BC Geological Survey
Coal Assessment Report
999

COAL ASSESSMENT REPORT TITLE PAGE AND SUMMARY

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

TOTAL COST: $103,080

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

YEAR OF WORK: **2014-2015** REPORT DATE: **September 16, 2015**

PROPERTY NAME: **Hermann**

COAL LICENSE(S) AND/OR LEASES ON WHICH PHYSICAL WORK WAS DONE: **none during the 2014-2015 reporting period. Only analytical work was done in 2014-2015, on samples from previously-reported drilling.**

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**
LATITUDE: **55° 59’ 45" N**
LONGITUDE: **121° 06’ 00" W** (at centre of work)
UTM Zone: **10N** EASTING: **621450** NORTHING: **6095980**

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

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

REPORT KEYWORDS
bituminous coal, Gates Formation, washability, ash chemistry, fluidity, proximate analysis, petrography

REFERENCES TO PREVIOUS ASSESSMENT WORK AND ASSESSMENT REPORT NUMBERS:
Coal Assessment Report 950 (principal reference); 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.

SUMMARY OF TYPES OF WORK IN THIS REPORT		EXTENT OF WORK	ON WHICH TENURES
		(in metric units)	
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	**none**	**not applicable**
	Resistivity	**none**	**not applicable**
	Caliper	**none**	**not applicable**
	Deviation	**none**	**not applicable**
	Dipmeter	**none**	**not applicable**
	Others (specify types)	**none**	**not applicable**
	Core **-- no further drilling during report period**	**none**	**not applicable**
	Non-core-- **no further drilling during report period**	**none**	**not applicable**
SAMPLING AND ANALYSES			
Total # of Samples**: 97, all of which were taken from year-2014 cores**			
	Proximate (including sulphur and FSI)	**251**	**383180 and 383181**
	Ultimate	**none**	**not applicable**
	Gieseler fluidity (ddpm)	**14**	**383180 and 383181**
	Ash chemistry	**209**	**383180 and 383181**
	Petrographic	**12**	**383180 and 383181**
	Vitrinite reflectance	**12**	**383180 and 383181**
	Coking	**none**	**not applicable**
	Wash tests (**float-sink tests**)	**38**	**383180 and 383181**
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**

Appendices B and C remain confidential under the terms of the Coal Act Regulation, and has 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

1.2 List of maps

1.3 List of figures

2 Introduction and situation

This report, titled *Coal Assessment Report for Hermann coal licences, Mt. Hermann area, British Columbia*, is intended to document results of coal-quality investigations on cores collected during the year-2014 exploration programme, and subsequently analysed during the 2014-2015 work term, after the submission of the year-2014 report, indexed as Coal Assessment Report No.950 (CAR-950). CAR-950 is the primary background reference source for the present report, and the interested reader is directed there to obtain a more detailed recounting of historic and current exploratory work, and of the geological setting of the Hermann coal property.

Geological and other property maps submitted with the present report are copied verbatim from CAR-950, as there has been no substantive change in understanding of the property's geology and situation.

The Hermann coal property consists of provincially-granted Crown coal tenures comprising twelve Coal Licences, numbered 383180-383183, 405136-405142, and 417327. No freehold coal rights are known to exist at Hermann.

These tenures 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.

Historic (prior to year-2000) exploratory work, comprising the drilling of 171 boreholes, trenching, geological mapping, seismic surveys and the driveage of several adits, was done by Denison Mines Ltd. and Quintette Coal Corporation, the previous owners of the Hermann property. Historic work is well-documented in several previously-submitted coal assessment reports, which are comprehensively referenced in CAR-950.

Historic work was performed within the boundaries of a much larger coal property (the former Quintette property), within which the Hermann coal property constitutes a smaller subset of contiguous coal tenures.

Current physical exploratory work, as already-reported in CAR-950, comprises the drilling of 97 boreholes, whose positions and depths are repeated within **Tables 2-2**, **2-3** and **2-4** of the present report.

Appendix A of the present report provides an inventory of samples collected from year-2014 boreholes and subsequently analysed over the winter and spring of the 2014-2015 work term. The sample inventory has been derived from sample tag booklets and a laboratory worksheet.

Appendices B and **C** of the present report provide analytical details concerning laboratory-scale washability studies on composites assembled from certain of the year-2014 samples, and petrographic/reflectometric analyses on simulated clean coal products.

Washability studies (**Appendix B**) and petrographic/reflectometric data (**Appendix C**) concerning clean coal are submitted on a confidential basis, in keeping with the provisions of the *Coal Act Regulation.*

2.1 Location and access

General location of the property is depicted as **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.

<u>Access to the western end of the property</u>

The Nabors Road passes across the western side of the Hermann coal property, ending at a natural-gas well situated south of the Hermann property's southern boundary (but within the 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 suitable as walking routes, or for usage by all-terrain vehicles.

<u>Access to the central portion of the property</u>

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.

<u>Access to the eastern end of the property</u>

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.

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.

2.1.1 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 has recently (summer of 2014) been actively produced from a wellhead (c-02-B/93-P-3) situated within Coal Licence 383181, although that well's present status is not known.

2.2 Property description

The Hermann property comprises 12 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 3,044 hectares, and whose annual rental cost is $51,600. Exploration has taken place between the years 1976 and 1989 ('historic work') and again between the years 2005 and 2014 ('current' work).

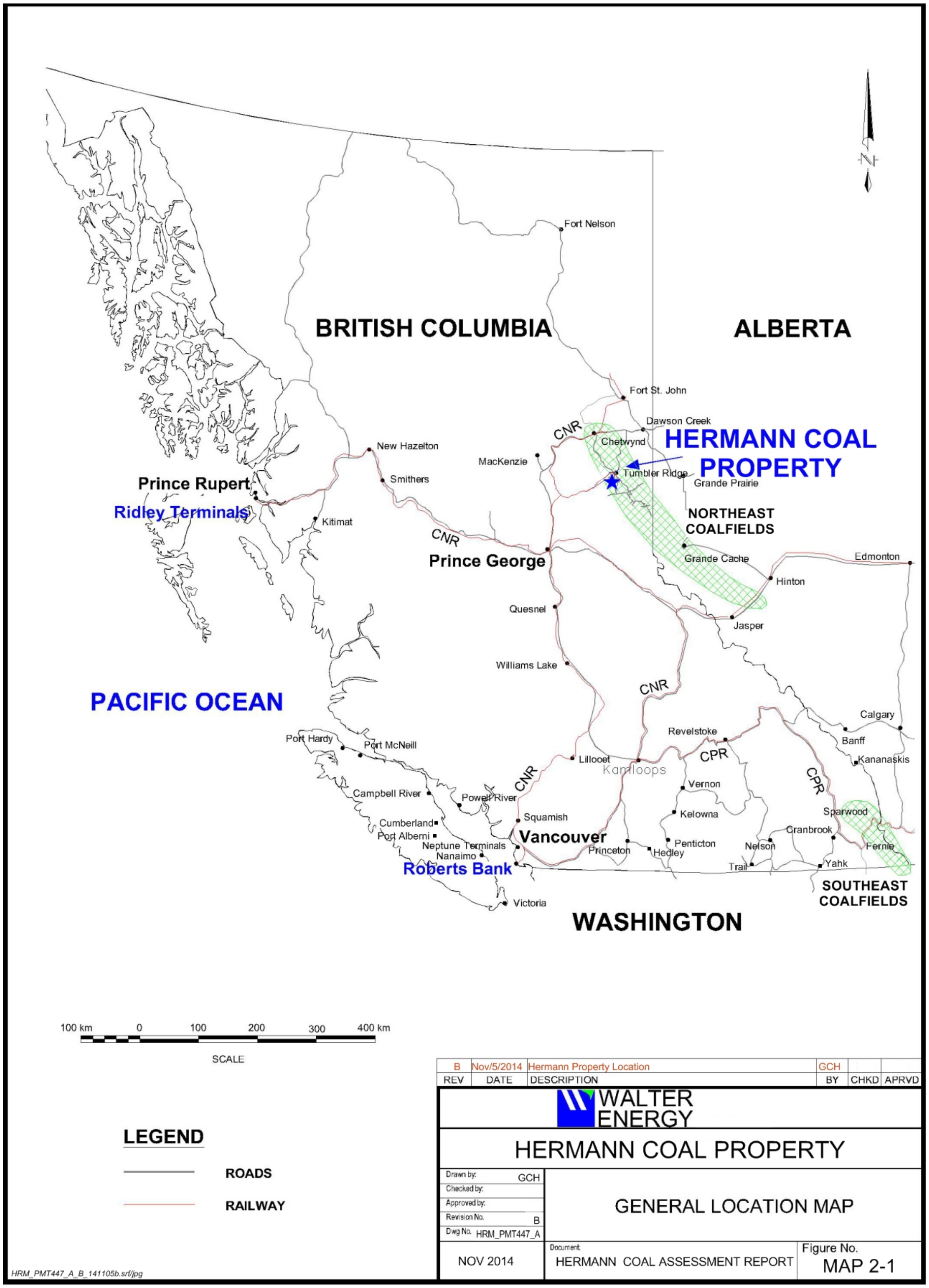

BRITISH COLUMBIA
ALBERTA
WASHINGTON
PACIFIC OCEAN
HERMANN COAL PROPERTY
NORTHEAST COALFIELDS
SOUTHEAST COALFIELDS
Fort Nelson
Fort St. John
Dawson Creek
Chetwynd
Tumbler Ridge
Grande Prairie
Grande Cache
Edmonton
Hinton
Jasper
MacKenzie
New Hazelton
Smithers
Prince Rupert
Ridley Terminals
Kitimat
CNR
Prince George
Quesnel
Williams Lake
Calgary
Banff
Kananaskis
Revelstoke
CPR
Lillooet
Kamloops
Vernon
Kelowna
Penticton
Hedley
Princeton
Nelson
Trail
Cranbrook
Sparwood
Fernie
Yahk
Port Hardy
Port McNeill
Campbell River
Powell River
Squamish
Cumberland
Port Alberni
Neptune Terminals
Nanaimo
Vancouver
Roberts Bank
Victoria
100 km
0
100
200
300
400 km
SCALE
LEGEND
ROADS
RAILWAY
B
Nov/5/2014
Hermann Property Location
GCH
REV
DATE
DESCRIPTION
BY
CHKD
APRVD
WALTER ENERGY
HERMANN COAL PROPERTY
Drawn by: GCH
Checked by:
Approved by:
Revision No. B
Dwg No. HRM_PMT447_A
GENERAL LOCATION MAP
NOV 2014
Document: HERMANN COAL ASSESSMENT REPORT
Figure No. MAP 2-1
HRM_PMT447_A_B_141105b.srf/jpg

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, 2015	$20	$5940
383181	93P/3 Block B	1, 2, 11, 12	297.00	Dec.18, 2000	Dec.18, 2015	$20	$5940
383182	93I/14 Block J	83, 84, 93, 94	297.00	Dec.18, 2000	Dec.18, 2015	$20	$5940
383183	93I/14 Block J	81, 82, 91, 92	297.00	Dec.18, 2000	Dec. 18, 2015	$20	$5940
405136	93P/3 Block A	5,16,15,16	297.00	Sep.19, 2003	Sep.19, 2015	$15	$4455
405137	93P/3 Block A	7, 8, 17, 18	297.00	Sep.19, 2003	Sep.19, 2015	$15	$4455
405138	93P/3 Block A	9, 10, 19, 20	297.00	Sep.19, 2003	Sep.19, 2015	$15	$4455
405139	93I/14 Block I	90, 100	148.00	Sep.19, 2003	Sep.19, 2015	$15	$2220
405140	93I/14 Block I	87, 88, 97, 98	297.00	Sep.19, 2003	Sep.19, 2015	$15	$4455
405141	93I/14 Block I	96	74.00	Sep.19, 2003	Sep.19, 2015	$15	$1110
405142	93I/14 Block I	67, 68, 77, 78	297.00	Sep.19, 2003	Sep.19, 2015	$15	$4455
417327	93P/3 Block B	22, 23	149.00	Apr.25, 2006	Apr. 25, 2016	$15	$2235
12 coal licences / 41 units			3044 ha				$51,600

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.

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.

2.3 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, have now been 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.

2.4 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 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. 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.

2.5 Current work

'Current work', for the purposes of this report, comprises drilling (**Map 2-4**) and ancillary geological and coal-quality studies conducted by Western Canada Coal Corporation and its successor companies Western Coal and Walter Energy (acting through its various subsidiaries, including the Walter Canadian Coal Partnership), leading to resource/reserve estimation and a feasibility study (both accomplished in year-2007). Current (and historic) work has been extensively documented by CAR-950 and by prior studies referenced therein.

Current exploratory work commenced with the year-2005 drilling programme, progressed through year-2006 drilling, and has culminated in the year-2014 programme. The drilling programmes have been discussed in detail within CAR-950 and are only revisited in summary former within the present report. However, as of the effective date of CAR-950 in November of 2014, coal-quality studies on year-2014 core samples had not yet commenced. Their subsequent analytical results (not previously reported) are here presented within **Appendices A**, **B**, and **C** of the present report.

Since the submission of CAR-950, no substantive progress has been made on structural and coal-resource modelling studies, and hence the geological map contained within the present report is copied verbatim from CAR-950.

2.5.1 Year-2005 work

Year-2005 exploratory work at Hermann comprised the drilling of 37 boreholes, totalling 5781.03 metres of drilling, as presented below in **Table 2-2**. These boreholes were devoted mainly to investigations of structural geology within proposed open-pit mine areas, with a lesser concern for coal-quality.

Nine of these boreholes, in the MW05-series were devoted to the investigation of groundwater hydrology within shallow (Drift-hosted) and deep (bedrock-hosted) aquifers.

2.5.2 Year-2006 work

Year-2006 exploratory work at Hermann comprised the drilling of 54 boreholes, totalling 4758.35 metres of drilling, as presented below in **Table 2-3**. Again, these boreholes were devoted mainly to investigations of structural geology, with some work being done on coal-quality, including the collection of bulk samples at three sites, for coal-quality and coking tests. Six of these boreholes, in the HD2006-series were devoted to the collection of cores for geotechnical studies.

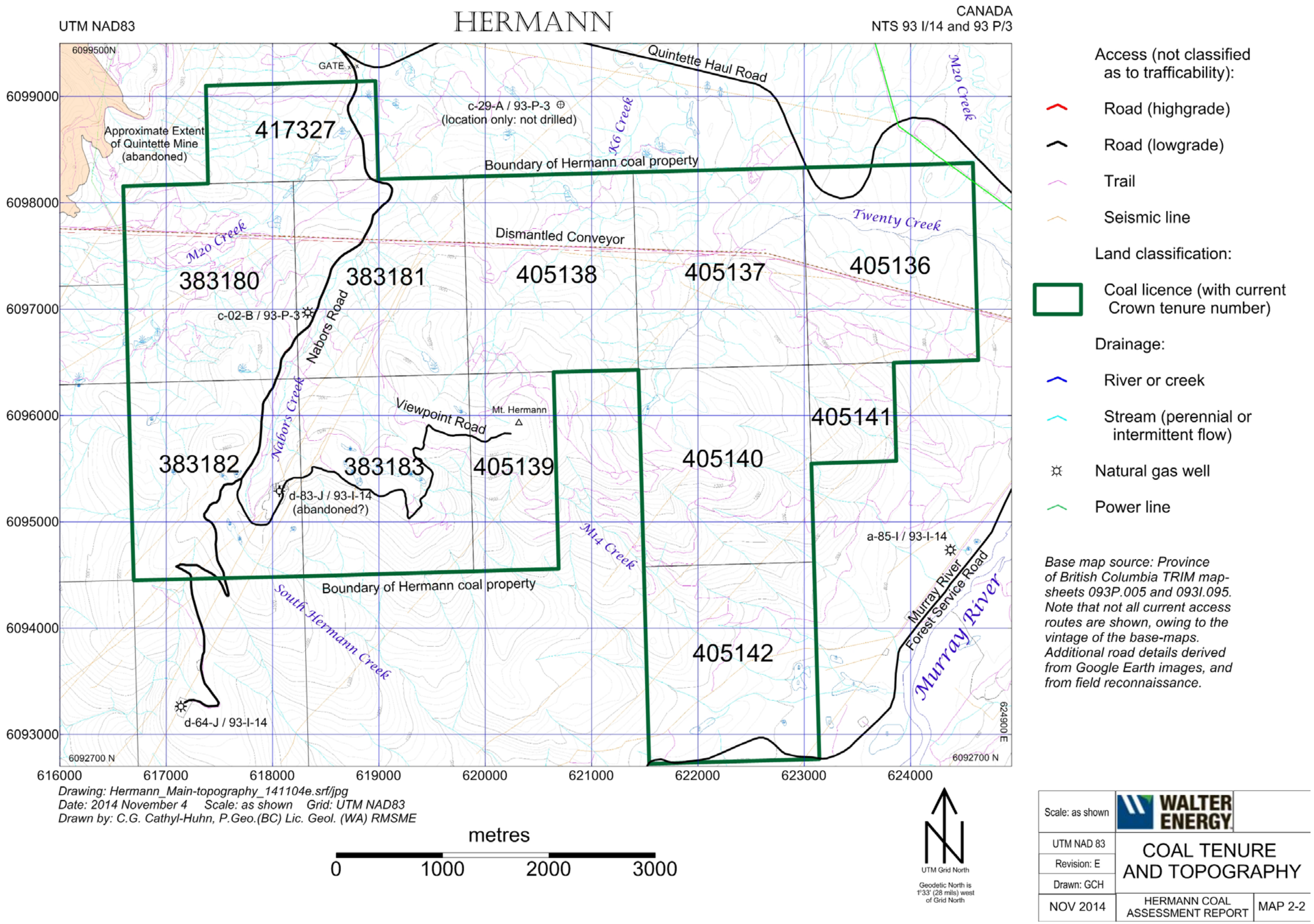
Most of the boreholes were geophysically logged, and their positions surveyed. Exceptions to this practice were borehole HR2006-11, which collapsed before it could be logged, and the letter-suffixed HRBS-series bulk sample holes, for which only their four rotary-drilled pilot holes were logged and surveyed. Exact positions of the associated cored holes, where the actual bulk-samples were taken, were not been surveyed, and they are therefore assigned the coordinates of their pilot holes (with the reasonable expectation that the bulk-sample holes were drilled within a short distance of their pilot holes).

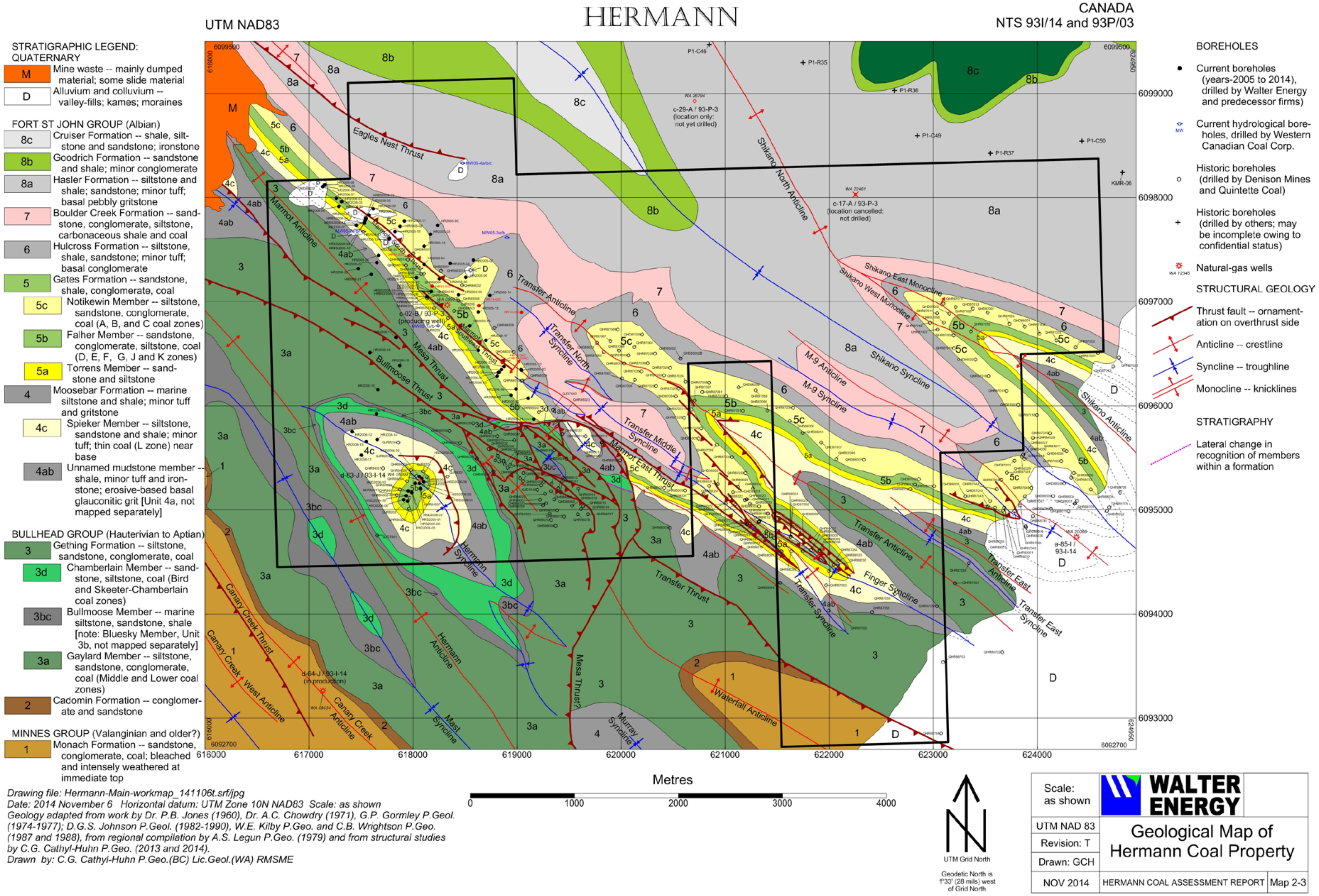
Table 2-2: Year-2005 drilling

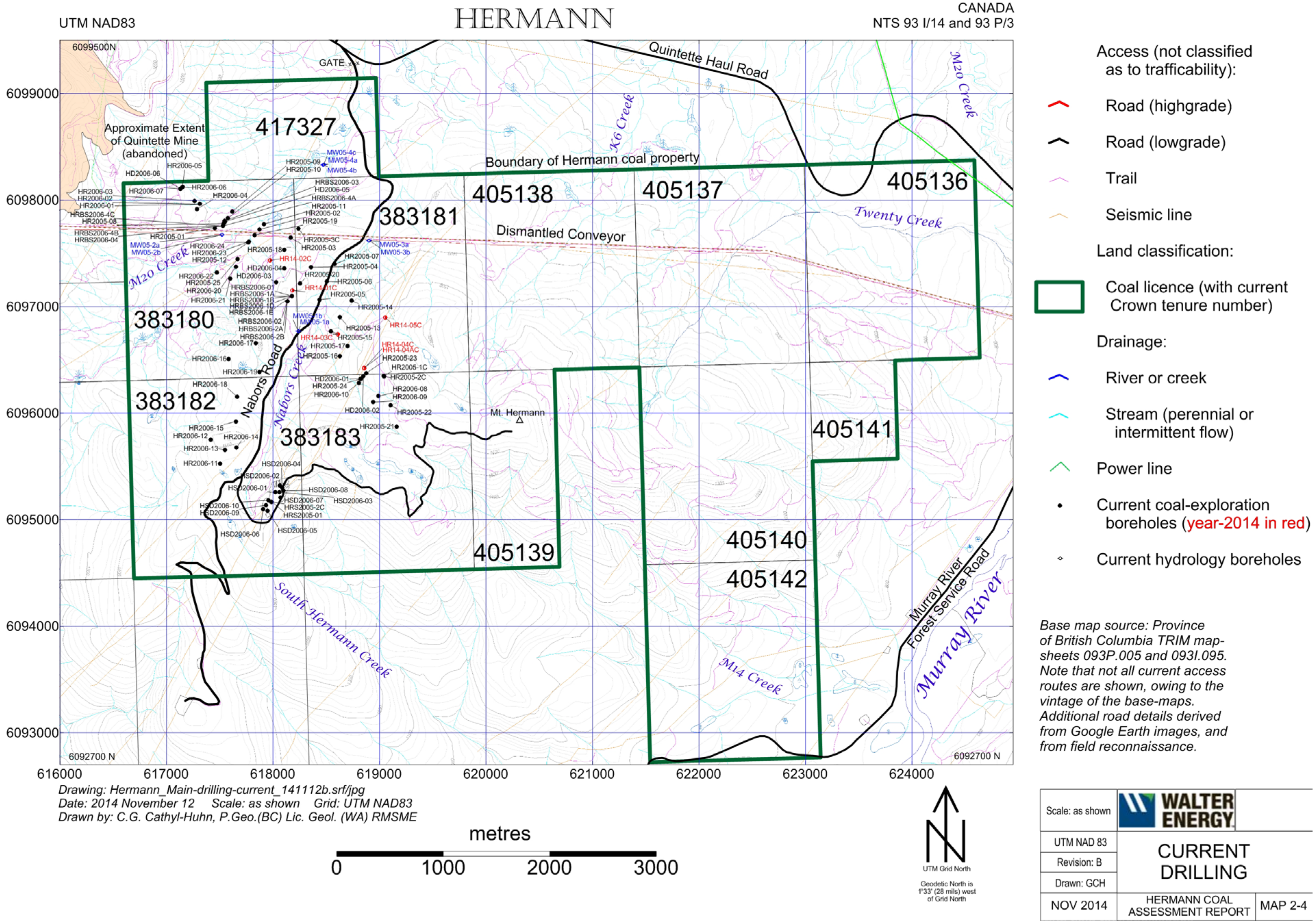
Borehole	NAD83 UTM		Metres		Drilling Method	Coal Assessment Report in which logs and other data located?
	Easting	Northing	Elevation	Total Depth		
HR2005-01	617454.415	6097733.493	1279.557	311.22	Rotary	950
HR2005-1C	619037.927	6096347.605	1573.272	160.99	Diamond	950
HR2005-02	617873.253	6097723.704	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

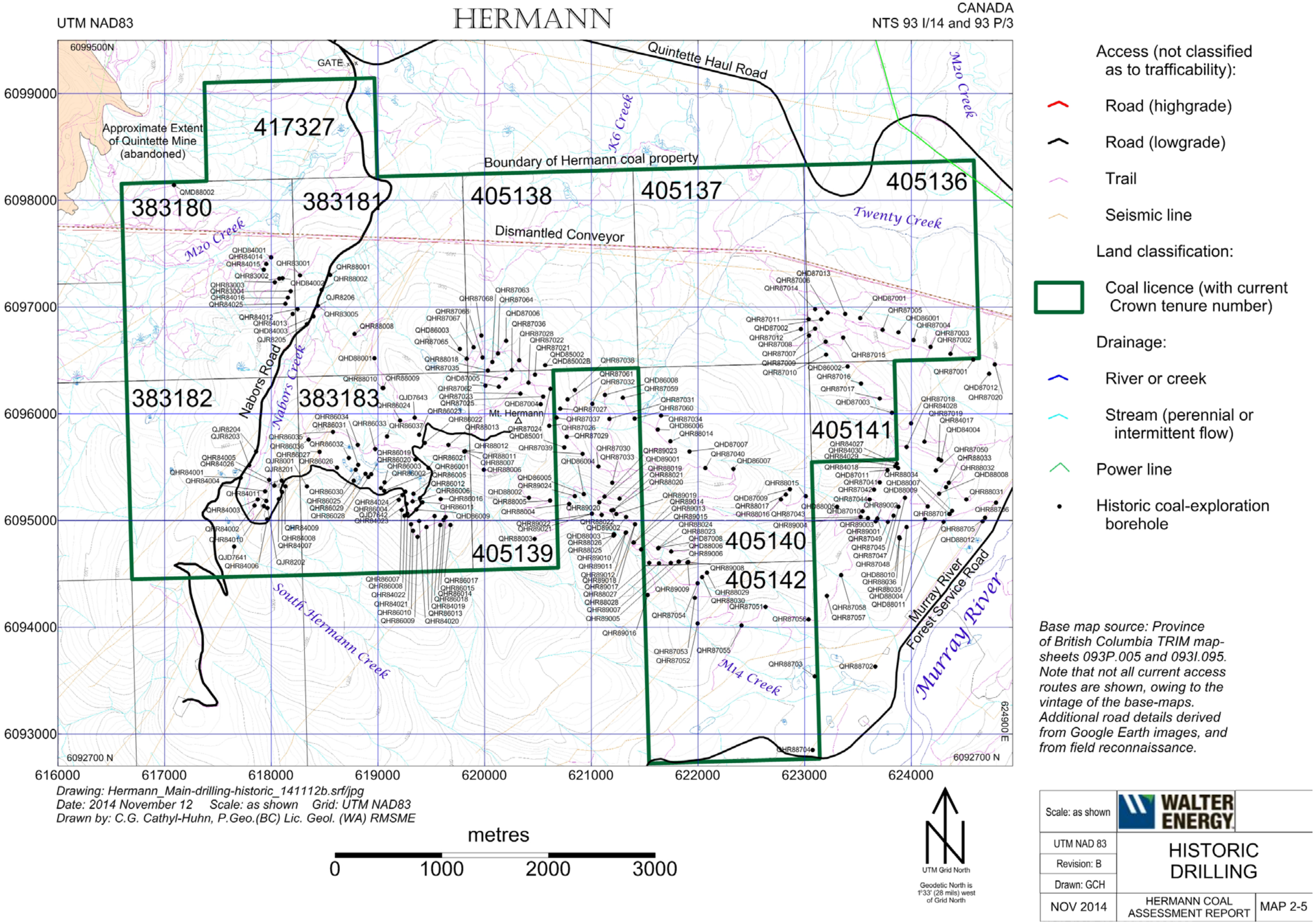
Table 2-2: Year-2005 drilling (concluded)

Borehole	NAD83 UTM		Metres		Drilling Method	Coal Assessment Report in which logs and other data located?
	Easting	Northing	Elevation	Total Depth		
HR2005-11	617915.562	6097774.347	1231.057	204.33	Rotary	950
HR2005-12	617769.049	6097601.105	1253.234	153.25	Rotary	950
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 Report No.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	


HERMANN
UTM NAD83
CANADA
NTS 93 I/14 and 93 P/3
Quintette Haul Road
GATE
Approximate Extent of Quintette Mine (abandoned)
417327
c-29-A / 93-P-3 (location only: not drilled)
K6 Creek
M20 Creek
Boundary of Hermann coal property
Twenty Creek
Dismantled Conveyor
M20 Creek
383180
383181
405138
405137
405136
c-02-B / 93-P-3
Nabors Road
Nabors Creek
Viewpoint Road
Mt. Hermann
405141
383182
383183
405139
405140
d-83-J / 93-I-14 (abandoned?)
M14 Creek
a-85-I / 93-I-14
Boundary of Hermann coal property
South Hermann Creek
Murray River Forest Service Road
Murray River
405142
d-64-J / 93-I-14
6099500N
6092700 N
624900 E
6099000
6098000
6097000
6096000
6095000
6094000
6093000
616000
617000
618000
619000
620000
621000
622000
623000
624000
Access (not classified as to trafficability):
Road (highgrade)
Road (lowgrade)
Trail
Seismic line
Land classification:
Coal licence (with current Crown tenure number)
Drainage:
River or creek
Stream (perennial or intermittent flow)
Natural gas well
Power line
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 Google Earth images, and from field reconnaissance.
Drawing: Hermann_Main-topography_141104e.srf/jpg
Date: 2014 November 4 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
WALTER ENERGY
UTM NAD 83
Revision: E
Drawn: GCH
COAL TENURE AND TOPOGRAPHY
NOV 2014
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 -- shale, siltstone and sandstone; ironstone
8b Goodrich Formation -- sandstone and shale; minor conglomerate
8a Hasler Formation -- siltstone and shale; sandstone; minor tuff; basal pebbly gritstone
7 Boulder Creek Formation -- sandstone, conglomerate, siltstone, carbonaceous shale and coal
6 Hulcross Formation -- siltstone, shale, sandstone; minor tuff; basal conglomerate
5 Gates Formation -- sandstone, shale, conglomerate, coal
5c Notikewin Member -- siltstone, sandstone, conglomerate, coal (A, B, and C coal zones)
5b Falher Member -- sandstone, conglomerate, siltstone, coal (D, E, F, G, J and K zones)
5a Torrens Member -- sandstone and siltstone
4 Moosebar Formation -- marine siltstone and shale; minor tuff and gritstone
4c Spieker Member -- siltstone, sandstone and shale; minor tuff; thin coal (L zone) near base
4ab Unnamed mudstone member -- shale, minor tuff and ironstone; erosive-based basal glauconitic grit [Unit 4a, not mapped separately]
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 [note: Bluesky Member, Unit 3b, not mapped separately]
3a Gaylard Member -- siltstone, sandstone, conglomerate, coal (Middle and Lower coal zones)
2 Cadomin Formation -- conglomerate and sandstone
MINNES GROUP (Valanginian and older?)
1 Monach Formation -- sandstone, conglomerate, coal; bleached and intensely weathered at immediate top
BOREHOLES
Current boreholes (years-2005 to 2014), drilled by Walter Energy and predecessor firms)
Current 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 -- knicklines
STRATIGRAPHY
Lateral change in recognition of members within a formation
Eagles Nest Thrust
Marmot Anticline
Bullmoose Thrust
Mesa Thrust
Transfer Anticline
Transfer North Syncline
Transfer Middle Syncline
Marmot East Thrust
Shikano North Anticline
Shikano East Monocline
Shikano West Monocline
Shikano Syncline
Shikano Anticline
M-9 Anticline
M-9 Syncline
Transfer Thrust
Transfer Syncline
Finger Syncline
Transfer East Anticline
Transfer East Syncline
Hermann Syncline
Hermann Anticline
Canary Creek Thrust
Canary Creek West Anticline
Canary Creek Anticline
Mast Syncline
Mesa Thrust?
Murray Syncline
Waterfall Anticline
616000
617000
618000
619000
620000
621000
622000
623000
624000
6099000
6098000
6097000
6096000
6095000
6094000
6093000
Metres
0
1000
2000
3000
4000
UTM Grid North
Geodetic North is 1°33' (28 mils) west of Grid North
Drawing file: Hermann-Main-workmap_141106t.srf/jpg
Date: 2014 November 6 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 and 2014).
Drawn by: C.G. Cathyl-Huhn P.Geo.(BC) Lic.Geol.(WA) RMSME
Scale: as shown
WALTER ENERGY
UTM NAD 83
Revision: T
Drawn: GCH
NOV 2014
Geological Map of Hermann Coal Property
HERMANN COAL ASSESSMENT REPORT
Map 2-3


HERMANN
UTM NAD83
CANADA
NTS 93 I/14 and 93 P/3
6099500N
GATE
Quintette Haul Road
M20 Creek
K6 Creek
Approximate Extent of Quintette Mine (abandoned)
417327
Boundary of Hermann coal property
405138
405137
405136
383181
Dismantled Conveyor
Twenty Creek
M20 Creek
383180
383182
383183
Nabors Road
Nabors Creek
Mt. Hermann
405141
405139
405140
405142
South Hermann Creek
M14 Creek
Murray River Forest Service Road
Murray River
6099000
6098000
6097000
6096000
6095000
6094000
6093000
6092700 N
616000
617000
618000
619000
620000
621000
622000
623000
624000
Access (not classified as to trafficability):
Road (highgrade)
Road (lowgrade)
Trail
Seismic line
Land classification:
Coal licence (with current Crown tenure number)
Drainage:
River or creek
Stream (perennial or intermittent flow)
Power line
Current coal-exploration boreholes (year-2014 in red)
Current hydrology boreholes
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 Google Earth images, and from field reconnaissance.
Drawing: Hermann_Main-drilling-current_141112b.srf/jpg
Date: 2014 November 12 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
WALTER ENERGY
UTM NAD 83
Revision: B
Drawn: GCH
CURRENT DRILLING
NOV 2014
HERMANN COAL ASSESSMENT REPORT
MAP 2-4



HERMANN
UTM NAD83
CANADA
NTS 93 I/14 and 93 P/3
Quintette Haul Road
GATE
Approximate Extent of Quintette Mine (abandoned)
Boundary of Hermann coal property
Dismantled Conveyor
417327
383180
383181
405138
405137
405136
383182
383183
405141
405139
405140
405142
M20 Creek
K6 Creek
Twenty Creek
Nabors Road
Nabors Creek
Mt. Hermann
South Hermann Creek
M14 Creek
Murray River Forest Service Road
Murray River
6099500N
6099000
6098000
6097000
6096000
6095000
6094000
6093000
6092700 N
616000
617000
618000
619000
620000
621000
622000
623000
624000
624900E
Access (not classified as to trafficability):
Road (highgrade)
Road (lowgrade)
Trail
Seismic line
Land classification:
Coal licence (with current Crown tenure number)
Drainage:
River or creek
Stream (perennial or intermittent flow)
Power line
Historic coal-exploration borehole
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 Google Earth images, and from field reconnaissance.
Drawing: Hermann_Main-drilling-historic_141112b.srf/jpg
Date: 2014 November 12 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
WALTER ENERGY
UTM NAD 83
Revision: B
Drawn: GCH
HISTORIC DRILLING
NOV 2014
HERMANN COAL ASSESSMENT REPORT
MAP 2-5

Table 2-3: Year-2006 drilling

Borehole	NAD83 UTM		Metres		Drilling Method	Coal Assessment Report in which logs and other data located?
	Easting	Northing	Elevation	Total Depth		
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
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 Report No.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 Report No.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	

Table 2-3: Year-2006 drilling (continued)

Borehole	NAD83 UTM		Metres		Drilling Method	Coal Assessment Report in which logs and other data located?
	Easting	Northing	Elevation	Total Depth		
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

2.5.3 Year-2007 work

No physical exploratory work was done at Hermann in year-2007. However, coal resources and reserves were estimated (Minnes, 2007), and a feasibility study for mining (Michaud and others, 2007) was prepared. Furthermore, an application for an Environmental Assessment Certificate was prepared and submitted (Pomeroy, 2007).

2.5.4 Year-2014 work

Year-2014 exploratory work performed at Hermann comprised the drilling of six boreholes, as presented below in **Table 2-4**. These boreholes were geophysically logged by Century Geophysical Corporation, using a standard coal-industry suite of sondes including (where possible) Century's dipmeter tool. Geophysical logs of these boreholes have been included in the previously-submitted CAR-950 report.

Table 2-4: Year-2014 drilling

Borehole	NAD83 UTM		Metres		Drilling Method	Coal Assessment Report in which logs and other data located?
	Easting	Northing	Elevation	Total Depth		
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

2.6 Cross-references to earlier studies

Geological mapping and exploratory drilling of the Hermann property was undertaken by staff of DuPont of Canada Exploration Limited, Denison Mines and Quintette Coal between 1976 and 1989, and a study of structural geology was undertaken by staff of Norwest Corporation in 2010 (Anonymous, 2010).

Cross-references to prior coal-assessment reports and other technical reports are given in CAR-950. Structural mapping, palaeobotanical and palynological studies, and measurement of stratigraphic sections were also undertaken by researchers working on behalf of both the federal and provincial geological surveys, two oil companies, and two universities. Feasibility and coal-resource studies, to *National Instrument 43-101* standards, were most recently conducted by Marston Canada Limited in 2007.

2.7 Cross-references to historic drilling

During Denison Mines' ownership of the property, extensive drilling was conducted (as shown on **Map 2-5** and in **Table 2-5**). In all, 171 historic boreholes were drilled between 1976 and 1989, with aggregate depth at least 17,117 metres. The depth total is a minimal estimate, owing to incomplete reporting of borehole details. Most boreholes were drilled with rotary rigs, but some were cored with diamond-drills. **Table 2-5** incorporates data (with some positional corrections) from the B.C. Geological Survey Branch's *COALFILE* database.

Table 2-5: Historic drilling during years 1976 through 1989

Borehole	UTM NAD83		Metres		Drilling method	Coal Assessment Report in which logs and other data located?
	Easting	Northing	Elevation	Total depth		
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
QJR8001	618332.99	6095320.63	1603	123	Rotary	614; coordinates corrected
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
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
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

Table 2-5: Historic drilling (continued)

Borehole	UTM NAD83		Metres		Drilling method	Coal Assessment Report in which logs and other data located?
	Easting	Northing	Elevation	Total depth		
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
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
QHD85002	620568.98	6096453.52	1519.76	145.08	Diamond	724
QHD85002B	620568.98	6096453.52	1519.76	225	Diamond	724
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

Table 2-5: Historic drilling (continued)

Borehole	UTM NAD83		Metres		Drilling method	Coal Assessment Report in which logs and other data located?
	Easting	Northing	Elevation	Total depth		
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
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
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

Table 2-5: Historic drilling (continued)

Borehole	UTM NAD83		Metres		Drilling method	Coal Assessment Report in which logs and other data located?
	Easting	Northing	Elevation	Total depth		
QHR87012	622966.53	6096796	1116.81	183.3	Rotary	739
QHR87013	623380.3	6096934.11	1041.15	143.7	Rotary	739
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
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 2-5: Historic drilling (concluded)

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
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

2.8 Natural-gas wells

In addition to the 171 historic coal-exploration boreholes, two natural-gas exploration wells have been drilled within the Hermann coal property, as shown on **Map 2-3** and listed in **Table 2-6**. 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 well (c-02-B / 93-P-03) was still producing gas as of the summer of 2014, although it may since have been shut-in owing to low gas prices.

Table 2-6: 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	active producer?	618330	6096968

2.9 Acknowledgements and professional responsibility

Manager of coal quality Christy Burres supervised the analysis of the year-2014 core samples, and forwarded copies of third-party reports as well as preparing the discussions of analytical methods and the analytical worksheet contained within **Appendix A** of this report. Data analyst Preetpal Singh catalogued the geophysical logs for the year-2014 boreholes, as part of an ongoing regional-scale data-archiving project.

Gwyneth Cathyl-Huhn P.Geo. 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 the Sukunka-Quintette coalfield is known mainly from the extensive work of D.F. Stott (1960; 1961; 1963; 1968; 1973; 1974; 1982; 1998), and D.W. Gibson (1992a, 1992b) on behalf of the Geological Survey of Canada. 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 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 operations, in the event that they are exposed at adverse orientations within mine walls.

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 paleontological evidence and limited tephrachronological dating.

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 are 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			
Quaternary			Drift			nil to 80 m	D			
Early Cretaceous	Late Albian	Fort St. John	Cruiser			>15 m?	8c			
Early Cretaceous	Late Albian	Fort St. John	Goodrich			50 m?	8b			
Early Cretaceous	Late Albian	Fort St. John	Hasler			150 m?	8a			
Early Cretaceous	Late Middle Albian to Late Albian	Fort St. John	Boulder Creek			130 m	7		thin unnamed coal(s)	
Early Cretaceous	Middle Albian	Fort St. John	Hulcross			105 m	6			
Early Cretaceous	Late Early Albian	Fort St. John	Gates	Notikewin		90 to 115 m	5	5c	A coal bed	
									B coal bed	
									C coal bed	
Early Cretaceous	Late Early Albian	Fort St. John	Gates	Falher		70 to 90 m	5	5b	D coal bed	
									E1-E3 coals	E
									E4 coal bed	E
									F1 coal bed	F
									F2 coal bed	F
									G1 coal bed	G
									G2 coal bed	G
									J1 coal bed	J
									J2 coal bed	J
									J3 coal bed	J
									K1-K3 coals	K
Early Cretaceous	Late Early Albian	Fort St. John	Gates	Torrens	Quintette Sandstone	25 to 32 m	5	5a		
Early Cretaceous	Late Early Albian	Fort St. John	Gates	Torrens	medial siltstone	15 to 18 m	5	5a	thin coaly stringers?	
Early Cretaceous	Late Early Albian	Fort St. John	Gates	Torrens	Torrens Sandstone	35 m	5	5a		
Early Cretaceous	Late Early Albian	Fort St. John	Moosebar	Spieker		49 to 55 m	4	4c	L coal bed near base	
Early Cretaceous	Late Early Albian	Fort St. John	Moosebar	Cowmoose		60 to 70 m	4	4b		
Early Cretaceous	Late Early Albian	Fort St. John	Moosebar	basal gritstone		0.1 to 17 m	4	4a		
Early Cretaceous	Late Early Albian	Bullhead	Gething	Chamberlain		30 to 40 m	3	3d	Bird coal zone	
									Skeeter – Chamberlain coal zone	
Early Cretaceous	Late Early Albian	Bullhead	Gething	Bullmoose		25 to 35 m	3	3c		
Early Cretaceous	Late Early Albian	Bullhead	Gething	Bluesky		nil to 15 m	3	3b		
Early Cretaceous	Hauterivian to Late Early Albian	Bullhead	Gething	Gaylard		150 to 160 m	3	3a	Gething coal zone(s)	
Early Cretaceous	Barremian	Bullhead	Cadomin			30 to 85 m	2			
Early Cretaceous	Valanginian and older?	Minnes	Monach (and older formations below)			1300 to 1400 m	1		Coals present	

4 Stratigraphic synopsis

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 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.

4.1 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.

4.1.1 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; more-precise determination would require access to dump plans and associated operating records.

4.1.2 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 great depths.

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.

4.2 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 nearly-complete sections were encountered in boreholes HR2005-3C and HR14-05C.

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

4.2.1 Cruiser Formation (map-unit 8c)

The Cruiser Formation is the uppermost formation within the Fort St. John Group. The Cruiser comprises 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 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.

<u>Cross-reference to Shaftesbury Formation</u>

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.

4.2.2 Goodrich Formation (map-unit 8b)

The Goodrich Formation comprises 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.

4.2.3 Hasler Formation (map-unit 8a)

The Hasler Formation 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.

4.2.4 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 members within the Boulder Creek Formation, on the basis of lithostratigraphy. Gibson's basal Cadotte Member is probably 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. Insofar as the Boulder Creek Formation has not yet been drilled at Hermann, and its outcrop trace lies outside the zone of immediate interest for mine-planning, no attempt is here made to map its subdivisions within the Hermann property.

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 at local scale, and likely gradational by intertonguing at regional scale.

Cross-reference to Commotion Formation

The Boulder Creek, Hulcross and Gates Formations were formerly considered to be members of the Commotion Formation (Stott, 1968). That prior usage was general within old coal assessment reports from the Sukunka-Quintette coalfield, including the Hermann area. All three of these sub-units of the Commotion are now regarded as having formational status within the Fort St. John Group.

Geologists from Denison Mines and Quintette Coal further considered the siltstone/sandstone interbeds of the Spieker Member to constitute a basal transitional facies of the Gates 'Member', and thus to constitute the basal part of the Commotion Formation. The Spieker beds are now, however, regarded as being the uppermost member of the Moosebar Formation.

4.2.5 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. 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 Hulcross Formation was formerly considered a member of the Commotion Formation (Stott, 1968), and that obsolete usage is evident in texts and illustrations accompanying historic coal-assessment reports from the Sukunka-Quintette coalfield, including the Hermann area.

The disconformable base of the Hulcross Formation is 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.

4.2.6 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.

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’ within the Notikewin Member, 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.

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 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, leading to their informal naming as ‘The Caprock’. The basal part of the Notikewin has also been informally termed the ‘Babcock Member’ by Quintette Coal’s geologists.

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 be useful in working-out thrust patterns in detail.

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

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 absent due to deep scouring at the base of the overlying Notikewin conglomerate ‘caprock’. 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.

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 Torrens sandstones, separated by a thick medial 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 thickness of the Torrens Member at Hermann is 75 to 85 metres.

The top of the Quintette Sandstone is almost always root-penetrated, at times distinctly softer, darker and carbonaceous to coaly (likely a paleosol beneath the Quintette J coal zone), and thus readily distinguishable from the harder, lighter-coloured and cleaner main body of the sandstone. The 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 Quintette Sandstone was frequently designated as the 'Sheriff Member' of the Gates Formation.

The Quintette Sandstone is 25 to 32 metres thick at Hermann. The underlying medial siltstone unit is 15 to 18 metres thick, and the basal Torrens Sandstone is 35 metres thick. All three of these units are intersected, nearly normal to their bedding within the core of the Hermann Syncline, in the d-83-J / 93-I-14 natural-gas well. Coal-exploration boreholes seldom penetrate far into the Quintette Sandstone, and have therefore generally left the medial siltstone unit untested as to the presence of coal.

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).

4.2.7 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.

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 member:

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; thus far this unit has 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.

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 basal gritstone unit of the Moosebar is gradational to abrupt, and generally easily-recognised on geophysical logs.

Basal gritstone member (map-unit 4a) -- not yet formally named

The basal gritstone member of the Moosebar Formation comprises 0.1 to 17 metres of locally-glauconitic, 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 basal gritstone member 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 basal gritstone by itself at the given scale of mapping.

4.3 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.

4.3.1 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).

<u>Chamberlain Member</u> (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.

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.

Bluesky Member (map-unit 3b)

The Bluesky Member 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 (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.

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.

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.

4.3.2 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).

4.4 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.

4.4.1 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 resources and coal reserves

The most recent coal resource and coal reserve estimates, compliant with the requirements of Canada's *National Instrument 43-101*, were compiled in December 2007 by E.H. Minnes P.E., mining consultant at Marston Canada Ltd. (Minnes, 2007, pages 19-1 through 19-9), with an effective date of October 2007.

Coal resources by seam were reported as follow (from Table 19.3 in Minnes (2007) report):

Table 5-1: Coal resources by seam

Seam	in situ tonnes (000s)	
	Measured	Indicated
E	3,832	3,953
E4	4,142	4,447
F	630	566
G	1,790	1,889
J	4,599	4,730
Total	14,993	15,584
	30,577	

Notes: Cutoff strip ratio limit of 20:1 bank cubic metres / tonne of product; measured and indicated coal resources include those resources which have been modified to produce coal reserves (Minnes, 2007, page 19-3). E.H. Minnes, P.E., was the Qualified Person responsible for this determination of coal resources.

In the December 2007 report, mineral reserves were reported upon the basis that the c-02-B / 93-P-03 gas well would have been decommissioned by the year 2013. Ultimate pit boundaries were derived by means of the Lerchs-Grossman optimisation algorithm, assuming "coal prices around $85" (Minnes, op.cit., page 19-3) and the following unit costs:

- Waste related cost: $3.60 per bank cubic metre;
- ROM related cost: $12.89 per ROM tonne; and
- Clean coal related cost: $22.10 per clean tonne plus 2.5% of selling price for miscellaneous selling-related costs.

Key assumptions included:

- Minimum coal mining thickness of 0.6 metres;
- Out-of-seam dilution of 5 to 10 centimetres per coal/waste contact, depending upon seam dip;
- Out-of-seam dilution material assumed to be 80% ash, at in-situ specific gravity of 2.3; and
- Coal loss of 5 to 10 cm per coal/waste contact, again depending upon seam dip.

Coal reserves, based on the gas well being decommissioned, and with ultimate pit design, were reported as follow (from Table 19.4 in Minnes (2007) report):

Table 5-2: Hermann Project estimated coal reserves

In situ coal resources (Mt)		ROM coal reserves (Mt)		Total reserves (Mt)	Waste (Mbcm)	ROM coal strip ratio (bcm/t)
Measured	Indicated	Proven	Probable			
10.0	3.3	10.7	3.6	14.3	85.4	6.0

Note: Measured and indicated coal resources include those resources which have been modified to produce coal reserves (Minnes, 2007, page 19-4). E.H. Minnes, P.E., was the Qualified Person responsible for this determination of coal reserves.

A detailed discussion of methods used to estimate coal resources and coal reserves is presented in the Marston Canada report (Minnes, 2007, pages 19-1 through 19-9).

Revised and updated geological modelling, as mentioned in the year-2014 coal-assessment report (Cathyl-Huhn and Singh, 2014) has been commenced, but owing to redeployment and turnover of technical staff over the past year, minimal progress has been made.

6 Coal quality

Coal quality data for ‘current’ boreholes drilled in year-2005 and year-2006 (including petrographic and reflectometric studies done during that time period) have been previously presented within the appendices of CAR-950, and are not here repeated.

However, subsequent to the submission of CAR-950 (in November of 2014), an extensive programme of in-house and third-party coal-quality investigations was undertaken on samples collected from year-2014 boreholes drilled at Hermann.

The present report sets forth the results of that analytical work. **Appendix A** establishes the sample inventory for year-2014 boreholes, and presents the analytical protocol and associated flowsheet. Confidential **Appendix B** discusses clean-coal quality as discerned from an extensive series of washability tests, and confidential **Appendix C** presents results of petrographic and reflectometric investigations of twelve clean-coal composite samples. Confidential submission of the latter two appendices is in keeping with the provisions of the *Coal Act Regulations*.

7 Statement of estimated costs

No detailed records have been located, as concerns the costing of the 2014-2015 analytical work performed on year-2014 core samples from the Hermann property, insofar as the majority of the work was done in-house at minesite laboratories, and the third-party laboratory (ALS) have wound-down their Canadian coal-analysis business.

Equivalent commercial costs can, however, be estimated from price-lists of other suppliers, and a general knowledge of the analytical service market. Unit costs presented in **Table 7-1**, below, are derived from discussions with Heather Dexter at Birtley Coal & Minerals Testing, and Walter Energy's Canadian manager of coal quality, Christy Burres. No allowances have been made for sample preparation, taxes and freight (on the cost side) or possible negotiated volume discount (on the beneficial side) of this estimate. Errors and omissions in estimation remain the responsibility of the author.

Table 7-1: Estimation of analytical costs for the 2014-2015 work programme

Work item	Assumed unit cost	Quantity	Estimated cost
Proximate analysis, with LECO sulphur and FSI	$110.55 each	251	$27,748
Light transmittance test (LT) for coal oxidation	$85.00 each	29	$2,465
Float-sink tests, set of five separations (at s.g. of 1.30, 1.40, 1.50. 1,60 and 1.70)	$260.00 per set	38	$9,880
Gieseler fluidity test (incl. ddpm)	$240.00 each	15	$3,600
Ash chemistry (set of thirteen oxides)	$243.00 per set	209	$50,787
Petrography and reflectance	$300.00 per set	12	$3,600
		Total	$98,080

To the analytical costs estimated above, an allowance for report preparation (comprising data assembly and the writing of the present report) by its author may be added. Ten days at $500/day (unloaded day-rate) would amount to $5,000 for this item, thus giving overall project costs of **$103,080**. To reiterate, this cost figure is an estimate, in light of lack of detailed cost allocation records.

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9 Conclusions

The Hermann coal property contains coal-measures of Early Cretaceous age, within the Bullhead and Fort St. John groups of sedimentary rocks. These rocks are deformed by folded, imbricate thrust faults and associated folds, consistent with the overall thin-skinned structural style of the Rocky Mountain Foothills of northeastern British Columbia.

No disturbant exploratory work was done on the Hermann coal property during the 2014-2015 work term. Analytical work was, however, performed upon coal samples obtained during the year-2014 drilling programme which has been previously mentioned in Coal Assessment Report No.950.

The present report documents the coal quality of these samples, as tested in Walter Energy's minesite laboratories and at third-party laboratories. Extensive washability testing was done, leading to the assembly of twelve clean-coal composite samples of float-1.50 s.g. material. Mean maximum vitrinite reflectance ($R_o$max) and petrographic constitution was measured in pellets made from these samples. Results of these studies are reported in confidential appendices to this report, in keeping with the provisions of the *Coal Act Regulation* of the Province of British Columbia.

Estimated cost of the analytical programme, including the in-house preparation of the present report, is **$103,080** (Canadian funds, exclusive of taxes).

The Hermann coal property merits further work.

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 by Walter Canadian Coal Partnership, a subsidiary of Walter Energy Inc., 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 coal licences, Mt. Hermann area, British Columbia*, dated September 16, 2015.

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, Member No.518350). I have worked as a colliery geologist in four countries for over 37 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 senior colliery geologist for Walter Canadian Coal Partnership's Canadian operations since November of 2011.

f) My most recent visit to the Hermann coal property was in September of 2015.

g) I am the author of this report, titled *Coal Assessment Report for the Hermann coal licences, Mt. Hermann area, British Columbia*, dated September 16, 2015, 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 Walter Canadian Coal Partnership and Walter Energy, pursuant to the tests in Section 1.4 of *National Instrument 43-101*, for the reason that I am a full-time employee of Walter Canadian Coal Partnership.

j) The effective date of this report is September 16, 2015.

“original signed and sealed by”

Dated this 16th day of September, 2015. C.G. Cathyl-Huhn P.Geo. Lic.Geol. RMSME

Appendix A: Sample inventory and analytical protocols

Following is an inventory (**Table A-1**) of samples taken of coals, associated partings, and roof and floor rocks as encountered in year-2014 boreholes. Geophysical logs of these boreholes have been previously presented in **Appendix A** of CAR-950, and the interested reader is referred to that report.

Following **Appendices B** and **C** (in the machine-readable CD copy of this report) are scans of third-party analytical certificates for year-2014 samples which were analysed during the 2014-2015 reporting period. Formal certificates are not available for proximate analyses, associated sulphur, free swelling index (FSI) and light transmission (LT) determinations, Gieseler fluidity results and washability test results, as these parts of the analytical programme were performed in-house at Walter Energy's minesite laboratories. Details of in-house analytical protocols, and a flowsheet (**Figure A-1**) are given further below.

Table A-1: Sample inventory

Borehole	sample number		from (m)	to (m)	thickness	recovered	% recovery	sample lithology	sample of
HR14-01c	9554		76.12	76.72	0.60	0.6	100	mudstone	roof
	9555/9556/9557/9558		76.72	82.00	5.28	5.17	98	coal / mudstone	E / parting
		9555	76.72	77.35	0.63	0.58	92	coal	E
		9557	77.35	77.56	0.21	0.21	100	mudstone	parting
		9556	77.56	78.06	0.50	0.50	100	coal	E
		9558	78.06	82.00	3.94	3.88	98	coal	E
	9559		82.00	82.79	0.79	0.79	100	mudstone	floor
	9560		83.15	89.57	6.42	6.04	94	coal	E4
	9561		89.57	90.94	1.37	1.37	100	mudstone	floor
	9551		99.00	99.45	0.45	0.45	100	coal	F
	9552		99.45	99.93	0.48	0.48	100	mudstone	floor
	9562		111.86	112.08	0.22	0.22	100	siltstone	roof
	9563		112.08	112.87	0.79	0.79	100	coal	GL
	9564		112.87	113.38	0.51	0.38	75	mudstone	floor

Table A-1: Sample inventory (continued)

Borehole	sample number		from (m)	to (m)	thickness	recovered	% recovery		sample lithology	sample of
HR14-01c (concluded)	9565		132.89	133.45	0.56	0.45	80		mudstone	roof
	9566		133.45	138.20	4.75	4.75	100		coal	J
	9567		138.20	138.98	0.78	0.60	77		floor	floor
HR14-02c	5766		49.08	49.68	0.60	0.60	100		mudstone	roof
	5767/5768/5769/5770/5771		49.68	54.04	4.36	3.69	85		coal / mudstone	E / parting
		5767	49.68	50.10	0.42	0.42	100		coal	E
		5768	50.10	50.78	0.68	0.25	37		mudstone	parting
		5769	50.78	52.27	1.49	1.49	100		coal	E
		5770	52.27	52.53	0.26	0.26	100		mudstone	parting
		5771	52.53	53.40	0.87	0.87	100	84	coal	E
			53.40	53.76	0.36	0.18	50		mudstone	parting
			53.76	54.04	0.28	0.22	79		coal	E
	5772		54.42	55.30	0.88	0.96	109		mudstone	parting
	5773		56.00	58.08	2.08	2.08	100	74	coal	E4
			58.08	58.42	0.34	0.06	18		mudstone	parting
			58.42	60.20	1.78	0.98	55		coal	E4
	5774		60.20	60.80	0.60	0.60	100		mudstone	floor
	5775		80.43	80.80	0.37	0.37	100		mudstone	roof
	5776		80.80	81.25	0.45	0.30	67		coal	GU
	5777		81.25	81.88	0.63	0.58	92		mudstone	parting
	5778		81.88	82.58	0.70	0.70	100		coal	GL
	5779		82.58	83.11	0.53	0.53	100		mudstone	floor
	5762		99.20	99.80	0.60	0.60	100		mudstone	roof
	5763		99.80	105.00	5.20	4.19	81		coal	J

Table A-1: Sample inventory (continued)

Borehole	sample number		from (m)	to (m)	thickness	recovered	% recovery		sample lithology	sample of
HR14-02c (concluded)	5764		105.00	105.77	0.77	0.55	71		mudstone	floor
	5765		114.48	115.40	0.92	0.20	22		coal	K2
HR14-03c	5780		49.68	50.16	0.48	0.43	90		mudstone	roof
	5781/5782/5783		50.16	53.54	3.38	2.49	74		coal / mudstone	E / parting
		5781	50.16	51.36	1.20	1.12	93		coal	E
		5782	51.36	51.84	0.48	0.28	58		mudstone	parting
		5783	51.84	52.52	0.68	0.68	100	64	coal	E
			52.52	53.00	0.48	0.08	17		mudstone	parting
			53.00	53.54	0.54	0.33	61		coal	E
	5784		53.54	54.08	0.54	0.54	100		mudstone	floor
	5785		55.54	55.80	0.26	all lost	0	64	coal	E4
			55.80	56.12	0.32	all lost	0		mudstone	parting
			56.12	57.68	1.56	1.56	100		coal	E4
			57.68	58.26	0.58	0.15	26		mudstone	parting
			58.26	60.20	1.94	1.29	66		coal	E4
	5786		60.20	62.78	2.58	1.69	66		mudstone	floor
	5951		72.08	72.50	0.42	0.42	100		mudstone	roof
	5952		72.50	73.00	0.50	0.42	84		coal	F
	5953		73.00	73.60	0.60	0.60	100		siltstone	floor
	5954		78.03	78.52	0.49	0.49	100		siltstone	roof
	5955		78.52	79.24	0.72	0.72	100		coal	GL
	5956		79.24	79.82	0.58	0.58	100		mudstone	floor
	5957		95.86	96.40	0.54	0.54	100		mudstone	roof
	5958		96.40	101.50	5.10	3.88	76		coal	J
	5959		101.50	102.33	0.83	0.83	100		mudstone	floor

Table A-1: Sample inventory (continued)

Borehole	sample number		from (m)	to (m)	thickness	recovered	% recovery	sample lithology	sample of
HR14-03c (concluded)	5960		111.02	111.62	0.60	0.60	100	mudstone	roof
	5961		111.62	112.43	0.81	0.30	37	coal	K1
	5962		112.43	113.04	0.61	0.61	100	mudstone	floor
HR14-04c	5984		3.75	5.20	1.45	1.45	100	coal	C
	5985		5.20	5.85	0.65	0.65	100	mudstone	floor
	5988		53.62	54.05	0.43	0.30	70	coal	E
		5980	53.06	53.45	0.39	0.30	77	mudstone	roof
	5979/5980/5988		52.60	54.65	2.05	1.35	66	coal / mudstone	E / roof /floor
		5979	54.50	55.65	1.15	0.77	67	coal	E
		5981	55.65	56.20	0.55	0.55	100	mudstone	floor
	5982/5983/5987		56.20	57.50	1.13	1.10	97	coal / mudstone	E / floor
		5982	56.20	56.65	0.45	0.45	100	coal	E
		5983	56.82	57.08	0.26	0.26	100	mudstone	floor
		5987	57.08	57.50	0.42	0.39	93	coal	E
	5974		57.50	57.75	0.25	0.25	100	mudstone	roof
	5975/5976/5977		60.30	65.00	4.70	3.90	83	coal / mudstone	E4 / floor
		5975	60.30	62.60	2.30	2.13	93	coal	E4
		5976	62.60	63.15	0.55	0.55	100	mudstone	floor
		5977	63.15	65.00	1.85	1.22	66	coal	E4
	5978		65.00	65.53	0.53	0.53	100	mudstone	floor
	5971		107.50	108.00	0.50	0.50	100	mudstone	roof
	5972		108.00	115.40	7.40	4.19	57	coal	J
	5973		115.40	116.00	0.60	0.60	100	mudstone	floor
	5963		126.80	127.05	0.25	0.25	100	mudstone	roof
	5964		127.05	127.80	0.75	0.68	91	coal	K1

Table A-1: Sample inventory (concluded)

Borehole	sample number	from (m)	to (m)	thickness	recovered	% recovery	sample lithology	sample of
HR14-04c (concluded)	5965	127.80	129.20	1.40	0.99	71	mudstone	floor
	5966	129.20	130.85	1.65	0.53	32	coal	K2
	5967	149.36	149.78	0.42	0.42	100	mudstone	floor
	5986	149.78	150.15	0.37	0.37	100	coal	K2 repeat
	5968	152.84	153.25	0.41	0.41	100	mudstone	roof
	5969	153.25	153.70	0.45	0.45	100	coal	K3 repeat
	5970	153.70	154.32	0.62	0.62	100	mudstone	floor
HR14-04Ac	5989	52.60	53.06	0.46	0.33	72	coal	E
	5990	53.45	54.65	1.20	0.66	55	coal	E
	5991	59.28	61.65	2.37	2.03	86	coal	E4
	5992	62.20	63.95	1.75	0.81	46	coal	E4
	5993	80.18	81.00	0.82	0.70	85	mudstone	roof
	5994	81.00	82.00	1.00	1.00	100	coal	F
	5995	82.00	82.40	0.40	0.4	100	mudstone	floor
	5996	83.25	83.93	0.68	0.68	100	coal	GU
	5997	83.93	84.60	0.67	0.45	67	siltstone	floor
	5998	84.60	85.45	0.85	0.67	79	coal	GL
	5999	85.45	85.95	0.50	0.50	100	mudstone	floor
	6000	108.23	115.20	6.97	3.42	49	coal	J
	5806	149.75	150.95	1.20	0.74	62	coal	K2 repeat
	5807	153.25	155.05	1.80	1.00	56	coal	K3 repeat
HR14-05A	5805	219.40	220.00	0.60	0.55	92	coal	coal
	5804	225.22	225.47	0.25	0.25	100	coal	coal
	5801	225.47	225.67	0.20	0.20	100	mudstone	floor
	5802	225.67	229.00	3.33	2.61	78	coal	coal

Note: recovery of sample 5772 is reported as greater than its interpreted thickness. Reasons for this discrepancy are unknown.

During the 2014-2015 programme of analytical work upon core samples taken in year-2014 boreholes, washability tests were done in-house at Walter Energy's minesite analytical laboratory, under the supervision of Walter Energy's manager of coal quality, Christy Burres.

Following is Ms. Burres' description and flowsheet (**Figure A-1**) of work on the year-2014 samples.

<u>Processing and analysis of year-2014 NEBC exploration core samples</u>

The following steps were undertaken:

1. Core samples were delivered to the Wolverine minesite laboratory by Walter Energy's exploration geologists, Dr. Muzaffer Sultan and Garry Holmlund.
2. Sample identification numbers were recorded in database when received.
3. All initial processing of the core samples was performed at the Wolverine laboratory.
4. Samples were dried at 95°F/35°C.
5. Manual specific gravity test was performed on three larger chunks of core (from 6-inch cores only).
6. Samples were then manually broken down to pass through a screen with 2-inch square openings.
7. Float/Sink tests were performed on samples at cutpoints of 1.30, 1.40, 1.50, 1.60, 1.70 (using perchloroethylene, dibromomethane, and mineral spirits).
8. Float/Sink fractions were dried and weights of each fraction recorded.
9. Each float/sink fraction was split down. Reserve uncrushed portions of 6-inch cores were retained for potential future testing.
10. Splits of each float/sink fraction were crushed.
11. Crushed portions of 1.30, 1.40, 1.50 float fractions were split down further in order to retain crushed splits to create 1.30/1.40/1.50 composite samples for petrographic and Gieseler fluidity analysis.
12. Portions of 1.30, 1.40, 1.50, and all of 1.60, 1.70 and sinks were then pulverised for analysis and the creation of pulverised 1.30/1.40/1.50 composite samples.
13. Proximate analysis, total sulphur and free swelling index (FSI) were performed on each float fraction, and on sinks, at the Willow Creek minesite laboratory.
14. All on-site Walter Energy (northeastern British Columbia labs) analysis was performed in duplicate or triplicate and the average result reported.
15. A subsample of each float and sink fraction was sent to ALS Coal Lab in Richmond, British Columbia, for ash chemistry analysis.

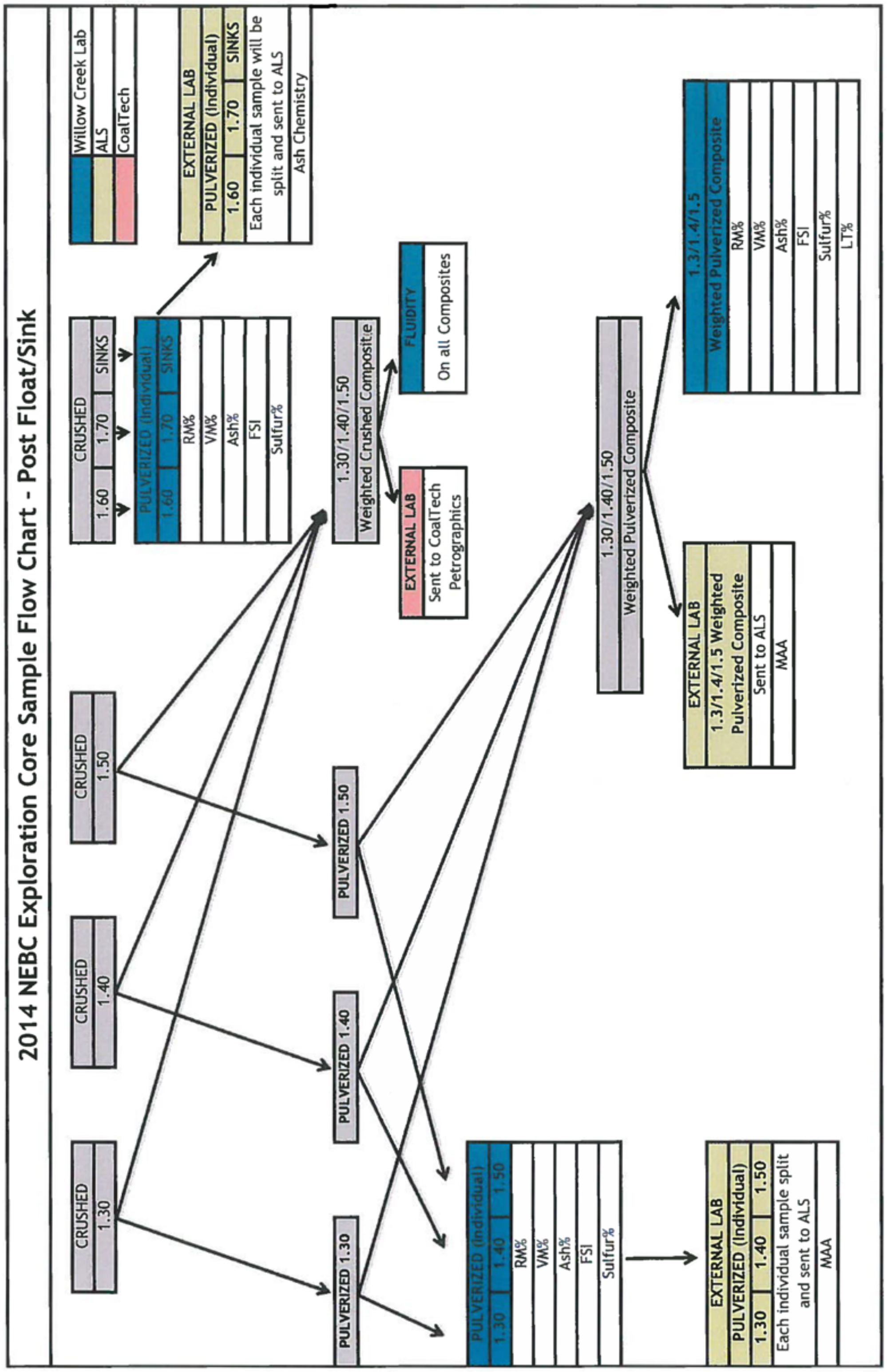
16. Proximate analysis, total sulphur, FSI, Gieseler fluidity and light transmittance (LT) testing were performed on a weighted 1.30/1.40/1.50 composite sample at the Willow Creek laboratory.
17. A subsample of each weighted 1.30/1.40/1.50 composite was sent to ALS Coal Lab in Richmond for ash chemistry analysis.
18. A subsample of each weighted 1.30/1.40/1.50 composite was sent to CoalTech Petrographic Associates, Inc., in Murrysville, Pennsylvanian, for petrographic analysis including determination of mean maximum reflectance of vitrinite.

Notes:

- Walter Energy's northeastern British Columbia round robin testing programme reference material was analysed and verified for accuracy with each sample batch during analysis of ash volatile matter, residual moisture, FSI and LT at the Willow Creek laboratory.
- The SC144-DR sulphur analyser was calibrated daily using LQCRM027, LQCRM066 and LQCRM094 certified reference material. A quality assurance (QA) check sample was analysed thereafter for every batch of ten core samples tested, to verify accuracy.
- Where applicable, all other equipment was calibrated on a daily basis prior to analysis

Testing Equipment used:

A&D HR 120 balance
Thermo Scientific Model 6958 oven
Vulcan 3-550 ashing furnace
FRICO free swelling index furnace
Thermo Scientific Lindberg Blue M volatile furnace
Leco SC-144 DR sulphur analyser
Preiser Model 4000 plastometer
Thermo Electron Corp Spectronic 20D+ spectrometer



2014-2015 analytical flowsheet: **Figure A-1**