F1304 C-MJV FOR B.C. HYDRO

HAT CREEK

BENEFICIATION OF LOW GRADE COALS

March 1978

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SIMON-CARVES CANADA

Internal Memorandum

To O.I. Johnson
Project Manager, CMJV

Date April 7, 1978
Our ref F1304.C20
Your ref 320
From S.G. Butcher
Subject BENEFICIATION OF LOW GRADE COALS

We enclose six copies of this March 1978 sub-report.

Please note that this report is concerned solely with the true low grade coals present in the coal to be mined from the deposit, i.e. in the range 5000/4000 - 2000 Btu/lb., and not with any run of mine material in this heat content range which is an admixture of better coals and partings materials.

The latter would be worth beneficiating if produced in significant quantities.

This report shows that beneficiation of low grade coals is likely to be a viable operation. However there is no data available other than by projections from the normal washability data. Thus it could be misleading to draw up any specific plant proposals.

Since the increase in available heat output from the mine by beneficiation of low grade coals is of the order of 3% we do not anticipate that the lack of specific proposals in this area is likely to be significant in the "go/no go" decision for the Hat Creek complex.

Present plans suggest that low grade coals will not be mined in significant quantities until year 15. Thus design of required plant should be left until the second decade of mine operations. Ballpark cost figures have been obtained by reference to the Modular Wash Plant design and should be adequate at this stage.

Stanley G. Butcher.

S.G. Butcher

SGB/cw

Encl.

cc: JPM/WHL/SGB

SIMON

C-MJV for B.C. Hydro - Hat Creek
Beneficiation of Low Grade Coals

March 1978

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SECTION 1

SUMMARY

In the absence of washability data of the low grade coals projections of yield and quality are made from the higher grade coals.

Stockpiling of low grade coals "for future use" can only be considered a realistic approach whilst the quantities are relatively small. Production of significant quantities of low grade coal is not expected until year 15.

A total washing process is outlined which would be viable in its own right leading to a 3% increase in heat value available from the mine. The benefits to be obtained are not, however, likely to affect the overall complex viability.

Investigations leading to a suitable beneficiation plant design can, therefore, be delayed until the commencement of the second decade, when "as mined" samples will be available.

SECTION 2

INTRODUCTION

The Hat Creek deposit will yield a wide variety of raw coals. The "best" coals will have calorific values in the range up to 10,000 BTU/lb (dry basis) whilst the bulk of the coal will be in the 6,000 to 8,000 BTU/lb range. Thus the whole deposit is considerably poorer than the 10,000 - 12,000 BTU/lb fuels used as the basis for most current thermal plant design.

Beneficiation of the Hat Creek coals which lie in the range sampled for Washability Tests (5,600 BTU/lb Sample A to 8,800 BTU/lb Sample Z) has been considered in our Report on the Potential Application of Alternative Processes for the Beneficiation of Hat Creek Coals (Draft - December 1977).

The initial concepts for mining the Hat Creek No. 1 Deposit envisaged average "Run of Mine" product quality being maintained by rejecting low grade material. The value below which low grade coal is determined to be reject is the Cut Off Grade. (For example the 1976 Integ-Ebasco and March 1978 PD-NCB Report No. 9 used a cut-off grade of 4,500 BTU/lb to achieve a product of 7,438 BTU/lb).

Energy conservation considerations have led to suggestions from the appropriate authorities that it would not be acceptable practice to pass to waste disposal any material mined with a calorific value above 2,000 BTU/lb. Thus a Low Grade Coal Stockpile is envisaged for material in the 2,000 BTU/lb to "Cut Off Grade" range. It is envisaged that future technological developments may permit the cleaning and/or combustion of this material.

An initial mine plan (A. Bell Revision 2 Ultimate Pit - January 3, 1978) shows the following production over the 35 year effective mine life: -

TABLE 1

Cut Off Grade BTU/lb.d.b.	Remaining R.O.M. Coal @ 5% Dilution Tonnes	Run of Mine Coal BTU/lb.d.b.
2000	398,387,300	6595
3000	376,531,900	6845
4000	360,790,600	7000
5000	327,335,100	7265
6000	241,377,700	7990

SECTION 2

INTRODUCTION

Since the thermal plant fuel requirements correspond to approximately 360 million tonnes at 7,000 BTU/lb (dry basis) a 4,000 BTU/lb Cut Off Grade is thus envisaged. The Low Grade Coal stockpile would thus amount to some 37 million tonnes (or 10% of run of mine output) over the mine life.

It has been noted that the stockpiling of this low grade coal may require

a) Separate stocking area

b) Separate handling system

To prevent spontaneous combustion of such a stockpile substantial crushing, say to -50mm, will be necessary, followed by compaction. Simon-Carves have advised that this stockpiling procedure, together with ageing and weathering, would render the low grade material much more difficult to clean and impracticable to use in the future.

The purpose of this report is to examine the potential beneficiation of poorer Hat Creek coals. (i.e. those with less than 5,000 BTU/lb with are not considered in the December report.) The philosophy is that since this coal has to be mined (to obtain access to some better coals), and must be handled, crushed and stockpiled there is a significant cost involved. The objective is therefore to partially clean to extract any relatively useful material and give a reject within the 2,000 BTU/lb criteria. Thus the stockpiling would be eliminated and the overall output increased.

Unfortunately the need to investigate the properties of these low grade coals had not been accepted prior to the 1977 Test Programme. This report is therefore based on projections of the data obtained from the normal fuel samples.

It must be noted that this report is concerned only with the substantial in-situ coal "blocks" in the range 5,000/4,000 to 2,000 BTU/lb, and does not consider the requirements for any run of mine coal which may be below cut-off grade due to admixture of better coal with quantities of partings.

SECTION 3

CONCLUSIONS AND RECOMMENDATIONS

Note that these conclusions are concerned solely with true low grade coals and not with diluted higher grade coals. No washability data is available for these coals.

3.1 Concern is expressed that the alternative of stockpiling the low grade coals will lead to contamination and ultimately loss of the higher value coarser material by its admixture with the virtually valueless fines. Beneficiation by screening out the fines and stockpiling or using the coarser material is recommended as a minimum.

3.2 Beneficiation of the lower grade coals gives a recovered material which is below the average grade, and thus lowers overall quality.

3.3 Partial washing does not give an additional yield which is likely to be viable in terms of savings in run-of-mine coal production costs as against costs of a conventional beneficiation plant.

3.4 Total washing of low grade coals will be viable if a simplified plant can be developed, with particular attention to minimization of tailings production.

3.5 Further investigations of the low grade beneficiation characteristics are necessary prior to the design of any facility. This may require some development of currently available processes to meet the particular problems of washing Hat Creek coals.

3.6 Whilst the total washing proposal is likely to be financially viable in its own right, the additional 3.0% heating value made available to the Boiler Plant is not likely to affect the overall scheme viability.

3.7 The bulk of the low grade coal is anticipated to be mined after year 15. Obtaining the necessary design data can therefore be deferred until the mine is in full production. This must be reviewed as alternative mine plans are presented.

3.8 Space for a Beneficiation Plant must be allowed in the raw coal handling scheme.

SECTION 4

BENEFICIATION CHARACTERISTICS

It is noted in the Introduction that no Washability Data has been obtained for the low grade coals. It is, therefore, necessary to see how available data shows trends which may be projected into this quality range.

Inspection of the Washability Data shows two general trends.

a) Finer Sizes are dirtier than coarser sizes.

b) For a given size fraction the higher ash of the poorer coals is due to a lower proportion of low gravity (low ash) coal/higher proportion of middlings and not to an increase in the high gravity (high ash) clay/shale partings material. (Note that this is evidence that we are concerned with a trend in coal quality and not a trend in admixture of even minute partings with relatively good coal. If the latter were the case we should, with appropriate crushing, have a coal with a relatively easy beneficiation potential.)

4.1 Beneficiation by Fines Extraction

This has been considered for the six sets of washability data in Section 9 of the Alternative Beneficiation Report. (e.g. see Table 9.1, Appendix II and Figures 15 and 16.) The potential of this method is seen to be greater for the dirtier coals to the extent that rejection of minus 28 mesh fines from the material less than 7,000 BTU/lb (greater than 38.5% ash) R.O.M. coal could be a viable means of beneficiation.

Thus as the raw coal has a lower calorific value an even coarser fines extraction size may be acceptable. Ash content relative to the size consist for samples B, Y, X and A are plotted as curves in Figure I. The similar geometric shape is observed and further curves 1, 2 and 3 were generated for coals of 4,500, 3,700 and 3,000 BTU/lb.

These results show that if a Hat Creek run of mine coal of X% ash is screened to give 50% overflow yield by weight then the overflow has an ash content of (X-6)% and the underflow of (X+6)%. This is followed relatively closely for all the samples except the D Zone Sample Z. However, it would appear, by projecting these curves that this differential is a peak of about $\pm$ 7% at 35% head ash and falls to about $\pm$ 4% at 65% head ash. This trend has been assumed in the calculated results which follow, Table 2.

SECTION 4

BENEFICIATION CHARACTERISTICS

4.1 Beneficiation by Fines Extraction - cont.

Screening for 50% overflow yield would correspond to about 13mm.

Thus beneficiation of low grade coal by screening at say 13mm could be an acceptable method for run of mine coal up to say 4,000 BTU/lb quality.

Similar predictions could be made for other size separations. This exercise has been done at 13mm since this is the smallest size at which a high screening efficiency could be achieved with conventional screening equipment. The potential of more sophisticated methods has been reviewed in Section 9 and Appendix II of the Alternative Beneficiation Report. From those tables it can be seen that a smaller size separation is necessary for higher C.V. raw coals to give an acceptably low C.V. (high ash) undersize reject. But with finer size separations the degree of beneficiation achieved is comparatively lower, and would probably not justify the higher plant costs involved.

TABLE 2

Beneficiation by Screening of Low Grade Coals

Raw Coal		Product = Screen Overflow @ 50% Yield		Reject = Screen Underflow @ 50% Yield	
CV BTU/lb	Ash d.b.%	CV BTU/lb	Ash d.b.%	CV BTU/lb	Ash d.b.%
2000	73.2	2493	69.8	1507	76.6
2500	69.7	3022	66.1	1978	73.3
3000	66.3	3564	62.4	2436	70.2
3500	62.8	4106	58.6	2894	67.0
4000	59.3	4670	54.7	3330	63.9
4500	55.9	5220	50.9	3780	60.9
5000	52.4	5769	47.1	4231	57.7

SECTION 4

BENEFICIATION CHARACTERISTICS

4.1 Beneficiation by Fines Extraction - cont.

4.1.1 On the basis of the relative values of the underflow and overflow materials as shown in Table 2, we would recommend screening the run of mine low grade coal (2000 - 4000 BTU quality) at 13mm. The underflow should be passed directly to waste dumps and would contain the bulk of the clayish material. The 50% by weight as screen overflow would contain some two thirds of the total heat content. The size of any stockpiling operation would thus be halved, and the "better" material would not be contaminated in crushing and storage.

4.1.2 Alternatively consideration should be given to blending the +13mm screen overflow directly into the normal grade product.

Taking the values given in Table 1, the 18,798,350 tonnes of screen overflow from the 2000 - 4000 low grade coal, blended back with the 360,790,600 at 7,000 BTU/lb would yield:

379,588,950 tonnes at 6815 BTU/lb.

This is equivalent to approximately 370 million tonnes at 7000 BTU/lb. Thus the quantity to be mined would be reduced by about 9 million tonnes, and there would be no stockpiling requirement. The acceptability of this lower fuel grade is, however, questionable.

4.2 Beneficiation by Partial Washing

Some considerable time was spent trying to define the washability data trends as generally observed - paragraph (ii) page 4-1.

This was done on the usual basis of raw coal and product ash contents and yields for a series of separating gravities. The data was examined for each individual size range, and also for the composite plus 100 mesh. It can be seen from the examples in Tables 3 and 4 and Figure 2 that the trends were by no means conclusive, and would not permit meaningful interpolation or extrapolation. Thus prediction of the beneficiation product qualities and yields for untested intermediate coals, and more particularly the Low Grade coals was thought to be impracticable. (This exercise was computer assisted.)

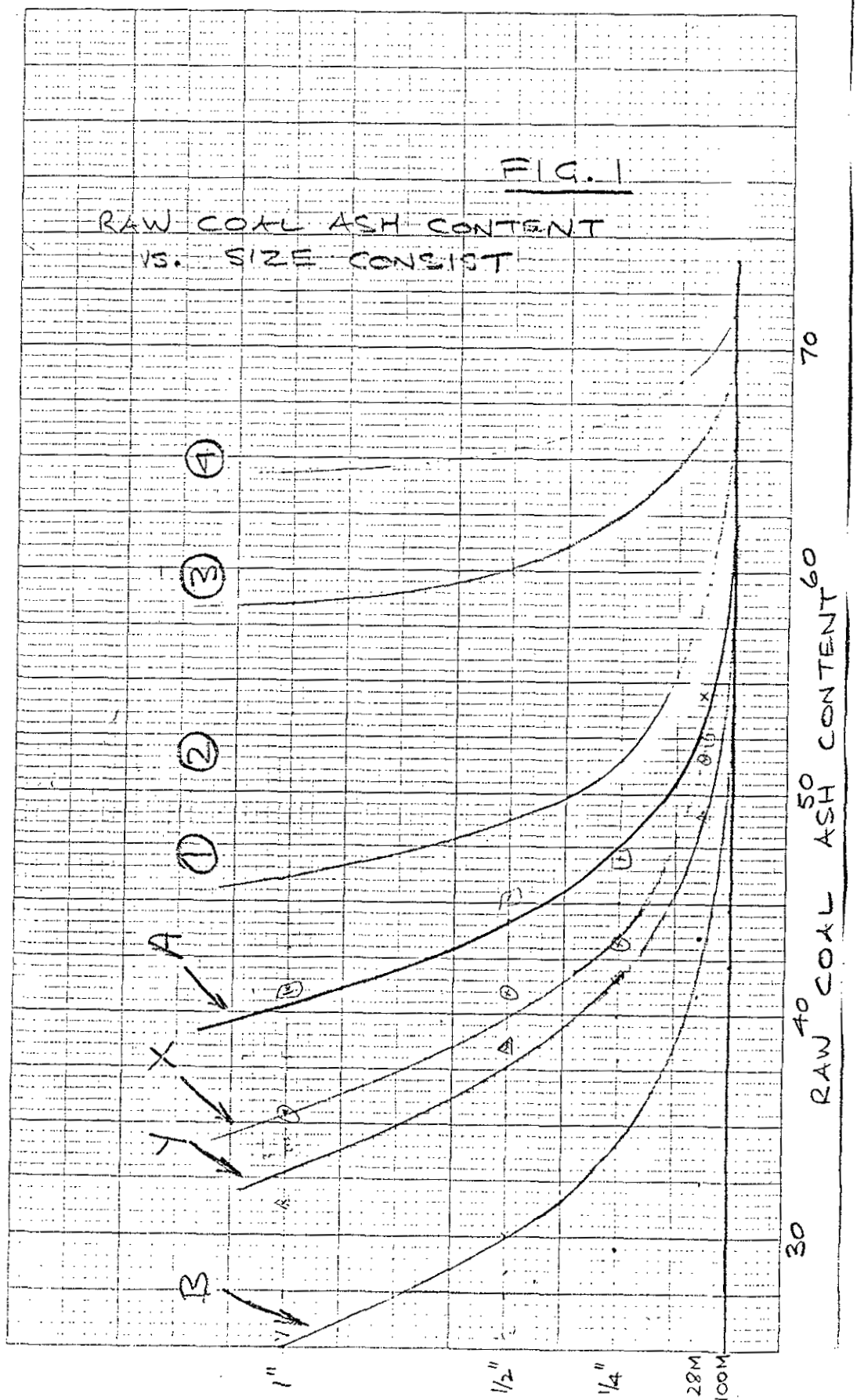


FIG. 1
RAW COAL ASH CONTENT
VS. SIZE CONSIST
RAW COAL ASH CONTENT
70
60
50
40
30
1"
1/2"
1/4"
28M
100M
1
2
3
A
X
B

SECTION 4

BENEFICIATION CHARACTERISTICS

TABLE 3

Quality Variation of Floats Product (at 1.80 S.G.) Compared to Raw Coal for Plus 1/2 Size Fractions

Sample	Ash Content of Raw Coal Size Fraction	Floats Product at 1.8 S.G. % Ash	Floats Product at 1.8 S.G. Wt. % Yield
A 2" x 1"	43.4	36.0	86.3
1" x ½"	45.7	39.5	88.7
X 4" x ½"	39.2	33.1	87.0
Y 4" x ½"	35.3	25.0	81.1
B 2" x 1"	25.6	22.4	92.9
1" x ½"	30.0	27.2	93.7
Z 4" x 1"	27.1	26.7	99.1
1" x ½"	27.3	26.2	97.8
C 2" x 1"	24.0	19.1	91.6
1" x ½"	22.1	18.8	94.0

TABLE 4

Quality Variation of Floats Product (at 1.80 S.G.) Compared to Raw Coal (Composite)

Sample	Ash Content of Raw Coal	Ash Content of 1.80 S.G. Floats Product
A	50.1	27.2
X	44.7	33.7
Y	42.1	41.7
B	36.4	27.7
Z	27.7	25.9
C	27.7	21.5

SECTION 4

BENEFICIATION CHARACTERISTICS

TABLE 5

Beneficiation Potential of 28 x 100 Mesh Coals
- Separation in Two-Stage Water Cyclones at 1:60 S.G.

SAMPLE	% ASH OF RAW COAL		CLEAN COAL, 28 x 100 MESH % YIELD		
	4" x 0	28 x 100M	% Ash	Theoretical	Actual
Z	26.9	29.2	22.0	75.0	63.2
C	29.1	36.7	27.0	77.2	59.4
B	36.3	50.7	32.6	50.7	31.1
X + Y*	42.9	59.2	38.6	44.0	28.9
A	57.2	68.5	41.7	44.8	25.1

*Clean Coal at 1.50 S.G.

TABLE 6

Beneficiation Potential of 1/4" x 28 Mesh Coals
- Separation in Two-Sage Water Cyclones

SAMPLE	% ASH OF RAW COAL		CLEAN COAL, ¼" x 28 MESH % YIELD		
	4" x 0	¼" x 28M	% Ash	Theoretical	Actual
Z	26.9	28.9	21.6	82.0	62.4
C	29.1	27.2	16.9	78.5	65.2
B	36.3	34.3	25.3	77.2	65.1
X + Y	42.9	37.9	25.5	77.3	65.4
A	57.2	48.8	37.9	77.7	65.3

SECTION 4

BENEFICIATION CHARACTERISTICS

4.2 Beneficiation by Partial Washing - cont.

(Table 6 and 7 do show some useful trends which were extrapolated for the finer sizes. They were, however, compiled with hindsight after the concept of floating the separation gravity had been developed below.)

However, an alternate method revealed an unexpected and relatively good correlation which may be unique to Hat Creek. (Hopefully not unique to these size sets of washability data!) This correlation was found between the raw coal ash content and clean coal ash content for a series of clean coal yield values. (The yield values chosen were 80%, 70% and 60%. These yields are achieved at widely differing separation gravities, yet, all the gravities thus required lie within the working range of the appropriate washing equipment for the respective coal size fractions.)

Even more surprising is the fact that at a given yield value a single correlation curve applies to all size fractions.

The quality/yield values were obtained from the interpolated washability data (see Appendix III of the Alternative Beneficiation Report) and the curves shown in Figures 3 and 4 were determined by a computerized quadratic curve fit.

(Results from the first curve fit included points marked "R" obtained from the second (cumulative) washability test conducted by CSMT on the 1976 Sample A, 28 x 100 mesh size fraction.

Computations from this first curve fit showed unexplicably high rejects ash contents/high degrees of beneficiation for poorer coals. Reference to the test report shows this point to be very dubious as it is largely dependent on the 1.90 S.G. Sinks ash content which had been "modified" to 95.0% ash, (Table 32). The earlier CSMT results (Table 6) yielded the points marked "A", which although not included in the curve fit shown in Figures 2, 3 and 4, give credence to the use of these curves at the higher ash values.)

FIG. 2

ASH CONTENT OF RAW COAL VS. ASH CONTENT OF CLEAN COAL

— THEORETICAL RESULTS AT GIVEN (1·80) SEPARATING GRAVITY.

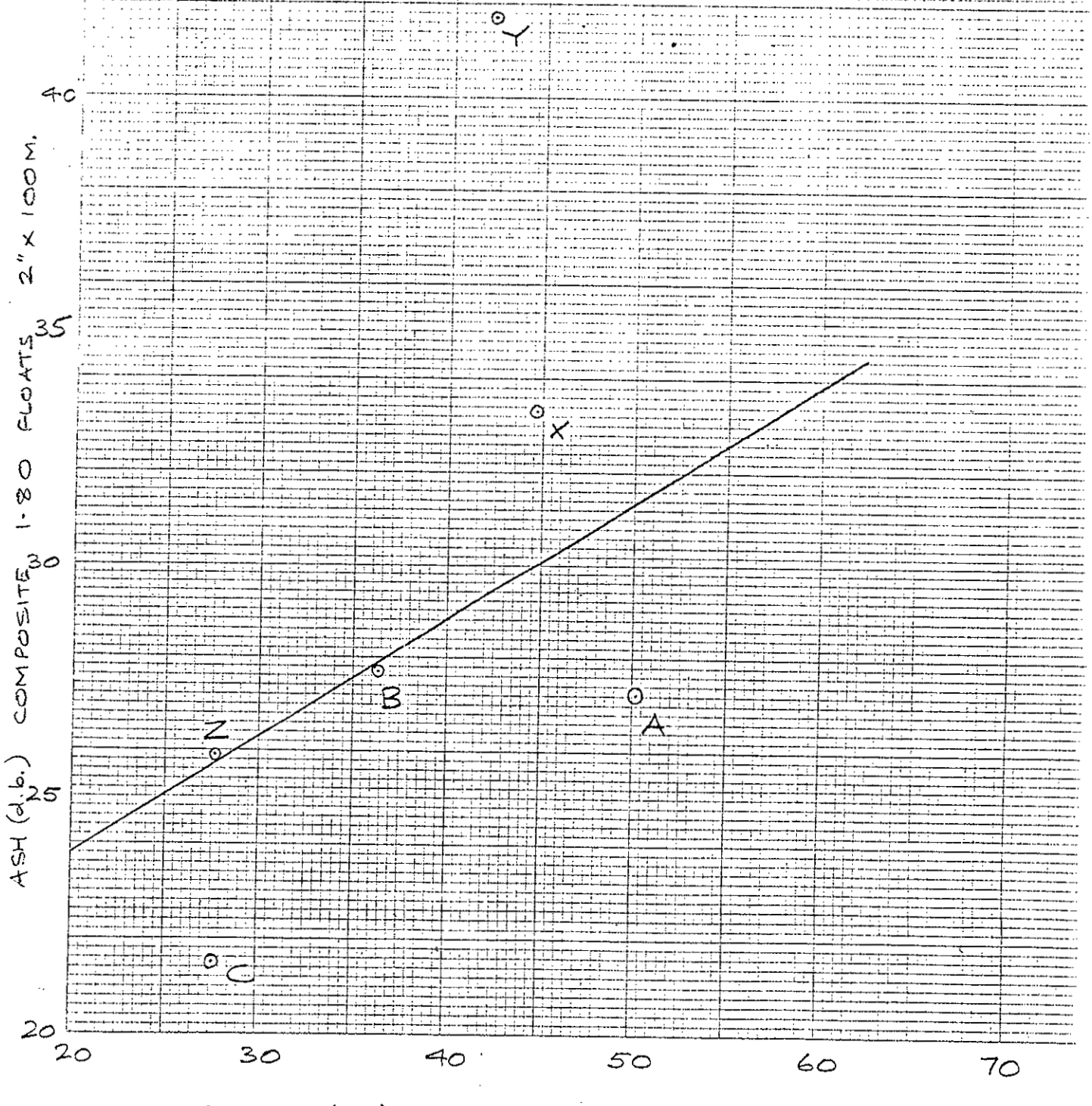


FIG. 3

THEORETICAL BENEFICIATION BY WASHING TO 70 % W.T. YIELD

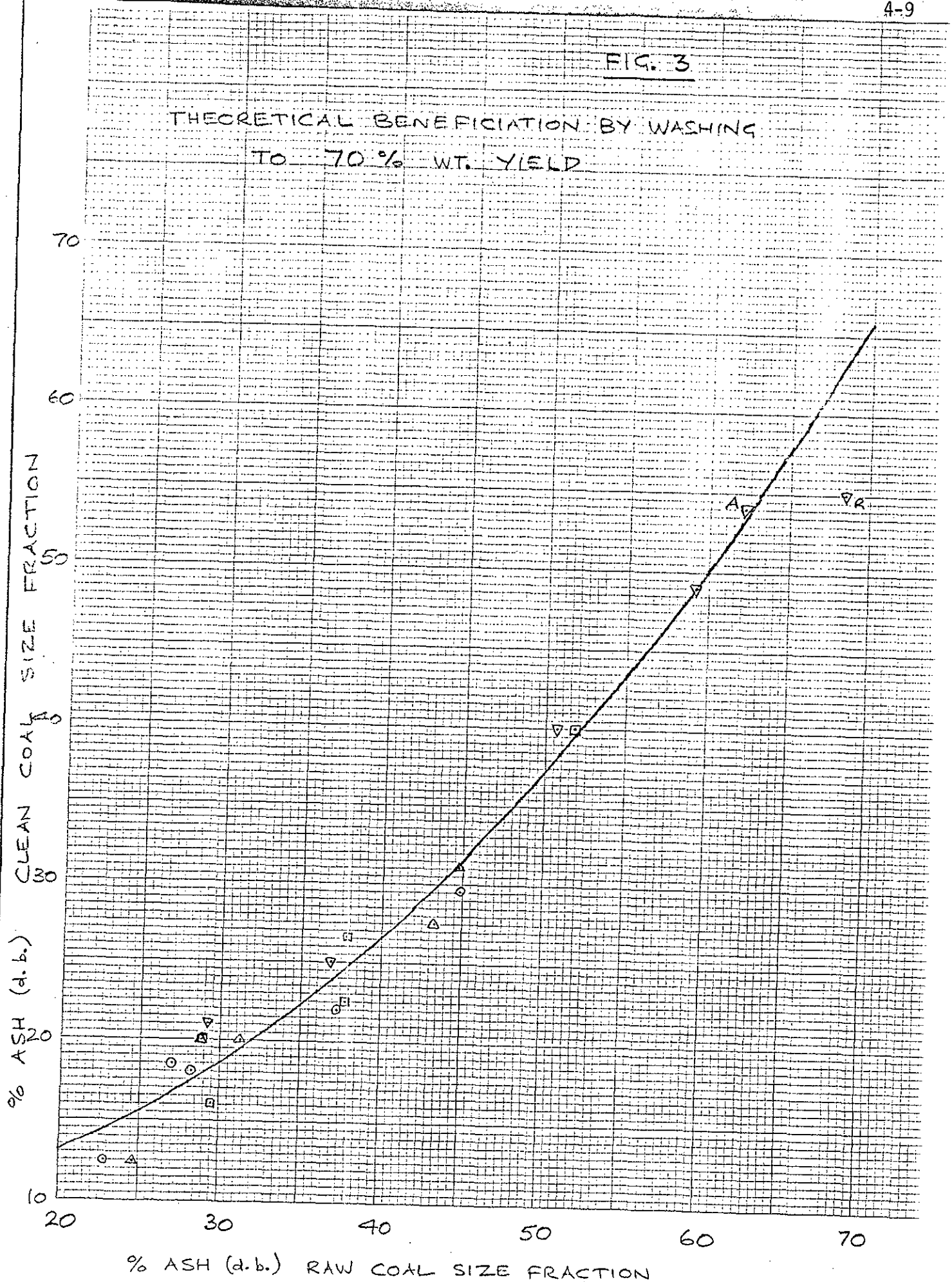
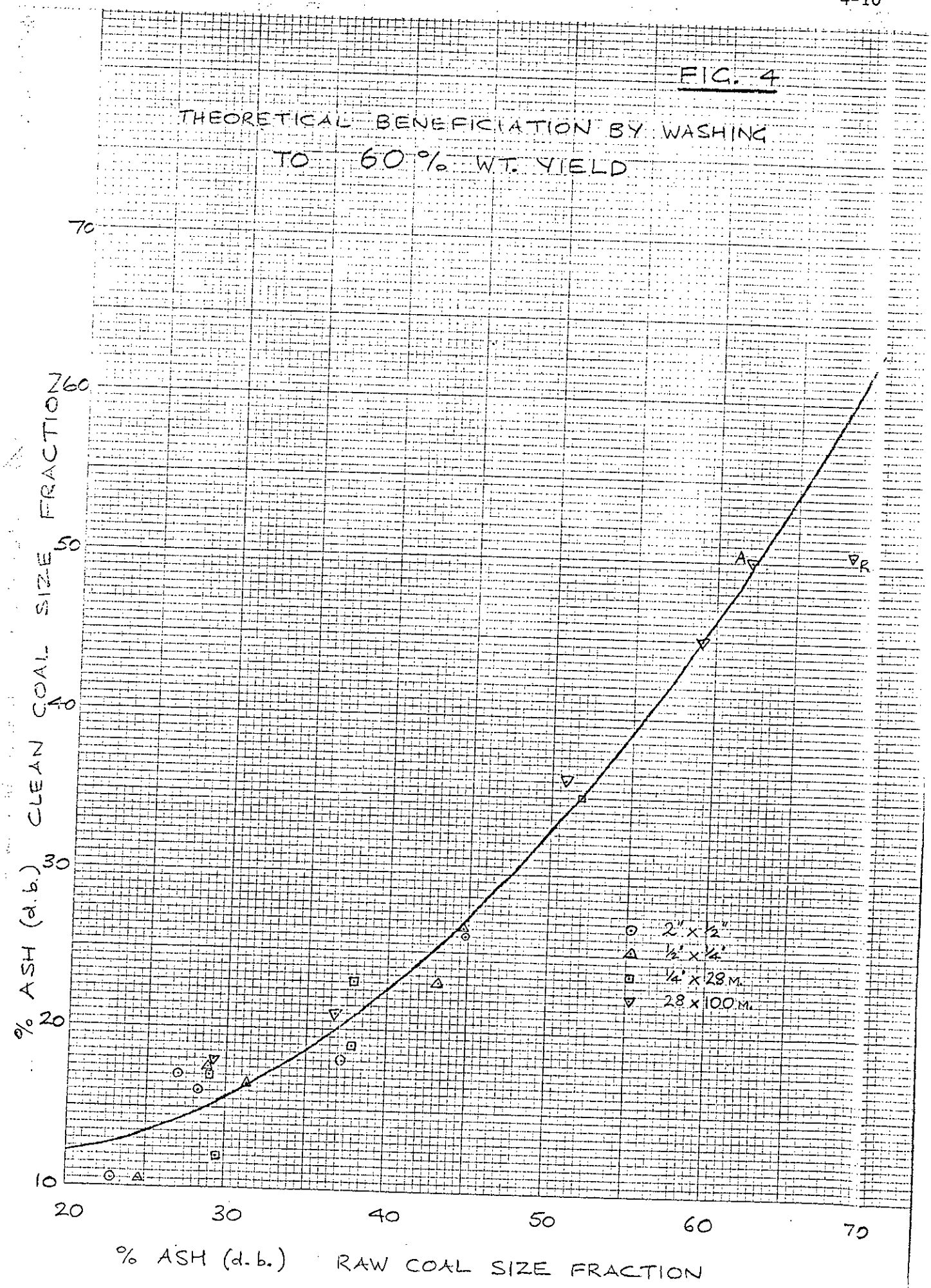


FIG. 4

THEORETICAL BENEFICIATION BY WASHING TO 60% WT. YIELD



SECTION 4

BENEFICIATION CHARACTERISTICS

4.2 Beneficiation by Partial Washing - cont.

The results which could theoretically be obtained by partial washing of the Low Grade Coals are shown in Table 6 below. This assumes that the raw coal would be screened at 13mm and only the Screen Overflow passed to the washing process. This is thus an extension of Table 2.

4.2.1 The coal recovered from the low grade coals by rejection of the minus 13mm dry fines and washing the plus 13mm raw coal does have a usefully enhanced calorific value, e.g. a 5350 BTU/lb product from a 3000 BTU/lb raw coal. Thus in terms of coal recovery and total rejects ash content this scheme may be considered more acceptable than stockpiling the low grade coals in the 2000 - 4000 BTU/lb. range.

4.2.2 The washed coal thus recovered is all below the 7,000 BTU/lb average quality of the coal above a 4,000 BTU/lb Cut-Off Grade.

Thus the 18,798,350 tonnes of Screen Overflow would yield on washing an estimated 11.279,000 tonnes at 4794 BTU/lb.

The overall result would therefore be 372,069,600 tonnes at 6933 BTU/lb.

The reduction in quality is considerably less than achieved without washing - see paragraph 4.1.2.

The quantity to be mined would be reduced by 7.7 million tons, and there would be no stockpiling requirement other than to provide a uniform washery feed.

The costs are by no means insignificant - a first estimate would be $10 million Capital plus $1.00 per tonne run-of-mine (i.e. $38 million) Operating Costs.

4.2.3 Similarly the partial washing of the 4000 - 5000 BTU/lb material may be considered. As in section 4.1 the Dry Fines (minus 13mm) have a significant head content, and could not be discarded.

SECTION 4

BENEFICIATION CHARACTERISTICS

TABLE 7

Partial Washing of Low Grade Coals
(Plus 13mm Size Fraction Washed at 60% Yield)

Raw Coal		30% Yield as Washing Product		20% Yield as Washing Reject		50% Yield Dry Fines		80% Yield Part Washed Blended Smalls
CV BTU/lb	Ash d.b.%	CV BTU/lb	Ash d.b.%	CV BTU/lb	Ash d.b.%	CV BTU/lb	Ash d.b.%	CV BTU/lb
2000	73.2	3514	62.7	940	80.5	1507	76.6	2260
2500	69.7	4470	56.1	853	81.1	1978	73.3	2912
3000	66.3	5350	50.0	867	81.0	2436	70.2	3529
3500	62.8	6189	44.2	983	80.2	2894	67.0	4130
4000	59.3	6984	38.7	1200	78.7	3330	63.9	4700
4500	55.9	7693	33.8	1504	76.6	3780	60.9	5247
5000	52.4	8314	29.5	1952	73.5	4231	57.7	5762
(7000	38.6	10,093	17.2	4526	55.7	6131	44.6	7617)

Note: These results do not allow for material misplaced in any washing process, and are therefore, somewhat optimistic in terms of product yield/rejects ash content. The more detailed calculations to allow for this factor were not performed in view of the generally poor benefit obtained by this operation as discussed below. Similarly a more serious tailings problem would be anticipated when washing these lower grade coals.

SECTION 4

BENEFICIATION CHARACTERISTICS

4.2 Beneficiation by Partial Washing - cont.

4.2.3 By comparison with the average value, 7000 BTU/lb., in the bottom line of Table 7, it can be seen that there is a case, in terms of heat content recovery and the degree of beneficiation achieved for concentrating any partial beneficiation required on the material just above the cut-off grade.

4.2.4 The benefit of recovering the plus 13mm coal from below cut-off grade, as in 4.2.2, on mine yield (as compared with the estimated additional costs involved) does not appear to be of significance to the overall project.

4.2.5 Similarly the benefit of partial washing on overall quality is significant only in terms of its effect on quality variation. A requirement for partial washing of lower grade coals may occur in conjunction with some mining schemes.

4.3 Beneficiation by Total Washing

The washability tests and test washes show that the lower grade coals will produce a very high quantity of washery tailings if subjected to total washing. Thus the general approach has been to concentrate on the application of partial washing if this can achieve the necessary degree of beneficiation.

Table 5 in Section 4.2 above shows that the plus 13mm clean coal recovered is of a useful quality from the low grade coals, but the Part Washed Blended Smalls are of dubious quality. Some consideration must, therefore, be given to washing the minus 13mm low grade coals.

As the fines content increases and becomes dirtier the potential coal recovery from the finer sizes is very low. (See Table 4, page 4-6) It is not, therefore, necessary to consider any washing of the minus 28 mesh material. However, whilst in Table 7 we have, for simplicity ignored the yield error (i.e. difference between theoretical and actual yields due to misplaced material in the washing process) this cannot be ignored in even the simplest consideration of the treatment of finer coals - see Table 6: yield errors here are approaching 12%.

SECTION 4

BENEFICIATION CHARACTERISTICS

4.3 Beneficiation by Total Washing - cont.

The results in Table 7 (page 4-5) are for the 1/4" x 28 mesh size fraction - as for the Table 6 these results were also obtained using Water Only Cyclones and show a significant yield error. These results are used to predict the recovery and beneficiation of the 13mm x 28 mesh size fraction and combined with the results of washing the plus 13mm material from Table 5. The total washing prediction is thus summarized in Table 8.

The results in Table 8 represent values which could be achieved by a plant specifically designed to treat low grade coals. They are, however, the result of data projections in respect of size consist, washability characteristics and tailings production which can only be proven by specific testwork on "as mined" coals. The results are, therefore, an indication of the best which could be achieved: actual yields may well be somewhat lower.

4.3.1 The coal recovered from the low grade coals by total washing does have a usefully enhanced calorific value, e.g. 5243 BTU/lb product from a 3000 BTU/lb raw coal. By comparison with the results in Tables 2 and 5 we conclude that total washing rather than beneficiation by screening or partial washing is more likely to permit incorporation of these materials in the total product.

4.3.2 The washed coal is, however, all below the 7000 BTU/lb average quality of the coal above the 4000 BGU/lb Cut-Off Grade. Thus the 37,596,700 tonnes of low grade coal would yield an estimated 16,388,000 tonnes on total washing at 4,633 BTU/lb.

The overall result would, therefore be 377,178,600 tonnes at 6,897 BTU/lb. The quality to be mined, to provide the same heat input to the boiler plant is reduced by some 10.8 million tons, and ther would be no stockpiling requirement other than to provide a uniform washery feed:

The costs are by no menas insignificant - a first estimate would be $12 million Capital plus $1.50 per tonne run-of-mine (i.e. $56 million) Operating Costs.

SECTION 4

BENEFICIATION CHARACTERISTICS

4.3 Beneficiation by Total Washing - cont.

4.3.3 Similarly total washing of the 4000 - 5000 BTU/lb material may be considered. In this case it is noted that the product calorific value is significantly enhanced. It may therefore, be prudent to consider a compromise scheme, e.g. beneficiating the 2000 - 5000 BTU/lb material so as to take advantage of the useful coal available without reducing the average grade below the 7000 BTU/lb value. This would reduce product quality variations.

SECTION 4

BENEFICIATION CHARACTERISTICS

TABLE 8

Total Washing Potential of Low Grade Coals

Raw Coal		+13mm Clean Coal		13mm x 28 Mesh Clean Coal		Total Washing Clean Coal			Rejects Including Tailings	
CV BTU/lb	Ash d.b.%	Yield Wt.%	Ash d.b.%	Yield Wt.%	Ash d.b.%	Yield Wt.%	Ash d.b.%	CV BTU/lb	Ash d.b.%	CV BTU/lb
2000	73.2	30.0	62.7	12.0	65.8	42.0	63.6	3383	80.1	999
2500	69.7	30.0	56.1	13.2	58.2	43.2	56.7	4381	79.6	1069
3000	66.3	30.0	50.0	14.4	52.4	44.4	50.8	5243	78.6	1209
3500	62.8	30.0	44.2	15.6	47.0	45.6	45.2	6044	77.5	1368
4000	59.3	30.0	38.7	16.8	42.6	46.8	40.1	6782	76.3	1553
4500	55.9	30.0	33.8	18.0	38.9	48.0	35.7	7418	74.5	1806
5000	52.4	30.0	29.5	19.2	35.0	49.2	31.6	8081	73.0	2016

NOTE: These results are optimistic in respect of the assumptions made as detailed in Table 5 for the plus 13mm coal fractions. The results may also be optimistic due to the simplified approach to the determination of tailings yield/quality. This will depend upon the type of plant/equipment found best suited to these coals.

SECTION 5

PLANT REQUIREMENTS FOR LOW GRADE COAL

It must be noted that the partial beneficiation characteristics of the lower grade coals, as discussed in Section 4, are based purely as projections of the very limited data available for the higher grade coals. Investigations of the lower grade coals are therefore essential prior to making any specific plant proposals or preliminary designs.

The initial mine plans (e.g. A. Bell Revision 2 Ultimate Pit - January 3, 1978) shows that the bulk of the coal below Cut-Off Grade will be mined in the period years 15 to 25. If this remains the case for the Final Report Mine Plan then the work to obtain design data for any lower grade coal beneficiation can be based on appropriate "as mined" coal samples taken during the first decade of the mine operations.

For the first 15 years the relatively small quantities of low grade coal would be segregated and stockpiled - unless of course it proves practicable to blend them into the product.

5.1 Beneficiation by Screening

The Raw Coal handling system will of necessity have to incorporate screening facilities to permit crushing of the plus 40mm material. However, the 13mm screening plant for 4.1 would require substantially larger screen area per unit feed. It would probably not justify putting in this facility as part of the main coal handling plant when only 10% of the run-of-mine coal would be beneficiated in this way.

It would, at an appropriate stage, be necessary to test the breaking and screening characteristics of the low grade coals. Based on observations during the 1977 Trench A Mining Operations an extended breaker drum might be useful. This would make use of the soft characteristics of the high ash material with the hope of breaking off as minus 13mm rejects even more of the high ash material than anticipated in Table 2. After this operation a large area of screens - possibly with heated decks or rod decks - would be necessary.

As for the washing schemes considered below, the spasmodic production of low grade coals would necessitate a stockpiling facility to give a uniform sustained feed rate to any economically sized low grade coal beneficiation scheme.

SECTION 5

PLANT REQUIREMENTS FOR LOW GRADE COAL

5.2 Partial Washing

As a preliminary indication of plant requirements the Modular Coal Washery Scheme provides both of the "operating modes" required for the alternatives in paragraphs 4.2.2 and 4.2.3.

If 2,000,000 MTPA of low grade coal is to be partially cleaned the input is -

$$\frac{2{,}000{,}000}{350 \times 24 \times 0.7} = 340 \text{ MTPH at 70\% availability}$$

Thus provide for one 400 MTPH Module with a single thickener, and incorporate two tailings centrifuges (See Tailings Disposal Equipment Report). The fine coal washing section would not be required.

This plant could also provide cleaning for higher grade coals which are diluted beyond an acceptable quality in the mining and handling operations. The true low grade coals considered in this report represent the worst possible beneficiation problem. Diluted higher grade coals would give correspondingly better clean coal products. There may, therefore, ultimately be a need for a plant to treat various substandard mixtures of low grade and diluted high grade coals.

5.3 Total Washing

The Modular Coal Washery Scheme complete with somewhat extended fines washing section could provide the facilities for total washing low grade coal. A 400 MTPH Module with a larger thickener and four tailings centrifuges is envisaged in the costs quoted in paragraph 4.3.2.

It is, however, noted in Table 5 and paragraph 4.3 that facilities for the 28 x 100 mesh fines would not give a useful coal recovery. Simpler plant configurations may therefore be appropriate.

5.3.1 The two stage Water-Only Cyclone System (e.g. EMR Canmet) may be considered for washing the raw low grade coal crushed to 75mm. The main disadvantage of this system is that the multitude of cyclone operations: feed classifying, first washing, second washing and product thickening requires large volumes of water in circulation.

SECTION 5

PLANT REQUIREMENTS FOR LOW GRADE COAL

5.3 Total Washing - cont.

5.3.1 Operating costs for pumping are thus high and the several passes with circulating water will give a high tailings problem as found in the CSMT and EMR Test Washes and the Wet Attrition Tests. Large numbers of cyclones are required due to their relatively limited rejects capacity (25 to 30% of feed).

5.3.2 An alternative form of autogenous medium cyclone is available - the Simdex. The Simdex system was specifically developed for re-washing the rejects from older Baum Washeries - some five plants are in use in UK and Belgium re-processing old colliery waste dumps.

The Simdex uses the minus 28 mesh fine shale present to form a thick shale suspension in water which then acts in the cyclone as a dense medium for the 75mm x 28 mesh material. Since it was designed for waste coal treatment a Simdex Cyclone has some three times the rejects capacity of similar sized magnetite medium cyclone or water-only cyclone.

The minus 75mm raw coal is added to the shale suspension and is pumped to the Simdex Cyclones. The separation takes place as in a magnetite dense medium cyclone, and the products pass to drain and spray screens. From the drainage sections the circulating medium is recirculated to the feed sump. Note that medium losses are immediately made up by the minus 28 mesh fines contained in the feed. However, to permit control of medium gravity, the diluted medium from the spraying sections is passed through recovery cyclones. Cyclone underflow will be added to the feed sump if required to raise the separating gravity, and the excess is a thick slurry which may be dewatered without thickening for disposal with the discard. Cyclone overflow is used as primary spray water, and to lower the separating gravity if required, with the excess overflowing to the tailings thickener for water recovery.

SECTION 5

PLANT REQUIREMENTS FOR LOW GRADE COAL

5.3 Total Washing - cont.

5.3.2 Thus the Simdex plant is much simpler and cheaper to operate than other cyclone systems. It may be possible to think in terms of a low grade coal washery for Hat Creek at less than half the costs quoted in paragraph 4.3.2. The most significant benefit may well lie in the greatly reduced fine shale/water contact as compared with conventional plant, giving a reduced breakdown to tailings.

The process does have disadvantages. Its efficiency is similar to two-stage water only cyclones, and thus much lower than conventional magnetite medium cyclones. The separation gravities attainable depend on the characteristics of the minus 28 mesh shale particles. These factors have been used, so far as they can be presently evaluated, in making the predictions in Table 8.

The dependence of the process on the fine shale particles must be noted. Firstly the clay content of the Hat Creek rejects may give too viscous a medium: this would result in lower separation efficiencies and lower separation gravities. Results could, therefore, be far less promising than forcast in Table 8. Secondly the use of the plant is limited to washing "coals" with a significant fine shale content - thus it cannot be used for raw coals of below say 50% ash content.

Specific testwork is thus required.

5.3.3 A simpler form of "total washing" scheme may be purposely developed for low-grade Hat Creek coals based on the ready breakdown in water of the clayish rejects materials. For example the raw coal could be tumbled in a drum or mill with a quantity of water. The objective would be to recover the coal as screen overflow and the reject as a thick screen underflow.

Specific testwork would be required.

SECTION 5

PLANT REQUIREMENTS FOR LOW GRADE COAL

The concepts outlined in paragraphs 5.3.2 and 5.3.3 suggest that a viable scheme for recovery of useful coal from the low grade coals can be developed. Such a facility may not, however, be needed or viable in the first decade of the mine operations. This period can therefore be used to obtain the necessary design data.

The additional heating value recovered from the deposit by beneficiating and using the low grade coal is relatively small. The absence of any definite provisions within the mine scheme at this stage will not, therefore, alter the overall mine viability. The scheme should allow for such facilities to be added when proven.