COAL ASSESSMENT REPORT TITLE PAGE AND SUMMARY

TITLE OF REPORT:
Coal Assessment Report for the Hermann Project, Mt. Hermann area, British Columbia

TOTAL COST: $1,394,469.07 (for Tenures 383180 through 383183)

AUTHOR(S): **C.G. Cathyl-Huhn P.Geo**
SIGNATURE(S):
NOTICE OF WORK PERMIT NUMBER(S)/DATE(S): **CX-9-9 / February 11, 2019**

YEAR OF WORK: **2018-2019 licence term** REPORT DATE: **December 17, 2019**

PROPERTY NAME: **Hermann Project (164053)**

COAL LICENSE(S) AND/OR LEASES ON WHICH PHYSICAL WORK WAS DONE: **Coal Licences 383180, 383181, 383182, 383183, 417036, and 417327**

MINERAL INVENTORY MINFILE NUMBER(S), IF KNOWN: **93P 031**
MINING DIVISION: **Liard (Peace region)**
NTS / BCGS: **NTS 93I/14 and 93P/3 BCGS 093P.004 and 093I.094**
LATITUDE: **55° 00’ 04.5" N**
LONGITUDE: **121° 08’ 50.5" W** (at centre of work)
UTM Zone: **10N** EASTING: **618500** NORTHING: **6096500**

OWNER(S): **Conuma Coal Resources Limited**
MAILING ADDRESS: **200-235 Front Street, Tumbler Ridge, B.C. V0C 2W0 Canada**

OPERATOR(S): **Conuma Coal Resources Limited**
MAILING ADDRESS: **200-235 Front Street, Tumbler Ridge, B.C. V0C 2W0 Canada**

REPORT KEYWORDS
bituminous coal, Gates Formation, Falher Member, Notikewin Member, Torrens Member, Gething Formation, Chamberlain Member, Bullmoose Member, Gaylard Member, Boulder Creek Formation, Paddy Member, Walton Creek Member, Cadotte Member, Bullmoose Fault, Mesa Fault, decollement

REFERENCES TO PREVIOUS ASSESSMENT WORK AND ASSESSMENT REPORT NUMBERS:
Coal Assessment Report 950 and 999 (principal references); also Reports 515, 609, 614, 616, 617, 618, 724, 739, 746, 753, 910, and 942; Petroleum Assessment Report 863; Oil and Gas Commission files WA 5099 and WA 9997.

Hermann_2019_191212j4.doc

SUMMARY OF TYPES OF WORK IN THIS REPORT		EXTENT OF WORK (in metric units)	ON WHICH TENURES
GEOLOGICAL (scale, area)			
	Ground, mapping	**none**	**not applicable**
	Photo interpretation	**none**	**not applicable**
GEOPHYSICAL (line-kilometres)			
	Ground (Specify types)	**none**	**not applicable**
		none	**not applicable**
	Airborne (Specify types)	**none**	**not applicable**
		none	**not applicable**
	Borehole		
	Gamma -- 9 boreholes	**2423.06 metres**	**383181 and 383183**
	Resistivity -- 8 boreholes	**2172.90 metres**	**383181 and 383183**
	Caliper -- 8 boreholes	**2172.90 metres**	**383181 and 383183**
	Deviation -- 9 boreholes	**2415 metres**	**383181 and 383183**
	Dipmeter -- 9 boreholes	**2421.12 metres**	**383181 and 383183**
	Other -- Sonic log -- 5 boreholes	**1685.32 metres**	**383181 and 383183**
	Other -- Sonic porosity -- 5 boreholes	**1683.68 metres**	**383181 and 383183**
	Core **-- 6 diamond-drill boreholes (HQ size)**	**1937.89 metres**	**383181 and 383183**
	Non-core -- **29 sonic geotechnical boreholes**	**290.94 metres**	**417036 and 417327**
	Non-core -- **23 rotary hydrological boreholes**	**1552.19 metres**	**383180, 383181, 383182, 383183, 417036, and 417327**
SAMPLING AND ANALYSES			
Total number of samples**: 147, all of which were taken from year-2019 cores**			
	Proximate (including sulphur and s.g.)	**147**	**383181 and 383183**
	Free swelling index (FSI)	**95**	**383181 and 383183**
	Light transmittance (oxidation test)	**95**	**383181 and 383183**
	Ultimate	**none**	**not applicable**
	Gieseler fluidity (ddpm)	**none**	**not applicable**
	Ash chemistry (mineral analysis of ash)	**none**	**not applicable**
	Petrographic (maceral determination)	**none**	**not applicable**
	Vitrinite reflectance	**none**	**not applicable**
	Coking	**none**	**not applicable**
	Wash tests (**float-sink tests**)	**none**	**not applicable**
PROSPECTING (scale/area)		**none**	**not applicable**
PREPARATORY/PHYSICAL		**none**	**not applicable**
Line/grid (km)		**none**	**not applicable**
Trench (number, metres)		**none**	**not applicable**
Bulk sample(s)		**none**	**not applicable**

Section 4 and Appendix B remain confidential under the terms of the Coal Act Regulation and have been removed from the public version.

http://www.bclaws.ca/civix/document/id/complete/statreg/251_2004

1 Table of contents

1.1 List of tables

<u>1.2 List of maps</u>

2 Introduction and situation

This report, titled *Coal Assessment Report for the Hermann Project, Mt. Hermann area, British Columbia*, presents results of an extended drilling programme conducted during the 2018-2019 work term by Conuma Coal Resources Limited (Conuma). The report has been submitted by Conuma in keeping with obligations under the *Coal Act* and the *Coal Act Regulation*.

2.1 Property description

The Hermann coal property consists of provincially-granted Crown coal tenures comprising thirteen Coal Licences, numbered 383180-383183, 405136-405142, 417327, and 417485. All tenures are contiguous, with no freehold inholdings or adjacencies. Tenure anniversary dates vary (refer to **Table 2-1**): the most immediately-upcoming date is December 18, 2019, for Coal Licences 383180, 383181, 383182, and 383183. An application to convert Coal Licences 383180, 383181, 383182, 383183, 405139, 417327, and 417485 into a Coal Lease was submitted by Conuma in October of 2019. At the time of this report's writing, the application is still being considered by the Crown.

2.2 Terms of reference of this report

The principal focus of this report is on coal-quality investigations, done on cores of coal and associated rocks, collected from within Tenures 383180 through 383183 and analysed during 2019. Mention is also made of year-2019 geotechnical and hydrological drilling conducted within these four tenures, and also within Tenures 417036 and 417327, in support of a mine permit application for the proposed Hermann Mine. The mine permit application is, at time of writing this report, undergoing the provincial mine review screening process.

Cost analysis, and interpretation of results, for the geotechnical and hydrological drilling is still underway, and will be reported with the upcoming Coal Assessment Report for Tenure 417327.

Tenure 417036 is held by Peace River Coal, who agreed to Conuma's access to the tenure for the purposes of geotechnical drilling.

2.3 Property history

The Hermann coal licences were awarded by the Crown to Western Canadian Coal Corp. (WCCC) between the years 2000 and 2006, and subsequently acquired by Walter Energy Inc. and associated firms – including the Walter Canadian Coal Partnership (WCCP) – in the course of a corporate merger in 2011. In 2016, WCCP's ownership of the Hermann property was transferred to Conuma, as part of a regional-scale purchase of WCCP's tenures.

Drilling of exploratory boreholes commenced at Hermann in 1976, under the auspices of Denison Mines and Quintette Coal Ltd. Up until 2014, and under the auspices of several companies, historic drilling totalled 268 boreholes with aggregate length of at least 28,555.31 metres. Length of drilling may have been somewhat greater, but historic records are incomplete. No drilling was done in years 2015 through 2018.

2.4 Current physical work

Current physical work on the entire property and also within adjoining Tenure 417036 (held by Peace River Coal, and accessed by agreement) comprises the drilling of 58 boreholes with total length of 3781.02 metres.

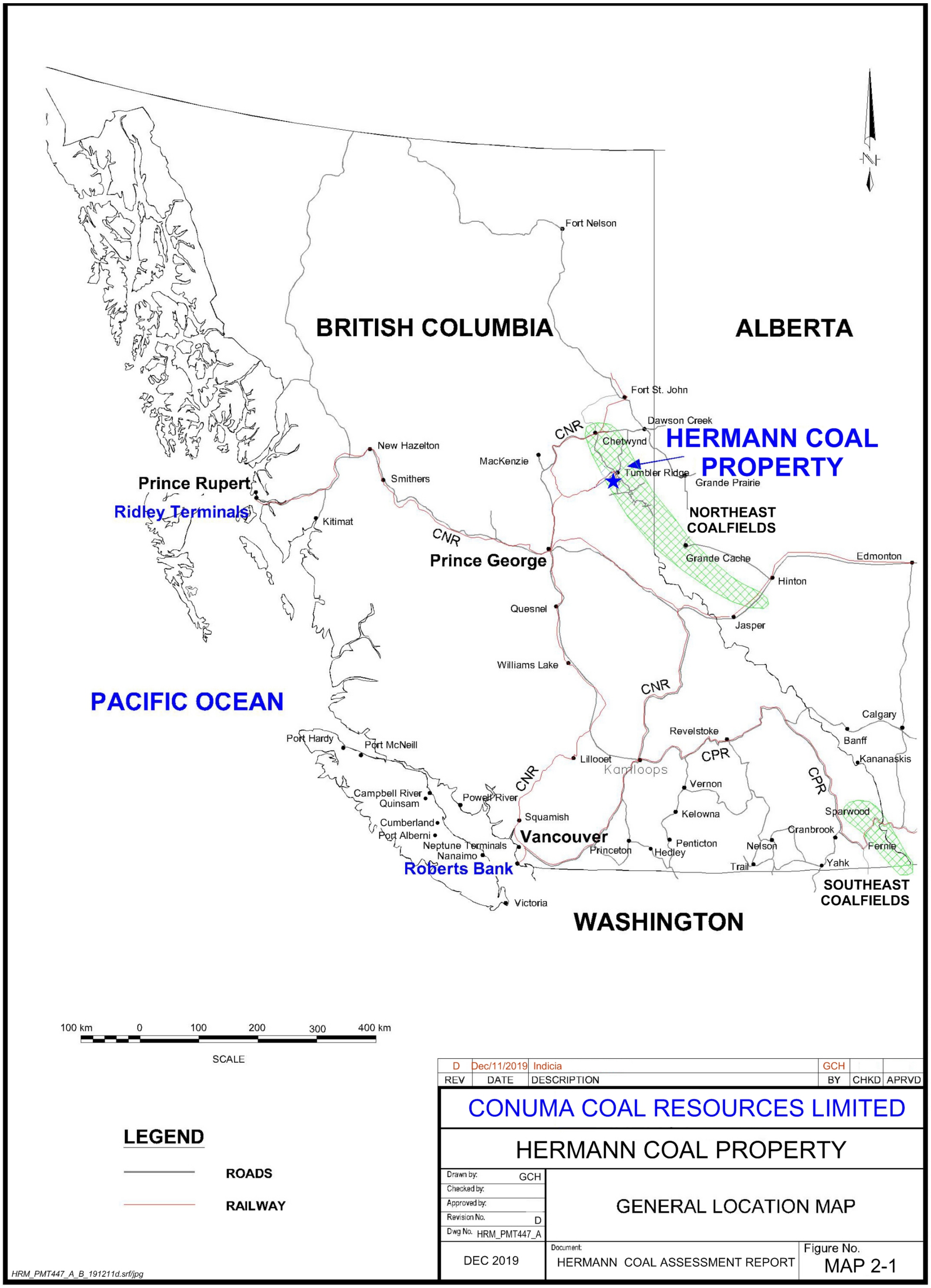
- Current work on the four December-anniversary coal licences (Tenures 383180 through 383183) comprises the drilling of 20 boreholes (included within the 58 boreholes mentioned above) with total length of 3085.71 metres, at an estimated total cost (inclusive of ancillary activities presented in **Table 7-1**) of $1,394,469.07.
- Current work on Peace River Coal's Tenure 417036 comprises the drilling of 19 boreholes (included within the 58 boreholes mentioned above), none of which approached known or potential coal-measures, with total length of 201.13 metres.

Positions, depths, and details of boreholes are reported within **Tables 2-3, A-1**, **A-2**, and **A-5** of this report. **Appendix A** presents construction and geophysical logging details of year-2019 boreholes, along with core descriptions for the six boreholes which were cored. **Appendix B** provides proximate and additional analyses on core samples of coal and rock. Daily narrative and statistical reports of current work are presented in **Appendix C**.

To date, 326 boreholes are known to have been drilled at Hermann, with total length of at least 32,336.33 metres. The majority of these boreholes have been geophysically logged.

Coal Assessment Report Nos.950 and 999 (CAR-950 and CAR-999) are the primary background reference sources for the present report, and the interested reader is directed there to obtain a more detailed recounting of historic (pre-2019) exploratory work, and of the broader geological setting of the Hermann coal property.

Estimated cost of exploratory work on Tenures 383180 through 383183 during the 2018-2019 work term is $1,394,469.07, for a unit cost of $451.91 per metre drilled.



Map 2-1: General location map

2.5 Location and access

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

The Hermann coal property is accessible via all-weather highways and roads, at a driving distance of 128 kilometres south from Chetwynd town, and 33 kilometres southwest from Tumbler Ridge town, within map-areas 93 P/03 and 93I/14 of Canada's National Topographic System.

Highway access is via route BC-29, connecting Chetwynd to Tumbler Ridge, thence southward a further 15 kilometres on route BC-52. From a well-marked junction at this point, access is via the first 9 kilometres of the Murray River Forest Service Road (FSR), which skirts the southern side of Teck Corporation's mothballed Quintette coal-washery, passes through two culverted tunnels beneath Quintette's former coal-haulage roads, and then crosses the Murray River.

Immediately past the river-crossing, Quintette's former Mesa coal-haulage road, now signposted as the Mast Creek Petroleum Development Road (Mast Creek PDR) extends a further 9 kilometres westward to its crossing with the non-status Nabors Road, which extends southward into the Hermann coal property (as shown on **Map 2-2**).

From this junction, the Mesa coal-haulage road extends northwestward to the former Quintette Mine open-pits atop Mt. Sheriff and Mt. Frame. The northward extension of the Nabors Road is now sign-posted as the Mast Creek PDR; following this route an additional 13.9 kilometres northward eventually leads to a steel bridge across Wolverine River, and a junction at kilometre 8.3 of the Wolverine FSR.

2.5.1 Road and trail access details

The non-status Nabors Road runs generally southerly, ending at a natural-gas well situated south of the Hermann property's southern boundary (but within Conuma's adjoining Hermann West coal property). A network of coal-exploration trails extends outward to the east and west of the Nabors Road; these trails are in various states of repair, but most are presently suitable as walking routes, or for usage by all-terrain vehicles.

Within the southwestern corner of the Hermann coal property, the non-status Viewpoint Road branches eastward from the Nabors Road, and winds around the contours of hills. Numerous coal-exploration trails, most of which are now overgrown by brush and windthrown timber, extend to the northeast and southeast from the road's termination on the southern flank of Mt. Hermann.

The upper slopes of Mt. Hermann and its adjoining western ridgeline are sparsely-timbered, affording good off-trail access by walking. A disused radio shack occupies the peak of the mountain.

The Hermann property's eastern end is more difficult to reach than its central area and western end. A network of old coal-exploration trails, now mostly overgrown, extends northwestward from the Murray River FSR, switch-backing up the southeastern and eastern flanks of Mt. Hermann. The initial portions of these trails are controlled by Teck Corporation, as part of their former Quintette minesite, and access must therefore be negotiated with Teck.

2.5.2 Airborne access

An unattended, paved airstrip is situated south of Tumbler Ridge; the airstrip is served by various chartered air-transportation firms, from airports at Prince George, Chetwynd and Dawson Creek. Numerous helicopter landing-points are available atop ridges above timberline, and in a large clearing situated west of the natural-gas wellsite at d-83-J/93-I-14.

2.5.3 Regulatory setting of surface access

Surface access for drilling and other exploratory works is regulated by the provincial government, subject to the *Coal Act Regulations* and the *Mines Act*. The Hermann coal property is situated within Block 4 of Canfor Inc.'s Tree Farm Licence No.48. The property is furthermore situated within the Dawson Creek Land and Resource Management Plan area, and the Foothills Resource Management Zone, allowing for multiple resource uses, including coal-mining. Oil and gas tenures exist throughout the Hermann coal property, and natural gas was recently (summer of 2014) actively produced from a wellhead (c-02-B/93-P-3) situated within Coal Licence 383181, although that well is presently suspended from production.

2.6 Tenure details

The Hermann property comprises 13 coal licences (**Maps 2-2 and 2-3**) which were acquired from the Crown by Western Canadian Coal at various times between the years 2000 and 2006, and subsequently acquired by Walter Energy after its acquisition of Western Coal. **Table 2-1** presents details of the coal tenures, whose aggregate area is 3,193 hectares, and whose annual rental cost is $62,370. Exploration has taken place between the years 1976 and 2014 ('historic work'), and during year-2019 ('current' work for purposes of this report).

Coal licences grant to their holder the exclusive right to explore for coal, subject to consultation with local First Nations, coordination of access with other tenure-holders (such as oil and gas firms, other mineral-tenure holders, guide-outfitters, trappers, and timber companies), and the successful submission of an exploratory work plan.

Coal licences do not, in and of themselves, confer the ownership of coal upon their holder (as the coal remains the property of the Crown via the province of British Columbia), but they can under appropriate circumstances be converted into coal leases, upon which a scheme of mining may be established. A coal lease application has recently (October, 2019) been made, covering portions of the Hermann coal property.

The term of coal licences is one year, which may normally be extended upon the payment of an area-based annual rental fee as prescribed by the provincial Coal Act Regulation. Hermann is now within its third and fourth five-year span of increased rental fees, at $15 to $20/hectare.

Table 2-1: Coal tenures comprising the Hermann coal property

Land description			Area (ha)	Dates		Annual rental rate ($/ha)	Annual rental fee (rate x area)
Tenure	Blocks	Units		Issued on	Renew by		
383180	93P/3 Block B	3, 4, 13, 14	297.00	Dec.18, 2000	Dec.18, 2019	$20	$5940
383181	93P/3 Block B	1, 2, 11, 12	297.00	Dec.18, 2000	Dec.18, 2019	$20	$5940
383182	93I/14 Block J	83, 84, 93, 94	297.00	Dec.18, 2000	Dec.18, 2019	$20	$5940
383183	93I/14 Block J	81, 82, 91, 92	297.00	Dec.18, 2000	Dec.18, 2019	$20	$5940
405136	93P/3 Block A	5,16,15,16	297.00	Sep.19, 2003	Sep.19, 2020	$20	$5940
405137	93P/3 Block A	7, 8, 17, 18	297.00	Sep.19, 2003	Sep.19, 2020	$20	$5940
405138	93P/3 Block A	9, 10, 19, 20	297.00	Sep.19, 2003	Sep.19, 2020	$20	$5940
405139	93I/14 Block I	90, 100	148.00	Sep.19, 2003	Sep.19, 2020	$20	$2960
405140	93I/14 Block I	87, 88, 97, 98	297.00	Sep.19, 2003	Sep.19, 2020	$20	$5940
405141	93I/14 Block I	96	74.00	Sep.19, 2003	Sep.19, 2020	$20	$1480
405142	93I/14 Block I	67, 68, 77, 78	297.00	Sep.19, 2003	Sep.19, 2020	$20	$5940
417327	93P/3 Block B	22, 23	149.00	Apr.25, 2006	Apr.25, 2020	$15	$2235
417485	93P/3 Block B	5, 6	149.00	Jul.20,2006	Jul.20,2020	$15	$2235
13 coal licences / 43 units			3193 ha				$62,370

2.7 Infrastructure and geomatics

Electrical power is potentially available from B.C. Hydro's Quintette substation, served by 230-KV transmission line 2L323, although no distribution lines are presently in place near the Hermann property. Sub-transmission and distribution lines, formerly serving the Quintette mines at Mt. Sheriff and Mt. Frame, were removed subsequent to those mines' closure.

Telecommunications are available via satellite and cellular telephone systems. Satellite access is excellent in upland areas, but unreliable in the heavily-wooded hillsides. Cellular coverage also likely to be inconsistent, owing to distance from transmitters, and issues of line-of-sight in mountainous country.

Base-mapping for Hermann is freely available from the provincial government's Base Map Online Store, which affords a facility for downloading shaded-relief topographic maps of the British Columbia Geographic System (BCGS) at 1:20,000 scale. BCGS map-sheets 093I.094, 093I.095, 093P.004, and 093P.005 cover the property and adjoining areas.

Georeferenced satellite photography is freely available via the *Google Earth* web-service. In general, this imagery is sufficiently detailed for studies of gross geological and geomorphological structure, and for the general tracing of roadways and vehicular access trails, but its level of detail is insufficient to allow for trafficability determinations.

2.8 Physiography, landscapes and climate of the Hermann property

Terrain (**Map 2-2**) is generally mountainous, with very steep hillslopes, capped by rolling sub-alpine plateaux which have been dissected by steep gullies and ravines. Two creeks, M20 Creek and Nabors Creek, drain the majority of the property, with lesser drainages into K6 Creek, Twenty Creek, M14 Creek and South Hermann Creek.

Coniferous forest covers the lower slopes of Mt. Hermann and adjoining ridgelines, declining in size and vigour with increasing altitude and wind-exposure. Near the treeline, forest cover is diminished to dense tangles of wind-sculpted krummholz. In the past several years, considerable clear-cut logging has been done within and adjacent to the Hermann coal property.

Soil cover is generally patchy, consisting mainly, till, alluvium and peat at lower elevations, and talus and colluvium at higher elevations. Thicker soils (including unconsolidated parent materials) are known to be present within the deep, glacially-rounded valley of Murray River, and in isolated areas on the southeastern face of Mt. Sheriff.

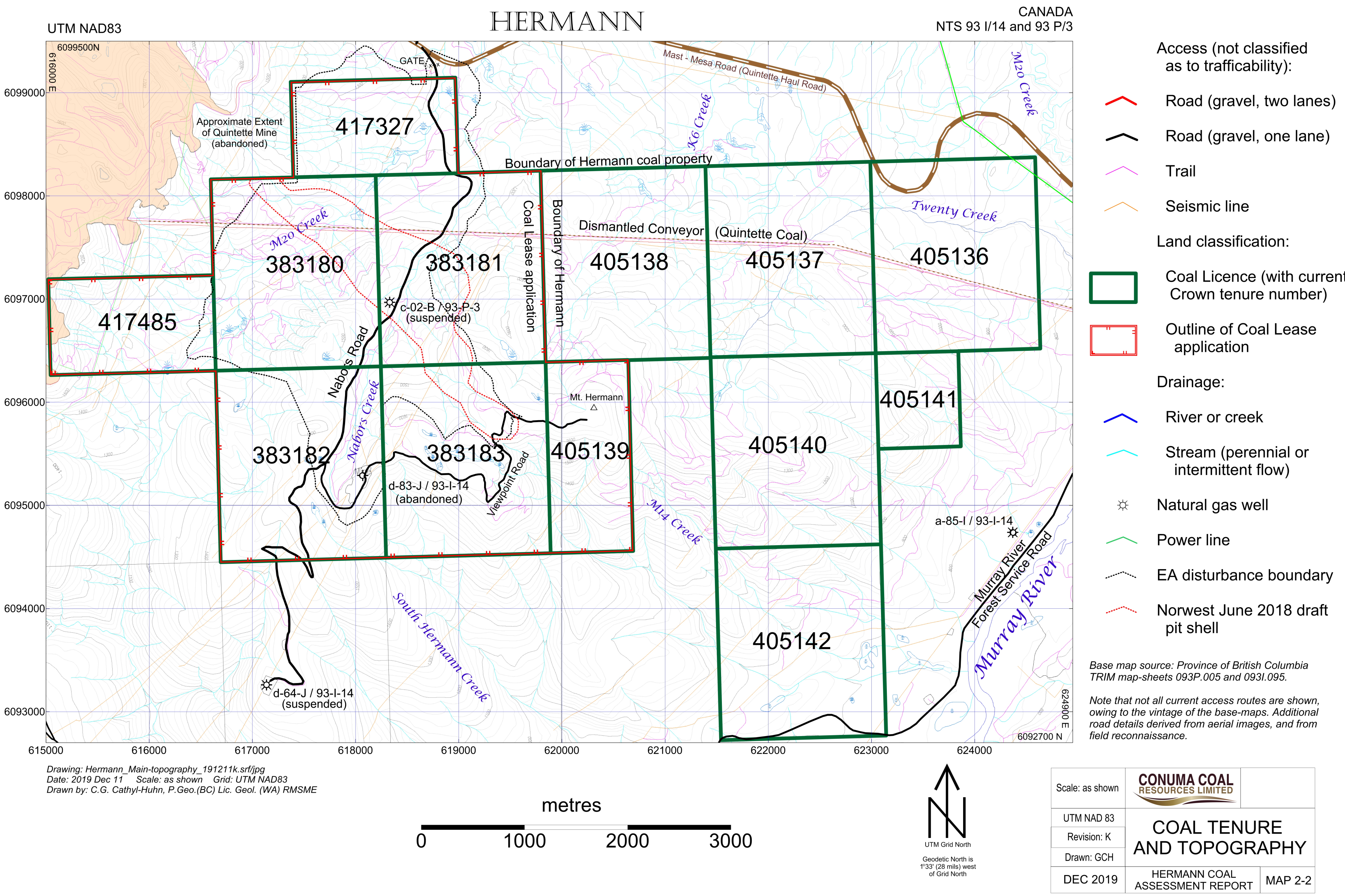
Hermann has a continental montane to alpine climate, characterised by long, moderately cold, snowy winters and short, rainy, warm summers. Snow and frost may occur in any month of the year, and isolated snowfields persist on north-facing slopes into July. The coldest weather usually occurs from January through March, where temperatures of –40C occasionally occur. Winds are generally gusty and ongoing, with rare calm periods. Convective thunderstorms frequently occur during summer months, bringing intense rain-showers and occasional hail.

2.9 Synopsis of current (year-2019) exploration

'Current work', for the purposes of this report, comprises drilling (**Map 2-3**, **Table 2-2**, and **Appendix A**), coal-quality sampling and analysis (**Appendix B**), and surveying of boreholes. Fieldwork was managed by contracted geologists from Apex Geoscience Ltd., who provided daily progress reports (**Appendix C**) throughout the drilling programmes.

In all, 58 boreholes were drilled, principally for geotechnical or hydrological exploration, with a lesser but still significant component of structural and coal-quality investigation via diamond-drilling. Amongst these 58 boreholes, 19 were drilled off tenure as part of geotechnical and hydrological investigations in support of mine facility design. The off-tenure work was done by agreement with Peace River Coal, the owners of the tenure (Coal Licence 417036) where 19 boreholes were drilled. None of the 19 holes entered known or potentially coal-bearing rocks.

Geotechnical and hydrological drilling concentrated on unconsolidated and semiconsolidated Drift materials, whereas diamond-drilling investigated bedrock geology within the Boulder Creek, Hulcross, Gates, and Moosebar formations. Some of the hydrological boreholes did penetrate a few to several tens of metres into bedrock (Helsen and Baxter, 2019).



HERMANN
UTM NAD83
CANADA
NTS 93 I/14 and 93 P/3
GATE
Mast - Mesa Road (Quintette Haul Road)
M20 Creek
K6 Creek
Approximate Extent of Quintette Mine (abandoned)
417327
Boundary of Hermann coal property
Twenty Creek
Dismantled Conveyor (Quintette Coal)
Coal Lease application
Boundary of Hermann
383180
383181
405138
405137
405136
417485
c-02-B / 93-P-3 (suspended)
Nabors Road
Nabors Creek
Mt. Hermann
405141
383182
383183
405139
405140
d-83-J / 93-I-14 (abandoned)
Viewpoint Road
M14 Creek
a-85-I / 93-I-14
Murray River Forest Service Road
Murray River
South Hermann Creek
405142
d-64-J / 93-I-14 (suspended)
6099500N
616000 E
6099000
6098000
6097000
6096000
6095000
6094000
6093000
615000
616000
617000
618000
619000
620000
621000
622000
623000
624000
624900 E
6092700 N
Access (not classified as to trafficability):
Road (gravel, two lanes)
Road (gravel, one lane)
Trail
Seismic line
Land classification:
Coal Licence (with current Crown tenure number)
Outline of Coal Lease application
Drainage:
River or creek
Stream (perennial or intermittent flow)
Natural gas well
Power line
EA disturbance boundary
Norwest June 2018 draft pit shell
Base map source: Province of British Columbia TRIM map-sheets 093P.005 and 093I.095.
Note that not all current access routes are shown, owing to the vintage of the base-maps. Additional road details derived from aerial images, and from field reconnaissance.
Drawing: Hermann_Main-topography_191211k.srf/jpg
Date: 2019 Dec 11 Scale: as shown Grid: UTM NAD83
Drawn by: C.G. Cathyl-Huhn, P.Geo.(BC) Lic. Geol. (WA) RMSME
metres
0
1000
2000
3000
UTM Grid North
Geodetic North is 1°33' (28 mils) west of Grid North
Scale: as shown
CONUMA COAL RESOURCES LIMITED
UTM NAD 83
Revision: K
Drawn: GCH
COAL TENURE AND TOPOGRAPHY
DEC 2019
HERMANN COAL ASSESSMENT REPORT
MAP 2-2

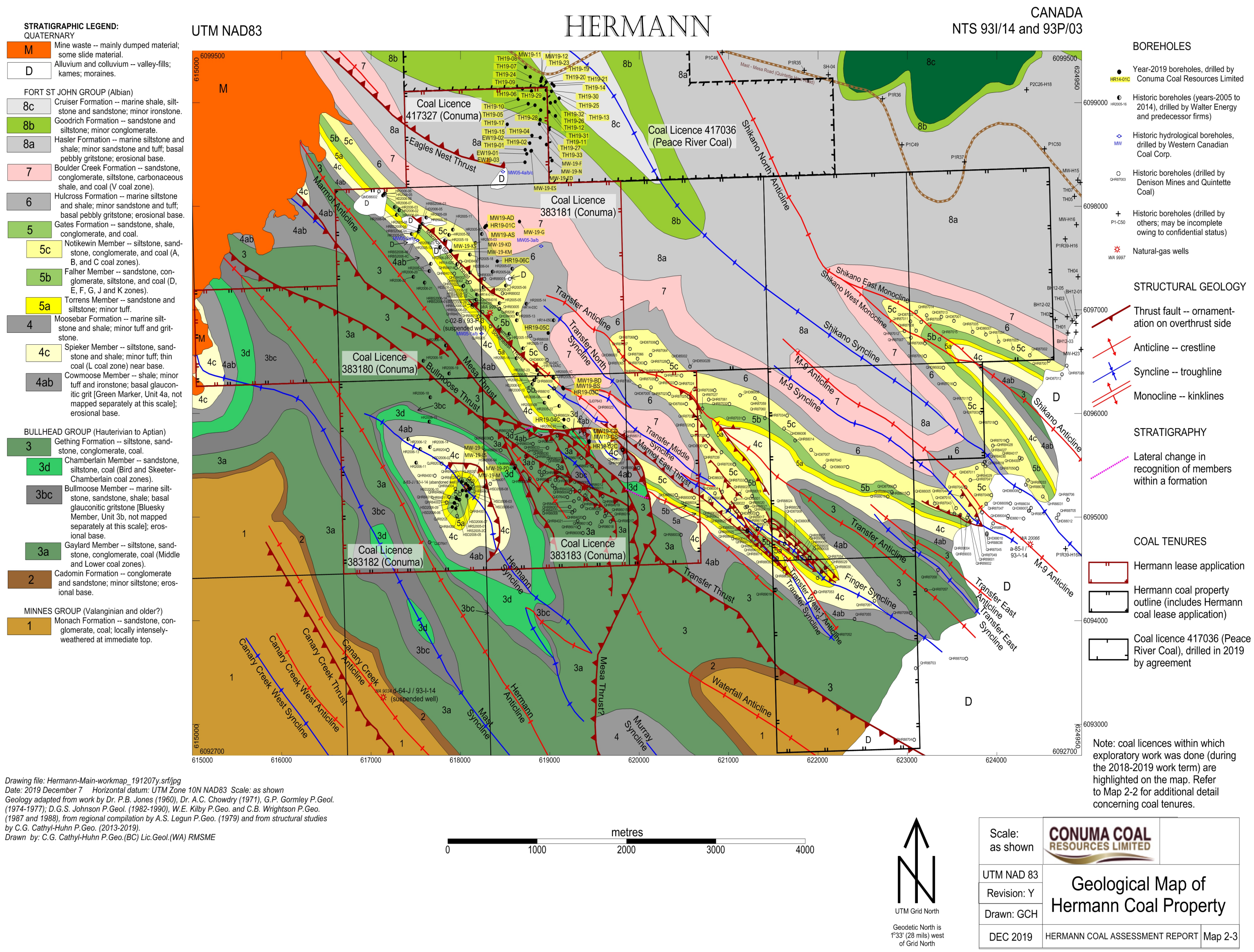

HERMANN
UTM NAD83
CANADA
NTS 93I/14 and 93P/03
STRATIGRAPHIC LEGEND:
QUATERNARY
M Mine waste -- mainly dumped material; some slide material.
D Alluvium and colluvium -- valley-fills; kames; moraines.
FORT ST JOHN GROUP (Albian)
8c Cruiser Formation -- marine shale, siltstone and sandstone; minor ironstone.
8b Goodrich Formation -- sandstone and siltstone; minor conglomerate.
8a Hasler Formation -- marine siltstone and shale; minor sandstone and tuff; basal pebbly gritstone; erosional base.
7 Boulder Creek Formation -- sandstone, conglomerate, siltstone, carbonaceous shale, and coal (V coal zone).
6 Hulcross Formation -- marine siltstone and shale; minor sandstone and tuff; basal pebbly gritstone; erosional base.
5 Gates Formation -- sandstone, shale, conglomerate, and coal.
5c Notikewin Member -- siltstone, sandstone, conglomerate, and coal (A, B, and C coal zones).
5b Falher Member -- sandstone, conglomerate, siltstone, and coal (D, E, F, G, J and K zones).
5a Torrens Member -- sandstone and siltstone; minor tuff.
4 Moosebar Formation -- marine siltstone and shale; minor tuff and gritstone.
4c Spieker Member -- siltstone, sandstone and shale; minor tuff; thin coal (L coal zone) near base.
4ab Cowmoose Member -- shale; minor tuff and ironstone; basal glauconitic grit [Green Marker, Unit 4a, not mapped separately at this scale]; erosional base.
BULLHEAD GROUP (Hauterivian to Aptian)
3 Gething Formation -- siltstone, sandstone, conglomerate, coal.
3d Chamberlain Member -- sandstone, siltstone, coal (Bird and Skeeter-Chamberlain coal zones).
3bc Bullmoose Member -- marine siltstone, sandstone, shale; basal glauconitic gritstone [Bluesky Member, Unit 3b, not mapped separately at this scale]; erosional base.
3a Gaylard Member -- siltstone, sandstone, conglomerate, coal (Middle and Lower coal zones).
2 Cadomin Formation -- conglomerate and sandstone; minor siltstone; erosional base.
MINNES GROUP (Valanginian and older?)
1 Monach Formation -- sandstone, conglomerate, coal; locally intensely-weathered at immediate top.
BOREHOLES
Year-2019 boreholes, drilled by Conuma Coal Resources Limited
Historic boreholes (years-2005 to 2014), drilled by Walter Energy and predecessor firms)
Historic hydrological boreholes, drilled by Western Canadian Coal Corp.
Historic boreholes (drilled by Denison Mines and Quintette Coal)
Historic boreholes (drilled by others; may be incomplete owing to confidential status)
Natural-gas wells
STRUCTURAL GEOLOGY
Thrust fault -- ornamentation on overthrust side
Anticline -- crestline
Syncline -- troughline
Monocline -- kinklines
STRATIGRAPHY
Lateral change in recognition of members within a formation
COAL TENURES
Hermann lease application
Hermann coal property outline (includes Hermann coal lease application)
Coal licence 417036 (Peace River Coal), drilled in 2019 by agreement
Note: coal licences within which exploratory work was done (during the 2018-2019 work term) are highlighted on the map. Refer to Map 2-2 for additional detail concerning coal tenures.
Coal Licence 417327 (Conuma)
Coal Licence 383181 (Conuma)
Coal Licence 417036 (Peace River Coal)
Coal Licence 383180 (Conuma)
Coal Licence 383182 (Conuma)
Coal Licence 383183 (Conuma)
Eagles Nest Thrust
Marmot Anticline
Bullmoose Thrust
Mesa Thrust
Transfer Anticline
Transfer North Syncline
Shikano North Anticline
Shikano East Monocline
Shikano West Monocline
Shikano Syncline
Shikano Anticline
M-9 Anticline
M-9 Syncline
Transfer Middle Syncline
Transfer Thrust
Finger Syncline
Transfer East Anticline
Transfer East Syncline
Hermann Syncline
Hermann Anticline
Canary Creek Anticline
Canary Creek Thrust
Canary Creek West Anticline
Canary Creek West Syncline
Mast Syncline
Mesa Thrust?
Murray Syncline
Waterfall Anticline
615000 616000 617000 618000 619000 620000 621000 622000 623000 624000
6099500 6099000 6098000 6097000 6096000 6095000 6094000 6093000 6092700
Drawing file: Hermann-Main-workmap_191207y.srf/jpg
Date: 2019 December 7 Horizontal datum: UTM Zone 10N NAD83 Scale: as shown
Geology adapted from work by Dr. P.B. Jones (1960), Dr. A.C. Chowdry (1971), G.P. Gormley P.Geol. (1974-1977); D.G.S. Johnson P.Geol. (1982-1990), W.E. Kilby P.Geo. and C.B. Wrightson P.Geo. (1987 and 1988), from regional compilation by A.S. Legun P.Geo. (1979) and from structural studies by C.G. Cathyl-Huhn P.Geo. (2013-2019).
Drawn by: C.G. Cathyl-Huhn P.Geo.(BC) Lic.Geol.(WA) RMSME
metres
0 1000 2000 3000 4000
UTM Grid North
Geodetic North is 1°33' (28 mils) west of Grid North
Scale: as shown
CONUMA COAL RESOURCES LIMITED
UTM NAD 83
Revision: Y
Drawn: GCH
DEC 2019
Geological Map of Hermann Coal Property
HERMANN COAL ASSESSMENT REPORT
Map 2-3

Table 2-2: Current drilling during year-2019

Borehole	UTM NAD83		Metres		Drilling method	Location in which logs and other data are presented?
	Easting	Northing	Elevation	Total depth		
Year-2019						
HR19-01C	618290.265	6097814.668	1284.111	397	Diamond	Appendices A and B
HR19-02C	619438.508	6095734.459	1620.333	353.2	Diamond	Appendices A and B
HR19-03C	619143.858	6096250.684	1597.888	352.85	Diamond	Appendices A and B
HR19-04C	619158.648	6095942.101	1613.341	250.65	Diamond	Appendices A and B
HR19-05C	618981.573	6096776.43	1516.424	249.65	Diamond	Appendices A and B
HR19-06C	618411.445	6097468.327	1372.192	334.54	Diamond	Appendices A and B
MW19-04-BD	619145.726	6096248.572	1597.998	224.6	Rotary	Appendices A and B
MW19-05-AD	618280.697	6097807.995	1283.631	127.4	Rotary	Appendices A and B
MW19-06-AS	618271.966	6097796.219	1283.573	54.96	Rotary	Appendix A
MW19-07-BS	619151.152	6096241.124	1599.388	100.5	Rotary	Appendix A
MW19-09-CD	619440.279	6095722.696	1620.902	137.16	Rotary	Appendices A and B
MW19-10-CS	619438.806	6095728.154	1620.981	76.2	Rotary	Appendix A
MW19-11	618910.91	6099238.379	1166.654	45.72	Rotary	Appendix A
MW19-12	618906.202	6099231.486	1166.087	4.57	Rotary	Appendix A
TH19-01	618725.317	6098546.628	1183.528	17	Sonic	Appendix A
TH19-02	618775.029	6098610.458	1184.307	17	Sonic	Appendix A
TH19-03	not drilled					
TH19-04	618800.142	6098683.01	1182.096	6	Sonic	Appendix A
TH19-05	618758.885	6098990.18	1186.082	15.2	Sonic	Appendix A
TH19-06	618795.538	6099112.098	1183.811	15.2	Sonic	Appendix A
TH19-07	618779.969	6099249.765	1185.401	6	Sonic	Appendix A
TH19-08	618727.796	6099340.819	1185.021	6	Sonic	Appendix A
TH19-09	618693.376	6099134.553	1208.62	15.2	Sonic	Appendix A
TH19-10	618645.489	6099035.145	1219.956	15.2	Sonic	Appendix A
TH19-11	618992.541	6098741.345	1186.165	9.14	Sonic	Appendix A
TH19-12	619061.09	6098871.479	1184.683	6	Sonic	Appendix A
TH19-13	619105.242	6099043.806	1181.834	6	Sonic	Appendix A
TH19-14	619046.162	6099163.488	1179.147	6.1	Sonic	Appendix A
TH19-15	618522.404	6098791.867	1219.986	15.2	Sonic	Appendix A
TH19-16	not drilled					
TH19-17	618832.626	6098974.881	1172.358	9.9	Sonic	Appendix A
TH19-18	not drilled					
TH19-19	618897.18	6099208.599	1166.484	15.7	Sonic	Appendix A
TH19-20	618957.985	6099199.268	1175.602	12.2	Sonic	Appendix A
TH19-21	619022.924	6099181.26	1181.777	12.8	Sonic	Appendix A
TH19-22	not drilled					
TH19-23	618907.574	6099234.819	1166.248	12.7	Sonic	Appendix A
TH19-24	618903.339	6099160.088	1172.693	12.2	Sonic	Appendix A
TH19-25	619018.474	6099110.316	1179.553	6	Sonic	Appendix A
TH19-26	619005.058	6098999.351	1178.104	6	Sonic	Appendix A
TH19-27	618892.454	6098836.373	1180.567	9.1	Sonic	Appendix A
TH19-28	618898.27	6098928.64	1176.101	6	Sonic	Appendix A
TH19-29	618935.685	6099037.778	1176.214	6	Sonic	Appendix A

Table 2-2: Current drilling during year-2019 (concluded)

Borehole	UTM NAD83		Metres		Drilling	Location in which logs and
	Easting	Northing	Elevation	Total depth	method	other data are presented?
TH19-30	618959.404	6099121.705	1176.28	6.7	Sonic	Appendix A
TH19-31	618986.801	6098910.447	1179.831	5.3	Sonic	Appendix A
TH19-32	619058.207	6099010.156	1180.874	6	Sonic	Appendix A
TH19-33	618884.427	6098793.589	1181.171	9.1	Sonic	Appendix A
MW-19-ES	618789.41	6098534.09	1195.69	10.85	Rotary	Appendix A
MW-19-ED	618795.1	6098536.11	1195.76	30	Rotary	Appendix A
MW-19-F	618963.15	6098597.71	1190.58	18	Rotary	Appendix A
MW-19-G	618664.2	6097848.88	1279.85	15.6	Rotary	Appendix A
MW-19-PD	619022.08	6098432.22	1200.23	131	Rotary	Appendix A
MW-19-KS	618609.6	6095500.95	1628.25	31.4	Rotary	Appendix A
MW-19-KM	617887.02	6097563.22	1255.87	49.7	Rotary	Appendix A
MW-19-KD	617892.27	6097566.7	1255.33	110	Rotary	Appendix A
MW-19-LS	617897.4	6097569.72	1254.72	10.9	Rotary	Appendix A
MW-19-L	618014.63	6095341.13	1593.19	37.3	Rotary	Appendix A
MW-19-M	618009.43	6095335.94	1593.1	45.4	Rotary	Appendix A
MW-19-N	618114.35	6095278.68	1596.85	16	Rotary	Appendix A
EW19-01	618742.4	6098506.2	1196	84.89	Rotary	Appendix A
EW19-02	618893	6098664	1186	86.41	Rotary	Appendix A
EW19-03	618722	6098426	1200	103.63	Rotary	Appendix A
Total: 58 boreholes				*Total: 3781.02 m*		

Note: GPS coordinates only for EW19-01 through -03, since as-built survey has not yet been done as of date of this report. Elevations of these wells are estimated from LIDAR contours.

2.10 Synopsis of historic (pre-2019) exploration

During their previous ownership of the property, Denison Mines, Quintette Coal Ltd., Western Canadian Coal Corporation, Western Coal, and Walter Energy (acting through its various subsidiaries, including the Walter Canadian Coal Partnership) conducted substantial but discontinuous drilling programmes within the Hermann property, initially under the designation of the Johnson prospect (Denison's earliest name for the area). Historic work commenced in 1976 with the helicopter-supported drilling of three diamond-drill boreholes in the QJD 76 series, and ended in 2005 with the HR-2005, HRS-2005, and MW05 series of ground-accessed boreholes.

Initial goals of this drilling included subregional-scale delineation of coal-bearing formations (CAR-609 by Gormley, 1976), and broad structural definition (CAR-515 by Gunn, 1980; CAR-616 by Johnson, 1983), progressing to intensive coal-quality, hydrological, geotechnical (Stewart, 2007; Stewart and Hogarth, 2007), and geochemical investigations (CAR-739 and -746 by Johnson, 1988 and 1989).

Historic work has been extensively synthesised in CAR-950 (Cathyl-Huhn and Avery, 2014) and CAR-999 (Cathyl-Huhn, 2015), and is not discussed further within the present report.

Table 2-3: Historic drilling during 1976 through 2015

Borehole	UTM NAD83		Metres		Drilling method	Coal Assessment Report in which logs and other data located?
	Easting	Northing	Elevation	Total depth		
Year-1976						
QJD7641	617654	6094756	1565	213	Diamond	609
QJD7642	619196.19	6095193.27	1627	183	Diamond	609
QJD7643	619343.67	6095961.5	1641.49	264.5	Diamond	609
Year-1980						
QJR8001	618332.99	6095320.63	1603	123	Rotary	614; coordinates corrected
Year-1982						
QJR8201	618097.57	6095370.88	1597.7	70	Rotary	616
QJR8202	617965.47	6095118.08	1608.3	70	Rotary	616
QJR8203	617792.67	6095516.58	1548.95	49	Rotary	616
QJR8204	617858.07	6095647.68	1540.9	70	Rotary	616
QJR8205	618334.89	6096840.53	1399	70	Rotary	616
QJR8206	618435.19	6097009.73	1373.1	61	Rotary	616
Year-1983						
QHR83001	618269.47	6097298.48	1409.9	164	Rotary	617
QHR83002	618076.27	6097265.18	1389.6	176	Rotary	617
QHR83003	618033.57	6097232.98	1387.7	96	Rotary	617
QHR83004	618182.77	6097149.18	1408.1	150	Rotary	617
QHR83005	618436.87	6097012.68	1373	187	Rotary	617
Year-1984						
QHD84001	618000.522	6097464.09	1302.92	215.3	Diamond	618
QHD84002	618107.117	6097269.71	1390.14	204.7	Diamond	618
QHD84003	618395.78	6096912.27	1388.48	153.29	Diamond	618
QHR84001	617713.311	6095398.37	1563.89	50	Rotary	618
QHR84002	617844.346	6095140.97	1588.8	30	Rotary	618
QHR84003	617872.152	6095195.69	1588.72	30	Rotary	618
QHR84004	617942.549	6095274.12	1588.68	30	Rotary	618
QHR84005	617980.367	6095381.75	1574.23	30	Rotary	618
QHR84006	617961.303	6095011.37	1605.85	50	Rotary	618
QHR84007	618072.043	6095199.36	1597.02	60	Rotary	618
QHR84008	618102.589	6095267.59	1597.71	60	Rotary	618
QHR84009	618131.774	6095317.53	1598.2	50	Rotary	618
QHR84010	617931.495	6095135.89	1609.84	60	Rotary	618
QHR84011	617952.922	6095180.97	1609.15	67	Rotary	618
QHR84012	618246.17	6096981.18	1400.9	109.5	Rotary	618
QHR84013	618202.57	6096935.98	1411.2	91.3	Rotary	618
QHR84014	617951.57	6097403.98	1310.9	97.4	Rotary	618
QHR84015	617930.87	6097349.08	1317.4	60.8	Rotary	618

Table 2-3: Historic drilling during 1976 through 2015 (continued)

Borehole	UTM NAD83		Metres		Drilling method	Coal Assessment Report in which logs and other data located?
	Easting	Northing	Elevation	Total depth		
QHR84016	618155.97	6097087.38	1408.8	83.5	Rotary	618
QHR84019	619529.98	6095041.52	1564.2	42.5	Rotary	618
QHR84020	619386.34	6094995.09	1582.43	36.6	Rotary	618
QHR84021	619311.592	6094963.96	1587.32	36	Rotary	618
QHR84022	619276.553	6095063.37	1605.49	41	Rotary	618
QHR84023	619268.175	6095154.01	1614.39	43	Rotary	618
QHR84024	619256.508	6095268.95	1624.91	42	Rotary	618
QHR84025	618133.37	6097031.58	1412.8	66.8	Rotary	618
QHR84026	618030.04	6095327.44	1597.16	42.5	Rotary	618
Year-1985						
QHD85002	620568.98	6096453.52	1519.76	145.08	Diamond	724
QHD85002B	620568.98	6096453.52	1519.76	225	Diamond	724
Year-1986						
QHD86001	623878.74	6096762.96	953.93	147	Diamond	724
QHD86002	623403.75	6096442.61	1025.53	120.1	Diamond	724
QHD86003	619768.2	6096605.89	1532.05	225.86	Diamond	724; coordinates corrected
QHD86006	621621.58	6095854.09	1325.06	99.06	Diamond	724
QHD86007	622330.32	6095482.36	1292.95	138.68	Diamond	724; coordinates corrected
QHD86009	619358.13	6095101.72	1598.15	*no data*	Diamond	724: missing from file
QHR86001	619058.09	6095278.59	1622.56	>44.4	Rotary	724: no logs on file
QHR86002	619028.93	6095305.4	1627	>40.5	Rotary	724: no logs on file
QHR86003	619062.35	6095355.98	1629.31	>35.0	Rotary	724: no logs on file
QHR86004	619229.06	6095238.56	1626.41	>24.9	Rotary	724: no logs on file
QHR86005	619332.13	6095251.75	1604.78	>114.4	Rotary	724: no logs on file
QHR86006	619326.21	6095178.77	1609.04	>76.0	Rotary	724: no logs on file
QHR86007	619220.75	6095096.56	1612.87	>33.5	Rotary	724: no logs on file
QHR86009	619369.95	6094845.4	1570.38	>30.0	Rotary	724: no logs on file
QHR86010	619327.92	6094902.92	1579.44	>29.0	Rotary	724: no logs on file
QHR86011	619416.02	6095169.03	1587.5	>77.5	Rotary	724: no logs on file
QHR86012	619395.56	6095208.63	1586.51	>91.0	Rotary	724: no logs on file
QHR86013	619453.23	6094936.73	1564.92	>39.0	Rotary	724: no logs on file
QHR86014	619615.01	6095008.43b	1539.35	>49.0	Rotary	724: no logs on file
QHR86015	619632.98	6095035.24	1538.6	*no data*	Rotary	724: no data given in report
QHR86016	619588.95	6095201.9	1557.95	*no data*	Rotary	724: no data given in report
QHR86017	619680.68	6094956.7	1515.45	*no data*	Rotary	724: no data given in report
QHR86018	619583	6094957	1536	>28.0	Rotary	724: no logs on file; coordinates corrected
QHR86019	619353.86	6095569.67	1632.26	>107.0	Rotary	724: no logs on file
QHR86020	618936.46	6095434.9	1619.51	>81.7	Rotary	724: no logs on file
QHR86021	619474.291	6095491.4	1610.81	*no data*	Rotary	724: no data given in report

Table 2-3: Historic drilling during 1976 through 2015(continued)

Borehole	UTM NAD83		Metres		Drilling method	Coal Assessment Report in which logs and other data located?
	Easting	Northing	Elevation	Total depth		
QHR86022	619437.96	6095728.415	1620.59	79	Rotary	724
QHR86023	619386.324	6095802.888	1622.7	103.5	Rotary	724
QHR86024	619208.86	6095938.593	1626.43	146	Rotary	724
QHR86025	618773.365	6095371.102	1610.18	*no data*	Rotary	724: no data given in report
QHR86026	618615.009	6095494.096	1628.64	*no data*	Rotary	724: no data given in report
QHR86027	618451.513	6095644.621	1649.64	*no data*	Rotary	724: no data given in report
QHR86028	618909.58	6095405.452	1618.35	*no data*	Rotary	724: no data given in report
QHR86029	618882.284	6095438.041	1618.19	*no data*	Rotary	724: no data given in report
QHR86030	618791.31	6095474.506	1613.15	*no data*	Rotary	724: no data given in report
QHR86031	618813.528	6095520.721	1615.17	*no data*	Rotary	724: no data given in report
QHR86032	618728.767	6095585.275	1620.62	*no data*	Rotary	724: no data given in report
QHR86033	618973.23	6095668.633	1616.82	*no data*	Rotary	724: no data given in report
QHR86034	618811.466	6095706.778	1604.73	*no data*	Rotary	724: no data given in report
QHR86035	618577.97	6095831.131	1613.9	*no data*	Rotary	724: no data given in report
QHR86036	618350.722	6095759.451	1605.34	*no data*	Rotary	724: no data given in report
QHR86037	619083.644	6095788.511	1604.72	*no data*	Rotary	724: no data given in report
Year-1987						
QHD87001	623521.58	6096895.18	1021.15	160.79	Diamond	739
QHD87002	623153.5	6096884.08	1081.36	99.12	Diamond	739
QHD87003	623818.71	6096008.56	996.29	177.52	Diamond	739
QHD87004	620525.53	6096090.78	1589.74	151.1	Diamond	739
QHD87005	620133.27	6096251.31	1573.26	185.78	Diamond	739
QHD87006	620201.83	6096684.3	1486.07	202.44	Diamond	739; coordinates corrected
QHD87007	621921.42	6095648.02	1329.15	120.63	Diamond	739
QHD87008	621630.18	6094744.46	1167	138.62	Diamond	739
QHD87009	622860.49	6095294.33	1108.43	105.14	Diamond	739
QHD87013	623380.3	6096934.41	1011.15	143.7	Diamond	739
QHR87002	624368.25	6096561.78	879.9	156.3	Rotary	739
QHR87003	624181.68	6096627.98	895.45	140	Rotary	739
QHR87004	624020.59	6096692.28	931.67	121.8	Rotary	739
QHR87005	623730.88	6096788.17	985.67	117.5	Rotary	739
QHR87006	623214.91	6096947.31	1057.87	182	Rotary	739
QHR87007	623039.86	6096732.32	1117.65	170.2	Rotary	739
QHR87008	623099.39	6096799.67	1107.99	107.3	Rotary	739
QHR87009	623196.43	6096676.79	1108.97	132.3	Rotary	739
QHR87010	623199.42	6096553.26	1109.67	164.4	Rotary	739
QHR87011	623035.36	6096887.3	1107.81	121.5	Rotary	739
QHR87012	622966.53	6096796	1116.81	183.3	Rotary	739
QHR87013	623380.3	6096934.11	1041.15	143.7	Rotary	739

Table 2-3: Historic drilling during 1976 through 2015 (continued)

Borehole	UTM NAD83		Metres		Drilling method	Coal Assessment Report in which logs and other data located?
	Easting	Northing	Elevation	Total depth		
QHR87014	623097.29	6096979.28	1076.9	207.4	Rotary	739
QHR87015	623359.48	6096714.25	1079.99	56.7	Rotary	739
QHR87016	623530.54	6096283.99	1071.99	146.6	Rotary	739
QHR87017	623704.65	6096142.28	1014.93	164.8	Rotary	739; coordinates corrected
QHR87021	620472.24	6096365.95	1572.82	168.8	Rotary	739
QHR87022	620411.11	6096292.93	1580.6	144.6	Rotary	739
QHR87023	620335.71	6096188.74	1601.62	171	Rotary	739
QHR87024	620615.88	6096232.49	1564.25	128.5	Rotary	739
QHR87025	620550.16	6096163.19	1585.04	110	Rotary	739
QHR87028	620324.69	6096500.05	1542.16	172	Rotary	739
QHR87034	621653.44	6095981.15	1319	108	Rotary	739; coordinates corrected
QHR87035	620196.65	6096330.93	1558.01	129	Rotary	739
QHR87036	620254.13	6096407.72	1544.31	117.6	Rotary	739
QHR87040	622069.76	6095489.37	1361.19	98.2	Rotary	739
QHR87051	622631.36	6094192.2	857.5	147.7	Rotary	739
QHR87052	621996.21	6094034.94	951.88	127.9	Rotary	739
QHR87053	621968.94	6094275.85	1034.79	86	Rotary	739
QHR87054	621996.2	6094412.84	1049.43	99	Rotary	739; coordinates corrected
QHR87055	622409.61	6094016.83	890.45	55.6	Rotary	739
QHR87056	623037.01	6094075.13	857.51	91.3	Rotary	739
QHR87062	620006.83	6096263.04	1544.99	178.9	Rotary	739
QHR87063	620071.55	6096485.17	1508.25	109.9	Rotary	739
QHR87064	620125.26	6096565.64	1499.61	103.6	Rotary	739
QHR87065	619832.81	6096517.06	1519.31	146.7	Rotary	739; coordinates corrected
QHR87066	619980.65	6096528.55	1505.69	85.2	Rotary	739
QHR87067	619898.33	6096623.04	1499.61	42	Rotary	739
QHR87068	619968.09	6096733.07	1484.15	79.3	Rotary	739
Year-2008						
QHD88001	618966.005	6096517.98	1556.25	217	Diamond	746
QHD88002	620413.656	6095211.855	1161.97	217.5	Diamond	746
QHD88006	621750.86	6094711.08	1168.19	73.76	Diamond	746
QHR88001	618549.86	6097300.11	1342.07	208.28	Rotary	746
QHR88002	618469.99	6097159.22	1352.07	200.18	Rotary	746
QHR88003	620468.26	6094828.61	1332.38	58.88	Rotary	746
QHR88005	620613.02	6095186.3	1444.25	147.72	Rotary	746
QHR88006	619992.97	6095474	1540.25	166.62	Rotary	746
QHR88007	619813.33	6095646.24	1586.88	78.2	Rotary	746
QHR88008	618782.11	6096749.33	1464.54	234.48	Rotary	746
QHR88009	619051	6096242.85	1566.86	96.56	Rotary	746
QHR88010	619042.4	6096240.89	1565.81	232.22	Rotary	746

Table 2-3: Historic drilling during 1976 through 2015 (continued)

Borehole	UTM NAD83		Metres		Drilling method	Coal Assessment Report in which logs and other data located?
	Easting	Northing	Elevation	Total depth		
QHR88011	619810.2	6095646.78	1586.98	198.2	Rotary	746
QHR88012	619818.71	6095650.44	1587.17	47.58	Rotary	746
QHR88013	619659.56	6095706.52	1610.59	138.72	Rotary	746
QHR88014	621742.86	6095740.51	1324.72	95.3	Rotary	746
QHR88015	623009.07	6095227.3	1068.53	111.88	Rotary	746
QHR88016	622779.21	6095197.79	1112.54	74.76	Rotary	746
QHR88017	622824.51	6095242.88	1117.09	84.08	Rotary	746
QHR88018	620031.27	6096404.65	1522.53	125.02	Rotary	746
QHR88023	621627.32	6094741.82	1166.96	173.78	Rotary	746
QHR88024	621626.85	6094741.08	1167.16	132.22	Rotary	746; coordinates corrected
QHR88027	621541.87	6094602.21	1081.14	53.44	Rotary	746
QHR88028	621635.07	6094600.83	1087.83	54.32	Rotary	746
QHR88029	622084.66	6094509.78	1072.37	53.32	Rotary	746
QHR88030	622040.26	6094470.09	1059.79	53.32	Rotary	746
QHR88703	623093.63	6093539.86	788.71	45.7	Rotary	746
QHR88704	623075.43	6092851.21	781.02	50.6	Rotary	746
QMD88002	617087.45	6098141.75	1360.9	247.5	Diamond	746
Year-1989						
QHR89005	621819.88	6094615.67	1126.23	108.16	Rotary	753
QHR89006	621819.54	6094615.15	1126.25	119.5	Rotary	753
QHR89007	621743.94	6094603.1	1121.83	48.32	Rotary	753
QHR89008	621910.65	6094609.43	1123.31	99.54	Rotary	753
QHR89009	621903.15	6094608.19	1123.34	130.88	Rotary	753
QHR89015	621468.85	6094730.16	1134.85	85	Rotary	753
QHR89016	621529.34	6094301.17	1078.01	192	Rotary	753
Year-2005						
HR2005-01	617454.415	6097733.493	1279.557	311.22	Rotary	950
HR2005-1C	619037.927	6096347.605	1573.272	160.99	Diamond	950
HR2005-02	617873.253	6097723.704	1243.078	192.33	Rotary	950
HR2005-2C	619042.235	6096343.362	1573.147	300.05	Diamond	950
HR2005-03	618167.727	6097645.879	1260.345	193.75	Rotary	950
HR2005-3C	618237.619	6097733.157	1280.896	276.67	Diamond	950
HR2005-04	618358.291	6097368.33	1392.579	278.26	Rotary	950
HR2005-05	618436.746	6097064.88	1366.2	166.98	Rotary	950
HR2005-06	618507.253	6097235.859	1347.686	208.35	Rotary	950
HR2005-07	618580.279	6097398.221	1334.03	204.55	Rotary	950
HR2005-08	617536.573	6097779.037	1280.17	137.31	Rotary	950
HR2005-09	617618.171	6097891.9	1271.439	226.57	Rotary	950
HR2005-10	617575.997	6097830.362	1277.385	188.81	Rotary	950
HR2005-11	617915.562	6097774.347	1231.057	204.33	Rotary	950
HR2005-12	617769.049	6097601.105	1253.234	153.25	Rotary	950

Table 2-3: Historic drilling during 1976 through 2015 (continued)

Borehole	UTM NAD83		Metres		Drilling method	Coal Assessment Report in which logs and other data located?
	Easting	Northing	Elevation	Total depth		
HR2005-13	618628.408	6096900.91	1394.19	195.42	Rotary	950
HR2005-14	618737.151	6097058.706	1393.754	188.19	Rotary	950
HR2005-15	618545.152	6096768.414	1402.552	128.2	Rotary	950
HR2005-16	618627.684	6096534.201	1452.933	170.42	Rotary	950
HR2005-17	618699.181	6096629.161	1460.85	94.11	Rotary	950
HR2005-18	618105.271	6097532.604	1312.069	206.12	Rotary	950
HR2005-19	617826.266	6097672.003	1246.955	174.74	Rotary	950
HR2005-20	618253.766	6097217.521	1412.759	231.54	Rotary	950
HR2005-21	619160.255	6095872.122	1605.118	162.15	Rotary	950
HR2005-22	619105.058	6096072.033	1590.969	171.38	Rotary	950
HR2005-23	618874.259	6096375.879	1519.92	180.31	Rotary	950
HR2005-24	618821.848	6096319.971	1501.834	125.17	Rotary	950
HR2005-25	617667.182	6097444.798	1263.23	100.36	Rotary	950
HRS2005-01	617989.262	6095167.898	1606.769	85.05	Rotary	950
HRS2005-2C	617984.534	6095166.252	1606.81	40.52	Diamond	950
MW05-1a	618240	6096769.9	1422.46	55	Rotary	Groundwater-monitoring (hydrological) boreholes -- see CAR-950 for details.
MW05-1b	618237.4	6096767.3	1422.46	20.7	Rotary	
MW05-2a	617520.5	6097672.6	1262.82	60.1	Rotary	
MW05-2b	617523.4	6097674.6	1262.82	27.1	Rotary	
MW05-3a	618902.2	6097617.5	1291.58	51.5	Rotary	
MW05-3b	618903.9	6097619.7	1291.58	26.2	Rotary	
MW05-4a	618477.7	6098334.4	1201.44	81.7	Rotary	
MW05-4b	618475.4	6098331.8	1201.44	51.2	Rotary	
MW05-4c	618473.5	6098328.8	1201.44	13	Rotary	
Year-2006						
HD2006-01	618827.329	6096321.766	1502.437	175.38	Diamond	950
HD2006-02	618849.035	6096348.117	1510.935	178.96	Diamond	950
HD2006-03	618029.092	6097230.022	1385.964	134.25	Diamond	950
HD2006-04	618106.087	6097359.688	1363.463	213.61	Diamond	950
HD2006-05	617548.83	6097796.998	1280.208	143.42	Diamond	950
HD2006-06	617135.161	6098106.903	1347.132	142.44	Diamond	950
HR2006-01	617313.684	6097961.961	1308.71	103.18	Rotary	950
HR2006-02	617314.81	6097963.346	1307.944	157.97	Rotary	950
HR2006-03	617262.564	6097992.294	1314.786	177.65	Rotary	950
HR2006-04	617286.179	6097915.647	1314.011	127.7	Rotary	950
HR2006-05	617149.073	6098120.927	1346.039	105.47	Rotary	950
HR2006-06	617153.933	6098123.222	1344.452	149.59	Rotary	950
HR2006-07	617131.494	6098104.002	1347.057	71.3	Rotary	950
HR2006-08	618988.509	6096159.796	1549.267	108.57	Rotary	950
HR2006-09	618940.192	6096102.269	1543.267	120.32	Rotary	950
HR2006-10	618806.323	6096285.003	1498.275	84.34	Rotary	950
HR2006-11	617502.624	6095526.003	1580.82	no data	Rotary	950; caved in
HR2006-12	617414.475	6095750.177	1595.686	107.02	Rotary	950

Table 2-3: Historic drilling during 1976 through 2015 (concluded)

Borehole	UTM NAD83		Metres		Drilling method	Coal Assessment Report in which logs and other data located?
	Easting	Northing	Elevation	Total depth		
HR2006-13	617550.785	6095656.159	1597.909	107.38	Rotary	950
HR2006-14	617656.484	6095675.823	1593.462	101.17	Rotary	950
HR2006-15	617650.684	6095922.313	1563.955	107.04	Rotary	950
HR2006-16	617585.001	6096509.52	1547.547	124.24	Rotary	950
HR2006-17	617837.452	6096655.771	1524.966	106.98	Rotary	950
HR2006-18	617662.963	6096155.429	1557.217	112.71	Rotary	950
HR2006-19	617872.843	6096386.208	1509.198	79.04	Rotary	950
HR2006-20	617651.4	6097373.8	1268	101.31	Rotary	950
HR2006-21	617597.411	6097262.975	1276.604	74.64	Rotary	950
HR2006-22	617473.467	6097317.927	1270.532	93.39	Rotary	950
HR2006-23	617773.397	6097608.433	1253.257	134.39	Rotary	950
HR2006-24	617768.216	6097602.312	1253.909	91	Rotary	950
HRBS2006-01	618177.024	6097098.576	1408.292	79.66	Rotary	Pilot holes for bulk-sample drilling -- see CAR-950
HRBS2006-02	618134.533	6097048.813	1413.409	36.72	Rotary	
HRBS2006-03	617546.429	6097803.723	1280.739	83.11	Rotary	
HRBS2006-04	617531.153	6097756.979	1277.563	91.6	Rotary	
HRBS2006-1A	618177.024	6097098.576	1408.292	74.7	Diamond	Bulk-sample drilling; logs and other data in CAR-950
HRBS2006-1B	618177.024	6097098.576	1408.292	49.26	Diamond	
HRBS2006-1D	618177.024	6097098.576	1408.292	46.29	Diamond	
HRBS2006-1E	618177.024	6097098.576	1408.292	44.8	Diamond	
HRBS2006-2A	618134.533	6097048.813	1413.409	32.46	Diamond	
HRBS2006-2B	618134.533	6097048.813	1413.409	29.64	Diamond	
HRBS2006-4A	617531.153	6097756.979	1277.563	19.91	Diamond	
HRBS2006-4B	617531.153	6097756.979	1277.563	77.08	Diamond	
HRBS2006-4C	617531.153	6097756.979	1277.563	83.01	Diamond	
HSD2006-01	618021.305	6095257.013	1595.782	32.24	Diamond	950
HSD2006-02	618062.259	6095320.725	1592.792	29.89	Diamond	950
HSD2006-03	618061.055	6095257.655	1592.663	34.37	Diamond	950
HSD2006-04	618085.454	6095301.732	1592.847	27.86	Diamond	950
HSD2006-05	617948.833	6095084.413	1606.064	37.33	Diamond	950
HSD2006-06	617908.288	6095098.615	1604.336	31.2	Diamond	950
HSD2006-07	618070.745	6095208.143	1591.477	29.67	Diamond	950
HSD2006-08	618098.479	6095272.235	1592.451	36.58	Diamond	950
HSD2006-09	617933.639	6095136.065	1604.413	33.83	Diamond	950
HSD2006-10	617955.365	6095182.607	1603.822	37.11	Diamond	950
Year-2014						
HR14-01C	618183.535	6097152.412	1407.367	158.6	Spot core	950
HR14-02C	617973.239	6097434.26	1305.282	122.72	Spot core	950
HR14-03C	618608.845	6096741.185	1419.816	119.32	Spot core	950
HR14-04C	618857.69	6096418.994	1517.806	171.29	Spot core	950
HR14-04AC	618856.965	6096424.924	1517.651	155	Spot core	950
HR14-05C	619053.861	6096895.978	1493.536	272	Spot core	950

2.11 Natural gas wells

In addition to the current and historic exploratory boreholes, testholes, and hydrological test wells, two natural gas exploration wells have been drilled within the Hermann coal property, as shown on **Map 2-3** and listed in **Table 2-4**. Both of these wells started within the Gates Formation (within the Lower Cretaceous Fort St. John Group), and they have gone onward to deeper exploration targets within underlying Triassic carbonate rocks. One of the wells (d-83-J / 93-I-14) was abandoned in 2013, whereas the other gas well (c-02-B / 93-P-03) is shut-in, and is not currently producing.

Table 2-4: Natural gas wells within Hermann property

Well Authorisation (WA) number	Well name	Status	NAD 83 position Easting	Northing
5099	d-83-J / 93-I-14	abandoned	618065	6095289
9997	c-02-B / 93-P-3	suspended (not currently producing)	618330	6096968

2.12 Acknowledgements and professional responsibility

Sam Payment GIT, Conuma's coordinator of permitting and exploration, gave yeoman service as the company's wrangler of drilling programmes. David Donison PEng, Conuma's capital projects manager, led the geotechnical and hydrological investigations.

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Wood Plc provided engineering support to the geotechnical drilling programme, led by geotechnical engineer Bruce Garlick PEng. DWB Consulting provided environmental support, led by environmental specialist Ryan Bouchard.

Conuma's chief geologist, Gwyneth Cathyl-Huhn PGeo., accepts overall professional responsibility for the contents of this report, and has duly signed and sealed the original copy thereof.

3 Geology

Regional and local geology (**Map 2-3**) of Hermann -- and of the Sukunka-Quintette coalfield in general -- is known mainly from the extensive work of D.F. Stott (1960; 1961; 1963; 1968; 1973; 1974; 1982; 1998), and D.W. Gibson (1992a, 1992b) on behalf of the Geological Survey of Canada. In 1970, a photogeological study of the eastern end of the Hermann coal property was published as an illustration within a technical paper by C.D.A. Dahlstrom.

As well, numerous coal-company technical reports (cited in **Section 8** of this report) are available as open-file documents from the British Columbia Geological Survey Branch. Copies of the reports are freely available for download via the provincial Survey's Coalfile website, and may also be purchased in CD or DVD format at a cost of $20 per report. Most of these reports have been censored to exclude clean-coal quality data, as such data are held confidential by the Crown in keeping with the provisions of the *Coal Act Regulation*.

3.1 Regional geology

The Hermann coal property lies within the Sukunka-Quintette coalfield of northeastern British Columbia, part of the Foothills structural province of the Canadian Cordillera. The majority of sedimentary rocks within the Sukunka-Quintette coalfield are clastic in nature, ranging in grain-size from claystones and mudstones through conglomerates. Lesser amounts of biologically- and chemically-derived sedimentary rocks are present, comprising coals, banded and nodular ironstones, glauconite-rich sandstones and gritstones, and impure dolomites.

Volcanic rocks constitute a very small component of the Early Cretaceous strata, comprising very fine- to fine-grained tuffs (locally altered to bentonites or tonsteins), interpreted to have originated as wind-borne distal ash-fall deposits from contemporaneous volcanoes situated upwind and far to the southwest of the property. The volcanic rocks characteristically occur as very thin (at most a few decimetres) yet regionally-extensive bands, thus useful as markers for structural and stratigraphic correlations (Duff and Gilchrist, 1981; Kilby, 1984a).

All rocks exposed at the ground surface are of Early Cretaceous age, belonging to the Minnes (Berriasian to Valanginian stages), Bullhead (Barremian to Aptian stages) and Fort St. John (Albian stage) groups. Within the Hermann property, total thickness of the Lower Cretaceous rocks is 2380 to 2560 metres, although some of this thickness is likely attributable to thrust-induced structural telescoping of the rock.

3.1.1 Tectonostratigraphic context of Early Cretaceous coal-measures

During much of the Early Cretaceous, the Western Interior of North America was occupied by a shallow seaway, variably-designated by different authors as the Western Interior Sea, the Boreal Sea, or by analogues of formation names, such as the Clearwater Sea, Hulcross Sea or Moosebar Sea. Depths of the seaway, magnitude of accommodation space for sediments, and overall shoreline trends, were largely controlled by vertical movements within a complexly-block-faulted crystalline basement terrane of Precambrian age, the Peace River Arch.

Sediments of the Minnes Group and the basal part of the Bullhead Group were derived from actively-eroding upland areas within the North American craton, particularly from the Peace River Arch. The receiving basin during this early time period lay to the west of the craton, within an actively-subsiding continental shelf which prograded westwards into the ancestral Pacific Ocean. Subsequently, slightly later within the earliest Cretaceous era, sediments of the upper part Bullhead Group and the Fort St. John Group were derived from actively-rising thrust-faulted tectonic forelands situated to the west and southwest of the seaway, synchronous with the docking of allochthonous tectonic terranes against the western margin of the North American craton.

Coal deposits formed within the non-marine portions of the clastic sedimentary successions. Kalkreuth and Leckie (1989) recognised the close association between actively-subsiding shoreface sandstone deposits and the overlying presence of thick coal beds; this association is well-established within the upper part (Chamberlain Member) of the Gething Formation and the middle part (Falher Member) of the Gates Formation, within the Sukunka-Quintette coalfield, including the Hermann property.

3.1.2 Thin-skinned deformation and thrust-faulting

The Hermann coal property, and the coalfield within which it is contained, is characterised by a thin-skinned deformational style comprising folded, laterally-arcuate thrust faults and associated fault-bend folds (Jones, 1979).

Age relationships amongst the thrusts are as generally observed within the Cordilleran fold-thrust belts of North America, with the oldest thrusts occupying stratigraphically-higher positions, generally to the tectonic inboard (hence, to the southwest) of the stratigraphically-lower and younger thrusts. Breakback structural stacking is generally absent. Most, but not all, of the thrusts dip to the southwest (except where subsequently folded) and strike to the northwest. Thrusts range in scale from mesoscopic features with stratigraphic displacements of a few decimetres to a few metres, to regionally-throughgoing faults and fault zones (such as the Bullmoose and Mesa faults) with stratigraphic displacements of several hundred metres.

Regionally, the basal Cowmoose Member of the Moosebar Formation, and the younger Hasler Formation, are often zones of *décollement* (tectonic detachment), characterised by near-bedding-parallel thrust faults (Cooper and others, 2004). Other *décollement* zones, of at least local significance, may be hosted by soft, low-strength tuff bands within the Hulcross and Gates formations. Such zones are of practical significance to mining, in the event that they are exposed at adverse orientations within mine walls (Rostad and Hogarth, 2019).

3.2 Local geology

A table of formations, including an enumeration of coal beds with coal zones, and estimates of formation thicknesses, is presented as **Table 3-1**. Stratigraphy is discussed in greater detail within **Section 4** of this report.

3.2.1 Local stratigraphy

Within the Hermann property, rocks belonging to the uppermost Minnes, Bullhead and all but the uppermost Fort St. John groups are exposed at the ground surface. Approximately 1130 metres of Bullhead and Fort St. John rocks remain in place, following Tertiary-Quaternary episodes of fluviatile erosion and glacial scouring. An additional 1350 metres of Minnes Group strata underlies the Bullhead Group; these deeper rocks are known mainly from the records of natural-gas wells.

Formations mapped (see **Map 2-3** and **Table 3-1**) as being present at outcrop range downwards from the Cruiser Formation (map-unit 8c, the youngest mapped formation) to the Monach Formation (map-unit 1, the oldest mapped formation). The ages of these rocks span

145 to 100.5 million years before present, based on off-property paleontological evidence and limited tephrachronological dating (also off-property).

3.2.2 Local structure

The Hermann coal property consists of a moderately-deformed stack of marine and non-marine strata, generally present in normal ('tops-up') stratigraphic position, albeit with generally-steep bedding-surface dips. Exceptions to this general situation are presented by the complexly-faulted and folded area between the Hermann Syncline and the northeast-facing 'nose' of the Mesa Thrust, which may be a displacement-transfer zone between the southward-terminating Bullmoose Thrust and the throughgoing Mesa Thrust.

As a general consideration, thrust faults at Hermann are inferred to have developed in the typical downward-younging sequence of successive faulting, although out-of-sequence thrusting is possible within the previously-mentioned 'nose' area.

Thrust faults are locally folded, as exemplified by the hairpin curvature of the Marmot East Thrust around the nose of the Transfer Syncline. A similar folded-thrust structure is mapped around the northwest-plunging nose of the Transfer Anticline. An imbricate stack of thrusts is mapped in the complexly-structured area between the Hermann Syncline and the Transfer Middle Syncline, where the Bullmoose Thrust appears to be truncated by, or possibly be involved in a displacement-transfer zone with, the underlying Mesa Thrust.

Thrust faults typically exhibit northeastward vergence, consistent with an overall northeastward direction of tectonic transport. The map pattern of the component thrusts within the Marmot thrust system suggests that these faults are southwest-verging components of a triangle zone; however, this supposition remains uncertain, and it is possible that instead these thrusts are simply the exposed trailing edge of an incipient klippe (in which case the Marmot thrusts might represent the 'beheaded' northeastward continuations of the Mesa Thrust).

The *en echelon* overlap of thrust-faults (as seen in the nearby Hermann West property, and in parts of the nearby former Quintette mines) is less well-developed at Hermann, other than within the complexly-faulted zone of the Mesa Thrust's 'nose' within Coal Licences 383183 and 405139. Bedding-plane detachments are occasionally seen within soft muddy siltstones and mudstones of the Falher Member of the Gates Formation, as well as within the relative less-competent upper part of the Spieker Member of the Moosebar Formation, immediately below the competent sandstones of the Torrens Member of the Gates Formation.

Bedding dips within the Hermann coal property are generally steeper than those observed in nearby properties such as Hermann West. Dips of 45 to 70 degrees are typical within the folded rocks of the property's northwestern and eastern portions. In the eastern part of the Hermann property the bulk of tectonic shortening appears to have been accomplished by folding rather than by overthrusting. The most economically-significant of the folds is the Hermann Syncline, whose gently-warped core (dips ranging from 8 to 20 degrees) preserves the basal coal-measures of the Falher Member. Also of significance is the Transfer Anticline, which brings the Falher coal measures close to the ground surface.

Table 3-1: Table of formations for the Hermann property

Geological Age		Lithostratigraphic Units: Group	Formation	Member	Division	Thickness	Map-Units		Coal Beds/Coal Zones: Bed	Zone
Quaternary			Mine waste			>50 m?	M			
			Drift			nil to 80 m	D			
Early Cretaceous	Late Albian	Fort St. John	Cruiser			>15 m?	8c			
			Goodrich			50 m?	8b			
			Hasler			150 m?	8a			
	Late Middle Albian to Late Albian		Boulder Creek	Paddy		130 m	7		V coal zone	
				Walton Creek						
				Cadotte						
	Middle Albian		Hulcross			105 m	6			
	Late Early Albian		Gates	Notikewin		90 to 115 m	5	5c	A coal bed	
									B coal bed	
									C coal bed	
				Falher		70 to 90 m		5b	D coal bed	
									E1-E3 coals	E
									E4 coal bed	
									F1 coal bed	F
									F2/G1 coal bed	
									G2 coal bed	G
									G3 coal bed	
									J1 coal bed	J
									J2 coal bed	
									J3 coal bed	
									K1-K3 coals	K
				Torrens	Upper Quintette sandstone	25 to 32 m		5a		
					medial siltstone	15 to 18 m			thin coaly stringers?	
					Lower Quintette sandstone	35 m				
			Moosebar	Spieker		49 to 55 m	4	4c	L coal bed near base	
				Cowmoose		60 to 70 m		4b		
				Green Marker		0.1 to 17 m		4a		
		Bull-head	Gething	Chamberlain		30 to 40 m	3	3d	Bird coal zone	
									Skeeter – Chamberlain coal zone	
				Bullmoose		25 to 35 m		3c		
				Bluesky		nil to 15 m		3b		
	Hauterivian to Late Early Albian			Gaylard		150 to 160 m		3a	Gething coal zone(s)	
	Barremian		Cadomin			30 to 85 m	2			
	Valanginian and older?	Minnes	Monach (and older formations below)			1300 to 1400 m	1		Coals present	

3.3 Stratigraphic details

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

3.3.1 Quaternary surficial deposits (map-units M and D)

Unconsolidated surficial deposits of Quaternary age comprise mine waste (map-unit M) and valley-bottom and hillside Drift (map-unit D). The extent of both classes of surficial deposits has been mapped by means of *Google Earth* satellite imagery, and by interpretation of topographic boundaries adjacent to the valley-floor of Murray River, supported by borehole records in those areas which have been drilled.

3.3.1.1 Mine waste (map-unit M)

Associated with the historic open-pit mining operations at Quintette are mine waste dumps, consisting of overburden and interburden rocks removed during mining operations. Thickness of dumped material is inferred to be substantial, locally greater than 50 metres.

3.3.1.2 Drift (map-unit D)

The flat-bottomed floor of the Murray River valley is occupied by the river's meander-belt, and by adjoining alluvial fans of tributary creeks which drain nearby upland areas. The banks of the river, where exposed by channel-migration processes, show crudely-bedded silts, sands and gravels which are interpreted as fluvial deposits. Glacial and glaciolacustrine sediments, of broadly Pleistocene age, may underlie the near-surface fluvial deposits. Thickness of the valley-filling Drift, where drilled within the M-9 and Shikano synclines, ranges from a few metres to at least 78 metres. The base of the valley-fill has often been unreachable by historic drilling, although this may be to some extent due to past workers being disinterested in pursuing bedrock to depths beyond those deemed reasonable for surface mining.

Isolated bodies of thick Drift also form narrow channel-fills and isolated hillside wedges within the northwestern corner of the Hermann property. The outlines of these bodies of Drift (as depicted in **Map 2-3**) are mapped at inferred 20-metre depth to bedrock.

3.3.2 Fort St. John Group (map-units 8c through 4a)

An incomplete section of the Fort St. John Group is present at Hermann, owing to the group's top contact having been stripped off by erosion during Tertiary uplift of the rocks, and further scouring by glaciers during the Quaternary era.

The youngest of the drilled Fort St. John rocks is the Hulcross Formation, of which a complete section was drilled in current boreholes HR19-01C and MW19-AD, and nearly-complete sections were encountered in historic boreholes HR2005-3C and HR14-05C. Partial sections of the basal beds of the overlying Boulder Creek Formation were drilled in current boreholes HR19-01C and MW19-AD.

Thicknesses and lithologies of the Cruiser, Goodrich, and Hasler formations are known only from examination of outcrop sections (augmented by partial information concerning their drilled thicknesses in nearby properties), as these rocks have not yet been drilled within the Hermann coal property.

The Cruiser, Goodrich and Hasler formations are considered by Stott (1968) to be lateral equivalents of the Shaftesbury Formation of the Alberta Syncline, where the Goodrich sandstone is not recognisable within a thick sequence of fine-grained rocks. During the Denison-Quintette era of exploration at Hermann, coal-company geologists did not recognise the tripartite division of the strata overlying the Boulder Creek Formation, and thus they mapped these rocks as Shaftesbury.

3.3.2.1 Cruiser Formation (map-unit 8c)

The Cruiser Formation is the uppermost formation within the Fort St. John Group. The Cruiser is reported by Stott (1968) to comprise 105 metres of dark grey mudstone with frequent interbeds of siltstone and occasional interbeds of fine-grained, silty sandstone. Bands of discoidal to spheroidal sideritic concretions occasionally occur. The formation's age, on the basis of marine fossils, ranges from Late Albian to Cenomanian.

Within the Hermann coal property, only the basal 15 metres or so of the Cruiser Formation is inferred to have been preserved from erosion, within the core of the Shikano Syncline; this part of the formation is therefore noted to be of Late Albian age in **Table 3-1**. The basal contact of the Cruiser Formation with the underlying Goodrich Formation is abrupt (Stott, 1968), and possibly disconformable.

3.3.2.2 Goodrich Formation (map-unit 8b)

The Goodrich Formation is reported (Stott, 1968) to comprise approximately 50 metres of medium- to thick-bedded, locally cliff-forming sandstone, with frequent interbeds of siltstone and mudstone. At Hermann, the Goodrich Formation is preserved within the core of the Shikano Syncline. The Goodrich is of Late Albian age, as established by its molluscan fauna (Stott, 1968). The basal contact of the Goodrich Formation with the underlying Hasler Formation is gradational.

3.3.2.3 Hasler Formation (map-unit 8a)

The Hasler Formation (Stott, 1968) comprises approximately 150 metres of dark grey, locally rusty-weathering mudstone with frequent interbeds of siltstone and occasional interbeds of fine-grained, silty sandstone. The Hasler is probably of Late Albian age, on the basis of the probable Late Albian age assigned to the underlying Boulder Creek Formation (Gibson, 1992b). The abrupt base of the Hasler Formation is locally marked by a thin (a few centimetres to decimetres) layer of pebbly mud-matrix conglomerate.

3.3.2.4 Boulder Creek Formation (map-unit 7)

The Boulder Creek Formation comprises 130 metres of ridge-forming, competent, thick-bedded to massive, coarse-grained sandstone and conglomerate, with thin interbeds of siltstone, variably-carbonaceous mudstone and occasional thin (a few decimetres) coal beds.

Gibson (1992b) recognised three members within the Boulder Creek Formation, on the basis of lithostratigraphy. Gibson's basal Cadotte Member is represented at Hermann by a conspicuous ridge-forming zone of conglomerate and sandstone (as recognised by Johnson, 1990), but it is difficult to distinguish the overlying Walton Creek Member coal-measures from the uppermost Paddy Member of the formation, owing to lack of good exposure of these rocks. The bottom part of the Cadotte Member was cored in current borehole HR19-01C, and drilled open-hole by borehole MW19-AD.

The Boulder Creek Formation is of Late Middle Albian to probable Late Albian age, based on its angiosperm flora (Gibson, 1992b). The basal contact of the Boulder Creek Formation with the underlying Hulcross Formation is abrupt or erosional at local scale, and possibly gradational by intertonguing at regional scale.

3.3.2.5 Hulcross Formation (map-unit 6)

The Hulcross Formation, of Middle Albian age within the Early Cretaceous (Stelck and Leckie, 1988; Gibson, 1992b) comprises 105 metres of thinly-interbedded, locally-concretionary medium grey siltstone, fine-grained sandstone and dark grey mudstone with occasional very thin but extremely-persistent interbeds of soft, light grey to white, tuffaceous volcanic ash. Regionally, 20 such 'ash bands' are traceable within the Hulcross Formation. At local scale within the Hermann property, 15 of these 20 ash bands (**Table 3-2**) have been recognised on the basis of their anomalously-high gamma-log geophysical response.

Mesoscale (a few decimetres to a few metres thick) fining-upward sequences reminiscent of proximate turbidites or tempestites are common within the Hulcross, as are trace-fossils and poorly-preserved shell fossils. Fine-grained pyrite is locally-abundant within the Hulcross rocks, which are inferred to have been deposited beneath a stratified water column within a restricted-circulation seaway (Stelck and Leckie, 1988). The disconformable base of the Hulcross Formation is characteristically marked by a thin (generally a few decimetres, and rarely up to a metre or so thick) erosive-based bed of cherty pebbly sandstone or gritstone.

3.3.2.6 Gates Formation (map-unit 5)

The Gates Formation, of late Early Albian age within the Early Cretaceous (Stott, 1982; Wan, 1996), comprises 235 to 290 metres of interbedded sandstone, siltstone, conglomerate, shale and coal at Hermann.

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

- Notikewin Member (map-unit 5c), comprising 90 to 115 metres of interbedded, locally-glauconitic sandstone and siltstone, with minor conglomerate, carbonaceous mudstone and generally-thin coal (A, B and C coal zones);

- Falher Member (map-unit 5b), comprising 70 to 90 metres of muddy to sandy siltstone, channel-filling sandstone and generally-thick coal (D, E, F, G, J and K coal zones), with lesser amounts of carbonaceous mudstone and silty mudstone; and

- Torrens Member (map-unit 5a), comprising 75 to 85 metres of sandstone, with a laterally-persistent medial zone of siltstone and mudstone.

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Details of Hulcross ash bands in current and selected historic boreholes: **Table 3-2**

Borehole	Drift	Tops of geological markers (depths in metres from geophysical log interpretation)																			Total depth
		Cadotte Mb. of Boulder Creek Fm.	Hulcross Fm.	Ash-20	Ash-18	Ash-17	Ash-16	Ash-15	Ash-13	Ash-12	Ash-9	Ash-8	Ash-7	Ash-6	Ash-5	Ash-4	Ash-2	Ash-1	Basal Hulcross grit unit	Notikewin Mb. of Gates Fm.	
HR19-01C	0.70	starts	16.3	28.40	36.75	38.90	45.30	51.40	60.20	61.95	NR	87.00	NR	107.00	113.10	114.45	NR	121.80	122.25	122.60	397.00
HR19-03C	0.30		starts										NR	15.90	24.20	25.50	NR	NR	33.87	34.05	353.20
HR19-05C ----- *Fault at 21.50* ----- *Fault at 37.00*	4.45		starts		16.90 ----- 25.55	18.65 ----- 29.22 -----	----- 43.20	53.30	55.50	57.40	89.95	91.80	NR	109.85	114.94	115.95	121.92	123.2	123.26	123.27	250.40
HR19-06C	2.3		starts									23.90	NR	43.20	48.85	50.00	NR	57.00	58.00	58.27	334.30
MW19-AD	0.7	starts	14.3	26.5	35.45	38.05	44.95	51.45	60.40	62.20	NR	79.55	100.35	106.90	112.90	114.25	NR	121.40	122.00	122.70	127.40
MW19-BD	1.75		starts										4.70	15.10	22.90	24.50	NR	NR	33.85	34.25	224.60
HR2005-3C	5.2		starts				12.70	18.55	24.90	26.55	36.55	37.40	NR	58.15	64.10	65.35	NR	72.95	74.10	74.50	278.59
HR14-05C ----- *Fault at 16.55* ----- *Fault at 25.10* ----- *Fault at 27.25*	8.9		starts				9.30	15.20 ----- 18.25	23.65 ----- ----- 27.45	28.80	51.20	51.85	NR	69.45	NR	75.50	81.80	82.25	82.55	83.70	275.84

Note: NR denotes 'not recognised'.

Coals of the Gates Formation, and their enclosing sedimentary rocks, were deposited on the shoreline of the Western Interior Seaway between 108.7 and 111.0 million years ago, as part of an extensive complex of coastal plains, deltas and estuaries within the Sukunka-Quintette coalfield. Throughout the period of Gates Formation sedimentation, the shallow waters of the Western Interior Seaway generally lay a few tens of kilometres northeast of Hermann, with the exception of a few isolated 'marine bands' associated with more substantial transgressions of the sea into and atop coal-forming coastal plain sediments. Splits were occasionally induced within the Gates coal beds, by crevasse-splays from river channels, and perhaps also by drowning of coal-forming wetlands beneath lakes and ponds.

Within the Hermann coal property, numerous coal zones, each comprising one or more individually-recognisable coal beds, are present within the Gates Formation. Coal zones and coal beds are designated by an upward-progressing system of lettering, from the K zone near the base of the formation, to the C, B and A zones near the top of the formation. This scheme of designation has been generally applied within the Quintette portion of the coalfield, and is the inverse of the 'bottoms-up' naming scheme used at Sukunka, Bullmoose and East Bullmoose.

3.3.2.6.1 Notikewin Member (map-unit 5c)

The Notikewin Member of the Gates Formation comprises 70 to 90 metres of siltstone and sandstone with minor conglomerate, variably-carbonaceous, locally root-bearing mudstone, and moderately-persistent coal beds (the A, B and C coal beds). The Notikewin coals locally attain potentially-mineable thicknesses, greater than 2.5 metres in the case of the B coal bed, as noted by Johnson (1990), most often in the cores of folds where the coal's thicknesses may have been increased by cataclastic or plastic flow.

At Hermann, the basal few metres to few tens of metres of the Notikewin Member are often represented by a competent, ledge-forming bed of erosive-based sandstone and conglomerate. The basal part of the Notikewin has also been informally termed the 'Babcock Member' by Quintette Coal's geologists, although this usage is now deprecated.

Carmichael (1983) established a more-detailed but still informal subdivision of the Notikewin Member into several sub-units within the Mt. Frame and Mt. Sheriff areas, to the northwest of Hermann. No attempt has yet been made to extend such subdivisions into the Hermann property, although this might ultimately be useful in the detailed working-out of thrust fault displacements.

The basal contact of the Notikewin Member with the underlying Falher Member is disconformable, and locally deeply-scoured.

3.3.2.6.2 Falher Member (map-unit 5b)

The Falher Member of the Gates Formation comprises 70 to 90 m of muddy to sandy siltstone, channel-filling sandstone and generally thick coal (within the D, E, F, G, J and K coal zones), accompanied by lesser proportions of carbonaceous mudstone and silty mudstone. Overall, the Falher Member contains proportionately more coal than the overlying Notikewin Member.

The D coal zone, at the top of the Falher Member, is often found to be absent in boreholes. This absence is possibly due to deep scouring at the base of the overlying Notikewin Member. In non-cored boreholes, recognition of the Falher-Notikewin contact is rendered more difficult when clay-poor Falher sandstone is directly overlain by clay-poor Notikewin conglomerate, inasmuch as gamma-ray logs fail to distinguish between the two lithologies.

The Falher Member is of Late Early Albian age (Wan, 1996). Its basal contact with the underlying Torrens Member of the Gates Formation is abrupt, marked by an undulating surface possibly originating as relict sandbars or sand-waves.

Regionally, within the Sukunka-Quintette coalfield and also within the adjoining Deep Basin hydrocarbon play area of northeastern British Columbia and northwestern Alberta, the Falher Member may readily be divided into five or six semi-formal subdivisions, designated by letters from top downwards, as the Falher A through Falher F (Leckie and Walker, 1982). Such a subdivision might be useful in resolving coal-zone splits and washouts at Hermann, but this has not yet been attempted.

3.3.2.6.3 Torrens Member (map-unit 5a)

Within the Sukunka-Quintette coalfield, the term 'Torrens Member' is often applied as a local name for the thick sandstone underlying the lowest of the mineable Gates coal beds. Within the northern part of the Quintette area (including the Hermann and Hermann West coal properties, and extending through the Perry Creek and East Bullmoose areas), however, there are two of these sandstone units, the Upper Quintette and Lower Quintette sandstones, separated by the Medial Siltstone, an informally-named, fine-grained 'silty zone' of interbedded siltstone, sandstone and shale. The two sandstones are probably of marine origin, but the silty zone comprises both marine and non-marine rocks, including thin coaly stringers at those few sites where it has been drilled within the Hermann coal property. The overall stratigraphic thickness of the three sub-units of the Torrens Member at Hermann is 75 to 85 metres.

The top of the Upper Quintette sandstone is almost always root-penetrated, at times distinctly softer, darker and carbonaceous to coaly (likely originating as an ancient soil horizon beneath the J3 coal bed), and thus readily distinguishable from the underlying harder, lighter-coloured and cleaner main body of the sandstone. The Upper Quintette sandstone's surface undulates at the scale of a few metres to a few tens of metres, probably representative of relict sand-bars and sand-waves, formed within a shallow-marine setting.

In earlier reports, the Upper Quintette sandstone was frequently designated as the 'Sheriff Member' of the Gates Formation.

The Upper Quintette sandstone is 25 to 32 metres thick at Hermann. The underlying medial siltstone unit is 15 to 18 metres thick, and the Lower Quintette sandstone is 35 metres thick. All three of these units were intersected, nearly normal to their bedding within the core of the Hermann Syncline, in the d-83-J / 93-I-14 natural-gas well.

Historically, coal-exploration boreholes have seldom penetrated far into the Torrens Member, and have therefore generally left the Medial Siltstone unit untested as to the presence of coal. This paucity of data was addressed by deep drilling in several of the year-2019 diamond-drill holes, which failed to encounter coal in the Medial Siltstone.

The age of the Torrens Member is presumed to be Late Early Albian. The basal contact of the Torrens Member with the underlying Spieker Member of the Moosebar Formation is gradational by interbedding (Carmichael, 1983).

3.3.2.7 Moosebar Formation (map-unit 4)

The Moosebar Formation comprises 109 to 125 metres of dark grey, locally-concretionary mudstone and siltstone, with minor thin interbeds of sandstone and tuff, and a thin basal conglomerate. Concretions are sideritic, and distinctly rusty-weathering, concentrated in laterally-persistent bands, a few decimetres thick, which may represent diastem-induced hardgrounds. Tuff bands within the Moosebar Formation are very thin (a few millimetres to a few decimetres) but also laterally-persistent. Variations in the Moosebar's thickness are likely due to intertonguing with the southward-thickening sandstone of the basal Torrens Member of the Gates Formation. Some variation in thickness may also be due to structural telescoping of the relatively-incompetent Moosebar rocks between the stronger rocks of the Gates and Gething formations.

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

At Hermann, and within the Sukunka-Quintette coalfield generally, the Moosebar Formation may be divided into three units. In order from top down, these are the Spieker, Cowmoose, and (unnamed) basal gritstone of the Green Marker.

3.3.2.7.1 Spieker Member (map-unit 4c)

The Spieker Member comprises 49 to 55 metres of thinly-interbedded, overall coarsening-upward sandy siltstone and sandstone, pervasively-bioturbated and possibly originating as proximal shallow-marine turbidites (Leckie, 1983) in front of the advancing Falher/Torrens paleodelta. Sandstone beds become thicker, coarser, and more abundant towards the top of the Spieker, and on the whole the Spieker Member is a transitional unit (Duff and Gilchrist, 1981) between the underlying Cowmoose mudstone and the overlying Torrens sandstones.

In contrast to previously-studied areas further to the northwest, the Spieker Member at Hermann contains a single thin coal bed (the L coal) near its base (Johnson, 1980). The thickest drilled intersection of the L coal bed is 0.5 metres, in borehole QHR88003.

The age of the Spieker Member is presumed to be Early Albian to possibly late Early Albian. However, this unit has thus far yielded no diagnostic fossils. The basal contact of the Spieker with the underlying Cowmoose Member is drawn at the base of the lowest band of sandy siltstone overlying the mudstones. This contact is inferred to be locally abrupt or erosional, but regionally-interfingering.

3.3.2.7.2 Cowmoose Member (map-unit 4b)

The Cowmoose Member of the Moosebar Formation comprises 60 to 70 metres of rubbly-weathering, dark grey to black siltstone and mudstone, punctuated by laterally-persistent bands crowded with ironstone concretions, locally-abundant dolomitic nodules, and several thin (a few millimetres to a few decimetres) but laterally-persistent bands of light olive drab to white tuff. The tuff bands are useful as local structural markers (Duff and Gilchrist, 1981; Kilby, 1984a).

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

3.3.2.7.3 Green Marker (map-unit 4a)

The basal Green Marker of the Moosebar Formation comprises 0.1 to 17 metres of locally-glauconitic, distinctively dark green to grey-green, chert-rich lithic arenite to pebble-conglomerate. Stott (1968, page 40, in his discussion of the "Gething-Moosebar Problem") suggested that the basal gritstone unit might be equivalent to the Bluesky Formation of the Alberta Plains, but that correlation is now understood to be incorrect (Kilby, 1984b; Gibson, 1992a). The age of the Green Marker is presumed to be Early Albian. Its basal contact with the underlying Chamberlain Member of the Gething Formation is presumed to be abrupt, and locally erosional.

Upon the accompanying geological map (**Map 2-3**), map-units 4a and 4b are depicted together as map-unit 4ab, owing to the impracticality of depicting the thin Green Marker by itself at the given scale of mapping.

3.3.3 Bullhead Group (map-units 3 and 2)

The Bullhead Group consists of two formations, the Gething Formation which comprises the majority of the group's thickness, and the thinner basal Cadomin Formation (Stott, 1963; 1968; 1973). Both formations are well-represented in outcrop at Hermann, and they have been extensively-drilled within those parts of the property where potentially-strippable coal might have been expected to exist. Documentation of this drilling is incomplete, and some question remains as to the stratigraphic horizon (within the Gething Formation as a whole) at which some of the coal was encountered.

3.3.3.1 Gething Formation (map-unit 3)

The Gething Formation, of Early Aptian to Early Albian age within the Early Cretaceous (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, of which two (the Gaylard and Chamberlain paleodeltas) extended into the Quintette Mountain area, including the Hermann coal property.

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

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

In the geological map accompanying this report (**Map 2-3**), the Gething Formation is locally mapped as three stratigraphically-based map-units: the Chamberlain Member (map-unit 3d), the undivided Bullmoose and Bluesky members (map-unit 3bc) and the Gaylard Member (map-unit 3a). Where the extent of outcrop exposure does not support this cartographic distinction, the Gething Formation has been mapped as an undivided whole (map-unit 3).

3.3.3.1.1 Chamberlain Member (map-unit 3d)

The Chamberlain Member comprises 30 to 40 metres of thickly-interbedded, brown-weathering sandstone and siltstone, containing two regionally-significant coal zones: the Bird Zone (containing one or more coal beds) near the member's top, and the Skeeter-Chamberlain Zone (again, containing one or more coal beds) within the member's middle. The basal quarter to third of the Chamberlain Member's thickness comprises one or two regionally-extensive thick beds of marine sandstone, known informally as the Chamberlain Sandstone (*per* prior usage by Wallis and Jordan, 1974).

The Chamberlain Member is inferred to form near-surface bedrock in small fault-bounded tectonic 'slices' immediately to the southwest of, and therefore structurally-above, the Mesa Thrust. An isolated outlier of the Chamberlain Member is also inferred to be present within the core of the Mast Syncline, near the southwestern corner of the Hermann property. The Chamberlain coal-measures were also encountered in natural-gas well d-83-J / 93-I-14, near the centre of the Hermann Syncline; these beds are therefore mappable around the periphery of the syncline, although they have been only sparsely-drilled within this area.

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

3.3.3.1.2 Bullmoose Member (map-unit 3c)

The Bullmoose Member comprises 25 to 35 metres of thinly-interbedded, recessive-weathering mudstone, siltstone and minor sandstone of turbiditic aspect, forming one or more coarsening-upward sequences. The Bullmoose does not contain any coal, other than isolated coalified logs and coarse, poorly-preserved 'plant trash', likely of drifted origin. Regionally, the Bullmoose does, however, contain locally-abundant molluscan fossils, including *Pecten (Entolium)* cf. *irenense* McLearn (Gibson, 1992a) and *Yoldia kissoumi* (Duff and Gilchrist, 1981), which, although not age-diagnostic, are characteristic of the unit.

In a departure from historic mapping (which placed the Moosebar Formation there), the Bullmoose Member of the Gething Formation has recently been interpreted to form most of the exposed core of the Mast Syncline, within the southwestern corner of the Hermann coal property (Cathyl-Huhn and Avery, 2014). The Bullmoose Member is also considered to form bedrock within the immediate northeastern corner of the Mesa Fault's structural 'nose', between the Hermann Syncline and the Transfer Middle Syncline.

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

3.3.3.1.3 Bluesky Member (map-unit 3b)

The Bluesky Member of the Gething Formation comprises up to 15 metres of pebbly mudstone to gritty pebble-conglomerate, at times slightly to moderately glauconitic, with occasional pyrite flecks. The basal contact of the Bluesky with the underlying Gaylard Member has not been directly observed at Hermann; however, elsewhere within the Sukunka-Quintette coalfield it is generally abrupt to erosional. The age of the Bluesky Member is likely to be late Early Albian. The Bluesky Member of the Gething Formation, as its name implies, is likely to be correlative and perhaps laterally-continuous (if not strictly coeval) with the Bluesky Formation of the Dawson Creek area (Kilby, 1984b; Legun, 1990).

Map-units 3b and 3c are depicted together as map-unit 3bc within **Map 2-3**, owing to the impracticability of representing the Bluesky Member separately at the given map-scale.

3.3.3.1.4 Gaylard Member (map-unit 3a)

The Gaylard Member comprises about 150 to 160 metres of thickly-interbedded siltstone, mudstone and brown-weathering channel-filling sandstone, accompanied by minor ironstone, tuff, gritstone and conglomerate. At Hermann, the Gaylard Member is contains numerous coal beds, some of which are several metres thick. Coal Assessment Reports 618 (Johnson, 1985) and 724 (Gormley, 1987) provide partial documentation of these coals, for which many borehole logs are missing. The most intensively-explored area of Gaylard coals lies within the structural 'nose' above the Mesa Thrust, within the 'Hermann Gething' area as named by Quintette Coal's geologists. Coal-quality results for these coals are frequently missing from their reports (and, following a diligent search of government records) now presumed lost.

The age of the Gaylard Member is Hauterivian to late Early Albian (Gibson, 1992a). Its basal contact with the underlying Cadomin Formation is gradational by interfingering at local and regional scale (Stott, 1968; Johnson, 1972; Gibson, 1992a), being most readily-drawn at the top of a bed of coarse-grained, often gritty and occasionally pebbly sandstone, which may laterally grade into more typical pebble-conglomerate characteristic of the Cadomin.

3.3.3.2 Cadomin Formation (map-unit 2)

The Cadomin Formation immediately underlies the Gething Formation, forming the basal part of the Bullhead Group (Stott, 1968). The Cadomin is resistant to erosion, and typically forms ledges to cliffs beneath the more-subdued slopes of the Gaylard Member. This ledge-forming geometry is locally well-developed along the southwest-facing slopes bounding Canary Creek, and along the southwestern shoulder of Mt. Frame.

The Cadomin Formation comprises one or more thick beds of coarse-grained, gritty to pebbly sandstone and pebble-to boulder-conglomerate (McLean, 1981) with occasional lenses of siltstone and pebbly gritstone, and rare thin lenses of dirty coal. Sandy phases of the Cadomin Formation thus strongly resemble the basal pebbly sandstones of the Gaylard Member, and the Cadomin's distinction from the Gaylard locally rests mainly upon the Cadomin Formation's greater lateral continuity. Within the Hermann coal property, the top of the Cadomin Formation has only been reached by the two natural-gas wells (c-02-B / 93-P-03, and d-83-J / 93-I-14).

At Hermann, the Cadomin Formation inferred to be 30 to 85 metres thick. Its basal contact with the underlying Monach Formation is likely to be erosional, with considerable local scour into the older sediments. Regionally, the base of the Cadomin marks a northeastward-deepening angular contact, cutting down into successively-older rocks of the Minnes Group (Stott, 1973).

3.3.4 Minnes Group (map-unit 1)

The Minnes Group, despite being known to contain coal within its outcrop belt along the southwestern fringe of the Sukunka-Quintette coalfield, is virtually unexplored in the vicinity of the Hermann property. The total thickness of the Minnes Group is estimated to be 1300 to 1400 metres, although some of this apparent thickness may be due to folding and thrust-faulting.

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

3.3.4.1 Monach Formation (map-unit 1)

The Monach Formation comprises ledge-forming sandstone and quartzite, with lesser amounts of interbedded siltstone and conglomerate, and occasional thin coals, inferred to locally form the uppermost part of the Minnes Group (Stott, 1998). The geophysical log of natural-gas well d-83-J indicates numerous coal beds within the Monach, although they are generally no more than a metre thick.

The Monach Formation is of Berriasian to Valanginian age (Stott, 1998). The Monach Formation is at least 420 metres thick in the Hermann area, as indicated by well d-83-J, although this thickness may reflect tectonic telescoping and thickening of the formation.

5 Coal quality

Coal quality data for boreholes drilled in year-2019 are presented in **Appendix B**. Work done to date comprises determination of proximate analysis, total sulphur, free swelling index (FSI), light transmittance, and apparent specific gravity on raw (unwashed) samples of coal and rock. FSI and light transmittance tests were only performed on samples with no more than 40% ash. Work yet to be done comprises single-point float-sink tests on composited samples, followed by determination of ash chemistry, and possibly petrography and reflectance. Results of these tests will be reported in due course.

In all, 147 plies (**Table B-1**) have been analysed, representing coals and associated rocks from the Falher and Notikewin members of the Gates Formation coal-measures. No samples were taken from the slightly-older Gething Formation coal-measures, owing to diamond-drilling not reaching those coals.

6 Reclamation

Technical records from the Denison-Quintette and Western-Walter eras of coal exploration at Hermann do not provide much detail of past reclamation practice. During site and access reconnaissance in 2018, previously-used drilling trails (from year-2014 and earlier) were found to be still open and driveable, with the exception of local areas of blowdowns, and some cross-ditching at the junctions of drill trails with main access roads.

The year-2019 diamond-drilling programme was conducted during the late winter months and into the spring thaw. Much of the road construction consisted of blading snow off existing roads, and scattering gravel as required for safe passage over steep or icy road segments. The geological and hydrological drilling was mostly conducted in warmer weather, such that the major site concern was thawing of the ground and collapse of roadways. Extensive use was made of wood mulching, and of portable rig mats, as a means to minimise disturbance and maintain safe access At the closure of work in each area, rig mats were removed and either transferred for use elsewhere, or sent back to the rental agency.

Although the original plan for exploratory drilling did include the construction of new trails, most drillsite access was by means of existing drill trails, logging-roads, or forestry skidder trails.

With the exception of those drill trails and pads required for ongoing access to hydrological wells, drill trails and pads have been reclaimed by pulling down cutbanks, and scattering of appropriately-bucked woody debris and/or wood mulch. Seeding with appropriate native species was done on drill pads and roads.

7 Statement of estimated costs

Cost records have been compiled for the initial exploratory phase (the Phase-1 programme) of drilling at Hermann, within Tenures 383180 through 383183 (whose anniversary date is December 18th). Invoicing still appears to be incomplete for some activities, notably geophysical logging, so the exploration costs shown below in **Table 7-1** are a minimum estimate. For purposes of comparison, British Columbia average unit costs are presented at the bottom line of the table.

The following major contractors serviced the Phase 1 programme:

- Geotech Drilling Services -- diamond core drilling (6 holes);
- RC Drilling -- rotary drilling (6 holes, as deep/shallow pairs at three diamond-drill sites);
- Anderson Drilling -- rotary drilling (12 hydrological holes);
- Century Wireline Services -- geophysical logging of 9 boreholes;
- Birtley Coal & Minerals Testing (GWIL Industries) -- coal analysis;
- Lorax Environmental -- hydrological supervision of Phase 1 rotary holes;
- APEX Geoscience -- project management and geological support; and
- Can-West Exploration -- catwork, including road maintenance, rig support, and reclamation.

Invoices are possibly incomplete for geotechnical and hydrological drilling within Tenures 417036 and 417327. Cost data for these programmes will be reported with the upcoming Coal Assessment Report for Tenure 417327 (whose anniversary date is April 25th), which saw the majority of this follow-on work.

Table 7-1: Estimated cost breakdown by activity, for exploratory and hydrological drilling, on Tenures 383180-383183

Year	Boreholes	Number of holes	Meterages		Estimated drilling costs		Estimated non-drilling costs					Totals
			Rotary drilling	Diamond core drilling	Rotary drilling	Diamond core drilling	Geophysical logging	Coal analyses	Catwork (incl. snow clearing, water truck, and mobility support)	Personnel (geological super- vision by contractprs	Photo-geological mapping	
2018-2019	HR19-01 through - 06, MW19-AD/S, BD/S, and CD/S; MW19-ED, ES, F, G, KD, KM, KS, L, LS, M, N, and PD	24 holes	1147.82 m	1937.89 m	$255,452.47	$767,051.38	$13,290.05	$28,438.80	$103,388.92	$226,347.50	nil	$1,394,469.07
			combined 3085.71 m									
			Meterages		unit costs per metre of drilling							
2018-2019	as above	24 holes	1147.82 m	1937.89 m	$222.55/m	$395.82/m	$5.48/m	$14.68/m (diamond only)	$38.89/m	$85.13/m	nil	$451.91/m
			combined 3085.71 m									
British Columbia average unit costs per metre, for comparison			n/a	n/a	$201.53/m	$210.34/m	$17.56/m	n/a	$23.30/m	$20.49/m	n/a	n/a

Note: total cost and unit cost of geophysical logging are minimum values, given incomplete information.

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9 Conclusions and recommendations

The Hermann coal property contains substantial coal resources and reserves (as enumerated in **Section 4** of this report) hosted by coal-measures of Early Cretaceous age, within the Gates Formation. Coal is also known to be present within the slightly older Gething Formation, but neither resources nor reserves are currently recognised within these older coals, and information concerning their quality is sparse, owing to loss of historic coal-quality reports.

9.1 Conclusions

The coal-measures of the Hermann property are deformed by folded, imbricate thrust faults and associated folds, consistent with an overall thin-skinned structural style. Normal stratigraphic sequences are preserved within the coal-measures, and their contained coal beds present recognisable and readily-correlatable geophysical log responses. Overturned strata are rare.

Structural complexity is greater in the fault-bend areas within Tenure 383183. The nature of the structural beheading of the Gates coal-measures is not well-understood, and its resolution will require appropriately-spaced drilling, supported by structural mapping of the exposed bedrock.

Physical work on all of the Hermann tenures during the 2018-2019 work programme comprised drilling of 58 boreholes, with total length of 3781.02 metres. Including historic work conducted between 1976 and 2014, total drilling to date comprises 268 boreholes with an aggregate length of at least 28,555.31 metres. Physical work on just the four December-anniversary tenures (Coal Licences 383180 through 383183) during the 2018-2019 work term comprised drilling of 12 boreholes, with a total length of 2658.71 metres.

Analytical work is underway on coal samples and associated rock samples. All samples have thus far been analysed at the Calgary laboratory of Birtley Coal & Minerals Testing. Results are presented in **Appendix B**. Results of work thus far are from raw (unwashed) coal. Further work is in progress.

Analytical results from previous years' work are reported in Coal Assessment Reports 950 and 999, or within earlier reports referenced by those two reports (with some gaps owing to loss of certain historical records). Cost to date of the analytical programme is **$28,438.80** (Canadian).

9.2 Recommendations

Continued maintenance of the Hermann coal tenures in 'good standing' under the *Coal Act* (through payment of rentals and submission of work reports) is essential to ongoing operations, including the construction of the Hermann open-pit and ancillary facilities. The next upcoming coal assessment reporting date is April 25th (for Tenure 417327).

The Hermann coal property merits further work:

- Structural mapping of exposed bedrock, in conjunction with appropriately-spaced drilling within the fault-bend area of Tenure 383183, between the Mesa and Bullmoose thrust faults, is recommended. This work is essential to defining the subsurface extent of the Gates coal-measures beneath the overthrust plates of Moosebar and Gething strata.

- Sampling and analysis of the Gething coals, exposed within the closely-drilled southwestern unit of Tenure 383183, is recommended. Historic drilling has outlined the existence of near-surface coals, but analytical details have been lost from the relevant Coal Assessment Reports. Hand-trenching and outcrop sampling will suffice for the determination of petrography and of ash chemistry, which in turn will allow prediction of coking potential, and assessment of the merits of core drilling.
- Structural infill and step-out drilling within Tenures 383180, 383181, and 417327. These drill sites have already been permitted. These boreholes will afford the potential for upgrading the level-of-assurance of coal resources, and further definition of geological structure within the northwestern portion of the Hermann property.

10 Statement of qualifications

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

a) I am currently employed on a full-time basis as Chief Geologist, by Conuma Coal Resources Limited, in their Canadian head office in Tumbler Ridge, British Columbia.

b) This certificate applies to the current report, titled *Coal Assessment Report for the Hermann Project, Mt. Hermann area, British Columbia*, dated December 17, 2019.

c) I am a member (Professional Geoscientist, Licence No.20550) of the Association of Professional Engineers and Geoscientists of British Columbia, licensed as a geologist (Licence No.2089) in Washington State, a member (No.152081) of the Association for Iron & Steel Technology, and a founding Registered Member of the Society for Mining, Metallurgy and Exploration (SME, Registered Member No.518350). I have worked as a colliery geologist in four countries for over 41 years since my graduation from university.

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

e) I have worked as Chief Geologist for Conuma Coal Resources Limited since September of 2016.

f) My most recent visit to the Hermann coal property was in November of 2019.

g) I am the sole author of this report, titled *Coal Assessment Report for the Hermann Project, Mt. Hermann area, British Columbia*, dated December 17, 2019, concerning the Hermann coal property.

h) I accept professional responsibility for this report.

i) As of the date of this report, I am not independent of Conuma Coal Resources Limited, pursuant to the tests in Section 1.4 of *National Instrument 43-101*, for the reason that I am a full-time employee of Conuma Coal Resources Limited.

j) The effective date of this report is December 17, 2019.

“original signed and sealed by”

Dated this 17th day of December, 2019. C.G. Cathyl-Huhn P.Geo. Lic.Geol. RMSME

Appendix A - Borehole details, geophysical logs, and core descriptions

A.1 Introduction to drilling programmes

During the year-2019 drilling programmes within the Hermann coal property, 58 boreholes were drilled for coal-quality sampling, hydrological monitoring, geotechnical studies, and groundwater supply. Work was divided into four phases, denoted as NOW-1, NOW-2, NOW-3, and NOW-4 respectively:

- NOW-1: 6 diamond-drill holes and 6 hydrological boreholes (which were drilled at diamond-drill sites);
- NOW-2: 29 geotechnical boreholes and 2 hydrological boreholes;
- NOW-3: 12 hydrological boreholes; and
- NOW-4: 3 water-supply wells.

Locations (including tenures upon which the holes were drilled) and construction details of these boreholes are presented in **Table A-1**.

A.2 Geophysical logging

Geophysical logging was undertaken in most of the NOW-1 boreholes, including all 6 of the diamond-drill holes and the 3 deep (suffixed 'D') hydrological holes. A summary of geophysical tools run down each borehole, and the depths reached by each logging run, is presented in **Table A-2**. Geophysical logs were not run within the subsequent phases of drilling.

Geophysical logs were run by Century Wireline Services, from their Canadian service base in Red Deer. During the year-2019 programme, Century's logging unit was locally-based in Tumbler Ridge, and called-out to the borehole sites on an as-needed basis. Two hardcopies of each log were provided by the logging engineers, with one copy devoted for reference in Conuma's core-shed and the other copy placed within the technical files held within Conuma's Tumbler Ridge office.

The primary means of geophysical log presentation is digital. All digital logs are incorporated as attachments to the present report, organised by borehole and further sorted by presentation file format: LAS (Log ASCII Standard, as promulgated by the Canadian Well Logging Society), PDF (Adobe's proprietary Portable Document Format), and TIF (Tagged Image Format). The PDF version of the logs is readily printable by plotters, and by office photocopiers which support piecewise printing.

Logging tool types are noted in **Table A-2**. Within the diamond-drill holes, preliminary logging runs were made within the drill rods, using small-diameter gamma-density and gamma-neutron tools. These runs were made as backups against the possibly of borehole collapse following withdrawal of drill rods. Drill rods were then withdrawn from the holes, and open-hole logging runs were conducted. Open-hole logs comprised the coal combination (compensated density-gamma-caliper-resistivity), gamma-neutron, deviation, dipmeter, and full-wave sonic. Interpretations of geophysical logs are discussed in **Section A.4**, with results presented in **Table A-5**.

A.3 Compilation, scanning, and presentation of core descriptions

Core descriptions were compiled by contracted geologists from Apex Geoscience, acting under the author's direction. A large-format (ledger-sized, 11x17 inches) core-logging form was used, allowing for easy hand-written entry of descriptive text as well as borehole features such as drillers' depth blocks, core-run numbers, and apparent dip of bedding within the recovered cores. A sample of the logging form is presented as **Table A-3**.

Core descriptions were scanned in PDF format, and are presented following the geophysical logs within the digital version of the present report. **Table A-4** presents the file names of the scanned descriptions, pertaining to the six year-2019 cored boreholes at Hermann.

Hermann 2019 borehole construction details -- **Table A-1**

Drilling phase	Borehole	UTM83-E	UTM83-N	Elevation	TD	Azimuth	Dip	Commenced	Completed	Geophysics?	Tenure
NOW-1	HR19-01C	618290.265	6097814.668	1284.111	397.0	216	-59.6	2019 Mar 10	2019 Mar 19	yes	383181
NOW-1	HR19-02C	619438.508	6095734.459	1620.333	353.2	216	-89.3	2019 Mar 20	2019 Mar 25	yes	383183
NOW-1	HR19-03C	619143.858	6096250.684	1597.888	352.85	219.3	-80.7	2019 Mar 27	2019 Apr 05	yes	383183
NOW-1	HR19-04C	619158.648	6095942.101	1613.341	250.65	217.9	-66.3	2019 Apr 05	2019 Apr 12	yes	383183
NOW-1	HR19-05C	618981.573	6096776.43	1516.424	249.65	214.4	-76	2019 Apr 12	2019 Apr 22	yes	383181
NOW-1	HR19-06C	618411.445	6097468.327	1372.192	334.54	216	-70.8	2019 Apr 23	2019 May 01	yes	382181
NOW-1	MW19-04-BD	619145.726	6096248.572	1597.998	224.6	154.3	-89.2	2019 May 08	2019 May 10	yes	383183
NOW-1	MW19-05-AD	618280.697	6097807.995	1283.631	127.4	141.6	-88.7	2019 May 04	2019 May 06	yes	383181
NOW-1	MW19-06-AS	618271.966	6097796.219	1283.573	54.96	0	-90	2019 May 06	2019 May 07	no	383181
NOW-1	MW19-07-BS	619151.152	6096241.124	1599.388	100.5	0	-90	2019 May 10	2019 May 12	no	383183
NOW-1	MW19-09-CD	619440.279	6095722.696	1620.902	137.16	141.6	-89	2019 May 12	2019 May 14	yes	383183
NOW-1	MW19-10-CS	619438.806	6095728.154	1620.981	76.2	0	-90	2019 May 14	2019 May 15	no	383183
NOW-2	MW19-11	618910.91	6099238.379	1166.654	45.72	0	-90	2019 Jun 05	2019 Jun 08	no	417036
NOW-2	MW19-12	618906.202	6099231.486	1166.087	4.57	0	-90	2019 Jun 09	2019 Jun 09	no	417036
NOW-2	TH19-01	618725.317	6098546.628	1183.528	17.0	0	-90	2019 May 31	2019 May 31	no	417327
NOW-2	TH19-02	618775.029	6098610.458	1184.307	17.0	0	-90	2019 May 30	2019 May 30	no	417327
NOW-2	TH19-03	*not drilled*									
NOW-2	TH19-04	618800.142	6098683.01	1182.096	6.0	0	-90	2019 May 25	2019 May 25	no	417327
NOW-2	TH19-05	618758.885	6098990.18	1186.082	15.2	0	-90	2019 May 25	2019 May 25	no	417327
NOW-2	TH19-06	618795.538	6099112.098	1183.811	15.2	0	-90	2019 May 26	2019 May 26	no	417327
NOW-2	TH19-07	618779.969	6099249.765	1185.401	6.0	0	-90	2019 May 25	2019 May 25	no	417036
NOW-2	TH19-08	618727.796	6099340.819	1185.021	6.0	0	-90	2019 May 25	2019 May 25	no	417036
NOW-2	TH19-09	618693.376	6099134.553	1208.62	15.2	0	-90	2019 May 27	2019 May 28	no	417327
NOW-2	TH19-10	618645.489	6099035.145	1219.956	15.2	0	-90	2019 May 27	2019 May 27	no	417327

Hermann 2019 borehole construction details -- **Table A-1 (continued)**

Drilling phase	Borehole	UTM83-E	UTM83-N	Elevation	TD	Azimuth	Dip	Commenced	Completed	Geophysics?	Tenure
NOW-2	TH19-11	618992.541	6098741.345	1186.165	9.14	0	-90	2019 May 23	2019 May 23	no	417036
NOW-2	TH19-12	619061.09	6098871.479	1184.683	6.0	0	-90	2019 May 23	2019 May 23	no	417036
NOW-2	TH19-13	619105.242	6099043.806	1181.834	6.0	0	-90	2019 May 23	2019 May 23	no	417036
NOW-2	TH19-14	619046.162	6099163.488	1179.147	6.1	0	-90	2019 Jun 01	2019 Jun 01	no	417036
NOW-2	TH19-15	618522.404	6098791.867	1219.986	15.2	0	-90	2019 May 26	2019 May 26	no	417327
NOW-2	TH19-16	*not drilled*									
NOW-2	TH19-17	618832.626	6098974.881	1172.358	9.9	0	-90	2019 May 29	2019 May 29	no	417327
NOW-2	TH19-18	*not drilled*									
NOW-2	TH19-19	618897.18	6099208.599	1166.484	15.7	0	-90	2019 Jun 04	2019 Jun 04	no	417036
NOW-2	TH19-20	618957.985	6099199.268	1175.602	12.2	0	-90	2019 Jun 02	2019 Jun 03	no	417036
NOW-2	TH19-21	619022.924	6099181.26	1181.777	12.8	0	-90	2019 Jun 02	2019 Jun 02	no	417036
NOW-2	TH19-22	*not drilled*									
NOW-2	TH19-23	618907.574	6099234.819	1166.248	12.7	0	-90	2019 Jun 04	2019 Jun 04	no	417036
NOW-2	TH19-24	618903.339	6099160.088	1172.693	12.2	0	-90	2019 Jun 03	2019 Jun 03	no	417036
NOW-2	TH19-25	619018.474	6099110.316	1179.553	6.0	0	-90	2019 May 24	2019 May 24	no	417036
NOW-2	TH19-26	619005.058	6098999.351	1178.104	6.0	0	-90	2019 May 24	2019 May 24	no	417036
NOW-2	TH19-27	618892.454	6098836.373	1180.567	9.1	0	-90	2019 May 29	2019 May 29	no	417327
NOW-2	TH19-28	618898.27	6098928.64	1176.101	6.0	0	-90	2019 May 29	2019 May 29	no	417327
NOW-2	TH19-29	618935.685	6099037.778	1176.214	6.0	0	-90	2019 May 24	2019 May 24	no	417327
NOW-2	TH19-30	618959.404	6099121.705	1176.28	6.7	0	-90	2019 Jun 02	2019 Jun 02	no	417036
NOW-2	TH19-31	618986.801	6098910.447	1179.831	5.3	0	-90	2019 May 24	2019 May 24	no	417036
NOW-2	TH19-32	619058.207	6099010.156	1180.874	6.0	0	-90	2019 May 24	2019 May 24	no	417036
NOW-2	TH19-33	618884.427	6098793.589	1181.171	9.1	0	-90	2019 May 29	2019 May 29	no	417327
NOW-3	MW-19-ES	618789.41	6098534.09	1195.69	10.85	0	-90	2019 Oct 29	2019 Oct 30	no	417327
NOW-3	MW-19-ED	618795.1	6098536.11	1195.76	30	0	-90	2019 Oct 28	2019 Oct 29	no	417327

Hermann 2019 borehole construction details -- **Table A-1 (concluded)**

Drilling phase	Borehole	UTM83-E	UTM83-N	Elevation (m)	Total depth (m)	Azimuth	Dip	Commenced	Completed	Geophysics?	Tenure
NOW-3	MW-19-F	618963.15	6098597.71	1190.58	18	0	-90	2019 Nov 01	2019 Nov 02	no	417327
NOW-3	MW-19-G	618664.2	6097848.88	1279.85	15.6	0	-90	2019 Nov 02	2019 Nov 03	no	383181
NOW-3	MW-19-KS	618609.6	6095500.95	1628.25	131	0	-90	2019 Nov 04	2019 Nov 05	no	383180
NOW-3	MW-19-KM	617887.02	6097563.22	1255.87	31.4	0	-90	2019 Nov 05	2019 Nov 07	no	383180
NOW-3	MW-19-KD	617892.27	6097566.7	1255.33	49.7	0	-90	2019 Nov 07	2019 Nov 11	no	383180
NOW-3	MW-19-LS	617897.4	6097569.72	1254.72	110	0	-90	2019 Oct 27	2019 Oct 27	no	383182
NOW-3	MW-19-L	618014.63	6095341.13	1593.19	10.9	0	-90	2019 Oct 24	2019 Oct 26	no	383182
NOW-3	MW-19-M	618009.43	6095335.94	1593.1	37.3	0	-90	2019 Oct 22	2019 Oct 24	no	383182
NOW-3	MW-19-N	618114.35	6095278.68	1596.85	45.4	0	-90	2019 Oct 30	2019 Oct 31	no	417036
NOW-3	MW-19-PD	619022.08	6098432.22	1200.23	16	0	-90	2019 Nov 15	2019 Nov 18	no	383183
NOW-4	EW19-01	618742.4	6098506.2	1196	84.89	0	-90	2019 Sep 16	2019 Sep 21	no	417327
NOW-4	EW19-02	618893	6098664	1186	86.41	0	-90	2019 Sep 18	2019 Sep 27	no	417327
NOW-4	EW19-03	7618722	6098426	1200	103.63	0	-90	2019 Sep 23	2019 Sep 25	no	417327

Hermann 2019 borehole geophysics -- **Table A-2**

Borehole details (metres)						Borehole geophysical logs run (metres)							
Borehole	UTM83 E	UTM83 N	Elevation	Total depth	Tenure	Compensated Density-Gamma-Caliper-Res.	Density Porosity-Gamma-Caliper	Gamma-Density through pipe	Gamma-Neutron	Gamma-Neutron through pipe	Deviation	Dipmeter	Full wave sonic
Tool used (Century Wireline Services tool number)						*9239 C1*	*9239 C1*	*9048 A*	*9058 A*	*9067 A*	*9411 A*	*9411 A*	*9325 A2*
HR19-01C	618290.265	6097814.668	1284.111	397.00	383181	396.62	396.62	395.00	396.20	395.00	397.00	398.90	397.06
HR19-02C	619438.508	6095734.459	1620.333	353.20	383183	350.80	350.80	348.00	350.20	348.00	351.00	351.90	350.04
HR19-03C	619143.858	6096250.684	1597.888	352.85	383183	352.94	352.94	346.20	352.94	346.20	352.00	352.20	352.94
HR19-04C	619158.648	6095942.101	1613.341	250.65	383183	250.66	250.66	250.42	250.66	250.42	250.00	250.10	250.60
HR19-05C	618981.573	6096776.43	1516.424	249.65	383181			250.16		250.16	248.00	248.70	
HR19-06C	618411.445	6097468.327	1372.192	334.54	382181	334.30	334.30	330.00	334.22	330.00	332.00	332.20	333.04
MW19-04-BD	619145.726	6096248.572	1597.998	224.60	383183	224.58			223.20		223.00	223.91	
MW19-05-AD	618280.697	6097807.995	1283.631	127.40	383181	127.20			126.50		127.00	127.30	
MW19-09-CD	619440.279	6095722.696	1620.902	137.16	383183	135.80			135.20		135.00	135.91	
			Total metres	2427.05		2172.90	1685.32	1919.78	2169.12		2415.00	2421.12	1683.68

Large-format core-logging form -- **Table A-3**

Borehole ___________________ *Page*__________ *of* _________

Core runs / total recovered length	*Samples / facies / environment*	*Ferm Code*	*Visual estimate of pyrite content*	*Core description: lithology – grain-size, colour, modifiers, minor constituents, sedimentology, palaeontology, tectonic features, physical condition, basal contact* (e.g. *abrupt./gradational/polished/ erosional/ground out).*	*RQD observation s*	*Recovery (metres), core boxes and DD (marker blocks*	*Thickness (metres) as interpreted from geophysics*	*Depth to base (metres)*	*Apparent bedding dip (BCN angle)*

Core logged by: Date: Page:

Table A-4: Cross-reference of cored boreholes and file names of scanned core descriptions

Borehole	File names of scanned core descriptions (all with .pdf file-name extensions)
HR19-01C	3128_001, 3128_012, 3128_024, 3128_035, 3128_046, 3128_056, and 3128_068
HR19-02C	3129_001, 3129_012, 3129_021, 3129_031, and 3129_040
HR19-03C	3130_001, 3130_011, 3130_022, 3130_031, 3130_040, 3130_049, 3130_060, and 3130_071
HR19-04C	3125_001. 3125_011, 3125_021, 3125_033, and 3125_046
HR19-05C	3126_001, 3126_014, 3126_024, and 3126_035
HR19-06C	3127_001, 3127_012, 3127_021, 3127_031, 3127_041, 3127_050, 3127_060, 3127_069, 3127_079, and 3127_091

A.4 Lithological interpretations of geophysical logs

Geophysical log interpretations (presented in **Table A-5**) were done by the author on the coal combination logs, based primarily on the compensated density log response. A four-component density-based classification of clean and dirty coal, and of coaly and carbonaceous rock, was employed. Only limited interpretive effort was directed at non-carbonaceous rock, mainly to define the apertures and confidence-of-existence of fault zones, and to recognise volcanic ash ('tonstein' or 'bentonite') bands. The following abbreviations and terms are given in **Table A-5**:

- ASH: volcanic ash (based upon high gamma-log response, generally over 300 API units)
- C: coal (based upon density log response less than 1.50 gm/cc)
- CBSH: carbonaceous rock (based upon density log response from 1.90 to ca. 2.20 gm/cc)
- CR: coaly rock (based upon density log response from 1.70 to 1.90 gm/cc)
- DC: dirty coal (based upon density log response from 1.50 to 1.70 gm/cc)
- DRIFT: unconsolidated and semi-consolidated surficial materials
- FAULT: fault zone (with estimated thickness of crush zone based on caliper log response, classified as to confidence-of-existence, as Established, Probable, and Possible.
- IRST: ironstone
- R: rock not represented by the above-listed four components (based upon density log response greater than ca. 2.20 gm/cc)

All thicknesses and depths in **Table A-5** are given in metres, with depths being geophysically-measured depths along the boreholes' trajectories, rather than true vertical depths.

Geophysical log interpretations -- **Table A-5**

HR19-01C				
From (m)	To (m)	Thickness (m)	Lithology	Name
0	0.7	0.7	DRIFT	DRIFT
0.7	16.3	15.6	R	CADOTTE
16.3	20.5	4.2	R	HULCROSS_TOP
20.5	20.51	0.01	R	T-MARKER
20.51	28.4	7.89	R	
28.4	28.5	0.1	ASH	ASH-20
28.5	36.75	8.25	R	
36.75	36.85	0.1	ASH	ASH-18
36.85	38.9	2.05	R	
38.9	39	0.1	ASH	ASH-17
39	45.3	6.3	R	
45.3	45.4	0.1	ASH	ASH-16
45.4	51.4	6	R	
51.4	51.5	0.1	ASH	ASH-15
51.5	60.2	8.7	R	
60.2	60.3	0.1	ASH	ASH-13
60.3	61.95	1.65	R	
61.95	62.2	0.25	ASH	ASH-12
62.2	87	24.8	R	
87	87.1	0.1	ASH	ASH-8
87.1	107	19.9	R	
107	107.4	0.4	ASH	ASH-6
107.4	113.1	5.7	R	
113.1	113.2	0.1	ASH	ASH-5
113.2	114.45	1.25	R	
114.45	114.55	0.1	ASH	ASH-4
114.55	121.8	7.25	R	
121.8	122.1	0.3	ASH	ASH-1
122.1	122.25	0.15	R	
122.25	122.6	0.35	R	BASAL-HULCROSS_TOP
122.6	129.5	6.9	R	NOTIKEWIN_TOP
129.5	129.85	0.35	CBSH	
129.85	130.2	0.35	DC	A1
130.2	130.4	0.2	C	A1
130.4	130.6	0.2	CBSH	
130.6	132.9	2.3	R	
132.9	133.5	0.6	CBSH	
133.5	143.5	10	R	

Geophysical log interpretations -- **Table A-5 (continued)**

From (m)	To (m)	Thickness (m)	Lithology	Name
143.5	143.7	0.2	CBSH	
143.7	144.5	0.8	C	A
144.5	144.7	0.2	CBSH	
144.7	155.15	10.45	R	
155.15	155.45	0.3	CR	B1
155.45	155.7	0.25	CBSH	
155.7	155.95	0.25	R	
155.95	156.7	0.75	CBSH	
156.7	157	0.3	CR	B2
157	157.4	0.4	CBSH	
157.4	157.6	0.2	CR	B3
157.6	157.7	0.1	CBSH	
157.7	174.8	17.1	R	
174.8	175.15	0.35	IRST	
175.15	192.9	17.75	R	
192.9	193.1	0.2	CBSH	
193.1	193.4	0.3	CR	
193.4	193.65	0.25	DC	C
193.65	193.85	0.2	CBSH	
193.85	237.5	43.65	R	
237.5	240.3	2.8	R	FALHER_TOP
240.3	240.49	0.19	CBSH	
240.49	240.95	0.46	CR	
240.95	241.15	0.2	CBSH	
241.15	241.24	0.09	DC	E1
241.24	241.37	0.13	C	E1
241.37	241.6	0.23	DC	E1
241.6	241.8	0.2	CBSH	
241.8	241.95	0.15	CR	
241.95	242.2	0.25	C	E2U
242.2	242.3	0.1	CR	E2U
242.3	242.4	0.1	DC	E2U
242.4	242.5	0.1	ASH	
242.5	243.2	0.7	C	E2L
243.2	243.6	0.4	CR	
243.6	243.95	0.35	C	E3U
243.95	244.2	0.25	DC	E3U
244.2	244.6	0.4	CBSH	
244.6	245.05	0.45	C	E3L

Geophysical log interpretations -- **Table A-5 (continued)**

From (m)	To (m)	Thickness (m)	Lithology	Name
245.05	245.2	0.15	CBSH	
245.2	245.9	0.7	R	
245.9	246.1	0.2	CBSH	
246.1	246.35	0.25	DC	E4U
246.35	246.45	0.1	CR	E4U
246.45	246.6	0.15	DC	E4U
246.6	246.8	0.2	CR	E4U
246.8	247.05	0.25	DC	E4U
247.05	248.25	1.2	C	E4U
248.25	248.5	0.25	CR	
248.5	248.65	0.15	CBSH	
248.65	248.8	0.15	CR	
248.8	250.1	1.3	C	E4L
250.1	250.3	0.2	DC	E4L
250.3	250.6	0.3	CR	
250.6	251.05	0.45	CBSH	
251.05	254.8	3.75	R	
254.8	255.1	0.3	CBSH	
255.1	255.3	0.2	CR	F
255.3	255.5	0.2	DC	F
255.5	255.65	0.15	CBSH	
255.65	258.7	3.05	R	
258.7	258.85	0.15	IRST	
258.85	260.25	1.4	R	
260.25	260.6	0.35	CBSH	
260.6	264.95	4.35	R	
264.95	265.05	0.1	CBSH	
265.05	265.3	0.25	CR	
265.3	265.4	0.1	DC	G2
265.4	265.5	0.1	CR	G2
265.5	265.7	0.2	DC	G2
265.7	265.8	0.1	CBSH	
265.8	266.2	0.4	R	
266.2	266.35	0.15	CBSH	
266.35	266.85	0.5	C	G3
266.85	267.4	0.55	CBSH	
267.4	282.01	14.61	R	
282.01	282.16	0.15	CBSH	
282.16	282.95	0.79	C	J1

Geophysical log interpretations -- **Table A-5 (continued)**

From (m)	To (m)	Thickness (m)	Lithology	Name
282.95	283.05	0.1	DC	J2
283.05	284.69	1.64	C	J2
284.69	285.9	1.21	C	J3
285.9	286.1	0.2	CBSH	
286.1	292.2	6.1	R	
292.2	292.6	0.4	CBSH	K1
292.6	296.6	4	R	
296.6	297	0.4	CBSH	K2
297	300.8	3.8	R	
300.8	301.4	0.6	CBSH	K3
301.4	301.65	0.25	CR	K3
301.65	301.8	0.15	CBSH	K3
301.8	302.5	0.7	R	
302.5	318.05	15.55	R	UP-QUINTETTE_TOP
318.05	318.4	0.35	IRST	
318.4	326.5	8.1	R	
326.5	326.75	0.25	IRST	
326.75	334.4	7.65	R	
334.4	349.85	15.45	R	MEDIAL-SLST_TOP
349.85	350.25	0.4	ASH	
350.25	352.05	1.8	R	
352.05	359.4	7.35	R	LW-QUINTETTE_TOP
359.4	364.5	5.1	R	SPIEKER_TOP
364.5	364.6	0.1	FAULT	POSSIBLE
364.6	373.4	8.8	R	
373.4	373.6	0.2	FAULT	POSSIBLE
373.6	376.15	2.55	R	MEDIAL-SLST
376.15	384.6	8.45	R	LW-QUINTETTE_TOP
384.6	384.75	0.15	FAULT	POSSIBLE
384.75	385.35	0.6	R	MEDIAL-SLST
385.35	385.9	0.55	ASH	
385.9	396.62	10.72	R	
396.62	397	0.38	ND	
HR19-02C				
From (m)	To (m)	Thickness (m)	Lithology	Name
0	0.8	0.7	DRIFT	DRIFT
0.8	35.5	34.7	R	COWMOOSE
35.5	35.9	0.4	FAULT	POSSIBLE

Geophysical log interpretations -- **Table A-5 (continued)**

From (m)	To (m)	Thickness (m)	Lithology	Name
35.9	38.7	2.8	R	
38.7	39	0.3	ASH	ASH-C
39	43.1	4.1	R	
43.1	43.2	0.1	ASH	ASH-B
43.2	61.75	18.55	R	
61.75	61.85	0.1	ASH	ASH-A
61.85	62	0.15	R	
62	62.87	0.87	R	GREEN-MKR_TOP
62.87	63.65	0.78	R	NOTIKEWIN_TOP
63.65	63.73	0.08	FAULT	ESTABLISHED
63.73	67.18	3.45	R	
67.18	67.4	0.22	FAULT	PROBABLE
67.4	73.7	6.3	R	
73.7	74	0.3	FAULT	ESTABLISHED
74	81.4	7.4	R	
81.4	81.5	0.1	CBSH	
81.5	87.91	6.41	R	
87.91	88	0.09	CGL	CAPROCK
88	90.25	2.25	R	
90.25	91	0.75	CBSH	C
91	112.36	21.36	R	
112.36	114.4	1.04	R	FALHER_TOP
114.4	114.7	0.3	CR	D
114.7	115.1	0.4	IRST	
115.1	120.6	5.5	R	
120.6	120.8	0.2	CBSH	E1
120.8	121	0.2	CR	E1
121	121.15	0.15	CBSH	E1
121.15	129.2	8.05	R	
129.2	129.4	0.2	CR	
129.4	129.55	0.15	DC	E2U
129.55	130.3	0.75	C	E2U
130.3	130.75	0.45	CR	
130.75	131.2	0.45	DC	E2L
131.2	131.4	0.2	C	E2L
131.4	131.95	0.55	DC	E2L
131.95	132.25	0.3	CR	
132.25	135.3	3.05	R	
135.3	135.55	0.25	DC	E3U

Geophysical log interpretations -- **Table A-5 (continued)**

From (m)	To (m)	Thickness (m)	Lithology	Name
135.55	142.95	7.4	C	E3U
142.95	143.2	0.25	DC	E3U
143.2	143.5	0.3	CR	
143.5	143.65	0.15	CBSH	
143.65	143.85	0.2	CR	
143.85	144.05	0.2	DC	E3L
144.05	144.15	0.1	CR	E3L
144.15	144.92	0.77	C	E3L
144.92	145	0.08	R	
145	145.2	0.2	DC	E4U
145.2	145.8	0.6	C	E4U
145.8	146.93	1.13	DC	E4L
146.93	147.42	0.49	C	E4L
147.42	147.6	0.18	CBSH	
147.6	147.8	0.2	R	
147.8	148.7	0.9	CBSH	
148.7	236.3	87.6	R	
236.3	236.45	0.15	CBSH	
236.45	236.8	0.35	DC	F1
236.8	236.95	0.15	CR	F1
236.95	237.3	0.35	DC	F1
237.3	239.1	1.8	C	F1
239.1	241.2	2.1	C	F2
241.2	241.25	0.05	R	F2
241.25	241.65	0.4	C	F2
241.65	242	0.35	CR	
242	242.1	0.1	CBSH	
242.1	242.5	0.4	R	
242.5	242.7	0.2	CR	
242.7	242.9	0.2	CBSH	
242.9	251.7	8.8	R	
251.7	252.8	1.1	DC	G1
252.8	253.3	0.5	C	G1
253.3	253.6	0.3	DC	G2
253.6	254.05	0.45	C	G2
254.05	254.3	0.25	CBSH	
254.3	255.3	1	R	
255.3	255.45	0.15	CBSH	
255.45	255.7	0.25	CR	

Geophysical log interpretations -- **Table A-5 (continued)**

From (m)	To (m)	Thickness (m)	Lithology	Name
255.7	256.11	0.41	C	G3
256.11	256.45	0.34	CR	
256.45	256.8	0.35	R	
256.8	256.9	0.1	FAULT	ESTABLISHED
256.9	257.2	0.3	R	
257.2	257.4	0.2	CBSH	
257.4	258.15	0.75	C	G1
258.15	259.05	0.9	C	G2
259.05	260.5	1.45	R	
260.5	260.75	0.25	CBSH	
260.75	261.2	0.45	C	G3
261.2	270.78	9.58	R	
270.78	270.85	0.07	FAULT	POSSIBLE
270.85	271.3	0.45	DC	G3
271.3	285.8	14.5	R	
285.8	286	0.2	DC	J1
286	286.15	0.15	CBSH	J1
286.15	286.4	0.25	R	J1
286.4	287.55	1.15	C	J1
287.55	287.6	0.05	DC	J1
287.6	288.05	0.45	C	J1
288.05	288.3	0.25	CBSH	
288.3	288.9	0.6	R	
288.9	290.55	1.65	C	J2
290.55	290.85	0.3	DC	J2
290.85	291.85	1	C	J2
291.85	291.95	0.1	DC	J2
291.95	292.15	0.2	C	J2
292.15	292.25	0.1	DC	J3
292.25	295.7	3.45	C	J3
295.7	295.95	0.25	DC	J3
295.95	296.55	0.6	R	
296.55	297	0.45	CR	
297	297.2	0.2	R	
297.2	297.45	0.25	CBSH	
297.45	297.8	0.35	CR	
297.8	298.1	0.3	CBSH	
298.1	298.2	0.1	CR	
298.2	298.6	0.4	C	K1

Geophysical log interpretations -- **Table A-5 (continued)**

From (m)	To (m)	Thickness (m)	Lithology	Name
298.6	298.7	0.1	DC	K1
298.7	298.9	0.2	C	K1
298.9	299	0.1	DC	K1
299	299.15	0.15	C	K1
299.15	299.4	0.25	CBSH	
299.4	299.75	0.35	R	
299.75	300.1	0.35	CBSH	
300.1	300.3	0.2	DC	K2
300.3	300.45	0.15	CR	K2
300.45	300.6	0.15	DC	K2
300.6	300.8	0.2	CR	K2
300.8	301.15	0.35	DC	K2
301.15	301.4	0.25	CBSH	
301.4	304.1	2.7	R	
304.1	304.5	0.4	CBSH	K3
304.5	309.2	4.7	R	
309.2	343.7	34.5	R	UP-QUINTETTE_TOP
343.7	349.6	5.9	R	MEDIAL-SLST_TOP
349.6	351.9	2.3	ND	
HR19-03C				
From (m)	To (m)	Thickness (m)	Lithology	Name
0	0.3	0.3	DRIFT	DRIFT
0.3	13.3	13	R	
13.3	13.7	0.4	CBSH	
13.7	15.9	2.2	R	
15.9	15.95	0.05	ASH	ASH-6
15.95	24.2	8.25	R	
24.2	24.3	0.1	ASH	ASH-5
24.3	25.5	1.2	R	
25.5	25.6	0.1	ASH	ASH-4
25.6	33.87	8.27	R	
33.87	34.05	0.18	R	BASAL-HULCROSS_TOP
34.05	41.2	7.15	R	NOTIKEWIN_TOP
41.2	41.7	0.5	CBSH	
41.7	41.9	0.2	R	
41.9	42	0.1	CR	A1
42	42.2	0.2	CBSH	A1
42.2	42.3	0.1	FAULT	ESTABLISHED

Geophysical log interpretations -- **Table A-5 (continued)**

From (m)	To (m)	Thickness (m)	Lithology	Name
42.3	47.85	5.55	R	
47.85	48.05	0.2	CBSH	
48.05	48.4	0.35	CR	A1
48.4	48.6	0.2	CBSH	
48.6	55.1	6.5	R	
55.1	55.5	0.4	CBSH	A2
55.5	64	8.5	R	
64	64.78	0.78	C	A
64.78	73.45	8.67	R	
73.45	73.85	0.4	IRST	
73.85	74.15	0.3	R	
74.15	74.83	0.68	CBSH	B
74.83	99.45	24.62	R	SST_BASE
99.45	111.5	12.05	R	
111.5	111.6	0.1	IRST	
111.6	112.85	1.25	R	
112.85	113	0.15	FAULT	ESTABLISHED
113	121.2	8.2	R	SST_BASE
121.2	126.3	5.1	R	
126.3	126.6	0.3	IRST	
126.6	137.45	10.85	R	
137.45	137.5	0.05	FAULT	ESTABLISHED
137.5	150.64	13.14	R	
150.64	150.97	0.33	CGL	CAPROCK
150.97	151.05	0.08	CBSH	
151.05	151.15	0.1	CR	
151.15	151.6	0.45	DC	C1
151.6	152.3	0.7	C	C1
152.3	152.9	0.6	CBSH	
152.9	153.1	0.2	CR	
153.1	153.35	0.25	DC	C2
153.35	153.9	0.55	CBSH	
153.9	177.02	23.12	R	
177.02	178	0.98	R	GRITSTONE
178	198.1	20.1	R	
198.1	199.21	1.11	R	FALHER_TOP
199.21	199.57	0.36	DC	E1
199.57	199.8	0.23	CR	
199.8	200.15	0.35	CBSH	

Geophysical log interpretations -- **Table A-5 (continued)**

From (m)	To (m)	Thickness (m)	Lithology	Name
200.15	200.58	0.43	C	E2U
200.58	200.67	0.09	DC	E2L
200.67	200.85	0.18	C	E2L
200.85	200.89	0.04	CBSH	E2L
200.89	201.3	0.41	C	E2L
201.3	201.51	0.21	CBSH	
201.51	201.87	0.36	R	
201.87	202.13	0.26	CBSH	
202.13	202.27	0.14	C	
202.27	202.61	0.34	CBSH	
202.61	203.51	0.9	R	
203.51	203.8	0.29	DC	
203.8	204.11	0.31	R	
204.11	204.3	0.19	CBSH	
204.3	204.7	0.4	C	E3U
204.7	204.85	0.15	ASH	ASH
204.85	205	0.15	DC	E3L
205	205.2	0.2	C	E3L
205.2	205.5	0.3	DC	E3L
205.5	206.32	0.82	CBSH	
206.32	206.5	0.18	FAULT	ESTABLISHED
206.5	206.55	0.05	DC	E3U
206.55	206.8	0.25	C	E3U
206.8	207.22	0.42	DC	E3U
207.22	207.34	0.12	CR	
207.34	207.4	0.06	DC	E3L
207.4	207.5	0.1	C	E3L
207.5	207.73	0.23	CR	
207.73	208.24	0.51	CBSH	
208.24	211.97	3.73	R	
211.97	212.4	0.43	CBSH	
212.4	212.7	0.3	DC	
212.7	212.85	0.15	R	
212.85	213	0.15	ASH	ASH
213	213.09	0.09	CR	
213.09	214.71	1.62	C	E4U
214.71	215.05	0.34	CBSH	
215.05	216.6	1.55	C	E4L
216.6	216.65	0.05	DC	E4L

Geophysical log interpretations -- **Table A-5 (continued)**

From (m)	To (m)	Thickness (m)	Lithology	Name
216.65	243.48	26.83	R	
243.48	243.9	0.42	C	F1
243.9	244.15	0.25	DC	F1
244.15	244.4	0.25	DC	F2
244.4	244.75	0.35	R	
244.75	245.22	0.47	CBSH	
245.22	245.5	0.28	DC	G2
245.5	245.69	0.19	C	G2
245.69	245.74	0.05	CR	G2
245.74	246	0.26	DC	G2
246	246.45	0.45	R	
246.45	246.67	0.22	CBSH	
246.67	247.5	0.83	C	G3
247.5	247.57	0.07	R	
247.57	247.8	0.23	CBSH	
247.8	269.3	21.5	R	
269.3	273.55	4.25	C	J1
273.55	275.85	2.3	C	J2
275.85	277.4	1.55	C	J3
277.4	277.43	0.03	CBSH	
277.43	282.15	4.72	R	
282.15	282.7	0.55	CBSH	
282.7	282.9	0.2	CR	
282.9	282.99	0.09	DC	K1
282.99	283.16	0.17	CBSH	K1
283.16	283.37	0.21	C	K1
283.37	283.64	0.27	DC	K1
283.64	284.05	0.41	C	K1
284.05	284.2	0.15	DC	K1
284.2	284.55	0.35	C	K1
284.55	286.7	2.15	R	
286.7	286.85	0.15	C	K2U
286.85	286.91	0.06	CBSH	K2U
286.91	287.15	0.24	DC	K2U
287.15	287.42	0.27	CR	K2U
287.42	287.65	0.23	DC	K2U
287.65	287.8	0.15	CBSH	
287.8	287.92	0.12	C	
287.92	288.05	0.13	CBSH	

Geophysical log interpretations -- **Table A-5 (continued)**

From (m)	To (m)	Thickness (m)	Lithology	Name
288.05	288.35	0.3	DC	K2L
288.35	288.5	0.15	CR	K2L
288.5	289.05	0.55	DC	K2L
289.05	291.93	2.88	R	
291.93	292.13	0.2	CR	K3U
292.13	294.15	2.02	R	
294.15	294.29	0.14	C	K3L
294.29	294.4	0.11	CBSH	
294.4	295.3	0.9	R	
295.3	320.23	24.93	R	UP-QUINTETTE_TOP
320.23	320.27	0.04	FAULT	PROBABLE
320.27	331.7	11.43	R	
331.7	346.45	14.75	R	MEDIAL-SLST_TOP
346.45	352.94	6.49	R	LW-QUINTETTE_TOP
352.94	353.2	0.26	ND	
352.94	353.2	0.26	ND	
HR19-04C				
From (m)	To (m)	Thickness (m)	Lithology	Name
0	1.2	1.2	DRIFT	DRIFT
1.2	2.7	1.5	R	FALHER
2.7	3.2	0.5	CBSH	
3.2	6.35	3.15	R	
6.35	6.7	0.35	CBSH	
6.7	6.9	0.2	CR	
6.9	8.6	1.7	DC	E4U
8.6	8.75	0.15	CR	
8.75	9.5	0.75	R	
9.5	10.25	0.75	DC	E4L
10.25	10.55	0.3	CR	E4L
10.55	10.9	0.35	DC	E4L
10.9	11.4	0.5	CR	E4L
11.4	11.85	0.45	DC	E4L
11.85	30.5	18.65	R	
30.5	30.6	0.1	CBSH	
30.6	30.8	0.2	C	F1
30.8	30.95	0.15	DC	F1
30.95	31.24	0.29	C	F1
31.24	31.4	0.16	DC	F2

Geophysical log interpretations -- **Table A-5 (continued)**

From (m)	To (m)	Thickness (m)	Lithology	Name
31.4	31.8	0.4	CBSH	
31.8	31.95	0.15	R	
31.95	32.07	0.12	CBSH	
32.07	32.65	0.58	C	G2
32.65	32.9	0.25	R	
32.9	33.05	0.15	CBSH	
33.05	33.6	0.55	C	G3
33.6	33.8	0.2	CBSH	
33.8	53.5	19.7	R	
53.5	55.6	2.1	C	J1
55.6	55.7	0.1	DC	J2
55.7	56.65	0.95	C	J2
56.65	58.4	1.75	C	J3
58.4	58.65	0.25	DC	J3
58.65	59	0.35	CBSH	
59	60.9	1.9	R	
60.9	61.12	0.22	CBSH	
61.12	61.3	0.18	CR	K1
61.3	61.4	0.1	DC	K1
61.4	61.8	0.4	CR	K1
61.8	62	0.2	DC	K1
62	62.1	0.1	CBSH	
62.1	62.65	0.55	R	
62.65	62.85	0.2	CBSH	
62.85	63.4	0.55	DC	K2
63.4	63.6	0.2	C	K2
63.6	63.7	0.1	DC	K2
63.7	63.95	0.25	C	K2
63.95	64.2	0.25	CBSH	
64.2	66.1	1.9	R	
66.1	66.28	0.18	CBSH	K3U
66.28	67.9	1.62	R	
67.9	68	0.1	CBSH	K3L
68	68.57	0.57	ASH	K-ASH
68.57	94.85	26.28	R	UP-QUINTETTE_TOP
94.85	107.6	12.75	R	MEDIAL-SLST_TOP
107.6	124.5	16.9	R	LW-QUINTETTE_TOP
124.5	170.97	46.47	R	SPIEKER_TOP
170.97	171.29	0.32	FAULT	POSSIBLE

Geophysical log interpretations -- **Table A-5 (continued)**

From (m)	To (m)	Thickness (m)	Lithology	Name
171.29	184.4	13.11	R	
184.4	184.5	0.1	R	SPIEKER_TOP
184.5	184.9	0.4	CBSH	
184.9	185.1	0.2	CR	
185.1	186.1	1	CBSH	
186.1	250.66	64.56	R	
250.66	250.93	0.27	ND	
HR19-05C				
From (m)	To (m)	Thickness (m)	Lithology	Name
0	4.45	4.45	DRIFT	DRIFT
4.45	16.9	12.45	R	HULCROSS
16.9	16.95	0.05	ASH	ASH-18
16.95	18.65	1.7	R	
18.65	18.75	0.1	ASH	ASH-17
18.75	21.35	2.6	R	
21.35	21.5	0.15	FAULT	PROBABLE
21.5	25.55	4.05	R	
25.55	25.6	0.05	ASH	ASH-18
25.6	29.22	3.62	R	
29.22	29.27	0.05	ASH	ASH-17
29.27	37	7.73	R	
37	37.6	0.6	FAULT	ESTABLISHED
37.6	43.2	5.6	R	
43.2	43.3	0.1	ASH	ASH-16
43.3	53.3	10	R	
53.3	53.35	0.05	ASH	ASH-15
53.35	55.5	2.15	R	
55.5	55.6	0.1	ASH	ASH-13
55.6	57.4	1.8	R	
57.4	57.5	0.1	ASH	ASH-12
57.5	89.95	32.45	R	
89.95	90.05	0.1	ASH	ASH-9
90.05	91.8	1.75	R	
91.8	91.85	0.05	ASH	ASH-8
91.85	109.85	18	R	
109.85	109.87	0.02	ASH	ASH-6
109.87	114.94	5.07	R	
114.94	114.97	0.03	ASH	ASH-5

Geophysical log interpretations -- **Table A-5 (continued)**

From (m)	To (m)	Thickness (m)	Lithology	Name
114.97	115.95	0.98	R	
115.95	116	0.05	ASH	ASH-4
116	121.92	5.92	R	
121.92	122	0.08	ASH	ASH-2
122	123.2	1.2	R	
123.2	123.22	0.02	ASH	ASH-1
123.22	123.26	0.04	R	
123.26	123.27	0.01	R	BASAL-HULCROSS_TOP
123.27	134.9	11.63	R	NOTIKEWIN_TOP
134.9	135.24	0.34	CBSH	A1
135.24	146.74	11.5	R	
146.74	146.75	0.01	CR	
146.75	147.36	0.61	C	A
147.36	147.53	0.17	DC	A
147.53	147.81	0.28	CBSH	
147.81	156.41	8.6	R	
156.41	156.44	0.03	CBSH	
156.44	156.53	0.09	R	
156.53	156.6	0.07	CBSH	
156.6	164.11	7.51	R	
164.11	165.53	1.42	R	
165.53	165.6	0.07	CR	B1
165.6	166.06	0.46	CBSH	
166.06	166.32	0.26	C	B2
166.32	199.69	33.37	R	
199.69	200.05	0.36	R	CAPROCK
200.05	200.45	0.4	C	C1
200.45	200.5	0.05	DC	C1
200.5	200.91	0.41	CBSH	
200.91	201.01	0.1	DC	C2
201.01	201.46	0.45	CBSH	
201.46	230.6	29.14	R	
230.6	248.7	18.1	R	FALHER_TOP
248.7	248.76	0.06	FAULT	POSSIBLE
248.76	250.4	1.64	R	
HR19-06C				
From (m)	To (m)	Thickness (m)	Lithology	Name
0	2.3	2.3	DRIFT	DRIFT

Geophysical log interpretations -- **Table A-5 (continued)**

From (m)	To (m)	Thickness (m)	Lithology	Name
2.3	23.9	21.6	R	HULCROSS
23.9	24	0.1	ASH	ASH-8
24	43.2	19.2	R	
43.2	43.25	0.05	ASH	ASH-6
43.25	48.85	5.6	R	
48.85	48.9	0.05	ASH	ASH-5
48.9	50	1.1	R	
50	50.3	0.3	ASH	ASH-4
50.3	57	6.7	R	
57	57.3	0.3	ASH	ASH-1
57.3	58	0.7	R	
58	58.27	0.27	R	BASAL-HULCROSS_TOP
58.27	65.3	7.03	R	NOTIKEWIN_TOP
65.3	65.35	0.05	ASH	
65.35	70.54	5.19	R	
70.54	70.66	0.12	CBSH	A1
70.66	70.83	0.17	C	A1
70.83	70.95	0.12	CBSH	A1
70.95	80.4	9.45	R	
80.4	80.6	0.2	CBSH	
80.6	81.4	0.8	C	A
81.4	81.89	0.49	CBSH	
81.89	91.08	9.19	R	
91.08	91.26	0.18	CBSH	B1
91.26	91.31	0.05	CR	B1
91.31	91.43	0.12	CBSH	B1
91.43	91.45	0.02	CR	B1
91.45	92.2	0.75	R	
92.2	93.3	1.1	CBSH	
93.3	93.35	0.05	DC	B2
93.35	93.52	0.17	R	B2
93.52	93.58	0.06	CBSH	B2
93.58	93.75	0.17	DC	B2
93.75	93.91	0.16	C	B2
93.91	94	0.09	CBSH	
94	95.3	1.3	R	
95.3	95.4	0.1	CBSH	B3
95.4	95.65	0.25	CR	B3
95.65	129.07	33.42	R	

Geophysical log interpretations -- **Table A-5 (continued)**

From (m)	To (m)	Thickness (m)	Lithology	Name
129.07	129.44	0.37	R	CAPROCK
129.44	129.64	0.2	DC	C1
129.64	129.79	0.15	CR	
129.79	129.93	0.14	CBSH	
129.93	130.06	0.13	DC	C2
130.06	130.18	0.12	CBSH	C2
130.18	130.28	0.1	DC	C2
130.28	130.4	0.12	CBSH	
130.4	176.04	45.64	R	
176.04	177.3	1.26	R	FALHER_TOP
177.3	177.45	0.15	ASH	
177.45	177.65	0.2	R	
177.65	178.13	0.48	DC	E1
178.13	178.17	0.04	C	E1
178.17	178.22	0.05	CR	E1
178.22	178.25	0.03	C	E1
178.25	178.34	0.09	CBSH	
178.34	178.53	0.19	R	
178.53	178.7	0.17	CBSH	
178.7	178.75	0.05	DC	E2U
178.75	178.91	0.16	C	E2U
178.91	179.18	0.27	DC	E2U
179.18	179.25	0.07	ASH	
179.25	179.31	0.06	DC	E2L
179.31	180.04	0.73	C	E2L
180.04	180.36	0.32	R	
180.36	180.85	0.49	C	E3U
180.85	181.59	0.74	DC	E3L
181.59	181.76	0.17	C	E3L
181.76	181.99	0.23	R	
181.99	182.07	0.08	DC	
182.07	183.31	1.24	CBSH	
183.31	183.4	0.09	DC	
183.4	183.6	0.2	ASH	
183.6	183.8	0.2	DC	E4U
183.8	183.82	0.02	ASH	E4U
183.82	183.93	0.11	DC	E4U
183.93	185.05	1.12	C	E4U
185.05	185.2	0.15	CBSH	

Geophysical log interpretations -- **Table A-5 (continued)**

From (m)	To (m)	Thickness (m)	Lithology	Name
185.2	185.45	0.25	R	
185.45	185.6	0.15	CBSH	
185.6	185.7	0.1	DC	E4L
185.7	185.95	0.25	C	E4L
185.95	186.06	0.11	DC	E4L
186.06	186.74	0.68	C	E4L
186.74	186.89	0.15	CBSH	E4L
186.89	187.45	0.56	C	E4L
187.45	187.5	0.05	DC	E4L
187.5	189.9	2.4	R	
189.9	190.2	0.3	CBSH	
190.2	194.3	4.1	R	
194.3	194.7	0.4	DC	F1
194.7	197.3	2.6	R	
197.3	197.52	0.22	CBSH	F2
197.52	203.19	5.67	R	
203.19	203.3	0.11	CR	
203.3	203.35	0.05	DC	G2
203.35	203.55	0.2	C	G2
203.55	203.8	0.25	DC	G2
203.8	204	0.2	CBSH	
204	204.46	0.46	R	
204.46	205.19	0.73	C	G3
205.19	205.43	0.24	DC	G3
205.43	205.55	0.12	CBSH	
205.55	220.5	14.95	R	
220.5	220.95	0.45	C	J1
220.95	221.16	0.21	DC	J1
221.16	221.38	0.22	CR	
221.38	221.44	0.06	DC	J2
221.44	222.67	1.23	C	J2
222.67	224.01	1.34	C	J3
224.01	224.05	0.04	DC	J3
224.05	232.3	8.25	R	
232.3	232.43	0.13	CBSH	K1
232.43	236.32	3.89	R	
236.32	236.6	0.28	CBSH	K2
236.6	240.55	3.95		
240.55	240.75	0.2	DC	K3

Geophysical log interpretations -- **Table A-5 (continued)**

From (m)	To (m)	Thickness (m)	Lithology	Name
240.75	241.08	0.33	CR	K3
241.08	241.16	0.08	DC	K3
241.16	241.35	0.19	CBSH	
241.35	242.5	1.15	R	
242.5	242.9	0.4	CBSH	
242.9	243.25	0.35	R	
243.25	243.55	0.3	CBSH	
243.55	271.8	28.25	R	UP-QUINTETTE_TOP
271.8	284.77	12.97	R	MEDIAL-SLST_TOP
284.77	285.15	0.38	ASH	ASH-L
285.15	285.25	0.1	R	
285.25	291.88	6.63	R	LW-QUINTETTE_TOP
291.88	292.39	0.51	FAULT	PROBABLE
292.39	294.24	1.85	R	
294.25	334.3	40.05	R	SPIEKER_TOP
MW19-AD				
From (m)	To (m)	Thickness (m)	Lithology	Name
0	0.7	0.7	DRIFT	DRIFT
0.7	14.3	13.6	R	CADOTTE
14.3	18.3	4	R	HULCROSS_TOP
18.3	18.31	0.01	R	T-MARKER
18.31	26.5	8.19	R	
26.5	26.6	0.1	ASH	ASH-20
26.6	35.45	8.85	R	
35.45	35.55	0.1	ASH	ASH-18
35.55	38.05	2.5	R	
38.05	38.15	0.1	ASH	ASH-17
38.15	44.95	6.8	R	
44.95	45.1	0.15	ASH	ASH-16
45.1	51.45	6.35	R	
51.45	51.55	0.1	ASH	ASH-15
51.55	60.4	8.85	R	
60.4	60.65	0.25	ASH	ASH-13
60.65	62.2	1.55	R	
62.2	62.55	0.35	ASH	ASH-12
62.55	79.55	17	R	
79.55	79.7	0.15	ASH	ASH-8
79.7	100.35	20.65	R	

Geophysical log interpretations -- **Table A-5 (continued)**

From (m)	To (m)	Thickness (m)	Lithology	Name
100.35	100.5	0.15	ASH	ASH-7
100.5	106.9	6.4	R	
106.9	107.4	0.5	ASH	ASH-6
107.4	112.9	5.5	R	
112.9	113.05	0.15	ASH	ASH-5
113.05	114.25	1.2	R	
114.25	114.4	0.15	ASH	ASH-4
114.4	121.4	7	R	
121.4	122	0.6	ASH	ASH-1
122	122.7	0.7	R	BASAL-HULCROSS_TOP
122.7	127.2	4.5	R	NOTIKEWIN_TOP
127.2	127.4	0.2	ND	
MW19-BD				
From (m)	To (m)	Thickness (m)	Lithology	Name
0	1.75	1.75	DRIFT	DRIFT
1.75	4.7	2.95	R	
4.7	4.8	0.1	ASH	ASH-7
4.8	12.35	7.55	R	
12.35	12.55	0.2	CBSH	
12.55	15.1	2.55	R	
15.1	15.25	0.15	ASH	ASH-6
15.25	22.9	7.65	R	
22.9	23	0.1	ASH	ASH-5
23	24.5	1.5	R	
24.5	24.65	0.15	ASH	ASH-4
24.65	33.85	9.2	R	
33.85	34.25	0.4	R	BASAL-HULCROSS_TOP
34.25	39.8	5.55	R	NOTIKEWIN_TOP
39.8	40	0.2	CR	A1
40	41.85	1.85	R	
41.85	42	0.15	FAULT	PROBABLE
42	52.6	10.6	R	
52.6	52.9	0.3	CBSH	
52.9	53.1	0.2	DC	A1
53.1	57.2	4.1	R	
57.2	57.35	0.15	CBSH	A2
57.35	65.8	8.45	R	
65.8	66	0.2	CBSH	

Geophysical log interpretations -- **Table A-5 (continued)**

From (m)	To (m)	Thickness (m)	Lithology	Name
66	66.6	0.6	C	A
66.6	75.3	8.7	R	
75.3	76.1	0.8	IRST	
76.1	76.3	0.2	R	
76.3	76.5	0.2	CBSH	B
76.5	76.9	0.4	CR	B
76.9	121.1	44.2	CBSH	B
121.1	121.5	0.4	R	CAPROCK
121.5	121.8	0.3	R	
121.8	122	0.2	CBSH	
122	122.75	0.75	C	C1
122.75	123.05	0.3	CBSH	
123.05	123.2	0.15	R	
123.2	123.45	0.25	CR	C2
123.45	137.45	14	R	
137.45	137.6	0.15	IRST	
137.6	145.45	7.85	R	
145.45	145.65	0.2	FAULT	ESTABLISHED
145.65	145.75	0.1	CR	C2
145.75	146	0.25	R	
146	146.1	0.1	CBSH	
146.1	190.8	44.7	R	
190.8	192.8	2	R	FALHER_TOP
192.8	192.95	0.15	CR	
192.95	193.1	0.15	DC	E1
193.1	193.2	0.1	C	E1
193.2	193.4	0.2	DC	E1
193.4	193.8	0.4	CBSH	
193.8	194.1	0.3	C	E2U
194.1	194.5	0.4	DC	E2L
194.5	194.85	0.35	C	E2L
194.85	195.15	0.3	DC	E2L
195.15	195.65	0.5	R	
195.65	195.85	0.2	CR	
195.85	196.4	0.55	C	E3U
196.4	196.6	0.2	DC	E3U
196.6	196.75	0.15	CR	
196.75	196.9	0.15	DC	E3L
196.9	197.15	0.25	CR	

Geophysical log interpretations -- **Table A-5 (continued)**

From (m)	To (m)	Thickness (m)	Lithology	Name
197.15	202	4.85	R	
202	202.5	0.5	CBSH	
202.5	202.9	0.4	CR	
202.9	203.05	0.15	ASH	
203.05	203.15	0.1	CR	
203.15	204.6	1.45	C	E4U
204.6	204.8	0.2	CBSH	
204.8	205.3	0.5	R	
205.3	206.95	1.65	C	E4L
206.95	207.15	0.2	R	
207.15	207.3	0.15	CBSH	
207.3	224.58	17.28	R	
224.58	224.6	0.02	ND	
MW19-CD				
From (m)	To (m)	Thickness (m)	Lithology	Name
0	0.55	0.55	DRIFT	DRIFT
0.55	6	5.45	R	COWMOOSE
6	6.1	0.1	FAULT	POSSIBLE
6.1	7.8	1.7	R	
7.8	7.9	0.1	FAULT	POSSIBLE
7.9	41.05	33.15	R	
41.05	41.4	0.35	ASH	ASH-C
41.4	46.45	5.05	R	
46.45	46.7	0.25	ASH	ASH-B
46.7	64.75	18.05	R	
64.75	64.8	0.05	ASH	ASH-A
64.8	66.1	1.3	R	GREEN-MKR_TOP
66.1	76.85	10.75	R	CHAMBERLAIN_TOP
76.85	77	0.15	FAULT	POSSIBLE
77	79.7	2.7	R	NOTIKEWIN
79.7	81.9	2.2	R	FALHER_TOP
81.9	82.05	0.15	CBSH	D
82.05	93.85	11.8	R	
93.85	94.1	0.25	CBSH	E1
94.1	97.3	3.2	R	
97.3	97.5	0.2	CBSH	
97.5	98.65	1.15	C	E2U
98.65	98.8	0.15	CR	

Geophysical log interpretations -- **Table A-5 (concluded)**

From (m)	To (m)	Thickness (m)	Lithology	Name
98.8	99	0.2	CBSH	
99	99.25	0.25	CR	
99.25	99.6	0.35	DC	E2L
99.6	99.85	0.25	CR	
99.85	100	0.15	CBSH	
100	102.3	2.3	R	
102.3	102.5	0.2	CR	
102.5	102.6	0.1	CBSH	
102.6	102.75	0.15	CR	
102.75	102.9	0.15	CBSH	
102.9	103.02	0.12	DC	
103.02	103.6	0.58	CR	
103.6	103.75	0.15	DC	E3U
103.75	111.05	7.3	C	E3U
111.05	111.15	0.1	DC	E3L
111.15	111.75	0.6	C	E3L
111.75	112	0.25	DC	E3L
112	112.7	0.7	R	
112.7	112.8	0.1	FAULT	POSSIBLE
112.8	127.7	14.9	R	
127.7	127.9	0.2	CBSH	E4U
127.9	128	0.1	R	
128	128.05	0.05	CBSH	E4L
128.05	135.8	7.75	R	
135.8	136.3	0.5	ND	

Appendix C: Daily exploration progress reports

This appendix presents scanned copies (in the machine-readable version of this report) or hardcopies (in the printed version of this report) of daily exploration progress reports submitted by Apex Geoscience's project geologists.