RESEARCH COUNCIL OF ALBERTA

PRELIMINARY REPORT 60-1

EVALUATIONS OF SOME ALBERTA COAL DEPOSITS

Part I. THE WIZARD LAKE DISTRICT

Part II. THE WESTLOCK-BARRHEAD DISTRICT

Part III. THE SHEEP CREEK-WILDHAY RIVER DISTRICT

by

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PREFACE

Results of examination made in 1959 of three Alberta coal-bearing districts are described in this report. Parts I and II give details of coal test drilling carried out in the Wizard Lake and Westlock-Barrhead districts, this being a continuation of a Research Council program of estimating strippable coal reserves that could be used to fuel thermal power stations. Part III of this report gives results of a preliminary geological survey of the Foothills and Front Ranges of the Rocky Mountains between Sheep Creek and Wildhay River, north of Jasper National Park. Extensive deposits of coking coals which occur in this district are currently being given considerable attention by private interests.

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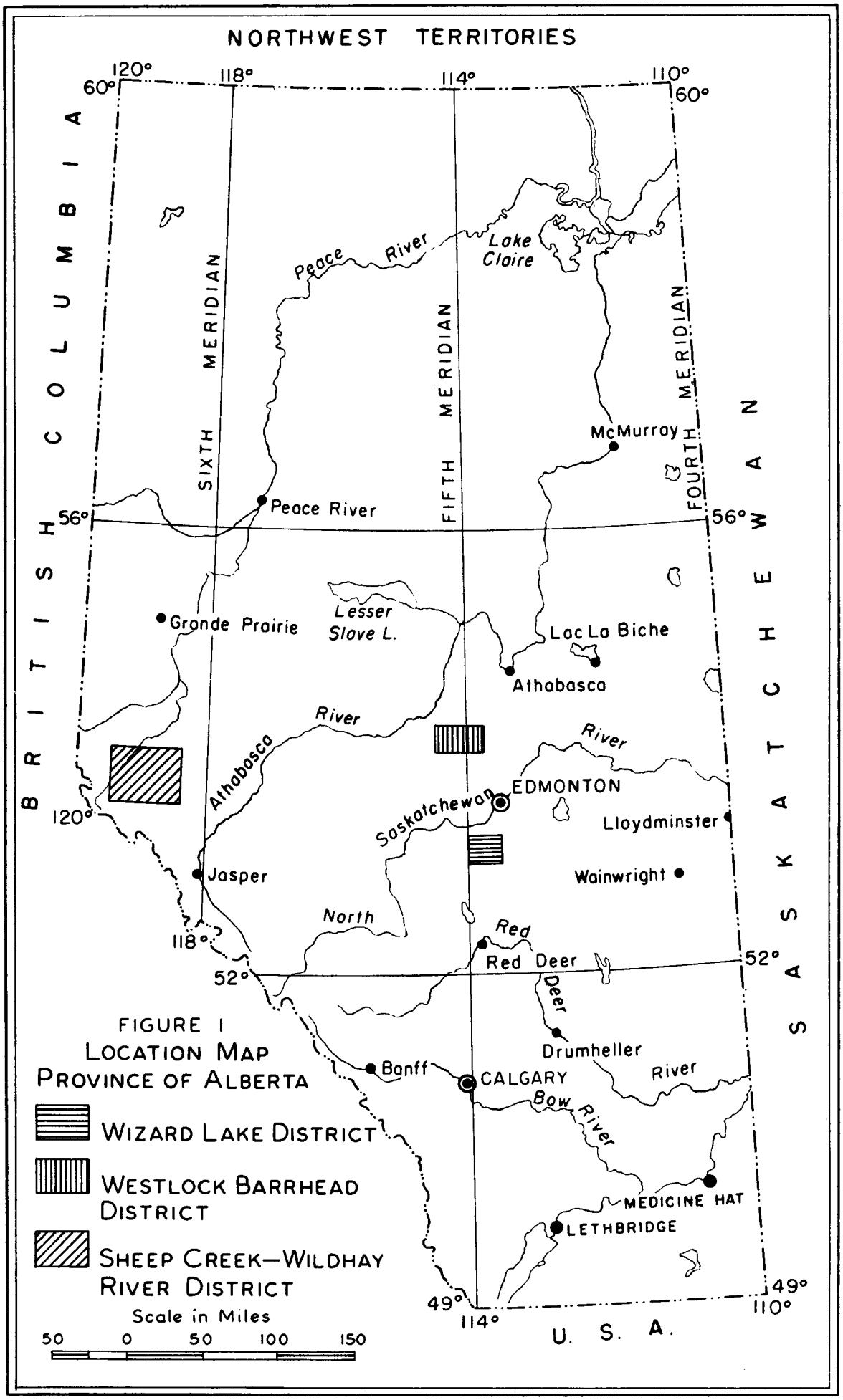

FIGURE 1
LOCATION MAP
PROVINCE OF ALBERTA

PART I.

STRIPPABLE COAL DEPOSITS OF THE WIZARD LAKE DISTRICT, ALBERTA

INTRODUCTION

General Statement

The Wizard Lake district was selected for examination because a fairly large area north of the lake was believed to be underlain, at shallow depth, by a coal seam several feet thick. Providing a large tonnage of coal were present that could be economically strip-mined, then Wizard Lake would make a suitable site for a thermal power station. The lake is only 30 miles from the Edmonton industrial area, and would provide the large water reservoir necessary for cooling purposes. Test-drilling has shown, however, that the coal zone contains a number of thick shale partings which separate the coal into several thin seams unsuitable for a large-scale mining operation.

Location and Access

The Wizard Lake district lies southwest of Edmonton between latitudes 53°00' and 53°15' and longitudes 113°30' and 114°00', in Tps. 47 - 49, Rs. 25 - 28, W. 4th Mer. (Fig. 1). The map (Fig. 2) accompanying this report covers about 360 square miles.

Provincial Highway 2 passes through the northeast corner of the map area, whilst Highway 39 runs east and west 1 mile north of the map area, and is paved from Leduc to Calmar (5 miles north of Conjuring Creek). Gravel and earth roads have been built along most sectional road allowances. The main Edmonton-Calgary line of the Canadian Pacific Railway follows Highway 2, and a branch line runs west from Leduc to Calmar and Warburg, then swings southeast to join the main line near Lacombe.

Topography and Drainage

The Wizard Lake district is an area of generally low relief, and belongs physiographically to the plains area of central Alberta. Elevations range between 2,350 feet in the northeast and 3,000 feet in the southwest. The main topographic features are the steep-sided, narrow, sinuous valleys in which lie Wizard and Long Lakes. These valleys, which have steep sides up to 125 feet in height, probably follow Pleistocene drainage channels which were cut through a capping of more resistant Paskapoo sandstone into the underlying Edmonton shales. The southwest corner of the map area has a more undulatory surface than the remainder, probably because it is underlain by Paskapoo sandstone. There is a gentle slope down to the shores of Pigeon Lake from this higher land.

Most of the Wizard Lake district has been cleared of tree growth and is intensively farmed, but the southwest part between Wizard and Pigeon Lakes is quite thickly forested with deciduous trees.

No major drainage pattern is present in the map area. Wizard Lake is drained by Conjuring Creek which runs northwards to North Saskatchewan River, but during the summer there is practically no flow in the creek. Long and Watelet Lakes are drained by Pipestone Creek which flows east and empties into Battle River east of Wetaskiwin. Battle River flows eastwards into the Province of Saskatchewan before entering into North Saskatchewan River.

Previous Geological Work

Rutherford (1929) made the first written contribution to the geology of the Wizard Lake district in a brief report on the Peace Hills area. He traced the Edmonton-Paskapoo contact from the North Saskatchewan River southeastwards to Red Deer River near Alix, and reported on coal occurrences at Telfordville, Wizard Lake and Wetaskiwin.

The Wizard Lake district is included in a geological map of central Alberta by Allan and Rutherford (1934), and in the Geological Survey of Canada Edmonton Sheet (Rutherford, 1939), but in neither case was any special attention paid to this specific area.

A number of oil companies engaged in the search for oil and gas in Alberta have done work in the Wizard Lake district in the past two decades. The Leduc Woodbend field (Tps. 48 - 51, Rs. 25 - 27, W. 4th Mer.) was discovered in 1947, and was the first major oil discovery in Alberta after the Second World War. The adjacent Wizard Lake field (Tp. 48, R. 27, W. 4th Mer.) was not discovered until 1951. It underlies a relatively small surface area, but is one of the richest known fields in Western Canada. Oil is produced from a dolomitized Upper Devonian reef.

Due to favorable geological conditions and the discovery of oil and gas in the Wizard Lake district, much geophysical exploration has been carried out and many wells have been drilled. Hence the deeper subsurface geology is known in great detail. In October, 1959, there were 48 oil wells in the Wizard Lake field capable of operation.

Ower (1958) made a detailed study of the Edmonton formation from outcrop and subsurface data, and included the McColl Wizard Lake well in his discussion.

History of Coal Mining

The Wizard Lake district forms part of the Wetaskiwin coal area* in which coal mining has been carried on intermittently since 1913. The Province of Alberta began issuing coal-mining licenses in 1905, since when a total of 18 licenses have

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* The term "coal area", where used in this report, refers to the areas as defined by Allan (1924, p. 55 - 58; 1925, p. 44 - 45; 1943, p. 161 - 165).

been taken out for the Wetaskiwin area. Eight of these were for mines in the vicinity of Wizard Lake. Of the 18 licenses issued, only three (for mines at Wizard Lake) were held for periods of five years or more. The Peter Gill mine (Lsd. 7, Sec. 3, Tp. 48, R. 27, W. 4th Mer.) has the longest record of operation; it was opened in 1938 and was abandoned on May 1st, 1955. The only mine operating in 1959 was the Blue Bird Coal Company stripping operation (Sec. 20, Tp. 48, R. 25, W. 4th Mer.), about 9 miles northeast of Wizard Lake.

All the mining has been on a small scale, and all but two mines have been underground operations. Coal mining in the Wetaskiwin area reached its peak in 1940 when six mines produced 3,831 tons of coal. In 1959 the one operating mine produced 4,634 tons of coal. This is a very small fraction of the Alberta coal production for 1959 (2,549,517 tons).

Methods of Study

Coal is exposed at a few places in the steep slopes along Wizard Lake, mainly in small prospecting pits and collapsed tunnels. These and other bedrock exposures along the lake were examined, and the Blue Bird Coal Company pit also was visited. No other coal exposures were found in the district, and estimates as to the extent and thickness of coal deposits have had to be made almost entirely from subsurface data.

Shot-hole logs supplied by Texaco Exploration Company indicated the approximate extent of the coal-bearing zone within 60 feet of the surface, but were later found to give an overestimate of the actual thickness of coal. These logs were also used for plotting isopachs of drift thickness and bedrock surface contours. With this information, an area around Wizard Lake in which coal might be present within 60 feet of the surface was selected for examination and a limited drilling program was planned.

Eight uncased 5-inch holes spaced at 1- to 2-mile intervals were drilled by means of a truck-mounted rotary Mayhew rig, during one week in late June and early July, 1959. The depths of the holes varied between 45 and 215 feet, and a total of 900 feet was drilled. Each hole was logged by the driller, and samples of rock fragments were collected at 5-foot intervals and retained for later examination. The holes were also electrically logged for resistance and self-potential characteristics. It has been found that accurate test-hole logs can be compiled from a combination of electrolog, driller's log and sample examination (Pearson, 1959).

Test drilling was discontinued after the eighth hole had been put down, as results up to that stage did not appear to justify completion of the planned program.

The holes were drilled close to the corners of surveyed sections, and were located with respect to them by pacing. Surface elevations at the holes were measured with a Paulin survey altimeter, stated by the makers to be accurate to within

5 feet under suitable weather conditions. Elevations given on the National Topographic Series map for points along the Thirteenth Base Line were used as base stations for the survey.

Acknowledgments

The loan of shot-hole logs by Texaco Exploration Company, and permission of the operator of the Blue Bird Coal Company to examine the property are gratefully acknowledged.

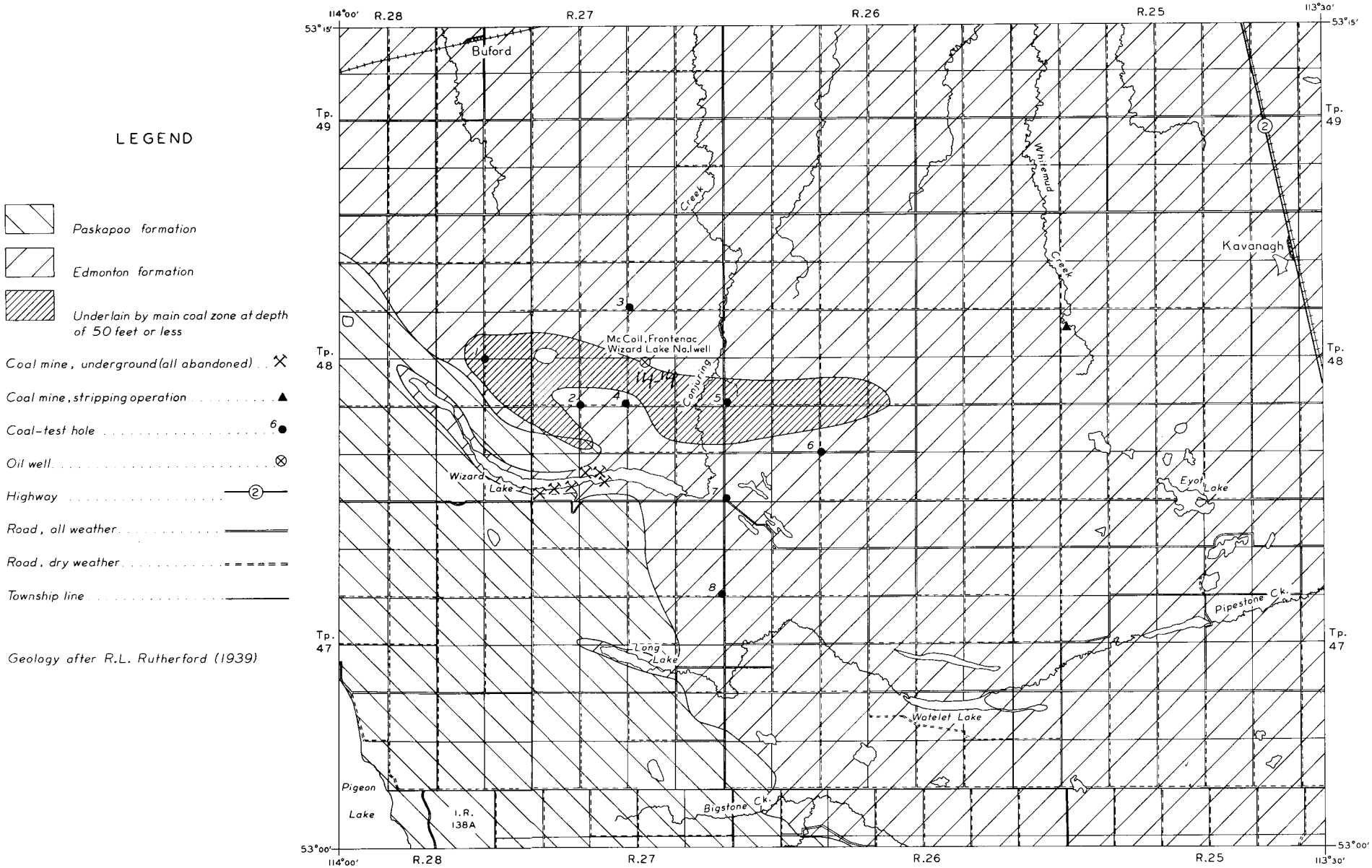


FIGURE 2

WIZARD LAKE DISTRICT, ALBERTA

WEST OF FOURTH MERIDIAN

GENERAL GEOLOGY

The Wizard Lake district is underlain by rocks of late Cretaceous and early Tertiary ages, covered by a rather thin mantle of Pleistocene drift. The Upper Cretaceous is represented by strata of the upper part of the Edmonton formation, first named by Selwyn (1874) as the coal-bearing formation in the neighborhood of the present City of Edmonton. The lower Tertiary is represented by beds of the Paskapoo formation, a name first used by Tyrrell (1887) to describe a sandstone and shale sequence along the lower part of the Blindman River, about 10 miles north of the present City of Red Deer.

The Edmonton Formation

One thousand, four hundred and seventy feet of Edmonton formation were intersected by the McColl Wizard Lake No. 14-14 well (Lsd. 14, Sec. 14, Tp. 48, R. 27, W. 4th Mer.). Since this well is located 4 miles northeast of the Edmonton-Paskapoo contact, about 100 feet of the upper Edmonton formation are estimated to be missing. There are several poor exposures of parts of the uppermost 50 feet of the Edmonton formation in the cliffs along Wizard Lake, but only a few very small exposures elsewhere, apart from the section exposed in the Blue Bird Coal mine.

The upper part of the Edmonton formation as seen in outcrop and drill hole samples consists largely of light-grey and green, silty, bentonitic shales. Interbedded with the shales are thinner beds of siltstone and pale grey, fine-grained, salt-and-pepper sandstones containing small, disseminated coal fragments. A carbonaceous zone from 5 to 15 feet thick occurs approximately 30 feet beneath the Paskapoo contact, and consists of coal seams up to 3 feet thick, together with grey, dark-brown and black shales. These beds were laid down as near-shore deposits in shallow water, and are practically devoid of animal remains. Similar sediments were deposited throughout Edmonton time in Alberta, following the retreat of the Bearpaw sea from the east of the province.

The Paskapoo Formation

Massive, grey, buff-weathering, medium-grained sandstone, termed Paskapoo by Rutherford (1929, 1939), overlies the Edmonton formation in the southwest corner of the Wizard Lake district. The contact shown in figure 2 is, with slight modification, that given by Rutherford.

Massive Paskapoo sandstones outcrop in the cliffs towards the northwest end of Wizard Lake, and in small road cuts to both north and south of the lake. These sandstones are similar to those in the Edmonton formation. Both are somewhat feldspathic, salt-and-pepper sandstones, and contain numerous small disseminated coal fragments. The Paskapoo sandstones tend to be coarser-grained, however.

The Edmonton-Paskapoo contact was not located in outcrop near Wizard Lake. On the North Saskatchewan River (Rutherford, 1928) and at Wabamun Lake

(Pearson, 1959) to the northwest, and on Red Deer River to the southeast (Allan and Sanderson, 1945), the Paskapoo beds appear to lie disconformably on the Edmonton strata. Elliott (1958), in a regional subsurface correlation of the Edmonton formation, presents an interpretation of the data which "requires a disconformity, and a major one, between the base of the Paskapoo and the underlying Edmonton strata".

However, Ower (1958) concludes that: "There is no evidence of irregular differential erosion of the Edmonton formation before deposition of the Paskapoo formation. There may be an angular disconformity between the two formations, but if it exists, it probably results in a slow progressive truncation of the uppermost Edmonton beds beneath the Paskapoo sandstone in an easterly direction".

Rutherford (1929) attributed the absence of thick coal seams in the upper part of the Edmonton formation throughout much of the Peace Hills region to pre-Paskapoo erosion of Edmonton strata.

Glacial Geology

A mantle of glacial drift overlies the Edmonton and Paskapoo strata around Wizard Lake. This deposit was not found to exceed 25 feet in thickness, except in holes Nos. 2, 7, and 8, in which the till is associated with gravels and unconsolidated sands.

The sinuous nature of the Wizard Lake-Watelet Lake topographic low suggests that it originated as a melt-water drainage channel developed along the edge of an ice-sheet during a period of glacier retreat. The thick till and gravel deposits (over 95 feet) encountered in holes Nos. 7 and 8 would then represent a partial filling of the Pleistocene drainage channel.

The till is grey at depth, but the top 10 to 20 feet are generally brown, probably due to surface oxidation (see Gravenor and Ellwood, 1956, for discussion of a similar feature). The till in practically all places has a clay-size fraction of over 50 per cent, the remainder consisting of silt, pebbles, and boulders in varying proportions. The erratics include fine-grained grey and brown quartzites, igneous rocks, gneisses and schists.

Structure

Regional geological studies suggest that the Cretaceous and Tertiary strata in the Wizard Lake district have a dip of about 30 feet per mile to the southwest. Actually the dip varies considerably, due to modifying influences.

Small folds or "rolls" up to a few hundred feet from crest to trough occur in near-surface Edmonton beds in the Wabamun Lake district (Pearson, 1959). Such folding is believed to have been produced by ice-movement during Pleistocene times. Although evidence is lacking, ice-movement probably produced similar crumpling of near-surface shales in the Wizard Lake district.

A more important structural feature of the district is due to the effect of the oil-bearing Devonian dolomite reef on younger strata. A structure contour map of the Fish Scale sand (at the base of the Upper Cretaceous), compiled by the Oil and Gas Conservation Board, shows that strata at least as high as this zone have quaquaversal dips due to draping over the reef. On the basis of outcrop and drill hole evidence, the Wizard Lake coal zone has a northwesterly dip for several miles to the north of the lake. This can best be accounted for by supposing the reef to have caused quaquaversal dips in strata right up to the present surface.

COAL DEPOSITS

General Statement

A thick coal-bearing zone has been noted near the top of the Edmonton formation at a number of places in central Alberta between Athabasca and Red Deer Rivers. This coal has been mined in the Pembina, Ardley and Big Valley coal areas, and possibly the seam mined around Wizard Lake is in the same zone.

The thick coal (Ardley seam) in the Ardley coal area lies 65 to 80 feet above the Kneehills Tuff zone, an important marker, and 80 feet below the Paskapoo contact (Ower, 1958). The thick coal (the Pembina coal-bearing zone) in the Wabamun Lake district is indicated by the Anglo Wabamun Lake well log to lie about 120 feet above the Kneehills Tuff zone. Its position varies from almost zero to over 100 feet below the Paskapoo-Edmonton contact. The Wizard Lake coal zone appears to lie about 50 feet beneath the base of the Paskapoo formation. It is possible that hole No. 5 intersected the Kneehills Tuff zone at 147 feet below the coal zone, as there is a sudden drop in the resistivity curve at this point - a characteristic feature of the marker bed. The Wizard Lake coal zone thus appears to be at approximately the same horizon as the thick coal occurrences at Wabamun Lake and on Red Deer River. Ower (1958) writes, however:

> The McColl Wizard Lake well shows the Pembina seam well developed and also shows the coal seam mined at Wizard Lake, 4 miles southwest in Sec. 4 - 48 - 27 W.4, as an upper horizon, probably the Upper Ardley horizon.

(Ower considers the Upper Ardley seam to lie about 100 feet above the Ardley seam in the Ardley area). The writer cannot agree with Ower's statement, for the coal zone intersected in hole No. 5 is certainly that mined at Wizard Lake, but no other thick seam was intersected for 185 feet beneath it. There seems little doubt that the Wizard Lake coal is a lateral equivalent of the Ardley seam and that there is no Upper Ardley equivalent at Wizard Lake.

Cutting samples of the McColl Frontenac Wizard Lake well were examined, and it was found that coal occurs almost at the surface in this locality (Lsd. 14, Sec. 14, Tp. 48, R. 27, W. 4th Mer.). The following descriptions were made:

Depth in feet

0	Coal and a little bone
10	Coal and bone
20	Shale, light-grey, minor brown siltstone
30	Coal and black carbonaceous shale
40	Shale, light-grey, silty
50	Shale, light-grey, and fine-grained; light-grey, feldspathic sandstone; minor black shale and coal fragments
60	Shale, light-grey, silty; also some black shale and bone
70	Shale, light-grey; minor white bentonite; a little black carbonaceous shale and coal
80	Shale, light-grey; minor white bentonite; a little black shale and coal
90	Shale, light-green and grey
100	Shale, light-grey

The well lies on the northern edge of the area, shown on figure 2, which is believed to be underlain by coal, and at this point the Wizard Lake coal zone would be expected to occur close to the surface. There is evidence of only one thick coaly facies in the upper part of the Edmonton formation at Wabamun Lake, Wizard Lake, and Ardley. Although the coal zone has a somewhat variable stratigraphic position, it probably developed at the same time in each of the three areas.

The Alberta Mines Division has records of eight mining operations that have been carried out around Wizard Lake in past years. This information is summarized in table 1, but in view of the recent work the data on seam thickness is not considered reliable.

Table 1. Coal Mines at Wizard Lake (all abandoned)

Mine No.	Location					Type of operation	Seam thickness (feet)	Cover thickness (feet)	Date of opening	Date of closing
	Lsd.	Sec.	Tp.	R.	Mer.					
414		4	48	27	4				1913	1914
908	2	4	48	27	4				1921	1921
1479	1 & 8	4	48	27	4	Slope			1935	1940
1482	6	4	48	27	4	Slope			1935	1941
1494	4 & 5	4	48	27	4	Slope	5		1936	1939
1534	7	3	48	27	4	Slope	6	100	1938	1955
1563	12	3	48	27	4	Tunnel			1939	1940
1656	11 & 12	3	48	27	4	Drift	6	100	1947	1948

Description of the Coal Seams

As previously noted, the only exposures of coal in the Wizard Lake district are in prospecting pits along the lake banks and in a producing coal pit west of Kavanagh. The following section was measured in a small prospect pit on the north shore of Wizard Lake (Mine No. 1656; Lsds. 11 and 12, Sec. 3, Tp. 48, R. 27, W. 4th Mer.):

	Feet
Till, brown, mainly clay-size	5.0
Sandstone, grey and buff, medium-grained, salt-and-pepper texture, feldspathic	3.0
Shale, medium-grey, carbonaceous lenses	1.4
Coal, weathered	0.9
Shale, medium-grey	1.1
Shale, dark-brown, carbonaceous	0.3
Shale, light-grey, silty	0.7
Coal, weathered	0.6
Shale, light-grey, silty, plant impressions	0.1
Coal, weathered	0.9
Shale, light-grey, silty, plant remains	0.2
Coal, weathered	0.9
Siltstone, light-grey, massive, plant remains	0.4
Coal, weathered	1.9
Shale, medium-grey, fissile	0.1
Coal, weathered	0.8
Base of exposure	

The following composite section was measured in the Blue Bird Coal Company pit (Mine No. 1571):

	Feet
Soil, black	0.8
Till, brown, sandy with pebbles	1.3
Till, dark-grey, mainly clay, with quartzite and ironstone pebbles	1.0
Shale, light-grey	1.3
Siltstone, light-grey, soft	0.6
Shale, black, carbonaceous, thin coal lenses	1.3
Coal	0.1
Shale, medium-grey, silty	1.3
Sandstone, light-grey, fine-grained	0.1
Shale, medium-grey, silty, lenses out laterally	0.3
Sandstone, light-grey, fine-grained	1.3
Shale, medium-grey, silty, dark-grey carbonaceous shale along bedding planes	0.3
Sandstone, light-grey, feldspathic	0.6
Sandstone and siltstone, interbedded	1.0
Sandstone, light-grey, fine-grained	1.0
Siltstone, medium-grey	1.3

Sandstone, light-grey, medium-grained, massive	10.0 (approx.)
Coal, bright, layered	1.0
Clay, light-grey, bentonitic	0.2
Coal, bright, layered	2.9
Shale, medium-grey, silty	0.5

Pit floor level

The stratigraphic level of this coal may be the same as that at Wizard Lake but very probably is another coal zone, lower down in the Edmonton formation. Coal is present in the McColl Frontenac Wizard Lake well at about 220 feet below the surface seam, and this appears to correspond quite well with the seam at the Blue Bird mine.

Logs of the eight coal test holes drilled in the vicinity of Wizard Lake are given in the appendix. Three of these holes (Nos. 1, 4, and 5) intersected the Wizard Lake coal seams.

It is deduced from the available data that the Wizard Lake coal-bearing zone varies between 10 and 15 feet in total thickness. In the McColl Frontenac well the coal appears to be considerably thicker, but this evidence is not too reliable. The coal-bearing zone contains from three to six separate coal beds, ranging from 0.5 to 4 feet in thickness, but the same bed is not always the thickest one. Although correlation of the coal-bearing zone as a whole is reasonably certain, it is very difficult to relate the separate units of the zone between holes. An attempt at correlation is shown in figure 3. There is good correlation between only two (holes Nos. 4 and 5) of the four logs obtained across the zone in the vicinity of Wizard Lake.

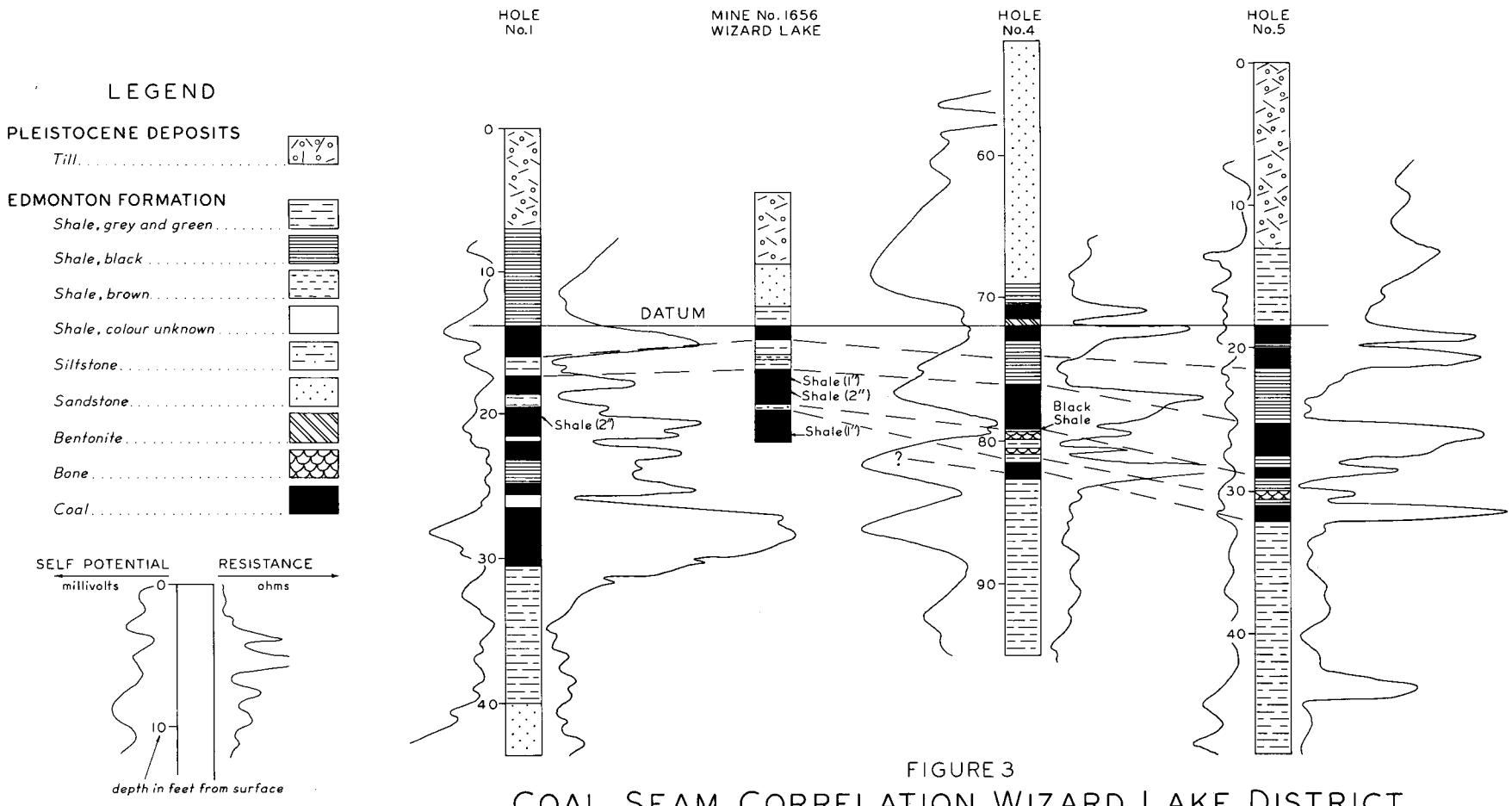
Extent of Coal Deposits

Mine evidence indicates that coal is present along both sides of Wizard Lake, although probably too deeply buried to be strip-mined. The coal-bearing zone was intersected in test holes Nos. 1, 4, and 5, to the north of the lake. Two holes (Nos. 3 and 6) lay outside the boundaries of the field, coal having been cut off by the pre-Pleistocene erosion surface. Hole No. 2 appears to be located above a bedrock depression filled with till and gravel, whilst holes Nos. 7 and 8 are situated in the buried Pleistocene drainage channel that passes through Wizard and Watelet Lakes.

From the coal test hole, outcrop, and shot hole log data, it is concluded that an area of about 10.6 square miles to the north of Wizard Lake is underlain by the coal-bearing zone at depths of 50 feet or less. In the four logs across the zone, the thickest coal seam in each section varies between 2 and 4 feet in thickness. Assuming an average thickness of 2.5 feet, then the area of 10.6 square miles outlined in figure 2 contains about 30 million tons of minable coal. The reserves are considered insufficient to be used as a fuel supply for a thermal power station.

Analytical Data

Coal in the Wetaskiwin coal area is Subbituminous B, and has free burning



Self-potential and resistance curve sensitivities vary from hole to hole

FIGURE 3

COAL SEAM CORRELATION, WIZARD LAKE DISTRICT

(HOLE LOCATIONS ARE SHOWN ON FIGURE 2)

and smokeless properties, according to Stansfield and Lang (1944). They give the following typical analysis, calculated from analyses of coal from two mines which formerly operated at Wizard Lake:

Analyses in weight per cent

Proximate		Ultimate (with 20 per cent moisture)	
Moisture	20.0	Carbon	55.8
Ash	7.6	Hydrogen	5.8
Volatile matter	28.0	Sulphur	0.2
Fixed carbon	44.0	Nitrogen	0.8
		Oxygen	29.8
		Ash	7.6

Fuel ratio (FC/VM), 1.60.
Calorific value, gross, in B.t.u. per lb., 9,520.

PART II.

STRIPPABLE COAL DEPOSITS OF THE WESTLOCK-BARRHEAD DISTRICT, ALBERTA

INTRODUCTION

General Statement

Coal test drilling has been carried out in the district between Westlock and Barrhead to determine the nature and extent of a coal seam which has been mined at Picardville, 7 miles south of Westlock. The district was selected as being potentially suitable for the site of a future steam power station. The Pembina River which passes through the district (Fig. 4) could be used as a source of cooling water, and the site would be within economic transmission distance of the Edmonton area with its heavy power requirements. Power will also be required in increasing amounts in the Swan Hills, 60 miles northwest of Barrhead, because of the development of the oil fields there.

Location and Access

The Westlock-Barrhead district lies 40 miles west-northwest of Edmonton, between latitudes 40°00' and 54°15', and longitudes 113°45' and 114°30', in Tps. 58 - 61, Rs. 26 - 27, W. 4th Mer., and Tps. 58 - 61, Rs. 1 - 4 W. 5th. Mer. (Fig. 1). The map (Fig. 4) accompanying this report covers about 530 square miles.

Provincial Highway 44 passes through the northeast corner of the map area. It is paved as far west as Westlock. Highway 18, a good gravel road, continues west from Westlock to a point 2 miles north of Barrhead, and then heads northwest towards the Athabasca River and Fort Assiniboine. The main Northern Alberta Railways line from Edmonton to Peace River passes through Picardville and Westlock, and a branch line terminates at Barrhead.

Topography and Drainage

The relief of the district is low, and varies between a minimum elevation of just over 2,000 feet in the northeast, and a maximum of just over 2,300 feet in the south at Highridge. The main topographic feature is the Pembina River Valley. The river has reached maturity, and flows in a broad valley with gently sloping banks which have a relief of less than 50 feet. Its drainage system dissects the Westlock-Barrhead district, and Paddle River and a number of small creeks flow into it from northwest and southeast. Redwater River drains the extreme southeast part of the map area, and flows southeast to join North Saskatchewan River near Redwater, whilst Pembina River flows north to join Athabasca River west of Flatbush.

Previous Geological Work

Geological reconnaissances were made along the Athabasca River during

the later years of the nineteenth century by several officers of the Geological Survey of Canada, including Dawson, McConnell and Tyrrell. Allan and Rutherford of the Research Council of Alberta examined the Westlock-Barrhead district as part of their work in central Alberta between 1925 and 1934, and the results are incorporated in their report and map (Allan and Rutherford, 1934). The most recently published work is a geological map and summary account of the surface geology of the Athabasca-Barrhead area by Feniak (1944).

In the last ten years there has been considerable oil and gas exploration in the district by means of structure test holes, seismic surveys, and wildcat wells. As a result, the rich Westlock gas field has been proven. This field has been little developed as yet, its only production so far being to supply the local utility.

History of Coal Mining

The Westlock-Barrhead district lies in the southwest part of the Westlock coal area. Coal has been mined in the Westlock area since 1932, and during this time the Province of Alberta has issued 11 coal mining licenses for operations there. Six of these were for mining coal near Thorhild and Opal, about 30 miles east of Westlock, where the coal is present in the Belly River formation. The other five licenses were taken out for operations in the Westlock-Barrhead district, where coal has been produced from the Edmonton formation.

Seams reported to be from 3 to 6 feet thick have been mined at shallow depths. Production has been fairly equally distributed between underground and stripping operations. Coal mining reached its peak in the Westlock area in 1951, when production amounted to 12,550 tons. The Thorhild coal mine (Lsd. 13, Sec. 12, Tp. 60, R. 21, W. 4th Mer.) and the North Point Coal Company mine (Lsd. 4, Sec. 12, Tp. 60, R. 21, W. 4th. Mer.) were the only ones in operation in the Westlock area in 1959, when 9,225 tons of coal were produced. Although it is only a small operation, formerly underground and now a strip-mine, the Thorhild Coal Mine property has been producing coal continuously since 1937. The Picardville Coal Company Limited mine (Lsd. 8, Sec. 35, Tp. 58, R. 27, W. 4th Mer.) was open from 1937 until 1956; no coal has been mined in the map area (Fig. 4) since it was abandoned.

Methods of Study

The district between Westlock and Barrhead (Fig. 4) was chosen for examination, because it was considered that the coal seam, formerly mined at Picardville, might subcrop at shallow depth in a northwesterly trending zone between Picardville and Bloomsbury. No bedrock outcrops were found, and the seam is not now exposed in the Picardville strip-mine. Shot-hole logs were examined to determine the approximate distribution of coal. They were also used for plotting isopachs of drift thicknesses and bedrock surface contours.

More exact data on the extent and thickness of the Picardville seam were obtained by drilling 20 uncased 4 3/4-inch holes, using a truck-mounted rotary

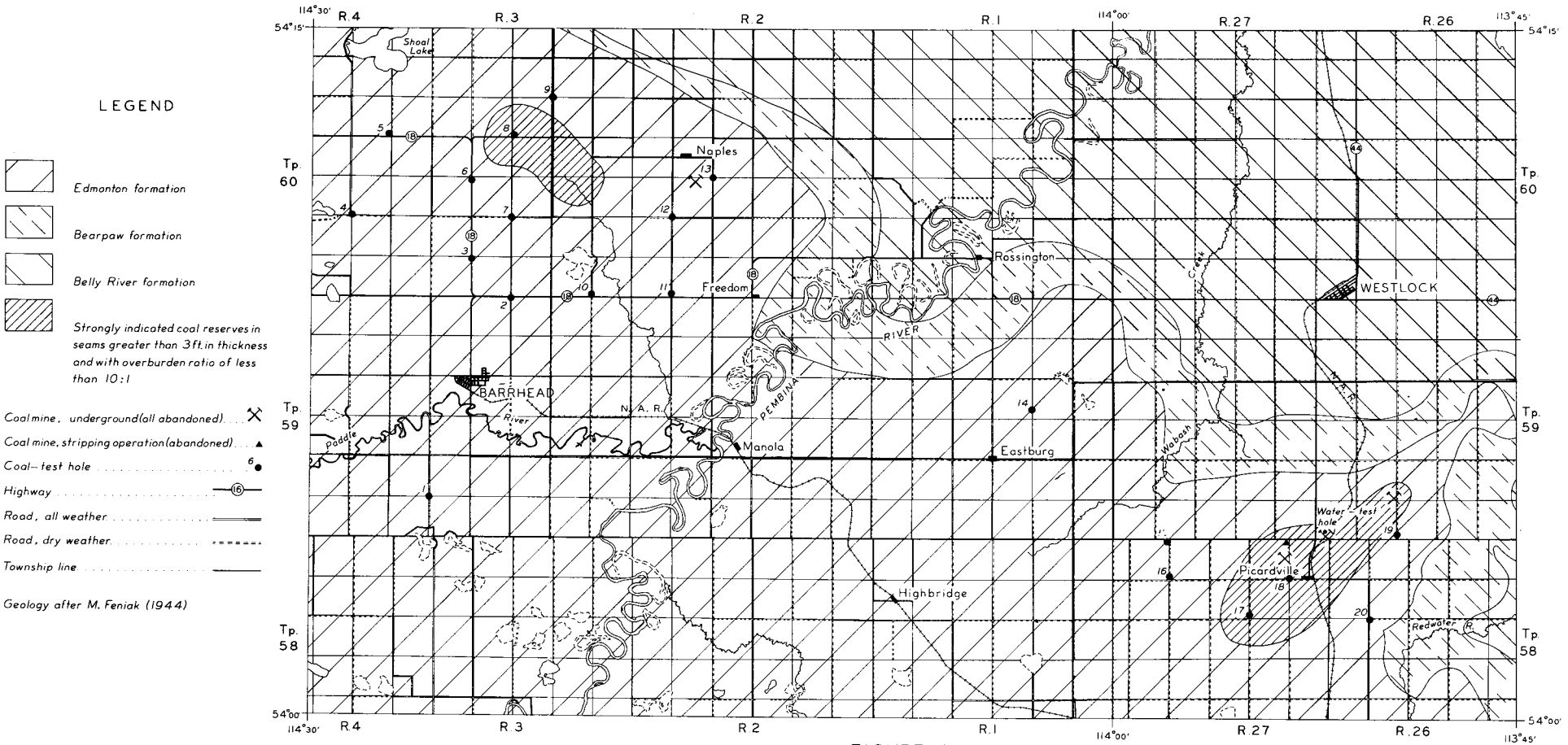


FIGURE 4

WESTLOCK—BARRHEAD DISTRICT, ALBERTA

Mayhew rig. This work was done during two weeks of late September and early October, 1959. The depths of the holes varied from 80 to 180 feet, and a total of 2,455 feet was drilled. Each hole was logged by the driller, who was particularly careful with his logging whilst the bit was passing through coal seams. He obtained a high degree of accuracy in his logging by collecting rock fragments from the bit in a large sieve at closely spaced intervals. The hole was washed out each time to remove chips from the section already drilled. Samples of rock fragments were collected at 5-foot intervals and retained for later examination. The holes were electrically logged for resistance and self-potential characteristics immediately after they were drilled.

Test holes were drilled in two main groups, one to the north of Barrhead and the other around Picardville. The two groups are about 10 miles apart, separated by the Pembina River Valley with its thick alluvial deposits.

Holes were drilled close to the corners of surveyed sections, and were located with respect to them by pacing. Surface elevations at the holes were measured with a Paulin survey altimeter. Surveyed elevations along Highway 18, shown on National Topographic Series maps, were used as base stations for the survey.

Acknowledgments

The writer is indebted to Texaco Exploration Company for supplying shot hole logs and location maps, and to Union Oil Company of California for supplying electrologs of structure test holes drilled near Westlock. Both sets of logs were obtained in the first instance by R. N. Farvolden of the Research Council of Alberta Groundwater Division.

Proximate coal analyses were made in the analytical laboratory of the Coal Division, Research Council of Alberta, under the direction of J. F. Fryer.

GENERAL GEOLOGY

Stratigraphy

Strata of late Cretaceous age constitute the bedrock in the Westlock-Barrhead district. The northeastern half of the map area is underlain by beds in the upper part of the Belly River formation, and the southwest half by beds of the lower part of the Edmonton formation. Both the Belly River and Edmonton beds are fresh- or brackish-water, near-shore deposits. They consist of light-grey and greenish-grey shales, fine-grained sandstones and coal seams. Marine shales of the Bearpaw formation possibly are present between the Belly River and Edmonton formations. Bearpaw shales have a broad outcrop area in southern Alberta, but exposures along the North Saskatchewan River northeast of Edmonton indicate a thinning along strike to the northwest. Feniak (1944) writes:

No marine shales are exposed along Athabaska River where the Bearpaw might be expected to occur. However, topographic features on the basis of which Rutherford (1939) mapped the Bearpaw in the Edmonton map-area continue into Athabaska map-area and the formation was projected across the map-area on the basis of this topography and on the assumption that it is continuous and maintains the same regional strike. Farther west, however, within the Barrhead map-area, the Bearpaw is represented as pinching out, and any equivalents beyond that point are mapped with the beds of the Edmonton formation.

Structure test hole electrologs of the Belly River formation in the vicinity of Westlock indicate very rapid changes in lithology. No correlation was possible between logs for holes only one mile apart. Results of the test drilling show that the Edmonton formation is also subject to very rapid facies changes. Coal seams in particular vary greatly in thickness and position in holes one or two miles apart.

Pleistocene and Recent Deposits

A mantle of till, varying in thickness from 10 to over 80 feet, covers the district. The shot hole logs that were examined indicate that at least half the map area has a drift cover exceeding 50 feet in thickness.

The till is grey, but brown near the surface, probably due to oxidation (Gravenor and Ellwood, 1956). It varies from mainly clay-size to mainly sand-size particles and contains scattered pebbles, cobbles, and boulders of fine-grained grey quartzites, schists, gneisses, and igneous rocks. The lack of sand and gravel deposits suggests that there are no buried Pleistocene drainage channels in the areas that were drilled, but thick alluvial clays, silts, sands, and gravels occupy the Pembina River Valley. These are recent deposits laid down by the river in its post-Pleistocene drainage channel.

Structure

The Westlock-Barrhead district lies on the east limb of the Alberta syncline and there is a regional southwesterly dip. Feniak (1944) reports that a few dip determinations across the Athabasca-Barrhead area suggest a steepening of dip to the southwest. Two of his observations are as follows:

Thorhild, in the southeast part of tp. 60, rge. 21, W. 4th mer. Strike north 76 degrees west (approx); dip south-southwest at 3 feet a mile.
Picardville, in the northeast part of tp. 58, rge. 27, W. 4th mer. Strike north 80 degrees west; dip south-southwest at 34 feet a mile.

Coal seams which were intersected in the coal test holes north of Barrhead were found to have an average strike of north 80 degrees west, and dip of about 40 feet per mile to the south-southwest. Lack of persistent marker beds makes it difficult to determine near-surface structural features in the lower Edmonton and upper Belly River formations of the district.

COAL DEPOSITS

General Statement

The coal seam, formerly mined at three small operations near Picardville, is believed (Feniak, 1944) to lie near the base of the Edmonton formation. Coal is commonly present at this stratigraphic level in Alberta, and has been mined in the Edmonton, Tofield, Camrose, Castor, Sheerness, Drumheller, Gleichen and Champion coal areas. The seams are not as thick as those near the top of the Edmonton formation, and generally do not exceed five feet in thickness.

The Picardville seam is nowhere exposed at present, and prior to the drilling program the only reliable data on seam thicknesses and depth of overburden were in Alberta Mines Division records. This information is summarized in table 2.

Table 2. Coal Mines in the Westlock-Barrhead District (all abandoned)

Mine No.	Location					Type of operation	Seam thickness (feet)	Cover thickness (feet)	Date of opening	Date of closing
	Lsd.	Sec.	Tp.	R.	Mer.					
1397	SW.1/4	5	59	26	4	Tunnel	4.5		1932	1934
1444	15 & 16	35	58	27	4	Stripping			1933	1941
1446	15	17	60	2	5	Slope	4 to 6	20	1933	1936
1481	1	9	59	26	4	Slope	4.5		1937	1947
1523	8	35	58	27	4	Slope	5	12	1937	1956

Description of Coal Seams

Logs of the 20 holes drilled in the Westlock-Barrhead district are given in the appendix. It will be noted that coal seams 2 feet or greater in thickness were intersected in 14 of the holes, and that in most of the holes several seams over 1 foot thick were intersected. Seven holes intersected seams 4 feet or greater in thickness.

A driller's log for a hole put down to test groundwater conditions in the old workings of mine No. 1397 reads as follows (R. McAuley, driller):

Feet	
0 - 7.0	Clay, brown
7.0 - 12.5	Coal
12.5 - 15.0	Shale, brown
15.0 - 34.5	Clay, grey
34.5 - 37.0	Shale, brown, and bentonite
37.0 - 38.3	Coal
38.3 - 69.0	Shale, grey
69.0 - 71.0	Shale, brown
71.0 - 77.5	Shale, grey
77.5 - 78.0	Coal

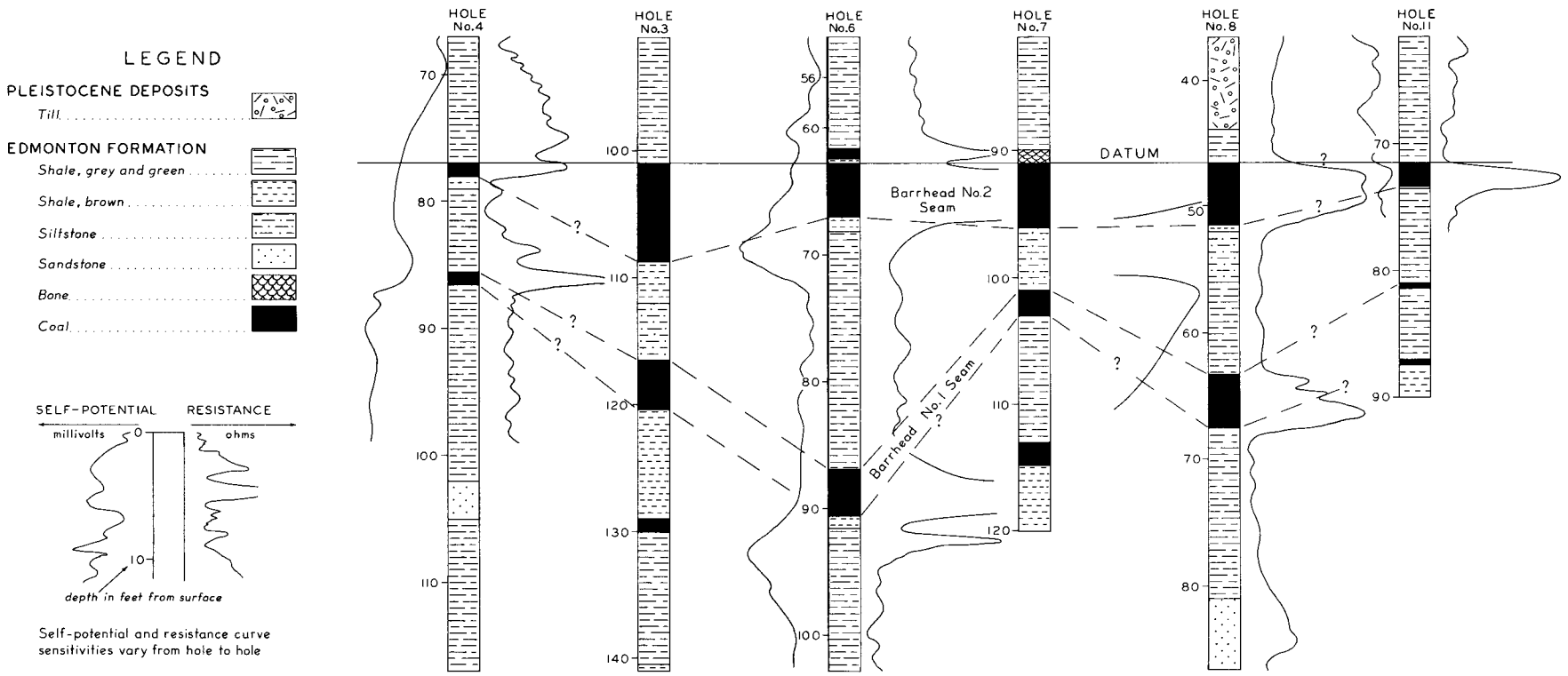


FIGURE 5

COAL SEAM CORRELATION IN HOLES DRILLED NORTH OF BARRHEAD

(HOLE LOCATIONS ARE SHOWN ON FIGURE 4)

78.0 - 82.0	Shale, grey
82.0 - 82.5	Shale, brown
82.5 - 83.5	Coal
83.5 - 96.5	Clay, grey
96.5 - 103.0	Clay, grey, sandy
103.0 - 105.0	Shale, dark-grey

The 5.5-foot seam near the surface is apparently the one that was mined, but the coal must be rather weathered since it is overlain by till and is near the surface.

Six seams over 1 foot in thickness were intersected in the upper 55 feet of hole No. 18 at Picardville. Assuming a southwesterly dip of about 30 feet per mile, the 4-foot coal bed intersected at a depth of 51.5 feet probably is the seam that was mined 1 mile to the north. The latter is termed the Picardville seam in this report. A 5-foot seam with a 6-inch shale and bone parting was encountered at a depth of 14 feet in hole No. 18. A 6-foot coaly zone in hole No. 16 is probably the equivalent of the Picardville seam, but two thick brown shale layers render it unsuitable for mining. Two coal seams, 3.3 and 2.6 feet thick, occur in the upper 30 feet of hole No. 17 but are at too high an elevation to be correlated with the Picardville seam. The latter should lie near the surface in hole No. 19, but it is absent, probably due to the fairly thick till cover there. A 4-foot coal seam was intersected in this hole at a depth of 59 feet, but because of its low elevation it cannot be correlated with the Picardville seam. The latter lies very close to the surface at the two abandoned mines northeast of Picardville.

The above data indicate that a 150-foot section of the lower Edmonton formation at Picardville contains at least two, and possibly three, coal beds of 4 to 5 feet in thickness, together with an undetermined number of thinner beds.

Four holes (Nos. 3, 6, 7, and 8) drilled north of Barrhead intersected two coal seams separated by from 5 to 20 feet of shales and siltstones. The lower seam ranged between 2 and 4 feet in thickness in the four holes. It is termed the Barrhead No. 1 seam in this report. The upper seam varied between 3.5 and 7.5 feet in thickness, and is termed the Barrhead No. 2 seam. These coals occupy a similar stratigraphic position in the lower part of the Edmonton formation to that of the Picardville seam, and could be equivalent, but no exact correlation has been possible. Figure 5 gives a tentative attempted correlation of coal seams intersected in six holes drilled to the north of Barrhead.

The Barrhead seams lens out along strike to the east and west, and also disappear down dip. It was anticipated that holes Nos. 4, 5, 10, 11, 12, and 13 would intersect the two Barrhead seams but only thin coal beds were found. In hole No. 11, the lower seam is 0.4 feet thick and the upper seam is 1.9 feet thick. An abandoned underground mine half-a-mile south of Naples is recorded as having worked a 4- to 6-foot seam with 20 feet of overburden, but no such seam was intersected in holes Nos. 12 and 13, drilled less than a mile away. Hole No. 9 intersected 1.7 feet

of coal lying immediately beneath the till cover, indicating that this hole is situated on the northern edge of the field where the Barrhead seams were removed by pre-Pleistocene or Pleistocene erosion.

Coal Reserves

Because of the great variations in position and thickness of the seams, and the limited information available, it has not been possible to construct isopachs for coal or overburden thicknesses. However, areas probably underlain by coal seams 3 feet or greater in thickness and with an overburden ratio of 10:1 or less are shown in figure 4. Two such areas have been outlined. One centred about Picardville covers 9.2 square miles, and assuming an average seam thickness of 4 feet, it contains about 40 million tons of strippable coal. North of Barrhead, 4.6 square miles are possibly underlain by the two Barrhead seams at a depth of 60 feet or less. Since only one hole intersected the seams at a depth of less than 60 feet, the extent of the area is doubtful. Assuming that 6 feet of coal are suitable for mining throughout 4.6 square miles, then strippable coal reserves total about 30 million tons.

The above estimates should be regarded as only very approximate. Detailed drilling would be required to accurately estimate coal deposits in the Westlock-Barrhead district. It is probable that the figures mentioned are too large, but coal might be found near surface at other places. Such conditions probably obtain between Picardville and the Pembina River, and between Bloomsbury and the Athabasca River to the northwest. If strippable coal reserves were located northwest of Bloomsbury, the Athabasca River might be a suitable power station site.

Analytical Data

Coal in the Westlock coal area is classified as Subbituminous C by Stansfield and Lang (1944). It is an Alberta domestic coal, free burning and smokeless. Stansfield and Lang give the following proximate typical analysis for coal from Mine No. 1446 near Naples:

	Weight per cent
Moisture	26.5
Ash	4.6
Volatile matter	29.7
Fixed carbon	39.2

Fuel ratio (FC/VM), 1.3
Calorific value, gross, in B.t.u. per lb., 8,730

A Canada Mines Branch analysis of a sample from the upper 2.8 feet of the Picardville seam at Mine No. 1444, Picardville, is given as follows (Nicolls, 1952):

Proximate analysis in weight per cent

	As received	Dry
Moisture	31.5	0.0
Ash	5.0	7.3
Volatile matter	26.2	38.3
Fixed carbon	37.3	54.4

Fuel ratio (FC/VM), 1.40
Calorific value, gross, in B.t.u. per lb., 7,830 and 11,430

Five analyses (table 3) have been obtained on samples collected from test holes near Picardville and Barrhead. Drill cuttings do not provide very satisfactory coal samples for analyses, as they are not fully representative of the seam, and when collected are likely to be dirty. The samples were well washed and all visible foreign fragments were removed by hand picking, but it is probable that the ash contents given in table 3 are higher than they should be.

Table 3. Analyses of Coal from the Westlock-Barrhead District
(a - on capacity moisture basis)
(b - on dry basis)
Proximate analyses in weight per cent

	1		2		3		4		5	
	a	b	a	b	a	b	a	b	a	b
Proximate										
Moisture	25.4	0.0	24.3	0.0	25.1	0.0	25.8	0.0	27.3	0.0
Ash	9.0	12.1	13.3	17.6	12.3	16.5	21.1	28.4	11.7	16.1
Volatile matter	27.4	36.8	26.7	35.3	28.0	37.4	23.9	32.2	25.9	35.6
Fixed carbon	38.2	51.1	35.7	47.1	34.6	46.1	29.2	39.4	35.1	48.3
Fuel ratio (FC/VM),	1.39		1.34		1.24		1.22		1.36	
Calorific value, gross, in B.t.u. per lb.	8,100	10,860	7,750	10,240	7,850	10,470	6,650	8,960	7,370	10,410

1. Cutting sample collected across Barrhead No. 2 seam, hole No. 6
2. Cutting sample collected across Barrhead No. 2 seam, hole No. 8
3. Cutting sample collected across Barrhead No. 1 seam, hole No. 8
4. Cutting sample collected across 19.9 to 23.0-foot interval, hole No. 17
5. Cutting sample collected across 41.0 to 45.0-foot interval, hole No. 18

Analyses made in the analytical laboratory of the Coal Division, Research Council of Alberta.

PART III.

COKING COAL DEPOSITS OF THE SHEEP CREEK-WILDHAY RIVER DISTRICT, ALBERTA

INTRODUCTION

General Statement

The Research Council of Alberta carried out a reconnaissance geological survey of parts of Wilderness Provincial Park during August, 1959 (Govett, 1960). In conjunction with this survey, the writer had the opportunity to examine a number of coal occurrences in the Inner Foothills between Sheep Creek and Wildhay River, along the east boundary of the provincial park. This district (Fig. 1) lies in the Smoky River and northern part of the Brûlé coal areas.

Although the coal deposits of the Smoky River area have not previously been reported to have good coking properties, a party engaged by private interests carried out extensive survey and coal sampling work in the district in the summers of 1958 and 1959, in search of coking coals. The Research Council party took advantage of tunnels made by this group to obtain detailed logs of the seams and unweathered coal samples. It now appears that there are large reserves of good quality coking coal in the Foothills of Alberta north of Athabasca River.

Location and Access

The Sheep Creek-Wildhay River district lies between latitudes 53°30' and 54°00', and longitudes 118°25' and 119°30', and comprises about 1,500 square miles. It occupies parts of the Foothills and Front Range sub-provinces of the Rocky Mountains in west-central Alberta, north of the Athabasca River.

The nearest railway is the transcontinental line of Canadian National Railways which passes through Entrance, a village some 20 miles southeast of the map district and about 190 miles west of Edmonton. The railway follows the Athabasca River Valley southwest to Jasper where it enters the Yellowhead Pass.

Entrance has been used as an outfitting and communications point by geological parties, coal prospectors, forest rangers and hunting parties. A gravelled road leads from the village to the Edmonton-Jasper highway, 2 miles to the south.

Until 1947, when a motor road was completed from Entrance to a wildcat oil well drilled near Muskeg River by the Northern Foothills Agreement, the map district was accessible only by two main forestry trails from Entrance. One, the Lower trail, follows the outer edge of the Foothills to Muskeg River, then continues down Grande Cache Valley and west to the Smoky River at Gustavs Flats. The more westerly Mountain trail branches from the Lower trail just north of Wildhay River, which it follows as far as Eagles Nest Creek. The trail follows Rock Creek to its

source, crosses over the height of land to Sulphur River, and joins the Lower trail near Grande Cache Lake.

The Muskeg road follows the route of the Lower trail as far as the Muskeg Forest Ranger station. Since the Muskeg No. 1 well was abandoned in 1948 after proving dry, the road has been maintained by the Alberta Department of Lands and Forests, and they have constructed a branch road to Rock Lake where a Forest Ranger station is maintained. Lumber companies have also added a number of branch roads, but these are poorly maintained. In 1959 the Muskeg road was connected with a forestry road which was built south from Highway 34, east of Grande Prairie. In the same year the party sampling coal deposits near Smoky River constructed a road west from the Muskeg River along the Grande Cache Valley and across to Smoky River at Gustavs Flats. This road was in fairly good condition during the summer, but there are several deep fords where it crosses Muskeg River. A temporary private ferry was operated across Smoky River just north of Gustavs Flats during the summer of 1959.

Trails follow most of the principal rivers and creeks in the map district, but there are very few places where horses can be taken without trails.

Topography and Drainage

The topography of the Sheep Creek-Wildhay River district is controlled by northwesterly trending ridges and valleys which parallel the structural trend, and have developed due to differential resistance to erosion of the underlying rocks. Smoky River lies in a broad, flat-bottomed, glaciated valley which cuts across the northwesterly trending structures.

The highest points in the district are in the southwest section where elevations of over 8,000 feet are reached. The lowest elevation is about 3,150 feet, where the Muskeg River crosses the northern boundary of the map district. Maximum topographic relief is thus about 5,000 feet. Relief between ridges and valley floors decreases towards the northeast, as the Foothills gradually merge into the Plains. Timber line is approximately 6,500 feet above sea-level, and throughout all the district except the northeast corner the ridge slopes are bare of tree growth.

Smoky River is responsible for the drainage of a large part of the district. Its tributaries include Sulphur River, Muskeg River, Muddywater River, Simonette River and Sheep Creek. Smoky River flows north to join Peace River at the Town of Peace River. The southeast section of the district is drained by Berland River and its tributaries, including Wildhay River and Cabin Creek. Berland River flows into Athabasca River about 60 miles west of Whitecourt.

Previous Geological Work

O'Neal (1914) first reported on the Smoky River coalfields, and in 1916 and 1919 MacVicar (1917, 1920, 1924) examined the geology and coal occurrences of an area between Brûlé Lake and Smoky River. In more recent years parts of the

Sheep Creek-Wildhay River district have been mapped by Irish (1947, 1951, 1954, and 1955), Thorsteinson (1952), and Eccles (1957), all of the Geological Survey of Canada.

A number of oil companies have carried out geological exploration in the district during the past ten years, but little of their work has been released. Shell Oil Company of Canada carried out a seismic survey along Sulphur and Smoky Rivers in 1959.

History of Coal Prospecting

Coal prospecting is believed to have been first done along Smoky River in 1909, when the Canadian Northern Railway had men in the field (McEvoy, 1925). By 1920, claims had been staked around most of the known coal occurrences between Sheep Creek and Wildhay River. Some diamond drilling was carried out along Thoreau Creek in the extreme southeast of the district in the early 1920's. At the present time McIntyre Porcupine Company Limited has a considerable area under lease along Smoky River northeast of Gustavs Flats.

Field Work and Acknowledgments

The field work which forms the basis of this report was carried out in August 1959. The party travelled by horse from Rock Lake Forest Ranger station to Smoky River and the headwaters of Sheep Creek, and returned by way of Gustavs Flats and Grande Cache Lake to the Muskeg River Forest Ranger station.

Thanks are due to G. J. Govett for his organization of the survey and for his cooperation during the time spent in the field. D. Clements ably performed the duties of junior assistant. The writer is indebted to K. K. Landes for his permission to examine and sample the prospect tunnels at Gustavs Flats.

Proximate analyses and coking tests of coal samples collected were made in the analytical laboratory of the Coal Division, Research Council of Alberta, under the direction of J. F. Fryer.

STRATIGRAPHY

General Statement

The map district (Fig. 6.) is underlain by rocks ranging in age from Precambrian or early Paleozoic up to late Cretaceous or Tertiary. They lie in a series of northwesterly trending folds which have been disturbed by strike thrust faulting. Precambrian (?) and Paleozoic rocks occur principally in the southwest part of the district; Lower Cretaceous strata outcrop in a broad, northwesterly trending zone through the centre; and Upper Cretaceous and Paleocene (?) rocks underlie the northeast part and outcrop in a few narrow belts in the center of the district.

Bedrock is best exposed along the bare ridges, and good sections are to be found along some stream valleys. Outcrops are hard to find on the tree-covered lower slopes of the mountains and on the lower ridges. The Upper Cretaceous formations in the northeast part of the district are poorly exposed; the ridges there are of lower elevation and thickly forested.

The geological map accompanying this report (Fig. 6) has been compiled from observations by G. J. Govett and the writer (mainly in the southwest quarter), and from maps published by the Geological Survey of Canada. References to these publications have been given under "Previous Geological Work". The table of formations (table 4) has been compiled from the same sources.

Only the Lower Cretaceous strata are of interest in connection with coal deposits of the district, and they alone will be described in this report.

Table 4. Strata Present in the Sheep Creek-Wildhay River District
[In part after Irish (1947, 1951, 1954, and 1955), Thorsteinson (1952) and Eccles (1957)].

Period or Epoch	Formation or group and approximate thickness in feet		Lithology
Pleistocene and Recent			Till, gravel, sand, alluvium, talus
Paleocene (?)			Sandstone, shale, conglomerate, coal (?) (nonmarine)
- - - - ? - - - -	Brazeau (6,000±)		Sandstone, shale, conglomerate (nonmarine), Solomon sandstone (marine) at base
Upper Cretaceous	Wapiabi (1,500 -)		Shale, shaly sandstone (marine)
	Bighorn (600±)		Quartzitic sandstone, shale (marine and nonmarine)
	Blackstone (1,500±)		Shale, minor siltstone (marine)
	Dunvegan (500±)		Sandstone, shale, sandy shale, coal (marine and nonmarine)
Lower Cretaceous	'Fort St. John' (400 - 500)		Shale and sandy shale (marine)
	Blairmore Group	Luscar (2,000±)	Sandstone, shale, conglomerate, greywacke, coal (nonmarine)
		Cadomin (50 - 200 +)	Pebble- and cobble-conglomerate (nonmarine)
	Nikanassin (1,000 - 4,000)		Quartzitic sandstone, siltstone, shale (marine and nonmarine)
Jurassic	Fernie (900±)		Dark-grey shale and siltstones, interbedded quartzitic sandstone (marine)

Triassic	Unit A (1,000±)	Limestone, dolomite (marine)
	Unit B (600)	Sandstone, dolomite, siltstone (marine)
	Unit C (300 -)	Shale, siltstone, dolomite (marine)
	Disconformity	
Pennsylvanian (?) and Permian	Rocky Mountain (100 -)	Chert, calcareous sandstone, phosphatic conglomerate (marine)
Mississippian	Rundle (1,300±)	Limestone and dolomite (marine)
	Banff (530±)	Calcareous shale, argillaceous limestone, silty shale at base (marine)
Devonian (Middle and Upper)	Palliser Alexo Mount Hawk Perdrix Flume (2,500± for Devonian)	Massive, fine-grained limestone Siltstone and silty limestone Calcareous shales, argillaceous ss. Black calcareous shale Limestone, dolomite, argillaceous limestone (marine)
	Unconformity	
Lower Paleozoic and Precambrian (?)	Undifferentiated	Quartzite, slaty shale (marine and nonmarine)

Nikanassin Formation

The Nikanassin formation is a series of sandstones interbedded with thinner siltstones and shales. According to Thorsteinson (1952), it is at least 4,000 feet thick in the Grande Cache area, but Irish (1954) found that it thinned to about 1,000 feet in the south and east. The sandstones and greywackes are medium- to dark-grey, weathering buff or brownish-grey, and are fine- to medium-grained. They are generally well bedded or flaggy, but massive beds up to 10 feet thick do occur. The Nikanassin formation is almost barren of faunal remains but a few poorly preserved pelecypods were found in the lower part. Thorsteinson and Irish believe that it contains both marine and nonmarine strata. The lower part of the formation may contain the Jurassic-Cretaceous boundary, for Irish notes that:

> Marine fossils have been collected from the lower 600 to 700 feet of this formation and tentative determinations of these fossils suggest that they are of Jurassic age.

Two thin sections of specimens that were considered to be normal Nikanassin rock types have been examined. Both consist predominantly of small, angular, quartz grains, and can be termed fine-grained sandstones or protoquartzites. They contain a small amount of plagioclase and a minor amount of rock fragments, the latter being largely brown, iron-stained, isotropic fragments (probably weathered shale) and sericitized argillite. The matrix constitutes up to 20 per cent of the rock, and consists of the authigenic minerals calcite, dolomite, chlorite, illite and possibly quartz. Detrital heavy minerals are rare; opaque iron oxides, zircon, tourmaline and epidote were noted.

Cadomin Formation

The Nikanassin formation is disconformably overlain by the Cadomin formation, a hard, massive conglomerate from 50 to over 200 feet in thickness. It is a very good marker due to its distinctive character and its ability to produce numerous and conspicuous outcrops. The conglomerate consists of black, grey, green, yellow, and white chert pebbles in a sandstone matrix. Chert and quartzite pebbles generally average 1 to 3 inches in diameter, but cobbles as large as 5 inches are reported by Thorsteinson (1952).

Luscar Formation

The Luscar formation conformably overlies the Cadomin conglomerate, and consists of medium- to dark-grey, green-grey, and brown-grey greywackes, sandstones, siltstones and silty shales, and coal seams. As scaled from diagrammatic cross-sections constructed by Irish and Thorsteinson, the Luscar formation appears to be about 2,000 feet thick in the vicinity of Gustavs Flats, although this must be considered a very approximate figure due to the complexity of folding and faulting. The formation is considered to be entirely nonmarine. The only faunal remains found were a few poorly preserved pelecypods, but there is an abundance of floral remains. Some

sandstone and greywacke beds contain abundant leaf impressions.

Six thin sections of coarser-grained rocks of the Luscar formation have been examined. They were found to vary from impure sandstones (quartz arenites) to low-rank quartz greywackes. Sandstone members consist of angular to subangular quartz grains in a calcite cement. The low-rank quartz greywackes contain quartz, plagioclase, and perthite grains, and rock fragments in an authigenic matrix of calcite, dolomite, chlorite, kaolinite, quartz, and montmorillonite (?). The rock fragments are principally chert and quartzite and brown, iron-stained argillite, together with small amounts of sericitized phyllite and volcanic rock. Accessory detrital heavy minerals include opaque iron oxides, zircon, apatite, tourmaline, and epidote (?). There appears to be some decrease in the amount of cherty material upwards from the base of the Luscar formation.

'Fort St. John' Group

'Fort St. John' dark-grey shales and silty shales conformably overlie the Luscar formation. Due to their relative ease of weathering they occur mainly along valley floors and are not common in outcrop, although Thorsteinson reports that good sections are exposed along Sulphur and Muskeg Rivers. Very little organic life has been found preserved in the marine 'Fort St. John' beds, and there is doubt as to whether they are early or late Cretaceous in age.

STRUCTURAL GEOLOGY

General Statement

The Sheep Creek-Wildhay River district extends across parts of the Foothills, Front Ranges and Main Ranges sub-provinces of the Rocky Mountains. Bedrock of all ages from Precambrian (?) to Tertiary suffered deformation during the Laramide (early Tertiary) orogeny. The chief structural features are northwest trending folds and strike thrust faults. There is a marked increase in the intensity of deformation across the map district from northeast to southwest. Names given in figure 6 for the more important folds and faults are those used in Geological Survey of Canada maps and reports.

Foothills Sub-province

The northeastern half of the district lies in the Foothills sub-province of the Rocky Mountains. There is no major break between the Foothills and Front Ranges sub-provinces in this district, but it appears, from extrapolation of the Nikanassin-Brulé thrust zone northwestwards from Brûlé Lake, that the Rocky Pass fault divides the two sub-provinces. However, the Rocky Pass fault, an important structural feature of the southeast part of the map district, disappears before reaching the Sulphur River. Farther northwest, a zone of smaller thrust faults paralleling the Llama Mountain anticline probably marks the northeast boundary of the Front Ranges sub-province.

The Foothills sub-province is characterized by open, fairly symmetrical folding, varying from small drag structures to large folds several miles across. The major faults are northwesterly trending, southwesterly dipping thrust or reverse faults.

Three Paleozoic limestone ridges occur within the Foothills sub-province in the Sheep Creek-Wildhay River district, but all pitch to the northwest and disappear south of Muskeg River. Two limestone blocks are brought up by thrust faults (the Mahon and Tip Top faults), and the other is exposed along the axis of the Cabin Creek anticline.

Front Ranges Sub-province

The Front Ranges sub-province extends from the Rocky Pass fault and the zone of thrust faults southwest to the Pyramid Mountain thrust, and is much narrower in this district than in southern Alberta. It is characterized by tight, assymmetrical, northwest trending folds and by two main thrust faults along which Devonian and Mississippian limestones are carried over Mesozoic strata. A prominent limestone range is brought up by the Llama Mountain anticline, but it disappears along strike to the southeast, near Kvass Creek. It does not seem possible to divide the Front Ranges sub-province into a series of ranges as has been done in southern Alberta.

Main Ranges Sub-province

That part of the map district southwest of the Pyramid Mountain thrust belongs to the Main Ranges sub-province of the Rocky Mountains. It consists of Precambrian and/or Lower Paleozoic rocks, which dip steeply away from the thrust zone but do not appear to be very complexly folded. Further south in Alberta, the Main Ranges sub-province is characterized by Precambrian and Lower Paleozoic rocks which have gentle dips and have not been severely faulted.

COAL DEPOSITS

General Statement

Thick coal seams are present in the Luscar formation throughout the map district and also along strike to the northwest and southeast. Thin seams, up to 6 inches thick, have been reported from the Dunvegan formation (Thorsteinson, 1952), and it is probable that coal is present in the Brazeau and Paleocene rocks since thick seams of this age are present to the south of Athabasca River. None has so far been reported in the map district, probably due mainly to the scarcity of exposures of these younger rocks.

Coal which occurs in the Luscar formation is of the same age as deposits which have been mined at Brûlé, Cadomin, and Luscar in the Foothills to the southeast. Seams occur throughout the formation, except in the upper few hundred feet, and

were examined in two localities: along the Wildhay River and Thoreau Creek in the southeast part of the district, and along the Smoky River and Sheep Creek in the north.

Wildhay River-Thoreau Creek

Three thick coal exposures occur in the southeastern part of the district at Thoreau Creek, at Thoreau Creek Pass, and at the summit between Wildhay River and South Berland River. Examination of these outcrops suggests that the same seam is exposed in each case, and that it lies stratigraphically about 900 feet above the Cadomin conglomerate.

The Luscar formation along the Wildhay Valley lies on the flanks of the Wildhay River syncline. Paleozoic limestones have been thrust faulted over the Luscar and Nikanassin formations along the southwest flank of the syncline by the Rocky Pass fault. Coal deposits in this locality occupy a position immediately in front of the Front Range sub-province. The coal is badly shattered in most outcrops, probably due to its nearness to the thrust plane.

The following section was logged across the seam exposed along Thoreau Creek, where the beds strike at 105 degrees and dip at 85 degrees to the north-northeast:

	Feet
Shale, medium-grey, silty	0.3
Coal, soft, friable, thin bony sections	9.8
Coal, bony	0.1
Coal, soft, appears clean	6.7
Coal, weathered dull, probably bony	3.3
Shale, light-grey	1.6
Shale, black	0.2
Coal, hard, mainly dull	2.3
Coal, bony	0.3
Shale, medium-grey	1.0
Shale, black, carbonaceous	0.3
Coal, finely layered	1.0
Shale, medium-grey	0.9
Coal, bright, finely layered	5.7
Coal, dull, bony	0.3
Coal, bright, finely layered	2.3
Sandstone and siltstone, dark-grey, weathering yellow-brown, salt-and-pepper	5.0

The total width of the seam is 36.5 feet, of which 31 feet is coal. A seam of similar thickness outcrops at the summit of Thoreau Creek Pass, about 1.5 miles northwest, but is poorly exposed and badly weathered. A very thick seam was reported by MacVicar (1924) near the summit between Wildhay and South

Berland Rivers (Sec. 2, Tp. 53, R. 5, W. 6th Mer.). The outcrop is high up on the hillside and only a few hundred feet from the thrust which has carried Upper Devonian Palliser limestones over Lower Cretaceous beds. MacVicar described the seam as over 100 feet thick, but this great width was found to be due to the coal lying along the axis of a tight syncline. It was difficult to examine the exposure owing to a thick blanket of rubble, but the following measurements were made:

	Feet
Sandstone, dark-grey, fine-grained, rusty weathering	5.0
Shale, grey and brown-grey, silty	5.0
Coal, hard, resistant to weathering, no apparent layering, dull	22.5
Clay, grey-brown	1.7
Coal, hard, resistant to weathering, dull, no apparent layering	10.8
Shale, grey-brown, soft	0.8
Coal, poorly exposed	106.0 (approximate)
Siltstone and shale, dark-grey, poorly exposed	19.5
Sandstone, medium-grey, fine-grained, hard, well bedded	2.0

Other, thinner, coal seams are exposed in the Wildhay River-Thoreau Creek-South Berland River region. These have been described by MacVicar (1924) and McEvoy (1925).

Table 5 gives a number of analyses of coal collected from the Wildhay River district. All the analyses show a rather poor quality of coal, low in fixed carbon and calorific value, and falling in the high volatile C bituminous or even subbituminous class. They have noncoking properties. It should be borne in mind, however, that the samples were probably collected from weathered outcrops and do not fully represent the coal present at depth. Due to the badly weathered nature of the exposures, no samples were collected by the writer.

Table 5 . Analyses of Coals of the Wildhay River and Thoreau Creek District
(After Nicolls, 1952).
(a - as received moisture basis)
(b - on dry basis)
Proximate and ultimate analyses in weight per cent

	1		2		3		4		5	
	a	b	a	b	a	b	a	b	a	b
Proximate analysis										
Moisture	4.8	0.0	13.7	0.0	10.8	0.0	14.9	0.0	1.9	0.0
Ash	14.0	14.7	12.4	14.4	13.6	15.2	8.9	10.4	13.1	13.4
Volatile matter	25.7	27.0	26.7	30.9	24.9	27.9	25.5	30.0	26.2	26.7
Fixed carbon	55.5	58.3	47.2	54.7	50.7	56.9	50.7	59.6	58.8	59.9
Ultimate analysis										
Carbon	66.3	69.7	-	-	-	-	-	-	-	-
Hydrogen	4.2	3.8	-	-	-	-	-	-	-	-
Ash	14.0	14.7	12.4	14.4	13.6	15.2	8.9	10.4	13.1	13.4
Sulphur	0.3	0.3	0.4	0.4	0.3	0.3	0.2	0.3	-	-
Nitrogen	0.9	1.0	-	-	-	-	-	-	-	-
Oxygen	14.3	10.5	-	-	-	-	-	-	-	-
Calorific value, gross, in B.t.u. per lb.	11,200	11,780	9,210	10,680	10,300	11,560	9,570	11,260	-	-
Fuel ratio (FC/VM),	2.15		1.75		2.05		2.00		2.25	
Coking properties	Nonagglomerating		Nonagglomerating		Nonagglomerating		Nonagglomerating		-	
Rank classification	-		-		-		-		Medium volatile bituminous	

1. Sample from 37-foot seam, west of Thoreau Creek (Sec. 27, Tp. 52, R. 4, W. 6th Mer.).
2. Sample from 7-foot seam, 1 1/2 miles up Thoreau Creek trail (Sec. 34, Tp. 52, R. 4, W. 6th Mer.).
3. Sample from 32.4-foot seam, west side of Thoreau Creek (Sec. 27, Tp. 52, R. 4, W. 6th Mer.). Clay bands omitted. Seam described in text.
4. Sample from 30-foot seam, 18,600 feet west of junction of Thoreau Creek and Wildhay River (Sec. 19, Tp. 52, R. 4, W. 6th Mer.).
5. Sample from "100-foot" seam, Wildhay River summit (Sec. 2, Tp. 53, R. 5, W. 6th Mer.). Seam described in text.

Samples for analyses 1 and 5 were collected by James McEvoy, Geologist, for the Dominion Fuel Board, in 1924.

Samples for analyses 2, 3, and 4 were collected by B. R. MacKay, of the Geological Survey of Canada, in August 1928.

Smoky River-Sheep Creek

Excellent exposures of the Luscar formation are to be found on the slopes of Mount Hamell facing Smoky River, north of Gustavs Flats. Numerous coal seams are visible in this section and also along small tributary creeks of Smoky River. Thorsteinson (1952) reports 19 seams in a logged section of the upper 958.8 feet of the Luscar formation, but there is only a 1.8-foot seam of "lignitic" coal in the top 401.5 feet. The 18 seams in the next 557.3 feet vary in thickness, between 0.8 and 28.7 feet. During the summer of 1959, the party employed by private interests used a bulldozer to strip a section of the Luscar formation on the west side of Smoky River at Gustavs Flats. Nine coal seams, totalling 71 feet in thickness were exposed in the lower 1,200 feet of the formation. Three of these seams were again exposed near Fox Creek, about two and one-quarter miles to the northeast. At Gustavs Flats, tunnels were driven into the mountainside along seven of the seams for distances of from 30 to 80 feet, until unweathered coal was encountered. Sections measured across the exposed seams are given below. Seam No. 1 is about 50 feet above the Cadomin conglomerate, and seam No. 9 is approximately 1,200 feet above the base of the formation.

Seam No. 1:	Feet
Sandstone, dark-grey, fine-grained, hard, massive	3.3
Shale, black, silty	0.3
Siltstone, dark-grey, hard, massive	3.0
Coal	1.0
Coal, hard, coarsely layered (sampled width)	7.7
Coal, soft	1.6
Coal, bony	0.2
Coal, soft	0.5
Siltstone, dark-grey, finely bedded	1.7
Siltstone, black	0.7

Siltstone, dark-grey, weathering buff		0.6
Siltstone, black		2.0
Seam No. 2:		
Siltstone, dark-grey, hard, massive		3.3
Coal, soft, shaly partings		1.7
Coal, coarse layered, thin bone layers	) sampled	5.6
Shale, carbonaceous	) width	0.2
Coal, coarsely layered	)	2.3
Coal, soft		1.7
Clay, brown,silty		0.5
Seam No. 3:		
Shale, brown, silty		2.3
Shale, black		0.3
Siltstone, dark-grey, finely bedded		2.1
Shale, black, carbonaceous		0.3
Coal, dull bony		0.5
Coal, hard, coarsely layered (sampled width)		8.7
Coal, weathered		2.0
Sandstone, grey, medium-grained		2.0
Seam No. 4:		
Siltstone, dark-grey, fine-grained, poorly bedded		5.0
Sandstone, medium-grey, fine-grained, massive		0.9
Siltstone, dark-grey, poorly bedded		0.8
Coal, dull, bony		0.5
Coal, coarsely layered, very good appearance (sampled width)		10.2
Seam No. 5:		
Sandstone, medium-grey, medium-grained, poorly bedded		6.0
Siltstone, fine-grained, weathers rusty-brown, finely bedded		3.0
Siltstone, medium-grey, poorly bedded		2.7
Shale, black, carbonaceous		0.8
Shale, weathers rusty-brown		0.1
Coal, dull, soft		1.4
Coal, coarsely layered, hard (sampled width)		3.5
Shale, black, carbonaceous		0.3
Shale, medium-grey, silty, well laminated		1.6
Siltstone, black, carbonaceous		0.3
Sandstone, soft, weathers red-brown		0.2
Sandstone, medium-grey, fine-grained, hard, massive		1.2
Seams Nos. 6 and 7:		
Sandstone, weathers brown, fine-grained, hard		4.2
Siltstone, thinly bedded, weathers red-brown		2.5
Shale, black, carbonaceous, fissile		0.8

Coal, bright	0.1
Shale, black, carbonaceous	0.1
Coal, good quality (No. 7 seam, 4.8 feet sampled)	6.3
Shale, black, carbonaceous	0.1
Siltstone, medium-grey, hard, contains irregular coal stringers up to 0.05 feet in width	4.3
Shale, dark-grey, silty	0.8
Coal, weathered, coarsely banded (No. 6 seam, not sampled)	3.3
Shale, black, carbonaceous	0.5
Shale, dark-grey, silty	2.0
Coal	0.2
Shale, black, carbonaceous	0.3
Shale, dark-grey, silty	0.2
Siltstone, light grey-brown, fine-grained, abundant plant remains	1.5

Seam No. 8:
Poorly exposed, no section measured.

Seam No. 9:

Sandstone, dark-grey, fine-grained, fine color layering	3.0
Siltstone, light brown-grey	0.3
Coal, soft bony layers (a 5.0 foot section of this seam was sampled 20 feet in from the tunnel entry)	10.7
Shale, light-grey, silty, poorly laminated	2.0

Channel samples were collected across seven of the seams at the tunnel faces. Table 6 shows the widths of sampled sections and the distance into the mountainside of the sampled face.

Table 6. Coal Samples Collected at Gustavs Flats

Seam No.	Total width (feet)	Sampled width (feet)	Distance along tunnel (feet)
1	10.2	7.7	70
2	11.3	8.1	52
3	11.5	8.8	70
4	10.7	10.2	80
5	5.0	3.5	50
7	6.3	4.8	33
9	10.7	5.0	20

A good coal exposure on Moyes Creek West, a southeast flowing tributary of Sheep Creek about 5.5 miles northwest along strike from Gustavs Flats, was examined and sampled. This coal is believed to be the No. 4 seam. The following

section was measured:

	Feet
Sandstone, dark brown-grey, fine-grained, massive	1.0
Coal, badly weathered	1.0
Coal, hard, breaks into pseudo "cone-in-cone" structure, coarsely layered	3.8
Coal, soft	0.5
Coal, hard, massive, finely layered, sparkling luster	1.7
Coal, dull, soft, weathered	0.3
Coal, hard, massive, finely layered, sparkling luster	4.2
Shale, dark-brown, carbonaceous	0.1
Coal, dull, soft, massive	0.7
Clay, brown weathering, silty	0.1
Coal, hard, friable, blue sheen	1.0
Shale, carbonaceous	0.5
Coal, finely layered, bright	0.7
Siltstone, dark-grey, hard, massive	0.2
Sandstone, dark-grey	2.7
Sandstone, dark-grey, ripple marked	1.0
Shale, grey, silty	6.0
Sandstone, grey	1.5

This seam has a total width of 15.4 feet, of which the upper 13.8 feet were sampled in three sections. Shale and clay partings of 0.1 feet or less in width were included in the sample; a thicker parting was excluded.

Results of proximate analysis and coking tests which were made on the samples in the analytical laboratory of the Coal Division, Research Council of Alberta, are given in tables 7 and 8. The coal is of low-volatile bituminous rank, and at least four seams have good coking properties. The tunnel in No. 9 seam was caving in, and a completely unweathered sample could not be collected, but it is believed (Dr. K. K. Landes, personal communication) that this seam is also good coking coal when unweathered. The ash content of five of the seven seams sampled is reasonably low. Analytical results for the Moyes Creek West seam are surprisingly good, in view of the fact that an outcrop section was sampled.

Coal Reserves

The writer has made no attempt at estimating the coal reserves in the Sheep Creek-Wildhay River district. Much more detailed surface and subsurface work will be required before accurate estimates could be made. However, MacVicar (1924) quotes the following figures, which he regards as conservative:

Middle division: (The Wildhay River and Thoreau Creek region), possible tonnage, bituminous 2,174,400,000

Northern division: (the Smoky River-Sheep Creek region),
possible tonnage, semianthracite and semibituminous 58,500,000
possible tonnage, bituminous 7,000,000,000

Total - 9,232,900,000 tons

McEvoy (1925) estimated the coal reserves of the National Coal Reserve (540 square miles of the Smoky River-Sheep Creek region) to be 3,424,363,000 tons. This figure was obtained by assuming that 73 feet of coal could be mined "to a vertical depth of 2,000 feet below access level".

Table 7. Analytical Data for Coal Exposed in Tunnels at Gustavs Flats
(a - as received moisture basis)
(b - on dry basis)
Proximate analyses in weight per cent

Seam No.	1		2		3		4		5		7		9	
	a	b	a	b	a	b	a	b	a	b	a	b	a	b
Proximate analysis														
Moisture	3.4	0.0	5.2	0.0	2.4	0.0	2.9	0.0	2.8	0.0	4.5	0.0	16.0	0.0
Ash	11.2	11.6	13.0	13.7	19.1	19.6	6.8	7.0	6.9	7.1	6.4	6.7	21.2	25.2
Volatile matter	13.7	14.2	15.5	16.3	14.5	14.9	18.4	19.0	19.1	19.7	18.7	19.5	19.0	22.6
Fixed carbon	71.7	74.2	66.3	70.0	64.0	65.5	71.9	74.0	71.2	73.2	70.4	73.8	43.8	52.2
Calorific value, gross, in B.t.u. per lb.	13,160	13,630	12,720	13,420	12,000	12,300	14,130	14,550	14,110	14,510	13,950	14,600	8,070	9,610
Fuel ratio (FC/VM)	5.25		4.29		4.40		3.90		3.72		3.77		2.31	
Free swelling index	-		4 1/2		1		8		above 9		9		-	
Coking properties	Noncoking		Coking		Agglomerating		Coking		Coking		Coking		Nongglomerating	
Rank classification	Low volatile bituminous		Low volatile bituminous		Low volatile bituminous		Low volatile bituminous		Low volatile bituminous		Low volatile bituminous		---	

Table 8. Analytical Data for Coal Outcrop on Moyes Creek West, Sheep Creek
(a - as received moisture basis)
(b - on dry basis)
Proximate analyses in weight per cent

Sample	1 Lower 5.5 feet of seam		2 Middle 5.5 feet of seam		3 Upper 2.8 feet of seam	
	a	b	a	b	a	b
Proximate analysis						
Moisture	7.5	0.0	6.5	0.0	6.9	0.0
Ash	3.1	3.3	5.2	5.6	8.2	8.8
Volatile matter	17.2	18.6	15.9	17.0	16.0	17.2
Fixed carbon	72.2	78.1	72.4	77.4	68.9	74.0
Calorific value, gross, in B.t.u. per lb.	13,130	14,190	13,310	14,230	12,530	13,460
Fuel ratio (FC/VM)	4.21		4.54		4.31	
Coking properties	Noncoking		Noncoking		Noncoking	
Rank classification	Low volatile bituminous		Low volatile bituminous		Low volatile bituminous	

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APPENDIX

COAL TEST HOLE LOGS

The following logs are based on the driller's logs, samples collected at 5-foot intervals, and electrolog interpretations. Sections across coal seam where coal, bone and shale are interlayered are based largely on electrolog interpretations. All depths are expressed in feet. Hole locations are shown in figures 2 and 4.

WIZARD LAKE DISTRICT TEST HOLES

No. 1

Location: 60 feet east and 35 feet south of NW. corner of Sec. 15, Tp. 48, R. 27, W. 4th Mer.
Surface elevation: 2,565 feet.

0 - 7.0 Till, light-brown, sandy
7.0 - 13.8 Shale, black, and bone
13.8 - 15.9 Coal
15.9 - 17.3 Shale, light-grey
17.3 - 18.5 Coal
18.5 - 19.5 Shale, light-grey, silty
19.5 - 20.1 Coal
20.1 - 20.3 Shale
20.3 - 22.1 Coal
22.1 - 22.5 Shale
22.5 - 23.2 Coal
23.2 - 24.8 Shale, black
24.8 - 25.6 Coal
25.6 - 26.5 Shale
26.5 - 30.5 Coal
30.5 - 40.0 Shale, light-grey, and siltstone
40.0 - 45.0 Sandstone, pale-grey, fine-grained

No. 2

Location: 60 feet north and 45 feet east of SW. corner of Sec. 15, Tp. 48, R. 27, W. 4th Mer.
Surface elevation: 2,585 feet.

0 - 15.0 Till, light-brown, silty
15.0 - 23.0 Till, light-grey, sandy
23.0 - 26.0 Gravel
26.0 - 34.0 Till, grey, silty
34.0 - 41.0 Gravel
41.0 - 48.0 Till, light-grey, silty
48.0 - 58.0 Siltstone, pale-grey, fine-grained
58.0 - 68.0 Shale, light green-grey, silty
68.0 - 72.0 Shale, dark-grey with thin coal stringer
72.0 - 75.0 Shale, pale-green

No. 3

Location: 115 feet north of SE. corner of Sec. 27, Tp. 48, R. 27, W. 4th Mer.
Surface elevation: 2,520 feet

0 - 10.0 Till, light-brown, sandy
10.0 - 14.0 Sand, buff, medium-grained, unconsolidated
14.0 - 16.0 Till, light-grey, mainly clay size
16.0 - 45.0 Shale, light green-grey, silty
45.0 - 46.0 Coal
46.0 - 55.0 Sandstone, pale-grey, fine-grained, feldspathic
55.0 - 58.0 Shale, medium-grey
58.0 - 62.0 Siltstone, light-grey, medium-grained, feldspathic
62.0 - 75.0 Shale, light green-grey
75.0 - 102.0 Sandstone, pale-grey, very-fine grained
102.0 - 105.0 Shale, light-grey, silty

No. 4

Location: 60 feet north and 25 feet west of SE. corner of Sec. 15, Tp. 48, R. 27, W. 4th Mer.
Surface elevation: 2,575 feet

0 - 14.0 Till, light-brown, mainly clay size
14.0 - 33.0 Shale, pale-grey
33.0 - 34.0 Coal
34.0 - 42.0 Shale, light grey-green
42.0 - 43.0 Coal
43.0 - 47.0 Shale, light-grey and black
47.0 - 69.0 Sandstone, grey, very fine-grained
69.0 - 70.5 Shale, black
70.5 - 71.4 Coal
71.4 - 72.0 Bentonite
72.0 - 73.0 Coal
73.0 - 76.1 Shale, black
76.1 - 79.1 Coal
79.1 - 79.3 Shale, black
79.3 - 79.9 Bone
79.9 - 80.5 Shale, grey
80.5 - 80.9 Bone
80.9 - 81.5 Shale, grey
81.5 - 82.6 Coal
82.6 - 95.0 Shale, light-green and grey

No. 5

Location: 45 feet east of SW. corner of Sec. 18, Tp. 48, R. 26, W. 4th Mer.
Surface elevation: 2,570 feet

0	- 13.0	Till, light-brown, sandy
13.0	- 18.5	Shale, light-grey
18.5	- 19.7	Coal
19.7	- 20.1	Shale, black
20.1	- 21.3	Coal
21.3	- 25.3	Shale, black
25.3	- 27.5	Coal
27.5	- 28.4	Shale, black, with white bentonite bed
28.4	- 29.0	Coal
29.0	- 29.9	Shale, black
29.9	- 30.5	Bone
30.5	- 31.0	Shale, black
31.0	- 32.1	Coal
32.1	- 60.0	Shale, pale-grey
60.0	- 80.0	Sandstone, pale-grey, fine-grained
80.0	- 84.0	Shale, medium-brown
84.0	- 85.0	Bentonite, white
85.0	- 90.0	Shale, pale-green
90.0	- 145.0	Sandstone, pale-grey, fine-grained
145.0	- 170.0	Shale, grey
170.0	- 198.0	Sandstone, pale-grey, very fine-grained
198.0	- 199.5	Coal and bone
199.5	- 205.0	Shale, light-grey
205.0	- 215.0	Sandstone, pale-grey, very-fine grained

No. 6

Location: 35 feet south and 50 feet east of NW. corner of Sec. 4, Tp. 48, R. 26, W. 4th Mer.
Surface elevation: 2,588 feet

0	- 5.0	Till, brown, mainly clay size
5.0	- 7.0	Shale, grey
7.0	- 8.0	Bentonite, white
8.0	- 10.0	Coal, soft, and black shale
10.0	- 14.0	Shale, light-grey
14.0	- 20.0	Sandstone, pale-grey, very-fine grained
20.0	- 25.0	Shale, light-green
25.0	- 44.0	Sandstone, pale-grey, very-fine grained
44.0	- 45.0	Shale, pale-green

No. 7

Location: 90 feet north and 50 feet east of SW. corner of Sec. 6, Tp. 48, R. 26, W. 4th Mer.
Surface elevation: 2,560 feet

0	- 5.0	Gravel and boulders
5.0	- 12.0	Till, buff, very sandy
12.0	- 15.0	Coal and black shale (lens in till)
15.0	- 40.0	Till, light-grey, mainly clay size
40.0	- 82.0	Till, grey, sandy
82.0	- 90.0	Sand, light-grey, unconsolidated
90.0	- 95.0	Till, light-grey, sandy

No. 8

Location: 35 feet west and 15 feet north of SE. corner of Sec. 25, Tp. 47, R. 27, W. 4th Mer.
Surface elevation: 2,583 feet

0	- 7.0	Gravel
7.0	- 35.0	Till, light-grey, mainly clay size, with few coal lenses
35.0	- 40.0	Till, light-grey, mainly clay size with quartzite pebbles
40.0	- 55.0	Till, light-grey, mainly clay size
55.0	- 96.0	Till, light-grey, sandy
96.0	- 100.0	Siltstone, light-grey, fine-grained
100.0	- 102.5	Shale, light-grey, silty
102.5	- 103.5	Coal
103.5	- 109.0	Shale, light-grey
109.0	- 110.0	Shale, black
110.0	- 112.1	Coal and white bentonite
112.1	- 115.0	Shale, black

WESTLOCK-BARRHEAD DISTRICT TEST HOLES

No. 1

Location: At NE. corner of
Sec. 6, Tp. 59, R. 3, W. 5th Mer.
Surface elevation: 2,145 feet

0	- 18.0	Till, light brown-grey
18.0	- 18.3	Gravel
18.3	- 20.4	Till, grey, sandy
20.4	- 33.0	Sandstone, pale-grey, fine-grained
33.0	- 33.3	Bentonite, white
33.3	- 38.5	Shale, dark-brown
38.5	- 45.0	Siltstone, light-grey, fine-grained
45.0	- 46.5	Shale, light-grey, hard
46.5	- 46.8	Coal
46.8	- 66.0	Shale, light grey-green, silty
66.0	- 66.7	Sandstone, soft
66.7	- 69.8	Shale, light-grey, bentonite layers
69.8	- 78.7	Shale, brown and light-grey, thin beds of coal
78.7	- 80.0	Shale, pale-green

No. 2

Location: 50 feet south of NE.
corner of Sec. 33, Tp. 59, R. 3, W. 5th Mer.
Surface elevation: 2,220 feet

0	- 26.6	Till, light-brown, mainly clay
26.6	- 29.0	Coal, hard
29.0	- 29.2	Shale, dark-brown, soft
29.2	- 35.0	Shale, light green-grey, bentonite layers
35.0	- 42.5	Shale, pale-grey, silty
42.5	- 43.2	Coal
43.2	- 46.7	Shale, medium-brown
46.7	- 47.0	Coal
47.0	- 61.0	Shale, light-grey, silty
61.0	- 65.0	Shale, pale-green
65.0	- 67.6	Coal
67.6	- 78.0	Shale, pale-grey
78.0	- 78.6	Coal
78.6	- 84.0	Shale, medium-grey, with white bentonite
84.0	- 94.0	Siltstone, pale-grey, medium-grained, soft
94.0	- 95.0	Siltstone, light-grey, fine-grained, hard
95.0	- 113.0	Shale, light-grey
113.0	- 120.0	Shale, pale-green and grey

No. 3

Location: 60 feet east and 90 feet south of NW.
corner of Sec. 4, Tp. 60, R. 3, W. 5th Mer.
Surface elevation: 2,187 feet

0	- 26.5	Till, brown and grey, mainly clay
26.5	- 26.8	Sand, light-grey
26.8	- 40.0	Till, grey, mainly clay
40.0	- 44.0	Till, grey, mainly silt
44.0	- 48.0	Till, grey, mainly clay
48.0	- 50.5	Shale, dark-brown
50.5	- 53.5	Coal, soft
53.5	- 53.8	Bentonite
53.8	- 87.0	Shale, pale-grey
87.0	- 88.0	Shale, brown
88.0	- 101.0	Shale, pale-grey
101.0	- 108.7	Coal
108.7	- 112.0	Shale, medium brown
112.0	- 116.5	Siltstone, light-grey, medium-grained
116.5	- 120.3	Coal, soft
120.3	- 129.0	Shale, medium-brown, and bentonite
129.0	- 130.0	Coal
130.0	- 140.5	Shale, pale-grey
140.5	- 141.0	Shale, brown
141.0	- 150.0	Shale, pale-grey

No. 4

Location: 50 feet north and 300 feet
east of SW. corner of Sec. 13, Tp. 60,
R. 4, W. 5th Mer.
Surface elevation: 2,230 feet

0	- 14.0	Till, light-brown, mainly clay
14.0	- 39.0	Till, light-grey, mainly silt
39.0	- 50.0	Shale, light-grey
50.0	- 77.0	Shale, light-grey, thin sandstone and coal stringers
77.0	- 78.0	Coal
78.0	- 79.0	Shale, brown
79.0	- 85.6	Shale, light-grey
85.6	- 86.5	Coal and brown
86.5	- 101.0	Shale, light-grey
101.0	- 104.0	Sandstone, light-grey, soft
104.0	- 122.0	Shale, grey, sandstone stringers
122.0	- 133.5	Sandstone, light-grey, soft, and shale layers
133.5	- 133.8	Sandstone, light-grey, hard
133.8	- 156.0	Shale, light-grey, and minor dark-brown shale
156.0	- 174.0	Shale, light-grey
174.0	- 180.0	Sandstone, pale-grey, fine grained, feldspathic, hard beds

No. 5

Location: 75 feet north and 75 feet west of SE. corner of Sec. 25, Tp. 60, R. 4, W. 5th Mer.
Surface elevation: 2,220 feet

0	- 47.0	Till, light-brown, sandy
47.0	- 58.0	Till, light brown-grey, mainly sand size
58.0	- 60.0	Till, light-grey, clay and rock fragments
60.0	- 66.7	Sandstone, pale-grey, fine-grained, soft
66.7	- 67.0	Sandstone, hard
67.0	- 68.0	Coal
68.0	- 71.0	Shale, light-brown
71.0	- 72.8	Coal
72.8	- 76.5	Shale, dark-brown
76.5	- 78.5	Bone, black
78.5	- 82.0	Shale, dark-brown
82.0	- 108.0	Shale, light-grey
108.0	- 109.0	Coal and black shale
109.0	- 121.0	Shale, grey, thin coal stringers
121.0	- 123.0	Shale, brown
123.0	- 134.0	Shale, light-green and grey
134.0	- 138.0	Sandstone, pale-grey, soft
138.0	- 150.0	Shale, pale-grey, thin coal stringers

No. 6

Location: 290 feet south of NE. corner of Sec. 17, Tp. 60, R. 3, W. 5th Mer.
Surface elevation: 2,227 feet

0	- 9.0	Till, light-brown, sandy
9.0	- 17.0	Till, light-grey, sandy
17.0	- 44.0	Shale, light-grey
44.0	- 45.0	Shale, light-green
45.0	- 50.0	Shale, brown, thin coal stringers
50.0	- 55.7	Shale, pale grey-green
55.7	- 56.0	Shale, light-grey, hard
56.0	- 61.6	Shale, brown-grey
61.6	- 62.3	Coal
62.3	- 62.8	Shale, brown
62.8	- 67.0	Coal
67.0	- 68.2	Shale, brown
68.2	- 87.0	Shale, light-grey, silty
87.0	- 90.5	Coal
90.5	- 91.5	Shale, dark-brown
91.5	- 92.5	Coal
92.5	- 93.0	Shale, brown
93.0	- 104.0	Shale, medium-grey, silty
104.0	- 104.2	Shale, dark-brown

No. 6 (cont'd)

104.2	- 127.0	Shale, light-grey and green, silty
127.0	- 133.0	Siltstone, pale-grey, medium-grained
133.0	- 135.0	Sandstone, pale-grey, fine-grained, hard

No. 7

Location: 45 feet east and 15 feet south of NW. corner of Sec. 10, Tp. 60, R. 3, W. 5th Mer.
Surface elevation: 2,224 feet

0	- 12.0	Till, light-brown, mainly clay size
12.0	- 13.0	Coal, soft and weathered
13.0	- 33.7	Shale, light-grey with minor brown shale
33.7	- 34.0	Shale, brown, hard
34.0	- 41.7	Shale, light-grey, coal stringer at 35.5 feet
41.7	- 42.5	Shale, grey
42.5	- 44.0	Coal
44.0	- 49.0	Shale, light-grey
49.0	- 54.0	Shale, light-green
54.0	- 62.0	Sandstone, pale-grey, fine-grained
62.0	- 62.3	Coal
62.3	- 89.5	Shale, light green-grey
89.5	- 90.0	Shale, light-grey, hard
90.0	- 91.0	Bone, black, soft
91.0	- 96.0	Coal
96.0	- 101.0	Siltstone, pale-grey, medium-grained, quartzitic
101.0	- 103.0	Coal
103.0	- 113.0	Shale, pale-grey, silty
113.0	- 114.8	Coal
114.8	- 120.0	Shale, medium-brown, thin coal stringers

No. 8

Location: 65 feet east and 220 feet north of SW. of Sec. 27, Tp. 60, R. 3, W. 5th Mer.
Surface elevation: 2,247 feet

0	- 14.0	Till, light-brown, mainly clay size
14.0	- 44.0	Till, light-grey, sandy
44.0	- 46.6	Shale, light-grey
46.6	- 51.5	Coal
51.5	- 52.0	Shale, brown
52.0	- 56.0	Siltstone, pale-grey, medium grained
56.0	- 63.3	Shale, light-grey
63.3	- 67.5	Coal
67.5	- 81.0	Shale, light-grey
81.0	- 87.0	Sandstone, pale-grey, fine-grained, quartzitic
87.0	- 90.0	Shale, light-grey
90.0	- 102.0	Shale, light green-grey
102.0	- 103.5	Coal
103.5	- 105	Shale, light-grey

No. 9

Location: 55 feet south of NE. corner of Sec. 27, Tp. 60, R. 3, W. 5th Mer.
Surface elevation: 2,300 feet

0	- 20.0	Till, light-brown, sandy
20.0	- 21.7	Coal
21.7	- 26.0	Shale, dark-brown, and thin coal stringers
26.0	- 28.0	Shale, grey
28.0	- 33.5	Sandstone, pale-grey, fine-grained, soft
33.5	- 36.0	Shale, pale-grey
36.0	- 54.0	Sandstone, pale-grey, fine grained, feldspathic, soft
54.0	- 61.0	Shale, pale-grey, silty
61.0	- 62.7	Coal
62.7	- 72.0	Shale, pale-grey, silty
72.0	- 79.0	Sandstone, pale-grey, fine-grained, quartzitic
79.0	- 95.0	Shale, light-grey, and sandstone lenses

No. 10

Location: 100 feet north and 220 feet east of SW. corner of Sec. 1, Tp. 60, R. 3, W. 5th Mer.
Surface elevation: 2,161 feet

0	- 15.0	Till, light-brown, mainly silt size with few pebbles
15.0	- 30.0	Till, light-grey, sandy
30.0	- 33.5	Shale, brown, and soft coal layers
33.5	- 34.0	Coal
34.0	- 42.0	Shale, medium-brown
42.0	- 44.7	Coal, soft
44.7	- 45.0	Bentonite, white
45.0	- 46.5	Shale, dark-brown
46.5	- 49.0	Coal
49.0	- 51.0	Shale, medium-brown
51.0	- 59.0	Sandstone, pale-grey, fine-grained, soft
59.0	- 62.0	Sandstone, pale-grey, hard
62.0	- 67.5	Sandstone, pale-grey, fine-grained
67.5	- 68.8	Coal
68.8	- 71.0	Shale, dark-brown
71.0	- 72.0	Shale, grey
72.0	- 78.5	Sandstone, pale-grey, fine grained
78.5	- 79.3	Shale, brown, hard
79.3	- 101.5	Shale, grey, with brown layers
101.5	- 103.0	Coal
103.0	- 106.0	Shale, dark-brown
106.0	- 111.0	Shale, pale green-grey
111.0	- 111.5	Coal
111.5	- 125.0	Shale, pale grey-green
125.0	- 125.2	Bentonite, white
125.2	- 125.5	Coal
125.5	- 127.0	Shale, brown with bentonite layers
127.0	- 150.0	Shale, light-brown and grey with siltstone beds
150.0	- 160.0	Shale, pale-grey
160.0	- 163.0	Siltstone, light-grey, fine-grained
163.0	- 165.0	Sandstone, pale-grey, fine-grained

No. 11

Location: 75 feet north and 50 feet west of SE. corner of Sec. 6, Tp. 60, R. 3, W. 5th Mer.
Surface elevation: 2,164 feet

0 - 16.0 Till, light brown, sandy
16.0 - 22.0 Till, light grey, silty
22.0 - 31.5 Shale, grey
31.5 - 34.9 Coal
34.9 - 37.5 Shale, brown
37.5 - 43.0 Sandstone, pale grey, fine grained, soft, with shale layers
43.0 - 45.0 Coal
45.0 - 45.3 Shale, black
45.3 - 47.0 Shale, grey
47.0 - 53.0 Siltstone, pale grey, medium grained
53.0 - 56.0 Shale, light brown, silty
56.0 - 58.0 Shale, grey, thin coal stringers
58.0 - 71.5 Shale, pale green
71.5 - 73.4 Coal
73.4 - 73.5 Shale, brown
73.5 - 81.0 Shale, light grey, silty
81.0 - 81.4 Coal, soft
81.4 - 87.0 Shale, light grey
87.0 - 87.4 Coal
87.4 - 90.0 Shale, brown, with thin bentonite stringers

No. 12

Location: 45 feet east and 10 feet south of NW. corner of Sec. 8, Tp. 60, R. 2, W. 5th Mer.
Surface elevation: 2,240 feet

0 - 14.0 Till, light brown, sandy
14.0 - 26.0 Till, light grey, sandy
26.0 - 34.0 Till, light grey, mainly clay size
34.0 - 40.0 Siltstone, pale grey, medium grained
40.0 - 56.0 Shale, pale grey
56.0 - 61.0 Sandstone, pale grey, fine grained, soft
61.0 - 61.4 Coal
61.4 - 65.0 Shale, medium brown
65.0 - 73.0 Shale, dark grey
73.0 - 73.4 Coal
73.4 - 78.0 Shale, medium brown
78.0 - 80.0 Coal
80.0 - 85.0 Shale, dark brown and black
85.0 - 93.0 Siltstone, pale grey, coarse grained

No. 12 (cont'd)

93.0 - 96.5 Shale, pale grey
96.5 - 99.0 Coal
99.0 - 101.0 Shale, light brown
101.0 - 102.5 Coal
102.5 - 114.0 Sandstone, pale grey, fine grained
114.0 - 123.0 Shale, pale grey
123.0 - 124.0 Coal
124.0 - 127.5 Shale, dark brown and white bentonite
127.5 - 128.0 Coal
128.0 - 133.0 Shale, brown and white bentonite
133.0 - 133.7 Coal
133.7 - 141.0 Shale, light brown
141.0 - 142.0 Coal
142.0 - 150.0 Shale, brown, with thin coal and white bentonite beds

No. 13

Location: 45 feet east of NW. corner of Sec. 16, Tp. 60, R. 2, W. 5th Mer.
Surface elevation: 2,210 feet

0	-	21.0	Till, light-brown, mainly clay
21.0	-	29.0	Shale, grey
29.0	-	36.0	Sandstone, pale-grey, fine-grained, feldspathic, soft
36.0	-	38.0	Shale, brown, with coal stringers
38.0	-	44.5	Shale, green, with thin sandstone stringers
44.5	-	45.0	Coal
45.0	-	54.7	Shale, light-green, silty
54.7	-	55.0	Coal
55.0	-	59.0	Shale, light-grey
59.0	-	59.2	Coal
59.2	-	64.2	Shale, light-grey
64.2	-	65.5	Coal
65.5	-	70.0	Shale, light-grey
70.0	-	70.2	Bentonite
70.2	-	72.0	Shale, light-grey
72.0	-	73.0	Coal
73.0	-	78.0	Shale, grey and brown
78.0	-	79.2	Coal
79.2	-	82.5	Shale, brown, and bentonite
82.5	-	84.7	Coal
84.7	-	85.0	Shale, brown, hard
85.0	-	97.0	Shale, light green-grey
97.0	-	98.0	Coal, soft, brown
98.0	-	99.0	Shale, grey and brown
99.0	-	105.0	Shale, light green-grey
105.0	-	109.0	Shale, light-grey
109.0	-	110.0	Sandstone, pale-grey, fine-grained, soft
110.0	-	122.0	Shale, pale grey
122.0	-	123.0	Shale, brown, and coal
123.0	-	126.0	Shale, brown, hard
126.0	-	142.7	Shale, pale-grey, with thin sandstone beds
142.7	-	143.0	Coal
143.0	-	150.0	Shale, pale-green, silty

No. 14

Location: 1,200 feet north of SE. corner of Sec. 22, Tp. 59, R. 1, W. 5th Mer.
Surface elevation: 2,240 feet

0	-	20.0	Till, light-brown, sandy
20.0	-	32.5	Till, light-grey, sandy
32.5	-	37.0	Shale, dark-brown, with thin coal seam
37.0	-	49.0	Shale, light-grey, silty
49.0	-	49.5	Sandstone, soft
49.5	-	70.0	Shale, light-grey, silty, with thin sandstone and bentonite beds
70.0	-	71.3	Shale, dark-brown
71.3	-	72.5	Coal
72.5	-	79.0	Shale, grey
79.0	-	84.0	Sandstone, pale-grey, fine grained, feldspathic, soft
84.0	-	86.0	Shale, grey
86.0	-	89.0	Sandstone, hard
89.0	-	105.0	Sandstone, pale-grey, fine-grained, feldspathic, soft
105.0	-	118.0	Shale, light-grey, silty
118.0	-	121.0	Siltstone, light-grey, coarse-grained
121.0	-	140.0	Shale, light-green and grey, sandstone at 140 feet

No. 15

Location: At NE. corner of Sec. 32,
Tp. 58, R. 27, W. 4th Mer.
Surface elevation: 2,175 feet

0	- 6.0	Till, brown, mainly clay
6.0	- 19.5	Till, grey, mainly clay
19.5	- 22.0	Sandstone, pale-grey, fine-grained
22.0	- 26.5	Shale, light-grey, silty
26.5	- 26.7	Coal
26.7	- 33.8	Shale, light-grey, silty
33.8	- 35.0	Shale, brown and black
35.0	- 45.0	Shale, light-grey, silty
45.0	- 57.5	Sandstone, pale-grey, fine-grained feldspathic
57.5	- 76.0	Shale, light-grey, silty
76.0	- 87.0	Siltstone, light-grey quartzitic
87.0	- 94.0	Shale, light-grey, hard
94.0	- 99.0	Shale, light-grey
99.0	- 101.0	Sandstone, pale-grey, fine-grained
101.0	- 107.0	Shale, light-grey, silty
107.0	- 109.0	Coal with bentonite layers
109.0	- 111.5	Coal
111.5	- 120.3	Shale, dark-brown
120.3	- 121.7	Coal
121.7	- 135.0	Shale, light-grey, silty and minor dark-brown shale

No. 16

Location: 100 feet north and 15 feet
east of SW. corner of Sec. 33,
Tp. 58, R. 27, W. 5th Mer.
Surface elevation: 2,265 feet

0	- 4.0	Till, brown, silty
4.0	- 6.0	Shale, medium-brown and soft weathered coal (layer in till)
6.0	- 12.0	Till, brown, consisting largely of brown shale and weathered coal
12.0	- 29.0	Till, light-grey, mainly clay size
29.0	- 33.0	Sandstone, pale-grey, fine-grained
33.0	- 38.0	Shale, brown and grey
38.0	- 40.1	Coal
40.1	- 40.9	Shale, brown
40.9	- 41.8	Coal
41.8	- 42.7	Shale, brown
42.7	- 44.1	Coal
44.1	- 55.9	Shale, pale-green
55.9	- 58.2	Coal
58.2	- 62.3	Shale, pale-grey
62.3	- 64.5	Coal and black shale

No. 16 (cont'd)

64.5	- 74.0	Shale, pale green-grey
74.0	- 74.5	Coal
74.5	- 84.0	Shale, pale green-grey
84.0	- 94.0	Sandstone, pale-grey, fine-grained
94.0	- 100.0	Shale, light-grey, silty
100.0	- 105.0	Sandstone, pale-grey, fine-grained

No. 17

Location: 90 feet north and 50 feet
east of SW. corner of Sec. 26,
Tp. 58, R. 27, W. 4th Mer.
Surface elevation: 2,304 feet

0	- 8.0	Till, light-brown, mainly clay
8.0	- 12.0	Till, light-grey, mainly clay
12.0	- 17.0	Till, light-grey, mainly fine-grained sand
17.0	- 21.7	Shale, grey
21.7	- 25.0	Coal
25.0	- 29.5	Siltstone, pale-grey, medium-grained
29.5	- 30.1	Sandstone, pale-grey, fine-grained
30.1	- 32.8	Coal
32.8	- 59.0	Shale, light-grey, silty
59.0	- 59.3	Ironstone, hard
59.3	- 75.0	Sandstone, pale-grey, very-fine grained
75.0	- 87.0	Shale, light-grey, silty
87.0	- 88.0	Shale, brown, and bone
88.0	- 89.5	Coal
89.5	- 99.0	Shale, light-grey
99.0	- 105.0	Sandstone, pale-grey, fine-grained

No. 18

Location: 340 feet north of SW. corner of Sec. 36, Tp. 58, R. 27, W. 4th Mer.
Surface elevation: 2,283 feet

0 - 14.0 Till, light-brown, sandy, quartzite pebbles
14.0 - 17.0 Coal
17.0 - 17.5 Shale, brown, and bone
17.5 - 19.0 Coal
19.0 - 26.0 Shale, medium-grey
26.0 - 38.7 Sandstone, pale-grey, fine-grained, feldspathic
38.7 - 39.8 Coal
39.8 - 41.0 Shale, black
41.0 - 43.0 Coal
43.0 - 43.3 Shale, dark-brown
43.3 - 45.0 Coal
45.0 - 45.2 Bentonite, white
45.2 - 51.5 Shale, light-grey
51.5 - 55.5 Coal
55.5 - 69.0 Shale, light-grey
69.0 - 75.0 Sandstone, pale-grey, fine-grained
75.0 - 81.3 Shale, medium-brown and grey
81.3 - 81.5 Coal
81.5 - 95.0 Shale, light-grey, silty, with thin beds of sandstone

No. 19

Location: 110 feet north and 50 feet east of SW. corner of Sec. 4, Tp. 59, R. 26, W. 4th Mer.
Surface elevation: 2,285 feet

0 - 11.0 Till, light-brown, mainly clay
11.0 - 16.5 Till, light-grey, sandy
16.5 - 17.0 Shale (lens in till)
17.0 - 36.5 Till, light-grey, mainly clay
36.5 - 37.0 Sandstone, pale-grey, fine-grained
37.0 - 38.7 Coal
38.7 - 54.0 Shale, pale green-grey
54.0 - 56.0 Sandstone, pale-grey, fine-grained, quartzitic
56.0 - 59.0 Shale, pale-grey
59.0 - 63.0 Coal
63.0 - 64.0 Shale, pale-grey and brown shale
64.0 - 69.0 Sandstone, pale-grey, fine-grained
69.0 - 74.0 Shale, medium-brown, and thin coal stringers
74.0 - 76.0 Siltstone, light-grey, coarse-grained
76.0 - 85.0 Sandstone, pale-grey, fine-grained
85.0 - 90.0 Shale, light grey-brown

No. 20

Location: 60 feet east and 90 feet south of NW. corner of Sec. 20, Tp. 58, R. 26, W. 4th, Mer.
Surface elevation: 2,271 feet

0 - 13.0 Till, light-brown, silty
13.0 - 41.0 Till, light-grey, silty
41.0 - 46.0 Sand, light-grey
46.0 - 47.0 Gravel
47.0 - 60.0 Till, light-grey, sandy
60.0 - 61.0 Gravel
61.0 - 74.0 Till, medium-grey, sandy
74.0 - 74.2 Coal (lens in till)
74.2 - 78.0 Till, light-grey
78.0 - 84.0 Sandstone, pale-grey, fine-grained
84.0 - 95.0 Shale, light-grey, silty

LEGEND

- 4d — Brazeau group
- 4c — Fort St. John group, Alberta group.
- 4b — Cadomin and Luscar formation
- 4a — Nikanassin formation
- 3b — Jurassic
- 3a — Triassic
- 3 — Triassic and Jurassic, undifferentiated
- 2b — Mississippian, Pennsylvanian, Permian
- 2a — Devonian
- 2 — Upper Paleozoic, undifferentiated
- Lower Paleozoic and Precambrian, undifferentiated

Geological boundary
Fault (arrow indicates direction of dip)
Anticlinal axis
Synclinal axis
Direction of dip
Coal outcrop
Location of tunnels made into coal seams in 1959
Wildcat oil well (abondoned)
Road, graded
Road, ungraded
Boundary, Wilderness Provincial Park
Township boundary (unsurveyed)

The following Geological Survey of Canada publications have been used in compilation of this map-sheet

Moon Creek, map 968A
Adams Lookout (West half) Preliminary map 54-19
Adams Lookout (East half) map 5-1957
Grande Cache, map 1049A
Pierre Greys Lakes, map 996A

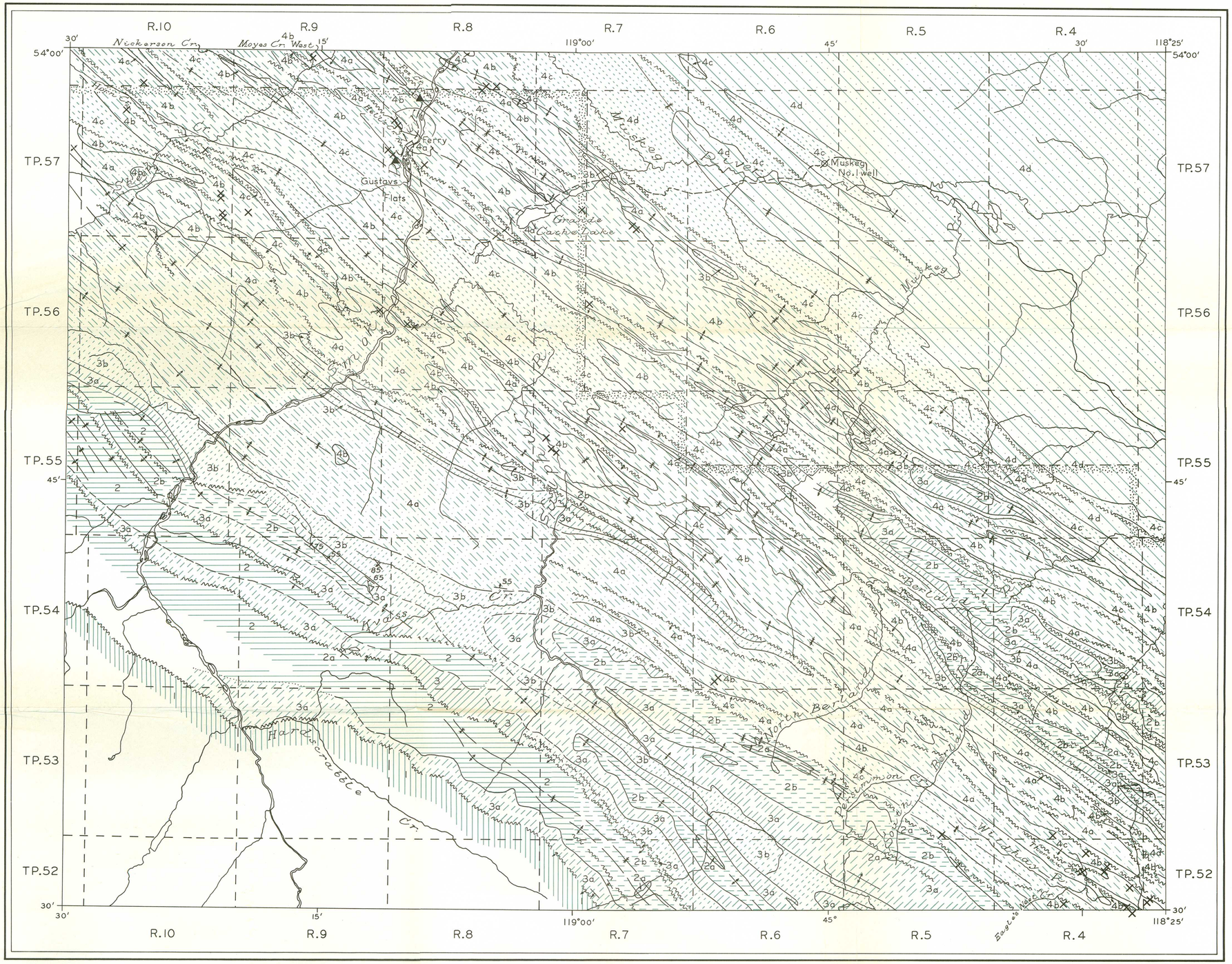

FIGURE 6

THE SHEEP CREEK–WILDHAY RIVER DISTRICT, ALBERTA

WEST OF SIXTH MERIDIAN

Scale in Miles

2 1 0 2 4 6 8