PR-MT. SPIEKER 77(1)A

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# REPORT
# ON
# THE GEOLOGICAL EXPLORATION
# OF
# THE MT. SPIEKER AREA

NOVEMBER, 1977

NICHIMEN RESOURCES LTD.
RANGER OIL (CANADA) LTD.



PREPARED BY
MITSUI MINING CO., LTD.

December 6th, 1977

Errata and Clarification
To accompany Report on the Geological
Exploration of the Mt. Speiker area
November, 1977

Page i, Line 12 .....which had not been previously investigated.

Page ii, Line 1 .....also summarizes the exploration results for the last three years.

Page 1, Line 17 .....of Mt. Speiker and to determine the mining potential of this area.

Page 2, line 6 ..... delete NQ - should read HQ

Page 3, line 4 should read 200ft. Polychain.

Page 4, line 9 .... of the Gates member are distributed 1000 ft. to 1,500 ft deep.

Page 5, Line 2 delete Birs - should read Bird

Line 6 ..... degrees using fault intersections in EB-12, EB-15 and fault outcrops on the surface.

Line 13 delete heds should read beds.

Page 7, Line 14 .... an alternation of....

Line 19 should read - The strata which overlie the Boulder Creek member are distributed along the main synclinal axis. They consist of .....

Page 8, Line 10 Imbricating faults were found in the hangingwall of the major thrust fault. These were observed along the access road east of EB-15. The strata ....

Page 9, Line 23 Delete ... are being cropped cut ... substitute ... are found outcropping.

Page 16,Line 6 Delete cleat substitute cleavage.

Page 17,Line 5 ... feet is as much as 1.5 feet thinner than the average coal thickness for this seam.

Page 24,Line 17 ... but is apparently thickened by minor faulting and the ...

Page 25,Line 3 should read Skeeter seam

Page 29,Line 3... coal reserves in the northeast area were revised as a result of the 1977 project. The distribution area of the bird seams was decreased but coal thickness was increased.

Line 10 No particular conditions were found in other areas that would necessitate any other reserve revisions.

Page 37, Line 9 should read-The exploration density in this area ...

Page 39, Line 11 should read .... low figures of 0.5% sulphur ....

Page 44, Line 16 should read - (1) Blending with low sulphur Gates coal after studies to determine which blend is metallurgically desirable.

Line 19 - (2) The development of additional coal reserves in as many seams as necessary to provide for blended coal production.

Page 45, Line 1 Delete (2) should read (3)

Line 2 should read - Further exploration is recommended before mining plans are formulated.

Line 5 Delete (3) should read (4)

Corrections have been made only where the original spelling or wording render the report unclear. No attempt was made to change the meaning of any part of the report.

Marvin A. Mitchell

December 5th 1977

Marvin A. Mitchell P. Eng.
Exploration Manager
Nichimen Resources Ltd.

# FOREWARD

This is the report of the geological exploration work in the Mt. Spieker Area which was carried by Mitsui Mining Co., Ltd. under the request of Nichimen Resources Ltd. and Ranger Oil (CANADA) Ltd.

This years' work is the extension of the past two years' exploration. The scope was to access the geological situation of Bird Seams which are distributed in the "Northeast area" and to ascertain the minable condition in the flat and steeper parts of the "Southeast area". The work also aimed to see the general geological situation in the "Southeast area of Bullmoose Thrust" where no investigation was made.

The actual work was undertaken for about two months from the last week of July, 1977 which involved drilling work of nine holes of 5,286 feet in length, six in the Northeast and three in the other areas, and the field mapping in the "Northeast Area" and the "Southeast Area of Bullmoose Thrust".

Messrs. H. Yayoshi and H. Wada who are dispatched by the Company were engaged in the field work and prepared this report and was grateful to Mr. M.A. Mitchell, Nichimen for his cooperation.

The report also piled the summary of the exploration work made in the last three years.

..... o .....

This project, which had been referred to as "East Bullmoose" was changed to call "Mt. Spieker Project" this year to avoid confusion with the adjacent Bullmoose Project of Brameda Resources Ltd.

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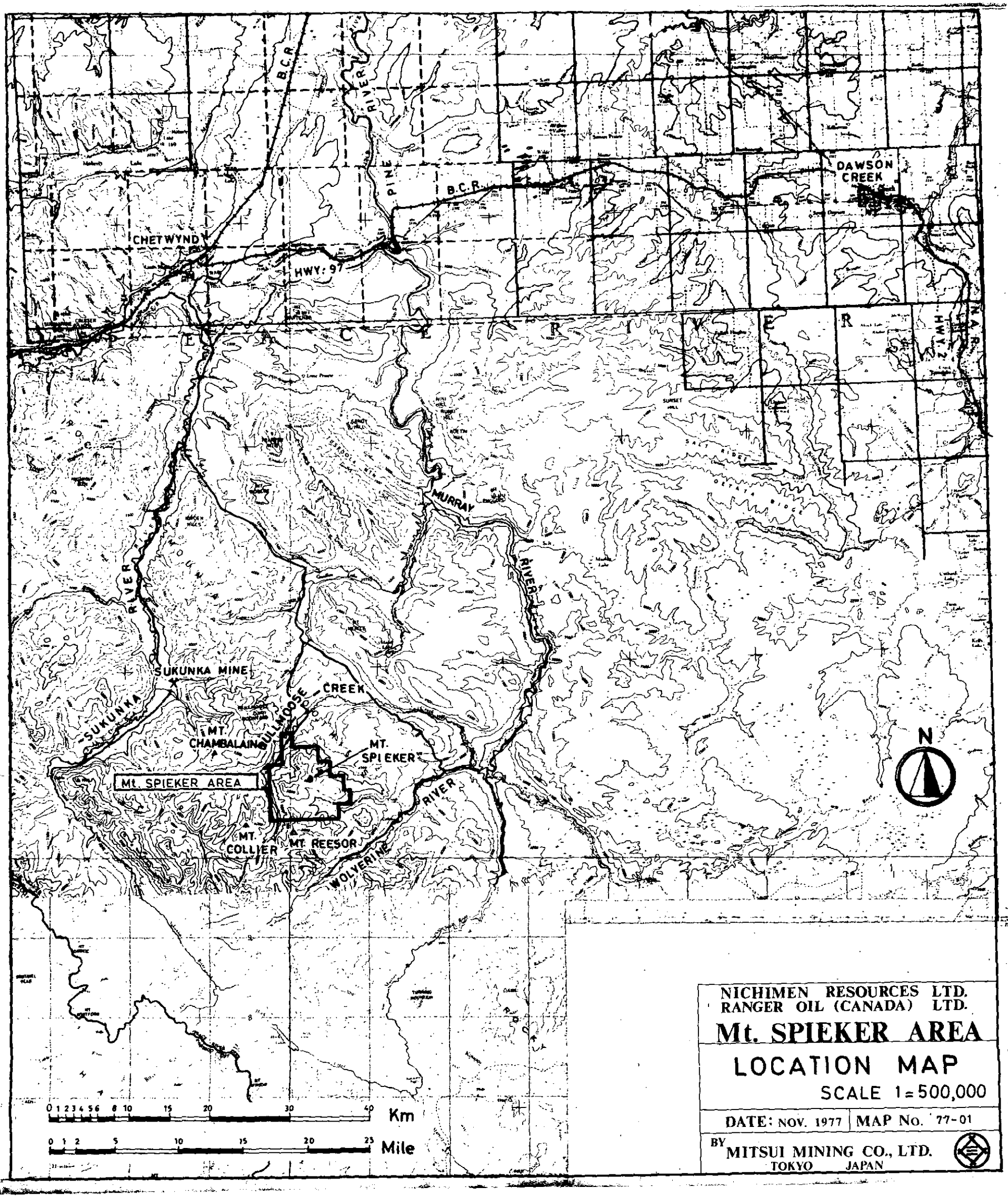


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# Mt. SPIEKER AREA

## LOCATION MAP

SCALE 1=500,000

DATE: NOV. 1977 | MAP No. 77-01

BY MITSUI MINING CO., LTD.
TOKYO JAPAN

# EXPLORATION AREA

SCALE 1=50,000

| | 1975 | 1976 | 1977 |
|---|---|---|---|
| DRILL HOLE | ○ | ● | ◎ |
| MAPPING AREA | ▬ ▬ | ▬ | ▬ · ▬ |
| ROAD | ▬ ▬ | ▬ | ▬ · ▬ |

N

EB-1
EB-2
EB-3
EB-4
EB-5
EB-6
EB-7
EB-8
EB-9
EB-10
EB-11
EB-12
EB-13
EB-14
EB-15

A B C D E F G

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## Mt. SPIEKER AREA

EXPLORATION AREA MAP

SCALE 1=50,000

DATE: NOV. 1977 | MAP No. 77-02

BY MITSUI MINING CO., LTD. TOKYO JAPAN

# I. EXPLORATION IN 1977

## I-1 Purpose of the Exploration

The 1977 exploration was planned to concentrate on the following works based on the results of 1975 and 1976 explorations.

(1) To drill the five holes in the northeast area, where coal seams are expected to be flat, for confirming the both Upper Bird and Lower Bird Seams in Gething Formation.

(2) To drill one hole at each flat and steeper part in the southeast area for affirming D, C and B Seams in Upper Gates Member. The drillhole in flat part was planned to penetrate Bird Seams of Gething Formation to see coal quality, especially sulphur contents.

(3) To make the geological mapping in south-eastern area of Mt.Spieker where exploration work has not yet done to assess the coal situation of the area considering potentiality of mining.

## I-2 Actual Exploration Work

The above exploration work was carried out for about two months from late July to September.

Nine holes, seven originally planned holes and two additional of 5,286 feet in total footage were drilled by Connors Drilling Ltd., and cores of NQ size (2-1/2 inches) were taken from every hole. EB-14 was additionally drilled 3,000 feet southeast to EB-9 to confirm Bird Seams because EB-9 was abandoned for the trouble of snapping of bit in the hole. EB-15 was placed 2,000 feet east to EB-7 to confirm the Bullmoose Thrust Fault.

In four drillholes, geophysical logging ---- Gamma Ray, Long Spaced Density, Bed Resolution Density, Caliper ---- was carried out by BPB Instruments (CANADA) Ltd. Loggings are attached.

Logging was not applied in following holes by the reasons which described as under.

| | |
|---|---|
| EB-8 | Hole collapsed at shallow part |
| EB-12 | No intercepted any coal seam |
| EB-14 | Mud condition of access road |
| EB-11 | No available equipment |
| EB-15 | " " " |

Mapping was made from the northeast area including Mt. Spieker to the south-eastern area of that. Field mapping was done in a scale of 1 inch to 400 feet with compass, hand level and polychain in 200 feet and it was compiled in a scale of 1 inch to 1,000 feet.

Map 77-02 shows the area explored in each year.

## I-3 Results of the Exploration

### I-3-1 Summary

A. Northeast area (See Fig.-2 Rough Drawing of Areas)

(1) In this area including Mt. Spieker, the strata of Upper Gates Member which consists mainly of conglomerate are flatly distributed with gentle undulation.

(2) The thickness of Upper Bird Seam and Lower Bird Seam is about 11 feet and 6 feet respectively. Coal quality of these seams is good, but sulphur contents are high.

(3) Since only a part of B Seam underlying the thick conglomerate was observed at the outcrop, the seam situation over the whole

area was not clarified in this years work.

(4) Minable coal reserves in Upper Bird and Lower Bird Seams are estimated at about 6,140 thousand tons.

B. Southeast area of Bullmoose Thrust

(1) The strata presented in the area mostly belong to Boulder Creek Member and are broadly distributed with undulation.

(2) Coal seams of Gates Member distribute in 1,000 to 1,500 feet deep. The dip of coal seams varies considerably due to foldings. D Seam (9 feet thick) and C Seam (12 feet) are outcropped at the southern edge of this area but B Seam is not observed.

C. Southeast area

(1) The coal seams confirmed in every drill-holes in this area showed more or less similar thickness as it was anticipated. A reverse fault was observed in EB-9 of which stratigraphic throw is 65 feet. Another fault was also observed in EB-13 and its throw is about 70 feet.

(2) Sulphur contents of Upper Bird Seam in EB-14 were high while those of Lower Birs Seam were low.

D. Bullmoose Thrust Fault

(1) The dip of this fault was confirmed to be 15 to 20 degrees by EB-12 and EB-15 in related with the outcrops of fault.

(2) The fault runs toward the Perry Creek.

I-3-2 Mapping

(1) Northeast area.

On the ridge of this area embracing Mt. Spieker, the remarkable thick conglomerate heds are exposed.

These strata are divided into three zones from rock facies, among which, the middle zone consists of platy sandstone, sandy shale and shale intercalating a few coal seams (about 3 feet).

These strata are distributed in flat but very gently undulated by foldings.

These strata are interpreted as the part of Upper Gates Member from the successive sequence of Moosebar Shale and Lower Gates strata which exposed underneath the thick conglomerate, and also from the correlation of the strata to the horizons of conglomerate in Upper Gates Member where were confirmed in EB-3 and EB-5.

Lower conglomerate zone of these strata corresponds to the overlying horizon of B Seam, so that the distribution of B Seam is expected underneath it. Actually, coal seam with good quality was found beneath the conglomerate cliff at the southeast side of EB-11. Though 6 feet thickness was measured but 8 to 10 feet thick appear to represent total thickness.

Since B Seam was only confirmed at the outcrop, and it was unable to clarify whether the seam develops throughout this area.

(2) Southeast area of Bullmoose Thrust

On the ridge in this area, the strata being of high proportion of conglomerate

and sandstone are broadly exposed. These strata appear to continue to the conglomerate strata overlying Mt. Spieker and the rock facies of both conglomerate quite similar to each other. There was argument whether the strata in this area belong to Gates or Boulder Creek Members.

However, it has been clarified that the strata belong to Boulder Creek Member by the study of rock facies and geological structure through the detailed mapping this year.

Boulder Creek Member in this area consists mainly of sandstone and conglomerate, but in the middle part, it consists of an alternation shale, sandy shale and sandstone, including 3 to 4 tuffaceous shale beds of 1 feet thick and 3 to 4 coal seams of 0.5 to 4 feet thick. The thickness of this Member in this area is about 340 feet.

Along the main syncline axis, there distributes the strata which overlie Boulder Creek Member and consists of dark grey shale with sandy laminae. It is difficult to distinguish

this strata from Hulcross Shale but it is interpreted that this may belong to Hasler Formation from the relationship with Boulder Creek Member. Its thickness is more than 300 feet.

As to Bullmoose Thrust Fault, following considerations were done by the observation of strata along the access road which extends toward east side from EB-15 and the outcrop around P-6 Creek.

West side fauls which derived from major fault was dug out at the east side of EB-15. The strata show gentle dip at the west side of the revealed fault, but on the east side of the fault, the strata are vertically dipping and are being exposed continuously from sandstone zone to shale which includes a few thin coal seams. These thin coal beds are 0.5 to 3 feet thick and accompany with faults. Since the thin coal beds occur with relatively thick sandstone zone, they are interpreted as A Seam which are repeated by fault.

At the east side of the above exposure, there is another vertically dipping outcrop which consists of the strata near the top of Upper Gates and Hulcross Shale. Thin bed of conglomerate (0.5 feet) which forms the key bed of the bottom of Hulcross Shale was found there. This Hulcross Shale zone was confirmed to continue as far as the shale exposure in P-6 Creek. As the result, it is interpreted that the exposure of shale in P-6 Creek is the overturned strata of Hulcross Shale and that main fault runs between the exposure including A Seam and another exposure to P-6 Creek.

Because the exposure of Boulder Creek Member is observed in P-7 Creek, another branch fault is presumed between P-6 Creek and P-7 Creek.

On the other hand, in the downstream of P-8 and P-9 Creeks, the strata, which mainly consist of shale and have sandy shale, very fine grained sandstone and rarely conglomerate, are being cropped out. In P-9 Creek, a coal seam was found. Although the strata show

such rock facies which were firstly observed in the investigated area, they are inferred to be correlated to the lower part of Gething Formation. Therefore, Bullmoose Thrust is interpreted to run between these strata and Hulcross Shale distribution.

In this area, it is expected that coal seams of Gates Member distribute in the depth of 1,000 to 1,500 feet below the surface from the geological information on the surface. Actually, coal seams are exposed themselves due to folding in the southern edge of this area, and D Seam and C Seam are confirmed at the B.P. Road. The thickness is rather thinner than the average, 9 feet and 12 feet respectively, and partings are also increasing. B Seam could not be confirmed.

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# MAIN COAL SEAM INTERCEPTS IN BOREHOLES.

Table 1

| | EB 1 | EB 2 | EB 3 | EB 4 | EB 5 | EB 6 | EB 7 | EB 8 | EB 9 | EB 10 | EB 11 | EB 12 | EB 13 | EB 14 | EB 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Local Co-ordinates Latitude ft | 6,260N | 3,870N | 3,750N | 1,928N | 1,208N | 90N | 10,970N | 10,390N | 5,440N | 11,570N | 13,755N | 16,290N | 4,660N | 3,550N | 10,560N |
| Local Co-ordinates Departure ft | 122,260E | 114,890E | 112,440E | 126,895E | 121,650E | 122,827E | 125,175E | 121,705E | 123,450E | 119,380E | 121,560E | 122,540E | 120,420E | 125,650E | 127,240E |
| National Co-ordinates Latitude | 55°06'36"N | 55°06'12"N | 55°06'11"N | 55°05'54"N | 55°05'47"N | 55°05'36"N | 55°07'21"N | 55°07'17"N | 55°06'28"N | 55°07'28"N | 55°07'49"N | 55°08'14"N | 55°06'21"N | 55°06'10"N | 55°07'17"N |
| National Co-ordinates Longitude | 121°24'15"W | 121°26'22"W | 121°27'05"W | 121°22'55"W | 121°24'25"W | 121°24'05"W | 121°23'24"W | 121°24'25"W | 121°23'54"W | 121°25'05"W | 121°24'27"W | 121°24'10"W | 121°24'47"W | 121°23'16"W | 121°22'49"W |
| Elevation ft | 5,805 | 5,100 | 4,460 | 4,728 | 5,043 | 5,027 | 5,917 | 5,653 | 5,617 | 5,459 | 5,777 | 5,663 | 5,530 | 4,778 | 5,971 |
| Total Depth ft | 1,668 | 658 | 548 | 378 | 466 | 516 | 906 | 368 | 838 | 254 | 600 | 583 | 907 | 497 | 333 |
| **D Seam** | | | | | | | | | | | | | | | |
| Intercept ft | 274.75 ∿ 286.5 | 220.8 ∿ 241.1 | | | 135.8 ∿ 151.6 | 205.8 ∿ 223.2 | | | 88.9 ∿ 100.3 | | | | 614.1 ∿ 626.9 | | 317.5 ∿ 328.7 |
| Thickness (apparent) ft | 11.75 | 20.3 (Lower part) (7.2) | | | 15.8 | 17.4 | | | 11.4 | | | | 12.8 | | 11.2 ? |
| Coal Thickness / Seam Thickness (true) ft | 9.15 / 11.75 | 5.90 / 14.00 | 4.90 / 4.90 | | ? / 12.78 | 11.82 / 14.48 | | | 9.50 / 11.29 | | | | 7.97 / 11.60 | | (4.44 / 7.20)? |
| Core Recovery % | 92 | 79 (89) | | | 3 | 64 | | | 96 | | | | 100 | | 58 |
| **C Seam** | | | | | | | | | | | | | | | |
| Intercept ft | 338.7 ∿ 350.3 | 357.3 ∿ 367.6 | | | 214.0 ∿ 229.7 | 283.8 ∿ 298.0 | | | 150.2 ∿ 165.1 | | | | 677.1 ∿ 690.0 | | |
| Thickness (apparent) ft | 11.6 | 10.3 | | | 15.7 | 14.2 | | | 14.9 | | | | 12.9 | | |
| Coal Thickness / Seam Thickness (true) ft | 8.30 / 11.60 | 6.70 / 7.50 | | | 11.04 / 12.56 | 9.58 / 11.54 | | | 10.64 / 14.68 | | | | 9.69 / 11.69 | | |
| Core Recovery % | 100 | 85 | | | 53 | 76 | | | 98 | | | | 100 | | |
| **B Seam** | | | | | | | | | | | | | | | |
| Intercept ft | 470.8 ∿ 486.1 | 533.6 ∿ 554.8 | | | 379.6 ∿ 396.0 | 438.6 ∿ 457.1 | | | 285.0 ∿ 299.0 | | | | 814.3 ∿ 839.7 | | |
| Thickness (apparent) ft | 15.3 | 21.2 | | | 16.4 | 18.5 | | | 14.0 | | | | 25.4 | | |
| Coal Thickness / Seam Thickness (true) ft | 14.70 / 15.30 | 16.50 / 17.20 | | | 13.04 / 13.12 | 15.02 / 15.14 | | | 12.98 / 13.72 | | | | (23.59 / 23.88) 16.63 / 16.82 (duplicated by fault) | | |
| Core Recovery % | 92 | 93 | | | 30 | 44 | | | 98 | | | | 90 | | |
| **A Seam** | | | | | | | | | (repeated by fault) | | | | | | |
| Intercept ft | 530.0 ∿ 534.0 | 589.0 ∿ 593.5 | | | 448.6 ∿ 454.5 | 500.0 ∿ 505.05 | | | 342.2 ∿ 347.5 403.3 ∿ 417.5 | | | | 888.5 ∿ 892.0 | | |
| Thickness (apparent) ft | 4.0 | 4.5 | | | 5.9 | 5.05 | | | 4.3 14.2 | | | | 3.5 | | |
| Coal Thickness / Seam Thickness (true) ft | 4.00 / 4.00 | 3.60 / 3.60 | | | 4.73 / 4.90 | 4.26 / 4.39 | | | 4.21 / 4.21 (13.9) 9.80 / 9.80 (duplicated by fault) | | | | 3.15 / 3.29 | | |
| Core Recovery % | 98 | 87 | | | 32 | 47 | | | 23 82 | | | | 100 | | |
| **Bird Seam, Upper** | | | (repeated by fault) | | | | | | | | | | | | |
| Intercept | 1,474.5 ∿ 1,482.4 | | 342.0 ∿ 343.3 | 249.6 ∿ 257.3 286.1 ∿ 296.7 | | | 780.0 ∿ 791.5 | 279.4 ∿ 291.2 | Hole abandoned due to drilling bit snapped off at the bottom. | 130.3 ∿ 142.0 | 478.6 ∿ 490.8 | [Fault] | | 316.0 ∿ 324.0 | [Fault] |
| Thickness (apparent) ft | 7.9 | | 1.3 | 7.7 10.6 | | | 11.5 | 11.8 | | 11.7 | 12.2 | | | 8.0 | |
| Coal Thickness / Seam Thickness (true) ft | 7.90 / 7.90 | | 1.20 / 1.20 | 7.70 / 7.70 10.60 / 10.60 | | | 10.98 / 11.27 | 11.39 / 11.68 | | 11.17 / 11.47 | 11.53 / 11.67 | | | 7.57 / 7.97 | |
| Core Recovery % | 38 | | 23 | 66 12 | | | 68 | 96 | | 97 | 100 | | | 91 | |
| **Bird Seam, Lower (A)** | | | | | | | | | | | | | | | |
| Intercept ft | 1,498.7 ∿ 1,503.7 | | 384.3 ∿ 393.7 | 339.3 ∿ 345.5 | | | 807.3 ∿ 810.8 | 297.6 ∿ 304.1 | | 159.1 ∿ 165.5 | 504.7 ∿ 511.5 | | | 337.3 ∿ 342.9 | |
| Thickness (apparent) ft | 5.0 | | 9.4 | 6.2 | | | 3.5 | 6.5 | | 6.4 | 6.8 | | | 5.6 | |
| Coal Thickness / Seam Thickness (true) ft | 5.00 / 5.00 | | 8.10 / 8.10 | 6.15 / 6.20 | | | 3.42 / 3.42 | 6.04 / 6.44 | | 6.27 / 6.27 | 6.50 / 6.50 | | | 5.58 / 5.58 | |
| Core Recovery % | 30 | | 34 | 51 | | | 0 | 100 | | 100 | 75 | | | 100 | |
| **Bird Seam, Lower (B)** | | | | | | | | | | | | | | | |
| Intercept ft | 1,509.0 ∿ 1,518.1 | | | | | | Thin bands | 306.7 ∿ 314.8 | | 168.2 ∿ 175.9 | 520.5 ∿ 535.0 | | | | |
| Thickness (apparent) ft | 9.1 | | | | | | | 8.1 | | 7.7 | 14.5 | | | | |
| Coal Thickness / Seam Thickness (true) ft | 4.40 / 9.10 | | | | | | | 5.44 / 8.02 | | 4.70 / 7.55 | 7.65 / 13.86 | | | | |
| Core Recovery % | 71 | | | | | | | 85 | | 100 | 88 | | | | |
| **Skeeter Seam** | | | | | | | | | | | | | | | |
| Intercept ft | 1,569.9 ∿ 1,573.8 | | 454.3 ∿ 456.6 | | | | 860.3 ∿ 868.5 | 363.6 ∿ 368.0 | | 215.5 ∿ 219.5 | 565.3 ∿ 566.5 | | | 444.0 ∿ 447.5 | |
| Thickness (apparent) ft | 3.9 | | 2.3 | | | | 8.2 | 4.4 (+) | | 4.0 | 1.2 | | | 3.5 | |
| Coal Thickness / Seam Thickness (true) ft | 3.80 / 3.90 | | 0.30 / 2.00 | | | | (7.40 / 7.49)? fault? | 4.36 / 4.36 (+) | | 3.92 / 3.92 | (1.17) faulted | | | 3.49 / 3.49 | |
| Core Recovery % | 74 | | 100 | | | | 26 | 100 | | 100 | 50 | | | 71 | |
| **Chamberlain Seam** | | | | | | | | | | | | | | | |
| Depth (roof) ft | 1,601.2 | | 500.0 | | | | | | | 235.7 | | | | 464.2 | |
| Thickness (true) ft | Thin bands | | 1.50 | | | | | | | Thin bands | | | | Thin bands | |

## I-3-3 Drilling

The thickness of main coal seams and the depth where the seams are intercepted in drillholes are summarized on Table-1. The geological correlation of drillholes are shown on Map No.77-05.

(1) Northeast area (EB-7, 8, 10, 11, 12, 15)

The variation of Bird Seams in this area is to great extent known by drillings. Bullmoose Thrust Fault was confirmed by EB-12 and EB-15, and consequently the eastern limit of Bird Seams distribution was clearly defined by this fault.

The thickness of Upper Bird Seam is about 11 feet. Lower Bird Seam is about 6 feet thick while it is only of 3.4 feet in EB-7.

According to the visual log of coal cores, the both seams are of good quality, but often contain pyrite patches. Lower Seam contains less pyrite patches than Upper Seam.

The roof of Upper Bird Seam is glauconite muddy sandstone of 2 to 3 feet thick. The sandstone is overlaid by the thick shale beds of Moosebar Formation accompanying a few tuffaceous shale beds of 0.2 to 0.4 feet thick at the bottom.

The interval between Upper and Lower Bird seams is 16 to 13 feet which consists of hard sandstone. In EB-8 the interval shows only 6.3 feet, but may be a local change. 2 to 3 thin coal seams are found closely below the minable part of Lower Bird Seam. In EB-7 Lower Bird Seam is thin and lower thin coal seams also become poor.

The followings are additional explanations concerning the results of drilling.

EB-7

A fault was observed 374 feet. The throw of this fault is interpreted about 80 feet from the stratigraphic correlation. On the other hand, the dips of strata of

the deep part from 820 feet become 20 to 30 degrees, while those of shallow part are about 13 degrees, and there are comparatively many calcite veins and slickensides in the cores. They may be caused by the effects of Bullmoose Thrust Fault. (See Cross section EB-7)

EB-12

In the drillhole one fault is logged at 451 feet. The stratigraphic section above the fault is Moosebar Shale and shows about 11 degree dips. The section below the fault is sandstone which is correlated with the middle part of Lower Gates Member from the rock facies. The sandstone shows 70 to 50 degree dips and has many slickensides and calcite veins. The stratigraphic throw of the fault indicates 580 feet. This fault was identified to be Bullmoose Thrust Fault which runs along the east side of Mt. Spieker. Consequently, the dip of the fault becomes very low, about 15 degrees.

The other fault is logged at 203 feet. The both stratigraphical section above and below the fault which are correlated with the upper part of the Moosebar Formation and the tuffaceous shale beds intercalated in it provided the key for the correlation. Stratigraphic throw of this fault is estimated to be 120 feet. This fault is now interpreted to the same fault as that observed in EB-7.

EB-15

A fault was observed about 141 feet deep. The section below the fault consists mainly of granule conglomerate and sandstone and shows 30 to 60 degree dips. A coal seam is intercepted near the bottom. This section is correlated with D Seam and above horizone of it. The fault was identified to the middle main fault in Bullmoose Thrust which diverged on the surface. The dip of the fault becomes about 20 degrees.

(2) Southeast (flat) area (EB-9, EB-14)

In the drillhole EB-9, the D, C and B Seams show average thickness around the area. In the upper half of D Seam at 89 feet, some brown stains were found along the cleat, but deterioration of the coal by oxidization was not recognized from test results.

At 403.3 feet, the fault duplicates A Seam. Stratigraphic throw of the fault is about 65 feet. Seam is 14.2 feet thick but it is interpreted likely that seam become thick due to minor fault, may be the normal thickness is 9.8 feet because scaly core and slickensides in the upper part occur.

The fault repeating A Seam was interpreted to be the same fault as that observed in sandstone zone below A Seam in EB-1.

EB-14 was added in order to confirm Bird Seams in this area. Upper Bird Seam is of about 8 feet and Lower Bird

Seam of about 6 feet. Pyrite patches were not found at all in the core of Lower Seam.

(3) Southeast (steeper) area (EB-13)

In the drillhole of EB-13 D Seam at 614 feet gives thinner coal thickness as much as 1.5 feet, where seam thickness is the average. B Seam showed about 24 feet thick. Normal thickness may be 16.8 feet because steep dipping core including slickenside is observed in the middle part.

The weakly fractured zone is appeared from 105 to 160 feet in depth and fault gouge is observed at 160 feet deep. Brown stains are also appeared as far as 164 feet deep. Though the fault gouge at 160 feet may indicate a fault, the throw is not clarified because it is in the thick shale zone of Hulcross Member.

The reverse fault of which throw is about 70 feet was affirmed at 440 feet.

On the surface, a thin bed of conglomerate with 0.5 feet thick which form the base of Hulcross Shale is observed at three places nearby. Since there is a break of continuation between two of them, it can be interpreted that this gap is caused by this fault.

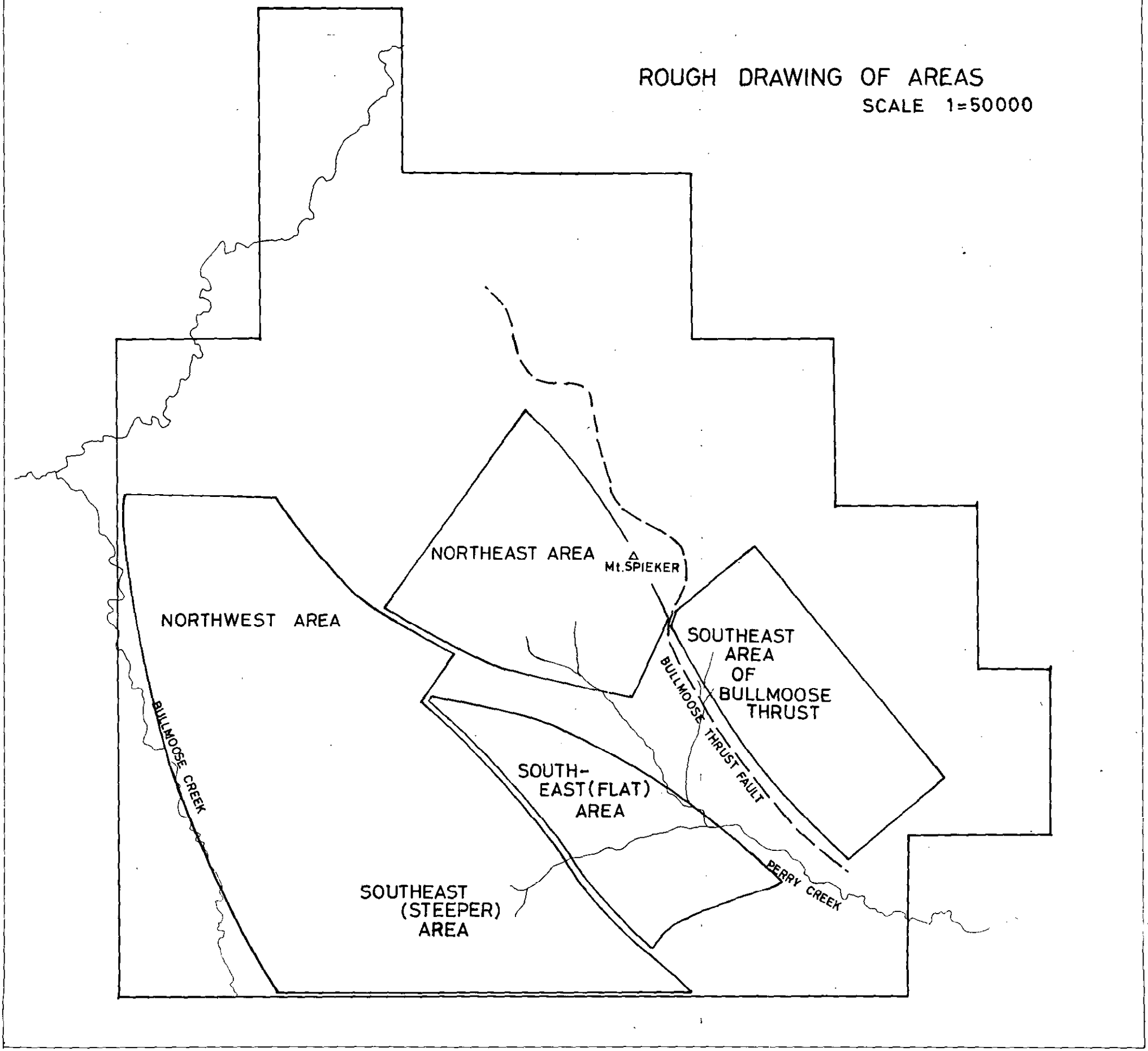
| | | |
|---|---|---|
| I-4 | Coal Reserves | See Section II-4 |
| I-5 | Coal Quality | See Section II-5 |

GENERAL STRATIGRAPHIC SECTION
IN THE Mt. SPIEKER AREA

Fig.-1

| Group | Formation (Thickness) | Coal Seam | Columnar Section | Description |
|---|---|---|---|---|
| FORT ST. JOHN G. | Hasler F. (300ft.+) | | | Gray Marine shale with fine silty stripes. |
| | Commotion F. — Boulder Creek M. (340-500ft.) | | | Conglomerate, coarse to fine grained sandstone and non-marine shale with thin coal seams and tuffacious shale beds. |
| | Commotion F. — Hulcross M. (470 - 520 ft.) | | | Gray marine shale with fine silty stripes, including sideritic concretions. |
| | Commotion F. — Gates M.(Upper) (520 - 600 ft.) | D C B A | | Wide alternation of fine to medium sandstone and shale, with conglomerate. Major coal seams exist in the lower half and other thin seams are near the top. |
| | Commotion F. — Gates M.(Lower) (550 - 620 ft.) | | | Fine to medium grained massive sandstone in the upper part and hard platy shale intercalating sandy shale in the lower part. |
| | Moosebar F. (300 - 350ft.) | | | Dark gray marine shale with sideritic concretions. Glauconitic sandstone is at base. |
| BULLHEAD G. | Gething F. (500 ft.+ ) | BIRD SKEETER CHAMBERLAIN | | Alternating sandstone and shale with several coal seams in the upper part. Sandstone facies is predominant in the lower part. |
| | Cadomin F. | | | Massive conglomerate. |

Fig.-2


ROUGH DRAWING OF AREAS
SCALE 1=50000
NORTHEAST AREA
Mt.SPIEKER
NORTHWEST AREA
SOUTHEAST AREA OF BULLMOOSE THRUST
BULLMOOSE THRUST FAULT
BULLMOOSE CREEK
SOUTH-EAST(FLAT) AREA
SOUTHEAST (STEEPER) AREA
PERRY CREEK

## II. SUMMARY OF EXPLORATION RESULTS DURING PAST THREE YEARS

The geological situation of the coal seams in the investigated area was reasonably clarified by the exploration work during past three years. The following is the summary of these three years' investigation, though there might be some duplicated explanation with the report in 1976.

### II-1 Stratigraphy

The strata distributed in the area are correlated to the Cadomin Formation of Bullhead Group as the lowest horizon and the Hasler Formation of Fort St. John Group as the top horizon which belong to the Lower Cretaceous in age. The major coal seams are present in Gething Formation and in Gates Member of the Commotion Formation.

The general stratigraphic section and brief discription of each Formation are shown on Fig.-1.

### II-2 Geological Structure

In view of the geological structure, the investigated area is divided into four units; the

northwest, southeast and northeast area, and southeast area of Bullmoose Thrust as shown on Fig.-2.

The northwest and southeast areas show broad synclinal structure with northwest axial trend. Within the areas, strata are undulated by several minor foldings. Gentle dipping areas of less than 10 degrees are found only in two places, one is around EB-1 to EB-4, and the other is near the F and G Creeks. The dips of strata in other places vary to 60 degrees in maximum. Faults with the stratigraphic throw of about seventy-foot are recognized in EB-9 to EB-1 and EB-13. These faults are seemed to be the same trend as the folding axis. Other faults with a fifty-foot throw and a thirty-foot throw are observed on the southern side of E Creek and in EB-4 respectively.

Most of the northeast area has gently dipping structure of less than 10 degrees and shows very gentle foldings. Bullmoose Thrust Fault runs with northwest trend in the east side of this area. This major fault was confirmed as low dip of 15-20 degrees in EB-12, EB-15 and the estimated outcrop of the fault. Thrust fault confirmed in EB-12 and

EB-7 which throw is about 100 feet, was interpreted as the fault incidental to the major fault.

The strata in the southeast area of Bullmoose Thrust are undulated moderately with foldings. Dips of the strata mostly show 15 to 30 degrees, and these strata are formed gentle inclination toward southwest as a whole.

## II-3 Coal Seams

### II-3-1 Coal Seams of Gates Member

The variation of D, C and B Seams is shown on Fig.-3

D Seam

D Seam is 11.5 - 14.5 feet thick in the eastern part of the southeast area. However, a shale parting in the middle part of coal seam is getting thicker towards northwest and the upper coal ply becomes thinner to the same direction. The thickness of the lower coal ply is also less than 5 feet there. Therefore, such area is excluded from the reserves estimation.

C Seam

This coal seam has the average thickness of 13 feet in the southeast area, however, the thinning trend is found toward northwest. The seam has a shale parting of about one foot in the middle part and other thin partings are found near the top and the bottom. The roof observed on the outcrop is soft shale containing carbonaceous materials, but it is hard in a few drillholes.

B Seam

This is the most prominent coal seam in this area. The seam is distributed in the northwest and southeast areas with average thickness of 14.9 feet. The seam is thicker in the southeast than in the northwest. In EB-13, the seam thickness is 23.9 feet, but it seems to become thick by minor fault and normal thickness is estimated as 16.8 feet.

A Seam

Although this seam is appeared to have the best quality among Gates Coals, the thickness is

mostly 3-5 feet which is insufficient for economical mining. In EB-9, A Seam is repeated by fault, with the thickness of 4.2 feet and 13.9 feet respectively. The latter is getting thick seemingly by minor fault and normal thickness is estimated as 9.8 feet. Although 9.5 feet thick of A Seam has been measured in E Creek, the thickness appears to show local variation and not to represent stable development throughout the whole area.

## II-3-2 Coal Seams of Gething Formation

### Bird Seams

Bird Seams consist of Upper Seam and Lower Seam. Upper Bird Seam is usually thicker than Lower Seam though it varies from 13.7 feet to 1.2 feet. Lower Bird Seam has a variation of thickness ranging from 8.1 feet to 3.0 feet. The interval between these two seams varies from 42 feet to 6 feet, and a few thin coal beds come to appear in the thicker interval. In the northeast area, a few thin coal seams are closely recognized below Lower Bird Seam. It seems that Bird Seams fairly vary their thickness, their interval and

the lithological facies of the interval. The variation of Bird Seams is shown on Fig.-4.

Sheeter Seam

This seam is 5 to 8 feet thick in the extreme southwestern outcrops of the property. The thickness in EB-7 is 7.5 feet but there seems to be a doubt of thickenning by minor fault. The thickness measured in the other areas is less than 5 feet. The area where the seam has 5 to 8 feet thick would be limited locally in the western part.

Chamberlain Seam

This seam is very thin in the property and shows the maximum thickness of about only 2 feet in E Creek.

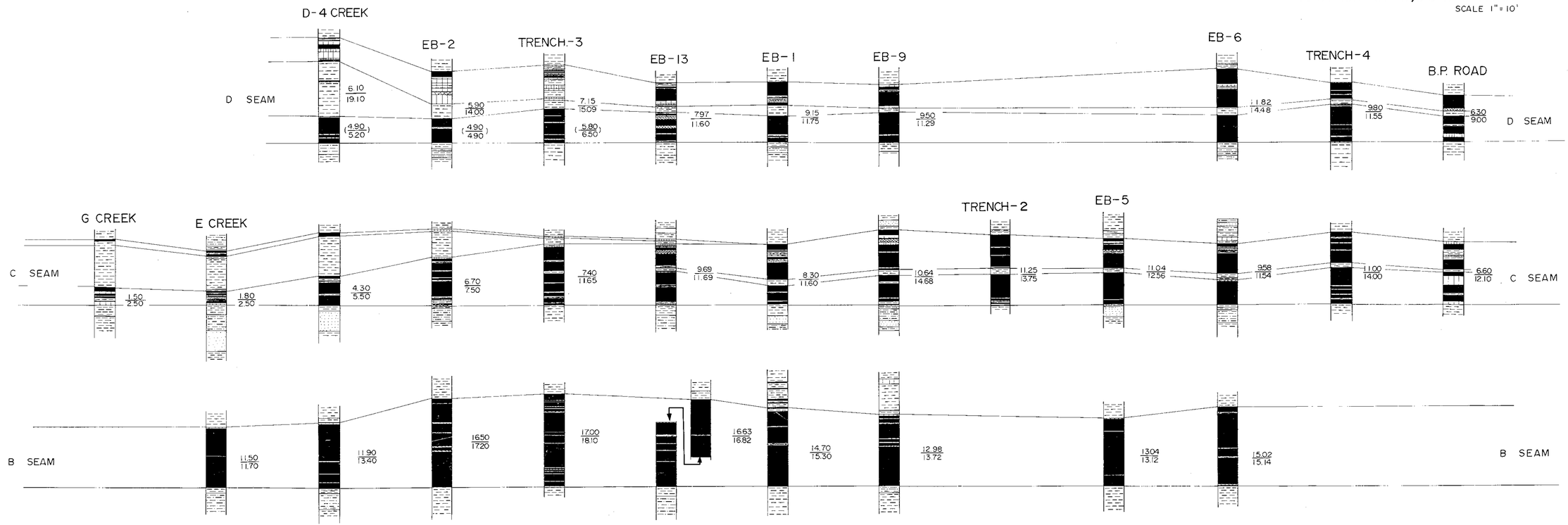
Middle Seam

This seam, which was observed at only one outcrop of the D Creek, is situated approximately 500 feet below Bird Seam and has the thickness of 4 to 5 feet.

Fig.-3

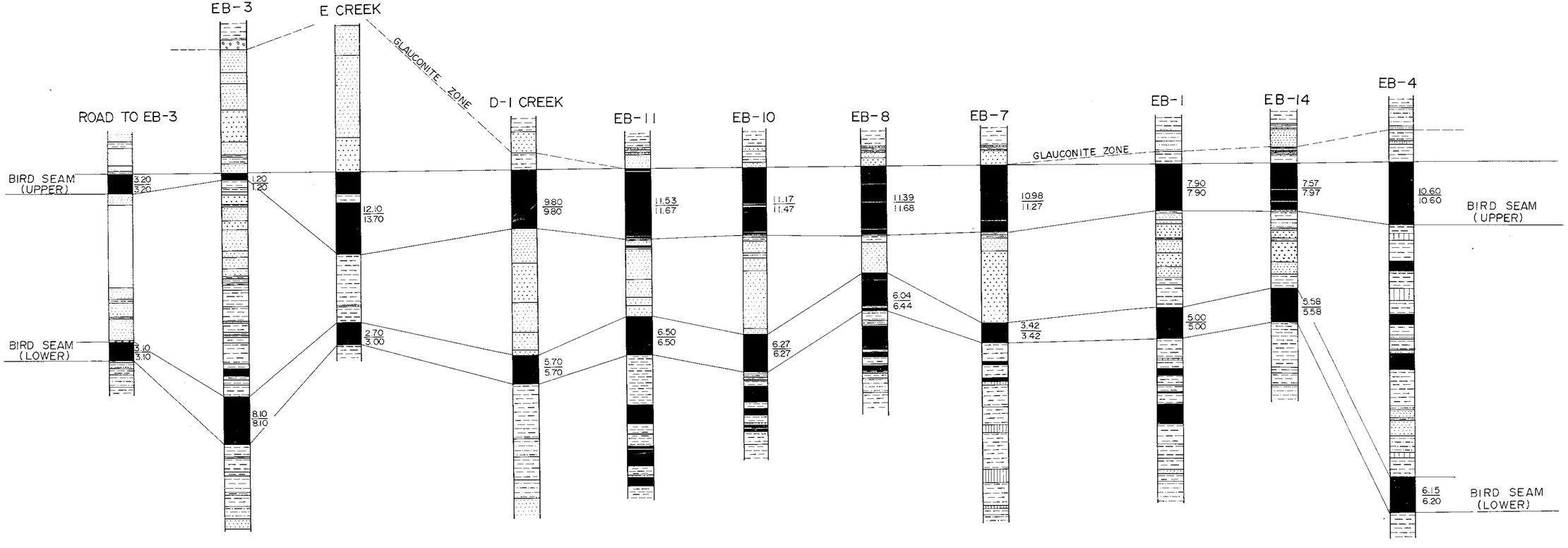
# VARIATION OF D, C & B SEAMS

SCALE 1" = 10'



# VARIATION OF BIRD SEAMS

SCALE 1" = 10'



## II-4 Coal Reserves

### II-4-1 Theoretically Minable Reserves in Place

The investigation in 1977 required to revise the coal reserves in the northeast area since the estimation of distributing area of Bird Seam decreases and that of the coal thickness increases. Therefore, the reserves of Upper Bird Seam is reviewed and those of Lower Bird Seam are additionally estimated in this area. (G-1 block)

There was no particular condition which require to revise the coal reserves in other areas. Each coal seam which was confirmed in the drillholes is of nearly same thickness as expected.

The theoretically minable coal reserves are summarized on Table-2, and those of each coal seam are shown on Table-3 to 6. The calculation is made on a clean coal basis, that is, the coal thickness (excluding partings) and specific gravity of 1.35 were used in the calculation process. Reserves are presented in metric ton.

The reserve distribution is summarized as follows.

Table- 2

## THEORETICALLY MINABLE RESERVES IN PLACE - SUMMARY

| Seam | Depth from Surface (Ft) | Seam Thick. (Ft) | Coal Thick. (Ft) | Theoretical Reserves | | |
|---|---|---|---|---|---|---|
| | | | | Flat Area (2) ($M.T.x10^3$) | Steeper Area (2) ($M.T.x10^3$) | Total ($M.T.x10^3$) |
| D | above 1500' | 13.10 | 9.80 | 2,028 | 14,607 | 16,635 |
| C | above 1500' | 12.90 | 10.10 | 2,143 | 24,173 | 26,316 |
| | above 1500' | 9.00 | 6.60 | 265 | 3,279 | 3,544 |
| | Sub-total | | | 2,408 | 27,452 | 29,860 |
| B | above 1500' | 14.90 | 14.20 | 9,450 | 61,328 | 70,778 |
| | below 1500' | 14.90 | 14.20 | 4,033 | 2,648 | 6,681 |
| | Sub-total | | | 13,483 | 63,976 | 77,459 |
| Total | | | | 17,919 | 106,035 | 123,954 |
| Bird (Upper) | above 1500' | (8.50) | (8.20) | 33,257 | 12,443 | 45,700 |
| | below 1500' | 8.50 | 8.20 | 4,049 | 18,988 | 23,037 |
| Total | | | | 37,306 | 31,431 | 68,737 |
| Bird (Lower) | above 1500' | 6.23 | 6.13 | 4,656 | — | 4,656 |
| | above 1500' | | | 51,799 | 115,830 | 167,629 |
| | below 1500' | | | 8,082 | 21,636 | 29,718 |
| Grand-total | | | | 59,881 | 137,466 | 197,347 |
| Additional Reserves (1) | | | | | | |
| Bird (Upper) | above 1500' | 8.50 | 8.20 | 0 | 11,330 | 11,330 |
| | below 1500' | 8.50 | 8.20 | 0 | 12,660 | 12,660 |
| Total | | | | | 23,990 | 23,990 |

Notes (1) The Upper Bird Seam is considered to be thin in the western part. Therefore, the reserves of this part are calculated separately from others.

(2) Flat Area : The area with the dips of less than 10 degrees. (approx.)

Steeper Area: The area with the dips of more than 10 degrees. (approx.)

Table - 3

## D SEAM RESERVES

| Block No. | Seam Thick. (Ft) | Coal Thick. (Ft) | Plane Area ($Ft^2 x 10^3$) | Dip (deg) | Dip Area ($Ft^2 x 10^3$) | Theoretical Coal Reserves (M.T.$x10^3$) |
|---|---|---|---|---|---|---|
| A - 2 | 13.10 | 9.80 | 877 | 27 | 983 | 368 |
| A - 3 | 13.10 | 9.80 | 6,539 | 26 | 7,278 | 2,722 |
| Sub-total | | | 7,416 | | 8,261 | 3,090 |
| B - 2 | 13.10 | 9.80 | 1,913 | 13 | 1,962 | 734 |
| B - 3 | 13.10 | 9.80 | 8,651 | 35 | 10,563 | 3,951 |
| B - 4 | 13.10 | 9.80 | 7,303 | 25 | 8,055 | 3,013 |
| Sub-total | | | 17,867 | | 20,580 | 7,698 |
| C - 2 | 13.10 | 9.80 | 7,206 | 10 | 7,314 | 2,736 |
| C - 4 | 13.10 | 9.80 | 2,457 | 32 | 2,897 | 1,083 |
| Sub-total | | | 9,663 | | 10,211 | 3,819 |
| G - 1 | 13.10 | 9.80 | 5,401 | 5 | 5,423 | 2,028 |
| Total | | | 40,347 | | 44,475 | 16,635 |

Table - 4

## C SEAM RESERVES

| Block No. | Seam Thick. (Ft) | Coal Thick. (Ft) | Plane Area ($Ft^2x10^3$) | Dip (deg) | Dip Area ($Ft^2x10^3$) | Theoretical Coal Reserves ($M.T.x10^3$) |
|---|---|---|---|---|---|---|
| A - 2 | 12.90 | 10.10 | 919 | 27 | 1,031 | 398 |
| A - 3 | 12.90 | 10.10 | 6,381 | 26 | 7,102 | 2,741 |
| Sub-total | | | 7,300 | | 8,133 | 3,139 |
| B - 1 | 12.90 | 10.10 | 2,263 | 20 | 2,407 | 929 |
| B - 2 | 12.90 | 10.10 | 1,260 | 13 | 1,293 | 499 |
| B - 3 | 12.90 | 10.10 | 8,580 | 35 | 10,476 | 4,044 |
| B - 4 | 12.90 | 10.10 | 8,199 | 25 | 9,044 | 3,491 |
| Sub-total | | | 20,302 | | 23,220 | 8,963 |
| C - 1 | 12.90 | 10.10 | 1,068 | 15 | 1,105 | 427 |
| C - 2 | 12.90 | 10.10 | 9,099 | 10 | 9,235 | 3,565 |
| C - 3 | 12.90 | 10.10 | 8,432 | 35 | 10,296 | 3,974 |
| C - 4 | 12.90 | 10.10 | 8,142 | 32 | 9,599 | 3,705 |
| Sub-total | | | 26,741 | | 30,235 | 11,671 |
| D - 3 | 12.90 | 10.10 | 897 | 30 | 1,036 | 400 |
| G - 1 | 12.90 | 10.10 | 5,530 | 5 | 5,552 | 2,143 |
| Total | | | 60,770 | | 68,176 | 26,316 |
| A'- 2 | 9.00 | 6.60 | 1,260 | 27 | 1,414 | 356 |
| A'- 3 | 9.00 | 6.60 | 3,058 | 26 | 3,404 | 858 |
| B'- 1 | 9.00 | 6.60 | 3,922 | 20 | 4,173 | 1,052 |
| C'- 1 | 9.00 | 6.60 | 1,504 | 15 | 1,556 | 392 |
| C'- 3 | 9.00 | 6.60 | 1,194 | 38 | 1,515 | 382 |
| D'- 3 | 9.00 | 6.60 | 820 | 30 | 947 | 239 |
| G'- 1 | 9.00 | 6.60 | 1,046 | 5 | 1,050 | 265 |
| Sub-total | | | 12,804 | | 14,059 | 3,544 |
| Grand-total | | | 73,574 | | 82,235 | 29,860 |

Table - 5

## B SEAM RESERVES

| Block No. | Seam Thick. (Ft) | Coal Thick. (Ft) | Plane Area ($Ft^2 x 10^3$) | Dip (deg) | Dip Area ($Ft^2 x 10^3$) | Theoretical Coal Reserves (M.T.$x10^3$) |
|---|---|---|---|---|---|---|
| A - 1 | 14.90 | 14.20 | 8,996 | 40 | 11,740 | 6,375 |
| A - 2 | 14.90 | 14.20 | 3,228 | 27 | 3,622 | 1,967 |
| A - 3 | 14.90 | 14.20 | 10,781 | 26 | 11,999 | 6,515 |
| A - 10 | 14.90 | 14.20 | 2,030 | 28 | 2,299 | 1,249 |
| Sub-total | | | 25,035 | | 29,660 | 16,106 |
| B - 1 | 14.90 | 14.20 | 8,886 | 20 | 9,454 | 5,134 |
| B - 2 | 14.90 | 14.20 | 1,700 | 13 | 1,745 | 947 |
| B - 3 | 14.90 | 14.20 | 10,457 | 35 | 12,768 | 6,933 |
| B - 4 | 14.90 | 14.20 | 7,611 | 25 | 8,395 | 4,558 |
| B - 10 | 14.90 | 14.20 | 1,166 | 15 | 1,206 | 655 |
| Sub-total | | | 29,820 | | 33,568 | 18,227 |
| C - 1 | 14.90 | 14.20 | 4,779 | 15 | 4,946 | 2,686 |
| C - 2 | 14.90 | 14.20 | 7,979 | 10 | 8,099 | 4,398 |
| C - 3 | 14.90 | 14.20 | 11,877 | 35 | 14,501 | 7,874 |
| C - 4 | 14.90 | 14.20 | 8,208 | 32 | 9,677 | 5,255 |
| C - 10 | 14.90 | 14.20 | 1,324 | 15 | 1,370 | 744 |
| Sub-total | | | 34,167 | | 38,593 | 20,957 |
| D - 1 | 14.90 | 14.20 | 8,217 | 17 | 8,595 | 4,667 |
| D - 2 | 14.90 | 14.20 | 3,178 | 25 | 3,505 | 1,903 |
| D - 3 | 14.90 | 14.20 | 3,374 | 30 | 3,897 | 2,116 |
| Sub-total | 14.90 | 14.20 | 14,769 | | 15,997 | 8,686 |
| F - 1 | 14.90 | 14.20 | 7,907 | 7 | 7,970 | 4,328 |
| F - 10 | 14.90 | 14.20 | 7,354 | 8 | 7,428 | 4,033 |
| Sub-total | | | 15,261 | | 15,398 | 8,361 |
| G - 1 | 14.90 | 14.20 | 9,396 | 5 | 9,434 | 5,122 |
| Total | | | 128,448 | | 142,650 | 77,459 |

Above 1500' cover 70,778 M.T.$x10^3$

Below 1500' cover 6,681 M.T.$x10^3$

Table - 6

## BIRD SEAMS RESERVES

Upper Bird Seam

| Block No. | Seam Thick. (Ft) | Coal Thick. (Ft) | Plane Area ($Ft^2x10^3$) | Dip (deg) | Dip Area ($Ft^2x10^3$) | Theoretical Coal Reserves ($M.T.x10^3$) |
|---|---|---|---|---|---|---|
| A - 1 | 8.50 | 8.20 | 6,970 | 37 | 8,726 | 2,731 |
| A - 2 | 8.50 | 8.20 | 5,294 | 36 | 6,543 | 2,048 |
| A - 3 | 8.50 | 8.20 | 3,325 | 35 | 4,060 | 1,271 |
| A - 4 | 8.50 | 8.20 | 5,446 | 23 | 5,914 | 1,851 |
| A - 10 | 8.50 | 8.20 | 3,873 | 35 | 4,728 | 1,480 |
| A - 11 | 8.50 | 8.20 | 4,748 | 26 | 5,284 | 1,654 |
| A - 12 | 8.50 | 8.20 | 9,125 | 24 | 9,992 | 3,127 |
| Sub-total | | | 38,781 | | 45,247 | 14,162 |
| B - 1 | 8.50 | 8.20 | 6,143 | 37 | 7,691 | 2,407 |
| B - 2 | 8.50 | 8.20 | 5,227 | 40 | 6,821 | 2,135 |
| B - 10 | 8.50 | 8.20 | 9,737 | 28 | 11,032 | 3,453 |
| B - 11 | 8.50 | 8.20 | 28,004 | 19 | 29,628 | 9,274 |
| Sub-total | | | 49,111 | | 55,172 | 17,269 |
| F - 1 | 8.50 | 8.20 | 29,216 | 3 | 29,245 | 9,154 |
| F - 10 | 8.50 | 8.20 | 3,657 | 7 | 3,686 | 1,154 |
| F - 11 | 8.50 | 8.20 | 5,736 | 5 | 5,759 | 1,803 |
| Sub-total | | | 38,609 | | 38,690 | 12,111 |
| G - 1 | 11.18 | 10.97 | 26,498 | 5 | 26,604 | 11,147 |
| H - 1 | 8.50 | 8.20 | 35,908 | 5 | 36,051 | 11,284 |
| H - 2 | 8.50 | 8.20 | 5,299 | 7 | 5,342 | 1,672 |
| H - 10 | 8.50 | 8.20 | 3,050 | 3 | 3,053 | 956 |
| H - 11 | 8.50 | 8.20 | 435 | 3 | 435 | 136 |
| Sub-total | | | 44,692 | | 44,881 | 14,048 |
| Above 1500' cover | | | | | | 45,700 |
| Below 1500' cover | | | | | | 23,037 |
| Total | | | 197,691 | | 210,594 | 68.737 |

Lower Bird Seam

| | | | | | | |
|---|---|---|---|---|---|---|
| G - 1 | 6.23 | 6.13 | 19,819 | 5 | 19,899 | 4,656 |

Additional Reserves* (Upper Bird Seam)

| | | | | | | |
|---|---|---|---|---|---|---|
| C - 1 | 8.50 | 8.20 | 6,160 | 25 | 6,795 | 2,127 |
| C - 2 | 8.50 | 8.20 | 5,001 | 40 | 6,526 | 2,043 |
| C - 3 | 8.50 | 8.20 | 2,846 | 42 | 3,828 | 1,198 |
| C - 10 | 8.50 | 8.20 | 12,792 | 27 | 14,352 | 4,492 |
| C - 11 | 8.50 | 8.20 | 8,095 | 24 | 8,864 | 2,774 |
| C - 12 | 8.50 | 8.20 | 16.796 | 13 | 17.233 | 5,394 |
| Sub-total | | | 51,690 | | 57,598 | 18,028 |
| D - 1 | 8.50 | 8.20 | 3,457 | 25 | 3,813 | 1,194 |
| D - 2 | 8.50 | 8.20 | 2,103 | 33 | 2,507 | 785 |
| D - 3 | 8.50 | 8.20 | 1.424 | 30 | 1,645 | 515 |
| Sub-total | | | 6,984 | | 7,965 | 2,494 |
| E - 1 | 8.50 | 8.20 | 2,900 | 17 | 3,034 | 950 |
| E - 2 | 8.50 | 8.20 | 3,798 | 29 | 4,341 | 1,359 |
| E - 3 | 8.50 | 8.20 | 3,433 | 22 | 3,704 | 1,159 |
| Sub-total | | | 10,131 | | 11,079 | 3,468 |
| Above 1500' cover | | | | | | 11,330 |
| Below 1500' cover | | | | | | 12,660 |
| Total | | | 68,805 | | 76,642 | 23,990 |

* See the "Note" of TABLE - 2

(1) Reserves of Gates Coal Seams

(a) About 90 million tons out of total reserves of 124 million tons are concentrated in the southern part of the whole area.

(b) Most of the reserves is present above 1,500 feet cover line.

(c) Major portion (85%) of the reserves is in the steeper area with the dips of more than 10 degrees.

(2) Reserves of Bird Seams

(a) The total reserves of Upper Bird Seam are estimated at 68 million tons which exclude the reserves of western area where the seam considered to be thin.

(b) The reserves above 1,500 feet cover line are 46 million tons, which are about two thirds of 68 million tons. About 33 million tons of above 46 million tons exist in the flat area.

(c) The reserves of Upper Bird Seam in the

northeast area (G-1 block) are almost unchanged due to increase of coal thickness, though the distributing area decreases.

(d) The reserves of Lower Bird Seam in the northeast area are estimated 4.6 million tons.

There is no drillhole in the southeast area of Bullmoose Thrust, where D and C Seams being of 9 and 12 feet respectively are confirmed at the outcrops at the southwest border. The coal to seam thickness ratio of C Seam is quite low, which is only 55%. Though the data points are less, the seam structure contour is drawn on D Seam. No reserves in this area are calculated.

II-4-2 Recoverable Reserves

(1) Northeast area (Bird Seams) ..... (G-1 block)

The density of exploration in this area is the highest of all area investigated. The recoverable factor is the figure on the assumption of conventional mining.

| Seam | Theoretical Resv.in Place ($M.T.x10^3$) | Geological Factor (%) | Recoverable Factor (%) | Recoverable Reserves ($M.T.x10^3$) |
|---|---|---|---|---|
| Upper Bird | 11,147 | 80 | 48 | 4,280 |
| Lower Bird | 4,656 | 80 | 50 | 1,862 |
| | | | Total | 6,142 |

(2) Southeast (flat) area (Upper Bird Seam)... (H-1 block)

The density in this area is lower than that of the northeast area, so it is necessary to examine further on geological and recoverable factors.

| Seam | Theoretical Resv. in Place ($M.T.x\ 10^3$) | Geological Factor (%) | Regional Rec. Factor (%) | Recoverable Reserves ($M.T.x\ 10^3$) |
|---|---|---|---|---|
| Upper Bird | 11,284 | 75 | 45 | 3,808 |

(3) Southeast (flat) area (D, C, B Seams)

The strip mining is expectable at the surrounding area of EB-1 and EB-9, where three Gates Seams are distributed near surface, though the area is small. It is necessary to discuss further in future on the stripping ratio. But,

*SEE PR-MT. SPIEKER 77(6)4. FOR RESERVES DATA.

if the stripping ratio were 8, the theoretical reserves come to about 3.3 million tons and the recoverable reserves come to about 2.5 million tons.

(4) Southeast (steeper) and Northwest areas (D, C, B Seams)

For reference, the recoverable reserves are shown as follows in case of assumption of geological factor and regional recoverable factor against the theoretical reserves of Gates Coals. The figures indicated in the above item (3) are included in following figures.

| Seam | Theoretical Resv. in Place (M.T.x10$^3$) | Geological Factor (%) | Regional Rec. Factor (%) | Recoverable Reserves (M.T.x10$^3$) |
|---|---|---|---|---|
| D,C,B | 123,954 | 75 | 45 | 41,834 |

II-5 Coal Quality

Test results of the drill core samples of the workable seams are summarized on Table-7. (above 65% of core recovery)

Clean coal floated at 1.5 S.G. of the Gates Coals shows 7-9% of ash contents, 22-25% of volatile matter, 6 - 7-1/2 of F.S.I. and 0.2-0.5% of total sulphur. The clean coal yield of B Seam is more than 76% but that of C and D Seams shows 50-60% due to some partings in each seam.

Upper Bird and Lower Bird Seams indicate high quality because of the clean coal ash is 6-8%, volatile matter 18-21% and F.S.I. value 8-9. However, the sulphur contents are high, 1.1-2.2%. Rarely, the low figures of 0.5% are found in Lower Bird Seam.

From the above figures a good metallurgical coal could be expected from these seams. Only one problem is high sulphur contents of Bird Seams.

The samples in 1977 were tested at Cyclone Engineering Sales Ltd., Edmonton, Alberta and the report is attached as Appendix. In the results, the clean coal ash contents of D, C and B Seams in EB-9 and EB-13 are as follows and higher than the figures which obtained from the results of float-sink test.

| Seam | Drillhole | Ash % (dry basis) |
|---|---|---|
| D | EB-9 | 10.81 |
| | EB-13 | 12.06 |
| C | EB-9 | 10.38 |
| | EB-13 | 9.89 |
| B | EB-9 | 9.34 |
| | EB-13 | 9.43 |

The reason would be that ash contents of the samples were increased due to the high ash product of floatation when the samples were prepared. Judging from the results of float-sink test, however, it is quite possible to get low ash contents of froth floatation products in actual operation.

Therefore the proximate analysis figures could be adjusted by using the results of float-sink tests. The data of EB-9 and EB-13 in Table-7 are filled up by the adjusted figures.

# SUMMARY OF TEST RESU

| SEAM | DH No. | THICK (appar.) ft. | CORE REC. % | THICK. (true) COAL SEAM. ft. | RAW COAL (dry basis) ASH % |
|---|---|---|---|---|---|
| D | EB-1 | (4.75) 11.75 (5.40) | 92 | 9.15 / 11.75 | 15.38 ✓ 17.20 ✓ |
| | EB-2 | 7.2 | 89 | 4.90 / 4.90 | 18.23 ✓ |
| | EB-9 | 11.4 | 96 | 9.50 / 11.29 | 28.75 |
| | EB-13 | 12.8 | 100 | 7.97 / 11.60 | 35.22 |
| | Average | | | | 27.40 |
| C | EB-1 | (6.70) 11.6 (3.60) | 100 | 8.30 / 11.60 | 7.77 ✓ 6.79 |
| | EB-2 | 10.3 | 85 | 6.70 / 7.50 | 26.65 ✓ |
| | EB-6 | 14.2 ✓ | 76 | 9.58 / 11.54 | 35.14 |
| | EB-9 | 14.9 | 98 | 10.64 / 14.68 | 37.34 |
| | EB-13 | 12.9 | 100 | 9.69 / 11.69 | 28.18 |
| | Average | | | | 31.83 |
| B D | EB-1 | 15.3 | 92 | 14.70 / 15.30 | 15.80 ✓ |
| | EB-2 | 21.2 | 93 | 16.50 / 17.20 | 10.92 ✓ |
| | EB-9 | 14.0 | 98 | 12.98 / 13.72 | 17.89 |
| | EB-13 | 25.4 | 90 | 16.63 / 16.82 | 14.07 |
| | Average | | | | 14.67 |
| BIRD (Upper) | EB-4 | 7.7 | 66 | 7.70 / 7.70 | 9.08 ✓ |
| | EB-7 | 11.5 | 68 | 10.98 / 11.27 | 14.82 |
| | EB-8 | 11.8 | 96 | 11.39 / 11.68 | 8.92 |
| | EB-10 | 11.7 | 97 | 11.17 / 11.47 | 12.50 |
| | EB-11 | 12.2 | 100 | 11.53 / 11.67 | 9.65 |
| | EB-14 | 8.0 | 91 | 7.57 / 7.97 | 13.17 |
| | Average | | | | 11.36 |
| BIRD (Lower) | EB-8 | 6.5 | 100 | 6.04 / 6.44 | 18.00 |
| | EB-10 | 6.4 | 100 | 6.27 / 6.27 | 8.88 |
| | EB-11 | 6.8 | 75 | 6.50 / 6.50 | 10.53 |
| | EB-14 | 5.6 | 100 | 5.58 / 5.58 | 6.15 |
| | Average | | | | 10.89 |

## III. CONCLUSION AND RECOMMENDATION

The geological situation of the coal seams is summarized as follows.

(1) The main coal seams in this property is present in Gates Member. B Seam is distributed both in the northwest and southeast areas with the average thickness of 15 feet. C and D Seams are developped only in the southeast area with the thickness of more than 10 feet.

(2) Gates Coal Seams are distributed in a broad synclinal structure with undulated dips. The dips of coal seams are varied from zero to 60 degrees.

(3) Other main coal seams are Bird Seams in Gething Formation and are expected to distribute over the area investigated. However, the half of calculated reserves concentrate on the northeast area and a part of flat area of the southeast and northwest areas, and above 1,500 feet cover line. In the northeast area, Upper Bird and Lower Bird Seams show about 11 feet and 6 feet respectively in thickness.

(4) The theoretically minable reserves in place are estimated at 197 million tons in total. Gates coal reserves in place are 124 million tons, most of which is distributed in above 1,500 feet cover line. 90 million tons out of the quantity indicated above are distributed in southern part of the area.

Upper Bird Seam reserves in place are 68 million tons. Out of them, 33 million tons are distributed in the flat area above 1,500 feet cover line.

(5) Since the density of exploration in the northeast area is comparatively high, the minable reserves of both Upper and Lower Bird Seams can be calculated as about 6.14 million tons in total.

(6) The distribution of Gates Coal Seams is expected in the southeast area of Bullmoose Thrust. But the thickness of coal seams and its variation is uncertain. It is estimated that the dip of coal seams varies largely due to folding structure and the depth becomes to 1,000 to 1,500 feet.

(7) The coal quality is, in general, of low ash, medium volatile and high F.S.I. with coking property. However, sulphur contents of Bird Seams are high.

The following points should be noted on the further exploration study.

1. Since Bird Seams in the northeast area and the southeast flat area are distributed in shallow depth with gentle dip, the mining condition in the above areas is better than that of other areas. Bird Seams are of low ash, high F.S.I. and high yield with coking property, but of high sulphur contents. From the view of metallurgical usage, the countermeasure is required to reduce sulphur contents. The following countermeasures are considered :-

(1) Blending with Gates Coals of low sulphur contents and study for permissibility of blending in view from the use.

(2) Increasing of coal reserves for the blending in case of allowing.

2. The recoverable coal reserves have been calculated for reference. But further exploration is required for the mining plan because the density of it is still low.

3. Additionally mentioning, there are still remained unsurveyed area in the eastern part of the property.