

RESEARCH COUNCIL OF ALBERTA

PRELIMINARY REPORT 61-1

THE CLOVER BAR COAL ZONE

EDMONTON - MORINVILLE DISTRICT, ALBERTA

by

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Research Council of Alberta
Edmonton, Alberta
1961

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INTRODUCTION

General Statement

As part of a Research Council of Alberta program directed towards estimating provincial reserves of coal amenable to strip-mining, near-surface coal deposits in the Edmonton-Morinville district have been examined. In view of the continually increasing power requirements of the City of Edmonton, information about these deposits was held to be of considerable industrial importance.

Location and Access

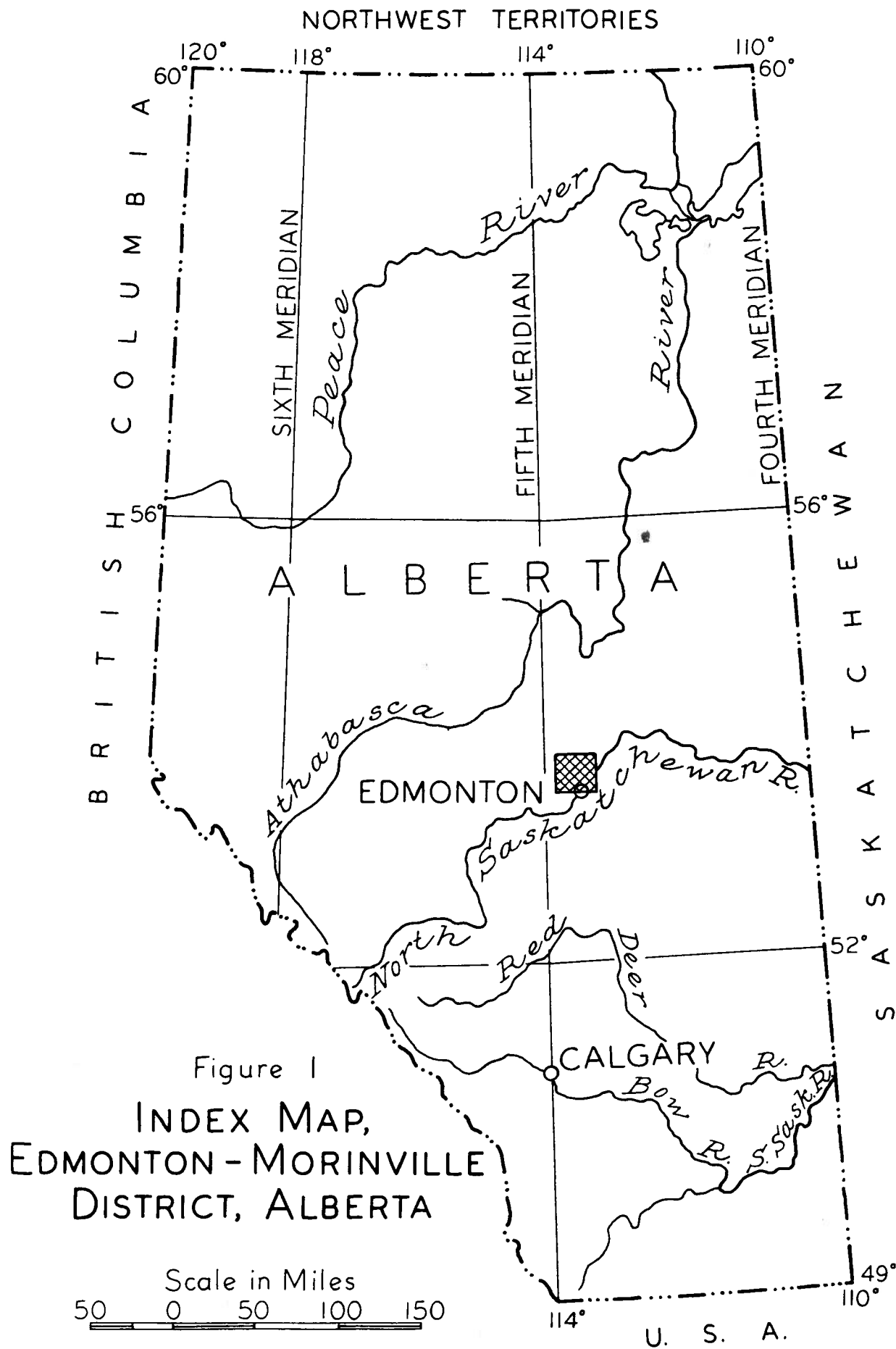
The district under consideration in this report (Fig. 1) lies beyond the north limits of the City of Edmonton and the Town of Jasper Place, and beyond the north and east limits of the Town of Beverly, in Tps. 53 - 57, Rs. 22 - 26, W. 4th Mer. It is crossed by Highways Nos. 2 and 28 which run north from Edmonton, and by Highway No. 15 which runs northeast from Edmonton. Many of the sectional roads are in good condition and provide ready access to much of the district. Branches of the Canadian National, Canadian Pacific and Northern Alberta Railways radiate out from Edmonton.

Topography and Drainage

The generally low relief of the district is only broken by the deeply incised valleys of the North Saskatchewan and Sturgeon Rivers. Elevations range between just over 2,000 feet at river level downstream from Clover Bar to 2,330 in the northwest near Manawan (Egg) Lake. The district lies in the North Saskatchewan drainage system, and is drained largely by the Sturgeon River and its tributary creeks. The Sturgeon River flows into the North Saskatchewan River at Fort Saskatchewan, a few miles east of the map district. The Sturgeon River occupies a 100-foot-deep valley with quite steeply sloping sides and a broad, flat, bottom. The North Saskatchewan River Valley has steeply sloping sides, in places almost vertical, about 125 feet in height.

Previous Geological Work

Selwyn (1874) and Tyrrell (1887) were the first to report on the geology of the region, each travelling the North Saskatchewan River during the course of exploratory geological surveys for the Federal Government. Dowling (1910) examined the Edmonton coal field and suggested possible correlation of the Clover Bar seam between Clover Bar and Morinville. A study of the various coal seams underlying the City of Edmonton was made by Beach (1934) who named ten seams and correlated them through outcrops, mine workings and bore holes.



The Edmonton sheet was geologically mapped by R.L. Rutherford for the Geological Survey of Canada (1939), and the geology of the Edmonton coal area* was compiled by MacKay (1949) in his "Atlas, Coal Areas of Alberta".

Oil exploration in the Edmonton-Morinville district has, since 1948, led to the discovery of the Acheson, Acheson East, Big Lake, Campbell-Namao, Excelsior, Fairydell-Bon Accord, Morinville, and St. Albert oil and gas fields within the map district. Nearby are the large Redwater and Leduc-Woodbend fields.

History of Coal Mining

The Edmonton-Morinville district constitutes part of the Edmonton coal area and has contributed considerable tonnages to the total production of the Edmonton area. Coal was for many years mined along the banks of the North Saskatchewan River at Clover Bar, and a strip along each side of the river upstream from the railway bridge is now largely mined out.

Ninety-nine coal mining licenses have been issued for the Edmonton area since 1905 by the Alberta Department of Mines and Minerals. However, a number of these were allowed to lapse shortly after being taken out. At present there are five operating mines in the area, of which three are in the Edmonton-Morinville district; of the latter, two are underground operations and one a strip mine. Most of the mining activity around Edmonton has been by underground methods, but in the past thirty years quite extensive stripping operations have been carried on at Cardiff and near Manawan Lake.

Coal production in the Edmonton coal area reached its peak in 1924, when 675,285 tons were mined. In that year, production for the whole of Alberta amounted to 5,203,713 tons. In 1917, the first year for which accurate records are available, the Edmonton area produced 661,241 tons, divided between the various districts as follows:

| | |
|------------|--------------|
| Clover Bar | 263,857 tons |
| Edmonton | 120,519 tons |
| Namao | 19,406 tons |
| Cardiff | 257,459 tons |

Production figures for other years, and the number of operating mines in those years, are given in Table 1.

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

Table 1. Mining Statistics for the Edmonton Coal Area

| Year | No. of Mines Producing | Coal Production (short tons) |
|------|---------------------------|---------------------------------|
| 1959 | 5 | 122,595 |
| 1955 | 11 | 218,259 |
| 1950 | 25 | 495,636 |
| 1945 | 26 | 408,068 |
| 1940 | 29 | 470,571 |
| 1935 | 35 | 493,263 |
| 1930 | 31 | 417,310 |
| 1925 | 35 | 558,710 |
| 1921 | 41 | 593,823 |
| 1916 | * | 465,265 |

* not available.

Methods of Study

Information about the continuity of the Clover Bar seam northwest from Clover Bar were first obtained from Dowling's (1910) report and from mine records on file at the Mines Division of the Alberta Department of Mines and Minerals. Thick coal seams were found to have been mined at Namao, Carbondale, Cardiff, Morinville, and Manawan (Egg) Lake. Also examined were coal outcrops along the North Saskatchewan and Sturgeon Rivers and at Carbondale, and all accessible coal exposures in strip pits. The thick seam present in the underground workings of Star-Key Mines Ltd. (Lsd. 4, Sec. 36, Tp. 52, R. 25, W. 4th Mer.) was logged. On the basis of this information, structure contours for the top of the coal zone were plotted, and these were then used to select suitable locations for drill holes. Drilling was carried out to check extant data and to provide additional information where necessary data were scanty. Three holes were also drilled between Clover Bar and Elk Island Park (to the east of the district shown in figure 2) in an attempt to trace the coal zone in that direction, but this part of the program met with little success.

Sixteen uncased 4 3/4-inch holes were drilled by a truck-mounted rotary Mayhew rig during two weeks in late June 1960. The depths of these holes varied from 35 to 200 feet, and their spacings ranged from one- to five-mile intervals. Total footage amounted to 1,805 feet. Each hole was logged by the driller, and samples of rock cuttings, collected at 5-foot intervals, were retained for later examination. The holes were also electrically logged to determine resistance and self-potential characteristics. The possibility of

compiling accurate test-hole logs from a combination of electrolog, driller's log, and sample examination had been previously established (Pearson, 1959).

All holes were drilled along road allowances close to the corners of quarter sections, and were sited by pacing from the corners. Surface elevations at the drill holes were measured with a Paulin survey altimeter which, under suitable weather conditions, is claimed to be accurate to within 5 feet. Grade elevations along the Northern Alberta Railways were used as base stations.

GENERAL GEOLOGY

The Edmonton-Morinville district is underlain by strata of late Cretaceous age and covered by a generally thin mantle of Pleistocene drift. The Upper Cretaceous is represented by clastic deposits ascribed to the upper part of the Belly River formation, the Bearpaw formation, and the lower part of the Edmonton formation.

The Belly River Formation

The Belly River formation outcrops to only a small extent in the northeast part of the district and requires little discussion. It consists of a series of shales, siltstones, and sandstones, with a few coal seams believed to have been laid down in fresh- and brackish-water environments. No coal seams of mineable thickness have been reported from the upper part of the Belly River formation exposed in the map district (Fig. 2 and 3).

Dawson (1875) first used the term "Belly River" for a series of largely continental deposits in the southern plains of Alberta, and Tyrrell (1887) later applied the name to similar deposits in east-central Alberta. Shaw and Harding (1954) describe the undivided Belly River formation as consisting of ".....a series of grey to brownish-grey to greenish-grey, argillaceous, bentonitic sand closely interbedded with brownish-grey to grey, carbonaceous shales and silts. Thin carbonaceous layers are characteristic of the normal facies. Thin coal seams characterize the continental to marine transition facies".

The upper part of the Belly River in southern Alberta is termed the Oldman formation (Russell, 1940), and this name has also been used in east-central Alberta with formational status (Nauss, 1945).

The Bearpaw Formation

A series of brown and grey marine shales called the Bearpaw formation occurs between the predominantly continental Belly River and Edmonton formations in the southern plains of Alberta. This formation thins out to the north,

but is believed to be represented by a 15-foot section of chocolate-brown shales on the North Saskatchewan River at Riverbend (J.D. Campbell, personal communication). The extent of Bearpaw shales shown on figures 2 and 3 is taken from Geological Survey of Canada Map 506A (1939), but is believed to be greatly overestimated. No Bearpaw formation has been reported north of the North Saskatchewan River, but was nevertheless mapped there by Rutherford on the basis of surface relief.

The Edmonton Formation

Selwyn (1874) first used the term "Edmonton" for coal-bearing Upper Cretaceous strata in the vicinity of the present City of Edmonton. As the strata were later traced throughout central Alberta, the term acquired formation status.

The Edmonton formation consists largely of light grey and green-grey, bentonitic shales and silty shales, together with dark grey shales, black carbonaceous shales, light grey, fine grained, salt-and-pepper sandstones, coal seams, and layers of clay-ironstone nodules.

Allan and Sanderson (1945) examined a complete section of the Edmonton formation at exposures along the Red Deer River in east-central Alberta and divided the formation into three members. Ower (1958) made a detailed study of the Edmonton formation from outcrop data and oil well electrologs, and divided the formation into five members. That part of the formation which underlies the map district is in the lowest member of both subdivisions.

Several good exposures of the Edmonton formation can be found along the North Saskatchewan River in the City of Edmonton and downstream, but nowhere else in the Edmonton-Morinville district are extensive sections available. However, a number of small exposures were examined in outcrops, roadcuts, and coal strip-mines.

Pleistocene Deposits

Throughout the Morinville-Clover Bar district bedrock strata are overlain by a mantle of glacial drift which consists of grey and brown till with associated sands and gravels. The till is commonly quite sandy and contains scattered pebbles and boulders of quartzite and a few "shield-type" rocks. The upper 10 to 30 feet of till are generally brown (probably due to surface oxidation), whilst the remainder is light grey.

Except in a few places where it appears to fill bedrock channels, the drift cover rarely exceeds 50 feet in thickness. One such "channel fill" occurs one mile northwest of Clover Bar, and was referred to by Beach (1934)

as a "washout". Drill hole No. 13 intersected 72 feet of till, although both to north and south the drift cover is quite thin. Thus this thick till deposit also fits the requirements for the site of a bedrock channel from which the Clover Bar coal zone was removed in pre-Pleistocene times.

Drift cover also appears to be quite thin to the east, from Clover Bar to Bremner, but a northeasterly trending moraine east of Bremner results in over 100 feet of drift above bedrock.

Structure

Regional geological observations suggest that the Cretaceous strata of the district have a dip of about 30 feet per mile to the southwest, but it is unlikely to be a uniform dip. Folds or "rolls", with horizontal dimensions of up to several hundred feet from crest to trough, occur in near-surface Edmonton beds in the Wabamun Lake district (Pearson, 1959), and are believed to have been produced by ice movement during Pleistocene times. Since a similar feature can be observed in the road-cut on Highway No. 16A, just east of the Edmonton city limits, it is probable that ice movement produced crumpling of near-surface shales throughout the entire Edmonton-Morinville district.

A major feature of the structure contour map (Fig. 3) is the large "syncline" trending northeast along Sturgeon River Valley northwest of Namao. This structure cannot be considered a normal tectonic fold and also appears too large to have been caused by ice movement. It is therefore regarded as a sedimentary feature caused by differential compaction over the pre-Cretaceous surface or within the Cretaceous sediments.

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 a similar pattern to that of figure 3. The district overlies Devonian dolomite reefs trending northeast through the Acheson and Redwater oil fields, and it is possible that these reefs have affected configuration of the overlying Cretaceous strata.

COAL DEPOSITS

General Statement

Coal has been mined in, and around, the City of Edmonton from several seams associated with the lowest 500 feet of the Edmonton formation. This stratigraphic zone is quite commonly coal-bearing in Alberta and has been worked in the Champion, Gleichen, Drumheller, Sheerness, Castor, Camrose, Tofield, Edmonton, and Westlock coal areas. However, the seams are generally thinner than those near the top of the Edmonton formation, and do not as a rule, exceed 5 feet in thickness. Coal seams thicker than 10 feet, while occurring at a few

places (e.g. in the vicinity of Morinville; Tp. 55, R. 25, W. 4th Mer.), are usually found to thin very rapidly in all directions.

Coal Seams of the Edmonton Area

Dowling (1910) made the first detailed report on coal seams in the Edmonton area. While he did not attempt detailed correlation of all seams intersected in borings and shafts put down near the city, his sectional diagram indicates at least eight seams to be present. More recent data on the occurrence of coal seams in the Edmonton "coal basin" were compiled by Beach (1934). He found ten seams in the lower part of the formation in the area and numbered them upwards from the base. The three seams formerly mined at Edmonton are the No. 3 or Lower seam, No. 4 or Clover Bar seam, and No. 7 or Weaver seam. The No. 9 or Big Island seam occurs about 280 feet above the Clover Bar seam. It is only 2 feet thick at its outcrop near the High Level bridge in Edmonton, but thickens to the west and reaches about 5 feet at Big Island where it has been mined.

The Lower or No. 3 seam has been reported by Beach (1934) to outcrop close to river level in Sec. 28, Tp. 53, R. 23, W. 4th Mer., but an examination of this outcrop in the south bank of the river failed to reveal the full thickness of the seam:

| | Feet |
|---|------|
| Coal, bright, finely layered, hard, massive | 1.5 |
| Bone | 0.1 |
| Shale, black, carbonaceous, coal lenses | 0.2 |
| Shale, dark brown to black | 0.3 |

Logging of an outcrop of the same seam in a nearby gravel pit south of the North Saskatchewan River (Lsd. 5, Sec. 28, Tp. 53, R. 23, W. 4th Mer.) yielded:

| | Feet |
|--|------|
| Gravel (river deposit) | 0.5 |
| Coal, bony, unweathered | 0.3 |
| Coal, dull, medium layering, hard, massive | 1.0 |
| Shale, black, and bone | 0.2 |
| Shale, black, with soft coal layers | 0.6 |
| Coal, bony, hard | 0.1 |
| Shale, black, carbonaceous | 0.3 |
| Shale, medium grey | 0.2 |
| Shale, black | 0.2 |
| Shale, dark grey | 0.2 |
| Coal | 0.1 |
| Shale, light grey | 0.5 |

No. 5 seam is reported to be a thin but persistent bed less than 3 feet thick and lying about 35 feet above the Clover Bar seam. It outcrops along the river bank from about 400 feet west of the Low Level bridge to the bend at Clover Bar.

More detailed descriptions of the coal seams underlying the City of Edmonton are to be found in the reports by Beach (1934) and Allan (1943).

The Clover Bar Coal Zone

Dowling (1910) suggested that the thick (4 - 7 ft.) coal seam, which outcrops along the North Saskatchewan River Valley from the Clover Bar bridge upstream to the present site of the Imperial Oil Limited refinery, could be traced to the northwest in drill holes as far as Morinville. He wrote:

In speaking of all these occurrences as being the extension of the Clover Bar seam as far west as Morinville, it would be perhaps misleading. This seam might not extend very far; but another seam within a few feet either above or below would continue until replaced by another, and so form the Clover Bar horizon.

The writer has adopted a similar approach. Because of the limited available data, it was impossible to make continuous correlations of the coal bed from Clover Bar to Manawan Lake, but it is assumed that the data collected on coal occurrences throughout the Edmonton-Morinville district relate to the same coal-bearing zone. This report therefore considers the coal deposits to constitute the Clover Bar coal zone rather than the Clover Bar seam.

Figure 2 (in pocket) shows the locations of mines in the Edmonton-Morinville district that have operated in the Clover Bar coal zone and also indicates the sites of holes drilled by the Research Council of Alberta. Isopachs drawn on figure 2 indicate observed and estimated total thicknesses of coal in the Clover Bar zone. In some cases, the total thickness of coal has been obtained by combining the widths of two relatively thin seams, but this has only been done where seams are separated by less than 3 feet of shale. The distribution of coal at each observation point can be checked by consulting the mine sections and drill hole logs in Appendices A and B.

Figure 3 (in pocket) shows structure contours for the top of the Clover Bar coal zone and isopachs indicating the thickness of cover above the coal zone. Both are subject to the limitations of available information and may need revision as more becomes known of coal seam distribution.

Sections measured and reported from mines and drill holes between Manawan Lake and Bremner are shown diagrammatically in figure 4. In the drill hole at Bremner only one coal seam was intersected, and since this is at about

the same stratigraphic level as the seam at Clover Bar it has been correlated with the Clover Bar coal zone. The seam at Clover Bar varies from 4 to 7 feet in thickness, generally with a 1- to 2-foot bone or shale parting. It proved difficult to trace the coal zone northwest from Clover Bar to Namao, although two rather thin coaly sequences were intersected in holes No. 2 and 3. In each case, the upper coal is considered to be the Clover Bar equivalent and the lower seam to be Beach's No. 3 seam. This arrangement best fits the structure contour pattern developed in the district. An outcrop near Namao (in Lsd. 7, Sec. 4, Tp. 55, R. 24, W. 4th Mer.) showed very badly weathered and poorly exposed coal, and only 2 feet of coal were uncovered although the seam could be considerably thicker. Dowling reported a 5-foot coal outcrop at this locality.

Further northwest at Carbondale the upper seam is 4 to 6 feet thick, but a 7-foot-thick lower seam is reported to have been mined 100 feet below it. The upper seam, correlated with the Clover Bar coal zone, outcrops in a roadcut at Carbondale (Lsd. 1, Sec. 17, Tp. 55, R. 24, W. 4th Mer.). The exposure is poor, but the following section was measured:

| | |
|------------------------|------|
| Shale, light grey | Feet |
| Coal, badly weathered | 1.0 |
| Bentonite, light brown | 0.8 |
| Coal, badly weathered | 0.3 |
| | 4.6 |

The Clover Bar coal thickens rapidly to the southwest of Carbondale, and in Sec. 35, Tp. 54, R. 25, W. 4th Mer. the Star-Key Mine is working a 10-foot seam. Hole No. 5, one mile west of Carbondale, intersected 4 feet of coal, but there is a rapid thickening from this point northwest to Cardiff. Hole No. 8 intersected a 23-foot coal section, including a 5-foot shale layer in the upper part. Mines operated at Cardiff for many years, principally in Sec. 24, Tp. 55, R. 25, W. 4th Mer., but are now all abandoned. The only coal section presently available for examination is in a strip pit, Mine No. 129 in Lsd. 36, Sec. 23, Tp. 55, R. 25; this was logged as follows:

| | |
|-------------------------------------|------|
| Coal, bony | Feet |
| Shale, black | 1.6 |
| Coal, massive | 0.6 |
| Clay, brown | 0.9 |
| Coal | * |
| Clay, brown | 0.3 |
| Coal, massive | 0.2 |
| Clay, brown | 4.3 |
| Coal, thinly layered, friable | * |
| Shale, black, with thin coal lenses | 1.4 |
| Clay, rusty brown | 0.9 |
| Coal, massive | * |
| Bone | 1.5 |
| Coal, very hard | 0.3 |
| | 3.7 |

* Partings of one-half inch or less in thickness.

The coal thins again rapidly northwest and west of Cardiff. Several thin seams between 2 and 3 feet in thickness were intersected in holes Nos. 10, 11 and 12, although it is reported that the two abandoned underground mines southwest of Morinville worked 6-foot seams. Detailed drilling is required to adequately determine the coal reserves in the vicinity of Morinville, where the coal zone shows great variation in thickness.

The thick coal seam is mined near Manawan (Egg) Lake, 6 miles northwest of Morinville, although hole No. 14 which was drilled 1 1/2 miles to the west intersected only three thin seams in a 10-foot interval. The Egg Lake Mine (Mine No. 1582, W. 1/2, Sec. 36, Tp. 56, R. 26, W. 4th Mer.) occupies a small area of slightly elevated land 1 mile west of Manawan Lake. The following section was measured at a recently exposed face:

| | Feet |
|---|----------|
| Till, sandy, with pebbles and cobbles of quartzite, gneiss and coal | 10.0 |
| Sand, yellow-buff, medium-grained, unconsolidated | 0.8 |
| Till, grey | 1.0 |
| Coal, badly weathered | 0 to 0.3 |
| Coal, bony | 0.5 |
| Shale, black | * |
| Coal | 0.8 |
| Shale, black | 0.1 |
| Coal | 2.9 |
| Clay, brown | * |
| Coal | 2.0 |

* Partings of one-half inch or less in thickness.

Strippable Coal Reserves

Insufficient information is available about the thickness and distribution of the Clover Bar coal zone between Clover Bar and Bremner to permit more than a provisional statement regarding reserves. Figure 3 indicates that coal could be mined along a rather narrow zone south of the subcrop margin, providing that the glacial drift is not thick and that the coal is still in place. Due to the thinness of the seams and to recent housing and air-base developments, there are probably no economically strippable coal deposits between Clover Bar and Namao.

A considerable area northwest of Sturgeon River is underlain by coal seams exceeding 5 feet in thickness and with a cover of less than 75 feet. But the great variability in thickness of the seam makes it impossible to calculate a reliable figure for coal reserves. Proved and possible reserves suitable for strip-mining, based on an assumed average coal thickness of 5 feet are considered, as an approximation, to exceed 50 million tons.

There is no economically mineable coal between Morinville and Manawan Lake, but a thick, near-surface seam is mined just west of the lake. Although this coal thins rapidly to the west, it may continue as a thick seam along strike to the northwest. Proved and possible reserves near Manawan Lake are low, but might be substantially increased if further exploration work were carried out to the northwest of the present mining area.

Analytical Data

Stansfield and Lang (1944) reported that two ranks of free-burning and smokeless coal - Subbituminous B and C - are mined in the Edmonton coal area. On the basis of analyses, they divided the area into three districts (table 2), of which two - A and B - fall within the Edmonton-Morinville area described in this report.

Table 2. Variation in Rank of Edmonton Area Coals
(after Stansfield and Lang, 1944)

| District | Township | Range | Rank (all subbituminous) |
|----------|----------|---------|-----------------------------|
| A | 54 - 56 | 24 - 25 | C and also B |
| B | 52 - 53 | 23 - 24 | B and C |
| C | 50 - 51 | 25 - 26 | B |

Typical analyses for each district, taken from their report, are as follows:

DISTRICT A

Canadian Classification - Subbituminous C and also Subbituminous B

Typical Analyses (in weight per cent)

| <u>Proximate</u> | | <u>Ultimate (with 25.3 per cent moisture)</u> | |
|------------------|------|---|-------|
| Moisture | 25.3 | Carbon | 50.25 |
| Ash | 7.1 | Hydrogen | 6.15 |
| Volatile matter | 28.6 | Sulphur | 0.3 |
| Fixed carbon | 39.0 | Nitrogen | 1.0 |
| | | Oxygen | 35.2 |
| | | Ash | 7.1 |

Fuel ratio (FC/VM): 1.35

Calorific value, gross, in B.t.u./lb.: 8,640

The net calorific value of this coal is approximately 560 B.t.u./lb. lower than the gross value.

DISTRICT B

This is the principal producing district in the area
Canadian Classification - Subbituminous B and C

Typical Analyses (in weight per cent)

| <u>Proximate</u> | | <u>Ultimate (with 25.0 per cent moisture)</u> | |
|------------------|------|---|------|
| Moisture | 25.0 | Carbon | 51.6 |
| Ash | 6.2 | Hydrogen | 6.2 |
| Volatile matter | 28.4 | Sulphur | 0.3 |
| Fixed carbon | 40.4 | Nitrogen | 1.0 |
| | | Oxygen | 34.7 |
| | | Ash | 6.2 |

Fuel ratio (FC/VM): 1.40

Calorific value, gross, in B.t.u./lb.: 8,860

The net calorific value of this coal is approximately 570 B.t.u./lb. lower than the gross value.

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APPENDIX A. COAL SEAMS EXPOSED IN MINE WORKINGS

The following logs were taken from plans of mine workings on file at the Mines Division, Department of Mines and Minerals, Province of Alberta:

Black Diamond Mine, No. 99; Lsd. 10, Sec. 7, Tp. 53, R. 23, W. 4th Mer.

| | Thickness | |
|------------|-----------|------------------------|
| | Feet | Inches |
| Cover | 0 to 300 | 0 |
| Coal | 1 | 0 |
| Shale | 2 | 0 (not always present) |
| Coal | 0 | 5 |
| Bone | 0 | 2 |
| Coal | 4 | 0 |
| Clay, hard | | |

Thompson Brothers Mine, No. 43; Lsd. 15, Sec. 7, Tp. 53, R. 23, W. 4th Mer.

| | Thickness | |
|---------------|-----------|--------|
| | Feet | Inches |
| Clover (clay) | 0 to 125 | 0 |
| Coal | 1 | 3 |
| Parting | 0 | 1/2 |
| Coal | 4 | 6 |
| Clay | | |

Booth Mine, No. 1167; Lsd. 1, Sec. 18, Tp. 53, R. 23, W. 4th Mer.

| West Part of Mine | Thickness | | Centre of Mine | Thickness | | East Part of Mine | Thickness | |
|-------------------|-----------|--------|----------------|-----------|--------|-------------------|-----------|--------|
| | Feet | Inches | | Feet | Inches | | Feet | Inches |
| Coal | 3 | 6 | Coal | 1 | 0 | Coal | 0 | 6 |
| Bone | 1 | 6 | Bone | 2 | 0 | Bone | 1 | 0 |
| Coal | 0 | 8 | Coal | 4 | 0 | Coal | 3 | 0 |
| Bone | 0 | 8 | | | | | | |
| Coal | 2 | 2 | | | | | | |

Long Mine, No. 1098; Lsd. 4, Sec. 31, Tp. 54, R. 24, W. 4th Mer.

| | Thickness | |
|--------------|-----------|--------|
| | Feet | Inches |
| Cover (clay) | 85 | 0 |
| Coal | 4 | 8 |
| Clay | 0 | 4 |
| Bone | 0 | 3 |
| Coal | 1 | 0 |
| Clay | | |

Star-Key Mines Limited, No. 1626; Lsd. 4, Sec. 36, Tp. 54, R. 25, W. 4th Mer.

| | Thickness | |
|------------|-----------|-------------------|
| | Feet | Inches |
| Cover | 80 | 0 |
| Coal, bony | 1 | 2 |
| Clay | 0 | 3 |
| Coal | 0 | 10 |
| Coal | 4 | 5) |
| Clay | 0 | 3) |
| Coal | 1 | 1) mined section |
| Clay | 0 | 1) |
| Coal | 2 | 0) |
| Bone | 0 | 3 |
| Clay | 3 | 0 |
| Coal | 2 | 0 |
| Clay | | |

Samis Mine, No. 1316; Lsd. 6, Sec. 36, Tp. 54, R. 25, W. 4th Mer.

| | Thickness | |
|---------------|-----------|-----------------------|
| | Feet | Inches |
| Clay | | |
| Coal, shaly | 3 | 0 |
| Coal | 3 | 0 |
| Coal | 6 | 2) |
| Clay | 0 | 1 1/2) mined section |
| Coal | 1 | 6) |
| Clay | 0 | 1 |
| Bone and clay | 4 | 0 |
| Coal | 3 | 0 |
| Clay | | |

Edmonton Collieries Limited, No. 1266; Lsd. 14, Sec. 36, Tp. 54, R. 25, W. 4th Mer.

| | Thickness | |
|-------|-----------|--------|
| | Feet | Inches |
| Cover | 0 to 115 | 0 |
| Coal | 1 | 6 |
| Coal | 5 | 10 |
| Clay | 0 | 2 |
| Coal | 1 | 6 |
| Clay | | |

Delaco Mine, No. 1006; SW., Sec. 4, Tp. 55, R. 24, W. 4th Mer.

| | Thickness | |
|---------------|-----------|--------|
| | Feet | Inches |
| Clay | | |
| Coal | 2 | 0 |
| Bone and clay | 2 | 0 |
| Coal | 1 | 3 |
| Clay | | |

Penn Mine, No. 428; Lsd. 10, Sec. 8, Tp. 55, R. 24, W. 4th Mer.

| Main Workings | Thickness | | | South End of Mine | |
|---------------|-----------|--------|---------------|-------------------|--------|
| | Feet | Inches | | Feet | Inches |
| Cover | 174 | 0 | Shale, black | 0 | 8 |
| Coal | 4 | 6 | Coal | 0 | 8 |
| Clay | | | Clay and coal | 2 | 3 |
| | | | Coal | 0 | 8 |
| | | | Bone | 0 | 3 |
| | | | Coal | 0 | 11 |
| | | | Bone and clay | 0 | 3 |
| | | | Coal | 2 | 2 |

Riverdale Coals Limited, No. 1463; Lsd. 14, Sec. 55, Tp. 24, W. 4th Mer.

| | Thickness | |
|--------------|-----------|--------|
| | Feet | Inches |
| Cover (clay) | 75 | 0 |
| Coal | 0 | 1 1/2 |
| Clay | 0 | 6 |
| Coal | 3 | 10 |
| Bone | 0 | 5 |
| Coal | 0 | 9 |
| Clay, shaly | | |

Bell Mine, No. 1476; NW.1/4, Sec. 9, Tp. 55, R. 24, W. 4th Mer.

| | Thickness | |
|--------------|-----------|--------|
| | Feet | Inches |
| Cover (clay) | 0 to 42 | 0 |
| Coal | 0 | 6 |
| Clay | 0 | 3 |
| Coal | 5 | 6 |
| Clay | | |

Banner Coals Limited, No. 1724; Lsd. 2, Sec. 24, Tp. 55, R. 25, W. 4th Mer.

| | Thickness | |
|--------------|-----------|--------|
| | Feet | Inches |
| Cover (clay) | 19 | 4 |
| Coal, bony | 1 | 0 |
| Clay | 0 | 1 |
| Coal | 2 | 6 |
| Clay | 0 | 3 |
| Coal | 1 | 2 |
| Bone | 0 | 3 |
| Coal | 2 | 2 |
| Clay | | |

Banner Coal Company, No. 237; Lsd. 5, Sec. 24, Tp. 55, R. 25, W. 4th Mer.

| | Thickness | |
|---------------------|-----------|--------|
| | Feet | Inches |
| Cover (clay) | 34 | 0 |
| Coal | 3 | 10 |
| Coal | 4 | 6 |
| Clay | 0 | 3 |
| Coal | 2 | 6 |
| "Bastard fire clay" | | |

Cardiff Collieries Limited, No. 32; Lsd. 11, Sec. 24, Tp. 55, R. 25, W. 4th Mer.

| | Thickness | |
|---------------------|-----------|--------|
| | Feet | Inches |
| Cover (clay) | 30 | 0 |
| Coal | 6 | 0 |
| Coal | 2 | 6 |
| Clay | 0 | 2 |
| Coal | 0 | 2 |
| Coal, "parrot" | 0 | 5 |
| Coal | 5 | 0 |
| Coal | 0 | 6 |
| "Bastard fire clay" | | |

D.O. Roberts Mine, No. 1321; Lsd. 15, Sec. 24, Tp. 55, R. 25, W. 4th Mer.

| | Thickness | |
|--------------|-----------|--------|
| | Feet | Inches |
| Cover (clay) | 25 | 0 |
| Coal | 3 | 5 |
| Clay | 0 | 4 |
| Coal | 1 | 3 |
| Clay | 0 | 3 |
| Coal | 1 | 9 |
| Clay, shale | | |

Morinville Collieries Limited, No. 1635; Lsd. 1, Sec. 32, Tp. 55, R. 25, W. 4th Mer.

| | Thickness | |
|--------------|-----------|--------|
| | Feet | Inches |
| Cover (clay) | 51 | 0 |
| Coal | 3 | 0 |
| Clay | 0 | 2 |
| Coal | 2 | 11 |
| Bane | | |
| Clay | | |

Egg Lake Mine, No. 1582; W.1/2, Sec. 36, Tp. 56, R. 26, W. 4th Mer.

| | Thickness | |
|----------------|-----------|--------|
| | Feet | Inches |
| Cover (clay) | 12 | 0 |
| Coal | 2 | 0 |
| Parting (thin) | | |
| Coal | 2 | 0 |
| Parting (thin) | | |
| Coal | 2 | 0 |
| Clay | 4 | 0 |
| Coal | 1 | 2 |
| Clay parting | | |
| Coal | 1 | 10 |
| Clay | | |

APPENDIX B. COAL TEST HOLE LOGS

The following logs are based on electrolog interpretation, the driller's logs, and samples collected at 5-foot intervals. All depths are expressed in feet. Hole locations are shown in figure 2.

| No. 1 | No. 2 (cont'd) |
|--|--|
| Location: 210 feet north of SE. corner of Sec. 25, Tp. 53, R. 22, W. 4th Mer. Surface elevation: 2,215 feet. | |
| 0 - 22.0 Till, pale yellow-brown | 54.5 - 56.5 Coal |
| 22.0 - 52.5 Till, light grey, sandy | 56.5 - 72.0 Shale, light grey and siltstone |
| 52.5 - 65.0 Siltstone, light grey, coarse grained | 72.0 - 73.5 Coal |
| 65.0 - 75.0 Shale, light grey | 73.5 - 74.5 Shale, dark brown |
| 75.0 - 78.0 Coal | 74.5 - 76.0 Coal |
| 78.0 - 78.8 Shale, black | 76.0 - 87.5 Shale, light grey |
| 78.8 - 79.8 Coal | 87.5 - 92.5 Siltstone, medium grey, coarse grained |
| 79.8 - 103.0 Shale, light grey | 92.5 - 97.5 Shale, dark grey-brown |
| 103.0 - 120.0 Siltstone, light grey, coarse grained | 97.5 - 110.0 Siltstone, light grey, coarse grained |
| | 110.0 - 136.0 Shale, light grey, silty |
| | 136.0 - 151.0 Sandstone, light grey, fine grained, silty |
| | 151.0 - 170.0 Shale, light grey |
| | No. 3 |
| | Location: 50 feet south of NE. corner of Sec. 3, Tp. 54, R. 24, W. 4th Mer. Surface elevation: 2,241 feet. |
| | 0 - 12.0 Till, light brown |
| | 12.0 - 17.0 Sandstone, light grey, soft |
| | 17.0 - 19.5 Shale |
| | 19.5 - 20.0 Coal |
| | 20.0 - 30.0 Shale, light grey |
| | 30.0 - 34.0 Siltstone, light grey |
| | 34.0 - 35.0 Coal |
| | 35.0 - 35.5 Shale, black |
| | 35.5 - 37.0 Coal |
| | 37.0 - 42.5 Shale, light grey |
| | 42.5 - 51.7 Siltstone, light grey, coarse grained |
| | 51.7 - 54.0 Coal |
| | 54.0 - 55.5 Shale, black |
| | 55.5 - 57.0 Coal |
| | 57.0 - 75.5 Shale, light grey |
| | 75.5 - 76.0 Coal |
| | 76.0 - 87.5 Siltstone, light grey |
| | 87.5 - 100.0 Shale, light grey |
| No. 2 | |
| Location: 125 feet south of NE. corner of Sec. 35, Tp. 53, R. 24, W. 4th Mer. Surface elevation: 2,220 feet. | |
| 0 - 6.5 Till, light brown | |
| 6.5 - 7.0 Coal, soft and weathered | |
| 7.0 - 14.0 Till, light brown, sandy, with coal lens | |
| 14.0 - 19.0 Shale, light grey, silty | |
| 19.0 - 24.0 Siltstone, light grey, coarsed grained | |
| 24.0 - 26.0 Shale, dark grey, silty | |
| 26.0 - 27.0 Coal (?) | |
| 27.0 - 37.0 Shale, light grey, and siltstone | |
| 37.0 - 38.2 Coal | |
| 38.2 - 54.5 Shaly, light grey, silty | |

No. 4

Location: 40 feet north and 160 feet east of SW. corner of Sec. 14, Tp. 54, R. 24, W. 4th Mer. Surface elevation: 2,224 feet.

- 0 - 17.0 Till, light brown
- 17.0 - 27.0 Till, light grey
- 27.0 - 30.0 Gravel and sand
- 30.0 - 32.0 Shale, light grey
- 32.0 - 32.5 Coal
- 32.5 - 70.0 Shale, light grey

No. 5

Location: 590 feet south of NW. corner of Sec. 29, Tp. 54, R. 24, W. 4th Mer. Surface elevation: 2,266 feet.

- 0 - 10.0 Till, light yellow-brown
- 10.0 - 28.0 Till, light yellow-brown, sandy
- 28.0 - 34.0 Till, light grey
- 34.0 - 37.5 Shale, light grey
- 37.5 - 57.0 Siltstone, light grey
- 57.0 - 59.5 Coal
- 59.5 - 75.0 Shale, light grey
- 75.0 - 85.0 Siltstone, light grey, coarsed grained
- 85.0 - 110.0 Shale, light grey
- 110.0 - 110.5 Coal
- 110.5 - 116.0 Siltstone, light grey
- 116.0 - 130.5 Shale, light grey
- 130.5 - 142.5 Sandstone, light grey, very fine grained
- 142.5 - 147.5 Shale, light grey
- 147.5 - 150.0 Siltstone, light grey, medium grained

No. 6

Location: 2,675 feet north of SW. corner of Sec. 16, Tp. 55, R. 24, W. 4th Mer. Surface elevation: 2,264 feet.

- 0 - 15.0 Till, light yellow-brown, and boulders
- 15.0 - 23.0 Till, light grey, sandy
- 23.0 - 26.0 Gravel and sand
- 26.0 - 35.0 Till, light grey, sandy

No. 7

Location: 50 feet south of NW. corner of Sec. 8, Tp. 55, R. 24, W. 4th Mer. Surface elevation: 2,262 feet.

- 0 - 12.0 Till, light brown
- 12.0 - 18.0 Till, light brown, with gravel and sand bed at 15 feet
- 18.0 - 19.5 Till, light grey
- 19.5 - 20.5 Coal
- 20.5 - 30.0 Siltstone, light grey, fine grained
- 30.0 - 35.5 Sandstone, light grey, very fine grained
- 35.5 - 62.0 Shale, light grey, silty
- 62.0 - 66.0 Coal
- 66.0 - 91.0 Shale, light grey
- 91.0 - 91.5 Coal
- 91.5 - 92.5 Shale
- 92.5 - 94.5 Coal
- 94.5 - 104.0 Shale, light grey
- 104.0 - 105.0 Shale, black
- 105.0 - 112.0 Shale, light grey
- 112.0 - 122.0 Sandstone, light grey, fine grained, soft
- 122.0 - 128.0 Shale, dark grey
- 128.0 - 138.5 Siltstone, medium grey, fine grained
- 138.5 - 142.5 Sandstone, light grey, fine grained
- 142.5 - 150.0 Shale, light grey

No. 8

Location: 50 feet east and 2,470 feet north of SW. corner of Sec. 24, Tp. 55, R. 25, W. 4th Mer. Surface elevation: 2,309 feet.

- 0 - 17.0 Till, light brown, very sandy, boulders
- 17.0 - 22.5 Till, light grey, sandy
- 22.5 - 23.5 Shale, black
- 23.5 - 24.5 Coal
- 24.5 - 24.8 Shale
- 24.8 - 28.5 Coal
- 28.5 - 33.5 Shale, dark grey
- 33.5 - 34.5 Coal
- 34.5 - 35.0 Shale, black
- 35.0 - 36.0 Coal
- 36.0 - 36.5 Shale, black
- 36.5 - 41.5 Coal
- 41.5 - 41.8 Shale, black
- 41.8 - 46.2 Coal
- 46.2 - 58.3 Shale, light grey
- 58.3 - 59.6 Coal
- 59.6 - 64.4 Shale, dark grey
- 64.4 - 65.3 Coal
- 65.3 - 80.0 Shale, light and medium grey

No. 9

Location: 130 feet south of NE. corner of Sec. 10, Tp. 55, R. 25, W. 4th Mer. Surface elevation: 2,300 feet

- 0 - 17.0 Till, light yellow-brown, sandy, boulders
- 17.0 - 25.0 Till, light grey, sandy
- 25.0 - 42.0 Till, light grey
- 42.0 - 47.2 Coal
- 47.2 - 56.0 Shale, light grey
- 56.0 - 57.5 Coal
- 57.5 - 60.0 Shale, light grey
- 60.0 - 61.0 Shale, black
- 61.0 - 65.2 Shale, light grey
- 65.2 - 67.0 Coal

No. 9 (cont'd)

- 67.0 - 67.2 Shale, light grey
- 67.2 - 68.0 Coal
- 68.0 - 73.0 Shale, medium brown
- 83.0 - 90.0 Shale, light grey

No. 10

Location: 120 feet south of NW. corner of Sec. 11, Tp. 55, R. 25, W. 4th Mer. Surface elevation: 2,302 feet.

- 0 - 13.0 Till, light brown, sandy
- 13.0 - 17.0 Gravel and sand
- 17.0 - 28.0 Till, light grey
- 28.0 - 49.5 Sandstone, light grey, very fine grained
- 49.5 - 51.5 Shale, dark brown
- 51.5 - 54.4 Coal
- 54.4 - 55.5 Shale, light grey
- 55.5 - 57.5 Coal
- 57.5 - 61.5 Shale, dark brown-grey
- 61.5 - 64.0 Coal
- 64.0 - 84.0 Shale, light grey, silty
- 84.0 - 85.0 Coal
- 85.0 - 90.0 Shale, light grey

No. 11

Location: 2,585 feet north of SW. corner of Sec. 17, Tp. 55, R. 25, W. 4th Mer. Surface elevation: 2,298 feet.

- 0 - 17.0 Till, light yellow-brown
- 17.0 - 42.0 Till, light grey, silty
- 42.0 - 49.5 Sandstone, light grey, very fine grained
- 49.5 - 51.5 Coal
- 51.5 - 65.0 Shale, light grey, silty
- 65.0 - 65.5 Coal
- 65.5 - 83.5 Shale, light grey
- 83.5 - 85.0 Coal
- 85.0 - 87.5 Shale, black
- 87.5 - 88.5 Coal
- 88.5 - 110.0 Shale, light grey

No. 12

Location: 50 feet east and 750 feet north of SW. corner of Sec. 7, Tp. 56, R. 25, W. 4th Mer. Surface elevation: 2,325 feet.

- 0 - 9.0 Gravel and sand
- 9.0 - 42.0 Till, light grey, sandy
- 42.0 - 44.5 Coal
- 44.5 - 47.5 Shale, light grey
- 47.5 - 50.0 Coal
- 50.0 - 51.5 Shale, light grey
- 51.5 - 55.5 Siltstone, light grey, medium grained
- 55.5 - 70.0 Shale, light grey

No. 13

Location: 260 feet north of SW. corner of Sec. 25, Tp. 56, R. 26, W. 4th Mer. Surface elevation: 2,327 feet.

- 0 - 3.5 Till, light brown
- 3.5 - 4.0 Coal (lens in till)
- 4.0 - 47.0 Till, light grey, sandy
- 47.0 - 57.5 Till, light grey, mainly clay size
- 57.5 - 72.0 Till, light grey, sandy
- 72.0 - 80.0 Sandstone, light grey, very fine grained

No. 14

Location: 50 feet north and 80 feet east of SW. corner of Sec. 35, Tp. 56, R. 26, W. 4th Mer. Surface elevation: 2,327 feet.

- 0 - 11.0 Till, light yellow-brown, sandy
- 11.0 - 13.0 Coal (lens in till)
- 13.0 - 25.0 Sand, light grey, medium grey, unconsolidated
- 25.0 - 49.0 Till, light grey, sandy
- 49.0 - 50.0 Coal

No. 14 (cont'd)

- 50.0 - 51.0 Shale, light grey
- 51.0 - 52.0 Coal
- 52.0 - 56.5 Shale, light grey
- 56.5 - 59.0 Coal
- 59.0 - 77.0 Shale, light grey
- 77.0 - 79.0 Coal
- 79.0 - 86.0 Shale, light grey
- 86.0 - 87.0 Siltstone, medium grey, fine grained
- 87.0 - 90.0 Shale, light grey

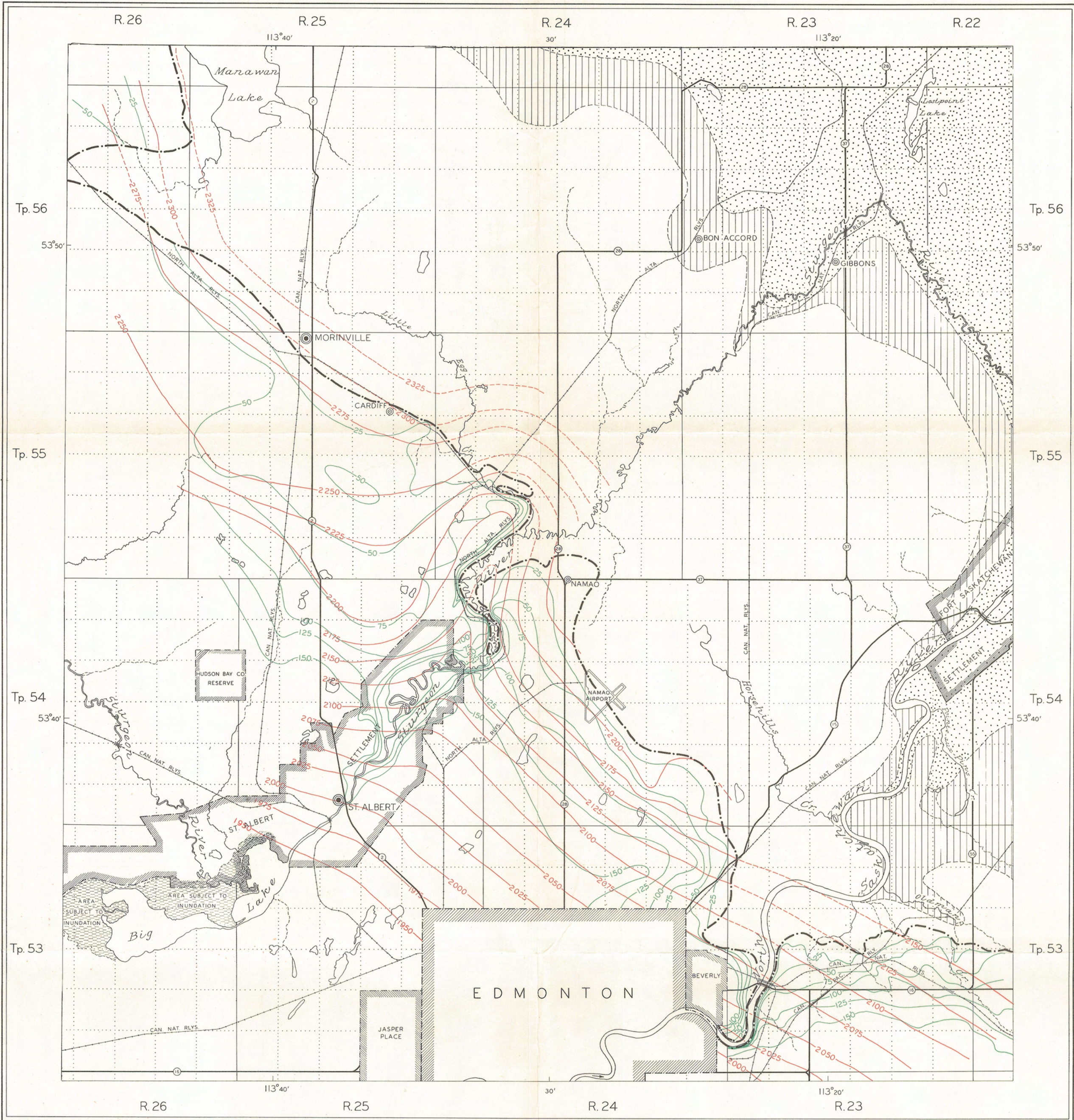
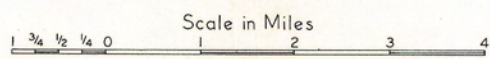


FIGURE 3
 ELEVATION AND OVERBURDEN FOR THE CLOVER BAR COAL ZONE,
 EDMONTON - MORINVILLE DISTRICT, ALBERTA
 (WEST OF FOURTH MERIDIAN)



LEGEND

- Subcrop and outcrop margin of the Clover Bar coal zone.....
 - Structure contour on top of the Clover Bar coal zone.
 (Contour Interval 25 Feet, Elevations in Feet
 above Mean Sea Level).....
 - As above, where coal is absent.....
 - Depth to top of the Clover Bar coal zone;
 depths inferred except new mine and drill hole
 localities. (Isopach Interval 25 Feet).....
 - Highway.....
 - Railroad.....
- UPPER CRETACEOUS
- Edmonton formation
 - Bearpaw formation
 - Belly River formation
- Geology taken from Geological Survey of Canada, Map 506 A,
 "Edmonton," Scale: 1 inch to 4 miles.*

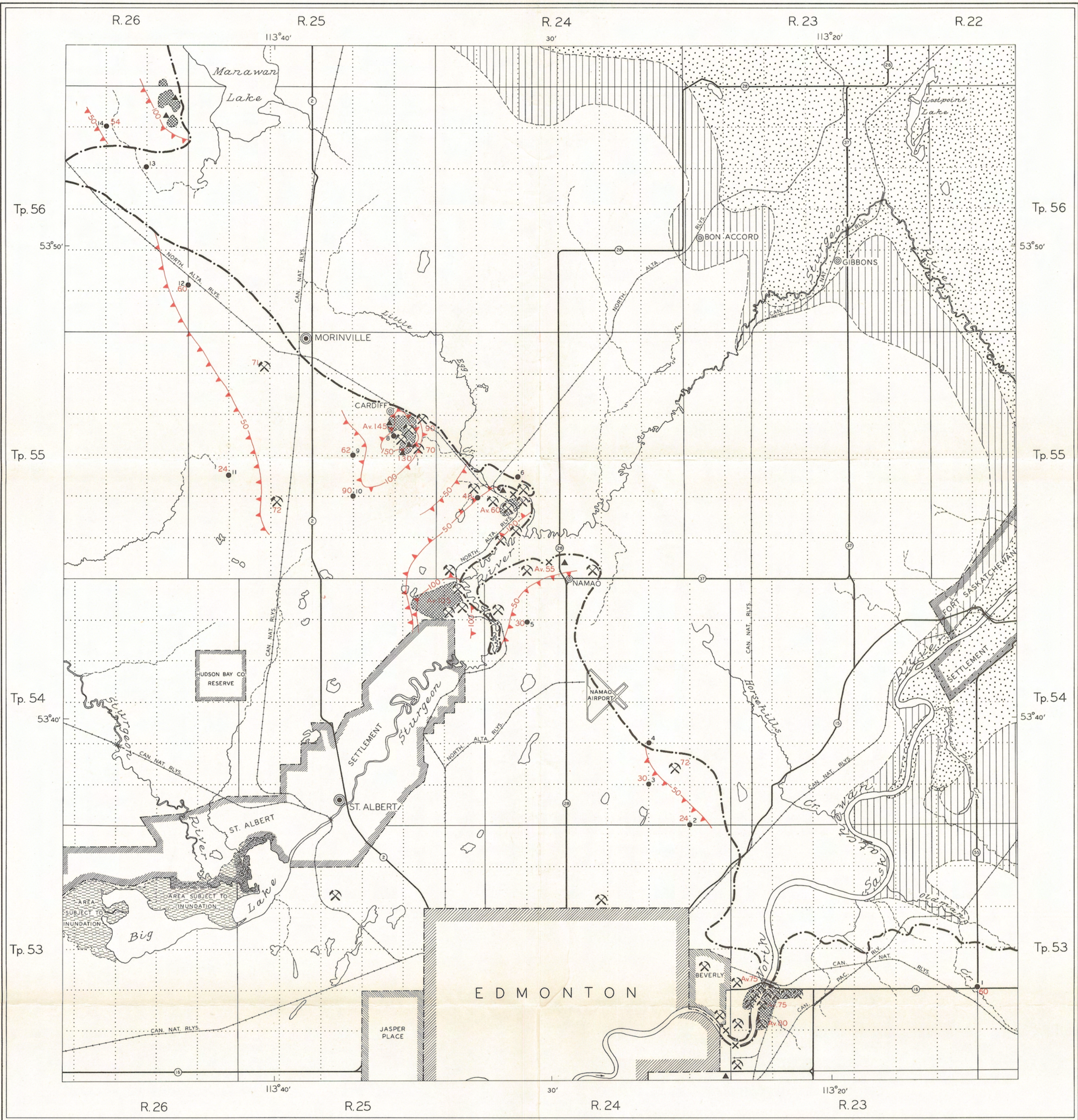


FIGURE 2

COAL THICKNESSES AND MINING OPERATIONS, CLOVER BAR COAL ZONE, EDMONTON - MORINVILLE DISTRICT, ALBERTA (WEST OF FOURTH MERIDIAN)

Scale in Miles
 1/4 1/2 3/4 0 1 2 3 4

LEGEND

- | | |
|---|--|
| Subcrop and outcrop margin of the Clover Bar coal zone..... | Coal mine, underground (mostly abandoned)..... |
| Isopach of coal, in inches, in Clover Bar coal zone, (in places the sum thickness of two thin seams). Teeth indicate direction of decreasing thickness..... | Coal mine, stripping (mostly abandoned)..... |
| Average total thickness of coal, in inches, in Clover Bar coal zone, in areas of mining activity..... | Test hole drilled by the Research Council of Alberta..... |
| Total thickness of coal, in inches, reported for Clover Bar coal zone from isolated mines and drill holes..... | Outcrop of Clover Bar coal zone..... |
| Areas where coal has been largely or partly mined out, (small, isolated operations not included)..... | Highway..... |
| | Railroad..... |
| UPPER CRETACEOUS | |
| Edmonton formation | |
| Bearpaw formation | |
| Belly River formation | |

Geology taken from Geological Survey of Canada, Map 506 A,
"Edmonton," Scale: 1 inch to 4 miles.