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"Notes on Tests on Hat Creek Coals by Birtley Engineering, Calgary to 20th June, 1976"

by Dr. J.H. Griffiths
and Mr. G. Armstrong

RMT

HAT CREEK PROJECT

Notes on visit to Calgary
and Vancouver with reference to
the Preparation of Hat Creek Coals.

J. Howard Griffiths

J. Howard Griffiths
20th June, 1976

Mr. Brealy

JHG/JM
TS 605

9th July, 1976

HAT CREEK PROJECT
NOTES ON THE WASHING TESTS
AT BIRTLEY ENGINEERING (CANADA) LTD,
CALGARY

Three samples of coal were taken from the Hat Creek deposit by means of a 3 ft dia churn drill. The samples were taken from three different areas and were chosen from bore-hole data to represent a range of qualities, particularly calorific values (See Table I).

TABLE I

SAMPLE	Calorific Value Btu/lb			Ash Content (Dry basis)
	Intended (20% H_2O)	Actual (20% H_2O)	Actual (Dry basis)	
A	3500 dry 4375	4700	5670	50.7
B	5500 6875	6300	7820	34.1
C	6500 8125	6900	8710	27.7

Sample 'A' represents a bad section of the deposit.

Sample 'B' represents a 'typical' section of the deposit.

Sample 'C' represents a good section of the deposit.

Due to the configuration of the deposit, it appears that Sample 'A' was taken in a salient of the deposit near the outcrop and consists of the top layer, but may not be representative of the top layer. Sample 'B' was taken at a point further into the deposit and contains the top layer and probably some of a lower layer, and the same applies to Sample 'C'.

As the coal was churned out, it was placed in 40-gallon metal drums. The individual drums were, therefore, not representative of the particular bulk samples. In order to homogenise the individual sample, all the drums containing the

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particular sample were tipped in a long pile and mixed using a yd^3 front-end loader. An inventory of the drums of coal is given in Appendix I.

IT MUST BE REMEMBERED THAT THE SAMPLES ARE TAKEN FROM THE TOP LAYERS OF THE DEPOSIT AND DO NOT REPRESENT THE BULK OF THE COAL WHICH LIES AT DEPTHS GREATER THAN THE LAYERS SAMPLED.

WASHABILITY DATA

Size Analyses and Ash Contents

Appendix II gives the size analyses of the coals crushed to minus 4 ins and the properties of the various fractions. It will be noted that in all three samples the ash content increases with decrease in size, and so does the calorific values. Sulphurs are erratic but tend to be highest in the minus 100 mesh material. The higher sulphur values (say over 1.1% will probably give too much sulphur per 10^6Btu to be acceptable for power stations due to the pollution laws.

It is inadvisable to pay too much attention to the size analyses because the samples were obtained by churn drilling and are unlikely to represent the size grading which would be obtained under orthodox mining conditions.

Birtley carried out washability tests on the 'A' and 'B' samples at sizes, 4 ins - ½ in; ½ in - 28M and 28M - 100M. Difficulties were experienced due to the coal disintegrating caused probably by the repeated wetting and drying during the tests. The resultant curves were not "normal". It was therefore, decided to take fresh increments for each density separation. The resultant curves were still not "normal". Dr. Simons,

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F. Harvat and G. Armstrong could not explain these curves, neither could Dr. Chaumbury, the coal preparation specialist employed by EBASCO. Actually, the explaination is simple and is made quite clear if the yeild is plotted against the specific gravity. The curve represents a three component material. (See Plate I). The 'X' section represents the coal which is approximately 67%; the 'Y' section represents an intermediate material with a density about 1.8/1.9 present to about 24% and is probably the clays; and the 'Z' section represents the stone with a density of plus 2.1 which is present to the extent of approximately 9%. For the smaller sizes the clays and stone are not so clearly separated. Similar data for the 'B' sample is plotted on Plate II from the data given in Appendix III. Because of the lack of understanding of the shape of the curves, float and sink tests were not carried out on sample 'C'.

Washing Tests

The pilot ~~dense~~ DSM dense medium cyclone plant is described in Gordon Armstrong's Report, and a schematic diagram is given in Appendix IV which gives also the washability data and curves and the analyses of the coals after the raw coal had been crushed to minus ¾ in and the minus 28M removed.

The amounts of minus 28M in the three samples were as follows:-

Sample A   19.4% with 50.8% Ash

Sample B   2.7% with 49.1% Ash

Sample C   18.6% with 36.3% Ash

Mr. Summers of EBASCO stated that:-

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28% of the deposit was worse than sample 'A'

70% of the deposit was worse than sample 'B'

10% of the deposit was better than sample 'C'

A precis of the percentage Ash, Yields, and percentage near gravity is given in Appendix V. It will be noted that the near gravity material is not unusual - it is only the clay which presents troubles.

The three coals are entirely different and no correlation is possible on the basis of ash and specific gravity, ie the three coals could not be washed together without accepting a wide variation in the ash content of the clean coal.

Coal A separated at 1.4 S.G. would give 15.7% Ash (db)
B separated at 1.4 S.G. would give 14.9% Ash (db)
C separated at 1.4 S.G. would give 11.9% Ash (db)

Coal C separated at 1.55 S.G. would give 15.0% Ash (db)
B separated at 1.55 S.G. would give 21.4% Ash (db)
A separated at 1.55 S.G. would give 25.2% Ash (db)

Washing Tests

A preliminary washing test was carried out on the 15th June, using Sample 'A', and cutting at a specific gravity of 1.4. The results available are given in Appendix VI from which it can be seen that the raw coal ¾ in - 0 in contained 45.5% ash. 55.0% of the coal was ¾in - 28M in size and was fed to the DSM cyclone to give 52.4% yield with an ash content of 14.3%. From the washability curve (Appendix IV) one would have expected a 28.6% yield with 15.7% ash. The increased

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yield at a lower ash content indicates that either the sample taken for washability tests was not representative of Sample 'A' or that the weights taken during the test were not accurate. When the full data is available, this test must be reconsidered.

A larger scale test was carried out on 16th June, again using Sample 'A' but cutting at a specific gravity of 1.65. The available results are given in Appendix VII. It will be noted that the raw coal $\frac{3}{4}$ in - 0 in contained 54.5% between $\frac{3}{4}$ in - 28M which when fed to the cyclone gave a 69.2% yield of clean coal with an ash content 27.6% Ash (corrected later to 32.5% Ash (dry basis). The curve in Appendix IV shows that at specific gravity 1.65 the yield should be 59% with an ash content of 34%. Again there is a discrepancy which needs explaining when the full data is available.

During the test, the material over $2\frac{1}{4}$ in x $2\frac{1}{2}$ in was broken by hand and fed into the undersize at the foot of the elevator discharging into the $\frac{3}{4}$ in hole trommel screen. Difficulties were experienced due to clay clogging the jaw crusher and later the curved screen and also the trommel, despite the fact that water lancing was used on the screens.

The impurities in the raw sample were of several types varying from sandy lumps (which disintegrated easily in water) through plastic clays to firm shales and some sandstone.

The circulating dense medium became progressively more viscous as the clay content built up during the test and finally was as viscous as a multi-grade motor car oil.

The troubles due to clay were expected from a visual examination of the raw coal, but I have never seen the circulating medium become so viscous as in this trial.

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There is no doubt that if wet cleaning is to be adopted, then some method must be found to reduce the clay before the coal enters the washery.

An ad hoc test showed that some of the clays sank in liquid density 1.6 and floated in liquid density 1.7.

The cut point for the second test was 1.65 specific gravity which was therefore a rather unfortunate choice. Samples 'B' and 'C' will be washed aiming at a cut point of 1.55 specific gravity.

The problem of the clay was accentuated by having to crush to minus ¾ in which was the maximum size which could be handled by the DSM 14 in diameter cyclone. Consideration should be given to the use of a dense medium bath process which could handle say lumps up to 8 in in size.

E. G. the Tromp (probably have trouble with the clay sticking to the scraper conveyor blades, but it may be possible to overcome this by water jets); Wemco drum (probably have trouble with the clay sticking to the reject lifters and the drainage holes and gaps would become clogged), and the same would probably apply to the Drew-boy. The Loess Shallow bath may be applicable although it may have the same trouble as the Tromp but to a lesser degree. The Ridley-Scholes process is another possibility but may not be available in large enough units, this needs checking. It must be remembered that the samples at Birtley may be worse than would be the case at Hat Creek. The coal obtained by a churn-bit and was loaded into 40-gallon drums which then had a rough passage to the Birtley plant and the clays may well have been "worked" due to the tossing

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and turning of the drums. There was also a time lag which obviously would not improve conditions.

Other possibilities for removing clay before the washery include:-

Krupp Siebra Crusher - screen - standard unit about 500tt/h. This would remove some of the clay but exactly how effective it would be is problematic. It is necessary to see this equip ment in action.

High-pressure water jets playing on the coal as it passes over a fine screen. There would be some loss of coal and also a clay-slurry problem.

The use of atritors such as are used for removing clay from haematitic particles. These could be used in conjunction with the Siebra screen or the high-pressure water jets.

Effect of Cleaning on Ash Fusion Temperatures

Reducing the ash content of the coal can affect the fusion temperatures. If during cleaning the Silica and alumina are removed, the clean coal will have a lower ash fusion than the raw coal. If on the other hand, Sodium, Calcium, Magnesium or iron impurities are removed, the clean coal will have a higher fusion temperature.

A general ratio is:-

$$\frac{SiO_2 + Al_2O_3}{Fe_2O_3 + CaO + MgO}$$

The higher this ratio, the higher the fusion temperatures. However, it must be remembered that pulverised fuel is not a h homogeneous material and consists of discrete particles. The individual particles may have a low fusion temperature and if there are sufficient of these present they could give clinker and "bird-nesting" problems in the boilers, although the ash fusion of the mixture is relatively high

Ash fusion temperatures determined by EBASCO showed, as would be expected that the removal of clay reduced the ash fusion temperatures. However, the lowest temperature was 2200°F (1210°C) which is on the border of what the CEGB would accept in the UK. They accept down to 1200°C but normally stipulate 1250°C.

Ash fusion tests carried out on the 'A', 'B' and 'C' samples are reported in Appendix VIII from which it can be seen that only some fractions of Sample 'A' give critical ash fusion temperatures.

DRY CLEANING

No one appears to have given consideration to dry-cleaning the coal, but size grading and washabilities are being determined on the following sizes:-

+ 4 in; 4 in - 2 in; 2 in - 1 in; 1 in - ½ in;
½ in - ¼ in; ¼ in - ⅛ in; ⅛ in - 1 mm

This will give the basic data for deciding whether or not dry-cleaning is a practical proposition.

The size range for dry cleaning is 2 in to 1 mm but it may be possible for the larger coal + 2 in to be treated in a dense medium bath as previously mentioned. Another difficulty would be the size of units - the largest standard unit has a capacity of about 50 t/h on 2 in - 1 in coal and the capacity is smaller for smaller sizes.

CONCLUSION

1. Samples 'A', 'B' and 'C' are indicative only of the top layers of the deposit. Coal from greater depths may be different.

2. The only difficulty in washing the Hat Creek coals is due to the clay content. Otherwise the coals could be washed very efficiently using dense medium type washers.

3. The problem is greatest in treating the coal of the type represented by the 'A' sample. It will be interesting to see the results of the tests on the 'B', and 'C' samples. It is to be expected that there would be less difficulties in washing these.

4. Sizing and washability data is required to assess the applicability of using dense medium baths and/or dry cleaning processes. This is already in hand.

5. The possiblity of using the Siebra crusher/screen should be further investigated.

6. The clays appear to have a density of plus 1.5 and less than 2.0

Mr. Brealy

B. C. HYDRO

SAMPLE INVENTORY

	BARRELS REC'D	OTTAWA BARRELS SHIPPED	BARRELS FOR WASHABILITY	PLANT WORK BARRELS	BARRELS IN STOCK
SAMPLE A	179	50	12	80	34 For detailed washability
SAMPLE B	138	50	12	not done yet	76 For plant wash and detailed washability
SAMPLE C	140	50	12	not done yet	72 For plant wash and detailed washability

BIRTLEY ENGINEERING (CANADA) LTD.

DATE ____________ 19____

CLIENT : BC HYDRO

SAMPLE : "A"

LAB No : 7366

SIZE ANALYSIS : OF GROSS SAMPLE CRUSHED TO −4"

WT% +4" = 0.7 %

SIZE FRACTION	WT%	RM%	ASH%	VM%	FC%	S%	BTU/LB.	CUMULATIVE WT%	CUMULATIVE ASH%	CUMULATIVE BTU/LB.	
4" × ½"	34.4	13.4	37.9	24.4	24.3	1.11	5646	34.4	37.9	5646	a.d.b
	31.2		43.8	28.2	28.0	1.28	6520	31.2	43.8	6520	d.b.
½" × 28M.	48.8	9.5	45.6	23.3	21.6	0.94	5163	83.2	42.4	5362	
	50.9	-	50.4	25.7	23.9	1.04	5705	82.1	47.9	6015	
28M. × 100M.	12.4	7.8	58.4	19.9	13.9	0.90	3780	95.6	44.5	5157	
	13.2		63.3	21.6	15.1	0.98	4100	95.3	50.0	5750	
100M. × 0	4.4	7.4	58.8	20.2	13.6	0.96	3783	100.0	45.1	5097	
	4.7	-	63.5	21.8	14.7	1.04	4085	100.0	50.7	5671	

ASH FUSION TEMP. (°F) : 100M. × 0

ATMOS.	Initial Deformation	Softening	Hemispherical	Fluid
OXIDIZING				
REDUCING				

BIRTLEY ENGINEERING (CANADA) LTD.

DATE ______________ 19___

CLIENT : BC HYDRO

SAMPLE : "C"

LAB No : 7370

SIZE ANALYSIS: OF GROSS SAMPLE CRUSHED TO −4"

WT% +4" = 1.3%

SIZE FRACTION	WT%	RM%	ASH%	VM%	FC%	S%	BTU/LB.	CUMULATIVE WT%	CUMULATIVE ASH%	CUMULATIVE BTU/LB.
4" × ½"	39.2	25.1	17.0	29.8	28.1	0.57	7091	39.2	17.0	7091
	36.9		22.7	39.8	37.5	0.76	9467	36.9	22.7	9467
½" × 28M.	48.9	18.0	24.1	29.4	28.5	0.60	6941	88.1	20.9	7008
	50.5		29.0	35.9	34.7	0.73	8485	87.4	26.6	8900
28M. × 100M.	7.2	16.5	30.5	27.9	25.1	0.60	6271	95.3	21.7	6952
	7.6		33.0	33.4	33.6	0.72	7510	95.0	27.1	8788
100M. × 0	4.7	15.3	32.5	27.7	24.5	0.74	6183	100.0	22.2	6916
	5.0		38.4	32.7	28.9	0.87	7300	100.0	27.7	8714

ASH FUSION TEMP. (°F): 100M. × 0

ATMOS.	Initial Deformation	Softening	Hemispherical	Fluid

BIRTLEY ENGINEERING (CANADA) LTD.

CLIENT : BC HYDRO

SAMPLE : "B"

LAB No : 7368

DATE ________________, 19__

SIZE ANALYSIS: OF GROSS SAMPLE CRUSHED TO -4"

WT% +4" = 1.1%

SIZE FRACTION	WT%	RM%	ASH%	VM%	FC%	S%	BTU/LB.	CUMULATIVE WT%	CUMULATIVE ASH%	CUMULATIVE BTU/LB.
4" x ½"	37.2	19.5	22.2	30.5	27.8	0.86	6957	37.2	22.2	6957
	34.0		27.6	37.9	34.5	1.07	8642	34.0	27.6	8642
½" x 28M.	59.3	8.8	33.5	28.9	28.8	0.91	6835	96.5	29.1	6882
	62.3		36.7	31.7	31.6	1.00	7495	96.3	33.5	7900
28M. x 100M.	2.7	6.5	46.5	26.4	20.6	1.34	5023	99.2	29.6	6842
	2.9		49.7	28.2	22.1	1.43	5800	99.2	34.0	7839
100M. x 0	0.8	6.0	53.1	24.2	16.7	1.55	4658	100.0	29.8	6825
	0.8		56.5	25.7	17.8	1.65	4955	100.0	34.1	7816

ASH FUSION TEMP. (°F): 100M. x 0

ATMOS.	Initial Deformation	Softening	Hemispherical	Fluid

BIRTLEY ENGINEERING (CANADA) LTD. III

CLIENT : BC HYDRO

SAMPLE : "A"

LAB No : 7366

DATE ________ 19__

SINK-FLOAT ANALYSIS: 4" × 1/2" wt% 34.4% adb

S.G. FRAC.	WT%	RM%	ASH%	CUMULATIVE WT%	CUMULATIVE ASH%	
-1.30	7.5	24.2	2.6	7.5	2.6	adb
	6.6		3.4	6.6	3.4	db
1.30 - 1.35	10.2	23.1	5.1	17.7	4.0	
	9.2		6.6	15.8	5.3	
1.35 - 1.40	9.5	21.4	13.1	27.2	7.2	
	8.7		16.7	24.5	9.3	
1.40 - 1.45	14.8	17.4	21.3	42.0	12.2	
	14.2		25.8	38.7	15.4	
1.45 - 1.50	13.2	12.5	31.6	55.2	16.8	
	13.5		36.1	52.2	20.7	
1.50 - 1.60	12.8	10.2	45.7	68.0	22.3	
	13.4		50.9	65.6	26.9	
1.60 - 1.70	0.8	8.8	50.3	68.8	22.6	
	0.9		55.2	66.5	27.3	
1.70 - 1.80	0.4	8.2	55.4	69.2	22.8	
	0.4		60.3	66.9	27.5	
1.80 - 1.90	5.6	10.8	58.9	74.8	25.5	
	5.8		66.0	72.7	30.5	
1.90 - 2.00	16.7	9.0	71.8	91.5	33.9	
	17.7		78.9	90.4	40.0	
2.00 - 2.10	0.5	5.0	72.9	92.0	34.1	
	0.6		76.7	91.0	40.3	
2.10 - 2.20	2.1	5.8	77.7	94.1	35.1	
	2.3		82.5	93.3	41.3	
+2.20	5.9	3.5	76.7	100.0	37.6	
	6.7		79.5	100.0	43.9	

BIRTLEY ENGINEERING (CANADA) LTD.

CLIENT: BC HYDRO

SAMPLE: "A"

LAB No: 7366

DATE ____________ 19___

ANALYSES ON 4"x ⅓" FLOATS @ 1.50 S.G.

PROXIMATE				S%	BTU per lb.	H.G.I.	
RM %	ASH %	VM%	FC %				
18.1	17.0	30.6	34.3	0.99	7716	35	adb
	20.8	37.4	41.8	1.21	9421	—	db

ASH FUSION TEMPERATURES (°F)					
ATMOS.	Initial Deform'n.	Softening	Hemi-spherical	Fluid	
OXID.					
RED.					

BIRTLEY ENGINEERING (CANADA) LTD.

CLIENT : BC HYDRO

SAMPLE : "A"

LAB No : 7366

DATE ____________ 19____

SINK-FLOAT ANALYSIS: ½" × 28M. wt% = 16.3 ad

S.G. FRAC.	WT%	RM%	ASH%	CUMULATIVE WT%	CUMULATIVE ASH%	
-1.30	0.5	8.2	3.6	0.5	3.6	calc
	0.5		3.9	0.5	3.9	lab
1.30 - 1.35	5.0	11.4	4.2	5.5	4.1	
	4.9		4.7	5.4	4.6	
1.35 - 1.40	4.7	8.4	6.7	10.2	5.3	
	4.8		7.3	10.2	5.9	
1.40 - 1.45	4.5	7.7	13.0	14.7	7.7	
	4.6		14.1	14.8	8.4	
1.45 - 1.50	5.7	8.7	17.3	20.4	10.4	
	5.7		18.9	20.5	11.3	
1.50 - 1.60	23.9	8.2	31.6	44.3	21.8	
	24.1		34.4	44.6	23.8	
1.60 - 1.70	1.2	8.2	33.1	45.5	22.1	
	1.2		36.1	45.8	24.1	
1.70 - 1.80	5.6	8.8	43.4	51.1	24.5	
	5.6		47.6	51.4	26.7	
1.80 - 1.90	9.5	10.5	50.9	60.6	28.6	
	9.3		56.1	60.7	31.2	
1.90 - 2.00	5.8	7.9	59.5	66.4	31.3	
	5.8		64.6	66.5	34.1	
2.00 - 2.10	11.1	10.4	64.5	77.5	36.1	
	11.0		72.0	77.5	39.5	
2.10 - 2.20	6.1	6.0	73.8	83.6	38.8	
	6.2		78.5	83.7	42.4	
+2.20	16.4	9.7	75.9	100.0	44.9	
	16.3		84.1	100.0	49.2	

BIRTLEY ENGINEERING (CANADA) LTD.

CLIENT: BC HYDRO

SAMPLE: "A"

LAB No: 7366

DATE ______ 19__

ANALYSES ON ½"x28 FLOATS @ 1.50 S.G.

PROXIMATE							
RM %	ASH %	VM %	FC %	S %	BTU per lb.	H.G.I.	
9.0	10.9	35.8	44.8	1.01	9614	36	adb
	11.4	39.3	49.3	1.11	10565	—	db

ASH FUSION TEMPERATURES (°F)					
ATMOS.	Initial Deform'n.	Softening	Hemi-spherical	Fluid	
OXID.					
RED.					

BIRTLEY ENGINEERING (CANADA) LTD.

CLIENT : BC HYDRO

SAMPLE : "A"

LAB No : 7366

DATE ______ 19__

SINK - FLOAT ANALYSIS : 25 M × 100 M. WT% - 12.4 aa.

S.G. FRAC.	WT%	RM%	ASH%	CUMULATIVE WT%	CUMULATIVE ASH%	
-1.30	nil					
1.30 - 1.35	nil			—		
1.35 - 1.40	nil			—		
1.40 - 1.45	3.0	8.1	7.6	3.0	7.6	adb
	2.9	–	8.3	2.9	8.3	db
1.45 - 1.50	4.0	9.8	13.4	7.0	10.9	
	3.8		14.9	6.7	12.0	
1.50 - 1.60	2.4	9.0	19.7	9.4	13.2	
	2.4	—	21.6	9.1	14.6	
1.60 - 1.70	6.3	10.1	26.5	15.7	18.5	
	6.1	—	29.5	15.2	20.6	
1.70 - 1.80	7.5	10.9	35.8	23.2	24.1	
	7.3	—	40.2	22.5	26.9	
1.80 - 1.90	8.3	9.5	45.4	31.5	29.7	
	8.1	—	50.2	30.6	33.1	
1.90 - 2.00	9.0	8.2	54.1	40.5	35.1	
	8.9	—	58.9	39.5	38.9	
2.00 - 2.10	8.8	7.9	60.6	49.3	39.7	
	8.8	—	65.8	48.3	43.8	
2.10 - 2.20	18.2	6.0	69.2	67.5	47.6	
	18.5	—	73.6	66.8	52.1	
+2.20	32.5	5.6	77.9	100.0	57.5	
	33.2	—	82.5	100.0	62.2	

BIRTLEY ENGINEERING (CANADA) LTD.

CLIENT: B.C. HYDRO

DATE ____________ 19__

SAMPLE: "A"

LAB No: 7366

ANALYSES ON 28M x 102M FLOATS @ 1.50 S.G.

PROXIMATE				S%	BTU per lb.	H.G.I.	
RM %	ASH %	VM %	FC %				
8.9	10.8	35.4	44.9	0.89	9558	X	adb
	11.9	38.9	49.2	0.98	10492		db

ASH FUSION TEMPERATURES (°F)					
ATMOS.	Initial Deform'n.	Softening	Hemi-spherical	Fluid	
OXID.					
RED.					

BIRTLEY ENGINEERING (CANADA) LTD.

CLIENT : BC HYDRO

SAMPLE : "B"

LAB No : 7368

DATE ______________, 19__

SINK-FLOAT ANALYSIS: 4" x 1/2"

S.G. FRAC.	WT%	RM%	ASH%	CUMULATIVE WT%	CUMULATIVE ASH%
-1.30	2.3 2.3	14.8	2.0 2.3	2.3 2.3	2.0 2.3
1.30-1.35	7.7 7.5	16.3	3.4 4.1	10.0 9.8	3.1 3.7
1.35-1.40	11.1 10.6	16.9	8.0 9.6	21.1 20.4	5.7 6.8
1.40-1.45	29.2 29.2	13.3	11.5 13.3	50.3 49.6	9.1 10.6
1.45-1.50	21.3 21.2	13.5	18.6 21.5	71.6 70.8	11.9 13.9
1.50-1.60	6.5 6.5	12.2	29.0 33.0	78.1 77.3	13.3 15.5
1.60-1.70	2.8 2.8	13.0	31.4 36.1	80.9 80.1	13.9 16.2
1.70-1.80	3.1 3.1	14.9	40.2 47.2	84.0 83.2	14.9 17.4
1.80-1.90	1.8 1.9	8.9	49.3 54.1	85.8 85.1	15.6 18.2
1.90-2.00	3.1 3.0	16.7	53.1 63.7	88.9 88.1	16.9 19.7
2.00-2.10	2.5 2.4	13.5	61.0 70.5	91.4 90.5	18.1 21.1
2.10-2.20	2.9 3.0	8.3	70.0 76.3	94.3 93.5	19.7 22.8
+2.20	5.7 6.5	1.9	75.3 76.8	100.0 100.0	22.9 26.4

CLIENT: BC HYDRO

SAMPLE: "B"

LAB No: 7368

DATE ____________, 19__

ANALYSES ON 4"x ½" FLOATS @ ______ S.G.

PROXIMATE							
RM %	ASH %	VM %	FC %	S %	BTU per lb.	H.G.I.	

ASH FUSION TEMPERATURES (°F)					
ATMOS.	Initial Deform'n.	Softening	Hemi-spherical	Fluid	
OXID.					
RED.					

BIRTLEY ENGINEERING (CANADA) LTD.

CLIENT : BC HYDRO

SAMPLE : "B"

LAB No : 7368

DATE ______ 19__

SINK-FLOAT ANALYSIS: ½" x 28M.

S.G. FRAC.	WT%	RM%	ASH%	CUMULATIVE WT%	CUMULATIVE ASH%
-1.30	4.4 4.5	6.8	3.7 4.0	4.4 4.5	3.7 4.0
1.30 - 1.35	10.5 10.7	6.8	6.8 7.3	14.9 15.2	5.9 6.3
1.35 - 1.40	3.9 3.9	7.7	9.6 10.4	18.8 19.1	6.7 7.2
1.40 - 1.45	3.1 3.1	8.6	11.2 12.3	21.9 22.2	7.3 7.9
1.45 - 1.50	7.4 7.4	9.1	15.1 16.6	29.3 29.6	9.3 10.1
1.50 - 1.60	16.8 16.0	13.1	20.1 23.1	46.1 456	13.2 14.6
1.60 - 1.70	10.8 10.6	10.5	30.5 34.1	56.9 56.2	16.5 18.3
1.70 - 1.80	11.8 11.5	11.2	41.1 46.3	68.7 67.7	20.7 23.1
1.80 - 1.90	5.9 5.9	8.7	47.7 52.2	74.6 73.6	22.9 25.4
1.90 - 2.00	7.3 7.4	7.0	56.2 60.4	81.9 81.0	25.8 28.6
2.00 - 2.10	5.8 5.9	7.6	61.9 67.0	87.7 86.9	28.2 31.2
2.10 - 2.20	3.5 3.7	6.1	69.4 73.9	91.2 90.6	29.8 32.9
+2.20	8.8 9.4	2.7	74.2 76.3	100.0 100.0	33.7 37.0

BIRTLEY ENGINEERING (CANADA) LTD.

CLIENT: BC HYDRO

DATE ______ 19__

SAMPLE: "B"

LAB No: 7368

ANALYSES ON ½"×28M FLOATS @ ______ S.G.

PROXIMATE				S%	BTU per lb.	H.G.I.	
RM %	ASH %	VM%	FC %				

ASH FUSION TEMPERATURES (°F)					
ATMOS.	Initial Deform'n.	Softening	Hemi-spherical	Fluid	
OXID.					
RED.					

BIRTLEY ENGINEERING (CANADA) LTD.

CLIENT : BC HYDRO

SAMPLE : "B"

LAB No : 7365

DATE ____________ 19__

SINK - FLOAT ANALYSIS: 28 M x 100 M

S.G. FRAC.	WT%	RM%	ASH%	CUMULATIVE WT%	CUMULATIVE ASH%
-1.30	—	–	–	—	
1.30 - 1.35	—	–	–	–	—
1.35 - 1.40	2.6	5.1	6.2	2.6	6.2
	2.6		6.5	2.6	6.5
1.40 - 1.45	4.7	6.6	9.2	7.3	8.1
	4.7		9.8	7.3	8.6
1.45 - 1.50	5.1	7.0	12.3	12.4	9.8
	5.1		13.2	12.4	10.5
1.50 - 1.60	11.5	7.8	20.1	23.9	14.8
	11.3		21.8	23.7	15.9
1.60 - 1.70	8.7	7.9	29.2	32.6	18.6
	8.6		31.7	32.3	20.1
1.70 - 1.80	9.0	8.0	37.3	41.6	22.7
	8.9		40.5	41.2	24.5
1.80 - 1.90	12.8	8.7	45.8	54.4	28.1
	12.6		50.2	53.8	30.5
1.90 - 2.00	15.1	7.8	53.7	69.5	33.7
	14.9		58.2	68.7	36.5
2.00 - 2.10	9.5	6.2	60.7	79.0	36.9
	9.6		64.7	78.3	40.0
2.10 - 2.20	6.5	4.8	67.3	85.5	39.2
	6.7		70.7	85.0	42.4
+2.20	14.5	3.0	74.6	100.0	44.4
	15.0		76.9	100.0	47.6

BIRTLEY ENGINEERING (CANADA) LTD.

CLIENT: BC HYDRO

DATE ____________ 19__

SAMPLE: "B"

LAB No: 7368

ANALYSES ON 28MX100M FLOATS @ ______ S.G.

PROXIMATE				S%	BTU per lb.	H.G.I.	
RM %	ASH %	VM%	FC %				

ASH FUSION TEMPERATURES (°F)					
ATMOS.	Initial Deform'n.	Softening	Hemi-spherical	Fluid	
OXID.					
RED.					

APPENDIX IV.

B.C. HYDRO - HAT CREEK PROJECT

HEAVY MEDIA AND WATER CYCLONE

Plant Washing Procedure for Sample "A"

Since the "A" sample contains appreciable quantities of plastic clay material, some modifications will be necessary to ensure that all the clay enters the plant as 3/4" x 0 feed.

1. The grizzly screen 2 1/4" oversize clay will be picked manually, placed in buckets and introduced, during the plant run, through a 3/4" screen ~~to the 28 mesh sieve bend desliming circuit~~. back to feed elevator

2. The 3/4" trommel oversize (i.e. 2 1/4" x 3/4") material will be water lanced to ensure that the crusher is not clogged. This material plus water will be recycled as usual via the bucket elevator and trommel screen to the desliming circuit.

3. Water spray ~~will~~ may be necessary at the grizzly discharge chute and the bucket elevator discharge due to the poorer flow characteristics of the wetted coal.

4. The water cyclone overflow will be cut at 65 mesh on the rapped .25mm sieve bend. The underflow will be discarded as tailings directly to the static thickener as will the water cyclone underflow.

Special samples, in addition to the usual over taken for a plant wash, are outlined as follows.

1. H.M. clean coal rinse screen underflow.
2. H.M. refuse rinse screen underflow.
3. .25mm sieve bend underflow.
4. Static thickener overflow (clarified water).
5. Slime thickening cone overflow

Birtley Engineering
Subsidiary of Great West Steel Industries

Plant Washing Procedure for Sample "A" (con't.)

We do not intend using flocculants for this run as it is anticipated that research tests will be conducted by B. C. Hydro on these samples. This should be discussed at the meeting Wednesday, June 16th, 1976.

Usual samples taken during a three circuit plant run are:-

-H.M. Feed, Clean Coal, Shale
-Water Cyclone Feed, Overflow and Underflow
-.25mm Sieve Bend Overflow
-Thickening Cyclone Feed, Overflow
-Froth Flotation Feed, Concentrates, Tails
-Filter Cake

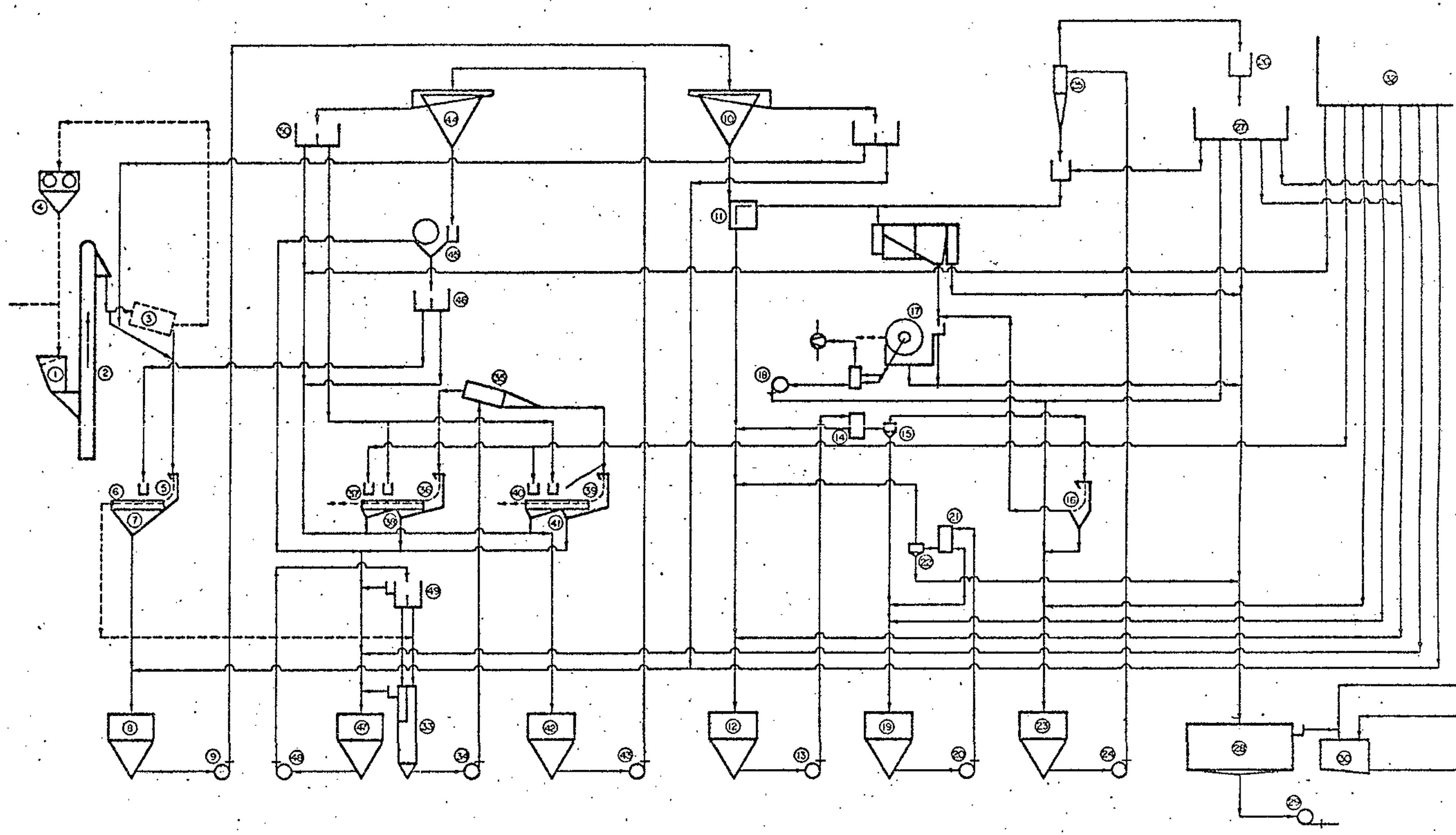
Re: 3/4" x 28 Mesh Washability

The washability results for samples "A" and "B" proved unreliable throughout the size ranges 4" x 1/4", 1/2" x 28 Mesh and 28 Mesh x 100 Mesh.

This unreliability stemmed from the breakdown of the coal during the float-sink process causing an undue amount of material reporting to sinks at 1.60 S.G. instead of being distributed through the fraction to 1.30 S.G.

After discussions with Gordon Armstrong, we decided to perform a modified float-sink on raw coal crushed to pass 3/4" and screened at 28 mesh for comparison with the Heavy Media plant circuit which would be conducted at 3/4" x 28 Mesh size.

Five representative samples of 3/4" x 28 Mesh coal were taken and each floated at one liquid in the S.G.'s of 1.40, 1.50, 1.60, 1.70, and 1.80. The weights and ash contents of each float and sink were determined. These values were then calculated as normal washability data and the curves drawn for each of Samples A, B, and C.

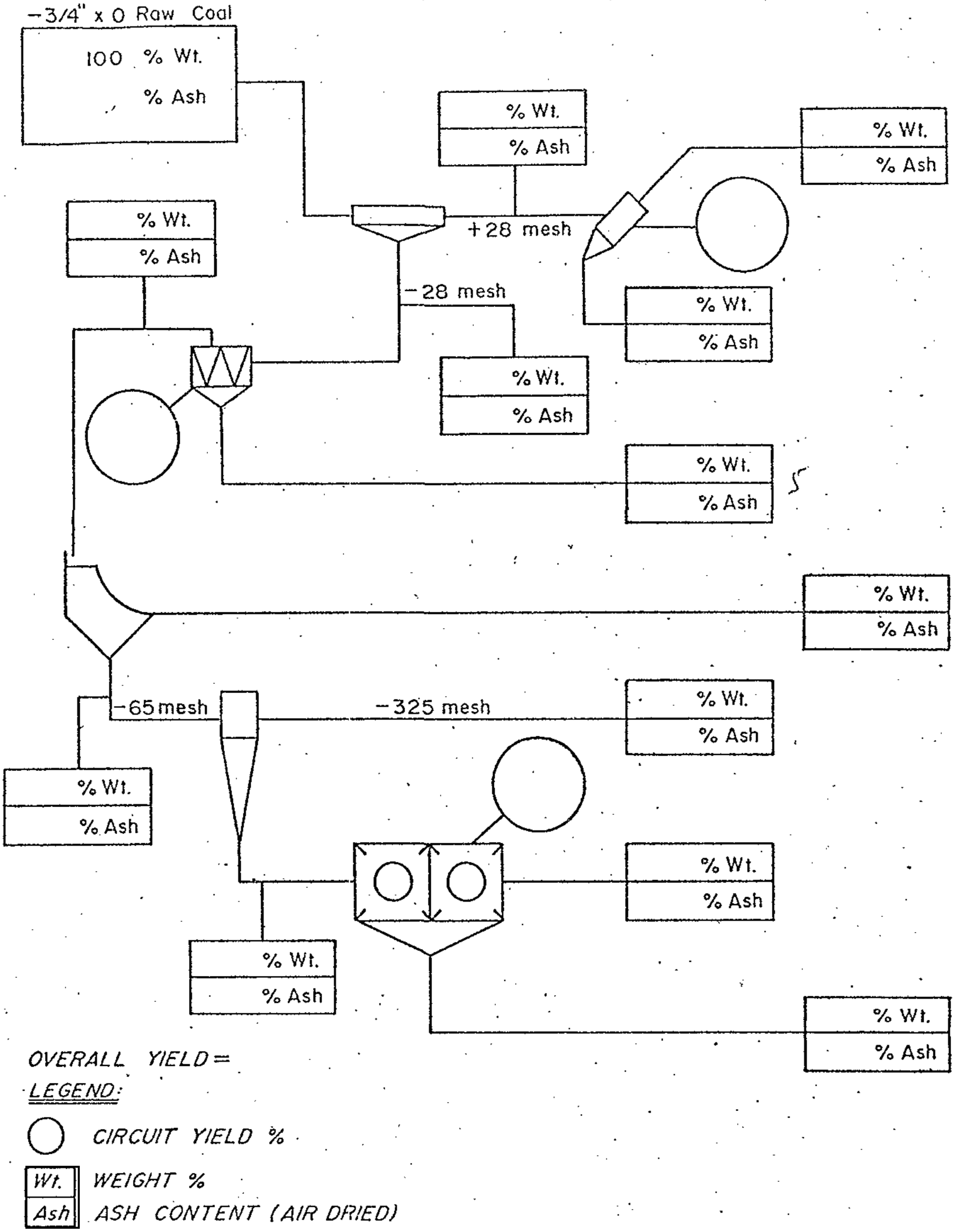


1. Feed Bin
2. Elevator
3. Rotary Screen
4. Jaw Crusher
5. Sieve Bend
6. Desliming Screen
7. Underflow Collector
8. 28M-0 Raw Coal Collection Tank
9. Pump
10. Settling Cone
11. Diverter
12. Primary Water Only Cyclone Feed Tank
13. Pump
14. Distributor
15. Primary Water Only Cyclone
16. Sieve Bend
17. Vacuum Filter
18. Filtrate Water Pump
19. Secondary Water Only Cyclone Feed Tank
20. Pump
21. Distributor
22. Secondary Water Only Cyclone
23. Thickening Cyclone Feed Tank
24. Pump
25. Thickening Cyclone
26. Overflow Distributor
27. Head Box
28. Thickener
29. Waste Disposal Pump
30. Clarified Water Collection Tank
31. Clarified Water Pump
32. Clarified Water Head Box
33. Cyclone Feed Tank
34. Pump
35. D.S.M. Cyclone
36. Sieve Bend
37. C.C. Drain and Rinse Screen
38. Underflow Collector
39. Sieve Bend
40. Discard Drain and Rinse Screen
41. Underflow Collector
42. Dilute Medium Tank
43. Pump
44. Settling Cone
45. Magnetic Separator
46. Splitter Box
47. Correct Medium Tank
48. Pump
49. Distribution Box
50. Splitter Box

TEST PLANT FLOWSHEET

COAL SCIENCE & MINERALS TESTING

DIV OF BIRTLEY ENGINEERING (CANADA) LTD, CALGARY,



BIRTLEY ENGINEERING (CANADA) LTD.

Title	Date
	Drawn

B C HYDRO   SAMPLE (A) RAW COAL   7366   3/4" X 28M

--DIRECT--					--CUM FLOATS--			--CUM SINKS--		+-0.1 DISTR	
S.G.	WT>	ASH>	WT> ASH TT	CUM WT> ASHTT	WT>	ASH>	SINK WT ASH>	WT>	ASH>	S.G.	WT>
1	2	3	4	5	6	7	8	9	10	11	12
1.40	28.60	15.70	4.49	4.49	28.60	15.70	46.37	71.40	64.95	1.40	0.00
1.50	14.20	36.50	5.18	9.67	42.80	22.60	41.19	57.20	72.01	1.50	24.10
1.60	9.90	53.50	5.30	14.97	52.70	28.41	35.89	47.30	75.88	1.60	22.00
1.70	12.10	67.50	8.17	23.14	64.80	35.71	27.73	35.20	78.76	1.70	20.40
1.80	8.30	78.00	6.47	29.61	73.10	40.51	21.25	26.90	79.00	1.80	0.00
9.99	26.90	79.00	21.25	50.86	100.00	50.86	0.00	.00	0.00	1.90	0.00

BIRTLEY ENGINEERING
15/06/76

SIZE ANALYSIS: -3/4" Raw Coal

SIZE FRACTION	WT%	RM%	ASH%	cum WT%	cum ASH%	
3/4" x 28M	80.9	21.6	40.0	80.9	40.0	adb
	80.6		51.0	80.6	51.0	db
28M x 0	19.1	20.0	40.6	100.0	42.0	adb
	19.4		50.8	100.0	51.0	db

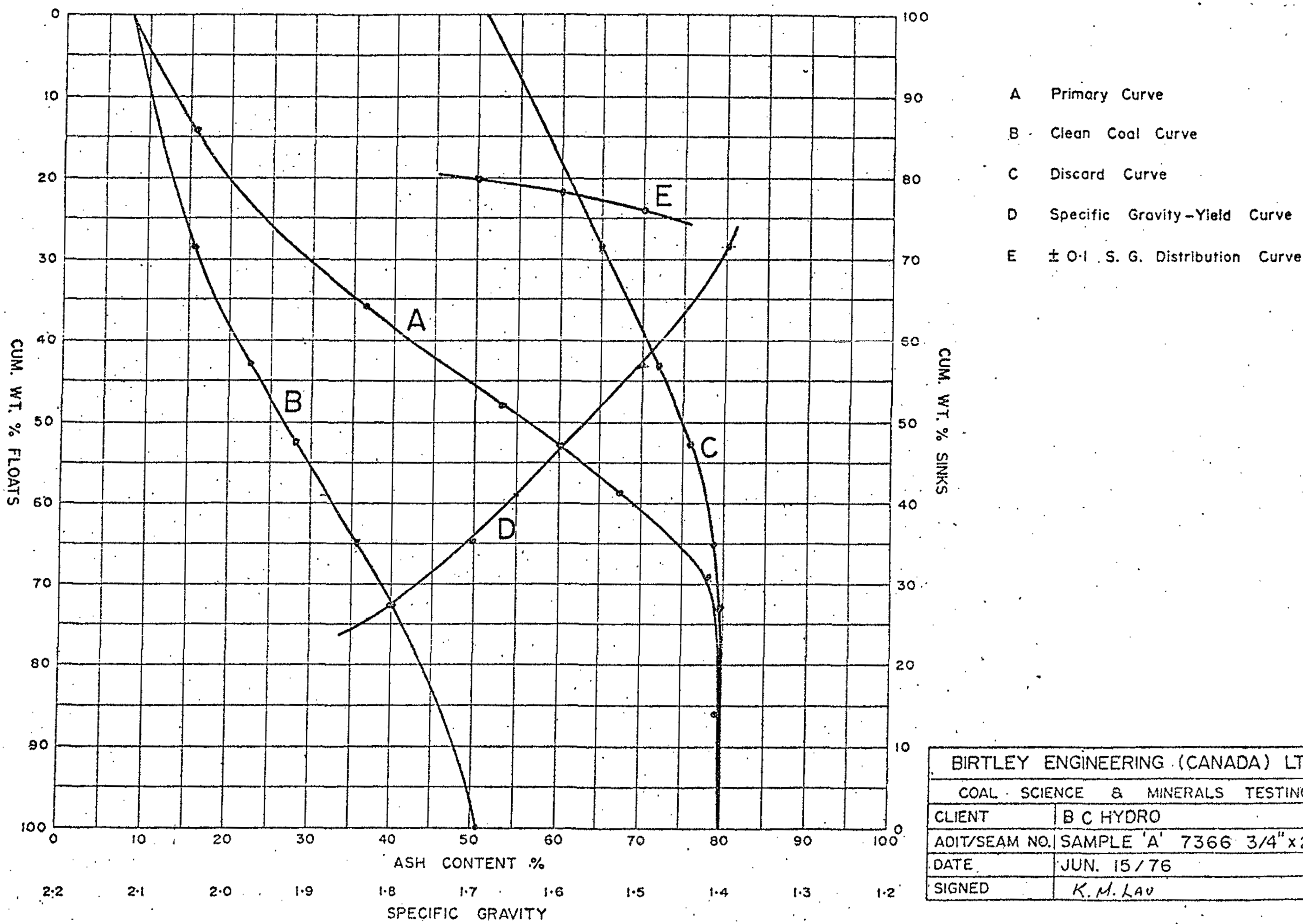
B. C. HYDRO

PROJECT: Hat Creek Project

Head Raw Analysis

SAMPLE	ADM%	R.M.%	ASH%	V.M.%	F.C.%	BTU	S.G.	H.G.I.	EQM	S.%	ASH S.G.
"A" Air Dry Basis	21.1	9.9	45.5	23.2	21.4	5136	1.75	63	28.6	0.99	2.66
7366 Dry Basis			50.5	25.7	23.8	5700					

THE CLASSICAL WASHABILITY CURVES



BIRTLEY ENGINEERING (CANADA) LTD.	
COAL SCIENCE & MINERALS TESTING	
CLIENT	B C HYDRO
ADIT/SEAM NO.	SAMPLE 'A' 7366 3/4"x28!
DATE	JUN. 15/76
SIGNED	K. M. LAU

B C HYDRO SAMPLE (B) RAW COAL 7368 3/4" X 28M

--DIRECT--					--CUM FLOATS--			--CUM SINKS--		+-0.1 DISTR	
S.G.	WT>	ASH>	WT> ASH TT	CUM WT> ASHTT	WT>	ASH>	SINK WT ASH>	WT>	ASH>	S.G.	WT>
1	2	3	4	5	6	7	8	9	10	11	12
1.40	40.90	14.90	6.09	6.09	40.90	14.90	28.21	59.10	47.72	1.40	0.00
1.50	16.80	30.40	5.11	11.20	57.70	19.41	23.10	42.30	54.61	1.50	30.30
1.60	13.50	40.00	5.40	16.60	71.20	23.32	17.70	28.80	61.45	1.60	24.20
1.70	10.70	48.60	5.20	21.80	81.90	26.62	12.50	18.10	69.05	1.70	13.00
1.80	2.30	63.20	1.45	23.26	84.20	27.62	11.04	15.80	69.90	1.80	0.00
9.99	15.80	69.90	11.04	34.30	100.00	34.30	0.00	.00	0.00	1.90	0.00

BIRTLEY ENGINEERING
14/06/76

SIZE ANALYSIS: 3/4"x0 Raw Coal

SIZE FRACTION	WT%	RM%	ASH%	Cum WT%	Cum ASH	
3/4"x28M	97.3	12.8	29.9	97.3	29.9	adb
	97.3		34.3	97.3	34.3	db
28M x 0	2.7	12.8	42.8	100.0	30.2	adb
	2.7		49.1	100.0	34.7	db

B. C. HYDRO

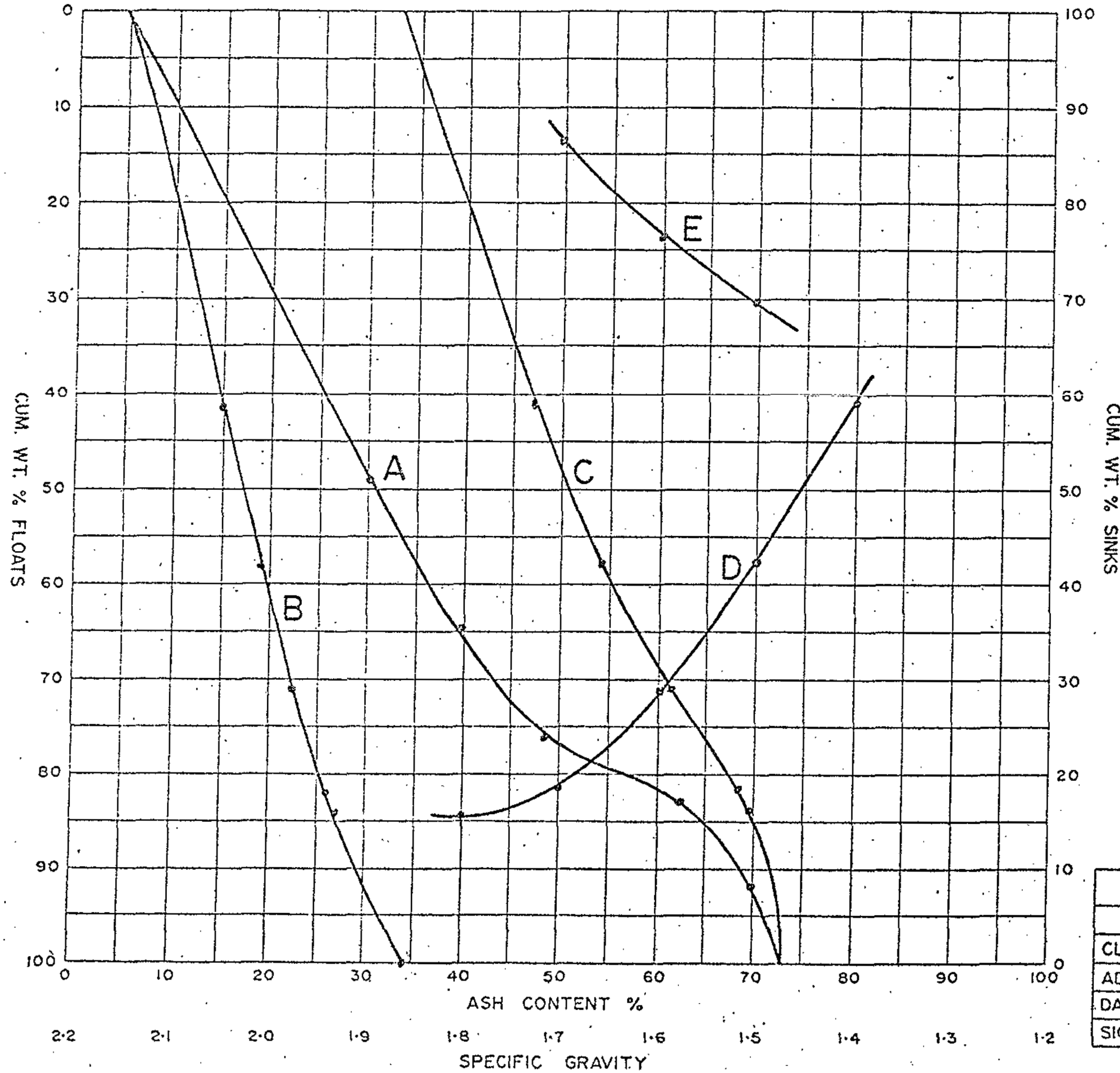
PROJECT: Hat Creek Project

Head Raw Analysis

SAMPLE	ADM%	R.M.%	ASH%	V.M.%	F.C.%	BTU	S.G.	H.G.I.	EQM	S.%	ASH S.G.
"B" Air Dry Basis	19.8	12.5	30.3	29.9	27.3	6819	1.57	39	38.0	0.93	2.62
7368 Dry Basis			34.6	34.2	31.2	7793					

Birtley Engineering
Subsidiary of Great West Steel Industries

THE CLASSICAL WASHABILITY CURVES



A Primary Curve

B Clean Coal Curve

C Discard Curve

D Specific Gravity – Yield Curve

E ± 0·1 S. G. Distribution Curve

BIRTLEY ENGINEERING (CANADA) LTD.	
COAL SCIENCE & MINERALS TESTING	
CLIENT	B C HYDRO
ADIT/SEAM NO.	SAMPLE 'B' 7368 3/4" x 28 M
DATE	JUN. 15/76
SIGNED	K. M. Lau

B C HYDRO   SAMPLE (C) RAW COAL   7370   3/4" X 28M

--DIRECT--					--CUM FLOATS--			--CUM SINKS--		+-0.1 DISTR	
S.G.	WT>	ASH>	WT> ASH TT	CUM WT> ASHTT	WT>	ASH>	SINK WT ASH>	WT>	ASH>	S.G.	WT>
1	2	3	4	5	6	7	8	9	10	11	12
1.40	65.90	11.90	7.84	7.84	65.90	11.90	19.06	34.10	55.91	1.40	0.00
1.50	10.20	29.80	3.04	10.88	76.10	14.30	16.02	23.90	67.05	1.50	14.30
1.60	4.10	43.60	1.79	12.67	80.20	15.80	14.24	19.80	71.91	1.60	7.80
1.70	3.70	63.40	2.35	15.02	83.90	17.90	11.89	16.10	73.86	1.70	8.10
1.80	4.40	69.50	3.06	18.07	88.30	20.47	8.83	11.70	75.50	1.80	0.00
9.99	11.70	75.50	8.83	26.91	100.00	26.91	0.00	.00	0.00	1.90	0.00

BIRTLEY ENGINEERING
14/06/76

SIZE ANALYSIS: -3/4" Raw Coal

SIZE FRAC	WT%	RM%	ASH %	cum WT%	cum ASH%	
3/4 x 28M	81.9	21.2	20.6	81.9	20.6	adb
	81.4		26.1	81.4	26.1	db
28M x O	18.1	19.0	29.4	100.0	22.2	adb
	18.6		36.3	100.0	28.0	db

B. C. HYDRO

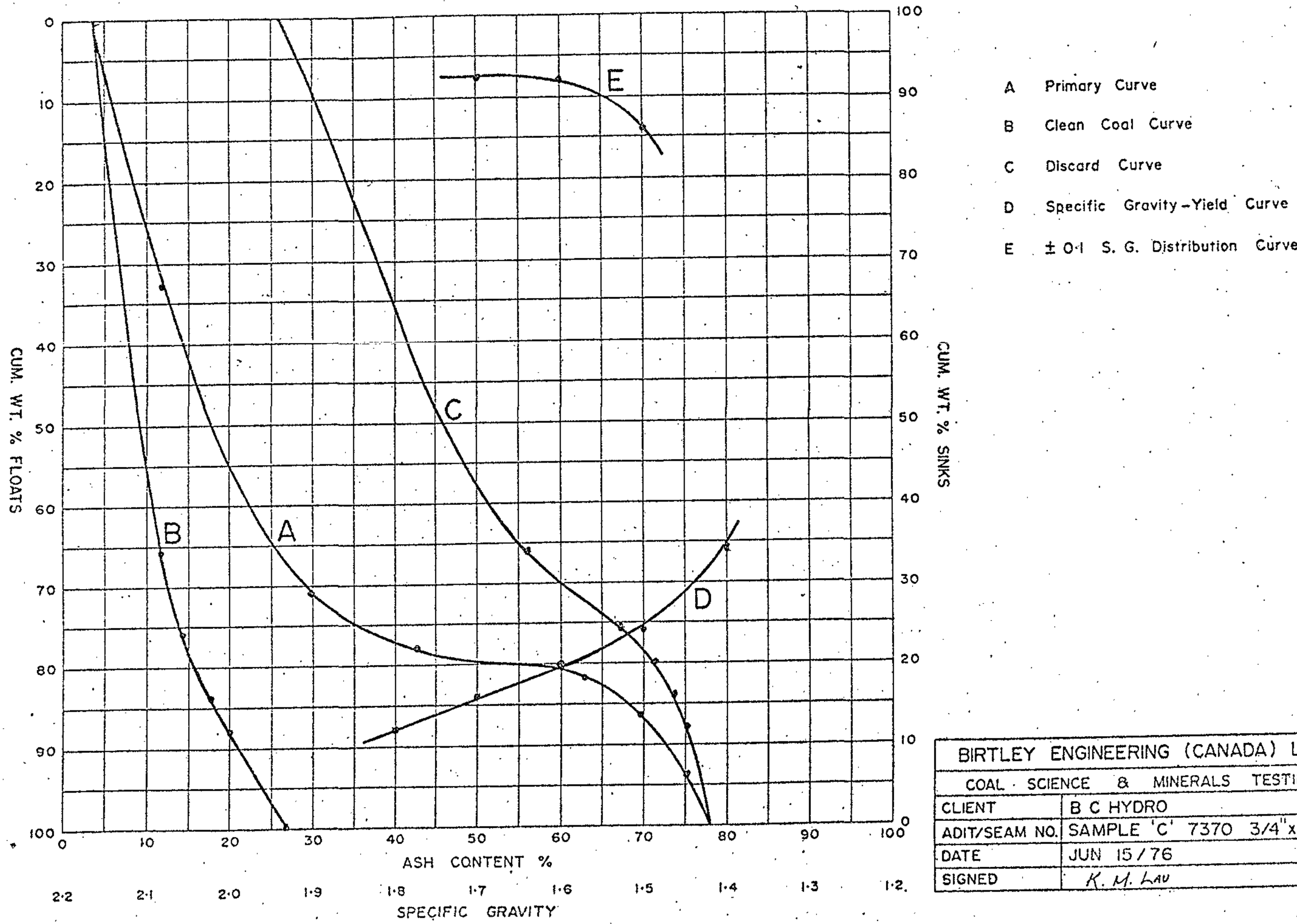
PROJECT: Hat Creek Project

Head Raw Analysis

SAMPLE	ADM%	R.M.%	ASH%	V.M.%	F.C.%	BTU	S.G.	H.G.I.	EQM	S.%	ASH S.G.
"C" Air Dry Basis	10.0	20.8	21.9	29.3	28.0	6942	1.48	43	29.2	0.57	2.75
7370 Dry Basis			27.7	37.0	35.3	8765					

Birtley Engineering
Subsidiary of Great West Steel Industries

THE CLASSICAL WASHABILITY CURVES



BIRTLEY ENGINEERING (CANADA) LTD.	
COAL · SCIENCE & MINERALS TESTING	
CLIENT	B C HYDRO
ADIT/SEAM NO.	SAMPLE 'C' 7370 3/4" x 28M
DATE	JUN 15 / 76
SIGNED	K. M. Lau

APPENDIX V

RAW COAL CRUSHED TO $\frac{3}{4}$ in AND SCREENED AT 28M ie $\frac{3}{4}$ in - 28M (Dry basis)

Percentage Ash versus Specific Gravity

Sample	A		B		C	
Sp. Gr.	Ash%	ΣAsh	Ash%	ΣAsh	Ash%	ΣAsh
- 1.4	15.7	15.7	14.9	14.9	11.9	11.9
1.4 - 1.5	36.5	22.6	30.4	19.4	29.8	14.3
1.5 - 1.6	53.5	28.4	40.0	23.3	43.6	15.8
1.6 - 1.7	67.5	55.7	48.6	26.6	63.4	17.9
1.7 - 1.8	78.0	40.5	63.2	27.6	69.5	20.5
+ 1.8	79.0	50.9	69.9	34.3	75.5	26.9

Percentage Yield (dB) versus Specific Gravity

	%wt	Σwt	%wt	Σwt	%wt	Σwt
1.4	28.6	28.6	40.9	40.9	65.9	65.9
1.4 - 1.5	14.2	42.8	16.8	57.7	10.2	76.1
1.5 - 1.6	9.9	52.7	13.5	71.2	4.1	80.2
1.6 - 1.7	12.1	64.8	10.7	81.9	3.7	83.9
1.7 - 1.8	8.3	73.1	2.3	84.2	4.4	88.3
+ 1.8	26.9	100.0	15.8	100.0	11.7	100.0
	100.0		100.0		100.0	

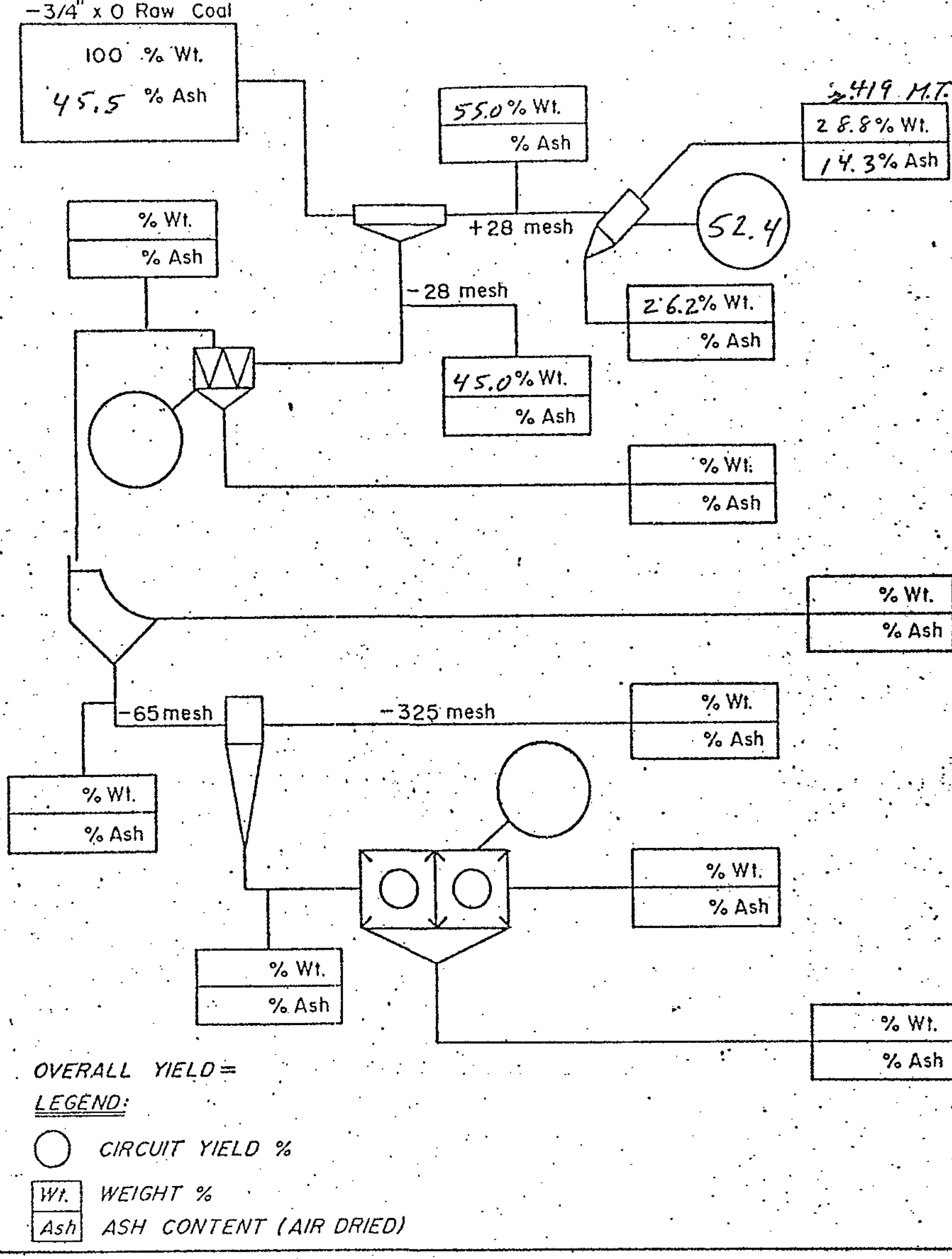
% ± 0.05 Specific Gravity of Cut Point

	A	B	C
1.4	28.4	28.9	38.05
1.45	7.2	8.4	5.10
1.55	4.95	6.75	2.05
1.65	6.05	5.35	1.85
1.75	4.15	1.15	2.20
+ 1.8	ND	ND	

Size Analysis (dry basis)

	%wt	%Ash	%wt	%Ash	%wt	%Ash
$\frac{3}{4}$ - 28M	80.6	51.0	97.3	34.3	81.4	26.1
28M - 0	19.4	50.8	2.7	49.1	18.6	36.3
		Σ51.0		Σ34.7		Σ28.0

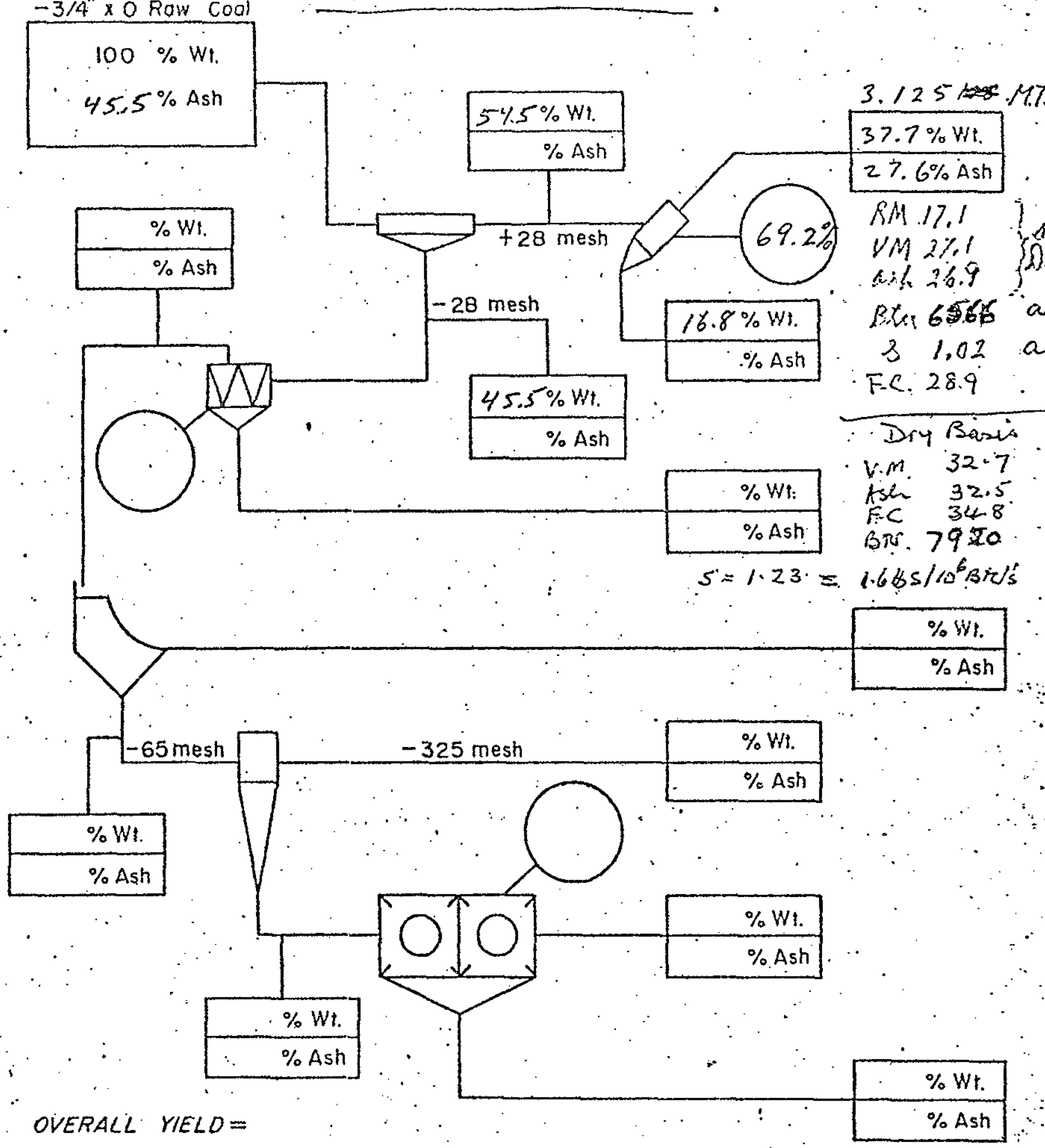
AIR DRIED BASIS



BIRTLEY ENGINEERING (CANADA) LTD.

Title: B.C. Hydro – Sample "A" H.M. S.G. @ 1.40 PLANT BALANCE SHEET	Date: June 17/76 Drawn:

AIR DRIED BASIS.



OVERALL YIELD =

LEGEND:

○ CIRCUIT YIELD %

Wt. WEIGHT %

Ash ASH CONTENT (AIR DRIED)

BIRTLEY ENGINEERING (CANADA) LTD.

Title B.C HYDRO – SAMPLE "A"

H4. S.G. @ 1.65

PLANT BALANCE SHEET

Date June 17/76.

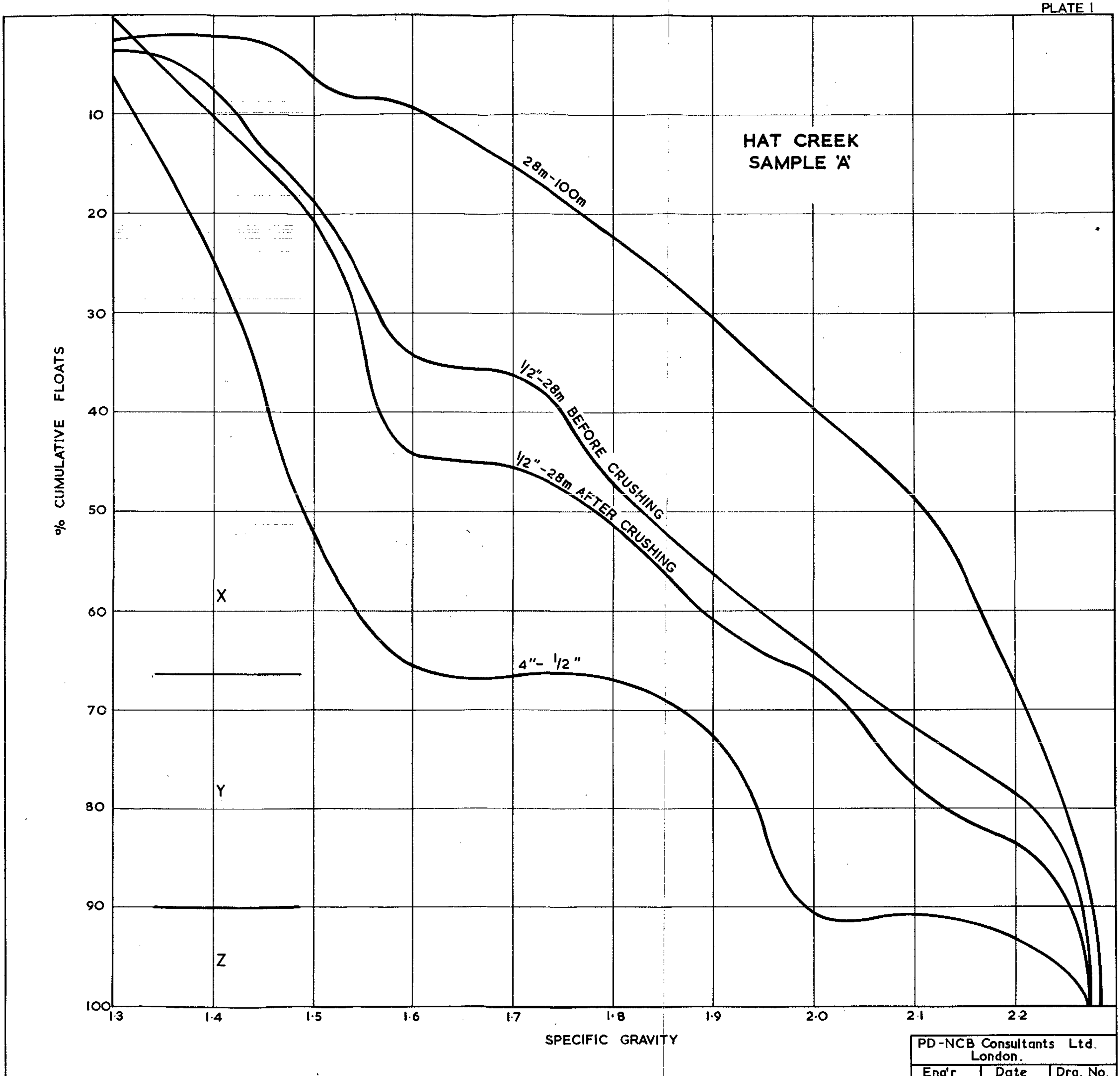
Drawn

APPENDIX VIII

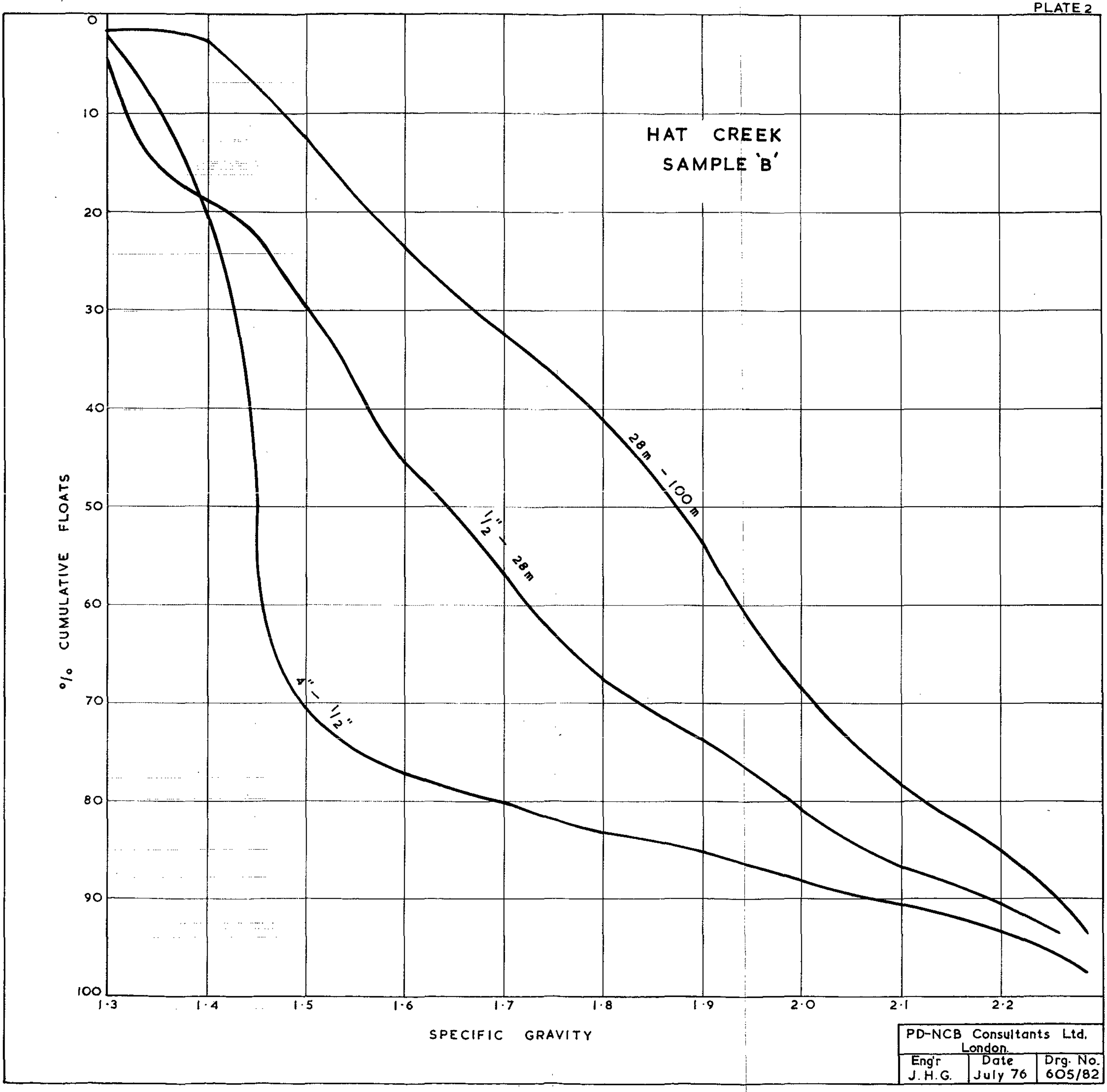
COAL SCIENCE & MINERALS TESTING
calgary — alberta

client : B.C Hydro
job no.:
date : June 15/76

LAB NO.	SAMPLE IDENTIFICATION	SAMPLE DESCRIPTION	TEST ATMOSPHERE	ASH FUSION TEMPERATURES (°F) Initial Deformation	Softening	Hemispherical	Fluid	GRINDABILITY INDEX
"A" 7366 HR	~~Head~~ Raw ~~Coal~~ 3/4" — 0"		oxidizing	2650+				
			reducing	2530	2650+			
"A" 7366 DR 100 X 0	100M — 0		oxid.	2650+				
			red.	2610	2650+			
"B" 7368 HR	~~Head~~ Raw Coal 3/4 — 0		oxid.	2650+				
			red.	2400	2620	2650	2650+	
"B" 7368 DR 0X0	100M — 0		oxid.	2650+				
			red.	2420	2650+			
"A" 1.50 7366 ~~Comp~~	4" X 1/2		oxid.	2580	2650+			
			red.	2480	2630	2650	2650+	
"A" 7366	~~-1.50 sp. gr.~~ Floats at 1.5 Sp. Gr. ~~B comp~~. 1/2" X 28M		oxid.	2290	2360	2400	2430	
			red.	2200	2260	2280	2350	
"A" 7366	-1.50 Floats at 1.5 Sp Gr ~~C Comp~~. 28M X 100 Mesh		oxid.	2260	2320	2360	2400	
			red.	2220	2260	2280	2330	
"C" 7370 HR	~~Head~~ Raw Coal 3/4" — 0"		oxid.	2650+				
			red.	2650	2650+			
"C" 7370 DR	Raw Coal 100M — 0 ~~100X0~~		oxid.	2650+				
			red.	2650+				
"A" 7366	~~-1.40~~ Floats at 1.4 Sp. Gr 3/4" X 28M		oxid.					
			red.	2360	2450	2480	2520	
"B" 7368	~~-1.40~~ ~~Floats~~ at 1.4 Sp Gr 3/4" X 28M		oxid.					
			red.	2380	2550	2580	2610	
"C" 7370	~~-1.50~~ Floats at 1.5 Sp Gr 3/4" X 28M		oxid.					
			red.	2500	2650+			
			oxid.					
			red.					



PD-NCB Consultants Ltd. London.		
Eng'r J. H. G.	Date July 76	Drg. No. 605/81


HAT CREEK
SAMPLE 'B'
% CUMULATIVE FLOATS
0
10
20
30
40
50
60
70
80
90
100
1·3
1·4
1·5
1·6
1·7
1·8
1·9
2·0
2·1
2·2
SPECIFIC GRAVITY
28m - 100m
1/2" - 28m
4" - 1/2"
PD-NCB Consultants Ltd, London.
Eng'r J.H.G.
Date July 76
Drg. No. 605/82

PD-NCB RECEIVED 21 JUN 1976 CHIEF ENGINEER

HAT CREEK PROJECT

Secondment to PD-NCB
of G. Armstrong

G. ARMSTRONG

Date: 15th June 1976

HAT CREEK PROJECT

At the present time the project is in the conceptual design stage for:-

1. An opencast pit to produce up to 12 million tons per annum;

2. A coal preparation plant to have a beneficiating effect on the quality of the coal;

3. A 2000 megawatt power station to be supplied with coal from the opencast pit.

This is Stage 1 of a plan subsequently to produce a further 20 million tons per annum of coal from a second opencast pit which would supply a 3000 megawatt power station.

The project has been devised by the British Columbia Hydro Board who own the mineral rights of Hat Creek. Coal resources at Hat Creek are considered to be of the order of 500 million tons in Pit 1 and 3000 million tons in Pit 2. The coal seam is thought to be 2000 feet thick and has been proved in a considerable number of diamond bore core holes to depths of 1600 feet. (See Appendix 1)

The BC Hydro Board have called in Integ-Ebasco (a joint Canadian-American consultancy firm) for the power station study and PD-NCB to examine the mining problems. PD-NCB have enlisted the services of Wright Engineering of Vancouver to assist.

Dolmage Campbell and Associates (Loring Laboratories Limited) and Commercial Testing and Engineering Laboratories, Vancouver, have been responsible for the initial laboratory analyses of the borehole cores and Golder Associates have acted as Geo-Technical Consultants.

Following initial tests by the Birtley Engineering (Canada) Ltd., Coal Science and Material Testing Laboratory and the NCB Corex Laboratory on small samples taken from 2" borehole cores and supplied by Dolmage Campbell, BC Hydro asked for pilot scale tests to be carried out on one quality of coal. This was subsequently modified by Ebasco and PD-NCB to the following three qualities:-

1. 3500 Btu (at 20% moisture basis) 4375
2. 5000 Btu (" " " ") 6250
3. 6500 Btu (" " " ") 8125

to establish what beneficiation would result on washing.

These tests included the requirements for:-

1. Washability data on each sample;

2. A pilot plant wash with weight and ash balance;

3. Combustion tests by the Canadian Combustion Research Laboratory in Ottawa;

4. A petrographic analysis to be carried out by the Canada Centre for Mineral and Energy Technology, Ottawa.

BC Hydro requested that Birtley Engineering (Canada) Ltd., should carry out tests 1 and 2 and be responsible for the despatch of samples for 3 and 4.

PD-NCB were requested to monitor the procedures carried out by the Birtley Engineering Testing Laboratory.

Mr. G. Armstrong, Deputy Chief Scientist, Scottish Area, National Coal Board, was seconded to PD-NCB for a period of 2 weeks to monitor this work in Calgary, Alberta, Canada, where the Coal Science and Material Testing Laboratories of Birtley Engineering (Canada) are located.

Terms of Reference for G. Armstrong

The following terms of reference were drawn up by PD-NCB and together with a general summary of the project were discussed by Mr. S. Brealey and myself at a briefing meeting held at Enfield, Middlesex, England on 27th May, 1976.

The terms were:-

1. To discover the standard methods used by Birtley Engineering in their tests;

2. To assess the quality of the equipment used by Birtley Engineering (Canada);

3. To assess the proficiency of the staff;

4. To assess the standard of the system of recording and calculation of results;

5. To report on the basis of the standards adopted, i.e. dry ash free, air dried, etc.

6. An assessment of the reliability of the results;

7. The training of Mr. Nick Krpan (Wright Engineering), Senior Engineer for future monitoring of tests;

8. A conclusion on overall washing prospects, possible processes, and likely yields.

Consequently I flew out to Calgary on 31st May and after a preliminary discussion with Mr. Krpan, visited the Birtley Engineering Laboratory on 1st June, 1976. The laboratory was subsequently visited daily until 9th June inclusive.

Terms of Reference for Birtley Engineering

My two main contacts at Birtley Engineering were:-

Dr. D. Symonds,
Manager,
Birtley Engineering (Canada)

and

Mr. F.J. Horvat,
Manager,
Coal Science and Minerals Testing Laboratory,
Birtley Engineering (Canada)

The involvement of this firm was explained and lay primarily in testing and despatching samples as per the attached schedule, Appendix 2.

They were interested in the engineering of a coal preparation plant of suitable design but I have no knowledge of any direct request from BC Hydro to Birtley Engineering for this.

Coal Science and Materials Testing Laboratory

There are four staff, the only one qualified as an assayer is F. Horvat, the Laboratory Manager. ASTM methods of analysis and sampling are used as laid down in the current year book of ASTM. These methods differ in minor detail to BS methods of analysis in sampling but are of no significant consequence, although British and North American terms for moisture can be confusing.

North American Term	British Term
Air Dried Moisture	Loss on Air Drying
Residual Moisture	Air Dried Moisture
Total Moisture	Total Moisture
Equilibium Moisture	Dried at 30°C and 70% RH (NCB Standard)

The staff not qualified, are competent in their job as far as I could judge. However an error in reporting a calorific value as Btu's when the result was in cals/gm was made prior to my arrival. Results and intermediate weighings, etc. are recorded on worksheets appertaining to each sample, the standard method of most laboratories.

The sample preparation laboratory and pilot wash plant is operated by 6 industrial staff supervised by a senior sampler who is responsible to F. Horvat. One at least of the samplers had had only a few months experience. The senior sampler during my stay was off sick but this was a recent event and the float and sink work was being supervised by one of the other samplers who also acts as the pilot wash plant operator, and F. Horvat's second-in-command.

Screening is done by spreading the coal over a suspended 8' x 4' wire mesh screen for sizes down to 1/8". Below 1/8" i.e. 6 mesh, a standard 8" screen using either hand or Rotap machine screening is utilised.

Two crushers are available, one a 5" x 3" jaw crusher for crushing down to ¼" x 0 and a 6" x 8" jaw crusher (part of the pilot wash plant) for crushing down to ¾" x 0.

¼" x 0 samples are ground to below 10 mesh in a Cornmill (a grinding plate mill) and the 10 mesh samples to below 60 mesh in a Holmes pulveriser.

Sample bulk reduction is by either cone and quartering or by means of a stainless steel Jones Riffle with single stream feed.

½" x 0 ¾" slot riffle with 16 divisions

¼" x 0 3/8" slot riffle with 24 divisions

(BS methods require 2½ times top size)

Float and sink analysis is carried out in organic media in containers; i.e.

$+\frac{3}{4}$" material in 20 gallon drums containing internal basket with $\frac{1}{4}$" perforations

$\frac{3}{4}$"-28m material in $2\frac{1}{2}$ gallon drums containing an internal basket with 60 mesh gauze

Minus 28 mesh is carried out in 2 litre separating funnels.

The organic solvents for correct gravity medium are in various proportions of media, below:-

Specific Gravity	0.78	IOSOL
" "	1.62	PERCHLORETHLENE
" "	2.20	CERTI-GRAW (Di-bromo-ethane)

These are used in preference to benzole and inorganic media because of the claimed equal evaporation rates for all fluids. (Where the fluids have unequal rates difficulties arise in maintaining constant gravities of mixed fluids, i.e. in the 1.30 sg. to 1.55 sg. range). The gravities are checked prior to each charge of run-of-mine coal.

The samples, after float and sinking are dried off on a 12' x 12' heating pad maintained at 95°F (35°C) - high gravity material is washed with IOSOL prior to drying.

Sample weights are recorded on work sheets and a simple identification code used for processing samples through the sample preparation and washability process.

This part of the laboratory had a general air of dirt and untidiness and was not to the standards maintained by NCB laboratories. The float and sink equipment was only the basic essentials. The NCB system of down-draught benches was discussed with F. Horvat and an offer of detailed drawings of an NCB Float and Sink Bench was accepted. Nevertheless this laboratory has considerable experience in washability float and sink testing as it is currently doing work for both Canadian and North American coal companies other than the BC Hydro. A comprehensive report for the Kaiser Coal Company was competently reported and the results of float and sink analysis meaningful while I was there.

Pilot Wash Plant

The feed to the pilot wash plant 5-7 tonnes per hour deals with 2" x 0 coal but the cyclone in the heavy media circuit (magnetite) can only deal with $\frac{3}{4}$" x 28 mesh and the water cyclone 28 x 100m with an effective cut-off at 63 mesh. Overflow from this cyclone and underflow from a 0.25 mm sieve bend can be treated in a froth flotation plant or passed to a thickener.

Appendix 3 shows the basic Birtley Engineering wash test. In the case of Hat Creek coal, the system will be modified as follows:-

1. Plus 2" material removed by the 2" x 2" wire mesh grid, if stone or coal, will be broken and added back through the grid.

2. Bentinitic clays +2" and 2" x ¾" will be removed and added back by hand, through a ¾" wire mesh after the rotary screen (3) but prior to the 28 mesh sieve bend (5). Should bentinitic clay less than ¾" cause problems with the crusher, a high pressure water lance will be used to wash the clay into the washery system.

   It is not the intention to use the froth flocation plant during the pilot wash of the Hat Creek coal and therefore underflow from the 65m sieve bend (16) and overflow from the primary water cyclone (15) will be retained by the thicknet (28).

◯ numbers refer to the Test Plant flow sheet in Appendix 3. The plant is compact and capable of good control by an experienced operator. Dense medium control is by density meter measurement of the magnetite concentrations. Sampling points are satisfactory.

I had hoped to see the plant operating and sampling being conducted but this was not possible because of the postponement of the Test Wash of 'A' Sample until at least 17th June, 1976.

The efficiency of washing is calculated on a plant feed/product balance on both a weight and ash content basis.

The cut point can be maintained at any level between 1.3 and 1.8 sg. gravity and the actual point will be selected on the basis of the results of the Washability of A, B and C samples.

Results

During my stay the following results became available:-

Sample A - Head Raw

Run-of-mine crushed to ¾" x 0

50.5% dry ash 5700 dry Btu (4560 Btu @ 20% moisture)

Washability data on A Table (1)

Sample B - Head Raw

34.6% dry ash 7793 dry Btu (6230 Btu @ 20% moisture)

Sample C - Head Raw

27.7% dry ash 8765 dry Btu (7010 Btu @ 20% moisture)

A modified washability on Samples A, B and C (Tables 3, 4 and 5)

Comments on Data

The results on the washability of Sample A indicate certain anomolies which make reliable interpretation of the data impossible,

i.e. For a given specific gravity range, the ash variation between size rangesis considerably greater than I would expect. Additionally if the $\frac{1}{2}$" x 28 mesh size range is examined there is an abnormal distribution of float material in the gravity ranges below 1.60 sg. These points can be examined in Table 2.

For these reasons discussions took place with D. Symonds, F. Horvat and myself on 9th June and general agreement was reached to recommend to BC Hydro to modify the float and sink procedure as follows:-

1. Use crushed 4" x 0 Run-of-Mine, i.e. $\frac{3}{4}$" x 0

2. Screen out 28 mesh x 0 material

3. Mix well and extract 5 samples

4. Air dry each sample

5. Use individual samples at specific gravities, i.e. 1.40 1.50 1.60 1.70 1.80 sg.

6. Ash on float and sink proportions at each gravity

7. Back calculate ash on each fraction at intermediate gravities

The results on samples A, B and C were subsequently 'phoned to me at the Ebasco Offices, New York on 11th June, 1976. BC Hydro agreed the procedure at their Headquarters on 9th June, 1976.

They are appended in Tables 3, 4 and 5 at the end of this report. A washability 'M' Curve (After Tables 3, 4 and 5) has been constructed for each and indicates the relative difficulty of washing this coal.

General Comments

1. Birtley Engineering (Canada) Ltd.

Birtley Engineering Laboratory (analyses section) has a good system of reception of samples which is simple but effective. Their analytical work (apart from one result reported in haste) appears to be satisfactory and reliable. However a system of duplicate analysis is not usually adopted and this could lead to inaccuracies in reporting.

The sample preparation section does not generally give the same impression of effectiveness. The general lack of cleanliness, tidiness (difficult but not impossible in a sample preparation laboratory) could have been due to the lack of direct supervision by the senior sampler although I do not think this was entirely the reason. The preparation is to normal ASTM standards which are not as precise as BS1017 standards. The float and sink analysis is crude but again could be adequate if carefully supervised. There is no laid down procedure as itemised in the NCB Analysts' Handbook. F. Horvat has accepted the offer of a copy of this handbook on float and sink analysis and also of the drawings of a down-draught float and sink bench.

Nevertheless the laboratory is capable of producing reliable samples for analysis (Kaiser Coal Company Report, etc.)

2. Hat Creek Coal

There are other reasons for the unacceptable results on the comprehensive washability test on A. The coal classed by ASTM as a sub-bituminous coal is obviously a very unusual coal by my standards. It is also considered to be unusual by other technical people who are familiar with North American coals.

For instance instead of splitting along normal cleats and bedding planes, the coal breaks in a conchoidal fashion - completely irregularly and in no definite manner. While lying out on the mixing pad, pieces can be heard to be cracking and eventually these cracks widen to a conchoidal fracture - immediate examination of the coal at this stage shows free water on the conchoidal face of the fracture. Thus any given piece of coal will have an apparent density not related to the true specific gravity of the coal but to the amount of air and water trapped in the interstitial structure of the coal. This in itself will lead to anomolies in the float and sink analysis or in the washing process so the coal will report to a lower gravity fraction than expected.

It was for the above reasons that together with F. Horvat and D. Symonds that I agreed to the modified procedure to obtain meaningful washability data. This was coupled with the fact that the pilot wash was to be carried out on $\frac{3}{4}$" x 0 material and therefore the data should be related to this.

I believe the selection of 4 x $\frac{1}{2}$ initially for Float and Sink work was based on cost but I would have preferred to have seen at least two additional size fractions inserted, i.e. at 2" and 1". Prior to Float and Sink a proximate analysis and calorific value could have given valuable information on the quality of the bulk sample. This has been done at Ebasco New York's request on one barrel of Sample A (not a homogenised sample) by Commercial Testing Vancouver.

3. Hat Creek - Sampling and Preparation of Homogenised Sample

The responsibility for the bucket augur sampling of the coal deposits at Hat Creek, labelling of samples was implemented by N. Krpan, Wright Engineers Vancouver. His synposis of the sampling levels related to drum numbers is given in Appendices 4, 5 and 6.

"Homogenising" an Americanism is a misnomer for bulking the contents of the individual drums and mixing to ensure that further division of the coal produced the same representative sample for Ottawa, the pilot wash and washability. It was accomplished by emptying the sealed barrels onto a steel plate and mixing as far as possible by using a small hydraulic shovel with lift. The shovel lacked sufficient height for good mixing but a reasonable job was done under the circumstances by moving the pile of coal around the steel plate in the same manner as mixing by coning.

After mixing, the coal was resealed in polythene bags in the 45 gallon drums, and marked with relevant identification prior to despatch.

Discussions with BC Hydro (Vancouver)

At BC Hydro on 9th June at their request I reported on my visit to Birtley Engineering. I met:-

C. Guelke M. French T. McCullough B. Woodley	-	BC Hydro
R. Merer	-	Integ
N. Krpan	-	Wright Engineers

N. Krpan has made notes of this meeting which I have not seen but the gist of the meeting related to:-

1. The quality of the A and B samples.

2. The anomolous results in the A washability.

3. The characteristics of this coal - conchoidal fractures.

4. The reasons for the modified washability on $\frac{3}{4}$" x 0.

5. My feelings that the pilot wash would give the most reliable results once a cut-point based on the data in 4 had been selected.

6. The difficulty of washing this coal based on available information.

7. The improved calorific value of A and B compared with the expected 3500 and 5000 Btu. My thoughts were that these samples should be more representative and McCullough admitted that there was only 50% core recovery which could have affected the validity of the previous diamond bore results.

8. C. Guelke and M. French acceptance of my observations and reasons for the revised washability to provide information for a meeting prior to the pilot scale wash on 16th/17th June, 1976.

9. That I should aquaint Ebasco New York of all these points on 11th June.

Discussions with Ebasco (New York)

At Ebasco New York, I met:-

W.A. Summers

J. Sweening

Eugene Chao	-	Vice-President of Planned Operation and Betterment
Ray Bennett	-	Chief Consultancy Engineer (Mechanical)
Betty Christie	-	Computer Systems

No notes of this meeting were made but again the gist of the subjects under discussion were:-

1. My meeting with BC Hydro and whether M. French accepted my views about the difficult nature of the coal particulary in washing and amount of misplaced material (he appeared to).

2. The washability results on Sample A and the anomolies - the reasons for modifying the washability procedure - my own views that 0.05 sg intervals were difficult to maintain in practice.

3. Summers showed me results by Commercial Testing Vancouver which indicated that beneficiation could result from screening only. This work had been initiated by Ebasco on the advice of Beech Charmberry, Secretary of Mines Pennsylvania (Retired), but on a retainer to Ebasco. A manuscript copy of the results has been sent to PD-NCB but they are summarised below:-

	% Fraction	ΣF %	Btu (dry)	Σ(dry)
+ 2"	5.5	5.5	10140	10140
2 x 1	14.3	19.8	9450	9640
1 x ½	14.6	34.4	9000	9370
½ x ¼	16.5	50.9	8380	9210
¼ x 28	33.0	83.9	7990	8730
28 - 48	7.1	91.0	6847	8585
48 x 100	4.6	95.6	6401	8480
100 - 0	4.4	100.0	6191	8380

You will note that this single barrel gives calorific values considerably higher than those obtained by Birtley on the bulked sample, i.e. 8380 @ 29.5% ash (dry) against Birtley's 5700 Btu @ 50.5% ash dry and was probably not representative.

I agreed that there was possibly in eliminating the fines problem at a coal preparation plant by dry screening.

4. I personally would have preferred to have seen an 1/8" screen size rather than 48 and 100 mesh. Summers agreed the value of this.

5. Beech Charmberry was telephoned and appraised of the situation.

6. Summers then discussed the computerisation of available borehole data for boiler design and handed over various analysis for onward transmission to PD-NCB.

7. On line monitoring using Phase IIIA AERE/NCB ash monitor and microwave moisture meters was discussed. I related my experience in Scotland where both were operating on-line for control and monitoring. Summers was extremely interested and a visit to surface plant in Scotland (Monktonhall and Bilston Glen) could be advantageous to the design of the project.

8. At the adjournment for lunch we were joined by E. Chao and R. Bennett who were also appraised of my meetings with Birtley Engineering and BC Hydro.

Chao was very concerned that C. Guelke should agreed and be aware of our general need for more information on the qualities of coal and our general agreement on what was required from Birtley, i.e.

1. ¾" x 0 crushed coal from raw coal A, B and C
Floats at 1.40 1.50 1.60 1.70 1.80 sg.
Ash on fractions as already discussed

2. From these results establish a cut point for pilot wash test.

3. Raw sample of A, B and C to be screened at 2", 1", ½", ¼", 1/8", 28m, 48m and 100 mesh.

Proximate analysis, calorific value, ash fusion and ash analysis on each fraction.

4. Following the meeting in Calgary at Birtley Engineering 16th/17th June and discussions of the above results, a float and sink analysis on each size fraction or bulked size fraction as required. I was only prepared to talk on this in general terms as a comprehensive washability on all sizes and all gravities may not be necessary.

9. C. Guelke approved this procedure and asked that F. Horvat should be requested to do this work with authority from him which would be confirmed later.

10. F. Horvat provided me with results of 1 in Para. 8 above and reported in Tables 3, 4 and 5.

He thought there could be difficulty in getting the work up to 3 Para 8 done by Wednesday and in the cost of the exercise but this was something the D. Symonds would take up with BC Hydro. Both the conversations with Guelke and Horvat, between myself and W. Summers were tape recorded.

11. Summers expressed an interest in the shale breakdown test and I promised to send him a copy of the NCB method.

Meeting adjourned for me to catch plane to London.

<u>Conclusions and Recommendations</u>

1. Birtley Engineering sample preparation and float and sink methods are crude but adequate under proper supervision.

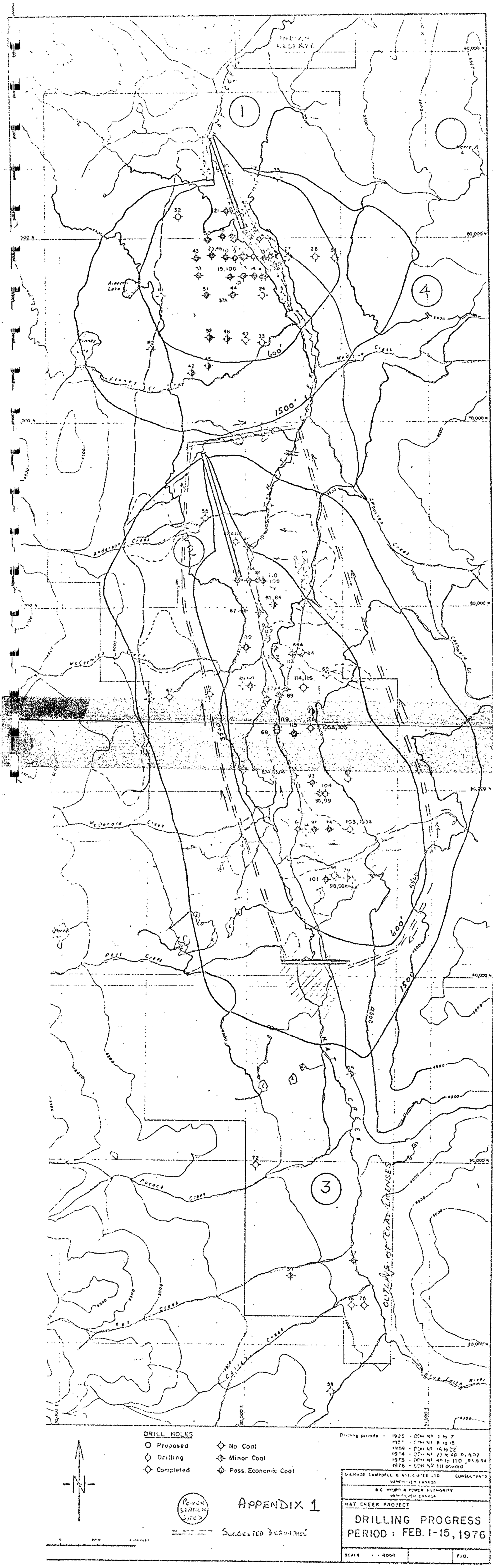
2. Hat Creek coal samples A, B and C is a complex coal not behaving in washability tests or on air drying as other coals with which I am familiar.

3. It will prove a difficult coal to wash unless a high proportion of misplaced material is acceptable.

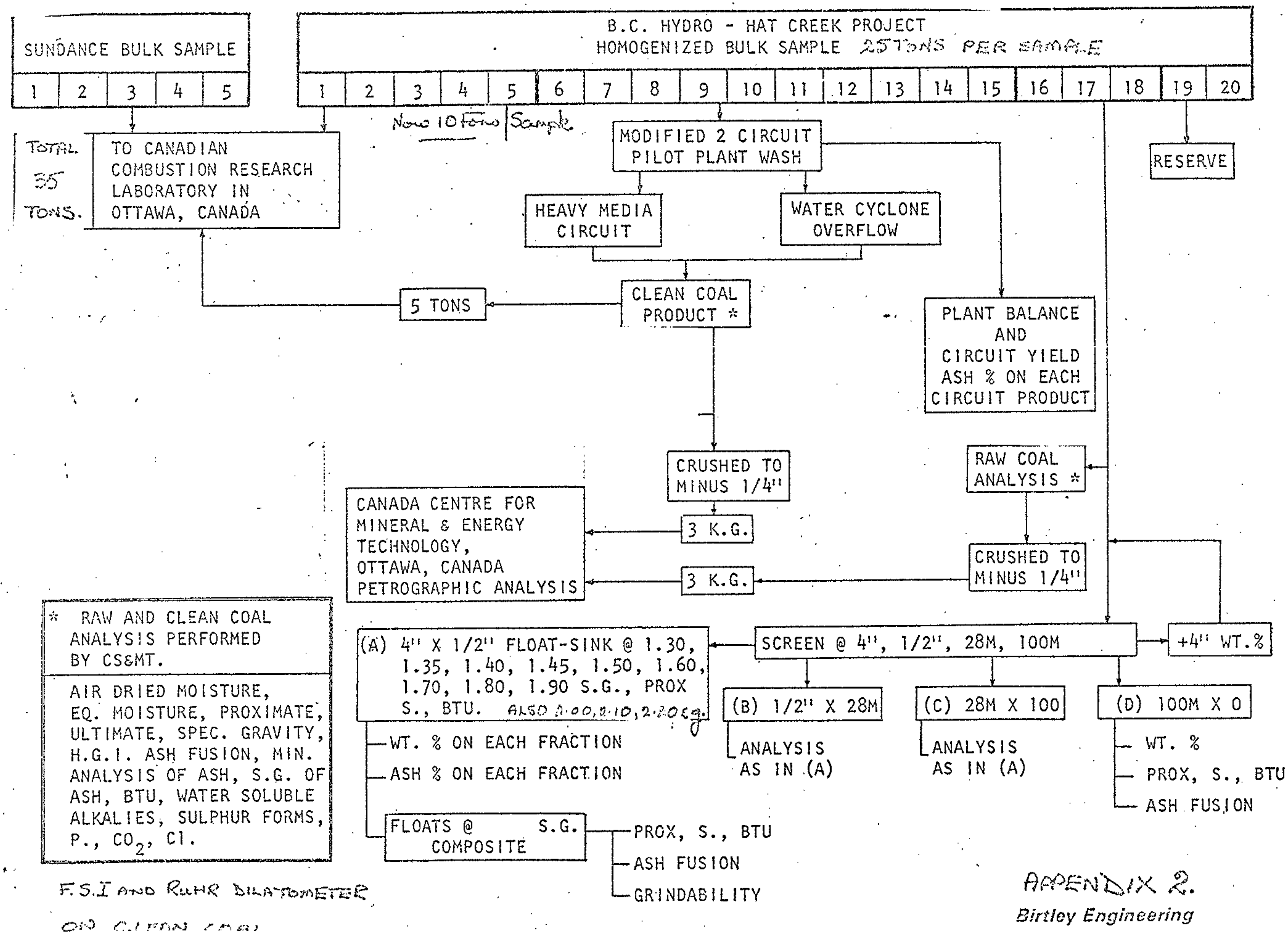
4. BC Hydro do not appear to be worried by fluctuations in calorific value of 500 Btu's or more and I got the impression over quite short time intervals, so 3 may not be too much of a problem.

5. As the coal itself is subject to rapid degradation on drying and because it is associated with appreciable quantities of bentonite, a consistent density in the wash media is going to prove difficult to maintain. This will increase the washing problem.

6. The use of a Bradford Breaker to remove oversize stones, and a screening plant to remove say $\frac{1}{4}$" x 0 undersize as a dry reject is worthy of consideration. The mid-size material could be part washed, part crushed raw, to give the flexibility required to produce a reasonably consistent product. On stream monitoring using an ash monitor and moisture meter would be capable of the necessary control. Preliminary assessment tests on the feasibility of an ash monitor could be carried out in Scotland if the required samples were made available.



Anderson Creek
McCormick Creek
McDonald Creek
Pocock Creek
Medicine Creek
Hat Creek
Bonaparte River
600'
1500'
1
2
3
4
DRILL HOLES
Proposed
Drilling
Completed
No Coal
Minor Coal
Poss. Economic Coal
Drilling periods - 1925 - DDH Nº 1 to 7
1957 - DDH Nº 8 to 15
1959 - DDH Nº 16 to 22
1974 - DDH Nº 23 to 48
1975 - DDH Nº 49 to 110
1976 - DDH Nº 111 onward
N
POWER STATION SITES
APPENDIX 1
SUGGESTED DRAINAGE
CONSULTANTS
VANCOUVER CANADA
B.C. HYDRO & POWER AUTHORITY
VANCOUVER CANADA
HAT CREEK PROJECT
DRILLING PROGRESS
PERIOD : FEB. 1-15, 1976
SCALE
FIG.



APPENDIX 2.

Birtley Engineering

APPENDIX 3

COAL SCIENCE & MINERALS TESTING DIVISION

BIRTLEY ENGINEERING (CANADA) LTD.

1976

PRICE LIST

Birtley Engineering

Subsidiary of Great West Steel Industries

COAL SCIENCE & MINERALS TESTING DIVISION

BIRTLEY ENGINEERING (CANADA) LTD.

1976

PRICE LIST

AIR DRIED MOISTURE (ASTM)		\$ 7.50 each
RESIDUAL MOISTURE		3.30 each
EQUILIBRIUM MOISTURE		14.30 each
ASH		3.85 each
PROXIMATE ANALYSIS (Residual Moisture, Ash, Volatile and Fixed Carbons)		11.00 each
ULTIMATE ANALYSIS (Carbon, Hydrogen, Nitrogen, Oxygen, Sulphur, Ash, Residual Moisture)		66.50 each
SPECIFIC GRAVITY (Bottle Method)		7.50 each
SPECIFIC GRAVITY (Bulk Buoyancy Loss Method)	Min.	5.00 each
FREE SWELLING INDEX		6.00 each
RUHR DILATOMETER TEST		50.00 each
HARDGROVE GRINDABILITY TEST		22.00 each
ASH FUSION TEMPERATURES 1) Oxidizing or Reducing Atmosphere		24.75 each
2) Oxidizing & Reducing Atmosphere		44.00 each
MINERAL ANALYSIS OF ASH FOR: SiO_2; Al_2O_3; Fe_2O_3; CaO; MgO; Na_2O; K_2O; TiO_2; P_2O_5; SO_3.		66.50 each
CALORIFIC VALUE		14.30 each
SULPHUR		7.15 each
PHOSPHOROUS		7.50 each
CARBON DIOXIDE		7.50 each
CHLORINE		19.50 each
LABORATORY SCALE FROTH FLOTATION TEST		40.00 each
SCREEN ANALYSIS (Dependent on size separation & bulk of sample)		15.00/hour
FLOAT-SINK ANALYSIS (Dependent on size fraction & bulk of sample)		
1) Below 1.60 S.G.	Min.	12.00 per Separation
2) From 1.60 to 2.2 S.G.	Min.	15.00 per Separation

Birtley Engineering

Subsidiary of Great West Steel Industries

1976 Price List (cont.)

PILOT PLANT BULK WASHING:-

Our Bulk washing facility has a feed rate capacity of 5 to 7.5 metric tons per hour of R.O.M. (run-of-mine) coal. The feed to the system is reduced to 3/4" x 0 by crushing the screened oversize to minus 3/4". The plant has the flexibility to wash 3/4" x 28 Mesh coal in the heavy media circuit and to either treat the 28 mesh x 0 coal directly by froth flotation or to route it through the water-only cyclone circuit first, scalping the 28 mesh x 65 mesh overflow product by means of a 0.25 mm sieve bend, thickening the 65 mesh x 0 underflow in an 8" classifying cone of which the underflow forms the feed to the froth cells. Both the sieve bend overflow and the froth concentrate enter a disc filter which dewaters this fine clean coal to approximately 22% moisture. The clean coal from the heavy media circuit is combined with the filter cake to form the clean coal product. This clean coal is representative of the product which can be expected to be produced from a commercial preparation plant.

1. Basic Two (2) Circuit Wash (Heavy Media & Froth Flotation)*

Up to 10 metric tons	$4,500.00
Each Additional Ton	150.00

2. Basic Three (3) Circuit Wash (Heavy media, Water-Only Cyclone, Froth Flotation)*

Up to 10 metric tons	$5,900.00
Each Additional Ton	200.00

*This price includes all the analysis required to produce a plant balance sheet with yields of the circuits and ash contents of products plus the overall yield and proximate analysis of the clean coal product. Any other work such as receiving the samples, homogenizing, blending of clean coal, drying, packaging for shipment, loading and storage will be charged at the following rates:- *waste disposal.

Labour	12.00/hour
Front End Loader & Operator	19.25/hour

All materials such as barrels, liners etc. can be supplied at cost plus 10%.

Costs for large continuing programmes are negotiable.

Birtley Engineering
Subsidiary of Great West Steel Industries

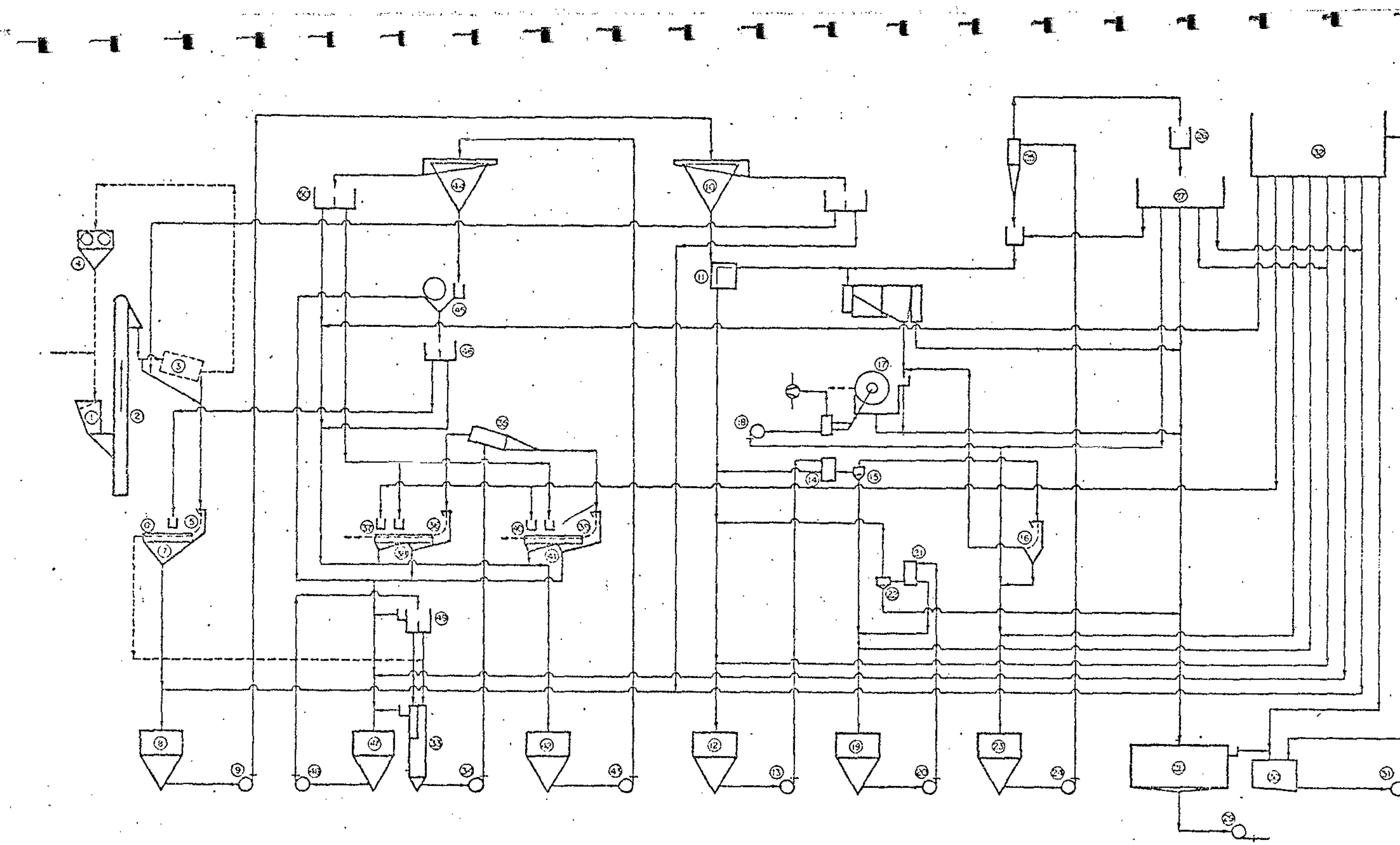


FIGURE 1

1. Feed Bin
2. Elevator
3. Rotary Screen
4. Jaw Crusher
5. Sieve Bend
6. Desliming Screen
7. Underflow Collector
8. 20M-0 Raw Coal Collection Tank
9. Pump
10. Settling Cone
11. Diverter
12. Primary Water Only Cyclone Feed Tank
13. Pump
14. Distributor
15. Primary Water Only Cyclone
16. Sieve Bend
17. Vacuum Filter
18. Filtrate Water Pump
19. Secondary Water Only Cyclone Feed Tank
20. Pump
21. Distributor
22. Secondary Water Only Cyclone
23. Thickening Cyclone Feed Tank
24. Pump
25. Thickening Cyclone
26. Overflow Distributor
27. Head Box
28. Thickener
29. Waste Disposal Pump
30. Clarified Water Collection Tank
31. Clarified Water Pump
32. Clarified Water Head Box
33. Cyclone Feed Tank
34. Pump
35. DSM Cyclone
36. Sieve Bend
37. C.C. Drain and Rinse Screen
38. Underflow Collector
39. Sieve Bend
40. Discard Drain and Rinse Screen
41. Underflow Collector
42. Dilute Medium Tank
43. Pump
44. Settling Cone
45. Magnetic Separator
46. Splitter Box
47. Correct Medium Tank
48. Pump
49. Distribution Box
50. Splitter Box

PILOT PLANT WASHING

Figure 1 is the flowsheet of the Coal Science & Minerals Testing pilot plant. Raw coal is dumped by a front end loader into a hopper at ground level, which has a heavy 2" square screen installed to ensure that the bucket elevator receiving the feed does not handle oversize material. The 2" oversize coal is crushed manually to pass the 2" screen, but "rock" is collected in barrels and reported as shale of the heavy media circuit. The bucket elevator discharges the minus 2" feed at a rate of 5 to 7 metric tons per hour into a rotary 3/4" screen on the third deck. The 3/4" oversize falls via a chute into a 5" x 8" jaw crusher where it is crushed to minus 3/4" and is recycled through the feed system. The 3/4" x 0 screen underflow is washed with water onto a 28 mesh sieve bend and slot screen for desliming.

The 3/4" x 28 mesh coal is the feed to the 14" DSM Heavy Media cone on the second deck. The slurry of coal and correct medium is pumped to the cyclone from the mixing tube at a pressure of 9 to 10 psi. The overflow and underflow products are discharged onto a common, but split 28 mesh slot screen preceded by a 28 mesh sieve bend where the magnetite is washed off into the correct and dilute medium tanks directly below. Additional clean spray water and baffles across the clean coal stream ensure that a minimum of magnetite is retained on the clean coal product. The clean coal and shale are collected in barrels by means of individual chutes for weighing.

The dilute medium is pumped to a thickening cone on the third deck from where it is fed to a 30" magnetic sparator. The recovered magnetite is sluiced back to the correct medium tank. The specific gravity of the medium is monitored manually, using a density meter, and adjusted for loss by adding cyclone grade magnetite directly to the correct medium tank.

The 28 mesh x 0 coal collected in the slimes tank ground level, is pumped to the thickening cone on the third deck. From this point it can be fed directly to the froth circuit, or as is usual, to the water-only cyclone system.

Coal to the 6" DSM water-only cyclone is pumped at a pulp density of 10% to 20% from the cyclone feed tank at a pressure of 20 psi, and a flow rate of 85 Imperial gallons per minute. A mechanically adjustable vortex finder facilitates settings for a desired ash content.

The underflow or waste product is routed to the static thickener while the overflow is fed by gravity to a rapped 0.25 mm sieve bend. The sieve bend overflow is the water-only cyclone product at approximately 65 mesh oversize, and directed to the Eimco disc filter for dewatering.

The sieve bend underflow flows by gravity to the thickening cyclone feed tank, from where it is pumped to the 20° - 8" cyclone. This thickening cone serves a dual purpose: 1) it removes undesireable -325 mesh slimes from the flotation feed, 2) it provides a feed of proper density (20% - 30% solids) to the froth cells. The overflow with the -325 mesh slimes flows to the static thickener.

The flotation circuit consists of two (2) Birtley-Humboldt Multi-Wobble Cells in series. Since these cells were installed on September 12, 1975 there appears to be a marked improvement in tailings ash contents, indicating excellent recovery of froth product. A rotary reagent feeder introduces 4:1 Kerosene:Methylisobutylcarbinol into the circuit at the feed entry point for better conditioning.

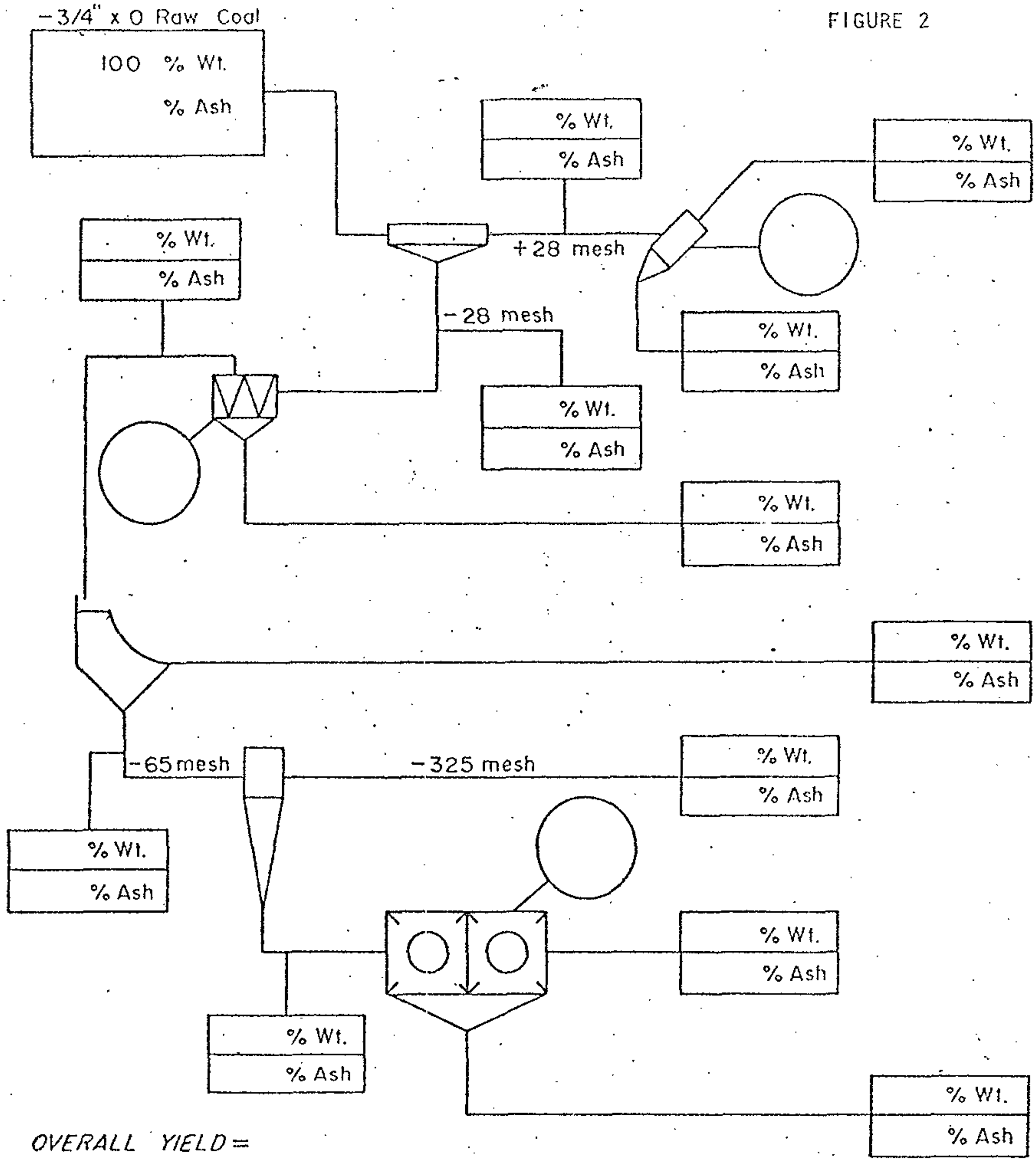
The tailings join the water-only cyclone underflow and thickener cone overflow to form the thickener tails. The froth enters the Eimco disc filter and is dewatered along with the sieve bend overflow to form the filter cake or fines product. This and the heavy media clean coal are combined to form the clean coal product or clean mix.

Each circuit is sampled for feed, product and waste in addition to the 0.25 mm sieve bend overflow and underflow, filter cake, thickening cyclone overflow and underflow and analysed for ash content. In addition, the water-only cyclone overflow is screened at 65 mesh as the plus 65 mesh figure is used to calculate the yield of the water-only cyclone circuit.

The heavy media clean coal and the filter cake are thoroughly homogenized and the resultant clean mix, sampled and analysed.

For shipping the clean coal, clean 45 gallon drums are double lined with polyethylene bags, the coal is placed into barrels, a tag fixed inside, and lids with gaskets securely put on. The déstinations are stencilled on the outside of the drums, and distributed by suitable carriers according to the client's instructions.

FIGURE 2



OVERALL YIELD =

LEGEND:

○ *CIRCUIT YIELD %*

Wt. *WEIGHT %*

Ash *ASH CONTENT (AIR DRIED)*

BIRTLEY ENGINEERING (CANADA) LTD.

Title	Date
	Drawn

APPENDIX 4.

Project No: 838-170

June 9, 1976

HAT CREEK COAL STUDY

BAH 76-2 (Date Begun: May 9/76)

79107 N
18311 E
3190.1 ELEV.

(Coal is in 3000 BTU range. Drums are marked "A 3000 btu")

HOLE DEPTH	COAL IS IN DRUMS NUMBERED	GROSS BTU WITH EST. IN SITU MOISTURE 20% AS PROJECTED FROM DDH 74-46
35 FT.	1 and 2	3636 BTU
36 FT.	2 and 3	"
37 FT.	4 and 5	"
38 FT.	5 and 6	"
39 FT.	6 and 7	"
40 FT.	8 and 9	"
41 FT.	9 and 10	"
42 FT.	10 and 11	"
43 FT.	12 and 13	"
44 FT.	13 and 14	"
45 FT.	14 and 15	"
46 FT.	16 and 17	"
47 FT.	18 and 19	"
48 FT.	20 and 21	4764 BTU
49 FT.	22 and 23	"
50 FT.	23 and 24	"
51 FT.	25 and 26	"
52 FT.	27 and 28	"
53 FT.	29 and 30	"
54 FT.	31 and 32	"
55 FT.	32 and 33	"
56 FT.	33 and 34	"
57 FT.	34 and 35	"
58 FT.	36 and 37	"

.../2

Project No: 838-170
June 9, 1976

Hat Creek Coal Study (cont'd)

BAH 76-2 (Date Begun: May 9/76)

79107 N
18311 E
3190.1 ELEV.

(Coal is in 3000 BTU range. Drums are marked "A 3000 btu")

HOLE DEPTH	COAL IS IN DRUMS NUMBERED	GROSS BTU WITH EST. IN SITU MOISTURE 20% AS PROJECTED FROM DDH 74-46
59 FT.	37,38 and 39	4764 BTU
60 FT.	40 and 41	"
61 FT.	42 and 43	"
62 FT.	44 and 45	"
63 FT.	45 and 46	"
64 FT.	46 and 47	"
65 FT.	48 and 49	"
66 FT.	49 and 50	"
67 FT.	51 and 52	"
68 FT.	53 and 54	"
69 FT.	55 and 56	"
70 FT.	57 and 58	"
71 FT.	59 and 60	"
72 FT.	61 and 62	"
73 FT.	63 and 64	"
74 FT.	64 and 65	"
75 FT.	66 and 67	"
76 FT.	68 and 69	"
77 FT.	70 and 71	"
78 FT.	72 and 73	"
79 FT.	74 and 75	"
80 FT.	76 and 77	"
81 FT.	78 and 79	"
82 FT.	80 and 81	"

.../3

Hat Creek Coal Study (cont'd)

Project No: 838-170
June 9, 1976

BAH 76-3 (Date Begun: May 10/76)

79143 N
18265 E
3191.2 ELEV.

(Coal is in 3000 BTU range. Drums are marked "A 3000 btu")

HOLE DEPTH	COAL IS IN DRUMS NUMBERED	GROSS BTU WITH EST. IN SITU MOISTURE 20% AS PROJECTED FROM DDH 74-46
28 FT.	1 and 2	3636 BTU
29 FT.	3 and 4	"
30 FT.	5 and 6	"
31 FT.	6 and 7	"
32 FT.	7 and 8	"
33 FT.	9 and 10	"
34 FT.	11 and 12	"
35 FT.	13 and 14	"
36 FT.	15 and 16	"
37 FT.	16 and 17	"
38 FT.	17 and 18	"
39 FT.	18 and 19	"
40 FT.	20 and 21	"
41 FT.	22 and 23	"
42 FT.	24 and 25	"
43 FT.	26 and 27	"
44 FT.	28 and 29	"
45 FT.	30 and 31	"
46 FT.	31 and 32	"
47 FT.	32 and 33	"
48 FT.	34 and 35	4764 BTU
49 FT.	35 and 36	"
50 FT.	37 and 38	"
51 FT.	39, 40 and 41	"
52 FT.	42 and 43	"
53 FT.	43 and 44	"
54 FT.	44 and 45	"

.../4

Hat Creek Coal Study (cont'd)

Project No: 838-170
June 9, 1976

BAH 76-5 (Date Begun: May 12/76)

79138 N
18318 E
3191.6 ELEV.

(Coal is in 3000 BTU range. Drums are marked "A 3000 btu")

HOLE DEPTH	COAL IS IN DRUMS NUMBERED	GROSS BTU WITH EST. IN SITU MOISTURE 20% AS PROJECTED FROM DDH 74-46
43 FT.	1 and 2	3636 BTU
44 FT.	2 and 3	"
45 FT.	4 and 5	"
46 FT.	6 and 7	"
47 FT.	7 and 8	"
48 FT.	9 and 10	4764 BTU
49 FT.	11 and 12	"
50 FT.	12 and 13	"
51 FT.	14 and 15	"
52 FT.	16 and 17	"
53 FT.	17 and 18	"
54 FT.	18 and 19	"
55 FT.	20 and 21	"
56 FT.	21 and 22	"
57 FT.	23 and 24	"
58 FT.	25 and 26	"
59 FT.	27 and 28	"
60 FT.	29 and 30	"

Hat Creek Coal Study (cont'd)

Project No: 838-170
June 9, 1976

BAH 76-12 (Date Begun: May 27/76)

N
E
ELEV.

(Coal is in 3000 BTU range. Drums are marked "A 3000 btu")

HOLE DEPTH	COAL IS IN DRUMS NUMBERED	GROSS BTU WITH EST. IN SITU MOISTURE 20% AS PROJECTED FROM DDH 74-46
31 FT.	1 and 2	3636 BTU
32 FT.	2 and 3	"
33 FT.	4 and 5	"
34 FT.	5 and 6	"
35 FT.	7 and 8	"
36 FT.	8 and 9	"
37 FT.	10 and 11	"
38 FT.	11 and 12	"
39 FT.	12 and 13	"
40 FT.	14 and 15	"
41 FT.	16 and 17	"
42 FT.	17 and 18	"
43 FT.	19 and 20	"
44 FT.	21 and 22	"
45 FT.	23 and 24	"
46 FT.	25 and 26	"
47 FT.	27 and 28	"
48 FT.	28 and 29	4764 BTU
49 FT.	29 and 30	"
50 FT.	31 and 32	"
51 FT.	33 and 34	"
52 FT.	35 and 36	"
53 FT.	37 and 38	"
54 FT.	39 and 40	"
55 FT.	41 and 42	"
56 FT.	42 and 43	"
57 FT.	44 and 45	"

Hat Creek Coal Study (cont'd)

Project No: 838-170
June 9, 1976

BAH 76-12 (Date Begun: May 27/76)

N
E
ELEV.

(Coal is in 3000 BTU range. Drums are marked "A 3000 btu")

HOLE DEPTH	COAL IS IN DRUMS NUMBERED	GROSS BTU WITH EST. IN SITU MOISTURE 20% AS PROJECTED FROM DDH 74-46
58 FT.	45 and 46	4764 BTU
59 FT.	47 and 48	"
60 FT.	48 and 49	"
61 FT.	50 and 51	"

APPENDIX 5

Project No: 838-170

June 9, 1976

HAT CREEK COAL STUDY

BAH 76-6 (Date Begun: May 17/76)

N
E
ELEV.

(Coal is in 5000 BTU range. Drums are marked "B 5000 btu")

HOLE DEPTH	COAL IS IN DRUMS NUMBERED	GROSS BTU WITH ESTIMATED IN SITU MOISTURE 20% AS PROJECTED FROM DDH 59-18
50 FT.	1 and 2	5359 BTU
51 FT.	3 and 4	"
52 FT.	4 and 5	"
53 FT.	5 and 6	"
54 FT.	7 and 8	"
55 FT.	8 and 9	"
56 FT.	9 and 10	"
57 FT.	11 and 12	"
58 FT.	13 and 14	"
59 FT.	15 and 16	"
60 FT.	16 and 17	"
61 FT.	18 and 19	"
62 FT.	20 and 21	"
63 FT.	21 and 22	"
64 FT.	22 and 23	"
65 FT.	24 and 25	"
66 FT.	26 and 27	"
67 FT.	28 and 29	"
68 FT.	30 and 31	"
69 FT.	31 and 32	"
70 FT.	33 and 34	"
71 FT.	35 and 36	"
72 FT.	37 and 38	"
73 FT.	39 and 40	"
74 FT.	41 and 42	"
75 FT.	42 and 43	"

.../2

Hat Creek Coal Study (cont'd)

Project No: 838-170
June 9, 1976

BAH 76-6 (Date Begun: May 17/76)

N
E
ELEV.

(Coal is in 5000 BTU range. Drums are marked "B 5000 btu")

HOLE DEPTH	COAL IS IN DRUMS NUMBERED	GROSS BTU WITH ESTIMATED IN SITU MOISTURE 20% AS PROJECTED FROM DDH 59-18
76 FT.	43 and 44	5359 BTU
77 FT.	45 and 46	"
78 FT.	47 and 48	"
79 FT.	49 and 50	"
80 FT.	50 and 51	"
81 FT.	52 and 53	"
82 FT.	54 and 55	"
83 FT.	56 and 57	"
84 FT.	58 and 59	"
85 FT.	59 and 60	"
86 FT.	60 and 61	"
87 FT.	62 and 63	"
88 FT.	64 and 65	"
89 FT.	66 and 67	"
90 FT.	67 and 68	"
91 FT.	69 and 70	"
92 FT.	70 and 71	"
93 FT.	71 and 72	"
94 FT.	72 and 73	"
95 FT.	74 and 75	"

Hat Creek Coal Study (cont'd)

Project No: 838-170
June 9, 1976

BAH 76-7 (Date Begun: May 19/76)

N
E
ELEV.

(Coal is in 5000 BTU range. Drums are marked "B 5000 btu")

HOLE DEPTH	COAL IS IN DRUMS NUMBERED	GROSS BTU WITH ESTIMATED IN SITU MOISTURE 20% AS PROJECTED FROM DDH 59-18
47 FT.	76 and 77	5359 BTU
48 FT.	78 and 79	"
49 FT.	80 and 81	"
50 FT.	82 and 83	"
51 FT.	84 and 85	"
52 FT.	86 and 87	"
53 FT.	87 and 88	"
54 FT.	88 and 89	"
55 FT.	90 and 91	"
56 FT.	92 and 93	"
57 FT.	94 and 95	"
58 FT.	95 and 96	"
59 FT.	97 and 98	"
60 FT.	98 and 99	"
61 FT.	100 and 101	"
62 FT.	102 and 103	"
63 FT.	104 and 105	"
64 FT.	105 and 106	"
65 FT.	107 and 108	"
66 FT.	109 and 110	"
67 FT.	111 and 112	"
68 FT.	112 and 113	"
69 FT.	114 and 115	"
70 FT.	116 and 117	"
71 FT.	118 and 119	"
72 FT.	120 and 121	"

Hat Creek Coal Study (cont'd)

Project No: 838-170
June 9, 1976

BAH 76-8 (Date Begun: May 20/76)

N
E
ELEV.

(Coal is in 5000 BTU range. Drums are marked "B 5000 btu")

HOLE DEPTH	COAL IS IN DRUMS NUMBERED	GROSS BTU WITH ESTIMATED IN SITU MOISTURE 20% AS PROJECTED FROM DDH 59-18
53 FT.	122 and 123	5359 BTU
54 FT.	124 and 125	"
55 FT.	126 and 127	"
56 FT.	128 and 129	"
57 FT.	130 and 131	"
58 FT.	131 and 132	"
59 FT.	133 and 134	"
60 FT.	134 and 135	"
61 FT.	135 and 136	"
62 FT.	137 and 138	"
63 FT.	139 and 140	"
64 FT.	141 and 142	"
65 FT.	143 and 144	"
66 FT.	145 and 146	"
67 FT.	146 and 147	"
68 FT.	148 and 149	"
69 FT.	149 and 150	"

Hat Creek Coal Study (cont'd)

Project No: 838-170
June 9, 1976

BAH 76-13 (Date Begun: May 28/76)

N
E
ELEV.

(Coal is in 5000 BTU range. Drums are marked "B 5000 btu")

HOLE *DEPTH*	COAL IS IN *DRUMS NUMBERED*	GROSS BTU WITH ESTIMATED IN SITU MOISTURE 20% AS PROJECTED *FROM DDH 57-8*
66 FT.	1 and 2	5341 BTU
67 FT.	3 and 4	"
68 FT.	5, 6 and 7	"
69 FT.	8 and 9	"
70 FT.	10 and 11	"
71 FT.	11 and 12	"
72 FT.	13 and 14	"
73 FT.	15, 16 and 17	"
74 FT.	18 and 19	"
75 FT.	20 and 21	"
76 FT.	22 and 23	"
77 FT.	24 and 25	"
78 FT.	25 and 26	"
79 FT.	27 and 28	"
80 FT.	29 and 30	"
81 FT.	31 and 32	"
82 FT.	33 and 34	"
83 FT.	34 and 35	"
84 FT.	36 and 37	"
85 FT.	38 and 39	"
86 FT.	39 and 40	"
87 FT.	41	"

APPENDIX 6.

Project No: 838-170

June 9, 1976

HAT CREEK COAL STUDY

BAH 76-9 (Date Begun: May 20/76)

N
E
ELEV.

(Coal is in 6000 BTU range. Drums are marked "C")

HOLE DEPTH	COAL IS IN DRUMS NUMBERED	GROSS BTU WITH ESTIMATED IN SITU MOISTURE 20% AS PROJECTED FROM DDH 59-19. RATING IS ESTIMATED AVERAGE FOR OVERALL DEPTH OF AUGER HOLE
13 FT.	1 and 2	6030 BTU
14 FT.	2 and 3	"
15 FT.	4 and 5	"
16 FT.	5 and 6	"
17 FT.	7 and 8	"
18 FT.	8 and 9	"
19 FT.	10 and 11	"
20 FT.	12 and 13	"
21 FT.	13 and 14	"
22 FT.	15 and 16	"
23 FT.	16 and 17	"
24 FT.	18 and 19	"
25 FT.	20 and 21	"
26 FT.	21 and 22	"
27 FT.	23 and 24	"
28 FT.	25 and 26	"
28 to 34 FT.	OPEN WORKINGS, NO COAL	
35 FT.	27 and 28	"
36 FT.	29 and 30	"
37 FT.	30 and 31	"
38 FT.	31 and 32	"

Hat Creek Coal Study (cont'd)

Project No: 838-170
June 9, 1976

BAH 76-10 (Date Begun: May 21/76)

N
E
ELEV.

(Coal is in 6000 BTU range. Drums are marked "C")

HOLE DEPTH	COAL IS IN DRUMS NUMBERED	GROSS BTU WITH ESTIMATED IN SITU MOISTURE 20% AS PROJECTED FROM DDH 59-19. RATING IS ESTIMATED AVERAGE FOR OVERALL DEPTH OF AUGER HOLE
32 FT.	33 and 34	6030 BTU
33 FT.	34 and 35	"
34 FT.	35 and 36	"
35 FT.	36 and 37	"
36 FT.	38 and 39	"
37 FT.	40 and 41	"
38 FT.	41 and 42	"
39 FT.	43 and 44	"
40 FT.	44 and 45	"
41 FT.	46 and 47	"
42 FT.	48 and 49	"
43 FT.	50 and 51	"
44 FT.	52 and 53	"
45 FT.	54 and 55	"
46 FT.	55 and 56	"
47 FT.	56 and 57	"
48 FT.	57 and 58	"

Hat Creek Coal Study (cont'd)

Project No: 838-170
June 9, 1976

BAH 76-11 (Date Begun: May 25/76)

N
E
ELEV.

(Coal is in 6000 BTU range. Drums are marked "C")

HOLE DEPTH	COAL IS IN DRUMS NUMBERED	GROSS BTU WITH ESTIMATED IN SITU MOISTURE 20% AS PROJECTED FROM DDH 59-19. RATING IS ESTIMATED AVERAGE FOR OVERALL DEPTH OF AUGER HOLE
16 FT.	59, 60 and 61	6030 BTU
17 FT.	62 and 63	"
18 FT.	64 and 65	"
19 FT.	65 and 66	"
20 FT.	66 and 67	"
21 FT.	67 and 68	"
22 FT.	68 and 69	"
23 FT.	70 and 71	"
24 FT.	71 and 72	"
25 FT.	73 and 74	"
26 FT.	75 and 76	"
27 FT.	76 and 77	"
28 FT.	78 and 79	"
29 FT.	80 and 81	"
30 FT.	82 and 83	"
31 FT.	83 and 84	"
32 FT.	85 and 86	"
33 FT.	87 and 88	"
34 FT.	89 and 90	"
35 FT.	90 and 91	"
36 FT.	92 and 93	"
37 FT.	94 and 95	"
38 FT.	95 and 96	"
39 FT.	97 and 98	"
40 FT.	98 and 99	"
41 FT.	99 and 100	"

Hat Creek Coal Study (cont'd)

Project No: 838-170
June 9, 1976

BAH 76-15 (Date Begun: May 31/76)

N
E
ELEV.

(Coal is in 6000 BTU range. Drums are marked "C")

HOLE DEPTH	COAL IS IN DRUMS NUMBERED	GROSS BTU WITH ESTIMATED IN SITU MOISTURE 20% AS PROJECTED FROM DDH 59-19. RATING IS ESTIMATED AVERAGE FOR OVERALL DEPTH OF AUGER HOLE
14 FT.	1, 2 and 3	6030 BTU
15 FT.	4, 5 and 6	"
16 FT.	7 and 8	"
17 FT.	9 and 10	"
18 FT.	11 and 12	"
19 FT.	13 and 14	"
20 FT.	15 and 16	"
21 FT.	16 and 17	"
22 FT.	17 and 18	"
23 FT.	19 and 20	"
24 FT.	21 and 22	"
25 FT.	23 and 24	"
26 FT.	24 and 25	"
27 FT.	26 and 27	"
28 FT.	28 and 29	"
29 FT.	29 and 30	"
30 FT.	31 and 32	"
31 FT.	33 and 34	"
32 FT.	34 and 35	"
33 FT.	36 and 37	"
34 FT.	37 and 38	"
35 FT.	39 and 40	"
36 FT.	41 and 42	"
37 FT.	43 and 44	"
38 FT.	45 and 46	"
39 FT.	47 and 48	"
40 FT.	49 and 50	"

Hat Creek Coal Study (cont'd)

Project No: 838-170
June 9, 1976

BAH 76-15 (Date Begun: May 31/76)

N
E
ELEV.

(Coal is in 6000 BTU range. Drums are marked "C")

HOLE DEPTH	COAL IS IN DRUMS NUMBERED	GROSS BTU WITH ESTIMATED IN SITU MOISTURE 20% AS PROJECTED FROM DDH 59-19. RATING IS ESTIMATED AVERAGE FOR OVERALL DEPTH OF AUGER HOLE
41 FT.	51 and 52	6030 BTU
42 FT.	52 and 53	"
43 FT.	54 and 55	"
44 FT.	56 and 57	"
45 FT.	58 and 59	"
46 FT.	59 and 60	"
47 FT.	61 and 62	"
48 FT.	63 and 64	"
49 FT.	65 and 66	"
50 FT.	66 and 67	"
51 FT.	68 and 69	"
52 FT.	70 and 71	"
53 FT.	71 and 72	"
54 FT.	73 and 74	"
55 FT.	74 and 75	"
56 FT.	76 and 77	"
57 FT.	78 and 79	"
58 FT.	80 and 81	"
59 FT.	82 and 83	"
60 FT.	84 and 85	"
61 FT.	86 and 87	"
62 FT.	88 and 89	"
63 FT.	89 and 90	"
64 FT.	91 and 92	"
65 FT.	92 and 93	"
66 FT.	94 and 95	"
67 FT.	96 and 97	"

TABLE I.

BIRTLEY ENGINEERING (CANADA) LTD.

CLIENT: BC HYDRO and POWER AUTHORITY DATE June 1976

SAMPLE: "A" — (3300 - 3600 BTU)

LAB No: 7366

ANALYSES of: HEAD RAW

A.D.M.%	PROXIMATE				BTU/lb.	S.G. of COAL	H.G.I.	EQUIL. MOIST.%	
	RM %	ASH %	VM %	FC %					
21.1	9.9	45.5	23.2	21.4		1.75	63	28.6	adb
	28.9	35.9	18.3	16.9					arb
		50.5	25.7	23.8	5950				db

S.G. of ASH	ASH FUSION TEMPERATURES (°F)					SULFUR FORMS				
	ATMOS.	Initial Deform'n	Softening	Hemispherical	Fluid	Total S %	Sulphate S %	Sulfide S %	Organic S %	
	OXID.									
	RED.									

MINERAL ANALYSIS of ASH										
Na_2O	K_2O	MgO	CaO	Fe_2O_3	Al_2O_3	SiO_2	SO_3	P_2O_5	TiO_2	

ULTIMATE ANALYSIS							%P on coal	$\%CO_2$ on coal	%Cl on coal	
H_2O	%C	%H	%N	%S	%Ash	%O Diff.				

S.I.	RUHR DILATOMETER TEST					WATER SOLUBLE ALKALIES
	Softening Temp. °C	Maximum Dilatation Temp °C	Maximum Contraction %	Maximum Dilatation %	G. No.	

BIRTLEY ENGINEERING (CANADA) LTD.

DATE ______________ 19____

CLIENT : BC HYDRO

SAMPLE : "A"

LAB No : 7366

SIZE ANALYSIS : OF GROSS SAMPLE CRUSHED TO -4".

WT% +4" = 0.7%

SIZE FRACTION	WT%	RM%	ASH%	VM%	FC%	S%	BTU/LB.	CUMULATIVE WT%	CUMULATIVE ASH%	CUMULATIVE BTU/LB.	
4" × ½"	34.4	13.4	37.9	24.4	24.3			34.4	37.9		a.d.b.
	31.2	--	43.8	28.2	28.0			31.2	43.8		d.b.
½" × 28M.	48.8	9.5	45.6	23.3	21.6	0.94	4855	83.2			
	50.9	—	50.4	25.7	23.9	1.04	5365	82.1			
28M. × 100M.	12.4	7.8	58.4	19.9	13.9	0.90		95.6			
	13.2	–	63.3	21.6	15.1	0.98		95.3			
100M. × 0	4.4	7.4	58.8	20.2	13.6	0.96		100.0			
	4.7	—	63.5	21.8	14.7	1.04		100.0			

ASH FUSION TEMP. (°F) : 100M. × 0

ATMOS.	Initial Deformation	Softening	Hemispherical	Fluid
OXIDIZING				
REDUCING				

BIRTLEY ENGINEERING (CANADA) LTD.

CLIENT: BC HYDRO

DATE ______ 19__

SAMPLE: "A"

LAB No: 7366

SINK-FLOAT ANALYSIS: 4" × ½" WT% = 34.4% ad

S.G. FRAC.	WT%	RM%	ASH%	CUMULATIVE WT%	CUMULATIVE ASH%	
-1.30	7.5	24.2	2.6	7.5	2.6	adb
1.39	6.6		3.4	6.6	3.4	db
1.30 - 1.35	10.2	23.1	5.1	17.7	4.0	
1.43	9.2		6.6	15.8	5.3	
1.35 - 1.40	9.5	21.4	13.1	27.2	7.2	
1.48	8.7		16.7	24.5	9.3	
1.40 - 1.45	14.8	17.4	21.3	42.0	12.2	
1.52	14.2		25.8	38.7	15.4	
1.45 - 1.50	13.2	12.5	31.6	55.2	16.8	
1.55	13.5		36.1	52.2	20.7	
1.50 - 1.60	12.8	10.2	45.7	68.0	22.3	
1.62	13.4		50.9	65.6	26.9	
1.60 - 1.70	0.8	8.8	50.3	68.8	22.6	
[illegible]	0.9		55.2	66.5	27.3	
1.70 - 1.80	0.4	8.2	55.4	69.2	22.8	
	0.4		60.3	66.9	27.5	
1.80 - 1.90	5.6	10.8	58.9	74.8	25.5	
	5.8		66.0	72.7	30.5	
1.90 - 2.00	16.7	9.0	71.8	91.5	33.9	
	17.7		78.9	90.4	40.0	
2.00 - 2.10	0.5	5.0	72.9	92.0	34.1	
	0.6		76.7	91.0	40.3	
2.10 - 2.20	2.1	5.8	77.7	94.1	35.1	
	2.3		82.5	93.3	41.3	
2.20	5.9	3.5	76.7	100.0	37.6	
	6.7		79.5	100.0	43.9	

BIRTLEY ENGINEERING (CANADA) LTD.

CLIENT: BC HYDRO DATE ______ 19__

SAMPLE: "A"

LAB No: 7366

ANALYSES ON 4" x 1/2" FLOATS @ 1.50 S.G.

PROXIMATE				S%	BTU per lb.	H.G.I.	
RM %	ASH %	VM %	FC %				
18.1	16.8	30.6	34.3			35	adb
	20.8	37.4	41.8				db

ASH FUSION TEMPERATURES (°F)					
ATMOS.	Initial Deform'n.	Softening	Hemi-spherical	Fluid	
OXID.					
RED.					

BIRTLEY ENGINEERING (CANADA) LTD.

CLIENT : BC HYDRO DATE ________, 19__

SAMPLE : "A"

AB No : 7366

SINK - FLOAT ANALYSIS : 1/2" x 28 M. WT% = 48.8 ad

S.G. FRAC.	WT%	RM%	ASH%	CUMULATIVE WT%	CUMULATIVE ASH%	
-1.30	0.5	8.2	3.6	0.5	3.6	adb
	0.5		3.9	0.5	3.9	db
1.30 - 1.35	5.0	11.4	4.2	5.5	4.1	
	4.9		4.7	5.4	4.6	
1.35 - 1.40	4.7	8.4	6.7	10.2	5.3	
	4.8		7.3	10.2	5.9	
1.40 - 1.45	4.5	7.7	13.0	14.7	7.7	
	4.6		14.1	14.8	8.4	
1.45 - 1.50	5.7	8.7	17.3	20.4	10.4	
	5.7		18.9	20.5	11.3	
1.50 - 1.60	23.9	8.2	31.6	44.3	21.8	
	24.1		34.4	44.6	23.8	
1.60 - 1.70	1.2	8.2	33.1	45.5	22.1	
	1.2		36.1	45.8	24.1	
1.70 - 1.80	5.6	8.8	43.4	51.1	24.5	
	5.6		47.6	51.4	26.7	
1.80 - 1.90	9.5	10.5	50.9	60.6	28.6	
	9.3		56.1	60.7	31.2	
1.90 - 2.00	5.8	7.9	59.5	66.4	31.3	
	5.8		64.6	66.5	34.1	
2.00 - 2.10	11.1	10.4	64.5	77.5	36.1	
	11.0		72.0	77.5	39.5	
2.10 - 2.20	6.1	6.0	73.8	83.6	38.8	
	6.2		78.5	83.7	42.4	
+2.20	16.4	9.7	75.9	100.0	44.9	
	16.3		84.1	100.0	49.2	

BIRTLEY ENGINEERING (CANADA) LTD.

CLIENT: BC HYDRO

DATE ______________ 19___

SAMPLE: "A"

LAB No: 7366

ANALYSES ON ½"x28 FLOATS @ 1.50 S.G.

PROXIMATE							
RM %	ASH %	VM %	FC %	S %	BTU per lb.	H.G.I.	
9.0	10.4	35.8	44.8			36	adb
	11.4	39.3	49.3				db

ASH FUSION TEMPERATURES (°F)					
ATMOS.	Initial Deform'n.	Softening	Hemi-spherical	Fluid	
OXID.					
RED.					

BIRTLEY ENGINEERING (CANADA) LTD.

CLIENT : BC HYDRO DATE ______, 19__

SAMPLE : "A"

AB No : 7366

SINK - FLOAT ANALYSIS : 28 M × 100 M. WT% = 12.4 ad.

S.G. FRAC.	WT%	RM%	ASH%	CUMULATIVE WT%	CUMULATIVE ASH%	
-1.30	nil	–	–	–	–	
1.30 - 1.35	nil	–	–	–	–	
1.35 - 1.40	nil	–	–	–	–	
1.40 - 1.45	3.0	8.1	7.6	3.0	7.6	adb
	2.9	–	8.3	2.9	8.3	db
1.45 - 1.50	4.0	9.8	13.4	7.0	10.9	
	3.8	–	14.9	6.7	12.0	
1.50 - 1.60	2.4	9.0	19.7	9.4	13.2	
	2.4	–	21.6	9.1	14.6	
1.60 - 1.70	6.3	10.1	26.5	15.7	18.5	
	6.1	–	29.5	15.2	20.6	
1.70 - 1.80	7.5	10.9	35.8	23.2	24.1	
	7.3	–	40.2	22.5	26.9	
1.80 - 1.90	8.3	9.5	45.4	31.5	29.7	
	8.1	–	50.2	30.6	33.1	
1.90 - 2.00	9.0	8.2	54.1	40.5	35.1	
	8.9	–	58.9	39.5	38.9	
2.00 - 2.10	8.8	7.9	60.6	49.3	39.7	
	8.8	–	65.8	48.3	43.8	
2.10 - 2.20	18.2	6.0	69.2	67.5	47.6	
	18.5	–	73.6	66.8	52.1	
+2.20	32.5	5.6	77.9	100.0	57.5	
	33.2	–	82.5	100.0	62.2	

BIRTLEY ENGINEERING (CANADA) LTD.

CLIENT: BC HYDRO

DATE ____________, 19__

SAMPLE: "A"

LAB No: 7366

ANALYSES ON 28M x 100M FLOATS @ 1.50 S.G.

PROXIMATE							
RM %	ASH %	VM %	FC %	S %	BTU per lb.	H.G.I.	
8.9	10.8	35.4	44.9				adb
	11.9	38.9	49.2				db

ASH FUSION TEMPERATURES (°F)					
ATMOS.	Initial Deform'n.	Softening	Hemi-spherical	Fluid	
OXID.					
RED.					

TABLE 2

'A' Sample B.C. Hydro

Hat Creek (May/June 1976)

Comparison of Cumulative Dry Weights and Dry Ashes of Fractions V S.G. Fractions

Proportion / S.G.	4" x ½" 34.4%		½" x 28m 48.8%		28m - 100m 12.4%	
	Σ Wt.	Ash	Σ Wt.	Ash	Σ Wt.	Ash
Float @ 1.30	6.6	3.4	0.5	3.9	Nil	-
1.30 - 1.35	15.8	6.6	5.4	4.7	Nil	-
1.35 - 1.40	24.5	16.7	10.2	7.3	Nil	-
1.40 - 1.45	38.7	25.8	14.8	14.1	2.9	8.3
1.45 - 1.50	52.2	36.1	20.5	18.9	6.7	14.9
1.50 - 1.60	65.6	50.9	44.6	34.4	9.1	21.6
1.60 - 1.70	66.5	55.2	45.8	36.1	15.2	29.5
1.70 - 1.80	66.9	60.3	51.4	47.6	22.5	40.2
1.80 - 1.90	72.7	66.0	60.7	56.1	30.6	50.2
1.90 - 2.00	90.4	78.9	66.5	64.6	39.5	58.9
2.00 - 2.10	91.0	76.7	77.5	72.0	48.3	65.8
2.10 - 2.20	93.3	82.5	83.7	78.5	66.8	73.6
Sinks @ 2.20	100.0	79.5	100.0	84.1	100.0	82.5

TABLE 3

Hat Creek 'A' - Crushed Raw to ¾" x 0

¾" x 28m 80.9% 28m x 0 19.1%

sg.	%Σ Weight	%Σ Ash	% Weight (Calculated)	% Ash (Calculated)
Floats @ 1.40 sg.	28.6	15.7	28.6	15.7
1.50 sg.	42.8	22.6	14.2	36.5
1.60 sg.	52.7	28.4	9.9	53.5
1.70 sg.	64.8	35.7	12.1	67.5
1.80 sg.	73.1	40.5	8.3	78.0
Total	100.0	50.9	26.9	79.0

¾" x 0 Head Raw 50.5% Ash Dry 5700 Btu Dry

TABLE 4

Hat Creek 'B' - ¾" x 28 97.3% 28m x 0 2.7%

Floats @ 1.40 sg.	40.9	14.9	40.9	14.9
1.50 sg.	57.7	19.4	16.8	30.4
1.60 sg.	71.2	23.3	13.5	40.0
1.70 sg.	81.9	26.6	10.7	48.6
1.80 sg.	84.2	27.6	2.3	63.2
Total	100.0	34.3	15.8	79.9

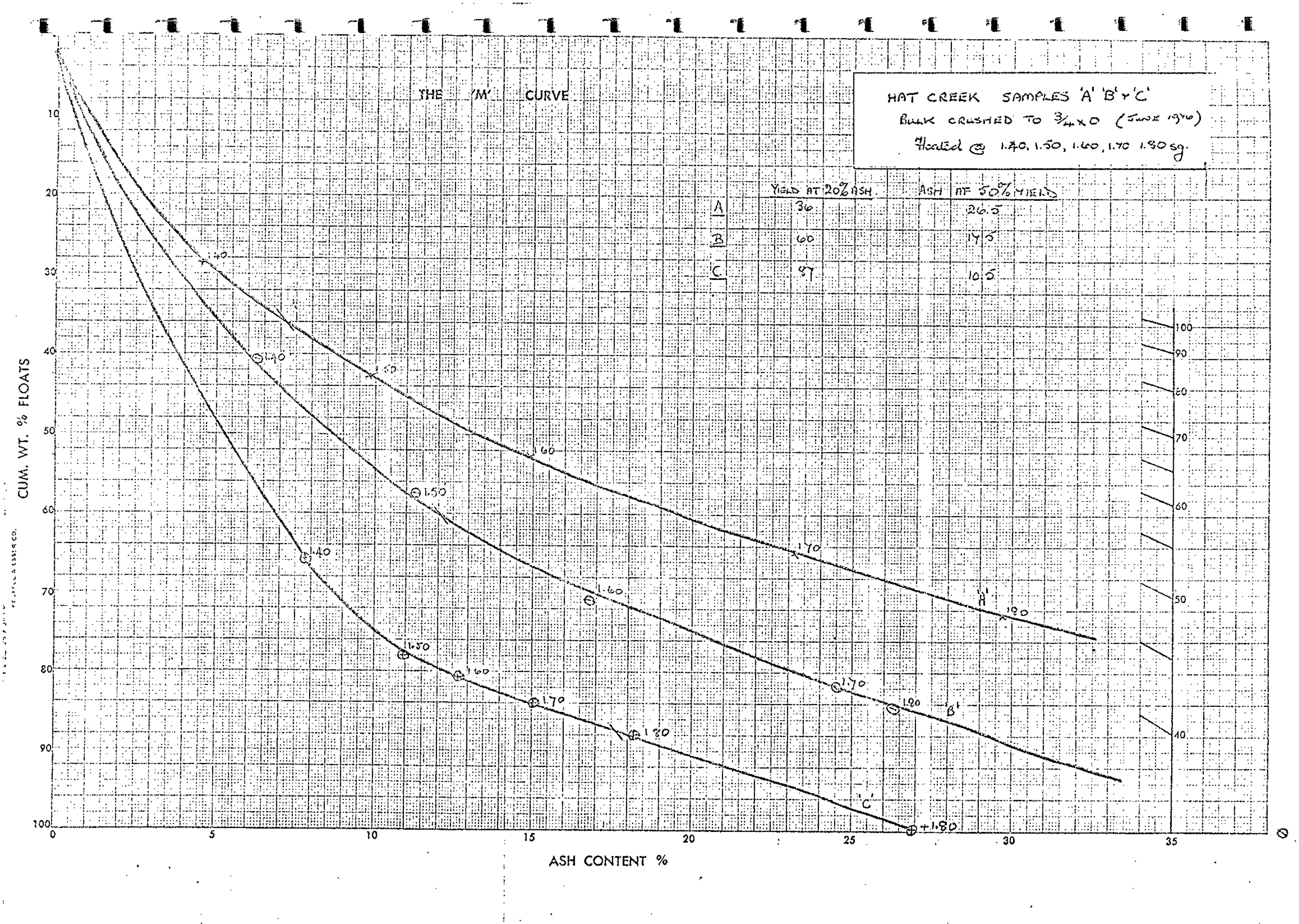
¾" x 0 Head Raw 34.6% Ash Dry 7793 Btu Dry

TABLE 5

Hat Creek 'C' - ¾" x 28 81.4% 28m x 0 18.6%

Floats @ 1.40 sg.	65.9	11.9	65.9	11.9
1.50 sg.	76.1	14.3	10.2	29.8
1.60 sg.	80.2	15.8	4.1	43.6
1.70 sg.	83.9	17.9	3.7	63.4
1.80 sg.	88.3	20.5	4.4	69.5
Total	100.0	26.9	11.7	75.5

¾" x 0 Head Raw 27.7% Ash Dry 8765 Btu Dry


THE 'M' CURVE
HAT CREEK SAMPLES 'A' 'B' + 'C'
BULK CRUSHED TO 3/4 x 0 (JUNE 1976)
Floated @ 1.40, 1.50, 1.60, 1.70 1.80 sg.
YIELD AT 20% ASH
ASH AT 50% YIELD
A 36 26.5
B 60 17.5
C 87 10.5
CUM. WT. % FLOATS
ASH CONTENT %
'A'
'B'
'C'
1.40
1.50
1.60
1.70
1.80
0
5
10
15
20
25
30
35
40
50
60
70
80
90
100