COAL ASSESSMENT REPORT TITLE PAGE AND SUMMARY

TITLE OF REPORT:
Coal Assessment Report for the EB West coal licences, Mt. Spieker area, British Columbia

TOTAL COST: $5000

AUTHOR(S): C.G.Cathyl-Huhn, P.Geo. and L. Avery, B.Sc.
SIGNATURE(S):

NOTICE OF WORK PERMIT NUMBER(S)/DATE(S): CX 9-7
STATEMENT OF WORK EVENT NUMBER(S)/DATE(S):

YEAR OF WORK: 2013

PROPERTY NAME: EB West

COAL LICENSE(S) (on which work was done): 410366, 410367, 410368, 410369, 410370, 410371

MINERAL INVENTORY MINFILE NUMBER(S),IF KNOWN: 93P 015

MINING DIVISION: Liard
NTS / BCGS: NTS 92P/3 / BCGS 093P.003 and 093P.013
LATITUDE: 55° 07' 00" North
LONGITUDE: 121° 25' 36" West (at centre of work)
UTM Zone: 10 EASTING: 600361 NORTHING: 6108901 (at centre of work)

OWNER(S): Walter Canadian Coal Partnership

MAILING ADDRESS: 800-688 West Hastings Street, Vancouver, B.C. V6B 1P1

OPERATOR(S): Wolverine Coal Partnership

MAILING ADDRESS: 800-688 West Hastings Street, Vancouver, B.C. V6B 1P1

REPORT KEYWORDS (lithology, age, stratigraphy, structure, alteration, mineralization, size and attitude)
Coal, sandstone, Early Cretaceous, Albian stage, Barremian stage, Fort St. John Group, Boulder Creek Formation, Walton Creek Member, Gates Formation, Notikewin Member, Falher Member, Bullhead Group, Gething Formation, Chamberlain Member, Gaylard Member, Minnes Group, Monach Formation, synclines, anticlines, thin-skinned tectonics, Birdbath Thrust, Overlook Thrust, Schilling Thrust, Upper Schilling Thrust, Duckpond Thrust, Bullmoose Thrust

REFERENCES TO PREVIOUS ASSESSMENT WORK AND ASSESSMENT REPORT NUMBERS:
Coal Assessment Reports 552, 553, 555, 556, 557, 558, 559.

TYPE OF WORK IN THIS REPORT	EXTENT OF WORK (in metric units)	ON WHICH CLAIMS	PROJECT COSTS APPORTIONED (incl. support)
GEOLOGICAL (scale, area)			
Ground, mapping			
Photo interpretation	1776 hectares	410366 410367 410368 410369 410370 410371	$835.16 $835.16 $832.35 $832.35 $832.35 $832.35
GEOPHYSICAL (line-kilometres)			
Ground			
(Specify types)			
Airborne			
(Specify types)			
Borehole			
Gamma, Resistivity,			
Resistivity			
Caliper			
Deviation			
Dip			
Others (specify)			
DRILLING (total metres, number of holes, size, storage location)			
Core			
Non-core			
SAMPLING AND ANALYSES			
Number of samples			
Proximate			
Ultimate			
Petrographic			
Vitrinite reflectance			
Coking			
Wash tests			
PROSPECTING (scale/area)			
PREPARATORY / PHYSICAL			
Line/grid (km)			
Topo/Photogrammetric (scale, area)			
Road, local access (km)/trail			
Trench (number/metres)			
Underground development (metres)			
Bulk sample(s)			
Other			

1 Table of contents

1.1 List of tables

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2 Objectives, situation, and details of work

This report presents a synthesis of the surface and subsurface geology of the EB West coal licences (comprising provincial mineral tenures 410366 through 410371 inclusive), as performed by Wolverine Coal Partnership on behalf of Walter Canadian Coal Partnership during the year 2013. In general terms, the present study is intended to summarise and review historic exploratory work conducted by various parties – as referenced in this report's bibliography – as far back as the year 1975, and to present an updated geological map based upon modern concepts of regional coalfield geology.

Results of the year-2013 geological study are intended to guide Walter Canadian Coal Partnership's ongoing mine-planning studies. To that end, recommendations are made for further surface and subsurface exploratory work at EB West.

2.1 Location, tenure, and access

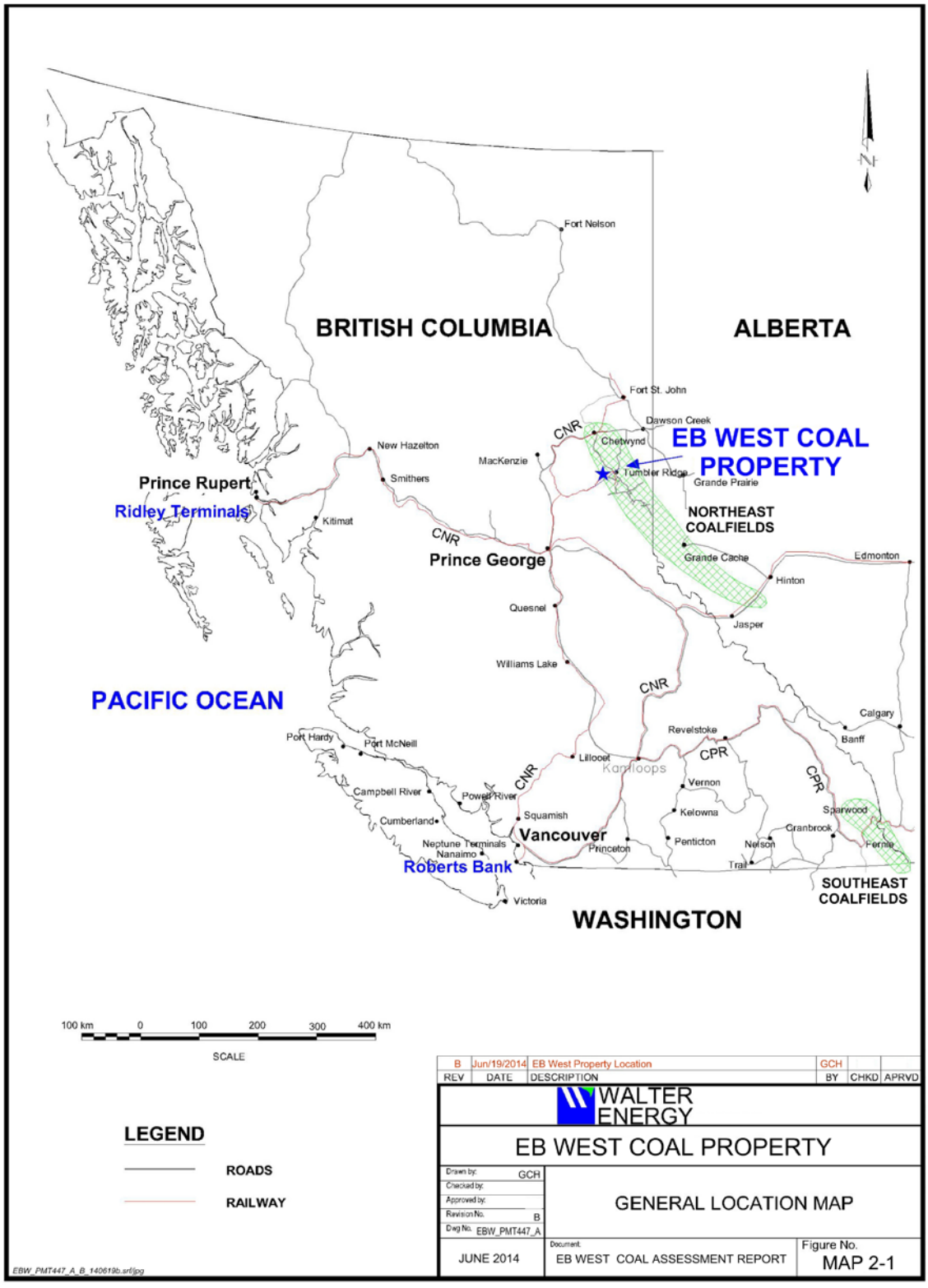
General location of the property, within northeastern British Columbia, is depicted as **Map 2-1**, and coal land tenure (**Table 2-1**) is depicted in relation to the local topographic setting of the EB West coal property as **Map 2-2**.

The EB West coal property is located 100 kilometres south of the town of Chetwynd, and 30 kilometres west of the town of Tumbler Ridge, within the western half of map-area 93 P/03 of Canada's National Topographic System. Road access to EB West is via paved provincial highway BC-29, southeastward from Chetwynd or northwestward from Tumbler Ridge, and thence southwestward along the paved Bullmoose Road, to Bullmoose Mine and thence eastward along a fairly well-maintained access road to gas well a-066-E.

The coal licences themselves are more easily accessible on foot or via all-terrain vehicle, by means of Schilling Road, and a network of disused coal-exploration drillsite access trails. The EB West coal licences can also be reached from the south and east foot, via the Wolverine Forest Service Road to kilometre 12, and thence northwestward up the valley of Perry Creek on the Perry Creek Forest Service Road, followed by a kilometre of walking up a steep hill, along the gas-pipeline right-of-way from well a-043-E.

Crushed sandstone and conglomerate from colluvial deposits and talus slopes are the only sources of good-quality rock for construction aggregate and road-building. Locally-quarried siltstone and mudstone (mostly from the Moosebar Formation) have been used for construction of natural-gas drilling-rig roads. These fine-grained materials pack down acceptably to make smooth roads, but they become muddy in wet weather and dusty in dry weather.

Alpine areas within the property are easily accessed via foot, although one should be prepared for sudden onslaught of high winds, foggy conditions, and rain or show showers. Access to areas beneath treeline is more difficult owing to closely-spaced forest cover and dense undergrowth, although seismic lines locally serve as good trails. Downed timber prevents the ready use of all-terrain vehicles on seismic lines, although with some effort they could be cleared for such usage. A disused airstrip is situated in the valley of Bullmoose Creek, immediately north of the property and close to the Bullmoose Road, and helicopter landings may be readily made


BRITISH COLUMBIA
ALBERTA
EB WEST COAL PROPERTY
Fort Nelson
Fort St. John
Dawson Creek
Chetwynd
Tumbler Ridge
Grande Prairie
New Hazelton
MacKenzie
Smithers
Prince Rupert
Ridley Terminals
Kitimat
CNR
Prince George
NORTHEAST COALFIELDS
Grande Cache
Edmonton
Hinton
Jasper
Quesnel
Williams Lake
PACIFIC OCEAN
Port Hardy
Port McNeill
Campbell River
Cumberland
Neptune Terminals
Nanaimo
Roberts Bank
Victoria
Powell River
Squamish
Vancouver
Lillooet
Kamloops
Revelstoke
Calgary
Banff
CPR
Vernon
Kelowna
Penticton
Princeton
Cranbrook
Nelson
Trail
Fernie
Sparwood
SOUTHEAST COALFIELDS
WASHINGTON
100 km 0 100 200 300 400 km
SCALE
LEGEND
ROADS
RAILWAY
B Jun/19/2014 EB West Property Location GCH
REV DATE DESCRIPTION BY CHKD APRVD
WALTER ENERGY
EB WEST COAL PROPERTY
Drawn by: GCH
Checked by:
Approved by:
Revision No. B
Dwg No. EBW_PMT447_A
GENERAL LOCATION MAP
JUNE 2014
Document: EB WEST COAL ASSESSMENT REPORT
Figure No. MAP 2-1
EBW_PMT447_A_B_140619b.srf/jpg

atop the sub-alpine plateaulands that cap the property. Helicopters are readily available for charter from the municipal airport at Chetwynd, and also from the municipal airstrip in Tumbler Ridge.

Surface access for drilling and other exploratory works is regulated by the provincial government, subject to the *Coal Act Regulations* and the *Mines Act*. The EB West coal property is situated within the Wapiti PSYU (Public Sustained Yield Unit), and timber cutting is subject to the terms of a Free Use Permit issued by the Ministry of Forests. Area-based stumpage fees are in effect.

2.2 Property description

The EB West coal property consists of six coal licences, originally granted to Gordon Gormley (formerly at Quintette Coal) on May 4, 2004, and subsequently sold on to Cline Mining and thence eventually to Western Coal Corporation (WCC) and, following WCC's acquisition by Walter Energy, onward to Walter Canadian Coal Partnership (WCCP).

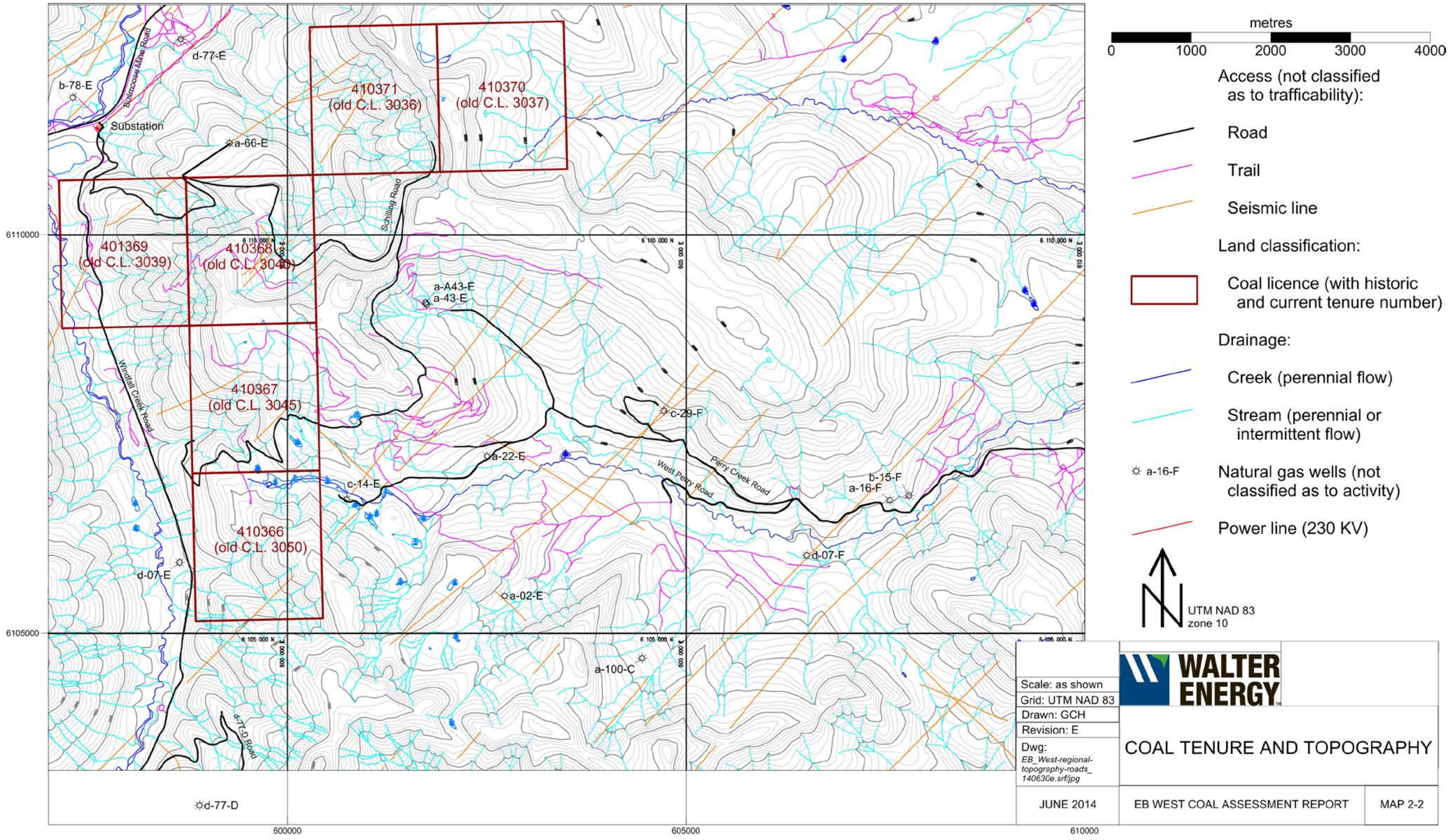
Table 2-1 presents details of the coal tenures at EB West, whose aggregate area is 1,778 hectares (approximately 4,394 acres) and whose annual rental cost is $26,670.

Coal licences grant to their holder the exclusive right to explore for coal, subject to consultation with local First Nations, coordination of access with other tenure-holders (such as oil and gas firms, other mineral-tenure holders, and timber companies), and the successful submission of an exploratory work plan. Coal licences do not, in and of themselves, confer the ownership of coal upon their holder (as the coal remains the property of the Crown via the province of British Columbia), but they can under appropriate circumstances be converted into coal leases, upon which a scheme of mining may be established.

The term of coal licences is one year, which may normally be extended upon the payment of an area-based annual rental fee as prescribed by the provincial Coal Act Regulation. EB West is now within its third five-year span of increased rental fees, at $15/hectare (approximately $37 per hectare).

Table 2-1: Coal tenures at EB West

Tenure Numbers		Land description		Area	Dates		Annual rental
Current	Historic	Blocks	Units		Issued on	Renew by	at $15/ha
410366	CL 3050	93P/03 Block E	5,6,15 and 16	297 ha	May 14, 2004	May 14, 2015	$4455
410367	CL 3045	93P/03 Block E	25,26,35 and 36	297 ha	May 14, 2004	May 14, 2015	$4455
410368	CL 3040	93P/03 Block E	45,46,55 and 56	296 ha	May 14, 2004	May 14, 2015	$4440
410369	CL 3039	93P/03 Block E	47,48,57 and 58	296 ha	May 14, 2004	May 14, 2015	$4440
410370	CL 3037	93P/03 Block E	61,62,71 and 72	296 ha	May 14, 2004	May 14, 2015	$4440
410371	CL 3036	93P/03 Block E	63.64,73 and 74	296 ha	May 14, 2004	May 14, 2015	$4440
Totals		6 coal licences / 24 units		1778 ha			$26,670


410371
(old C.L. 3036)
410370
(old C.L. 3037)
401369
(old C.L. 3039)
410368
(old C.L. 3040)
410367
(old C.L. 3045)
410366
(old C.L. 3050)
Substation
Bishoprose Mines Road
Schilling Road
Windfall Creek Road
West Perry Road
Perry Creek Road
d-77-D Road
b-78-E
d-77-E
a-66-E
a-A43-E
a-43-E
c-29-F
a-22-E
c-14-E
b-15-F
a-16-F
d-07-F
d-07-E
a-02-E
a-100-C
d-77-D
6110000
6105000
600000
605000
610000
metres
0
1000
2000
3000
4000
Access (not classified as to trafficability):
Road
Trail
Seismic line
Land classification:
Coal licence (with historic and current tenure number)
Drainage:
Creek (perennial flow)
Stream (perennial or intermittent flow)
a-16-F
Natural gas wells (not classified as to activity)
Power line (230 KV)
UTM NAD 83
zone 10
Scale: as shown
Grid: UTM NAD 83
Drawn: GCH
Revision: E
Dwg:
EB_West-regional-topography-roads_140630e.srf/jpg
WALTER ENERGY
COAL TENURE AND TOPOGRAPHY
JUNE 2014
EB WEST COAL ASSESSMENT REPORT
MAP 2-2

2.3 Infrastructure

Electrical power is potentially available from B.C. Hydro's Bullmoose Mine substation, served by 230-KV transmission line 2L322, although no distribution lines are presently in place within the boundaries of the EB West property. Telecommunications are available via satellite and cellular telephone systems. Satellite access is excellent in upland areas, but unreliable in the heavily-wooded hillsides. Cellular coverage also likely to be inconsistent, owing to distance from transmitters, and issues of line-of-sight in mountainous country.

Natural-gas pipelines cross the property, connecting various wellheads to a gas-processing plant situated in the Bullmoose Creek valley, north of the EB West property's northern boundary.

2.4 Base-maps, imagery, and surveys

Base-mapping for EB West is freely available from the provincial government's Base Map Online Store, which affords a facility for downloading shaded-relief topographic maps at 1:20,000 scale. Hardcopy British Columbia Geographic System (BCGS) and digital Terrain Resource Information Management (TRIM) map-sheets 093P.013 and 093P.014 cover the property. Canada's national Army Survey Establishment (ASE) has also for several decades maintained a series of topographic maps at 1:50,000 scale, as part of the National Topographic System (NTS). MTS map-sheet 92P/3 covers the EB West property.

Detailed base-maps of the original Mt. Spieker coal property were produced in the late 1970s: copies of these maps are included in various of the historic Coal Assessment Reports, although they are generally marked-up and their depicted coordinate systems are clearly not the modern Universal Transverse Mercator (UTM) grid system relative to the North American Datum of 1983 (NAD83). UTM NAD83 grid references are used exclusively within the current report.

Georeferenced satellite photography is freely available via the *Google Earth* web-service, as discussed further below. In general, this imagery is sufficiently detailed for studies of gross geological and geomorphological structure, but mostly of year-2005 to year-2006 vintage (despite its copyright date of 2014), and therefore lacking in details of recent road-construction by the logging, mining and petroleum industries.

Various archival aerial photographs are held in WCCP's Canadian technical files; the vintage of these photographs is clearly quite old, as few roads or forestry cutblocks are shown on them. Nevertheless, the aerial photographs are useful for stereo-viewing of landforms.

Legal survey control points have been installed in conjunction with petroleum development, but their specific locations within the EB West coal property are not known.

2.5 Physiography, landscapes, climate, and forest cover

Elevations range from 1165 metres above sea level, in the valley-bottom of South Bullmoose Creek (along the property's western edge) to 1945 metres above sea level, along Mount Spieker Ridge (within the north-central part of the property). Terrain is generally mountainous, with very steep hill slopes (locally-overhanging at cliff tops), capped by rolling sub-alpine plateaux which

have been dissected by steep gullies, ravines and glacial cirques.

Small ponds and seasonal wetlands dot the poorly-drained plateau surfaces. On east- and north-facing slopes, winter snow-cover lingers into late summer, and small patches of firn persist year-round in the headwalls of some cirques.

Soil cover is patchy, consisting mainly, till, alluvium and peat at lower elevations, and talus and colluvium at higher elevations. Much of the upland plateau surface is covered by frost-shattered bedrock with interspersed patches of organic muck in poorly-drained areas.

EB West has a continental alpine climate, characterised by long, moderately cold, snowy winters and short, rainy summers. Snow and frost may occur in any month of the year. Winds are generally gusty and ongoing, with rare calm periods. Convective thunderstorms frequently occur during summer months, bringing intense rain-showers and occasional hail.

Coniferous forest covers the lower slopes of the property, declining in size and vigour with increasing altitude and wind-exposure. Subalpine slopes are occupied by patchy, stunted, densely-tangled coniferous krummholz, and the upland areas are covered by grasses, mosses and lichens. The EB West coal property is situated within three biogeoclimatic zones (Aldritt-McDowell, 1998; Macdonald and Hewitt, 2007).

- BWBS: the Boreal White and Black Spruce zone, beneath 1200 metres' elevation, characterised by dense coniferous forest;
- ESSF: the Engelmann Spruce-Subalpine Fir zone, beneath 1700 to 1800 metres' elevation, depending upon topographic aspect; characterised by a less dense coniferous forest; and
- BAFA: the Boreal Altai Fescue Alpine zone, above 1700 to 1800 metres' elevation, characterised by alpine tundra with willows, grasses, sedges and lichens and patches of krummholz subalpine fir and lodgepole pine, often comprising excellent habitat for caribou.

2.6 Historic work

All drilling at EB West is historic work, done by others between 1975 and 1982.

12 boreholes (**Table 2-2**), totalling 2178.28 metres, were drilled at EB West between 1975 and 1982, prior to WCC's acquisition of the property in 2012. All of the boreholes were cored. All but one were geophysically logged.

Records of boreholes are presented within coal assessment reports previously filed with the British Columbia Ministry of Energy and Mines. Logs for borehole EB(MS)-2 are presented within report No.552 (Shima and Nishio, 1975); logs for borehole EB(MS)-12 are presented within report No.555 (Yayoshi and Wada, 1977); logs for boreholes MS-27 through -33 are presented within report No.556 (Jordan and Dawson, 1978); and logs for boreholes MS-41, -42 and -45 are presented within report No.559 (Mitchell, 1982).

Table 2-2: Summary of historic drilling

Borehole	NAD83 Easting	NAD83 Northing	Collar	Depth	Type	Size	Logged?	Completed	Logs in CAR?
EB(MS)-2	599496.47	6107417.48	1553.5	200.56	Core	NQ	yes	1975-09-18	552
EB(MS)-12	601741.37	6111272.78	1722.4	177.7	Core	NQ	no	1977	555, graphic
MS-27	600289.37	6108230.28	1806.7	416.77	Core	HQ	yes	1978-08-22	556
MS-28	598925.17	6109645.78	1750.1	224.7	Core	HQ	yes	1978-08-24	556
MS-29	599010.97	6108757.18	1766.5	309.98	Core	HQ	yes	1978-09-05	556
MS-30	598443.17	6109390.18	1560.8	138.11	Core	HQ	yes	1978-08-31	556
MS-31	598481.27	6109277.58	1583.1	187.5	Core	HQ	yes	1978-09-10	556
MS-32	598762.27	6109795.98	1666	117.98	Core	HQ	yes	1978-09-20	556
MS-33	599266.77	6109859.88	1793.2	252.07	Core	HQ	yes	1978-09-24	556
MS-41	597341.75	6109900.67	1152	37.68	Core	AXT	yes	1982-08-02	559
MS-42	597238.68	6109334.52	1181	31.65	Core	AXT	yes	1982-08-09	559
MS-45	597592.52	6108974.52	1207	83.58	Core	?	yes	1982-10-17	559
Totals: 12 boreholes				2178.28 m					

Notes: CAR: Coal Assessment Report; all depths and collar elevations given in metres; all dates given in international style of *yyyy-mm-dd*. Coordinates are UTM Zone 10N in metres, to NAD83 datum.

2.7 Current work

No exploratory work was done at EB West during the year 2012.

Exploratory work performed at EB West during the year 2013 was completely non-disturbant, comprising the re-examination of historic borehole data in light of current understanding of regional and local coalfield geology, and the compilation of a revised geological map in keeping with that understanding. Much of the compilation work was guided by interpretation of aerial and ground imagery, which is much more readily-available nowadays than during the historic period of prior exploration during the 1970s and 1980s.

2.7.1 Sources of imagery

During year-2013 geological work, use was made of aerial imagery from three sources: LIDAR mapping commissioned by Western Coal, aerial photography of unknown vintage commissioned by Brameda Resources Ltd. (dating to before commencement of significant coal-exploration activity in the mid-1970s), and year-2006 imagery hosted online via *Google Earth*. Of the three sources of imagery, *Google Earth* was the most useful, as it was presently in colour via a rotatable, tiltable and scalable format. The ability to thus manipulate imagery was important in that it allowed cross-sectional mark-ups of hillsides to be rotated into a vertical view, and vice versa.

Ground imagery comprised panoramic views of cliff faces and landforms, collected with a hand-held digital camera during the summer and autumn of 2013.

2.7.2 Use of *Google Earth* as a geological cartographic tool

Google Earth images of the EB West area were marked-up with UTM grid lines, using a tool available via that service. Copied imagery was then imported into *Surfer 10*, a cartographic programme for Windows-based computers, and 'stitched' together into composite images upon which geological contacts and structural features could be projected. As a check on the accuracy of *Google Earth*'s UTM mark-up, natural-gas wellsites were overlain on the assembled maps, and the images were warped into final position according to the surface positions of the wellsites as reported by the provincial Oil and Gas Commission.

Scanned images of publicly-available coal-exploration and geological maps (Mitchell, 1979; Kilby and Wrightson, 1987b; Legun, 2009b), were then orthorectified and tied to UTM grid lines via another cartographic programme, *Didger*, and the resultant images added to the composite maps via *Surfer 10*. Geological contacts and structural features were then further refined by comparison with measured stratigraphic sections from the Geological Survey of Canada (Gibson, unpublished work, 1985; Gibson, 1992b), and with the logs of historic coal-exploration boreholes. The resultant geological map (**Map 2-3**) was then converted into a high-quality JPEG-format image for plotting, proofing and document-assembly.

2.7.3 Year-2013 site visit

As a further check upon the interpretation of aerial imagery, one vehicle-borne traverse was made in the mid-September of 2013, passing along the Bullmoose Mine access road, and along the gravelled access road to Talisman's a-066-E gas well. Opportunity was taken to visually examine the geological structure of the western and northern cliff faces of Mount Spieker Ridge, and to confirm the expected subcrop position of the Skeeter coal zone in Tenure 410369.

2.8 Cross-reference to selected earlier studies

As noted above, geological mapping of the EB West property has been undertaken by staff of several companies since exploration commenced in 1975, and reported on an annual basis in Coal Assessment Reports 552, 553 and 555 through 559. Structural mapping and measurement of stratigraphic sections has also been undertaken by researchers working on behalf of both the federal and provincial geological surveys, and various universities. Citations to earlier work are presented in summary form as **Table 2-3**, below, and presented in full bibliographic detail in **Section 7** of this report.

2.9 Acknowledgements and professional responsibility

Thanks are due to senior geologist Blake Snodsmith at Walter Energy for providing a scalable TRIM base layer for **Map 2-2**. Thanks are also due to Preetpal Singh for assistance with scanning and expert data-wrangling of source materials, and for help with the assembly of this report into a coherent whole. Gwyneth Cathyl-Huhn P.Geo. accepts overall professional responsibility for the contents of this report.

Table 2-3: Cross-references to previous mapping and stratigraphic studies

Year of report	*Report author(s) and venue of publication*	*Sponsoring organisation*	*Nature of work done*
1975	T. Shima and T. Nishio, Coal Assessment Report No.552	Mitsui Mining	Geological mapping and drilling
1976	T. Shima and K. Kinoshita, Coal Assessment Report No.553	Mitsui Mining	Geological mapping and drilling
1977	H. Yayoshi and H. Wada, Coal Assessment Report No.555	Mitsui Mining	Geological mapping and drilling
1978	G.R. Jordan and F.M. Dawson, Coal Assessment Report No.556	Robertson Research	Geological mapping and drilling
1979	M.A. Mitchell, Coal Assessment Report No.557	Ranger Oil (Canada)	Geological mapping
1980	L.M. Little, Coal Assessment Report No.558	Ranger Oil	Drilling
1981	P.McL.D. Duff and R.D. Gilchrist, *MEMPR* Paper 1981-3	B.C. Geological Survey Branch	Geophysical and palaeontological correlation
1982	M.A. Mitchell, Coal Assessment Report No.559	Ranger Oil	Geological mapping and drilling
1982	D.A. Leckie and R.G. Walker, *AAPG Bulletin*, volume 66	McMaster University	Geological mapping and section measurement
1983	D.A. Leckie; Ph.D. thesis	McMaster University	Geological mapping and section measurement
1982	D.W. Gibson, *GSC* Bulletin 431	Geological Survey of Canada	Stratigraphic sections (Gething Formation)
1982	D.W. Gibson, *GSC* Bulletin 440	Geological Survey of Canada	Stratigraphic sections (Hulcross and Boulder Creek formations)
1985	D.A. Leckie; *Bulletin of Canadian Petroleum Geology*	McMaster University	Geological mapping and section measurement
1987	W.E. Kilby and C.B. Wrightson, *Geological Fieldwork* 1986 and *MEMPR* Open File 1987-06	B.C. Geological Survey Branch	Geological mapping (Bullmoose Creek map-sheet)
1999	E.M. Caddel; M.Sc. thesis	University of Calgary	Geological mapping (Falher Member)
2003	J. Wadsworth and others; *Bulletin of Canadian Petroleum Geology*	University of Newcastle	Stratigraphic sections (Falher Member)
2006-2009	A.S. Legun; four papers in *Geological Fieldwork*	B.C. Geological Survey Branch	Stratigraphic and geophysical correlations
2009	A.S. Legun, *MEMPR* Open File 2009-7	B.C. Geological Survey Branch	Geological mapping (digital compilation)

3 Geology

Regional and local geology of EB West and the Sukunka-Quintette coalfield is known mainly from the extensive work of D.F. Stott (1960; 1961; 1963; 1968; 1973; 1974; 1982; 1998), and D.W. Gibson (1992a, 1992b) on behalf of the Geological Survey of Canada (1968; 1973; 1982; 1998). As well, numerous coal-company reports are available as open file documents from the provincial Geological Survey Branch. The most useful of these reports (available as Coal Assessment Report No.556) was written by G.R. Jordan and F.M. Dawson (1978), working for Robertson Research (North American) Limited, on behalf of Ranger Oil (Canada) Limited.

3.1 Regional geology

The EB West coal property lies within the Sukunka-Quintette coalfield of northeastern British Columbia, part of the Foothills structural province of the Canadian Cordillera. All rocks exposed at the ground surface are of Early Cretaceous age, belonging to the Minnes (Berriasian to Valanginian stages), Bullhead (Barremian to Aptian stages) and Fort St. John (Albian stage) groups. Where the entire section has been preserved from erosion, total thickness of the Lower Cretaceous rocks is about 2.5 kilometres. Depth to Precambrian continental basement, including both Mesozoic and Palaeozoic rocks, is more substantial, in the range of 10 to 12 kilometres (McMechan, 1984), although some of this thickness is attributable to thrust-induced structural telescoping of the rock.

Regional geological mapping by M. McMechan (1994), also on behalf of the Geological Survey of Canada, covers the EB West property and nearby portions of the Sukunka-Quintette coalfield, at a scale of 1:250,000.

The majority of sedimentary rocks within the Sukunka-Quintette coalfield are clastic in nature, ranging in grain-size from claystones and mudstones through pebble-conglomerates. Lesser amounts of biologically- and chemically-derived sedimentary rocks are present, comprising coals, banded and nodular ironstones, glauconite-rich sandstones and gritstones, and impure dolomites.

Volcanic rocks constitute a very small component of the Jurassic and Early Cretaceous strata, comprising very fine- to fine-grained tuffs, interpreted to have originated as wind-borne distal ash-fall deposits from contemporaneous volcanoes situated within the Coast Plutonic Complex, far to the southwest of the property. The volcanic rocks characteristically occur as very thin (at most a few decimetres) yet regionally-extensive bands, which are of use as markers for structural and stratigraphic correlations. No intrusive rocks are known to occur at EB West, nor within the Sukunka-Quintette coalfield in general.

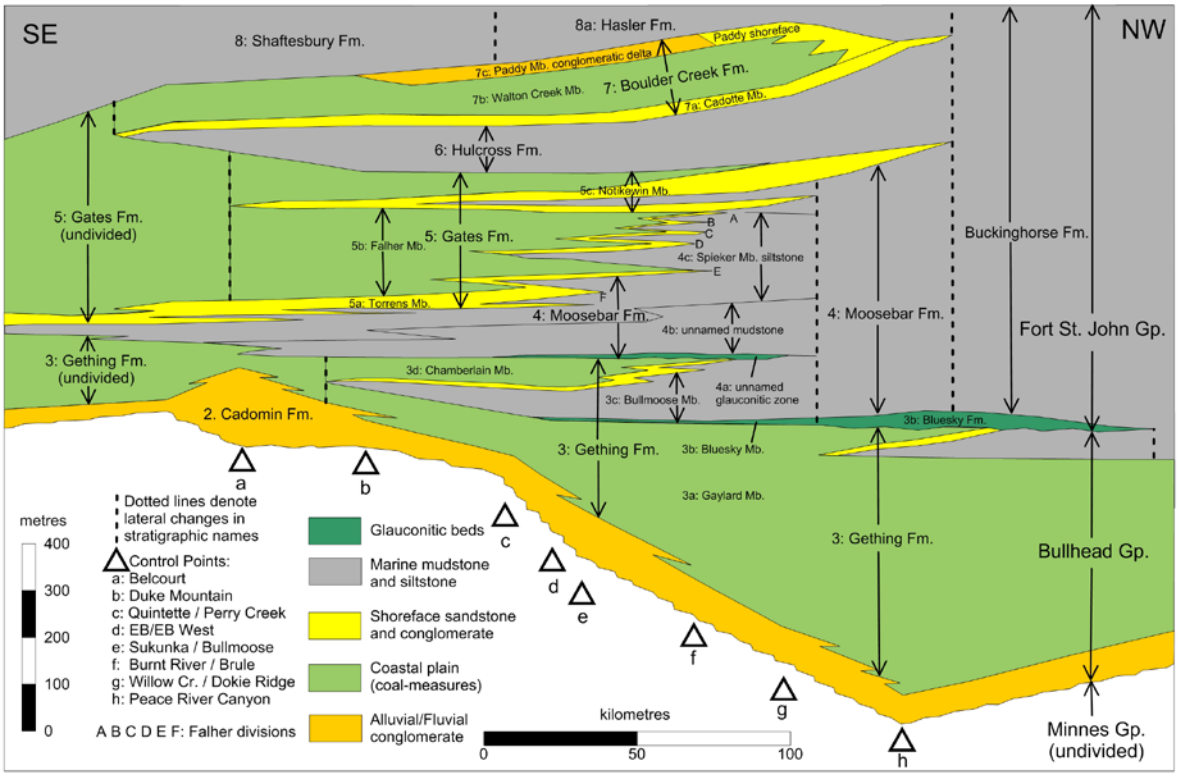
3.1.1 Regional stratigraphy

Regionally, coal is known to be present within five paleodelta systems, within the Boulder Creek, Gates, and Gething formations. Of these three formations, only the Gates and Gething formations have attracted any exploratory interest within the Sukunka-Quintette coalfield, including at EB West, and of those two formation, the Gates Formation (whose contained coals were derived from peat-forming processes within two of those five paleodeltas) appears to have more consistently-developed thick coals.

During much of the Early Cretaceous, the Western Interior of North America was occupied by a shallow seaway, variably-designated by different authors as the Western Interior Sea, the Boreal Sea, or by various analogues of formation names, such as the Clearwater Sea, Hulcross Sea or Moosebar Sea. Into this seaway, the various paleodeltas were built.

Coal deposits formed atop the paleodeltas, as a result of plant growth, peat accumulation, and burial of that peat beneath sufficient sediment to protect the peat from subsequent erosion. Peat-forming and peat-burial processes were repeated several times, in concert with autogenic fluvial/deltaic processes such as meandering, avulsion and deltaic lobe-switching, and also in concert with wider-ranging allogenic processes such as eustatic sea-level change. The outcome of these processes was the development of several vertically-stacked coal zones, each comprised of one or more coal beds.

Kalkreuth and Leckie (1989) recognised the close association between actively-subsiding shoreface sandstone deposits and the overlying presence of thick coal beds; this association is well-established within the upper part of the Gething Formation and the middle part of the Gates Formation, within the Sukunka-Quintette coalfield, including the EB West property.



Drawing: NEBC-regional-stratigraphy_140710e.srf/jpg
Date: 5.July 2014 Scale: diagrammatic, as shown
Drawn by: C.G.Cathyl-Huhn P.Geo. Lic.Geol. RMSME,
modified from work by W.Kalkreuth and D.A. Leckie (1989)

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Figure 3-1: Regional Stratigraphy of the Lower Cretaceous Bullhead Group and basal part of the Fort St. John Group

Figure 3-1, substantially adapted from Kalkreuth and Leckie's Figure 3 of their 1989 paper, summarises regional stratigraphic relationships within the Bullhead Group and the lower part of the Fort St. John Group. Younger beds, which elsewhere form the top of the Fort St. John Group, have been completely removed by erosion within the EB West area, and so are

omitted from the stratigraphic diagram. Details of the older Minnes Group (including the Monach Formation, which immediately underlies the Cadomin Formation) are not shown, as these rocks seldom outcrop, and they have thus received minimal attention from the coal industry.

Within the diagram, the Early Cretaceous rocks are broadly classified by facies, with the most economically-significant facies being the coastal-plain coal-measures of the various paleodeltas. All of the coastal-plain strata contain coal, although within the Sukunka-Quintette coalfield the bulk of known coal resources lie within the Chamberlain Member of the Gething Formation, and the Falher Member of the Gates Formation.

3.1.2 Regional tectonic setting

The EB West coal property, and its regional surroundings, is characterised by a thin-skinned deformational style comprising folded, laterally-arcuate thrust faults and associated fault-bend folds (Barss and Montandon, 1981).

Age relationships amongst the thrusts are as generally observed within the Cordilleran fold-thrust belts of North America, with the oldest thrusts occupying stratigraphically-higher positions, generally to the tectonic inboard side (hence, to the southwest) of the stratigraphically-lower and younger thrusts. Most, but not all, of the thrusts dip generally to the southwest and strike to the northwest. Exceptions to the general observation of southwestward dip occur where several thrusts are stacked upon each other, and more than one bedding-oblique ramp structure is present. In such cases, thrusts may be stacked so deeply (and the uppermost thrusts folded so intensely) as to cause the uppermost thrusts to appear to be steep northeast-dipping normal faults. Thrusts, however, typically exhibit northeastward vergence, consistent with an overall northeastward direction of tectonic transport.

Thrusts range in scale from mesoscopic features with stratigraphic displacements of a few decimetres to a few metres, to regionally-throughgoing faults and fault zones (such as the Bullmoose Fault and associated splays) with stratigraphic displacements of several hundred metres to more than a thousand metres. Thrusts characteristically overlap in *en echelon* manner, with displacement gradually transferring from one fault to another via trains of folds.

Bedding dips within the Sukunka-Quintette coalfield are generally less than 20 degrees within the broad synclinoria which characterise the coalfield. Steep dips (rarely near-vertical to overturned) are occasionally observed within tightly-folded displacement-transfer zones near the ends of *en echelon* thrusts.

Regionally, the Hasler and Moosebar formations are often zones of décollement (tectonic detachment), characterised by near-bedding-parallel thrust faults (Cooper and others, 2004). Near-bedding detachments are occasionally seen within soft muddy siltstones and mudstones of the basal Falher Member of the Gates Formation, as well as within the weak lower mudstone unit of the Moosebar Formation. Some of the Gates Formation coals may also host décollements, as expressed by the concentration of shearing within internal partings of impure coal or coaly rock.

Table 3-1: Table of lithostratigraphic units and major coal beds

Geological Age		Lithostratigraphic Units				Thickness	Map-Units		Coal Beds/Coal Zones	
		Group	Formation	Member	Division				Bed	Zone
Early Cretaceous	Late Albian	Fort St. John	Hasler			>25 m	8a			
			Boulder Creek	Paddy		9 to 30 m	7	7c		
				Walton Creek		95 to 115 m		7b	V coal bed	
	Late Middle Albian			Cadotte		20 to 40 m		7a		
	Middle Albian		Hulcross			105 to 110m	6			
	Late Early Albian		Gates	Notikewin 63 to 105 m	Division 4	17 to 35 m	5	5c	R coal bed	
									QR coal bed	Q
									Q coal bed	
									P coal bed	
					Division 3	6 to 15 m				
					Division 2	20 to 50 m				
					Division 1	3 to 18 m				
				Falher 75 to 85 m	Falher A			5b	E bed (washed out?)	
					Falher B				DU coal bed	D
					Falher C				DL coal bed	
									CU coal bed	C
									CL coal bed	
									C2U coal bed	C2
					Falher D				C2L coal bed	
									BU coal bed	B
					Falher E				BL coal bed	
									AU coal bed	A
					Falher F				AL coal bed	
				Torrens 50 m	Quintette sandstone	25m		5a		
					(unnamed siltstone)	13 m				
					Torrens sandstone	12 m				
			Moosebar	Spieker		150 to 170 m	4	4c		
				unnamed mudstone unit		80 to 110 m		4b		
				basal glauconitic zone		nil to 1 m		4a		
		Bull-head	Gething	Chamberlain		100 m	3	3d	Upper Bird	Bird
									Lower Bird	
									Skeeter coal bed	
									Chamberlain coal bed	
				Bullmoose		75 m		3c		
				Bluesky		0.3 to 1m		3b		
	Late Aptian to Late Early Albian			Gaylard		150 m		3a	'Middle Coals' (unexplored)	
	Hauterivian to Barremian		Cadomin			50 m	2			
	Berriasian to Valanginian	Minnes	Monach			>300 m	1		not yet explored	

Table 3-2: Stratigraphic tops within boreholes

Hole	*Collar*	*Drift*	*PADD*	*WALT*	*CADT*	*HULC*	*HC-20*	*HC-16*	*HC-12*	*HC-8*	*HC-4*	*HGRT*	*NTK4*	*NTK3*	*NTK2*	*NTK1*	*FLHA*	*FLHB*	*FLHC*	*FALD*	*FALE*	*FALF*	*TORR*	*SPIE*	*MSHL*	*GLAU*	*CHAM*	*BULL*	*TD*
EB-2	1553.5	4.0													starts	31.85	43.34	63.64	70.29										
fault, possible at 79.49 m (Falher C [including DL coal] over DL coal?)																													
EB-2 (concluded)																			starts	135.39	162.76	176.72	179.83	DNR	DNR	DNR	DNR	DNR	200.56
EB-12	1722.4	8.5																						starts	16.5				
fault, possible (Upper Schilling Thrust) at 37.5 m (Moosebar shale over Moosebar shale)																													
EB-12 (continued)																									starts				
fault, established (Schilling Thrust) at 58 to 63 m (Moosebar shale over Moosebar shale)																													
EB-12 (continued)																									starts				
fault, established (Duckpond Thrust?) at 137.5 m (Moosebar shale over Spieker)																													
EB-12 (continued)																								starts					
fault, established (Bullmoose Thrust) at 147.5 m (Spieker over Torrens)																													
EB-12 (concluded)																							starts	167.0	DNR	DNR	DNR	DNR	177.70
MS-27	1806.7	0	starts	21.4	116.50	139.0	168.4	180.0	197.95	227.2	236.3	248.7	249.0	281.06	288.2	314.0	324.5	332.15	336.5	376.53	394.76	407.55	410.08	DNR	DNR	DNR	DNR	DNR	416.77
MS-28	1750.1	8.7				starts				38.0	48.0	61.7	62.8	83.4	89.02	119.5	125.8	134.05	138.9	185.03	202.84	217.88	DNR	DNR	DNR	DNR	DNR	DNR	224.70
MS-29	1766.5	5.88			starts	27.9	52.8	64.9	88.9	120.4	130.4		143.00	168.75	176.0	201.3	219.0	226.83	232.51	274.2	293.73	303.45	305.55	DNR	DNR	DNR	DNR	DNR	309.98
MS-30	1560.8	6.30													starts	21.3	29.0	33.2	37.73	91.71	109.09								
fault, established at 114.10 m (floor of BL coal over partial BL coal)																													
MS-30 (concluded)																					starts	129.14	130.24	DNR	DNR	DNR	DNR	DNR	138.11
MS-31	1583.1	8.15											starts	30.5	37.9	69.7	78.15	83.10	88.66	141.78	165.69	180.58	181.38	DNR	DNR	DNR	DNR	DNR	187.50
MS-32	1666	3.6															starts	13.05	20.8	74.5	93.93	109.42	111.18	DNR	DNR	DNR	DNR	DNR	117.98
MS-33	1793.2	3.6		starts	5.8	23.4		30.7		77.5				88.6															
fault, probable at 96.6 m (Falher A [floor of E coal] over Notikewin Division 2)																													
MS-33 (continued)															starts		98.75		102.6										
fault, probable at 110.05 m (Falher A over Notikewin Division 1)																													
MS-33 (continued)																starts													
fault, established at 126.0 m (Notikewin Division 1 over Notikewin Division 2)																													
MS-33 (continued)															starts	126.7	130.8	142.0	144.15	197.05	216.15	231.2							
fault, established at 231.95 m (Falher F [roof of A coal] over Falher E [floor of BL coal])																													
MS-33 (concluded)																					starts	242.4	245.7	DNR	DNR	DNR	DNR	DNR	252.07
MS-41	1152	3.27																							starts	10.75	11.88	DNR	37.68
MS-42	1181	3.84																							starts	4.10	5.55		
faults, established, at 15.32 m and 16.76 m (Chamberlain over Chamberlain, with partial repeat of Lower Bird coal bed)																													
MS-42	1181																										starts	DNR	31.65
MS-45	1207	14.40																							starts	NP	68.60	DNR	83.58

Stratigraphic legend (all depths given in metres, as downhole measured depths based upon geophysical logs, except for borehole EB(MS)-12 which lacks geophysical logs):

Drift = depth to bedrock	PADD = Paddy Mb.	WALT = Walton Creek Mb.	CADT = Cadotte Mb.	HULC = Hulcross Fm.	HC-20 = Ash/Mkr-20	HC-16 = Ash/Mkr-16	HC-12 = Ash/Mkr-12
HC-8 = Ash/Mkr-8	HC-4 = Ash/Mkr-4	HGRT = Hulcross Basal Grit	NTK4 = Notikewin Division 4	NTK3 = Notikewin Division 3	NTK2 = Notikewin Division 2	NTK1 = Notikewin Division 1	FLHA = Falher Div. A
FLHB = Falher Div. B	FLHC = Falher Div. C	FLHD = Falher Div. D	FLHE = Falher Div. E	FLHF = Falher Div. F	TORR = Torrens Mb.	SPIE = Spieker Mb.	NP = not present
MSHL = Basal Mudstone Member of Moosebar Fm.		GLAU = Basal sandstone unit of Moosebar Fm.		CHAM = Chamberlain Mb.	BULL = Bullmoose Mb.	TD = Total depth	DNR = did not reach

Table 3-3: Coal bed intersections within boreholes

Hole	*Collar*	*V-roof*	*V-floor*	*Gates coals:*	*R-roof*	*R-floor*	*RL-roof*	*RL-floor*	*QR-roof*	*QR-floor*	*Q-roof*	*Q-floor*	*P-roof*	*P-floor*	*E-roof*	*E-floor*	*DU-roof*	*DU-floor*	*DL-roof*	*DL-floor*	*CU-roof*	*CU-floor*	*CL-roof*	*CL-floor*	*C2U-roof*	*C2U-floor*	*C2L-roof*	*C2L-floor*
EB(MS)-2	1553.5																65.56	67.51	70.29	72.48								
Fault, possible at 79.49 m (repeats DL coal?)																												
EB(MS)-2	1553.5																		84.12	85.59	107.84	109.36	109.82	110.86	129.08	129.78	(135.67)	(136,12)
EB(MS-12)	----- no coals in this borehole (collared below A-floor and does not reach Bird zone) -----																											
MS-27	1806.7	99.6	100.1		249.4	249.7	NP	NP	NP	NP	257.0	257.6	(268.7)	(269.0)	NP	324.50?	334.10	334.66	336.50	337.84	356.57	357.25	357.51	358.905	375.74	376.53	377.01	377.08
MS-28	1750.1				64.35	65.0	67.0	67.8	NP	NP	71.05	71.75	NP	NP	NP	NP	135.05	135.5	136.9	139.8	(166.9)	(167.15)	(169.3)	(170.0)	181.96	182.85	NP	NP
MS-29	1766.5				149.2	150	151.9	152.7	157.2	158.0	(159.8)	(160.4)	NP	NP	NP	NP	232.15	232.37	232.51	233.85	259.5	259.9	260.3	260.95	270.94	271.86	(274.8)	(275.1)
MS-30	1560.8																34.40	36.00	38.04	38.97	(66.0)	(66.2)	(70.5)	(70.75)	87.10	88.96	(91.71)	(91.94)
MS-31	1583.1				13.3	13.6	14.5	14.7	NP	NP	18.9	19.3	(21.70)	(22.00)	NP	NP	85.08	86.04	88.80	89.71	119.55	119.70	128.05	128.45	137.95	140.27	(142.10)	(142.41)
MS-32	1666																17.03	18.00	20.8	21.7	NP	NP	57.1	57.5	70.93	72.07	NP	NP
MS-33	1793.2				8.00	8.51	8.63	8.88	NP	NP	10.00	10.30	NP	NP	(93.95)	(94.40)												
Fault, probable at 96.60 m																												
Fault, probable at 110.05 m																												
Fault, established at 126.0 m (repeat of Falher A)																												
MS-33	1793.2														NP	NP	NP	NP	144.15	145.65	176.00	176.28	178.05	178.5	192.96	193.82	(197.4)	(198.0)
MS-41	1152	----- collared in Moosebar Formation, and only tested Bird zone ----																										
MS-42	1181	----- collared in Moosebar Formation, and only tested Bird zone ----																										
MS-45	1207	----- collared in Moosebar Formation, and only tested Bird zone ----																										

Hole	*Collar*	*Gates coals (continued):*	*BU-roof*	*BU-floor*	*BL-roof*	*BL-floor*	*AU-roof*	*AU-floor*	*A-roof*	*A-floor*	*Chamberlain coals:*	*BdU-roof*	*BdU-floor*	*BdL-roof*	*BdL-floor*	*Sk-roof*	*Sk-floor*	*Ch-roof*	*Ch-floor*	*Gaylard coals:*	*Middle coal(s)*	*TD*
EB(MS)-2	1553.5		161.54	162.76	162.76	167.94	175.20	175.93	178.55	179.83		DNR	DNR	DNR	DNR	DNR	DNR	DNR	DNR		DNR	200.56
EB(MS-12)	----- no coals in this borehole (collared below A-floor and does not reach Bird zone) -----																					
MS-27	1806.7		393.20	394.76	394.78	398.40	NP	NP	409.11	410.08		DNR	DNR	DNR	DNR	DNR	DNR	DNR	DNR		DNR	416.77
MS-28	1750.1		201.70	202.84	202.84	206.11	212.84	213.37	216.70	217.88		DNR	DNR	DNR	DNR	DNR	DNR	DNR	DNR		DNR	224.70
MS-29	1766.5		292.8	293.73	293.78	297.55	NP	NP	304.7	305.55		DNR	DNR	DNR	DNR	DNR	DNR	DNR	DNR		DNR	309.98
MS-30	1560.8		107.88	109.09	109.09	112.35																
Fault, established, at 114.10 m (partial repeat of BL coal)																						
MS-30	1560.8				*faulted*	115.50	122.17	122.95	129.14	130.24		DNR	DNR	DNR	DNR	DNR	DNR	DNR	DNR		DNR	138.11
MS-31	1583.1		164.60	165.69	165.73	169.13	175.43	176.26	180.58	181.38		DNR	DNR	DNR	DNR	DNR	DNR	DNR	DNR		DNR	187.50
MS-32	1666		93.12	93.93	94.05	97.40	109.42	109.94	110.29	111.18		DNR	DNR	DNR	DNR	DNR	DNR	DNR	DNR		DNR	117.98
MS-33	1793.2		215.11	216.15	216.15	219.40	228.00	228.21														
Fault, established at 231.95 m (repeat of AU coal)																						
MS-33	1793.2						241.15	241.60	244.06	244.66		DNR	DNR	DNR	DNR	DNR	DNR	DNR	DNR		DNR	252.07
MS-41	1152											15.86	16.32	17.58	21.93	DNR	DNR	DNR	DNR		DNR	37.68
MS-42	1181											11.24	11.34	11.53	13.49							
Fault, established, at 15.32 and 16.76 (partial repeat of Lower Bird coal)																						
MS-42	1181													*faulted*	17.47	DNR	DNR	DNR	DNR		DNR	31.65
MS-45	1207											(71.99)	(74.10)	75/84	76.37	DNR	DNR	DNR	DNR		DNR	83.58

Notes: All depths are given in metres, as measured downhole depths interpreted from geophysical logs. Depths given (thus) are for roof and floor of coaly rock zones regarded as being the lateral equivalents of the coals. NP indicates that the coal bed is inferred to be not present. DNR indicates that the coal bed was not reached by the borehole. TD is total depth of the borehole. BdU and BdL refer to Upper and Lower Bird coal beds respectively. Sk refers to the Skeeter coal bed. Ch refers to the Chamberlain coal bed. Middle coals are a generic term for sparsely-explored coals within the Gaylard Member of the Gething Formation.

3.2 Local geology

At least 1400 metres of Mesozoic (mostly Early Cretaceous) strata are present at EB West, locally thickened to 1800 to 1900 metres by structural telescoping along thrust-faults. With the exception of thin bands of tuffaceous volcanic ash, all of the strata within the EB West area are sedimentary rocks. Intrusive igneous rocks, volcanic flows, and evaporites are unknown within the EB West area. A generalised stratigraphic profile of the coal beds and associated sedimentary rocks at EB West is presented as **Table 3-1**.

3.2.1 Local stratigraphy

Within the EB West property, rocks belonging to the Bullhead and Fort St. John groups are exposed at the ground surface, with the older rocks of the Minnes Group inferred to be present within the deeper subsurface.

Formations mapped (see **Map 2-3** and **Table 3-1**) as being present at outcrop range downwards from the Hasler Formation (map-unit 8a, the youngest mapped formation) to the Monach Formation (map-unit 1, the oldest mapped formation). **Table 3-2** presents stratigraphic tops (of formations, members, internal subdivisions and selected marker beds) and significant faults within boreholes drilled at EB West. **Section 4** of this report presents a more detailed synopsis of stratigraphy, and the interrelationship between marker-beds and coal zones, based on local-scale mapping and drilling.

3.2.2 Local structural geology

The EB West coal property consists, essentially, of a gently-deformed layer cake of sedimentary rocks, generally present in normal (‘tops-up’) stratigraphic position, with upward-younging age relationships (as shown in Cross-Section D-D’, presented as **Figure 3-2**, taken along the section-line D-D’ shown on **Map 2-3**).

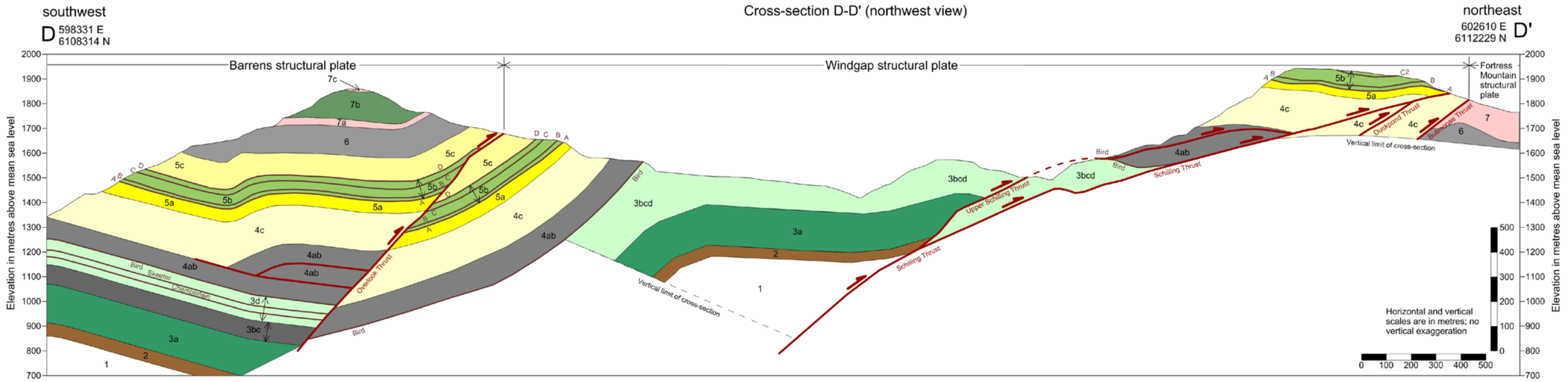
Exceptions to this general situation are presented by several northeast-verging , northwest-striking thrust faults, defining three broad structural ‘plates’ (thrust sheets) separated by complexly-crumpled smash zones adjacent to the thrusts. Each of the structural plates is thus telescoped upon the underlying plate, acting to structurally shorten (in a southwest-northeast direction) and thicken (in a vertical direction) the overall section of sedimentary rocks. Thrust faults are inferred to have developed in the typical downward-younging sequence of successive faulting.

For sake of convenience, the structural plates have been given informal names, each derived from local topographic features. From southwest to northeast, the structural plates are:

Barrens Plate, comprising a broad, open syncline underlain by the Overlook Thrust;

Windgap Plate, comprising (from southwest to northeast) a southwest-dipping homocline, a box-folded anticline and a gently-warped northeast-dipping homocline, all underlain by the Schilling Thrust, Upper Schilling Thrust, Duckpond Thrust and Bullmoose Thrust; and

Fortress Mountain Plate, comprising a tightly-folded train of cylindrical to conical anticlines and synclines.



Drawing file: EB_West-Section-D_140705d.srf/jpg
Date: 2014 July 5 Datum: geodetic (mean sea level in metres), Coordinate system: UTM NAD83.
Geological compilation: C.G. Cathyl-Huhn P.Geo. Lic.Geol RMSME, modified after original section by G.R. Jordan P.Geo. (in CAR-556, 1978).
Scale: as shown by scale bars: no exaggeration.

FORT ST JOHN GROUP (Albian) -- Units 4 through 8

- 8a Hasler Formation (not in cross-section) -- marine shale and siltstone.
- 7 Boulder Creek Formation -- sandstone, shale, conglomerate and coal.
- 7c Paddy Member -- conglomerate and sandstone.
- 7b Walton Creek Member -- siltstone, sandstone, conglomerate and minor coal (V zone).
- 7a Cadotte Member -- conglomerate and sandstone.
- 6 Hulcross Formation -- marine shale and siltstone; minor tuff; basal erosive-based gritstone.
- 5 Gates Formation -- sandstone, shale, conglomerate and coal.
- 5c Notikewin Member -- sandstone, siltstone; minor coal (P, Q and R zones) and carbonaceous mudstone.
- 5b Falher Member -- conglomerate, sandstone, coal (A, B, C2, C and D; E is absent), carbonaceous mudstone and siltstone.
- 5a Torrens Member -- sandstone (Quintette and Torrens sandstone beds), minor siltstone, shale and tuff.
- 4 Moosebar Formation -- marine siltstone and shale; minor sandstone and tuff; basal glauconitic sandstone.
- 4c Spieker Member -- marine siltstone and sandstone.
- 4ab Unnamed mudstone (Unit 4b) -- mudstone; minor tuff; pebbly glauconitic sandstone (Unit 4a) at base.

BULLHEAD GROUP (Barremian to Aptian) -- Units 2 and 3

- 3 Gething Formation -- siltstone, sandstone, conglomerate and coal (Bird, Skeeter, Chamberlain and 'Middle' zones).
- 3bcd
  - 3d Chamberlain Member -- sandstone, siltstone and coal.
  - 3bc Bullmoose Member -- marine shale and siltstone.
  - Bluesky Member -- glauconitic sandstone.
- 3a Gaylard Member -- sandstone, siltstone and coal; lenses of conglomerate near base.
- 2 Cadomin Formation -- cliff-forming conglomerate; minor siltstone.
- 1 MINNES GROUP (Berriasian to Valanginian) -- Unit 1
  Monach Formation -- sandstone, conglomerate and coal.

Legend

- Fault, with arrow depicting inferred or observed sense of displacement in plane of section
- Geological contact between rock-units
- Bird Coal zone, comprising one or more coal beds

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Dwn:	GCH
Scale:	as shown
Ref.:	EB_West-Section-D-140705d.srf/jpg

Cross-section D-D' across EB West coal licences

JULY 2014	EB WEST COAL ASSESSMENT REPORT	FIG. 3-2

Of the faults enumerated above, the Bullmoose Thrust is the major through-going structural feature at regional scale, with the Overlook Thrust having a lesser degree of lateral continuity. (albeit to some extent constrained by lack of exploratory data in either direction). Stratigraphic displacement across the Bullmoose Thrust is estimated to be 300 to 350 metres, with the Spieker Member of the Moosebar Formation being overthrust over the undivided Boulder Creek Formation and the Hasler Formation. Stratigraphic displacement across the Overlook Thrust is inferred to be markedly less, at 100 metres.

Fault-to-bedding cut-off angles (alpha-angles) have not yet been studied in detail at EB West. In drawing the cross-section across the property, an alpha-angle of 30 degrees to bedding within competent strata was assumed, consistent with regional experience within the Foothills structural province; alpha-angles considerably less than 30 degrees (down to zero degrees in particularly weak strata) are assumed to be locally possible, and near-bedding-parallel detachments are suspected to be present within soft muddy siltstones and mudstones of the basal Falher Member of the Gates Formation, as well as within the mudstone unit of the Moosebar Formation.

4 Stratigraphic synopsis

The following discussion presents details of the lithology, contained coal beds, inferred origin, typical thickness and contact relationships of the various rock-units present at EB West, keyed to the map-unit numbers used in **Map 2-3** and **Table 3-1**. Rock-units are discussed in stratigraphic order from uppermost (youngest) to lowermost (oldest) within the exposed sequence of strata.

4.1 Fort St. John Group (map-units 8a through 4ab)

An incomplete section of the Fort St. John Group is present at EB West, owing to the group's uppermost rocks (of the Dunvegan, Cruiser and Goodrich formations) having been stripped off by erosion. The youngest remaining rocks belong to the basal part of the Hasler Formation.

4.1.1 Hasler Formation (map-unit 8a)

Only the basal 25 metres of the Hasler Formation, comprising dark grey, rusty-weathering, rubbly- to platy-weathering shale, siltstone and sandstone, of shallow-marine origin, is present within the EB West property. Ironstone concretions are locally-abundant within the Hasler Formation. These rocks are poorly-exposed as colluvial rubble and felsenmeer, within the northeastern upland area of Coal Licence 410367. In earlier work (Jordan and Dawson, 1978), the Hasler Formation was incorrectly termed the Shaftesbury Formation.

The Hasler formation is of Late Albian age (Koke and Stelck, 1985). The Hasler's presumed upper contact with the overlying Goodrich Formation has been removed by erosion throughout the EB West property, whilst its disconformable contact with the underlying Paddy Member of the Boulder Creek Formation is placed at the base of a few decimetres of erosive-based pebbly mudstone to silty gritstone.

4.1.2 Boulder Creek Formation (map-unit 7)

The Boulder Creek Formation comprises 145 to 160 metres of interbedded conglomerate, sandstone, siltstone, mudstone and coal. Within the EB West property, the Boulder Creek is generally readily-divisible into three members: the upper coarse-grained Paddy Member (map-unit 7c), the medial, dominantly fine-grained coal-measures of the Walton Creek Member (map-unit 7b), and the lower coarse-grained Cadotte Member (map-unit 7a). The Paddy and Cadotte members correspond to similarly-named coarse-grained strata of the subsurface Deep Basin of northwestern Alberta, whereas the Walton Creek appears to be present only within the Foothills, including the EB West area (Gibson, 1992b; Krawetz, 2008; Roca and others, 2008).

The undivided Boulder Creek Formation as a whole (map-unit 7) has only been mapped within the tightly-folded area lying to the northeast of, and structurally-below, the Bullmoose Thrust, situated in the eastern two-thirds of Coal Licence 410370. Within this structural-complicated area, the overall thickness of the Boulder Creek Formation is unknown.

Elsewhere within the EB West property, the three members of the formation can be readily recognised in borehole logs and measured outcrop sections, and as such they have been mapped separately as well as distinguished within the cross-section accompanying this report.

The basal contact of the Boulder Creek Formation with the underlying Hulcross Formation is generally abrupt and therefore considered to be conformable at local scale (Gibson, 1992b), although it may intertongue at regional scale.

4.1.2.1 Paddy Member (map-unit 7c)

The Paddy Member of the Boulder Creek Formation comprises 9 to 30 metres of thick-bedded to massive, cliff-forming pebble-conglomerate, gritstone, sandstone and minor siltstone, forming caprock and rimrock around the periphery of the Barrens structural plate. The basal part of the Paddy Member has been intersected by only one borehole (MS-27) at EB West. No coal, other than isolated discontinuous lenses of coalified plant trash, is known from the Paddy Member at EB West.

The Paddy Member's age at EB West is not directly known, owing to lack of diagnostic fossils, but its age is constrained to Late Albian by the ages of underlying and overlying rocks. The basal contact of the Paddy Member with the underlying Walton Creek Member is inferred to be intertonguing at property-wide scale, and abrupt to erosional at local scale.

4.1.2.2 Walton Creek Member (map-unit 7b)

The Walton Creek Member of the Boulder Creek Formation comprises 95 to 115 metres of generally-recessive siltstone, variably-carbonaceous, locally root-penetrated mudstone and thin coal beds, of which only one (designated as the V coal bed) appears to be laterally-continuous. The swale-forming fine-grained rocks are punctuated by cliff-forming lenses of sandstone, gritstone and pebble-conglomerate, inferred to be channel-fills. One downhole intersection of the V coal bed (in borehole MS-27) is listed in **Table 3-3**.

Gibson (1992b) regards the Walton Creek Member as being of probable Late Albian Age, based on angiosperm flora. The basal contact of the Walton Creek Member with the underlying Cadotte Member is generally abrupt, and regarded by Gibson (1992a) as being conformable, although Krawetz (2008) noted that the top of the Cadotte is usually distinctively 'lumpy' within the vicinity of Mt. Spieker.

4.1.2.3 Cadotte Member (map-unit 7a)

The Cadotte Member of the Boulder Creek Formation comprises 20 to 40 metres of cliff-forming sandstone and pebble-conglomerate with rare thin interbeds of siltstone. The Cadotte generally coarsens upward, with its sandstones being at its base and its conglomerates being in its middle and at its top. In the EB West area, conglomerate forms 50% to 80% of the Cadotte's thickness. Other than isolated coalified logs, the Cadotte

Member is devoid of coal.

Gibson (1992b) regards the Cadotte Member as being of Late Middle Albian age. The abrupt Cadotte-Hulcross contact is readily recognised on gamma-ray logs, as a rapid upward decrease in count-rate.

4.1.3 Hulcross Formation (map-unit 6)

The Hulcross Formation comprises 105 to 110 metres of thinly-interbedded, locally-concretionary medium grey siltstone, fine-grained sandstone and dark grey mudstone with occasional very thin but extremely-persistent interbeds of soft, light grey to white, tuffaceous volcanic ash. Mesoscale (a few decimetres to a few metres thick) fining-upward sequences reminiscent of proximate turbidites or tempestites are common within the Hulcross, as are trace-fossils and poorly-preserved shell fossils. Sideritic concretions are commonly found in isolated, laterally-persistent bands.

Fine-grained pyrite is locally-abundant within the Hulcross rocks, which are inferred to have been deposited beneath a stratified water column within a restricted-circulation seaway (Stelck and Leckie, 1988). The formation's immediate base is marked by a thin (generally a few decimetres, and rarely up to 2.2 metres thick) erosive-based bed of cherty pebbly sandstone or gritstone, locally informally termed the Basal Hulcross grit.

Tuffaceous volcanic ash bands (colloquially termed as 'ash bands' or as 'bentonites' although their mineralogy may vary from that of typical bentonites) form laterally-extensive, readily-correlatable, distinctively light-weathering, locally popcorn-weathering, lithological and geophysical markers a few centimetres to a few decimetres thick (Kilby, 1985; Gibson, 1992b). Ash bands are of practical value in property-scale structural studies, as they aid the tracing of faults and folds through the Hulcross Formation.

Typical gamma-log responses of ash bands range from 170 to 260 API units, substantially greater response than that of their surrounding rocks. At least 5, and locally up to 20, such bands can be readily identified within complete sections of the Hulcross; ash bands are numbered upwards from No.1, immediately above the base of the formation, to No.20, near its top. Immediately below the top of the formation, and above No.20 ash band, a less-intense gamma-ray marker (possibly a black shale band), is designated as the T-marker. Depths of ash bands Nos. 4, 8, 12, 16 and 20, as observed in boreholes, are presented in **Table 3-2** and noted on the geophysical records presented in **Appendix A**.

The Hulcross Formation is of Middle Albian age (Stelck and Leckie, 1988; Gibson, 1992b). Erosional relief of the Hulcross-Gates contact, as suggested by the variable distance down to the R coal bed within the Gates Formation, is at least 5.8 metres at EB West.

4.1.4 Gates Formation (map-unit 5)

The Gates Formation comprises 220 to 230 metres of interbedded sandstone, siltstone, conglomerate, shale and coal at EB West. The Gates, as were the Boulder Creek and Hulcross formations, was formerly considered a member of the Commotion Formation (Stott, 1968); such usage is evident in old coal assessment reports (*e.g.* Jordan and Dawson, 1978).

At EB West, and within the Sukunka-Quintette coalfield generally, the Gates Formation may be usefully subdivided into three members, in order from top down:

Notikewin Member, comprising 63 to 105 metres of interbedded, locally-glauconitic sandstone and siltstone, with minor conglomerate, carbonaceous mudstone and generally-thin coal (P, Q and R coal zones);

Falher Member, comprising 75 to 85 metres of conglomerate, sandstone and generally-thick coal (A, B, C2, C, D and E coal zones), with muddy siltstone, carbonaceous mudstone and silty mudstone; and

Torrens Member, comprising sandstone, with minor siltstone, and lacking coal.

Each of these members may in turn be further subdivided into informal or formal lithostratigraphic divisions (Leckie and Walker; 1982; Leckie, 1983; 1986; Wadsworth and others, 2003), largely corresponding to changes in the shoreline position of the Western Interior Seaway. These finer subdivisions of the Gates Formation are useful to the determination of the stratigraphic displacements of thrust-faults, and to the correct correlation of the formation's coal beds.

Coals of the Gates Formation, and their enclosing sedimentary rocks, were deposited on the shoreline of the Western Interior Seaway between 108.7 and 111.0 million years ago, as part of an extensive complex of coastal plains, deltas and estuaries, broadly referable to the Upper Notikewin and Falher paleodeltas within the Sukunka-Quintette coalfield. Throughout the period of Gates Formation sedimentation, the shallow waters of the Western Interior Seaway generally lay a few kilometres to a few tens of kilometres northeast of EB West, with the exception of a few isolated 'marine bands' associated with more substantial transgressions of the sea into and atop coal-forming coastal plain sediments. Such transgressions occasionally induced splitting within the Gates Formation coals (Wadsworth and others, 2003); splits were also occasionally induced by crevasse-splays from river channels, and perhaps also by drowning of coal-forming wetlands beneath lakes and ponds.

Within the EB West coal property, numerous coal zones (**Table 3-3**) each comprising one or more individually-recognisable coal beds, are present within the Gates Formation. Coal zones and coal beds are designated by an upward-progressing system of lettering, from the A zone near the base of the formation, to the P, Q and R zones near the top of the formation. This scheme of designation resembles the upward-progressing lettering used at Teck Corporation's nearby Bullmoose Mine (with the exception that coal zones P, Q and R are not recognised at Bullmoose), and is the inverse of the downward-progressing lettering used at Walter Energy's Perry Creek Mine.

The Gates Formation is of late Early Albian age (Stott, 1982; Wan, 1996). The basal contact of the Gates Formation with the underlying Moosebar Formation is gradational by interbedding. Details of the three members of the Gates are presented below.

4.1.4.1 Notikewin Member (map-unit 5c)

The Notikewin Member of the Gates Formation comprises 63 to 105 metres of siltstone and sandstone with minor conglomerate, variably-carbonaceous, locally root-bearing mudstone, and thin coal beds. Overall, the Notikewin is finer-grained than the underlying Falher Member of the Gates Formation (Leckie and Walker, 1982), and it tends to be more recessive-weathering than the Falher, although the Notikewin's basal sandstone/conglomerate division locally forms a cliff band in hillside exposures.

The Notikewin Member at EB West, and in nearby parts of the Sukunka-Quintette coalfield, may be readily divided into four informal lithostratigraphic divisions, numbered upwards from Division 1 through Division 4, corresponding to the four general facies (designated as Facies A through Facies D) recognised by Leckie (1985). These fine stratigraphic subdivisions of the Notikewin Member are useful in working-out the extent and magnitude of thrust faults within the Notikewin (as, for example, in the case of borehole MS-33, presented as **Figure A-8** within **Appendix A**). Downhole tops of Notikewin subdivisions, as interpreted from geophysical logs of historic boreholes, are presented in **Table 3-2**. Borehole intersections of Notikewin coals (coal zones from R down to P) are listed in **Table 3-3**.

A distinctively-fossiliferous mudstone bed, the Blue Marker, is generally present within the Notikewin Member. The Blue Marker contains a characteristic molluscan fauna including abundant *Ostrea* sp., interpreted as being an oyster reef (Leckie, 1985). The shell-bearing bed is readily recognised in core, and less-readily recognised by a slightly-elevated gamma-ray response on geophysical logs.

The basal contact of the Notikewin Member atop the underlying Falher Member is abrupt to erosional, almost always marked by a few centimetres to decimetres of pebbly gritstone to pebble-conglomerate. Depth of scour at the base of this probable lag deposit is locally sufficient to remove the E coal bed, near the top of the Falher Member, along with the coal's root-bearing immediate floor.

4.1.4.2 Falher Member (map-unit 5b)

The Falher Member of the Gates Formation comprises 75 to 85 m of conglomerate, sandstone and generally thick coal (within the A, B, C2, C, D and E coal zones), accompanied by lesser proportions of muddy siltstone, carbonaceous mudstone and silty mudstone.

Overall, the Falher Member contains proportionately-more sandstone and conglomerate, and consistently thicker coals, than does the overlying Notikewin Member. Although the undeformed thickness of the Falher Member appears to be locally consistent at EB West, considerable variations of thickness occur within its more lenticular internal subdivisions, and the entire Falher section is inferred to be locally doubled-up by overthrusting along one of the major thrust faults (as shown in cross-section on **Figure 3-2**).

Regionally, within the Sukunka-Quintette coalfield and also within the adjoining Deep Basin hydrocarbon play area of northeastern British Columbia and northwestern Alberta, the Falher Member may readily be divided into five or six semi-formal

subdivisions (Wadsworth and others, 2003), designated by letters from top downwards, as the Falher A through Falher F (and, locally, far to the south of the EB West property, the basal Falher G). At EB West, Divisions B through F of the Falher each host one or more coal beds of workable thickness.

Drilled depths of the Falher subdivisions, as interpreted from geophysical logs of historic boreholes, are presented in **Table 3-2**. Borehole intersections of Falher coals (coal zones from E down to A) are listed in **Table 3-3**.

The Falher Member is of Late Early Albian age (Wan, 1996). The basal contact of the Falher Member atop the Torrens Member is universally abrupt, and locally-undulating in detail.

4.1.4.3 Torrens Member (map-unit 5a)

Within the Sukunka-Quintette coalfield, the term 'Torrens Member' is often applied as a local name for the thick sandstone underlying the lowest of the mineable Gates coal beds. Within the Mt. Spieker area (including the EB West, EB and EB Trend coal properties), however, there are two of these sandstone units, the Quintette and Torrens sandstones, separated by a thick medial fine-grained 'silty zone' of interbedded siltstone, sandstone and shale. The silty zone lacks mineable coal at Mt. Spieker, despite it having possibly been the host of the K coal zone in the Quintette mines, further to the south within the coalfield.

The top of the Quintette Sandstone is almost always root-penetrated, at times distinctly softer, darker and carbonaceous to coaly (likely a paleosol beneath the A coal bed), readily distinguishable from the harder, lighter-coloured and cleaner main body of the sandstone.

At EB West, the Torrens Member has not been completely drilled-through, and so its thickness is only known from map patterns, which indicate that the Torrens is about 50 metres thick. The Quintette Sandstone is assumed to be about 25 metres thick (Jordan and Dawson, 1979); the medial silty zone is assumed to be about 13 metres thick, and the basal Torrens Sandstone is assumed to be about 12 metres thick.

The age of the Torrens Member is not directly known, but presumed to be Late Early Albian. The basal contact of the Torrens Member with the underlying Spieker Member of the Moosebar Formation is gradational by interbedding.

4.1.5 Moosebar Formation (map-unit 4)

The Moosebar Formation comprises 225 to 380 metres of dark grey, locally-concretionary mudstone and siltstone, with minor thin interbeds of sandstone and tuff, and a thin basal conglomerate. The wide variation of the Moosebar's thickness is likely due to overthrusting and concomitant tectonic thickening of its incompetent shales.

The Moosebar Formation is of Early Albian age (Stott, 1968). Its basal contact with the underlying Gething Formation is abrupt, and generally erosional, characteristically marked by a very thin band of variably-glauconitic gritty sandstone or pebbly gritstone.

At EB West, and within the Sukunka-Quintette coalfield generally, the Moosebar Formation may be divided into three units. In order from top down, these are:

- Spieker Member: thinly-interbedded siltstone and sandstone, 150 to 165 metres thick;
- Unnamed mudstone member: massive-appearing dark grey to black mudstone, with occasional thin bands of tuff, generally 75 to 90 metres thick. but locally tectonically-thickened to 230 metres thick;
- Basal sandstone member: variably-glauconitic gritty sandstone or pebbly gritstone, 0.2 to 2 metres thick.

4.1.5.1 Spieker Member (map-unit 4c)

The Spieker Member comprises 150 to 165 metres of thinly-interbedded, overall coarsening-upward sandy siltstone and sandstone, pervasively-bioturbated and possibly originating as proximal shallow-marine turbidites (Leckie, 1981) in front of the advancing Falher paleodelta. Sandstone beds become thicker, coarser, and more abundant towards the top of the Spieker, and on the whole the Spieker Member is a transitional unit (Duff and Gilchrist, 1981) between the lower Moosebar mudstone and the overlying Torrens sandstones. In some earlier reports, the Spieker Member is termed the ‘Sukunka Member’ (e.g. Jordan and Wallis, 1974, and various coal assessment reports).

The age of the Spieker Member is not directly known, but presumed to be Early Albian to possibly late Early Albian. The basal contact of the Spieker Member with the underlying unnamed mudstone member is drawn at the base of the lowest band of sandy siltstone overlying the mudstones.

4.1.5.2 Unnamed mudstone member (map-unit 4b)

The unnamed mudstone member of the Moosebar Formation comprises 75 to 90 metres of monotonous, rubbly-weathering, massive-appearing black mudstone, punctuated by laterally-persistent bands crowded with ironstone concretions, and several thin (a few millimetres to a few decimetres) but laterally-persistent bands of light olive drab to white tuff. The tuff bands are useful as local structural markers (Duff and Gilchrist, 1981; Kilby, 1984a; Jordan and Dawson, 1988).

The Moosebar mudstones are sparsely-bioturbated, and locally contain sparse to abundant burrow-fillings, irregular blebs and euhedral crystals of pyrite, indicative of overall anoxic depositional conditions. Pyrite is particularly abundant near the base of the mudstone unit.

The age of the Moosebar mudstones is Early Albian (Stott, 1968). The basal contact of the mudstones over the underlying basal sandstone unit is gradational to abrupt, and generally easily-recognised on geophysical logs.

4.1.5.3 Basal sandstone member (map-unit 4a)

The basal sandstone member of the Moosebar Formation comprises 0.2 to perhaps 2 metres of variably-glauconitic, chert-rich lithic arenite, locally containing stringers or lenses of gritstone or pebble-conglomerate. Glauconite development within this unit is patchy, in contrast with its more obvious presence in other parts of the Sukunka-Quintette coalfield.

Earlier reports (Wallis and Jordan, 1974; Jordan and Dawson, 1978) termed this sandstone the Bluesky Formation, but that correlation is now understood to be incorrect (Kilby, 1984b; Gibson, 1992b).

The age of the basal sandstone member is not directly known, but presumed to be Early Albian. Its basal contact with the underlying Chamberlain Member of the Gething Formation is abrupt, and locally erosional, with several metres of relief at local scale.

4.2 Bullhead Group (map-units 3 and 2)

The Bullhead Group consists of two formations, the Gething Formation which comprises the majority of the group's thickness, and the thinner basal Cadomin Formation (Stott, 1963; 1968; 1973). Both formations are well-represented in outcrop at EB West, although only the uppermost part of the Gething Formation has been tested by drilling.

4.2.1 Gething Formation (map-unit 3)

The Gething Formation, of Early Aptian to Early Albian age within the Early Cretaceous (Gibson, 1992), comprises thin to thick interbeds of siltstone, sandstone, mudstone and coal, with lesser amounts of gritstone, pebble-conglomerate, ironstone and tuff.

The Gething Formation originated as a complex of non-marine to shallow-marine sedimentary deposits, laid down by meandering and braided streams and rivers within a widely-extensive belt of coastal deltas, of which two (the Gaylard and Chamberlain paleodeltas) extended into the Mt. Spieker area, including the EB West coal property.

Coals of the Gething Formation at EB West, and their enclosing sedimentary rocks, were deposited between 111 and 123 million years ago (Gibson, *ibid.*), on the basis of regional plant-fossil and foraminiferal zonations.

Following upon suggestions made by coal-company geologists (Wallis and Jordan, 1974) and subsequent correlation by the British Columbia Geological Survey (Duff and Gilchrist, 1981; Legun, 1990), Gibson formally divided the Gething Formation into three members: the upper, non-marine to transitional Chamberlain Member, the middle marine Bullmoose Member, and the basal, non-marine to transitional Gaylard Member. A fourth member of the Gething Formation, the Bluesky Member, is also inferred to be present between the base of the Bullmoose Member and the top of the Gaylard Member.

In the geological map accompanying this report (**Map 2-3**), the Gething Formation is mapped as two stratigraphically-based map-units: the Chamberlain, Bullmoose and Bluesky members (map-unit 3bcd) and the Gaylard Member (map-unit 3a). Correlation studies and structural studies of the Gething rocks are presently being undertaken to better clarify the mappability of all four of the Gething Formation's members at EB West; the discussion given below is therefore preliminary in scope.

4.2.1.1 Chamberlain Member (map-unit 3d)

The Chamberlain Member comprises about 100 metres of thickly-interbedded, brown-weathering sandstone and siltstone, containing three regionally-significant coal zones (Wallis and Jordan, 1974): the Bird Zone (containing the Upper Bird and Lower Bird coal beds) near the member's top, and the Skeeter and Chamberlain coal beds within the member's middle. The two Bird coal beds, and the Skeeter coal bed, locally attain drilled thicknesses of 1.5 to over 4 metres, whereas the Chamberlain coal bed (in contrast to its greater thickness in the nearby Sukunka coal property) is only a few centimetres to a decimetre thick. Coal thicknesses encountered by drilling are set forth in **Table 3-3**.

Some seam-tracing, trenching, and test-pitting was done in the Chamberlain coals during the early exploration of the Mt. Spieker property, including within the area now held by WCCP.

Drilling in the valley of South Bullmoose Creek (boreholes MS-41, MS-42, MS-43 and MS-45) showed that the thickness of the two Bird-zone coal beds varies markedly. Some of this variation may be due to depositional factors, but it is also conceivable that the coals have been tectonically thickened and thinned, or locally stacked upon themselves, by thrust-faults (as suggested in the case of borehole MS-42).

The age of the Chamberlain Member is late Early Albian (Gibson, 1992a). The basal contact of the Chamberlain Member with the underlying Bullmoose Member is drawn at the base of the lowest of the (usually two) thick sandstones beneath the Chamberlain coal bed. This contact is generally abrupt at local scale, but probably gradational by interfingering at the regional scale.

4.2.1.2 Bullmoose Member

The Bullmoose Member comprises about 75 metres of thinly-interbedded, recessive-weathering mudstone, siltstone and minor sandstone of turbiditic aspect, forming one or more coarsening-upward sequences. The Bullmoose Member forms bedrock along Schilling Road, within the northern part of Tenure 410368; it is also exposed within steep west-facing cliffs in the southwestern quarter of Tenure 410371. The Bullmoose does not contain any coal, other than isolated coalified logs and coarse, poorly-preserved 'plant trash', likely of drifted origin. The Bullmoose does contain abundant molluscan fossils, including *Pecten (Entolium)* cf. *irenense* McLearn (Gibson, 1992a) and *Yoldia kissoumi* (Duff and Gilchrist, 1981), which, although not age-diagnostic, are locally-characteristic of the unit.

The Bullmoose Member is of late Early Albian age (Gibson, 1992a); its basal contact with the underlying Bluesky Member is generally gradational but locally abrupt.

4.2.1.3 Bluesky Member

The Bluesky Member comprises 0.3 to 1 metre of pebbly mudstone, at times slightly to moderately glauconitic, with occasional pyrite flecks. The basal contact of the Bluesky with the underlying Gaylard Member has not been observed at EB West; however,

elsewhere within the Sukunka-Quintette coalfield it is generally abrupt to erosional. The age of the Bluesky Member is not directly known, but likely to be late Early Albian. The Bluesky Member of the Gething Formation, as its name implies, is likely to be correlative if not strictly coeval with the Bluesky Formation of the Dawson Creek area.

4.2.1.4 Gaylard Member

The Gaylard Member comprises about 150 metres of thickly-interbedded siltstone, mudstone and brown-weathering channel-filling sandstone, accompanied by minor ironstone, tuff, gritstone and conglomerate. Numerous poorly-exposed coal beds are present within the Gaylard Member at EB West, most notably a 1.5-metre coal bed (the Middle Coal) reported by Shima and Nishio (1975) at the base of the west-facing cliff of Mt. Spieker Ridge, in Tenure 410371. The Gaylard Member, and its constituent coals, have not yet been drilled at EB West.

The age of the Gaylard Member is Hauterivian to late Early Albian (Gibson, 1992a). Its basal contact with the underlying Cadomin Formation is abrupt to possibly erosional at the local scale (Cant, 1996) and interfingering at the regional scale (Stott, 1968; Gibson, 1992a), drawn at the top of a bed of coarse-grained, often gritty and occasionally pebbly sandstone which may laterally grade into more typical pebble-conglomerate characteristic of the Cadomin.

4.2.2 Cadomin Formation (map-unit 2)

The Cadomin Formation immediately underlies the Gething Formation, forming the basal part of the Bullhead Group (Stott, 1968). The Cadomin is resistant to erosion, and typically forms ledges to cliffs beneath the more-subdued slopes of the Gaylard Member.

The Cadomin comprises one or more thick beds of coarse-grained, gritty to pebbly sandstone and pebble-to cobble-conglomerate (McLean, 1981; Jordan and Dawson, 1978) with occasional lenses of siltstone and pebbly gritstone, and rare thin lenses of dirty coal. Sandy phases of the Cadomin Formation thus strongly resemble the basal pebbly sandstones of the Gaylard Member, and the Cadomin's distinction from the Gaylard locally rests mainly upon the Cadomin Formation's greater lateral continuity. The top of Cadomin Formation has not been reached by any of the boreholes drilled at EB West, nor in any boreholes drilled at Walter Energy's adjoining properties.

At EB West and within the Mt. Spieker area in general, the Cadomin Formation is estimated to be 50 metres thick (Jordan and Dawson, 1978). Its basal contact with the underlying Monach Formation is likely to be erosional, with considerable local scour into the older sediments. Regionally, the base of the Cadomin marks a northeastward-deepening angular contact, cutting down into successively-older rocks of the Minnes Group (Stott, 1973).

4.3 Minnes Group (map-unit 1)

The Minnes Group, despite being known to contain coal within its outcrop belt along the southwestern fringe of the Sukunka-Quintette coalfield, is virtually unexplored in the vicinity of

the EB West property, owing to its outcropping position in valley-bottoms, where thick Drift cover generally obscures bedrock. The total thickness of the Minnes Group is at least 2000 metres.

The Minnes Group in EB West area comprises three formations: from top down, the Monach, Beattie Peaks and Monteith formations. Of these three, only the Monach Formation is expected to outcrop at or near EB West.

4.3.1 Monach Formation (map-unit 1)

The Monach Formation comprises cliff-forming sandstone and quartzite, with lesser amounts of interbedded siltstone and conglomerate, and occasional thin coals, part of the Minnes Group (Stott, 1998). The coal content of the Monach Formation appears to be minimal, on a regional basis, and the formation's principal economic significance is as a marker bed in drilling and geological mapping.

The Monach Formation is at least 300 metres thick in the Mt. Spieker area (described as Nikanassin Formation by Jordan and Dawson, 1978), but within the current extent of the EB West property, at most a few tens of metres of Monach rocks form bedrock within the extreme southwestern corner of Tenure No.410366.

5 Coal resources

No current coal-resource estimate is known to exist for the EB West coal licences.

Historic coal resource estimates (reported as coal ‘reserves’, although they would not so qualify nowadays) were reported in Coal Assessment Report 556 (Jordan and Dawson, 1978). These historic estimates cover the Mt. Spieker coal property as it then existed, including areas outside the boundaries of the present EB West coal property. Furthermore, the year-1978 estimates, although they appear to have been conscientiously-done according to the standards of their day, were not conducted according to the requirements of present-day Canadian practice under *National Instrument 43-101*; they are therefore regarded as having no current validity.

Geological modelling is now being undertaken by Walter Canadian Coal Partnership’s technical staff, in support of coal-resource estimation to modern standards of practice.

The recommended exploratory work (outlined in **Section 9** of this report) is intended to increase the level of assurance-of-existence of potentially-mineable coal at EB West, in support of coal-resource estimation.

6 Statement of costs

No record has been found of any exploration work done by WCC, WCCP, or allied firms at EB West during year-2012. During year-2013, no detailed accounting was made of the division of geological labour involved in the regional photogeological compilation study, but a reasonable estimate of work time on the senior geologist's part (Gwyneth Cathyl-Huhn) is ten days at nine hours/day. Given direct labour cost of $55.58/hour, the 90 working hours would amount to $5002.20, which may be rounded to $5000 in keeping with the estimated nature of this cost. **Table 6-1** presents standardised cost breakdown by activity. The photogeological compilation is here allocated as 'report preparation.'

Table 6-1: Cost breakdown by activity

Item	Quantity [Q]	Unit cost [C]	Cost of work [Q x C]
Field personnel	0 person-days	not applicable	$nil
Consultants	0 person-days	not applicable	$nil
Food/accommodation	0 person-days	not applicable	$nil
Mobe/demob within BC	nil	$nil	$nil
Aircraft support	nil	$nil	$nil
Vehicle rentals	nil	$nil	$nil
Equipment/supplies	nil	$nil	$nil
Instrument rentals	nil	$nil	$nil
Laboratory analysis	nil	$nil	$nil
Contract jobs/unit costs	nil	$nil	$nil
Report preparation	90 hours	$55.58/hour	$5000 (rounded)
Management	0 person-days	not applicable	$nil
		TOTAL (rounded)	$5000

Table 6-2 presents apportioned costs of year-2013 work, ascribable to each coal licence on the basis of equal cost per hectare. Hectare cost basis was derived by dividing the $5000 estimated total cost by 1778 hectares' total area, yielding a cost per hectare of $2.812 per hectare.

Table 6-2: Apportioned costs of year-2013 work

Tenure	Area (hectares) [A]	Unit cost/hectare [C]	Cost of work [A x C]
410366	297	$2.812	$835.16
410367	297	$2.812	$835.16
410368	296	$2.812	$832.35
410369	296	$2.812	$832.35
410370	296	$2.812	$832.35
410371	296	$2.812	$832.35
		Sum of costs: $4999.72 (rounded, $5000.00)	

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8 Conclusions

The EB West coal property contains coal-measures of latest Jurassic to Early Cretaceous age, within the Minnes, Bullhead and Fort St. John groups of sedimentary rocks. These rocks are deformed by folded, imbricate thrust faults and associated folds, consistent with the overall thin-skinned structural style of the Rocky Mountain Foothills of northeastern British Columbia. Coal of potentially-mineable thickness is present within the Chamberlain Member of the Gething Formation (part of the Bullhead Group) and the Falher Member of the Gates Formation (part of the Fort St. John Group).

The most recent historic exploration work at EB West had been done by Ranger Oil and associated companies, as has previously been reported in Coal Assessment Reports Nos. 552, 553, and 556 through 559. Most of the historic exploration effort has been devoted to the Falher coals.

The present work on the EB West coal property, here reported as concerns the years 2012 and 2013, comprises the construction of a geological map from aerial and satellite imagery, supported by collection and re-interpretation of data from previous reports. This work was conducted by members of Walter Canadian Coal Partnership's regional geological staff, as part of a broader examination of coal properties within the Brazion and Sukunka-Quintette coalfields of northeastern British Columbia, Canada.

Geological modelling is underway, to more-precisely define the coal resources at EB West, and to identify areas which may be suitable for surface mining. The EB West property merits further work, as recommended within **Section 9** of this report.

9 Recommendations

1. The EB West coal property should continue to be held in good standing.

2. A programme of field geological mapping should be undertaken within the Falher coal-measures within the southwestern four tenures of the property.

   Structure of the rocks should be mapped, and an effort made to identify the potential for near-surface thrust-repeats of major coal beds.

   Exposed coals should be excavated to fresh material, and sampled for reflectance, petrography and proximate analysis, with the goal of more clearly establishing the coking potential of these coals.

   Coal exposures should be surveyed, to determine their position to an accuracy which is adequate for coal-resource estimation.

3. A similar programme of mapping and sampling is recommended for the Chamberlain coal-measures within the southwestern part of the property, where coals are known to outcrop, but minimal coal-quality data are available.

4. If results of work items 2) and 3) above are favourable, drill targets may then be identified and tested, with the aim of establishing whether commercially-significant quantities of saleable coal are present within practicable mining geometries.

10 Statements of qualifications

I, Laura Rose Avery B.Sc. B.Ed., do hereby certify that:

a) I am currently employed on a full-time basis by Walter Canadian Coal Partnership, a subsidiary of Walter Energy, in their Northeast British Columbia office in Chetwynd, British Columbia.

b) This certificate applies to the current report, titled *Coal Assessment Report for the EB West coal licences, Mt. Spieker area, British Columbia,* dated July 17, 2014.

c) I am in the processes of applying for my Professional Engineers and Geoscientists of British Columbia status.

d) I received my Bachelor of Science from Saint Mary's University in Halifax in 2006.

e) I have worked in the coal industry for 2 years and 10 months.

f) I have been pit geologist for the Brazion group since March 2012.

g) I have been co-chair of the Joint Occupational Health, Safety and Environment Committee for both Brule and Willow for 2 years.

I, C.G. Cathyl-Huhn P.Geo.(BC) Lic.Geol.(WA) RMSME, do hereby certify that:

a) I am currently employed on a full-time basis by Walter Canadian Coal Partnership, a subsidiary of Walter Energy, in their Northeast British Columbia office in Tumbler Ridge, British Columbia.

b) This certificate applies to the current report, titled *Coal Assessment Report for the EB West coal licences, Mt. Spieker area, British Columbia,* dated July 17, 2014.

c) I am a member (Professional Geoscientist, Licence No.20550) of the Association of Professional Engineers and Geoscientists of British Columbia, licenced as a geologist (Licence No.2089) in Washington State, and a founding Registered Member of the Society for Mining, Metallurgy and Exploration (SME, Member No.518350). I have worked as a colliery geologist in several countries for over 36 years since my graduation from university.

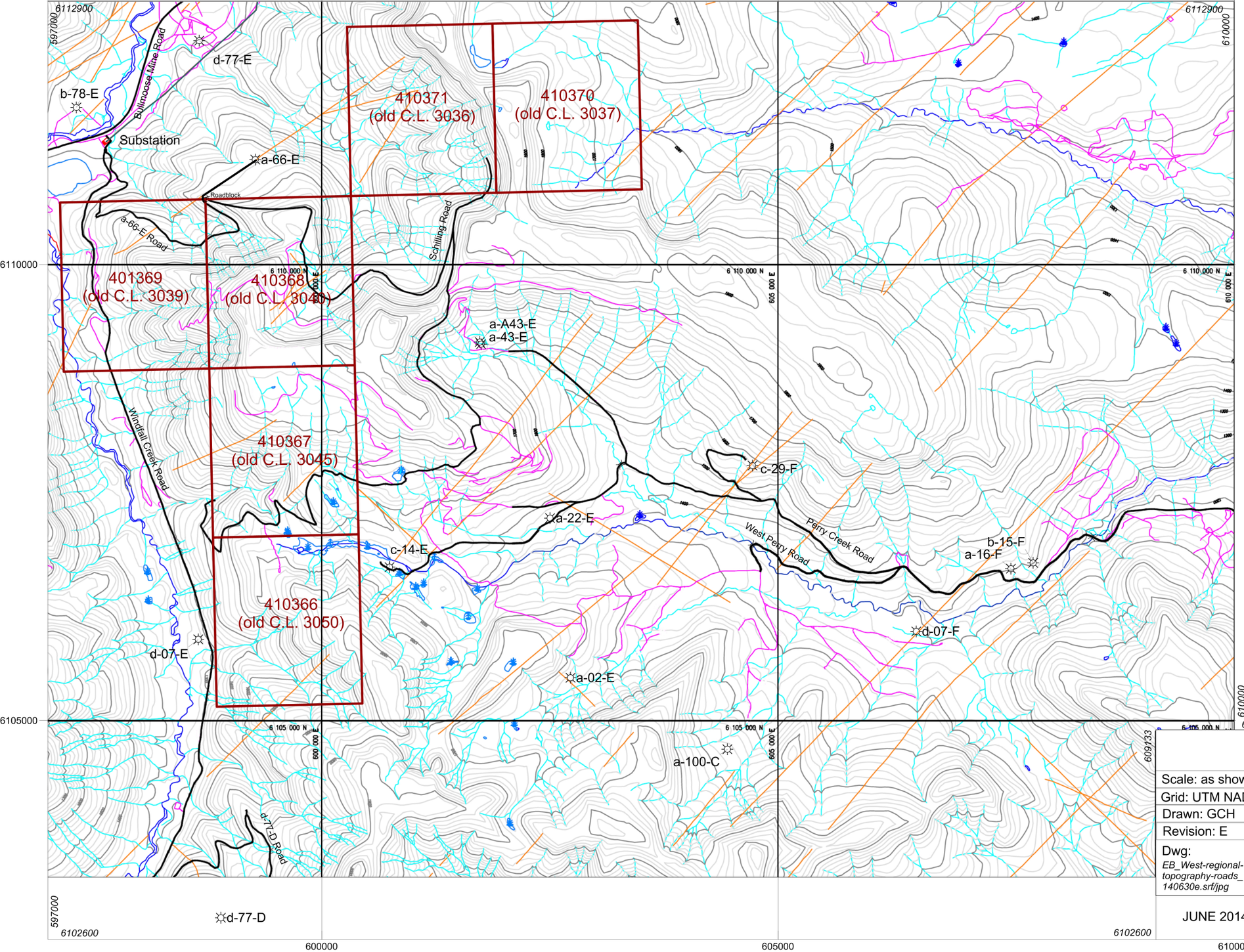
d) I certify that by reason of my education, affiliation with professional associations, and past relevant work experience, having written numerous published and private geological reports and technical papers concerning coalfield geology, coal-mining geology and coal-resource estimation, that I am qualified as a Qualified Person as defined by Canadian *National Instrument 43-101* and a Competent Person as defined by the Australian *JORC Code*.

e) My most recent visit to the EB West coal property was in July 2014.

f) I am principal author of this report, titled *Coal Assessment Report for the EB West coal licences, Mt. Spieker area, British Columbia,* dated July 17, 2014, concerning the EB West coal property.

g) As of the date of the writing of this report, I am not independent of Walter Canadian Coal Partnership and Walter Energy, pursuant to the tests in Section 1.4 of *National Instrument 43-101*.

"original signed and sealed by"
Dated this 17th day of July, 2014. C.G. Cathyl-Huhn P.Geo. Lic.Geol. RMSME



metres

0 1000 2000 3000 4000

Access (not classified as to trafficability):

- Road
- Trail
- Seismic line

Land classification:

- Coal licence (with historic and current tenure number)

Drainage:

- Creek (perennial flow)
- Stream (perennial or intermittent flow)

a-16-F — Natural gas wells (not classified as to activity)

- Power line (230 KV)

UTM NAD 83
zone 10

Scale: as shown	WALTER ENERGY
Grid: UTM NAD 83	
Drawn: GCH	
Revision: E	COAL TENURE AND TOPOGRAPHY
Dwg: *EB_West-regional-topography-roads_140630e.srf/jpg*	
JUNE 2014	EB WEST COAL ASSESSMENT REPORT — MAP 2-2

UTM NAD83 — MOUNT SPIEKER — NTS 93 P/03

metres

0 500 1000 1500 2000 2500 3000

LEGEND

Thrust fault -- ornament marks position of overthrust plate

Anticline -- line marks crestline of fold

Syncline -- line marks troughline of fold

Attitude of bedding (dip in degrees)

Trace of coal zone (approximate, inferred)

Road -- major, minor (unclassed as to trafficability or state of reclamation/restoration)

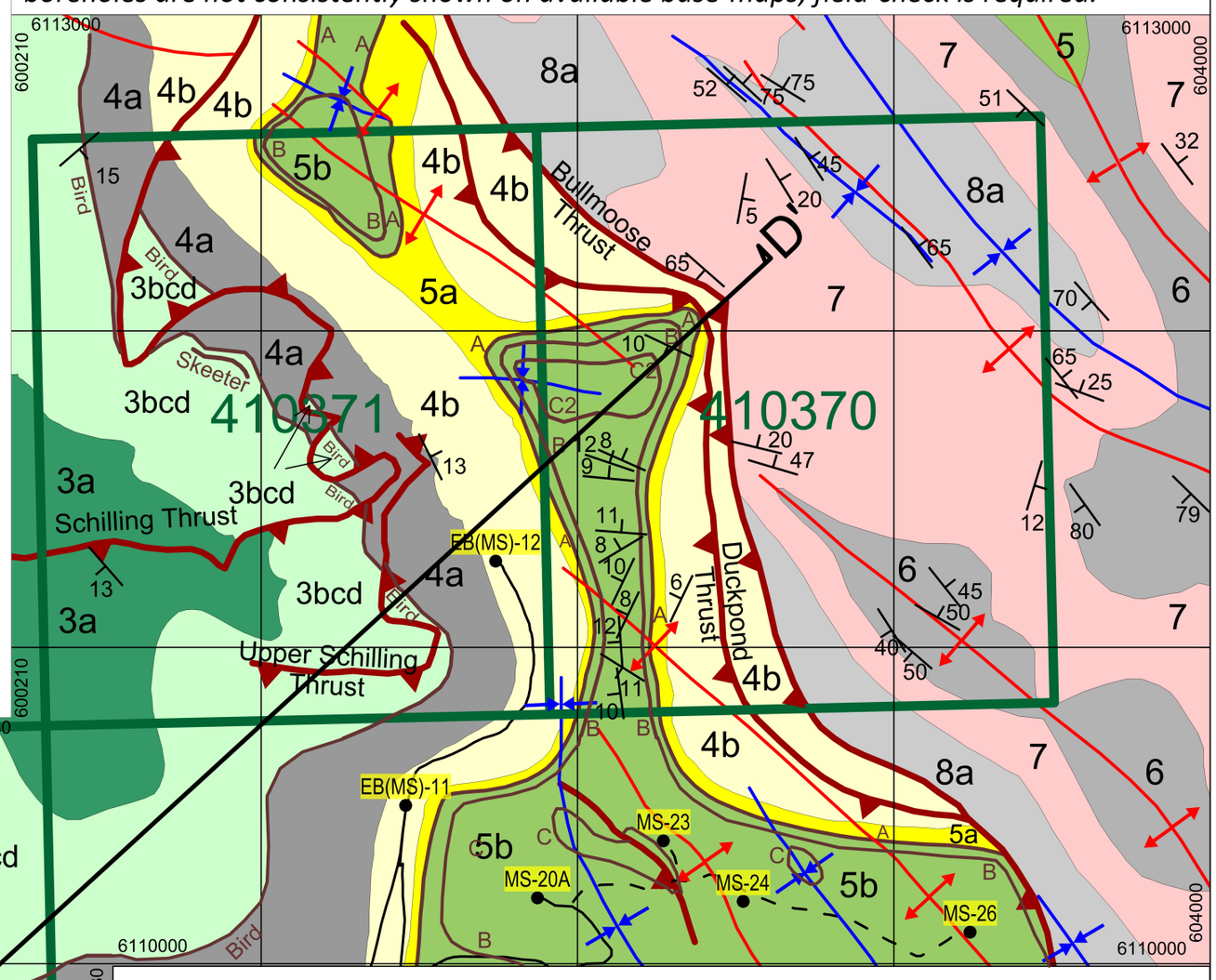
Seismic line -- as visible in satellite imagery

a-066-E Gas well (active, suspended or abandoned)

MS-28 Coal exploration borehole

B-2 Adit site (underground test driveage on coal)

Drawing file: EB-workmap-geology-west-140705j.srf Scale: as shown on bar-scale Date: 2014 July 5 Horizontal datum: UTM Zone 10N NAD83 Cadastre: BC TRIM-derived rasters, with additional wellsite and road data from Oil and Gas Commission well-location files. Geological compilation by C.G. Cathyl-Huhn P.Geo. Lic.Geol. RMSME, based on work by T. Shima and T. Nishio (1975), G.R. Jordan P.Geol. (1978), M.A. Mitchell P.Eng. (1979), D.W. Gibson P.Geo. (1992) and A. Legun P.Geo. (2009), further revised by interpretation of satellite imagery and aerial photography. Caution to the user: locations of historic boreholes are not consistently shown on available base-maps; field-check is required.



Historic Boreholes and Adits

Property Name	Operator	Owner	Work
East Bullmoose	Mitsui Mining	Nichimen/ Brameda	1975: EB-2
East Bullmoose	Mitsui Mining	Nichimen	1977: EB-12
Mt. Spieker	Robertson Research	Nichimen/ Ranger Oil	1978: MS-27 to 30, 32 and 33
Mt. Spieker	Robertson Research	Ranger Oil	1980: Adit B-2
Mt. Spieker	Ranger Oil	Ranger Oil	1982: MS- 41, 42 and 45

Total: 11 boreholes, 1 adit

UTM NAD 83

FORT ST JOHN GROUP (Albian) -- Units 4 through 8

8a Hasler Formation -- marine shale and siltstone.

7 Boulder Creek Formation -- sandstone, shale, conglomerate and coal.

7c Paddy Member -- conglomerate and sandstone.

7b Walton Creek Member -- siltstone, sandstone, conglomerate and minor coal (V zone).

7a Cadotte Member -- conglomerate and sandstone.

6 Hulcross Formation -- marine shale and siltstone; minor tuff; basal erosive-based gritstone.

5 Gates Formation -- sandstone, shale, conglomerate and coal.

5c Notikewin Member -- sandstone, siltstone; minor coal (P, Q and R zones) and carbonaceous mudstone.

5b Falher Member -- conglomerate, sandstone, coal (A, B, C2, C, and D; E is absent), carbonaceous mudstone and siltstone.

5a Torrens Member -- sandstone (Quintette and Torrens sandstone beds), minor siltstone, shale and tuff.

4 Moosebar Formation -- marine siltstone and shale; minor sandstone and tuff; basal glauconitic sandstone.

4b Spieker Member -- marine siltstone and sandstone.

4a Mudstone member (informal) -- mudstone; minor tuff; pebbly glauconitic sandstone at base.

BULLHEAD GROUP (Barremian to Aptian) -- Units 2 and 3

3 Gething Formation -- siltstone, sandstone, conglomerate and coal (Bird, Skeeter, Chamberlain and 'Middle' zones).

Chamberlain Member -- sandstone, siltstone and coal.

3bcd Bullmoose Member -- marine shale and siltstone.

Bluesky Member -- glauconitic sandstone.

3a Gaylard Member -- sandstone, siltstone and coal; lenses of conglomerate near base.

2 Cadomin Formation -- cliff-forming conglomerate; minor siltstone.

MINNES GROUP (Berriasian to Valanginian) -- Unit 1

1 Monach Formation -- sandstone, conglomerate and coal.

REV	DATE	DESCRIPTION
H	Jul/05/2014	Cross-section line and coal traces

WALTER ENERGY

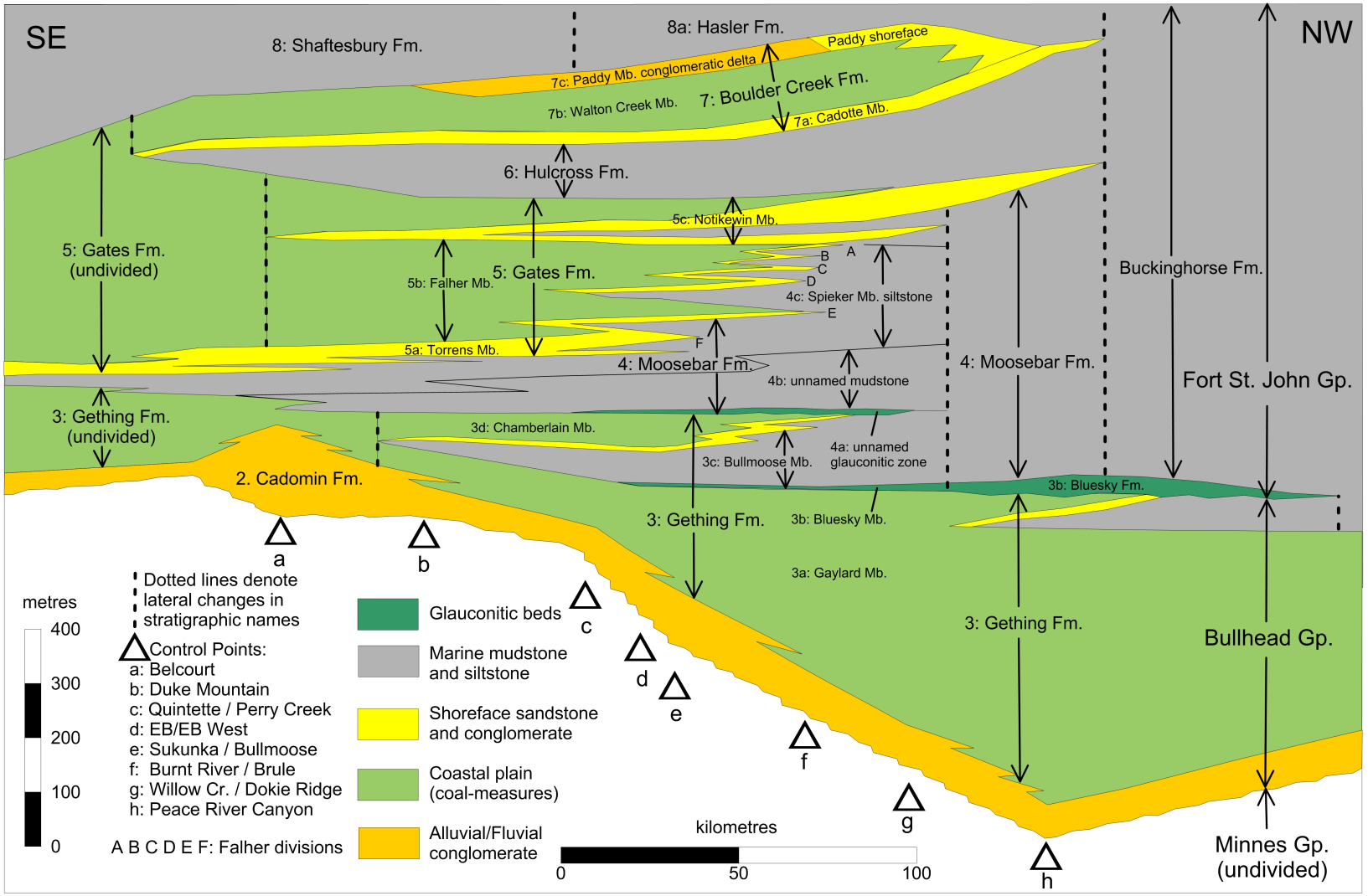
Drawn by:	GCH
Checked by:	GCH
Approved by:	GCH
Revision Serial	H
Dwg. No.	

GEOLOGICAL MAP: COAL LICENCES 410366 - 410371

JULY 2014 | EB WEST COAL ASSESSMENT REPORT | Reference MAP 3-1

6113000 6112000 6111000 6110000 6109000 6108000 6107000 6106000 6105000 6104000 6103000

597000 598000 599000 600000 601000 602000 603000 604000



Drawing: NEBC-regional-stratigraphy_140710e.srf/jpg
Date: 5.July 2014 Scale: diagrammatic, as shown
Drawn by: C.G.Cathyl-Huhn P.Geo. Lic.Geol. RMSME, modified from work by W.Kalkreuth and D.A. Leckie (1989)

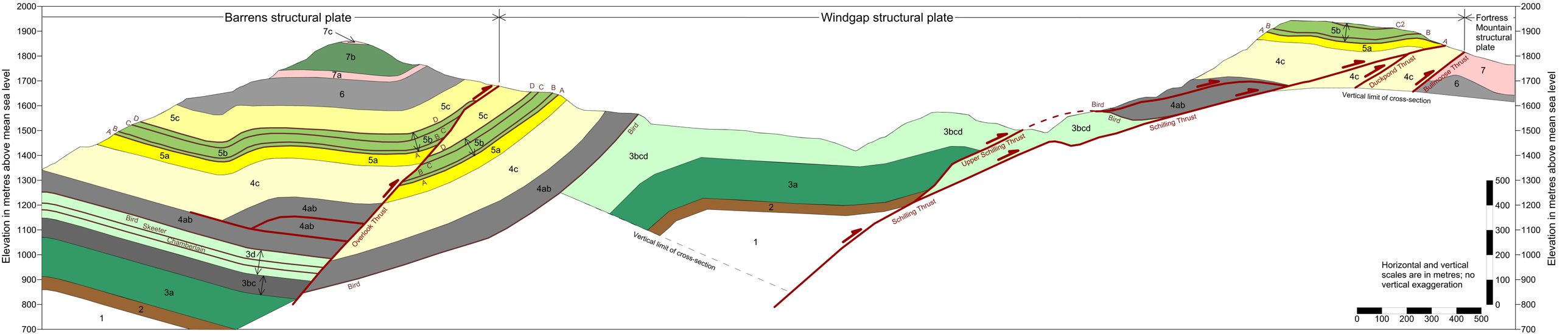
WALTER ENERGY

Figure 3-1: Regional Stratigraphy of the Lower Cretaceous Bullhead Group and basal part of the Fort St. John Group

Cross-section D-D' (northwest view)

southwest
D 598331 E
6108314 N

northeast
602610 E
6112229 D'
6112229 N



Drawing file: EB_West-Section-D_140705d.srf/jpg
Date: 2014 July 5 Datum: geodetic (mean sea level in metres). Coordinate system: UTM NAD83.
Geological compilation: C.G. Cathyl-Huhn P.Geo. Lic.Geol RMSME, modified after original section by G.R. Jordan P.Geo. (in CAR-556, 1978).
Scale: as shown by scale bars; no exaggeration.

FORT ST JOHN GROUP (Albian) -- Units 4 through 8

- 8a — Hasler Formation (not in cross-section) -- marine shale and siltstone.
- 7 — Boulder Creek Formation -- sandstone, shale, conglomerate and coal.
- 7c — Paddy Member -- conglomerate and sandstone.
- 7b — Walton Creek Member -- siltstone, sandstone, conglomerate and minor coal (V zone).
- 7a — Cadotte Member -- conglomerate and sandstone.
- 6 — Hulcross Formation -- marine shale and siltstone; minor tuff; basal erosive-based gritstone.
- 5 — Gates Formation -- sandstone, shale, conglomerate and coal.
- 5c — Notikewin Member -- sandstone, siltstone; minor coal (P, Q and R zones) and carbonaceous mudstone.
- 5b — Falher Member -- conglomerate, sandstone, coal (A, B, C2, C and D; E is absent), carbonaceous mudstone and siltstone.
- 5a — Torrens Member -- sandstone (Quintette and Torrens sandstone beds), minor siltstone, shale and tuff.
- 4 — Moosebar Formation -- marine siltstone and shale; minor sandstone and tuff; basal glauconitic sandstone.
- 4c — Spieker Member -- marine siltstone and sandstone.
- 4ab — Unnamed mudstone (Unit 4b) -- mudstone; minor tuff; pebbly glauconitic sandstone (Unit 4a) at base.

BULLHEAD GROUP (Barremian to Aptian) -- Units 2 and 3

- 3 — Gething Formation -- siltstone, sandstone, conglomerate and coal (Bird, Skeeter, Chamberlain and 'Middle' zones).
- 3bcd
  - 3d — Chamberlain Member -- sandstone, siltstone and coal.
  - 3bc — Bullmoose Member -- marine shale and siltstone.
  - Bluesky Member -- glauconitic sandstone.
- 3a — Gaylard Member -- sandstone, siltstone and coal; lenses of conglomerate near base.
- 2 — Cadomin Formation -- cliff-forming conglomerate; minor siltstone.
- 1 — MINNES GROUP (Berriasian to Valanginian) -- Unit 1
  Monach Formation -- sandstone, conglomerate and coal.

Legend

- Fault, with arrow depicting inferred or observed sense of displacement in plane of section
- Geological contact between rock-units
- Bird — Coal zone, comprising one or more coal beds

WALTER ENERGY

Dwn: GCH	Cross-section D-D' across EB West coal licences
Scale: as shown	
Ref.: EB_West-Section-D-140705d.srf/jpg	

JULY 2014 | EB WEST COAL ASSESSMENT REPORT | FIG. 3-2

Appendix A

Interpreted geophysical logs of boreholes within the Gates Formation

Following are interpreted downhole geophysical logs (presented as **Figures A-1** through **A-8**), as measured by Roke Oil Enterprises Ltd., from eight historic boreholes which partially or completely intersected the Gates Formation within the EB West coal property. The log of borehole EB(MS)-2 was obtained from Coal Assessment Report No.552 (Shima and Nishio, 1975), and the logs of boreholes MS-27 through MS-33 were obtained from Coal Assessment Report No.556 (Jordan and Dawson, 1978). All logs were obtained with a gamma-neutron sonde, in some cases run open-hole and in some cases run through drill rods. Depths given on the log of EB(MS)-2 are in feet, and the other holes' depths are given in metres.

All logs follow similar presentations, with rightward-increasing gamma response in the left track, and rightward-increasing neutron response in the right track. Gamma and neutron readings are given in API (American Petroleum Institute) units. The top of the logged section presented at the top of the logs, and the base of the section is presented at the base of the logs, to constant vertical scale. Spans (minimum and maximum track values) vary from hole to hole.

Interpretation and correlation of the logs was done by Gwyneth Cathyl-Huhn P.Geo. Marker beds, formation and member tops, and the tops and bases of coal beds as shown on the interpreted logs are presented in **Tables 3-2** and **3-3** of this report.

ROKE

OIL ENTERPRISES LTD. CALGARY, ALBERTA

FILE NO. | COMPANY NICHIMEN RESOURCES LTD

LSD | WELL EB - 2

SEC

TWP

RGE

W | LOCATION MT. SPIEKER

M | FIELD

PROVINCE BRITISH COLUMBIA

Permanent Datum GROUND LEVEL Elev.

Log Measured from GROUND LEVEL Ft. Above Perm. Datum

Drill Floor Measured from RIG FLOOR

Other Services:

DENS

K.B.

CSG

G.L.

Run No.	ONE
Date	18 SEPTEMBER 1975
First Reading	609
Last Reading	00
Feet(m) Logged	609
Depth Reached	610
Depth Driller	608
Casing Size	
Casing Driller	
Fluid Type	AIR/QUICK GEL
Fluid Level	
Max. Rec. Temp.	2-3/4
Rec. Equip. No.	
Operating Time	2 HOURS
Truck No.	SU-5
Recorded By	EDIN
	Witnessed By ROBERTS

Figure A-1:
Annotated geophysical log of borehole EB(MS)-2

Interpretation: C.G.Cathyl-Huhn P.Geo. Lic.Geol.
Date: 31.May, 2014 Scale: as shown, in metres
Reference: to accompany EB West coal assessment report

Log source: Coal Assessment Report 552

EQUIPMENT DATA

GAMMA RAY	
RUN NO.	ONE
TOOL MODEL NO.	340
DIAMETER	$1\frac{11}{16}$
DETECTOR MODEL NO.	
TYPE	SCINTILLATION
LENGTH	4 INCH
DISTANCE TO N. SOURCE	5.5 FT.

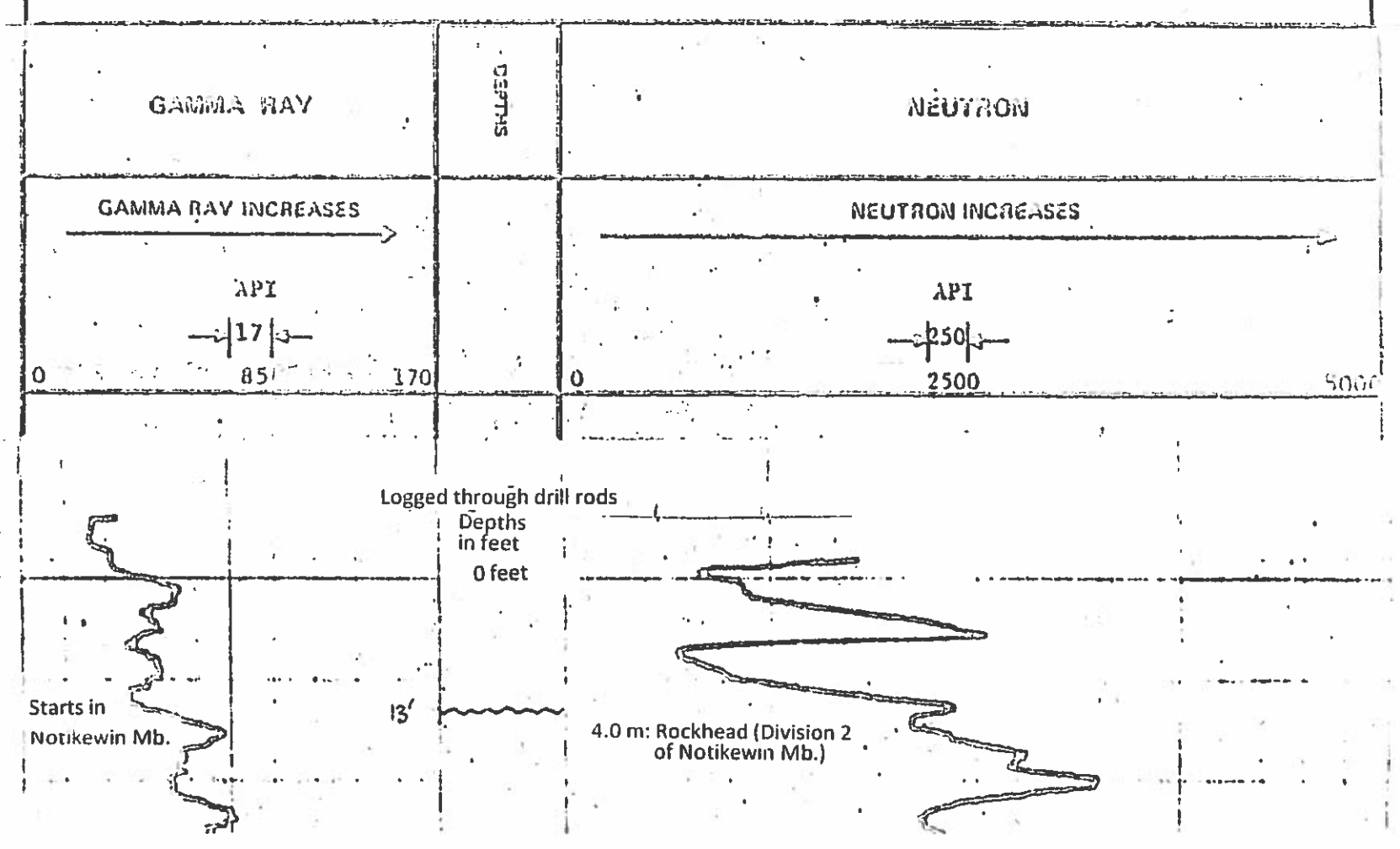
GENERAL	
HOIST TRUCK NO.	SU-5
INSTRUMENT TRUCK NO.	SU-5
TOOL SERIAL NO.	340

NEUTRON	
RUN NO.	ONE
LOG TYPE	NEUTRON/NEUTRON
TOOL MODEL NO.	340
DIAMETER	$1\frac{11}{16}$
DETECTOR MODEL NO.	
TYPE	PROPORTIONAL
LENGTH	8 INCH
SOURCE MODEL NO.	MRC-N-SS-W
SERIAL NO.	171
SPACING	
TYPE	AmBe
STRENGTH	3 CURIES

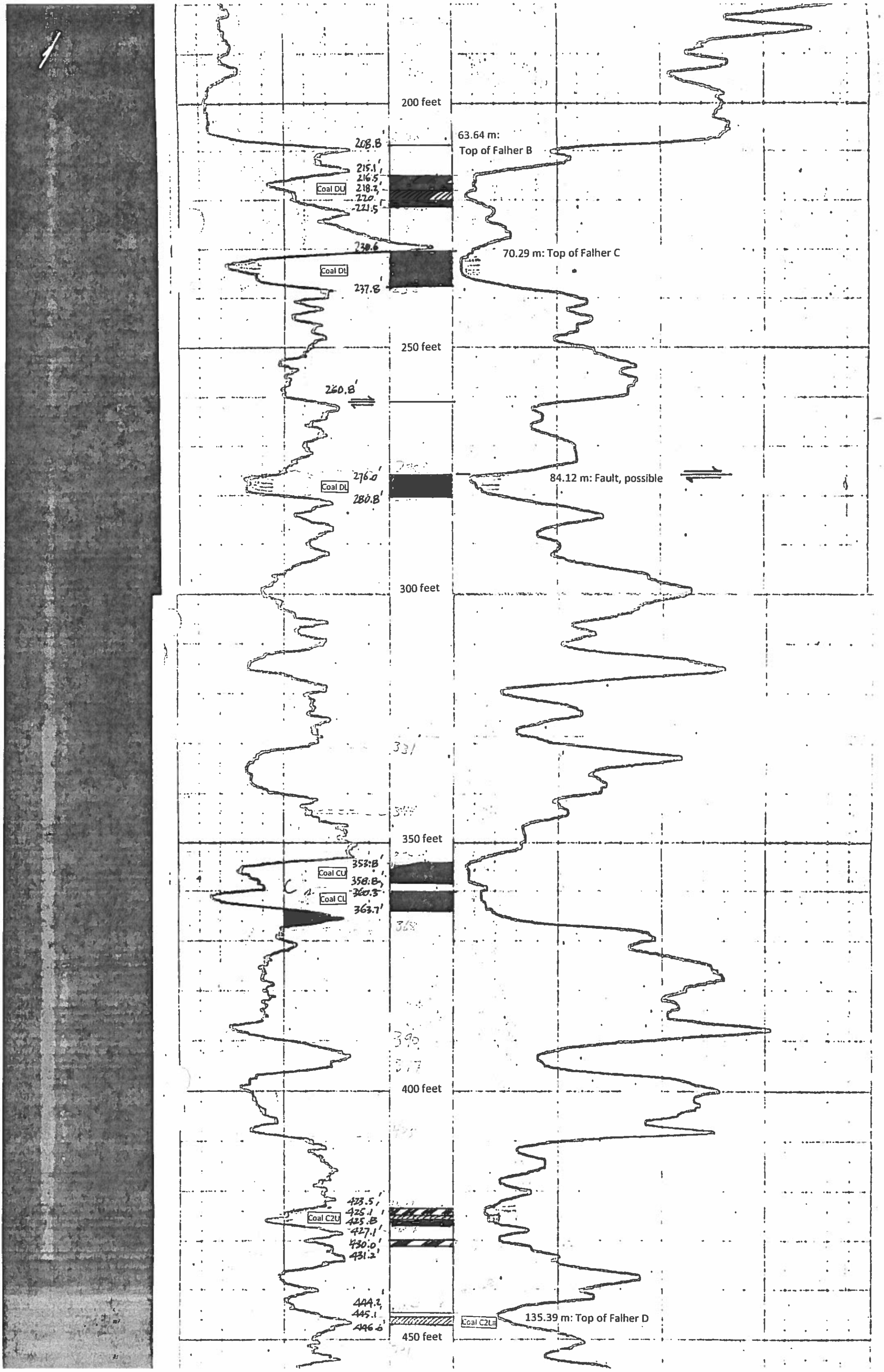
LOGGING DATA

RUN	GENERAL DEPTHS FROM	GENERAL DEPTHS TO	GENERAL SPEED FT/MIN	GAMMA RAY T.C. SEC.	GAMMA RAY SENS SETTINGS	GAMMA RAY ZERO DIV. L OR R	GAMMA RAY API G. R. UNITS PER LOG DIV.	NEUTRON T. C. SEC.	NEUTRON SENS SETTINGS	NEUTRON ZERO DIV L OR R	NEUTRON API N. UNITS PER LOG DIV
	00	609	12	5	100	-	17 API	3	500	-	250 API

REMARKS LOGGED THROUGH DRILL PIPE




API
17
0
85
170
API
250
0
2500
5000
Logged through drill rods
Depths in feet
0 feet
Starts in Notikewin Mb.
13'
4.0 m: Rockhead (Division 2 of Notikewin Mb.)
50 feet
100 feet
104.5'
31.85 m: Top of Notikewin Division 1
Notikewin Mb.
Falher Mb.
142.2'
43.34 m:
Top of Falher A
150 feet
200 feet
208.8'
63.64 m:
Top of Falher B
215.1'
216.5'
Coal DU
218.2'
220'
221.5'
230.6'
70.29 m: Top of Falher C
Coal DL
237.8'


200 feet
208.8'
63.64 m:
Top of Falher B
215.1'
216.5'
Coal DU
218.2'
220'
221.5'
230.6'
70.29 m: Top of Falher C
Coal DL
237.8'
250 feet
260.8'
276.0'
Coal DL
280.8'
84.12 m: Fault, possible
300 feet
350 feet
353.8'
Coal CU
358.8'
360.3'
Coal CL
363.7'
400 feet
423.5'
425.1'
Coal C2U
425.8'
427.1'
430.0'
431.2'
444.2'
445.1'
446.6'
Coal C2L
135.39 m: Top of Falher D
450 feet

400 feet

423.5'
425.1'
Coal C2U
425.8'
427.1'
430.0'
431.2'

444.2'
445.1'
446.6'
Coal C2L
135.39 m: Top of Falher D

450 feet

500 feet

536'
Coal BU
534'
536.9'
Coal BU

162.76 m: Top of Falher E

550 feet
551'

574.8'
Coal AU
577.2'
579.8'
176.72 m: Top of Falher F

586.8'
Coal A
590'
Falher Mb.
Torrens Mb.

179.83 m: Top of Torrens Mb. (Quintette Sandstone)

600 feet

P.R.

ZERO
100 CPS CAL.

ZERO

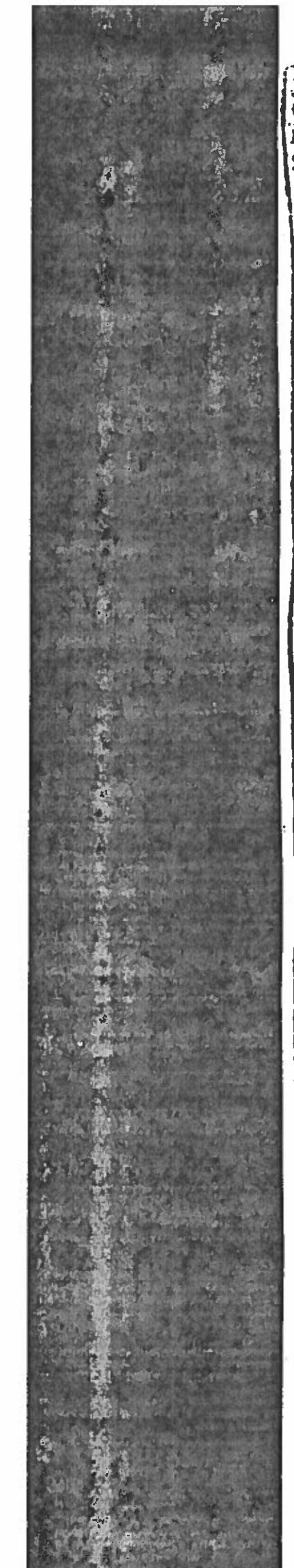
650 feet

Figure A-1:

Annotated geophysical log of borehole EB(MS)-2

Interpretation: C.G.Cathyl-Huhn P.Geo. Lic.Geol.
Date: 31.May, 2014 Scale: as shown, in metres
Reference: to accompany EB West coal assessment report

Log source: Coal Assessment Report 552



Gamma Ray

Neutron

Logged through drill rods

MS-27

Depths in metres

0 m

10 m

Starts in Paddy Mb. of Boulder Creek Fm.

Rockhead (Paddy Mb.)

Paddy conglomerate

Paddy conglomerate

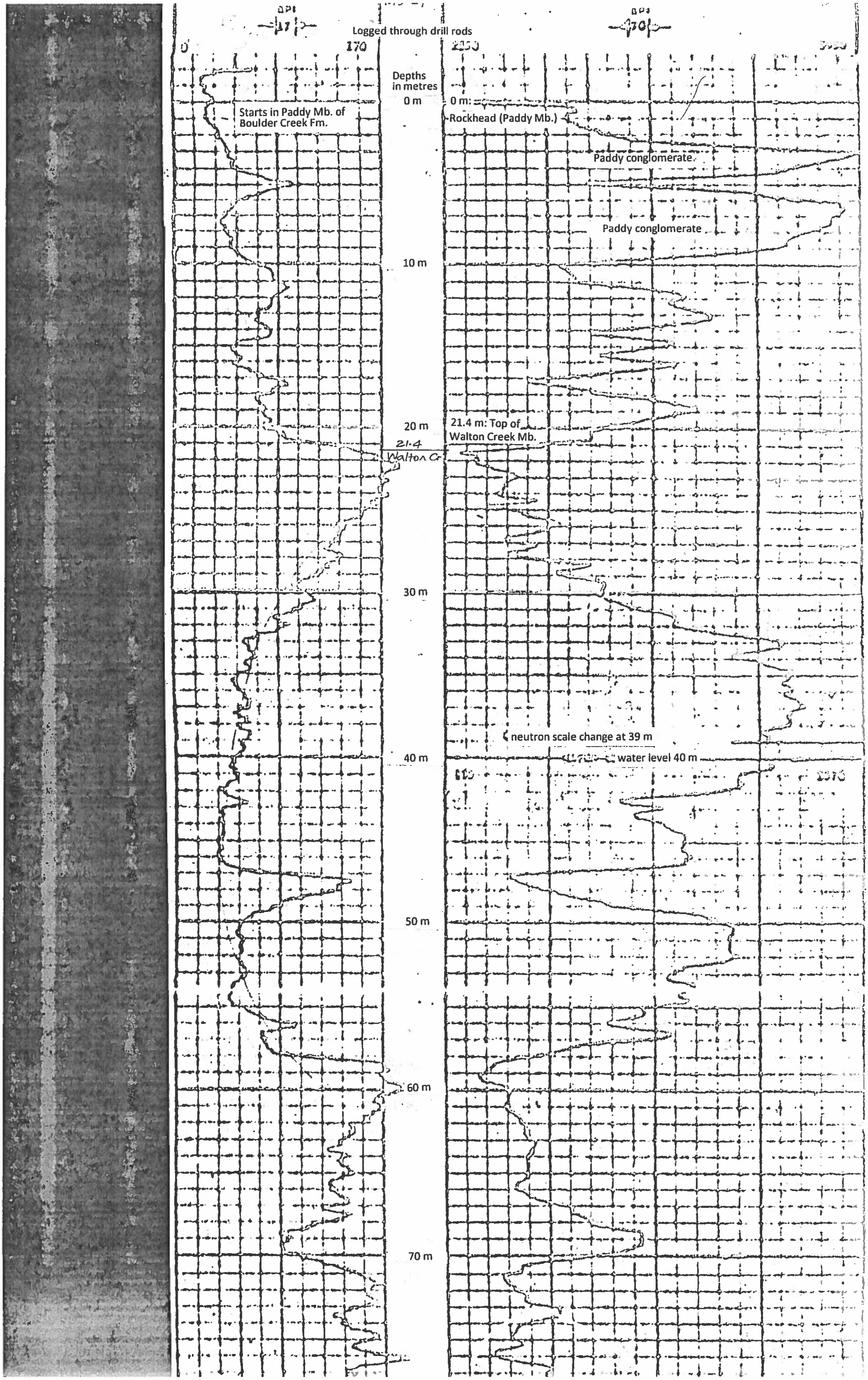
Figure A-2: Annotated geophysical log of borehole MS-27

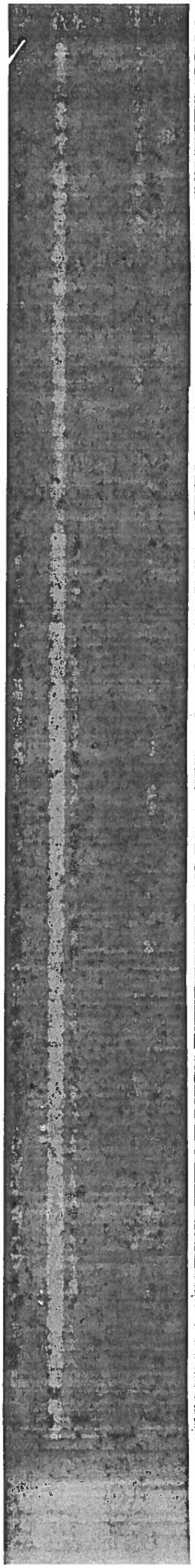
Interpretation: C.G.Cathyl-Huhn P.Geo. Lic.Geol.

Date: 31.May, 2014 Scale: as shown, in metres

Reference: to accompany EB West coal assessment report

Log source: Coal Assessment Report 556


Logged through drill rods
Depths in metres
0 m
Starts in Paddy Mb. of Boulder Creek Fm.
0 m:
Rockhead (Paddy Mb.)
Paddy conglomerate
Paddy conglomerate
10 m
20 m
21.4 m: Top of Walton Creek Mb.
21.4
Walton Cr
30 m
neutron scale change at 39 m
40 m
water level 40 m
50 m
60 m
70 m



70 m

80 m

90 m

99.6

Coal V

100.1

100 m

Walton Creek conglomerate
and sandstone

110 m

116.50

Cadotte

Walton Creek Mb.
Cadotte Mb.

116.5 m: Top of Cadotte Mb.

120 m

125.80

C-marker

Cadotte conglomerate
Cadotte sandstone

130 m

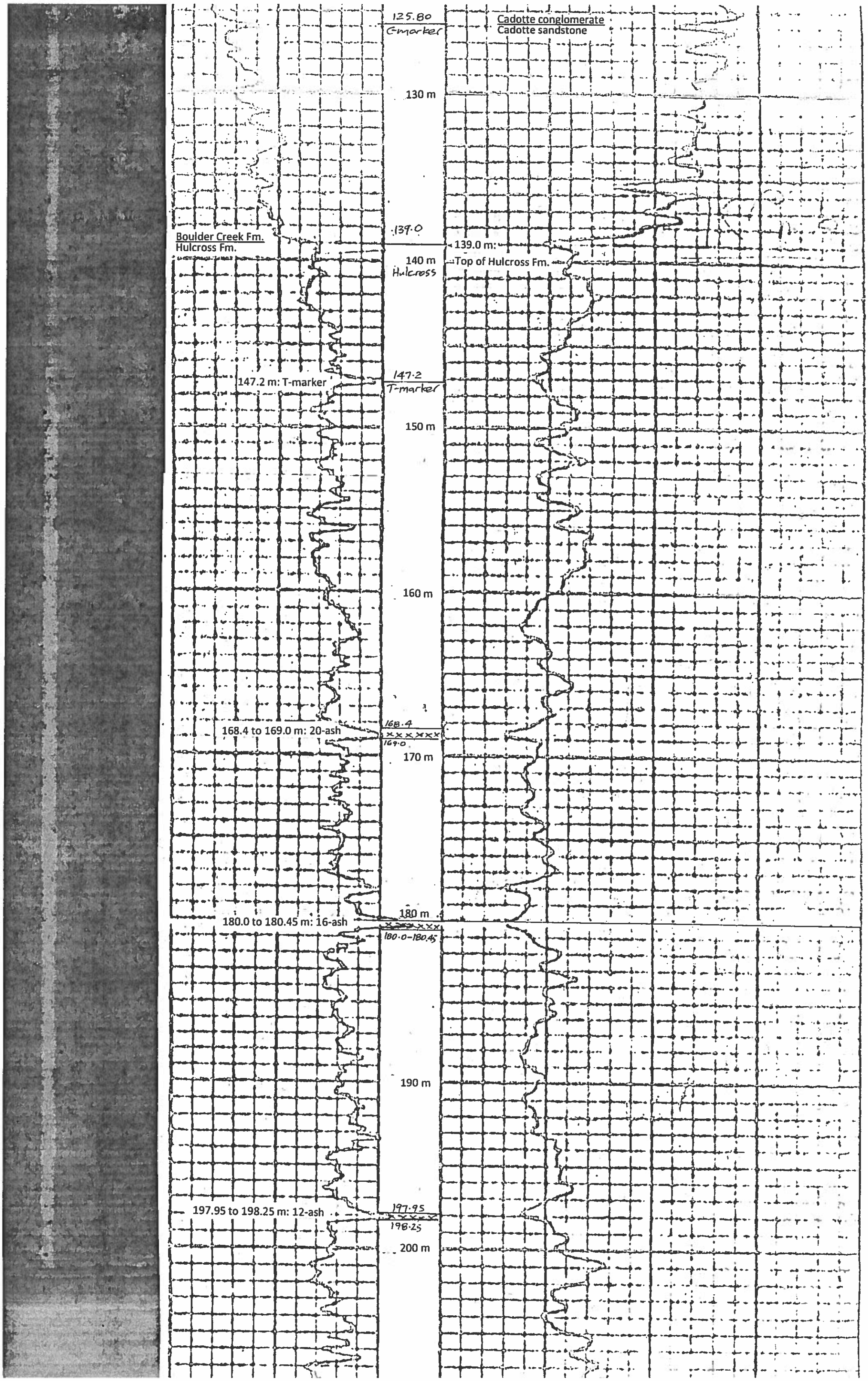
139.0

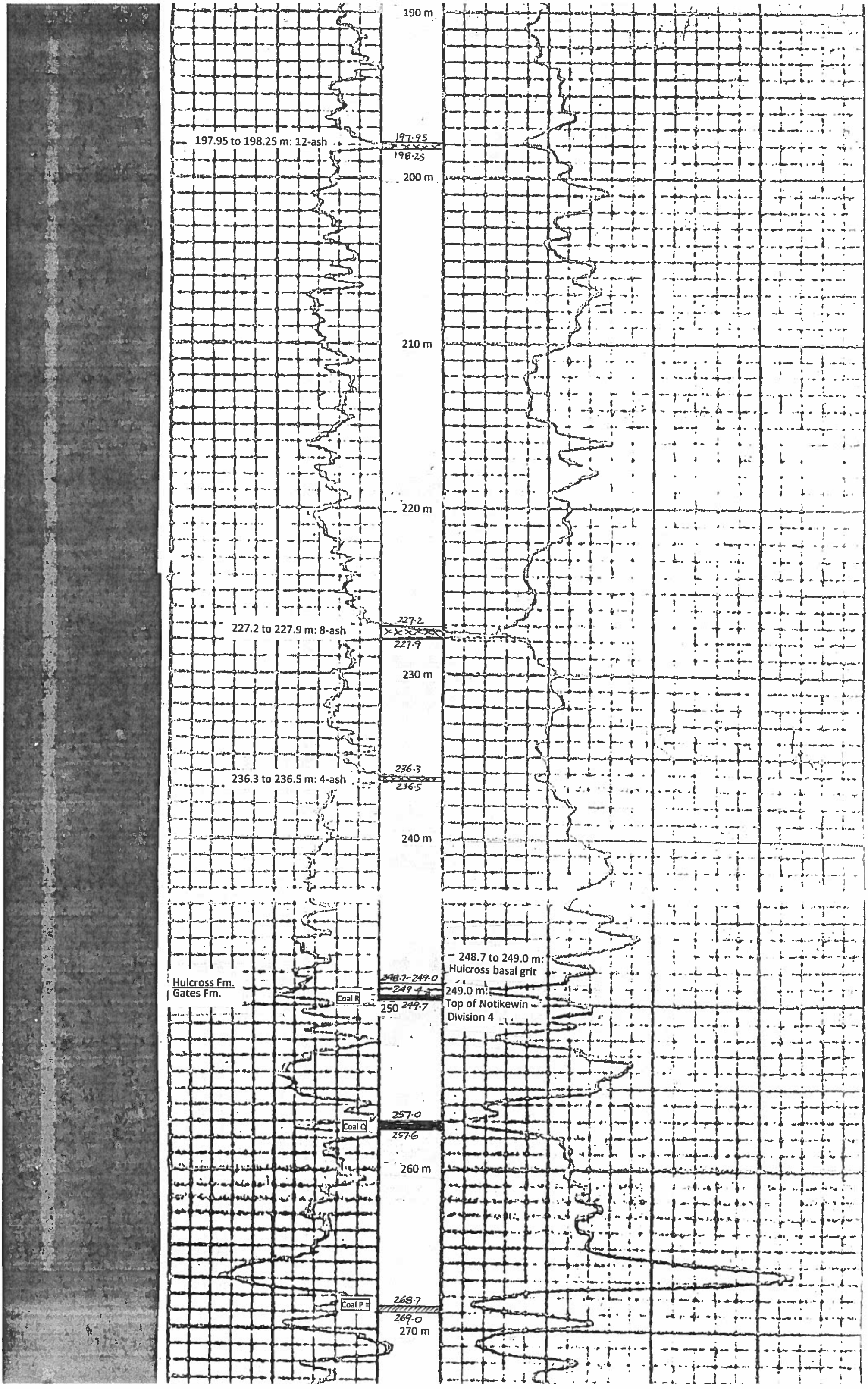
Boulder Creek Fm.
Hulcross Fm.

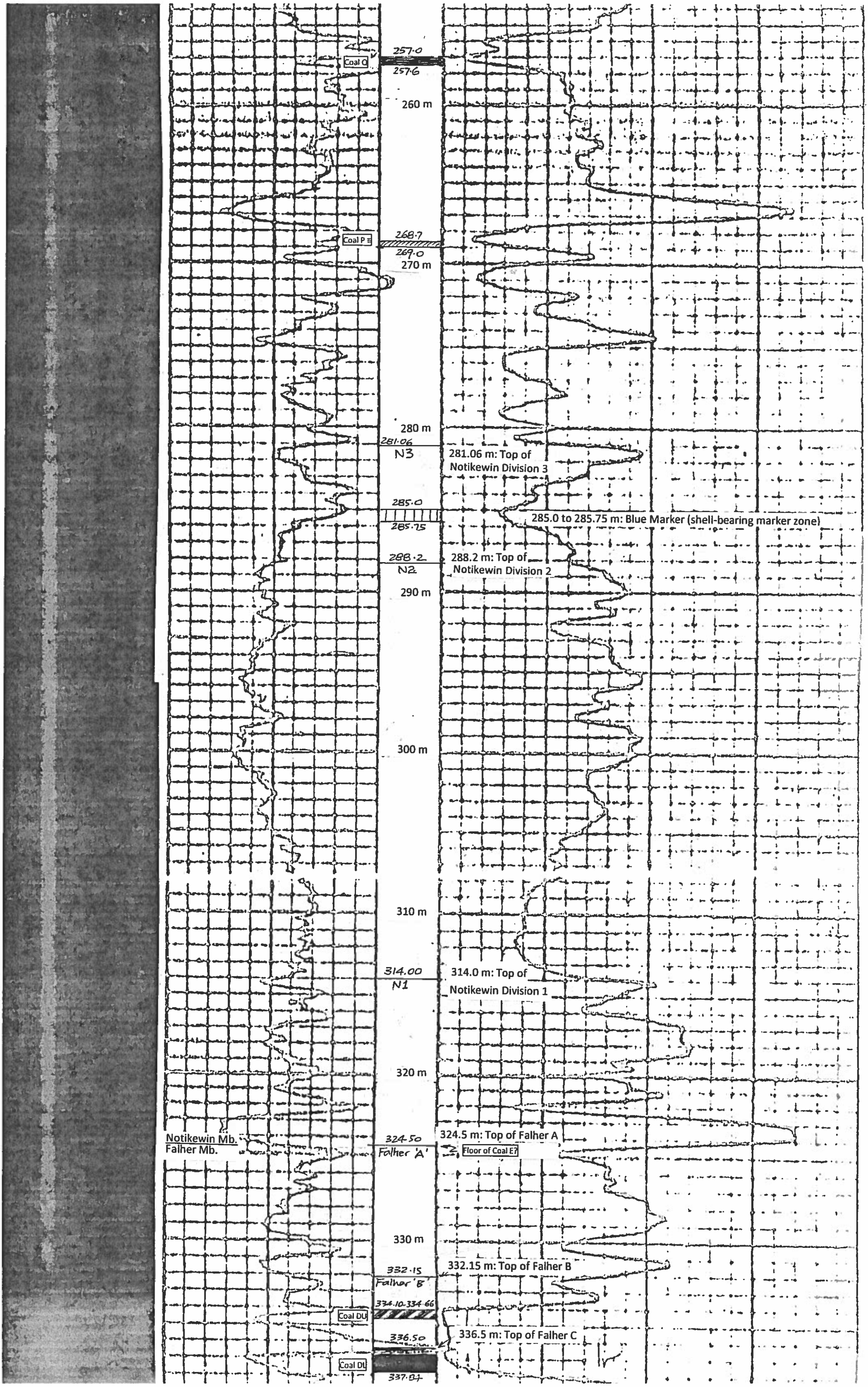
139.0 m:
Top of Hulcross Fm.

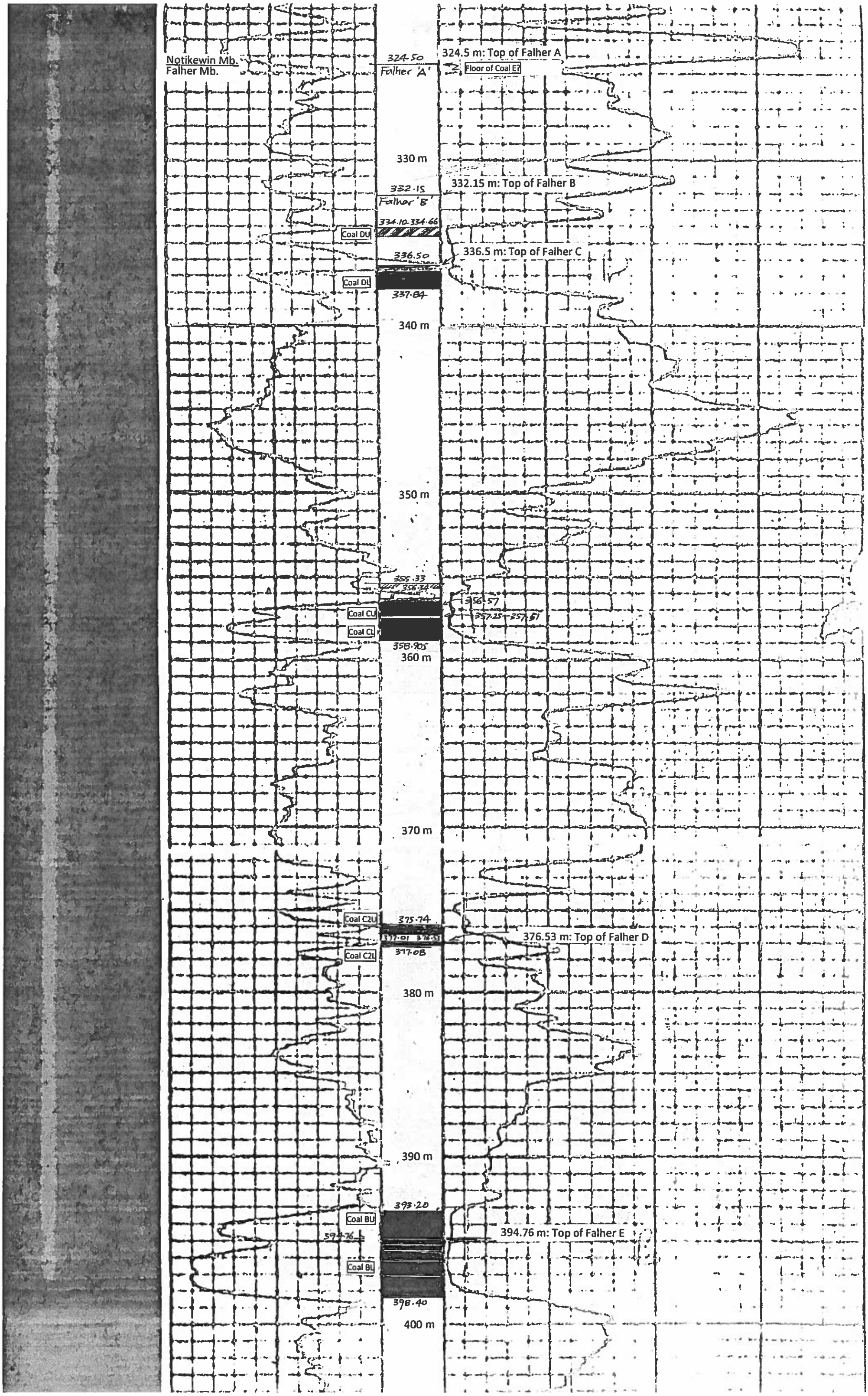
140 m

Hulcross


125.80
C-marker
Cadotte conglomerate
Cadotte sandstone
130 m
139.0
Boulder Creek Fm.
Hulcross Fm.
139.0 m:
Top of Hulcross Fm.
140 m
Hulcross
147.2 m: T-marker
147.2
T-marker
150 m
160 m
168.4 to 169.0 m: 20-ash
168.4
169.0
170 m
180 m
180.0 to 180.45 m: 16-ash
180.0-180.45
190 m
197.95 to 198.25 m: 12-ash
197.95
198.25
200 m


190 m
197.95 to 198.25 m: 12-ash
197·95
198·25
200 m
210 m
220 m
227.2 to 227.9 m: 8-ash
227·2
227·9
230 m
236.3 to 236.5 m: 4-ash
236·3
236·5
240 m
Hulcross Fm.
Gates Fm.
Coal R
248.7 to 249.0 m:
Hulcross basal grit
248.7-249.0
249 4
249.0 m:
Top of Notikewin
Division 4
250
249.7
257·0
Coal Q
257·6
260 m
Coal P
268·7
269·0
270 m


Coal Q
257.0
257.6
260 m
Coal P
268.7
269.0
270 m
280 m
281.06
N3
281.06 m: Top of
Notikewin Division 3
285.0
285.75
285.0 to 285.75 m: Blue Marker (shell-bearing marker zone)
288.2
N2
288.2 m: Top of
Notikewin Division 2
290 m
300 m
310 m
314.00
N1
314.0 m: Top of
Notikewin Division 1
320 m
Notikewin Mb.
Falher Mb.
324.50
Falher 'A'
324.5 m: Top of Falher A
Floor of Coal E?
330 m
332.15
Falher 'B'
332.15 m: Top of Falher B
334.10-334.66
Coal D1
336.50
336.5 m: Top of Falher C
Coal D1
337.84


Notikewin Mb.
Falher Mb.
324.50
Falher 'A'
324.5 m: Top of Falher A
Floor of Coal E?
330 m
332.15
Falher 'B'
332.15 m: Top of Falher B
334.10-334.66
Coal DU
336.50
336.5 m: Top of Falher C
Coal DL
337.84
340 m
350 m
355.33
356.34
356.57
Coal CU
357.25-357.61
Coal CL
358.905
360 m
370 m
Coal C2U
375.74
377.01-378.51
376.53 m: Top of Falher D
Coal C2L
377.08
380 m
390 m
393.20
Coal BU
394.76
394.76 m: Top of Falher E
Coal BL
398.40
400 m

334.10-334.66
Coal DU
336.50
336.5 m: Top of Falher C
Coal DL
337.84
340 m
350 m
355.33
356.34
356.57
Coal CU
357.25-357.61
Coal CL
358.905
360 m
370 m
Coal C2U
375.74
377.01 376.53
Coal C2L
377.08
376.53 m: Top of Falher D
380 m
390 m
393.20
Coal BU
394.76 m: Top of Falher E
394.76
Coal BL
398.40
400 m
407.55
407.55 m: Top of Falher F
Falher 'F'
409.11
Coal A
Falher Mb.
Torrens Mb.
410.08
410.08 m: Top of Quintette Sandstone
Torrens Mb. (Quintette Sst.)
FR

Figure A-2:

Annotated geophysical log of borehole MS-27

Interpretation: C.G.Cathyl-Huhn P.Geo. Lic.Geol.
Date: 31.May, 2014 Scale: as shown, in metres
Reference: to accompany EB West coal assessment report
Log source: Coal Assessment Report 556

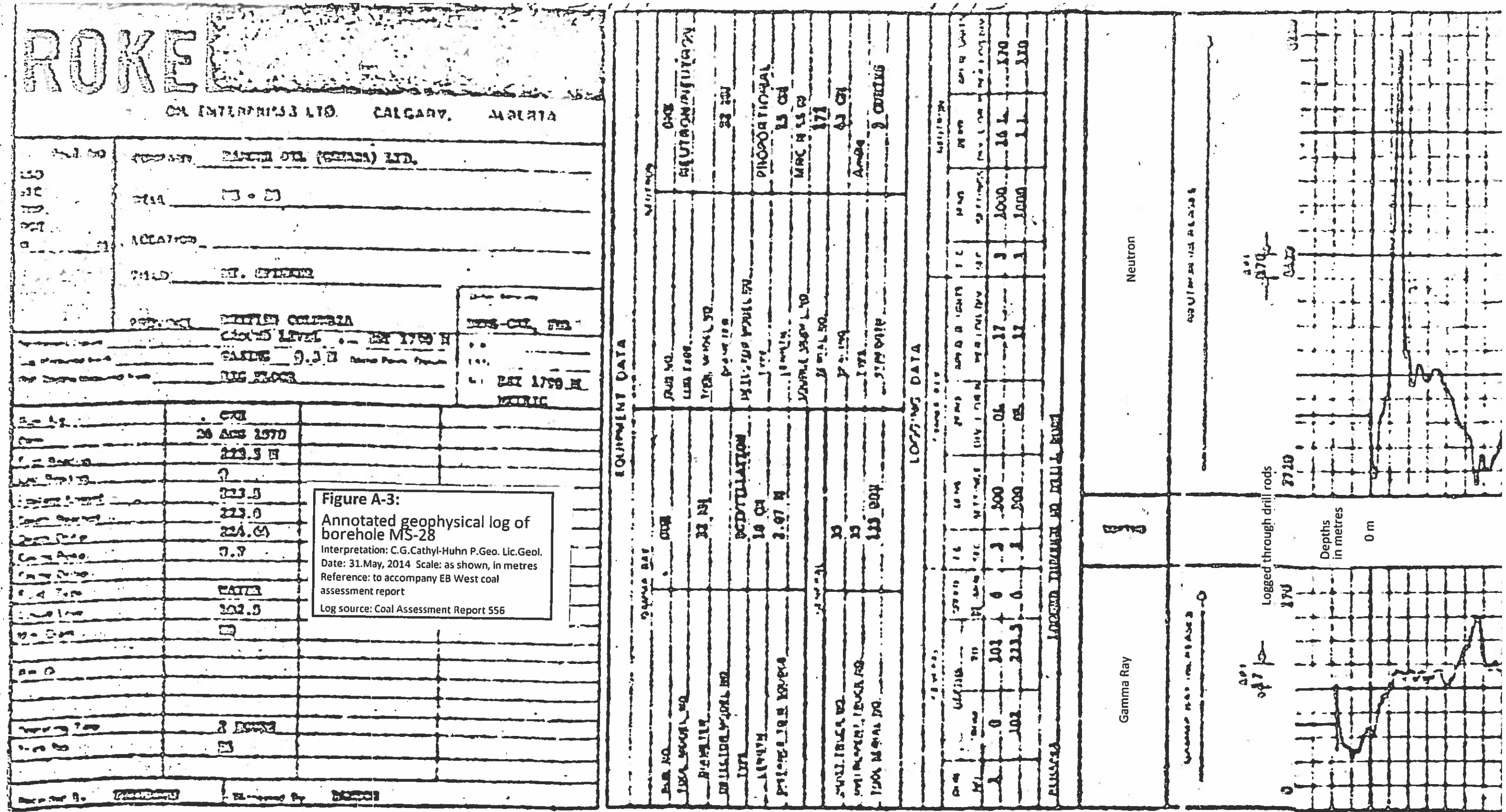
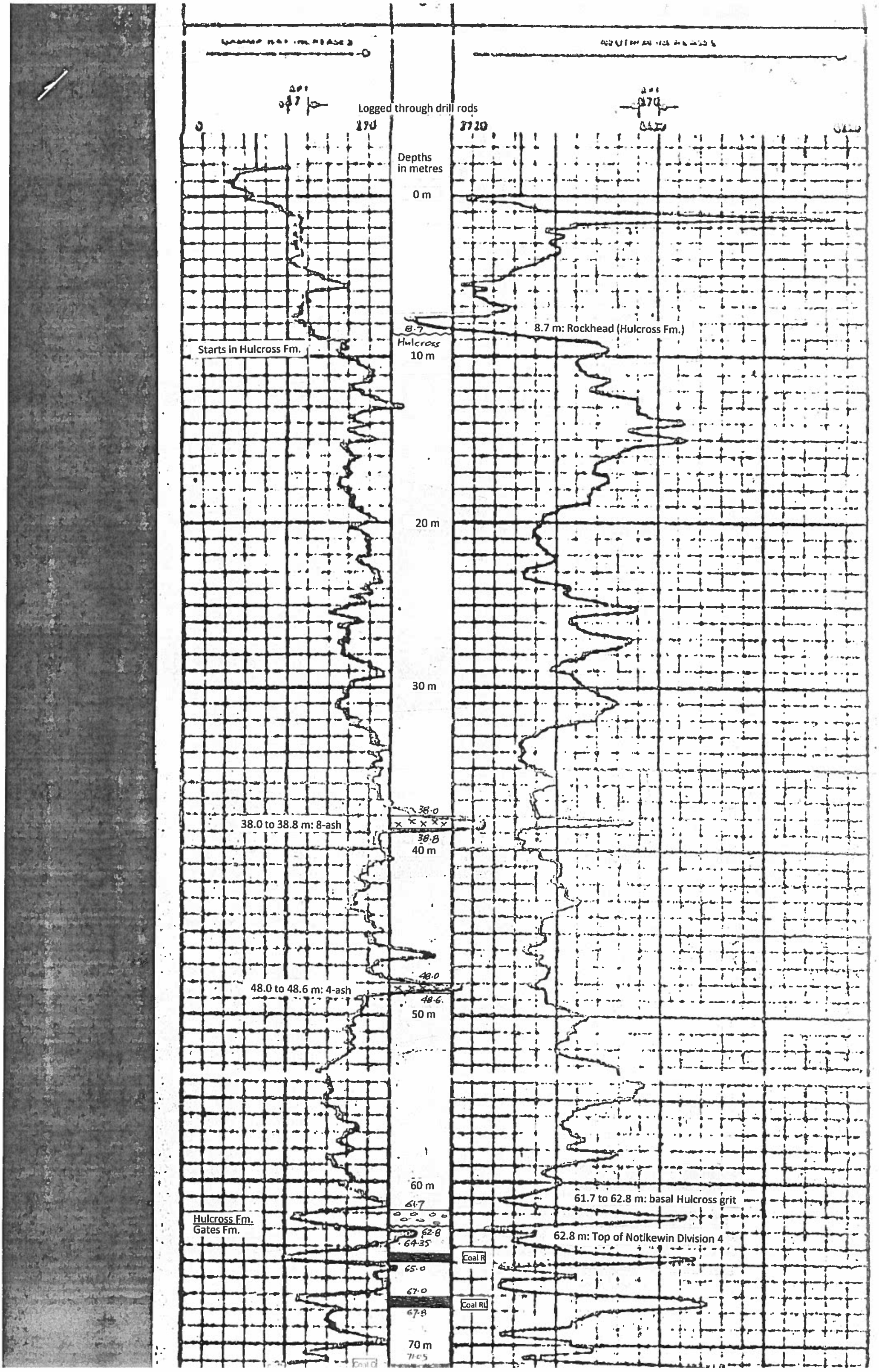


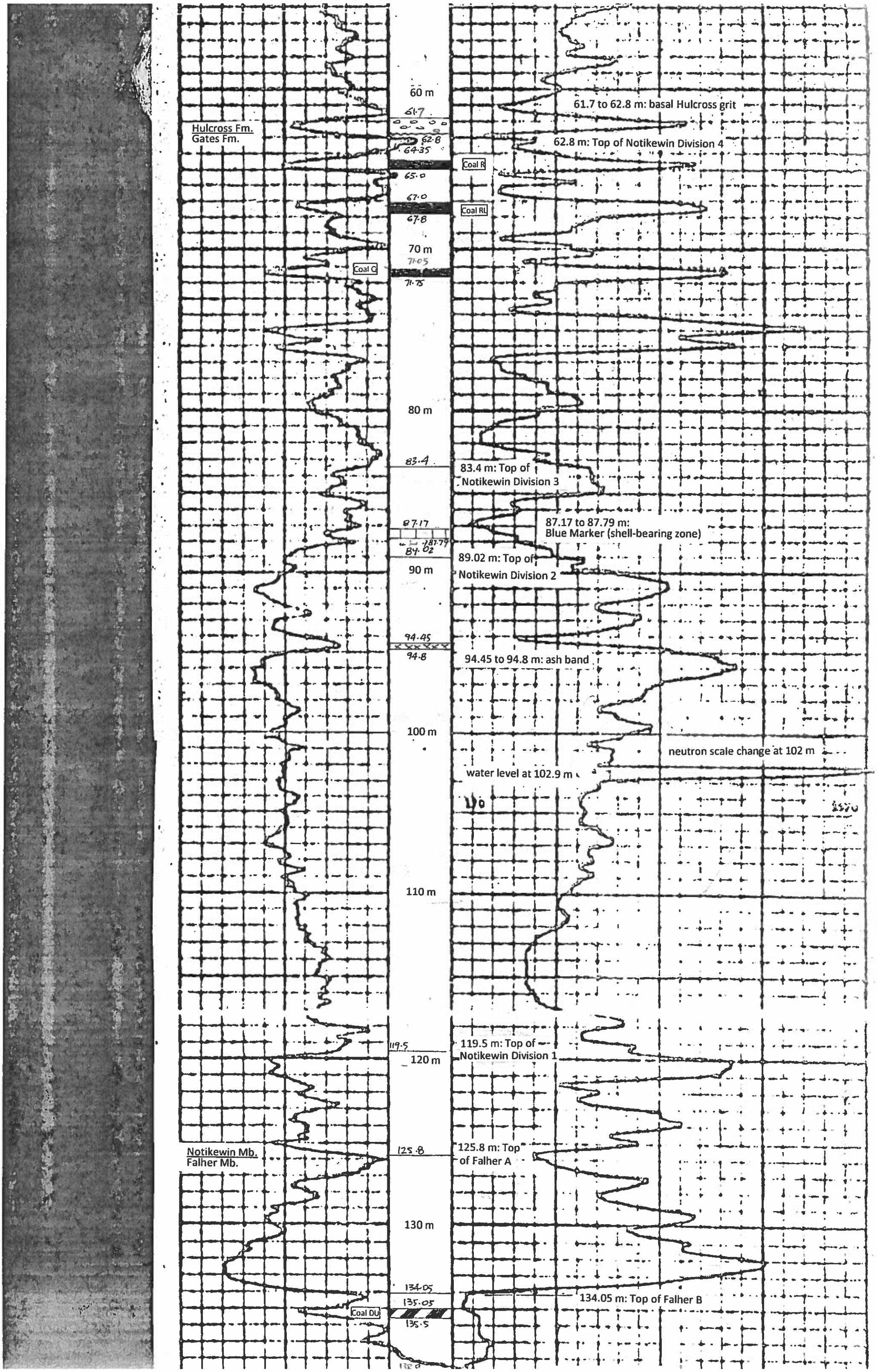
Figure A-3:

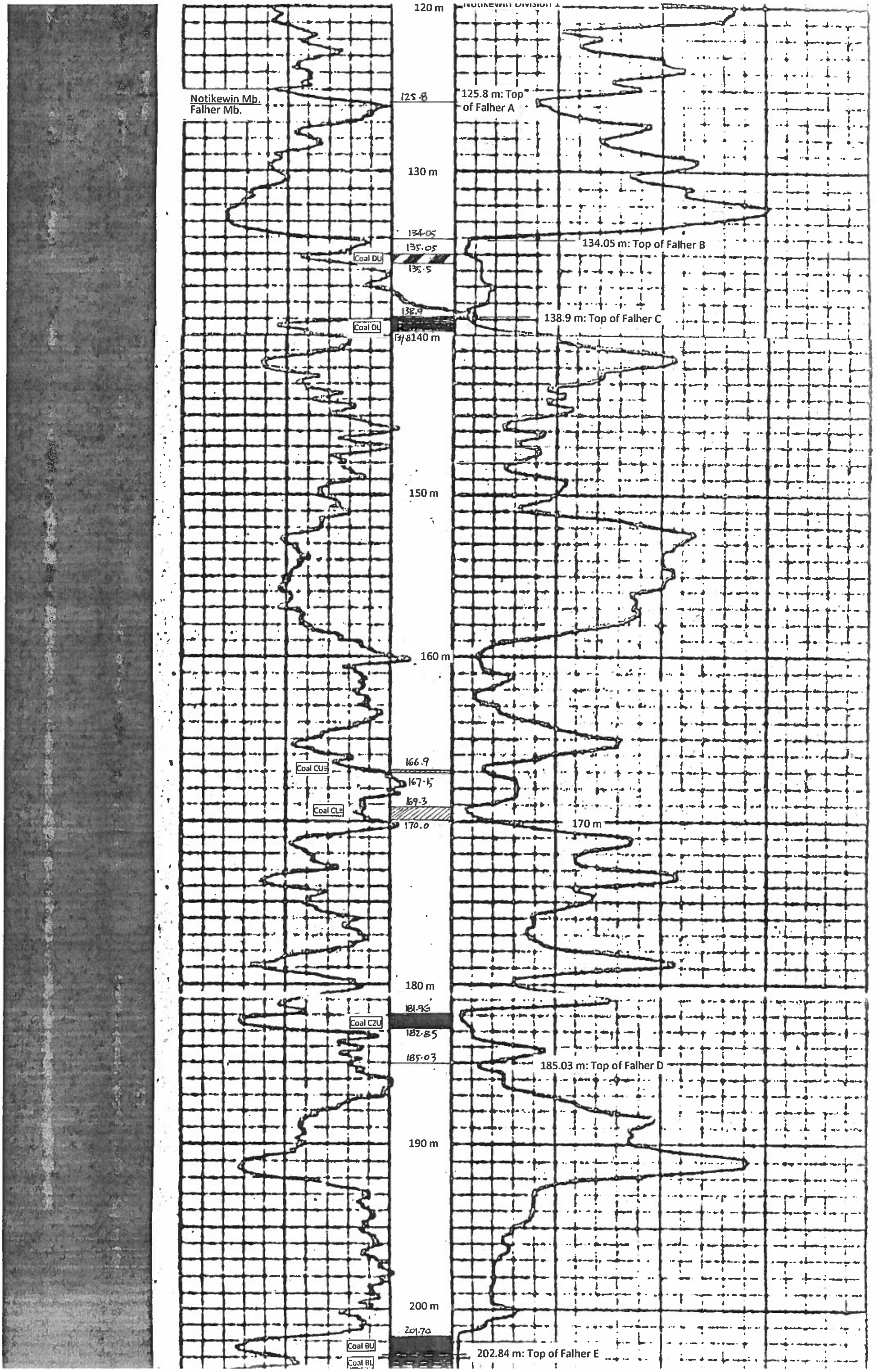
Annotated geophysical log of borehole MS-28

Interpretation: C.G.Cathyl-Huhn P.Geo. Lic.Geol.
Date: 31.May, 2014 Scale: as shown, in metres
Reference: to accompany EB West coal assessment report

Log source: Coal Assessment Report 556


Logged through drill rods
Depths in metres
0 m
20 m
30 m
40 m
50 m
60 m
70 m
Starts in Hulcross Fm.
8.7
Hulcross
10 m
8.7 m: Rockhead (Hulcross Fm.)
38.0
38.8
38.0 to 38.8 m: 8-ash
48.0
48.6
48.0 to 48.6 m: 4-ash
61.7
62.8
64.35
61.7 to 62.8 m: basal Hulcross grit
62.8 m: Top of Notikewin Division 4
Coal R
65.0
67.0
Coal RL
67.8
Hulcross Fm.
Gates Fm.


Hulcross Fm.
Gates Fm.
Notikewin Mb.
Falher Mb.
60 m
61.7
62.8
64.35
Coal R
65.0
67.0
Coal RL
67.8
70 m
71.05
Coal C
71.75
80 m
83.4
87.17
87.79
84.62
90 m
94.45
94.8
100 m
110 m
119.5
120 m
125.8
130 m
134.05
135.05
Coal DU
135.5
61.7 to 62.8 m: basal Hulcross grit
62.8 m: Top of Notikewin Division 4
83.4 m: Top of Notikewin Division 3
87.17 to 87.79 m: Blue Marker (shell-bearing zone)
89.02 m: Top of Notikewin Division 2
94.45 to 94.8 m: ash band
neutron scale change at 102 m
water level at 102.9 m
119.5 m: Top of Notikewin Division 1
125.8 m: Top of Falher A
134.05 m: Top of Falher B


120 m
Notikewin Mb.
Falher Mb.
125.8
125.8 m: Top of Falher A
130 m
134.05
135.05
Coal DU
135.5
134.05 m: Top of Falher B
138.9
Coal DL
139.8140 m
138.9 m: Top of Falher C
150 m
160 m
166.9
Coal CU
167.5
169.3
Coal CL
170.0
170 m
180 m
181.96
Coal C2U
182.85
185.03
185.03 m: Top of Falher D
190 m
200 m
201.70
Coal BU
Coal BL
202.84 m: Top of Falher E

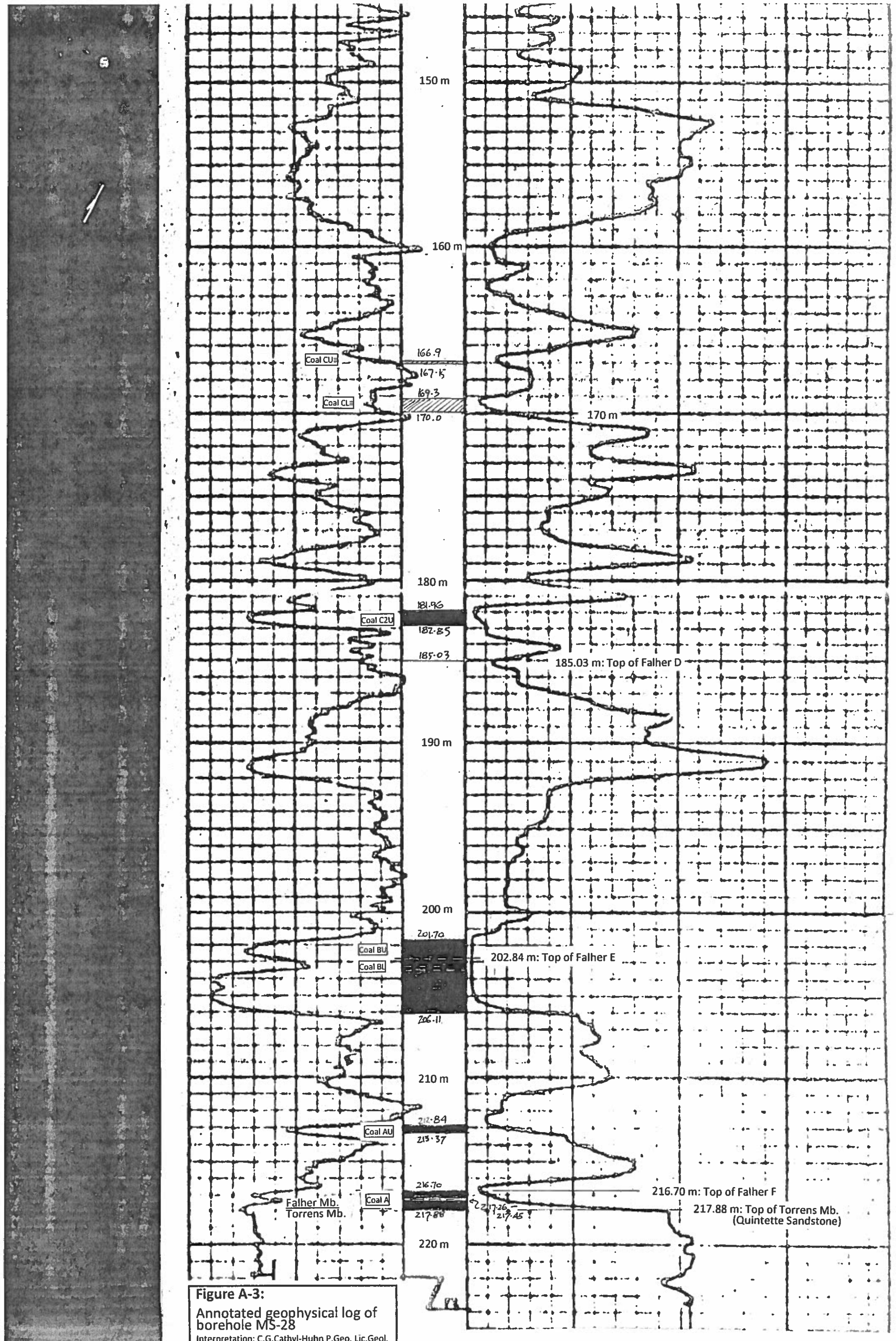


Figure A-3:

Annotated geophysical log of borehole MS-28

Interpretation: C.G.Cathyl-Huhn P.Geo. Lic.Geol.
Date: 31.May, 2014 Scale: as shown, in metres
Reference: to accompany EB West coal assessment report

Log source: Coal Assessment Report 556

Gamma Ray

Neutron

Depths in metres

0 m

5.8

5.8 m: Rockhead (Cadotte Mb.)

Starts in Cadotte Mb. of

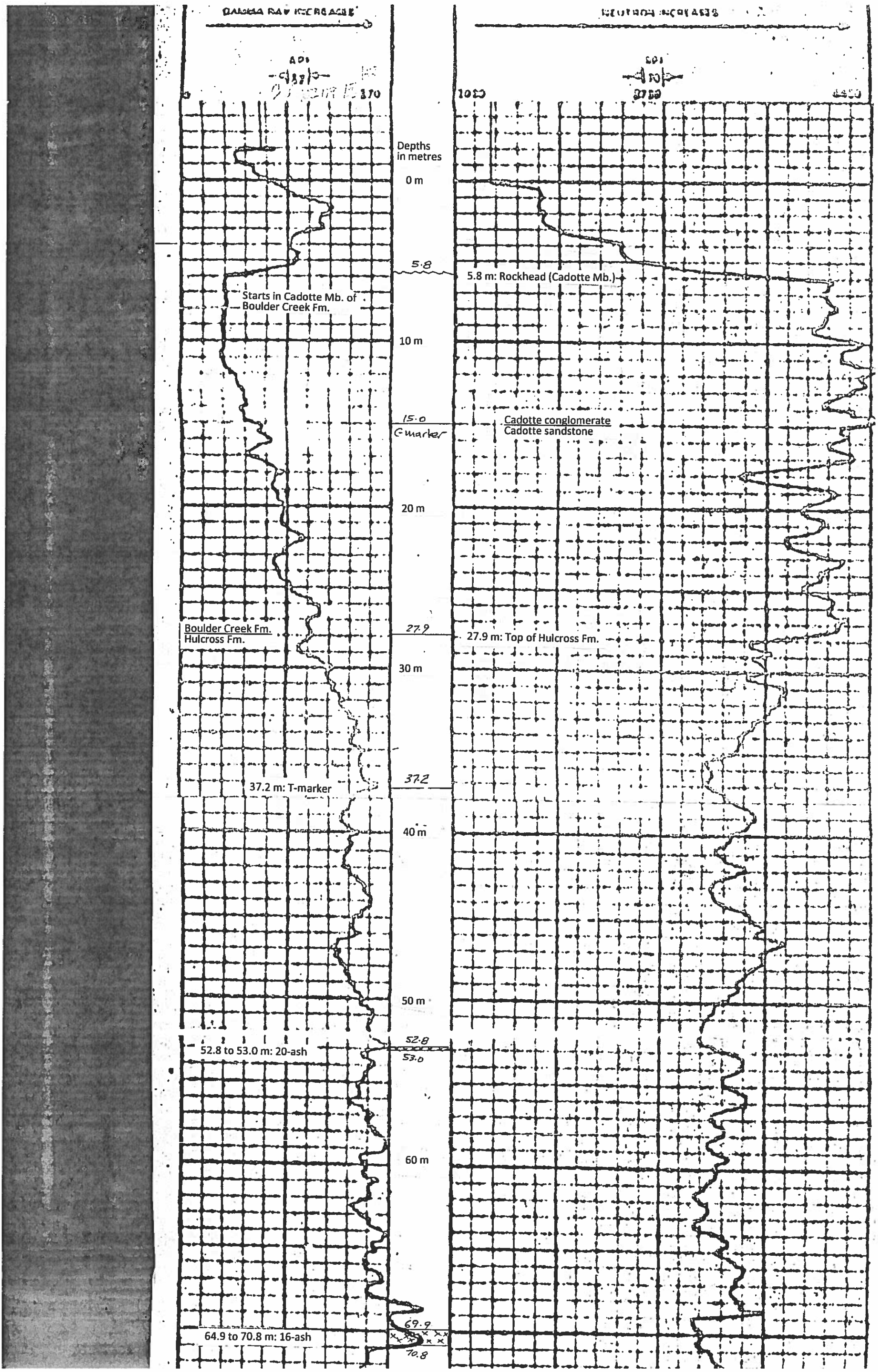
Figure A-4: Annotated geophysical log of borehole MS-29

Interpretation: C.G.Cathyl-Huhn P.Geo. Lic.Geol.

Date: 31.May, 2014 Scale: as shown, in metres

Reference: to accompany EB West coal assessment report

Log source: Coal Assessment Report 556


Depths in metres
0 m
5.8
5.8 m: Rockhead (Cadotte Mb.)
Starts in Cadotte Mb. of Boulder Creek Fm.
10 m
15.0
C-marker
Cadotte conglomerate
Cadotte sandstone
20 m
Boulder Creek Fm.
Hulcross Fm.
27.9
27.9 m: Top of Hulcross Fm.
30 m
37.2
37.2 m: T-marker
40 m
50 m
52.8
53.0
52.8 to 53.0 m: 20-ash
60 m
69.9
64.9 to 70.8 m: 16-ash
70.8

52.8 to 53.0 m: 20-ash

52.8

53.0

60 m

64.9 to 70.8 m: 16-ash

69.9

70.8

80 m

88.9 to 89.6 m: 12-ash

88.9-89.6

90 m

100 m

110 m

neutron scale change at 110 m

3370

120 m

120.4 to 121.2 m: 8-ash

120.4

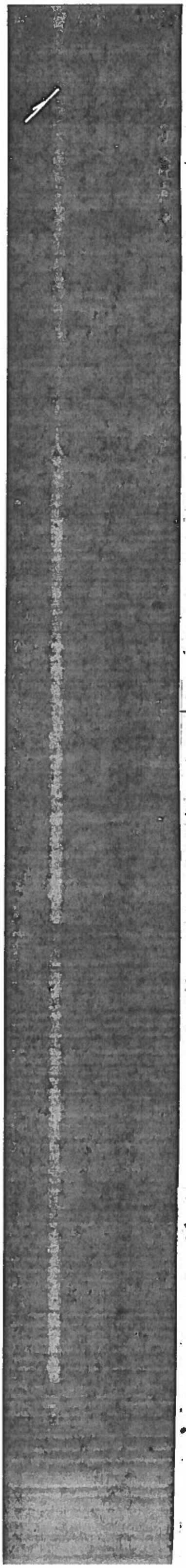
121.2

water level 121.2 m

130 m

130.4 to 130.7 m: 4-ash

130.4-130.7



120 m

120.4

120.4 to 121.2 m: 8-ash

121.2

WATER water level 121.2 m

130 m

130.4 to 130.7 m: 4-ash

130.4-130.7

140 m

142.87

Hulcross Fm.
Gates Fm.

143.00

142.87 to 143.0 m: basal Hulcross grit

143.0 m: Top of Notikewin Division 4

149.2-150.0

Coal R

150 m

151.9-152.3

Coal RL

152.7

157.2

Coal QR

157.7-158.0

159.8

160 m

Coal Q

160.4

168.75

170 m

168.75 m: Top of Notikewin Division 3

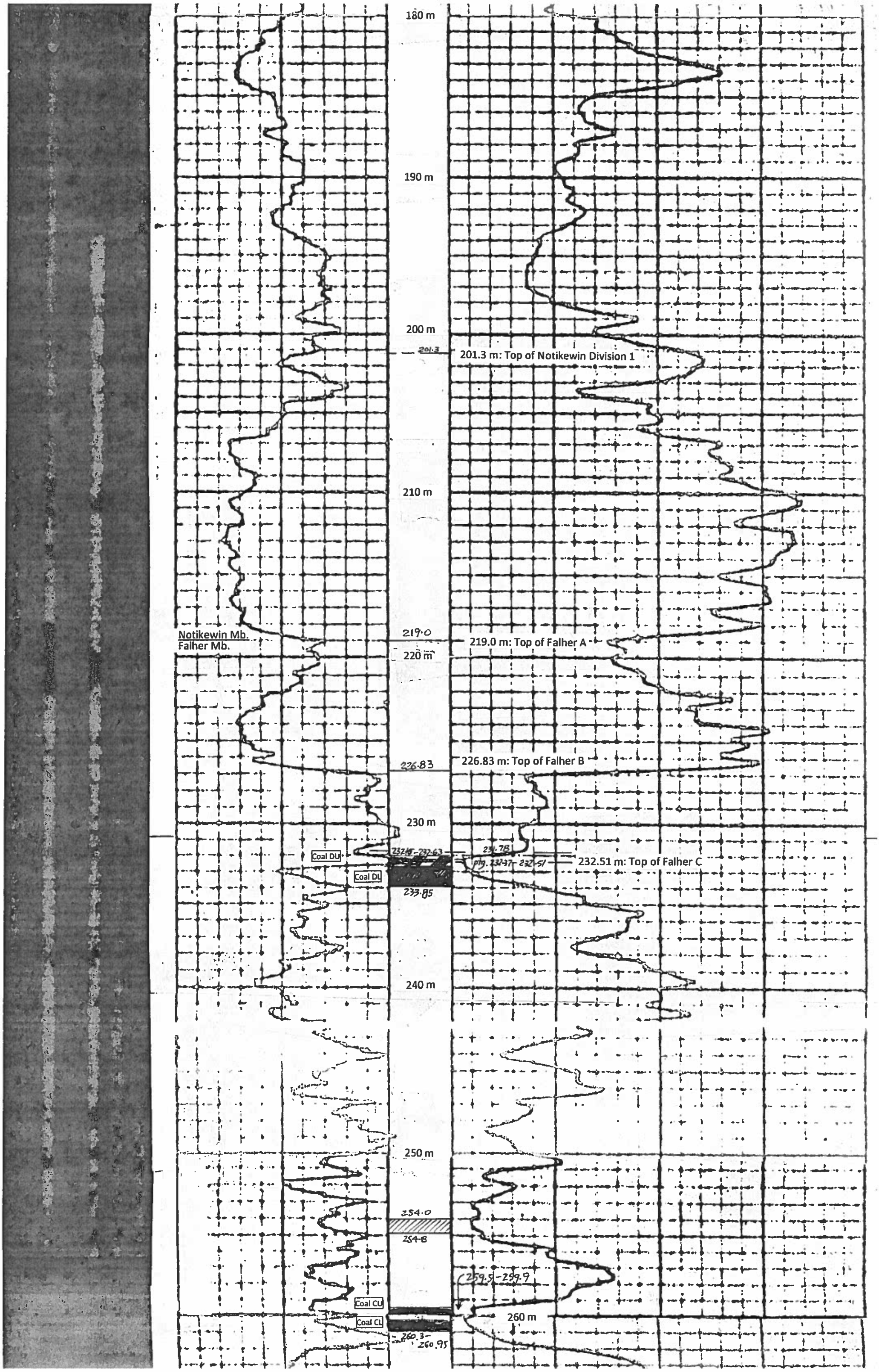
176.0

176.0 m: Top of Notikewin Division 2

180 m

190 m

200 m


180 m
190 m
200 m
201.3
201.3 m: Top of Notikewin Division 1
210 m
Notikewin Mb.
Falher Mb.
219.0
219.0 m: Top of Falher A
220 m
226.83
226.83 m: Top of Falher B
230 m
Coal DU
232.49 - 232.63
231.78
pkg. 232.37 - 232.51
232.51 m: Top of Falher C
Coal DU
233.85
240 m
250 m
254.0
254.8
259.5 - 259.9
Coal CU
Coal CL
260 m
260.3 - 260.95

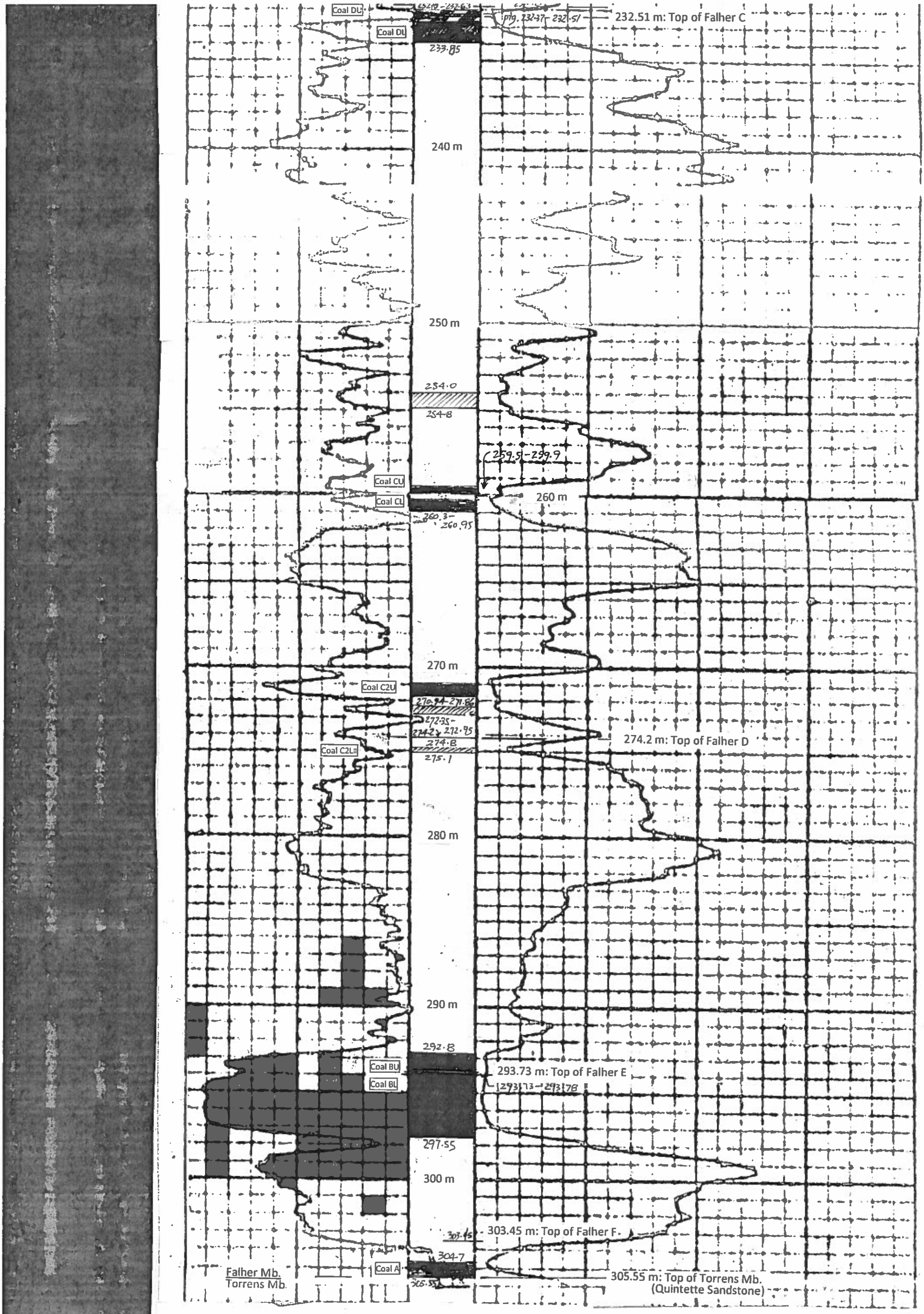


Figure A-4:

Annotated geophysical log of borehole MS-29

Interpretation: C.G.Cathyl-Huhn P.Geo. Lic.Geol.
Date: 31.May, 2014 Scale: as shown, in metres
Reference: to accompany EB West coal assessment report
Log source: Coal Assessment Report 556

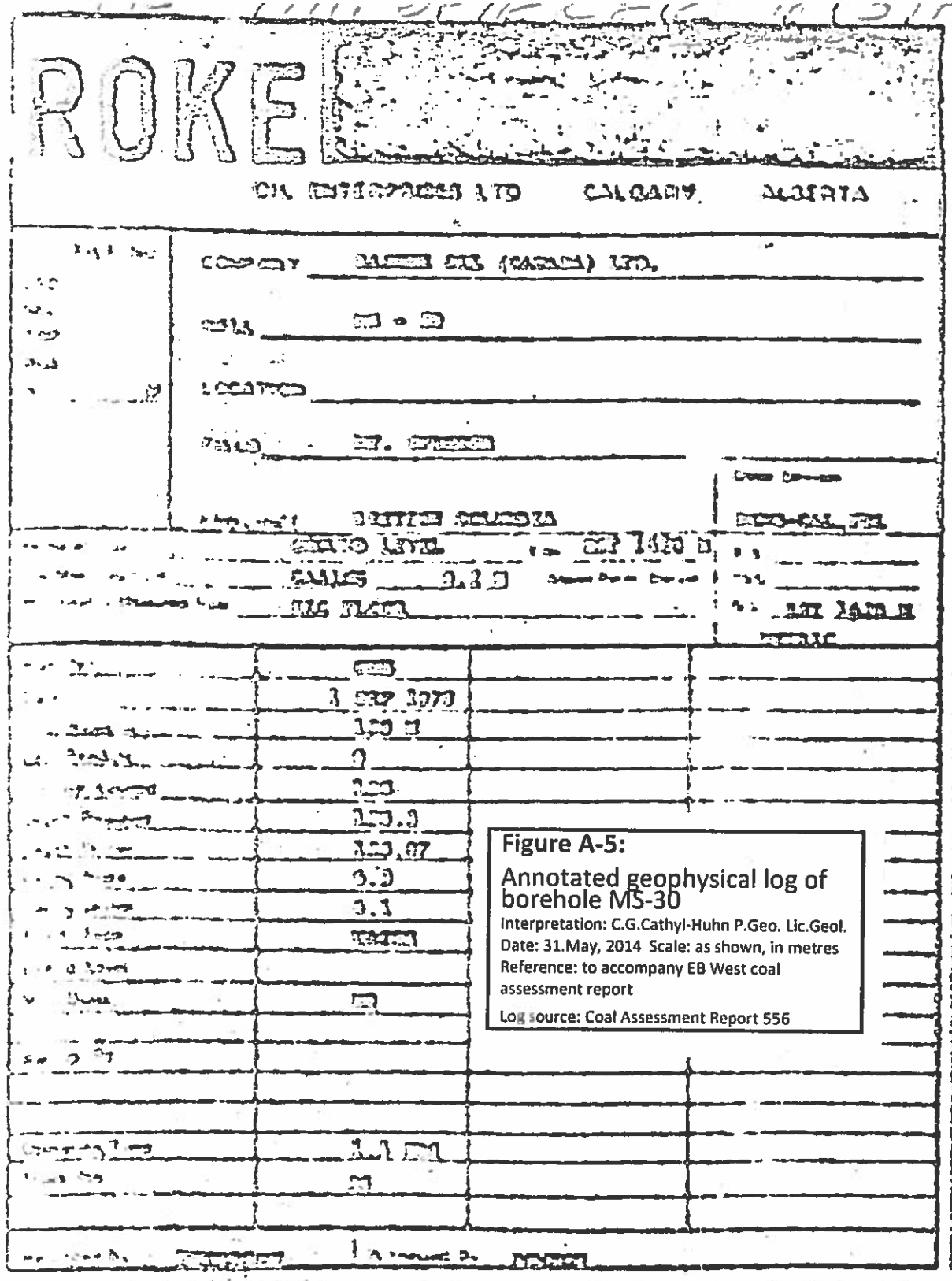
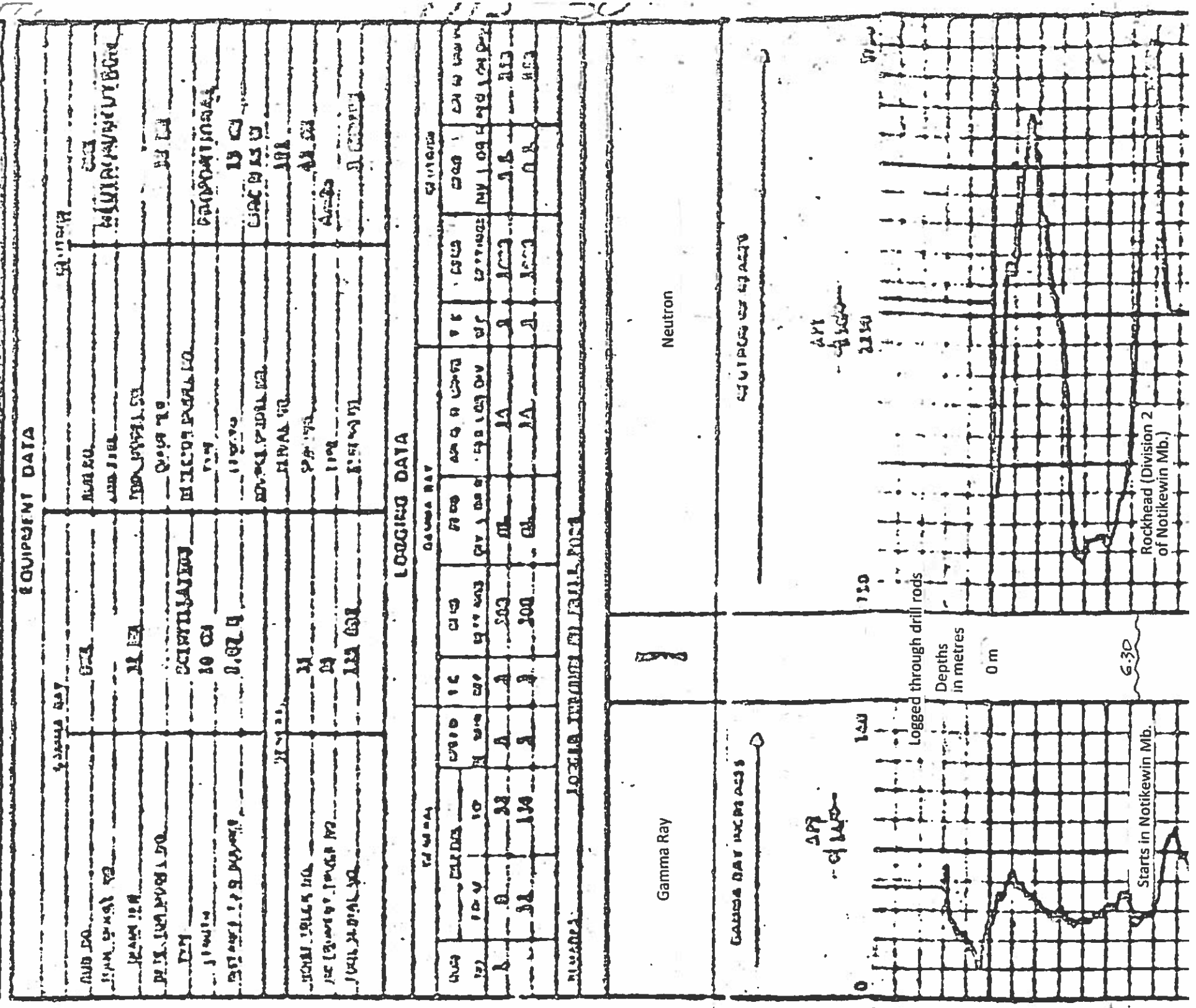


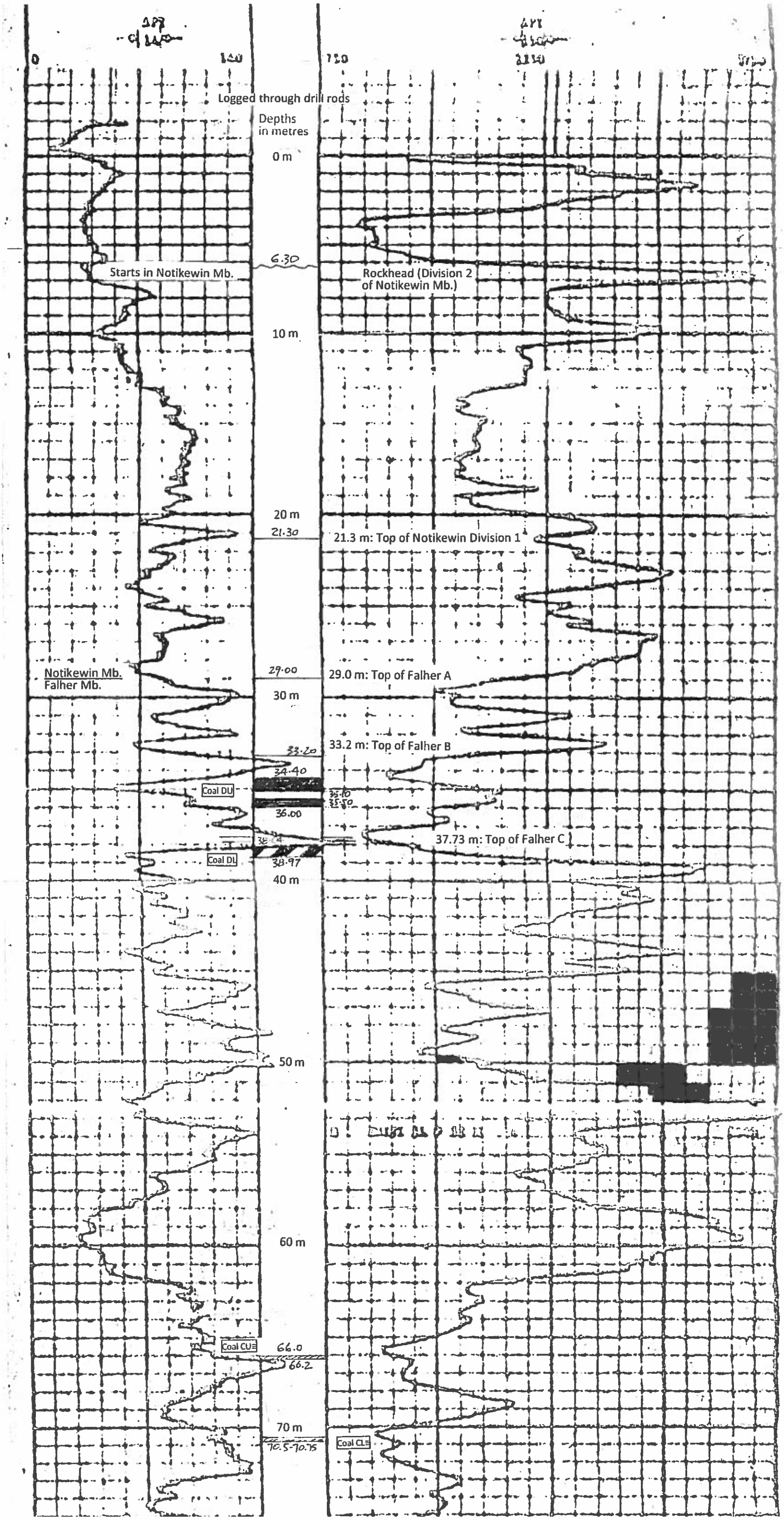
Figure A-5:

Annotated geophysical log of borehole MS-30

Interpretation: C.G.Cathyl-Huhn P.Geo. Lic.Geol.
Date: 31.May, 2014 Scale: as shown, in metres
Reference: to accompany EB West coal assessment report

Log source: Coal Assessment Report 556




Logged through drill rods
Depths in metres
0 m
6.30
Starts in Notikewin Mb.
Rockhead (Division 2 of Notikewin Mb.)
10 m
20 m
21.30
21.3 m: Top of Notikewin Division 1
Notikewin Mb.
Falher Mb.
29.00
29.0 m: Top of Falher A
30 m
33.20
33.2 m: Top of Falher B
34.40
Coal DU
35.10
35.50
36.00
37.73 m: Top of Falher C
Coal DL
38.97
40 m
50 m
60 m
Coal CU
66.0
66.2
70 m
70.5-70.75
Coal CL

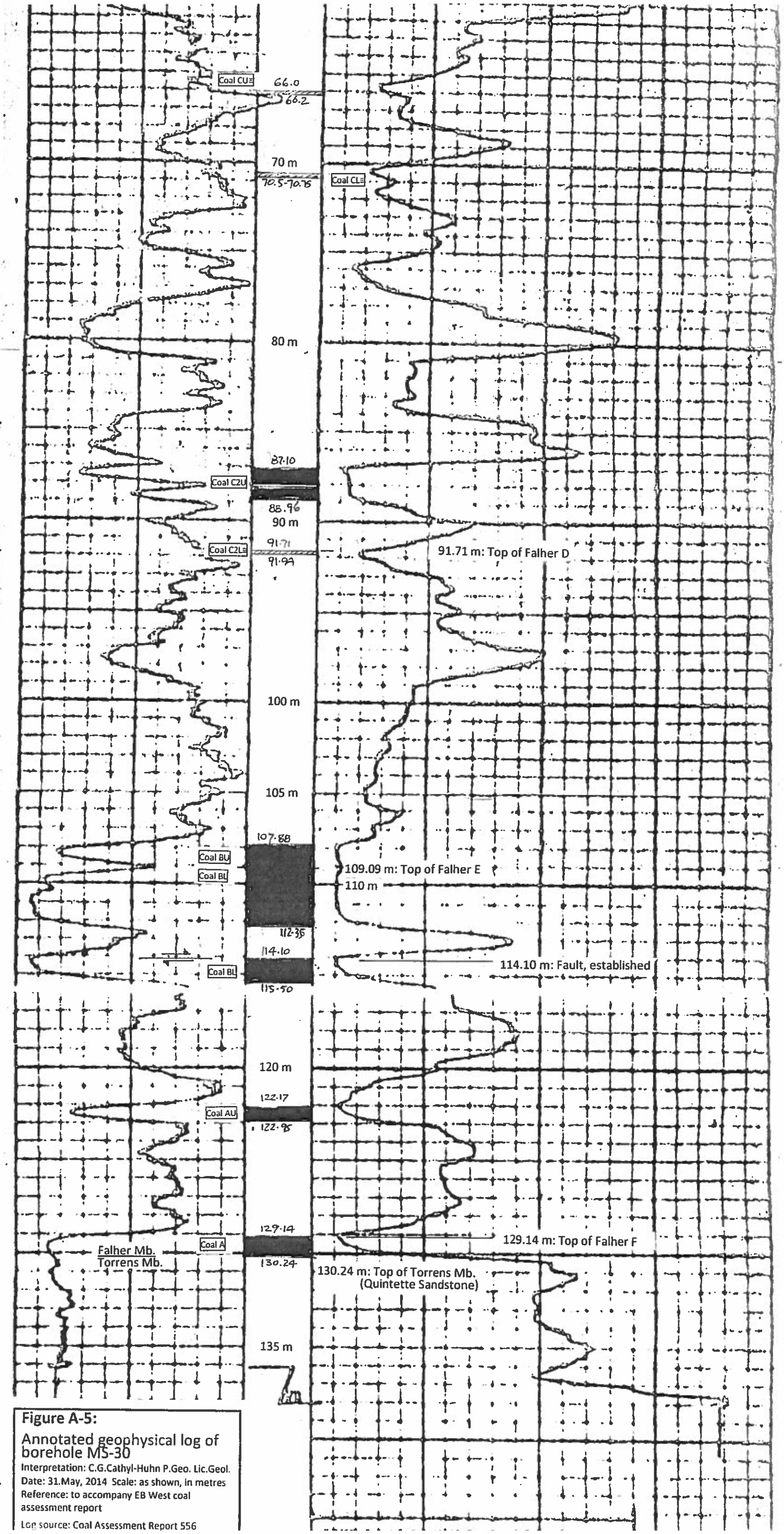


Figure A-5:

Annotated geophysical log of borehole MS-30

Interpretation: C.G.Cathyl-Huhn P.Geo. Lic.Geol.
Date: 31.May, 2014 Scale: as shown, in metres
Reference: to accompany EB West coal assessment report

Log source: Coal Assessment Report 556

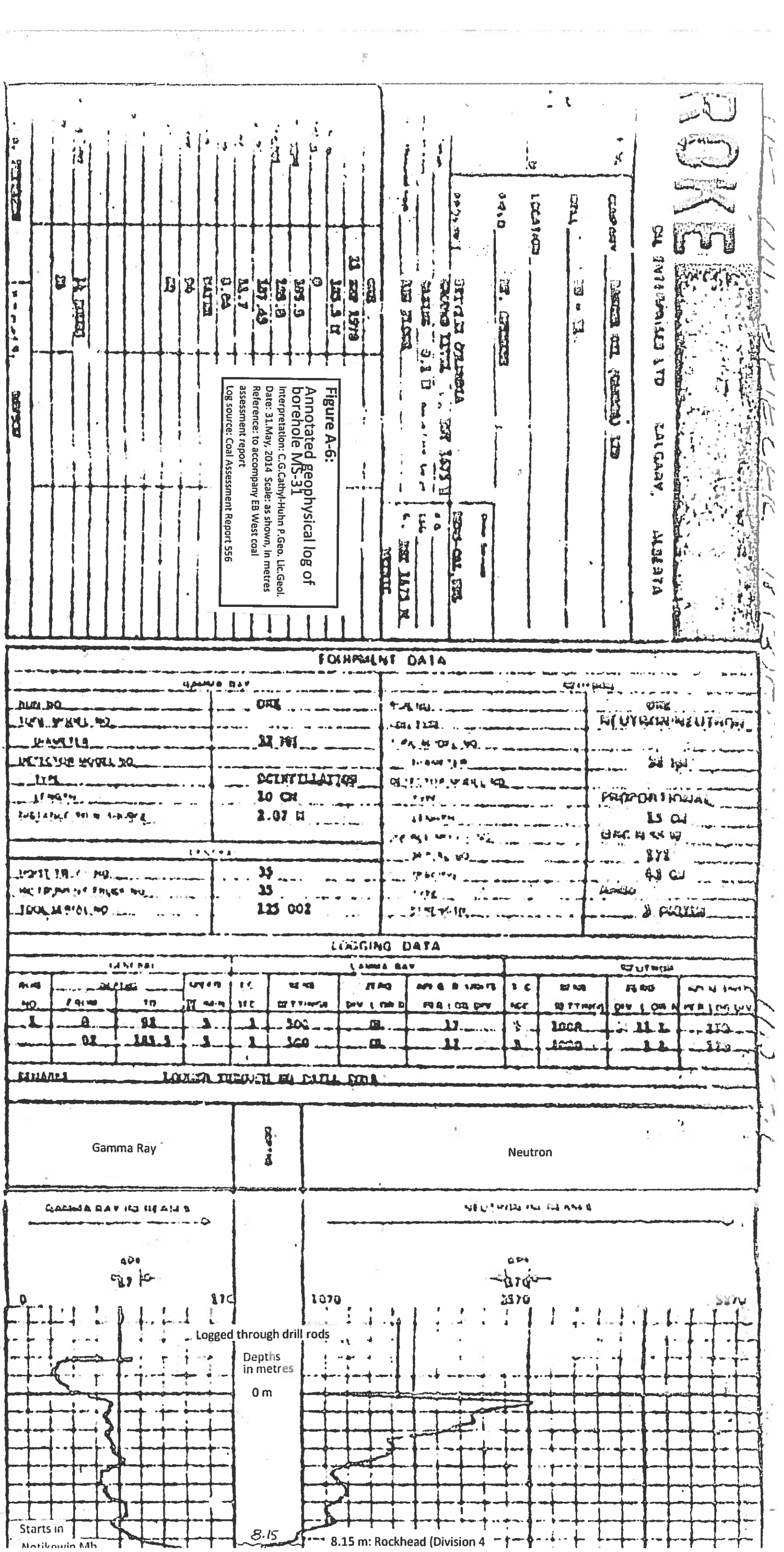
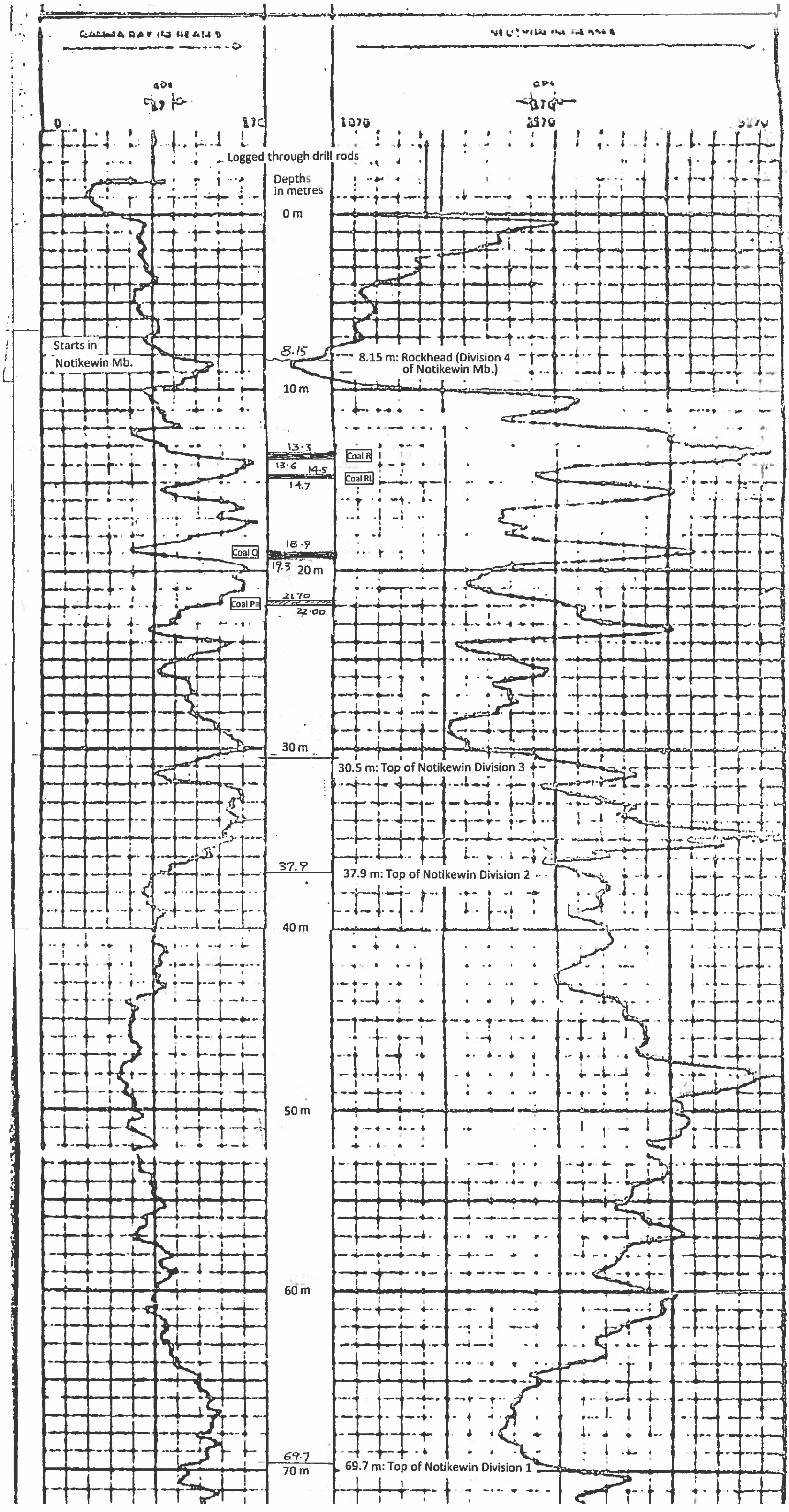
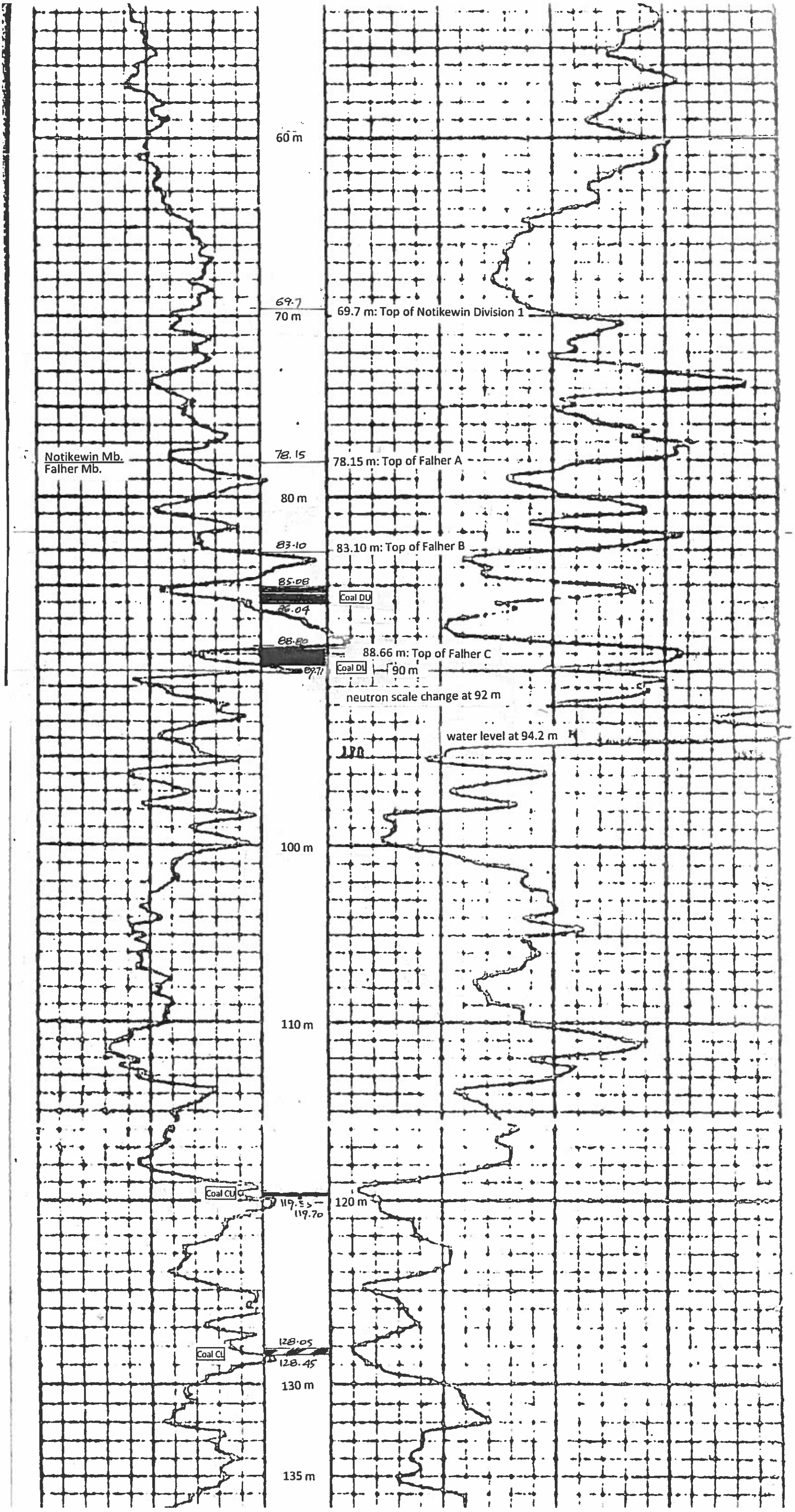


Figure A-6: Annotated geophysical log of borehole MS-31

Interpretation: C.G.Cathyl-Huhn P.Geo. Lic.Geol.
Date: 31.May, 2014 Scale: as shown, in metres
Reference: to accompany EB West coal assessment report
Log source: Coal Assessment Report 556


Logged through drill rods
Depths in metres
0 m
Starts in Notikewin Mb.
8.15
8.15 m: Rockhead (Division 4 of Notikewin Mb.)
10 m
13·3
13·6
14·5
14.7
Coal R
Coal RL
18·9
Coal Q
19.3
20 m
21.70
22·00
Coal P
30 m
30.5 m: Top of Notikewin Division 3
37.9
37.9 m: Top of Notikewin Division 2
40 m
50 m
60 m
69.7
70 m
69.7 m: Top of Notikewin Division 1


60 m
69.7
70 m
69.7 m: Top of Notikewin Division 1
Notikewin Mb.
Falher Mb.
78.15
78.15 m: Top of Falher A
80 m
83.10
83.10 m: Top of Falher B
85.08
Coal DU
86.04
88.50
88.66 m: Top of Falher C
Coal DL
89.71
90 m
neutron scale change at 92 m
water level at 94.2 m
100 m
110 m
Coal CU
119.55
119.70
120 m
128.05
Coal CL
128.45
130 m
135 m

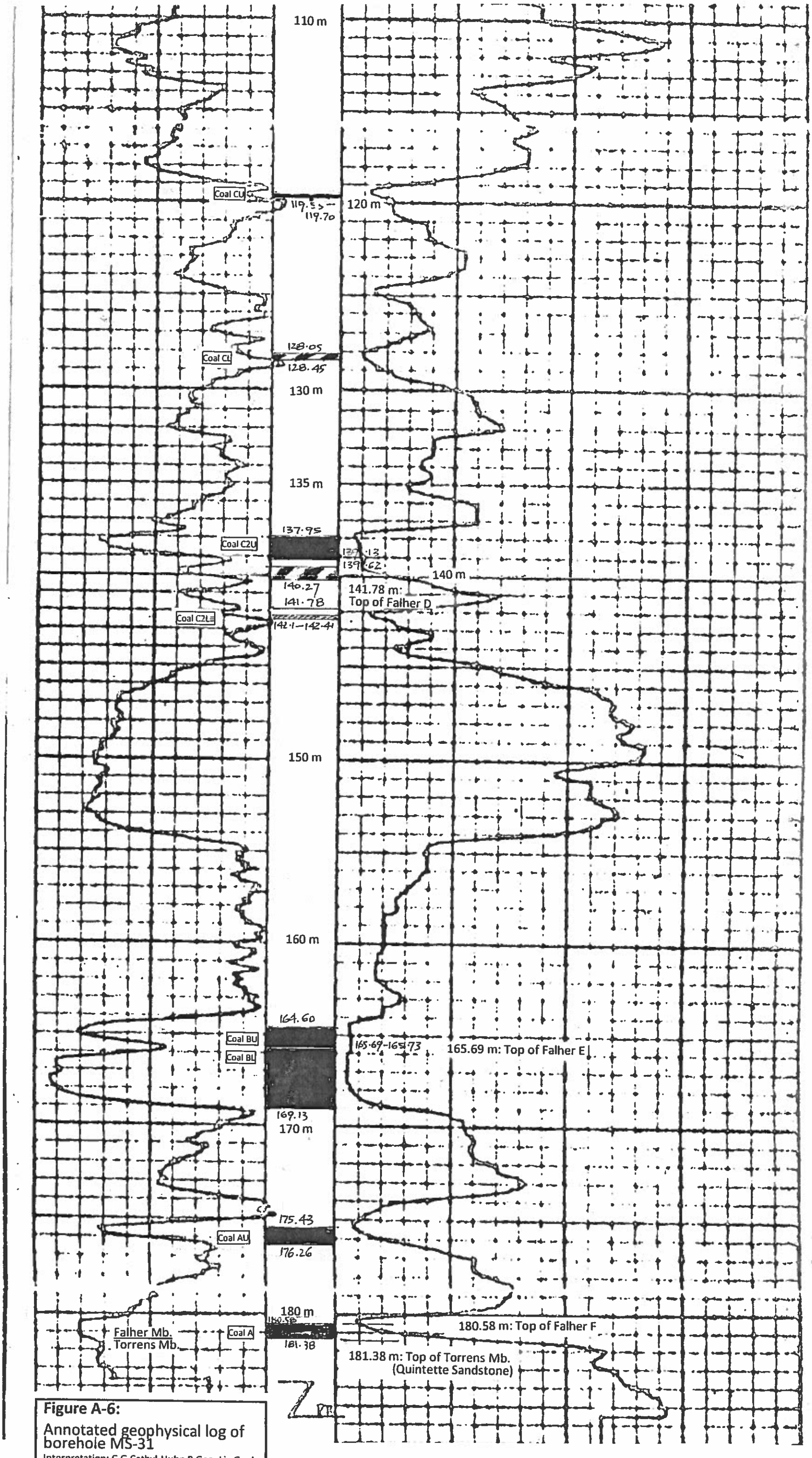


Figure A-6:

Annotated geophysical log of borehole MS-31

Interpretation: C.G.Cathyl-Huhn P.Geo. Lic.Geol.
Date: 31.May, 2014 Scale: as shown, in metres
Reference: to accompany EB West coal assessment report
Log source: Coal Assessment Report 556

EQUIPMENT DATA

GAMMA RAY		NEUTRON	
[illegible]	OTHER	[illegible]	DISC
[illegible]		[illegible]	NEUTRON-NEUTRON
[illegible]	32.33	[illegible]	
[illegible]		[illegible]	32.33
[illegible]	SCINTILLATION	[illegible]	
[illegible]	10 CM	[illegible]	PROPORTIONAL
[illegible]	1.07 M	[illegible]	13 CM
		[illegible]	LARGE SCREEN
SONDE		[illegible]	171
[illegible]	13	[illegible]	40 CM
[illegible]	13	[illegible]	AMOCO
[illegible]	121.001	[illegible]	3 OUNCE

LOGGING DATA

RUN NO.	CASING FROM	CASING TO	CASING SIZE	GAMMA RAY TC	GAMMA RAY SPEED	GAMMA RAY SENSITIVITY	GAMMA RAY SPACING	NEUTRON TC	NEUTRON SPEED	NEUTRON SENSITIVITY	NEUTRON SPACING
1	0	64	3	3	300	64	17	3	1000	13 b	170
	44	333	3	3	300	64	17	3	1000	1 b	170

REMARKS: LOGGED THROUGH DRILL RODS

Gamma Ray | Depth | Neutron

GAMMA RAY (API) 0 — 170

NEUTRON (API) 2000 — 0

Logged through drill rods

Depths in metres

0 m

3.6

Starts in Falher Mb.

3.6 m: Rockhead (Division A of Falher Mb.)

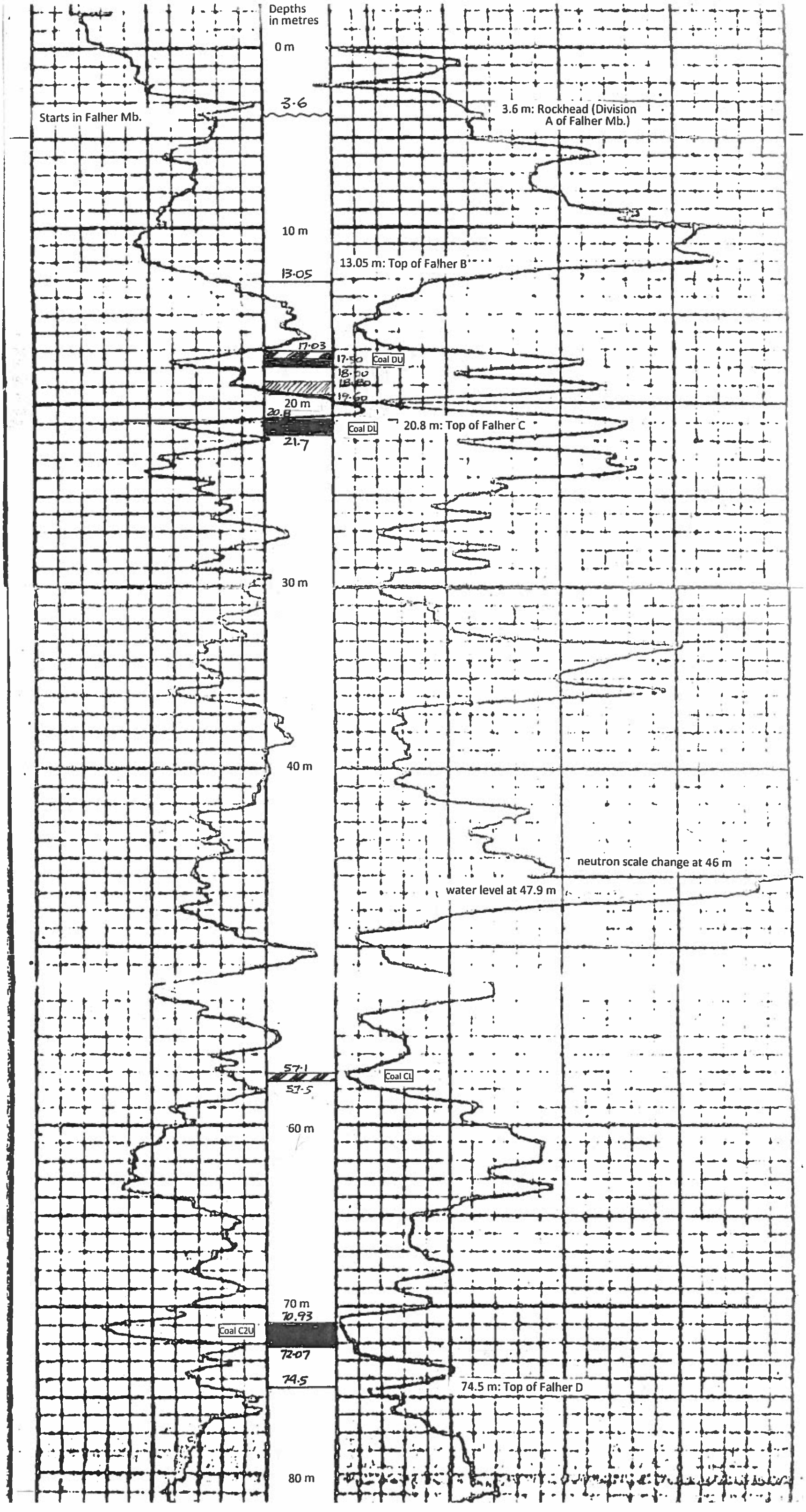
Figure A-7: Annotated geophysical log of borehole MS-32

Interpretation: C.G.Cathyl-Huhn P.Geo. Lic.Geol.

Date: 31.May, 2014 Scale: as shown, in metres

Reference: to accompany EB West coal assessment report

Log source: Coal Assessment Report 556


Depths in metres
0 m
3·6
Starts in Falher Mb.
3.6 m: Rockhead (Division A of Falher Mb.)
10 m
13.05 m: Top of Falher B
13·05
17·03
17·50
Coal DU
18·00
18·80
19·60
20 m
20.8
Coal DL
20.8 m: Top of Falher C
21·7
30 m
40 m
neutron scale change at 46 m
water level at 47.9 m
57·1
Coal CL
57·5
60 m
70 m
70.93
Coal C2U
72·07
74.5
74.5 m: Top of Falher D
80 m

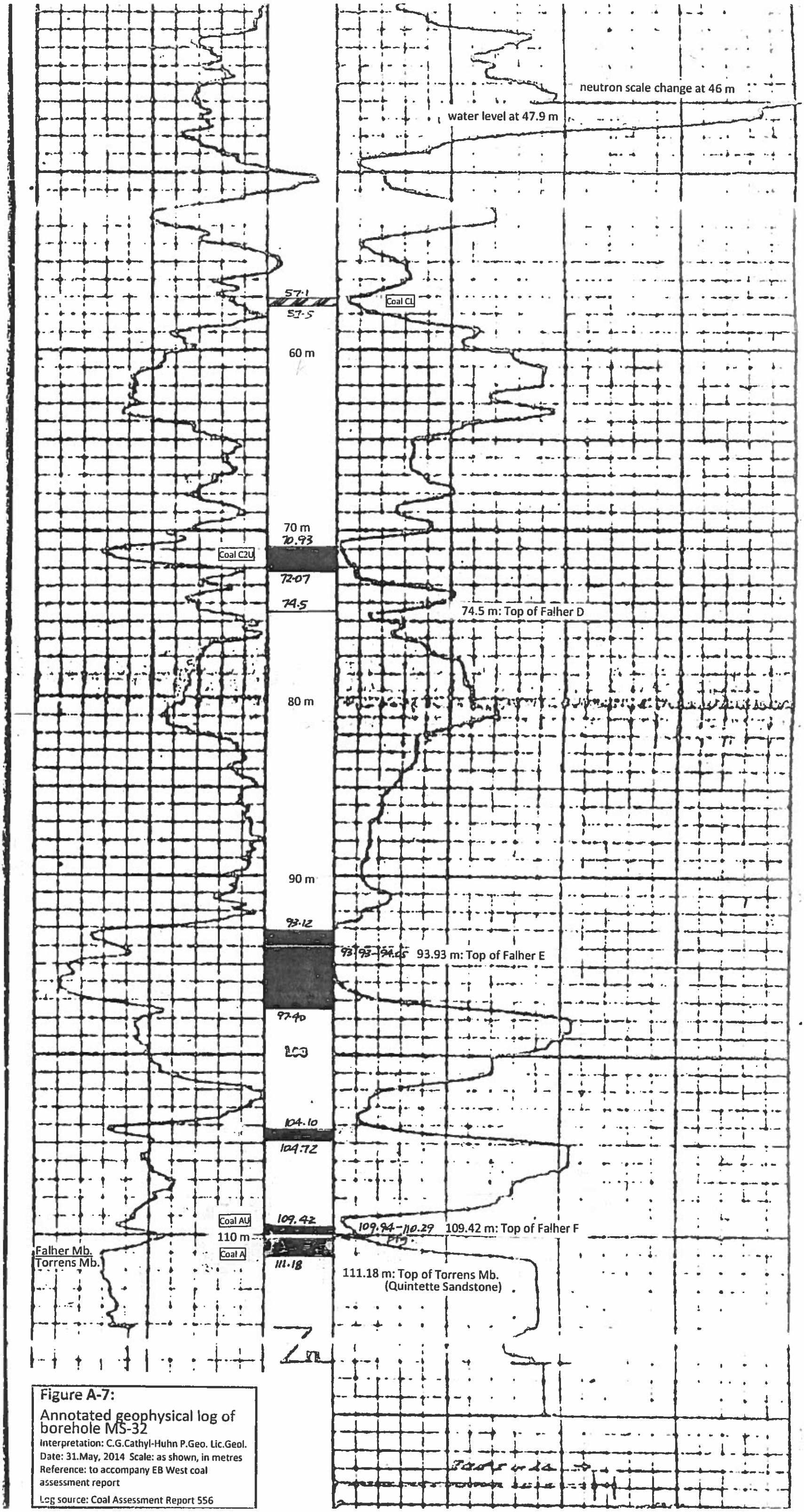


Figure A-7:

Annotated geophysical log of borehole MS-32

Interpretation: C.G.Cathyl-Huhn P.Geo. Lic.Geol.
Date: 31.May, 2014 Scale: as shown, in metres
Reference: to accompany EB West coal assessment report

Log source: Coal Assessment Report 556

ROKE

OIL ENTERPRISES LTD CALGARY ALBERTA

COMPANY CANEX OIL (CANADA) LTD.

WELL EB - 33

LOCATION

FIELD MT. ERICSON

PROV. BRITISH COLUMBIA

GROUND LEVEL

CASING 0.3 M

KB FLOOR

	OIL
	25 SEP 1970
	252 M
	0
	252
	252.3
	252.60
	3
	3.05
	WATER
	50
	EB
	2 INCH
	29

Drawn by: PETERSEN Checked by: DAWSON

Figure A-8:

Annotated geophysical log of borehole MS-33

Interpretation: C.G.Cathyl-Huhn P.Geo. Lic.Geol.
Date: 31.May, 2014 Scale: as shown, in metres
Reference: to accompany EB West coal assessment report
Log source: Coal Assessment Report 556

EQUIPMENT DATA

LOGGING DATA

Neutron

Logged through drill rods

Depths in metres

0 m

3.6 m: Rockhead (basal sandstone of Hulcross Fm.)

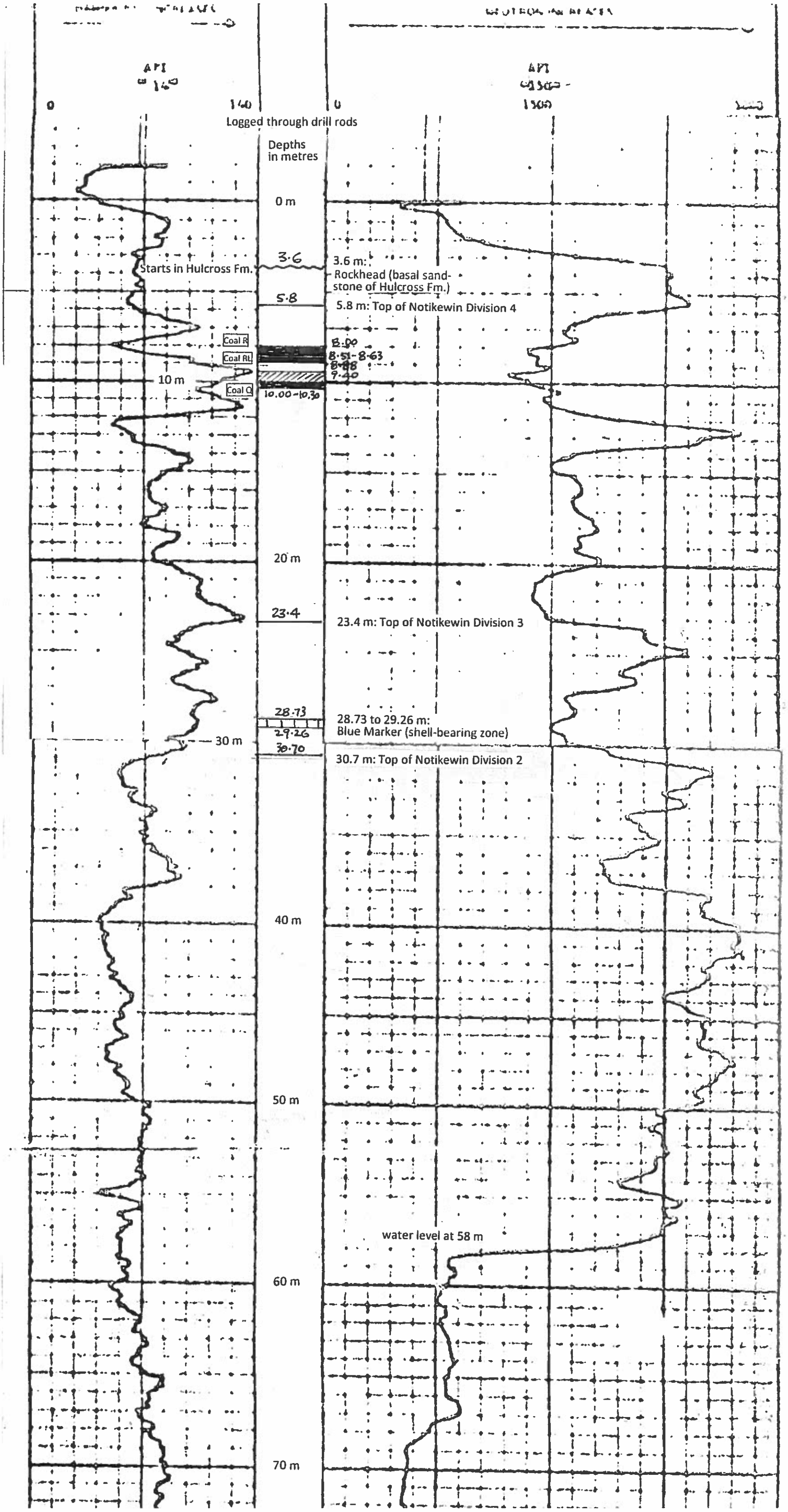
5.8 m: Top of Notikewin Division 4

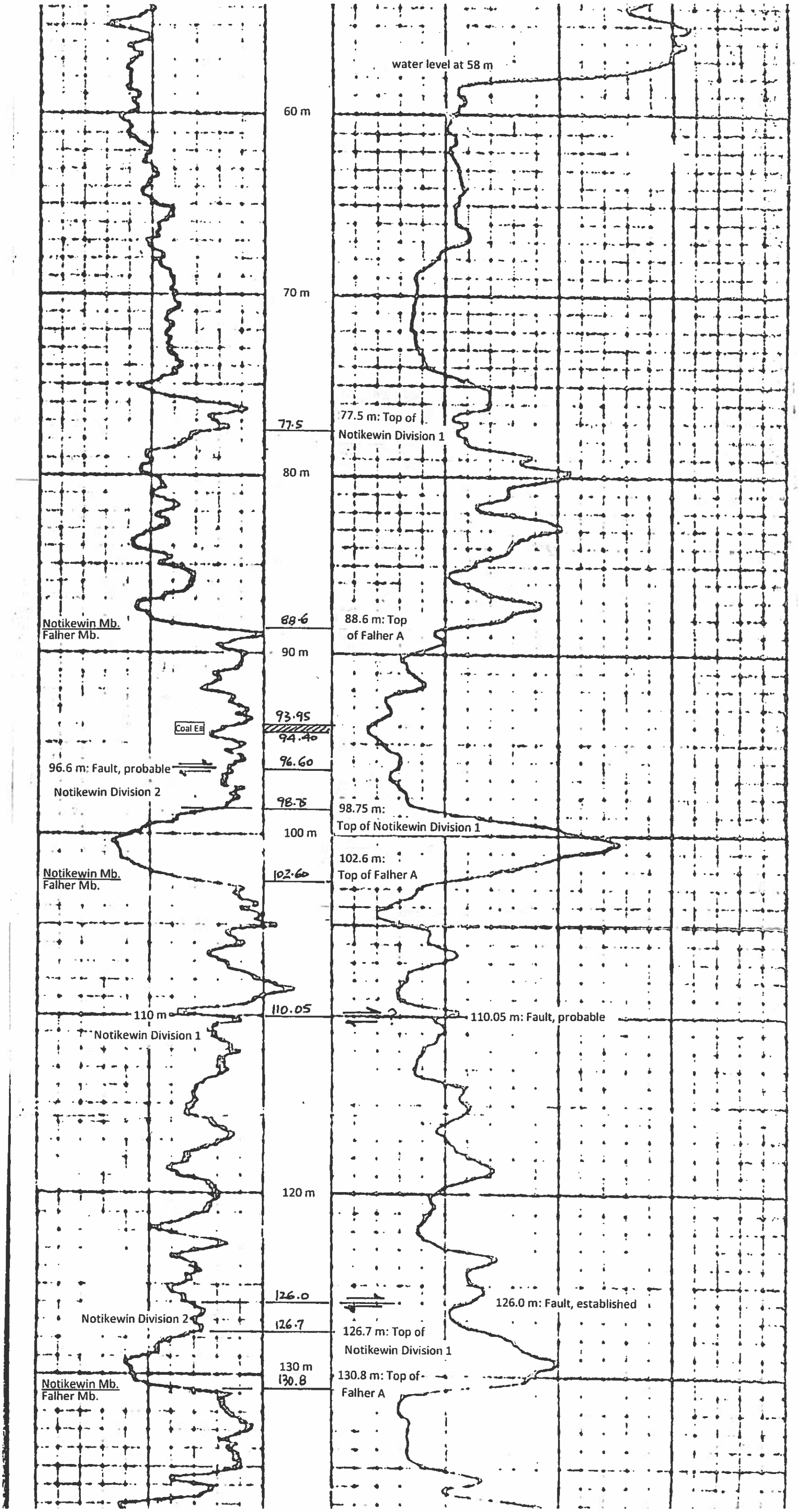
Gamma Ray

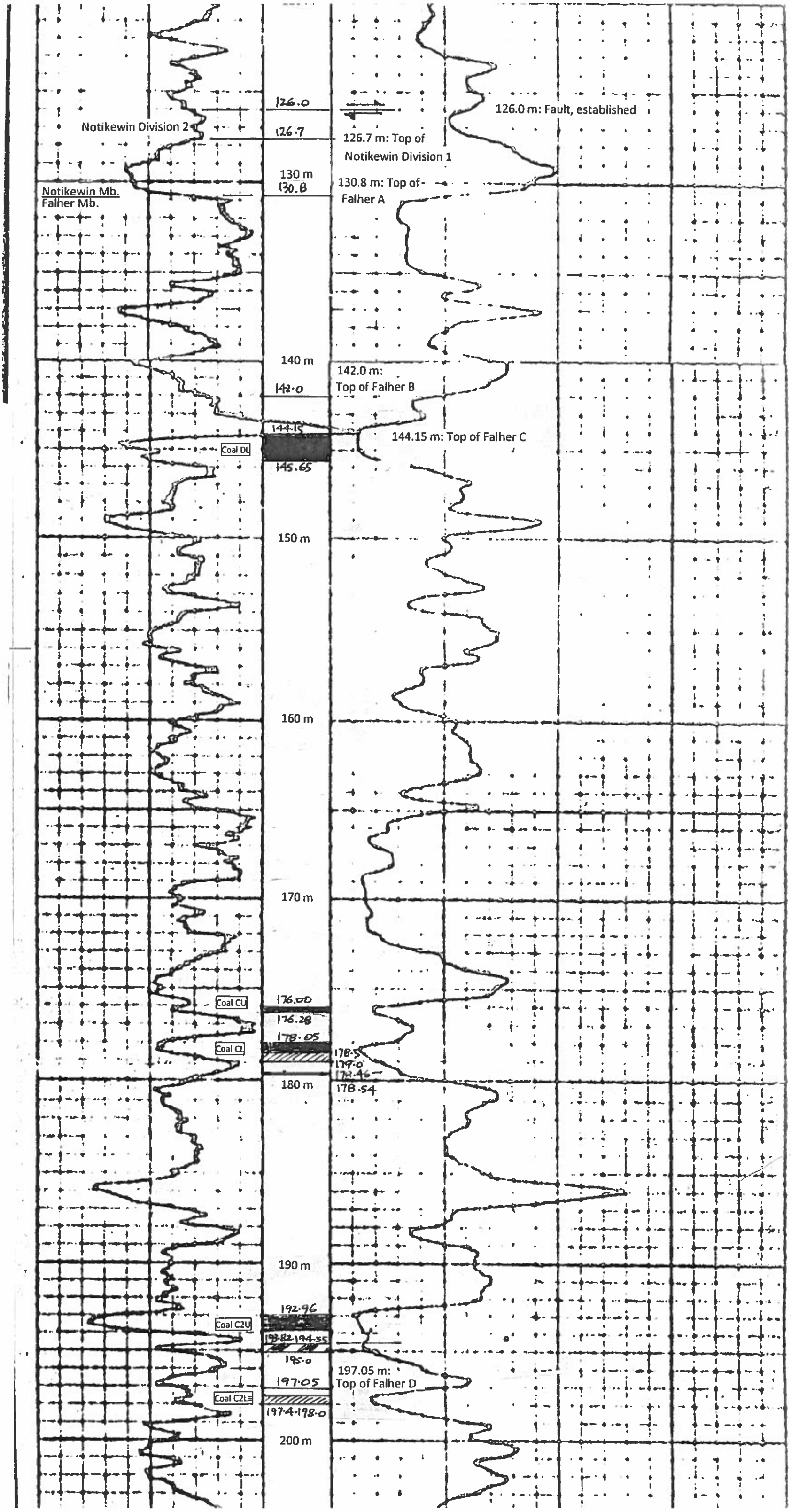
Starts in Hulcross Fm.

Coal R

DO NOT DELETE MEDIA


API
0
140
Logged through drill rods
Depths in metres
0 m
3.6
Starts in Hulcross Fm.
3.6 m: Rockhead (basal sandstone of Hulcross Fm.)
5.8
5.8 m: Top of Notikewin Division 4
Coal R
Coal R1
8.00
8.51-8.63
8.88
9.40
10 m
Coal Q
10.00-10.30
20 m
23.4
23.4 m: Top of Notikewin Division 3
28.73
29.26
28.73 to 29.26 m: Blue Marker (shell-bearing zone)
30 m
30.70
30.7 m: Top of Notikewin Division 2
40 m
50 m
water level at 58 m
60 m
70 m


water level at 58 m
60 m
70 m
77.5
77.5 m: Top of
Notikewin Division 1
80 m
Notikewin Mb.
Falher Mb.
88.6
88.6 m: Top
of Falher A
90 m
93.95
Coal E
94.40
96.60
96.6 m: Fault, probable
Notikewin Division 2
98.75
98.75 m:
Top of Notikewin Division 1
100 m
102.6 m:
Top of Falher A
Notikewin Mb.
Falher Mb.
102.60
110 m
110.05
110.05 m: Fault, probable
Notikewin Division 1
120 m
126.0
126.0 m: Fault, established
Notikewin Division 2
126.7
126.7 m: Top of
Notikewin Division 1
130 m
130.8
130.8 m: Top of
Falher A
Notikewin Mb.
Falher Mb.


126.0
126.7
130 m
130.8
140 m
142.0
144.15
145.65
150 m
160 m
170 m
176.00
176.28
178.05
178.5
179.0
172.46
180 m
178.54
190 m
192.96
193.82-194.55
195.0
197.05
197.4-198.0
200 m
Notikewin Division 2
Notikewin Mb.
Falher Mb.
Coal DL
Coal CU
Coal CU
Coal C2U
Coal C2L
126.0 m: Fault, established
126.7 m: Top of
Notikewin Division 1
130.8 m: Top of
Falher A
142.0 m:
Top of Falher B
144.15 m: Top of Falher C
197.05 m:
Top of Falher D

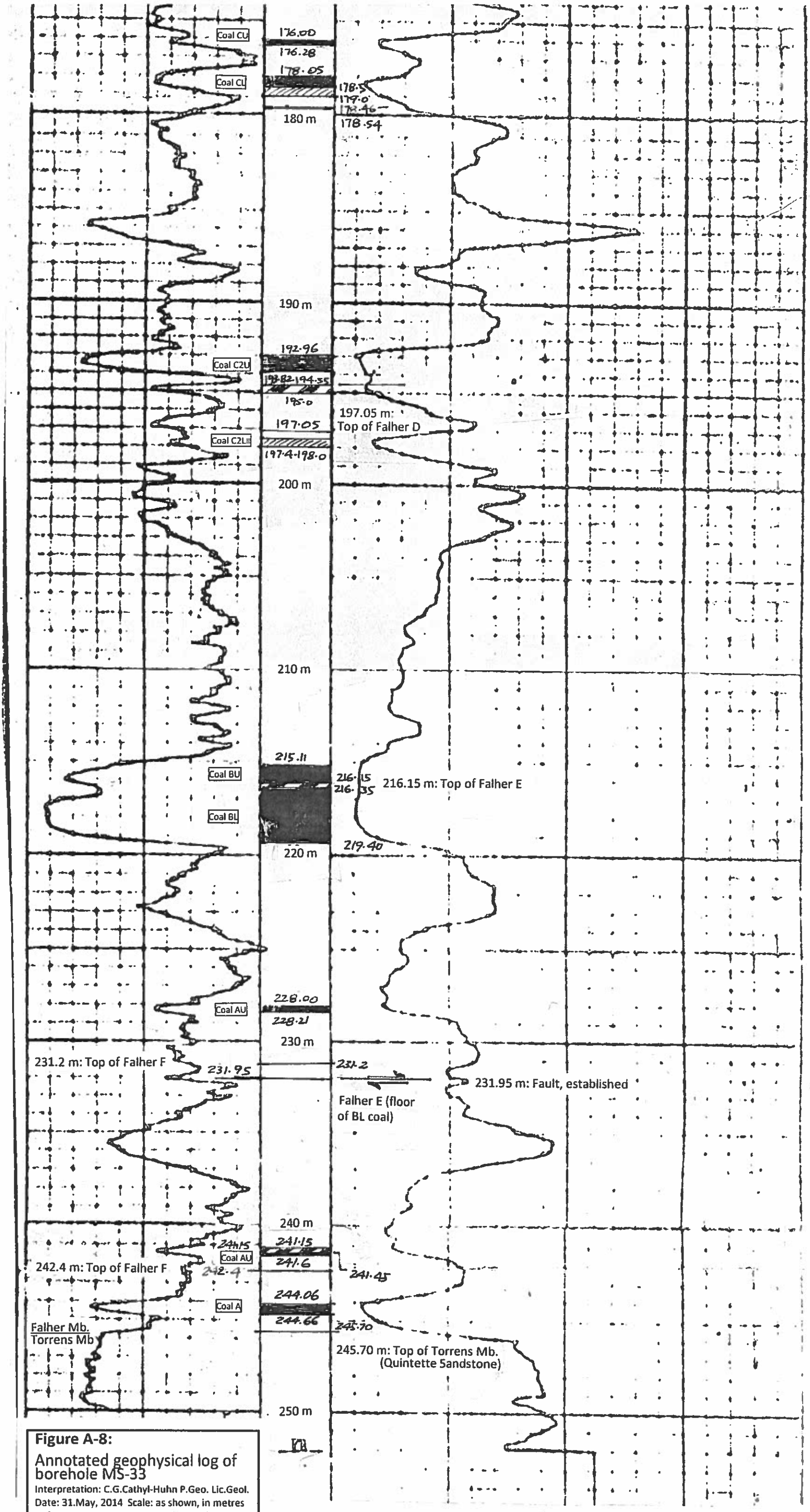


Figure A-8:

Annotated geophysical log of borehole MS-33

Interpretation: C.G.Cathyl-Huhn P.Geo. Lic.Geol.
Date: 31.May, 2014 Scale: as shown, in metres
Reference: to accompany EB West coal assessment report
Log source: Coal Assessment Report 556