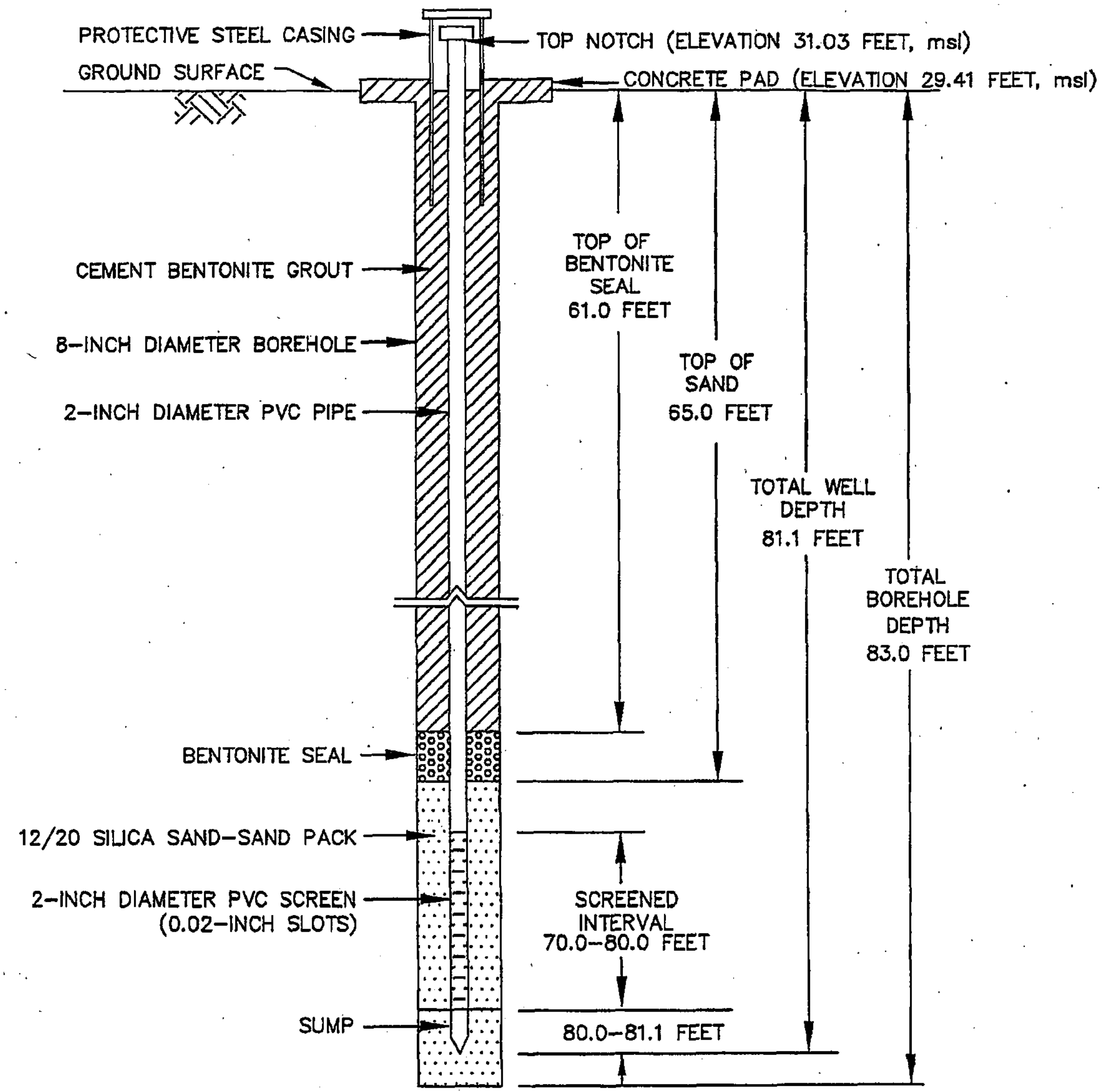
NOTE: 1.) BORING B-348 WAS USED TO DESIGN OW-348-U.
2.) DRAWING NOT TO SCALE.

P:\AutoCAD Drawings Only\Geotechnical\2008\6234-08-4632 STP COL Project\OW.348U.dwg Thu, 24 Apr 2008 - 8:47am mharriso

Project Name: STP COL PROJECT Project Number: 6234-08-4632	MACTEC	WELL CONSTRUCTION LOG: OW-349-L
Type of Boring: WASH ROTARY		Boring Location: HEAVY HAUL ROAD N 362901.84 E 2943602.97
		DATE COMPLETED: 11/04/06

Prepared by MJH 5-25-08

Checked by KAW 5.28.08



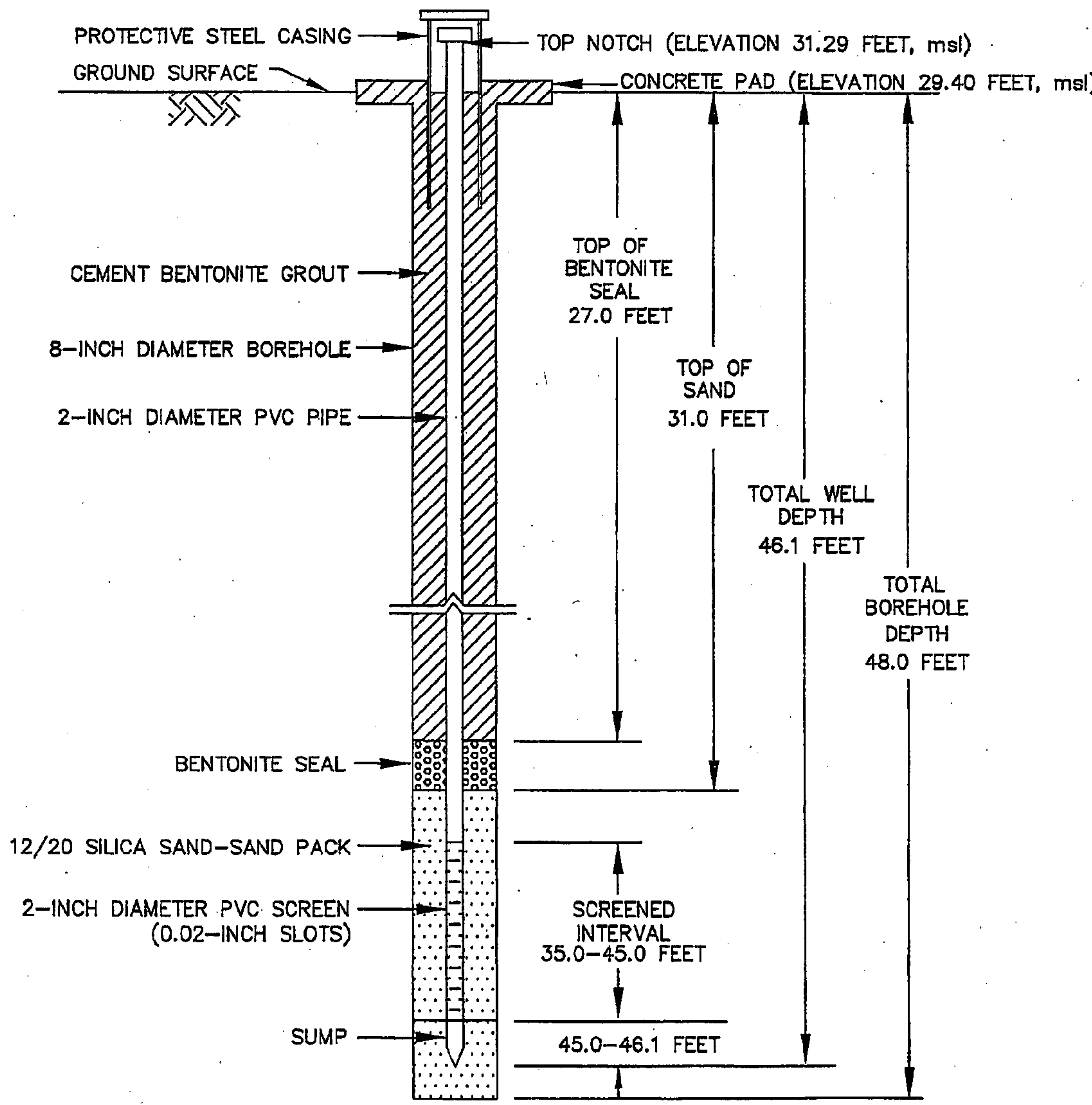
NOTE: 1.) BORING B-349 WAS USED TO DESIGN OW-349-L.
2.) DRAWING NOT TO SCALE.

P:\AutoCAD Drawings Only\Geotechnical\2008\6234-08-4632 STP COL Project\OW.349L.dwg Thu, 24 Apr 2008 - 8:49am mharriso

Project Name: STP COL PROJECT Project Number: 6234-08-4632	MACTEC	WELL CONSTRUCTION LOG: OW-349-U
Type of Boring: WASH ROTARY		Boring Location: HEAVY HAUL ROAD N 3602902.4 E 2943582.28
		DATE COMPLETED: 11/27/06

Prepared by MJH 5-25-08

Checked by KAW 5.28.08



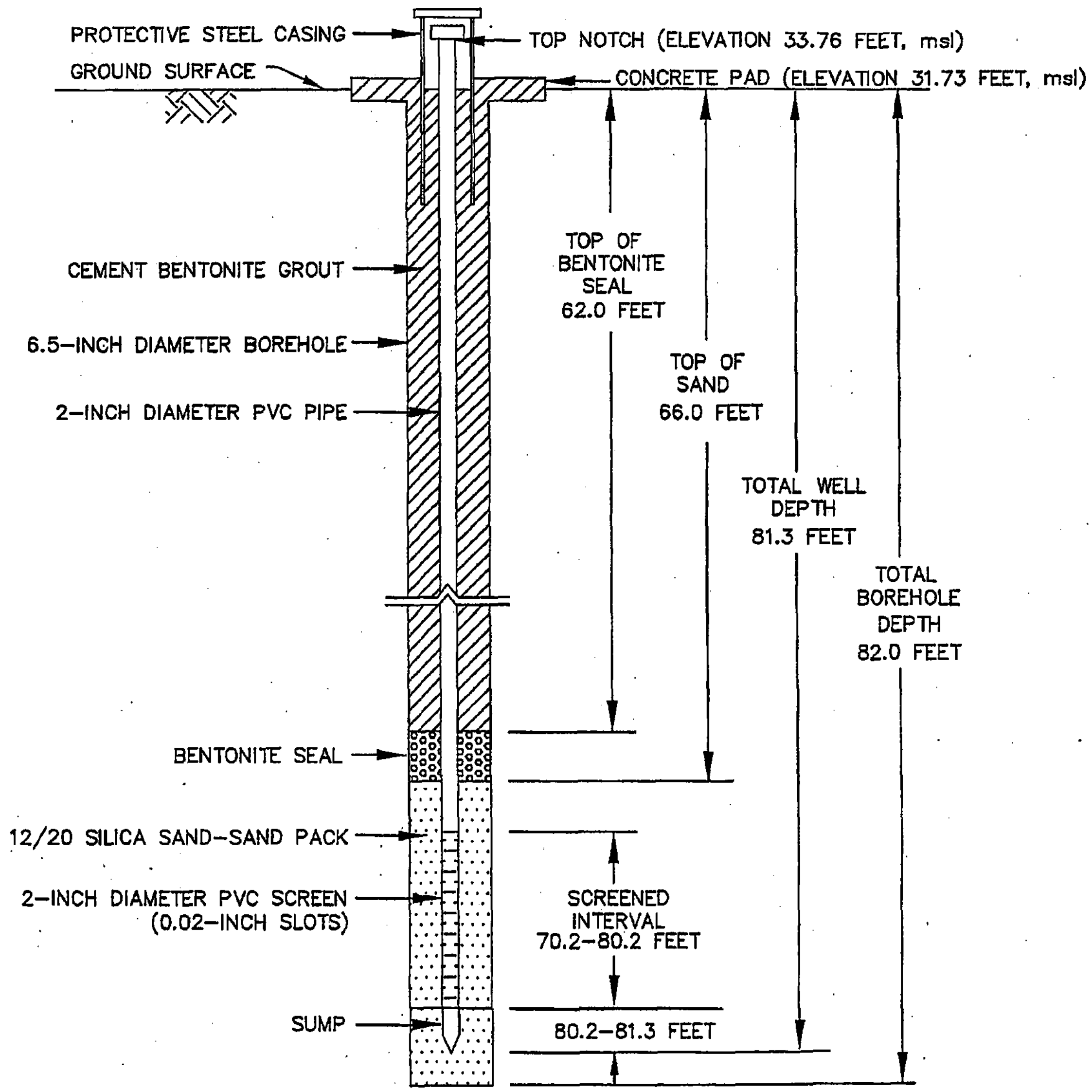
NOTE: 1.) BORING B-349 WAS USED TO DESIGN OW-349-U.
2.) DRAWING NOT TO SCALE.

P:\AutoCAD Drawings Only\Geotechnical\2008\6234-08-4632 STP COL Project\OW.349U.dwg Thu, 24 Apr 2008 - 8:50am mharriso

Project Name: STP COL PROJECT Project Number: 6234-08-4632	MACTEC	WELL CONSTRUCTION LOG: OW-408-L
Type of Boring: WASH ROTARY		Boring Location: UNIT 4 – REACTOR BUILDING N 363196.18 E 2942472.54
		DATE COMPLETED: 11/20/06

Prepared by MJH 5-25-08

Checked by KAW 5.28.08



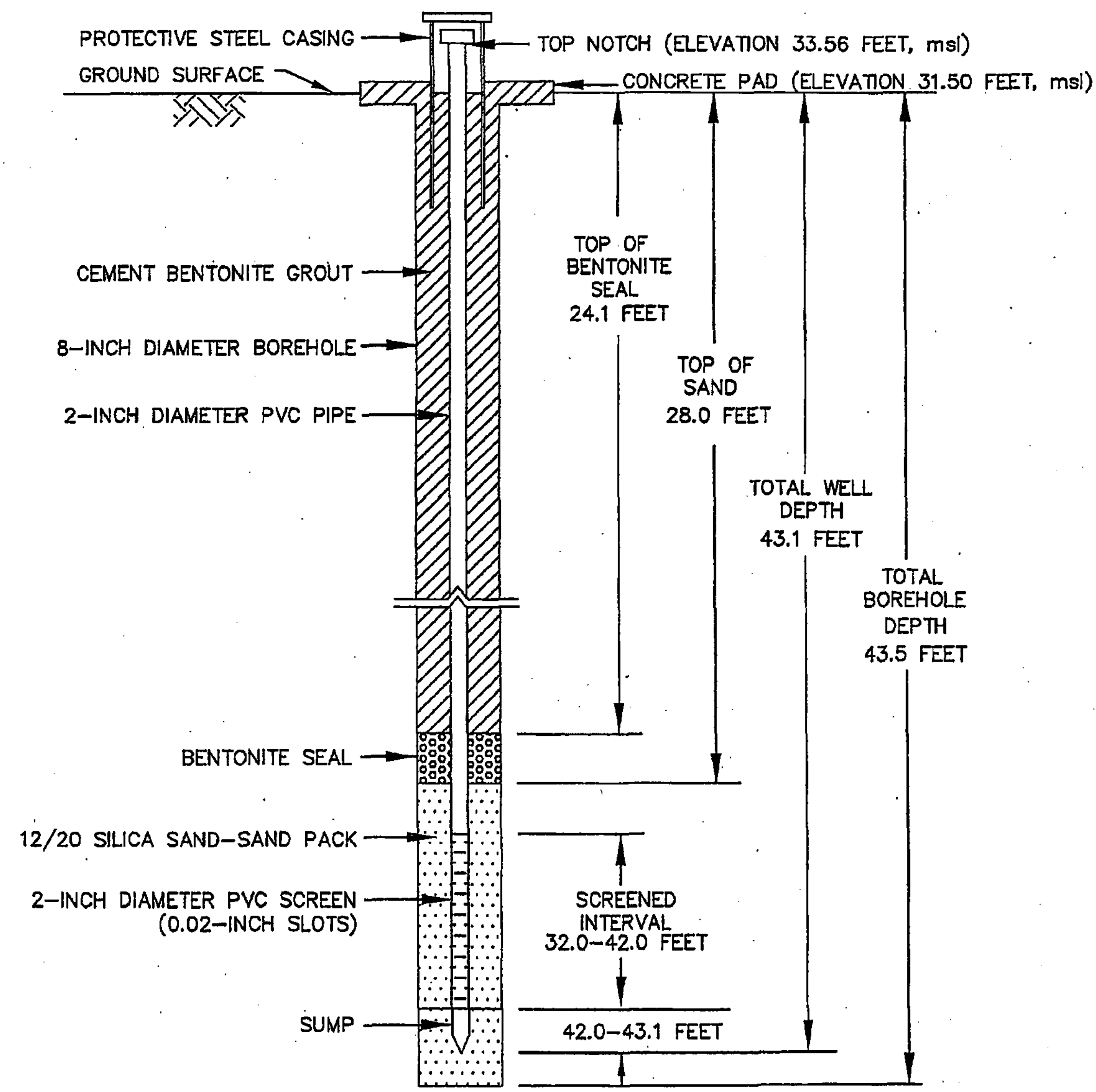
NOTE: 1.) BORING B-408 WAS USED TO DESIGN OW-408-L.
2.) DRAWING NOT TO SCALE.

P:\AutoCAD Drawings Only\Geotechnical\2008\6234-08-4632 STP COL Project\OW.408L.dwg Thu, 24 Apr 2008 - 8:51am mfarriso

Project Name: STP COL PROJECT Project Number: 6234-08-4632	MACTEC	WELL CONSTRUCTION LOG: OW-408-U
Type of Boring: HOLLOW STEM AUGER		Boring Location: UNIT 4 – REACTOR BUILDING N 363194.01 E 2942456.01
		DATE COMPLETED: 11/20/06

Prepared by MJH 5-25-08

Checked by KAW 5.28.08

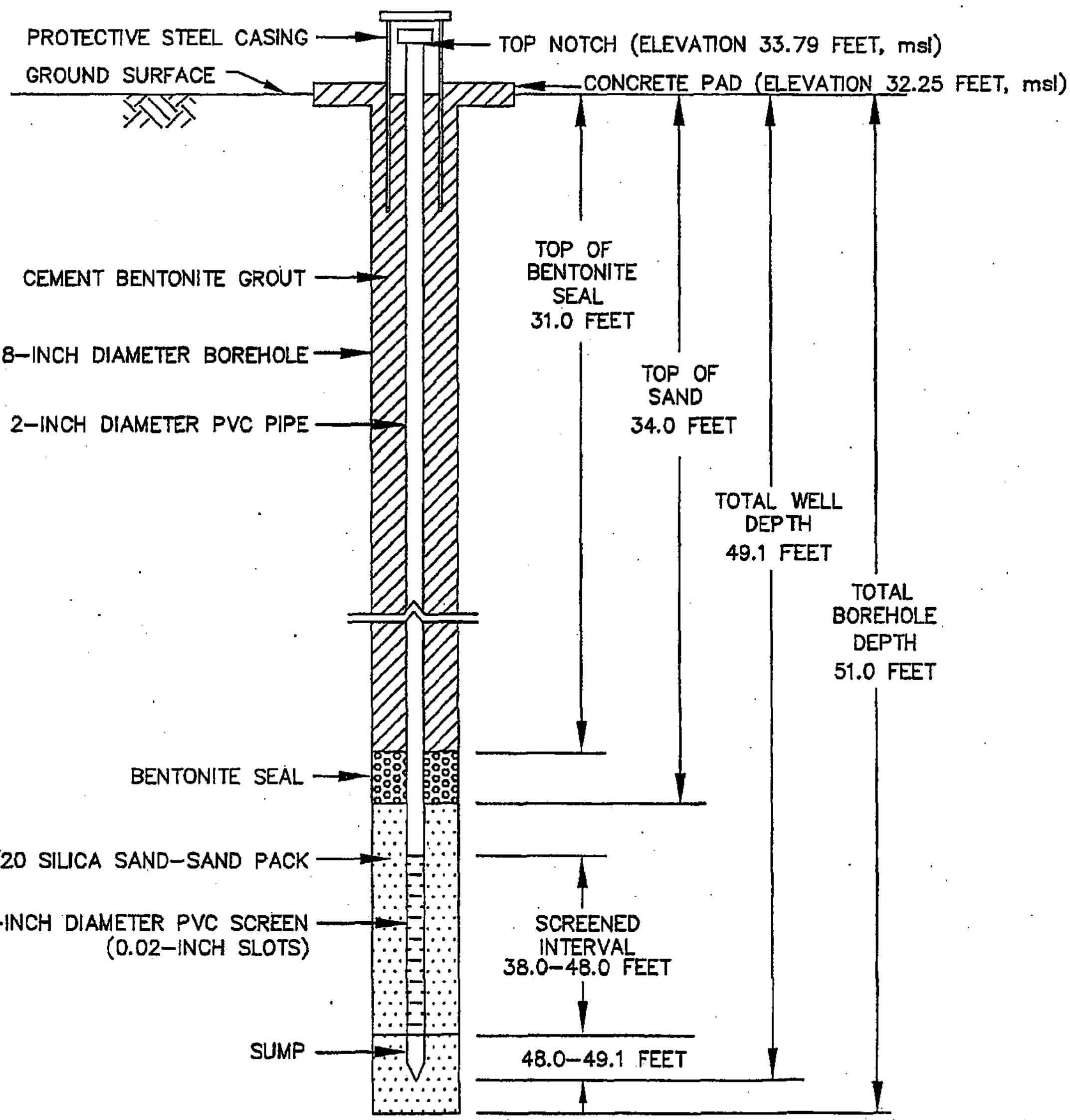


NOTE: 1.) BORING B-408 WAS USED TO DESIGN OW-408-U.
2.) DRAWING NOT TO SCALE.

P:\AutoCAD Drawings Only\Geotechnical\2008\6234-08-4632 STP COL Project\OW.408U.dwg Mon, 19 May 2008 - 2:40pm mharriso

Project Name: STP COL PROJECT Project Number: 6234-08-4632	MACTEC	WELL CONSTRUCTION LOG: OW-420-U
Type of Boring: WASH ROTARY		Boring Location: HEAVY HAUL ROAD N 362902.15 E 2942018.94
		DATE COMPLETED: 11/20/06

Prepared by MJH 5-25-08
Checked by KAW 5.28.08



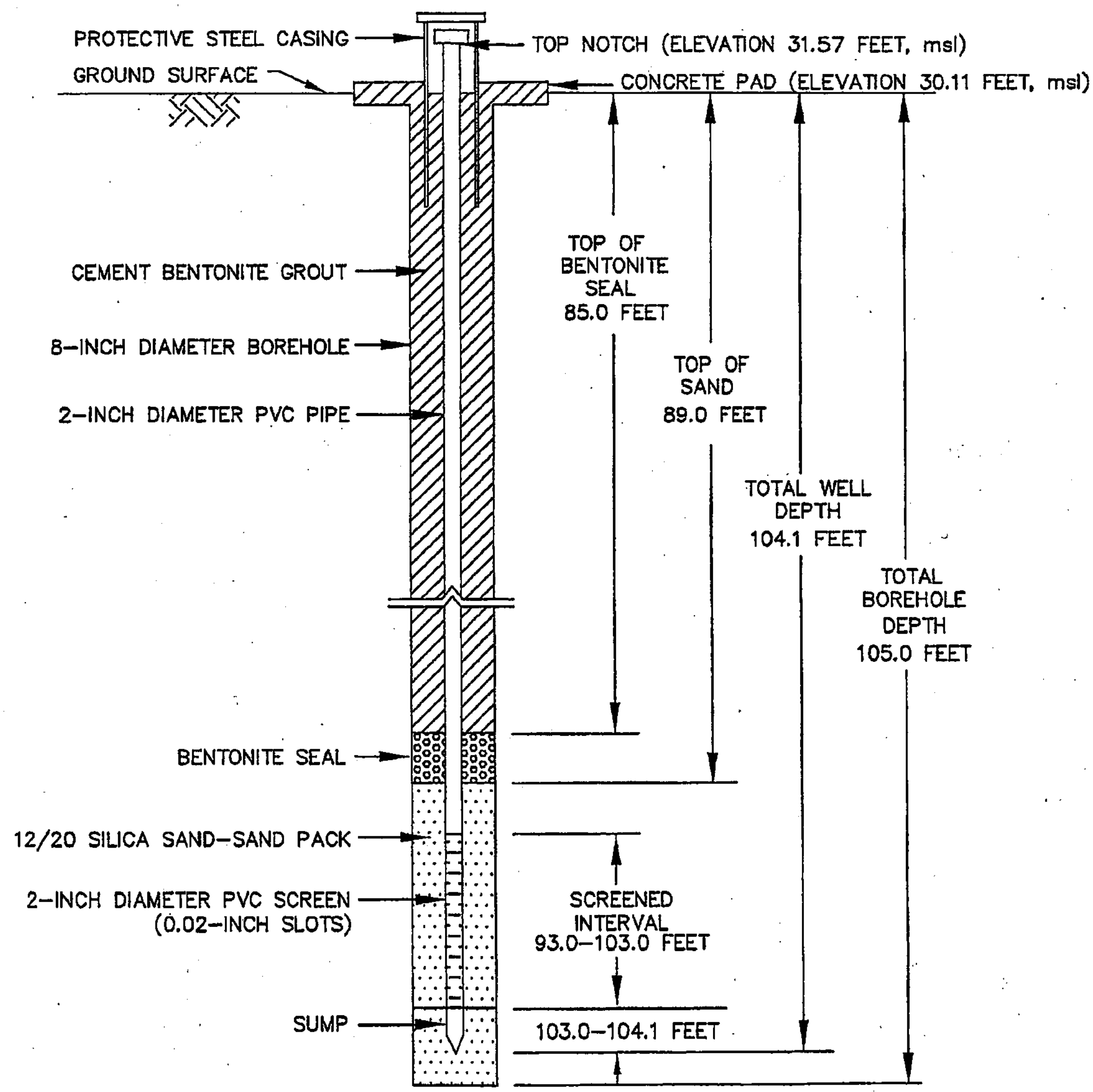
NOTE: 1.) BORING B-420 WAS USED TO DESIGN OW-420-U.
2.) DRAWING NOT TO SCALE.

P:\AutoCAD Drawings Only\Geotechnical\2008\6234-08-4632 STP COL Project\OW.420U.dwg Thu, 24 Apr 2008 - 8:53am mharriso

Project Name: STP COL PROJECT Project Number: 6234-08-4632	MACTEC	WELL CONSTRUCTION LOG: OW-438-L
Type of Boring: WASH ROTARY		Boring Location: MAINTENANCE SHOP N 363790.77 E 2942045.09
		DATE COMPLETED: 12/01/06

Prepared by MJH 5-25-08

Checked by KAW 5-28-08



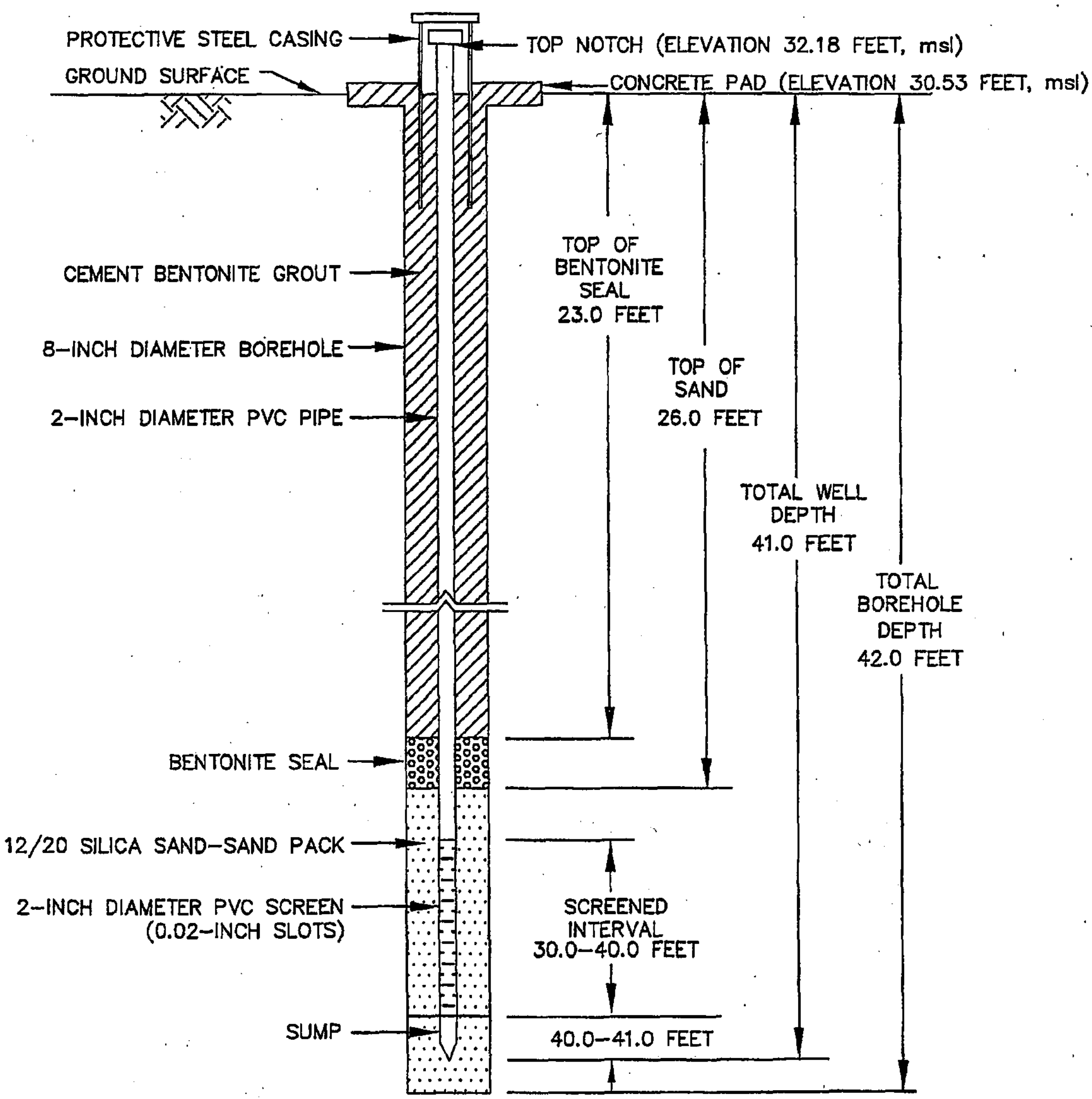
NOTE: 1.) BORING B-438 WAS USED TO DESIGN OW-438-L.
2.) DRAWING NOT TO SCALE.

P:\AutoCAD Drawings Only\Geotechnical\2008\6234-08-4632 STP COL Project\OW.438L.dwg Mon, 19 May 2008 - 2:36pm mharriso

Project Name: STP COL PROJECT Project Number: 6234-08-4632	MACTEC	WELL CONSTRUCTION LOG: OW-438-U
Type of Boring: WASH ROTARY		Boring Location: MAINTENANCE SHOP N 363792.04 E 2942025.17
		DATE COMPLETED: 12/01/06

Prepared by MJH 5-25-08

Checked by KAW 5.28.08



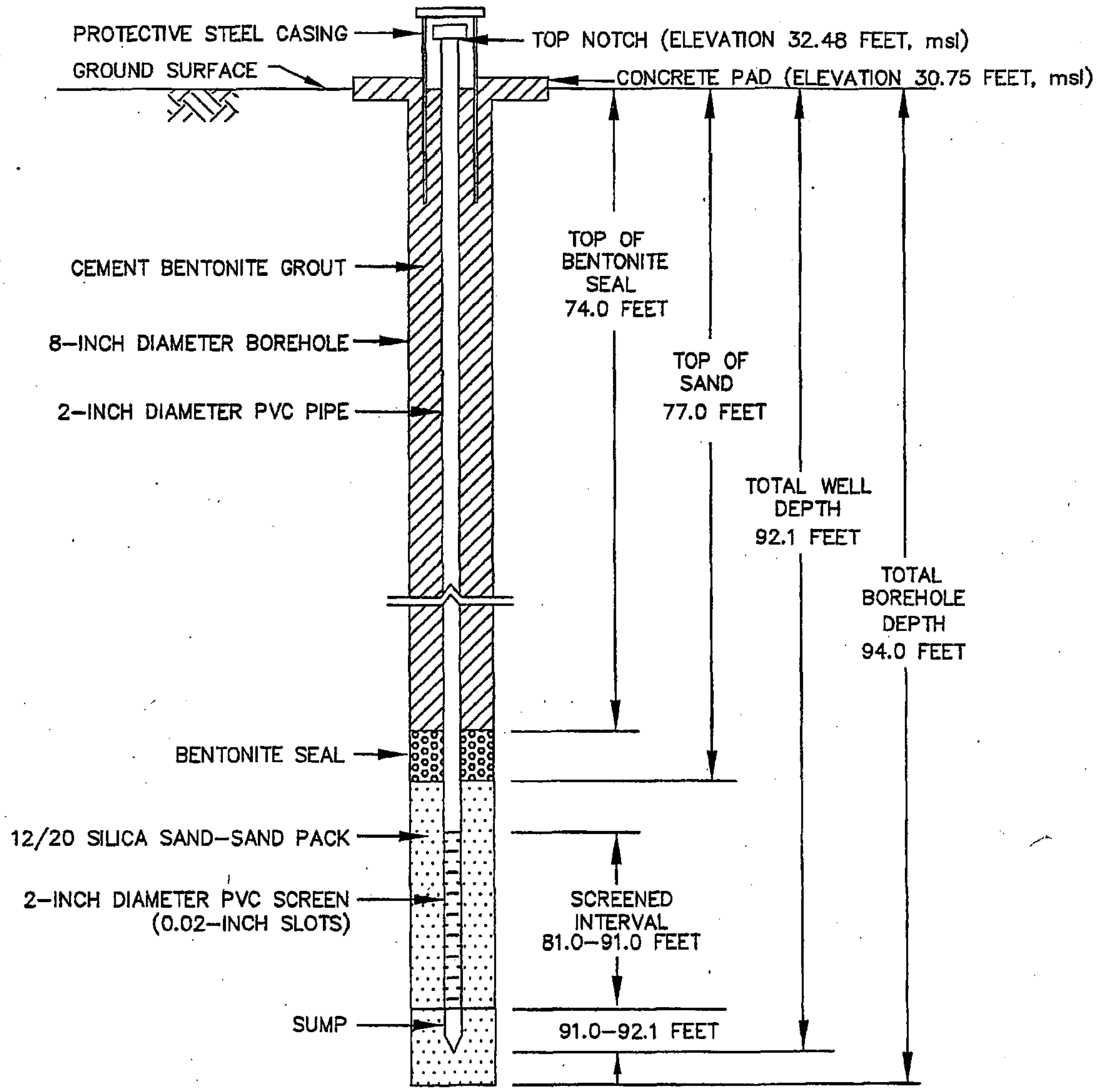
NOTE: 1.) BORING B-438 WAS USED TO DESIGN OW-438-U.
2.) DRAWING NOT TO SCALE.

P:\AutoCAD Drawings Only\Geotechnical\2008\6234-08-4632 STP COL Project\OW.438U.dwg Thu, 24 Apr 2008 - 9:09am mharriso

Project Name: STP COL PROJECT Project Number: 6234-08-4632	MACTEC	WELL CONSTRUCTION LOG: OW-910-L
Type of Boring: WASH ROTARY		Boring Location: UHS BASIN N 363363.45 E 2941266.45
		DATE COMPLETED: 12/20/06

Prepared by MJH 5-25-08

Checked by KAW 5-28-08

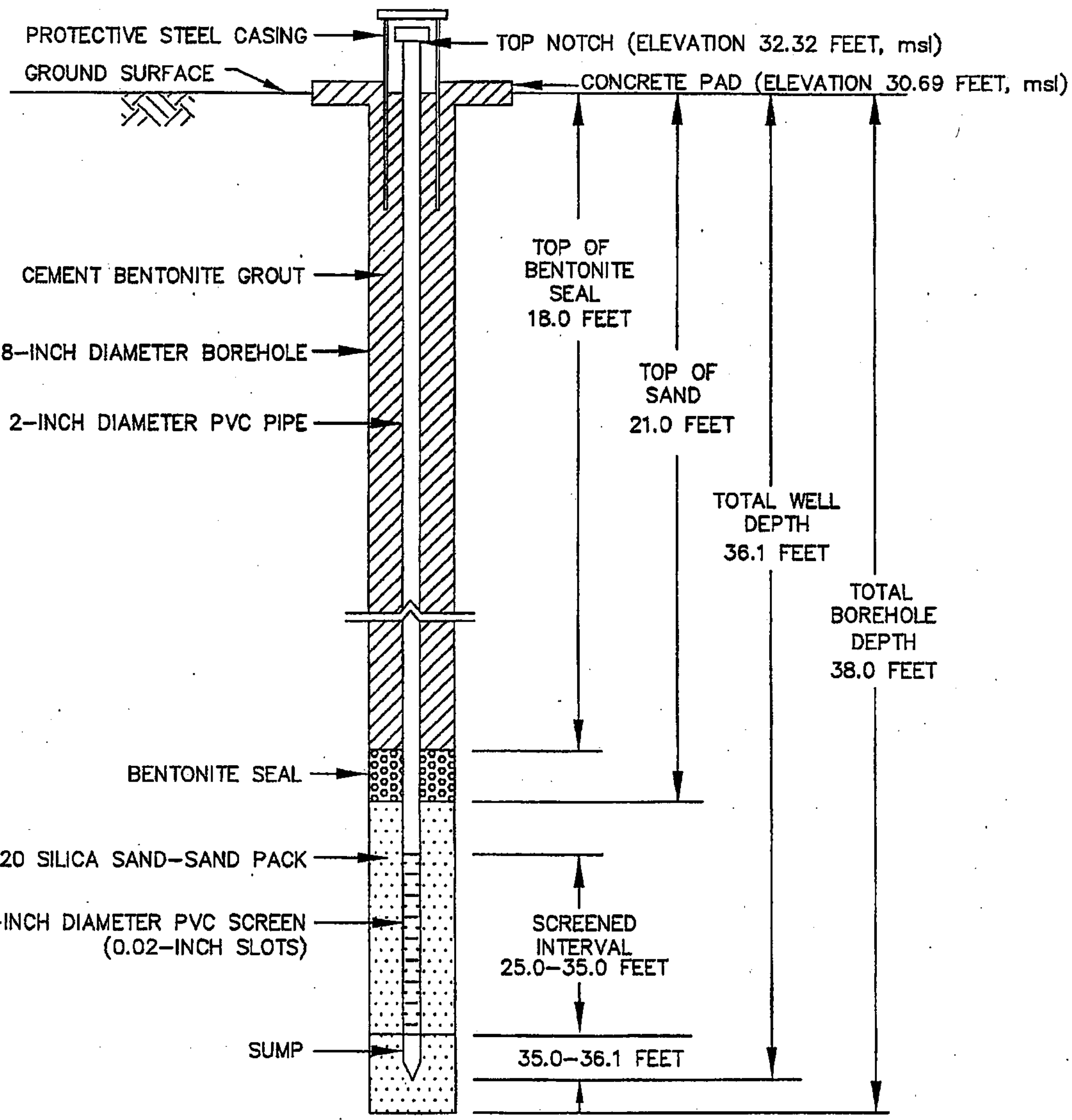


NOTE: 1.) BORING B-910 WAS USED TO DESIGN OW-910-L.
2.) DRAWING NOT TO SCALE.

P:\AutoCAD Drawings Only\Geotechnical\2008\6234-08-4632 STP COL Project\OW.910L.dwg Thu, 24 Apr 2008 - 9:10am mharriso

Project Name: STP COL PROJECT Project Number: 6234-08-4632	MACTEC	WELL CONSTRUCTION LOG: OW-910-U
Type of Boring: WASH ROTARY		Boring Location: UHS BASIN N 363362.02 E 2941246.57
		DATE COMPLETED: 12/20/06

Prepared by MJH 5-25-08
Checked by KAW 5.28.08



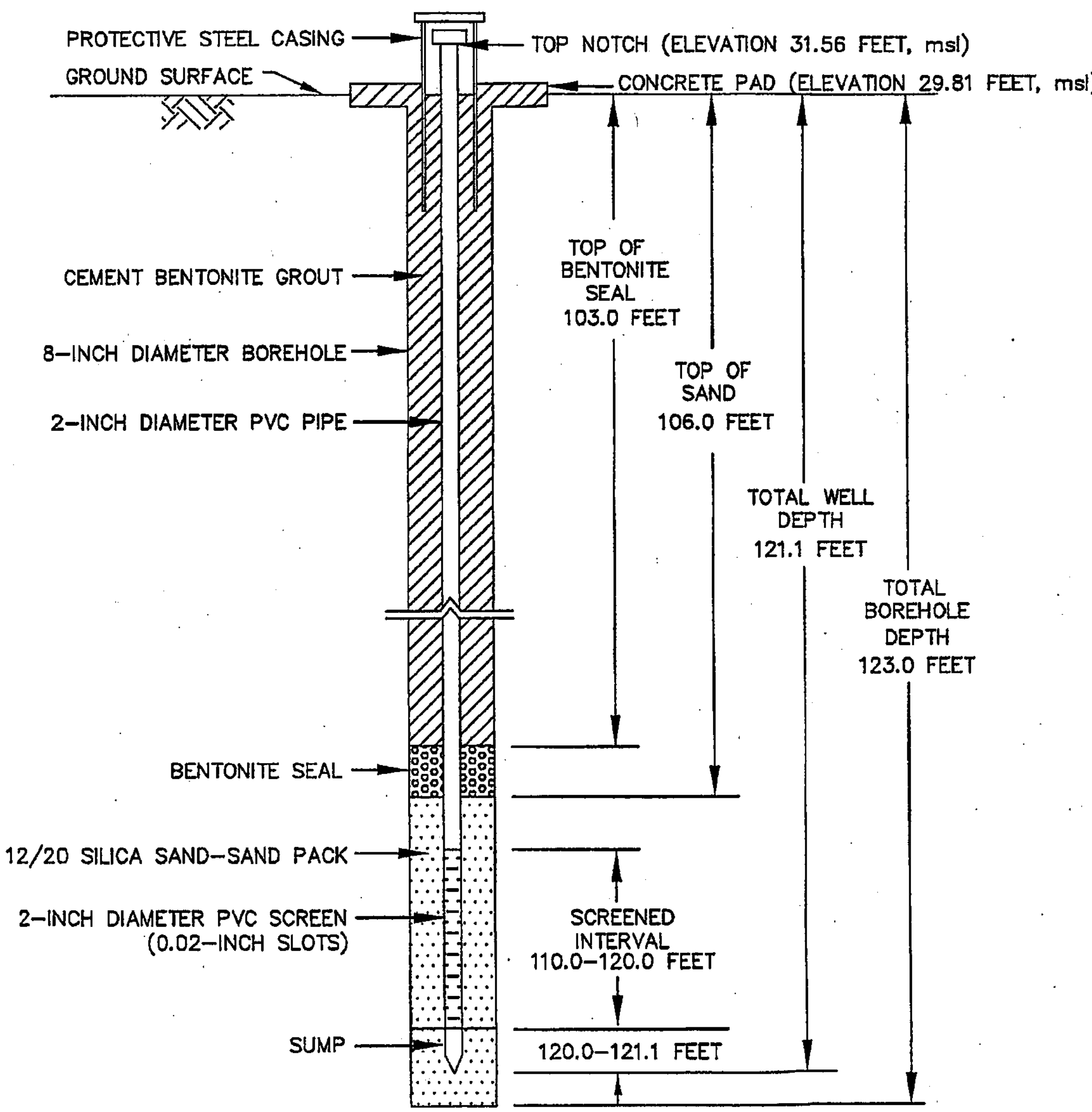
NOTE: 1.) BORING B-910 WAS USED TO DESIGN OW-910-U.
2.) DRAWING NOT TO SCALE.

P:\AutoCAD Drawings Only\Geotechnical\2008\6234-08-4632 STP COL Project\OW.910U.dwg Thu, 24 Apr 2008 - 9:11am mharriso

Project Name: STP COL PROJECT Project Number: 6234-08-4632	MACTEC	WELL CONSTRUCTION LOG: OW-928-L
Type of Boring: WASH ROTARY		Boring Location: NORTHWEST OF POWER BLOCK N 364932.3 E 2940376.21
		DATE COMPLETED: 12/19/06

Prepared by MJH 5-25-08

Checked by KAW 5-28-08



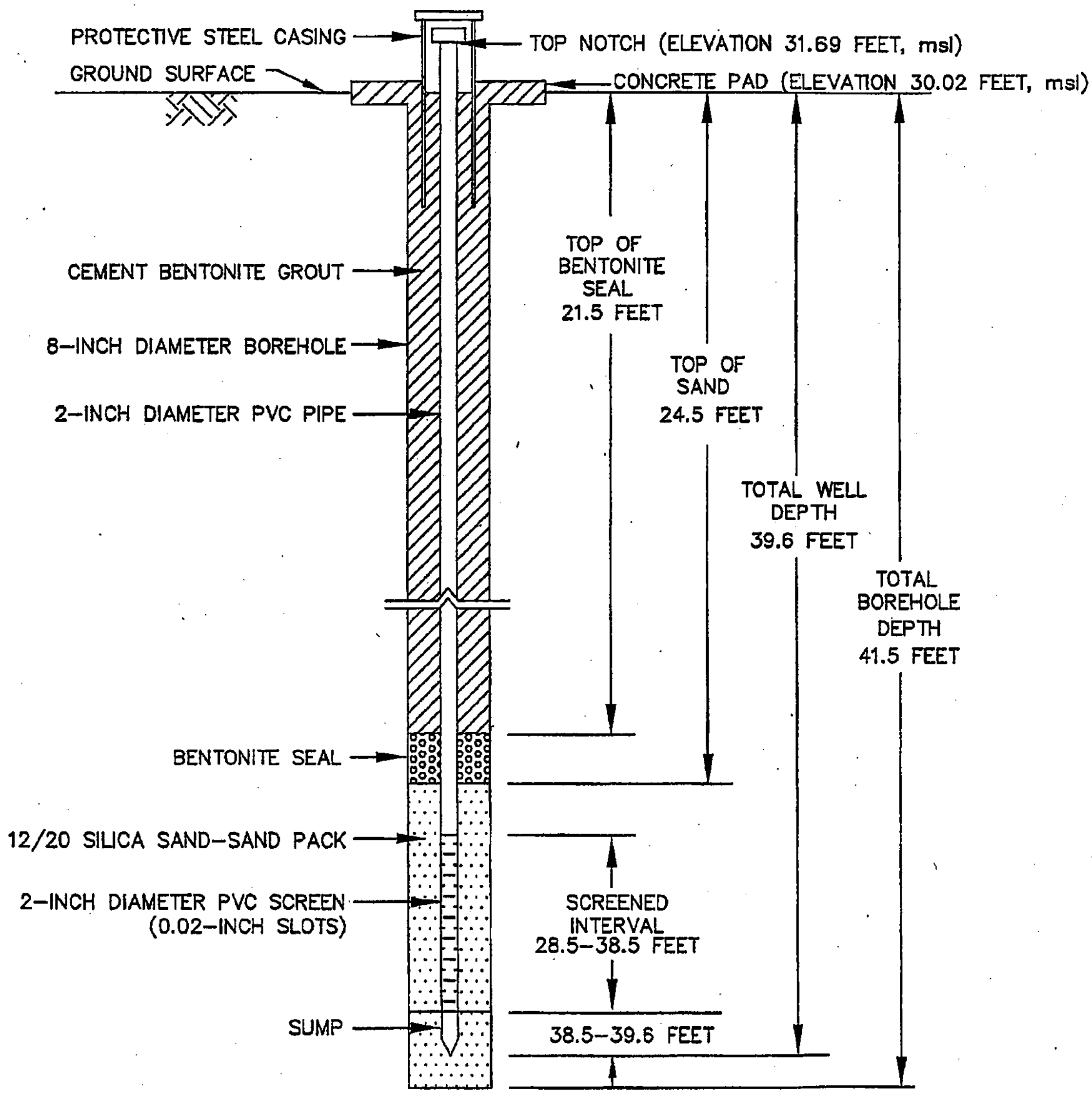
NOTE: 1.) BORING B-928 WAS USED TO DESIGN OW-928-L.
2.) DRAWING NOT TO SCALE.

P:\AutoCAD Drawings Only\Geotechnical\2008\6234-08-4632 STP COL Project\OW.928L.dwg Thu, 24 Apr 2008 - 9:12am mharriso

Project Name: STP COL PROJECT Project Number: 6234-08-4632	MACTEC	WELL CONSTRUCTION LOG: OW-928-U
Type of Boring: WASH ROTARY		Boring Location: NORTHWEST OF POWER BLOCK N 364933.86 E 2940356.48
		DATE COMPLETED: 12/19/06

Prepared by MJH 5-25-08

Checked by KAW 5.28.08

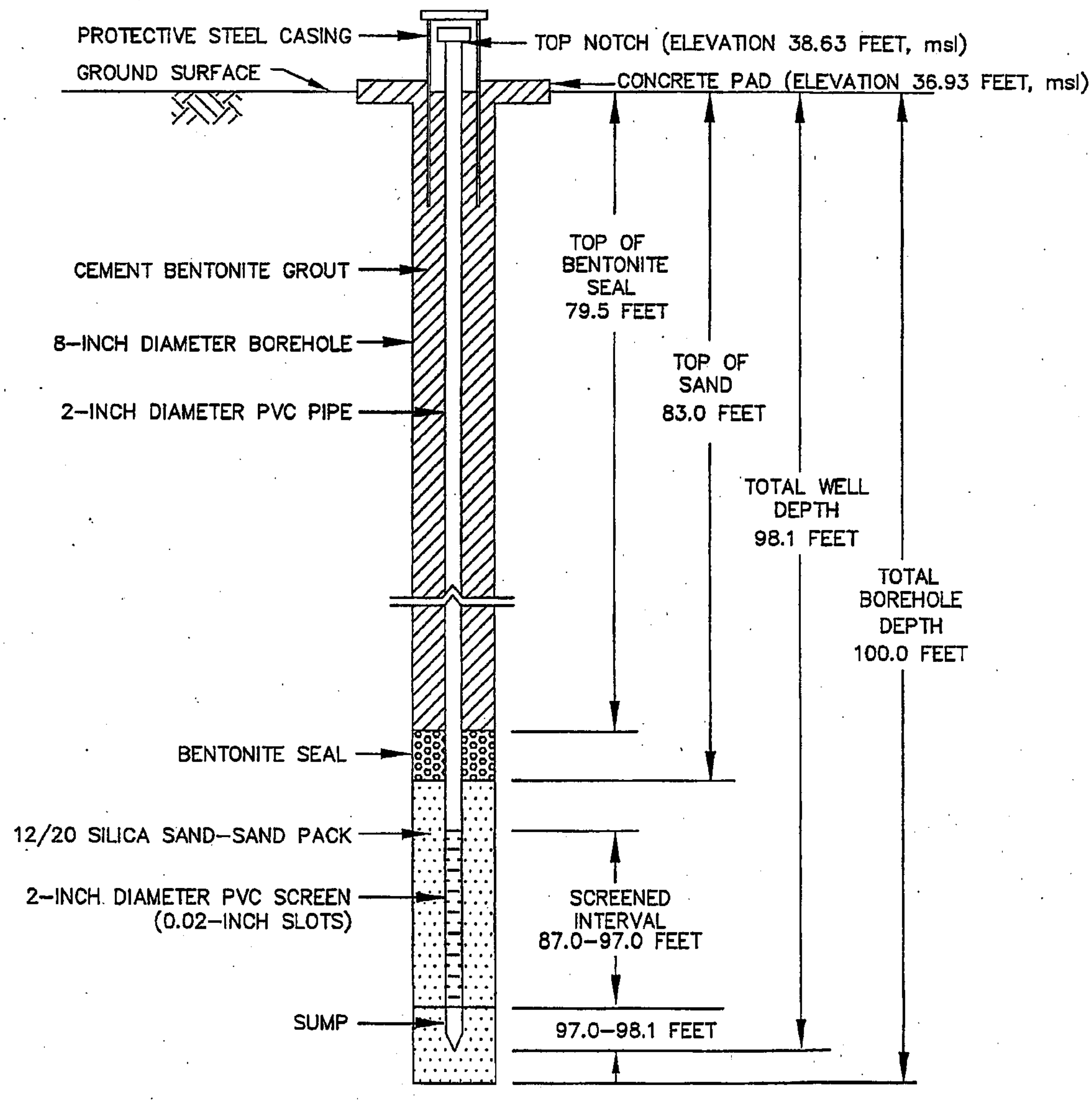


NOTE: 1.) BORING B-928 WAS USED TO DESIGN OW-928-U.
2.) DRAWING NOT TO SCALE.

P:\AutoCAD Drawings Only\Geotechnical\2008\6234-08-4632 STP COL Project\OW.928U.dwg Thu, 24 Apr 2008 - 9:13am mharriso

Project Name: STP COL PROJECT Project Number: 6234-08-4632	MACTEC	WELL CONSTRUCTION LOG: OW-929-L
Type of Boring: WASH ROTARY		Boring Location: NORTHEAST OF POWER BLOCK N 364671.5 E 2945497.78
		DATE COMPLETED: 12/30/06

Prepared by MJH 5-25-08
Checked by KAW 5.28.08



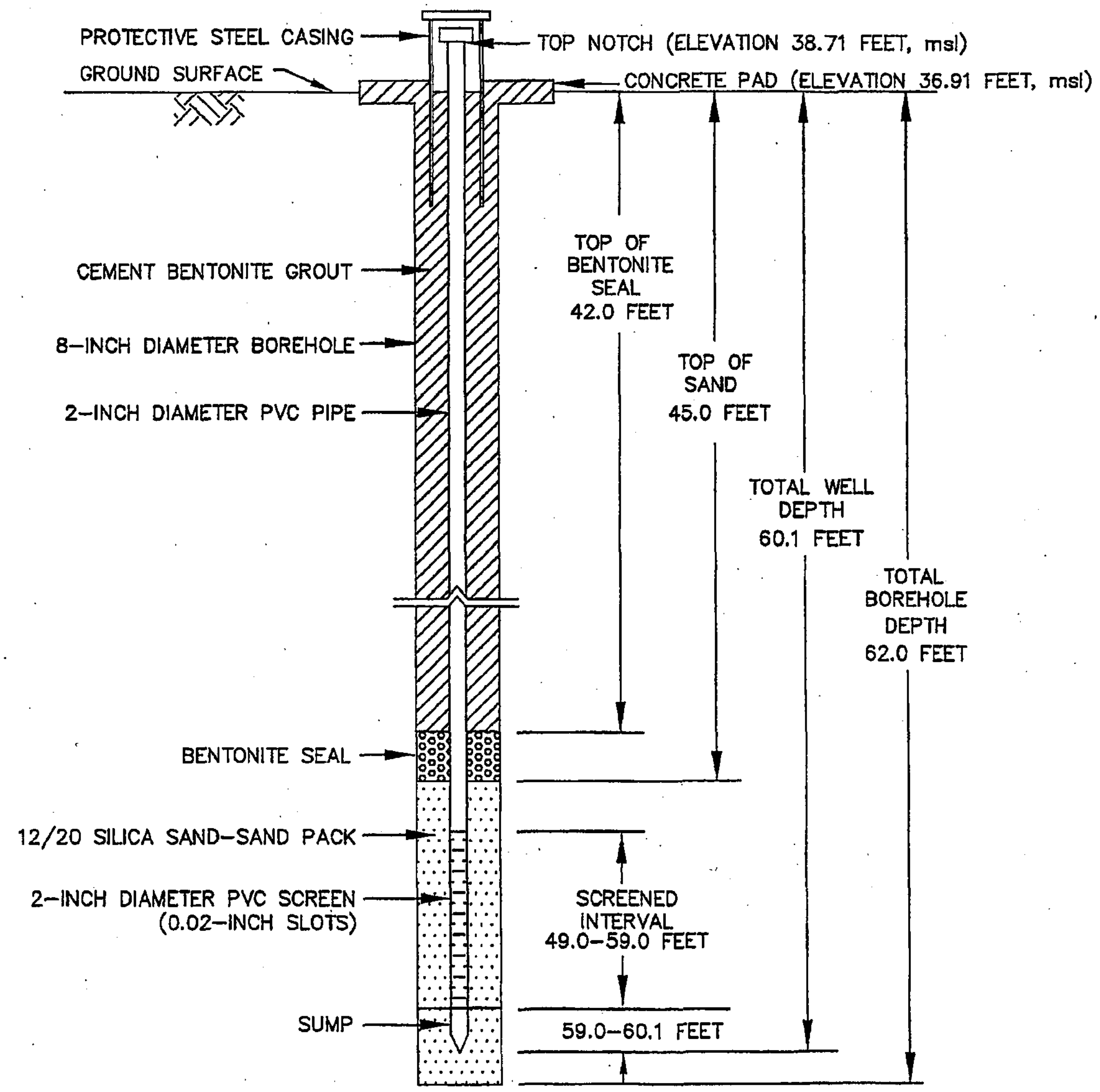
NOTE: 1.) BORING B-929 WAS USED TO DESIGN OW-929-L.
2.) DRAWING NOT TO SCALE.

P:\AutoCAD Drawings Only\Geotechnical\2008\6234-08-4632 STP COL Project\OW.929Ldwg.dwg Thu, 24 Apr 2008 - 9:20am mharriso

Project Name: STP COL PROJECT Project Number: 6234-08-4632	MACTEC	WELL CONSTRUCTION LOG: OW-929-U
Type of Boring: WASH ROTARY		Boring Location: NORTHEAST OF POWER BLOCK N 364672.34 E 2945477.58
		DATE COMPLETED: 12/15/06

Prepared by MJH 5-25-08

Checked by KAW 5.28.08



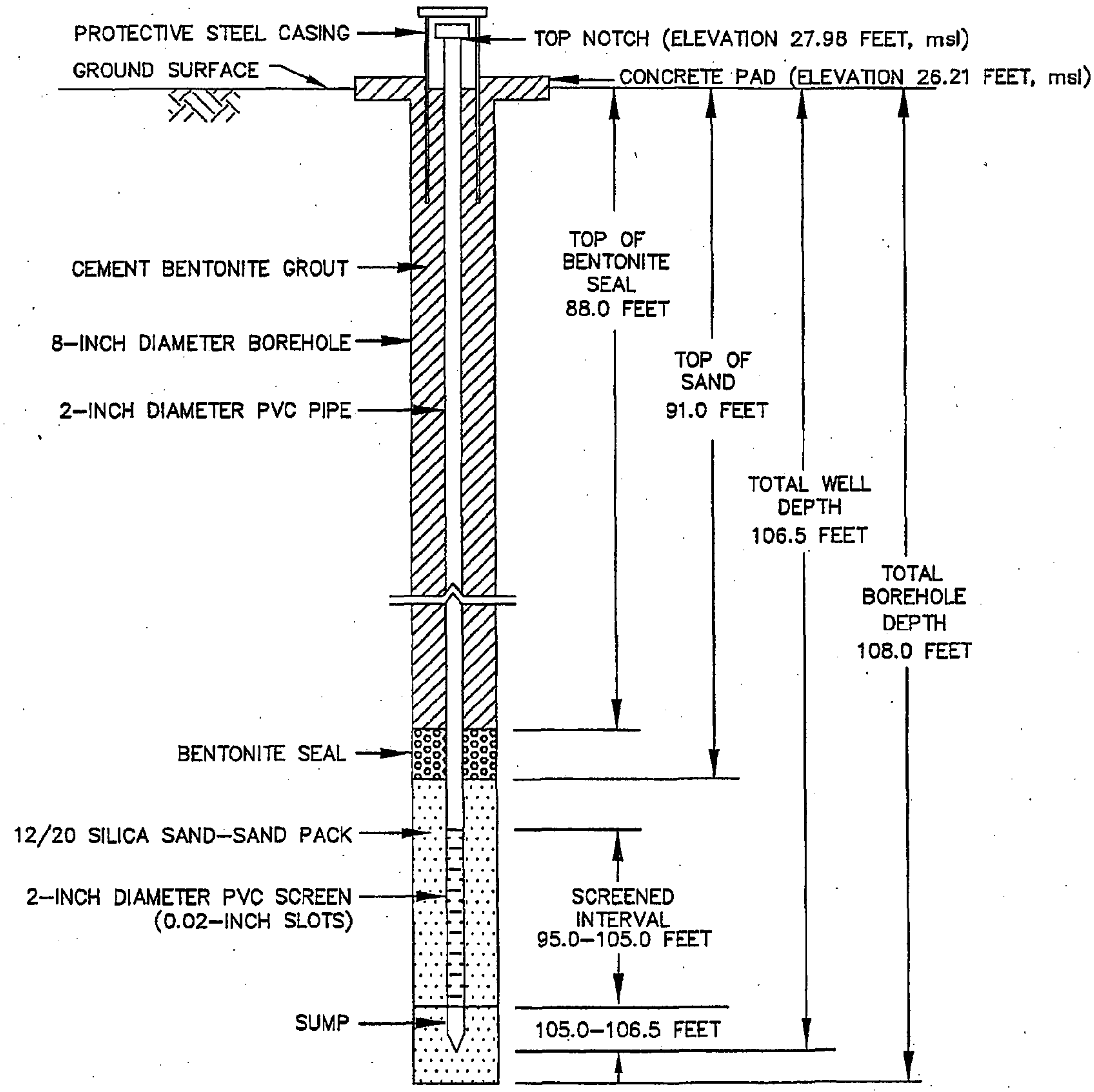
NOTE: 1.) BORING B-929 WAS USED TO DESIGN OW-929-U.
2.) DRAWING NOT TO SCALE.

P:\AutoCAD Drawings Only\Geotechnical\2008\6234-08-4632 STP COL Project\OW.929Udwg.dwg Thu, 24 Apr 2008 - 9:21am mharriso

Project Name: STP COL PROJECT Project Number: 6234-08-4632	MACTEC	WELL CONSTRUCTION LOG: OW-930-L
Type of Boring: WASH ROTARY		Boring Location: SOUTHEAST OF UNIT 1&2 ECR/UHS N 360214.45 E 2949525.96
		DATE COMPLETED: 12/18/06

Prepared by MJH 5-25-08

Checked by KAW 5.28.08



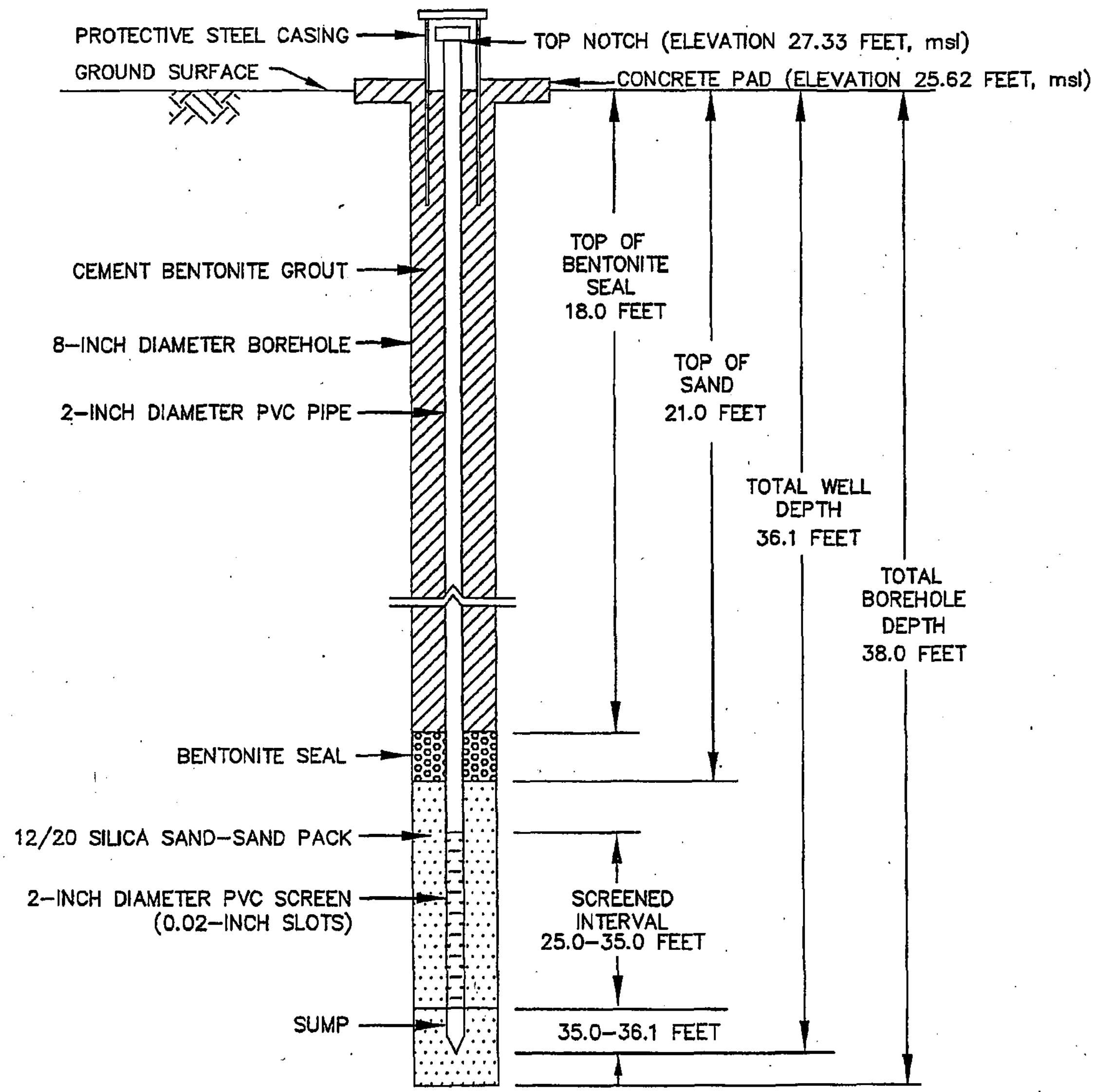
NOTE: 1.) BORING B-930 WAS USED TO DESIGN OW-930-L.
2.) DRAWING NOT TO SCALE.

P:\AutoCAD Drawings Only\Geotechnical\2008\6234-08-4632 STP COL Project\OW.930Ldwg.dwg Thu, 24 Apr 2008 - 9:22am mharriso

Project Name: STP COL PROJECT Project Number: 6234-08-4632	MACTEC	WELL CONSTRUCTION LOG: OW-930-U
Type of Boring: WASH ROTARY		Boring Location: SOUTHEAST OF UNIT 1&2 ECR/UHS N 360209.72 E 2949506.58
		DATE COMPLETED: 12/18/06

Prepared by MJH 5-25-08

Checked by KAW 5-28-08

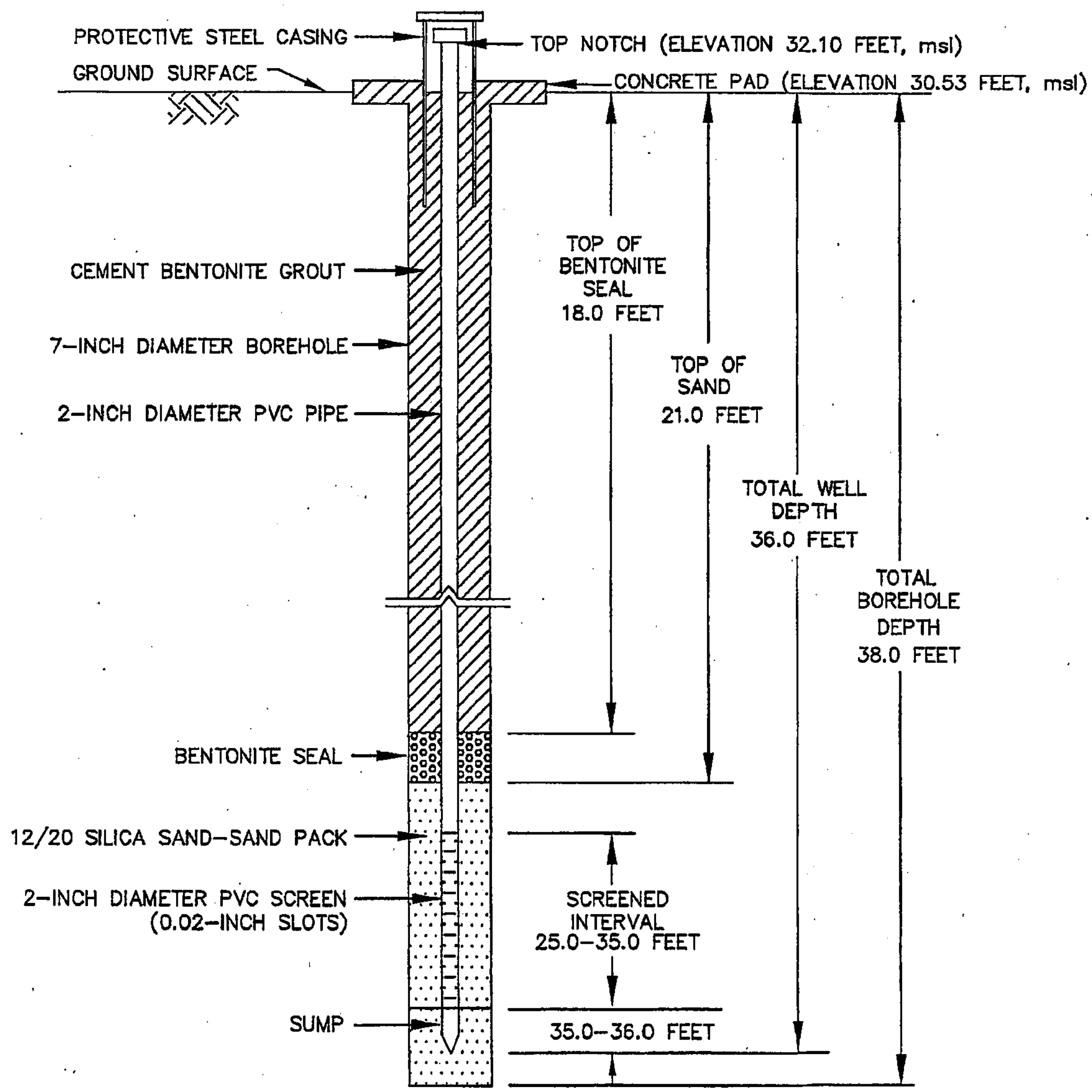


NOTE: 1.) BORING B-930 WAS USED TO DESIGN OW-930-U.
2.) DRAWING NOT TO SCALE.

P:\AutoCAD Drawings Only\Geotechnical\2008\6234-08-4632 STP COL Project\OW.930Udwg.dwg Thu, 24 Apr 2008 - 9:23am mharriso

Project Name: STP COL PROJECT Project Number: 6234-08-4632	MACTEC	WELL CONSTRUCTION LOG: OW-931-U
Type of Boring: WASH ROTARY		Boring Location: SOUTHWEST POWER BLOCK N 361979.42 E 2939520.36
		DATE COMPLETED: 12/15/06

Prepared by MJH 5-25-08
Checked by KAW 5.28.08

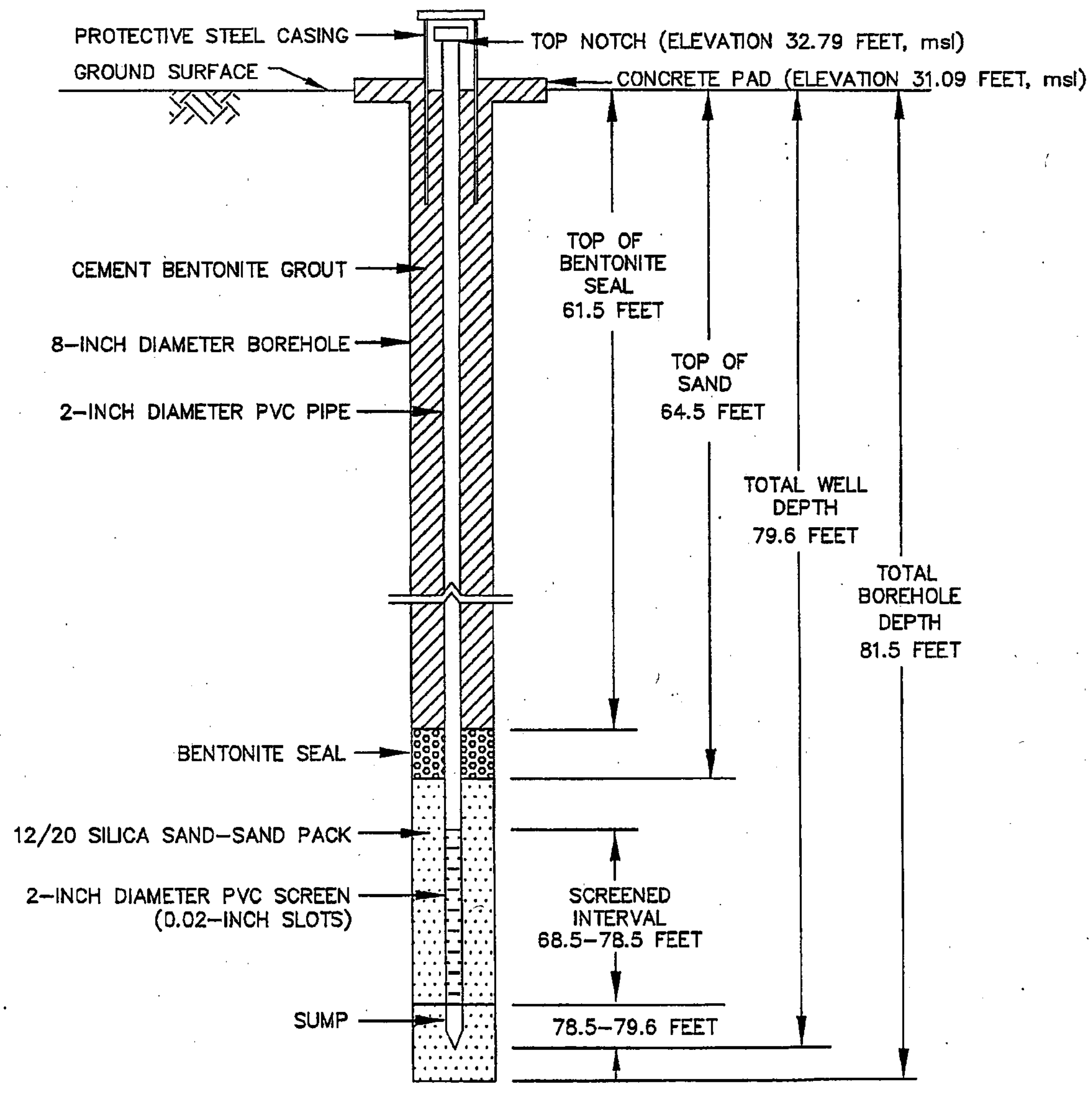


NOTE: 1.) BORING B-931 WAS USED TO DESIGN OW-931-U.
2.) DRAWING NOT TO SCALE.

P:\AutoCAD Drawings Only\Geotechnical\2008\6234-08-4632 STP COL Project\OW.931Udwg.dwg Thu, 24 Apr 2008 - 9:24am mharriso

Project Name: STP COL PROJECT Project Number: 6234-08-4632	MACTEC	WELL CONSTRUCTION LOG: OW-932-L
Type of Boring: WASH ROTARY		Boring Location: SOUTH OF POWER BLOCK N 361899.37 E 2942115.9
		DATE COMPLETED: 12/19/06

Prepared by 5-25-08 MJH
Checked by KAW 5.28.08



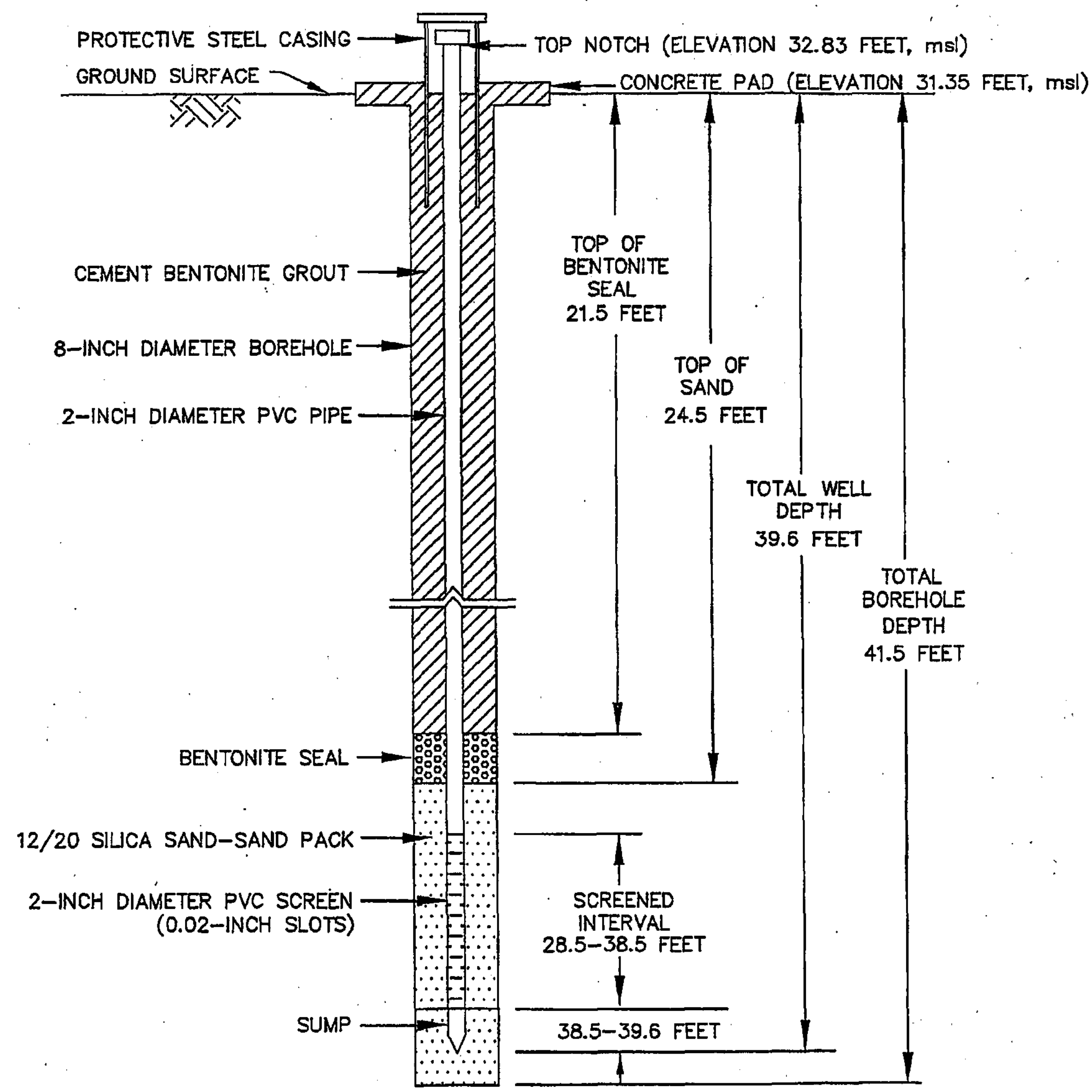
NOTE: 1.) BORING B-932 WAS USED TO DESIGN OW-932-L
2.) DRAWING NOT TO SCALE.

P:\AutoCAD Drawings Only\Geotechnical\2008\6234-08-4632 STP COL Project\OW.932Ldwg.dwg Thu, 24 Apr 2008 - 9:25am mharrisa

Project Name: STP COL PROJECT Project Number: 6234-08-4632	MACTEC	WELL CONSTRUCTION LOG: OW-932-U
Type of Boring: WASH ROTARY		Boring Location: SOUTH OF POWER BLOCK N 361898.53 E 2942097.29
		DATE COMPLETED: 12/19/06

Prepared by MJH 5-25-08

Checked by KAW 5.28.08



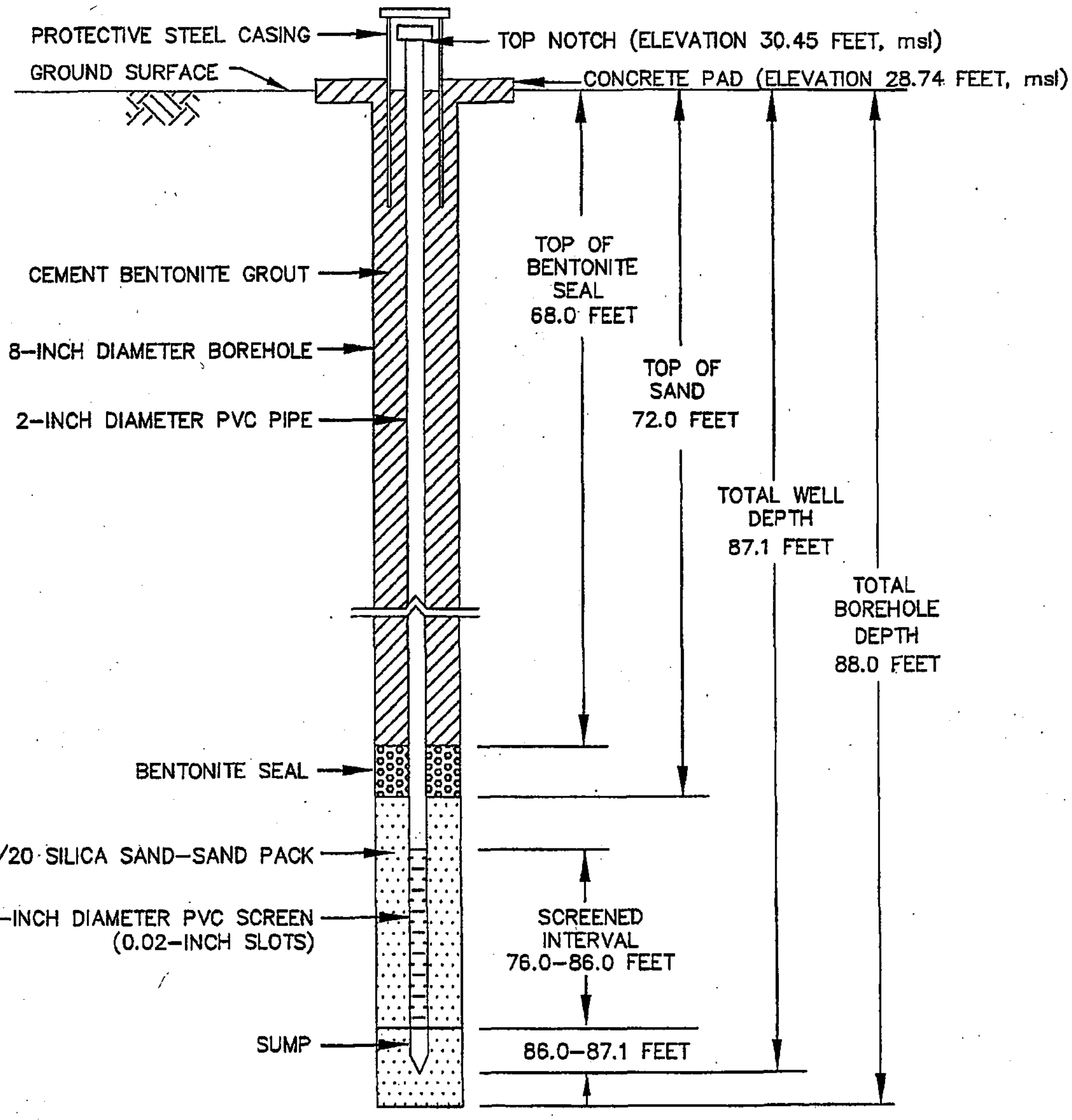
NOTE: 1.) BORING B-932 WAS USED TO DESIGN OW-932U.
2.) DRAWING NOT TO SCALE.

P:\AutoCAD Drawings Only\Geotechnical\2008\6234-08-4632 STP COL Project\OW.932Udwg.dwg Thu, 24 Apr 2008 - 9:26am mharriso

Project Name: STP COL PROJECT Project Number: 6234-08-4632	MACTEC	WELL CONSTRUCTION LOG: OW-933-L
Type of Boring: WASH ROTARY		Boring Location: SOUTH OF POWER BLOCK N 361898.05 E 2943515.01
		DATE COMPLETED: 11/28/06

Prepared by MJH 5-25-08

Checked by KAW 5.28.08



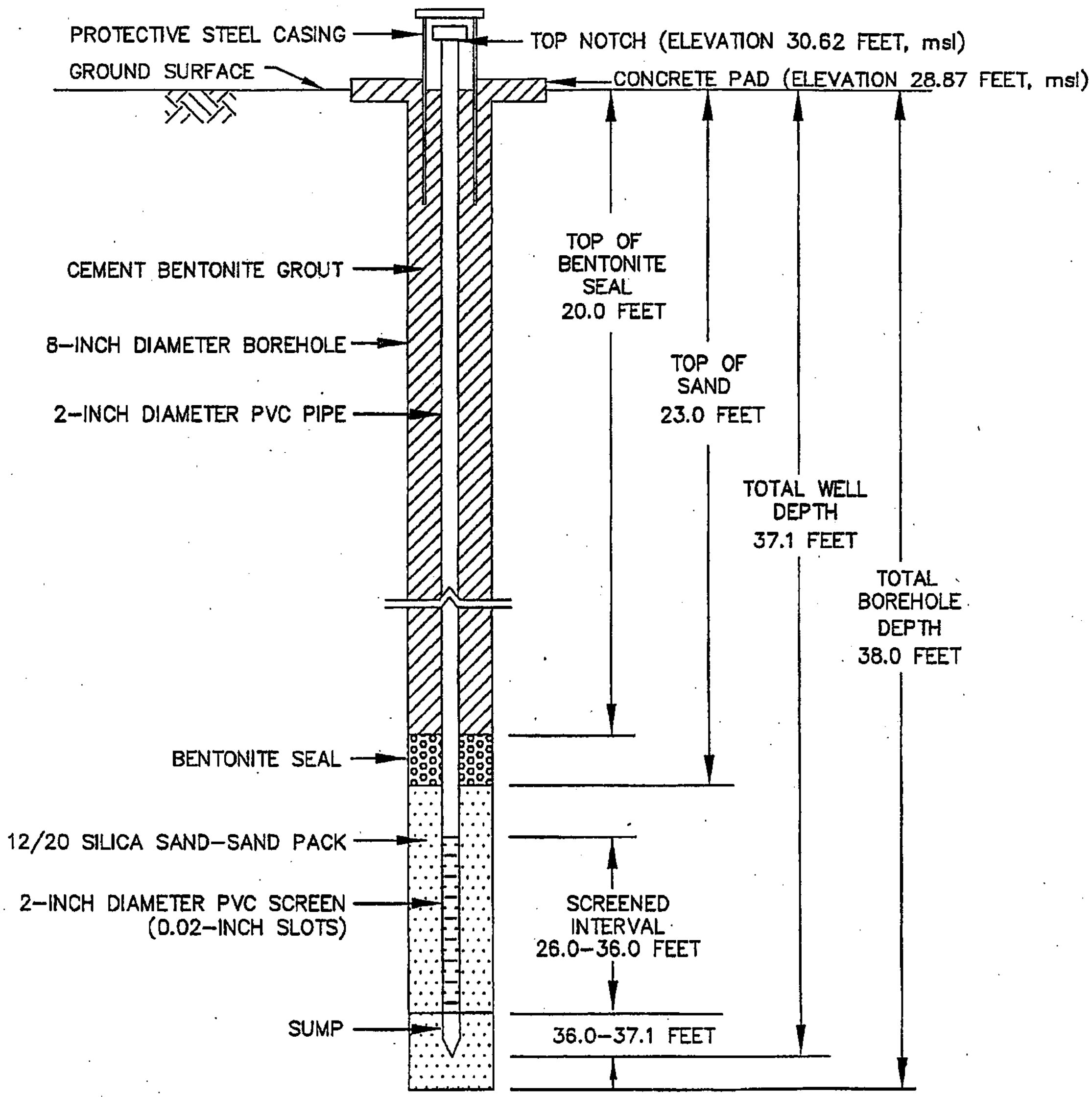
NOTE: 1.) BORING B-933 WAS USED TO DESIGN OW-933-L.
2.) DRAWING NOT TO SCALE.

P:\AutoCAD Drawings Only\Geotechnical\2008\6234-08-4632 STP COL Project\OW.933L.dwg.dwg Thu, 24 Apr 2008 - 9:33am mharriso

Project Name: STP COL PROJECT Project Number: 6234-08-4632	MACTEC	WELL CONSTRUCTION LOG: OW-933-U
Type of Boring: WASH ROTARY		Boring Location: SOUTH OF POWER BLOCK N 361897.65 E 2943494.66
		DATE COMPLETED: 11/28/06

Prepared by MJH 5-25-08

Checked by KAW 5.28.08



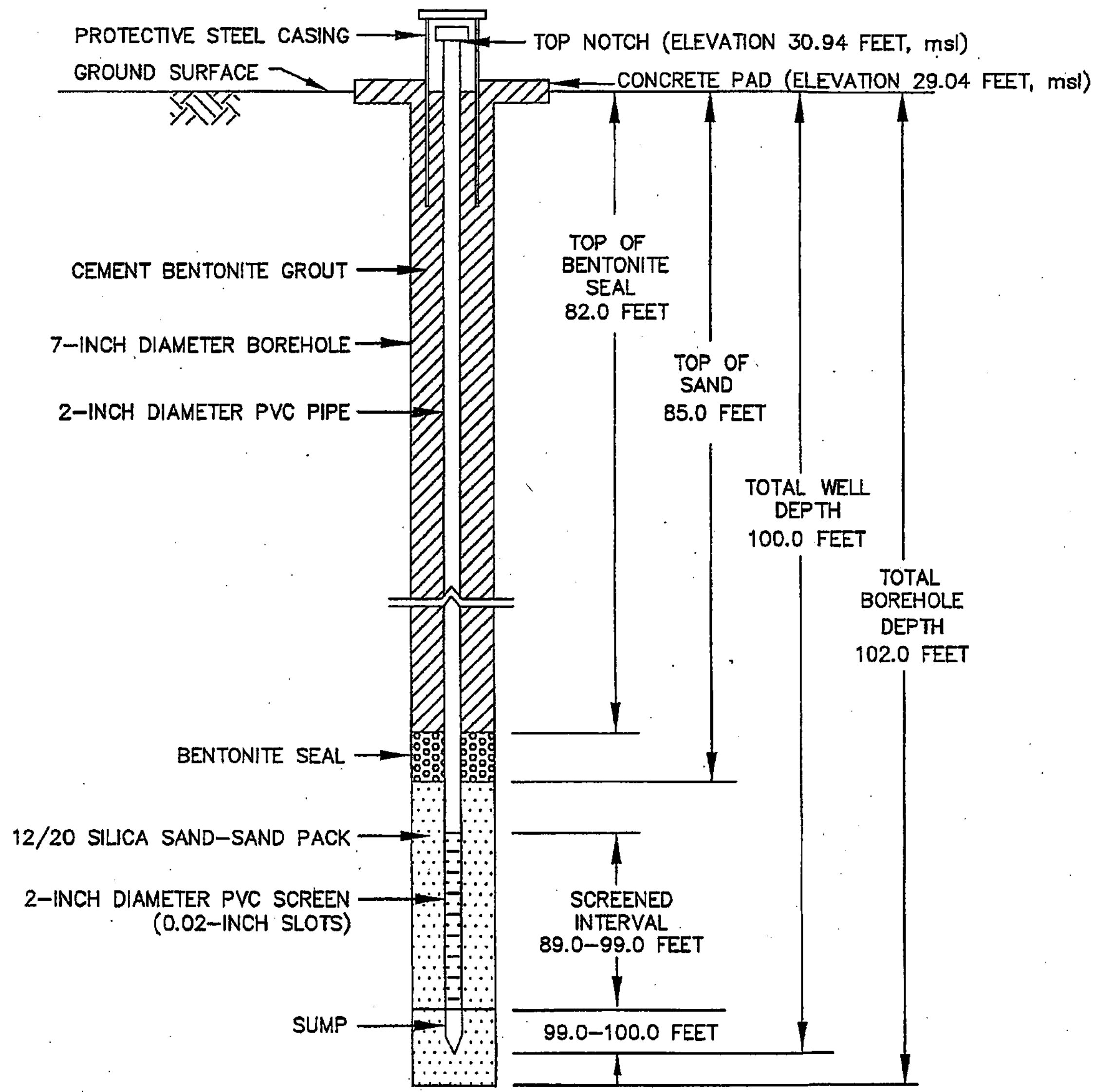
NOTE: 1.) BORING B-933 WAS USED TO DESIGN OW-933-U.
2.) DRAWING NOT TO SCALE.

P:\AutoCAD Drawings Only\Geotechnical\2008\6234-08-4632 STP COL Project\OW.933Udwg.dwg Thu, 24 Apr 2008 - 9:34am mharriso

Project Name: STP COL PROJECT Project Number: 6234-08-4632	MACTEC	WELL CONSTRUCTION LOG: OW-934-L
Type of Boring: WASH ROTARY		Boring Location: NORTHEAST OF UNIT 1&2 ECR/UHS N 362082.08 E 2948254.12
		DATE COMPLETED: 12/15/06

Prepared by MJH 5-25-08

Checked by KAW 5.28.08



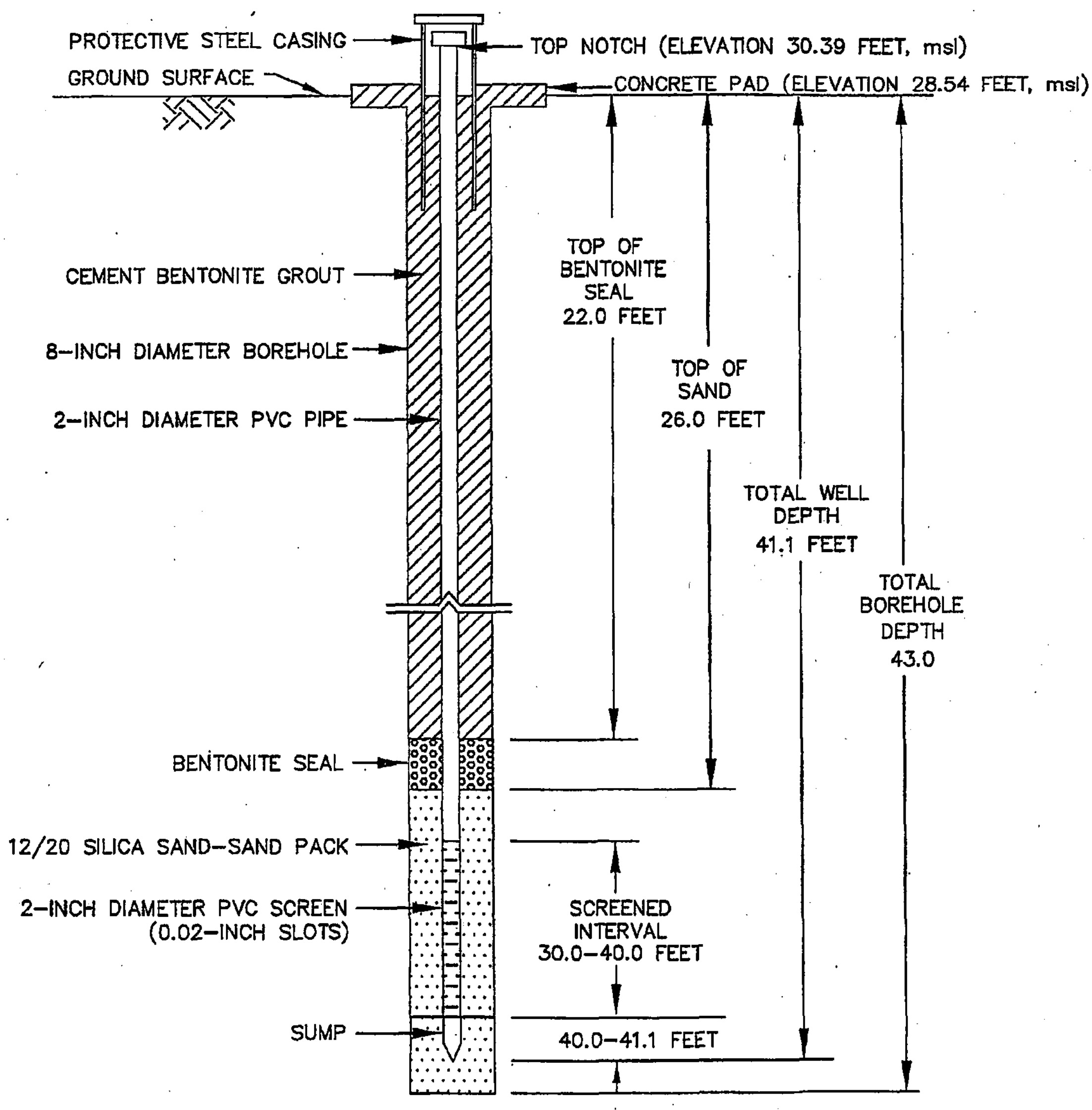
NOTE: 1.) BORING B-934 WAS USED TO DESIGN OW-934-L.
2.) DRAWING NOT TO SCALE.

P:\AutoCAD Drawings Only\Geotechnical\2008\6234-08-4632 STP COL Project\OW.934Ldwg.dwg Thu, 24 Apr 2008 - 9:35am mharriso

Project Name: STP COL PROJECT Project Number: 6234-08-4632	MACTEC	WELL CONSTRUCTION LOG: OW-934-U
Type of Boring: WASH ROTARY		Boring Location: NORTHEAST OF UNIT 1&2 ECR/UHS N 362079.87 E 2948234.2
		DATE COMPLETED: 12/01/06

Prepared by MJH 5-25-08

Checked by KAW 5·28·08



NOTE: 1.) BORING B-934 WAS USED TO DESIGN OW-934-U.
2.) DRAWING NOT TO SCALE.

P:\AutoCAD Drawings Only\Geotechnical\2008\6234-08-4632 STP COL Project\OW.934Udwg.dwg Thu, 24 Apr 2008 - 9:36am mharriso

ATTACHMENT D

CONE PENETROMETER TEST RESULTS

CONSISTS OF:

Gregg Report dated February 5, 2007
Revised: April 3, 2007

Volume 1 of 1

ATTACHMENT D

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GREGG

GREGG IN SITU, INC.

GEOTECHNICAL AND ENVIRONMENTAL INVESTIGATION SERVICES

February 5, 2007

MACTEC
Attn: Michael D. Sufnarski
2801 Yorkmout Road, Suite 100
Charlotte, North Carolina 28208

Subject: CPT Site Investigation
South Texas Project
Bay City, Texas
GREGG Project Number: 06-109SC

Dear Mr. Sufnarski:

The following report presents the results of GREGG Drilling & Testing's Cone Penetration Test investigation for the above referenced site. The following testing services were performed:

1	Cone Penetration Tests	(CPTU)	☒
2	Pore Pressure Dissipation Tests	(PPD)	☒
3	Seismic Cone Penetration Tests	(SCPTU)	☒
4	Resistivity Cone Penetration Tests	(RCPTU)	☐
5	UVIF Cone Penetration Tests	(UVIFCPTU)	☐
6	Groundwater Sampling	(GWS)	☐
7	Soil Sampling	(SS)	☐
8	Vapor Sampling	(VS)	☐
9	Vane Shear Testing	(VST)	☐
10	SPT Energy Calibration	(SPTE)	☐

A list of reference papers providing additional background on the specific tests conducted is provided in the bibliography following the text of the report. If you would like a copy of any of these publications or should you have any questions or comments regarding the contents of this report, please do not hesitate to contact our office at (925) 313-5800.

Sincerely,
GREGG Drilling & Testing, Inc.

Pam Carty
for

Peter Robertson
Technical Operations

1112 Pasture Lane • Columbia, South Carolina 29201 • (803) 253-7633 • FAX (803) 253-7634
OTHER OFFICES: LOS ANGELES • SAN FRANCISCO • HOUSTON
www.greggdrilling.com

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Cone Penetration Test Sounding Summary

-Table 1-

CPT Sounding Identification	Date	Termination Depth (Feet)	Depth of Groundwater Samples (Feet)	Depth of Soil Samples (Feet)	Depth of Pore Pressure Dissipation Tests (Feet)
C-301	12/01/06	50.0	-	-	-
C-302	11/29/06	36.1	-	-	-
C-303	12/01/06	50.0	-	-	-
C-304	12/15/06	100.1	-	-	30.0, 74.8
C-305s	12/16/06	97.1	-	-	38.1, 67.1, 92.0
C-306s	11/30/06	66.3	-	-	28.1, 56.1
C-307s	12/14/06	95.1	-	-	74.0
C-308	12/15/06	79.4	-	-	31.0, 70.0
C-309	12/14/06	100.1	-	-	-
C-310	12/12/06	100.1	-	-	26.1
C-401	12/01/06	50.0	-	-	-
C-402	12/01/06	50.0	-	-	-
C-403	12/01/06	50.0	-	-	-
C-404	12/19/06	37.6	-	-	30.0
C-406s	12/13/06	93.3	-	-	29.2, 58.4, 71.4
C-407s	12/12/06	98.3	-	-	-
C-408	12/06/06	100.2	-	-	27.4, 70.2
C-409	12/02/06	92.0	-	-	-
C-410	12/05/06	92.0	-	-	29.0, 83.3
C-411	12/02/06	50.0	-	-	-
C-901	12/17/06	98.1	-	-	-
C-902	12/17/06	90.1	-	-	-
C-903	12/28/06	93.2	-	-	-
C-904	12/20/06	90.1	-	-	-
C-905	12/13/07	50.0	-	-	-
C-906	12/18/06	50.0	-	-	-
C-907	12/16/06	50.0	-	-	-
C-908	12/16/06	50.0	-	-	-
C-909	12/02/06	40.0	-	-	-
C-916	12/17/06	39.0	-	-	-
C-917	12/19/06	50.0	-	-	-
C-918	12/18/06	50.0	-	-	-

Cone Penetration Testing Procedure (CPT)

Gregg In Situ, Inc. carries out all Cone Penetration Tests (CPT) using an integrated electronic cone system, *Figure CPT*. The soundings were conducted using a 20 ton capacity cone with a tip area of 15 cm^2 and a friction sleeve area of 225 cm^2. The cone is designed with an equal end area friction sleeve and a tip end area ratio of 0.79.

The cone takes measurements of cone bearing (q_c), sleeve friction (f_s) and penetration pore water pressure (u_2) at 5-cm intervals during penetration to provide a nearly continuous hydrogeologic log. CPT data reduction and interpretation is performed in real time facilitating on-site decision making. The above mentioned parameters are stored on disk for further analysis and reference. All CPT soundings are performed in accordance with revised (2002) ASTM standards (D 5778-95).

The cone also contains a porous filter element located directly behind the cone tip (u_2), *Figure CPT*. It consists of porous plastic and is 5.0mm thick. The filter element is used to obtain penetration pore pressure as the cone is advanced as well as Pore Pressure Dissipation Tests (PPDT's) during appropriate pauses in penetration. It should be noted that prior to penetration, the element is fully saturated with silicon oil under vacuum pressure to ensure accurate and fast dissipation.

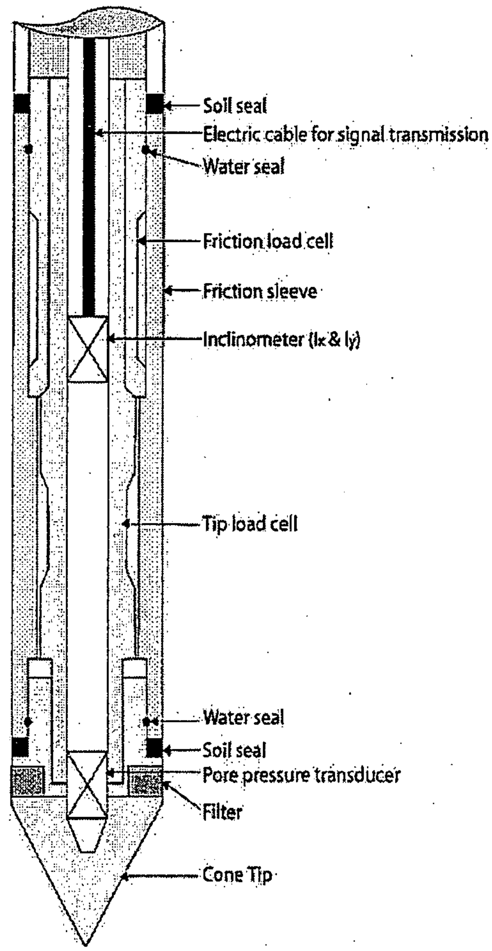


Figure CPT

When the soundings are complete, the test holes are grouted using a Gregg In Situ support rig. The grouting procedures generally consist of pushing a hollow CPT rod with a "knock out" plug to the termination depth of the test hole. Grout is then pumped under pressure as the tremie pipe is pulled from the hole. Disruption or further contamination to the site is therefore minimized.

Cone Penetration Test Data & Interpretation

Soil behavior type and stratigraphic interpretation is based on relationships between cone bearing (q_c), sleeve friction (f_s), and pore water pressure (u_2). The friction ratio (R_f) is a calculated parameter defined by $100 f_s / q_c$ and is used to infer soil behavior type. Generally:

Cohesive soils (clays)

- High friction ratio (R_f) due to small cone bearing (q_c)
- Generate large excess pore water pressures (u_2)

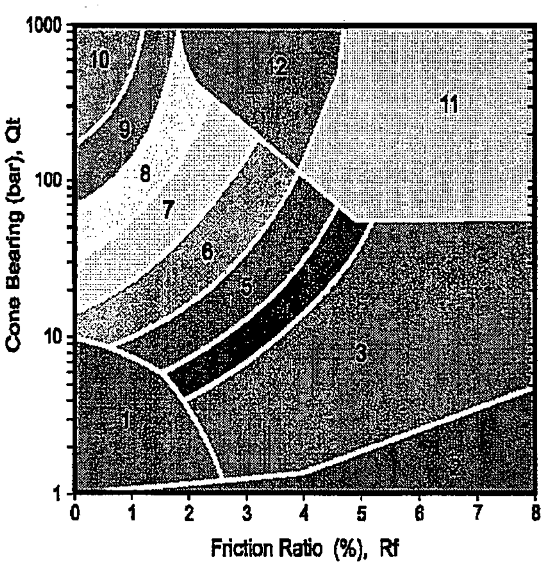
Cohesionless soils (sands)

- Low friction ratio (R_f) due to large cone bearing (q_c)
- Generate very little excess pore water pressures (u_2)

A complete set of baseline readings are taken prior to and at the completion of each sounding to determine temperature shifts and any zero load offsets. Corrections for temperature shifts and zero load offsets can be extremely important, especially when the recorded loads are relatively small. In sandy soils, however, these corrections are generally negligible.

The cone penetration test data collected from your site is presented in graphical form in Appendix CPT. The data includes CPT logs of measured soil parameters, computer calculations of interpreted soil behavior types (SBT), and additional geotechnical parameters. A summary of locations and depths is available in Table 1. Note that all penetration depths referenced in the data are with respect to the existing ground surface.

Soil interpretation for this project was conducted using recent correlations developed by Robertson, 1990, *Figure SBT*. Note that it is not always possible to clearly identify a soil type based solely on q_c, f_s, and u_2. In these situations, experience, judgment, and an assessment of the pore pressure dissipation data should be used to infer the soil behavior type.



ZONE	Qt/N	SBT
1	2	Sensitive, fine grained
2	1	Organic materials
3	1	Clay
4	1.5	Silty clay to clay
5	2	Clayey silt to silty clay
6	2.5	Sandy silt to clayey silt
7	3	Silty sand to sandy silt
8	4	Sand to silty sand
9	5	Sand
10	6	Gravely sand to sand
11	1	Very stiff fine grained*
12	2	Sand to clayey sand*

*over consolidated or cemented

Figure SBT

Gregg In Situ Interpretations as of June 30, 2004 (Release 1.22A)

Gregg In Situ's interpretation routine provides a tabular output of geotechnical parameters based on current published CPT correlations and is subject to change to reflect the current state of practice. The interpreted values are not considered valid for all soil types. The interpretations are presented only as a guide for geotechnical use and should be carefully scrutinized for consideration in any geotechnical design. Reference to current literature is strongly recommended. Gregg In Situ does not warranty the correctness or the applicability of any of the geotechnical parameters interpreted by the program and does not assume liability for any use of the results in any design or review. Representative hand calculations should be made for any parameter that is critical for design purposes. The end user of the interpreted output should also be fully aware of the techniques and the limitations of any method used in this program. The purpose of this document is to inform the user as to which methods were used and what the appropriate papers and/or publications are for further reference.

The CPT interpretations are based on values of tip, sleeve friction and pore pressure averaged over a user specified interval (e.g. 0.20m). Note that q_t is the tip resistance corrected for pore pressure effects and q_c is the recorded tip resistance. Since all Gregg In Situ cones have equal end area friction sleeves, pore pressure corrections to sleeve friction, f_s, are not required.

The tip correction is: $q_t = q_c + (1-a) \bullet u_2$

where: q_t is the corrected tip resistance
q_c is the recorded tip resistance
u_2 is the recorded dynamic pore pressure behind the tip (u_2 position)
a is the Net Area Ratio for the cone (typically 0.85 for Gregg In Situ cones)

The total stress calculations are based on soil unit weights that have been assigned to the Soil Behavior Type zones, from a user defined unit weight profile or by using a single value throughout the profile. Effective vertical overburden stresses are calculated based on a hydrostatic distribution of equilibrium pore pressures below the water table or from a user defined equilibrium pore pressure profile (this can be obtained from CPT dissipation tests). For over water projects the effects of the column of water have been taken into account as has the appropriate unit weight of water. How this is done depends on where the instruments were zeroed (i.e. on deck or at mud line).

Details regarding the interpretation methods for all of the interpreted parameters are provided in Table 1. The appropriate references cited in Table 1 are listed in Table 2. Where methods are based on charts or techniques that are too complex to describe in this summary the user should refer to the cited material.

The estimated Soil Behavior Types (normalized and non-normalized) are based on the charts developed by Robertson and Campanella shown in Figures 1 and 2. The Bq classification charts are not reproduced in this document but can be reviewed in Lunne, Robertson and Powell (1997) or Robertson (1990).

Where the results of a calculation/interpretation are declared *'invalid'* the value will be represented by the text strings "-9999" or "-9999.0". In some cases the value 0 will be used. Invalid results will occur because of (and not limited to) one or a combination of:

1. Invalid or undefined CPT data (e.g. drilled out section or data gap).

2. Where the interpretation method is inappropriate, for example, drained parameters in an undrained material (and vice versa). The user must evaluate the site specific soil conditions and characteristics to properly apply the appropriate interpretation method.

3. Where interpretation input values are beyond the range of the referenced charts or specified limitations of the interpretation method.

4. Where pre-requisite or intermediate interpretation calculations are invalid.

The parameters selected for output from the program are often specific to a particular project. As such, not all of the interpreted parameters listed in Table 1 may be included in the output files delivered with this report.

The output files are in one format:

File Type	Typical Extensions	Description
Spreadsheet	XLS	IFI, NLI files exported directly to Excel format. Column and cell formatting has been done. Header information is exported to start in Column C allowing the depth columns A and/or B to be duplicated on each printed page without repetition of part of the header information.

Table 1
CPT Interpretation Methods

Interpreted Parameter	Description	Equation	Ref
Depth	Mid Layer Depth *(where interpretations are done at each point then Mid Layer Depth = Recorded Depth)*	*Depth (Layer Top) + Depth (Layer Bottom) / 2.0*	
Elevation	Elevation of Mid Layer based on sounding collar elevation supplied by client	Elevation = Collar Elevation – Depth	
Avgqc	Averaged recorded tip value (q_c)	$Avgqc = \frac{1}{n}\sum_{i=1}^{n} q_c$ *n=1 when interpretations are done at each point*	
Avgqt	Averaged corrected tip (q_t) where: $q_t = q_c + (1-a) \bullet u$	$Avgqt = \frac{1}{n}\sum_{i=1}^{n} q_t$ *n=1 when interpretations are done at each point*	
Avgfs	Averaged sleeve friction (f_s)	$Avgfs = \frac{1}{n}\sum_{i=1}^{n} fs$ *n=1 when interpretations are done at each point*	
AvgRf	Averaged friction ratio (Rf) where friction ratio is defined as: $Rf = 100\% \bullet \frac{fs}{qt}$	$AvgRf = 100\% \bullet \frac{Avgfs}{Avgqt}$ *n=1 when interpretations are done at each point*	
Avgu	Averaged dynamic pore pressure *(u)*	$Avgu = \frac{1}{n}\sum_{i=1}^{n} u_i$ *n=1 when interpretations are done at each point*	
AvgRes	Averaged Resistivity (this data is not always available since it is a specialized test requiring an additional module)	$Avgu = \frac{1}{n}\sum_{i=1}^{n} RESISTIVITY_i$ *n=1 when interpretations are done at each point*	
AvgUVIF	Averaged UVIF ultra-violet induced fluorescence (this data is not always available since it is a specialized test requiring an additional module)	$Avgu = \frac{1}{n}\sum_{i=1}^{n} UVIF_i$ *n=1 when interpretations are done at each point*	
AvgTemp	Averaged Temperature (this data is not always available since it is a specialized test)	$Avgu = \frac{1}{n}\sum_{i=1}^{n} TEMPERATUE_i$ *n=1 when interpretations are done at each point*	

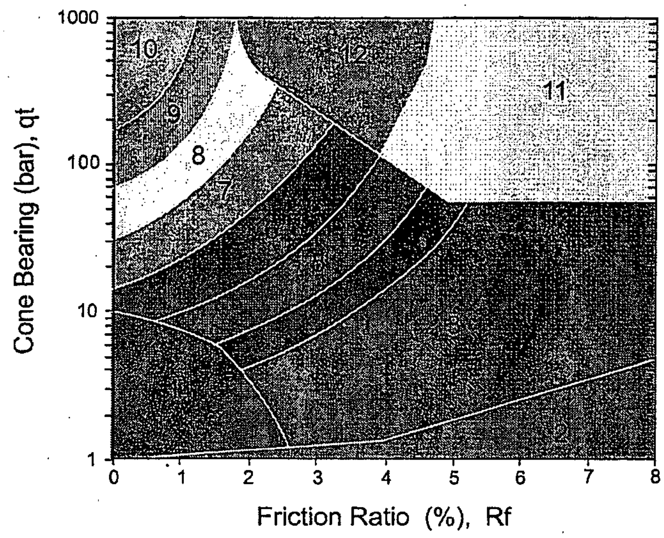
Interpreted Parameter	Description	Equation	Ref
AvgGamma	Averaged Gamma Counts (this data is not always available since it is a specialized test requiring an additional module)	$Avgu = \frac{1}{n}\sum_{i=1}^{n} GAMMA$ *n=1 when interpretations are done at each point*	
SBT	Soil Behavior Type as defined by Robertson and Campanella	See Figure 1	2, 5
SBTn	Normalized Soil Behavior Type as defined by Robertson and Campanella	See Figure 2	2, 5
SBT-BQ	Non-normalized soil behavior type based on the Bq parameter	See Figure 5.7 (reference 5)	2, 5
SBT-BQn	Normalized Soil Behavior base on the Bq parameter	See Figure 5.8 (reference 5) or Figure 3 (reference 2)	2, 5
k	Coefficient of permeability (assigned to each SBT zone)		5
U.Wt.	Unit Weight of soil determined from one of the following user selectable options: 1) uniform value 2) value assigned to each SBT zone 3) user supplied unit weight profile	See references	5
T. Stress σ_v	Total vertical overburden stress at Mid Layer Depth. *A layer is defined as the averaging interval specified by the user. For data interpreted at each point the Mid Layer Depth is the same as the recorded depth.*	$TStress = \sum_{i=1}^{n} \gamma_i h_i$ *where* γ_i is layer unit weight h_i is layer thickness	
Ueq	Equilibrium pore pressure determined from one of the following user selectable options: 1) hydrostatic from water table depth 2) user supplied profile	For hydrostatic option: $u_{eq} = \gamma_w \bullet (D - D_{wt})$ where u_{eq} is equilibrium pore pressure γ_w is unit weight of water D is the current depth D_{wt} is the depth to the water table	
E. Stress σ_v'	Effective vertical overburden stress at Mid Layer Depth	*Estress = Tstress -* u_{eq}	
Cn	SPT N_{60} overburden correction factor	$Cn=(\sigma_v')^{-0.5}$ where σ_v' *is in tsf* $0.5 < C_n < 2.0$	
N_{60}	SPT N value at 60% energy calculated from qt/N ratios assigned to each SBT zone. This method has abrupt N value changes at zone boundaries.	*See Figure 1*	4, 5
$(N_1)_{60}$	SPT N_{60} value corrected for overburden pressure	$(N_1)_{60} = Cn \bullet N_{60}$	4
$N_{60}I_c$	SPT N_{60} values based on the Ic parameter	$(qt/pa)/ N_{60} = 8.5 (1 - Ic/4.6)$	5
$(N_1)_{60}Ic$	SPT N_{60} value corrected for overburden pressure (using N_{60} I_c). User has 2 options.	1) $(N_1)_{60}Ic = Cn \bullet (N_{60}Ic)$ 2) $q_{c1n}/ (N_1)_{60}Ic = 8.5 (1 - Ic/4.6)$	4 5
$(N_1)_{60cs}Ic$	Clean sand equivalent SPT $(N_1)_{60}Ic$. User has 3 options.	1) $(N_1)_{60cs}Ic = a + ß((N_1)_{60}Ic)$ 2) $(N_1)_{60cs}Ic = K_{SPT} * ((N_1)_{60}Ic)$ 3) $q_{c1ncs})/ (N_1)_{60cs}Ic = 8.5 (1 - Ic/4.6)$ FC = 5%: a = 0, ß=1.0 FC = 35% a = 5.0, ß=1.2 5% < FC < 35% a = exp[1.76 – (190/FC^2)] ß = [0.99 + (FC$^{1.5}$/1000)]	10 10 5

Interpreted Parameter	Description	Equation	Ref
Q_t	Normalized q_t for Soil Behavior Type classification as defined by Robertson, 1990	$Qt = \frac{qt - \sigma_v}{\sigma'_v}$	2, 5
F_r	Normalized Friction Ratio for Soil Behavior Type classification as defined by Robertson, 1990	$Fr = 100\% \bullet \frac{fs}{qt - \sigma_v}$	2, 5
Bq	Pore pressure parameter	$Bq = \frac{\Delta u}{qt - \sigma_v}$ *where:* $\Delta u = u - u_{eq}$ *and* u = *dynamic pore pressure* u_{eq} = *equilibrium pore pressure*	1, 5
I_c	Soil index for estimating grain characteristics	$Ic = [(3.47 - \log_{10} Q)^2 + (\log_{10} Fr + 1.22)^2]^{0.5}$ *Where:* $Q = \left(\frac{qt - \sigma_v}{P_{a2}}\right)\left(\frac{P_a}{\sigma'_v}\right)^n$ *And* *Fr is in percent* P_a = *atmospheric pressure* P_{a2} = *atmospheric pressure* *n varies from 0.5 to 1.0 and is selected in an iterative manner based on the resulting* I_c	3, 8
FC	Apparent fines content (%)	$FC = 1.75(Ic^{3.25}) - 3.7$ $FC = 100$ *for* $Ic > 3.5$ $FC = 0$ *for* $Ic < 1.26$ $FC = 5\%$ *if* $1.64 < Ic < 2.36$ *AND* $F_r < 0.5$	3
Ic Zone	This parameter is the Soil Behavior Type zone based on the Ic parameter (valid for zones 2 through 7 on SBTn chart)	$Ic < 1.31$ Zone = 7 $1.31 < Ic < 2.05$ Zone = 6 $2.05 < Ic < 2.60$ Zone = 5 $2.60 < Ic < 2.95$ Zone = 4 $2.95 < Ic < 3.60$ Zone = 3 $Ic > 3.60$ Zone = 2	3
Dr	Relative Density determined from one of the following user selectable options: a) Ticino Sand b) Hokksund Sand c) Schmertmann 1976 d) Jamiolkowski - All Sands	See reference	5
PHI ϕ	Friction Angle determined from one of the following user selectable options: a) Campanella and Robertson b) Durgunoglu and Mitchel c) Janbu	See reference	5
State Parameter	The state parameter is used to describe whether a soil is contractive (SP is positive) or dilative (SP is negative) at large strains based on the work by Been and Jefferies	See reference	8, 6, 5
Es/qt	Intermediate parameter for calculating Youngs Modulus, E, in sands. It is the Y axis of the reference chart.	Based on Figure 5.59 in the reference	5

Interpreted Parameter	Description	Equation	Ref
Youngs Modulus E	Youngs Modulus based on the work by Baldi. There are three types of sands considered in this technique. The user selects the appropriate type for the site from: a) OC Sands b) Aged NC Sands c) Recent NC Sands Each sand type has a family of curves that depend on mean normal stress. The program calculates mean normal stress and linearly interpolates between the two extremes provided in Baldi's chart.	Mean normal stress is evaluated from: $\sigma'_m = \frac{1}{3} \bullet (\sigma'_v + \sigma'_h + \sigma'_h)$ where σ_v'= vertical effective stress σ_h'= horizontal effective stress and $\sigma_h = K_o * \sigma_v'$ with Ko assumed to be 0.5	5
Su	Undrained shear strength - N_{kt} is user selectable	$Su = \frac{qt - \sigma_v}{N_{kt}}$	1, 5
OCR	Over Consolidation Ratio	a) Based on Schmertmann's method involving a plot of S_u/σ_v' /(S_u/σ_v')$_{NC}$ and OCR where the Su/p' ratio for NC clay is user selectable	9

The following parameters are not presented but may be interpreted for use in liquefaction analysis. Further detailed interpretation may be completed by using the Liquefaction Spreadsheet following the committee recommendations of the NCEER. This Spreadsheet is available for purchase. A promotional document is presented in the Interpretations directory on the Data Disk with this report.

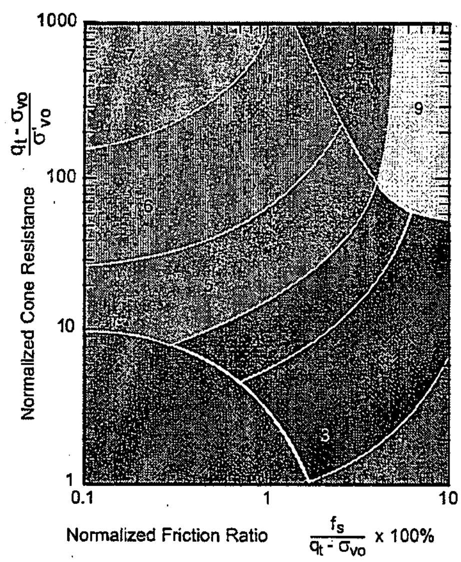
Interpreted Parameter	Description	Equation	Ref
q_{c1}	q_t normalized for overburden stress used for seismic analysis	$q_{c1} = q_t \bullet (Pa/\sigma_v')^{0.5}$ where: Pa = atm. Pressure; q_t is in Mpa	3
q_{c1n}	q_{c1} in dimensionless form used for seismic analysis	$q_{c1n} = (q_{c1} / Pa)(Pa/\sigma_v')$ where: Pa = atm. Pressure and n ranges from 0.5 to 0.75 based on Ic.	3
K_{SPT}	Equivalent clean sand factor for $(N_1)60$	$K_{SPT} = 1 + ((0.75/30) * (FC - 5))$	10
K_{CPT}	Equivalent clean sand correction for q_{c1N}	$K_{cpt} = 1.0$ for $I_c \leq 1.64$; $K_{cpt} = f(I_c)$ for $I_c > 1.64$ (see reference)	10
q_{c1ncs}	Clean sand equivalent q_{c1n}	$q_{c1ncs} = q_{c1n} \bullet K_{cpt}$	3
CRR	Cyclic Resistance Ratio (for Magnitude 7.5)	$q_{c1ncs} < 50$: $CRR_{7.5} = 0.833 [(q_{c1ncs}/1000] + 0.05$ $50 \leq q_{c1ncs} < 160$: $CRR_{7.5} = 93 [(q_{c1ncs}/1000]^3 + 0.08$	10
CSR	Cyclic Stress Ratio	$CSR = (\tau_{av}/\sigma_v') = 0.65 (a_{max} / g) (\sigma_v / \sigma_v') r_d$ $r_d = 1.0 - 0.00765 z$ $z \leq 9.15m$ $r_d = 1.174 - 0.0267 z$ $9.15 < z \leq 23m$ $r_d = 0.744 - 0.008 z$ $23 < z \leq 30m$ $r_d = 0.50$ $z > 30m$	10
MSF	Magnitude Scaling Factor	See Reference	10
FofS	Factor of Safety against Liquefaction	$FS = (CRR_{7.5} / CSR)\ MSF$	10
Liquefaction Status	Statement indicating possible liquefaction	Takes into account FofS and limitations based I_c and q_{c1ncs}.	10



Zone	qt/N	Soil Behavior Type
1	2	sensitive fine grained
2	1	organic material
3	1	clay
4	1.5	silty clay to clay
5	2	clayey silt to silty clay
6	2.5	sandy silt to clayey silt
7	3	silty sand to sandy silt
8	4	sand to silty sand
9	5	sand
10	6	gravelly sand to sand
11	1	very stiff fine grained *
12	2	sand to clayey sand *

* overconsolidated or cemented

Figure 1 Non-Normalized Behavior Type Classification Chart



Zone	Normalized Soil Behavior Type
1	sensitive fine grained
2	organic material
3	clay to silty clay
4	clayey silt to silty clay
5	silty sand to sandy silt
6	clean sands to silty sands
7	gravelly sand to sand
8	very stiff sand to clayey sand
9	very stiff fine grained

Figure 2 Normalized Behavior Type Classification Chart

Table 2 References

No.	References
1	Robertson, P.K., Campanella, R.G., Gillespie, D. and Greig, J., 1986, "Use of Piezometer Cone Data", Proceedings of InSitu 86, ASCE Specialty Conference, Blacksburg, Virginia.
2	Robertson, P.K., 1990, "Soil Classification Using the Cone Penetration Test", Canadian Geotechnical Journal, Volume 27.
3	Robertson, P.K. and Fear, C.E., 1998, "Evaluating cyclic liquefaction potential using the cone penetration test", Canadian Geotechnical Journal, 35: 442-459.
4	Robertson, P.K. and Wride, C.E., 1998, "Cyclic Liquefaction and its Evaluation Based on SPT and CPT", NCEER Workshop Paper, January 22, 1997
5	Lunne, T., Robertson, P.K. and Powell, J. J. M., 1997, " Cone Penetration Testing in Geotechnical Practice," Blackie Academic and Professional.
6	Plewes, H.D., Davies, M.P. and Jefferies, M.G., 1992, "CPT Based Screening Procedure for Evaluating Liquefaction Susceptibility", 45th Canadian Geotechnical Conference, Toronto, Ontario, October 1992.
7	Jefferies, M.G. and Davies, M.P., 1993. "Use of CPTu to Estimate equivalent N_{60}", Geotechnical Testing Journal, 16(4): 458-467.
8	Been, K. and Jefferies, M.P., 1985, "A state parameter for sands", Geotechnique, 35(2), 99-112.
9	Schmertmann, 1977, "Guidelines for Cone Penetration Test Performance and Design", Federal Highway Administration Report FHWA-TS-78-209, U.S. Department of Transportation
10	Proceedings of theNCEER Workshop on Evaluation of Liquefaction Resistance of Soils, Salt LakeCity, 1996. Chaired by Leslie Youd.

Pore Pressure Dissipation Tests (PPDT)

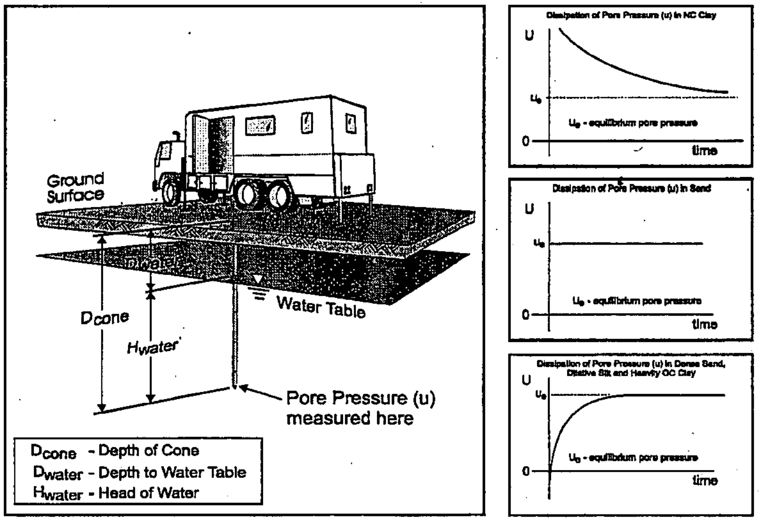
Pore Pressure Dissipation Tests (PPDT's) conducted at various intervals measured hydrostatic water pressures and determined the approximate depth of the ground water table. A PPDT is conducted when the cone is halted at specific intervals determined by the field representative. The variation of the penetration pore pressure (u) with time is measured behind the tip of the cone and recorded by a computer system.
Pore pressure dissipation data can be interpreted to provide estimates of:

- Equilibrium piezometric pressure
- Phreatic Surface
- In situ horizontal coefficient of consolidation (c_h)
- In situ horizontal coefficient of permeability (k_h)

In order to correctly interpret the equilibrium piezometric pressure and/or the phreatic surface, the pore pressure must be monitored until such time as there is no variation in pore pressure with time, *Figure PPDT.* This time is commonly referred to as t_{100}, the point at which 100% of the excess pore pressure has dissipated.

A complete reference on pore pressure dissipation tests is presented by Robertson et al. 1992.

A summary of the pore pressure dissipation tests is summarized in Table 1.



Water Table Calculation

$$D_{water} = D_{cone} - H_{water}$$

where $H_{water} = U_e$ (depth units)

Useful Conversion Factors: 1psi = 0.704m = 2.31 feet (water)
1tsf = 0.958 bar = 13.9 psi
1m = 3.28 feet

Figure PPDT

Seismic Cone Penetrometer Testing
(SCPTu)

Gregg In Situ, Inc. uses a modified CPT cone that contains a built in seismometer to measure compression and shear wave velocities in addition to the standard piezocone parameters (q_c, f_s, and u_2). Therefore, four independent readings are compiled with depth in a single sounding. The standard CPT parameters are recorded continuously while the seismic test is usually performed at 5-foot intervals.

Gregg generates shear waves by striking a seismic beam coupled to the ground surface by a hydraulic cylinder under the CPT rig, *Figure SCPTu.* Compression waves are generated by striking an auger in the ground. The sledgehammer that strikes the beam/auger acts as a trigger, initiating the recording of the seismic wave trace. Before measurements are taken, the rods are decoupled from the CPT rig to prevent energy transmission down the rods.

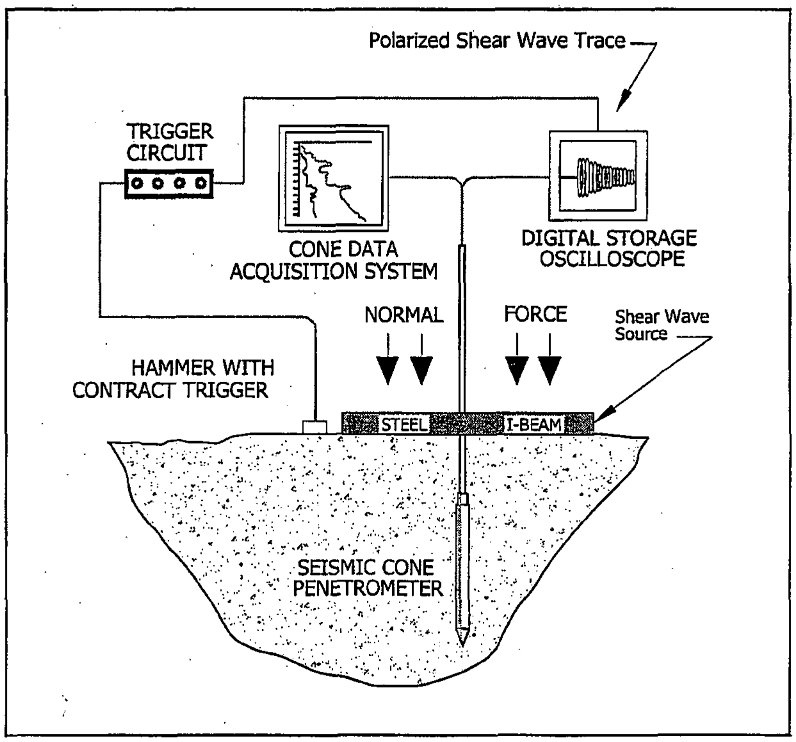


Figure SCPTu

Geophones in the body of the piezocone recognize the arriving waves generated at the ground surface, *Figure Seismic*. Any waves received by the geophones on the cone penetrometer are sent back up to the truck to be displayed on an oscilloscope. On site software then plots the wave amplitude versus time to calculate wave velocities.

At least two waves are recorded for each test depth so the operator can check consistency of the waveforms. Shear wave data is sampled at a frequency of 20 kHz (20,000 samples per second) and compression wave data is sampled at 50 kHz (50,000 samples per second). To maintain a desired signal resolution, the input sensitivity (gain) is increased with depth.

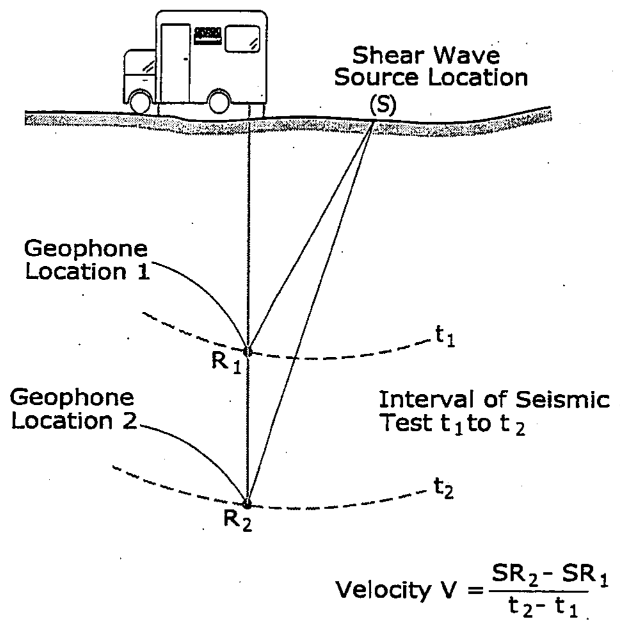


Figure Seismic

Offset distances of the beam from the cone and the location of the geophone are all taken into account in calculations.

The shear wave velocity (V_s) provides information about small-strain stiffness while the penetration data provides information about large-strain strength. From interval shear wave velocity (V_s) and the mass density (ρ) of a soil layer, the dynamic shear modulus (G_o) of the soil can be calculated in a specific depth interval. The dynamic shear modulus (G_0) is a key parameter for the analysis of soil behavior in response to dynamic loading from earthquakes, vibrating machine foundations, waves and wind.

A summary of the data collected including the depth and location identification is displayed in Table 1 and graphical formats and can be found with the corresponding CPT plot.

For a detailed reference on seismic CPT, refer to Robertson et. al., 1986.

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Lunne, T., Robertson, P.K. and Powell, J.J.M., "Cone Penetration Testing in Geotechnical Practice" E & FN Spon. ISBN 0 419 23750, 1997

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Mayne, P.W., "NHI (2002) Manual on Subsurface Investigations: Geotechnical Site Characterization", available through www.ce.gatech.edu/~geosys/Faculty/Mayne/papers/index.html, Section 5.3, pp. 107-112.

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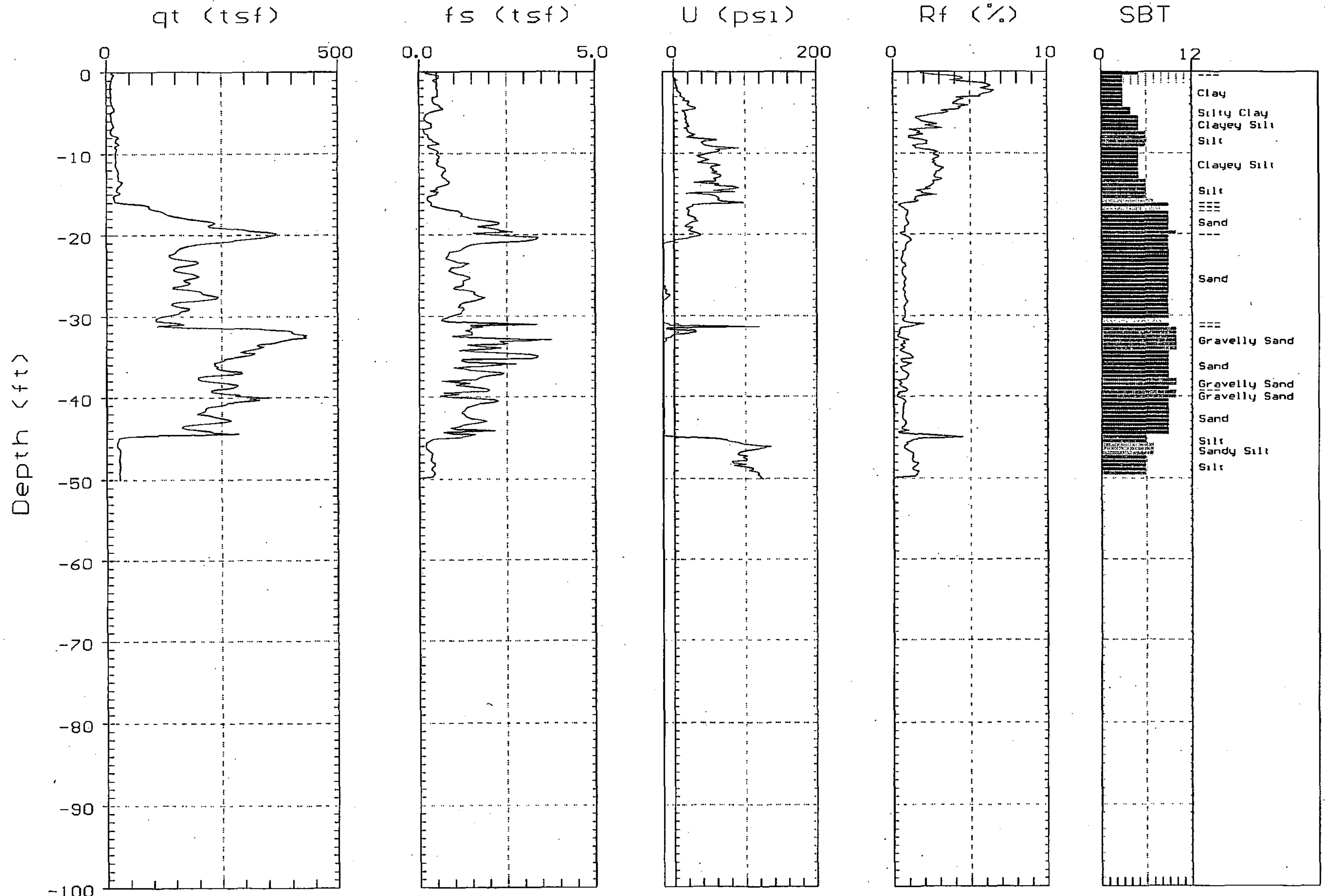
Zemo, D.A., T.A. Delfino, J.D. Gallinatti, V.A. Baker and L.R. Hilpert, "Field Comparison of Analytical Results from Discrete-Depth Groundwater Samplers" BAT EnviroProbe and QED HydroPunch, Sixth national Outdoor Action Conference, Las Vegas, Nevada Proceedings, 1992, pp 299-312.

Copies of ASTM Standards are available through www.astm.org

GREGG

MACTEC

Site:N=362772.55 E=2943448.74 Operator:R.AGUILLAR
Location:C-301ELEV=27.37 Date:12/01/06 13:25

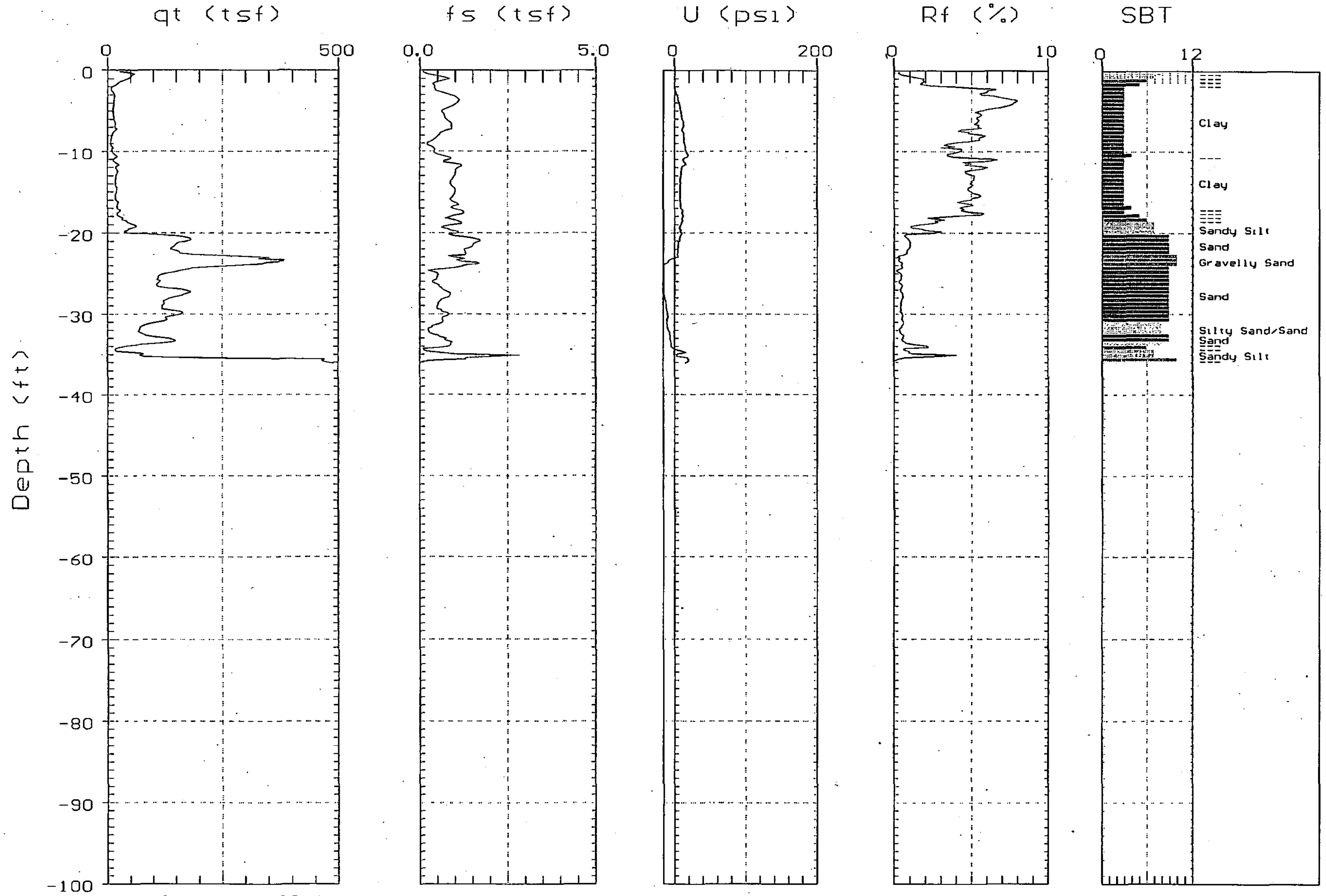


Max. Depth: 50.03 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)

GREGG MACTEC

Site: N=362824.38 E=2943502.25 Operator: R.AGUILLAR
Location: C-302ELEV=28.72 Date: 11/29/06 12:54

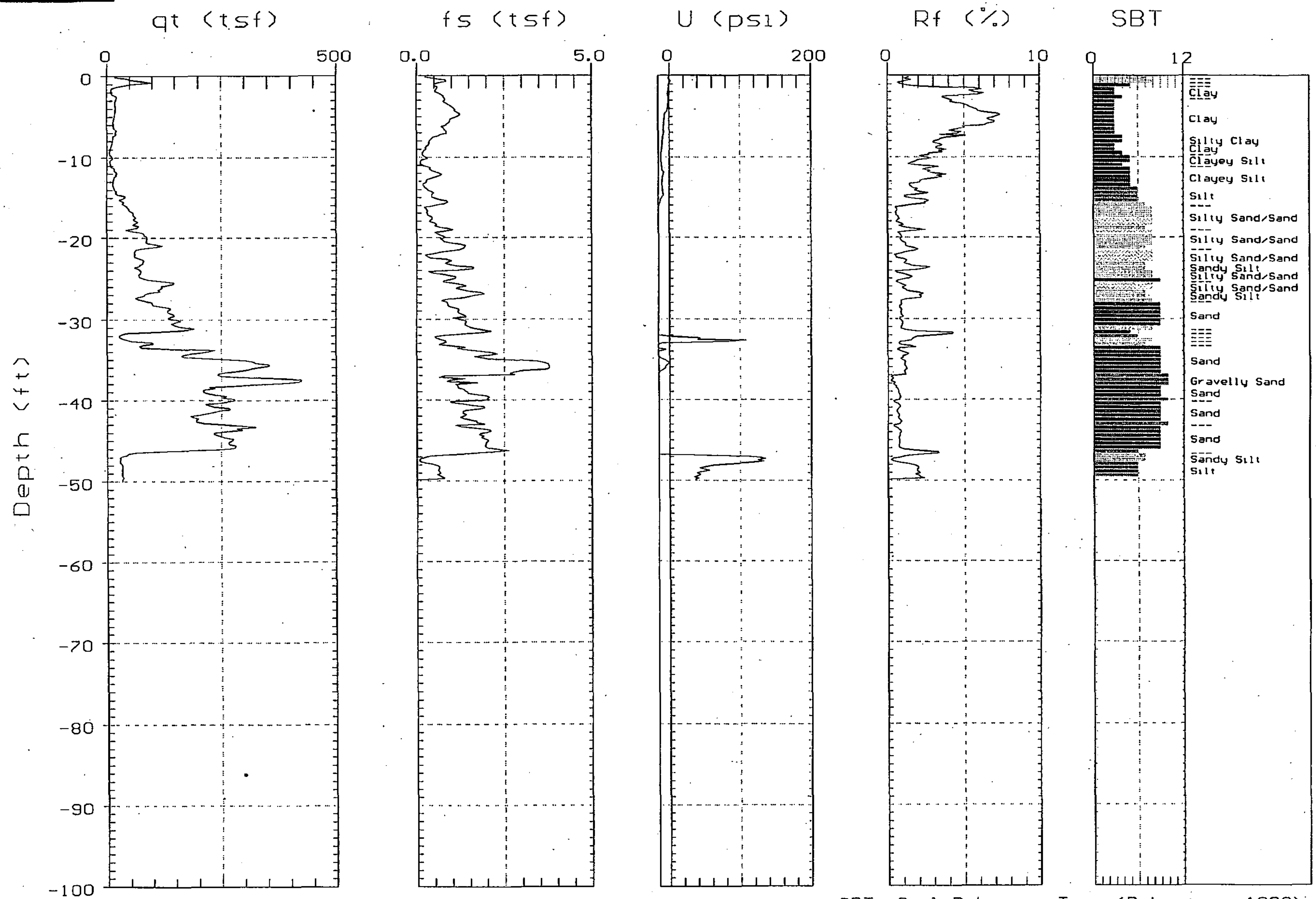


Max. Depth: 36.09 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)

MACTEC

Site: N=362823.77 E=2943190.19 Operator: R.AGUILLAR
Location: C-303ELEV=30.19 Date: 12/01/06 12:02

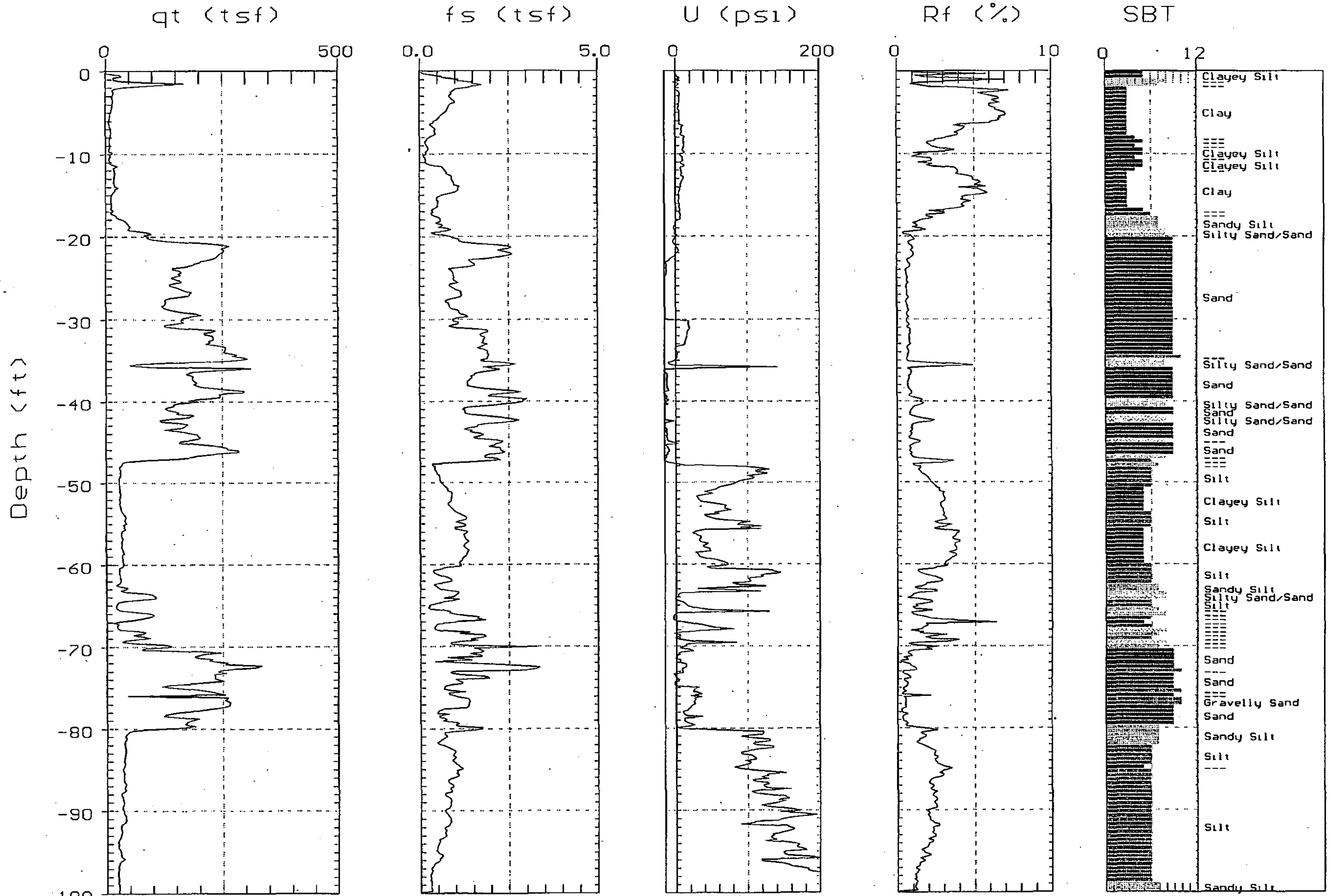


Max. Depth: 50.03 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)

MACTEC

Site: N=362910.77 E=2943394.73 Operator: R.AGUILLAR
Location: C-304ELEV=29.39 Date: 12/15/06 12:01



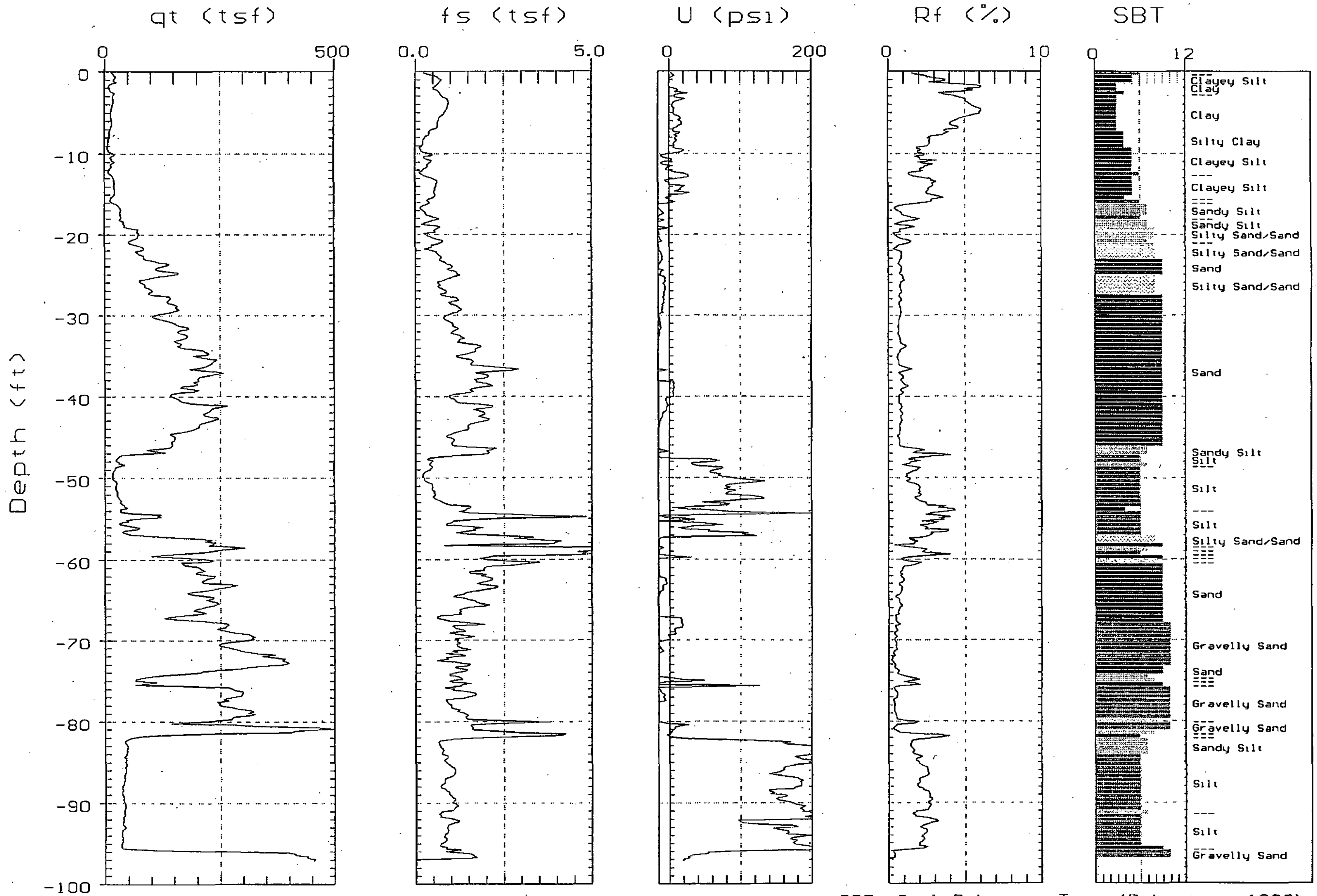
Max. Depth: 100.06 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)

GREGG

MACTEC

Site: N=363126.80 E=2943174.06 Operator: R.AGUILLAR
Location: C-305sELEV=30.88 Date: 12/16/06 06:14

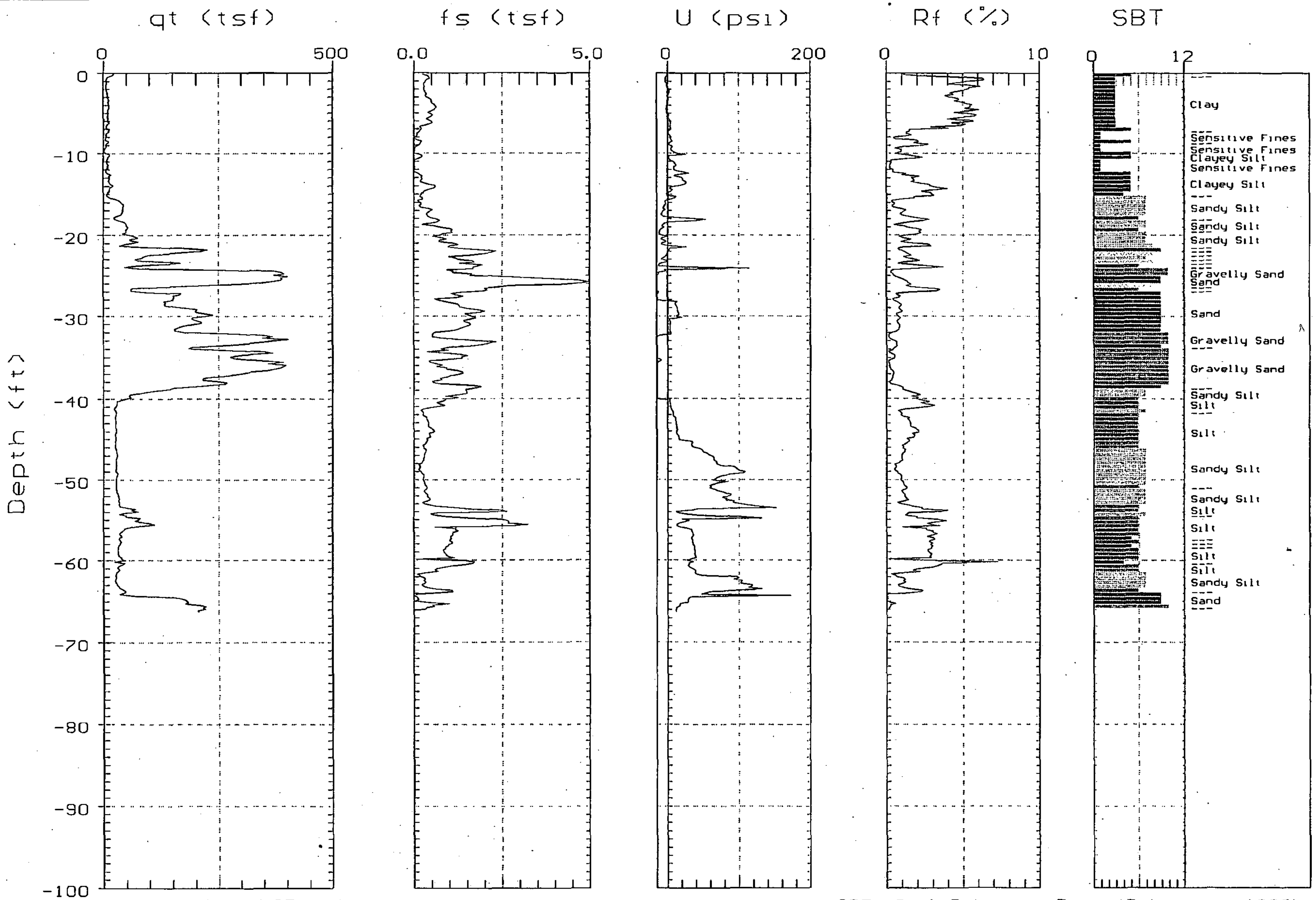


Max. Depth: 97.11 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)

MACTEC

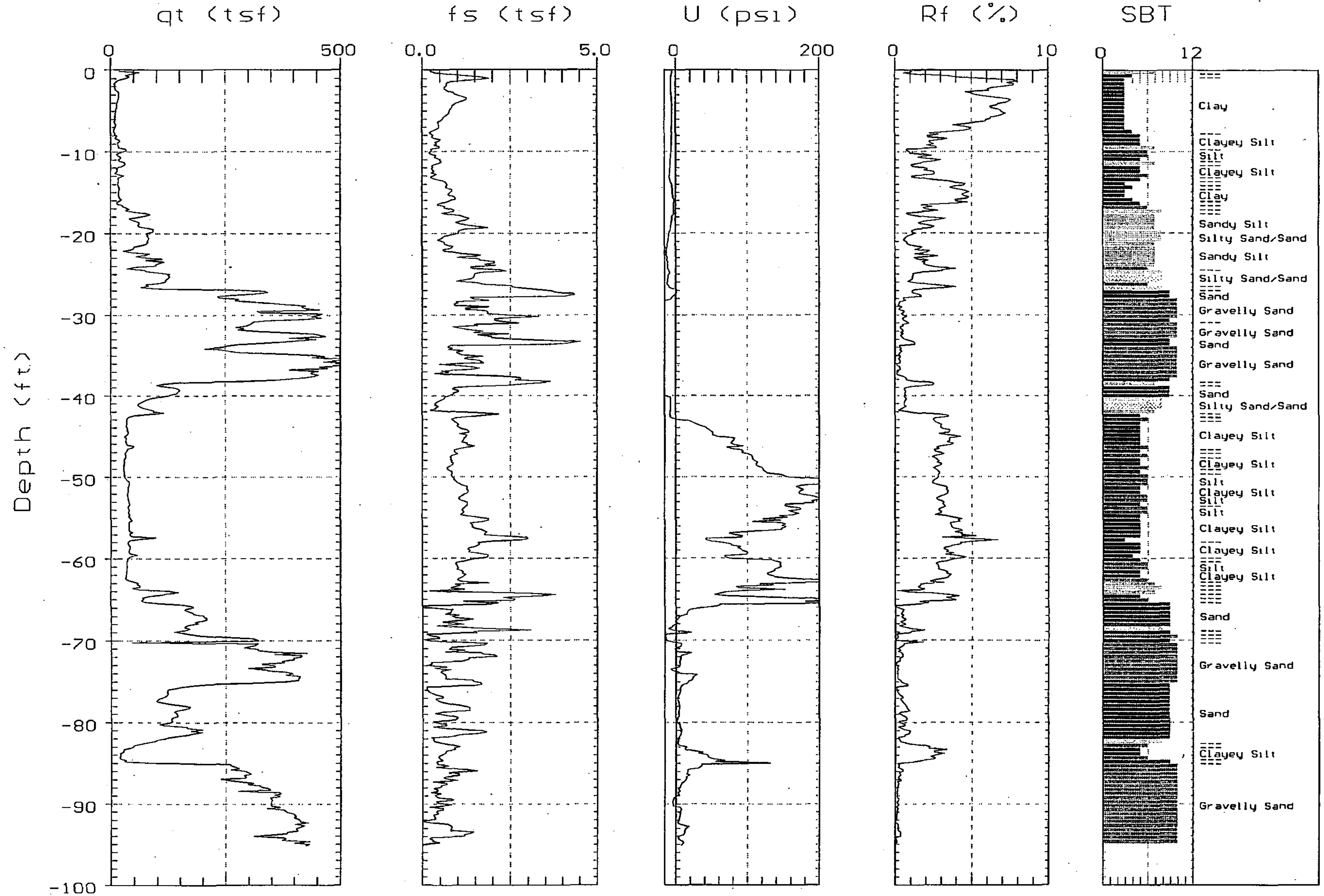
Site: N=363483.22 E=2943296.00 Operator: R.AGUILLAR
Location: C-306sELEV=29.68 Date: 11/30/06 06:37



Max. Depth: 66.27 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)

GREGG MACTEC Site:N=363573.00 E=2943407.68 Operator:R.AGUILLAR
Location:C-307sELEV=30.02 Date:12/14/06 07:52

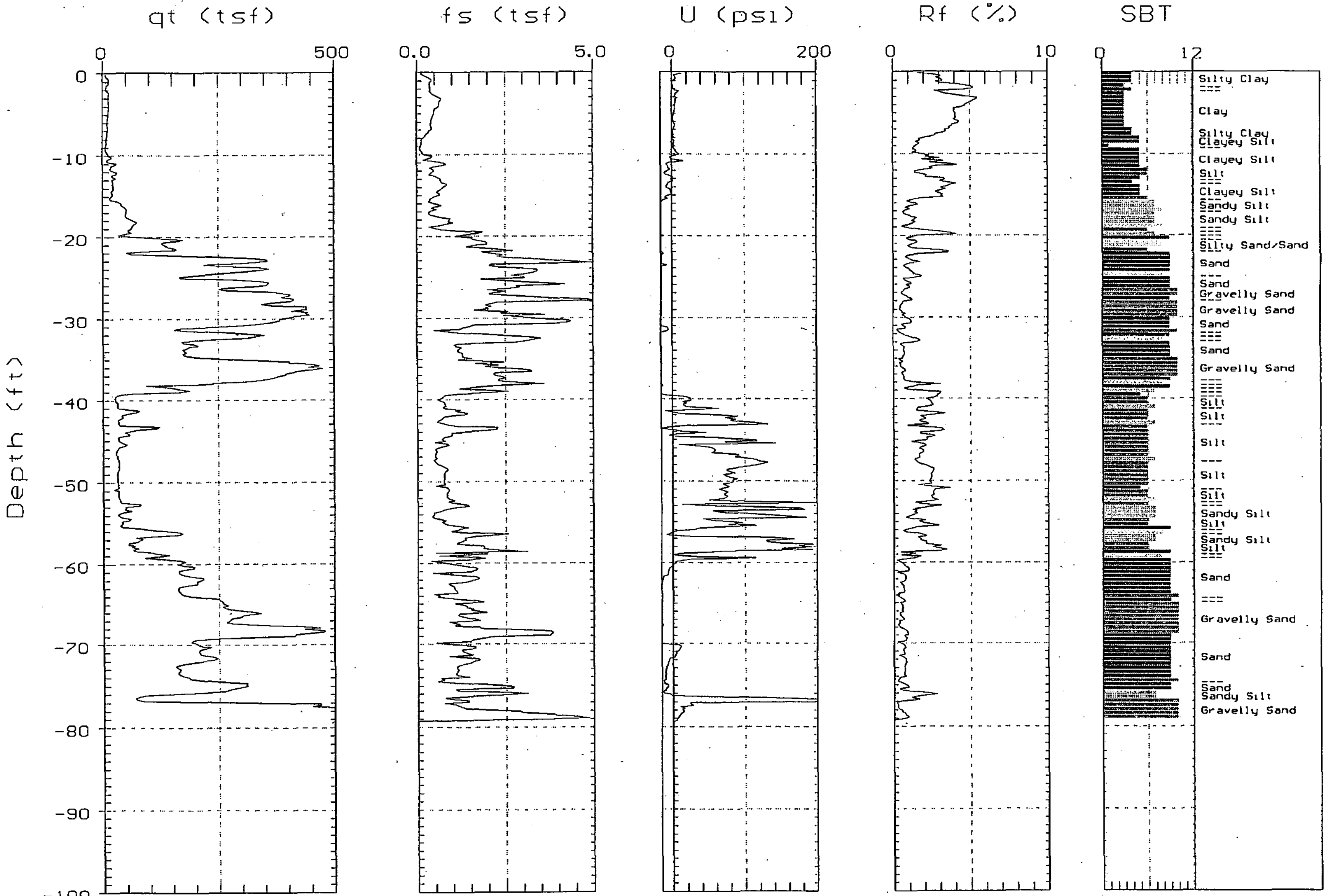


Max. Depth: 95.14 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)

MACTEC

Site: N=363711.62 E=2943481.16 Operator: R.AGUILLAR
Location: C-308ELEV=29.89 Date: 12/15/06 06:06



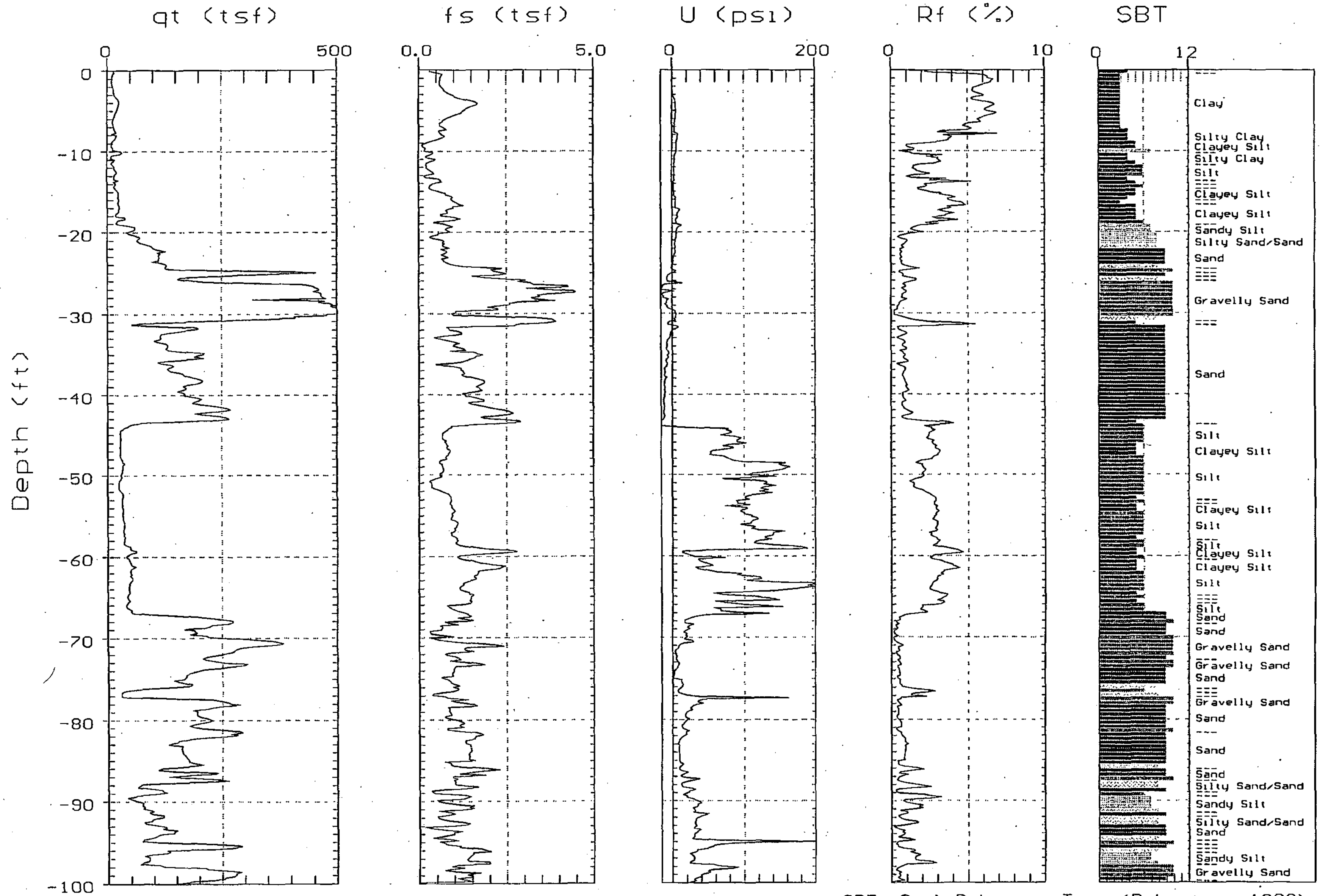
Max. Depth: 79.40 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)

GREGG

MACTEC

Site: N=363680.96 E=2943037.71 Operator: R.AGUILLAR
Location: C-309ELEV=30.69 Date: 12/14/06 12:47

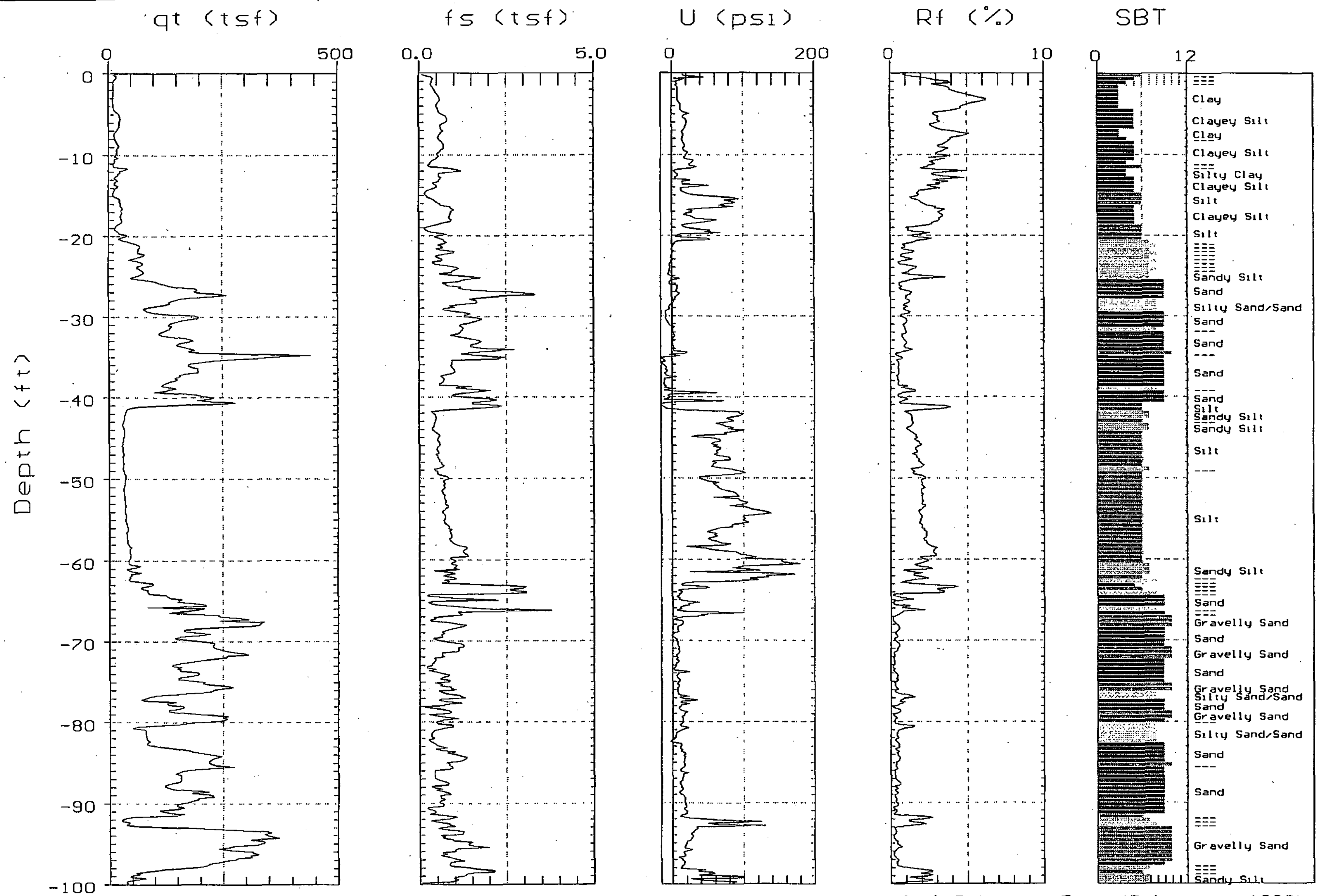


Max. Depth: 100.06 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)

MACTEC

Site: N=363792.39 E=2943037.94 Operator: R.AGUILLAR
Location: C-310ELEV=31.38 Date: 12/12/06 09:17



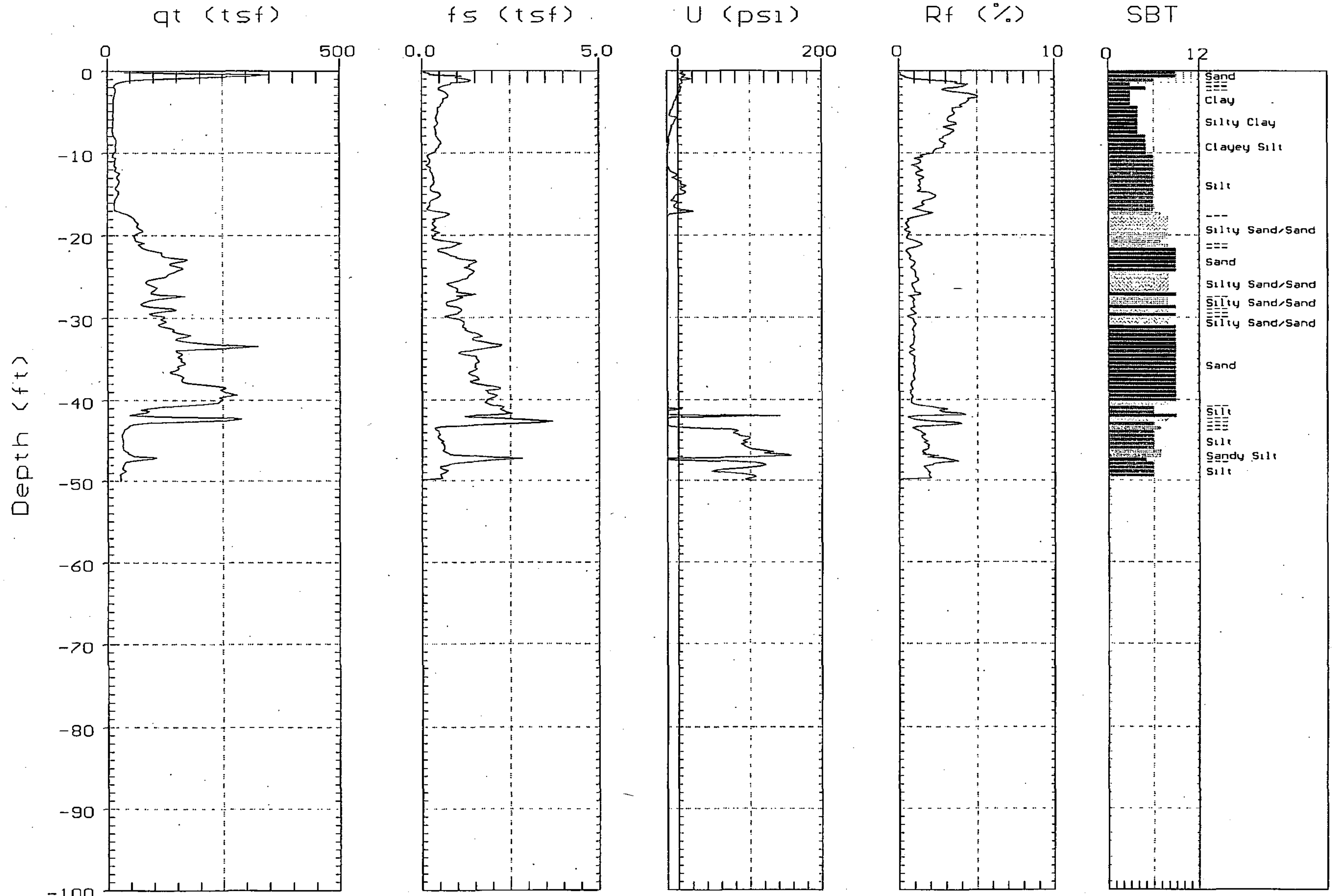
Max. Depth: 100.06 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)

GREGG

MACTEC

Site: N=362772.46 E=2942547.21 Operator: R.AGUILLAR
Location: C-401ELEV=31.08 Date: 12/01/06 08:27

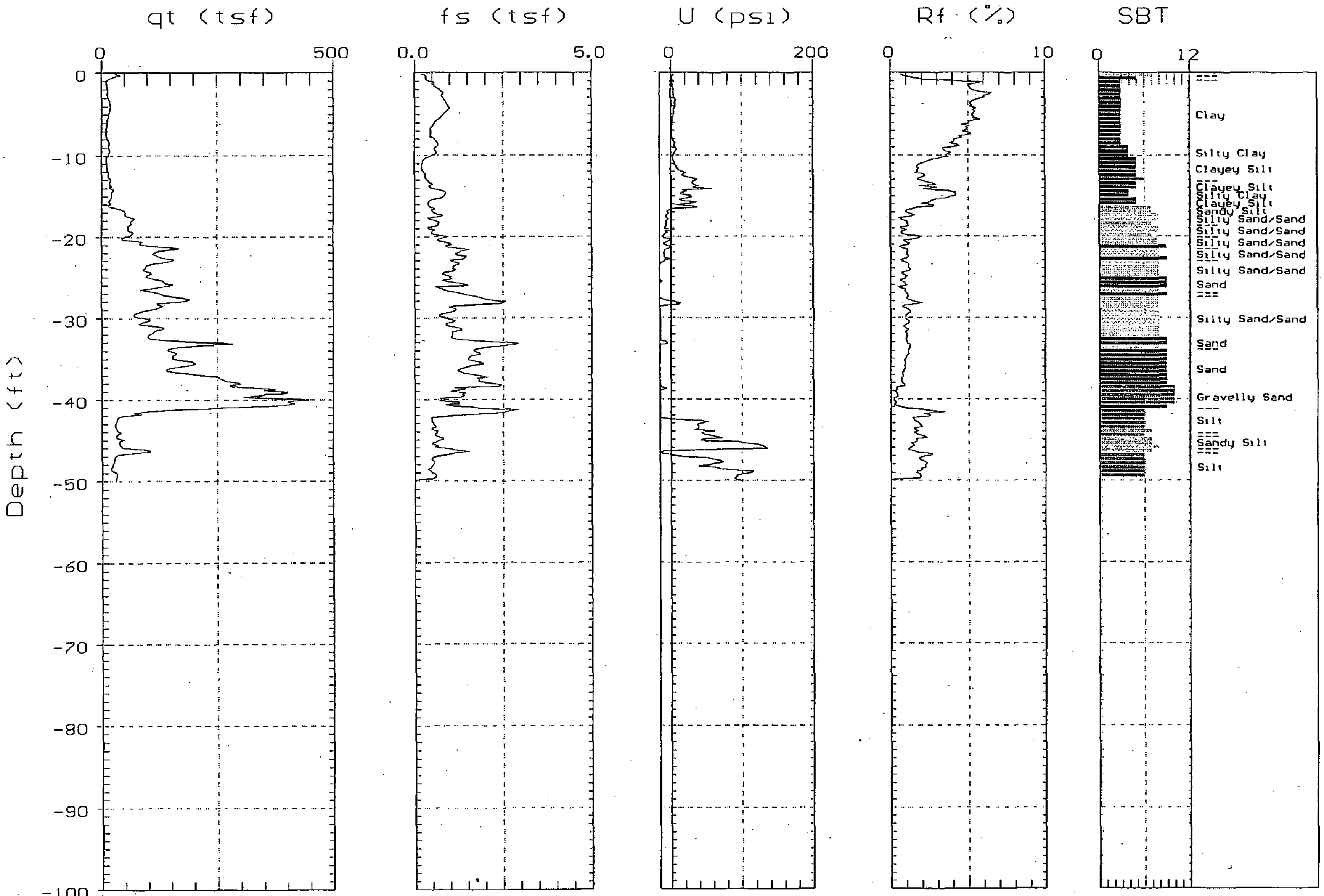


Max. Depth: 50.03 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)

GREGG MACTEC

Site: N=362824.68 E=2942600.77 Operator: R.AGUILLAR
Location: C-402ELEV=30.82 Date: 12/01/06 09:24

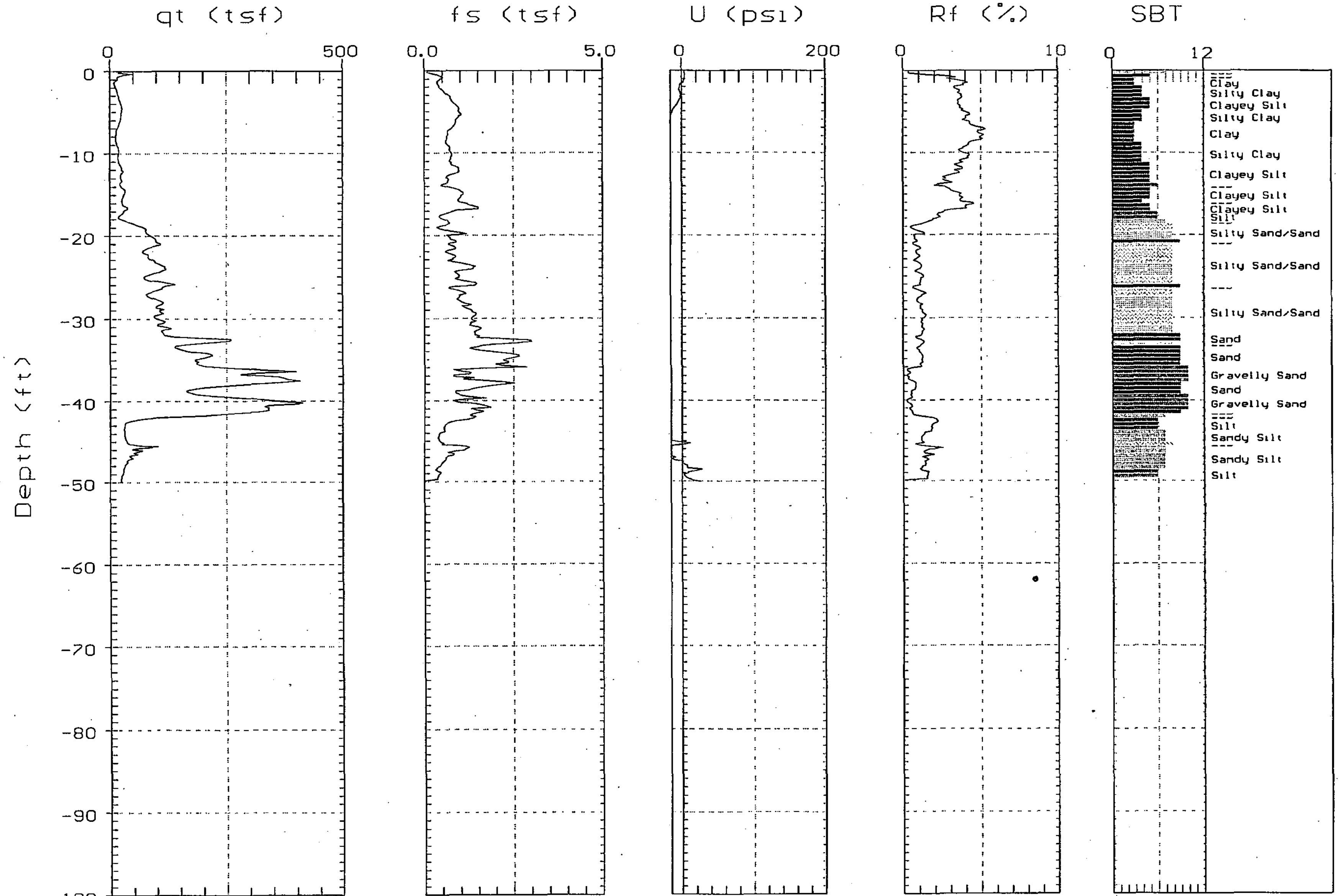


Max. Depth: 50.03 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)

GREGG MACTEC

Site: N=362825.36 E=2942289.73 Operator: R.AGUILLAR
Location: C-403ELEV=31.59 Date: 12/01/06 07:04



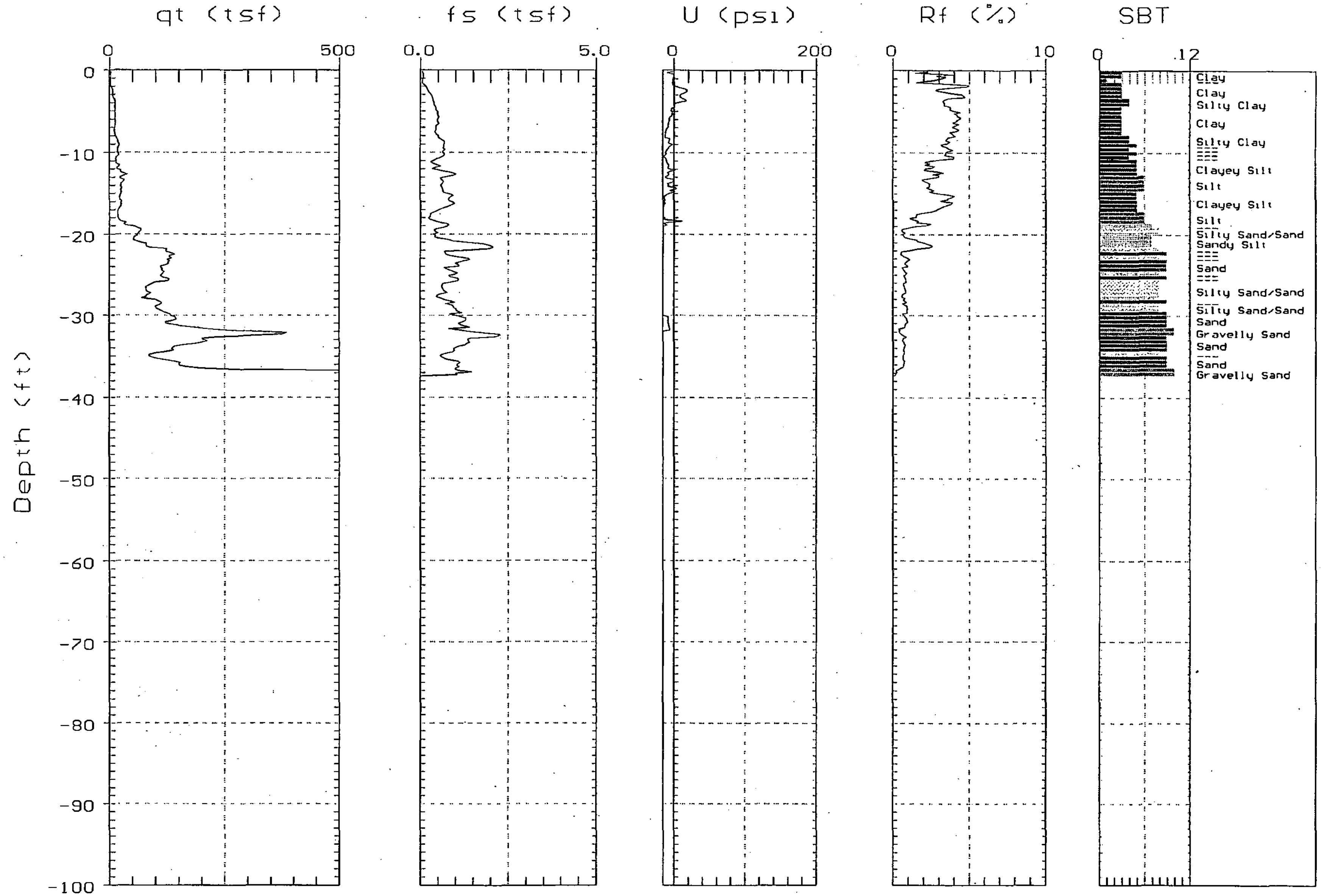
Max. Depth: 50.03 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)

GREGG

MACTEC

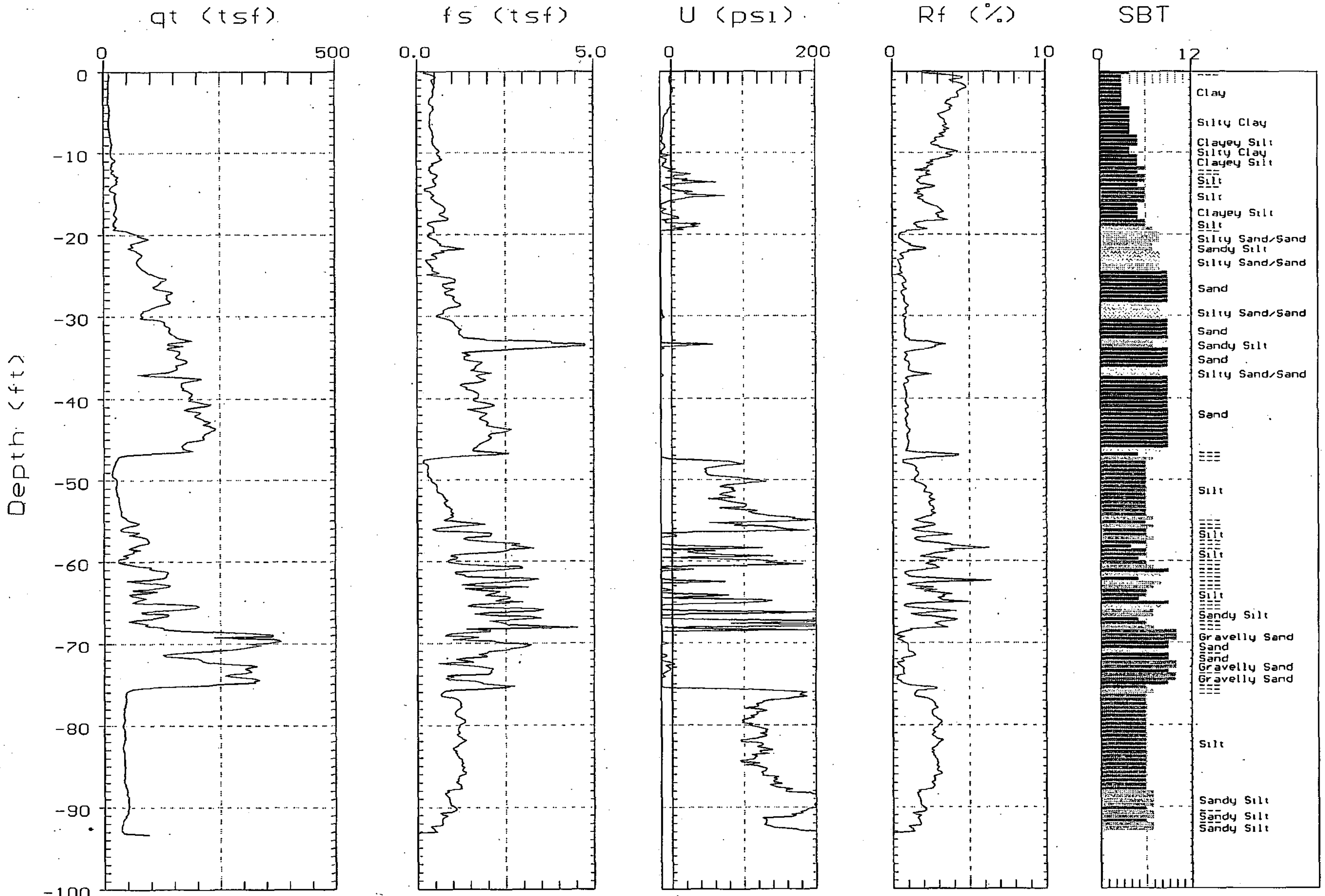
Site: N=362912.73 E=2942499.09 Operator: R.AGUILLAR
Location: C-404ELEV=31.38 Date: 12/19/06 06:32



Max. Depth: 37.57 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)

GREGG | MACTEC | Site: N=363481.68 E=2942400.33 | Operator: R.AGUILLAR
Location: C-406sELEV=31.05 | Date: 12/13/06 08:15



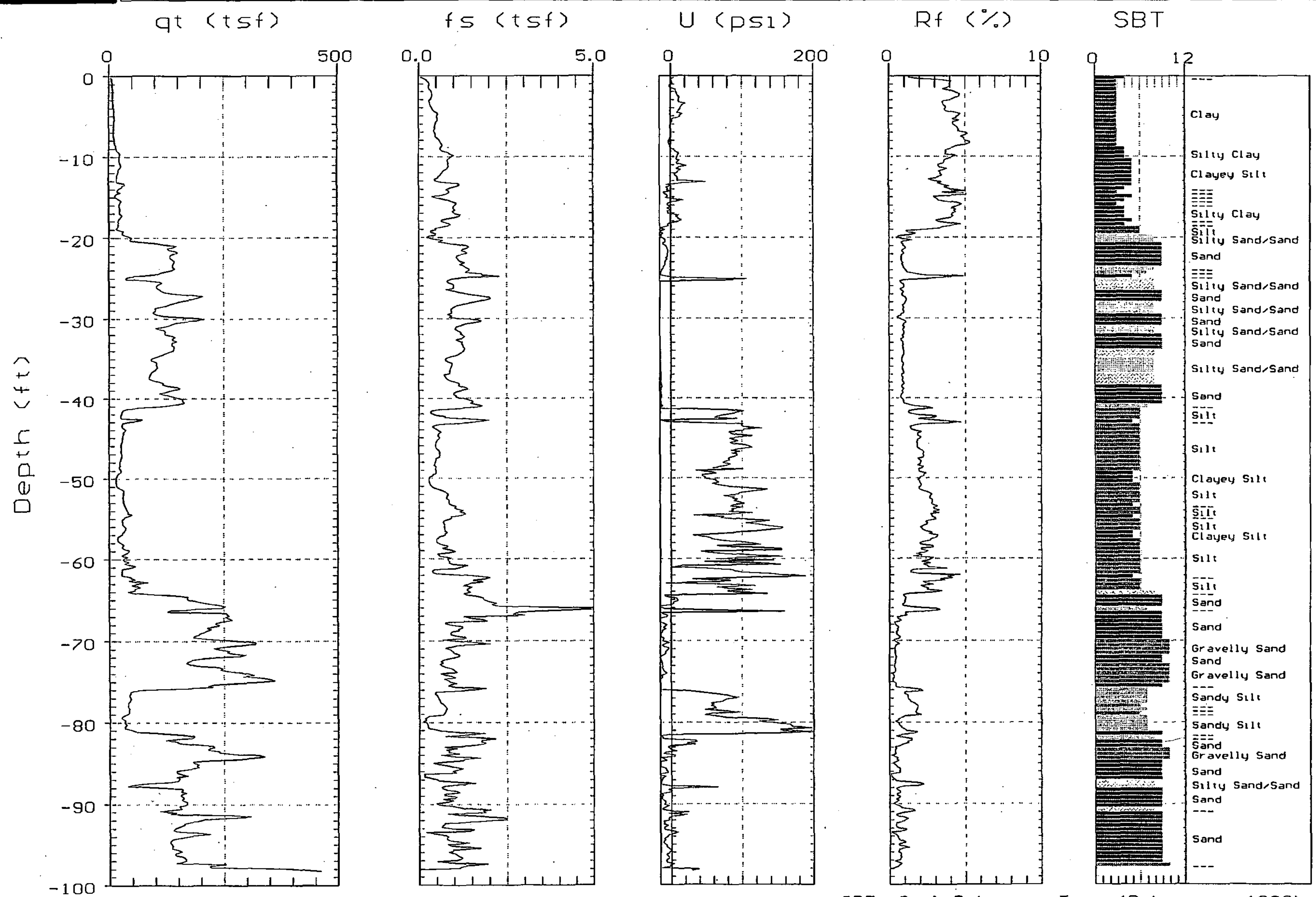
Max. Depth: 93.34 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)

GREGG

MACTEC

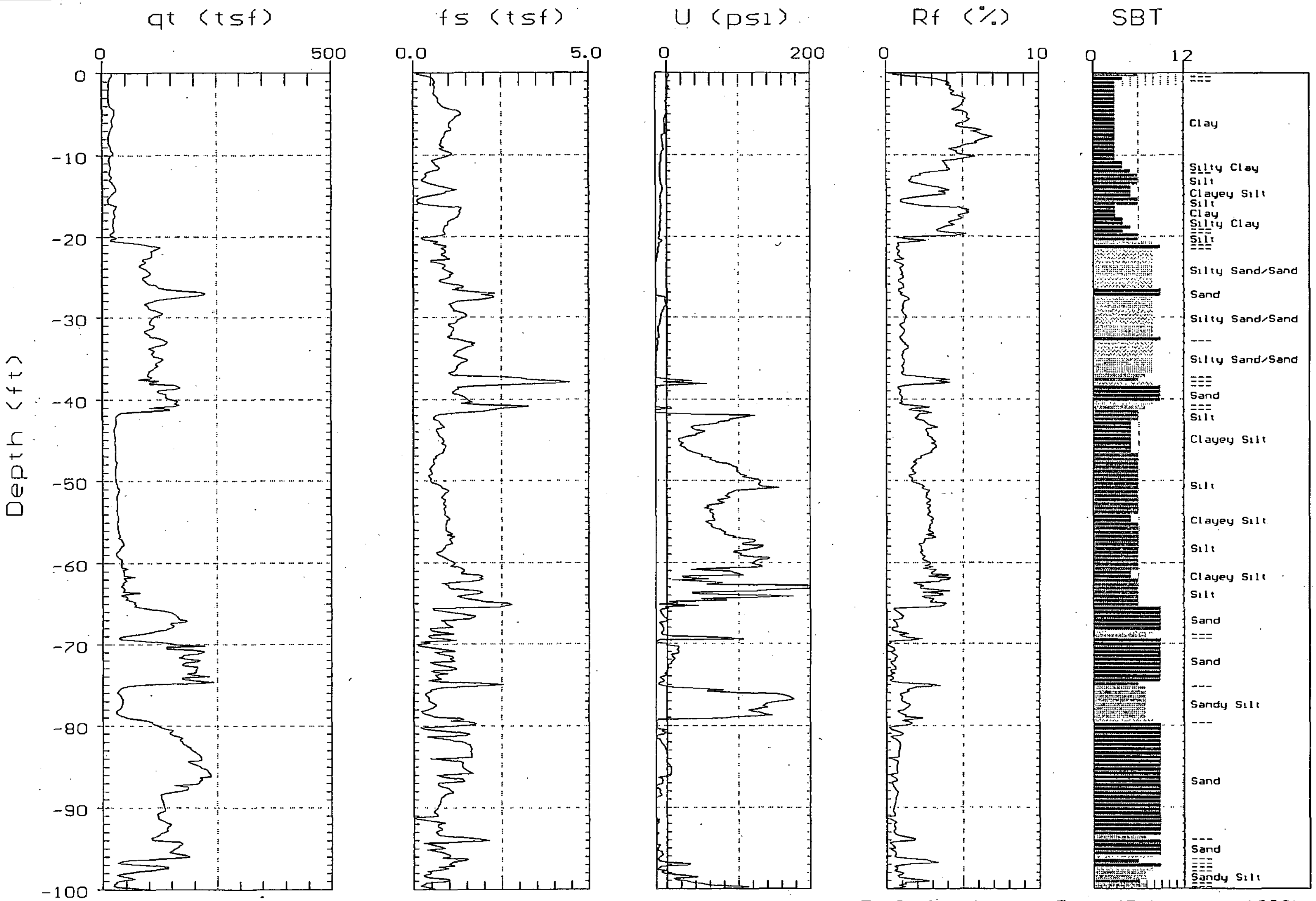
Site: N=363570.38 E=2942507.31 Operator: R.AGUILLAR
Location: C-407sELEV=30.79 Date: 12/12/06 06:11



Max. Depth: 98.26 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)

GREGG MACTEC	Site: N=363710.02 E=2942579.59 Location: C-408ELEV=31.70	Operator: R.AGUILLAR Date: 12/06/06 06:51



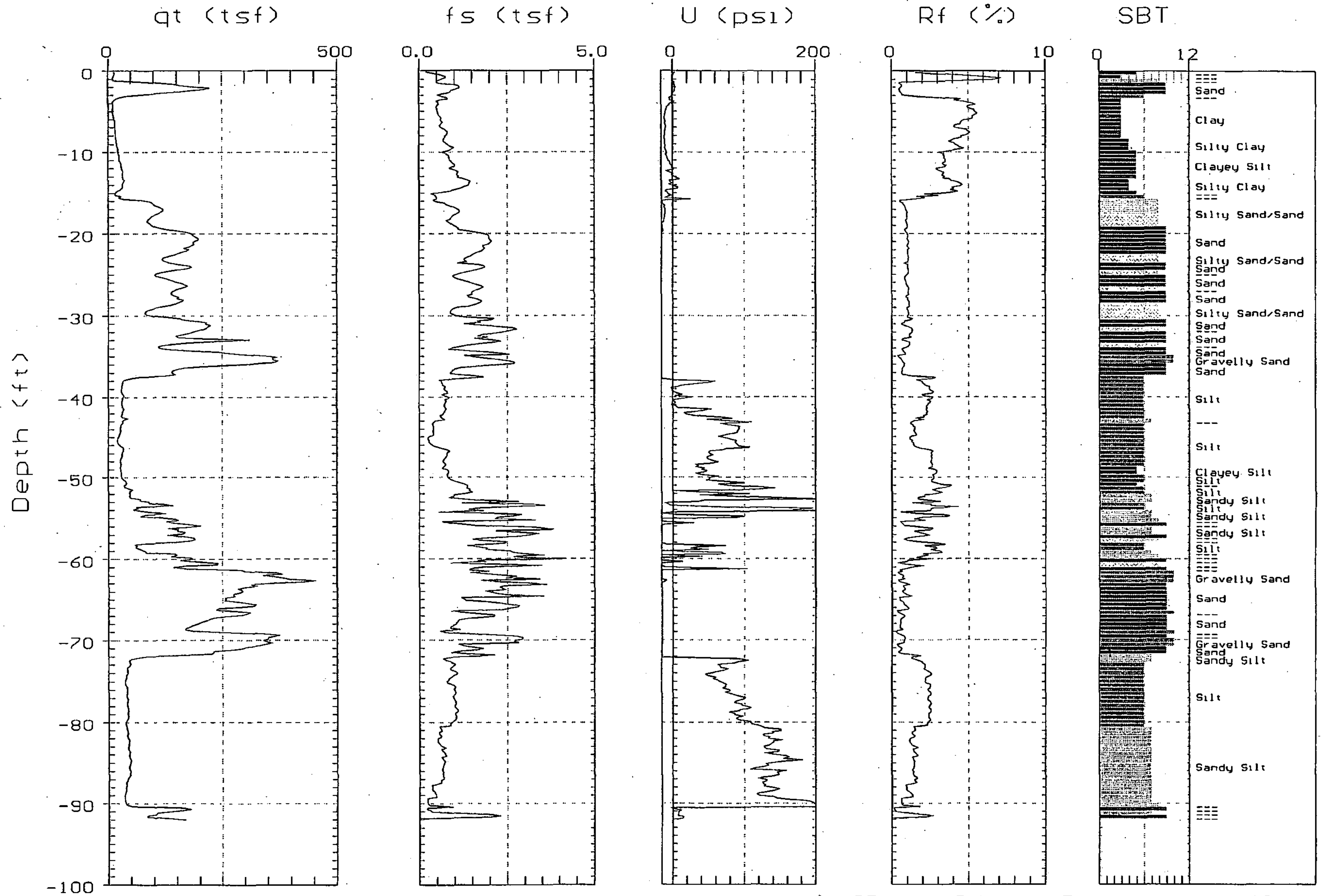
Max. Depth: 100.23 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)

GREGG

MACTEC

Site: N=363678.81 E=2942142.10 Operator: R.AGUILLAR
Location: C-409ELEV=27.93 Date: 12/02/06 12:36



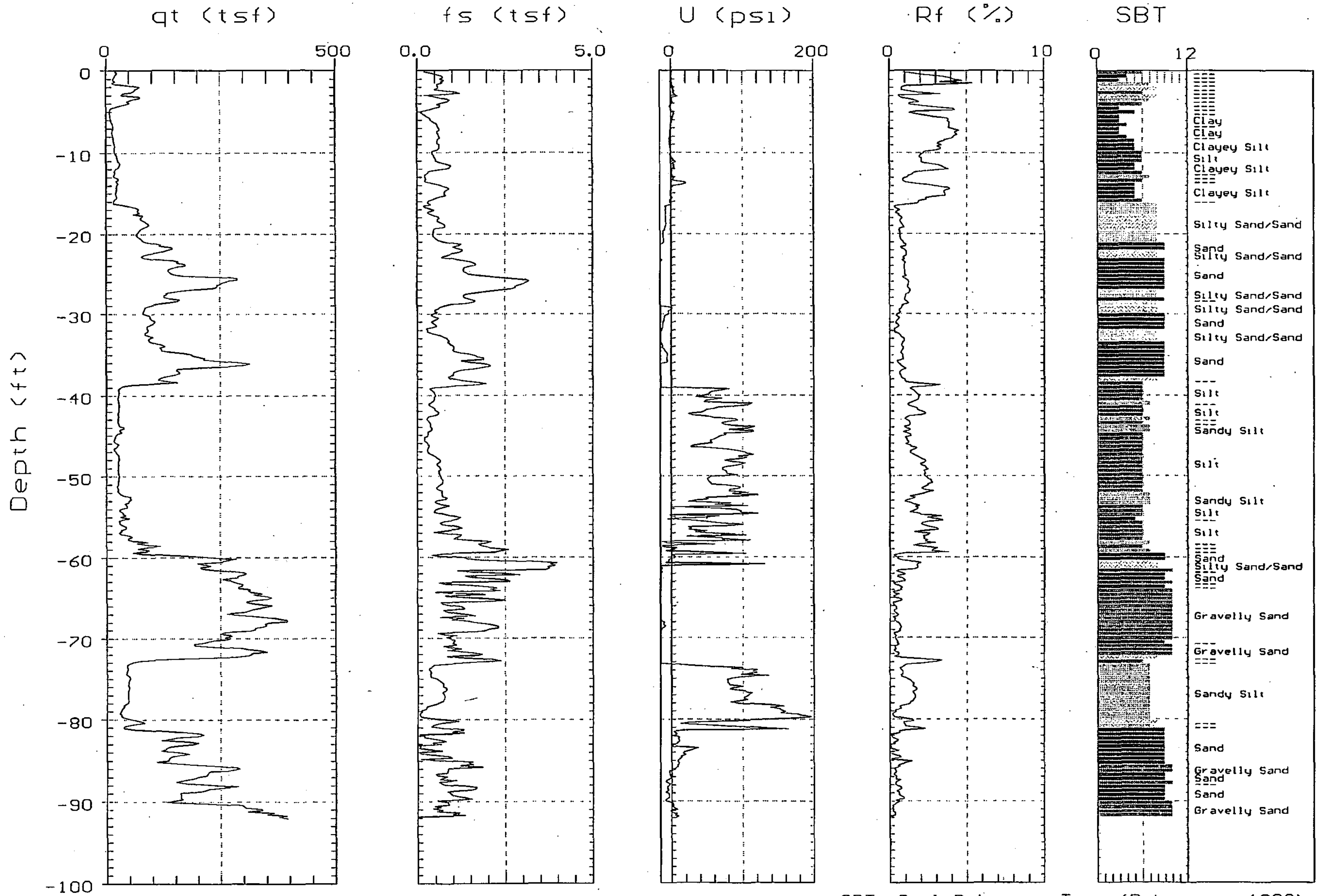
Max. Depth: 92.03 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)

GREGG

MACTEC

Site: N=363788.88 E=2942140.63 Operator: R.AGUILLAR
Location: C-410ELEV=28.93 Date: 12/05/06 12:44

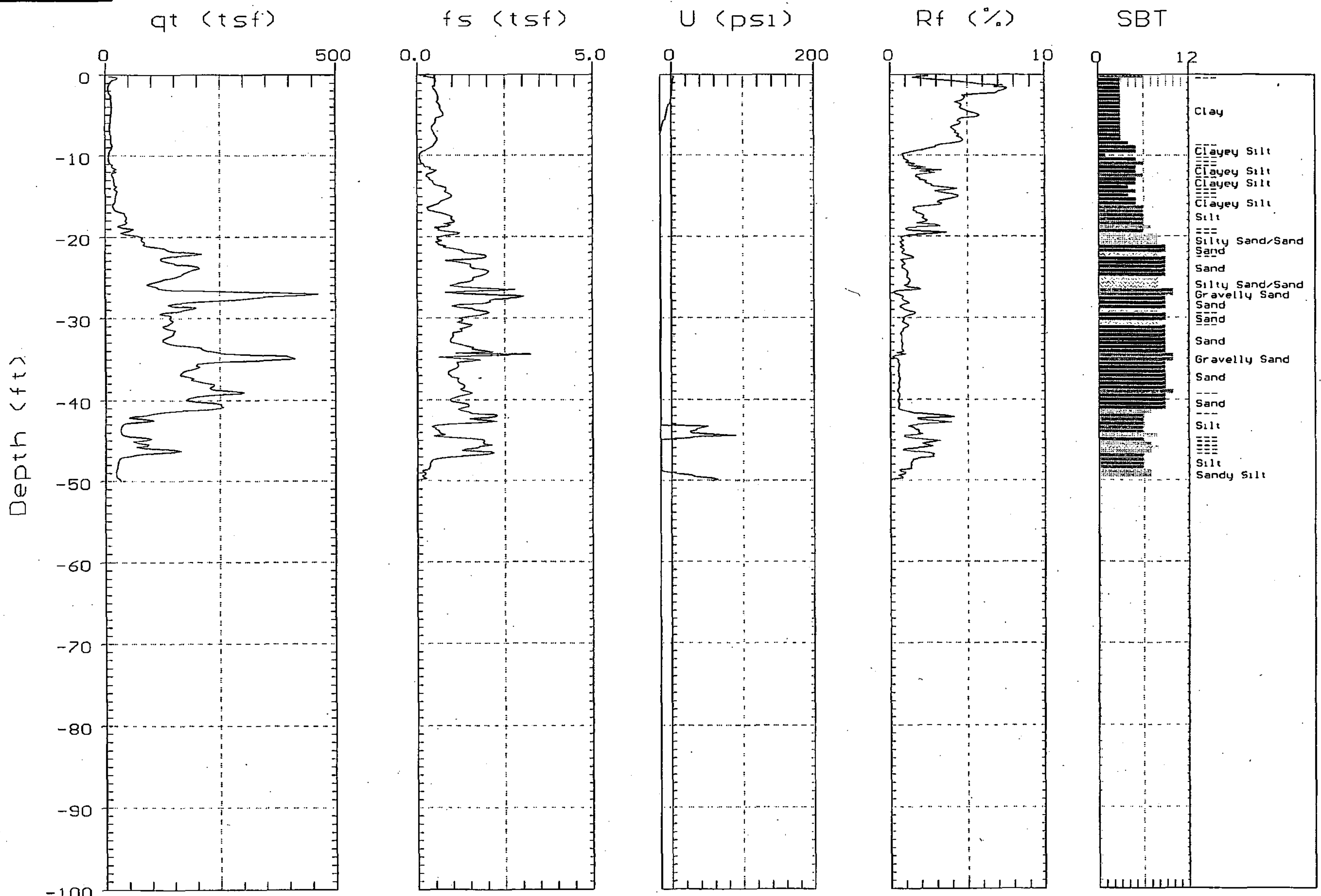


Max. Depth: 92.03 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)

MACTEC

Site: N=362902.74 E=2942803.77 Operator: R.AGUILLAR
Location: C-411ELEV=31.10 Date: 12/02/06 06:37

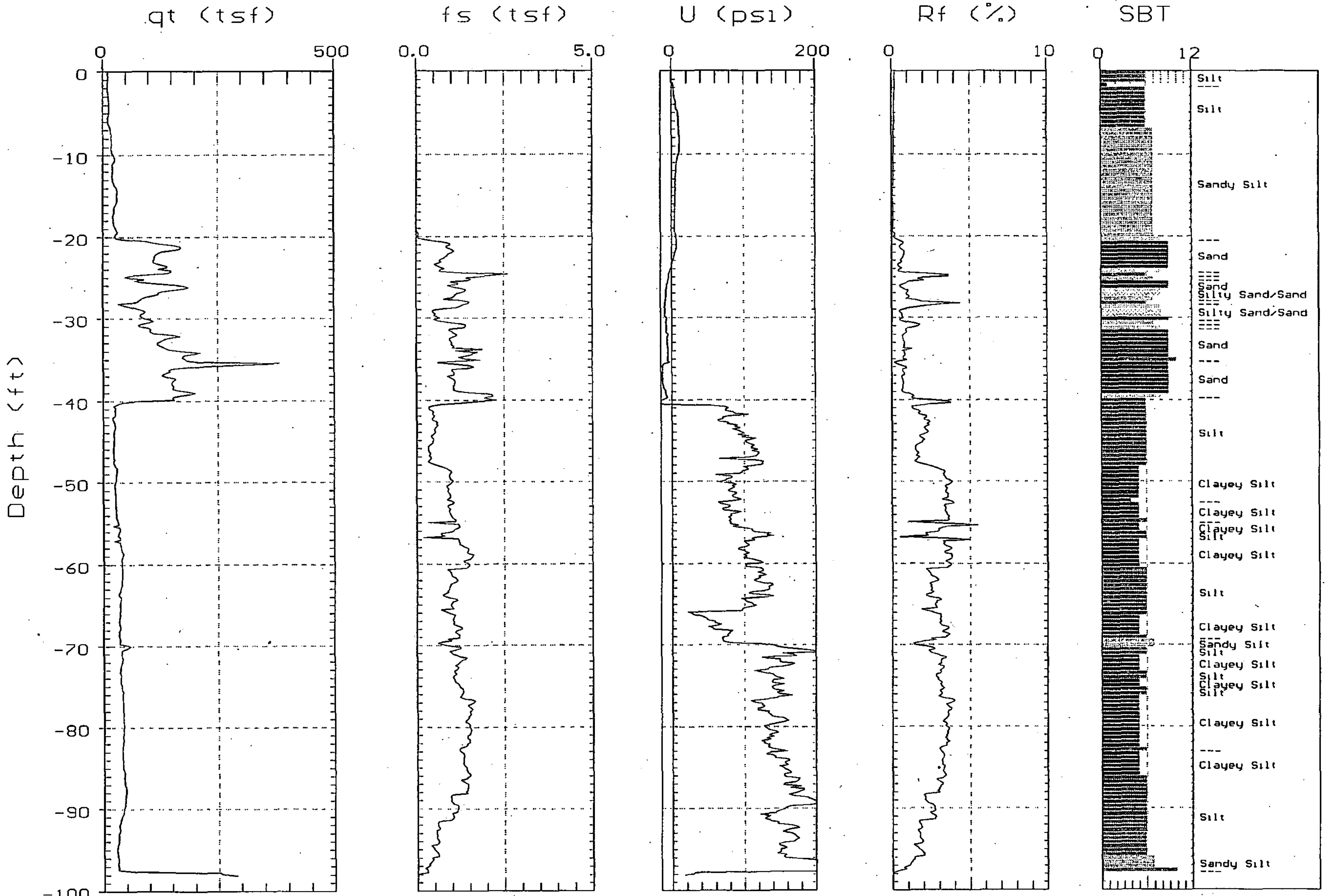


Max. Depth: 50.03 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)

GREGG MACTEC

Site:N=363539.44 E=2941694.20 Operator:R.AGUILLAR
Location:C-901ELEV=29.57 Date:12/17/06 08:28

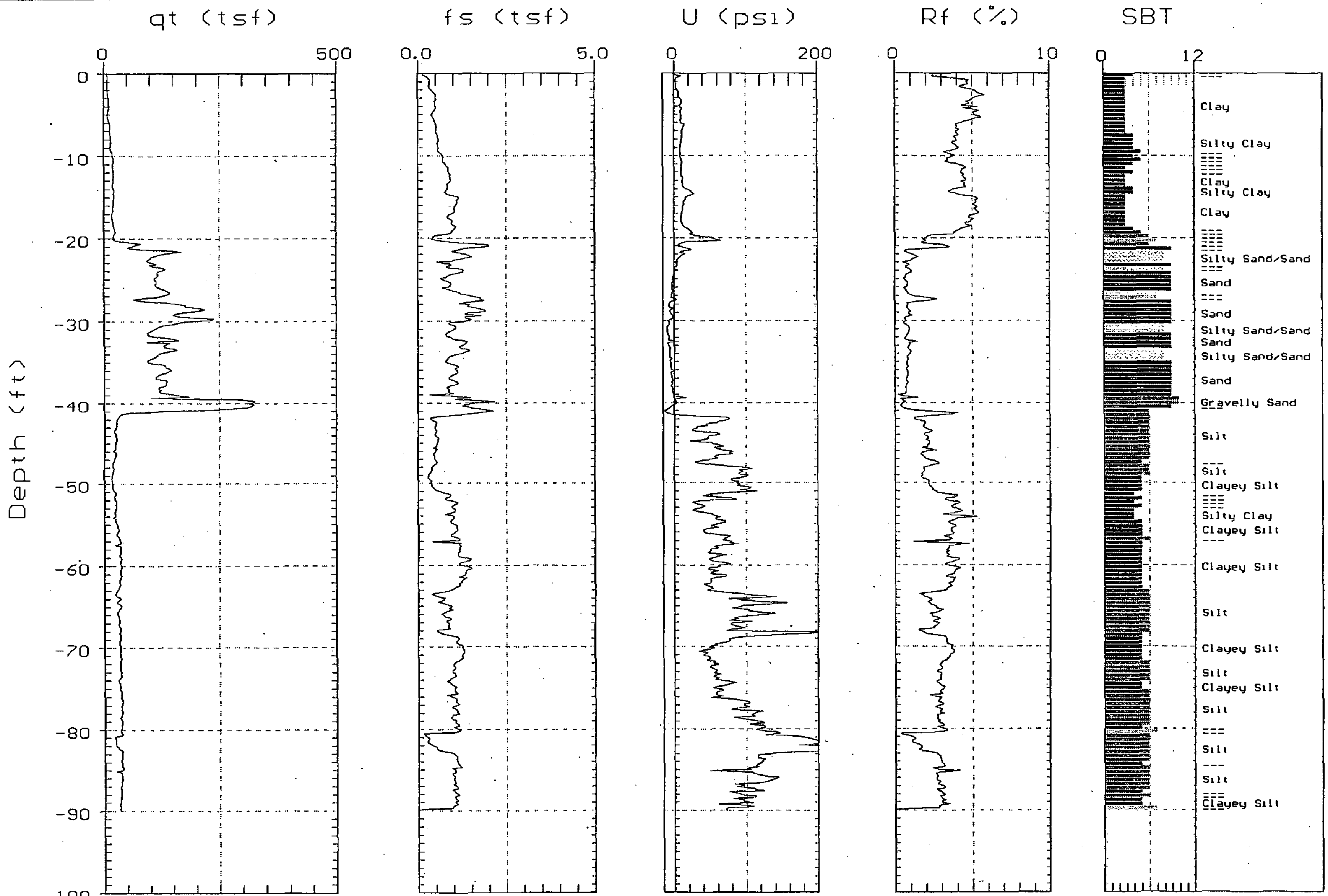


Max. Depth: 98.10 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)

GREGG MACTEC

Site: N=363448.19 E=2941623.82 Operator: R.AGUILLAR
Location: C-902ELEV=28.94 Date: 12/17/06 12:00

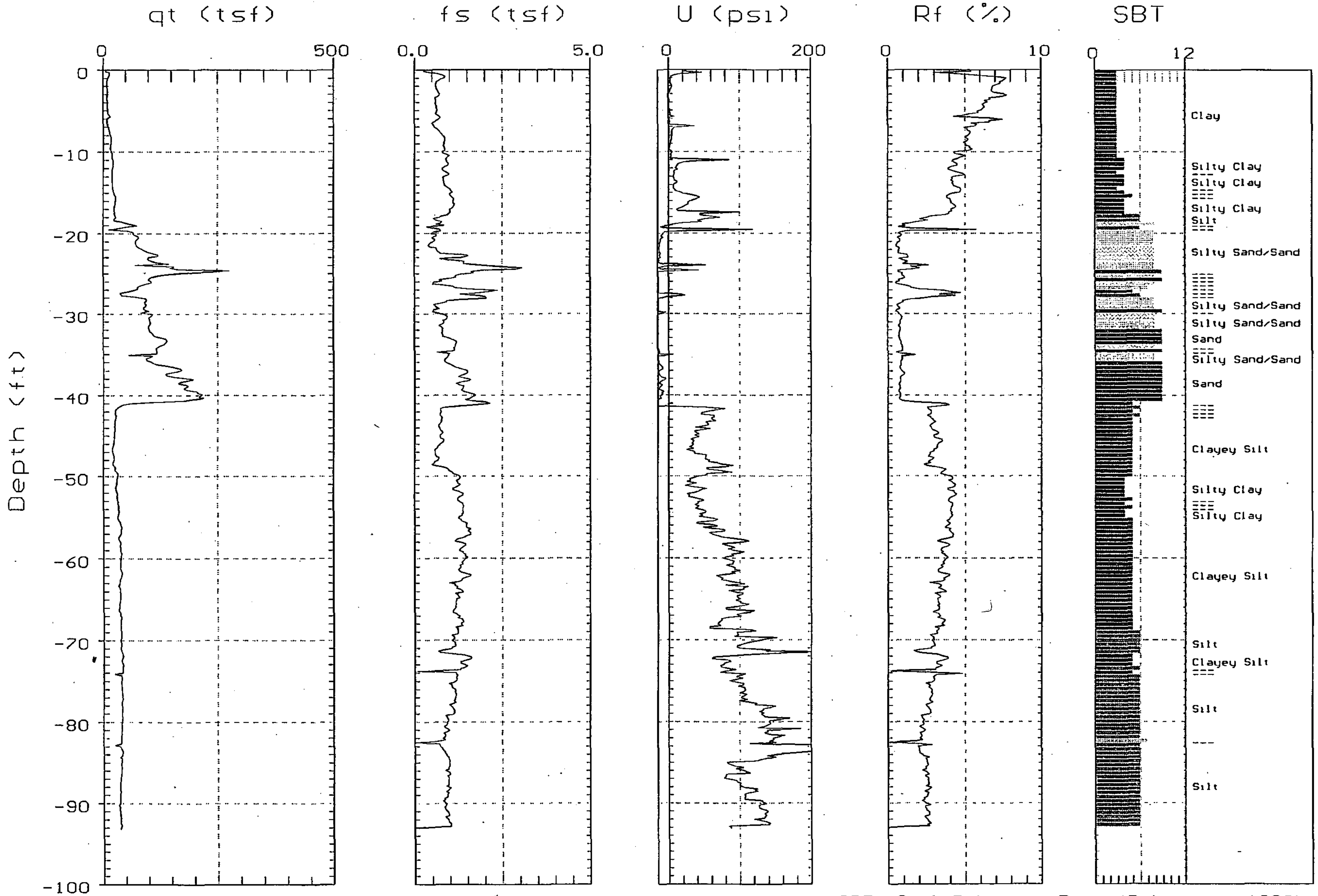


Max. Depth: 90.06 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)

GREGG | MACTEC

Site: N=363466.93 E=2941498.80 Operator: R.AGUILLAR
Location: C-903ELEV=29.22 Date: 12/18/06 06:42

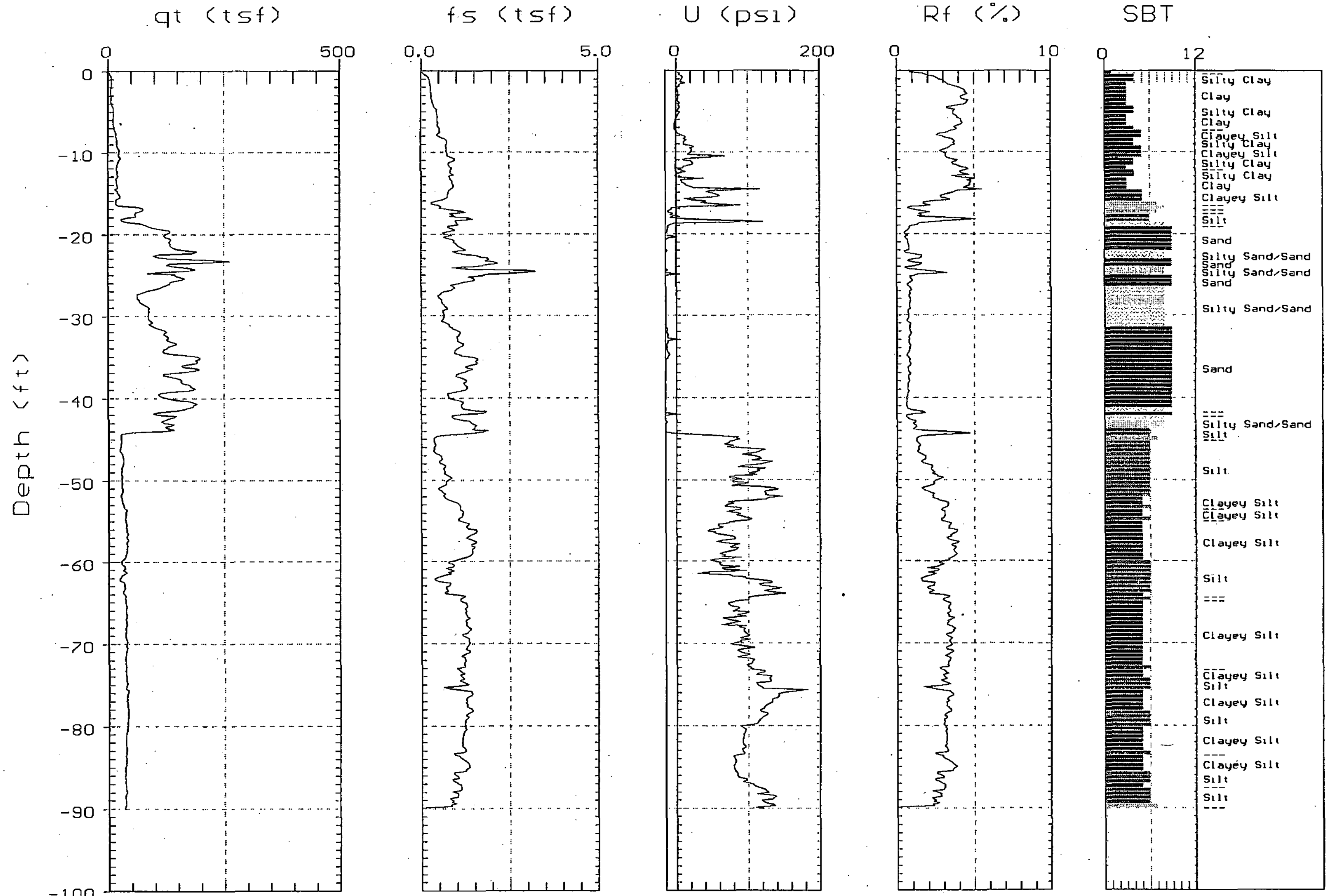


Max. Depth: 93.17 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)

MACTEC

Site: N=363392.47 E=2941651.23 Operator: R.AGUILLAR
Location: C-904ELEV=24.17 Date: 12/20/06 05:40

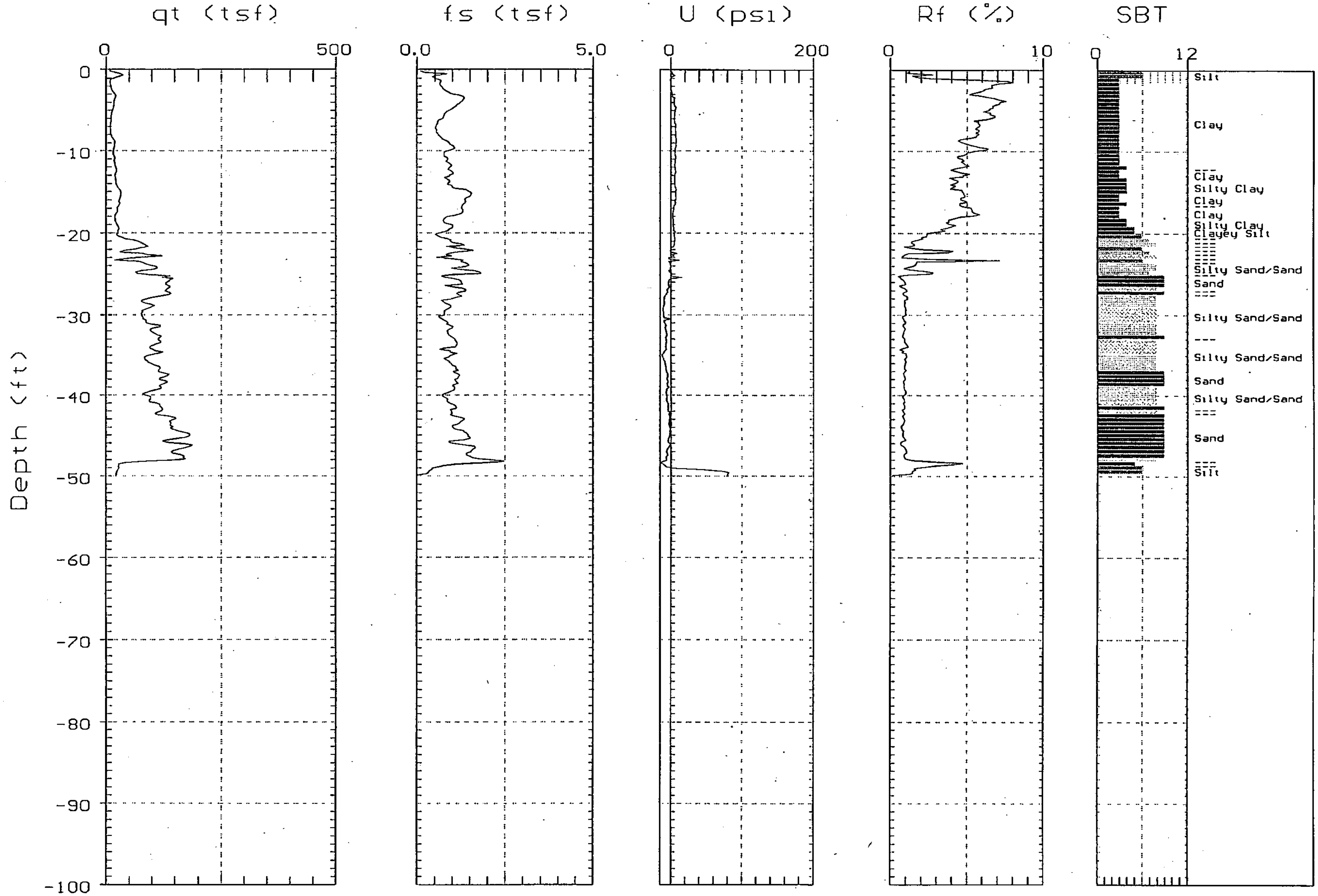


Max. Depth: 90.06 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)

MACTEC

Site: N=363298.98 E=2941713.69 Operator: R.AGUILLAR
Location: C-905ELEV=31.21 Date: 12/13/06 14:28

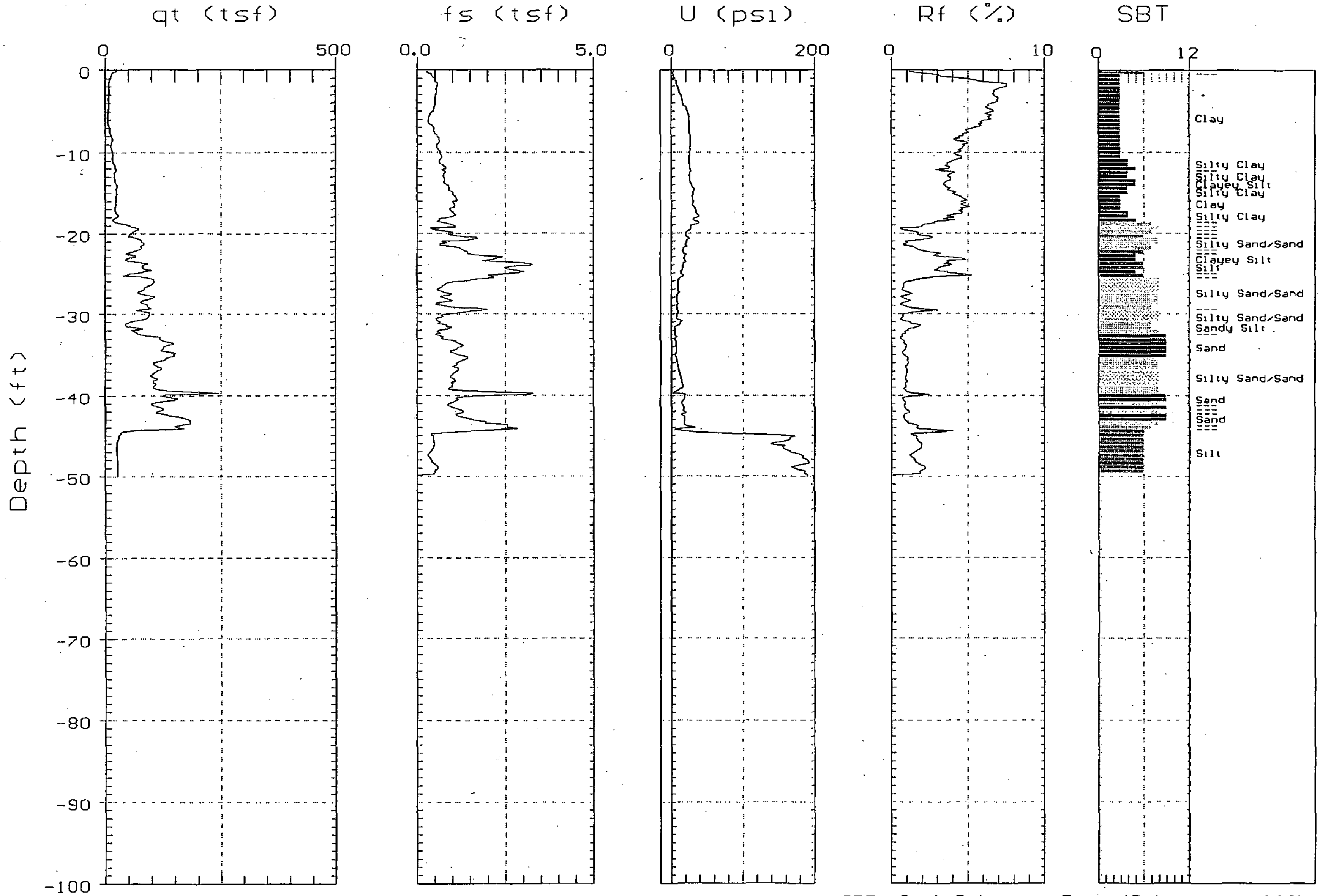


Max. Depth: 50.03 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)

MACTEC

Site: N=363212.72 E=2941758.97 Operator: R.AGUILLAR
Location: C-906ELEV=30.19 Date: 12/18/06 12:40

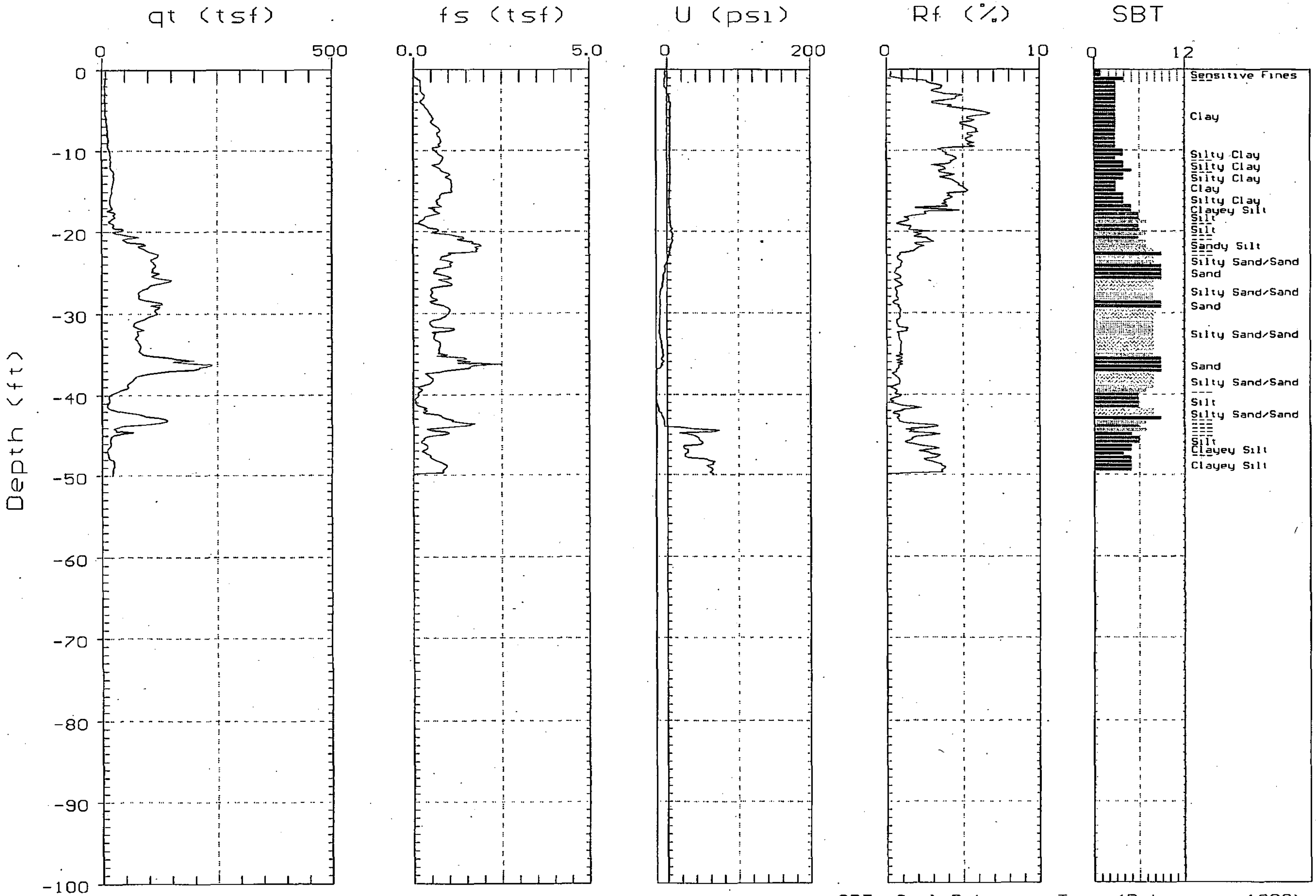


Max. Depth: 50.03 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)

MACTEC

Site: N=363219.02 E=2941968.73 Operator: R.AGUILLAR
Location: C-907 ELEV=28.53 Date: 12/16/06 13:57



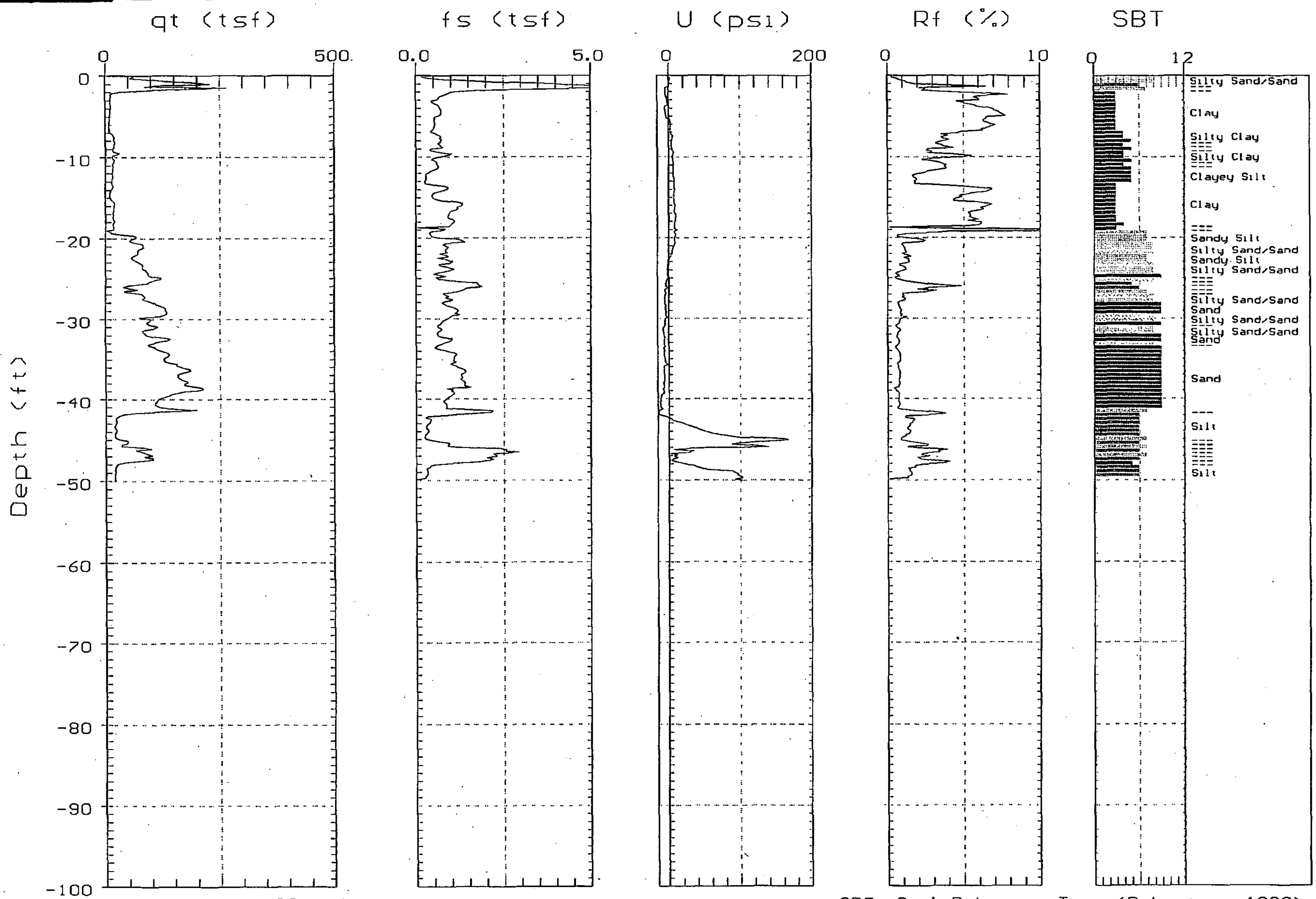
Max. Depth: 50.03 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)

GREGG

MACTEC

Site: N=363219.72 E=2942082.33 Operator: R.AGUILLAR
Location: C-908ELEV=30.89 Date: 12/16/06 13:11

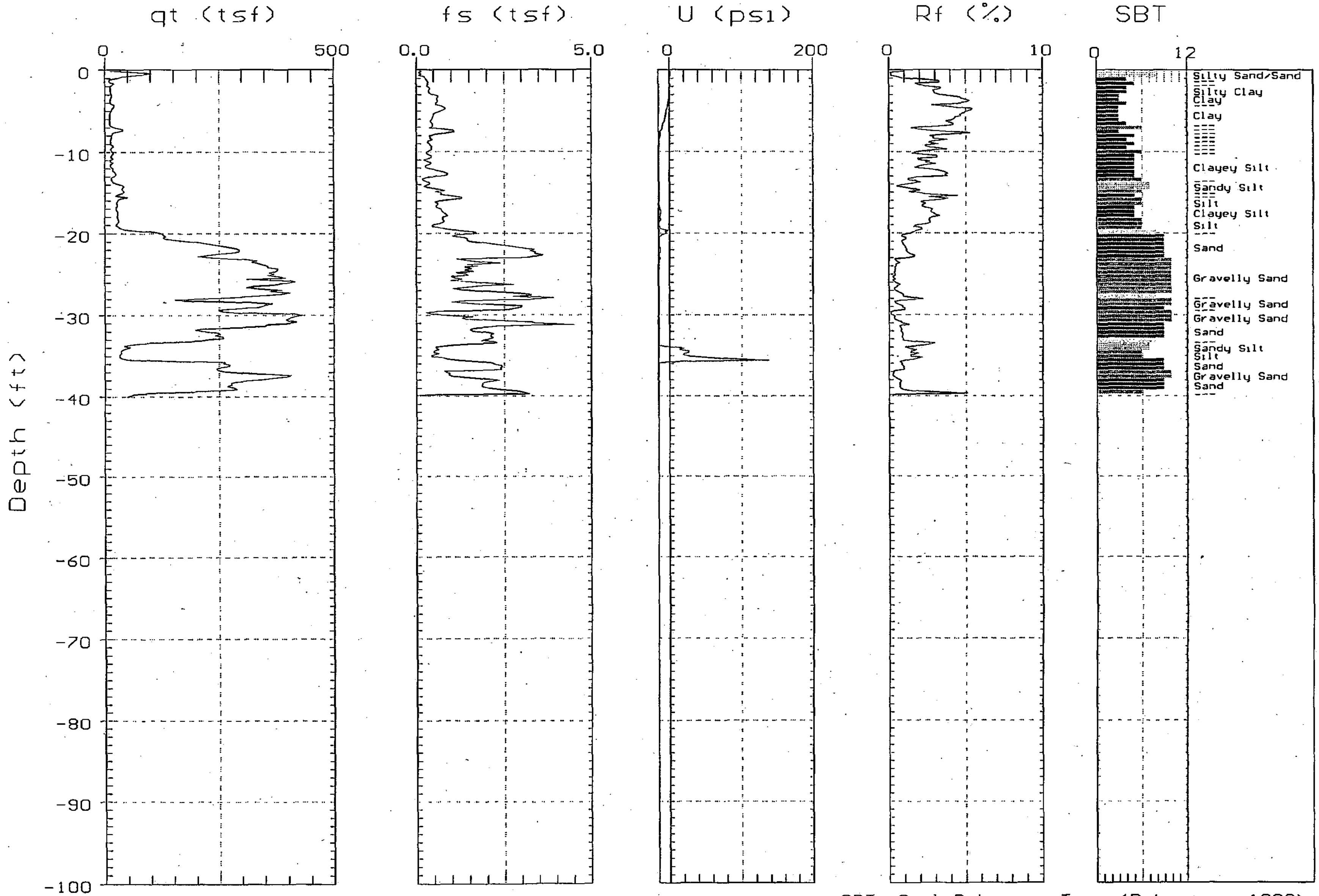


Max. Depth: 50.03 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)

MACTEC

Site: N=363464.25 E=2943948.29 Operator: R.AGUILLAR
Location: C-909ELEV=30.22 Date: 12/02/06 08:08



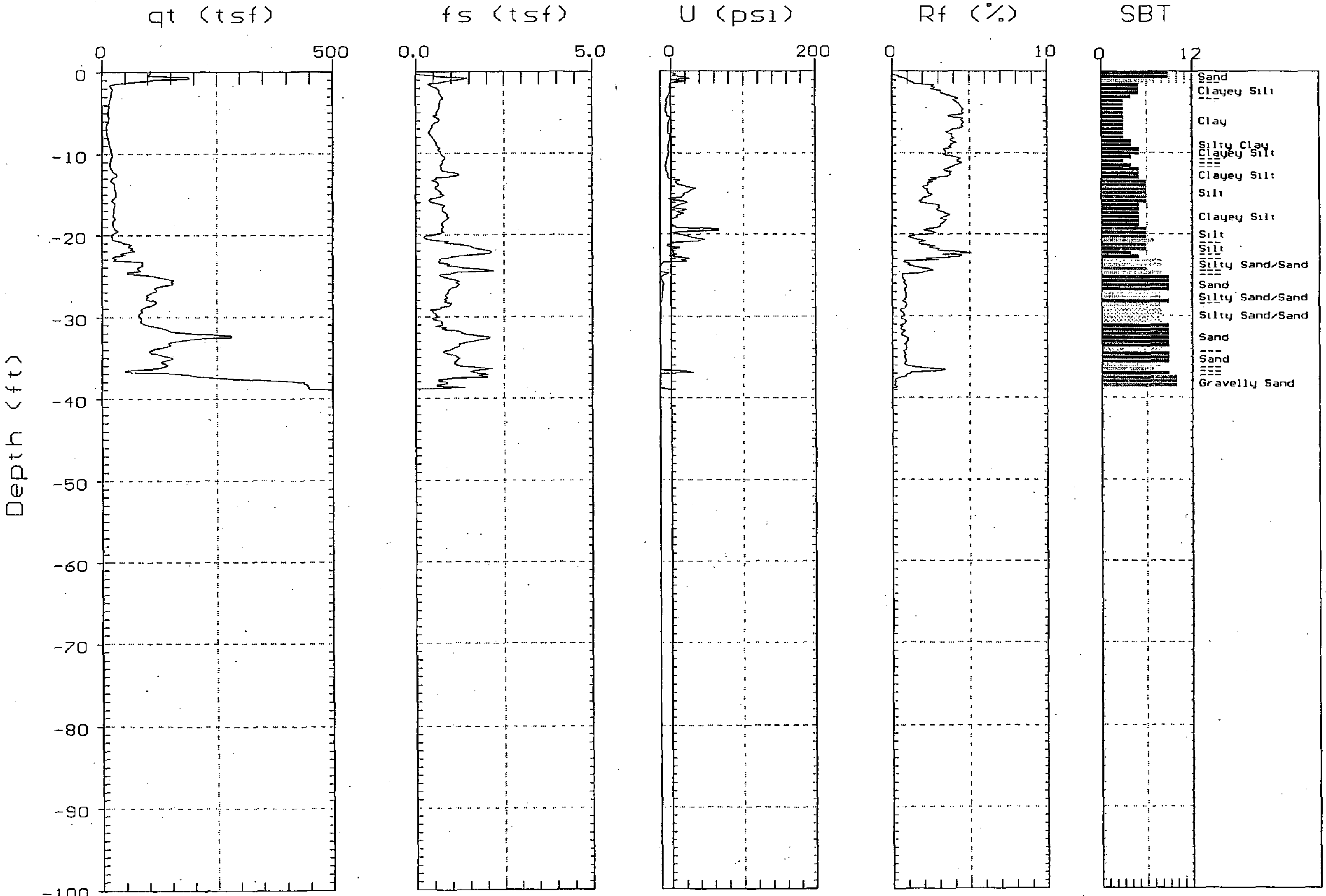
Max. Depth: 40.03 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)

GREGG

MACTEC

Site: N=363217.32 E=2942280.50 Operator: R.AGUILLAR
Location: C-916ELEV=31.41 Date: 12/17/06 06:18



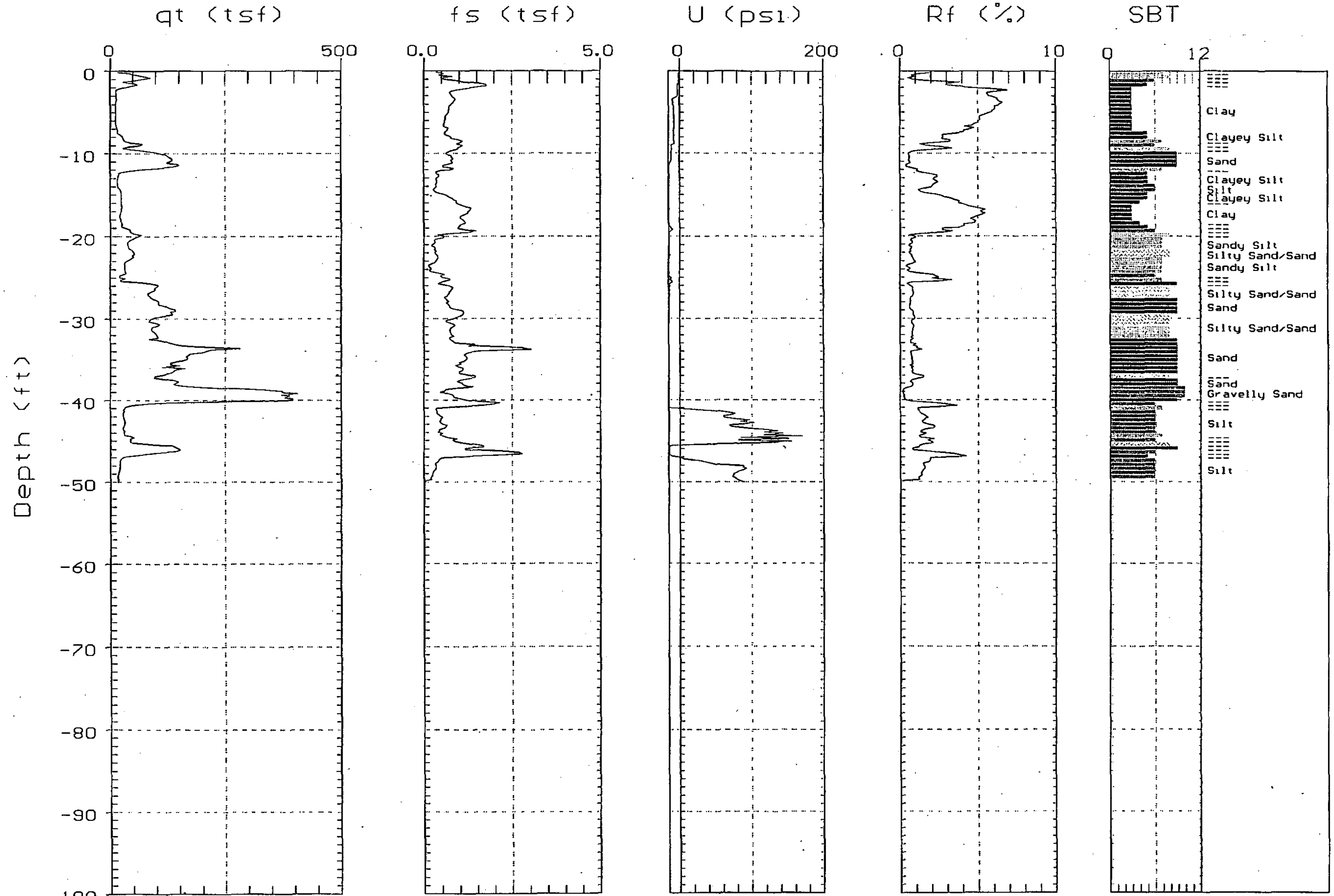
Max. Depth: 39.04 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)

GREGG

MACTEC

Site: N=363281.30 E=2942122.51 Operator: R.AGUILLAR
Location: C-917ELEV=30.65 Date: 12/19/06 11:03

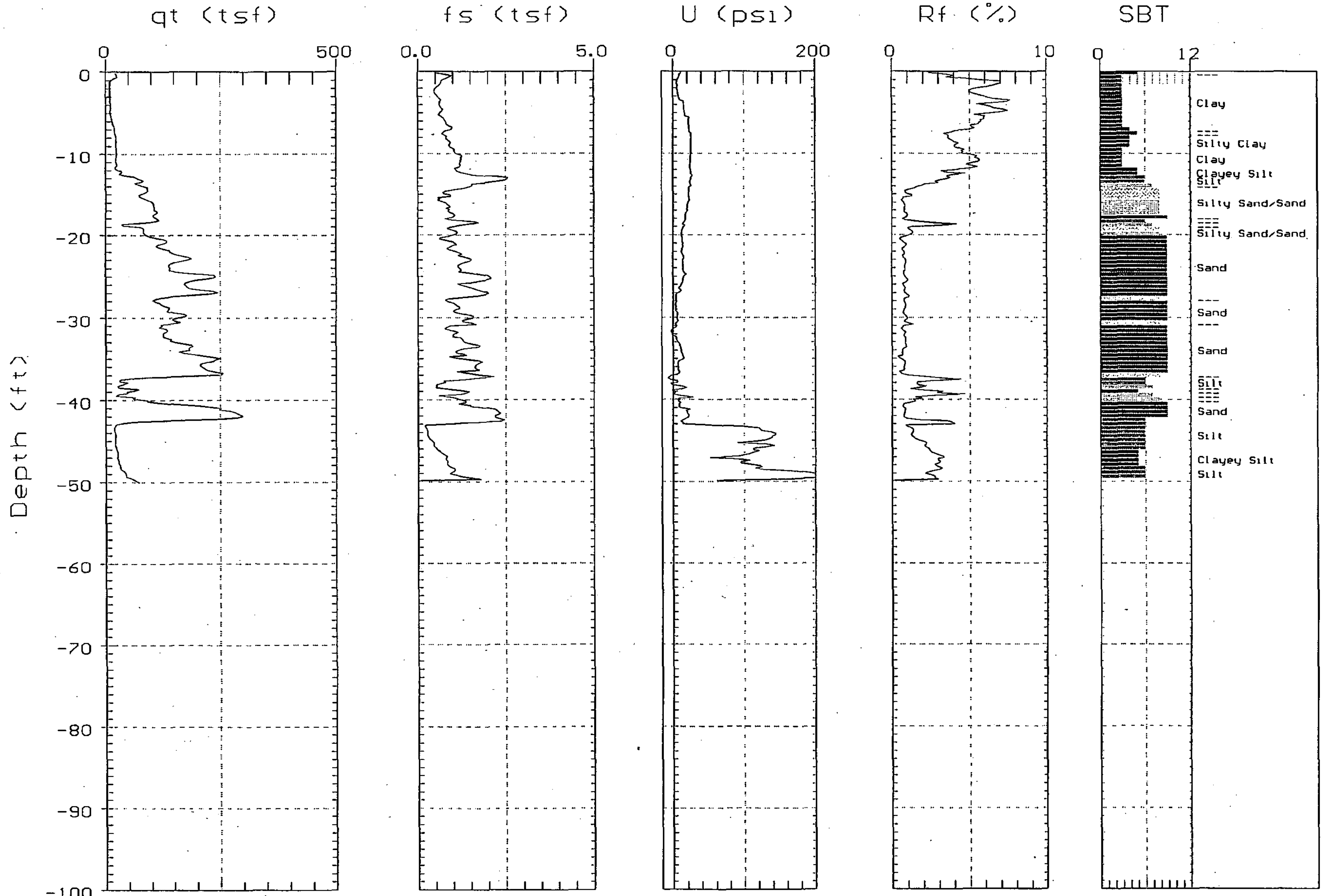


Max. Depth: 50.03 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)

MACTEC

Site: N=363484.09 E=2942118.30 Operator: R.AGUILLAR
Location: C-918ELEV=25.36 Date: 12/18/06 10:33

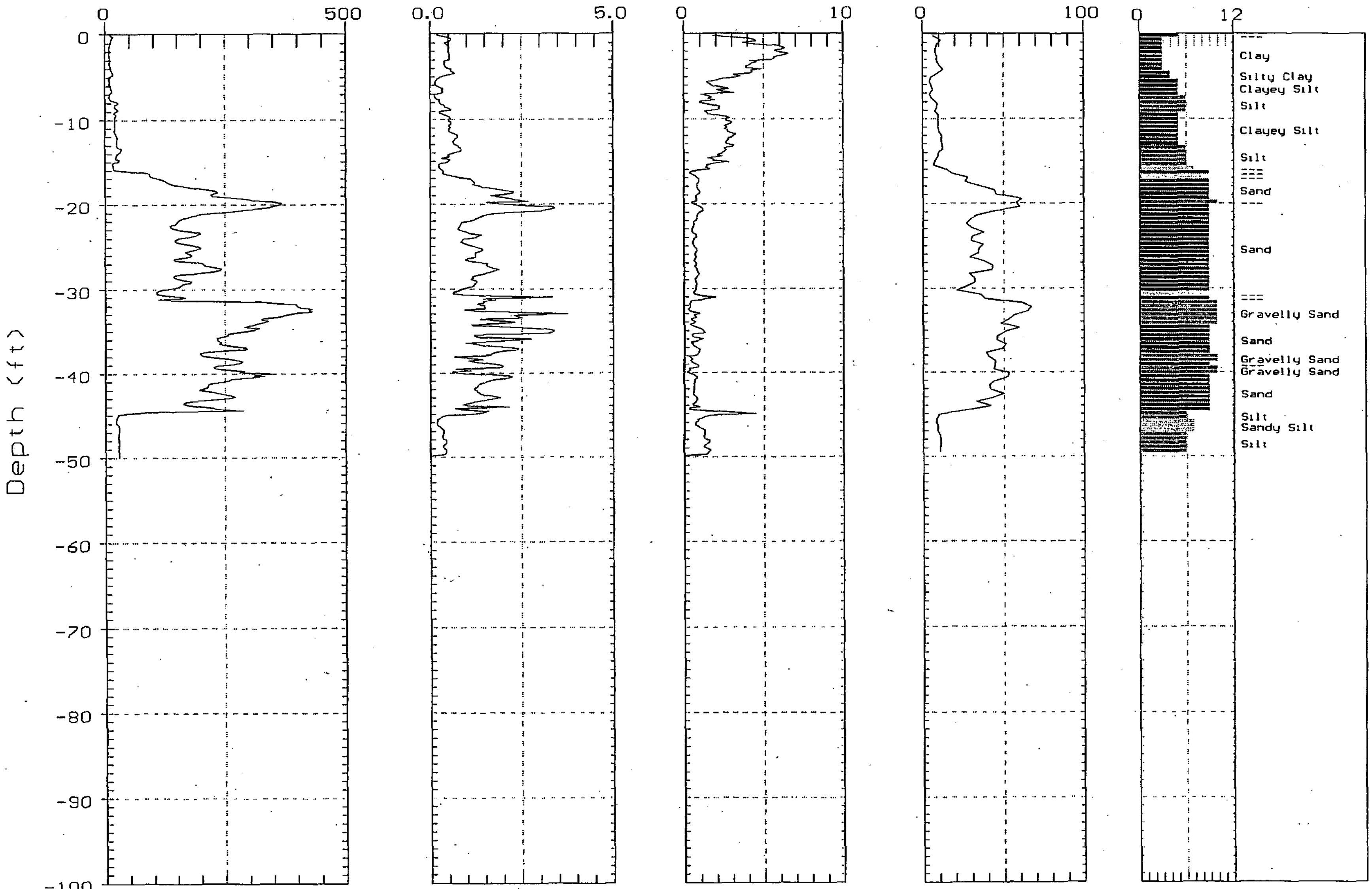


Max. Depth: 50.03 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)

GREGG MACTEC

Site: N=362772.55 E=2943448.74 Operator: R.AGUILLAR
Location: C-301 ELEV=27.37 Date: 12/01/06 13:25



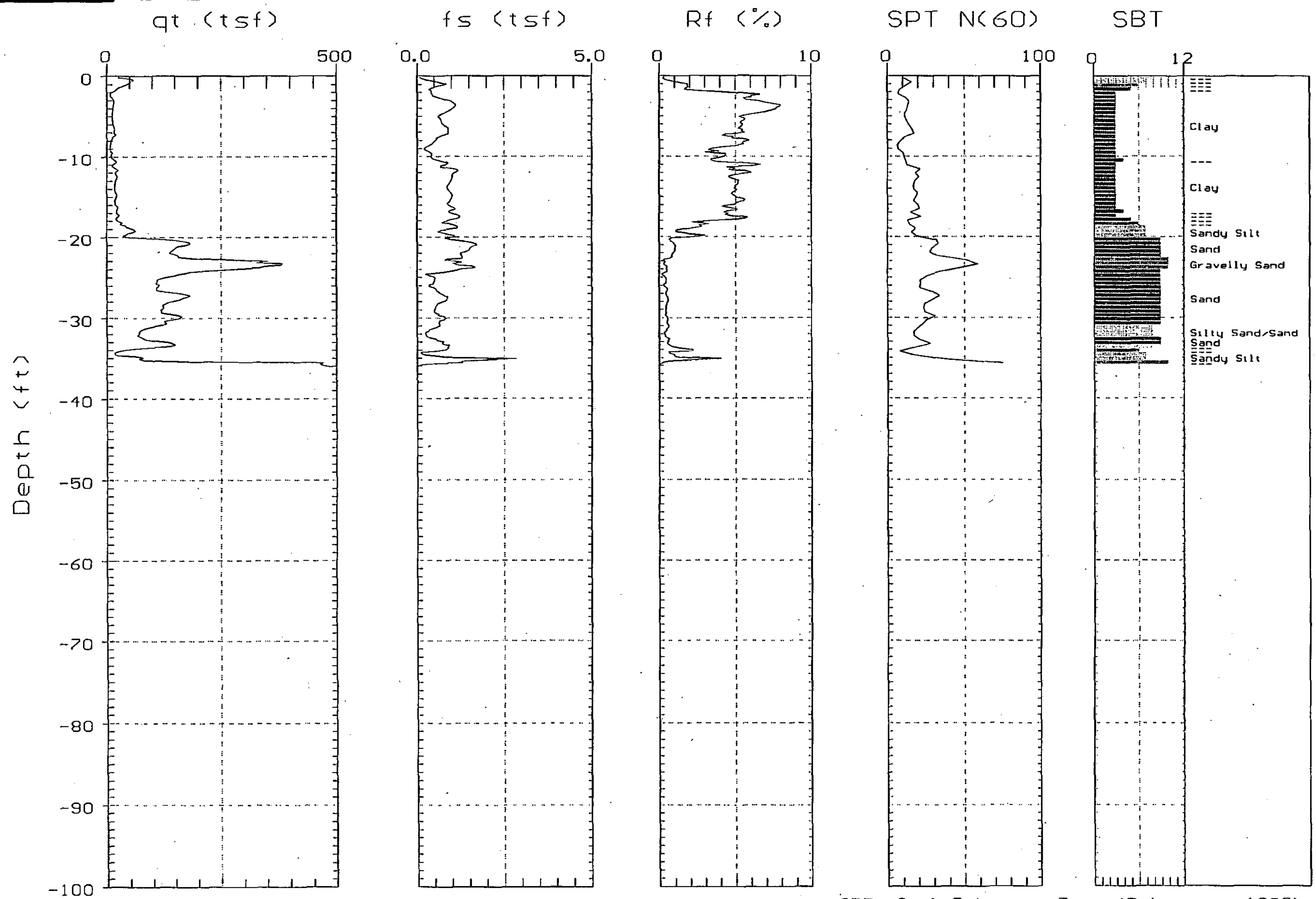
Max. Depth: 50.03 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)

GREGG

MACTEC

Site: N=362824.38 E=2943502.25 Operator: R.AGUILLAR
Location: C-302ELEV=28.72 Date: 11/29/06 12:54



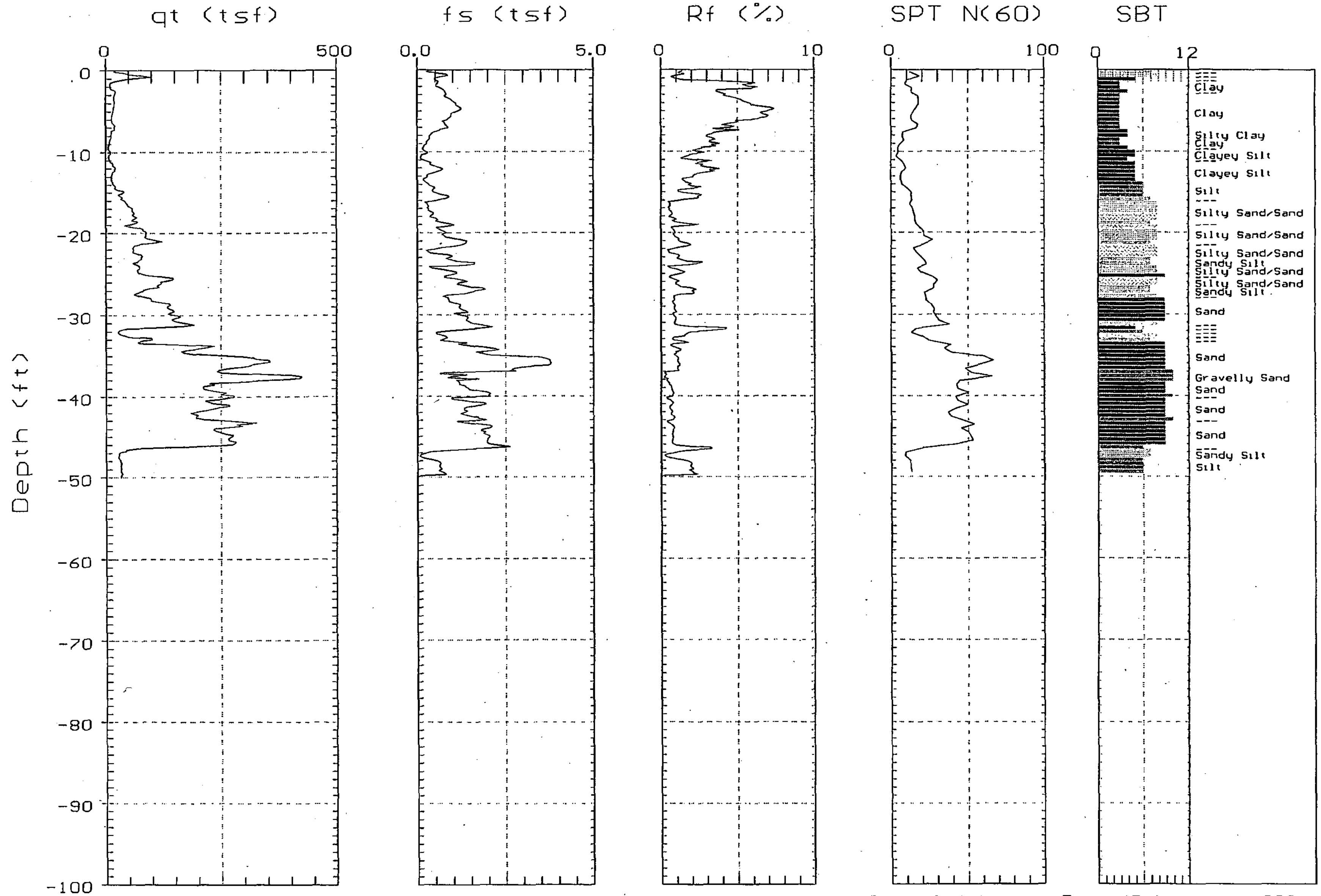
Max. Depth: 36.09 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)

GREGG

MACTEC

Site: N=362823.77 E=2943190.19 Operator: R.AGUILLAR
Location: C-303ELEV=30.19 Date: 12/01/06 12:02



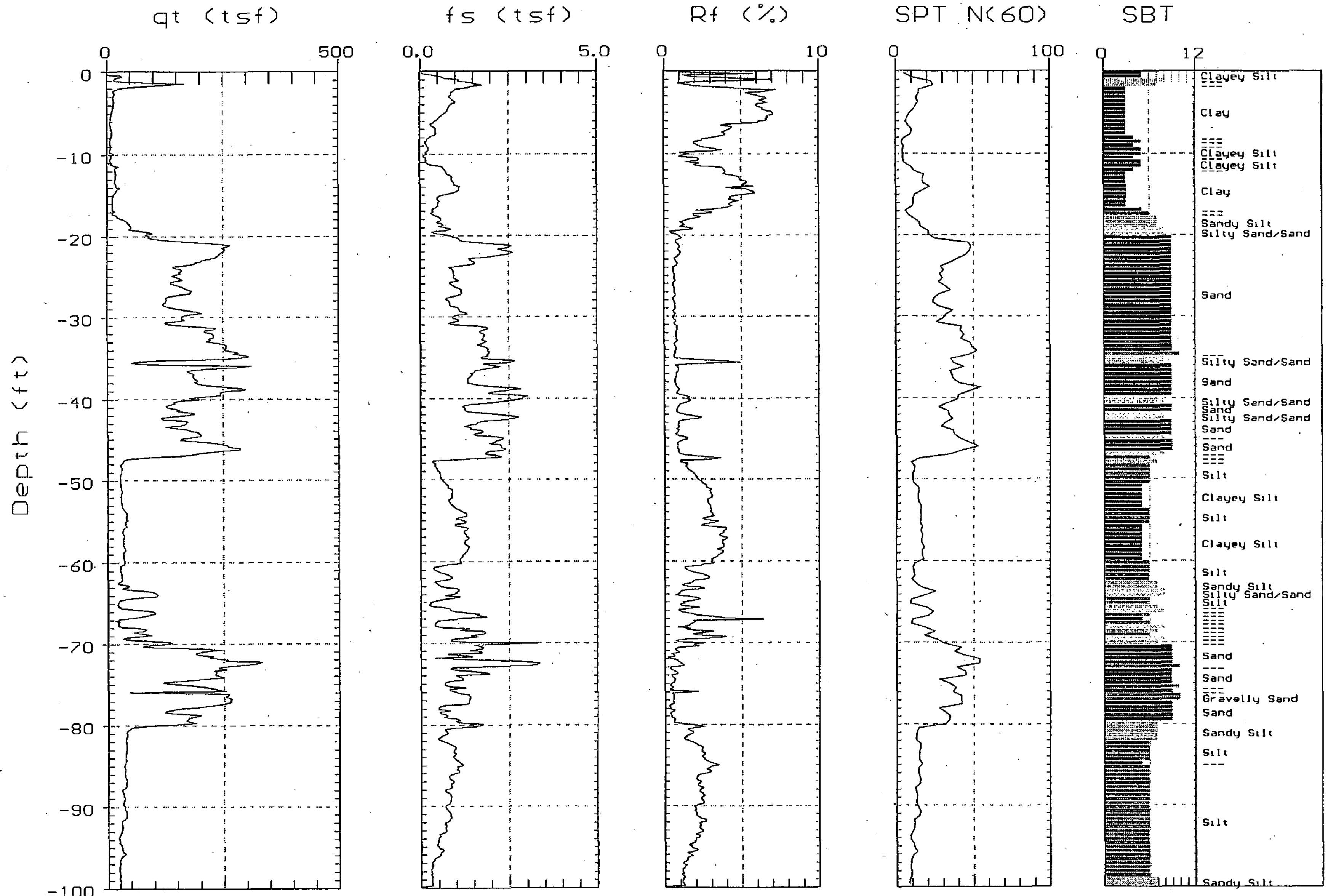
Max. Depth: 50.03 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)

GREGG

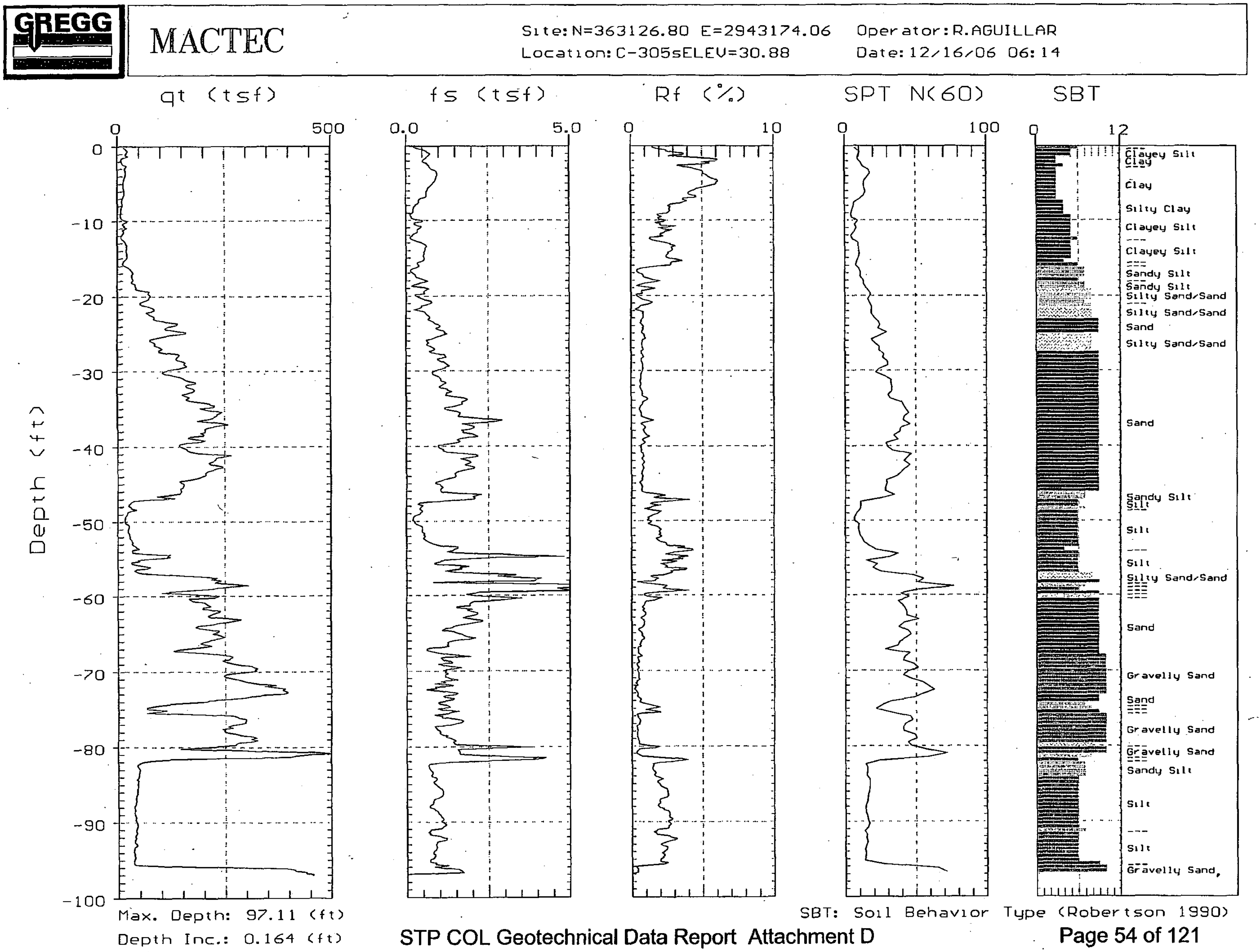
MACTEC

Site: N=362910.77 E=2943394.73 Operator: R.AGUILLAR
Location: C-304ELEV=29.39 Date: 12/15/06 12:01



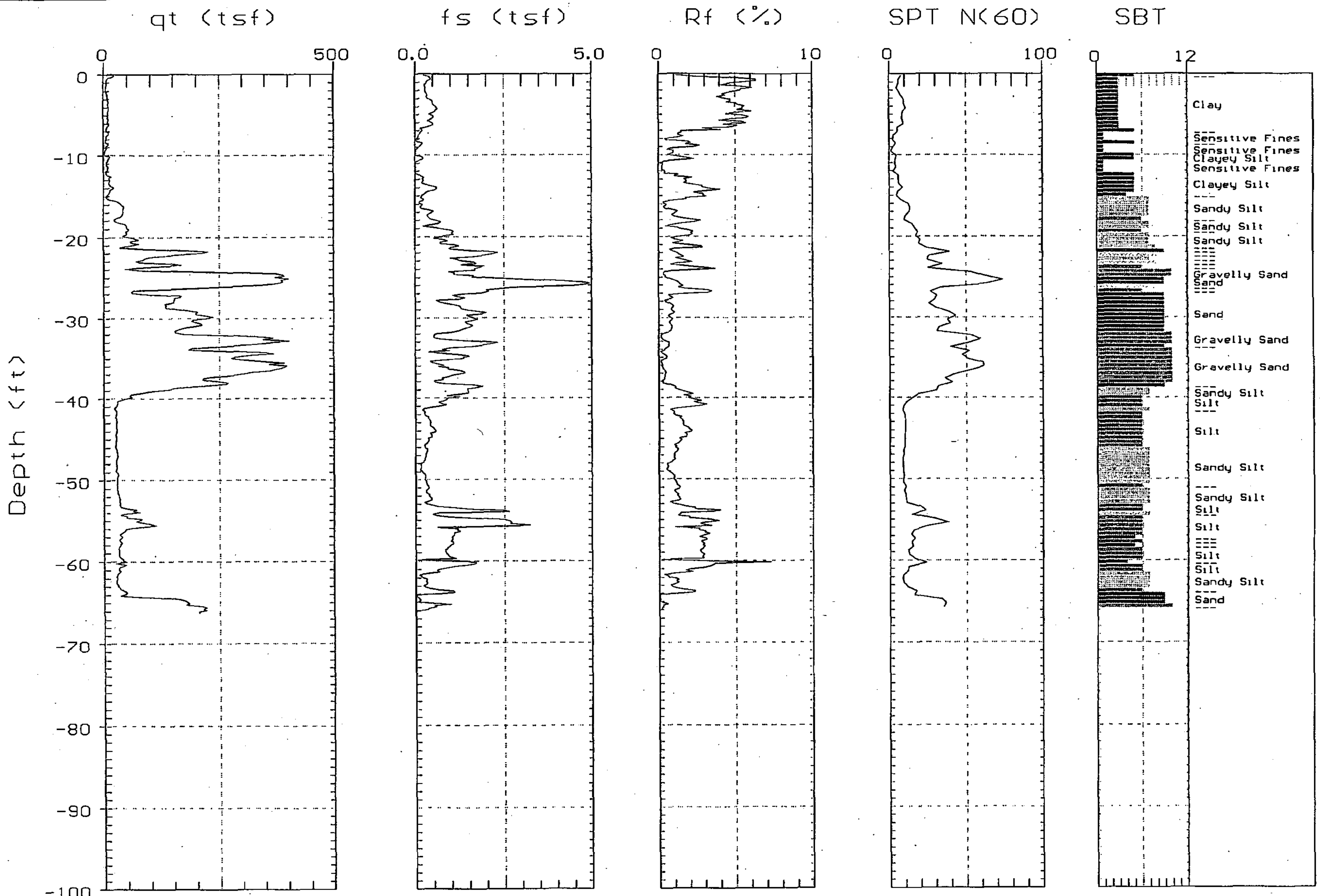
Max. Depth: 100.06 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)


GREGG
MACTEC
Site: N=363126.80 E=2943174.06
Location: C-305sELEV=30.88
Operator: R.AGUILLAR
Date: 12/16/06 06:14
qt (tsf)
fs (tsf)
Rf (%)
SPT N(60)
SBT
Depth (ft)
Clayey Silt
Clay
Clay
Silty Clay
Clayey Silt
Clayey Silt
Sandy Silt
Sandy Silt
Silty Sand/Sand
Silty Sand/Sand
Sand
Silty Sand/Sand
Sand
Sandy Silt
Silt
Silt
Silt
Silty Sand/Sand
Sand
Gravelly Sand
Sand
Gravelly Sand
Gravelly Sand
Sandy Silt
Silt
Silt
Gravelly Sand
Max. Depth: 97.11 (ft)
Depth Inc.: 0.164 (ft)
SBT: Soil Behavior Type (Robertson 1990)

MACTEC

Site: N=363483.22 E=2943296.00 Operator: R.AGUILLAR
Location: C-306sELEV=29.68 Date: 11/30/06 06:37



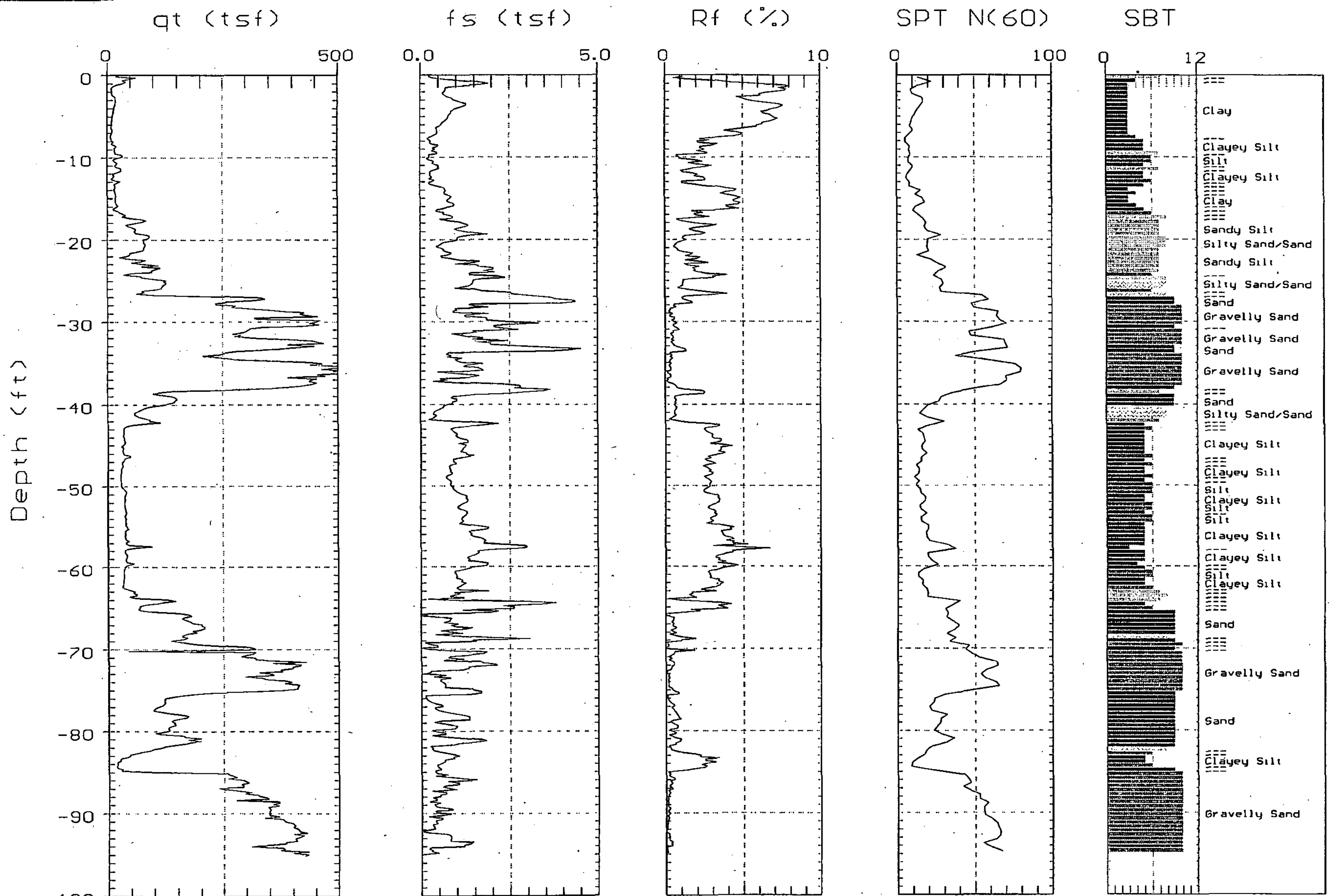
Max. Depth: 66.27 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)

GREGG

MACTEC

Site: N=363573.00 E=2943407.68 Operator: R.AGUILLAR
Location: C-307sELEV=30.02 Date: 12/14/06 07:52



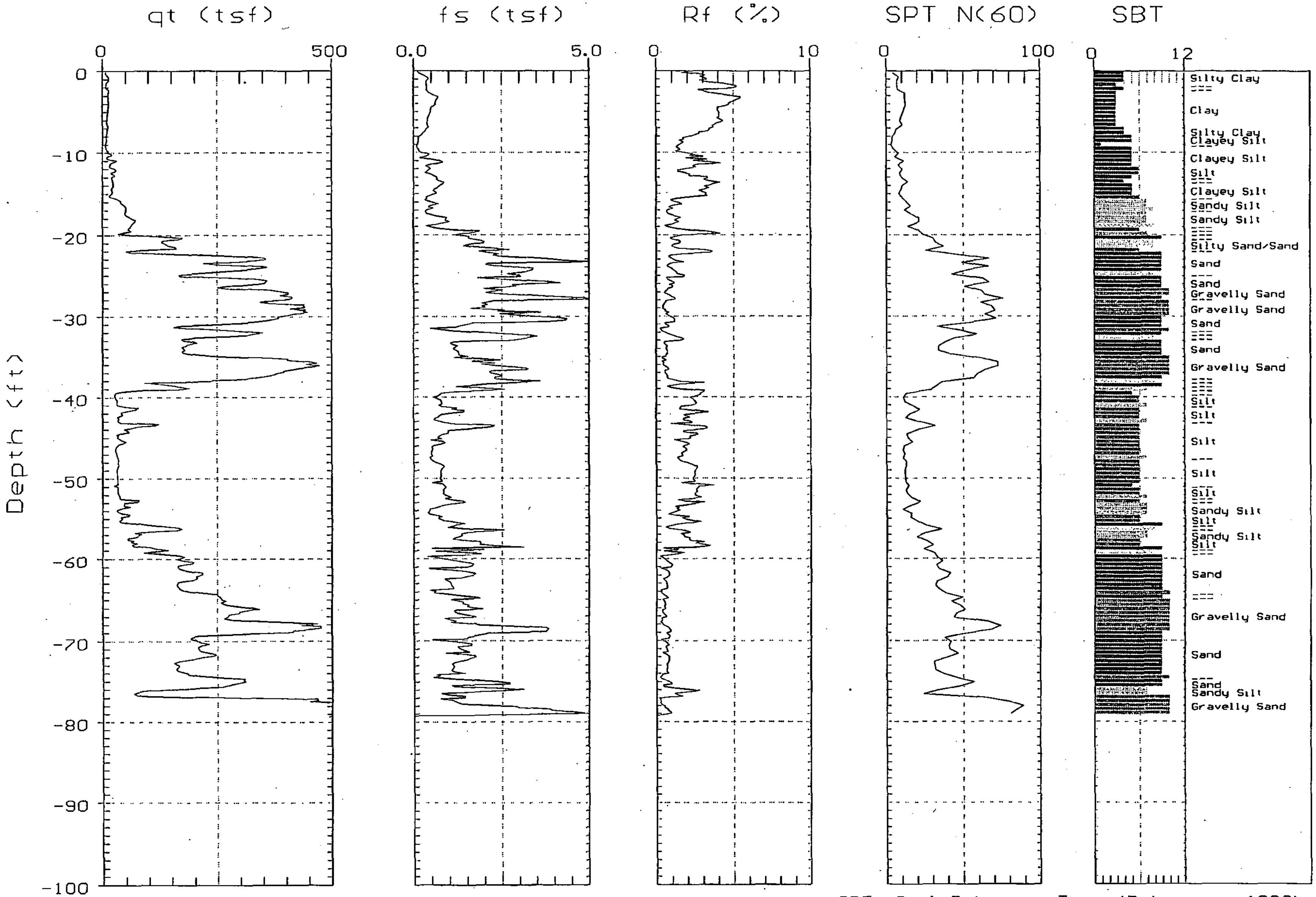
Max. Depth: 95.14 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)

GREGG

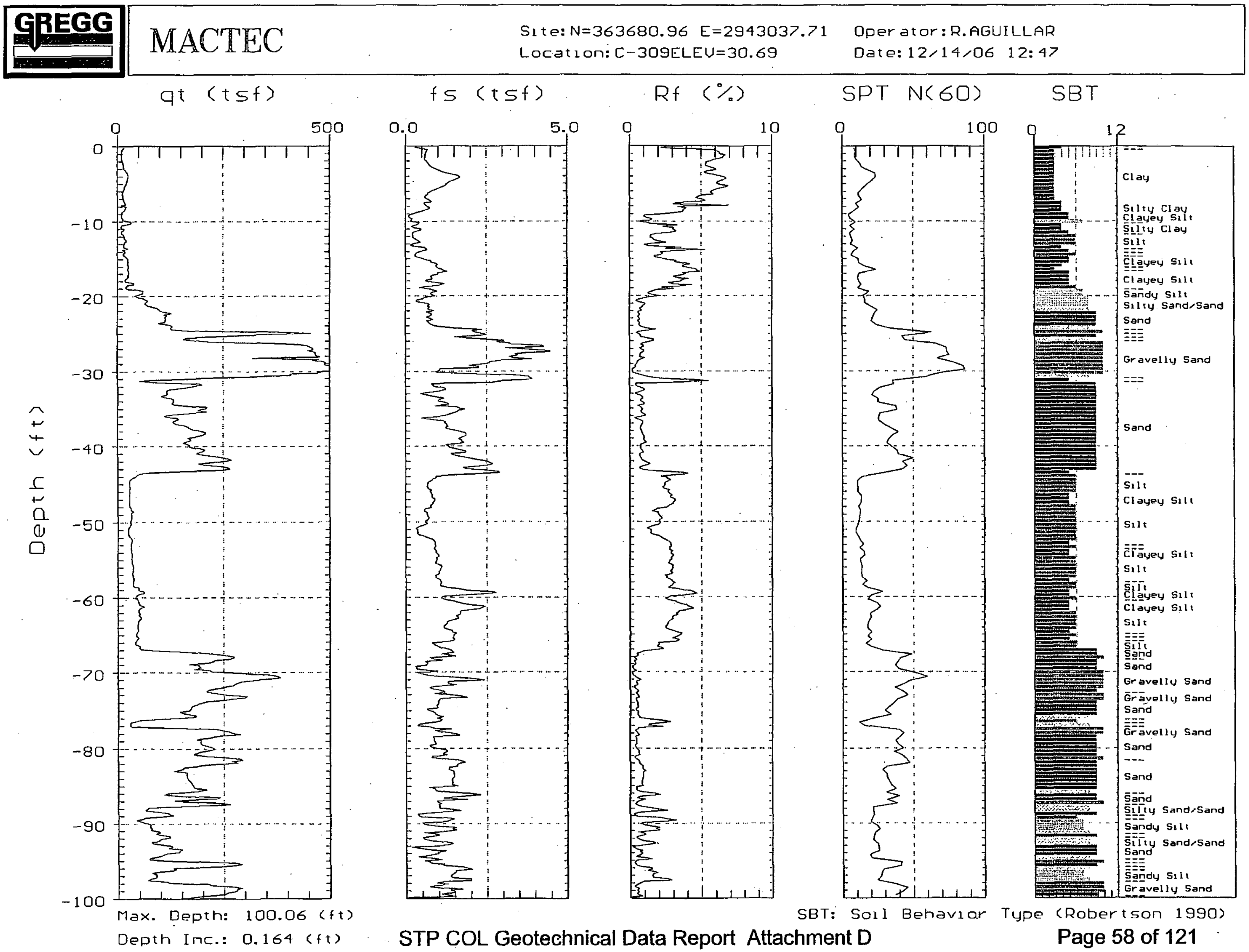
MACTEC

Site: N=363711.62 E=2943481.16 Operator: R.AGUILLAR
Location: C-308ELEV=29.89 Date: 12/15/06 06:06



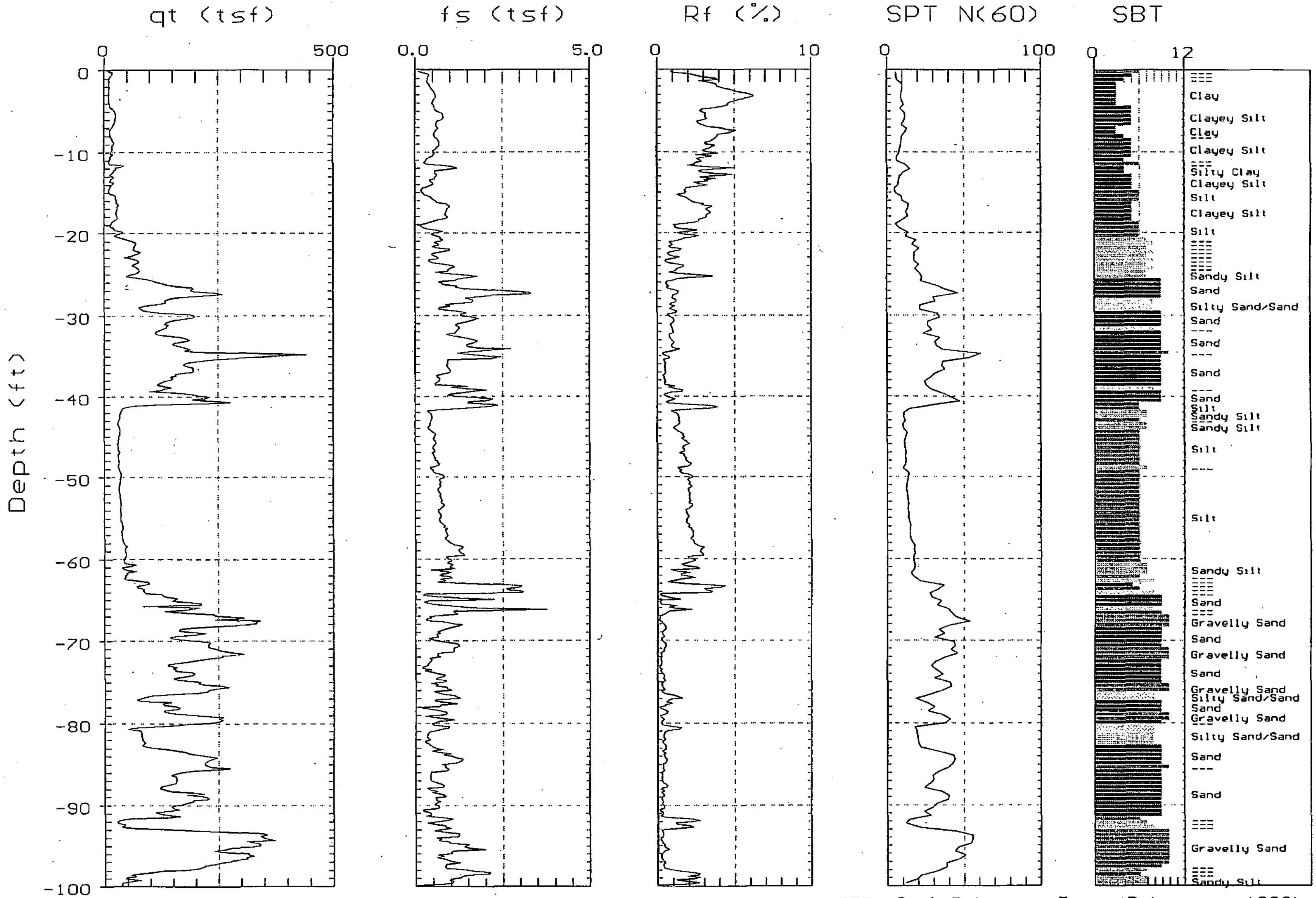
Max. Depth: 79.40 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)


GREGG
MACTEC
Site: N=363680.96 E=2943037.71
Location: C-309ELEV=30.69
Operator: R.AGUILLAR
Date: 12/14/06 12:47
qt (tsf)
fs (tsf)
Rf (%)
SPT N(60)
SBT
Depth (ft)
Clay
Silty Clay
Clayey Silt
Silty Clay
Silt
Clayey Silt
Clayey Silt
Sandy Silt
Silty Sand/Sand
Sand
Gravelly Sand
Sand
Silt
Clayey Silt
Silt
Clayey Silt
Silt
Silt
Clayey Silt
Clayey Silt
Silt
Silt
Sand
Sand
Gravelly Sand
Gravelly Sand
Sand
Gravelly Sand
Sand
Sand
Sand
Silty Sand/Sand
Sandy Silt
Silty Sand/Sand
Sand
Sandy Silt
Gravelly Sand
Max. Depth: 100.06 (ft)
Depth Inc.: 0.164 (ft)
SBT: Soil Behavior Type (Robertson 1990)

GREGG MACTEC

Site: N=363792.39 E=2943037.94 Operator: R.AGUILLAR
Location: C-310ELEV=31.38 Date: 12/12/06 09:17

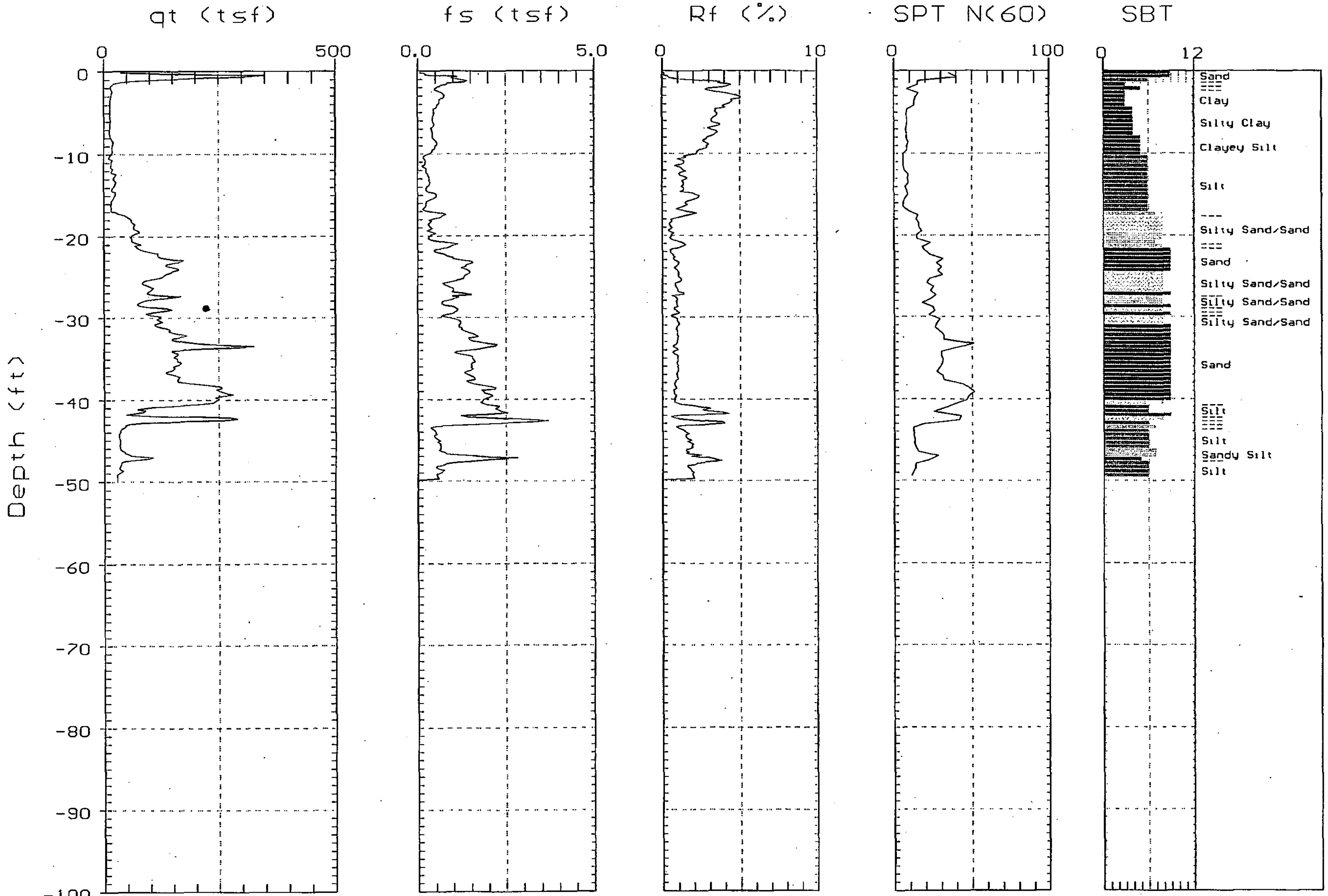


Max. Depth: 100.06 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)

MACTEC

Site: N=362772.46 E=2942547.21 Operator: R.AGUILLAR
Location: C-401ELEV=31.08 Date: 12/01/06 08:27

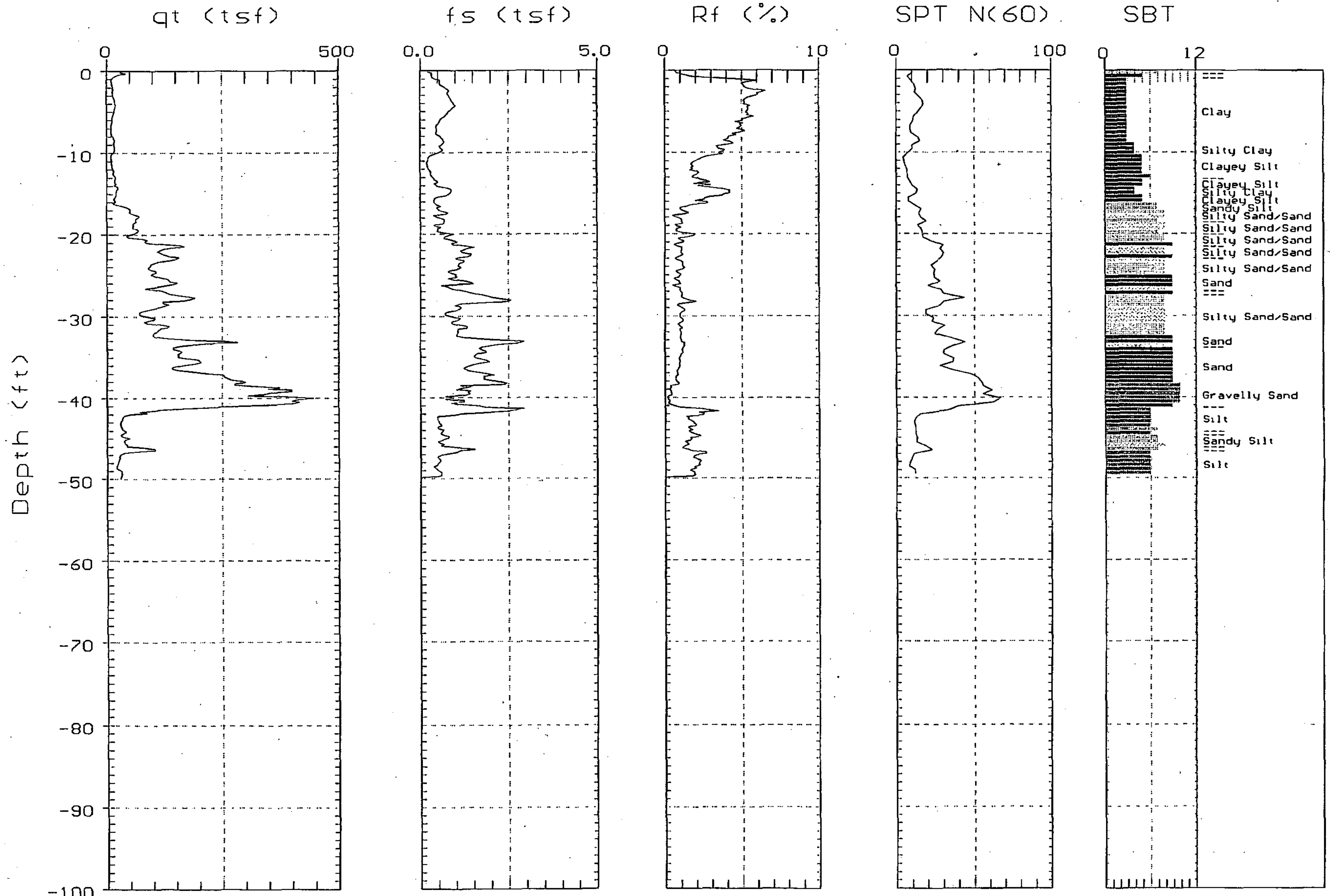


Max. Depth: 50.03 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)

MACTEC

Site: N=362824.68 E=2942600.77 Operator: R.AGUILLAR
Location: C-402ELEV=30.82 Date: 12/01/06 09:24



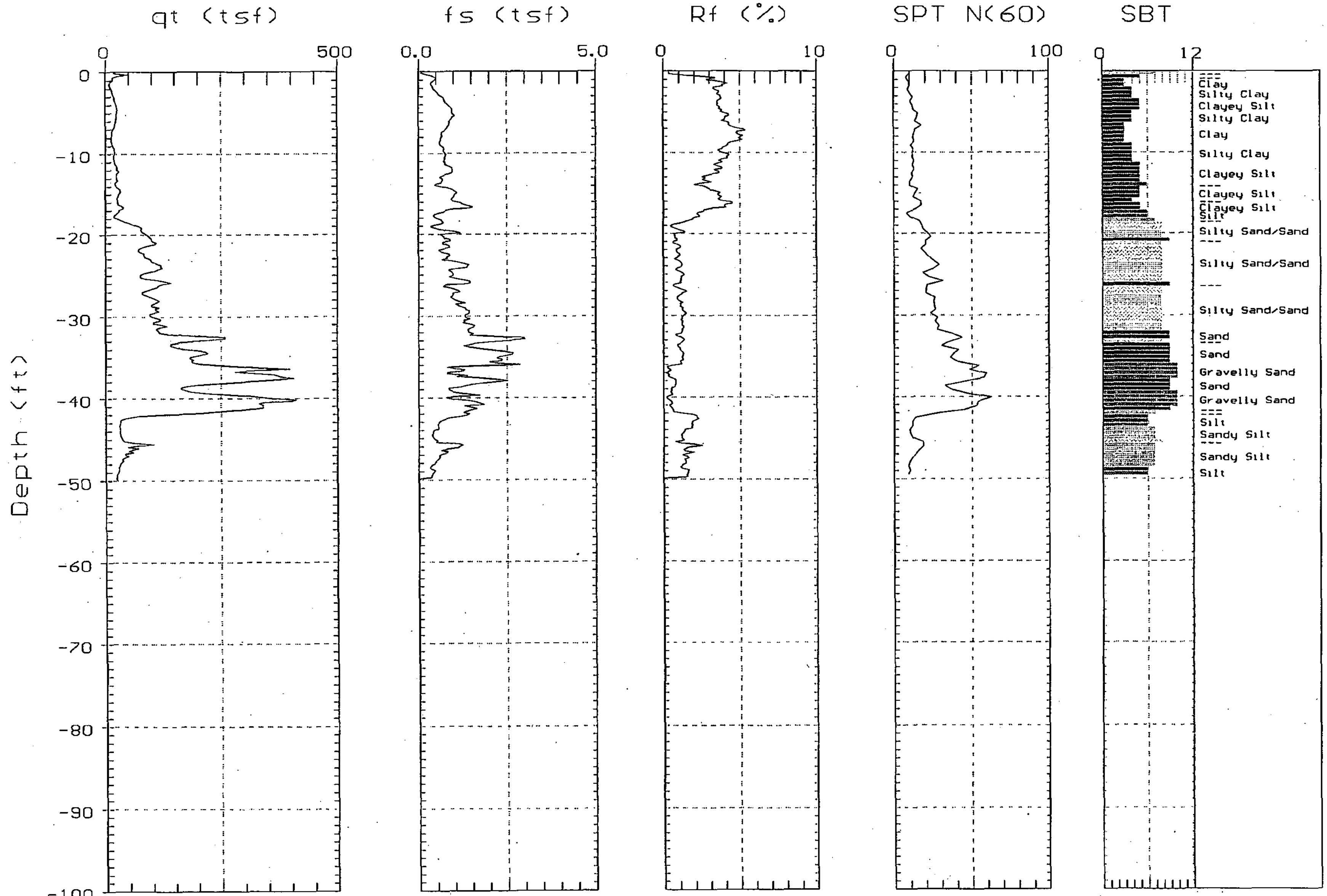
Max. Depth: 50.03 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)

GREGG

MACTEC

Site: N=362825.36 E=2942289.73 Operator: R.AGUILLAR
Location: C-403ELEV=31.59 Date: 12/01/06 07:04



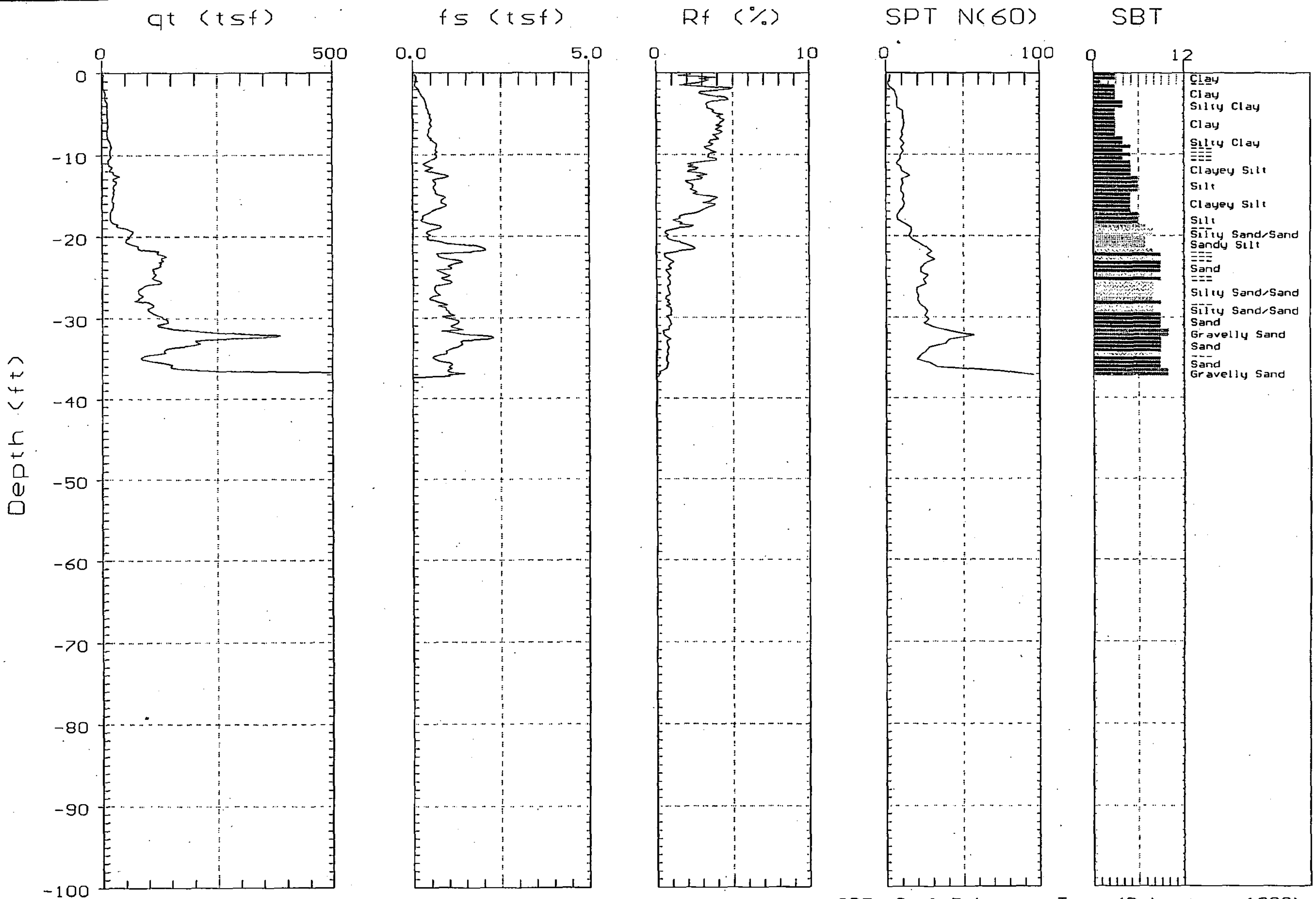
Max. Depth: 50.03 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)

GREGG

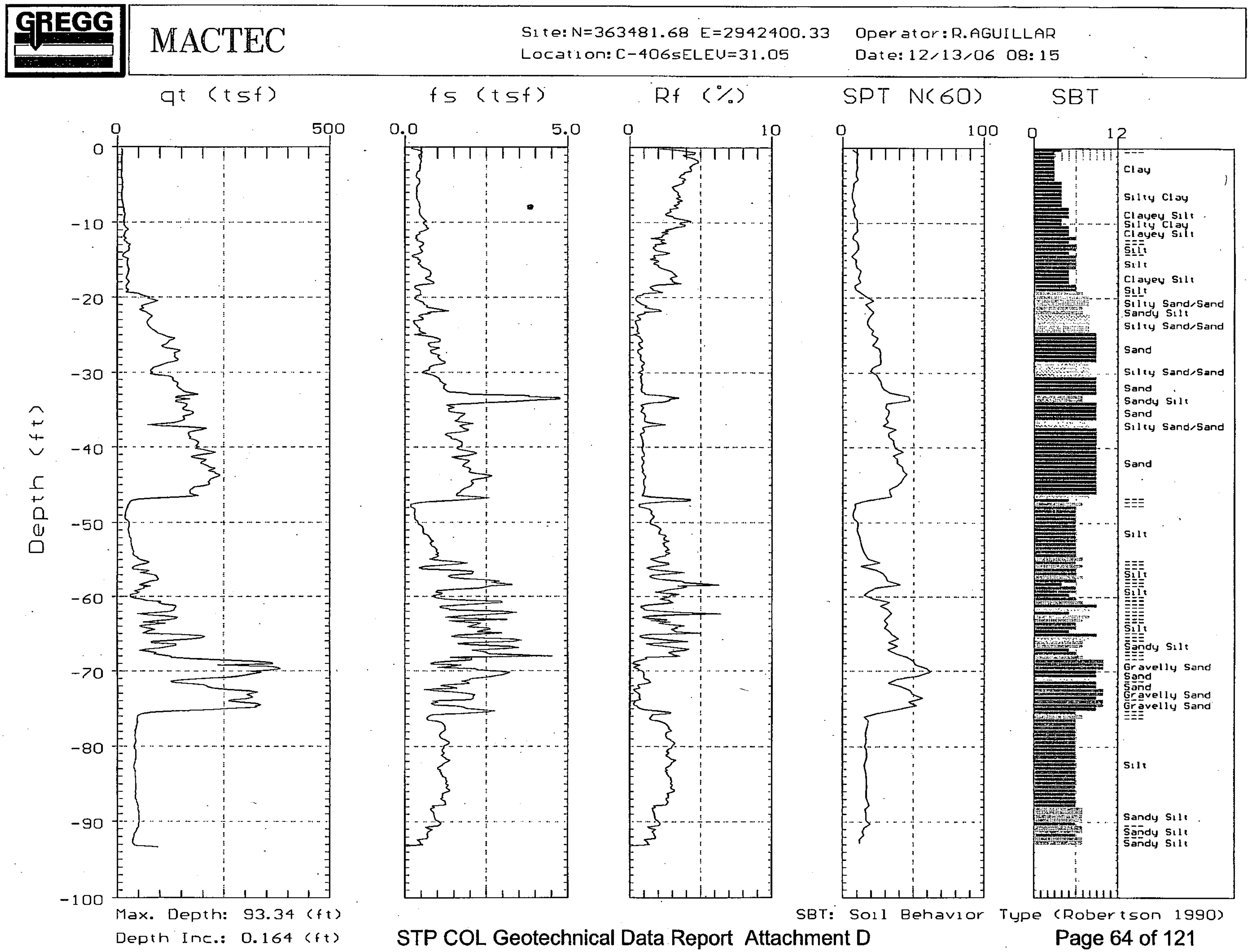
MACTEC

Site: N=362912.73 E=2942499.09 Operator: R.AGUILLAR
Location: C-404ELEV=31.38 Date: 12/19/06 06:32



Max. Depth: 37.57 (ft)
Depth Inc.: 0.164 (ft)

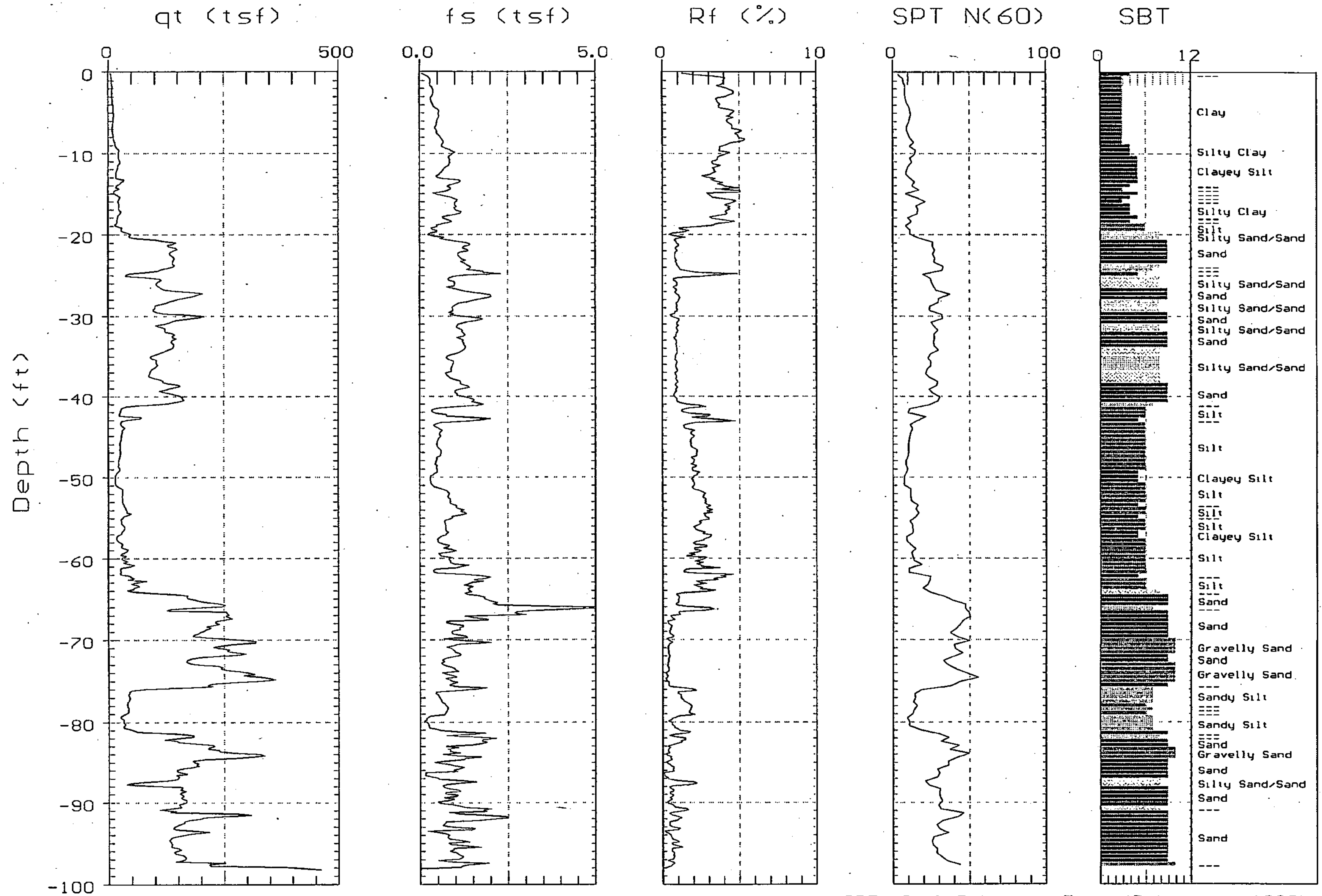
SBT: Soil Behavior Type (Robertson 1990)


GREGG
MACTEC
Site: N=363481.68 E=2942400.33
Location: C-406sELEV=31.05
Operator: R.AGUILLAR
Date: 12/13/06 08:15
qt (tsf)
fs (tsf)
Rf (%)
SPT N(60)
SBT
Depth (ft)
Clay
Silty Clay
Clayey Silt
Silt
Silty Sand/Sand
Sandy Silt
Sand
Gravelly Sand
Max. Depth: 93.34 (ft)
Depth Inc.: 0.164 (ft)
SBT: Soil Behavior Type (Robertson 1990)

GREGG

MACTEC

Site: N=363570.38 E=2942507.31 Operator: R.AGUILLAR
Location: C-407sELEV=30.79 Date: 12/12/06 06:11



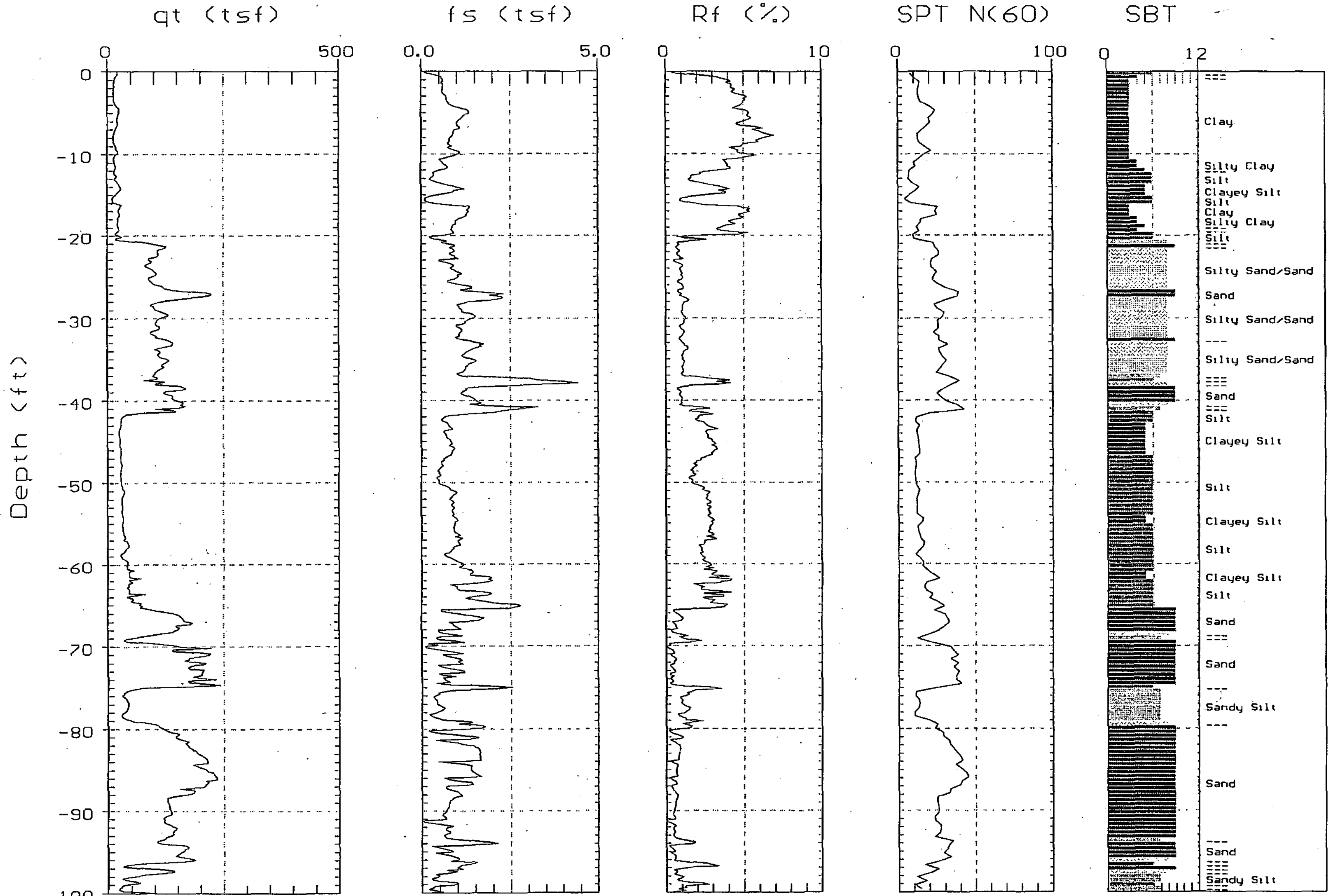
Max. Depth: 98.26 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)

GREGG

MACTEC

Site: N=363710.02 E=2942579.59 Operator: R.AGUILLAR
Location: C-408ELEV=31.70 Date: 12/06/06 06:51



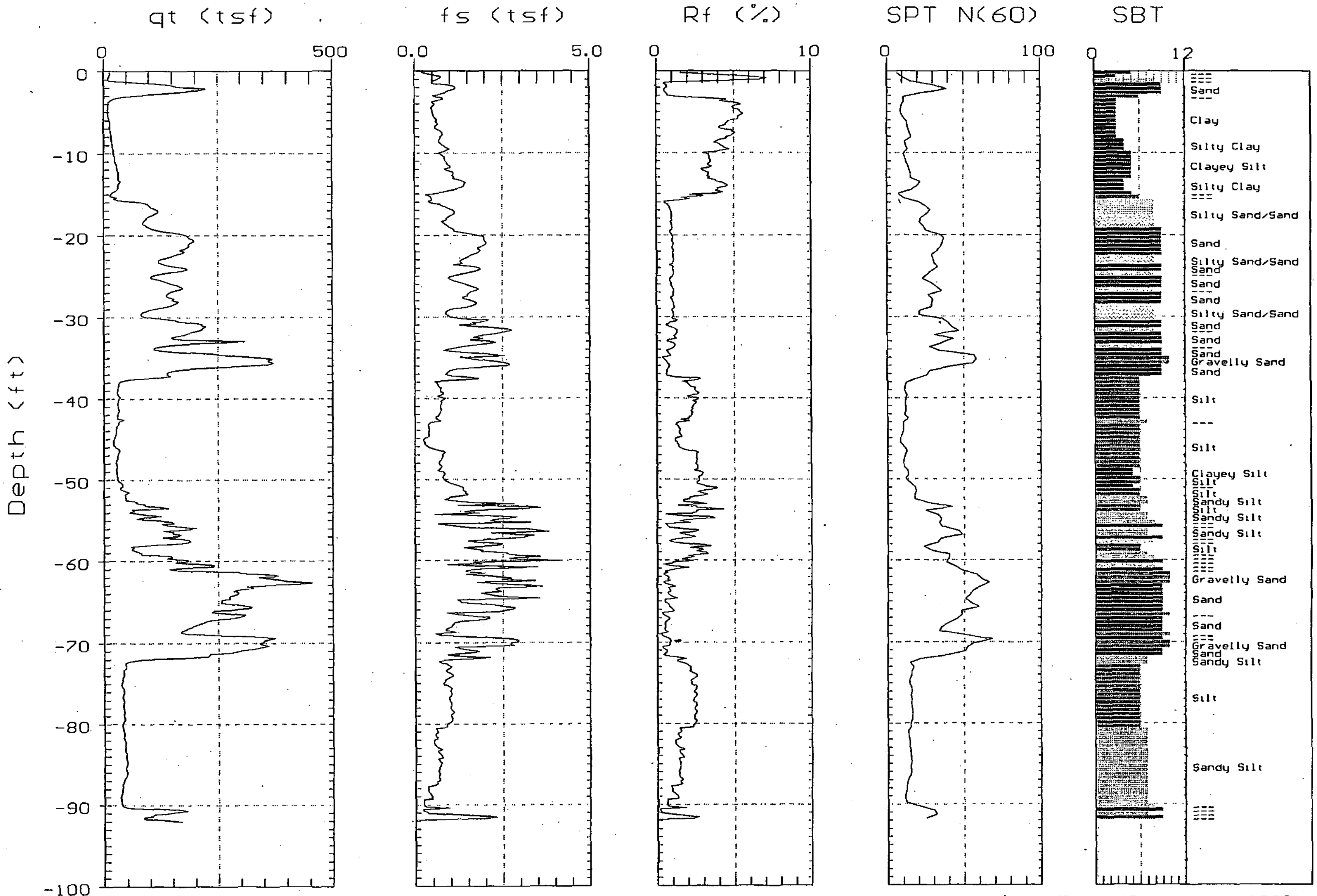
Max. Depth: 100.23 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)

GREGG

MACTEC

Site: N=363678.81 E=2942142.10 Operator: R.AGUILLAR
Location: C-409ELEV=27.93 Date: 12/02/06 12:36



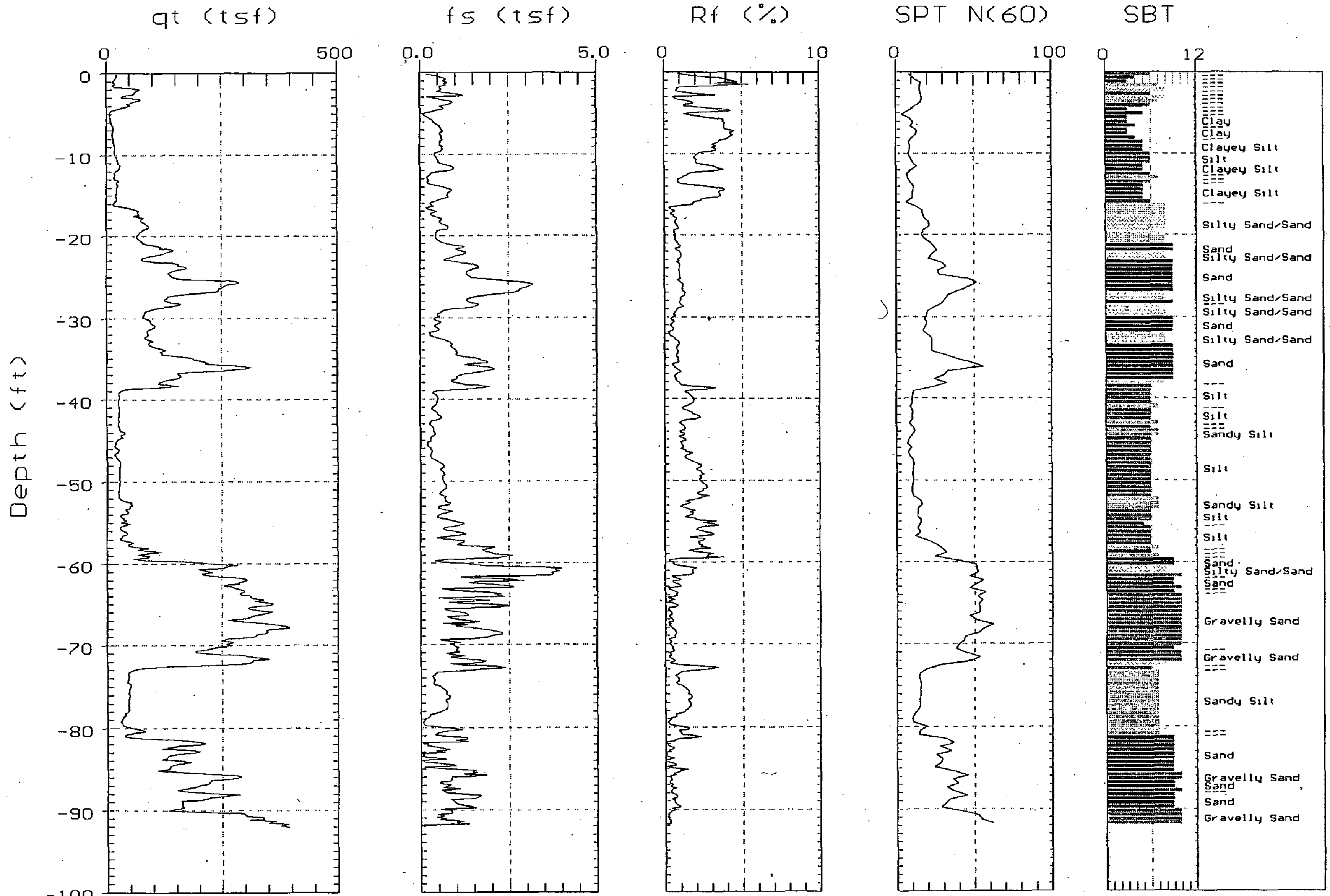
Max. Depth: 92.03 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)

GREGG

MACTEC

Site: N=363788.88 E=2942140.63 Operator: R.AGUILLAR
Location: C-410ELEV=28.93 Date: 12/05/06 12:44



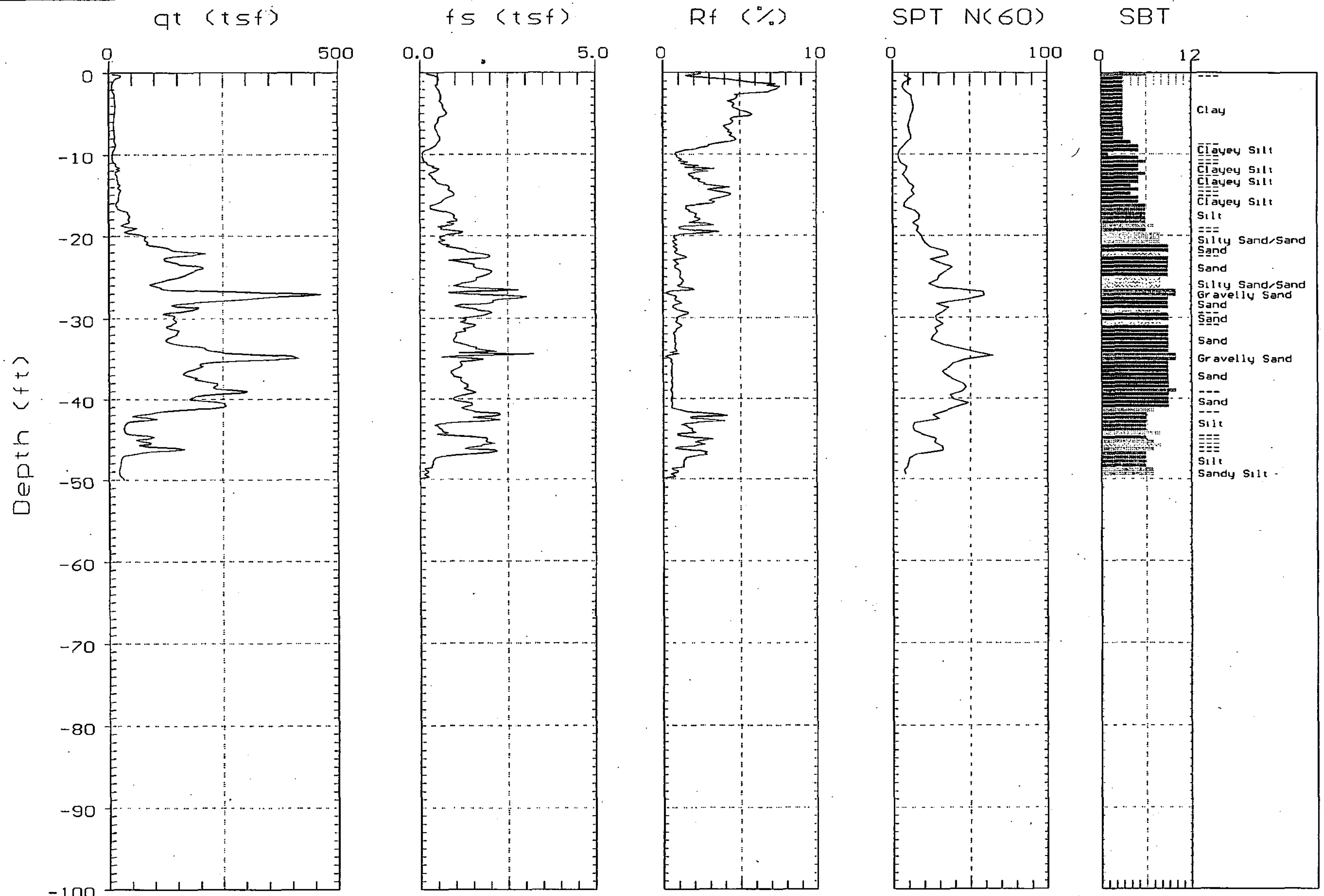
Max. Depth: 92.03 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)

GREGG

MACTEC

Site: N=362902.74 E=2942803.77 Operator: R.AGUILLAR
Location: C-411ELEV=31.10 Date: 12/02/06 06:37



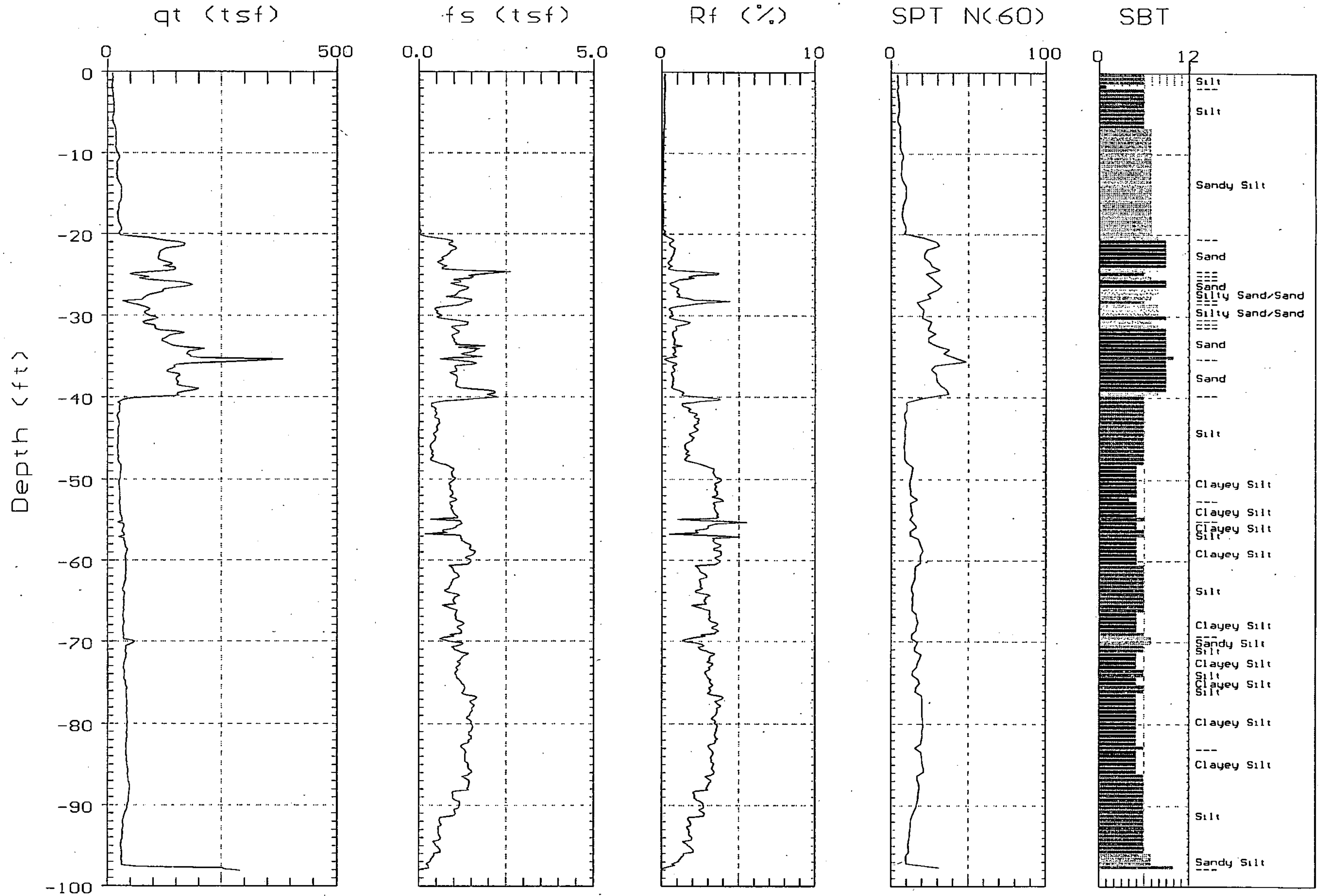
Max. Depth: 50.03 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)

GREGG

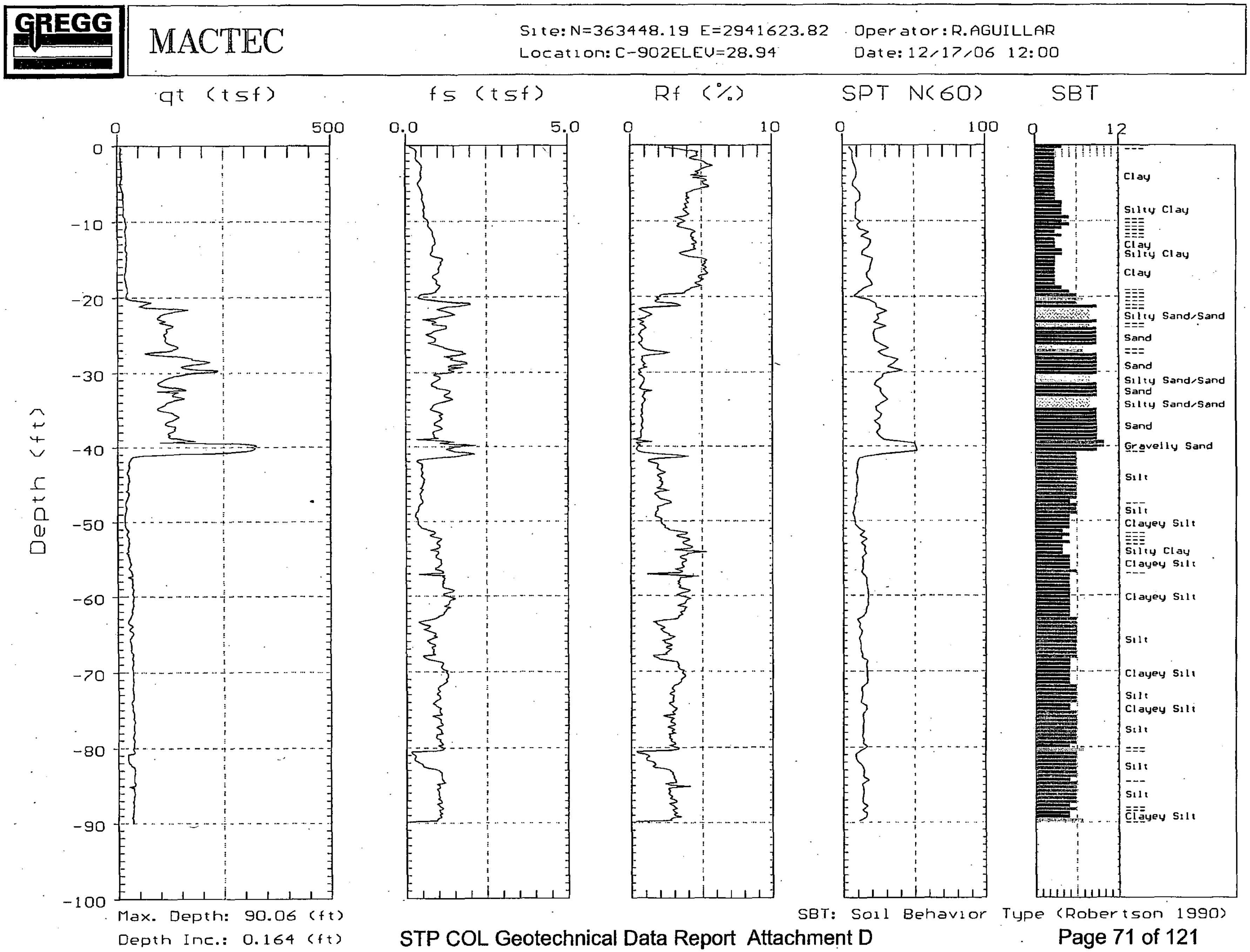
MACTEC

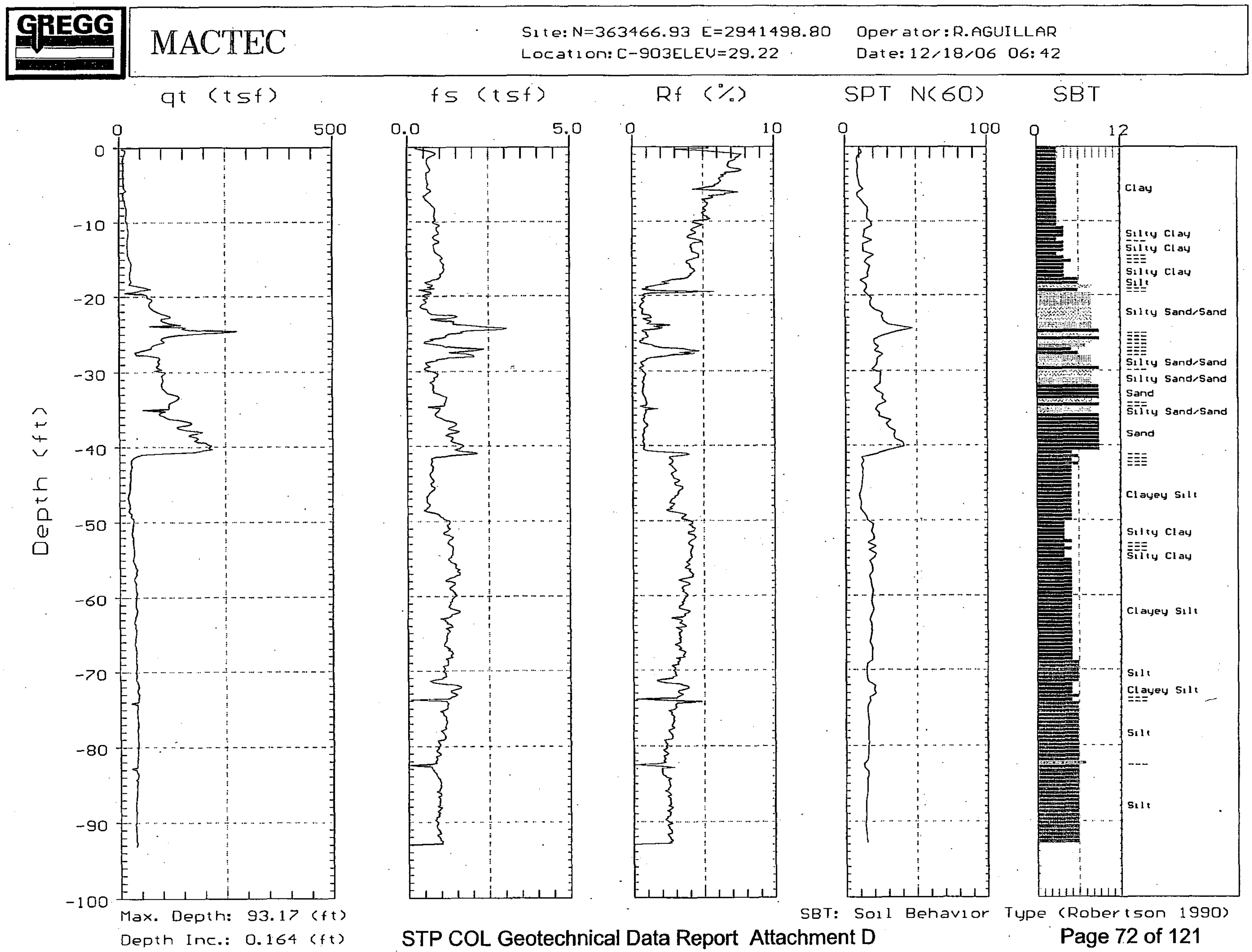
Site: N=363539.44 E=2941694.20 Operator: R.AGUILLAR
Location: C-901ELEV=29.57 Date: 12/17/06 08:28



Max. Depth: 98.10 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)

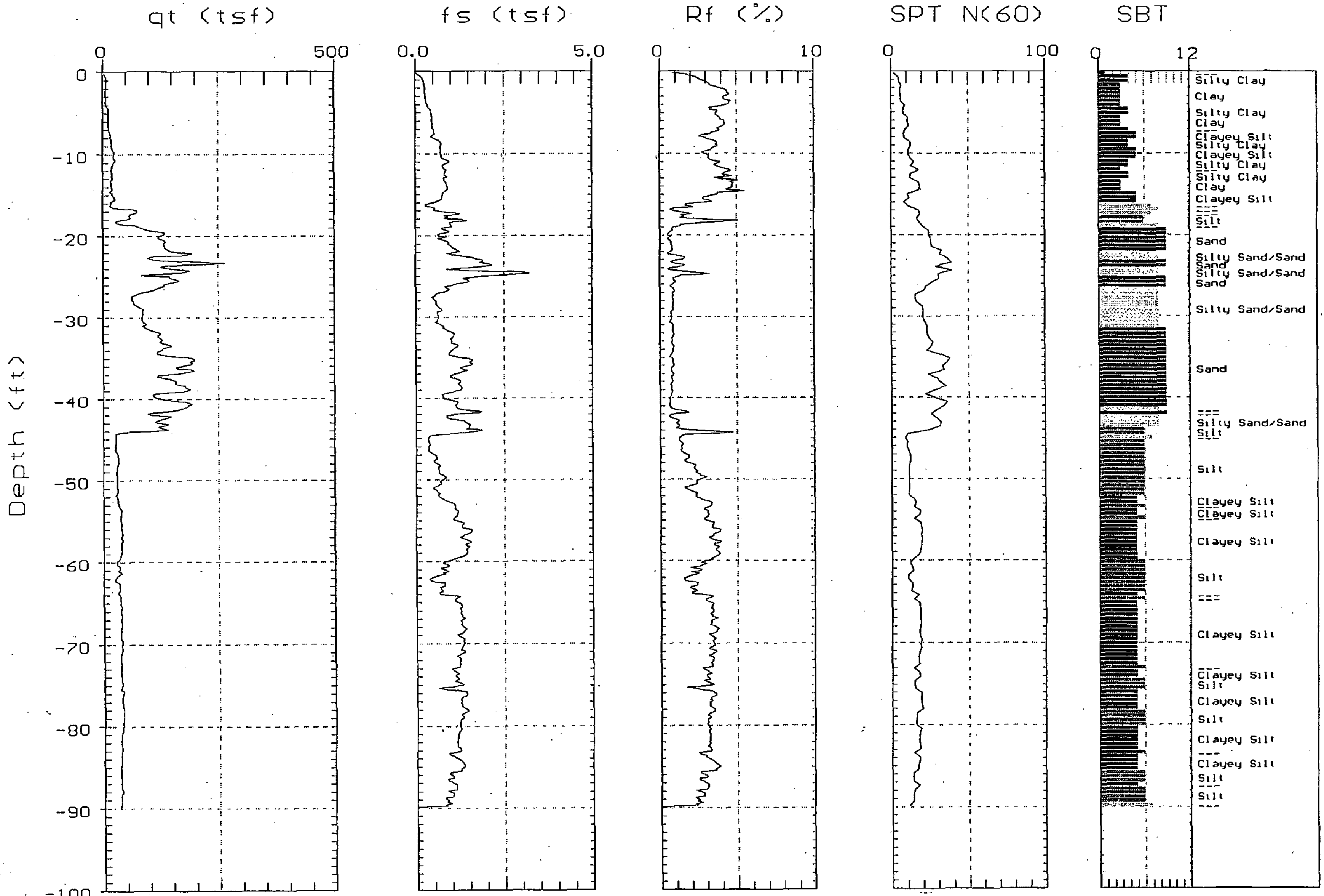

GREGG
MACTEC
Site: N=363448.19 E=2941623.82
Location: C-902ELEV=28.94
Operator: R.AGUILLAR
Date: 12/17/06 12:00
qt (tsf)
fs (tsf)
Rf (%)
SPT N(60)
SBT
Depth (ft)
Clay
Silty Clay
Clay
Silty Clay
Clay
Silty Sand/Sand
Sand
Sand
Silty Sand/Sand
Sand
Silty Sand/Sand
Sand
Gravelly Sand
Silt
Silt
Clayey Silt
Silty Clay
Clayey Silt
Clayey Silt
Silt
Clayey Silt
Silt
Clayey Silt
Silt
Silt
Silt
Clayey Silt
Max. Depth: 90.06 (ft)
Depth Inc.: 0.164 (ft)
SBT: Soil Behavior Type (Robertson 1990)


GREGG
MACTEC
Site: N=363466.93 E=2941498.80
Location: C-903ELEV=29.22
Operator: R.AGUILLAR
Date: 12/18/06 06:42
qt (tsf)
fs (tsf)
Rf (%)
SPT N(60)
SBT
Depth (ft)
Clay
Silty Clay
Silty Clay
Silty Clay
Silt
Silty Sand/Sand
Silty Sand/Sand
Silty Sand/Sand
Sand
Silty Sand/Sand
Sand
Clayey Silt
Silty Clay
Silty Clay
Clayey Silt
Silt
Clayey Silt
Silt
Silt
Max. Depth: 93.17 (ft)
Depth Inc.: 0.164 (ft)
SBT: Soil Behavior Type (Robertson 1990)

GREGG

MACTEC

Site: N=363392.47 E=2941651.23 Operator: R.AGUILLAR
Location: C-904ELEV=24.17 Date: 12/20/06 05:40



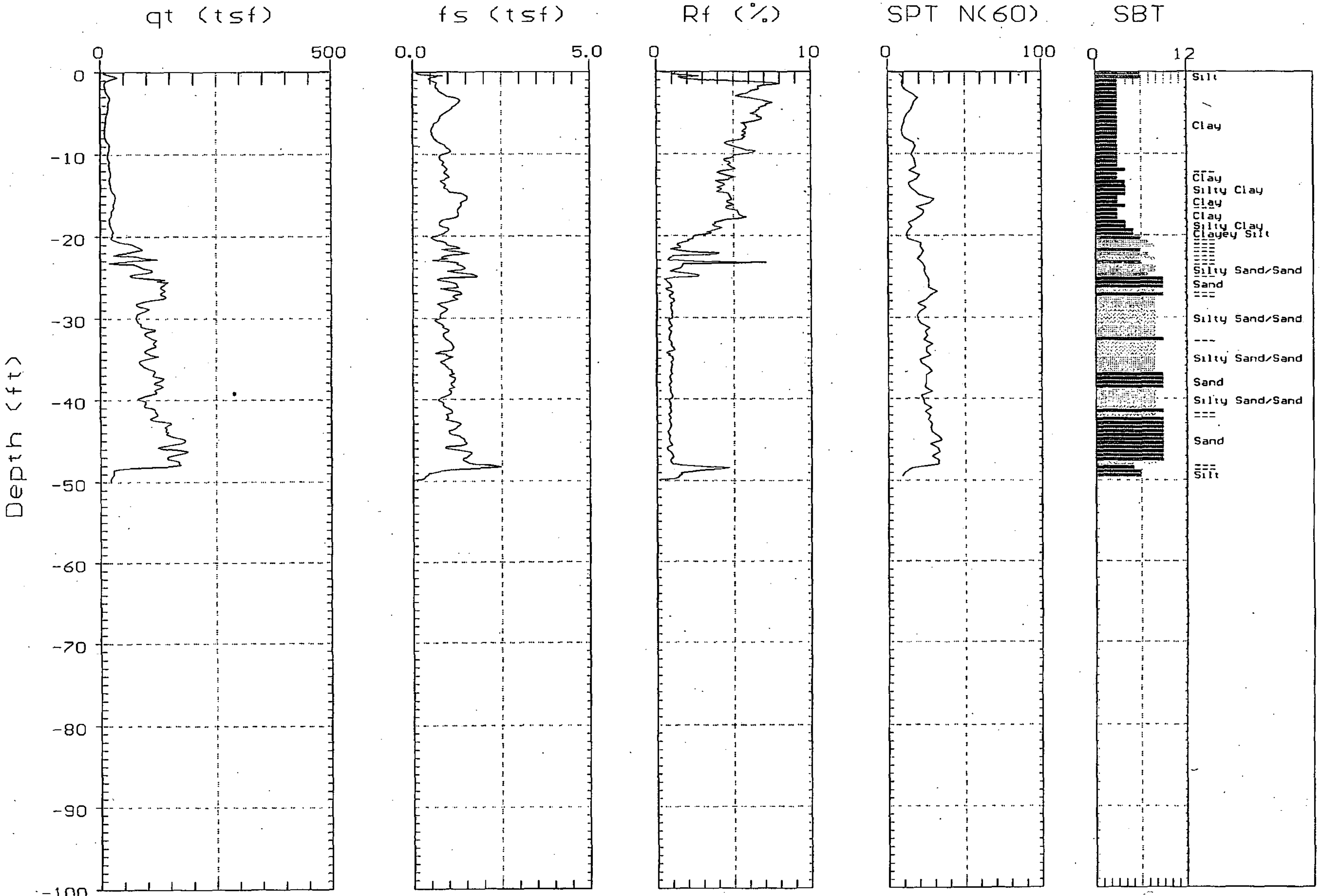
Max. Depth: 90.06 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)

GREGG

MACTEC

Site: N=363298.98 E=2941713.69 Operator: R.AGUILLAR
Location: C-905ELEV=31.21 Date: 12/13/06 14:28



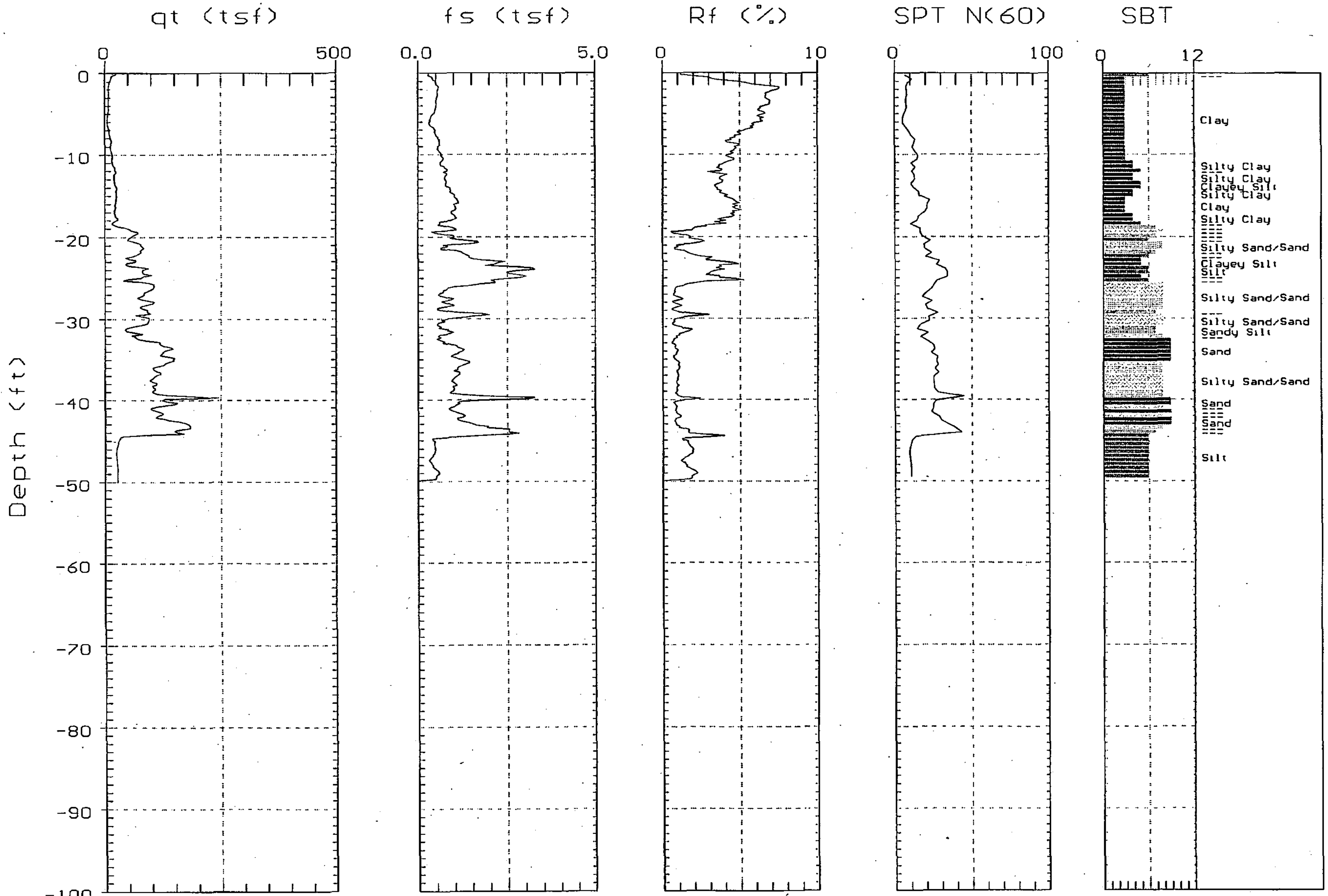
Max. Depth: 50.03 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)

GREGG

MACTEC

Site: N=363212.72 E=2941758.97 Operator: R.AGUILLAR
Location: C-906ELEV=30.19 Date: 12/18/06 12:40



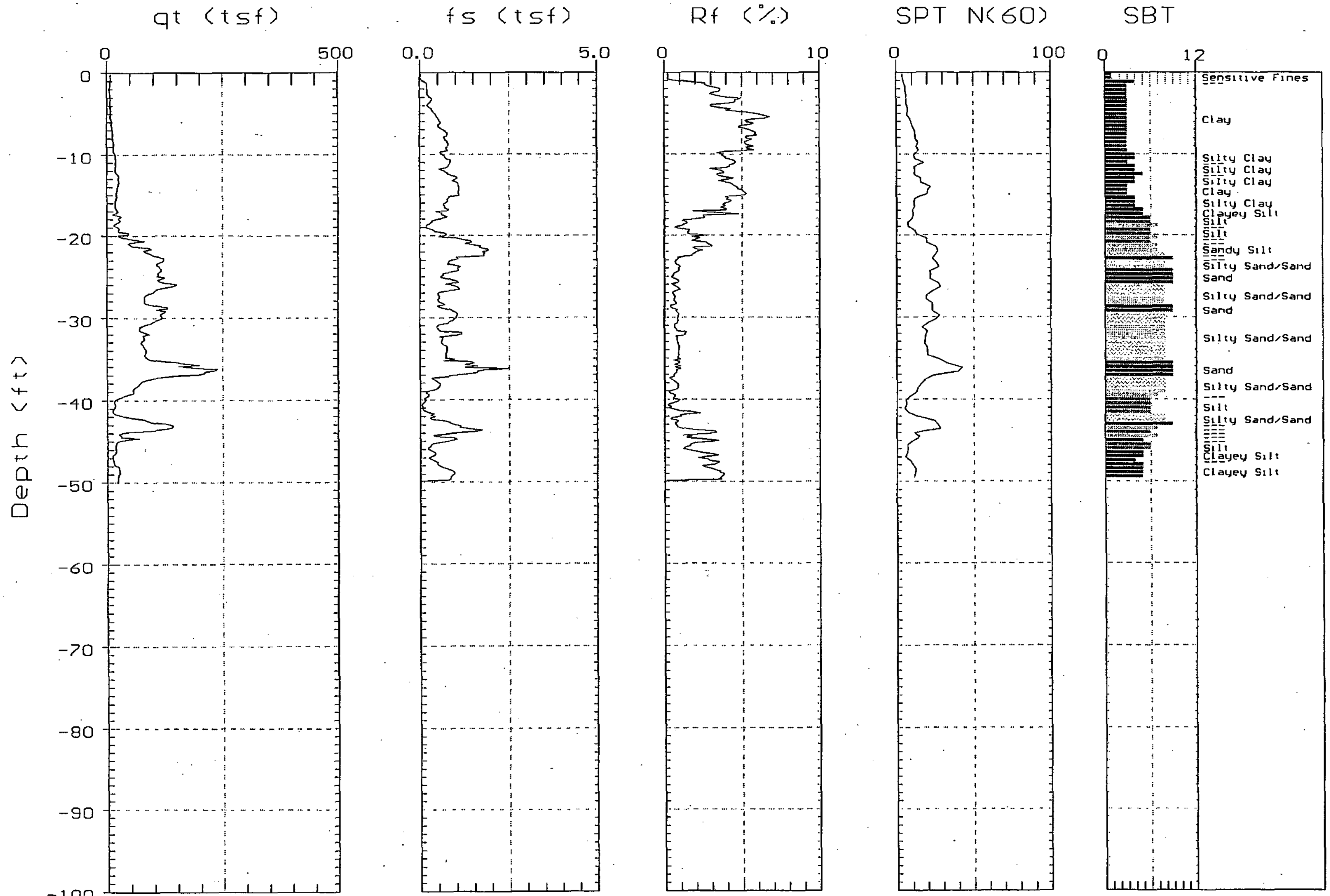
Max. Depth: 50.03 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)

GREGG

MACTEC

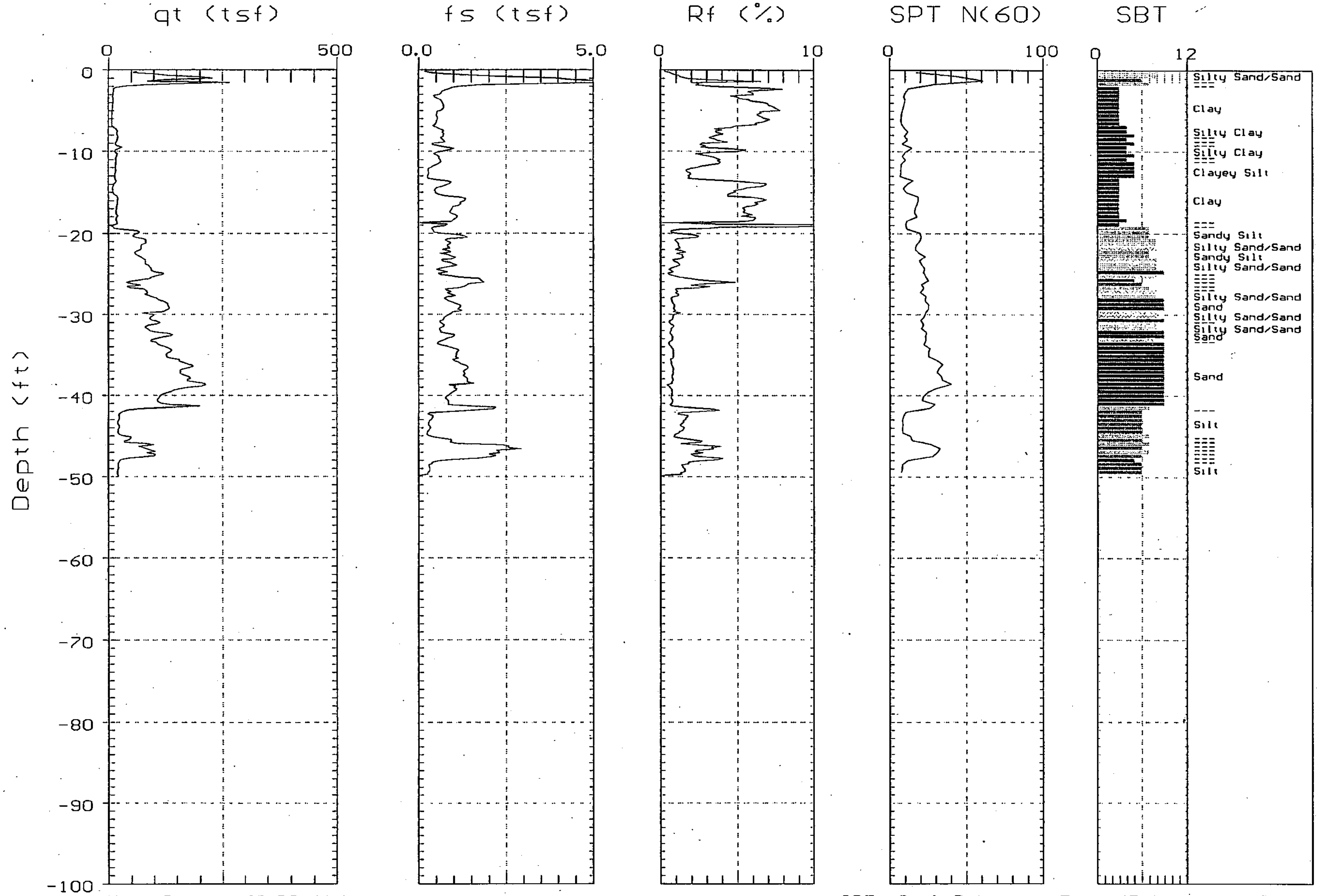
Site: N=363219.02 E=2941968.73 Operator: R.AGUILLAR
Location: C-907ELEV=28.53 Date: 12/16/06 13:57



Max. Depth: 50.03 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)

GREGG | MACTEC | Site: N=363219.72 E=2942082.33 Operator: R.AGUILLAR
Location: C-908ELEV=30.89 Date: 12/16/06 13:11

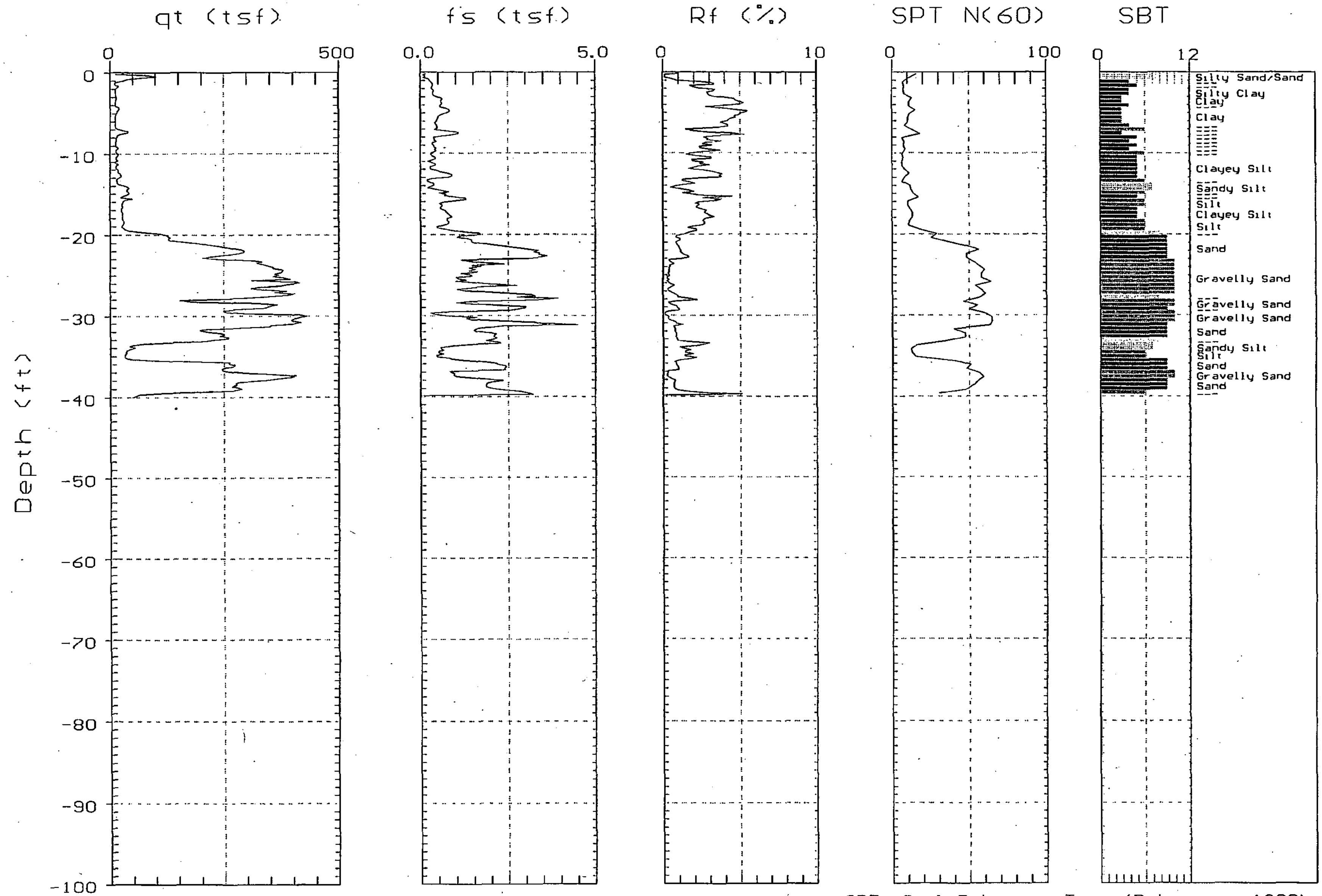


Max. Depth: 50.03 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)

MACTEC

Site: N=363464.25 E=2943948.29 Operator: R.AGUILLAR
Location: C-909ELEV=30.22 Date: 12/02/06 08:08



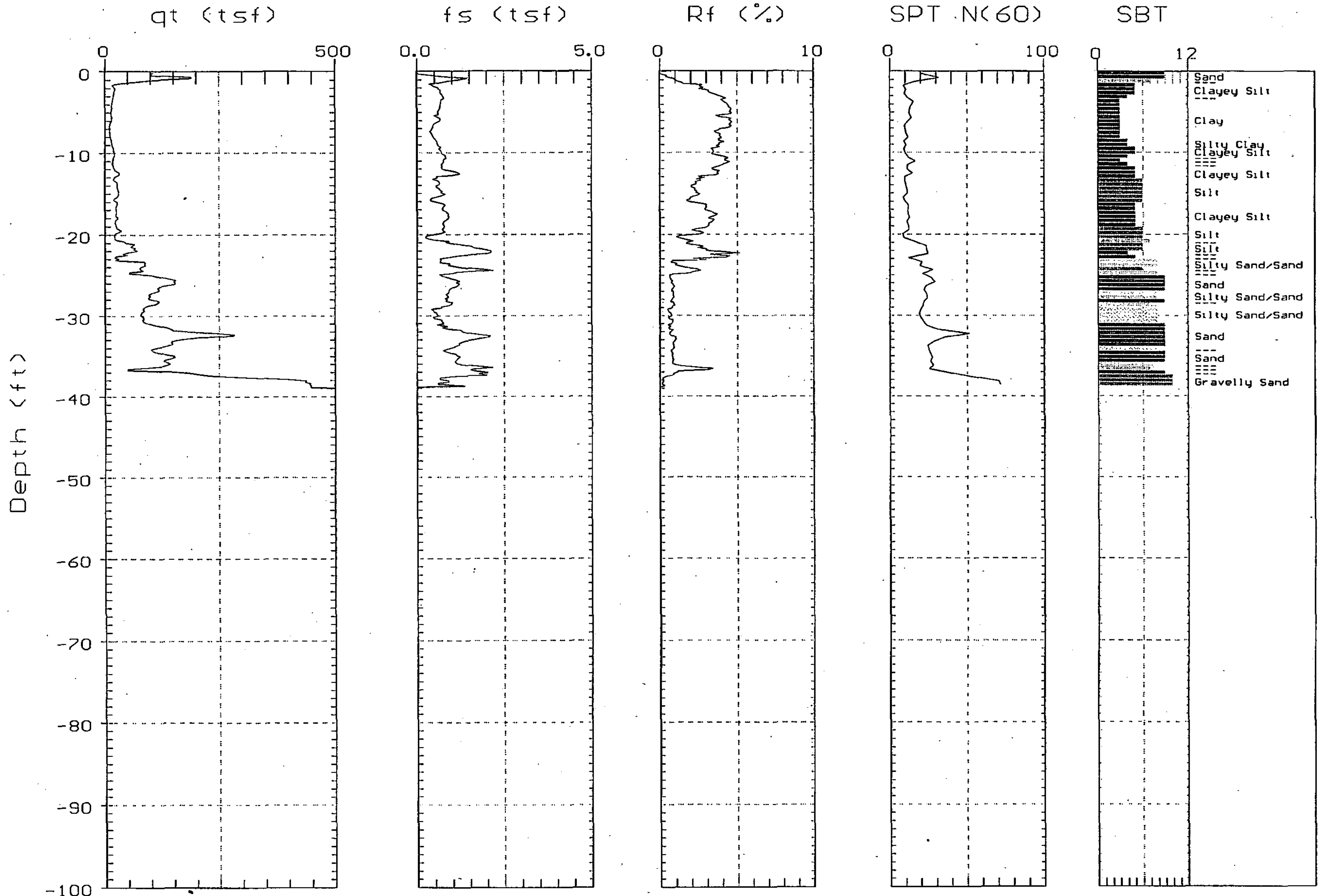
Max. Depth: 40.03 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)

GREGG

MACTEC

Site: N=363217.32 E=2942280.50 Operator: R.AGUILLAR
Location: C-916ELEV=31.41 Date: 12/17/06 06:18

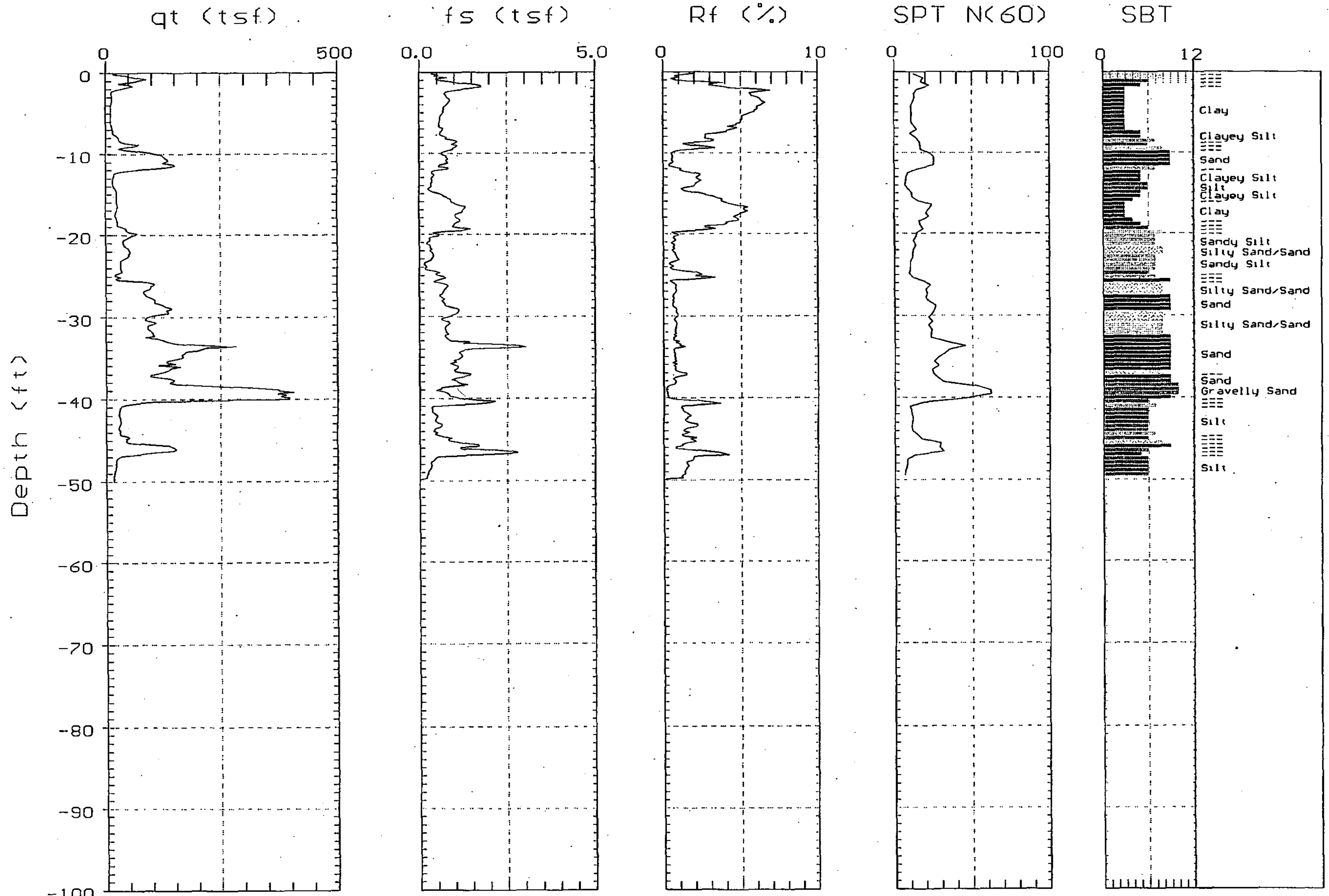


Max. Depth: 39.04 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)

MACTEC

Site: N=363281.30 E=2942122.51 Operator: R.AGUILLAR
Location: C-917ELEV=30.65 Date: 12/19/06 11:03

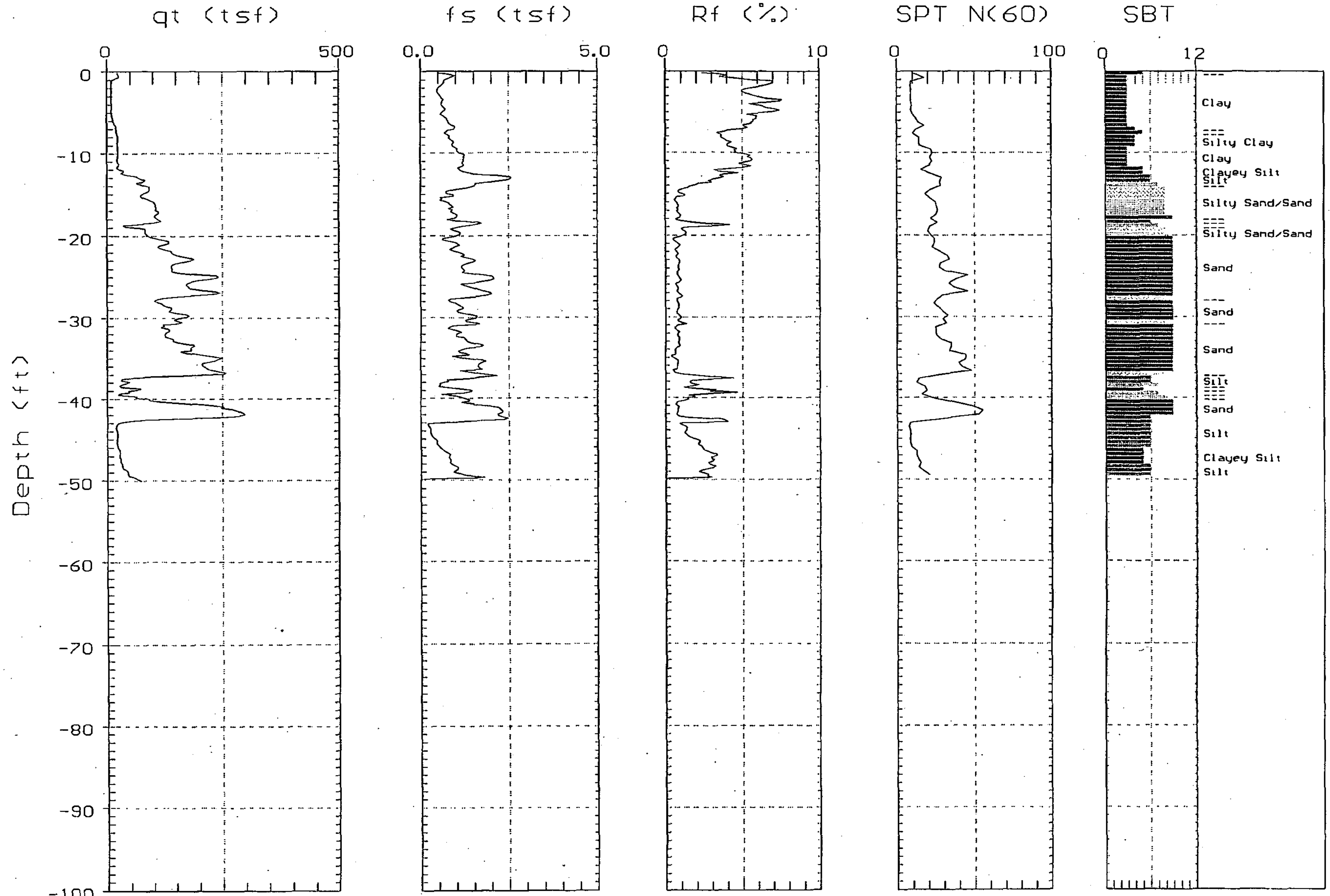


Max. Depth: 50.03 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)

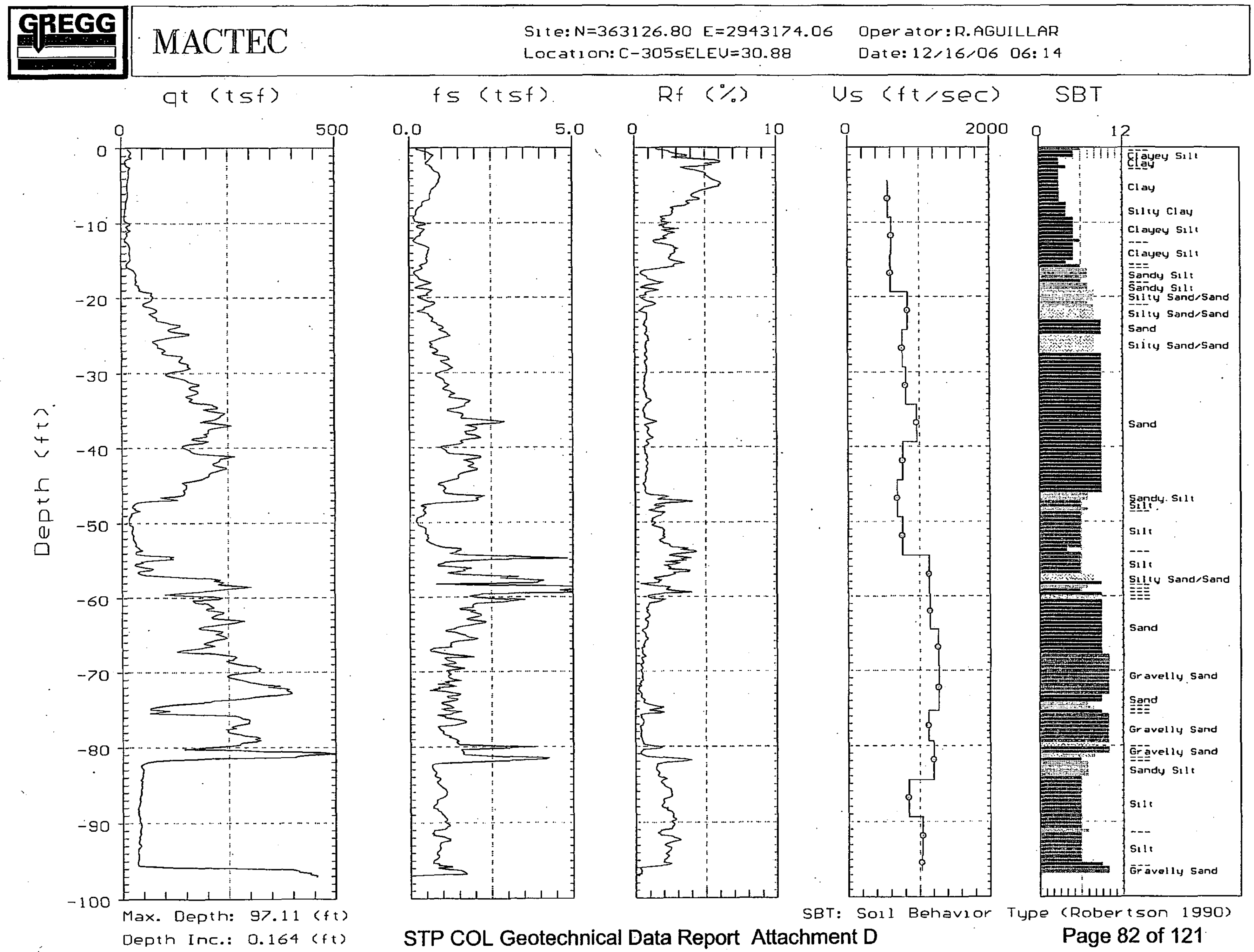
MACTEC

Site: N=363484.09 E=2942118.30 Operator: R.AGUILLAR
Location: C-918ELEV=25.36 Date: 12/18/06 10:33



Max. Depth: 50.03 (ft)
Depth Inc.: 0.164 (ft)

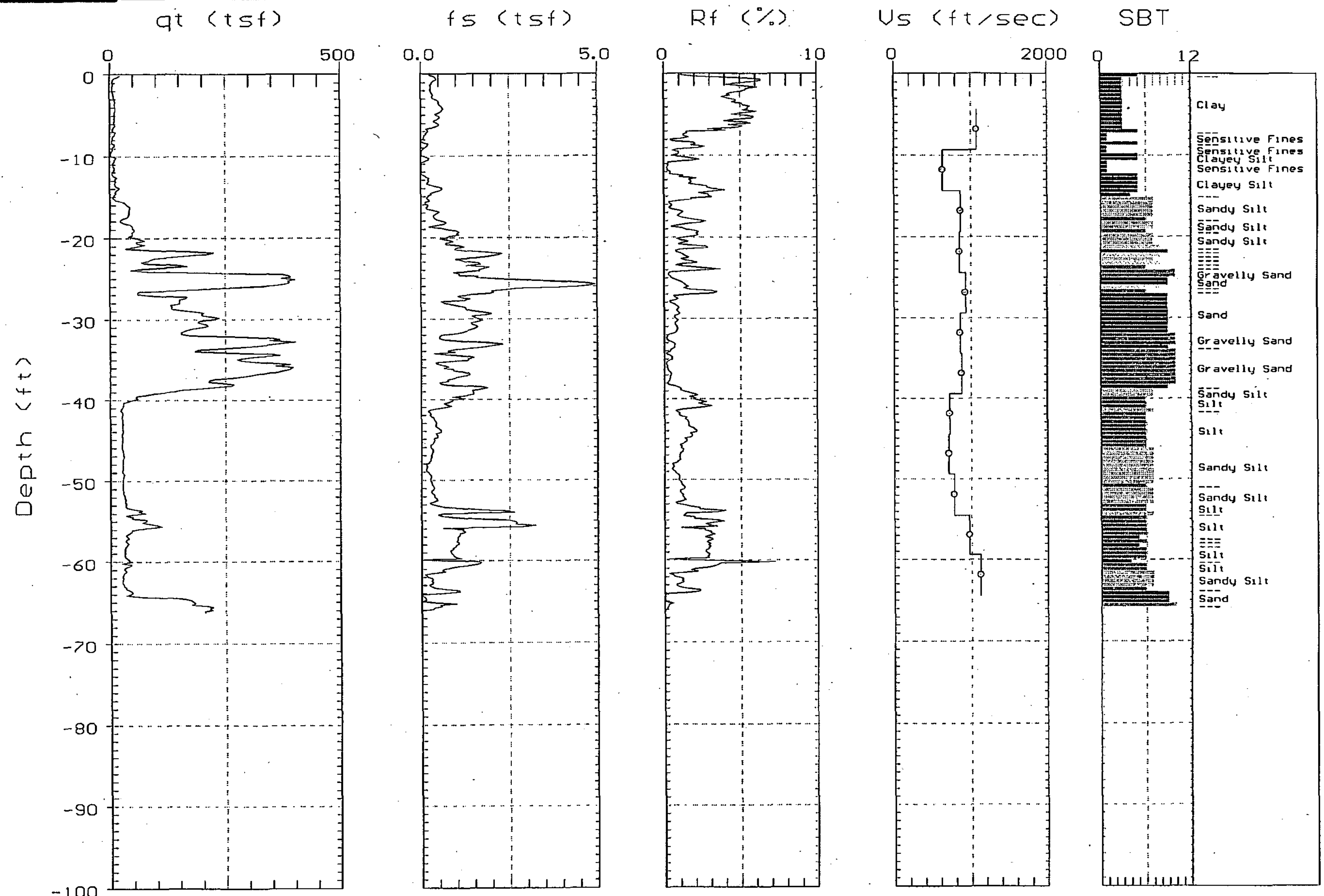
SBT: Soil Behavior Type (Robertson 1990)


GREGG
MACTEC
Site: N=363126.80 E=2943174.06
Location: C-305sELEV=30.88
Operator: R.AGUILLAR
Date: 12/16/06 06:14
qt (tsf)
fs (tsf)
Rf (%)
Vs (ft/sec)
SBT
Depth (ft)
Clayey Silt
Clay
Clay
Silty Clay
Clayey Silt
Clayey Silt
Sandy Silt
Sandy Silt
Silty Sand/Sand
Silty Sand/Sand
Sand
Silty Sand/Sand
Sand
Sandy Silt
Silt
Silt
Silt
Silty Sand/Sand
Sand
Gravelly Sand
Sand
Gravelly Sand
Gravelly Sand
Sandy Silt
Silt
Silt
Gravelly Sand
Max. Depth: 97.11 (ft)
Depth Inc.: 0.164 (ft)
SBT: Soil Behavior Type (Robertson 1990)

GREGG

MACTEC

Site: N=363483.22 E=2943296.00 Operator: R.AGUILLAR
Location: C-306sELEV=29.68 Date: 11/30/06 06:37

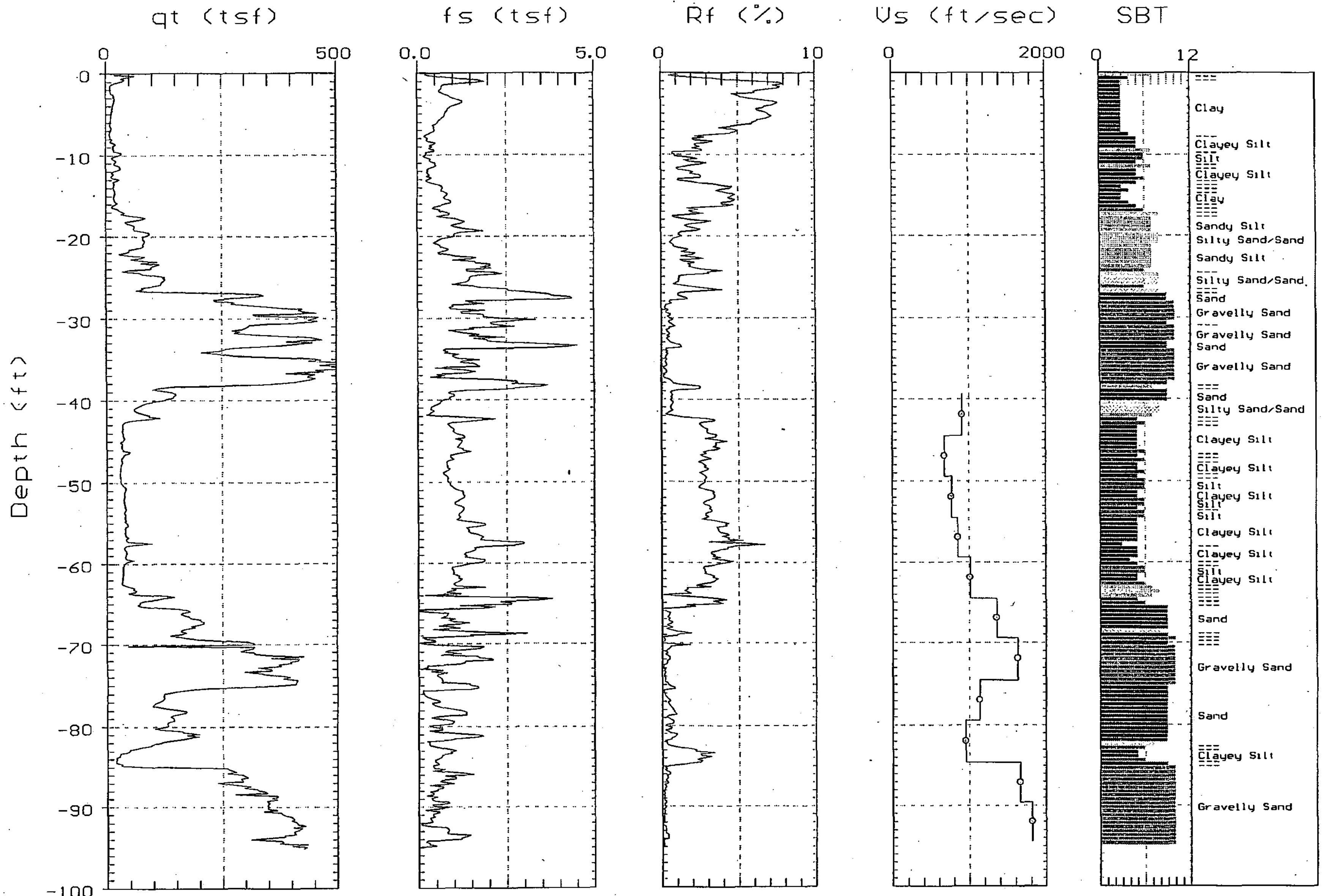


Max. Depth: 66.27 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)

GREGG MACTEC

Site:N=363573.00 E=2943407.68 Operator:R.AGUILLAR
Location:C-307sELEV=30.02 Date:12/14/06 07:52



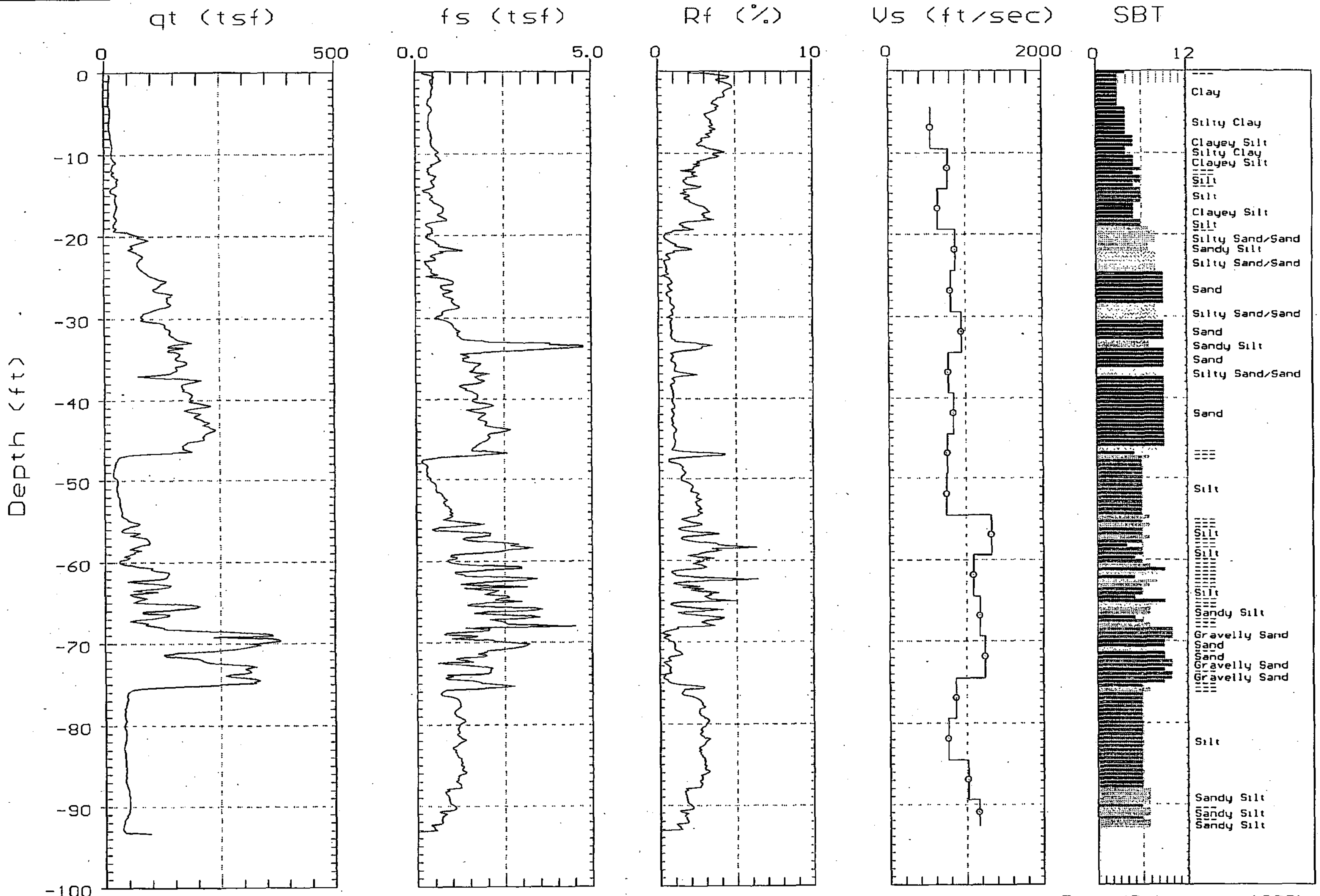
Max. Depth: 95.14 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)

GREGG

MACTEC

Site: N=363481.68 E=2942400.33 Operator: R.AGUILLAR
Location: C-406sELEV=31.05 Date: 12/13/06 08:15



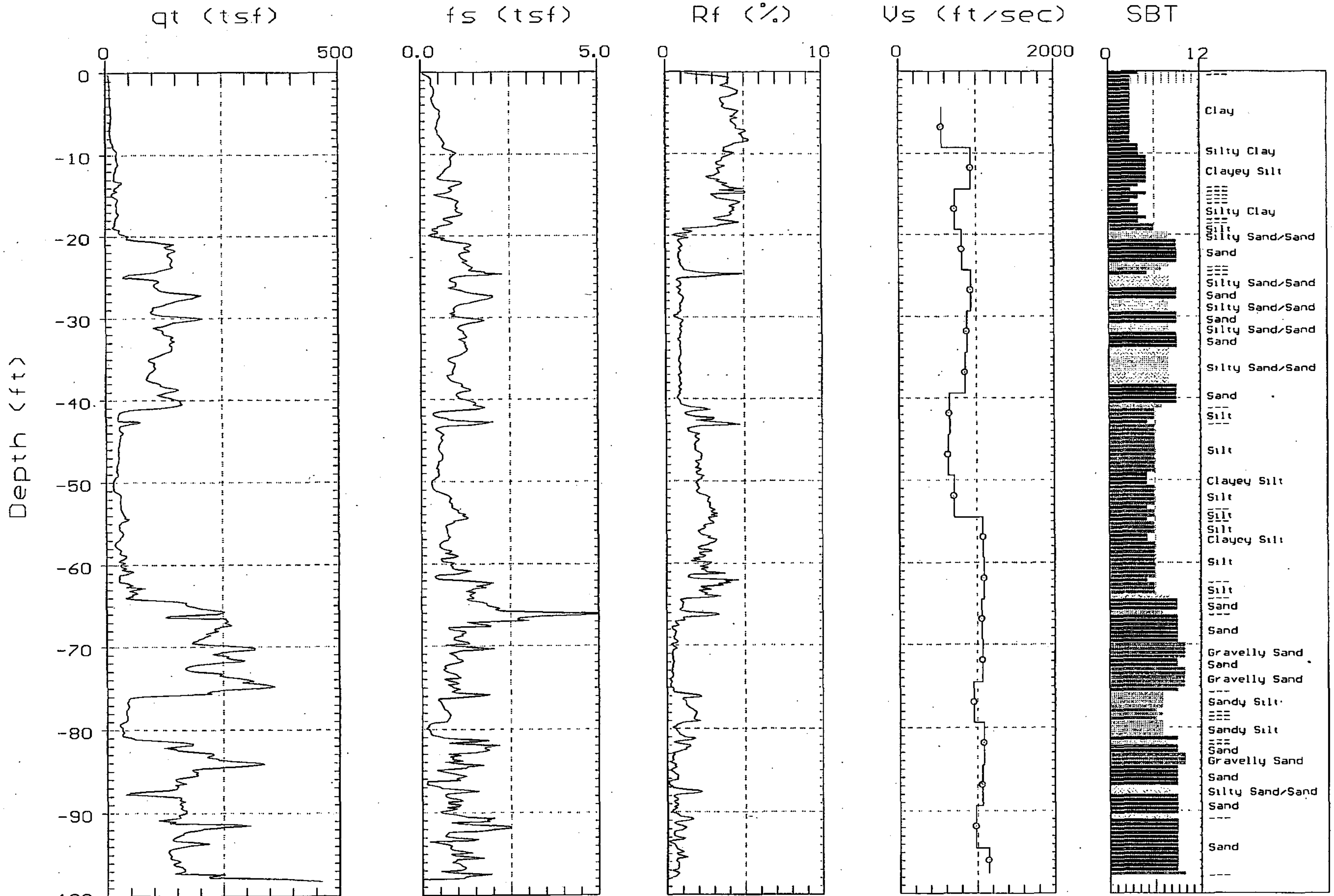
Max. Depth: 93.34 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)

GREGG

MACTEC

Site: N=363570.38 E=2942507.31 Operator: R.AGUILLAR
Location: C-407sELEV=30.79 Date: 12/12/06 06:11



Max. Depth: 98.26 (ft)
Depth Inc.: 0.164 (ft)

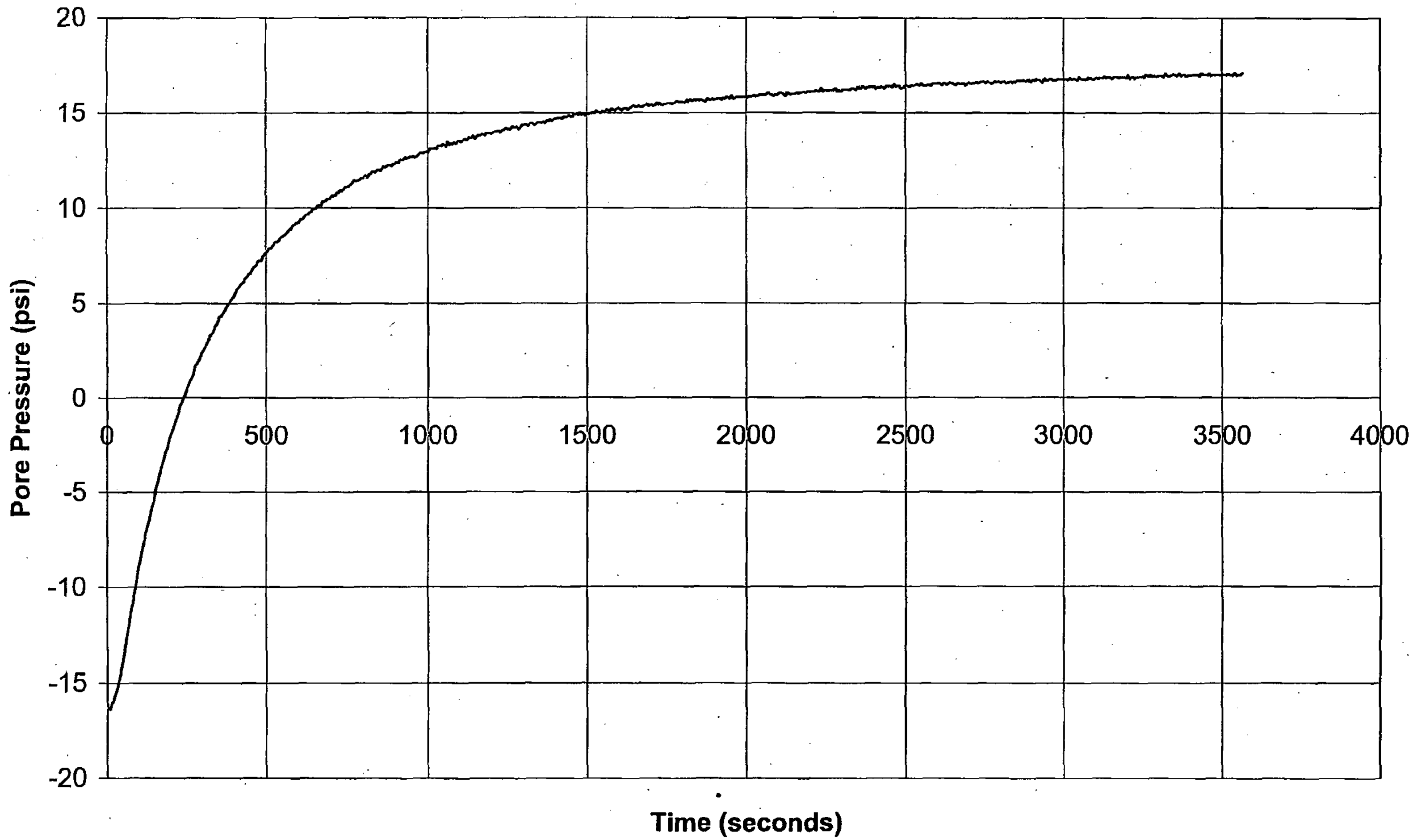
SBT: Soil Behavior Type (Robertson 1990)

GREGG

GREGG DRILLING & TESTING

Pore Pressure Dissipation Test

Sounding: c-304
Depth: 30.02
Site: S. TEXAS
Operator: R.AGUILLAR

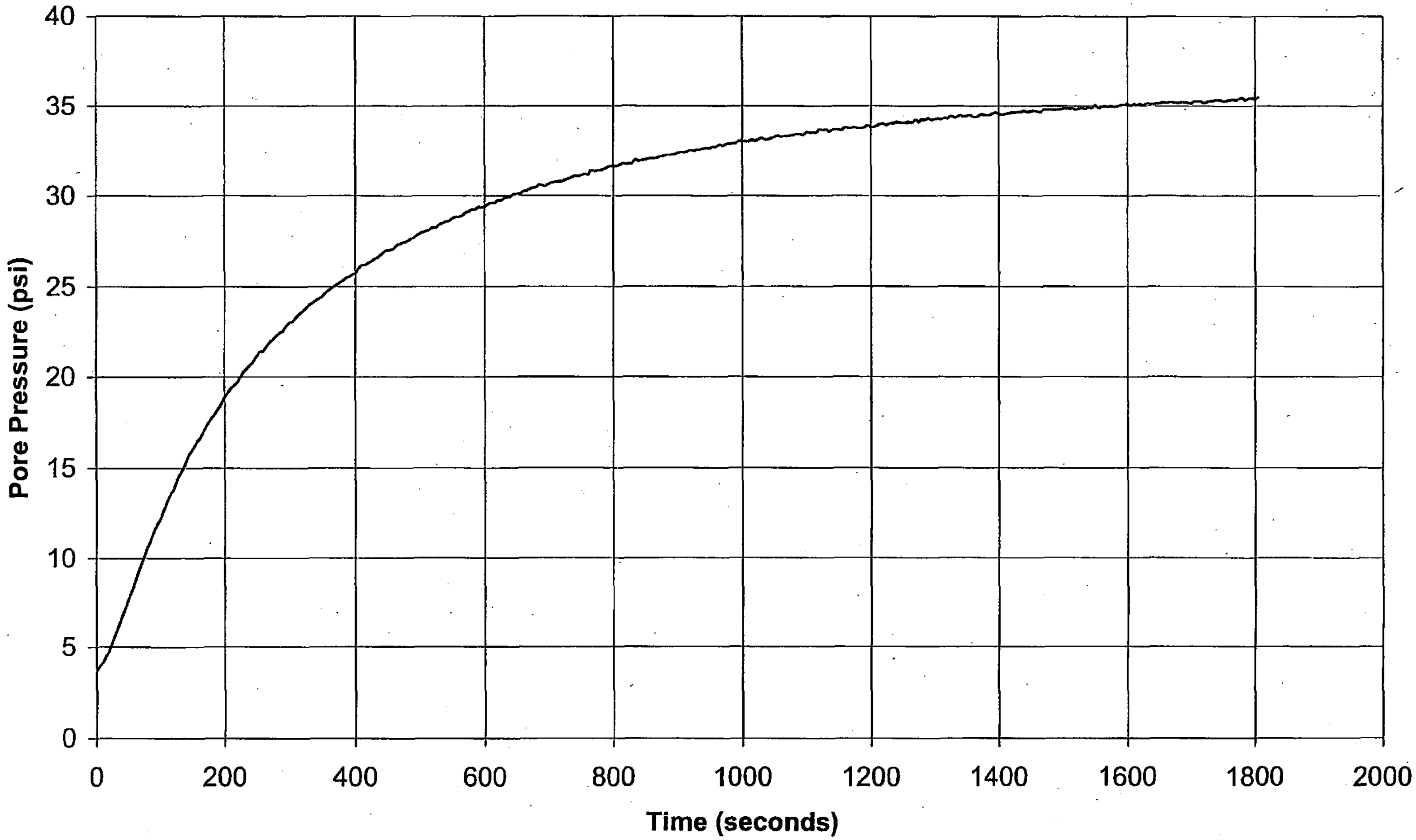


GREGG

GREGG DRILLING & TESTING

Pore Pressure Dissipation Test

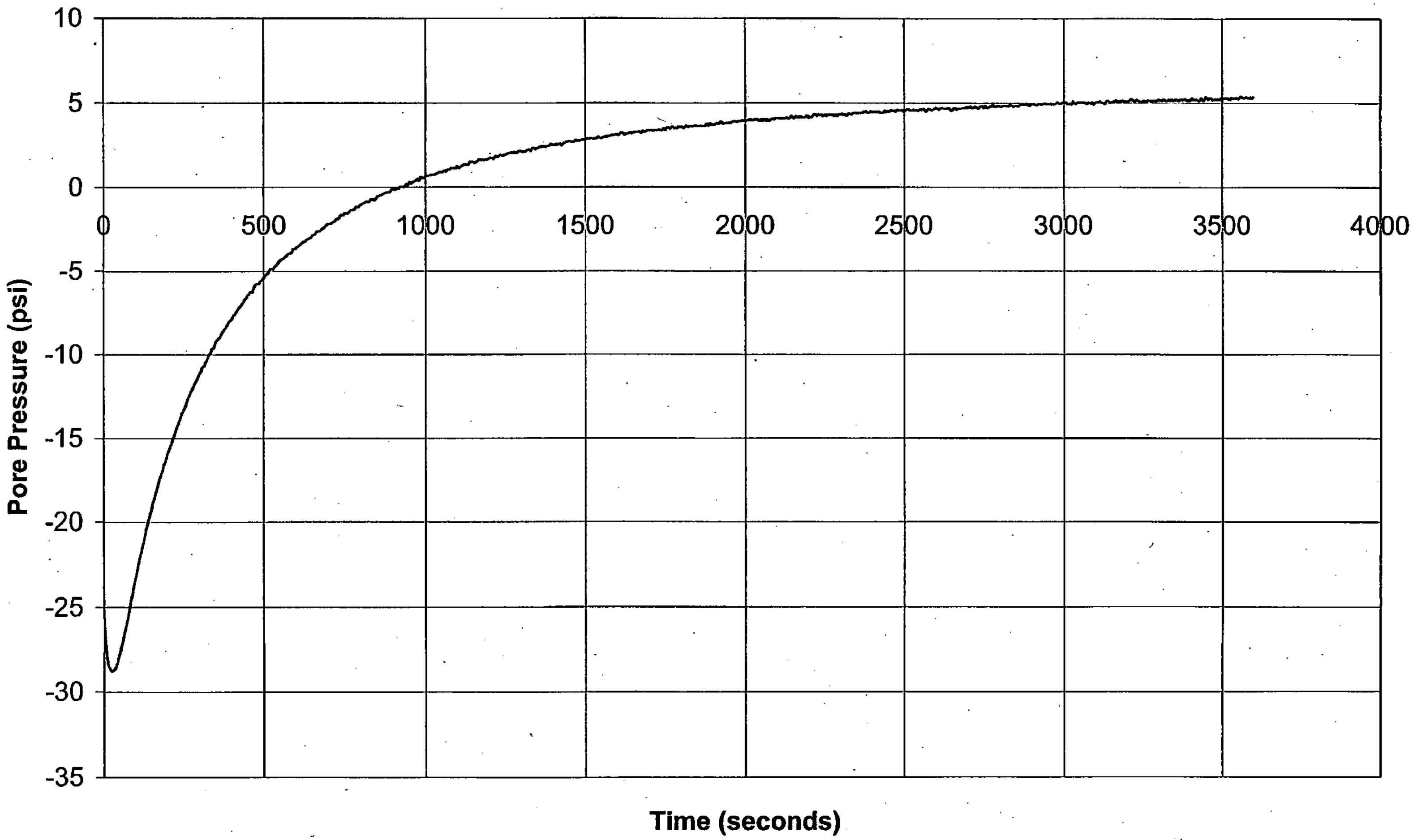
Sounding: c-304
Depth: 74.803
Site: S. TEXAS
Operator: R.AGUILLAR



GREGG DRILLING & TESTING

Pore Pressure Dissipation Test

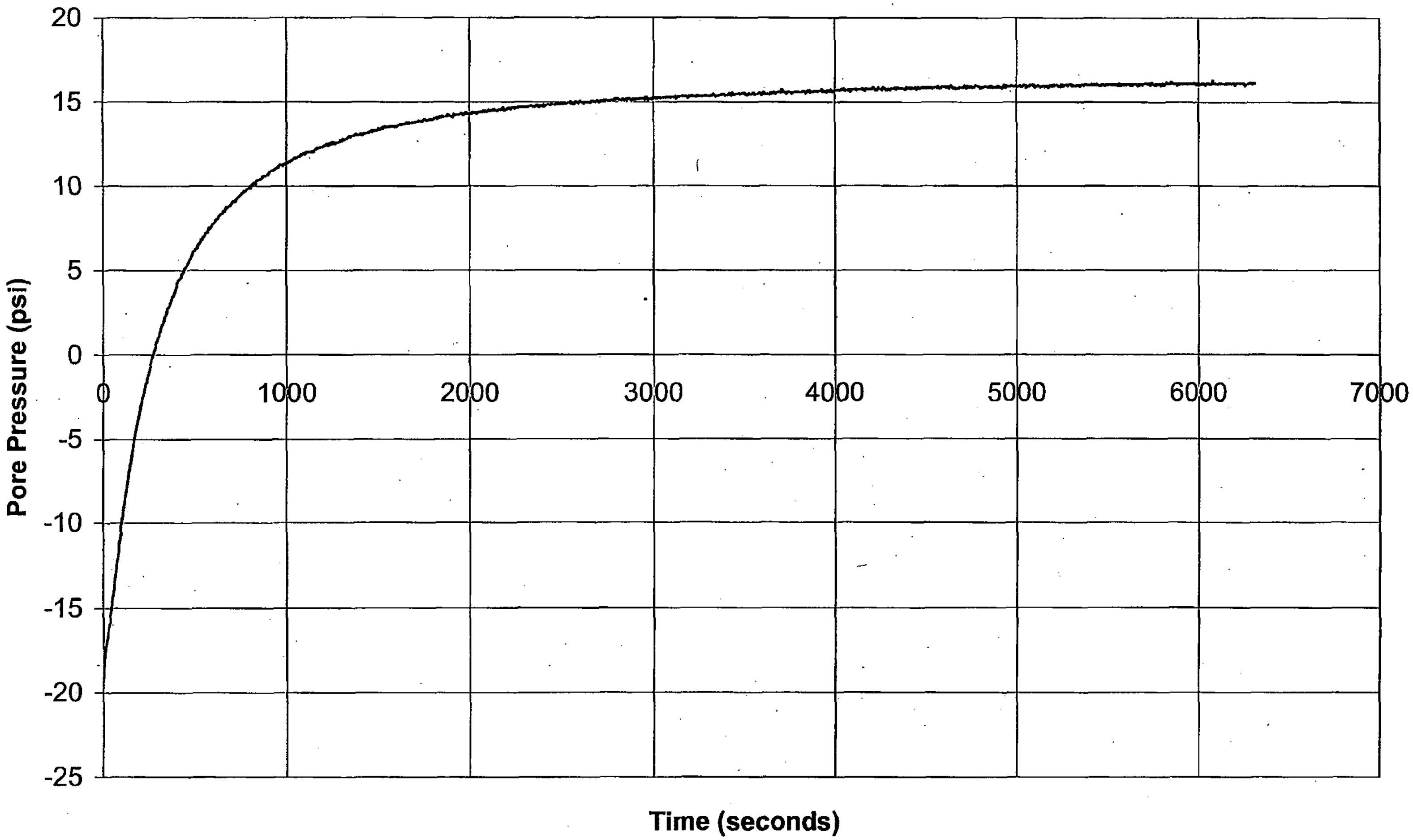
Sounding: c-305s
Depth: 38.058
Site: S. TEXAS
Operator: R.AGUILLAR



GREGG DRILLING & TESTING

Pore Pressure Dissipation Test

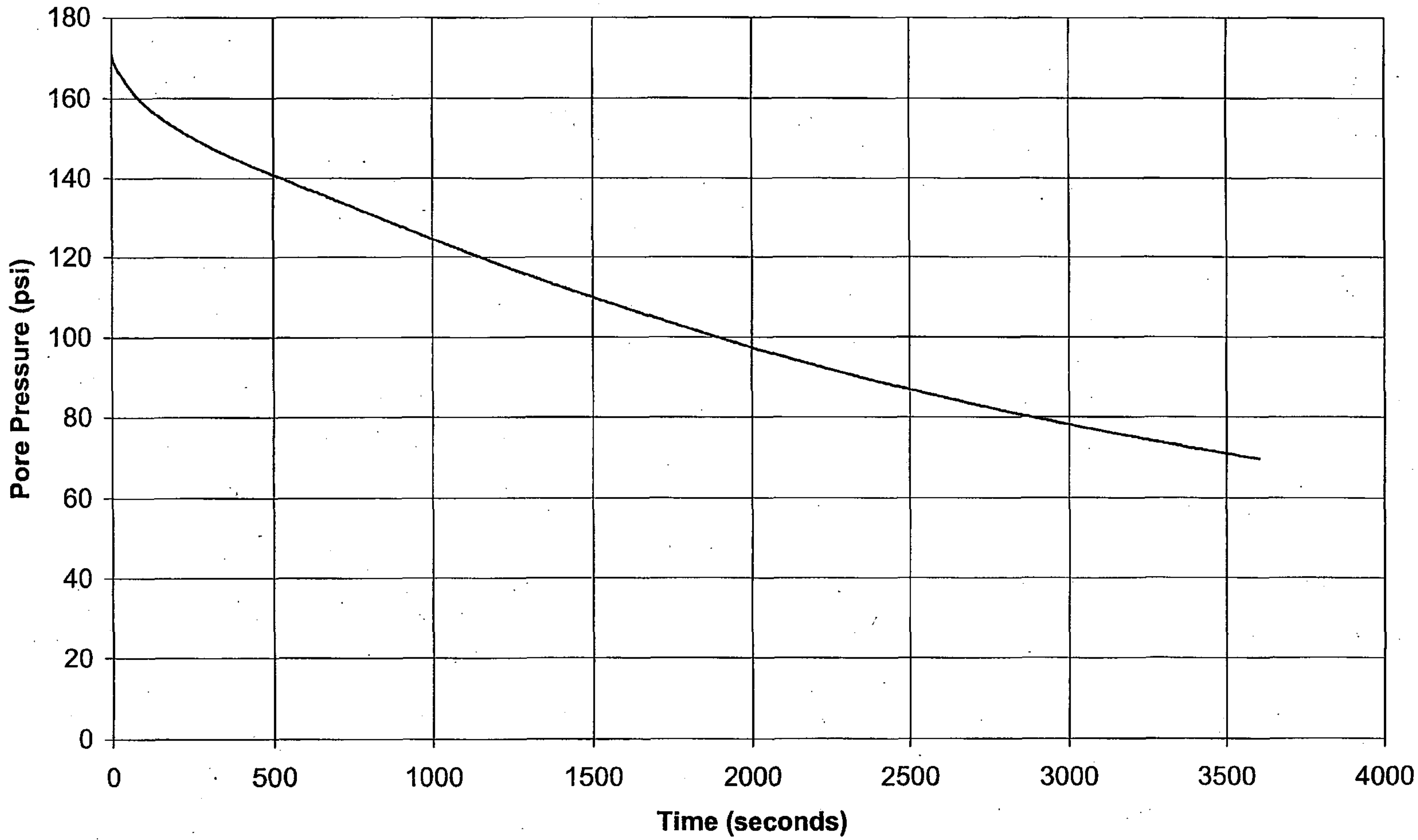
Sounding: c-305s
Depth: 67.093
Site: S. TEXAS
Operator: R.AGUILLAR



GREGG DRILLING & TESTING

Pore Pressure Dissipation Test

Sounding: c-305s
Depth: 92.027
Site: S. TEXAS
Operator: R.AGUILLAR

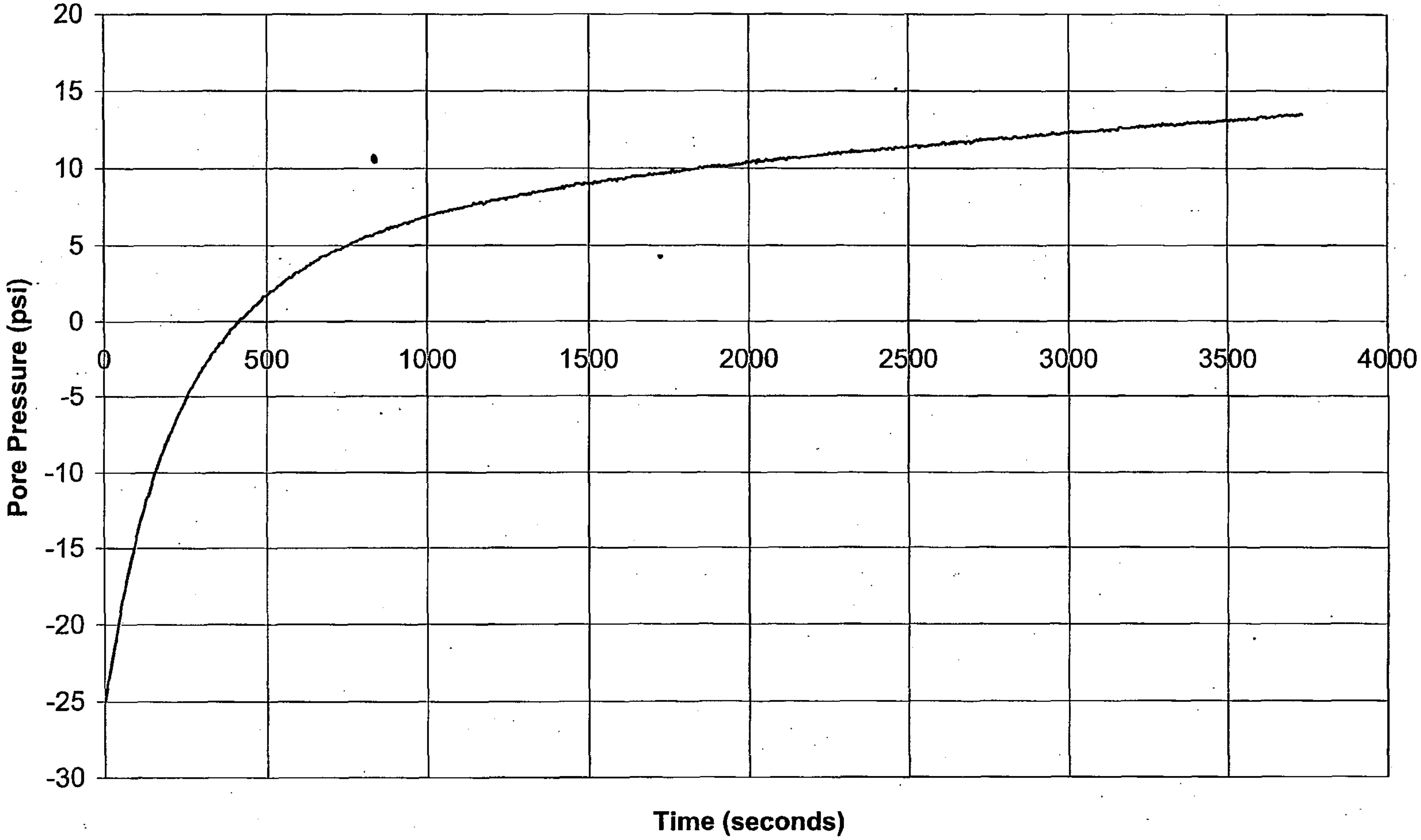


GREGG

GREGG DRILLING & TESTING

Pore Pressure Dissipation Test

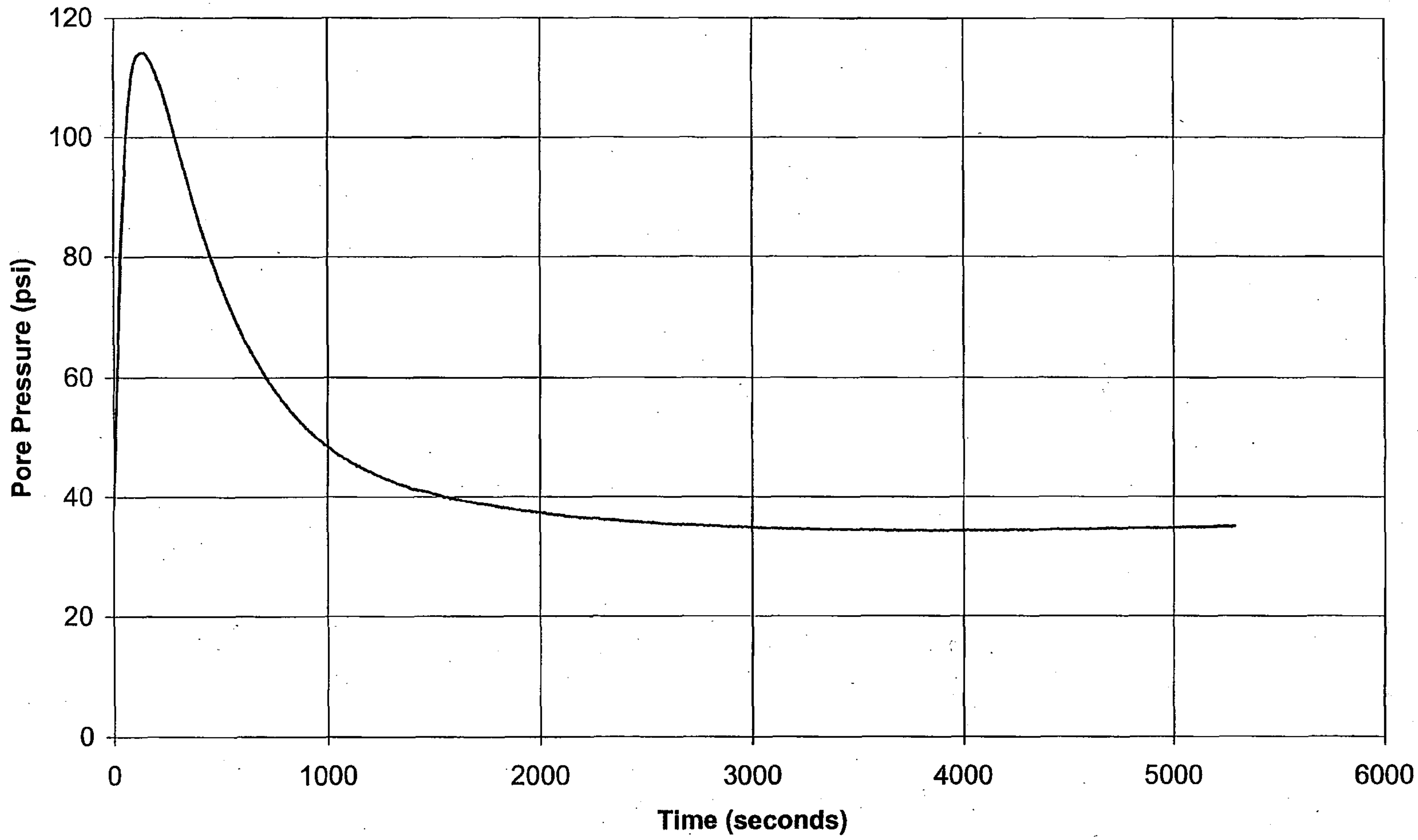
Sounding: c-306s
Depth: 28.051
Site: S. TEXAS
Operator: R.AGUILLAR



GREGG DRILLING & TESTING

Pore Pressure Dissipation Test

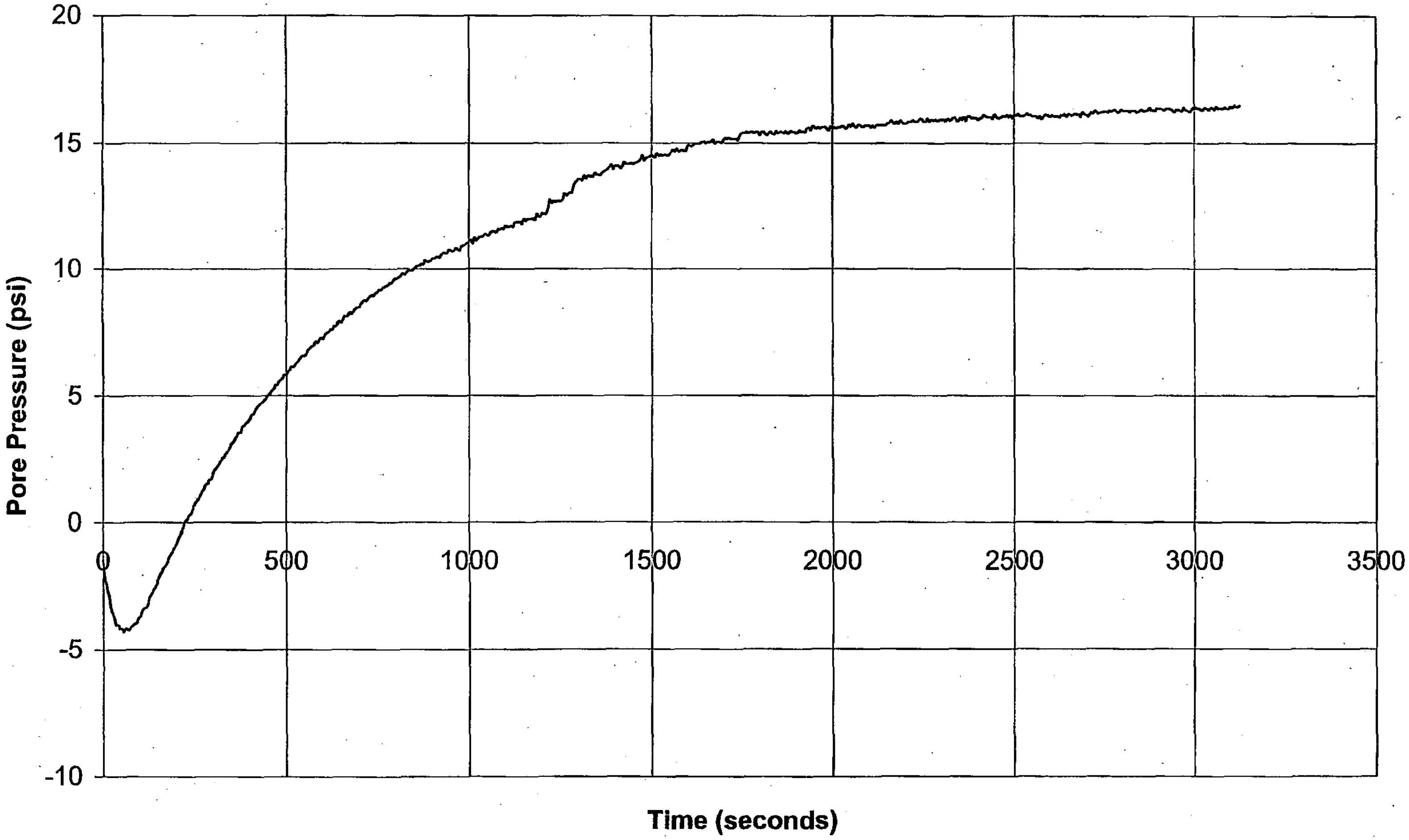
Sounding: c-306s
Depth: 56.102
Site: S. TEXAS
Operator: R.AGUILLAR



GREGG DRILLING & TESTING

Pore Pressure Dissipation Test

Sounding: c-307s
Depth: 73.983
Site: S. TEXAS
Operator: R.AGUILLAR

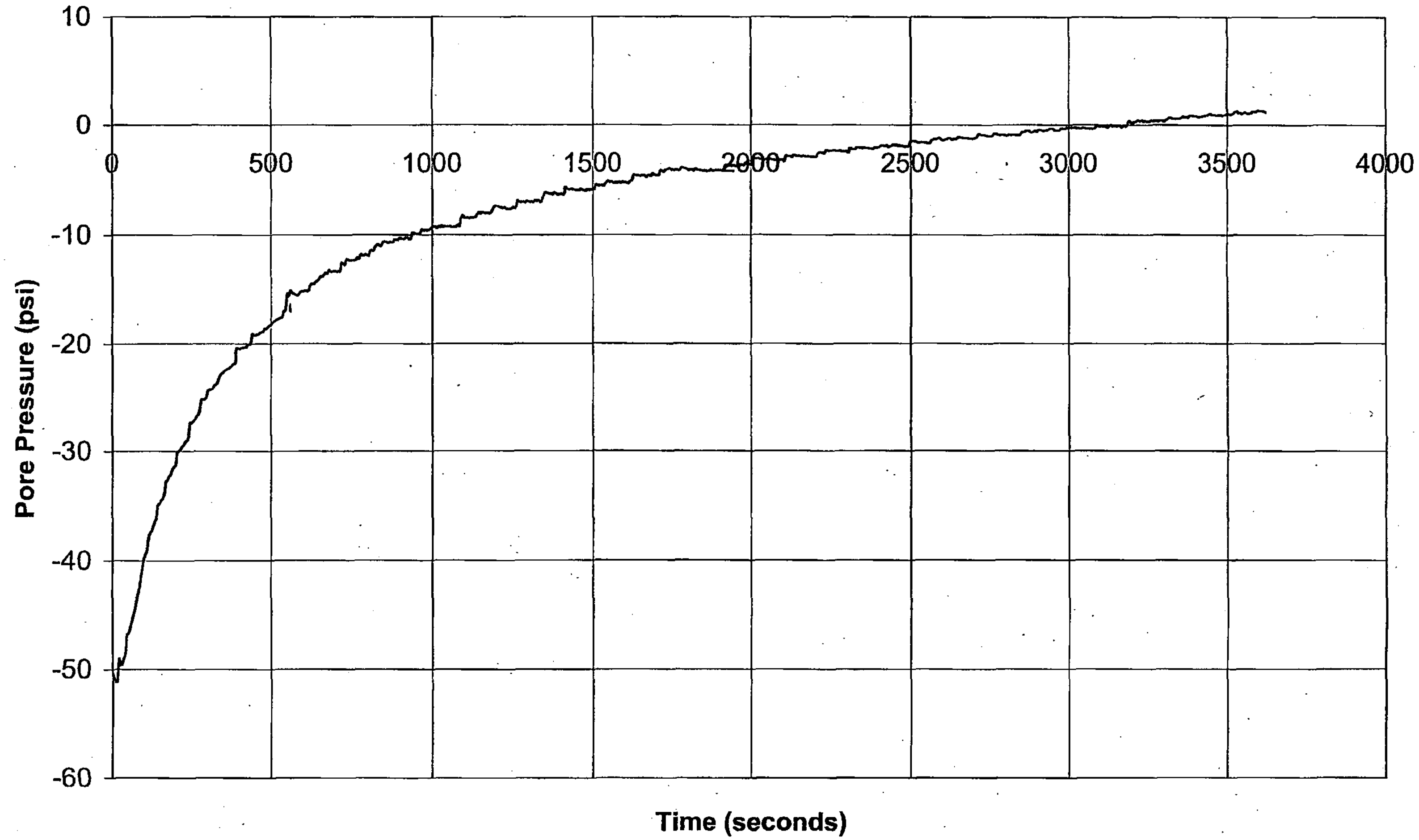


GREGG

GREGG DRILLING & TESTING

Pore Pressure Dissipation Test

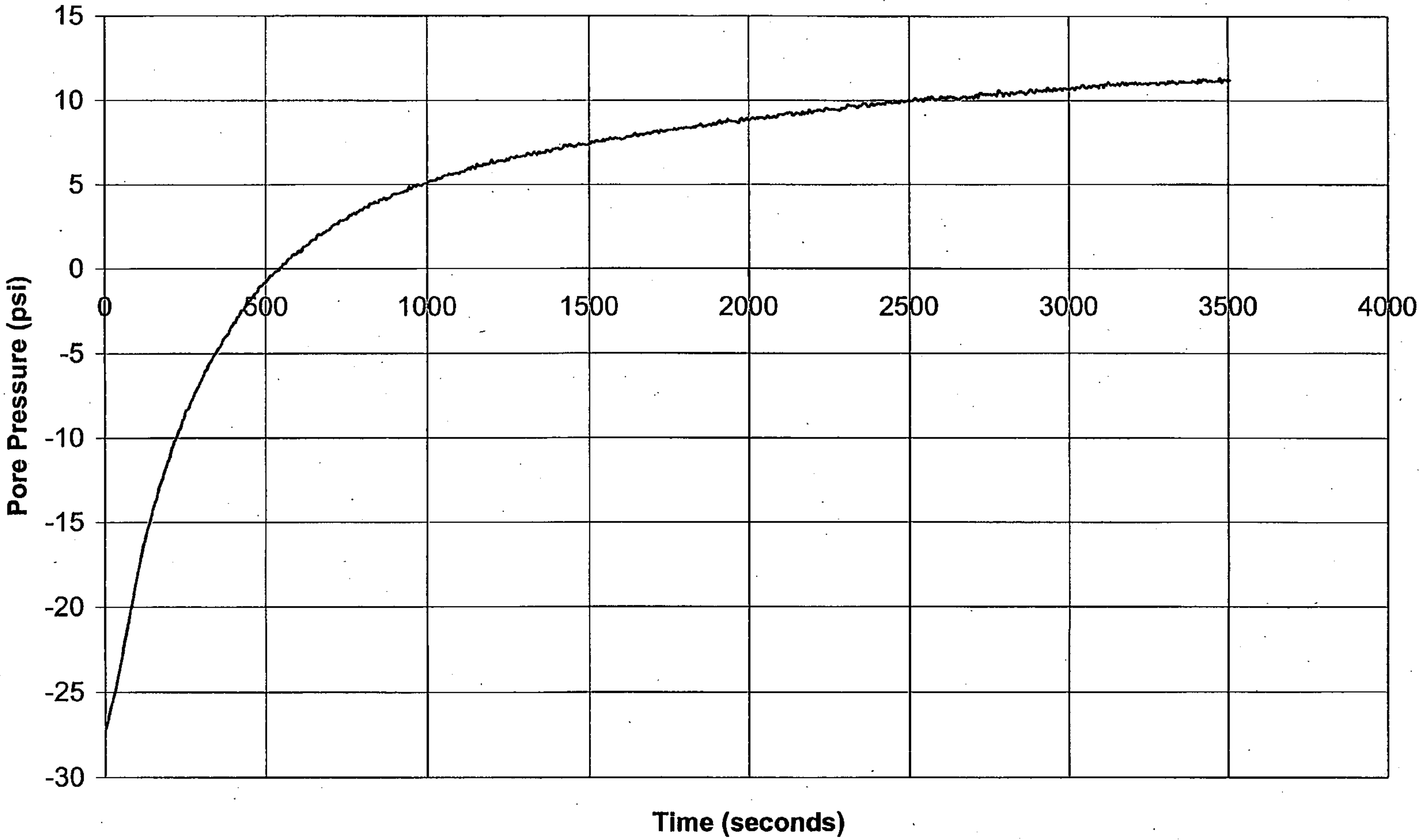
Sounding: c-308
Depth: 31.004
Site: S. TEXAS
Operator: R.AGUILLAR



GREGG DRILLING & TESTING

Pore Pressure Dissipation Test

Sounding: c-308
Depth: 70.046
Site: S. TEXAS
Operator: R.AGUILLAR

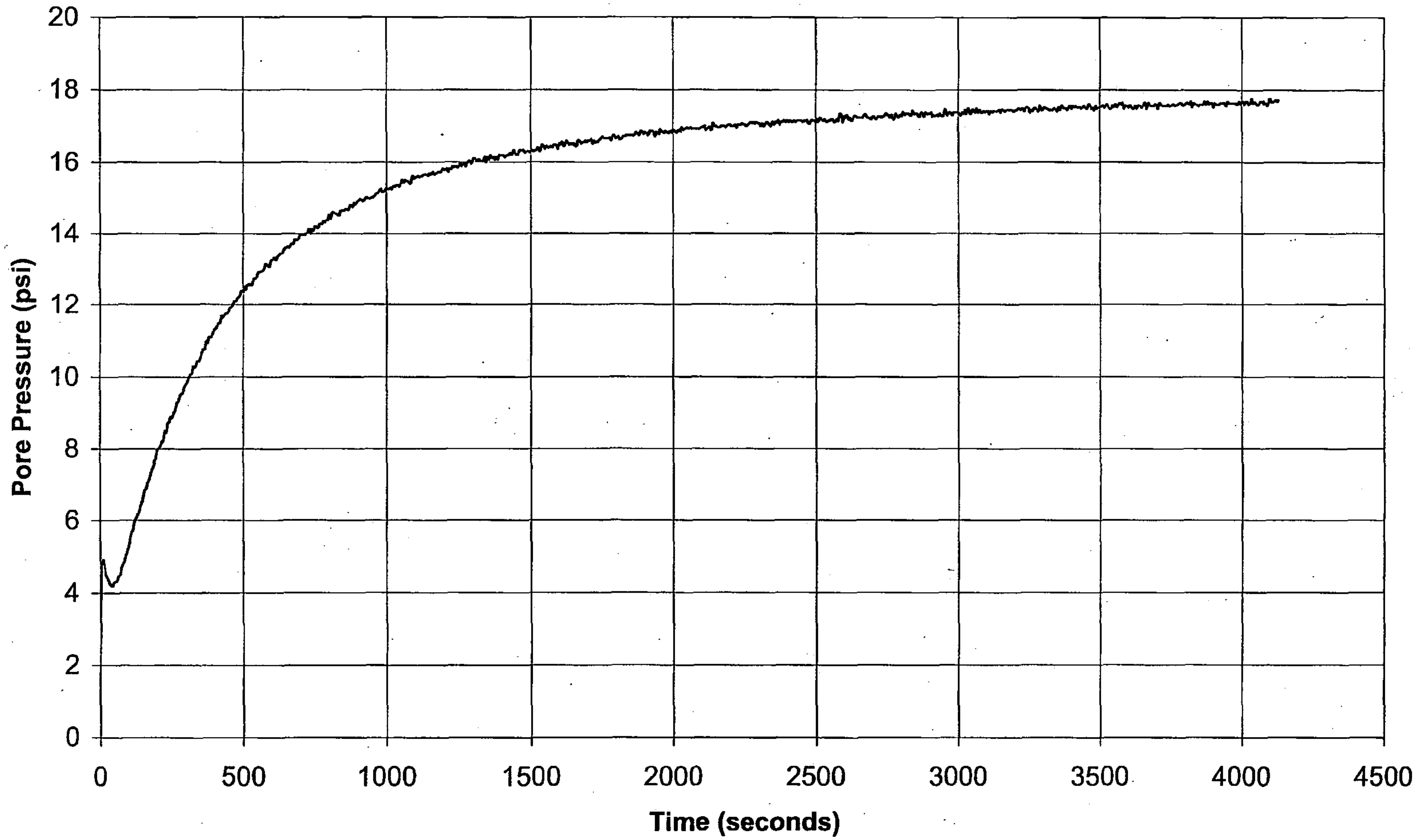


GREGG

GREGG DRILLING & TESTING

Pore Pressure Dissipation Test

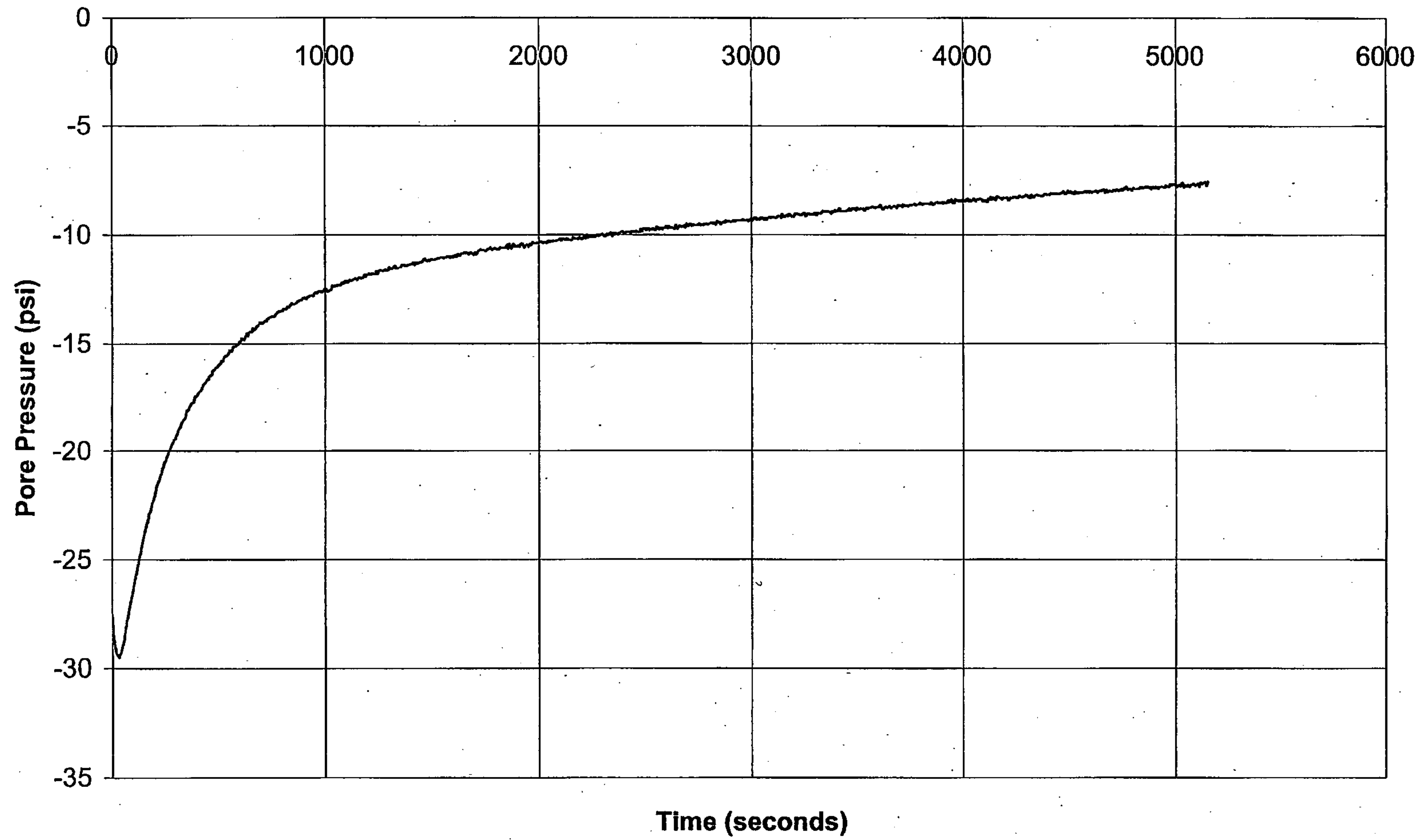
Sounding: c-310
Depth: 26.083
Site: S. TEXAS
Operator: R.AGUILLAR



GREGG DRILLING & TESTING

Pore Pressure Dissipation Test

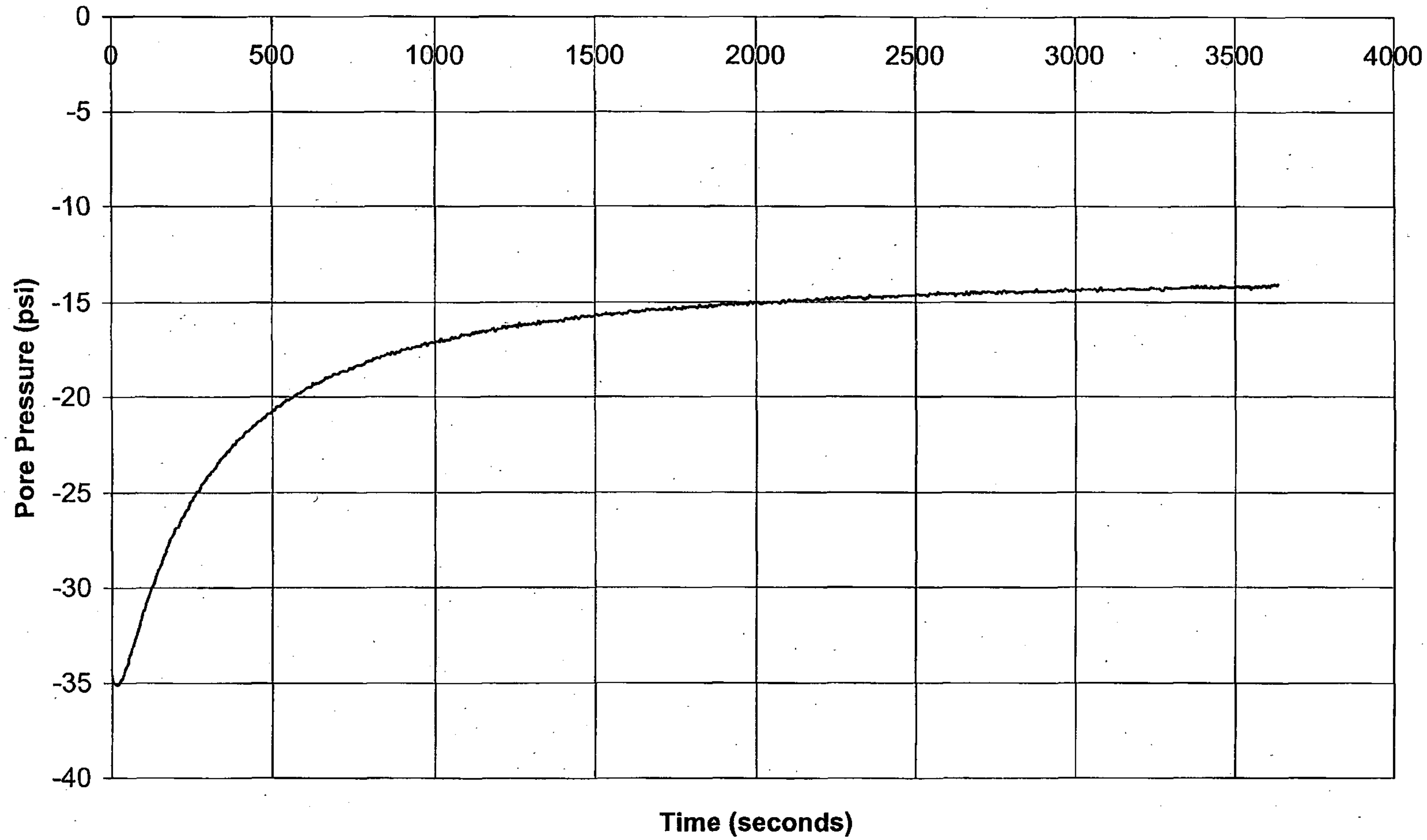
Sounding: c-404
Depth: 30.02
Site: S. TEXAS
Operator: R.AGUILLAR



GREGG DRILLING & TESTING

Pore Pressure Dissipation Test

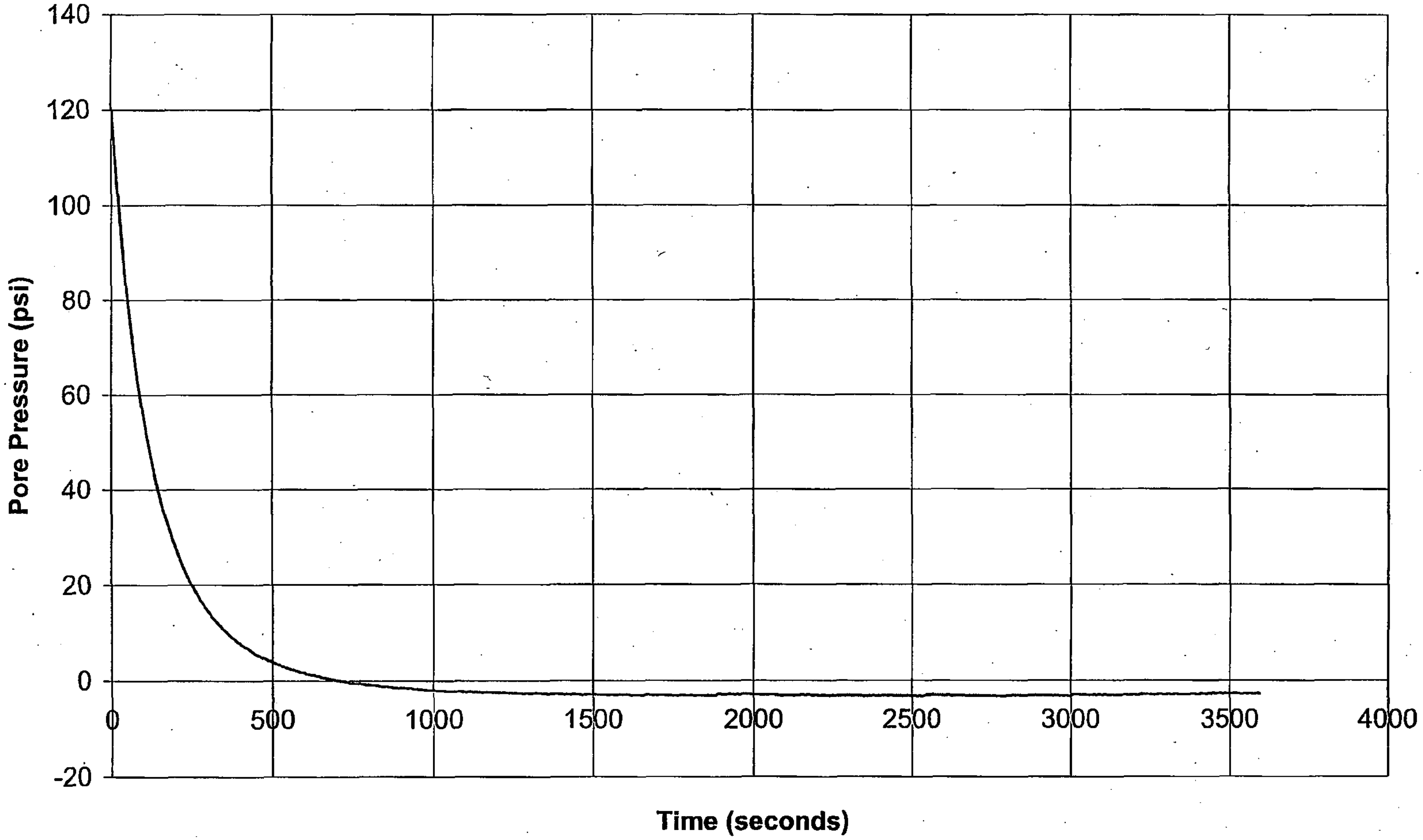
Sounding: c-406s
Depth: 29.199
Site: S. TEXAS
Operator: R.AGUILLAR



GREGG DRILLING & TESTING

Pore Pressure Dissipation Test

Sounding: c-406s
Depth: 58.399
Site: S. TEXAS
Operator: R.AGUILLAR

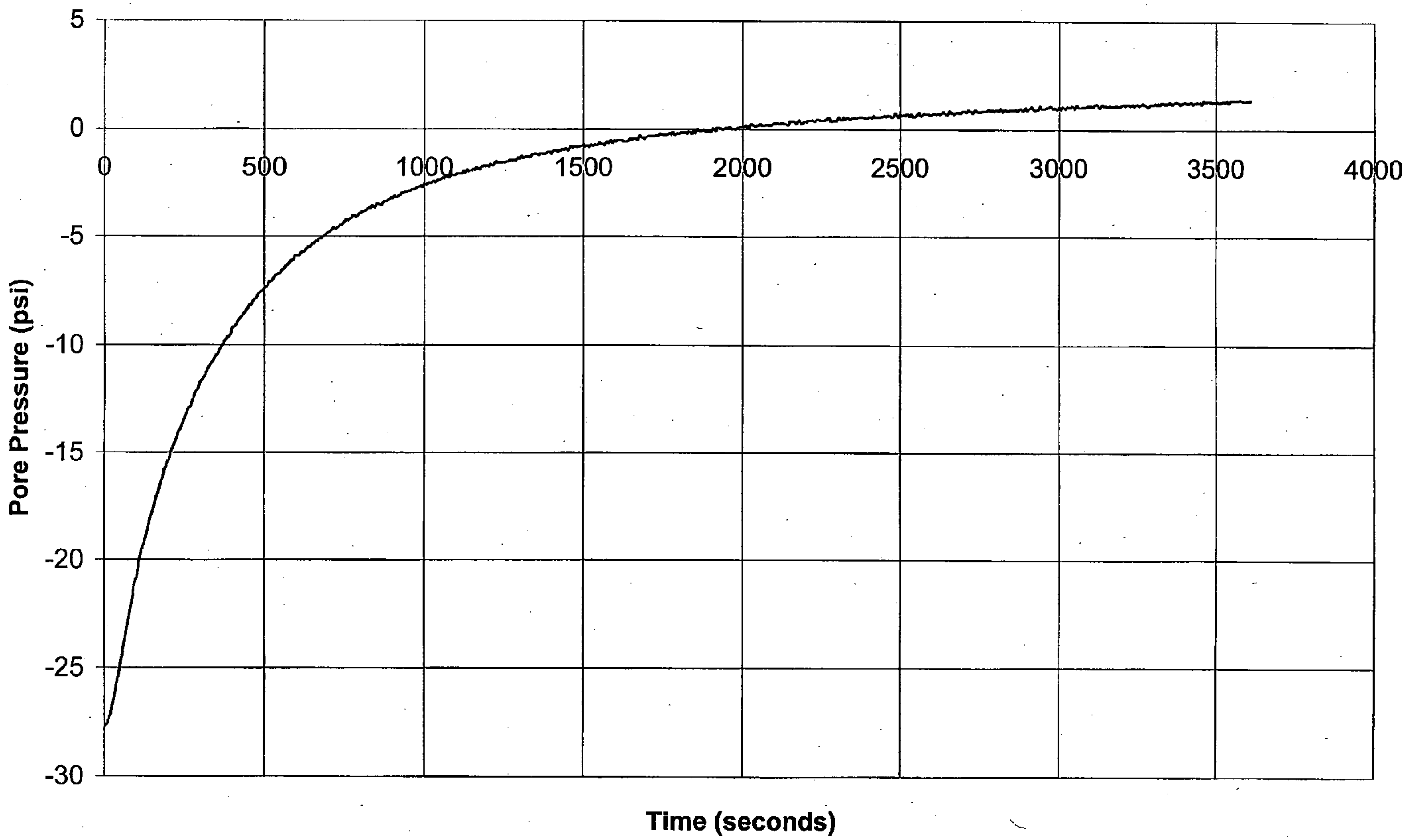


GREGG

GREGG DRILLING & TESTING

Pore Pressure Dissipation Test

Sounding:	c-406s
Depth:	71.358
Site:	S. TEXAS
Operator:	R.AGUILLAR

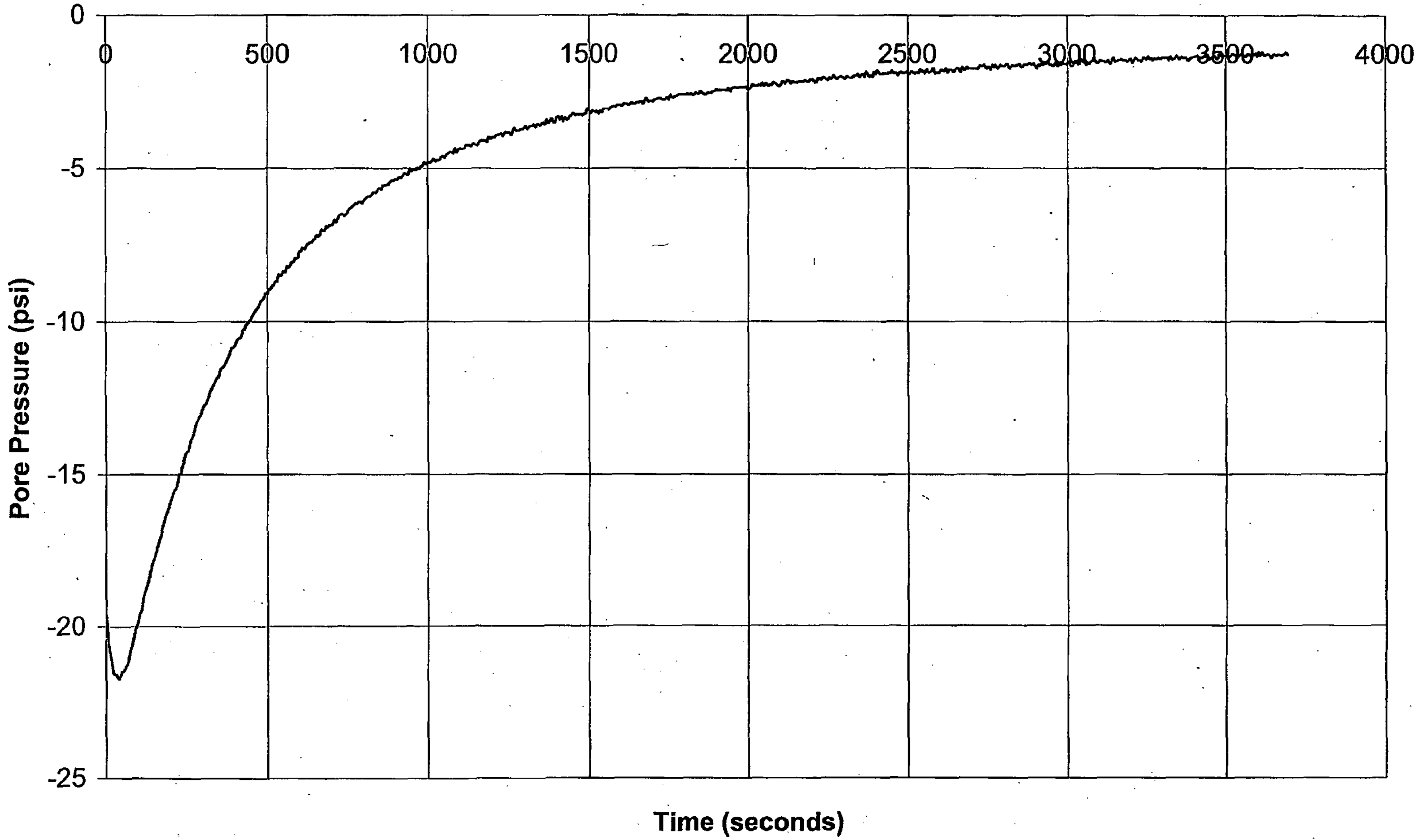


GREGG

GREGG DRILLING & TESTING

Pore Pressure Dissipation Test

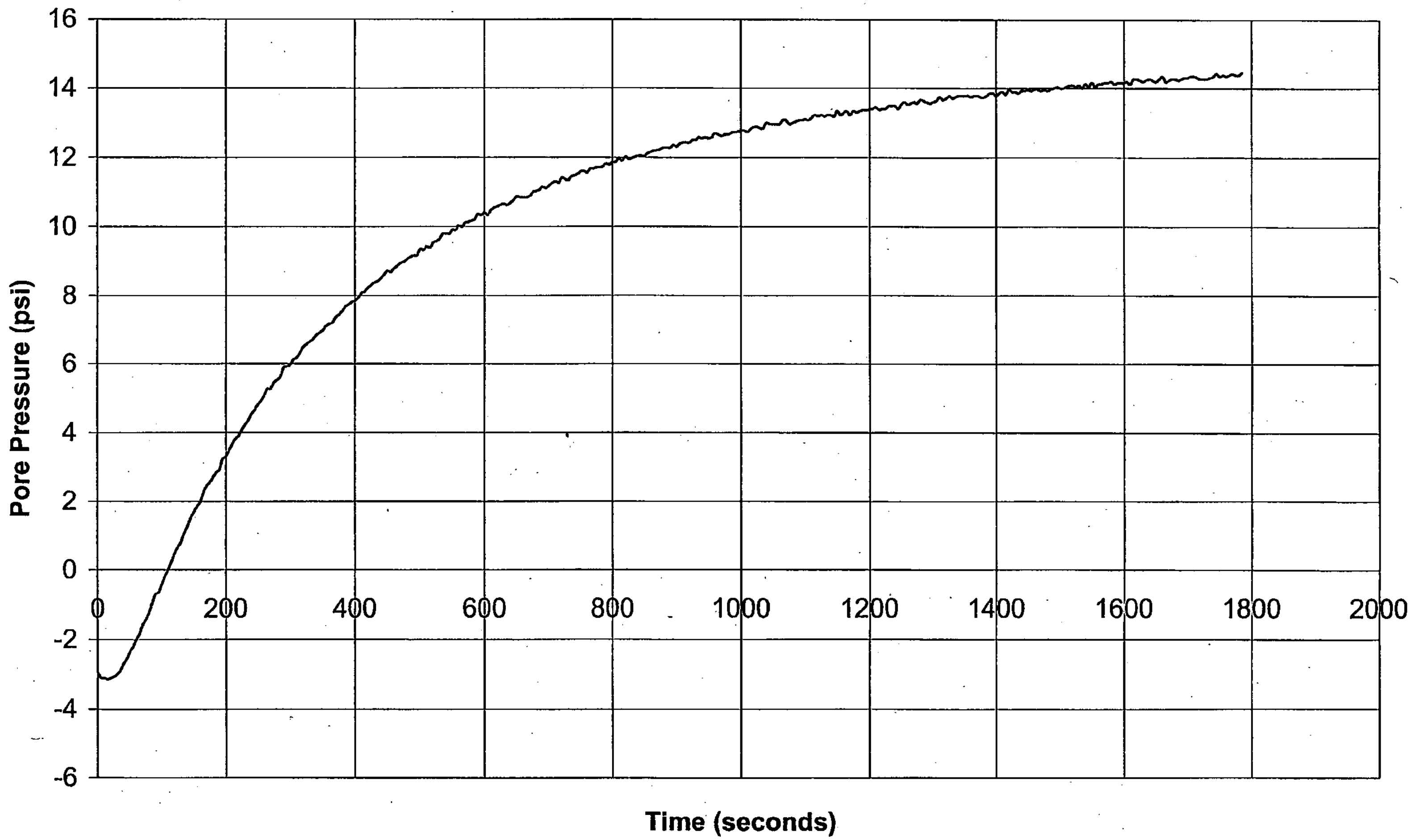
Sounding: c-408
Depth: 27.395
Site: S. TEXAS
Operator: R.AGUILLAR



GREGG DRILLING & TESTING

Pore Pressure Dissipation Test

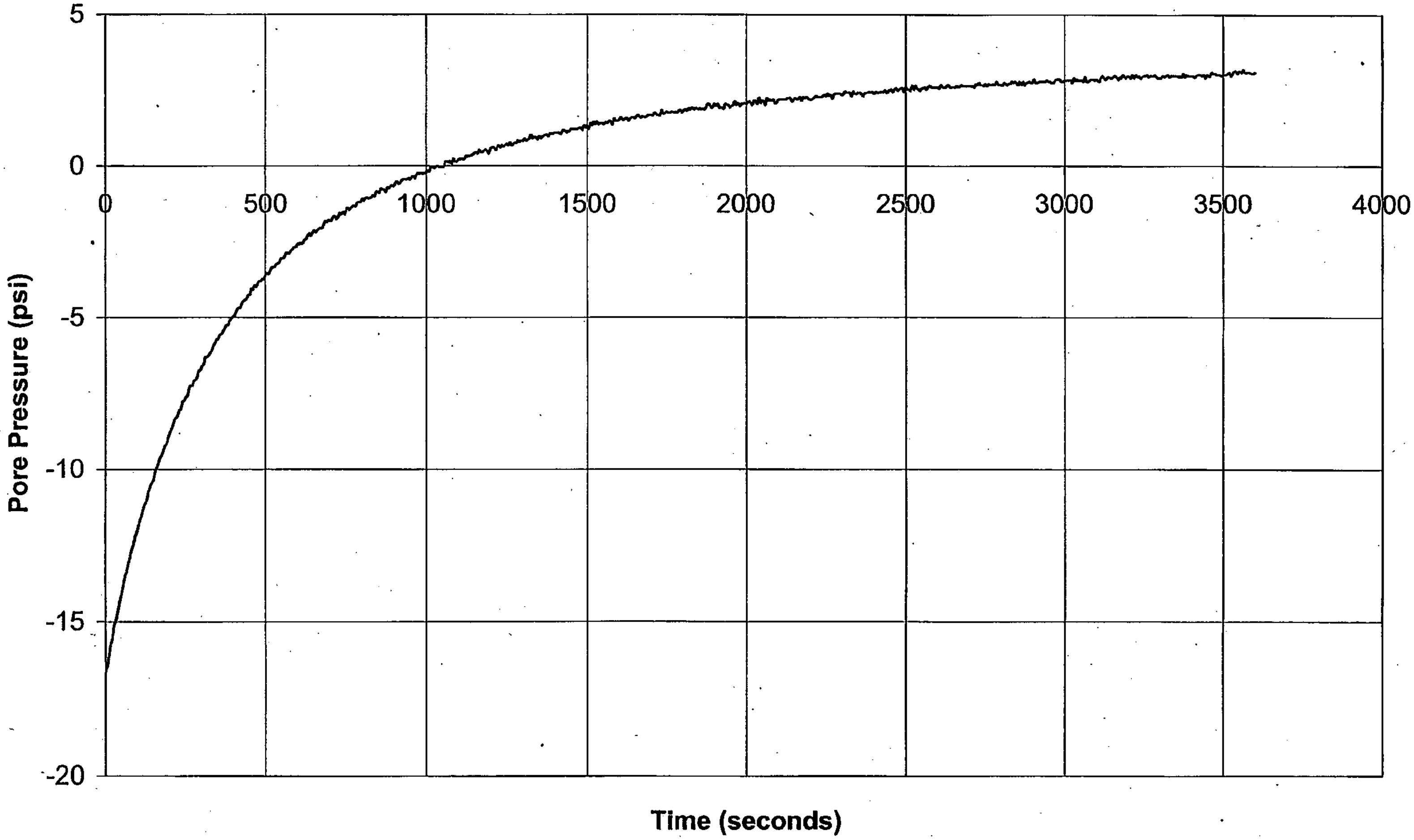
Sounding: c-408
Depth: 70.21
Site: S. TEXAS
Operator: R.AGUILLAR



GREGG DRILLING & TESTING

Pore Pressure Dissipation Test

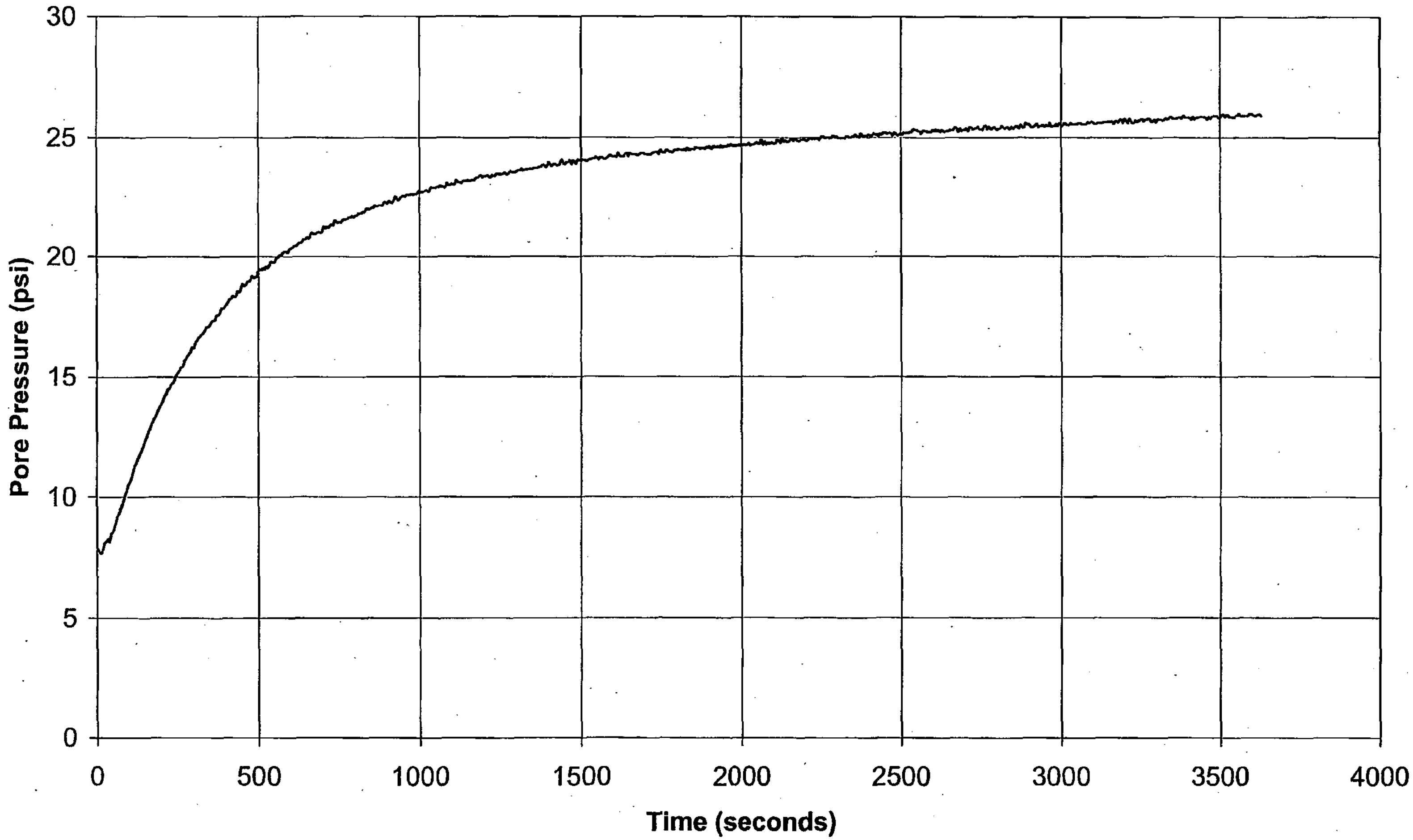
Sounding: c-410
Depth: 29.035
Site: S. TEXAS
Operator: R.AGUILLAR



GREGG DRILLING & TESTING

Pore Pressure Dissipation Test

Sounding: c-410
Depth: 83.333
Site: S. TEXAS
Operator: R.AGUILLAR



Shear Wave Velocity Calculations

S. TEXAS PROJECT
MACTEC

Geophone Offset: 0.66 Feet
Source Offset: 9.17 Feet

c-305s

Test Depth (Feet)	Geophone Depth (Feet)	Waveform Ray Path (Feet)	Incremental Distance (Feet)	Characteristic Arrival Time (ms)	Incremental Time Interval (ms)	Interval Velocity (Ft/Sec)	Interval Depth (Feet)
5.09	4.43	10.18	10.18	20.4500			
10.01	9.35	13.09	2.91	25.6000	5.1500	565.4	6.89
15.09	14.43	17.10	4.00	32.1500	6.5500	611.4	11.89
20.01	19.35	21.42	4.32	39.4000	7.2500	595.4	16.89
25.10	24.44	26.10	4.69	45.0000	5.6000	836.9	21.90
30.02	29.36	30.76	4.66	51.1000	6.1000	763.3	26.90
35.10	34.44	35.64	4.89	57.1500	6.0500	807.7	31.90
40.03	39.37	40.42	4.78	62.1000	4.9500	964.7	36.91
45.11	44.45	45.39	4.97	68.6000	6.5000	764.2	41.91
50.03	49.37	50.22	4.83	75.6500	7.0500	685.0	46.91
55.12	54.46	55.22	5.01	82.2500	6.6000	758.7	51.92
60.37	59.71	60.41	5.18	86.8000	4.5500	1139.1	57.08
65.12	64.46	65.11	4.71	90.9000	4.1000	1147.8	62.09
70.05	69.39	69.99	4.88	94.7500	3.8500	1266.4	66.93
75.95	75.29	75.85	5.86	99.3500	4.6000	1273.6	72.34
80.05	79.39	79.92	4.07	102.9500	3.6000	1131.2	77.34
85.14	84.48	84.97	5.05	107.1500	4.2000	1203.3	81.93
90.06	89.40	89.87	4.89	112.9500	5.8000	843.8	86.94
95.14	94.48	94.93	5.06	117.8000	4.8500	1043.3	91.94
97.11	96.45	96.89	1.96	119.7000	1.9000	1031.3	95.47

Shear Wave Velocity Calculations

S. TEXAS PROJECT
MACTEC

Geophone Offset: 0.66 Feet
Source Offset: 9.17 Feet

c-306s

Test Depth (Feet)	Geophone Depth (Feet)	Waveform Ray Path (Feet)	Incremental Distance (Feet)	Characteristic Arrival Time (ms)	Incremental Time Interval (ms)	Interval Velocity (Ft/Sec)	Interval Depth (Feet)
5.09	4.43	10.18	10.18	28.9000			
10.01	9.35	13.09	2.91	31.6000	2.7000	1078.4	6.89
15.09	14.43	17.10	4.00	37.9000	6.3000	635.7	11.89
20.01	19.35	21.42	4.32	42.9000	5.0000	863.4	16.89
25.10	24.44	26.10	4.69	48.4000	5.5000	852.1	21.90
30.02	29.36	30.76	4.66	53.4000	5.0000	931.2	26.90
35.10	34.44	35.64	4.89	59.1000	5.7000	857.2	31.90
40.03	39.37	40.42	4.78	64.5500	5.4500	876.2	36.91
45.11	44.45	45.39	4.97	71.4500	6.9000	719.9	41.91
50.03	49.37	50.22	4.83	78.3000	6.8500	705.1	46.91
55.12	54.46	55.22	5.01	84.7500	6.4500	776.4	51.92
60.04	59.38	60.08	4.86	89.7500	5.0000	971.7	56.92
65.12	64.46	65.11	5.03	94.2500	4.5000	1117.9	61.92

Shear Wave Velocity Calculations

S. TEXAS PROJECT
MACTEC

Geophone Offset: 0.66 Feet
Source Offset: 9.17 Feet

c-307s

Test Depth (Feet)	Geophone Depth (Feet)	Waveform Ray Path (Feet)	Incremental Distance (Feet)	Characteristic Arrival Time (ms)	Incremental Time Interval (ms)	Interval Velocity (Ft/Sec)	Interval Depth (Feet)
5.09	4.43	10.18	10.18	23.6000			
10.01	9.35	13.09	2.91	30.4000	6.8000	428.2	6.89
15.09	14.43	17.10	4.00	35.0000	4.6000	870.6	11.89
20.01	19.35	21.42	4.32	41.3000	6.3000	685.2	16.89
25.10	24.44	26.10	4.69	46.4500	5.1500	910.0	21.90
30.18	29.52	30.91	4.81	51.8000	5.3500	899.6	26.98
35.10	34.44	35.64	4.73	56.5000	4.7000	1006.3	31.98

GREGG

Shear Wave Velocity Calculations

S. TEXAS PROJECT
MACTEC

Geophone Offset: 0.66 Feet
Source Offset: 9.17 Feet

c-307s-a

Test Depth (Feet)	Geophone Depth (Feet)	Waveform Ray Path (Feet)	Incremental Distance (Feet)	Characteristic Arrival Time (ms)	Incremental Time Interval (ms)	Interval Velocity (Ft/Sec)	Interval Depth (Feet)
40.03	39.37	40.42	40.42	61.3500			
45.11	44.45	45.39	4.97	66.8000	5.4500	911.4	41.91
50.03	49.37	50.22	4.83	73.9500	7.1500	675.5	46.91
55.12	54.46	55.22	5.01	80.4500	6.5000	770.4	51.92
60.04	59.38	60.08	4.86	86.1500	5.7000	852.4	56.92
65.12	64.46	65.11	5.03	91.1000	4.9500	1016.2	61.92
70.05	69.39	69.99	4.88	94.7000	3.6000	1354.3	66.93
75.13	74.47	75.03	5.04	97.8000	3.1000	1627.2	71.93
80.05	79.39	79.92	4.89	102.1000	4.3000	1136.4	76.93
85.30	84.64	85.14	5.22	107.5500	5.4500	957.2	82.02
90.22	89.56	90.03	4.89	110.5000	2.9500	1659.0	87.10
95.14	94.48	94.93	4.90	113.2000	2.7000	1813.7	92.02

GREGG

Shear Wave Velocity Calculations

S. TEXAS PROJECT
MACTEC

Geophone Offset: 0.66 Feet
Source Offset: 9.17 Feet

c-406s

Test Depth (Feet)	Geophone Depth (Feet)	Waveform Ray Path (Feet)	Incremental Distance (Feet)	Characteristic Arrival Time (ms)	Incremental Time Interval (ms)	Interval Velocity (Ft/Sec)	Interval Depth (Feet)
5.09	4.43	10.18	10.18	28.7000			
10.17	9.51	13.21	3.03	34.2000	5.5000	550.8	6.97
15.09	14.43	17.10	3.89	39.2500	5.0500	769.8	11.97
20.01	19.35	21.42	4.32	46.0000	6.7500	639.5	16.89
25.10	24.44	26.10	4.69	51.4000	5.4000	867.9	21.90
30.02	29.36	30.76	4.66	57.1500	5.7500	809.8	26.90
35.10	34.44	35.64	4.89	62.3000	5.1500	948.8	31.90
40.03	39.37	40.42	4.78	68.4500	6.1500	776.5	36.91
45.11	44.45	45.39	4.97	74.3500	5.9000	841.9	41.91
50.03	49.37	50.22	4.83	80.7000	6.3500	760.6	46.91
55.12	54.46	55.22	5.01	87.4000	6.7000	747.4	51.92
60.04	59.38	60.08	4.86	91.0500	3.6500	1331.1	56.92
65.12	64.46	65.11	5.03	95.6500	4.6000	1093.6	61.92
70.05	69.39	69.99	4.88	99.8000	4.1500	1174.9	66.93
75.13	74.47	75.03	5.04	103.8500	4.0500	1245.5	71.93
80.05	79.39	79.92	4.89	109.5000	5.6500	864.9	76.93
85.14	84.48	84.97	5.05	116.1500	6.6500	760.0	81.93
90.06	89.40	89.87	4.89	120.9500	4.8000	1019.6	86.94
93.34	92.68	93.13	3.26	123.7500	2.8000	1165.8	91.04

Shear Wave Velocity Calculations

S. TEXAS PROJECT
MACTEC

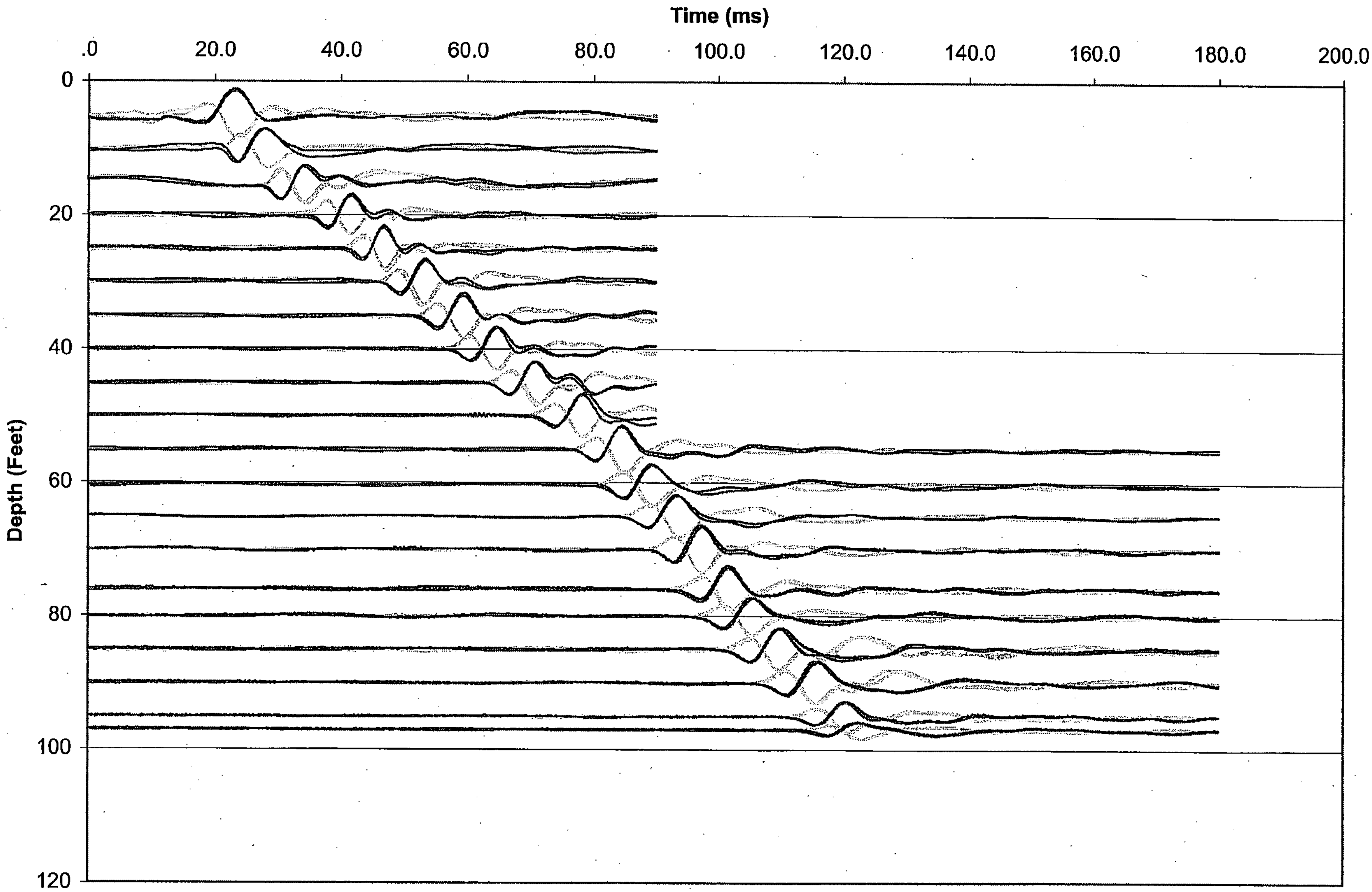
Geophone Offset: 0.66 Feet
Source Offset: 9.17 Feet

c-407s

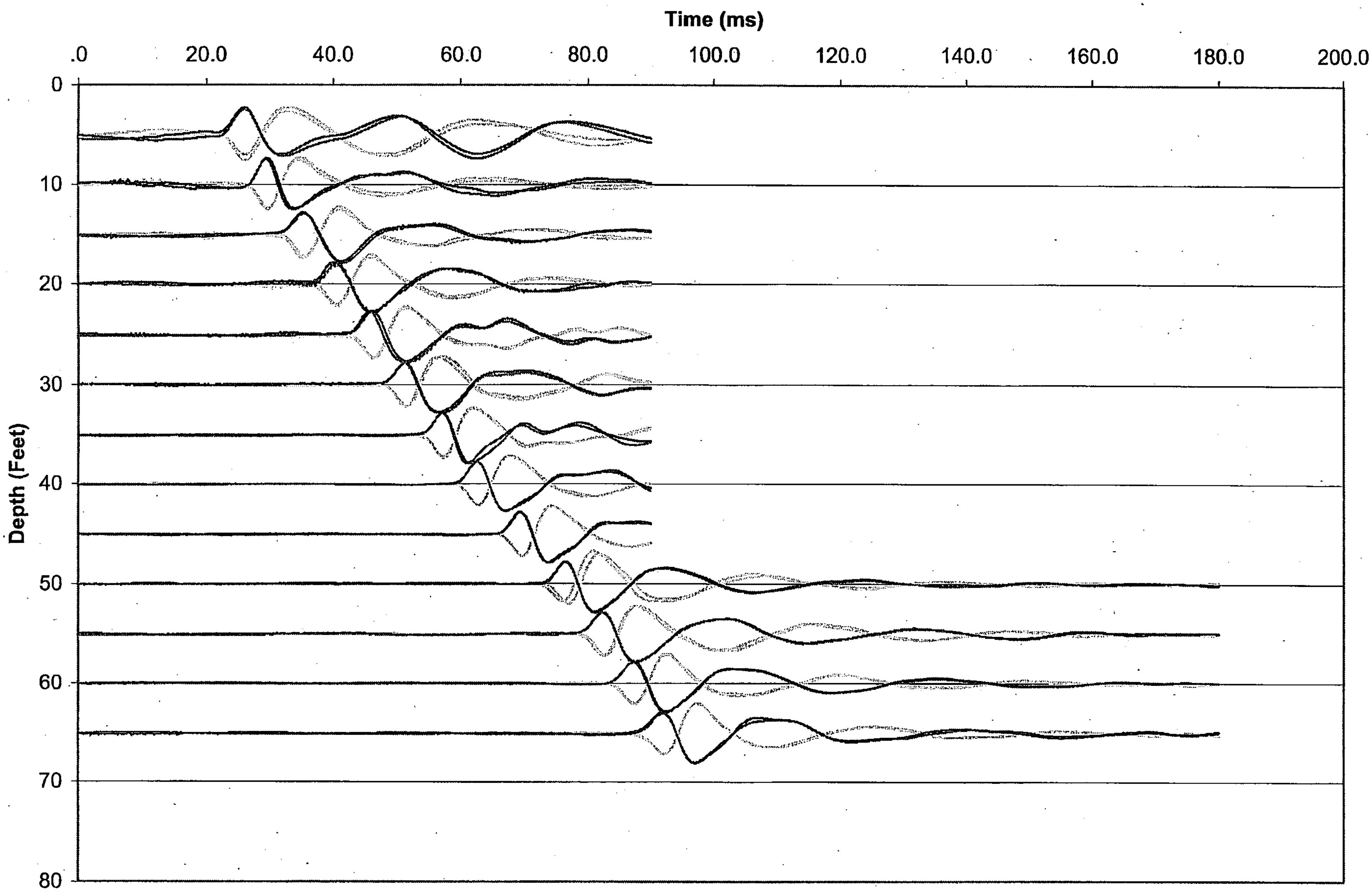
Test Depth (Feet)	Geophone Depth (Feet)	Waveform Ray Path (Feet)	Incremental Distance (Feet)	Characteristic Arrival Time (ms)	Incremental Time Interval (ms)	Interval Velocity (Ft/Sec)	Interval Depth (Feet)
5.09	4.43	10.18	10.18	29.2000			
10.01	9.35	13.09	2.91	34.4000	5.2000	560.0	6.89
15.09	14.43	17.10	4.00	38.7000	4.3000	931.4	11.89
20.01	19.35	21.42	4.32	44.6500	5.9500	725.5	16.89
25.10	24.44	26.10	4.69	50.4000	5.7500	815.0	21.90
30.02	29.36	30.76	4.66	55.4000	5.0000	931.2	26.90
35.10	34.44	35.64	4.89	60.9500	5.5500	880.4	31.90
40.03	39.37	40.42	4.78	66.5500	5.6000	852.8	36.91
45.11	44.45	45.39	4.97	74.1500	7.6000	653.6	41.91
50.03	49.37	50.22	4.83	81.8000	7.6500	631.3	46.91
55.12	54.46	55.22	5.01	88.8500	7.0500	710.3	51.92
60.04	59.38	60.08	4.86	93.3500	4.5000	1079.7	56.92
65.12	64.46	65.11	5.03	97.9500	4.6000	1093.6	61.92
70.05	69.39	69.99	4.88	102.5500	4.6000	1059.9	66.93
75.13	74.47	75.03	5.04	107.2500	4.7000	1073.3	71.93
80.05	79.39	79.92	4.89	112.3500	5.1000	958.2	76.93
85.14	84.48	84.97	5.05	117.0000	4.6500	1086.8	81.93
90.06	89.40	89.87	4.89	121.6000	4.6000	1063.9	86.94
95.14	94.48	94.93	5.06	126.7500	5.1500	982.6	91.94
98.26	97.60	98.03	3.10	129.4500	2.7000	1149.1	96.04

GREGG

Waveforms for Sounding C-305s

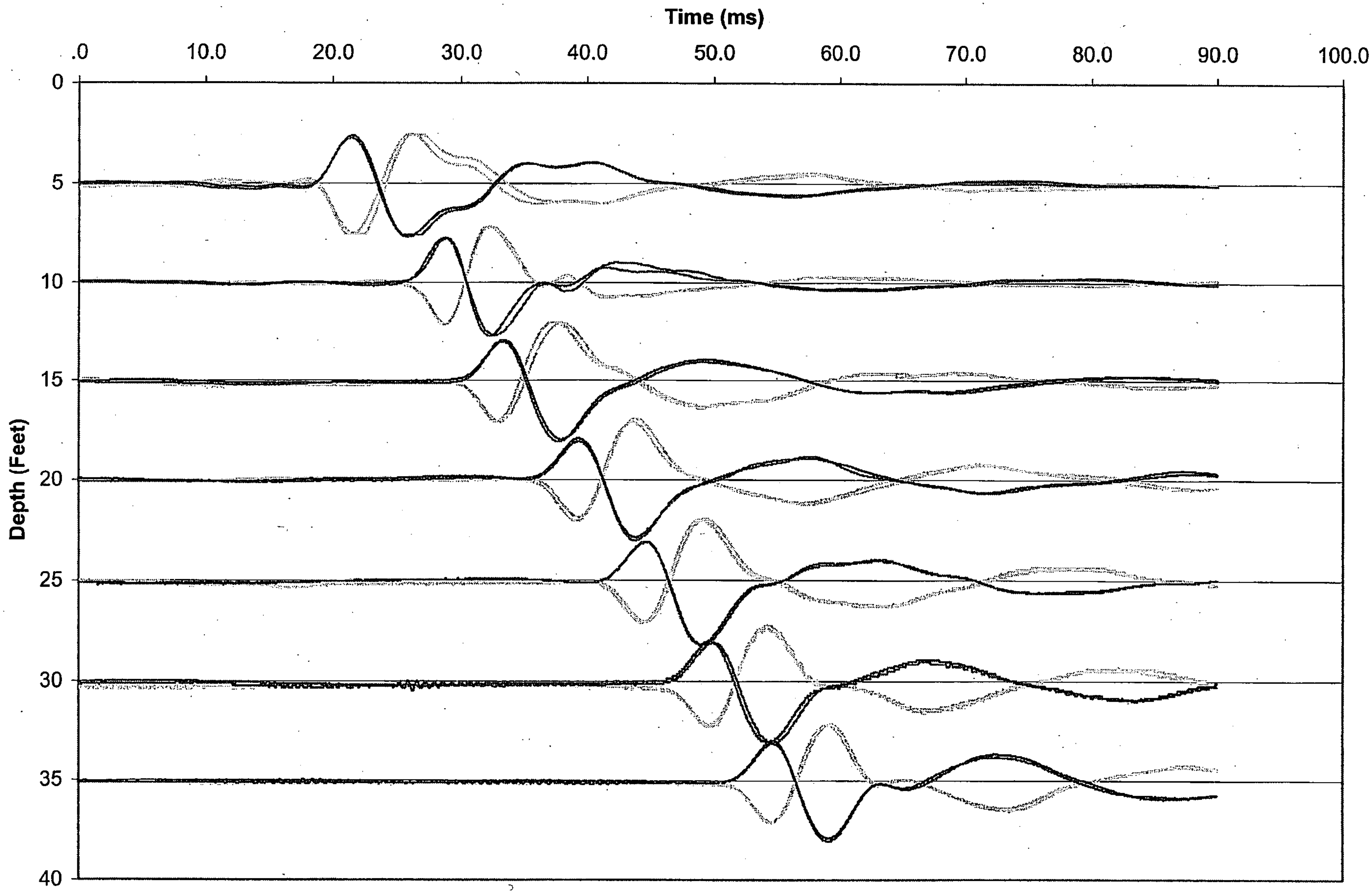


Waveforms for sounding c-306s

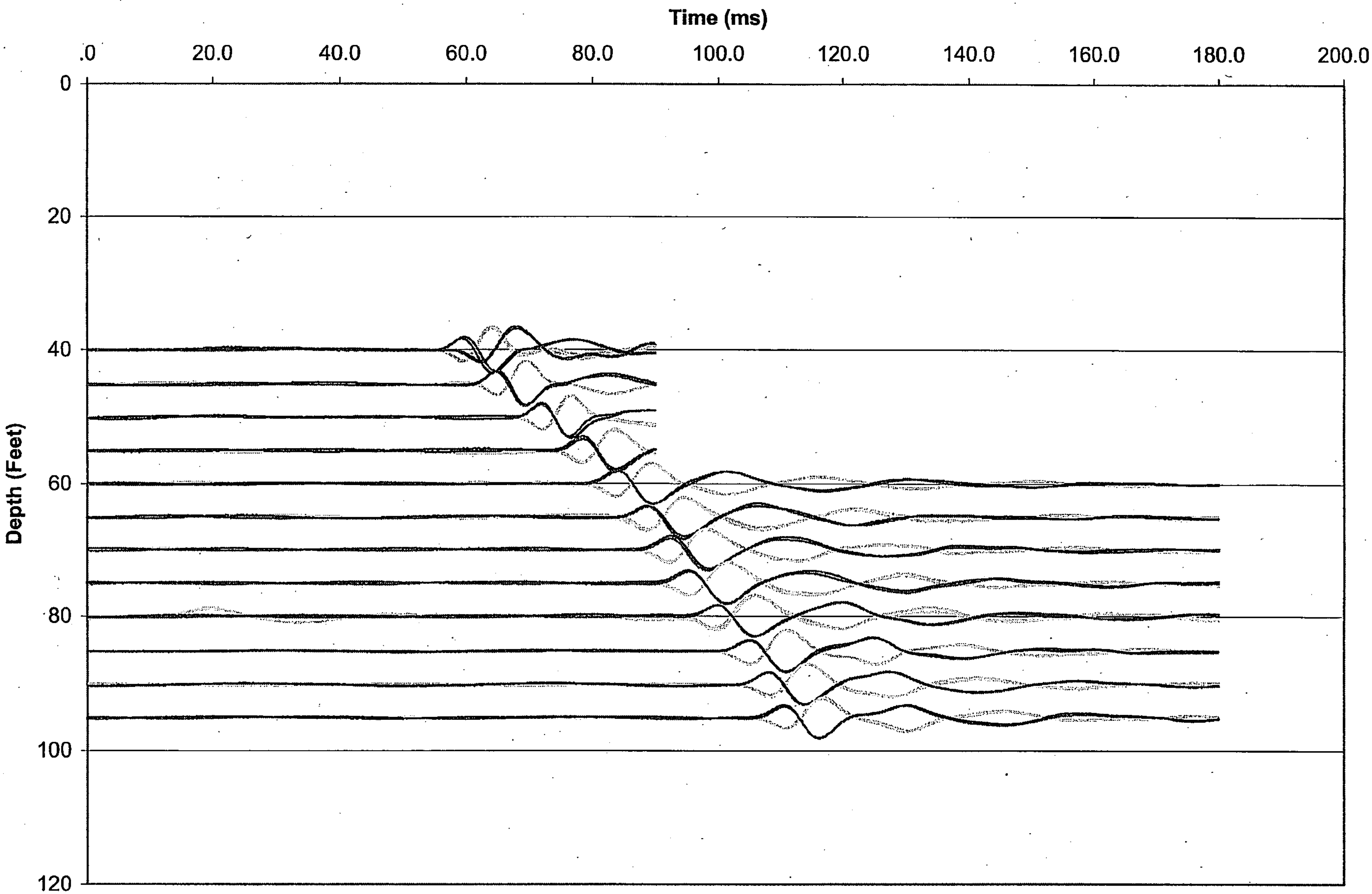


GREGG

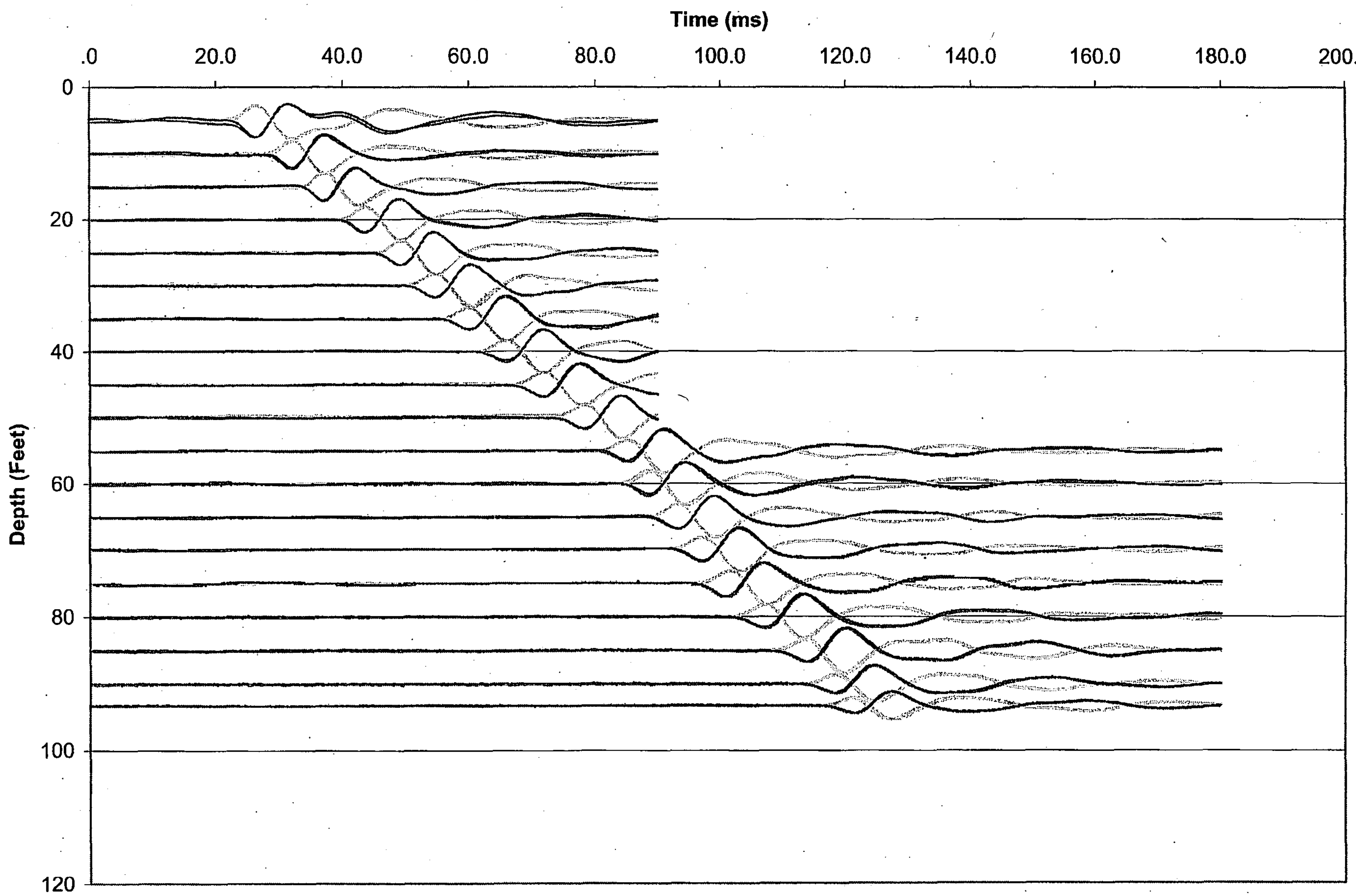
Waveforms for Sounding C-307s



Waveforms for Sounding C-307sA

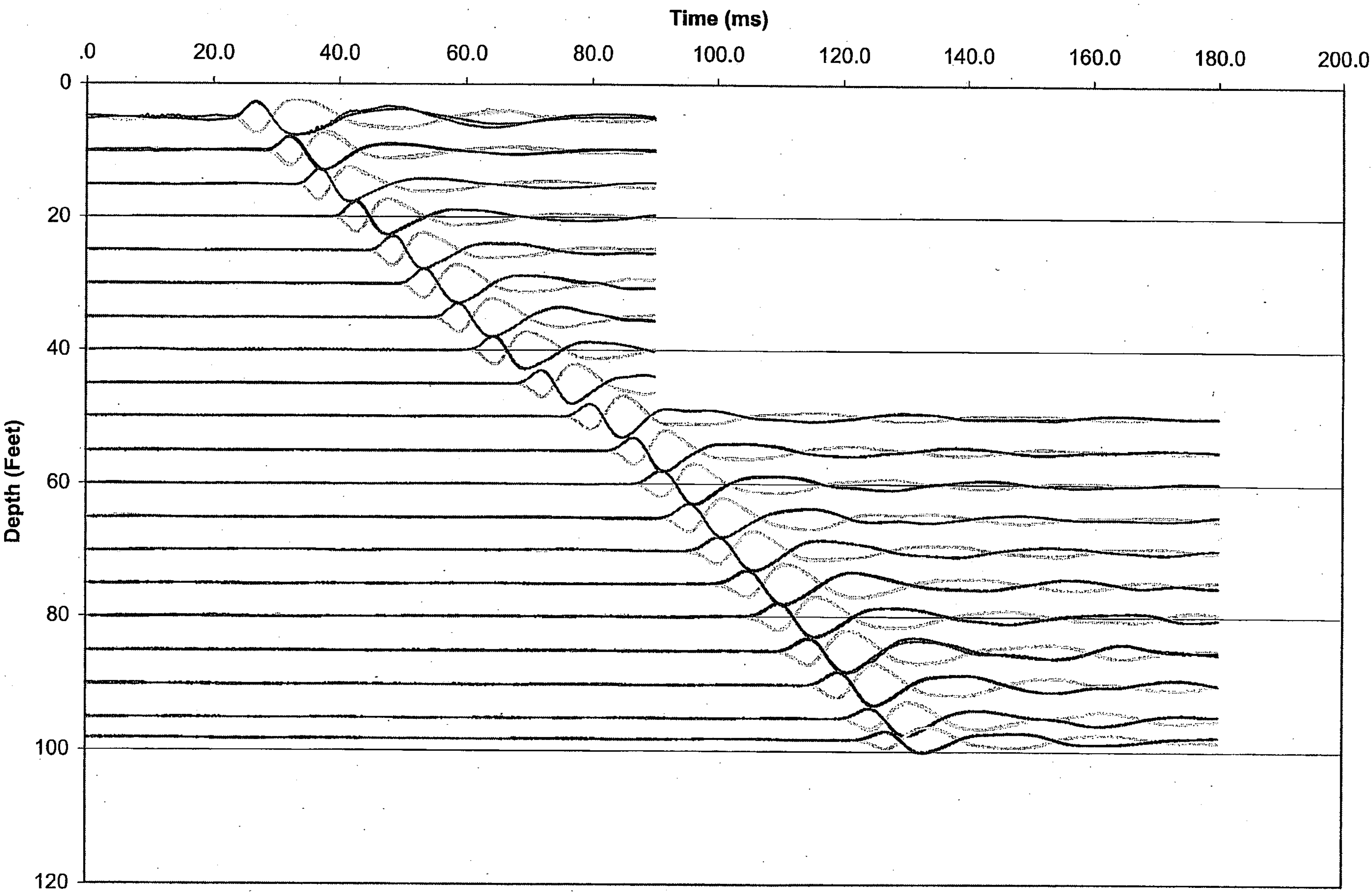


Waveforms for Sounding C-406s



GREGG

Waveforms for Sounding C-407s



GREGG IN SITU
Digital File Formats

CPT Data Files

Unless otherwise requested by the client, Gregg CPT data files are named such that the first 3 characters contain the job number, the next two characters are typically CP followed by two characters indicating the sounding number. The last DOS character position is reserved for the letters a, b, c, d etc to uniquely identify multiple soundings at the same location. The CPT sounding file has the extension COR and pore pressure dissipation files have the extension PPD. As an example, for job number 99-127 the first sounding will have file names 127CP01.COR and 127CP01.PPD.

The CPT (COR) file consists of the following components:

1. Two lines of header information
2. Data records
3. End of data marker
4. Units information

Header Lines

Line 1: Columns 1-6 are blank (future use)
Columns 7-21 contain the sounding Date and Time
Columns 22-36 contain the sounding Operator

Line 2: Columns 1-16 contain the Job Location
Columns 17-31 contain the Cone ID
Columns 32-47 contain the sounding number

Data Records

The data records contain 4 or more columns of data in floating point format. A comma (and spaces) separates each data item:

Column 1:	Sounding Depth (m)
Column 2:	Tip (q_c) data uncorrected for pore pressure effects. Recorded in units selected by the operator.
Column 3:	Sleeve (f_s) data. Recorded in units selected by the operator
Column 4:	Dynamic pore pressure readings. Recorded in units selected by the operator
Column 5:	Exists only if specialty modules (Resistivity and/or UVIF) have been used

End of Data Marker

After the last line of data a line containing ASCII 26 (CTL-Z) and a newline (carriage return/ line feed) character. This is used to mark the end of data.

Units Information

The last section of the file contains information about the units that were selected for the sounding. A separator bar makes up the first line. The second line contains the type of units used for depth, q_c, f_s and u. The third line contains the conversion values required for Gregg's software to convert the recorded data to an internal set of base units (bar for q_c, bar for f_s and meters for u).

CPT Dissipation Files

CPT Dissipation files have the same naming convention as the CPT sounding files and have the extension PPD. PPD files consist of the following components:

1. Two lines of header information
2. Data records

Header Lines (same as COR file):

Line 1: Columns 1-6 are blank (future use)
Columns 7-21 contain the sounding Date and Time
Columns 22-36 contain the sounding Operator

Line 2: Columns 1-16 contain the Job Location
Columns 17-31 contain the Cone ID
Columns 32-47 contain the sounding number

Data Records

The data records immediately follow the header lines. Each data record can occupy several lines in the file and is a complete record of a dissipation test at a particular depth. Each data record starts with a line containing two values separated by spaces; the first value being an index number (not currently used by the Software) and the second being the dissipation test depth in meters. Following this line are the dissipation pore pressure values stored at 5 second intervals with a maximum of 12 entries per line. The last line of the dissipation record may not contain a full 12 entries. The data record is terminated with an ASCII 30 character (appears as a triangle in some editors).

This sequence is repeated for every dissipation test in the sounding. No marker is used to indicate end of file. Units information is not stored in this file. Users would have to check the CPT file for the units that were used.

CPT Interpretations

Gregg's CPT interpretation output files are generally delivered in two styles knows as IFP and IFI files (printable and importable). One style has page formatting (IFP) and only uses up to 132 columns across the file. This allows the file to be printed on standard office printers. The files are usually formatted for 70 lines per page with form feed characters embedded into the file. They have been designed for use with the HP laserjet lineprinter or compressed (16.7 characters/inch) fixed pitch font style. Multiple pages are required to print an entire sounding. There are multiple parts to each page (pages 1a and 1b) to accommodate all the geotechnical parameters that are output.

The Importable file type (IFI) contains the same data as the IFP files but is set up with all the columns across the file. No page formatting is done. This file is designed for importing into spreadsheet programs.

Dilatometer Data Files

The dilatometer data files are prepared as input files for the program UBCDILLY (an enhanced version of DILLY originally created by Schmertmann and Crapps, Inc of Gainesville FL). The format of the files is almost identical to that described in Report Number FHWA-PA-87-014+84-24, Volume IV (of IV), GUIDELINES FOR GEOTECHNICAL DESIGN USING THE MARCHETTI DMT – DESIGN METHODS AND EXAMPLES, prepared for the Pennsylvania Department of Transportation by Schmertmann and Crapps, Inc. of Gainesville, FL, February 1998.

The only change to the input data is that the C reading is recorded as the fourth item of the data records immediately following the B reading. The input lines are as follows:

Line 1 Company Name (80 characters)
Line 2 Job Location (80 characters)
Line 3 Job Number (20 characters)
Line 4 Dilatometer Sounding Number (20 characters)
Line 5 Dilatometer Sounding Location (80 characters)
Line 6 Sounding Date (80 characters)
Line 7 Sounding Crew Names (80 characters)
Line 8 Delta A
Delta B
Vented gauge reading (gauge zero)
Depth to groundwater table (m)
Plot Option – vertical effective stress vs depth
Plot Option – undrained shear strength vs depth
Plot Option – phi angle vs depth
Plot Option – constrained modulus vs depth
Plot Option – plot interval (cm)
Unit weight of water in tonnes/m^3

Line 9 Phi Option
OCR Option
Diameter of friction reducer (cm)
Lineal weight of push rods (kg/m)
Diameter of push rods (cm)
Ratio of soil to dilatometer friction angle
Blade thickness (mm)

Line 10 (Test Cards)
Test reading depth (m)
A value (bars)
B value (bars)
C value (bars)
Thrust (kg)
Vertical effective stress (required on first test card)
Porewater pressure if known (bars)
Unit weight of soil (tonnes/m^3)
Plasticity index of soil

This card is repeated (usually only up to the Thrust data) for each test depth.

Dilatometer Output Files

These files are generated by UBCDILLY and are not easily modified.

ATTACHMENT E

GEOPHYSICAL TEST RESULTS

CONSISTS OF:

Final Report Boring Geophysical Logging
Dated February 22, 2007

Volume 1 Text and Figures
Volume 2 (DVD with pdf of Vol. 1 plus electronic files)

followed by

Final Report of Field Electrical Resistivity Test Results
Dated February 23, 2007

Volume 1 of 1

ATTACHMENT E

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FINAL REPORT

BORING GEOPHYSICAL LOGGING BORINGS B-302-DH, B-305-DHA, B-308-DH, B-319-DH, B-328-DH, B-402-DH, B-405-DH, B-408-DH, B-419-DH, AND B-428-DH

STP COL PROJECT SOUTH TEXAS PROJECT NUCLEAR STATION

Report 6533-01 vol 1 of 2 rev a

February 22, 2007

Prepared for:

MACTEC Engineering and Consulting, Inc.
2801 Yorkmont Road, Suite 100
Charlotte, N. C. 28208
704-357-5570
MACTEC Job number 5050-06-0496

Prepared by

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1151 Pomona Road, Unit P
Corona, California 92882
(951) 549-1234

GEOVision
geophysical services

FINAL REPORT

BORING GEOPHYSICAL LOGGING
BORINGS B-302-DH, B-305-DHA, B-308-DH, B-319-DH, B-328-DH, B-402-DH, B-405-DH, B-408-DH, B-419-DH, AND B-428-DH

STP COL PROJECT
SOUTH TEXAS PROJECT NUCLEAR STATION

Report 6533-01 vol 1 of 2 rev a

February 22, 2007

Final Report

Appendix E-1

Geophysical Test Data (Downhole)

GEOVision Report 6533-02 and DVD

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APPENDICES

INTRODUCTION

Boring geophysical measurements were collected in ten uncased borings located at the South Texas Project (STP) Nuclear Power Station, located in Matagorda County, Texas. Geophysical data acquisition was performed between November 7 and December 19, 2006 by Rob Steller and Chuck Carter of **GEO***Vision*. Data analysis and report preparation was performed by Rob Steller and reviewed by John Diehl of GEOVision. The work was performed under subcontract with MACTEC Engineering and Consulting, Inc., (MACTEC) with Mike Sufnarski serving as the point of contact for MACTEC.

This report describes the field measurements, data analysis, and results of this work.

SCOPE OF WORK

This report presents the results of boring geophysical measurements collected between November 7 and December 19, 2006, in ten uncased borings, as detailed below. The purpose of these studies was to supplement stratigraphic information obtained during MACTEC's soil and rock sampling program and to acquire shear wave velocities and compressional wave velocities as a function of depth, as a component of the STP Combined Operating License (COL) Application Project.

BORING DESIGNATION	DATES LOGGED	ELEVATION - FEET ABOVE MSL (1) NGVD 29	COORDINATES – FEET (1) NAD 27	
			NORTHING	EASTING
B-302-DH	12/5/2006	30.01	363000.73	2943364.78
B-305-DH	NOT LOGGED	29.82	363099.59	2943364.19
B-305-DHA	12/8/2006 12/18-19/2006	29.75	363100.87	2943343.98
B-308-DH	12/7/2006	29.80	363196.49	2943363.84
B-319-DH	12/7/2006	28.39	363364.17	2943407.90
B-328-DH	11/8/2006	29.92	363660.26	2943298.12
B-402-DH	12/6/2006	30.89	362998.09	2942462.29
B-405-DH	11/7-8/2006	31.06	363098.12	2942462.95
B-408-DH	11/9/2006	31.17	363194.11	2942463.86
B-419-DH	12/4/2006	29.73	363362.12	2942506.69
B-428-DH	12/5/2006	30.90	363660.05	2942398.55

(1) Survey data provided by MACTEC

Table 1 Boring locations and logging dates

The OYO Model 170 Suspension Logging Recorder and Suspension Logging Probe were used to obtain in-situ horizontal shear and compressional wave velocity measurements at 1.6 foot intervals. The acquired data were analyzed and a profile of velocity versus depth was produced for both compressional and horizontally polarized shear waves.

A detailed reference for the velocity measurement techniques used in this study is:

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

INSTRUMENTATION

Suspension Instrumentation

Suspension soil velocity measurements were performed in all borings using the PS suspension logging system, manufactured by OYO Corporation, and their subsidiary, Robertson Geologging. This system directly determines the average velocity of a 3.3 foot high segment of the soil column surrounding the boring of interest by measuring the elapsed time between arrivals of a wave propagating upward through the soil column. The receivers that detect the wave, and the source that generates the wave, are moved as a unit in the boring producing relatively constant amplitude signals at all depths.

Winch GEOVision 4-conductor
Sheave - Measuring wheel GEOVision S/N 102
Robertson PS telemetry unit M/N 3403 S/N 160023
Robertson Micrologger II S/N 5310
OYO PS Logger Borehole Probe, includes:
Isolation tube, 1m Model 3387B S/N 28068
Weight Model 3302W S/N 12007
OYO PS 170 Source Model 3304 S/N 19043
Receiver/Sensor S/N 30086
Driver Model 3386A S/N 27073

The suspension system probe consists of a combined reversible polarity solenoid horizontal shear-wave source (S_H) and compressional-wave source (P), joined to two biaxial receivers by a flexible isolation cylinder, as shown in Figure 1. The separation of the two receivers is 3.3 feet, allowing average wave velocity in the region between the receivers to be determined by inversion of the wave travel time between the two receivers. The total length of the probe as used in these surveys is 19 feet, with the center point of the receiver pair 12.1 feet above the bottom end of the probe.

The probe receives control signals from, and sends the digitized receiver signals to, instrumentation on the surface via an armored 4 conductor cable. The cable is wound onto the drum of a winch and is used to support the probe. Cable travel is measured to provide probe depth data, using a 3.28 foot circumference sheave fitted with a digital rotary encoder.

The entire probe is suspended in the boring by the cable, therefore, source motion is not coupled directly to the boring walls; rather, the source motion creates a horizontally propagating impulsive pressure wave in the fluid filling the boring and surrounding the source. This pressure wave is converted to P and S_H-waves in the surrounding soil and rock as it passes through the casing and grout annulus and impinges upon the wall of the boring. These waves propagate through the soil and rock surrounding the boring, in turn causing a pressure wave to be generated in the fluid surrounding the receivers as the soil waves pass their location. Separation of the P and S_H-waves at the receivers is performed using the following steps:

1. Orientation of the horizontal receivers is maintained parallel to the axis of the source, maximizing the amplitude of the recorded S_H -wave signals.
2. At each depth, S_H-wave signals are recorded with the source actuated in opposite directions, producing S_H-wave signals of opposite polarity, providing a characteristic S_H-wave signature distinct from the P-wave signal.
3. The 6.3 foot separation of source and receiver 1 permits the P-wave signal to pass and damp significantly before the slower S_H-wave signal arrives at the receiver. In faster soils or rock, the isolation cylinder is extended to allow greater separation of the P- and S_H-wave signals.
4. In saturated soils, the received P-wave signal is typically of much higher frequency than the received S_H-wave signal, permitting additional separation of the two signals by low pass filtering.

5. Direct arrival of the original pressure pulse in the fluid is not detected at the receivers because the wavelength of the pressure pulse in fluid is significantly greater than the dimension of the fluid annulus surrounding the probe (meter versus centimeter scale), preventing significant energy transmission through the fluid medium.

In operation, a distinct, repeatable pattern of impulses is generated at each depth as follows:

1. The source is fired in one direction producing dominantly horizontal shear with some vertical compression, and the signals from the horizontal receivers situated parallel to the axis of motion of the source are recorded.
2. The source is fired again in the opposite direction and the horizontal receiver signals are recorded.
3. The source is fired again and the vertical receiver signals are recorded. The repeated source pattern facilitates the picking of the P and S_H-wave arrivals; reversal of the source changes the polarity of the S_H-wave pattern but not the P-wave pattern.

The data from each receiver during each source activation is recorded as a different channel on the recording system. The Suspension PS system has six channels (two simultaneous recording channels), each with a 1024 sample record. The recorded data are displayed as six channels with a common time scale. Data are stored on disk for further processing. Up to 8 sampling sequences can be summed to improve the signal to noise ratio of the signals.

Review of the displayed data on the recorder or computer screen allows the operator to set the gains, filters, delay time, pulse length (energy), sample rate, and summing number to optimize the quality of the data before recording. Verification of the calibration of the Suspension PS digital recorder is performed every twelve months using a NIST traceable frequency source and counter, as outlined in Appendix C.

Caliper / Natural Gamma Instrumentation

Caliper and natural gamma data were collected using a Model 3ACS 3-leg caliper probe, serial number 5368, manufactured by Robertson Geologging, Ltd. With the short arm configuration used in these surveys, the probes permitted measurement of boring diameters between 1.6 and 16 inches. With this tool, caliper measurements were collected concurrent with measurement of natural gamma emission from the boring walls. The probe was 6.82 feet long, and 1.5 inches in diameter.

This probe is useful in the following studies:

- Measurement of boring diameter and volume
- Location of hard and soft formations
- Location of fissures, caving, pinching and casing damage
- Bed boundary identification
- Strata correlation between borings

The probe receives control signals from, and sends the digitized measurement values to, a Robertson Micrologger II, S/N 5310, on the surface via an armored 4 conductor cable. The cable is wound onto the drum of a winch and is used to support the probe. Cable travel is measured to provide probe depth data, using a 3.28 foot circumference sheave fitted with a digital rotary encoder. The probe and depth data are transmitted by USB link from the Micrologger unit to a laptop computer where it is displayed and stored on hard disk.

The caliper consists of three arms, each with a toothed quadrant at their base, pivoted in the lower probe body. A toothed rack engages with each quadrant, thus constraining the arms to move together. Linear movement of the rack is converted to opening and closing of the arms. Springs hold the arms open in the operating position. A motor drive is provided to retract the arms, allowing the probe to be lowered into the boring. The rack is coupled to a potentiometer which converts movement into a voltage sensed by the probe's microprocessor.

Natural gamma measurements rely upon small quantities of radioactive material contained in all rocks to emit gamma radiation as they decay. Trace amounts of Uranium and Thorium are present in a few minerals, where potassium-bearing minerals such as feldspar, mica and clays will include traces of a radioactive isotope of Potassium. These emit gamma radiation as they decay with an extremely long half-life. This radiation is detected by scintillation - the production of a tiny flash of light when gamma rays strike a crystal of sodium iodide. The light is converted into an electrical pulse by a photomultiplier tube. Pulses above a threshold value of 60 KeV are counted by the probe's microprocessor. The measurement is useful because the radioactive elements are concentrated in certain rock types e.g. clay or shales, and depleted in others e.g. sandstone or coal.

Resistivity / Spontaneous Potential / Natural Gamma Instrumentation

Resistivity, spontaneous potential and natural gamma data were collected using a Model ELXG electric log probe, S/N 5490, manufactured by Robertson Geologging, Ltd. This probe measures Single Point Resistance (SPR), short normal (16") resistivity, long normal (64") resistivity, Spontaneous Potential (SP) and natural gamma. The probe is 8.20 feet long, and 1.73 inches in diameter.

This probe is useful in the following studies:

- Bed boundary identification
- Strata correlation between borings
- Strata geometry and type (shale indication)

The probe receives control signals from, and sends the digitized measurement values to, a Robertson Micrologger II, S/N 5310, on the surface via an armored 4 conductor cable. The cable is wound onto the drum of a winch and is used to support the probe. Cable travel is measured to provide probe depth data, using a 3.28 foot circumference sheave fitted with a digital rotary encoder. The probe and depth data are transmitted by USB link from the Micrologger unit to a laptop computer where it is displayed and stored on hard disk.

The resistivity section of the probe operates by driving an alternating current into the formation from the central SPR/DRIVE electrode. The current returns via the logging cable armor. To ensure adequate penetration of the formation the logging cable is insulated for approximately 30 feet from the cablehead. Voltages are measured between the 16" and 64" electrodes and the remote earth connection at surface, as noted below:

- Single Point Resistance (SPR): The current flowing to the cable armor is measured along with the voltage at the SPR electrode. The voltage divided by current gives resistance.

- Spontaneous Potential (SP): This is the DC bias of the 16" electrode with respect to the voltage return at the surface (ground stake).

Data quality depends upon good grounding at the surface. This is achieved with a metal stake driven into the mud-pit.

Acoustic Televiewer / Boring Deviation Instrumentation

Boring deviation data were collected in all ten borings using a High Resolution Acoustic Televiewer probe (HiRAT), serial number 5174, manufactured by Robertson Geologging, Ltd. The probe is 7.58 feet long, and 1.9 inches in diameter.

In this application, this probe is useful in the following studies:

- Measurement of boring inclination and deviation from vertical
- Determination of need to correct soil and geophysical log depths to true vertical depths

The probe receives control signals from, and sends the digitized measurement values to, a Robertson Micrologger II, S/N 5310, on the surface via an armored 4 conductor cable. The cable is wound onto the drum of a winch and is used to support the probe. Cable travel is measured to provide probe depth data, using a 3.28 foot circumference sheave fitted with a digital rotary encoder. The probe and depth data are transmitted by USB link from the Micrologger unit to a laptop computer where it is displayed and stored on hard disk.

The probe contains a fluxgate magnetometer to monitor magnetic north, and all raw televiewer data are referenced to magnetic north. A three-axis accelerometer is enclosed in the probe, providing boring dip data that, when processed with the orientation data, allows boring deviation data to be obtained.

The data are presented on a computer screen for operator review during the logging run, and stored on hard disk for later processing.

MEASUREMENT PROCEDURES

Suspension Measurement Procedures

All ten borings were logged as un-cased or partially cased borings, filled with bentonite or polymer based drilling mud. Measurements followed the **GEO***Vision* Procedure for P-S Suspension Seismic Velocity Logging, revision 1.3, as presented in Appendix E. These procedures were supplied and approved in advance of the work. In each boring, the probe was positioned with the top of the probe at the top of the casing, and the electronic depth counter was set to 6.6 feet, the distance between the mid-point of the receiver and the top of the probe, minus the height of the casing stick-up, as verified with a tape measure, and recorded on the field logs. The probe was lowered to the bottom of the boring, and then returned to the surface, stopping at 1.6 foot intervals to collect data, as summarized in Table 2.

At each measurement depth the measurement sequence of two opposite horizontal records and one vertical record was performed, and the gains were adjusted as required. The data from each depth were viewed on the computer display, checked, and recorded on disk before moving to the next depth.

Upon completion of the measurements, the probe zero depth indication at the depth reference point was verified prior to removal from the boring.

Caliper / Natural Gamma Measurement Procedures

All ten borings were logged as un-cased or partially cased borings, filled with bentonite or polymer based drilling mud. Measurements followed the ASTM D6167 Conducting Borehole Geophysical Logging – Mechanical Caliper, as presented in Appendix E.

Prior to and following each logging run, the caliper tool was verified, using the manufacturer's supplied three point calibration jig, and a PVC coupling provided by MACTEC with an inside diameter traceable to NIST. The three point jig is a circular plate with a series of holes in the top surface into which the tips of the caliper arms fit. This has circles of diameters from 2" to 12", with NIST traceable calibration as documented in Appendix C. The calibration jig is placed over a bucket with the probe standing upright with its nose section passing through the jig's central hole. The caliper probe arms are opened under program control, and a log is recorded as the tips of the arms are placed in the holes on the calibration jig and inside the PVC coupling. The measured dimensions, as displayed on the recording computer screen was recorded on the field log sheet, as well as in the digital files, and compared with the calibration jig dimensions. These files are presented in LAS 2.0 format in the boring specific sub-directories of the data directory on volume 2 of 2 (DVD-R) of this report. If the verification records did not fall within +/- 0.05 inches of the calibration jig values, the caliper tool was re-calibrated, using the three point calibration jig, and the log repeated. As with the verification, the tips of the caliper arms are placed in the holes marked with the required diameter. During calibration, the value of the current calibration point, as stamped on the jig, is entered via the control computer. The system counts for 15 seconds to make an average of the response. The procedure is repeated for the second and third required openings.

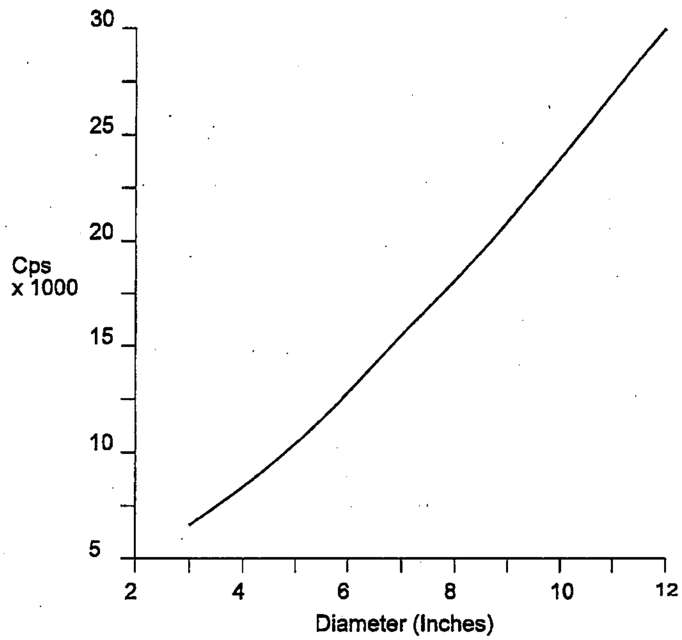


Figure 1. Example Calibration Curve for Caliper Probe

The computation and generation of the calibration coefficient file is entirely automatic. The calibration file is simply the set of coefficients of a quadratic curve which fits the three data points. Figure 1 shows the response of a caliper probe using data gathered during calibration.

Natural gamma was not calibrated in the field, as it is a qualitative measurement, not a quantitative value, and is used only to assist in picking transitions between stratigraphic units, as described in ASTM D6274, Conducting Borehole Geophysical Logging - Gamma, which is included in Appendix E.

In each boring, the probe was positioned with the top of the probe at the top of the mud box, and the electronic depth counter was set to 6.82 feet, the specified length of the probe, minus the height of the mud box, as verified with a tape measure, and recorded on the field logs. The probe was lowered to the bottom of the boring, where the caliper legs were opened, and data collection begun. The probe was then returned to the surface at 10 feet/minute, collecting data continuously at 0.05 foot spacing, as summarized in Table 2.

Upon completion of the measurements, the probe zero depth indication at the depth reference point was verified prior to removal from the boring, as summarized in Table 3.

Resistivity / Spontaneous Potential Measurement Procedures

All ten borings were logged as un-cased or partially cased borings, filled with bentonite or polymer based drilling mud. The probe was connected to the logging cable using a 32.8 foot long insulating cable section or "yoke". The probe head was insulated by wrapping all exposed metal of the cablehead and probe with self-amalgamating insulation tape. The 32.8 foot insulating yoke was checked for any damage, and repaired with self-amalgamating insulation tape as needed.

The reference ground stake was driven firmly into the mud pit, and connected to the ground socket on the winch switch box.

This sonde was not calibrated in the field, as it is used to provide qualitative measurements, not quantitative values, and is used only to assist in picking transitions between stratigraphic units, as described in ASTM D5753, Planning and Conducting Borehole Geophysical Surveys, which is included in Appendix E. A functional test is performed prior to each logging run by applying fixed resistance values across the probe electrodes, as well as a 100 millivolt signal across the SP electrodes, and recording the resultant output of the system. These functional checks are presented in LAS 2.0 format in the boring specific sub-directories of the data directory on volume 2 of 2 (DVD-R) of this report.

In each boring, the probe was positioned with the top of the probe at the top of the casing or mud box, and the electronic depth counter was set to 8.2 feet, the specified length of the probe, minus the height of the casing stick-up or mud box, as verified with a tape measure. When logging on smaller drill rigs, the depth was zeroed to the top of the yoke, and 32.8 feet was added to the zero depth, as recorded in the field logs. The probe was lowered to the bottom of the boring, where data collection was begun. The probe was then returned to the surface at 10 feet/minute, collecting data continuously at 0.05 foot spacing, as summarized in Table 2. The natural gamma data collected in these logs is redundant with the data collected in the caliper / natural gamma logs, and the caliper / natural data may be used to verify the natural gamma data collected in these logs.

Normally, when the un-insulated section of the logging cable leaves the boring fluid, the log is terminated, as the electrical measurements do not function under these conditions. However, in these surveys, the log was continued, in order to collect as much natural gamma data as possible before the yoke connector reached the measuring wheel.

Upon completion of the measurements, the probe zero depth indication at the depth reference point was verified prior to removal from the boring, as summarized in Table 3.

Acoustic Televiewer / Boring Deviation Measurement Procedures

All ten borings were logged as un-cased or partially cased borings, filled with bentonite or polymer based drilling mud. Although the acoustic televiewer cannot image in the soft soils at this site, the logs were run in order to provide a deviation log for the boring. Measurements followed the **GEO***Vision* standard field procedures, as presented in Appendix E.

Prior to use, the HiRAT probe tiltmeter and compass functions were checked by comparison with a Brunton surveyors' compass.

In each boring, the HiRAT probe was positioned with the top of the probe at the top of the casing, and the electronic depth counter was set to 4.71 feet, the specified length of the probe, minus the height of the casing stick-up, as verified with a tape measure, and recorded on the field logs. The probe was lowered to the bottom of the boring, and data collection begun. The probe was then returned to the surface at 10.0 feet/minute, collecting data continuously at 0.04 foot intervals, as summarized in Table 2.

Upon completion of the measurements, the probe zero depth indication at grade was verified prior to removal from the boring. The log was reviewed in the field, and the data processed with Robertson Geologging RGLDIP software, version 6.2, to produce a boring deviation plot and data in ASCII format. These files are presented in the boring specific sub-directories of the data directory on volume 2 of 2 (DVD-R) of this report, and summarized in Table 4.

BORING NUMBER	TOOL AND RUN NUMBER	DEPTH RANGE (FEET)	OPEN HOLE (FEET)	DEPTH TO BOTTOM OF CASING (FEET)	SAMPLE INTERVAL (FEET)	DATE LOGGED
B-302-DH	ELOG/GAMMA 1	218.0 – 37.2	218.0	20.0 AUGER	0.05	12/5/2006
B-302-DH	SUSPENSION 1	19.7 – 205.1	-	20.0 AUGER	1.6	12/5/2006
B-302-DH	CALIPER/GAMMA 1	210.0 – 0.0	-	20.0 AUGER	0.05	12/5/2006
B-302-DH	DEVIATION 1	210.0 – 2.5	-	20.0 AUGER	0.04	12/5/2006
B-305-DHA	ELOG/GAMMA 1	90.0 – 35.0	90.0	NONE	0.05	12/8/2006
B-305-DHA	SUSPENSION 1	1.6 – 77.1	-	NONE	1.6	12/8/2006
B-305-DHA	CALIPER/GAMMA 1	88.0 – 0.0	-	NONE	0.05	12/8/2006
B-305-DHA	DEVIATION 1	88.0 – 0.0	-	NONE	0.04	12/8/2006
B-305-DHA	ELOG/GAMMA 2	583.0 – 19.0	583.0	53.0 AUGER	0.05	12/18/2006
B-305-DHA	SUSPENSION 2	60.7 – 565.9	-	53.0 AUGER	1.6	12/18/2006
B-305-DHA	CALIPER/GAMMA 2	579.0 – 0.0	-	53.0 AUGER	0.05	12/18/2006
B-305-DHA	DEVIATION 2	582.5 – 0.0	-	53.0 AUGER	0.04	12/18/2006
B-305-DHA	ELOG/GAMMA 3	575.0 – 18.1	575.0	53.0 AUGER	.05	12/19/2006
B-308-DH	ELOG/GAMMA 1	215.5 – 35.0	215.5	NONE	0.05	12/7/2006
B-308-DH	SUSPENSION 1	3.3 – 201.8	-	NONE	1.6	12/7/2006
B-308-DH	CALIPER/GAMMA 1	210.0 – 0.0	-	NONE	0.05	12/7/2006
B-308-DH	DEVIATION 1	210.0 – 2.5	-	NONE	0.04	12/7/2006
B-319-DH	ELOG/GAMMA 1	215.0 – 34.5	215.0	NONE	0.05	12/7/2006
B-319-DH	SUSPENSION 1	1.6 – 201.8	-	NONE	1.6	12/7/2006
B-319-DH	CALIPER/GAMMA 1	210.0 – 0.1	-	NONE	0.05	12/7/2006
B-319-DH	DEVIATION 1	210.0 – 0.0	-	NONE	0.04	12/7/2006
B-328-DH	SUSPENSION 1	3.3 – 205.1	-	NONE	1.6	11/8/2006
B-328-DH	ELOG/GAMMA 1	217.8 – 35.0	217.8	NONE	0.05	11/8/2006
B-328-DH	CALIPER/GAMMA 1	210.0 – 0.5	-	NONE	0.05	11/8/2006
B-328-DH	DEVIATION 1	217.5 – 0.0	217.5	NONE	0.04	11/8/2006
B-402-DH	ELOG/GAMMA 1	216.0 – 34.8	216.0	1.0 PVC	0.05	12/6/2006
B-402-DH	SUSPENSION 1	3.3 – 201.8	-	1.0 PVC	1.6	12/6/2006
B-402-DH	CALIPER/GAMMA 1	210.0 – 0.1	-	1.0 PVC	0.05	12/6/2006
B-402-DH	DEVIATION 1	210.0 – 0.0	-	1.0 PVC	0.04	12/6/2006
B-405-DH	SUSPENSION 1	93.5 – 607.0	-	93.0 STEEL	1.6	11/7/2006

B-405-DH	ELOG/GAMMA 1	617.6 – 20.0	617.6	93.0 STEEL	0.05	11/7/2006
B-405-DH	CALIPER/GAMMA 1	610.0 – 0.0	-	93.0 STEEL	0.05	11/7/2006
B-405-DH	DEVIATION 1	619.2– 0.0	619.2	93.0 STEEL	0.04	11/7/2006
B-405-DH	SUSPENSION 2	21.3 – 106.6	-	20.0 AUGER	1.6	11/8/2006
B-405-DH	ELOG/GAMMA 2	120.0 – 18.5	120.0	20.0 AUGER	0.05	11/8/2006
B-405-DH	DEVIATION 2	115.0– 0.0	-	20.0 AUGER	0.04	11/8/2006
B-405-DH	CALIPER/GAMMA 2	115.0 – 0.0	-	20.0 AUGER	0.05	11/8/2006
B-408-DH	ELOG/GAMMA 1	215.5 – 35.0	215.5	NONE	0.05	11/9/2006
B-408-DH	SUSPENSION 1	3.3 – 201.8	-	NONE	1.6	11/9/2006
B-408-DH	CALIPER/GAMMA 1	210.0 – 0.4	-	NONE	0.05	11/9/2006
B-408-DH	DEVIATION 1	210.0 – 0.0	-	NONE	0.04	11/9/2006
B-419-DH	ELOG/GAMMA 1	216.0 – 17.9	216.0	2.0 PVC	0.05	12/4/2006
B-419-DH	SUSPENSION 1	3.3 – 203.2	-	2.0 PVC	1.6	12/4/2006
B-419-DH	CALIPER/GAMMA 1	210.0 – 0.0	-	2.0 PVC	0.05	12/4/2006
B-419-DH	DEVIATION 1	210.0 – 94.0	-	2.0 PVC	0.04	12/4/2006
B-419-DH	DEVIATION 2	91.0 – 0.0	-	2.0 PVC	0.04	12/4/2006
B-428-DH	ELOG/GAMMA 1	215.0 – 34.5	215.0	NONE	0.05	12/5/2006
B-428-DH	SUSPENSION 1	1.6 – 201.8	-	NONE	1.6	12/5/2006
B-428-DH	CALIPER/GAMMA 1	210.0 – 0.0	-	NONE	0.05	12/5/2006
B-428-DH	DEVIATION 1	210.0 – 1.3	-	NONE	0.04	12/5/2006

- PROBE DID NOT TOUCH BOTTOM OF BORING

Table 2. Logging dates and depth ranges

BORING NUMBER	TOOL AND RUN NUMBER	TOOL HIT BOTTOM DEPTH (FEET)	DRILLER DEPTH (FEET)	STARTING DEPTH REF. (FEET)	ENDING DEPTH REF. (FEET)	ASDE (FEET)
B-302-DH	ELOG/GAMMA 1	218.0	215.0	39.4	39.3	-0.1
B-302-DH	SUSPENSION 1	-	-	6.6	6.4	-0.2
B-302-DH	CALIPER/GAMMA 1	-	-	5.2	5.2	0.0
B-302-DH	DEVIATION 1	-	-	3.1	3.1	0.1
B-305-DHA	ELOG/GAMMA 1	90.0	90.0	41.0	41.0	0.0
B-305-DHA	SUSPENSION 1	-	-	1.6	1.6	0.0
B-305-DHA	CALIPER/GAMMA 1	-	-	6.8	6.8	0.0
B-305-DHA	DEVIATION 1	-	-	4.7	4.7	0.0
B-305-DHA	ELOG/GAMMA 2	583.0	618.0	38.8	39.5	0.7
B-305-DHA	SUSPENSION 2	-	-	5.9	5.8	-0.1
B-305-DHA	CALIPER/GAMMA 2	-	-	4.6	4.5	-0.1
B-305-DHA	DEVIATION 2	-	-	2.5	2.5	0.0
B-305-DHA	ELOG/GAMMA 3	575.0	-	38.8	38.5	-0.3
B-308-DH	ELOG/GAMMA 1	215.5	215.0	41.0	41.1	0.1
B-308-DH	SUSPENSION 1	-	-	8.2	8.5	0.3

B-308-DH	CALIPER/GAMMA 1	-	-	6.8	6.8	0.0
B-308-DH	DEVIATION 1	-	-	4.7	4.9	0.2
B-319-DH	ELOG/GAMMA 1	215.0	215.0	41.0	NA	NA
B-319-DH	SUSPENSION 1	-	-	8.2	NA	NA
B-319-DH	CALIPER/GAMMA 1	-	-	6.8	6.9	0.1
B-319-DH	DEVIATION 1	-	-	4.7	4.8	0.1
B-328-DH	SUSPENSION 1	-	-	8.2	8.2	0.0
B-328-DH	ELOG/GAMMA 1	217.8	215.0	41.0	NA	NA
B-328-DH	CALIPER/GAMMA 1	-	-	6.8	6.8	0.0
B-328-DH	DEVIATION 1	217.5	215.0	4.7	4.7	0.0
B-402-DH	ELOG/GAMMA 1	216.0	215.0	39.6	39.6	0.0
B-402-DH	SUSPENSION 1	-	-	6.9	6.8	-0.1
B-402-DH	CALIPER/GAMMA 1	-	-	5.4	5.5	0.1
B-402-DH	DEVIATION 1	-	-	3.3	3.3	0.0
B-405-DH	SUSPENSION 1	-	-	6.7	6.4	-0.3
B-405-DH	ELOG/GAMMA 1	617.6	618.0	39.5	39.7	0.2
B-405-DH	CALIPER/GAMMA 1	-	-	5.3	5.4	0.1
B-405-DH	DEVIATION 1	619.2	618.0	4.2	4.0	-0.2
B-405-DH	SUSPENSION 2	-	-	6.7	6.7	0.0
B-405-DH	ELOG/GAMMA 2	120.0	120.0	39.5	39.5	0.0
B-405-DH	DEVIATION 2	-	-	3.2	3.4	0.2
B-405-DH	CALIPER/GAMMA 2	-	-	5.3	5.4	0.1
B-408-DH	ELOG/GAMMA 1	215.5	215.0	41.0	41.1	0.1
B-408-DH	SUSPENSION 1	214.5	215.0	NA	NA	NA
B-408-DH	CALIPER/GAMMA 1	-	-	6.8	6.9	0.1
B-408-DH	DEVIATION 1	-	-	4.7	4.7	0.0
B-419-DH	ELOG/GAMMA 1	216.0	215.0	39.8	40.0	0.2
B-419-DH	SUSPENSION 1	215.5	215.0	7.0	7.0	0.0
B-419-DH	CALIPER/GAMMA 1	-	-	5.6	5.6	0.0
B-419-DH	DEVIATION 1	-	-	3.5	3.4	-0.1
B-428-DH	ELOG/GAMMA 1	215.0	215.0	41.0	41.1	0.1
B-428-DH	SUSPENSION 1	215.2	215.0	6.6	NA	NA
B-428-DH	CALIPER/GAMMA 1	-	-	6.8	NA	NA
B-428-DH	DEVIATION 1	-	-	4.7	4.7	0.0

- PROBE DID NOT TOUCH BOTTOM OF BORING

Table 3. Boring Bottom Depths and After Survey Depth Error (ASDE)

DATA ANALYSIS

Suspension Analysis

Using the proprietary OYO program PSLOG.EXE version 1.0, included in volume 2 of 2 (DVD-R) of this report, the recorded digital waveforms were analyzed to locate the most prominent first minima, first maxima, or first break on the vertical axis records, indicating the arrival of P-wave energy. The difference in travel time between receiver 1 and receiver 2 (R1-R2) arrivals was used to calculate the P-wave velocity for that 3.3 foot segment of the soil column. When observable, P-wave arrivals on the horizontal axis records were used to verify the velocities determined from the vertical axis data. The time picks were then transferred into an EXCEL template (EXCEL version 2003 SP2) to complete the velocity calculations based upon the arrival time picks made in PSLOG. The PSLOG pick files and the EXCEL analysis files are included in the boring specific directories on volume 2 of 2 (DVD-R) of this report.

The P-wave velocity over the 6.3 foot interval from source to receiver 1 (S-R1) was also picked using PSLOG, and calculated and plotted in EXCEL, for quality assurance of the velocity derived from the travel time between receivers. In this analysis, the depth values as recorded were increased by 4.8 feet to correspond to the mid-point of the 6.3 foot S-R1 interval. Travel times were obtained by picking the first break of the P-wave signal at receiver 1 and subtracting 0.3 milliseconds, the calculated and experimentally verified delay from source trigger pulse (beginning of record) to source impact. This delay corresponds to the duration of acceleration of the solenoid before impact.

As with the P-wave records, using PSLOG, the recorded digital waveforms were analyzed to locate the presence of clear S_H-wave pulses, as indicated by the presence of opposite polarity pulses on each pair of horizontal records. Ideally, the S_H-wave signals from the 'normal' and 'reverse' source pulses are very nearly inverted images of each other. Digital FFT - IFFT lowpass filtering was used to remove the higher frequency P-wave signal from the S_H-wave signal. Different filter cutoffs were used to separate P- and S_H-waves at different depths, ranging from 600 Hz in the slowest zones to 2000 Hz in the regions of highest velocity. At each depth, the filter frequency was selected to be at least twice the fundamental frequency of the S_H-wave signal being filtered.

Generally, the first maxima were picked for the 'normal' signals and the first minima for the 'reverse' signals, although other points on the waveform were used if the first pulse was distorted. The absolute arrival time of the 'normal' and 'reverse' signals may vary by +/- 0.2 milliseconds, due to differences in the actuation time of the solenoid source caused by constant mechanical bias in the source or by boring inclination. This variation does not affect the R1-R2 velocity determinations, as the differential time is measured between arrivals of waves created by the same source actuation. The final velocity value is the average of the values obtained from the 'normal' and 'reverse' source actuations.

As with the P-wave data, S_H-wave velocity calculated from the travel time over the 6.3 foot interval from source to receiver 1 was calculated and plotted for verification of the velocity derived from the travel time between receivers. In this analysis, the depth values were increased by 4.8 foot to correspond to the mid-point of the 6.3 foot S-R1 interval. Travel times were obtained by picking the first break of the S_H-wave signal at the near receiver and subtracting 0.3 milliseconds, the calculated and experimentally verified delay from the beginning of the record at the source trigger pulse to source impact.

These data and analysis were reviewed by John Diehl and Tony Martin as a component of **GEO***Vision*'s in-house QA-QC program.

Figure 2 shows an example of R1 - R2 measurements on a sample filtered suspension record. In Figure 2, the time difference over the 3.3 foot interval of 1.88 milliseconds for the horizontal signals is equivalent to an S_H-wave velocity of 1745 feet/second. Whenever possible, time differences were determined from several phase points on the S_H-waveform records to verify the data obtained from the first arrival of the S_H-wave pulse. Figure 3 displays the same record before filtering of the S_H-waveform record with a 1400 Hz FFT - IFFT digital lowpass filter, illustrating the presence of higher frequency P-wave energy at the beginning of the record, and distortion of the lower frequency S_H-wave by residual P-wave signal.

Caliper / Natural Gamma Analysis

No analysis is required with the caliper or natural gamma data, however depths to identifiable boring features were compared to verify compatible depth readings on all logs. Using Robertson Geologging Winlogger software version 1.5, build 401J, these data were combined with the resistivity, ELOG based natural gamma and spontaneous potential (SP) logs, and converted to LAS 2.0 and PDF formats for transmittal to the client.

Resistivity / Natural Gamma / Spontaneous Potential Analysis

No analysis is required with the resistivity, natural gamma or spontaneous potential data, however depths to identifiable boring features were compared to verify compatible depth readings on all logs. Using Robertson Geologging Winlogger software version 1.5, build 401J, these data were combined with the caliper and caliper-based natural gamma logs, and converted to LAS 2.0 and PDF formats for transmittal to the client.

Acoustic Televiewer / Boring Deviation Analysis

The collected Acoustic Televiewer data were processed with Robertson Geologging's RGLDIP program, version 6.2, to extract the deviation data and produce an ASCII file and plots of deviation data as presented in the boring specific sub-directories in the data directory on volume 2 of 2 (DVD-R) of this report, and summarized in Table 4.

RESULTS

Suspension Results

Suspension R1-R2 P- and S_H-wave velocities are plotted in Figures 5, 8, 12, 15, 18, 21, 24, 28, 31 and 34 The suspension velocity data presented in these figures are presented in Tables 5 - 14 The PSLOG and EXCEL analysis files for each boring are included in the boring specific directories on volume 2 of 2 (DVD-R) of this report, along with the raw and filtered waveforms.

P- and S_H-wave velocity data from R1-R2 analysis and quality assurance analysis of S-R1 data are plotted together in Figures A-1 through A-10 to aid in visual comparison. It should be noted that R1-R2 data are an average velocity over a 3.3 foot segment of the soil column; S-R1 data are an average over 6.3 feet, creating a significant smoothing relative to the R1-R2 plots. S-R1 data are presented in Tables A-1 through A-10, and included in the EXCEL analysis files for each boring on volume 2 of 2 (DVD-R) of this report.

Calibration procedures and records for the suspension PS measurement system are presented in Appendix C, and **GEO***Vision* standard field log sheets for all borings are reproduced in Appendix D.

The **GEO***Vision* standard field procedures are reproduced in Appendix E.

Caliper/ Natural Gamma Results

Caliper and natural gamma data are presented in combined log plots with resistivity and spontaneous potential as single page logs in Figures 6, 9, 10, 13, 16, 19, 22, 25, 26, 29, 32 and 35, as well as multi-page logs in Appendix B. On these plots, the following acronyms are used:

- NGAM: Natural gamma data collected with the ELOG probe.
- SP: Spontaneous (self) potential.
- CNGA: Natural gamma data collected with the caliper probe.
- CALP: Caliper (borehole diameter)
- SHN: Short normal resistivity (16 inch resistivity)
- LON: Long normal resistivity (64 inch resistivity)
- SPR: Single point resistance

LAS 2.0 data and Acrobat files of the plots for each boring are included in the boring specific sub-directories in the data directory on volume 2 of 2 (DVD-R) of this report.

Resistivity / Spontaneous Potential Results

Resistivity and spontaneous potential data are presented in combined log plots with caliper and natural gamma data as single page logs in Figures 6, 9, 10, 13, 16, 19, 22, 25, 26, 29, 32 and 35, as well as multi-page logs in Appendix B. LAS 2.0 data and Acrobat files for each boring are included in the boring specific sub-directories in the data directory on volume 2 of 2 (DVD-R) of this report.

Acoustic Televiewer / Boring Deviation Results

Boring deviation data are presented graphically in Figures 7, 11, 14, 17, 20, 23, 27, 30, 33 and 36, and summarized in Table 4. Deviation data plots in Acrobat format and deviation data at 1.0 foot stations are presented in ASCII format in the boring specific sub-directories of the data directory on volume 2 of 2 (DVD-R) of this report.

SUMMARY

Discussion of Suspension Results

Suspension PS velocity data are ideally collected in an uncased fluid filled boring, drilled with rotary mud (rotary wash) methods. Most of the borings at this site were ideal for collection of suspension PS velocity data, though the upper 30 feet of these borings tended to be enlarged by collapse and fluid erosion.

Suspension PS velocity data quality is judged based upon 5 criteria:

1. Consistent data between receiver to receiver (R1 – R2) and source to receiver (S – R1) data.
2. Consistent relationship between P-wave and S_H -wave (excluding transition to saturated soils)
3. Consistency between data from adjacent depth intervals.
4. Clarity of P-wave and S_H-wave onset, as well as damping of later oscillations.
5. Consistency of profile between adjacent borings, if available.

These data show excellent correlation between R1 – R2 and S – R1 data, as well as excellent correlation between P-wave and S_H-wave velocities. Only in B-405-DH is a divergence of R1 – R2 and S – R1 data observed, between 95.1 – 116.5 feet, due to the large diameter washout from 103 – 108 feet, as indicated on the caliper log. These velocity data are not presented. P-wave and S_H-wave onsets are generally clear, and later oscillations are well damped.

Discussion of Caliper / Natural Gamma Results

Caliper and natural gamma data were collected for the entire depth of each boring, as natural gamma data can be collected through PVC casing without attenuation, and through steel casing with some attenuation. The caliper logs for these borings generally show consistent gauge below 30 feet, with the exception of B-405-DH, which had a very large diameter washout between 103 – 108 feet, which corresponded with anomalous suspension PS velocity data. Natural gamma data were collected with this tool in all the borings, as well as with the ELOG probe, and the comparison between the two data sets provides an almost exact match, verifying the performance of the natural gamma measuring systems.

Discussion of Resistivity / Spontaneous Potential Results

These electrical methods provide clear demarcation of different lithologic units at this site. All three resistivity logs show the same structure, and match very closely with the structure indicated by the natural gamma logs. The electrical data are not valid above 40 feet, as the upper yoke electrode moves out of the boring fluid at this depth. The natural gamma data remains valid up into the casing, and agrees well with the caliper probe. The comparison between the two data sets provides an almost exact match, verifying the performance of the natural gamma measuring systems.

Discussion of Acoustic Televiewer / Boring Deviation Results

All ten borings were inclined at 1.5 degrees, or less, from vertical, and the maximum error in depth value was 0.3 feet in 582 ft, or 0.05 percent, as presented in Table 4. This error is less than depth errors from other causes, and no adjustment of log depth is indicated.

BORING NUMBER	MEAN DEVIATION AND AZIMUTH (DEGREES)	SURVEY DEPTH (FEET)	VERTICAL DEPTH (FEET)	DEPTH ERROR (FEET)	HORIZONTAL OFFSET (FEET)
B-302-DH	0.6 – N48.5	209.8	209.7	0.1	2.3
B-305-DHA	1.5 – N162.3	582.4	582.1	0.3	14.7
B-308-DH	0.6 – N276.4	209.9	209.9	0.0	2.1
B-319-DH	0.5 – N201.5	209.8	209.8	0.0	1.6
B-328-DH	0.3 – N37.4	217.3	217.3	0.0	1.2
B-402-DH	0.4 – N151.2	209.8	209.7	0.1	1.3
B-405-DH	0.4 – N179.0	619.1	619.0	0.1	4.4
B-408-DH	0.7 – N88.1	209.9	209.9	0.0	2.7
B-419-DH	0.7 – 216.3	209.9	209.9	0.0	2.5
B-428-DH	0.6 – N61.0	210.0	209.9	0.1	2.3

Table 4. Boring Deviation Data Summary

Quality Assurance

These boring geophysical measurements were performed using industry-standard or better methods for measurements and analyses. All work was performed under **GEO***Vision* quality assurance procedures, which include:

- Use of NIST-traceable calibrations, where applicable, for field and laboratory instrumentation
- Use of standard field data logs
- Use of independent verification of velocity data by comparison of receiver-to-receiver and source-to-receiver velocities
- Independent review of calculations and results by a registered professional engineer, geologist, or geophysicist.

Suspension Data Reliability

P- and S_H-wave velocity measurement using the Suspension Method gives average velocities over a 3.3 foot interval of depth. This high resolution results in the scatter of values shown in the graphs. Individual measurements are very reliable with estimated precision of +/- 5%. Standardized field procedures and quality assurance checks contribute to the reliability of these data.

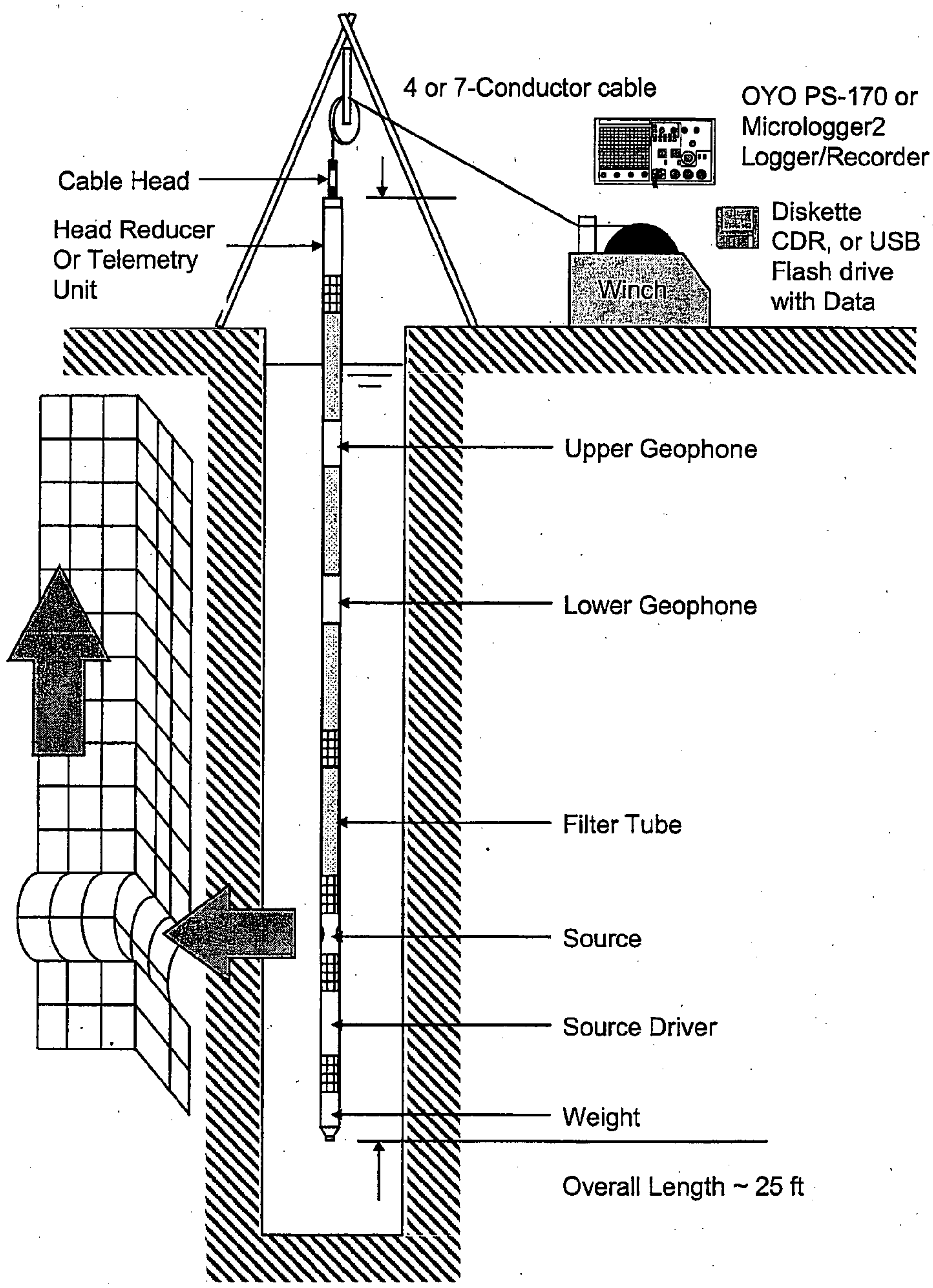


Figure 2: Concept illustration of P-S logging system

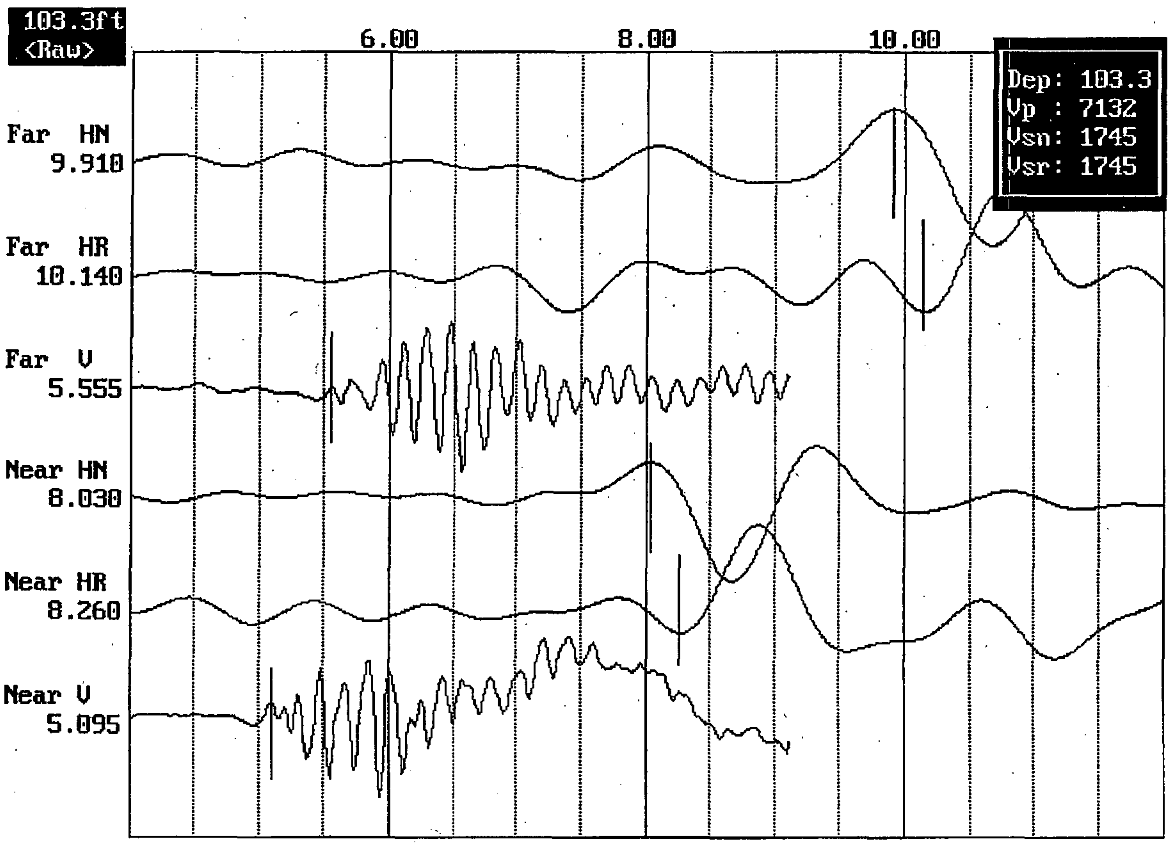


Figure 3: Example of filtered (1400 Hz lowpass) record

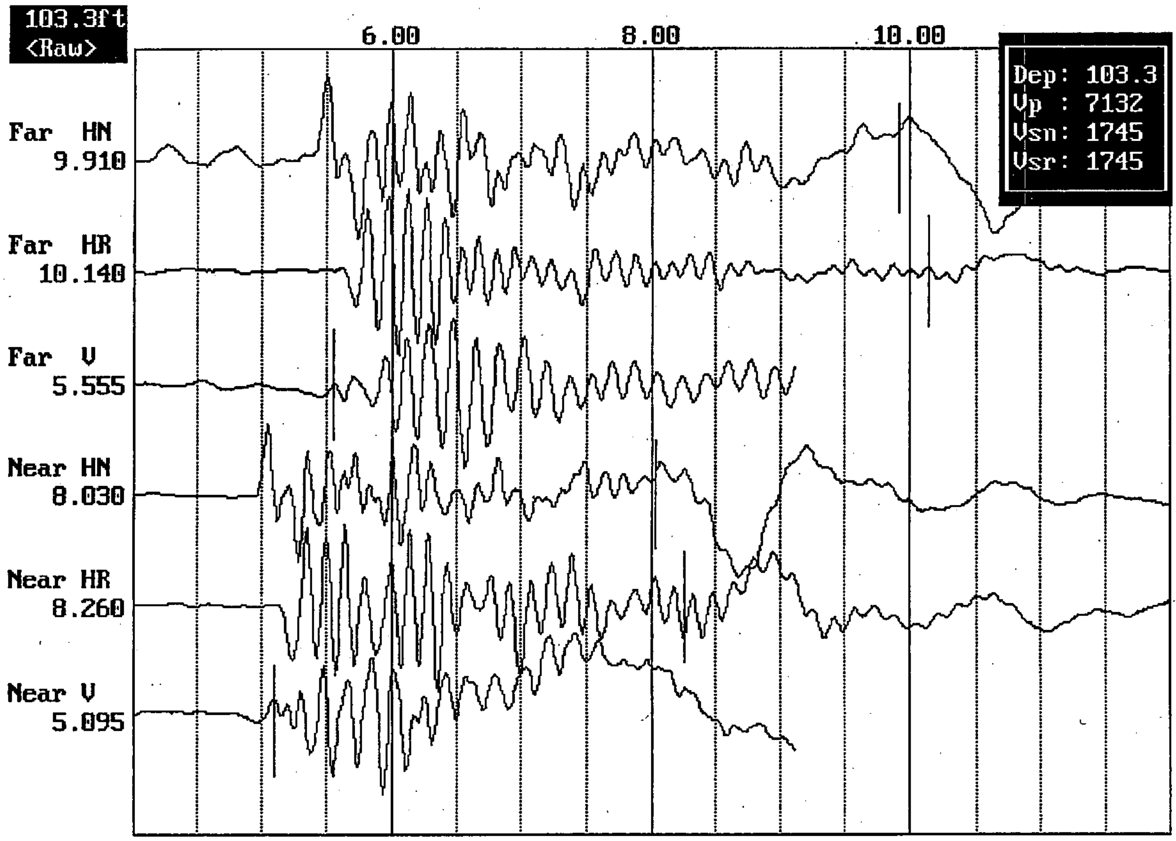


Figure 4. Example of unfiltered record

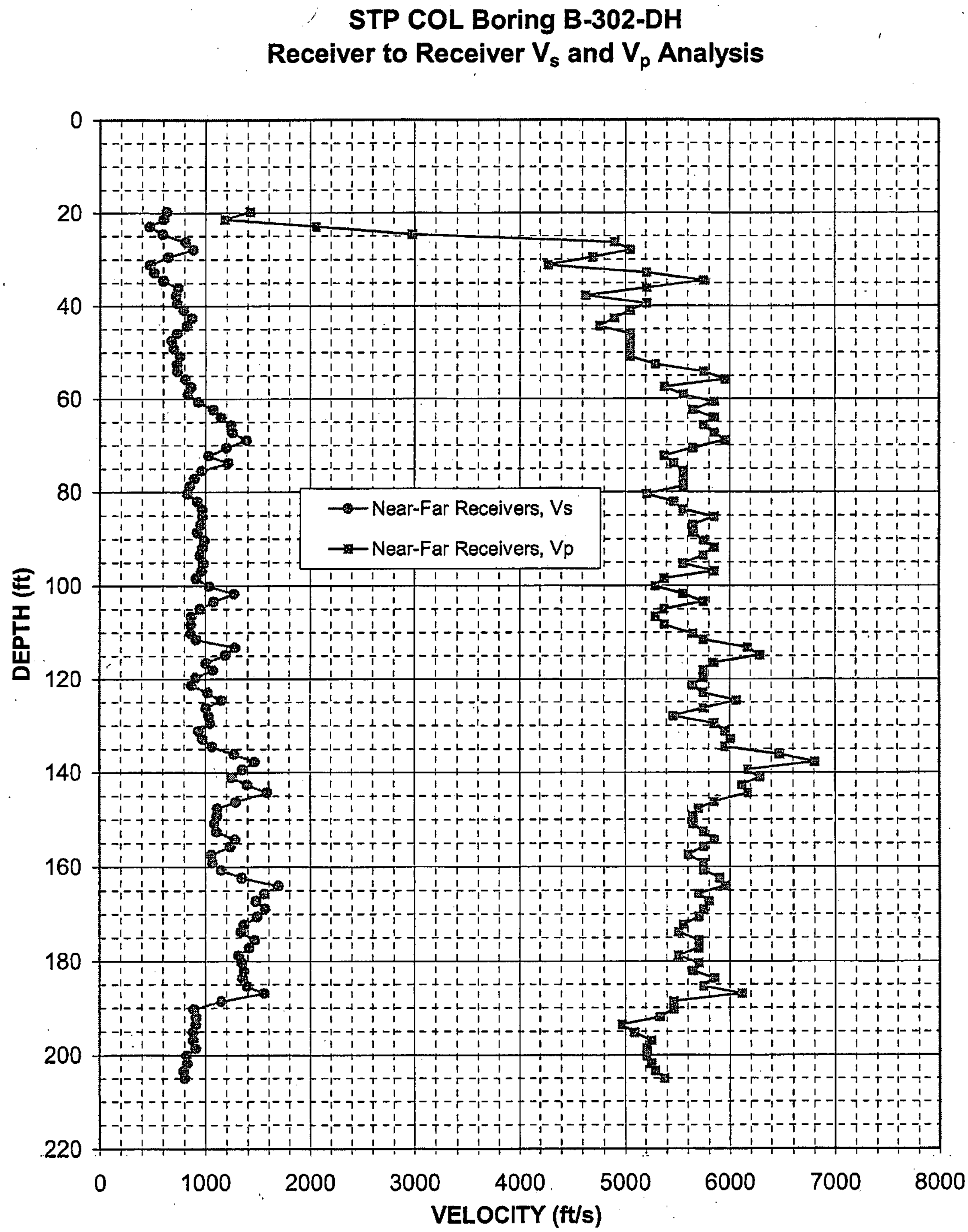


Figure 5: Boring B-302-DH, Suspension R1-R2 P- and S_H-wave velocities

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)	Depth (feet)	V_s (feet/sec)	V_p (feet/sec)	Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
19.7	630	1420	101.7	1270	5560	183.7	1360	5850
21.3	610	1180	103.4	1080	5750	185.4	1390	5750
23.0	470	2060	105.0	950	5380	187.0	1560	6120
24.6	590	2980	106.6	870	5290	188.7	1160	5460
26.3	810	4900	108.3	870	5380	190.3	890	5460
27.9	880	5050	110.2	860	5650	191.9	910	5330
29.5	650	4690	111.6	910	5750	193.6	910	4980
31.2	480	4270	113.2	1280	6170	195.2	880	5090
32.8	520	5210	114.8	1190	6290	196.9	890	5250
34.5	600	5750	116.5	1010	5850	198.5	910	5210
36.1	740	5210	118.1	1070	5750	200.1	820	5210
37.7	720	4630	119.8	910	5750	201.8	830	5250
39.4	730	5210	121.4	870	5650	203.4	800	5290
41.0	790	5050	123.0	1030	5750	205.1	810	5380
42.7	870	4900	124.7	1150	6060			
44.3	820	4760	126.3	1010	5750			
45.9	730	5050	128.0	1040	5460			
47.6	680	5050	129.6	1050	5850			
49.2	700	5050	131.2	940	5950			
50.9	760	5050	132.9	970	6010			
52.5	730	5290	134.5	1060	5950			
54.1	730	5750	136.2	1270	6470			
55.8	810	5950	137.8	1470	6800			
57.4	870	5380	139.4	1360	6170			
59.1	830	5560	141.1	1250	6290			
60.7	930	5850	142.7	1390	6120			
62.3	1080	5650	144.4	1590	6170			
64.0	1150	5850	146.3	1290	5850			
65.6	1240	5750	147.6	1120	5700			
67.3	1260	5850	149.3	1110	5650			
68.9	1390	5950	150.9	1090	5650			
70.5	1200	5650	152.6	1110	5750			
72.2	1030	5380	154.2	1280	5850			
73.8	1220	5460	155.8	1240	5750			
75.5	970	5560	157.5	1060	5600			
77.1	890	5560	159.1	1070	5750			
78.7	850	5560	160.8	1150	5750			
80.4	830	5210	162.4	1350	5900			
82.0	930	5460	164.0	1690	5950			
83.7	970	5560	165.7	1560	5700			
85.3	970	5850	167.3	1480	5800			
86.9	960	5650	169.0	1560	5750			
88.6	930	5650	170.6	1490	5700			
90.2	990	5750	172.2	1370	5560			
91.9	970	5850	173.9	1330	5510			
93.5	950	5750	175.5	1470	5700			
95.1	980	5560	177.2	1410	5700			
96.8	960	5850	178.8	1310	5510			
98.4	910	5380	180.5	1350	5700			
100.1	1040	5290	182.1	1370	5650			

Table 5. Boring B-302-DH, Suspension R1-R2 depths and P- and S_H-wave velocities

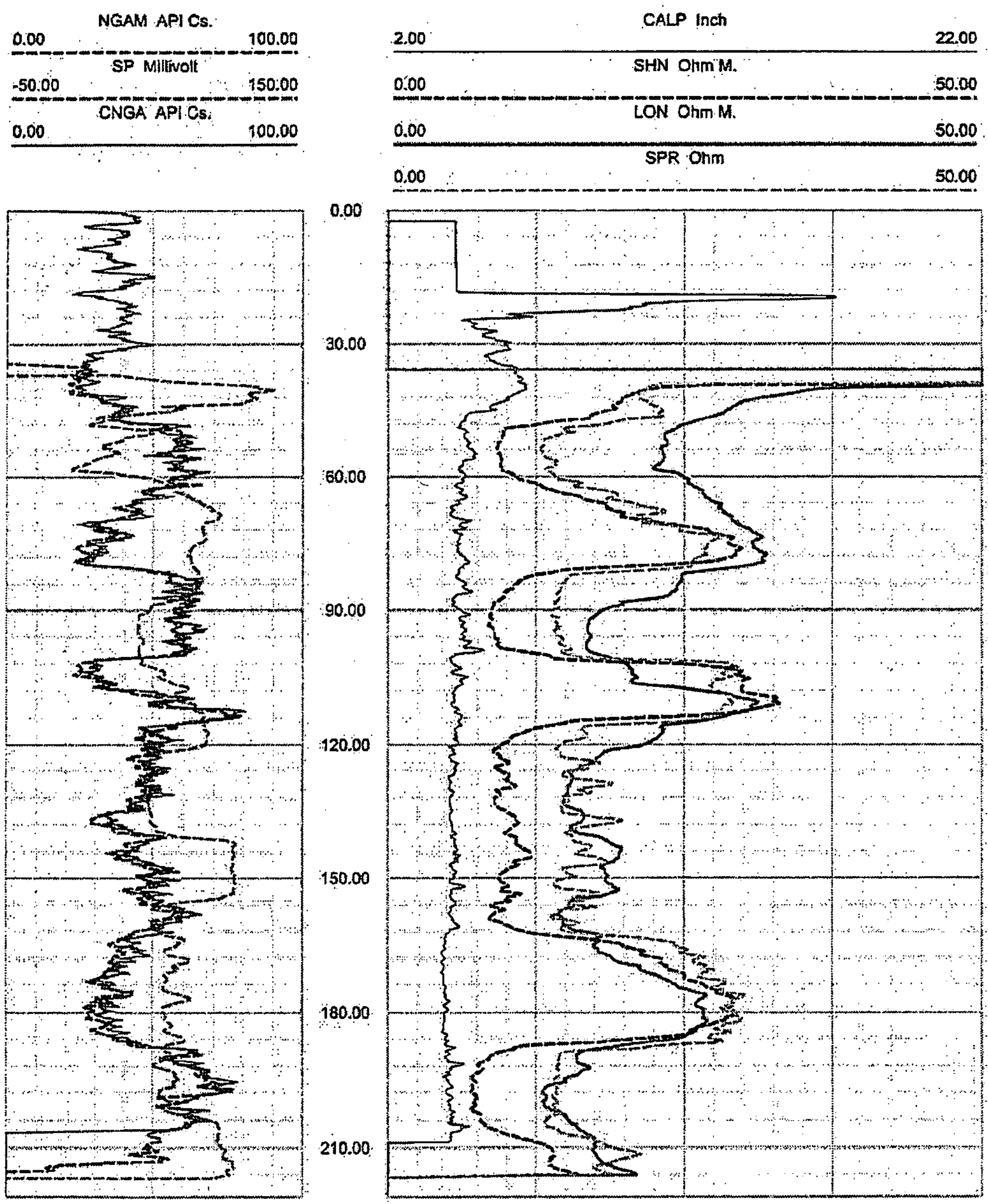


Figure 6. Boring B-302-DH, Caliper, Natural gamma, Resistivity and SP logs

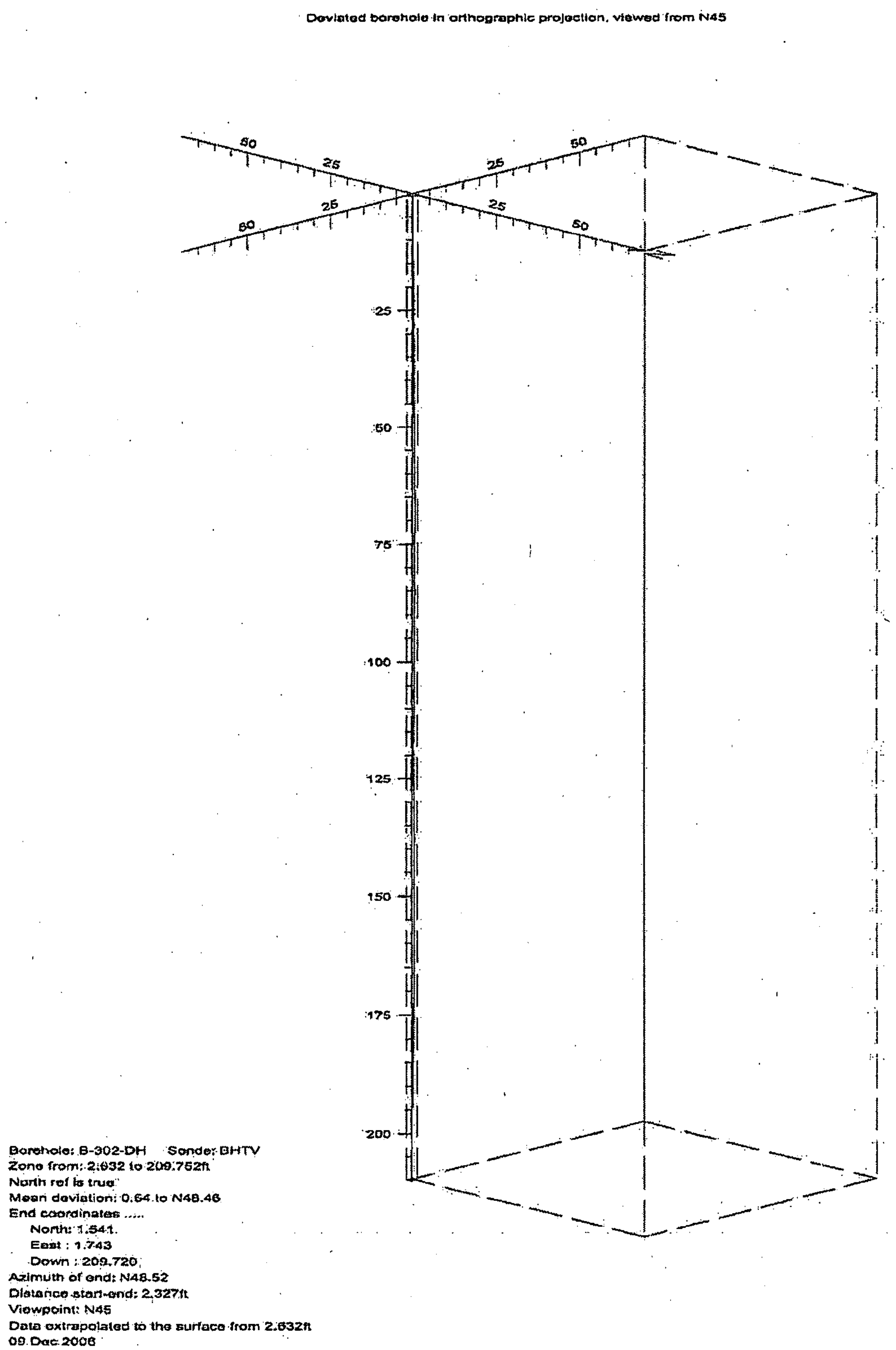


Figure 7. Boring B-302-DH, Deviation Projection (dimensions in feet)

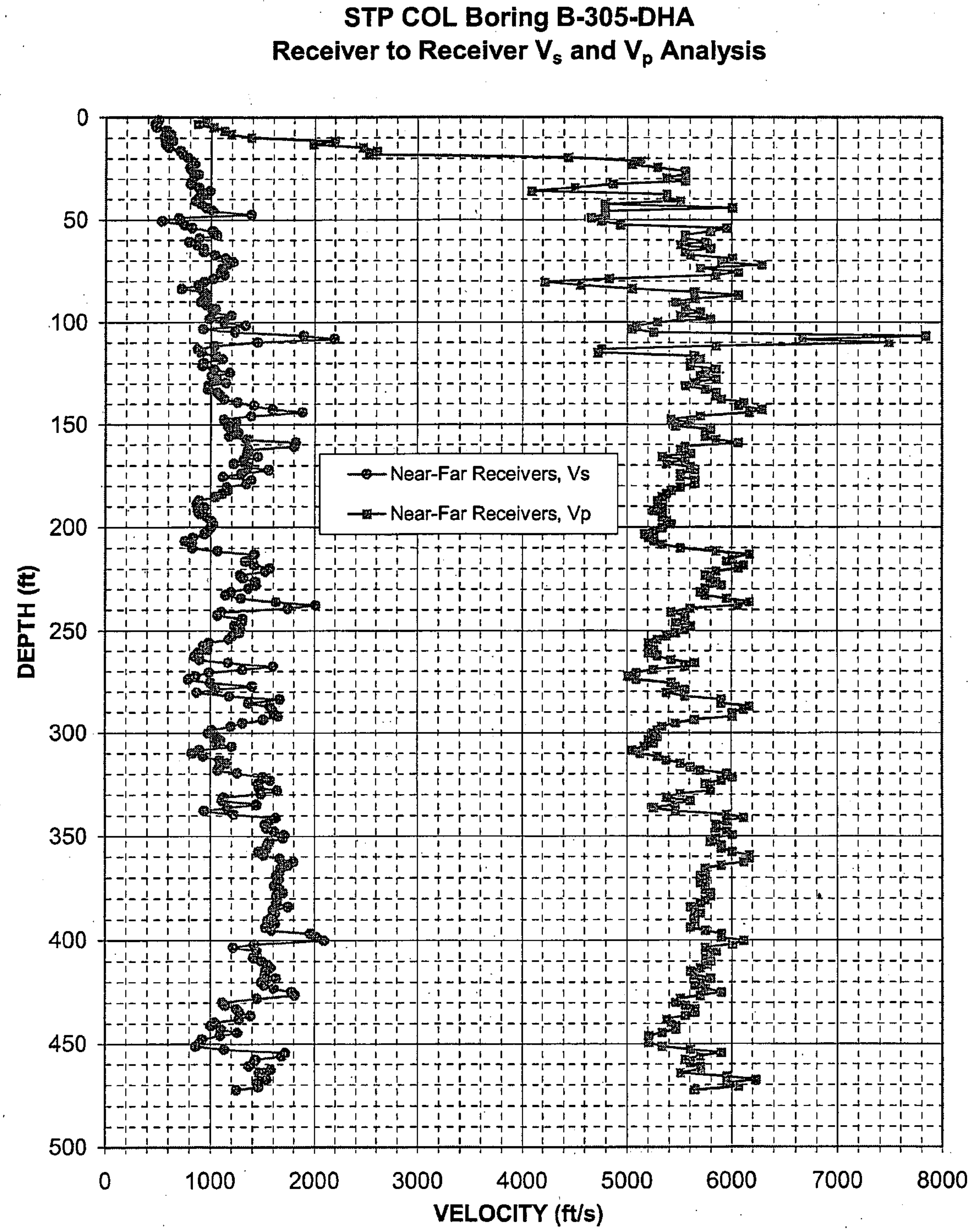


Figure 8. Boring B-305-DHA, Suspension R1-R2 P- and S_H-wave velocities

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)	Depth (feet)	V_s (feet/sec)	V_p (feet/sec)	Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
1.6	500	950	83.7	720	5050	165.7	1450	5330
3.3	470	870	85.3	930	5650	167.3	1320	5560
4.9	480	1020	86.9	960	6060	169.0	1220	5380
6.6	580	1130	88.6	940	5650	170.6	1360	5600
8.2	610	1190	90.2	910	5460	172.2	1560	5650
9.8	560	1390	91.9	970	5560	173.9	1300	5510
11.5	640	2190	93.5	1040	5560	175.5	1120	5510
13.1	580	1980	95.1	1020	5700	177.2	1390	5650
14.8	600	2470	96.8	1190	5510	178.8	1350	5650
16.4	710	2600	98.4	990	5800	180.5	1160	5510
18.0	740	2530	100.1	1130	5290	182.1	1170	5420
19.7	780	4440	101.7	1330	5090	183.7	1110	5380
21.3	820	5130	103.4	930	5050	185.4	1040	5330
23.0	850	5050	105.0	1230	5250	187.0	890	5290
24.6	810	5290	106.6	1890	7840	188.7	870	5290
26.3	820	5560	108.3	2190	6670	190.3	940	5330
27.9	880	5560	109.9	1450	7490	191.9	880	5250
29.5	840	5380	111.6	1040	5850	193.6	900	5330
31.2	820	5560	113.2	880	4760	195.2	960	5330
32.8	810	4870	114.8	910	4730	196.9	1010	5380
34.5	890	4500	116.5	1050	5650	198.5	1020	5420
36.1	990	4090	118.1	1110	5700	200.1	1000	5330
37.7	960	5380	119.8	930	5600	201.8	980	5250
39.4	880	5380	121.4	920	5600	203.4	940	5170
41.0	850	5510	123.0	1030	5850	205.1	830	5210
42.7	910	4800	124.7	1180	5750	206.7	760	5250
44.3	960	6010	126.3	1010	5700	208.3	820	5330
45.9	1020	4800	128.0	1060	5850	210.0	830	5510
47.6	1390	4800	129.6	1150	5650	211.6	1070	5850
49.2	700	4660	131.2	980	5560	213.3	1420	6170
50.9	540	4760	132.9	970	5750	214.9	1400	6010
52.5	750	4940	134.5	1060	5850	216.5	1330	5950
54.1	830	5950	136.2	1090	5850	218.2	1420	6120
55.8	1020	5800	137.8	1130	5900	219.8	1560	6060
57.4	1060	5560	139.4	1260	6120	221.5	1520	5850
59.1	890	5560	141.1	1420	6060	223.1	1290	5750
60.7	800	5750	142.7	1590	6290	224.7	1310	5800
62.3	870	5510	144.4	1880	6170	226.4	1430	5850
64.0	930	5800	146.0	1390	5700	228.0	1440	5900
65.6	930	5560	147.6	1130	5420	229.7	1370	5750
67.3	1040	5600	149.3	1250	5600	231.3	1190	5700
68.9	1150	6010	150.9	1170	5460	232.9	1140	5750
70.5	1220	5900	152.6	1240	5800	234.6	1290	5950
72.2	1150	6290	154.2	1270	5750	236.2	1630	6170
73.8	1110	5700	155.8	1180	5750	237.9	2010	6060
75.5	1100	6060	157.5	1350	5850	239.5	1750	5600
77.1	1130	5850	159.1	1820	6060	241.1	1100	5420
78.7	1030	4830	160.8	1800	5560	242.8	1070	5560
80.4	940	4220	162.4	1360	5510	244.4	1310	5560
82.0	880	4570	164.0	1360	5600	246.1	1300	5460

Table 6. Boring B-305-DHA, Suspension R1-R2 depths and P- and S_H-wave velocities

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
247.7	1230	5600
249.3	1280	5560
251.0	1280	5460
252.6	1210	5380
254.3	1170	5290
255.9	990	5210
257.6	940	5210
259.2	970	5250
260.8	890	5210
262.5	860	5290
264.1	900	5420
265.8	1170	5650
267.4	1600	5560
269.0	1310	5250
270.7	990	5090
272.3	860	5010
274.0	800	5090
275.6	1000	5420
277.2	1400	5460
278.9	1050	5560
280.5	870	5380
282.2	1180	5560
283.8	1670	5900
285.4	1370	5900
287.1	1570	6170
288.7	1590	6120
290.4	1610	6010
292.0	1650	6010
293.6	1510	5650
295.3	1310	5460
296.9	1190	5330
298.6	1010	5290
300.2	980	5250
301.8	1060	5290
303.5	1100	5210
305.1	1050	5250
306.8	1200	5170
308.4	900	5050
310.0	830	5130
311.7	930	5290
313.3	1090	5380
315.0	1160	5510
316.6	1090	5600
318.2	1070	5700
319.9	1260	5950
321.5	1500	6010
323.2	1570	5900
324.8	1460	5750
326.4	1470	5800
328.1	1640	5800

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
329.7	1490	5510
331.4	1130	5380
333.0	1110	5600
334.7	1440	5460
336.3	1170	5250
337.9	940	5460
339.6	1230	5950
341.2	1630	6120
342.9	1570	5950
344.5	1520	5850
346.1	1540	5850
347.8	1610	5950
349.4	1710	6010
351.1	1690	5850
352.7	1560	5800
354.3	1540	5900
356.0	1540	5900
357.6	1460	6010
359.3	1510	6170
360.9	1670	6170
362.5	1790	6120
364.2	1750	5900
365.8	1680	5750
367.5	1670	5750
369.1	1630	5700
370.7	1660	5750
372.4	1640	5700
374.0	1610	5750
375.7	1670	5750
377.3	1690	5800
378.9	1630	5800
380.6	1640	5750
382.2	1630	5700
383.9	1750	5600
385.5	1600	5650
387.1	1620	5700
388.8	1590	5650
390.4	1550	5650
392.1	1620	5650
393.7	1530	5600
395.3	1590	5750
397.0	1960	5900
398.6	2020	5900
400.3	2100	6120
401.9	1420	6010
403.5	1220	5750
405.2	1440	5850
406.8	1440	5800
408.5	1410	5750
410.1	1490	5800

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
411.8	1550	5750
413.4	1580	5700
415.0	1530	5600
416.7	1520	5650
418.3	1630	5800
420.0	1490	5700
421.6	1520	5650
423.2	1610	5750
424.9	1780	5900
426.5	1810	5700
428.2	1450	5510
429.8	1120	5460
431.4	1150	5560
433.1	1250	5650
434.7	1280	5650
436.4	1390	5560
438.0	1270	5380
439.6	1040	5420
441.3	1000	5460
442.9	1100	5460
444.6	1260	5330
446.2	1100	5210
447.8	920	5210
449.5	910	5210
451.1	870	5330
452.8	1130	5600
454.4	1720	5900
456.0	1680	5700
457.7	1440	5560
459.3	1420	5600
461.0	1370	5700
462.6	1580	5700
464.2	1470	5510
465.9	1520	5950
467.5	1540	6230
469.2	1450	5950
470.8	1460	6060
472.4	1250	5650

Table 6, continued. Boring B-305-DHA, Suspension R1-R2 depths and P- and S_H-wave velocities

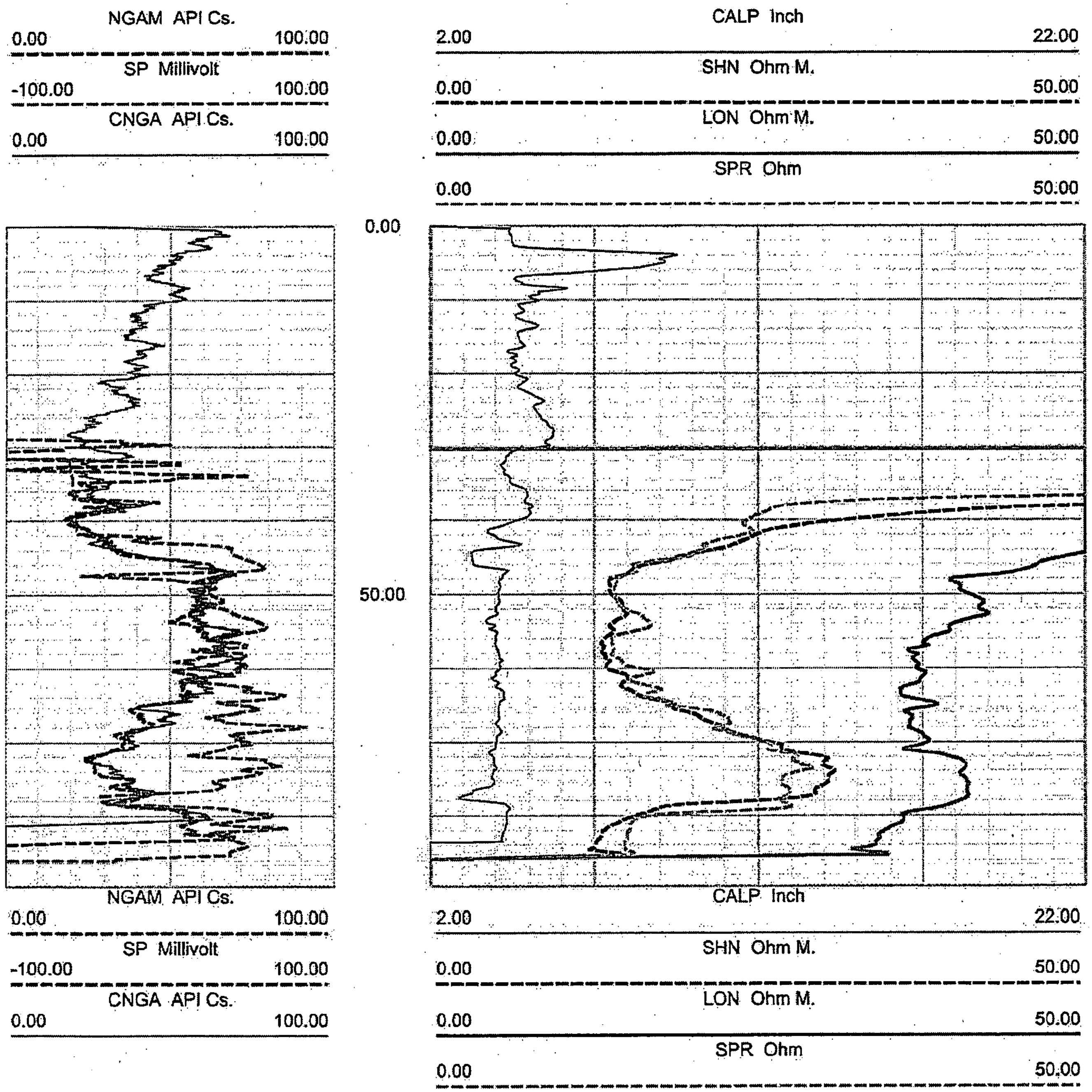


Figure 9. Boring B-305-DHA, Top Section, Caliper, Natural gamma, Resistivity and SP logs

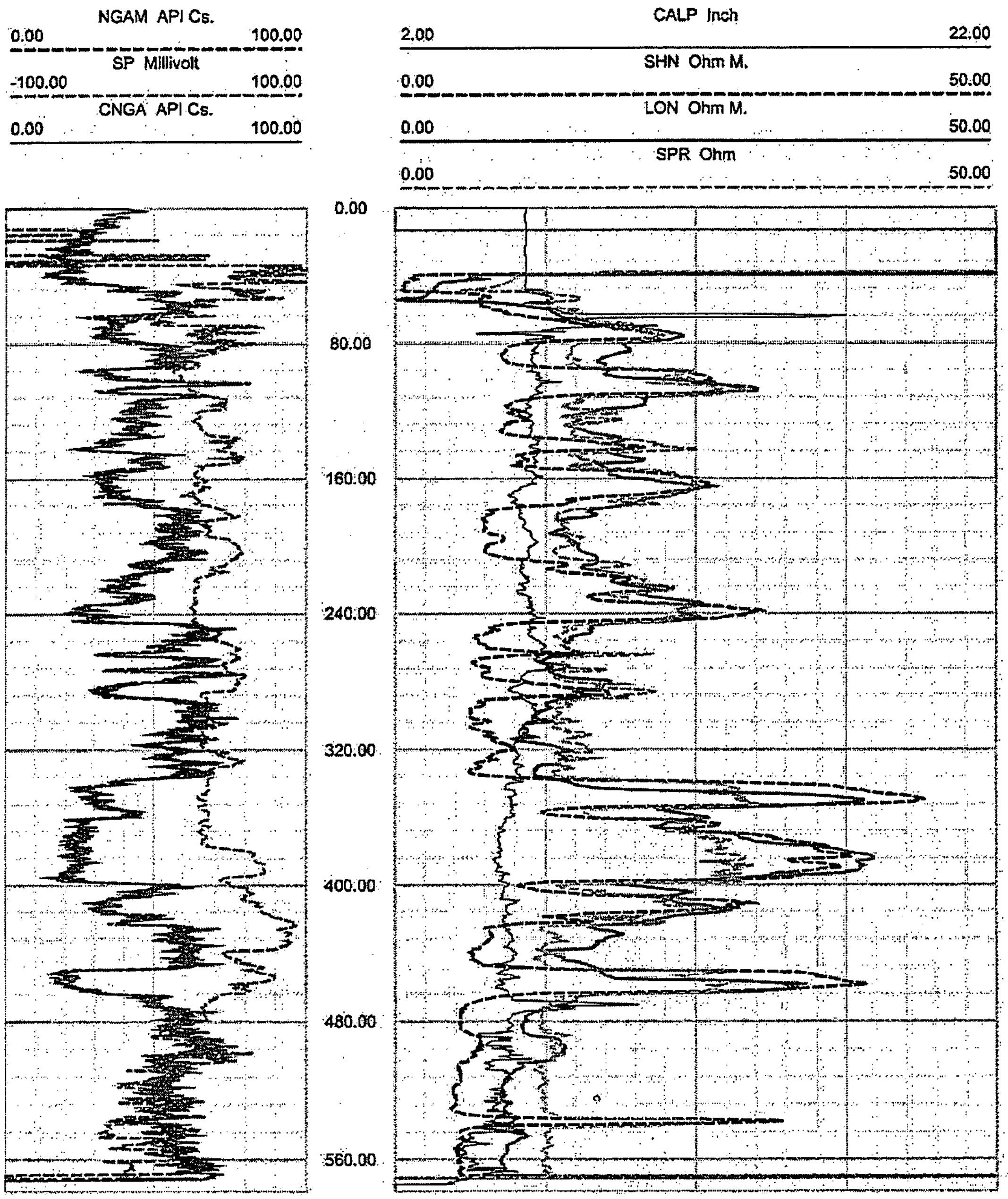


Figure 10. Boring B-305-DHA, Bottom Section, Caliper, Natural gamma, Resistivity and SP logs

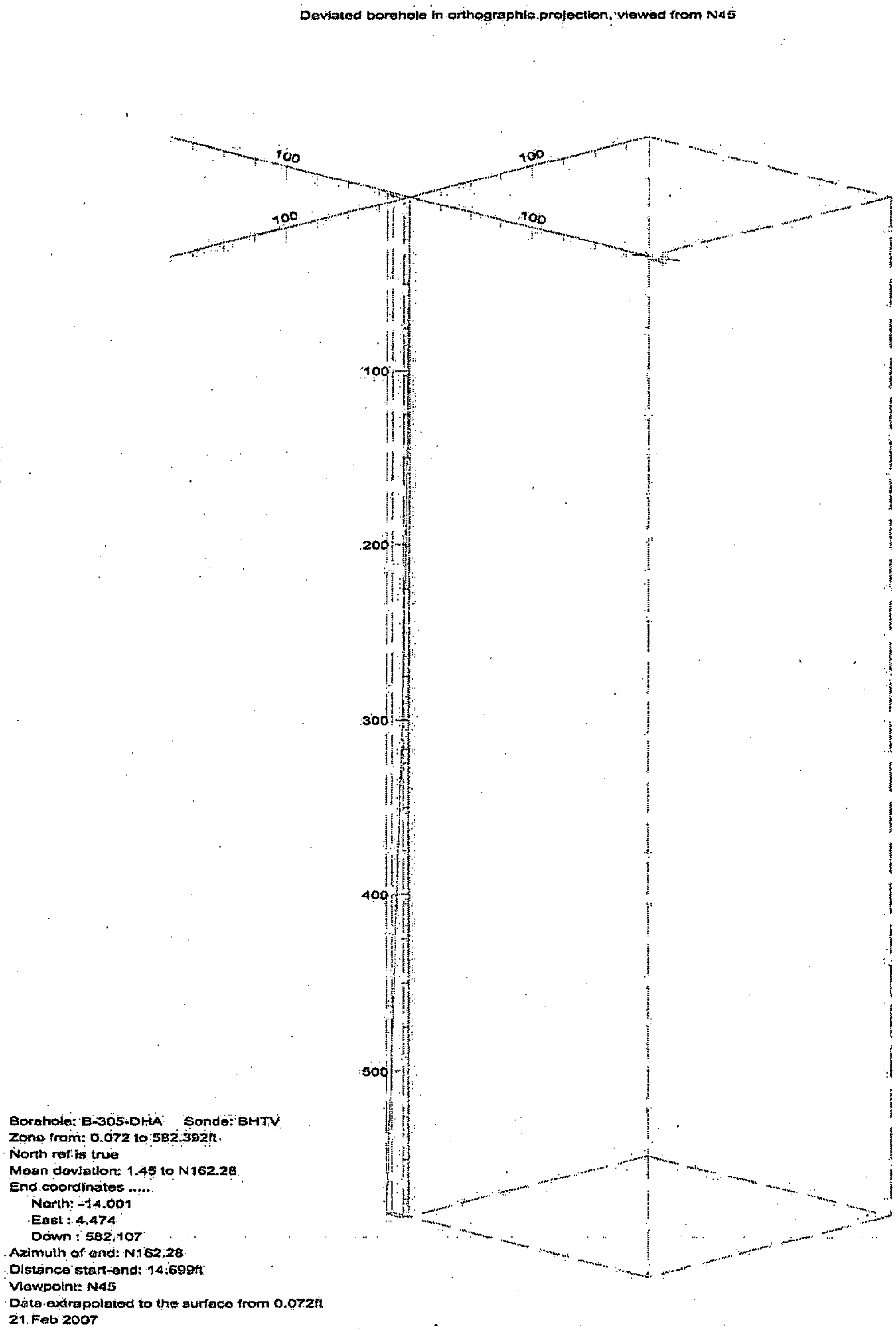


Figure 11. Boring B-305-DHA, Deviation Projection (dimensions in feet)

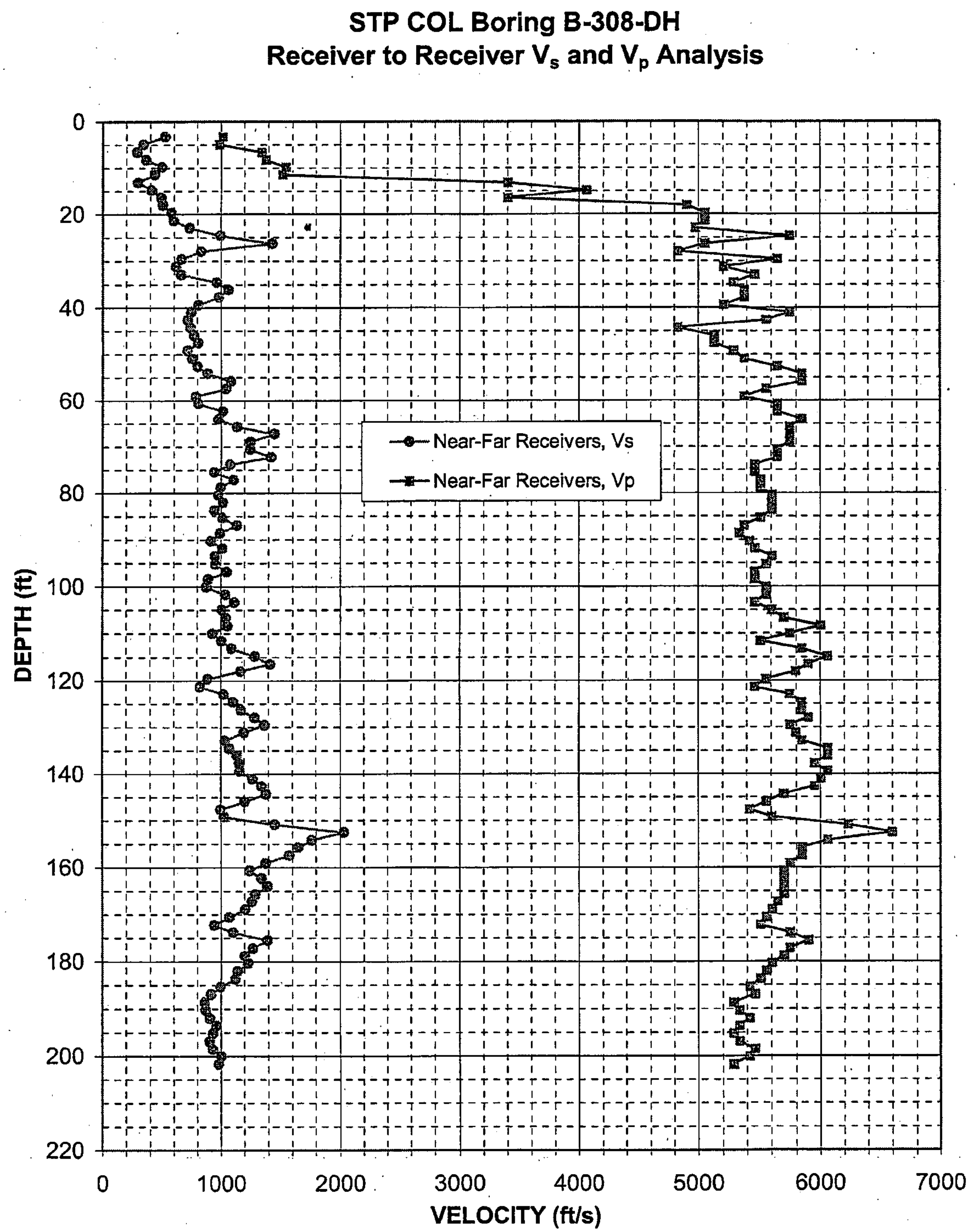


Figure 12. Boring B-308-DH, Suspension R1-R2 P- and S_H-wave velocities

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
3.3	530	1020
4.9	340	990
6.6	290	1340
8.2	370	1380
9.8	500	1540
11.5	440	1520
13.1	300	3400
14.8	410	4070
16.4	490	3400
18.0	510	4900
19.7	580	5050
21.3	600	5050
23.0	730	4980
24.6	1000	5750
26.3	1430	5050
27.9	830	4830
29.5	670	5650
31.2	620	5210
32.8	660	5460
34.5	970	5290
36.1	1070	5380
37.7	980	5380
39.4	810	5210
41.0	750	5750
42.7	720	5560
44.3	740	4830
45.9	770	5130
47.6	810	5130
49.2	720	5290
50.9	760	5380
52.5	800	5650
54.1	880	5850
55.8	1090	5850
57.4	1050	5560
59.1	790	5380
60.7	810	5650
62.3	1020	5650
64.0	980	5850
65.6	1140	5750
67.3	1450	5750
68.9	1250	5750
70.5	1250	5650
72.2	1420	5650
73.8	1080	5460
75.5	940	5460
77.1	1110	5510
78.7	1000	5510
80.4	980	5600
82.0	1020	5600
83.7	940	5600
85.3	1010	5510
86.9	1130	5380
88.6	990	5330
90.2	910	5420
91.9	1010	5460
93.5	950	5600
95.1	960	5560
96.8	1050	5460
98.4	890	5460
100.1	880	5560
101.7	1040	5560
103.4	1110	5460
105.0	1010	5600
106.6	1040	5700
108.3	1060	6010
109.9	930	5750
111.6	1000	5510
113.2	1090	5850
114.8	1290	6060
116.5	1420	5900
118.1	1170	5800
119.8	890	5560
121.4	830	5460
123.0	1030	5750
124.7	1110	5850
126.3	1170	5850
128.0	1290	5900
129.6	1370	5750
131.2	1190	5800
132.9	1040	5850
134.5	1070	6060
136.2	1140	6060
137.8	1160	5950
139.4	1160	6060
141.1	1270	6010
142.7	1350	5950
144.4	1380	5700
146.0	1200	5560
147.6	1000	5420
149.3	1030	5600
150.9	1460	6230
152.6	2030	6600
154.2	1760	6060
155.8	1650	5850
157.5	1570	5850
159.1	1380	5750
160.8	1240	5700
162.4	1340	5700
164.0	1390	5700
165.7	1290	5700
167.3	1260	5650
169.0	1210	5600
170.6	1070	5560
172.2	940	5510
173.9	1110	5750
175.5	1390	5900
177.2	1270	5750
178.8	1200	5700
180.5	1230	5600
182.1	1140	5560
183.7	1120	5510
185.4	1000	5420
187.0	920	5460
188.7	860	5290
190.3	870	5330
191.9	910	5420
193.6	960	5330
195.2	930	5290
196.9	900	5330
198.5	930	5460
200.1	1000	5420
201.8	980	5290

Table 7. Boring B-308-DH, Suspension R1-R2 depths and P- and S_H-wave velocities

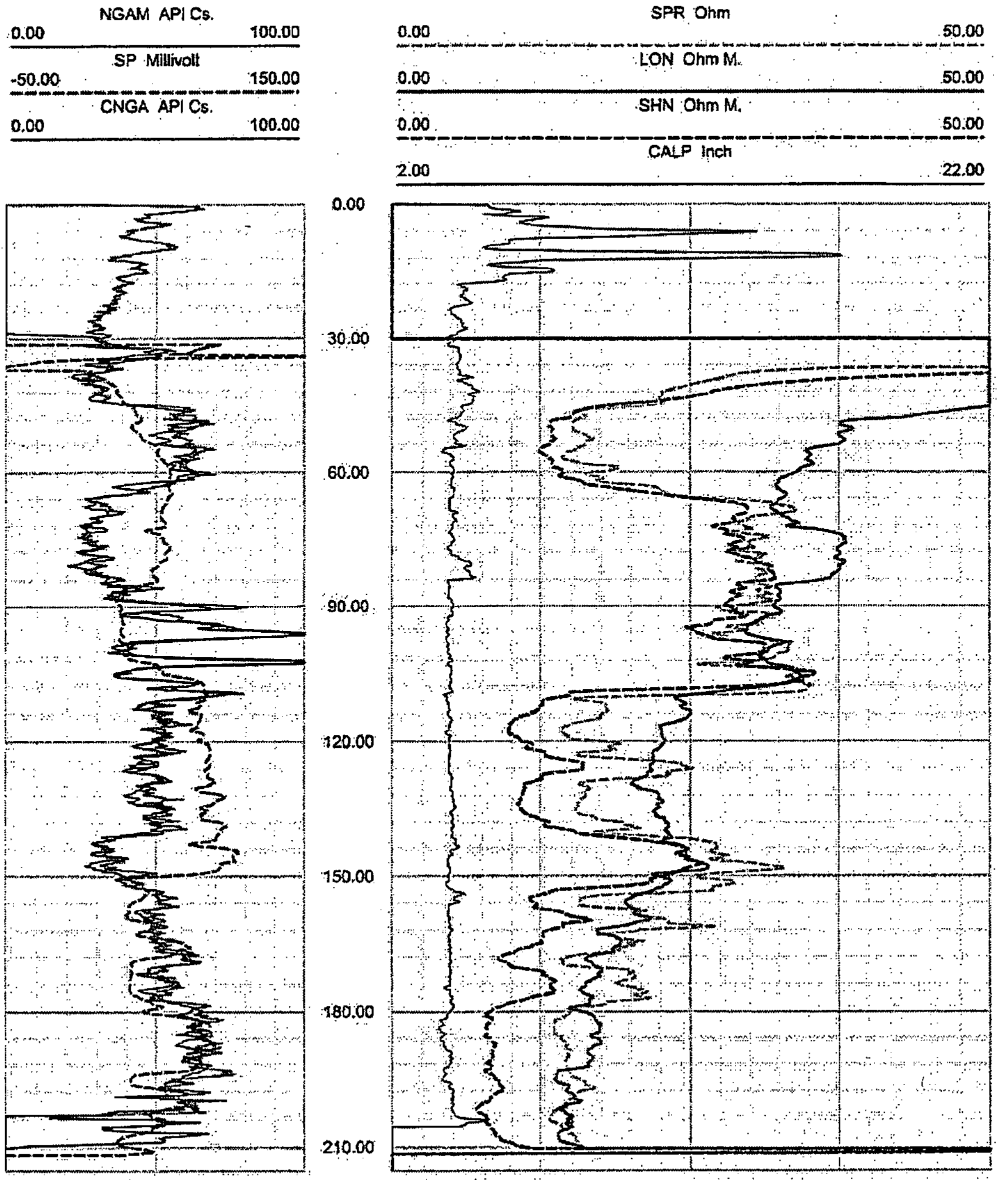


Figure 13. Boring B-308-DH, Caliper, Natural gamma, Resistivity and SP logs

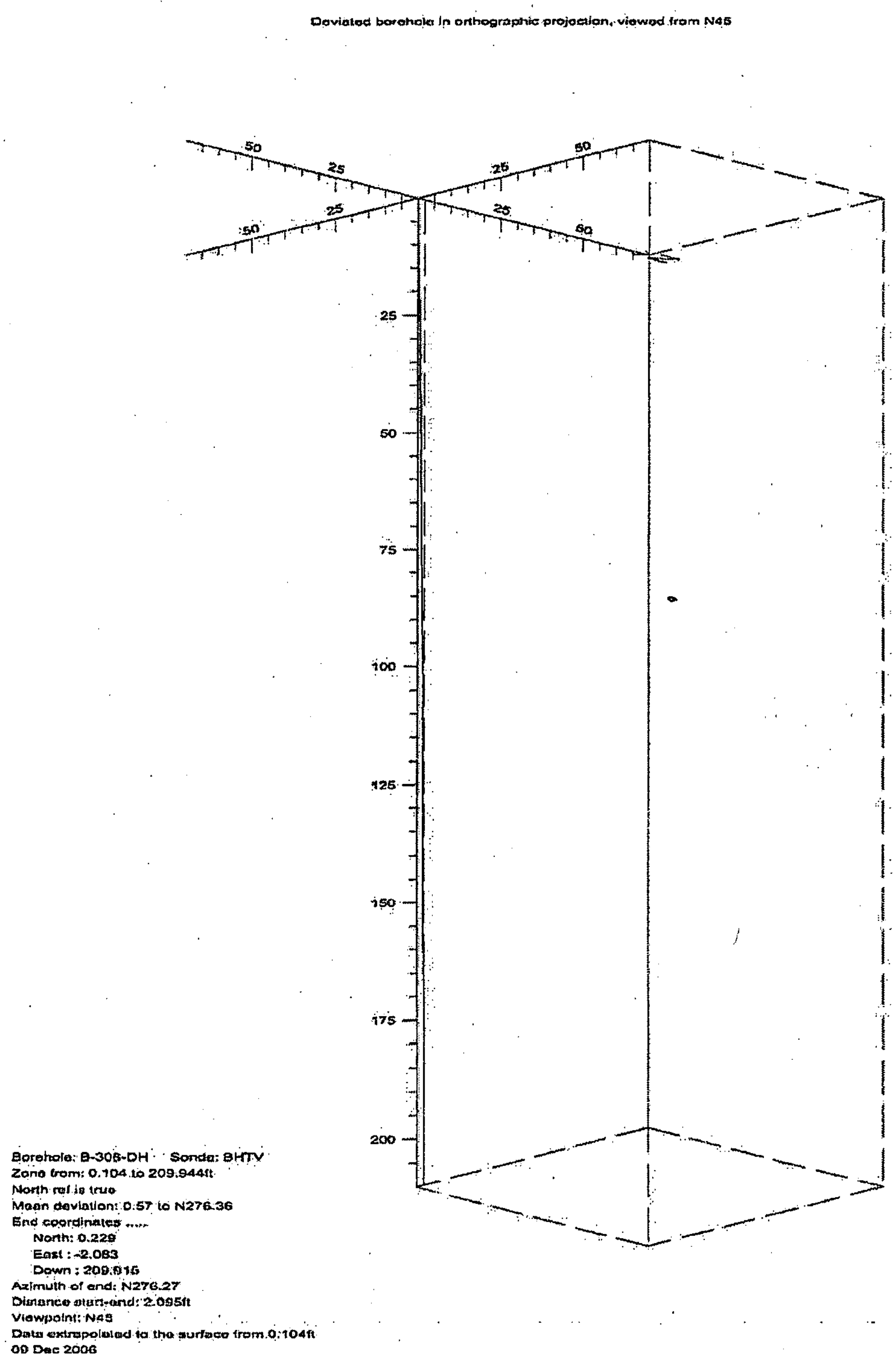


Figure 14. Boring B-308-DH, Deviation Projection (dimensions in feet)

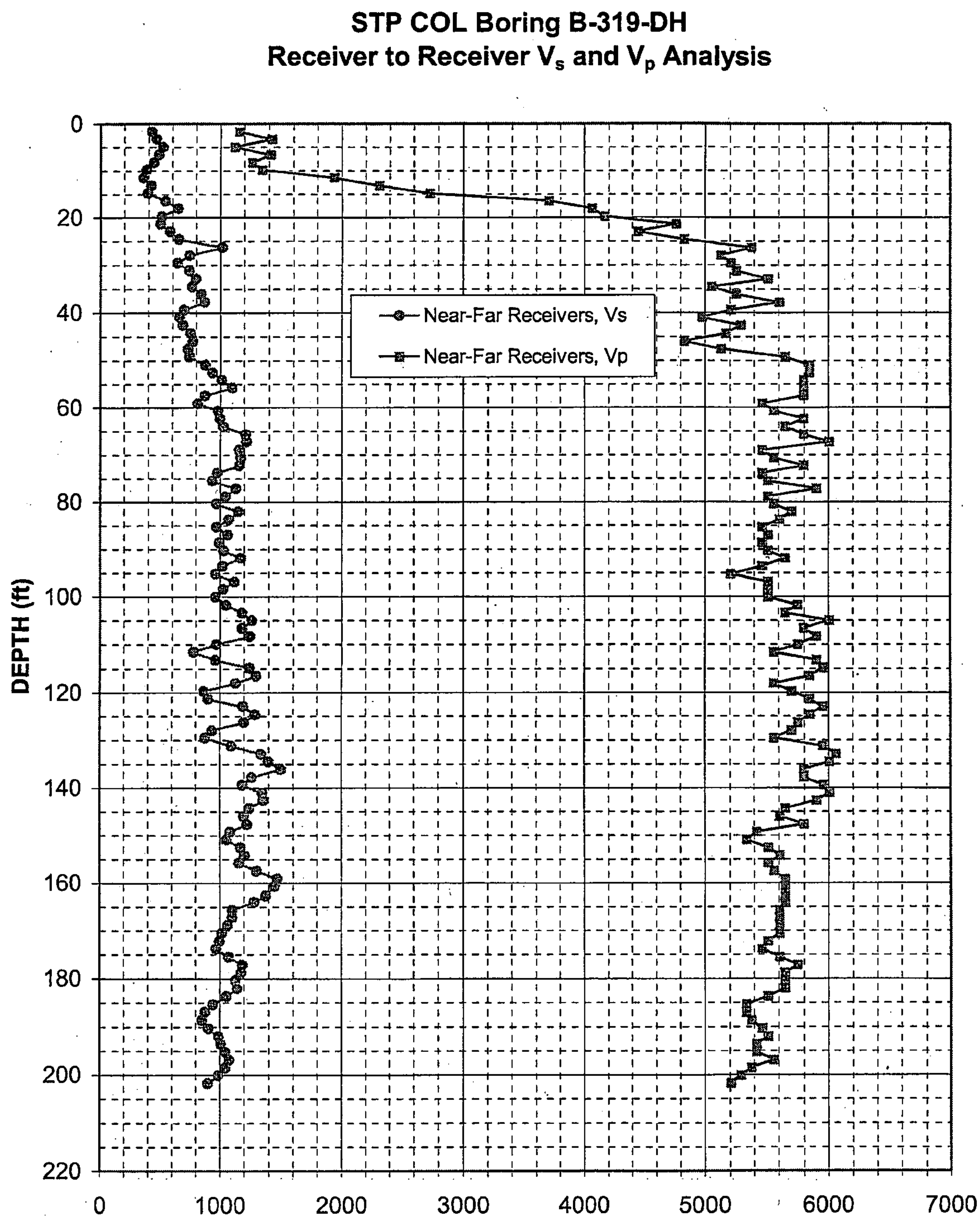


Figure 15. Boring B-319-DH, Suspension R1-R2 P- and S_H-wave velocities

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
1.6	430	1160
3.3	460	1420
4.9	520	1120
6.6	490	1410
8.2	450	1260
9.8	390	1340
11.5	360	1940
13.1	420	2310
14.8	400	2730
16.4	540	3700
18.0	650	4070
19.7	510	4170
21.3	500	4760
23.0	580	4440
24.6	660	4830
26.3	1020	5380
27.9	740	5130
29.5	650	5210
31.2	740	5250
32.8	800	5510
34.5	760	5050
36.1	840	5250
37.7	870	5600
39.4	700	5210
41.0	660	4980
42.7	690	5290
44.3	750	5170
45.9	770	4830
47.6	730	5130
49.2	740	5650
50.9	880	5850
52.5	940	5850
54.1	1010	5800
55.8	1100	5800
57.4	870	5800
59.1	810	5460
60.7	980	5560
62.3	1000	5800
64.0	1030	5650
65.6	1210	5800
67.3	1220	6010
68.9	1160	5460
70.5	1170	5560
72.2	1160	5800
73.8	980	5460
75.5	940	5510
77.1	1130	5900
78.7	1050	5510
80.4	970	5560
82.0	1150	5700
83.7	1070	5600
85.3	970	5460
86.9	1060	5510
88.6	990	5460
90.2	1030	5510
91.9	1170	5650
93.5	1020	5460
95.1	960	5210
96.8	1120	5510
98.4	1030	5510
100.1	960	5510
101.7	1050	5750
103.4	1180	5650
105.0	1260	6010
106.6	1180	5800
108.3	1250	5900
109.9	970	5750
111.6	780	5560
113.2	960	5900
114.8	1240	5950
116.5	1300	5850
118.1	1130	5560
119.8	870	5700
121.4	900	5850
123.0	1190	5950
124.7	1290	5850
126.3	1200	5750
128.0	940	5700
129.6	880	5560
131.2	1100	5950
132.9	1340	6060
134.5	1400	6010
136.2	1500	5800
137.8	1260	5800
139.4	1190	5950
141.1	1350	6010
142.7	1360	5900
144.4	1240	5650
146.0	1200	5600
147.6	1230	5800
149.3	1090	5420
150.9	1050	5330
152.6	1170	5510
154.2	1200	5600
155.8	1160	5510
157.5	1310	5560
159.1	1470	5650
160.8	1450	5650
162.7	1380	5650
164.0	1280	5650
165.7	1100	5600
167.3	1100	5600
169.0	1060	5600
170.6	1020	5600
172.2	1000	5510
173.9	970	5460
175.5	1070	5600
177.2	1190	5750
178.8	1180	5650
180.5	1130	5650
182.1	1150	5650
183.7	1050	5510
185.4	940	5330
187.0	880	5330
188.7	850	5380
190.3	910	5460
191.9	990	5510
193.6	1010	5420
195.2	1050	5420
196.9	1080	5560
198.5	1040	5380
200.1	990	5290
201.8	900	5210

Table 8. Boring B-319-DH, Suspension R1-R2 depths and P- and S_H-wave velocities

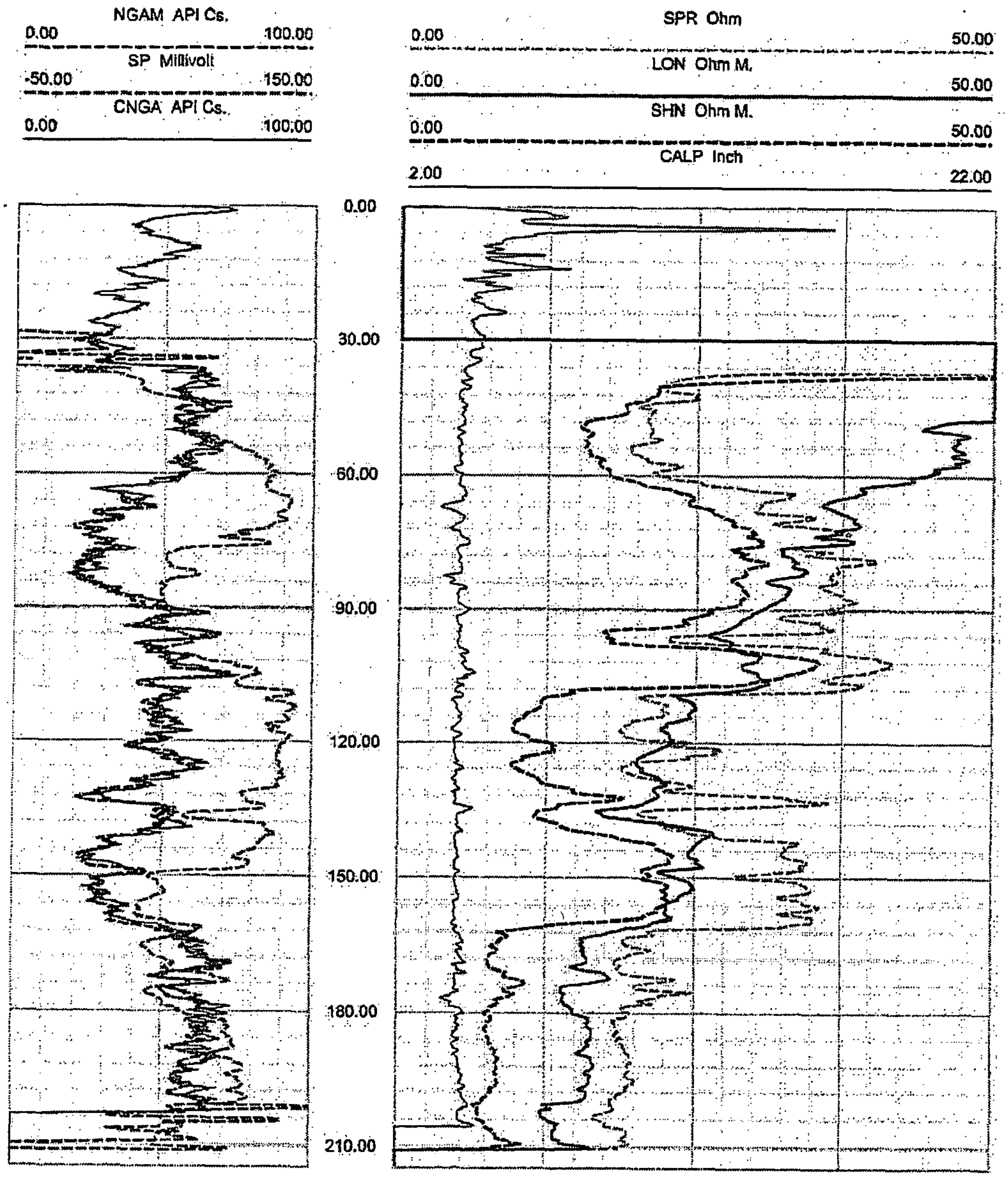
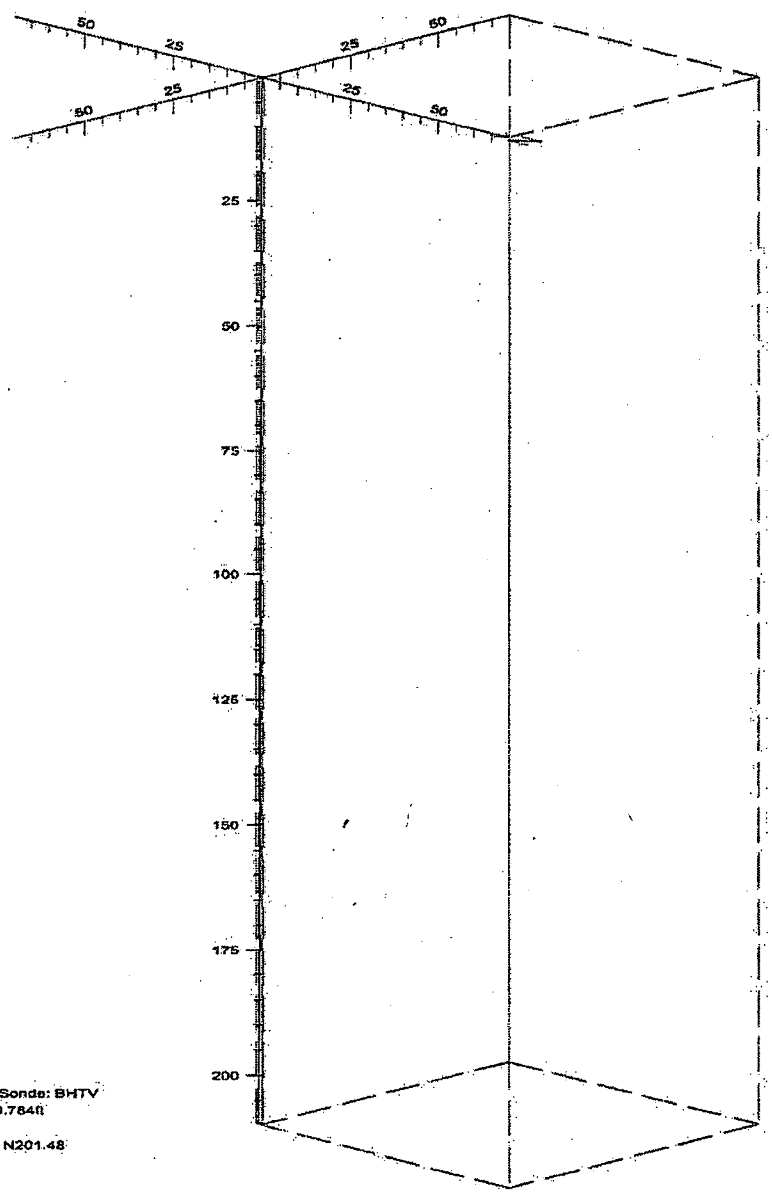


Figure 16. Boring B-319-DH, Caliper, Natural gamma, Resistivity and SP logs

Deviated borehole in orthographic projection, viewed from N45



Borehole: B-319-DH Sonde: BHTV
Zone from: 0.104 to 209.784ft
North ref is true
Mean deviation: 0.45 to N201.48
End coordinates .....
North: -1.534
East : -0.603
Down : 209.767
Azimuth of end: N201.44
Distance start-end: 1.648ft
Viewpoint: N45.
Data extrapolated to the surface from 0.104ft
09 Dec 2006

Figure 17. Boring B-319-DH, Deviation Projection (dimensions in feet)

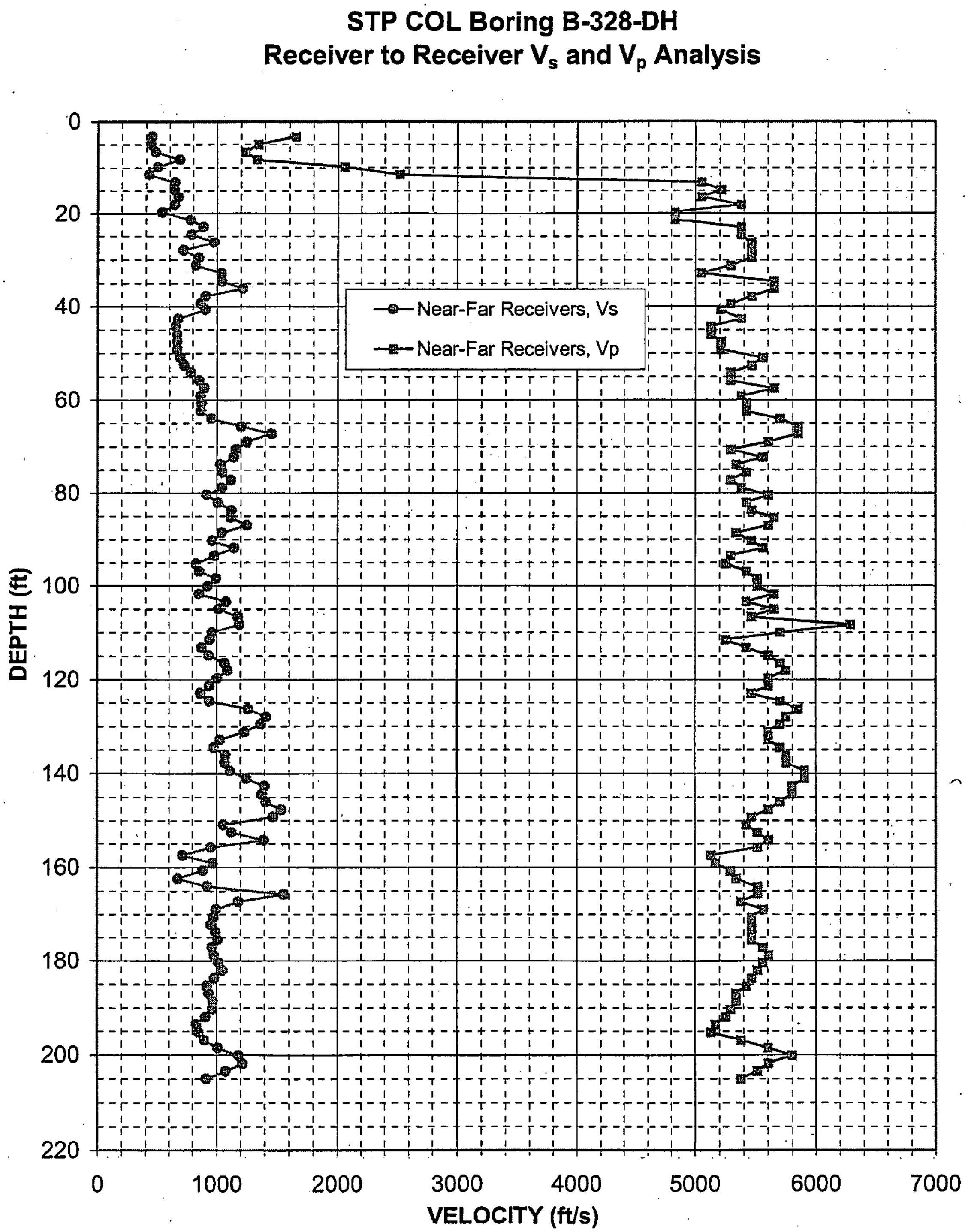


Figure 18. Boring B-328-DH, Suspension R1-R2 P- and S_H-wave velocities

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
3.3	450	1650
4.9	440	1340
6.6	480	1240
8.2	690	1330
9.8	500	2060
11.5	430	2530
13.1	640	5050
14.8	640	5210
16.4	680	5050
18.0	640	5380
19.7	540	4830
21.3	780	4830
23.0	880	5380
24.6	790	5380
26.3	980	5460
27.9	720	5460
29.5	850	5460
31.2	830	5290
32.8	1040	5050
34.5	1040	5650
36.1	1220	5650
37.7	900	5460
39.4	860	5290
40.7	900	5210
42.7	670	5380
44.3	650	5130
45.9	670	5130
47.6	660	5210
49.2	660	5210
50.9	690	5560
52.5	730	5460
54.1	780	5290
55.8	850	5290
57.4	890	5650
59.1	860	5380
60.7	870	5420
62.3	870	5420
64.0	960	5700
65.6	1210	5850
67.3	1460	5850
68.9	1250	5600
70.5	1160	5290
72.2	1150	5560
73.8	1030	5330
75.5	1050	5420
77.1	1120	5290
78.7	1050	5380
80.4	920	5600
82.0	1010	5420
83.7	1130	5460
85.3	1120	5650
86.9	1250	5600
88.6	1040	5330
90.2	960	5460
91.9	1150	5560
93.5	980	5290
95.1	830	5250
96.8	850	5420
98.4	1000	5510
100.1	930	5510
101.7	850	5650
103.4	1080	5420
105.0	1020	5650
106.6	1180	5460
108.3	1190	6290
109.9	960	5700
111.6	940	5250
113.2	870	5420
114.8	940	5600
116.5	1070	5700
118.1	1090	5750
119.8	1010	5600
121.4	940	5600
123.0	870	5460
124.7	940	5700
126.3	1260	5850
128.0	1410	5750
129.6	1370	5700
131.2	1230	5600
132.9	1030	5600
134.5	980	5700
136.2	1080	5750
137.8	1070	5750
139.4	1110	5900
141.1	1250	5900
142.7	1400	5800
144.4	1380	5800
146.0	1410	5700
147.6	1540	5600
149.3	1470	5460
150.9	1060	5420
152.6	1130	5510
154.2	1390	5600
155.8	960	5510
157.5	720	5130
159.1	970	5170
160.8	890	5290
162.4	680	5330
164.0	930	5510
165.7	1560	5510
167.3	1180	5380
169.0	1000	5560
170.6	980	5460
172.2	960	5460
173.9	990	5460
175.5	1010	5460
177.2	960	5560
178.8	980	5600
180.5	1020	5560
182.1	1050	5510
183.7	980	5460
185.4	920	5420
187.0	940	5330
188.7	970	5330
190.3	970	5290
191.9	910	5250
193.6	830	5170
195.2	850	5130
196.9	900	5380
198.5	1010	5600
200.1	1180	5800
201.8	1220	5600
203.4	1080	5510
205.1	910	5380

Table 9. Boring B-328-DH, Suspension R1-R2 depths and P- and S_H-wave velocities

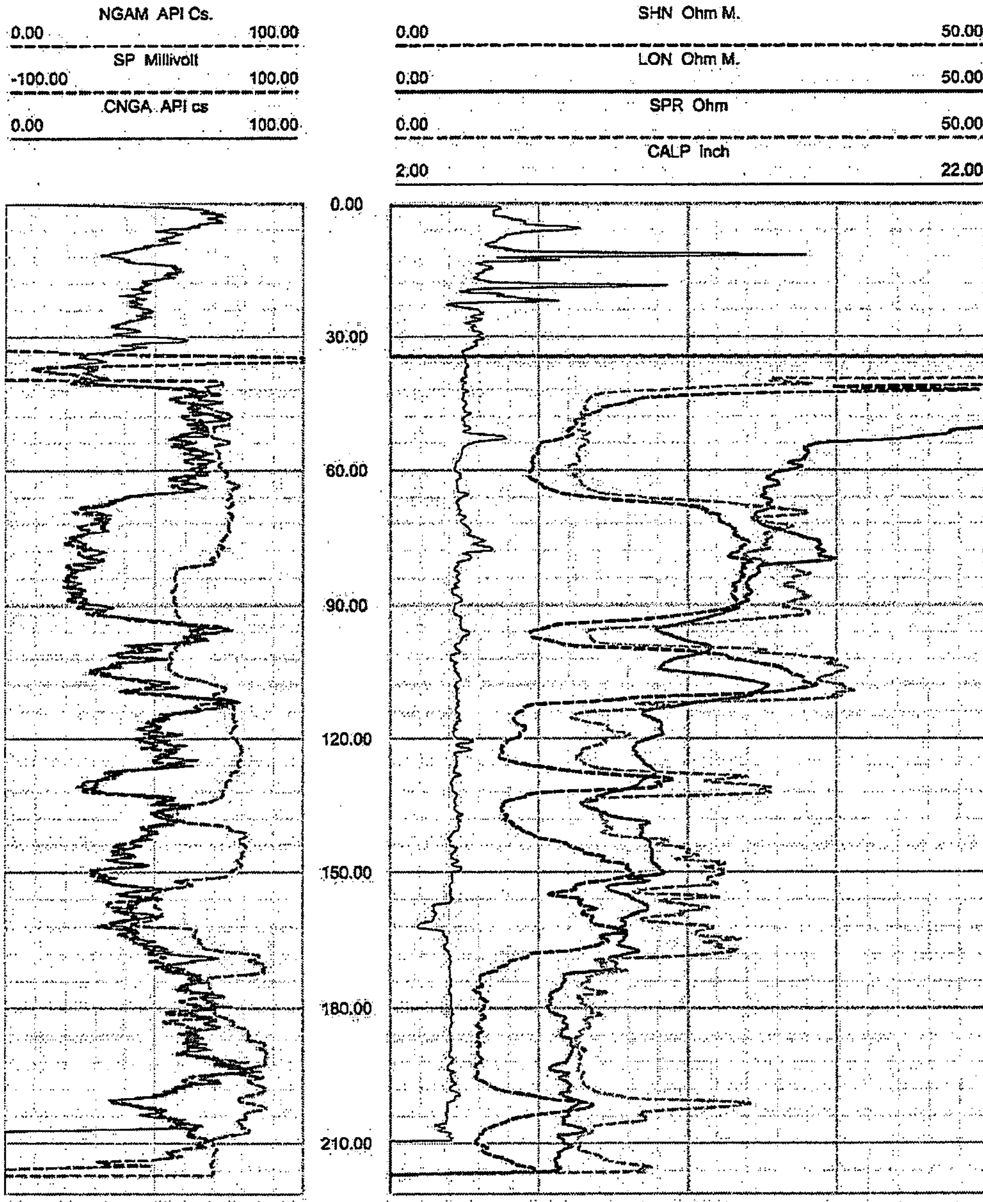


Figure 19. Boring B-328-DH, Caliper, Natural gamma, Resistivity and SP logs

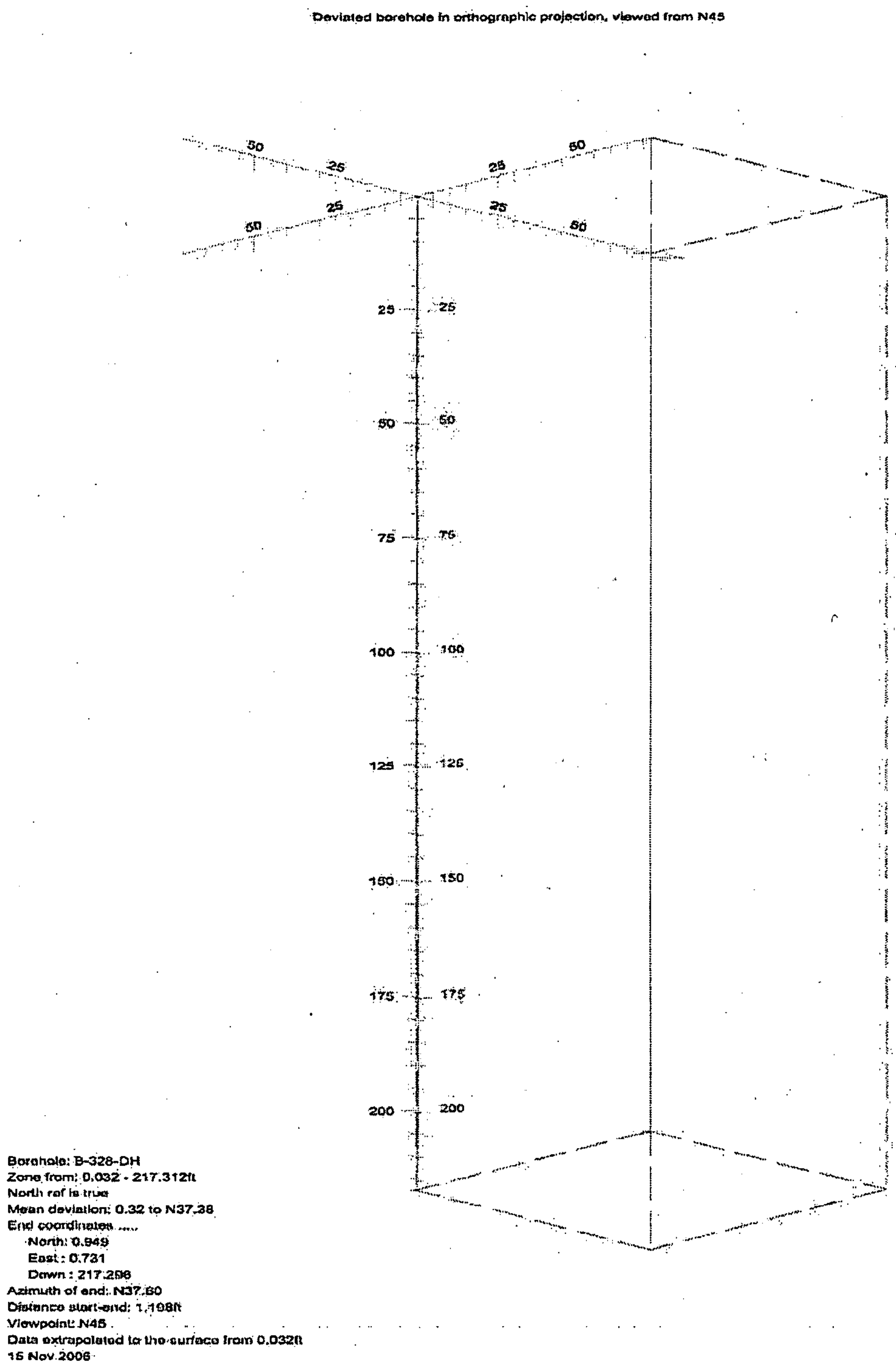


Figure 20. Boring B-328-DH, Deviation Projection (dimensions in feet)

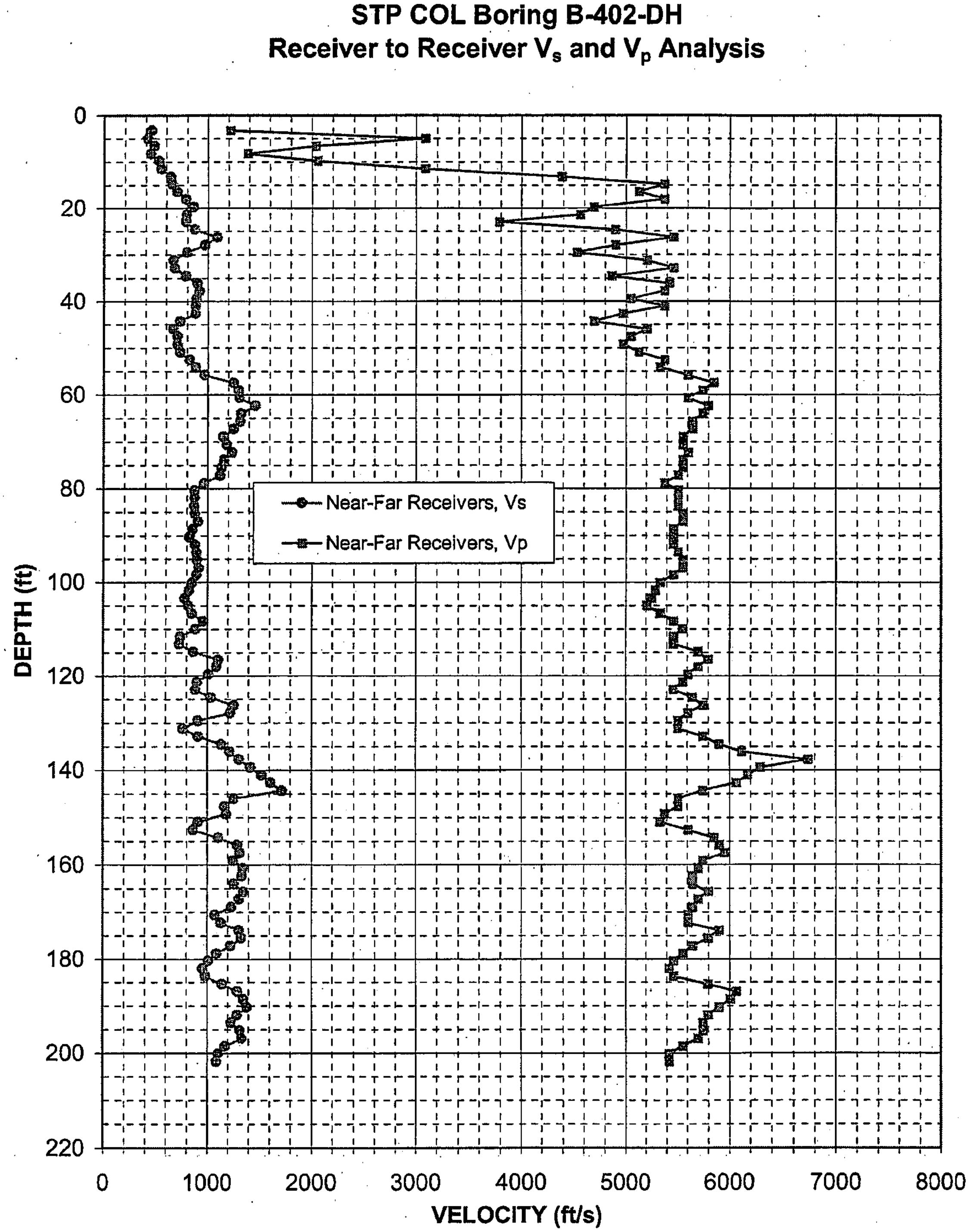


Figure 21: Boring B-402-DH, Suspension R1-R2 P- and S_H-wave velocities

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
3.3	460	1220
4.9	420	3090
6.6	480	2030
8.2	450	1390
9.8	530	2060
11.5	550	3090
13.1	640	4390
14.8	660	5380
16.4	700	5130
18.0	780	5380
19.7	860	4690
21.3	790	4570
23.0	780	3790
24.6	870	4900
26.3	1090	5460
27.9	970	4900
29.5	800	4540
31.2	670	5210
32.8	680	5460
34.5	790	4870
36.1	900	5420
37.7	920	5380
39.4	890	5050
41.0	880	5380
42.7	880	4980
44.3	730	4690
45.9	670	5210
47.6	710	5050
49.2	710	4980
50.9	730	5130
52.5	820	5380
54.1	890	5330
55.8	970	5600
57.4	1250	5850
59.1	1300	5750
60.7	1310	5600
62.3	1460	5800
64.0	1330	5750
65.6	1320	5650
67.3	1250	5650
68.9	1150	5560
70.5	1190	5560
72.2	1240	5600
73.8	1160	5560
75.5	1130	5560
77.1	1120	5510
78.7	970	5380
80.4	870	5510
82.0	870	5510
83.7	870	5510
85.3	880	5560
86.9	910	5560
88.6	850	5460
90.2	830	5460
91.9	880	5460
93.5	900	5510
95.1	900	5560
96.8	920	5560
98.4	890	5460
100.1	850	5330
101.7	820	5290
103.4	780	5250
105.0	810	5210
106.6	850	5330
108.3	960	5460
109.9	880	5560
111.6	740	5460
113.2	730	5460
114.8	870	5700
116.5	1110	5800
118.1	1090	5700
119.8	1010	5600
121.4	900	5560
123.0	890	5460
124.7	1040	5650
126.3	1260	5750
128.0	1220	5600
129.6	910	5510
131.2	770	5510
132.9	910	5750
134.5	1140	5900
136.2	1220	6120
137.8	1310	6730
139.4	1420	6290
141.1	1530	6170
142.7	1610	6060
144.4	1720	5750
146.0	1260	5510
147.6	1170	5510
149.3	1190	5380
150.9	910	5330
152.6	860	5600
154.2	1110	5850
155.8	1290	5900
157.5	1310	5950
159.1	1250	5750
160.8	1350	5700
162.4	1330	5650
164.0	1260	5650
165.7	1360	5800
167.3	1310	5700
169.0	1230	5650
170.6	1080	5600
172.2	1130	5600
173.9	1310	5900
175.5	1330	5800
177.2	1230	5650
178.8	1090	5560
180.5	1010	5460
182.1	960	5420
183.7	980	5460
185.4	1150	5800
187.0	1290	6060
188.7	1360	6010
190.3	1390	5900
191.9	1290	5800
193.6	1230	5750
195.2	1320	5750
196.9	1330	5700
198.5	1170	5560
200.1	1110	5420
201.8	1090	5420

Table10. Boring B-402-DH, Suspension R1-R2 depths and P- and SH-wave velocities

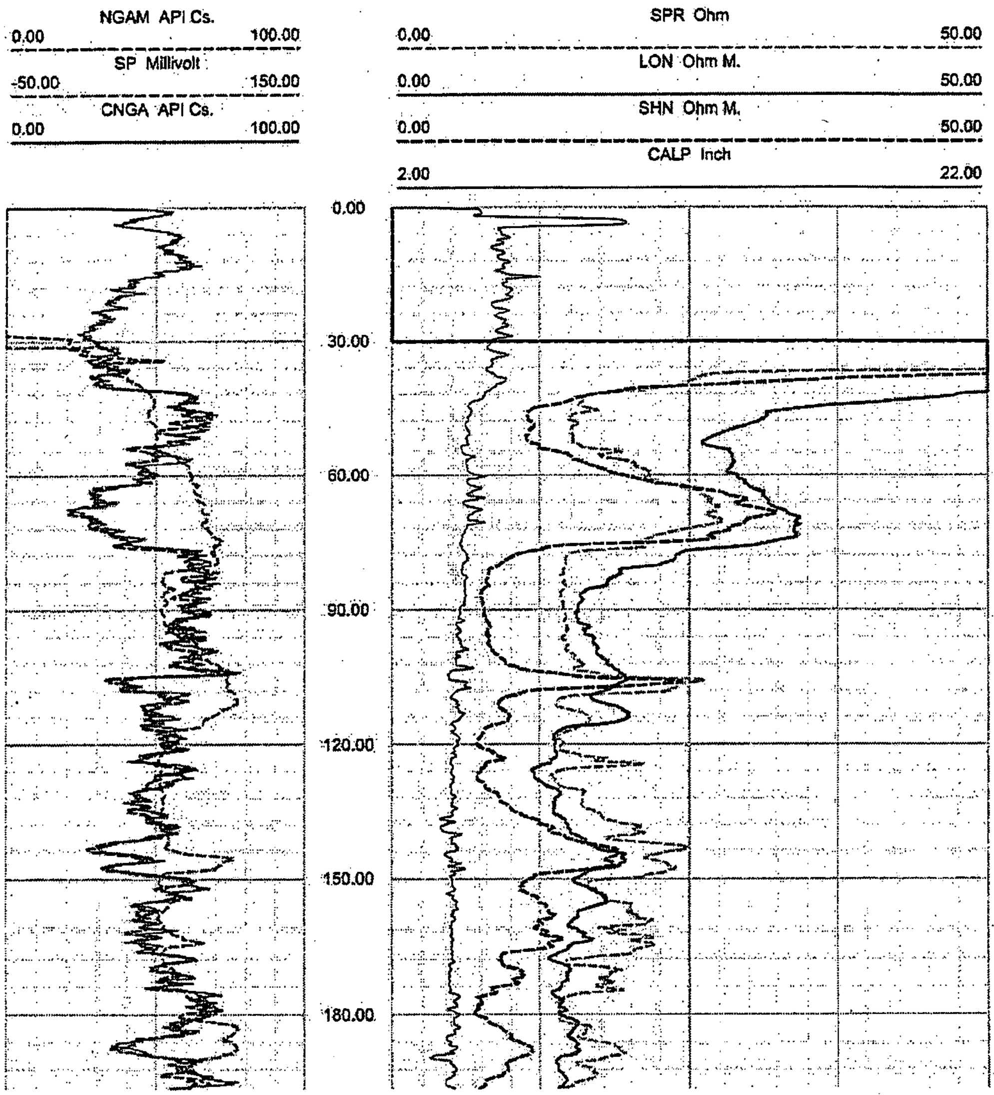


Figure 22. Boring B-402-DH, Caliper, Natural gamma, Resistivity and SP logs

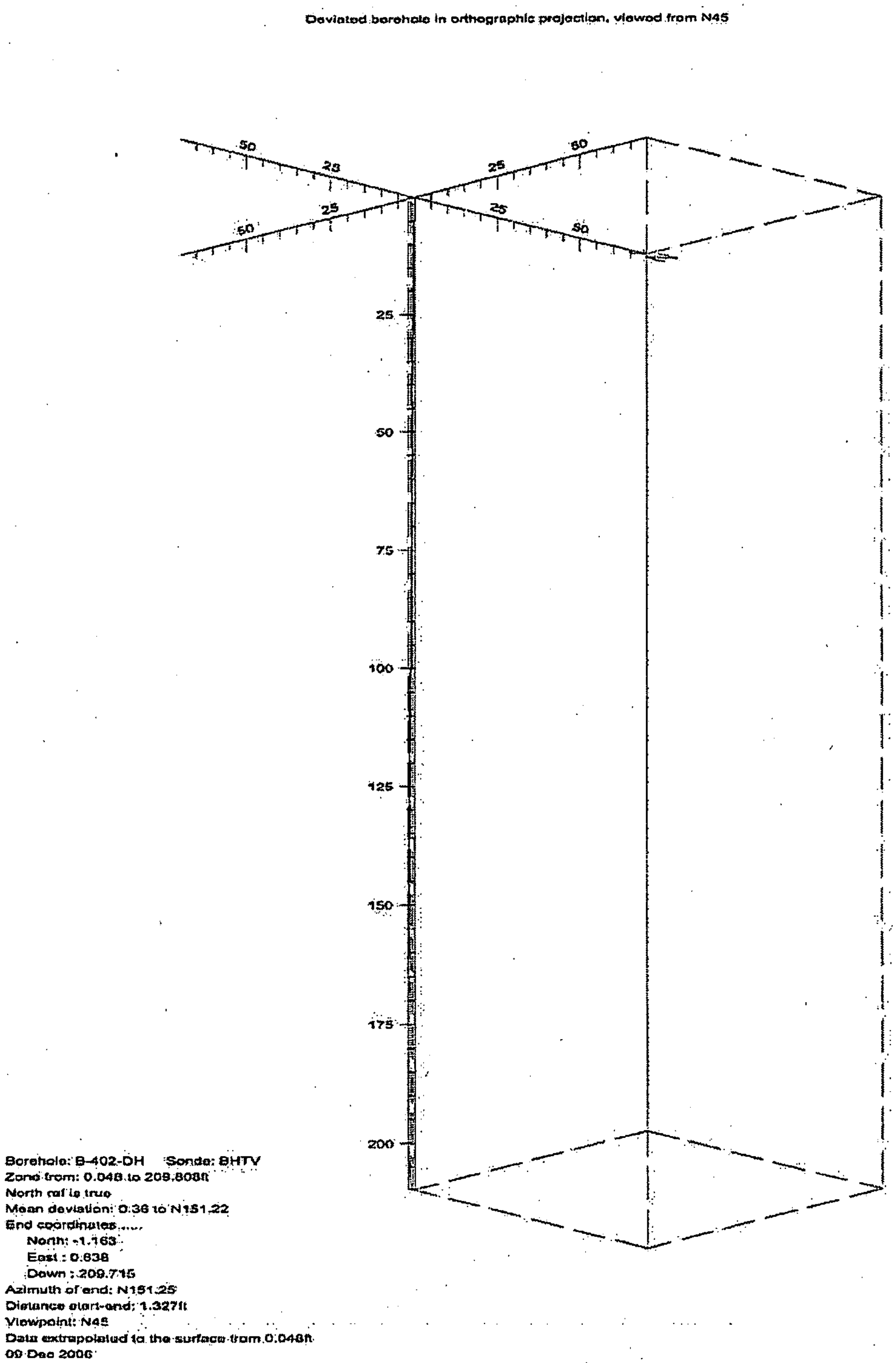


Figure 23. Boring B-402-DH, Deviation Projection (dimensions in feet)

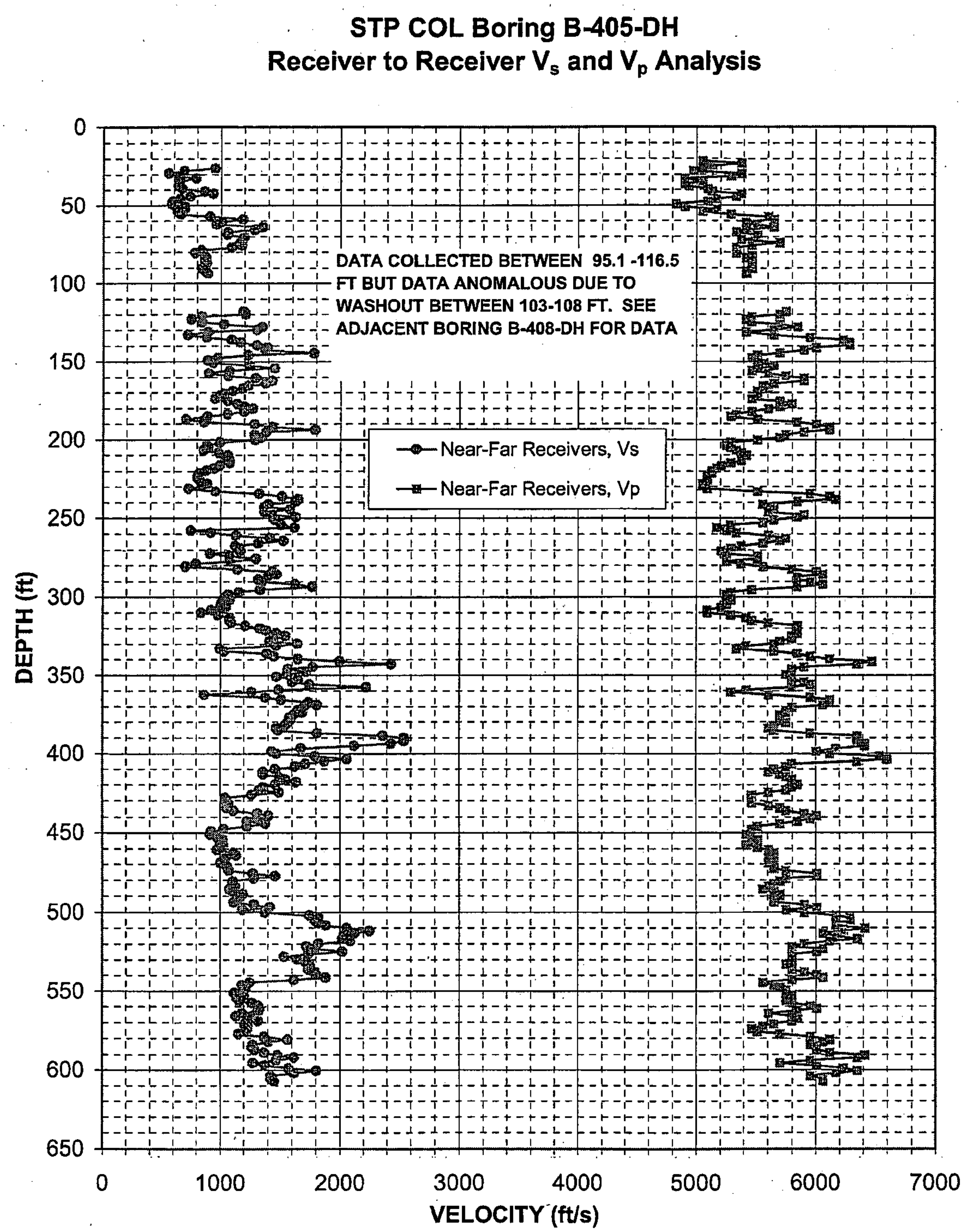


Figure 24: Boring B-405-DH, Suspension R1-R2 P- and S_H-wave velocities

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
21.3	-	5050
23.0	-	5380
24.6	-	5130
26.3	950	5050
27.9	690	4980
29.5	550	5380
31.2	650	5290
32.8	790	4900
34.5	650	5050
36.1	640	4900
37.7	640	4940
39.4	670	5090
41.0	860	5130
42.7	940	5380
44.3	740	5330
45.9	650	5170
47.6	590	5090
49.2	580	4830
50.9	690	4900
52.5	690	5170
54.1	630	5050
55.8	660	5290
57.4	910	5600
59.1	1190	5650
60.7	1010	5420
62.3	960	5510
64.0	1350	5650
65.6	1290	5420
67.3	1060	5330
68.9	1050	5510
70.5	1200	5510
72.2	1180	5380
73.8	1170	5700
75.5	1180	5460
77.1	1090	5330
78.7	840	5330
80.4	780	5330
82.0	860	5460
83.7	870	5420
85.3	870	5460
86.9	880	5460
88.6	870	5460
90.2	840	5460
91.9	860	5420
93.5	890	5420
95.1	-	-
96.8	-	-
98.4	-	-
100.1	-	-
101.7	-	-
103.4	-	-
105.0	-	-
106.6	-	-
93.5	-	-
95.1	-	-
96.8	-	-
98.4	-	-
100.1	-	-
101.7	-	-
103.4	-	-
105.0	-	-
106.6	-	-
108.3	-	-
109.9	-	-
111.6	-	-
113.2	-	-
114.8	-	-
116.5	-	-
118.1	1190	5750
119.8	1210	5700
121.4	840	5460
123.0	750	5420
124.7	840	5460
126.3	1030	5700
128.0	1350	5850
129.6	1310	5650
131.2	890	5420
132.9	720	5650
134.5	880	5950
136.2	1090	6230
137.8	1170	6290
139.4	1310	6290
141.1	1390	6010
142.7	1370	5900
144.4	1780	5700
146.0	1230	5510
147.6	970	5460
149.3	890	5510
150.9	940	5560
152.6	1250	5650
154.2	1450	5510
155.8	1080	5460
157.5	900	5600
159.1	1070	5750
160.8	1290	5900
162.4	1430	5900
164.0	1370	5650
165.7	1230	5560
167.3	1190	5600
169.0	1100	5510
170.6	1030	5510
172.2	990	5510
173.9	960	5460
175.5	1060	5700
177.2	1140	5800
178.8	1200	5700
180.5	1270	5600
182.1	1190	5460
183.7	1060	5330
185.4	880	5290
187.0	700	5510
188.7	860	5850
190.3	1280	6010
191.9	1440	6120
193.6	1790	6120
195.2	1380	5900
196.9	1280	5750
198.5	1340	5700
200.1	1290	5510
201.8	990	5290
203.4	890	5250
205.1	890	5290
206.7	860	5330
208.3	980	5380
210.0	1060	5420
211.6	1050	5380
213.3	1080	5380
214.9	1080	5290
216.5	990	5210
218.2	940	5170
219.8	880	5130
221.5	820	5130
223.1	810	5090
224.7	810	5090
226.4	820	5090
228.0	880	5050
229.7	840	5050
231.3	730	5090
232.9	960	5510
234.6	1320	5950
236.2	1520	6120
237.9	1650	6170
239.5	1630	5850
241.1	1400	5560
242.8	1370	5650
244.4	1580	5650
246.1	1370	5600
247.7	1440	5900
249.3	1630	5850
251.0	1450	5650

Table 11. Boring B-405-DH, Suspension R1-R2 depths and P- and S_H-wave velocities

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)	Depth (feet)	V_s (feet/sec)	V_p (feet/sec)	Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
252.6	1490	5560	334.7	1030	5650	416.7	1540	5800
254.3	1510	5290	336.3	1390	5850	418.3	1630	5800
255.9	1620	5170	337.9	1450	5950	420.0	1460	5850
257.6	750	5250	339.6	1650	6120	421.6	1360	5800
259.2	920	5330	341.2	2000	6470	423.2	1330	5750
260.8	1130	5600	342.9	2430	6350	424.9	1490	5600
262.5	1410	5750	344.5	1770	5900	426.5	1260	5460
264.1	1530	5700	346.1	1560	5800	428.2	1050	5460
265.8	1320	5560	347.8	1720	5800	429.8	1040	5460
267.4	1130	5380	349.4	1560	5750	431.4	1070	5460
269.0	1160	5290	351.1	1470	5800	433.1	1060	5600
270.7	1170	5210	352.7	1650	5800	434.7	1050	5700
272.3	910	5250	354.3	1600	5900	436.4	1110	5750
274.0	1070	5510	356.0	1750	5950	438.0	1310	5900
275.6	1300	5510	357.6	2220	5800	439.6	1400	6010
277.2	1090	5250	359.3	1490	5420	441.3	1310	5950
278.9	790	5380	360.9	1260	5290	442.9	1230	5850
280.5	700	5560	362.5	870	5600	444.6	1380	5700
282.2	1150	5800	364.2	1380	5950	446.2	1230	5510
283.8	1440	6010	365.8	1510	6120	447.8	1030	5460
285.4	1470	6060	367.5	1740	6120	449.5	930	5460
287.1	1400	5850	369.1	1810	6060	451.1	910	5420
288.7	1320	5850	370.7	1700	5800	452.8	970	5460
290.4	1340	5950	372.4	1650	5750	454.4	1020	5510
292.0	1630	6060	374.0	1680	5750	456.0	1000	5510
293.6	1760	5850	375.7	1610	5700	457.7	1030	5420
295.3	1330	5460	377.3	1580	5700	459.3	1020	5510
296.9	1160	5290	378.9	1590	5700	461.0	970	5600
298.6	1060	5250	380.6	1560	5750	462.6	1110	5650
300.2	1040	5250	382.2	1540	5650	464.2	1130	5650
301.8	1080	5290	383.9	1470	5600	465.9	1050	5600
303.5	1020	5250	385.5	1480	5650	467.5	1030	5650
305.1	1000	5250	387.1	1810	5950	469.2	1000	5600
306.8	1050	5210	388.8	2360	6350	470.8	1060	5650
308.4	930	5090	390.4	2540	6350	472.4	1060	5650
310.0	840	5090	392.1	2540	6350	474.1	1080	5750
311.7	980	5290	393.7	2430	6410	475.7	1280	6010
313.3	1080	5420	395.3	2120	6410	477.4	1460	6010
315.0	1080	5460	397.0	1680	6170	479.0	1280	5750
316.6	1090	5600	398.6	1430	6010	480.6	1110	5700
318.2	1210	5850	400.3	1470	6120	482.3	1110	5650
319.9	1330	5850	401.9	1790	6540	483.9	1130	5600
321.5	1380	5850	403.5	2060	6600	485.6	1080	5560
323.2	1470	5850	405.2	1870	6350	487.2	1120	5650
324.8	1540	5800	406.8	1710	5800	488.9	1190	5700
326.4	1440	5800	408.5	1630	5750	490.5	1170	5700
328.1	1410	5700	410.1	1460	5650	492.1	1150	5650
329.7	1640	5650	411.8	1360	5600	493.8	1110	5650
331.4	1470	5420	413.4	1360	5700	495.4	1280	5900
333.0	1000	5330	415.0	1490	5750	497.1	1420	6010

Table 11, continued. Boring B-405-DH, Suspension R1-R2 depths and P- and S_H-wave velocities

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
498.7	1190	5750
500.3	1380	5900
502.0	1750	6170
503.6	1820	6290
505.3	1790	6290
506.9	1820	6170
508.5	1880	6170
510.2	2060	6410
511.8	2250	6230
513.5	2120	6060
515.1	2030	6170
516.7	2020	6350
518.4	2080	6120
520.0	1820	5900
521.7	1720	5800
523.3	1790	6060
524.9	2020	6010
526.6	1740	5800
528.2	1540	5800
529.9	1650	5800
531.5	1710	5800
533.1	1750	5750
534.8	1750	5800
536.4	1740	5800
538.1	1790	5900
539.7	1800	6010
541.3	1880	6060
543.0	1620	5800
544.6	1250	5560
546.3	1180	5650
547.9	1220	5700
549.5	1190	5750
551.2	1120	5750
552.8	1200	5800
554.5	1140	5750
556.1	1160	5750
557.7	1270	5800
559.4	1320	5950
561.0	1330	6010
562.7	1320	5850
564.3	1190	5600
565.9	1130	5800
567.6	1270	5850
569.2	1320	5800
570.9	1210	5650
572.5	1230	5560
574.2	1230	5460
575.8	1220	5510
577.4	1160	5700
579.1	1370	5950
580.7	1560	6120
582.4	1400	6060
584.0	1280	5950
585.6	1270	6010
587.3	1290	6010
588.9	1370	6120
590.6	1480	6410
592.2	1620	6350
593.8	1470	5950
595.5	1280	5700
597.1	1380	6010
598.8	1570	6230
600.4	1800	6350
602.0	1620	6170
603.7	1420	5950
605.3	1420	6060
607.0	1450	6060

Table 11, continued. Boring B-405-DH, Suspension R1-R2 depths and P- and S_H-wave velocities

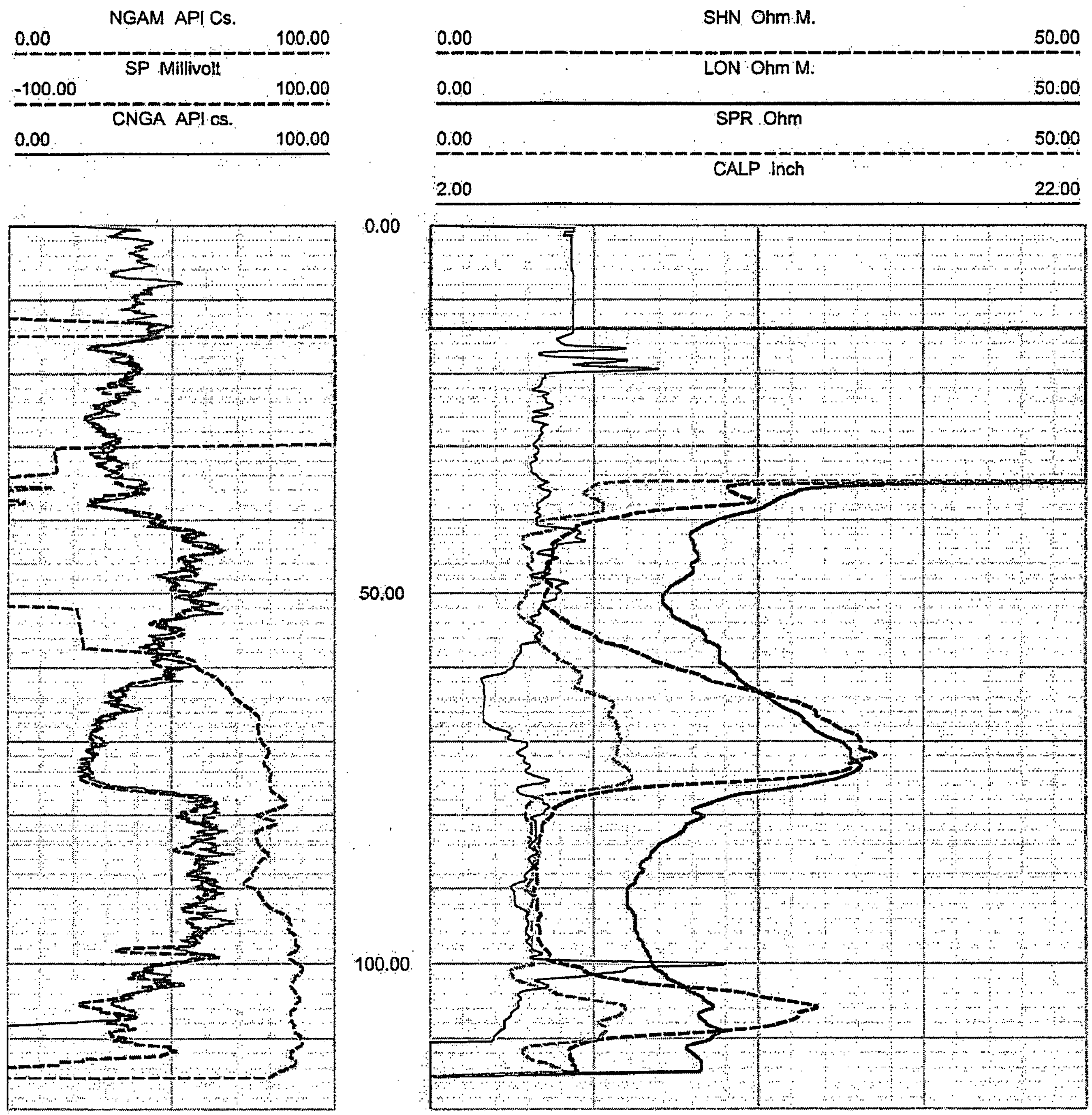


Figure 25. Boring B-405-DH upper section, Caliper, Natural gamma, Resistivity and SP logs

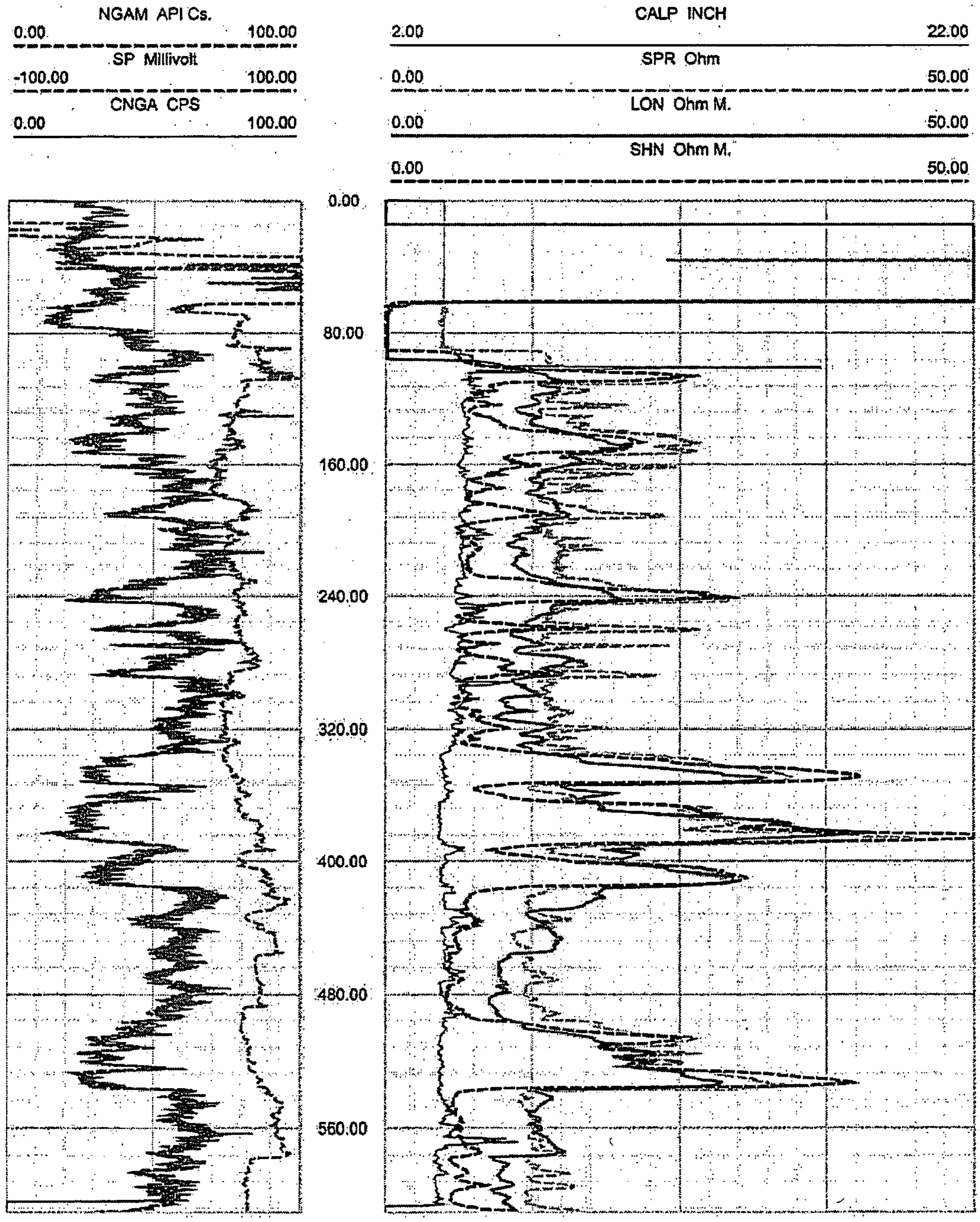


Figure 26. Boring B-405-DH lower section, Caliper, Natural gamma, Resistivity and SP logs

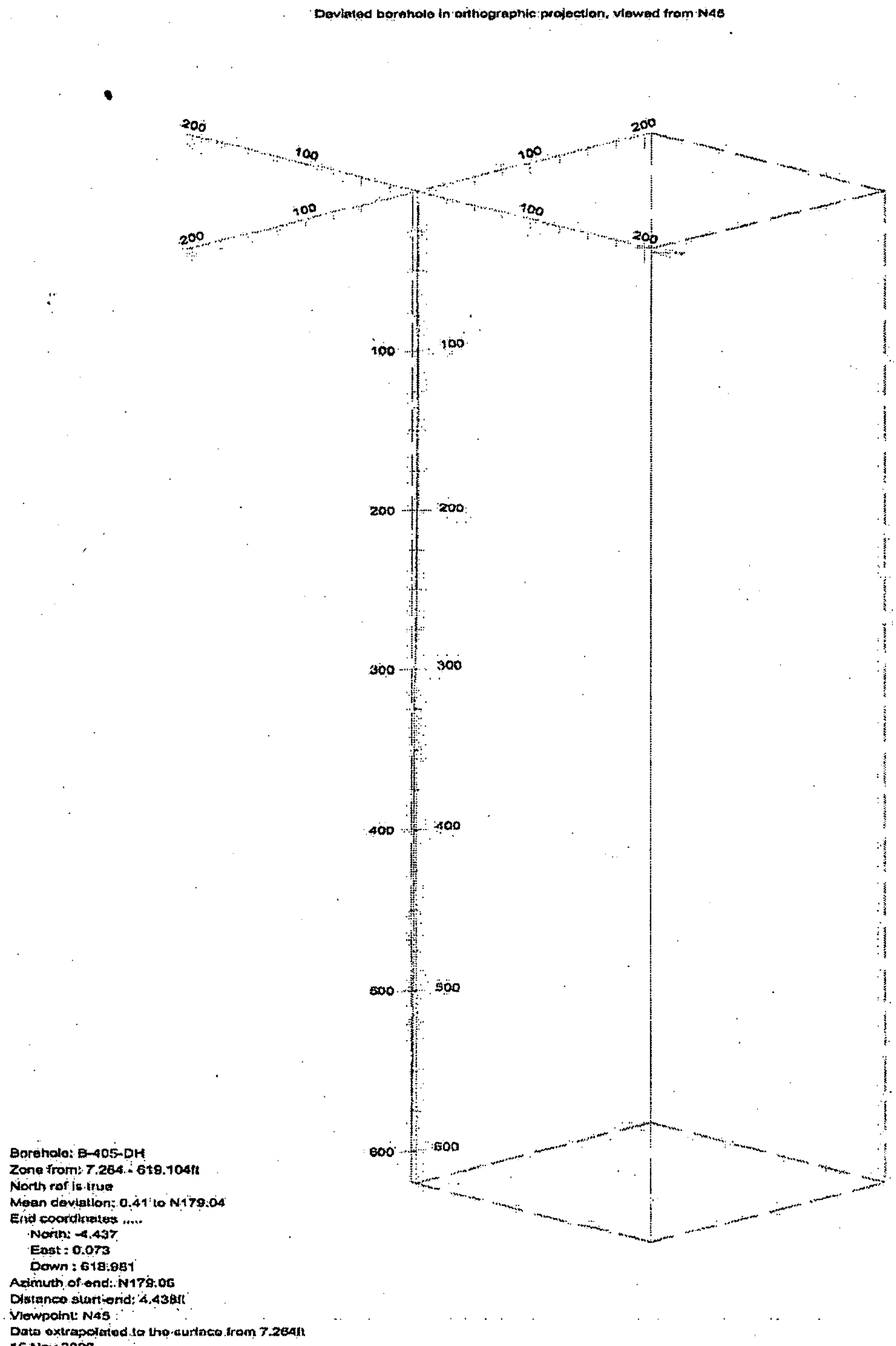


Figure 27. Boring B-405-DH, Deviation Projection (dimensions in feet)

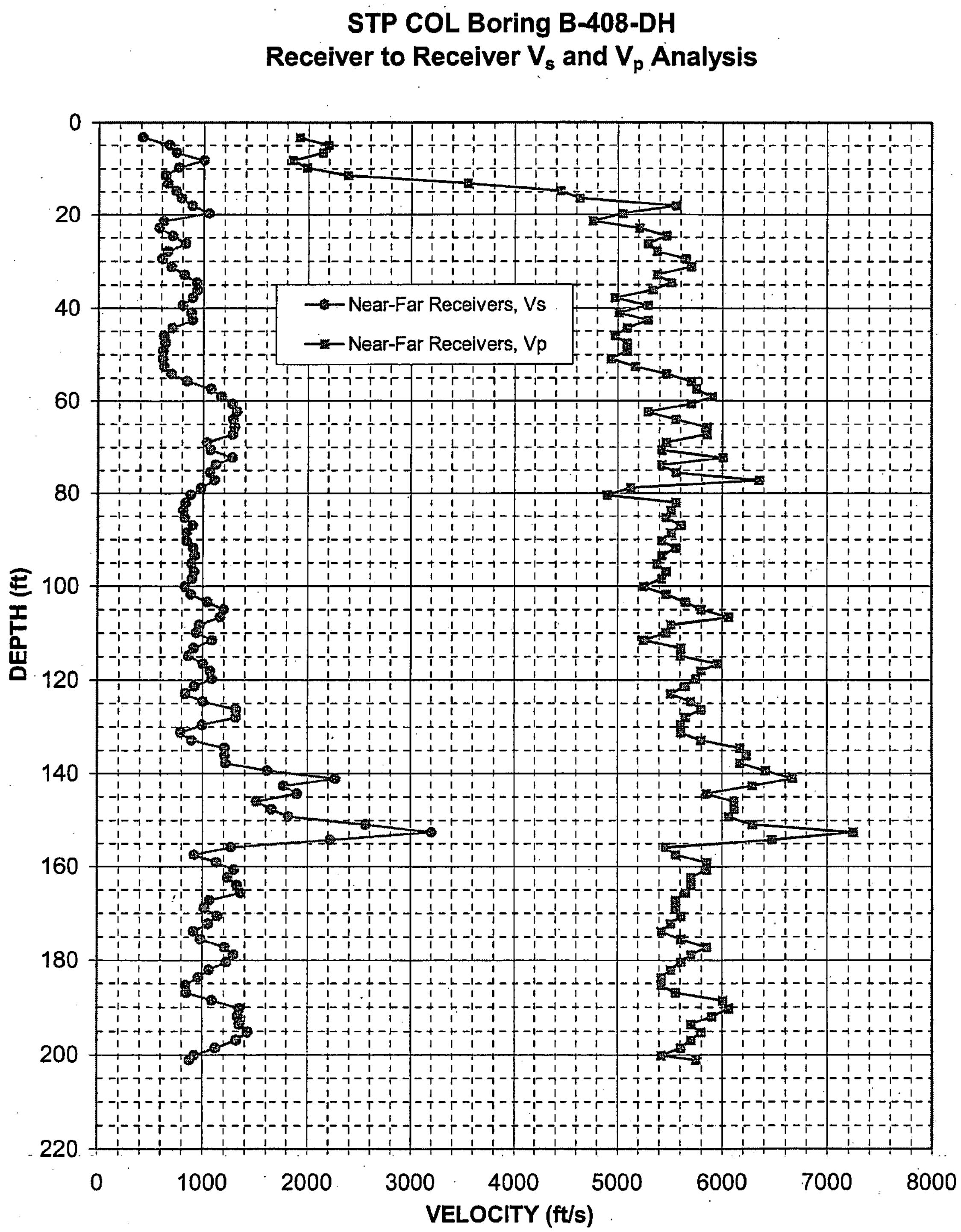


Figure 28: Boring B-408-DH, Suspension R1-R2 P- and S_H-wave velocities

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
3.3	420	1920
4.9	670	2190
6.6	740	2140
8.2	1000	1850
9.8	760	1980
11.5	630	2380
13.1	660	3550
14.8	740	4440
16.4	790	4630
18.0	890	5560
19.7	1060	5050
21.3	620	4760
23.0	580	5210
24.6	710	5460
26.3	830	5290
27.9	660	5380
29.5	610	5650
31.2	690	5700
32.8	810	5380
34.5	940	5510
36.1	940	5330
37.7	900	4980
39.4	800	5290
41.0	890	5010
42.7	900	5290
44.3	710	5090
45.9	630	4980
47.6	640	5090
49.2	620	5090
50.9	620	4940
52.5	630	5170
54.1	690	5460
55.8	850	5700
57.4	1080	5750
59.1	1170	5900
60.7	1280	5700
62.3	1320	5290
64.0	1290	5560
65.6	1300	5850
67.3	1280	5850
68.9	1040	5460
70.5	1070	5420
72.2	1280	6010
73.8	1120	5420
75.5	1070	5560
77.1	1110	6350
78.7	980	5130
80.4	880	4900
82.0	840	5560
83.7	810	5510
85.3	830	5460
86.9	900	5600
88.6	850	5510
90.2	850	5420
91.9	910	5560
93.5	920	5420
95.1	900	5380
96.8	920	5460
98.4	900	5420
100.1	830	5250
101.7	890	5460
103.4	1040	5650
105.0	1200	5800
106.6	1170	6060
108.3	970	5510
109.9	940	5460
111.6	1090	5250
113.2	920	5600
114.8	870	5600
116.5	1010	5950
118.1	1070	5800
119.8	1090	5750
121.4	920	5650
123.0	840	5510
124.7	1010	5700
126.3	1320	5800
128.0	1320	5650
129.6	1000	5600
131.2	790	5600
132.9	900	5800
134.5	1210	6170
136.2	1210	6230
137.8	1220	6170
139.4	1620	6410
141.1	2270	6670
142.7	1770	6290
144.4	1900	5850
146.0	1520	6120
147.6	1660	6120
149.3	1820	6060
150.9	2560	6290
152.6	3210	7250
154.2	2220	6470
155.8	1270	5460
157.5	930	5560
159.1	1130	5850
160.8	1300	5850
162.4	1240	5700
164.0	1330	5700
165.7	1360	5650
167.3	1070	5560
169.0	1020	5560
170.6	1150	5600
172.2	1060	5510
173.9	920	5420
175.5	980	5600
177.2	1210	5850
178.8	1300	5700
180.5	1230	5600
182.1	1060	5510
183.7	970	5420
185.4	840	5420
187.0	850	5560
188.7	1100	6010
190.3	1360	6060
191.9	1330	5900
193.6	1360	5700
195.2	1430	5800
196.9	1320	5700
198.5	1130	5600
200.1	930	5420
201.1	880	5750

Table 12. Boring B-408-DH, Suspension R1-R2 depths and P- and S_H-wave velocities

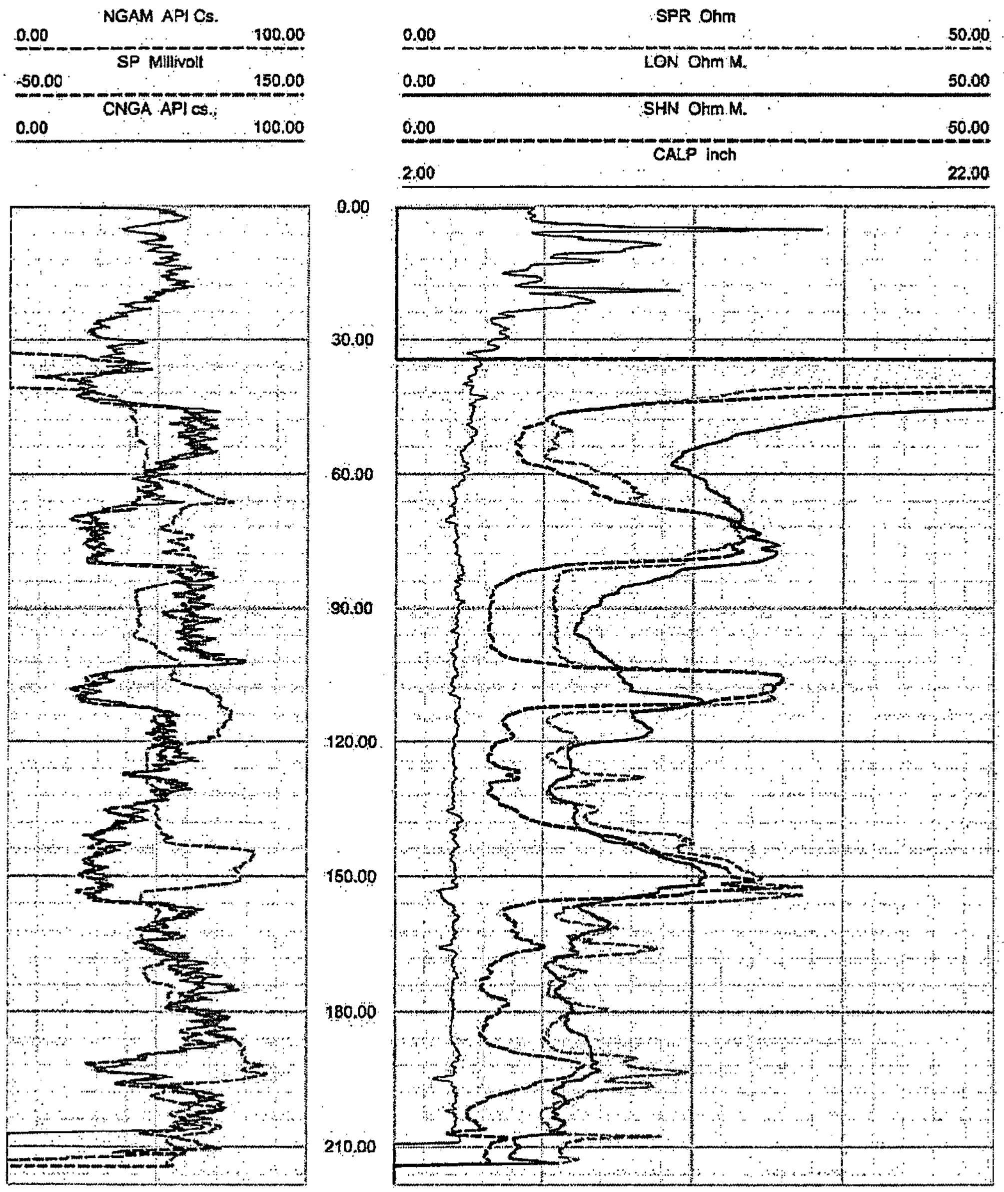


Figure 29. Boring B-408-DH, Caliper, Natural gamma, Resistivity and SP logs

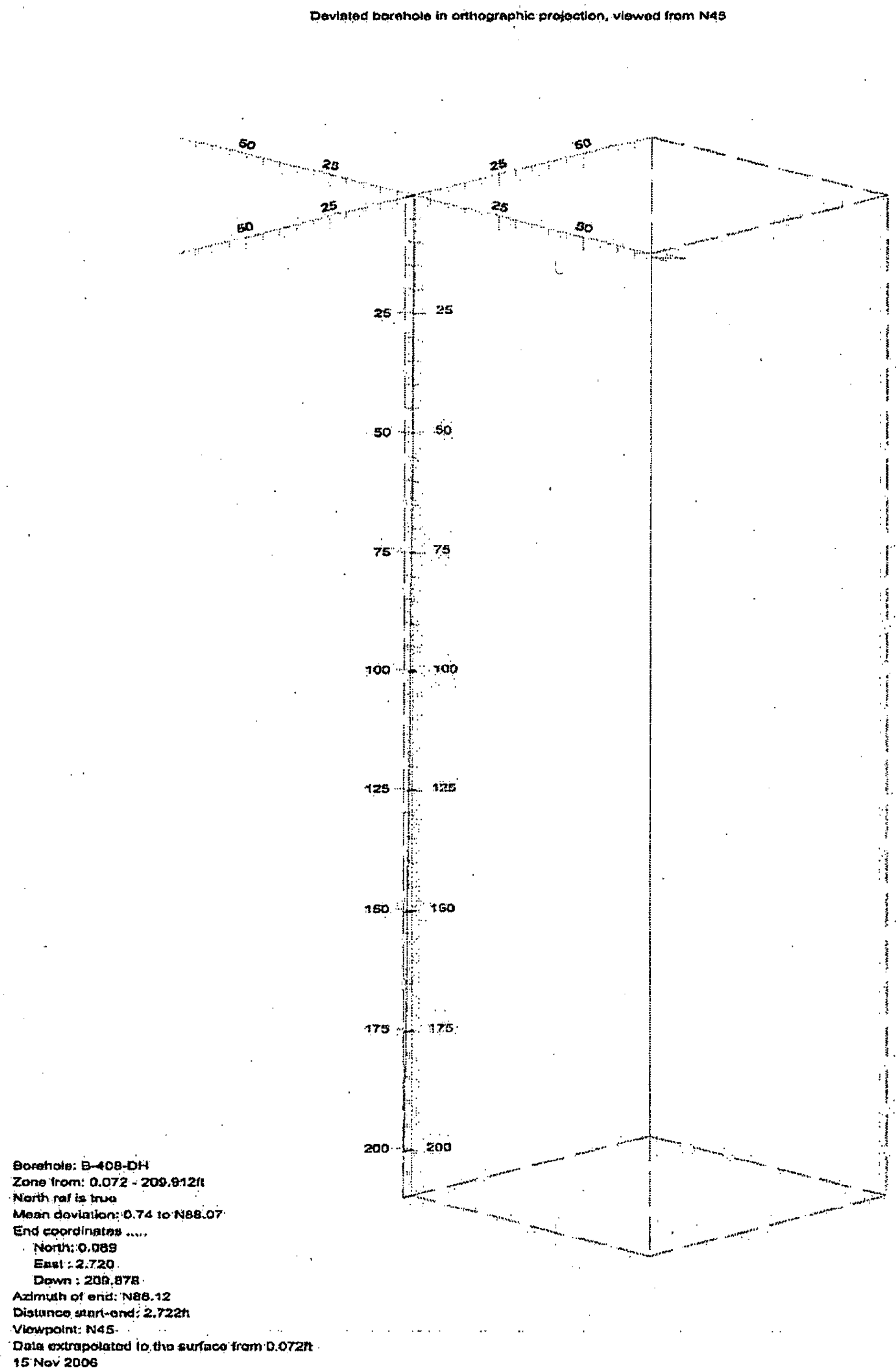


Figure 30. Boring B-408-DH, Deviation Projection (dimensions in feet)

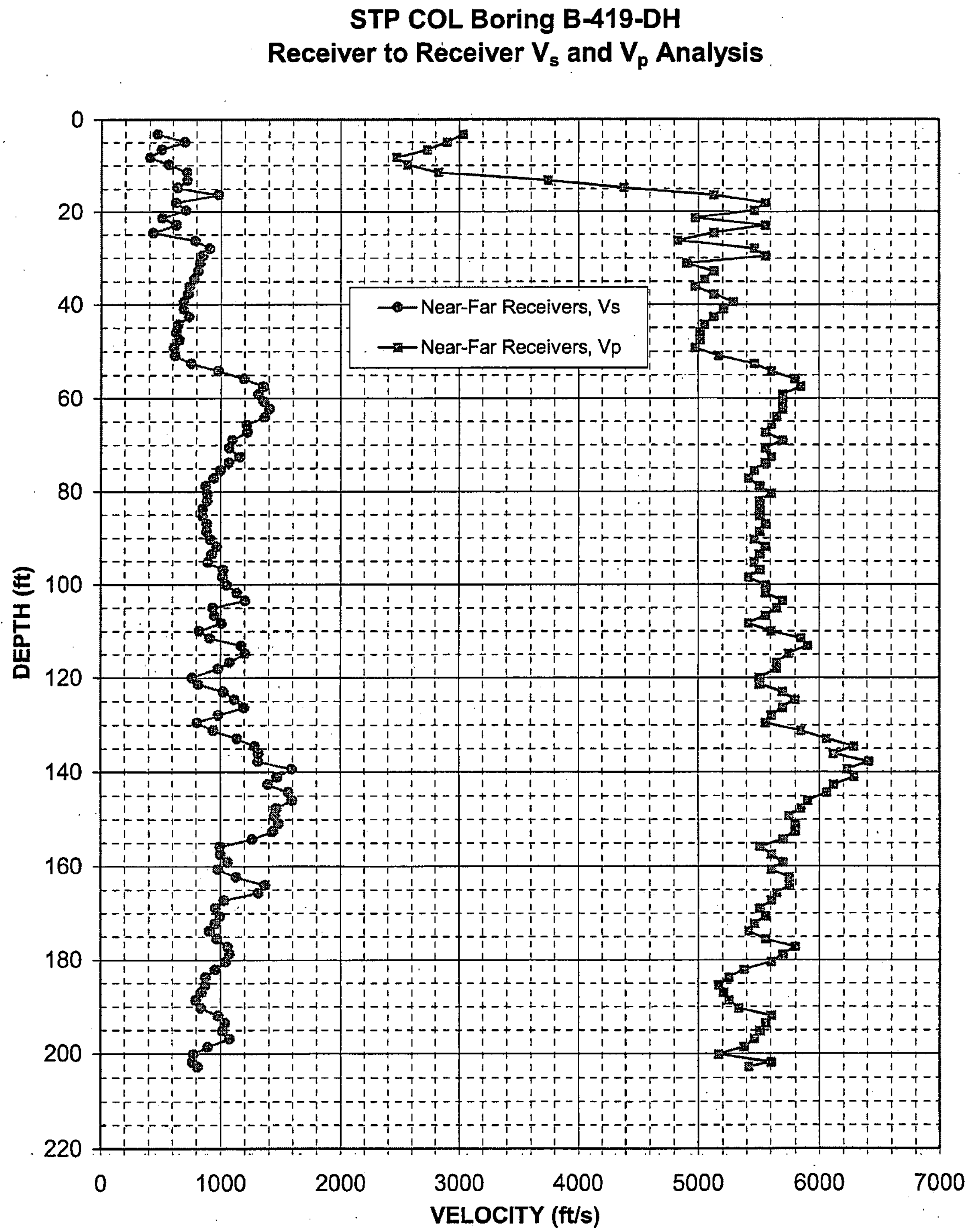


Figure 31: Boring B-419-DH, Suspension R1-R2 P- and S_H-wave velocities

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
3.3	470	3030
4.9	700	2900
6.6	510	2730
8.2	410	2470
9.8	560	2560
11.5	720	2820
13.1	720	3750
14.8	640	4390
16.4	980	5130
18.0	630	5560
19.7	710	5460
21.3	510	4980
23.0	630	5560
24.6	440	5130
26.3	790	4830
27.9	910	5460
29.5	850	5560
31.2	830	4900
32.8	810	5130
34.5	780	5050
36.1	740	4980
37.7	730	5130
39.4	690	5290
41.0	690	5210
42.7	740	5130
44.3	650	5050
45.9	630	5010
47.6	660	5010
49.2	610	4980
50.9	620	5170
52.5	760	5460
54.1	980	5600
55.8	1190	5800
57.4	1360	5850
59.1	1310	5700
60.7	1360	5700
62.3	1410	5700
64.0	1370	5650
65.6	1220	5600
67.3	1220	5560
68.9	1100	5700
70.5	1070	5560
72.5	1160	5600
73.8	1070	5560
75.5	1000	5460
77.1	940	5420
78.7	880	5510
80.4	890	5600
82.0	890	5510
83.7	850	5510
85.3	850	5510
86.9	890	5560
88.6	890	5510
90.2	920	5460
91.9	970	5560
93.5	930	5510
95.1	900	5460
96.8	1020	5510
98.4	1020	5420
100.1	1050	5560
101.7	1140	5560
103.4	1210	5700
105.0	940	5650
106.6	950	5560
108.3	1010	5420
109.9	830	5600
111.6	910	5850
113.2	1170	5900
114.8	1210	5750
116.8	1080	5650
118.1	980	5650
120.1	760	5510
121.4	820	5510
123.0	1030	5700
124.7	1110	5800
126.3	1190	5700
128.0	980	5600
129.6	810	5560
131.2	940	5850
132.9	1140	6060
134.5	1290	6290
136.2	1320	6120
137.8	1310	6410
139.4	1590	6230
141.1	1470	6290
142.7	1390	6120
144.4	1560	6060
146.0	1590	5900
147.6	1460	5850
149.3	1450	5750
150.9	1480	5800
152.6	1440	5800
154.2	1260	5700
155.8	1000	5510
157.5	1000	5600
159.1	1060	5700
160.8	980	5600
162.4	1130	5750
164.0	1370	5750
165.7	1310	5650
167.3	1030	5600
169.0	960	5510
170.6	1000	5560
172.2	960	5460
173.9	910	5420
175.5	970	5560
177.2	1060	5800
178.8	1080	5700
180.5	1050	5600
182.1	960	5380
183.7	880	5250
185.4	880	5170
187.0	850	5210
188.7	800	5250
190.3	840	5330
191.9	980	5600
193.6	1040	5560
195.2	1020	5510
196.9	1080	5460
198.5	900	5380
200.1	780	5170
201.8	770	5600
202.8	810	5420

Table 13. Boring B-419-DH, Suspension R1-R2 depths and P- and S_H-wave velocities

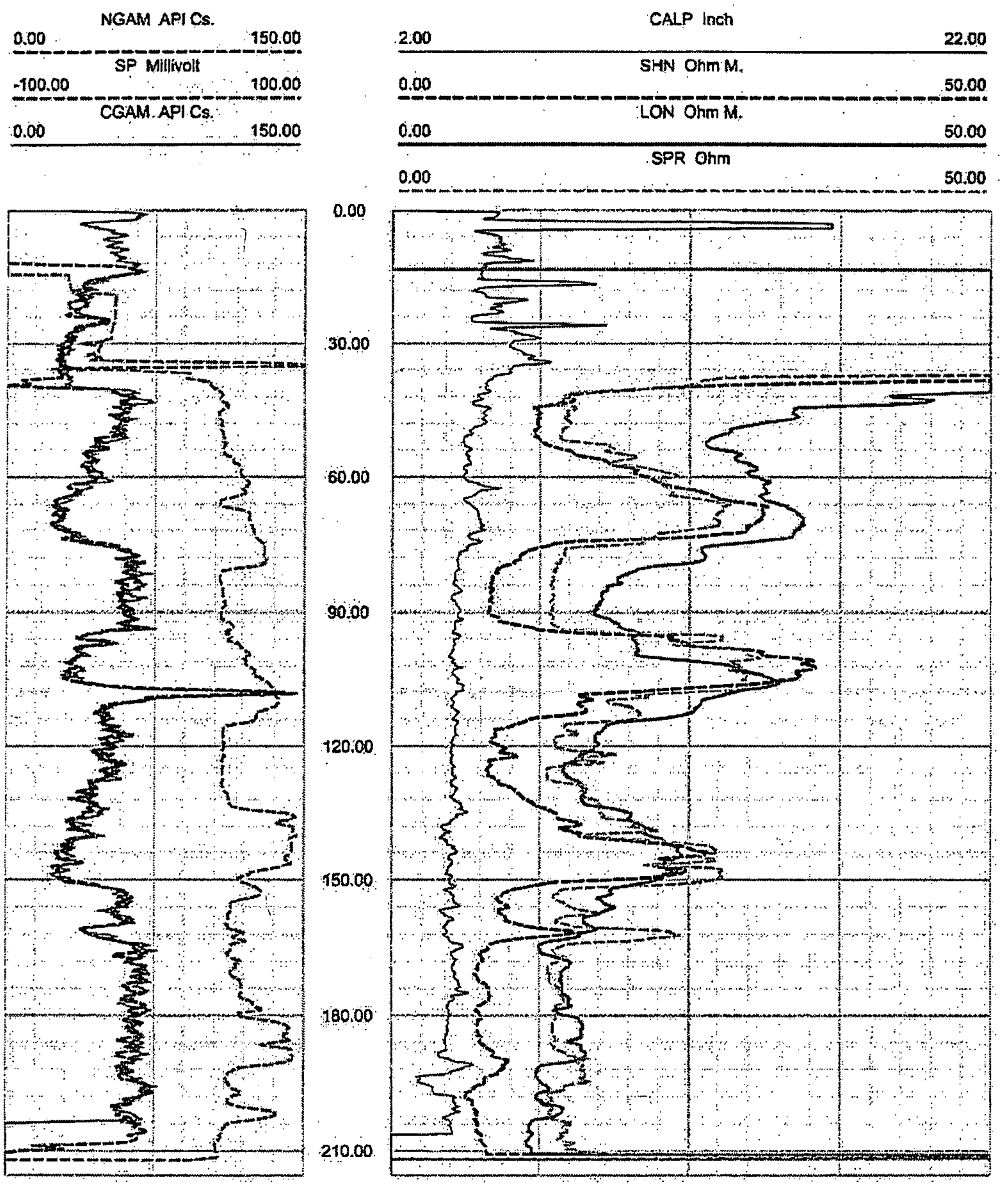


Figure 32. Boring B-419-DH, Caliper, Natural gamma, Resistivity and SP logs

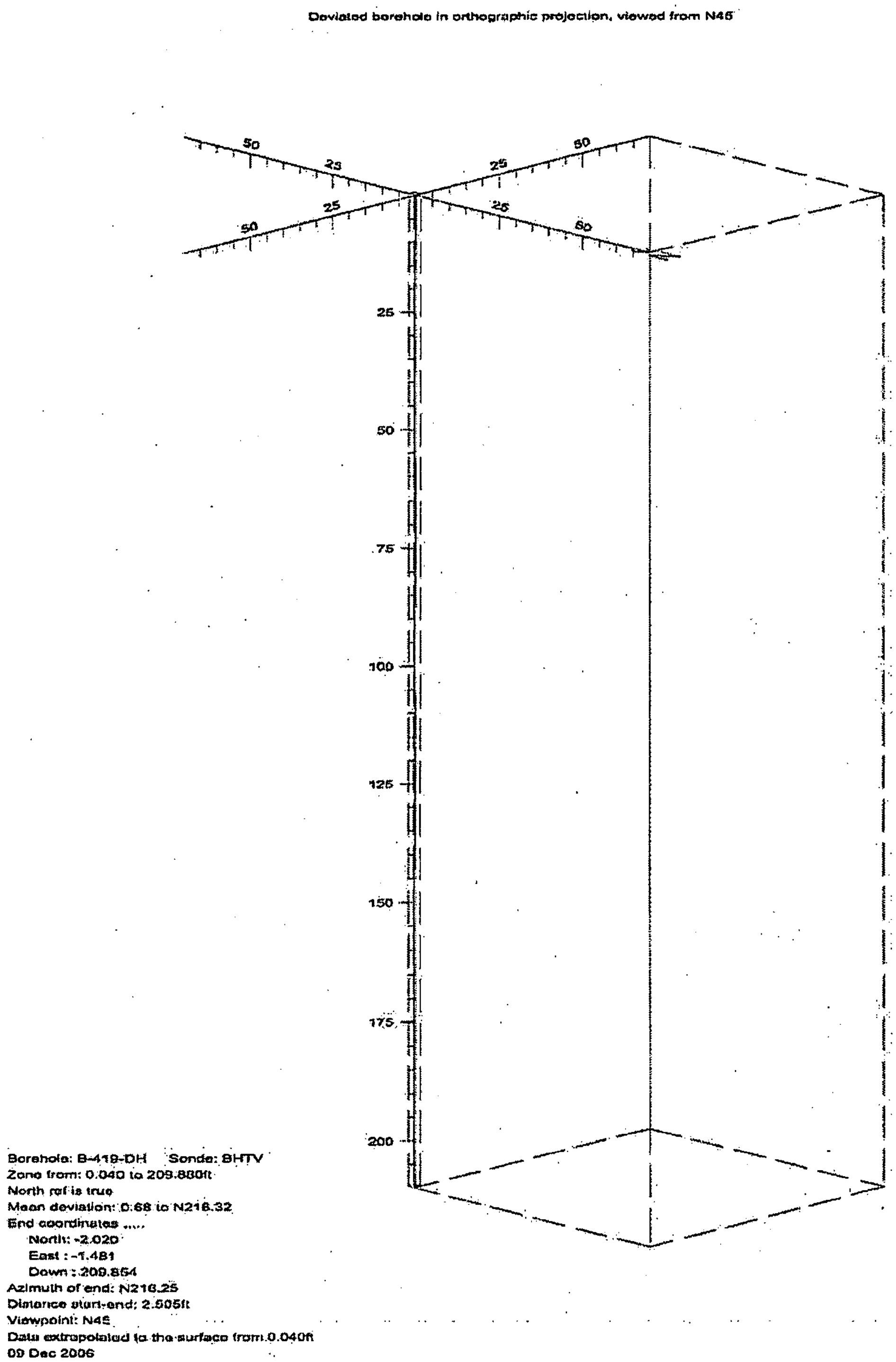


Figure 33. Boring B-419-DH, Deviation Projection (dimensions in feet)

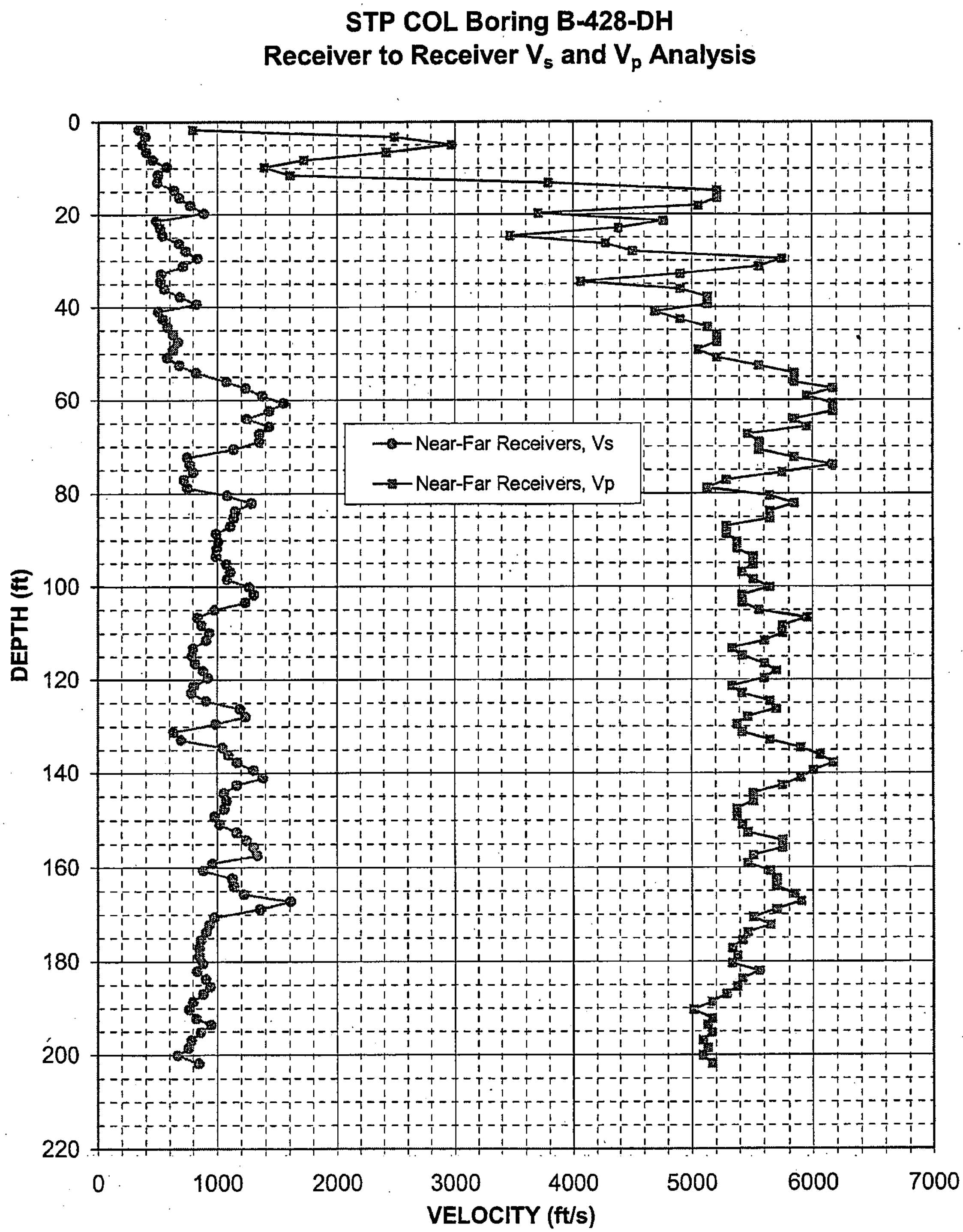


Figure 34: Boring B-428-DH, Suspension R1-R2 P- and S_H-wave velocities

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
1.6	330	790
3.3	390	2490
4.9	370	2980
6.6	400	2420
8.2	460	1720
9.8	580	1390
11.5	500	1600
13.1	500	3790
14.8	640	5210
16.4	680	5210
18.0	780	5050
19.7	890	3700
21.3	480	4760
23.0	520	4390
24.6	540	3470
26.3	680	4270
27.9	740	4500
29.5	830	5750
31.2	710	5560
32.8	530	4900
34.5	520	4070
36.1	560	4900
37.7	690	5130
39.4	830	5130
41.0	510	4690
42.7	540	4900
44.3	580	5130
45.9	630	5210
47.6	670	5210
49.2	630	5050
50.9	580	5210
52.5	680	5560
54.1	820	5850
56.1	1080	5850
57.4	1230	6170
59.1	1370	5950
60.7	1550	6170
62.3	1430	6170
64.0	1250	5850
65.6	1430	5950
67.3	1350	5460
68.9	1350	5560
70.5	1140	5560
72.2	750	5850
73.8	770	6170
75.5	800	5750
77.1	720	5290
78.7	750	5130
80.4	1080	5650
82.0	1280	5850
83.7	1150	5650
85.3	1140	5650
86.9	1110	5290
88.6	990	5290
90.2	1010	5380
91.9	1000	5380
93.5	990	5510
95.1	1080	5510
96.8	1110	5420
98.4	1090	5510
100.1	1270	5650
101.7	1310	5420
103.4	1230	5420
105.0	980	5560
106.6	840	5950
108.3	870	5750
109.9	940	5750
111.6	910	5600
113.2	800	5330
114.8	790	5420
116.5	820	5600
118.1	890	5700
119.8	930	5600
121.4	810	5330
123.0	790	5420
124.7	910	5650
126.3	1190	5700
128.0	1240	5460
129.6	990	5380
131.2	640	5420
132.9	700	5650
134.5	1040	5900
136.2	1100	6060
137.8	1170	6170
139.4	1300	6010
141.1	1380	5900
142.7	1170	5750
144.4	1060	5510
146.0	1080	5510
147.6	1060	5380
149.3	980	5380
150.9	1020	5420
152.6	1170	5460
154.2	1240	5750
155.8	1300	5750
157.5	1330	5510
159.1	960	5460
160.8	880	5650
162.4	1130	5700
164.0	1140	5700
165.7	1220	5850
167.3	1610	5900
169.0	1360	5700
170.6	980	5510
172.2	940	5650
173.9	910	5460
175.5	870	5420
177.2	850	5330
178.8	850	5380
180.5	880	5330
182.1	830	5560
183.7	910	5420
185.4	940	5380
187.0	890	5290
188.7	800	5170
190.3	770	5010
192.3	830	5170
193.6	950	5130
195.2	860	5170
196.9	790	5090
198.5	760	5130
200.1	670	5090
201.8	850	5170

Table 14. Boring B-428-DH, Suspension R1-R2 depths and P- and S_H-wave velocities

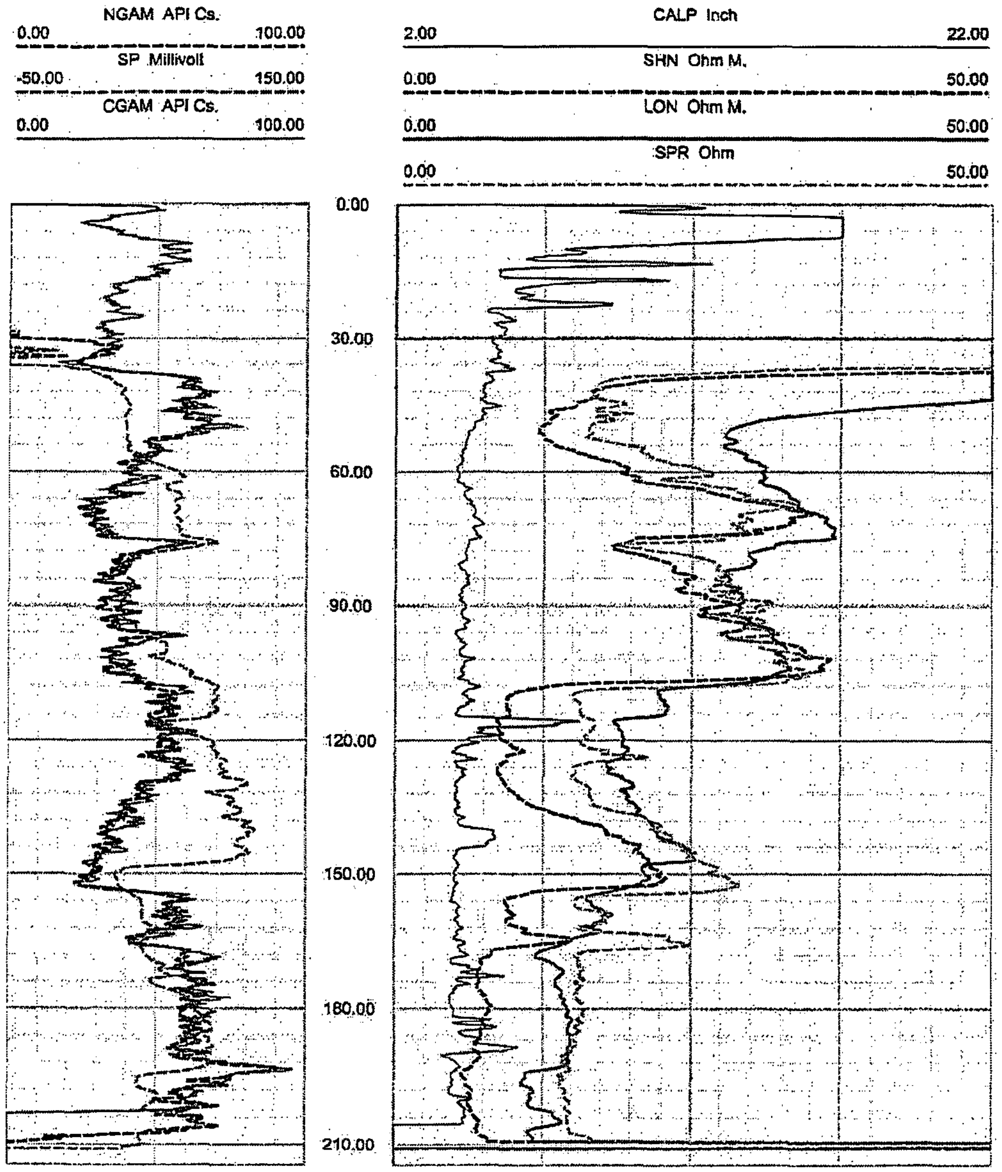
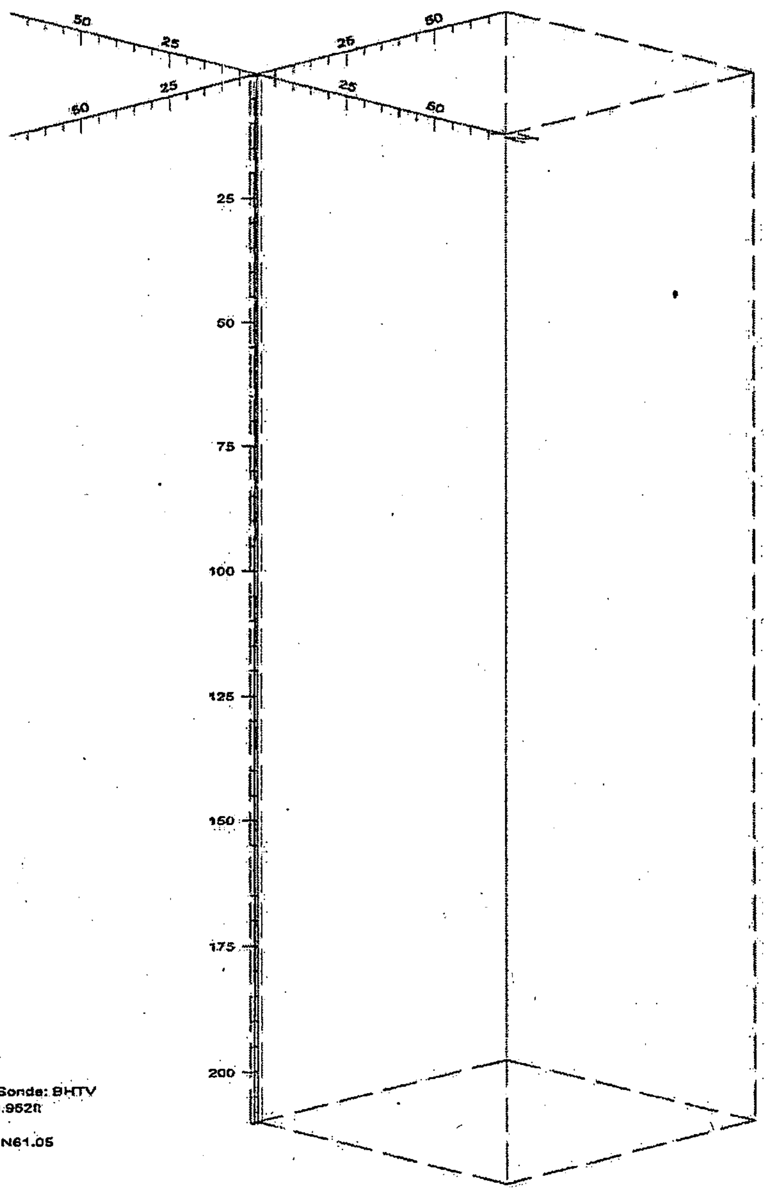


Figure 35. Boring B-428-DH, Caliper, Natural gamma, Resistivity and SP logs

Deviated borehole in orthographic projection, viewed from N45



Borehole: B-428-DH Sonde: BHTV
Zone from: 1.298 to 209.952ft
North ref is true
Mean deviation: 0.63 to N61.05
End coordinates .....
North: 1.122
East : 2.026
Down : 209.827
Azimuth of end: N61.03
Distance start-end: 2.316ft
Viewpoint: N45
Data extrapolated to the surface from 1.298ft
05 Dec 2006

Figure 36. Boring B-428-DH, Deviation Projection (dimensions in feet)

APPENDIX A

SUSPENSION VELOCITY MEASUREMENT QUALITY ASSURANCE SUSPENSION SOURCE TO RECEIVER ANALYSIS RESULTS

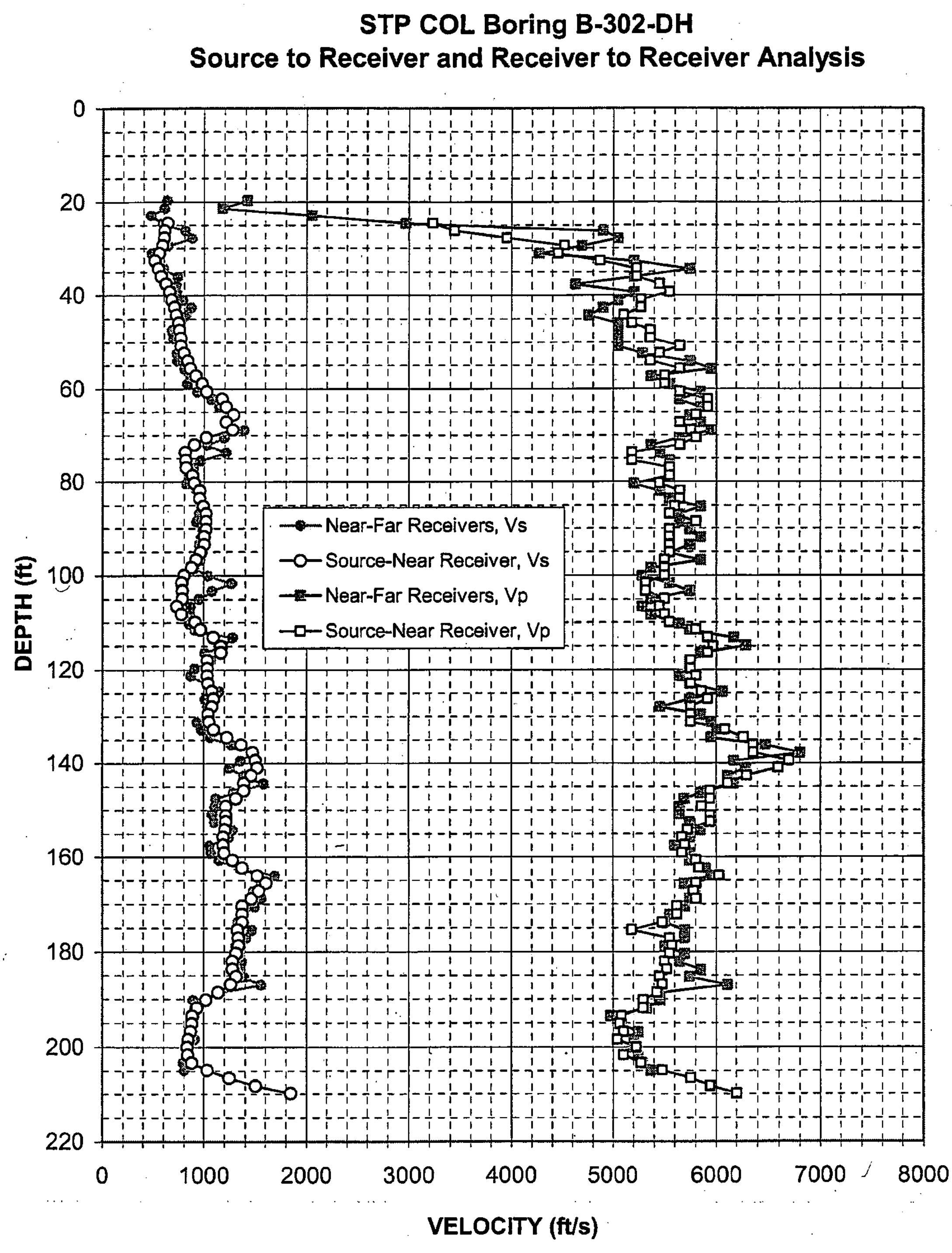


Figure A-1. Boring B-302-DH, R1 - R2 high resolution analysis and S - R1 quality assurance analysis P- and S_H-wave data

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
24.5	640	3230
26.2	610	3440
27.8	600	3960
29.4	590	4520
31.1	560	4460
32.7	510	4870
34.4	550	5230
36.0	570	5230
37.6	620	5460
39.3	660	5550
40.9	680	5280
42.6	710	5280
44.2	730	5100
45.8	750	5190
47.5	760	5360
49.1	770	5360
50.8	770	5650
52.4	800	5460
54.0	840	5360
55.7	870	5650
57.3	920	5500
59.0	980	5500
60.6	1030	5650
62.2	1180	5920
63.9	1220	5920
65.5	1290	5810
67.2	1220	5650
68.8	1280	5750
70.5	1020	5810
72.1	910	5650
73.7	820	5190
75.4	820	5190
77.0	820	5550
78.7	890	5550
80.3	910	5460
81.9	960	5650
83.6	960	5650
85.2	990	5600
86.9	1020	5550
88.5	1020	5810
90.1	1020	5550
91.8	1000	5550
93.4	1000	5550
95.1	970	5550
96.7	920	5500
98.3	880	5500
100.0	810	5500
101.6	790	5320
103.3	790	5320
104.9	790	5500

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
106.5	740	5460
108.2	780	5500
109.8	910	5550
111.5	970	5810
113.1	1090	5920
115.1	1170	5970
116.4	1170	5920
118.0	1030	5750
119.7	1030	5750
121.3	1030	5810
122.9	1040	5750
124.6	1080	5860
126.2	1100	5920
127.9	1080	5750
129.5	1040	5750
131.1	1050	5750
132.8	1100	6090
134.4	1230	6270
136.1	1360	6360
137.7	1480	6360
139.3	1510	6700
141.0	1520	6590
142.6	1470	6300
144.3	1390	6120
145.9	1390	5940
147.6	1320	5940
149.2	1220	5860
151.2	1220	5940
152.5	1220	5940
154.1	1210	5730
155.8	1190	5680
157.4	1190	5700
159.0	1200	5680
160.7	1280	5810
162.3	1380	5830
164.0	1520	6030
165.6	1610	5810
167.2	1540	5780
168.9	1470	5810
170.5	1380	5630
172.2	1380	5630
173.8	1380	5480
175.4	1330	5190
177.1	1340	5550
178.7	1340	5580
180.4	1320	5550
182.0	1280	5500
183.6	1280	5530
185.3	1320	5460
186.9	1260	5480

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
188.6	1140	5430
190.2	1020	5300
191.8	930	5300
193.5	890	5080
195.1	880	5060
196.8	870	5100
198.4	850	5040
200.0	840	5230
201.7	840	5100
203.3	880	5280
205.0	1030	5480
206.6	1250	5750
208.2	1510	5940
209.9	1850	6210

Table A-1. Boring B-302-DH, S - R1 quality assurance analysis P- and S_H-wave data

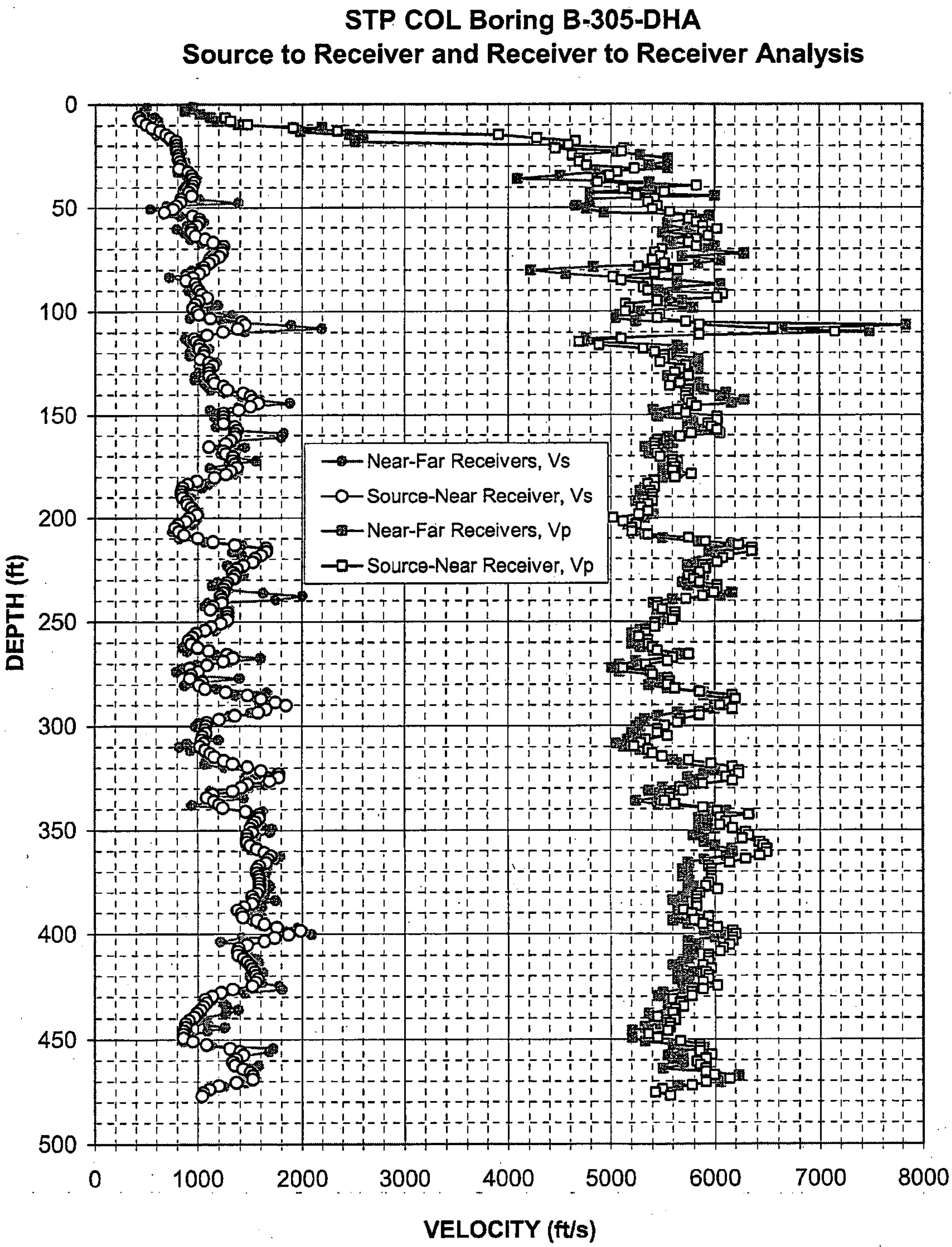


Figure A-2. Boring B-305-DHA, R1 - R2 high resolution analysis and S - R1 quality assurance analysis P- and S_H-wave data

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)	Depth (feet)	V_s (feet/sec)	V_p (feet/sec)	Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
6.5	420	1260	88.5	1000	5320	170.5	1340	5480
8.1	440	1310	90.1	1020	5360	172.2	1340	5600
9.8	500	1470	91.8	1040	6090	173.8	1360	5600
11.4	550	1920	93.4	1090	6030	175.4	1380	5630
13.0	630	2350	95.1	1010	5460	177.1	1320	5600
14.7	690	3910	96.7	980	5150	178.7	1270	5780
16.3	730	4280	98.3	950	5190	180.4	1160	5630
18.0	790	4650	100.0	990	5150	182.0	1000	5430
19.6	790	4590	101.6	1010	5480	183.6	900	5360
21.2	790	4460	103.3	1120	5460	185.3	860	5430
22.9	800	5100	104.9	1430	5730	186.9	850	5390
24.5	810	4620	106.5	1450	5860	188.6	850	5410
26.2	810	4690	108.2	1380	6560	190.2	860	5410
27.8	830	4690	109.8	1250	7150	191.8	890	5410
29.4	830	4760	111.5	1100	5860	193.5	900	5360
31.1	820	5230	113.1	970	5100	195.1	940	5300
32.7	900	5060	114.7	990	4690	196.8	960	5360
34.4	940	4980	116.4	1020	4890	198.4	1000	5280
36.0	950	4910	118.0	1020	5320	200.0	920	5020
37.6	960	4870	119.7	1060	5430	201.7	890	5130
39.3	950	5830	121.3	1060	5530	203.3	810	5250
40.9	940	5130	122.9	1030	5530	205.0	790	5210
42.6	910	5530	124.6	1110	5480	206.6	820	5210
44.2	940	5250	126.2	1150	5730	208.2	870	5360
45.8	840	5430	127.9	1110	5680	209.9	1000	5750
47.5	830	5360	129.5	1110	5630	211.5	1150	5920
49.1	790	5460	131.1	1110	5750	213.2	1360	6240
50.8	760	5410	132.8	1150	5600	214.8	1660	6360
52.4	680	5580	134.4	1160	5680	216.4	1660	6360
54.0	950	5780	136.1	1250	5580	218.1	1610	6150
55.7	1020	5750	137.7	1290	5750	219.7	1550	6090
57.3	1020	5830	139.3	1440	5730	221.4	1530	6030
59.0	1000	5890	141.0	1510	5730	223.0	1440	5890
60.6	940	6030	142.6	1530	5750	224.7	1380	5920
62.2	940	5890	144.3	1580	5780	226.3	1340	5860
63.9	980	5940	145.9	1510	5830	227.9	1360	5750
65.5	1070	5830	147.6	1390	5650	229.6	1340	5810
67.2	1150	5750	149.2	1250	5730	231.2	1290	5860
68.8	1250	5830	150.8	1250	6030	232.9	1270	6030
70.5	1240	5500	152.5	1250	6030	234.5	1250	6030
72.1	1240	5430	154.1	1250	5940	236.1	1250	6000
73.7	1210	5480	155.8	1360	5970	237.8	1220	5890
75.4	1150	5410	157.4	1380	6030	239.4	1240	5730
77.0	1110	5530	159.0	1360	5780	241.1	1240	5460
78.7	1060	5280	160.7	1360	5680	242.7	1150	5460
80.3	1060	5650	162.3	1320	5460	244.3	1120	5500
81.9	1020	5430	164.0	1270	5430	246.0	1290	5630
83.6	950	5020	165.6	1110	5430	247.6	1290	5630
85.2	890	5100	167.2	1250	5430	249.3	1290	5600
86.9	980	5360	168.9	1270	5460	250.9	1220	5430

Table A-2. Boring B-305-DHA, S - R1 quality assurance analysis
P- and S_H-wave data

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
252.5	1130	5430
254.2	1070	5340
255.8	990	5340
257.5	950	5280
259.1	910	5360
260.7	940	5360
262.4	1000	5410
264.0	1110	5460
265.7	1290	5750
267.3	1340	5600
268.9	1250	5550
270.6	1100	5340
272.2	930	5130
273.9	1010	5390
275.5	940	5410
277.1	930	5550
278.8	1050	5580
280.4	1020	5550
282.1	1070	5630
283.7	1270	5860
285.3	1480	6180
287.0	1610	6210
288.6	1750	6120
290.3	1850	6060
291.9	1660	6180
293.5	1580	5860
295.2	1360	5860
296.8	1210	5680
298.5	1100	5650
300.1	1080	5530
301.8	1070	5460
303.4	1080	5460
305.0	1050	5550
306.7	1040	5340
308.3	1060	5300
310.0	1030	5230
311.6	1070	5360
313.2	1120	5410
314.9	1160	5500
316.5	1250	5750
318.2	1340	5970
319.8	1480	6180
321.4	1610	6240
323.1	1780	6240
324.7	1780	6120
326.4	1690	6180
328.0	1480	5890
329.6	1420	5680
331.3	1340	5700
332.9	1150	5580

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
334.6	1100	5580
336.2	1160	5530
337.8	1210	5630
339.5	1250	5890
341.1	1460	6030
342.8	1590	6330
344.4	1590	6060
346.0	1550	6120
347.7	1520	6060
349.3	1510	6180
351.0	1520	6300
352.6	1470	6330
354.2	1470	6270
355.9	1470	6430
357.5	1510	6460
359.2	1570	6490
360.8	1640	6490
362.4	1700	6430
364.1	1670	6300
365.7	1660	6150
367.4	1590	5940
369.0	1570	5970
370.6	1570	5970
372.3	1590	5970
373.9	1590	5970
375.6	1590	5940
377.2	1590	5920
378.9	1590	6030
380.5	1570	5860
382.1	1520	5830
383.8	1540	5830
385.4	1520	5830
387.1	1450	5830
388.7	1380	5700
390.3	1420	5780
392.0	1430	5940
393.6	1570	5810
395.3	1640	5890
396.9	1760	6030
398.5	1990	6180
400.2	1870	6210
401.8	1740	6180
403.5	1640	6180
405.1	1470	6150
406.7	1390	6090
408.4	1380	6060
410.0	1390	5940
411.7	1440	5940
413.3	1470	5940
414.9	1510	5890

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
416.6	1520	5970
418.2	1540	5920
419.9	1560	5940
421.5	1570	5940
423.1	1560	5890
424.8	1520	6030
426.4	1340	5890
428.1	1230	5780
429.7	1140	5780
431.3	1070	5600
433.0	1090	5680
434.6	1060	5700
436.3	1030	5630
437.9	1000	5600
439.5	970	5460
441.2	920	5630
442.8	890	5580
444.5	890	5580
446.1	870	5550
447.7	860	5360
449.4	860	5460
451.0	950	5680
452.7	1090	5860
454.3	1310	5860
456.0	1410	5860
457.6	1440	5970
459.2	1360	5920
460.9	1340	5830
462.5	1360	5860
464.2	1430	5920
465.8	1510	5920
467.4	1530	6000
469.1	1530	6150
470.7	1370	5920
472.4	1200	5780
474.0	1110	5500
475.6	1060	5430
477.3	1040	5580

Table A-2, continued. Boring B-305-DHA, S - R1 quality assurance analysis
P- and S_H-wave data

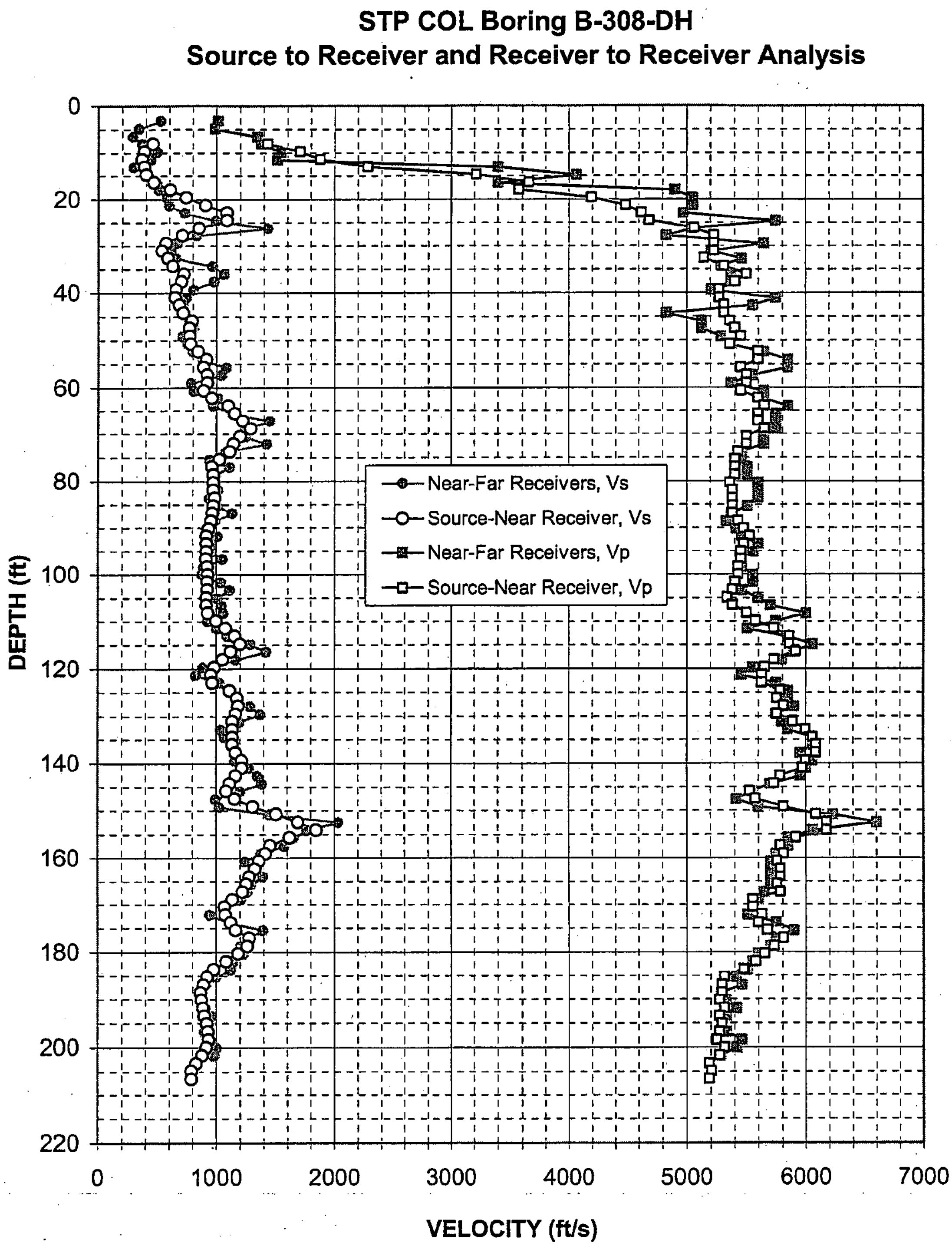


Figure A-3. Boring B-308-DH, R1 - R2 high resolution analysis and S - R1 quality assurance analysis P- and S_H-wave data

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
8.1	460	1430
9.8	390	1710
11.4	370	1880
13.0	390	2290
14.7	400	3210
16.3	470	3660
18.0	610	3580
19.6	740	4190
21.2	910	4490
22.9	1090	4620
24.5	1090	4690
26.2	850	5060
27.8	710	5230
29.4	570	5230
31.1	540	5230
32.7	590	5150
34.4	630	5320
36.0	730	5500
37.6	710	5410
39.3	660	5280
40.9	650	5280
42.6	690	5320
44.2	720	5320
45.8	800	5360
47.5	770	5410
49.1	770	5460
50.8	780	5360
52.4	850	5600
54.0	920	5600
55.7	890	5460
57.3	930	5500
59.0	930	5500
60.6	890	5460
62.2	960	5600
63.9	1100	5650
65.5	1160	5600
67.2	1220	5600
68.8	1290	5650
70.5	1200	5500
72.1	1140	5500
73.7	1110	5430
75.4	1030	5410
77.0	960	5410
78.7	980	5410
80.3	980	5360
81.9	980	5390
83.6	990	5390
85.2	980	5390
86.9	970	5390
88.5	960	5430

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
90.1	940	5480
91.8	920	5530
93.4	920	5480
95.1	920	5460
96.7	910	5460
98.3	920	5430
100.0	930	5430
101.6	920	5410
103.3	920	5390
104.9	920	5340
106.5	920	5390
108.2	930	5500
109.8	1000	5580
111.5	1080	5730
113.1	1160	5860
114.7	1200	5860
116.4	1120	5920
118.0	1050	5730
119.7	980	5650
121.3	960	5630
122.9	970	5630
124.6	1110	5780
126.2	1170	5750
127.9	1180	5810
129.5	1160	5750
131.1	1140	5890
132.8	1140	6000
134.4	1140	6060
136.1	1140	6090
137.7	1170	6090
139.3	1210	6000
141.0	1210	5970
142.6	1170	5780
144.3	1110	5730
145.9	1090	5530
147.6	1160	5580
149.2	1310	5810
150.8	1500	6090
152.5	1690	6180
154.1	1850	6180
155.8	1620	5920
157.4	1460	5780
159.0	1420	5810
160.7	1360	5750
162.3	1320	5780
164.0	1280	5780
165.6	1250	5750
167.2	1220	5780
168.9	1140	5550
170.5	1070	5550

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
172.2	1080	5630
173.8	1120	5600
175.4	1170	5680
177.1	1280	5810
178.7	1260	5730
180.4	1180	5650
182.0	1090	5580
183.6	980	5480
185.3	930	5320
186.9	890	5300
188.6	870	5300
190.2	880	5280
191.8	890	5320
193.5	900	5280
195.1	920	5300
196.8	930	5280
198.4	940	5250
200.0	920	5320
201.7	880	5280
203.3	830	5190
205.0	790	5210
206.6	790	5190

Table A-3. Boring B-308-DH, S - R1 quality assurance analysis
P- and S_H-wave data

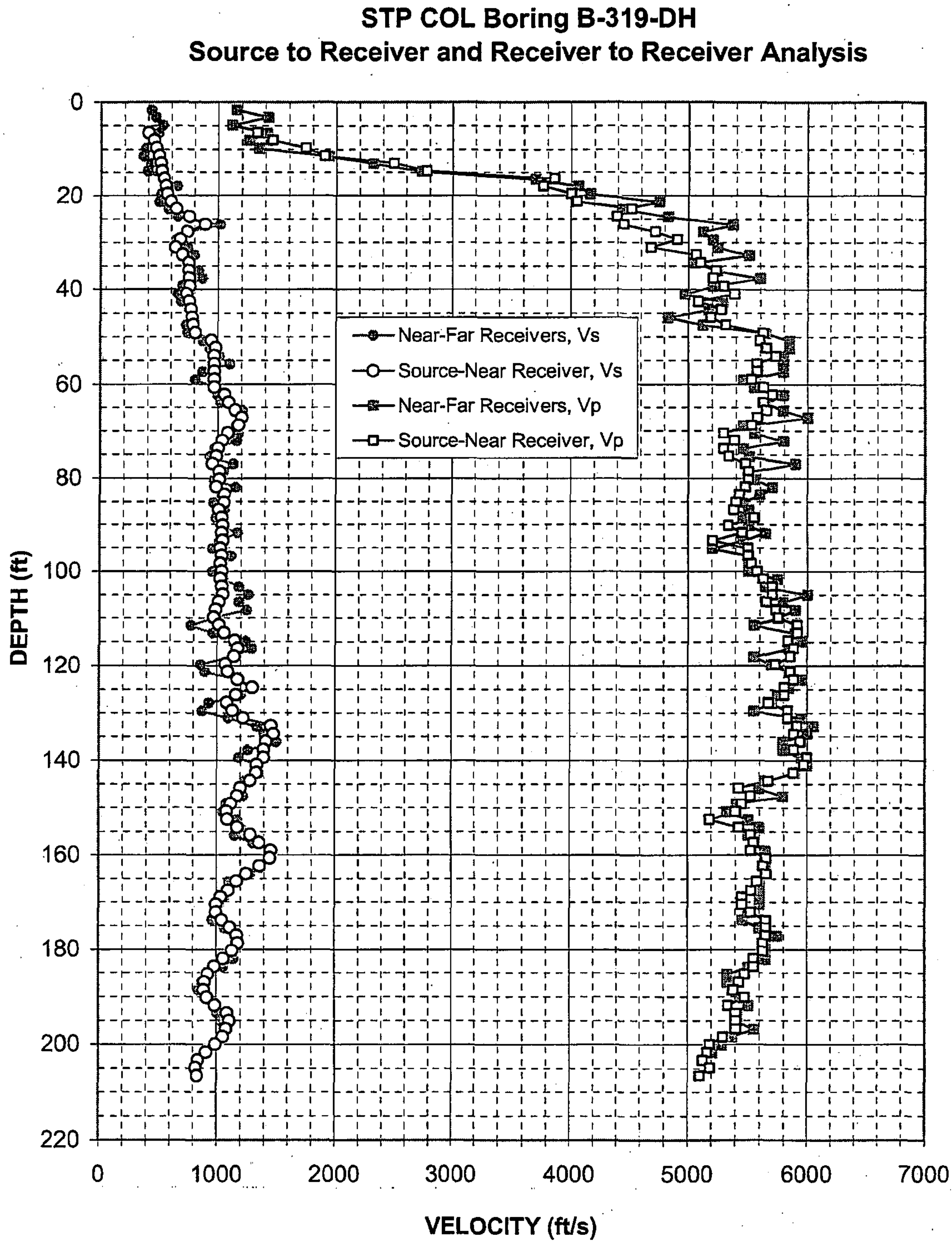


Figure A-4. Boring B-319-DH, R1 - R2 high resolution analysis and S - R1 quality assurance analysis P- and S_H-wave data

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
6.5	400	1330
8.1	450	1460
9.8	470	1740
11.4	490	1900
13.0	510	2490
14.7	520	2780
16.3	540	3860
18.0	550	3770
19.6	570	4010
21.2	600	4060
22.9	650	4520
24.5	760	4400
26.2	890	4460
27.8	740	4720
29.4	680	4910
31.1	640	4690
32.7	700	5060
34.4	750	5100
36.0	750	5230
37.6	760	5210
39.3	760	5300
40.9	730	5390
42.6	760	5080
44.2	770	5280
45.8	780	5190
47.5	790	5320
49.1	810	5630
50.8	950	5600
52.4	980	5650
54.0	970	5730
55.7	970	5580
57.3	970	5580
59.0	970	5530
60.6	970	5630
62.2	1060	5700
63.9	1100	5630
65.5	1150	5650
67.2	1200	5580
68.8	1180	5530
70.5	1080	5300
72.1	1040	5390
73.7	1000	5300
75.4	990	5340
77.0	960	5480
78.7	1010	5500
80.3	1010	5500
81.9	990	5480
83.6	1060	5430
85.2	1060	5410
86.9	1010	5390
88.5	1040	5550
90.1	1050	5340
91.8	1040	5460
93.4	1050	5210
95.1	1030	5500
96.7	1040	5500
98.3	1030	5530
100.0	1040	5580
101.6	1030	5630
103.3	1040	5700
104.9	1050	5700
106.5	1010	5650
108.2	990	5730
109.8	970	5750
111.5	1010	5920
113.1	1060	5920
114.7	1150	5830
116.4	1180	5890
118.0	1150	5860
119.7	1070	5730
121.3	1100	5860
122.9	1180	5890
124.6	1300	5810
126.2	1160	5810
127.9	1080	5680
129.5	1130	5830
131.1	1220	5830
132.8	1460	5920
134.4	1480	5890
136.1	1410	5940
137.7	1390	5890
139.3	1390	6000
141.0	1340	5970
142.6	1340	5890
144.3	1290	5680
145.9	1200	5430
147.6	1180	5530
149.2	1120	5460
150.8	1080	5410
152.5	1100	5190
154.1	1180	5430
155.8	1290	5530
157.4	1360	5550
159.0	1460	5530
160.7	1450	5650
162.3	1360	5630
164.0	1250	5650
165.6	1170	5580
167.6	1100	5530
168.9	1030	5460
170.5	1000	5460
172.2	1000	5530
173.8	1040	5650
175.4	1110	5650
177.1	1170	5650
178.7	1180	5630
180.4	1130	5630
182.0	1060	5550
183.6	980	5550
185.3	930	5480
186.9	900	5430
188.6	890	5390
190.2	920	5480
191.8	990	5340
193.5	1090	5410
195.1	1110	5410
196.8	1080	5410
198.4	1060	5300
200.0	990	5190
201.7	910	5170
203.3	840	5130
205.0	820	5190
206.6	840	5100

Table A-4. Boring B-319-DH, S - R1 quality assurance analysis P- and S_H-wave data

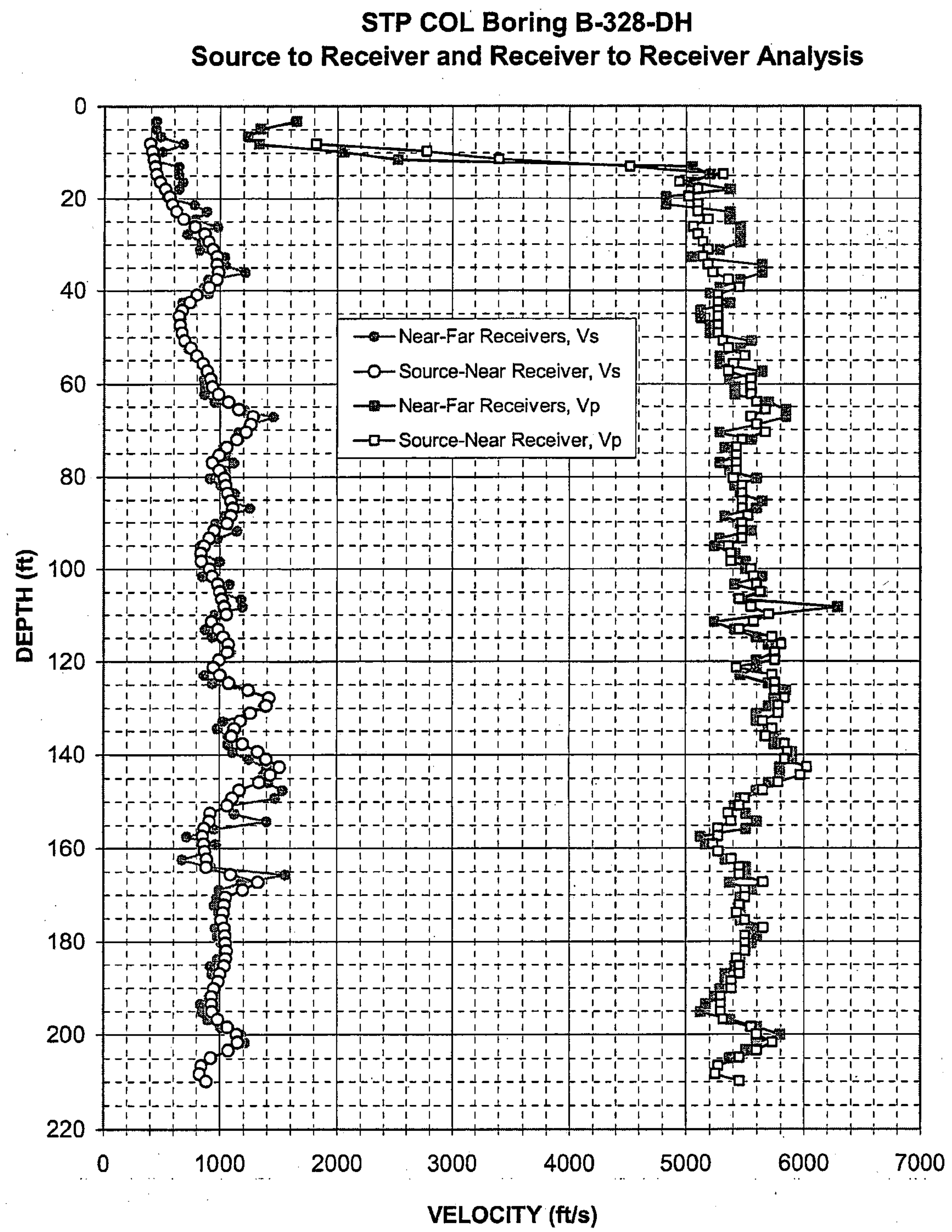


Figure A-5. Boring B-328-DH, R1 - R2 high resolution analysis and S - R1 quality assurance analysis P- and S_H-wave data

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
8.1	400	1820
9.8	410	2780
11.4	430	3400
13.0	440	4520
14.7	450	5320
16.3	480	4950
18.0	530	5100
19.6	560	5020
21.2	590	5100
22.9	620	5100
24.5	690	5190
26.2	780	5060
27.8	870	5100
29.4	900	5150
31.1	940	5190
32.7	980	5150
34.4	980	5190
36.0	990	5230
37.6	970	5360
39.3	910	5460
40.9	800	5280
42.6	740	5280
44.2	670	5280
45.5	650	5280
47.5	660	5280
49.1	670	5280
50.8	690	5320
52.4	750	5360
54.0	800	5500
55.7	860	5410
57.3	890	5360
59.0	920	5550
60.6	940	5550
62.2	990	5550
63.9	1070	5600
65.5	1160	5680
67.2	1280	5550
68.8	1260	5600
70.5	1220	5680
72.1	1140	5480
73.7	1060	5430
75.4	1000	5430
77.0	940	5430
78.7	1000	5430
80.3	1040	5410
81.9	1050	5480
83.6	1070	5480
85.2	1090	5480
86.9	1110	5480
88.5	1100	5530
90.1	1060	5480
91.8	950	5480
93.4	910	5480
95.1	860	5360
96.7	840	5390
98.3	840	5390
100.0	910	5550
101.6	940	5580
103.3	980	5600
104.9	1000	5630
106.5	1020	5460
108.2	1040	5550
109.8	1060	5700
111.5	930	5580
113.1	990	5460
114.7	1030	5730
116.4	1070	5810
118.0	1070	5750
119.7	1000	5750
121.3	950	5430
122.9	1000	5730
124.6	1080	5750
126.2	1240	5750
127.9	1420	5830
129.5	1400	5780
131.1	1260	5780
132.8	1180	5650
134.4	1130	5730
136.1	1100	5680
137.7	1190	5830
139.3	1320	5860
141.0	1390	5830
142.6	1510	6030
144.3	1430	5970
145.9	1340	5780
147.6	1170	5650
149.2	1110	5500
150.8	1070	5460
152.5	920	5360
154.1	910	5390
155.8	870	5280
157.4	860	5280
159.0	860	5230
160.7	870	5280
162.3	890	5390
164.0	880	5460
165.6	1100	5460
167.2	1320	5650
168.9	1190	5500
170.5	1050	5500
172.2	1040	5460
173.8	1030	5430
175.4	1010	5500
177.1	1040	5650
178.7	1040	5500
180.4	1050	5500
182.0	1060	5500
183.6	1050	5430
185.3	1040	5460
186.9	1000	5460
188.6	990	5390
190.2	950	5390
191.8	930	5300
193.5	930	5300
195.1	940	5300
196.8	980	5320
198.4	1070	5550
200.0	1140	5600
201.7	1150	5730
203.3	1070	5600
205.0	930	5460
206.6	840	5280
208.2	830	5250
209.9	880	5460

Table A-5. Boring B-328-DH, S - R1 quality assurance analysis P- and S_H-wave data

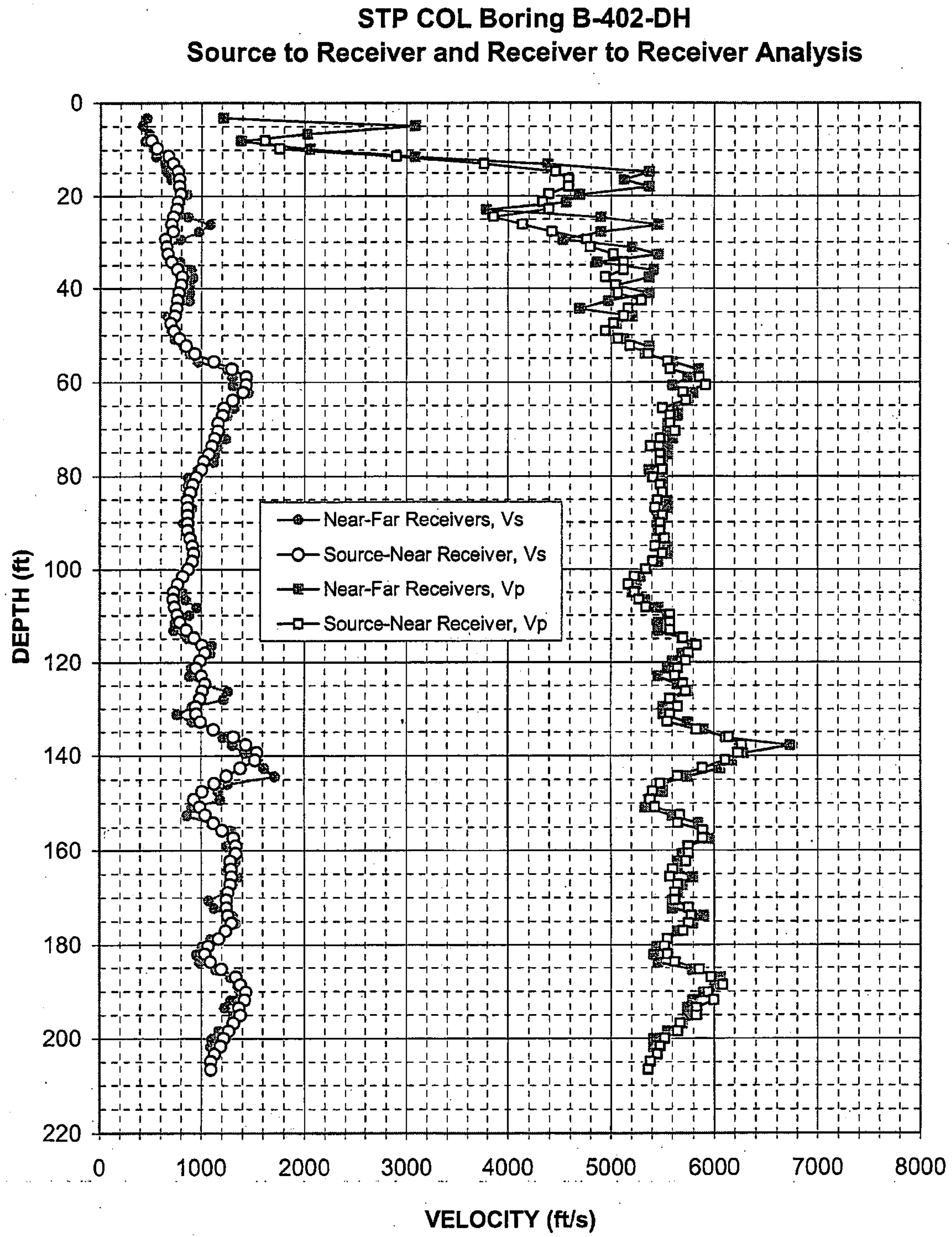


Figure A-6. Boring B-402-DH, R1 - R2 high resolution analysis and S - R1 quality assurance analysis P- and S_H-wave data

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
8.1	510	1620
9.8	560	1760
11.4	670	2900
13.0	720	3770
14.7	770	4460
16.3	780	4590
18.0	780	4590
19.6	800	4400
21.2	770	4340
22.9	760	4400
24.5	730	3860
26.2	710	4140
27.8	720	4430
29.4	650	4760
31.1	660	4800
32.7	670	5020
34.4	710	5130
36.0	760	5130
37.6	810	4950
39.3	800	5040
40.9	780	5060
42.6	760	5300
44.2	760	5170
45.8	740	5130
47.5	700	5020
49.1	730	4950
50.8	780	5060
52.4	850	5190
54.0	940	5360
55.7	1120	5550
57.3	1300	5580
59.0	1440	5860
60.6	1440	5920
62.2	1410	5700
63.9	1310	5730
65.5	1220	5500
67.2	1210	5580
68.8	1160	5580
70.5	1160	5630
72.1	1130	5480
73.7	1110	5390
75.4	1080	5480
77.0	1020	5480
78.7	1000	5500
80.3	950	5410
81.9	920	5480
83.6	900	5500
85.2	860	5460
86.9	870	5430
88.5	870	5500
90.1	870	5480
91.8	870	5480
93.4	890	5530
95.1	910	5430
96.7	930	5500
98.3	910	5410
100.0	870	5340
101.6	820	5230
103.3	770	5170
104.9	730	5230
106.5	730	5280
108.2	740	5340
109.8	760	5580
111.5	790	5580
113.1	860	5580
114.7	930	5700
116.4	1010	5830
118.0	1040	5750
119.7	990	5730
121.3	950	5650
122.9	1000	5630
124.6	1040	5700
126.2	1010	5730
127.9	990	5580
129.5	950	5650
131.1	960	5580
132.8	1000	5550
134.4	1130	5830
136.1	1320	6150
137.7	1440	6270
139.3	1540	6240
141.0	1530	6120
142.6	1380	5890
144.3	1250	5650
145.9	1130	5480
147.6	1010	5410
149.2	930	5390
150.8	990	5430
152.5	1040	5680
154.1	1130	5650
155.8	1210	5890
157.4	1320	5890
159.0	1340	5750
160.7	1340	5750
162.3	1290	5730
164.0	1300	5600
165.6	1300	5580
167.2	1290	5650
168.9	1260	5630
170.5	1250	5630
172.2	1250	5750
173.8	1260	5780
175.4	1300	5750
177.1	1240	5700
178.7	1170	5550
180.4	1070	5530
182.0	1040	5550
183.6	1090	5630
185.3	1200	5860
186.9	1340	5970
188.6	1380	6090
190.2	1440	5940
191.8	1430	6000
193.5	1370	5830
195.1	1380	5830
196.8	1320	5680
198.4	1270	5650
200.0	1220	5530
201.7	1190	5480
203.3	1130	5460
205.0	1100	5390
206.6	1100	5360

Table A-6. Boring B-402-DH, S - R1 quality assurance analysis P- and S_H-wave data

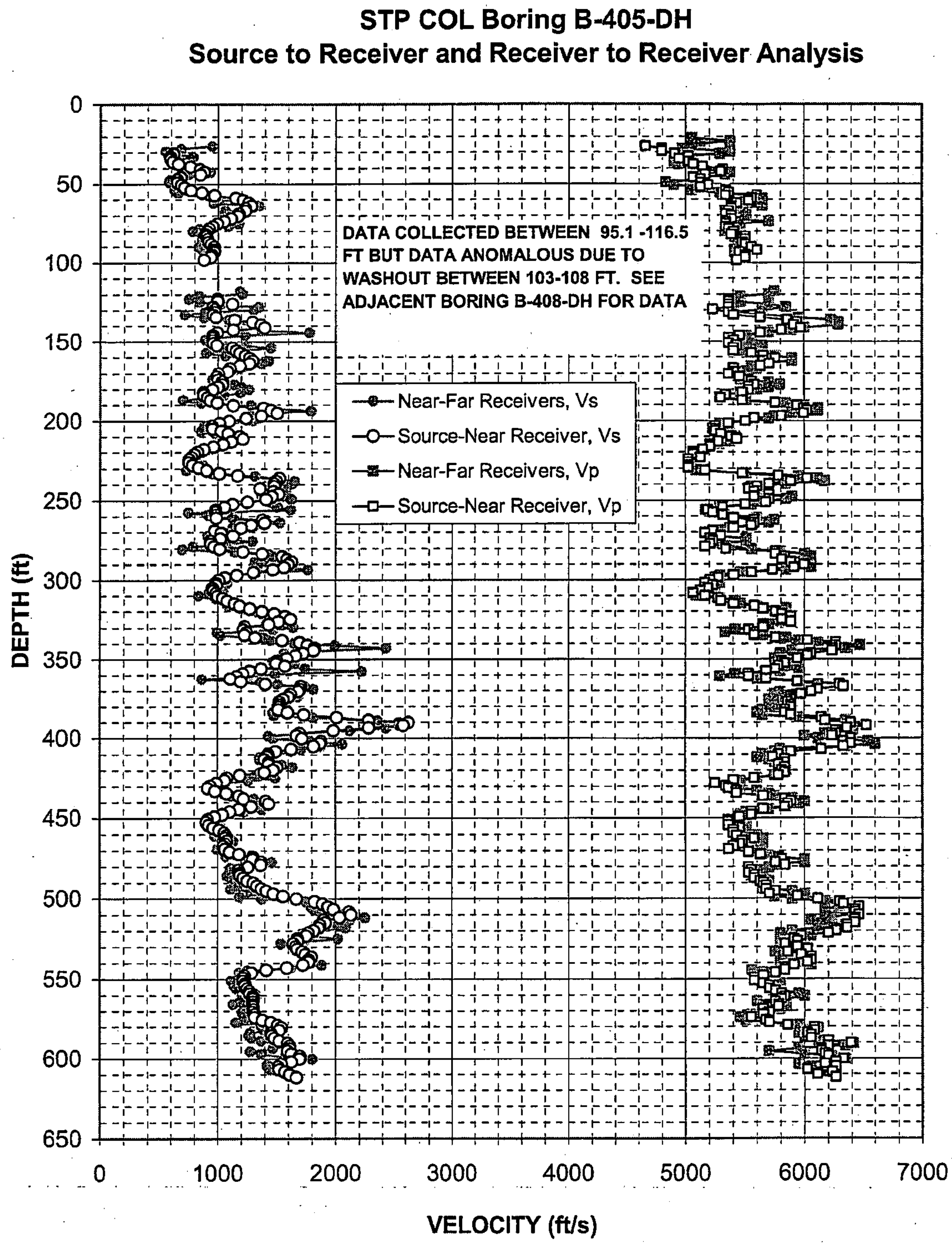


Figure A-7. Boring B-405-DH, R1 - R2 high resolution analysis and S - R1 quality assurance analysis P- and S_H-wave data

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)	Depth (feet)	V_s (feet/sec)	V_p (feet/sec)	Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
26.2	-	4650	108.2	-	-	175.4	1040	5550
27.8	-	4800	109.8	-	-	177.1	1040	5580
29.4	-	4800	111.5	-	-	178.7	1000	5530
31.1	620	4910	98.3	-	-	180.4	960	5530
32.7	590	5020	100.0	-	-	182.0	880	5480
34.4	590	4950	101.6	-	-	183.6	880	5340
36.0	610	5020	103.3	-	-	185.3	910	5300
37.6	660	5060	104.9	-	-	186.9	940	5480
39.3	760	5150	106.5	-	-	188.6	1000	5750
40.9	850	5320	108.2	-	-	190.2	1130	5940
42.6	880	5300	109.8	-	-	191.8	1390	6000
44.2	850	5170	111.5	-	-	193.5	1460	6030
45.8	680	5060	113.1	-	-	195.1	1500	6000
47.5	650	5130	114.7	-	-	196.8	1370	5810
49.1	650	5130	116.4	-	-	198.4	1240	5580
50.8	690	5190	118.0	-	-	200.0	1100	5500
52.4	710	5130	119.7	-	-	201.7	1020	5360
54.0	770	5340	121.3	-	-	203.3	950	5250
55.7	860	5360	122.9	1000	5360	205.0	950	5230
57.3	970	5340	124.6	1000	5360	206.6	1030	5250
59.0	1150	5550	126.2	1120	5360	208.2	1090	5300
60.6	1210	5530	127.9	960	5360	209.9	1190	5390
62.2	1260	5430	129.5	980	5230	211.5	1210	5430
63.9	1280	5390	131.1	980	5360	213.2	1120	5280
65.5	1230	5390	132.8	960	5410	214.8	1050	5210
67.2	1230	5360	134.4	980	5630	216.4	960	5210
68.8	1180	5340	136.1	1140	5860	218.1	880	5150
70.5	1170	5390	137.7	1300	5940	219.7	830	5060
72.1	1110	5390	139.3	1370	5920	221.4	800	5060
73.7	1050	5340	141.0	1400	5970	223.0	770	5130
75.4	1000	5340	142.6	1130	5810	224.7	760	5020
77.0	950	5340	144.3	990	5630	226.3	750	5020
78.7	930	5360	145.9	960	5460	227.9	780	5020
80.3	910	5410	147.6	950	5360	229.6	830	5020
81.9	900	5390	149.2	950	5410	231.2	910	5170
83.6	900	5500	150.8	960	5360	232.9	1020	5480
85.2	910	5500	152.5	990	5430	234.5	1170	5780
86.9	920	5480	154.1	1120	5410	236.1	1530	6030
88.5	940	5500	155.8	1160	5410	237.8	1500	5890
90.1	970	5550	157.4	1190	5550	239.4	1480	5700
91.8	970	5600	159.0	1230	5650	241.1	1480	5600
93.4	970	5460	160.7	1270	5750	242.7	1360	5530
95.1	950	5500	162.3	1300	5650	244.3	1480	5580
96.7	940	5500	164.0	1270	5700	246.0	1520	5700
98.3	880	5430	165.6	1190	5630	247.6	1460	5580
100.0	-	-	167.2	1100	5410	249.3	1410	5700
101.6	-	-	168.9	1090	5410	250.9	1250	5680
103.3	-	-	170.5	1010	5360	252.5	1130	5500
104.9	-	-	172.2	990	5460	254.2	1060	5320
106.5	-	-	173.8	1000	5530	255.8	980	5190

Table A-7. Boring B-405-DH, S - R1 quality assurance analysis P- and S_H-wave data

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)	Depth (feet)	V_s (feet/sec)	V_p (feet/sec)	Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
257.5	980	5230	339.5	1700	6270	421.5	1400	5830
259.1	990	5320	341.1	1760	6270	423.1	1190	5780
260.7	990	5410	342.8	1820	6240	424.8	1080	5580
262.4	1390	5580	344.4	1810	6240	426.4	1060	5410
264.0	1400	5580	346.0	1720	6060	428.1	990	5250
265.7	1280	5550	347.7	1660	6030	429.7	940	5340
267.3	1200	5410	349.3	1590	5940	431.3	920	5360
268.9	980	5230	351.0	1500	5810	433.0	980	5430
270.6	1030	5170	352.6	1500	5830	434.6	1080	5430
272.2	1130	5300	354.2	1570	5780	436.3	1180	5650
273.9	1020	5210	355.9	1370	5750	437.9	1220	5830
275.5	940	5230	357.5	1270	5680	439.5	1410	5890
277.1	940	5210	359.2	1210	5530	441.2	1440	5860
278.8	970	5170	360.8	1170	5530	442.8	1290	5830
280.4	1020	5340	362.4	1110	5680	444.5	1180	5650
282.1	1210	5750	364.1	1200	5940	446.1	1100	5550
283.7	1380	5750	365.7	1410	6300	447.7	1040	5550
285.3	1550	5830	367.4	1710	6330	449.4	980	5460
287.0	1590	5810	369.0	1700	6120	451.0	920	5360
288.6	1630	5890	370.6	1680	6060	452.7	910	5360
290.3	1600	6000	372.3	1620	5970	454.3	920	5360
291.9	1560	5920	373.9	1600	5890	456.0	960	5460
293.5	1470	5730	375.6	1560	5890	457.6	1020	5410
295.2	1310	5550	377.2	1530	5860	459.2	1060	5410
296.8	1170	5410	378.9	1530	5890	460.9	1070	5430
298.5	1060	5280	380.5	1520	5890	462.5	1070	5580
300.1	1010	5210	382.1	1520	5830	464.2	1080	5480
301.8	980	5170	383.8	1590	5830	465.8	1070	5460
303.4	990	5230	385.4	1730	5890	467.4	1050	5410
305.0	960	5190	387.1	2010	6150	469.1	1060	5360
306.7	960	5130	388.7	2290	6180	470.7	1100	5530
308.3	980	5060	390.3	2630	6390	472.4	1180	5630
310.0	1000	5170	392.0	2580	6530	474.0	1300	5780
311.6	1040	5280	393.6	2290	6360	475.6	1300	5810
313.2	1080	5300	395.3	1980	6270	477.3	1370	5750
314.9	1140	5410	396.9	1700	6270	478.9	1370	5830
316.5	1190	5580	398.5	1670	6240	480.6	1260	5530
318.2	1270	5650	400.2	1720	6390	482.2	1180	5550
319.8	1380	5750	401.8	1880	6330	483.8	1190	5530
321.4	1480	5810	403.5	1870	6390	485.5	1190	5580
323.1	1570	5890	405.1	1810	6330	487.1	1220	5580
324.7	1620	5810	406.7	1630	6150	488.8	1250	5630
326.4	1520	5890	408.4	1490	5890	490.4	1310	5650
328.0	1430	5650	410.0	1430	5780	492.0	1340	5680
329.6	1230	5650	411.7	1420	5730	493.7	1370	5680
331.3	1220	5530	413.3	1400	5830	495.3	1420	5750
332.9	1240	5580	414.9	1440	5830	497.0	1480	5700
334.6	1230	5580	416.6	1440	5780	498.6	1560	5940
336.2	1320	5750	418.2	1500	5830	500.2	1670	6120
337.8	1550	6030	419.9	1480	5810	501.9	1820	6300

Table A-7, continued. Boring B-405-DH, S - R1 quality assurance analysis
P- and S_H-wave data

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
503.5	1890	6330
505.2	1940	6460
506.8	1980	6430
508.4	2120	6430
510.1	2130	6460
511.7	2040	6430
513.4	1900	6430
515.0	1910	6430
516.6	1870	6360
518.3	1850	6360
519.9	1810	6270
521.6	1770	6210
523.2	1750	5970
524.8	1680	5920
526.5	1680	5940
528.1	1640	5830
529.8	1660	5940
531.4	1680	6030
533.1	1720	5860
534.7	1740	5970
536.3	1790	6060
538.0	1770	6060
539.6	1770	6030
541.3	1720	5920
542.9	1590	5830
544.5	1420	5830
546.2	1290	5750
547.8	1230	5650
549.5	1220	5580
551.1	1220	5580
552.7	1230	5650
554.4	1230	5700
556.0	1250	5700
557.7	1270	5750
559.3	1270	5810
560.9	1300	5830
562.6	1300	5810
564.2	1300	5750
565.9	1300	5780
567.5	1310	5780
569.1	1310	5650
570.8	1310	5700
572.4	1320	5650
574.1	1320	5550
575.7	1390	5680
577.3	1460	5700
579.0	1510	5860
580.6	1540	6090
582.3	1530	6090
583.9	1460	6030

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
585.5	1460	6060
587.2	1480	6060
588.8	1530	6210
590.5	1590	6390
592.1	1610	6210
593.7	1610	6150
595.4	1590	6150
597.0	1630	6180
598.7	1700	6210
600.3	1700	6330
601.9	1630	6270
603.6	1540	6180
605.2	1520	6270
606.9	1530	6030
608.5	1570	6240
610.1	1610	6120
611.8	1670	6270

Table A-7, continued. Boring B-405-DH, S - R1 quality assurance analysis
P- and S_H-wave data

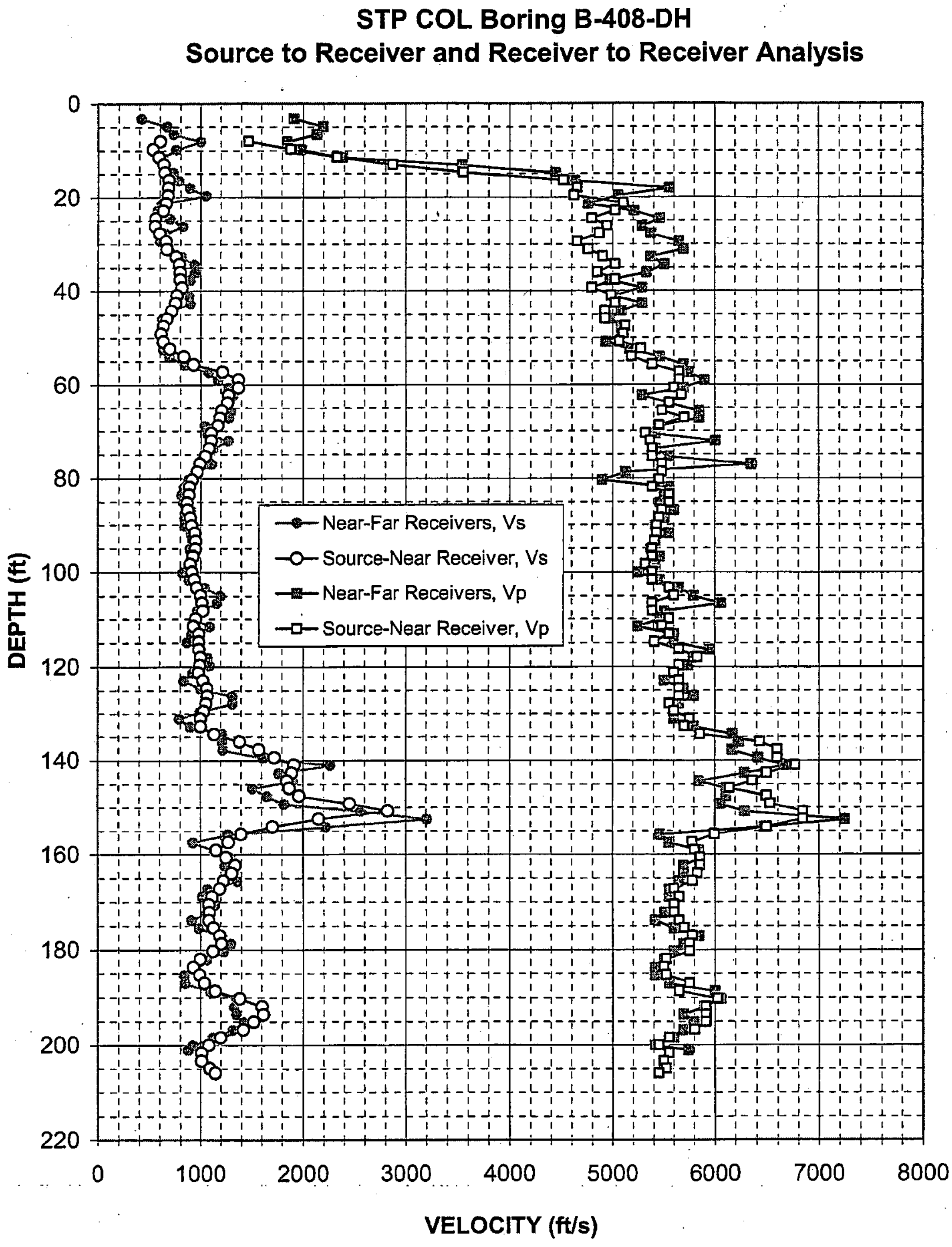


Figure A-8. Boring B-408-DH, R1 - R2 high resolution analysis and S - R1 quality assurance analysis P- and S_H-wave data

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
8.1	600	1470
9.8	530	1880
11.4	590	2330
13.0	640	2880
14.7	650	3560
16.3	690	4520
18.0	690	4650
19.6	680	4620
21.2	660	5100
22.9	630	5020
24.5	560	4800
26.2	560	4950
27.8	600	4870
29.4	660	4650
31.1	670	4760
32.7	760	4910
34.4	790	5020
36.0	800	4850
37.6	800	5020
39.3	820	4800
40.9	770	4980
42.6	760	5020
44.2	720	4930
45.8	670	4930
47.5	630	5130
49.1	610	5100
50.8	640	5060
52.4	700	5280
54.0	840	5190
55.7	930	5390
57.3	1220	5650
59.0	1380	5650
60.6	1380	5600
62.2	1280	5680
63.9	1270	5550
65.5	1210	5480
67.2	1190	5700
68.8	1170	5460
70.5	1110	5320
72.1	1110	5360
73.7	1080	5390
75.4	1050	5390
77.0	990	5480
78.7	970	5480
80.3	920	5460
81.9	890	5390
83.6	890	5550
85.2	870	5550
86.9	870	5480
88.5	900	5460
90.1	910	5430
91.8	950	5430
93.4	960	5410
95.1	950	5390
96.7	930	5390
98.3	900	5320
100.0	920	5390
101.6	940	5390
103.3	960	5550
104.9	1000	5600
106.5	1020	5390
108.2	1020	5390
109.8	960	5550
111.5	930	5480
113.1	990	5550
114.7	990	5410
116.4	990	5650
118.0	1000	5830
119.7	990	5650
121.3	980	5600
122.9	1020	5650
124.6	1070	5650
126.2	1070	5650
127.9	1060	5550
129.5	1030	5600
131.1	1000	5750
132.8	1000	5700
134.4	1140	5860
136.1	1390	6430
137.7	1570	6590
139.3	1730	6590
141.0	1920	6770
142.6	1900	6490
144.3	1850	6360
145.9	1870	6150
147.6	1970	6490
149.2	2450	6530
150.8	2830	6840
152.5	2150	6840
154.1	1710	6490
155.8	1400	6000
157.4	1280	5780
159.0	1160	5810
160.7	1260	5860
162.3	1340	5860
164.0	1310	5830
165.6	1230	5780
167.2	1190	5600
168.9	1110	5650
170.5	1080	5600
172.2	1090	5600
173.8	1080	5650
175.4	1130	5700
177.1	1190	5780
178.7	1210	5750
180.4	1120	5750
182.0	1000	5530
183.6	930	5500
185.3	990	5530
186.9	1040	5750
188.6	1150	5650
190.2	1390	6030
191.8	1610	5920
193.5	1620	5920
195.1	1530	5920
196.8	1430	5810
198.4	1200	5550
200.0	1080	5460
201.7	1010	5550
203.3	1010	5500
205.0	1090	5530
206.0	1150	5460

Table A-8. Boring B-408-DH, S - R1 quality assurance analysis P- and S_H-wave data

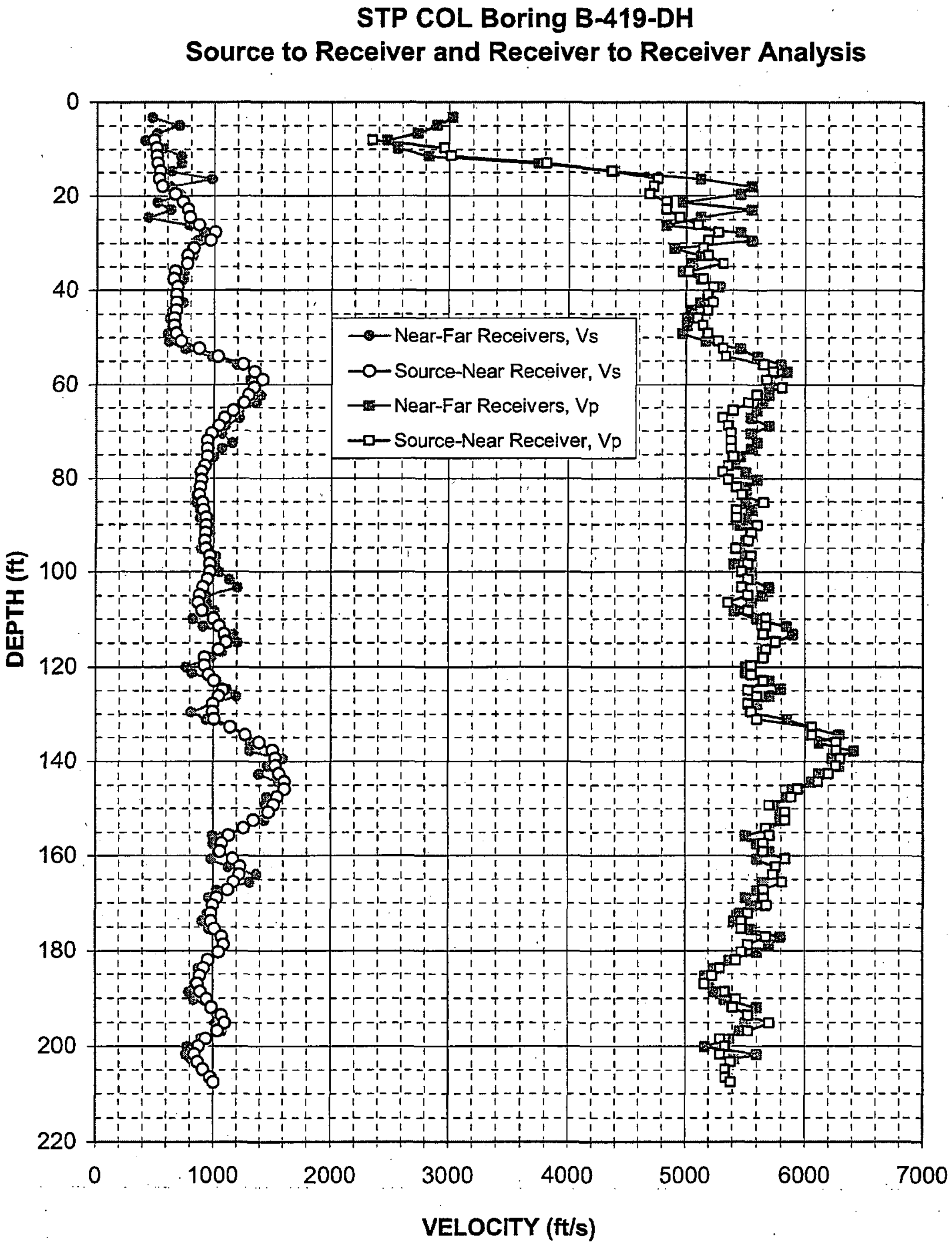


Figure A-9. Boring B-419-DH, R1 - R2 high resolution analysis and S - R1 quality assurance analysis P- and S_H-wave data

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
8.1	490	2340
9.8	500	2960
11.4	510	3010
13.0	520	3810
14.7	540	4370
16.3	530	4760
18.0	560	4720
19.6	670	4690
21.2	730	4830
22.9	770	4830
24.5	790	4950
26.2	870	5100
27.8	1010	5280
29.4	970	5190
31.1	820	5150
32.7	770	5190
34.4	770	5320
36.0	670	5020
37.6	650	5150
39.3	690	5230
40.9	680	5190
42.6	680	5230
44.2	680	5190
45.8	660	5100
47.5	660	5150
49.1	680	5190
50.8	720	5280
52.4	870	5320
54.0	1040	5340
55.7	1250	5650
57.3	1350	5730
59.0	1420	5680
60.6	1350	5810
62.2	1300	5600
63.9	1260	5530
65.5	1170	5410
67.2	1100	5320
68.8	1040	5360
70.5	980	5390
72.1	950	5390
73.7	950	5390
75.4	950	5410
77.3	930	5360
78.7	900	5320
80.3	900	5360
81.9	880	5430
83.6	880	5480
85.2	900	5650
86.9	910	5430
88.5	940	5430

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
90.1	940	5600
91.8	930	5550
93.4	930	5530
95.1	940	5430
96.7	970	5550
98.3	970	5530
100.0	970	5480
101.6	950	5530
103.3	910	5480
104.9	880	5530
106.5	870	5360
108.2	900	5530
109.8	1000	5680
111.5	1050	5680
113.1	1100	5650
114.7	1110	5750
116.4	1040	5680
118.0	930	5650
119.7	930	5550
121.6	960	5550
122.9	1010	5650
124.9	1080	5530
126.2	1040	5600
127.9	1000	5530
129.5	1000	5550
131.1	1010	5600
132.8	1140	6060
134.4	1270	6060
136.1	1390	6270
137.7	1510	6270
139.3	1530	6300
141.0	1540	6270
142.6	1570	6210
144.3	1610	6120
145.9	1610	5940
147.6	1550	5890
149.2	1520	5700
150.8	1480	5830
152.5	1350	5830
154.1	1260	5680
155.8	1130	5700
157.4	1070	5650
159.0	1060	5650
160.7	1170	5830
162.3	1230	5750
164.0	1220	5730
165.6	1180	5810
167.2	1130	5650
168.9	1030	5650
170.5	1000	5680

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
172.2	980	5530
173.8	980	5480
175.4	1010	5480
177.1	1080	5680
178.7	1100	5530
180.4	1050	5480
182.0	960	5430
183.6	920	5300
185.3	890	5230
186.9	870	5170
188.6	890	5340
190.2	950	5430
191.8	990	5410
193.5	1070	5530
195.1	1100	5700
196.8	1040	5530
198.4	940	5300
200.0	880	5340
201.7	840	5300
203.3	870	5390
205.0	910	5340
206.6	980	5340
207.6	1000	5390

Table A-9. Boring B-419-DH, S - R1 quality assurance analysis P- and S_H-wave data

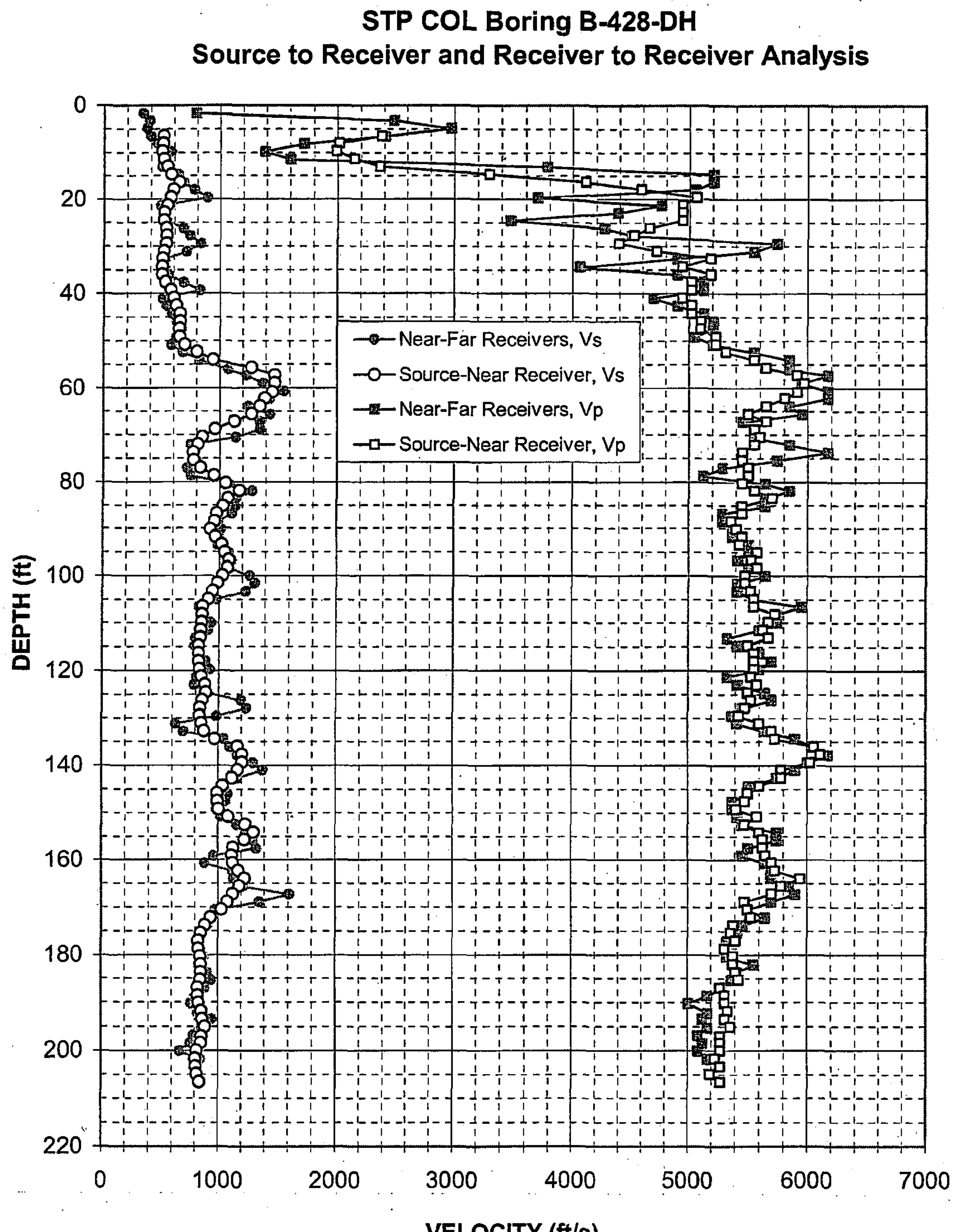


Figure A-10. Boring B-428-DH, R1 - R2 high resolution analysis and S - R1 quality assurance analysis P- and S_H-wave data

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
6.5	510	2380
8.1	510	2020
9.8	500	1990
11.4	510	2150
13.0	550	2360
14.7	580	3300
16.3	650	4110
18.0	590	4590
19.6	570	5060
21.2	540	4950
22.9	520	4950
24.5	510	4950
26.2	530	4650
27.8	540	4520
29.4	540	4400
31.1	520	4720
32.7	510	5190
34.4	500	4950
36.0	500	5190
37.6	530	5020
39.3	580	5020
40.9	600	4950
42.6	620	5020
44.2	650	5020
45.8	650	5100
47.5	650	5100
49.1	650	5230
50.8	700	5230
52.4	800	5320
54.0	940	5550
55.7	1280	5650
57.3	1470	5920
59.0	1470	5970
60.9	1460	5920
62.2	1390	5810
63.9	1350	5650
65.5	1280	5500
67.2	1130	5650
68.8	960	5550
70.5	850	5600
72.1	810	5550
73.7	770	5460
75.4	780	5460
77.0	830	5500
78.7	950	5500
80.3	1060	5460
81.9	1170	5550
83.6	1070	5700
85.2	1030	5460
86.9	980	5460
88.5	960	5360
90.1	930	5410
91.8	970	5460
93.4	1020	5430
95.1	1050	5580
96.7	1080	5530
98.3	1070	5580
100.0	1030	5480
101.6	990	5480
103.3	950	5530
104.9	910	5550
106.5	860	5550
108.2	860	5730
109.8	860	5680
111.5	850	5630
113.1	840	5680
114.7	830	5500
116.4	830	5550
118.0	830	5550
119.7	830	5550
121.3	850	5530
122.9	880	5580
124.6	890	5500
126.2	860	5530
127.9	840	5480
129.5	840	5430
131.1	860	5600
132.8	880	5700
134.4	970	5730
136.1	1170	6060
137.7	1210	6120
139.3	1210	6030
141.0	1170	5780
142.6	1120	5780
144.3	1040	5600
145.9	990	5500
147.6	1000	5480
149.2	1000	5410
150.8	1080	5580
152.5	1240	5480
154.1	1310	5600
155.8	1230	5630
157.4	1130	5630
159.0	1120	5650
160.7	1130	5700
162.3	1180	5730
164.0	1230	5940
165.6	1180	5780
167.2	1130	5700
168.9	1080	5480
170.5	1030	5500
172.2	940	5530
173.8	890	5390
175.4	850	5360
177.1	830	5410
178.7	830	5320
180.4	850	5390
182.0	860	5390
183.6	860	5410
185.3	850	5430
186.9	830	5280
188.6	830	5320
190.2	840	5320
191.8	860	5340
193.5	860	5320
195.1	890	5360
197.1	860	5280
198.4	850	5280
200.0	820	5280
201.7	810	5230
203.3	810	5280
205.0	820	5190
206.6	840	5280

Table A-10. Boring B-428-DH, S - R1 quality assurance analysis P- and S_H-wave data

APPENDIX B

CALIPER, NATURAL GAMMA, RESISTIVITY, AND SPONTANEOUS POTENTIAL LOGS

ROBERTSON GEOLOGGING LIMITED

STP COL

B302ELOGUP01

COMPANY	GEOVISION	OTHER SERVICES
WELL	B-302-DH	
FIELD		
COUNTRY		
STATE		
COUNTY		
LAT.:		
LONG.:		

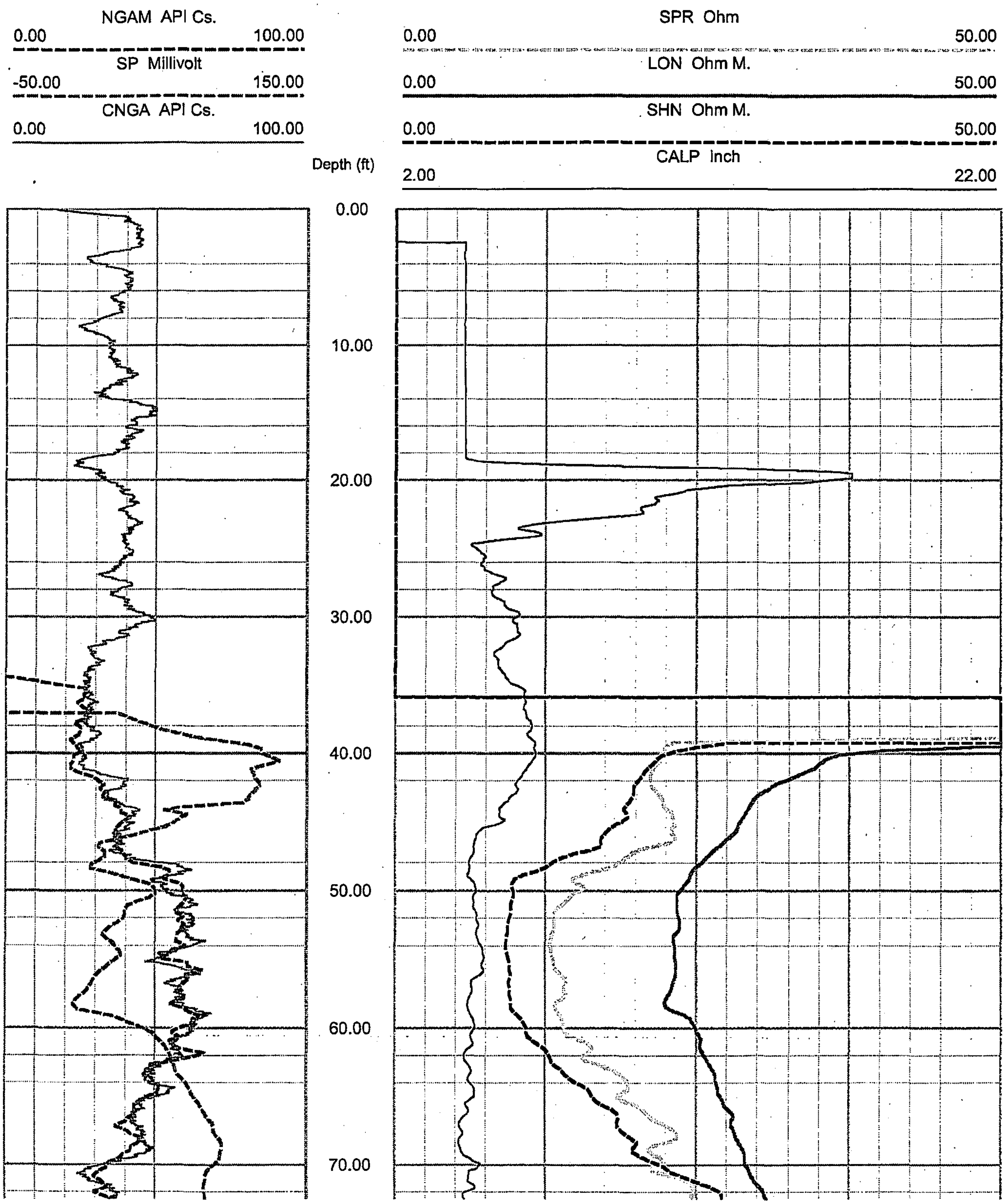
Perm. Da..	Elev	KB	0.00
Log. Da..		DF	0.00
Drill Datum		GL	0.00

DATE	05 Dec 06	05 Dec 06	05 Dec 06
RUN#	2	0	0
TYPE OF LOG	ELOG		
DEPTH DRILLER	215.00	0.00	0.00
DEPTH LOGGER	218.00	0.00	0.00
LOG DEEPEST	0.00	0.00	0.00
LOG SHALLOW	0.00	0.00	0.00
FLUID IN HOLE	DRILLING MUD		
SALINITY			
DENSITY			
LEVEL			
MAX TEMP °C	0.00	0.00	0.00
RIG TIME			
RECORDED BY	R. STELLER		
WITNESSED BY			

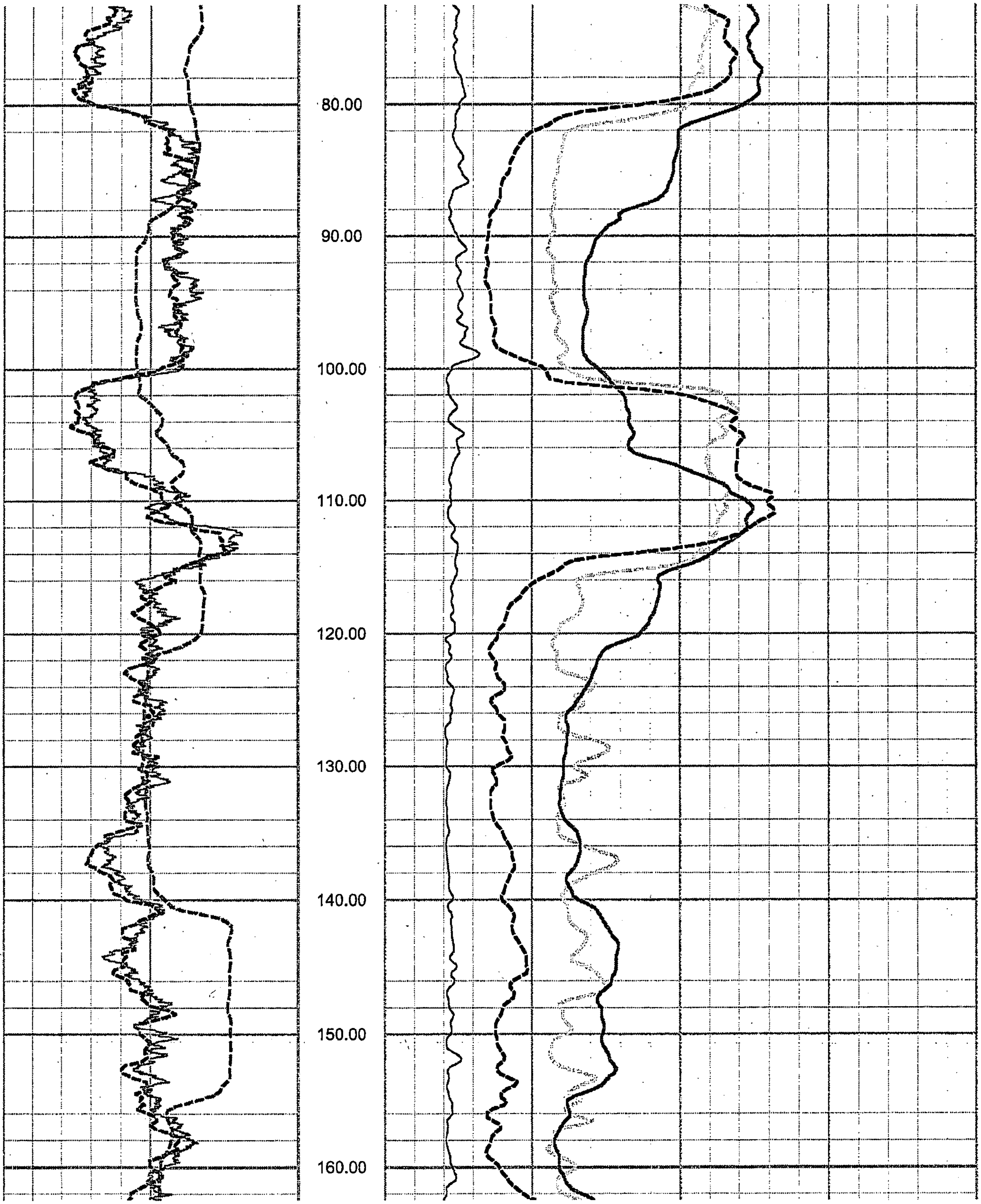
RUN#	BIT RECORD			CASING RECORD			
	SIZE	FROM	TO	SIZE	WEIGHT	FROM	TO
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00

ROBERTSON GEOLOGGING TECHNOLOGY

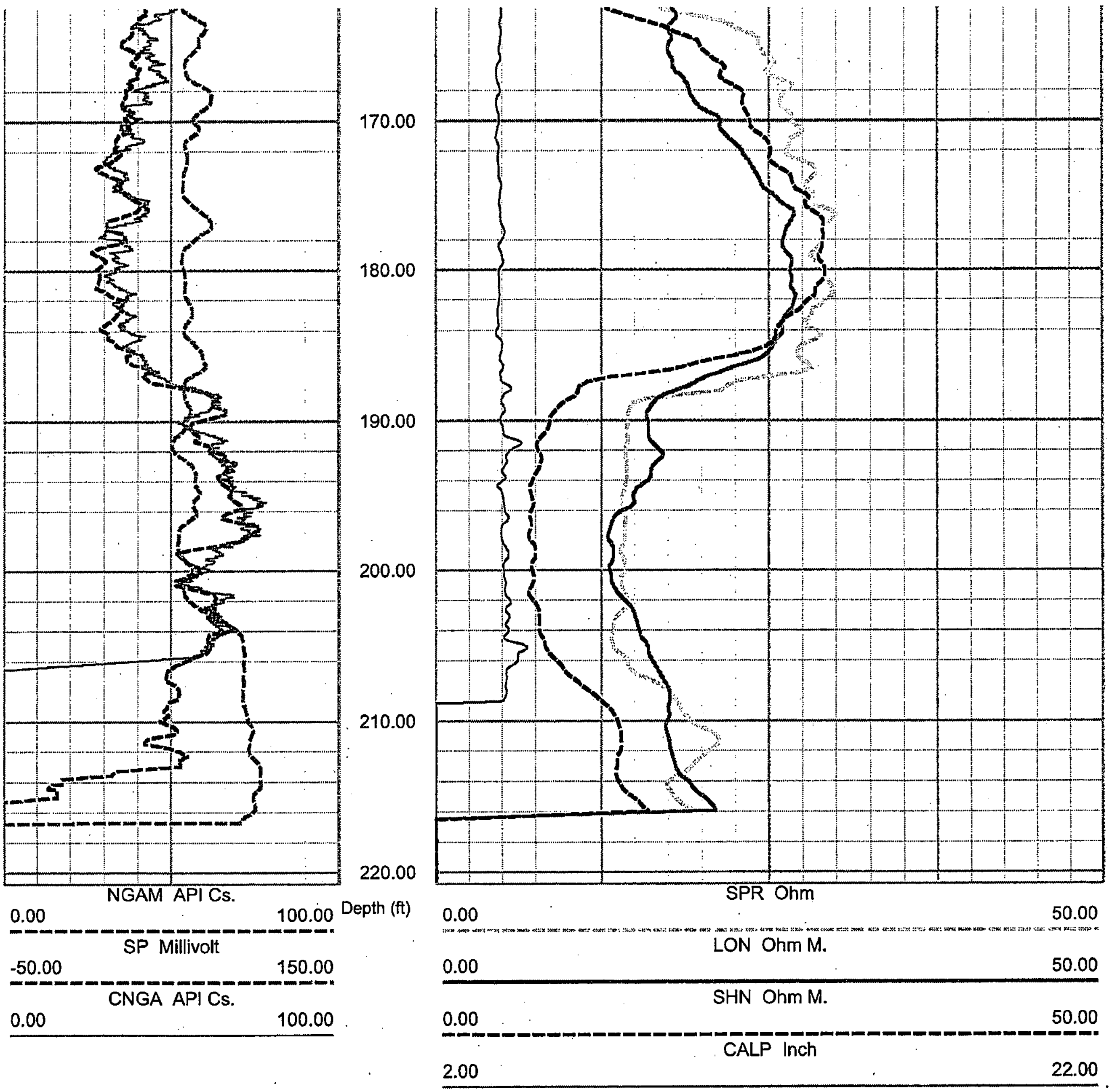
REMARKS (C:\Data\PS\STP\B-302-DH 5 December 2006 ..



STP COL Boring B-302-DH ELOG, Caliper and Gamma rev 1 Sheet 2 of 4



STP COL Boring B-302-DH ELOG, Caliper and Gamma rev 1 Sheet 3 of 4



STP COL Boring B-302-DH ELOG, Caliper and Gamma rev 1 Sheet 4 of 4

ROBERTSON GEOLOGGING LIMITED

STP COL

B305ELOGUP01

COMPANY	GEOVISION	OTHER SERVICES
WELL	B-305-DHA	
FIELD		
COUNTRY		
STATE		
COUNTY		
LAT.:		
LONG.:		

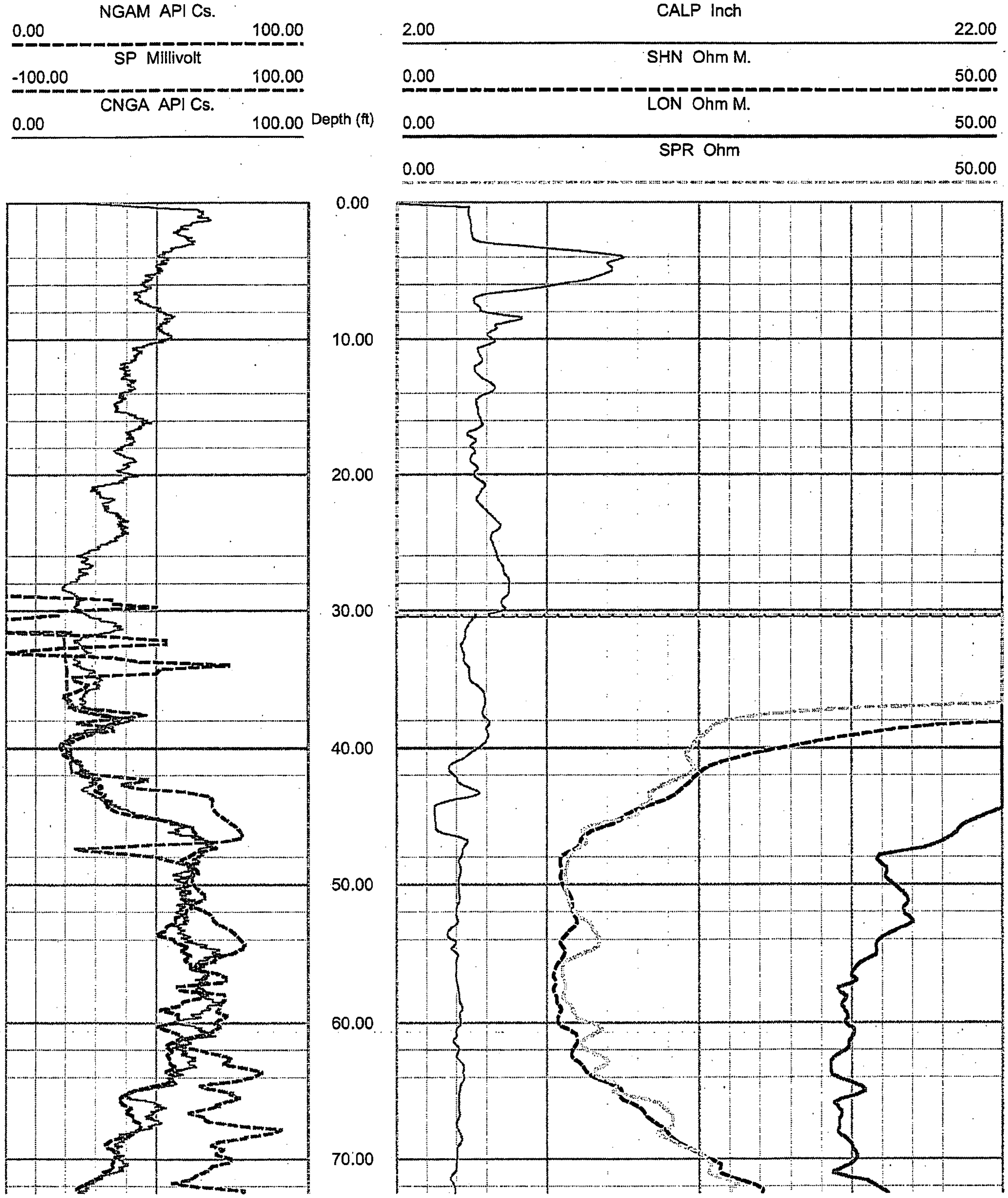
Perm. Da..	Elev	KB	0.00
Log. Da..		DF	0.00
Drill Datum		GL	0.00

DATE	08 Dec 06	08 Dec 06	08 Dec 06
RUN#	2	0	0
TYPE OF LOG	ELOG		
DEPTH DRILLER	90.00	0.00	0.00
DEPTH LOGGER	90.00	0.00	0.00
LOG DEEPEST	90.00	0.00	0.00
LOG SHALLOW	35.00	0.00	0.00
FLUID IN HOLE	DRILLING MUD		
SALINITY			
DENSITY			
LEVEL			
MAX TEMP °C	0.00	0.00	0.00
RIG TIME			
RECORDED BY	R. STELLER		
WITNESSED BY			

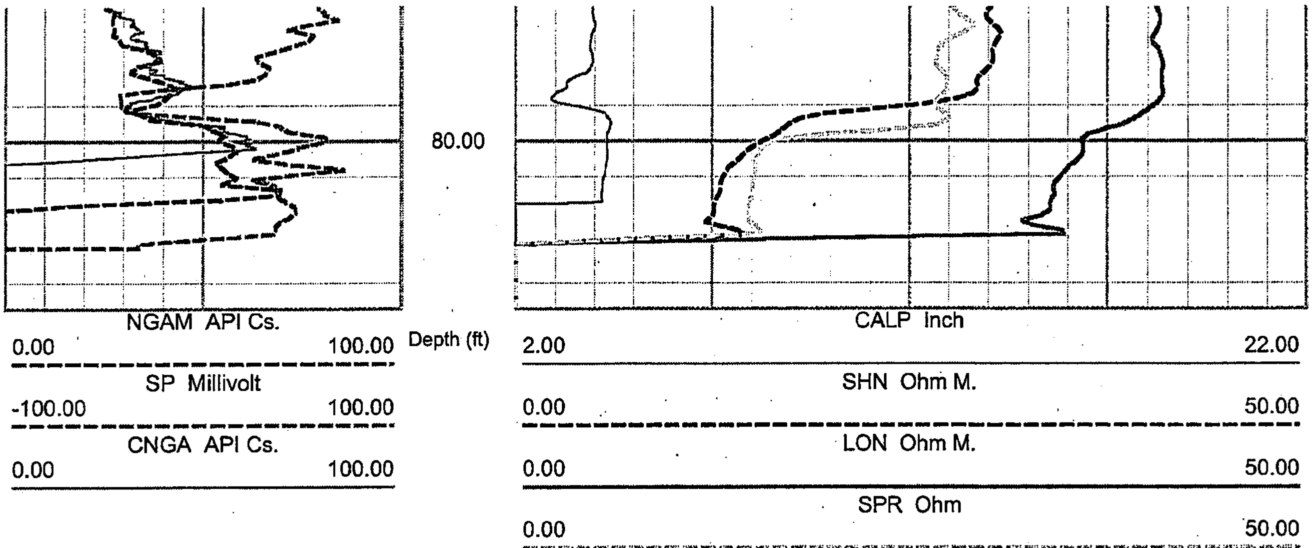
RUN#	BIT RECORD			CASING RECORD			
	SIZE	FROM	TO	SIZE	WEIGHT	FROM	TO
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00

ROBERTSON GEOLOGGING TECHNOLOGY

REMARKS (C:\Data\PS\STP\B-305-DHA 8-19 December 2..



STP COL Boring B-305-DHA top section ELOG, Caliper and Gamma rev 1.1 Sheet 2 of 3



STP COL Boring B-305-DHA top section ELOG, Caliper and Gamma rev 1.1 Sheet 3 of 3

ROBERTSON GEOLOGGING LIMITED

STP COL

B305ELOGUP03

COMPANY	GEOVISION		OTHER SERVICES
WELL	B-305DHA		
FIELD			
COUNTRY			
STATE			
COUNTY			
LAT.:			
LONG.:			

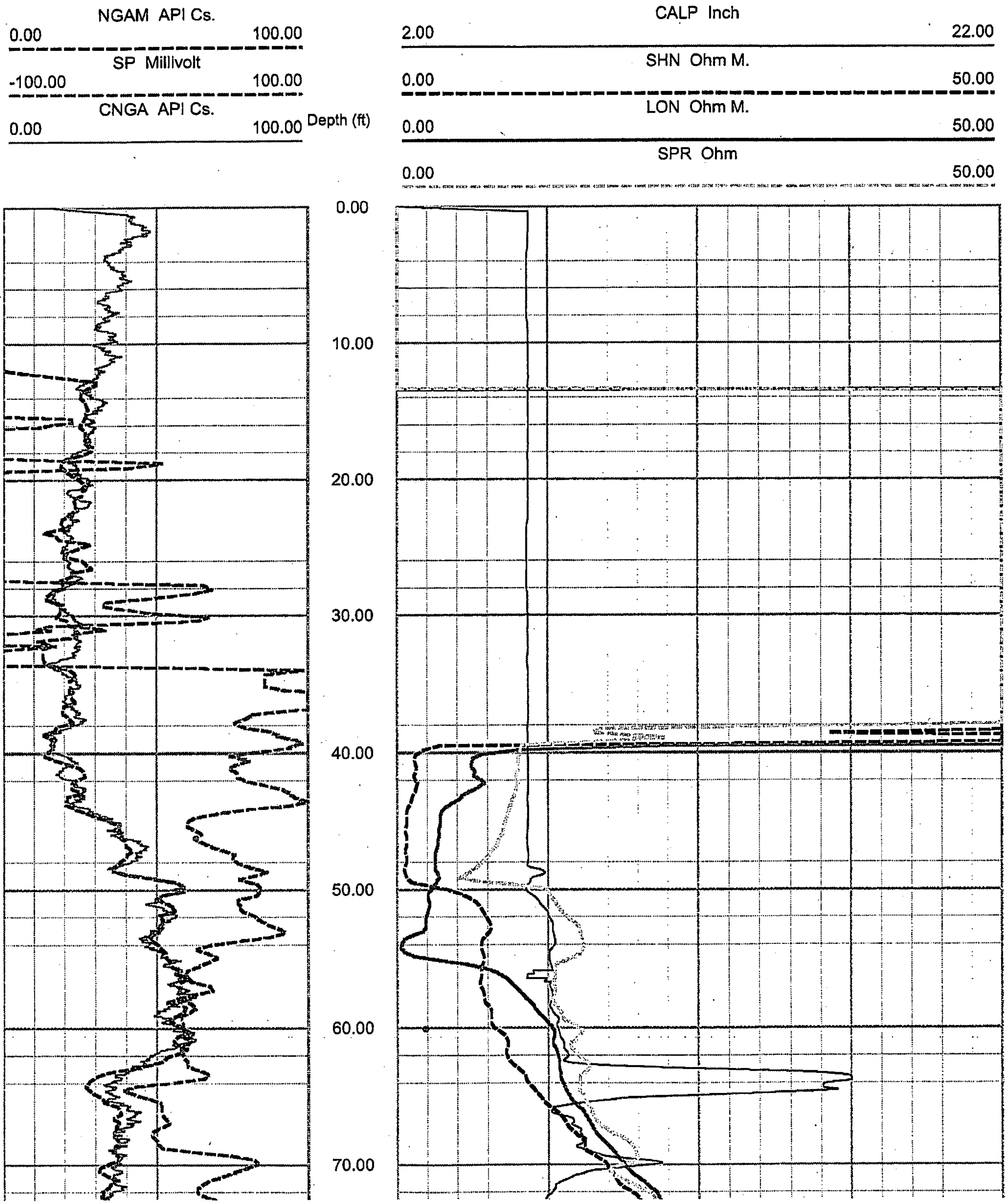
Perm. Da..	Elev	KB	0.00
Log. Da..		DF	0.00
Drill Datum		GL	0.00

DATE	19 Dec 06	15 Dec 06	15 Dec 06
RUN#	2	0	0
TYPE OF LOG	ELOG		
DEPTH DRILLER	618.00	0.00	0.00
DEPTH LOGGER	618.00	0.00	0.00
LOG DEEPEST	618.00	0.00	0.00
LOG SHALLOW	20.00	0.00	0.00
FLUID IN HOLE	DRILLING MUD		
SALINITY			
DENSITY			
LEVEL			
MAX TEMP °C	0.00	0.00	0.00
RIG TIME			
RECORDED BY	R. STELLER		
WITNESSED BY			

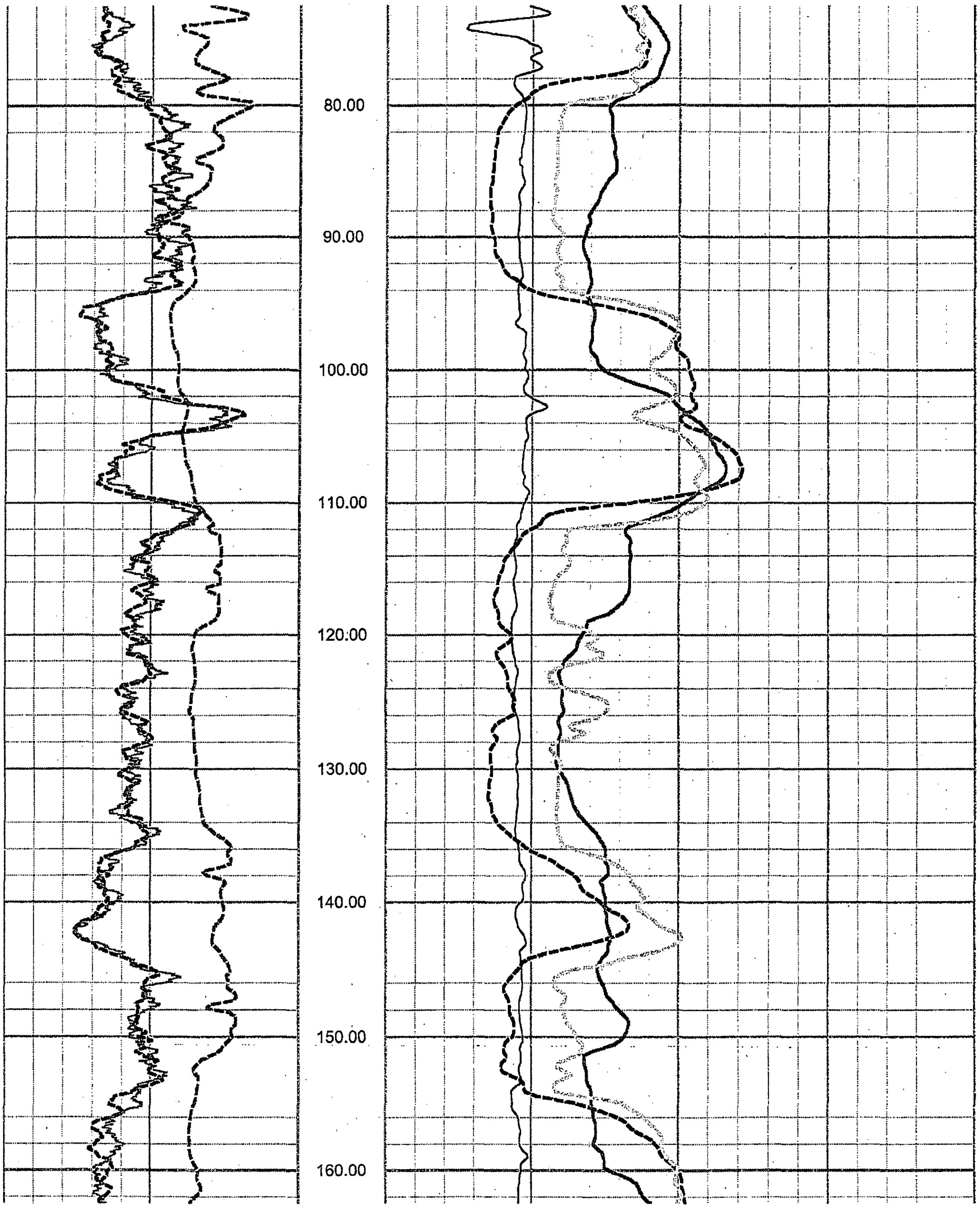
RUN#	BIT RECORD SIZE	BIT RECORD FROM	BIT RECORD TO	CASING RECORD SIZE	CASING RECORD WEIGHT	CASING RECORD FROM	CASING RECORD TO
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00

ROBERTSON GEOLOGGING TECHNOLOGY

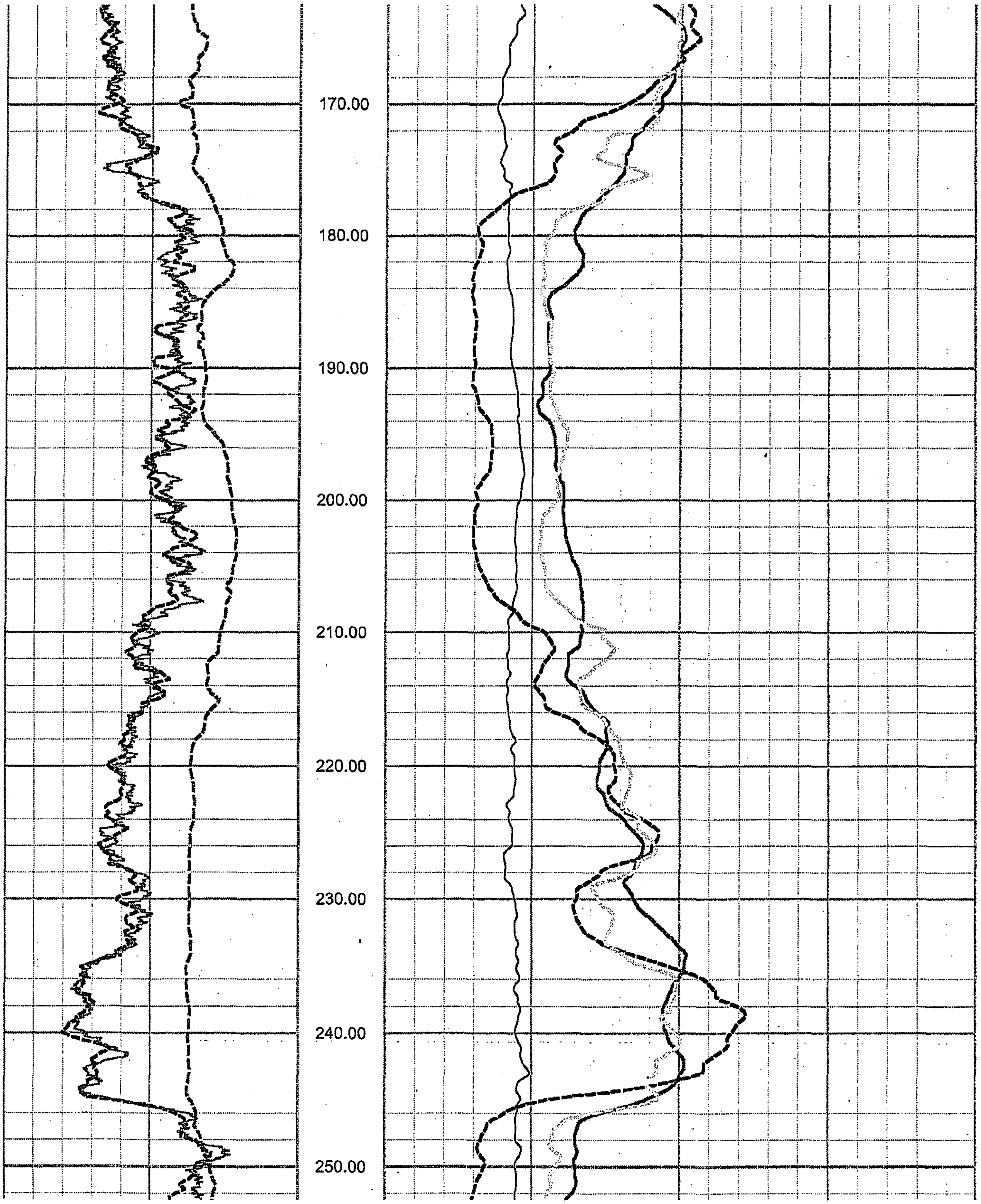
REMARKS (C:\Data\PS\STP\B-305-DHA 8-19 December 2..



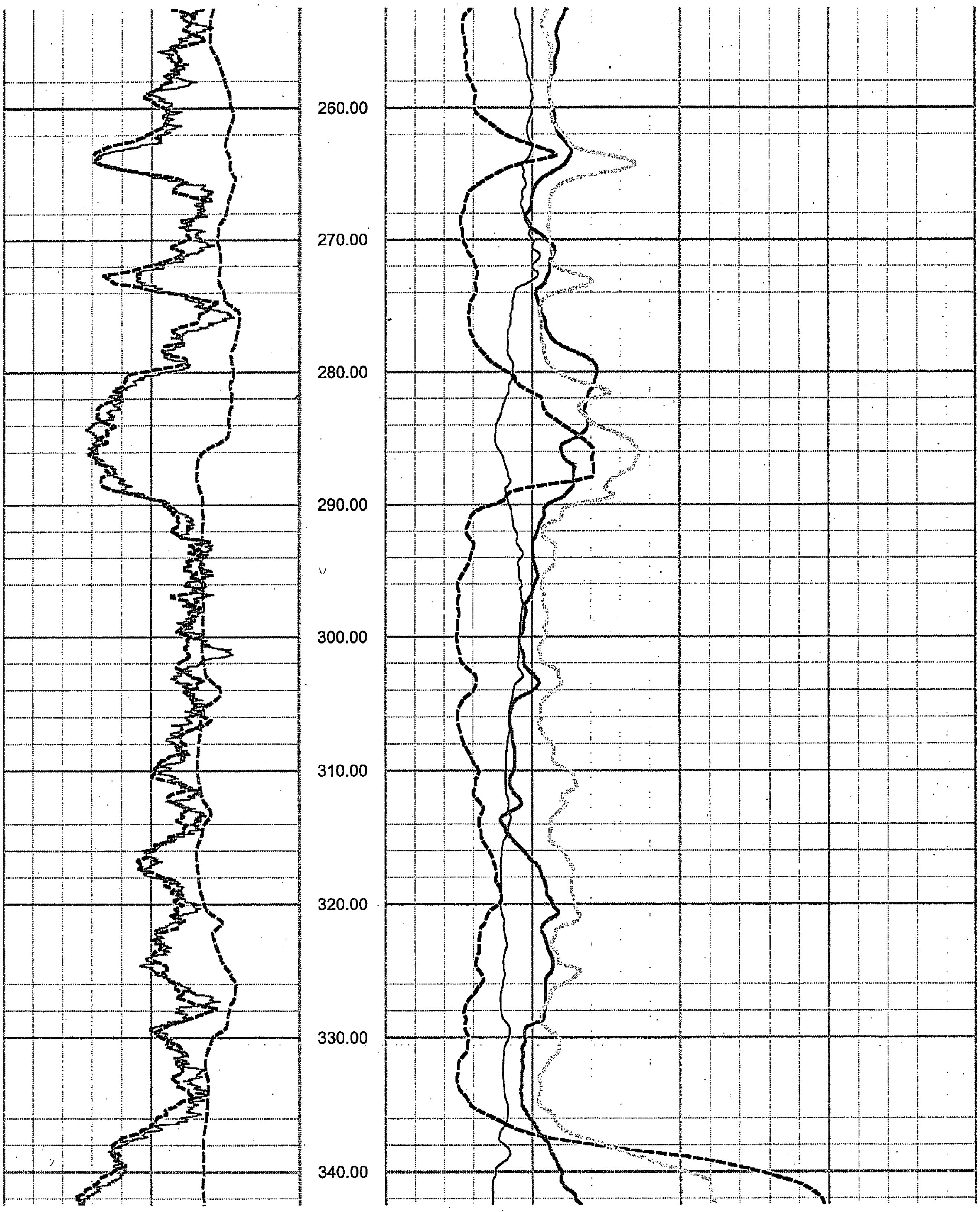
STP COL Boring B-305-DHA bottom section ELOG, Caliper and Gamma rev 1 Sheet 2 of 8



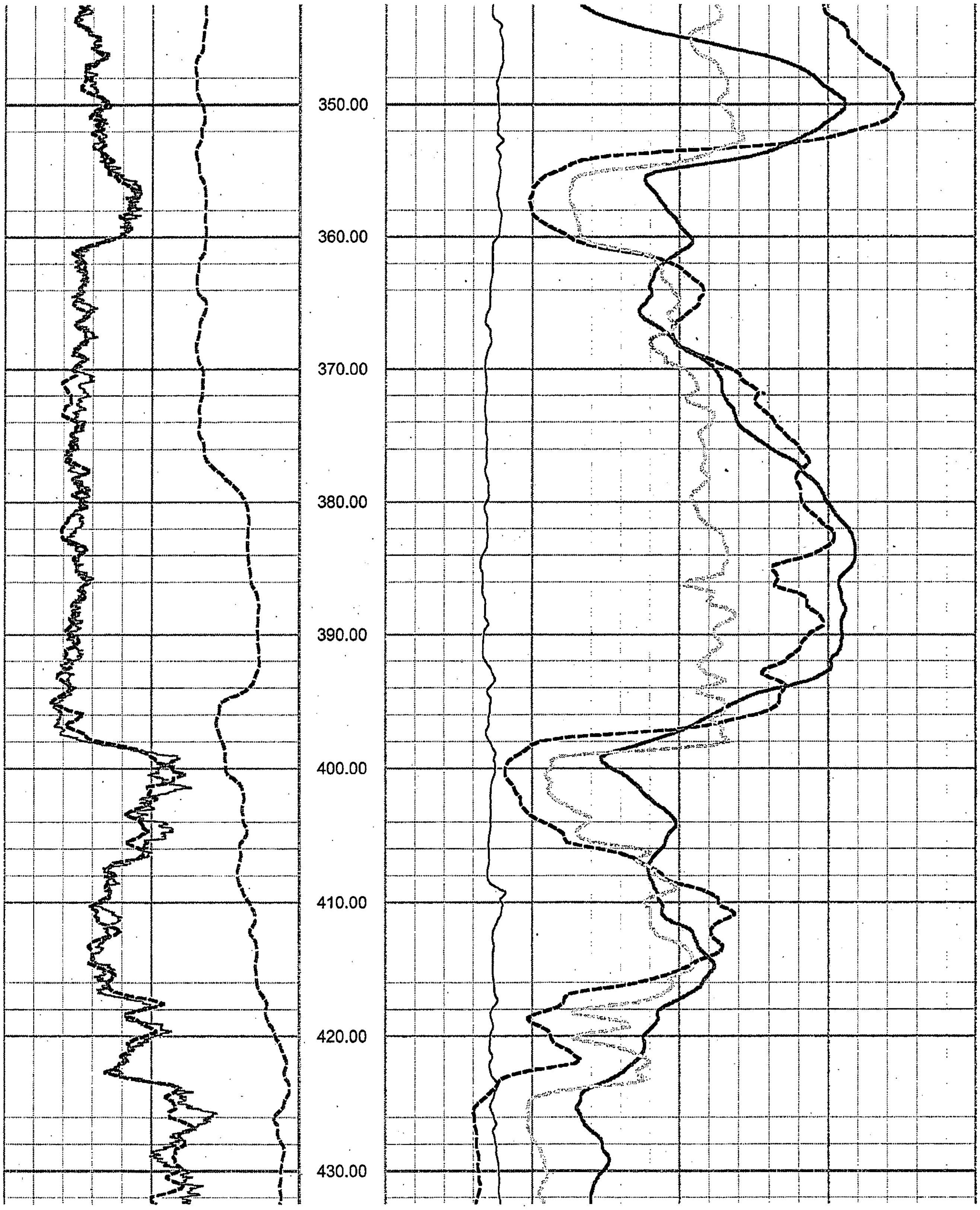
STP COL Boring B-305-DHA bottom section ELOG, Caliper and Gamma rev 1 Sheet 3 of 8



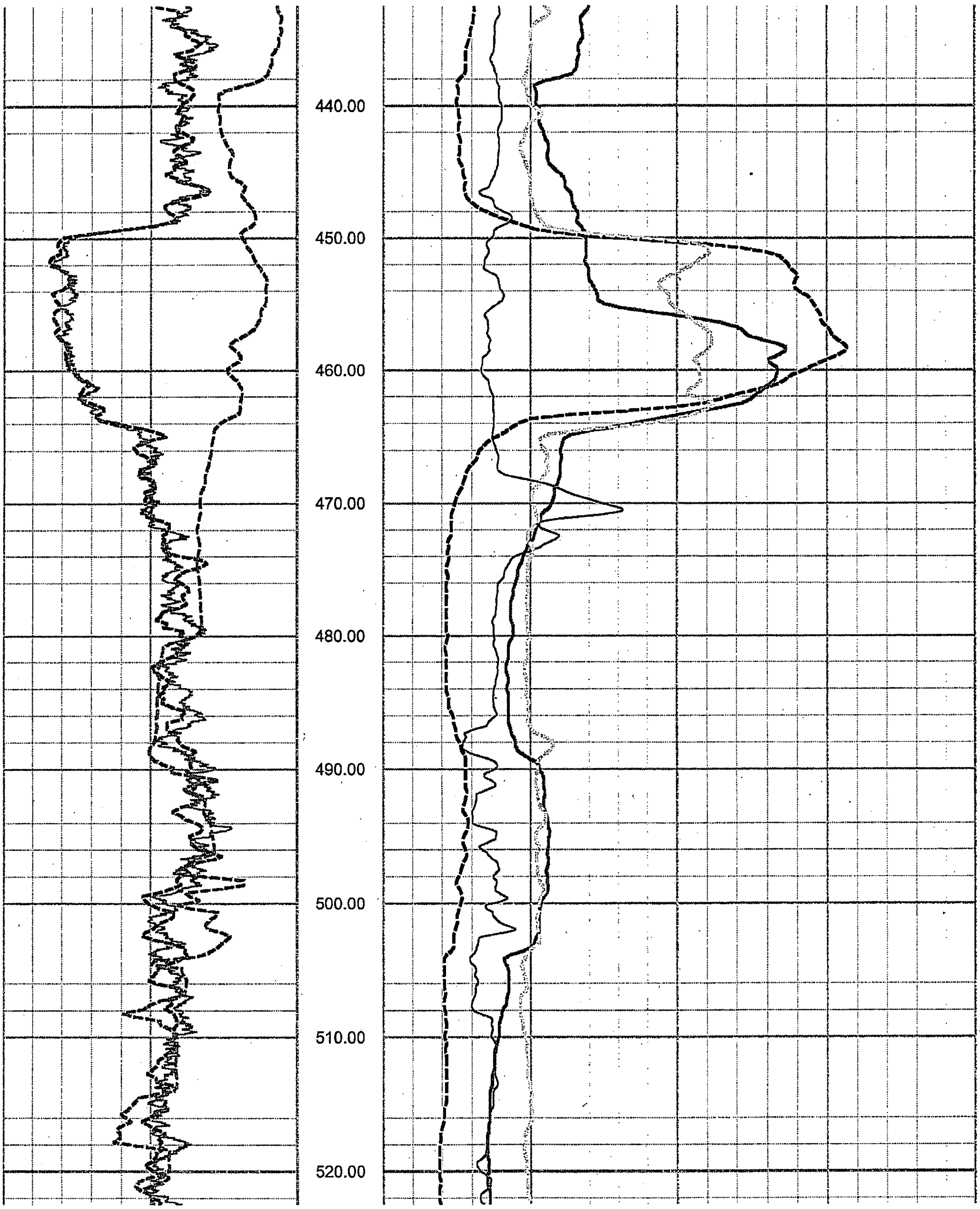
STP COL Boring B-305-DHA bottom section ELOG, Caliper and Gamma rev 1 Sheet 4 of 8



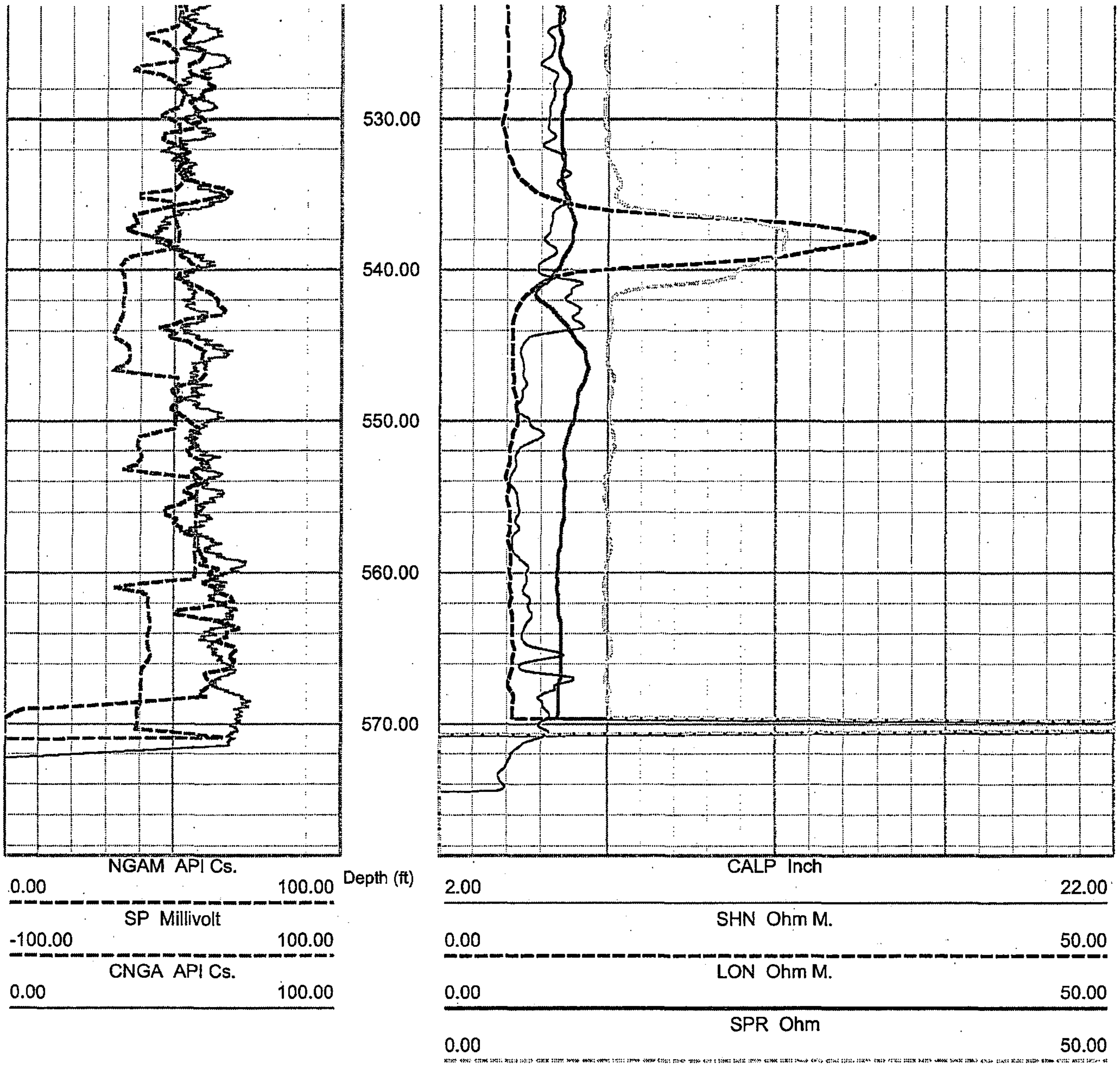
STP COL Boring B-305-DHA bottom section ELOG, Caliper and Gamma rev 1 Sheet 5 of 8



STP COL Boring B-305-DHA bottom section ELOG, Caliper and Gamma rev 1 Sheet 6 of 8



STP COL Boring B-305-DHA bottom section ELOG, Caliper and Gamma rev 1 Sheet 7 of 8



STP COL Boring B-305-DHA bottom section ELOG, Caliper and Gamma rev 1 Sheet 8 of 8

ROBERTSON GEOLOGGING LIMITED

STP COL

B308ELOGUP01

COMPANY	GEOVISION
WELL	B-319-DH
FIELD	
COUNTRY	
STATE	
COUNTY	
LAT.:	
LONG.:	

OTHER SERVICES

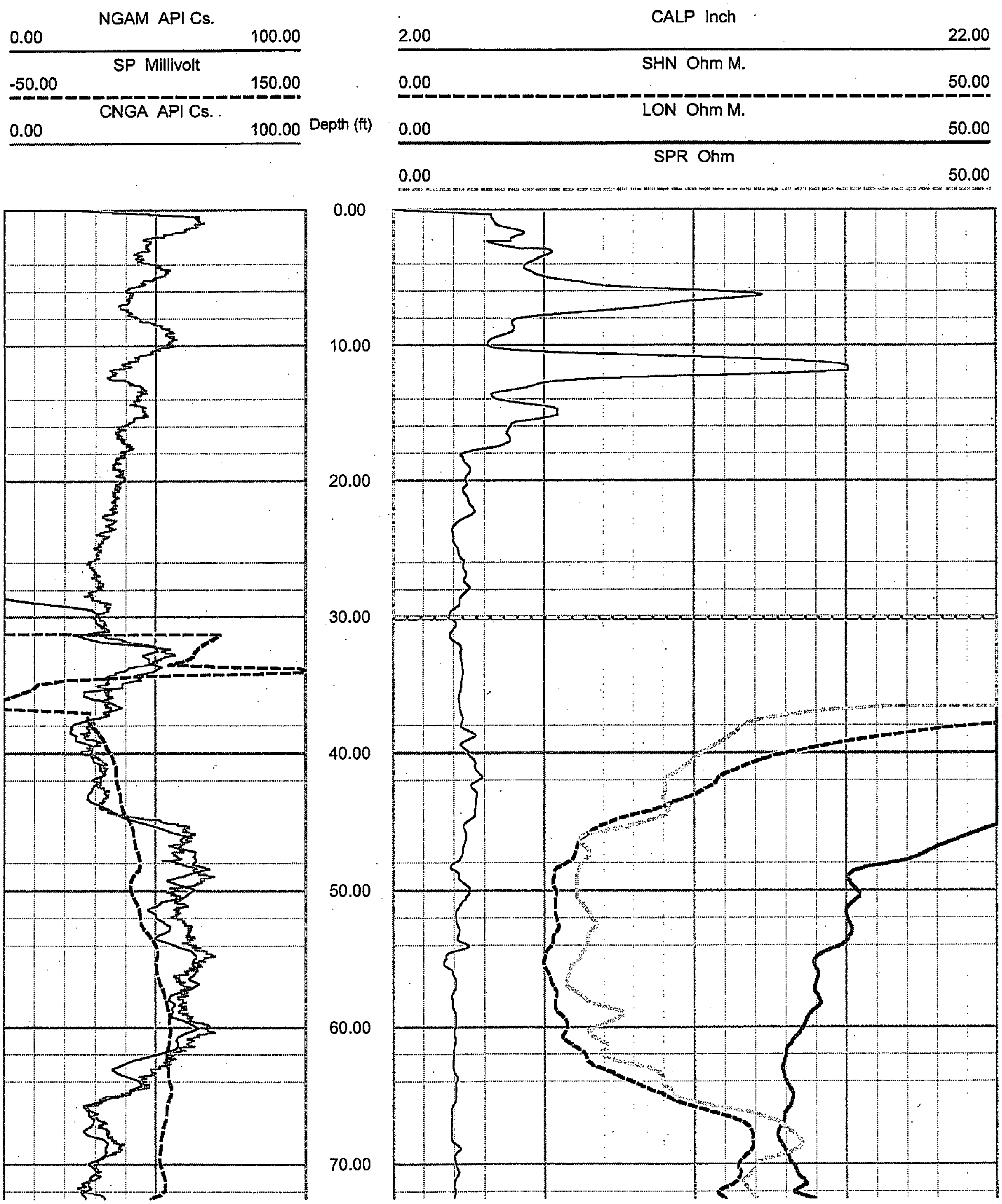
Perm. Da..	Elev	KB	0.00
Log. Da..		DF	0.00
Drill Datum		GL	0.00

DATE	07 Dec 06	05 Dec 06	05 Dec 06
RUN#	2	0	0
TYPE OF LOG	ELOG		
DEPTH DRILLER	215.00	0.00	0.00
DEPTH LOGGER	215.00	0.00	0.00
LOG DEEPEST	210.00	0.00	0.00
LOG SHALLOW	0.00	0.00	0.00
FLUID IN HOLE	DRILLING MUD		
SALINITY			
DENSITY			
LEVEL			
MAX TEMP °C	0.00	0.00	0.00
RIG TIME			
RECORDED BY	R. STELLER		
WITNESSED BY			

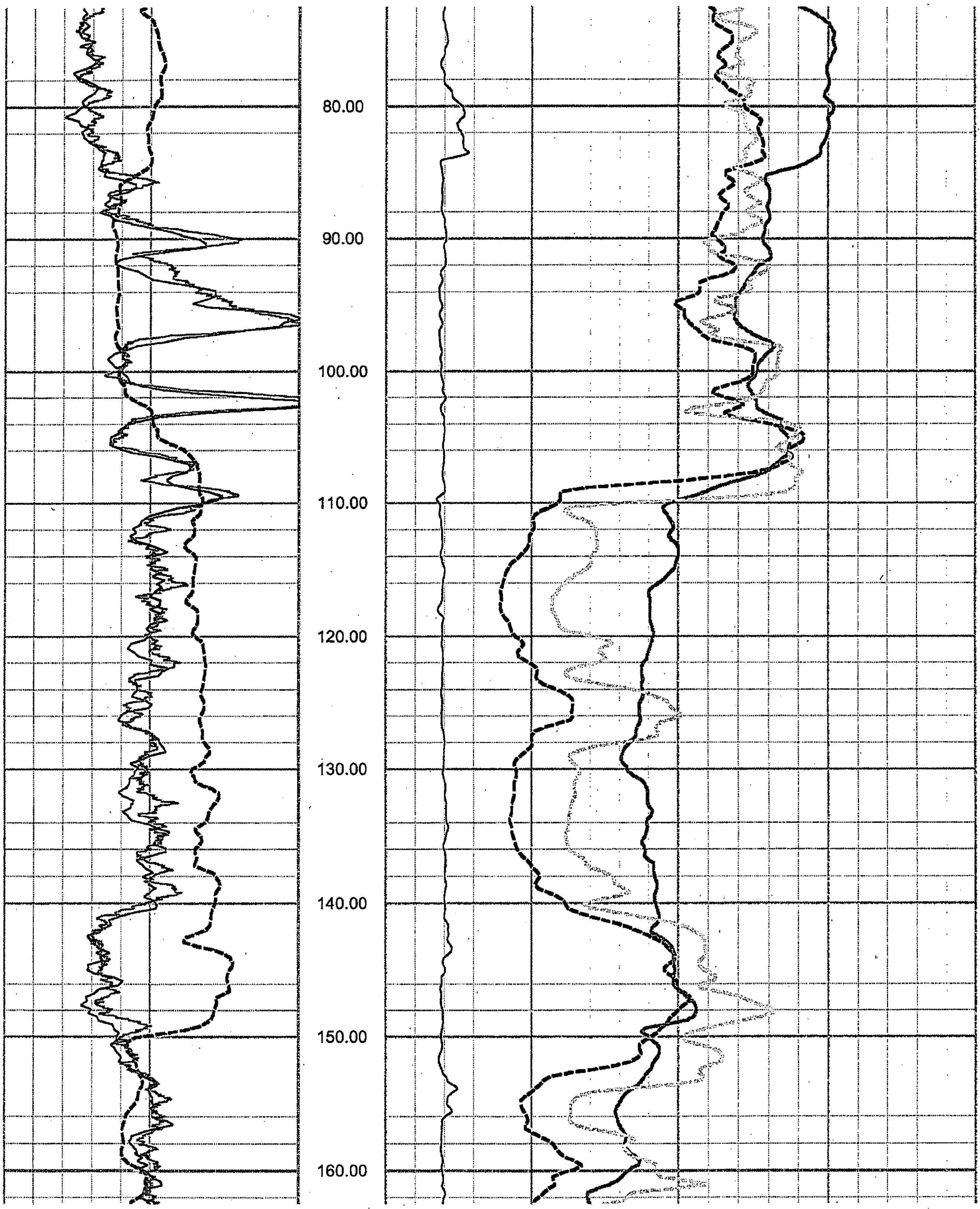
RUN#	BIT RECORD			CASING RECORD			
	SIZE	FROM	TO	SIZE	WEIGHT	FROM	TO
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00

ROBERTSON GEOLOGGING TECHNOLOGY

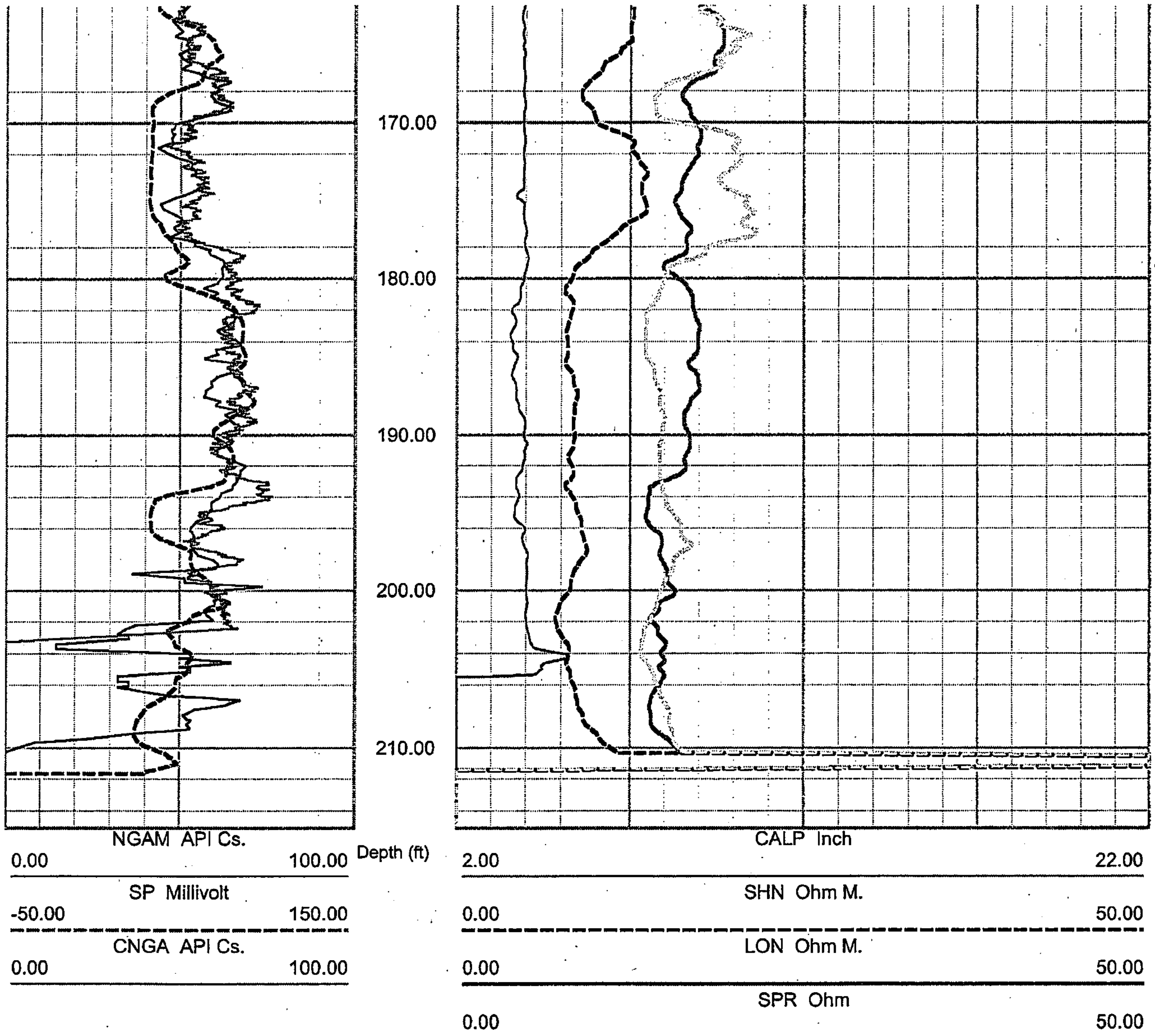
REMARKS (C:\Data\PS\STP\B-308-DH 7 December 2006 ..



STP COL Boring B-308-DH ELOG, Caliper and Gamma rev 1 Sheet 2 of 4



STP COL Boring B-308-DH ELOG, Caliper and Gamma rev 1 Sheet 3 of 4



STP COL Boring B-308-DH ELOG, Caliper and Gamma rev 1 Sheet 4 of 4

ROBERTSON GEOLOGGING LIMITED

STP COL

B319ELOGUP01

COMPANY	GEOVISION	OTHER SERVICES
WELL	B-319-DH	
FIELD		
COUNTRY		
STATE		
COUNTY		
LAT.:		
LONG.:		

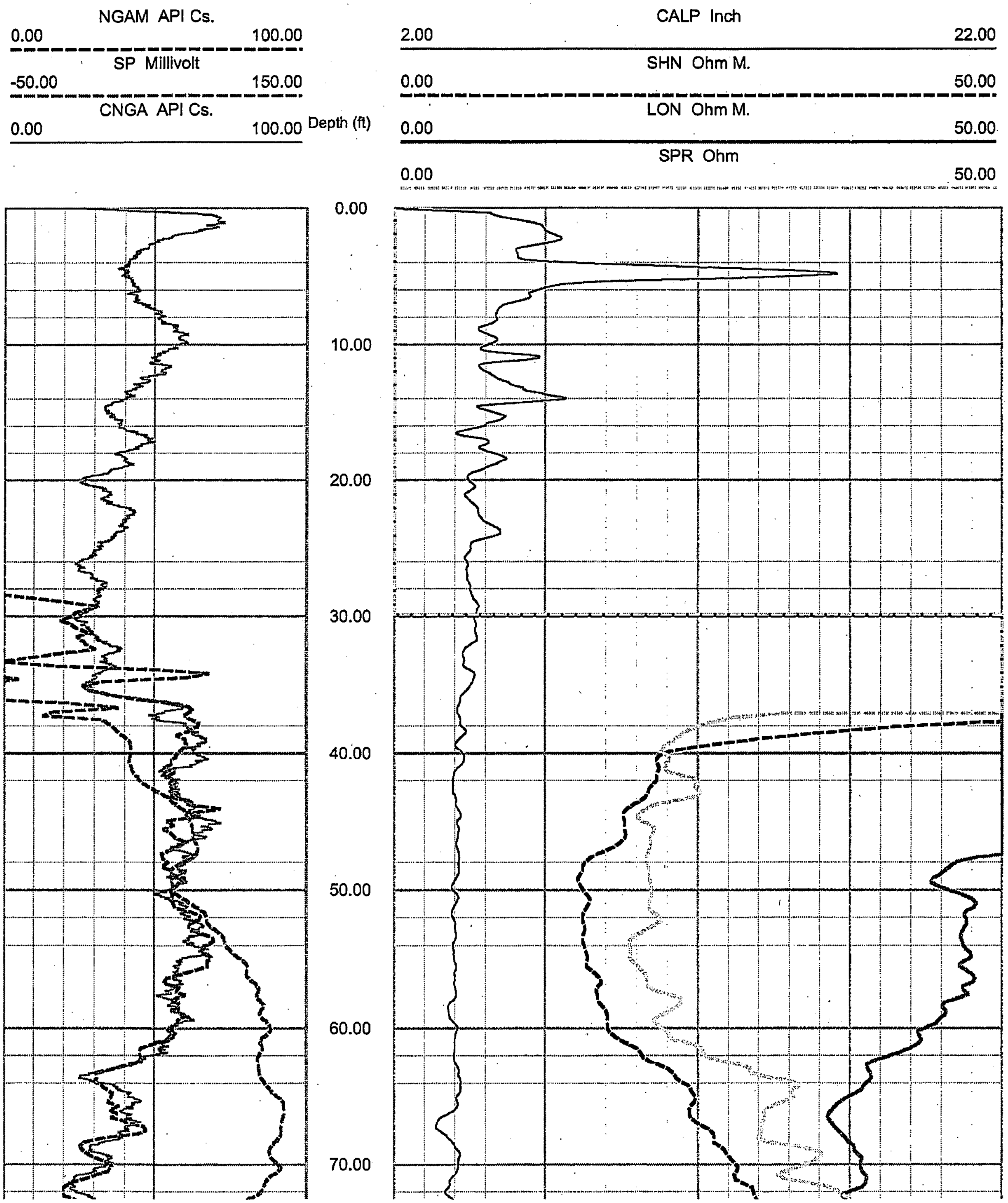
Perm. Da..	Elev	KB	0.00
Log. Da..		DF	0.00
Drill Datum		GL	0.00

DATE	07 Dec 06	05 Dec 06	05 Dec 06
RUN#	2	0	0
TYPE OF LOG	CALIPER		
DEPTH DRILLER	215.00	0.00	0.00
DEPTH LOGGER	215.00	0.00	0.00
LOG DEEPEST	215.00	0.00	0.00
LOG SHALLOW	41.00	0.00	0.00
FLUID IN HOLE	DRILLING MUD		
SALINITY			
DENSITY			
LEVEL			
MAX TEMP °C	0.00	0.00	0.00
RIG TIME			
RECORDED BY	R. STELLER		
WITNESSED BY			

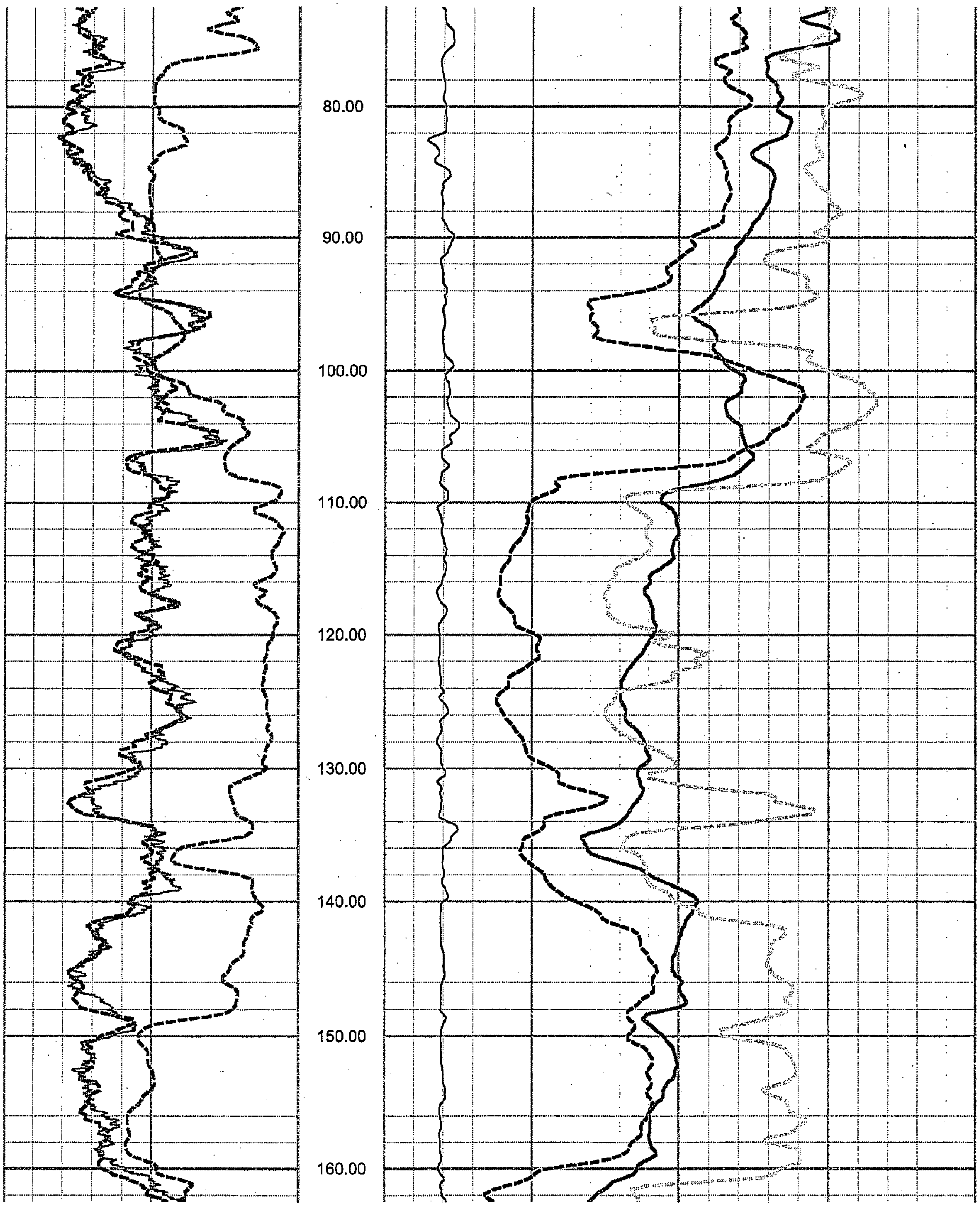
RUN#	BIT RECORD			CASING RECORD			
	SIZE	FROM	TO	SIZE	WEIGHT	FROM	TO
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00

ROBERTSON GEOLOGGING TECHNOLOGY

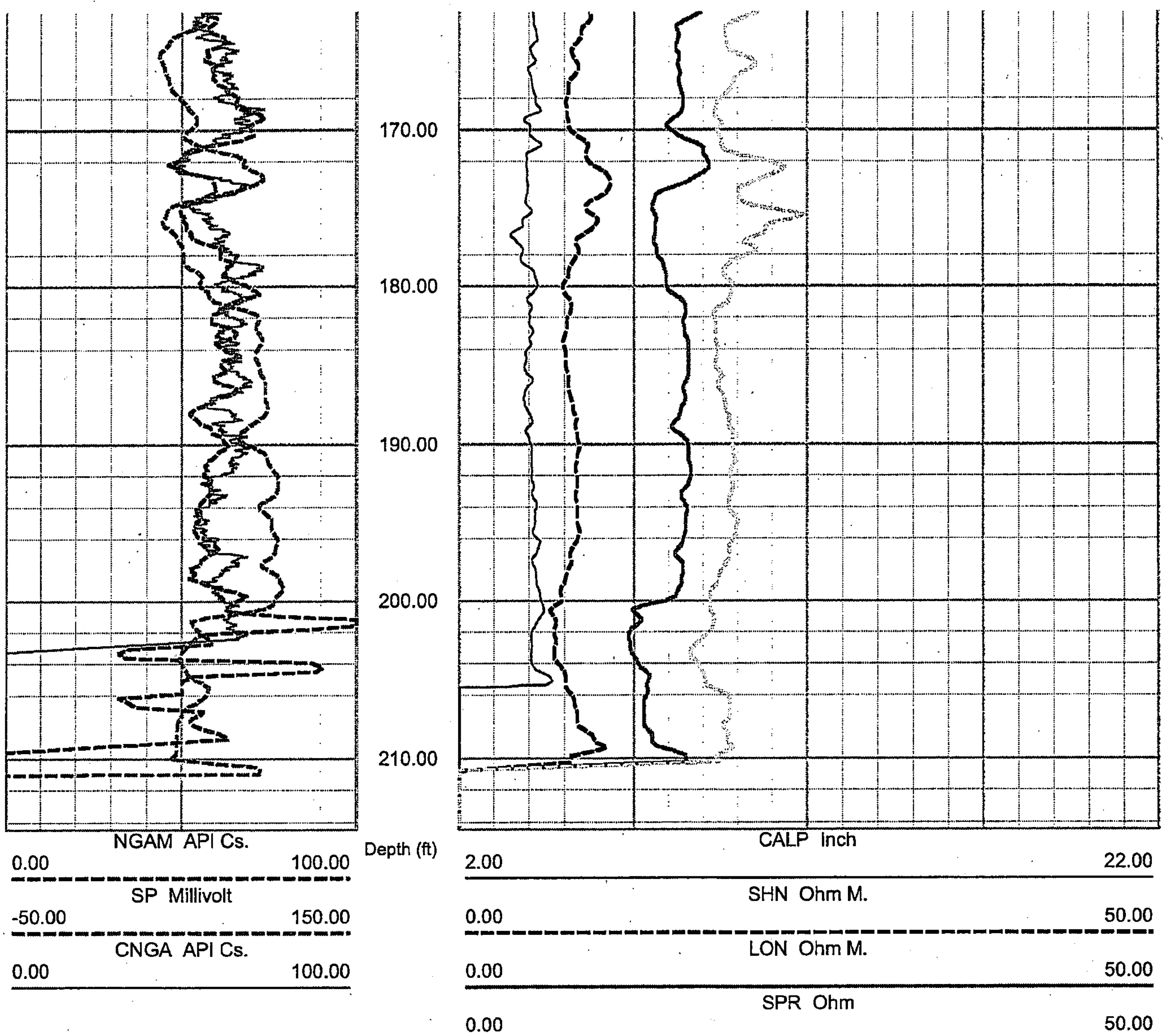
REMARKS (C:\Data\PS\STP\B-319-DH 7 December 2006 ..



STP COL Boring B-319-DH ELOG, Caliper and Gamma rev 1 Sheet 2 of 4



STP COL Boring B-319-DH ELOG, Caliper and Gamma rev 1 Sheet 3 of 4



STP COL Boring B-319-DH ELOG, Caliper and Gamma rev 1 Sheet 4 of 4

ROBERTSON GEOLOGGING LIMITED

STP COL

B328ELOGUP01CALUP01

COMPANY	GEOVision
WELL	B-328-DH
FIELD	
COUNTRY	
STATE	
COUNTY	
LAT.:	
LONG.:	

OTHER SERVICES

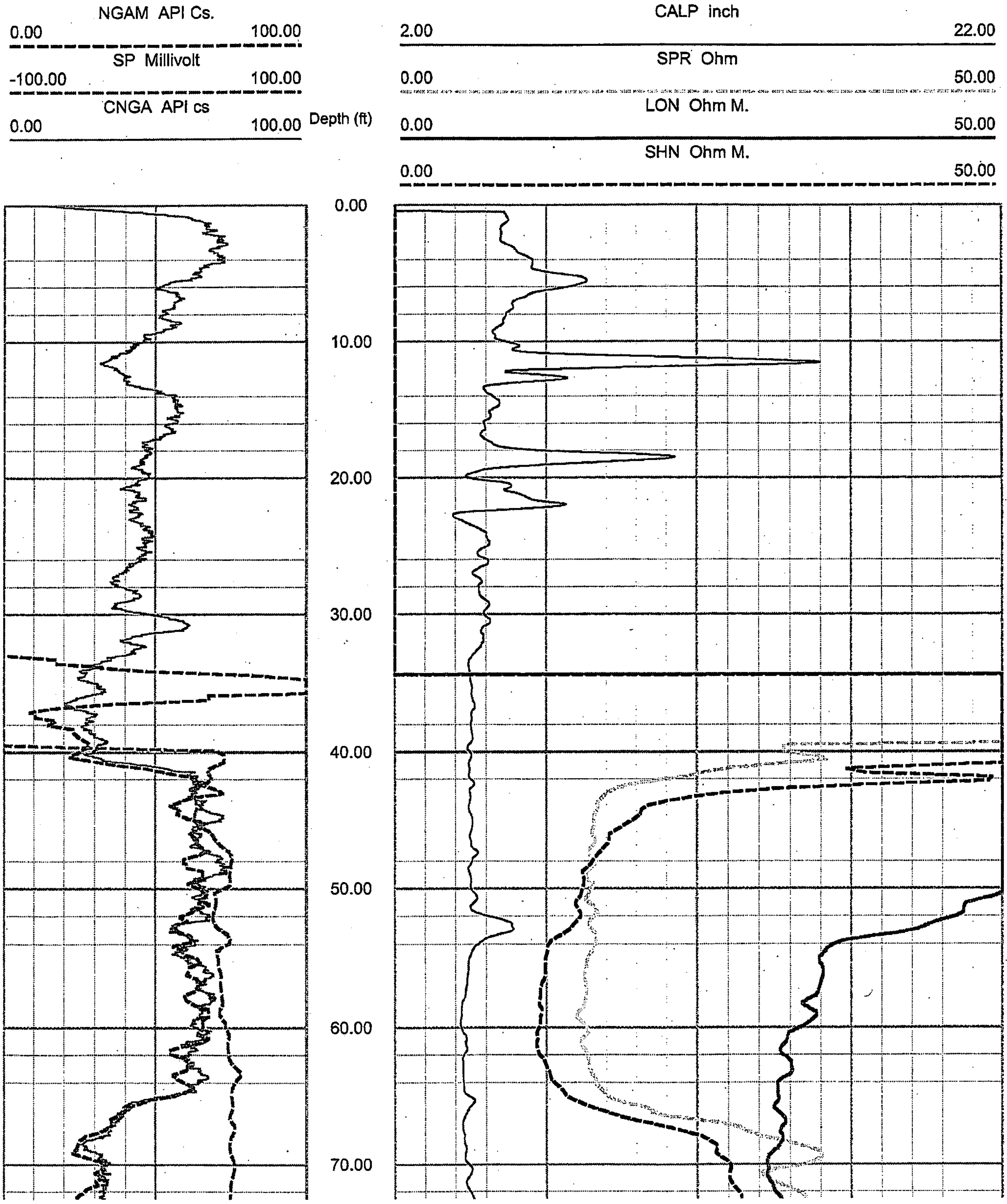
Perm. Da..	Elev	KB	0.00
Log. Da..		DF	0.00
Drill Datum		GL	0.00

DATE	08 Nov 06	21 Oct 05	21 Oct 05
RUN#	3	0	0
TYPE OF LOG	ELOG, CALI..		
DEPTH DRILLER	215.00	0.00	0.00
DEPTH LOGGER	218.00	0.00	0.00
LOG DEEPEST	218.00	0.00	0.00
LOG SHALLOW	0.00	0.00	0.00
FLUID IN HOLE	DRILLING MUD		
SALINITY			
DENSITY			
LEVEL			
MAX TEMP °C	0.00	0.00	0.00
RIG TIME			
RECORDED BY	R. STELLER		
WITNESSED BY			

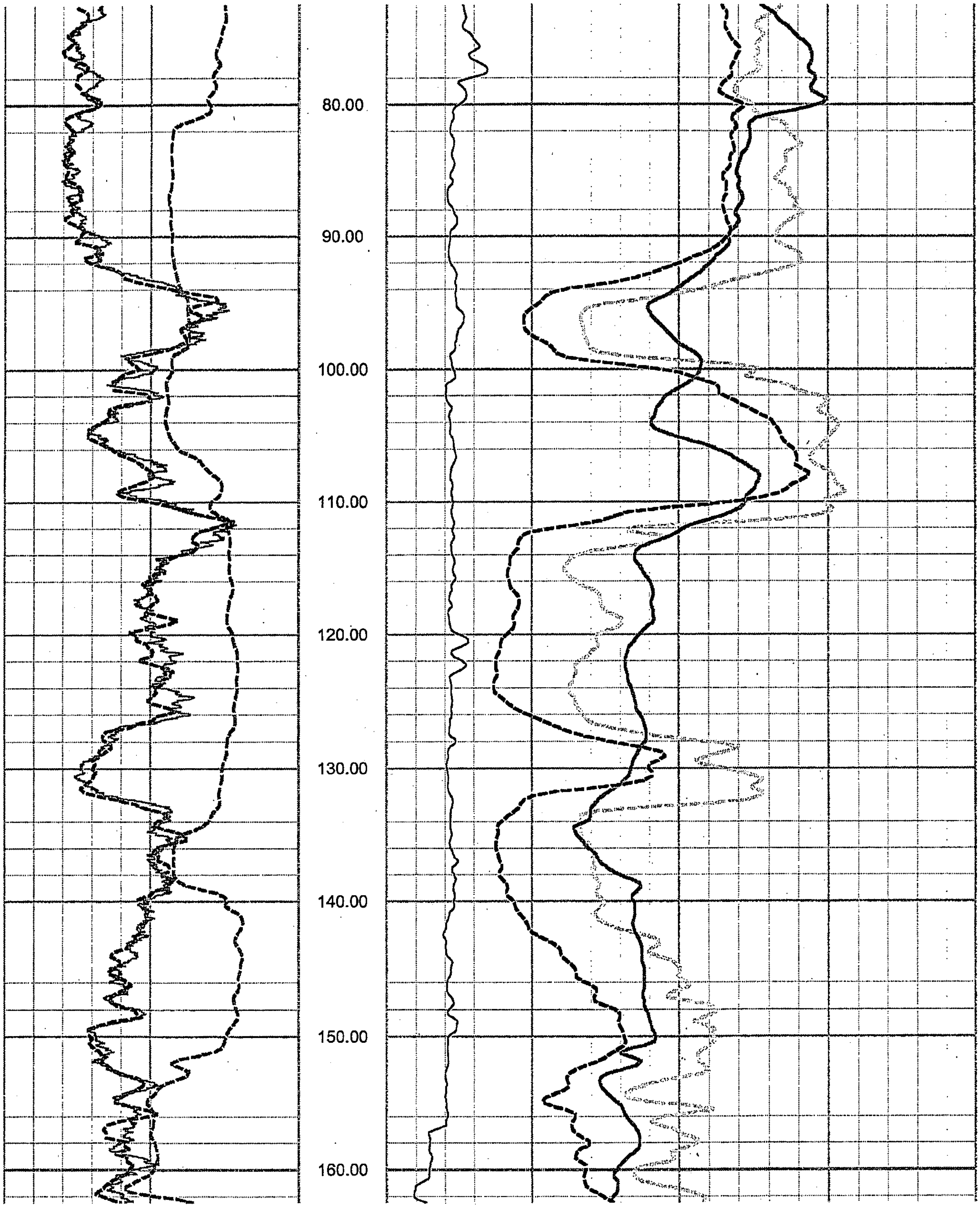
RUN#	BIT RECORD			CASING RECORD			
	SIZE	FROM	TO	SIZE	WEIGHT	FROM	TO
3	4.00	0.00	218.00	0.00	0.00	0.00	0.00
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00

ROBERTSON GEOLOGGING TECHNOLOGY

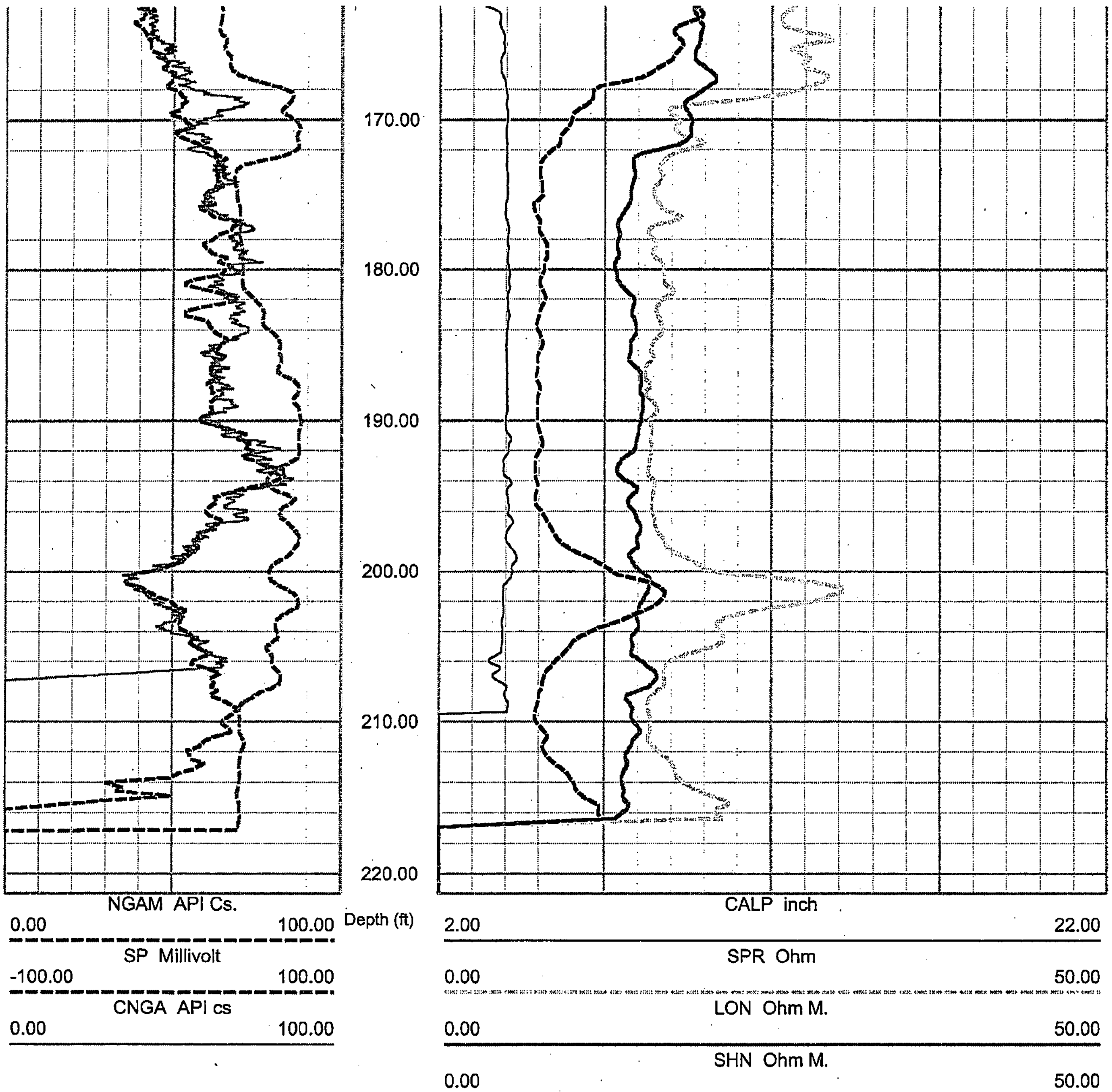
REMARKS (C:\Data\PS\STP\B-328-DH 8 November 2006 ..



STP COL Boring B-328-DH ELOG, Caliper and Gamma rev 2 Sheet 2 of 4



STP COL Boring B-328-DH ELOG, Caliper and Gamma rev 2 Sheet 3 of 4



STP COL Boring B-328-DH ELOG, Caliper and Gamma rev 2 Sheet 4 of 4

ROBERTSON GEOLOGGING LIMITED

STP COL

B402ELOGUP01

COMPANY	GEOVISION	OTHER SERVICES
WELL	B-402-DH	
FIELD		
COUNTRY		
STATE		
COUNTY		
LAT.:		
LONG.:		

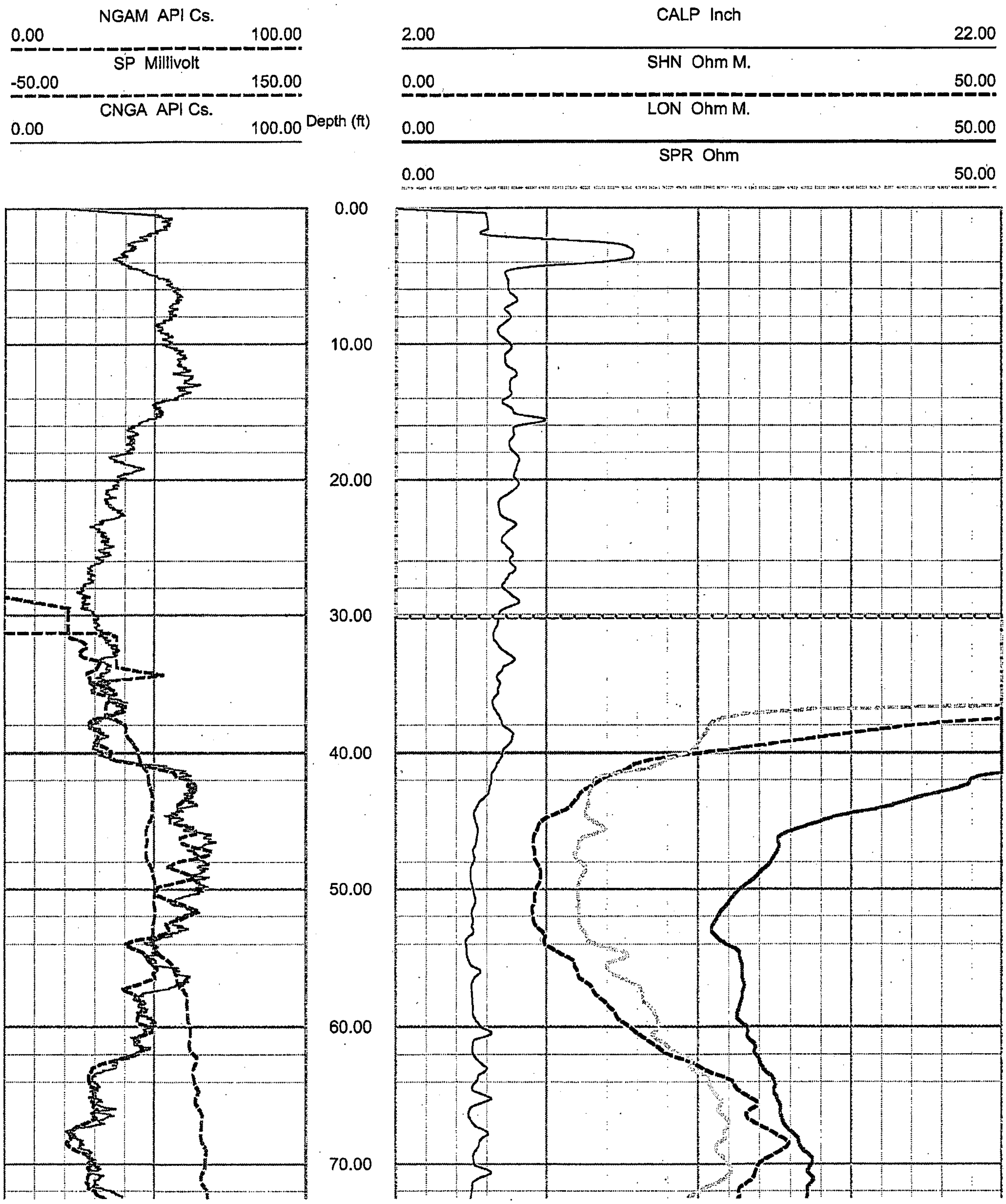
Perm. Da..	Elev	KB	0.00
Log. Da..		DF	0.00
Drill Datum		GL	0.00

DATE	06 Dec 06	05 Dec 06	05 Dec 06
RUN#	2	0	0
TYPE OF LOG	CAL		
DEPTH DRILLER	215.00	0.00	0.00
DEPTH LOGGER	215.00	0.00	0.00
LOG DEEPEST	215.00	0.00	0.00
LOG SHALLOW	39.00	0.00	0.00
FLUID IN HOLE	DRILLING MUD		
SALINITY			
DENSITY			
LEVEL			
MAX TEMP °C	0.00	0.00	0.00
RIG TIME			
RECORDED BY	R. STELLER		
WITNESSED BY			

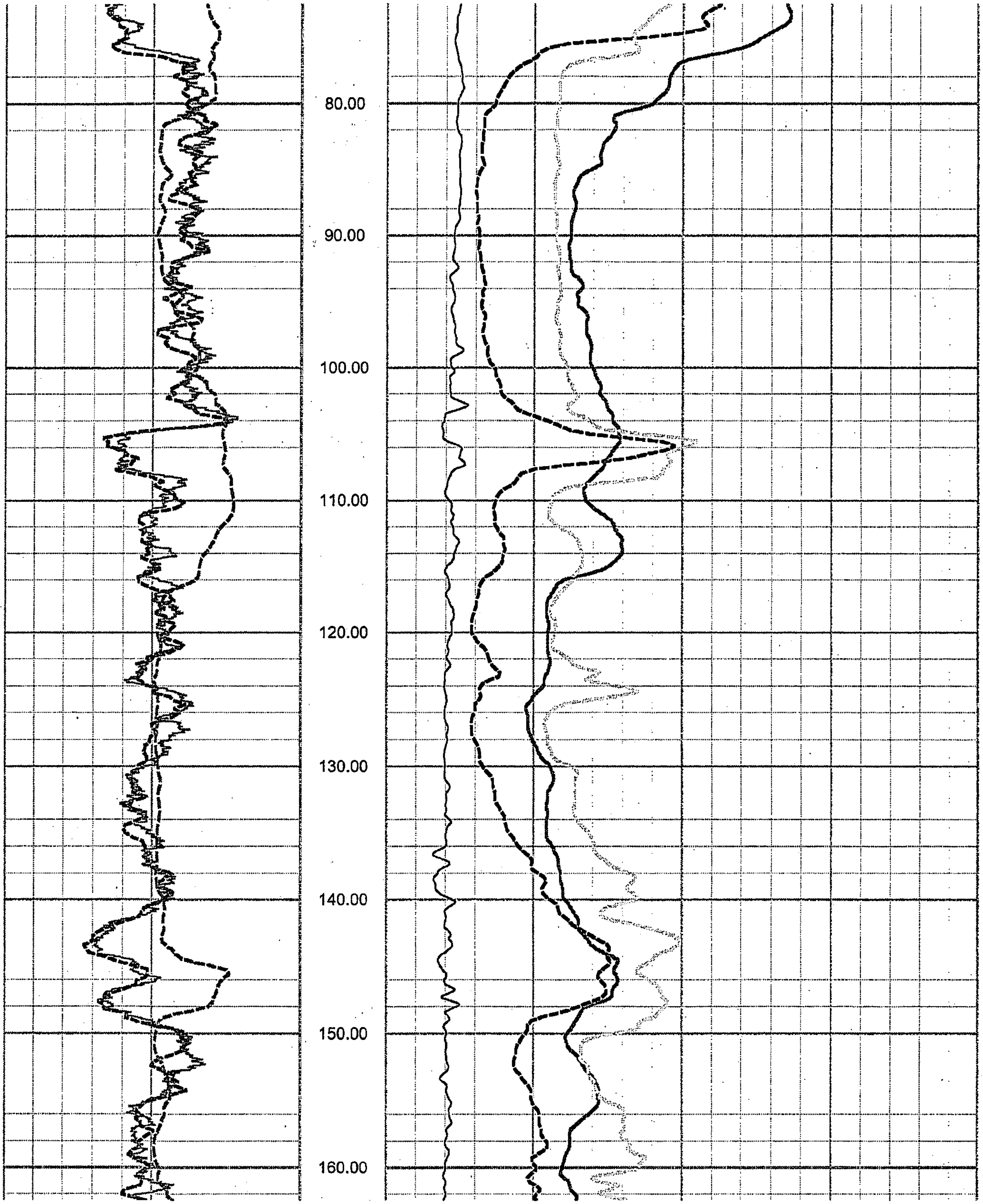
RUN#	BIT RECORD			CASING RECORD			
	SIZE	FROM	TO	SIZE	WEIGHT	FROM	TO
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00

ROBERTSON GEOLOGGING TECHNOLOGY

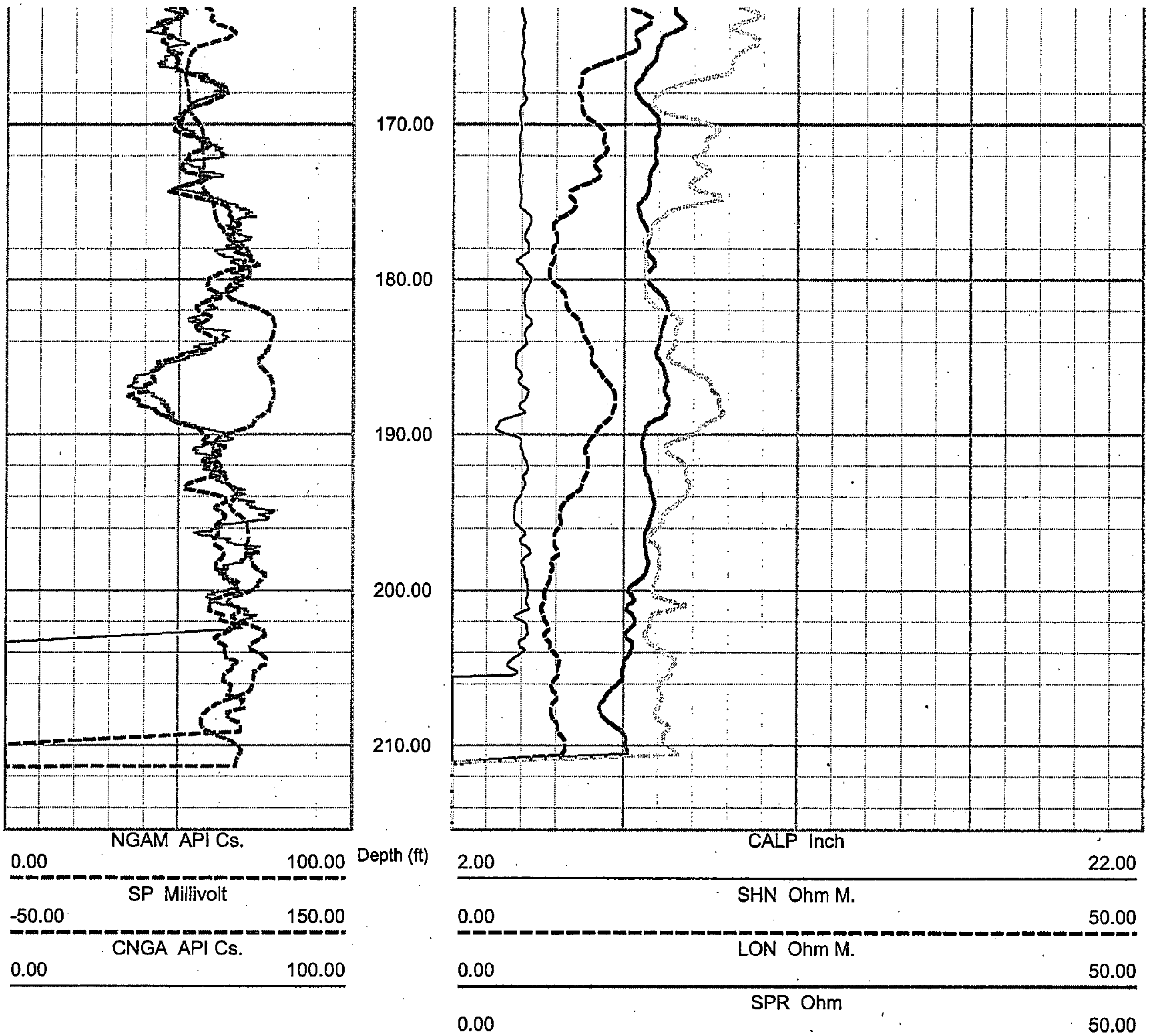
REMARKS (C:\Data\PS\STP\B-402-DH 6 December 2006 ..



STP COL Boring B-402-DH ELOG, Caliper and Gamma rev 1 Sheet 2 of 4



STP COL Boring B-402-DH ELOG, Caliper and Gamma rev 1 Sheet 3 of 4



STP COL Boring B-402-DH ELOG, Caliper and Gamma rev 1 Sheet 4 of 4

ROBERTSON GEOLOGGING LIMITED

STP COL

B405ELOGUP02

COMPANY	GEOVision
WELL	B-405-DH
FIELD	
COUNTRY	
STATE	
COUNTY	
LAT.:	
LONG.:	

OTHER SERVICES

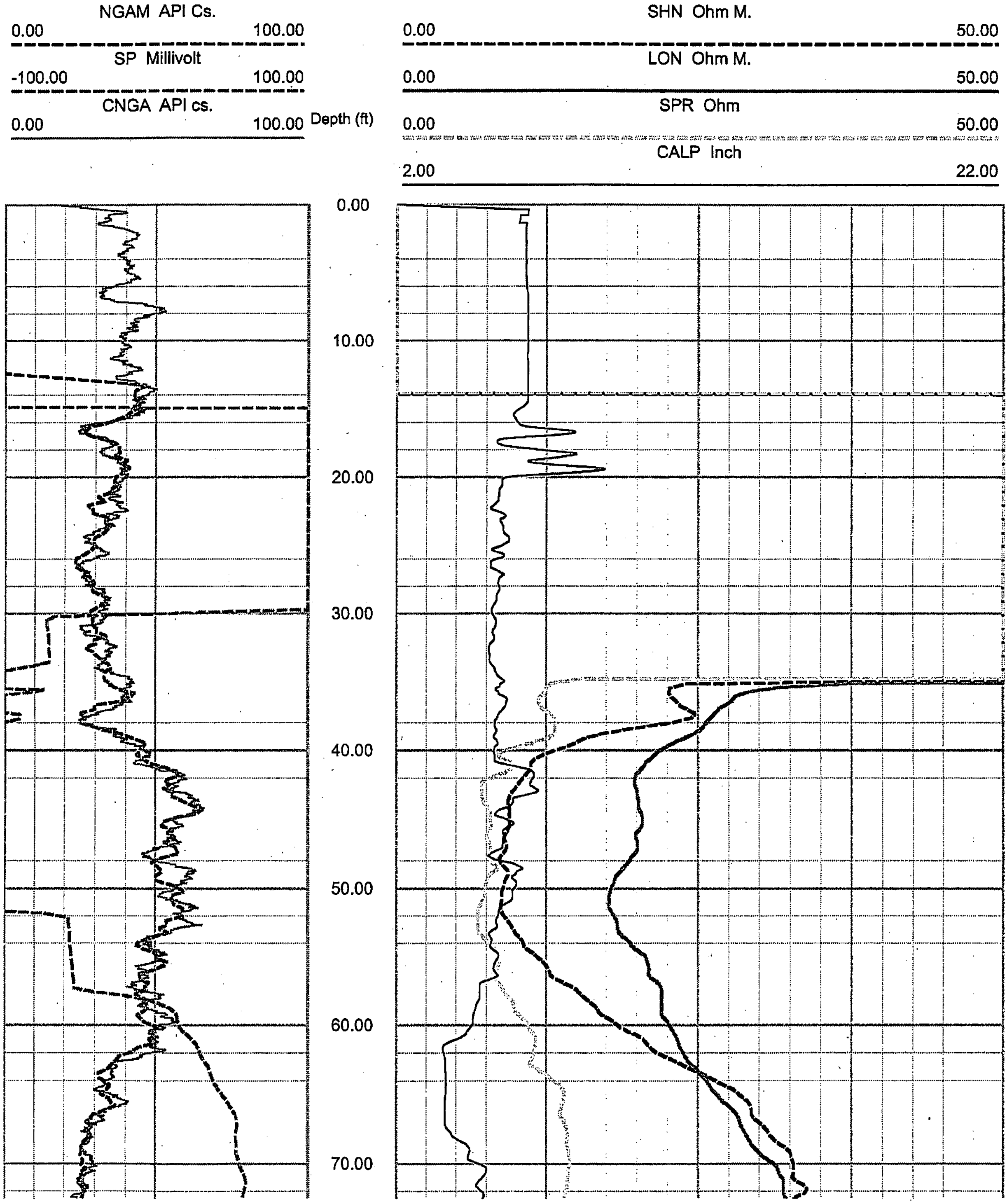
Perm. Da..	Elev	KB	0.00
Log. Da..		DF	0.00
Drill Datum		GL	0.00

DATE	08 Nov 06	21 Oct 05	21 Oct 05
RUN#	2	0	0
TYPE OF LOG	ELOG		
DEPTH DRILLER	120.00	0.00	0.00
DEPTH LOGGER	120.00	0.00	0.00
LOG DEEPEST	120.00	0.00	0.00
LOG SHALLOW	20.00	0.00	0.00
FLUID IN HOLE	DRILLING MUD		
SALINITY			
DENSITY			
LEVEL			
MAX TEMP °C	0.00	0.00	0.00
RIG TIME			
RECORDED BY	R. STELLER		
WITNESSED BY			

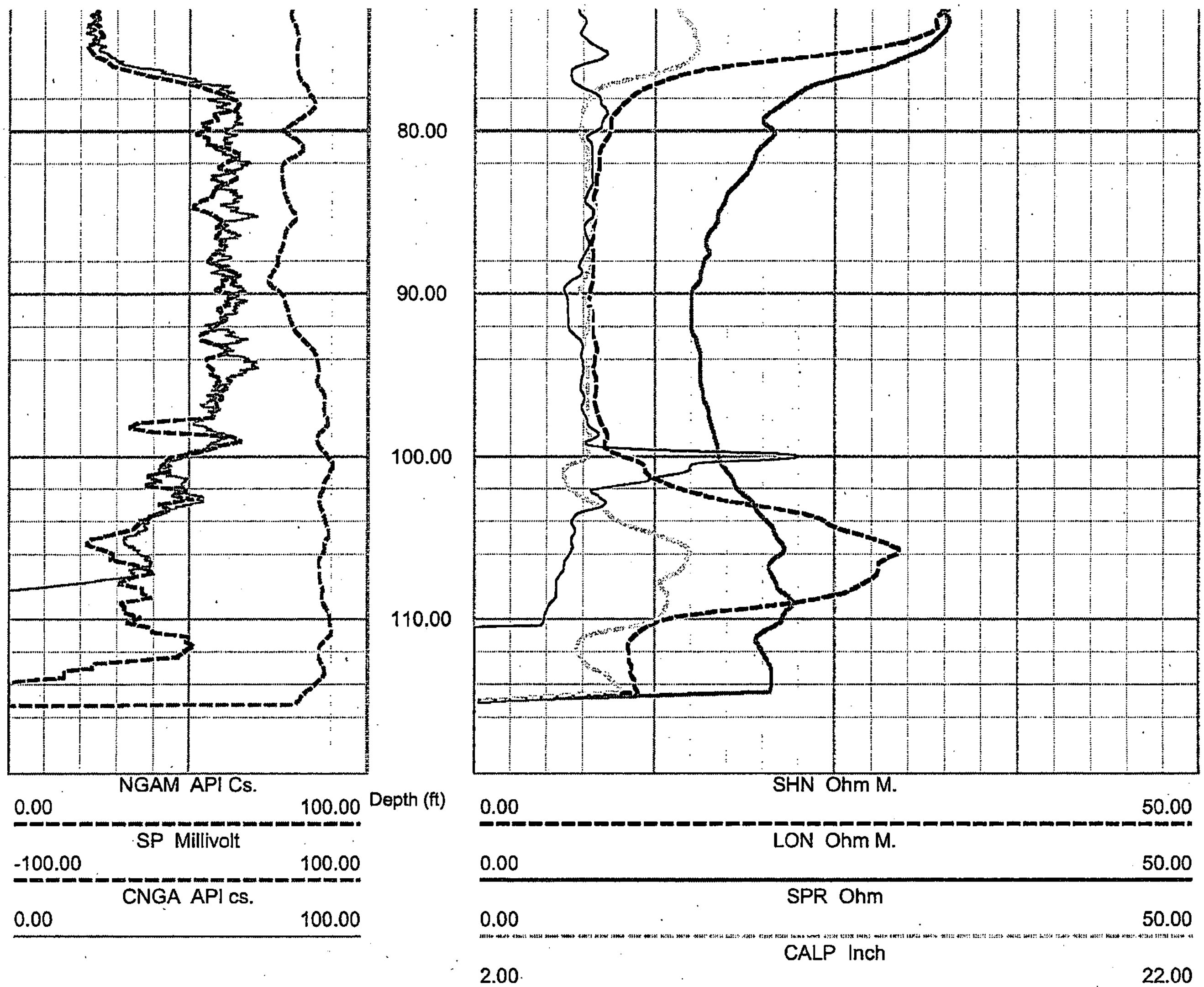
RUN#	BIT RECORD			CASING RECORD			
	SIZE	FROM	TO	SIZE	WEIGHT	FROM	TO
2	4.00	0.00	120.00	0.00	0.00	0.00	0.00
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00

ROBERTSON GEOLOGGING TECHNOLOGY

REMARKS (C:\Data\PS\STP\B-405-DH 7-8 November 200..



STP COL Boring B-405-DH top section ELOG, Caliper and Gamma rev 1 Sheet 2 of 3



STP COL Boring B-405-DH top section ELOG, Caliper and Gamma rev 1 Sheet 3 of 3

ROBERTSON
GEOLOGGING
LIMITED

STP COL

B405ELOGUP01

COMPANY	GEOVision
WELL	B-405-DH
FIELD	
COUNTRY	
STATE	
COUNTY	
LAT.:	
LONG.:	

OTHER SERVICES

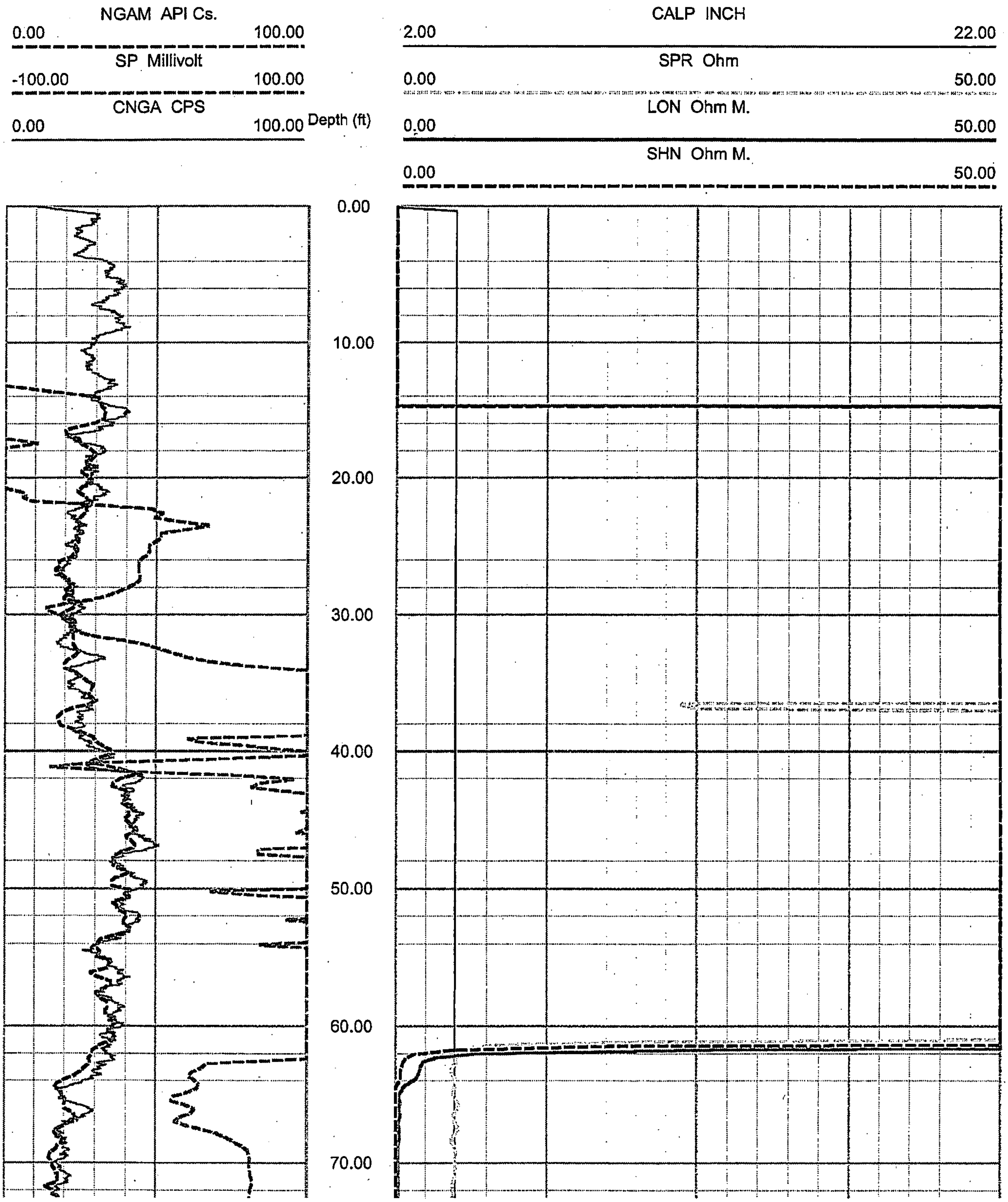
Perm. Da..	Elev	KB	0.00
Log. Da..		DF	0.00
Drill Datum		GL	0.00

DATE	07 Nov 06	21 Oct 05	21 Oct 05
RUN#	3	0	0
TYPE OF LOG	ELOG		
DEPTH DRILLER	618.00	0.00	0.00
DEPTH LOGGER	618.00	0.00	0.00
LOG DEEPEST	618.00	0.00	0.00
LOG SHALLOW	30.00	0.00	0.00
FLUID IN HOLE	DRILLING MUD		
SALINITY			
DENSITY			
LEVEL			
MAX TEMP °C	0.00	0.00	0.00
RIG TIME			
RECORDED BY	R. STELLER		
WITNESSED BY			

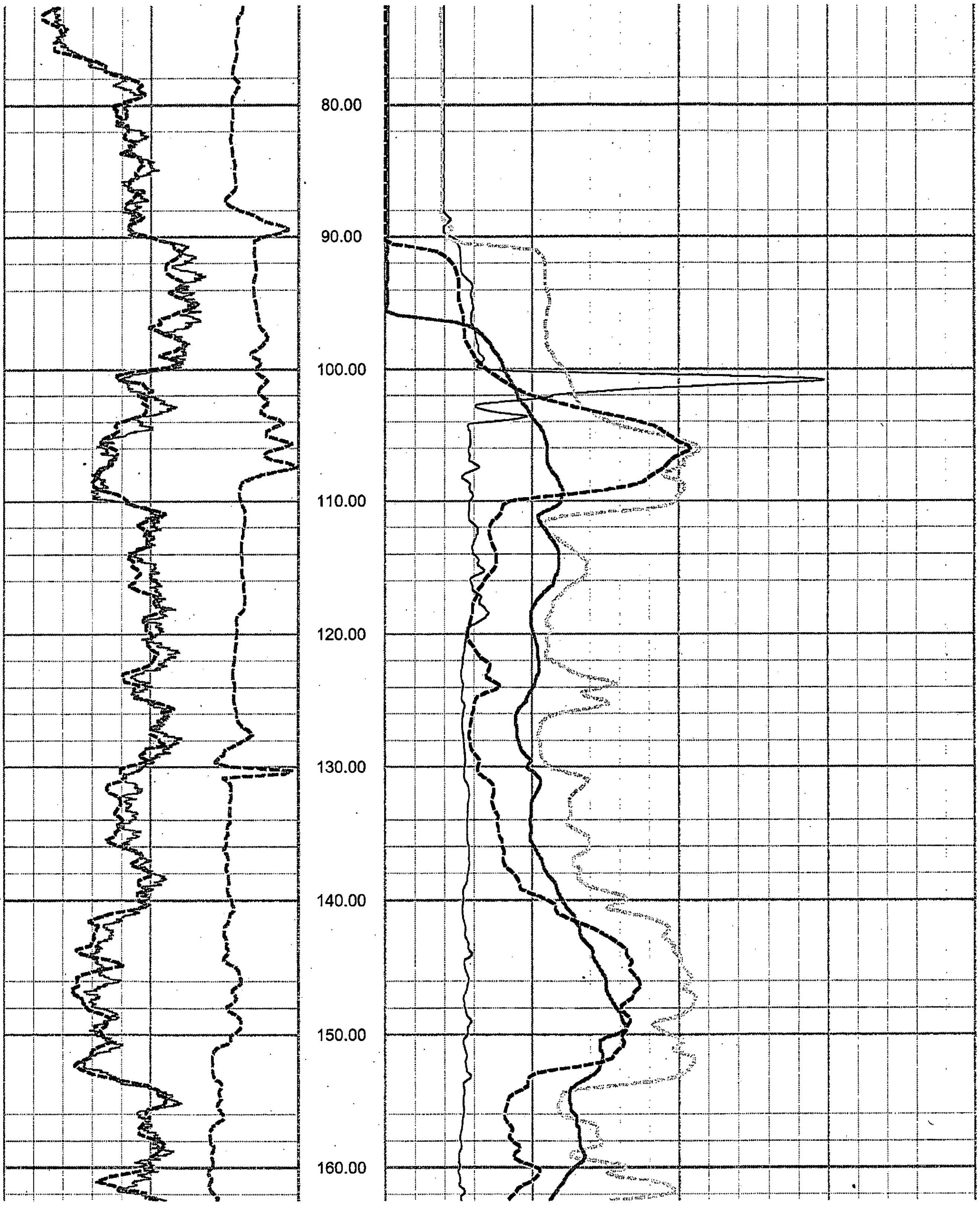
RUN#	BIT RECORD			CASING RECORD			
	SIZE	FROM	TO	SIZE	WEIGHT	FROM	TO
3	4.00	0.00	618.00	0.00	0.00	0.00	0.00
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00

ROBERTSON GEOLOGGING TECHNOLOGY

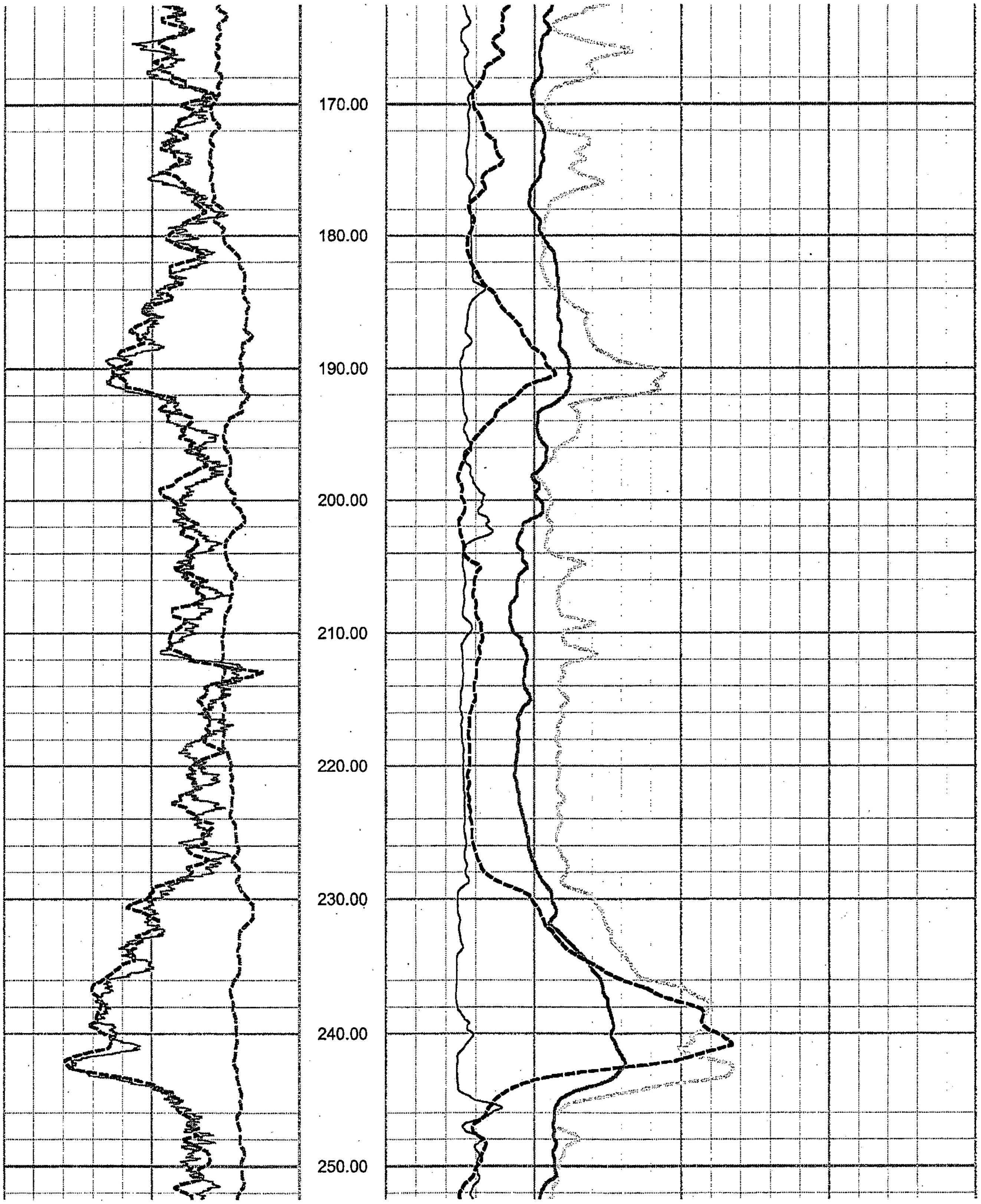
REMARKS (C:\Data\PS\STP\B-405-DH 7-8 November 200..



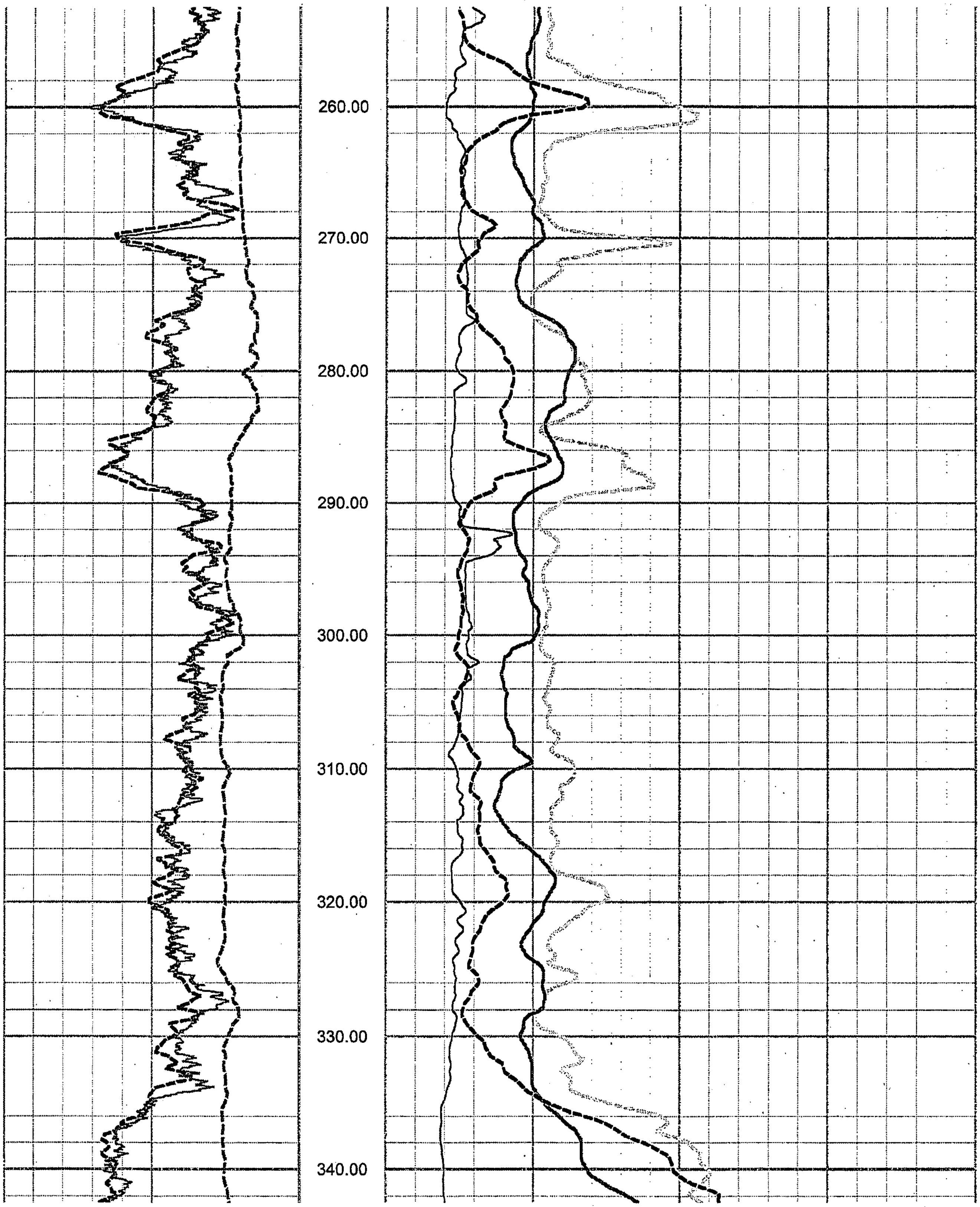
STP COL Boring B-405-DH bottom section ELOG, Caliper and Gamma rev 1 Sheet 2 of 9



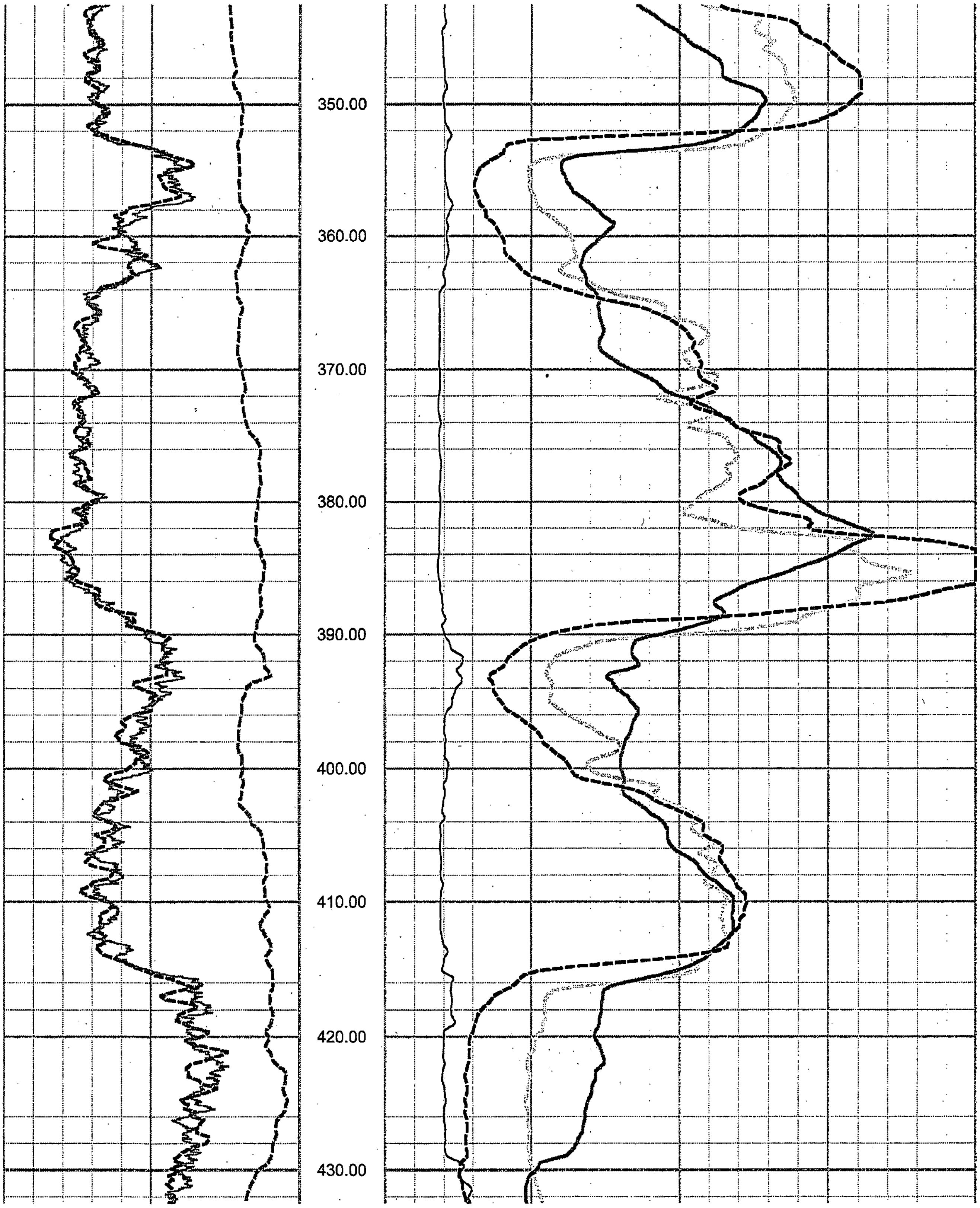
STP COL Boring B-405-DH bottom section ELOG, Caliper and Gamma rev 1 Sheet 3 of 9



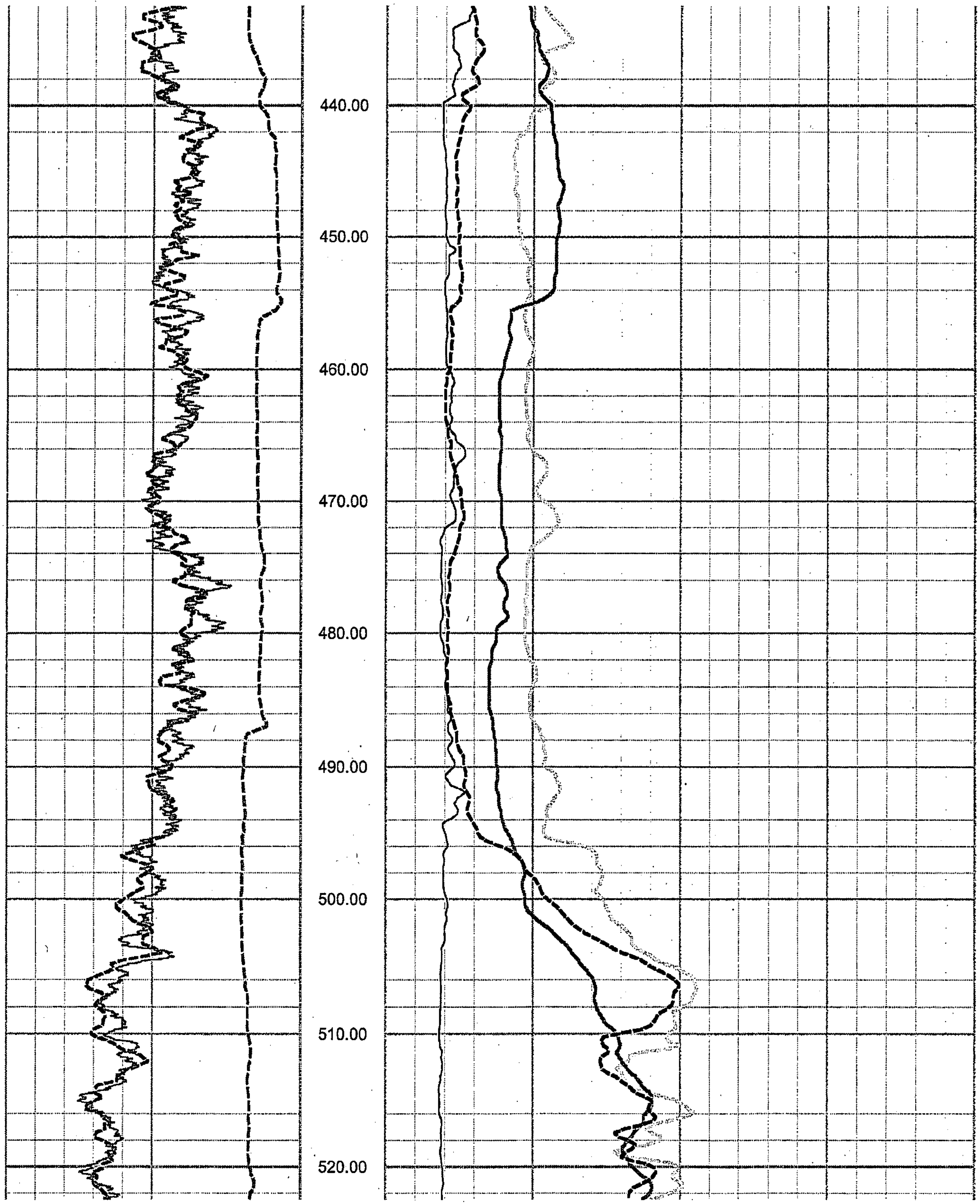
STP COL Boring B-405-DH bottom section ELOG, Caliper and Gamma rev 1 Sheet 4 of 9



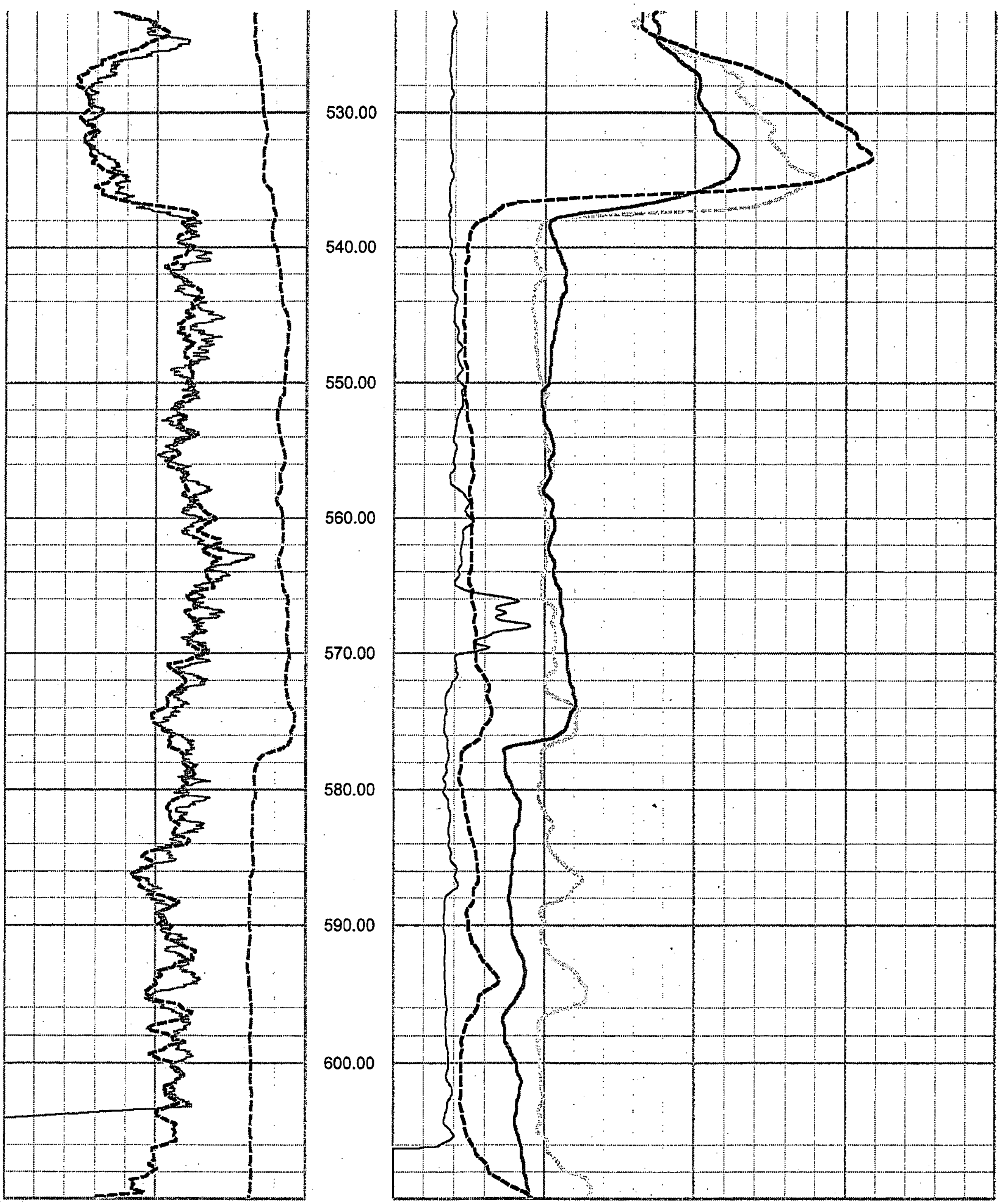
STP COL Boring B-405-DH bottom section ELOG, Caliper and Gamma rev 1 Sheet 5 of 9



STP COL Boring B-405-DH bottom section ELOG, Caliper and Gamma rev 1 Sheet 6 of 9



STP COL Boring B-405-DH bottom section ELOG, Caliper and Gamma rev 1 Sheet 7 of 9



STP COL Boring B-405-DH bottom section ELOG, Caliper and Gamma rev 1 Sheet 8 of 9

NGAM API Cs.		Depth (ft)	CALP INCH	
0.00	100.00		2.00	22.00
SP Millivolt			SPR Ohm	
-100.00	100.00		0.00	50.00
CNGA CPS			LON Ohm M.	
0.00	100.00		0.00	50.00
			SHN Ohm M.	
			0.00	50.00

STP COL Boring B-405-DH bottom section ELOG, Caliper and Gamma rev 1 Sheet 9 of 9

ROBERTSON GEOLOGGING LIMITED

STP COL

B408ELOGUP01CALUP01

COMPANY	GEOVision	OTHER SERVICES	
WELL	B-408-DH		
FIELD			
COUNTRY			
STATE			
COUNTY			
LAT.:			
LONG.:			

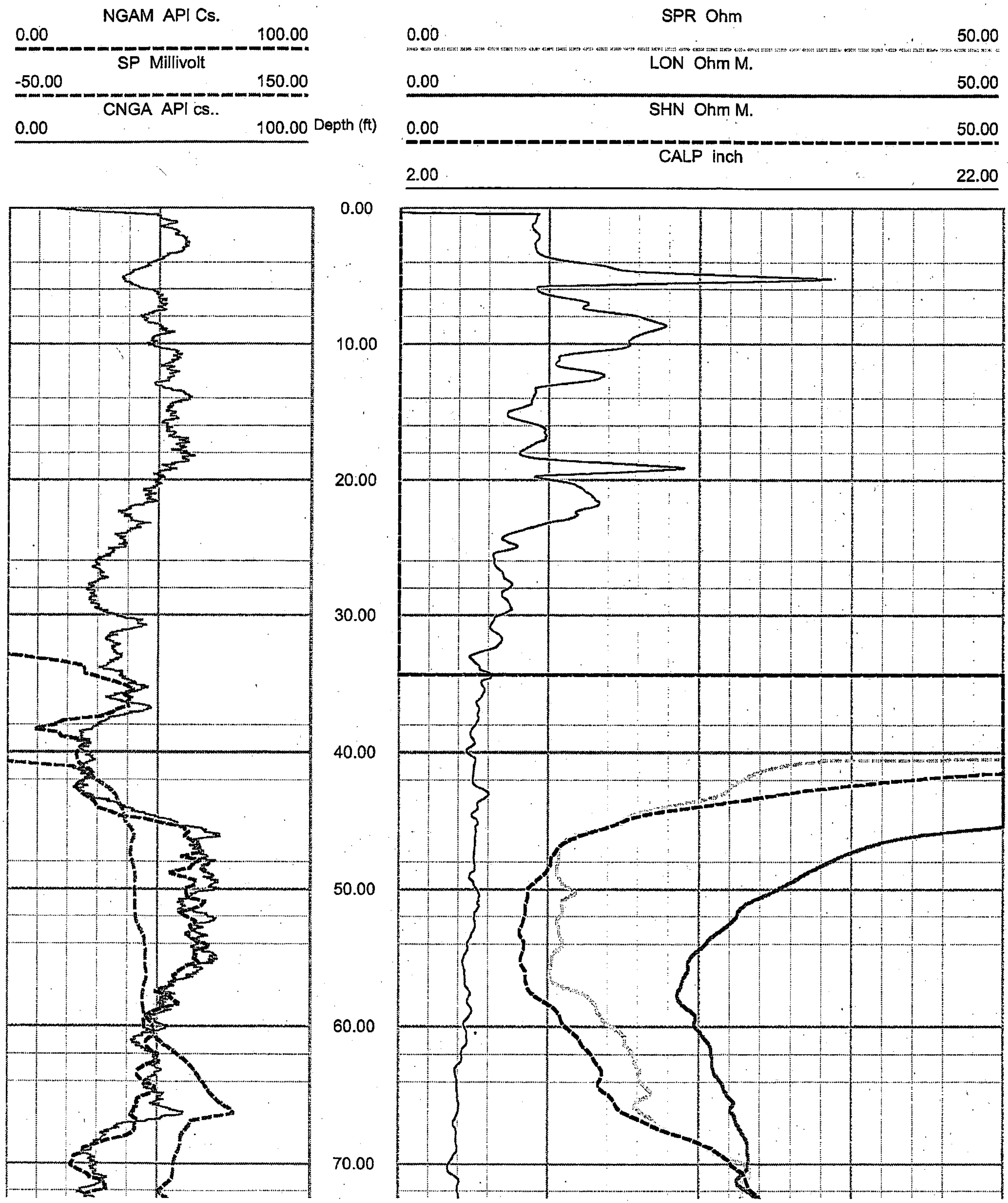
Perm. Da..	Elev	KB	0.00
Log. Da..		DF	0.00
Drill Datum		GL	0.00

DATE	09 Nov 06	21 Oct 05	21 Oct 05
RUN#	1	0	0
TYPE OF LOG	ELOG, CALI..		
DEPTH DRILLER	215.00	0.00	0.00
DEPTH LOGGER	215.00	0.00	0.00
LOG DEEPEST	215.00	0.00	0.00
LOG SHALLOW	0.00	0.00	0.00
FLUID IN HOLE	DRILLING MUD		
SALINITY			
DENSITY			
LEVEL			
MAX TEMP °C	0.00	0.00	0.00
RIG TIME			
RECORDED BY	R. STELLER		
WITNESSED BY			

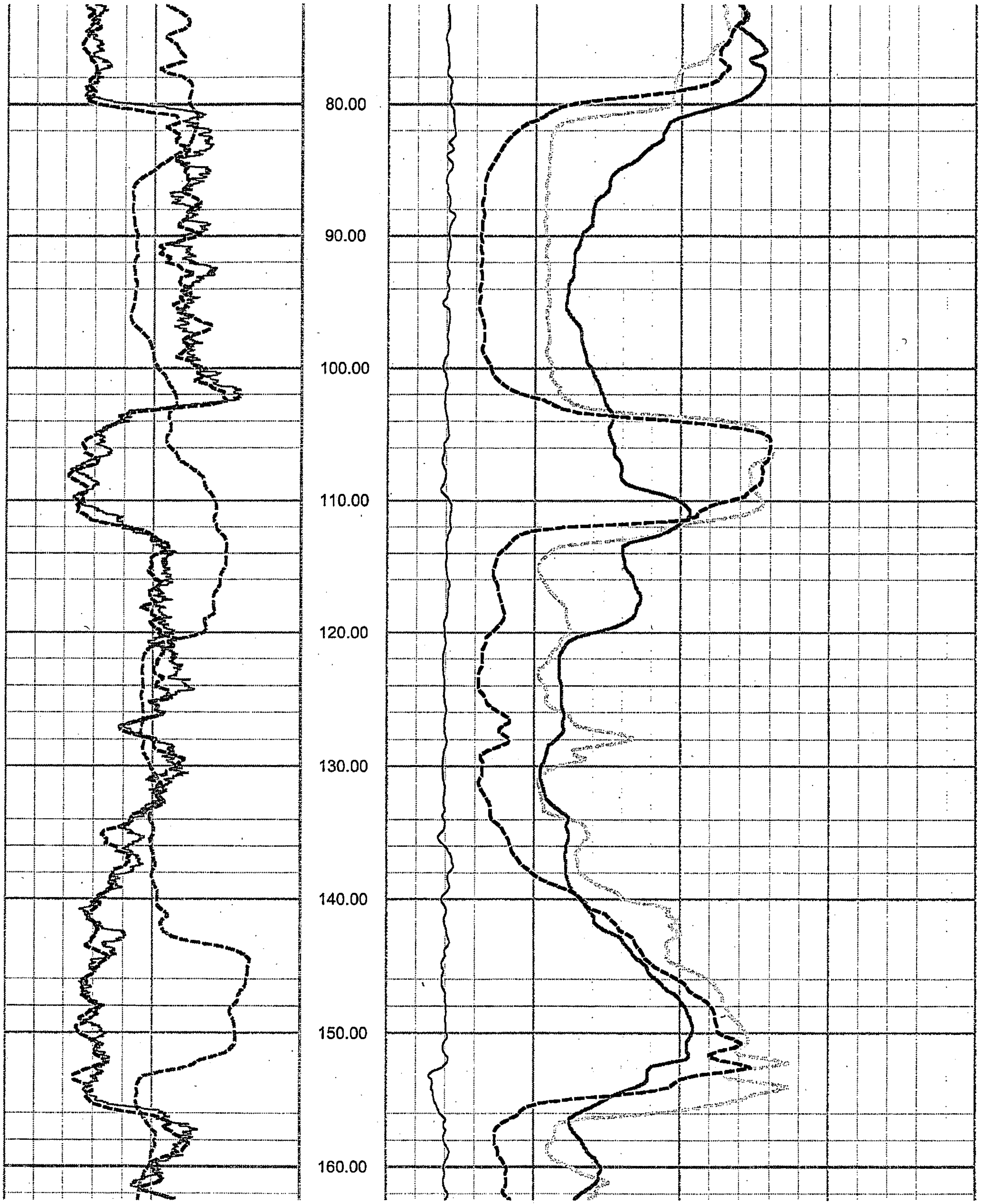
RUN#	BIT RECORD			CASING RECORD			
	SIZE	FROM	TO	SIZE	WEIGHT	FROM	TO
1	4.00	0.00	215.00	0.00	0.00	0.00	0.00
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00

ROBERTSON GEOLOGGING TECHNOLOGY

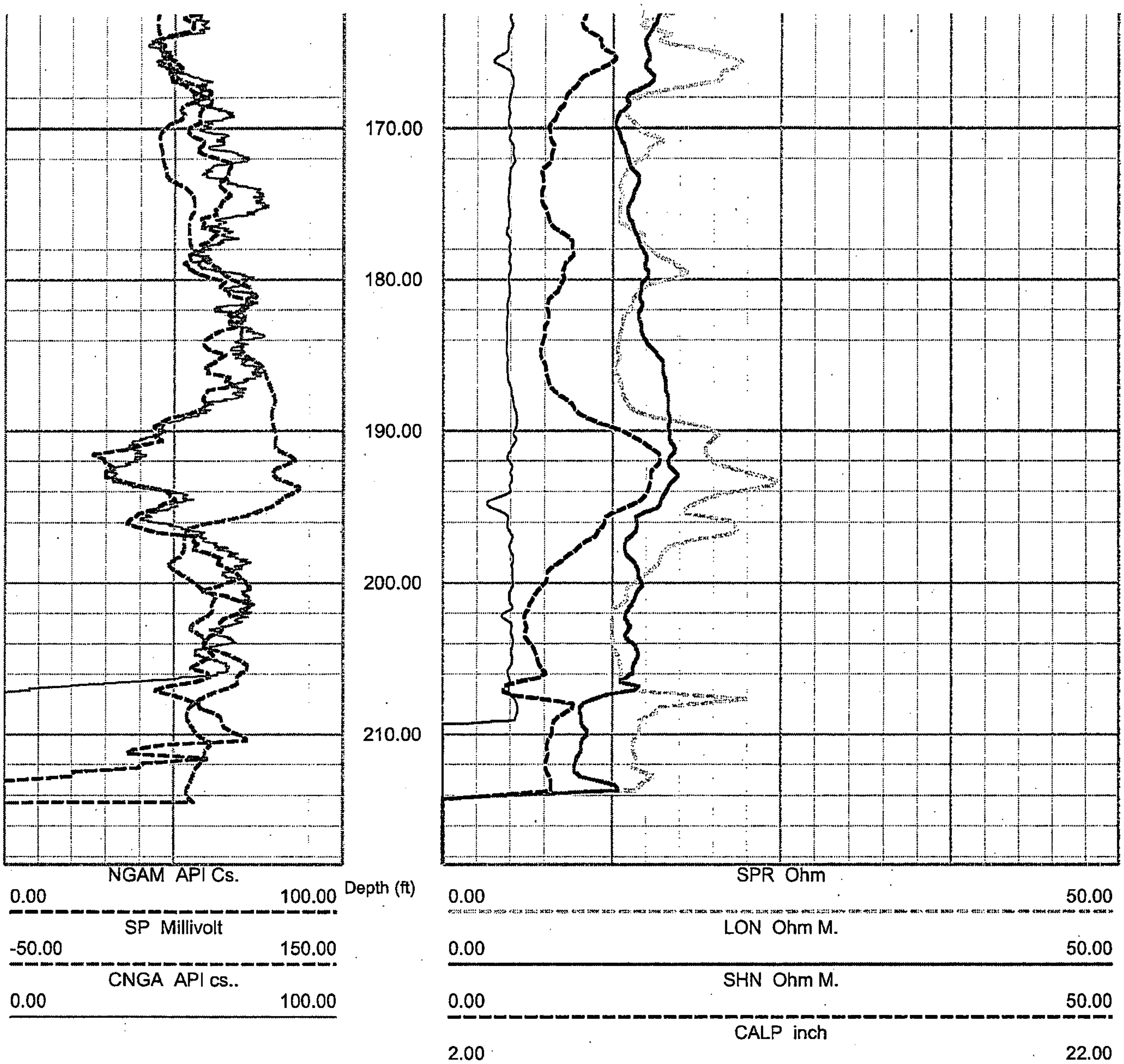
REMARKS (C:\Data\PS\STP\B-408-DH 9 November 2006 ..



STP COL Boring B-408-DH ELOG, Caliper and Gamma rev 2 Sheet 2 of 4



STP COL Boring B-408-DH ELOG, Caliper and Gamma rev 2 Sheet 3 of 4



STP COL Boring B-408-DH ELOG, Caliper and Gamma rev 2 Sheet 4 of 4

ROBERTSON GEOLOGGING LIMITED

STP COL

B419ELOGUP01

COMPANY	GeoVision	OTHER SERVICES
WELL	B-419-DH	
FIELD		
COUNTRY		
STATE		
COUNTY		
LAT.:		
LONG.:		

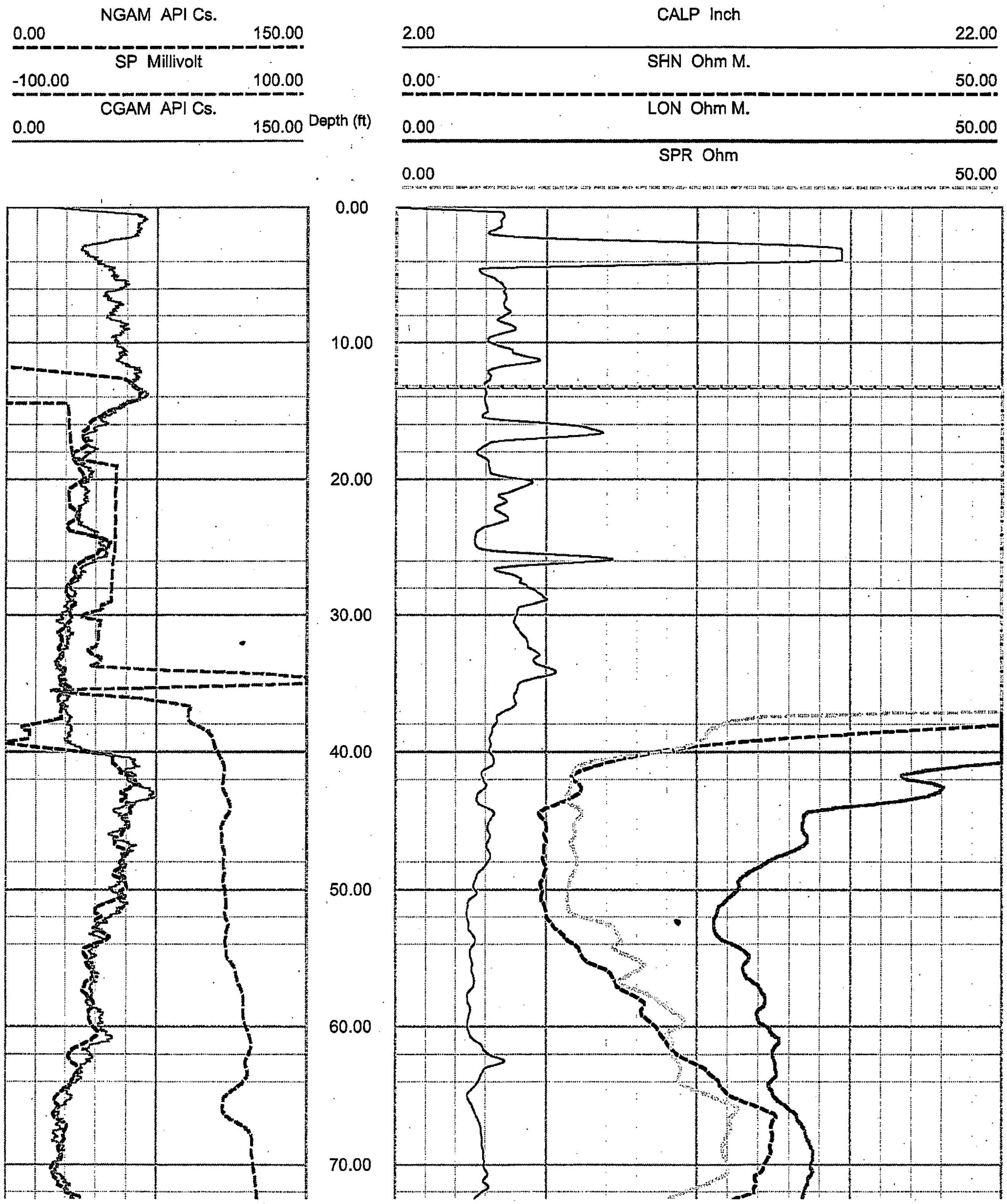
Perm. Da..	Elev	KB	0.00
Log. Da..		DF	0.00
Drill Datum		GL	0.00

DATE	04 Dec 06	01 Oct 06	01 Oct 06
RUN#	2	0	0
TYPE OF LOG	ELOG		
DEPTH DRILLER	215.00	0.00	0.00
DEPTH LOGGER	0.00	0.00	0.00
LOG DEEPEST	215.00	0.00	0.00
LOG SHALLOW	0.00	0.00	0.00
FLUID IN HOLE	DRILLING MUD		
SALINITY			
DENSITY			
LEVEL			
MAX TEMP °C	0.00	0.00	0.00
RIG TIME			
RECORDED BY	R.STELLER		
WITNESSED BY			

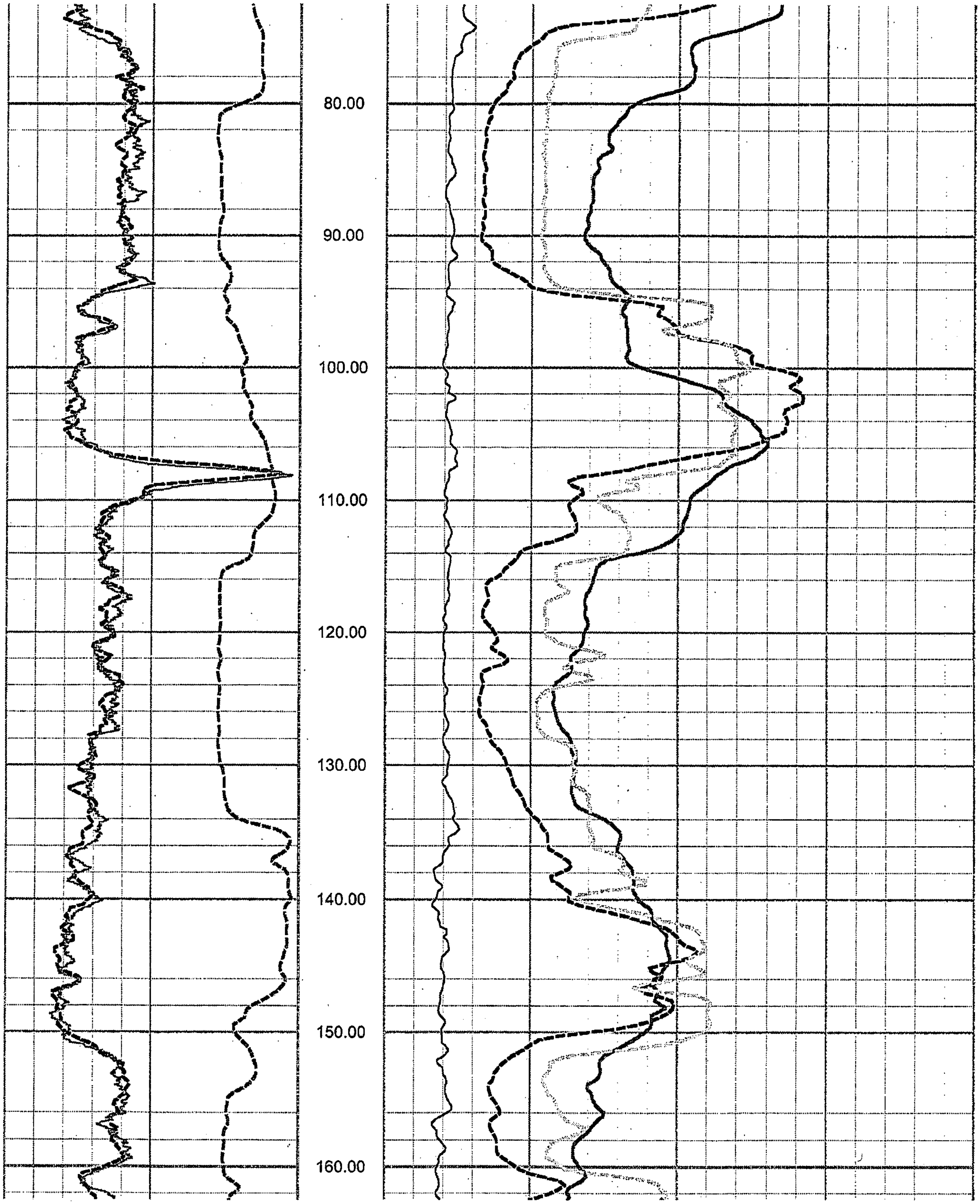
RUN#	BIT RECORD			CASING RECORD			
	SIZE	FROM	TO	SIZE	WEIGHT	FROM	TO
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00

ROBERTSON GEOLOGGING TECHNOLOGY

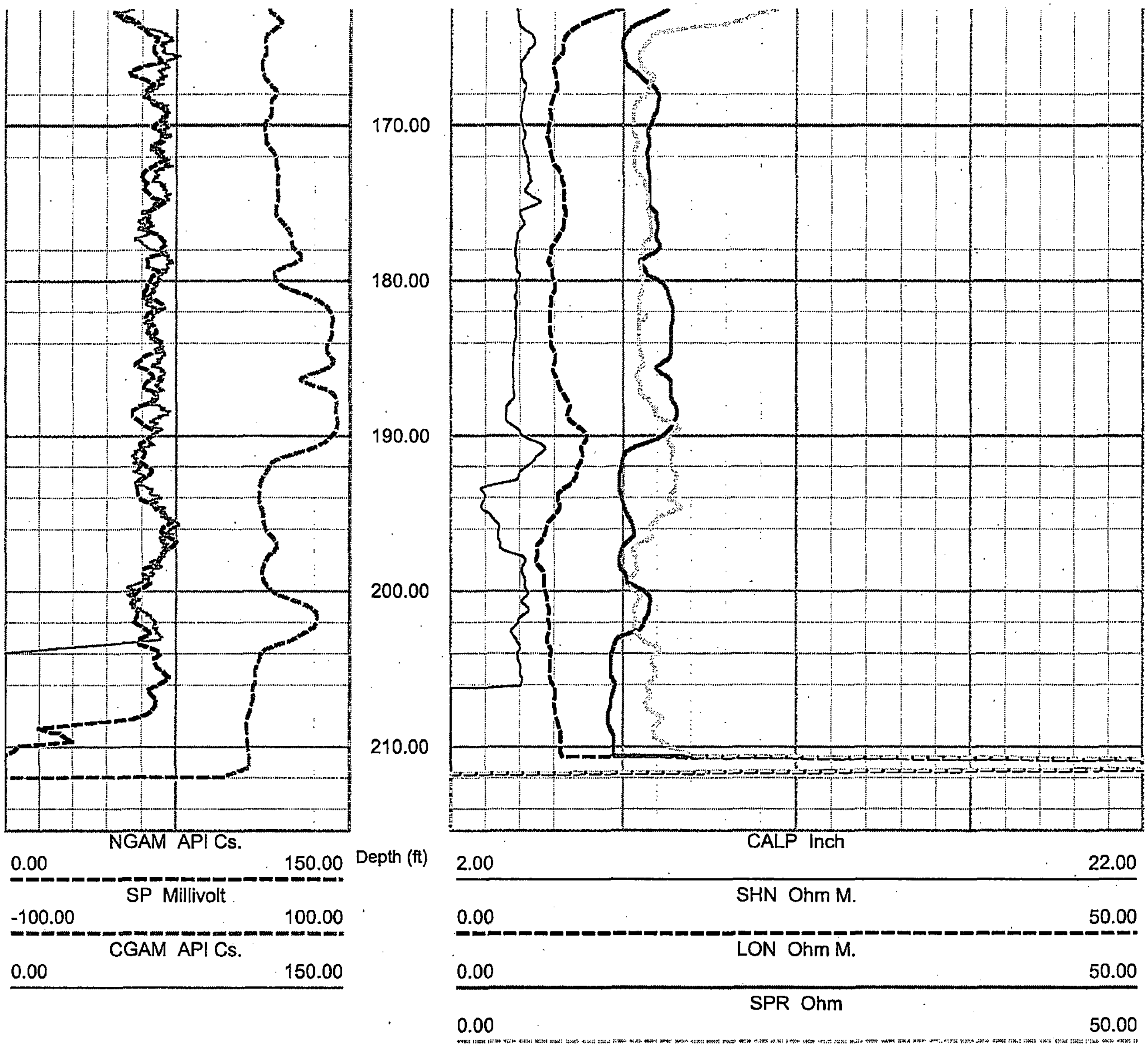
REMARKS (C:\Data\PS\STP\B-419-DH 4 December 2006 ..



STP COL Boring B-419-DH ELOG, Caliper and Gamma rev 1 Sheet 2 of 4



STP COL Boring B-419-DH ELOG, Caliper and Gamma rev 1 Sheet 3 of 4



STP COL Boring B-419-DH ELOG, Caliper and Gamma rev 1 Sheet 4 of 4

ROBERTSON GEOLOGGING LIMITED

STP COL

B428ELOGUP01

COMPANY	GEOVISION	OTHER SERVICES
WELL	B-428-DH	
FIELD		
COUNTRY		
STATE		
COUNTY		
LAT.:		
LONG.:		

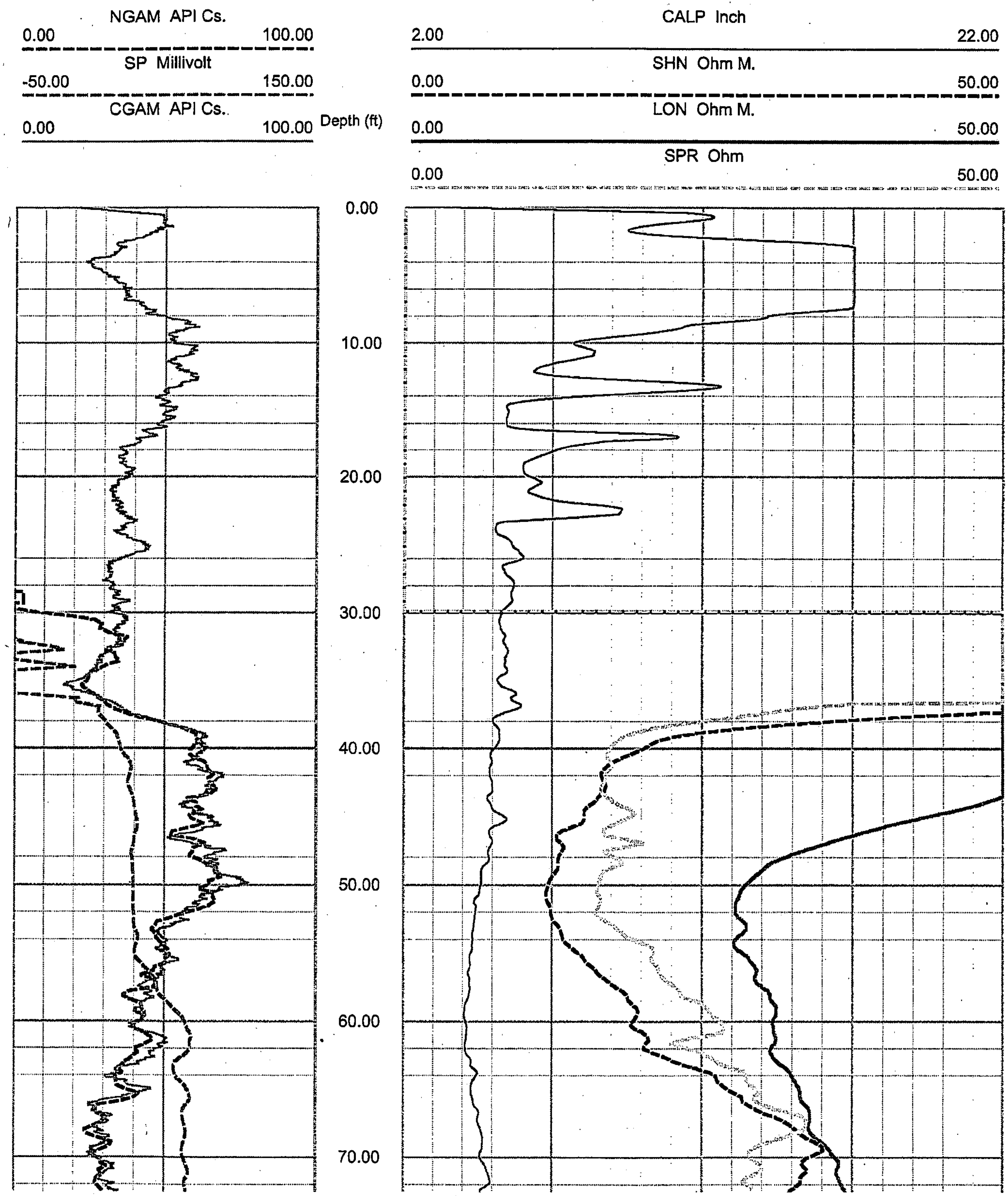
Perm. Da..	Elev	KB	0.00
Log. Da..		DF	0.00
Drill Datum		GL	0.00

DATE	05 Dec 06	05 Dec 06	05 Dec 06
RUN#	2	0	0
TYPE OF LOG	ELOG		
DEPTH DRILLER	215.00	0.00	0.00
DEPTH LOGGER	215.00	0.00	0.00
LOG DEEPEST	0.00	0.00	0.00
LOG SHALLOW	0.00	0.00	0.00
FLUID IN HOLE	DRILLING MUD		
SALINITY			
DENSITY			
LEVEL			
MAX TEMP °C	0.00	0.00	0.00
RIG TIME			
RECORDED BY	R. STELLER		
WITNESSED BY			

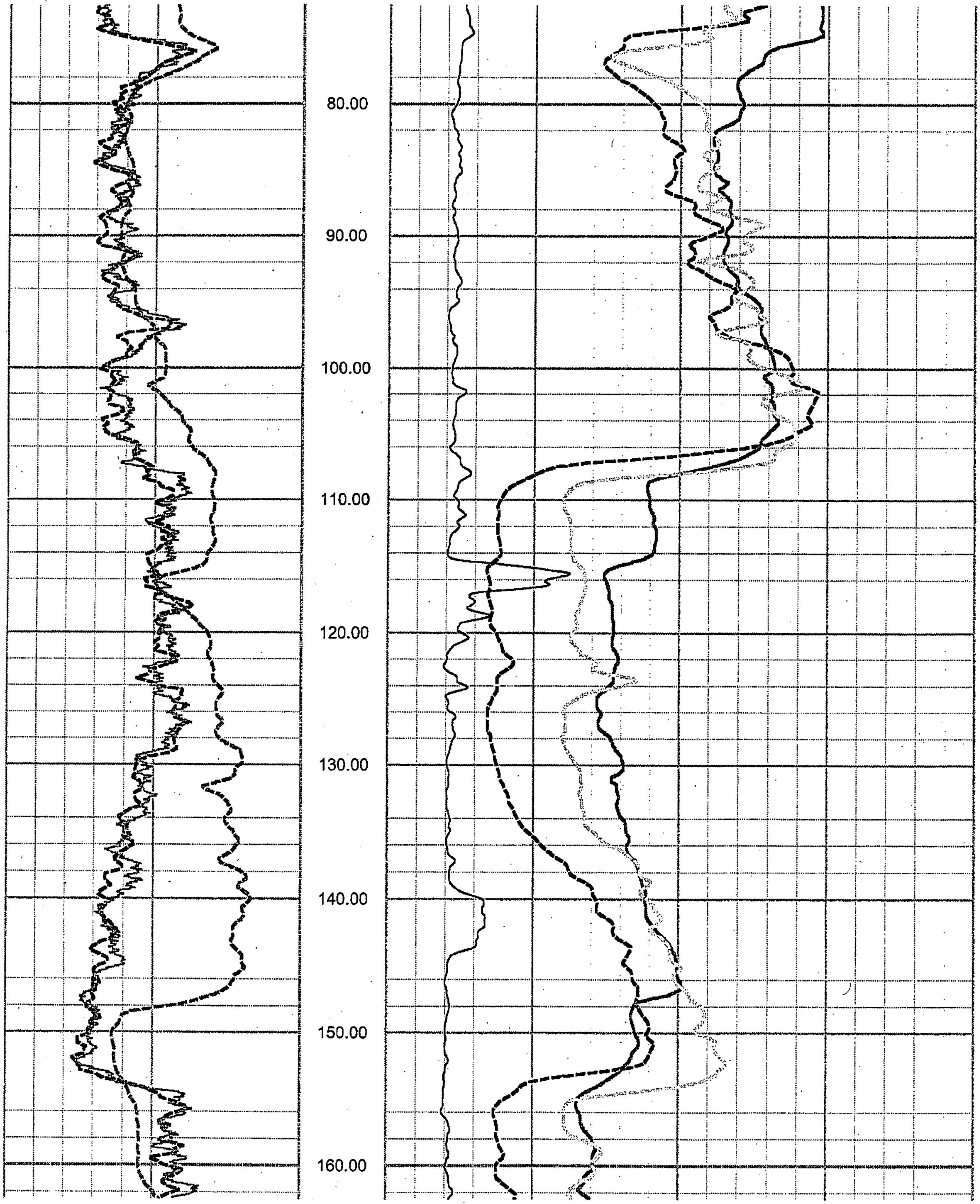
RUN#	BIT RECORD			CASING RECORD			
	SIZE	FROM	TO	SIZE	WEIGHT	FROM	TO
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00

ROBERTSON GEOLOGGING TECHNOLOGY

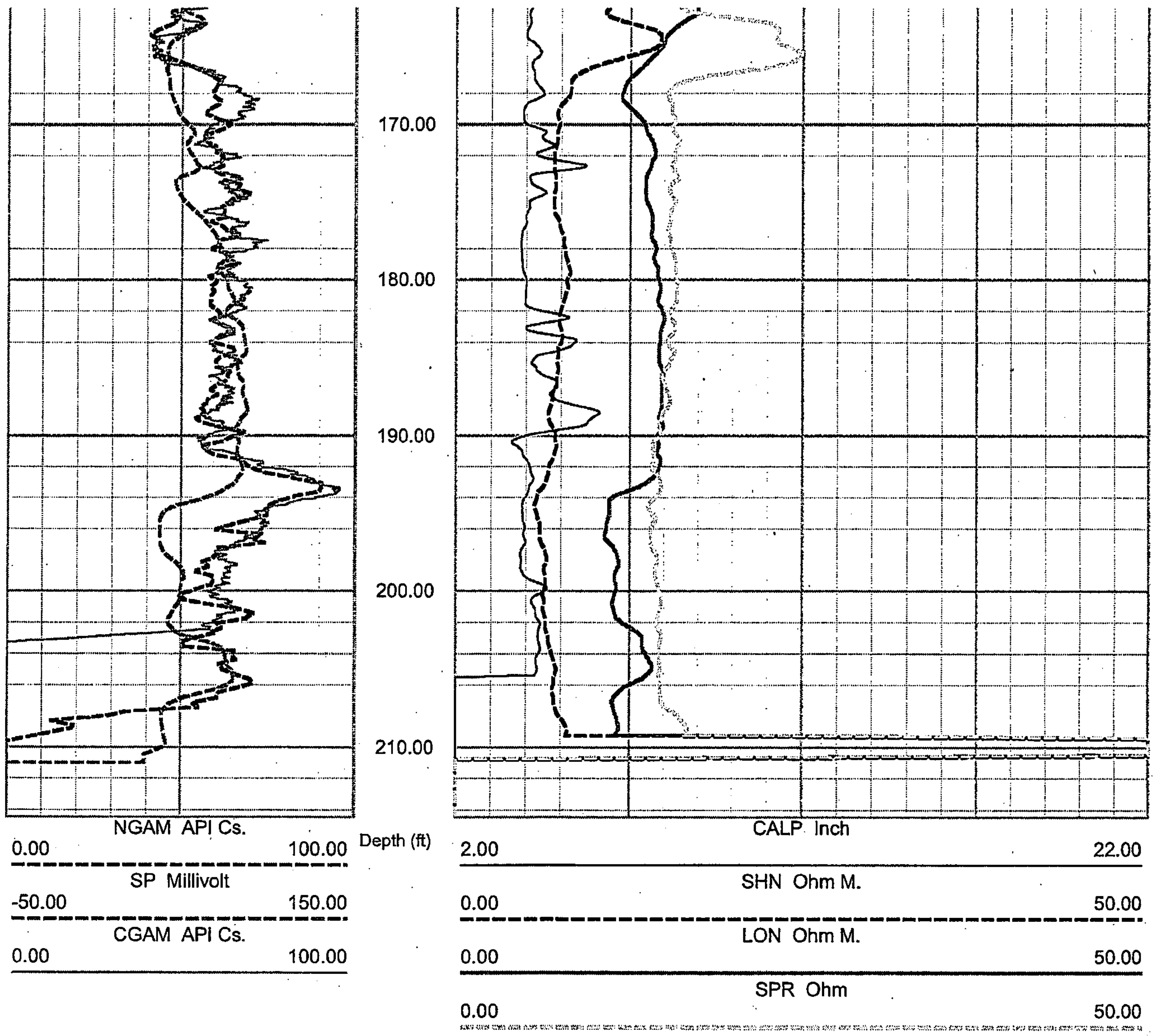
REMARKS (C:\Data\PS\STP\B-428-DH 5 December 2006 ..



STP COL Boring B-428-DH ELOG, Caliper and Gamma rev 1 Sheet 2 of 4



STP COL Boring B-428-DH ELOG, Caliper and Gamma rev 1 Sheet 3 of 4



STP COL Boring B-428-DH ELOG, Caliper and Gamma rev 1 Sheet 4 of 4

APPENDIX C

BORING GEOPHYSICAL LOGGING SYSTEMS - NIST TRACEABLE CALIBRATION PROCEDURES AND CALIBRATION RECORDS

CALIBRATION PROCEDURE FOR

GEOVision SEISMIC RECORDER/LOGGER

Reviewed 4/6/06

Objective

The timing/sampling accuracy of seismic recorders or data loggers is required for several GEOVision field procedures including Seismic Refraction, Downhole Seismic Velocity Logging, and P-S Suspension Logging. This procedure describes the method for measuring the timing accuracy of a seismic data logger, such as the OYO Model 170, OYO/Robertson Model 3403, Geometrics Strataview or Geometrics Geode. The objective of this procedure is to verify that the timing accuracy of the recorder is accurate to within 1%.

Frequency of Calibration

The calibration of each GEOVision seismic data logger is twelve (12) months. In the case of rented seismic data loggers, calibration must be performed prior to use.

Test Equipment Required

The following equipment is required. Item #2 must have current NIST traceable calibration.

1. Function generator, Krohn Hite 5400B or equivalent
2. Frequency counter, HP 5315A or equivalent
3. Test cables, from item 1 to item 2, and from item 1 to subject data logger.

Procedure

This procedure is designed to be performed using the accompanying Seismograph Calibration Data Sheet with the same revision number. All data must be entered and the procedure signed by the technician performing the test.

1. Record all identification data on the form provided.
2. Connect function generator to data logger (such as OYO Model 170) using test cable
3. Connect the function generator to the frequency counter using test cable.

4. Set up generator to produce a 100.0 Hz, 0.25 volt (amplitude is approximate, modify as necessary to yield less than full scale waveforms on logger display) peak square wave or sine wave. Verify frequency using the counter and initial space on the data sheet.

5. Initialize data logger and record a data record of at least 0.1 second using a 100 microsecond or less sample period.

6. Measure the recorded square wave frequency by measuring the duration of 9 cycles of data. This measurement can be made using the data logger display device, or by printing out a paper tape. If a paper tape can be printed, the resulting printout must be attached to this procedure. Record the data in the space provided.

7. Repeat steps 5 and 6 three more times using separate files.

Criteria

The duration for 9 cycles in any file must be 90.0 milliseconds plus or minus 0.9 milliseconds, corresponding to an average frequency for the nine cycles of 100.0 Hz. plus or minus 1 Hz (obtained by dividing 9 cycles by the duration in milliseconds).

If the results are outside this range, the data logger must be marked with a GEOVision REJECT tag until it can be repaired and retested.

If results are acceptable affix label indicating the initials of the person performing the calibration, the date of calibration, and the due date for the next calibration (12 months).

Procedure Approval

Approved by:

John G. Diehl	President
Name	Title
[signature]	April 6, 2006
Signature	Date

Client Approval (if required):

Name	Title
Signature	Date

TEST NUMBER
501203

EDISON ESI

Calibration Report

METROLOGY
7300 Fenwick Lane
Westminster, CA 92683
866-735-2257
edisonmetrology.com

GEOVision Geophysical Services
1151 Pomona Road, Unit P
Corona, CA 92882
P.O. No.: 6162-060414-01

Manufacturer:	Oyo	**Calibration Date:**	04/21/2006
Model Number:	3403	**Calibration Due Date:**	04/21/2007
Description:	Unit, Suspension Telemetry,	**Calibration Interval:**	12 Months
Asset Number:	160023	**Condition As Found:**	In Tolerance
Serial Number:	160023	**Condition As Left:**	In Tolerance

Remarks:
The UUT (unit under test) was calibrated using the customer's procedure. The UUT was operated by the customer's personnel and data collection was observed by SCE personnel. The UUT was found to be in tolerance to customer supplied specifications. The reference standards used are in compliance with ISO/IEC 17025:1999 and laboratory accreditation criteria established by NIST/NVLAP under the specific scope of accreditation for lab code 105014-0. Frequency is accredited.
Please see attached data.

Standards Utilized

I.D. No.	Mfg.	Model No.	Description	Cal. Date	Due Date
S1-01252	Hewlett Packard	5335A OPT 010,203040	Counter, Universal	12/09/2005	06/09/2006
S1-03355	Hewlett Packard	3325B OPT 001,-002	Generator, Function, Synthesizer	11/03/2005	11/03/2006
S1-03686	Fluke	910	Standard, Frequency, Controlled, Gps	01/16/2006	01/16/2007

Procedure: Customer
Temperature: 23° C
Humidity: 40% RH
Test No.: 501203

Calibration Performed By:			Quality Reviewer:	
Branson, Craig A CA	Metrologist	714-895-0714		04-21-06
Name	Title	Phone	Name	Date

Page 2 of 2
MMO
4-21-06

GEOVision
geophysical services

SEISMOGRAPH CALIBRATION DATA SHEET REV 4/6/06

INSTRUMENT DATA

SYSTEM MFR:	OYO	MODEL NO.:	3403
SERIAL NO.:	160023	CALIBRATION DATE:	4/21/2006
BY:	ROBERT STELLER	DUE DATE:	4/21/2007
COUNTER MFR:	HEWLETT PACKARD	MODEL NO.:	5335A
SERIAL NO.:	2626A09881	CALIBRATION DATE:	12/9/2005
BY:	SCE #S1-01252	DUE DATE:	6/9/2006
FCTN GEN MFR:	HEWLETT PACKARD	MODEL NO.:	3325B
SERIAL NO.:	2847A14447	CALIBRATION DATE:	11/3/2005
BY:	SCE #S1-03355	DUE DATE:	11/3/2006

SYSTEM SETTINGS:

GAIN:	2
FILTER:	10 KHZ
RANGE:	100 MILLISEC, 100 MICROSECOND SAMPLE RATE
DELAY:	0
STACK: 1 (STD)	1
PULSE:	1.6
DISPLAY:	NA
SYSTEM: DATE = CORRECT DATE & TIME	4/21/2006, 11:07AM

PROCEDURE:
SET FREQUENCY TO 100.0HZ SQUAREWAVE WITH AMPLITUDE APPROXIMATELY 0.25 VOLT PEAK. RECORD BOTH ON DISK AND PAPER TAPE, IF AVAILABLE. ANALYZE AND PRINT WAVEFORMS FROM ANALYSIS UTILITY. ATTACH PAPER COPIES OF PRINTOUT AND PAPER TAPES, IF AVAILABLE, TO THIS FORM. AVERAGE FREQUENCY MUST BE BETWEEN 99.0 AND 101.0 HZ.

AS FOUND 100.0 AS LEFT 100.0

WAVEFORM	FILE NO	FREQUENCY	TIME FOR 9 CYCLES Hn	TIME FOR 9 CYCLES Hr	TIME FOR 9 CYCLES V	AVERAGE FREQ.
SQUARE	305	100.0	90.0	90.0	90.0	100.0
SQUARE	306	100.0	90.0	90.0	90.0	100.0
SINE	307	100.0	90.0	90.0	90.0	100.0
SINE	308	100.0	90.1	90.0	90.0	100.0

CALIBRATED BY:	ROBERT STELLER	4/21/2006	Rob Steller
	NAME	DATE	SIGNATURE

Seismic recorder/Logger Calibration Data Sheet Rev 1.30 4-6-06

TEST NUMBER
501204

EDISON ESI
A SOUTHERN CALIFORNIA EDISON® Company

Calibration Report

METROLOGY
7300 Fenwick Lane
Westminster, CA 92683
800-725-2257
edisonmetrology.com

GEOVision Geophysical Services
1151 Pomona Road, Unit P
Corona, CA 92882
P.O. No.: 6162-060414-01

Manufacturer: Oyo
Model Number: 3403
Description: Unit, Suspension Telemetry,
Asset Number: 160024
Serial Number: 160024

Calibration Date: 04/21/2006
Calibration Due Date: 04/21/2007
Calibration Interval: 12 Months
Condition As Found: In Tolerance
Condition As Left: In Tolerance

Remarks:
The UUT (unit under test) was calibrated using the customer's procedure. The UUT was operated by the customer's personnel and data collection was observed by SCE personnel. The UUT was found to be in tolerance to customer supplied specifications. The reference standards used are in compliance with ISO/IEC 17025:1999 and laboratory accreditation criteria established by NIST/NVLAP under the specific scope of accreditation for lab code 105014-0. Frequency is accredited.
Please see attached data.

Standards Utilized

I.D. No.	Mfg.	Model No.	Description	Cal. Date	Due Date
S1-01252	Hewlett Packard	5335A OPT 010,203040	Counter, Universal	12/09/2005	06/09/2006
S1-03355	Hewlett Packard	3325B OPT 001, 002	Generator, Function, Synthesizer	11/03/2005	11/03/2006
S1-03686	Fluke	910	Standard, Frequency, Controlled, Gps	01/16/2006	01/16/2007

Procedure: Customer
Temperature: 23° C
Humidity: 40% RH
Test No.: 501204

Calibration Performed By:			Quality Reviewer:	
Branson, Craig A. CAB	Metrologist	714-895-0714		04-21-06
Name	Title	Phone	Name	Date

page 2 of 2
MO
4-21-06

GEOVision
geophysical services

SEISMOGRAPH CALIBRATION DATA SHEET REV 4/6/06

INSTRUMENT DATA

SYSTEM MFR: OYO — MODEL NO.: 3403
SERIAL NO.: 160024 — CALIBRATION DATE: 4/21/2006
BY: ROBERT STELLER — DUE DATE: 4/21/2007

COUNTER MFR: HEWLETT PACKARD — MODEL NO.: 5335A
SERIAL NO.: 2626A09881 — CALIBRATION DATE: 12/9/2005
BY: SCE #S1-01252 — DUE DATE: 6/9/2006

FCTN GEN MFR: HEWLETT PACKARD — MODEL NO.: 3325B
SERIAL NO.: 2847A14447 — CALIBRATION DATE: 11/3/2005
BY: SCE #S1-03355 — DUE DATE: 11/3/2006

SYSTEM SETTINGS:

GAIN: 2
FILTER: 10 KHZ
RANGE: 100 MILLISEC, 100 MICROSECOND SAMPLE RATE
DELAY: 0
STACK: 1 (STD) 1
PULSE: 1.6
DISPLAY: NA
SYSTEM: DATE = CORRECT DATE & TIME 4/21/2006, 11:30AM

PROCEDURE:

SET FREQUENCY TO 100.0HZ SQUAREWAVE WITH AMPLITUDE APPROXIMATELY 0.25 VOLT PEAK. RECORD BOTH ON DISK AND PAPER TAPE, IF AVAILABLE. ANALYZE AND PRINT WAVEFORMS FROM ANALYSIS UTILITY. ATTACH PAPER COPIES OF PRINTOUT AND PAPER TAPES, IF AVAILABLE, TO THIS FORM. AVERAGE FREQUENCY MUST BE BETWEEN 99.0 AND 101.0 HZ.

AS FOUND 100.0 AS LEFT 100.0

WAVEFORM	FILE NO	FREQUENCY	TIME FOR 9 CYCLES Hn	TIME FOR 9 CYCLES Hr	TIME FOR 9 CYCLES V	AVERAGE FREQ.
SQUARE	401	100.0	90.0	90.0	90.0	100.0
SQUARE	402	100.0	90.0	90.0	90.0	100.0
SINE	403	100.0	89.9	90.0	90.1	100.0
SINE	404	100.0	90.0	90.1	90.1	99.9

CALIBRATED BY: ROBERT STELLER (NAME) 4/21/2006 (DATE) Robt Steller (SIGNATURE)

Seismic recorder/Logger Calibration Data Sheet Rev 1.30 4-6-06

United States Department of Commerce
National Institute of Standards and Technology

NVLAP®

Certificate of Accreditation to ISO/IEC 17025:1999

NVLAP LAB CODE: 105014-0

Southern California Edison Company
Westminster, CA

is recognized by the National Voluntary Laboratory Accreditation Program for conformance with criteria set forth in NIST Handbook 150:2001 and all requirements of ISO/IEC 17025:1999. Accreditation is granted for specific services, listed on the Scope of Accreditation, for:

CALIBRATION LABORATORIES

2006-04-01 through 2007-03-31
Effective dates

For the National Institute of Standards and Technology

NVLAP-01C (REV. 2005-05-19)

NVLAP® National Voluntary Laboratory Accreditation Program

SCOPE OF ACCREDITATION TO ISO/IEC 17025:1999

Southern California Edison Company
7300 Fenwick Lane
Westminster, CA 92683
Ms. Jennifer E. Smith
Phone: 714-895-0133 Fax: 714-895-0781
E-mail: Jennifer.Smith@sce.com
URL: http://www.edisonmetrology.com

CALIBRATION LABORATORIES **NVLAP LAB CODE 105014-0**

NVLAP Code: 20/A01 ANSI/NCSL Z540-1-1994; Part 1 Compliant

DIMENSIONAL

NVLAP Code: 20/D03
Gage Blocks

Nominal Length in in	*Best Uncertainty (±) in μin* [note 1]
0.01 to < 0.05	1.9
0.05 to < 0.1	1.7
0.1 to < 1.0	1.2
1.0	1.4
2.0	1.8
3.0	2.2
4.0	2.9
5.0	5.4
6.0	5.6
7.0	5.8
8.0	6.0
10.0	6.8
12.0	7.2
16.0	8.1
20.0	9.4

2006-04-01 through 2007-03-31
Effective dates

For the National Institute of Standards and Technology

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CALIBRATION LABORATORIES **NVLAP LAB CODE 105014-0**

Nominal Length in mm	*Best Uncertainty (±) in nm* [note 1]
0.5 to < 1.0	52
1.0 to < 2.5	44
2.5 to < 25.0	39
25.0	44
50.0	47
75.0	60
100.0	80

NVLAP Code: 20/D11
Spherical Diameter; Ring Gages

Range in inches	*Best Uncertainty (±) in μin* [note 1]	*Remarks*
0.040 to 0.825	6	Comparison to gage blocks
> 0.825 to 1.510	7	Comparison to gage blocks
> 1.510 to 2.510	8	Comparison to gage blocks
> 2.510 to 4.510	12	Comparison to gage blocks
> 4.510 to 6.510	14	Comparison to gage blocks
> 6.510 to 9.010	16	Comparison to gage blocks
> 9.010 to 12.010	19	Comparison to gage blocks
> 12.010 to 13.25	31	Comparison to gage blocks

ELECTROMAGNETICS - DC/LOW FREQUENCY

NVLAP Code: 20/E02
AC Current

Range	*Best Uncertainty (±) in ppm* [note 1] *Frequency in Hz*			
	10	*20*	*40*	*400 to 10 k*
10 mA	270	199	127	116
20 mA	270	199	127	116
30 mA	270	199	127	116
50 mA	286	208	141	130
100 mA	270	199	127	116

2006-04-01 through 2007-03-31
Effective dates

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CALIBRATION LABORATORIES **NVLAP LAB CODE 105014-0**

200 mA	270	199	127	116
300 mA	270	199	127	116
500 mA	270	208	141	130

	10	*20*	*40*	*400 to 5 k*	*10 k*
1A	270	199	127	116	130

	10	*20*	*40*	*400 to 10 k*
2A	271	200	129	118
3A	271	200	129	118

	10	*20*	*40*	*400 to 5 k*	*10 k*
5A	286	209	142	132	148

	10	*20*	*40*	*400*	*1 k*	*5 k*	*10 k*
10A	273	233	132	121	121	143	143

	400 to 10 k
20A	144

NVLAP Code: 20/E05
DC Current

Range	*Best Uncertainty (±) in ppm* [note 1]
10 nA	2.9
100 nA	2.3
1 µA	2.0
10 µA	2.0
100 µA	2.0
1 mA	1.9
10 mA	1.9
100 mA	1.9
1 A	10.4
10 A	10.4
30 A	20.6

2006-04-01 through 2007-03-31
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CALIBRATION LABORATORIES **NVLAP LAB CODE 105014-0**

DC Resistance

Nominal Value in Ω	*Best Uncertainty (±) in ppm* [note 1]	*Remarks*
100 μ	8.20	Automated DC Resistance Calibration System
1 m	5.50	Automated DC Resistance Calibration System
10 m	3.70	Automated DC Resistance Calibration System
100 m	2.10	Automated DC Resistance Calibration System
1	0.40	Automated DC Resistance Calibration System
10	0.40	Automated DC Resistance Calibration System
25	0.50	Automated DC Resistance Calibration System
100	0.50	Automated DC Resistance Calibration System
1 k	0.50	Automated DC Resistance Calibration System
10 k	0.50	Automated DC Resistance Calibration System
100 k	1.50	Automated DC Resistance Calibration System
1 M	2.30	Automated DC Resistance Calibration System
10 M	3.30	Automated DC Resistance Calibration System
100 M	4.00	Automated DC Resistance Calibration System

NVLAP Code: 20/E06
DC Voltage

Range	*Best Uncertainty (±) in ppm* [notes 1,2]	*Remarks*
1.018 V	0.80	Automated DC Calibration System
10.00 V	0.20	Automated DC Calibration System
1.000 V	0.80	Automated DC Calibration System
1 mV to 100 mV	1.3 [note 6]	Ratiometric Measurement Techniques performed by voltage transfer utilizing a high precision voltage
100 mV	0.7	Ratiometric Measurement Techniques performed by voltage transfer utilizing a high precision voltage
1.0 V	0.3	Ratiometric Measurement Techniques performed by voltage transfer utilizing a high precision voltage

2006-04-01 through 2007-03-31
Effective dates

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For the National Institute of Standards and Technology

NVLAP® **National Voluntary Laboratory Accreditation Program**

DEPARTMENT OF COMMERCE · UNITED STATES OF AMERICA

CALIBRATION LABORATORIES **NVLAP LAB CODE 105014-0**

10.0 V	0.3	Ratiometric Measurement Techniques performed by voltage transfer utilizing a high precision voltage
20.0 V	0.5	Ratiometric Measurement Techniques performed by voltage transfer utilizing a high precision voltage
100.0 V	0.3	Ratiometric Measurement Techniques performed by voltage transfer utilizing a high precision voltage
1000.0 V	0.7	Ratiometric Measurement Techniques performed by voltage transfer utilizing a high precision voltage

NVLAP Code: 20/E09
LF AC Voltage

Best Uncertainty (±) in ppm *notes 1,3,4*
Frequency in Hz

Range	*10*	*20*	*40*	*100*	*1k*	*10k*	*20k*	*50k*	*100k*	*300k*	*500k*	*800k*	*1M*
2 mV	448	912	889	969	379	865	1073	405	1131	1265	2116	2595	2938
10 mV	119	230	102	177	245	169	180	220	343	243	676	425	488
20 mV	83	70	67	67	66	76	76	165	261	361	521	372	442
30 mV	134	111	80	78	62	63	71	133	219	345	535	688	791
100 mV	36	72	23	42	34	35	34	43	77	169	220	287	225
190 mV	36	31	22	20	21	26	21	42	80	136	124	264	215
300 mV	46	61	30	32	34	19	28	36	59	116	143	189	205
1 V	120	36	18	10	13	12	11	25	14	87	102	104	98
1.9 V	36	22	22	9	9	9	8	18	11	94	101	85	89
3 V	26	34	25	17	14	14	13	27	14	100	108	95	97
10 V	20	42	19	10	10	9	10	11	16	80	100	111	100
19 V	26	23	20	11	9	9	10	11	16	98	109	82	82
30 V	30	37	26	19	15	16	19	37	44	118			
100 V	140	46	20	16	15	19	11	40	22				
190 V	47	27	20	20	13	13	13	41	26				
300 V			37	29	18	27	22	29	46				
500 V			33	25	17	20	19	38	52				

2006-04-01 through 2007-03-31
Effective dates

For the National Institute of Standards and Technology

NVLAP® National Voluntary Laboratory Accreditation Program

CALIBRATION LABORATORIES **NVLAP LAB CODE 105014-0**

700 V	29	23	18	17	19	44	54
1000 V	22	23	21	19	22		

TIME AND FREQUENCY

NVLAP Code: 20/F01
Frequency Dissemination

Range	*Best Uncertainty (±)* note 1	*Remarks*
10 MHz	1.2×10^{-12}	GPS Receiver

MECHANICAL

NVLAP Code: 20/M05
Flow Rate

Nominal Flow Rate	*Best Uncertainty (±) in percent* notes 1, 5
(0.8 to 30) L/s	0.3
(0.1 to 800) mL/s	0.4
(0.006 to 0.1) mL/s	0.7

NVLAP Code: 20/M06
Force

Nominal Force in lb	*Best Uncertainty (±)* note 1	*Remarks*
2 to 200	0.025 %	Dead Weight
> 200 to 300	0.086 lb	Proving Ring
> 300 to 500	0.14 lb	Proving Ring
> 500 to 1000	0.28 lb	Proving Ring
> 1000 to 2000	0.55 lb	Proving Ring
> 2000 to 5000	0.84 lb	Proving Ring
> 5000 to 10 000	1.7 lb	Proving Ring
> 10 000 to 20 000	5.5 lb	Proving Ring
> 20 000 to 35 000	5.8 lb	Proving Ring
> 35 000 to 50 000	13 lb	Proving Ring

2006-04-01 through 2007-03-31
Effective dates

C D Faison
For the National Institute of Standards and Technology

NVLAP® National Voluntary Laboratory Accreditation Program

CALIBRATION LABORATORIES **NVLAP LAB CODE 105014-0**

> 50 000 to 60 000	16 lb	Proving Ring
> 60 000 to 100 000	26 lb	Proving Ring
> 100 000 to 300 000	113 lb	Proving Ring

NVLAP Code: 20/M08
Mass

Range	*Best Uncertainty (±) in mg* notes 1,2	*Remarks*
10 kg	2.3	Echelon I
5 kg	0.93	Echelon I
3 kg	0.65	Echelon I
2 kg	0.43	Echelon I
1 kg	0.052	Echelon I
500 g	0.043	Echelon I
300 g	0.041	Echelon I
200 g	0.034	Echelon I
100 g	0.020	Echelon I
50 g	0.013	Echelon I
30 g	0.013	Echelon I
20 g	0.0095	Echelon I
10 g	0.0073	Echelon I
5 g	0.0048	Echelon I
3 g	0.0038	Echelon I
2 g	0.0029	Echelon I
1 g	0.0030	Echelon I
500 mg	0.0017	Echelon I
300 mg	0.0013	Echelon I
200 mg	0.0010	Echelon I
100 mg	0.0009	Echelon I
50 mg	0.0007	Echelon I
30 mg	0.0007	Echelon I
20 mg	0.0005	Echelon I
10 mg	0.0005	Echelon I
5 mg	0.0006	Echelon I
3 mg	0.0006	Echelon I

2006-04-01 through 2007-03-31
Effective dates

C D Faison
For the National Institute of Standards and Technology

National Voluntary Laboratory Accreditation Program

CALIBRATION LABORATORIES **NVLAP LAB CODE 105014-0**

2 mg	0.0005	Echelon I
1 mg	0.0005	Echelon I
30 kg	56	Echelon II
20 kg	22	Echelon II

THERMODYNAMIC

NVLAP Code: 20/T05
Pressure

Range	*Best Uncertainty (±) in ppm* [note 1]	*Remarks*
> 1.5 to 50	20	Gas
> 50 to 1450	45	Gas
> 1450 to 16 000	90	Gas
> 1000 to 10 000	60	Oil
> 10 000 to 30 000	110	Oil
> 30 000 to 50 000	210	Oil

1. Represents an expanded uncertainty using a coverage factor, k = 2, at an approximate level of confidence of 95 %.
2. Approximate value. Actual value determined by the test statistics.
3. All ACV measurements performed via AC/DC transfer system.
4. Uncertainties listed are representative of the laboratory's accredited capabilities within the stated ranges. Accreditation is not limited to only those fixed values shown.
5. Dependent upon principle of operation of device being calibrated and its performance relative to standards at the time of the test.
6. The equation: uncert. = $(A + B/mVDC^2)^{0.5}$ (where A = 0.16 and B = 0.013333) is provided in order for potential customers to calculate approximate uncertainties for values down to 1 mV. Example: uncertainty at 1 mVDC would calculate to approximately ±115.47 ppm.
7. The laboratory maintains Echelon II capability for ranges 20 kg to 1 mg and separate Echelon III for all ranges.
8. Avoirdupois mass calibration services are available by comparison to equivalent metric standards. Uncertainties may be appropriately larger.

2006-04-01 through 2007-03-31
Effective dates

C D Faison
For the National Institute of Standards and Technology

MICRO PRECISION CALIBRATION INC.

12686 Hoover Street, Garden Grove, CA 92841
Ph. (714) 901-5659 Fax (714) 901-5649

Calibration Report

Customer: GEOVISION
Corona CA 92882
Account#: 15214
Cust PO#:
Page 1 of 2

MPC Ctrl#: AM6766
Report#: 199974
Print Date: 041006
MPC Job#: L25384

Instrument: Caliper Calibration Plate

Mfg: Robertson Geo Logging
Model: N/A
Size:
Res.:

Serial#: 201
Cust Ctrl#:
Location:
Department:

Work Performed: Inspected, cleaned, and calibrated.
Parts Replaced: None

Calibration Condition as Received: In tolerance
Calibration Condition as Returned: In tolerance

Functions/Parameters Tested

Actual Values (inch)	As Measured
1.969	1.965
3.937	3.939
8.000	7.995
12.00	11.9965

Unless noted otherwise, Pass/Fail criteria is based on published manufacturer specifications and, unless noted otherwise, this instrument meets these specifications.
Services provided comply with ISO 17025:1999, ISO 9001:2000, MPC QM rev.3, MPC CSD rev.2 and customer purchase order requirements as required.

Calibration standards used for performance testing:

MPC#	Instrument	Due Date	Traceability
K3263	Pratt & Whitney C Super Micrometer	060706	192068
I2111	Mitutoyo 516-126 Gage Block Set	082406	397060

Environmental: 69 Deg. / 40% Rh
Accuracy Ratio: 4:1
Cal Procedure: 33K6-4-552-1
Technician: CHRIS SPANGLER

Cal Int.: 12
Cal Date: 040606
Due Date: 040607
Quality Approval: QC 32

Form Cert 04-25-05

All standards used are either traceable to the National Institute of Standards and Technology or have intrinsic accuracy. All services performed have used proper manufacturer and industrial service techniques and are warranted for no less than (30) days. This report may not be reproduced in part without written permission of Micro Precision's Quality Assurance Manager.

GEOVision Borehole Geophysics depth wheel verification

Performed by Robert Steller on September 23, 2006

	Depth reading in #1	Depth reading out	Depth reading in #2
Depth wheel S/N 101 500 pulse/revolution Circumference = 983mm (3225.07 millifeet)	100.1 feet (30.51 m)	99.95 feet (30.46 m)	100.05 feet (30.50 m)
Depth wheel S/N 102 500 pulse/revolution Circumference = 994mm (3261.15 millifeet)	100.00 feet (30.48) m	100.05 feet (30.50 m)	100.00 feet (30.48) m
Aries winch 200 pulse/revolution Circumference = 305.9mm (1003.51 millifeet)	100.05 feet (30.50) m	100.05 feet (30.50 m)	100.00 feet (30.48) m
Depth wheel S/N 103 500 pulse/revolution Circumference = 1000mm (3.281 feet)			
Comprobe winch 500 pulse/revolution Circumference = 1000mm (3.281 feet)			

All measurements taken with a Stanley 100ft flexible stainless steel tape model number 34-130, and a Keeson 300 foot fiberglass tape, both marked in feet, inches and 1/8ths of inches. Enough cable was spooled off of the winch to allow the cable and tape measures to be laid flat on the parking lot surface side-by-side. A permanent marker was used to mark a 100.0 foot interval on the cable, and the marks were also tagged with electrical tape for visibility. The cable was then spooled back onto the winch. When the first mark was at the top of the measuring wheel, a matching permanent mark was placed, and the recording system (Robertson Micrologger) was set to 0.0 feet depth. The cable was spooled in to the second mark, and the distance was recorded. The recording system was set to 0.0 feet again, and the cable spooled out to the first mark again, and the distance was recorded. The process was repeated one more time to spool the cable back onto the winch, and the distance was recorded.

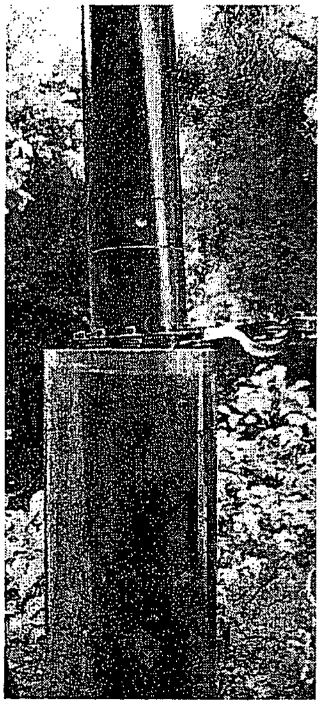
Estimated accuracy is of these measurements is +/- 0.1 foot or +/- 0.03m.

GEOVision Suspension PS probe Receiver 1–Receiver 2 (R1-R2) spacing verification

Performed by Robert Steller on September 23, 2006

	R2 center to R1 center hanging dry	R2 center to R1 center hanging submerged	R1 bottom to source center hanging submerged with 1m isolation tube S/N 280068
Receiver S/N 30086	40.2in 1.02m	40.0in 1.02m	76.0in 1.93m
Receiver S/N 20042	39.8in 1.01m	39.6in 1.01m	75.7in 1.92m
Receiver S/N 12008	40.2in 1.02m	40.0in 1.02m	76.0in 1.93m

All measurements taken with a Lufkin 3.7m flexible steel tape model number HV1034DM, marked in mm and 100th of feet. Probe suspended in 3-inch diameter clear PVC pipe, using chain clamp placed between bottom and center of Receiver 2 hard section (See Figure). Probe "bounced" to establish unrestricted hanging length before measurement. Probe allowed to relax for 5 minutes prior to each measurement. Water level set to submerge bottom of Receiver 2 hard section.. Estimated accuracy due to hysterisis in rubber section approximately +/- 0.01' or +/- 0.003m.



APPENDIX D

BORING GEOPHYSICAL LOGGING
FIELD DATA LOGS

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B-302 BORING GEOPHYSICS FIELD LOG SUMMARY

SITE: SOUTH TEXAS PROJECT COL DATE: 12/5/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 1 OF 1

CONTACT: MIKE SUFNARSKI PHONE: 704-357-5633

BOREHOLE CONSTRUCTION: CASED ___ UNCASED ✓
DIAMETERS AND DEPTH RANGES: 4 7/8" 0 TO 215 ; ___, ___ TO ___
BOREHOLE TOTAL DEPTH AS DRILLED: 215
CONDUCTOR CASING?: YES ✓ DEPTH TO BOTTOM OF CASING 20'; NO ___ AUGER
DEPTH TO BEDROCK: NA
BOREHOLE FLUID: WATER ___; FRESH WATER MUD ✓; SALT WATER MUD ___;

LOGGING CREW: R. STELLER, C. CARTER

LOG TYPE	FILE NAME	DEPTH RANGE	DATE	TIMES
ELOGTEST	B302ELOGTEST01	Ø	12/5/06	14:35 - 14:38
ELOG/GAMMA	B302ELOGLP01	218.0' - 37.2'	12/5/06	15:46 - 16:07
SUSPENSION PS	B302_001 - 116.ORD	19.7' - 205.1'	"	16:23 - 18:04
CALIPER TEST	B302CALTEST01	Ø	"	18:18 - 18:21
CALIPER/GAMMA	B302CALLP01	210.0' - Ø	"	18:40 - 19:05
CALIPER TEST	B302CALTEST02	Ø	"	19:08 - 19:11
DEVIATION	B302AULLP01	210.0' - 2.5'	"	19:28 - 19:48

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B-302 ELOG FIELD LOG

SITE: SOUTH TEXAS PROJECT COL DATE: 12/5/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 1 OF 2

CONTACT: ________ _OFFICE_ PHONE: ________
CELL PHONE: ________
CONTACT: ________ _OFFICE_ PHONE: ________
________ PHONE: ________
CONTACT: ________ ________ PHONE: ________
________ PHONE: ________
CONTACT: ________ ________ PHONE: ________
________ PHONE: ________
DRILLER: ________ ________ PHONE: ________
COMPANY: ________ ________ PHONE: ________

GENERAL SITE CONDITIONS/LOCATION: ________

BOREHOLE DESIGNATION: B-302-DH LOCATION: ________

COUNTY: ________ RANGE: ________ TOWNSHIP: ________ SECTION: ________
BOREHOLE CONSTRUCTION: CASED ____ UNCASED ✓
DIAMETERS AND DEPTH RANGES: 4 7/8" 0 TO 215' ; ____, ____ TO ____
BOREHOLE TOTAL DEPTH AS DRILLED: 215'
CONDUCTOR CASING?: YES ___ DEPTH TO BOTTOM OF CASING ____; NO ___
DEPTH TO BEDROCK: NA DEPTH TO WATER TABLE: ____
BOREHOLE FLUID: WATER ____; FRESH WATER MUD ✓; SALT WATER MUD ____;
OTHER: ________
DEPTH TO BOREHOLE FLUID: Ø TIME SINCE LAST CIRCULATION: ½ hr

LOGGING CREW: R. STELLER, C. CARTER
VEHICLE(S) USED AND MILEAGE: RENTAL
MOBILIZED FROM: BAY CITY, TX DEPARTURE TIME: 06:30
ARRIVED ON SITE: 07:00
STANDBY TIME: ________ CAUSE: ________
LOGGING STARTED: 14:35 LOGGING COMPLETED: 16:07

SITE:_SOUTH TEXAS PROJECT COL B-302 DATE: 12/5/06
CLIENT:_MACTEC JOB:_6533
AUTHOR:_R. STELLER PAGE 2 OF 2

WINCH: COMPROBE____ SILVER ✓ OYO____ OTHER____
MICROLOGGER 5301 ✓ OTHER____
ELOG PROBE 5490 ✓ OTHER____

PROBE LENGTH	2.50M(8.20 FT)	
PLUS YOKE 10.0M (32.8 FT)	32.8'	
MINUS CASING STICK-UP	- 1.6'	
DEPTH REF. OFFSET AT START	39.4'	
DEPTH REF. OFFSET AT END	39.3'	
AFTER SURVEY DEPTH ERROR	-0.1'	LESS THAN 0.4%? YES

LOG NAME	START DEPTH	START TIME	END DEPTH	END TIME
B302ELOGTEST01	Ø	14:35	Ø	14:38
B302ELOGUP01	218.0'	15:46	37.2'	16:07

MAINTENANCE PERFORMED ON SITE:____

EQUIPMENT PROBLEMS OR FAILURES:____

SUGGESTIONS, ADDITIONS, CHANGES:____

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P-S SUSPENSION VELOCITY FIELD LOG

SITE: SOUTH TEXAS PROJECT COL B-302 DATE: 12/5/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 1 OF ____

CONTACT: MIKE SUFNARSKI OFFICE PHONE: 704-357-5633
CELL PHONE: 704-309-0624
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: 4 7/8 0 TO 215' ; ____ ____ TO ____
BOREHOLE TOTAL DEPTH AS DRILLED: 215
CONDUCTOR CASING?: YES ✓ DEPTH TO BOTTOM OF CASING 20'; NO ____ Auger.
DEPTH TO BEDROCK: NA DEPTH TO WATER TABLE: ≈20'
BOREHOLE FLUID: WATER ____; FRESH WATER MUD ✓; SALT WATER MUD ____;
OTHER: ____
DEPTH TO BOREHOLE FLUID: ∅ TIME SINCE LAST CIRCULATION: 1 HR

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SITE: SOUTH TEXAS PROJECT COL B-302 DATE: 12/5/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 2 OF

LOGGING CREW: R. STELLER, C. CARTER
VEHICLE(S) USED AND MILEAGE: RENTAL
MOBILIZED FROM: BAY CITY, TX DEPARTURE TIME: 06:30
ARRIVED ON SITE: 07:00
STANDBY TIME: CAUSE:
LOGGING STARTED: 16:23 LOGGING COMPLETED: 18:04
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 ☐	30086 ☑

MAINTENANCE PERFORMED ON SITE:

EQUIPMENT PROBLEMS OR FAILURES:

SUGGESTIONS, ADDITIONS, CHANGES:

COMMENTS: START DEPTH = 8.2' - 1.6' = 6.6' => 2.0 m.
EXIT DEPTH = 1.96 m

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GEOVISION SUSPENSION LOGGING FIELD NOTES

SITE: SOUTH TEXAS COL B-302 DATE: 12/5/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 3 OF 6

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	001		AUGER TO ≈ 20'
6.5	21.33	2		
7.0	22.97	3		
7.5	24.61	4		
8.0	26.25	5		
8.5	27.89	6		
9.0	29.53	7		
9.5	31.17	8		
10.0	32.81	9		
10.5	34.45	10		
11.0	36.09	11		
11.5	37.73	12		
12.0	39.37	13		
12.5	41.01	14		
13.0	42.65	15		
13.5	44.29	16		
14.0	45.93	17		
14.5	47.57	18		
15.0	49.21	19		
15.5	50.85	20		
16.0	52.49	21		
16.5	54.13	22		
17.0	55.77	23		
17.5	57.41	24		
18.0	59.06	25		
18.5	60.70	26		
19.0	62.34	27		
19.5	63.98	28		
20.0	65.62	29		

GEOVISION SUSPENSION LOGGING FIELD NOTES

SITE:_SOUTH TEXAS COL B-302 DATE: 12/5/06
CLIENT:__MACTEC JOB:_6533
AUTHOR:_R. STELLER PAGE 4 OF 6

DEPTH METERS	DEPTH FEET	UNFILTERED FILE NO.	FILTERED FILE NO.	COMMENTS CASING, WATER, ROCK, ETC
20.5	67.26	30		
21.0	68.90	31		
21.5	70.54	32		
22.0	72.18	33		
22.5	73.82	34		
23.0	75.46	35		
23.5	77.10	36		
24.0	78.74	37		
24.5	80.38	38		
25.0	82.02	39		
25.5	83.66	40		
26.0	85.30	41		
26.5	86.94	42		
27.0	88.58	43		
27.5	90.22	44		
28.0	91.86	45		
28.5	93.50	46		
29.0	95.14	47		
29.5	96.78	48		
30.0	98.43	49		
30.5	100.07	50		
31.0	101.71	51		
31.5	103.35	52		
32.0	104.99	53		
32.5	106.63	54		
33.0	108.27	55		
33.5	109.91	56		
34.0	111.55	57		
34.5	113.19	58		
35.0	114.83	59		
35.5	116.47	60		
36.0	118.11	61		
36.5	119.75	62		
37.0	121.39	63		
37.5	123.03	64		
38.0	124.67	65		
38.5	126.31	66		
39.0	127.95	67		
39.5	129.59	68		
40.0	131.23	69		

GEOVISION SUSPENSION LOGGING FIELD NOTES

SITE: SOUTH TEXAS COL B-302 DATE: 12/5/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 5 OF 6

DEPTH METERS	DEPTH FEET	UNFILTERED FILE NO.	FILTERED FILE NO.	COMMENTS CASING, WATER, ROCK, ETC
40.5	132.87	70		
41.0	134.51	71		
41.5	136.15	72		
42.0	137.80	73		
42.5	139.44	74		
43.0	141.08	75		
43.5	142.72	76		
44.0	144.36	77		
44.5	146.00	78		
45.0	147.64	79		
45.5	149.28	80		
46.0	150.92	81		
46.5	152.56	82		
47.0	154.20	83		
47.5	155.84	84		
48.0	157.48	85		
48.5	159.12	86		
49.0	160.76	87		
49.5	162.40	88		
50.0	164.04	89		
50.5	165.68	90		
51.0	167.32	91		
51.5	168.96	92		
52.0	170.60	93		
52.5	172.24	94		
53.0	173.88	95		
53.5	175.52	96		
54.0	177.17	97		
54.5	178.81	98		
55.0	180.45	99		
55.5	182.09	100		
56.0	183.73	101		
56.5	185.37	102		
57.0	187.01	103		
57.5	188.65	104		
58.0	190.29	105		
58.5	191.93	106		
59.0	193.57	107		
59.5	195.21	108		
60.0	196.85	109		

GEOVISION SUSPENSION LOGGING FIELD NOTES

SITE: SOUTH TEXAS COL B-302 DATE: 12/5/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 6 OF 6

DEPTH METERS	DEPTH FEET	UNFILTERED FILE NO.	FILTERED FILE NO.	COMMENTS CASING, WATER, ROCK, ETC
60.5	198.49	110		
61.0	200.13	111		
61.5	201.77	112		
62.0	203.41	113		BOTTOM MEASUREMENT?
62.5	205.05	114		HIT @ 62.7 m.
63.0	206.69			
63.5	208.33			
64.0	209.97			
64.5	211.61			
65.0	213.25			
65.5	214.90			T.D.
66.0	216.54			
66.5	218.18			
67.0	219.82			
67.5	221.46			
68.0	223.10			
68.5	224.74			
69.0	226.38			
69.5	228.02			
70.0	229.66			
70.5	231.30			
71.0	232.94			
71.5	234.58			
72.0	236.22			
72.5	237.86			
73.0	239.50			
73.5	241.14			
74.0	242.78			
74.5	244.42			
75.0	246.06			
75.5	247.70			
76.0	249.34			
76.5	250.98			
77.0	252.62			
77.5	254.27			
78.0	255.91			
78.5	257.55			
79.0	259.19			
79.5	260.83			
80.0	262.47			

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B-302 CALIPER FIELD LOG

SITE: SOUTH TEXAS PROJECT COL DATE: 12/5/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 1 OF 2

CONTACT: MIKE SUFNARSKI OFFICE PHONE:
CELL PHONE: 704-357-5633
CONTACT: OFFICE PHONE:
PHONE:
CONTACT: PHONE:
PHONE:
CONTACT: PHONE:
PHONE:
DRILLER: PHONE:
COMPANY: PHONE:

GENERAL SITE CONDITIONS/LOCATION:

BOREHOLE DESIGNATION: B-302-DH LOCATION:

COUNTY: RANGE: TOWNSHIP: SECTION:
BOREHOLE CONSTRUCTION: CASED UNCASED ✓
DIAMETERS AND DEPTH RANGES: 4 7/8" 0 TO 215' ; , TO
BOREHOLE TOTAL DEPTH AS DRILLED: 215'
CONDUCTOR CASING?: YES ✓ DEPTH TO BOTTOM OF CASING 20' ; NO Auger
DEPTH TO BEDROCK: NA DEPTH TO WATER TABLE: ≈20'
BOREHOLE FLUID: WATER ; FRESH WATER MUD ✓ ; SALT WATER MUD ;
OTHER:
DEPTH TO BOREHOLE FLUID: ϕ TIME SINCE LAST CIRCULATION:

LOGGING CREW: R. STELLER, C. CARTER
VEHICLE(S) USED AND MILEAGE: RENTAL
MOBILIZED FROM: BAY CITY, TX DEPARTURE TIME:
ARRIVED ON SITE:
STANDBY TIME: CAUSE:
LOGGING STARTED: LOGGING COMPLETED:

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SITE:_SOUTH TEXAS PROJECT COL B-302 DATE: 12/5/06
CLIENT:_MACTEC JOB:_6533
AUTHOR:_R. STELLER PAGE 2 OF 2

WINCH: COMPROBE___ SILVER ✓ OYO___ OTHER___
MICROLOGGER 5301 ✓ OTHER___
CALIPER PROBE 5368 ✓ OTHER___

PROBE OFFSET	2.08M(6.82 FT) 12 IN MAX	
MINUS CASING STICK-UP	1.6'	
DEPTH REF. OFFSET AT START	5.22'	
DEPTH REF. OFFSET AT END	5.15	
AFTER SURVEY DEPTH ERROR	-0.07	LESS THAN 0.4%? YES

LOG NAME	START DEPTH	START TIME	END DEPTH	END TIME
B302CALTEST01	Ø	18:18	Ø	18:21
B302CALUP01	210.0'	18:40	Ø	19:05
B302 CALTEST02	Ø	19:08	Ø	19:11

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.	B302CALTEST01	2.00	3.94	8.02	4.55
AS MEAS.	B302 CALTEST 02	1.98	3.94	7.99	4.50
AS MEAS.					
AS MEAS.					
AS MEAS.					
AS MEAS.					

MAINTENANCE PERFORMED ON SITE:___

EQUIPMENT PROBLEMS OR FAILURES:___

SUGGESTIONS, ADDITIONS, CHANGES:___

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B-302 ACOUSTIC TELEVIEWER FIELD LOG

SITE: SOUTH TEXAS PROJECT COL DATE: 12/5/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 1 OF 2

CONTACT: MIKE SUFNARSKI OFFICE PHONE: 704-357-5633
CELL PHONE: 704-309-0624
CONTACT: OFFICE PHONE:
PHONE:
CONTACT: PHONE:
PHONE:
CONTACT: PHONE:
PHONE:
DRILLER: PHONE:
COMPANY: PHONE:

DIRECTIONS TO SITE:

GENERAL SITE CONDITIONS/LOCATION:

BOREHOLE DESIGNATION: B-302-DH LOCATION:

COUNTY: RANGE: TOWNSHIP: SECTION:
BOREHOLE CONSTRUCTION: CASED UNCASED ✓
DIAMETERS AND DEPTH RANGES: 4 7/8 0 TO 218' ; , TO
BOREHOLE TOTAL DEPTH AS DRILLED: 215'
CONDUCTOR CASING?: YES ✓ DEPTH TO BOTTOM OF CASING 20' ; NO Auger
DEPTH TO BEDROCK: NA DEPTH TO WATER TABLE: ≈20'
BOREHOLE FLUID: WATER ; FRESH WATER MUD ✓ ; SALT WATER MUD ;
OTHER:
DEPTH TO BOREHOLE FLUID: ∅ TIME SINCE LAST CIRCULATION: ≈1 HR

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SITE:_SOUTH TEXAS PROJECT COL B-302 DATE: 12/5/06
CLIENT:_MACTEC JOB:_6533
AUTHOR:_R. STELLER PAGE 2 OF 2

LOGGING CREW:_R. STELLER, C. CARTER
VEHICLE(S) USED AND MILEAGE: _RENTAL
MOBILIZED FROM: BAY CITY, TX DEPARTURE TIME:
ARRIVED ON SITE:
STANDBY TIME: CAUSE:
LOGGING STARTED: 19:28 LOGGING COMPLETED: 19:48

WINCH: COMPROBE___ SILVER ✓ OYO___ OTHER___
MICROLOGGER 5301 ✓ OTHER___
TELEVIEWER ACOUSTIC #5174 ✓ OTHER___

PROBE TILT TEST 88.3° BRUNTON TILT 87°
PROBE TILT TEST ___ BRUNTON TILT ___
PROBE TILT TEST ___ BRUNTON TILT ___
PROBE AZIMUTH TEST 299.40 BRUNTON AZIMUTH 300°
PROBE AZIMUTH TEST 212.4 BRUNTON AZIMUTH 209°
PROBE AZIMUTH TEST ___ BRUNTON AZIMUTH ___

PROBE OFFSET	1.44M(4.72FT)	
MINUS CASING STICK-UP	1.6'	
DEPTH REF. OFFSET AT START	3.12'	
DEPTH REF. OFFSET AT END	3.20	
AFTER SURVEY DEPTH ERROR	+0.08	LESS THAN 0.4%? YES

LOG NAME	START DEPTH	START TIME	END DEPTH	END TIME
B302 AMUP 01	210.0'	19:28	2.5'	19:48

MAINTENANCE PERFORMED ON SITE:

EQUIPMENT PROBLEMS OR FAILURES:

SUGGESTIONS, ADDITIONS, CHANGES:

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B-305-DHA BORING GEOPHYSICS FIELD LOG SUMMARY

SITE: SOUTH TEXAS PROJECT COL DATE: 12/19/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 1 OF 1

CONTACT: MIKE SUFNARSKI PHONE: 704-357-5633

BOREHOLE CONSTRUCTION: CASED____ UNCASED ✓
DIAMETERS AND DEPTH RANGES: 6" 0 TO 618' ; ____, ____ TO ____
BOREHOLE TOTAL DEPTH AS DRILLED: 618'
CONDUCTOR CASING?: YES ✓ DEPTH TO BOTTOM OF CASING 53' ; NO AUGER
DEPTH TO BEDROCK: NA
BOREHOLE FLUID: WATER____; FRESH WATER MUD ✓; SALT WATER MUD ____;

LOGGING CREW: R. STELLER

LOG TYPE	FILE NAME	DEPTH RANGE	DATE	TIMES
ELOG-TEST	B305ELOGTEST03	0	12/19/06	13:30 - 13:33
ELOG/GAMMA	B305ELOGU03	575.0' - 18.1'	"	14:09 - 15:08

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B-305DHA ELOG FIELD LOG

SITE: SOUTH TEXAS PROJECT COL DATE: 12/19/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 1 OF 2

CONTACT: _OFFICE_ PHONE:
CELL PHONE:
CONTACT: _OFFICE_ PHONE:
PHONE:
CONTACT: PHONE:
PHONE:
CONTACT: PHONE:
PHONE:
DRILLER: PHONE:
COMPANY: PHONE:

GENERAL SITE CONDITIONS/LOCATION:

BOREHOLE DESIGNATION: B-305-DHA LOCATION:

COUNTY: RANGE: TOWNSHIP: SECTION:
BOREHOLE CONSTRUCTION: CASED ___ UNCASED ✓
DIAMETERS AND DEPTH RANGES: 6" 0 TO 618' ; ___, ___ TO ___
BOREHOLE TOTAL DEPTH AS DRILLED: 618'
CONDUCTOR CASING?: YES ✓ DEPTH TO BOTTOM OF CASING 53' ; NO Auger
DEPTH TO BEDROCK: NA DEPTH TO WATER TABLE: ≈20'
BOREHOLE FLUID: WATER ___; FRESH WATER MUD ✓; SALT WATER MUD ___;
OTHER:
DEPTH TO BOREHOLE FLUID: 0 TIME SINCE LAST CIRCULATION: ≤ 1 HR

LOGGING CREW: R. STELLER
VEHICLE(S) USED AND MILEAGE: RENTAL
MOBILIZED FROM: BAY CITY, TX DEPARTURE TIME: 12:30
ARRIVED ON SITE: 13:00
STANDBY TIME: NA CAUSE: NA
LOGGING STARTED: 13:30 LOGGING COMPLETED: 15:08

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

SITE: SOUTH TEXAS PROJECT COL B-305-DHA DATE: 12/19/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 2 OF 2

WINCH: COMPROBE____ SILVER ✓ OYO____ OTHER____
MICROLOGGER 5301 ✓ OTHER____
ELOG PROBE 5490 ✓ OTHER____

PROBE LENGTH	2.50M(8.20 FT)	
PLUS YOKE 10.0M (32.8 FT)	+ 32.8'	
MINUS CASING STICK-UP	− 2.25	
DEPTH REF. OFFSET AT START	38.75'	
DEPTH REF. OFFSET AT END	38.45'	
AFTER SURVEY DEPTH ERROR	−0.35'	LESS THAN 0.4%? YES

LOG NAME	START DEPTH	START TIME	END DEPTH	END TIME
B305ELOGTEST03	Ø	13:30	Ø	13:35
B305ELOGUP05	575.0	14:09	18.1	15:08

MAINTENANCE PERFORMED ON SITE:

EQUIPMENT PROBLEMS OR FAILURES:

SUGGESTIONS, ADDITIONS, CHANGES: SLUDGING ≈ 560' → HIT OBSTACLE @ 575.8'

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B-305-DHA BORING GEOPHYSICS FIELD LOG SUMMARY

SITE: SOUTH TEXAS PROJECT COL DATE: 12/18/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 1 OF 1

CONTACT: MIKE SUFNARSKI PHONE: 704-357-5633

BOREHOLE CONSTRUCTION: CASED____ UNCASED ✓
DIAMETERS AND DEPTH RANGES: 6" 0 TO 598' ; 3 7/8" , 598' TO 618'
BOREHOLE TOTAL DEPTH AS DRILLED: 618'
CONDUCTOR CASING?: YES ✓ DEPTH TO BOTTOM OF CASING 53' ; NO AUGER
DEPTH TO BEDROCK: NA
BOREHOLE FLUID: WATER____; FRESH WATER MUD ✓ ; SALT WATER MUD ____;

LOGGING CREW: R. STELLER

LOG TYPE	FILE NAME	DEPTH RANGE	DATE	TIMES
ELOG TEST	B305ELOGTEST02	Ø	12/18/06	16:00 – 16:05
ELOG/GAMMA	B305ELOGUP02	583.0' – 19.0'	"	16:43 – 17:46
SUSPENSION PS	B305_101 → 410.SR6	60.7' – 565.9'	"	18:10 – 21:42
CALIPER TEST	B305CALTEST03	Ø	"	~~18~~ 22:04 – 22:07
CALIPER/GAMMA	B305CALUP02	579.0' – Ø	"	22:24 – 23:21
CALIPER TEST	B305CALTEST04	Ø	"	23:27 – 23:30
DEVIATION	B305AUUP02	582.5' – Ø	"	23:53 – 00:21

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B-305 OH A ELOG FIELD LOG

SITE: SOUTH TEXAS PROJECT COL DATE: 12/18/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 1 OF 2

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

GENERAL SITE CONDITIONS/LOCATION: SUNNY, CLEAR ~70°F

BOREHOLE DESIGNATION: B-305-OHA LOCATION: _____

COUNTY: _____ RANGE: _____ TOWNSHIP: _____ SECTION: _____
BOREHOLE CONSTRUCTION: CASED _____ UNCASED ✓
DIAMETERS AND DEPTH RANGES: 6" 0 TO 598'; 3 7/8, 598' TO 618
BOREHOLE TOTAL DEPTH AS DRILLED: 618'
CONDUCTOR CASING?: YES ✓ DEPTH TO BOTTOM OF CASING 53'; NO AUGER
DEPTH TO BEDROCK: NA DEPTH TO WATER TABLE: ~20'
BOREHOLE FLUID: WATER _____; FRESH WATER MUD ✓; SALT WATER MUD _____;
OTHER: _____
DEPTH TO BOREHOLE FLUID: Ø TIME SINCE LAST CIRCULATION: <1HR

LOGGING CREW: R. STELLER
VEHICLE(S) USED AND MILEAGE: RENTAL
MOBILIZED FROM: GRANBURY, TX DEPARTURE TIME: 03:00
ARRIVED ON SITE: 11:00
STANDBY TIME: NA CAUSE: NA
LOGGING STARTED: 16:00 LOGGING COMPLETED: 17:46

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SITE:_SOUTH TEXAS PROJECT COL B-305 DATE: 12/18/06
CLIENT:_MACTEC JOB:_6533
AUTHOR:_R. STELLER PAGE 2 OF 2

WINCH: COMPROBE___ SILVER ✓ OYO___ OTHER___
MICROLOGGER 5301 ✓ OTHER___
ELOG PROBE 5490 ✓ OTHER___

PROBE LENGTH	2.50M(8.20 FT)
PLUS YOKE 10.0M (32.8 FT)	+32.8'
MINUS CASING STICK-UP	-2.25'
DEPTH REF. OFFSET AT START	38.75'
DEPTH REF. OFFSET AT END	39.45
AFTER SURVEY DEPTH ERROR	+0.70' LESS THAN 0.4%? YES

LOG NAME	START DEPTH	START TIME	END DEPTH	END TIME
B305ELOGTEST02	⌀	16:00	⌀	16:05
B305ELOGUP02	605.0'	16:43	19.0'	17:46

MAINTENANCE PERFORMED ON SITE:

EQUIPMENT PROBLEMS OR FAILURES: PULLED @ 583' - TRUE START DEPTH OF VALID DATA.

SUGGESTIONS, ADDITIONS, CHANGES: 931-242-6501 GLEN

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P-S SUSPENSION VELOCITY FIELD LOG

SITE: SOUTH TEXAS PROJECT COL B-305-DHA DATE: 12/18/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 1 OF 12

CONTACT: MIKE SUFNARSKI OFFICE PHONE: 704-357-5633
CELL PHONE: 704-309-0624
CONTACT: OFFICE PHONE:
PHONE:
CONTACT: PHONE:
PHONE:
CONTACT: PHONE:
PHONE:
DRILLER: PHONE:
COMPANY: PHONE:

DIRECTIONS TO SITE:

GENERAL SITE CONDITIONS/LOCATION:

EA#:
BOREHOLE DESIGNATION: B-305-DHA LOCATION:

COUNTY: RANGE: TOWNSHIP: SECTION:
BOREHOLE CONSTRUCTION: CASED UNCASED ✓
DIAMETERS AND DEPTH RANGES: 6" 0 TO 598' ; 3⅞, 598 TO 618
BOREHOLE TOTAL DEPTH AS DRILLED: 618
CONDUCTOR CASING?: YES ✓ DEPTH TO BOTTOM OF CASING 53' ; NO AUGER
DEPTH TO BEDROCK: NA DEPTH TO WATER TABLE: ≈20'
BOREHOLE FLUID: WATER ; FRESH WATER MUD ✓ ; SALT WATER MUD ;
OTHER:
DEPTH TO BOREHOLE FLUID: Ø TIME SINCE LAST CIRCULATION: 02HR

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SITE: SOUTH TEXAS PROJECT COL B-305 DATE: 12/18/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 2 OF 2

LOGGING CREW: R. STELLER
VEHICLE(S) USED AND MILEAGE: RENTAL
MOBILIZED FROM: GRANBURY, TX DEPARTURE TIME: 05:00
ARRIVED ON SITE: 11:00
STANDBY TIME: NA CAUSE: NA
LOGGING STARTED: 18:10 LOGGING COMPLETED: 21:42
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 ☐	30086 ☑

MAINTENANCE PERFORMED ON SITE:

EQUIPMENT PROBLEMS OR FAILURES:

SUGGESTIONS, ADDITIONS, CHANGES:

COMMENTS: DEPTH ZERO = 2.5m - 0.7m = 1.8m
END DEPTH ZERO = 1.76
ASDE = -0.04 m.

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GEOVISION SUSPENSION LOGGING FIELD NOTES

SITE: SOUTH TEXAS COL B-305 DATE: 12/18/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 3 OF 12

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			Steel case (auger) to 53'
17.0	55.77			
17.5	57.41			
18.0	59.06			
18.5	60.70	101		
19.0	62.34	102		
19.5	63.98	103		
20.0	65.62	104		

GEOVISION SUSPENSION LOGGING FIELD NOTES

SITE: SOUTH TEXAS COL B-305 DATE: 12/18/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 4 OF 12

DEPTH METERS	DEPTH FEET	UNFILTERED FILE NO.	FILTERED FILE NO.	COMMENTS CASING, WATER, ROCK, ETC
20.5	67.26	105		
21.0	68.90	106		
21.5	70.54	107		
22.0	72.18	108		
22.5	73.82	109		
23.0	75.46	110		
23.5	77.10	111		
24.0	78.74	112		
24.5	80.38	113		
25.0	82.02	114		
25.5	83.66	115		
26.0	85.30	116		
26.5	86.94	117		
27.0	88.58	118		
27.5	90.22	119		
28.0	91.86	120		
28.5	93.50	121		
29.0	95.14	122		
29.5	96.78	123		
30.0	98.43	124		
30.5	100.07	125		
31.0	101.71	126		
31.5	103.35	127		
32.0	104.99	128		
32.5	106.63	129		
33.0	108.27	130		
33.5	109.91	131		
34.0	111.55	132		
34.5	113.19	133		
35.0	114.83	134		
35.5	116.47	135		
36.0	118.11	136		
36.5	119.75	137		
37.0	121.39	138		
37.5	123.03	139		
38.0	124.67	140		
38.5	126.31	141		
39.0	127.95	142 RAS 12/18/06		
39.5	129.59	143		
40.0	131.23	144		

GEOVISION SUSPENSION LOGGING FIELD NOTES

SITE:_SOUTH TEXAS COL B-305 DATE: 12/18/06
CLIENT:__MACTEC JOB:_6533
AUTHOR:_R. STELLER PAGE 5 OF 12

DEPTH METERS	DEPTH FEET	UNFILTERED FILE NO.	FILTERED FILE NO.	COMMENTS CASING, WATER, ROCK, ETC
40.5	132.87	145		
41.0	134.51	146		
41.5	136.15	147		
42.0	137.80	148		
42.5	139.44	149		
43.0	141.08	150		
43.5	142.72	151		
44.0	144.36	152		
44.5	146.00	153		
45.0	147.64	154		
45.5	149.28	155		
46.0	150.92	156		
46.5	152.56	157		
47.0	154.20	158		
47.5	155.84	159		
48.0	157.48	160		
48.5	159.12	161		
49.0	160.76	162		
49.5	162.40	163		
50.0	164.04	164		
50.5	165.68	165		
51.0	167.32	166		
51.5	168.96	167		
52.0	170.60	168		
52.5	172.24	169		
53.0	173.88	170		
53.5	175.52	171		
54.0	177.17	172		
54.5	178.81	173		
55.0	180.45	174		
55.5	182.09	175		
56.0	183.73	176		
56.5	185.37	177		
57.0	187.01	178		
57.5	188.65	179		
58.0	190.29	180		
58.5	191.93	181		
59.0	193.57	182		
59.5	195.21	183		
60.0	196.85	184		

GEOVISION SUSPENSION LOGGING FIELD NOTES

SITE: SOUTH TEXAS COL B-305 DATE: 12/18/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 6 OF 12

DEPTH METERS	DEPTH FEET	UNFILTERED FILE NO.	FILTERED FILE NO.	COMMENTS CASING, WATER, ROCK, ETC
60.5	198.49	185		
61.0	200.13	186		
61.5	201.77	187		
62.0	203.41	188		
62.5	205.05	189		
63.0	206.69	190		
63.5	208.33	191		
64.0	209.97	192		
64.5	211.61	193		
65.0	213.25	194		
65.5	214.90	195		
66.0	216.54	196		
66.5	218.18	197		
67.0	219.82	198		
67.5	221.46	199		
68.0	223.10	200		
68.5	224.74	201		
69.0	226.38	202		
69.5	228.02	203		
70.0	229.66	204		
70.5	231.30	205		
71.0	232.94	206		
71.5	234.58	207		
72.0	236.22	208		
72.5	237.86	209		
73.0	239.50	210		
73.5	241.14	211		
74.0	242.78	212		
74.5	244.42	213		
75.0	246.06	214		
75.5	247.70	215, 216		
76.0	249.34	217		
76.5	250.98	218		
77.0	252.62	219		
77.5	254.27	220		
78.0	255.91	221		
78.5	257.55	222		
79.0	259.19	223		
79.5	260.83	234		
80.0	262.47	225		

GEOVISION SUSPENSION LOGGING FIELD NOTES

SITE: SOUTH TEXAS COL B-305 DATE: 12/18/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 7 OF 12

DEPTH METERS	DEPTH FEET	UNFILTERED FILE NO.	FILTERED FILE NO.	COMMENTS CASING, WATER, ROCK, ETC
80.5	264.11	226		
81.0	265.75	227		
81.5	267.39	228		
82.0	269.03	229		
82.5	270.67	230		
83.0	272.31	231		
83.5	273.95	232		
84.0	275.59	233		
84.5	277.23	234		
85.0	278.87	235		
85.5	280.51	236		
86.0	282.15	237		
86.5	283.79	238		
87.0	285.43	239		
87.5	287.07	240		
88.0	288.71	241		
88.5	290.35	242		
89.0	291.99	243		
89.5	293.64	244		
90.0	295.28	245		
90.5	296.92	246		
91.0	298.56	247		
91.5	300.20	248		
92.0	301.84	249		
92.5	303.48	250		
93.0	305.12	251		
93.5	306.76	252		
94.0	308.40	253		
94.5	310.04	254		
95.0	311.68	255		
95.5	313.32	256		
96.0	314.96	257		
96.5	316.60	258		
97.0	318.24	259		
97.5	319.88	260		
98.0	321.52	261		
98.5	323.16	262		
99.0	324.80	263		
99.5	326.44	264		
100.0	328.08	265		

GEOVISION SUSPENSION LOGGING FIELD NOTES

SITE: SOUTH TEXAS COL B-305 DATE: 12/18/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 8 OF 12

DEPTH METERS	DEPTH FEET	UNFILTERED FILE NO.	FILTERED FILE NO.	COMMENTS CASING, WATER, ROCK, ETC
100.5	329.72	266		
101.0	331.36	267		
101.5	333.01	268		
102.0	334.65	269		
102.5	336.29	270		
103.0	337.93	271		
103.5	339.57	272		
104.0	341.21	273		
104.5	342.85	274		
105.0	344.49	275		
105.5	346.13	276		
106.0	347.77	277		
106.5	349.41	278		
107.0	351.05	279		
107.5	352.69	280		
108.0	354.33	281		
108.5	355.97	282		
109.0	357.61	283		
109.5	359.25	284		
110.0	360.89	285		
110.5	362.53	286		
111.0	364.17	287		365 - 397.5 HARD ZONE
111.5	365.81	288		ACOO
112.0	367.45	289		
112.5	369.09	290		
113.0	370.73	291		
113.5	372.38	292		
114.0	374.02	293		
114.5	375.66	294		
115.0	377.30	295		
115.5	378.94	296		
116.0	380.58	297		
116.5	382.22	298		
117.0	383.86	299		
117.5	385.50	300		
118.0	387.14	301		
118.5	388.78	302		
119.0	390.42	303		
119.5	392.06	304		
120.0	393.70	305		

GEOVISION SUSPENSION LOGGING FIELD NOTES

SITE: SOUTH TEXAS COL B-305 DATE: 12/18/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 9 OF 12

DEPTH METERS	DEPTH FEET	UNFILTERED FILE NO.	FILTERED FILE NO.	COMMENTS CASING, WATER, ROCK, ETC
120.5	395.34	306		
121.0	396.98	307		
121.5	398.62	308		
122.0	400.26	309		
122.5	401.90	310		
123.0	403.54	311		
123.5	405.18	312		
124.0	406.82	313		
124.5	408.46	314		
125.0	410.10	315		
125.5	411.75	316		
126.0	413.39	317		
126.5	415.03	318		
127.0	416.67	319		
127.5	418.31	320		
128.0	419.95	321		
128.5	421.59	322		
129.0	423.23	323		
129.5	424.87	324		
130.0	426.51	325		
130.5	428.15	326		
131.0	429.79	327		
131.5	431.43	328		
132.0	433.07	329		
132.5	434.71	330		
133.0	436.35	331		
133.5	437.99	332		
134.0	439.63	333		
134.5	441.27	334		
135.0	442.91	335		
135.5	444.55	336		
136.0	446.19	337		
136.5	447.83	338		
137.0	449.48	339		
137.5	451.12	340		
138.0	452.76	341		
138.5	454.40	342		
139.0	456.04	343		
139.5	457.68	344		
140.0	459.32	345		

GEOVISION SUSPENSION LOGGING FIELD NOTES

SITE: SOUTH TEXAS COL B-305 DATE: 12/18/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 10 OF 12

DEPTH METERS	DEPTH FEET	UNFILTERED FILE NO.	FILTERED FILE NO.	COMMENTS CASING, WATER, ROCK, ETC
140.5	460.96	346		
141.0	462.60	347		
141.5	464.24	348		
142.0	465.88	349		
142.5	467.52	350		
143.0	469.16	351		
143.5	470.80	352		
144.0	472.44	353		
144.5	474.08	354		
145.0	475.72	355		
145.5	477.36	356		
146.0	479.00	357		
146.5	480.64	358		
147.0	482.28	359		
147.5	483.92	360		
148.0	485.56	361		
148.5	487.20	362		
149.0	488.85	363		
149.5	490.49	364		
150.0	492.13	365		
150.5	493.77	366		
151.0	495.41	367		
151.5	497.05	368		
152.0	498.69	369		
152.5	500.33	370		
153.0	501.97	371		
153.5	503.61	372		SANDS @ 503?
154.0	505.25	373		
154.5	506.89	374		
155.0	508.53	375		
155.5	510.17	376		
156.0	511.81	377		
156.5	513.45	378		
157.0	515.09	379		
157.5	516.73	380		
158.0	518.37	381		
158.5	520.01	382		
159.0	521.65	383		
159.5	523.29	384		
160.0	524.93	385		

GEOVISION SUSPENSION LOGGING FIELD NOTES

SITE: SOUTH TEXAS COL B-305 DATE: 12/18/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 11 OF 12

DEPTH METERS	DEPTH FEET	UNFILTERED FILE NO.	FILTERED FILE NO.	COMMENTS CASING, WATER, ROCK, ETC
160.5	526.57	386		
161.0	528.22	387		
161.5	529.86	388		
162.0	531.50	389		
162.5	533.14	390		
163.0	534.78	391		
163.5	536.42	392		
164.0	538.06	393		
164.5	539.70	394		540-541.5 HARD ACCORD
165.0	541.34	395		TO DRILLER. QUARTZ GRAVEL?
165.5	542.98	396		
166.0	544.62	397		HARD AGAIN. 544-545
166.5	546.26	398		
167.0	547.90	399		
167.5	549.54	400		
168.0	551.18	401		
168.5	552.82	402		
169.0	554.46	403		
169.5	556.10	404		
170.0	557.74	405		
170.5	559.38	406		
171.0	561.02	407		
171.5	562.66	408		
172.0	564.30	409		
172.5	565.94	410		
173.0	567.59			HIT @ 172.77 m.
173.5	569.23			
174.0	570.87			BOTTOM MEASUREMENT?
174.5	572.51			
175.0	574.15			
175.5	575.79			
176.0	577.43			
176.5	579.07			
177.0	580.71			
177.5	582.35			
178.0	583.99			ELOG HIT BOTTOM?
178.5	585.63			
179.0	587.27			
179.5	588.91			
180.0	590.55			

GEOVISION SUSPENSION LOGGING FIELD NOTES

SITE: SOUTH TEXAS COL B-308 DATE: 12/18/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 12 OF 12

DEPTH METERS	DEPTH FEET	UNFILTERED FILE NO.	FILTERED FILE NO.	COMMENTS CASING, WATER, ROCK, ETC
180.5	592.19			
181.0	593.83			
181.5	595.47			
182.0	597.11			
182.5	598.75			
183.0	600.39			
183.5	602.03			
184.0	603.67			
184.5	605.31			
185.0	606.96			
185.5	608.60			
186.0	610.24			
186.5	611.88			
187.0	613.52			
187.5	615.16			
188.0	616.80			
188.5	618.44			T.D.@618'
189.0	620.08			
189.5	621.72			
190.0	623.36			
190.5	625.00			
191.0	626.64			
191.5	628.28			
192.0	629.92			
192.5	631.56			
193.0	633.20			
193.5	634.84			
194.0	636.48			
194.5	638.12			
195.0	639.76			
195.5	641.40			
196.0	643.04			
196.5	644.69			
197.0	646.33			
197.5	647.97			
198.0	649.61			
198.5	651.25			
199.0	652.89			
199.5	654.53			
200.0	656.17			

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B-305DHA CALIPER FIELD LOG

SITE: SOUTH TEXAS PROJECT COL DATE: 12/18/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 1 OF 2

CONTACT: MIKE SUFNARSKI OFFICE PHONE:
CELL PHONE: 704-357-5633
CONTACT: OFFICE PHONE:
PHONE:
CONTACT: PHONE:
PHONE:
CONTACT: PHONE:
PHONE:
DRILLER: PHONE:
COMPANY: PHONE:

GENERAL SITE CONDITIONS/LOCATION:

BOREHOLE DESIGNATION: B-305-DHA LOCATION:

COUNTY: RANGE: TOWNSHIP: SECTION:
BOREHOLE CONSTRUCTION: CASED UNCASED ✓
DIAMETERS AND DEPTH RANGES: 6" 0 TO 598'; 3⅞, 598 TO 618
BOREHOLE TOTAL DEPTH AS DRILLED: 618
CONDUCTOR CASING?: YES ✓ DEPTH TO BOTTOM OF CASING 53'; NO AUGER
DEPTH TO BEDROCK: NA DEPTH TO WATER TABLE: ≈20'
BOREHOLE FLUID: WATER ; FRESH WATER MUD ✓; SALT WATER MUD ;
OTHER:
DEPTH TO BOREHOLE FLUID: Ø TIME SINCE LAST CIRCULATION: ≈5HR

LOGGING CREW: R. STELLER
VEHICLE(S) USED AND MILEAGE: RENTAL
MOBILIZED FROM: GRANBURY, TX DEPARTURE TIME: 05:00
ARRIVED ON SITE: 11:00
STANDBY TIME: NA CAUSE: NA
LOGGING STARTED: 10:04 LOGGING COMPLETED: 11:30

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SITE: SOUTH TEXAS PROJECT COL B-305 DATE: 12/18/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 2 OF 2

WINCH: COMPROBE____ SILVER ✓ OYO____ OTHER____
MICROLOGGER 5301 ✓ OTHER____
CALIPER PROBE 5368 ✓ OTHER____

PROBE OFFSET	2.08M(6.82 FT) 12 IN MAX	
MINUS CASING STICK-UP	-2.25	
DEPTH REF. OFFSET AT START	4.57'	
DEPTH REF. OFFSET AT END	4.50'	
AFTER SURVEY DEPTH ERROR	-0.07'	LESS THAN 0.4%? YES

LOG NAME	START DEPTH	START TIME	END DEPTH	END TIME
B305CALTEST03	Ø	10:04 pm	Ø	10:07 pm
B305CAL4P02	579.0'	10:24 pm	Ø	11:21 pm
B305 CALTEST04	Ø	11:27 pm	Ø	11:30 pm

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.	B305 CALTEST03	2.00	3.92	8.02	4.52
AS MEAS.	B305 CALTEST04	1.96	3.93	8.03	4.50
AS MEAS.					
AS MEAS.					
AS MEAS.					
AS MEAS.					

MAINTENANCE PERFORMED ON SITE:____

EQUIPMENT PROBLEMS OR FAILURES:____

SUGGESTIONS, ADDITIONS, CHANGES:____

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B-305-DH A ACOUSTIC TELEVIEWER FIELD LOG

SITE: SOUTH TEXAS PROJECT COL DATE: 12/18/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 1 OF 2

CONTACT: MIKE SUFNARSKI OFFICE PHONE: 704-357-5633
CELL PHONE: 704-309-0624
CONTACT: OFFICE PHONE:
PHONE:
CONTACT: PHONE:
PHONE:
CONTACT: PHONE:
PHONE:
DRILLER: PHONE:
COMPANY: PHONE:

DIRECTIONS TO SITE:

GENERAL SITE CONDITIONS/LOCATION: NIGHT, MISTY ≈ 60°F

BOREHOLE DESIGNATION: LOCATION:

COUNTY: RANGE: TOWNSHIP: SECTION:
BOREHOLE CONSTRUCTION: CASED UNCASED ✓
DIAMETERS AND DEPTH RANGES: 6" 0 TO 598 ; 3⅞, 598' TO 618'
BOREHOLE TOTAL DEPTH AS DRILLED: 618'
CONDUCTOR CASING?: YES ✓ DEPTH TO BOTTOM OF CASING 53' ; NO AUGER
DEPTH TO BEDROCK: NA DEPTH TO WATER TABLE: ≈20'
BOREHOLE FLUID: WATER ; FRESH WATER MUD ✓ ; SALT WATER MUD ;
OTHER:
DEPTH TO BOREHOLE FLUID: Ø TIME SINCE LAST CIRCULATION: ≈8HR

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SITE: SOUTH TEXAS PROJECT COL B-305-OHA DATE: 12/18/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 2 OF 2

LOGGING CREW: R. STELLER
VEHICLE(S) USED AND MILEAGE: RENTAL
MOBILIZED FROM: GRANBURY TX DEPARTURE TIME: 03:00
ARRIVED ON SITE: 11:00
STANDBY TIME: NA CAUSE: NA
LOGGING STARTED: 23:53 LOGGING COMPLETED: 00:21

WINCH: COMPROBE___ SILVER ✓ OYO___ OTHER___
MICROLOGGER 5301 ✓ OTHER___
TELEVIEWER ACOUSTIC #5174 ✓ OTHER___

PROBE TILT TEST 90.1° BRUNTON TILT 90°
PROBE TILT TEST 18.5° BRUNTON TILT 19°
PROBE TILT TEST 14.3 BRUNTON TILT 14°
PROBE AZIMUTH TEST 196.7° BRUNTON AZIMUTH 194°
PROBE AZIMUTH TEST 351.2 BRUNTON AZIMUTH 350°
PROBE AZIMUTH TEST 217.3 BRUNTON AZIMUTH 220°

PROBE OFFSET	1.44M(4.72FT)	
MINUS CASING STICK-UP	-2.25	
DEPTH REF. OFFSET AT START	2.47'	
DEPTH REF. OFFSET AT END	2.45	
AFTER SURVEY DEPTH ERROR	-0.02'	LESS THAN 0.4%? YES

LOG NAME	START DEPTH	START TIME	END DEPTH	END TIME
B305AUL02	582.5'	23:53	∅	00:21

MAINTENANCE PERFORMED ON SITE: ___

EQUIPMENT PROBLEMS OR FAILURES: CAUGHT ON TRIP OUT @ 360'.

SUGGESTIONS, ADDITIONS, CHANGES: ___

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B-305 BORING GEOPHYSICS FIELD LOG SUMMARY

SITE: SOUTH TEXAS PROJECT COL DATE: 12/8/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 1 OF 1

CONTACT: MIKE SUFNARSKI PHONE: 704-357-5633

BOREHOLE CONSTRUCTION: CASED____ UNCASED ✓
DIAMETERS AND DEPTH RANGES: 4" 0 TO 90' ; ____, ____ TO ____
BOREHOLE TOTAL DEPTH AS DRILLED: 90'
CONDUCTOR CASING?: YES____ DEPTH TO BOTTOM OF CASING____; NO ✓
DEPTH TO BEDROCK: NA
BOREHOLE FLUID: WATER____; FRESH WATER MUD ✓; SALT WATER MUD ____;

LOGGING CREW: R. STELLER

LOG TYPE	FILE NAME	DEPTH RANGE	DATE	TIMES
LOG 12/8/06 ~~B305 ELOG TEST~~	B305ELOGTEST01	Ø	12/8/06	07:30 – 07:53
ELOG/GAMMA	B305ELOGUP01	90.0' – 35.0'	"	08:41 – 08:48
SUSPENSION P.S.	B305_001-047.ORG	1.6' – 77.1'	"	08:59 – 09:35
CALIPER TEST	B305CALTEST01	Ø	"	09:44 – 09:51
CALIPER/GAMMA	B305CALUP01	88.0 – Ø	"	09:57 – 10:07
CALIPER TEST	B305CALTEST02	Ø	"	10:08 – 10:11
DEVIATION	B305ALLUP01	88.0 – Ø	"	10:40 – 10:50

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B-305 ELOG FIELD LOG

SITE: SOUTH TEXAS PROJECT COL DATE: 12/8/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 1 OF 2

CONTACT: _____ OFFICE PHONE: _____
CELL PHONE: _____
CONTACT: _____ OFFICE PHONE: _____
PHONE: _____
CONTACT: _____ PHONE: _____
PHONE: _____
CONTACT: _____ PHONE: _____
PHONE: _____
DRILLER: _____ PHONE: _____
COMPANY: _____ PHONE: _____

GENERAL SITE CONDITIONS/LOCATION: _____

BOREHOLE DESIGNATION: B-305-DH LOCATION: _____

COUNTY: _____ RANGE: _____ TOWNSHIP: _____ SECTION: _____
BOREHOLE CONSTRUCTION: CASED _____ UNCASED ✓
DIAMETERS AND DEPTH RANGES: 4" 0 TO 98' ; _____, _____ TO _____
BOREHOLE TOTAL DEPTH AS DRILLED: 98'
CONDUCTOR CASING?: YES ___ DEPTH TO BOTTOM OF CASING _____; NO ✓
DEPTH TO BEDROCK: NA DEPTH TO WATER TABLE: ≈20'
BOREHOLE FLUID: WATER _____; FRESH WATER MUD ✓; SALT WATER MUD _____;
OTHER: _____
DEPTH TO BOREHOLE FLUID: 0 TIME SINCE LAST CIRCULATION: 1/2 HR

LOGGING CREW: R. STELLER, C. CARTER
VEHICLE(S) USED AND MILEAGE: RENTAL
MOBILIZED FROM: BAY CITY, TX DEPARTURE TIME: 06:30
ARRIVED ON SITE: 07:00
STANDBY TIME: _____ CAUSE: _____
LOGGING STARTED: 07:30 LOGGING COMPLETED: 08:48

SITE: SOUTH TEXAS PROJECT COL B-305 DATE: 12/8/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 2 OF 2

WINCH: COMPROBE____ SILVER ✓ OYO____ OTHER____
MICROLOGGER 5301 ✓ OTHER____
ELOG PROBE 5490 ✓ OTHER____

PROBE LENGTH	2.50M(8.20 FT)	
PLUS YOKE 10.0M (32.8 FT)	32.8'	
MINUS CASING STICK-UP	Ø	
DEPTH REF. OFFSET AT START	41.0	
DEPTH REF. OFFSET AT END	41.0	
AFTER SURVEY DEPTH ERROR	Ø	LESS THAN 0.4%? YES

LOG NAME	START DEPTH	START TIME	END DEPTH	END TIME
B305ELOG TEST01	Ø	07:30	Ø	07:35
B305 ELOG UP 01	90.0'	08:41	35.0	08:48

MAINTENANCE PERFORMED ON SITE:____

EQUIPMENT PROBLEMS OR FAILURES:____

SUGGESTIONS, ADDITIONS, CHANGES:____

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P-S SUSPENSION VELOCITY FIELD LOG

SITE: SOUTH TEXAS PROJECT COL B-305 DATE: 12/8/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 1 OF 4

CONTACT: MIKE SUFNARSKI OFFICE PHONE: 704-357-5633
CELL PHONE: 704-309-0624
CONTACT: OFFICE PHONE:
PHONE:
CONTACT: PHONE:
PHONE:
CONTACT: PHONE:
PHONE:
DRILLER: PHONE:
COMPANY: PHONE:

DIRECTIONS TO SITE:

GENERAL SITE CONDITIONS/LOCATION:

EA#:
BOREHOLE DESIGNATION: B-305 - DH LOCATION:

COUNTY: RANGE: TOWNSHIP: SECTION:
BOREHOLE CONSTRUCTION: CASED UNCASED ✓
DIAMETERS AND DEPTH RANGES: 4" 0 TO 90' ; , TO
BOREHOLE TOTAL DEPTH AS DRILLED: 90'
CONDUCTOR CASING?: YES DEPTH TO BOTTOM OF CASING ; NO ✓
DEPTH TO BEDROCK: NA DEPTH TO WATER TABLE: ≈20'
BOREHOLE FLUID: WATER ; FRESH WATER MUD ✓; SALT WATER MUD ;
OTHER:
DEPTH TO BOREHOLE FLUID: 0 TIME SINCE LAST CIRCULATION: 1HR

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SITE: SOUTH TEXAS PROJECT COL B-305 DATE: 12/8/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 2 OF 4

LOGGING CREW: R. STELLER, C. CARTER
VEHICLE(S) USED AND MILEAGE: RENTAL
MOBILIZED FROM: BAY CITY, TX DEPARTURE TIME: 06:30
ARRIVED ON SITE: 07:00
STANDBY TIME: CAUSE:
LOGGING STARTED: 08:59 LOGGING COMPLETED: 09:35
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 ☐		30086 ☑

MAINTENANCE PERFORMED ON SITE:

EQUIPMENT PROBLEMS OR FAILURES:

SUGGESTIONS, ADDITIONS, CHANGES:

COMMENTS: DEPTH ZERO @ 0.5 m
ZERO GYRO @ 0.5 m

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GEOVISION SUSPENSION LOGGING FIELD NOTES

SITE: SOUTH TEXAS COL B-305 DATE: 12/18/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 3 OF 4

DEPTH METERS	DEPTH FEET	UNFILTERED FILE NO.	FILTERED FILE NO.	COMMENTS CASING, WATER, ROCK, ETC
0.5	1.64	1		
1.0	3.28	2		
1.5	4.92	3		
2.0	6.56	4		
2.5	8.20	5		
3.0	9.84	6		
3.5	11.48	7		
4.0	13.12	8		
4.5	14.76	9		
5.0	16.40	10		
5.5	18.04	11		
6.0	19.69	12		
6.5	21.33	13		
7.0	22.97	14		
7.5	24.61	15		
8.0	26.25	16		
8.5	27.89	17		
9.0	29.53	18		
9.5	31.17	19		
10.0	32.81	20		
10.5	34.45	21		
11.0	36.09	22		
11.5	37.73	23		
12.0	39.37	24		
12.5	41.01	25		
13.0	42.65	26		
13.5	44.29	27		
14.0	45.93	28		
14.5	47.57	29		
15.0	49.21	30		
15.5	50.85	31		
16.0	52.49	32		
16.5	54.13	33		
17.0	55.77	34		
17.5	57.41	35		
18.0	59.06	36		
18.5	60.70	37		
19.0	62.34	38		
19.5	63.98	39		
20.0	65.62	40		

GEOVISION SUSPENSION LOGGING FIELD NOTES

SITE: SOUTH TEXAS COL B-305 DATE: 12/13/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 4 OF 4

DEPTH METERS	DEPTH FEET	UNFILTERED FILE NO.	FILTERED FILE NO.	COMMENTS CASING, WATER, ROCK, ETC
20.5	67.26	41		
21.0	68.90	42		
21.5	70.54	43		
22.0	72.18	44		
22.5	73.82	45		
23.0	75.46	46		
23.5	77.10	47		BOTTOM MEASUREMENT?
24.0	78.74			HK BOTTOM @ 23.6 m
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			T.D. @ 90
28.0	91.86			
28.5	93.50			
29.0	95.14			
29.5	96.78			
30.0	98.43			
30.5	100.07			
31.0	101.71			
31.5	103.35			
32.0	104.99			
32.5	106.63			
33.0	108.27			
33.5	109.91			
34.0	111.55			
34.5	113.19			
35.0	114.83			
35.5	116.47			
36.0	118.11			
36.5	119.75			
37.0	121.39			
37.5	123.03			
38.0	124.67			
38.5	126.31			
39.0	127.95			
39.5	129.59			
40.0	131.23			

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B-305 CALIPER FIELD LOG

SITE: SOUTH TEXAS PROJECT COL DATE: 12/18/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 1 OF 2

CONTACT: MIKE SUFNARSKI OFFICE PHONE:
CELL PHONE: 704-357-5633
CONTACT: OFFICE PHONE:
PHONE:
CONTACT: PHONE:
PHONE:
CONTACT: PHONE:
PHONE:
DRILLER: PHONE:
COMPANY: PHONE:

GENERAL SITE CONDITIONS/LOCATION:

BOREHOLE DESIGNATION: B-305-DH LOCATION:

COUNTY: RANGE: TOWNSHIP: SECTION:
BOREHOLE CONSTRUCTION: CASED UNCASED ✓
DIAMETERS AND DEPTH RANGES: 4" 0 TO 90' ; TO
BOREHOLE TOTAL DEPTH AS DRILLED: 90'
CONDUCTOR CASING?: YES DEPTH TO BOTTOM OF CASING ; NO ✓
DEPTH TO BEDROCK: NA DEPTH TO WATER TABLE: ≈20'
BOREHOLE FLUID: WATER ; FRESH WATER MUD ✓; SALT WATER MUD ;
OTHER:
DEPTH TO BOREHOLE FLUID: ∅ TIME SINCE LAST CIRCULATION: ≤2HR

LOGGING CREW: R. STELLER C. CARTER
VEHICLE(S) USED AND MILEAGE: RENTAL
MOBILIZED FROM: BAY CITY, TX DEPARTURE TIME: 06:30
ARRIVED ON SITE: 07:00
STANDBY TIME: CAUSE:
LOGGING STARTED: 09:49 LOGGING COMPLETED: 10:11

SITE:_SOUTH TEXAS PROJECT COL B-305 DATE: 12/8/06
CLIENT:_MACTEC JOB:_6533
AUTHOR:_R. STELLER PAGE 2 OF 2

WINCH: COMPROBE___ SILVER ✓ OYO___ OTHER___
MICROLOGGER 5301 ✓ OTHER___
CALIPER PROBE 5368 ✓ OTHER___

PROBE OFFSET	2.08M(6.82 FT) 12 IN MAX	
MINUS CASING STICK-UP	Ø	
DEPTH REF. OFFSET AT START	6.82'	
DEPTH REF. OFFSET AT END	6.80	
AFTER SURVEY DEPTH ERROR	-0.02	LESS THAN 0.4%? YES

LOG NAME	START DEPTH	START TIME	END DEPTH	END TIME
B305 CAL TEST 01	Ø	09:49	Ø	09:51
B305 CAL UP 01	88.0	09:57	Ø	10:07
B305 CAL TEST 02	Ø	10:08	Ø	10:11

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.	B305 CAL TEST 01	2.00	3.96	8.02	4.52
AS MEAS.	B305 CAL TEST 02	1.97	3.94	8.01	4.49
AS MEAS.					
AS MEAS.					
AS MEAS.					
AS MEAS.					

MAINTENANCE PERFORMED ON SITE:___

EQUIPMENT PROBLEMS OR FAILURES:___

SUGGESTIONS, ADDITIONS, CHANGES:___

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B-305 ACOUSTIC TELEVIEWER FIELD LOG

SITE: SOUTH TEXAS PROJECT COL DATE: 12/8/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 1 OF 2

CONTACT: MIKE SUFNARSKI OFFICE PHONE: 704-357-5633
CELL PHONE: 704-309-0624
CONTACT: OFFICE PHONE:
PHONE:
CONTACT: PHONE:
PHONE:
CONTACT: PHONE:
PHONE:
DRILLER: PHONE:
COMPANY: PHONE:

DIRECTIONS TO SITE:

GENERAL SITE CONDITIONS/LOCATION:

BOREHOLE DESIGNATION: B-305 - DH LOCATION:

COUNTY: RANGE: TOWNSHIP: SECTION:
BOREHOLE CONSTRUCTION: CASED UNCASED ✓
DIAMETERS AND DEPTH RANGES: 4" 0 TO 90' ; , TO
BOREHOLE TOTAL DEPTH AS DRILLED: 90'
CONDUCTOR CASING?: YES DEPTH TO BOTTOM OF CASING ; NO ✓
DEPTH TO BEDROCK: NA DEPTH TO WATER TABLE: ≈28'
BOREHOLE FLUID: WATER ; FRESH WATER MUD ✓ ; SALT WATER MUD ;
OTHER:
DEPTH TO BOREHOLE FLUID: 0 TIME SINCE LAST CIRCULATION: ≈ 3HR

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SITE: SOUTH TEXAS PROJECT COL B-305 DATE: 12/8/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 2 OF 2

LOGGING CREW: R. STELLER, C. CARTER
VEHICLE(S) USED AND MILEAGE: RENTAL
MOBILIZED FROM: BAY CITY, TX DEPARTURE TIME: 06:30
ARRIVED ON SITE: 07:00
STANDBY TIME: CAUSE:
LOGGING STARTED: 10:40 LOGGING COMPLETED: 10:50

WINCH: COMPROBE ___ SILVER ✓ OYO ___ OTHER ___
MICROLOGGER 5301 ✓ OTHER ___
TELEVIEWER ACOUSTIC #5174 ✓ OTHER ___

PROBE TILT TEST 89.5° BRUNTON TILT 89°
PROBE TILT TEST ___ BRUNTON TILT ___
PROBE TILT TEST ___ BRUNTON TILT ___
PROBE AZIMUTH TEST 212.5° BRUNTON AZIMUTH 211°
PROBE AZIMUTH TEST 105.1° BRUNTON AZIMUTH 107°
PROBE AZIMUTH TEST ___ BRUNTON AZIMUTH ___

PROBE OFFSET	1.44M(4.72FT)	
MINUS CASING STICK-UP	Ø	
DEPTH REF. OFFSET AT START	4.72	
DEPTH REF. OFFSET AT END	4.70	
AFTER SURVEY DEPTH ERROR	-0.02	LESS THAN 0.4%? YES

LOG NAME	START DEPTH	START TIME	END DEPTH	END TIME
B305 Au UP 01	88.0	10:40	Ø	10:50

MAINTENANCE PERFORMED ON SITE:

EQUIPMENT PROBLEMS OR FAILURES:

SUGGESTIONS, ADDITIONS, CHANGES:

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B-308-DH BORING GEOPHYSICS FIELD LOG SUMMARY

SITE: SOUTH TEXAS PROJECT COL DATE: 12/7/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 1 OF 1

CONTACT: MIKE SUFNARSKI PHONE: 704-357-5633

BOREHOLE CONSTRUCTION: CASED___ UNCASED ✓
DIAMETERS AND DEPTH RANGES: 4" 0 TO 215' ; ___, ___ TO ___
BOREHOLE TOTAL DEPTH AS DRILLED: 215
CONDUCTOR CASING?: YES___ DEPTH TO BOTTOM OF CASING___; NO ✓
DEPTH TO BEDROCK: NA
BOREHOLE FLUID: WATER___; FRESH WATER MUD ✓; SALT WATER MUD___;

LOGGING CREW: R. STELLER, C. CARTER

LOG TYPE	FILE NAME	DEPTH RANGE	DATE	TIMES
ELOG TEST	B308ELOGTEST01	Ø	12/7/06	13:30 - 13:34
ELOG/GAMMA	B308 ELOGUP01	215.5' - 35.0'	"	13:44 - 14:04
SUSPENSION PS	B308_001 - 122.004	3.3' - 201.8'	"	14:15 - 16:00
CALIPER TEST	B308CALTEST01	Ø	"	16:08 - 16:11
CALIPER/GAMMA	B308 CALUP01	210.0' - Ø	"	16:20 - 16:41
CALIPER TEST	B308 CALTEST02	Ø	"	16:44 - 16:46
DEVIATION	B308AUUP01	210.0' - Ø	"	17:00 - 17:15

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B-308 CALIPER FIELD LOG

SITE: SOUTH TEXAS PROJECT COL DATE: 12/7/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 1 OF 2

CONTACT: MIKE SUFNARSKI OFFICE PHONE:
CELL PHONE: 704-357-5633
CONTACT: OFFICE PHONE:
PHONE:
CONTACT: PHONE:
PHONE:
CONTACT: PHONE:
PHONE:
DRILLER: PHONE:
COMPANY: PHONE:

GENERAL SITE CONDITIONS/LOCATION:

BOREHOLE DESIGNATION: B-308-DH LOCATION:

COUNTY: RANGE: TOWNSHIP: SECTION:
BOREHOLE CONSTRUCTION: CASED UNCASED ✓
DIAMETERS AND DEPTH RANGES: 4" 0 TO 215' ; , TO
BOREHOLE TOTAL DEPTH AS DRILLED: 215'
CONDUCTOR CASING?: YES DEPTH TO BOTTOM OF CASING ; NO ✓
DEPTH TO BEDROCK: NK DEPTH TO WATER TABLE: ≈20'
BOREHOLE FLUID: WATER ; FRESH WATER MUD ✓; SALT WATER MUD ;
OTHER:
DEPTH TO BOREHOLE FLUID: ∅ TIME SINCE LAST CIRCULATION: ≈3HR

LOGGING CREW: R. STELLER, C. CARTER
VEHICLE(S) USED AND MILEAGE: RENTAL
MOBILIZED FROM: BAY CITY, TX DEPARTURE TIME: 06:15
ARRIVED ON SITE: 06:45
STANDBY TIME: CAUSE:
LOGGING STARTED: 16:08 LOGGING COMPLETED: 16:46

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

SITE: SOUTH TEXAS PROJECT COL B-308 DATE: 12/7/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 2 OF 2

RAS 12/7/06

WINCH: COMPROBE ~~✓~~ SILVER ✓ OYO ___ OTHER ___
MICROLOGGER 5301 ✓ OTHER ___
CALIPER PROBE 5368 ✓ OTHER ___

PROBE OFFSET	2.08M(6.82 FT) 12 IN MAX	
MINUS CASING STICK-UP	Ø	
DEPTH REF. OFFSET AT START	6.82'	
DEPTH REF. OFFSET AT END	6.80	
AFTER SURVEY DEPTH ERROR	-0.02'	LESS THAN 0.4%? YES

LOG NAME	START DEPTH	START TIME	END DEPTH	END TIME
B-308 CALTEST01	Ø	16:09	Ø	16:11
B308 CAL01	210.0'	16:20	Ø	16:41
B308 CALTEST02	Ø	16:44	Ø	16:46

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.	B308 CALTEST01	1.97	3.92	7.98	4.51
AS MEAS.	B308 CALTEST02	1.94	391	8.01	4.50
AS MEAS.					
AS MEAS.					
AS MEAS.					
AS MEAS.					

MAINTENANCE PERFORMED ON SITE: ___

EQUIPMENT PROBLEMS OR FAILURES: ___

SUGGESTIONS, ADDITIONS, CHANGES: ___

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B-308 ACOUSTIC TELEVIEWER FIELD LOG

SITE: SOUTH TEXAS PROJECT COL DATE: 12/7/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 1 OF 2

CONTACT: MIKE SUFNARSKI OFFICE PHONE: 704-357-5633
CELL PHONE: 704-309-0624
CONTACT: OFFICE PHONE:
PHONE:
CONTACT: PHONE:
PHONE:
CONTACT: PHONE:
PHONE:
DRILLER: PHONE:
COMPANY: PHONE:

DIRECTIONS TO SITE:

GENERAL SITE CONDITIONS/LOCATION:

BOREHOLE DESIGNATION: B-308-DH LOCATION:

COUNTY: RANGE: TOWNSHIP: SECTION:
BOREHOLE CONSTRUCTION: CASED UNCASED ✓
DIAMETERS AND DEPTH RANGES: 4" 0 TO 215' ; , TO
BOREHOLE TOTAL DEPTH AS DRILLED: 215'
CONDUCTOR CASING?: YES DEPTH TO BOTTOM OF CASING ; NO ✓
DEPTH TO BEDROCK: NA DEPTH TO WATER TABLE: ≈20'
BOREHOLE FLUID: WATER ; FRESH WATER MUD ✓ ; SALT WATER MUD ;
OTHER:
DEPTH TO BOREHOLE FLUID: ϕ TIME SINCE LAST CIRCULATION: ≈4HR

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SITE: SOUTH TEXAS PROJECT COL B-308 DATE: 12/7/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 2 OF 2

LOGGING CREW: R. STELLER, C. CARTER
VEHICLE(S) USED AND MILEAGE: RENTAL
MOBILIZED FROM: BAY CITY, TX DEPARTURE TIME: 06:15
ARRIVED ON SITE: 06:45
STANDBY TIME: CAUSE:
LOGGING STARTED: 17:00 LOGGING COMPLETED: 17:15

WINCH: COMPROBE___ SILVER ✓ OYO___ OTHER___
MICROLOGGER 5301 ✓ OTHER___
TELEVIEWER ACOUSTIC #5174 ✓ OTHER___

PROBE TILT TEST 90.2° BRUNTON TILT 91.0°
PROBE TILT TEST 0.9 BRUNTON TILT Ø
PROBE TILT TEST ___ BRUNTON TILT ___
PROBE AZIMUTH TEST 328.2° BRUNTON AZIMUTH 326°
PROBE AZIMUTH TEST 273.6° BRUNTON AZIMUTH 269°
PROBE AZIMUTH TEST ___ BRUNTON AZIMUTH ___

PROBE OFFSET	1.44M(4.72FT)	
MINUS CASING STICK-UP	Ø	
DEPTH REF. OFFSET AT START	4.72'	
DEPTH REF. OFFSET AT END	4.85	
AFTER SURVEY DEPTH ERROR	+0.13'	LESS THAN 0.4%? YES

LOG NAME	START DEPTH	START TIME	END DEPTH	END TIME
B308AMUP01.	210.0'	17:00	Ø	17:15

RAS 12/7/06

MAINTENANCE PERFORMED ON SITE:

EQUIPMENT PROBLEMS OR FAILURES:

SUGGESTIONS, ADDITIONS, CHANGES:

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P-S SUSPENSION VELOCITY FIELD LOG

SITE:_SOUTH TEXAS PROJECT COL B-308 DATE: 12/7/06
CLIENT:_MACTEC JOB:_6533
AUTHOR:_R. STELLER PAGE 1 OF 6

CONTACT:_MIKE SUFNARSKI OFFICE PHONE:_704-357-5633
CELL PHONE:_704-309-0624
CONTACT: OFFICE PHONE:
PHONE:
CONTACT: PHONE:
PHONE:
CONTACT: PHONE:
PHONE:
DRILLER: PHONE:
COMPANY: PHONE:

DIRECTIONS TO SITE:

GENERAL SITE CONDITIONS/LOCATION:

EA#:
BOREHOLE DESIGNATION: B-308-DH LOCATION:

COUNTY: RANGE: TOWNSHIP: SECTION:
BOREHOLE CONSTRUCTION: CASED UNCASED ✓
DIAMETERS AND DEPTH RANGES: 4" 0 TO 215' ; , TO
BOREHOLE TOTAL DEPTH AS DRILLED: 215'
CONDUCTOR CASING?: YES DEPTH TO BOTTOM OF CASING ; NO ✓
DEPTH TO BEDROCK: NA DEPTH TO WATER TABLE: ~20'
BOREHOLE FLUID: WATER ; FRESH WATER MUD ✓ ; SALT WATER MUD ;
OTHER:
DEPTH TO BOREHOLE FLUID: 0 TIME SINCE LAST CIRCULATION: ~2HR

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SITE: SOUTH TEXAS PROJECT COL B-308 DATE: 12/7/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 2 OF 6

LOGGING CREW: R. STELLER, C. CARTER
VEHICLE(S) USED AND MILEAGE: RENTAL
MOBILIZED FROM: BAY CITY, TX DEPARTURE TIME: 06:15
ARRIVED ON SITE: 06:45
STANDBY TIME: CAUSE:
LOGGING STARTED: 14:15 LOGGING COMPLETED: 16:00
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 ☐	30086 ☑

MAINTENANCE PERFORMED ON SITE:

EQUIPMENT PROBLEMS OR FAILURES:

SUGGESTIONS, ADDITIONS, CHANGES:

COMMENTS: DEPTH ZERO = 2.5m - 0.0 = 2.5 m
DEPTH EXT = 2.6 m.

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GEOVISION SUSPENSION LOGGING FIELD NOTES

SITE: SOUTH TEXAS COL B-308 DATE: 12/7/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 5 OF 6

DEPTH METERS	DEPTH FEET	UNFILTERED FILE NO.	FILTERED FILE NO.	COMMENTS CASING, WATER, ROCK, ETC
0.5	1.64			
1.0	3.28	1		
1.5	4.92	2		
2.0	6.56	3		
2.5	8.20	4		
3.0	9.84	5		
3.5	11.48	6		
4.0	13.12	7		
4.5	14.76	8		
5.0	16.40	9		
5.5	18.04	10		
6.0	19.69	11		
6.5	21.33	12		
7.0	22.97	13		
7.5	24.61	14		
8.0	26.25	15		
8.5	27.89	16		
9.0	29.53	17		
9.5	31.17	18.		
10.0	32.81	19		
10.5	34.45	20		
11.0	36.09	21		
11.5	37.73	22		
12.0	39.37	23		
12.5	41.01	24		
13.0	42.65	25		
13.5	44.29	26		
14.0	45.93	27		
14.5	47.57	28		
15.0	49.21	29		
15.5	50.85	30		
16.0	52.49	31		
16.5	54.13	32		
17.0	55.77	33		
17.5	57.41	34		
18.0	59.06	35		
18.5	60.70	36		
19.0	62.34	37		
19.5	63.98	38		
20.0	65.62	39		

GEOVISION SUSPENSION LOGGING FIELD NOTES

SITE: SOUTH TEXAS COL B-308 DATE: 12/7/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 4 OF 6

DEPTH METERS	DEPTH FEET	UNFILTERED FILE NO.	FILTERED FILE NO.	COMMENTS CASING, WATER, ROCK, ETC
20.5	67.26	40		
21.0	68.90	41		
21.5	70.54	42		
22.0	72.18	43		
22.5	73.82	44		
23.0	75.46	45		
23.5	77.10	46		
24.0	78.74	47		
24.5	80.38	48		
25.0	82.02	49		
25.5	83.66	50		
26.0	85.30	51		
26.5	86.94	52		
27.0	88.58	53		
27.5	90.22	54		
28.0	91.86	55		
28.5	93.50	56		
29.0	95.14	57		
29.5	96.78	58		
30.0	98.43	59		
30.5	100.07	60		
31.0	101.71	61		
31.5	103.35	62		
32.0	104.99	63		
32.5	106.63	64		
33.0	108.27	65		
33.5	109.91	66		
34.0	111.55	67		
34.5	113.19	68		
35.0	114.83	69		
35.5	116.47	70		
36.0	118.11	71		
36.5	119.75	72		
37.0	121.39	73		
37.5	123.03	74		
38.0	124.67	75		
38.5	126.31	76		
39.0	127.95	77		
39.5	129.59	78		
40.0	131.23	79		

GEOVISION SUSPENSION LOGGING FIELD NOTES

SITE: SOUTH TEXAS COL B-308 DATE: 12/7/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 5 OF 6

DEPTH METERS	DEPTH FEET	UNFILTERED FILE NO.	FILTERED FILE NO.	COMMENTS CASING, WATER, ROCK, ETC
40.5	132.87	80		
41.0	134.51	81		
41.5	136.15	82		
42.0	137.80	83		
42.5	139.44	84		
43.0	141.08	85		
43.5	142.72	86		
44.0	144.36	87		
44.5	146.00	88		
45.0	147.64	89		
45.5	149.28	90		
46.0	150.92	91		
46.5	152.56	92		
47.0	154.20	93		
47.5	155.84	94		
48.0	157.48	95		
48.5	159.12	96		
49.0	160.76	97		
49.5	162.40	98		
50.0	164.04	99		
50.5	165.68	100		
51.0	167.32	101		
51.5	168.96	102		
52.0	170.60	103		
52.5	172.24	104		
53.0	173.88	105		
53.5	175.52	106		
54.0	177.17	107		
54.5	178.81	108		
55.0	180.45	109		
55.5	182.09	110		
56.0	183.73	111		
56.5	185.37	112		
57.0	187.01	113		
57.5	188.65	114		
58.0	190.29	115		
58.5	191.93	116		
59.0	193.57	117		
59.5	195.21	118		
60.0	196.85	119		

GEOVISION SUSPENSION LOGGING FIELD NOTES

SITE:_SOUTH TEXAS COL B-308 DATE: 12/7/06
CLIENT:__MACTEC JOB:_6533
AUTHOR:_R. STELLER PAGE 6 OF 6

DEPTH METERS	DEPTH FEET	UNFILTERED FILE NO.	FILTERED FILE NO.	COMMENTS CASING, WATER, ROCK, ETC
60.5	198.49	120		
61.0	200.13	121		
61.5	201.77	122		BOTTOM MEASUREMENT ?
62.0	203.41			HIT BOTTOM @ 61.7
62.5	205.05			
63.0	206.69			
63.5	208.33			
64.0	209.97			
64.5	211.61			
65.0	213.25			
65.5	214.90			T.D. @ 215'
66.0	216.54			
66.5	218.18			
67.0	219.82			
67.5	221.46			
68.0	223.10			
68.5	224.74			
69.0	226.38			
69.5	228.02			
70.0	229.66			
70.5	231.30			
71.0	232.94			
71.5	234.58			
72.0	236.22			
72.5	237.86			
73.0	239.50			
73.5	241.14			
74.0	242.78			
74.5	244.42			
75.0	246.06			
75.5	247.70			
76.0	249.34			
76.5	250.98			
77.0	252.62			
77.5	254.27			
78.0	255.91			
78.5	257.55			
79.0	259.19			
79.5	260.83			
80.0	262.47			

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B-308 ELOG FIELD LOG

SITE: SOUTH TEXAS PROJECT COL DATE: 12/7/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 1 OF 2

CONTACT: ______ _OFFICE__ PHONE: ______
_CELL___ PHONE: ______
CONTACT: ______ _OFFICE__ PHONE: ______
PHONE: ______
CONTACT: ______ PHONE: ______
PHONE: ______
CONTACT: ______ PHONE: ______
PHONE: ______
DRILLER: ______ PHONE: ______
COMPANY: ______ PHONE: ______

GENERAL SITE CONDITIONS/LOCATION: ______

BOREHOLE DESIGNATION: B-308-DH LOCATION: ______

COUNTY: ______ RANGE: ______ TOWNSHIP: ______ SECTION: ______
BOREHOLE CONSTRUCTION: CASED ____ UNCASED ✓
DIAMETERS AND DEPTH RANGES: 4 0 TO 215' ; ______, ______ TO ______.
BOREHOLE TOTAL DEPTH AS DRILLED: 215'
CONDUCTOR CASING?: YES ___ DEPTH TO BOTTOM OF CASING ______; NO ✓
DEPTH TO BEDROCK: NA DEPTH TO WATER TABLE: ±20'
BOREHOLE FLUID: WATER ____; FRESH WATER MUD ✓; SALT WATER MUD ____;
OTHER: ______
DEPTH TO BOREHOLE FLUID: Ø TIME SINCE LAST CIRCULATION: 2 HR

LOGGING CREW: R. STELLER, C. CARTER
VEHICLE(S) USED AND MILEAGE: RENTAL
MOBILIZED FROM: BAY CITY, TX DEPARTURE TIME: 06:15
ARRIVED ON SITE: 06:45
STANDBY TIME: ______ CAUSE: ______
LOGGING STARTED: 13:30 LOGGING COMPLETED: 14:04

SITE: SOUTH TEXAS PROJECT COL B-308 DATE: 12/7/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 2 OF 2

WINCH: COMPROBE ___ SILVER √ OYO ___ OTHER ___
MICROLOGGER 5301 ✓ OTHER ___
ELOG PROBE 5490 ✓ OTHER ___

PROBE LENGTH	2.50M(8.20 FT)	
PLUS YOKE 10.0M (32.8 FT)	32.8 FT	
MINUS CASING STICK-UP	-0.0	
DEPTH REF. OFFSET AT START	41.0'	
DEPTH REF. OFFSET AT END	41.1	
AFTER SURVEY DEPTH ERROR	+0.1	LESS THAN 0.4%? YES.

LOG NAME	START DEPTH	START TIME	END DEPTH	END TIME
B308ELOGTEST01	Ø	13:30	Ø	13:34
B308ELOGUP01	215.5'	13:44	35.0'	14:04

MAINTENANCE PERFORMED ON SITE: ___

EQUIPMENT PROBLEMS OR FAILURES: ___

SUGGESTIONS, ADDITIONS, CHANGES: ___

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B-319-DH BORING GEOPHYSICS FIELD LOG SUMMARY

SITE: SOUTH TEXAS PROJECT COL DATE: 12/7/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 1 OF 1

CONTACT: MIKE SUFNARSKI PHONE: 704-357-5633

BOREHOLE CONSTRUCTION: CASED___ UNCASED ✓
DIAMETERS AND DEPTH RANGES: 4" 0 TO 215' ; ___ , ___ TO ___
BOREHOLE TOTAL DEPTH AS DRILLED: 215'
CONDUCTOR CASING?: YES___ DEPTH TO BOTTOM OF CASING___; NO ✓
DEPTH TO BEDROCK: NA
BOREHOLE FLUID: WATER___; FRESH WATER MUD ✓; SALT WATER MUD ___;

LOGGING CREW: R. STELLER, C. CARTER

LOG TYPE	FILE NAME	DEPTH RANGE	DATE	TIMES
ELOG TEST	B319ELOGTEST01	Ø	12/7/06	08:15 - 08:17
ELOG/GAMMA	B319ELOGUP01	215.0' - 34.5	"	08:35 - 09:01
SUSPENSION PS	B319_001 - 123.004	1.6' - 201.8'	"	09:16 - 10:40
CALIPER TEST	B319 CALTEST01	Ø	"	10:51 - 10:55
CALIPER/GAMMA	B319 CALUP01	210.0' - 0.1'	"	11:14 - 11:37
CALIPER TEST	B319 CALTEST02	Ø	"	11:40 - 11:43
DEVIATION	B319AUUP01	210.0' - Ø	"	11:55 - 12:16

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B-319 ELOG FIELD LOG

SITE: SOUTH TEXAS PROJECT COL DATE: 12/7/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 1 OF 2

CONTACT: _OFFICE_ PHONE:
CELL PHONE:
CONTACT: _OFFICE_ PHONE:
PHONE:
CONTACT: PHONE:
PHONE:
CONTACT: PHONE:
PHONE:
DRILLER: PHONE:
COMPANY: PHONE:

GENERAL SITE CONDITIONS/LOCATION:

BOREHOLE DESIGNATION: B-319-DH LOCATION:

COUNTY: RANGE: TOWNSHIP: SECTION:
BOREHOLE CONSTRUCTION: CASED UNCASED ✓
DIAMETERS AND DEPTH RANGES: 4" 0 TO 215' ; , TO ✓
BOREHOLE TOTAL DEPTH AS DRILLED: 215'
CONDUCTOR CASING?: YES DEPTH TO BOTTOM OF CASING ; NO ✓
DEPTH TO BEDROCK: NA DEPTH TO WATER TABLE: ≈20'
BOREHOLE FLUID: WATER ; FRESH WATER MUD ✓; SALT WATER MUD ;
OTHER:
DEPTH TO BOREHOLE FLUID: 0 TIME SINCE LAST CIRCULATION: ≈1 HR

LOGGING CREW: R. STELLER, C. CARTER
VEHICLE(S) USED AND MILEAGE: RENTAL
MOBILIZED FROM: BAY CITY, TX DEPARTURE TIME: 06:15
ARRIVED ON SITE: 06:45
STANDBY TIME: CAUSE:
LOGGING STARTED: 08:15 LOGGING COMPLETED: 09:01

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SITE:_SOUTH TEXAS PROJECT COL B-319 DATE: 12/7/06
CLIENT:_MACTEC JOB:_6533
AUTHOR:_R. STELLER PAGE 2 OF 2

WINCH: COMPROBE___ SILVER ✓ OYO___ OTHER___
MICROLOGGER 5301 ✓ OTHER___
ELOG PROBE 5490 ✓ OTHER___

PROBE LENGTH	2.50M(8.20 FT)	
PLUS YOKE 10.0M (32.8 FT)	32.8'	
MINUS CASING STICK-UP	-0.0	RPS 12/7/06
DEPTH REF. OFFSET AT START	41.0'	
DEPTH REF. OFFSET AT END		
AFTER SURVEY DEPTH ERROR		LESS THAN 0.4%?

LOG NAME	START DEPTH	START TIME	END DEPTH	END TIME
B319ELOG TEST01	0	08:15	0'	08:17
B319 ELOG UP01	215.0'	08:35	34.5'	09:01

MAINTENANCE PERFORMED ON SITE:

EQUIPMENT PROBLEMS OR FAILURES:

SUGGESTIONS, ADDITIONS, CHANGES:

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P-S SUSPENSION VELOCITY FIELD LOG

SITE: SOUTH TEXAS PROJECT COL B-319 DATE: 12/7/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 1 OF 6

CONTACT: MIKE SUFNARSKI OFFICE PHONE: 704-357-5633
CELL PHONE: 704-309-0624
CONTACT: OFFICE PHONE:
PHONE:
CONTACT: PHONE:
PHONE:
CONTACT: PHONE:
PHONE:
DRILLER: PHONE:
COMPANY: PHONE:

DIRECTIONS TO SITE:

GENERAL SITE CONDITIONS/LOCATION:

EA#:
BOREHOLE DESIGNATION: B-319-DH LOCATION:

COUNTY: RANGE: TOWNSHIP: SECTION:
BOREHOLE CONSTRUCTION: CASED ___ UNCASED ✓
DIAMETERS AND DEPTH RANGES: 4" 0 TO 215'; ___, ___ TO ___
BOREHOLE TOTAL DEPTH AS DRILLED: 215'
CONDUCTOR CASING?: YES ___ DEPTH TO BOTTOM OF CASING ___; NO ✓
DEPTH TO BEDROCK: NA DEPTH TO WATER TABLE: ≈20'
BOREHOLE FLUID: WATER ___; FRESH WATER MUD ✓; SALT WATER MUD ___;
OTHER:
DEPTH TO BOREHOLE FLUID: Ø TIME SINCE LAST CIRCULATION: ≈1 HR

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SITE:_SOUTH TEXAS PROJECT COL B-319 DATE: 12/7/06
CLIENT:_MACTEC JOB:_6533
AUTHOR:_R. STELLER PAGE 2 OF 6

LOGGING CREW: R. STELLER, C. CARTER
VEHICLE(S) USED AND MILEAGE: _RENTAL
MOBILIZED FROM: BAY CITY, TX DEPARTURE TIME: 06:15
ARRIVED ON SITE: 06:45
STANDBY TIME: CAUSE:
LOGGING STARTED: 9:16 LOGGING COMPLETED: 10:40
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 ☐	30086 ☑

MAINTENANCE PERFORMED ON SITE:

EQUIPMENT PROBLEMS OR FAILURES:

SUGGESTIONS, ADDITIONS, CHANGES:

COMMENTS: START ZERO @ 2.5m - 0 = 2.5m.

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GEOVISION SUSPENSION LOGGING FIELD NOTES

SITE: SOUTH TEXAS COL B-314 DATE: 12/7/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 3 OF 6

DEPTH METERS	DEPTH FEET	UNFILTERED FILE NO.	FILTERED FILE NO.	COMMENTS CASING, WATER, ROCK, ETC
0.5	1.64	1		
1.0	3.28	2		
1.5	4.92	3		
2.0	6.56	4		
2.5	8.20	5		
3.0	9.84	6		
3.5	11.48	7		
4.0	13.12	8		
4.5	14.76	9		
5.0	16.40	10		
5.5	18.04	11		
6.0	19.69	12		
6.5	21.33	13		
7.0	22.97	14		
7.5	24.61	15		
8.0	26.25	16		
8.5	27.89	17		
9.0	29.53	18		
9.5	31.17	19		
10.0	32.81	20		
10.5	34.45	21		
11.0	36.09	22		
11.5	37.73	23		
12.0	39.37	24		
12.5	41.01	25		
13.0	42.65	26		
13.5	44.29	27		
14.0	45.93	28		
14.5	47.57	29		
15.0	49.21	30		
15.5	50.85	31		
16.0	52.49	32		
16.5	54.13	33		
17.0	55.77	34		
17.5	57.41	35		
18.0	59.06	36		
18.5	60.70	37		
19.0	62.34	38		
19.5	63.98	39		
20.0	65.62	40		

GEOVISION SUSPENSION LOGGING FIELD NOTES

SITE: SOUTH TEXAS COL B-319 DATE: 12/7/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 4 OF 6

DEPTH METERS	DEPTH FEET	UNFILTERED FILE NO.	FILTERED FILE NO.	COMMENTS CASING, WATER, ROCK, ETC
20.5	67.26	41		
21.0	68.90	42		
21.5	70.54	43		
22.0	72.18	44		
22.5	73.82	45		
23.0	75.46	46		
23.5	77.10	47		
24.0	78.74	48		
24.5	80.38	49		
25.0	82.02	50		
25.5	83.66	51		
26.0	85.30	52		
26.5	86.94	53		
27.0	88.58	54		
27.5	90.22	55		
28.0	91.86	56		
28.5	93.50	57		
29.0	95.14	58		
29.5	96.78	59		
30.0	98.43	60		
30.5	100.07	61		
31.0	101.71	62		
31.5	103.35	63		
32.0	104.99	64		
32.5	106.63	65		
33.0	108.27	66		
33.5	109.91	67		
34.0	111.55	68		
34.5	113.19	69		
35.0	114.83	70		
35.5	116.47	71		
36.0	118.11	72		
36.5	119.75	73		
37.0	121.39	74		
37.5	123.03	75		
38.0	124.67	76		
38.5	126.31	77		
39.0	127.95	78		
39.5	129.59	79		
40.0	131.23	80		

GEOVISION SUSPENSION LOGGING FIELD NOTES

SITE: SOUTH TEXAS COL B-319 DATE: 12/7/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 5 OF 6

DEPTH METERS	DEPTH FEET	UNFILTERED FILE NO.	FILTERED FILE NO.	COMMENTS CASING, WATER, ROCK, ETC
40.5	132.87	81		
41.0	134.51	82		
41.5	136.15	83		
42.0	137.80	84		
42.5	139.44	85		
43.0	141.08	86		
43.5	142.72	87		
44.0	144.36	88		
44.5	146.00	89		
45.0	147.64	90		
45.5	149.28	91		
46.0	150.92	92		
46.5	152.56	93		
47.0	154.20	94		
47.5	155.84	95		
48.0	157.48	96		
48.5	159.12	97		
49.0	160.76	98		
49.5	162.40	99		
50.0	164.04	100		
50.5	165.68	101		
51.0	167.32	102		
51.5	168.96	103		
52.0	170.60	104		
52.5	172.24	105		
53.0	173.88	106		
53.5	175.52	107		
54.0	177.17	108		
54.5	178.81	109		
55.0	180.45	110		
55.5	182.09	111		
56.0	183.73	112		
56.5	185.37	113		
57.0	187.01	114		
57.5	188.65	115		
58.0	190.29	116		
58.5	191.93	117		
59.0	193.57	118		
59.5	195.21	119		
60.0	196.85	120		

GEOVISION SUSPENSION LOGGING FIELD NOTES

SITE: SOUTH TEXAS COL B-319 DATE: 12/7/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 6 OF 6

DEPTH METERS	DEPTH FEET	UNFILTERED FILE NO.	FILTERED FILE NO.	COMMENTS CASING, WATER, ROCK, ETC
60.5	198.49	121		
61.0	200.13	122		
61.5	201.77	123		BOTTOM MEASUREMENT?
62.0	203.41			HIT BOTTOM@61.7 m
62.5	205.05			
63.0	206.69			
63.5	208.33			
64.0	209.97			
64.5	211.61			
65.0	213.25			
65.5	214.90			T.D. @ 215'
66.0	216.54			
66.5	218.18			
67.0	219.82			
67.5	221.46			
68.0	223.10			
68.5	224.74			
69.0	226.38			
69.5	228.02			
70.0	229.66			
70.5	231.30			
71.0	232.94			
71.5	234.58			
72.0	236.22			
72.5	237.86			
73.0	239.50			
73.5	241.14			
74.0	242.78			
74.5	244.42			
75.0	246.06			
75.5	247.70			
76.0	249.34			
76.5	250.98			
77.0	252.62			
77.5	254.27			
78.0	255.91			
78.5	257.55			
79.0	259.19			
79.5	260.83			
80.0	262.47			

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B-319 CALIPER FIELD LOG

SITE: SOUTH TEXAS PROJECT COL DATE: 12/7/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 1 OF 2

CONTACT: MIKE SUFNARSKI OFFICE PHONE:
CELL PHONE: 704-357-5633
CONTACT: OFFICE PHONE:
PHONE:
CONTACT: PHONE:
PHONE:
CONTACT: PHONE:
PHONE:
DRILLER: PHONE:
COMPANY: PHONE:

GENERAL SITE CONDITIONS/LOCATION:

BOREHOLE DESIGNATION: B-319-DH LOCATION:

COUNTY: RANGE: TOWNSHIP: SECTION:
BOREHOLE CONSTRUCTION: CASED UNCASED ✓
DIAMETERS AND DEPTH RANGES: 4" 0 TO 215' ; , TO
BOREHOLE TOTAL DEPTH AS DRILLED: 215'
CONDUCTOR CASING?: YES DEPTH TO BOTTOM OF CASING ; NO ✓
DEPTH TO BEDROCK: NA DEPTH TO WATER TABLE: ≈20'
BOREHOLE FLUID: WATER ; FRESH WATER MUD ✓ ; SALT WATER MUD ;
OTHER:
DEPTH TO BOREHOLE FLUID: Ø TIME SINCE LAST CIRCULATION: < 3 HR

LOGGING CREW: R. STELLER C. CARTER
VEHICLE(S) USED AND MILEAGE: RENTAL
MOBILIZED FROM: BAY CITY, TX DEPARTURE TIME: 6:15
ARRIVED ON SITE: 6:45
STANDBY TIME: CAUSE:
LOGGING STARTED: 10:51 LOGGING COMPLETED: 11:43

SITE:_SOUTH TEXAS PROJECT COL B-319 DATE: 12/7/06
CLIENT:_MACTEC JOB:_6533
AUTHOR:_R. STELLER PAGE 2 OF 2

WINCH: COMPROBE____ SILVER ✓ OYO____ OTHER____
MICROLOGGER 5301 ✓ OTHER____
CALIPER PROBE 5368 ✓ OTHER____

PROBE OFFSET	2.08M(6.82 FT) 12 IN MAX	
MINUS CASING STICK-UP	Ø	
DEPTH REF. OFFSET AT START	6.82'	
DEPTH REF. OFFSET AT END	6.90	
AFTER SURVEY DEPTH ERROR	+.08'	LESS THAN 0.4%? YES

LOG NAME	START DEPTH	START TIME	END DEPTH	END TIME
B319CALTEST01	Ø	10:51	Ø	10:55
B319CALUP01	210.0'	11:14	0.1'	11:37
B319CALTEST02	Ø	11:40	Ø	11:45

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.	B319CALTEST01	1.95	3.91	8.00	4.49
AS MEAS.	B319CALTEST02	1.97	3.91	7.99	4.50
AS MEAS.					
AS MEAS.					
AS MEAS.					
AS MEAS.					

MAINTENANCE PERFORMED ON SITE:____

EQUIPMENT PROBLEMS OR FAILURES:____

SUGGESTIONS, ADDITIONS, CHANGES:____

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B-319 ACOUSTIC TELEVIEWER FIELD LOG

SITE: SOUTH TEXAS PROJECT COL DATE: 12/7/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 1 OF 2

CONTACT: MIKE SUFNARSKI OFFICE PHONE: 704-357-5633
CELL PHONE: 704-309-0624
CONTACT: OFFICE PHONE:
PHONE:
CONTACT: PHONE:
PHONE:
CONTACT: PHONE:
PHONE:
DRILLER: PHONE:
COMPANY: PHONE:

DIRECTIONS TO SITE:

GENERAL SITE CONDITIONS/LOCATION:

BOREHOLE DESIGNATION: B-319-DH LOCATION:

COUNTY: RANGE: TOWNSHIP: SECTION:
BOREHOLE CONSTRUCTION: CASED UNCASED ✓
DIAMETERS AND DEPTH RANGES: 4" 0 TO 215' ; , TO
BOREHOLE TOTAL DEPTH AS DRILLED: 215'
CONDUCTOR CASING?: YES DEPTH TO BOTTOM OF CASING ; NO ✓
DEPTH TO BEDROCK: NA DEPTH TO WATER TABLE: ≤20'
BOREHOLE FLUID: WATER ; FRESH WATER MUD ✓; SALT WATER MUD ;
OTHER:
DEPTH TO BOREHOLE FLUID: 0 TIME SINCE LAST CIRCULATION: ≤ 4 HR

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SITE:_SOUTH TEXAS PROJECT COL B-319 DATE: 12/7/06
CLIENT:_MACTEC JOB:_6533
AUTHOR:_R. STELLER PAGE 2 OF 2

LOGGING CREW:_R. STELLER, C. CARTER
VEHICLE(S) USED AND MILEAGE:_RENTAL
MOBILIZED FROM: BAY CITY, TX DEPARTURE TIME: 6:15
ARRIVED ON SITE: 6:45
STANDBY TIME: CAUSE:
LOGGING STARTED: 11:55 LOGGING COMPLETED: 12:16

WINCH: COMPROBE___ SILVER ✓ OYO___ OTHER___
MICROLOGGER 5301 ✓ OTHER___
TELEVIEWER ACOUSTIC #5174 ✓ OTHER___

PROBE TILT TEST 90.0° BRUNTON TILT 89.0°
PROBE TILT TEST 87.8° BRUNTON TILT 88.0°
PROBE TILT TEST ___ BRUNTON TILT ___
PROBE AZIMUTH TEST 271.0° BRUNTON AZIMUTH 264°
PROBE AZIMUTH TEST 351.7° BRUNTON AZIMUTH 351°
PROBE AZIMUTH TEST ___ BRUNTON AZIMUTH ___

PROBE OFFSET	1.44M(4.72FT)
MINUS CASING STICK-UP	Ø
DEPTH REF. OFFSET AT START	4.72'
DEPTH REF. OFFSET AT END	4.75'
AFTER SURVEY DEPTH ERROR	+0.03	LESS THAN 0.4%? YES

LOG NAME	START DEPTH	START TIME	END DEPTH	END TIME
B319AuuP 01	210.0'	11:55	Ø	12:16

MAINTENANCE PERFORMED ON SITE:

EQUIPMENT PROBLEMS OR FAILURES:

SUGGESTIONS, ADDITIONS, CHANGES:

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

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B-328-DH BORING GEOPHYSICS FIELD LOG SUMMARY

SITE: SOUTH TEXAS PROJECT COL DATE: 11/8/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 1 OF 1

CONTACT: MIKE SUFNARSKI PHONE: 704-357-5633

BOREHOLE CONSTRUCTION: CASED____ UNCASED ✓
DIAMETERS AND DEPTH RANGES: 4" 0 TO 215' ; ____, ____ TO ____
BOREHOLE TOTAL DEPTH AS DRILLED: 215'
CONDUCTOR CASING?: YES____ DEPTH TO BOTTOM OF CASING____; NO ✓
DEPTH TO BEDROCK: NA
BOREHOLE FLUID: WATER____; FRESH WATER MUD ✓; SALT WATER MUD ____;

LOGGING CREW: R. STELLER

LOG TYPE	FILE NAME	DEPTH RANGE	DATE	TIMES
SUSPENSION PS	B328_001-125.ORG	3.3' – 205.1'	11/8/06	08:00 – 09:20
ELOG TEST	B328ELOGTEST01	Ø	"	09:45 – 09:48
ELOG/GAMMA	B328ELOGUP01	217.8' – 35.0'	"	10:05 – 10:25
CALIPER TEST	B328CALTEST01	Ø	"	15:23 – 15:26
CALIPER/GAMMA	B328CALUP01	210.0' – 0.5'	"	15:34 – 15:57
CALIPER TEST	B328CALTEST02	Ø	"	16:03 – 16:05
DEVIATION	B328AUUP01	217.5' – Ø	"	16:23 – 16:35

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P-S SUSPENSION VELOCITY FIELD LOG

SITE: SOUTH TEXAS PROJECT COL B-328 DH DATE: 11/8/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 1 OF 6

CONTACT: MIKE SUFNARSKI OFFICE PHONE: 704-357-5633
CELL PHONE: 704-309-0624
CONTACT: OFFICE PHONE:
PHONE:
CONTACT: PHONE:
PHONE:
CONTACT: PHONE:
PHONE:
DRILLER: PHONE:
COMPANY: PHONE:

DIRECTIONS TO SITE:

GENERAL SITE CONDITIONS/LOCATION:

EA#:
BOREHOLE DESIGNATION: B-328-DH LOCATION:

COUNTY: RANGE: TOWNSHIP: SECTION:
BOREHOLE CONSTRUCTION: CASED UNCASED ✓
DIAMETERS AND DEPTH RANGES: 4" 0 TO 215 ; , TO
BOREHOLE TOTAL DEPTH AS DRILLED: 215'
CONDUCTOR CASING?: YES DEPTH TO BOTTOM OF CASING ; NO ✓
DEPTH TO BEDROCK: NA DEPTH TO WATER TABLE: ~20'
BOREHOLE FLUID: WATER ; FRESH WATER MUD ✓ ; SALT WATER MUD ;
OTHER:
DEPTH TO BOREHOLE FLUID: ∅ TIME SINCE LAST CIRCULATION: 16 HR.

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SITE: SOUTH TEXAS PROJECT COL B-328DH DATE: 11/8/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 2 OF 6

LOGGING CREW: R STELLER
VEHICLE(S) USED AND MILEAGE: RENTAL
MOBILIZED FROM: BAY CITY, TX DEPARTURE TIME: 6:00
ARRIVED ON SITE: 6:30
STANDBY TIME: CAUSE:
LOGGING STARTED: 08:00 LOGGING COMPLETED: 09:20
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 ☐	30086 ☑

MAINTENANCE PERFORMED ON SITE:

EQUIPMENT PROBLEMS OR FAILURES:

SUGGESTIONS, ADDITIONS, CHANGES:

COMMENTS: DEPTH REFERENCE AT GROUND LEVEL. PROBE OFFSET = 2.5 m = 8.2 FT. ON START OF LOG. 2.5 m = 8.2 FT AT END OF LOG. ASDE = 0.0'

GEOVISION SUSPENSION LOGGING FIELD NOTES

SITE: SOUTH TEXAS COL B-328-DH DATE: 11/8/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 5 OF 6

DEPTH METERS	DEPTH FEET	UNFILTERED FILE NO.	FILTERED FILE NO.	COMMENTS CASING, WATER, ROCK, ETC
0.5	1.64			
1.0	3.28	2		
1.5	4.92	3		
2.0	6.56	4		
2.5	8.20	001, 5		USE RECORD # 5
3.0	9.84	6		
3.5	11.48	7		
4.0	13.12	8		
4.5	14.76	9		
5.0	16.40	10		
5.5	18.04	11		
6.0	19.69	12		
6.5	21.33	13		
7.0	22.97	14		
7.5	24.61	15		
8.0	26.25	16		
8.5	27.89	17		
9.0	29.53	18		
9.5	31.17	19		
10.0	32.81	20		
10.5	34.45	21		
11.0	36.09	22		
11.5	37.73	23		
12.0	39.37	24		
12.5	41.01	25		
13.0	42.65	26		
13.5	44.29	27		
14.0	45.93	28		
14.5	47.57	29		
15.0	49.21	30		
15.5	50.85	31		
16.0	52.49	32		
16.5	54.13	33		
17.0	55.77	34		
17.5	57.41	35		
18.0	59.06	36		
18.5	60.70	37		
19.0	62.34	38		
19.5	63.98	39		
20.0	65.62	40		

GEOVISION SUSPENSION LOGGING FIELD NOTES

SITE: SOUTH TEXAS COL B-328-DH DATE: 11/8/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 4 OF 6

DEPTH METERS	DEPTH FEET	UNFILTERED FILE NO.	FILTERED FILE NO.	COMMENTS CASING, WATER, ROCK, ETC
20.5	67.26	41		
21.0	68.90	42		
21.5	70.54	43		
22.0	72.18	44		
22.5	73.82	45		
23.0	75.46	46		
23.5	77.10	47		
24.0	78.74	48		
24.5	80.38	49		
25.0	82.02	50		
25.5	83.66	51		
26.0	85.30	52		
26.5	86.94	53		
27.0	88.58	54		
27.5	90.22	55		
28.0	91.86	56		
28.5	93.50	57		
29.0	95.14	58		
29.5	96.78	59		
30.0	98.43	60		
30.5	100.07	61		
31.0	101.71	62		
31.5	103.35	63		
32.0	104.99	64		
32.5	106.63	65		
33.0	108.27	66		
33.5	109.91	67		
34.0	111.55	68		
34.5	113.19	69		
35.0	114.83	70		
35.5	116.47	71		
36.0	118.11	72		
36.5	119.75	73		
37.0	121.39	74		
37.5	123.03	75		
38.0	124.67	76		
38.5	126.31	77		
39.0	127.95	78		
39.5	129.59	79		
40.0	131.23	80		

GEOVISION SUSPENSION LOGGING FIELD NOTES

SITE: SOUTH TEXAS COL B-328-DH DATE: 11/8/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 5 OF 6

DEPTH METERS	DEPTH FEET	UNFILTERED FILE NO.	FILTERED FILE NO.	COMMENTS CASING, WATER, ROCK, ETC
40.5	132.87	81		
41.0	134.51	82		
41.5	136.15	83		
42.0	137.80	84		
42.5	139.44	85		
43.0	141.08	86		
43.5	142.72	87		
44.0	144.36	88		
44.5	146.00	89		
45.0	147.64	90		
45.5	149.28	91		
46.0	150.92	92		CAUGHT ON WAY DOWN ?
46.5	152.56	93		
47.0	154.20	94		
47.5	155.84	95		
48.0	157.48	96		
48.5	159.12	97		
49.0	160.76	98		
49.5	162.40	99		
50.0	164.04	100		
50.5	165.68	101		
51.0	167.32	102		
51.5	168.96	103		
52.0	170.60	104		
52.5	172.24	105		
53.0	173.88	106		
53.5	175.52	107		
54.0	177.17	108		
54.5	178.81	109		
55.0	180.45	110		
55.5	182.09	111		
56.0	183.73	112		
56.5	185.37	113		
57.0	187.01	114		
57.5	188.65	115		
58.0	190.29	116		
58.5	191.93	117		
59.0	193.57	118		
59.5	195.21	119		
60.0	196.85	120		

GEOVISION SUSPENSION LOGGING FIELD NOTES

SITE: SOUTH TEXAS COL B-328-DH DATE: 11/8/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 6 OF 6

DEPTH METERS	DEPTH FEET	UNFILTERED FILE NO.	FILTERED FILE NO.	COMMENTS CASING, WATER, ROCK, ETC
60.5	198.49	121		
61.0	200.13	122		
61.5	201.77	123		BOTTOM MEASUREMENT?
62.0	203.41	124		
62.5	205.05	125		HIT BOTTOM @ 62.6m. = 205.4
63.0	206.69			SO TIP @ 217.5'
63.5	208.33			
64.0	209.97			
64.5	211.61			
65.0	213.25			
65.5	214.90			T.D. @ 215'
66.0	216.54			
66.5	218.18			
67.0	219.82			
67.5	221.46			
68.0	223.10			
68.5	224.74			
69.0	226.38			
69.5	228.02			
70.0	229.66			
70.5	231.30			
71.0	232.94			
71.5	234.58			
72.0	236.22			
72.5	237.86			
73.0	239.50			
73.5	241.14			
74.0	242.78			
74.5	244.42			
75.0	246.06			
75.5	247.70			
76.0	249.34			
76.5	250.98			
77.0	252.62			
77.5	254.27			
78.0	255.91			
78.5	257.55			
79.0	259.19			
79.5	260.83			
80.0	262.47			

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B-328-DH ELOG FIELD LOG

SITE: SOUTH TEXAS PROJECT COL DATE: 11/8/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 1 OF 2

CONTACT: _OFFICE_ PHONE:
CELL PHONE:
CONTACT: _OFFICE_ PHONE:
PHONE:
CONTACT: PHONE:
PHONE:
CONTACT: PHONE:
PHONE:
DRILLER: PHONE:
COMPANY: PHONE:

GENERAL SITE CONDITIONS/LOCATION:

BOREHOLE DESIGNATION: B-328-DH LOCATION:

COUNTY: RANGE: TOWNSHIP: SECTION:
BOREHOLE CONSTRUCTION: CASED UNCASED ✓
DIAMETERS AND DEPTH RANGES: 4" 0 TO 215' ; , TO
BOREHOLE TOTAL DEPTH AS DRILLED: 215'
CONDUCTOR CASING?: YES DEPTH TO BOTTOM OF CASING ; NO ✓
DEPTH TO BEDROCK: NA DEPTH TO WATER TABLE: ≈20'
BOREHOLE FLUID: WATER ; FRESH WATER MUD ✓ ; SALT WATER MUD ;
OTHER:
DEPTH TO BOREHOLE FLUID: 0 TIME SINCE LAST CIRCULATION: ≈17 HR

LOGGING CREW: R. STELLER
VEHICLE(S) USED AND MILEAGE: RENTAL
MOBILIZED FROM: BAY CITY, TX DEPARTURE TIME: 06:00
ARRIVED ON SITE: 06:30
STANDBY TIME: CAUSE:
LOGGING STARTED: 09:45 LOGGING COMPLETED: 10:25

SITE:_SOUTH TEXAS PROJECT COL B-328-DH DATE: 11/8/06
CLIENT:_MACTEC JOB:_6533
AUTHOR:_R. STELLER PAGE 2 OF 2

WINCH: COMPROBE____ SILVER ✓ OYO____ OTHER____
MICROLOGGER 5301 ✓ OTHER____
ELOG PROBE 5490 ✓ OTHER____

PROBE LENGTH	2.50M(8.20 FT)	
PLUS YOKE 10.0M (32.8 FT)	~~41.0~~ 32.8'	RAS 11/8/06
MINUS CASING STICK-UP	Ø	
DEPTH REF. OFFSET AT START	41.0'	
DEPTH REF. OFFSET AT END		
AFTER SURVEY DEPTH ERROR		LESS THAN 0.4%?

LOG NAME	START DEPTH	START TIME	END DEPTH	END TIME
B328ELOGTEST01	Ø	09:45	Ø	09:48
B328ELOG UP01	217.8'	10:05	~~[illegible]~~ 35.0'	10:26

RAS 11/8/06

MAINTENANCE PERFORMED ON SITE:____

EQUIPMENT PROBLEMS OR FAILURES:____

SUGGESTIONS, ADDITIONS, CHANGES: Hit Bottom @ 217.9'

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B-328-OH CALIPER FIELD LOG

SITE: SOUTH TEXAS PROJECT COL DATE: 11/8/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 1 OF 2

CONTACT: MIKE SUFNARSKI OFFICE PHONE:
CELL PHONE: 704-357-5633
CONTACT: OFFICE PHONE:
PHONE:
CONTACT: PHONE:
PHONE:
CONTACT: PHONE:
PHONE:
DRILLER: PHONE:
COMPANY: PHONE:

GENERAL SITE CONDITIONS/LOCATION:

BOREHOLE DESIGNATION: LOCATION:

COUNTY: RANGE: TOWNSHIP: SECTION:
BOREHOLE CONSTRUCTION: CASED UNCASED ✓
DIAMETERS AND DEPTH RANGES: 4" 0 TO 215' ; , TO
BOREHOLE TOTAL DEPTH AS DRILLED: 215'
CONDUCTOR CASING?: YES DEPTH TO BOTTOM OF CASING ; NO ✓
DEPTH TO BEDROCK: NA DEPTH TO WATER TABLE: ≈20'
BOREHOLE FLUID: WATER ; FRESH WATER MUD ✓ ; SALT WATER MUD ;
OTHER:
DEPTH TO BOREHOLE FLUID: 5' TIME SINCE LAST CIRCULATION: ≈24 HR

LOGGING CREW: R. STELLER
VEHICLE(S) USED AND MILEAGE: RENTAL
MOBILIZED FROM: BAY CITY, TX DEPARTURE TIME: 06:00
ARRIVED ON SITE: 06:30
STANDBY TIME: CAUSE:
LOGGING STARTED: 15:23 LOGGING COMPLETED: 16:05

SITE: SOUTH TEXAS PROJECT COL B-328-DH DATE: 11/8/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 2 OF 2

WINCH: COMPROBE___ SILVER ✓ OYO___ OTHER___
MICROLOGGER 5301 ✓ OTHER___
CALIPER PROBE 5368 ✓ OTHER___

PROBE OFFSET	2.08M(6.82 FT) 12 IN MAX
MINUS CASING STICK-UP	ø
DEPTH REF. OFFSET AT START	6.82'
DEPTH REF. OFFSET AT END	6.80
AFTER SURVEY DEPTH ERROR	-.02 LESS THAN 0.4%? YES

LOG NAME	START DEPTH	START TIME	END DEPTH	END TIME
B328CALTEST01	ø	15:23	ø	15:26
B328CALUP01	210.0'	15:34	.5	15:57
B328CALTEST02	0	16:03	ø	16:05

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.	B328CALTEST01	2.01	3.94	8.02	4.54
AS MEAS.	B328CALTEST02	2.01	3.96	8.00	4.54
AS MEAS.					
AS MEAS.					
AS MEAS.					
AS MEAS.					

MAINTENANCE PERFORMED ON SITE:

EQUIPMENT PROBLEMS OR FAILURES:

SUGGESTIONS, ADDITIONS, CHANGES:

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

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B-328 DH ACOUSTIC TELEVIEWER FIELD LOG

SITE: SOUTH TEXAS PROJECT COL DATE: 11/6/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 1 OF 2

CONTACT: MIKE SUFNARSKI OFFICE PHONE: 704-357-5633
CELL PHONE: 704-309-0624
CONTACT: OFFICE PHONE:
PHONE:
CONTACT: PHONE:
PHONE:
CONTACT: PHONE:
PHONE:
DRILLER: PHONE:
COMPANY: PHONE:

DIRECTIONS TO SITE:

GENERAL SITE CONDITIONS/LOCATION:

BOREHOLE DESIGNATION: B-328-DH LOCATION:

COUNTY: RANGE: TOWNSHIP: SECTION:
BOREHOLE CONSTRUCTION: CASED UNCASED ✓
DIAMETERS AND DEPTH RANGES: 4" 0 TO 215' ; , TO
BOREHOLE TOTAL DEPTH AS DRILLED: 215'
CONDUCTOR CASING?: YES DEPTH TO BOTTOM OF CASING ; NO ✓
DEPTH TO BEDROCK: NA DEPTH TO WATER TABLE: ≈20'
BOREHOLE FLUID: WATER ; FRESH WATER MUD ✓ ; SALT WATER MUD ;
OTHER:
DEPTH TO BOREHOLE FLUID: 5' TIME SINCE LAST CIRCULATION: ≈24 HR

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SITE: SOUTH TEXAS PROJECT COL B-328-DH DATE: 11/8/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 2 OF 2

LOGGING CREW: R. STELLER
VEHICLE(S) USED AND MILEAGE: RENTAL
MOBILIZED FROM: BAY CITY, TX DEPARTURE TIME: 06:00
ARRIVED ON SITE: 06:30
STANDBY TIME: CAUSE:
LOGGING STARTED: 16:23 LOGGING COMPLETED: 16:35

WINCH: COMPROBE ___ SILVER ✓ OYO ___ OTHER ___
MICROLOGGER 5301 ✓ OTHER ___
TELEVIEWER ACOUSTIC #5174 ✓ OTHER ___

PROBE TILT TEST 89.7° BRUNTON TILT 90°
PROBE TILT TEST 0.5° BRUNTON TILT Ø
PROBE TILT TEST ___ BRUNTON TILT ___
PROBE AZIMUTH TEST 126.6 BRUNTON AZIMUTH 128°
PROBE AZIMUTH TEST 341.2° BRUNTON AZIMUTH 343°
PROBE AZIMUTH TEST ___ BRUNTON AZIMUTH ___

PROBE OFFSET	1.44M(4.72FT)	
MINUS CASING STICK-UP	Ø	
DEPTH REF. OFFSET AT START	4.72	
DEPTH REF. OFFSET AT END	4.72	
AFTER SURVEY DEPTH ERROR	Ø	LESS THAN 0.4%? YES

LOG NAME	START DEPTH	START TIME	END DEPTH	END TIME
B328AU401	27.5'	16:23	Ø	16:35

MAINTENANCE PERFORMED ON SITE:

EQUIPMENT PROBLEMS OR FAILURES:

SUGGESTIONS, ADDITIONS, CHANGES:

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B-402-DH BORING GEOPHYSICS FIELD LOG SUMMARY

SITE: SOUTH TEXAS PROJECT COL DATE: 12/6/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 1 OF 1

CONTACT: MIKE SUFNARSKI PHONE: 704-357-5633

BOREHOLE CONSTRUCTION: CASED____ UNCASED ✓
DIAMETERS AND DEPTH RANGES: 4" 0 TO 215' ; ____, ____ TO ____
BOREHOLE TOTAL DEPTH AS DRILLED: 215'
CONDUCTOR CASING?: YES ✓ DEPTH TO BOTTOM OF CASING 1' ; NO____
DEPTH TO BEDROCK: NA
BOREHOLE FLUID: WATER____; FRESH WATER MUD ✓; SALT WATER MUD ____;

LOGGING CREW: R. STELLER

LOG TYPE	FILE NAME	DEPTH RANGE	DATE	TIMES
ELOG TEST	B402ELOGTEST01	Ø	12/6/06	12:30 - 12:33
ELOG/GAMMA	B402ELOGUP01	216.0' - 34.8'	"	13:19 - 13:39
SUSPENSION PS	B402_001 - 122.ORG	3.3 - 201.8'	"	14:15 - 16:10
CALIPER TEST	B402CALTEST01	Ø	"	16:28 - 16:31
CALIPER/GAMMA	B402CALUP01	210.0' - Ø	"	16:38 - 17:02
CALIPER TEST	B402CALTEST02	Ø	"	17:06 - 17:08
DEVIATION	B402 AULPO1	210.0' - Ø	"	17:20 - 17:42

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B-402 ELOG FIELD LOG

SITE:_SOUTH TEXAS PROJECT COL_________ DATE: 12/6/06
CLIENT:_MACTEC_________ JOB:_6533_________
AUTHOR:_R. STELLER_________ PAGE 1 OF 2

CONTACT:_________ _OFFICE__ PHONE:_________
_CELL__ PHONE:_________
CONTACT:_________ _OFFICE__ PHONE:_________
_________ PHONE:_________
CONTACT:_________ _________ PHONE:_________
_________ PHONE:_________
CONTACT:_________ _________ PHONE:_________
_________ PHONE:_________
DRILLER:_________ _________ PHONE:_________
COMPANY:_________ _________ PHONE:_________

GENERAL SITE CONDITIONS/LOCATION:_________

BOREHOLE DESIGNATION: B-402-DH LOCATION:_________

COUNTY:_________ RANGE:_________ TOWNSHIP:_________ SECTION:_________
BOREHOLE CONSTRUCTION: CASED_____ UNCASED_____
DIAMETERS AND DEPTH RANGES: 4" 0 TO 215' ; ______, ______ TO ______
BOREHOLE TOTAL DEPTH AS DRILLED: 215'
CONDUCTOR CASING?: YES___ DEPTH TO BOTTOM OF CASING_______; NO___
DEPTH TO BEDROCK: NA DEPTH TO WATER TABLE: ≈20'
BOREHOLE FLUID: WATER_____; FRESH WATER MUD ✓; SALT WATER MUD _____;
OTHER:_________
DEPTH TO BOREHOLE FLUID: Ø TIME SINCE LAST CIRCULATION: ½ HR

LOGGING CREW:_R. STELLER, C. CARTER
VEHICLE(S) USED AND MILEAGE: _RENTAL_________
MOBILIZED FROM: BAY CITY, TX DEPARTURE TIME: 10:30
ARRIVED ON SITE: 11:00
STANDBY TIME:_________ CAUSE:_________
LOGGING STARTED: 12:30 LOGGING COMPLETED: 13:39

SITE: SOUTH TEXAS PROJECT COL B-402 DATE: 12/6/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 2 OF 2

WINCH: COMPROBE____ SILVER ✓ OYO____ OTHER____
MICROLOGGER 5301 ✓ OTHER____
ELOG PROBE 5490 ✓ OTHER____

PROBE LENGTH	2.50M(8.20 FT)	
PLUS YOKE 10.0M (32.8 FT)	+ 32.8'	
MINUS CASING STICK-UP	− 1.4'	
DEPTH REF. OFFSET AT START	39.6'	
DEPTH REF. OFFSET AT END	39.6	
AFTER SURVEY DEPTH ERROR		LESS THAN 0.4%?

LOG NAME	START DEPTH	START TIME	END DEPTH	END TIME
B402ELOG TEST01	Φ	12:30	Φ	12:33
B402 ELOGWELL01	216.0'	13:19	34.75	13:39

MAINTENANCE PERFORMED ON SITE:

EQUIPMENT PROBLEMS OR FAILURES:

SUGGESTIONS, ADDITIONS, CHANGES:

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P-S SUSPENSION VELOCITY FIELD LOG

SITE: SOUTH TEXAS PROJECT COL B-402 DATE: 12/6/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 1 OF 6

CONTACT: MIKE SUFNARSKI OFFICE PHONE: 704-357-5633
CELL PHONE: 704-309-0624
CONTACT: ________ OFFICE PHONE: ________
________ PHONE: ________
CONTACT: ________ ________ PHONE: ________
________ PHONE: ________
CONTACT: ________ ________ PHONE: ________
________ PHONE: ________
DRILLER: ________ ________ PHONE: ________
COMPANY: ________ ________ PHONE: ________

DIRECTIONS TO SITE: ________

GENERAL SITE CONDITIONS/LOCATION: ________

EA#: ________
BOREHOLE DESIGNATION: B-402-DH LOCATION: ________

COUNTY: ________ RANGE: ________ TOWNSHIP: ________ SECTION: ________
BOREHOLE CONSTRUCTION: CASED ____ UNCASED ✓
DIAMETERS AND DEPTH RANGES: 4" 0 TO 215' ; ____, ____ TO ____
BOREHOLE TOTAL DEPTH AS DRILLED: 215'
CONDUCTOR CASING?: YES ✓ DEPTH TO BOTTOM OF CASING 3' ; NO ____
DEPTH TO BEDROCK: NA DEPTH TO WATER TABLE: ≈20'
BOREHOLE FLUID: WATER ____; FRESH WATER MUD ✓ ; SALT WATER MUD ____;
OTHER: ________
DEPTH TO BOREHOLE FLUID: Ø TIME SINCE LAST CIRCULATION: 1 HR

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SITE: SOUTH TEXAS PROJECT COL B-402 DATE: 12/6/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 2 OF 6

LOGGING CREW: R. STELLER, C. CARTER
VEHICLE(S) USED AND MILEAGE: RENTAL
MOBILIZED FROM: BAY CITY, TX DEPARTURE TIME: 10:30
ARRIVED ON SITE: 11:00
STANDBY TIME: CAUSE:
LOGGING STARTED: 14:15 LOGGING COMPLETED: 16:10
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	☐	30086	☑

MAINTENANCE PERFORMED ON SITE:

EQUIPMENT PROBLEMS OR FAILURES:

SUGGESTIONS, ADDITIONS, CHANGES:

COMMENTS: DEPTH ZERO @START = 2.5m − 0.4m = 2.1m.
Depth zero @ end = 2.06m

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GEOVISION SUSPENSION LOGGING FIELD NOTES

SITE: SOUTH TEXAS COL B-302 DATE: 12/6/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 3 OF 6

DEPTH METERS	DEPTH FEET	UNFILTERED FILE NO.	FILTERED FILE NO.	COMMENTS CASING, WATER, ROCK, ETC
0.5	1.64			
1.0	3.28	122		
1.5	4.92	121		
2.0	6.56	120		
2.5	8.20	119		
3.0	9.84	118		
3.5	11.48	117		
4.0	13.12	116		
4.5	14.76	115		
5.0	16.40	114		
5.5	18.04	113		
6.0	19.69	1		
6.5	21.33	2		
7.0	22.97	3		
7.5	24.61	4		
8.0	26.25	5		
8.5	27.89	6		
9.0	29.53	7		
9.5	31.17	8		
10.0	32.81	9		
10.5	34.45	10		
11.0	36.09	11		
11.5	37.73	12		
12.0	39.37	13		
12.5	41.01	14		
13.0	42.65	15		
13.5	44.29	16		
14.0	45.93	17		
14.5	47.57	18		
15.0	49.21	19		
15.5	50.85	20		
16.0	52.49	21		
16.5	54.13	22		
17.0	55.77	23		
17.5	57.41	24		
18.0	59.06	25		
18.5	60.70	26		
19.0	62.34	27		
19.5	63.98	28		
20.0	65.62	29		

GEOVISION SUSPENSION LOGGING FIELD NOTES

SITE: SOUTH TEXAS COL B-402 DATE: 12/6/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 4 OF 6

DEPTH METERS	DEPTH FEET	UNFILTERED FILE NO.	FILTERED FILE NO.	COMMENTS CASING, WATER, ROCK, ETC
20.5	67.26	30		
21.0	68.90	31		
21.5	70.54	32		
22.0	72.18	33		
22.5	73.82	34		
23.0	75.46	35		
23.5	77.10	36		
24.0	78.74	37		
24.5	80.38	38		
25.0	82.02	39		
25.5	83.66	40		
26.0	85.30	41		
26.5	86.94	42		
27.0	88.58	43		
27.5	90.22	44		
28.0	91.86	45		
28.5	93.50	46		
29.0	95.14	47		
29.5	96.78	48		
30.0	98.43	49		
30.5	100.07	50		
31.0	101.71	51		
31.5	103.35	52		
32.0	104.99	53		
32.5	106.63	54		
33.0	108.27	55		
33.5	109.91	56		
34.0	111.55	57		
34.5	113.19	58		
35.0	114.83	59		
35.5	116.47	60		
36.0	118.11	61		
36.5	119.75	62		
37.0	121.39	63		
37.5	123.03	64		
38.0	124.67	65		
38.5	126.31	66		
39.0	127.95	67		
39.5	129.59	68		
40.0	131.23	69		

GEOVISION SUSPENSION LOGGING FIELD NOTES

SITE: SOUTH TEXAS COL B-402 DATE: 12/6/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 5 OF 6

DEPTH METERS	DEPTH FEET	UNFILTERED FILE NO.	FILTERED FILE NO.	COMMENTS CASING, WATER, ROCK, ETC
40.5	132.87	70		
41.0	134.51	71		
41.5	136.15	72		
42.0	137.80	73		
42.5	139.44	74		
43.0	141.08	75		
43.5	142.72	76		
44.0	144.36	77		
44.5	146.00	78		
45.0	147.64	79		
45.5	149.28	80		
46.0	150.92	81		
46.5	152.56	82		
47.0	154.20	83		
47.5	155.84	84		
48.0	157.48	85		
48.5	159.12	86		
49.0	160.76	87		
49.5	162.40	88		
50.0	164.04	89		
50.5	165.68	90		
51.0	167.32	91		
51.5	168.96	92		
52.0	170.60	93		
52.5	172.24	94		
53.0	173.88	95		
53.5	175.52	96		
54.0	177.17	97		
54.5	178.81	98		
55.0	180.45	99		
55.5	182.09	100		
56.0	183.73	101		
56.5	185.37	102		
57.0	187.01	103		
57.5	188.65	104		
58.0	190.29	105		
58.5	191.93	106		
59.0	193.57	107		
59.5	195.21	108		
60.0	196.85	109		

GEOVISION SUSPENSION LOGGING FIELD NOTES

SITE: SOUTH TEXAS COL B-402 DATE: 12/6/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 6 OF 6

DEPTH METERS	DEPTH FEET	UNFILTERED FILE NO.	FILTERED FILE NO.	COMMENTS CASING, WATER, ROCK, ETC
60.5	198.49	110		
61.0	200.13	111		
61.5	201.77	112		
62.0	203.41			BOTTOM MEASUREMENT?
62.5	205.05			hit bottom 61.8
63.0	206.69			
63.5	208.33			
64.0	209.97			
64.5	211.61			
65.0	213.25			
65.5	214.90			T.D. @ 215'
66.0	216.54			
66.5	218.18			
67.0	219.82			
67.5	221.46			
68.0	223.10			
68.5	224.74			
69.0	226.38			
69.5	228.02			
70.0	229.66			
70.5	231.30			
71.0	232.94			
71.5	234.58			
72.0	236.22			
72.5	237.86			
73.0	239.50			
73.5	241.14			
74.0	242.78			
74.5	244.42			
75.0	246.06			
75.5	247.70			
76.0	249.34			
76.5	250.98			
77.0	252.62			
77.5	254.27			
78.0	255.91			
78.5	257.55			
79.0	259.19			
79.5	260.83			
80.0	262.47			

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B-402 CALIPER FIELD LOG

SITE: SOUTH TEXAS PROJECT COL DATE: 12/6/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 1 OF 2

CONTACT: MIKE SUFNARSKI OFFICE PHONE:
CELL PHONE: 704-357-5633
CONTACT: OFFICE PHONE:
PHONE:
CONTACT: PHONE:
PHONE:
CONTACT: PHONE:
PHONE:
DRILLER: PHONE:
COMPANY: PHONE:

GENERAL SITE CONDITIONS/LOCATION:

BOREHOLE DESIGNATION: B-402-DH LOCATION:

COUNTY: RANGE: TOWNSHIP: SECTION:
BOREHOLE CONSTRUCTION: CASED UNCASED ✓
DIAMETERS AND DEPTH RANGES: 4" 0 TO 215' ; , TO
BOREHOLE TOTAL DEPTH AS DRILLED: 215
CONDUCTOR CASING?: YES ✓ DEPTH TO BOTTOM OF CASING 1'; NO
DEPTH TO BEDROCK: NA DEPTH TO WATER TABLE: ~20'
BOREHOLE FLUID: WATER ; FRESH WATER MUD ✓ ; SALT WATER MUD ;
OTHER:
DEPTH TO BOREHOLE FLUID: Ø TIME SINCE LAST CIRCULATION: ~3HR

LOGGING CREW: R. STELLER, C. CARTER
VEHICLE(S) USED AND MILEAGE: RENTAL
MOBILIZED FROM: BAY CITY, TX DEPARTURE TIME: 10:30
ARRIVED ON SITE: 11:00
STANDBY TIME: CAUSE:
LOGGING STARTED: 16:28 LOGGING COMPLETED: 17:08

SITE:_SOUTH TEXAS PROJECT COL B-402 DATE: 12/6/06
CLIENT:_MACTEC JOB:_6533
AUTHOR:_R. STELLER PAGE 2 OF 2

WINCH: COMPROBE___ SILVER ✓ OYO___ OTHER___
MICROLOGGER 5301 ✓ OTHER___
CALIPER PROBE 5368 ✓ OTHER___

PROBE OFFSET	2.08M(6.82 FT) 12 IN MAX	
MINUS CASING STICK-UP	1.4'	
DEPTH REF. OFFSET AT START	5.42'	
DEPTH REF. OFFSET AT END	5.50	
AFTER SURVEY DEPTH ERROR	+0.08	LESS THAN 0.4%? YES

LOG NAME	START DEPTH	START TIME	END DEPTH	END TIME
B402CALTEST01	Ø	16:28	Ø	16:31
B402CALUP01	210.0'	16:38	Ø	17:02
B402CALTEST02	Ø	17:06	Ø	17:06

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.	B402CALTEST01	1.96	3.94	7.99	4.49
AS MEAS.	B402CALTEST02	1.98	3.94	8.02	4.52
AS MEAS.					
AS MEAS.					
AS MEAS.					
AS MEAS.					

MAINTENANCE PERFORMED ON SITE:___

EQUIPMENT PROBLEMS OR FAILURES:___

SUGGESTIONS, ADDITIONS, CHANGES:___

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B-402 ACOUSTIC TELEVIEWER FIELD LOG

SITE: SOUTH TEXAS PROJECT COL DATE: 12/6/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 1 OF 2

CONTACT: MIKE SUFNARSKI OFFICE PHONE: 704-357-5633
CELL PHONE: 704-309-0624
CONTACT: OFFICE PHONE:
PHONE:
CONTACT: PHONE:
PHONE:
CONTACT: PHONE:
PHONE:
DRILLER: PHONE:
COMPANY: PHONE:

DIRECTIONS TO SITE:

GENERAL SITE CONDITIONS/LOCATION:

BOREHOLE DESIGNATION: B-402-DH LOCATION:

COUNTY: RANGE: TOWNSHIP: SECTION:
BOREHOLE CONSTRUCTION: CASED UNCASED ✓
DIAMETERS AND DEPTH RANGES: 4" 0 TO 215 ; , TO
BOREHOLE TOTAL DEPTH AS DRILLED: 215'
CONDUCTOR CASING?: YES ✓ DEPTH TO BOTTOM OF CASING 1'; NO
DEPTH TO BEDROCK: NA DEPTH TO WATER TABLE: F20
BOREHOLE FLUID: WATER ; FRESH WATER MUD ✓; SALT WATER MUD ;
OTHER:
DEPTH TO BOREHOLE FLUID: 0 TIME SINCE LAST CIRCULATION: >3HR

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SITE: SOUTH TEXAS PROJECT COL B-402 DATE: 12/6/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 2 OF 2

LOGGING CREW: R. STELLER, C. CARTER
VEHICLE(S) USED AND MILEAGE: RENTAL
MOBILIZED FROM: BAY CITY, TX DEPARTURE TIME: 10:50
ARRIVED ON SITE: 11:00
STANDBY TIME: CAUSE:
LOGGING STARTED: 17:20 LOGGING COMPLETED: 17:42

WINCH: COMPROBE___ SILVER ✓ OYO___ OTHER___
MICROLOGGER 5301 ✓ OTHER___
TELEVIEWER ACOUSTIC #5174 ✓ OTHER___

PROBE TILT TEST 88.8° BRUNTON TILT 87°
PROBE TILT TEST 90.2° BRUNTON TILT 91°
PROBE TILT TEST ___ BRUNTON TILT ___
PROBE AZIMUTH TEST 223.8° BRUNTON AZIMUTH 220°
PROBE AZIMUTH TEST 106.1 BRUNTON AZIMUTH 111°
PROBE AZIMUTH TEST ___ BRUNTON AZIMUTH ___

PROBE OFFSET	1.44M(4.72FT)	
MINUS CASING STICK-UP	1.4'	
DEPTH REF. OFFSET AT START	3.32'	
DEPTH REF. OFFSET AT END	3.30	
AFTER SURVEY DEPTH ERROR	-0.02	LESS THAN 0.4%? YES

LOG NAME	START DEPTH	START TIME	END DEPTH	END TIME
B402AuuP01	210.0'	17:20	0	~~0~~ 17:42

MAINTENANCE PERFORMED ON SITE:

EQUIPMENT PROBLEMS OR FAILURES:

SUGGESTIONS, ADDITIONS, CHANGES:

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B-405-DH BORING GEOPHYSICS FIELD LOG SUMMARY

SITE: SOUTH TEXAS PROJECT COL DATE: 11/7/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 1 OF 1

CONTACT: MIKE SUFNARSKI PHONE: 704-357-5633

BOREHOLE CONSTRUCTION: CASED____ UNCASED ✓
DIAMETERS AND DEPTH RANGES: 4" 0 TO 93' ; 3 7/8", 93' TO 618'
BOREHOLE TOTAL DEPTH AS DRILLED: 618'
CONDUCTOR CASING?: YES ✓ DEPTH TO BOTTOM OF CASING 98'; NO____
DEPTH TO BEDROCK: NA
BOREHOLE FLUID: WATER____; FRESH WATER MUD ✓; SALT WATER MUD ____;

LOGGING CREW: R. STELLER

LOG TYPE	FILE NAME	DEPTH RANGE	DATE	TIMES
SUSPENSION PS	B405_001-314.OBG	93.5 - 607.0	11/7/06	08:45 - 12:15
ELOG TEST	B405ELOGTEST01	Ø	11/7/06	13:12 - 13:22
ELOG	B405ELOGUP01	617.6' - 20.0'	11/7/06	13:36 - 14:40
CALIPER TEST	B405CALTEST01	Ø	11/7/06	15:02 - 15:03
"	B405CALTEST02	Ø	11/7/06	15:08 - 15:12
CALIPER	B405CALUP01	610.0' - Ø'	11/7/06	15:22 - 16:26
CALIPER TEST	B405CALTEST03	Ø	11/7/06	16:34 - 16:39
ACOUSTIC TV / DEVIATION	B405AMUP01	619.2' - Ø'	11/7/06	17:06 - 17:35

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P-S SUSPENSION VELOCITY FIELD LOG

SITE: SOUTH TEXAS PROJECT COL B-405-DH DATE: 11/7/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 1 OF 12

CONTACT: MIKE SUFNARSKI OFFICE PHONE: 704-357-5633
CELL PHONE: 704-309-0624
CONTACT: OFFICE PHONE:
PHONE:
CONTACT: PHONE:
PHONE:
CONTACT: PHONE:
PHONE:
DRILLER: PHONE: 281 242-6321
COMPANY: PHONE:

DIRECTIONS TO SITE:

GENERAL SITE CONDITIONS/LOCATION:

EA#:
BOREHOLE DESIGNATION: B-405-DH LOCATION:

COUNTY: RANGE: TOWNSHIP: SECTION:
BOREHOLE CONSTRUCTION: CASED UNCASED ✓
DIAMETERS AND DEPTH RANGES: 4 0 TO 93 ; 3 7/8 93' TO 618.
BOREHOLE TOTAL DEPTH AS DRILLED: 618
CONDUCTOR CASING?: YES ✓ DEPTH TO BOTTOM OF CASING 93'; NO
DEPTH TO BEDROCK: NA DEPTH TO WATER TABLE: ≈20'
BOREHOLE FLUID: WATER ; FRESH WATER MUD ✓; SALT WATER MUD ;
OTHER:
DEPTH TO BOREHOLE FLUID: Ø TIME SINCE LAST CIRCULATION: 1/2 HR.

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SITE: SOUTH TEXAS PROJECT COL B-405-DH DATE: 11/7/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 2 OF 12

LOGGING CREW: R. STELLER
VEHICLE(S) USED AND MILEAGE: RENTAL
MOBILIZED FROM: BAY CITY, TX DEPARTURE TIME: 0:630
ARRIVED ON SITE: 07:00
STANDBY TIME: CAUSE:
LOGGING STARTED: 08:45 LOGGING COMPLETED: 12:15
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 ☐	30086 ☑

MAINTENANCE PERFORMED ON SITE:

EQUIPMENT PROBLEMS OR FAILURES:

SUGGESTIONS, ADDITIONS, CHANGES:

COMMENTS: DEPTH REFERENCE TO ~~TOP OF~~ CASING 1.5' ABOVE GRADE PER DRILLER SO: TOP OF PROBE = 8.2' - 1.5' = 6.7' AT START OF LOG, 6.43' AT END
AFTER SURVEY DEPTH ERROR (ASDE) = -.27'

GEOVISION SUSPENSION LOGGING FIELD NOTES

SITE: SOUTH TEXAS COL B-405-DH DATE: 11/7/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 3 OF 12

DEPTH METERS	DEPTH FEET	UNFILTERED FILE NO.	FILTERED FILE NO.	COMMENTS CASING, WATER, ROCK, ETC
0.5	1.64			
1.0	3.28			
1.5	4.92			
2.0	6.56			
2.5	8.20			
3.0	9.84			
3.5	11.48			
4.0	13.12			
4.5	14.76			
5.0	16.40			
5.5	18.04			
6.0	19.69			
6.5	21.33			
7.0	22.97			
7.5	24.61			
8.0	26.25			
8.5	27.89			
9.0	29.53			
9.5	31.17			
10.0	32.81			
10.5	34.45			
11.0	36.09			
11.5	37.73			
12.0	39.37			
12.5	41.01			
13.0	42.65			
13.5	44.29			
14.0	45.93			
14.5	47.57			
15.0	49.21			
15.5	50.85			
16.0	52.49			
16.5	54.13			
17.0	55.77			
17.5	57.41			
18.0	59.06			
18.5	60.70			
19.0	62.34			
19.5	63.98			
20.0	65.62			

RAS 11/7/06

GEOVISION SUSPENSION LOGGING FIELD NOTES

SITE: SOUTH TEXAS COL B-405-DH DATE: 11/7/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 4 OF 12

DEPTH METERS	DEPTH FEET	UNFILTERED FILE NO.	FILTERED FILE NO.	COMMENTS CASING, WATER, ROCK, ETC
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		11/7/06	
24.0	78.74			
24.5	80.38			
25.0	82.02		RAS	
25.5	83.66			
26.0	85.30			
26.5	86.94			
27.0	88.58			
27.5	90.22			
28.0	91.86			RAS
28.5	93.50	001		BOTTOM OF STEEL CASE @ ~~91~~ 93'
29.0	95.14	2		
29.5	96.78	3		
30.0	98.43	4		
30.5	100.07	5		
31.0	101.71	6		
31.5	103.35	7		
32.0	104.99	8		
32.5	106.63	9		
33.0	108.27	10		
33.5	109.91	11		
34.0	111.55	12		
34.5	113.19	13		
35.0	114.83	14		
35.5	116.47	15		
36.0	118.11	16		
36.5	119.75	17		
37.0	121.39	18		
37.5	123.03	19		
38.0	124.67	20		
38.5	126.31	21		
39.0	127.95	22		
39.5	129.59	23		
40.0	131.23	24		

GEOVISION SUSPENSION LOGGING FIELD NOTES

SITE:_SOUTH TEXAS COL B-405 - DH DATE: 11/7/06
CLIENT:__MACTEC JOB:_6533
AUTHOR:_R. STELLER PAGE 5 OF 12

DEPTH METERS	DEPTH FEET	UNFILTERED FILE NO.	FILTERED FILE NO.	COMMENTS CASING, WATER, ROCK, ETC
40.5	132.87	25		
41.0	134.51	26		
41.5	136.15	27		
42.0	137.80	28		
42.5	139.44	29		
43.0	141.08	30		
43.5	142.72	31		
44.0	144.36	32		
44.5	146.00	33		
45.0	147.64	34		
45.5	149.28	35		
46.0	150.92	36		
46.5	152.56	37		
47.0	154.20	38		
47.5	155.84	39		
48.0	157.48	40		
48.5	159.12	41		
49.0	160.76	42		
49.5	162.40	43		
50.0	164.04	44		
50.5	165.68	45		
51.0	167.32	46		
51.5	168.96	47		
52.0	170.60	48		
52.5	172.24	49		
53.0	173.88	50		
53.5	175.52	51		
54.0	177.17	52		
54.5	178.81	53		
55.0	180.45	54		
55.5	182.09	55		
56.0	183.73	56		
56.5	185.37	57		
57.0	187.01	58		
57.5	188.65	59		
58.0	190.29	60		
58.5	191.93	61		
59.0	193.57	62		
59.5	195.21	63		
60.0	196.85	64		

GEOVISION SUSPENSION LOGGING FIELD NOTES

SITE: SOUTH TEXAS COL B-405-DH DATE: 11/7/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 6 OF 12

DEPTH METERS	DEPTH FEET	UNFILTERED FILE NO.	FILTERED FILE NO.	COMMENTS CASING, WATER, ROCK, ETC
60.5	198.49	65		
61.0	200.13	66		
61.5	201.77	67		
62.0	203.41	68		
62.5	205.05	69		
63.0	206.69	70		
63.5	208.33	71		
64.0	209.97	72		
64.5	211.61	73		
65.0	213.25	74		
65.5	214.90	75		
66.0	216.54	76		
66.5	218.18	77		
67.0	219.82	78		
67.5	221.46	79		
68.0	223.10	80		
68.5	224.74	81		
69.0	226.38	82		
69.5	228.02	83		
70.0	229.66	84		
70.5	231.30	85		SAND LAYER? ↓
71.0	232.94	86		
71.5	234.58	87		
72.0	236.22	88		
72.5	237.86	89		
73.0	239.50	90		
73.5	241.14	91		
74.0	242.78	92		
74.5	244.42	93		
75.0	246.06	94		
75.5	247.70	95		
76.0	249.34	96		
76.5	250.98	97		
77.0	252.62	98		
77.5	254.27	99		
78.0	255.91	100		
78.5	257.55	101		
79.0	259.19	102		
79.5	260.83	103		
80.0	262.47	104		

GEOVISION SUSPENSION LOGGING FIELD NOTES

SITE:_SOUTH TEXAS COL B-405-DH DATE: 11/7/06
CLIENT:__MACTEC JOB:_6533
AUTHOR:_R. STELLER PAGE 7 OF 12

DEPTH METERS	DEPTH FEET	UNFILTERED FILE NO.	FILTERED FILE NO.	COMMENTS CASING, WATER, ROCK, ETC
80.5	264.11	105		
81.0	265.75	106		
81.5	267.39	107		
82.0	269.03	108		
82.5	270.67	109		
83.0	272.31	110		
83.5	273.95	111		
84.0	275.59	112		
84.5	277.23	113		
85.0	278.87	114		
85.5	280.51	115		
86.0	282.15	116		
86.5	283.79	117		
87.0	285.43	118		
87.5	287.07	119		
88.0	288.71	120		
88.5	290.35	121		
89.0	291.99	122		
89.5	293.64	123		
90.0	295.28	124		
90.5	296.92	125		
91.0	298.56	126		
91.5	300.20	127		
92.0	301.84	128		
92.5	303.48	129		
93.0	305.12	130		
93.5	306.76	131		
94.0	308.40	132		
94.5	310.04	133		
95.0	311.68	134		
95.5	313.32	135		
96.0	314.96	136		
96.5	316.60	137		
97.0	318.24	138		
97.5	319.88	139		
98.0	321.52	140		
98.5	323.16	141		
99.0	324.80	142		
99.5	326.44	143		
100.0	328.08	~~143~~ 144	RAS 11/7/06	

GEOVISION SUSPENSION LOGGING FIELD NOTES

SITE: SOUTH TEXAS COL B-405-DH DATE: 7/11/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 8 OF 12

DEPTH METERS	DEPTH FEET	UNFILTERED FILE NO.	FILTERED FILE NO.	COMMENTS CASING, WATER, ROCK, ETC
100.5	329.72	~~144~~ 145		
101.0	331.36	~~145~~ 146		
101.5	333.01	~~146~~ 147		
102.0	334.65	~~147~~ 148		
102.5	336.29	~~148~~ 149		
103.0	337.93	~~149~~ 150	RAS	11/7/06
103.5	339.57	~~150~~ 151		
104.0	341.21	~~151~~ 152		
104.5	342.85	~~152~~ 153		
105.0	344.49	~~153~~ 154		
105.5	346.13	~~154~~ 155		
106.0	347.77	~~155~~ 156		
106.5	349.41	~~156~~ 157		
107.0	351.05	158		
107.5	352.69	159		
108.0	354.33	160		
108.5	355.97	161		
109.0	357.61	162		
109.5	359.25	163		
110.0	360.89	164		
110.5	362.53	165		
111.0	364.17	166		
111.5	365.81	167		
112.0	367.45	168		
112.5	369.09	169		
113.0	370.73	170		
113.5	372.38	171		
114.0	374.02	172		
114.5	375.66	173		
115.0	377.30	174		
115.5	378.94	175		
116.0	380.58	176		
116.5	382.22	177		
117.0	383.86	178		
117.5	385.50	179		
118.0	387.14	180		
118.5	388.78	181		
119.0	390.42	182		
119.5	392.06	183		
120.0	393.70	184		

GEOVISION SUSPENSION LOGGING FIELD NOTES

SITE: SOUTH TEXAS COL B-405-DH DATE: 11/7/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 9 OF 12

DEPTH METERS	DEPTH FEET	UNFILTERED FILE NO.	FILTERED FILE NO.	COMMENTS CASING, WATER, ROCK, ETC
120.5	395.34	185		
121.0	396.98	186		
121.5	398.62	187		
122.0	400.26	188		
122.5	401.90	189		
123.0	403.54	190		
123.5	405.18	191		
124.0	406.82	192		
124.5	408.46	193		
125.0	410.10	194		
125.5	411.75	195		
126.0	413.39	196		
126.5	415.03	197		
127.0	416.67	198		
127.5	418.31	199		
128.0	419.95	200		
128.5	421.59	201		
129.0	423.23	202		
129.5	424.87	203		
130.0	426.51	204		
130.5	428.15	205		
131.0	429.79	206		
131.5	431.43	207		
132.0	433.07	208		
132.5	434.71	209		
133.0	436.35	210		
133.5	437.99	211		
134.0	439.63	212		
134.5	441.27	213		
135.0	442.91	214		
135.5	444.55	215		
136.0	446.19	216		
136.5	447.83	217		
137.0	449.48	218		
137.5	451.12	219		
138.0	452.76	220		
138.5	454.40	221		
139.0	456.04	222		
139.5	457.68	223		
140.0	459.32	224		

GEOVISION SUSPENSION LOGGING FIELD NOTES

SITE:_SOUTH TEXAS COL B-405-DH DATE: 11/7/06
CLIENT:__MACTEC JOB:_6533
AUTHOR:_R. STELLER PAGE 10 OF 12

DEPTH METERS	DEPTH FEET	UNFILTERED FILE NO.	FILTERED FILE NO.	COMMENTS CASING, WATER, ROCK, ETC
140.5	460.96	225		
141.0	462.60	226		
141.5	464.24	227		
142.0	465.88	228		
142.5	467.52	229		
143.0	469.16	230		
143.5	470.80	231		
144.0	472.44	232		
144.5	474.08	233		
145.0	475.72	234		
145.5	477.36	235		
146.0	479.00	236		
146.5	480.64	237		
147.0	482.28	238		
147.5	483.92	239		
148.0	485.56	240		
148.5	487.20	241		
149.0	488.85	242		
149.5	490.49	243		
150.0	492.13	244		
150.5	493.77	245		
151.0	495.41	246		
151.5	497.05	247		
152.0	498.69	248		
152.5	500.33	249		
153.0	501.97	250		
153.5	503.61	251		
154.0	505.25	252		
154.5	506.89	253		
155.0	508.53	254		
155.5	510.17	255		
156.0	511.81	256		
156.5	513.45	257		
157.0	515.09	258		
157.5	516.73	259		
158.0	518.37	260		
158.5	520.01	261		
159.0	521.65	262		
159.5	523.29	263		
160.0	524.93	264		

GEOVISION SUSPENSION LOGGING FIELD NOTES

SITE: SOUTH TEXAS COL B-405-DH DATE: 11/7/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 11 OF 12

DEPTH METERS	DEPTH FEET	UNFILTERED FILE NO.	FILTERED FILE NO.	COMMENTS CASING, WATER, ROCK, ETC
160.5	526.57	265		
161.0	528.22	266		
161.5	529.86	267		
162.0	531.50	268		
162.5	533.14	269		
163.0	534.78	270		
163.5	536.42	271		
164.0	538.06	272		
164.5	539.70	273		
165.0	541.34	274		
165.5	542.98	275		SAND LAYER @ 542'
166.0	544.62	276		
166.5	546.26	277		
167.0	547.90	278		
167.5	549.54	279		
168.0	551.18	280		
168.5	552.82	281		
169.0	554.46	282		
169.5	556.10	283		
170.0	557.74	284		
170.5	559.38	285		
171.0	561.02	286		
171.5	562.66	287		
172.0	564.30	288		
172.5	565.94	289		
173.0	567.59	290		
173.5	569.23	291		
174.0	570.87	292		
174.5	572.51	293		
175.0	574.15	294		
175.5	575.79	295		
176.0	577.43	296		
176.5	579.07	297		
177.0	580.71	298		
177.5	582.35	299		
178.0	583.99	300		
178.5	585.63	301		
179.0	587.27	302		
179.5	588.91	303		
180.0	590.55	304		

GEOVISION SUSPENSION LOGGING FIELD NOTES

SITE: SOUTH TEXAS COL B-405 - DH DATE: 11/7/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 12 OF 12

DEPTH METERS	DEPTH FEET	UNFILTERED FILE NO.	FILTERED FILE NO.	COMMENTS CASING, WATER, ROCK, ETC
180.5	592.19	305		
181.0	593.83	306		
181.5	595.47	307		
182.0	597.11	308		
182.5	598.75	309		
183.0	600.39	310		
183.5	602.03	311		
184.0	603.67	312		
184.5	605.31	313		B.M. ?
185.0	606.96	314		
185.5	608.60			
186.0	610.24			
186.5	611.88			
187.0	613.52			
187.5	615.16			
188.0	616.80			
188.5	618.44			T.D. @ 618'
189.0	620.08			
189.5	621.72			
190.0	623.36			
190.5	625.00			
191.0	626.64			
191.5	628.28			
192.0	629.92			
192.5	631.56			
193.0	633.20			
193.5	634.84			
194.0	636.48			
194.5	638.12			
195.0	639.76			
195.5	641.40			
196.0	643.04			
196.5	644.69			
197.0	646.33			
197.5	647.97			
198.0	649.61			
198.5	651.25			
199.0	652.89			
199.5	654.53			
200.0	656.17			

GEOVision
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B-405-DH ELOG FIELD LOG

SITE: SOUTH TEXAS PROJECT COL
DATE: 11/7/06
CLIENT: MACTEC
JOB: 6533
AUTHOR: R. STELLER
PAGE 1 OF 2

CONTACT: ______ _OFFICE_ PHONE: ______
CELL PHONE: ______
CONTACT: ______ _OFFICE_ PHONE: ______
PHONE: ______
CONTACT: ______ PHONE: ______
PHONE: ______
CONTACT: ______ PHONE: ______
PHONE: ______
DRILLER: ______ PHONE: ______
COMPANY: ______ PHONE: ______

GENERAL SITE CONDITIONS/LOCATION: ______

BOREHOLE DESIGNATION: B-405-DH LOCATION: ______

COUNTY: ______ RANGE: ______ TOWNSHIP: ______ SECTION: ______
BOREHOLE CONSTRUCTION: CASED ______ UNCASED ✓
DIAMETERS AND DEPTH RANGES: 4 0 TO 93' ; 3 7/8 93' TO 618
BOREHOLE TOTAL DEPTH AS DRILLED: 618'
CONDUCTOR CASING?: YES ✓ DEPTH TO BOTTOM OF CASING 93' ; NO ______
DEPTH TO BEDROCK: NA DEPTH TO WATER TABLE: ≤20'
BOREHOLE FLUID: WATER ______; FRESH WATER MUD ✓; SALT WATER MUD ______;
OTHER: ______
DEPTH TO BOREHOLE FLUID: ≤20' TIME SINCE LAST CIRCULATION: 5 HR.

LOGGING CREW: R. STELLER
VEHICLE(S) USED AND MILEAGE: RENTAL
MOBILIZED FROM: BAY CITY, TX DEPARTURE TIME: 06:30
ARRIVED ON SITE: 07:00
STANDBY TIME: ______ CAUSE: ______
LOGGING STARTED: 13:12 LOGGING COMPLETED: 14:40

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

SITE:_SOUTH TEXAS PROJECT COL B-405-DH DATE: 11/7/06
CLIENT:_MACTEC JOB:_6533
AUTHOR:_R. STELLER PAGE 2 OF 2

WINCH: COMPROBE ✓ SILVER ✓ OYO____ OTHER________
MICROLOGGER 5301 ✓ OTHER________
ELOG PROBE 5490 ✓ OTHER________

PROBE LENGTH	2.50M(8.20 FT)	
PLUS YOKE 10.0M (32.8 FT)	32.8'	
MINUS CASING STICK-UP	1.5'	
DEPTH REF. OFFSET AT START	39.5'	
DEPTH REF. OFFSET AT END	39.7	
AFTER SURVEY DEPTH ERROR	0.2	LESS THAN 0.4%? YES

LOG NAME	START DEPTH	START TIME	END DEPTH	END TIME
B405ELOGTEST01	Ø	13:12	Ø	13:22
B405 ELOG UP 01	67.6	13:36	20	14:40

MAINTENANCE PERFORMED ON SITE:________

EQUIPMENT PROBLEMS OR FAILURES:________

SUGGESTIONS, ADDITIONS, CHANGES:________

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B-405-DH CALIPER FIELD LOG

SITE:_SOUTH TEXAS PROJECT COL ______ DATE: 11/7/06
CLIENT:_MACTEC ______ JOB:_6533
AUTHOR:_R. STELLER ______ PAGE 1 OF 2

CONTACT:_MIKE SUFNARSKI ______ _OFFICE__ PHONE:
_CELL___ PHONE:_704-357-5633
CONTACT: ______ _OFFICE__ PHONE:
PHONE:
CONTACT: ______ PHONE:
PHONE:
CONTACT: ______ PHONE:
PHONE:
DRILLER: ______ PHONE:
COMPANY: ______ PHONE:

GENERAL SITE CONDITIONS/LOCATION: ______

BOREHOLE DESIGNATION: B-405-DH LOCATION: ______

COUNTY: ______ RANGE: ______ TOWNSHIP: ______ SECTION: ______
BOREHOLE CONSTRUCTION: CASED ___ UNCASED ✓
DIAMETERS AND DEPTH RANGES: 4" 0 TO 93' ; 3⅞" 93 TO 618
BOREHOLE TOTAL DEPTH AS DRILLED: 618'
CONDUCTOR CASING?: YES ✓ DEPTH TO BOTTOM OF CASING 93' ; NO ___
DEPTH TO BEDROCK: NA DEPTH TO WATER TABLE: ≈20'
BOREHOLE FLUID: WATER ___; FRESH WATER MUD ✓; SALT WATER MUD ___;
OTHER: ______
DEPTH TO BOREHOLE FLUID: ≈20' TIME SINCE LAST CIRCULATION: 6.5 HR.

LOGGING CREW:_R. STELLER
VEHICLE(S) USED AND MILEAGE: _RENTAL
MOBILIZED FROM: BAY CITY, TX DEPARTURE TIME: 06:30
ARRIVED ON SITE: 07:00
STANDBY TIME: ______ CAUSE: ______
LOGGING STARTED: 15:02 LOGGING COMPLETED: 16:39

SITE:_SOUTH TEXAS PROJECT COL B-405-DH DATE: 11/7/06
CLIENT:_MACTEC JOB:_6533
AUTHOR:_R. STELLER PAGE 2 OF 2

WINCH: COMPROBE____ SILVER ✓ OYO____ OTHER________
MICROLOGGER 5301 ✓ OTHER________
CALIPER PROBE 5368 ✓ OTHER________

PROBE OFFSET	2.08M(6.82 FT) 12 IN MAX	
MINUS CASING STICK-UP	1.5'	
DEPTH REF. OFFSET AT START	5.32'	
DEPTH REF. OFFSET AT END	5.35	
AFTER SURVEY DEPTH ERROR	.03	LESS THAN 0.4%? YES

LOG NAME	START DEPTH	START TIME	END DEPTH	END TIME
B405CALTEST01	Ø	15:02	Ø	15:03
B405CALTEST02	Ø	15:08	Ø	15:12
B405CALUP01	610	15:22	Ø	16:26
B405CALTEST03	Ø	16:34	Ø	16:39

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.	B405CALTEST01	2.05.	NOT COMPLETED	RECALIBRATED.	
AS MEAS.	B405CALTEST02	2.00	3.93	7.99	4.52
AS MEAS.	B405CALTEST03	2.01	3.91	7.99	4.54
AS MEAS.					
AS MEAS.					
AS MEAS.					

MAINTENANCE PERFORMED ON SITE:________

EQUIPMENT PROBLEMS OR FAILURES:________

SUGGESTIONS, ADDITIONS, CHANGES:________

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B-405-DH ACOUSTIC TELEVIEWER FIELD LOG

SITE: SOUTH TEXAS PROJECT COL DATE: 11/7/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 1 OF 2

CONTACT: MIKE SUFNARSKI OFFICE PHONE: 704-357-5633
CELL PHONE: 704-309-0624
CONTACT: OFFICE PHONE:
PHONE:
CONTACT: PHONE:
PHONE:
CONTACT: PHONE:
PHONE:
DRILLER: PHONE:
COMPANY: PHONE:

DIRECTIONS TO SITE:

GENERAL SITE CONDITIONS/LOCATION:

BOREHOLE DESIGNATION: B-405-DH LOCATION:

COUNTY: RANGE: TOWNSHIP: SECTION: –
BOREHOLE CONSTRUCTION: CASED UNCASED ✓
DIAMETERS AND DEPTH RANGES: 4" 0 TO 93'; 3 7/8", 93' TO 618'
BOREHOLE TOTAL DEPTH AS DRILLED: 618'
CONDUCTOR CASING?: YES ✓ DEPTH TO BOTTOM OF CASING 93'; NO
DEPTH TO BEDROCK: NA DEPTH TO WATER TABLE: ≈20'
BOREHOLE FLUID: WATER ~~≈20'~~; FRESH WATER MUD ✓; SALT WATER MUD ;
RDS 11/7/06
OTHER:
DEPTH TO BOREHOLE FLUID: ≈20' TIME SINCE LAST CIRCULATION: 7.5 HR

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SITE: SOUTH TEXAS PROJECT COL B-405-DH DATE: 11/7/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 2 OF 2

LOGGING CREW: R. STELLER
VEHICLE(S) USED AND MILEAGE: RENTAL
MOBILIZED FROM: BAY CITY, TX DEPARTURE TIME: 06:30
ARRIVED ON SITE: 07:00
STANDBY TIME: CAUSE:
LOGGING STARTED: 17:06 LOGGING COMPLETED: 17:35

WINCH: COMPROBE___ SILVER ✓ OYO___ OTHER___
MICROLOGGER 5301 ✓ OTHER___
TELEVIEWER ACOUSTIC #5174 ✓ OTHER___

PROBE TILT TEST 88.7° BRUNTON TILT 89°
PROBE TILT TEST 0.6° BRUNTON TILT 0°
PROBE TILT TEST ___ BRUNTON TILT ___
PROBE AZIMUTH TEST 356.9 BRUNTON AZIMUTH 359°
PROBE AZIMUTH TEST 180.9° BRUNTON AZIMUTH 178°
PROBE AZIMUTH TEST ___ BRUNTON AZIMUTH ___

PROBE OFFSET	1.44M(4.72FT)	
MINUS CASING STICK-UP	1.5'	
DEPTH REF. OFFSET AT START	4.22'	
DEPTH REF. OFFSET AT END	3.95	
AFTER SURVEY DEPTH ERROR	-.071	LESS THAN 0.4%? YES

LOG NAME	START DEPTH	START TIME	END DEPTH	END TIME
B405AnuP01	~~410~~ 619.2 RMS 11/7/06	17:06	Ø	17:55

MAINTENANCE PERFORMED ON SITE:

EQUIPMENT PROBLEMS OR FAILURES:

SUGGESTIONS, ADDITIONS, CHANGES:

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B-405-DH BORING GEOPHYSICS FIELD LOG SUMMARY

SITE: SOUTH TEXAS PROJECT COL DATE: 11/8/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 1 OF 1

CONTACT: MIKE SUFNARSKI PHONE: 704-357-5633

BOREHOLE CONSTRUCTION: CASED____ UNCASED ✓
DIAMETERS AND DEPTH RANGES: 4" 0 TO 120' ; ____, ____ TO ____
BOREHOLE TOTAL DEPTH AS DRILLED: 120' CLEAR
CONDUCTOR CASING?: YES ✓ DEPTH TO BOTTOM OF CASING 20' ; NO____ (AUGER)
DEPTH TO BEDROCK: NA
BOREHOLE FLUID: WATER____; FRESH WATER MUD ✓; SALT WATER MUD ____;

LOGGING CREW: R. STELLER

LOG TYPE	FILE NAME	DEPTH RANGE	DATE	TIMES
SUSPENSION PS	B405S01-S53.OR4	21.5' - 106.6'	11/8/06	11:45 - 12:25
ELOG TEST	B405ELOGTEST02	Ø	"	11:01 - 11:04
ELOG/GAMMA	B405ELOGUP02	120.0' - 18.5'	"	11:12 - 11:23
DEVIATION	B405AMUP02	115.0' - Ø	"	13:43 - 13:49
CALIPER TEST	B405CALTEST04	Ø	"	13:56 - 14:12
CALIPER/GAMMA	B405CALUP02	115.0' - Ø	"	14:20 - 14:32
CALIPER TEST	B405CALTEST05	Ø	"	14:41 - 14:44

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P-S SUSPENSION VELOCITY FIELD LOG

SITE: SOUTH TEXAS PROJECT COL B-405-DH DATE: 11/8/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 1 OF ____

CONTACT: MIKE SUFNARSKI OFFICE PHONE: 704-357-5633
CELL PHONE: 704-309-0624
CONTACT: ____ OFFICE PHONE: ____
PHONE: ____
CONTACT: ____ PHONE: ____
PHONE: ____
CONTACT: ____ PHONE: ____
PHONE: ____
DRILLER: ____ PHONE: ____
COMPANY: ____ PHONE: ____

DIRECTIONS TO SITE: ____

GENERAL SITE CONDITIONS/LOCATION: ____

EA#: ____
BOREHOLE DESIGNATION: B-405-DH LOCATION: ____

COUNTY: ____ RANGE: ____ TOWNSHIP: ____ SECTION: ____
BOREHOLE CONSTRUCTION: CASED ____ UNCASED ✓
DIAMETERS AND DEPTH RANGES: 4 0 TO 120' ; ____, ____ TO ____
BOREHOLE TOTAL DEPTH AS DRILLED: Clear to 120'
CONDUCTOR CASING?: YES ✓ DEPTH TO BOTTOM OF CASING 20'; NO ____ (Auger)
DEPTH TO BEDROCK: NA DEPTH TO WATER TABLE: ≈20'
BOREHOLE FLUID: WATER ____; FRESH WATER MUD ✓; SALT WATER MUD ____;
OTHER: ____
DEPTH TO BOREHOLE FLUID: ∅ TIME SINCE LAST CIRCULATION: 1 HR

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SITE: SOUTH TEXAS PROJECT COL B-405-DH DATE: 11/8/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 2 OF

LOGGING CREW: R. STELLER
VEHICLE(S) USED AND MILEAGE: RENTAL
MOBILIZED FROM: BAY CITY, TX DEPARTURE TIME: 06:00
ARRIVED ON SITE: 06:30
STANDBY TIME: CAUSE:
LOGGING STARTED: 11:45 LOGGING COMPLETED: 12:25
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	☐	30086	☑

MAINTENANCE PERFORMED ON SITE:

EQUIPMENT PROBLEMS OR FAILURES:

SUGGESTIONS, ADDITIONS, CHANGES:

COMMENTS: DEPTH OFFSET = PROBE LENGTH 2.5 m = 8.2' - STICKUP (1.5') = 6.7' = 2.04 m. AT START. DEPTH REF = 2.04m AT END OF LOG. ASDE = Ø

GEOVISION SUSPENSION LOGGING FIELD NOTES

SITE: SOUTH TEXAS COL B- 405 - DH DATE: 11/8/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 3 OF 4

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			AUGER TO 20'
6.5	21.33	501		
7.0	22.97	502		
7.5	24.61	503		
8.0	26.25	504		
8.5	27.89	505		
9.0	29.53	506		
9.5	31.17	507		
10.0	32.81	508		
10.5	34.45	509		
11.0	36.09	510		
11.5	37.73	511		
12.0	39.37	512		
12.5	41.01	513		
13.0	42.65	514		
13.5	44.29	515		
14.0	45.93	516		
14.5	47.57	517		
15.0	49.21	518		
15.5	50.85	519		
16.0	52.49	520		
16.5	54.13	521		
17.0	55.77	522		
17.5	57.41	523		
18.0	59.06	524		
18.5	60.70	525		
19.0	62.34	526		
19.5	63.98	527		
20.0	65.62	528		

GEOVISION SUSPENSION LOGGING FIELD NOTES

SITE: SOUTH TEXAS COL B-405-DH DATE: 11/8/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 4 OF 4

DEPTH METERS	DEPTH FEET	UNFILTERED FILE NO.	FILTERED FILE NO.	COMMENTS CASING, WATER, ROCK, ETC
20.5	67.26	529		
21.0	68.90	530		
21.5	70.54	531		
22.0	72.18	532		
22.5	73.82	533		
23.0	75.46	534		
23.5	77.10	535		
24.0	78.74	536		
24.5	80.38	537		
25.0	82.02	538		
25.5	83.66	539		
26.0	85.30	540		
26.5	86.94	541		
27.0	88.58	542		
27.5	90.22	543		
28.0	91.86	544		
28.5	93.50	545		PREVIOUS LOG START.
29.0	95.14	546		
29.5	96.78	547		
30.0	98.43	548		
30.5	100.07	549		
31.0	101.71	550		
31.5	103.35	551		
32.0	104.99	552		
32.5	106.63	553		HIT BOTTOM? TIP@ 118.7'
33.0	108.27			
33.5	109.91			
34.0	111.55			
34.5	113.19			
35.0	114.83			
35.5	116.47			
36.0	118.11			
36.5	119.75			
37.0	121.39			
37.5	123.03			
38.0	124.67			
38.5	126.31			
39.0	127.95			
39.5	129.59			
40.0	131.23			

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B-405-DH ELOG FIELD LOG

SITE: SOUTH TEXAS PROJECT COL DATE: 11/8/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 1 OF 2

CONTACT: _OFFICE_ PHONE:
CELL PHONE:
CONTACT: _OFFICE_ PHONE:
PHONE:
CONTACT: PHONE:
PHONE:
CONTACT: PHONE:
PHONE:
DRILLER: PHONE:
COMPANY: PHONE:

GENERAL SITE CONDITIONS/LOCATION:

BOREHOLE DESIGNATION: B-405-DH LOCATION:

COUNTY: RANGE: TOWNSHIP: SECTION:
BOREHOLE CONSTRUCTION: CASED UNCASED ✓
DIAMETERS AND DEPTH RANGES: 4" 0 TO 120' ; , TO
BOREHOLE TOTAL DEPTH AS DRILLED: CLEAR TO 120'
CONDUCTOR CASING?: YES ✓ DEPTH TO BOTTOM OF CASING 20' ; NO (AUGER)
DEPTH TO BEDROCK: NA DEPTH TO WATER TABLE: ≈20'
BOREHOLE FLUID: WATER ; FRESH WATER MUD ✓ ; SALT WATER MUD ;
OTHER:
DEPTH TO BOREHOLE FLUID: Ø TIME SINCE LAST CIRCULATION: ≈1/2 HR

LOGGING CREW: R. STELLER
VEHICLE(S) USED AND MILEAGE: RENTAL
MOBILIZED FROM: BAY CITY, TX DEPARTURE TIME: 06:00
ARRIVED ON SITE: 06:30
STANDBY TIME: CAUSE:
LOGGING STARTED: 11:12 LOGGING COMPLETED: 11:23

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SITE:_SOUTH TEXAS PROJECT COL B-405-DH DATE: 11/8/06
CLIENT:_MACTEC JOB:_6533
AUTHOR:_R. STELLER PAGE 2 OF 2

WINCH: COMPROBE_____ SILVER ✓ OYO_____ OTHER_____
MICROLOGGER 5301 ✓ OTHER_____
ELOG PROBE 5490 ✓ OTHER_____

PROBE LENGTH	2.50M(8.20 FT)	
PLUS YOKE 10.0M (32.8 FT)	32.8'	
MINUS CASING STICK-UP	1.5	
DEPTH REF. OFFSET AT START	39.5'	
DEPTH REF. OFFSET AT END	39.45	
AFTER SURVEY DEPTH ERROR	.05	LESS THAN 0.4%? YES

LOG NAME	START DEPTH	START TIME	END DEPTH	END TIME
B405ELOGTEST02	Ø	11:01	Ø	11:04
B405ELOGUP02	120.0'	11:12	18.5'	11:23

MAINTENANCE PERFORMED ON SITE:_____

EQUIPMENT PROBLEMS OR FAILURES:_____

SUGGESTIONS, ADDITIONS, CHANGES:_____

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B-405-DH ACOUSTIC TELEVIEWER FIELD LOG

SITE: SOUTH TEXAS PROJECT COL DATE: 11/8/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 1 OF 2

CONTACT: MIKE SUFNARSKI OFFICE PHONE: 704-357-5633
CELL PHONE: 704-309-0624
CONTACT: OFFICE PHONE:
PHONE:
CONTACT: PHONE:
PHONE:
CONTACT: PHONE:
PHONE:
DRILLER: PHONE:
COMPANY: PHONE:

DIRECTIONS TO SITE:

GENERAL SITE CONDITIONS/LOCATION:

BOREHOLE DESIGNATION: B-405-DH LOCATION:

COUNTY: RANGE: TOWNSHIP: SECTION:
BOREHOLE CONSTRUCTION: CASED UNCASED ✓
DIAMETERS AND DEPTH RANGES: 4" 0 TO 120' ; , TO
BOREHOLE TOTAL DEPTH AS DRILLED: CLEAR TO 120'
CONDUCTOR CASING?: YES ✓ DEPTH TO BOTTOM OF CASING 20' ; NO (AUGER)
DEPTH TO BEDROCK: NA DEPTH TO WATER TABLE:
BOREHOLE FLUID: WATER ; FRESH WATER MUD ✓ ; SALT WATER MUD ;
OTHER:
DEPTH TO BOREHOLE FLUID: Ø TIME SINCE LAST CIRCULATION: ≈2.0 HR

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SITE: SOUTH TEXAS PROJECT COL B-405-04 DATE: 4/8/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 2 OF 2

LOGGING CREW: R. STELLER
VEHICLE(S) USED AND MILEAGE: RENTAL
MOBILIZED FROM: BAY CITY, TX DEPARTURE TIME: 06:00
ARRIVED ON SITE: 06:30
STANDBY TIME: CAUSE:
LOGGING STARTED: 13:43 LOGGING COMPLETED: 13:49

WINCH: COMPROBE___ SILVER ✓ OYO___ OTHER___
MICROLOGGER 5301 ✓ OTHER___
TELEVIEWER ACOUSTIC #5174 ✓ OTHER___

PROBE TILT TEST 91.6° BRUNTON TILT 92°
PROBE TILT TEST 0.5° BRUNTON TILT 0°
PROBE TILT TEST ___ BRUNTON TILT ___
PROBE AZIMUTH TEST 357.6° BRUNTON AZIMUTH 360°
PROBE AZIMUTH TEST 159.6 BRUNTON AZIMUTH 160°
PROBE AZIMUTH TEST ___ BRUNTON AZIMUTH ___

PROBE OFFSET	1.44M(4.72FT)	
MINUS CASING STICK-UP	1.5'	
DEPTH REF. OFFSET AT START	3.22'	
DEPTH REF. OFFSET AT END	3.40'	
AFTER SURVEY DEPTH ERROR	+0.18'	LESS THAN 0.4%? YES

LOG NAME	START DEPTH	START TIME	END DEPTH	END TIME
B405Auuf02	115	13:43	∅	13:49

MAINTENANCE PERFORMED ON SITE:

EQUIPMENT PROBLEMS OR FAILURES:

SUGGESTIONS, ADDITIONS, CHANGES:

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B-405-DH CALIPER FIELD LOG

SITE: SOUTH TEXAS PROJECT COL DATE: 4/8/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 1 OF 2

CONTACT: MIKE SUFNARSKI OFFICE PHONE:
CELL PHONE: 704-357-5633
CONTACT: OFFICE PHONE:
PHONE:
CONTACT: PHONE:
PHONE:
CONTACT: PHONE:
PHONE:
DRILLER: PHONE:
COMPANY: PHONE:

GENERAL SITE CONDITIONS/LOCATION:

BOREHOLE DESIGNATION: B-405-DH LOCATION:

COUNTY: RANGE: TOWNSHIP: SECTION:
BOREHOLE CONSTRUCTION: CASED UNCASED ✓
DIAMETERS AND DEPTH RANGES: 4" 0 TO 120' ; , TO
BOREHOLE TOTAL DEPTH AS DRILLED: CLEAR TO 120'
CONDUCTOR CASING?: YES ✓ DEPTH TO BOTTOM OF CASING 20' ; NO (AUGER)
DEPTH TO BEDROCK: NA DEPTH TO WATER TABLE:
BOREHOLE FLUID: WATER ; FRESH WATER MUD ✓ ; SALT WATER MUD ;
OTHER:
DEPTH TO BOREHOLE FLUID: ∅ TIME SINCE LAST CIRCULATION: ≈3 HR.

LOGGING CREW: R. STELLER
VEHICLE(S) USED AND MILEAGE: RENTAL
MOBILIZED FROM: BAY CITY, TX DEPARTURE TIME: 06:00
ARRIVED ON SITE: 06:30
STANDBY TIME: CAUSE:
LOGGING STARTED: 13:56 LOGGING COMPLETED: 14:44

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SITE: SOUTH TEXAS PROJECT COL B-405-DH DATE: 11/8/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 2 OF 2

WINCH: COMPROBE____ SILVER ✓ OYO____ OTHER____
MICROLOGGER 5301 ✓ OTHER____
CALIPER PROBE 5368 ✓ OTHER____

PROBE OFFSET	2.08M(6.82 FT) 12 IN MAX	
MINUS CASING STICK-UP	1.5	
DEPTH REF. OFFSET AT START	5.32'	
DEPTH REF. OFFSET AT END	5.35'	
AFTER SURVEY DEPTH ERROR	+.03	LESS THAN 0.4%? YES

LOG NAME	START DEPTH	START TIME	END DEPTH	END TIME
B405CALTEST04	Ø	13:56	Ø	14:12
B405 CAL UP 02	115.0'	14:20	Ø	14:32
B405 CAL TEST 05	Ø	14:41	Ø	14:44

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.	B405CALTEST04	2.01	3.95	8.03	4.52
AS MEAS.	B405CALTEST05	2.02	3.96	8.02	4.54
AS MEAS.					
AS MEAS.					
AS MEAS.					
AS MEAS.					

MAINTENANCE PERFORMED ON SITE:____

EQUIPMENT PROBLEMS OR FAILURES:____

SUGGESTIONS, ADDITIONS, CHANGES:____

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B-408- DH BORING GEOPHYSICS FIELD LOG SUMMARY

SITE:_SOUTH TEXAS PROJECT COL ______________________ DATE: 11/9/06
CLIENT:_MACTEC ______________________ JOB:_6533________
AUTHOR:_R. STELLER ______________________ PAGE 1 OF 1

CONTACT:_MIKE SUFNARSKI ______________________ PHONE:_704-357-5633_

BOREHOLE CONSTRUCTION: CASED_____ UNCASED ✓
DIAMETERS AND DEPTH RANGES: 4" 0 TO 215' ; ______, ______ TO ________
BOREHOLE TOTAL DEPTH AS DRILLED: 215'
CONDUCTOR CASING?: YES____ DEPTH TO BOTTOM OF CASING______; NO ✓
DEPTH TO BEDROCK: NA
BOREHOLE FLUID: WATER_____; FRESH WATER MUD ✓; SALT WATER MUD _____;

LOGGING CREW:_R. STELLER______

LOG TYPE	FILE NAME	DEPTH RANGE	DATE	TIMES
ELOG TEST	B408ELOG TEST01	Ø	11/9/06	08:57 – 08:40
ELOG/GAMMA	B408ELOGUP01	215.5' – 35.0'	"	12:29 – 12:50
SUSPENSION PS	B408_001-122.DOG	3.3' - 201.8'	"	13:04 – 14:11
CALIPER TEST	B408CALTEST01	Ø	"	14:30 – 14:33
CALIPER/GAMMA	B408CALUP01	210.0' – 0.35'	"	14:41 – 15:07
CALIPERTEST	B408CALTEST02	Ø	"	15:10 – 15:15
DEVIATION	B408AHUP01	210.0' – Ø	"	15:35 – 15:46

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B-408- DH ELOG FIELD LOG

SITE: SOUTH TEXAS PROJECT COL DATE: 11/9/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 1 OF 2

CONTACT: _OFFICE_ PHONE:
CELL PHONE:
CONTACT: _OFFICE_ PHONE:
PHONE:
CONTACT: PHONE:
PHONE:
CONTACT: PHONE:
PHONE:
DRILLER: PHONE:
COMPANY: PHONE:

GENERAL SITE CONDITIONS/LOCATION:

BOREHOLE DESIGNATION: B-408-DH LOCATION:

COUNTY: RANGE: TOWNSHIP: SECTION:
BOREHOLE CONSTRUCTION: CASED___ UNCASED ✓
DIAMETERS AND DEPTH RANGES: 4" 0 TO 215' ; ___, ___ TO ___
BOREHOLE TOTAL DEPTH AS DRILLED: 215
CONDUCTOR CASING?: YES___ DEPTH TO BOTTOM OF CASING___; NO ✓
DEPTH TO BEDROCK: NA DEPTH TO WATER TABLE: ≈20'
BOREHOLE FLUID: WATER___; FRESH WATER MUD ✓; SALT WATER MUD ___;
OTHER:
DEPTH TO BOREHOLE FLUID: Ø TIME SINCE LAST CIRCULATION: ≈ 1/2 HR

LOGGING CREW: R. STELLER
VEHICLE(S) USED AND MILEAGE: RENTAL
MOBILIZED FROM: BAY CITY, TX DEPARTURE TIME: 07:00
ARRIVED ON SITE: 07:30
STANDBY TIME: CAUSE: BORING OBSTRUCTED.
LOGGING STARTED: 08:37 LOGGING COMPLETED: 12:50.

SITE: SOUTH TEXAS PROJECT COL B-408-DH
DATE: 11/9/06
CLIENT: MACTEC
JOB: 6533
AUTHOR: R. STELLER
PAGE 2 OF 2

WINCH: COMPROBE___ SILVER √ OYO___ OTHER___
MICROLOGGER 5301 √ OTHER___
ELOG PROBE 5490 √ OTHER___

PROBE LENGTH	2.50M(8.20 FT)
PLUS YOKE 10.0M (32.8 FT)	32.8
MINUS CASING STICK-UP	~~41.0~~ 0'
DEPTH REF. OFFSET AT START	41.0'
DEPTH REF. OFFSET AT END	41.1'
AFTER SURVEY DEPTH ERROR	+.1' LESS THAN 0.4%? YES

LOG NAME	START DEPTH	START TIME	END DEPTH	END TIME
B408 ELOG TEST 01	Ø	08:37	Ø	08:40
B408 ELOG UP01	215.5'	12:29	35.0'	12:50

MAINTENANCE PERFORMED ON SITE:___

EQUIPMENT PROBLEMS OR FAILURES:___

SUGGESTIONS, ADDITIONS, CHANGES:___

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P-S SUSPENSION VELOCITY FIELD LOG

SITE: SOUTH TEXAS PROJECT COL B-~~505~~ 408 -DH (RPS 11/9/06) DATE: 11/9/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 1 OF 6

CONTACT: MIKE SUFNARSKI OFFICE PHONE: 704-357-5633
CELL PHONE: 704-309-0624
CONTACT: OFFICE PHONE:
PHONE:
CONTACT: PHONE:
PHONE:
CONTACT: PHONE:
PHONE:
DRILLER: PHONE:
COMPANY: PHONE:

DIRECTIONS TO SITE:

GENERAL SITE CONDITIONS/LOCATION:

EA#:
BOREHOLE DESIGNATION: B-408-DH LOCATION:

COUNTY: RANGE: - TOWNSHIP: SECTION:
BOREHOLE CONSTRUCTION: CASED UNCASED ✓
DIAMETERS AND DEPTH RANGES: 4" 0 TO 215' ; , TO
BOREHOLE TOTAL DEPTH AS DRILLED: 215'
CONDUCTOR CASING?: YES DEPTH TO BOTTOM OF CASING ; NO ✓
DEPTH TO BEDROCK: NA DEPTH TO WATER TABLE: <20'
BOREHOLE FLUID: WATER ; FRESH WATER MUD ✓ ; SALT WATER MUD ;
OTHER: -
DEPTH TO BOREHOLE FLUID: Ø TIME SINCE LAST CIRCULATION: 1 HR.

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SITE: SOUTH TEXAS PROJECT COL B-408-DH DATE: 11/9/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 2 OF 6

LOGGING CREW: R. STELLER
VEHICLE(S) USED AND MILEAGE: RENTAL
MOBILIZED FROM: BAY CITY, TX DEPARTURE TIME: 07:00
ARRIVED ON SITE: 07:30
STANDBY TIME: CAUSE:
LOGGING STARTED: 13:04 LOGGING COMPLETED: 14:11
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 ☐	30086 ☑	

MAINTENANCE PERFORMED ON SITE:

EQUIPMENT PROBLEMS OR FAILURES:

SUGGESTIONS, ADDITIONS, CHANGES:

COMMENTS:

GEOVISION SUSPENSION LOGGING FIELD NOTES

SITE: SOUTH TEXAS COL B-408 - OH DATE: 11/9/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 3 OF 6

DEPTH METERS	DEPTH FEET	UNFILTERED FILE NO.	FILTERED FILE NO.	COMMENTS CASING, WATER, ROCK, ETC
0.5	1.64			
1.0	3.28	1		
1.5	4.92	2		
2.0	6.56	3		
2.5	8.20	4		
3.0	9.84	5		
3.5	11.48	6		
4.0	13.12	7		
4.5	14.76	8		
5.0	16.40	9		
5.5	18.04	10		
6.0	19.69	11		
6.5	21.33	12		
7.0	22.97	13		
7.5	24.61	14		
8.0	26.25	15		
8.5	27.89	16		
9.0	29.53	17		
9.5	31.17	18		
10.0	32.81	19		
10.5	34.45	20		
11.0	36.09	21		
11.5	37.73	22		
12.0	39.37	23		
12.5	41.01	24		
13.0	42.65	25		
13.5	44.29	26		
14.0	45.93	27		
14.5	47.57	28		
15.0	49.21	29		
15.5	50.85	30		
16.0	52.49	31		
16.5	54.13	32		
17.0	55.77	33		
17.5	57.41	34		
18.0	59.06	35		
18.5	60.70	36		
19.0	62.34	37		
19.5	63.98	38		
20.0	65.62	39		

GEOVISION SUSPENSION LOGGING FIELD NOTES

SITE: SOUTH TEXAS COL B-408-DH DATE: 11/9/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 4 OF 6

DEPTH METERS	DEPTH FEET	UNFILTERED FILE NO.	FILTERED FILE NO.	COMMENTS CASING, WATER, ROCK, ETC
20.5	67.26	40		
21.0	68.90	41		
21.5	70.54	42		
22.0	72.18	43		
22.5	73.82	44		
23.0	75.46	45		
23.5	77.10	46		
24.0	78.74	47		
24.5	80.38	48		
25.0	82.02	49		
25.5	83.66	50		
26.0	85.30	51		
26.5	86.94	52		
27.0	88.58	53		
27.5	90.22	54		
28.0	91.86	55		
28.5	93.50	56		
29.0	95.14	57		
29.5	96.78	58		
30.0	98.43	59		
30.5	100.07	60		
31.0	101.71	61		
31.5	103.35	62		
32.0	104.99	63		
32.5	106.63	64		
33.0	108.27	65		
33.5	109.91	66		
34.0	111.55	67		
34.5	113.19	68		
35.0	114.83	69		
35.5	116.47	70		
36.0	118.11	71		
36.5	119.75	72		
37.0	121.39	73		
37.5	123.03	74		
38.0	124.67	75		
38.5	126.31	76		
39.0	127.95	77		
39.5	129.59	78		
40.0	131.23	79		

GEOVISION SUSPENSION LOGGING FIELD NOTES

SITE: SOUTH TEXAS COL B-408-DH DATE: 11/9/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 5 OF 6

DEPTH METERS	DEPTH FEET	UNFILTERED FILE NO.	FILTERED FILE NO.	COMMENTS CASING, WATER, ROCK, ETC
40.5	132.87	80		
41.0	134.51	81		
41.5	136.15	82		
42.0	137.80	83		
42.5	139.44	84		
43.0	141.08	85		
43.5	142.72	86		
44.0	144.36	87		
44.5	146.00	88		
45.0	147.64	89		
45.5	149.28	90		
46.0	150.92	91		
46.5	152.56	92		
47.0	154.20	93		
47.5	155.84	94		
48.0	157.48	95		
48.5	159.12	96		
49.0	160.76	97		
49.5	162.40	98		
50.0	164.04	99		
50.5	165.68	100		
51.0	167.32	101		
51.5	168.96	102		
52.0	170.60	103		
52.5	172.24	104		
53.0	173.88	105		
53.5	175.52	106		
54.0	177.17	107		
54.5	178.81	108		
55.0	180.45	109		
55.5	182.09	110		
56.0	183.73	111		
56.5	185.37	112		
57.0	187.01	113		
57.5	188.65	114		
58.0	190.29	115		
58.5	191.93	116		
59.0	193.57	117		
59.5	195.21	118		
60.0	196.85	119		

GEOVISION SUSPENSION LOGGING FIELD NOTES

SITE:_SOUTH TEXAS COL B-408-DH DATE: 11/9/06
CLIENT:__MACTEC JOB:_6533
AUTHOR:_R. STELLER PAGE 6 OF 6

DEPTH METERS	DEPTH FEET	UNFILTERED FILE NO.	FILTERED FILE NO.	COMMENTS CASING, WATER, ROCK, ETC
60.5	198.49	120		
61.0	200.13	121		
61.5	201.77	122		BOTTOM MEASUREMENT
62.0	203.41			HIT BOTTOM @ 61.7m
62.5	205.05			
63.0	206.69			
63.5	208.33			
64.0	209.97			
64.5	211.61			
65.0	213.25			
65.5	214.90			T.D @ 215
66.0	216.54			
66.5	218.18			
67.0	219.82			
67.5	221.46			
68.0	223.10			
68.5	224.74			
69.0	226.38			
69.5	228.02			
70.0	229.66			
70.5	231.30			
71.0	232.94			
71.5	234.58			
72.0	236.22			
72.5	237.86			
73.0	239.50			
73.5	241.14			
74.0	242.78			
74.5	244.42			
75.0	246.06			
75.5	247.70			
76.0	249.34			
76.5	250.98			
77.0	252.62			
77.5	254.27			
78.0	255.91			
78.5	257.55			
79.0	259.19			
79.5	260.83			
80.0	262.47			

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B-408-DH CALIPER FIELD LOG

SITE: SOUTH TEXAS PROJECT COL DATE: 11/9/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 1 OF 2

CONTACT: MIKE SUFNARSKI OFFICE PHONE:
CELL PHONE: 704-357-5633
CONTACT: OFFICE PHONE:
PHONE:
CONTACT: PHONE:
PHONE:
CONTACT: PHONE:
PHONE:
DRILLER: PHONE:
COMPANY: PHONE:

GENERAL SITE CONDITIONS/LOCATION:

BOREHOLE DESIGNATION: B-408-DH LOCATION:

COUNTY: RANGE: TOWNSHIP: SECTION:
BOREHOLE CONSTRUCTION: CASED UNCASED ✓
DIAMETERS AND DEPTH RANGES: 4" 0 TO 215' ; , TO
BOREHOLE TOTAL DEPTH AS DRILLED: 215'
CONDUCTOR CASING?: YES DEPTH TO BOTTOM OF CASING ; NO ✓
DEPTH TO BEDROCK: NA DEPTH TO WATER TABLE: ≈20'
BOREHOLE FLUID: WATER ; FRESH WATER MUD ✓ ; SALT WATER MUD ;
OTHER:
DEPTH TO BOREHOLE FLUID: Ø TIME SINCE LAST CIRCULATION: 2 HR

LOGGING CREW: R. STELLER
VEHICLE(S) USED AND MILEAGE: RENTAL
MOBILIZED FROM: BAY CITY, TX DEPARTURE TIME: 07:00
ARRIVED ON SITE: 07:30
STANDBY TIME: CAUSE:
LOGGING STARTED: 14:30 LOGGING COMPLETED: 15:15

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SITE: SOUTH TEXAS PROJECT COL B-408-DH DATE: 11/9/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 2 OF 2

WINCH: COMPROBE____ SILVER ✓ OYO____ OTHER____
MICROLOGGER 5301 ✓ OTHER____
CALIPER PROBE 5368 ✓ OTHER____

PROBE OFFSET	2.08M(6.82 FT) 12 IN MAX
MINUS CASING STICK-UP	Ø
DEPTH REF. OFFSET AT START	6.82
DEPTH REF. OFFSET AT END	6.90
AFTER SURVEY DEPTH ERROR	+.09' LESS THAN 0.4%? YES

LOG NAME	START DEPTH	START TIME	END DEPTH	END TIME
B408CALTEST01	Ø	14:30	Ø	14:33
B408CALUP01	210.0'	14:41	0.35'	15:07
B408CALTEST02	Ø	~~15:10~~ 15:10	Ø	15:15
		RBS 11/14/06		

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.	B408CALTEST01	2.00	3.95	8.00	4.52
AS MEAS.	B408CALTEST02	2.00	3.94	8.02	4.51
AS MEAS.					
AS MEAS.					
AS MEAS.					
AS MEAS.					

MAINTENANCE PERFORMED ON SITE:____

EQUIPMENT PROBLEMS OR FAILURES:____

SUGGESTIONS, ADDITIONS, CHANGES:____

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B-408-DH ACOUSTIC TELEVIEWER FIELD LOG

SITE: SOUTH TEXAS PROJECT COL DATE: 11/9/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 1 OF 2

CONTACT: MIKE SUFNARSKI OFFICE PHONE: 704-357-5633
CELL PHONE: 704-309-0624
CONTACT: OFFICE PHONE:
PHONE:
CONTACT: PHONE:
PHONE:
CONTACT: PHONE:
PHONE:
DRILLER: PHONE:
COMPANY: PHONE:

DIRECTIONS TO SITE:

GENERAL SITE CONDITIONS/LOCATION:

BOREHOLE DESIGNATION: B-408-DH LOCATION:

COUNTY: RANGE: TOWNSHIP: SECTION:
BOREHOLE CONSTRUCTION: CASED UNCASED ✓
DIAMETERS AND DEPTH RANGES: 4" 0 TO 215'; , TO
BOREHOLE TOTAL DEPTH AS DRILLED: 215'
CONDUCTOR CASING?: YES DEPTH TO BOTTOM OF CASING ; NO ✓
DEPTH TO BEDROCK: NA DEPTH TO WATER TABLE: ?20'
BOREHOLE FLUID: WATER ; FRESH WATER MUD ✓; SALT WATER MUD ;
OTHER:
DEPTH TO BOREHOLE FLUID: Ø TIME SINCE LAST CIRCULATION: 3 HR.

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SITE: SOUTH TEXAS PROJECT COL B-408-OH DATE: 11/9/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 2 OF 2

LOGGING CREW: R. STELLER
VEHICLE(S) USED AND MILEAGE: RENTAL
MOBILIZED FROM: BAY CITY, TX DEPARTURE TIME: 07:00
ARRIVED ON SITE: 07:30
STANDBY TIME: CAUSE:
LOGGING STARTED: 15:35 LOGGING COMPLETED: 15:46

WINCH: COMPROBE____ SILVER ✓ OYO____ OTHER____
MICROLOGGER 5301 ✓ OTHER____
TELEVIEWER ACOUSTIC #5174 ✓ OTHER____

PROBE TILT TEST 88.1° BRUNTON TILT 89°
PROBE TILT TEST 0.8° BRUNTON TILT 0°
PROBE TILT TEST ____ BRUNTON TILT ____
PROBE AZIMUTH TEST 333.9° BRUNTON AZIMUTH 332°
PROBE AZIMUTH TEST 167.5° BRUNTON AZIMUTH 168°
PROBE AZIMUTH TEST ____ BRUNTON AZIMUTH ____

PROBE OFFSET 1.44M(4.72FT)
MINUS CASING STICK-UP Ø
DEPTH REF. OFFSET AT START 4.72'
DEPTH REF. OFFSET AT END 4.70
AFTER SURVEY DEPTH ERROR -.02' LESS THAN 0.4%? YES

LOG NAME	START DEPTH	START TIME	END DEPTH	END TIME
BA08AGAP01	210.0'	15:35	Ø	15:46

MAINTENANCE PERFORMED ON SITE:

EQUIPMENT PROBLEMS OR FAILURES:

SUGGESTIONS, ADDITIONS, CHANGES:

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

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B-419 BORING GEOPHYSICS FIELD LOG SUMMARY

SITE: SOUTH TEXAS PROJECT COL DATE: 12/4/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 1 OF 1

CONTACT: MIKE SUFNARSKI PHONE: 704-357-5633

BOREHOLE CONSTRUCTION: CASED___ UNCASED ✓
DIAMETERS AND DEPTH RANGES: 4 7/8" 0 TO 215' ; ___, ___ TO ___
BOREHOLE TOTAL DEPTH AS DRILLED: 215
CONDUCTOR CASING?: YES ✓ DEPTH TO BOTTOM OF CASING 2' ; NO___
DEPTH TO BEDROCK: NA
BOREHOLE FLUID: WATER___; FRESH WATER MUD ✓; SALT WATER MUD___;

LOGGING CREW: R. STELLER, C. CARTER

LOG TYPE	FILE NAME	DEPTH RANGE	DATE	TIMES
ELOG TEST	B419ELOGTEST01	∅	12/4/06	09:35 – 09:38
ELOG/GAMMA	B419ELOGUP01	216.0' – 17.9'	"	09:54 – 10:16
SUSPENSION P.S.	B419_001-123.ORG	3.3' – 203.2'	"	10:35 – 12:04
CALIPER TEST	B419CALTEST01	∅	"	12:24 – 12:31
CALIPER/GAMMA	B419CALUP01	210.0' – ∅	"	12:48 – 13:10
CALIPER TEST	B419CALTEST02	∅	"	13:19 – 13:22
DEVIATION	B419AAUP01	210.0' – 94.0	"	13:40 – 13:50
DEVIATION	B419AAUP02	91.0' – ∅	"	14:03 – 14:16

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B-419 ELOG FIELD LOG

SITE: SOUTH TEXAS PROJECT COL
DATE: 12/4/06
CLIENT: MACTEC
JOB: 6533
AUTHOR: R. STELLER
PAGE 1 OF 2

CONTACT: _____ OFFICE PHONE: _____
CELL PHONE: _____
CONTACT: _____ OFFICE PHONE: _____
PHONE: _____
CONTACT: _____ PHONE: _____
PHONE: _____
CONTACT: _____ PHONE: _____
PHONE: _____
DRILLER: _____ PHONE: _____
COMPANY: _____ PHONE: _____

GENERAL SITE CONDITIONS/LOCATION: _____

BOREHOLE DESIGNATION: B-419 LOCATION: _____

COUNTY: B-419 RANGE: _____ TOWNSHIP: _____ SECTION: _____
BOREHOLE CONSTRUCTION: CASED _____ UNCASED ✓
DIAMETERS AND DEPTH RANGES: 4 7/8" 0 TO 215' ; _____, _____ TO _____
BOREHOLE TOTAL DEPTH AS DRILLED: 215'
CONDUCTOR CASING?: YES ✓ DEPTH TO BOTTOM OF CASING 2' ; NO _____
DEPTH TO BEDROCK: NA DEPTH TO WATER TABLE: _____
BOREHOLE FLUID: WATER _____; FRESH WATER MUD ✓; SALT WATER MUD _____;
OTHER: _____
DEPTH TO BOREHOLE FLUID: Ø TIME SINCE LAST CIRCULATION: 1/2 HR

LOGGING CREW: R. STELLER, C. CARTER
VEHICLE(S) USED AND MILEAGE: RENTAL
MOBILIZED FROM: HOUSTON DEPARTURE TIME: 0:4:30
ARRIVED ON SITE: 07:30
STANDBY TIME: _____ CAUSE: _____
LOGGING STARTED: 09:30 LOGGING COMPLETED: 10:10

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SITE: SOUTH TEXAS PROJECT COL B-419 DATE: 12/4/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 2 OF 2

WINCH: COMPROBE___ SILVER ✓ OYO___ OTHER___
MICROLOGGER 5301 ✓ OTHER___
ELOG PROBE 5490 ✓ OTHER___

PROBE LENGTH	2.50M(8.20 FT)	
PLUS YOKE 10.0M (32.8 FT)	32.8	
MINUS CASING STICK-UP	1.2'	
DEPTH REF. OFFSET AT START	39.8'	
DEPTH REF. OFFSET AT END	40.0	
AFTER SURVEY DEPTH ERROR	+0.2	LESS THAN 0.4%?

LOG NAME	START DEPTH	START TIME	END DEPTH	END TIME
B419 ELOG TEST01	Ø	09:35	Ø	09:38
B419 ELOG UP01	216	09:54	17.9'	10:16

MAINTENANCE PERFORMED ON SITE:___

EQUIPMENT PROBLEMS OR FAILURES:___

SUGGESTIONS, ADDITIONS, CHANGES:___

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P-S SUSPENSION VELOCITY FIELD LOG

SITE: SOUTH TEXAS PROJECT COL B-419 DATE: 12/4/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 1 OF ____

CONTACT: MIKE SUFNARSKI OFFICE PHONE: 704-357-5633
CELL PHONE: 704-309-0624
CONTACT: ____ OFFICE PHONE: ____
____ PHONE: ____
CONTACT: ____ ____ PHONE: ____
____ PHONE: ____
CONTACT: ____ ____ PHONE: ____
____ PHONE: ____
DRILLER: ____ ____ PHONE: ____
COMPANY: ____ ____ PHONE: ____

DIRECTIONS TO SITE: ____

GENERAL SITE CONDITIONS/LOCATION: ____

EA#: ____
BOREHOLE DESIGNATION: B-419 LOCATION: ____

COUNTY: ____ RANGE: ____ TOWNSHIP: ____ SECTION: ____
BOREHOLE CONSTRUCTION: CASED ____ UNCASED ✓
DIAMETERS AND DEPTH RANGES: 4 7/8 0 TO 215 ; ____, ____ TO ____
BOREHOLE TOTAL DEPTH AS DRILLED: 215
CONDUCTOR CASING?: YES ✓ DEPTH TO BOTTOM OF CASING 2' ; NO ____
DEPTH TO BEDROCK: NA DEPTH TO WATER TABLE: ≈20'
BOREHOLE FLUID: WATER ____; FRESH WATER MUD ✓; SALT WATER MUD ____;
OTHER: ____
DEPTH TO BOREHOLE FLUID: ∅ TIME SINCE LAST CIRCULATION: 2 Hr

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SITE: SOUTH TEXAS PROJECT COL B-419 DATE: 12/4/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 2 OF ____

LOGGING CREW: R. STELLER, C. CARTER
VEHICLE(S) USED AND MILEAGE: RENTAL
MOBILIZED FROM: HOUSTON DEPARTURE TIME: 04:30
ARRIVED ON SITE: 07:30
STANDBY TIME: ____ CAUSE: ____
LOGGING STARTED: 10:35 LOGGING COMPLETED: 12:04
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	☐	30086	☑

MAINTENANCE PERFORMED ON SITE: ____

EQUIPMENT PROBLEMS OR FAILURES: ____

SUGGESTIONS, ADDITIONS, CHANGES: ____

COMMENTS: DEPTH ZERO = 8.2' - 1.2' = 7.0' = 2.13m.
EXT ZERO = 2.13m

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GEOVISION SUSPENSION LOGGING FIELD NOTES

SITE: SOUTH TEXAS COL B-419 DATE: 12/4/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 3 OF

DEPTH METERS	DEPTH FEET	UNFILTERED FILE NO.	FILTERED FILE NO.	COMMENTS CASING, WATER, ROCK, ETC
0.5	1.64			
1.0	3.28	001		
1.5	4.92	2		
2.0	6.56	3		
2.5	8.20	4		
3.0	9.84	5		
3.5	11.48	6		
4.0	13.12	7		
4.5	14.76	8		
5.0	16.40	9		
5.5	18.04	10		
6.0	19.69	11		
6.5	21.33	12		
7.0	22.97	13		
7.5	24.61	14		
8.0	26.25	15		
8.5	27.89	16		
9.0	29.53	17		
9.5	31.17	18		
10.0	32.81	19		
10.5	34.45	20		
11.0	36.09	21		
11.5	37.73	22		
12.0	39.37	23		
12.5	41.01	24		
13.0	42.65	25		
13.5	44.29	26		
14.0	45.93	27		
14.5	47.57	28		
15.0	49.21	29		
15.5	50.85	30		
16.0	52.49	31		
16.5	54.13	32		
17.0	55.77	33		
17.5	57.41	34		
18.0	59.06	35		
18.5	60.70	36		
19.0	62.34	37		
19.5	63.98	38		
20.0	65.62	39		

GEOVISION SUSPENSION LOGGING FIELD NOTES

SITE: SOUTH TEXAS COL B-419 DATE: 12/4/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 4 OF

DEPTH METERS	DEPTH FEET	UNFILTERED FILE NO.	FILTERED FILE NO.	COMMENTS CASING, WATER, ROCK, ETC
20.5	67.26	40		
21.0	68.90	41		
21.5	70.54	42		
22.0	72.18	43		
22.5	73.82	44		
23.0	75.46	45		
23.5	77.10	46		
24.0	78.74	47		
24.5	80.38	48		
25.0	82.02	49		
25.5	83.66	50		
26.0	85.30	51		
26.5	86.94	52		
27.0	88.58	53		
27.5	90.22	54		
28.0	91.86	55		
28.5	93.50	56		
29.0	95.14	57		
29.5	96.78	58		
30.0	98.43	59		
30.5	100.07	60		
31.0	101.71	61		
31.5	103.35	62		
32.0	104.99	63		
32.5	106.63	64		
33.0	108.27	65		
33.5	109.91	66		
34.0	111.55	67		
34.5	113.19	68		
35.0	114.83	69		
35.5	116.47	70		
36.0	118.11	71		
36.5	119.75	72		
37.0	121.39	73		
37.5	123.03	74		
38.0	124.67	75		
38.5	126.31	76		
39.0	127.95	77		
39.5	129.59	78		
40.0	131.23	79		

GEOVISION SUSPENSION LOGGING FIELD NOTES

SITE:_SOUTH TEXAS COL B-419 DATE: 12/4/06
CLIENT:__MACTEC JOB:_6533
AUTHOR:_R. STELLER PAGE 5 OF 6

DEPTH METERS	DEPTH FEET	UNFILTERED FILE NO.	FILTERED FILE NO.	COMMENTS CASING, WATER, ROCK, ETC
40.5	132.87	80		
41.0	134.51	81		
41.5	136.15	82		
42.0	137.80	83		
42.5	139.44	84		
43.0	141.08	85		
43.5	142.72	86		
44.0	144.36	87		
44.5	146.00	88		
45.0	147.64	89		
45.5	149.28	90		
46.0	150.92	91		
46.5	152.56	92		
47.0	154.20	93		
47.5	155.84	94		
48.0	157.48	95		
48.5	159.12	96		
49.0	160.76	97		
49.5	162.40	98		
50.0	164.04	99		
50.5	165.68	100		
51.0	167.32	101		
51.5	168.96	102		
52.0	170.60	103		
52.5	172.24	104		
53.0	173.88	105		
53.5	175.52	106		
54.0	177.17	107		
54.5	178.81	108		
55.0	180.45	109		
55.5	182.09	110		
56.0	183.73	111		
56.5	185.37	112		
57.0	187.01	113		
57.5	188.65	114		
58.0	190.29	115		
58.5	191.93	116		
59.0	193.57	117		
59.5	195.21	118		
60.0	196.85	119		

GEOVISION SUSPENSION LOGGING FIELD NOTES

SITE: SOUTH TEXAS COL B-419 DATE: 12/4/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 6 OF 6

DEPTH METERS	DEPTH FEET	UNFILTERED FILE NO.	FILTERED FILE NO.	COMMENTS CASING, WATER, ROCK, ETC
60.5	198.49	120		
61.0	200.13	121		
61.5	201.77	122		B.M.?
61.4 ~~62.0~~	203.41	123		HK @ 62.0 m.
62.5	205.05			
63.0	206.69			
63.5	208.33			
64.0	209.97			
64.5	211.61			
65.0	213.25			
65.5	214.90			T.D. @ 215'
66.0	216.54			
66.5	218.18			
67.0	219.82			
67.5	221.46			
68.0	223.10			
68.5	224.74			
69.0	226.38			
69.5	228.02			
70.0	229.66			
70.5	231.30			
71.0	232.94			
71.5	234.58			
72.0	236.22			
72.5	237.86			
73.0	239.50			
73.5	241.14			
74.0	242.78			
74.5	244.42			
75.0	246.06			
75.5	247.70			
76.0	249.34			
76.5	250.98			
77.0	252.62			
77.5	254.27			
78.0	255.91			
78.5	257.55			
79.0	259.19			
79.5	260.83			
80.0	262.47			

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B-419 CALIPER FIELD LOG

SITE: SOUTH TEXAS PROJECT COL DATE: 12/4/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 1 OF 2

CONTACT: MIKE SUFNARSKI OFFICE PHONE:
CELL PHONE: 704-357-5633
CONTACT: OFFICE PHONE:
PHONE:
CONTACT: PHONE:
PHONE:
CONTACT: PHONE:
PHONE:
DRILLER: PHONE:
COMPANY: PHONE:

GENERAL SITE CONDITIONS/LOCATION:

BOREHOLE DESIGNATION: B-419 LOCATION:

COUNTY: RANGE: TOWNSHIP: SECTION:
BOREHOLE CONSTRUCTION: CASED UNCASED ✓
DIAMETERS AND DEPTH RANGES: 4 7/8" 0 TO 215' ; , TO
BOREHOLE TOTAL DEPTH AS DRILLED: 215'
CONDUCTOR CASING?: YES ✓ DEPTH TO BOTTOM OF CASING 2' ; NO
DEPTH TO BEDROCK: NA DEPTH TO WATER TABLE: ≈20'
BOREHOLE FLUID: WATER ; FRESH WATER MUD ✓ ; SALT WATER MUD ;
OTHER:
DEPTH TO BOREHOLE FLUID: Ø TIME SINCE LAST CIRCULATION: ≈3 HR

LOGGING CREW: R. STELLER, C. CARTER
VEHICLE(S) USED AND MILEAGE: RENTAL
MOBILIZED FROM: HOUSTON DEPARTURE TIME: 04:30
ARRIVED ON SITE: 07:30
STANDBY TIME: CAUSE:
LOGGING STARTED: 12:29 LOGGING COMPLETED: 13:22

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SITE: SOUTH TEXAS PROJECT COL B-419 DATE: 12/4/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 2 OF 2

WINCH: COMPROBE ✓ SILVER ✓ OYO ____ OTHER ____
MICROLOGGER 5301 ✓ OTHER ____
CALIPER PROBE 5368 ✓ OTHER ____

PROBE OFFSET	2.08M(6.82 FT) 12 IN MAX	
MINUS CASING STICK-UP	1.2	
DEPTH REF. OFFSET AT START	5.62'	
DEPTH REF. OFFSET AT END	5.60	
AFTER SURVEY DEPTH ERROR	-0.02	LESS THAN 0.4%? YES

LOG NAME	START DEPTH	START TIME	END DEPTH	END TIME
B419CALTEST01	Ø	12:29	Ø	12:31
B419CALUP01	210.0'	12:48	Ø	13:10
B419 CALTEST01	Ø	13:19	Ø	13:22

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.	B419CALTEST01	1.97	3.94	8.01	4.49
AS MEAS.	B419 CALTEST02	2.03	3.98	8.00	4.54
AS MEAS.					
AS MEAS.					
AS MEAS.					
AS MEAS.					

MAINTENANCE PERFORMED ON SITE: ____

EQUIPMENT PROBLEMS OR FAILURES: ____

SUGGESTIONS, ADDITIONS, CHANGES: ____

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B-419 ACOUSTIC TELEVIEWER FIELD LOG

SITE: SOUTH TEXAS PROJECT COL DATE: 12/4/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 1 OF 2

CONTACT: MIKE SUFNARSKI OFFICE PHONE: 704-357-5633
CELL PHONE: 704-309-0624
CONTACT: OFFICE PHONE:
PHONE:
CONTACT: PHONE:
PHONE:
CONTACT: PHONE:
PHONE:
DRILLER: PHONE:
COMPANY: PHONE:

DIRECTIONS TO SITE:

GENERAL SITE CONDITIONS/LOCATION:

BOREHOLE DESIGNATION: B-419 LOCATION:

COUNTY: RANGE: TOWNSHIP: SECTION:
BOREHOLE CONSTRUCTION: CASED UNCASED ✓
DIAMETERS AND DEPTH RANGES: 4 7/8 0 TO 215' ; , TO
BOREHOLE TOTAL DEPTH AS DRILLED: 215
CONDUCTOR CASING?: YES ✓ DEPTH TO BOTTOM OF CASING 2' ; NO
DEPTH TO BEDROCK: NA DEPTH TO WATER TABLE: 20'
BOREHOLE FLUID: WATER ; FRESH WATER MUD ✓ ; SALT WATER MUD ;
OTHER:
DEPTH TO BOREHOLE FLUID: Ø TIME SINCE LAST CIRCULATION: 3 HR

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SITE: SOUTH TEXAS PROJECT COL B-419 DATE: 12/6/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 2 OF 2

LOGGING CREW: R. STELLER, C. CARTER
VEHICLE(S) USED AND MILEAGE: RENTAL
MOBILIZED FROM: HOUSTON DEPARTURE TIME: 04:30
ARRIVED ON SITE: 07:30
STANDBY TIME: CAUSE:
LOGGING STARTED: 13:40 LOGGING COMPLETED: 14:16

WINCH: COMPROBE ___ SILVER ✓ OYO ___ OTHER ___
MICROLOGGER 5301 ✓ OTHER ___
TELEVIEWER ACOUSTIC #5174 ✓ OTHER ___

PROBE TILT TEST 87.3 BRUNTON TILT 86°
PROBE TILT TEST 0.7° BRUNTON TILT 0°
PROBE TILT TEST ___ BRUNTON TILT ___
PROBE AZIMUTH TEST 323.2° BRUNTON AZIMUTH 320
PROBE AZIMUTH TEST 271.0° BRUNTON AZIMUTH 280
PROBE AZIMUTH TEST 131.9° BRUNTON AZIMUTH 132°

PROBE OFFSET	1.44M(4.72FT)	
MINUS CASING STICK-UP	1.2'	
DEPTH REF. OFFSET AT START	3.52'	
DEPTH REF. OFFSET AT END	3.42	
AFTER SURVEY DEPTH ERROR	-0.1'	LESS THAN 0.4%? YES

LOG NAME	START DEPTH	START TIME	END DEPTH	END TIME
B419Acu*01	210'	13:40	94'	13:50
B419Acu*02	97	14:03	∅	14:16

MAINTENANCE PERFORMED ON SITE:

EQUIPMENT PROBLEMS OR FAILURES:

SUGGESTIONS, ADDITIONS, CHANGES:

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B-428 BORING GEOPHYSICS FIELD LOG SUMMARY

SITE:_SOUTH TEXAS PROJECT COL DATE: 12/5/06
CLIENT:_MACTEC JOB:_6533
AUTHOR:_R. STELLER PAGE 1 OF 1

CONTACT:_MIKE SUFNARSKI PHONE:_704-357-5633_

BOREHOLE CONSTRUCTION: CASED____ UNCASED ✓
DIAMETERS AND DEPTH RANGES: ~~215~~ 4 7/8" 0 TO 215' ; ______, ______ TO ______
BOREHOLE TOTAL DEPTH AS DRILLED: 215
CONDUCTOR CASING?: YES____ DEPTH TO BOTTOM OF CASING______; NO ✓
DEPTH TO BEDROCK: NA
BOREHOLE FLUID: WATER____; FRESH WATER MUD ✓; SALT WATER MUD ____;

LOGGING CREW:_R. STELLER, C. CARTER

LOG TYPE	FILE NAME	DEPTH RANGE	DATE	TIMES
ELOG TEST	B428ELOGTEST01	Ø	12/5/06	08:05 – 09:08
ELOG/GAMMA	B428ELOGUP01	215.0' – 54.5'	"	09:37 – 10:05
SUSPENSION	B428-001-124.ORG	1.6' – 201.8'	"	10:30 – 12:10
CALIPER TEST	B428CALTEST01	Ø	"	12:26 – 12:34
CALIPER/GAMMA	B428CALUP01	210.0' – Ø'	"	12:42 – 13:03
CALIPER TEST	B428CALTEST02	Ø	"	13:10 – 13:13
DEVIATION	B428AUUP01	210.0' – 1.3'	"	13:33 – 13:55

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B-428 ELOG FIELD LOG

SITE: SOUTH TEXAS PROJECT COL
DATE: 12/5/06
CLIENT: MACTEC
JOB: 6533
AUTHOR: R. STELLER
PAGE 1 OF 2

CONTACT: ______ OFFICE ___ PHONE: ______
CELL ___ PHONE: ______
CONTACT: ______ OFFICE ___ PHONE: ______
PHONE: ______
CONTACT: ______ PHONE: ______
PHONE: ______
CONTACT: ______ PHONE: ______
PHONE: ______
DRILLER: ______ PHONE: ______
COMPANY: ______ PHONE: ______

GENERAL SITE CONDITIONS/LOCATION: ______

BOREHOLE DESIGNATION: B-428 LOCATION: ______

COUNTY: ______ RANGE: ______ TOWNSHIP: ______ SECTION: ______
BOREHOLE CONSTRUCTION: CASED ______ UNCASED ✓
DIAMETERS AND DEPTH RANGES: 4" 0 TO 215' ; ______, ______ TO ______
BOREHOLE TOTAL DEPTH AS DRILLED: 215'
CONDUCTOR CASING?: YES ___ DEPTH TO BOTTOM OF CASING ______; NO ✓
DEPTH TO BEDROCK: NA
DEPTH TO WATER TABLE: ~20'
BOREHOLE FLUID: WATER ___; FRESH WATER MUD ✓; SALT WATER MUD ___;
OTHER: ______
DEPTH TO BOREHOLE FLUID: Ø
TIME SINCE LAST CIRCULATION: 1/2 HR

LOGGING CREW: R. STELLER, C. CARTER
VEHICLE(S) USED AND MILEAGE: RENTAL
MOBILIZED FROM: BAY CITY
DEPARTURE TIME: 06:30
ARRIVED ON SITE: 07:00
STANDBY TIME: ______
CAUSE: ______
LOGGING STARTED: 08:05
LOGGING COMPLETED: 10:05

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SITE:_SOUTH TEXAS PROJECT COL B-428 DATE: 12/15/06
CLIENT:_MACTEC JOB:_6533
AUTHOR:_R. STELLER PAGE 2 OF 2

WINCH: COMPROBE____ SILVER ✓ OYO____ OTHER____
MICROLOGGER 5301 ✓ OTHER____
ELOG PROBE 5490 ✓ OTHER____

PROBE LENGTH	2.50M(8.20 FT)	
PLUS YOKE 10.0M (32.8 FT)	32.8'	
MINUS CASING STICK-UP	Ø	
DEPTH REF. OFFSET AT START	41.0'	
DEPTH REF. OFFSET AT END	41.1'	
AFTER SURVEY DEPTH ERROR	+0.1	LESS THAN 0.4%? YES

LOG NAME	START DEPTH	START TIME	END DEPTH	END TIME
B428ELOGTEST01	Ø	08:05	Ø	08:08
B428ELOGUP01	215.0'	09:37	34.5	10:05

MAINTENANCE PERFORMED ON SITE:____

EQUIPMENT PROBLEMS OR FAILURES:____

SUGGESTIONS, ADDITIONS, CHANGES:____

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P-S SUSPENSION VELOCITY FIELD LOG

SITE: SOUTH TEXAS PROJECT COL B-428 DATE: 12/5/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 1 OF 6

CONTACT: MIKE SUFNARSKI OFFICE PHONE: 704-357-5633
CELL PHONE: 704-309-0624
CONTACT: OFFICE PHONE:
PHONE:
CONTACT: PHONE:
PHONE:
CONTACT: PHONE:
PHONE:
DRILLER: PHONE:
COMPANY: PHONE:

DIRECTIONS TO SITE:

GENERAL SITE CONDITIONS/LOCATION:

EA#:
BOREHOLE DESIGNATION: B-428-DH LOCATION:

COUNTY: RANGE: TOWNSHIP: SECTION:
BOREHOLE CONSTRUCTION: CASED UNCASED ✓
DIAMETERS AND DEPTH RANGES: 4 7/8" 0 TO 215' ; , TO
BOREHOLE TOTAL DEPTH AS DRILLED: 215'
CONDUCTOR CASING?: YES DEPTH TO BOTTOM OF CASING ; NO ✓
DEPTH TO BEDROCK: NA DEPTH TO WATER TABLE: ≈20'
BOREHOLE FLUID: WATER ; FRESH WATER MUD ✓; SALT WATER MUD ;
OTHER:
DEPTH TO BOREHOLE FLUID: Ø TIME SINCE LAST CIRCULATION: 1HR

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SITE: SOUTH TEXAS PROJECT COL B-428 DATE: 12/5/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 2 OF 6

LOGGING CREW: R. STELLER, C. CARTER
VEHICLE(S) USED AND MILEAGE: RENTAL
MOBILIZED FROM: BAY CITY, TX DEPARTURE TIME: 06:30
ARRIVED ON SITE: 07:00
STANDBY TIME: CAUSE:
LOGGING STARTED: 10:30 LOGGING COMPLETED: 12:10
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 ☐	30086 ☑

MAINTENANCE PERFORMED ON SITE:

EQUIPMENT PROBLEMS OR FAILURES:

SUGGESTIONS, ADDITIONS, CHANGES:

COMMENTS: START DEPTH ZERO = 2.5m - 0.0 STICKUP = 2.5m.

GEOVISION SUSPENSION LOGGING FIELD NOTES

SITE: SOUTH TEXAS COL B-428 DATE: 12/5/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 3 OF 6

DEPTH METERS	DEPTH FEET	UNFILTERED FILE NO.	FILTERED FILE NO.	COMMENTS CASING, WATER, ROCK, ETC
0.5	1.64	1		
1.0	3.28	2		
1.5	4.92	3		
2.0	6.56	4		
2.5	8.20	5		
3.0	9.84	6		
3.5	11.48	7		
4.0	13.12	8		
4.5	14.76	9		
5.0	16.40	10		
5.5	18.04	11		
6.0	19.69	12		
6.5	21.33	13		
7.0	22.97	14		
7.5	24.61	15		
8.0	26.25	16		
8.5	27.89	17		
9.0	29.53	18		
9.5	31.17	19		
10.0	32.81	20		
10.5	34.45	21		
11.0	36.09	22		
11.5	37.73	23		
12.0	39.37	24		
12.5	41.01	25		
13.0	42.65	26		
13.5	44.29	27		
14.0	45.93	28		
14.5	47.57	29		
15.0	49.21	30		
15.5	50.85	31		
16.0	52.49	32		
16.5	54.13	33		
17.0	55.77	34		
17.5	57.41	35		
18.0	59.06	36		
18.5	60.70	37		
19.0	62.34	38		
19.5	63.98	39		
20.0	65.62	40		

GEOVISION SUSPENSION LOGGING FIELD NOTES

SITE:_SOUTH TEXAS COL B-428 DATE: 12/5/06
CLIENT:__MACTEC JOB:_6533
AUTHOR:_R. STELLER PAGE 4 OF 6

DEPTH METERS	DEPTH FEET	UNFILTERED FILE NO.	FILTERED FILE NO.	COMMENTS CASING, WATER, ROCK, ETC
20.5	67.26	41		
21.0	68.90	42		
21.5	70.54	43		
22.0	72.18	44		
22.5	73.82	45		
23.0	75.46	46		
23.5	77.10	47		
24.0	78.74	48		
24.5	80.38	49		
25.0	82.02	50		
25.5	83.66	51		
26.0	85.30	52		
26.5	86.94	53		
27.0	88.58	54		
27.5	90.22	55		
28.0	91.86	56		
28.5	93.50	57,58		
29.0	95.14	~~58~~ 59 RA	12/5/06	
29.5	96.78	60		
30.0	98.43	61		
30.5	100.07	62		
31.0	101.71	63		
31.5	103.35	64		
32.0	104.99	65		
32.5	106.63	66		
33.0	108.27	67		
33.5	109.91	68		
34.0	111.55	69		
34.5	113.19	70		
35.0	114.83	71		
35.5	116.47	72		
36.0	118.11	73		
36.5	119.75	74		
37.0	121.39	75		
37.5	123.03	76		
38.0	124.67	77		
38.5	126.31	78		
39.0	127.95	79		
39.5	129.59	80		
40.0	131.23	81		

GEOVISION SUSPENSION LOGGING FIELD NOTES

SITE: SOUTH TEXAS COL B-428 DATE: 12/5/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 5 OF 6

DEPTH METERS	DEPTH FEET	UNFILTERED FILE NO.	FILTERED FILE NO.	COMMENTS CASING, WATER, ROCK, ETC
40.5	132.87	82		
41.0	134.51	83		
41.5	136.15	84		
42.0	137.80	85		
42.5	139.44	86		
43.0	141.08	87		
43.5	142.72	88		
44.0	144.36	89		
44.5	146.00	90		
45.0	147.64	91		
45.5	149.28	92		
46.0	150.92	93		
46.5	152.56	94		
47.0	154.20	95		
47.5	155.84	96		
48.0	157.48	97		
48.5	159.12	98		
49.0	160.76	99		
49.5	162.40	100		
50.0	164.04	101		
50.5	165.68	102		
51.0	167.32	103		
51.5	168.96	104		
52.0	170.60	105		
52.5	172.24	106		
53.0	173.88	107		
53.5	175.52	108		
54.0	177.17	109		
54.5	178.81	110		
55.0	180.45	111		
55.5	182.09	112		
56.0	183.73	113		
56.5	185.37	114		
57.0	187.01	115		
57.5	188.65	116		
58.0	190.29	117		
58.5	191.93	118		
59.0	193.57	119		
59.5	195.21	120		
60.0	196.85	121		

GEOVISION SUSPENSION LOGGING FIELD NOTES

SITE: SOUTH TEXAS COL
DATE:
CLIENT: MACTEC
JOB: 6533
AUTHOR: R. STELLER
PAGE 6 OF 6

DEPTH METERS	DEPTH FEET	UNFILTERED FILE NO.	FILTERED FILE NO.	COMMENTS CASING, WATER, ROCK, ETC
60.5	198.49	122		
61.0	200.13	123		
61.5	201.77	124		
62.0	203.41			BOTTOM MEASUREMENT ?
62.5	205.05			HR BOTTOM @ 61.9 m
63.0	206.69			
63.5	208.33			
64.0	209.97			
64.5	211.61			
65.0	213.25			
65.5	214.90			T.D. @ 215'
66.0	216.54			
66.5	218.18			
67.0	219.82			
67.5	221.46			
68.0	223.10			
68.5	224.74			
69.0	226.38			
69.5	228.02			
70.0	229.66			
70.5	231.30			
71.0	232.94			
71.5	234.58			
72.0	236.22			
72.5	237.86			
73.0	239.50			
73.5	241.14			
74.0	242.78			
74.5	244.42			
75.0	246.06			
75.5	247.70			
76.0	249.34			
76.5	250.98			
77.0	252.62			
77.5	254.27			
78.0	255.91			
78.5	257.55			
79.0	259.19			
79.5	260.83			
80.0	262.47			

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B-428 CALIPER FIELD LOG

SITE: SOUTH TEXAS PROJECT COL DATE: 12/5/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 1 OF 2

CONTACT: MIKE SUFNARSKI OFFICE PHONE:
CELL PHONE: 704-357-5633
CONTACT: OFFICE PHONE:
PHONE:
CONTACT: PHONE:
PHONE:
CONTACT: PHONE:
PHONE:
DRILLER: PHONE:
COMPANY: PHONE:

GENERAL SITE CONDITIONS/LOCATION:

BOREHOLE DESIGNATION: B-428-DH LOCATION:

COUNTY: RANGE: TOWNSHIP: SECTION:
BOREHOLE CONSTRUCTION: CASED UNCASED ✓
DIAMETERS AND DEPTH RANGES: 4 7/8" 0 TO 215' ; , TO
BOREHOLE TOTAL DEPTH AS DRILLED: 215'
CONDUCTOR CASING?: YES DEPTH TO BOTTOM OF CASING ; NO ✓
DEPTH TO BEDROCK: NA DEPTH TO WATER TABLE: ≈20'
BOREHOLE FLUID: WATER ; FRESH WATER MUD ✓ ; SALT WATER MUD ;
OTHER:
DEPTH TO BOREHOLE FLUID: 0 TIME SINCE LAST CIRCULATION: ≈3HR

LOGGING CREW: R. STELLER, C.CARTER
VEHICLE(S) USED AND MILEAGE: RENTAL
MOBILIZED FROM: BAY CITY, TX DEPARTURE TIME: 06:30
ARRIVED ON SITE: 07:00
STANDBY TIME: CAUSE:
LOGGING STARTED: LOGGING COMPLETED:

SITE: SOUTH TEXAS PROJECT COL B-428 DATE: 12/5/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 2 OF 2

WINCH: COMPROBE___ SILVER ✓ OYO___ OTHER___
MICROLOGGER 5301 ✓ OTHER___
CALIPER PROBE 5368 ✓ OTHER___

PROBE OFFSET	2.08M(6.82 FT) 12 IN MAX	
MINUS CASING STICK-UP	Ø	
DEPTH REF. OFFSET AT START	6.82	
DEPTH REF. OFFSET AT END		
AFTER SURVEY DEPTH ERROR		LESS THAN 0.4%?

LOG NAME	START DEPTH	START TIME	END DEPTH	END TIME
B428CALTEST01	Ø	12:26	Ø	12:34
B428CALUP01	210.0'	12:42	Ø	13:03
B428CALTEST02	Ø	13:10	Ø	13:13

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.	B428CALTEST01	1.97	3.92	7.98	4.52
AS MEAS.	B428CALTEST02	2.01	3.90	8.02	4.53
AS MEAS.					
AS MEAS.					
AS MEAS.					
AS MEAS.					

MAINTENANCE PERFORMED ON SITE:___

EQUIPMENT PROBLEMS OR FAILURES:___

SUGGESTIONS, ADDITIONS, CHANGES:___

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B-428 ACOUSTIC TELEVIEWER FIELD LOG

SITE: SOUTH TEXAS PROJECT COL DATE: 12/5/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 1 OF 2

CONTACT: MIKE SUFNARSKI OFFICE PHONE: 704-357-5633
CELL PHONE: 704-309-0624
CONTACT: OFFICE PHONE:
PHONE:
CONTACT: PHONE:
PHONE:
CONTACT: PHONE:
PHONE:
DRILLER: PHONE:
COMPANY: PHONE:

DIRECTIONS TO SITE:

GENERAL SITE CONDITIONS/LOCATION:

BOREHOLE DESIGNATION: B-428-DH LOCATION:

COUNTY: RANGE: TOWNSHIP: SECTION:
BOREHOLE CONSTRUCTION: CASED UNCASED ✓
DIAMETERS AND DEPTH RANGES: 4 7/8" 0 TO 215' ; , TO
BOREHOLE TOTAL DEPTH AS DRILLED: 215
CONDUCTOR CASING?: YES DEPTH TO BOTTOM OF CASING ; NO ✓
DEPTH TO BEDROCK: NA DEPTH TO WATER TABLE: ~20'
BOREHOLE FLUID: WATER ; FRESH WATER MUD ✓; SALT WATER MUD ;
OTHER:
DEPTH TO BOREHOLE FLUID: ∅ TIME SINCE LAST CIRCULATION: ~4 HR

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SITE: SOUTH TEXAS PROJECT COL B-428 DATE: 12/5/06
CLIENT: MACTEC JOB: 6533
AUTHOR: R. STELLER PAGE 2 OF 2

LOGGING CREW: R. STELLER C. CARTER
VEHICLE(S) USED AND MILEAGE: RENTAL
MOBILIZED FROM: BAY CITY, TX DEPARTURE TIME: 06:30
ARRIVED ON SITE: 07:00
STANDBY TIME: CAUSE:
LOGGING STARTED: LOGGING COMPLETED:

WINCH: COMPROBE___ SILVER ✓ OYO___ OTHER___
MICROLOGGER 5301 ✓ OTHER___
TELEVIEWER ACOUSTIC #5174 ✓ OTHER___

PROBE TILT TEST 91.1 BRUNTON TILT 92.0
PROBE TILT TEST ___ BRUNTON TILT ___
PROBE TILT TEST ___ BRUNTON TILT ___
PROBE AZIMUTH TEST 81.2 BRUNTON AZIMUTH 90.0
PROBE AZIMUTH TEST ___ BRUNTON AZIMUTH ___
PROBE AZIMUTH TEST ___ BRUNTON AZIMUTH ___

PROBE OFFSET	1.44M(4.72FT)	
MINUS CASING STICK-UP	Ø	
DEPTH REF. OFFSET AT START	4.72'	
DEPTH REF. OFFSET AT END	4.66	
AFTER SURVEY DEPTH ERROR	+.06	LESS THAN 0.4%? YES

LOG NAME	START DEPTH	START TIME	END DEPTH	END TIME
B428 AU UP 01	210.0'	13:33	1.3'	13:55

MAINTENANCE PERFORMED ON SITE:

EQUIPMENT PROBLEMS OR FAILURES:

SUGGESTIONS, ADDITIONS, CHANGES:

APPENDIX E

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 ASCII data files and digital records transmitted on diskette.

Instrumentation

1. OYO Model 170 Digital Logging Recorder or equivalent
2. OYO P-S Suspension Logger probe 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 5 meters above the bottom end of the probe.

The probe receives control signals from, and sends the amplified geophone signals to, the instrumentation package on the surface via an armored 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 ____________ Date 4/10/06

QA Review ____________ Date 4/10/06

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

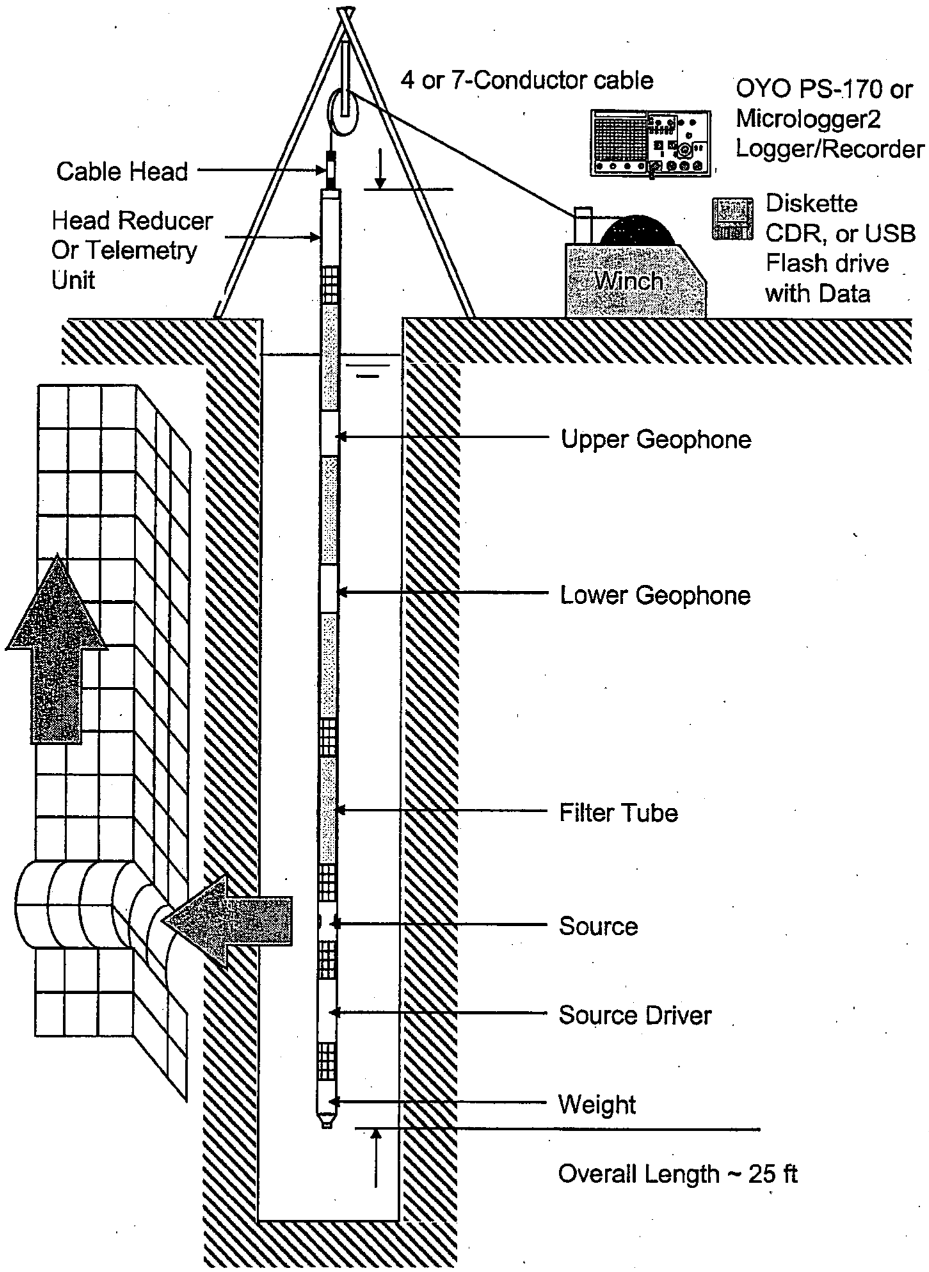

Figure 1. Suspension PS logging method setup

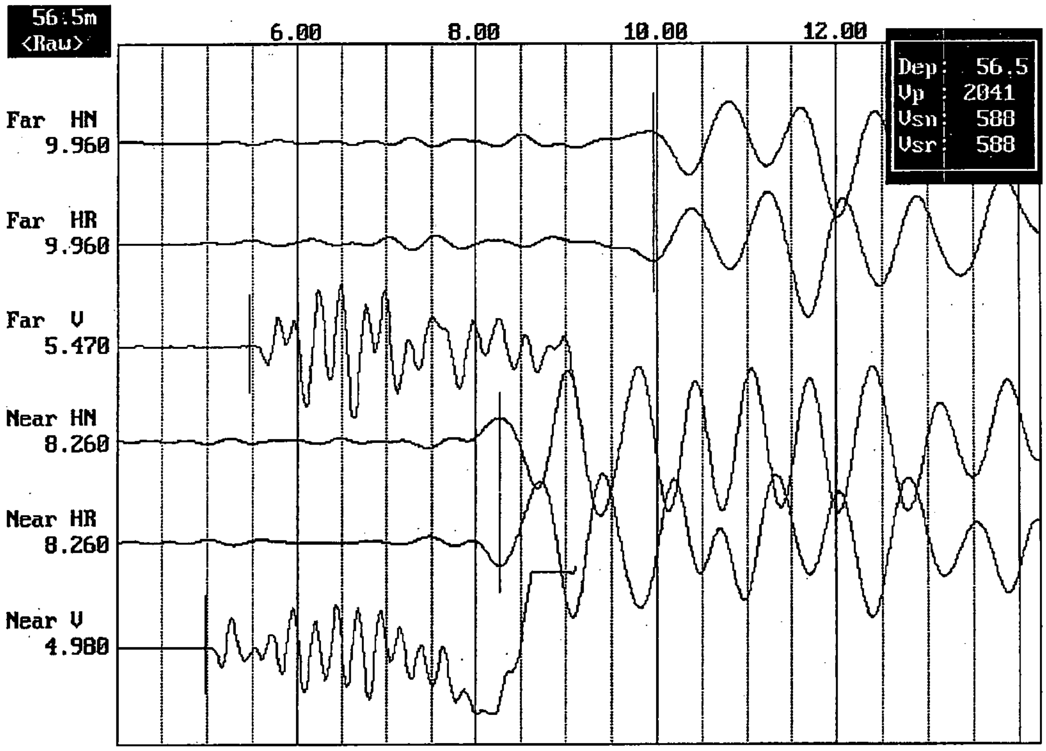

Figure 2. Sample suspension method waveform data showing horizontal normal and reversed (HR and HN), and vertical (V) waveforms received at the near (bottom 3 channels) and far (top 3 channels) geophones. The arrivals in milliseconds for each pick are shown on the left. The box in the upper right corner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

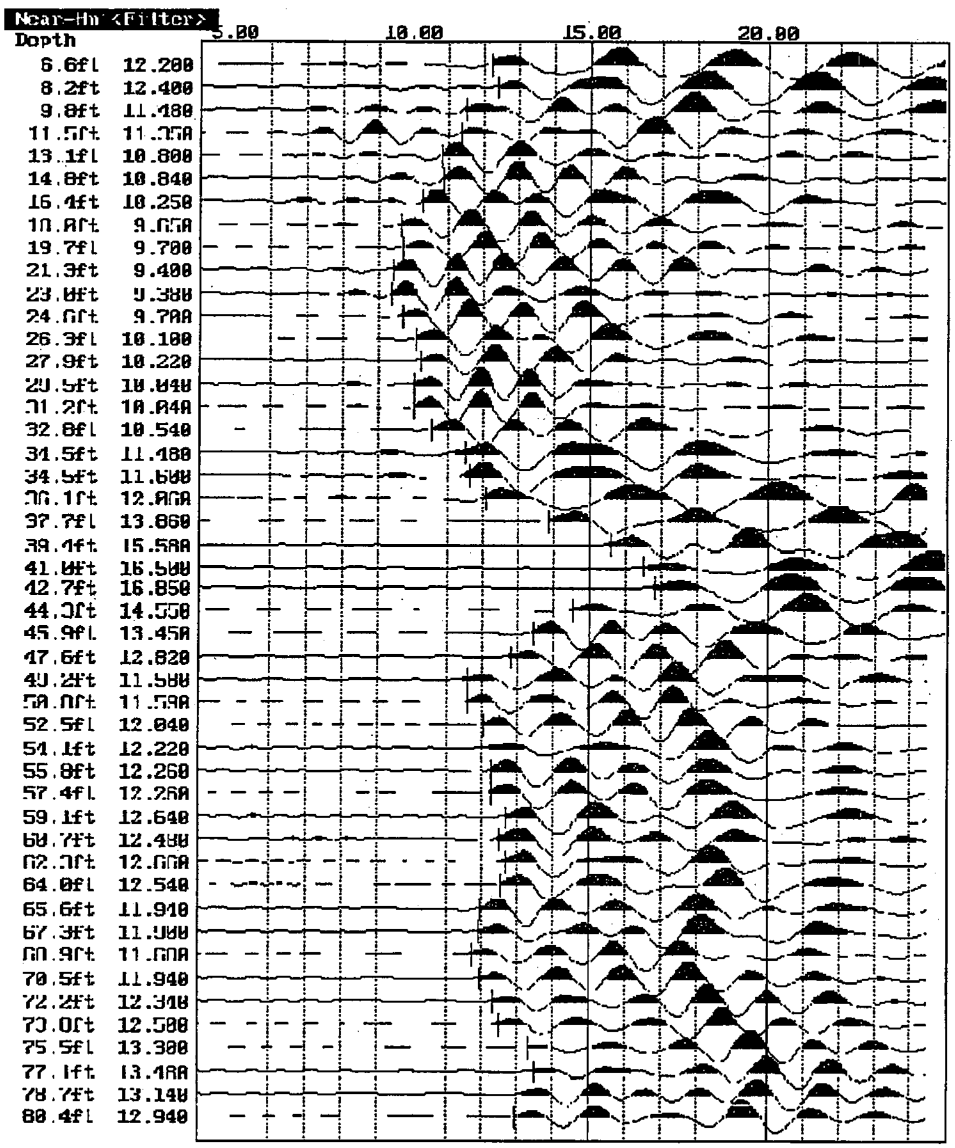

Figure 3. Sample composite waveform plot for normal shear waves received at the near geophone in a single borehole

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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:__________

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

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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			

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
36.5	119.75			
37.0	121.39			
37.5	123.03			
38.0	124.67			
38.5	126.31			
39.0	127.95			
39.5	129.59			
40.0	131.23			
40.5	132.87			
41.0	134.51			
41.5	136.15			
42.0	137.80			
42.5	139.44			
43.0	141.08			
43.5	142.72			
44.0	144.36			
44.5	146.00			
45.0	147.64			
45.5	149.28			
46.0	150.92			
46.5	152.56			
47.0	154.20			
47.5	155.84			
48.0	157.48			
48.5	159.12			
49.0	160.76			
49.5	162.40			
50.0	164.04			
50.5	165.68			
51.0	167.32			
51.5	168.96			
52.0	170.60			
52.5	172.24			
53.0	173.88			
53.5	175.52			
54.0	177.17			

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
54.5	178.81			
55.0	180.45			
55.5	182.09			
56.0	183.73			
56.5	185.37			
57.0	187.01			
57.5	188.65			
58.0	190.29			
58.5	191.93			
59.0	193.57			
59.5	195.21			
60.0	196.85			
60.5	198.49			
61.0	200.13			
61.5	201.77			
62.0	203.41			
62.5	205.05			
63.0	206.69			
63.5	208.33			
64.0	209.97			
64.5	211.61			
65.0	213.25			
65.5	214.90			
66.0	216.54			
66.5	218.18			
67.0	219.82			
67.5	221.46			
68.0	223.10			
68.5	224.74			
69.0	226.38			
69.5	228.02			
70.0	229.66			
70.5	231.30			
71.0	232.94			
71.5	234.58			
72.0	236.22			

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
72.5	237.86			
73.0	239.50			
73.5	241.14			
74.0	242.78			
74.5	244.42			
75.0	246.06			
75.5	247.70			
76.0	249.34			
76.5	250.98			
77.0	252.62			
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			
82.5	270.67			
83.0	272.31			
83.5	273.95			
84.0	275.59			
84.5	277.23			
85.0	278.87			
85.5	280.51			
86.0	282.15			
86.5	283.79			
87.0	285.43			
87.5	287.07			
88.0	288.71			
88.5	290.35			
89.0	291.99			
89.5	293.64			
90.0	295.28			

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
90.5	296.92			
91.0	298.56			
91.5	300.20			
92.0	301.84			
92.5	303.48			
93.0	305.12			
93.5	306.76			
94.0	308.40			
94.5	310.04			
95.0	311.68			
95.5	313.32			
96.0	314.96			
96.5	316.60			
97.0	318.24			
97.5	319.88			
98.0	321.52			
98.5	323.16			
99.0	324.80			
99.5	326.44			
100.0	328.08			
100.5	329.72			
101.0	331.36			
101.5	333.01			
102.0	334.65			
102.5	336.29			
103.0	337.93			
103.5	339.57			
104.0	341.21			
104.5	342.85			
105.0	344.49			
105.5	346.13			
106.0	347.77			
106.5	349.41			
107.0	351.05			
107.5	352.69			
108.0	354.33			

GEOVISION SUSPENSION LOGGING FIELD NOTES

SITE: ____ DATE: ____
CLIENT: ____ JOB: ____
AUTHOR: ____ PAGE ____ OF ____

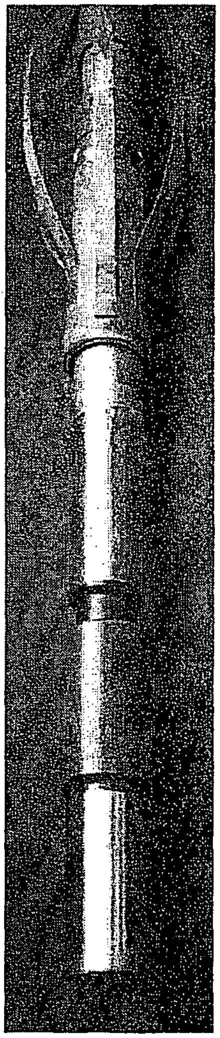
DEPTH METERS	DEPTH FEET	UNFILTERED FILE NO.	FILTERED FILE NO.	COMMENTS CASING, WATER, ROCK, ETC
108.5	355.97			
109.0	357.61			
109.5	359.25			
110.0	360.89			
110.5	362.53			
111.0	364.17			
111.5	365.81			
112.0	367.45			
112.5	369.09			
113.0	370.73			
113.5	372.38			
114.0	374.02			
114.5	375.66			
115.0	377.30			
115.5	378.94			
116.0	380.58			
116.5	382.22			
117.0	383.86			
117.5	385.50			
118.0	387.14			
118.5	388.78			
119.0	390.42			
119.5	392.06			
120.0	393.70			
120.5	395.34			
121.0	396.98			
121.5	398.62			
122.0	400.26			
122.5	401.90			
123.0	403.54			
123.5	405.18			
124.0	406.82			
124.5	408.46			
125.0	410.10			
125.5	411.75			
126.0	413.39			

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

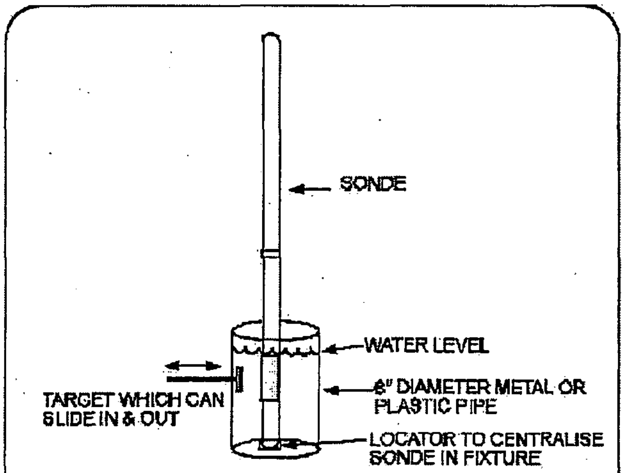
This tool is designed for fluid-filled boreholes between 67 and 150mm (3-6in) in rock. Since fine cracks are usually not visible in the walls of soil borings, the televiewers add very little information from a soil boring than a simple video. Now if the boring has soil AND rock, televiewer visuals in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



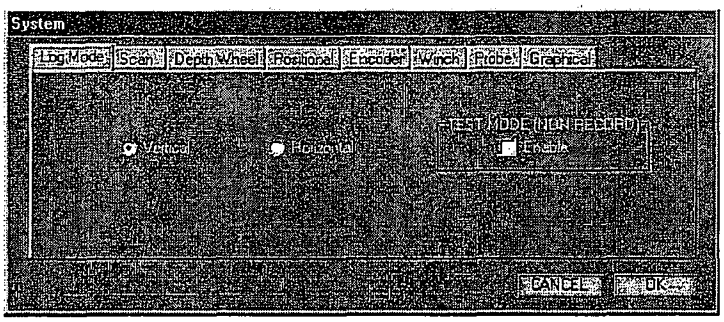
TELEVIEWER TEST JIG

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

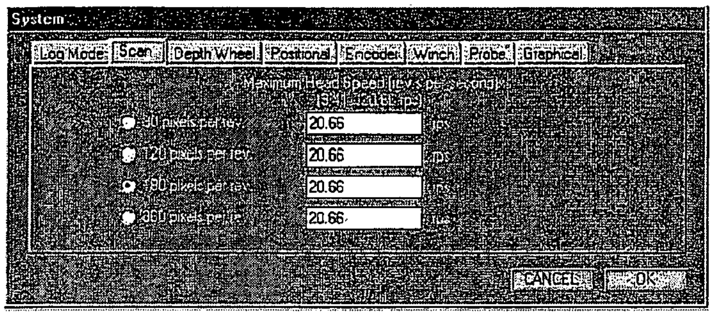
The sonde can operate in three distinct modes:



- 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

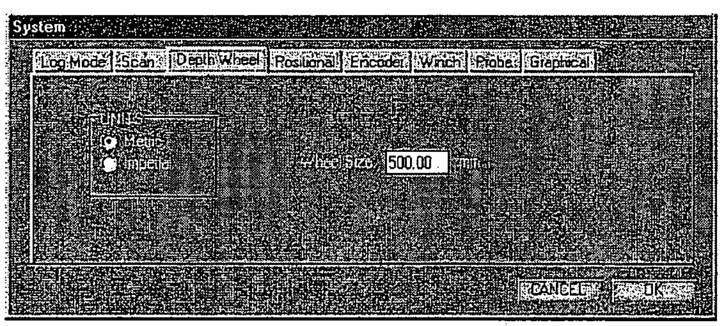
The scan parameters control the radial sampling of the borehole. The values will be retained between logging sessions, so the sonde will be initialized correctly at power-on. There are three parameters in the dialog:



- The radial sampling rate can be set to one of 90, 120, 180, 360 samples per revolution. There is a relationship between the logging speed and the radial sampling rate, since the time taken to send the dataset to the surface depends upon its length. The size of the log file is also determined by the radial sampling rate. The probe will always try to use the maximum head speed entered. If limited by a low Baud rate or a large 'window' setting then the probe will reduce its head speed automatically to compensate - see sonde operation section.

3.0 Depth Wheel Configuration

The depth measurement system is dependent upon the combination of depth measurement wheel with its calibrated groove, and the shaft encoder which translates rotation into pulses which are counted by the logging system controller. Two parameters are therefore required: depth wheel circumference and encoder pulse rate. The encoder parameters are covered in a subsequent topic.

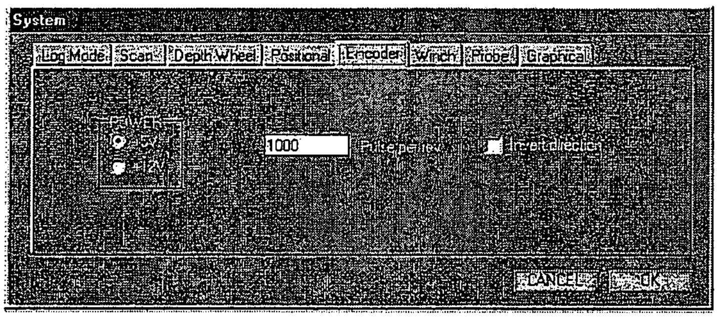


- Select Metric or Imperial depth measurement units from the left-hand pane.

- Type the circumference of the depth measurement wheel into the 'wheel size' box. The standard sizes of GEOVision wheels are 1000mm. If you are measuring in Imperial units (or changing back to metric units), the standard wheel size can be converted automatically by clicking the left mouse button and choosing the appropriate conversion. The size is always specified in units of 1/1000 of the depth unit i.e. millimetres (mm) or millifeet (mft).

4.0 Encoder Configuration

The depth measurement system is dependent upon the combination of depth measurement wheel with its calibrated groove, and the shaft encoder which translates rotation into pulses which are counted by the logging system controller. The depth wheel circumference is covered in a previous topic. In order to accommodate a variety of encoders, their operational characteristics can be configured in the software.



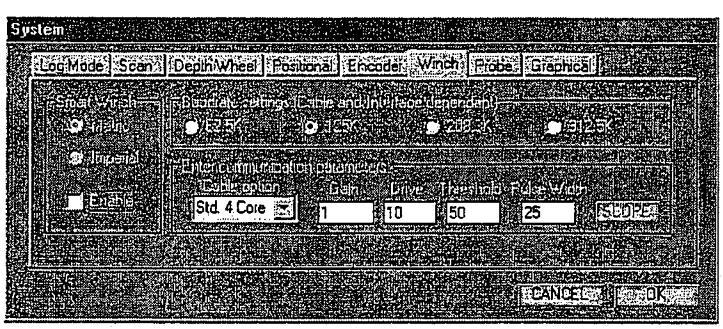
- Select supply voltage from the radio buttons in the left-hand pane. The options are 5 Volt and 12 Volt. GEOVision encoders are always specified for 5 Volt operation.

- Type the number of pulses emitted per revolution into the central box. The standard values for all GEOVision winches are 500 pulses/rev.

- The logical direction of movement can be reversed if required to accommodate the directional characteristics (phase lead or lag) of the different encoder types.

5.0 Winch and Cable Configuration

Support for remote control of the RG Smart Winch is provided, and can be enabled by checking the ***Enable*** control in the left-hand Smart Winch pane. If the Smart Winch control is enabled, it is also necessary to select the measure units in force - select ***Metric*** or ***Imperial*** from the radio buttons on offer.



The Baud settings can be chosen to match the *quality* of the communication channel. The channel will be effected by cable type and length. Typically a Baudrate of 312.5K is used. The remaining controls in the dialog relate to the communications parameters. The operation is entirely compatible with the WinLogger software operation and the values would be expected to be the same as those in force for logging six-channel type sondes with that software. (Certain probe types may be fitted with a digital interface that does not require set-up and in this case the parameter edit boxes will not appear.)

- ***Cable Option*** is used to select the logging cable type which is available on the winch. The options are *Not Connected*, *Std. 4 Core*, *Differential* and *Monocable*. The only cable types used in GEOVision systems is Std. 4 Core. Select the appropriate type from the drop-down menu box. Note this value can only be changed when the probe power is turned off.

- ***Gain*** is related to cable length and uphole signal attenuation. Gain values range from 0-3 and control the amplification applied to the incoming signal. Use the *Scope* dialog to visualize the incoming signals. Gain should be set so that the signal reaches between 70% and 100% of the height of the display, generally obtained with a setting of 0 for GEOVision winches. If the peak height exceeds this level, clipping will result in artifacts which will be detected erroneously. Click *Apply* to set the parameters before proceeding to the *Scope* dialog.

- ***Threshold*** is the level at which the incoming signals are detected. Gain and Threshold are related, and can be visualized using the *Scope* dialog. Set the gain so that the signal reaches between 70% and 100% of the height of the display. Then adjust the threshold so that it is between 50% and 70% of the height of the pulses displayed and clear of any region of 'overshoot' of the positive and negative pulses. This will ensure that peaks are detected and noise is ignored. Generally a setting of 25 is used for GEOVision winches. When the scope dialog is displayed, the position of the mouse is reported as a threshold value to make it simpler to infer the correct setting. The scope option is greyed out when the probe power is turned off.

- ***Drive*** sets the strength of the downhole signal. It is not possible to visualize the downhole signal, but the effect of insufficient drive is to disable downhole communication, which will result in the commands being ignored by the sonde. Values range from 0 -127, and for GEOVision winches will be around 10. Increase the drive for longer cables.

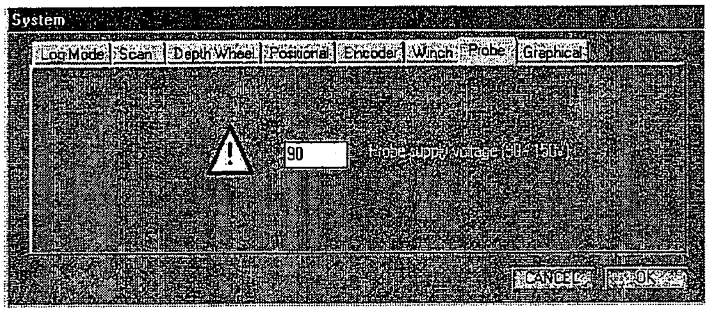
- ***Pulse Width*** This is the width of the transmitted communication pulses in 100nS steps. The default is 25 equivalent to 2.5uS. The range is from 8 to 64. The pulse width can be reduced to prevent signal overshoot on short cables. The default value is used in most cases. Note any changes only come into effect during a log. (Note setting too large a pulse width when using the highest Baud rates will automatically be prevented within the probe and the pulse width reduced.)

IMPORTANT Please note the effects of changing 'Baud' will not appear until the first new log is made. The setting for 'threshold' may be effected by an increase in the 'Baud' rate please recheck 'threshold' if 'Baud' is altered using the 'Scope' function after making a short test log.

The parameters which are entered will be applied automatically if you close the dialog with ***OK***. The above parameters once set correctly will be remembered by the system and should never need to be altered.

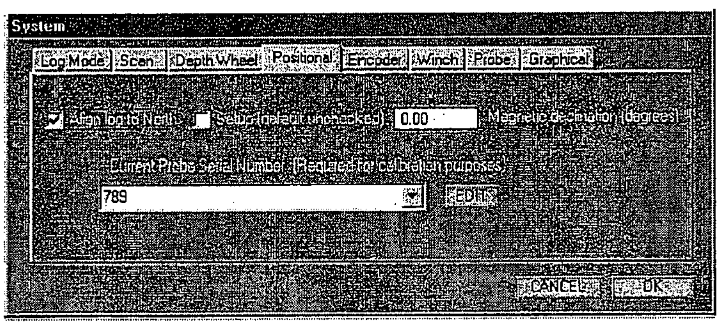
6.0 Probe Configuration

The probe is normally energized at 90 Volts from the surface. However, it may be necessary to compensate for voltage drop on longer cables due to the higher power draw of this sonde. The voltage at the surface may be increased in order to deliver 90 Volts at the sonde. Simply type the value into the text box provided. The voltage should be set at 90V for all GEOVision winches. Values outside the indicated range will be rejected.



7.0 Positional Configuration

The probe includes a 3-axis orientation package, and is capable of producing a borehole image aligned to geographic North. This is achieved by determining and applying two image rotation parameters:



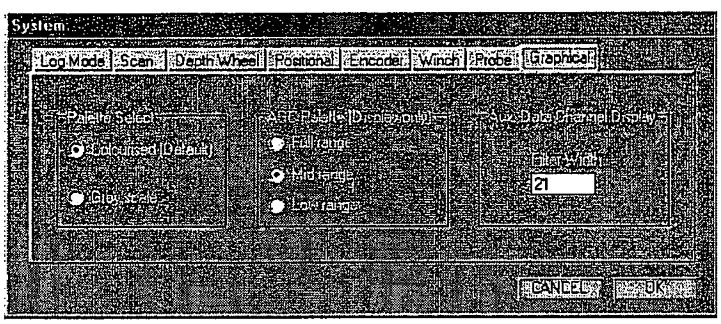
- ***Magnetic Declination*** is used to correct for the difference between Magnetic North and True North. The value varies from place to place, so the local value must be inserted here if you wish to perform this correction during data collection. This correction may also be made during processing. If the value is zero, the log will be referred to Magnetic North.
- ***Align to North*** is a check-box used to select image rotation to start at Magnetic North. If in addition a value is set for Magnetic Declination (see above) the image will be rotated to start at True North. If the box is not checked, the image will not be oriented to geographic co-ordinates, but will use the local co-ordinate frame of the sonde (X, Y, Z axis of the orientation module). This mode may be used to inspect the inside of magnetic casing, where an orientated image would be subjected to random effects caused by the metalwork.
- Set-up mode is selected by checking the ***Setup*** box, and is used to determine the required image rotation offset to correct for the angle between the axis of the orientation package and the index mark of the rotating transducer section. In set-up mode the normal sonde azimuth display is modified, and will instead show the 'relative bearing' which is measured between the high side of the borehole and the orientation sensor index. Check ***Setup***, then OK to close the dialog. The icon adjacent to the sonde azimuth readout at the top of the screen is modified with the legend CAL when the system is in set-up mode. The sonde must now be placed in a stand or jig so that it

is inclined at about 20 degrees to the vertical, and adjacent to a target fixed to the jig so that it is directly above the transducer in the vertical plane. Lower the sonde with its attachment into a large bucket of water so that the transducer and target are fully immersed. Start the radial amplitude display, when it will be possible to see the strong signal returning from the target. Rotate the sonde so that the image of the target moves to the top of the display. When the two are coincident, the 'relative bearing' reads out the image rotation offset. This value is fixed for the sonde unless it is disassembled and rebuilt, at which point the procedure MUST be repeated. Please see the additional topic on the Radial Amplitude Display for further details.

- The ***Serial Number*** list box is used to select the sonde which is in use. When the appropriate sonde is selected, the image rotation offset determined by the above procedure is selected. To edit the image offset click the '***Edit***' and enter the new offset. Several serial numbers and associated offsets can be stored and selected as required.

8.0 Graphical

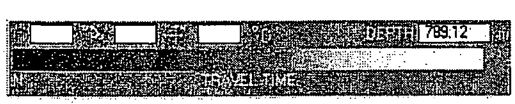
The palette can be changed between a colored and grey scale setting. The changes affect the log screen palette display and are also applied when replaying a log. Selecting Full range in the 'AGC Palette' will cause the software to spread the palette over the full 16bit signal. 'Mid range' will spread the palette over the first quarter of the 16bit range and 'Low range' will spread the palette over the first eighth of the 16 bit range. In most cases the 'Low range' selection is used. Note these settings do not affect the stored log data in any way. The 'Filter Width' is applied to the Natural Gamma trace data and is a simply running average filter. The range of the filter width is from 1 to 50 (x 10 millidepth units ie. mm or mft).



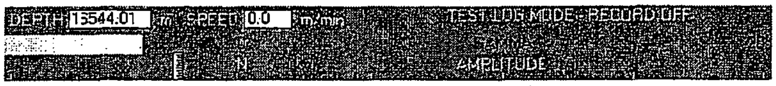
9.0 Sonde Operation

When the operations specified above have been reviewed and the correct settings have been selected, the system is ready for use. The main screen area is divided into 3 horizontal elements. At the top is the depth and orientation readout, together with the scale headings for the scrolling display of unwrapped borehole image.

On the left side of the depth track is the travel time display, with text boxes for sonde inclination, azimuth and head temperature.



On the right side is the display of amplitude and indication of current operating mode. Located in the center above the depth track are the text boxes for depth and cable speed (computed at the surface). The ranges for the 'Natural Gamma' channel overlay (optional) are shown above the Amplitude..



The central area is utilized for the scrolling display of unwrapped borehole data. The display is orientated with the left edge corresponding to North point of the aligned image data (if orientation is selected) according to the outputs of the sonde's orientation package.

The lower area has controls for the winch (applicable to RG Smart Winch only), depth initialization and sonde control.

The winch control area is only displayed when RG SmartWinch operation is enabled - see section 5 - and has four controls. Set Target Speed by typing the required speed into the window and pressing Enter.

Cable movement is initiated by clicking on either the UP or DOWN arrow control.

Cable movement is halted by clicking on the square STOP control.

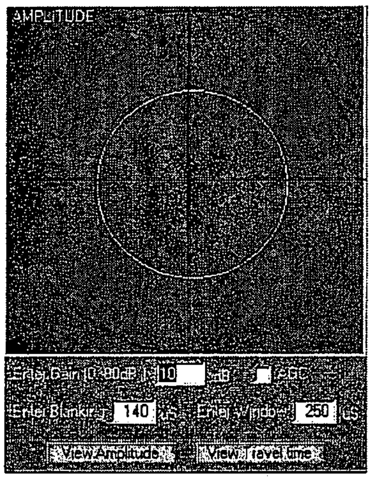
Depth is initialized by typing the required value into the entry box and pressing Enter. The entry box is not available at times when the system is in logging mode and the depth should not be changed by user entry.

Sonde power is applied by clicking on the green-colored 1 button. Power is turned off by clicking on the red-colored 0 button. There is no indicator for the state of the power supply on the desktop, so the external indicators should be observed for this purpose.

To make a log ensure that the Test Mode is disabled - see section 1, Log Mode setting. Click File|New Log and select a filename. Old logs may be overwritten if necessary -TAKE CARE. The header editor will be started automatically. A previous set of header data may be loaded by clicking LOAD and choosing a template.

To start logging, click on the red Record (circle) control. The log data will start to scroll down the screen after a brief pause for synchronization. The messages "DSP2: Detecting data stream" and "Updating probe settings" will be observed at the bottom of the screen during this process. Note that the screen scrolling direction is not affected by the actual direction of movement of the sonde. To cease logging, click on the black STOP control (square). The data should be immediately backed up to a USB drive, CD, or other data storage prior to beginning another log.

If the data display from a probe which is properly connected appears to occupy only half of the track area, with the remainder filled with random colors such as green which are not part of the regular palette, then it is most likely that the downhole data communication is not functioning properly. This symptom is due to the fact that the probe settings cannot be communicated properly, and it is operating in its default power-up mode. If this is the case, the Drive setting of the System|Winch dialog should be increased or decreased accordingly. See section 5 for full details.



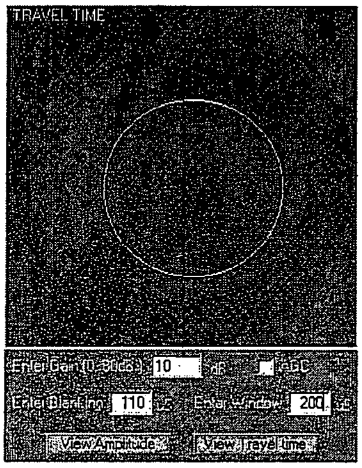

To adjust the sonde gain it is necessary to use the Radial Amplitude plot, which is enabled by clicking on the circle with cross-hairs symbol. When the dialog is active a new window will open on top of the unwrapped data display. In this display, the data is presented as a 'polar' plot. Press the 'View Amplitude' button to display the amplitude plot. This plot shows amplitude increasing towards the outside of the circle and the compass direction following the sweep of the transducer. The line indicating the data is drawn in the regular palette, so that high amplitudes are drawn in white and low amplitudes in black/brown. The picture here shows the image of the inside of a cylinder.

If the data is concentrated in a small circle at the center, the gain is too low and should be increased. If the data is obviously clipped at the outside of the circle, then the gain should be reduced. Type the new gain value into the entry box and press Enter. The ideal would be to set a gain value which allows the peak values to be displayed without clipping, with the majority of the data around the half-way level. It may also be necessary to adjust the blanking to ensure that internal reflections from the acoustic housing are not detected at the new gain value. This will be apparent in the unwrapped data display as pronounced patterning unrelated to the true target. The AGC option causes the probe to set gain automatically thus preventing signal saturation in most cases. (The gain is varied in 6dB steps

Blanking Period and window length can be set independently. Blanking is set to avoid reflections from the housing of the acoustic transducer or random reflections from a rugose borehole, and window length is set to accommodate the range of borehole radius that might be expected. An error will be indicated if the sum of the blanking period and window length would be greater than 409 microseconds, which is the maximum range of the timer. The default value for the blanking period is 145 microseconds, which is the minimum required for the two-way transit from the transceiver to the outer surface of the acoustic housing. It is not advisable to reduce this value beyond the default setting, although it may be increased for larger boreholes at the rate of 1.5mm of one-way travel per microsecond.

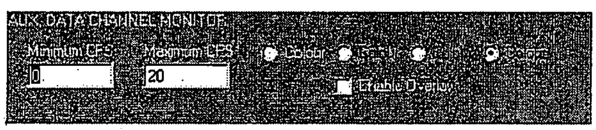
Window Length (sample time) defines the period during which the arrival gate remains open to detect the returned acoustic pulse. The acoustic pulse will travel in water at a speed of approximately 1.5mm per microsecond. The default window length is 150 microseconds, which is equivalent to 225 mm of (two-way) travel in the borehole fluid, or approximately 110mm of borehole diameter. If this is added to the default blanking period, which is equivalent to the outside diameter of the acoustic housing, it can be seen that the default set-up will be correct for boreholes up to 150mm. An error will be indicated if the sum of the blanking period and window length would be greater than 409 microseconds, which is the maximum range of the timer. Choose your window setting to best match the borehole diameter.

Pressing the 'View Travel time' button changes the display to that shown below:



The unhatched ring between the two cross hatched zones represents the sample window. The width of this ring will vary with window length value. The profile of a cylinder is represented here appearing as a circle in the sample window.

Pressing this button displays the following dialog box:



This box allows you to enable the Natural Gamma option by checking the 'Enable Overlay' check box. The Overlay appears as a trace upon the Amplitude plot. The trace range and color can also be set by this dialog. The level of filtering can also be altered (see section 8) (note that any displayed trace data is automatically aligned with the acoustic scan data but only when logging up. The Natural Gamma sensor occupies a higher position in the probe so sufficient data has to be prebuffered so that the acoustic data can depth aligned with gamma. The prebuffering results in a delay at the start of a log before correct gamma data appears this is normal.)

Data Analysis and Interpretation

RG-DIP, the manufacturer's image interpretation package, offers manual and automatic feature recognition options. Feature orientations (dip/strike and azimuth) are automatically calculated. Display options include stereographic projections of zone axes, orientation frequency plots and 'synthetic cores' for comparison with real core data. The last option is invaluable for orientating core samples, particularly in the case of incomplete recovery.

Reporting

The final report will include the objective and scope of the survey, location of the boreholes, discussion of instrumentation and procedures in the field and lab. For each borehole there will be a plot showing the dip/strike and azimuth of features. The next page shows an example.

Assumptions and limitations of the results will be discussed. Supporting references will be listed as necessary

Required Field Records

Field log for each borehole showing

a) Location and description of the borehole

b) Date of test

c) Field personnel

d) Instrumentation

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

This procedure has been reviewed and approved by the undersigned:

Professional Geophysicist Antony J Martin Date Feb 13. 2006

QA Review __________ Date Feb 13. 2006

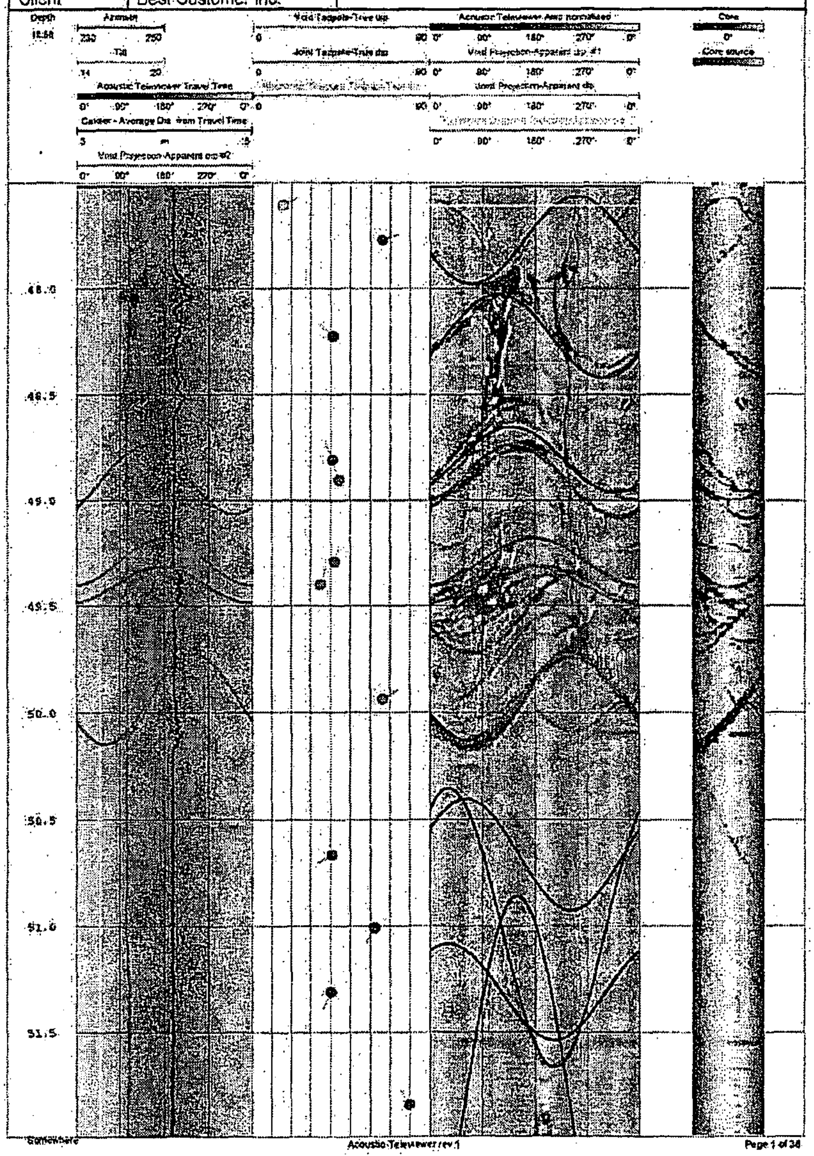
B-XXX	Company	Geovision Geophysical Services
	Location	Somewhere Dam

BH	B-XXX Acoustic Televiewer		
Date	7/8/05	BH Fluid	Air/Water
Casing	4" Steel to 15 ft		
File Name	BXXXdown1		
Depth Drilled	300 feet		
Depth Logged	299.3 feet		
Logged by	Rob Steller		
Client	Best Customer Inc.		

Notes:

1) All orientations referenced to True North

2) Tadpole tails indicate dip direction with True North as up.



Designation: D 5753 – 05

Standard Guide for Planning and Conducting Borehole Geophysical Logging[1]

This standard is issued under the fixed designation D 5753; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This guide covers the documentation and general procedures necessary to plan and conduct a geophysical log program as commonly applied to geologic, engineering, ground-water, and environmental (hereafter referred to as geotechnical) investigations. It is not intended to describe the specific or standard procedures for running each type of geophysical log and is limited to measurements in a single borehole. It is anticipated that standard guides will be developed for specific methods subsequent to this guide.

1.2 Surface or shallow-depth nuclear gages for measuring water content or soil density (that is, those typically thought of as construction quality assurance devices), measurements while drilling (MWD), cone penetrometer tests, and logging for petroleum or minerals are excluded.

1.3 Borehole geophysical techniques yield direct and indirect measurements with depth of the (*1*) physical and chemical properties of the rock matrix and fluid around the borehole, (*2*) fluid contained in the borehole, and (*3*) construction of the borehole.

1.4 To obtain detailed information on operating methods, publications (for example, **2, 5, 7, 18, 24, 29, 34, 35,** and **36**)[2] should be consulted. A limited amount of tutorial information is provided, but other publications listed herein, including a glossary of terms and general texts on the subject, should be consulted for more complete background information.

1.5 This guide provides an overview of the following: (*1*) the uses of single borehole geophysical methods, (*2*) general logging procedures, (*3*) documentation, (*4*) calibration, and (*5*) factors that can affect the quality of borehole geophysical logs and their subsequent interpretation. Log interpretation is very important, but specific methods are too diverse to be described in this guide.

1.6 Logging procedures must be adapted to meet the needs of a wide range of applications and stated in general terms so that flexibility or innovation are not suppressed.

1.7 *This standard does not purport to address all of the safety and liability concerns, if any, (for example, lost or lodged probes and radioactive sources*[3]*) associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

1.8 *This guide offers an organized collection of information or a series of options and does not recommend a specific course of action. This document cannot replace education or experience and should be used in conjunction with professional judgment. Not all aspects of this guide may be applicable in all circumstances. This ASTM standard is not intended to represent or replace the standard of care by which the adequacy of a given professional service must be judged, nor should this document be applied without consideration of a project's many unique aspects. The word "Standard" in the title of this document means only that the document has been approved through the ASTM consensus process.*

2. Referenced Documents

2.1 *ASTM Standards:* [4]

D 653 Terminology Relating to Soil, Rock, and Contained Fluids

D 5088 Practice for the Decontamination of Field Equipment Used at Non-Radioactive Waste Sites

D 5608 Practice for the Decontamination of Field Equipment Used at Low Level Radioactive Waste Sites

3. Terminology

3.1 Definitions—Definitions shall be in accordance with Terminology D 653.

[1] This guide is under the jurisdiction of ASTM Committee D18 on Soil and Rock and is the direct responsibility of Subcommittee D18.01 on Surface and Subsurface Characteristics.

Current edition approved June 1, 2005. Published June 2005. Originally approved in 1995. Last previous edition approved in 1995 as D 5753–95.

[2] The boldface numbers in parentheses refer to the list of references at the end of this standard.

[3] The use of radioactive materials required for some log measurements is regulated by federal, state, and local agencies. Specific requirements and restrictions must be addressed prior to their use.

[4] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

3.2 *Definitions of Terms Specific to This Standard:* Descriptions of Terms Specific to This Standard—Terms shall be in accordance with Ref (1).

4. Summary of Guide

4.1 This guide applies to borehole geophysical techniques that are commonly used in geotechnical investigations. This guide briefly describes the significance and use, apparatus, calibration and standardization, procedures and reports for planning and conducting borehole geophysical logging. These techniques are described briefly in Table 1 and their applications in Table 2.[5]

4.2 Many other logging techniques and applications are described in the textbooks in the reference list. There are a number of logging techniques with potential geotechnical applications that are either still in the developmental stage or have limited commercial availability. Some of these techniques and a reference on each are as follows: buried electrode direct current resistivity (**37**), deeply penetrating electromagnetic techniques (**38**), gravimeter (**39**), magnetic susceptibility (**40**), magnetometer, nuclear activation (**41**), dielectric constant (**42**), radar (**50**), deeply penetrating seismic (**39**), electrical polarizability (**45**), sequential fluid conductivity (**46**), and diameter (**48**). Many of the guidelines described in this guide also apply to the use of these newer techniques that are still in the research phase. Accepted practices should be followed at the present time for these techniques.

5. Significance and Use

5.1 An appropriately developed, documented, and executed guide is essential for the proper collection and application of borehole geophysical logs.

5.1.1 The benefits of its use include improving the following:

5.1.1.1 Selection of logging methods and equipment,

5.1.1.2 Log quality and reliability, and

5.1.1.3 Usefulness of the log data for subsequent display and interpretation.

5.1.2 This guide applies to commonly used logging methods (see Table 1 and Table 2) for geotechnical investigations.

5.1.3 It is essential that personnel (see 7.3.3) consult up-to-date textbooks and reports on each of the logging techniques, applications, and interpretation methods. A partial list of selected publications is given at the end of this guide.

5.1.4 This guide is not meant to describe the specific or standard procedures for running each type of geophysical log and is limited to measurements in a single borehole.

6. Apparatus

6.1 *Geophysical Logging System,* including probes, cable, draw works, depth measurement system, interfaces and surface controls, and digital and analog recording equipment.

6.1.1 Logging probes, also called sondes or tools, enclose the sensors, sources, electronics for transmitting and receiving signals, and power supplies.

[5] The references indicated in these tables should be consulted for detailed information on each of these techniques and applications.

6.1.2 Logging cable routinely carries signals to and from the logging probe and supports the weight of the probe.

6.1.3 The draw works move the logging cable and probe up and down the borehole and provide the connection with the interfaces and surface controls.

6.1.4 The depth measurement system provides probe depth information for the interfaces and surface controls and recording systems.

6.1.5 The surface interfaces and controls provide some or all of the following: electrical connection, signal conditioning, power, and data transmission between the recording system and probe.

6.1.6 The recording system includes the digital recorder and an analog display or hard copy device.

7. Calibration and Standardization of Geophysical Logs

7.1 *General:*

7.1.1 National Institute of Standards and Technology (NIST) calibration and operating procedures do not exist for the borehole geophysical logging industry. However, calibration or standardization physical models are available (see Appendix X1).

7.1.2 Geophysical logs can be used in a qualitative (for example, comparative) or quantitative manner, depending on the project objectives. (For example, a gamma-gamma log can be used to indicate that one rock is more or less dense than another, or it can be expressed in density units.)

7.1.3 The calibration and standardization scope and frequency shall be sufficient for project objectives.

7.1.3.1 Calibration or standardization should be performed each time a logging probe is modified or repaired or at periodic intervals.

7.2 *Calibration:*

7.2.1 Calibration is the process of establishing values for log response. It can be accomplished with a representative physical model or laboratory analysis of representative samples. Calibration data values related to the physical properties (for example, porosity) may be recorded in units (for example, pulses/s or μm/ft) that can be converted to apparent porosity units.

7.2.1.1 At least three, and preferably more, values are needed to establish a calibration curve, and the interface or contact between different values in the model should be recorded. Because of the variability in subsurface conditions, many more values are needed if sample analyses are used for calibration.

7.2.1.2 The statistical scatter in regression of core analysis against geophysical log values may be caused by the difference between the sample size and geophysical volume of investigation and may not represent measurement error.

7.2.2 *Physical Models*—A representative model simulates the chemical and physical composition of the rock and fluids to be measured.

7.2.2.1 Physical models include calibration pits, coils, resistors, rings, temperature baths, etc.

7.2.2.2 The calibration of nuclear probes should be performed in a physical model that is nearly infinite with respect to probe response.

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TABLE 1 Common Geophysical Logs

Type of Log (References)	Varieties and Related Techniques	Properties Measured	Required Hole Conditions	Other Limitations	Typical Measuring Units and Calibration or Standardization	Brief Probe Description
Spontaneous potential (7, 8, 12)	differential	electric potential caused by salinity differences in borehole and interstitial fluids, streaming potentials	uncased hole filled with conductive fluid	salinity difference needed between borehole fluid and interstitial fluids; needs correction for other than NaCl fluids	mV; calibrated power supply	records natural voltages between electrode in well and another at surface
Single-point resistance (7)	conventional, differential	resistance of rock, saturating fluid, and borehole fluid	uncased hole filled with conductive fluid	not quantitative; hole diameter effects are significant	Ω; V-Ω meter	constant current applied across lead electrode in well and another at surface of well
Multi-electrode resistivity (7, 8, 13)	various normal focused, guard, lateral arrays	resistivity and saturating fluids	uncased hole filled with conductive fluid	reverses or provides incorrect values and thickness in thin beds	Ω-m; resistors across electrodes	current and potential electrodes in probe and remote current and potential electrodes
Induction (10, 11)	various coil spacings	conductivity or resistivity of rock and saturating fluids	uncased hole or nonconductive casing; air or fluid filled	not suitable for high resistivities	mS or Ω-m; standard dry air zero check or conductive ring	transmitting coil(s) induce eddy currents in formation; receiving coil(s) measures induced voltage from secondary magnetic field
Gamma (5, 7, 22)	gamma spectral (44)	gamma radiation from natural or artificial radioisotopes	any hole conditions	may be problem with very large hole, or several strings of casing and cement	pulses per second or API units; gamma source	scintillation crystal and photomultiplier tube measure gamma radiation
Gamma-gamma (23, 24)	compensated (dual detector)	electron density	optimum results in uncased hole; can be calibrated for casing	severe hole-diameter effects; difficulty measuring formation density through casing or drill stem	gs/cm³; Al, Mg, or Lucite blocks	scintillation crystal(s) shielded from radioactive source measure Compton scattered gamma
Neutron (7, 14, 25)	epithermal, thermal, compensated sidewall, activation, pulsed	hydrogen content	optimum results in uncased hole; can be calibrated for casing	hole diameter and chemical effects	pulses/s or API units; calibration pit or plastic sleeve	crystal(s) or gas-filled tube(s) shielded from radioactive neutron source
Acoustic velocity (5, 26, 27)	compensated, waveform, cement bond	compressional wave velocity or transit time, or compressional wave amplitude	fluid filled, uncased, except cement bond	does not detect secondary porosity; cement bond and wave form require expert analysis	velocity units, for example, ft/s or m/s or μs/ft; steel pipe	1 or more transmitters and 2 or more receivers
Acoustic televiewer (28, 7)	acoustic caliper	acoustic reflectivity of borehole wall	fluid filled, 3 to 16-in. diameter; problems in deviated holes	heavy mud or mud cake attenuate signal; very slow logging speed	orientated image-magnetometer must be checked	rotating transducer sends and receives high-frequency pulses
Borehole video	axial or side view (radial)	visual image on tape	air or clean water; clean borehole wall	may need special cable	NA[A]	video camera and light source
Caliper (29, 7)	oriented, 4-arm high-resolution, *x-y* or max-min bow spring	borehole or casing diameter	any conditions	deviated holes limit some types; significant resolution difference between tools	distance units, for example, in.; jig with holes or rings	1 to 4 retractable arms contact borehole wall
Temperature (30, 31, 32)	differential	temperature of fluid near sensor	fluid filled	large variation in accuracy and resolution of tools	°C or °F; ice bath or constant temperature bath	thermistor or solid-state sensor
Fluid conductivity (7)	fluid resistivity	most measure resistivity of fluid in hole	fluid filled	accuracy varies, requires temperature correction	μS/cm or Ω-m; conductivity cell	ring electrodes in a tube
Flow (12, 33, 7)	impellers, heat pulse	vertical velocity of fluid column	fluid filled	impellers require higher velocities. Needs to be centralized.	velocity units, for example, ft/min; lab flow column or log in casing	rotating impellers; thermistors detect heated water; other sensors measure tagged fluid.
Deviation (4, 7, 47)	magnetic, gyroscopic, or mechanical	horizontal and vertical displacement of borehole	any conditions (see limitations)	magnetic methods orientation not valid in steel casing	degrees and depth units; orientation and inclination must be checked	various techniques to measure inclination and bearing of borehole

[A] NA = not applicable.

TABLE 2 Log Selection Chart for Geotechnical Applications Using Common Geophysical Logs[A]

	Acoustic		Electric and Induction					Fluid Logs				Radioactive or Nuclear				Other Methods			
Information Desired	Acoustic Tele-viewer	Acoustic Velocity, Δt, CBL, VDL, FWS	Induced Polari-zation	Multi-electrode Resistivity, Normal, Lateral, Micro Guard Resistivity	Single-Point Resis-tance	Sponta-neous Poten-tial	Induc-tion (Conduc-tivity)	Flow Meter	Fluid Resistivity	Fluid Sampler	Temper-ature, Differ-ential Temper-ature	Gamma-Gamma Density	Gamma	Neutron	Spectral Gamma	Borehole Video	Caliper	Casing Collar Locator	Deviation
Lithology and Correlation																			
Bed/aquifer thickness; correlation, structure	●	●		●	●	●	★					Δ	√	Δ	√	◇	√		
Lithology—depositional environment	?	●		●	●	●	★					Δ	√	Δ	√	◇	√		
Shale or clay content			●	●		●	★					Δ	√	Δ	√				
Bulk density												Δ							
Formation resistivity				●			★												
Injection/production profiles				?			?	□	□		□	Δ		Δ					
Permeability estimates		●						□	□		□		√						
Porosity (amount and type)	●	●		●			★					Δ		Δ					
Mineral Identification			●									Δ			√				
Potassium-uranium thorium content (KUT)															√				
Rock Structure																			
Strike and dip of bedding	●															◇			√
Fracture detection (number of fractures), RQD	●	●		●	●											◇	√		
Fracture orientation and character	●															◇			√
Thin bed resolution	●			?	●											◇	√		
Fluid Parameters																			
Borehole fluid characteristics								?	□	□	□								
Fluid flow						●		□	□		□					◇			
Formation water quality				●		●	★			□									
Moisture content—water saturation				?			?					Δ		Δ					
Temperature		?									□								
Water level and water table	●	●		●	●	●	?		□		□	Δ		Δ		◇			
Borehole Parameters																			
Casing evaluation integrity, leaks, damage, screen location	■	■					?	■			■					◆	√	†	
Deviation of borehole																			√
Diameter of borehole	●																√		
Examination behind casing		●					★					Δ		Δ					
Location of debris in wells	●															◆	√	√	
Well completion evaluation, for example, cement bond, seal location, grout location	?	■					★					Δ	√	Δ					

[A] Required hole conditions: ■ = cased fluid-filled hole, ◆ = clear fluid or dry cased hole, □ = screened or open fluid-filled hole, ◇ = clear fluid or dry open hole, † = steel casing only, Δ = active nuclear log to be run in stable holes, ★ = open or nonconductive cased holes, dry or fluid filled, √ = no restrictions, ● = open fluid-filled hole only, and ? = possible applications.

7.2.2.3 Some probes have internal devices such as resistors, but this does not substitute for checking the probe response in an environment that simulates borehole conditions, and the use of such devices is considered standardization.

7.2.2.4 *Calibration Facilities*—Commonly used calibration pits or models for use by anyone at the present time are listed in Appendix X1 (**14-18**). The user should inquire concerning the present validity of any facility.

7.2.3 *Sample Analyses*:

7.2.3.1 Representative samples from boreholes in the project area that have been collected carefully and analyzed quantitatively also may be used to calibrate log response.

7.2.3.2 To reduce depth errors, the sample recovery of rock cores in calibration holes needs to approach 100 % for the intervals used for calibration. Log response should be used to select sample depths to span the range of desired log calibration values and to be within thick units to minimize the effects of potential depth errors. Samples need to be analyzed immediately or steps taken to preserve them for later analysis.

7.2.3.3 Samples to be used for log calibration should be analyzed only from depth intervals at which the log response is relatively uniform for a depth interval considerably greater than the vertical dimension of the volume of investigation of the logging probe. Samples near lithologic contacts or fluid interfaces should not be used because of possible boundary effects or depth errors.

7.3 *Standardization*:

7.3.1 Standardization is the process of checking the log response to reveal evidence of repeatability and consistency.

7.3.2 Standardization is needed to establish comparability between logs made with different equipment or at different times and to ensure the accuracy of measurements.

7.3.2.1 Standardization checks should include at least two different measurement values approximating the range of interest (For example, aluminum and magnesium or plastic blocks are used commonly to check the response of gamma-gamma density logging systems in the field.)

7.3.3 Standardization uses some type of a standard that may be used in the field or laboratory and repeat logs.

7.3.3.1 Log response needs to be checked using field standards often enough to satisfy the project objectives. Standardization of the log response provides the basis for correcting for changes (for example, changes in output with time due to system drift or changes of equipment).

7.3.3.2 Selected log intervals should be repeated (that is, re-logged). Repeat logs provide information on the stability of logging equipment.

7.3.3.3 A representative borehole may be used to check log response periodically. This borehole environment and the rocks and fluids penetrated may change with time.

8. Procedure

8.1 *Planning the Logging Program*:

8.1.1 A work plan should be developed prior to implementing the logging program.

8.1.2 The key steps in developing a logging work plan should include the following:

8.1.2.1 *Log Selection*—See Table 1 and Table 2.

8.1.2.2 *Personnel Selection*—See 8.3.2.

8.1.2.3 *Quality Control and Documentation*—See 8.4.

8.1.2.4 *Calibration and Standardization Procedures*—See Section 7.

8.1.2.5 *Equipment Liability*—See 1.7.

8.1.2.6 *Equipment Decontamination*—In environmental investigations, equipment decontamination may be required before, after, and between individual wells. Equipment decontamination may involve a number of standardized procedures, depending on the nature of the project (see Practices D 5088 and D 5608). A decontamination program should be agreed upon by all parties before logging commences, and procedures specified by the work plan should be followed.[6]

8.1.2.7 *Log Interpretation*—See 8.5.

8.2 *Field Assessment of Borehole Conditions*:

8.2.1 Borehole conditions can have a profound influence on the quality of log data and subsequent interpretation. Important parameters to consider include the following:

8.2.1.1 Drilling method, casing, drill hole history, and well completion materials.

8.2.1.2 *Borehole Fluid Properties*—Resistivity, temperature, density, viscosity, and chemistry at the time of logging.

8.2.1.3 Borehole diameter, rugosity, and stability.

8.2.1.4 Deviation of borehole.

8.2.1.5 Wellhead pressure.

8.2.2 *Logging Operations*:

8.2.2.1 Determine the sequence and direction of logging. The sequence in which a suite of logs is run is important from both a data quality and operational viewpoint. Because logging operations mix the borehole fluid, logs of fluid properties (for example, temperature, fluid resistivity, and fluid sampling should be run prior to other logs). Consideration should also be given to when borehole video surveys are performed because some logging tools may degrade borehole clarity. Tools that have arms or bowsprings that contact the borehole wall should be run late in the logging sequence because of the greater possibility of material from the borehole wall falling into the borehole. Because of the consequences of losing a tool with a radioactive source, these tools should be run last, and after a caliper log. Unstable boreholes should not be logged with radioactive source probes. All logs except fluid properties and video should be run with the probe moving up the borehole to reduce depth errors.

8.2.2.2 Select the depth reference. The selected depth reference needs to be stable and accessible.

8.2.2.3 Select horizontal and vertical scales.

8.2.2.4 Select the digitizing interval. See 8.3.1.2.

8.3 *Other Considerations*:

8.3.1 *Data Formats*—There are two methods of recording log data, digital and analog. Digital recording of logs should be used because of the numerous benefits of data manipulation. Digital recording is not yet practical for some logs such as video or acoustic televiewer.

8.3.1.1 An analog display should be available to be viewed in the field to verify the correct tool operation. Depth scales and units of measurement for the horizontal scale must be indicated clearly on each log.

8.3.1.2 The digital data are recorded at an operator-selected depth interval that should be as small as possible, at most, half the thickness of the smallest rock unit that can be resolved. The time interval for digital samples can also be selected by the operator. ASCII is the recommended format except for such logs as spectral gamma, full waveform sonic, borehole video, and acoustic televiewer. The digital file header should include all of the necessary information to reconstruct the logging

[6] Equipment decontamination procedures may have specific safety and equipment limitations that must be addressed prior to their use.

procedures accurately and should duplicate the information included in the written header of the log.

8.3.1.3 Unprocessed data should be available. Nonproprietary processing algorithms shall be furnished if processed data is provided.

8.3.2 *Personnel*:

8.3.2.1 Personnel not having specialized training or experience should be cautious about using borehole geophysics and should solicit assistance from qualified practitioners or attend courses on borehole geophysics.

8.3.2.2 Personnel operating logging equipment should have an understanding of the theory, field procedures, and methods of log interpretation.

8.3.2.3 A geoscientist, with experience in borehole geophysics, who understands the project objectives and local geohydrology may need to be available to examine logging results during logging operations when consistent with objectives of the program. This geoscientist is responsible for determining whether the instructions selected in the prelogging conference are being followed and whether changes should be made.

8.3.2.4 Log interpretation should be performed by a geoscientist with experience in borehole geophysics and knowledge of the site geology and hydrology.

8.4 *Field Documentation*—A documentation plan for both the analog plot and digital data file should be established and become part of the work plan. Documentation of the following procedures is needed: calibration of logging probes, field operation of geophysical logging equipment, applicable decontamination, and format for presenting geophysical well log data. Repair, standardization, and calibration information should also be documented. Probes should be numbered to simplify the identification of associated documentation. Document all field problems including equipment malfunctions. This should include the steps taken to solve the problem and how the logs might have been affected. Repeat runs and field standardization should be more frequent when equipment problems occur. The use of one borehole on the project to check the probe response may aid in the identification of equipment or other problems. Probes should be recalibrated in a physical model after major repairs have been made.

8.4.1 *Log Headings (Headers)*—The log heading should contain all of the information that is necessary to analyze the log trace. Because auxiliary documents are frequently unavailable to other users of the log, all of the critical information concerning the log should be included on the final log heading. The header information should also be included in the same computer file as the log data. The following items listed are necessary and should be included on the log headings and computer files when appropriate. If information is not available or applicable, it should be noted on the heading. The following information should be included:

8.4.1.1 *Background Well Information*:

Owner of well and address, location of well (UTM coordinates, ¼ section, etc.); date; logging contractor and address; logging operator; drilling contractor and address; client and address; observer and address; elevation of top casing and distance above ground; and drilling history, methods etc.

8.4.1.2 *Borehole Conditions*:

Casing description; description of log depth datum; elevation of log depth datum; type of drilling fluid; resistivity and temperature of borehole fluid; depth of origin of borehole fluid samples; fluid level; time since last mud circulation; bottom hole temperature; and problems and unusual conditions.

8.4.1.3 *Equipment Data and Logging Parameters*:

Description of probe reference point; model and manufacturer of logging tools; logging company tool number; date and type of last calibration; date, type, and response of field standardization; top and bottom of logged interval; logging speed and direction; vertical depth error after logging; time constant or the time interval of digital samples; identification of disk containing digitized logs; and equipment problems.

8.4.1.4 *Specific Information for Nuclear Logging Probes*:

Source description, initial source strength, and date determined; source to detector or receiver spacing; detector description; and data filtering or enhancement parameters.

8.4.1.5 *Specific Information for Acoustic and Electric Logging Probes*:

source or transmitter description and signal output; source or transmitter to detector or receiver spacing; detector or receiver description; and data filtering or enhancement parameters.

8.4.2 *Quality Control During Logging Operations*:

request changes in logging speed and time constant; repeat logs or log intervals based on field log analysis; check depth readout against log; note errors or changes on the log; and verify documentation listed above.

8.5 *Log Interpretation*—The full potential of a logging program cannot be realized until the logging measurements are interpreted. Log interpretation should start at the time of data acquisition and should continue as an iterative process throughout the project.

8.5.1 Logs should be analyzed and described as a suite and combined with information on lithology and fluid quality because of the synergistic nature of log data. The nonunique response of logs dictates the use of data from other sources to check the log interpretation, and this background data must be included in the report. A computer will be used in most cases to aid analysis of the logs, and information on the software and algorithms used should be included in the report.

8.5.2 Important interpretation steps include the following:

8.5.2.1 Establishing database (for example, format conversion, depth corrections, editing, and filtering).

8.5.2.2 Applying borehole corrections (for example, correct electric logs for borehole diameter and fluid resistivity).

8.5.2.3 Performing initial data inversion-conversion log units to values appropriate for investigation (for example, density units to porosity).

8.5.2.4 Performing large-scale data inversion (for example, cross sections, regional correlation, and model parameters).

9. Report

9.1 Depending on the project objective, report only data or data and interpretations.

9.1.1 Both types of reports should include the following:

9.1.1.1 Objectives and scope.

9.1.1.2 Field Documentation (for example, site conditions, borehole conditions, data collection procedures, calibration and standardization of logging probes, field operation of geophysical logging equipment, and format for recording geophysical log data, including any filtering or processing of the data, problems, and unusual conditions; see 8.4).

9.1.1.3 Both the digital log data and log plots.

9.1.1.4 Abstract, executive summary, or conclusions.

9.1.2 Interpretation reports should include the following:

9.1.2.1 Log composites (for example, summary plots showing logs, lithology, well construction, and water quality zones). These composites are commonly annotated to indicate the features of interest and correlated with lithologic descriptions.

9.1.2.2 Brief description of the geologic and hydrologic setting.

9.1.2.3 Specific information on log analysis, that is, depth corrections and recalibration of logs, physical models or sample analyses that were used for calibration, methods of log interpretation, software used, and copies of cross-plots or other plots of data resulting from log analysis.

9.1.2.4 Well-to-well correlation sections and comparison to surface geophysical and other testing data, when available.

10. Keywords

10.1 acoustic logging; acoustic televiewer; borehole geophysics; borehole video; caliper logging; chemical properties and physical properties; deviation; electric logging; environmental; fluid conductivity/resistivity logging; fluid logging; gamma logging; gamma-gamma logging; geology; geophysics; geotechnical; ground water; hydrology; induction logging; log calibration and standardization; log headings; neutron logging; nuclear logging; resistivity logging; singlepoint resistance logging; spontaneous potential logging; temperature logging; well logging

APPENDIX

(Nonmandatory Information)

X1. CALIBRATION FACILITIES AVAILABLE FOR PUBLIC USE (1989)

X1.1 *Name and Location*—American Petroleum Institute Calibration Facility, University of Houston, Houston, TX: four pits (**14, 19, 20**).

X1.2 *Who to Contact:* University of Houston, Cullen College of Engineering, (713) 749-3423.

X1.3 *Probes That Can Be Calibrated*—Pit 1: neutron and gamma-gamma; Pit 2: gamma (simulated shale); Pits 3 and 4: spectral gamma.

X1.3.1 *Name and Location*—U.S. Department of Energy, Grand Junction, CO: 20 models or pits (**18**).

X1.3.2 *Who to Contact*—U.S. Department of Energy, Grand Junction Operations Office, or the prime contractor at the U.S. Department of Energy office, (303) 248-7768 or 6702.

X1.4 *Probes That Can Be Calibrated*—Gamma, gamma spectral, neutron, gamma-gamma, and magnetic susceptibility. Also, wet and dry borehole size factors and a 300-ft borehole with radium foil at known depths for check of depth measurements.

X1.4.1 *Name and Location*—U.S. Bureau of Mines density pits Pit 1: six holes and magnetic susceptibility (Pits 2). Denver Federal Center, Lakewood, CO: Pit six holes; Pit 2: three holes (**17**).

X1.4.2 *Who to Contact*—U.S. Geological Survey, Water Resources Division, Borehole Geophysics Project, Building 25, Denver Federal Center, (303) 236-5913.

X1.5 *Probes That Can Be Calibrated*—Pit 1: gamma-gamma, acoustic, resistivity; and Pit 2: magnetic susceptibility.

X1.5.1 *Name and Location*—U.S. Department of Energy, Fractured igneous rock calibration models, Denver Federal Center, Lakewood, CO: Three models or pits (**16**).

X1.5.2 *Who to Contact*—U.S. Geological Survey, Water Resources Division, Borehole Geophysics Project, Building 25, Denver Federal Center, (303) 236-5913.

X1.6 *Probes That Can Be Calibrated*—Fracture detection probes, neutron, gamma-gamma, short-spaced resistivity, and acoustic velocity.

X1.7 *Other Facilities*—The Geological Survey of Canada is developing a system of deep test holes and calibration facilities that are presently available at several locations in Canada. Gamma, gamma spectral, and coal property models are completed, and other physical property models are under construction (**15**). Calibration facilities at universities, private logging companies, and government agencies may also be available at other locations for use by outside logging groups.

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Designation: D 6167 – 97 (Reapproved 2004)

Standard Guide for Conducting Borehole Geophysical Logging: Mechanical Caliper[1]

This standard is issued under the fixed designation D 6167; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This guide covers the general procedures necessary to conduct caliper logging of boreholes, wells, access tubes, caissons, or shafts (hereafter referred as boreholes) as commonly applied to geologic, engineering, ground-water, and environmental (hereafter referred as geotechnical) investigations. Caliper logging for mineral or petroleum exploration and development are excluded.

1.2 This guide defines a caliper log as a record of borehole diameter with depth.

1.2.1 Caliper logs are essential in the interpretation of geophysical logs since they can be significantly affected by borehole diameter.

1.2.2 Caliper logs are commonly used to measure borehole diameter, shape, roughness, and stability; calculate borehole volume; provide information on borehole construction; and delineate lithologic contacts, fractures, and solution cavities and other openings.

1.3 This guide is restricted to mechanically based devices with spring-loaded arms, which are the most common calipers used in caliper logging with geotechnical applications.

1.4 This guide provides an overview of caliper logging, including general procedures, specific documentation, calibration and standardization, and log quality and interpretation.

1.5 To obtain additional information on caliper logs see Section 9 of this guide.

1.6 This guide is to be used in conjunction with Guide D 5753.

1.7 This guide should not be used as a sole criterion for caliper logging and does not replace professional judgement. Caliper logging procedures should be adapted to meet the needs of a range of applications and stated in general terms so that flexibility or innovation is not suppressed.

1.8 The geotechnical industry uses English or SI units. The caliper log is typically recorded in units of inches, millimetres, or centimetres.

1.9 *This guide does not purport to address all of the safety and liability problems (for example, lost or lodged probes and equipment decontamination) associated with its use.*

1.10 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:* [2]

D 653 Terminology Relating to Soil, Rock and Contained Fluids

D 5088 Practice for Decontamination of Field Equipment Used at Nonradioactive Waste Sites

D 5608 Practice for Decontamination of Field Equipment Used at Low Level Radioactive Waste Sites

D 5753 Guide for Planning and Conducting Borehole Geophysical Logging

3. Terminology

3.1 *Definitions:* Definitions shall be in accordance with Terminology D 653, Section 12, Ref (1),[3] or as defined below:

3.1.1 *accuracy, n*—how close a measured log values approaches true value. It is determined in a controlled environment. A controlled environment represents a homogeneous sample volume with known properties.

3.1.2 *depth of investigation, n*—the radial distance from the measurement point to a point where the predominant measured response may be considered centered, that is not to be confused with borehole depth (for example, distance) measured from the surface.

3.1.3 *measurement resolution, n*—the minimum change in measured value that can be detected.

[1] This guide is under the jurisdiction of ASTM Committee D18 on Soil and Rock and is the direct responsibility of Subcommittee D18.01 on Surface and Subsurface Characterization.

Current edition approved July 1, 2004. Published August 2004. Originally approved in 1997. Last previous edition approved in 1997 as D 6167 - 97ε1.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] The boldface numbers given in parentheses refer to a list of references at the end of the text.

3.1.4 *repeatability, n*—the difference in magnitude of two measurements with the same equipment and in the same environment.

3.1.5 *vertical resolution, n*—the minimum thickness that can be separated into distinct units.

3.1.6 *volume of investigation, n*—the volume that contributes 90 % of the measured response. It is determined by a combination of theoretical and empirical modeling. The volume of investigation is non-spherical and has gradational boundaries.

4. Summary of Guide

4.1 This guide applies to borehole caliper logging and is to be used in conjunction with Guide D 5753.

4.2 This guide briefly describes the significance and use, apparatus, calibration and standardization, procedures, and reports for conducting borehole caliper logging.

5. Significance and Use

5.1 An appropriately developed, documented, and executed guide is essential for the proper collection and application of caliper logs. This guide is to be used in conjunction with Guide D 5753.

5.2 The benefits of its use include the following: improving selection of caliper logging methods and equipment, caliper log quality and reliability, and usefulness of the caliper log data for subsequent display and interpretation.

5.3 This guide applies to commonly used caliper logging methods for geotechnical applications.

5.4 It is essential that personnel (see the Personnel section of Guide D 5753) consult up-to-date textbooks and reports on the caliper technique, application, and interpretation methods.

6. Interferences

6.1 Most extraneous effects on caliper logs are caused by instrument problems and borehole conditions.

6.2 Instrument problems include the following: electrical leakage of cable and grounding problems, temperature drift, wear of mechanical components including the hinge pins and in the linear potentiometer (mechanical hysteresis), damaged or bent arms, and lack of lubrication of the mechanical components.

6.3 Borehole conditions include heavy drilling mud, borehole deviation, and drilling-related borehole irregularities.

7. Apparatus

7.1 A geophysical logging system has been described in the general guide (see the Apparatus section of Guide D 5753).

7.2 Caliper logs may be obtained with probes having a single arm, three arms (averaging or summation), multiple independent arms (x-y caliper), multiple-feeler arms, bow springs, or gap wheels. Single-arm and three-arm averaging probes are most commonly used for geotechnical investigations.

7.2.1 A single-arm caliper commonly provides a record of borehole diameter while being used to decentralize another type of log, such as a side-collimated gamma-gamma probe (see Fig. 1). The caliper arm generally follows the high side of a deviated hole. The single-arm decentralizing caliper may not have the resolution needed for some applications.

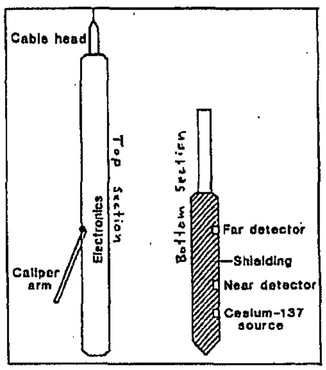


FIG. 1 Probe for Making Side-Collimated Gamma-Gamma Logs with Single-Arm Caliper (2)

7.2.2 The three-arm averaging or summation caliper has arms of equal length oriented 120° apart (see Fig. 2). All arms move together, which provides an average diameter measurement. This caliper provides higher resolution than the single-arm caliper measurement (see Fig. 3).

7.2.3 Multiple independent arm calipers generally have three or four independent arms of equal length; these arms are sometimes oriented. Horizontal resolution, that provides accurate borehole-diameter measurement regardless of borehole shape, is related to the number of independent arms. In general, calipers with four or more independent arms will have higher resolution than three-arm averaging (see Fig. 3). The four independent-arm caliper log may show borehole elongation (elliptical borehole shape) and better indicates the actual irregularity of the borehole.

7.3 Caliper probes using arms are typically spring loaded. The arms are retracted and opened with an electric motor and

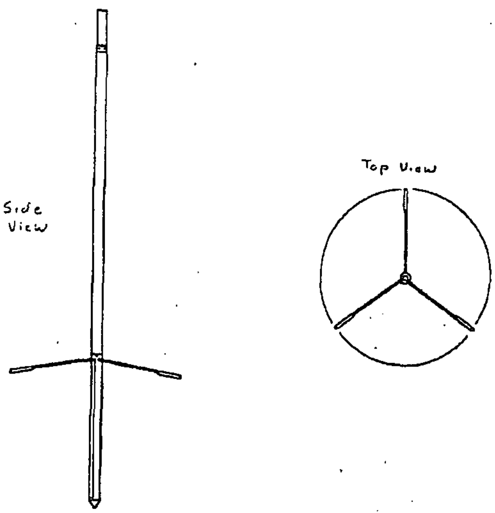


FIG. 2 Three-Arm Averaging Caliper

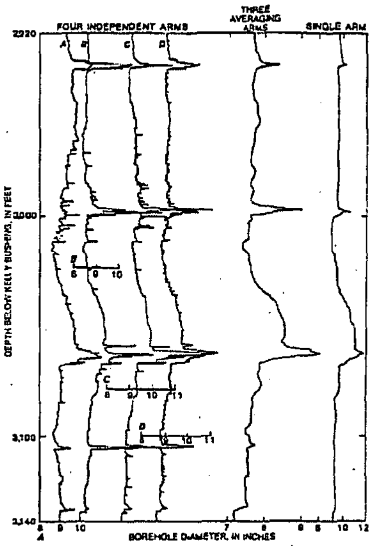


FIG. 3 Caliper Logs From Probes Having Four Independent Arms, Three Averaging Arms, and a Single Arm, Madison Limestone Test Well 1, Wyoming (2)

retention spring. The arms and gears are lubricated. Caliper probes closed by hand are held closed with an electric solenoid or weighted retention ring that is released with a sudden drop. Typically, the caliper arms are mechanically connected to a linear or rotary potentiometer such that changes in the angle of the arms causes changes in resistance. These changes in resistance are proportional to average borehole diameter. In some probes, the voltage changes are converted to a varying pulse rate or digitized downhole to eliminate or minimize cable transmission noise. Different arm length can be used to optimize sensitivity for the borehole-diameter range expected.

7.4 The concepts of volume of investigation and depth of investigation are not applicable to caliper logs since it is a surface-contact measurement.

7.5 Vertical resolution of caliper measurements is a function of the size of the contact surface (arm tip or pad), the response of the mechanical and electronic components, and digitizing interval used. The theoretical limit of vertical resolution is equal to the width of the caliper pad or tip. Selection of arm lengths and angle, and tip diameter will affect sensitivity. Shorter arms generally will provide more detail of the rugosity (borehole roughness as defined by Ref. (2)) of the borehole wall than longer arms. However, size of caliper probe and borehole diameter may also determine arm lengths used.

7.6 Measurement resolution of typical caliper probes is 0.05 in. (0.13 cm) of borehole diameter.

7.7 A variety of caliper logging equipment is available for geotechnical investigations. It is not practical to list all of the sources of potentially acceptable equipment.

8. Calibration and Standardization of Caliper Logs

8.1 *General:*

8.1.1 National Institute of Standards and Technology (NIST) calibration and standardization procedures do not exist for caliper logging.

8.1.2 Caliper logs can be used in a qualitative (for example, comparative) or quantitative (for example, borehole diameter corrections) manner depending upon the project objectives.

8.1.3 Caliper calibration methods and frequency shall be sufficient to meet project objectives.

8.1.3.1 Calibration and standardization should be performed each time a caliper probe is suspected to be damaged, modified, repaired, and at periodic intervals.

8.2 Calibration is the process of establishing values for caliper response and is accomplished with a physical model of a known diameter. Calibration data values related to the physical properties (for example, borehole diameter, roughness) may be recorded in units (for example, counts per second), that can be converted to units of length (for example, inches, millimetres, or centimetres.)

8.2.1 At least two, and preferably more, values, which approximate the anticipated operating range, are needed to establish a calibration curve (for example, 4- and 10-in. (10.2- and 25.4-cm) rings) if the borehole diameter to be logged is 5 in. (12.7 cm)).

8.2.2 Physical models of measured diameter that may be used to calibrate the caliper response may include rings or bars made of rigid materials that are not easily deformed and resist wear.

8.2.2.1 Calibration of caliper probes is done most accurately in rings of different diameters.

8.2.2.2 A calibration bar is a plate that is drilled and marked at regular intervals and machined to fit over the body of the probe (see Fig. 4). One arm is placed in the appropriate hole for the range to be logged.

8.2.2.3 Calibration can be checked by using casing of measured diameter logged in the borehole.

8.3 Standardization is the process of checking logging response to show evidence of repeatability and consistency.

8.3.1 Calibration serves as a check of standardization.

8.3.2 A representative borehole may be used to periodically check caliper response providing the borehole environment does not change with time. Caliper response may not repeat exactly because the probe may rotate, causing the arms to follow slightly different paths within the borehole.

9. Procedure

9.1 See the Procedure section of Guide D 5753 for planning a logging program, data formats, personnel qualifications, field documentation, and header documentation.

9.2 Caliper specific information (for example, arm length) should be documented.

9.3 Identify caliper logging objectives.

9.4 Select appropriate equipment to meet objectives.

9.4.1 Caliper equipment decontamination is addressed according to project specifications (see Practice D 5088 for non-radioactive waste sites and Practice D 5608 for low level radioactive waste sites). Some materials commonly used for caliper-arm lubrication may be environmentally sensitive.

9.5 Select the order in the logging sequence in which the caliper probe is to be run (see 8.2.2.1 of Guide D 5753).

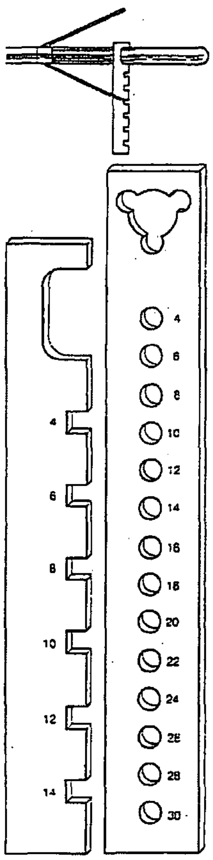


FIG. 4 Calibration Bars for Caliper Probes (3)

9.5.1 Caliper probes are run before any probe utilizing nuclear sources and more expensive centralized probes.

9.5.2 Caliper probes are run after any television camera and fluid property probes are run.

9.6 Caliper operation and calibration are checked at the start of each borehole or at an interval consistent with project objectives. (see the Procedure section of Guide D 5753). After calibration, the caliper arms are closed before lowering.

9.7 Select and document the depth reference.

9.7.1 The selected depth reference needs to be stable and accessible (for example, top of borehole casing).

9.8 Determine and document probe zero reference point (for example, top of probe or cablehead) and depth offset to caliper measurement point.

9.8.1 The measurement point of a caliper is the end of caliper arms and it changes as the arms open and close with the sine of arm angle multiplied by length of arm. Typically, the measurement point varies less than a few tenths of a foot (a few centimetres).

9.8.2 The measurement point will change if the arm length is changed.

9.9 Select horizontal and vertical scales for log display.

9.10 Select digitizing interval (or sample rate if applicable) to meet project objectives (see 8.3.1.2 of Guide D 5753).

9.10.1 Maximum vertical resolution requires the selection of a digitizing interval at least as small as the arm tip contact height.

9.10.2 Typically, this interval is no larger than 0.1 ft (0.03 m) for high-resolution applications.

9.11 The caliper probe is lowered to the bottom of the borehole.

9.11.1 Any time the caliper probe is lowered in the borehole, the arms should be closed to avoid damaging equipment or borehole.

9.11.2 Selection of probe speed while lowering is based on knowledge of borehole depth, stability, and other conditions.

9.12 Open caliper arm(s).

9.13 Select logging speed.

9.13.1 A logging speed of approximately 15 ft (5 m) per min is recommended for high-resolution applications. Faster logging speeds may induce noise due to the caliper probe bumping the borehole wall. Slower logging speeds will not enhance measurement resolution for most systems.

9.14 Collect caliper data while the probe is moving up the borehole.

9.15 When the probe reaches the top of the borehole:

9.15.1 If surface casing is present, compare and document caliper measurement.

9.15.2 Check depth reference and document after survey depth error (ASDE).

9.15.3 Determine if ASDE meets project objectives.

9.15.4 Typical tolerance for ASDE is ±0.4 ft per 100-ft (0.4 m per 100-m) interval logged.

9.16 Selected borehole intervals should be repeated (that is, relogged) under similar logging parameters as the initial log. Repeat logs provide information on the stability of the caliper equipment. The interval repeated should have enough variability, if possible, to check repeatability and resolution.

9.16.1 Repeat logs should be compared with the original log to ensure correct operation of the probe prior to ending a logging event.

9.16.2 Repeat sections may not repeat exactly due to a different orientation of the logging probe on the repeat run or changes in the borehole between logging runs (see Section 6).

9.16.3 Close caliper arms prior to lowering the probe down the borehole for a repeat section.

9.17 Evaluate the field log quality and compare log with drilling and completion information.

9.17.1 A reduction in borehole diameter over large depth sections may be indicative of borehole deviation on three-arm averaging caliper logs.

9.17.1.1 The magnitude of borehole deviation that causes this effect depends upon the length of the caliper arms being used and the strength of the tensioning spring within the caliper. Typically, a borehole deviation of greater than 15° is likely to produce this effect.

9.17.1.2 Converting the three-arm averaging caliper by removing two of the caliper arms may allow a good log to be obtained in these types of boreholes.

9.17.2 Mud can prevent caliper arms from opening fully, and thick mud cake may prevent accurate measurement of drilled diameter. Lack of caliper arm movement, especially in the bottom of a mud drilled borehole, may be indicative of arm sticking due to heavy mud.

9.17.2.1 If mud interferences are suspected, the borehole may be reconditioned, the caliper probe cleaned and lubricated, and the caliper log repeated.

9.18 Post-acquisition calibration checks may be required (surface casing or calibration standard) to meet the objectives of the logging program. Typical tolerances between pre- and post-calibration are ±0.2 in. (0.5 cm).

10. Interpretation of Results

10.1 See the Log Interpretation section of Guide D 5753 for procedures on log interpretation.

10.2 A valid caliper log is essential in the interpretation of the logs that are affected by changes in borehole diameter, including those logs that are labeled 'borehole compensated.' It is not always possible to compensate logs for substantial differences in borehole diameter.

10.2.1 Caliper logs can be analyzed individually (that is, borehole volume).

10.2.2 Caliper logs can be analyzed as part of a suite to take advantage of the synergistic nature of log data.

10.3 The caliper log should be depth correlated with the other geophysical logs as the first step to interpretation. This is especially important for logs that use the caliper data for borehole correction and depth adjustment.

10.4 Other pertinent information, including borehole construction (casing size), drilling history (hole size, drill method, penetration rate, core loss, fluid loss, etc.), and geologic information, should be integrated with the caliper-log data.

10.5 Interpretations based on changes in borehole diameter may be related to changes in drilling, mud cake, mud rings, borehole construction, lithology and structure, fractures and solution openings, and stress-induced breakouts.

10.6 The measured borehole diameter may be significantly different than the drilled diameter because of plastic formations extruded into the borehole and friable formations enlarging the borehole. A series of caliper logs may also show increases or decreases in borehole diameter with time.

10.6.1 Caliper logs are useful for determining what other logs can be made and what range of borehole diameters will be accepted by centralizers or decentralizers.

10.7 Fractures and solution openings may be obvious on a caliper log; however, their character may not be uniquely defined.

10.7.1 The single-arm caliper log may completely miss a feature or indicate only a small anomaly.

10.7.2 The three-arm averaging caliper log of a fracture dipping at an angle such that the three arms enter the opening at different depths will indicate three separate anomalies rather than one.

10.8 Borehole-diameter information is essential for calculation of volumetric rate from flowmeter logs.

10.9 Caliper logs provide useful information for borehole completion and testing.

10.9.1 Caliper logs are used to locate the optimum placement of inflatable packers for borehole testing. Inflatable packers can only form an effective seal within a specified range of borehole diameters, and can be damaged if they are set in rough or irregular parts of the borehole.

10.9.2 Caliper logs are used to estimate the volume of borehole completion material (cement, gravel, etc.) needed to fill the annular space between borehole and casing(s) or well screen.

10.10 Caliper logs may be applied to correlate lithology between boreholes based upon enlargements related to lithology.

11. Report

11.1 Consult the Report section, Guide D 5753 for requirements of the report.

11.2 Reports presenting caliper logs shall describe the components of the caliper logging system, the principles of the methods used, and their limits, methods and results of calibration and standardization, and performance verification (for example, diameter of surface casing, correlation with other logs, repeat sections, ASDE, etc.).

11.3 Information on the software and algorithms used should be included in the report.

11.4 Any deviations from this guide should be justified with documentation.

11.5 Presentation of caliper logs should be designed to meet project objectives. At a minimum, depth (y-axis) and units of measurement (x-axis) scales should be clearly marked (see Fig. 3). There may be a difference between presentations of data collected in the field versus in final report. Any scale "wraps" should be clearly marked.

11.5.1 Caliper logs are typically displayed with linear scales in inches, millimetres, or centimetres.

12. Keywords

12.1 borehole correction; borehole diameter; borehole geophysics; borehole volume; caliper log; ground water; single-arm caliper; three-arm caliper; well construction; well logging

REFERENCES

(1) *Glossary of Terms and Expressions Used in Well Logging*, 2nd Ed., Society of Professional Well Log Analysts, Houston, TX, 1984.
(2) Keys, W. S., *Borehole Geophysics Applied To Ground-Water Investigations, Techniques of Water-Resources Investigations of the United States Geological Survey, Book 2*, Chapter E2, 1990.
(3) Hodges, R. E., Calibration and Standardization of Geophysical Well-Logging Equipment for Hydrologic Applications, *U.S. Geological Survey Water Resources Investigations Report 88-4058*, 1988.

Designation: D 6274 – 98 (Reapproved 2004)

Standard Guide for Conducting Borehole Geophysical Logging - Gamma[1]

This standard is issued under the fixed designation D 6274; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This guide covers the general procedures necessary to conduct gamma, natural gamma, total count gamma, or gamma ray (hereafter referred to as gamma) logging of boreholes, wells, access tubes, caissons, or shafts (hereafter referred to as boreholes) as commonly applied to geologic, engineering, ground-water, and environmental (hereafter referred to as geotechnical) investigations. Spectral gamma and logging where gamma measurements are made in conjunction with a nuclear source are excluded (for example, neutron activation and gamma-gamma density logs). Gamma logging for minerals or petroleum applications are excluded.

1.2 This guide defines a gamma log as a record of gamma activity of the formation adjacent to a borehole with depth (See Fig. 1).

1.2.1 Gamma logs are commonly used to delineate lithology, correlate measurements made on different logging runs, and define stratigraphic correlation between boreholes (See Fig. 2).

1.3 This guide is restricted to gamma logging with nuclear counters consisting of scintillation detectors (crystals coupled with photomultiplier tubes), which are the most common gamma measurement devices used in geotechnical applications.

1.4 This guide provides an overview of gamma logging including general procedures, specific documentation, calibration and standardization, and log quality and interpretation.

1.5 To obtain additional information on gamma logs, see Section 13.

1.6 This guide is to be used in conjunction with Guide D 5753.

1.7 Gamma logs should be collected by an operator that is trained in geophysical logging procedures. Gamma logs should be interpreted by a professional experienced in log analysis.

1.8 The geotechnical industry uses English or SI units. The gamma log is typically recorded in units of counts per second (cps) or American Petroleum Institute (API) units.

1.9 *This guide does not purport to address all of the safety and liability problems (for example, lost or lodged probes and equipment decontamination) associated with its use.*

1.10 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

1.11 *This guide offers an organized collection of information or a series of options and does not recommend a specific course of action. This document cannot replace education or experience and should be used in conjunction with professional judgment. Not all aspects of this guide may be applicable in all circumstances. This ASTM standard is not intended to represent or replace the standard of care by which the adequacy of a given professional service must be judged, nor should this document be applied without consideration of a project's many unique aspects. The word "Standard" in the title of this document means only that the document has been approved through the ASTM consensus process.*

2. Referenced Documents

2.1 *ASTM Standards:* [2]

D 653 Terminology Relating to Soil, Rock and Contained Fluids

D 5088 Practice for Decontamination of Field Equipment Used at Nonradioactive Waste Sites

D 5608 Practice for Decontamination of Field Equipment Used at Low Level Radioactive Waste Sites

D 5753 Guide for Planning and Conducting Borehole Geophysical Logging

D 6167 Guide for Conducting Borehole Geophysical Logging: Mechanical Caliper

3. Terminology

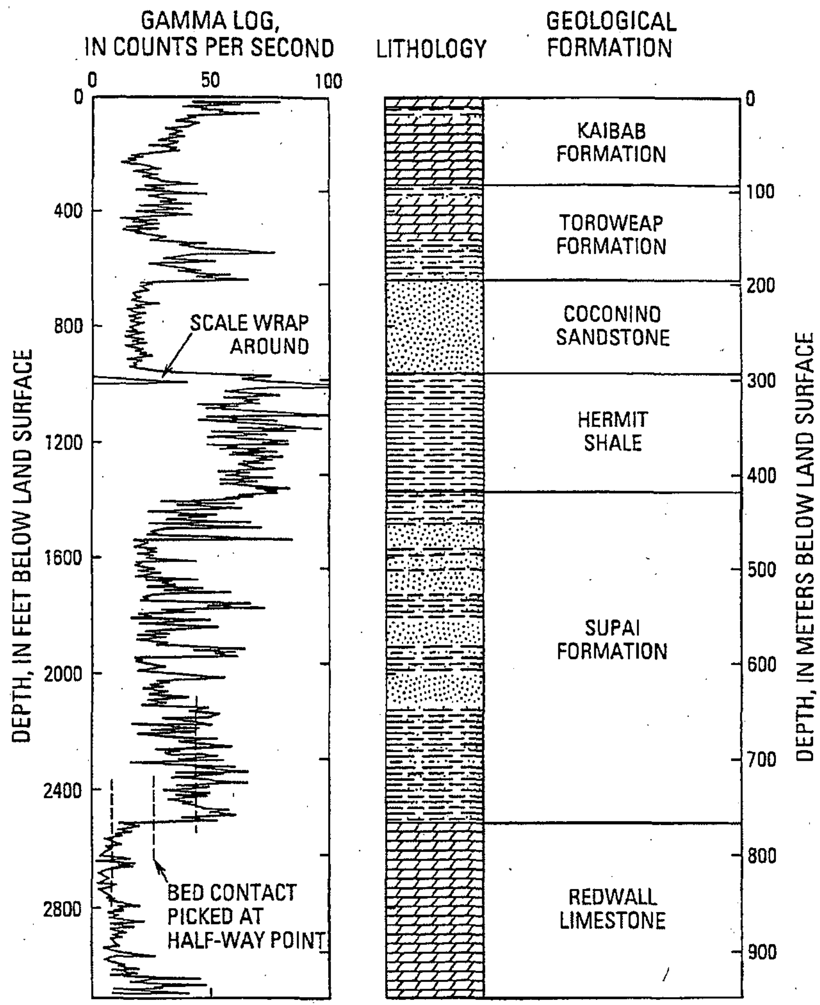
3.1 *Definitions:*

3.1.1 Definitions shall be in accordance with Terminology D 653, Section 13, Ref (1), or as defined below.

[1] This guide is under the jurisdiction of ASTM Committee D18 on Soil and Rock and is the direct responsibility of Subcommittee D18.01 on Surface and Subsurface Characterization.

Current edition approved July 1, 2004. Published August 2004. Originally approved in 1998. Last previous edition approved in 1998 as D 6274 - 98.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.



NOTE 1—This figure demonstrates how the log can be used to identify specific formations, illustrating scale wrap-around for a local gamma peak, and showing how the contact between two formations is picked to coincide with the half-way point of the transition between the gamma activities of the two formations.

FIG. 1 Example of a Gamma Log From Near the South Rim of the Grand Canyon

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *accuracy, n*—how close measured log values approach true value. It is determined in a controlled environment. A controlled environment represents a homogeneous sample volume with known properties.

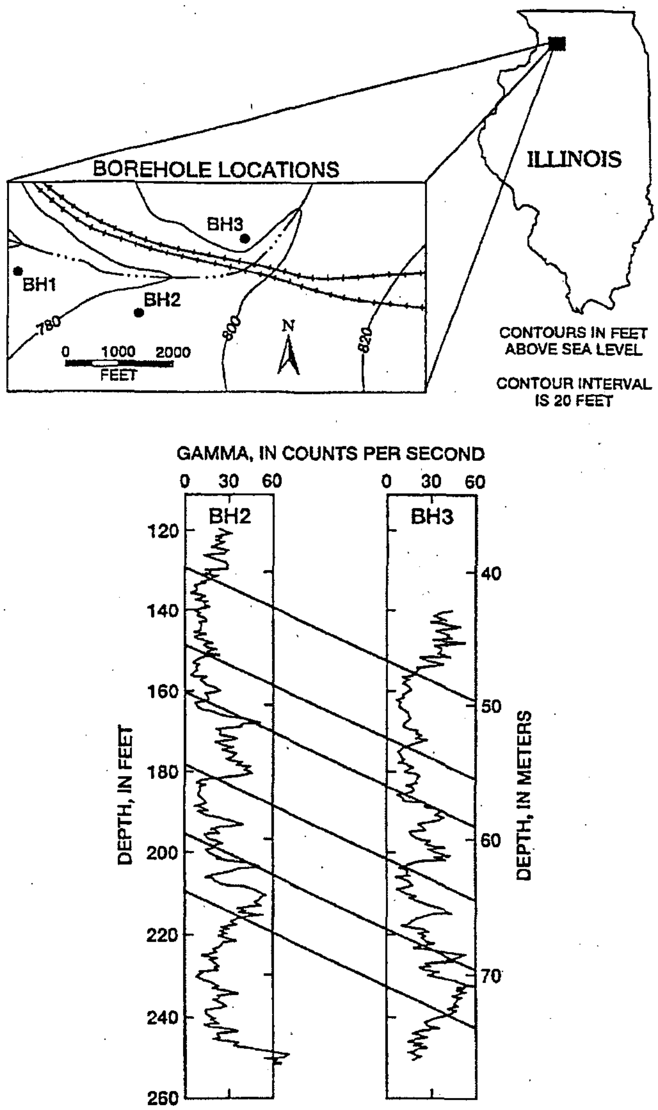
3.2.2 *dead time, n*—the time after each pulse when a second pulse cannot be detected.

3.2.3 *dead time effect, n*—the inability to distinguish closely-spaced nuclear counts leads to a significant underestimation of gamma activity in high radiation environments and is known as the "dead time effect".

3.2.4 *depth of investigation, n*—the radial distance from the measurement point to a point where the predominant measured response may be considered centered, which is not to be confused with borehole depth (for example, distance) measured from the surface.

3.2.5 *measurement resolution, n*—the minimum change in measured value that can be detected.

3.2.6 *repeatability, n*—the difference in magnitude of two measurements with the same equipment and in the same environment.



NOTE 1—From a study site showing how the gamma logs can be used to identify where beds intersect each of the individual boreholes, demonstrating lateral continuity of the subsurface geology.

FIG. 2 Example of Gamma Logs From Two Boreholes

3.2.7 *vertical resolution, n*—the minimum thickness that can be separated into distinct units.

3.2.8 *volume of investigation, n*—the volume that contributes 90 % of the measured response. It is determined by a combination of theoretical and empirical modeling. The volume of investigation is non-spherical and has gradational boundaries.

4. Summary of Guide

4.1 This guide applies to borehole gamma logging and is to be used in conjunction with Guide D 5753.

4.2 This guide briefly describes the significance and use, apparatus, calibration and standardization, procedures, and reports for conducting borehole gamma logging.

5. Significance and Use

5.1 An appropriately developed, documented, and executed guide is essential for the proper collection and application of gamma logs. This guide is to be used in conjunction with Guide D 5753.

5.2 The benefits of its use include improving selection of gamma logging methods and equipment, gamma log quality and reliability, and usefulness of the gamma log data for subsequent display and interpretation.

5.3 This guide applies to commonly used gamma logging methods for geotechnical applications.

5.4 It is essential that personnel (see the Personnel section of Guide D 5753) consult up-to-date textbooks and reports on the gamma technique, application, and interpretation methods.

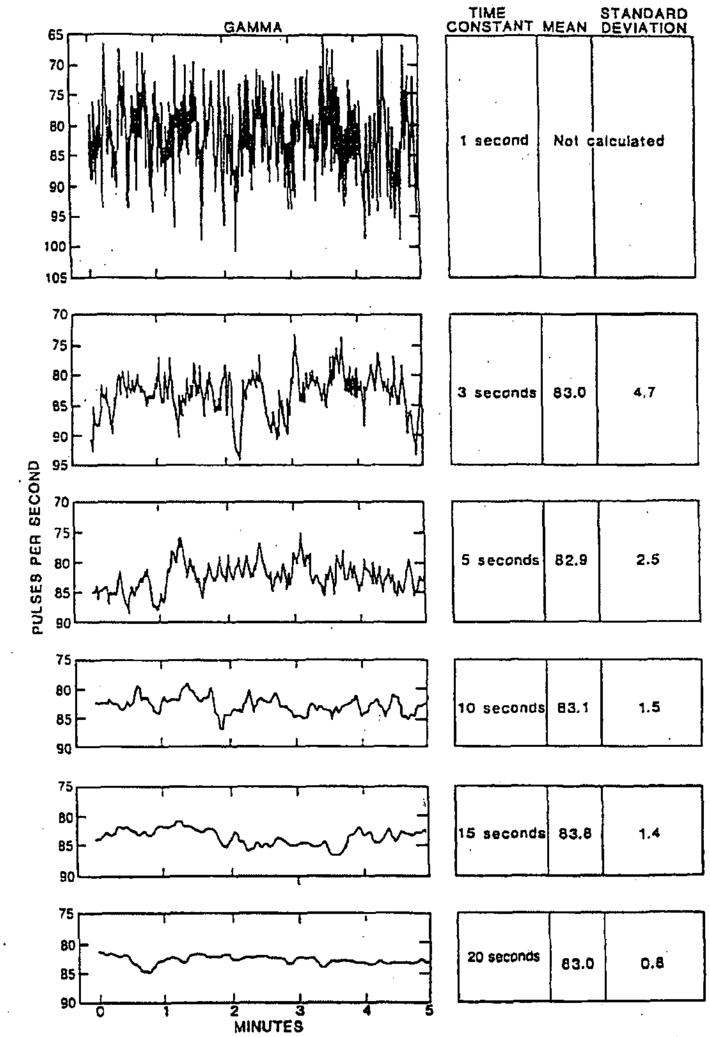
6. Interferences

6.1 Most extraneous effects on gamma logs are caused by logging too fast, instrument problems, borehole conditions, and geologic conditions.

6.2 Logging too fast can significantly degrade the quality of gamma logs. Gamma counts originating at a given depth need to be averaged over a time interval such that the natural statistical variation in the rate of gamma photon emission is negligible (see Fig. 3).

6.3 Instrument problems include electrical leakage of cable and grounding problems, degradation of detector efficiency attributed to loss of crystal transparency (fogging) or fractures or breaks in the crystal, and mechanical damage causing separation of crystal and photomultiplier tube.

6.4 Borehole conditions include changes in borehole diameter (especially in the fluid-filled portion); casing type and number; radioactive elements in drilling fluid in the borehole, or in cement or slurry behind casing; and steel casing or cement in the annulus around casing, and thickness of the annulus.



NOTE 1—The fluctuations in gamma activity in counts per second is shown to vary by progressively smaller amounts as the averaging period (time constant) is increased from 1 to 20 s.

FIG. 3 Example of Natural Statistical Fluctuation of Gamma Counts From a Test Source of Given Strength

6.5 Geologic conditions include high levels of radiation which can degrade the efficiency of gamma counting through the dead time effect, energy level of emitted gammas, formation density, and lithologic bed geometry.

7. Apparatus

7.1 A geophysical logging system has been described in the general guide (the Apparatus section of Guide D 5753).

7.2 Gamma logs are collected with probes using scintillation detectors.

7.2.1 The most common gamma detectors are sodium iodide (NaI).

7.2.2 Other gamma detectors include cesium iodide (CsI) and bismuth germanate (BGO).

7.3 Gamma probes generate nuclear counts as pulses of voltage that are amplified and clipped to a uniform amplitude.

7.3.1 Gamma probes used for geotechnical applications typically can be logged inside of a 2-in. (5-cm) diameter monitoring well.

7.4 The volume of investigation and depth of investigation are determined by the density of the material near the probe, which controls the average distance a gamma photon can travel before being absorbed.

7.4.1 The volume of investigation for gamma logs is generally considered spherical with a radius of 0.5 to 1.0 ft (15 to 30 cm) from the center of the detector in typical geological formations. The volume becomes elongated when detector length exceeds approximately 0.5 ft (15 cm).

7.4.2 The depth of investigation for gamma logs is generally considered to be 0.5 to 1.0 ft (15 to 30 cm).

7.5 Vertical resolution of gamma logs is determined by the size of the volume from which gammas can reach a nuclear detector suspended in the borehole. In typical geological formations surrounding a fluid-filled borehole, this is a roughly spherical volume about 1 to 2 ft (30 to 60 cm) in diameter. Excessive logging speed can decrease vertical resolution.

7.6 Measurement resolution of gamma probes is determined by the counting efficiency of the nuclear detector being used in the probe. Typical measurement resolution is 1 cps.

7.7 A variety of gamma logging equipment is available for geotechnical investigations. It is not practical to list all of the sources of potentially acceptable equipment.

8. Calibration and Standardization of Gamma Logs

8.1 *General:*

8.1.1 National Institute of Standards and Technology (NIST) calibration and standardization procedures do not exist for gamma logging.

8.1.2 Gamma logs can be used in a qualitative (for example, comparative) or quantitative (for example, estimating radioisotope concentration) manner depending upon the project objectives.

8.1.3 Gamma calibration and standardization methods and frequency shall be sufficient to meet project objectives.

8.1.3.1 Calibration and standardization should be performed each time a gamma probe is suspected to be damaged, modified, repaired, and at periodic intervals.

8.2 Calibration is the process of establishing values for gamma response associated with specific levels of radioisotope concentration in the sampled volume and is accomplished with a representative physical model. Calibration data values related to the physical properties (for example, radioisotope concentration) may be recorded in units (for example, cps), that can be converted to units of radioactive element concentration (for example, ppm Radium-226 or percent Uranium-238 equivalents).

8.2.1 Calibration is performed by recording gamma log response in cps in boreholes centered within volumes containing known homogenous concentrations of radioactivity elements.

8.2.2 Calibration volumes should be designed to contain material as close as possible to that in the environment where the logs are to be obtained to allow for effects such as gamma energy level, formation density, and activity of daughter isotopes on the calibration process.

8.3 Standardization is the process of checking logging response to show evidence of repeatability and consistency, and to ensure that logging probes with different detector efficiencies measure the same amount of gamma activity in the same formation. The response in cps of every gamma detector is different for the same radioactive environment.

8.3.1 Calibration ensures standardization.

8.3.2 The American Petroleum Institute maintains a borehole in Houston, Texas, where two formations have been fabricated to provide homogeneous levels of gamma activity so that probes can be standardized on the basis of the response in these boreholes. 1 API gamma unit is $1/200^{th}$ of the full scale response in the representative shale model in this borehole (see Guide D 5753).

8.3.3 For geotechnical applications, gamma logs should be presented in API units for standardization.

8.3.4 A representative borehole may be used to periodically check gamma probe response providing the borehole and surrounding environment does not change with time or their effects on gamma response can be documented.

8.3.5 A small radioactive source(s) (thorium-treated lantern mantles, small bottles of potassium chloride, laboratory radioactive test sources, or sleeves containing natural radioisotopes (phosphate sands, etc.)) placed over the gamma detector can be used to check calibration if the sources have been related to a calibration facility.

8.4 Gamma log output needs to be corrected for dead time when logging in formations with unusually large count rates, such as uranium-rich pegmatites or phosphatic sands, and areas contaminated with radioactive waste.

8.4.1 Dead time corrections are usually negligible under typical logging conditions when measured gamma counts are less than a few hundred counts per second.

8.4.2 Dead time corrections are estimated by comparing the gamma log response under the influence of two similar radioactive sources. The measured count rate would approximately double over that with one source when both sources are placed in the sample volume of the logging tool. The dead time causes the count rates to be slightly less than double. Dead time is given by the formula:

$$\text{Dead Time} = t_0 = 2(N_1 + N_2 - N_{12})/(N_{12}(N_1 + N_2)) \quad (1)$$

$$\text{Corrected count rate} = N^* = N/(1 - N\,t_0)$$

where:

N_1, N_2 = the count rates measured using each of the two similar sources,
N_{12} = the count rate obtained using both of the similar sources in counts per second,
t_0 = the dead time correction in seconds,
N = the measured count rate in a formation in counts per second, and
N^* = the count rate after correction for the dead time effect.

t_0 is usually found to be a few microseconds for most gamma logging equipment.

9. Procedure

9.1 See the Procedure section of Guide D 5753 for planning a logging program, data formats, personnel qualifications, field documentation, and header documentation.

9.1.1 Document gamma specific information (for example, crystal size, type, and location).

9.2 Identify gamma logging objectives. Select appropriate equipment to meet objectives.

9.3 Gamma logs are commonly run with other logging measurements in combination probes for correlation purposes. This is most often done by equipping other classes of logging probes (electric, indication, neutron porosity, etc.) with gamma detectors (see Fig. 4).

9.3.1 Detector location on the probe needs to be appropriate to meet the project objectives. Long combination probe strings with the gamma detector located at a significant distance from the bottom of the probe may be inappropriate. Gamma detection position on the logging probe is especially important in shallow boreholes where over drilling the borehole is not possible.

9.3.2 Gamma probes are usually run free-hanging where the probe lies against one side of the borehole that is, as a mandrel. However, gamma detectors are sometimes included with combination probes that are run centralized or decentralized in the borehole. Gamma response may be somewhat different depending upon the method used (for example, free-hanging or centralized) in a given geologic environment.

9.3.3 Gamma equipment decontamination is addressed according to project specifications (see Practice D 5088 for non-radioactive waste sites and Practice D 5608 for low level radioactive waste sites).

9.4 Select when the gamma probe is to be run in the logging sequence (see 8.2.2.1 of Guide D 5753).

9.4.1 Gamma probes are run after or in combination with any television camera and fluid property probes to insure that there is minimum disturbance to the borehole fluid that can degrade those logs.

9.4.2 Gamma probes are run before any probe utilizing nuclear sources and more expensive centralized probes to ensure borehole stability possible.

9.4.3 Whenever possible, gamma probes should be run open hole or through the least amount of completion material to minimize well construction effects and to provide a base line for comparing subsequent logs.

9.5 Gamma probe operation is typically checked before the start of each run to insure that equipment is operating and that nuclear counters are producing output.

9.5.1 Gamma operation may be checked by placing a small radioactive source over the gamma detector. Common materials, such as thorium-treated lantern mantles, small bottles of potassium chloride, laboratory radioactive test sources, or sleeves containing natural radioisotopes (phosphatic sands, etc.), are frequently used.

9.6 Select and document the depth reference point.

9.6.1 The selected depth reference needs to be stable and accessible (for example, top of borehole casing).

9.7 Determine and document probe zero reference point (for example, top of probe or cablehead) and depth offset to gamma measurement point.

9.7.1 The measurement point of the gamma logging probe is the distance along the probe corresponding with the center of the crystal within the logging tool; this position is not visible unless the position is marked on the outside of the tool or the operator has information specifying that position with respect to a prominent reference point on the probe housing.

9.7.2 Position the probe zero reference point to the depth reference point (ground level, top of casing, etc.) and initialize depth recording/display systems.

9.8 Select horizontal and vertical scales for log display to meet project objectives.

9.8.1 Preferred horizontal scale divisions are multiples of two or five inches, such that the log value is easily determined on the plot (for example, 0 to 100, 0 to 200, 50 to 150, etc.).

9.8.2 Preferred vertical scales are multiples of two or five, such that depth can be easily determined on a log plot (for example, 1/5, 1/10...1/100, etc.).

9.9 Select digitizing interval (or sample rate if applicable) to meet project objectives (see 8.3.1.2 of Guide D 5753).

9.9.1 Digitizing interval needs to be at least as small as the vertical resolution of the gamma probe, that is typically about 1 ft (30 cm).

9.9.2 Typically, this interval is no larger than 0.5 ft (15 cm) to ensure that the optimum vertical resolution is achieved.

9.9.3 Even though field plots may be generated with smoothing, the rawest (non-filtered) form of the data should be recorded.

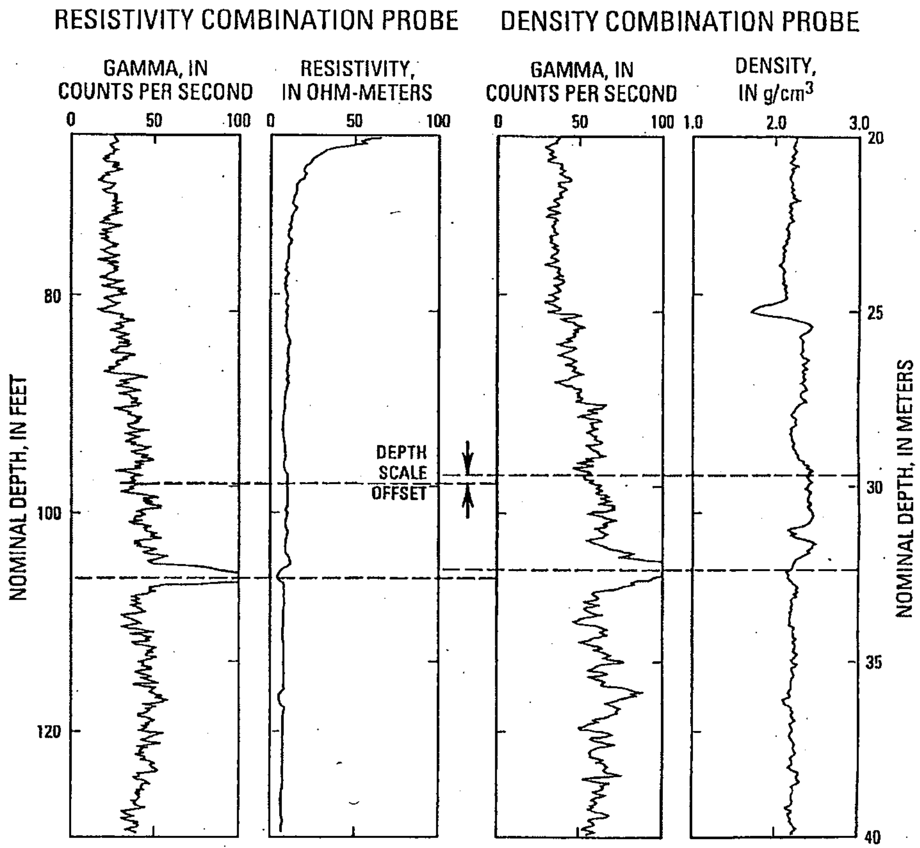
9.10 The gamma probe is lowered to the bottom of the borehole.

9.10.1 Gamma counts should be monitored as the probe is lowered because knowledge of the average count rates produced by the formation is important in determining proper logging speed. Gamma value range is also needed to determine proper horizontal scale and with some instrumentation, to determine sensitivity/gain settings.

9.10.2 Selection of probe speed while lowering is based on knowledge of borehole depth, stability, and other conditions; tension on the measuring wheel and smoothness of probe descent should be monitored to ensure that depth errors are not being introduced.

9.11 Select logging speed.

9.11.1 Logging speed should be determined by the application of the data acquired to meet project objectives.



NOTE 1—This figure shows a small depth offset that should be removed by adjusting the depth scale on one of the logs; note that the average count rates for the two different gamma detectors differ as a result of different detector efficiencies.

FIG. 4 Example of Gamma Logs From Gamma Detectors in Two Different Logging Tools (Electrical Resistivity on Density)

9.11.2 Typical gamma logging speed is approximately 20 ft/min (6 m/min), but slower speeds may be needed if formation gamma activity is low.

9.11.3 Proper logging speed is indicated by gamma logs that show distinct beds, which correlate with other information such as core descriptions or driller's logs, and where there is relatively little random fluctuation within beds (see Fig. 1).

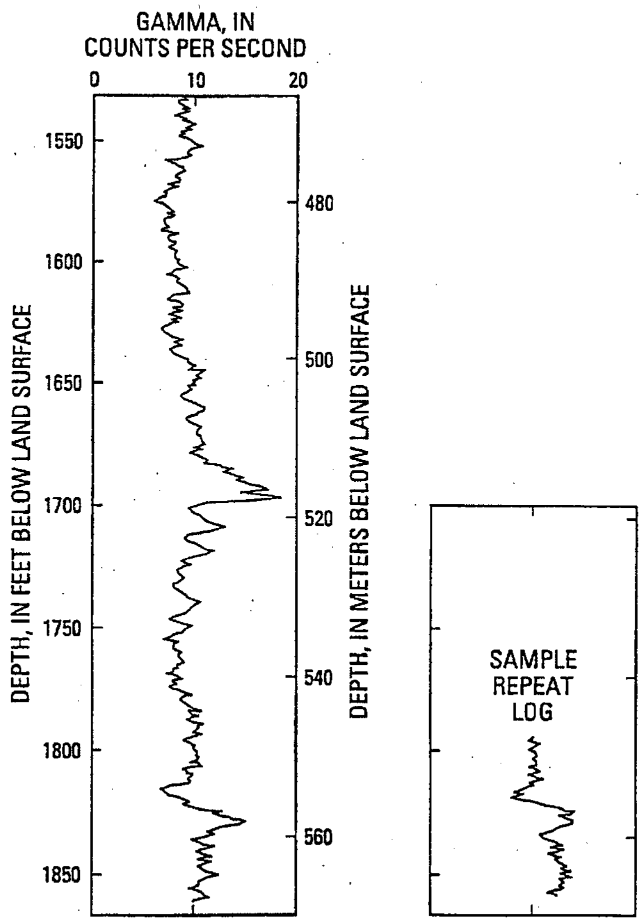
9.11.4 If the operator is concerned about whether logging speed is affecting the quality of the gamma log, the operator should repeat a representative section of the log (representative of the geologic variation in the borehole) using the same speed; if the log reproduces interpreted bed boundaries that agree with other log and geologic data and the initial run, then the logging speed is adequate. If there are significant changes in the interpreted bed boundaries or if bed boundaries (lithologic contacts) are not indicated, the operator should try logging at a reduced speed.

9.11.5 In situations where gamma activity is extremely low, such as in many basalts and some carbonate and quartzite formations, the operator can estimate the maximum logging speed from the formula:

$$S_f < 0.50G \quad \text{or} \quad S_m < 0.15G \tag{2}$$

where:
S_f = the logging speed in feet per minute,
S_m = the logging speed in metres per minute, and
G = the average measured gamma activity of the interval or intervals of interest in counts per second.

This formula gives the logging speed required to ensure that the standard nuclear statistical error is less than about 5 %. In some situations, the available time and budget and the length of borehole to be logged may indicate that a trade-off be made between statistical errors and log resolution; an effective trade-off for a given situation can be made by experimenting



NOTE 1—In this figure, experimentation with logging speed demonstrates that a 10 ft (m) per minute logging speed generates useful and repeatable gamma logs with statistical errors somewhat greater than 5 %, but where beds can be effectively detected.

FIG. 5 Example of a Gamma Log From a Basalt Formation of Very Low Gamma Activity

with repeat logging runs over representative intervals containing bed contacts (see Fig. 5).

9.12 Collect gamma log data while the probe is moving up the borehole; data collection while logging upward ensures that the probe is retrieved smoothly and continuously.

9.12.1 In unstable boreholes, it is sometimes advantageous to collect data both while probe is being lowered and being pulled up the borehole.

9.13 When the probe reaches the top of the borehole:

9.13.1 Check depth reference and document after survey depth error (ASDE).

9.13.2 Determine if ASDE meets project objectives.

9.13.3 Typical tolerance for ASDE is ±0.4 per 100-ft interval logged (±0.4 m per 100-m).

9.13.4 Typical depth tolerance for repeat logs is within 0.4 %.

9.14 Selected borehole intervals should be repeated (that is, relogged) under similar logging parameters as the initial log. Repeat logs verify that the gamma electronics are functioning correctly, and that the logging speed (effect of nuclear statistical fluctuations) is adequate for project objectives. The interval repeated should have enough variability, if possible, to check repeatability and resolution; also note that nuclear statistical noise is most likely to affect intervals with relatively low gamma count rates.

9.14.1 Repeat logs should be compared with the original log to ensure correct operation of the probe prior to ending a logging event.

9.14.2 Repeat sections may not repeat exactly because of the statistical nature of nuclear activity that introduces some random fluctuation into the measured count rate. Individual log values should typically repeat within one standard deviation, and the character and shape of the logs should be similar. Note that the importance of high count rates to reduce the statistical variations between log runs.

9.14.3 Repeat sections may not repeat exactly due to a different orientation of the logging probe on the repeat run or changes in the borehole between logging runs (see Section 6, Interferences).

9.15 Evaluate the quality of field logs and compare logs with drilling and completion information.

9.16 Gamma logs are usually smoothed by filtering (in hardware or software) with an N-point averaging window (for example, running average, weighted average, etc.) to minimize the effects of statistical variation caused by radioactive decay. The window width:

$$(N-1)\Delta z \tag{3}$$

where:

N = the number of points, and
Δz = the digitizing interval, which should correspond with the vertical resolution, which is typically about 1 ft (30 cm) in most geological formations.

9.16.1 Larger filters are frequently applied to gamma logs for presentation purposes (compression of the vertical scale); however, this filtering generally results in loss of some log information.

9.16.2 The rawest form of the gamma data and the filtered data should be saved.

9.17 Post-acquisitions calibration checks may be required to meet the objectives of the logging program to verify gamma log standardization and dead time correction.

10. Interpretation of Results

10.1 See the Log Interpretation section of Guide D 5753 for procedures on log interpretation.

10.2 A valid gamma log is important to establish the distribution of lithology and bedding within a borehole for correlation purposes, for different logs run in the same borehole (see Fig. 4), and for the extrapolation of results between boreholes (see Fig. 2).

10.2.1 Except at sites contaminated by radioactive waste, the measured gamma photons originate from the radioactive decay of naturally-occurring isotopes of Potassium-40 and daughter products of Uranium-238 and Thorium-232 (see Fig. 6).

10.2.2 Gamma logs can be analyzed individually (that is, borehole lithology).

10.2.3 Gamma logs can be analyzed as part of a suite to take advantage of the synergistic nature of log data.

10.3 The gamma log should be depth correlated with the other geophysical logs as the first step to interpretation. This is especially important for logs that use the gamma data for depth adjustment.

10.3.1 The gamma log data may be filtered, edited, combined, and merged with other log values.

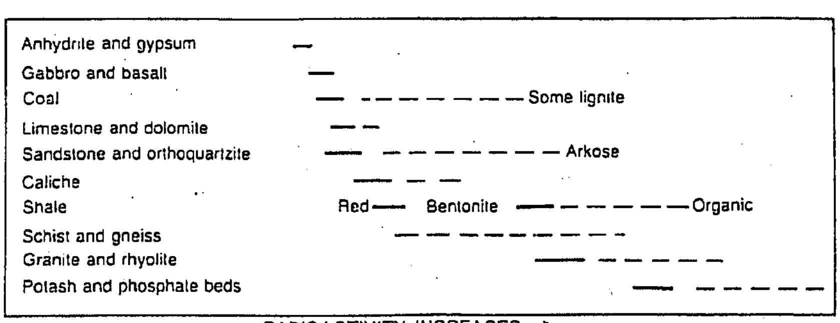


FIG. 6 Range of Relative Gamma Activity of Common Rocks

10.3.2 Final log headers are filled out and attached to the data.

10.3.3 The gamma log may be plotted at different scales for the purpose of interpreting, summarizing, and presenting the final data.

10.4 Other pertinent information, including borehole construction (casing size), drilling history (hole size, drill method, penetration rate, core loss, fluid loss, etc.), and geologic information should be integrated with the gamma log data.

10.4.1 Many of the borehole effects on the gamma log, such as correction for attenuation of steel casing and borehole fluid, can be normalized with empirical data to facilitate interpretation. This is especially important in comparing gamma logs from boreholes logged with different completion designs.

10.4.2 It is also possible to normalize the gamma log for well construction if it is possible to log a similar borehole prior to completion and again after a similar scheme.

10.5 Gamma logs commonly are the primary indicator of geologic structure and stratigraphy to be used as a guide in installing well screens, positioning cement plugs, bentonite seals or packers, etc.

10.5.1 When gamma logs are used as indicators of bed boundaries, the bed contact is usually identified as the point where the log measures half of the total change in amplitude across the bed contact (see Fig. 5).

10.6 Gamma logs obtained for depth correlation on logging runs using different probes may not produce the same count rates at each depth because of differences in detector efficiencies and probe designs.

10.7 Gamma logs may be applied to correlate lithology between boreholes based upon the characteristic gamma activity of specific beds or formations (See Fig. 6). Gamma logs can be used to determine the continuity of lithology, strike, and dip of beds between boreholes, and to infer the existence of faults and other discontinuities.

10.8 The primary application of gamma logs for geotechnical applications assumes a correlation between gamma activity and the proportion of fine-grained material in the formation. The gamma log may be used to calculate a clay volume or percentage. This assumption is frequently not valid (for example, phosphatic sands, arkosic sands, non-sedimentary environments, areas of natural radioactive mineralization, etc.) and should be tested in the project area. This testing may consist of cross plots, principal component analysis, and other multivariate statistical techniques. The application of gamma log analysis in the estimation of clay fraction may also be complicated by the presence of more than one clay type, each of which has a distinctly different level of gamma activity.

10.9 Gamma logs can be used to detect the presence of radioisotopes in borehole tracer studies, calibrated in units of radioisotope concentration to assess the degree of radioisotope contamination at radioactive waste sites, and used to locate source rocks in natural radium and radon hazard assessment studies.

11. Report

11.1 The Report section of Guide D 5753 should be consulted for requirements of the report.

11.2 Providers of gamma logs shall describe the components of the gamma logging system, the principles of the methods used, methods and results of calibration and standardization, performance verification (repeat sections, ASDE, correlation with other logs and key features such as bottom of steel casing, etc.), and uniqueness of interpretation.

11.3 Information on the software and algorithms used should be documented.

11.4 Any deviations from this guide should be documented.

11.5 Presentation of gamma logs should be designed to meet project objectives. At a minimum, depth (y-axis) and units of measurement (x-axis) scales should be clearly marked. There may be a difference between presentations of data collected in the field versus in the final report. Any scale "wraps" should be clearly marked (see Fig. 1).

11.5.1 Gamma logs are typically displayed with linear scales in counts per second or API units (see Fig. 1).

11.5.2 The digital data should be provided in ASCII format and include depth referenced gamma values and all pertinent header and calibration information; for example, Log ASCII Standard format (LAS).

11.5.3 Field plots typically are generated at the time of logging or immediately upon completion of data acquisition. These plots may be delivered in the field or may be discarded at some point later in the project. They are not typically included in the report.

11.5.4 Final log plots are typically generated post acquisition. They consist of the filtered and edited gamma data combined and merged with logical combinations of other log data. Final log plots are typically plotted in an industry standard format such as API format and may be included in the report.

11.5.5 Summary log plots may be generated (typically at reduced scales) to incorporate other logs, relevant data, and interpretations. These plots are generally included in the report.

12. Keywords

12.1 borehole geophysics; dead time correction; gamma log; natural gamma log; nuclear statistics; radioisotope; well construction; well logging

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Final Report

Appendix E-2

Field Electrical Resistivity Test Results

GEOVision
geophysical services

February 23, 2007

GEOVision Project Number 6355

Mr. Michael D. Sufnarski
MACTEC Engineering and Consulting
2801 Yorkmont Road, Ste 100
Charlotte, NC 28208

Subject: **Four Electrode Wenner Resistivity Tests**
South Texas Project Energy Generating Station
South Texas COL Project – MACTEC JOB NUMBER 5050-06-0496

Dear Mr. Sufnarksi:

A geophysical survey was conducted January 3, 2007 at the South Texas Project Energy Generating Station near Bay City, Texas. The purpose of the geophysical survey was to measure soil resistivity according to ASTM standard G57-2006. Site conditions consisted of soft clayey soils with heavy (locations ER-901 and ER-902) or minor (locations ER-401 and ER-301) vegetation

METHODOLOGY

Resistivity equipment used during this investigation included a MiniRes HP earth resistivity meter coupled to 1/4- inch stainless steel electrode stakes with 20 gauge insulated copper wire. A test resistor rated at 19.935 ohms (at 72 degrees Fahrenheit) was used to verify the MiniRes HP was operating within calibrated levels. The MiniRes HP operates at two selectable power levels: "Low Power" with a 1 mA output current and 730 V peak to peak, and "High Power" with an output current of 10 mA and 530 V peak to peak. Typically, the "High Power" setting is only used in resistive environments or for very long arrays where soil conditions limit transmission of current through the subsurface. The "High Power" setting increases output current; however with a corresponding decrease in sensitivity to very low measured resistance values.

FIELD PROCEDURES

Before conducting the geophysical survey the battery level was checked on the resistivity meter and found to be within acceptable limits. Ambient temperature and soil conditions were recorded on the field log. Electrode spacing was pre-determined based on information provided by the client.

A test resistor rated at 19.935 ohms was connected to the positive and negative current and potential leads on the MiniRes HP immediately before the first sounding and immediately after the final sounding, at each of the survey locations. The resistance value across the test resistor and the time of the test measurement was recorded on the field log.

Resistivity measurements (soundings) were made at four locations (ER-901, ER-902, ER-401 AND ER-301) at the selected intervals using a surveyor's measuring tape for spatial control. See Attachment A of the MACTEC Geotechnical Data Report for surveyed locations of the four field resistivity test locations.

Resistivity measurements at ten electrode spacings were made on each line. For each resistivity meaurement, four stainless steel electrodes were placed at equal distances (*a* spacing) in a straight line. A current was applied from the outer electrodes, and a potential reading (voltage) was measured across the inner electrodes. The MiniRes HP displays the resistance value, which was recorded along with the *a* spacing on a field data sheet and later transferred to a spreadsheet. Two or more measurements were recorded at each station for quality control. If there was significant variation between the first and second measurements the control leads, electrode cable and electrode coupling were field checked to ensure proper survey conditions. After each measurement, the electrodes were moved to the next *a* spacing and another set of measurements was taken. Due to conductive soil conditions, the instrument was operated at the lower power setting. Measurements were also taken at the higher output power setting, but conductive soil conditions limited the usefulness of data recorded at that power setting. Measurements labeled "NA" on the attached Tables 1-4 indicate readings recorded with the instrument at "High Power", outside the sensitivity range for that power setting.

DATA REDUCTION

Six spreadsheets were generated from the collected resistivity data. Probe spacing (*a*) and resistance reading (ΔV/I), were entered for each resistivity measurement. A generalized form of the four-electrode array is shown in Figure 1.

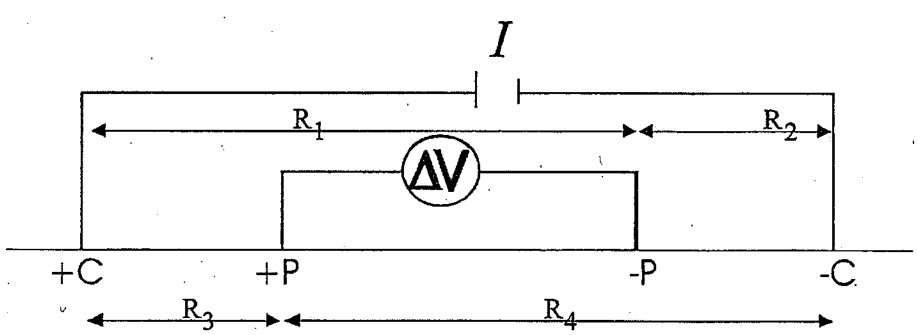

Figure 1: The generalized form of the four electrode array

When the material upon which the current is induced is uniform, the resistivity calculated will be constant independent of electrode configuration. However, in a field investigation where subsurface heterogeneities exist, the calculated resistivity values will vary with electrode array. This calculated resistivity is referred to as apparent resistivity (ρ_a), and can be calculated using the relationship:

$$\rho_a = \frac{2\pi\Delta V}{I\left\{\left(\frac{1}{R_3}-\frac{1}{R_4}\right)-\left(\frac{1}{R_1}-\frac{1}{R_2}\right)\right\}}$$

For the Wenner array, which was used during this investigation, where $R_1 = R_4$; $R_3 = R_2$ and $R_1 = 2R_2 = 2a$, it can be shown that the formula for calculated apparent resistivity can be reduced to the following form:

$$\rho_a = 2\pi a\left(\frac{\Delta V}{I}\right)$$

RESULTS

Data collected from the four Wenner resistivity arrays are attached as Tables 1-4. Electrode *a* spacing was converted to meters in order to provide an average soil resistivity in ohm-meters. According to ASTM Standard G57-2006, data is also presented in the ohm-centimeter unit. Measurements labeled "NA" on the attached Tables 1-4 indicate readings recorded with the instrument at "High Power", outside the sensitivity range for that power setting.

All completed data processing forms are retained in project files. All files generated during the processing sequence were archived on CD-ROM.

SUMMARY

Four-electrode soil resistivity measurements were made at the South Texas Project Energy Generating Station according to ASTM standard G57-2006. Soil and rock resistivity values were made at four locations, using electrode spacings determined by the client. Field measurements and calculated values were consistent and repeatable at all locations, as summarized in Tables 1-4.

If you have any questions concerning this investigation, please call us at 951-549-1234.

Sincerely,
GEO*Vision* Geophysical Services

JB Shawver

Antony J Martin

Submitted by:
JB Shawver
Senior Project Geophysicist

Reviewed and Approved by:
Antony J. Martin
Technical Director

Attachments:

Table 1: Resistivity Soundings ER-901
Table 2: Resistivity Soundings ER-902
Table 3: Resistivity Soundings ER-401
Table 4: Resistivity Soundings ER-301
Applied Technical Services, Incorporated Certificate of Calibration
Applied Technical Services, Incorporated Calibration Data Sheet

TABLE 1 ELECTRICAL RESISTIVITY SOUNDING ER-901

Job Number 6533 Date 3-Jan-07
19.935 ohm Test Resistor Reading
19.95 ohm at 1010 19.931 ohm at 1120

A-Spacing [ft.]	Resistance Reading [Ohm]	Geometric Multiplier [2(pi)A]	Calculated Magnitude [Ohm-ft.]	Converted Magnitude [Ohm-m]	Calculated to Ohm-cm [Ohm-cm]	Repeat Resistance [Ohm]	Repeat Magnitude [Ohm-ft.]	Repeat Conversion [Ohm-m]	Repeat Calculation to Ohm-cm [Ohm-cm]
3.0	1.340	18.850	25.258	7.699	769.876	1.300	24.504	7.469	746.9
5.0	0.671	31.416	21.080	6.425	642.521	0.700	21.991	6.703	670.3
7.5	0.364	47.124	17.153	5.228	522.826	0.400	18.850	5.745	574.5
10.0	0.259	62.832	16.273	4.960	496.015	0.300	18.850	5.745	574.5
15.0	0.177	94.248	16.682	5.085	508.463	0.200	18.850	5.745	574.5
30.0	0.130	188.496	24.504	7.469	746.895	0.100	18.850	5.745	574.5
50.0	0.098	314.159	30.788	9.384	938.406	0.100	31.416	9.576	957.6
100.0	0.060	628.319	37.699	11.491	1149.069	0.100	62.832	19.151	1915.1
200.0	0.034	1256.637	42.726	13.023	1302.278	NA	NA	NA	NA
300.0	0.023	1884.956	43.354	13.214	1321.429	NA	NA	NA	NA

TABLE 2 ELECTRICAL RESISTIVITY SOUNDING ER-902

Job Number 6355 Date 3-Jan-07
19.935 ohm Test Resistor Reading
19.930 ohm at 1240 19.931 ohm at 1316

A-Spacing [ft.]	Resistance Reading [Ohm]	Geometric Multiplier [2(pi)A]	Calculated Magnitude [Ohm-ft.]	Converted Magnitude [Ohm-m]	Calculated to Ohm-cm [Ohm-cm]	Repeat Resistance [Ohm]	Repeat Magnitude [Ohm-ft.]	Repeat Conversion [Ohm-m]	Repeat Calculation to Ohm-cm [Ohm-cm]
3.0	1.130	18.850	21.300	6.492	649.224	1.100	20.735	6.320	632.0
5.0	0.616	31.416	19.352	5.899	589.855	0.600	18.850	5.745	574.5
7.5	0.339	47.124	15.975	4.869	486.918	0.300	14.137	4.309	430.9
10.0	0.258	62.832	16.211	4.941	494.100	0.300	18.850	5.745	574.5
15.0	0.178	94.248	16.776	5.113	511.336	0.200	18.850	5.745	574.5
30.0	0.128	188.496	24.127	7.354	735.404	0.100	18.850	5.745	574.5
50.0	0.096	314.159	30.159	9.193	919.255	0.100	31.416	9.576	957.6
100.0	0.055	628.319	34.558	10.533	1053.313	0.100	62.832	19.151	1915.1
200.0	0.033	1256.637	41.469	12.640	1263.976	NA	NA	NA	NA
300.0	0.022	1884.956	41.469	12.640	1263.976	NA	NA	NA	NA

TABLE 3 ELECTRICAL RESISTIVITY SOUNDING ER-401

Job Number 6533 Date 3-Jan-07

19.935 ohm Test Resistor Reading

19.930 ohm at 1444 19.930 ohm at 1521

A-Spacing [ft.]	Resistance Reading [Ohm]	Geometric Multiplier [2(pi)A]	Calculated Magnitude [Ohm-ft.]	Converted Magnitude [Ohm-m]	Calculated to Ohm-cm [Ohm-cm]	Repeat Resistance [Ohm]	Repeat Magnitude [Ohm-ft.]	Repeat Conversion [Ohm-m]	Repeat Calculation to Ohm-cm [Ohm-cm]
3.0	1.222	18.850	23.034	7.021	702.081	1.200	22.619	6.894	689.4
5.0	0.688	31.416	21.614	6.588	658.800	0.700	21.991	6.703	670.3
7.5	0.423	47.124	19.933	6.076	607.570	0.400	18.850	5.745	574.5
10.0	0.315	62.832	19.792	6.033	603.261	0.300	18.850	5.745	574.5
15.0	0.215	94.248	20.263	6.176	617.625	0.200	18.850	5.745	574.5
30.0	0.137	188.496	25.824	7.871	787.112	0.100	18.850	5.745	574.5
50.0	0.101	314.159	31.730	9.671	967.133	0.100	31.416	9.576	957.6
100.0	0.061	628.319	38.327	11.682	1168.220	0.100	62.832	19.151	1915.1
200.0	0.032	1256.637	40.212	12.257	1225.674	NA	NA	NA	NA
300.0	0.023	1884.956	43.354	13.214	1321.429	NA	NA	NA	NA

TABLE 4 ELECTRICAL RESISTIVITY SOUNDING ER-301

Job Number 6533 Date 3-Jan-07

19.935 ohm Test Resistor Reading

19.93 ohm at 1554 19.93 ohm at 1630

A-Spacing [ft.]	Resistance Reading [Ohm]	Geometric Multiplier [2(pi)A]	Calculated Magnitude [Ohm-ft.]	Converted Magnitude [Ohm-m]	Calculated to Ohm-cm [Ohm-cm]	Repeat Resistance [Ohm]	Repeat Magnitude [Ohm-ft.]	Repeat Conversion [Ohm-m]	Repeat Calculation to Ohm-cm [Ohm-cm]
3.0	2.011	18.850	37.906	11.554	1155.389	2.000	37.699	11.491	1149.1
5.0	1.135	31.416	35.657	10.868	1086.828	1.100	34.558	10.533	1053.3
7.5	0.708	47.124	33.364	10.169	1016.926	0.700	32.987	10.054	1005.4
10.0	0.269	62.832	16.902	5.152	515.166	0.300	18.850	5.745	574.5
15.0	0.178	94.248	16.776	5.113	511.336	0.200	18.850	5.745	574.5
30.0	0.141	188.496	26.578	8.101	810.094	0.100	18.850	5.745	574.5
50.0	0.110	314.159	34.558	10.533	1053.313	0.100	31.416	9.576	957.6
100.0	0.062	628.319	38.956	11.874	1187.371	0.100	62.832	19.151	1915.1
200.0	0.035	1256.637	43.982	13.406	1340.580	NA	NA	NA	NA
300.0	0.024	1884.956	45.239	13.789	1378.883	NA	NA	NA	NA

APPLIED TECHNICAL SERVICES, INCORPORATED

CERTIFICATE OF CALIBRATION

ATS Reference No.: M502064-1 **Date:** October 24, 2006 Page 1 of 2

Purchase Order: 66252

MACTEC Engr. & Consult.
396 Plasters Avenue, N.E.
Atlanta, GA 30324

Test Instrument: Low Resistivity Meter **Manufacturer:** LRI

Model No: Unknown **Asset No.:** 107 **Serial No:** 107

Status When Received: *IN TOLERANCE* **Location:** In-Lab

Calibration Environmental Conditions: Temperature: 70 °F **Relative Humidity:** 40 %

Date of Calibration: July 10, 2006 **Calibration Due:** July 10, 2007

This certificate attests that the calibration was performed in compliance with ANSI/NCSL Z540-1 and ISO/IEC 17025 and is traceable to the National Institute of Standards and Technology. Applied Technical Services, Inc., certifies that the above named instrument has been calibrated by comparison standards traceable to the National Institute of Standards and Technology through the following test numbers and is certified and returned within required tolerance/accuracy.

Master Shunt Box **Due:** February 25, 2007 **Trace:** 02014

Calibrated by: [signature]
John O'toole
Senior Calibration Technician

ACCREDITED
CERT. # 1888-03

APPLIED TECHNICAL SERVICES, INCORPORATED

1280 Field Parkway, Marietta, Georgia 30066 • (770) 514-3288 Fax (678) 819-1055

CALIBRATION DATA SHEET

Page 2 of 2

Customer: MACTEC Engr. & Consult., Atlanta — Purchase Order No.: 66252

Item Name: Low Resistivity Meter — Asset No.: 107 — ATS Reference No.: M502064-1

Manufacturer: LRI — Model No.: Unknown — Proc. No.: 1032 — Rev.: 1

Serial No.: 107 — Calibration Date: 07-10-06 — Calibration Due Date: 07-10-07

Reason For Service: ☒ Initial Calibration ☐ Due For Calibration ☐ Repair and Calibration

Equipment Used: ATS-02014 Due: 02-25-07 Guildline Master Shunt Box

Due:

Due:

Due:

Due:

Due:

Calibrated By: John O'Toole

Customer Instrument Under Test

UNCERTAINTY (SEE NOTE)	RANGE	ATS STANDARD	TOLERANCE	AS FOUND READING	AS CALIBRATED READING
± .01	Auto	1.000	.92 to 1.08	1.0	1.0
± .01	Auto	10.000	9.65 to 10.35	10.0	10.0
± .01	Auto	100.000	96.95 to 103.05	100.1	100.1
± .01	Auto	1000.000	965 to 1035	1000.1	1000.1
± .01	Cal resistor	19 Ohms	As Found data only	19.939	19.939

* Indicates out of tolerance readings.

Remarks: Measurement Uncertainty reported at coverage factor K = 2 or 95% confidence level.