HAT CREEK PROJECT

MINING FEASIBILITY REPORT

VOLUME II

GEOLOGY AND COAL QUALITY

prepared for
British Columbia Hydro and Power Authority

by
Cominco-Monenco Joint Venture

1978

HAT CREEK PROJECT

MINING FEASIBILITY REPORT

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OBJECTIVE

The objective of this portion of the mining feasibility study was to review and interpret all existing geological and analytical data, and to organize these and related new data from the 1977/78 drilling program and trench excavations into a format suitable for quality evaluations, estimating of reserves, and mine planning.

SUMMARY

The Hat Creek No. 1 Deposit consists of a thick, complex series of alternating coal and sedimentary rock beds located in a topographic and structural depression in the Upper Hat Creek valley. Geological correlations of the structure and detailed stratigraphy of the coal deposit have been made on the basis of diamond drilling on approximately 150-metre centres. The deposit extends over a north/south strike length of 2000 metres, has a maximum width of 1500 metres, and a maximum depth of 580 metres below ground level.

The deposit has been subdivided into four broad coal zones and two broad rock and low-grade coal zones on the basis of coal quality. Many additional subdivisions have been made on the basis of correlations of the top of rock partings aided by down-the-hole geophysical logs. Twelve sub-zones have been used to define the deposit for coal quality purposes; however, the qualities of adjacent sub-zones in each major zone are quite similar.

Reserves have been calculated on the basis of a modified inverse distance quared method. Reserves that have been defined from drilling at 150-metre centres and which are included within the boundaries of the 35-year pit are classified as "proven". Those reserves beyond the 35-year pit limits which are equally as well-defined, but which are not included in a detailed mine plan are classified as "probable". The total proven and probable reserves of the No. 1 Deposit are summarized as follows (dry basis):

	Tonnes $\times 10^6$	Calorific Value (Btu/lb)	Ash Content %	Sulphur Content %
Proven	344	7515	35.1	0.49
Probable	373	6645	40.9	0.53
Total	717			
Average		7060	38.0	0.51

The cut-off grade for calculation of reserves is 4000 Btu/lb, and an average in situ moisture content of 25% is assumed. Reserve estimates include all in-seam partings.

These reserves are considered to be well-defined for quantities greater than 20 million tonne blocks, but may be subject to errors of geological correlation in smaller blocks.

RECOMMENDATIONS

Geological correlations based on diamond drill holes are generally simplified idealized versions of the actual detailed geological picture. Although reserves are well-substantiated over fairly broad areas, it is recommended that short, close-spaced drilling be done in the initial production area to improve structural control and grade data during the early production years. This work should cover an area and depth adequate to detail about 20 million tonnes of coal.

In some areas the 150-metre pattern of diamond drilling is incomplete and areas of structural complexity require further drilling. It is recommended that this work be completed.

SECTION 1

HISTORY

OF

EXPLORATION AND DEVELOPMENT

1.1 PRE 1974 PERIOD

The Hat Creek coal deposits were first reported by Dr. G.M. Dawson of the Geological Survey of Canada in 1877 and again in 1894. The first known attempt to develop the deposits was in 1893 by a local rancher, George Finney, who is reported to have sunk a shaft to a depth of 38 metres on one of the sparse outcrops along the west bank of Upper Hat Creek. Finney developed small open cuts which provided sporadic production of wagon-load lots which were sold to other local ranchers. A Chinese syndicate acquired the property in 1923, sank three shallow shafts, and drove No. 1 Adit into the exposed coal on the west side of Hat Creek (Figure 1-1) to a depth of 57 metres. It was planned to ship coal by motor truck to Pavilion and then by Pacific Great Eastern (PGE) Railway to Vancouver; however, the syndicate ran into financial difficulties before this was accomplished. The Clear Mountain Coal Company then took over the property and shipped three carloads of coal via the PGE to Vancouver; the financial loss on this shipment caused their bankruptcy. Early in 1925, the coal deposits were acquired by the Hat Creek Coal Company who drove No. 2 Adit, and drilled seven holes to cover a strike length of 2300 metres, mainly along the western bank of Hat Creek where the original outcrops had been discovered (Figure 1-1).

The results of these initial drill holes and mapping in No. 1 and No. 2 Adits were reported by the B.C. Minister of Mines (1925) and by the Geological Survey of Canada (1925). Initial estimates of proven and potential reserves were made in these two reports, with proven reserves stated as 29 million tonnes and probable reserves in the range of 68 to 79 million tonnes.

Between 1925 and 1957, the only recorded development is intermittent production of a few hundred tonnes a year for local needs. In 1944, Ridgeway R. Wilson acquired the property for Ventures Limited, but in 1951 the controlling interest was regained by a Wilson Mining Corporation subsidiary, Inland Resources Company. In 1957, the holdings were optioned to Western Development and Power Company, a subsidiary of B.C. Electric Railway Company. Drilling programs were carried out in 1957 and 1959 under the supervision of the Vancouver firm of Dolmage, Mason and Stewart Ltd., consulting geologists and mining engineers. During 1957, eight diamond drill holes (Nos. 8-15 inclusive) were completed, and Nos. 16-22 inclusive were drilled in 1959. Figure 1-1 shows the locations of all exploration and development drill holes completed to date.

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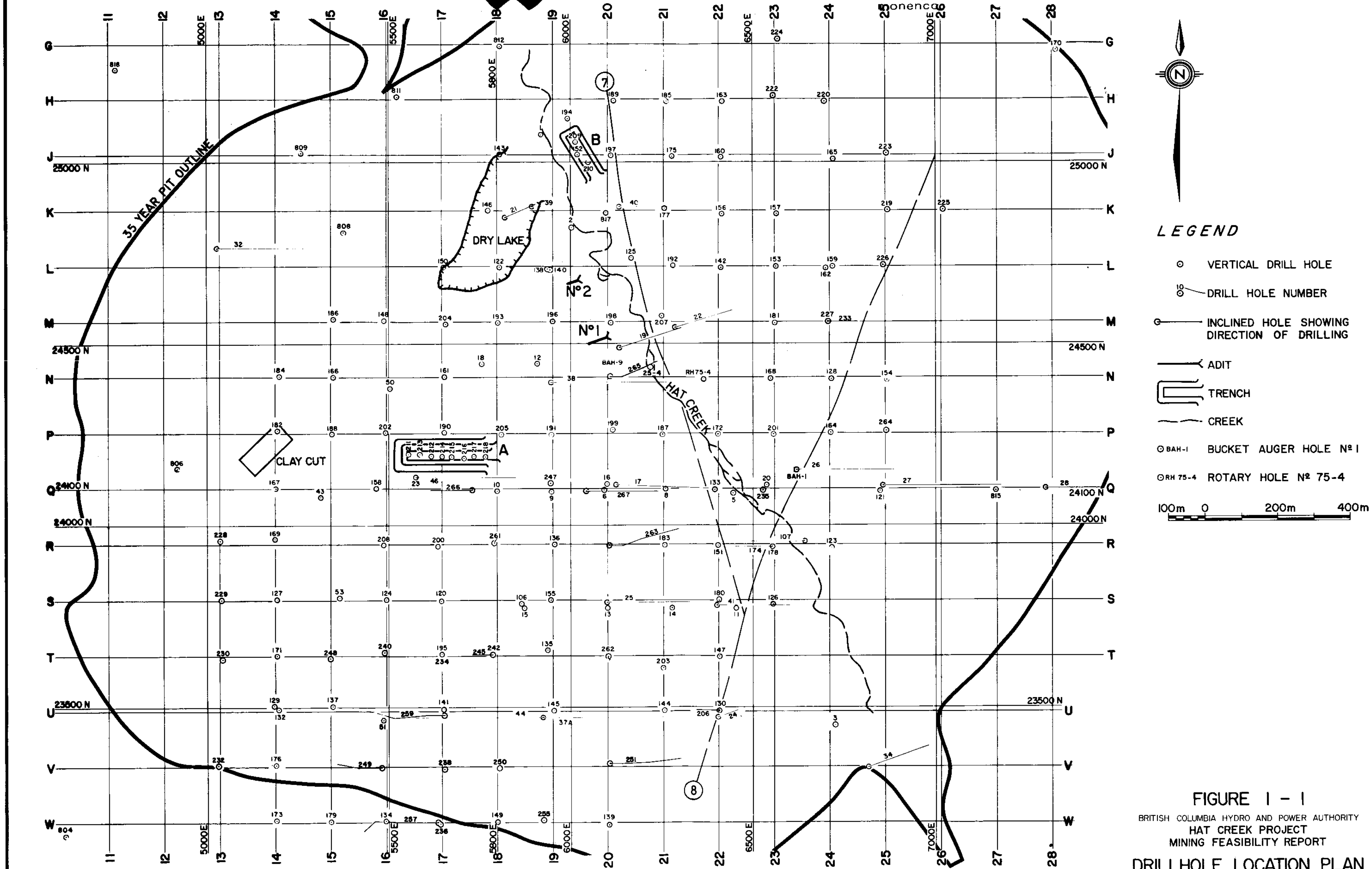

FIGURE 1 - 1

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY
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DRILLHOLE LOCATION PLAN

By the end of 1959, Dolmage, Mason and Stewart were able to report that proven reserves amounted to 308 million tonnes, mainly underlying the original Crown-granted coal license (one mile square). Western Development and Power Company exercised its option in early 1960, and purchased the property for B.C. Electric Railway Company. No further drilling was done until 1974, but in the interval, the B.C. Electric Railway Company was acquired by the Government of British Columbia.

1.2 POST 1974 PERIOD

121 DRILLING

During 1974 and subsequent years, continuing programs of exploration and development drilling were conducted by B.C. Hydro and Power Authority. Dolmage, Campbell and Associates, Consulting Geologists, were engaged to organize and supervise the field drilling programs and to arrange and record the resulting analytical work.

A test program of reverse circulation rotary drilling was attempted in late 1974 to evaluate a cheaper drilling method as an alternate to diamond coring. Four vertical holes were drilled and chip samples were collected through the coal bearing zones. The reverse circulation rotary drilling proved impractical because of the sticky claystone present in the hanging wall strata and as partings within the coal bearing zones. Since the analytical data for only one hole were input into the computer data file, Figure 1-1 shows only RH. 75-4 from this test program.

As shown on Table 1-1, only a few diamond drill holes were drilled during 1975 in No. 1 Deposit; at that time, exploration was diverted temporarily to No. 2 Deposit, about 5 kilometres south of No. 1. Comprehensive programs were undertaken in both 1976 and 1977/78 to complete testing of No. 1 Deposit at 150 metre spacing, to outline the subcrop limits, and to test some of the structurally complicated areas.

The 1977/78 drilling program commenced in September 1977 and ended in February 1978. The general objectives were:

(a) to outline the subcrop of No. 1 Deposit in the northeast region, to provide "fill-in" quality data from D-Zone between No. 7 and No. 8 faults, and to test locally for No. 8 fault;

(b) to outline the approximate subcrop of D-Zone in the southwest region, e.g., DDH. 228, 229, 230, and 232 were drilled to confirm that the subcrop projection was considerably east of Section 13;

TABLE 1-1

Summary of Exploration and Development Drilling
in No. 1 Deposit
Hat Creek Project Mining Feasibility Report 1978

Year	No. of Holes	Total Metres	Remarks
1925	7	754.4	DDH. 1-7 incl.
1957	8	1731.6	DDH. 8-15 incl.
1959	7	1889.8	DDH. 16-22 incl.
1974	26	10 797.2	DDH. 23-48 incl.
1974/75	4	1415.2	RH. 1-4 incl., test program - not practical
1975	7	2794.4	DDH. 49-53, 106, 107
1976	89	20 701.4	DDH. 120-208 incl. (excl. geotech. holes)
1977	10	236.2	DDH. 209-218 incl. (trench locations)
1977/78	49	13 725.1	DDH. 219-267 to Feb. 28, 1978
TOTALS	207	54 045.3	

(c) to test the southward projections of A, B, and C coal zones on Section W and beyond, as represented by holes 257, 236, 255, 237, 254, 241, 244, 243, 239, 246, 252, 260, 256, and 258 as shown on Figure 1-1;

(d) to provide fill-in coverage of the central part of No. 1 Deposit at approximately 150-metre spacing, e.g., DDH. 249, 238, 250, 251, 259, 240, 248, 262, 261, 263, 266, and 267.

This latter group of holes was the most important with regards to provision of additional quality sources for the proposed pit(s). Pit planning was well advanced by November 1977, but many of these critical quality fill-in holes were the last drilled in the fall and winter 1977/78 program, as evidenced by the high hole numbers. Revision and update of the computer model had to await completion of the fill-in holes and their quality analyses. When completed the program had provided a significant number of additional grade intersections of the coal zones (12 additional A-Zone intersections, 11 in B-Zone, 10 in C-Zone, and 9 in D-Zone). It is noteworthy that prior to this the number of complete grade cross-sections of A coal zone was only 19; thus, the number of quality sources here was increased by more than half.

Throughout the 1977/78 fall and winter drilling program a working liaison was maintained between the CMJV and B.C. Hydro geologists. Many geological interpretations were developed jointly. By early spring of 1978, B.C. Hydro geologists had commenced preparation of 1:1500 scale geological cross-sections which depicted detailed lithological units within the six major stratigraphic subdivisions of the coal formation, i.e., A-1, A-2, B-1, C-1, C-2, D. These latter sections were made available to CMJV geologists after March 1978.

122 BULK SAMPLING AND TESTWORK

In May 1976, a large rotary drill was used to drill 15 bucket-auger holes (BAH) to collect near-surface samples of coal for washability and other tests. BAH-1 and BAH-9 are the only bucket-auger holes shown on Figure 1-1, because the collar locations of the other auger holes very nearly coincide with prior diamond drill holes. The deepest auger hole was to 95 feet. Approximately 17 tonnes of coal were obtained by this sample method in three lots (A, B, C) of varied calorific value and ash content. The samples were sent in sealed barrels to Birtley Engineering (Canada) Ltd. at Calgary for analyses and for washability tests. The results were reported in detail to B.C. Hydro (Birtley Engineering, 1976a). Blended portions of both raw and washed coal from the test lots received by Birtley were subsequently forwarded to the Canadian Combustion Research Laboratory of the Canadian Centre for Mineral and Energy Technology (CANMET), Department of Energy, Mines and Resources (EMR) at Ottawa. Various pilot scale burn tests were undertaken at this laboratory (CANMET, 1976).

During the summer of 1977, two large trenches, A and B, were excavated by B.C. Hydro to obtain bulk samples for burn tests and for washability tests; the locations of these trenches are shown on Figure 1-1. A bulk sample of 6350 tonnes was shipped to the Battle River plant of Alberta Power Ltd. where burn tests were undertaken between August 5 and August 31, 1977. Details of the excavation, the handling procedures, etc., have been reported by B.C. Hydro personnel, and the "Burn Test" results have been documented (B.C. Hydro, 1978a). A summary of the bulk sample analyses and general furnace behaviour is included in Section 5 of this volume. Bulk sample lots were also excavated from two localities in Trench A for washability tests done at Warnock-Hersey Professional Services Ltd. in Calgary. These samples, designated as X and Y, each consisted of approximately five tonnes which were put through a Bradford Breaker and collected in sealed 45 gallon drums for shipment. Equivalent samples of approximately 72 tonnes were taken for washability tests at the EMR test facility at Edmonton. Another bulk sample (Z sample) of some 12 tonnes was collected from Trench B and sent to Warnock-Hersey for washability tests. All of these tests have been separately reported to B.C. Hydro and Power Authority (Warnock-Hersey, 1977a, b, c; CANMET, 1978).

123 TOPOGRAPHIC SURVEYS AND MAPS

Essential surveying was done during 1974, 1975, and 1976 to provide adequate topographic maps and control grids. These surveys were based on aerial photographs taken during the summer of 1975, after elevation control traverses had been run from a Dominion Government geodetic bench mark at Carquile, near the junction of Highways 12 and 97. Additional ground control surveys were done in October 1976 by McElhanney Surveying and Engineering Ltd. Following this revised control survey, all drill hole collars were resurveyed for improved accuracy. CMJV produced interim metric topographic maps for the current study through a combination of photographic reproduction and manual drafting techniques. Metric scale Universal Transverse Mercator (UTM) grid topographic maps were not available for the 1977 mine planning studies. Although B.C. Hydro has now produced digitized metric topographic maps at various scales based on the UTM grid, the interim metric scale maps used for most of CMJV's mine plans incorporate the earlier Dolmage, Campbell grid, with adjusted metric values for coordinates and section lines. Imperial measurement coordinates were converted to metric values using a multiplication factor of 0.3048, and the addition of 20.8 metres and 8.8 metres, respectively, to the latitude and departure values. The latter adjustments achieved reference values of 24 100 N and 5800 E for the previous Imperial measurements of 79 000 N and 19 000 E. The section lines on the current CMJV geological plans and sections are designated by letters H to Z, with O omitted, and with section line Q also labelled at the reference values of 24 100 N, and with departure section 18 also denoted as 5800 E. The general geology map (Figure 2-2 of Section 2) is based on the UTM grid, but also shows reference section lines Q and 18 of the Dolmage, Campbell grid.

124 GEOPHYSICAL SURVEYS

Various types of geophysical surveys have been performed on the Hat Creek property since 1974, with varying degrees of success. Those used by CMJV were:

(a) Ground magnetometer surveys which determined gross outlines of "baked zones" containing baked claystone and clinker-like rocks. These zones were previously interpreted as pockets of burned coal. Figure 2-15 in Section 2.5 shows the location and outline of the known baked zones as indicated by appreciably higher magnetic readings. This is attributed to the presence of magnetite produced by thermal metamorphism of claystone strata. Section 2.5 of this volume describes other physical aspects of these baked zones.

(b) Gravity surveys which outlined the extent of the low gravity coal-bearing formation by the distinct negative gravity anomaly.

(c) Down-the-hole geophysical surveys (i.e., electro-logs) carried out whenever possible since the start of the 1974 drilling program. Electro-log records are available for more than 90% of post-1974 drillhole footage. Natural gamma and side-wall density logs are the combination generally used at Hat Creek, because these are the most definitive. During the 1976 and 1977/78 drilling programs, occasional stable holes were logged with a focussed beam resistivity tool. This type of survey requires an open, stable hole condition which is only rarely encountered at Hat Creek. To avoid caving and squeezing conditions, most holes were logged through surface casing and the wire-line drill rods.

1.3 SUMMARY OF GEOLOGICAL AND ANALYTICAL DATA AVAILABLE

The vast amount of geological and analytical data available for this study can only be summarized to indicate their scope. The types of data and their general adequacy are as follows:

(a) Dolmage, Campbell's descriptive geological logs for all diamond drill holes drilled in 1957 and subsequent years.

Some lithological names were incorrectly used, e.g. "shale" rather than claystone or mudstone. The records of missing or "short" core are often inadequate. Sample analytical records do not accompany the lithological descriptions.

(b) Geophysical logs for the majority of holes drilled in and since 1974.

Gama ray-density logs at 1 inch: 20 feet and 1 inch: 40 feet linear scale were available for the 1974, 1975, and 1976 holes. The same geophysical log combinations were done for the 1977/78 drill holes at 1:250 metric linear scale and were reduced to 1:500 for convenience in handling. A few "focused beam" resistivity logs were done for stable, open holes in 1976 and in the 1977/78 program, but these were seldom used. The gamma ray-sidewall densilog combination logs were invaluable for recognition and correlation of the coal zones, parting markers for the sub-zones, repetition of or loss of section due to faulting, etc.

(c) Dolmage, Campbell geological sections at 1 inch : 200 feet for 17 cross-sections from 74 500 N to 83 500 N, and 14 longitudinal sections from 23 000 E to 16 500 E.

These provided the initial means of studying the coal zone correlations and general structure.

(d) Proximate analyses data (dry basis) in the form of B.C. Hydro's computer "printouts" of sample intervals for contents of ash, volatile matter, sulphur, moisture (as received), and calorific value.

These were the basic proximate quality variables input to CMJV's geological data file. The fixed carbon content was also listed in the original B.C. Hydro printouts. Proximate analyses provided by the 1977/78 drilling program were ash, moisture, and sulphur contents and calorific value.

(e) Ultimate analyses, ash analyses, and special test results.

These data were listed in the same initial B.C. Hydro computer printout file as the proximate variables. Composite samples had been tested for a few 1974 and 1975 diamond drill holes, but most data are from the 1976 diamond drill holes. Because of the generally adequate prior coverage of No. 1 Deposit, no additional ultimate analyses were done on samples from the 1977/78 drilling program.

Further discussion of proximate, ultimate, and ash analyses and the special test is provided in Section 5. Examples of B.C. Hydro's computer printouts of various analyses for samples from DDH. 76-135 and 136 are also provided.

(f) The B.C. Hydro geological cross-sections previously discussed were available after March 1978.

SECTION 2

REGIONAL AND LOCAL GEOLOGY

2.1 GEOLOGICAL SETTING

The Hat Creek coal basin occurs in a topographic and structural depression in the Upper Hat Creek Valley. Coal measures and intercalated sediments of considerable thickness in a sequence of Tertiary sediments and volcanics were deposited in a sedimentary basin formed by faulting. This basin, or graben structure, was created by downfaulting of a central panel along the steep east and west boundary faults. Thus the younger rocks of the Hat Creek basin on the lower slopes and valley floor are separated by faults from the older formations on the ridges. Coal occurs in two deposits within the basin: the No. 1 Deposit, the subject of this feasibility study, lies near the north end of the basin, and the No. 2 Deposit occurs some 5 kilometres to the south. Sediments within the basin have been divided into three formations. The Coldwater (lower) and Medicine Creek (upper) formations are predominantly detrital sediments, whereas the Hat Creek Coal Formation (central) comprises coal with lenses and interbeds of claystone, siltstone, and sandstone. Alternating layers of coal and clastic debris characterize the sedimentary style of the upper portion of the coal formation while the lower portion contains somewhat cleaner coal with fewer partings. Bedrock in the area is masked by a thick mantle of till on the west side of the valley, and by glaciofluvial material on the east.

The stratigraphic sequence of the geological formations in the Hat Creek area is shown on Figure 2-1, with subdivisions and nomenclature based on a report by the B.C. Department of Mines and Petroleum Resources (Church, 1975). The general geology of the area, Figure 2-2, is based on a map by B.C. Hydro.

Coal in the No. 1 Deposit occurs in two synclines; the axial portion of the intervening anticline has been removed by faulting.

The northerly-trending boundary faults appear as lineaments on aerial photographs and have been confirmed by geophysical surveys by Dolmage, Campbell. Three additional faults appear to off-set these two as shown on Figure 2-2.

FIGURE 2-1

Stratigraphic Sequence of Geological Formations
Hat Creek Area

	KAMLOOPS GROUP	OLIVINE BASALT (Possibly Miocene)	Minor outliers.
EOCENE	KAMLOOPS GROUP	FINNEY LAKE FORMATION Approximate thickness 290 metres	Andesite and dacite flows and coarsely bedded volcaniclastics (lahar) with interbedded sandstone, and conglomerate.
EOCENE	KAMLOOPS GROUP	---------UNCONFORMITY---------	
EOCENE	KAMLOOPS GROUP	MEDICINE CREEK FORMATION Thickness +500 metres	Blue grey claystone, siltstone, vaguely bedded lacustrine deposits, highly bentonitic.
EOCENE	KAMLOOPS GROUP	HAT CREEK COAL FORMATION Thickness 450-500 metres	Coal bearing zones A, B, C, and D containing varied proportions of interbedded claystone, siltstone, minor sandstone, and grit.
EOCENE	KAMLOOPS GROUP	COLDWATER FORMATION Thickness +500 metres	Interbedded sandstone, siltstone, conglomerate; minor lenses of shaly coal. (The Footwall Detrital Rocks.)
		------- UNCONFORMITY AND/OR FAULT CONTACT -------	
CRETACEOUS	BASEMENT ROCKS	SPENCES BRIDGE GROUP	Andesite, rhyolite, basalt, dacite flows.
CRETACEOUS	BASEMENT ROCKS	MOUNT MARTLEY INTRUSIVE	Granodiorite.
PERMIAN	BASEMENT ROCKS	CACHE CREEK GROUP	
PERMIAN	BASEMENT ROCKS	MARBLE CANYON FORMATION	Limestone, marble.
PERMIAN	BASEMENT ROCKS	GREENSTONE MEMBER	Greenstone, chert, phyllite.

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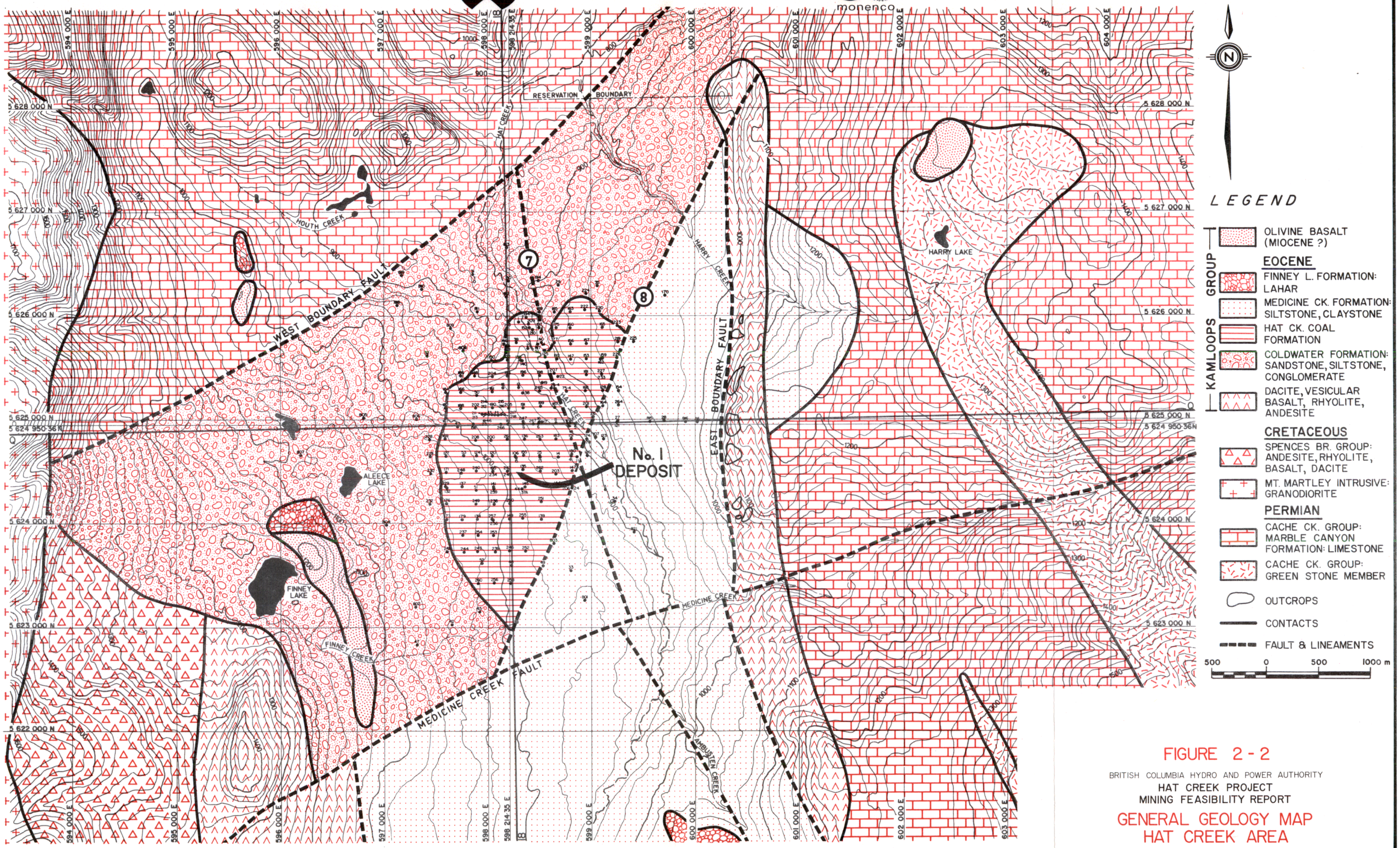

FIGURE 2 - 2

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY
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GENERAL GEOLOGY MAP
HAT CREEK AREA

Full size 1:1500 scale geological sections have been drafted by CMJV to show the interpreted structure and stratigraphic subdivisions of No. 1 Deposit. Fourteen cross-sections (H to W inclusive, omitting O) were prepared, as well as longitudinal section 19. Selected geological cross-sections are provided on Figures 2-3 to 2-8, inclusive, and Figure 3-11 of Section 3. Examples of B.C. Hydro's geological sections are included in this report as well, and are shown on Figures BCH-1 and BCH-2 following Figure 2-8.

The presence of undulating slide surfaces is shown on Sections T and V, Figures 2-7 and 2-8, respectively. These have been interpreted from drill log descriptions of mixed detrital rocks (with poor core recovery) and "disturbed or rubbly" claystone that often contains large boulders of granodiorite and volcanic rocks, as well as biotite-rich sand derived from weathering of granodiorite. Local lenses or isolated blocks of weathered coal are also reported in these mixed detrital rocks, for example, in DDH. 76-171 (Section T, Figure 2-7). In DDH. 77-230, also shown on Section T, weathered granodiorite boulders and altered basalt (boulders) are described as unconformable on baked siltstone and mixed detritals that are possibly of the Coldwater Formation. These interpreted slide zones are considered similar to others described by Golder Associates (1978).

Outcrops of the Basement Rocks occur in the region but are separated from the Kamloops Group by the boundary faults. To the northwest and north, the Marble Canyon limestones are in fault contact with the Tertiary rocks of Upper Hat Creek Valley. Spences Bridge Group volcanics outcrop along the wooded lower slopes of the Clear Range, southwest of Finney Lake. The Mount Martley Intrusive flanks the northwest corner of Upper Hat Creek Valley, some 3500 metres west of No. 1 Deposit.

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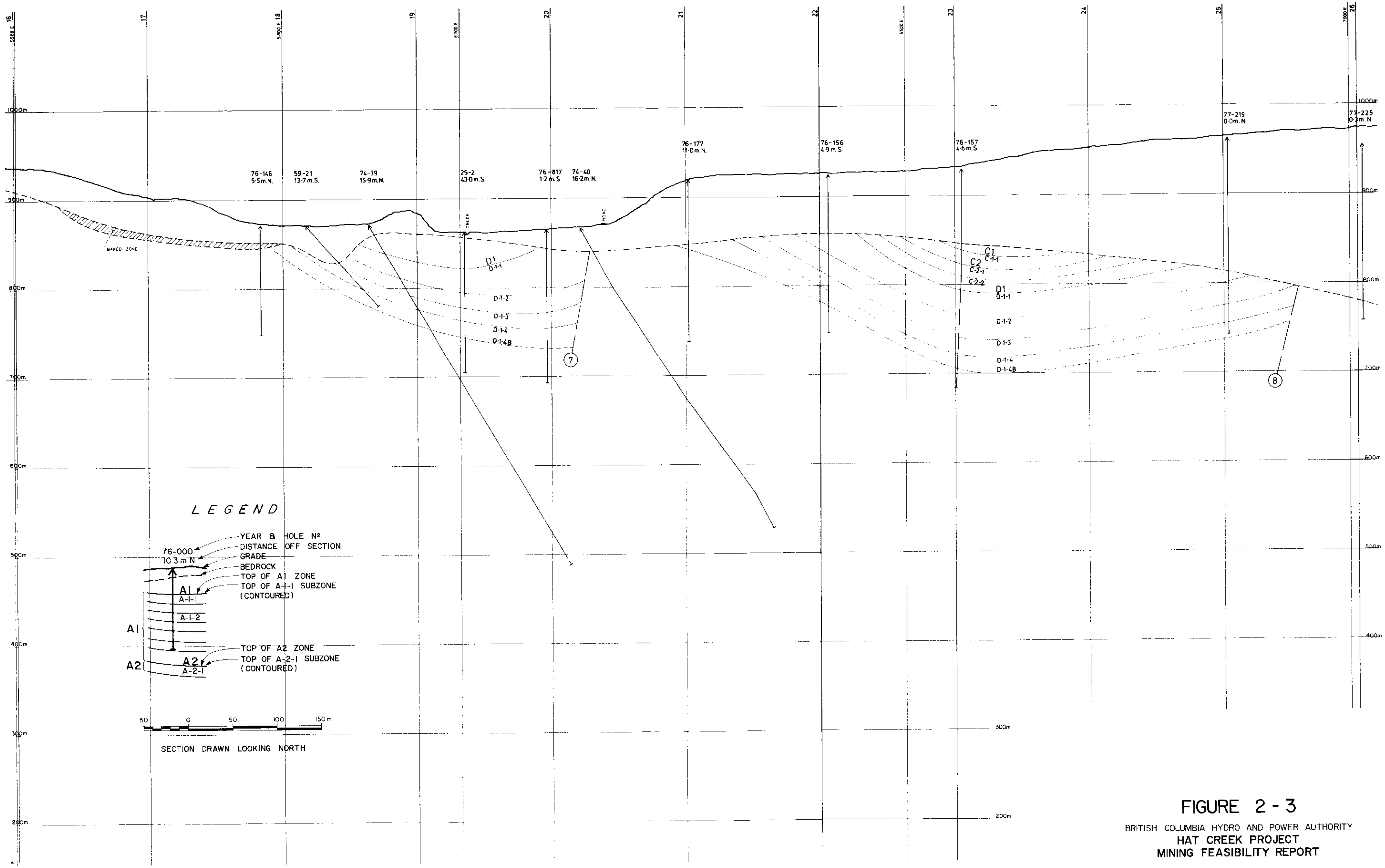

FIGURE 2 - 3

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY
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SECTION K

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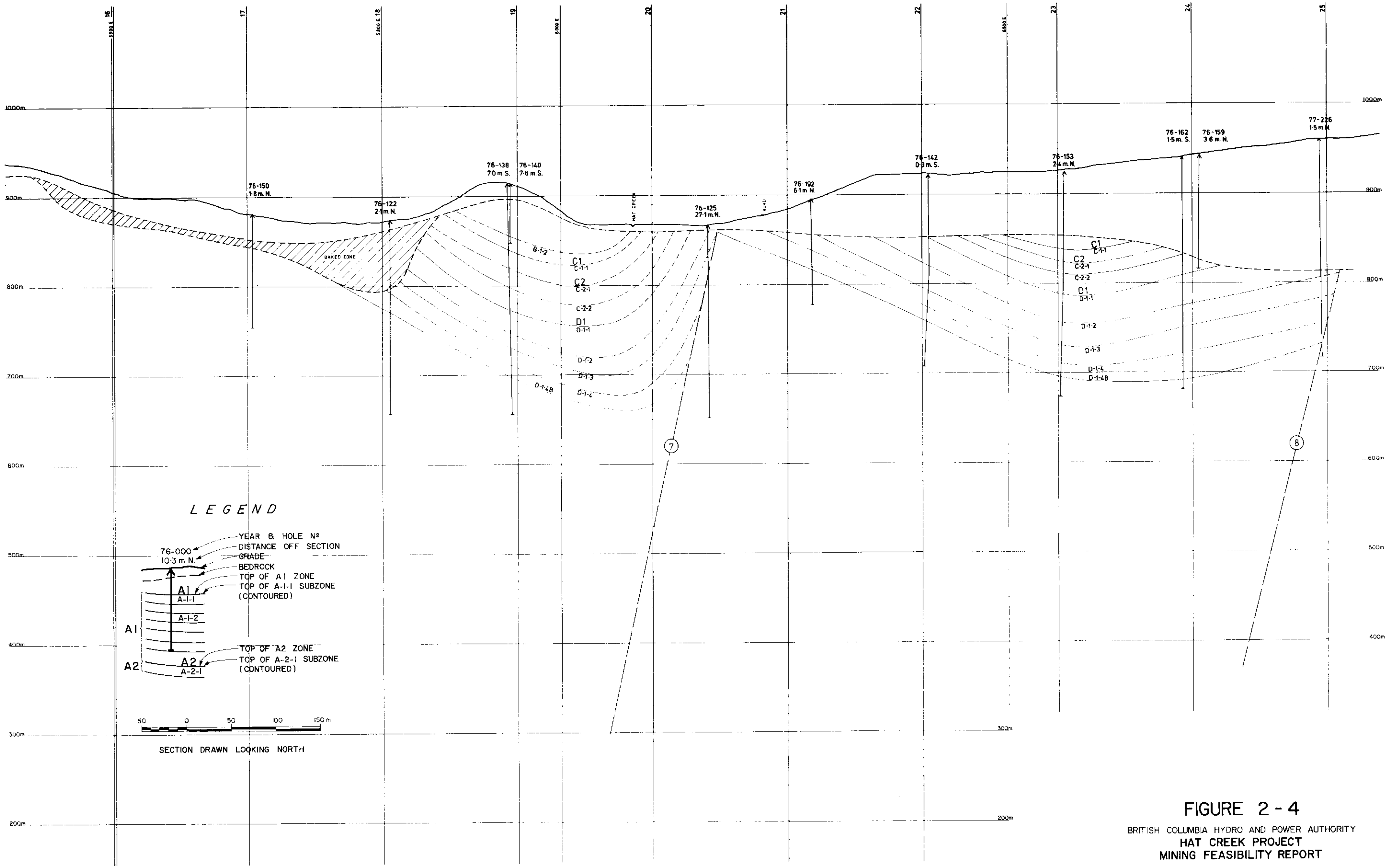

FIGURE 2 - 4

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY
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SECTION L

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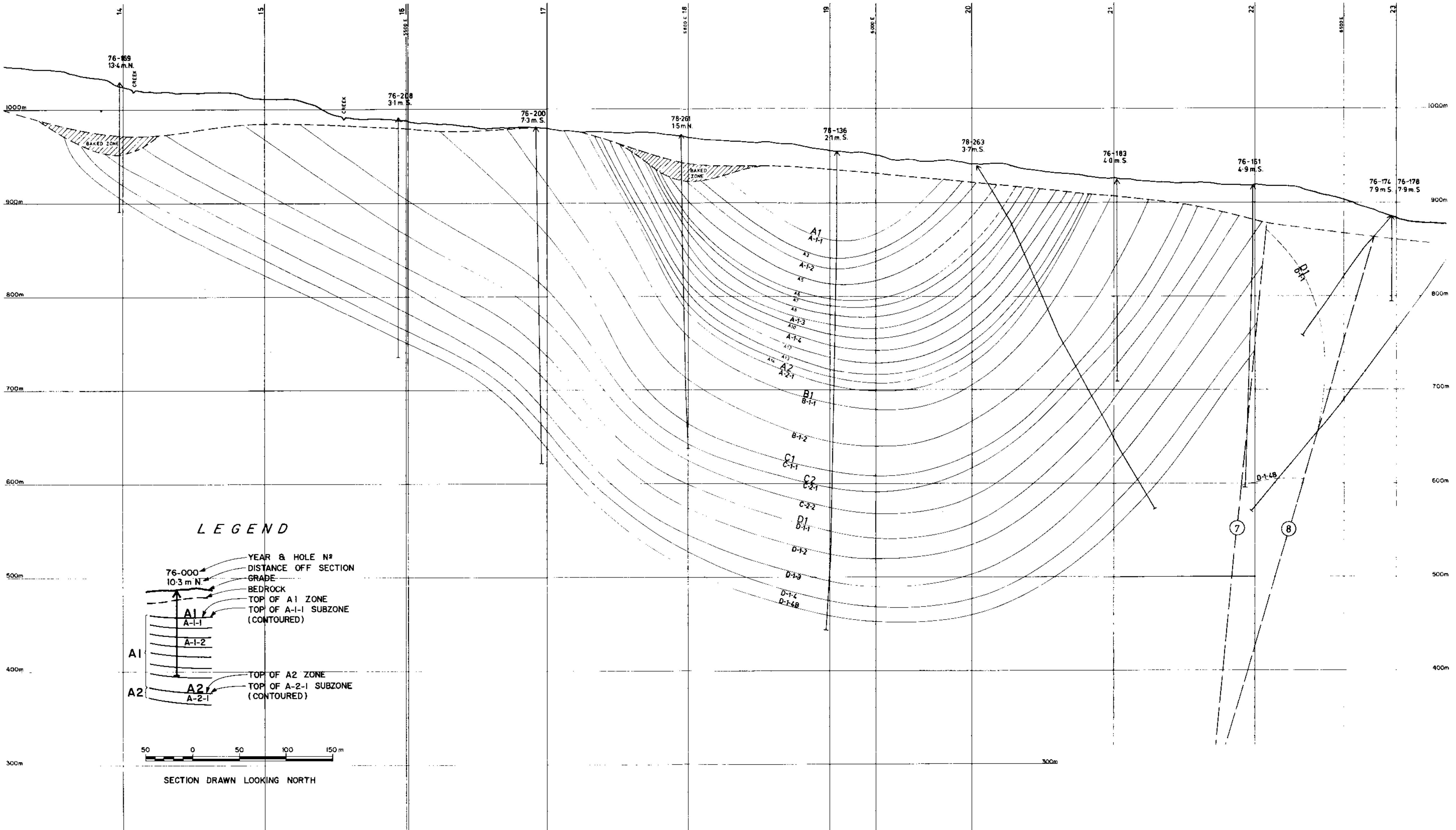

FIGURE 2 - 5

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY
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SECTION R

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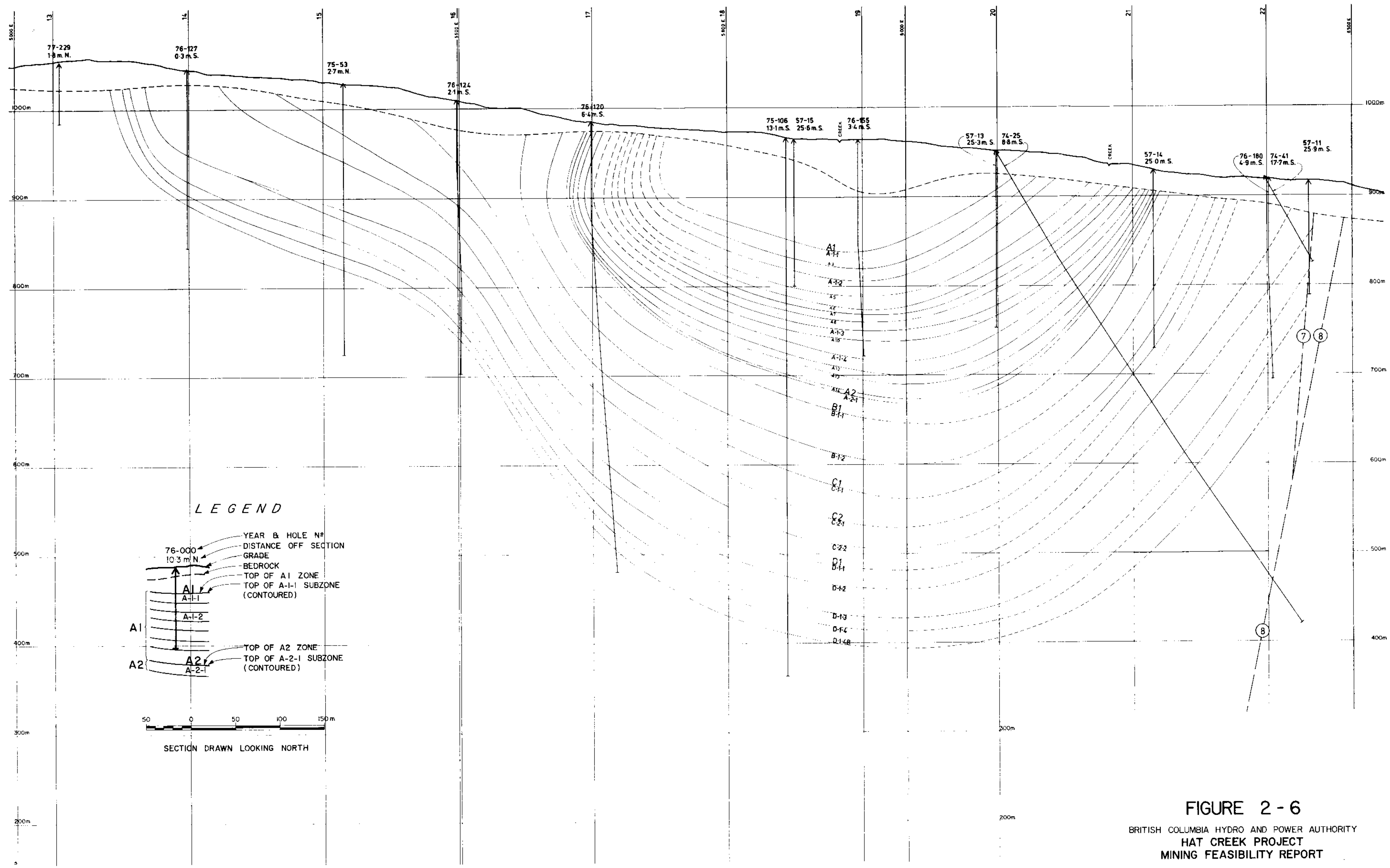

FIGURE 2 - 6

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY
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SECTION S

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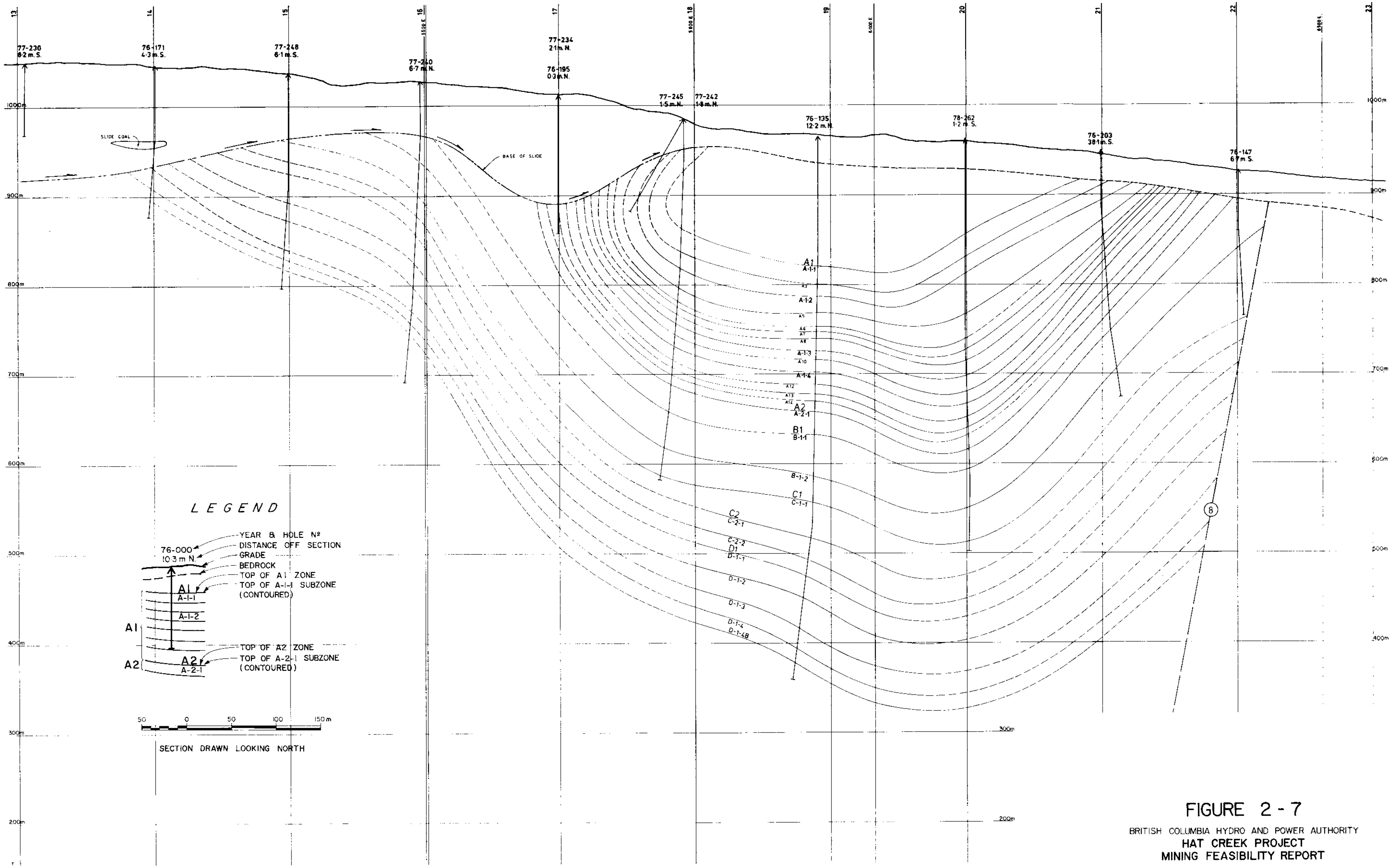

FIGURE 2 - 7

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY
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SECTION T

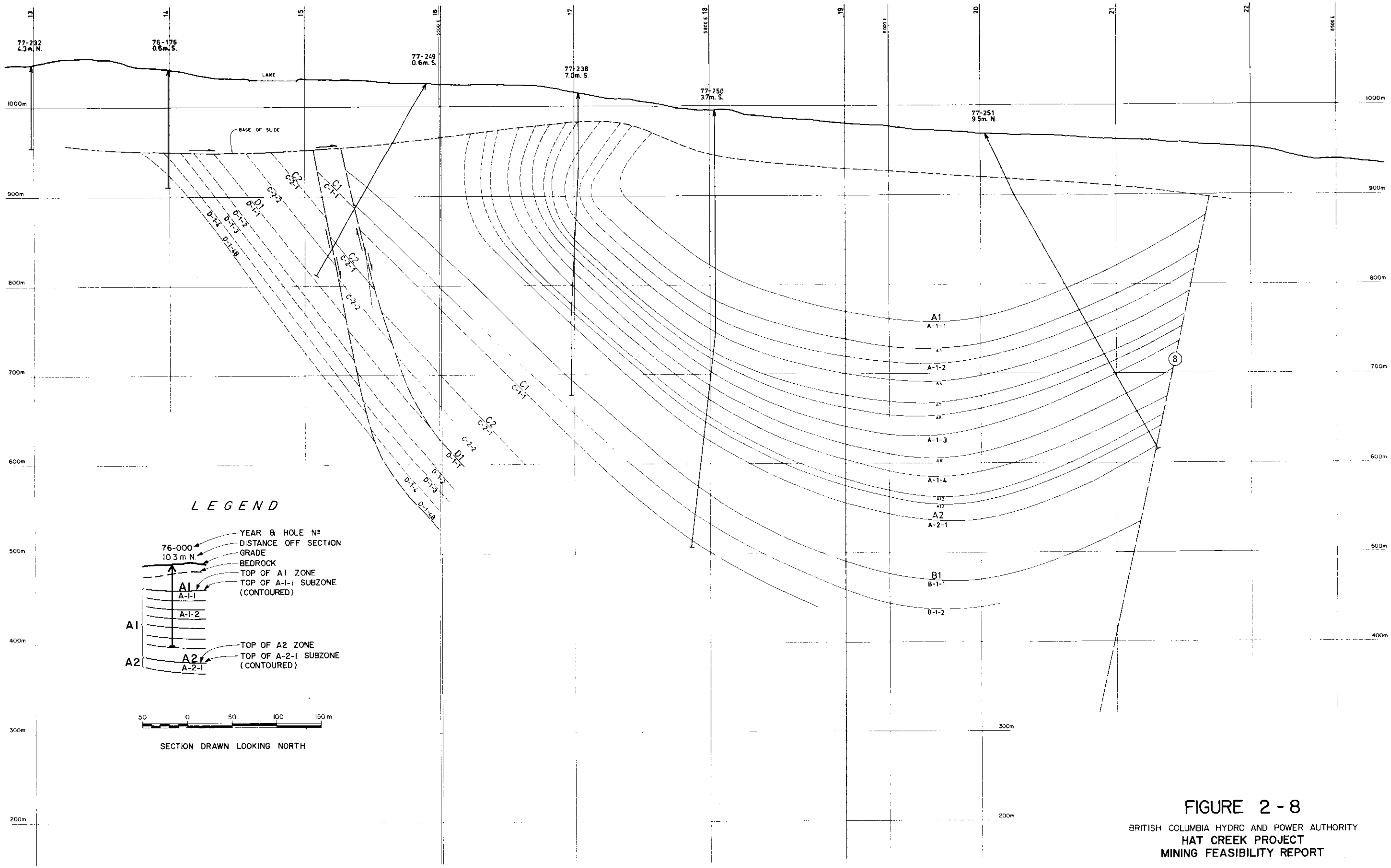

FIGURE 2 - 8

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY
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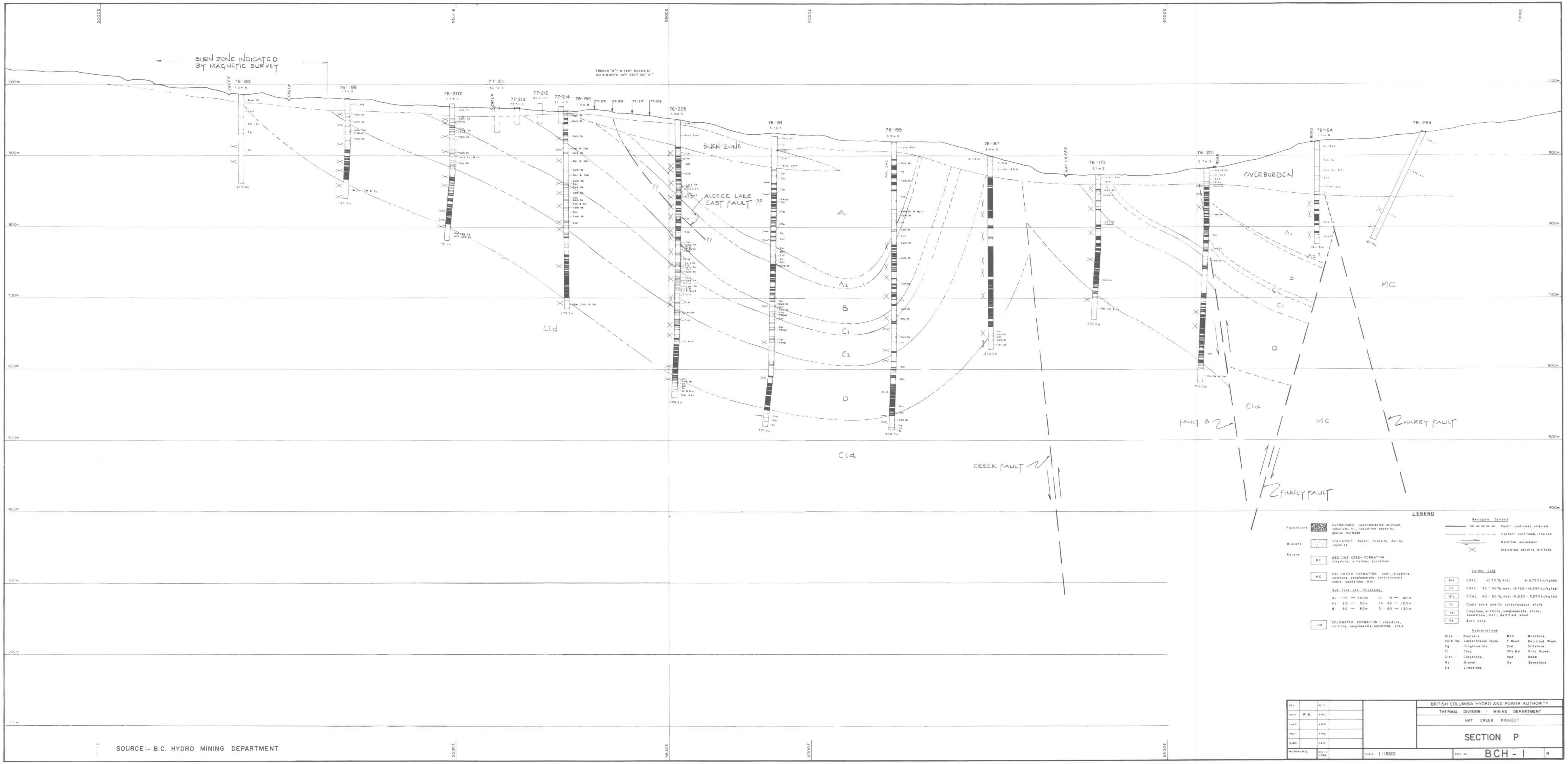
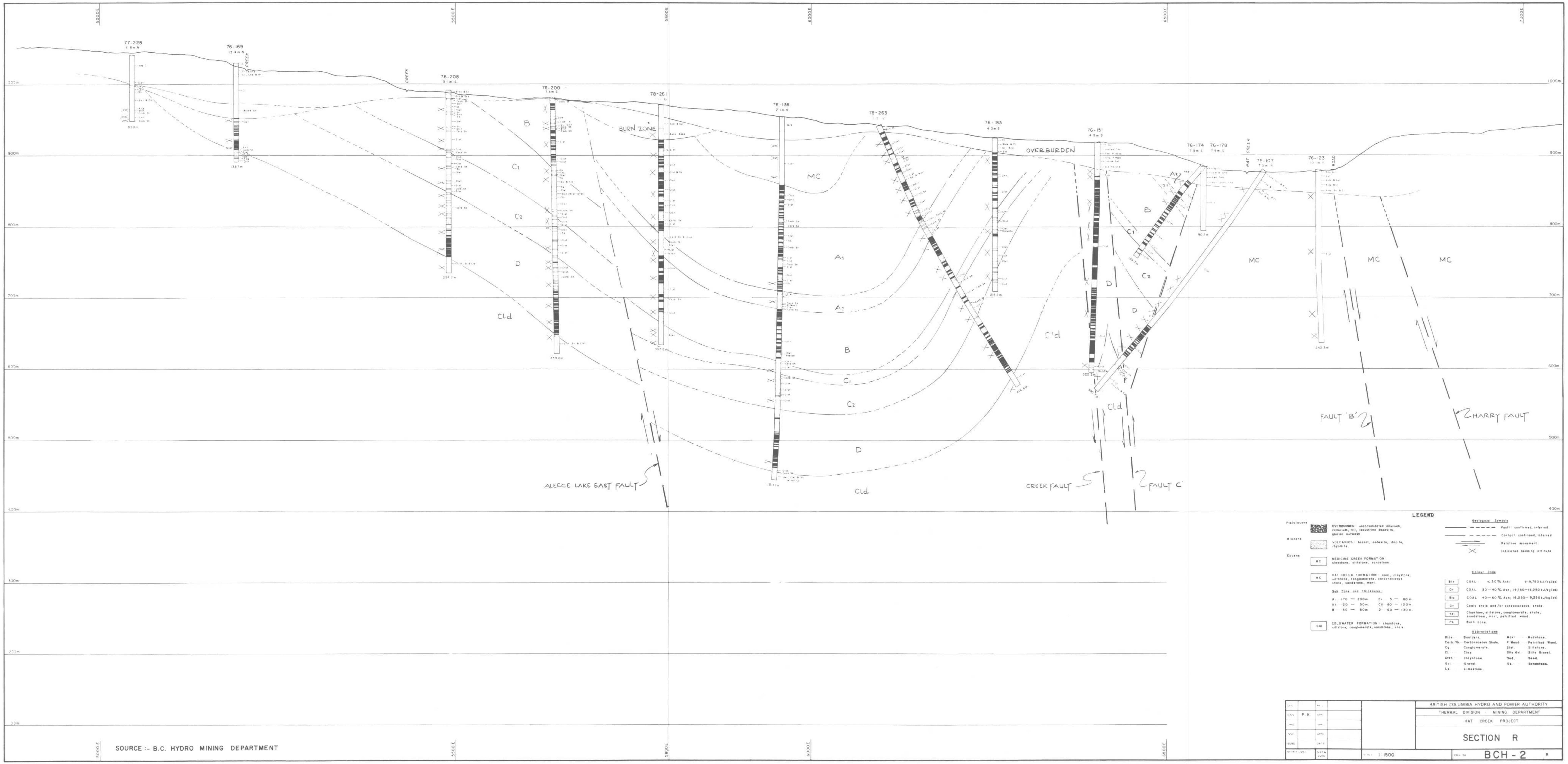
SECTION V



SOURCE:- B.C. HYDRO MINING DEPARTMENT


77-228
76-169
76-208
76-200
78-261
76-136
78-263
76-183
76-151
76-174
76-178
75-107
76-123
CREEK
ROAD
HAT CREEK
BURN ZONE
OVERBURDEN
B
C1
C2
D
MC
A1
A2
Cld
FAULT 'B'
HARRY FAULT
ALEECE LAKE EAST FAULT
CREEK FAULT
FAULT 'C'
900m
800m
700m
600m
500m
400m
LEGEND
Pleistocene
OVERBURDEN: unconsolidated alluvium, colluvium, fill, lacustrine deposits, glacial outwash
Miocene
VOLCANICS: basalt, andesite, dacite, rhyolite.
Eocene
MC MEDICINE CREEK FORMATION: claystone, siltstone, sandstone.
HC HAT CREEK FORMATION: coal, claystone, siltstone, conglomerate, carbonaceous shale, sandstone, marl.
Sub Zone and Thickness:
A1 170 — 200m C1 5 — 80m
A2 20 — 50m C2 60 — 120m
B 50 — 80m D 60 — 130m
Cld COLDWATER FORMATION: claystone, siltstone, conglomerate, sandstone, shale.
Geological Symbols
Fault confirmed, inferred
Contact confirmed, inferred
Relative movement
Indicated bedding attitude
Colour Code
Blk COAL: < 30 % Ash; +19,750 kJ/kg (db)
Or COAL: 30 — 40 % Ash; 19,750 — 16,250 kJ/kg (db)
Blu COAL: 40 — 60 % Ash; 16,250 — 9,250 kJ/kg (db)
Gr Coaly shale and/or carbonaceous shale.
Yel Claystone, siltstone, conglomerate, shale, sandstone, marl, petrified wood.
Pk Burn zone.
Abbreviations
Blds. Boulders.
Carb. Sh. Carbonaceous Shale.
Cg. Conglomerate.
Cl. Clay.
Clst. Claystone.
Gvl. Gravel.
Ls. Limestone.
Mdst. Mudstone.
P. Wood. Petrified Wood.
Slst. Siltstone.
Slty Gvl. Silty Gravel.
Sd. Sand.
Ss. Sandstone.
SOURCE :- B.C. HYDRO MINING DEPARTMENT
BRITISH COLUMBIA HYDRO AND POWER AUTHORITY
THERMAL DIVISION MINING DEPARTMENT
HAT CREEK PROJECT
SECTION R
DWN P.K
1:1500
BCH-2 R

2.2 GEOLOGICAL STRUCTURE OF NO. 1 DEPOSIT

221 MAJOR STRUCTURES

No. 1 Deposit is confined within two fault-modified synclines with only sparse evidence of an eroded, compressed or faulted, medial anticline. No. 7 fault was interpreted by CMJV as a strike-slip fault which dislocates the two synclines; it is shown on the CMJV cross-sections as parallel in strike and dip to the steep east limb of the main syncline, i.e., a bedding plane fault within the coal formation along this steep, east limb. An alternate interpretation has been developed by B.C. Hydro geologists, principally from re-interpretation of the No. 7 fault structure as related to footwall type detritals occurring above faulted D-Zone coal in DDH. 76-197, Section J (not included in this report). The revised interpretation of this fault is shown on Section P, Figure BCH-1. This alternate interpretation appears to be valid at this location; it should be confirmed elsewhere along the strike, however, because although it does not cause any appreciable change in mineable reserves, it could have some affect on geotechnical consideratons for interim pit walls and faces.

No. 8 fault is interpreted by CMJV as a high angle reverse fault whose location has been approximately determined from a few scattered drill holes. The presence of deep coal east of No. 8 fault is indicated in DDH. 74-26 and DDH. 76-126, and also by negative gravity anomalies in this region. The identification of the coal occurrences east of No. 8 fault is uncertain at this time. Two additional faults are inferred in this region by B.C. Hydro geologists, as depicted on their Section R, Figure BCH-2.

Although no coal reserves are included east of No. 8 fault the possibility of fault zones here may also affect geotechnical considerations near this eastern edge of the proposed pit, where very weak rocks are to be expected in any case.

The configuration of the synclines and the general northerly trend of the synclinal axes are shown by zone contours and in sub-crop outlines on Figures 2-13 and 2-14, respectively, which are included in the following section on coal sub-zones. The contrast in dip of the western and eastern limbs of the main syncline is evident on Sections L and R, Figures 2-4 and 2-5, respectively.

The east limb of this main syncline appears to have undergone a drag effect and to have been oversteepened by No. 7 fault. The main syncline plunges southerly at an average of 17°. The smaller, eastern syncline plunges at about 12° to the south and is truncated by No. 8 fault so that south of Section M, the structure is a homocline dipping easterly at 23 to 40° (see Figure 2-13).

Coal petrologists of the Institute of Sedimentary and Petroleum Geology at Calgary, Alberta (Geological Survey of Canada, 1978) have concluded that the main syncline was developed as an early structure, and that coalification is indicated to be mainly post-folding. This unexpected conclusion is based on petrographic determinations of vitrinite reflectance values and related rank plots of Hat Creek coal samples from drill cores. The CMJV geologists consider that this conclusion needs further studies before it can be unequivocally accepted, but it may indicate that the present synclinal structures were formed early, in separate structural troughs in which progressive subsidence was concomitant with peat accumulation and cyclic deposition of argillic sediments.

222 SUBSIDIARY FAULTS AND FOLDS

The present study has resulted in interpretation of two minor faults towards the southern edge of the deposit as shown on Section V, Figure 2-8, and Section W (not included in this report). These are considered to be growth faults merging into the stratification. Minor faults and folds have also been identified from the Trench A exposure and from the short adits driven westerly from the west bank of Hat Creek in 1924. It is significant that in 35 metres of advance, Adit No. 2 (see Figure 1-1) transected two minor synclinal folds separated by a fault dislocated anticline. Undoubtedly the general structure interpreted at present for No. 1 Deposit is oversimplified, but this is probably the most practical approach in a broad interpretation based almost wholly on drill hole correlations (geological logs and electrologs).

Both reverse and normal type displacements were indicated on minor faults mapped in Trench A. A series of closely-spaced step faults were noted in C-1* detrital rocks that are exposed

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* Sub-zones within the four major coal-bearing zones of the Hat Creek Coal Formation referred to in this discussion are described in more detail in Sections 2.3 and 2.4.

below B coal zone. These westerly dipping minor faults with apparent normal displacement were described as strike-slip faults with the western block having moved northward relative to the eastern block. The minor faults mapped as thrusts are more complex in that changes in strike and/or dip are apparent within short distances.

An overturned fold is depicted in A-1 coal zone on Sections S, T, U, V, and W. This is interpreted from overturned, repeated sections of A-1 in several drill holes, varying from inverted mirror images to partial duplications as interpreted via the electrologs. Both the general bedding angles in core and the coal analyses lend additional confirmation of the overturned repetitions. The structural style represented is totally different from that of the rest of the deposit; this type of folding is considered to be the result of plastic deformation of weakly lithified, interbedded coal and argillic sediments. The axis of the overturn may be just below a now-eroded, nearly horizontal thrust, with eastward directed movement of the upper plate. Differential compaction and slump dislocations are considered to have been sedimentation-allied processes that probably occurred at various times along the western margin of the deposit. In this region, fluctuations in bottom slope, velocity, and sediment load of near-shore currents have resulted in a "shelf" marginal zone where a variety of primary sedimentary structures are to be expected, as well as minor folds and growth type faults typical of "soft sediment deformation".

2.3 COAL ZONES

The No. 1 Deposit was divided initially by Dolmage, Campbell and Associates (DCA, 1977) into four broad coal zones - A, B, C, and D; two predominantly waste zones, one at the base of A and another at the top of C-Zone, were distinguished by CMJV from the better quality coal zones, and designated A-2 and C-1, respectively. These stratigraphic zones are distinguishable by their distinctive profiles on electrologs and by their varied lithology noted in drill core. Figure 2-5 shows the broad zones A-1, A-2, B-1, C-1, C-2, and D-1, as well as the quality sub-zones subsequently established by CMJV (see Section 2.4). General lithological descriptions of the zones are as follows:

A-Zone (A-1) consists of up to 170 metres of coal seams and interbedded claystone and carbonaceous mudstone, with minor siltstone and sandstone. Partings comprise up to 25 % of the total section in beds varying in depth from a few centimetres to 6 metres. The contact with strata of the overlying Medicine Creek Formation is sharp and represents an abrupt change in sedimentation from a homogenous, vaguely bedded lacustrine claystone sequence to cyclic sequences of carbonaceous material and claystone-mudstone. Most of the coal in A-1 is of better quality, but is significantly diluted by the interbedded claystone, mudstone partings.

A-2 Zone, in the basal part of A-Zone, consists mainly of light olive grey claystone with thin interbeds of carbonaceous mudstone and "shaly coal". The "shaly coal" interbeds are typically up to 3 metres of carbonaceous material with an ash content of about 60% and an average calorific value of 4000 Btu/lb. This zone varies from 9 to 24 metres in thickness; the thinnest spots occur in the east limb of the main syncline, and possibly represent deformational thinning in this region. A-2 Zone thickens towards the southwestern margin of the deposit. This is predominantly a rock unit and throughout the deposit, presents a distinctive profile on electrologs.

B-Zone is a layer about 75 metres deep containing better quality coal with generally minor claystone or siltstone partings; towards the western and southwest flanks of the main syncline, however, there is an obvious gradational increase in the number and thickness of claystone interbeds. The ranges of calorific values shown on Section P. Figure 3-11 of Section 3, illustrate the east to west "shale-out" effect in B and C zones. Bulk sample Trench A is located in this western fringe area, and the quality here is reduced because of increased ash content. B-Zone coal often contains bands of resin "beads".

C-1 Zone, the upper portion of C-Zone, is predominantly a "waste" to low-grade coal unit, i.e., with an average calorific value of less than 4000 Btu/lb, in the central portion of the main syncline and in its western limb. Thin lenses of muddy coal are interspersed with beds of clay-rich materials, sandy claystone to bentonitic sandstone, and minor grit and pebble conglomerate. The thickness of C-1 varies from 10 to 30 metres. In the steep east limb of the main syncline, C-1 Zone contains thicker lenses of better quality coal (>4000 Btu/lb) and contributes to the planned boiler feed. This is also true in the East Bench area between No. 7 and No. 8 faults, where all of C-1 and C-2 zones are well above the cut-off grade of 4000 Btu/lb.

C-2 Zone consists of lenticular coal seams of variable thickness, interbedded with lenticular and wedge beds of siltstone to coarse sandstone, grit, and pebble conglomerate. Thickness varies from 30 to 60 metres. C-2 Zone manifests an obvious western shale-out fringe, with pronounced thickening of detrital rock units and corresponding thinning of the coal sequences. The content of lenses of siderite and petrified wood is noticeably higher in C-2 Zone; limestone lenses and calcareous concretions are also evident. These occurrences suggest that some of the detrital wedges are at least partly of marine origin.

D-Zone contains the most consistent better quality coal of the entire deposit, usually with an average calorific value greater than 8000 Btu/lb. It varies from 60 metres to slightly over 100 metres in thickness, with a gradual westward thinning evident in the western limb of the main syncline. The upper "leaf" of D is missing in this region (Section S, Figure 2-6) as evidenced on the geophysical logs, and C-Zone detritals consequently overlie a diminished D. This may be due to erosion of the upper part of D, or alternatively, to non-deposition. D-Zone contains a few partings up to two-thirds metre thick, and several thin (10 cm), light-coloured ash beds are commonly present. Broadly banded zones of resin beads are characteristic. The D-Zone coal is distinctively blocky, with a generally bright lustre and conchoidal fracture.

2.4 COAL SUB-ZONES

From the six stratigraphic coal zones described in the previous section, further divisions of sub-zones as shown on Table 2-1 were made by CMJV to improve local coal quality definitions.

The four sub-zones in A-1 coal zone are defined by the tops of the three most continuous partings in the zone. The parting markers are A-4, A-9, and A-11 as labelled on the included sample geophysical log (Figure 2-9) for DDH. 76-136. Characteristic gamma ray and density log peaks are used to identify these marker horizons throughout most of the deposit. The basic principle is that the geophysical logs reflect the varied coal zone lithologies and provide a means of sub-zone correlation between drill holes that is better than interpretation of available descriptive logs or analytical data. Gamma ray log peaks essentially reflect claystone interbeds (partings) with relatively high radioactive K ion content. The corresponding density log peak is the result of the increase in density of rock versus coal or coaly material.

Two sub-divisions of B-1 Zone are based on sub-zones of nearly equal thickness that are identifiable on geophysical logs. C-2 coal zone is divided into two sub-zones that are also identified and correlated via geophysical logs. C-2 often contains lenticular waste partings of substantial thickness but of limited continuity. D-1 coal zone is sub-divided into four quality sub-zones to provide narrower units of generally better quality coal, with calorific value >8000 Btu/lb. These D sub-zones are also distinguished and correlated via the geophysical logs.

In the western limb of the main syncline, Zones B-1 and C-2 exhibit a marked increase in shale content. Some of the seams and partings used as marker beds in this region are impossible to identify; separate sub-zones are projected as approximate correlations in order to provide continuity of structural surfaces that control quality trending in the subsequent computer modelling process.

Structural contour plans are drawn for the top of each parting which identify the respective sub-zone surfaces. Figures 2-10, 2-11, and 2-12 are the contour plans for the tops of A-1-1, A-2-1, and B-1-1 sub-zones, and Figure 2-13 shows the contours for the base of sub-zone D-1-4. Figure 2-14 similarly represents

TABLE 2-1

Development of Stratigraphic Sub-Divisions
in No. 1 Coal Deposit
Hat Creek Project Mining Feasibility Report 1978

STAGE 1 (Dolmage, Campbell) 1976	STAGE 2 (CMJV) 1977	STAGE 3 (CMJV) 1977, 78
A	A-1	A-1-1 Sub-zone
		A-1-2 Sub-zone
		A-1-3 Sub-zone
		A-1-4 Sub-zone
	A-2	A-2-1 (generally waste)
B	B-1	B-1-1 Sub-zone
		B-1-2 Sub-zone
C	C-1	C-1-1 (waste and variable grade coal)
	C-2	C-2-1 Sub-zone
		C-2-2 Sub-zone
D	D-1	D-1-1 Sub-zone
		D-1-2 Sub-zone
		D-1-3 Sub-zone
		D-1-4 Sub-zone
Four broad coal zones	Designation of two waste zones, A-2 and C-1	

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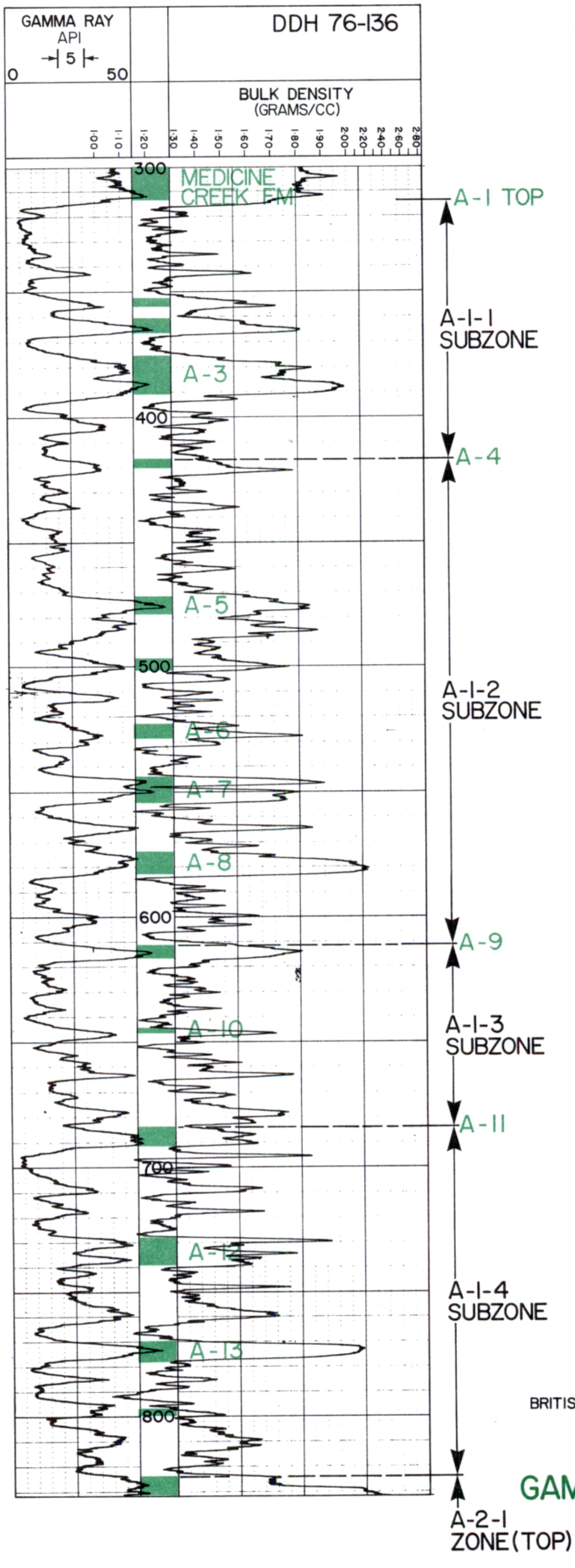

NOTES.

GAMMA RAY-DENSITY LOG IS USED TO ILLUSTRATE THE IDENTIFIABLE PARTINGS IN A-1 COAL ZONE.

TOP OF PARTINGS A-4, A-9, A-11, ARE CONTOURED TO DEFINE SUBZONES A-1-1, A-1-2, A-1-3 AND A-1-4.

DEPTHS SHOWN ARE IN FEET FROM HOLE COLLAR.

FIGURE 2-9

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY
HAT CREEK PROJECT
MINING FEASIBILITY REPORT

GAMMA-RAY DENSITY LOG OF A-1 ZONE DDH 76-136

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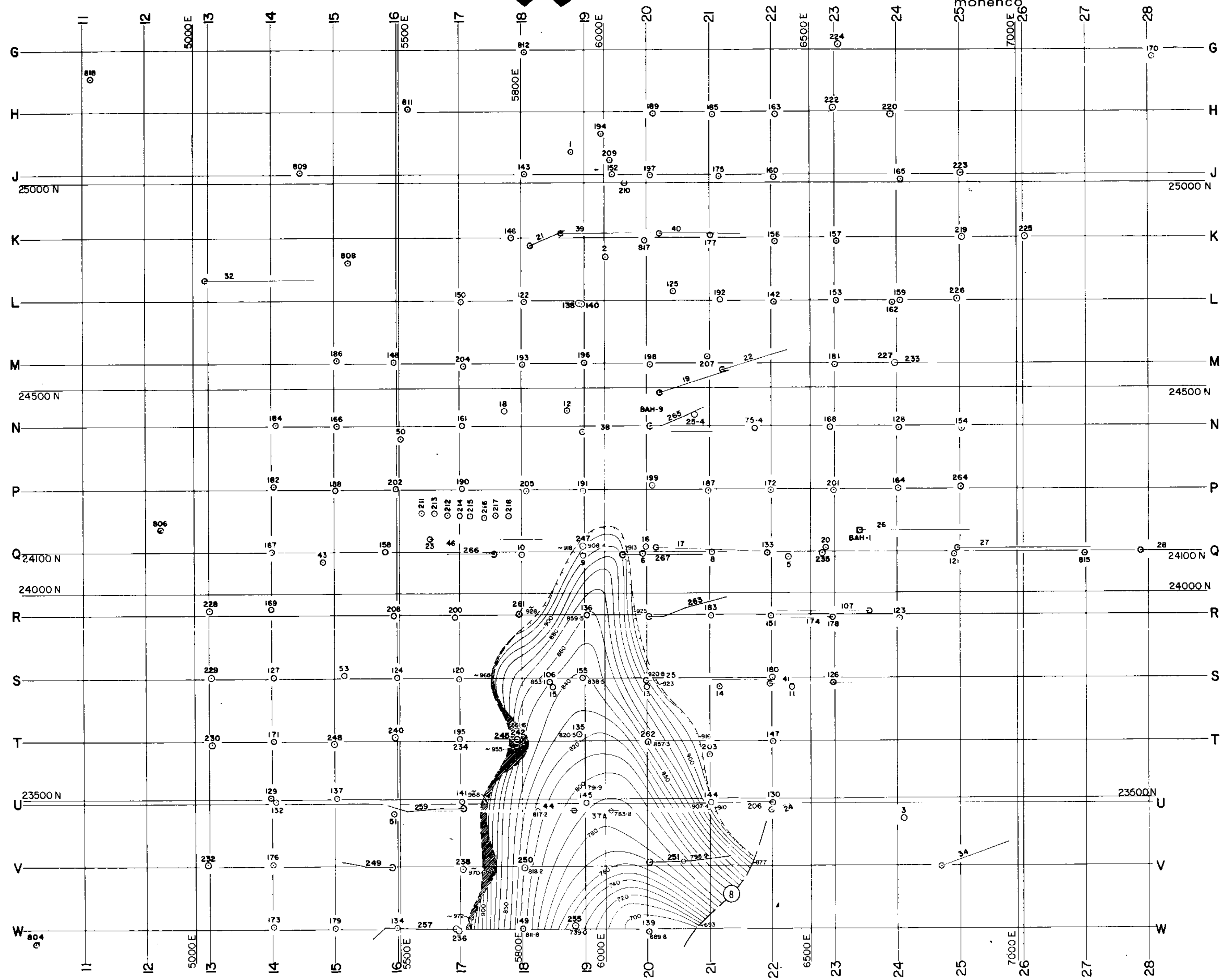

LEGEND

- VERTICAL DRILL HOLE
- DRILL HOLE NUMBER
- HOLE ELEVATION AT ZONE INTERSECT
- INCLINED HOLE SHOWING DIRECTION OF DRILLING
- HOLE LOCATION AT SUBZONE INTERSECT
- ZONE CONTOUR
- FAULT
- ZONE SUBCROP
- ZONE SUBCROP ELEVATION

10 METER CONTOUR INTERVAL

100m 0 200m 400m

FIGURE 2-10

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY
HAT CREEK PROJECT
MINING FEASIBILITY REPORT

CONTOURS OF TOP OF A-1-1 SUB-ZONE

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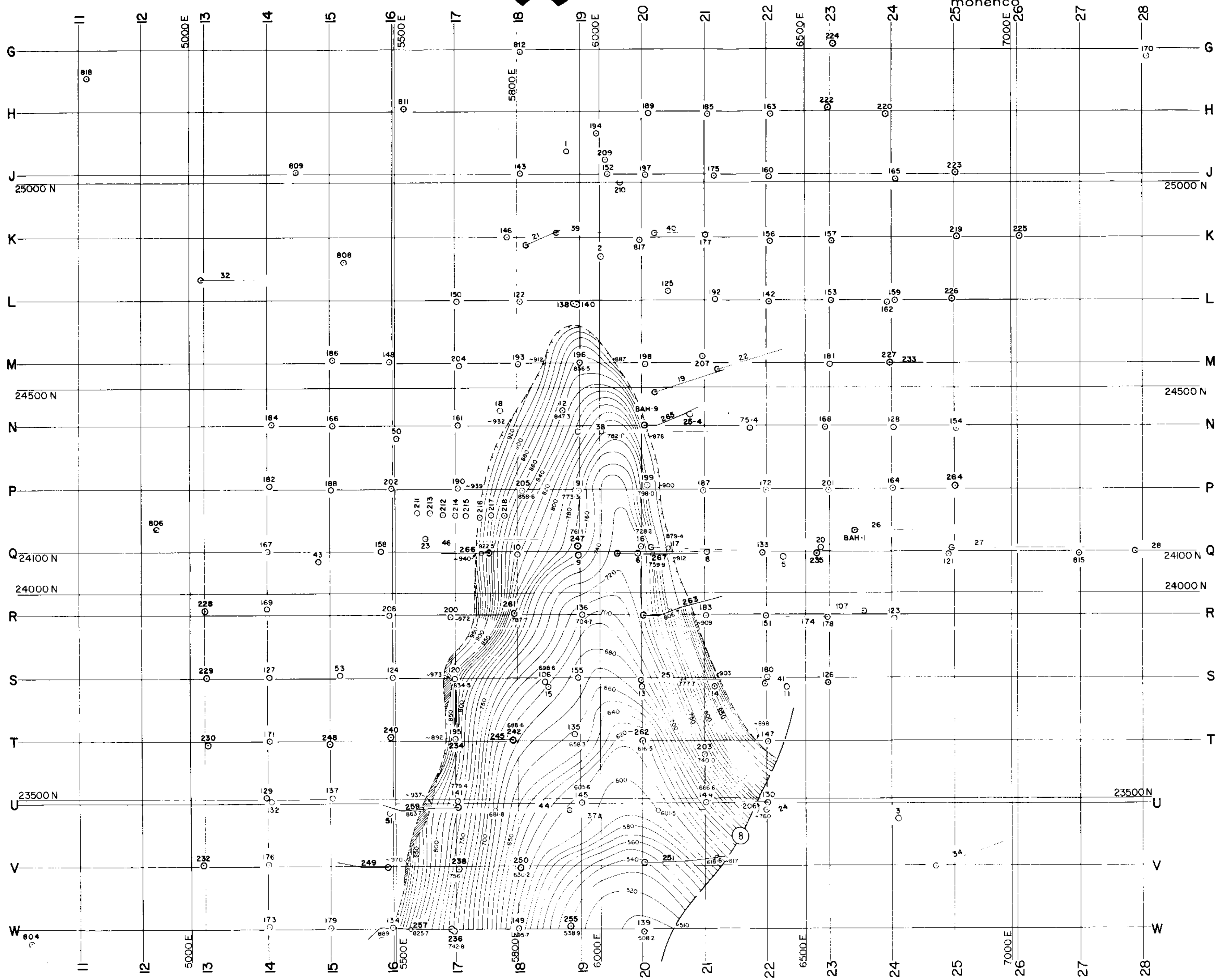

LEGEND

- VERTICAL DRILL HOLE
- DRILL HOLE NUMBER
- HOLE ELEVATION AT ZONE INTERSECT
- INCLINED HOLE SHOWING DIRECTION OF DRILLING
- HOLE LOCATION AT SUBZONE INTERSECT
- ZONE CONTOUR
- FAULT
- ZONE SUBCROP
- ZONE SUBCROP ELEVATION

10 METER CONTOUR INTERVAL

100m 0 200m 400m

FIGURE 2-11

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY
HAT CREEK PROJECT
MINING FEASIBILITY REPORT

CONTOURS OF TOP OF A-2-1 SUB-ZONE

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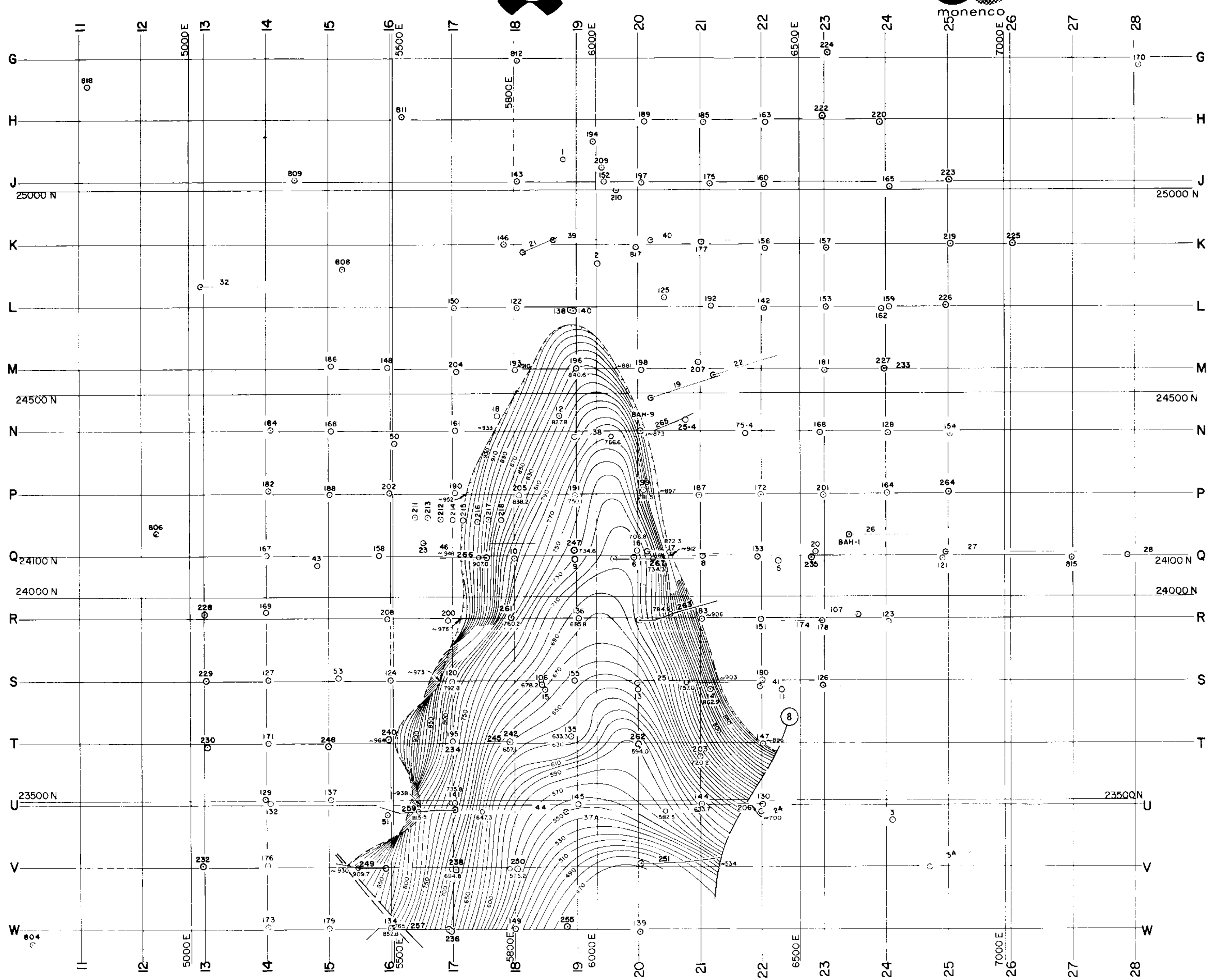

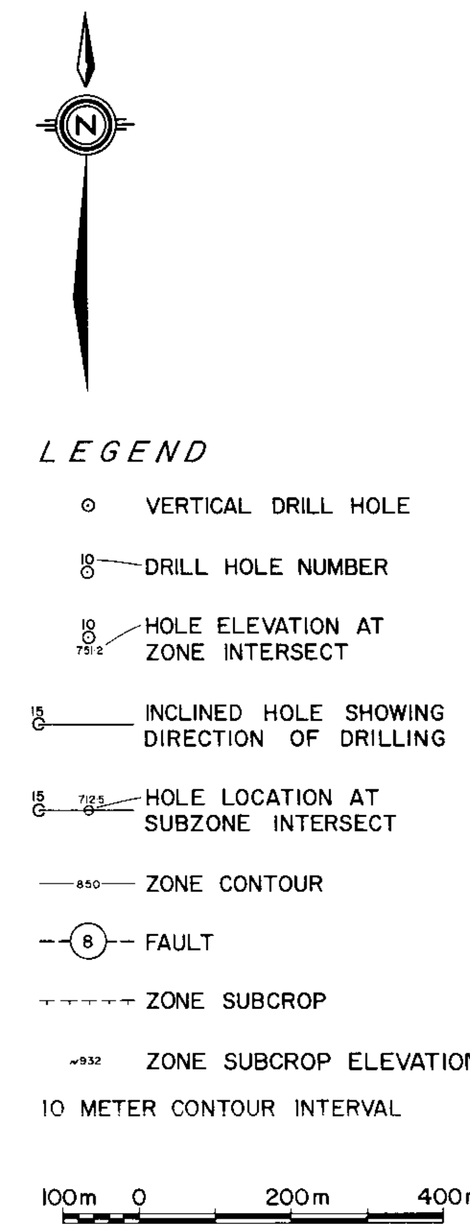

FIGURE 2-12

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY
HAT CREEK PROJECT
MINING FEASIBILITY REPORT

CONTOURS OF TOP OF B-1-1 SUB-ZONE

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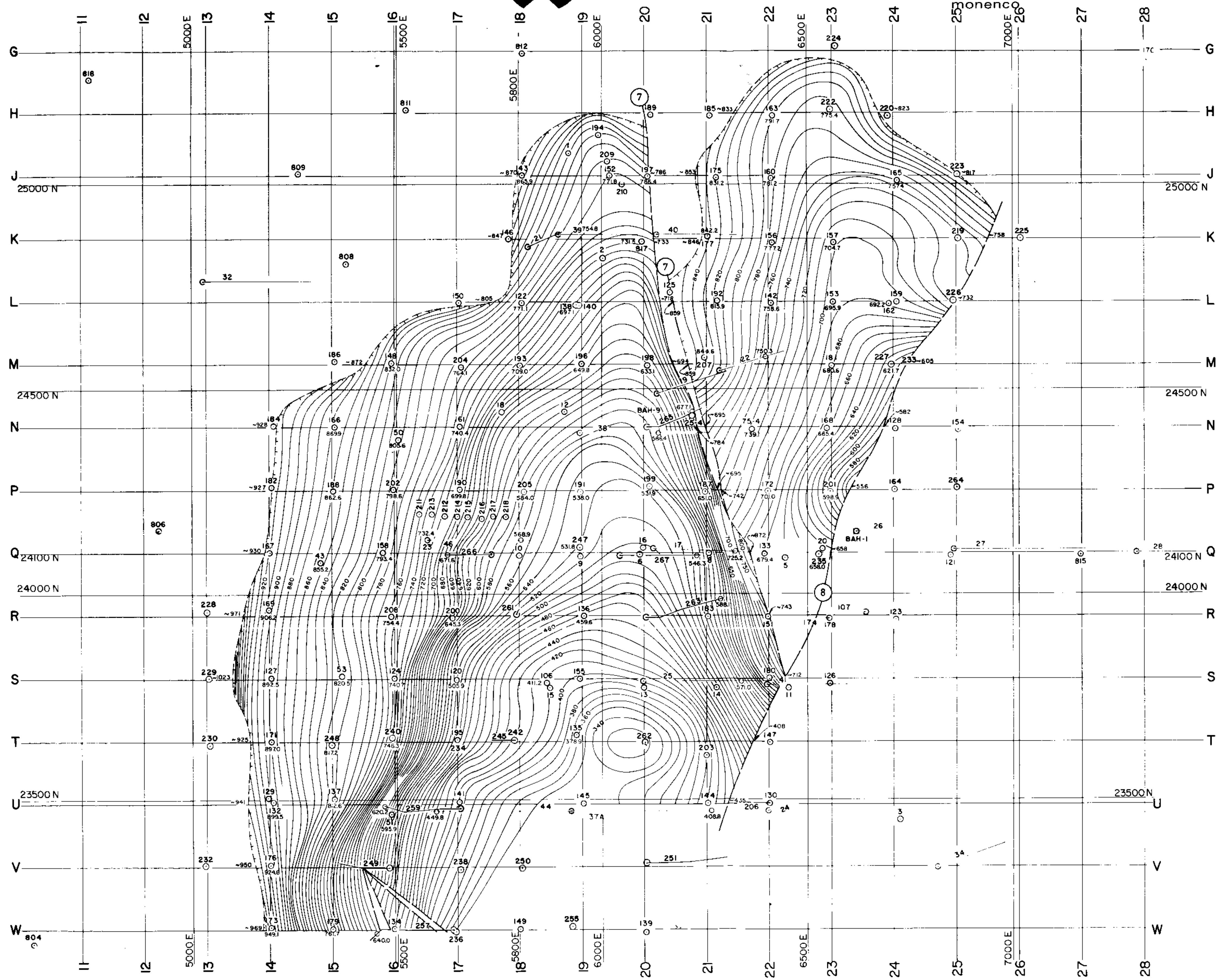

LEGEND

- VERTICAL DRILL HOLE
- DRILL HOLE NUMBER
- HOLE ELEVATION AT ZONE INTERSECT
- INCLINED HOLE SHOWING DIRECTION OF DRILLING
- HOLE LOCATION AT SUBZONE INTERSECT
- ZONE CONTOUR
- FAULT
- ZONE SUBCROP
- ZONE SUBCROP ELEVATION

10 METER CONTOUR INTERVAL

100m 0 200m 400m

FIGURE 2-13

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY
HAT CREEK PROJECT
MINING FEASIBILITY REPORT

CONTOURS OF BASE OF
D-1-4 SUB-ZONE
(BASE OF D ZONE)

cominco-monenco joint venture

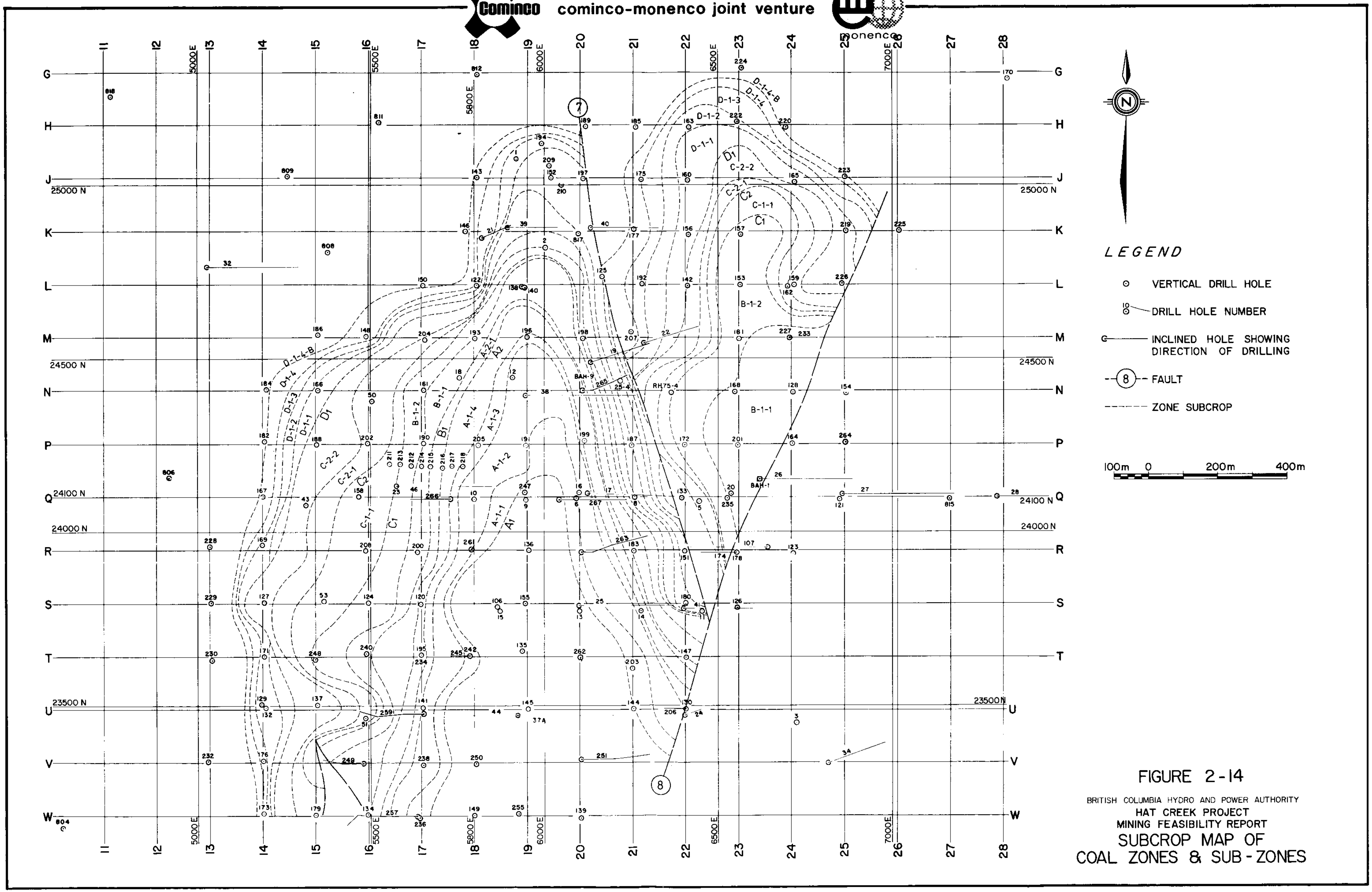

FIGURE 2-14

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY
HAT CREEK PROJECT
MINING FEASIBILITY REPORT
SUBCROP MAP OF COAL ZONES & SUB-ZONES

a map of the traces of the coal zones where they subcrop below surficials. These contours are prepared with the aid of the structural interpretation of the various sub-zones designated on geological cross-sections. The contours are cross-checked against these cross-sections and longitudinal sections prior to being digitized for entry into the computer's geological file.

The tops and bottoms of the respective sub-zones as intersected by drill holes are used to define the intervals of sub-zone analytical averages. In many cases, the original sample interval did not conform to the sub-zone boundaries. The revised meterages and the analytical variable such as ash and sulphur content and calorific value in Btu/lb or Mega Joules/kg are coded and entered on punch card format for inclusion within the data file.

2.5 BAKED ZONES

251 GENERAL FEATURES

Figure 2-15 shows the outlines and depths of three known baked zones; these have previously been designated as burned or burnt zones. During the current study, no direct evidence of burned coal or of a burned zone was observed; rather, the features noted in the baked claystone exposed in Trench A have led to adoption of the term "baked zones" in this report.

The gross outlines of the unusual suite of rocks contained in the baked zones have been interpreted from magnetic anomalies plotted from ground magnetometer surveys. Reconnaissance surveys were conducted by B.C. Hydro in 1974 and 1975, and additional surveys were done in the summer of 1977. The latter were plotted by B.C. Hydro in March 1978, and a supplementary report by the System Design Division of B.C. Hydro attributes the magnetic anomalies to magnetite developed by partial fusion of the "burned claystones". In the Powder River Basin of Montana and Wyoming, burn facies have been effectively mapped with magnetometer surveys (Hasbrouck and Hadsell, 1976). These authors cite other reports of a significant increase in the remnant magnetism of baked claystone upon cooling from temperatures as low as 200°C.

At Hat Creek numerous drill holes have penetrated the baked zones; those that were cored generally report low recovery. Many holes were triconed through these zones, with limited descriptions available from drillers' reports. Trench A contains a 150-metre long exposure of baked zone material. A few small pillar-like outcrops of yellowish-red and tan coloured baked claystone are present on the hillsides flanking Dry Lake, and open cuts dug in 1959 on the south and west sides of the lake exposed fragments of reddish, vesicular breccia in the soil. The site of Dry Lake, as indicated on Figure 1-1, has been interpreted by many investigators as an eroded, collapse structure that resulted from burned, former outcrop coal. Golder Associates reports that the Dry Lake area is a groundwater discharge zone; a highly permeable zone in the "burn zone" material occurs above a level some 50 metres below that of Hat Creek. A deep piezometer in DDH. 76-150 shows an anomalous, low piezometric elevation of 797 metres ASL; this is 100 metres west of the relatively thick baked zone (65 m) present in DDG. 76-122 (Section L, Figure 2-4).

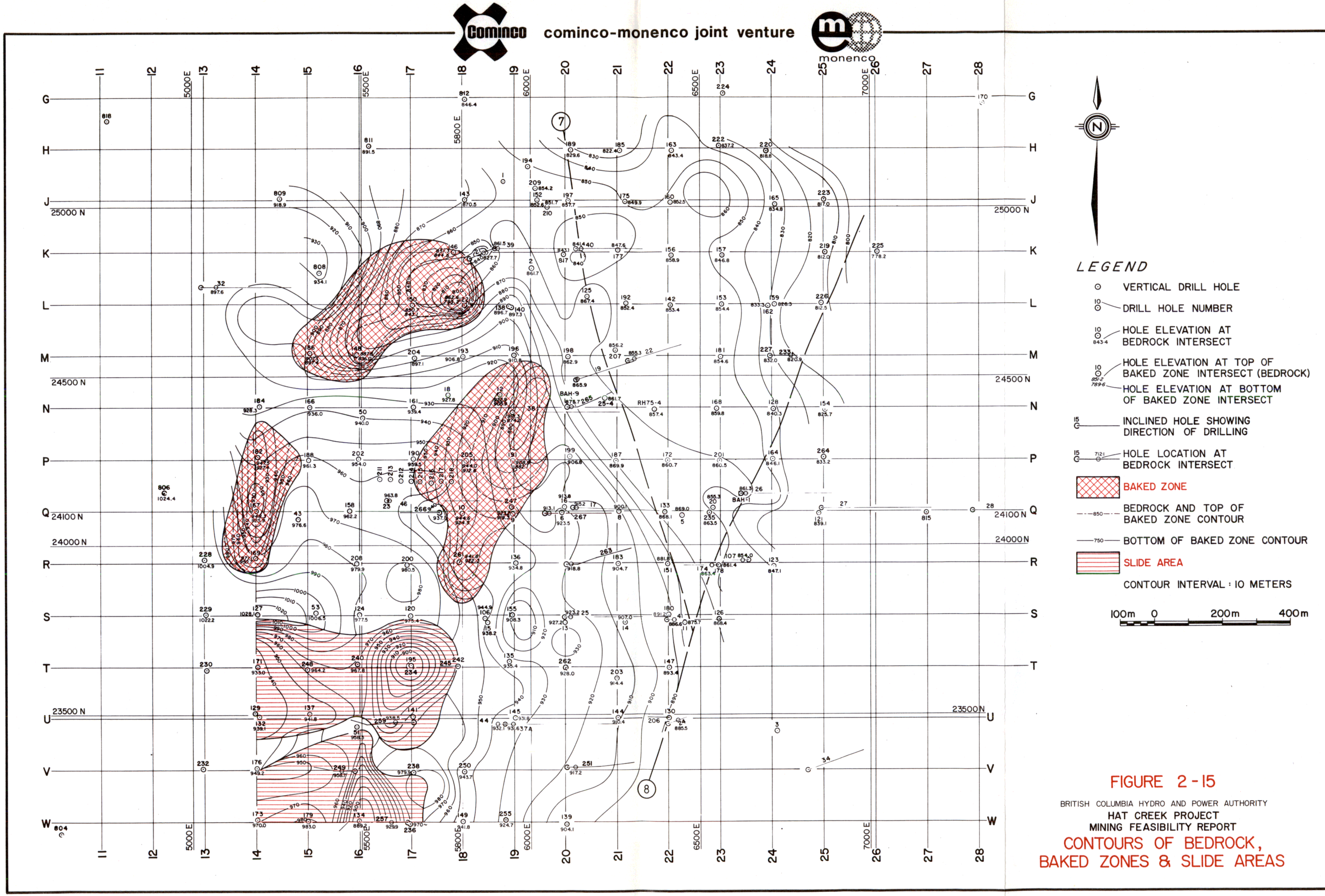

FIGURE 2-15

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY
HAT CREEK PROJECT
MINING FEASIBILITY REPORT
CONTOURS OF BEDROCK, BAKED ZONES & SLIDE AREAS

252 ROCK TYPES AND ORIGIN

The baked zones contain a wide variety of distinctively coloured and textured rock types. Many of these are reddish to purple or orange-hued, baked, fine-grained claystone, with irregular, contorted bedding. A notable constituent is often described as nests of hard, coarse "clinker". Trench A contains a broad stratiform zone of clinker blocks about 8 metres thick. Here the blocks are essentially bombs of vesicular and scoriaceous volcanic rock in a baked claystone between overlying glacial till and the underlying B coal zone. Further east on Sections P and R (Figure 3-11 of Section 3, and Figure 2-5, respectively), and also on Section M, the baked zone extends westerly beyond the projected subcrop of the base of D-Zone coal, and overlies Coldwater Formation detrital rocks. Thus, it is apparent that baked claystone containing nests of coarse ejective blocks and volcanic bombs overlies widely different stratigraphic members in and immediately adjacent to No. 1 Deposit.

The baked zones may have resulted from volcanic activity rather than from burning of outcrop coal; the baked zones can also be interpreted as overlying a pre-glacial erosion surface that truncates all of the coal zones and probably the Coldwater Formation detrital rocks. Dr. B. Nandi (Nandi and Brown, 1977) states that the Hat Creek coal appears to have been subjected to significant thermal action during formation. The reddish and purple baked appearance and the development of the magnetite in the claystones are considered in the present report to be caused by heat build-up before and during volcanism, during which the ejection of large blocks and bombs of lava and fused wallrock material was merely one link in a chain of related events.

Still unresolved is determination of whether the baked claystone is part of the Hat Creek Coal Formation, or whether it is equivalent to part of the Medicine Creek Formation. If the latter is the case, Medicine Creek strata would be at least locally unconformable on the Coal Formation.

SECTION 3

COMPUTER MODEL DEVELOPMENT

3.1 INTRODUCTION

Due to the size and complexity of the Hat Creek deposit, it was decided at the beginning of the study to use a computerized approach to compile the coal reserves and to assist in the mine planning process. This section deals with construction of the geological model; Section 5.5 in Volume III deals with the application of computer systems in mine planning.

Several geological factors complicate the definition of coal reserves in the deposit:

(a) the coal occurs in a complex series of alternating coal and rock beds, and coal quality varies significantly in marked trends across the deposit. A large amount of data in a vertical sense was gathered for interpretation;

(b) the coal occurs in a deep, graben-shaped deposit bounded by weak clay-like rocks; and

(c) faults and folds in the geological strata further complicate reserve definition and mine planning.

The computer mine model serves two functions: (a) building up a data file of selected geological and analytical data and organizing it in a manner suitable for retrieval in specific applications, and (b) applying the organized data to the formulation and evaluation of mine plans. Cominco had developed a computerized mining system called MEPS (Mine Evaluation and Production Scheduling) which had been used in a range of situations from massive porphyry copper deposits to open pit coal mining operations in mountainous terrain. This system was adapted to the Hat Creek Project.

In addition to MEPS, Cominco had access to other computer programs that could be applied to supplement the principal system. These included DATAPOST and OMNITAB. The applications of DATAPOST to assist in a rapid assessment of coal quality sectors and of OMNITAB to generate regression equations and to assist in geostatistical evaluations are described in Sections 3.4 and 3.5 of this volume.

3.2 MEPS - (BASIC SYSTEM)

The basic concept of the MEPS system is that a controlling supervisor function interacts with four main elements; this principle is illustrated on the logic diagram shown on Figure 3-1. The program language is Fortran. The relative organization within the system is based on blocks of various materials within columns bounded by predetermined grid dimensions. The following sections describe the type of routines shown in Figure 3-1.

321 MEPS SUPERVISOR

This element controls the subsequent computer functions listed.

322 MEPS INITIALIZATION

Procedures are set out to initiate development of a MEPS model, such as load error messages, and to define disk file sizes.

323 MEPS DATA

Functions of input, storage, and manipulation of input data are controlled by the following routines:

(a) Data Definition - provides input data for checking the "in-bounds" limits of input values such as co-ordinates and sets tonnage factors, weighting parameters, and bench heights.

(b) Data Entry - provides specific job steps for each type of data, such as drill data designated by seam.

(c) Maintenance of Data - allows updating of data and will delete specified data entries on command.

(d) Statistics - provides statistical listing of data stored within geological files.

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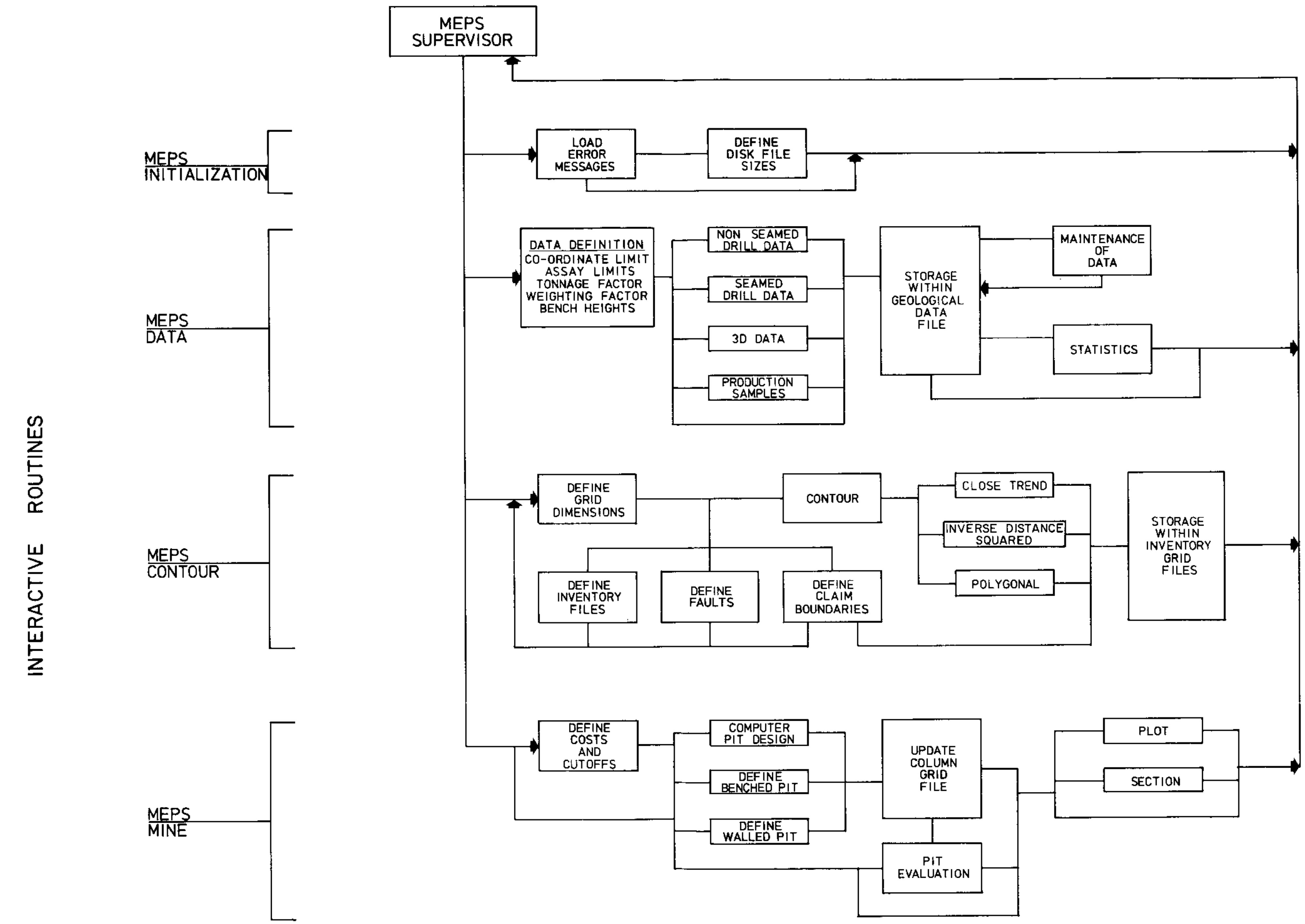

FIGURE 3 - 1

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY
HAT CREEK PROJECT
MINING FEASIBILITY REPORT

LOGIC DIAGRAM
MEPS SYSTEM

324 MEPS CONTOUR

This series allows development of contours of geological horizons and of coal assay variables within the constraints of faults, specified grid dimensions, etc., through use of the following routines:

(a) Define Grid Dimensions - sets out specific dimensions of the gridded area to be considered during subsequent steps. The block grid dimensions are also defined at this stage.

(b) Define Inventory Files - specifies order of storage for seams and assay variables within inventory grid files.

(c) Define Faults - defines the geometry of faults to be applied during contouring.

(d) Define Boundaries in Plan - defines boundaries used to sub-divide the deposit into specific sectors for subsequent pit evaluation results.

(e) Contour - allows development of contours of geological horizons and grade variables by one of four optional methods: close trending, inverse distance squared, polygonal, and trend surface. The inverse distance squared method employed in the Hat Creek model was modified by use of a smoothing radius as described in more detail below.

Following is a discussion of the MEPS contour step for trending calorific value and ash and sulphur contents.

Geological interpretation of the deposit has resulted in a stratigraphic breakdown comprising 14 coal sub-zones, including two units that are mainly low-grade coal, at less than 4000 Btu/lb, or waste. When drill hole data were prepared for key-punching, each sample was identified according to the sub-zone with which it had been correlated. The contouring procedure for estimation of block grades in a specific sub-zone is as follows: all samples belonging to a specific sub-zone in each hole are weighted according to length and specific gravity, and the average value for each of the essential proximate variables is calculated. The result for each stratigraphic sub-zone is a series of weighted average values for that sub-zone at the projected location of each drill hole intersection. These averages are then extrapolated or interpolated over a uniform grid by a procedure referred to as contouring. The size of the grid is variable, and was chosen to be 75-metres square in the Phase II model and 25-metres square in the Phase III model. In assigning a value to a grid corner, the procedure followed in the Phase III Hat Creek model involved first selecting the complement of the eight projected intersections closest to the grid corner which fell within the search radius of 500 metres. The influence which each of the eight points contributes to the estimate of the point grade is proportional to the inverse square of the distance from the point to the grid corner being evaluated. Since sample values are subject to errors arising from core losses, sampling and correlation errors, and analytical inaccuracies, the estimation of grade by a single intersection is not permitted. In order to prevent a very close hole from completely dominating the estimate of a grid point, all holes closer than 100 metres to the grid point are weighted as if they were 100 metres from the point. This 100-metre radius is called the smoothing radius. The procedure is repeated for each grid corner across the sub-zone. In effect a moving weighted average is developed, enabling reflection of the apparent trends in coal quality.

Concurrently with the development of the grade grid described above, the sub-zone isopach was developed, and where the sub-zone thickness was zero, the grade grids were also reduced to zero to eliminate the extrapolation of grade estimates into overburden and air. In estimating the grade of an individual block, the grades of the four grid corners of the block were weighted according to the tonnage of the sub-zone material represented by each grid corner (derived from the isopach) and averaged.

A sub-zone isopach for each of 14 sub-zones described in the Phase III geological computer model is stored as a series of grid blocks in the inventory file of the MEPS Contour element of the computer package. In the MEPS Mine element, they can be withdrawn from storage and included in the numerical evaluation of any increment of pit development or can be displayed graphically for mine planning purposes. Displays may be in the form of plan projections of grid blocks, or of cross-sections which show the vertical columns. Examples of these displays are described in Section 3.6 following.

Itemized coal reserves are displayed both as bench summaries and as total pit summaries. Reserve quantities and summaries of blocks in each sub-zone can be listed by ranges of calorific values and sulphur and ash contents.

325 MEPS MINE

This series of programs enables the user to develop pit designs and to calculate the quantity and quality of material within these pits. The application of MEPS Mine is reviewed in Section 5.5 of Volume III - Mine Planning.

3.3 CHRONOLOGY OF COMPUTER MODEL DEVELOPMENT

Application of computer systems to geological modelling for use in mine planning of No. 1 Deposit at Hat Creek progressed as follows:

(a) Mine planning was initiated using 10 quality sectors for the entire deposit. Coal qualities were averaged by the DATAPOST computer routines and tonnages were calculated manually. Meanwhile geological interpretations of the deposit were being defined by CMJV.

(b) A 4-zone model (Phase I) was developed using reinterpreted structural geology and zone correlations. Pre-1977 drill holes, with the exception of the 1925 series, were used to define the coal reserves and the stratigraphic location of waste materials. A number of additional points were required to describe the topographical and bedrock surfaces in areas where data were sparse. MEPS surface trending routines were used to provide a three-dimensional contour of all stratigraphic surfaces.

(c) The 12-sub-zone model (Phase II) allowed a more detailed interpretation of the coal into 12 coal sub-zones and two inter-zonal waste zones. Again the basis was pre-1977 drilling. Reinterpreted major zonal surfaces were not significantly different from those of the Phase I model. Sub-zonal surfaces were interposed to break A-1 Zone into four sub-zones, B-1 Zone into two sub-zones, C-2 Zone into two sub-zones, and D-1 Zone into four sub-zones. All surfaces were drafted manually under supervision of the geologists and digitized into the model. Extensive use was made of this model.

(d) While the Phase II model was being applied as the basis for mine planning, the specifications of the final model, Phase III, were being reviewed. The results of the 1977/78 drilling program were used to revise previous stratigraphic and structural interpretations.

A-1 Zone was divided into 12 provisional sub-zones, each including a marker consisting of a correlatable, significant waste parting. An analysis using DATAPOST was carried out to examine the distribution of calorific values. As a result it was concluded that a finer discrimination than the original four sub-zones (each containing several partings) was not warranted. However, the obvious presence of some coal occurrences in both A-2 and C-1 zones warranted their reclassification as coal sub-zones, rather than waste zones as previously designated.

A study was conducted comparing the practicalities of computing time costs to modelling accuracy over the range of 75, 30, 25, 20, 15, and 10-metre square vertical blocks. The 25 x 25-metre block size was chosen as a reasonable compromise and this was built into the Phase III model.

The final Phase III model was completed in mid-May 1978 and used thereafter to evaluate the series of nesting pits that form the basis for statistics and cost estimating in the final report. This model incorporated all new assay data available to the end of April 1978. Certain older holes were deleted from the model when data from redrilled holes became available.

(e) From time to time it was necessary to carry out calculations that paralleled the mainstream of geological modelling, including calculation of parameters such as specific gravities, and the geostatistical research that provided certain basic data for the modelling process.

3.4 DATAPOST APPLICATIONS

This system was developed by Cominco and had been used in preliminary mineral deposit evaluations. DATAPOST is a simple storage and retrieval program that calculates average intersections over specified stratigraphic intervals and displays the calculated values on scaled plans or sections.

DATAPOST was used twice in this study. In the first application, it provided preliminary proximate variable averages that included calorific values and sulphur contents before the initial MEPS model was constructed. In this analysis the deposit was divided into 10 sectors or reserve provinces (see Figure 3-2) as follows:

(a) the uppermost zone, A-Zone, had too few drill intersections to be broken into more than one reserve province; and

(b) there were three clearly defined coal reserve provinces for each of the three remaining coal zones B, C, and D. These provinces were the western limb, the central area of the syncline combined with the steeply inclined eastern limb, and the portion of the deposit between No. 7 and No. 8 faults.

The dividing line between provinces varied somewhat for each of the sub-zones. The following calorific values (Btu/lb) were designated for the various provinces:

	West Province	Central Province	East Province
A-Zone	-	5550	-
B-Zone	2680	7250	8680
C-Zone	2505	5600	7775
D-Zone	8115	9285	9535

This simple geological model of the deposit was used for preliminary mine planning and pit evaluations. It was replaced with the MEPS model series early in the study.

cominco-monenco joint venture

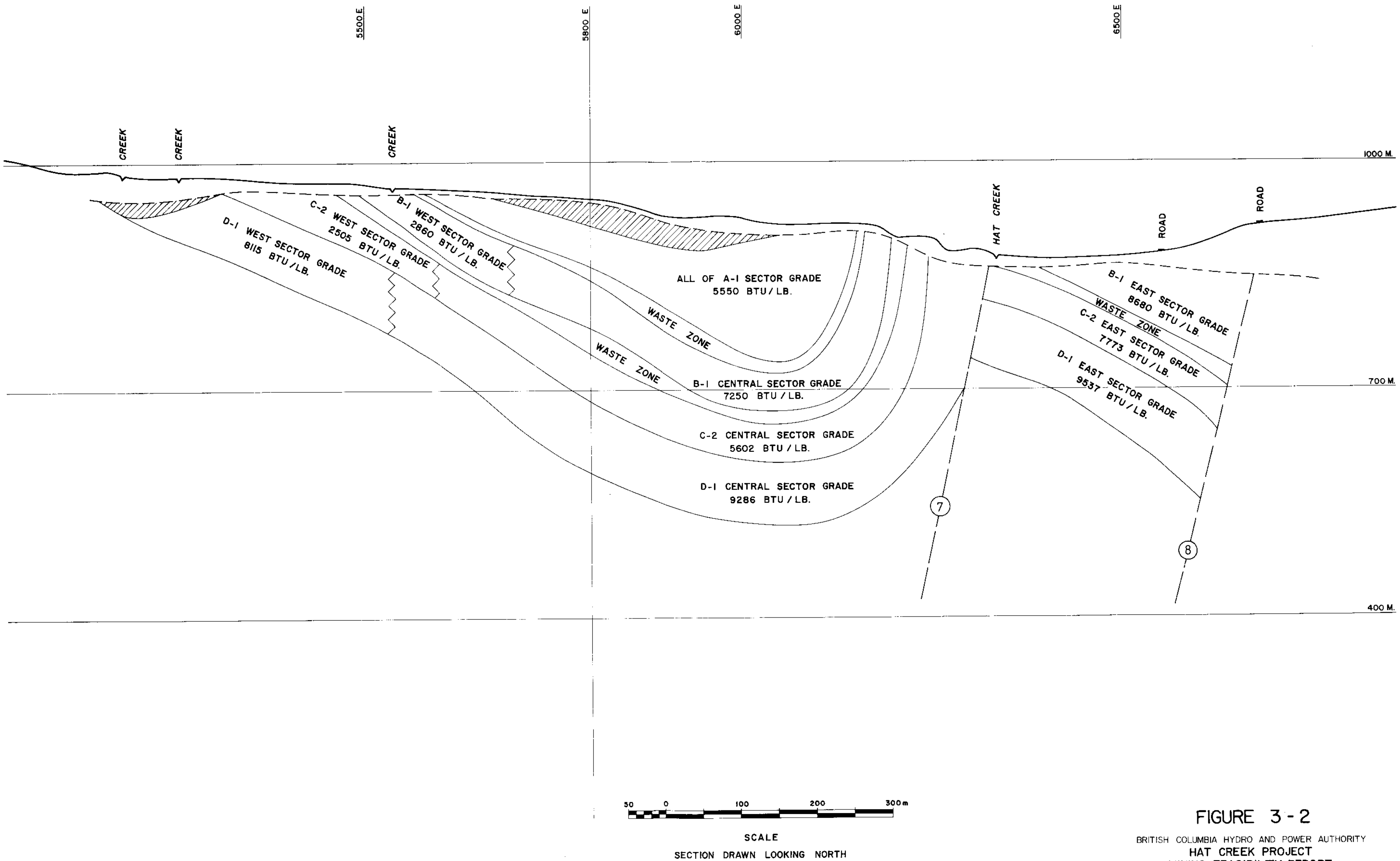

FIGURE 3-2

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY
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PRELIMINARY COAL QUALITY SECTORS

In the second application, DATAPOST was used to examine in detail the distribution of calorific values in A-1 Zone prior to the development of the 14-sub-zone model as discussed in Section 3.3. The 1977/78 drill results were available for this study.

3.5 FUNDAMENTAL STATISTICS

The computer program OMNITAB was applied to provide linear regression equations to evaluate the relationship between proximate variables such as ash and calorific value, and to display frequency distribution of the average assay values of the proximate variables. The first application provided input parameters to the computer model and the latter assisted in statistical studies.

Equations derived by OMNITAB for use in the MEPS modelling process and for other mine planning applications in the project included:

(a) the dry basis ash analysis to in situ specific gravity linear regression, i.e.,

specific gravity = 1.170 + (.0096 x % ash)

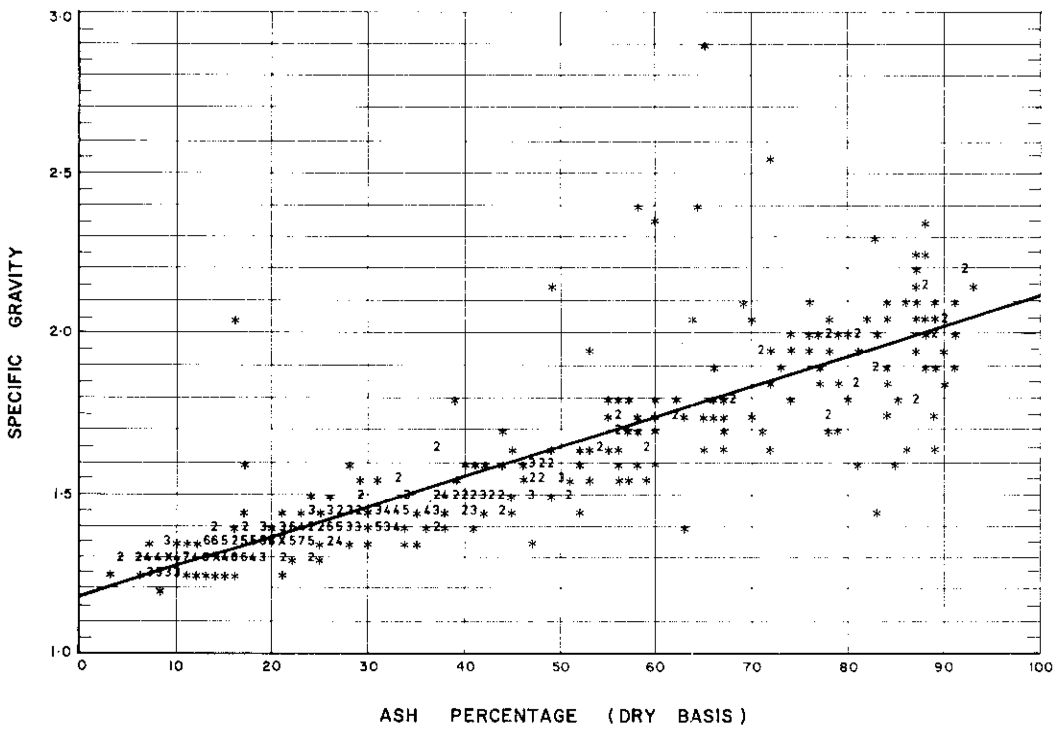
This was applied to coal in all sub-zones and was considered to represent the in situ state, including capacity moisture. The equation was derived from data provided by B.C. Hydro for DDH. 76-135 and 136. The data scatter and number of sources are obvious in Figure 3-3. Asterisks represent single data points, numbers represent coincident points, and X's are 10 or more coincident points.

(b) the ash to calorific values (dry basis) linear regressions for various coal zones and a composite for all zones, i.e.,

Seam	Observations	Equation	Coefficient of Determination
A-1	747	Btu = 12,373.5 - 139.9 (x ash%)	0.994
A-2	48 *	Btu = 10,037.7 - 102.6 (x ash%)	0.865
B-1	330	Btu = 12,333.5 - 139.0 (x ash%)	0.940
C-1	80 *	Btu = 10,588.3 - 111.1 (x ash%)	0.775
C-2	414	Btu = 11,986.4 - 135.3 (x ash%)	0.935
D-1	1024	Btu = 12,829.8 - 149.8 (x ash%)	0.966
ALL	2643	Btu = 12,580.5 - 144.6 (x ash%)	0.966

* The low value for the coefficient of determination for A-2 and C-1 zones are not considered serious as neither of these zones contributes significant coal of fuel quality to the mine production.

cominco-monenco joint venture



RESULTING EQUATION FOR THE LINEAR RELATIONSHIP

SPECIFIC GRAVITY = $1{\cdot}170 + (0{\cdot}0096 \times \%\,ASH)$

FIGURE 3-3

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY

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ASH VS. SPECIFIC GRAVITY CURVE

3.6 GEOSTATISTICAL STUDIES

Geostatistical studies preceded and paralleled geological model building, providing CMJV with guidelines for selecting the most applicable of the several optional MEPS Contour routines and for setting out parameters such as smoothing radius, search radius, etc., in those routines.

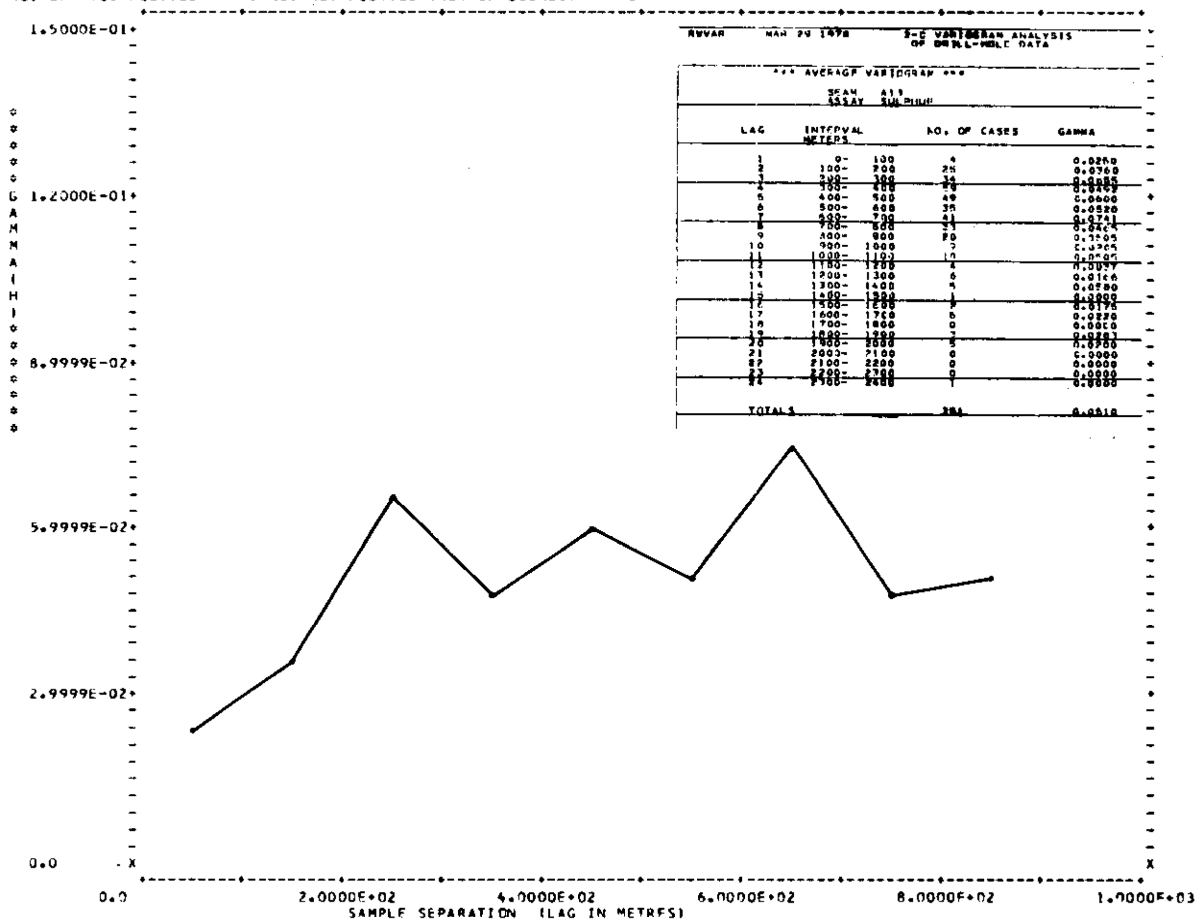
In order to examine the variability of sulphur content and calorific value in the Hat Creek deposit, a statistic was calculated which quantifies the degree of correlation between pairs of data points at measured distances and directions from one another. This statistic, which resembles the variance, displays the degree of interdependence between sample points at different separations. A graph of the value of the statistic (gamma h) calculated at various separations of data points is termed a variogram, or more correctly, an experimental semivariogram.

Experimental semivariograms in the plane of the strata were calculated for 9 of the 12 stratigraphic subdivisions in the Hat Creek deposit. Examples are provided on Figures 3-4 and 3-5. Since D-Zone coal is generally of higher calorific value, low sulphur content, and low variances, variograms of only one of the four sub-zones were calculated. Only Phase II data (pre-1977 drill holes) were utilized, as the results of the 1977/78 drilling program were unavailable at the time of this study.

In order to ensure that the sample points were in correct relative positions, the coordinates of the drill hole intersections were re-established by graphically unfolding the syncline about its north-south axis. No attempt was made to compensate for the gentle northerly plunge. Further, only drill holes on the western side of No. 7 and 8 faults were considered, correlation across the faults being uncertain. The working data, therefore, consisted of a series of drill hole intersections of each stratigraphic sub-zone. The drill hole intersections themselves were composed of the average of the core samples, weighted by length and specific gravity.

AVERAGE 2-D SEMIVARIOGRAM A13 SULPHUR

ABS- COLUMN 1; ORD- COLUMN 2 (.).
NO. OF PTS. PLOTTED 9 NO. NOT PLOTTED (OUT OF BOUNDS) 0



RWVAR MAR 29 1978 2-D VARIOGRAM ANALYSIS OF DRILL-HOLE DATA

*** AVERAGE VARIOGRAM ***

SEAM A13
ASSAY SULPHUR

LAG	INTERVAL METERS		NO. OF CASES	GAMMA
1	0-	100	4	0.0250
2	100-	200	25	0.0360
3	200-	300	34	[illegible]
4	300-	400	[illegible]	[illegible]
5	400-	500	49	0.0600
6	500-	600	35	0.0520
7	600-	700	41	0.0741
8	700-	800	[illegible]	[illegible]
9	800-	900	20	[illegible]
10	900-	1000	[illegible]	[illegible]
11	1000-	1100	10	[illegible]
12	1100-	1200	4	[illegible]
13	1200-	1300	6	0.0166
14	1300-	1400	5	0.0580
15	1400-	1500	1	0.0000
16	1500-	1600	[illegible]	0.0175
17	1600-	1700	6	0.0220
18	1700-	1800	0	0.0000
19	1800-	1900	[illegible]	[illegible]
20	1900-	2000	5	0.0700
21	2000-	2100	0	0.0000
22	2100-	2200	0	0.0000
23	2200-	2300	0	0.0000
24	2300-	2400	1	0.0000
TOTALS			[illegible]	[illegible]

FIGURE 3-4

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY
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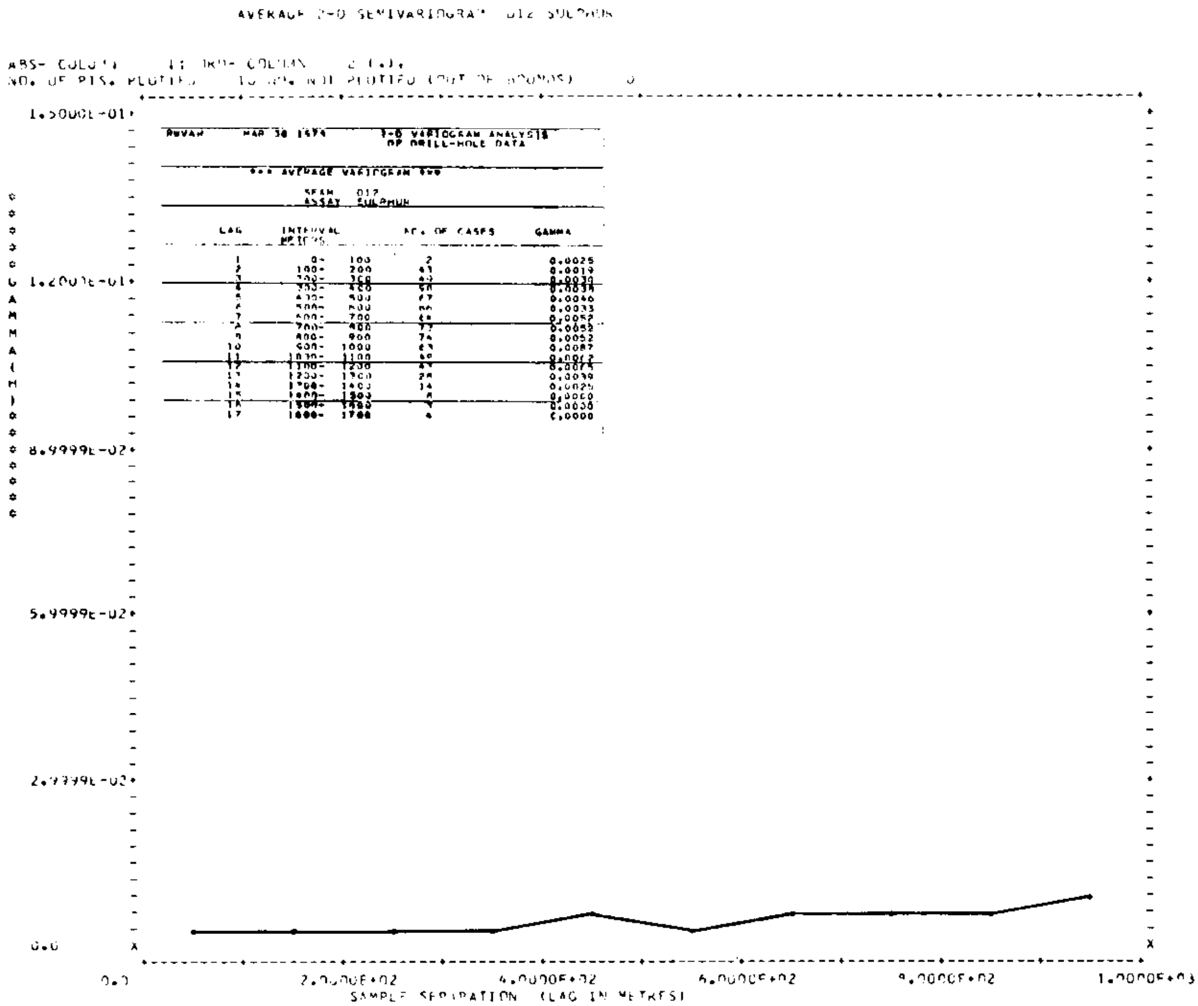
SEMIVARIOGRAM OF SULPHUR VALUES A-I-3 SUB-ZONE



LAG	INTERVAL METRES		NO. OF CASES	GAMMA
1	0-	100	2	0.0025
2	100-	200	43	0.0019
3	200-	300	49	0.0030
4	300-	400	58	0.0034
5	400-	500	67	0.0046
6	500-	600	66	0.0033
7	600-	700	64	0.0052
8	700-	800	77	0.0052
9	800-	900	74	0.0052
10	900-	1000	63	0.0087
11	1000-	1100	69	0.0072
12	1100-	1200	47	0.0075
13	1200-	1300	28	0.0039
14	1300-	1400	14	0.0025
15	1400-	1500	8	0.0050
16	1500-	1600	7	0.0030
17	1600-	1700	4	0.0000

FIGURE 3-5

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY

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SEMIVARIOGRAM OF SULPHUR VALUES D-1-2 SUB-ZONE

The experimental semivariograms for each sub-zone were calculated by determining half the mean squared difference between all pairs of intersections in the sub-zone. These values were then grouped and averaged according to the separation between the sample pairs, and the direction between the sample pairs. Thus, the variability of correlation with distance and in different directions could theoretically be evaluated. In the Hat Creek case, it was found that too few pairs of samples were present in the various directional fields, particularly in A-Zone, to permit reliable directional semivariograms to be calculated; therefore only the average (omnidirectional) semivariograms have been utilized. These are discussed below.

The variability of calorific, or Btu, value and sulphur content over short distances and the degree to which a sample is representative of the volume of material immediately surrounding it is best demonstrated by close-spaced sampling of one kind or another. With the drilling pattern at Hat Creek, very little close-spaced information is available to define local variability. A common practice is to infer the variability of a variable over short distances from the degree of correlation over greater distances by projecting the semivariogram curve back to the point where the distance between hypothetical sample pairs is zero.

This technique should be applied with appropriate caution, however, since it is fundamentally an estimate of local behaviour based on wide sample spacing, and several factors are likely to contribute to inaccuracies in local estimation. These include analytical error, sampling errors from such causes as core losses, incorrect footages, etc., and errors in correlation.

361 BTU VARIABILITY

A-Zone The character of the average semivariograms in each sub-zone is somewhat different. A-1-1, A-1-2, and A-1-4 show increasing correlation between sample pairs at distances up to 250 - 350 metres, beyond which the correlation appears to be random. The presence of a nugget effect can be inferred from the correlation of sample pairs greater than 100 metres apart; however, there are very few close-spaced sample pairs available to define this parameter. A-1-3 samples appear to be randomly distributed at this sample spacing, and a substantial nugget effect can be inferred.

B Zone The average variograms in the B sub-zones are quite similar, with a range of about 400 metres and an inferred small nugget effect.

C-Zone These variograms show decreasing correlation with increasing distance and reflect the presence of the regional trend. A nugget effect can be inferred in C-2-2.

D-Zone Since only one sub-zone, D-1-2, was calculated, the behaviour of the variables in the remaining three zones is inferred. D-1-2 average semivariogram shows increasing correlation between sample pairs at distances less than about 350 metres, beyond which the correlation appears random. The presence of a small or zero nugget effect can be inferred.

362 SULPHUR VARIABILITY

A-Zone The semivariograms for A-1-1 and A-1-2 show high average gamma values between few pairs of points with less than 100-metre separation. Although there are too few pairs of points to be reliable, it does indicate that pronounced fluctuations in grade are possible over short distances. The remainder of the semivariogram for A-1-1, with increasing separation between points, displays a fairly random scatter of values. At this sample spacing, sulphur in A-1-1 zone appears to be randomly distributed. The remainder of the semivariogram for A-1-2 shows generally increasing variance with increasing sample separation, implying the presence of a regional drift. Semivariograms of sulphur in A-1-3 and A-1-4 show increasing variance with sample separation, up to a distance of about 400 or 500 metres, then random behaviour with greater separation. A small nugget effect may be implied.

B-Zone B-Zone semivariograms are very similar, with erratic behaviour at small sample separation and the suggestion of a regional trend across the sampled portion of the deposit.

C-Zone C-Zone semivariograms are much different from both B and A zones, having a lower overall variance and much more regular distribution. Both indicate increasing variability with sample separation up to at least 800 metres, probably reflecting the change in sedimentary environment across the deposit.

D-Zone: Behaviour of sulphur in D zones is inferred from the semivariograms in one zone, D-1-2, as shown on Figure 3-5. Both the sulphur grade and variance in this zone are relatively low; problems associated with high sulphur in this zone are not anticipated. The semivariogram indicates increasing correlation to approximately 400 metres and random behaviour at greater sample spacing. The scale of Figures 3-4 and 3-5 is the same and the difference in variance between the zones is illustrated. The degree of correlation of sulphur in D-Zone is indicated by the table in Figure 3-5.

363 CONCLUSION

Semivariograms were used in a qualitative role in this study to gain further understanding of the behaviour of sulphur and calorific value in the deposit, and to assist in the selection of certain of the parameters used in the MEPS models. Geostatistics was not used extensively in the Hat Creek study.

Table 3-1 summarizes the classical statistics studied for calorific and sulphur values in No. 1 Deposit. The standard deviations and standard errors were used to assess general confidence limits for the average quality of the proposed pit reserves. As regional quality trending was recognized and incorporated into the computer system of coal reserve estimating, the actual chance of error in assessing the average quality variables within the No. 1 Deposit is probably lower than indicated in those zones displaying pronounced trends.

TABLE 3-1

Classical (Gaussian) Statistics for
Calorific and Sulphur Values

Phase III Model

Hat Creek Project Mining Feasibility Report 1978

Sub-Zone	Calorific Value (Btu/lb)				Sulphur Content (%)			
	N	Mean	Std. Dev.	Std. Error	N	Mean	Std. Dev.	Std. Error
A-1-1	21	5735	985	215	17	0.795	0.192	0.0466
A-1-2	30	5503	724	132	24	0.723	0.244	0.050
A-1-3	33	5364	1430	249	26	0.604	0.185	0.036
A-1-4	36	4921	1352	225.3	28	0.677	0.120	0.023
B-1-1	44	7123	1721	259.5	36	0.683	0.197	0.033
B-1-2	48	6480	2055	296.6	40	0.710	0.229	0.036
C-2-1	50	4288	2463	348.3	44	0.438	0.197	0.030
C-2-2	62	4850	2538	322.4	54	0.351	0.186	0.025
D-1-1	67	7971	1541	188.3	62	0.303	0.120	0.015
D-1-2	74	9123	1370	159.3	68	0.266	0.133	0.013
D-1-3	79	9685	948	106.6	74	0.299	0.107	0.012
D-1-4	87	9251	879	94.2	81	0.375	0.107	0.012

Notes:

1. Variables analyzed are from sub-zone intersections in drill holes from the Phase III model of the Hat Creek Deposit.

2. Statistics for the low-grade sub-zones A-2-1 and C-1-1 have been omitted.

3. Gaussian statistics consider no correlation between data points, i.e., random distribution.

4. The high standard deviations in calorific values in B-1 and C-2 sub-zones reflect the wide ranges that occur in these units.

3.7 COMPUTER MODELLING DETAILS

371 PHASE I - FOUR ZONE MODEL

This preliminary model provided the first computerized estimates of the coal reserves and the first opportunity to analyze the contents of manually constructed pits. The salient features are listed below. References are metric units.

(a) Initiation

- assigned property dimension:
  east/west .... 3450 E to 8585 E
  north/south .... 20 650 N to 26 350 E

(b) Data

- size of the vertical column grid ..... 75 x 75 metres
  108 pre-1977 drill holes used for coal quality data - holes from the 1925 series excluded

- seven fill-in dummy holes inserted for contouring surface and bedrock

- interpretation based on four coal zones named A-1, B-1, C-2, D-1

- topographical surface described by a large number of three-dimensional points input manually to aid trending; all other surfaces digitized for input

- non-sampled drill hole intersections of parting material assigned values of 80% ash and 1000 Btu/lb

- "Baked Zone" included with overburden

(c) Contour

Three-dimensional surfaces were modelled by the close trending method. Seam Btu values were contoured by the modified inverse square of the distance method.

372 PHASE II - TWELVE SUB-ZONE MODEL

This model superseded the Phase I model at the mid-point of the study and was used extensively as a mine planning tool. Differences in modelling compared to Phase I are listed below.

(a) Initiation

- no changes in property dimension

(b) Data

- no changes in drill hole data

The four zones of Phase I were split into a series of sub-zones by selecting correlatable partings as markers. Splits were as follows:

A-1 into A-1-1, A-1-2, A-1-3, A-1-4
B-1 into B-1-1, B-1-2
C-2 into C-2-1, C-2-2
D-1 into D-1-1, D-1-2, D-1-3, D-1-4

A-2 and C-1 zones were designated as waste. All three-dimensional surfaces were manually contoured and digitized. Non-sampled intersections of parting materials were arbitrarily assigned values of 80% ash and 1000 Btu/lb.

(c) Contouring

- no changes in method from the Phase I model

373 PHASE III - FOURTEEN SUB-ZONE MODEL

This model was completed in mid-April 1978 after analytical results from the 1977/78 drilling program and the subsequent geological reinterpretations became available. The results included a steepening of A and B zones on the west flank and indicated localized overturning of some A-Zone coal beds. As a result much of the seam waste (< 3000 Btu/lb) and low-grade coal (3000 to 4000 Btu/lb) that was interpreted as B-Zone is shown as C-Zone in the final model. Similar materials previously in A-Zone are now in B-Zone. Other changes in seam surface contours resulted not only from new information in the 1977/78 drill holes but also from revised correlations in previous holes.

Other significant changes included:

- reduction of the column grid from 75 x 75 metres to 25 x 25 metres for computing economy
- use of a more recent topographical surface map
- replacement in the model of some old drill holes with new, redrilled holes in which sample discrimination was more precise
- inclusion of the coal in A-2 and C-1 zones in the model

Modelling differences are listed below.

(a) Initiation

- property dimensions reduced to:
  east/west .... 4050 E to 8550 E
  north/south .... 22 450 N to 26 450 N

(b) Data

- seven of the 1957, 1959 drill holes deleted and replaced with holes drilled in 1977/78

- 19 pre-1977 holes and eight 1977/78 holes excluded - they were either too shallow or outside the outlines of the defined deposit

- 13 pre-1977 and six 1977/78 drill holes excluded - they fell outside the limits of the reserves. These holes were either south of Section W where detailed geological interpretation is complete, or east of No. 8 fault. It is known that stripping for the 35-year pit will encounter some coal east of No. 8 fault, but drilling to date has been unable to quantify the amount or quality. This is not expected to have a significant effect on feasibility.

- two holes excluded that showed overturned coal beds; a manual approximation was modelled

- 14 holes used only for definition of bedrock surface; coal intersections were out of bounds for one of the reasons outlined above

- sulphur assays not available in 11 of the 1977/78 holes when the model was assembled

- one 1977/78 rotary hole with chip samples only was not modelled

- in summary, 23 of the 49 drill holes from the 1977/78 program were useful in providing coal data within the limits of the model and the influence of the 35-year ultimate pit

- non-sampled intervals (generally expected to have an ash quality greater than 75% [dry basis]) arbitrarily assigned values of 80% ash and zero Btu/lb; for those samples having an ash determination reported as less than 80% ash, the ash/Btu regression curve for the designated zone was used to assign an equivalent calorific value. For those samples having ash reported as 80% or greater, an arbitrary value of zero Btu/lb was assigned.

- except as noted, all other available drill hole data assembled into the Phase III model

- A-2-1 and C-1-1 zones modelled as coal zones, but with no significant effect towards feasibility; in total they added about 9 million tonnes of somewhat lower than average quality fuel coal and contributed significantly to the stockpile of low-grade coal in the 3000 to 400C Btu/lb range.

(c) Contour

All three-dimensional surfaces were manually contoured, digitized, and modelled using the close trending method; the modified inverse distance squared trending technique was applied to the seam proximate variables.

3.8 COMPUTER ILLUSTRATIONS OF QUALITY TRENDS

Graphic displays produced by the MEPS Mine routines were used to illustrate the coal quality trends demonstrated by geostatistical studies. Variations in computer generated values are illustrated as follows:

Figure 3-6 shows a portion of the coordinate grid for B-1-1 sub-zone, namely, Sections N, P, Q, R and 17, 18, 19, and displays the computer calculated block Btu values for 25-metre grid blocks. The approximate subcrop of the base of B-1-1 sub-zone also serves as a reference. East to west variations are in the order of 270 Btu/lb at Section N, 500 Btu/lb at P, 1200 Btu/lb at Q, 1300 Btu/lb at R, and 1700 Btu/lb at Section S. Obviously, there is also a marked north/south trend in calorific value along the approximate subcrop and for a border zone up to 200 metres wide.

Figures 3-7, 3-8, and 3-9 are character plots of iso-calorific values for sub-zones B-1-2, C-2-2, and D-1-1, respectively, (described as Seams 7, 10, and 11 in this sequence of the MEPS program). On these figures, contours at 200 Btu intervals are shown across the western edge of the main syncline. The general trends depicted are east to west or northeast to southwest. The typical cross-section on Figure 3-10 shows a computer produced geological cross-section with outlines of the 14 sub-zones and 25-metre blocks with imprinted Btu values, so that the eastwest trend is again illustrated in the sub-zones. The ranges in calorific value displayed on Sections P and 19, Figures 3-11 and 3-12, illustrate idealized quality variations between diamond drill holes at approximately 150-metre spacing.

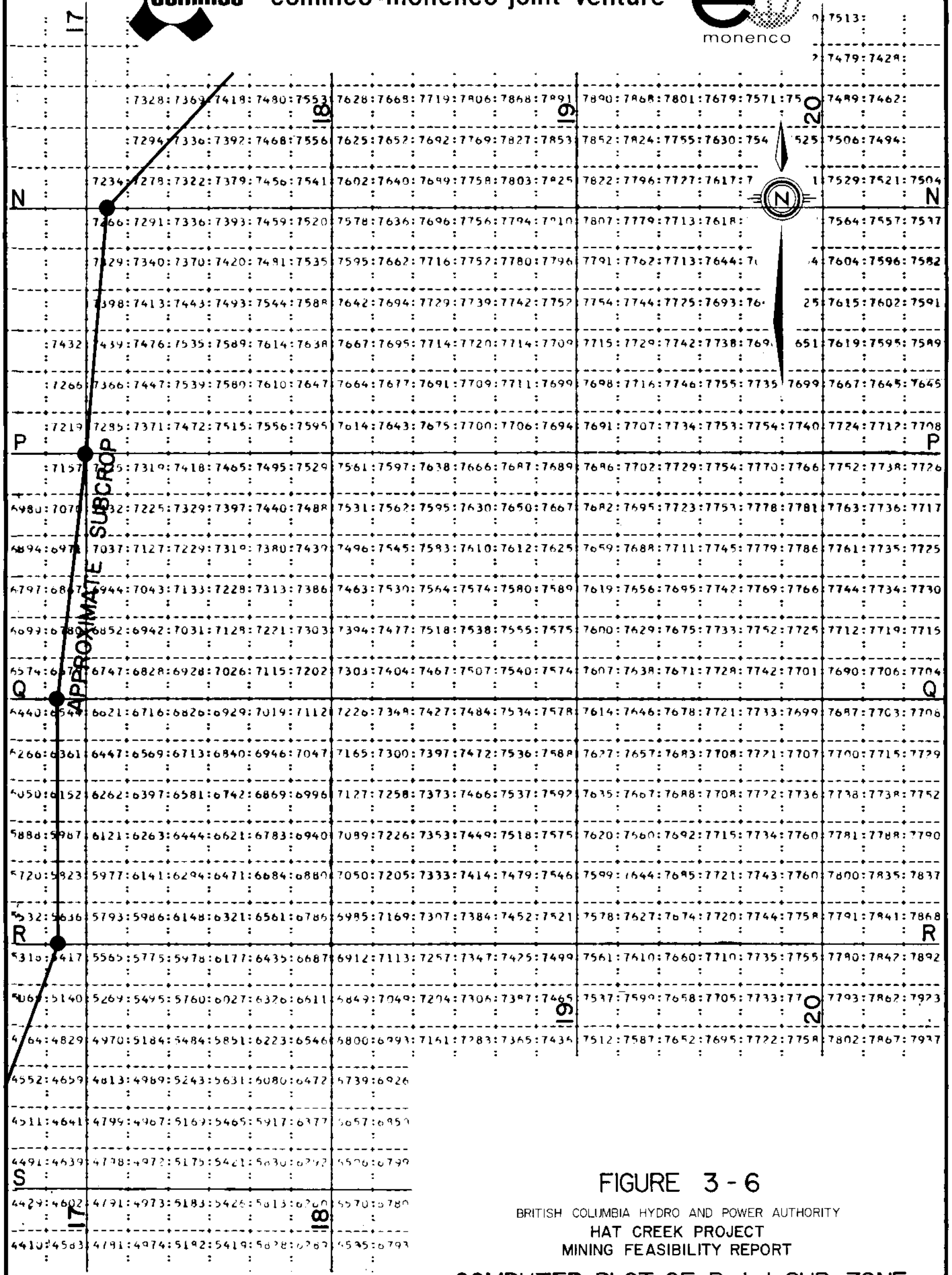

FIGURE 3-6

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY
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COMPUTER PLOT OF B-1-1 SUB-ZONE
Btu BLOCK VALUES

-CHARACTER PLOT OF ISO-CALORIFIC VALUES FOR SELECTED SUBZONES

The following codes apply in interpretation of the iso-calorific character plots presented on Figures 3-7, 3-8, and 3-9.

	Latitude	Departure
Northeast corner	24587.50	6387.50
Southwest corner	23612.50	5012.50

Code Name and Units (Btu/lb) of Plotted Variable

A	1000 to 1200	M	5800 to 6000
	1200 to 1400		6000 to 6200
B	1400 to 1600	N	6200 to 6400
	1600 to 1800		6400 to 6600
C	1800 to 2000	O	6600 to 6800
	2000 to 2200		6800 to 7000
D	2200 to 2400	P	7000 to 7200
	2400 to 2600		7200 to 7400
E	2600 to 2800	Q	7400 to 7600
	2800 to 3000		7600 to 7800
F	3000 to 3200	R	7800 to 8000
	3200 to 3400		8000 to 8200
G	3400 to 3600	S	8200 to 8400
	3600 to 3800		8400 to 8600
H	3800 to 4000	T	8600 to 8800
	4000 to 4200		8800 to 9000
I	4200 to 4400	U	9000 to 9200
	4400 to 4600		9200 to 9400
J	4600 to 4800	V	9400 to 9600
	4800 to 5000		9600 to 9800
K	5000 to 5200	W	9800 to 10000
	5200 to 5400		
L	5400 to 5600		
	5600 to 5800		

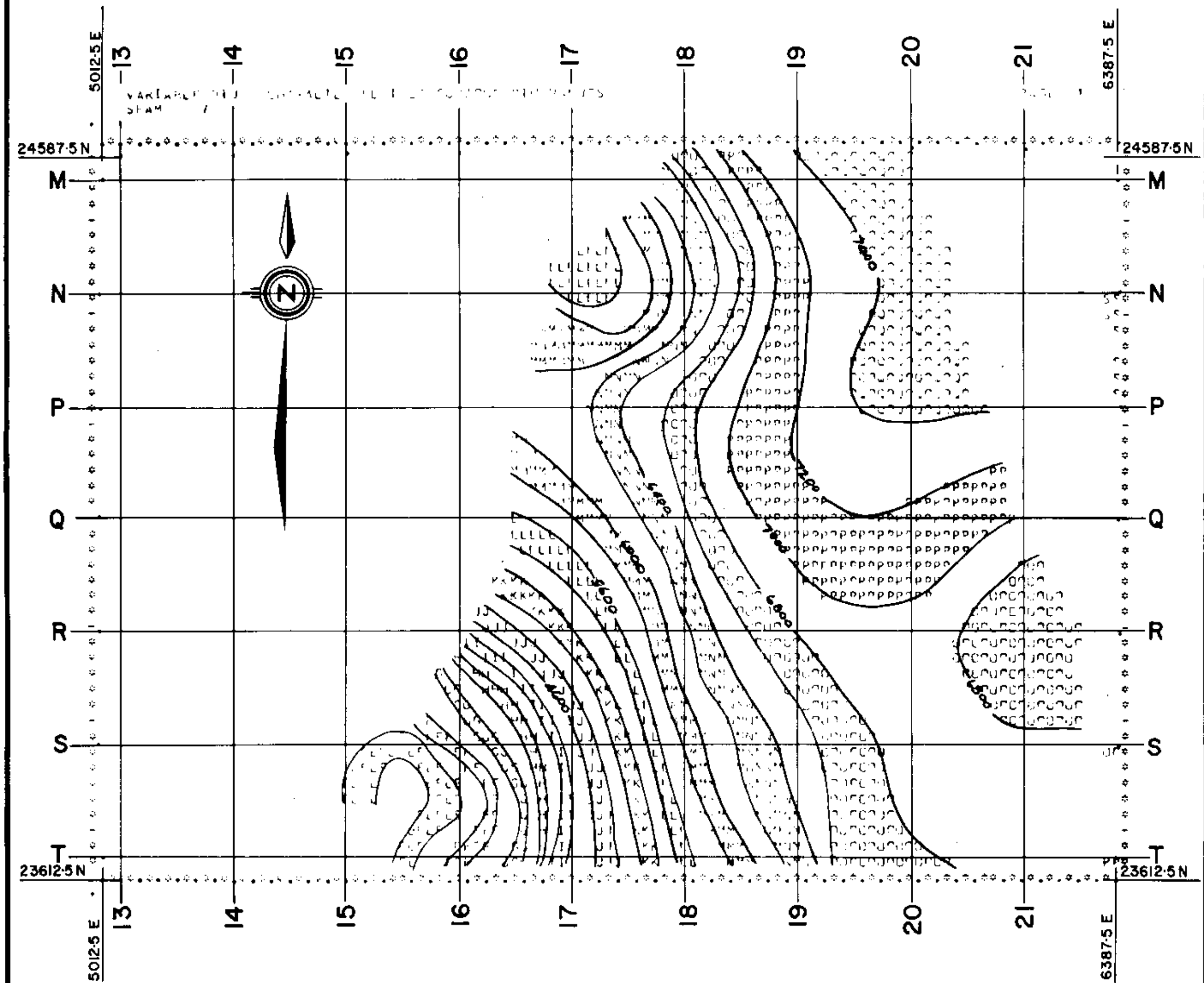

FIGURE 3-7

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY
HAT CREEK PROJECT
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CHARACTER PLOT
OF ISO-CALORIFIC VALUES
B-1-2 SUB-ZONE

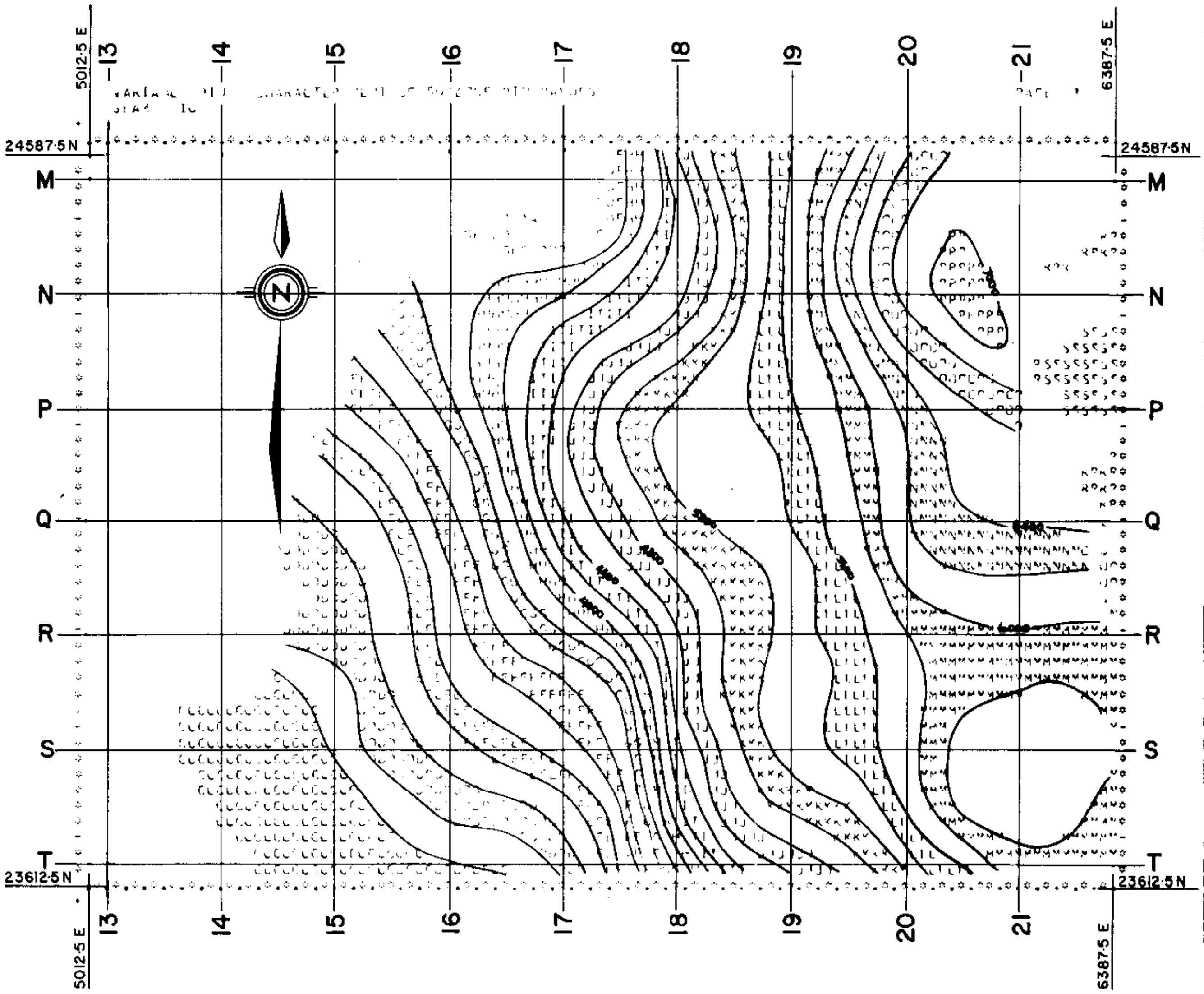

FIGURE 3 - 8

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY
HAT CREEK PROJECT
MINING FEASIBILITY REPORT

CHARACTER PLOT
OF ISO - CALORIFIC VALUES
C - 2 - 2 SUB - ZONE

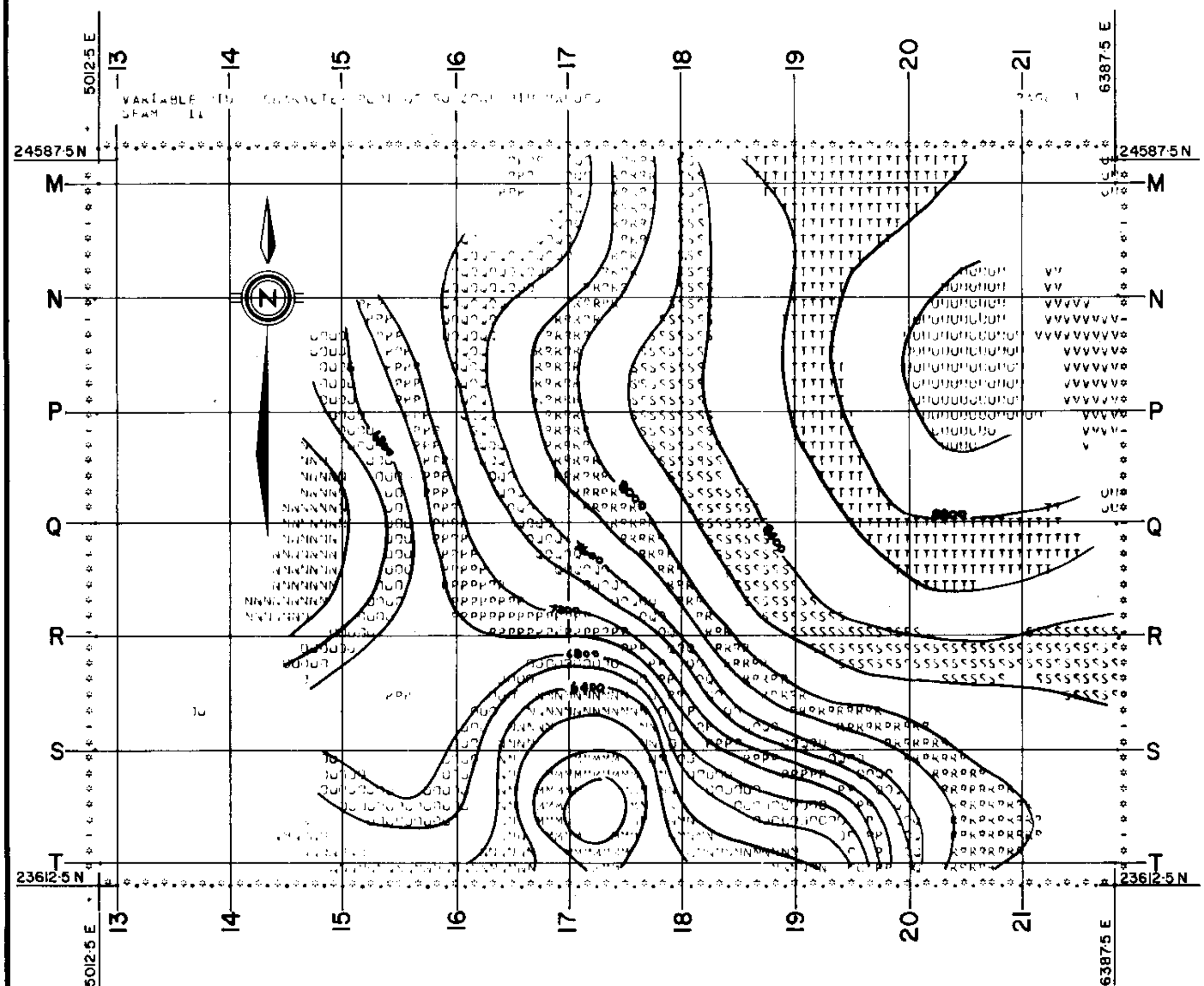

FIGURE 3-9

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY
HAT CREEK PROJECT
MINING FEASIBILITY REPORT

CHARACTER PLOT
OF ISO-CALORIFIC VALUES
D-1-1 SUB-ZONE

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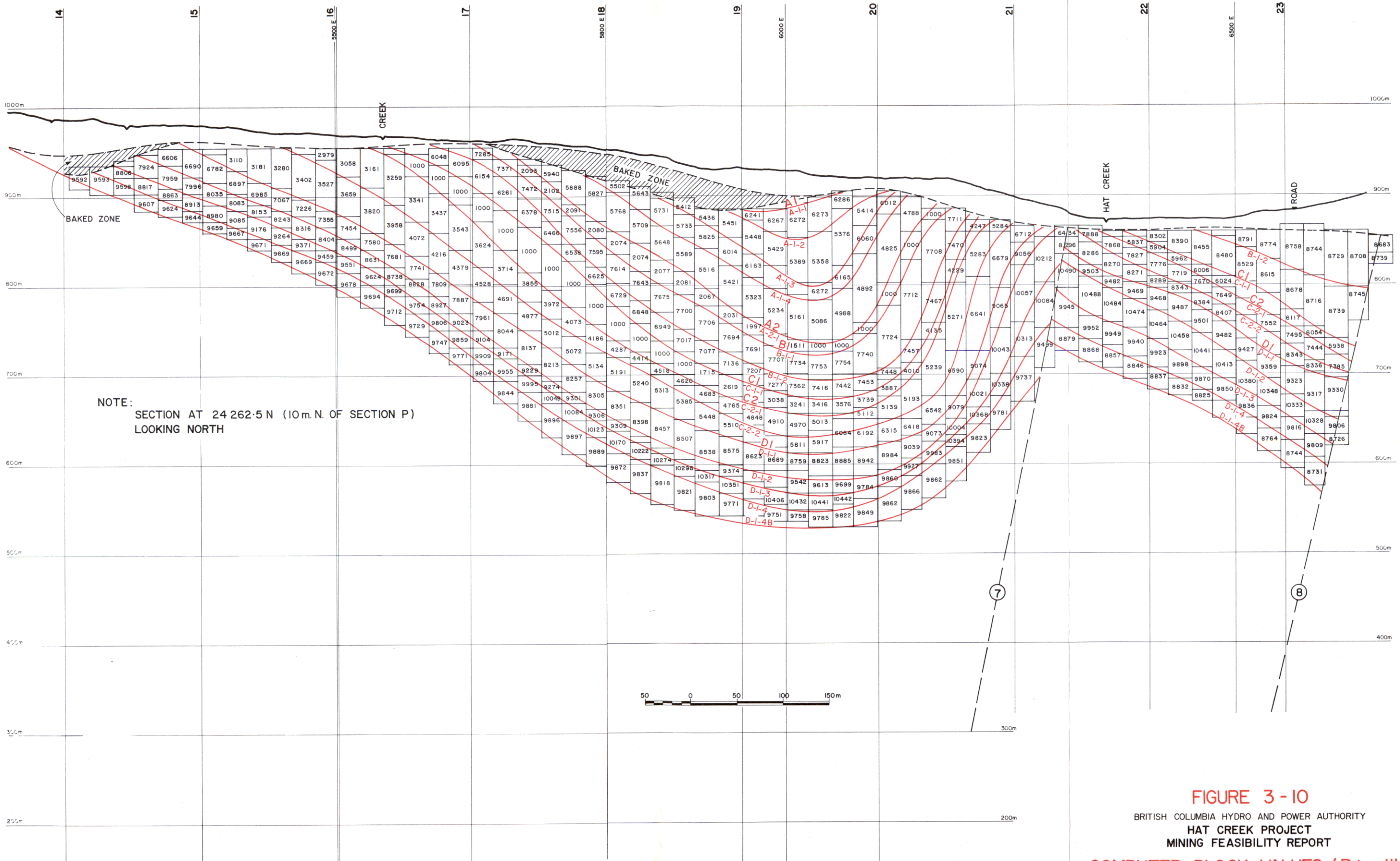

FIGURE 3-10

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY
HAT CREEK PROJECT
MINING FEASIBILITY REPORT

COMPUTER BLOCK VALUES (Btu/lb)
FOR SUB-ZONES

SECTION 4

RESERVES

4.1 COAL RESERVES

411 IN SITU RESERVES

The estimated coal reserves of No. 1 Deposit are divided into three categories - proven, probable, and marginal, as explained below. Proven and probable reserves are tabulated in Table 4-1.

411.1 Proven Reserves

Proven reserves are classified as mineable reserves contained within the 35-year pit that have a calorific value greater than 4000 Btu/lb (dry basis) and that are selected from the deposit on a statistical basis. All coal and waste partings in each sub-zone are included in the coal reserve calculations. These reserves are defined on the basis of diamond drill hole intersections on a 150-metre grid.

Although these reserves are classified as "measured" in an overall sense, they are not located in detail and there will be considerable error in specific areas due to actual seam boundaries deviating from the correlations. Underground development could provide for observations that would confirm correlations and further improve the quality of these reserves. Close-spaced diamond drilling should precede initial stripping operations.

Geostatistical studies indicate that the true average calorific value of A-Zone coal will lie within ± 300 Btu/lb of the estimated average. Wider ranges of calorific value are expected to occur in B and C coal zones, where the true average calorific value may differ by ± 600 Btu/lb from the estimated average. For D-Zone, the true average is shown to have a very low standard error, in the order of ± 150 Btu/lb. Because recognizable trends in coal quality were incorporated into the computer system of coal reserve estimation, the actual standard deviations and errors should be considerably less than those indicated by classical statistics.

Proven reserves are detailed by sub-zone in Table 4-2.

TABLE 4-1

Summary of Estimated Proven and
Probable Coal Reserves in No. 1 Deposit

Hat Creek Project Mining Feasibility Report 1978

	Tonnes* ($\times 10^6$)	% of Total	Calorific Value (Btu/lb)	Ash Content %	Sulphur Content %
PROVEN RESERVES (35-year pit reserves > 4000 Btu/lb, undiluted, dry basis)					
Zone A-1	77.5	22.5	5613	47.8	0.72
A-2	-	-	-	-	-
B-1	57.2	16.6	7373	35.6	0.68
C-1, C-2	60.4	17.6	6061	44.4	0.44
D-1	149.1	43.3	9147	24.5	0.31
Total	344.2				
Weighted Average			7515	35.1	0.49
PROBABLE RESERVES (beyond 35-year pit, calorific value > 4000 Btu/lb, undiluted, dry basis)					
Zone A	139.5	37.4	5227	50.0	0.69
B	66.8	17.9	6310	43.6	0.72
C	31.6	8.5	5157	51.1	0.40
D	134.9	36.2	8627	27.9	0.30
Total	372.8				
Weighted Average			6645	40.9	0.53
TOTAL PROVEN + PROBABLE RESERVES (calorific value > 4000 Btu/lb, undiluted, dry basis)					
Zone A	217	30.3	5365	49.2	0.70
B	124	17.3	6800	39.9	0.70
C	92	12.8	5750	46.7	0.42
D	284	39.6	8900	26.1	0.31
Total	717				
Weighted Average			7060	38.0	0.51

* Specific gravities used to compute tonnages reflect in situ moisture. The average in situ moisture is 25% for the total in place reserves.

TABLE 4-2

Sub-zone Breakdown of Hat Creek
No. 1 Deposit Proven Reserves*

Hat Creek Project Mining Feasibility Report 1978

	Tonnes (x 10^6)	% of Total	Calorific Value (Btu/lb)	Ash Content %	Sulphur Content %
Sub-zone A-1-1	12.6		6115	44.5	0.80
A-1-2	28.9		5624	47.7	0.74
A-1-3	12.1		5874	46.2	0.63
A-1-4	23.9		5204	50.4	0.69
Total Zone A-1	77.5	22.5	5613	47.8	0.72
Zone A-2-1	-		-	-	-
Sub-zone B-1-1	30.5		7494	34.6	0.66
B-1-2	26.7		7234	36.7	0.70
Total Zone B-1	57.2	16.6	7373	35.6	0.68
Zone C-1	9.2		5529	48.7	0.49
Sub-zone C-2-1	21.5		5926	45.3	0.49
C-2-2	29.7		6323	42.4	0.38
Total Zone C-1	60.4	17.6	6061	44.4	0.44
Sub-zone D-1-1	45.1		8411	29.1	0.30
D-1-2	36.7		9511	21.9	0.29
D-1-3	32.1		9706	20.7	0.30
D-1-4	35.2		9201	24.8	0.37
Total Zone D-1	149.1	43.3	9147	24.5	0.31
TOTAL...........	344.2	100.0			
WEIGHTED AVERAGE			7515	35.1	0.49

* Reserves of 35-year pit > 4000 Btu/lb, undiluted, dry basis

411.2 Probable Reserves

Reserves of the No. 1 Deposit classified as probable are those lying beyond the boundary of the 35-year pit which are not included in a definitive mining plan, but which are as well-defined by diamond drilling as the proven reserves.

Most of the probable reserves lie within an "expanded pit" which extends both laterally and vertically from the limits of the 35-year pit (see Figure 4-1), and which reaches a bottom elevation of 450 metres ASL; although drawn to geotechnically designed slopes, detailed mine planning for this pit has not been carried out.

The probable reserves, which are tabulated on Table 4-1, were calculated as follows. The outline of the expanded pit was plotted on sections and digitized into the computer model. The computer subsequently produced tonnage and quality estimates to an elevation of 500 metres ASL, and the additional tonnage to 450 metres was calculated manually. To calculate the remaining probable reserves beyond the expanded pit, the coal zones below this elevation were projected to reasonable, specific limits as outlined below:

Sections S, T, and U	to the base of D-Zone coal
Section V	to the west of Longitudinal Section 18, coal zones B to D inclusive above 500 m ASL
....	to the east of Longitudinal Section 18, down to the base of B-Zone
Section W .... (extending to latitude 23 100 N)	above 500 m ASL only, coal zones B to D inclusive

The expanded pit provides for mining 93% of the total proven and probable reserves to 450 metres ASL at an overall strip ratio of 2:1. Further deepening of the pit to include the additional probable reserves projected below it could not be attained without a major incremental increase in strip ratio.

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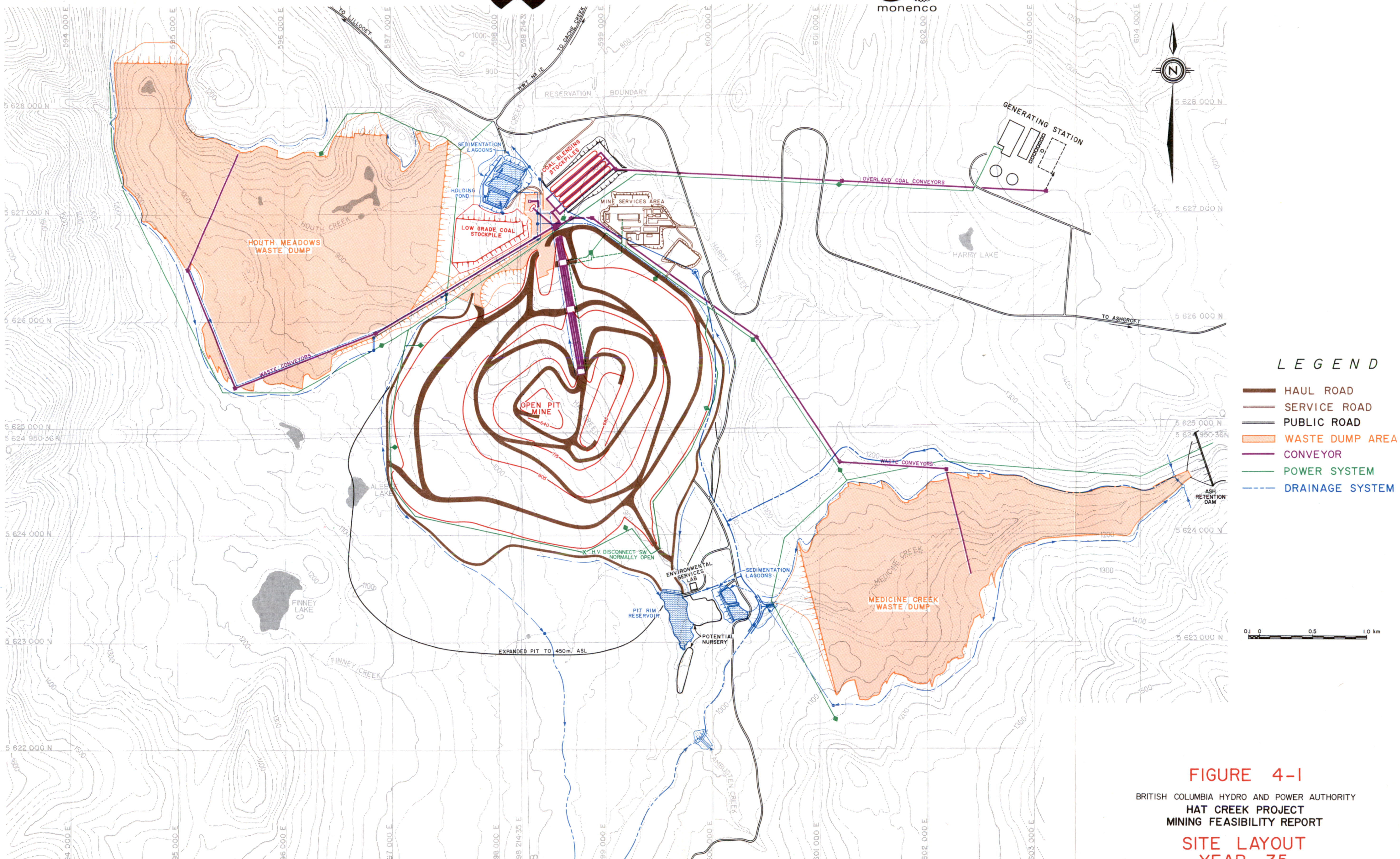

FIGURE 4-1

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY
HAT CREEK PROJECT
MINING FEASIBILITY REPORT

SITE LAYOUT
YEAR 35

411.3 Marginal Reserves

These reserves consist of the estimated quantities of low-grade coal at calorific values between 3000 and 4000 Btu/lb.

Unlike the proven and probable reserves, the low-grade coal included as marginal reserves is not differentiated here with regards to zone and proximate quality analyses. The tonnages of low-grade coal by zone to be mined over the life of the 35-year pit are listed in Volume III; C-Zone contains 82% of this material, with 64% in C-2 sub-zone in particular. The marginal reserves contained within the 35-year pit are estimated to be approximately 16 million tonnes. The total marginal reserves of the No. 1 Deposit are estimated to be 83 million tonnes at a calorific value between 3000 and 4000 Btu/lb (dry basis).

412 MINEABLE RESERVES

The estimated mineable reserves in the 35-year pit and in the expanded pit are diluted reserves, i.e., they are derived from the in situ coal by reducing reserve calculations by 1% to allow for mining losses, and increasing quantities by 2.5% dilution.

Mineable reserves are tabulated in Table 4-3.

TABLE 4-3

Summary of Mineable Reserves for
35-Year Pit and Expanded Pit

Hat Creek Project Mining Feasibility Report 1978

Production Material	CMJV 35-yr Pit	Increment to 450 m ASL	Expanded Pit
	Bank Cubic Metres x 10^6		
Coal (> 4000 Btu/lb)	234.3	205.2	439.5
Non-Fuel Materials			
Low-grade coal (3000-4000 Btu/lb)	8.9	38.3	47.2
Wastes above bedrock	161.1	642.3	803.5
Wastes below bedrock	281.8	215.0	496.9
Total non-fuel materials	451.8	895.6	1347.6
	Tonnes x 10^6		
Coal - diluted (> 4000 Btu/lb)	349.5	327.2	676.7
Low-Grade Coal (3000-4000 Btu/lb)	16.0	67.0	83.0
Strip Ratios (volume of non-fuel grade materials per tonne of coal)	1.3:1	2.7:1	2.0:1

4.2 RESERVE ESTIMATING PARAMETERS

421 IN SITU MOISTURE

An in situ moisture content of 25% was adopted for the calculation of all undiluted reserves in place. This decision was based on the following considerations:

(a) The arithmetic mean of a statistical summary of all available drill hole sample results for capacity moisture determination is 24.5% H_2O.

(b) The "as received" moisture content of the 1977 burn test samples at Battle River averaged 22%; this average moisture condition was prevalent after several weeks of storage in the Hat Creek area and transit to Alberta in mid-summer weather.

(c) The average run-of-mine moisture content of 12 analyses reported for 1924 adit samples was 28.3% (B.C. Minister of Mines, 1925; Geological Survey of Canada, 1925). These sources also indicate an average "as received" moisture content of 29.4% for 10 channel samples taken in No. 2 Adit. The Minister of Mines report also cites 17.4% H_2O as the average air-dried analysis for 55 adit samples tested in 1924.

(d) The 1976 washability tests of bucket-auger samples analyzed by Birtley Engineering (1976a) reported an average "as received" moisture content of 23%.

(e) In the 1977 EMR washing tests (CANMET, 1978) a mean "as received" moisture content of 23.4% was reported.

The effects of various "as received" moisture contents on calorific values and ash contents as compared to calculations done on "dry basis" are plotted on Figure 4-2.

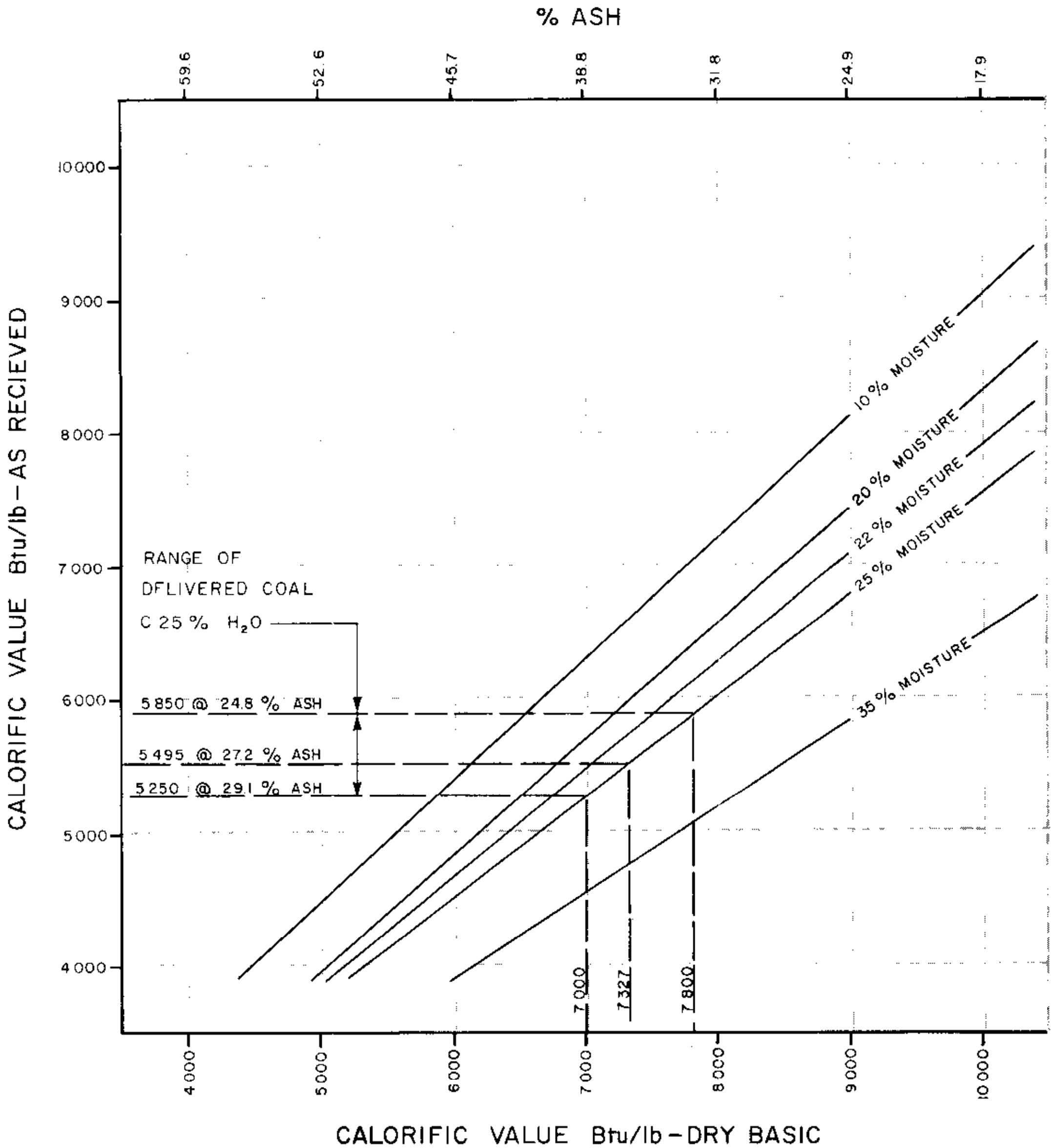

FIGURE 4-2

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY

HAT CREEK PROJECT

MINING FEASIBILITY REPORT

CALORIFIC VALUES AT VARIOUS IN SITU MOISTURE CONTENTS

422 SPECIFIC GRAVITY

All MEPS-generated quality averages for drill hole data involve weighting by sample length and specific gravity. Similarly, all tonnage calculations, either manual or by computer, have used tonnage factors based upon a calculated regression equation relating specific gravity and ash content, as described in Section 3.3 of Volume III, Mine Planning, and shown on Figure 3-3 in Section 3 of this volume.

423 CALORIFIC VALUE

A minimum average calorific value of 4000 Btu/lb (9.3 MJ/kg) has been used as the cut-off grade in estimating both proven and probable reserves. Reasons for the selection of this cut-off grade are described in Volume III, Section 4.3.

424 PARTINGS

All partings are included in the sub-zone reserves. The question of selectivity of coal in these folded and faulted soft rock formations has been studied and the results are also contained in Volume III.

4.3 VERIFICATION OF COMPUTER CALCULATED RESERVES

The modified inverse distance squared method of ore reserve calculation was developed for use where drill hole averages are known to have errors due to the distribution of values in the deposit, or in correlation of stratigraphy, sample size, assaying, etc.; this precaution appears warranted for the Hat Creek deposit. The method is similar to one developed in South Africa and described by MacGillivray et al. (1969).

A random check was made of data input to the computer and differences were found to be rare. A similar check of drill hole averages using specific gravity was made and the work was again found to be precise. The weighted moving averages calculated by the computer were not duplicated in a manual check; however, a rough check was made by weighting holes within 150 metres of a point by a factor of two, and holes from 150 to 300 metres away from the point by a factor of one. This check approximated the value at points picked off sub-zone Btu isoline maps.

One of the best checks of the method is by observation of the broad, smooth Btu isolines on the grade contour maps which highlight a trend of values across the deposit. This strong trend overrides the principle of applying single grade sources to a local block.

Manual checks of ore reserve calculations were made for nesting pits 1-3 years, 4-5 years, and 6-9 years to determine the measure of the precision of the computer simulation.

The manual method was approximate, a projection of cross-sectional area to calculate tonnes and a projection of the nearest drill hole for applicable grade. In effect this check introduces a random difference to the geological correlation that very likely simulates the results that will be experienced due to multiple faults, folds, and other graben-type structures that will become evident when close-spaced drilling or actual mining operations are carried out.

The results of the manual check indicate that, percentage-wise, there may be large sub-zone tonnage differences on blocks of less than 8 million tonnes. However, indications are that grade differences will be quite small, probably due to the small grade variations between adjacent sub-zones in a zone.

Tabulated below are the decreasing probable differences with increasing tonnages.

STATISTICAL AVERAGE OF DIFFERENCES

Size of Blocks (tonnes x 10^6)	% Difference in Tonnage	% Difference in Grade
0-1	55%	5%
1-2	25%	2.8%
2-4	15%	1.9%
4-8	8.8%	1.0%
8-16	7.0%	1.2%
16	8.5%	2.3%

More specifically, the manual check indicates that in spite of a reasonable amount of deviation from geological correlations, the proposed pit will provide forecast tonnages and grades within accurate limits for each of a series of nesting pits as follows:

	NESTING PIT YEARS			
	1-3	4-5	6-9	1-9
Manual Check				
tonnes	20 398 000	22 912 000	43 663 000	86 973 000
Btu/lb	7677	7715	7592	7644
Computer Calculation				
tonnes	18 773 000	26 568 000	46 512 000	91 853 000
Btu/lb	7497	7543	7523	7523
% Difference by Computer				
in tonnage	-8.0%	+16.0%	+6.5%	+5.6%
in grade	-2.3%	- 2.3%	-0.9%	-1.6%

SECTION 5

COAL QUALITY

AND

FUEL SPECIFICATIONS

5.1 COAL QUALITY ANALYSES

Reproductions of several computer listings that provide statistical summaries of the various chemical analyses and physical tests carried out in the overall assessment of Hat Creek coal as a boiler fuel are included on the following pages. Figures 5-1 and 5-2 are examples of B.C. Hydro's computer analytical file, showing proximate, ultimate, and ash analyses, as well as special test results for seven samples from DDH. 76-136. (It should be noted that calorific values are reported under Higher Heat Values, and that ash analyses are reported as both % Dry Ash and Mole%.)

Figures 5-3 to 5-14 inclusive provide a series of three computer summaries of various analyses of samples from each of coal zones A, B, C, and D. The first sheet of each series shows results of proximate, ultimate, moisture, and selected chemical analyses; the second sheet for each zone lists ash fusion temperatures under reducing and oxidizing atmospheres. The third sheet summarizes ash analyses as both % Dry Ash and Mole %. Those samples reporting Fe_2O_3 >30% and CaO >20% were excluded because their values were in extreme variance with the general range.

These computer listings are extracted from a file at B.C. Hydro's Computer Science Department. Other computer-generated reports organized by CMJV from this file are the following:

(a) Mole % for the mineral oxides in coal ash, previously only reported as % dry ash. Molecular weights were input and normalized mole % were calculated by the B.C. Hydro computer. Mole percentages are needed for several boiler fuel evaluation formulae and ratios.

(b) Tabulated listings and summaries by each coal zone for analyses, as summarized above, for samples that have ash fusion temperatures (initial deformation-reducing atmosphere) which are below the following "yardstick" temperatures:

<1315° C (2400° F)
<1200° C (2192° F)
<1150° C (2102° F)
<1100° C (2012° F)

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COMBINED DRILL HOLES - DEPOSIT 1

ZONE A LABORATORY COMPOSITE AND FIELD SAMPLES
EXCLUDING SAMPLES CONTAINING FE2O3 > 29.99% AND CAO > 19.99%

DRILL HOLE NUMBER	DDH 76-0136	DDH 76-0136	DDH 76-0136	DDH 76-0136	DDH 76-0136	DDH 76-0136	DDH 76-0136
SAMPLE NUMBER	79U	81U	83U	84U	86U	87U	89U
SINK-FLOAT NUMBER							
WASH SIZE FRACTION							
SCREEN TYPE							
SP. GRAVITY							
SP. GR. WEIGHT%							
MOISTURE %							
METRES -SAMPLE START	213.3	216.4	219.4	220.9	224.0	225.5	228.6
-SAMPLE END	216.4	219.4	220.9	224.0	225.5	228.6	231.6
-SAMPLE LENGTH	3.1	3.0	1.5	3.1	1.5	3.1	3.0
-VERTICAL HGT.	3.1	3.0	1.5	3.1	1.5	3.1	3.0
LATITUDE TOP	5624799.8	5624799.8	5624799.8	5624799.8	5624799.9	5624799.9	5624799.9
DEPARTURE TOP	598373.8	598373.7	598373.6	598373.6	598373.6	598373.6	598373.6
ELEVATION TOP	742.7	739.6	736.6	735.1	732.0	730.5	727.4
LATITUDE BOT	624799.8	624799.8	624799.8	624799.9	624799.9	624799.9	624800.0
DEPARTURE BOT	598373.7	598373.6	598373.6	598373.6	598373.6	598373.6	598373.5
ELEVATION BOT	739.6	736.6	735.1	732.0	730.5	727.4	724.4
ZONE(S)	A	A	A	A	A	A	A
MOISTURES							
AS RECEIVED %	24.94	27.02	26.57	23.10	25.54	23.14	19.81
AIR DRY LOSS %	16.07	18.40	16.62	15.99	19.22	17.52	16.30
AIR DRY LOSS TEMP(C)	29	29	29	29	29	29	29
RESIDUAL (LAB) %	8.38	10.56	11.93	8.46	7.82	6.81	4.19
EQUILIBRIUM %							
PROXIMATE ANALYSIS-DRY							
H. H. VALUE - KJ/KG	17175	19352	21662	14670	14712	14304	11257
ASH %	35.16	30.99	23.39	44.72	43.85	43.62	54.39
FIXED CARBON %	29.13	35.72	39.44	26.86	26.49	25.26	21.05
VOLATILE MATTER %	35.71	33.29	37.17	28.42	29.66	31.12	24.56
SULPHUR TOTAL %	.73	.94	.46	.78	.89	.83	.59
-PYRITIC %	.29	.33	.04	.41	.41	.37	.18
-SULPHATE %	.00	.00	.00	.00	.00	.00	.00
-ORGANIC %	.44	.61	.42	.37	.48	.46	.41
TOT. ALKALI AS NA2O %	0.46	0.39	0.44	0.46	0.46	0.39	0.84
CARBON DIOXIDE %	4.98	.62	2.26	1.46	1.88	4.49	.28
ULTIMATE - %DRY COAL							
CARBON %	43.22	48.71	53.70	37.07	36.43	36.56	29.63
HYDROGEN %	3.64	4.10	4.29	3.53	3.54	3.25	2.59
NITROGEN %	.68	1.34	.76	.55	.80	.97	.84
CHLORINE %	.10	.03	.10	.05	.05	.09	.07
SULPHUR %	.73	.94	.46	.78	.89	.83	.59
ASH %	35.16	30.99	23.39	44.72	43.85	43.62	54.39
OXYGEN(DETERMINED)%	18.10	17.26	18.68	15.67	15.41	16.70	13.40
UNDETERMINED+ERROR%	- 1.63	- 3.37	- 1.38	- 2.37	- .97	- 2.02	- 1.51
OXYGEN(DIFFERENCE)%	16.47	13.89	17.30	13.30	14.44	14.68	11.89
SAM #	79U	81U	83U	84U	86U	87U	89U
DH #	DDH 76-0136	DDH 76-0136	DDH 76-0136	DDH 76-0136	DDH 76-0136	DDH 76-0136	DDH 76-0136

FIGURE 5 - 1

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY
HAT CREEK PROJECT
MINING FEASIBILITY REPORT

B.C. HYDRO
COMPUTER ANALYTICAL FILE
EXAMPLE 1

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COMBINED DRILL HOLES - DEPOSIT 1

ZONE A LABORATORY COMPOSITE AND FIELD SAMPLES
EXCLUDING SAMPLES CONTAINING FE2O3 > 29.99% AND CAO > 19.99%

DRILL HOLE NUMBER	DDH 76-0136	DDH 76-0136	DDH 76-0136	DDH 76-0136	DDH 76-0136	DDH 76-0136	DDH 76-0136
SAMPLE NUMBER	79U	81U	83U	84U	86U	87U	89U
SINK-FLOAT NUMBER							
FUSION TEMPS. -CELSIUS							
INIT DEFORM -REDUCE	1112	+1482	1357	+1482	+1482	1365	1243
HGT = WIDTH -REDUCE	1126	+1482	1393	+1482	+1482	1390	1248
HGT=.5WIDTH -REDUCE	1143	+1482	1409	+1482	+1482	1404	1259
FLUID -REDUCE	1168	+1482	1418	+1482	+1482	1432	1271
INIT DEFORM -OXID	1165	+1482	1387	+1482	+1482	1393	1259
HGT = WIDTH -OXID	1215	+1482	1407	+1482	+1482	1412	1271
HGT=.5WIDTH -OXID	1304	+1482	1421	+1482	+1482	1432	1282
FLUID -OXID	1354	+1482	1434	+1482	+1482	1454	1293
MINERAL							
SIO2 %DRY ASH -MOLE%	43.11 56.15	54.62 66.06	49.01 61.48	53.34 65.98	50.94 63.11	46.48 60.77	54.47 66.34
AL2O3 %DRY ASH -MOLE%	24.70 18.95	32.65 23.26	28.03 20.72	33.03 24.08	34.38 25.10	31.34 24.14	32.98 23.67
TIO2 %DRY ASH -MOLE%	.72 .71	.32 .29	.47 .44	.20 .19	.73 .68	.92 .90	1.21 1.11
FE2O3 %DRY ASH -MOLE%	20.44 10.01	5.38 2.45	13.33 6.29	6.38 2.97	5.82 2.71	13.13 6.46	5.27 2.42
CAO %DRY ASH -MOLE%	4.01 5.59	1.98 2.57	3.28 4.41	1.25 1.66	2.02 2.68	2.07 2.90	1.62 2.11
MGO %DRY ASH -MOLE%	1.70 3.30	1.32 2.38	.87 1.63	1.52 2.80	1.13 2.09	.94 1.83	1.16 2.11
NA2O %DRY ASH -MOLE%	.82 1.04	.82 .96	1.56 1.90	.74 .89	.72 .86	.60 .76	.83 .98
K2O %DRY ASH -MOLE%	.48 .40	.68 .52	.49 .39	.44 .35	.50 .40	.45 .38	1.08 .84
MN3O4 %DRY ASH -MOLE%	.04 .01	.02 .01	.29 .10	.05 .02	.05 .02	.02 .01	.05 .02
V2O5 %DRY ASH -MOLE%	.08 .03	.06 .02	.04 .02	.09 .04	.01 .00	.06 .03	.08 .03
P2O5 %DRY ASH -MOLE%	.18 .10	1.26 .64	.24 .13	.16 .08	2.69 1.41	.42 .23	.22 .11
SO3 %DRY ASH -MOLE%	3.80 3.71	.93 .84	2.65 2.49	1.01 .94	1.01 .94	1.62 1.59	.28 .26
UNDETERMINED +ERROR %	- .08	- .04	- .26	+ 1.79	+ .00	+ 1.95	+ .75
OTHER ANALYSES							
WATER SOLUBLE NA2O%						.22	
WATER SOLUBLE K2O %						.02	
SP. GRAVITY							
SP. GR. MOISTURE %							
HGI #1						72	
HGI MOISTURE #1 %						14.40	
HGI #2						68	
HGI MOISTURE #2 %						21.90	
HGI #3						61	
HGI MOISTURE #3 %						22.40	
SAM #	79U	81U	83U	84U	86U	87U	89U
DH #	DDH 76-0136	DDH 76-0136	DDH 76-0136	DDH 76-0136	DDH 76-0136	DDH 76-0136	DDH 76-0136

FIGURE 5-2

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY
HAT CREEK PROJECT
MINING FEASIBILITY REPORT

B.C. HYDRO
COMPUTER ANALYTICAL FILE
EXAMPLE 2

17 MAY 78 HAT CREEK COAL DEVELOPMENT - STATISTICAL ANALYSIS OF TEST DATA BY ZONE PAGE 66A

COMBINED DRILL HOLES - DEPOSIT 1

ZONE A LABORATORY COMPOSITE AND FIELD SAMPLES
EXCLUDING SAMPLES CONTAINING FE2O3 > 29.99% AND CAO > 19.99%

PROXIMATE, MOISTURE AND OTHER SUMMARY

	HHV (KJ/KG)	% ASH	% F.C.	% V.M.	% S	% MOISTURES AS RECVD.	AIR DRY	RES-IDUAL	EQUIL.	% CO2	%ALK. AS NA2O	WATER SOLUBLE % NA2O	% K2O
MAXIMUM	26079	87.26	47.72	44.44	2.66	36.00	28.76	20.87	35.30	21.22	2.40	.31	.12
MINIMUM	1442	12.29	.78	10.60	.12	5.46	2.02	1.43	21.60	.04	.10	.18	.02
RANGE	24637	74.97	46.94	33.84	2.54	30.54	26.74	19.44	13.70	21.18	2.30	.13	.10
WEIGHTED MEAN	14975	42.83	26.58	30.60	.70	21.72	12.97	9.83	30.01	1.88	.65	.22	.04
SAMPLE COUNTS	451	451	450	450	451	444	430	437	4	433	451	6	6
SAMPLE CORE LENGTHS	2285	2285	2279	2279	2285	2118	1807	1975	152	1822	2285	18	18
ARITHMETIC MEAN	14728	43.64	26.29	30.06	.69	21.93	13.18	10.01	30.39	1.95	.66	.21	.04
SAMPLE COUNTS	451	451	450	450	451	444	430	437	4	433	451	6	6
SAMPLE CORE LENGTHS	2285	2285	2279	2279	2285	2118	1807	1975	152	1822	2285	18	18
STANDARD DEVIATION	5239	15.69	10.35	6.06	.33	4.66	5.33	4.07	6.11	2.25	.35	.04	.03
COEFF. OF VARIATION %	35.57	35.95	39.36	20.17	48.22	21.27	40.48	40.68	20.11	14.91	54.00	21.94	87.16

ULTIMATE SUMMARY

	% C	% H	% N	% CL	% S	% ASH	% OXY	% UNDET +ERR	% OXY (DIFF)
MAXIMUM	62.55	5.98	2.07	.93	2.66	87.26	19.68	3.52	19.21
MINIMUM	5.09	1.28	.06	.00	.12	12.29	6.36	-3.75	5.42
RANGE	57.46	4.70	2.01	.93	2.54	74.97	13.32	7.27	13.79
WEIGHTED MEAN	38.35	3.48	.90	.04	.70	42.83	15.04	-.95	13.70
SAMPLE COUNTS	451	451	451	439	451	451	128	128	451
SAMPLE CORE LENGTHS	2285	2285	2285	2236	2285	2285	338	338	2285
ARITHMETIC MEAN	37.64	3.45	.85	.03	.69	43.64	14.89	-.92	13.66
SAMPLE COUNTS	451	451	451	439	451	451	128	128	451
SAMPLE CORE LENGTHS	2285	2285	2285	2236	2285	2285	338	338	2285
STANDARD DEVIATION	12.57	.97	.31	.05	.33	15.69	2.52	1.30	2.29
COEFF. OF VARIATION %	33.39	28.20	37.02	54.73	48.22	35.95	16.96	-41.41	16.80

FIGURE 5 - 3

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY
HAT CREEK PROJECT
MINING FEASIBILITY REPORT

COMPUTER SUMMARY OF
PROXIMATE & ULTIMATE ANALYSES
A ZONE

17 MAY 78 HAT CREEK COAL DEVELOPMENT - STATISTICAL ANALYSIS OF TEST DATA BY ZONE PAGE 66B

COMBINED DRILL HOLES - DEPOSIT 1

ZONE A LABORATORY COMPOSITE AND FIELD SAMPLES
EXCLUDING SAMPLES CONTAINING FE2O3 > 29.99% AND CAO > 19.99%

FUSION SUMMARY - CELSIUS

	REDUCING				OXIDIZING			
	INIT. DEFORM	H=W	H=.5W	FLUID	INIT. DEFORM	H=W	H=.5W	FLUID
MAXIMUM	1482	1482	1482	1482	1476	1473	1482	1482
MINIMUM	1087	1101	1115	1126	1165	1215	1259	1273
RANGE	395	381	367	356	311	258	223	209
WEIGHTED MEAN	1309	1330	1356	1383	1358	1384	1410	1409
SAMPLE COUNTS	214	180	156	129	36	32	28	25
SAMPLE CORE LENGTHS	1010	826	716	564	172	160	148	99
ARITHMETIC MEAN	1303	1324	1348	1372	1362	1379	1393	1413
SAMPLE COUNTS	214	180	156	129	36	32	28	25
SAMPLE CORE LENGTHS	1010	826	716	564	172	160	148	99
STANDARD DEVIATION	107	98	92	89	86	75	64	58
COEFF. OF VARIATION %	8.25	7.39	6.85	6.54	6.31	5.47	4.64	4.16
SAMPLE COUNTS OF + DATA	236	270	294	321	105	109	113	116
SAMPLE CORE LENGTHS OF + DATA	1271	1455	1565	1717	513	525	537	586

FIGURE 5-4

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY
HAT CREEK PROJECT
MINING FEASIBILITY REPORT

COMPUTER SUMMARY OF
ASH FUSION TEMPERATURES
A ZONE

cominco-monenco joint venture

monenco

17 MAY 78 HAT CREEK COAL DEVELOPMENT - STATISTICAL ANALYSIS OF TEST DATA BY ZONE PAGE 66C

COMBINED DRILL HOLES - DEPOSIT 1

ZONE A LABORATORY COMPOSITE AND FIELD SAMPLES
EXCLUDING SAMPLES CONTAINING FE2O3 > 29.99% AND CAO > 19.99%

MINERAL SUMMARY - %DRY ASH

	% SIO2	% AL2O3	% TIO2	% FE2O3	% CAO	% MGO	% NA2O	% K2O	% MN3O4	% V2O5	% P2O5	% SO3	% UNDET +ERR
MAXIMUM	64.98	38.02	1.85	29.79	17.11	8.07	3.67	2.03	1.15	.49	3.14	7.64	7.57
MINIMUM	31.44	13.37	.06	2.18	.33	.63	.21	.10	.01	.00	.00	.12	-1.56
RANGE	33.54	24.65	1.79	27.61	16.78	7.44	3.46	1.93	1.14	.49	3.14	7.52	9.13
WEIGHTED MEAN	52.91	28.42	.97	8.07	2.68	1.63	1.06	.70	.13	.05	.33	2.01	1.09
SAMPLE COUNTS	451	451	451	451	451	451	451	451	433	433	451	451	451
SAMPLE CORE LENGTHS	2285	2285	2285	2285	2285	2285	2285	2285	1822	1822	2285	2285	2285
ARITHMETIC MEAN	52.80	28.27	.95	8.35	2.66	1.65	1.04	.71	.12	.05	.32	1.91	1.12
SAMPLE COUNTS	451	451	451	451	451	451	451	451	433	433	451	451	451
SAMPLE CORE LENGTHS	2285	2285	2285	2285	2285	2285	2285	2285	1822	1822	2285	2285	2285
STANDARD DEVIATION	5.14	3.87	.30	4.51	2.00	.67	.55	.31	.14	.03	.33	1.20	1.10
COEFF. OF VARIATION %	9.74	13.69	31.74	54.08	75.23	40.71	53.78	44.32	21.70	68.16	6.18	63.11	97.60

MINERAL SUMMARY - MOLE%

	% SIO2	% AL2O3	% TIO2	% FE2O3	% CAO	% MGO	% NA2O	% K2O	% MN3O4	% V2O5	% P2O5	% SO3
MAXIMUM	75.34	27.51	1.69	15.75	21.90	14.37	4.27	1.55	.42	.19	1.75	7.36
MINIMUM	37.56	9.15	.06	.98	.43	1.16	.24	.08	.00	.00	.00	.11
RANGE	37.78	18.36	1.63	14.77	21.47	13.21	4.03	1.47	.42	.19	1.75	7.25
WEIGHTED MEAN	64.54	20.46	.89	3.75	3.51	2.97	1.25	.54	.04	.02	.17	1.85
SAMPLE COUNTS	451	451	451	451	451	451	451	451	433	433	451	451
SAMPLE CORE LENGTHS	2285	2285	2285	2285	2285	2285	2285	2285	1822	1822	2285	2285
ARITHMETIC MEAN	64.50	20.39	.87	3.89	3.51	3.02	1.23	.56	.04	.02	.16	1.77
SAMPLE COUNTS	451	451	451	451	451	451	451	451	433	433	451	451
SAMPLE CORE LENGTHS	2285	2285	2285	2285	2285	2285	2285	2285	1822	1822	2285	2285
STANDARD DEVIATION	4.92	2.80	.27	2.26	2.63	1.25	.65	.24	.05	.01	.17	1.13
COEFF. OF VARIATION %	7.62	13.76	31.37	58.01	75.03	41.54	53.26	43.63	25.91	66.84	7.60	64.26

FIGURE 5-5

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY
HAT CREEK PROJECT
MINING FEASIBILITY REPORT

COMPUTER SUMMARY
OF ASH ANALYSES
A ZONE

cominco-monenco joint venture

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17 MAY 78 HAT CREEK COAL DEVELOPMENT - STATISTICAL ANALYSIS OF TEST DATA BY ZONE PAGE 89A

COMBINED DRILL HOLES - DEPOSIT 1

ZONE B LABORATORY COMPOSITE AND FIELD SAMPLES
EXCLUDING SAMPLES CONTAINING FE2O3 > 29.99% AND CAO > 19.99%

PROXIMATE, MOISTURE AND OTHER SUMMARY

	HHV (KJ/KG)	% ASH	% F.C.	% V.M.	% S	% MOISTURES AS RECVD.	AIR DRY	RES- IDUAL	EQUIL.	% CO2	%ALK. AS NA2O	WATER SOLUBLE % NA2O	% K2O
MAXIMUM	24611	73.37	47.06	44.33	5.54	32.91	24.14	18.98	30.40	14.66	1.72	.32	.03
MINIMUM	3823	15.34	4.23	17.27	.15	9.85	2.43	1.10	26.20	.18	.16	.21	.02
RANGE	20788	58.03	42.83	27.06	5.39	23.06	21.71	17.88	4.20	14.48	1.56	.11	.01
WEIGHTED MEAN	16833	37.21	30.65	32.15	.79	20.85	13.05	8.66	28.47	1.86	.57	.27	.02
SAMPLE COUNTS	148	148	148	148	148	146	141	143	2	141	148	6	6
SAMPLE CORE LENGTHS	851	851	851	851	851	764	548	634	86	548	851	18	18
ARITHMETIC MEAN	17017	36.97	31.40	31.62	.83	21.45	13.87	8.72	28.29	1.75	.58	.26	.02
SAMPLE COUNTS	148	148	148	148	148	146	141	143	2	141	148	6	6
SAMPLE CORE LENGTHS	851	851	851	851	851	764	548	634	86	548	851	18	18
STANDARD DEVIATION	4308	12.43	8.51	5.03	.55	3.58	3.86	3.50	2.96	2.11	.25	.04	
COEFF. OF VARIATION %	25.31	33.63	27.10	15.91	66.78	16.70	27.86	40.19	10.49	20.35	43.12	17.52	22.13

ULTIMATE SUMMARY

	% C	% H	% N	% CL	% S	% ASH	% OXY	% UNDET +ERR	% OXY (DIFF)
MAXIMUM	61.10	6.08	1.43	.17	5.54	73.37	19.06	1.22	18.15
MINIMUM	12.98	1.58	.21	.00	.15	15.34	12.16	-4.01	9.10
RANGE	48.12	4.50	1.22	.17	5.39	58.03	6.90	5.23	9.05
WEIGHTED MEAN	43.03	3.79	.94	.04	.79	37.21	16.04	-1.62	14.21
SAMPLE COUNTS	148	148	148	147	148	148	65	65	148
SAMPLE CORE LENGTHS	851	851	851	844	851	851	146	146	851
ARITHMETIC MEAN	43.31	3.84	.92	.03	.83	36.97	15.89	-1.59	14.06
SAMPLE COUNTS	148	148	148	147	148	148	65	65	148
SAMPLE CORE LENGTHS	851	851	851	844	851	851	146	146	851
STANDARD DEVIATION	10.30	.94	.23	.03	.55	12.43	1.49	.95	1.60
COEFF. OF VARIATION %	23.79	24.46	25.19	2.27	66.78	33.63	9.39	-59.73	11.40

FIGURE 5-6

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY
HAT CREEK PROJECT
MINING FEASIBILITY REPORT

COMPUTER SUMMARY OF
PROXIMATE & ULTIMATE ANALYSES
B ZONE

17 MAY 78 HAT CREEK COAL DEVELOPMENT - STATISTICAL ANALYSIS OF TEST DATA BY ZONE PAGE 89B

COMBINED DRILL HOLES - DEPOSIT 1

ZONE B LABORATORY COMPOSITE AND FIELD SAMPLES
EXCLUDING SAMPLES CONTAINING FE2O3 > 29.99% AND CAO > 19.99%

FUSION SUMMARY - CELSIUS

	REDUCING				OXIDIZING			
	INIT. DEFORM	H=W	H=.5W	FLUID	INIT. DEFORM	H=W	H=.5W	FLUID
MAXIMUM	1471	1476	1476	1482	1443	1448	1482	1482
MINIMUM	1101	1107	1126	1137	1187	1193	1198	1204
RANGE	370	369	350	345	256	255	284	278
WEIGHTED MEAN	1330	1354	1365	1360	1374	1383	1423	1339
SAMPLE COUNTS	65	53	47	38	14	13	13	12
SAMPLE CORE LENGTHS	421	318	242	154	114	75	75	28
ARITHMETIC MEAN	1298	1319	1337	1351	1328	1334	1350	1351
SAMPLE COUNTS	65	53	47	38	14	13	13	12
SAMPLE CORE LENGTHS	421	318	242	154	114	75	75	28
STANDARD DEVIATION	104	104	101	94	86	88	94	92
COEFF. OF VARIATION %	8.02	7.89	7.61	7.00	6.48	6.66	7.01	6.87
SAMPLE COUNTS OF + DATA	83	95	101	110	57	58	58	59
SAMPLE CORE LENGTHS OF + DATA	429	532	608	696	297	336	336	383

FIGURE 5-7

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY
HAT CREEK PROJECT
MINING FEASIBILITY REPORT

COMPUTER SUMMARY OF
ASH FUSION TEMPERATURES
B ZONE

17 MAY 78 HAT CREEK COAL DEVELOPMENT - STATISTICAL ANALYSIS OF TEST DATA BY ZONE PAGE 89C

COMBINED DRILL HOLES - DEPOSIT 1

ZONE B LABORATORY COMPOSITE AND FIELD SAMPLES
EXCLUDING SAMPLES CONTAINING FE2O3 > 29.99% AND CAO > 19.99%

MINERAL SUMMARY - %DRY ASH

	% SIO2	% AL2O3	% TIO2	% FE2O3	% CAO	% MGO	% NA2O	% K2O	% MN3O4	% V2O5	% P2O5	% SO3	% UNDET +ERR
MAXIMUM	64.06	37.62	1.33	28.57	17.72	4.87	2.13	1.64	.75	.22	3.27	6.33	5.16
MINIMUM	33.93	14.67	.41	2.43	.60	.31	.17	.21	.00	.00	.00	.15	-.21
RANGE	30.13	22.95	.92	26.14	17.12	4.56	1.96	1.43	.75	.22	3.27	6.18	5.37
WEIGHTED MEAN	52.48	28.40	.84	8.40	2.79	1.70	1.04	.73	.11	.06	.38	2.15	.98
SAMPLE COUNTS	148	148	148	148	148	148	148	148	141	141	148	148	148
SAMPLE CORE LENGTHS	851	851	851	851	851	851	851	851	548	548	851	851	851
ARITHMETIC MEAN	51.64	29.32	.82	8.17	2.91	1.68	1.11	.68	.09	.05	.34	1.95	.97
SAMPLE COUNTS	148	148	148	148	148	148	148	148	141	141	148	148	148
SAMPLE CORE LENGTHS	851	851	851	851	851	851	851	851	548	548	851	851	851
STANDARD DEVIATION	5.44	4.44	.19	5.34	2.64	.78	.32	.23	.13	.02	.48	1.43	.86
COEFF. OF VARIATION %	10.49	15.15	23.67	65.43	90.75	46.57	29.18	34.05	43.54	49.57	41.43	73.59	88.74

MINERAL SUMMARY - MOLE%

	% SIO2	% AL2O3	% TIO2	% FE2O3	% CAO	% MGO	% NA2O	% K2O	% MN3O4	% V2O5	% P2O5	% SO3
MAXIMUM	73.90	27.06	1.20	14.72	22.17	9.41	2.48	1.24	.26	.10	1.75	5.80
MINIMUM	43.99	12.04	.36	1.11	.77	.57	.23	.16	.00	.00	.00	.14
RANGE	29.91	15.02	.84	13.61	21.40	8.84	2.25	1.08	.26	.10	1.75	5.66
WEIGHTED MEAN	64.06	20.45	.77	3.93	3.66	3.11	1.23	.56	.04	.02	.20	1.99
SAMPLE COUNTS	148	148	148	148	148	148	148	148	141	141	148	148
SAMPLE CORE LENGTHS	851	851	851	851	851	851	851	851	548	548	851	851
ARITHMETIC MEAN	63.41	21.15	.76	3.83	3.83	3.08	1.32	.53	.03	.02	.18	1.81
SAMPLE COUNTS	148	148	148	148	148	148	148	148	141	141	148	148
SAMPLE CORE LENGTHS	851	851	851	851	851	851	851	851	548	548	851	851
STANDARD DEVIATION	5.40	3.09	.17	2.70	3.38	1.46	.37	.17	.04	.01	.25	1.36
COEFF. OF VARIATION %	8.52	14.63	22.97	70.57	88.29	47.56	28.54	32.79	52.10	50.69	41.85	75.09

FIGURE 5-8

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY
HAT CREEK PROJECT
MINING FEASIBILITY REPORT

COMPUTER SUMMARY OF ASH ANALYSES B ZONE

1[illegible] MAY 78 HAT CREEK COAL DEVELOPMENT - STATISTICAL ANALYSIS OF TEST DATA BY ZONE PAGE 118A

COMBINED DRILL HOLES - DEPOSIT 1

ZONE C LABORATORY COMPOSITE AND FIELD SAMPLES
EXCLUDING SAMPLES CONTAINING FE2O3 > 29.99% AND CAO > 19.99%

PROXIMATE, MOISTURE AND OTHER SUMMARY

	HHV (KJ/KG)	% ASH	% F.C.	% V.M.	% S	% MOISTURES AS RECVD.	AIR DRY	RES-IDUAL	EQUIL.	% CO2	%ALK. AS NA2O	WATER SOLUBLE % NA2O	% K2O
MAXIMUM	23627	81.16	46.18	42.66	2.98	32.84	26.30	16.61		16.74	2.75	.31	.04
MINIMUM	2386	18.90	2.35	12.10	.14	6.33	2.08	1.97		.20	.13	.23	.02
RANGE	21241	62.26	43.83	30.56	2.84	26.51	24.22	14.64		16.54	2.62	.08	.02
WEIGHTED MEAN	11795	51.45	21.54	27.02	.47	20.29	14.02	7.25		3.35	.82	.27	.03
SAMPLE COUNTS	192	192	192	192	192	191	185	186		183	192	4	4
SAMPLE CORE LENGTHS	1101	1101	1101	1101	1101	1051	933	982		857	1101	12	12
ARITHMETIC MEAN	11433	52.57	20.63	26.79	.49	19.87	13.21	7.60		3.66	.82	.26	.02
SAMPLE COUNTS	192	192	192	192	192	191	185	186		183	192	4	4
SAMPLE CORE LENGTHS	1101	1101	1101	1101	1101	1051	933	982		857	1101	12	12
STANDARD DEVIATION	4591	13.37	8.73	6.12	.35	5.50	5.83	3.53		2.99	.45	.03	
COEFF. OF VARIATION %	40.15	25.43	42.32	22.85	72.28	27.69	44.11	46.49		81.62	54.88	13.08	34.81

ULTIMATE SUMMARY

	% C	% H	% N	% CL	% S	% ASH	% OXY	% UNDET +ERR	% OXY (DIFF)
MAXIMUM	58.96	5.59	1.50	.14	2.98	81.16	17.10	2.39	22.65
MINIMUM	7.89	1.10	.14	.00	.14	18.90	10.19	-5.12	6.78
RANGE	51.07	4.49	1.36	.14	2.84	62.26	6.91	7.51	15.87
WEIGHTED MEAN	31.61	2.89	.74	.02	.47	51.45	13.86	-1.75	12.82
SAMPLE COUNTS	192	192	192	187	192	192	38	38	192
SAMPLE CORE LENGTHS	1101	1101	1101	1080	1101	1101	111	111	1101
ARITHMETIC MEAN	30.63	2.84	.68	.01	.49	52.57	13.89	-1.74	12.74
SAMPLE COUNTS	192	192	192	187	192	192	38	38	192
SAMPLE CORE LENGTHS	1101	1101	1101	1080	1101	1101	111	111	1101
STANDARD DEVIATION	10.97	.84	.22	.01	.35	13.37	1.92	1.13	2.21
COEFF. OF VARIATION %	35.81	29.84	32.47	14.39	72.28	25.43	13.86	-65.17	17.38

FIGURE 5-9

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY
HAT CREEK PROJECT
MINING FEASIBILITY REPORT

COMPUTER SUMMARY OF
PROXIMATE & ULTIMATE ANALYSES
C ZONE

COMBINED DRILL HOLES - DEPOSIT 1

ZONE C LABORATORY COMPOSITE AND FIELD SAMPLES
EXCLUDING SAMPLES CONTAINING FE2O3 > 29.99% AND CAO > 19.99%

FUSION SUMMARY - CELSIUS

	REDUCING				OXIDIZING			
	INIT. DEFORM	H=W	H=.5W	FLUID	INIT. DEFORM	H=W	H=.5W	FLUID
MAXIMUM	1476	1479	1482	1482	1471	1473	1465	1482
MINIMUM	1076	1086	1098	1148	1176	1182	1187	1193
RANGE	400	393	384	334	295	291	278	289
WEIGHTED MEAN	1322	1335	1355	1360	1376	1380	1393	1414
SAMPLE COUNTS	122	108	95	76	14	12	11	11
SAMPLE CORE LENGTHS	721	591	520	376	110	86	83	83
ARITHMETIC MEAN	1295	1316	1334	1346	1316	1316	1322	1340
SAMPLE COUNTS	122	108	95	76	14	12	11	11
SAMPLE CORE LENGTHS	721	591	520	376	110	86	83	83
STANDARD DEVIATION	105	100	97	86	101	94	87	95
COEFF. OF VARIATION %	8.11	7.67	7.27	6.46	7.73	7.21	6.64	7.12
SAMPLE COUNTS OF + DATA	69	83	96	115	34	36	37	37
SAMPLE CORE LENGTHS OF + DATA	376	505	576	721	280	303	306	306

FIGURE 5-10

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY
HAT CREEK PROJECT
MINING FEASIBILITY REPORT

COMPUTER SUMMARY OF
ASH FUSION TEMPERATURES
C ZONE

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COMBINED DRILL HOLES - DEPOSIT 1

ZONE C LABORATORY COMPOSITE AND FIELD SAMPLES
EXCLUDING SAMPLES CONTAINING FE2O3 > 29.99% AND CAO > 19.99%

MINERAL SUMMARY - %DRY ASH

	% SIO2	% AL2O3	% TIO2	% FE2O3	% CAO	% MGO	% NA2O	% K2O	% MN3O4	% V2O5	% P2O5	% SO3	% UNDET +ERR
MAXIMUM	63.86	36.55	1.84	28.37	18.53	4.89	3.14	1.76	1.94	.21	6.08	4.78	5.81
MINIMUM	32.74	12.95	.15	2.22	.69	.59	.26	.15	.00	.00	.00	.25	-1.26
RANGE	31.12	23.60	1.69	26.15	17.84	4.30	2.88	1.61	1.94	.21	6.08	4.53	7.07
WEIGHTED MEAN	52.69	27.02	.89	9.66	3.14	1.77	.99	.82	.19	.05	.33	1.53	.99
SAMPLE COUNTS	192	192	192	192	192	192	192	192	182	182	192	192	192
SAMPLE CORE LENGTHS	1101	1101	1101	1101	1101	1101	1101	1101	822	822	1101	1101	1101
ARITHMETIC MEAN	52.27	27.04	.87	9.81	3.35	1.64	.98	.81	.18	.04	.36	1.49	.91
SAMPLE COUNTS	192	192	192	192	192	192	192	192	182	182	192	192	192
SAMPLE CORE LENGTHS	1101	1101	1101	1101	1101	1101	1101	1101	822	822	1101	1101	1101
STANDARD DEVIATION	5.82	4.07	.23	5.61	3.06	.73	.52	.31	.23	.03	.55	.89	1.00
COEFF. OF VARIATION %	11.13	15.05	27.05	57.19	91.24	39.96	53.42	38.11	27.57	75.08	52.44	59.84	10.00

MINERAL SUMMARY - MOLE%

	% SIO2	% AL2O3	% TIO2	% FE2O3	% CAO	% MGO	% NA2O	% K2O	% MN3O4	% V2O5	% P2O5	% SO3
MAXIMUM	74.49	27.25	1.72	14.52	23.79	8.07	3.68	1.35	.69	.09	3.45	4.46
MINIMUM	45.46	9.15	.15	.98	.90	1.07	.28	.13	.00	.00	.00	.23
RANGE	29.03	16.10	1.57	13.54	22.89	7.00	3.40	1.22	.69	.09	3.45	4.23
WEIGHTED MEAN	64.35	19.48	.82	4.53	4.13	3.24	1.17	.64	.06	.02	.17	1.41
SAMPLE COUNTS	192	192	192	192	192	192	192	192	182	182	192	192
SAMPLE CORE LENGTHS	1101	1101	1101	1101	1101	1101	1101	1101	822	822	1101	1101
ARITHMETIC MEAN	63.84	19.51	.80	4.60	4.40	3.36	1.16	.63	.06	.01	.19	1.38
SAMPLE COUNTS	192	192	192	192	192	192	192	192	182	182	192	192
SAMPLE CORE LENGTHS	1101	1101	1101	1101	1101	1101	1101	1101	822	822	1101	1101
STANDARD DEVIATION	5.54	2.92	.21	2.86	3.94	1.35	.62	.23	.08	.01	.30	.84
COEFF. OF VARIATION %	8.68	14.98	26.88	62.22	89.58	40.14	53.26	36.99	36.15	76.01	59.21	61.08

FIGURE 5-11

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY
HAT CREEK PROJECT
MINING FEASIBILITY REPORT

COMPUTER SUMMARY
OF ASH ANALYSES
C ZONE

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COMBINED DRILL HOLES - DEPOSIT 1

ZONE D LABORATORY COMPOSITE AND FIELD SAMPLES
EXCLUDING SAMPLES CONTAINING FE2O3 > 29.99% AND CAO > 19.99%

PROXIMATE, MOISTURE AND OTHER SUMMARY

	HHV (KJ/KG)	% ASH	% F.C.	% V.M.	% S	% MOISTURES AS RECVD.	AIR DRY	RES-IDUAL	EQUIL.	% CO2	%ALK. AS NA2O	WATER SOLUBLE % NA2O	% K2O
MAXIMUM	27398	73.13	63.33	46.61	2.11	32.82	30.33	22.62	25.50	13.53	1.74	.35	.03
MINIMUM	4407	8.13	6.95	.62	.12	5.75	2.32	.65	23.60	.08	.08	.15	.01
RANGE	22991	65.00	76.38	45.99	1.99	27.07	28.01	21.97	1.90	13.45	1.66	.20	.02
WEIGHTED MEAN	21388	24.33	39.10	36.60	.32	23.56	13.61	10.91	24.61	1.33	.45	.26	.02
SAMPLE COUNTS	469	469	467	467	469	461	447	455	2	433	469	6	6
SAMPLE CORE LENGTHS	3335	3335	3326	3326	3335	2968	2406	2774	96	2287	3335	18	18
ARITHMETIC MEAN	21379	24.58	39.08	36.36	.33	23.73	13.42	11.72	24.54	1.36	.46	.25	.01
SAMPLE COUNTS	469	469	467	467	469	461	447	455	2	433	469	6	6
SAMPLE CORE LENGTHS	3335	3335	3326	3326	3335	2968	2406	2774	96	2287	3335	18	18
STANDARD DEVIATION	3908	11.15	8.68	5.27	.17	4.20	5.20	4.52	1.34	1.90	.22	.06	
COEFF. OF VARIATION %	18.28	45.36	22.21	14.49	51.71	17.73	38.76	38.61	5.47	40.20	48.72	25.95	41.06

ULTIMATE SUMMARY

	% C	% H	% N	% CL	% S	% ASH	% OXY	% UNDET +ERR	% OXY (DIFF)
MAXIMUM	68.99	6.62	1.64	.41	2.11	73.13	20.83	.20	19.59
MINIMUM	13.88	1.60	.12	.00	.12	8.13	13.40	-7.42	6.45
RANGE	55.11	5.02	1.52	.41	1.99	65.00	7.43	7.62	13.14
WEIGHTED MEAN	54.02	4.32	.92	.03	.32	24.33	16.63	-1.60	16.06
SAMPLE COUNTS	469	469	469	468	469	469	78	78	469
SAMPLE CORE LENGTHS	3335	3335	3335	3333	3335	3335	181	181	3335
ARITHMETIC MEAN	53.98	4.35	.88	.02	.33	24.58	16.63	-1.56	15.82
SAMPLE COUNTS	469	469	469	468	469	469	78	78	469
SAMPLE CORE LENGTHS	3335	3335	3335	3333	3335	3335	181	181	3335
STANDARD DEVIATION	9.26	.86	.15	.03	.17	11.15	1.21	1.14	1.81
COEFF. OF VARIATION %	17.16	19.77	17.91	48.17	51.71	45.36	7.29	-73.29	11.48

FIGURE 5-12

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY
HAT CREEK PROJECT
MINING FEASIBILITY REPORT

COMPUTER SUMMARY OF
PROXIMATE & ULTIMATE ANALYSES
D ZONE

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COMBINED DRILL HOLES - DEPOSIT 1

ZONE D LABORATORY COMPOSITE AND FIELD SAMPLES
EXCLUDING SAMPLES CONTAINING FE2O3 > 29.99% AND CAO > 19.99%

FUSION SUMMARY - CELSIUS

	REDUCING				OXIDIZING			
	INIT. DEFORM	H=W	H=.5W	FLUID	INIT. DEFORM	H=W	H=.5W	FLUID
MAXIMUM	1476	1476	1476	1482	1448	1465	1482	1482
MINIMUM	1065	1098	1104	1107	1182	1193	1204	1215
RANGE	411	378	372	375	266	272	278	267
WEIGHTED MEAN	1313	1338	1349	1371	1322	1342	1355	1371
SAMPLE COUNTS	253	202	169	148	23	22	21	19
SAMPLE CORE LENGTHS	1453	1152	963	841	62	60	59	56
ARITHMETIC MEAN	1305	1329	1338	1358	1341	1351	1359	1357
SAMPLE COUNTS	253	202	169	148	23	22	21	19
SAMPLE CORE LENGTHS	1453	1152	963	841	62	60	59	56
STANDARD DEVIATION	99	100	97	93	79	80	82	77
COEFF. OF VARIATION %	7.59	7.57	7.25	6.84	5.92	5.96	6.05	5.74
SAMPLE COUNTS OF + DATA	216	267	300	321	75	76	77	79
SAMPLE CORE LENGTHS OF + DATA	1882	2183	2371	2494	1043	1045	1046	1050

FIGURE 5-13

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY
HAT CREEK PROJECT
MINING FEASIBILITY REPORT

COMPUTER SUMMARY OF ASH FUSION TEMPERATURES D ZONE

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COMBINED DRILL HOLES - DEPOSIT 1

ZONE D LABORATORY COMPOSITE AND FIELD SAMPLES
EXCLUDING SAMPLES CONTAINING FE2O3 > 29.99% AND CAO > 19.99%

MINERAL SUMMARY - %DRY ASH

	% SIO2	% AL2O3	% TIO2	% FE2O3	% CAO	% MGO	% NA2O	% K2O	% MN3O4	% V2O5	% P2O5	% SO3	% UNDET +ERR
MAXIMUM	77.16	40.19	1.77	29.40	18.19	4.22	5.42	1.80	1.30	.30	3.56	6.10	6.45
MINIMUM	31.86	13.97	.04	.10	.33	.00	.30	.00	.00	.00	.00	.04	-.91
RANGE	45.30	26.22	1.73	29.30	17.86	4.22	5.12	1.80	1.30	.30	3.56	6.06	7.36
WEIGHTED MEAN	54.16	27.95	.94	6.89	3.35	1.28	1.70	.35	.18	.06	.37	1.99	.83
SAMPLE COUNTS	469	469	469	469	469	469	469	469	445	445	469	469	469
SAMPLE CORE LENGTHS	3335	3335	3335	3335	3335	3335	3335	3335	2305	2305	3335	3335	3335
ARITHMETIC MEAN	54.02	27.86	.92	6.93	3.45	1.27	1.79	.31	.18	.05	.39	1.93	.84
SAMPLE COUNTS	469	469	469	469	469	469	469	469	445	445	469	469	469
SAMPLE CORE LENGTHS	3335	3335	3335	3335	3335	3335	3335	3335	2305	2305	3335	3335	3335
STANDARD DEVIATION	7.36	5.29	.26	5.49	2.03	.63	.89	.23	.20	.04	.64	1.05	.99
COEFF. OF VARIATION %	13.62	19.00	28.93	79.25	58.73	49.67	49.63	74.12	15.07	74.63	61.74	54.55	17.83

MINERAL SUMMARY - MOLES

	% SIO2	% AL2O3	% TIO2	% FE2O3	% CAO	% MGO	% NA2O	% K2O	% MN3O4	% V2O5	% P2O5	% SO3
MAXIMUM	85.69	28.83	1.63	15.49	22.29	8.28	6.08	1.38	.45	.12	1.79	5.30
MINIMUM	43.39	9.26	.04	.04	.42	.00	.35	.00	.00	.00	.00	.04
RANGE	42.30	19.57	1.59	15.45	21.87	8.28	5.73	1.38	.45	.12	1.79	5.26
WEIGHTED MEAN	65.11	19.90	.85	3.19	4.33	2.32	1.98	.27	.06	.02	.19	1.80
SAMPLE COUNTS	469	469	469	469	469	469	469	469	445	445	469	469
SAMPLE CORE LENGTHS	3335	3335	3335	3335	3335	3335	3335	3335	2305	2305	3335	3335
ARITHMETIC MEAN	64.86	19.87	.83	3.24	4.48	2.31	2.08	.24	.05	.02	.20	1.75
SAMPLE COUNTS	469	469	469	469	469	469	469	469	445	445	469	469
SAMPLE CORE LENGTHS	3335	3335	3335	3335	3335	3335	3335	3335	2305	2305	3335	3335
STANDARD DEVIATION	6.57	4.05	.23	2.79	2.62	1.20	1.00	.18	.07	.01	.32	.95
COEFF. OF VARIATION %	10.12	20.41	28.61	86.05	58.59	52.75	48.08	74.88	20.82	73.71	60.94	54.74

FIGURE 5-14

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY
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COMPUTER SUMMARY
OF ASH ANALYSES
D ZONE

For these selective initial deformation listings, 23 samples >3 m thick from C coal zone and which reported calorific values <4000 Btu/lb (<9304 KJ/kg) were excluded, as these were considered to represent coal below cut-off grade that would not be included in boiler feed.

There is a significant correlation for samples from all zones that have ash initial deformation temperatures (reducing atmosphere) less than 1200° C, because these samples report distinctly above zonal average values of % CaO, Fe_2O_3, and CO_2. As an example, for the <1200° C selective listing, the mean % Ash values for D-Zone samples with this I.D. range are 17.8% Fe_2O_3, 5.11% CaO, 3.27% CO_2 as compared to D-Zone average of 6.89% Fe_2O_3, 3.35% CaO, 1.33% CO_2. The majority of samples that indicate these lower ranges of ash deformation temperature are therefore logically identified as containing an appreciably above-average content of siderite.

(c) A report that consisted of ultimate and ash analyses, and special test results for samples by each zone that yielded calorific values in the following seven ranges:

Btu/lb	KJ/kg
4000 - 4500	9300 - 10 500
4501 - 5500	10 501 - 12 800
5501 - 6500	12 801 - 15 100
6501 - 7500	15 101 - 17 500
7501 - 8500	17 501 - 19 800
8501 - 9500	19 801 - 22 100
9501 - 10,500	22 101 - 24 400

A special tabulation lists the ultimate and ash variables for 11 samples from each of DDH. 76-135 and 136, together with Hardgrove Grindability Indices reported at three moisture levels. The Hardgrove Grindability Indices of these samples at various moisture contents are plotted on Figure 5-15.

An additional special listing of hole numbers and sample numbers was prepared to show locations of samples from D coal zone that reported 3% Na_2O in the ash. These occurrences were scattered local "nuggets" except possibly those reported in DDH. 142, DDH. 156, and DDH. 163 in the north-east corner of the deposit (see Figure 1-1 of Section 1).

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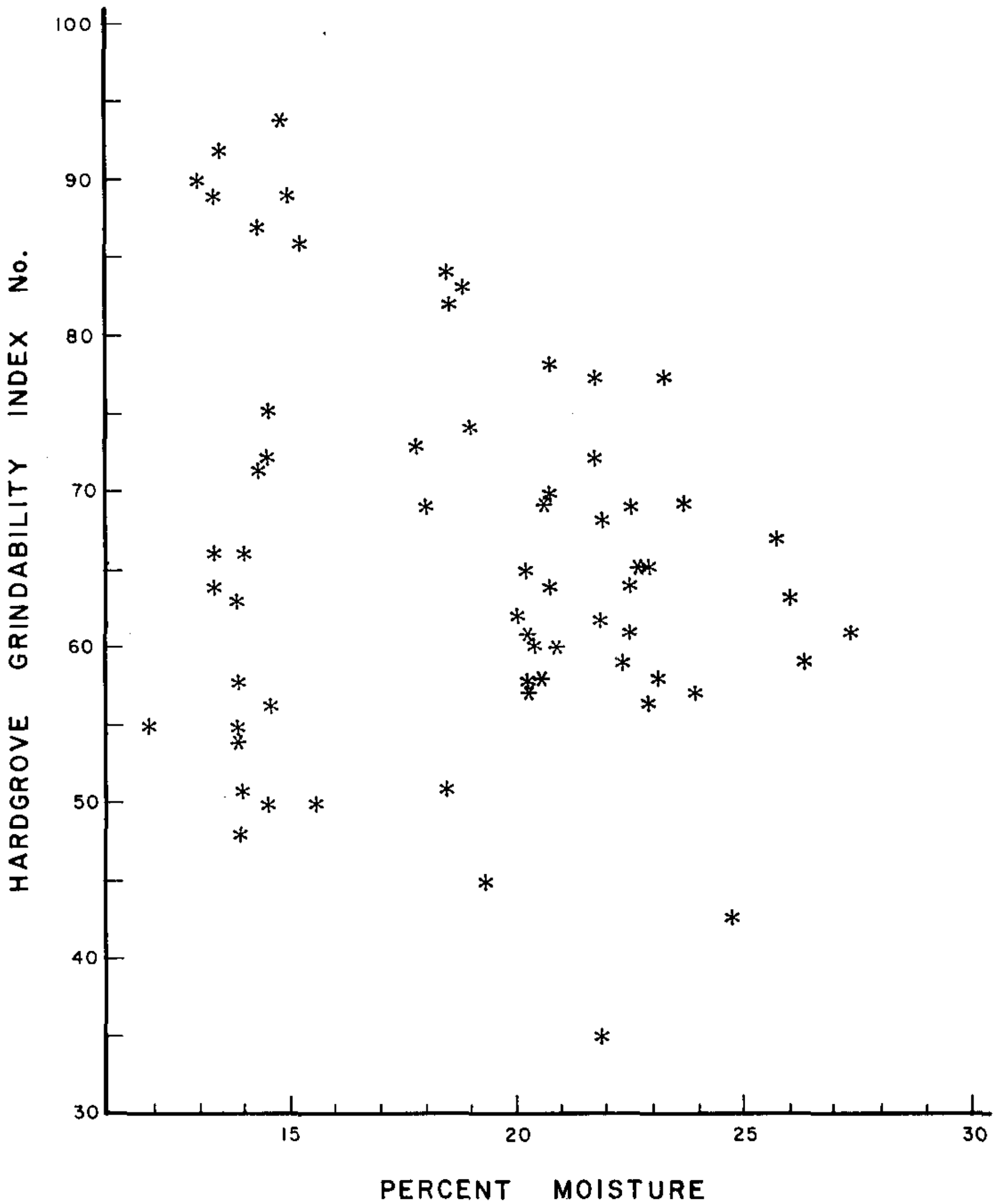

FIGURE 5-15

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY
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HARDGROVE GRINDABILITY INDICES
OF SAMPLES FROM DDH 76-135 & 136

(d) Listings equivalent to those of Figures 5-1 and 5-2 were tabulated and summaries printed to show the same variables for CMJV's planned production for Year -1 (pre-production) to Year 5, and Years 6-10. These are given on Table 5-1 following.

TABLE 5-1

Pro-Rated Ultimate and Ash Analyses
for Two Pit Increments

Hat Creek Project Mining Feasibility Report 1978

	Pre-production to Year 5					Years 6 to 10				
Zone	A	B	C	D	Weighted Mean	A	B	C	D	Weighted Mean
% of TOTAL TONNAGE (undiluted)										
	21.8	24.9	20.0	33.0		21.9	20.4	27.6	30.1	
ULTIMATE ANALYSIS (weighted mean values)										
% C	43.32	48.01	29.44	57.81	46.54	40.61	47.05	34.55	56.56	45.05
% H	4.19	4.21	2.89	4.27	3.96	3.73	4.61	3.00	4.23	3.86
% N	1.05	0.98	0.64	0.84	0.88	0.88	0.96	0.65	0.95	0.85
% Cl	0.94	0.02	0.01	0.01	0.02	0.04	0.02	0.01	0.02	0.02
% S	0.73	0.67	0.44	0.33	0.52	0.72	0.62	0.43	0.30	0.49
% CO_2	2.34	2.27	3.42	0.82	2.03	1.89	1.84	3.10	0.82	1.89
% O_2	13.90	15.17	12.55	17.01	14.98	13.96	14.32	13.52	16.53	14.69
ASH ANALYSIS (weighted mean values, dry basis)										
% SiO_2	49.80	47.75	53.10	55.45	51.83	51.36	46.42	51.85	56.00	51.90
% Al_2O_3	25.97	23.75	26.14	25.66	25.35	27.32	24.28	27.22	26.51	26.43
% TiO_2	0.82	0.87	0.95	1.11	0.96	0.91	0.75	0.90	0.99	0.90
% Fe_2O_3	11.03	13.95	9.15	5.87	9.66	10.00	15.02	9.27	6.09	9.65
% CaO	3.67	5.16	3.77	4.97	4.49	2.96	4.26	4.30	4.11	3.94
% MgO	2.49	1.95	1.96	1.30	1.85	2.01	2.33	1.73	1.10	1.72
% Na_2O	0.66	1.04	1.16	2.17	1.36	0.80	0.99	1.14	1.84	1.25
% K_2O	0.64	0.55	1.00	0.16	0.53	0.81	0.53	0.84	0.28	0.60

5.2 1977 BURN TEST ANALYSES AND PERFORMANCE CONCLUSIONS

Technical reports have been submitted to B.C. Hydro by Combustion Engineering Canada Ltd. and Babcock & Wilcox Canada Ltd. on analyses, test results, and conclusions from observations at the 1977 Burn Test at the Battle River Power Station - August 1 to September 1, 1977. Proximate and ultimate analyses are included in their reports, of which summary averages are provided on Table 5-2 for comparison with the ultimate analyses, ash analyses, and other equivalent test results presented in Section 5.1 above. Mr. D. Burnett of MBB Mechanical Services Limited of Halifax, N.S., acted as boiler fuel sub-consultant for CMJV, and was an observer at the Battle River burn tests. His main conclusion was that the Hat Creek bulk sample did not present any significant problem in combustion, slagging, or fouling to the boiler design. Minor ash clinkering problems that were encountered in the furnace may have been due to low excess air conditions. Trench B coal (D-Zone) burned with no noticeable difference, and with a moisture content generally equivalent to coal from Trench A (B-Zone).

TABLE 5-2

Battle River Burn Test Results

Hat Creek Project Mining Feasibility Report 1978

Analysis of Raw Coal	SOURCE: Babcock & Wilcox Average	SOURCE: Babcock & Wilcox Standard Deviation	SOURCE: Combustion Engineering Average
PROXIMATE ANALYSIS (%)			
Number of samples	23		
Moisture	22.3	±1.0	
Ash	33.4	±2.25	
Volatile Matter	24.9	±1.2	
Calorific Value (Btu/lb)	5013	±271	
ULTIMATE ANALYSIS (%)			
Number of samples	10		8
C	29.41	±1.86	30.01
H	2.54	±0.14	2.49
N	0.55	±0.07	0.55
S	0.54	±0.16	0.55
O_2	11.01	±0.39	11.99
ASH ANALYSIS (%)			
Number of samples	5		
SiO_2	54.24		
Al_2O_3	26.48		
Fe_2O_3	7.95		
CaO	2.02		
MgO	1.51		
TiO_2	1.22		
Na_2O	0.43		
K_2O	0.95		
HARDGROVE GRINDABILITY INDEX	40+		39-54 (average: 44.3)

5.3 PROPOSED FUEL SPECIFICATIONS

After a joint decision not to beneficiate the coal was made in March 1978 by B.C. Hydro, CMJV, and B.C. Hydro's power plant consultant, the proposed specifications for a "Performance" or "Average Blend" of delivered fuel (including 2.5% by weight mine dilution allowance) were developed by CMJV and B.C. Hydro according to the following procedure:

(a) The means and standard deviations for proximate, ultimate, and ash analyses were summarized for each of the four zones A, B, C, and D as listed in Figures 5-3 to 5-14, inclusive.

(b) A series of preliminary average analyses for the 35-year pit were calculated by weighting the zonal averages by the proportions of the proposed pit that would be derived from each zone.

(c) The above weighted averages were compared to equivalent analyses from samples that fell within specific calorific value ranges for each zone. These ranges approximate those for the individual coal zones in the planned 35-year pit as follows:

Zone	Calorific Value
A	5473 ± 300 Btu/lb
B	7188 ± 300 Btu/lb
C	5908 ± 300 Btu/lb
D	8918 ± 300 Btu/lb

Analyses from samples included within these ranges were then averaged arithmetically to produce "balanced" proximate, ultimate, and ash analyses. These averages showed no significant difference between the parameters of an individual fuel with a specific range of calorific value and the parameters for a blended fuel with the same range of calorific value.

(d) The average values of the "balanced" analyses were weighted by the percentage that each coal zone represents in the planned pit (e.g., A-Zone - 22.5%) to produce the averages for the 35-year pit, that together with a range of ±1 standard deviation were considered to represent the performance values for the boiler fuel specification. The standard deviations were calculated by weighting the variances for each zone's average values; the weighting here was also by the percentage each zone represents in the proposed pit.

The proposed specifications for a "performance blend" of delivered fuel (including 2.5% by weight mine dilution) are listed as follows:

	WEIGHTED AVERAGE	STANDARD DEVIATION
<u>Ultimate Analysis</u>		
% Carbon	43.90	±1.49
% Hydrogen	3.74	±0.56
% Nitrogen	0.89	±0.15
% Oxygen	14.58	±1.44
% Sulphur (dry basis)	0.48	±0.25
% Chlorine	0.03	±0.02
% Ash (dry basis)	36.30	±1.80
<u>Calorific Value</u> (dry basis)	7327 Btu/lb	±300
	17 043 KJ/kg	±700
<u>% Moisture</u> (run-of-mine)	25.0	±10.0
<u>Ash Analysis</u> (% dry ash)		
SiO_2	53.72	±6.02
Al_2O_3	28.85	±5.01
CaO	2.63	±1.99
MgO	1.41	±0.65
Fe_2O_3	7.62	±4.97
K_2O	0.52	±0.21
Na_2O	1.18	±0.51
Mn_3O_4	0.11	±0.13
V_2O_5	0.05	±0.03
P_2O_5	0.29	±0.30
SO_3	1.82	±0.90
Undetermined	0.88	±0.94
<u>Proximate Analysis</u> (dry basis)		
% Ash	36.30	±1.80
% Volatile Matter	32.20	±4.17
% Fixed Carbon	31.40	±4.20
<u>Carbon Dioxide</u> (dry basis)	1.77	n.d. (not determined)

(listing continues on following page)

	WEIGHTED AVERAGE	STANDARD DEVIATION
<u>Water Soluble Alkalies</u>		
as Na_2O	0.24	n.d.
as K_2O	0.03	n.d.
<u>Ash Fusion Temperatures</u>		
Reducing Atmosphere:		
Initial Deformation	1330°C	±200°
Ash Softening (H=W)	1325	
Ash Softening (H=1/2 W)	1340	
Fluid	1400+	

Approximately 8.6% of the average fuel indicates an I.D.T. <1200°C.

Approximately 4.2% of the average fuel indicates an I.D.T. <1150°C.

Oxidizing Atmosphere:		
Initial Deformation	1340°C	±200°
Ash Softening (H=W)	1350	
Ash Softening (H=1/2 W)	1360	
Fluid	1400+	
<u>Hardgrove Grindability Index</u>	50	±10

5.4 SULPHUR CONTENT OF PERFORMANCE BLEND FUEL

Preliminary evaluations of sulphur content variations in the quality sub-zones of No. 1 Deposit are discussed in Section 3.6. It is expected that on-going programs of close-spaced auger holes will be required for definition of coal quality in advance of all planned production faces to provide detailed, local area forecasts of calorific values and sulphur content. Allowances for this type of operational quality control drilling have been included in capital and operating budget estimates. Also included are provisions for adequate laboratory facilities and staff to provide rapid determinations of the analyses required for these local area forecasts, and for average quality estimates of the various stockpiles. Whereas the main emphasis in blending functions and facilities in this overall study has been to achieve optimum calorific values, it may become equally important to "blend" short-term mine production in order to attain satisfactory sulphur grades.

A statistical and histogram summary was produced by B.C. Hydro in January 1978 of pyritic and organic sulphur by zones, showing maximum and minimum values of these sulphur forms, together with the number of data points (samples) exceeding a high of 1.5% total sulphur. These statistics were as follows:

A-Zone	33 of 704 samples	>1.5% S
B-Zone	5 of 175 samples	>1.5% S
C-Zone	5 of 445 samples	>1.5% S
D-Zone	2 of 840 samples	>1.5% S

APPENDIX 1

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