

BC Geological Survey Coal Assessment Report 1079

Coal assessment report for the Willow Creek coal lease --Volume 7:
Willow Creek Mine, 2021/2022 infill drilling

COAL ASSESSMENT REPORT TITLE PAGE AND SUMMARY

TITLE OF REPORT: Coal Assessment Report for the Willow Creek coal lease --
Volume 7: Willow Creek Mine, 2021/2022 infill drilling

TOTAL COST: \$470,484.84

AUTHOR(S): C.G. Cathyl-Huhn P.Geol, April 7, 2022

SIGNATURE(S):

NOTICE OF WORK PERMIT NUMBER(S)/DATE(S):

YEAR OF WORK: 2021-2022 lease term (anniversary March 31)

PROPERTY NAME: Willow Creek

COAL LICENSE(S) AND/OR LEASES ON WHICH PHYSICAL WORK WAS DONE:
Coal Lease 389294

MINERAL INVENTORY MINFILE NUMBER(S), IF KNOWN: 930.008

MINING DIVISION: Liard

NTS / BCGS: NTS 930/9 / BCGS 930.059, 930.060, 930.069, and 930.070

LATITUDE: 55° 36' 00" North; **LONGITUDE:** 122° 12' 50" West (at centre of work)

UTM Zone: 10N **EASTING:** 549540 **NORTHING:** 6161855

OWNER(S): Conuma Resources Limited

MAILING ADDRESS: 200-235 Front St. (P.O. Box 2140), Tumbler Ridge, BC, V0C 2W0

OPERATOR(S) [who paid for the work]: Conuma Coal Resources Limited

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REPORT KEYWORDS (lithology, age, stratigraphy, structure, alteration, mineralisation, size and attitude). coal, Gething Formation, Gaylard Member, thrust faults

REFERENCES TO PREVIOUS ASSESSMENT WORK AND ASSESSMENT REPORT NUMBERS:

Coal Assessment Reports 984, 986, 988, 1001, and 1048 (primary references); also 490, 526, 667, 861, 936, 937, 952, 966, 972, and 1066; Petroleum Reports 582, 746, 863, and 1161.

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SUMMARY OF TYPES OF WORK IN THIS REPORT		EXTENT OF WORK (in metric units)	ON WHICH TENURES
GEOLOGICAL (scale, area)			
	Ground, mapping	nil	n/a
	Photo interpretation	nil	n/a
GEOPHYSICAL (line-kilometres)			
	Ground (Specify types)	nil	n/a
	Airborne (Specify types)	nil	n/a
	Borehole -- geophysical logs in 11 of 12 holes		
	Gamma-density (logged within drill rods)	nil	n/a
	Compensated gamma-density-caliper- resistivity	922.57 m in 11 holes	389294
	Deviation	918.80 m in 11 holes	389294
	Gamma-neutron (logged within drill rods)	nil	n/a
	Gamma-neutron	nil	n/a
	Dipmeter	84.00 m in 1 hole	389294
	Sonic	nil	n/a
	Spectral gamma-ray (KUT-log)	nil	n/a
	Others	nil	n/a
	Core drilling (large-diameter)	489.16 m in 6 holes	389294
	Non-core (rotary) drilling	530.90 m in 6 holes	389294
SAMPLING AND ANALYSES			
	Total number of head raw samples analysed	159 samples	389294
	Proximate (with sulphur)	159 samples	389294
	Ultimate	nil	n/a
	Apparent specific gravity	159 samples	389294
	Ash chemistry (reported as oxides)	159 samples	389294
	Ash fusibility	nil	n/a
	Petrographic	nil	n/a
	Vitrinite reflectance	nil	n/a
	Light transmission (oxidation test)	89 samples	389294
	Caking (Free Swelling Index determination)	89 samples	389294
	Coking	nil	n/a
	Wash tests (multiple-point 1.30 - 2.00, plus froth)	9 samples	389294
PROSPECTING (scale/area)		nil	n/a
PREPARATORY/PHYSICAL			
	Line/grid (km)	nil	n/a
	Trench (number, metres)	nil	n/a
	Bulk sample(s):	nil	n/a

Section 7, Appendix C, and Appendix D remain confidential under the terms of the Coal Act Regulation and have been removed from the public version.

https://www.bclaws.gov.bc.ca/civix/document/id/complete/statreg/251_2004

1 Table of contents

<i>Serial and section title</i>	<i>Page</i>
1 Table of contents	1
2 Introduction	4
2.1 Arrangement of this report	4
2.2 Distinction of historic and current work	4
2.3 Regulatory basis of this report	5
2.3.1 Tenure description	5
2.4 Situation and current drilling objectives	5
2.5 Coal production history	5
2.5.1 Mine operation under Conuma ownership	6
2.5.2 Production statistics	6
2.6 Geological setting of Willow Creek Mine	8
2.6.1 Stratigraphic summary	8
2.6.2 Deformational summary	8
2.6.3 Nomenclature and context of coal zones	8
2.6.3.1 Topological nomenclature of split coal beds	12
2.6.3.2 Informal stratigraphic subdivisions of the Gaylard coal-measures	12
2.7 Location and access	12
2.7.1 Coal-loading facility and railway connections	13
2.8 Climate	13
2.9 Landforms and forest cover	13
2.9.1 Biogeoclimatic ecosystem classification	13
2.10 Acknowledgements and statement of professional responsibility	13
3 Exploration	14
3.1 History of coalfield development	14
3.2 Historic (years-1980 through 2020) exploration	15
3.2.1 Cross-reference to historic borehole positions and depths	16
3.2.2 Coordinate transformation from minesite grid to UTM (NAD83 Zone 10)	16
3.3 Current (winter-2021/2022) in-mine drilling	17
3.3.1 Borehole geophysics	18
3.4 Comments on validity of exploratory work	19
4 Review of coalfield geology	20
4.1 Regional structural setting	20
4.2 Regional stratigraphic setting	21
4.2.1 The Gething-Bluesky controversy and its resolution	21
4.3 Local structural geology	21
4.3.1 Tectonostratigraphic coherence	22
4.4 Local stratigraphy	22
4.4.1 Stratigraphic identity of rocks drilled in winter-2021/2022	23
4.5 Drift (map-unit D)	24
4.6 Fort St. John Group (map-units 8a, 7, 6, 5, 4, and upper part of map-unit 3)	24

<i>Serial and section title (continued)</i>	<i>Page</i>
4.6.1 Hasler Formation (map-unit 8a)	24
4.6.2 Boulder Creek Formation (map-unit 7)	25
4.6.2.1 Paddy Member (absent)	25
4.6.2.2 Walton Creek Member	25
4.6.2.3 Cadotte Member	25
4.6.3 Hulcross Formation (map-unit 6)	26
4.6.4 Gates Formation (map-unit 5)	26
4.6.5 Moosebar Formation (map-units 4c, 4b, 3d, and 3c)	27
4.6.5.1 Spieker Member (map-unit 4c)	27
4.6.5.2 Cowmoose Member (map-unit 4b)	28
4.6.5.3 Green Marker (map-unit 4a)	28
4.6.5.4 Chamberlain Member (map-unit 3d)	29
4.6.5.5 Bullmoose Member (map-unit 3c)	29
4.6.6 Bluesky Formation (map-unit 3b)	30
4.7 Bullhead Group (map-units 3a and 2)	31
4.7.1 Gething Formation (map-unit 3a)	31
4.7.1.1 Gaylard Member	32
4.7.1.2 Subdivisions of the Gaylard Member (map-units 3a1 through 3a5)	32
4.7.1.3 Sedimentological and cyclothemic details	32
4.7.1.4 Discussion concerning the thickness of the Gaylard Member	33
4.7.2 Cadomin Formation (map-unit 2)	33
4.8 Minnes Group (map-unit 1)	34
5 Coal	35
5.1 Regional correlations of major Gaylard coal zones	35
5.2 Local naming scheme for Gaylard coals	35
5.2.1 Caveat concerning coal bed designations	35
5.3 Coals intersected by current boreholes at Willow Creek Mine	38
6 Coal quality	40
6.1 Cross-reference to historic coal-quality data	40
7 Coal-resource and coal-reserve estimation	41
7.1 Coal resources	41
7.2 Coal reserves	41
8 Reclamation	44
9 Statement of costs	45
9.1 Contractor list	46
10 References	47
11 Conclusions and recommendations	51
11.1 Recommendations	51
12 Statement of qualifications	52

<i>Serial and section title (continued)</i>	<i>Page</i>
Appendix A: Geophysical logs and borehole statistics	A-1
A-1 Log formats	A-1
A-2 Basic principles of geophysical logging	A-1
A-3 Log presentation and scaling	A-1
Appendix B: Core descriptions	B-1
Appendix C: Head raw analyses of coal and rock samples	C-1
Appendix D: Clean coal quality from wash/froth tests	D-1

List of tables

<i>Serial</i>	<i>Title</i>	<i>Page</i>
2-1	Tenure details of the Willow Creek coal lease	5
2-2	Production statistics by year and material type	6
2-3	Comparison of topological terminology for split coal beds	12
2-4	Informal subdivisions of the Gaylard coal-measures	12
3-1	Statistical summary of historic and current drilling	16
3-2	Coordinate transformation notes	17
3-3	Details of year-2021/2022 (current) boreholes	17
3-4	Details of year-2020 (historic) boreholes	18
4-1	Table of formations, members, and subdivisions	23
5-1	Hierarchy of coals and carbonaceous zones at Willow Creek Mine	36 to 38
5-2	Cored intersections of major coal beds	39
7-1	Willow Creek Mine -- in-place coal resource estimate	42
7-2	ROM and clean coal reserves	43
9-1	Cost breakdown by activity for the 2021-2022 work term	46
A-1	Positions and statistics of year 2021-2022 boreholes	A-2
A-2	Geophysical log inventory	A-2
B-1	Summary of WC22LD-01	B-2 to B-5
B-2	Summary of WC22LD-02	B-5 to B-10
B-3	Summary of WC21LD-03	B-11 to B-18
B-4	Summary of WC22LD-04	B-18 to B-21
B-5	Summary of WC22LD-05	B-21 to B-28
B-6	Summary of WC22LD-06	B-29 to B-38
C-1	Assay numbers of washed composites	C-1
C-2	Head raw analyses (adb)	C-2 to C-7
C-3	Head raw ash oxides and base-acid ratios	C-8 to C-14
D-1	Sample inventory and composite assembly	D-2 to D-6

List of maps

<i>Serial</i>	<i>Title</i>	<i>Page</i>
Map 2-1	General location map	7
Map 2-2	Coal tenure and topography	9
Map 2-3	Bedrock geology of Willow Creek Mine block	10
Map 2-4	Willow Creek Mine year 2020-2022 infill drilling	11

2 Introduction

The Willow Creek coal lease, although held as one tenure, has been in recent years been explored and developed as three geographically (and to some extent tectonically) distinct blocks, although these blocks do not have independent identities as mineral tenures in their own right:

- Willow Creek Mine block, the subject of the present study, previously-reported in Coal Assessment Reports (CARs) 988, 1001, 1048, and 1066;
- Willow West block, situated along the southwestern bank of Willow Creek, and thus lying to the west of Willow Creek Mine, previously reported in CAR-984; and
- Willow South block, situated along the northeastern bank of Willow Creek, and thus lying to the southeast of Willow West, previously reported in CAR-986.

The present volume is the seventh in a series of reports concerning portions of the Willow Creek coal lease, covered by Crown tenure 389294. Previous volumes have focussed on the Willow South and Willow West exploration activities, previous work at Willow Creek Mine itself, and archival presentation of borehole data from exploration conducted at the mine in 1997. The present report discusses results of years-2021/2022 infill drilling, conducted to investigate coal-quality trends and geological structure (both of tectonic and sedimentological origin) within the 4N1, 4N2, and 4C areas of Willow Creek Mine.

2.1 Arrangement of this report

This report's text and **Appendix A** discuss years-2021/2022 infill diamond core-drilling, associated non-coring air-hammer drilling, and a limited programme of downhole geophysical surveys. Geological descriptions of the cored 2021/2022 boreholes are presented in **Appendix B** of this report, whereas raw-coal analytical results are presented in **Appendix C**, and initial results of washing and froth flotation tests are presented in **Appendix D**.

All of this work was done within the mine's permitted disturbance boundary, specifically within the 4N1, 4N2, and 4C development areas of the mine (as depicted within **Map 2-4**). Results of this infill work are being incorporated into a geological model and an updated mine plan, currently being prepared by the mine's Technical Services staff.

2.2 Distinction of historic and current work

Historic work . Historic work was conducted between 1980 and 2020. This work comprises drilling of 767 boreholes (a majority of which were non-coring rotary-holes) and ancillary downhole geophysical surveys, as previously reported in Coal Assessment Reports 984, 986, 988, 1001, 1048, and 1066.

Current work (**Table 3-1**) comprises winter-2021/2022 drilling of 6 non-cored rotary-drill pilot holes and 6 diamond-cored boreholes (all of which were hammered down to predetermined core-points, and thence spot-cored with diamond coring bits), accompanied by a limited programme of downhole wireline geophysical surveys (as documented in **Appendix A** of this report).

The total number of boreholes drilled to date at Willow Creek Mine is therefore 779. This number excludes poorly-documented regional drilling by the Coal Control Unit of the former British Columbia Department of Mines, inasmuch as the locations of these older boreholes are not well-known.

2.3 Regulatory basis of this report

This report has been compiled and submitted by Conuma Resources Limited (Conuma), in keeping with the provisions of the *Coal Act* and the *Coal Act Regulation*, with respect of exploratory activities on Crown coal tenures within British Columbia.

2.3.1 Tenure description

Willow Creek Mine occupies the northeastern portion of the Willow Creek coal lease (Tenure 389294), within the Liard Mining District of northeastern British Columbia, situated within the eastern half of map-area 93O/9 of Canada's National Topographic System.

Table 2-1: Tenure details of the Willow Creek coal lease

Tenure Number	Map	Block	Units	Date Acquired	Area (hectares)	Former coal lease number
389294 (84 units)	93O/9E	B	61, 62, 63, 64, 71, 72, 73, 74, 81, 82, 83, 84, 85, 86, 87, 88, 91, 92, 93, 94, 95, 96, 97, 98	March 31, 1998	6151	Coal Lease 15
	93O/9W	F	1, 2, 11, 12, 21, 22, 31, 32, 41, 42, 51, 52, 61, 62, 63, 64, 71, 72, 73, 74, 83, 84, 93, 94			
	93O/9E	G	3, 4, 5, 6, 7, 8, 9, 10, 13, 14, 15, 16, 17, 18, 19, 20, 25, 26, 27, 28, 29, 30, 35, 36, 37, 38, 39, 40, 47, 48, 49, 50, 57, 58, 59, 60			
Totals:	1 tenure		84 units		6,151 hectares	

Note: Map sheets listed are within the 1:50,000 series of the National Topographic System. Blocks and Units refer to the British Columbia Coal Tenures Grid System, whose unit cells are based upon NAD 27 surveys, and translated into NAD 83 coordinates for purposes of mapping.

The aggregate area of the Willow Creek coal lease is 6151 hectares. Tenure 389294 was granted by the Crown on March 31, 1998 (as listed in **Table 2-1**). Annual reporting and rental-payment anniversary dates are therefore March 31. The Willow Creek Mine block is an informal operational subdivision within the coal lease, with no formal stand-alone identity within the Crown mineral-tenure system of British Columbia. The outline of the Willow Creek Mine block is depicted upon **Map 2-2** and **Map 2-3** of the present report.

2.4 Situation and current drilling objectives

The objective of current work was to increase Conuma's level of understanding of coal quality and geological structure within the 4N1, 4N2 and 4C development areas of Willow Creek Mine. The No.4 coal zone was the primary drilling target, and the Nos. 1, 2, and 3 coal zones were secondary targets.

Current work has consisted of diamond-drilling, a limited programme of downhole geophysical logging, and coal-quality studies including proximate analysis, determination of total sulphur, caking (FSI) tests, major-oxide ash chemistry, tests for oxidation by optical means, determination of specific gravity of coal and rock, step-washing (s.g. 1.30 through 2.00) and froth flotation.

2.5 Coal production history

Willow Creek Mine's coals have been extensively worked by open-pit operations, commencing in year-2001 and proceeding with some interruptions thereafter. Pine Valley Mining, Western

Canadian Coal, and Walter Energy were former operators of the mine, prior to Conuma's acquisition of the mine in the late summer of 2016.

2.5.1 Mine operation under Conuma ownership

Mining operations recommenced in July 2018, and were again curtailed in February 2019, and again restarted in December 2020. The mine has most recently been working within its 4N1 and 4N2 mining areas, which had previously been worked by Walter Energy.

Workshops and other requisite support facilities (including administrative, environmental, quality-control, and technical offices) exist at Willow Creek Mine. A coal-washery and railcar-loader with railway-sidings are also present.

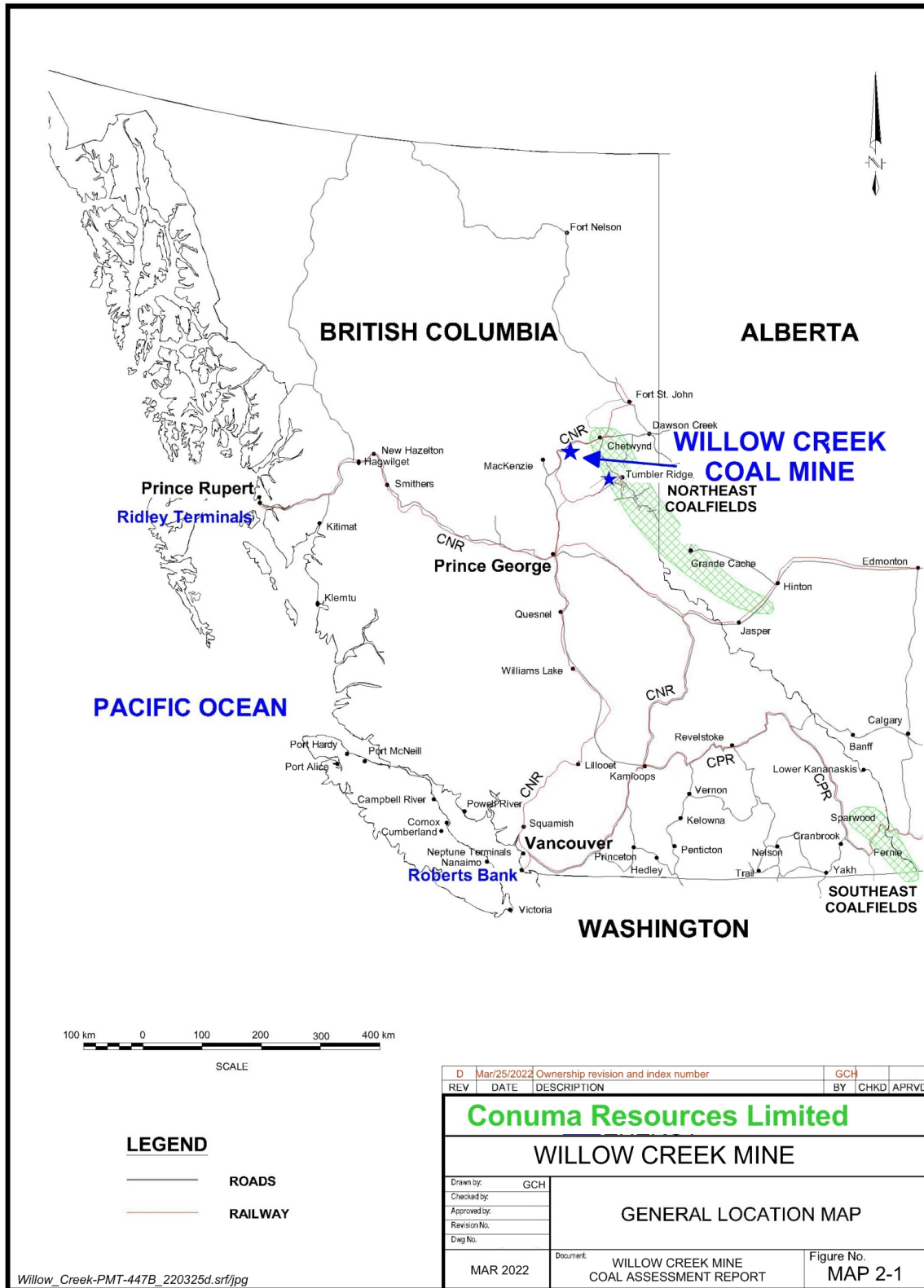
2.5.2 Production statistics

During the overall period of operation, Willow Creek Mine has produced slightly more than 6.05 million run-of-mine (ROM) tonnes of coal, at a strip ratio of 9.35 cubic metres/ROM tonne. Breakdown by year and material type is presented as **Table 2-2**.

Table 2-2: Production statistics by year and material type						
Year	Bank cubic metres			Tonnes		
	Total mined	Waste	Coal	Total mined	Waste	Coal
2001	186,690	160,000	26,690	452,031	416,000	36,031
2002	215,811	180,000	35,811	516,345	468,000	48,345
2003	0	0	0	0	0	0
2004	1,594,963	1,412,000	182,963	3,918,200	3,671,200	247,000
2005	5,748,955	5,219,615	529,339	14,285,608	13,571,000	714,608
2006	4,779,093	4,328,231	450,861	11,862,062	11,253,400	608,662
2007	0	0	0	0	0	0
2008	1,249,000	1,212,000	37,000	3,201,150	3,151,200	49,950
2009	0	0	0	0	0	0
2010	6,415,816	6,078,157	337,659	16,259,048	15,803,208	455,840
2011	6,285,249	5,594,582	690,667	15,478,314	14,545,913	932,401
2012	16,228,129	15,245,144	982,985	40,964,404	39,637,374	1,327,030
2013	7,942,988	7,433,970	509,018	20,015,496	19,328,322	687,174
2014	1,727,828	1,581,502	146,326	4,309,445	4,111,905	197,540
2015	0	0	0	0	0	0
2016	0	0	0	0	0	0
2017	0	0	0	0	0	0
2018 (Jul-Dec)	n/a	5,907,000	n/a	n/a	n/a	549,000
2019 (Jan-Feb)	n/a	2,186,000	n/a	n/a	n/a	197,000
2020 (Dec)	n/a	n/a	n/a	n/a	n/a	n/a
2021	n/a	n/a	n/a	n/a	n/a	n/a
2022 (Jan-Feb)	n/a	n/a	n/a	n/a	n/a	n/a
Totals		56,538,201				6,050,081

Notes: data to end of 2014 compiled by Allen Baron, P.Eng. Figures for years prior to 2010 were taken from annual reports. Year-2018 and 2019 data provided by Salvatore Bafaro and by Lukas Klemke P.E.

Map 2-1: General location map



2.6 Geological setting of Willow Creek Mine

Near-surface sedimentary rocks within and adjacent to the Willow Creek Mine block are of Lower Cretaceous age, comprising (from youngest to oldest) the basal formations of the Fort St. John Group, and the entirety of the Bullhead Group. The older and stratigraphically-lower Minnes Group is inferred to underlie the Willow Creek Mine block, but it is not mapped at outcrop at any point, and it likely has not yet been reached by coal-exploration drilling within the block, although oil and gas wells have drilled through these rocks.

2.6.1 Stratigraphic summary

Other than the coals which have been the principal focus of exploratory activities within the Willow Creek Mine block, associated sedimentary rocks comprise conglomerates, sandstones, siltstones, mudstones, carbonaceous mudstones, concretionary or banded ironstone, and very thin (centimetres to decimetres) but distinctive bands of igneous tuff (Kilby, 1984a; 1985).

Marine mudstones and siltstones occur within the Fort St. John Group (Wickenden and Shaw, 1943; Hughes, 1963), most notably within the Moosebar and Hulcross formations. Furthermore, the local occurrence of bioturbated mudstones and siltstones between coal zones No.7 and No.8 in the basal half of the Gething Formation's Gaylard Member hints at the presence of marine conditions, there too, during deposition. The facies of the remainder of the Gaylard Member, of the overlying Gates and Boulder Creek coal-measures, and also that of the underlying Cadomin and Bickford formations, is otherwise alluvial, fluvial, or deltaic.

2.6.2 Deformational summary

Bedrock within the Willow Creek Mine block is moderately- to complexly-deformed, possibly more-so than is the case in the adjoining Willow West and Willow South blocks (James, 1998; Jordan and Acott, 2005; Cathyl-Huhn *et al.*, 2015a; 2015b). Southwest-verging thrust-faults, some of which may be folded, and associated northwest-striking, southwest-verging folds predominate at Willow Creek Mine, consistent with a structural setting within a passive-roof duplex system.

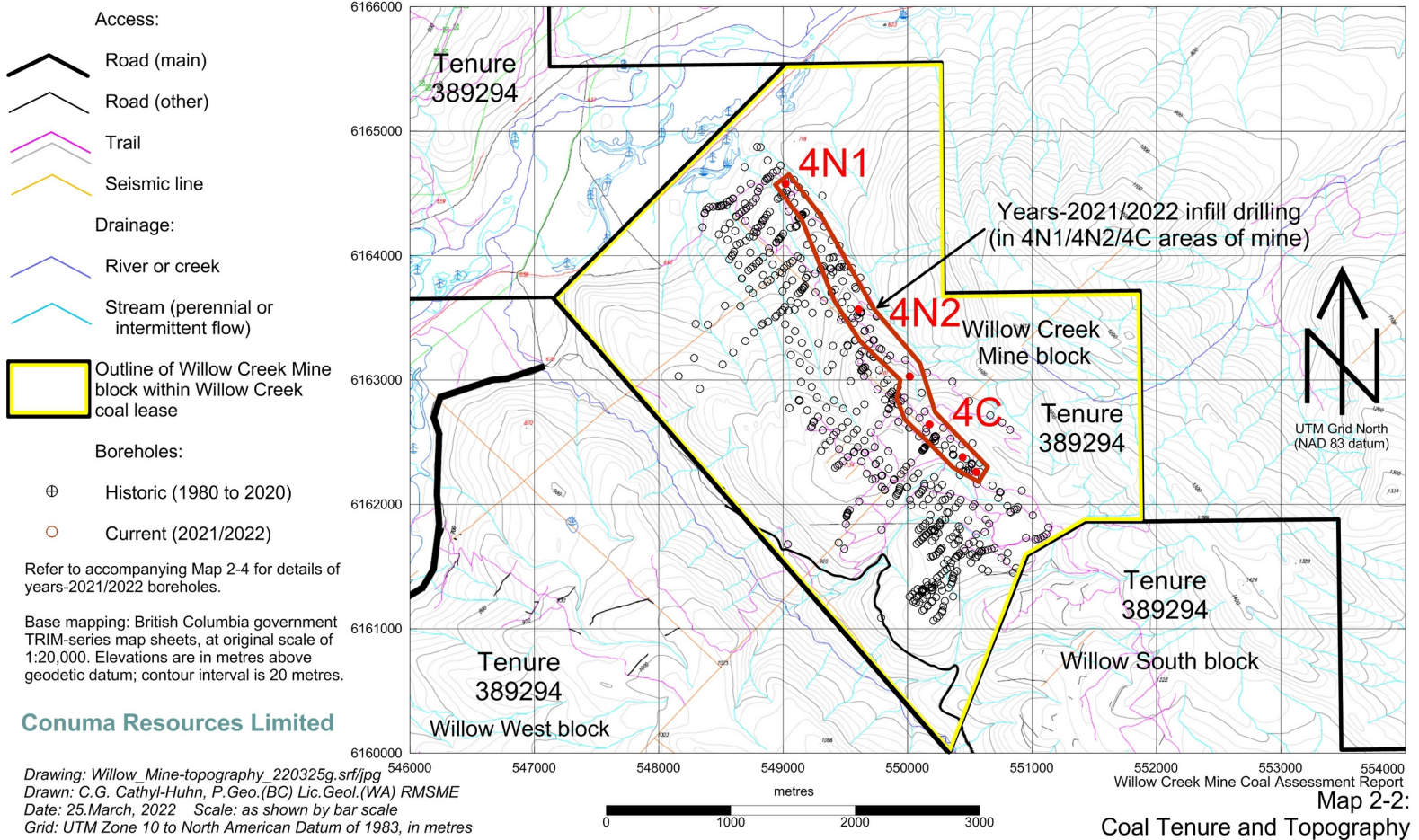
Folding of the southwest-verging near-surface thrust-faults, and refolding of some of the folds and faults, is very likely due to tectonic ramping of underlying northeast-verging thrust-faults, as suggested by oilfield seismic surveys. The opposing vergences of the shallow and deep structures is consistent with the triangle-zone structure which is well-established to be present within the Pine Pass area (Lingrey, 1996).

The Geological Survey of Canada has published a regional-scale structural synthesis (McMechan, 1984), consisting of a map and cross-section at a scale of 1:250,000, followed by a journal article concerning the geometry of thrust-faults (McMechan, 1985).

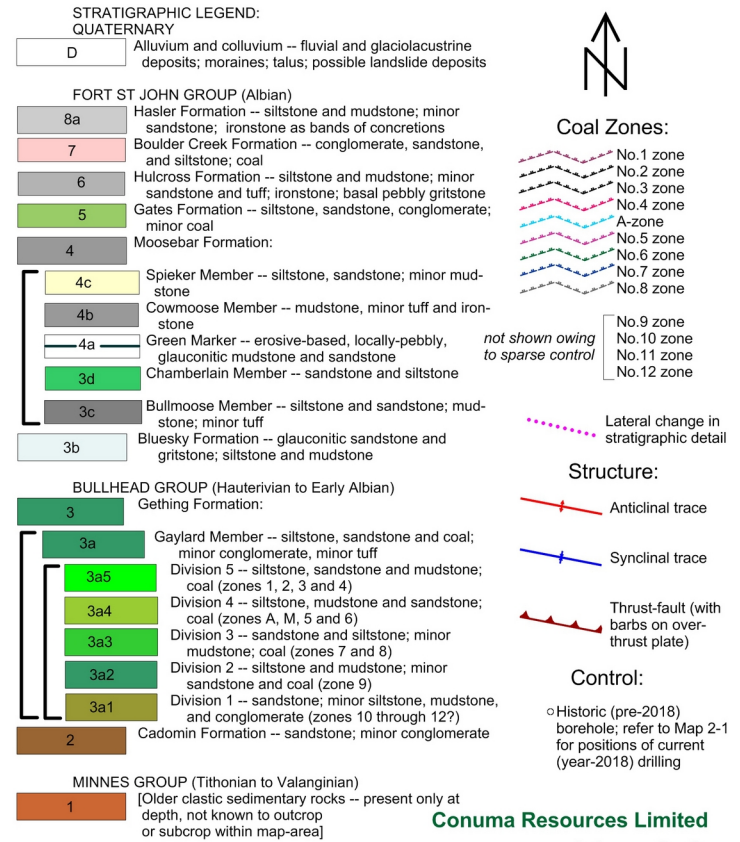
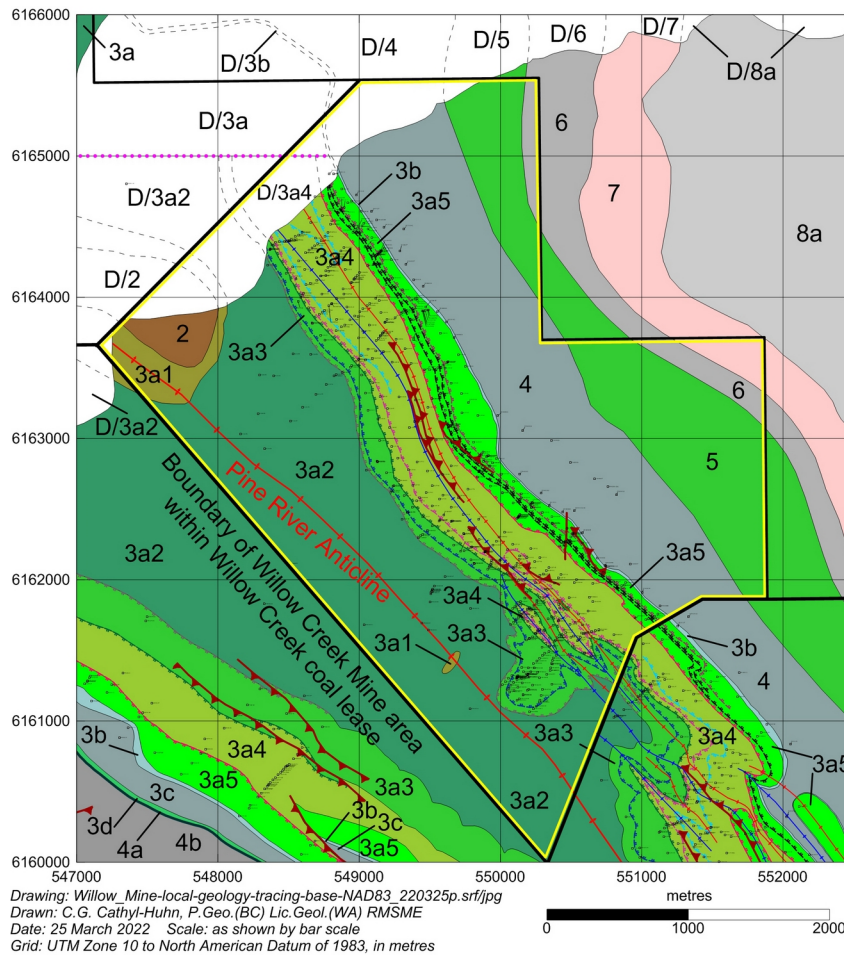
2.6.3 Nomenclature and context of coal zones

Numerous coal zones have been found by historic and current drilling at Willow Creek Mine. Coal zones are numbered in downward succession from the No.1 (near the top of the coal-measures) through No.12, following a long-established schema (McKechnie, 1955). As well, a coal zone at the immediate top of the coal-measures has been given the local name of Bird Seam, although this coal is by no means correlative with the Bird Seam as previously-recognised (Wallis and Jordan, 1974) in other coal properties of northeastern British Columbia.

Map 2-2: Coal Tenure and Topography

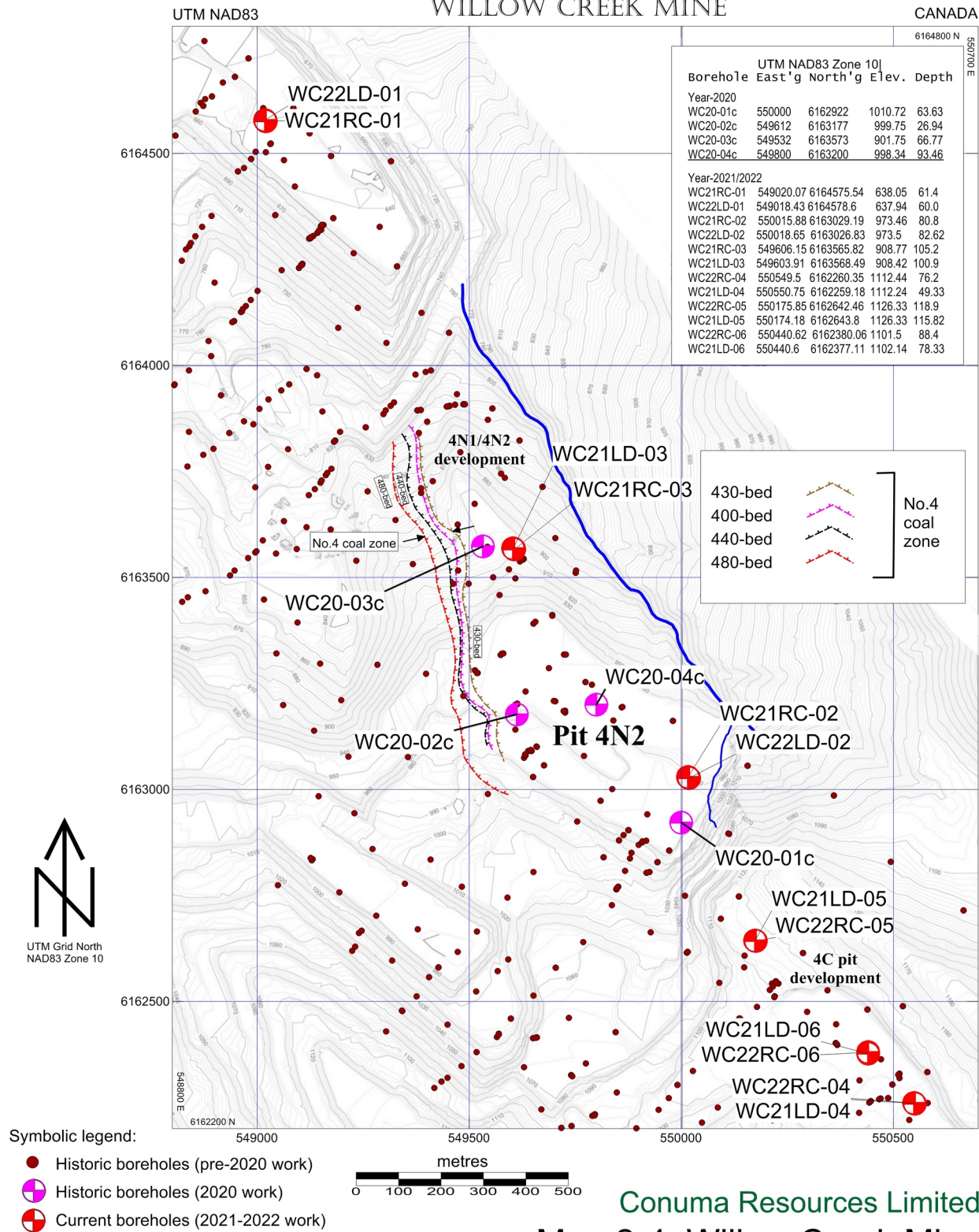


Map 2-3: Bedrock geology of Willow Creek Mine block



Conuma Resources Limited
 Map 2-3:
 Bedrock geology of
 Willow Creek Mine

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Drawing: Willow-Mine-drilling-2020-2022_220401d.srf/jpg
 Scale: as shown Date: 1 April 2022 Contours: 2 m / 10 m
 Projection / grid: UTM NAD83 Zone 10, in metres
 Drawn: C.G.Cathyl-Huhn P.Geo(BC) Lic.Geol(WA) RMSME
 Topographic base: M.Sales P.E., 28 March 2022

Conuma Resources Limited
Map 2-4: Willow Creek Mine
years 2020-2022 infill drilling

2.6.3.1 Topological nomenclature of split coal beds

Most of the coal zones at Willow Creek Mine comprise one or more laterally-persistent 'major' coal beds, often associated with laterally-branching subseams, locally designated as 'splits', 'stringers' and 'stringer plies' (defined in **Table 2-3** and graphically summarised in **Table 5-1**). Individual coal beds and subseams range in thickness from a few decimetres to several metres.

Table 2-3: Comparison of topological terminology for split coal beds

Topological term	Coal zone	Major coal bed	First-order subseam	Second-order subseam	Third-order subseam
Local term			'Split'	'Stringer'	'Stringer ply'

2.6.3.2 Informal stratigraphic subdivisions of the Gaylard coal-measures

At Willow Creek Mine, the Gaylard coal-measures may be conveniently subdivided into five informal divisions (**Table 4-1**), numbered in upward succession from Division 1 at the base of the Gaylard, to Division 5 at the top of the Gaylard.

Drilling has established that the thickest, and possibly more laterally-extensive, coals occur within Divisions 3, 4, and 5 of the Gaylard Member, at Willow Creek Mine. All twelve of the winter-2021/2022 boreholes solely intersected coal-measures of Division 5.

Table 2-4: Informal subdivisions of the Gaylard coal-measures

Formation	Member	Map-unit	Lithology	Division	Sub-unit	Characteristic lithology and coal zones
Gething Fm.	Gaylard Mb.	3a	Numerous fining-upward cycles of sandstone, siltstone, mudstone and coal (zones 'Bird' and 1 through 12); minor tuff; local concentration of sandstone beds; 260 to 360? metres thick	Div 5	3a5	Siltstone, sandstone, mudstone and coal (zones 'Bird' and 1 through 4); minor tuff as very thin bands
				Div4	3a4	Siltstone and mudstone; coal (zones A, 5 and 6)
				Div3	3a3	Sandstone; minor siltstone and mudstone; coal (zones 7 and 8)
				Div2	3a2	Siltstone and mudstone; minor sandstone and coal (zone 9)
				Div1	3a1	Basal sandy unit: sandstone and siltstone; minor coal (zones 10 to 12 -- correlations tentative)
Cadomin Fm.		2	Gritty to pebbly, siliceous sandstone and sandy conglomerate with 'blocky' gamma-log motif; minor siltstone and coal; 2.5 to 14? m thick; erosional base			

2.7 Location and access

Chetwynd town, located on Highway 97 and situated approximately 50 kilometres northeast of Willow Creek Mine, is the closest incorporated settlement to Willow Creek Mine. Chetwynd's population was reported as 2,633 persons in the year-2006 census.

In the context of more-distant communities within British Columbia, Willow Creek Mine is located 130 kilometres south of Fort St John, 95 kilometres west of Dawson Creek, and 315 kilometres northeast of Prince George. Vancouver is situated 730 kilometres to the south-southwest of the mine.

Commercially-scheduled aircraft flights connect Vancouver to Fort St. John and Dawson Creek. A municipal airstrip is maintained at Chetwynd for non-scheduled use.

2.7.1 Coal-loading facility and railway connections

A coal-loading facility is situated on the southern bank of the Pine River, 2 kilometres to the northwest of Willow Creek Mine. This load-out site, which fills railway cars with coal produced from Brule Mine and from the Willow Creek coal washery, allows rail access to ports along the Pacific Coast of Canada, and elsewhere within the North American railway network. CN Rail are the operator of the former BC Rail line to which the load-out site is connected.

2.8 Climate

The nearest climate station to Willow Creek Mine is at Chetwynd, with 'cool continental' climate of frigid winters and warm summers. Average annual rainfall and snowfall at Chetwynd are 306 millimetres and 169 centimetres respectively. The average frost free period ranges between 84 to 91 days, and about 30 foggy days are expected per year. The mean daily temperature at Chetwynd is 15.4 C in July and -10.7 C in January. Winter temperatures below -40C are not uncommon, with the coldest weather occurring in January and February of most years.

2.9 Landforms and forest cover

Willow Creek Mine is within the Inner Foothills of the Rocky Mountains. Topography comprises deeply-dissected, steep-sided, rounded hills and mountains, with elevations ranging from 635 to 1345 metres above sea level. Topographic contours at 20-metre intervals, based upon provincial government mapping (TRIM map-sheets 93O.059 and 93O.069), are shown in **Map 2-2**.

The Willow Creek Mine block as a whole is variably-forested, chiefly with lodgepole pine, trembling aspen, balsam poplar, white and black spruce, and tamarack. The property lies within Tree Farm Licence 48, part of the Dawson Creek Timber Supply Area. Some cut-blocks have been operated for timber harvesting within the Willow Creek Mine block. As well, areas of forest cover have been cleared in preparation for mine development. As a result, forest cover exhibits a range of ages and states of maturity, from non-restocked status through juvenile and mature, to overmature.

2.9.1 Biogeoclimatic ecosystem classification

Willow Creek Mine lies within the Sub-Boreal Interior ecoprovince, within which are three biogeoclimatic ecosystem classification variants:

- Boreal White and Black Spruce moist warm Peace variant (*BWBSmw1*),
- Sub-boreal Spruce wet cool Finlay-Peace variant (*SBSwk2*), and
- Engelmann Spruce Subalpine Fir moist very cold Bullmoose variant (*ESSFmv2*).

2.10 Acknowledgements and statement of professional responsibility

Thanks are due to many past and present workers:

- Mike Sales P.E., mining engineer from Lone Tree Consulting;
- Theresa Lavender P.Eng, mining engineer at Willow Creek Mine;
- Adriana Matesoi, from A.M.M. Geological;
- David Thompson P.Geo. and Frank Pilecki P.Geo., in Conuma's Tumbler Ridge office.

The author accepts professional responsibility for data and conclusions presented within this report.

3 Exploration

Both historic (pre-2020) and current (year-2020) coal exploration has been done by various parties within the Willow Creek Mine segment of the Willow Creek coal lease. The majority of the work is of historic vintage. In all, 763 historic and current boreholes (**Table 3-1**) are known to have been drilled between the years 1980 and 2020. Earlier (1946 to 1951) government-sponsored diamond-drilling is known to have occurred (as reported by McKechnie, 1955), but has not yet been accurately-located within the Willow Creek Mine block.

3.1 History of coalfield development

The following discussion is adapted in part from an unpublished report (Ryan, 2010) on behalf of Unicorn International Mines Group Inc.

Coal was first discovered in the Peace River District in 1793, by Alexander MacKenzie's exploring expedition (MacKenzie, 1801). Prior to 1980, less than 100,000 tonnes of coal were mined at all locations within northeastern British Columbia (Ryan, 2002).

At a location on Hasler Creek, situated about 17 kilometres southeast of Willow Creek Mine, the Hasler Creek Coal Company commenced small-scale underground coal-mining in 1943, continuing through 1944 and 1945. At this time, considerable geological mapping and some prospecting were undertaken within the Pine River Anticlinorium, including the Willow Creek Mine area (Wickenden and Shaw, 1943, Spivak, 1944; reviewed by Stott, 1973).

From 1946 onward to 1951, British Columbia's former Department of Mines conducted a government-funded diamond-drilling and trenching programme of the then-known coal deposits near the Pine River valley (McKechnie, 1955). This programme entailed extensive drilling within the Willow Creek Mine block. Summary records were published in McKechnie's report. Detailed logs of these boreholes have not yet been located, although they might eventually be found within the working files of the British Columbia Geological Survey Branch, or within the manuscript records collection held by the British Columbia Archives.

From the late 1950s onward, several oil companies undertook structural and stratigraphic mapping within and adjacent to Willow Creek Mine. Two reports prepared on behalf of Triad Oil by Dr. Peter Jones (1960; 1963) are the most useful of those reports which are publicly-available, as they incorporate detailed structural and stratigraphic mapping. Oil-company work culminated in the drilling of several deep exploratory wells, all of them being outside the mine's operating area.

Government-sponsored academic surveys were carried on concurrently. In 1963, Dr. John Hughes compiled a Ph.D. dissertation for McGill University, concerning structural geology and tectonics of the Pine River valley, including the Willow Creek Mine area (Hughes, 1963). Dr. Hughes' work was sponsored by the then-extent British Columbia Department of Mines, leading to the publication of two provincial Geological Survey Bulletins (Hughes, 1964; 1967).

The expansion of steel production in mid-1960s stimulated exploration for metallurgical coking coal. By the mid-1970s within northeastern British Columbia, most of the land with coal potential had been acquired by mining companies, or by oil and gas companies seeking to enter the coal industry as a means of diversification. Initial development interest was along the existing railway (then known as the British Columbia Railway) which passed through Pine Pass

and thus connected Chetwynd and Dawson Creek with then-existing ports along British Columbia's western coast.

Interest in coal development increased with rapid increase in crude oil prices, and concomitant increase in coal prices. These price increases were followed in short order by the signing of a joint government-industry agreement between Japan and Canada, to develop new coal mines, highways, railways, other infrastructure, and a workers' townsite at Tumbler Ridge. Shipments of northeastern British Columbia coal through a new port at Ridley Island (near Prince Rupert, British Columbia) commenced in 1984, and have continued to the present day.

3.2 Historic (years-1980 through 2020) exploration

The bulk of historic exploratory work at Willow Creek Mine has been by means of drilling, although considerable trenching and test-pitting was also done, especially within coal outcrops exposed during the construction of access trails and drill pads. A continuous miner (an underground coal-cutting and loading machine) was transported to the property from the Sukunka Mines in 1981, but it remains unclear whether it was ever put into use to drive adits into the property, although such work was planned (A.S. Marton, personal communication, 1981).

Historic work has been documented within coal-assessment reports and unpublished technical reports prepared by third parties (Marton, 1981; Marton and Jones, 1981; Anonymous, 1997; James; 1998; Jordan and Acott, 2005) and by Walter Energy (Cathyl-Huhn, 2015b; Cathyl-Huhn *et al.*, 2015c). By the late 1990s, the structure and general characteristics of the Willow Creek coals were sufficiently well-understood, to appreciate that the coal-measures were complexly-folded and faulted, and that principal structures had a southwestern vergence (in contrast to the usual northeastern structural vergence of the Peace River coalfields).

Locations of historic boreholes are generally well-established by means of surveying, initially established in terms of local (mine-site) coordinate systems (see **Section 3.2.2**, and **Table 3-2**, below), but subsequently translated into Universal Transverse Mercator (UTM) coordinates referred to the older NAD27 (North American Datum of 1927) or the modern NAD83 (North American Datum of 1983) metrologies.

A conspicuous exception concerns the locations of numerous year-1997 boreholes from which cores were aggregated to form drilled bulk-samples for coking tests (Anonymous, 1997). These boreholes' positions are only known in general terms, from graphic symbols presented on a small-scale drilling plan. The reason for the lack of surveyed coordinate data for these holes is unknown.

The substantial majority (**Table 3-1**, below) of historic boreholes were drilled by means of non-coring rotary methods. Rotary-drilled holes were generally shallower than diamond-cored boreholes. Drilling of the property in 1980-81 was entirely by means of coring, in keeping with the need to establish stratigraphy and structural style through the examination of cores (A.S. Marton, personal communication, 1980).

The numerous boreholes drilled in years-1980 through 1996 are documented in maps and data tables within coal-assessment reports (Marton, 1981; Marton and Jones, 1981; James, 1998). More recent historic work, by Western Coal and by Walter Energy, has also been documented within Walter Energy's coal-assessment reports (*vide* Cathyl-Huhn, 2015b; Cathyl-Huhn *et al.*, 2015c).

Year-2020 historic large-diameter core-drilling solely sampled coals within the No.4 coal zone, ranging from the uppermost samples of 430-bed, through the main sequence of 401-bed and 400-bed, and down to the lowermost samples of 442-bed. Stratigraphically-higher coals were hammered-through in some of the boreholes, but therefore not cored and thus only observed in geophysical logs.

Table 3-1: Statistical summary of historic and current drilling

Year in which drilled	Core drilling		Rotary drilling		All boreholes	
	Total holes	Total metres	Total holes	Total metres	Total holes	Total metres
<i>historic drilling</i>						
1980	3	854.70	0	nil	3	854.70
1981	43	11,240.30	0	nil	43	11,240.30
1994	3	107.91	54	2,694.29	57	2,802.20
1996	55	2,041.76	145	4,781.04	200	6,822.80
1997	73	2,052.30	67	3,119.88	140	5,172.18
1999	16	299.95	24	627.83	40	927.78
2001	5	708.80	15	576.20	20	1,285.00
2005	0	nil	28	1,975.40	28	1,975.40
2007	3	201.16	74	8,079.65	77	8,280.81
2008	3	475.30	50	5,887.68	53	6,362.98
2009	13	380.00	25	1,983.15	38	2,363.15
2010	5	493.05	1	13.00	6	506.05
2011	0	nil	7	1,024.35	6	1,024.35
2013	14	1,083.83	0	nil	14	1,083.83
2018	27	3,676.59	10	1,022.94	37	4,699.53
2020	4	250.80	0	nil	4	250.80
totals	267 core	23,866.45	500 rotary	31,785.41	767 overall	55,651.86
<i>current drilling</i>						
2021/2022	6	489.16	6	530.90	12	1,020.06
totals	6 core	489.16	6 rotary	530.90	12 overall	1,020.06
<i>all years</i>	<i>273 core</i>	<i>24,355.61</i>	<i>506 rotary</i>	<i>32,316.31</i>	<i>779 overall</i>	<i>56,671.92</i>

3.2.1 Cross-reference to historic borehole positions and depths

Positions and depths of pre-2018 historic boreholes are presented in Tables 3-2 and 3-3 of the year-2015 coal assessment report for Willow Creek Mine (Cathyl-Huhn *et al.*, 2015c). Positions and depths of year-2018 historic boreholes are presented in Table 3-3 of the year-2019 coal assessment report (CAR-1048, Cathyl-Huhn, 2019), and positions and depths of year-2020 historic boreholes are presented within the year-2020 coal assessment report (Cathyl-Huhn, 2021), as well as within **Table 3-4** of the present report.

3.2.2 Coordinate transformation from minesite grid to UTM (NAD83 Zone 10)

Prior to 2008, most exploration activities were surveyed in terms of a local mine grid, for convenience in locating boreholes along cross-section lines. Although the mine grid is no longer in active use, mathematical transformations are required to bring earlier work into present-day terms of the UTM grid system used in governmental base-mapping. The following notes summarise the transformation algorithm.

Table 3-2: Coordinate transformation notes

<u>Minesite grid</u>	
Origin east 14652.254	Origin north 14950.671
<u>UTM grid</u>	
Transformed east 534954.317	Transformed north 6146860.561
Rotation -46° 55' 52.918088"	
Scale factor 0.99946605	Elevation adjustment -2.623 metres

3.3 Current (winter-2021/2022) in-mine drilling

Conuma conducted a twelve-hole programme of paired open-holes (as pilots for coring) and large-diameter diamond-cored boreholes within Willow Creek Mine block in the winter of 2021/2022. Drilling contractor for this work was Anderson Water Services.

The goal of the drilling was to assess the extent of high-FSI coal within the No.1 through No.4 coal zones of Willow Creek Mine, with the secondary objective of infilling structural details of the coals.

Table 3-3 (given below) and **Table A-1** (within **Appendix A**) present positional details and depths of the winter-2021/2022 boreholes. Positions are given in terms of Zone 10 of the UTM grid, relative to the North American Datum of 1983 (NAD 83). Lithological interpretations, including name assignments of cored coal beds, are presented as **Tables B-1 through B-6**, within **Appendix B**.

Table 3-3: Details of year-2021/2022 (current) boreholes

Borehole (‘LD’ indicates cored hole)	Surveyed borehole position (metres: UTM NAD83 Zone 10)			Particulars of boreholes		Borehole orientation (degrees)	
	Easting	Northing	Elevation	Drilling method	Total depth	Azimuth	Dip
WC21RC-01	549020.07	6164575.54	638.05	Rotary open-hole	61.40	0	-90
WC22LD-01	549018.43	6164578.60	637.94	Large-diameter spot core	61.00	0	-90
WC21RC-02	550015.88	6163029.19	973.46	Rotary open-hole	80.80	0	-90
WC22LD-02	550018.65	6163026.83	973.50	Large-diameter spot core	82.62	0	-90
WC21RC-03	549606.15	6163565.82	908.77	Rotary open-hole	105.20	0	-90
WC21LD-03	549603.91	6163568.49	908.42	Large-diameter spot core	102.00	0	-90
WC22RC-04	550549.50	6162260.35	1112.44	Rotary open-hole	76.20	0	-90
WC21LD-04	550550.75	6162259.18	1112.24	Large-diameter spot core	49.33	0	-90
WC22RC-05	550175.85	6162642.46	1126.33	Rotary open-hole	118.90	0	-90
WC21LD-05	550174.18	6162643.80	1126.33	Large-diameter spot core	115.88	0	-90
WC22RC-06	550440.62	6162380.06	1101.50	Rotary open-hole	88.40	0	-90
WC21LD-06	550440.60	6162377.11	1102.14	Large-diameter spot core	78.33	0	-90
totals				12 boreholes	1020.06		

Note: borehole orientation was set-up to be vertical at commencement of drilling. All positions, elevations, and depths are in metres. Surveyed positions of boreholes were as laid-out by the mine's Technical Services department, using staff-mounted GPS instrument, or by comparison with blast-pattern surveys.

Individual borehole depths ranged from 49.33 to 118.9 metres, with overall depth of 1020.06 metres. Of these boreholes, six were open-holes and six were spot-cored, with the construction details of the cored boreholes as follow:

- install 254 mm surface casing in a 267 mm hole,
- air-hammer 222 mm open-hole down to a predetermined core-point, and thence
- run ahead with open-hole between multiple core points (if desired); and
- core (150 mm core diameter) in a 222 mm hole, to final depth.

Two of the twelve drill sites were situated on existing benches of the 4N1 working area of Willow Creek Mine. Six of the boreholes were situated on existing benches of the 4C working area, and the remaining four sites were situated in area 4N2 of the mine.

Table 3-4: Details of year-2020 (historic) boreholes

Borehole (‘c’ indicates cored hole)	Surveyed borehole position (metres: UTM NAD83 Zone 10)			Drilled depth (metres)		Borehole orientation (degrees)	
	Easting	Northing	Elevation	Non-cored (267 / 222 mm hole)	Cored (150 mm size in 222 mm hole)	Azimuth	Dip
WC20-01C	550000.0	6162922.0	1010.72	46.22	17.41 (TD 63.63)	0	-90
WC20-02C	549612.0	6163177.0	999.75	10.24	16.70 (TD 26.94)	0	-90
WC20-03C	549532.0	6163573.0	901.75	46.11	20.66 (TD 66.77)	0	-90
WC20-04C	549800.0	6163200.0	998.34	73.57	19.89 (TD 93.46)	0	-90
		totals	4 boreholes	176.14	74.66 (TD 250.80)		

Note: borehole orientation was set-up to be vertical at commencement of drilling. TD: total depth. All positions, lengths, and depths are in metres. Surveyed positions of year-2020 boreholes were as laid-out by Allen Baron EIT, using staff-mounted GPS instrument.

For both the winter-2021/2022 drill programme, and the immediately-preceding summer-2020 drill programme, core recovery was generally excellent, although in rare cases (owing to drilling problems) core losses were substantial. Furthermore, the geophysical logs were of consistently-good quality, and it is therefore considered unlikely that any coals were erroneously noted as being absent.

3.3.1 Borehole geophysics

Downhole geophysical logging of all but one of the twelve 2021/2022 boreholes (one borehole being lost prior to logging), and of all four of the year-2020 boreholes was done by Century Wireline Services. The logging-unit operated on a call-out basis (from a hotel in Chetwynd) using a truck-mounted recording system complete with draw-works and generator-derived power supply.

An abbreviated suite of logs was run in the winter 2021/2022 boreholes:

- Gamma/caliper/resistivity/compensated density (9239C tool) -- in 11 boreholes;
- Deviation/verticality (9058A tool) -- in 11 boreholes; and
- Dipmeter (9411A tool) -- in 1 borehole.

The gamma-neutron and sonic logs were not run in during the winter-2021/2022 drilling programme.

Efforts were made to keep the boreholes topped-up with water for purposes of electrical connectivity between the geophysical tools and the borehole wall. This was not always practical, owing to near-surface blast-induced fracturing of the strata.

Geophysical logs were plotted at 1:100 vertical scale. Digital copies of downhole geophysical logs are presented in **Appendix A**, with an inventory of logs given as **Table A-1**. The digital logs are presented in LAS (Log ASCII Standard, as promulgated by the Canadian Well Logging Society) format, in TIF (Tagged Image File) format, and as PDF (Portable Document Format) files.

- LAS files can readily be imported into, and manipulated by, geophysical-processing software such as *LAS Viewer* or *WellCAD*, whereas
- TIF files may be opened by the native *Microsoft Windows* image-viewer, or by image-processing programmes such as *Photoshop*, and
- PDF files are suitable for printing via plotter, or as sectionalised images via an appropriately-capable printer.

3.4 Comments on validity of exploratory work

Historic and current drilling at Willow Creek Mine, comprising 56,671.92 metres' total length (**Table 3-1**), is regarded as having validly tested the coal potential of the coal-measures of the Gaylard Member of the Gething Formation -- such that a revised coal-quality model can be compiled (once the analytical work currently underway is completed, and that resource estimates of coal-in-place can be undertaken with reasonable confidence. Scope remains for further structural and coal-quality drilling, as means to improve confidence in mine geometry and product quality.

Stratigraphic variations in coal quality (notably, in the characteristic caking propensities of the various coal beds) between coal zones are reasonably-well established by existing drilling and analytical work. However, understanding of spatial variations of coal quality within individual coal beds, or closely-associated coal beds within a given coal zone, is hampered by the absence of positional data for numerous historic boreholes, which would otherwise be useful in refining the spatial variations of coal quality.

Coal-resource and coal-reserve estimation are discussed in detail within **Section 7** of the this report.

4 Review of coalfield geology

This chapter of the report is updated from the discussion presented in Coal Assessment Report No. 1066 (Cathyl-Huhn, 2021). Discussion proceeds from regional setting to local scale.

The coalfields of northeastern British Columbia are hosted by marine and non-marine clastic sediments of Jurassic, Cretaceous and earliest Tertiary age. These rocks form a series of thick sequences of molasse and flysch, all of which was deposited into the Rocky Mountain Foreland Basin of Western Canada. The basin is bounded by the mobile crustal terranes of the Cordilleran Orogen to the west, and the cratonic rocks and Palaeozoic cover sequences of the Canadian Shield to the east.

4.1 Regional structural setting

Most of the Jura-Cretaceous sediments were derived from orogenically-uplifted landmasses lying to the southwest of the Rocky Mountain Foreland Basin. Patterns of sedimentation were to some extent influenced by occasional vertical movements of underlying structures within the cratonic basement rocks, chief amongst which was the Peace River Arch (Stott, 1968).

During Late Mesozoic and Early Cenozoic time, the Cordilleran Orogen underwent two main phases of deformation: the Late Jurassic to earliest Late Cretaceous Columbian Orogeny, and the Late Cretaceous to Oligocene Laramide Orogeny (Douglas *et al*, 1970). Both of these orogenies were driven by transpressional crustal movements along the outboard (western) edge of the North American continent. In each case, orogenic activity was driven by the collision of northward-moving exotic crustal terranes, which in turn caused compressive strains within the previously-accreted western margin of the continent. Northeast-directed overthrusting of Palaeozoic rocks caused episodic uplift of the Cordilleran Orogen, in turn providing a variably-effective source of sediment into the Foreland Basin (Cant and Stockmal, 1989; Cant, 1996; Cant and Abrahamson, 1996).

At the time of formation of paleoswamp precursors of the Willow Creek coal deposit, the position of the orogenic mountain front (and hence the source of sediments) may have been 100 to 200 kilometres to the southwest,

The present-day Rocky Mountains are the most visible manifestation of Columbian and Laramide overthrusting, which gradually proceeded northeastward, with successively-younger thrusts tending to break through the Foreland's rocks at successively-deeper stratigraphic levels. As successively-younger thrusts developed, they generated passive folding within overlying, previously-deformed rocks. Overlying, older thrusts were therefore passively folded along with their adjoining strata.

Geometric and kinematic recognition of folded thrusts is therefore essential to understanding the structural geology of the Foothills coal deposits of northeastern British Columbia.

From southwest to northeast, the Cordilleran fold-thrust belt gradually changes structural styles (Thompson, 1979) from a thrust-dominant regime (within the mostly-Palaeozoic carbonate-clastic rocks of the Rocky Mountain Main Ranges and Front Ranges) to a mixed fold-thrust regime (within the Inner Foothills, including the Willow Creek Mine property) to a gently-folded frontal regime (within the Outer Foothills, five to ten kilometres to the northeast of Willow Creek Mine).

4.2 Regional stratigraphic setting

Stratigraphic nomenclature within the coalfields of northeastern British Columbia has undergone considerable revision during the past fifty years. Principal workers, whose reports were used as primary references for the present report, were J.E. Hughes (1964, 1967), D. Stott (1968, 1973, 1981, 1998), P.McL.D. Duff and R.D. Gilchrist (1981), and D.W. Gibson (1992).

The strata at Willow Creek Mine comprise Lower Cretaceous rocks of the Fort St. John and Bullhead groups, and older Jurassic to Lower Cretaceous rocks of the Minnes Group (**Table 4-1**). Almost all of the block is covered with coal-measures of the Gaylard Member of the Gething Formation, which forms the upper part of the Bullhead Group, or by the marine rocks of the overlying Bluesky and Moosebar formations, which form the basal part of the Fort St. John Group.

Fort St. John Group rocks are present only along the northeastern fringe of the Willow Creek Mine block, owing to substantial erosion. Minnes Group rocks are present only in the subsurface at Willow Creek Mine, inasmuch as the Bullhead Group rocks are at no point completely stripped-away by erosion (**Map 2-3**).

4.2.1 *The Gething-Bluesky controversy and its resolution*

Considerable stratigraphic controversy (as expressed in works of Hughes and Stott, studied further by Oppelt (1988), and to some extent resolved by Gibson's 1992a report) has revolved around the stratonymy and chronological topology of rocks underlying and overlying the coal-measures of the Gething Formation. In this report, the Gething Formation, as well as immediate sub-Gething rocks, are assigned to the Bullhead Group, following Stott's extensive regional work. Hughes' previous stratonymy, comprising the Crassier and Beaudette groups, is now formally deprecated, although it is still being used by some industrial geologists.

At the latitude of the Willow Creek Mine block, and within the Pine Pass area in general, only the Gaylard Member of the Gething Formation is known to contain coal of potentially-mineable thickness.

Owing to the southwestward back-stepping of the Gething paleodelta complex at Willow Creek Mine, the Bluesky is here-recognised as a formation in its own right (homotaxial with the more-extensive Bluesky strata of the Deep Basin of the Alberta Syncline), and the Bullmoose and Chamberlain members (elsewhere regarded as being part of the Gething Formation) are both considered to be members of the Moosebar Formation, as neither the Bullmoose rocks nor the Chamberlain rocks manifest any non-marine indicators. Supra-Gething rocks (from the Bluesky Formation upwards) are assigned to the Fort St. John Group, following Stott's work.

4.3 Local structural geology

Structural geology of the Willow Creek Mine area would be difficult to decipher on the sole basis of bedding attitudes within exposed bedrock, owing to the isolated nature of the outcrops, other than those formed by temporary or longer-lived open-pit walls. Current-day understanding of local structural geology comes from boreholes through faulted coal-measures, supplemented by bedrock alongside roads and trails. An additional source of structural information, albeit indirectly-so, is from the interpretation of landforms as visible in aerial photographs and on detailed topographic maps, although this indirect observation is locally hampered by Drift cover.

Map 2-3 depicts, in general terms, our understanding of bedrock structure at property scale. Willow Creek Mine comprises a series of moderately-tight southwest-verging folds,

overlain and bounded to the northeast by a northeast-dipping monoclinal panel of coal-measures and cover rocks, dislocated by southwest-verging thrust-faults. The Willow Creek Mine block occupies the leading (northeastern) limb and central duplex zone of the Pine River Anticlinorium, which in turn lies within a regional-scale triangle zone (McMechan, 1984; 1985; Lingrey, 1996). Willow Creek Mine's coal-measures appear to occupy a shallower structural position within the triangle-zone than those of the Willow South or Willow West blocks.

Within the 4N2 mining area (the site of year-2020 drilling, as well as most of the winter-2021/2022 drilling), the upper portion of the Gaylard coal-measures appears to form a consistent northeast-dipping homoclinal panel of strata. This panel is broken and to some extent dislocated by metre- to dekametre-scale southwest-verging thrust-faults. Faulting is visible as contorted and shattered zones within the rocks.

Faults, as interpretable from downhole duplication of geophysical-log response patterns, may readily subdivided into three levels-of-assurance:

- Fault, established -- where there is a demonstrable repeat of log-response or of cored lithologies, interpreted to be associated with a consistently-developed coal bed
- Fault, probable -- where there appears to be a repeat of a minor coal, or of a characteristic sequence of non-coal strata
- Fault, possible -- where there appears to be a local thickening or duplication of stratal pattern, generally-associated with borehole breakout(s), but the interpretation is not robust-enough to justify classification as 'probable'.

This tripartite structural classification follows practice developed by geologists of BP Coal, working in the late 1970s and early 1980s on their then-operated Sukunka coal property (Andrew Bowler, personal communication, 1977).

Bedding-plane shearing is pervasive within incompetent strata such as dirty coals or coaly mudstones, and some of this shearing might be associated with bedding-parallel faulting.

4.3.1 Tectonostratigraphic coherence

Normal stratigraphic sequences are generally preserved at Willow Creek Mine, despite the thrust-faulting of the rocks and concomitant folding and tectonic stacking. Overturned strata are rare.

4.4 Local stratigraphy

Based largely upon the interpretation of downhole geophysical logs of coal-exploration boreholes and natural-gas wells, the local stratigraphic sequence (as shown in **Table 4-1**) has been identified within and adjacent to the Willow Creek Mine block.

Relationships between the various rock-units that occur within and adjacent to the Willow Creek Mine block are shown on the geological map (**Map 2-3**), which presents the property-scale bedrock geology as understood in 2018 (not greatly changed as of the spring of 2022), incorporating results of historic drilling and geological mapping done by others, as cross-referenced in **Section 10** of this report. Geological contacts shown on the map are approximate to

inferred, owing to the generally-discontinuous nature of bedrock exposures, and paucity of documented stratigraphic and structural fieldwork.

4.4.1 Stratigraphic identity of rocks drilled in winter-2021/2022

In the winter of 2021/2022, all of the drilled rocks, including coal, were within Division 5 (map-unit 3a5) of the Gaylard coal-measures.

Table 4-1: Table of formations, members, and subdivisions

Group/Formation/Member			Map-unit	Lithology and thickness		
Quaternary Drift			D	Alluvium; lodgement till; moraines; talus; glaciolacustrine silts, up to ?150 m thick within Pine Valley.		
Fort St. John Group	Hasler Fm.		8a	Siltstone and mudstone; minor sandstone; ironstone as bands of concretions; at least 180 m thick		
	Boulder Creek Fm.		7	Sandstone and siltstone; conglomerate; coal; 75 to 95 m	Presence of coal not yet proven within Willow Creek Mine block	
	Hulcross Fm.		6	Siltstone and mudstone; minor sandstone and tuff; basal pebbly gritstone; erosional base; 120 to 130 m thick		
	Gates Fm.		5	Siltstone, sandstone and conglomerate; minor coal; 190 to 230 m thick	Presence of coal not yet proven within Willow Creek Mine block	
	Moosebar Fm. 165 to 280 m thick	Spieker Mb.	4	4c	Siltstone, sandstone; minor mudstone; 60 to 90 m thick	May be locally structurally-thickened due to internal thrust-induced telescoping, or repeated outright by thrusting. Possible detachment zones at base of Cowmoose Member and Bullmoose Member.
		Cowmoose Mb.		4b	Mudstone; minor tuff and ironstone; erosive-based basal glauconitic grit; 80 to 100 m thick	
		Green Marker		4a	Locally-glauconitic siltstone and sandstone; nil to ca. 3 m thick	
		Chamberlain Mb.		3d	Sandstone and siltstone; 3 to 6 m thick	
		Bullmoose Mb.		3c	Siltstone and sandstone; mudstone; minor tuff; 100 to 120 m thick	
	Bluesky Fm.		3b	Glauconitic sandstone and gritstone; siltstone and mudstone; 1 to 8 m		
Bullhead Group	Gething Fm.	Gaylard Mb.	3a	3a5	Siltstone, sandstone, mudstone and coal (zones 'Bird' and 1 through 4); minor tuff	
				3a4	Siltstone and mudstone; coal (zones A, 5 and 6)	
				3a3	Sandstone; minor siltstone and mudstone; coal (zones 7 and 8)	
				3a2	Siltstone and mudstone; minor sandstone and coal (zone 9)	
				3a1	Basal sandy unit: sandstone and siltstone; minor coal (zones 10 to 12 -- correlations tentative)	
	Cadomin Fm.		2	Gritty to pebbly, siliceous sandstone and sandy conglomerate with distinctive 'blocky' gamma-log motif; minor siltstone and coal; 2.5 to 14? m thick; erosional base		
Minnes Gp.	Bickford Fm.		Siltstone, sandstone, conglomerate, and mudstone; minor coal; 285 to 300 m thick		present only at depth beneath the property, as encountered by gas wells	
	Monach Fm.		Sandstone and conglomerate; siltstone; 210 to 260 m thick			
	Beattie Peaks Fm.		Siltstone, sandstone and mudstone; minor coal; 285 to 350 m thick			
	Monteith Fm.		Quartzite and sandstone; minor siltstone; 340 to 425 m thick			

Rock-units are discussed in detail below, in order from youngest (generally nearest the ground surface) to oldest. Localised inversions of stratigraphic position have been induced by stratal shuffling consequent upon thrust-faulting. Notwithstanding this shuffling, overall stratigraphic relations remain readily-recognisable, owing to distinctive geophysical and lithological characteristics of the various rock-units.

4.5 Drift (map-unit D)

Unconsolidated sediments, inferred to be of Quaternary age, form a patchy blanket at the ground surface throughout the Willow Creek Mine portion of the Willow Creek coal lease. For reasons of clarity, Drift is not mapped as a separate entity within **Map 2-3**, except along the floor of the Pine River valley.

The most pervasive Drift cover consists of glacial till, usually less than 10 metres thick within the upland areas of the property. Patches of sandy, gravelly and bouldery alluvium are present within stream channels. McKechnie (1955) noted the possible presence of glacio-lacustrine silt deposits within the southeastern portion of the Willow South area; although an extension of such deposits into Willow Creek Mine area is considered possible, the extent of such deposits has yet to be assessed in detail, owing to lack of lithological records in Drift-penetrating boreholes.

The Pine River valley is inferred to be floored and possibly flanked by valley-filling alluvial, glacial, and glaciolacustrine sediments. By inference with results of sparse drilling in other valleys within the Foothills of northeastern British Columbia, such deposits are inferred to be locally more than 150 metres thick.

4.6 Fort St. John Group (map-units 8a, 7, 6, 5, 4, and upper part of map-unit 3)

The uppermost of the Early Cretaceous rocks of the Fort St. John Group have been completely removed by erosion at Willow Creek Mine. Most of this erosion is likely to have occurred during a prolonged episode of regional uplift during the Tertiary era (Cant and Stockmal, 1989), followed by further glacial scouring during the Quaternary era, and continuing through fluvial down-cutting to the present time.

Within the Group, the remainder of its constituent formations remain at least locally-present within the Willow Creek Mine map-area. From top down, these are the basal half of the Hasler Formation, and the entirety of the Boulder Creek, Hulcross, Gates, Moosebar and Bluesky formations.

4.6.1 Hasler Formation (map-unit 8a)

The Hasler Formation, of late Middle Albian to Late Albian age (Gibson, 1992b) forms subdued slopes within the upland area northeast of the Willow Creek Mine block. The Hasler Formation is not interpreted to form bedrock within the boundaries of the block, but its basal portion (at least 180 metres thick) is mapped as forming bedrock within the northeastern corner of the mapped area of **Map 2-3**, completely outside the Willow Creek lease's extent.

The Hasler Formation comprises marine siltstone, overlain by dark grey to black marine mudstone with occasional bands of sideritic concretions. The complete, undeformed thickness of the formation is approximately 335 to 365 metres (Wickenden and Shaw, 1943).

A few centimetres to decimetres of erosive-based cherty gritstone commonly mark the Hasler Formation's abrupt basal contact with the underlying Boulder Creek Formation (*ibid.*, page 6). This gritstone is not recognised as a mappable horizon, owing to its thin nature and the lack of borehole intersections.

4.6.2 Boulder Creek Formation (map-unit 7)

The Boulder Creek Formation, of late Middle Albian age (Gibson, 1992b) forms prominent cliffs in the upland area, along and immediately to the northeast of the Willow Creek Mine block's northeastern boundary. The Boulder Creek Formation is the uppermost of the three formations (Boulder Creek, Hulcross, and Gates) formerly covered by the now-superseded Commotion Formation of Wickenden and Shaw (1943).

Regionally, the Boulder Creek formation consists of three members (Gibson, 1992b):

- Paddy Member -- coarse clastic rocks, minor thin coal;
- Walton Creek Member -- dominantly-fine clastic rocks, thin tuff bands, thin and thick coal;
- Cadotte Member -- coarse clastic rocks.

Regionally, conglomerate and sandstone are the predominant lithologies of the Boulder Creek Formation, but the Walton Creek Member of the formation also contains fine-grained rocks including siltstone, root-penetrated, variably-carbonaceous mudstone, and coal, some of which locally attains thicknesses of interest for underground mining.

Conglomerate and sandstone are concentrated in the basal Cadotte Member of the formation, while fine-grained rocks are concentrated in the overlying Walton Creek Member (Gibson, 1992b). The uppermost regionally-mapped division of the Boulder Creek Formation, comprising the conglomerate of the Paddy Member, is not recognised within the Willow Creek Mine area.

The overall thickness of the Boulder Creek Formation is tentatively inferred to be 75 to 95 metres at Willow Creek Mine, of which the basal 30 to 45 metres comprise the Cadotte Member and the overlying 45 to 50 metres comprise the coal-bearing Walton Creek Member. The basal contact of the Boulder Creek Formation with the underlying Hulcross Formation is abrupt to erosional at local scale, and likely to be interfingering at regional scale.

4.6.2.1 Paddy Member (absent)

Within the vicinity of Willow Creek Mine, the Paddy Member appears to be absent. It is not clear whether the absence is due to non-deposition or to post-depositional erosion.

4.6.2.2 Walton Creek Member

The Walton Creek Member of the Boulder Creek Formation comprises 45 to 50 metres of generally-recessive siltstone, variably-carbonaceous, locally root-penetrated mudstone and variably-thick coal beds.

The swale-forming fine-grained rocks of the Walton Creek Member are punctuated by cliff-forming lenses of sandstone, gritstone and pebble-conglomerate, inferred to be channel-fills. Gibson (1992b) considered the Walton Creek Member to be 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 (*op. cit.*) as being conformable.

4.6.2.3 Cadotte Member

The Cadotte Member of the Boulder Creek Formation comprises 30 to 45 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. Other than isolated coalified logs, the Cadotte Member is devoid of coal. The basal contact of the Cadotte Member 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.

4.6.3 Hulcross Formation (map-unit 6)

The Hulcross Formation, of middle Albian age within the Early Cretaceous (Stelck and Leckie, 1988) comprises thinly-interbedded, locally-concretionary grey siltstone, fine-grained sandstone and dark grey mudstone with occasional very thin but extremely-persistent interbeds of soft, light grey to white tuff (Kilby, 1985; Gibson, 1992b) and rare thin stringers of coal. Sideritic concretions are commonly found in isolated, laterally-persistent bands.

Within the area covered by **Map 2-3**, the Hulcross Formation forms a recessive band along the northeastern margin of the Willow Creek Mine block. The thickness of the Hulcross Formation at Willow Creek Mine is estimated to be 120 to 130 metres, based on borehole data and measured outcrop sections from nearby properties, as reported by Gibson (1992b). The formation's immediate base is characteristically marked by a thin (generally less than a metre thick) erosive-based bed of pebbly sandstone or gritstone, lying erosionally upon the underlying strata of the Notikewin Member of Gates Formation.

4.6.4 Gates Formation (map-unit 5)

The Gates Formation, of late Early Albian age within the Early Cretaceous, comprises thin to thick interbeds of sandstone, siltstone, conglomerate, and shale, locally accompanied by coal beds.

Coals of the Gates Formation, and their enclosing sedimentary rocks, were deposited on the shoreline of the Clearwater Sea (part 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 collectively known as the Gates Delta.

At Willow Creek Mine, the Gates coal-measures are present along the northeastern margin of the property. No boreholes have yet penetrated the Gates Formation at or near Willow Creek Mine, and hence its coal potential is unknown in detail, although expected to be low on account of the well-established northward diminishment of coal content within the formation.

Regionally, the Gates Formation may be readily subdivided into three members: the uppermost, dominantly fine-grained Notikewin coal-measures (90 to 120 metres thick?), the medial, dominantly coarse-grained conglomeratic Falher coal-measures (50 to 90 metres thick?), and the basal Torrens sandstone (30 to 40 metres thick?). The Notikewin, Falher and Torrens members can be reasonably-distinguished in the logs of oil and gas wells drilled to within the Highhat gas field, situated to the southeast of Willow South, but these units cannot be easily mapped separately without the aid of detailed aerial imagery, so no attempt has been made to depict them separately on **Map 2-3**.

The Gates Formation is inferred to be 190 to 230 metres at Willow Creek. The nature of its contact with the underlying Moosebar Formation appears to be abrupt at local scale, but likely to be interfingering at the regional scale.

4.6.5 *Moosebar Formation (map-units 4c, 4b, 3d, and 3c)*

The Moosebar Formation, of early Albian age (Stott, 1968) forms the basal part of the Fort St John Group. At and near Willow Creek Mine, the Moosebar Formation has a typical stratigraphic thickness of at least 165 metres (Wickenden and Shaw, 1943, page 4) and perhaps as great as 240 to 280 metres, although the latter figure likely indicates substantial structural thickening due to thrust-induced telescoping of the Moosebar rocks.

The Moosebar Formation comprises an overall coarsening-upward sequence, consisting of several lesser coarsening-upward cycles of mudstone passing upward to sandy siltstone. A basal pebbly, locally-glaucconitic gritstone (the informally-designated Green Marker) occurs within the middle of the formation in some sections. Very thin (a few millimetres to a few decimetres) bands of tuff form conspicuous marker bands, generally concentrated within the basal 30 metres of the formation (Kilby, 1984a; 1985).

At Willow Creek Mine, the Moosebar Formation is inferred to form bedrock along the block's northeastern side, flanking the Gething coal-measures exposed within the northeastern limb of the Pine River Anticlinorium (**Map 2-3**).

Regionally, deep exploratory drilling for natural gas targets allows the recognition of five lithological subdivisions (from top down, the Spieker and Cowmoose members, the Green Marker, and the Chamberlain and Bullmoose members) within the Moosebar Formation of the Willow Creek Mine area. All but the uppermost of these subdivisions are present and recognisable in pit-slope exposures at Willow Creek Mine, although one (the Green Marker, map-unit 4a) is consistently too thin to be mappable as anything other than a single line at the scale of **Map 2-3**.

Owing to the sparse extent of drilling within the Moosebar Formation, and the lack of detailed borehole records, no attempt has been made to map the subdivisions of the formation within the Willow Creek Mine block *per se*, although such mapping has been accomplished within the adjoining Willow West block.

4.6.5.1 *Spieker Member (map-unit 4c)*

The Spieker Member of the Moosebar Formation (Duff and Gilchrist, 1981), of early Albian age (Stott, 1968), comprises thinly-interbedded, coarsening-upward units of siltstone and very fine sandstone, within an overall coarsening-upward sequence. Bioturbation is pervasive and intense within the Spieker Member, which is interpreted to have formed as shallow-water turbidites within a proximal shelf setting in advance of the northward-prograding Gates paleodelta. The undeformed thickness of the Spieker Member at Willow Creek Mine is estimated to be 60 to 90 metres, possibly being locally thickened through thrust-induced structural telescoping.

The Spieker Member's existence at the latitude of the Willow Creek coal lease is established by drilling within the western part of the Willow West area (Cathyl-Huhn, 2015c), outside the extent of **Map 2-3**. The Spieker Member is also likely to be present within the northeastern part of the Willow Creek Mine block, but beyond the area which has been tested by drilling.

The basal contact of the Spieker Member with the underlying Cowmoose Member is abrupt, generally drawn at the base of an upward decrease in gamma-log response, which appears to coincide with an upward increase in the silt content of the rocks, and a concomitant

passage from dark greyish-black to medium grey rock colour. The immediate base of the Spieker Member is in some sections marked by one or two metres of distinctly-sandy siltstone.

4.6.5.2 *Cowmoose Member (map-unit 4b)*

At and near Willow Creek Mine, the Cowmoose Member of the Moosebar Formation comprises 80 to 100 metres of rubbly-weathering, massive, dark greyish-black to black mudstone, punctuated by occasional bands crowded with ironstone concretions, and several very thin (a few millimetres to a few decimetres) but laterally-persistent and visually-prominent 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 Cowmoose 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 Cowmoose Member.

The name 'Cowmoose' was introduced by Cathyl-Huhn and Singh (2014) as an informal and pragmatic stratigraphic name, for the purposes of former mine-owner Walter Canadian Coal Partnership's coal-assessment studies. These rocks had been previously referred to as the 'basal mudstone member' of the Moosebar Formation or simply as the 'mudstone member' (Duff and Gilchrist, 1981).

The recommended type-section of the Cowmoose Member (Cathyl-Huhn and Singh, 2014) is on the northeastern face of Cowmoose Mountain, situated between Sukunka River and the western fork of Bullmoose Creek. Within the Willow Creek Mine block, the Cowmoose Member is locally exposed in road-cuttings and ballast-quarries along access roads within the northeastern fringe of the block.

Without recourse to cored sections or gamma-neutron logs, isolated exposures of the Cowmoose Member would be quite similar in weathering-habit to, and thus difficult to distinguish from, the basal part of the older Bullmoose Member. The Cowmoose Member is locally thickened to over 200 metres by thrust-induced structural telescoping (Cathyl-Huhn *et al.*, 2015).

The age of the Cowmoose Member is Early Albian (as noted for the mudstones of the Moosebar Formation by Stott, 1968). The basal contact of the Cowmoose mudstones over the underlying Green Marker (an informal lithostratigraphic unit previously designated as the 'Bluesky-S unit' by Kilby, 1984b) is gradational to abrupt, and generally easily-recognised on geophysical logs as a downward decrease of gamma-log counts, and in cores and outcrops by the downward appearance of distinctively-greenish glauconitic sediments.

4.6.5.3 *Green Marker (map-unit 4a)*

The Green Marker is a thin but regionally-persistent zone of erosive-based, pebbly, intensely-bioturbated, commonly-glauconitic sandstone, siltstone and mudstone. The Green Marker comprises zero to perhaps 3 metres of variably-glauconitic siltstone or chert-rich lithic arenite, locally containing stringers or lenses of gritstone or pebble-conglomerate. Owing to its minimal thickness, the Green Marker is depicted as a single line upon **Map 2-3**.

The Green Marker is locally altogether absent; hence its minimum thickness of 'nil' as given in **Table 4-1**. At Willow Creek, glauconite development within this unit is patchy, in contrast with its more obvious presence in other areas.

Earlier reports (Wallis and Jordan, 1975; Jordan and Dawson, 1978) denoted this zone as the Bluesky Formation, on the grounds of its lithologic similarity to the typical Bluesky rocks of the Alberta Syncline and Deep Basin, but that correlation is now understood to be incorrect. Although the lithology of the Green Marker is superficially similar to that of the older Bluesky Formation, these two glauconite-bearing zones are stratigraphically distinct, both in space and in time (Kilby, 1984b; Legun, 1990).

Kilby's (*op. cit.*) 'Bluesky-S unit' corresponds to the beds currently mapped as the Green Marker, whereas his older and stratigraphically-lower 'Bluesky-N' unit corresponds to beds here mapped as the Bluesky Formation.

The basal contact of the Green Marker with the underlying Chamberlain Member, or with the Bullmoose Member where the Chamberlain is absent, is characteristically abrupt and may at least locally be erosional.

4.6.5.4 *Chamberlain Member (map-unit 3d)*

At Willow Creek Mine, the Chamberlain Member of the Moosebar Formation is a geophysically-distinctive (moderately-low gamma-log responses) unit within the Moosebar, comprising a few (3 to perhaps 6) metres of rocks with a low to moderate gamma-ray count, consistent with the regionally-known Chamberlain lithologies of interbedded sandstone and siltstone.

In contrast with the Chamberlain sections drilled in the Sukunka area (to the southeast of Willow Creek Mine), no coal has been found within the Chamberlain Member at Willow Creek Mine. Regionally, the Chamberlain Member is well-established as thinning to the east and northeast; it is locally altogether absent within oil and gas wells drilled at Highhat Mountain (a few tens of kilometres east of Willow Creek Mine), and in those wells the Cowmoose mudstones appear to directly overlie the Bullmoose siltstones.

In its type area at Sukunka Colliery and Bullmoose Mountain, the Chamberlain Member was defined by Gibson (1992a) as the uppermost member of the Gething Formation. However, in the Willow Creek area the Chamberlain's much-reduced thickness and apparent non-coal-bearing nature support its being more properly assigned to the Moosebar Formation.

The Chamberlain Member lacks diagnostic fossils; it has therefore been assigned an Early Albian age by Gibson (1992) on the basis of fossils found within the overlying Cowmoose Member of the Moosebar Formation. The basal contact of the Chamberlain Member with the underlying Bullmoose Member is gradational by interbedding, being drawn at the base of the Chamberlain's lowest thick sandstone. The Chamberlain-Bullmoose contact possibly rises stratigraphically, to the north and east (Cathyl-Huhn *et al.*, 2015), but available drilling does not suffice to confirm nor contradict this supposition.

4.6.5.5 *Bullmoose Member (map-unit 3c)*

The Bullmoose Member within the Willow Creek Mine block comprises 100 to 120 metres of thinly-interbedded, recessive-weathering mudstone, siltstone and minor sandstone of turbiditic aspect, forming several fining-upward sequences within an overall coarsening-upward sequence.

The Bullmoose Member comprises the youngest (stratigraphically-highest) rocks programmed to be mined in Pit 4N2 of Willow Creek Mine. The Bullmoose, in keeping with its turbiditic aspect, contains no workable coal.

The geophysical log response of the Bullmoose Member is distinctive, as compared with the overlying Chamberlain Member and the underlying Bluesky Formation. Bullmoose rocks have characteristically-higher natural-gamma log responses than their bounding rock-units. On the other hand, the Bullmoose Member is difficult to distinguish from the younger Cowmoose Member.

The Bullmoose Member is well-exposed in the southeastern highwall of the 4N2 open-pit workings (as shown in **Plate 4**). The Bullmoose is inferred to form extensive areas of bedrock along the northeastern margin of the Willow Creek Mine block, extending into the adjoining Willow South block (**Map 2-3**).

As mentioned above, the Bullmoose lacks coal, other than isolated coalified logs and coarse, poorly-preserved 'plant trash', likely of drifted origin. The Bullmoose does, however, 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 likely corresponds with the 'Lower Silty Member' of the Moosebar Formation, as originally suggested and locally-recognised by Duff and Gilchrist (1981), within those areas (for example, the deep subsurface under Highhat Mountain, southeast of the Willow Creek Mine block) where the overlying Chamberlain Member is absent. Geophysical logs of the Bullmoose Member show a characteristic high-gamma response at two horizons situated a few tens of metres above the Bullmoose/Bluesky contact. These gamma 'spikes' are interpreted to be thin bands of tuff, each of them one to two decimetres thick, with the lower of the two bands being more persistent. These bands provide a regionally-extensive geophysical marker throughout the Falling Creek region (Kilby, 1984a).

The basal contact of the Bullmoose, with the underlying Bluesky Formation, is drawn at the top of the underlying glauconitic sandy mudstone. In geophysical logs, the Bullmoose/Bluesky contact is readily recognised as a rapid downward change in log response to higher resistivity response, lower natural-gamma counts, and higher API neutron counts. This downward change is interpreted to correspond with a rapid downward passage from fine-grained mudstone of the basal Bullmoose, to the sandy mudstone and sandstone of the uppermost Bluesky.

The Bullmoose Member is of late Early Albian age (Gibson, 1992a). The original stratigraphic thickness of the Bullmoose is approximately 100 to 120 metres at Willow Creek Mine, although thicker sections (likely structurally-thickened by thrust-induced telescoping of the strata) are suspected to exist

4.6.6 Bluesky Formation (map-unit 3b)

The Bluesky Formation is a transitional unit between marine and non-marine facies. Accordingly, there has been considerable debate within the geological literature -- starting with Stott (1968), and further discussed by Kilby (1984b) and Legun (1990) -- as to the Bluesky's stratigraphic affinities. In the present report, the Bluesky is considered to constitute a formation in its own right, bounded above by the Moosebar Formation, and beneath by the Gething Formation, following earlier workers (*cf.* Legun, 1990 and James, 1998). Further to the south within the Mink-Brazion coalfield, the Bluesky is considered to be a member within the Gething Formation.

The Bluesky Formation generally consists of coarsening-upward cycles of interbedded mudstone, siltstone, and sandstone. The top of the Bluesky is characteristically marked by a glauconitic horizon, a few decimetres thick, comprising abundant fine-grained, green glauconite within sandy mudstone and argillaceous, locally-pebbly, sandstone. The base of the Bluesky (shown in **Plate 4**) is marked by a distinctive erosive-based chert- and quartz-pebble conglomerate up to a metre thick, grading to argillaceous sandstone with few randomly-distributed chert and quartz pebbles. The conglomerate horizon's presence has been noted on numerous historic borehole records at Willow Creek Mine.

Bluesky sediments likely represent the initial transgressive deposits of an early tongue of the Clearwater Sea, which shortly after deposition of the Bluesky had transgressed to a southerly limit several hundred kilometres southeast of the Willow Creek area (Gibson, 1992a). The Bluesky Formation, as-drilled at and near Willow Creek Mine, is 1 to 8 metres thick. The age of the Bluesky is not directly known, but inferred to be late Early Albian on the basis of the ages of its bounding strata. The basal contact of the Bluesky Formation within the underlying Gething Formation is almost always erosional, locally with substantial downward scour into the older Gething rocks. Scour is locally evidenced by the absence of the Bird Seam coal of the uppermost Gaylard coal-measures

4.7 Bullhead Group (map-units 3a and 2)

Both formations of the Bullhead Group -- the Gething and the older Cadomin -- are present at Willow Creek Mine, with the Gething containing all known potentially-mineable coal beds. The twelve 2021/2022 boreholes were solely drilled within the Gething Formation.

4.7.1 Gething Formation (map-unit 3a)

The Gething Formation, of Hauterivian to late Early Albian age (Gibson, 1992a), 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 and an intervening marine-influenced bay, of which the basal delta (the coal-bearing Gaylard paleodelta) extended throughout the Mink-Brazion coalfield, including the Willow Creek Mine block. At the latitude of Willow Creek Mine, the overlying (and therefore younger) Chamberlain paleodelta is presumed to have been only represented by a thin, non-coal-bearing, fringe of sandy/silty delta-front to prodeltaic deposits (Gibson, 1992a).

The Gething Formation forms the top of the Bullhead Group (Stott, 1968, as used in the present report), and of the Crassier Group (Hughes, 1964).

During historic (pre-2021) as well as current (winter-2021/2022) drilling within the Willow Creek Mine block, nearly every coal-exploration borehole has intersected some section of the Gething Formation. However, the formation's thickness can only be indirectly estimated from this work, owing to lack of drilling into the underlying Cadomin Formation, as well pervasive structural complexity within the Gething Formation.

At local scale, the basal contact of the Gething Formation with the underlying Cadomin Formation is inferred to be abrupt to possibly erosional (Cant, 1996). At Willow Creek Mine, the Gething/Cadomin contact has been 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 or multi-storey sandstone characteristic of the underlying Cadomin beds. At regional scale, the two formations likely interfinger (Stott, 1968; Gibson, 1992a).

4.7.1.1 *Gaylard Member*

Only one member (the Gaylard Member) is recognised within the Gething Formation at Willow Creek Mine, with the overlying Bullmoose and Chamberlain rocks being assigned to the Moosebar Formation, instead of to the Gething Formation as has been the case in areas lying further to the southeast.

Coals of the Gaylard Member at Willow Creek Mine, and their enclosing sedimentary rocks, were deposited during Hauterivian to late Early Albian time, between 112 and 133 million years ago, on the basis of plant-fossil and foraminiferal zonations, as presented by Gibson (1992a).

4.7.1.2 *Subdivisions of the Gaylard Member (map-units 3a1 through 3a5)*

Table 4-1 (given above) summarises the subdivisions of the Gaylard Member. Major coal zones and other lithologies used as division markers are:

- No.4 coal zone, marking the base of Division 5;
- No.6 coal zone, marking the base of Division 4;
- No.8 coal zone, marking the base of Division 3;
- heterolithic, mainly silty, strata forming Division 2; and
- dominantly-sandy strata, comprising Division 1.

4.7.1.3 *Sedimentological and cyclothem details*

The Gaylard Member consists mainly of non-marine sedimentary rocks within the Willow Creek Mine block, although the presence (at the immediate top as well as in the bottom third of the formation) of coal zones with elevated sulphur content suggests that some marine influence may have occurred. The coal zones in question are the Bird (at the top of the Gaylard) and No.8 zone.

The Gaylard Member consists principally of many vertically-stacked, locally erosive-based, fining-upward bed-sets, such as are typical of fluvial and deltaic depositional settings. A typical cyclic succession of Gaylard sediments commences with basal sandstone (rarely basal gritstone or pebble-conglomerate), passing upward through coarse- to fine-grained sandstone, siltstone, variably-carbonaceous mudstone, rooty seatearth mudstone and coal.

Most, but not all, Gaylard cycles are capped by coal beds, or by laterally-correlative carbonaceous to coaly mudstones. Coals vary in thickness: some are too thin (less than 30 cm) or too dirty, to be considered potentially-mineable, whereas other coals locally coalesce to form thick conjoint zones up to 4 metres thick. The individual component coal beds of these conjoint zones are readily-traceable on gamma-density logs, and they thus may be interpreted to maintain their identity as discrete sedimentation-units despite their bounding coal-on-coal contacts.

Conjoint coals often have distinctly different maceral populations (thus proportion of reactive to inert components) and chemical compositions (such as base-acid ratio).

Gaylard coals frequently contain partings of siltstone or variably-carbonaceous mudstone, and sometimes of tuff (the 'tonstein' bands of Kilby, 1984a and 1985, including the regionally-extensive Fisher Creek tonstein), and rarely of nodular or banded sideritic ironstone. Splitting and lateral coalescence of coals is interpreted to represent the near-isochronous interaction between peat accumulation in wetlands, avulsive processes within nearby river distributaries, and concomitant crevasse-splay sedimentation atop the coeval coal-forming wetlands (Banerjee and others, 1996).

Gamma-log motifs of the Gaylard sandstones (within and between these cycles) are typically ragged, occasionally capped by an upward-increasing bell-shaped motif. In contrast, the siliceous sandstones and conglomerates within the underlying Cadomin Formation display distinctly blockier motifs than those of the Gaylard sandstones.

4.7.1.4 Discussion concerning the thickness of the Gaylard Member

The thickness of the Gaylard Member is not directly known at Willow Creek Mine, owing to the lack of completely-drilled sections, and the pervasive presence of incompetent structures comprising folds and both small- and large-scale thrust-faults within the Gaylard's coal-measures. From incomplete sections within homoclinal strata, the Gaylard is established to be at least 260 metres thick at Willow Creek Mine, and possibly up to 360 metres thick.

In contrast, within the nearby Highhat gas field (15 kilometres to the southeast of Willow Creek Mine), complete sections of the Gething Formation are 475 to 720 metres thick (Cathyl-Huhn, 2015a).

4.7.2 Cadomin Formation (map-unit 2)

The Cadomin Formation immediately underlies the Gething Formation, forming the basal part of the Bullhead Group (Stott, 1968). As such, the Cadomin Formation includes strata which may alternatively be assigned to the now-deprecated Dresser Formation of the Crassier Group *sensu* Hughes (1964).

Regionally, the Cadomin Formation comprises one or more thick beds of coarse-grained, gritty to pebbly sandstone and pebble-conglomerate (McLean, 1977) with occasional lenses of siltstone and pebbly gritstone, and rare thin lenses of coal, several tens of metres thick overall.

The Cadomin Formation may be distinguished from the sandier parts of the Gaylard Member by means of the Cadomin Formation's greater lateral continuity, the Cadomin's distinctly-blocky gamma-log response, and the frequent (but not universal, *cf.* Cant and Abrahamson, 1996) presence of an intervening zone of fine-grained coal-measures strata.

The base of the Cadomin marks a northeastward-deepening angular unconformity, cutting down into successively-older rocks of the Minnes Group (Stott, 1973).

Locally, it remains uncertain whether the Cadomin Formation has been reached by any of the historic or current boreholes at Willow Creek Mine. By comparison with nearby properties, the Cadomin's basal contact with the underlying Bickford Formation of the Minnes Group is presumed to be erosional, with considerable local scour into the older sediments. The thickness of the Cadomin Formation at Willow Creek Mine is unknown, on account of lack of drilling through the formation. The estimated thickness of 2.5 to ca. 14

metres, as given in **Table 4-1** above, is derived from studies of the Gething and Cadomin formations within the adjoining Willow South coal property.

4.8 Minnes Group (map-unit 1)

The Minnes Group comprises 1000 to 1200 metres of clastic sedimentary rocks of latest Jurassic and earliest Cretaceous age, forming a poorly-exposed deltaic/shelfal/basinal complex which is overlain by the Bullhead Group.

Four formations are locally recognised within the Minnes Group. From top down, they are the Bickford (equivalent to most of the now-deprecated Brenot Formation of Hughes, 1964), the Monach, the Beattie Peaks, and the Monteith formations (Stott, 1981; 1998). Coal is known to at least locally occur in all four of the Minnes Group's formations (Chowdry, 1980), but only the Bickford Formation is inferred to occur at accessible depths within the Willow Creek Mine block, and therefore to be a credible (albeit thus-far apparently-untested) target for coal exploration.

5 Coal

As discussed above in **Section 4**, the Gaylard Member contains numerous coal beds, some of which are sufficiently thick and apparently laterally-continuous to constitute reasonable exploratory and mining targets, within the Willow Creek Mine block.

5.1 Regional correlations of major Gaylard coal zones

Regional correlations of Gaylard coals are here proposed, although not examined in detail:

- The sulphurous 'Bird' zone at Willow Creek Mine may be correlative with the uppermost A zone at Hudette and the Lower Gething A zone at Sukunka Colliery. It is definitely not correlative with the type Bird Seam at Sukunka, which instead lies near the top of the Chamberlain Member of the Gething Formation.
- No.4 zone at Willow Creek Mine may be correlative with the Brenda Seam at Hasler Creek, Hudette F zone at Mink Creek and Hudette, Seam C60 (the Conuma 'A' coal zone) at Burnt River, and the Lower Gething B zone at Sukunka Colliery;
- No.6 zone at Willow Creek Mine may be correlative with the Upper Seam (Conuma 'B' zone) at Burnt River; and
- No.7 zone at Willow Creek Mine may be correlative with the Lower Seam (Conuma 'C' zone) at Burnt River.

5.2 Local naming scheme for Gaylard coals

Table 5-1 depicts the conceptual stratigraphic hierarchy of coal zones, coal beds, and lesser subdivisions of coal beds, at Willow Creek Mine. Coal zones are numbered downwards from the Bird at the immediate top of the Gaylard Member, and then proceeding downward from the No.1 zone to the No.4 zone, then the A zone, followed by the No.5 through No.12 zones. The No.12 zone is postulated to lie close to the base of the Gaylard Member.

Each coal zone contains at least one major coal bed, and numerous subordinate and associated 'splits', 'stringers' and 'stringer plies'. Designations of the various major and minor coal beds have evolved with time from McKechnie's (1955) original concept of a series of numbered coal beds, into a more complex scheme of subordinate relationships. A system of split numbering was established by James (1998), who assigned odd terminal digits to subordinate coals lying above a major coal bed, and even terminal digits to those lying below a major coal bed.

5.2.1 Caveat concerning coal bed designations

The system of coal-bed designation presented within **Table 5-1** is not intended to imply that major ('0' terminal-digit) coal beds are invariably and completely split into subordinate beds. Furthermore, not all 'stringers' necessarily originate as laterally-continuous extensions of major coal beds. Considerable work likely remains to fully-establish splitting and coalescent relationships of the Gaylard Member coals at Willow Creek Mine, and within the Willow Creek coal lease in general.

**Coal assessment report for the Willow Creek coal lease --Volume 7:
Willow Creek Mine, 2021/2022 infill drilling**

Table 5-1: Hierarchy of coals and carbonaceous zones at Willow Creek

Formation	Member	Division	Coal Zone	Major Bed	'Split' -- first-order subseam	'Stringer' -- second-order subseam	'Stringer Ply' -- third-order subseam
Gething	Gay-lard	Division 5	Bird	Bird			
			No.1	190			
				170			
				150			
				130			
					/ 111		
				110	--110		
					/ 101		
				100	--100		
			No.2		/ 201		
				200	--200 (?)		
					\ 202		
				203 (rare)			
			No.3	330 (rare)			
				310			
					/ 301		
				300	--300		
				320			
				340	--340		
					\ 342		
				360			
			No.4	430			
							/ 411
						/ 410	--410
					/ 401	--401	--401
				400	--400	--400	--400
						\	\ 402
						\ 420	--420
							\ 422
				440	--440	--440	
						\ 442	
				460			
				463			
				480	--480		
					\ 483		
		Division 4			/ A71		
				A7	--A7		
					\ A72		
							/ A55 (rare)
						/ A53	--A53
					/ A51	--A51	
				A5	--A5		
					/ A3		
				A1	--A1		
						/ A03 (?)	
					/ A01	--A01 (?)	
				A0	--A0		
					\ A02		
				A2 (?)			

Table 5-1: Hierarchy of coals and carbonaceous zones at Willow Creek (continued)

Formation	Member	Division	Coal Zone	Major Bed	'Split' -- first-order subseam	'Stringer' -- second-order subseam	'Stringer Ply' -- third-order subseam
Gething Formation (continued)	Gaylard Member (continued)		No.5	550			
				530			
					/ 511		
				510	--510		
		Division 3	No.5 (continued)	550			
				530			
					/ 511		
				510	--510		
					/ 501		
				500 (?)	--500 (?)		
					\ 502		
				520			
				540			
				560			
				580			
			No.6	670			
				650			
					/ 631		
				630	--630		
				610			
					/ 601		
				600	--600		
					\ 602 ?		
			No.7	620			
				640			
				770			
				750			
					/ 731		
				730	--730		
					/ 703		
					/		/ 712 ?
					/	/ 710	--710
					/ / 701	--701	
				700	--700		
					\ 702		
					/ 721		
			No.8	720	--720		
					\ 722		
				740			
				760			
				830			
				810			
				800	--800		
					\ 802		
				820			

Table 5-1: Hierarchy of coals and carbonaceous zones at Willow Creek (concluded)

Formation	Member	Division	Coal Zone	Major Bed	'Split' -- first-order subseam	'Stringer' -- second-order subseam	'Stringer Ply' -- third-order subseam
Gething (continued)	Gaylard (continued)	Division 2	No.9	900	--900		
					\ 920 ?		
				980			
		Division 1	No.10	1090			
				1070			
					/ 1003		
					/	/ 1010	
					// 1001	--1001	
				1000	--1000		
			No.10	1020			
				1060			
				1080			
			No.11		/ 1101		
				1100	--1100		
					\ \ 1102	--1102	
					\	\	/ 1121 (?)
					\	\ 1120 (?)	--1120
					\		\ 1122 (?)
					\ 1104		
				1140			
				1160			
				1180			
			No.12		/ 1210 (?)		
				1200	--1200		
					\ 1220 (?)		

Note: table compiled from Willow Creek Mine year-2001 through year-2020 drilling. Drilling of coal zones No.9 through No.12 is sparse; existence of No.12 zone in any of the year-2001 or more recent boreholes is not adequately established. Assignment of coal zone 12 to the Gething Formation is speculative, and merits further critical consideration. (?) indicates uncertainty of correlation. Symbols \ and / denote postulated downward and upward splitting relationships.

5.3 Coals intersected by current boreholes at Willow Creek Mine

Correlatable coal intersections within the six winter-2021/2022 cored boreholes are presented below as **Table 5-2**, wherein they have been given identifying codes, such as '410' or '442'. These codes have been assigned in aid of generating digital deposit models, subject to explicit hierarchical rules (presented graphically above as **Table 5-1**) denoting their postulated 'parent-child' relationships as the various coal zones and coal beds are interpreted to split and possibly rejoin laterally.

Coal bed name codes are also noted within the core logs presented as **Tables B-1** through **B-6**, in **Appendix B** of this report, and cross-referenced on summary tables of analytical results.

Table 5-2: Cored intersections of major coal beds

Borehole / Coal bed	Cored intersections (depths in metres)						
	WC22LD-01	WC22LD02	WC21LD-03	WC22LD-04	WC22LD-05	WC22-LD-06 (upper plate)	WC22LD-06 (lower plate)
111			12.98 to 13.70				
110			14.30 to 14.97				
100			16.42 to 19.81		42.84 to 46.15		
201			25.75 to 26.90		69.22 to 70.63	11.98 to 13.30	
200			NR		NR	13.51 to 13.87	
202			29.82 to 30.66		71.25 to 72.67	14.27 to 15.98	
310		34.12 to 34.36			NR	22.36 to 23.81	
301		NR			77.45 to 77.85	NR	
300		34.82 to 36.58			78.91 to 80.97	23.90 to 26.86	
320		36.70 to 37.52					
430	45.61 to 46.38		87.15 to 87.54	38.88 to 39.22			
410	46.42 to 47.13		91.80 to 92.60	40.68 to 41.35	106.92 to 107.46	NR	68.45 to 68.77
401	47.20 to 48.61		NR	42.82 to 46.10	NR	33.17 to 34.27	69.42 to 72.92
400	49.72 to 52.31	68.67 to 76.18	93.83 to 97.04		113.70 to 115.02 ***	34.66 to 39.20	73.22 to 75.88
440	53.53 to 55.42	80.17 to 80.83	99.30 to 100.11				

Notes: *** denotes substantial core loss within the intersection. NR denotes 'not recognised'

6 Coal quality

Coal-quality data on head raw samples of coal, parting rock, and immediate roof and floor rocks, are presented in **Tables C-2** and **C-3**, within **Appendix B**.

Table C-2 presents head raw proximate analyses, including total sulphur and specific gravity on all samples, plus light transmittance and FSI (free swelling index) in the case of samples with air-dried ash of 40% or less. **Table C-3** presents head raw major-oxide ash chemistry of coal and rock samples; again as with proximate analyses, all samples were analysed for ash chemistry.

Appendix D presents results clean coal quality tests, commencing with screen size separations, followed by float-sink washability tests, accompanied by froth flotation analyses of fine coal. This work was still underway as of this report's effective date (March 31, 2022, coinciding with the Willow Creek lease's anniversary date). Therefore, the results of the subsequent work are not presented within this report.

Appendices C and **D** are submitted to the Crown on a confidential basis, in keeping with the *Coal Act* and the *Coal Act Regulation*.

6.1 Cross-reference to historic coal-quality data

A considerable volume of historic (pre-2021) coal quality data is available; these data are presented (again, on a confidential basis) within prior coal assessment reports.

8 Reclamation

Drilling at Willow Creek Mine in winter-2021/2022 required no construction work, inasmuch as ten of the boreholes were drilled from locations atop mine benches, and the other two were drilled on an existing forestry trail within an area which had been cleared of timber.

As per usual practice, the drill sites were cleared of equipment, supplies and trash prior to demobilisation of the drilling rigs. Boreholes were marked with flagged wooden-stake tripods. No other reclamation work was required.

9 Statement of costs

‘Current work’ at Willow Creek Mine, for purposes of the present report, comprises the drilling, logging, and sampling of twelve boreholes during the 2021-2022 tenure term, incorporating allocated costs (derived from agreed unit-costs covered by purchase orders) up to the Willow Creek property's anniversary (March 31, 2022). No additional invoices are expected to be received, except for further analytical work on composite samples of cored coal beds.

Drilling comprised six air-rotary (non-coring) boreholes (as set forth in **Table 3-3**) at unit cost of \$122.46 per metre, and six large-diameter cored boreholes at unit cost of \$424.30 per metre. Drilling was supported by site supervision, and by water-trucking by third-party contractors. All but one of the boreholes were logged by means of downhole geophysical surveys (as discussed in **Appendix A** of this report). Cored holes were geologically-logged and their cores were sampled for analysis (as set forth in **Appendix B**). Analytical work (see **Appendices C and D**) was done on core samples recovered from the diamond-drilled portions of the six cored boreholes.

Unit costs given below in **Table 9-1** (given on the following page), have been determined via division of invoiced cost by relevant total meterages of drilling, with exception of analytical costs which are derived from committed samples and tests, supported by quotations and purchase orders.

Overall cost of current work is estimated as \$470,484.84.

Cost breakdown by activity for the 2021-2022 work term: Table 9-1

Year / activity	Air-rotary open-hole drilling (including casing and bit charges, and consumables)		Core drilling (including casing and bit charges, hammering down to and between core points, and consumables)		Geophysical logging (including move/demove of logging unit, subsistence, and crew rotation costs)		Lab analysis (Birtley)		Water-supply trucking		Consultants (supervision and core-logging, including vehicle and equipment rentals, and consumables)		Cost totals
	metres	cost	metres	cost	metres	cost	metres	cost	metres	cost	metres	cost	
2021/2022	530.9	\$65,014.65	489.16	\$207,420.15	937.44	\$38,895	489.16	\$111,269.55	1020.06	\$13,976.25	1020.06	\$33,909.24	\$470,484.84
Totals	530.9	\$65,014.65	489.16	\$207,420.15	937.44	\$38,895	489.16	\$111,269.55	1020.06	\$13,976.25	1020.06	\$33,909.24	\$470,484.84
Unit cost	\$122.46 / metre		\$424.03 / metre		\$41.49 / metre		\$227.47 / metre		\$13.70 / metre		\$33.24 / metre		\$461.23 / metre

Notes: unit costs are on per-metre drilled/logged length basis, by division of the costs by the length of drilling/logging. No roadwork was done. Overall unit cost is based on all costs divided by all metres drilled.

9.1 Contractor list

The following contractors provided goods or services in support of the winter-2021/2022 drilling programme:

- A.M.M. Geological -- core-logging, coal and rock sampling, and overall field supervision by Adriana Matesoi.
- Century Wireline Services -- geophysical logging of eleven boreholes by field supervisors M. Lebeda and D. Stewart.
- Anderson Water Services -- drilling of six rotary non-coring pilot hole, and six large-diameter spot-cored holes.
- Commotion Creek -- water-supply trucking and general support.
- Birtley Coal & Minerals Testing -- analyses of coal and rock samples, and wash and froth tests on composites.

10 References

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Willow Creek Mine, 2021/2022 infill drilling**

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1943: Stratigraphy and structure in Mount Hulcross - Commotion Creek map-area, British Columbia; *Geological Survey of Canada*, Paper 43-13 [accompanied by Preliminary Map 43-13A at scale of 1:63,360].

11 Conclusions and recommendations

An additional 12 current boreholes (here-reported for the first time), with overall length of 1020.06 metres, were drilled on the property in winter-2021/2022. Overall drilling totals to date are 779 boreholes and 56,671.92 metres. This total does not include earlier drilling (at locations not yet confirmed by site surveys, and for which logs are as-yet unavailable) of boreholes by the British Columbia Department of Mines (reported by McKechnie, 1955) in years-1946 through 1951.

Drilling at Willow Creek Mine is regarded as sufficient to support the recalculation of coal-resources to current Canadian geometric standards (Hughes *et al.*, 1989), provided that an updated structural model is maintained, and an updated coal-quality model is likewise maintained, in order to support the distinction of coking-coal, PCI coal, and possibly also low-FSI coking-coal within the deposit. This modelling work is being undertaken by in-house technical staff at Willow Creek Mine.

Estimated current exploratory cost to date (from April 1, 2021 through to March 31, 2022, are \$470,484.84, at a unit cost of \$461.23 / metre.

11.1 Recommendations

Recommended follow-up work includes (as a highest priority) continuation and completion of screen size analysis and washability tests, including froth flotation tests on fine coal.

Petrographic examinations should be undertaken of simulated clean coal products, followed by coking tests of multi-zone product composites in the interest of further characterising the extent of coking vs. PCI coals.

Furthermore, consideration should be given to extending the large-diameter coring and analytical programme to coal zones A, 5, 6, 7, and 8.

Willow Creek Mine is regarded as being a property of merit. The effective date of this report is March 31, 2022, and the signature/sealing date is April 7, 2022.

12 Statement of qualifications

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

- a) I am currently employed on a full-time basis as Chief Geologist by Conuma Resources Limited, in their Canadian regional office in 200-235 Front Street (PO Box 2140), Tumbler Ridge, British Columbia, V0C 2W0 Canada, with permanent domicile at 2719 Dunsmuir Avenue (P.O. Box 40), Cumberland, British Columbia, V0R 1S0 Canada.
- b) This certificate applies to the current report, titled *Coal Assessment Report for the Willow Creek coal lease -- Volume 7: Willow Creek Mine, 2021/2022 infill drilling*, dated April 7, 2022, and with an effective date of March 31, 2022.
- c) I am a member (Professional Geoscientist, Licence No.20550) of the Association of Professional Engineers and Geoscientists of British Columbia, a founding Registered Member of the Society for Mining, Metallurgy and Exploration (SME, Member No.518350), a licensed geologist in Washington State, and a Life Member of the Canadian Institute of Mining, Metallurgy, and Petroleum (CIM). I hold British Columbia certification as a Mine Supervisor (No.835247, valid until May 31, 2023). I have worked as a colliery geologist in several countries for 43 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 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 visits to Willow Creek Mine were in the summer of 2020, to oversee and direct an in-pit drilling and geophysical logging programme in my capacity as Chief Geologist.
- f) I am the author of this report, titled *Coal Assessment Report for the Willow Creek coal lease - Volume 7: Willow Creek Mine, 2021/2022 infill drilling*, dated April 7, 2022, concerning the Willow Creek Mine block of the Willow Creek coal property.
- g) As of the date of the writing of this report, I am not independent of Conuma Resources Limited, pursuant to the tests in Section 1.4 of *National Instrument 43-101*.

“original signed and sealed by”
Dated this 7th day of April, 2022.

C.G. Cathyl-Huhn P.Geo. (BC) Lic.Geol. (WA) RMSME
British Columbia Mine Supervisor No.835247

Appendix A: Geophysical logs and borehole statistics

Geophysical logging and the pertinent statistics of the current (winter-2021/2022) boreholes at Willow Creek Mine are summarised in **Tables A-1 and A-2** (commencing on the following page). Copies of the geophysical logs are submitted as digital files, in LAS, TIF, and/or PDF formats, as explained below.

As well, scans of marked-up gamma-density logs (of the five cored boreholes which were logged) are for convenience included within this appendix, as hardcopies in the printed version, and as PDF files in the digital version of this report.

A-1 Log formats

LAS and TIF are the primary digital formats within which geophysical logs are customarily (in modern practice) provided by borehole-logging service companies. PDF is a secondary format, provided for convenience in printed reproduction.

A-2 Basic principles of geophysical logging

Geophysical logs are obtained by lowering a self-contained cylindrical sonde to the bottom of a borehole (or as close to the bottom as is safely practicable, given borehole wall stability conditions), and then drawing the sonde upward by means of a cable which contains power and data-transfer conductors. Depth reference on each log is based upon readings of a depth transponder connected to the geophysical logging system's draw-works. A very small amount of cable stretch may occur, depending upon the weight and diameter of each sonde; this accounts for slight variations in reported depths of log measurements as compared from one log suite to another.

Ordinarily, geophysical logs are run within boreholes once the drilling rods have been withdrawn. This practice allows for measurement of borehole diameter with a caliper instrument, and further allows for the effective collection of properly-calibrated log measurements. In some occasions, logs may be run within the drill rods, owing to concerns regarding borehole stability; these logs may or may not be subsequently be re-run with the rods withdrawn, again depending upon borehole conditions.

A-3 Log presentation and scaling

Unadjusted 'field prints' of logs may be produced soon after logging is completed, by means of a thermo-electrical printer. Field prints allow for rapid determination of whether a given borehole warrants being deepened to reach a given target zone.

The standard vertical scale of processed 'final' logs at Willow Creek Mine is 1:100, although scales ranging from 1:20 to 1:250 may be used if desired. Depths given on all geophysical logs are also given in metres, below the datum points mentioned in the headers of each log. Downhole depths reached by individual logging suites will vary, according to the length of each sonde, and also according to the source/detector geometry (and hence the measurement reference point) of each sonde. Geophysical log depth is therefore typically slightly less than driller's reported depth of each hole.

**Coal assessment report for the Willow Creek coal lease --Volume 7:
Willow Creek Mine, 2021/2022 infill drilling**

Table A-1: Positions and statistics of year 2021-2022 boreholes

Borehole	UTM NAD83 Zone 10		Borehole statistics				Pit/ area
	Easting	Northing	Elev- ation	Depth	Spud date	Log date	
WC21RC-01	549020.07	6164575.54	638.05	61.40	13 Dec 2021	17 Dec 2021	4N1
WC22LD-01	549018.43	6164578.60	637.94	60.00	13 Jan 2022	19 Jan 2022	4N1
WC21RC-02	550015.88	6163029.19	973.46	80.80	17 Dec 2021	18 Dec 2021	4N2
WC22LD-02	550018.65	6163026.83	973.50	82.62	9 Jan 2022	not logged	4N2
WC21RC-03	549606.15	6163565.82	908.77	105.20	18 Dec 2021	19 Dec 2021	4N2
WC21LD-03	549603.91	6163568.49	908.42	100.90	20 Dec 2021	17 Jan 2022	4N2
WC22RC-04	550549.50	6162260.35	1112.44	76.20	16 Jan 2022	17 Jan 2022	4C
WC22LD-04	550550.75	6162259.18	1112.24	49.33	2 Feb 2022	11 Feb 2022	4C
WC22RC-05	550175.85	6162642.46	1126.33	118.90	18 Jan 2022	19 Jan 2022	4C
WC22LD-05	550174.18	6162643.80	1126.33	115.82	27 Jan 2022	11 Feb 2022	4C
WC22RC-06	550440.62	6162380.06	1101.50	88.40	19 Jan 2022	20 Jan 2022	4C
WC22LD-06	550440.60	6162377.11	1102.14	78.33	27 Jan 2022	11 Feb 2022	4C

File: WC 2021-2022 spud table_220320b.doc/xls/dat

Notes: in borehole names, RC denotes rotary-drilled pilot hole, and LD denotes large-diameter cored hole

Table A-2: Geophysical log inventory

Borehole	Depth	Spud date	Log date	Gamma / Density/ Resistivity/ Caliper	Gamma / Neutron	Sonic	Dipmeter	Deviation	Pit/area
WC21RC-01	61.40	13 Dec 2021	17 Dec 2021	61.15	not run	not run	not run	60.98	4N1
WC22LD-01	61.00	13 Jan 2022	19 Jan 2022	59.06	not run	not run	not run	58.98	4N1
WC21RC-02	80.80	17 Dec 2021	18 Dec 2021	80.26	not run	not run	not run	79.98	4N2
WC22LD-02	82.62	9 Jan 2022	not logged	not run	not run	not run	not run	not run	4N2
WC21RC-03	105.20	18 Dec 2021	19 Dec 2021	104.96	not run	not run	not run	103.98	4N2
WC21LD-03	102.00	20 Dec 2021	17 Jan 2022	101.48	not run	not run	not run	100.98	4N2
WC22RC-04	76.20	16 Jan 2022	17 Jan 2022	75.66	not run	not run	not run	74.98	4C
WC22LD-04	49.33	2 Feb 2022	11 Feb 2022	46.97	not run	not run	not run	46.94	4C
WC22RC-05	118.90	18 Jan 2022	19 Jan 2022	118.56	not run	not run	not run	117.98	4C
WC22LD-05	115.88	27 Jan 2022	11 Feb 2022	114.41	not run	not run	not run	114.24	4C
WC22RC-06	88.40	19 Jan 2022	20 Jan 2022	84.74	not run	not run	84.00	84.00	4C
WC22LD-06	78.33	27 Jan 2022	11 Feb 2022	75.32	not run	not run	not run	75.76	4C
Totals			12 holes / 1020.06 m	11 logs / 922.57	0 logs / 0	0 logs / 0	1 log / 84.00	11 logs / 918.80	

Filename: WC2021-2022 geophysics_220320b.xls

Note: depths given in log columns are the first readings (as reported on log headers).

Century
WIRELINE SERVICES

**COMPENSATED DENSITY
GAMMA - CALIPER - RES.
WC22LD-01**

COMPANY CONUMA COAL RESOURCES
WELL WC22LD-01
WELL EXT
FIELD WILLOW CREEK MINE
COUNTY CANADA
PROVINCE BRITISH COLUMBIA
COUNTRY CANADA
LICENSE N/A

COMPANY : CONUMA COAL RESOURCES
WELL : WC22LD-01
WELL EXT :
FIELD : WILLOW CREEK MINE
COUNTY : CANADA
PROVINCE : BRITISH COLUMBIA
COUNTRY : CANADA
LICENSE : N/A
UNIQ ID : N/A
LSD : N/A SECTION: N/A TOWNSHIP N/A RANGE: N/A
LOCATION : N/A
LAT, UTM-N : N/A
LONG, UTM-E : N/A

DISPLAY7_JL63w

PERMANENT DATUM
DRL MEASURED FROM
LOG MEASURED FROM
ELEV. PERM. DATUM

Elevations:
KB
DF
GL
M
M
M
Other Services:
DEV

DATE

DEPTH - DRILLER

DEPTH - LOGGER

LOG TOP

LOG BOTTOM

BIT SIZE

CASING - DRILLER

CASING - LOGGER

CASING O.D.

CASING TYPE

FLUID TYPE

FLUID DENSITY

FLUID VISCOSITY

FLUID PH

MUD SOURCE

RM @ MEAS TEMP

RM @ MEAS TEMP

RM @ MEAS TEMP

RM @ MEAS TEMP

CIRC STOPPED

RIG NUMBER

FLUID LEVEL

RECORDED BY

WITNESSED BY

REMARKS 1

REMARKS 2

REMARKS 3

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS

MAIN LOG 1:100 WC22LD-01 01/19/22

LOG PARAMETERS

MATRIX DENSITY : 2.65

NEUTRON MATRIX : SANDSTONE

MATRIX DELTA T : 177

MAGNETIC DECL : 16.48

ELECT. CUTOFF : 75000

BIT SIZE : 250.80 MM

PRESENTATION : Conuma DEN 100LD.0 - 12/13/2021

DISPLAY7_JL63w

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CALIPERL		
200	MM	400
GAMMA		
0	API-GR	200

METERS
SPEED -

COMP		
0.45	G/CC	-0.05
DEN(CDL)		
1	G/CC	3
RES(SG)		
0	OHM-M	5000

2

BIT_SIZE		
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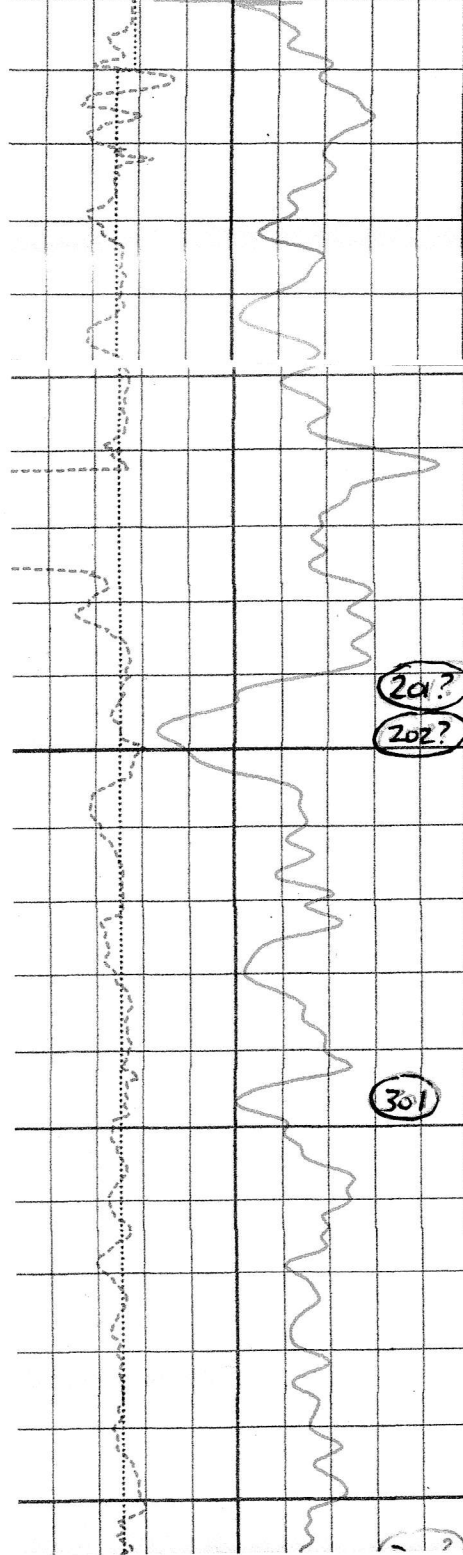
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200	MM	400

GAMMA		
0	API-GR	200

METERS
SPEED --

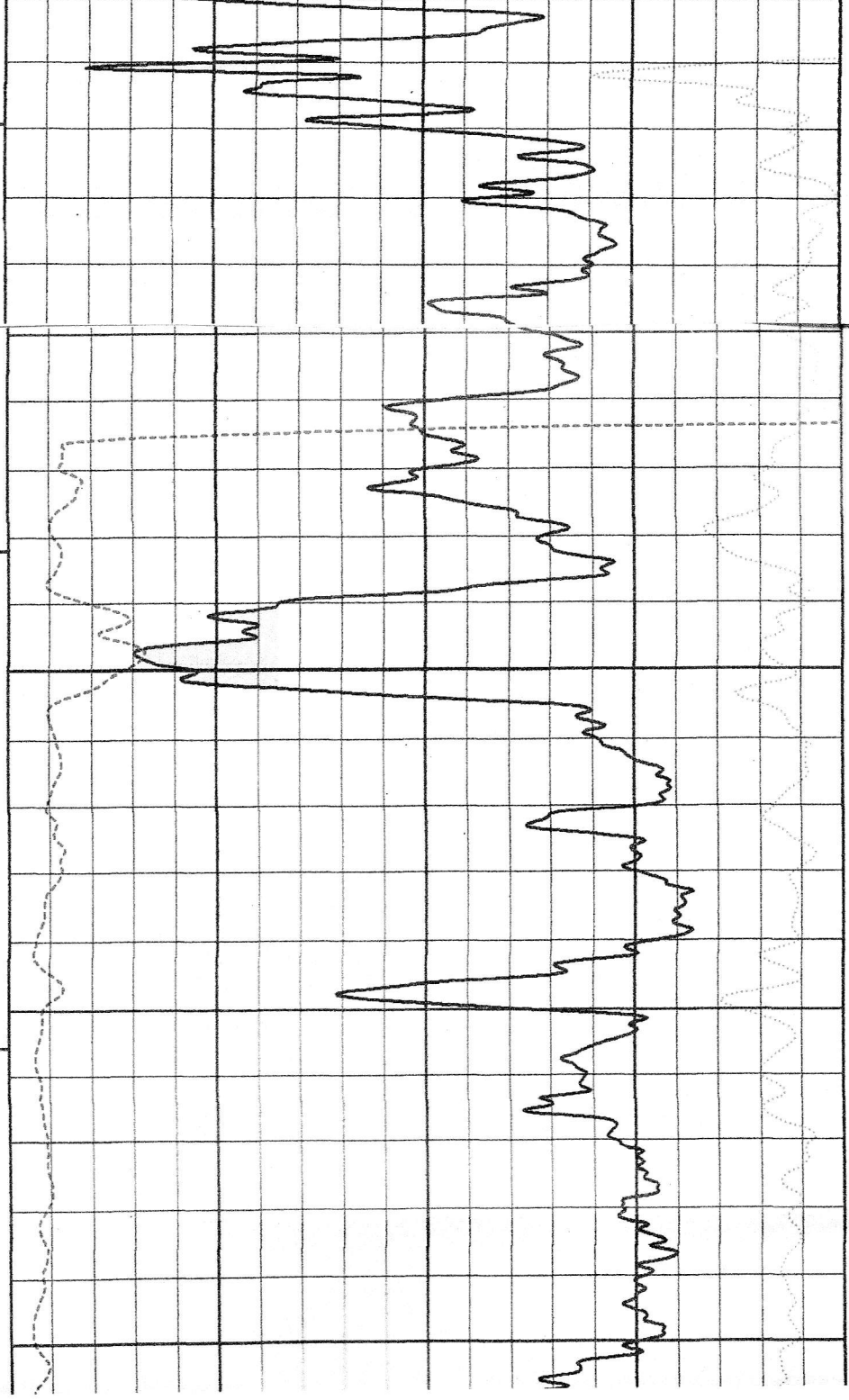
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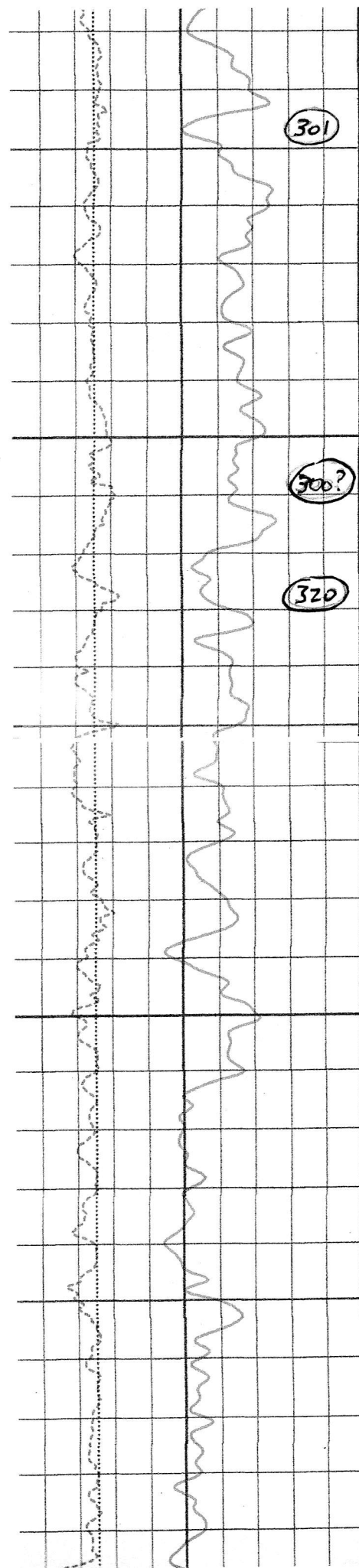
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1	G/CC	3
RES(SG)		
0	OHM-M	5000



Casing

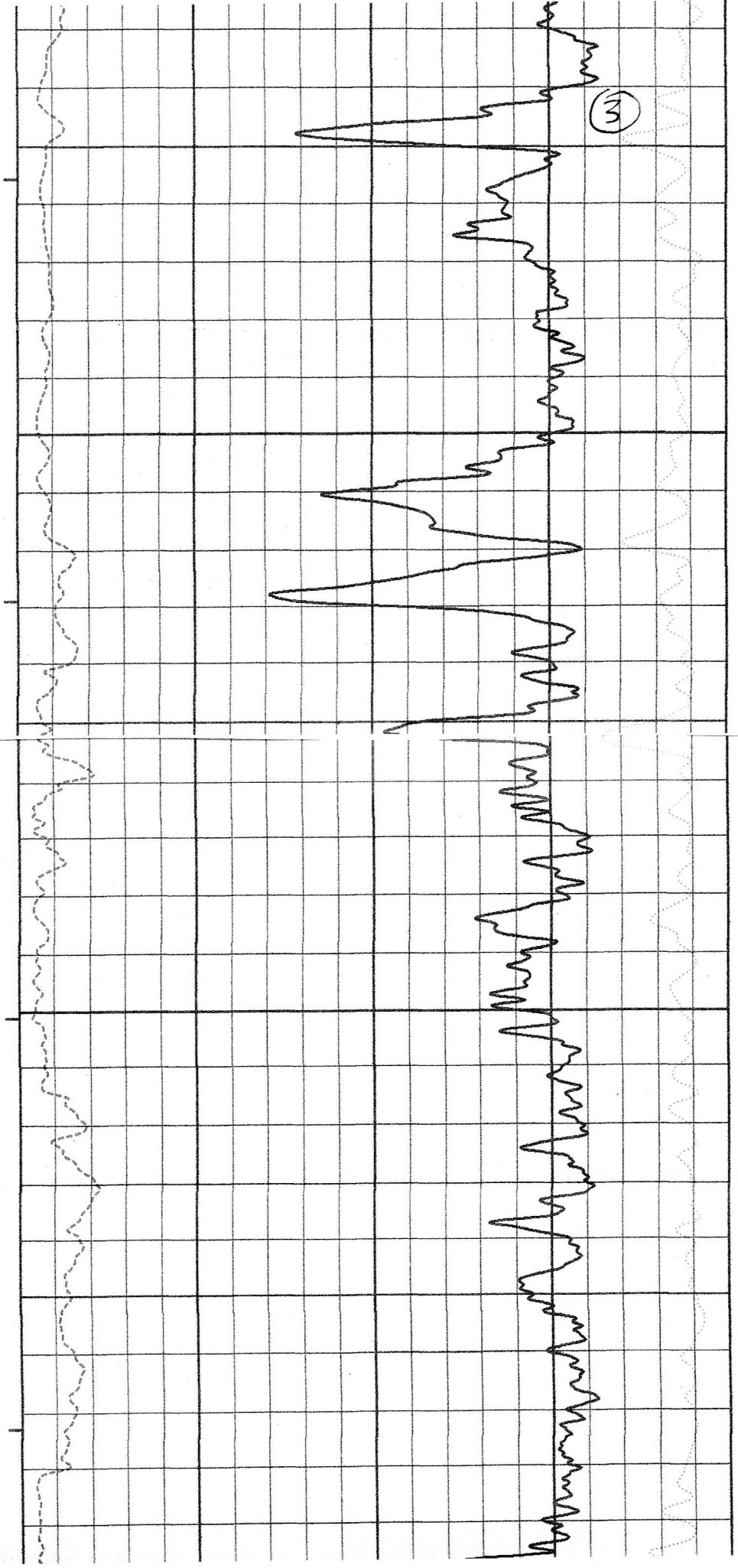
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Fluid

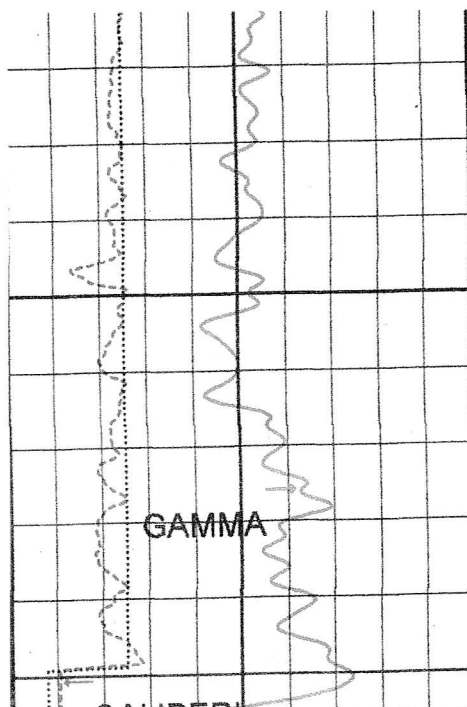




20

30





GAMMA

40

CALIPERL

(430)

(410)

(401)

BIT_SIZE

50

(400)

(440)

59.06m
1st Read

TD 59.30m

0 API-GR 200

GAMMA

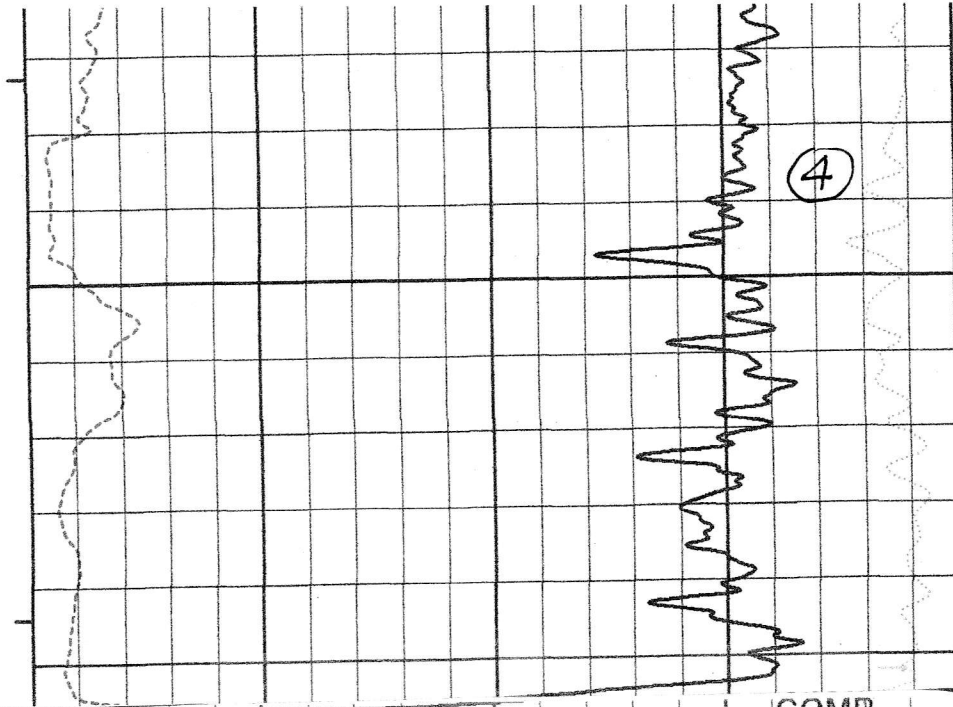
200 MM 400

CALIPERL

200 MM 400

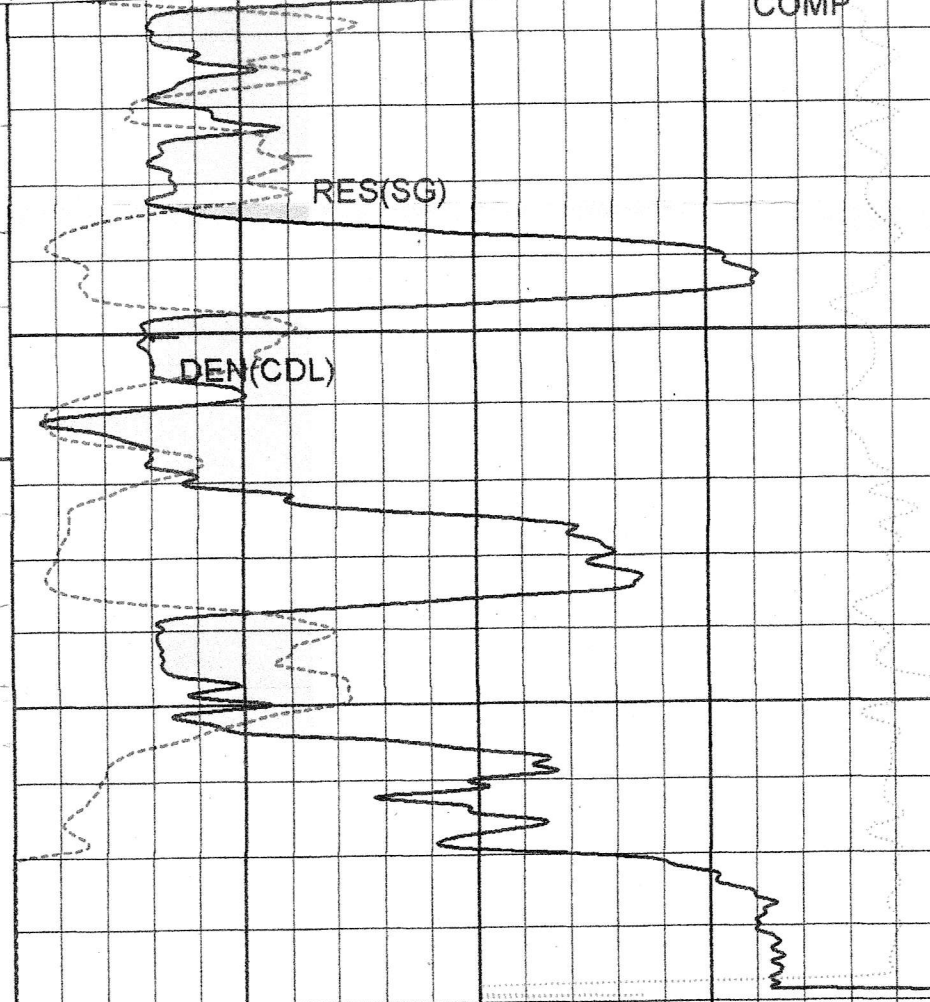
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SPEED --
METERS



(4)

COMP



RES(SG)

DEN(CDL)

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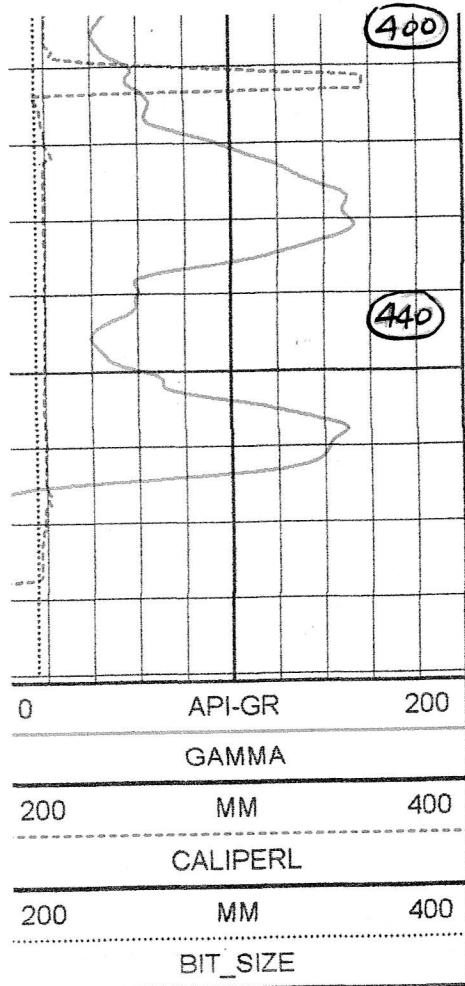
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1 G/CC 3

DEN(CDL)

0.45 G/CC -0.05

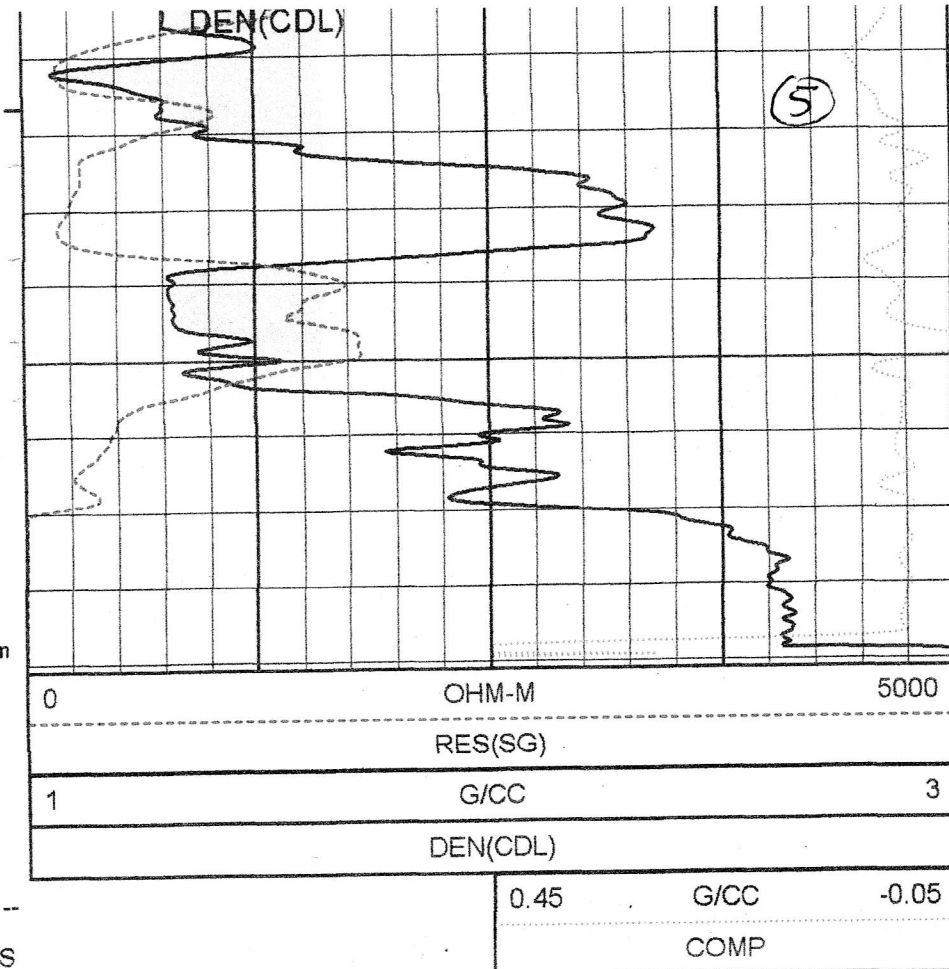
COMP



59.06m
1st Read

TD 59.30m

SPEED --
METERS



MAIN LOG 1:100 WC22LD-01 01/19/22

LOG PARAMETERS

MATRIX DENSITY : 2.65 NEUTRON MATRIX : SANDSTONE MATRIX DELTA T : 177
 MAGNETIC DECL : 16.48 ELECT. CUTOFF : 75000 BIT SIZE : 250.80 MM
 PRESENTATION : Conuma DEN 100LD.0 - 12/13/2021 DISPLAY7_JL63w

TOOL CALIBRATION WC22LD-01 01/19/22 14:15
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 SERIAL NUMBER 2859

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2	Jan12,22	10:12:46	VOLTAGE [MV]	32.200	234.000	16142	43438
3	Jan12,22	10:12:27	CALIPER [MM]	76.200	200.000	139838	264264
4	Jan12,22	13:31:24	DEN(LS) [G/CC]	1.620	2.612	13464	1931
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6	Jan17,22	10:34:05	CALIPERL [MM]	200.000	258.000	261915	324501
7	Jan12,22	10:13:01	CURRENT [UA]	32.200	234.000	5345	23980
8	Jan12,22	10:13:09	F [CPS]	Default		Default	
9	Jan12,22	10:13:19	X [CPS]	Default		Default	

Century
WIRELINE SERVICES

COMPENSATED DENSITY
GAMMA - CALIPER - RES.
WC22LD-03

COMPANY CONUMA COAL RESOURCES
WELL WC22LD-03
WELL EXT
FIELD WILLOW CREEK MINE
COUNTY CANADA
PROVINCE BRITISH COLUMBIA
COUNTRY CANADA
LICENSE N/A

COMPANY : CONUMA COAL RESOURCES
WELL : WC22LD-03
WELL EXT :
FIELD : WILLOW CREEK MINE
COUNTY : CANADA
PROVINCE : BRITISH COLUMBIA
COUNTRY : CANADA
LICENSE : N/A
UNIQ ID : N/A
LSD : N/A
LOCATION : N/A
LAT, UTM-N : 6163568
LONG, UTM-E : 549603.9
SECTION: N/A TOWNSHIP: N/A
RANGE: N/A

DISPLAY7_JL63w

PERMANENT DATUM GL
DRL MEASURED FROM GL
LOG MEASURED FROM GL
ELEV. PERM. DATUM 908.60 M
GL
Elevations: KB N/A
DF N/A
GL 908.60 M
Other Services: M DEV

DATE 01/17/22 16:55

DEPTH - DRILLER 102.00 M

DEPTH - LOGGER 101.80 M

LOG TOP 0.00 M

LOG BOTTOM 101.48 M

BIT SIZE 250.80 MM

CASING - DRILLER 6.10 M

CASING - LOGGER 5.90 M

CASING O.D. 270.00 MM

CASING TYPE SURFACE

FLUID TYPE H2O

FLUID DENSITY 1.00 G/CC

FLUID VISCOSITY N/A

FLUID PH N/A

MUD SOURCE N/A

RM @ MEAS TEMP N/A @ N/A C

RMF @ MEAS TEMP N/A @ N/A C

RMC @ MEAS TEMP N/A @ N/A C

CIRC STOPPED N/A

RIG NUMBER AD 20

FLUID LEVEL 17.20

RECORDED BY M. LEBEDA

WITNESSED BY A. MATEOSI

REMARKS 1

REMARKS 2

REMARKS 3

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS

MAIN LOG 1:100 WC22LD-03 01/17/22

LOG PARAMETERS

MATRIX DENSITY : 2.65

NEUTRON MATRIX : SANDSTONE

MATRIX DELTA T : 177

MAGNETIC DECL : 16.48

ELECT. CUTOFF : 75000

BIT SIZE : 250.80 MM

PRESENTATION : Conuma DEN 100LD.0 - 12/13/2021

DISPLAY7_JL63w

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GAMMA		
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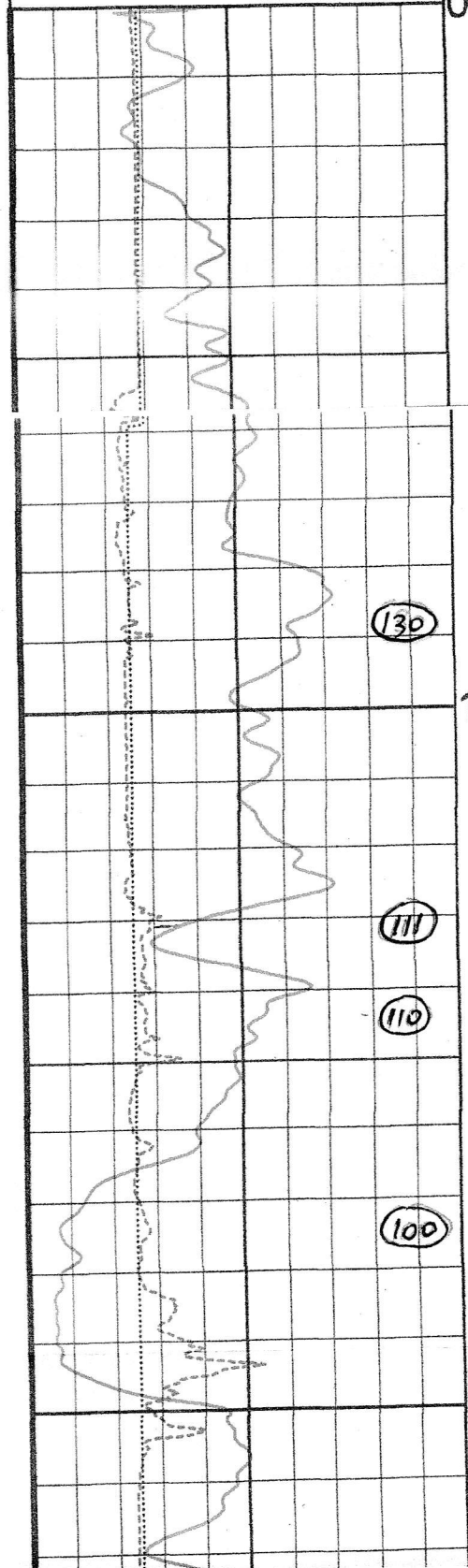
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SPEED --

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DEN(CDL)		
1	G/CC	3
RES(SG)		
0	OHM-M	5000

BIT_SIZE		
200	MM	400
CALIPERL		
200	MM	400
GAMMA		
0	API-GR	200

METERS
SPEED --

COMP		
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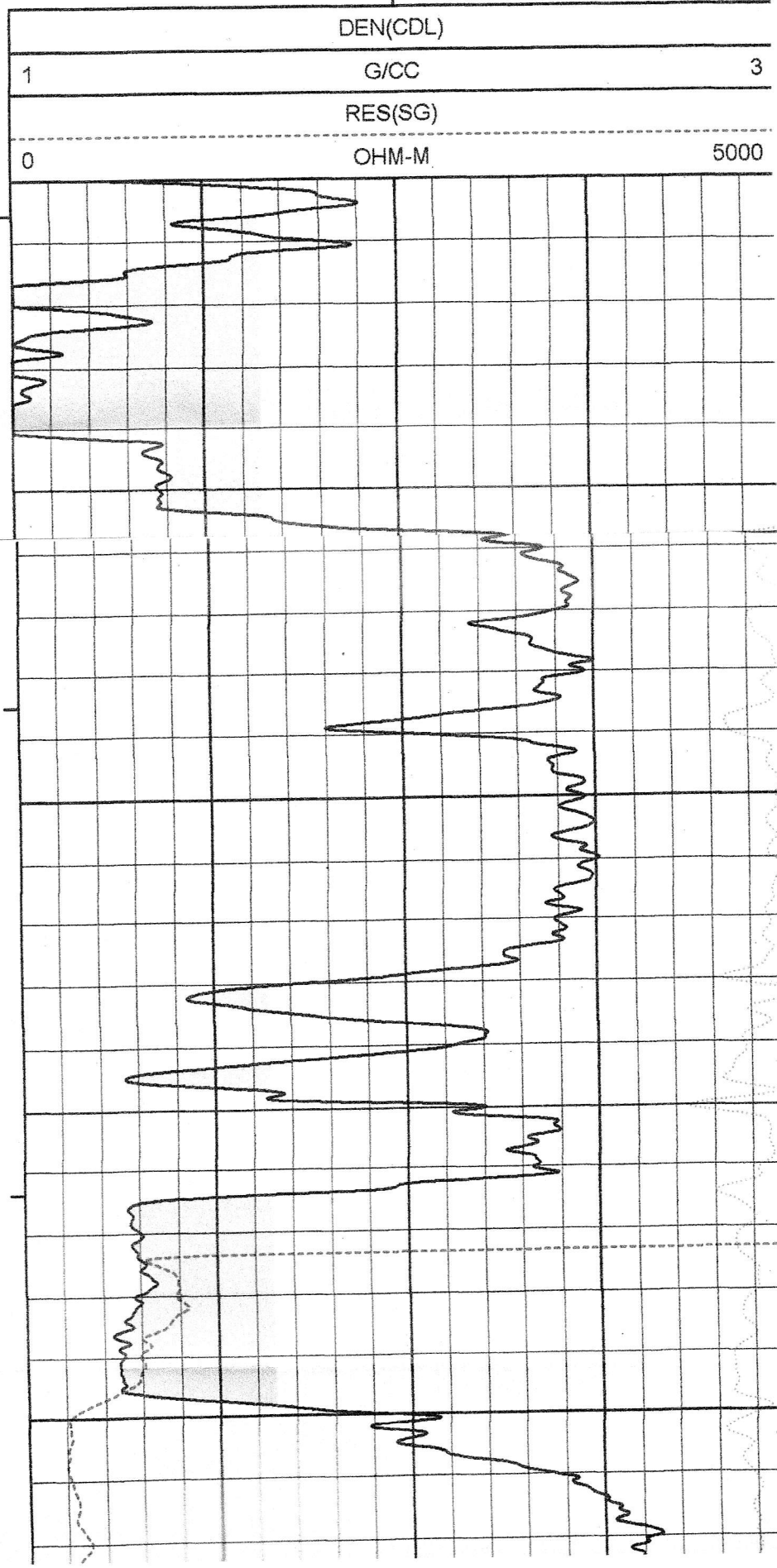
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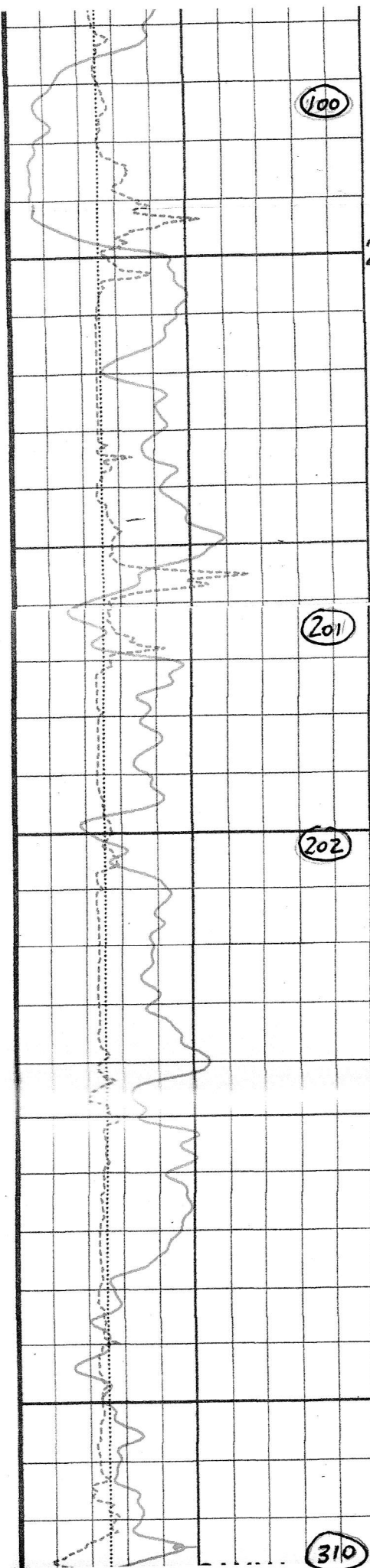
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20

Casing

Level Fluid



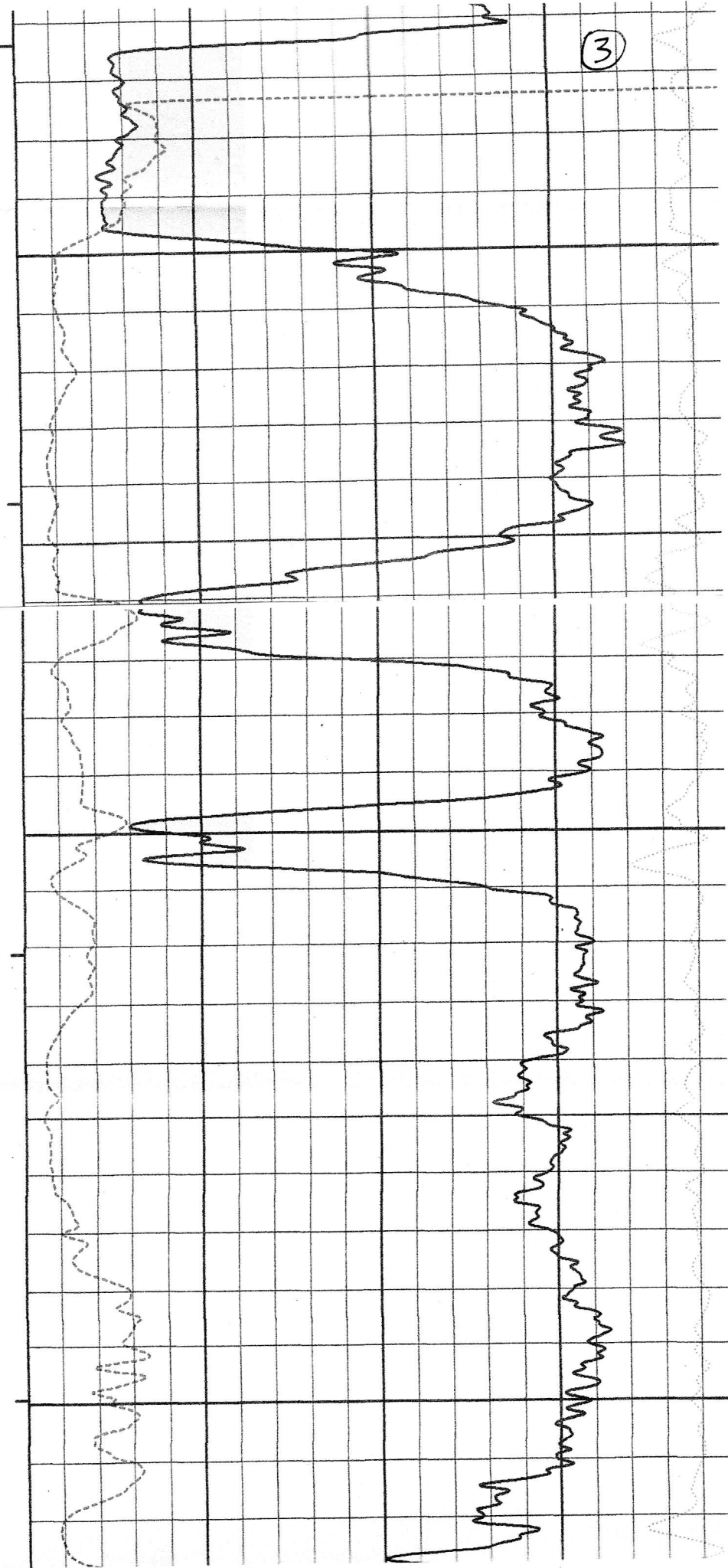


Level
Fluid

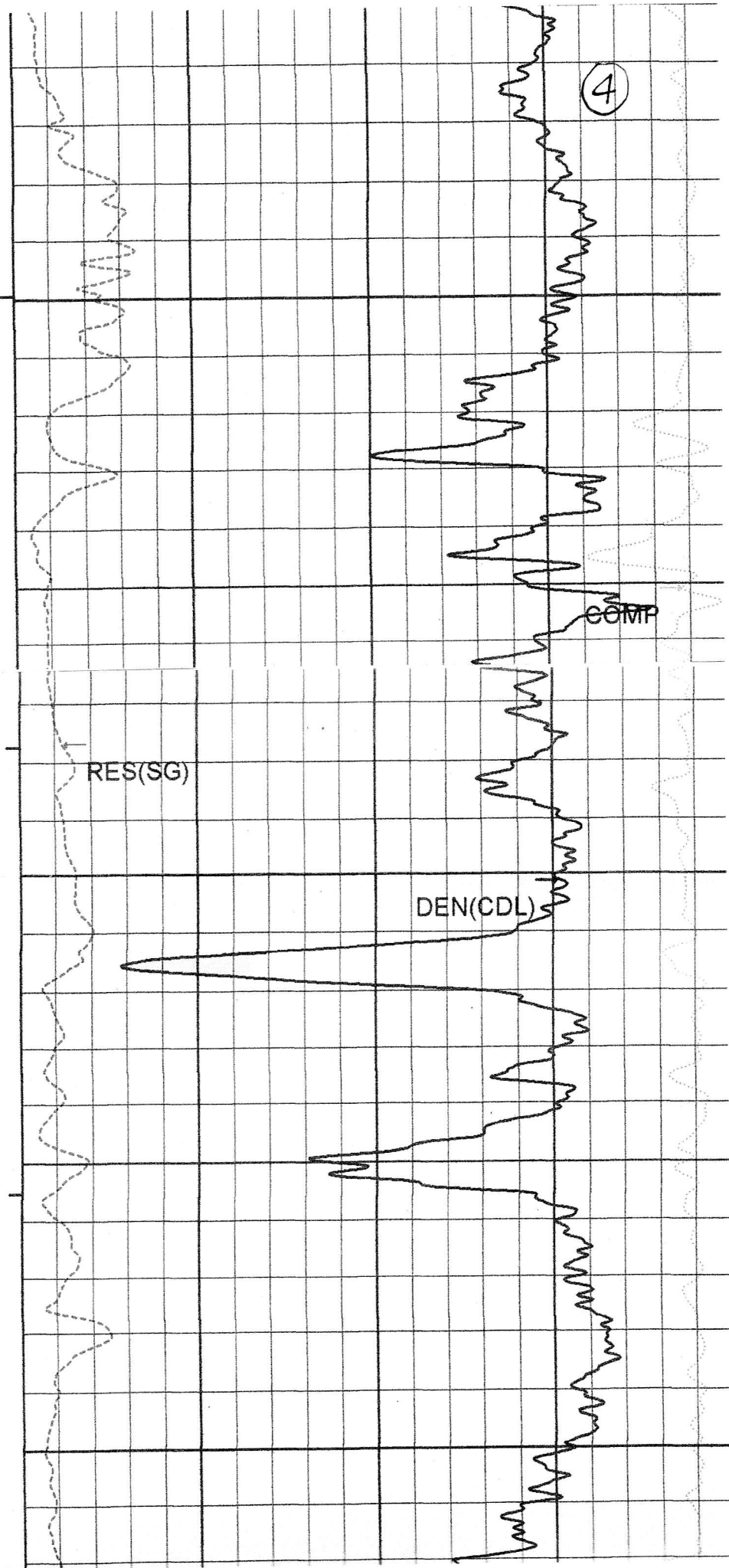
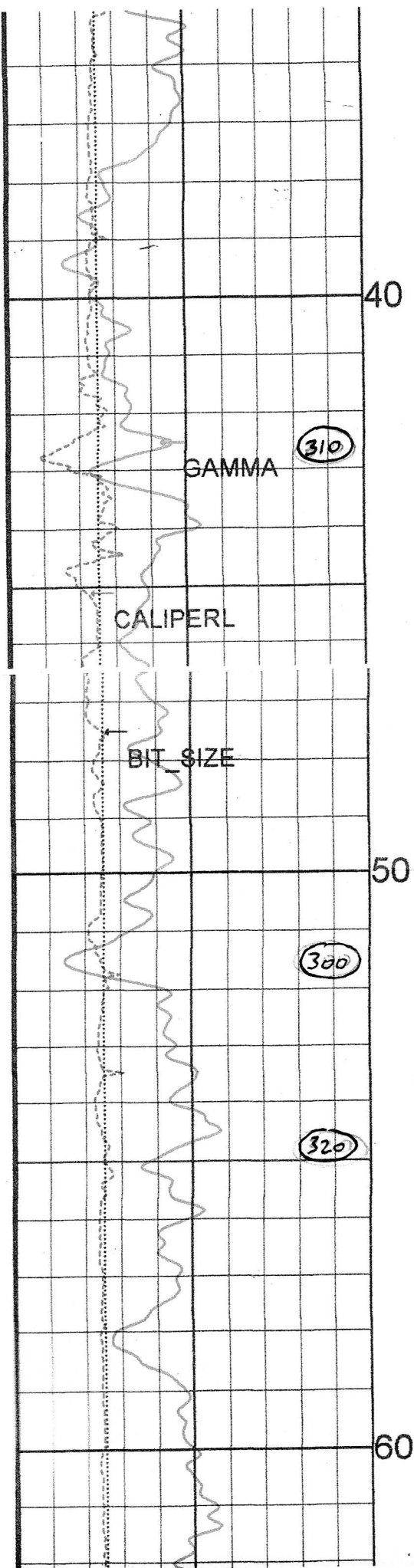
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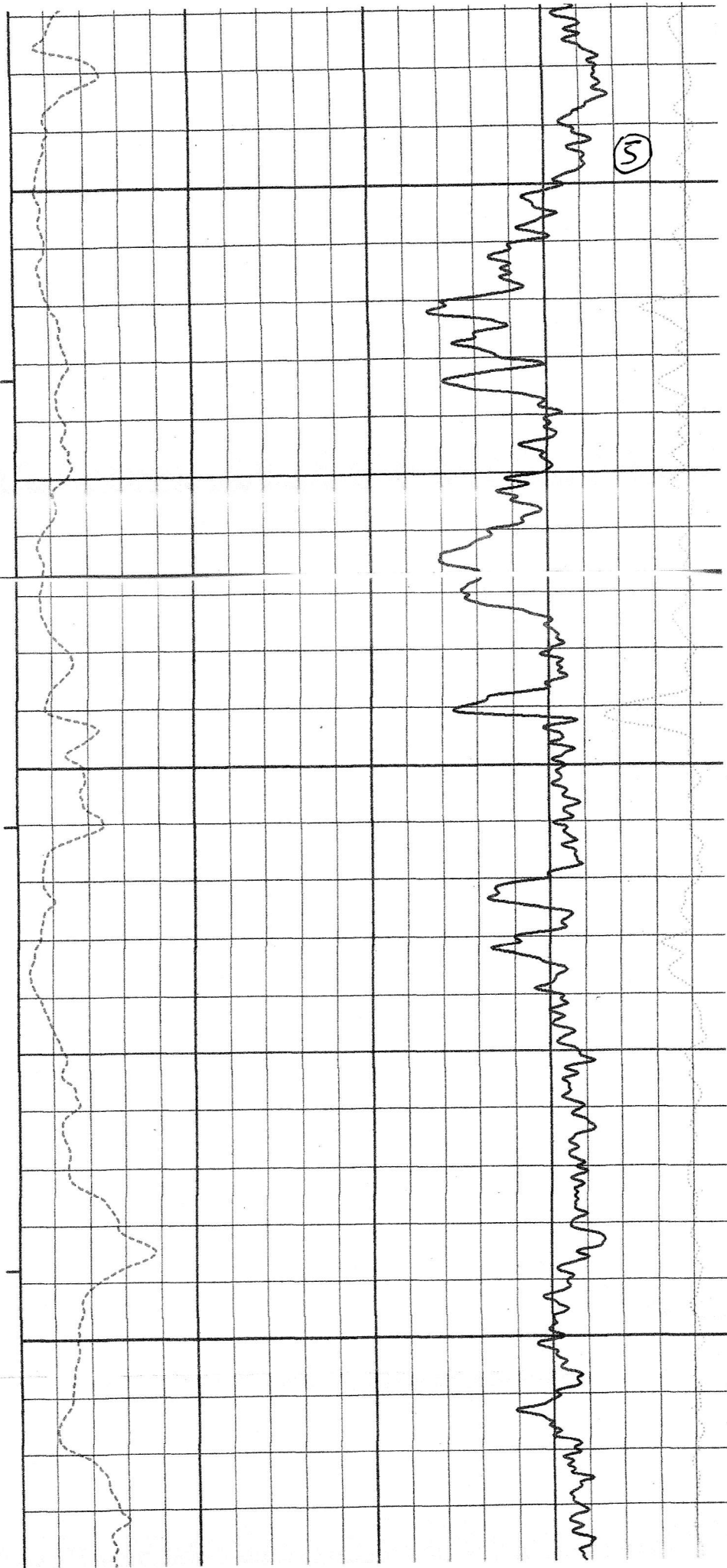
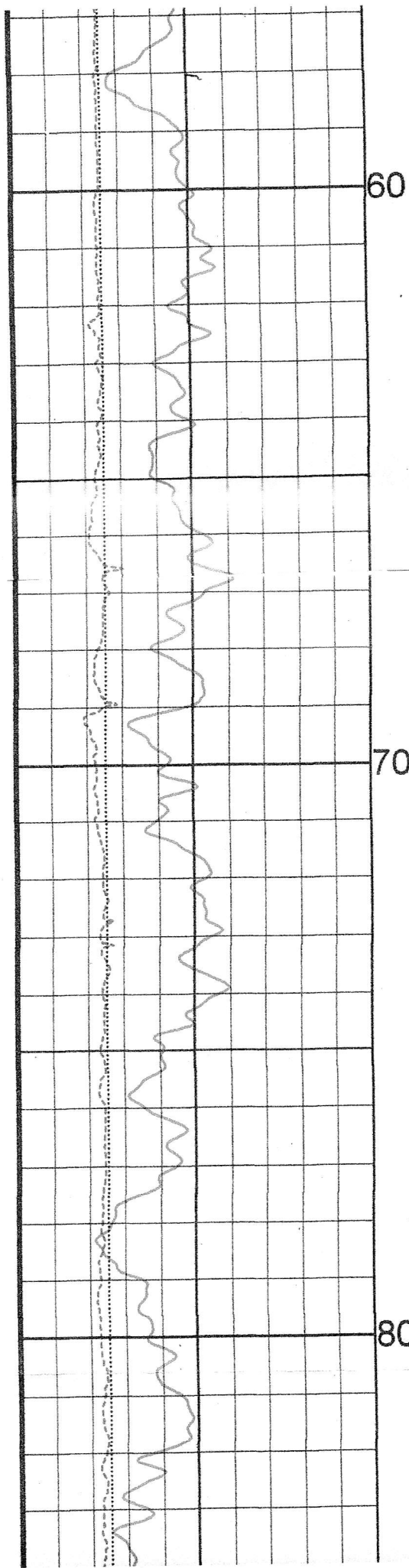
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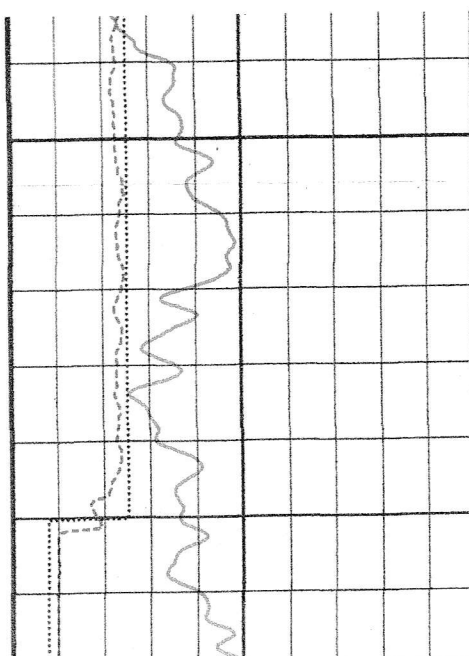
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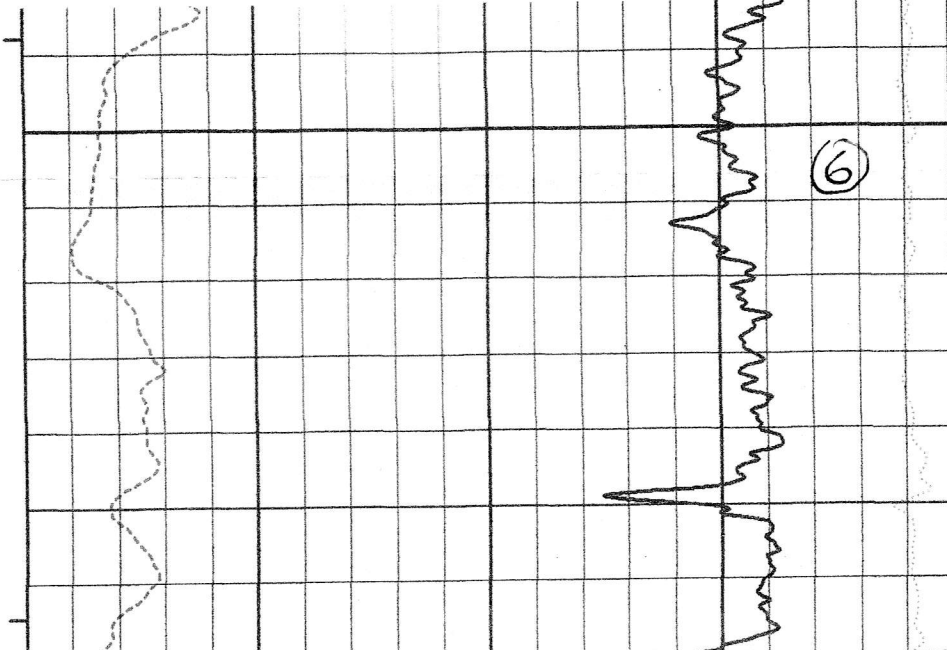
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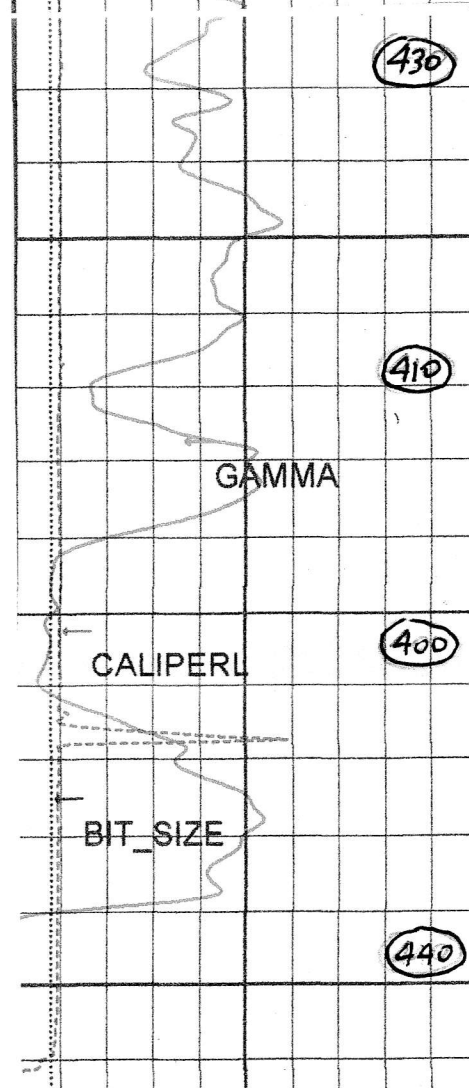




80



6



430

90

410

GAMMA

CALIPERL

400

BIT_SIZE

101.48m
1st Read

440

100

TD 101.80m

0 API-GR 200

GAMMA

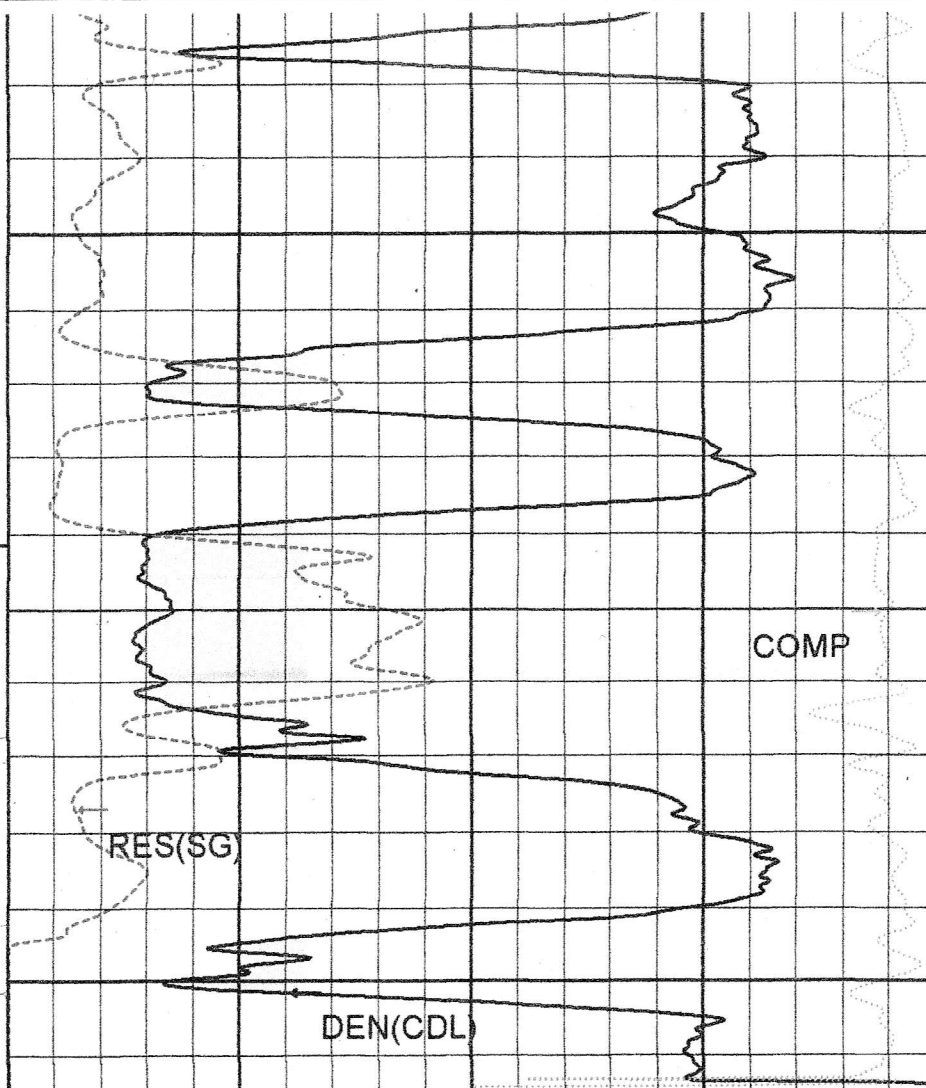
200 MM 400

CALIPERL

200 MM 400

BIT_SIZE

SPEED --
METERS



RES(SG)

COMP

DEN(CDL)

0 OHM-M 5000

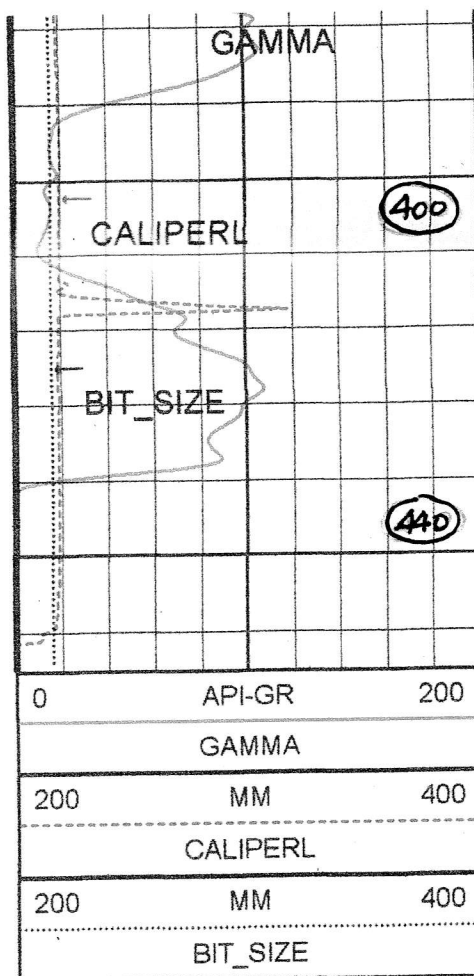
RES(SG)

1 G/CC 3

DEN(CDL)

0.45 G/CC -0.05

COMP

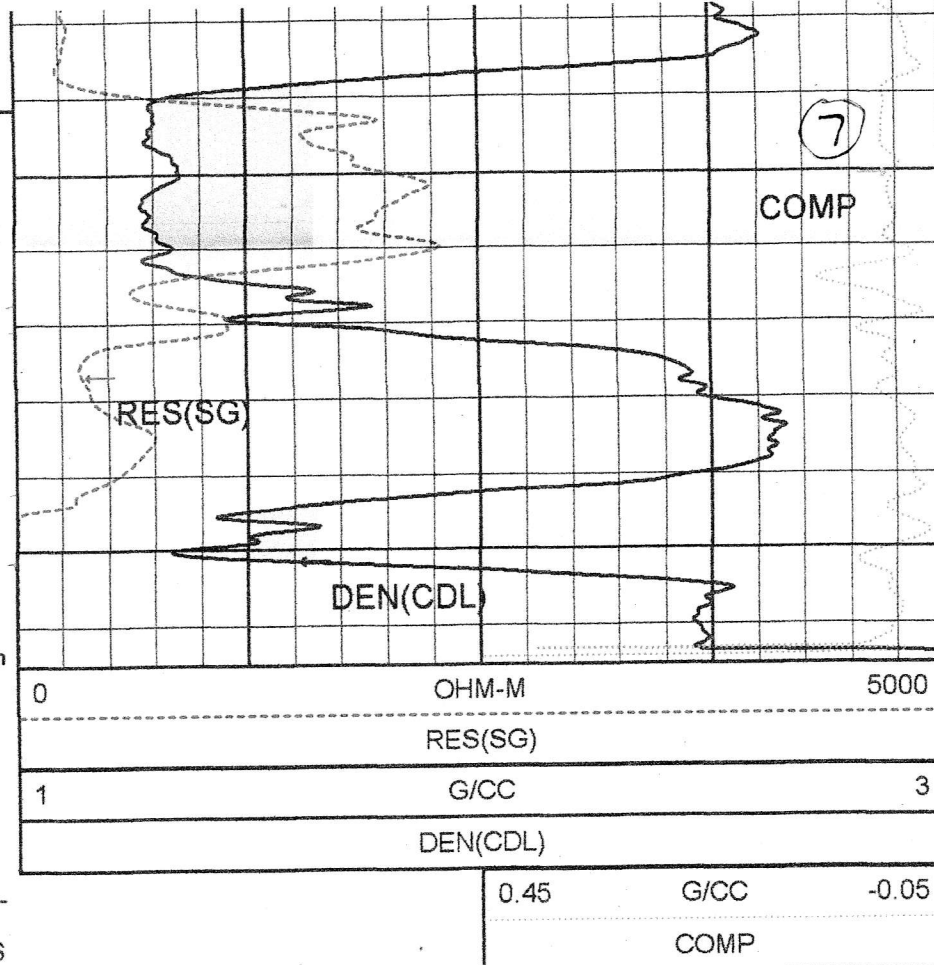


101.48m
1st Read

100

TD 101.80m

SPEED --
METERS



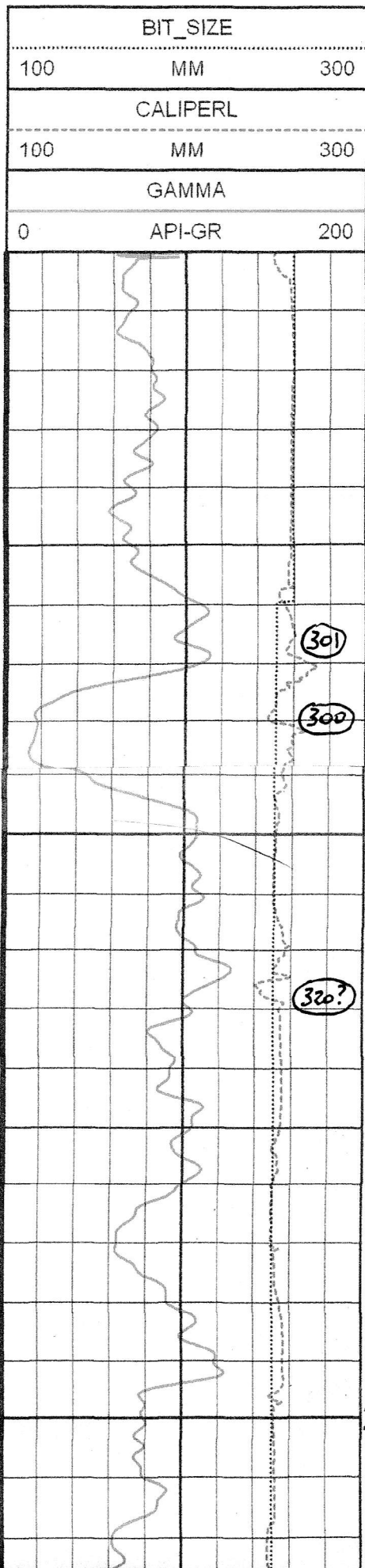
MAIN LOG 1:100 WC22LD-03 01/17/22

LOG PARAMETERS

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PRESENTATION : Conuma DEN 100LD.0 - 12/13/2021 DISPLAY7_JL63w

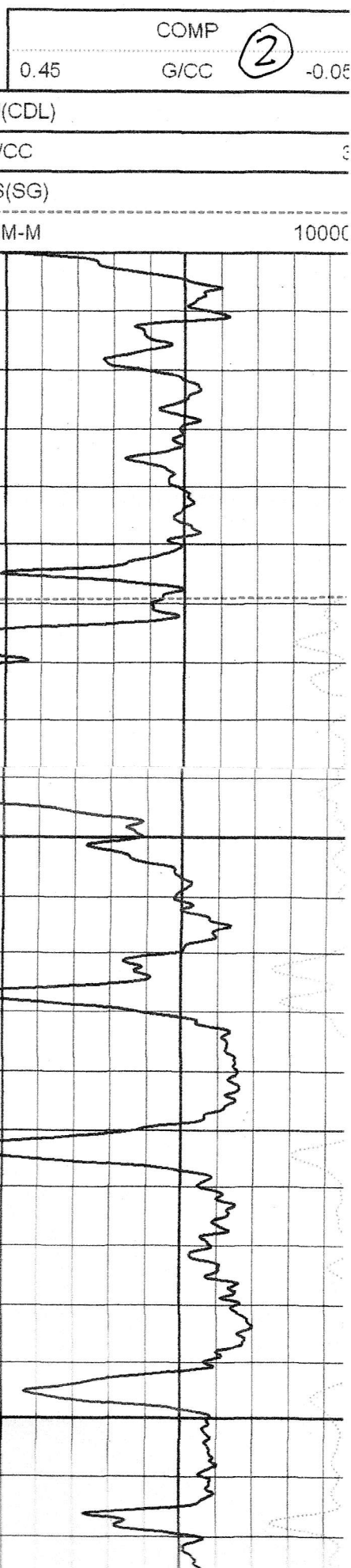
TOOL CALIBRATION WC22LD-03 01/17/22 16:55
TOOL 9239C1 TM VERSION 5026
SERIAL NUMBER 2859

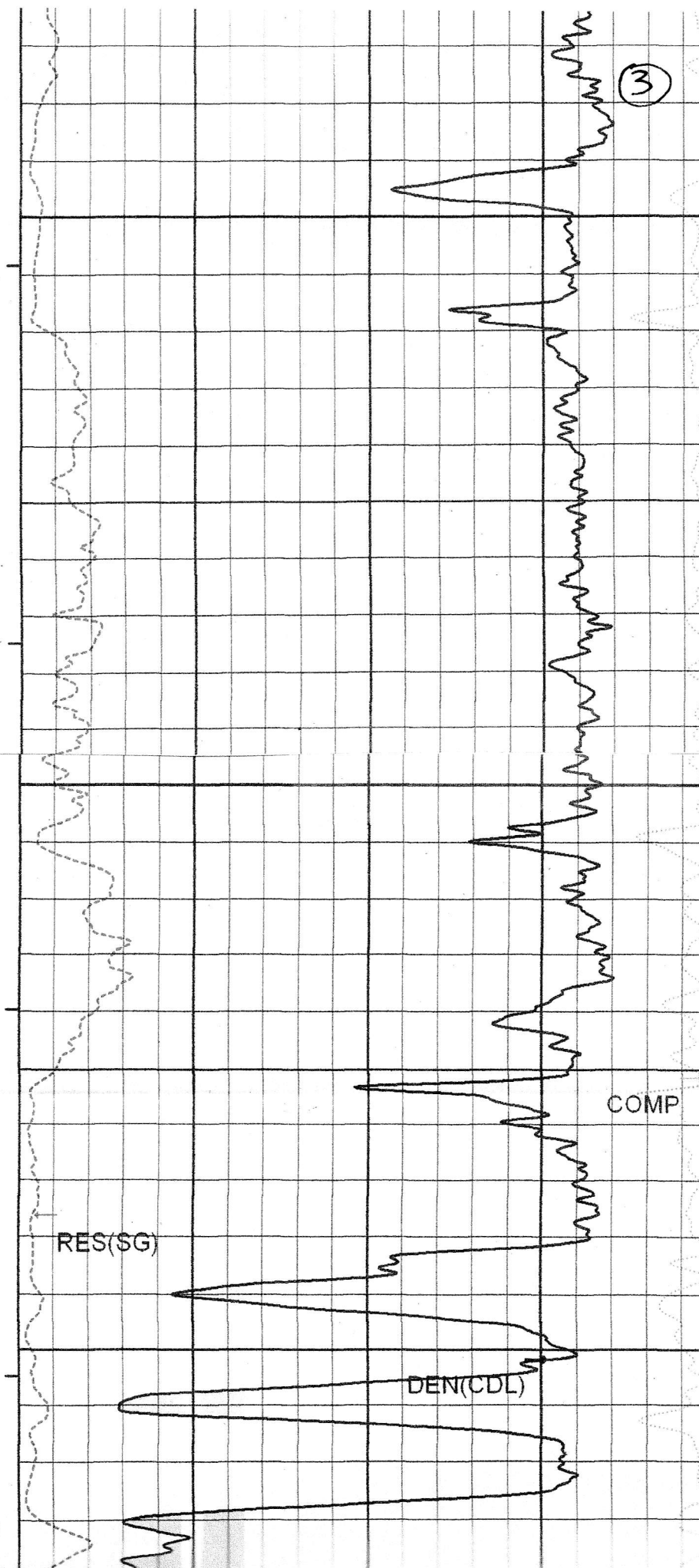
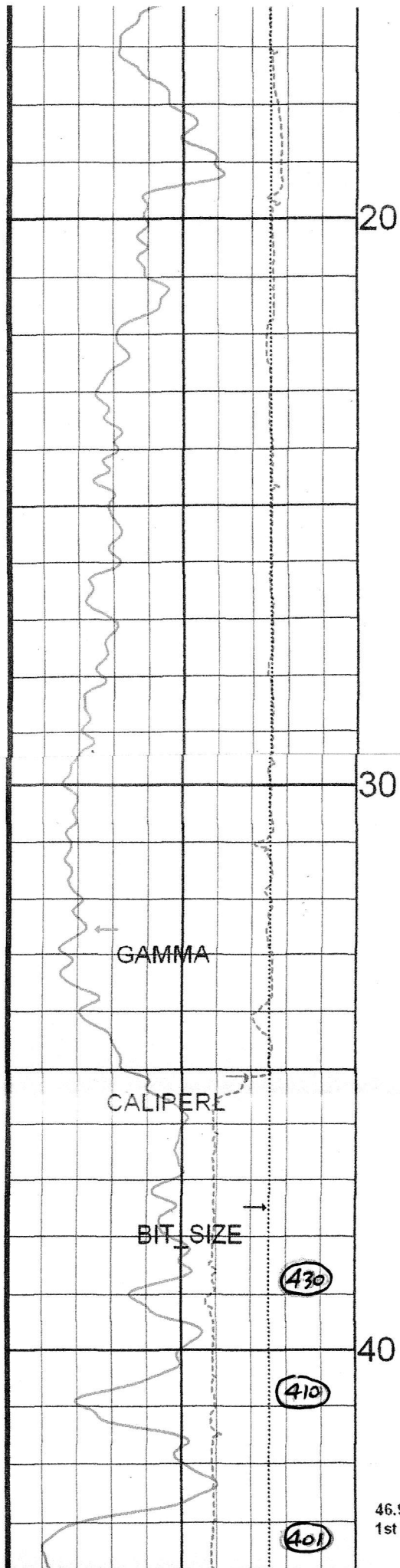
				STANDARD		RESPONSE [CPS]	
				Point1	Point2	Point1	Point2
1	Jan12,22	09:08:39	GAMMA [API-GR]	0.100	545.000	0.000	677
2	Jan12,22	10:12:46	VOLTAGE [MV]	32.200	234.000	16142	43438
3	Jan12,22	10:12:27	CALIPER [MM]	76.200	200.000	139838	264264
4	Jan12,22	13:31:24	DEN(LS) [G/CC]	1.620	2.612	13464	1931
5	Jan12,22	13:31:44	DEN(SS) [G/CC]	1.590	2.580	45251	18201
6	Jan17,22	17:34:05	CALIPERL [MM]	200.000	258.000	261915	324501
7	Jan12,22	10:13:01	CURRENT [UA]	32.200	234.000	5345	23980
8	Jan12,22	10:13:09	F [CPS]	Default		Default	
9	Jan12,22	10:13:19	X [CPS]	Default		Default	

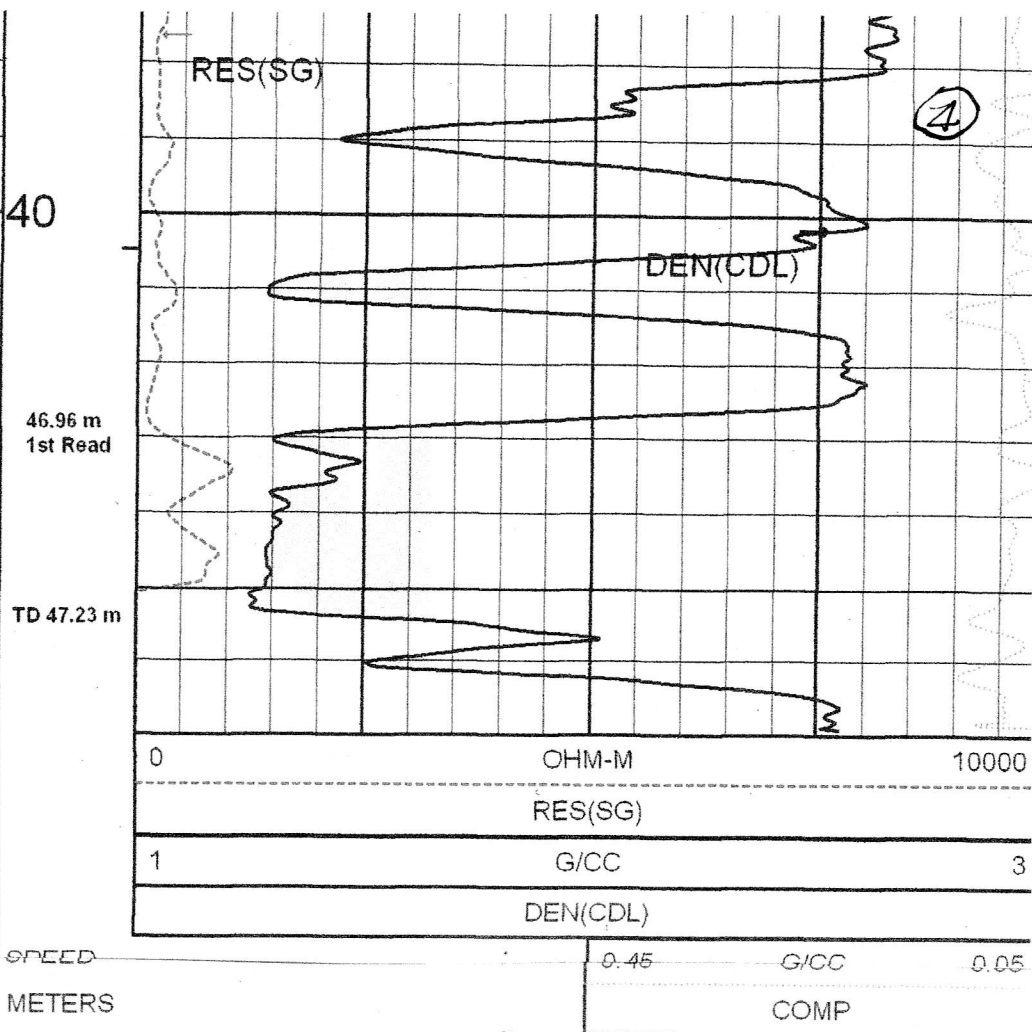
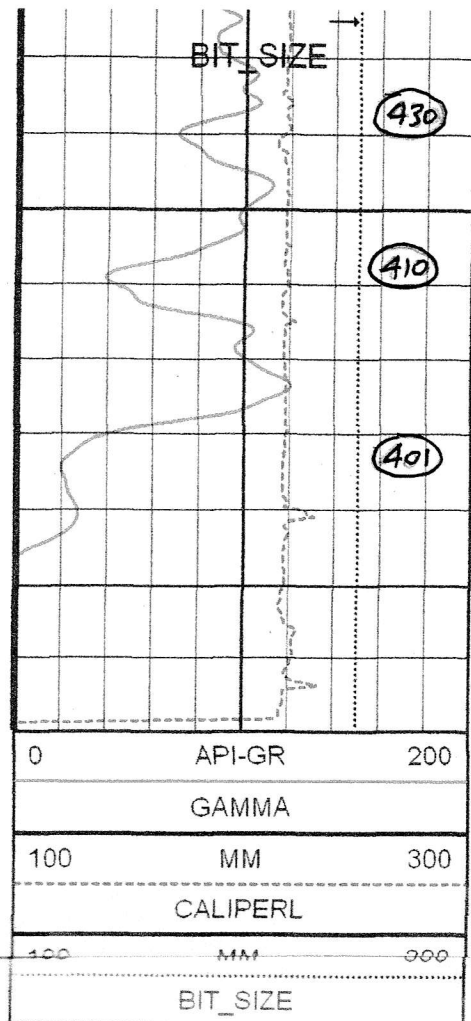


METERS

SPEED --







MAIN LOG 1:100 WC22LD-04 02/11/22

LOG PARAMETERS

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NEUTRON MATRIX : SANDSTONE

MATRIX DELTA T : 177

MAGNETIC DECL : 16.48

ELECT. CUTOFF : 75000

BIT SIZE : 250.80 MM

PRESENTATION : \Conuma DEN 100.0 - 11/23/2021

DISPLAY7_JL63w

TOOL CALIBRATION WC22LD-04 02/11/22 15:31

TOOL 9239C1 TM VERSION 5026

SERIAL NUMBER 2859

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2	Jan12,22	10:12:46	VOLTAGE	[MV]	32.200	234.000	16142	43438
3	Jan12,22	10:12:27	CALIPER	[MM]	76.200	200.000	139838	264264
4	Jan12,22	13:31:24	DEN(LS)	[G/CC]	1.620	2.612	13464	1931
5	Jan12,22	13:31:44	DEN(SS)	[G/CC]	1.590	2.580	45251	18201
6	Feb11,22	18:33:13	CALIPERL	[MM]	200.000	260.000	261915	327505
7	Jan12,22	10:13:01	CURRENT	[UA]	32.200	234.000	5345	23980
8	Jan12,22	10:13:09	F	[CPS]	Default		Default	
9	Jan12,22	10:13:19	X	[CPS]	Default		Default	

COMPANY : CONUMA COAL RESOURCES
WELL : WC22LD-05
WELL EXT :
FIELD : WILLOW CREEK MINE
COUNTY : CANADA
PROVINCE : BRITISH COLUMBIA
COUNTRY : CANADA
LICENSE : N/A

COMPANY : CONUMA COAL RESOURCES
WELL : WC22LD-05
WELL EXT :
FIELD : WILLOW CREEK MINE
COUNTY : CANADA
PROVINCE : BRITISH COLUMBIA
COUNTRY : CANADA
LICENSE : N/A
UNIQ ID : N/A
LSD : N/A
LOCATION : N/A
LAT. UTM-N : N/A
LONG. UTM-E : N/A
SECTION : N/A
TOWNSHIP : N/A
RANGE : N/A
DISPLAY7_JL63w

DEPTH - DRILLER	GL	Elevations:	Other Services:
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OG TOP	GL	DF	
OG BOTTOM	M	N/A	M
BIT SIZE	114.41	N/A	M
ASING - DRILLER	250.80	N/A	M
ASING - LOGGER	6.00	N/A	M
ASING O.D.	5.74	N/A	M
ASING TYPE	270.00	N/A	MM
LUID TYPE	SURFACE		
LUID DENSITY	H2O		
LUID VISCOSITY	1.00	G/C	
LUID PH	N/A		
LUID SOURCE	N/A		
MEAS TEMP	N/A @ N/A C		
MEAS TEMP	N/A @ N/A C		
MEAS TEMP	N/A @ N/A C		
MEAS TEMP	N/A @ N/A C		
STOPPED	N/A		
NUMBER	N/A		
LUID LEVEL	37.78		
RECORDED BY	D STEWART		
WITNESSED BY	A. MATESOI		
REMARKS 1			
REMARKS 2			
REMARKS 3			

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS

MAIN LOG 1:100 WC22LD-05 02/11/22

LOG PARAMETERS

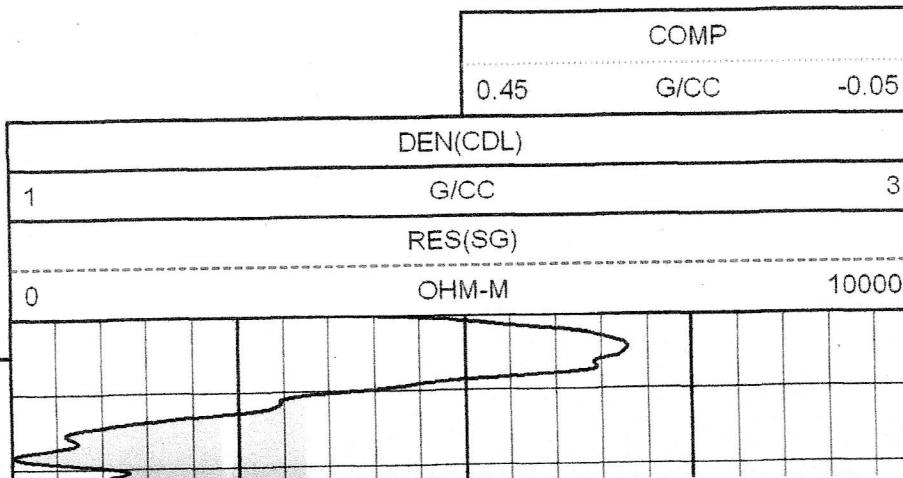
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MAGNETIC DECL : 16.48
PRESENTATION : \Conuma DEN 100.0 - 11/23/2021

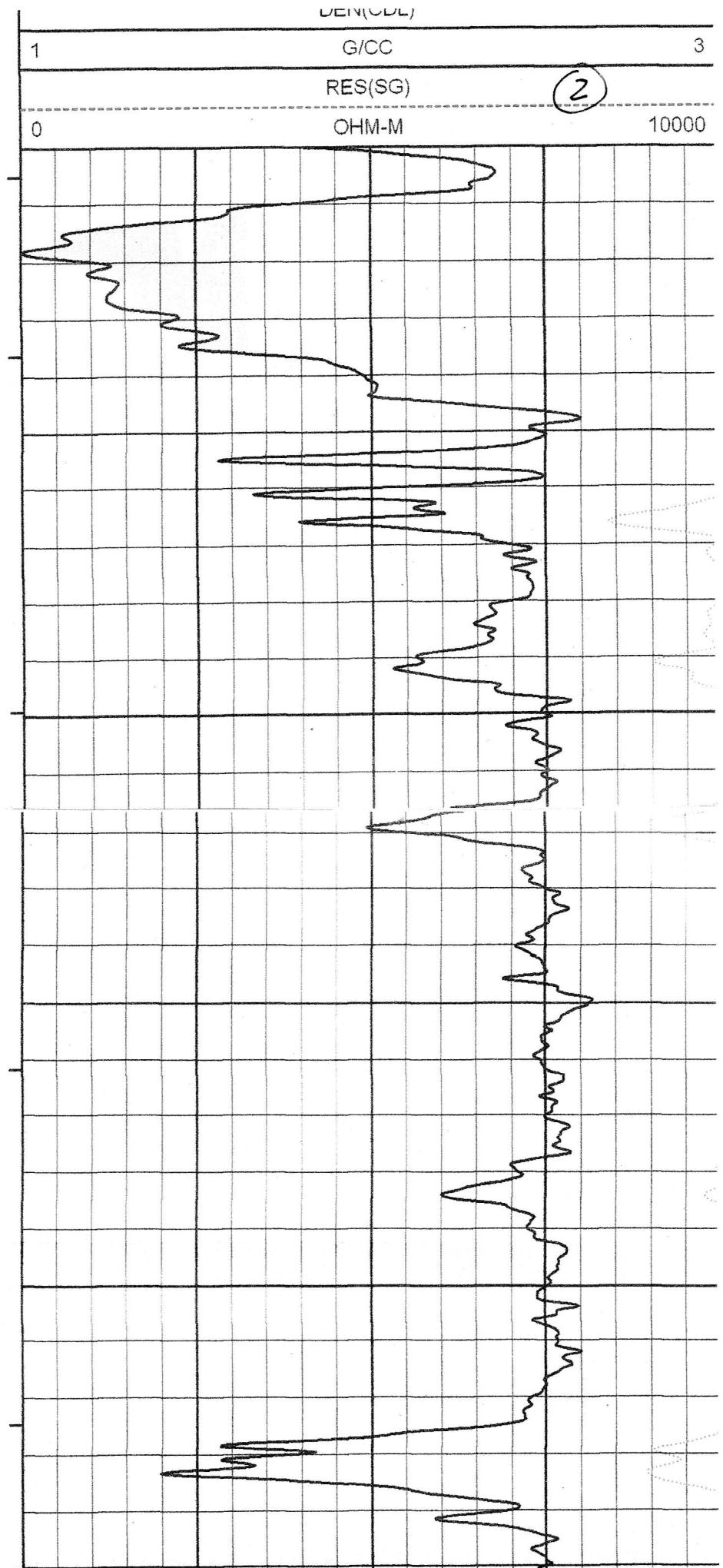
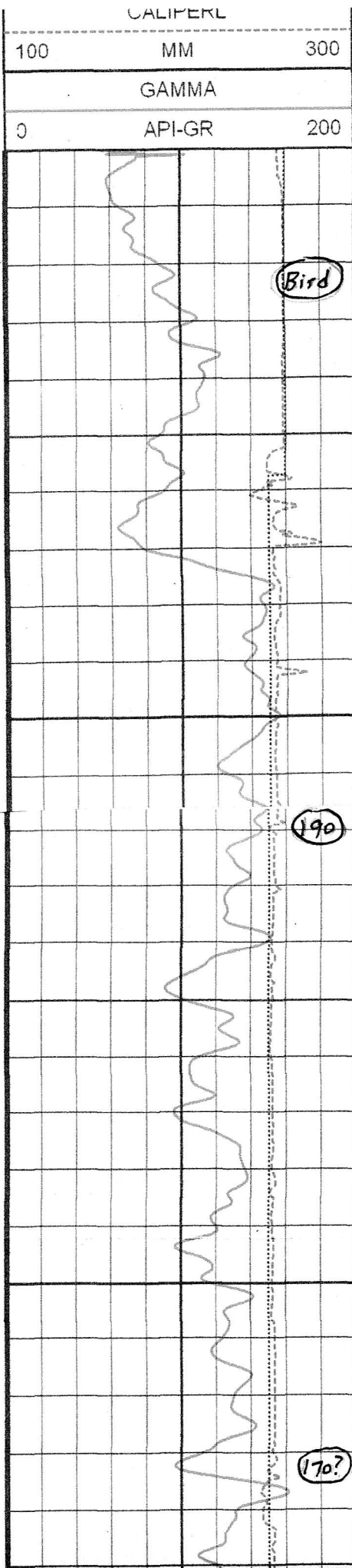
NEUTRON MATRIX : SANDSTONE
ELECT. CUTOFF : 75000

MATRIX DELTA T : 177
BIT SIZE : 250.80 MM
DISPLAY7_JL63w

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MM		
CALIPERL	100	300
MM		
GAMMA	0	200
API-GR		

METERS
SPEED --





20

(170?)

(150?)

30

(130)

(115)

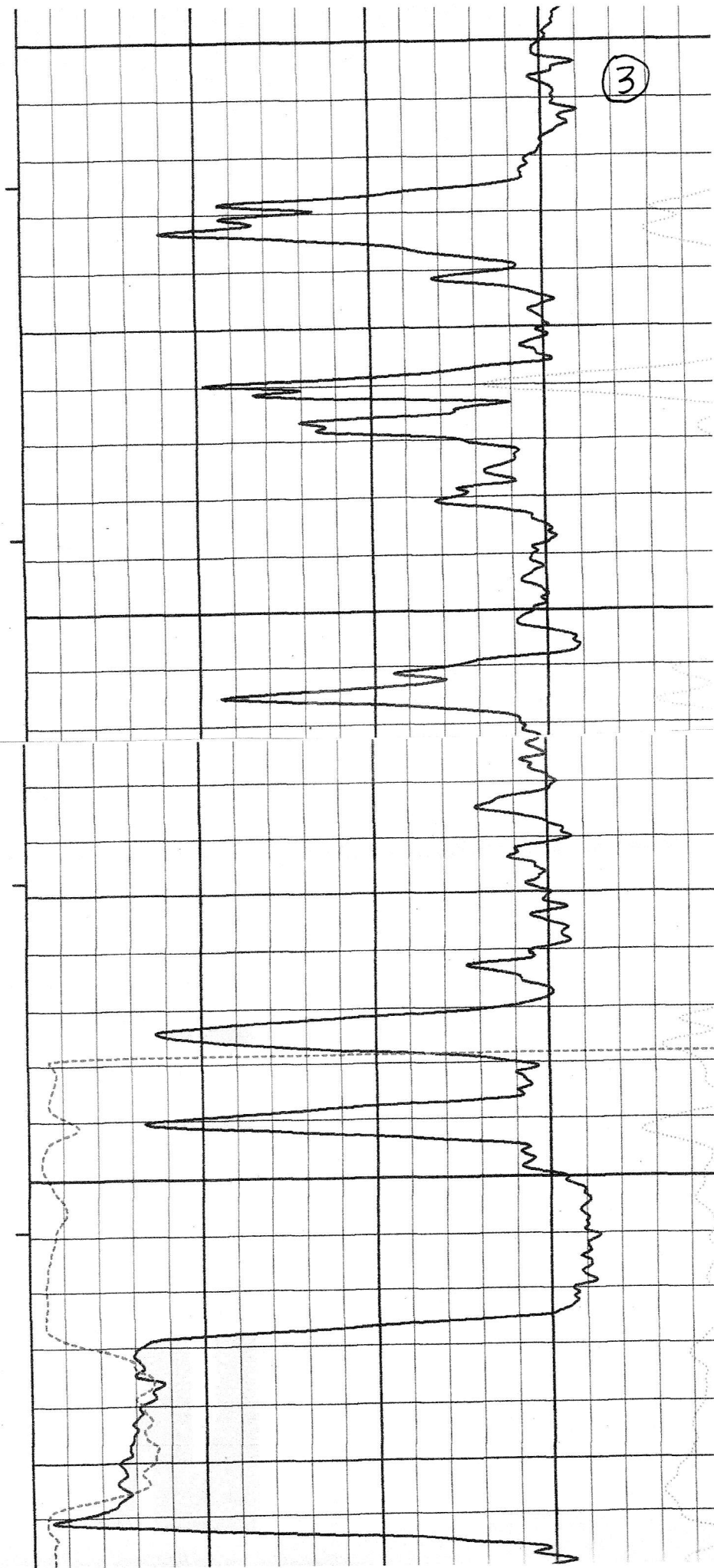
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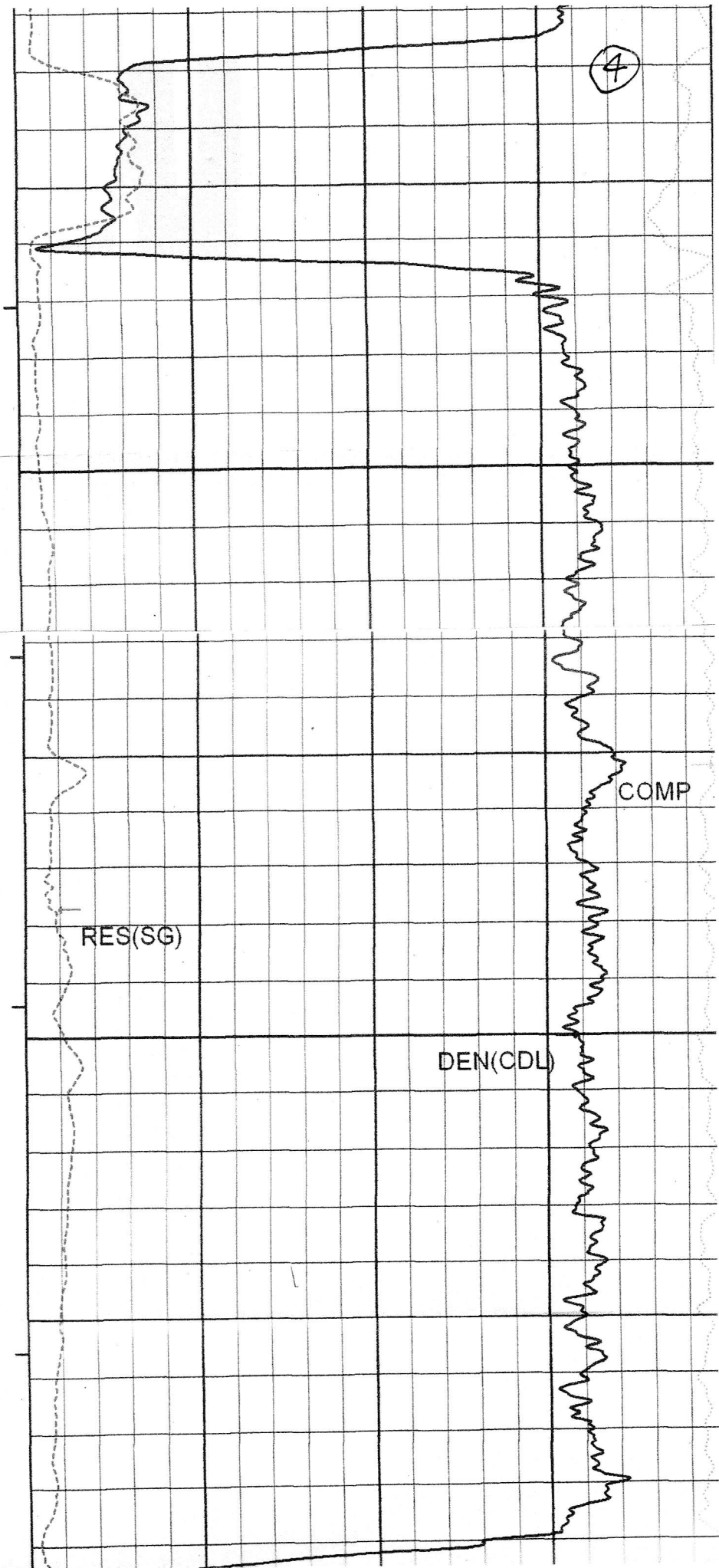
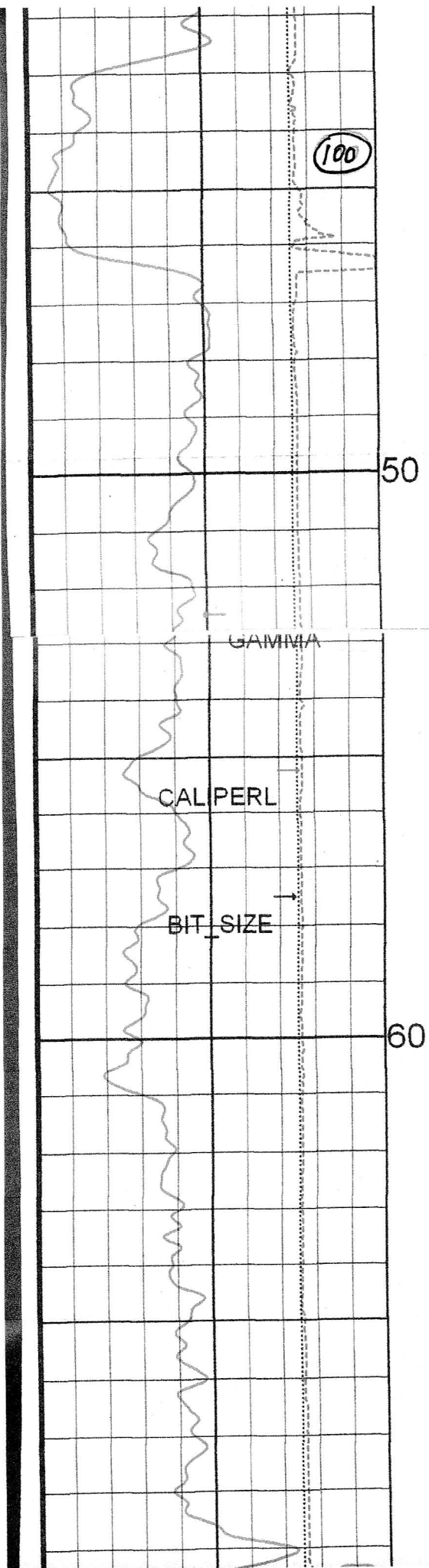
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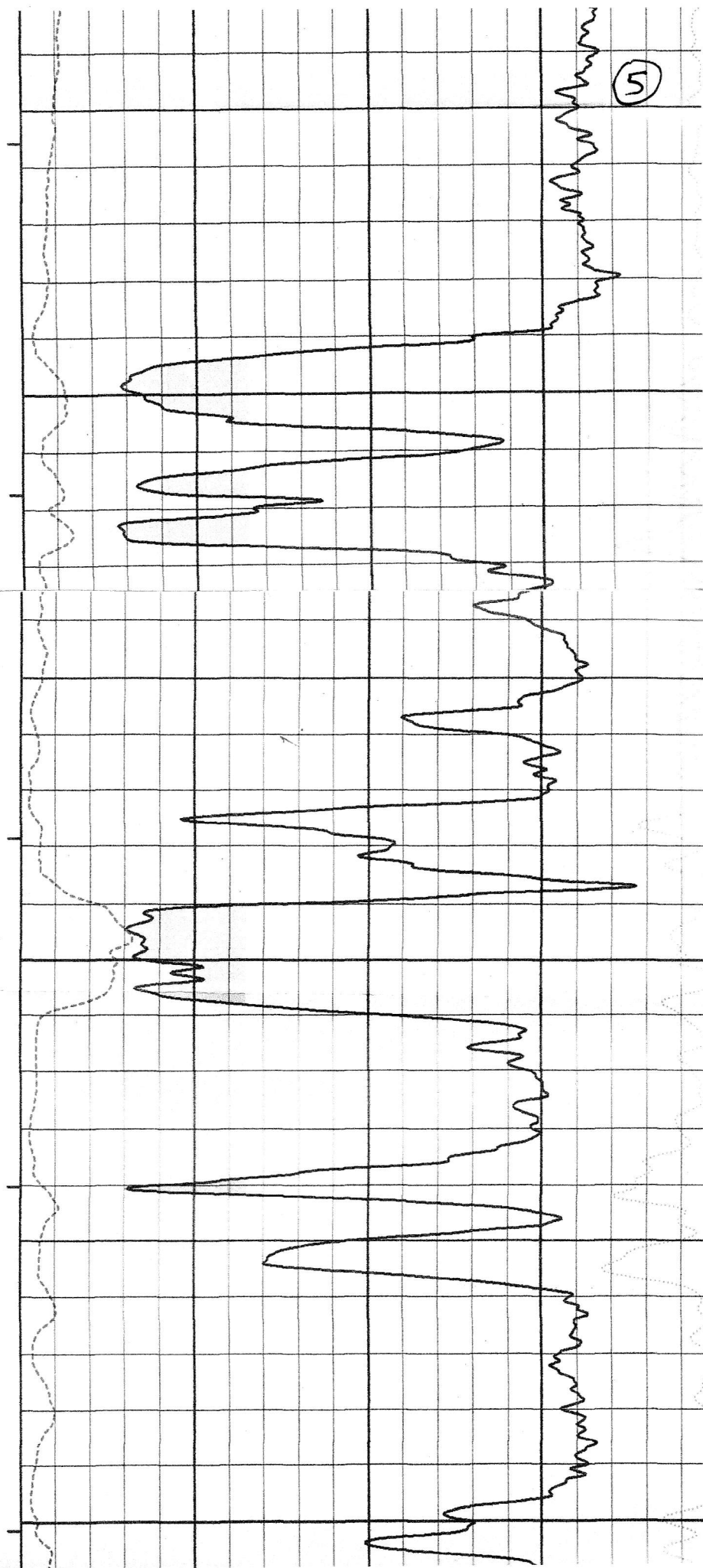
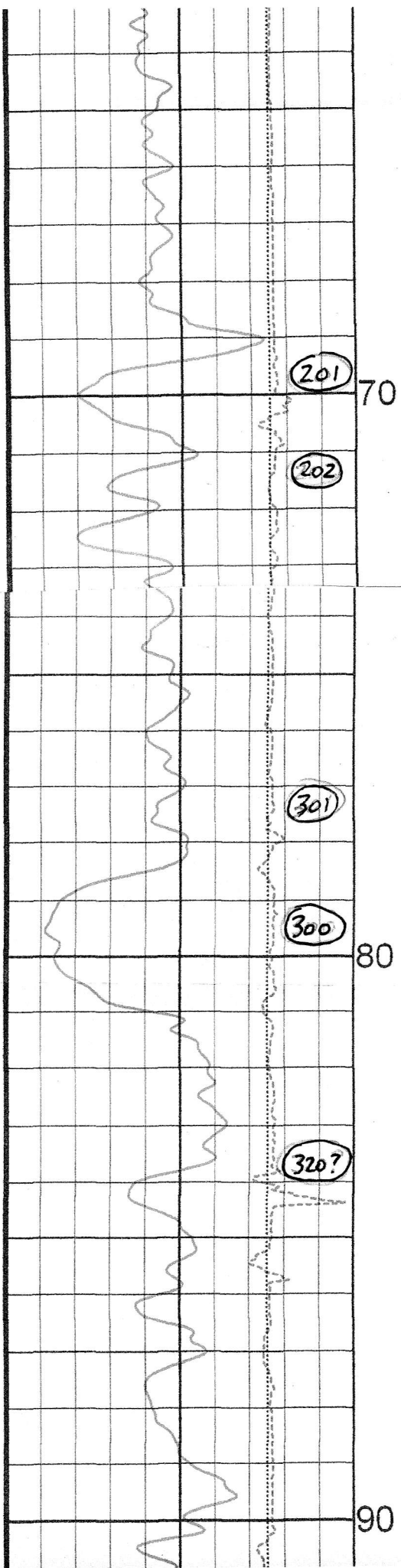
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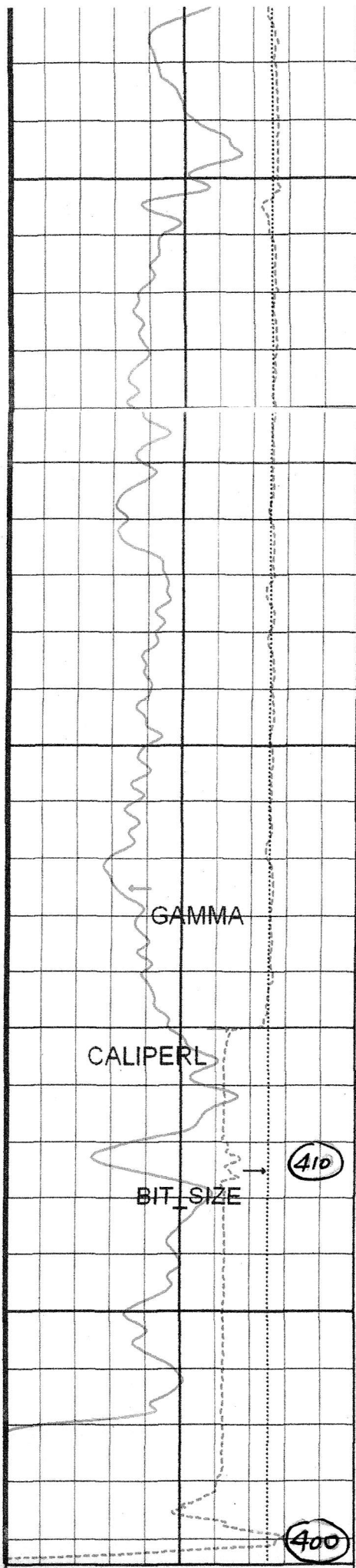
Level
Fluid

(3)







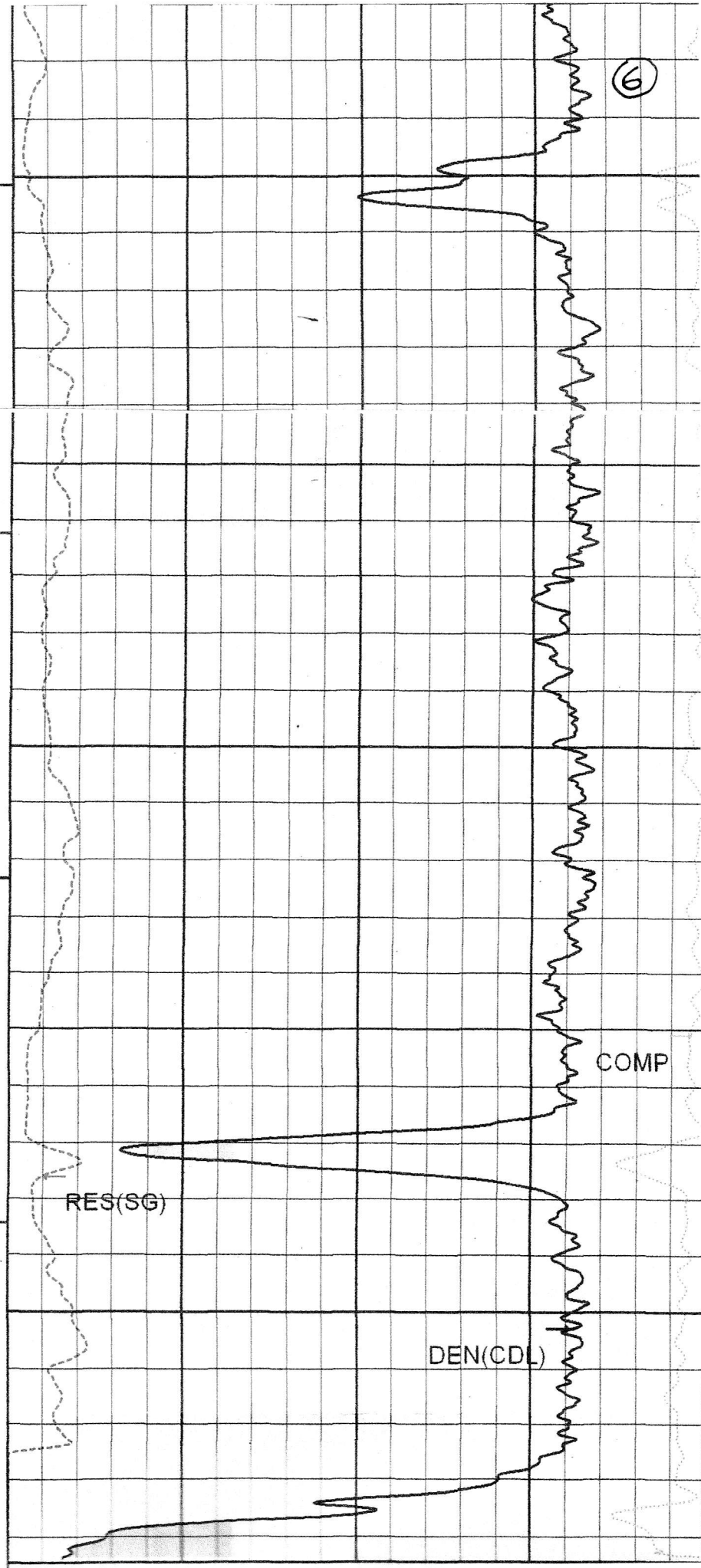


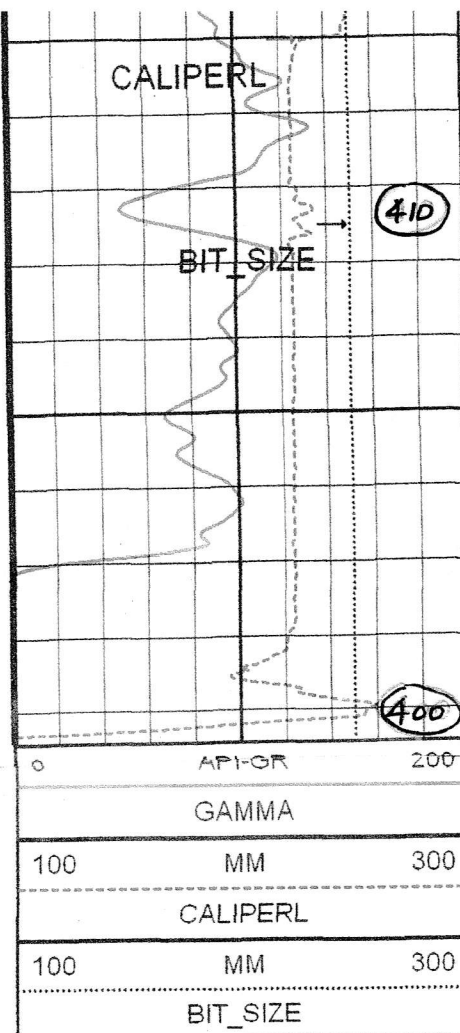
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100

110
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1st Read

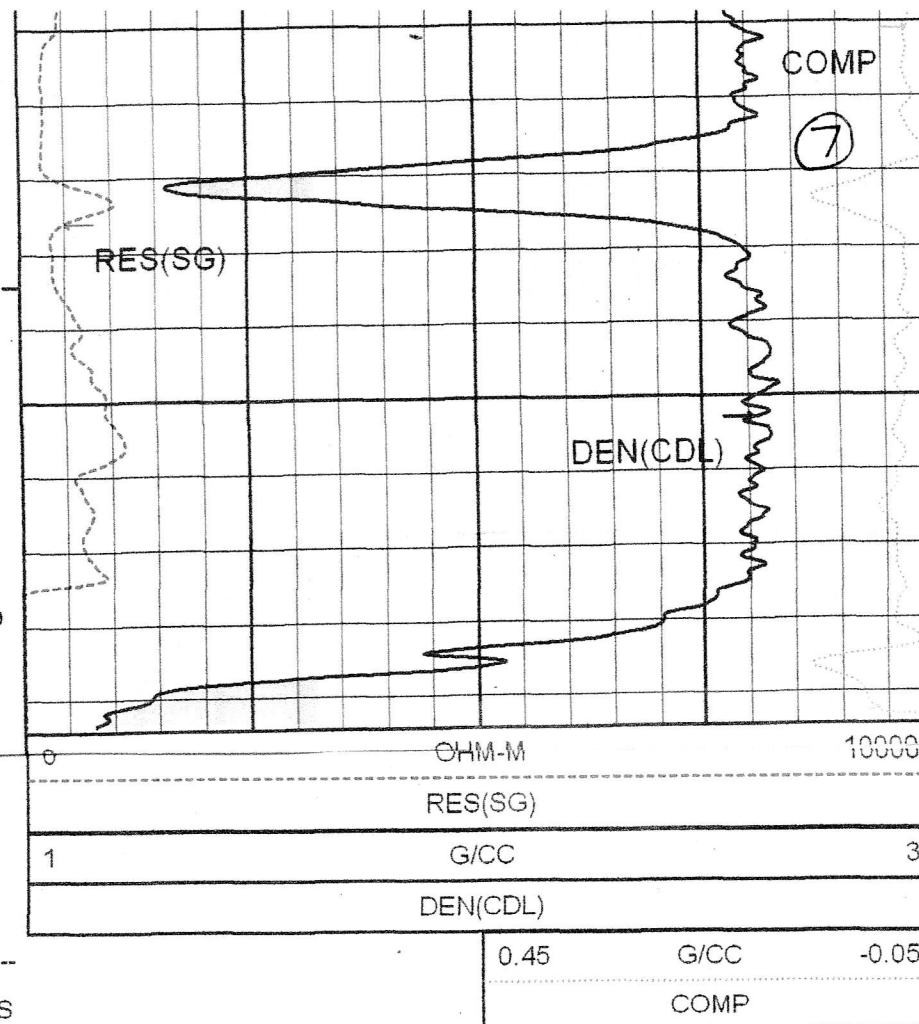
m
TD 114.69





110
114.40
1st Read

m
TD 114.69



MAIN LOG 1:100 WC22LD-05 02/11/22

LOG PARAMETERS

MATRIX DENSITY : 2.65 NEUTRON MATRIX : SANDSTONE MATRIX DELTA T : 177
MAGNETIC DECL : 16.48 ELECT. CUTOFF : 75000 BIT SIZE : 250.80 MM
PRESENTATION : \Conuma DEN 100.0 -- 11/23/2021 DISPLAY7_JL63w

TOOL CALIBRATION WC22LD-05 02/11/22 12:00
TOOL 9239C1 TM VERSION 5026
SERIAL NUMBER 2859

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				Point1	Point2	Point1	Point2
1	Jan12,22	09:08:39	GAMMA [API-GR]	0.100	545.000	0.000	677
2	Jan12,22	10:12:46	VOLTAGE [MV]	32.200	234.000	16142	43438
3	Jan12,22	10:12:27	CALIPER [MM]	76.200	200.000	139838	264264
4	Jan12,22	13:31:24	DEN(LS) [G/CC]	1.620	2.612	13464	1931
5	Jan12,22	13:31:44	DEN(SS) [G/CC]	1.590	2.580	45251	18201
6	Feb11,22	18:01:19	CALIPERL [MM]	200.000	260.000	261915	327505
7	Jan12,22	10:13:01	CURRENT [UA]	32.200	234.000	5345	23980
8	Jan12,22	10:13:09	F [CPS]	Default		Default	
9	Jan12,22	10:13:19	X [CPS]	Default		Default	

COMPENSATED DENSITY GAMMA - CALIPER - RES. WC22LD-06

COMPANY CONUMA COAL RESOURCES
WELL WC22LD-06
WELL EXT
FIELD WILLOW CREEK MINE
COUNTY CANADA
PROVINCE BRITISH COLUMBIA
COUNTRY CANADA
LICENSE N/A

COMPANY : CONUMA COAL RESOURCES
WELL : WC22LD-06
WELL EXT :
FIELD : WILLOW CREEK MINE
COUNTY : CANADA
PROVINCE : BRITISH COLUMBIA
COUNTRY : CANADA
LICENSE : N/A
UNIQ ID : N/A
LSD : N/A SECTION: N/A TOWNSHIP: N/A RANGE: N/A
LOCATION : N/A
LAT. UTM-N : N/A
LONG. UTM-E : N/A

DISPLAY7_JL63w

PERMANENT DATUM GL Elevations: N/A M M DEV
DRL MEASURED FROM GL KB DF N/A M M
LOG MEASURED FROM GL N/A M M
ELEV. PERM. DATUM N/A M

DATE	02/11/22 14:05		
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DEPTH - LOGGER	75.58	M	
LOG TOP	0.00	M	
LOG BOTTOM	75.32	M	
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CASING - DRILLER	6.70	M	
CASING - LOGGER	5.76	M	
CASING O.D.	270.00	MM	
CASING TYPE	SURFACE		
FLUID TYPE	H2O		
FLUID DENSITY	1.00	G/CC	
FLUID VISCOSITY	N/A		
FLUID PH	N/A		
MUD SOURCE	N/A		
RM @ MEAS TEMP	N/A @ N/A C		
RMF @ MEAS TEMP	N/A @ N/A C		
RMG @ MEAS TEMP	N/A @ N/A C		
CIRC STOPPED	N/A		
RIG NUMBER	N/A		
FLUID LEVEL	0.00		
RECORDED BY	D. STEWART		
WITNESSED BY	A. MATEOSI		
REMARKS 1			
REMARKS 2			
REMARKS 3			

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS

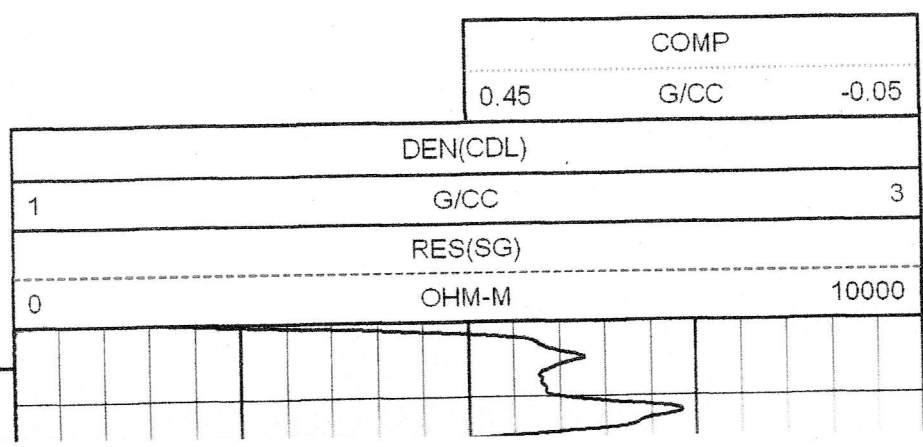
MAIN LOG 1:100 WC22LD-06 02/11/22

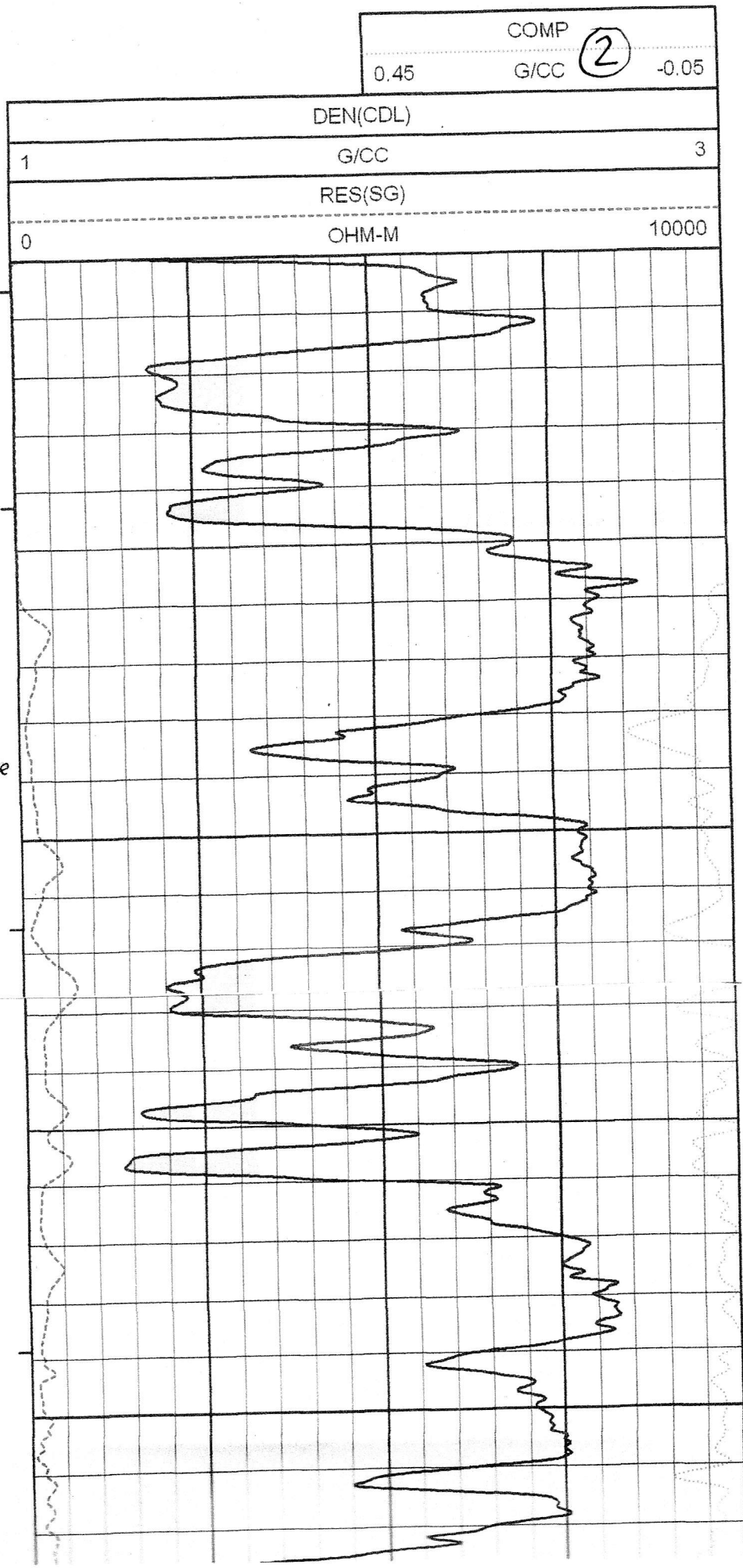
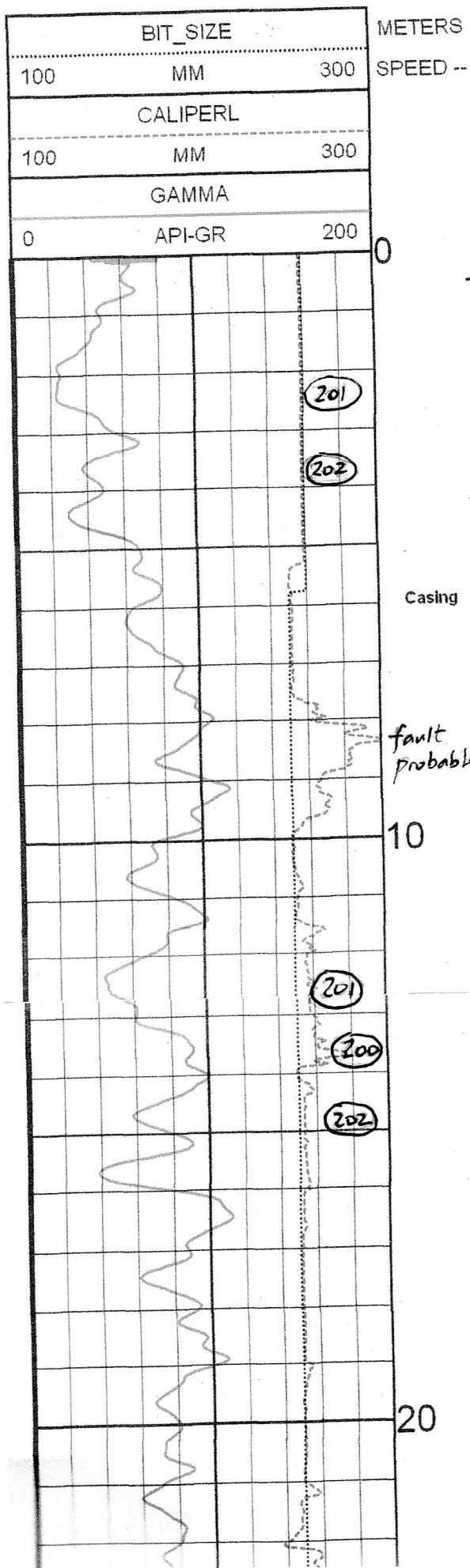
LOG PARAMETERS

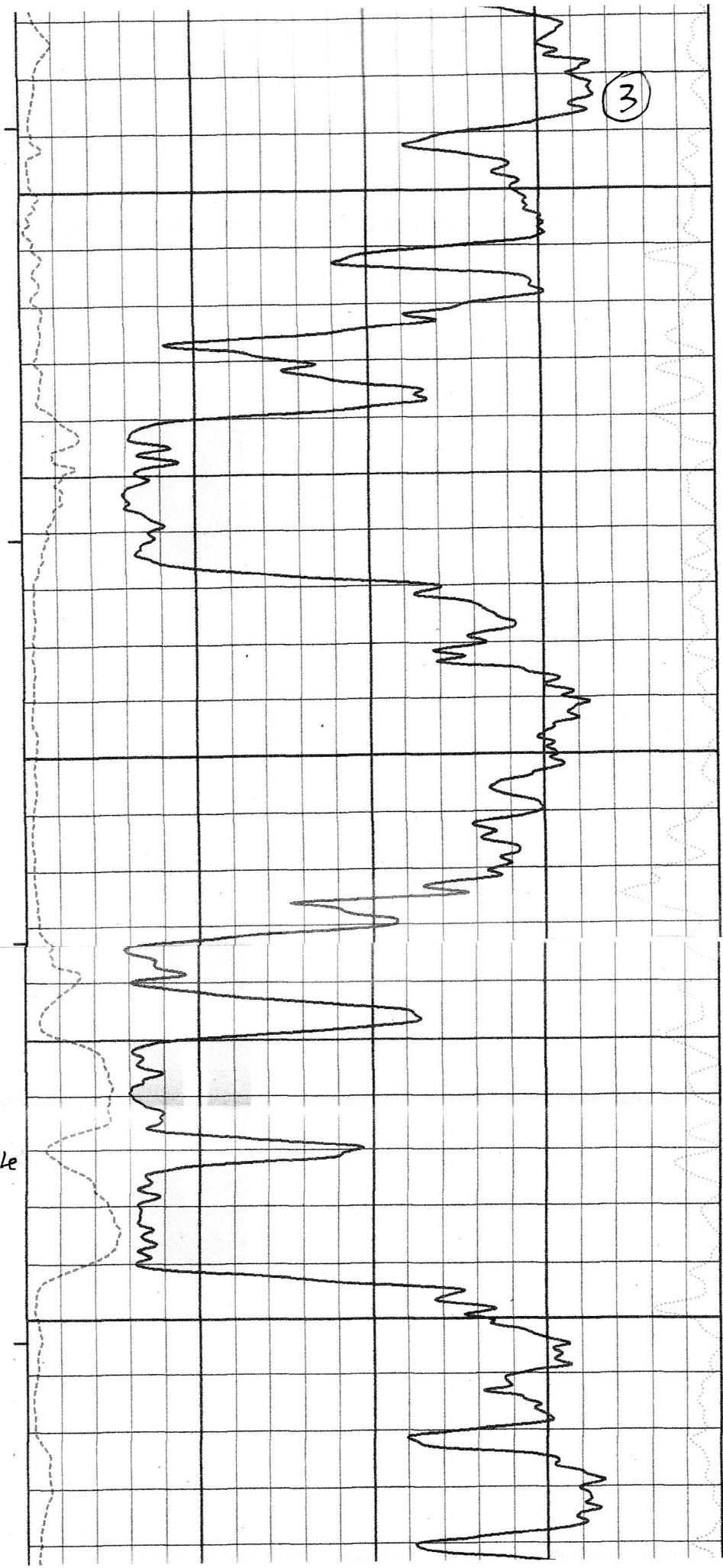
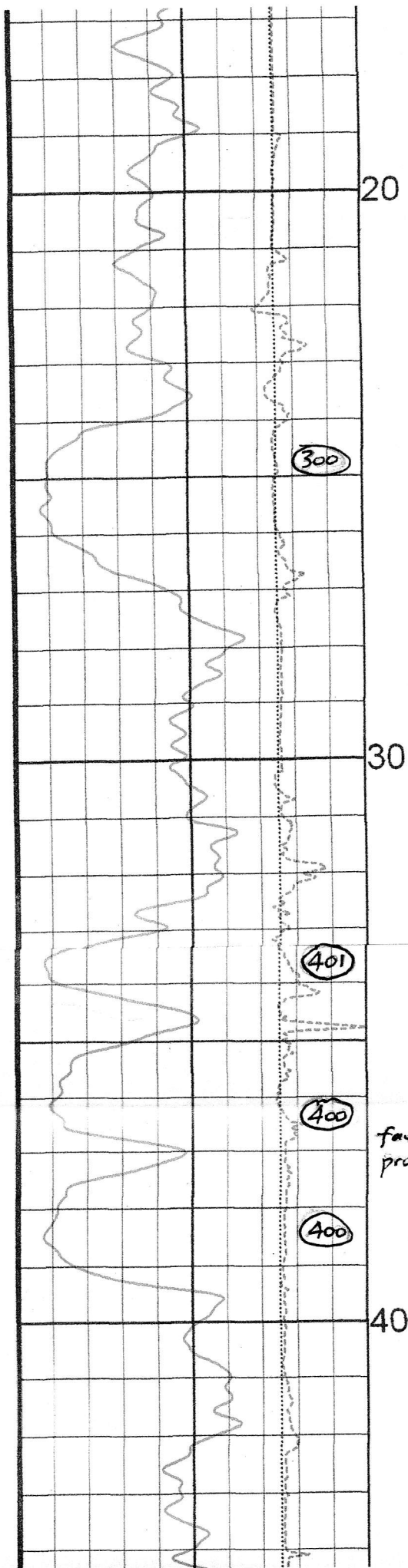
MATRIX DENSITY : 2.65 NEUTRON MATRIX : SANDSTONE MATRIX DELTA T : 177
MAGNETIC DECL : 16.48 ELECT. CUTOFF : 75000 BIT SIZE : 250.80 MM
PRESENTATION : \Conuma DEN 100.0 - 11/23/2021 DISPLAY7_JL63w

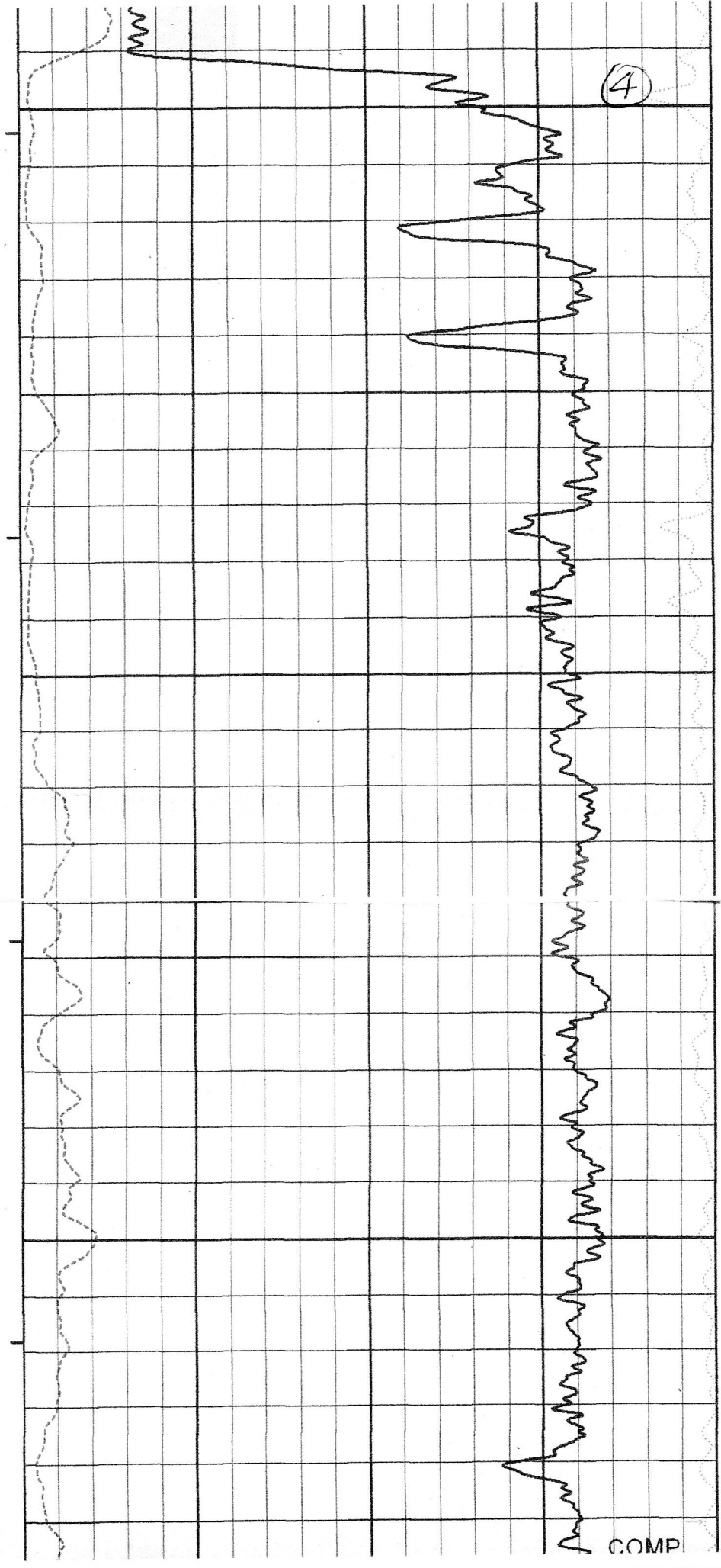
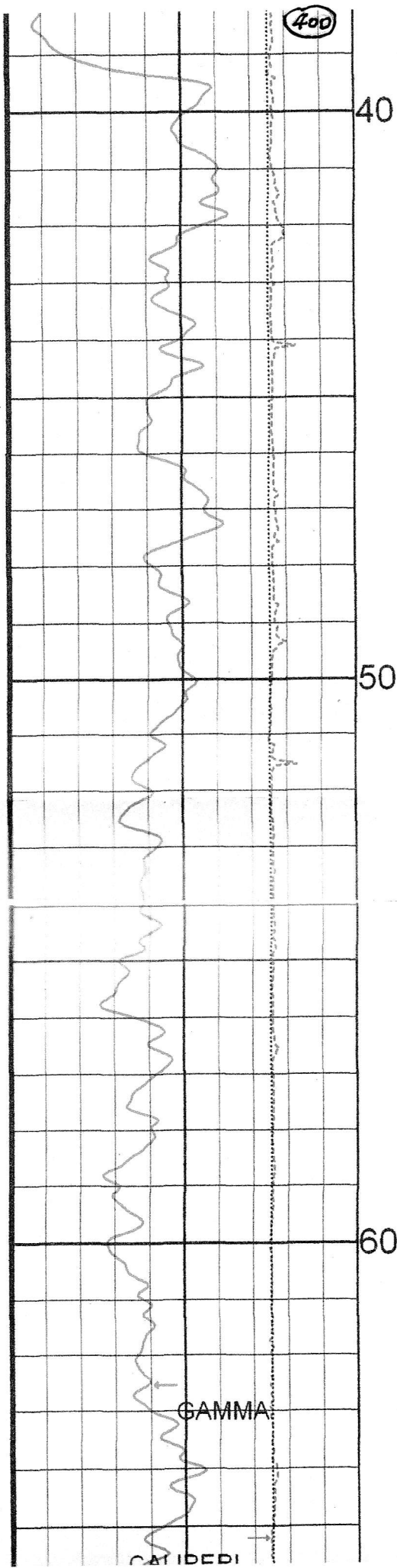
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CALIPERL		
100	MM	300
GAMMA		
0	API-GR	200

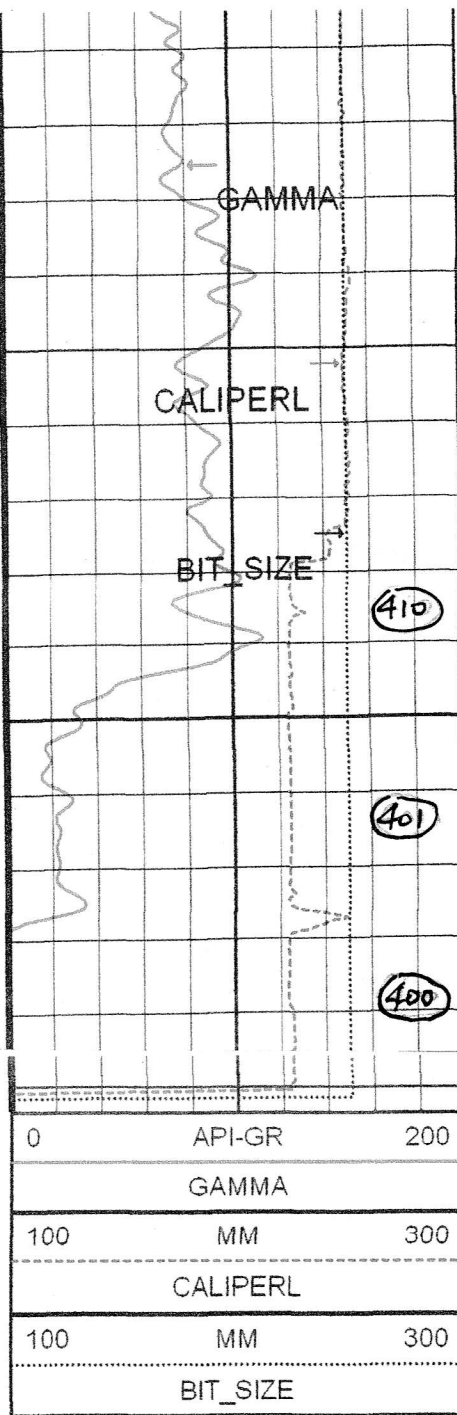
METERS
SPEED --











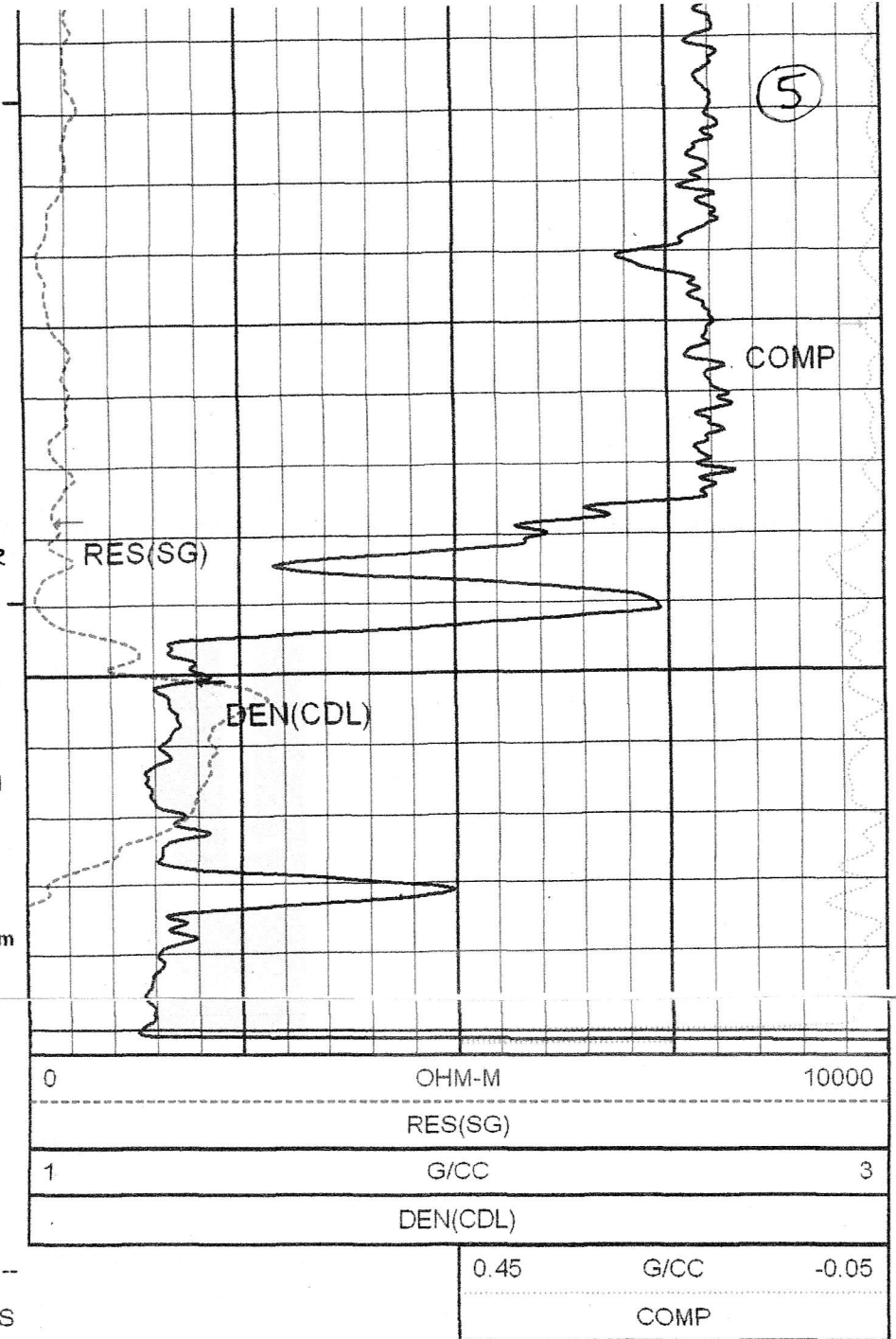
fault
probable

70

75.32 m
1st Read

TD 75.58 m

SPEED --
METERS



MAIN LOG 1:100 WC22LD-06 02/11/22

LOG PARAMETERS

MATRIX DENSITY : 2.65 NEUTRON MATRIX : SANDSTONE MATRIX DELTA T : 177
 MAGNETIC DECL : 16.48 ELECT. CUTOFF : 75000 BIT SIZE : 250.80 MM
 PRESENTATION : \Conuma DEN 100.0 -- 11/23/2021 DISPLAY7_JL63w

TOOL CALIBRATION WC22LD-06 02/11/22 14:05
 TOOL 9239C1 TM VERSION 5026
 SERIAL NUMBER 2859

STANDARD

RESPONSE 10001

Appendix B: Core descriptions

Following (as **Tables B-1** through **B-6**) are summary core descriptions for the six large-diameter cored boreholes, adjusted to geophysical logs by Adriana Matesoi, who also performed the core-logging and sampling of coals and associated roof and floor rocks. These core descriptions are sourced from more-extensive *Excel* data-tables, which accompany this report in digital form.

The 'sample no.' column in **Tables B-1** through **B-6** records field sample tag numbers. Samples sometimes span several adjacent thin bands of coal and/or rock.

The 'Birtley head lab no.' column presents assay serial numbers as assigned upon receipt at Birtley Coal and Minerals Testing's laboratory in Calgary. Some Birtley assay numbers span several adjacent sample tags, individual samples were judged worthy of compositing at the raw analytical level.

All tagged samples were submitted for head raw analysis, as discussed further in **Appendix C**.

The 'Wash / froth lab no.' column documents the Birtley numbers of samples submitted for step-washing and froth flotation, and whose results were received prior to March 31, 2022, as discussed further in **Appendix D**. Numbers prefixed 'C-' are follow-up composites, in progress.

**Coal assessment report for the Willow Creek coal lease --Volume 7:
Willow Creek Mine, 2021/2022 infill drilling**

Summary of WC22LD-01: Table B-1

Cores	From	To	Re-cov- ered	Core loss	Sample no.	Birtley head lab no.	Wash / froth lab no.	Coal bed	Lithology code	Roof appt. dip	Floor appt. dip	Comments	
	0	1.82	0	1.82					R-LOSS			CASING: 6ft = 1.82m.	
	1.82	45.05	0	43.23					R-LOSS			Open hole (no core) to 147'8" = 45.05 m.	
Core 1													
	45.05	45.21	0.16	0					SST			Sandstone: medium brown-grey, fine grained, calcareous (strong HCL reaction in the rock mass.	
	45.21	45.56	0.35	0					CST			Shale: dark grey-brown, v. fine grained, slightly carbonaceous towards floor. Weak HCL reaction.	
	45.56	45.61	0.05	0	21132	220580		roof	CCST		38	Carbonaceous shale: Dark grey to black, v. fine grained. Floor contact with coal below - intact, at ~38° BCN. Roof dilution sample.	
	45.61	46.17	0.56	0	21133	220534	C-10	430	CD&B			COAL: banded (dull and bright), hard and competent. Moderately sheared at the roof contact (for ~3cm)	
Core 2													
	46.17	46.28	0.11	0	21134	220534		430	CD&B			COAL: banded (dull & bright).	
	46.28	46.38	0.10	0				430	CBN			COAL: bony	
	46.38	46.42	0.04	0					CST			Shale: dark brown-grey, v. fine grained, somewhat silty.	
	46.42	46.62	0.20	0				410	CD&B			COAL: banded (dull & bright).	
	46.62	47.13	0.51	0	21135	220535		410	CD&B		25	COAL: as above. BCN at floor ~25°.	
	47.13	47.20	0.07	0					CCST		25	Carbonaceous shale: dark brown to black, v. fine grained. BCN at floor ~25°	
	47.20	47.57	0.37	0	21136	220536		C-11	401	CD&B			COAL: banded (dull & bright).
	47.57	47.63	0.06	0					401	CBN			COAL: bony
	47.63	47.69	0.06	0			401		COAL			COAL: mostly dull (v. broken core).	
Core 3													
	47.69	47.93	0.24	0	21137	220537	401		CDB			COAL: dull banded (kind of hard).	
	47.93	48.08	0.15	0	21138		401		COAL			COAL: sheared and partially pulverised (a fault zone look)	
	48.08	48.47	0.39	0			401		CD&B			COAL: banded (dull & bright). Crushed at roof and floor contacts	
	48.47	48.61	0.14	0			401		COAL			COAL: very sheared (possible dull & bright?). Floor contact at 27° BCN.	
	48.61	48.66	0.05	0	21139	220581	floor		CCST			Carbonaceous shale: black to dark grey, v. fine grained, sheared. Floor dilution sample.	

**Coal assessment report for the Willow Creek coal lease --Volume 7:
Willow Creek Mine, 2021/2022 infill drilling**

Summary of WC22LD-01: Table B-1 (continued)

Cores	From	To	Re- cov- ered	Core loss	Sample no.	Birtley head lab no.	Wash / froth lab no.	Coal bed	Lithology code	Roof appt. dip	Floor appt. dip	Comments	
	48.66	48.71	0.05	0	21139	220581		floor	CST			Shale: dark grey-brown, v. fine grained, with very think coal stringers. FLOOR dilution sample.	
	48.71	48.86	0.15	0					CST			Shale: as above.	
	48.86	49.29	0.43	0					SLT			Siltstone: dark brown grey, fine grained, thinly laminated.	
Core 4													
	49.29	49.51	0.22	0					SLT	35		Siltstone: as above	
	49.51	49.62	0.11	0					SLT			Siltstone: grey and white, v. fine grained , brecciated (breccia filled with white gypsum?).	
	49.62	49.72	0.10	0	21140	220582		roof	CCST		30	Carbonaceous shale: black to dark grey, v. fine grained, v. broken roof contact, floor contact with coal below at ~30° BCN. ROOF dilution sample.	
	49.72	49.94	0.22	0	21141	220538	C-12	400	CD&B			COAL: banded (dull & bright). Slightly sheared, soft.	
	49.94	50.26	0.32	0				400	CD&B			COAL: banded (dull & bright). Hard and competent.	
	50.26	50.84	0.58	0	21142	220539		400	CD&B			COAL: banded (dull & bright).	
Core 5													
	50.84	51.00	0	0.16				400	R-LOSS				Core loss - rock (or a cave?)
	51.00	51.32	0.32	0				400	CDB				COAL: dull banded.
	51.32	51.45	0.13	0	21143	220540		400	COAL				COAL: pulverised, wet coal. Fault gouge aspect. POSSIBLE coal core loss AT TOP and/or AT BOTTOM!
	51.45	51.49	0	0.04				400	C-LOSS				Core loss - coal
	51.49	52.00	0.51	0				400	CD&B				COAL: dull and bright. Floor contact intact, at ~30° BCN
	52.00	52.06	0.06	0	21144	220541		400	CCST		30		Carbonaceous shale: dark brown to black, v. fine grained. BCN at floor 30° .
	52.06	52.21	0.15	0				400	CD&B		30		COAL: dull and bright.
Core 6													
	52.21	52.24	0	0.03	21144			400	C-LOSS			Core loss - coal	
	52.24	52.31	0.07	0	21145	220541		400	COAL		30	COAL: highly sheared, some white clay as thin coating on cleats. Solid floor contact at ~30° BCN. POSSIBLE C_Loss AT TOP!	
	52.31	52.41	0.10	0	21146	220583		floor	CCST			Carbonaceous shale: almost black, v.fine grained, laminated; a few coal stringers. Floor dilution sample.	

**Coal assessment report for the Willow Creek coal lease --Volume 7:
Willow Creek Mine, 2021/2022 infill drilling**

Summary of WC22LD-01: Table B-1 (continued)

Cores	From	To	Re- cov- ered	Core loss	Sample no.	Birtley head lab no.	Wash / froth lab no.	Coal bed	Lithology code	Roof appt. dip	Floor appt. dip	Comments
	52.41	52.43	0.02	0					CCST			Carbonaceous shale: as above, with coal stringers/bands throughout.
	53.43	53.53	0.10	0	21147	220584		roof	CCST		27	Carbonaceous shale: as above. BCN at floor contact with coal ~27°. Roof dilution sample.
	53.53	53.73	0.20	0	21148			440	CDB			COAL: dull banded; hard and competent.
Core 7						220542						
	53.73	54.23	0.50	0	21149			440	CBB			COAL: bright banded. Hard and competent
	54.23	54.73	0.50	0	21150			440	CBB			COAL: bright banded. Hard and competent
	54.69	54.77	0.08	0	21151	220543		440	CD&B			COAL: dull and bright. Hard and competent. Irreg. shaped contact with the floor rock.
	54.77	54.91	0.14	0	21152	220585		440	HCST			Coaly shale: black with dark brown streak, v. fine grained, massive bedding. Irreg. shaped contact with the coal below.
	54.91	55.30	0.39	0	21153			440	CBB			COAL: bright banded.
Core 8						220544						
	55.30	55.39	0.09	0				440	CDB			COAL: dull banded. Highly sheared.
	55.39	55.42	0.03	0	21154			440	CBN		27	COAL: bony; very sheared. Floor contact at ~27°.
	55.42	55.56	0.14	0	21155	220586		floor	HCST		28	Coaly shale: black with dark brown streak, v. fine grained. Floor contact at ~28°. Floor dilution contact.
	55.56	56.09	0.53	0					CCST		35	Carbonaceous shale: dark brown/grey, f. fine grained, with bright coal stringers (up to 2 cm thick). BCN near floor ~35°. Irreg shaped contact with the coal below.
	56.09	56.21	0.12	0					CBB		35	COAL: bright banded. Sheared; few mm-thin calcite stringers sub-parallel to bedding (at ~35°BCN).
	56.21	56.27	0.06	0					HCST			Coaly shale: black with dark brown streak, v. fine grained.
	56.27	56.64	0.37	0					CCST			Carbonaceous shale: dark brown/grey, f. fine grained, with bright coal stringers (up to 2 cm thick). Grades into coaly shale.
	56.64	56.68	0.04	0					HCST			Coaly shale: black with dark brown streak, v. fine grained, with coal stringers. Sheared.
	56.20	56.30	0.10	0					COAL			COAL: friable, sheared with polished surfaces.

**Coal assessment report for the Willow Creek coal lease --Volume 7:
Willow Creek Mine, 2021/2022 infill drilling**

Summary of WC22LD-01: Table B-1 (concluded)

Cores	From	To	Re-cov-ered	Core loss	Sample no.	Birtley head lab no.	Wash / froth lab no.	Coal bed	Lithology code	Roof appt. dip	Floor appt. dip	Comments
Core 9												
	56.30	56.45	0	0.15					R-LOSS			Core loss - rock
	56.45	56.54	0.09	0					COAL		28	COAL: Sheared and friable. Floor contact at ~28° BCN.
	56.54	56.83	0.29	0					CCST	28	30	Carbonaceous shale: dark grey, v. fine grained, laminated; a few mm-thin calcite stringers sub-parallel to bedding (at ~28 to 30° BCN).
	56.83	56.96	0.13	0					HCST			Coaly shale: black with dark brown streak, highly sheared.
	56.96	57.40	0.44	0					SLT			Siltstone: grey, fine grained , irreg. lamination, some bioturbation. Calcitic rock mass.
Core 10												
	57.40	59.10	1.70	0					SLT	33	36	Siltstone: as above, but more calcite in the rock mass.
												End of hole, at driller's declared final depth 196 ft = 59.75 m

File: Summary table LD-01_220326c.doc. Data source: core description by A.M. Matesoi

Summary of WC22LD-02: Table B-2

Cores	From	To	Re-cov-ered	Core loss	Sample no.	Birtley head lab no.	Wash / froth lab no.	Coal bed	Lithology code	Roof appt. dip	Floor appt. dip	Comments
	0	5.70	0	5.70					R-LOSS			CASING: 5.70m.
	5.70	32.92	0	27.22					R-LOSS			Open hole (no core) to 32.92 m = 108ft.
Core 1												
	32.92	33.95	1.03	0					CST	40	38	Dark grey-brown, fine grained, thinly lamin shale; minor coaly stringers. Few fract/joints with rust coating. Calcite: as thin stringers sub-parallel to bedding/lam as well as in the matrix. Ichnofossils visible (worm burrows, flame struts).
	33.95	34.02	0.07	0					CCST			Dark brown to black , v. fine grained carbonaceous shale; minor coaly stringers.

**Coal assessment report for the Willow Creek coal lease --Volume 7:
Willow Creek Mine, 2021/2022 infill drilling**

Summary of WC22LD-02: Table B-2 (continued)

Cores	From	To	Re-cov- ered	Core loss	Sample no.	Birtley head lab no.	Wash / froth lab no.	Coal bed	Lithology code	Roof appt. dip	Floor appt. dip	Comments		
	34.02	34.10	0.08	0	20906			roof	CCST			As above. Roof dilution sample.		
	34.10	34.12	0.02	0				roof	HCST			Coaly shale: black with dark brown streak ,sheared, polished surfaces. Roof dilution sample.		
	34.12	34.25	0.13	0			20907	220558	310	CDB			COAL: possibly dull banded; sheared, very broken core.	
Core 2														
	33.95	33.99	0.04	0	20908			310	HCST			Coaly shale: black with dark brown streak , v. broken and sheared.		
	33.99	34.36	0.37	0				310	CDB			COAL: dull banded; crushed at roof and floor contacts.		
	34.36	34.52	0.16	0	20909	220573			CST			Shale: dark brown-grey, fine grained, somewhat silty.		
	34.52	34.60	0.08	0					CD			COAL: dull. Crushed coal.		
	34.60	34.82	0.22	0					CST			Shale: dark grey-brown, fine grained. Few coal stringers, minor v. thin calcite stringers.		
	34.82	35.17	0.35	0	20910	220559	C-14	300	CDB			COAL: dull banded.		
	35.17	35.37	0.20	0	20911	220574		300	CCST			Carbonaceous shale: dark brown to black, v. fine grained, moderately carbonaceous.		
	35.37	35.59	0.22	0	20912	220560		300	CD			COAL: mostly dull (v. few thin bright stringers).		
Core 3														
	35.59	35.95	0.36	0					300	CDB		38	COAL: dull banded. Bottom half is sheared. BCN near floor ~38°. Irreg. shaped floor contact.	
	35.95	36.58	0.63	0				CST				Shale: dark grey-brown, v. fine grained, almost massive bedding. Few thin coal stringers. Grades into carbonaceous shale.		
	36.58	36.70	0.12	0	20913	220575		roof	CCST			Carbonaceous shale: black to dark grey, v. fine grained, coal stringers up to 25mm thick. ROOF dilution sample.		
	36.70	36.99	0.29	0	20914	220561	220561	320	CD&B	22		COAL: dull and bright. BCN near roof at ~22°		
Core 4														
	36.99	37.29	0.30	0					320	CD&B	22		COAL: dull and bright. BCN near roof at ~22°	
	37.29	37.49	0.20	0	20915			320	CDB		22	COAL: dull banded		
	37.49	37.52	0.03	0				320	CBN		40	Bony COAL. Some shearing at the floor contact.		

**Coal assessment report for the Willow Creek coal lease --Volume 7:
Willow Creek Mine, 2021/2022 infill drilling**

Summary of WC22LD-02: Table B-2 (continued)

Cores	From	To	Re-cov- ered	Core loss	Sample no.	Birtley head lab no.	Wash / froth lab no.	Coal bed	Lithology code	Roof appt. dip	Floor appt. dip	Comments
	37.52	37.64	0.12	0	20916	220576		floor	CCST		40	Carbonaceous shale: black to dark grey, v. fine grained, coal stringers throughout. FLOOR dilution sample.
	37.64	38.54	0.90	0					CST			Shale: dark grey, v. fine grained, massive to finely bedded, slightly carbonaceous.
	38.54	64.00							R-LOSS			Hammered down to 210ft =64m. No core.
Core 5												
	64.00	64.80	0.80	0					SST	43	42	Sandstone: medium-light grey, fine grained, wavy bedded/lamin, with trace fossils (worm burrows) and plant fossils. Weak HCL reaction, some thin calcite veinlets running subparallel to bedding. BCN 40° -43°
Core 6												
	64.80	66.25	1.45	0					SST	40	40	Sandstone: as above. BCN at floor ~40°.
Core 7												
	66.25	67.88	1.63	0					SST	40	40	Sandstone: as above. BCN 37° -40°
Core 8												
	67.88	68.26	0.38	0					SLT		38	Siltstone: medium grey, fine grained, wavy bedded/lamin with clayey bands/laminae. BCN near floor -38°
	68.26	68.35	0.09	0					CD			COAL: dull, with minor mm-thin shale (carb) bands. Crushed at floor.
	68.35	68.55	0.20	0					CST			Shale: Dark brown-grey, v. fine grained, with thin coaly stringers at floor; grades into carbonaceous shale. :
	68.55	68.67	0.12	0	20917	220577		roof	CCST			Carbonaceous shale: dark brown to black, v. fine grained, with thin irregular coal stringers. Roof dilution sample.
	68.67	68.91	0.24	0	20918	220523	C-15	400	COAL			COAL: highly sheared. Very broken core.
	68.91	69.41	0.50	0				400	CD			COAL: dull, sheared.
Core 9												
	69.41	70.16	0.75	0	20919	220524			400	CDB		

**Coal assessment report for the Willow Creek coal lease --Volume 7:
Willow Creek Mine, 2021/2022 infill drilling**

Summary of WC22LD-02: Table B-2 (continued)

Cores	From	To	Re-cov- ered	Core loss	Sample no.	Birtley head lab no.	Wash / froth lab no.	Coal bed	Lithology code	Roof appt. dip	Floor appt. dip	Comments	
	70.16	70.51	0.35	0	20920	220525	C-15	400	CDB			COAL: dull banded, as above (somewhat more bright bands?). Slightly sheared.	
	70.51	70.91	0.40	0				400	CDB			COAL: as above but no shearing.	
Core 10													
	70.91	71.05	0.14	0	20921	220526	C-16	400	CD			COAL: dull	
	71.05	71.14	0.09	0				400	CDB			COAL: dull banded.	
	71.14	71.66	0.52	0	400	CDB				COAL: dull banded.			
	71.66	72.52	0.86	0	20922	220527		400	CDB			COAL: dull banded. Sheared.	
Core 11													
	72.52	73.04	0.52	0	20923	220528		400	CDB				COAL: dull banded. Slightly sheared; v. broken/crushed at the top 2-3 cm.
	73.04	73.17	0.13	0				400	CDB			COAL: dull banded. Folded and very sheared.	
	73.17	73.27	0.10	0	20924	220529		400	CDB				COAL: dull banded. Folded but less severely sheared.
	73.27	74.02	0.75	0				400	CDB			COAL: dull banded. Slightly sheared. Mostly intact core, broken at floor only.	
Core 12													
	74.02	74.17	0.15	0	20925	220530		400	COAL				COAL: highly sheared.
	74.17	74.77	0.60	0				400	CDB			COAL: dull banded. Sheared.	
	74.77	75.45	0.68	0	21126	220531	C-17	400	CDB			COAL: dull banded; hard and competent.	
	75.45	75.60	0.15	0				400	CD			COAL: dull, moderately sheared.	
Core 13													
	75.60	76.03	0.43	0	21127	220532	400	COAL				COAL: crushed.	
	76.03	76.18	0.15	0	21128		400	COAL			COAL: pulverised, wet coal. Fault zone aspect.		
	76.18	76.53	0.35	0				CST	30			Shale: dark brown-grey, v. fine grained, slightly carbonaceous with minor coal stringers. BCN at roof ~30°. Floor contact intact.	
	76.53	76.57	0.04	0				CCST				Carbonaceous shale: dark brown to black; crushed and mixed with pulverised coal.	

**Coal assessment report for the Willow Creek coal lease --Volume 7:
Willow Creek Mine, 2021/2022 infill drilling**

Summary of WC22LD-02: Table B-2 (continued)

Cores	From	To	Re- cov- ered	Core loss	Sample no.	Birtley head lab no.	Wash / froth lab no.	Coal bed	Lithology code	Roof appt. dip	Floor appt. dip	Comments
	76.57	77.11	0.54	0					CST			Shale: dark brown/grey, fine grained, massive bedding. Minor thin carb + coaly stringers.
Core 14												
	77.11	77.34	0.23	0					CST		28	Shale: dark grey to brown, v. fine grained, thinly lam. BCN at floor ~28°
	77.34	77.70	0.36	0					CD&B		28	COAL: dull & bright, with shaly bands (up to 3cm thick); sheared and blocky coal. BCN at floor: 28°
	77.16	77.36	0.20	0					CST			Shale: dark grey to brown, fine grained, weakly laminated.
	77.36	77.50	0.14	0					C&B			COAL: sheared, some shaly bands; crushed at roof and floor contacts.
	77.50	77.91	0.41	0					CST			Shale: grey, fine grained, moderately calcareous with some calcite stringers near the bottom of interval. Includes on 25mm thick coal band/stringers.
Core 15												
	77.91	78.13	0.22	0					CST			Shale: dark grey, with light grey irreg. sandstone bands/laminae. Some bioturbation. Strongly calcitic.
	78.13	78.26	0.13	0					HCST			Coaly shale: black with dark brown streak, highly sheared, crushed at roof (for ~4cm of core) - a fault gouge looking aspect.
	78.26	79.58	1.32	0					CST	35	38	Calcareous shale: medium grey/brown, very fine grained, irreg lamination, some bioturbation signs, occasional trace fossils. BCN: 35° near roof, 38° near floor.
Core 16												
	79.58	79.72	0.14	0					CST			Calcareous shale: as the above.
	79.72	80.07	0.35	0					CCST		30	Carbonaceous Shale: dark brown to black, v. fine grained, with occasional coaly stringers aligned sup-parallel to bedding (@ ~30° BCN).
	80.07	80.13	0.06	0				roof	CCST			Carbonaceous shale: as the above. Roof dilution sample
	80.13	80.17	0.04	0	21129	220578		roof	HCST			Coaly shale: black with dark brown streak, highly sheared, thin coal stringers throughout. Roof dilution sample

**Coal assessment report for the Willow Creek coal lease --Volume 7:
Willow Creek Mine, 2021/2022 infill drilling**

Summary of WC22LD-02: Table B-2 (concluded)

Cores	From	To	Re-cov- ered	Core loss	Sample no.	Birtley head lab no.	Wash / froth lab no.	Coal bed	Lithology code	Roof appt. dip	Floor appt. dip	Comments
	80.17	80.59	0.42	0	21130	220533	220533	440	CDB			COAL: dull banded. Sheared at roof (for ~5cm), crushed at floor contact.
	80.59	80.63	0.04	0				440	CST			Shale: dark brown-grey, v. fine grained, very sheared, slightly carbonaceous.
	80.63	80.80	0.17	0				440	CD&B			COAL: dull & bright.
	80.80	80.83	0.03	0				440	CBN			Bony COAL; very broken core.
	80.83	80.88	0.05	0	21131	220579		floor	SST			Sandstone: light grey, fine to medium grained, with a "salt and pepper" look. Occasional coal stringers. Irreg. shaped contact with the coal above.
Core 17												
	80.88	80.92	0.04	0				floor	SST			Sandstone: as above; broken contact with the shale below.
	80.92	81.15	0.23	0					CST			Shale: dark grey, fine grained, rip-up clasts from the sandstone below near the floor contact.
	81.15	82.19	1.04	0					SST			Sandstone: light grey, fine to medium grained, irreg. laminated; signs of bioturbation; rip-up clasts at the roof contact. Non-calcitic mass, but there are monot mm-thin calcite stringers (as fracture fillings). Very irreg shaped floor contact.
	82.19	82.40	0.21	0					CST			Shale: dark grey, v. fine grained.
Core 18												
	82.40	82.62	0	0.22					R-LOSS			This run has been drilled only so the driller can reach to unscrew the top pipe. The core catcher didn't catch any core.
												End of hole at driller's declared final depth: 275 ft = 78.33m

File: Summary table LD-02_220326e.doc. Data source: core description by A.M. Matesoi

**Coal assessment report for the Willow Creek coal lease --Volume 7:
Willow Creek Mine, 2021/2022 infill drilling**

Summary of WC21LD-03: Table B-3

Cores	From	To	Re-cov- ered	Core loss	Sample no.	Birtley head lab no.	Wash / froth lab no.	Coal bed	Lithology code	Roof appt. dip	Floor appt. dip	Comments
	0	5.70	0	5.70					R-LOSS			CASING: 5.70m.
	5.70	5.83	0	5.83					R-LOSS			Open hole (no core) to 5.83 m ~19ft.
Core 1												
	5.83	5.89	0	0.06					R-LOSS			Core loss - rock.
	5.89	7.11	1.22						CST	40		Dark grey-brown , fine grained, thinly laminated shale; minor coaly stringers. Few fract/joints with rust coating. Calcite: as thin stringers sub-parallel to bedding/lam as well as in the matrix. Ichnofossils visible (worm burrows, flame struts).
Core 2												
	7.11	8.46	1.35						CST	36	40	Shale, as above but core is more broken.
Core 3												
	8.46	8.74	0.28						CST		42	Calcareous shale, as above
	8.74	8.82	0.08						CSST			Carbonaceous shale
	8.82	9.02	0.20						COAL			COAL; rust on some surfaces.
	9.02	9.20	0.18						HCST			Highly carbonaceous shale
	9.20	9.98	0.78						CST			Calcareous shale.
Core 4												
	9.98	11.66	1.68						CST			Calcareous shale. Few fract/joints with rusty coating.
Core 5												
	11.66	12.48	0.82						CST			Shale (as above). Increasingly carbonaceous near floor contact.
	12.48	12.98	0.50						CCST			Moderately carbonaceous shale with minor coal stringers.
	12.98	13.14	0.16					111	CD&B			COAL: banded (dull and bright)
Core 6												
	13.14	13.70	0.56		20876	220551	220551	111	CD&B	30	24	COAL: banded (dull and bright)
	13.70	14.30	0.60						CST			Shale; more carbonaceous at bottom 0.15m.
	14.30	14.76	0.46					110	CD&B			COAL: banded (dull and bright)
Core 7												
	14.76	14.97	0.21		20877	220552	220552	110	CD&B		38	COAL: banded (dull and bright); crushed at floor contact.
	14.97	15.01	0.04						CCST			Carbonaceous shale; sheared. Grades into shale.
	15.01	15.15	0.14						CST			Shale.

**Coal assessment report for the Willow Creek coal lease --Volume 7:
Willow Creek Mine, 2021/2022 infill drilling**

Summary of WC21LD-03: Table B-3 (continued)

Cores	From	To	Re- cov- ered	Core loss	Sample no.	Birtley head lab no.	Wash / froth lab no.	Coal bed	Lithology code	Roof appt. dip	Floor appt. dip	Comments
	15.15	15.20	0.05						CST			Fault zone (crushed core).
	15.20	15.30	0.10						CST		38	Shale: silty (grades into siltstone).
	15.30	15.72	0.42						SLT			Siltstone; grades into sandstone
	15.72	16.27	0.55						SST			Fine grained sandstone.
Core 8												
	16.27	16.42	0.15		20878	220562		roof	HCST			Coaly shale; sheared: Roof of seam 100; dilution sample.
	16.42	17.17	0.75		20879			100	CDB		32	COAL: dull banded.
	17.17	17.97	0.80		20880			100	CDB			COAL: as above
Core 9												
	17.97	18.72	0.75		20881	220553	220553	100	CDB		18	COAL: dull banded.
	18.72	19.47	0.75		20882			100	CDB	18		COAL: as above. Very broken (crushed) at bottom 0.15m.
Core 10												
	19.47	19.61	0.14		20882			100	CD&B		35	COAL: banded (dull and bright).
	19.61	19.81	0.20		20882			100	CDB			COAL: dull banded.
	19.81	19.97	0.16		20883	220563		floor	HCST		35	Coaly shale with thin coal bands/stringers. Floor of seam 100; dilution sample.
	19.97	20.29	0.32						CCST		42	Carbonaceous shale: dark grey to black, with minor coal stringers.
	20.29	20.49	0.20						COAL			Moderately sheared (at roof and floor contacts), minor coaly shale bands.
	20.49	21.02	0.53						CCST		38	Carbonaceous shale: dark grey to black, with minor coal stringers. Locally thin calcite veinlets sub-parallel to a thin bedding. Grades into shale.
Core 11												
	21.02	21.34	0.32						CST		28	Shale: weakly carbonaceous with minor coal band (~1.5cm thin) near bottom. Increasingly silty downwards.
	21.34	22.57	1.23						SLT	35	25	Siltstone with fine sandstone bands; some calcite in the matrix. Mostly intact core (broken only at the bottom 5cm). BCN varies from 28°-35°-38°-25°

**Coal assessment report for the Willow Creek coal lease --Volume 7:
Willow Creek Mine, 2021/2022 infill drilling**

Summary of WC21LD-03: Table B-3 (continued)

Cores	From	To	Re- cov- ered	Core loss	Sample no.	Birtley head lab no.	Wash / froth lab no.	Coal bed	Lithology code	Roof appt. dip	Floor appt. dip	Comments
Core 12												
	22.57	24.13	1.56						CST	38		Shale: silty bands, calcite rich matrix, also occasional calcite bands/stringers sub-parallel to bedding. Some plant fossils, also bioturbation.
Core 13												
	24.13	24.95	0.82						CST		40	Calcareous shale (calcite in the rock mass as well as occasional fine stringers sub-parallel to bedding). Slightly carbonaceous near floor contact.
	24.95	25.05	0.10						CCST		40	Carbonaceous shale with very fine coal stringers.
	25.05	25.10	0.05						COAL		35	Few stringers of coaly shale.
	25.10	25.17	0.07						SST		32	Light grey, finely laminated sandstone. BCN ~32° (near floor contact).
	25.17	25.56	0.39						CCST		32	Carbonaceous shale with thin coal stringers. BCN ~32° (near floor contact).
	25.56	25.65	0.09					roof	HCST			Highly carbonaceous (coaly) shale. Roof of seam 201.
Core 14												
	25.65	25.75		0.10	20884	220564		roof	R-LOSS			Core loss - rock
	25.75	26.10		0.35				201	C-LOSS			Core loss - coal
	26.10	26.85	0.75		20885	220554	220554	201	CD&B			Banded coal (dull and bright); well cleated, slightly sheared with some polished surfaces.
Core 15												
	26.85	26.90	0.05					201	COAL			Highly sheared coal, very broken core. Silvery-black colour. Occasional <1mm - 3mm bright bands.
	26.90	27.00	0.10		20886	220565		floor	HCST			Coaly shale: sheared, with polished surfaces. Slightly broken core. Floor of seam 201.
	27.00	27.26	0.26						CCST	35		Carbonaceous shale: black to dark brown, coaly at top 3-4 cm. COAL stringers throughout. BCN ~35 (near roof).

**Coal assessment report for the Willow Creek coal lease --Volume 7:
Willow Creek Mine, 2021/2022 infill drilling**

Summary of WC21LD-03: Table B-3 (continued)

Cores	From	To	Re- cov- ered	Core loss	Sample no.	Birtley head lab no.	Wash / froth lab no.	Coal bed	Lithology code	Roof appt. dip	Floor appt. dip	Comments
	27.26	28.09	0.83						CST	35	32	Shale: grey to dark grey, fine grained, bedded to laminated. Somewhat calcareous (calcite in the rock mass as well as thin stringers sub-parallel to bedding). Occasional coaly stringers (up to 15mm thin). BCN from 35°-32°. Mostly intact core, broken only at bottom 5-6cm.
Core 16												
	28.09	28.41	0.32		20887	220555			C&B			COAL & BANDS: well banded coal with up to 30% thin (<3mm) bandlets of carbonaceous shale.
	28.41	28.61	0.20						CCST	30		Shale: dark grey to black, v. fine grained, bedded to laminated. Moderately carbonaceous with occasional coaly stringers. BCN near roof ~30°.
	28.61	29.73	1.12						CST	38	32	Shale: somewhat calcareous. Medium grey to brown, wavy bedded/laminated. BCN from 38°-32°.
Core 17												
	29.73	29.82	0	0.09					LOSS			Core loss
	29.82	30.19	0.37		20889	220556	220556	202	CD&B			COAL: well banded (dull and bright).
	30.19	30.32	0.13					202	CST			Shale with light grey sandy bands (wavy, irreg. shaped); minor coal stringers.
	30.32	30.66	0.34					202	CD&B	28		COAL: well banded (dull and bright). BCN ~28° (at roof).
	30.66	30.75	0.09		20888	220566		Floor	HCST			Coaly shale: black to dark brown, very sheared, with polished surfaces. Broken core. Floor of seam 202.
	30.75	31.02	0.27						CCST	28		Carbonaceous shale: black to dark grey, with coal stringers throughout. BCN ~28° (near roof).
	32.02	32.26	0.24						CST			Shale: calcareous, occasionally v. thin calcite stringers.
Core 18												
	32.26	33.56	1.30						SLT			Siltstone with sandstone bands. Wavy bedding/lamin; calcite enriched. :BCN varies along the interval: 40°-36°-40°.
	33.56	85.40	0	51.84								Hammered down to 280ft = 85.40m. No core.

**Coal assessment report for the Willow Creek coal lease --Volume 7:
Willow Creek Mine, 2021/2022 infill drilling**

Summary of WC21LD-03: Table B-3 (continued)

Cores	From	To	Re-cov- ered	Core loss	Sample no.	Birtley head lab no.	Wash / froth lab no.	Coal bed	Lithology code	Roof appt. dip	Floor appt. dip	Comments
Core 19												
	85.40	86.83	1.43						SLT	35	32	Siltstone: medium grey, fine grained, wavy bedding/lamin. with bands of sandstone and/or claystone; bottom 15cm - irreg banding with bioturbation. Some ichnofossils. Calcite rich rock.
Core 20												
	86.83	87.09	0.26						CST			Silty shale: as above. *Major water burst from hole in the first half of this run: driller said it comes from above the coring depth (around 80m depth) where a large water burst also happened. So, I suspect there might be a fault zone around 80m.
	87.09	87.13	0.04		20890	220567		roof	CCST			Carbonaceous shale: dark grey to black, increasingly coaly near bottom.
	87.13	87.15	0.02					roof	HCST			Coaly shale: black with dark brown streak; some coal stringers.
	87.15	87.54	0.39		20891	220557		430	CDB		32	COAL: dull banded; slightly sheared, moderately broken (crushed at roof and floor contacts).
	87.54	87.63	0.09		20892	220568		floor	HCST			Coaly shale: black with dark brown streak; some coal stringers.
	87.63	87.98	0.35					floor	CSST			Carbonaceous shale: dark grey to black, grades into shale.
	87.98	88.41	0.43						CST		35	Shale: calcareous; grey-brownish colour.
Core 21												
	88.41	88.65	0.24						CST			Shale: slightly carbonaceous, few calcite filled fractures near bottom.
	88.65	89.88	1.23						CST	38	38	Calcareous shale: medium grey-brown, wavy banding/lamination (with sandstone bands), some bioturbation and plant fossils. BCN varies: 38°-40°-32°-40°-38°.
Core 22												
	89.88	90.12	0.24						CST			Shale: calcareous, medium grey-brown, wavy banding/lamination.

**Coal assessment report for the Willow Creek coal lease --Volume 7:
Willow Creek Mine, 2021/2022 infill drilling**

Summary of WC21LD-03: Table B-3 (continued)

Cores	From	To	Re- cov- ered	Core loss	Sample no.	Birtley head lab no.	Wash / froth lab no.	Coal bed	Lithology code	Roof appt. dip	Floor appt. dip	Comments
	90.12	90.63	0.51						CST			Shale: slightly carbonaceous.
Core 23												
	90.63	91.70	1.07						CST			Shale: somewhat calcareous, bedding/lamin at 40°-33°-38°
Core 24												
	91.70	91.74	0.04					roof	CSST			Carbonaceous shale with a few coal stringers.
	91.74	91.80	0.06		20893	220569		roof	HCST			Coaly shale: black with dark brown streak; some coal stringers.
	91.80	92.41	0.61		20894	220515	220515	410	CDB			COAL: possibly dull banded; very broken (crushed).
	92.41	92.60	0.19		20895			410	CDB			COAL: dull banded; friable, crushed at the floor contact.
	92.60	92.70	0.10		20896	220570		floor	CSST			Carbonaceous shale: with coal stringers and fine calcite coating on fract/joint surfaces. Floor dilution sample.
	92.70	92.93	0.23						CSST			Carbonaceous shale: as above (with fewer coal stringers).
	92.93	93.36	0.43						CST			Shale: dark grey-brownish colour, slightly calcareous.
Core 25												
	93.36	93.63	0.27						CST			Shale: as above, with a few calcite stringers. Increasingly carbonaceous near bottom.
	93.63	93.74	0.11						CSST			Carbonaceous shale: with coal stringers. (very broken at bottom 0.03m)
	93.74	93.83	0.09		20897	220571			HCST			Coaly shale: black with dark brown streak. Sharp, irreg. shaped floor contact with the coal below. :Roof dilution sample.
	93.83	94.56	0.73		20898	220516		400	CD&B			COAL: banded (dull and bright).
	94.56	94.96	0.40					400	CD&B			COAL: banded (dull and bright).
Core 26					20899	220517	C-18					
	94.96	95.31	0.35					400	CD&B			COAL: banded (dull and bright).
	95.31	95.95	0.64		20900	220518		400	CD&B			COAL: banded (dull and bright).
	95.95	96.48	0.53		20901	220519		400	CD&B			COAL: banded (dull and bright).
Core 27							C-19					
	96.48	96.62	0.14		20902	220520		400	CD			COAL: dull

Coal assessment report for the Willow Creek coal lease --Volume 7:
Willow Creek Mine, 2021/2022 infill drilling

Summary of WC21LD-03: Table B-3 (continued)

Cores	From	To	Re- cov- ered	Core loss	Sample no.	Birtley head lab no.	Wash / froth lab no.	Coal bed	Lithology code	Roof appt. dip	Floor appt. dip	Comments
	96.62	96.72	0.10		20902	220520	C-19	400	CD&B		38	COAL: banded (dull and bright). Floor contact at ~38°BCN, intact.
	96.72	96.79	0.07		20903	220521		400	SLT		38	Siltstone (or silty shale?): medium grey, fine grained. Floor contact at ~38°BCN
	96.79	97.04	0.25					400	CD&B		38	COAL: banded (dull and bright). Floor contact at ~38°BCN, intact.
	97.04	97.06	0.02		20904	220572		floor	CCST			Carbonaceous shale: dark grey to black, very fine grained, with thin coal stringers.
	97.06	97.16	0.10					floor	CST		30	Shale: dark grey, fine grained, with coal stringers. BCN at floor ~30°. Floor dilution sample.
	97.16	97.78	0.62						CST		32	Shale: as above. BCN at floor ~32°.
Core 28												
	97.78	98.22	0.44						CST		37	Shale: dark grey, fine grained, locally with thin calcite and coal stringers running sub-parallel to bedding (~37°BCN). Increasingly silty towards bottom.
	98.22	99.03	0.81						SLT		35	Siltstone: medium-light grey, fine grained, wavy bedding with soft sediment. deformation, bioturbation. Weakly calcareous. Minor coaly stringers. BCN ~35 at floor.
	99.03	99.30	0.27						CST			Shale: dark grey, very fine grained, slightly carbonaceous at bottom 0.07m (with minor coal stringers).
Core 29												
	99.30	99.49	0.19		20905	220522	220522	440	CD&B		38	COAL: banded (dull and bright). Floor contact at ~38°BCN, irreg./wavy shaped.
	99.49	99.51	0.02					440	CST			Shale: grey, very fine grained, irreg. shaped contacts with coal above and below.
	99.51	99.68	0.17					440	CD&B		32	COAL: banded (dull and bright). Floor contact at ~32°BCN.
	99.68	99.71	0.03					440	CST			Shale: grey, very fine grained, irreg. shaped contacts with coal above and below.
	99.71	100.11	0.40					440	CD&B		32	COAL: banded (dull and bright). Floor contact at ~32°BCN.

**Coal assessment report for the Willow Creek coal lease --Volume 7:
Willow Creek Mine, 2021/2022 infill drilling**

Summary of WC21LD-03: Table B-3 (concluded)

Cores	From	To	Re- cov- ered	Core loss	Sample no.	Birtley head lab no.	Wash / froth lab no.	Coal bed	Lithology code	Roof appt. dip	Floor appt. dip	Comments
	100.11	100.16	0.05		20905	220522	220522	440	CBN			COAL: bony (dull but hard).
	100.16	100.90	0.74						CST	34		Shale: medium to dark grey, fine to very fine grained, somewhat silty; bioturbation and ichnofossils. BCN near roof at ~34°
												End of hole: driller's declared final depth: 333 ft = 101.5m

Summary table LD-03_220326d.doc. Data source: core description by A.M. Matesoi

Summary of WC22LD-04: Table B-4

Cores	From	To	Re- cov- ered	Core loss	Sample no.	Birtley head lab no.	Wash / froth lab no.	Coal bed	Lithology code	Roof appt. dip	Floor appt. dip	Comments
	0	6.00	0	6.00					R-LOSS			CASING: 6.00 m.
	6.00	35.62	0	29.62					R-LOSS			Open hole (no core) to 122ft =37.19 m: driller's declared depth (actual coring depth: 116'10" = 35.62 m)
Core 1												
	35.62	36.84	1.22	0					CST		36	Shale: dark brown-grey fine grained, with carbonaceous bands and laminae (up to 8-9 cm thick). Strong HCL reaction in the rock mass; also occasional calcite stringers. Grades into siltstone. BCN near floor ~36°
	36.84	37.88	1.04	0					SLT		27	Siltstone/sandstone: medium-light grey, fine grained, laminated siltstone with sandstone bands and laminae up to 25cm thick; strong HCL reaction. BCN varies from 32-28-27°.
Core 2												
	37.88	38.43	0.55	0					CST		25	Siltstone/sandstone: as above. BCN at floor ~25°.
	38.43	38.53	0.10	0					COAL			COAL: crushed, highly sheared.
	38.53	38.59	0.06	0					HCST			Coaly shale: black with dark brown streak, v. fine grained, sheared.
	38.59	38.69	0.10	0					CST			Shale: dark grey-brown, v.fine grained, with coal stringers/bands. ROOF dilution sample

**Coal assessment report for the Willow Creek coal lease --Volume 7:
Willow Creek Mine, 2021/2022 infill drilling**

Summary of WC22LD-04: Table B-4 (continued)

Cores	From	To	Re-cov-ered	Core loss	Sample no.	Birtley head lab no.	Wash / froth lab no.	Coal bed	Lithology code	Roof appt. dip	Floor appt. dip	Comments
	38.69	38.88	0.19	0	21242	221056		roof	CCST			Carbonaceous shale: dark grey, v.fine grained, with coal stringers and bands.
	38.88	38.94	0.06	0	21243	221057		430	COAL			COAL: pulverised
	38.94	39.03	0.09	0				430	CD&B			COAL: dull & bright
	39.03	39.22	0.19	0				430	COAL			COAL: crushed, highly sheared.
	39.22	39.34	0.12	0	21244	221058		floor	ST			Stony COAL: black to dark grey (with black streak), v. dull, no cleating, light (much lighter than coaly shale!). FLOOR dilution sample.
	39.34	39.44	0.10	0					CCST			Carbonaceous shale: dark grey to black, v. fine grained.
	39.44	39.62	0.18	0					CST			Carbonaceous shale: dark brown/grey, fine grained. (Initially intact core, but was smashed in pieces by the drillers during its removing from the core barrel).
	39.62	39.80	0	0.18								Core loss
Core 3												
	39.80	40.59	0.79	0					SLT	30	32	Siltstone/sandstone: dark brown/grey, fine-medium grained, siltstone with sandstone bands and laminae, also some carbonaceous bands at the bottom 0.24m. Broken at the floor contact. Weak HCL reaction. BCN at top 30°, at bottom 32°.
	40.59	40.63	0.04	0	21245	221059		roof	SLT		32	Siltstone: dark grey-brown, fine-medium grained, laminated. BCN ~32°. ROOF dilution sample.
	40.63	40.68	0.05	0				roof	CST		30	Shale: dark grey-brown, v. fine grained, slightly carbonaceous. Crushed core. Sheared at the contact with the coal below (very sharp contact at ~30° BCN). ROOF dilution sample.
	40.68	41.35	0.67	0	21246	221060		410	CD&B			COAL: dull & bright; slightly sheared, a few intervals with v. fractured/crushed core (especially 4cm above the floor contact).
	41.35	41.39	0.04	0	21247	221061		floor	CCST			Carbonaceous shale: crushed, highly sheared core. Grades into shale (more silty). FLOOR dilution sample.
	41.39	41.42	0.03	0				floor	CST			Shale: dark brown-grey, v.fine grained, weak HCL fizz. FLOOR dilution sample.

**Coal assessment report for the Willow Creek coal lease --Volume 7:
Willow Creek Mine, 2021/2022 infill drilling**

Summary of WC22LD-04: Table B-4 (continued)

Cores	From	To	Re-cov-ered	Core loss	Sample no.	Birtley head lab no.	Wash / froth lab no.	Coal bed	Lithology code	Roof appt. dip	Floor appt. dip	Comments
	41.42	41.54	0.12	0					CST			Shale: as above but more silty, weak HCL fizz. Grades into siltstone.
	41.54	42.22	0.68	0					SLT		25	Siltstone: medium-light grey, fine-medium grained, sandy bands/laminae, moderate HCL fizz. Fines downwards grading into shale.
	42.22	42.73	0.51	0					CST			Shale: dark grey-brown, v.fine grained, increasingly carbonaceous towards floor.
	42.73	42.82	0.09	0	21248	221062		roof	CCST			Carbonaceous shale: dark brown to black, v. fine grained, with coal stringers; bottom end has an ~1cm thick coal coating. ROOF dilution sample.
Core 4												
	42.82	43.52	0.70	0	21249	221063	C-20	400	CDB			COAL: dull banded. Hard, competent core, mostly clarain (less than 40% vitrain bands).
	43.52	43.82	0.30	0	21250	221064	C-21	400	CDB			COAL: dull banded, as above.
	43.82	44.34	0.52	0				400	CDB			COAL: dull banded, moderately sheared, mostly crushed core.
Core 5												
	44.34	44.44	0	0.10				400	HCST			Core loss -- coal
	44.44	44.65	0.21	0	20751	221066	C-22	400	CDB			COAL: dull banded, slightly sheared.
	44.65	44.94	0.29	0				400	CDB			COAL: dull banded, moderately sheared.
	44.94	45.45	0.51	0	20752	221067		400	CDB			COAL: dull banded, soft, wet.
	45.45	46.10	0.65	0	20753	221068			400	GO		22
	46.10	46.19	0.09	0	20754	221313		floor	C&B	22	22	Coal & Bands: clay gouge aspect (as above) but with some thin dark brown bands. BCN ~22°.
	46.19	46.23	0.04	0	20755			floor	CCST			Carbonaceous shale: dark brown to black, v. fine grained, slightly sheared with polished surfaces. FLOOR dilution sample.
	46.23	46.29	0.06	0				floor	CST			Shale: dark grey, v.fine grained, massive bedding. FLOOR dilution sample.

**Coal assessment report for the Willow Creek coal lease --Volume 7:
Willow Creek Mine, 2021/2022 infill drilling**

Summary of WC22LD-04: Table B-4 (concluded)

Cores	From	To	Re-cov- ered	Core loss	Sample no.	Birtley head lab no.	Wash / froth lab no.	Coal bed	Lithology code	Roof appt. dip	Floor appt. dip	Comments
	46.29	46.44	0.15	0					CST			Shale: as above; grades into carbonaceous shale.
	46.44	46.48	0.04	0					CCST			Carbonaceous shale: dark brown to black, v. fine grained, slightly sheared.
	46.48	46.50	0.02	0					COAL			COAL: crushed
	46.50	46.89	0.39	0					CST			Shale: dark grey, v. fine grained, irreg. lamination, plant fossils, occasional coal stringers.
End of hole: driller's declared depth at the end of Run No. 5: 161ft = 49.06m												

Summary table LD-04_220327d.doc. Core description by A.M. Matesoi

Summary of WC22LD-05: Table B-5

Cores	From	To	Re-cov- ered	Core loss	Sample no.	Birtley head lab no.	Wash / froth lab no.	Coal bed	Lithology code	Roof appt. dip	Floor appt. dip	Comments
	0.00	5.80	0	1.82					R-LOSS			CASING: 19ft = 5.8m.
	5.80	40.95	0	35.15					R-LOSS			Open hole (no core) to 135ft = 41.15 m: driller's declared depth (actual coring depth: 134'4" = 40.95 m)
Core 1												
	40.95	41.70	0.75	0					CST			Shale: dark brown-grey, fine grained, silty, laminated. BCN ~33°
Core 2												
	41.70	42.74	1.04	0					CST			Shale: as above.
	42.74	42.81	0.07	0				roof	CST			Shale: as above but slightly carbonaceous. Roof dilution sample.
	42.81	42.84	0.03	0	21209	221023		roof	CCST			Carbonaceous shale: dark grey to black, v. fine grained, massive bedding. Roof dilution sample.
	42.84	43.34	0.50	0	21210	221024		100	CD&B			COAL: dull & bright. Harder at top 0.12 m.
Core 3												
	43.34	43.54	0	0.20				100?	C-LOSS?			Core loss -- coal?

**Coal assessment report for the Willow Creek coal lease --Volume 7:
Willow Creek Mine, 2021/2022 infill drilling**

Summary of WC22LD-05: Table B-5 (continued)

Cores	From	To	Re-cov- ered	Core loss	Sample no.	Birtley head lab no.	Wash / froth lab no.	Coal bed	Lithology code	Roof appt. dip	Floor appt. dip	Comments
	43.54	43.95	0.41	0	21211	221025		100	CD&B			COAL: dull & bright, as above.
	43.95	44.08	0.13	0				100	COAL			COAL: hard, poor cleating, thin vitrain bands.
	44.08	44.29	0.21	0				100	CD&B			COAL: dull & bright.
	44.29	45.06	0.77	0	21212			100	CD&B		30	COAL: dull & bright. Hard, competent core, well banded (clarain/vitrain bands).
Core 4						221314						
	45.06	45.26	0.20	0	21213			100	CD&B			COAL: dull & bright. Hard, competent core, well banded (clarain/vitrain bands).
	45.26	46.15	0.89	0	21214	221028		100	CBB			COAL: bright banded (more vitrain than clarain bands, much easier to break than the coal above).
Core 5												
	46.15	46.27	0.12	0	21215	221315		floor	HCST		22	Coaly stone: black with dark brown streak, mm-thin vitrain stringers/laminae. BCN at floor 22°, sharp floor contact. FLOOR dilution sample.
	46.27	46.35	0.08	0	21216			floor	CCST			Carbonaceous shale: dark brown to black, v. fine grained, laminated, coal stringers at both ends of interval.
	46.35	47.24	0.89	0					CST	23	35	Shale: dark grey/brown, fine grained, wavy bedded/lamin., somewhat silty, plant fossils. BCN varies 23°-35°.
	47.24	66.38	0	19.14					R-LOSS			No core: drilled open hole down to 217ft 9in = 66.38m (driller's declared depth: 220ft = 67.0m questionable?).
Core 6												
	66.38	67.78	1.40	0					CST	43	43	Shale: strong HCL fizz (calcareous shale?), medium grey/brown, fine grained, wavy bedded/laminated, with carbonaceous and coaly stringers sub-parallel to bedding. BCN generally at 43°.
	67.78	67.90	0	0.12					R-LOSS			Core loss -- rock
Core 7												
	67.90	68.50	0.60	0					SLT			Siltstone: medium grey-brown, fine grained, wavy bedded/laminated.

**Coal assessment report for the Willow Creek coal lease --Volume 7:
Willow Creek Mine, 2021/2022 infill drilling**

Summary of WC22LD-05: Table B-5 (continued)

Cores	From	To	Re-cov- ered	Core loss	Sample no.	Birtley head lab no.	Wash / froth lab no.	Coal bed	Lithology code	Roof appt. dip	Floor appt. dip	Comments
	68.50	68.92	0.42	0					CST			Shale: as above but slightly carbonaceous; locally coal stringers up to 2cm thick.
	68.92	68.95	0.03	0					CCST		45	Carbonaceous shale: dark grey to black, v. fine grained, massive bedding. Floor contact at 45° BCN.
	68.95	69.01	0.06	0					SST		45	Sandstone: light grey, fine grained. Floor contact sharp, at 45° BCN.
	69.01	69.07	0.06	0	21217	221031		roof	ST		40	Stony coal: black, v.fine grained, dull, no cleating. BCN at floor ~40°
	69.07	69.16	0.09	0				roof	SST		37	Sandstone: light grey, fine grained, silty. Floor contact at 37° BCN.
	69.16	69.22	0.06	0				roof	CSST		40	Carbonaceous shale: dark grey to black, v.fine grained. Floor contact at 40° BCN.
	69.22	69.27	0.05	0	21218	221032		201	CBN			Bony coal
	69.27	69.39	0.12	0				201	CDB			COAL: dull banded.
	69.39	69.42	0	0.03				201	C-LOSS			Core loss -- coal
Core 8												
	69.42	69.53	0	0.11	21219	221033		201	C-LOSS			Core loss -- coal
	69.53	69.80	0.27	0				201	CDB			COAL: dull banded.
	69.80	69.94	0.14	0				201	CDB			COAL: dull banded.
	69.94	70.63	0.69	0	21220	221034		201	COAL			COAL: crushed, highly sheared. (Looks like fault zone!)
	70.63	70.70	0.07	0				floor	CCST	25		Carbonaceous shale: black to dark brown, v. fine grained, massive bedding. BCN near roof ~25°. Floor dilution sample.
	70.70	71.00	0.30	0					CST			Shale: medium grey/brown, fine grained, wavy bedded/laminated, with carbonaceous and coaly stringers.
	71.00	71.10	0.10	0					CCST		25	Carbonaceous shale: black to dark brown, v. fine grained, massive bedding. BCN near floor ~25°. (Possible loss at bottom?)
Core 9												
	71.10	71.17	0.07	0					CCST		30	Carbonaceous shale: dark grey to black, v. fine grained, massive bedding, a few coal stringers. Floor contact at ~30° BCN .

**Coal assessment report for the Willow Creek coal lease --Volume 7:
Willow Creek Mine, 2021/2022 infill drilling**

Summary of WC22LD-05: Table B-5 (continued)

Cores	From	To	Re-cov- ered	Core loss	Sample no.	Birtley head lab no.	Wash / froth lab no.	Coal bed	Lithology code	Roof appt. dip	Floor appt. dip	Comments	
	71.17	71.25	0.08	0	21221	221035		roof	HCST		28	Coaly shale: black with dark brown streak, v. fine grained, laminated; Floor contact with the coal below at ~28°BCN). ROOF dilution sample	
	71.25	71.82	0.57	0	21222	221316		202	CDB			COAL: dull banded, sheared.	
Core 10							221038		202	CDB			COAL: dull banded.
	71.82	71.84	0.02	0	21223				202	ST		30	Stony (?) coal.
	71.84	71.88	0.04	0				21224		202	SLT		30
	71.88	72.00	0.12	0		221039			202	CDB			COAL: dull banded, sheared and v. broken
	72.00	72.06	0.06	0	21225			202	HCST			Coaly shale: highly sheared, crushed	
	72.06	72.10	0.04	0				202	CDB			COAL: dull banded, highly sheared and almost pulverised.	
	72.10	72.67	0.57	0			21226	221040	floor	CCST			Carbonaceous shale: dark brown to black , highly broken to pulverised. Floor dilution sample.
	72.67	72.71	0.04	0		floor		CCST		23	Carbonaceous shale: dark brown to black , v.fine grained, solid core. BCN at top ~23°. Floor dilution sample.		
	72.71	72.77	0.06	0				CCST			Carbonaceous shale: as above, with coal stringers/bands throughout.		
	72.77	73.41	0.64	0					CCST				
Core 11													
	73.41	73.68	0	0.27					R-LOSS			Core loss -- rock	
	73.68	74.08	0.40	0					CST	37		Shale: dark grey-brown, v. fine grained, massive bedding/lamin, plant fossils; slightly carbonaceous with few coal stringers. BCN near top at 37° .	
	74.08	74.17	0.09	0					CCST			Carbonaceous shale: dark grey/black, v. fine grained, carbonaceous to coaly with coal stringers.	
	74.17	75.12	0.95	0					CST	33	38	Shale: medium grey-brown, v.fine grained, irregular bedding/lamin, trace fossils, locally soft sediment deformations. Strong HCL fizz. BCN varies from 33-38° .	
Core 12													
	75.12	75.28	0	0.16					R-LOSS			Core loss -- rock?	

**Coal assessment report for the Willow Creek coal lease --Volume 7:
Willow Creek Mine, 2021/2022 infill drilling**

Summary of WC22LD-05: Table B-5 (continued)

Cores	From	To	Re-cov- ered	Core loss	Sample no.	Birtley head lab no.	Wash / froth lab no.	Coal bed	Lithology code	Roof appt. dip	Floor appt. dip	Comments	
	75.28	75.71	0.43	0					CST			Shale: as above, but more silty with a few sandstone bands (up to 5-6cm thick). Broken at bottom.	
	75.71	75.94	0.23	0					CCST	40		Carbonaceous shale: dark brown to black, v. fine grained, massive bedding/lamin, with coal stringers throughout. BCN near top at 30° .	
	75.94	76.23	0.29	0					CST			Shale (or Ironstone?): medium brown, v. fine grained, very hard!	
	76.23	76.64	0.41	0							28	Siltstone: grey, fine grained, massive bedding/lamin. BCN near bottom ~28°	
Core 13													
	76.64	77.21	0.57	0					CST			Shale: dark brown/grey, v.fine grained, somewhat silty; massive bedding, some plant fossils.	
	77.21	77.31	0.10	0					CCST			Carbonaceous shale: slightly carbonaceous increasing downwards.	
	77.31	77.45	0.14	0	21227	221041		roof	CCST		28	Carbonaceous shale: dark grey to black, v. fine grained, with coal stringers. Floor contact intact at ~28° BCN. Roof dilution sample.	
	77.45	77.50	0.05	0	21228	221042		301	CD			COAL: dull. Crushed and highly sheared	
	77.50	77.65	0.15	0				301	COAL			COAL: pulverised (possibly dull).	
	77.65	77.84	0.19	0				301	CD			COAL: dull; highly broken to pulverised, sheared.	
	77.84	77.85	0.01	0				301	CBN			Bony coal	
	77.85	77.87	0.02	0	21229	221043		floor	HCST			Coaly shale: black with dark brown streak, fine grained, thinly laminae of bright coal.	
	77.87	78.07	0	0.20	21229	221043		floor	R-LOSS			Core loss -- rock	
Core 14													
	78.07	78.20	0.13	0				floor	HCST				Coaly shale: as above. Partially broken contact with the coal below.
	78.20	78.36	0.16	0	21230	221044			CBN			Bony coal: mostly crushed, highly sheared, minor shaly bands.	
	78.36	78.42	0.06	0	21231	221045			HCST		40		
	78.42	78.51	0.09	0					ST				Stony COAL: black to dark grey, sheared, soft, very dull, almost no cleating (possibly stony coal?)

**Coal assessment report for the Willow Creek coal lease --Volume 7:
Willow Creek Mine, 2021/2022 infill drilling**

Summary of WC22LD-05: Table B-5 (continued)

Cores	From	To	Re- cov- ered	Core loss	Sample no.	Birtley head lab no.	Wash / froth lab no.	Coal bed	Lithology code	Roof appt. dip	Floor appt. dip	Comments
	78.51	78.67	0.16	0	21231	221045		roof	HCST		47	Coaly shale: black with dark brown streak, fine grained, a few bright stringers. Floor contact at ~47° BCN, rather irreg shaped, with some brown concretions.
	78.67	78.91	0.24	0				roof	CSST			Coaly Sandstone: dark brown to black, fine-medium grained, very hard, with a few coal stringers. Contact with coal below is very irreg shaped, almost subvertical.
	78.91	79.13	0.22	0	21232	221046		300	CDB		25	COAL: dull banded. BCN near bottom ~25°
	79.13	79.60	0.47	0				300	CD&B		25	COAL: well banded dull & bright. BCN near bottom ~25°
	79.60	79.73	0.13	0	Core 15	21233		300	CD&B			COAL: as above.
	79.73	79.75	0.02	0				300	COAL			COAL: pulverised
	79.75	79.90	0.15	0				300	CD&B			COAL: dull & bright
	79.90	80.02	0.12	0				300	CDB			CDB: dull banded; crushed to pulverised, sheared.
	80.02	80.29	0.27	0				300	CD&B	32		COAL: dull & bright; soft, friable. 32 °BCN at top.
	80.29	80.47	0.18	0	21234	221317		300	CDB			COAL: dull banded, somewhat hard.
	80.47	80.97	0.50	0	21235			300	CD&B		25	COAL: dull & bright, wet, slightly sheared. BCN at floor contact ~25°
	80.97	81.08	0.11	0	21236	221050		floor	HCST	25		Coaly shale: black to dark brown, with mm-thin bright stringers throughout. FLOOR dilution sample.
	81.08	105.16	0	24.08					R-LOSS			No core: drilled open hole down to 345ft = 105.16m (driller's declared depth...)
Core 16												
	105.16	106.65	1.49	0					SLT	27	27	Siltstone: strong HCL fizz (calcareous?). Dark grey, fine grained, thin calcite stringers aligned sub-parallel to bedding/lamination(at ~27° BCN). Upper half is dominated by joints+fracts (with calcite coating on surfaces), running at 18-32° TCA.
Core 17												
	106.55	106.82	0.27	0					CST		40	Shale: silty and calcareous, similar to the one above but finer grained. BCN near floor ~40°

**Coal assessment report for the Willow Creek coal lease --Volume 7:
Willow Creek Mine, 2021/2022 infill drilling**

Summary of WC22LD-05: Table B-5 (continued)

Cores	From	To	Re- cov- ered	Core loss	Sample no.	Birtley head lab no.	Wash / froth lab no.	Coal bed	Lithology code	Roof appt. dip	Floor appt. dip	Comments
	106.82	106.92	0.10	0	21237	221051		roof	CCST			Carbonaceous shale: dark grey to black, v.fine grained; crushed core, mixed with some coal. Looks like a fault zone. ROOF dilution sample.
	106.92	107.46	0.54	0	21238	221052		410	CD&B			COAL: crushed to pulverised, mostly dull & bright. Looks like a fault zone!
	107.46	107.58	0.12	0	21239	221053		floor	C&B			COAL & Bands: coaly shale mixed with coal (up to 40%). Crushed core, looks like a fault zone.. FLOOR dilution sample.
	107.58	107.69	0.11	0					CCST			Carbonaceous shale: dark grey to black, v.fine grained, sheared with polished surfaces. Many coal stringers.
	107.69	108.07	0.38	0					CST		40	Shale: calcareous, as previously described.
Core 18												
	108.07	109.60	1.53	0					SLT	58	55	Siltstone: medium grey-brown, fine grained, irreg lamination with soft sediment deformation and trace fossils; good HCL fizz, calcite as stringers and fracture fillings (either cross-cutting bedding or sub-parallel to bedding). BCN varies, but trend is steep: 58-65-55°
Core 19												
	109.60	109.96	0.36	0					SLT		58	Siltstone: medium grey-brown, fine grained, thin and irreg lamination with bioturbation and trace fossils; good HCL fizz. Floor contact sharp, intact at 58° BCN.
	109.96	110.90	0.94	0					SST		56	Sandstone: light grey, fine-med. grained, soft sediment deformations and trace fossils (worm burrows indicating tops up). Strong HCL fizz in the rock mass; also some calcite stringers. Floor contact v. irreg shaped. BCN near floor at 56° .
	110.90	111.05	0.15	0					CST			Shale: dark grey, v. fine grained, thin lamination, plant fossils. Weak HCL fizz.
Core 20												
	111.05	112.63	1.58	0					SLT			Siltstone: light-medium grey, fine grained, wavy/irregular bedding-lamination, some cross bedding at bottom ~20 cm. Strong HCL fizz. BCN varies: 52-32-42-35°.

**Coal assessment report for the Willow Creek coal lease --Volume 7:
Willow Creek Mine, 2021/2022 infill drilling**

Summary of WC22LD-05: Table B-5 (concluded)

Cores	From	To	Re- cov- ered	Core loss	Sample no.	Birtley head lab no.	Wash / froth lab no.	Coal bed	Lithology code	Roof appt. dip	Floor appt. dip	Comments
Core 21												
	112.63	113.01	0.38	0					CST		40	Shale: silty, dark grey, v. fine grained, irreg laminated, plant fossils. BCN near floor ~40°
	113.01	113.11	0.10	0					ST			Stony coal: black, very dull, no cleating, no bright stringers, massive look. Very broken (almost crushed) core.
	113.11	113.24	0.13	0					CCST			Carbonaceous shale: dark grey to black, v. fine grained, sheared. (Possible coal loss at the end of run?)
	113.24	113.70	0	0.46				roof	R-LOSS			Core loss -- rock
	113.70	114.15	0	0.45				400	C-LOSS			Core loss -- coal
Core 22												
	114.15	114.77	0	0.62				400	C-LOSS			Core loss -- coal
	114.77	115.02	0.25	0	21240	221054		400	COAL			COAL: pulverised, wet, sheared.
	115.02	115.04	0.02	0	21241	221055		floor	CST			Shale: dark grey-brown, v. fine grained; mixed with some coal from above. FLOOR dilution sample.
	115.04	115.12	0.08	0				floor	SLT			Siltstone: medium grey, fine grained, weak lamination, FLOOR dilution sample.
	115.12	115.67	0.55	0					CST	20	20	Shale: dark grey, v. fine grained, irreg. lamination with soft sediment deformations and bioturbation. BCN ~20°.
												End of hole at driller's declared depth at the end of Run #22: 380ft = 115.82m

Summary table LD-05_220327d.doc. Core description by A.M. Matesoi

**Coal assessment report for the Willow Creek coal lease --Volume 7:
Willow Creek Mine, 2021/2022 infill drilling**

Summary of WC22LD-06: Table B-6

Cores	From	To	Re-cov-ered	Core loss	Sample no.	Birtley head lab no.	Wash / froth lab no.	Coal bed	Lithology code	Roof appt. dip	Floor appt. dip	Comments
	0.00	5.80		1.82					R-LOSS			CASING: 19ft = 5.8m.
	5.80	11.88		6.08					R-LOSS			Open hole (no core) to 39ft = 11.88 m.
Core 1												
	11.88	11.98	0.10	0	21156	220970		roof	HCST			Coaly shale: black with dark brown streak, v. fine grained, strongly sheared, polished surfaces; mixed with some coal. ROOF dilution sample.
	11.98	12.27	0.29	0	21157	220971		201	CBN			COAL: possibly bony. Very broken, sheared, with polished surfaces.
	12.27	12.77	0.50	0	21158	220972		201	CDB			COAL: dull banded, sheared, polished surfaces.
	12.77	13.30	0.53	0	21159	220973		201	CDB			COAL: as above.
Core 2												
	13.30	13.51	0.21	0	21160	220974		floor / roof	CST			Shale: dark grey-brown, v. fine grained, faintly bedded/laminated, with very thin coal stringers. BCN at the floor contact ~32° (intact). FLOOR dilution sample.
	13.51	13.87	0.36	0	21161	220975		200	COAL			COAL: crushed, highly sheared, contains one <2 cm thin shale band. Floor contact intact ~38° at BCN
	13.87	13.90	0.03	0					HCST			Coaly shale: black with dark brown streak, v. fine grained.
	13.90	14.27	0.37	0					CST			Shale: dark brown/grey, v. fine grained, fainted bedding/lamin, minor coal stringers. Floor contact intact, irreg. shaped.
	14.27	14.41	0.14	0	21162	220976		202	C&B			COAL and Bands: coal with up to 30% thin bands of carbonaceous shale. Highly sheared, crushed core.
	14.41	14.55	0.14	0	21163	220977		202	CCST	38	42	Carbonaceous shale: with mm-thin coaly bands/laminae, and vitrain stringers. BCN 38-42°
	14.55	14.80	0.25	0				202	CDB			COAL: dull banded; hard and competent.
Core 3					21164	220978						
	14.80	15.07	0.27	0				202	CDB			COAL: dull banded, as above. Floor contact irreg.

**Coal assessment report for the Willow Creek coal lease --Volume 7:
Willow Creek Mine, 2021/2022 infill drilling**

Summary of WC22LD-06: Table B-6 (continued)

Cores	From	To	Re- cov- ered	Core loss	Sample no.	Birtley head lab no.	Wash / froth lab no.	Coal bed	Lithology code	Roof appt. dip	Floor appt. dip	Comments
	15.07	15.11	0.04	0	21165	221318		202	CCST			Carbonaceous shale: brown-black, v. fine grained, laminated, some thin stringers. BCN at floor ~30°
	15.11	15.21	0.10	0				202	CST			Shale: dark grey-brown, v. fine grained, wavy bedding/lamination, thin carbonaceous and coaly stringers. Floor contact at 30° BCN (solid).
	15.21	15.33	0.12	0				202	CST		30	Shale: as above. Floor contact wavy, at ~30° BCN. Roof dilution sample.
	15.33	15.98	0.65	0	21167	220981		202	CD&B			COAL: banded, Dull & Bright; hard, slightly sheared at the bottom 0.05m.
	15.98	16.08	0.10	0	21168	220982			HCST			Coaly shale: black with dark-brown streak, v. fine grained. Very sheared, crushed core. FLOOR dilution sample.
	16.08	16.31	0.23	0					CCST	30	20	Carbonaceous shale: dark brown to black, v. fine grained, laminated, a few coal stringers. BCN: at roof 30°, at floor 20°
Core 4												
	16.31	16.63	0.32	0					CCST	33	30	Carbonaceous shale: dark grey to black, v. fine grained, laminated, with coal stringers. BCN varies: from 30°-55° - 30°
	16.63	16.67	0.04	0					COAL			COAL: highly sheared, minor mm-thin shale stringers.
	16.67	16.76	0.09	0					CCST		30	Carbonaceous shale: as previously described. Grades into shale (non-carbonaceous).
	16.76	16.94	0.18	0					CST		30	Shale: medium grey to brown, v. fine grained, laminated. Solid floor contact at ~30° BCN.
	16.94	17.25	0.31	0					SLT		35	Siltstone: medium grey, fine grained, weak lamination, some bioturbation, plant fossils. Weak HCL fizz. BCN at floor ~35° .
	17.25	17.57	0.32	0					SST		38	Sandstone: medium-light grey, fine-medium grained, irreg. thin lamination, some bioturbation. Calcite in the rock mass and as coating on fracts/joints surfaces BCN at floor ~38° .
Core 5												
	17.57	17.66	0.09	0					SST		38	Sandstone: as the previous one. BCN at floor ~38° .

**Coal assessment report for the Willow Creek coal lease --Volume 7:
Willow Creek Mine, 2021/2022 infill drilling**

Summary of WC22LD-06: Table B-6 (continued)

Cores	From	To	Re- cov- ered	Core loss	Sample no.	Birtley head lab no.	Wash / froth lab no.	Coal bed	Lithology code	Roof appt. dip	Floor appt. dip	Comments
	17.66	18.36	0.70	0					CST	38		Shale: medium grey to brown, v. fine grained, massive bedding, moderately calcitic.
	18.36	19.09	0.73	0					CST	45	40	Shale: as above only weakly calcitic. BCN varies 45°-40°.
Core 6												
	19.09	19.18	0	0.09					R-LOSS			Core loss -- rock?
	19.18	19.23	0.05	0					HCST			Coaly shale: slightly sheared, with coal stringers up to 15mm thick, some cream-white clay as thin coating on cleats (no HCL fizz). Grades into carbonaceous shale. POSSIBLE core Loss AT TOP of run!
	19.23	19.45	0.22	0					CCST			Carbonaceous shale: dark grey/brown, v. fine grained, with coal stringers throughout. Occasional mm-thin calcite stringers (no calcite in the rock mass)
	19.45	19.75	0.30	0					CST			Shale: dark brown/grey, v. fine grained, irreg. lamination, with carbonaceous/coaly stringers. Minor mm-thin calcite stringers (no calcite in the rock mass). Increasingly silty downwards.
	19.75	20.61	0.86	0					SLT			Siltstone: dark-medium grey, fine grained, wavy/irreg lamination/bedding with some soft sediment deformation; trace fossils. V. broken at bottom 3-4 cm.
Core 7												
	20.61	21.13	0.52	0					SLT			Siltstone: as above. Very irreg floor contact.
	21.13	21.23	0.10	0					COAL			COAL: crushed.
	21.23	21.89	0.66	0					SLT			Siltstone: as above but more massive bedding, occasional bioturbation; thin & irreg calcite stringers, minor coaly/carbonaceous stringers at bottom. Grades into shale.
	21.89	22.11	0.22	0					CST		27	Shale: dark grey, v. fine grained, massive bedding. Slightly carbonaceous near bottom; some plant fossils. BCN near bottom ~27°.
Core 8												
	22.11	22.26	0.15	0					CCST			Carbonaceous shale: v. fine grained, dark grey to black, with coal stringers.

**Coal assessment report for the Willow Creek coal lease --Volume 7:
Willow Creek Mine, 2021/2022 infill drilling**

Summary of WC22LD-06: Table B-6 (continued)

Cores	From	To	Re- cov- ered	Core loss	Sample no.	Birtley head lab no.	Wash / froth lab no.	Coal bed	Lithology code	Roof appt. dip	Floor appt. dip	Comments	
	22.26	22.36	0.10	0	21169	220983		roof	CCST		57	Carbonaceous shale: as above. Very sharp & steep (~57° BCN) contact with the coal below. Roof dilution sample.	
	22.36	22.81	0.45	0	21170	220984		310	CD&B		58	COAL: dull & bright, sheared. Steep bedding (~58° BCN). Floor contact irreg shaped.	
	22.81	22.85	0.04	0	21171	220985		floor	HCST			Coaly shale: black with dark brown streak, v. fine grained, very sheared with polished surfaces. BCN ~58°. Floor dilution sample.	
	22.85	22.90	0.05	0				floor	CCST			Carbonaceous shale: dark grey to black, v. fine grained, sheared with polished surfaces. BCN ~58°. Floor dilution sample.	
	22.90	23.04	0.14	0					CCST			Carbonaceous shale: as above.	
	23.04	23.11	0.07	0					COAL		50	COAL: very sheared. BCN ~50°.	
	23.11	23.15	0.04	0					HCST			Coaly shale: black with dark brown streak, v. fine grained, with coal stringers. Highly sheared.	
	23.15	23.52	0.37	0					CCST			Carbonaceous shale: v. fine grained, dark grey/brown, moderately carbonaceous with minor coal stringers.	
	23.52	23.63	0	0.11					R-LOSS			Core loss -- rock?	
Core 9													
	23.63	23.72	0	0.09					R-LOSS			Core loss -- rock?	
	23.72	23.83	0.11	0					CCST			Carbonaceous shale: one lonely piece that matches the end of previous run; same description as above. Possible rock loss at top?	
	23.83	23.90	0.07	0	21172	220986		roof	CST		45	Shale: dark brown/grey, fine grained, irreg. laminated; sharp (somewhat irreg. shaped) contact with the coal below (at ~45°BCN). ROOF dilution sample	
	23.90	24.16	0.26	0	21173	221319		300	COAL			COAL: highly sheared, crushed, wet.	
	24.16	24.47	0.31	0				300	CDB			COAL: dull banded.	
	24.47	25.15	0.68	0	21174			300	CDB			COAL: dull banded.	
Core 10													
	25.15	25.60	0.45	0	21175			300	CDB			COAL: dull banded.	

**Coal assessment report for the Willow Creek coal lease --Volume 7:
Willow Creek Mine, 2021/2022 infill drilling**

Summary of WC22LD-06: Table B-6 (continued)

Cores	From	To	Re- cov- ered	Core loss	Sample no.	Birtley head lab no.	Wash / froth lab no.	Coal bed	Lithology code	Roof appt. dip	Floor appt. dip	Comments
	25.60	26.25	0.65	0	21176	221320		300	CD&B			COAL: dull & bright.
	26.25	26.68	0.43	0				300	CD&B			COAL: dull & bright.
Core 11					21177	220992						
	26.68	26.86	0.18	0				300	COAL		20	COAL: highly sheared. Crushed at the floor contact
	26.86	26.94	0.08	0	21178			floor	HCST			Coaly shale: black with dark brown streak, v. fine grained, with coal stringers. Highly sheared, polished surfaces. FLOOR dilution sample.
	26.94	27.11	0.17	0					CCST	20		Carbonaceous shale: dark grey to black, v. fine grained, sheared, coal stringers throughout. BCN at top ~20°.
	27.11	28.01	0.90	0					CST	48	28	Shale: dark brown/grey, fine grained, slightly carbonaceous with minor coal stringers aligned sub-parallel to bedding/lamin (at 48 to 28°BCN).
	28.01	28.21	0	0.20					R-LOSS			Core loss -- rock?
Core 12												
	28.21	28.37	0.16	0					CCST		50	Carbonaceous shale: as previously described, with coal bands up to 2-3 cm thick Weak HCL fizz near bottom.. BCN at floor ~50°.
	28.37	29.68	1.31	0					CST	55	30	Shale: dark brown/grey, fine grained, with carbonaceous stringers defining bedding/lamin (varies from 55-45-30°BCN). Locally irreg brown(sideritic?) stringers. Strong HCL fizz (calcareous?)
Core 13												
	29.68	30.23	0.55	0					CST			Shale: as above.
	30.23	30.27	0.04	0					COAL			COAL: possibly dull & bright.
	30.27	30.33	0.06	0					HCST			Coaly shale: black with dark brown streak, v. fine grained, with coal stringers.
	30.33	30.72	0.39	0					CST			Shale: dark brown-grey, v.fine grained, irreg laminated (some soft sediment deform.), a few coal stringers. Moderate HCL fizz.
	30.72	31.17	0.45	0					CCST		48	Carbonaceous shale: Dark grey to black, v. fine grained, a few coal stringers. BCN at floor ~48°.

**Coal assessment report for the Willow Creek coal lease --Volume 7:
Willow Creek Mine, 2021/2022 infill drilling**

Summary of WC22LD-06: Table B-6 (continued)

Cores	From	To	Re-cov- ered	Core loss	Sample no.	Birtley head lab no.	Wash / froth lab no.	Coal bed	Lithology code	Roof appt. dip	Floor appt. dip	Comments	
Core 14													
	31.17	31.25	0	0.08					R-LOSS			Core loss -- rock?	
	31.25	31.58	0.33	0					CCST			Carbonaceous shale: dark grey to black, v.fine grained. Crushed core, polished surfaces: looks like fault zone.	
	31.58	32.45	0.87	0					CCST			Carbonaceous shale: dark grey to black, v.fine grained, highly fractured (fractures sub-parallel to core axis, surfaces coated with some white clay); coal stringers throughout.	
	32.45	32.57	0.12	0					COAL			COAL: crushed to pulverised; looks like a fault gouge.	
	32.57	32.77	0.20	0					CST			Shale: dark brown-grey, fine grained, massive bedding/lamin. Coal (1-2cm) coating at bottom.	
Core 15													
	32.77	32.92	0.15	0					CCST			Carbonaceous shale: dark grey brown, fine grained, crushed - looks like fault zone.	
	32.92	33.05	0.13	0					CST			Shale: as above but some more thin coal stringers. No discernible bedding, bioturbation signs.	
	33.05	33.17	0.12	0	21179	220993		roof	CST			Shale: as above but very sheared. ROOF sample of 401 seam.	
	33.17	33.39	0.22	0	21180	220994	C-23	401	CD&B			COAL: dull & bright; sheared.	
	33.39	33.70	0.31	0				401	CD&B			COAL: dull & bright.	
	33.70	34.07	0.37	0	21181	220995		401	CD&B			COAL: dull & bright; sheared.	
	34.07	34.17	0	0.10				401	C-LOSS			Core loss -- coal	
Core 16													
	34.17	34.27	0.10	0	21182	220996		401	COAL			COAL: Highly broken and sheared (possible dull & bright?)	
	34.27	34.32	0.05	0				floor / roof	C&B			Coal and Bands: sheared dull coal with up to 40% thin coaly shale.	
	34.32	34.42	0.10	0				floor / roof	HCST			Coaly shale: black with dark brown streak, v. fine grained, massive bedding.	
	34.42	34.62	0.20	0				floor / roof	CCST			Carbonaceous shale: dark grey brown, fine grained, with many coal stringers. Irregular floor contact.	
	34.62	34.66	0.04	0				floor / roof	CST			Shale: brown-grey, fine grained; irreg floor contact.	

**Coal assessment report for the Willow Creek coal lease --Volume 7:
Willow Creek Mine, 2021/2022 infill drilling**

Summary of WC22LD-06: Table B-6 (continued)

Cores	From	To	Re- cov- ered	Core loss	Sample no.	Birtley head lab no.	Wash / froth lab no.	Coal bed	Lithology code	Roof appt. dip	Floor appt. dip	Comments		
	34.66	34.79	0.13	0	21183	220997		400?	C&B			COAL & Bands: wet, highly sheared and crushed (almost pulverised) core; looks like dull coal with carbonaceous shale.		
	34.79	35.57	0.78	0	21184	220998	C-24	400	CDB			COAL: dull banded; slightly sheared.		
	35.57	35.75	0	0.18				400	C-LOSS			Core loss -- coal		
Core 17														
	35.75	35.94	0.19	0	21185	220999		400	CDB			COAL: dull banded.		
	35.94	36.25	0.31	0				400	CD&B	27		COAL: dull & bright. BCN ~27°		
	36.25	36.60	0.35	0	21186	221000		400	CD&B		23	COAL: dull & bright. BCN varies 25 -20°		
	36.60	36.75	0.15	0				400	CD&B			COAL: dull & bright, crushed, slightly sheared		
	36.75	36.85	0.10	0				400	COAL			COAL: wet, pulverised.		
	36.85	36.90	0.05	0	21187	221001			400?	HCST			Coaly shale: black with dark brown streak, v. fine grained, sheared, very broken.	
	36.90	37.15	0.25	0					400?	CCST		20	Carbonaceous shale: dark brown to black, massive bedding, minor coal stringers. BCN at floor ~20° .	
	37.15	37.21	0.06	0	21188	221002		C-25	400	CD&B			COAL: dull & bright.	
Core 18														
	37.21	37.28	0.07	0			400		CD&B					
	37.28	37.33	0.05	0			400		CDB				COAL: soft, slightly sheared. (Probably dull banded.)	
	37.33	37.68	0.35	0			400		CDB				COAL: dull banded.	
	37.68	38.17	0.49	0			21189		221003	400	CDB			COAL: dull banded, hard and competent
	38.17	38.59	0.42	0	21190	221004		400	CDB			COAL: dull banded, hard and competent. (Mostly intact, v. broken only at bottom).		
Core 19														
	38.59	39.20	0.61	0	21191	221005		400	CD&B		25	COAL: dull & bright, hard and competent. Slightly sheared around floor contact. BCN at floor ~25° .		
	39.20	39.24	0.04	0	21192	221006		floor	HCST			Coaly shale: black with dark brown streak, v. fine grained, crushed, sheared. Abundant coal stringers (up to 30%). Floor dilution sample.		

**Coal assessment report for the Willow Creek coal lease --Volume 7:
Willow Creek Mine, 2021/2022 infill drilling**

Summary of WC22LD-06: Table B-6 (continued)

Cores	From	To	Re- cov- ered	Core loss	Sample no.	Birtley head lab no.	Wash / froth lab no.	Coal bed	Lithology code	Roof appt. dip	Floor appt. dip	Comments
	39.24	39.30	0.06	0	21192	221006		floor	CCST			Carbonaceous shale: dark brown to black, slightly sheared, a few coal stringers. Floor dilution sample.
	39.30	39.53	0.23	0					CCST			Carbonaceous shale: as above.
	39.53	39.58	0.05	0					C&B		18	COAL and Bands: sheared dull coal with up to 40% thin shale. BCN at floor ~18°
	39.58	39.80	0.22	0					CST		15	Shale: dark brown-grey, v.fine grained, massive bedding, slightly carbonaceous with a few coal stringers. BCN at floor ~15°
	39.80	39.88	0.08	0					CCST			Carbonaceous shale: dark brown to black, with coal stringers. Crushed, highly sheared.
	39.88	40.22	0.34	0					CST		18	Shale: dark brown-grey, v.fine grained, massive bedding, a few coal stringers. BCN at floor ~18°
	40.22	67.97	0	27.75								Drilled open-hole down to 223ft = 67.97m. No core [Driller's declared footage at the end of Run #19: 133ft = 40.54m]
Core 20												
	67.97	68.04	0	0.07					R-LOSS			Core loss -- rock?
	68.04	68.13	0.09	0					CST			Shale: dark brown-grey, v.fine grained, massive bedding, slightly carbonaceous
	68.13	68.18	0.05	0					CCST			Carbonaceous shale: crushed core, looks like fault zone
	68.18	68.33	0.15	0					CCST			Carbonaceous shale: dark brown to black, with coal stringers. Intact floor contact with the coal below, at 20° BCN.
	68.33	68.45	0.12	0	21193	221007		roof	CCST		20	Carbonaceous shale: as above. Intact floor contact with the coal below, at 20° BCN. Roof dilution sample.
	68.45	68.62	0.17	0	21194	221008		410	CDB			COAL: sheared, v. soft (pulverises at touch). Possibly dull banded coal.
	68.62	68.77	0.15	0				410	COAL			COAL: highly sheared, crushed to pulverised. Pieces of bony coal at bottom 2-3 cm of interval.
	68.77	68.82	0.05	0	21195	221009		floor	C&B			Coal & Bands: coaly shale with up to 40% vitrain stringers/bands. FLOOR dilution sample.
	68.82	68.84	0.02	0					HCST			Coaly shale: black with dark brown streak, v. fine grained, minor coal stringers. FLOOR dilution sample.

**Coal assessment report for the Willow Creek coal lease --Volume 7:
Willow Creek Mine, 2021/2022 infill drilling**

Summary of WC22LD-06: Table B-6 (continued)

Cores	From	To	Re-cov- ered	Core loss	Sample no.	Birtley head lab no.	Wash / froth lab no.	Coal bed	Lithology code	Roof appt. dip	Floor appt. dip	Comments	
	68.84	69.02	0.18	0					CCST			Carbonaceous shale: dark grey-brown, v.fine grained, massive bedded, minor coal stringers.	
	69.02	69.39	0.37	0					CST			Shale: dark grey, fine grained, massive bedding/lamin., plant fossils.	
Core 21													
	69.39	69.42	0.03	0	21196	221010		roof	HCST			Coaly shale: dark brown to black, v fine grained. Very broken core. ROOF of 401-R seam.	
	69.42	69.52	0.10	0	21197	221011	C-26	401	CD&B			COAL: dull & bright.	
	69.52	69.91	0.39	0				401	CDB			COAL: dull banded. Highly sheared, crushed to pulverised.	
	69.91	70.31	0.40	0				401	CDB			COAL: dull banded. Soft and friable, slightly sheared.	
	70.31	70.66	0.35	0	21198	221012		401	CDB			COAL: dull banded.	
	70.66	70.79	0.13	0				401	CD			COAL: dull	
	70.79	70.94	0.15	0				401	CDB			COAL: dull banded	
Core 22													
	70.94	71.12	0	0.18				401	C-LOSS			Core loss -- coal?	
	71.12	71.36	0.24	0	21199	221013	C-27	401	CD&B			COAL: dull & bright. Sheared, almost crushed.	
	71.36	71.95	0.59	0				401	COAL			COAL: highly sheared, v. soft and friable (pulverises easily); possibly dull.	
	71.95	72.24	0.29	0				401	CD			COAL: dull	
	72.24	72.29	0.05	0	21200	221014		401	COAL			COAL: pulverised. Possibly dull.	
	72.29	72.39	0.10	0				401	CBN			Bony coal: black with black streak, v. dull with some mm-thin bright stringers, no cleating.	
Core 23													
	72.39	72.66	0.27	0	21201	221015		401	CD&B				COAL: dull & bright. Highly sheared, almost pulverised.
	72.66	72.92	0.26	0				401	CD&B			COAL: dull & bright, highly fractured and crushed. V. irreg contact with the shale below.	
	72.92	73.22	0.30	0				21202	221016	floor / roof	CCST		

**Coal assessment report for the Willow Creek coal lease --Volume 7:
Willow Creek Mine, 2021/2022 infill drilling**

Summary of WC22LD-06: Table B-6 (concluded)

Cores	From	To	Re-cov- ered	Core loss	Sample no.	Birtley head lab no.	Wash / froth lab no.	Coal bed	Lithology code	Roof appt. dip	Floor appt. dip	Comments		
	73.22	73.59	0.37	0	21203	221017	C-28	400	CDB			COAL: dull banded.		
Core 24														
	73.79	73.91	0.12	0				400	COAL			Black, light, v. dull, almost no cleating; minor mm-thin bright coal stringers.		
	73.91	74.00	0.09	0	21204	221018		400	CD			COAL: dull		
	74.00	74.03	0.03	0				400	COAL			COAL: pulverised. Possibly dull.		
	74.03	74.61	0.58	0				400	CDB			COAL: dull banded.		
	74.61	75.09	0.48	0	21205	221019		400	CDB			COAL: dull banded.		
	75.09	75.41	0.32	0				400	CD&B			COAL: dull & bright.		
Core 25														
	75.41	75.46	0.05	0	21206	221020		400	CD&B			COAL: dull and bright; crushed at the floor contact.		
	75.46	75.51	0.05	0				400	CCST			Carbonaceous shale: dark brown-grey, v. fine grained, massive bedding, some coal stringers at roof contact.		
	75.51	75.55	0.04	0				400	GO			Clay gouge: mud of carbonaceous shale (dark brown/grey, mixed with some coal). Looks like "liquefied" dark shale.		
	75.55	75.65	0.10	0	21207	221021		400	COAL			COAL: wet, pulverised, highly sheared		
	75.65	75.88	0.23	0				400	CD&B		20	COAL: dull and bright, sheared. Very sharp floor contact, at 20° BCN		
	75.88	75.98	0.10	0	21208	221022			floor	CST			Shale: dark grey to black, v.fine grained, massive bedding, plant fossils, coal stingers at roof contact. FLOOR dilution sample.	
	75.98	76.46	0.48	0					CST			Shale: as above; one 15mm thick bright coal band at floor. BCN at bottom of interval ~ 20°.		
	76.46	77.06	0.60	0					CST			Calcareous shale:		
Core 26														
	77.06	77.17	0.11	0					CST			Shale: as above.		
	77.17	77.27	0.10	0					CBB			COAL: bright banded; crushed.		
	77.27	77.32	0.05	0					HCST			Coaly shale: black with dark brown streak, v. fine grained, floor contact wavy shaped.		
	77.32	78.52	1.20	0					SLT			Siltstone: grey, fine grained, wavy bedding/lamination, plant fossils. BCN 19 - 22°.		
												End of hole. Driller's declared depth at the end of Run #26: 257 ft = 78.33m		

Summary table LD-06_220327d.doc. Core description by A.M. Matesoi