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ROSEBUD AND REDLAND MONITORING WELL INSTALLATION REPORT

Alberta Environment
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Rosebud and Redland Monitoring Well Installation Report

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1 INTRODUCTION

The Alberta Environment (AENV) Groundwater Observation Well Network (GOWN) is a network of groundwater wells that monitor groundwater levels in aquifers across Alberta. Within the network some wells are also monitored for a variety of groundwater quality parameters. The network, starting with three wells in 1957, has grown to over 200 wells for better provincial coverage. Regional AENV staff maintain the wells, download data, take manual readings and archive the data into AENV's GOWN database. The AENV Groundwater Information Centre checks the data and maintains the GOWN database.

The Alberta Research Council (ARC) was contracted by AENV to supervise the drilling and installation of three new wells for the GOWN network. This report details the site selection, drilling and well installation data for these monitoring wells.

2 MONITORING WELL LOCATIONS

Monitoring well locations were determined by several regional and local factors including:

- Expand the GOWN network into areas that were not covered;
- Monitoring wells at one site were to be in a nest (at different completion depths) to be representative of hydrogeologic conditions at the local (shallow well) and intermediate (deeper well) scales;
- Monitoring well at the second site was to be representative of hydrogeological conditions at the local scale;
- Monitoring wells were to be located in order to minimize impact from nearby pumping wells (domestic or industrial water supply wells);
- Monitoring well sites needed to be accessible to the drilling rig and the AENV sampling trailer at all times of the year; and
- Wells were to be located in the valley to minimize drilling footage.

Two monitoring wells (nest) were installed in the town of Rosebud, Alberta, Wheatland County, in the SW-18-27-21-W4M (Figure 1) on County owned land. The deeper well (Rosebud #1) was located at N 51.18095°, W 112.56919° at a surface elevation of 793 m. The shallower well (Rosebud #2) was located at N 51.18092°, W 112.56922° at a surface elevation of 793 m. The wells were completed in the Horseshoe Canyon Formation of the Late Cretaceous Edmonton Group (Borneuf, 1972; Hydrogeological Consultants Ltd., 2003). A site survey plan is presented in Figure 2.

One monitoring well was installed in the town of Redland, Alberta, Wheatland County, in 9-10-27-22-W4M (Figure 1). The well (Redland #1) was located at N 51.292437°, W 113.005688° at a surface elevation of 800.6 m. The wells were completed in the Horseshoe Canyon Formation of the Late Cretaceous Edmonton Group (Borneuf, 1972; Hydrogeological Consultants Ltd., 2003). A site survey plan is presented in Figure 3.

3 MONITORING WELL INSTALLATIONS

The monitoring wells were installed by Gerritsen Drilling Limited of Rockyford Alberta using an Ingersoll Rand TH60 drilling rig (Figure 4). The drilling fluids used included bentonite mud and air in the overburden, and foam and air in the bedrock. Specific details of the drilling operation and the completion details for each well are presented below.

3.1 Rosebud Well #1

Drilling of Rosebud Monitoring Well #1 commenced on March 8, 2007. A test hole was advanced to 18.9 m (62') with a 152 mm (6") tricone drill bit using air to remove cuttings. Cuttings were continuously monitored and logged. Loose sand from the upper section of the hole was noted falling into the hole. The hole was reamed with a 200 mm (7⅞") bit and a temporary 152 mm (6") plastic well casing was set. The hole was then advanced to the final depth of 141.4 m (464') using a 130 mm (5⅛") bit. Cuttings were lifted by air. Cuttings were continuously monitored and logged. A detailed lithological description and well completion details are presented Appendix A.

The temporary plastic casing was pulled and bentonite chips were smeared around the borehole (using the bit and stabilizer) to control the loose sand at 14 to 16 feet. The bentonite chips were unsuccessful at controlling the sands so the hole was reamed with a 219 mm (8⅝") bit and 8.23 m (27') of 219 mm (8⅝") steel conductor pipe was inserted to control the sand. The hole was then reamed with a 200 mm (7⅞") bit to a depth of 137.77 m (452') using air and foam to lift the cuttings. A downhole camera revealed that sand continued to wash down the hole from behind the conductor pipe. An additional 2.59 m (8.5') of 219 mm (8⅝") steel conductor pipe was welded on and pushed into the ground. This was successful at controlling the sand.

A 141 mm (5.56") steel casing with threaded joints was grouted into the ground by pushing bentonite grout down the centre of the casing and getting grout returns up the annulus to the surface. The casing was then driven a short distance into the bedrock to make a good grouted and driven seal. A 114 mm (4.5") OD schedule 40 PVC liner with environmental threads and o-rings, along with 12 evenly spaced K-packers were simultaneously lowered and grouted into place (Figure 4) from above the surface to 141.42 m (464'). The lower end of the liner had a 2.74 m (9') section of 20 slot machined screen. Calcium hypochlorite was used on the threaded joints for disinfection. A schematic diagram of the well completion is presented in Appendix A.

Following completion, the well was Gamma Ray logged by ENZeeTech Inc of Calgary, Alberta. A copy of the gamma log is included in Appendix B.

The well had a casing stick-up of 0.64 m and a total depth of 141.12 m. The well was dry in the completed coal zone and methane gas was present. A compression cap with sampling valve and pressure gauge was fitted to the well and a locking mechanism restricts access to the well.

3.2 Rosebud Well #2

Drilling of Rosebud Monitoring Well #2 commenced on March 22, 2007. A test hole was advanced to 18.9 m (62') with a 200 mm (7⅞") tricone drill bit using bentonite mud to remove cuttings. A temporary 152 mm (6") plastic well casing was set. The hole was then advanced to the final depth of 55.47 m (182') using a 130 mm (5⅛") bit. Cuttings were lifted with air. Cuttings

were continuously monitored and logged. A detailed lithological description and well completion details are presented Appendix A.

The temporary plastic casing was pulled and the hole was then reamed with a 200 mm (7⅞") bit to a depth of 53.34 m (175') using bentonite mud to lift the cuttings. A 168 mm (6⅝") steel casing with welded joints was grouted into the ground by pushing bentonite grout down the centre of the casing and getting grout returns up the annulus to the surface. The casing was then driven a short distance into the bedrock to make a good grouted and driven seal. A 125 mm (4.94") OD schedule 40 PVC liner with threaded joints, along with 3 evenly spaced K-packers were simultaneously lowered and grouted into place from above the surface to 55.47 m (182'). The lower end of the liner had a 2.74 m (9') section of 20 slot machined screen. Calcium hypochlorite was used on the threaded joints for disinfection. A schematic diagram of the well completion is presented in Appendix A. The well was developed with air until the water produced was clear. The apparent well yield was approximately 0.5 Imperial gallons per minute (IGPM).

Following completion, the well was Gamma Ray logged by ENZeeTech Inc of Calgary, Alberta. A copy of the gamma log is included in Appendix B.

The well had a casing stick-up of 0.59 m and a total depth of 55.34 m. The apparent static water level in the well was 13.11 m below ground surface. The well was fitted with a locking cap. The well was shock chlorinated at the completion of the project.

3.3 Redland Well

Drilling of Redland Monitoring Well #1 commenced on March 26, 2007. A test hole was advanced to 22.1 m (72.5') with a 200 mm (7⅞") tricone drill bit using bentonite mud to remove cuttings. A temporary 152 mm (6") plastic well casing was set. The hole was then advanced to the final depth of 51.51 m (169') using a 130 mm (5⅛") bit. Cuttings were lifted with air. Cuttings were continuously monitored and logged. A detailed lithological description and well completion details are presented Appendix A.

The temporary plastic casing was pulled and the hole was then reamed with a 200 mm (7⅞") bit to a depth of 50.29 m (165') using bentonite mud to lift the cuttings. A 168 mm (6⅝") steel casing with welded joints was grouted into the ground by pushing bentonite grout down the centre of the casing and getting grout returns up the annulus to the surface. The casing was then driven a short distance into the bedrock to make a good grouted and driven seal. A 125 mm (4.94") OD schedule 40 PVC liner with threaded joints, along with 4 evenly spaced K-packers was simultaneously lowered and grouted into place from above the surface to 51.51 m (169'). The lower end of the liner had a 2.74 m (9') section of 20 slot machined screen. Calcium hypochlorite was used on the threaded joints for disinfection. A schematic diagram of the well completion is presented in Appendix A. The well was developed with air until the water produced was clear. The apparent well yield was approximately 1 IGPM.

Following completion, the well was Gamma Ray logged by ENZeeTech Inc of Calgary, Alberta. A copy of the gamma log is included in Appendix B.

The well had a casing stick-up of 0.60 m and a total depth of 51.44 m. The apparent static water level in the well was 4.76 m below ground surface. The well was fitted with a locking cap. The well was shock chlorinated at the completion of the project.

4 CONCLUSIONS AND RECCOMMENDATIONS

The following key points are summarized for the drilling programs in Rosebud and Redland.

- Exploration drilling in Rosebud encountered an apparently saturated silty sand and sand from about 2 to 5 m.

- Exploration drilling in Rosebud encountered several water bearing coal zones above 55 m. The main water bearing coal zone was encountered from 54.25 to 55.17 m. The well completed in this zone (Rosebud Well #2) yielding approximately 0.5 IGPM. This is consistent with the depth and yield of most local water wells (Alberta Environment Provincial Water Well Data Base, 2004).

- In Rosebud no water was encountered from below about 55 m to the maximum depth drilled (about 141 m). No water was encountered in the screened interval of Rosebud Well #1 but methane gas was encountered.

- Exploration drilling in Redland encountered a fine gravel from about 6.4 to 7.3 m.

- Exploration drilling in Redland encountered a minor water bearing sandstone at approximately 48 m. The main water bearing coal zone was encountered from 50.59 to 51.21 m. The well completed in this zone (Redland Well #1) yielded approximately 1 IGPM. This is consistent with the depth and yield of most local water wells (Alberta Environment Provincial Water Well Data Base 2004).

Based on the drilling and testing program at Rosebud and Redland, the following recommendations are made.

- These monitoring wells should be equipped with an automatic water level monitoring device (such as an In-Situ MiniTROLL) to monitor impacts of stresses on the regional aquifer system by water withdrawals or drought.

- Prior to geochemical sampling of Rosebud Well #2 and Redland Well #1, the wells should undergo a pumping test to determine aquifer hydraulic properties. This will also remove residual chlorine resulting from the shock chlorination of the wells.

- Rosebud Well #1 gas should be sampled and analysed for composition (GC analysis) and carbon and hydrogen isotopes.

- The Rosebud Well #1 will need to be licensed by the Alberta Energy and Utilities Board (AEUB). This process has been initiated by AENV.

This work was carried out in accordance with accepted hydrogeological and groundwater engineering practices.

Respectfully submitted,

Alberta Research Council

Alexander Blyth, Ph.D., P.Geol.
Research Hydrogeologist

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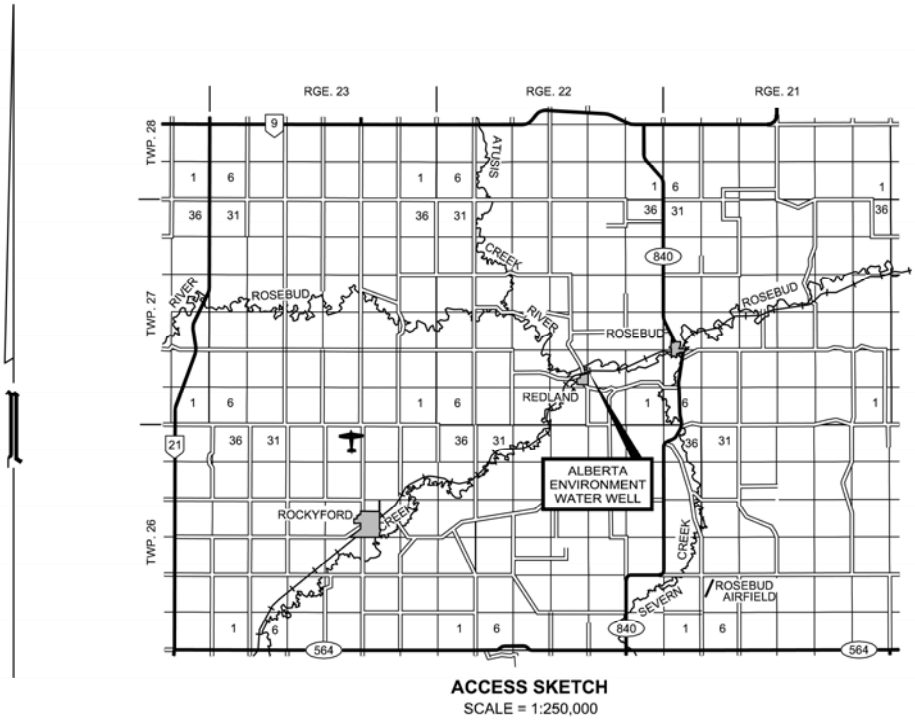


Figure 1. General site location map.

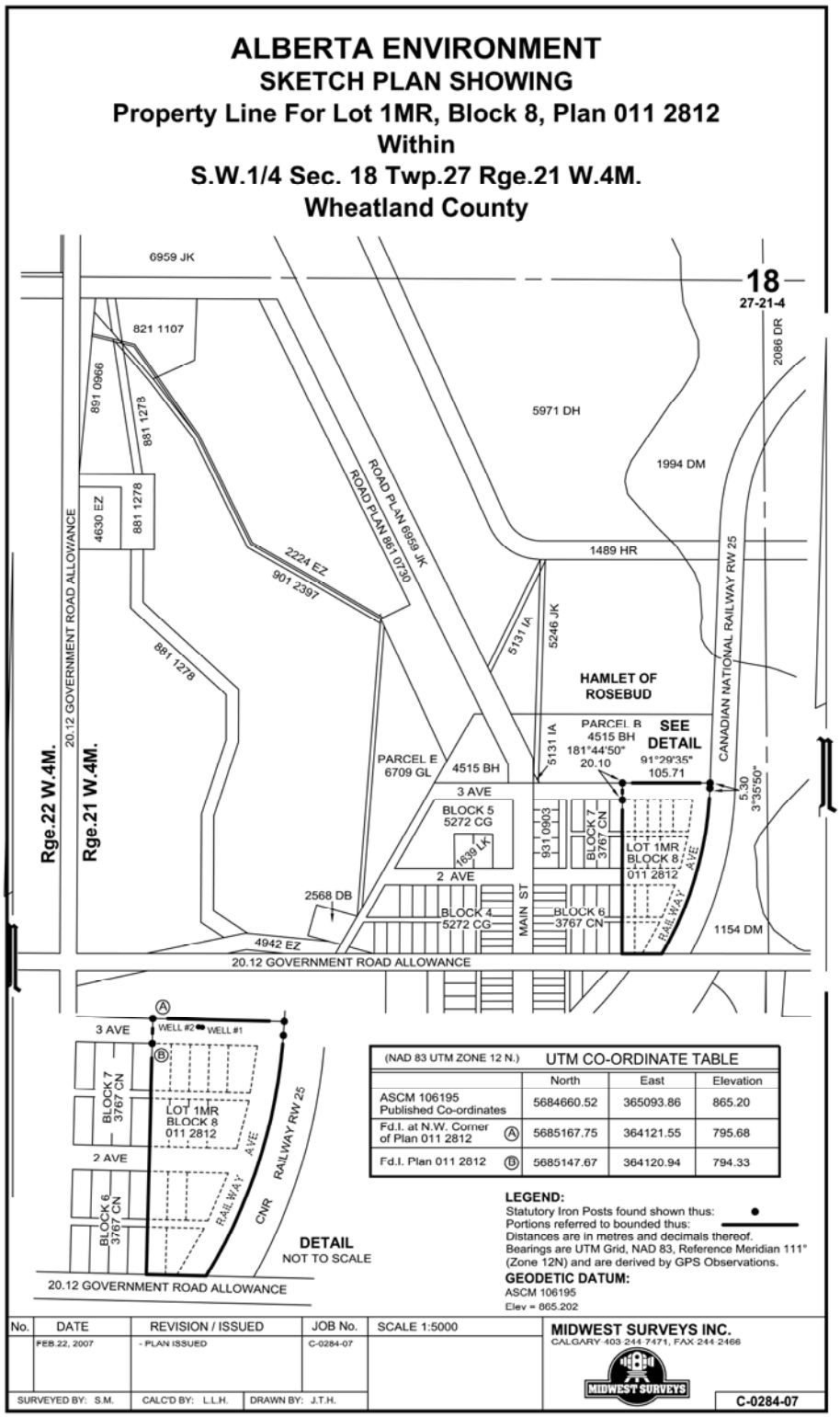


Figure 2. Detailed map of Rosebud area.

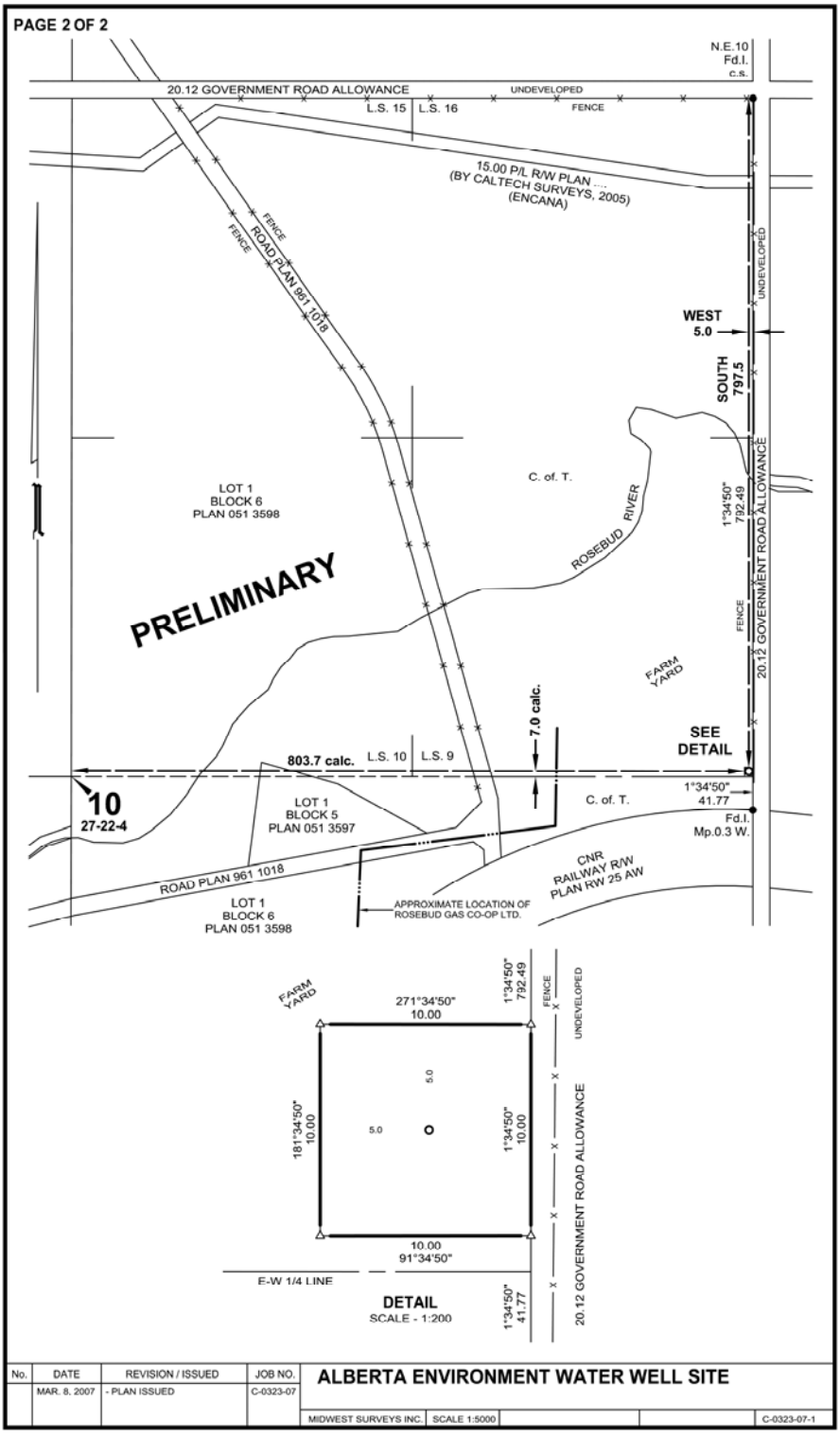


Figure 3. Detailed map of Redland area.

Ingersoll-Rand TH60 Drilling Rig

Tricone bit and Stabilizer

Wildon M15 Diaphragm Grout Pump

Installing and Grouting Liner

K-Packer on Casing Liner

Figure 4. Photographs

Ingersoll-Rand TH60 Drilling Rig

Tricone bit and Stabilizer

Wildon M15 Diaphragm Grout Pump

Installing and Grouting Liner

K-Packer on Casing Liner

Figure 4. Photographs

Appendix A

Lithological Description and Well Completion Details

Rosebud Well #1
SW-18-27-21 W4
N 51.18095°, W 112.5619, 793 m

Depth from Ground (feet)		Lithology Description
0	2	**Clayey Silt**, med. brown
2	3	**Silty Clay**, med. brown
3	5	**Clayey Silt**, med. brown
5	6.5	**Sandy Silt**, lt. brown
6.5	14	**Silty Sand**, lt. brown, occasional pebble
14	16	**Sand**, medium, occasional pebble, poorly sorted, subrounded
16	32	**Clayey Silt**, sand from above mixed with returns
32	62	**Silty Clay**, med. grey
62	66	**Siltstone**, med. grey, highly weathered, soft
66	80	**Siltstone**, med. grey
80	82	**Sandstone**, lt. Grey, fine grained
82	97	**Siltstone**, med. grey
97	99	**Sandstone**, lt. grey, soft. Water ~0.5 IGPM
99	112	**Shale**, black, silty in places
112	117	**Sandstone**, lt. grey, soft, fine grained
117	120	**Siltstone**, med. grey
120	124	**Sandstone**, lt. grey, hard, fine grained
124	132	**Shale**, black, occasional lt brown surfaces
132	133	**COAL** (Weaver coal). Water ~1 IGPM
133	145	**Shale**, black
145	147	**Sandstone**, lt. Grey, fine grained
147	148	**COAL** (Weaver coal). Water minor
148	155	**Shale**, med. brown, silty
155	158	**Sandstone**, lt. grey, hard, fine grained
158	159.5	**COAL** (Weaver coal). Water minor
159.5	165	**Siltstone**, med. grey
165	167	**Sandstone**, lt. grey, fine grained
167	170	**Shale**, black
170	178	**Sandstone**, lt. grey, hard, fine grained
178	181	**COAL** (Weaver coal). Water ~1.5 IGPM
181	190	**Shale**, black
190	193	**Sandstone**, lt. grey, fine grained
193	209	**Shale**, black, occasional lt brown, hard siliceous layers
209	216	**Sandstone**, lt. grey, fine grained
216	235	**Shale**, black. Bentonitic clay layer at 219'
235	236	**Sandstone**, lt. grey, very hard, siliceous, fine grained
236	258	**Shale**, black
258	263	**Sandstone**, lt. grey, hard, fine grained
263	310	**Siltstone**, med. grey. Minor coal at 278'
310	311	**COAL** (Garden Plains)
311	314	**Shale**, black
314	317	**Sandstone**, lt. grey, fine grained
317	328	**Shale**, black, minor siliceous layer, minor coal at 326'
328	329	**Sandstone**, lt. grey, hard, fine grained
329	330	**Shale**, black
330	333	**Sandstone**, grey, hard, fine grained
333	334	**Shale**, black
334	335	**Sandstone**, grey, hard, fine grained
335	337	**Siltstone**, med. grey
337	339	**Sandstone**, lt. grey, fine grained. Siliceous layer at 338'
339	342	**Shale**, black
342	343	**COAL** (Garden Plains)
343	354	**Shale**, black. Sandy at 351'
354	357	**Sandstone**, lt. grey, hard, fine grained
357	358	**COAL** (Garden Plains)
358	359	**Sandstone**, lt. grey, fine grained
359	368	**Siltstone**, med. grey
368	370	**Sandstone**, lt. grey, fine grained, silty
370	372	**Siltstone**, med. grey
372	373	**Sandstone**, lt. grey, fine grained
373	374.5	**Siltstone**, med. grey. Siliceous layer at 374'
374.5	400	**Shale**, black. Siliceous layer at 395'
400	406	**Sandstone**, lt. grey, hard, fine grained
406	407	**Siltstone**, med. grey
407	409	**Sandstone**, lt. grey, hard, fine grained
409	425	**Siltstone**, med. grey. Sandy from 424-425"
425	432	**Shale**, black
432	434	**COAL** (Garden Plains coal)
434	437	**Siltstone**, med. grey
437	443	**Sandstone**, lt. grey, fine grained. Siliceous layer at 439' and 442'
443	454	**Siltstone**, med. grey
454	460	**COAL** (Garden Plains)
460	461	**Siltstone**, med. grey
461	463	**COAL** (Garden Plains), shaley lenses
463	464	**Siltstone**, med. grey
End of hole		

Completion Details

Borehole diameter 7 7/8" from surface to 450 ' (137.16 m)
Borehole diameter 5 15/16" from 450-464' (137.16 to 141.42 m)

Steel conductor pipe 8 5/8" from surface to 35.5' (10.82 m)
Steel Casing diameter 5 9/16" (ID), threaded joints, from -2.1 - 452' (-0.64m to 137.77 m)
Liner diameter 4.5" (OD), environmental threads with o-rings, from -2.1 to 464' (-0.64 to 141.42 m)
Screened section of liner, 20 slot machined

Bentonite grout from surface to 452' (137.77 m) outside steel casing
Bentonite grout from surface to 452' (137.77 m) between steel casing and liner

12 evenly spaced K-Packers

Completed Well Measurements
Depth of well 464.97' (141.76 m) to Top of Casing
Casing Stick up 2.10' (0.64 m)
Total depth of well 463' (141.12 m) below ground surface
Static Water Level - no water, 54 PSI pressure

Rosebud Drilling	Rosebud/Redland		BOREHOLE: Rosebud Well 1
INSTALLED BY: Alberta Research Council			SITE: 8789009
DRILL TYPE: Air Rotary	North: 51.181	West: 112.569	ELEVATION: 2601.706 (ftasl)

FILL TYPE: Slough | Bentonite | Grout | Backfill | Sand | Peltonite | Open Hole | Unknown

SAMPLE TYPE: Shelby Tube | No Recovery | Split Spoon | Disturbed | Dynamic Cone | Core | Grab Sample

Depth (ft)	LITHOLOGIC DESCRIPTION	WELL INSTALLATION	Elev (ftasl)
1.0	Clayey Silt	Casing diam. = 0.464 ft Borehole diam. = 0.654 ft	2602.0
2.0			2603.0
3.0	Silty Clay		2604.0
4.0			2605.0
5.0	Clayey Silt		2606.0
6.0			2607.0
7.0			2608.0
8.0	Sandy Silt		2609.0
9.0			2610.0
10.0	Silty Sand - Occasional pebble		2611.0
11.0			2612.0
12.0			2613.0
13.0			2614.0
14.0			2615.0
15.0	Sand - Medium, occasional pebble, poorly		2616.0
16.0			2617.0
17.0	sorted, subrounded		2618.0
18.0			2619.0
19.0	Clayey Silt - Sand from above mixed with		2620.0
20.0			2621.0
21.0	returns		2622.0
22.0			2623.0
23.0			2624.0
24.0			2625.0
25.0			2626.0
26.0			2627.0
27.0			2628.0
28.0			2629.0
29.0			2630.0
30.0			2631.0
31.0			2632.0
32.0			2633.0
33.0	Silty Clay		2634.0
34.0			2635.0
35.0			2636.0
36.0			2637.0
37.0			2638.0
38.0			2639.0
39.0			2640.0
40.0			2641.0
41.0			2642.0
42.0			2643.0
43.0			2644.0
44.0			2645.0
45.0			2646.0
46.0			2647.0
47.0			2648.0
48.0			2649.0
49.0			2650.0
50.0			2651.0
51.0			2652.0
52.0			2653.0
53.0			2654.0
54.0			2655.0
55.0			2656.0
56.0			2657.0
57.0			2658.0
58.0			2659.0
59.0			2660.0
60.0			2661.0
61.0			2662.0
62.0			2663.0
63.0	Siltstone - Highly weathered, soft		2664.0
64.0			2665.0
65.0			2666.0
66.0			2667.0
67.0	Siltstone		2668.0
68.0			2669.0
69.0			2670.0
70.0			2671.0
71.0			2672.0
72.0			2673.0
73.0			2674.0
74.0			2675.0
75.0			2676.0
76.0			2677.0
77.0			2678.0
78.0			2679.0
79.0			2680.0
80.0			2681.0
81.0	Sandstone - Fine grained		2682.0
82.0			2683.0
83.0	Siltstone		2684.0
84.0			2685.0
			2686.0

Alberta Research Council	LOGGED BY: Alec Blyth	COMPLETION DEPTH: 464.00 (ft)
Date printed: 12-Apr-2007	TYPE: Gas Monitoring Well	COMPLETED:

Rosebud Drilling	Rosebud/Redland		BOREHOLE: Rosebud Well 1
INSTALLED BY: Alberta Research Council			SITE: 8789009
DRILL TYPE: Air Rotary	North: 51.181	West: 112.569	ELEVATION: 2601.706 (ftasl)

FILL TYPE: Slough | Bentonite | Grout | Backfill | Sand | Peltonite | Open Hole | Unknown

SAMPLE TYPE: Shelby Tube | No Recovery | Split Spoon | Disturbed | Dynamic Cone | Core | Grab Sample

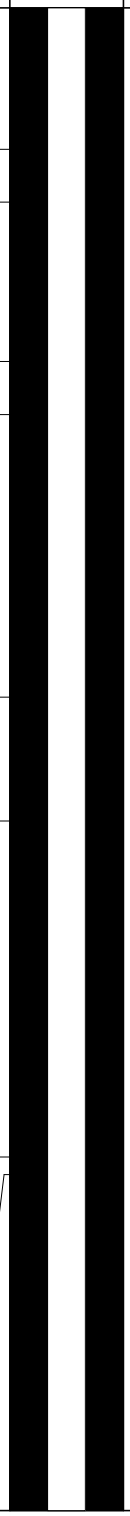
Depth (ft)	LITHOLOGIC DESCRIPTION	WELL INSTALLATION (Casing diam. = 0.464 ft, Borehole diam. = 0.654 ft)	Elev (ftasl)
86.0 – 98.0			2687.0 – 2699.0
99.0	Sandstone - Soft, water ~0.5 IGPM		2700.0
100 – 111	Shale - Silty in places		2701 – 2712
112			2713
113 – 116	Sandstone - Soft, fine grained		2714 – 2717
117			2718
118 – 119	Siltstone		2719 – 2720
120			2721
121 – 123	Sandstone - Hard, fine grained		2722 – 2724
124			2725
125 – 131	Shale - Occasional light brown surfaces		2726 – 2732
132			2733
133	Coal - WEAVER COAL, water ~1 IGPM		2734
134 – 145	Shale		2735 – 2746
146			2747
147	Sandstone - Fine grained		2748
148			2749
149	Coal - WEAVER COAL, water minor		2750
150 – 155	Shale - Silty		2751 – 2756
156			2757
157	Sandstone - Hard, fine grained		2758
158			2759
159	Coal - WEAVER COAL, water minor		2760
160 – 165	Siltstone		2761 – 2766
166			2767
167	Sandstone - Fine grained		2768
168 – 169	Shale		2769 – 2771

Alberta Research Council	LOGGED BY: Alec Blyth	COMPLETION DEPTH: 464.00 (ft)
Date printed: 12-Apr-2007	TYPE: Gas Monitoring Well	COMPLETED:

Rosebud Drilling	Rosebud/Redland		BOREHOLE: Rosebud Well 1
INSTALLED BY: Alberta Research Council			SITE: 8789009
DRILL TYPE: Air Rotary	North: 51.181	West: 112.569	ELEVATION: 2601.706 (ftasl)

FILL TYPE: Slough | Bentonite | Grout | Backfill | Sand | Peltonite | Open Hole | Unknown

SAMPLE TYPE: Shelby Tube | No Recovery | Split Spoon | Disturbed | Dynamic Cone | Core | Grab Sample

Depth (ft)	LITHOLOGIC DESCRIPTION	WELL INSTALLATION (Casing diam. = 0.464 ft, Borehole diam. = 0.654 ft)	Elev (ftasl)
171–254	Sandstone - Hard, fine grained		2772–2856
	Coal - WEAVER COAL, water ~1.5 IGPM		
	Shale		
	Sandstone - Fine grained		
	Shale - Ocassional light brown, hard siliceous layers		
	Sandstone - Fine grained		
	Shale - Bentonitic clay layer at 219'		
	Sandstone - Very hard, siliceous, fine grained		
	Shale		

Alberta Research Council	LOGGED BY: Alec Blyth	COMPLETION DEPTH: 464.00 (ft)
Date printed: 12-Apr-2007	TYPE: Gas Monitoring Well	COMPLETED:

Rosebud Drilling	Rosebud/Redland		BOREHOLE: Rosebud Well 1
INSTALLED BY: Alberta Research Council			SITE: 8789009
DRILL TYPE: Air Rotary	North: 51.181	West: 112.569	ELEVATION: 2601.706 (ftasl)

FILL TYPE: Slough | Bentonite | Grout | Backfill | Sand | Peltonite | Open Hole | Unknown

SAMPLE TYPE: Shelby Tube | No Recovery | Split Spoon | Disturbed | Dynamic Cone | Core | Grab Sample

Depth (ft)	LITHOLOGIC DESCRIPTION	WELL INSTALLATION	Elev (ftasl)
256–339	Sandstone - Hard, fine grained Siltstone - Minor coal at 278' Coal - GARDEN PLAINS Shale Sandstone - Fine grained Shale - Minor siliceous layer, minor coal at 326' Sandstone - Hard, fine grained Shale Sandstone - Hard, fine grained Shale Sandstone - Hard, fine grained Siltstone	Casing diam. = 0.464 ft Borehole diam. = 0.654 ft	2857–2941

Alberta Research Council

Date printed: 12-Apr-2007

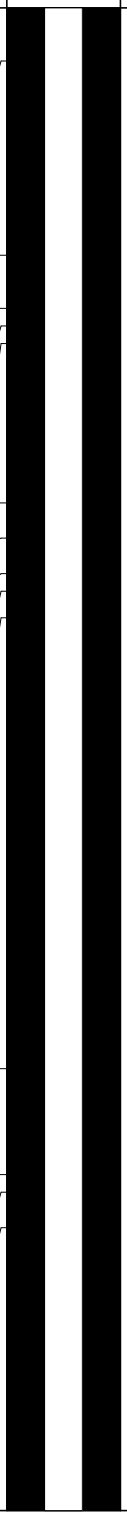
LOGGED BY: Alec Blyth | COMPLETION DEPTH: 464.00 (ft)

TYPE: Gas Monitoring Well | COMPLETED:

Rosebud Drilling	Rosebud/Redland		BOREHOLE: Rosebud Well 1
INSTALLED BY: Alberta Research Council			SITE: 8789009
DRILL TYPE: Air Rotary	North: 51.181	West: 112.569	ELEVATION: 2601.706 (ftasl)

FILL TYPE: Slough | Bentonite | Grout | Backfill | Sand | Peltonite | Open Hole | Unknown

SAMPLE TYPE: Shelby Tube | No Recovery | Split Spoon | Disturbed | Dynamic Cone | Core | Grab Sample

Depth (ft)	LITHOLOGIC DESCRIPTION	WELL INSTALLATION (Casing diam. = 0.464 ft, Borehole diam. = 0.654 ft)	Elev (ftasl)
341–424	Coal - GARDEN PLAINS Shale - Sandy at 351' Sandstone - Hard, fine grained Coal - GARDEN PLAINS Sandstone - Fine grained Siltstone Sandstone - Fine grained, silty Siltstone Sandstone - Fine grained Siltstone - Siliceous layer at 374' Shale - Siliceous layer at 395' Sandstone - Hard, fine grained Siltstone Sandstone - Hard, fine grained Siltstone - Sandy from 424-425'		2942–3026

Alberta Research Council Date printed: 12-Apr-2007	LOGGED BY: Alec Blyth	COMPLETION DEPTH: 464.00 (ft)
	TYPE: Gas Monitoring Well	COMPLETED:

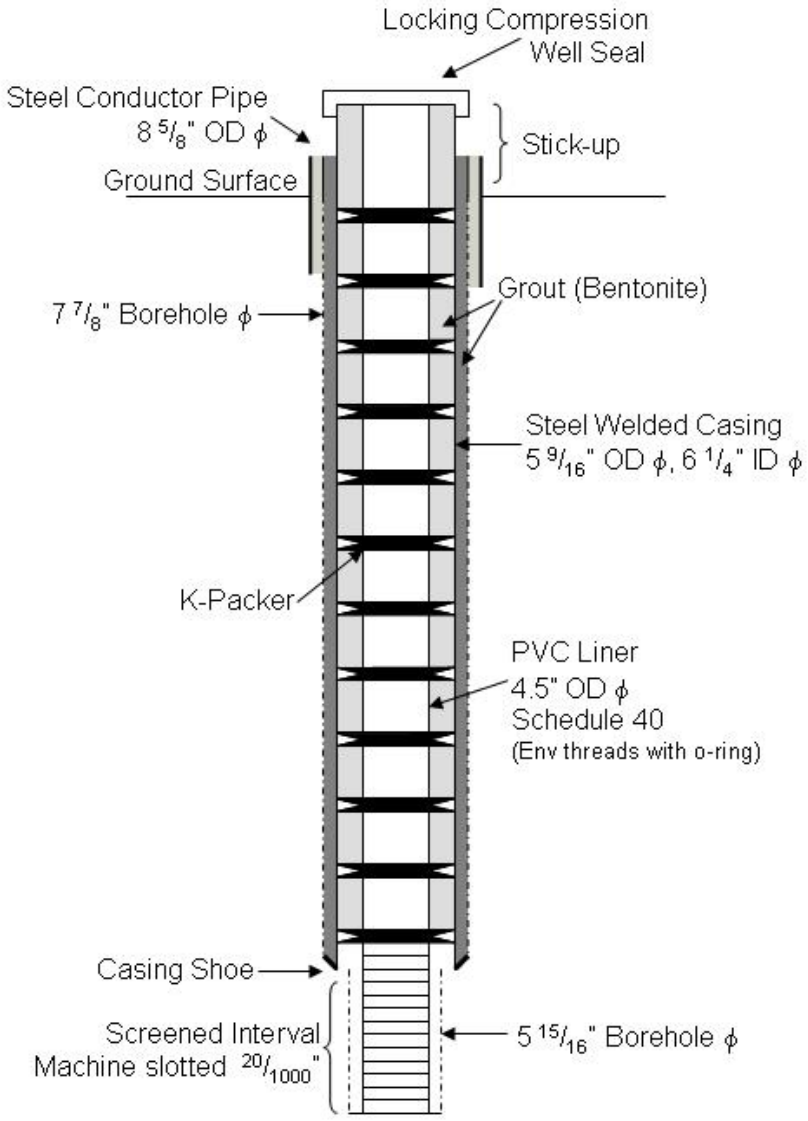
Rosebud Drilling	Rosebud/Redland		BOREHOLE: Rosebud Well 1
INSTALLED BY: Alberta Research Council			SITE: 8789009
DRILL TYPE: Air Rotary	North: 51.181	West: 112.569	ELEVATION: 2601.706 (ftasl)

FILL TYPE: Slough | Bentonite | Grout | Backfill | Sand | Peltonite | Open Hole | Unknown

SAMPLE TYPE: Shelby Tube | No Recovery | Split Spoon | Disturbed | Dynamic Cone | Core | Grab Sample

Depth (ft)	LITHOLOGIC DESCRIPTION	WELL INSTALLATION	Elev (ftasl)
426	Shale	Casing diam. = 0.464 ft Borehole diam. = 0.654 ft	3027
427			3028
428			3029
429			3030
430			3031
431			3032
432			3033
433	Coal - GARDEN PLAINS		3034
434			3035
435	Siltstone		3036
436			3037
437	Siltstone		3038
438			3039
439	Sandstone - Fine grained, siliceous		3040
440	layer at 439' and 442'		3041
441			3042
442			3043
443			3044
444	Siltstone		3045
445			3046
446			3047
447			3048
448			3049
449			3050
450			3051
451			3052
452			3053
453			3054
454	Coal - GARDEN PLAINS		3055
455			3056
456			3057
457			3058
458			3059
459			3060
460			3061
461	Siltstone		3062
462			3063
463	Coal - GARDEN PLAINS, shaley lenses		3064
464			3065
465	END OF HOLE AT 464.0 ft		3066
466	Other wells in nest: 1		3067
467	Well status: Active		3068
468			3069
469			3070
470			3071
471			3072
472			3073
473			3074
474			3075
475			3076
476			3077
477			3078
478			3079
479			3080
480			3081
481			3082
482			3083
483			3084
484			3085
485			3086
486			3087
487			3088
488			3089
489			3090
490			3091
491			3092
492			3093
493			3094
494			3095
495			3096
496			3097
497			3098
498			3099
499			3100
500			3101
501			3102
502			3103
503			3104
504			3105
505			3106
506			3107
507			3108
508			3109
509			3110
			3111

Alberta Research Council	LOGGED BY: Alec Blyth	COMPLETION DEPTH: 464.00 (ft)
Date printed: 12-Apr-2007	TYPE: Gas Monitoring Well	COMPLETED:



Schematic Completion Diagram for Rosebud Monitoring Well #1
(not to scale)

Rosebud Well #2
SW-18-27-21 W4
N 51.18092°, W 112.56922, 793 m

Depth from Ground (feet)		Lithology Description
0	2	**Clayey Silt**, med. brown
2	3	**Silty Clay**, med. brown
3	5	**Clayey Silt**, med. brown
5	6.5	**Sandy Silt**, lt. brown
6.5	14	**Silty Sand**, lt. brown, occasional pebble
14	15	**Sand**, medium to coarse grained, poorly sorted, subrounded
15	17	**Silty Sand**, lt brown, some clay
17	20	**Clayey Silt**, lt. grey, some sand
20	26	**Silty Clay**, lt. grey, with occasional pebble
26	28	**Clayey Silt**, lt. Grey
28	51	**Silty Clay**, lt. grey, with occasional pebble
51	61	**Silty Clay**, bluish grey
61	67	**Siltstone**, med. brown, highly weathered, soft
67	83	**Siltstone**, med. grey
83	86	**Sandstone**, lt. grey, fine grained
86	90	**Siltstone**, med. grey
90	96	**Shale**, black
96	99	**Siltstone**, med. grey
99	99.5	**COAL** (Carbon Thompson), shaley. Water ~ 0.25 IGPM
99.5	103	**Shale**, black
103	104	**Siltstone**, med. grey
104	112	**Shale**, black
112	118	**Sandstone**, lt. grey, fine grained
118	120	**Siltstone**, med. grey
120	127	**Sandstone**, lt. grey, fine grained
127	129	**Siltstone**, med. grey
129	130	**Shale**, black
130	131.0	**Siltstone**, med. grey
131.0	132.5	**COAL** (Weaver). Water ~ 0.5 IGPM
132.5	142	**Shale**, black
142	145	**Sandstone**, lt. grey, fine grained
145	145.5	**Shale**, brown
145.5	146	**COAL** (Weaver). Water minor
146	146.5	**Shale**, bentonitic
146.5	153	**Shale**, black
153	161	**Sandstone**, lt. grey, fine grained
161	172	**Shale**, black
172	176	**Sandstone**, lt. grey, fine grained
176	178	**Shale**, black
178	181	**COAL** (Weaver). Water ~0.75 IGPM
181	182	**Shale**, black

End of Hole

Completion Details

Borehole diameter 7 7/8" from surface to 175 ' (53.34 m)
Borehole diameter 5 15/16" from 175-182' (53.34 to 55.47 m)

Steel Casing diameter 6 5/8" (OD), 6 1/4" (ID), welded joints, from -1.94 - 175' (-0.59m to 53.34 m)
Liner diameter 4.94" (OD), 4.5" (ID), threaded, from -1.94 - 182' (-0.59m to 55.47 m)
Screened section of liner, 20 slot machined, 173-182' (52.73 to 55.47 m)

Bentonite grout from surface to 175' (53.34 m) outside steel casing
Bentonite grout from surface to 173' (52.73 m) between steel casing and liner

K-Packers at 60, 120 and 172'

Completed Well Measurements
Depth of well 183.45' (55.92 m) to Top of Casing
Casing Stick up 1.94' (0.59 m)
Total depth of well 181.51' (55.34 m) below ground surface
Static Water Level 13.11 m (below ground surface)

Rosebud Drilling	Rosebud/Redland	BOREHOLE:	Rosebud Well 2
INSTALLED BY: Alberta Research Council		SITE:	8789009
DRILL TYPE: Air Rotary	North: 51.181 West: 112.569	ELEVATION:	2601.706 (ftasl)

FILL TYPE: Slough | Bentonite | Grout | Backfill | Sand | Peltonite | Open Hole | Unknown

SAMPLE TYPE: Shelby Tube | No Recovery | Split Spoon | Disturbed | Dynamic Cone | Core | Grab Sample

Depth (ft)	LITHOLOGIC DESCRIPTION	WELL INSTALLATION	Elev (ftasl)
1.0	Clayey Silt - medium brown	Casing diam. = 0.552 ft Borehole diam. = 0.654 ft	2602.0
3.0	Silty Clay - medium brown		2604.0
5.0	Clayey Silt - medium brown		2606.0
7.0	Sandy Silt - light brown		2608.0
9.0	Silty Sand - light brown, occasional pebble		2610.0
15.0	Sand - medium to coarse grained, poorly sorted, subrounded		2616.0
19.0	Silty Sand - light brown, some clay		2620.0
21.0	Clayey Silt - light gray, some sand		2622.0
26.0	Silty Clay - light gray, with occasional pebble		2627.0
28.0	Clayed Silt - light gray		2629.0
51.0	Silty Clay - blueish gray		2652.0
61.0	Siltstone - medium brown, highly weathered, soft	K-Packer	2662.0
67.0	Siltstone - medium gray		2668.0
74.0			2676.0

Alberta Research Council	LOGGED BY: Alec Blyth	COMPLETION DEPTH: 183.45 (ft)
Date printed: 12-Apr-2007	TYPE: Groundwater Monitoring Well	COMPLETED:

Rosebud Drilling	Rosebud/Redland	BOREHOLE: Rosebud Well 2
INSTALLED BY: Alberta Research Council		SITE: 8789009
DRILL TYPE: Air Rotary	North: 51.181 West: 112.569	ELEVATION: 2601.706 (ftasl)

FILL TYPE: Slough | Bentonite | Grout | Backfill | Sand | Peltonite | Open Hole | Unknown

SAMPLE TYPE: Shelby Tube | No Recovery | Split Spoon | Disturbed | Dynamic Cone | Core | Grab Sample

Depth (ft)	LITHOLOGIC DESCRIPTION	WELL INSTALLATION (Casing diam. = 0.552 ft, Borehole diam. = 0.654 ft)	Elev (ftasl)
84.0–86.0	Sandstone - light gray, fine grained		2685.0–2687.0
86.0–90.0	Siltstone - medium gray		2687.0–2691.0
90.0–96.0	Shale - black		2691.0–2697.0
96.0–99.0	Siltstone - medium gray		2697.0–2700.0
99.0–102.0	Coal - CARBON THOMPSON, shaley, water ~0.25 IGPM		2700.0–2703.0
102.0–104.0	Shale - black		2703.0–2705.0
104.0–106.0	Siltstone - medium gray		2705.0–2707.0
106.0–112.0	Shale - black		2707.0–2713.0
112.0–118.0	Sandstone - light gray, fine grained		2713.0–2719.0
118.0–120.0	Siltstone - medium gray		2719.0–2721.0
120.0–127.0	Sandstone - light gray, fine grained	K-Packer	2721.0–2728.0
127.0–129.0	Siltstone - medium gray		2728.0–2730.0
129.0–130.0	Shale - black		2730.0–2731.0
130.0–132.0	Siltstone - medium gray		2731.0–2733.0
132.0–134.0	Coal - WEAVER, water ~0.5 IGPM		2733.0–2735.0
134.0–142.0	Shale - black		2735.0–2742.0
142.0–146.0	Sandstone - light gray, fine grained		2742.0–2746.0
146.0–147.0	Shale - brown		2746.0–2747.0
147.0–148.0	Coal - WEAVER, water minor		2747.0–2748.0
148.0–149.0	Shale - bentonitic		2748.0–2749.0
149.0–150.0	Shale - black		2749.0–2750.0

Alberta Research Council

Date printed: 12-Apr-2007

LOGGED BY: Alec Blyth | COMPLETION DEPTH: 183.45 (ft)

TYPE: Groundwater Monitoring Well | COMPLETED:

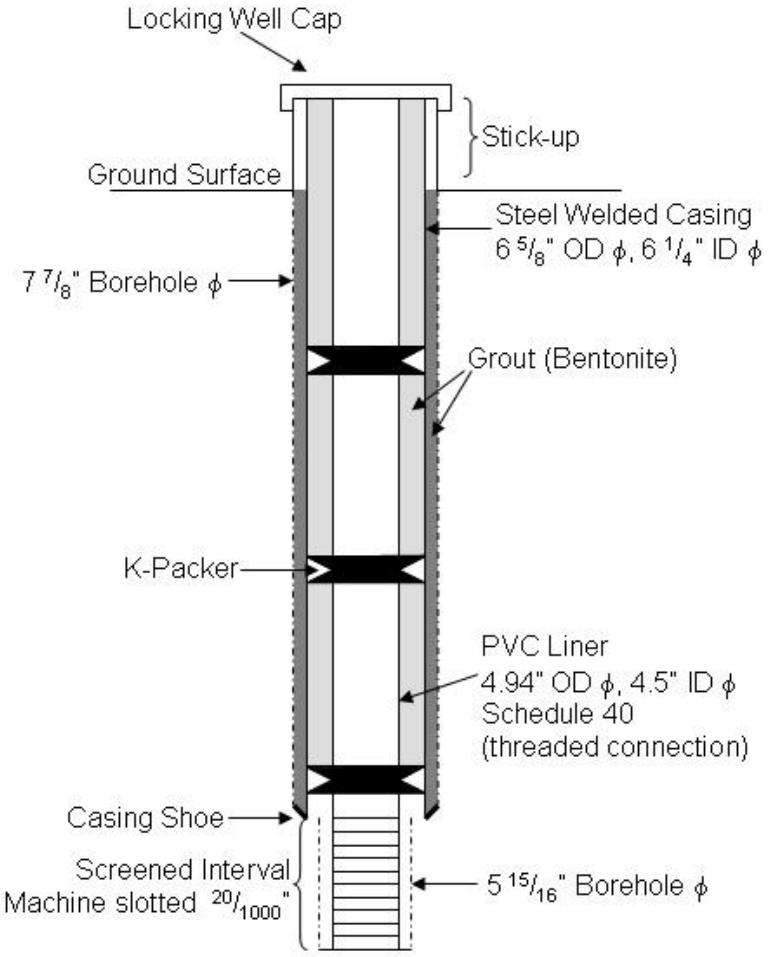
Rosebud Drilling	Rosebud/Redland		BOREHOLE: Rosebud Well 2
INSTALLED BY: Alberta Research Council			SITE: 8789009
DRILL TYPE: Air Rotary	North: 51.181	West: 112.569	ELEVATION: 2601.706 (ftasl)

FILL TYPE: Slough | Bentonite | Grout | Backfill | Sand | Peltonite | Open Hole | Unknown

SAMPLE TYPE: Shelby Tube | No Recovery | Split Spoon | Disturbed | Dynamic Cone | Core | Grab Sample

Depth (ft)	LITHOLOGIC DESCRIPTION	WELL INSTALLATION (Casing diam. = 0.552 ft, Borehole diam. = 0.654 ft)	Elev (ftasl)
151–161	Sandstone - light gray, fine grained		2752–2762
161–172	Shale - black		2762–2773
172–177	Sandstone - light gray, fine grained	K-Packer	2773–2778
177–178	Shale - black		2778–2779
178–181	Coal - WEAVER, water ~0.75 IGPM		2779–2782
181–183	Shale - black		2782–2784
183–224	END OF HOLE AT 183.45 ft Well status: Active		2784–2826

Alberta Research Council	LOGGED BY: Alec Blyth	COMPLETION DEPTH: 183.45 (ft)
Date printed: 12-Apr-2007	TYPE: Groundwater Monitoring Well	COMPLETED:



Schematic Completion Diagram for Rosebud Monitoring Well #2
(not to scale)

Redland
9-10-27-22 W4
N 51.292437°, W 113.005688, 800.6 m

Depth from Ground (feet)		Lithology Description
0	1	**Silty Loam Top Soil**, drk. brown
1	9	**Clayey Silt**, med. brown
9	21	**Clayey Silt**, med. brown, some pebbles
21	24	**Gravel**, fine, poorly sorted, subrounded
24	35	**Silty Clay**, med. grey, occasional pebble
35	40	**Silty Sandy Clay**, med. grey, occasional pebble
40	43	**Silty Clay**, med. grey, bits of coal
43	48	**Clay**, bluish grey, hard
48	49	**Coal**, loose (not bedrock)
49	50	**Clay**, brown
50	64	**Clay**, bluish grey, hard
64	68	**Siltstone**, med. grey, highly weathered, soft
68	76	**Siltstone**, med. grey
76	80	**Sandstone**, lt. grey, fine grained
80	84	**Shale**, black
84	84.5	**Sandstone**, lt. brown, siliceous
84.5	90	**Shale**, black
90	96	**Sandstone**, lt. grey, fine grained
96	97	**Shale**, black
97	100	**Sandstone**, lt. grey, fine grained
100	107	**Shale**, black
107	108	**Sandstone**, lt. grey, fine grained
108	109	**Shale**, black
109	110	**Sandstone**, lt. grey, fine grained
110	116.0	**Shale**, black
116.0	118	**Sandstone**, lt. grey, fine grained
118	143	**Shale**, black
143	143.5	**Sandstone**, lt. grey, fine grained
143.5	145	**Shale**, black
145	145.5	**Sandstone**, lt. grey, fine grained
145.5	158	**Shale**, black, hard siliceous layers at 155' and 158'
158	160	**Sandstone**, lt. grey, fine grained. Water ~0.25 IGPM
160	166	**Shale**, black
166	168	**COAL** (Weaver coal). Water ~1.25 IGPM
168	169	**Shale**, black
End of hole		

Completion Details

Borehole diameter 7 7/8" from surface to 165 ' (50.29 m)
Borehole diameter 5 15/16" from 165-169' (50.92 to 51.51 m)

Steel Casing diameter 6 5/8" (OD), 6 1/4" (ID), welded joints, from -1.97 - 165' (-0.60m to 50.29 m)
Liner diameter 4.94" (OD), 4.5" (ID), threaded, from -1.97 - 169' (-0.60m to 51.51 m)
Screened section of liner, 20 slot machined, 160-169' (48.77 to 51.51 m)

Bentonite grout from surface to 165' (50.29 m) outside steel casing
Bentonite grout from surface to 160' (50.29 m) between steel casing and liner

K-Packers at 40, 80, 120 and 160'

Completed Well Measurements
Depth of well 170.69' (52.04 m) to Top of Casing
Casing Stick up 1.97' (0.60 m)
Total depth of well 168.7' (51.44 m) below ground surface
Static Water Level 4.76 m (below ground surface)

Rosebud Drilling	Rosebud/Redland		BOREHOLE: Redland Well
INSTALLED BY: Alberta Research Council			SITE: 8789009
DRILL TYPE: Air Rotary	North: 51.292	West: 113.005	ELEVATION: 2626.640 (ftasl)

FILL TYPE: Slough | Bentonite | Grout | Backfill | Sand | Peltonite | Open Hole | Unknown

SAMPLE TYPE: Shelby Tube | No Recovery | Split Spoon | Disturbed | Dynamic Cone | Core | Grab Sample

Depth (ft)	LITHOLOGIC DESCRIPTION	WELL INSTALLATION	Elev (ftasl)
1.0	Silty Loam Top Soil - dark brown	Casing diam. = 0.552 ft Borehole diam. = 0.654 ft	2627.0
2.0	Clayey Silt - medium brown		2628.0
3.0			2629.0
4.0			2630.0
5.0			2631.0
6.0			2632.0
7.0			2633.0
8.0			2634.0
9.0			2635.0
10.0	Clayey Silt - medium brown, some pebbles		2636.0
11.0			2637.0
12.0			2638.0
13.0			2639.0
14.0			2640.0
15.0			2641.0
16.0			2642.0
17.0			2643.0
18.0			2644.0
19.0			2645.0
20.0			2646.0
21.0			2647.0
22.0	Gravel - fine, poorly sorted, subrounded		2648.0
23.0			2649.0
24.0			2650.0
25.0	Silty Clay - medium gray, occasional pebble		2651.0
26.0			2652.0
27.0			2653.0
28.0			2654.0
29.0			2655.0
30.0			2656.0
31.0			2657.0
32.0			2658.0
33.0			2659.0
34.0			2660.0
35.0			2661.0
36.0	Silty Sandy Clay - medium gray, occassional pebble		2662.0
37.0			2663.0
38.0			2664.0
39.0			2665.0
40.0			2666.0
41.0	Silty Clay - medium gray, bits of coal	K-Packer	2667.0
42.0			2668.0
43.0			2669.0
44.0	Clay - blueish gray, hard		2670.0
45.0			2671.0
46.0			2672.0
47.0			2673.0
48.0			2674.0
49.0	Coal - loose (not bedrock)		2675.0
50.0			2676.0
51.0	Clay - brown		2677.0
52.0			2678.0
53.0	Clay - blueish gray, hard		2679.0
54.0			2680.0
55.0			2681.0
56.0			2682.0
57.0			2683.0
58.0			2684.0
59.0			2685.0
60.0			2686.0
61.0			2687.0
62.0			2688.0
63.0			2689.0
64.0			2690.0
65.0	Siltstone - medium gray, highly weathered, soft		2691.0
66.0			2692.0
67.0			2693.0
68.0			2694.0
69.0	Siltstone - medium gray		2695.0
70.0			2696.0
71.0			2697.0
72.0			2698.0
73.0			2699.0
74.0			2700.0
			2701.0

Alberta Research Council Date printed: 12-Apr-2007	LOGGED BY: Alec Blyth	COMPLETION DEPTH: 170.69 (ft)
	TYPE: Groundwater Monitoring Well	COMPLETED:

Rosebud Drilling	Rosebud/Redland	BOREHOLE:	Redland Well
INSTALLED BY: Alberta Research Council		SITE:	8789009
DRILL TYPE: Air Rotary	North: 51.292 West: 113.005	ELEVATION:	2626.640 (ftasl)

FILL TYPE: Slough, Bentonite, Grout, Backfill, Sand, Peltonite, Open Hole, Unknown

SAMPLE TYPE: Shelby Tube, No Recovery, Split Spoon, Disturbed, Dynamic Cone, Core, Grab Sample

Depth (ft)	LITHOLOGIC DESCRIPTION	WELL INSTALLATION (Casing diam. = 0.552 ft; Borehole diam. = 0.654 ft)	Elev (ftasl)
76.0	Sandstone - light gray, fine grained		2702.0
77.0			2703.0
78.0			2704.0
79.0			2705.0
80.0	Shale - black	K-Packer	2706.0
81.0			2707.0
82.0			2708.0
83.0			2709.0
84.0			2710.0
85.0	Sandstone - light brown, siliceous		2711.0
86.0			2712.0
87.0	Shale - black		2713.0
88.0			2714.0
89.0			2715.0
90.0	Sandstone - light gray, fine grained		2716.0
91.0			2717.0
92.0			2718.0
93.0			2719.0
94.0			2720.0
95.0			2721.0
96.0			2722.0
97.0	Shale - black		2723.0
98.0			2724.0
99.0	Sandstone - light gray, fine grained		2725.0
100			2726
101	Shale - black		2727
102			2728
103			2729
104			2730
105			2731
106			2732
107			2733
108	Sandstone - light gray, fine grained		2734
109			2735
110	Shale - black		2736
111			2737
112	Sandstone - light gray, fine grained		2738
113			2739
114	Shale - black		2740
115			2741
116			2742
117	Sandstone - light gray, fine grained		2743
118			2744
119	Shale - black		2745
120			2746
121		K-Packer	2747
122			2748
123			2749
124			2750
125			2751
126			2752
127			2753
128			2754
129			2755
130			2756
131			2757
132			2758
133			2759
134			2760
135			2761
136			2762
137			2763
138			2764
139			2765
140			2766
141			2767
142			2768
143			2769
144	Sandstone - light gray, fine grained		2770
145			2771
146	Shale - black		2772
147			2773
148	Sandstone - light gray, fine grained		2774
149			2775
	Shale - black, hard siliceous layers at 155' and 158'		2776

Alberta Research Council	LOGGED BY: Alec Blyth	COMPLETION DEPTH: 170.69 (ft)
Date printed: 12-Apr-2007	TYPE: Groundwater Monitoring Well	COMPLETED:

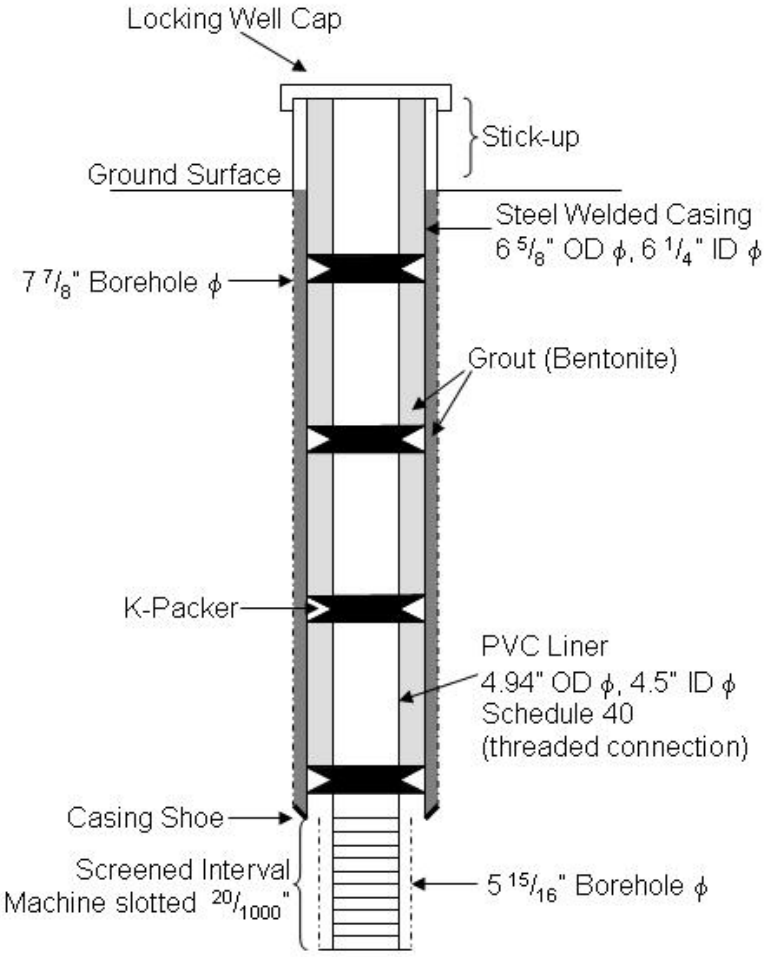
Rosebud Drilling	Rosebud/Redland		BOREHOLE: Redland Well
INSTALLED BY: Alberta Research Council			SITE: 8789009
DRILL TYPE: Air Rotary	North: 51.292	West: 113.005	ELEVATION: 2626.640 (ftasl)

FILL TYPE: Slough | Bentonite | Grout | Backfill | Sand | Peltonite | Open Hole | Unknown

SAMPLE TYPE: Shelby Tube | No Recovery | Split Spoon | Disturbed | Dynamic Cone | Core | Grab Sample

Depth (ft)	LITHOLOGIC DESCRIPTION	WELL INSTALLATION (Casing diam. = 0.552 ft, Borehole diam. = 0.654 ft)	Elev (ftasl)
151–224	Sandstone - light gray, fine grained, water at ~0.25 IGPM	K-Packer	2777–2851
	Shale - black		
	Coal - WEAVER, Water ~1.25 IGPM		
	Shale - black		
	END OF HOLE AT 170.69 ft Well status: Active		

Alberta Research Council	LOGGED BY: Alec Blyth	COMPLETION DEPTH: 170.69 (ft)
Date printed: 12-Apr-2007	TYPE: Groundwater Monitoring Well	COMPLETED:



Schematic Completion Diagram for Redland Monitoring Well
(not to scale)

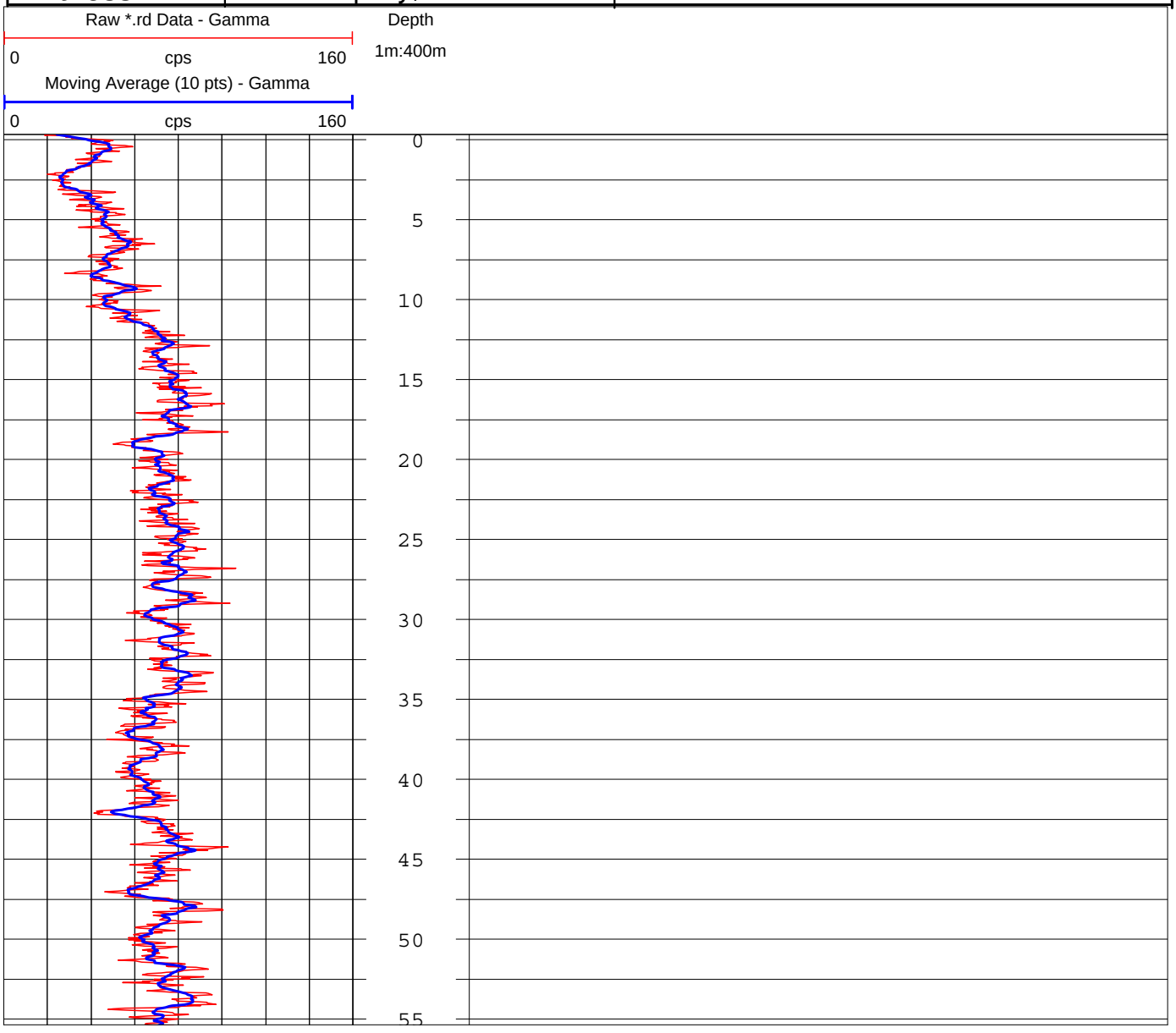
Appendix B
E-Log

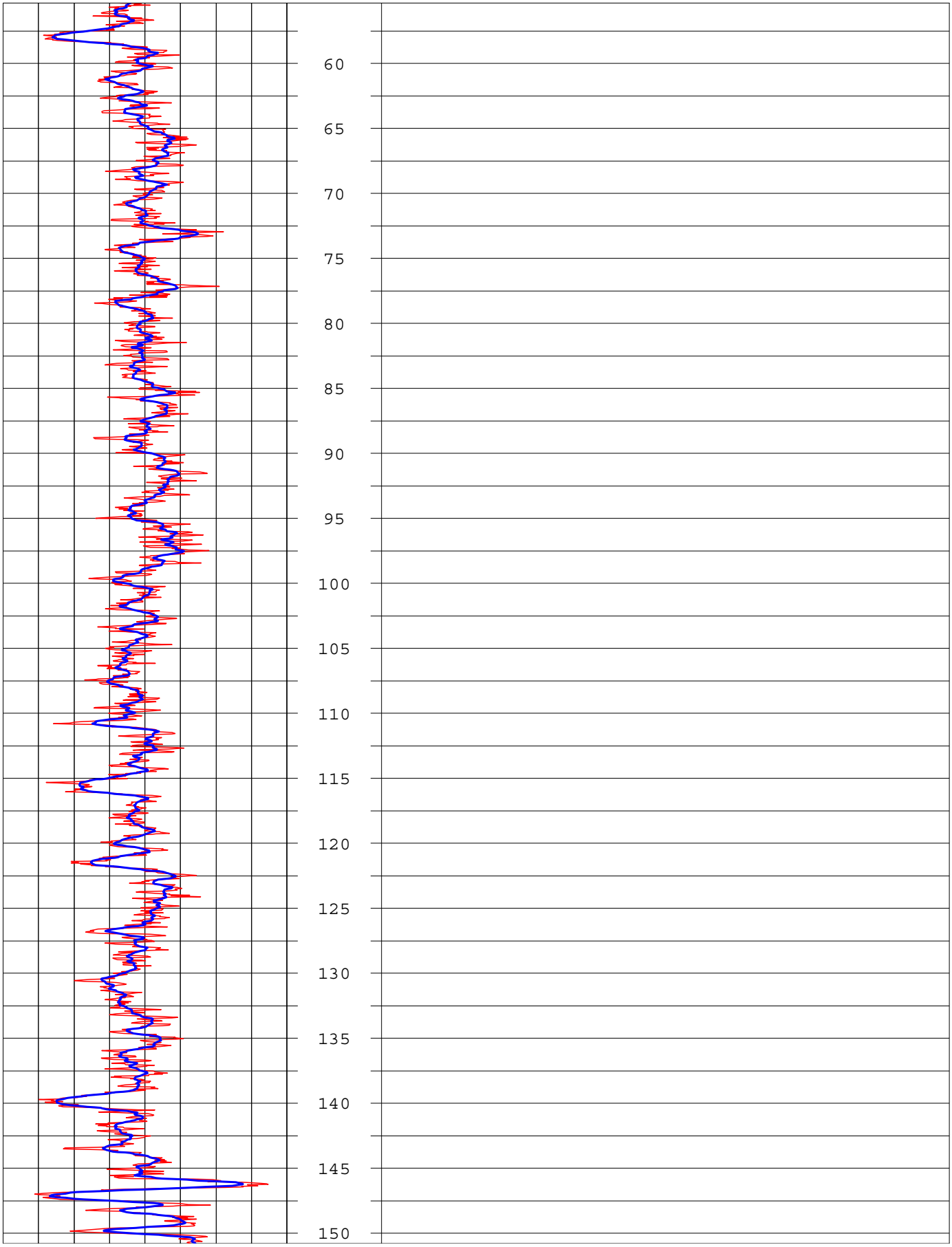
	COMPANY: ENZeeTech Inc.
	Location: Rosebud, Alberta

Well	Rosebud-1		
Date	March 28, 2007	BH Fluid	H2O
Casing	Steel/PVC		
File Name	Rosebud-1 up.WCL		
Depth Driller			
Depth Logger	Mount Sopris MGX II		
Logged by:	Robert Kyle		
Witness:	Cliff Dempsey, C.Tech.		

OTHER SERVICES

LSD - SW-18-27-21 W4M
Elev. - 795.68
Lat. - 51.30158927
Long. - 112.94917373

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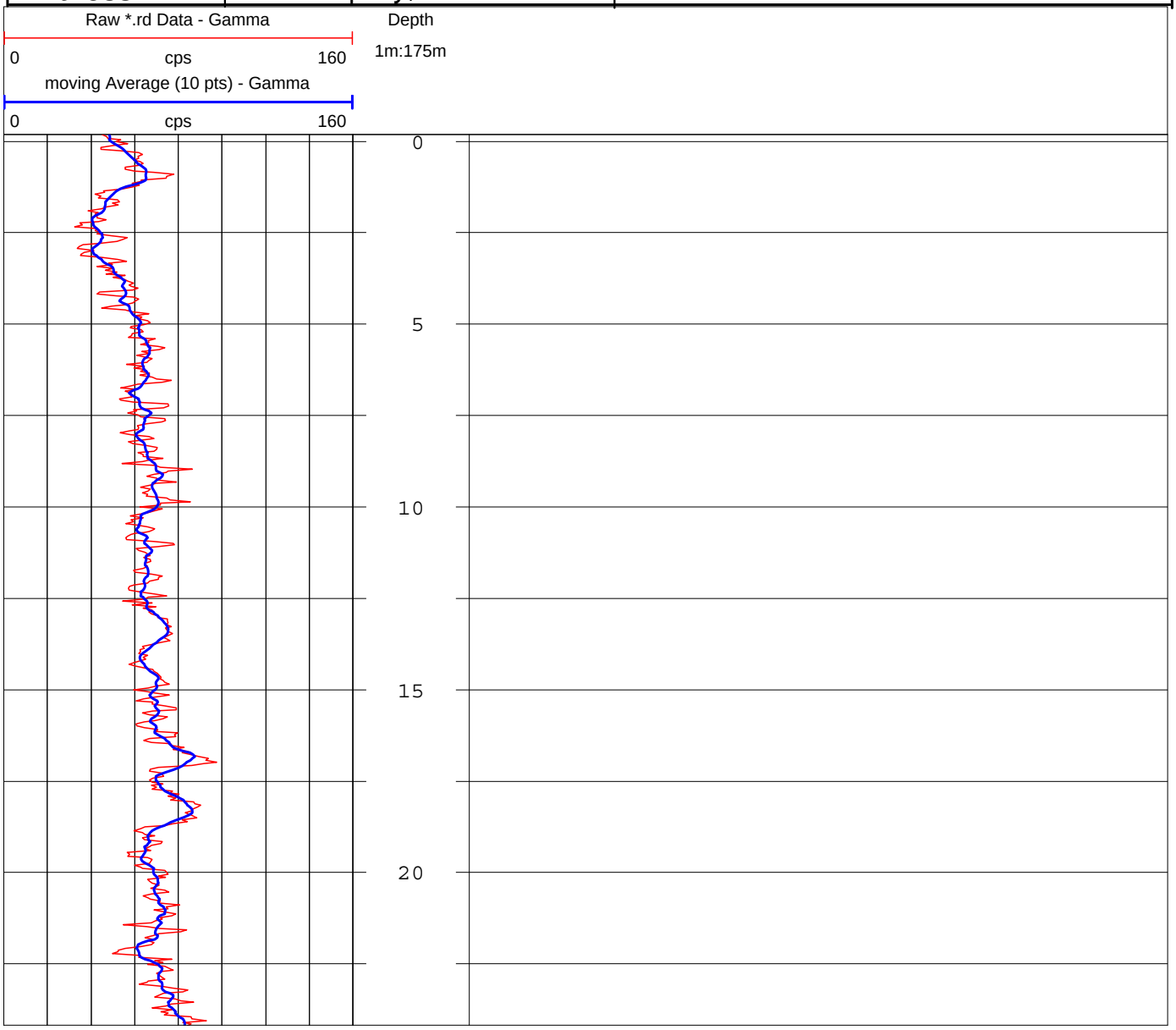
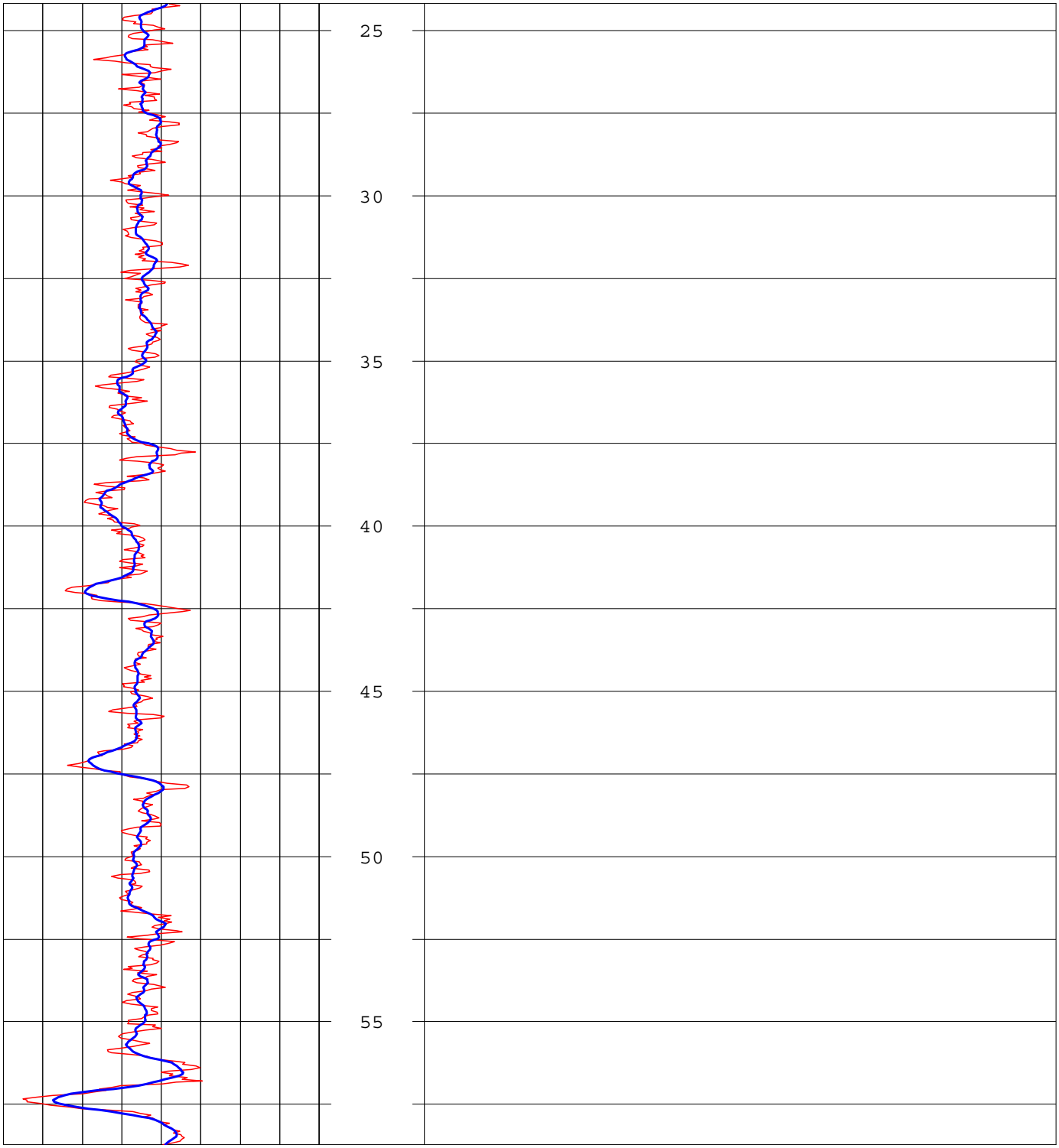
	COMPANY: ENZeeTech Inc.			
	Location: Rosebud, Alberta			
Well	Rosebud-2			OTHER SERVICES
Date	March 28, 2007	BH Fluid	H2O	LSD - SW-18-27-21 W4M Elev. - 795.68 Lat. - 51.30158927 Long. - 112.94917373
Casing	Steel/PVC			
File Name	Rosebud-2 up.WCL			
Depth Driller				
Depth Logger	Mount Sopris MGX II			
Logged by:	Robert Kyle			
Witness:	Cliff dempsey, C.Tech.			

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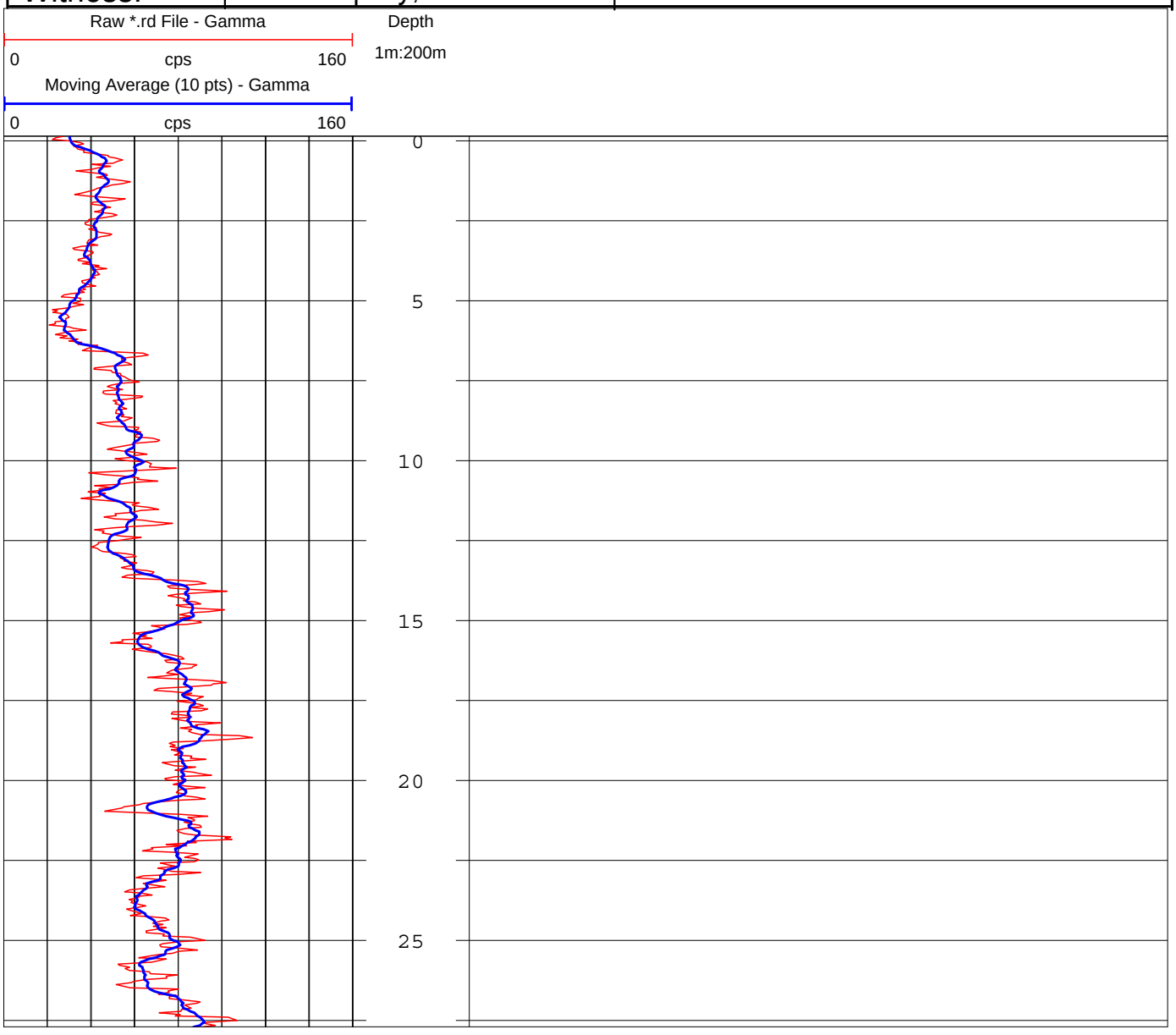
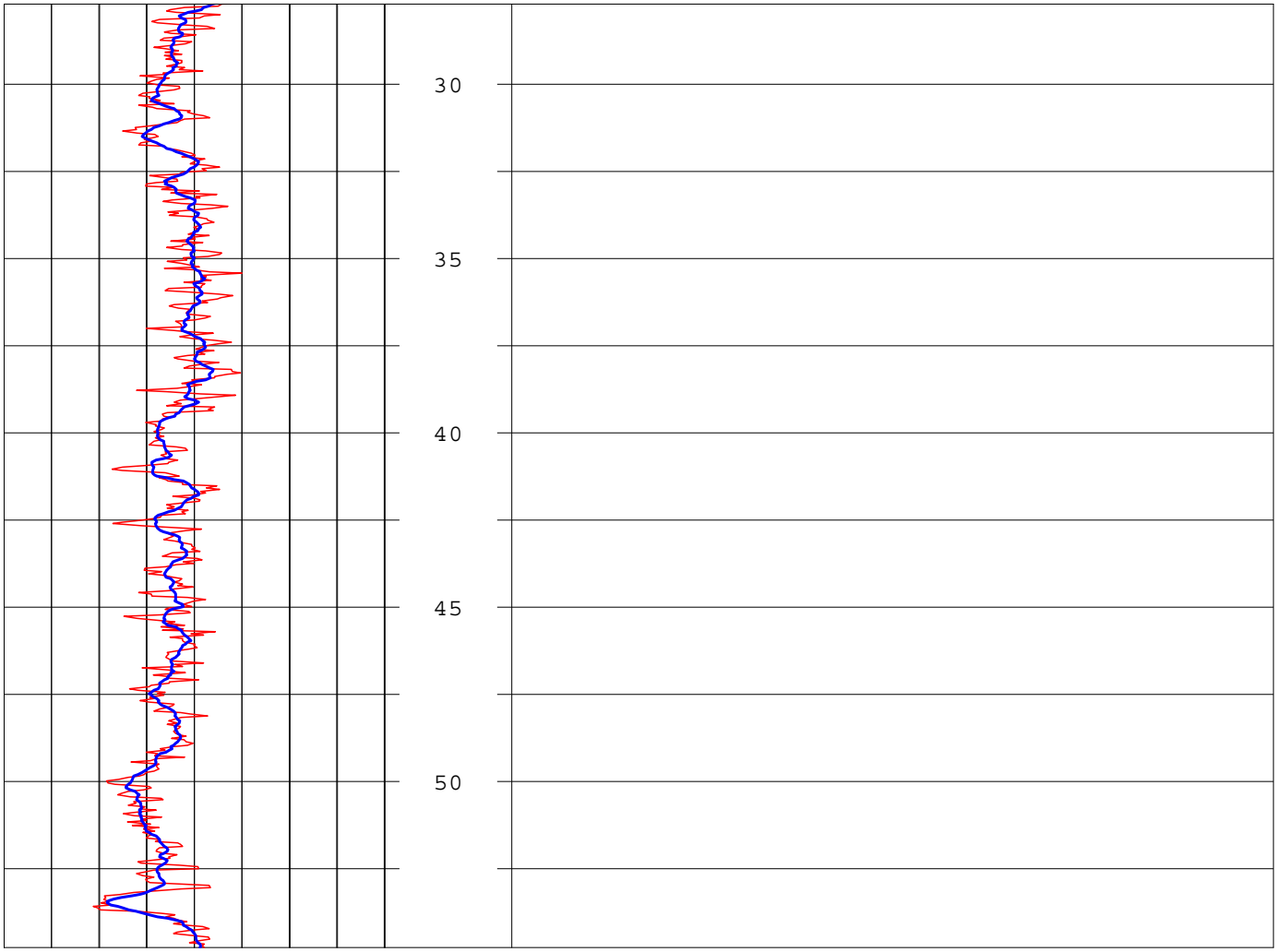
	COMPANY: ENZeeTech Inc.			
	Location: Redland, Alberta			
Well	Redland 1			OTHER SERVICES
Date	March 28, 2007	BH Fluid	H2O	LSD - 09-10-27-22 W4M Elev. - 800.6 Lat. - 51.292437 Long. - 113.005688
Casing	Steel/PVC			
File Name	Redland-1 up.WCL			
Depth Driller				
Depth Logger	Mount Sopris MGX II			
Logged by:	Robert Kyle			
Witness:	Cliff Dempsey, C.Tech.			

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