

Borehole Geophysical Services

Area 3

DOE Y-12 Facility

Oak Ridge, Tennessee

Subcontract Number: 4000019106

Geophex Job No. 1210

Submitted to:

UT-Battelle

Oak Ridge National Laboratory

Environmental Sciences Division

Building 1505, MS-6038

P.O. Box 2008, 1 Bethel Valley Road

Oak Ridge, TN 37831-6038

Headquarters

Geophex, Ltd.

605 Mercury Street

Raleigh, NC 27603-2343

Tel: (919) 839-8515

Fax: (919) 839-0096

Website: www.geophex.com

Email: geophex@geophex.com

May 2003

Borehole Geophysical Services
Area 3
DOE Y-12 Facility
Oak Ridge, Tennessee

Table of Contents

Table of Contents	i
List of Figures	i
List of Tables	ii
1.0 Introduction.....	1
2.0 Geophysical Methods and Procedures.....	3
2.1 Natural Gamma.....	4
2.2 Borehole Deviation.....	5
2.3 EM Induction.....	6
2.4 Full-Waveform Sonics.....	7
3.0 Results.....	8
3.01 FW024 Results	11
3.02 FW026 Results	15
3.03 FW103 Results	19
3.04 FW104 Results	23
3.05 FW105 Results	27
3.06 FW106 Results	31
3.07 FW107 Results	35
3.08 FW108 Results	39
3.09 FW109 Results	43

List of Figures

Figure 1. Vicinity map and well layout	1
Figure 2. Geophex portable logging system	3
Figure 3. Mount Sopris 2PGA-1000 Poly-Gamma probe	4
Figure 4. 10 uCi checksource.....	4
Figure 5. Results from a typical operational check.....	4
Figure 6. 2DVA-1000 schematic	5
Figure 7. Mount Sopris 2SAA-1000/F Sonic probe	7
Figure 8. Composite East-West profile plot of all nine wells.....	8
Figure 9. Composite North-South profile plot of all nine wells	8
Figure 10. 3D view of deviation data from all nine wells	9
Figure 11. Well layout showing section locations.....	10
Figure 12. Section 1, from well FW106 to well FW108	10
Figure 13. Section 2, from well FW105 to well FW024	10
Figure 14. FW024 Bullseye plot of borehole orientation	12
Figure 15. FW024 East-West profile of borehole orientation	13
Figure 16. FW024 North-South profile of borehole orientation.....	13
Figure 17. FW024 geophysical logs	14
Figure 18. FW026 Bullseye plot of borehole orientation	16
Figure 19. FW026 East-West profile of borehole orientation	17
Figure 20. FW026 North-South profile of borehole orientation.....	17
Figure 21. FW026 geophysical logs	18
Figure 22. FW103 Bullseye plot of borehole orientation	20
Figure 23. FW103 East-West profile of borehole orientation	21

Figure 24. FW103 North-South profile of borehole orientation.....	21
Figure 25. FW103 geophysical logs	22
Figure 26. FW104 Bullseye plot of borehole orientation	24
Figure 27. FW104 East-West profile of borehole orientation	25
Figure 28. FW104 North-South profile of borehole orientation.....	25
Figure 29. FW104 geophysical logs	26
Figure 30. FW105 Bullseye plot of borehole orientation	28
Figure 31. FW105 East-West profile of borehole orientation	29
Figure 32. FW105 North-South profile of borehole orientation.....	29
Figure 33. FW105 geophysical logs	30
Figure 34. FW106 Bullseye plot of borehole orientation	32
Figure 35. FW106 East-West profile of borehole orientation	33
Figure 36. FW106 North-South profile of borehole orientation.....	33
Figure 37. FW106 geophysical logs	34
Figure 38. FW107 Bullseye plot of borehole orientation	36
Figure 39. FW107 East-West profile of borehole orientation	37
Figure 40. FW107 North-South profile of borehole orientation.....	37
Figure 41. FW107 geophysical logs	38
Figure 42. FW108 Bullseye plot of borehole orientation	40
Figure 43. FW108 East-West profile of borehole orientation	41
Figure 44. FW108 North-South profile of borehole orientation.....	41
Figure 45. FW108 geophysical logs	42
Figure 46. FW109 Bullseye plot of borehole orientation	44
Figure 47. FW109 East-West profile of borehole orientation	45
Figure 48. FW109 North-South profile of borehole orientation.....	45
Figure 49. FW109 geophysical logs	46

List of Tables

Table 1. Summary of geophysical logs run in each well	2
Table 2. Well location and drill data.....	2
Table 3. Well completion information.....	2
Table 4. FW024 borehole deviation survey results	11
Table 5. FW026 borehole deviation survey results	15
Table 6. FW103 borehole deviation survey results	19
Table 7. FW104 borehole deviation survey results	23
Table 8. FW105 borehole deviation survey results	27
Table 9. FW106 borehole deviation survey results	31
Table 10. FW107 borehole deviation survey results	35
Table 11. FW108 borehole deviation survey results	39
Table 12. FW109 borehole deviation survey results	43

1.0 Introduction

On December 3 and 4th, 2002 Geophex, Ltd provided borehole geophysical services in nine wells located in Area 3 at the DOE Y-12 Oak Ridge Facility, Oak Ridge, Tennessee (Figure 1).

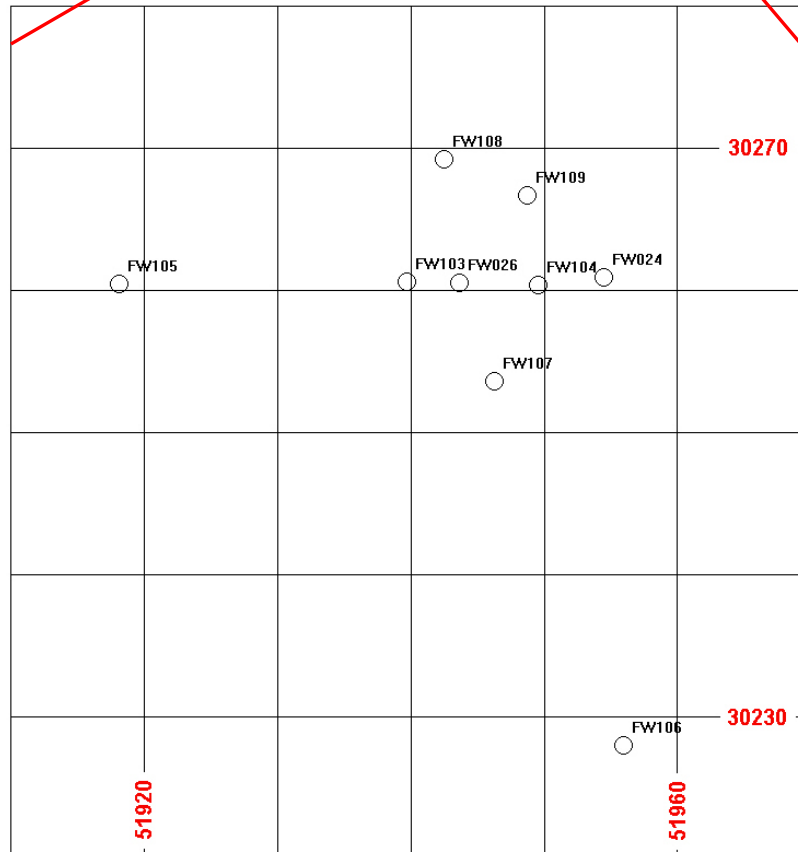
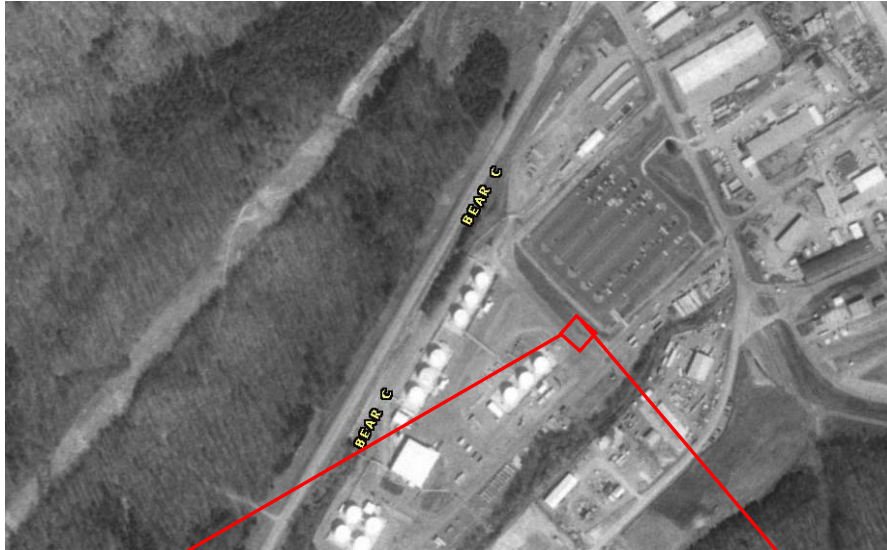


Figure 1. Vicinity map and well layout

Table 1 lists the logs that were run in each well. Tables 2 and 3 list well drill information and well completion information.

Table 1. Summary of geophysical logs run in each well

Location	Natural Gamma	Borehole Deviation	EM Induction	Full-waveform Sonics	Comments
FW024	X	X			PVC Cased
FW026	X	X			PVC Cased
FW103	X	X			PVC Cased
FW104	X	X			PVC Cased
FW105	X	X			PVC Cased
FW106	X	X			PVC Cased
FW107	X	X	X	X	open borehole w/ temp "FLUTe" liner
FW108	X	X	X	X	open borehole w/ temp "FLUTe" liner
FW109	X	X	X	X	open borehole w/ temp "FLUTe" liner

Table 2. Well location and drill data

Location	Northing	Easting	TOC Elev	Ground Elev	TOC Stickup	Casing Depth Bottom	Boring Depth	Boring Diameter
FW024	30260.64	51954.54	1008.86	1009.1457	-0.29	45.82	48	11.5
FW026	30260.64	51943.54	1008.11	1008.4005	-0.29	45.6	50	11.5
FW103	30260.5933	51939.6772	1007.901	1008.2643	-0.3633	45.74	48	9.5
FW104	30260.3454	51949.5364	1008.268	1008.6131	-0.3451	45.19	48	11.5
FW105	30260.4475	51918.1458	1006.83	1007.17	-0.34	43.27	48	9.5
FW106	30227.7218	51956.0958	1008.922	1008.353	0.569	37.17	41.21	3.25
FW107	30253.56	51946.26	NA	1008.28	None	NA	51.42	4
FW108	30269.23	51942.5	NA	1008.54	None	NA	51.46	4
FW109	30266.69	51948.73	NA	1008.49	None	NA	51.54	4

Table 3. Well completion information

Location	Screen Type	Screen Depth Top	Casing Type	Casing Diameter ID	Seal Type	Seal Depth Bottom	Packing Type	Completion Date
FW024	PVC	38.74	PVC	4	Bentonite slurry	37	sand	07/26/02
FW026	PVC	38.52	PVC	4	Bentonite slurry	37	sand	07/31/02
FW103	PVC	38.66	PVC	4	Bentonite pellets	37	sand	06/25/02
FW104	PVC	38.11	PVC	4	Bentonite slurry	37	sand	07/26/02
FW105	PVC	36.19	PVC	4	Bentonite pellets	35	sand	06/27/02
FW106	PVC	30.09	PVC	2	Bentonite pellets		sand	05/01/02
FW107	None	None	None	None	NA	NA	NA	10/22/02
FW108	None	None	None	None	NA	NA	NA	10/23/02
FW109	None	None	None	None	NA	NA	NA	10/31/02

2.0 Geophysical Methods and Procedures

Geophex used our portable logging system (Figure 2) to complete this project. The geophysical logs requested for this investigation were natural gamma, full-waveform sonics, and EM induction.

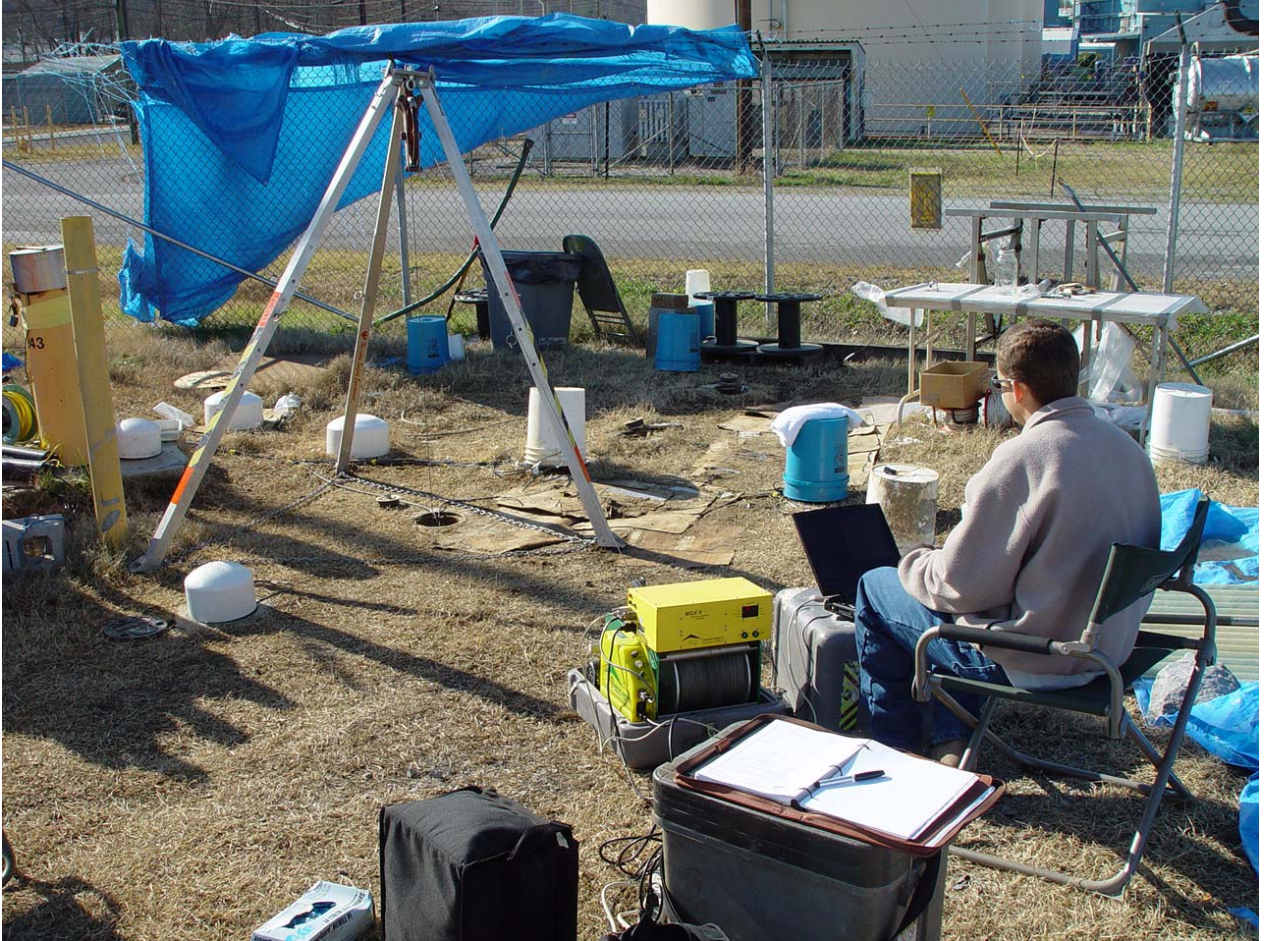


Figure 2. Geophex portable logging system

Our portable system is a Mount Sopris MGXII Logger with a Mount Sopris 4WNA-1000 winch with 1000 feet of single conductor logging cable.

2.1 Natural Gamma

A Mount Sopris 2PGA-1000 poly-gamma probe (Figure 3) was used to acquire natural gamma. The natural gamma sensor is a Sodium Iodide crystal that emits a pulse of light when struck by a gamma photon. This tool measures the gamma photons that originate from the radioactive decay of naturally occurring isotopes of Potassium-40 and daughter products of Uranium-238 and Thorium-232.



Figure 3. Mount Sopris 2PGA-1000 Poly-Gamma probe



Figure 4. 10 uCi checksource

Before each run a 10 uCi checksource (Figure 4) was used to confirm the operation of the 2PGA-1000 Gamma probe (Figure 5). The recorded counts should be approximately 17000 CPS

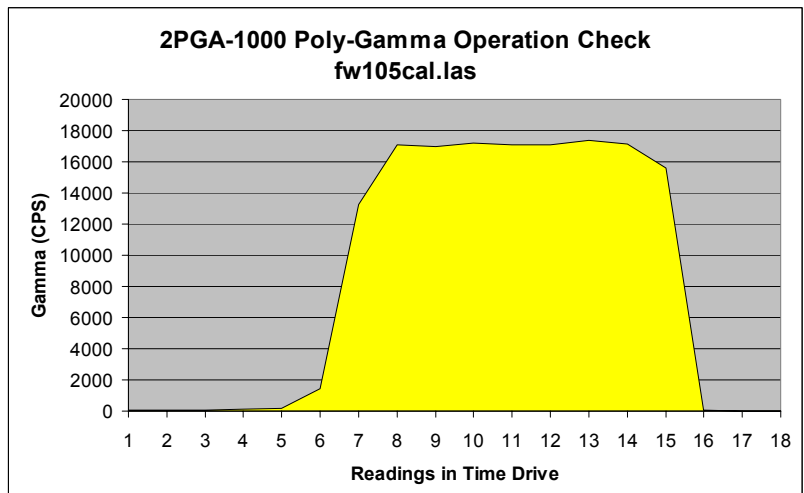
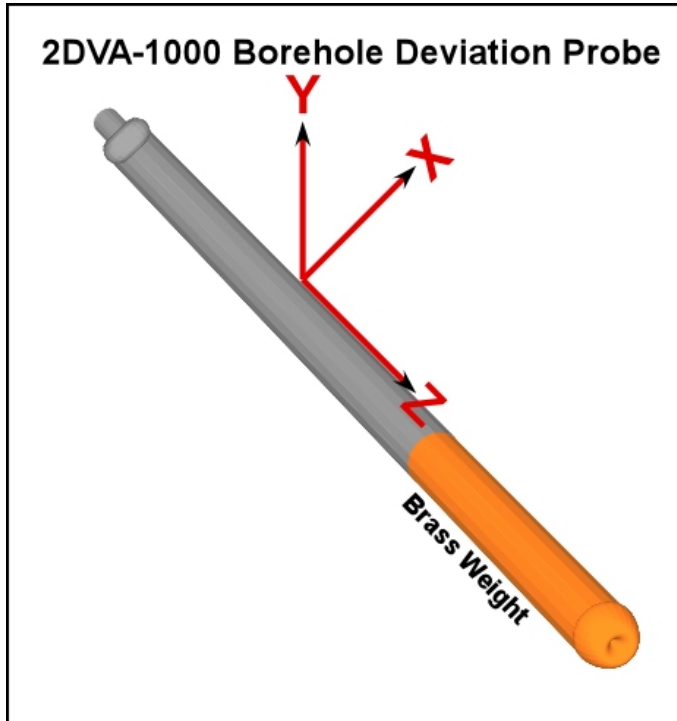


Figure 5. Results from a typical operational check

Data was recorded logging down and up each well for QC repeat runs. The logging speed was 7 ft/min. Data was recorded at 0.1-ft depth sample interval.

2.2 Borehole Deviation

A Mount Sopris 2DVA-1000 borehole probe was used to acquire the borehole deviation (orientation) logs. This tool is used to measure the borehole inclination (tilt) and azimuth. This probe is equipped with three flux gate magnetometers and three piezo electric accelerometers.



This probe measures the magnetic field and acceleration in three different directions; along three orthogonal axis. The probe has an index mark (a 'V') stamped on the lower part of the housing. This mark indicates the side of the probe from which the positive X axis extends. The Z axis is the longitudinal axis and points down. The Y axis is defined using a right hand coordinate system where the cross product of X and Y equal Z. The X and Y axis are in the horizontal plane when the probe is vertical (Figure 6).

Figure 6. 2DVA-1000 schematic

Specifications

Length:	59.4 inches, 151 cm
Diameter:	1.50 inches, 3.81 cm
Weight:	16 lbs, 7.3 Kg
Operating Temperature:	0 - 70 degrees C
Maximum Pressure:	200 Bar (3000 psi)
Directional Accuracy:	(Azimuth) +/- 0.5 degrees
Range of measurable inclination:	0 - 90 degrees
Operating Voltage:	52-88 VDC
Operating Current:	150 mADC

Data was recorded logging down and up each well for QC repeat runs. The logging speed was 7 ft/min. Data was recorded at 0.1-ft depth sample interval.

2.3 EM Induction

A Mount Sopris 2PIA-1000 EM Induction probe was used to acquire conductivity logs. This tool measures the conductivity of the material surrounding the borehole by using a magnetic field to induce an electric field. This induced electric field produces electric currents in the material being surveyed. The magnitude of these currents is proportional to the conductivity of the material.

Specifications

Output:	Pulse type, positive & negative going, 1.25uS wide from ~ 12.5 KHz to 17.5 KHz.
Radius of Investigation:	Maximum sensitivity 28 cm, Minimum sensitivity 10 cm
Vertical Resolution:	65 cm
Ranges or Scales:	100mS/m, 1000mS/m, 10000mS/m
Accuracy:	5% of full scale
Resolution:	0.02 % of full scale
Repeatability:	+/- 2% full scale for temperature changes <10 degrees Centigrade
Noise Level:	Less than 0.5 mS/m
Operating Frequency:	39.2 KHz
Primary Field Source:	Self contained dipole transmitter
Sensor:	Self contained dipole receiver
Coil Separation:	50 cm

Data was recorded logging down and up each well for QC repeat runs. The logging speed was 7 ft/min. Data was recorded at 0.1-ft depth sample interval. Data was recorded using the 0-1000 ms probe file.

2.4 Full-Waveform Sonics

Geophex used a Mount Sopris model 2SAA-1000/F two receiver sonic probe (Figure 7). This probe uses a monopole transmitter that generates a sonic signal at a frequency of 15 kHz. The transmitter is located at the bottom of the probe, and the two receivers are located three and four feet above.

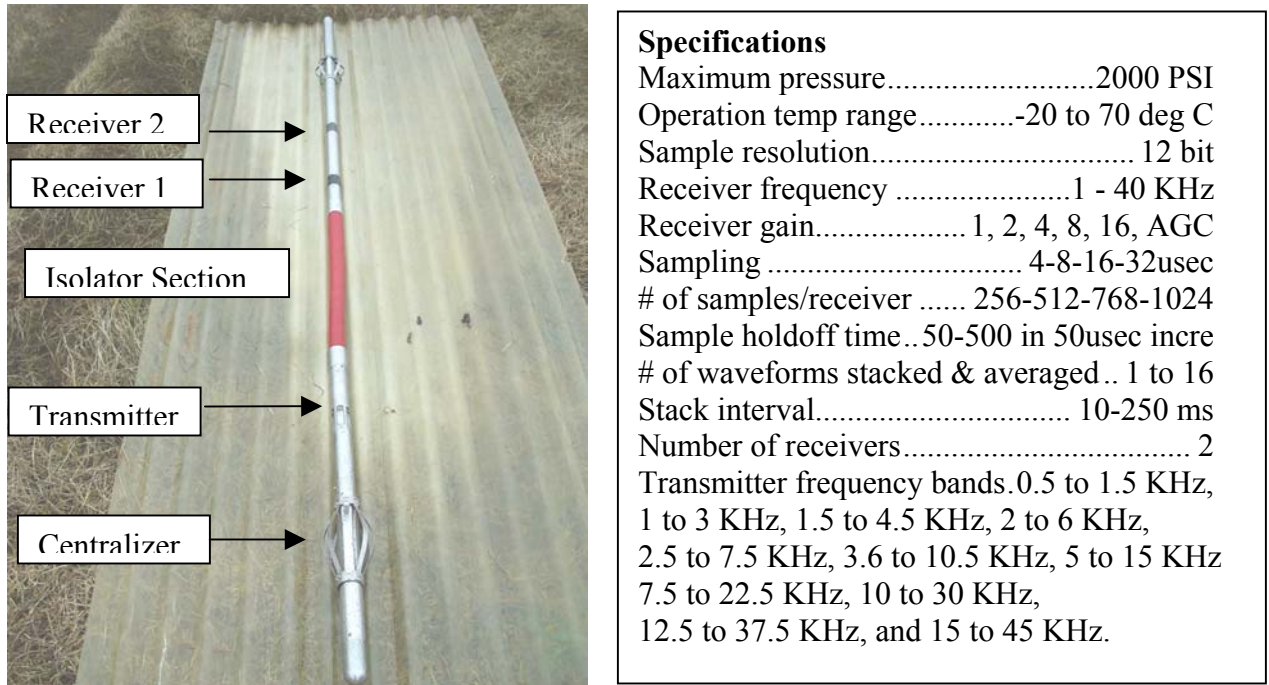


Figure 7. Mount Sopris 2SAA-1000/F Sonic probe

Data was acquired as the probe was logged up the well at approximately 7 ft/min. The tool was run fully centralized.. All logs were corrected for sensor offset and casing stick-up to ground surface in post processing.

3.0 Results

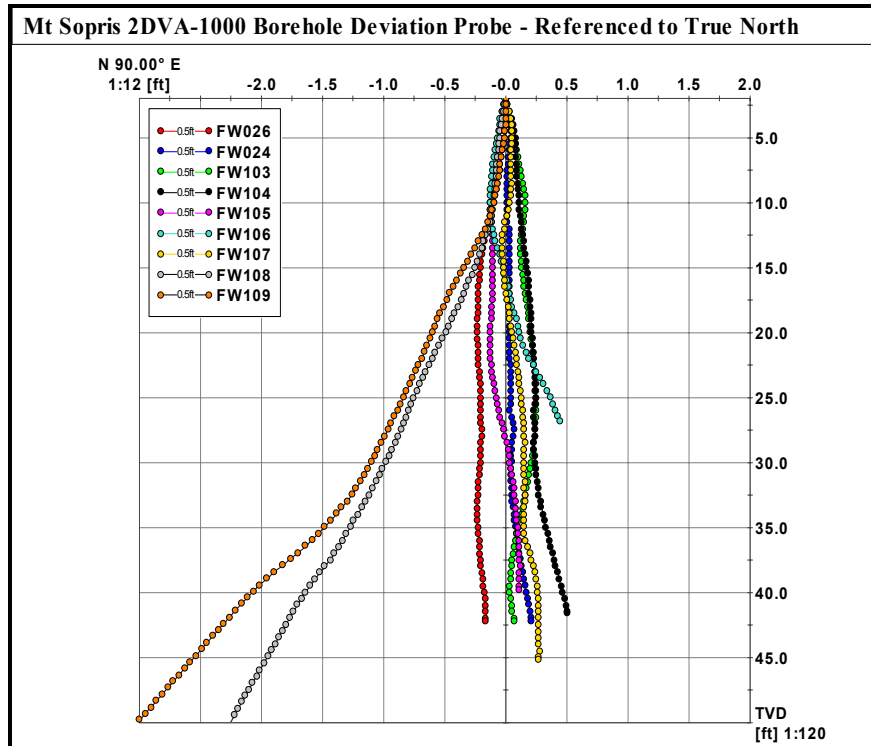


Figure 8. Composite East-West profile plot of all nine wells

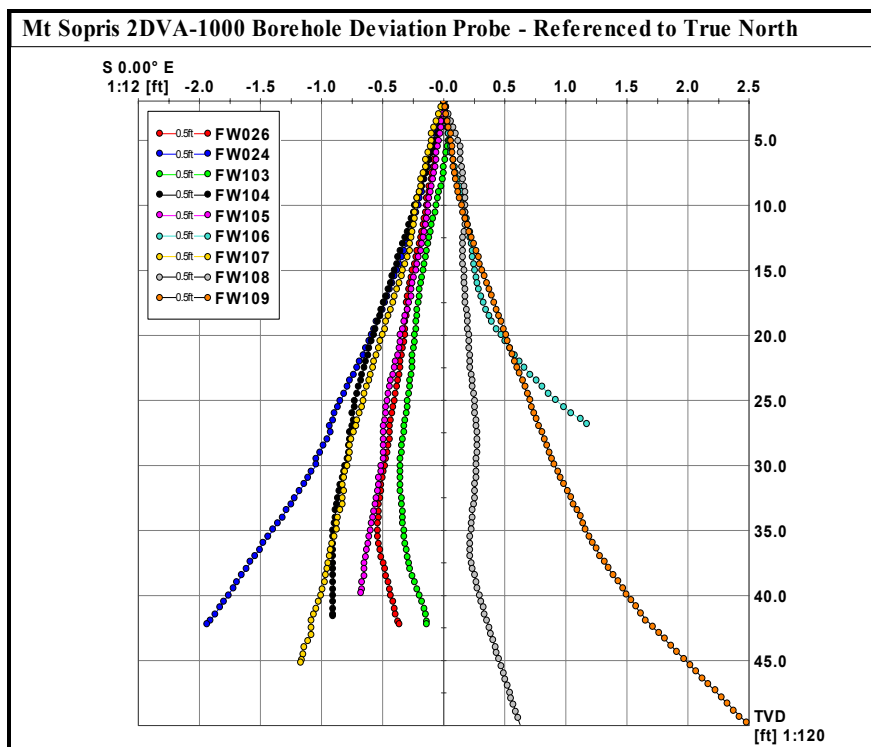


Figure 9. Composite North-South profile plot of all nine wells

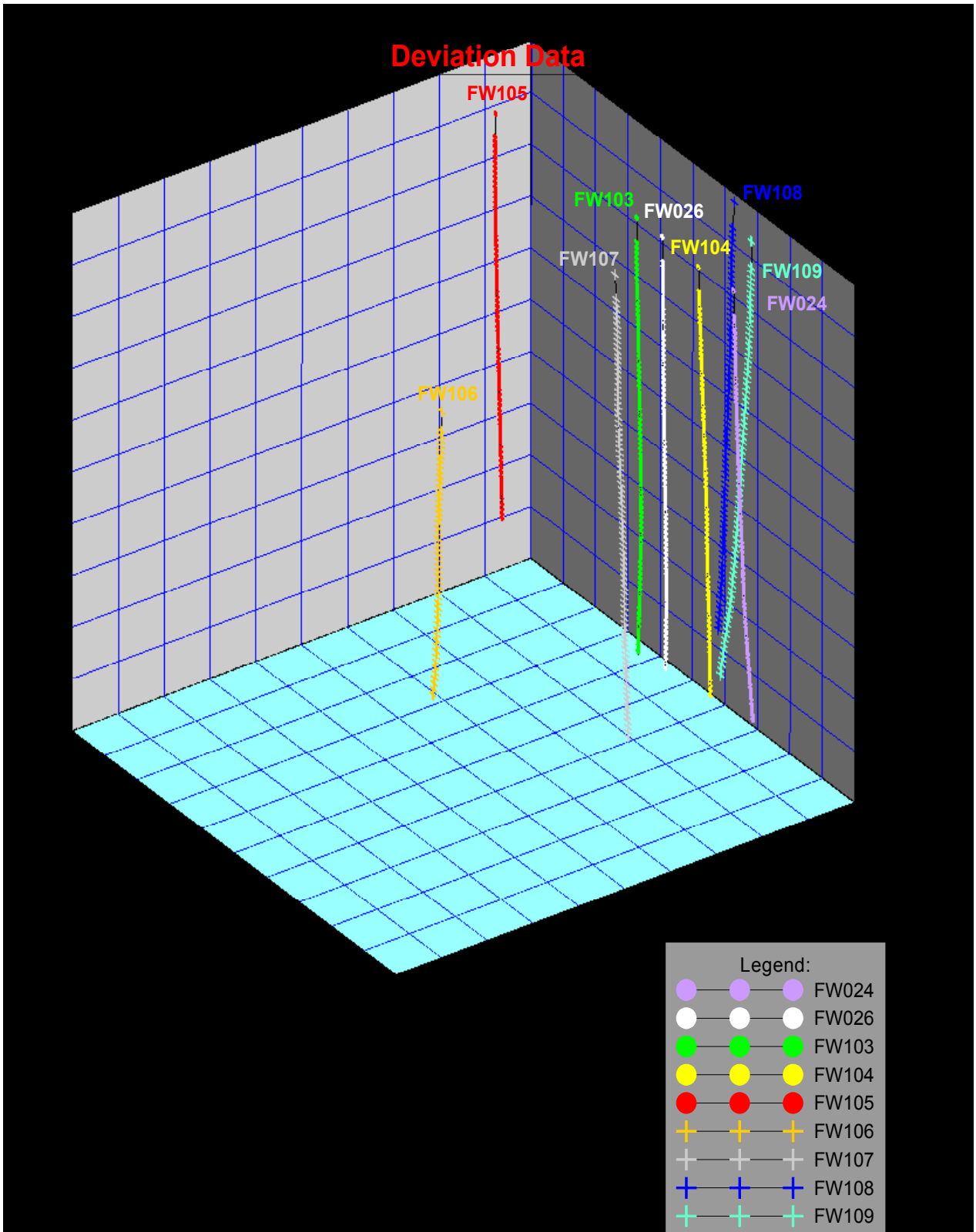


Figure 10. 3D view of deviation data from all nine wells

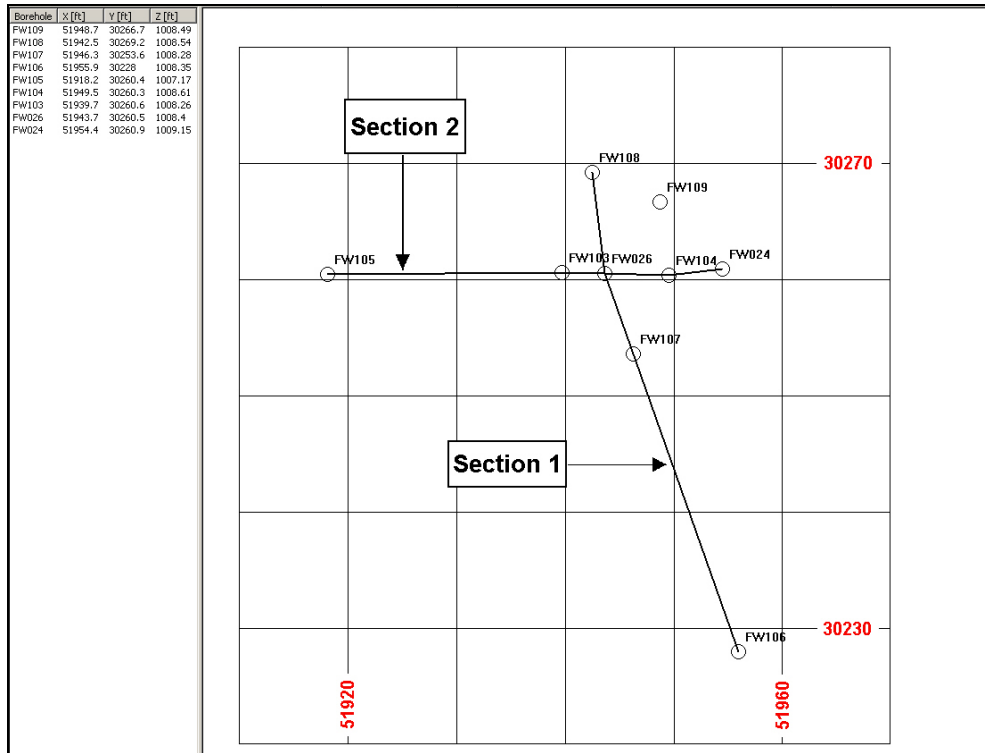


Figure 11. Well layout showing section locations

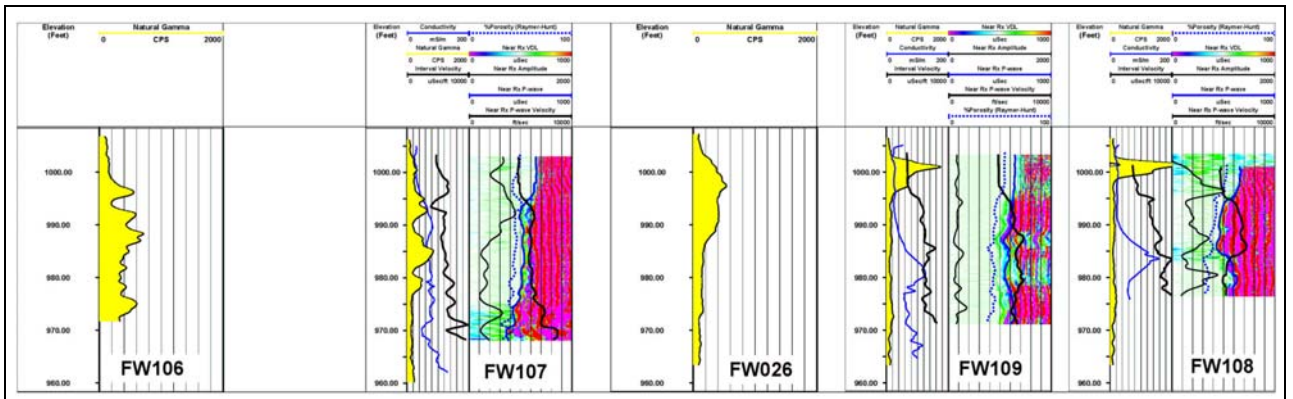


Figure 12. Section 1, from well FW106 to well FW108

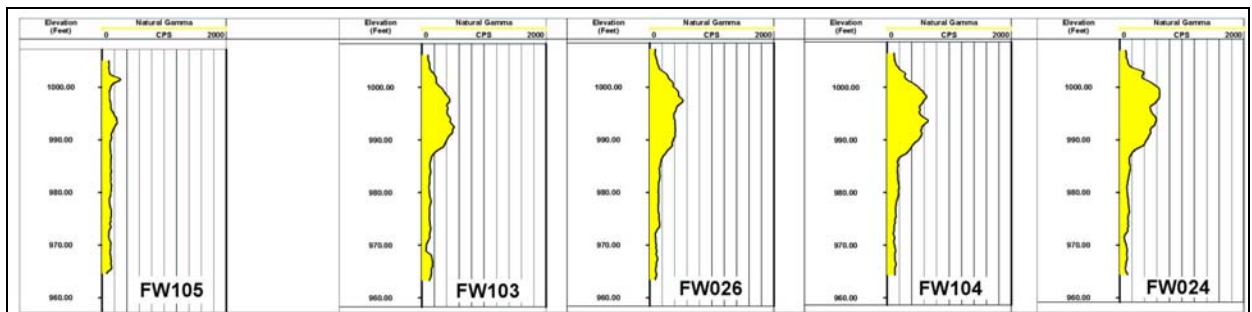


Figure 13. Section 2, from well FW105 to well FW024

3.01 FW024 Results

Table 4. FW024 borehole deviation survey results

Well FW024	Borehole Deviation Survey Results			Easting:	51954.44	
Ground Elev.	1009.1457			Northing:	30260.92	
	Ground	True Vertical				
Depth	Elevation	Depth	Tilt	Azimuth)	Easting	Northing
(feet)	(feet)	(feet)	(Degrees)	(Degrees)	(feet)	(feet)
0	1009.1457	0			51954.44	30260.92
2	1007.1772	1.9685		54.0305	51954.44	30260.92
3	1006.1797	2.96598	1.75139	37.7736	51954.45992	30260.94209
4	1005.1823	3.96341	1.97057	23.9924	51954.47239	30260.97063
5	1004.1850	4.96072	1.97908	74.8303	51954.48179	30261.00255
6	1003.1876	5.95807	1.88165	342.028	51954.47236	30261.01994
7	1002.1902	6.95547	1.82385	351.12	51954.46069	30261.04992
8	1001.1928	7.95289	1.78214	354.17	51954.45467	30261.08104
9	1000.0956	9.05009	1.71324	3.83994	51954.45248	30261.0992
10	999.0982	10.0475	1.88235	6.18985	51954.45366	30261.13143
11	998.1009	11.0448	2.06228	2.62751	51954.45359	30261.16665
12	997.1037	12.042	2.1929	5.65114	51954.47105	30261.19055
13	996.1065	13.0392	2.26882	4.74921	51954.47104	30261.22991
14	995.1094	14.0363	2.19396	4.00471	51954.47119	30261.2687
15	994.1121	15.0336	2.10484	3.17674	51954.47062	30261.30599
16	993.1149	16.0308	2.13245	3.26685	51954.46948	30261.34232
17	992.1177	17.028	2.2796	6.5367	51954.47005	30261.38145
18	991.1207	18.025	2.46802	8.73149	51954.4728	30261.42309
19	990.1237	19.022	2.53458	3.11872	51954.47358	30261.46686
20	989.1268	20.0189	2.63137	4.86042	51954.47297	30261.51219
21	988.1300	21.0157	2.71726	7.1332	51954.47437	30261.55904
22	987.1333	22.0124	2.82973	6.88455	51954.47698	30261.60747
23	986.1366	23.0091	2.91954	4.74763	51954.47846	30261.65787
24	985.1400	24.0057	3.02212	4.7867	51954.4787	30261.70978
25	984.1435	25.0022	3.06786	3.33773	51954.47859	30261.76317
26	983.1470	25.9987	3.08869	1.05334	51954.47654	30261.81635
27	982.1507	26.995	3.2694	0.661487	51954.50046	30261.85461
28	981.1545	27.9912	3.42329	357.228	51954.49774	30261.87579
29	980.1584	28.9873	3.51399	356.843	51954.48867	30261.93567
30	979.1624	29.9833	3.66392	0.618837	51954.48591	30261.96653
31	978.1667	30.979	3.85664	5.20837	51954.48399	30262.03198
32	977.1711	31.9746	4.03012	9.47114	51954.48718	30262.10087
33	976.1757	32.97	4.1434	12.791	51954.49642	30262.1714
34	975.1805	33.9652	4.2881	11.7194	51954.50578	30262.2443
35	974.1854	34.9603	4.32626	14.9141	51954.51774	30262.31829
36	973.1904	35.9553	4.35903	17.3271	51954.53334	30262.39224
37	972.1953	36.9504	4.28936	19.5565	51954.55198	30262.46547
38	971.2001	37.9456	4.2631	17.8827	51954.57035	30262.53681
39	970.2049	38.9408	4.25534	18.9523	51954.58839	30262.60867
40	969.2098	39.9359	4.28618	19.5152	51954.60753	30262.68047
41	968.2147	40.931	4.47028	19.3973	51954.62761	30262.75355
42	967.2201	41.9256	4.77139	19.8232	51954.64769	30262.83114

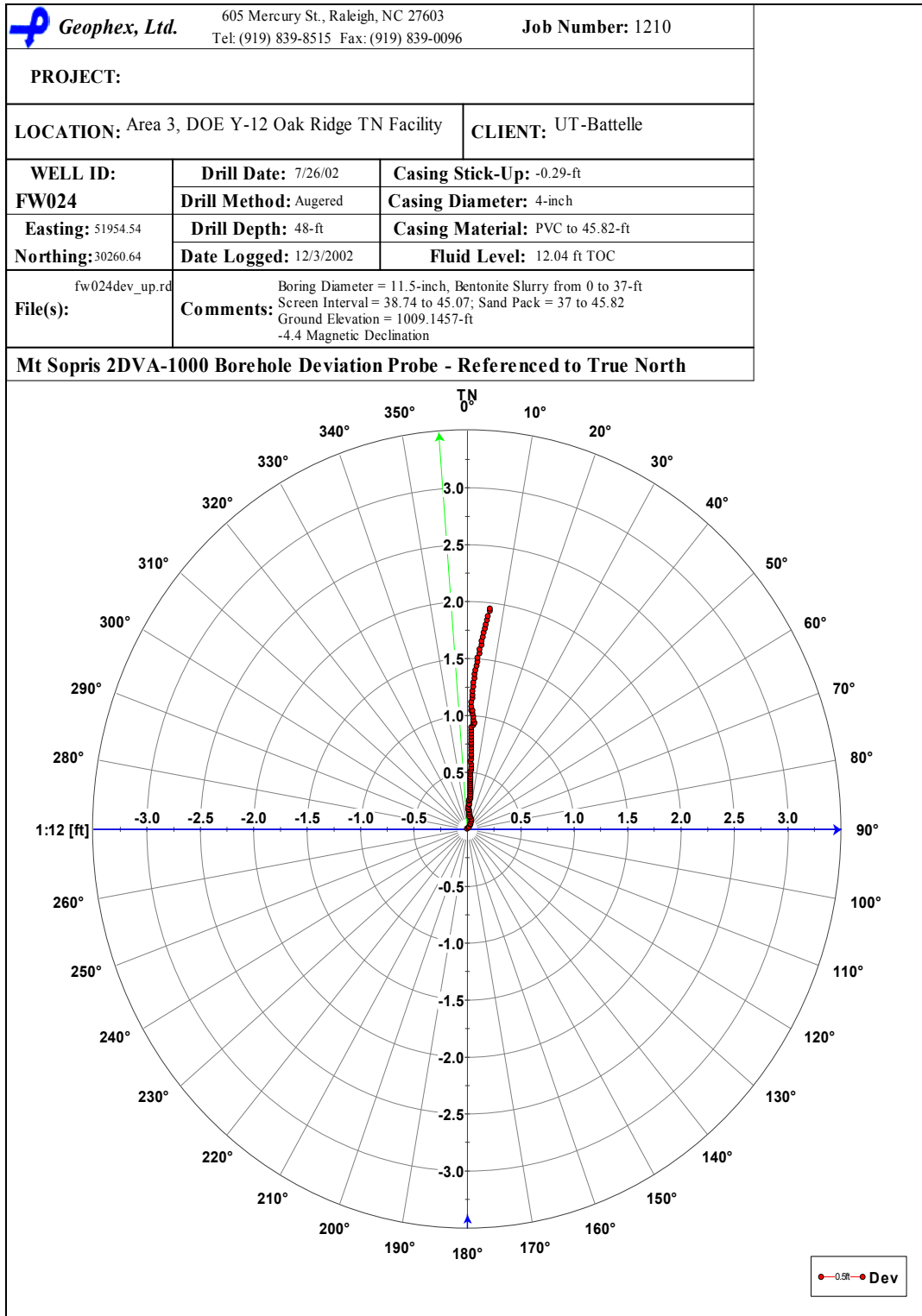


Figure 14. FW024 Bullseye plot of borehole orientation

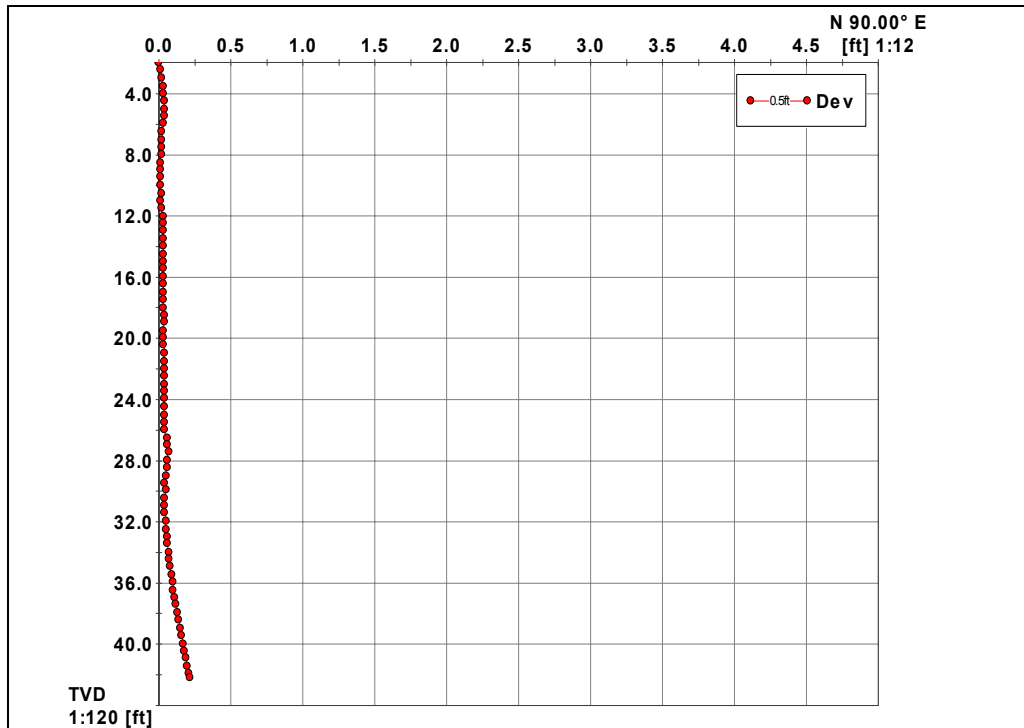


Figure 15. FW024 East-West profile of borehole orientation

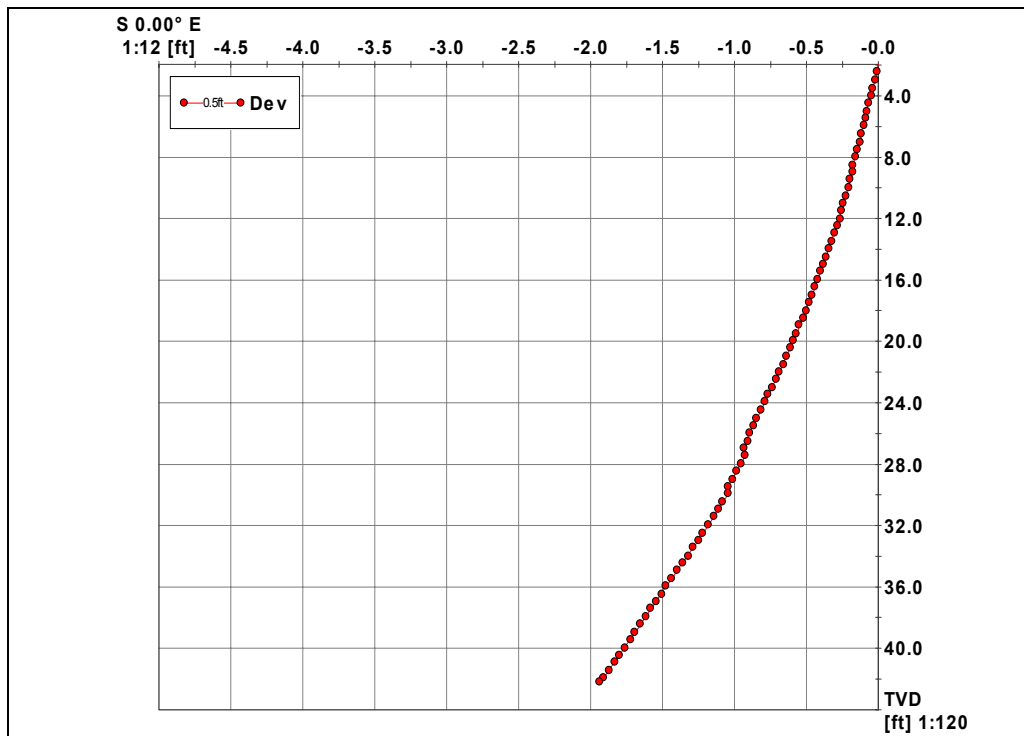


Figure 16. FW024 North-South profile of borehole orientation

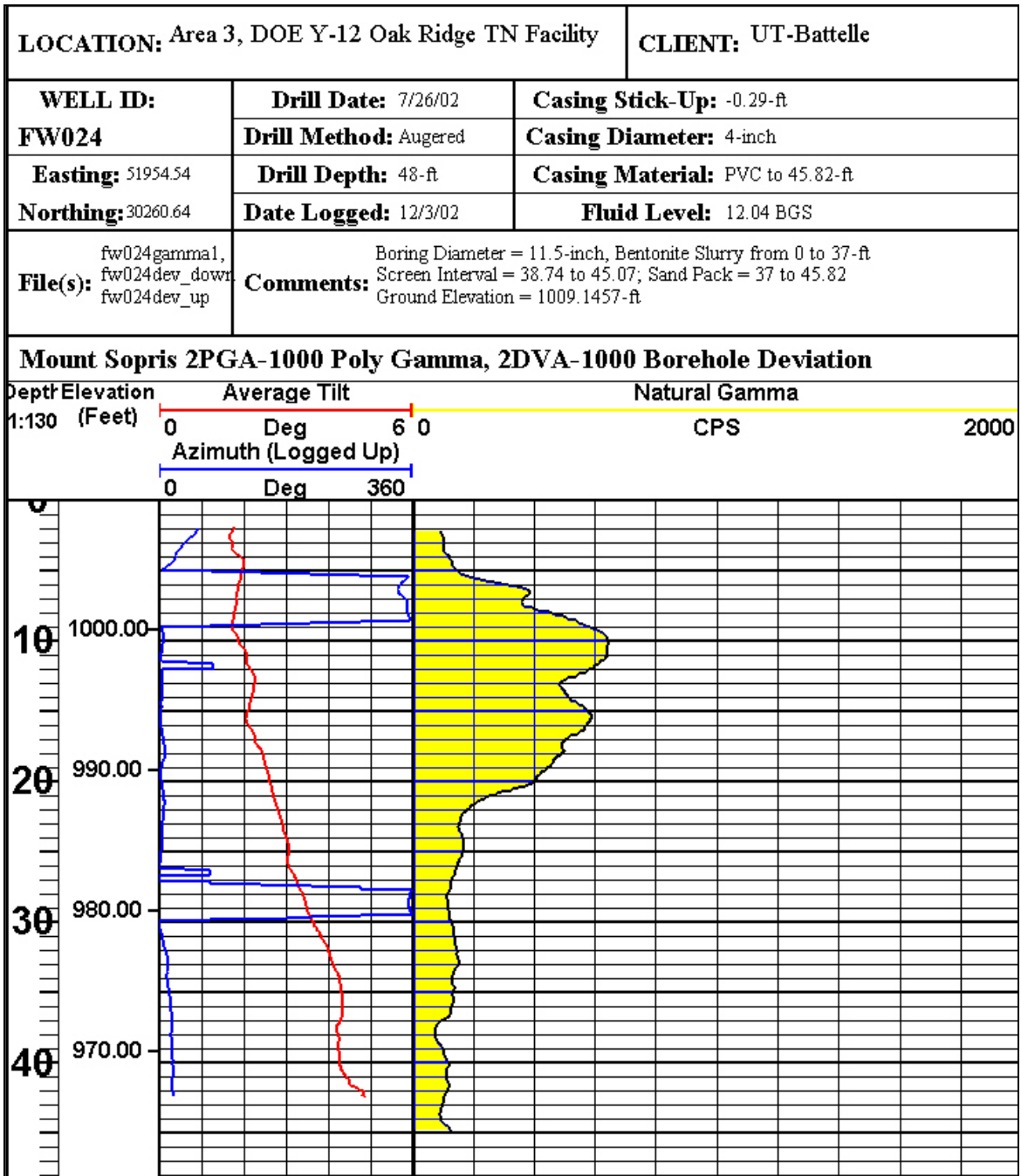


Figure 17. FW024 geophysical logs

3.02 FW026 Results

Table 5. FW026 borehole deviation survey results

Well FW026	Borehole Deviation Survey Results			Easting:	51943.69	
Ground Elev.	1008.4			Northing:	30260.54	
	Ground	True Vertical				
Depth	Elevation	Depth	Tilt	Azimuth)	Easting	Northing
(feet)	(feet)	(feet)	(Degrees)	(Degrees)	(feet)	(feet)
0	1008.40	0.00			51943.690	30260.540
2	1006.43	1.97		62.89	51943.690	30260.540
3	1005.43	2.97	1.22	354.60	51943.697	30260.546
4	1004.44	3.96	1.32	349.00	51943.693	30260.568
5	1003.44	4.96	1.39	324.02	51943.681	30260.588
6	1002.44	5.96	1.40	315.52	51943.663	30260.605
7	1001.44	6.96	1.40	332.79	51943.646	30260.623
8	1000.45	7.95	1.56	322.12	51943.630	30260.643
9	999.35	9.05	1.48	319.47	51943.610	30260.665
10	998.35	10.05	1.69	311.97	51943.588	30260.682
11	997.35	11.05	1.77	309.15	51943.564	30260.700
12	996.36	12.04	1.78	307.28	51943.538	30260.718
13	995.36	13.04	1.97	324.61	51943.510	30260.739
14	994.36	14.04	1.69	337.73	51943.495	30260.766
15	993.36	15.04	1.59	342.41	51943.483	30260.792
16	992.37	16.03	1.34	344.01	51943.475	30260.815
17	991.37	17.03	1.18	351.75	51943.469	30260.836
18	990.37	18.03	1.07	144.77	51943.466	30260.839
19	989.37	19.03	1.07	355.59	51943.459	30260.852
20	988.38	20.02	0.92	9.01	51943.459	30260.860
21	987.38	21.02	0.84	21.39	51943.462	30260.874
22	986.38	22.02	0.90	29.48	51943.467	30260.889
23	985.38	23.02	1.00	25.47	51943.475	30260.904
24	984.38	24.02	1.10	15.85	51943.480	30260.921
25	983.39	25.01	1.19	10.26	51943.482	30260.941
26	982.39	26.01	1.22	8.66	51943.484	30260.962
27	981.39	27.01	1.07	8.83	51943.486	30260.982
28	980.39	28.01	1.11	281.43	51943.493	30260.981
29	979.40	29.00	1.31	345.46	51943.486	30261.001
30	978.40	30.00	1.14	343.96	51943.479	30261.021
31	977.40	31.00	1.02	341.47	51943.473	30261.039
32	976.40	32.00	1.07	336.50	51943.464	30261.055
33	975.40	33.00	0.80	345.88	51943.458	30261.070
34	974.41	33.99	0.78	214.85	51943.453	30261.077
35	973.41	34.99	0.70	68.34	51943.461	30261.084
36	972.41	35.99	1.23	158.07	51943.472	30261.075
37	971.41	36.99	1.81	179.97	51943.478	30261.047
38	970.42	37.98	1.70	147.26	51943.488	30261.019
39	969.42	38.98	1.66	157.52	51943.503	30260.994
40	968.42	39.98	1.63	158.87	51943.515	30260.968
41	967.42	40.98	1.61	163.46	51943.526	30260.942
42	966.43	41.97	1.76	188.77	51943.530	30260.914

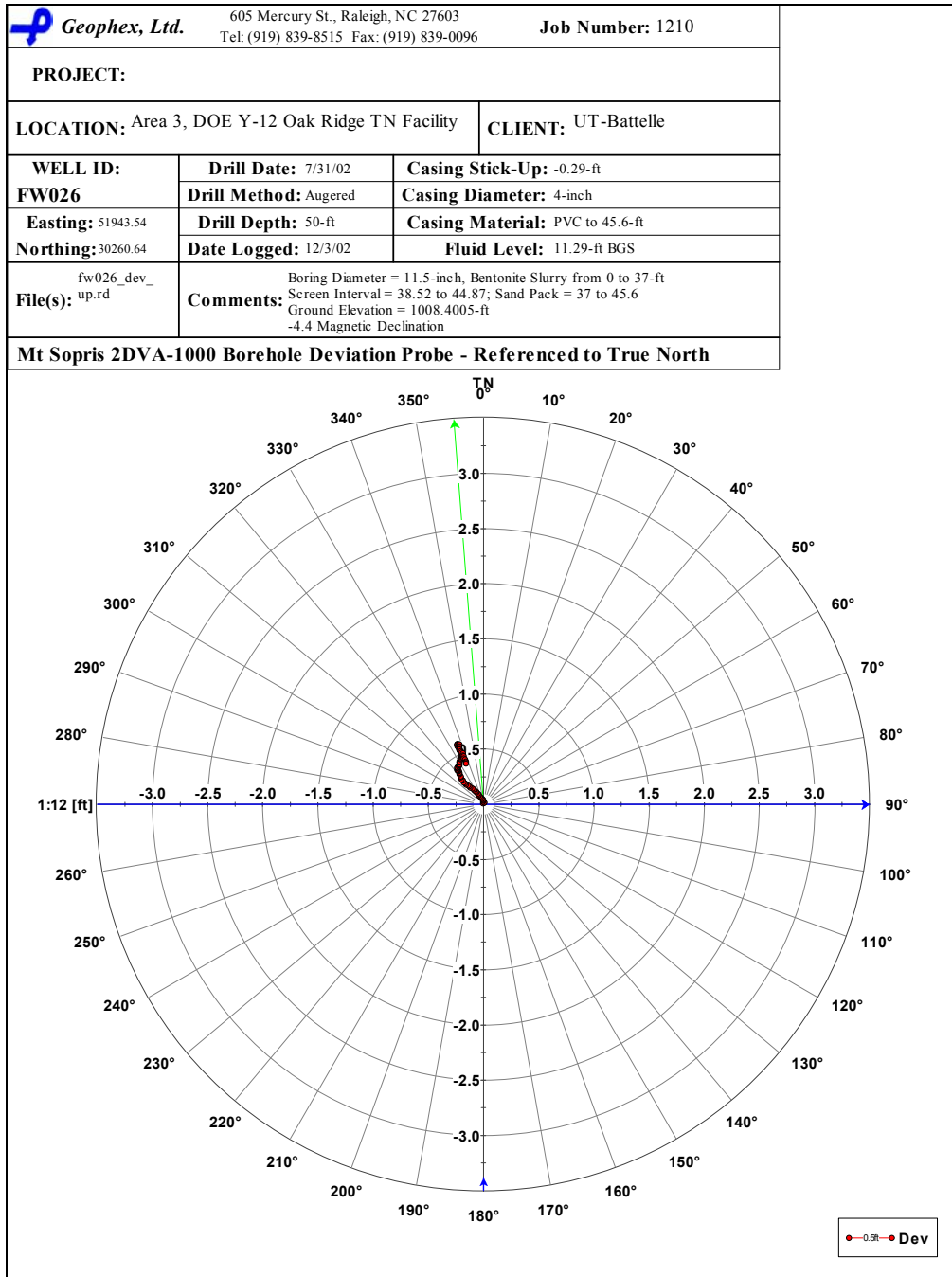


Figure 18. FW026 Bullseye plot of borehole orientation

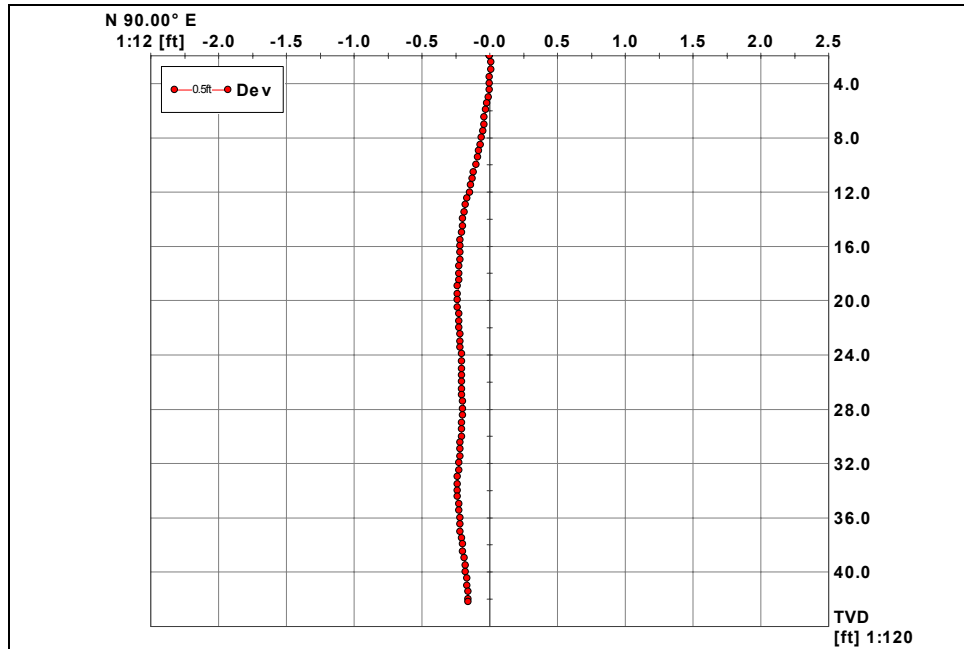


Figure 19. FW026 East-West profile of borehole orientation

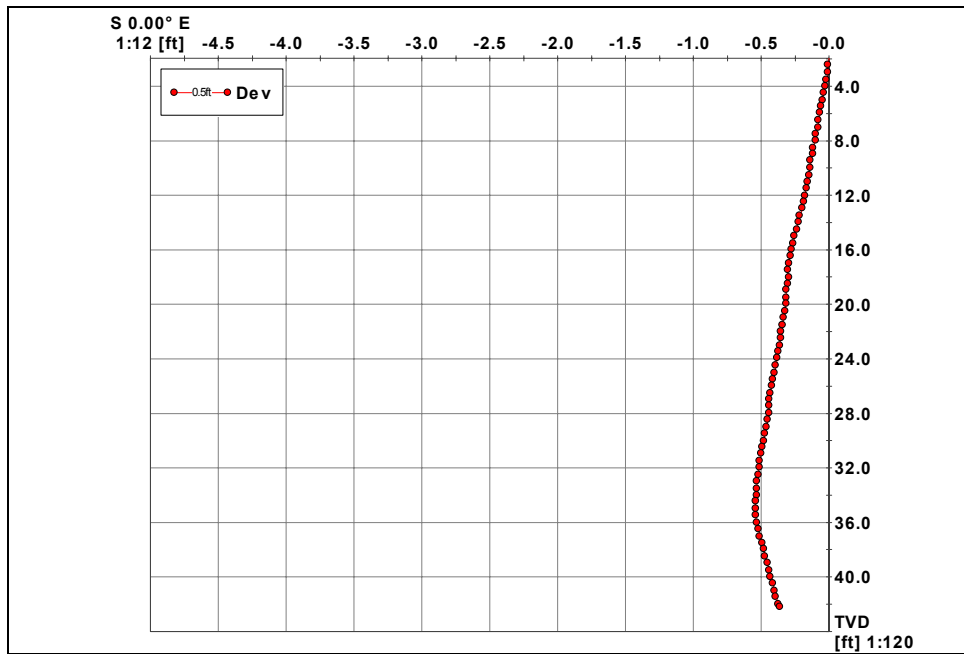


Figure 20. FW026 North-South profile of borehole orientation

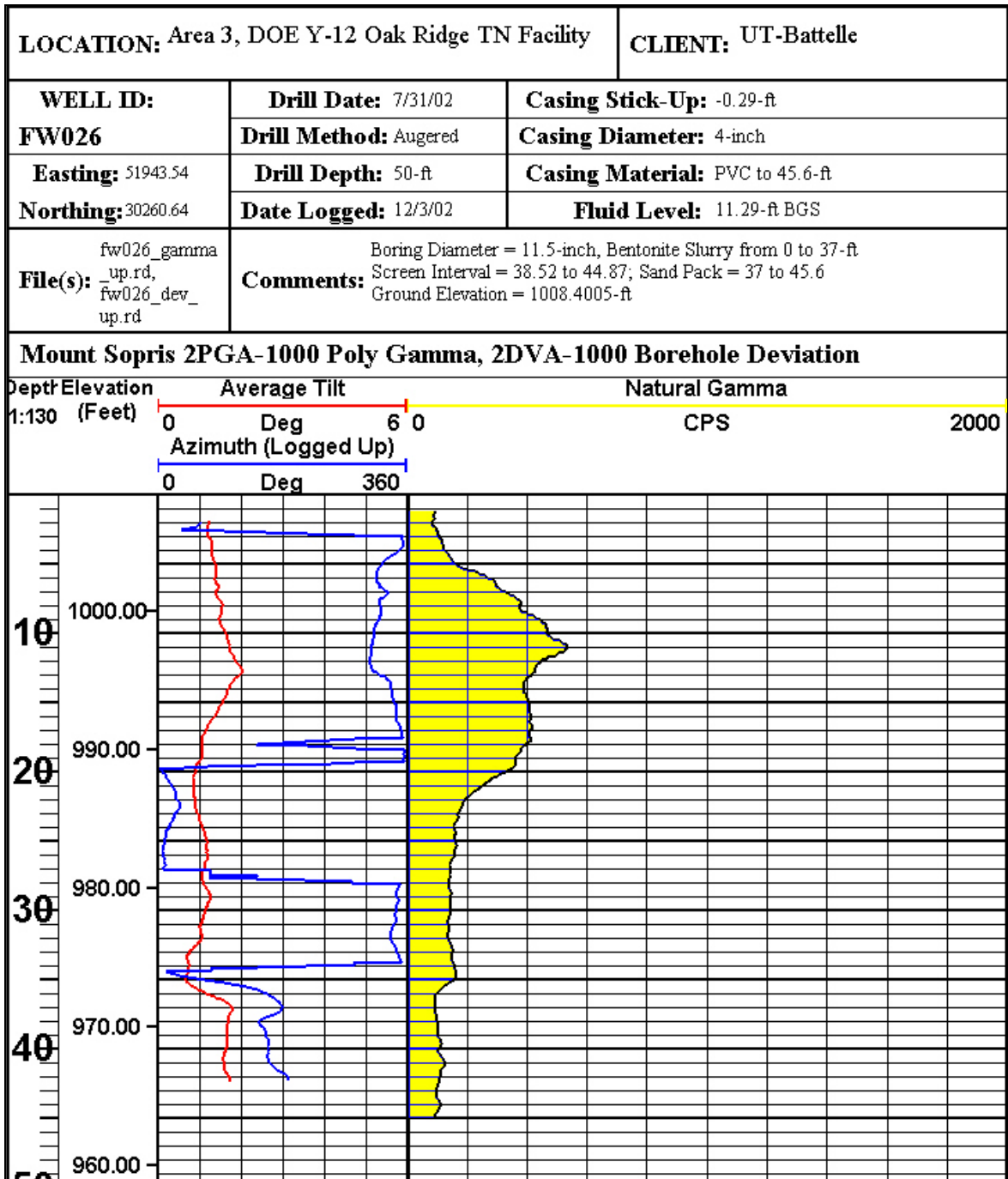


Figure 21. FW026 geophysical logs

3.03 FW103 Results

Table 6. FW103 borehole deviation survey results

Well FW103	Borehole Deviation Survey Results			Easting:	51939.68	
Ground Elev.	1008.26			Northing:	30260.59	
	Ground	True Vertical				
Depth	Elevation	Depth	Tilt	Azimuth)	Easting	Northing
(feet)	(feet)	(feet)	(Degrees)	(Degrees)	(feet)	(feet)
0	1008.26	0.00			51939.680	30260.590
2	1006.29	1.97		130.24	51939.680	30260.590
3	1005.29	2.97	1.46	141.78	51939.700	30260.575
4	1004.30	3.96	1.53	116.46	51939.720	30260.559
5	1003.30	4.96	1.59	89.63	51939.746	30260.555
6	1002.30	5.96	1.60	38.59	51939.770	30260.566
7	1001.30	6.96	1.61	70.01	51939.787	30260.588
8	1000.31	7.95	1.60	53.34	51939.811	30260.602
9	999.21	9.05	1.66	40.73	51939.832	30260.625
10	998.21	10.05	1.51	358.88	51939.838	30260.651
11	997.21	11.05	1.58	339.59	51939.831	30260.677
12	996.22	12.04	1.54	322.08	51939.816	30260.699
13	995.22	13.04	1.41	339.17	51939.799	30260.718
14	994.22	14.04	1.35	25.27	51939.803	30260.741
15	993.22	15.04	1.32	39.83	51939.815	30260.762
16	992.23	16.03	1.14	43.81	51939.828	30260.779
17	991.23	17.03	1.17	55.08	51939.842	30260.793
18	990.23	18.03	1.11	55.51	51939.857	30260.804
19	989.23	19.03	1.00	44.88	51939.872	30260.814
20	988.23	20.03	0.95	48.01	51939.883	30260.827
21	987.24	21.02	0.90	52.19	51939.895	30260.837
22	986.24	22.02	0.92	58.84	51939.907	30260.848
23	985.24	23.02	0.96	62.08	51939.921	30260.855
24	984.24	24.02	0.82	23.51	51939.929	30260.868
25	983.25	25.01	0.90	357.33	51939.929	30260.884
26	982.25	26.01	0.84	349.05	51939.925	30260.898
27	981.25	27.01	0.78	347.08	51939.921	30260.912
28	980.25	28.01	0.85	334.11	51939.918	30260.925
29	979.25	29.01	0.84	314.68	51939.908	30260.936
30	978.26	30.00	1.06	287.63	51939.891	30260.941
31	977.26	31.00	1.17	272.01	51939.871	30260.942
32	976.26	32.00	1.20	264.66	51939.850	30260.940
33	975.26	33.00	1.36	255.06	51939.828	30260.934
34	974.27	33.99	1.31	257.38	51939.806	30260.925
35	973.27	34.99	1.36	251.18	51939.784	30260.917
36	972.27	35.99	1.51	240.68	51939.762	30260.905
37	971.27	36.99	1.63	226.37	51939.741	30260.888
38	970.28	37.98	1.98	202.47	51939.726	30260.861
39	969.28	38.98	2.22	192.77	51939.718	30260.825
40	968.28	39.98	2.18	178.42	51939.715	30260.786
41	967.28	40.98	1.92	158.48	51939.726	30260.752
42	966.29	41.97	1.74	134.24	51939.746	30260.729

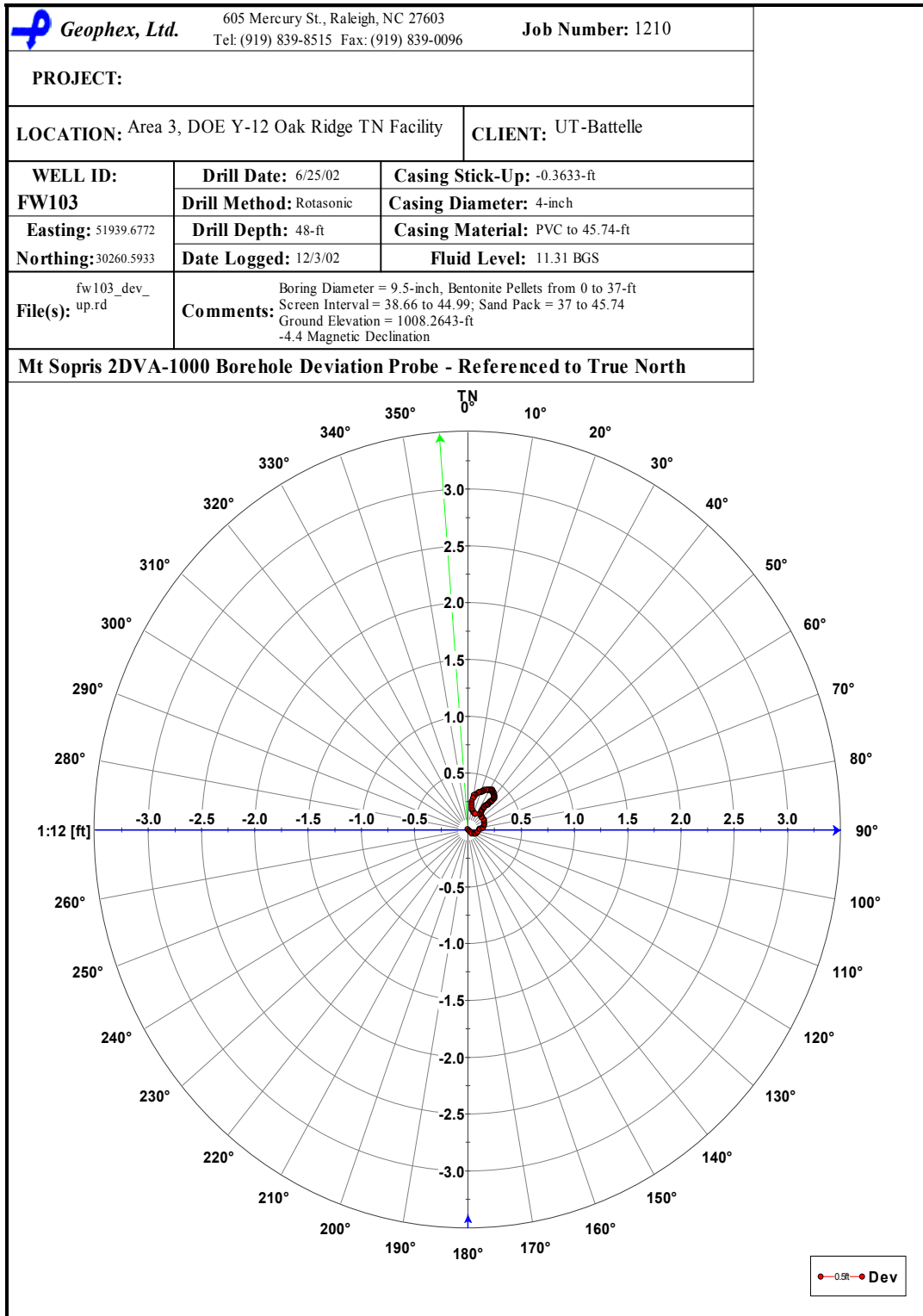


Figure 22. FW103 Bullseye plot of borehole orientation

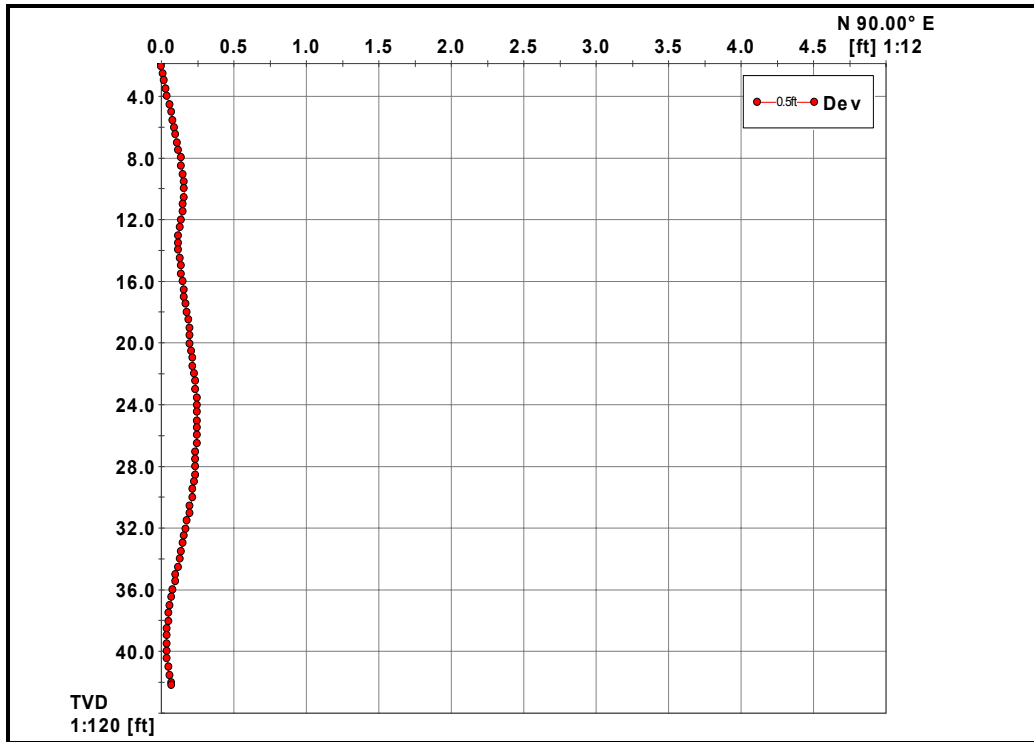


Figure 23. FW103 East-West profile of borehole orientation

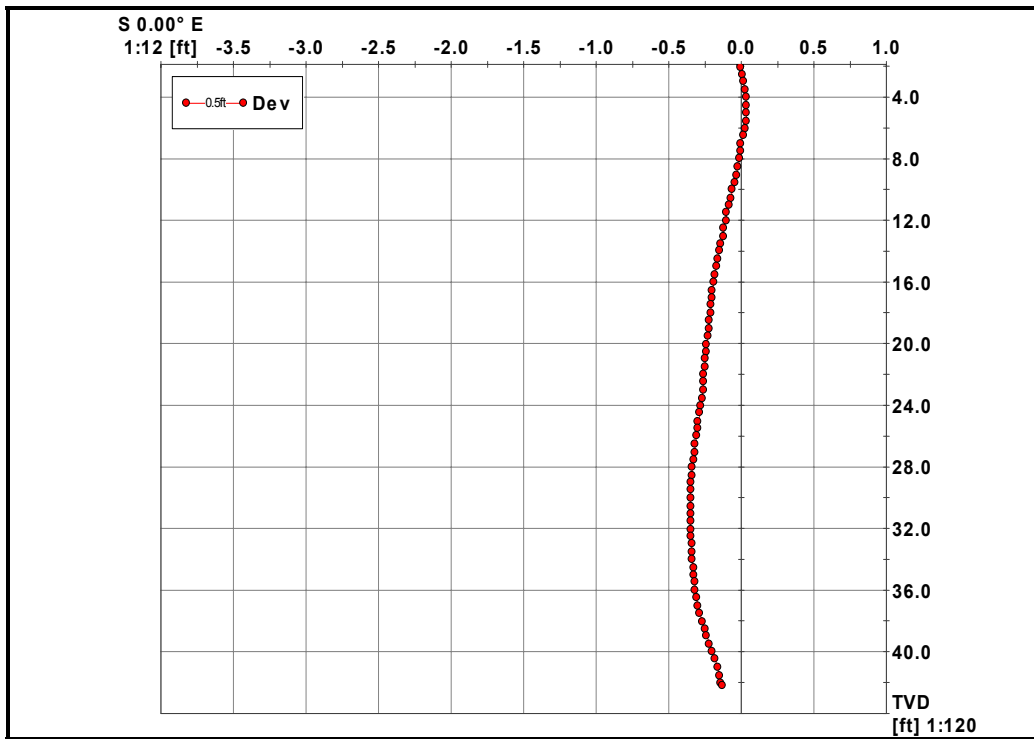


Figure 24. FW103 North-South profile of borehole orientation

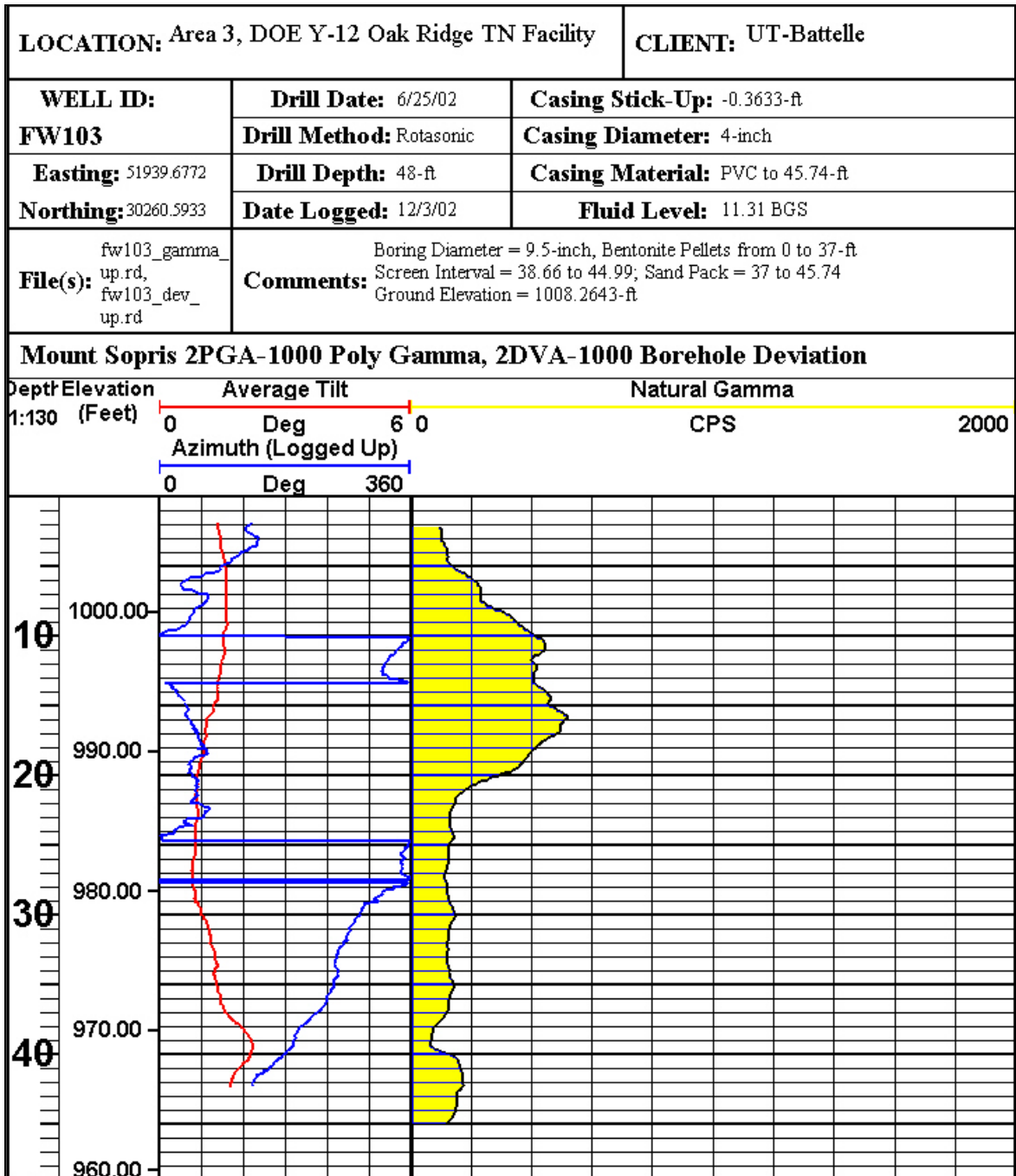


Figure 25. FW103 geophysical logs

3.04 FW104 Results

Table 7. FW104 borehole deviation survey results

Well FW104	Borehole Deviation Survey Results			Easting:	51949.54	
Ground Elev.	1008.61			Northing:	30260.35	
	Ground	True Vertical				
Depth	Elevation	Depth	Tilt	Azimuth)	Easting	Northing
(feet)	(feet)	(feet)	(Degrees)	(Degrees)	(feet)	(feet)
0	1008.61	0.00			51949.540	30260.350
2	1006.64	1.97		72.65	51949.540	30260.350
3	1005.64	2.97	2.05	75.69	51949.572	30260.363
4	1004.65	3.96	2.02	50.37	51949.602	30260.381
5	1003.65	4.96	2.03	17.01	51949.617	30260.413
6	1002.65	5.96	2.02	7.60	51949.620	30260.448
7	1001.65	6.96	1.88	23.15	51949.625	30260.481
8	1000.66	7.95	1.92	15.17	51949.634	30260.514
9	999.56	9.05	1.95	19.57	51949.643	30260.550
10	998.56	10.05	2.01	19.16	51949.652	30260.583
11	997.57	11.04	2.02	19.06	51949.660	30260.617
12	996.57	12.04	2.12	23.44	51949.671	30260.651
13	995.57	13.04	2.20	28.69	51949.685	30260.686
14	994.57	14.04	2.17	27.20	51949.700	30260.720
15	993.58	15.03	2.12	25.48	51949.714	30260.755
16	992.58	16.03	2.07	19.31	51949.725	30260.789
17	991.58	17.03	2.01	17.30	51949.733	30260.824
18	990.59	18.03	1.97	17.64	51949.742	30260.857
19	989.59	19.02	2.01	12.46	51949.748	30260.891
20	988.59	20.02	1.96	15.68	51949.754	30260.925
21	987.59	21.02	1.88	17.94	51949.761	30260.958
22	986.60	22.01	1.81	18.85	51949.768	30260.989
23	985.60	23.01	1.72	12.56	51949.775	30261.019
24	984.60	24.01	1.74	7.02	51949.778	30261.049
25	983.60	25.01	2.13	146.56	51949.785	30261.074
26	982.61	26.00	1.98	288.06	51949.770	30261.095
27	981.61	27.00	1.83	1.94	51949.776	30261.099
28	980.61	28.00	1.76	357.67	51949.775	30261.114
29	979.61	29.00	1.69	7.85	51949.774	30261.129
30	978.62	29.99	1.54	42.64	51949.781	30261.156
31	977.62	30.99	1.51	24.97	51949.793	30261.179
32	976.62	31.99	1.59	37.65	51949.804	30261.203
33	975.62	32.99	1.58	52.56	51949.823	30261.223
34	974.63	33.98	1.57	56.67	51949.844	30261.241
35	973.63	34.98	1.58	75.28	51949.868	30261.254
36	972.63	35.98	1.58	91.00	51949.895	30261.259
37	971.63	36.98	1.57	106.07	51949.922	30261.256
38	970.64	37.97	1.58	95.93	51949.950	30261.253
39	969.64	38.97	1.58	98.45	51949.977	30261.252
40	968.64	39.97	1.59	96.51	51950.004	30261.250
41	967.64	40.97	1.59	95.03	51950.032	30261.250

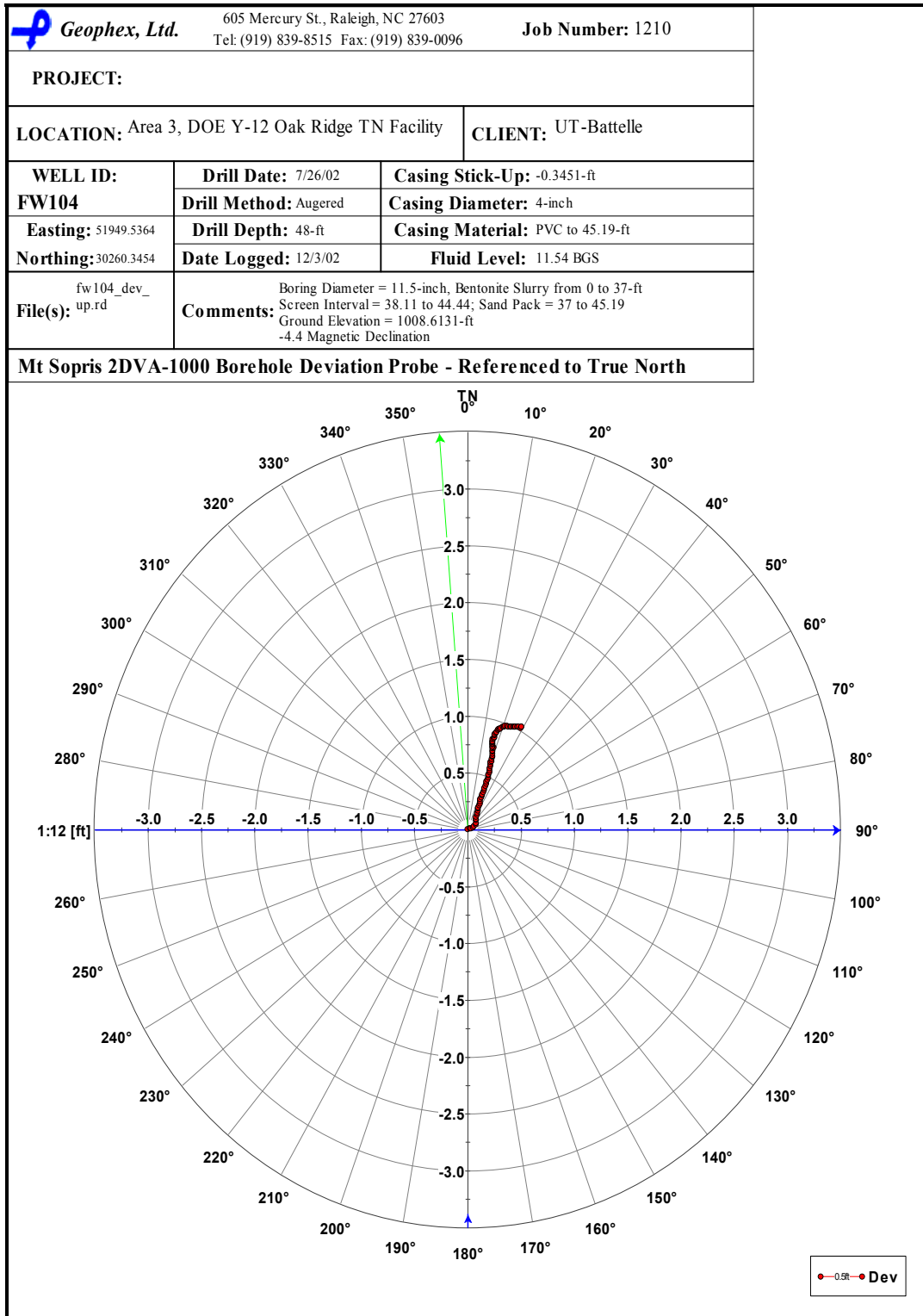


Figure 26. FW104 Bullseye plot of borehole orientation

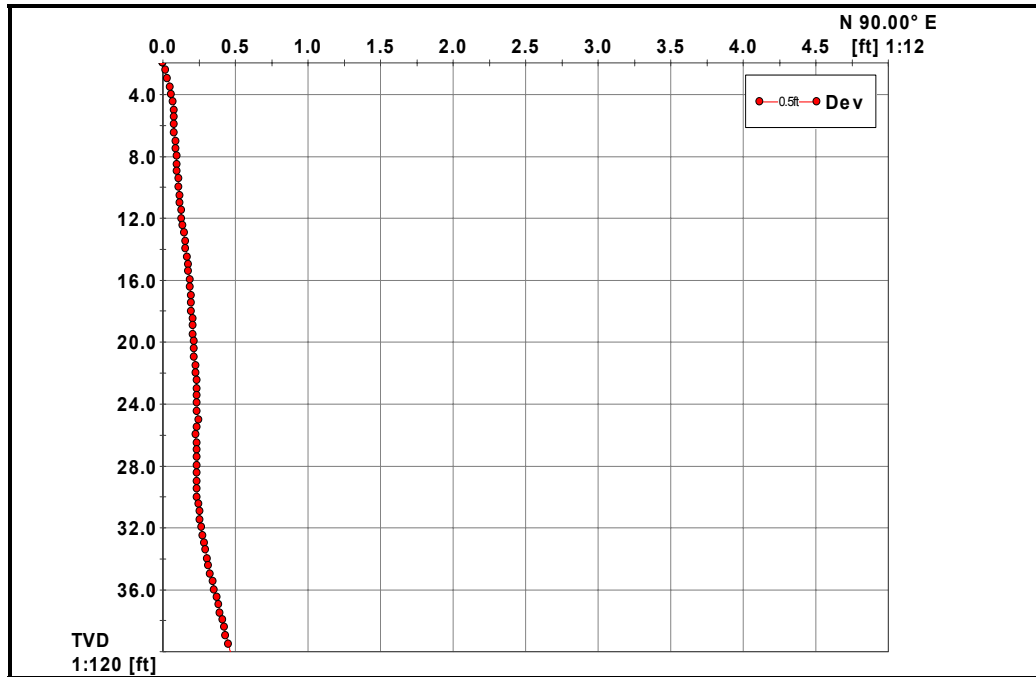


Figure 27. FW104 East-West profile of borehole orientation

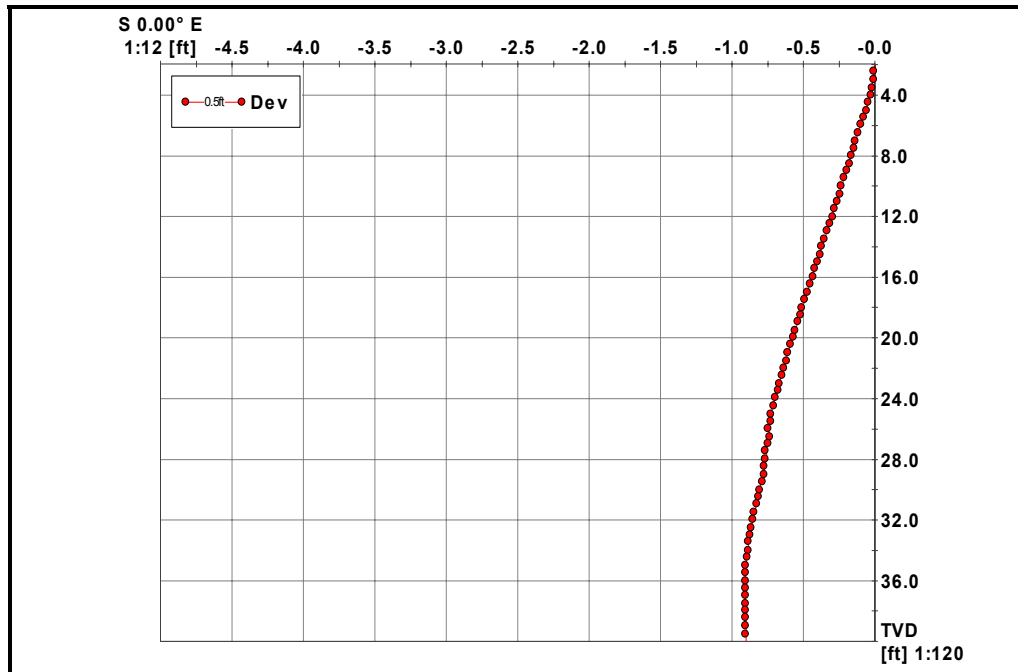


Figure 28. FW104 North-South profile of borehole orientation

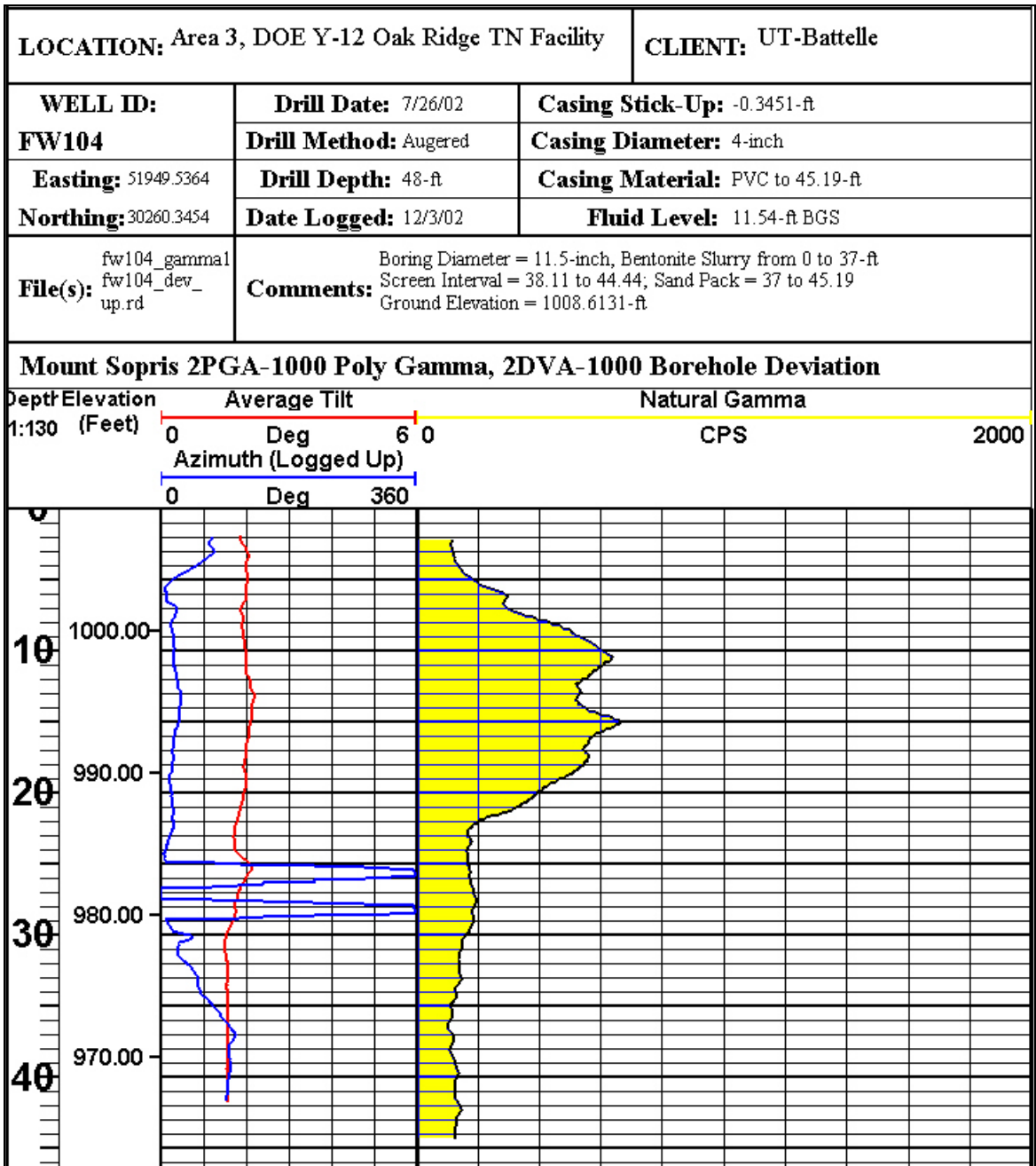


Figure 29. FW104 geophysical logs

3.05 FW105 Results

Table 8. FW105 borehole deviation survey results

Well FW105	Borehole Deviation Survey Results			Easting:	51918.15	
Ground Elev.	1007.17			Northing:	30260.45	
	Ground	True Vertical				
Depth	Elevation	Depth	Tilt	Azimuth)	Easting	Northing
(feet)	(feet)	(feet)	(Degrees)	(Degrees)	(feet)	(feet)
0	1007.17	0.00			51918.150	30260.450
2	1005.20	1.97		260.06	51918.150	30260.450
3	1004.20	2.97	1.34	317.47	51918.129	30260.459
4	1003.21	3.96	1.30	314.89	51918.112	30260.474
5	1002.21	4.96	1.24	316.99	51918.095	30260.489
6	1001.21	5.96	1.24	325.78	51918.081	30260.505
7	1000.21	6.96	1.22	317.19	51918.067	30260.521
8	999.22	7.95	1.28	323.57	51918.051	30260.536
9	998.12	9.05	1.31	334.35	51918.037	30260.556
10	997.12	10.05	1.30	353.93	51918.029	30260.578
11	996.12	11.05	1.32	10.58	51918.030	30260.584
12	995.13	12.05	1.34	20.33	51918.036	30260.607
13	994.13	13.04	1.37	13.90	51918.042	30260.630
14	993.13	14.04	1.45	6.57	51918.044	30260.654
15	992.13	15.04	1.52	2.49	51918.044	30260.680
16	991.13	16.04	1.58	2.76	51918.043	30260.708
17	990.14	17.03	1.59	358.20	51918.041	30260.720
18	989.14	18.03	1.60	354.83	51918.037	30260.747
19	988.14	19.03	1.61	352.18	51918.032	30260.775
20	987.14	20.03	1.63	356.75	51918.026	30260.802
21	986.15	21.02	1.63	5.28	51918.025	30260.815
22	985.15	22.02	1.63	13.67	51918.028	30260.843
23	984.15	23.02	1.58	32.28	51918.035	30260.870
24	983.15	24.02	1.53	45.65	51918.052	30260.891
25	982.16	25.01	1.57	53.69	51918.071	30260.910
26	981.16	26.01	1.59	62.23	51918.094	30260.926
27	980.16	27.01	1.52	72.22	51918.118	30260.939
28	979.16	28.01	1.57	101.49	51918.144	30260.941
29	978.17	29.00	1.55	73.55	51918.172	30260.938
30	977.17	30.00	1.38	39.27	51918.187	30260.957
31	976.17	31.00	1.30	41.57	51918.201	30260.976
32	975.17	32.00	1.27	44.33	51918.215	30260.993
33	974.18	32.99	1.27	40.33	51918.229	30261.011
34	973.18	33.99	1.25	31.41	51918.240	30261.029
35	972.18	34.99	1.20	26.73	51918.248	30261.049
36	971.18	35.99	1.17	21.56	51918.255	30261.068
37	970.19	36.98	1.14	13.64	51918.260	30261.088
38	969.19	37.98	1.17	144.17	51918.267	30261.102
39	968.19	38.98	1.17	350.54	51918.259	30261.115

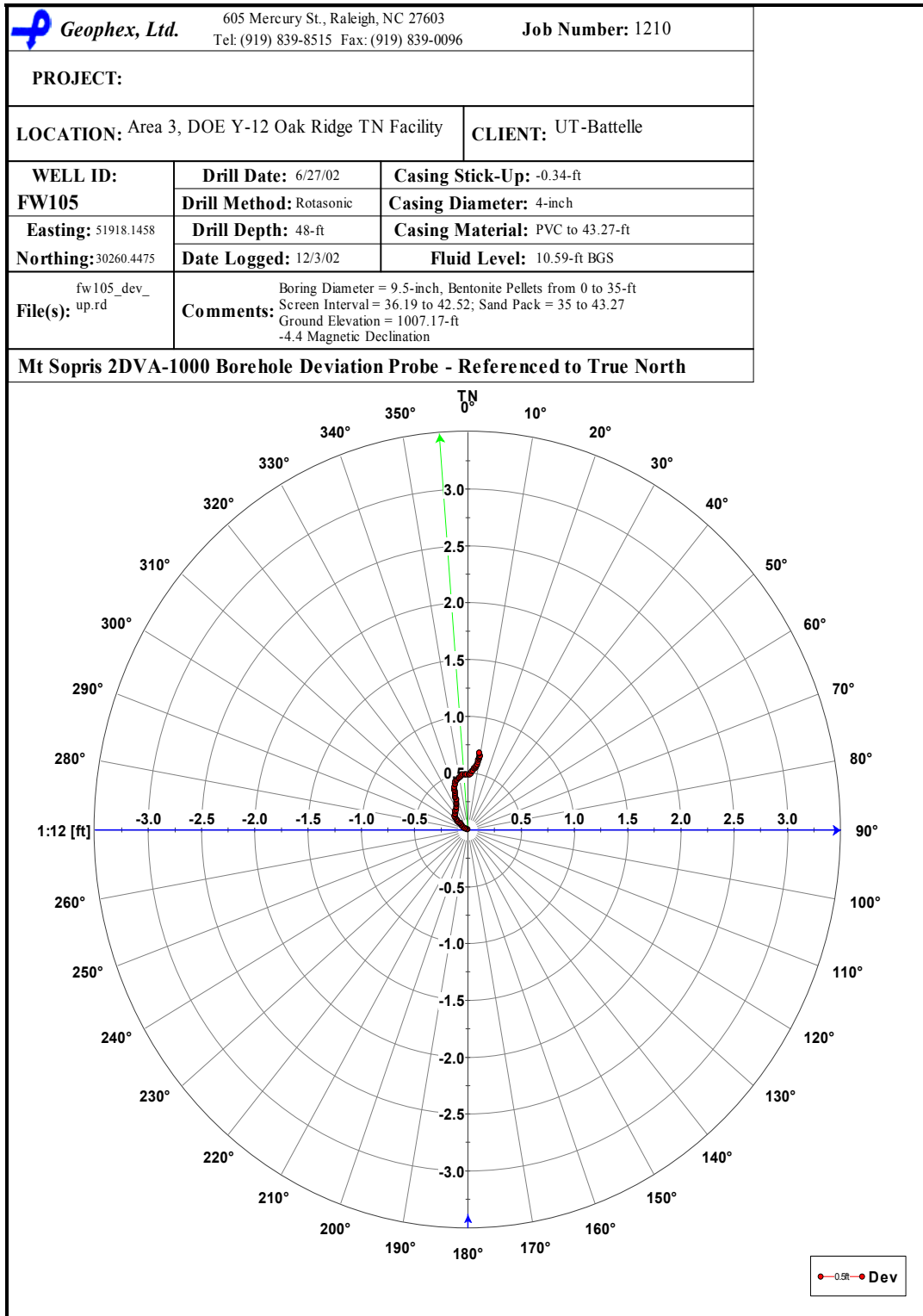


Figure 30. FW105 Bullseye plot of borehole orientation

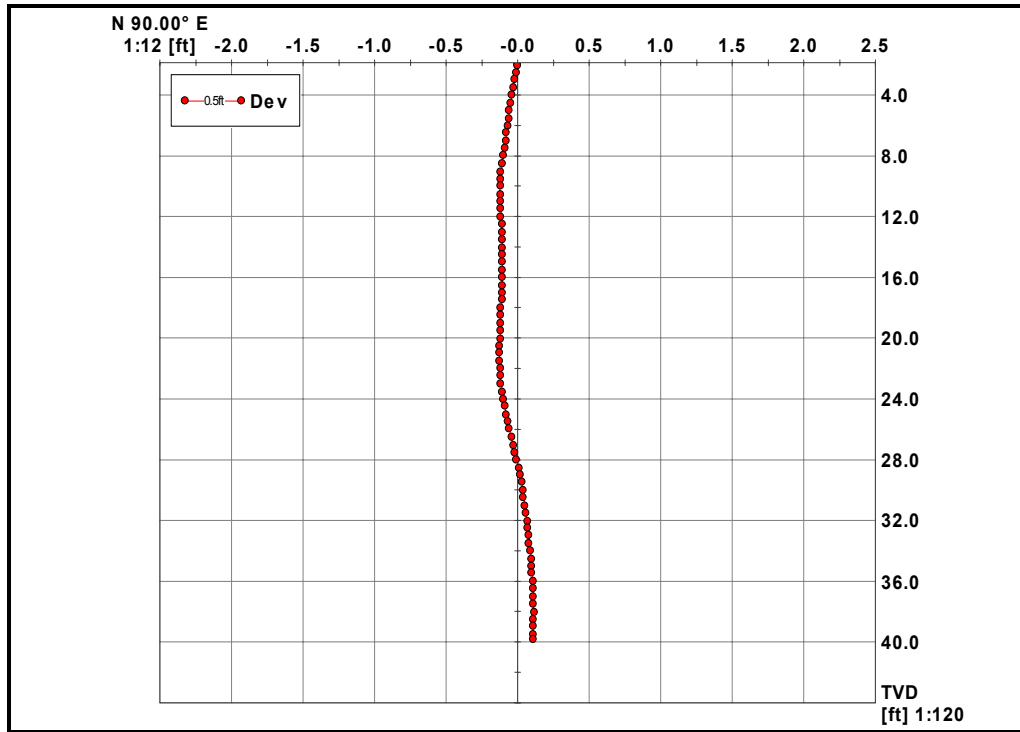


Figure 31. FW105 East-West profile of borehole orientation

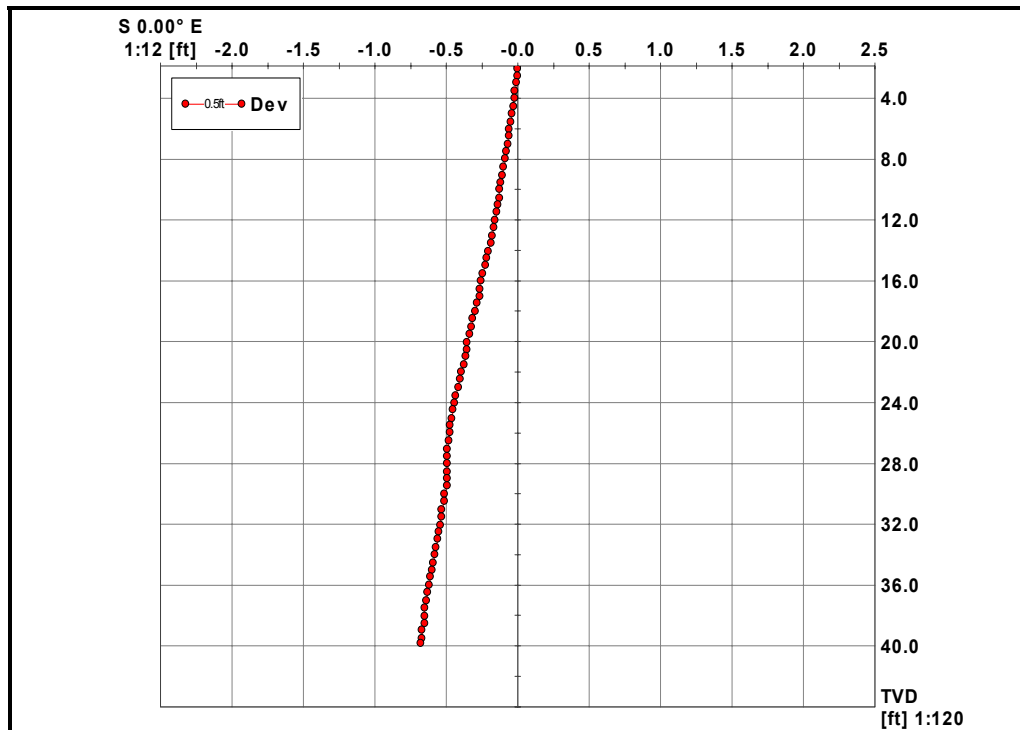


Figure 32. FW105 North-South profile of borehole orientation

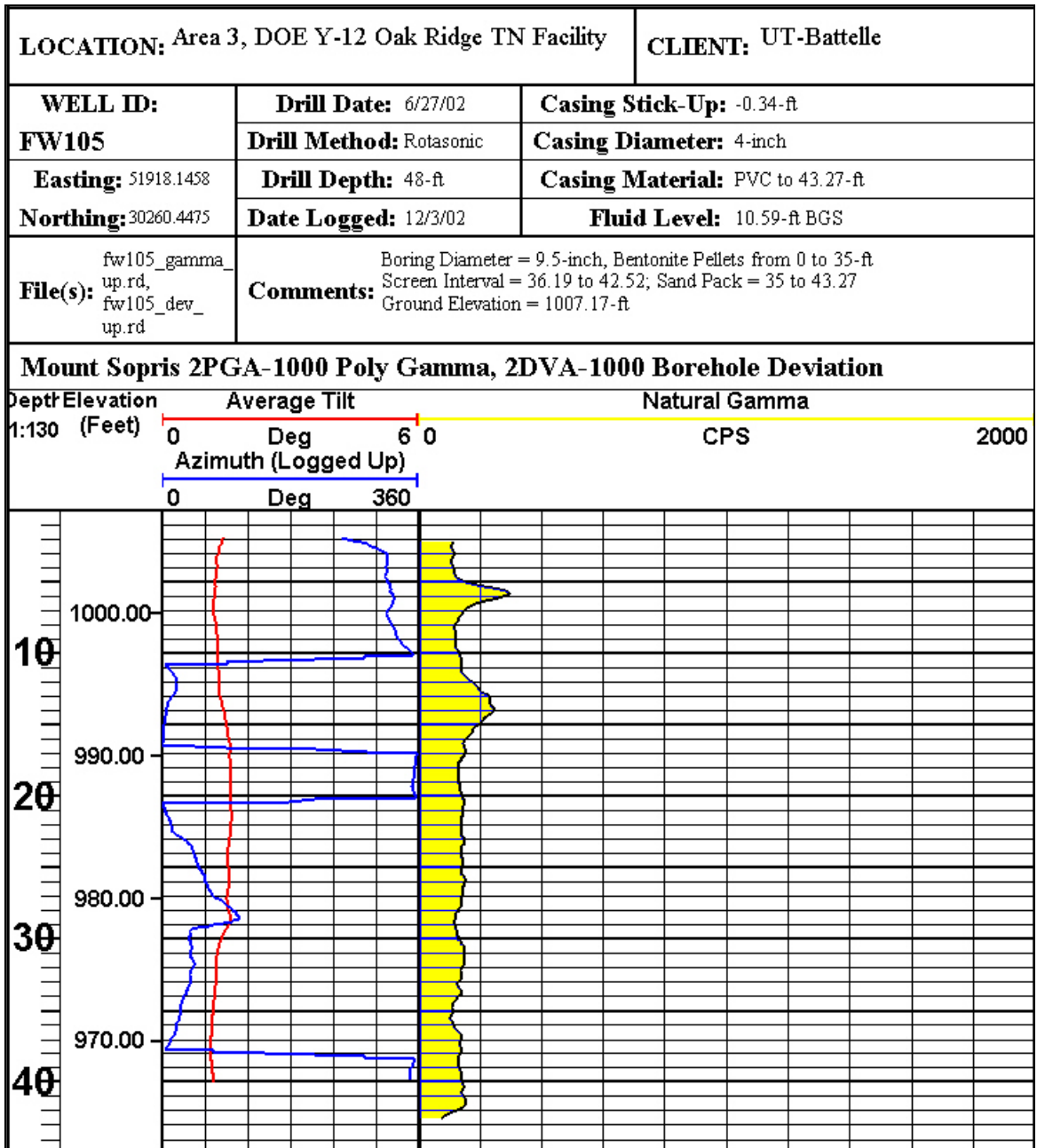


Figure 33. FW105 geophysical logs

3.06 FW106 Results

Table 9. FW106 borehole deviation survey results

Well FW106	Borehole Deviation Survey Results			Easting:	51955.91
Ground Elev.	1008.35			Northing:	30228.02
	Ground	True Vertical			
Depth	Elevation	Depth	Tilt	Azimuth)	Easting
(feet)	(feet)	(feet)	(Degrees)	(Degrees)	(feet)
0	1008.35	0.00			51955.910
2	1006.36	1.99	1.32	238.95	51955.900
3	1005.37	2.98	1.43	245.47	51955.879
4	1004.37	3.98	1.28	243.71	51955.859
5	1003.37	4.98	1.30	234.13	51955.842
6	1002.37	5.98	1.64	225.96	51955.824
7	1001.37	6.98	1.69	210.10	51955.808
8	1000.38	7.97	1.64	205.19	51955.797
9	999.38	8.97	1.59	197.70	51955.790
10	998.38	9.97	1.28	184.80	51955.786
11	997.38	10.97	1.26	171.79	51955.789
12	996.39	11.96	1.64	146.71	51955.798
13	995.39	12.96	1.97	116.62	51955.826
14	994.39	13.96	2.01	118.41	51955.859
15	993.40	14.96	1.99	119.29	51955.891
16	992.40	15.95	1.97	130.86	51955.919
17	991.40	16.95	2.36	160.76	51955.941
18	990.30	18.05	2.91	153.28	51955.968
19	989.31	19.04	3.65	162.89	51956.001
20	988.31	20.04	4.33	164.91	51956.018
21	987.32	21.03	4.93	154.01	51956.053
22	986.32	22.03	6.05	150.14	51956.107
23	985.33	23.02	6.37	152.80	51956.166
24	984.34	24.01	6.74	155.89	51956.220
25	983.35	25.00	7.41	160.68	51956.276
26	982.36	25.99	8.28	167.09	51956.320

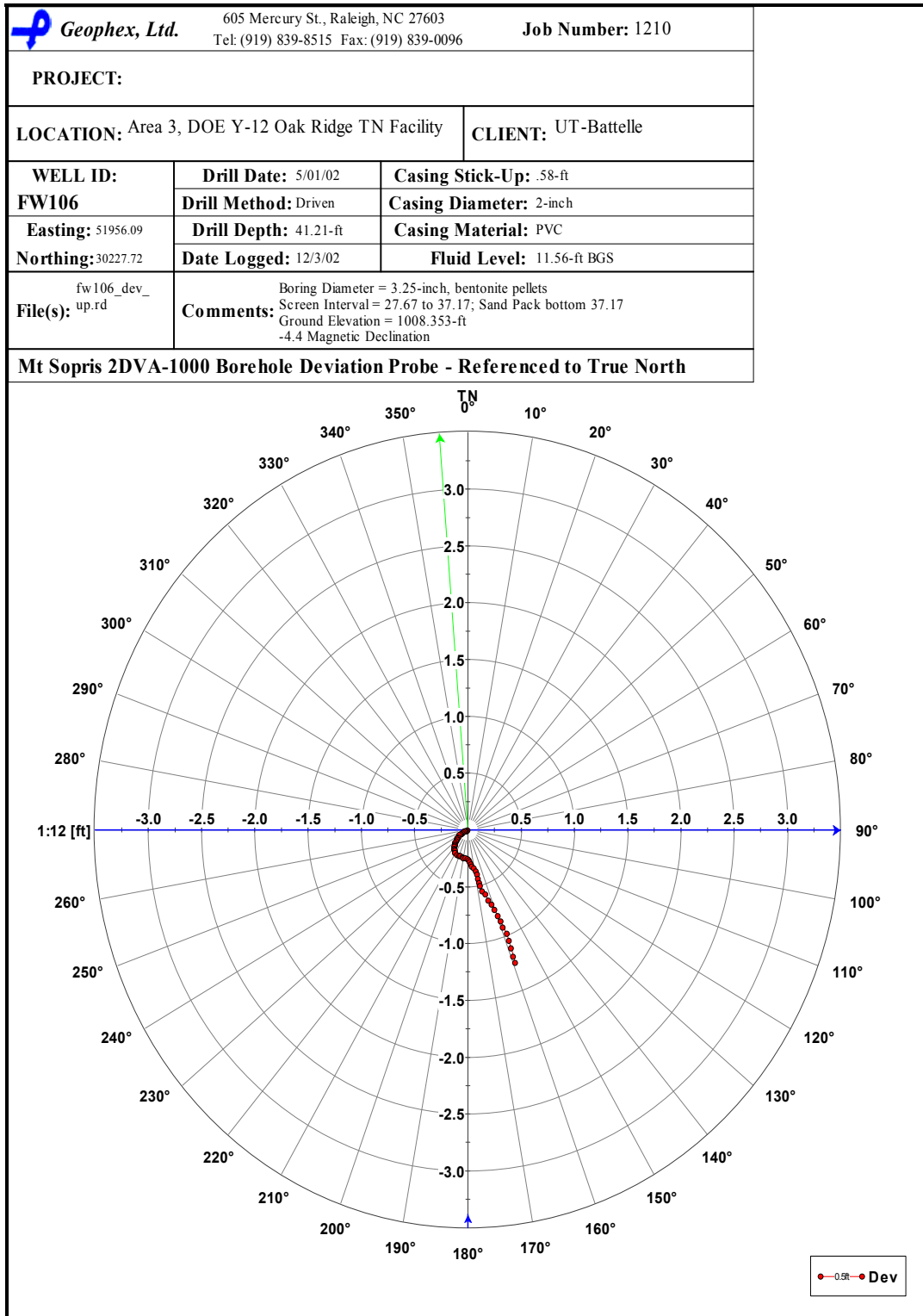


Figure 34. FW106 Bullseye plot of borehole orientation

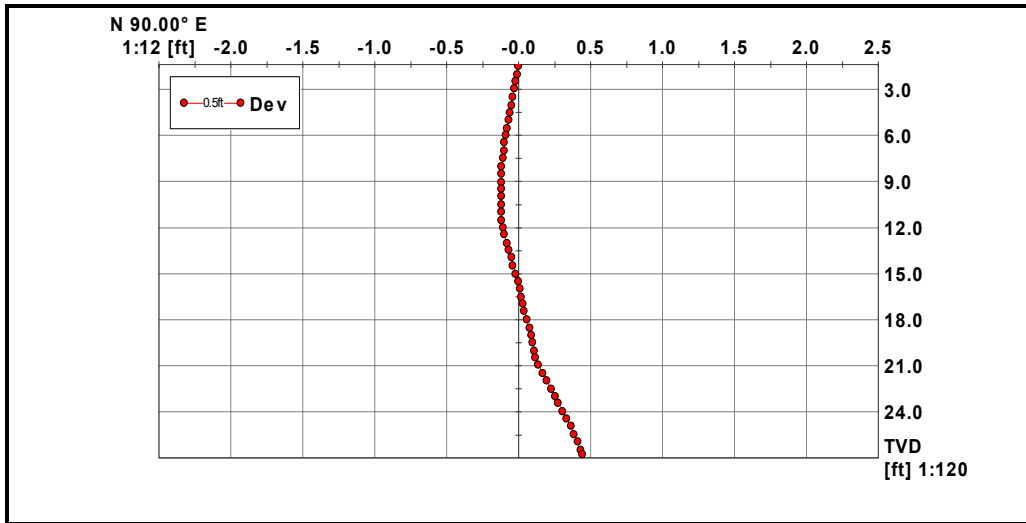


Figure 35. FW106 East-West profile of borehole orientation

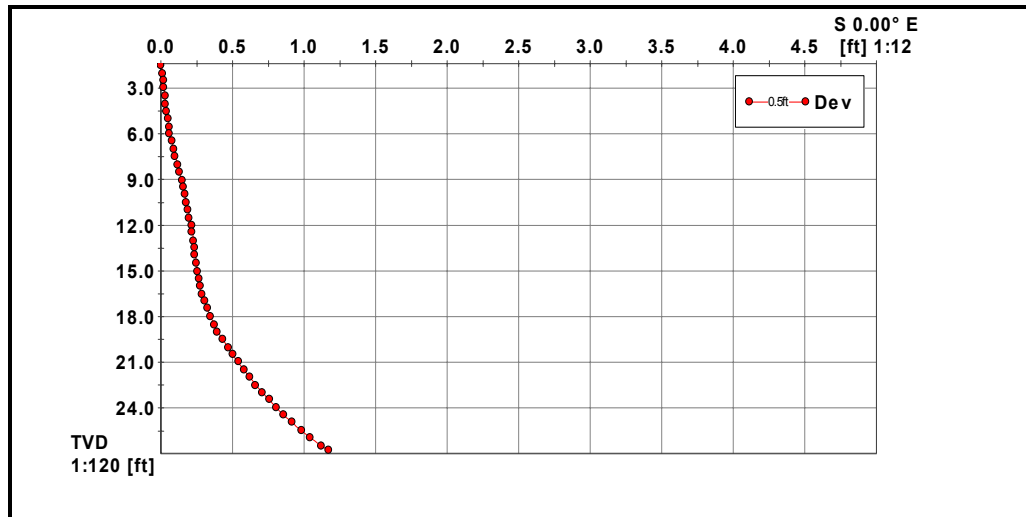


Figure 36. FW106 North-South profile of borehole orientation

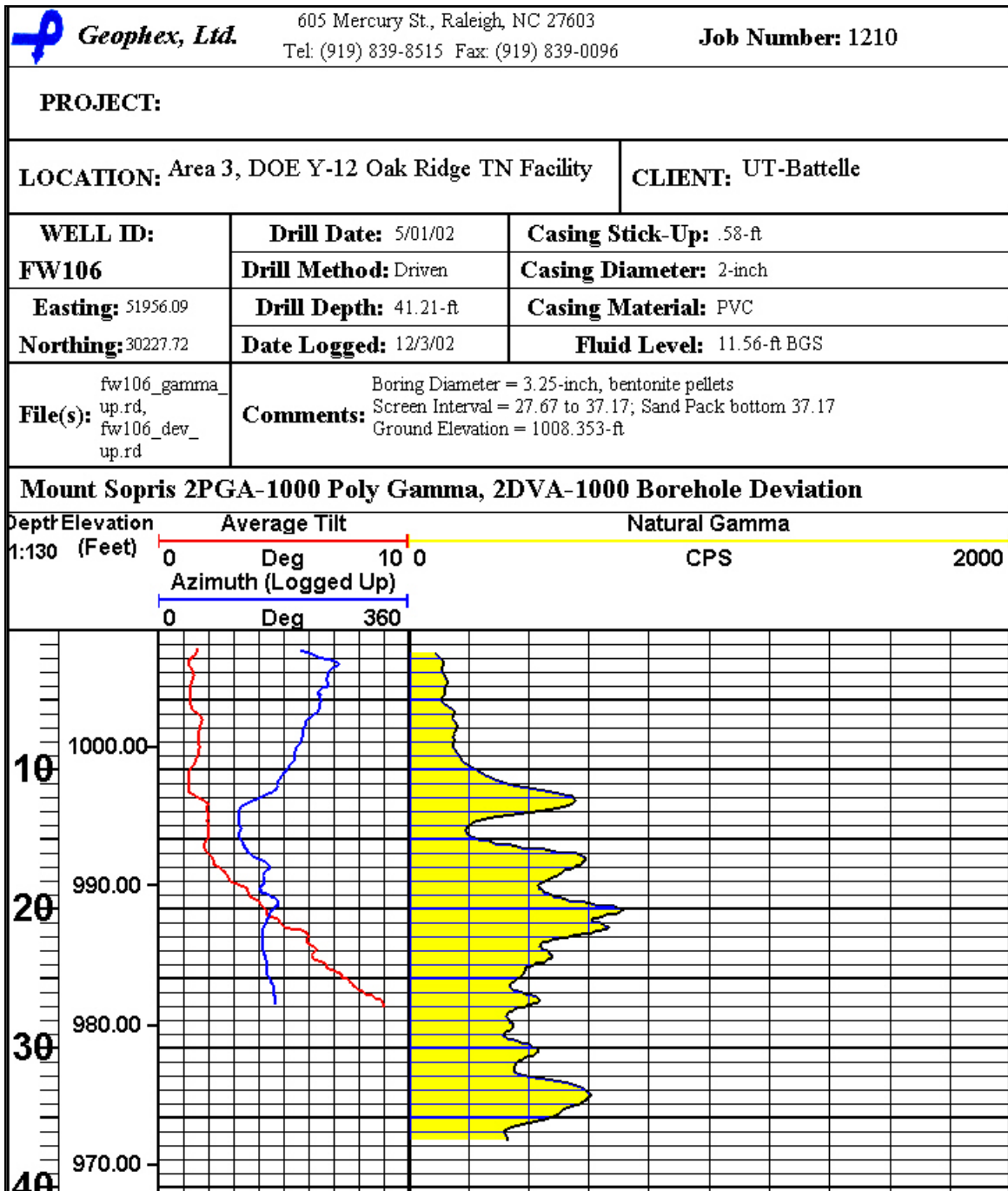


Figure 37. FW106 geophysical logs

3.07 FW107 Results

Table 10. FW107 borehole deviation survey results

Well FW107	Borehole Deviation Survey Results			Easting:	51946.26	
Ground Elev.	1008.28			Northing:	30253.56	
	Ground	True Vertical				
Depth	Elevation	Depth	Tilt	Azimuth)	Easting	Northing
(feet)	(feet)	(feet)	(Degrees)	(Degrees)	(feet)	(feet)
0	1008.28	0.00			51946.260	30253.560
2	1006.31	1.97		42.30	51946.260	30253.560
3	1005.31	2.97	2.54	38.61	51946.287	30253.596
4	1004.32	3.96	2.40	26.45	51946.307	30253.634
5	1003.32	4.96	2.09	285.03	51946.312	30253.653
6	1002.32	5.96	1.98	347.38	51946.305	30253.688
7	1001.33	6.95	2.27	12.99	51946.301	30253.703
8	1000.33	7.95	2.19	5.13	51946.305	30253.743
9	999.23	9.05	1.95	351.07	51946.303	30253.758
10	998.23	10.05	1.69	322.19	51946.288	30253.784
11	997.24	11.04	1.78	264.78	51946.268	30253.801
12	996.24	12.04	1.68	319.52	51946.247	30253.818
13	995.24	13.04	1.49	280.85	51946.230	30253.838
14	994.24	14.04	1.95	13.04	51946.236	30253.857
15	993.25	15.03	2.02	15.58	51946.243	30253.891
16	992.25	16.03	2.11	17.45	51946.250	30253.927
17	991.25	17.03	2.16	26.60	51946.262	30253.962
18	990.26	18.02	2.24	36.47	51946.281	30253.996
19	989.26	19.02	2.13	28.34	51946.297	30254.029
20	988.26	20.02	2.18	32.63	51946.314	30254.063
21	987.26	21.02	2.11	31.79	51946.332	30254.096
22	986.27	22.01	2.05	34.02	51946.348	30254.128
23	985.27	23.01	1.87	25.42	51946.362	30254.159
24	984.27	24.01	1.97	28.64	51946.376	30254.189
25	983.27	25.01	1.76	22.09	51946.388	30254.219
26	982.28	26.00	1.81	20.13	51946.396	30254.249
27	981.28	27.00	1.98	21.03	51946.404	30254.281
28	980.28	28.00	2.09	8.16	51946.411	30254.315
29	979.28	29.00	1.85	353.97	51946.410	30254.332
30	978.29	29.99	1.89	3.31	51946.409	30254.348
31	977.29	30.99	1.87	6.29	51946.410	30254.380
32	976.29	31.99	1.89	145.64	51946.415	30254.373
33	975.30	32.98	2.01	355.74	51946.417	30254.388
34	974.30	33.98	1.94	355.70	51946.411	30254.421
35	973.30	34.98	2.05	12.65	51946.410	30254.438
36	972.30	35.98	2.24	37.95	51946.423	30254.473
37	971.31	36.97	2.22	70.05	51946.456	30254.495
38	970.31	37.97	1.89	51.52	51946.484	30254.515
39	969.31	38.97	1.86	46.29	51946.507	30254.538
40	968.31	39.97	1.72	12.77	51946.521	30254.563
41	967.32	40.96	2.27	7.31	51946.524	30254.600
42	966.32	41.96	2.64	2.99	51946.523	30254.643
43	965.32	42.96	3.07	1.75	51946.530	30254.641
44	964.33	43.95	3.14	7.28	51946.531	30254.695
45	963.33	44.95	3.28	356.44	51946.530	30254.722

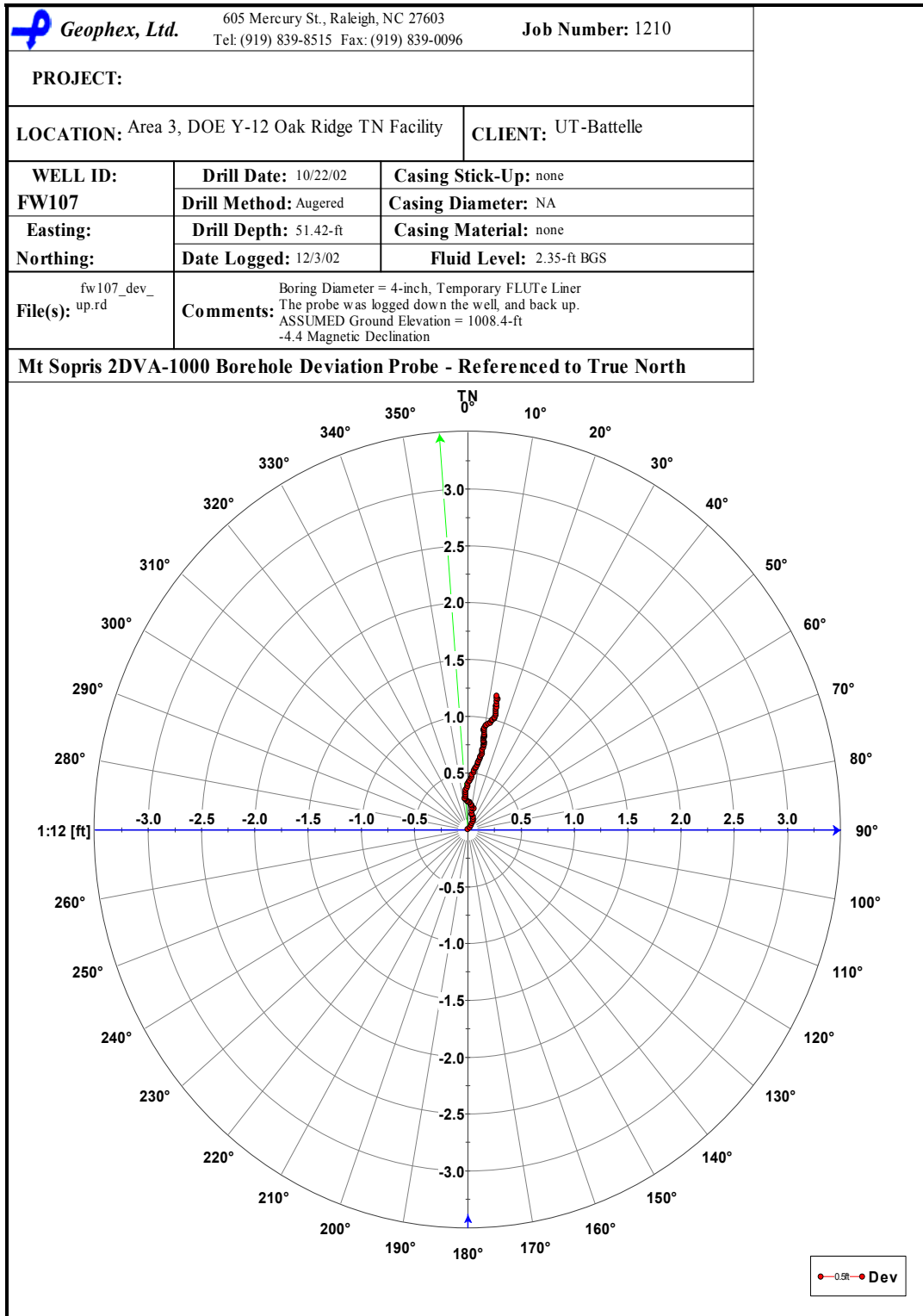


Figure 38. FW107 Bullseye plot of borehole orientation

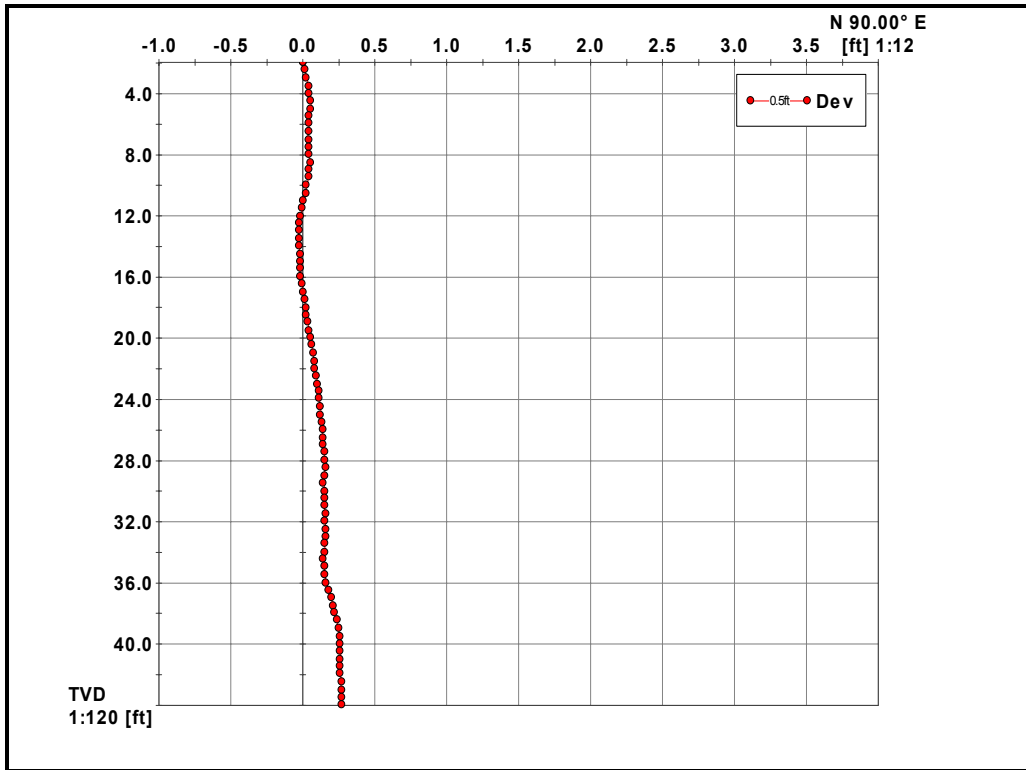


Figure 39. FW107 East-West profile of borehole orientation

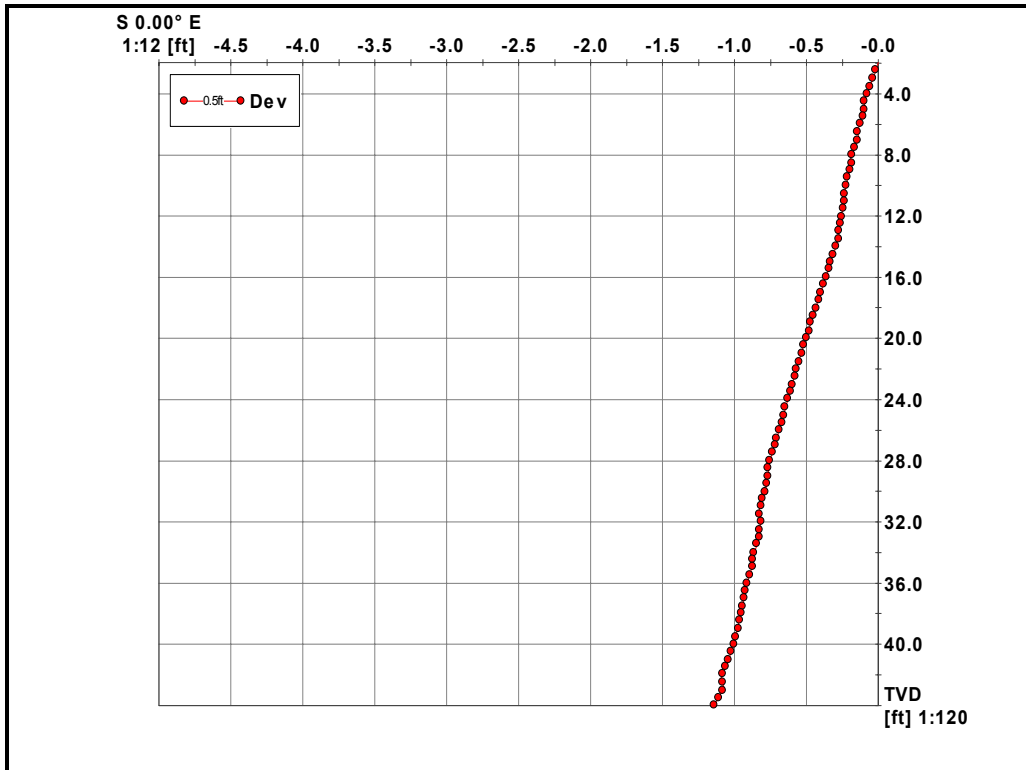


Figure 40. FW107 North-South profile of borehole orientation

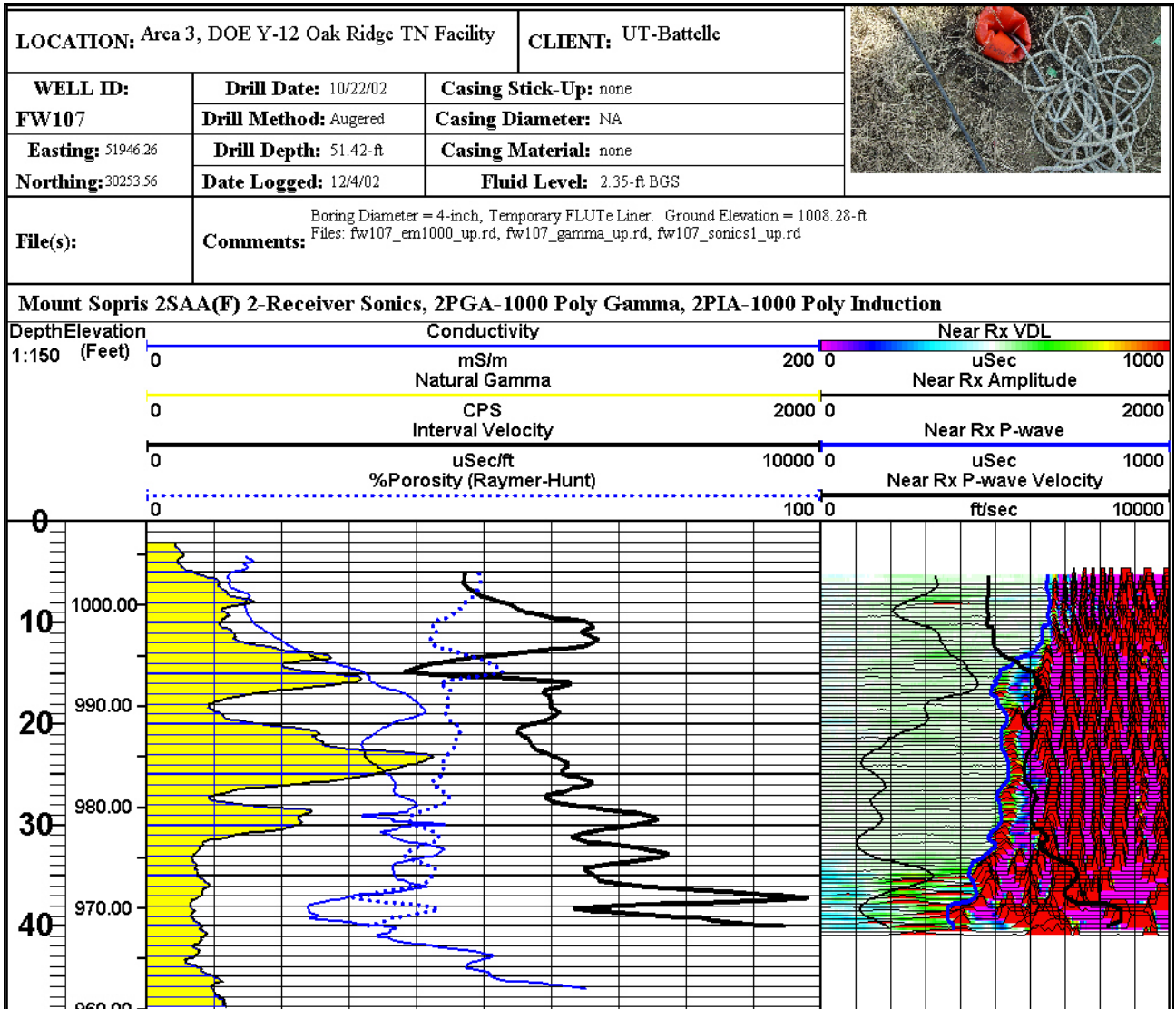


Figure 41. FW107 geophysical logs

3.08 FW108 Results

Table 11. FW108 borehole deviation survey results

Well FW108	Borehole Deviation Survey Results			Easting:	51942.5
Ground Elev.	1008.54			Northing:	30269.23
	Ground	True Vertical			
Depth	Elevation	Depth	Tilt	Azimuth)	Easting
(feet)	(feet)	(feet)	(Degrees)	(Degrees)	(feet)
0	1008.54	0.00			51942.500
2	1006.54	2.00			51942.500
3	1005.54	3.00	2.69	209.52	51942.479
4	1004.55	3.99	2.40	203.71	51942.462
5	1003.55	4.99	1.88	199.11	51942.451
6	1002.55	5.99	0.96	249.85	51942.439
7	1001.55	6.99	0.93	231.81	51942.427
8	1000.56	7.98	0.92	208.08	51942.419
9	999.56	8.98	0.81	221.06	51942.412
10	998.56	9.98	0.85	263.82	51942.400
11	997.56	10.98	1.29	289.85	51942.382
12	996.56	11.98	1.88	293.14	51942.356
13	995.57	12.97	2.03	277.54	51942.322
14	994.57	13.97	2.17	269.40	51942.285
15	993.57	14.97	2.34	268.68	51942.246
16	992.58	15.96	2.51	267.14	51942.204
17	991.58	16.96	2.63	265.67	51942.159
18	990.58	17.96	2.92	260.33	51942.111
19	989.59	18.95	3.02	265.12	51942.060
20	988.59	19.95	3.07	267.66	51942.008
21	987.59	20.95	3.09	267.74	51941.955
22	986.60	21.94	3.17	269.10	51941.900
23	985.60	22.94	2.97	258.09	51941.847
24	984.60	23.94	2.83	260.35	51941.798
25	983.61	24.93	2.66	262.13	51941.751
26	982.61	25.93	2.57	263.11	51941.707
27	981.51	27.03	2.48	266.11	51941.659
28	980.52	28.02	2.62	270.08	51941.616
29	979.52	29.02	2.85	279.58	51941.569
30	978.52	30.02	3.08	278.38	51941.517
31	977.53	31.01	3.24	277.58	51941.462
32	976.53	32.01	3.37	284.52	51941.405
33	975.53	33.01	3.48	285.22	51941.346
34	974.54	34.00	3.54	285.10	51941.287
35	973.54	35.00	3.62	281.90	51941.225
36	972.55	35.99	3.69	275.77	51941.162
37	971.55	36.99	3.77	268.03	51941.097
38	970.56	37.98	4.94	260.06	51941.019
39	969.56	38.98	4.82	257.29	51940.937
40	968.57	39.97	4.61	252.82	51940.860
41	967.57	40.97	4.15	248.02	51940.791
42	966.58	41.96	3.91	245.84	51940.730

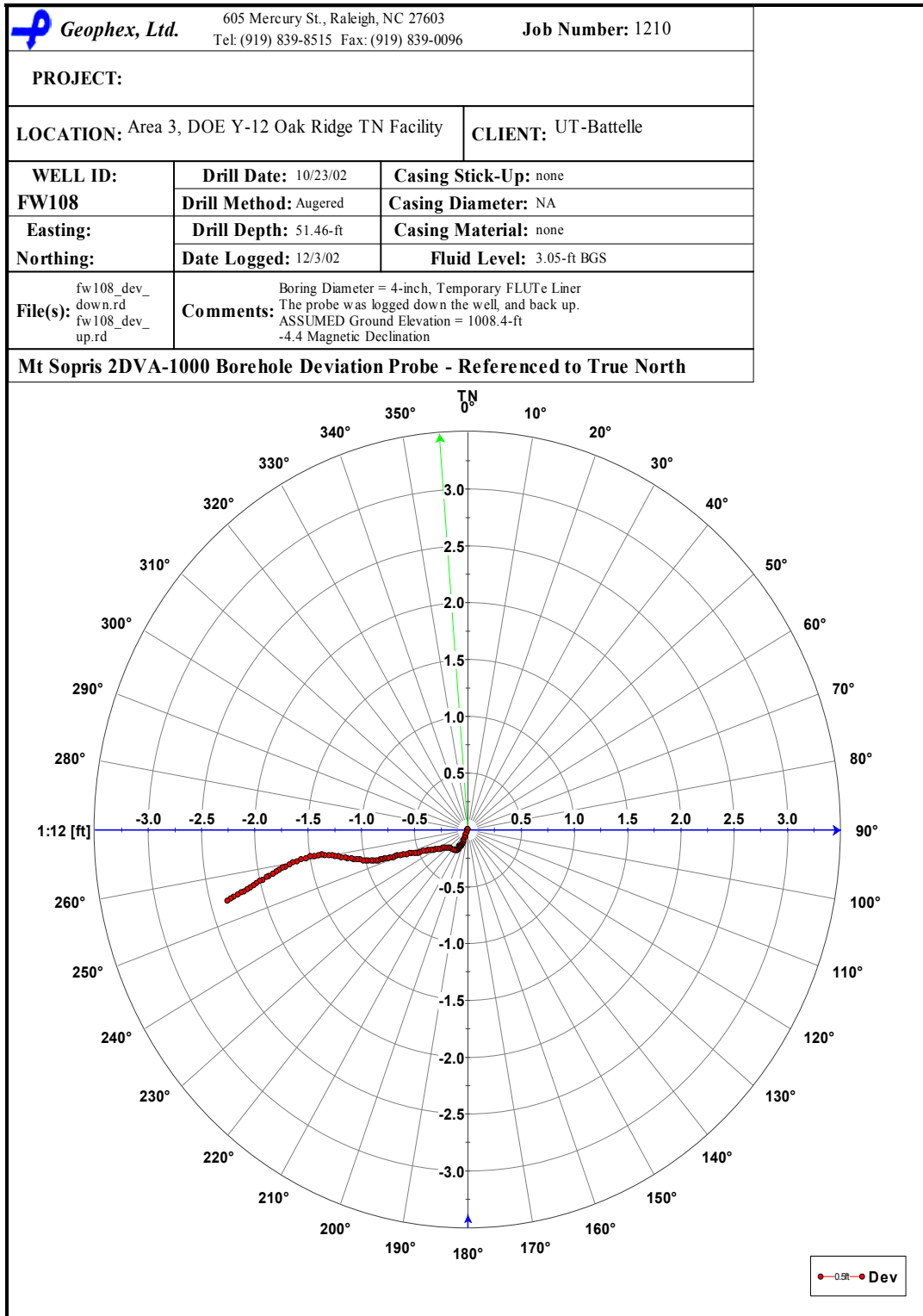


Figure 42. FW108 Bullseye plot of borehole orientation

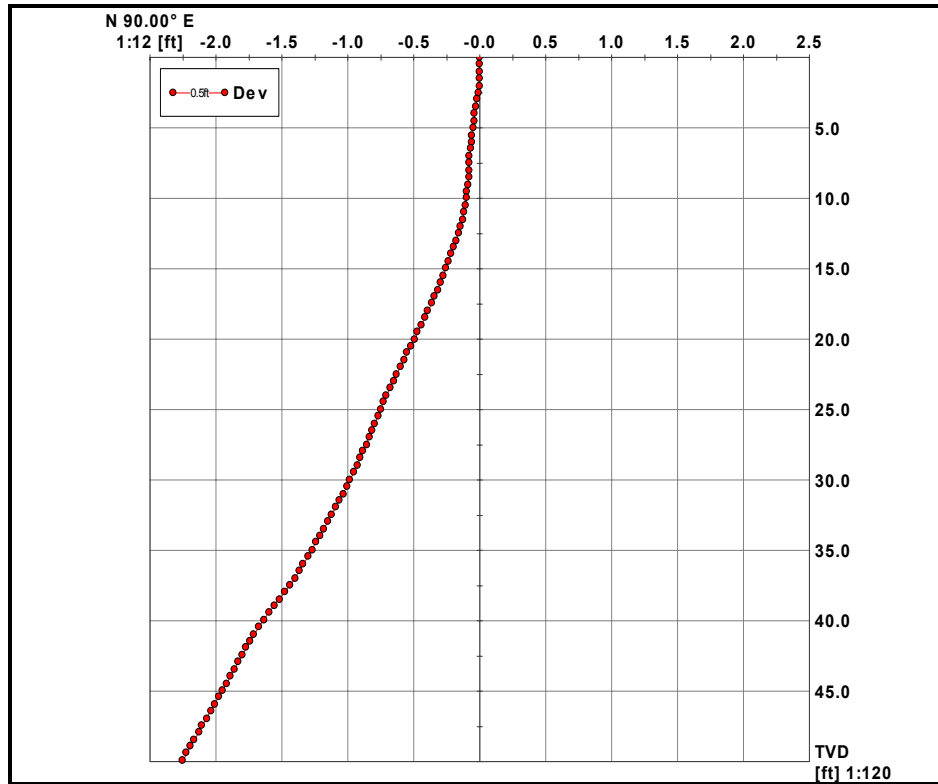


Figure 43. FW108 East-West profile of borehole orientation

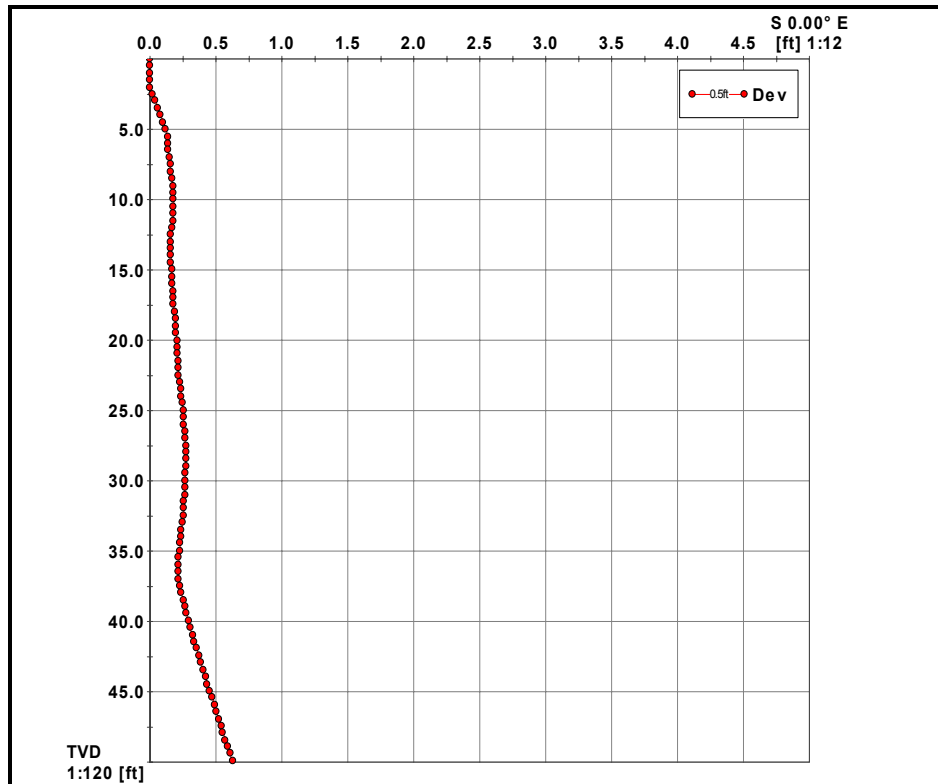


Figure 44. FW108 North-South profile of borehole orientation

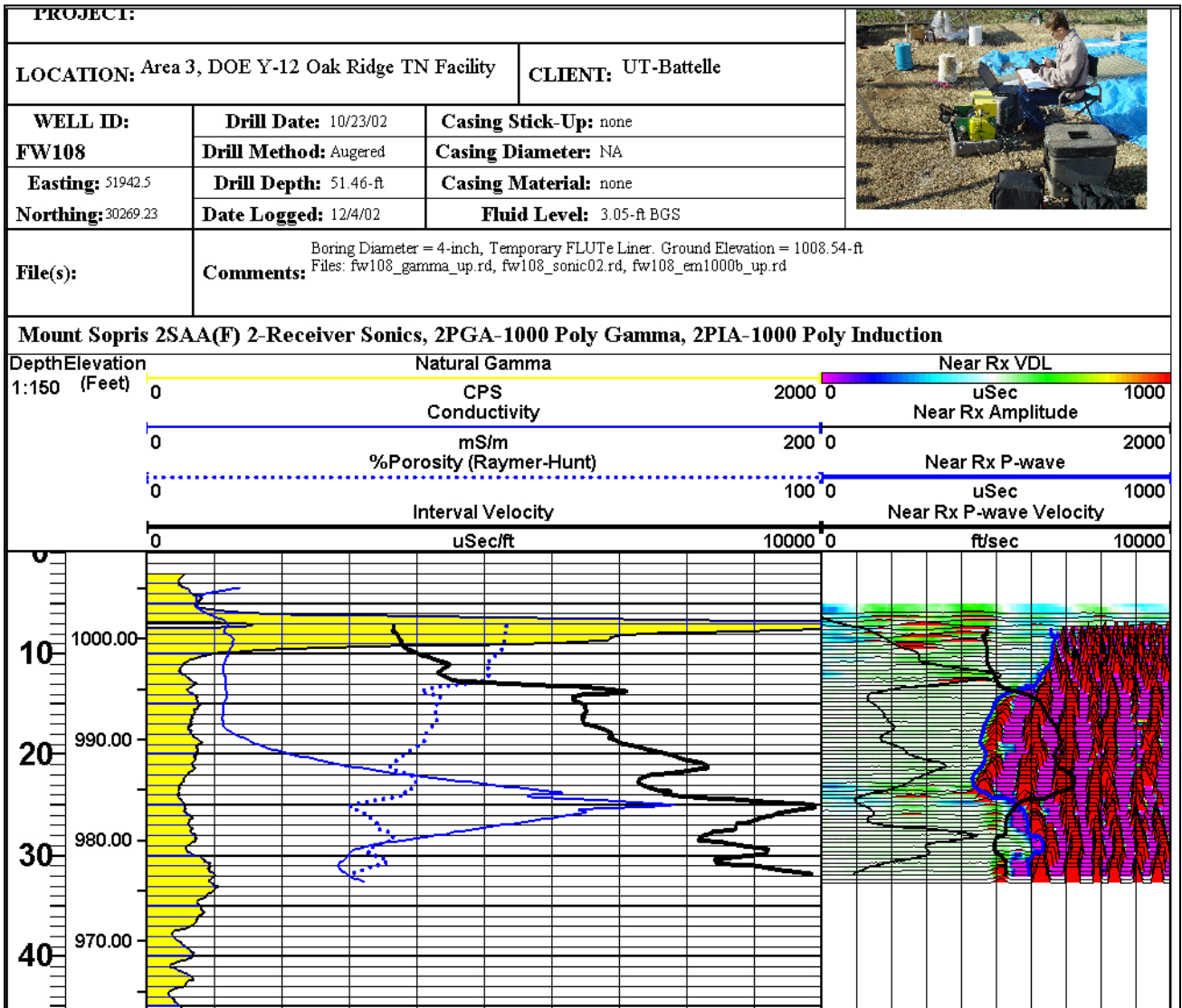


Figure 45. FW108 geophysical logs

3.09 FW109 Results

Table 12. FW109 borehole deviation survey results

Well FW109	Borehole Deviation Survey Results			Easting:	51948.73	
Ground Elev.	1008.49			Northing:	30266.69	
	Ground	True Vertical				
Depth	Elevation	Depth	Tilt	Azimuth)	Easting	Northing
(feet)	(feet)	(feet)	(Degrees)	(Degrees)	(feet)	(feet)
0	1008.49	0.00			51948.730	30266.690
2	1006.49	2.00	1.07	150.77	51948.730	30266.690
3	1005.49	3.00	1.35	190.66	51948.732	30266.670
4	1004.49	4.00	1.38	198.07	51948.728	30266.645
5	1003.50	4.99	1.13	228.44	51948.720	30266.626
6	1002.50	5.99	1.27	265.34	51948.699	30266.621
7	1001.50	6.99	1.19	213.09	51948.684	30266.609
8	1000.50	7.99	1.40	221.45	51948.670	30266.591
9	999.51	8.98	1.67	224.48	51948.654	30266.570
10	998.51	9.98	2.29	232.09	51948.627	30266.545
11	997.51	10.98	2.75	229.30	51948.598	30266.516
12	996.52	11.97	3.55	236.78	51948.554	30266.479
13	995.52	12.97	3.99	243.14	51948.499	30266.441
14	994.52	13.97	4.01	244.20	51948.439	30266.406
15	993.53	14.96	4.01	242.20	51948.379	30266.369
16	992.53	15.96	3.83	240.93	51948.322	30266.333
17	991.54	16.95	3.76	237.88	51948.268	30266.295
18	990.54	17.95	3.65	236.46	51948.217	30266.255
19	989.55	18.94	3.41	236.89	51948.168	30266.218
20	988.55	19.94	3.16	234.81	51948.124	30266.183
21	987.55	20.94	3.32	233.06	51948.081	30266.147
22	986.56	21.93	3.59	233.37	51948.036	30266.106
23	985.56	22.93	3.64	234.46	51947.987	30266.065
24	984.57	23.92	3.68	235.13	51947.938	30266.025
25	983.57	24.92	3.56	236.90	51947.889	30265.986
26	982.57	25.92	3.60	237.11	51947.839	30265.949
27	981.48	27.01	3.89	236.41	51947.782	30265.904
28	980.48	28.01	3.83	239.07	51947.728	30265.864
29	979.49	29.00	3.99	236.80	51947.674	30265.825
30	978.49	30.00	4.37	233.50	51947.617	30265.779
31	977.50	30.99	4.62	231.26	51947.558	30265.725
32	976.50	31.99	4.98	235.71	51947.497	30265.671
33	975.51	32.98	5.68	242.63	51947.420	30265.617
34	974.52	33.97	5.96	247.29	51947.331	30265.568
35	973.52	34.97	6.57	248.11	51947.233	30265.520
36	972.53	35.96	6.82	245.27	51947.131	30265.463
37	971.54	36.95	8.52	247.67	51947.013	30265.402
38	970.56	37.93	8.53	245.40	51946.881	30265.333
39	969.57	38.92	8.08	241.50	51946.758	30265.258
40	968.58	39.91	7.30	238.42	51946.649	30265.182
41	967.59	40.90	7.05	235.51	51946.551	30265.107
42	966.60	41.89	7.72	230.20	51946.456	30265.022

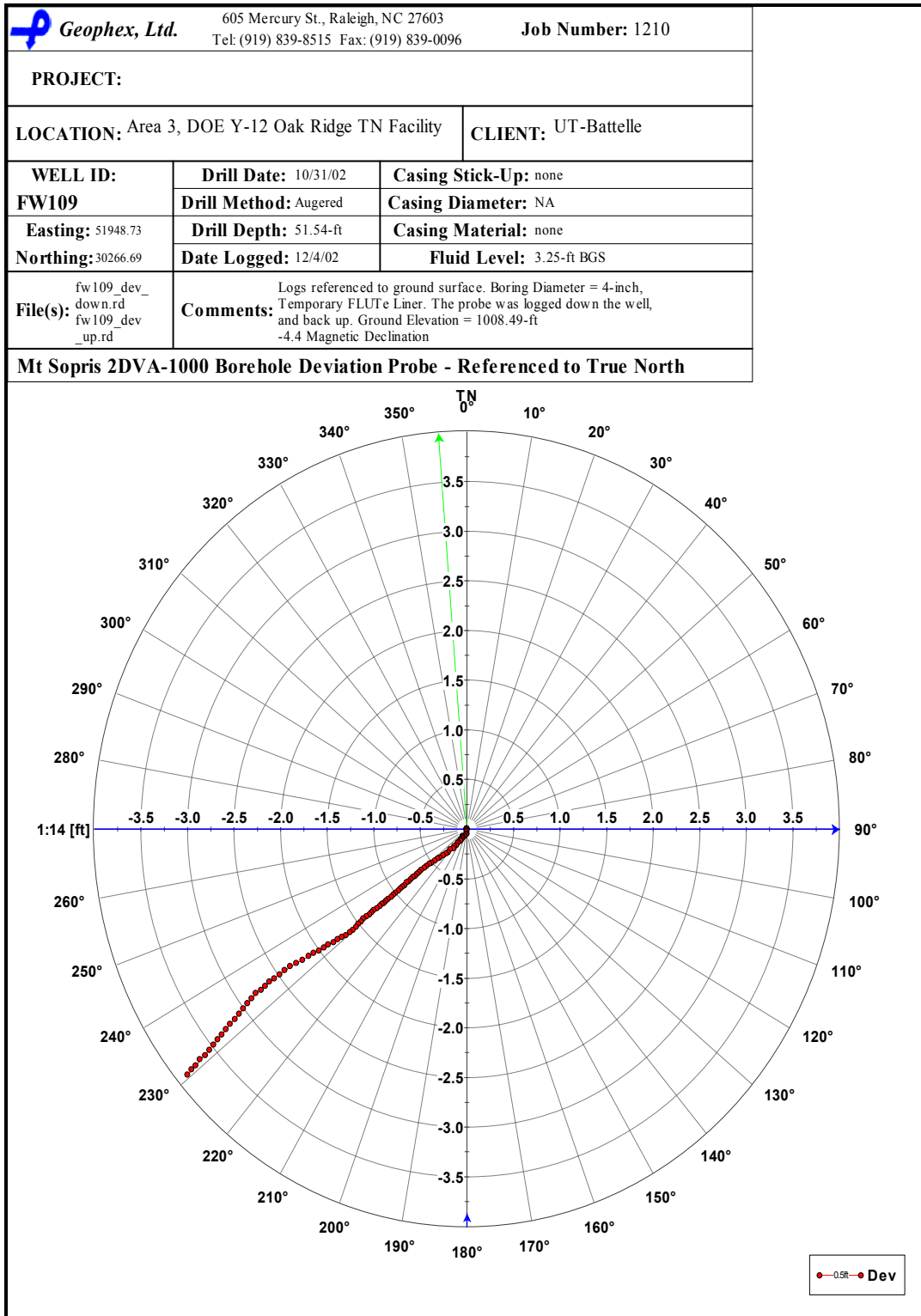


Figure 46. FW109 Bullseye plot of borehole orientation

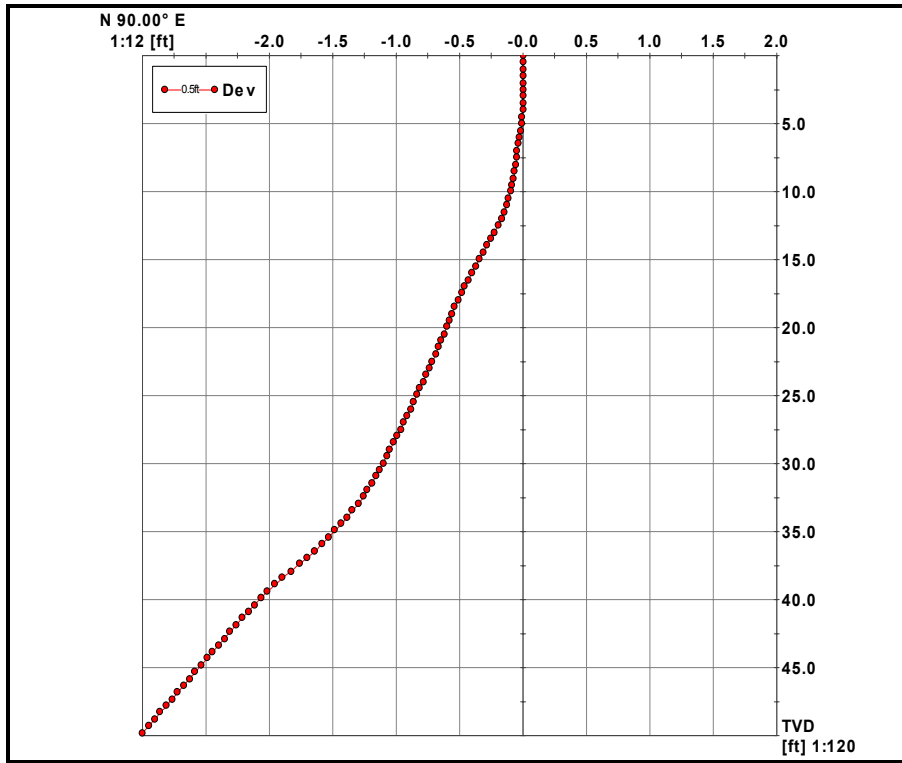


Figure 47. FW109 East-West profile of borehole orientation

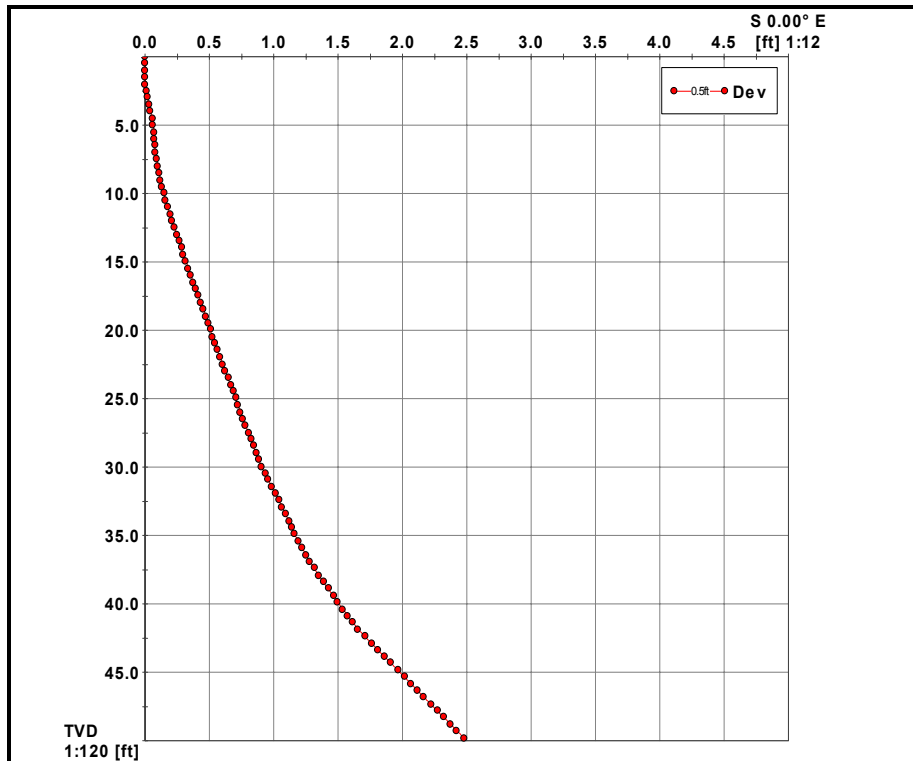


Figure 48. FW109 North-South profile of borehole orientation

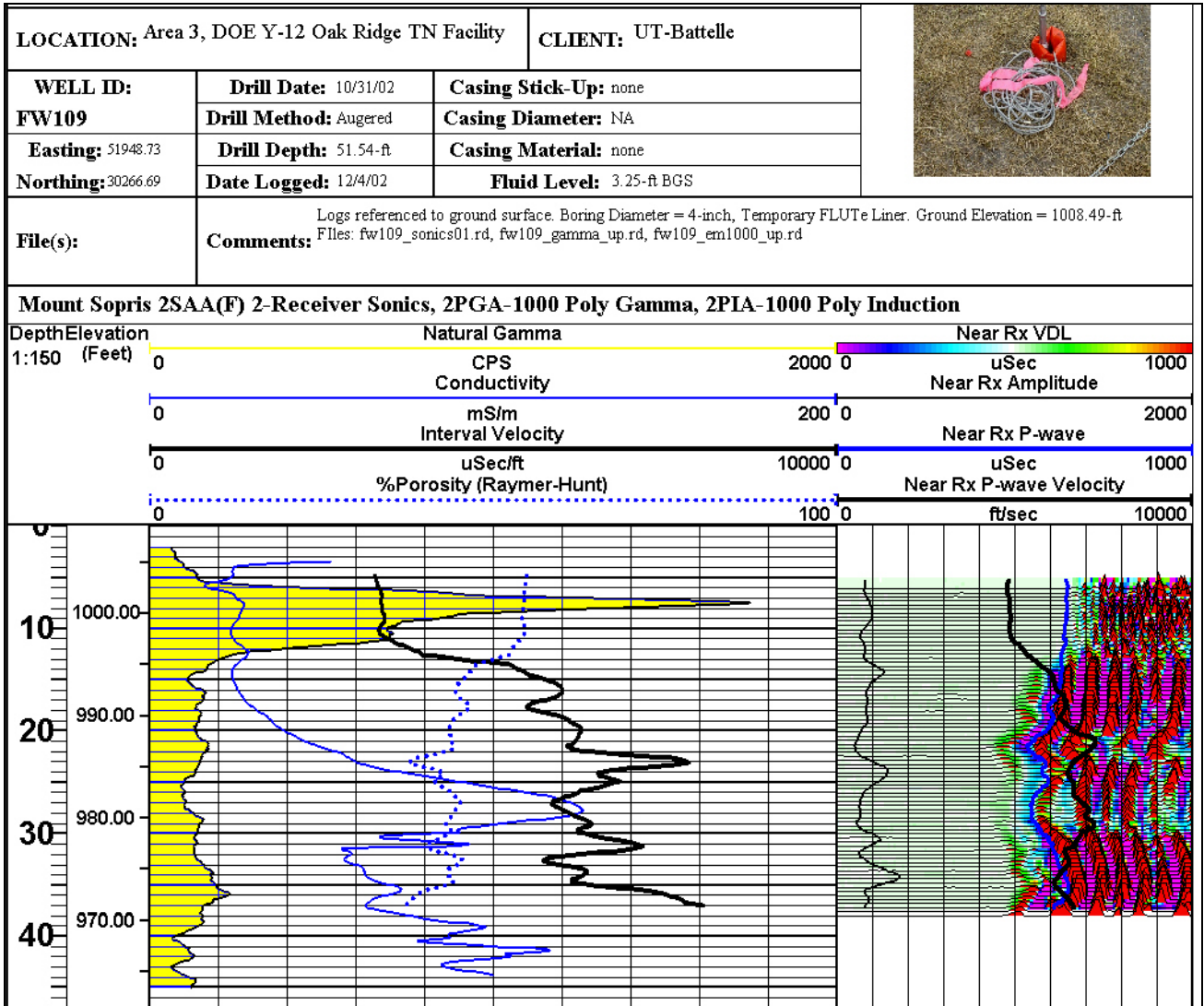


Figure 49. FW109 geophysical logs