Canada

Department of Mines and Resources

MINES AND GEOLOGY BRANCH

BUREAU OF MINES

PHYSICAL AND CHEMICAL SURVEY OF COALS FROM CANADIAN COLLIERIES
(Number Three)

—NOVA SCOTIA—

PICTOU COUNTY COALFIELD

(Westville, Stellarton and Thorburn Districts)

Memorandum Series
No. 79
April, 1941

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DEPARTMENT OF MINES AND RESOURCES

OTTAWA, CANADA

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Pictou County Coalfield

(Westville, Stellarton and Thorburn Districts)

by

R.A. Strong, E. Swartzman, E.J. Burrough,
J.H.H. Nicolls and R.E. Gilmore

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FOREWORD

This is the third of a series of mimeographed reports entitled "Physical and Chemical Survey of Coals from Canadian Collieries". Memorandum Series No. 74 (December 1939) for Inverness County Coalfield was the first, and No. 78 (June 1940) for Cumberland County Coalfield the second of this series.

The general purpose of the survey has been to study the characteristics of the coals from the different collieries. In particular, it was desired to ascertain to what extent an improvement in grade may be effected by specially preparing the coal by screening, with or without subsequent washing and blending of the different sizes, thus resulting in a wider use of Canadian coals.

The survey, which to date has been restricted to bituminous coal producing collieries, has proceeded according to provinces, starting in the east and working westward, and subdividing into coalfields and areas within the provinces. The work pertaining to the maritime provinces was completed in 1938, that for Alberta mostly in 1939, and at the end of 1940 only a few mines in British Columbia remained to be visited and sampled.

The samples from the mines in the Pictou County coalfield in Nova Scotia were collected during the summer of 1937, and on completion of the study of each sample a typewritten report was forwarded to the operator of the colliery concerned and to other interested parties. The present report comprises the results of examination of coals from ten collieries in this coalfield, together with a detailed comparison of the coals, in respect to rank and grade, according to the three districts, namely: Westville, Stellarton and Thorburn (Vale), in which they are mined.

The physical and chemical tests involved were conducted by the staff of the Fuel Research Laboratories. The geological information contained in this report has been abstracted mainly from published bulletins of the Bureau of Geology and Topography of this Department. It is hoped that this collection of data and similar reports will serve as a means of acquainting all interested with the characteristics of Canadian coal and result in its more efficient utilization, to the benefit of both producer and consumer.

B. F. HAANEL

Chief, Division of Fuels

PHYSICAL AND CHEMICAL SURVEY OF COALS FROM CANADIAN COLLIERIES - NOVA SCOTIA -

Pictou County Coalfield

The Pictou County coalfield, as illustrated in Figure 1, is located in the north central part of the County on the southern shores of inlets from Northumberland Strait and is directly south of the eastern portion of Prince Edward Island. New Glasgow, Stellarton and Westville, which are about 40 miles northeast of Truro on the Truro-Sydney branch of the Canadian National Railways, are, in the order given, the three largest towns in or immediately adjoining the coalfield.

Ten (ton-lot) samples were collected from different seams in this coalfield by an engineer of the Fuels Division, namely: Mr. Swartzman. Two seams in the Westville district, six in the Stellarton district and two in the Thorburn (Vale) district were sampled. The manner in which the coals described were sampled is detailed in Chapter III, and a description of the methods of analyses and their significance is given in the Appendix. The examination of the samples collected comprised:- (a) physical tests including screen analyses, bulk density and apparent specific gravity of each size, size stability and grindability; (b) chemical analyses including both proximate and ultimate analyses, calorific value, sulphur and forms of sulphur, fusibility of ash, and analyses of ash; (c) classification; (d) distribution of fusain; (e) washability characteristics; and (f) laboratory coking tests. The analytical and other data obtained are tabulated in Chapter III, and the results are discussed in Chapter IV.

The advantages of coal preparation are quite obvious, and a knowledge of the washing characteristics of the coals produced, in conjunction with their sizing possibilities, is of great importance in deciding on the operation of the collieries to yield the best results for both the producer and the consumer. The comparisons made in the summary and discussion of results in Chapter IV are not intended to indicate the superiority of any one of the coals reviewed, but are recorded for the purpose of indicating their relative merits to those interested in the use of these coals.

Chapter I

DESCRIPTION OF THE COALFIELD AND SEAMS(1)

The Pictou coalfield proper (see Figure 1) forms the major part, about 10 miles long by 3 miles broad, of a down-faulted block. In form it is roughly an isosceles triangle, with apex at Thorburn, with north, south and east sides determined by faults, and with a western base of early Pennsylvanian sediments barren of coal. The coal measures are folded into a number of open anticlines and synclines. They are cut by several major and numerous minor faults.

Workable coal seams are confined to the Stellarton series, which is of Carboniferous age, and are localized to parts of the Westville, Albion and Thorburn members of the series. For convenience, the area has been divided into three districts, namely, from west to east, Westville, Stellarton and Thorburn, these districts being separated from each other by strata of barren rock. The Westville district contains the coals of the lowest member of the series, whereas the Thorburn district contains the coals of the highest member, these being eroded away from the other two districts. The coal measures in the Westville district dip about 20 degrees to the northeast and have been traced into the Stellarton district, underlying the coal measures of this latter area. The coal seams in the three districts are discussed below.

Westville District

The coal seams in this area are as follows, in descending order:

(a) The Acadia Main (Westville) Seam: The thickness of the seam varies from 5 feet at the Culton adit on McCulloch brook to 18 feet at the Drummond No. 1 and No. 5 mines. In early operations, the top half of the seam was worked, whereas, at present, work is confined to the bottom half, with an average thickness of 7 feet. There are several distinct partings, including a clay band which varies from 4 to 7 inches in thickness.

(b) The Second (Scott) Seam: This seam lies from 184 to 260 feet below the Main seam and its thickness varies to some extent, the maximum recorded being approximately 17 feet. As mined at Drummond No. 2 mine, the coal averages about 12 feet in thickness, with only about 5 to 7 feet being extracted, depending upon the quality. There are various stone partings in

(1) The Pictou County Coalfield -- W.A. Ball -- Canadian Geological Survey Memoir 225.

the coal, the present floor (i.e. in 1937) being an ironstone band situated about 12 inch from the real pavement of the seam.

(c) The Third Seam: This seam lies 107 to 126 feet below the Second seam and is generally known as the Six-Foot seam. It is not being mined at present.

Below the Third seam there is only one more of workable size, namely: the Fourth seam. This seam lies about 100 feet below the Third. The indications are that there is about 8 feet of inferior coal which probably decreases with depth. No mining has apparently been conducted in this seam. There are several more thin coal bands below the horizon of the Fourth seam, but none are of commercial importance.

Stellarton District

The seams in this area increase in thickness toward the northeast in the direction of the dip, reaching their maximum in the area mined near the Allan Shaft. The various seams are mined mainly on the west side of East river. In descending order they are as follows:-

(a) A seam about 3 feet 6 inches thick has been traced by outcrop for a short distance. It has only about 20 inches of good coal.

(b) The Main or Foord Seam: This seam, lying about 1126 feet below the seam mentioned above, is now worked only through the Allan Shaft mine. The seam dips to the north about 23 degrees and reaches the bottom of the syncline at the Allan Shaft. It varies in thickness from approximately 7 feet to over 45 feet, the average thickness where mined being about 40 feet. However, only 10 to 12 feet was being worked, the thickness worked depending on the quality of the coal. The seam is very irregular in quality, and in the portion being worked are found considerable amounts of pyrites in the form of balls and streaks and also bands of shale.

(c) The Four-Foot (or Little Cage) Seam: This seam is considered to be the upper leaf of the Cage seam, being separated from the lower or main portion by a 5-foot stratum. This seam has an average thickness of 42 inches, contains no distinct partings and appears to be composed of a bright and comparatively clean coal. In 1937, development work on this seam was started in the Allan Shaft.

(d) The Cage or Deep Seam: This seam lies about 148 feet below the Foord, and varies in thickness from approximately 34 feet down to 9 feet. In 1937, this seam was being worked in

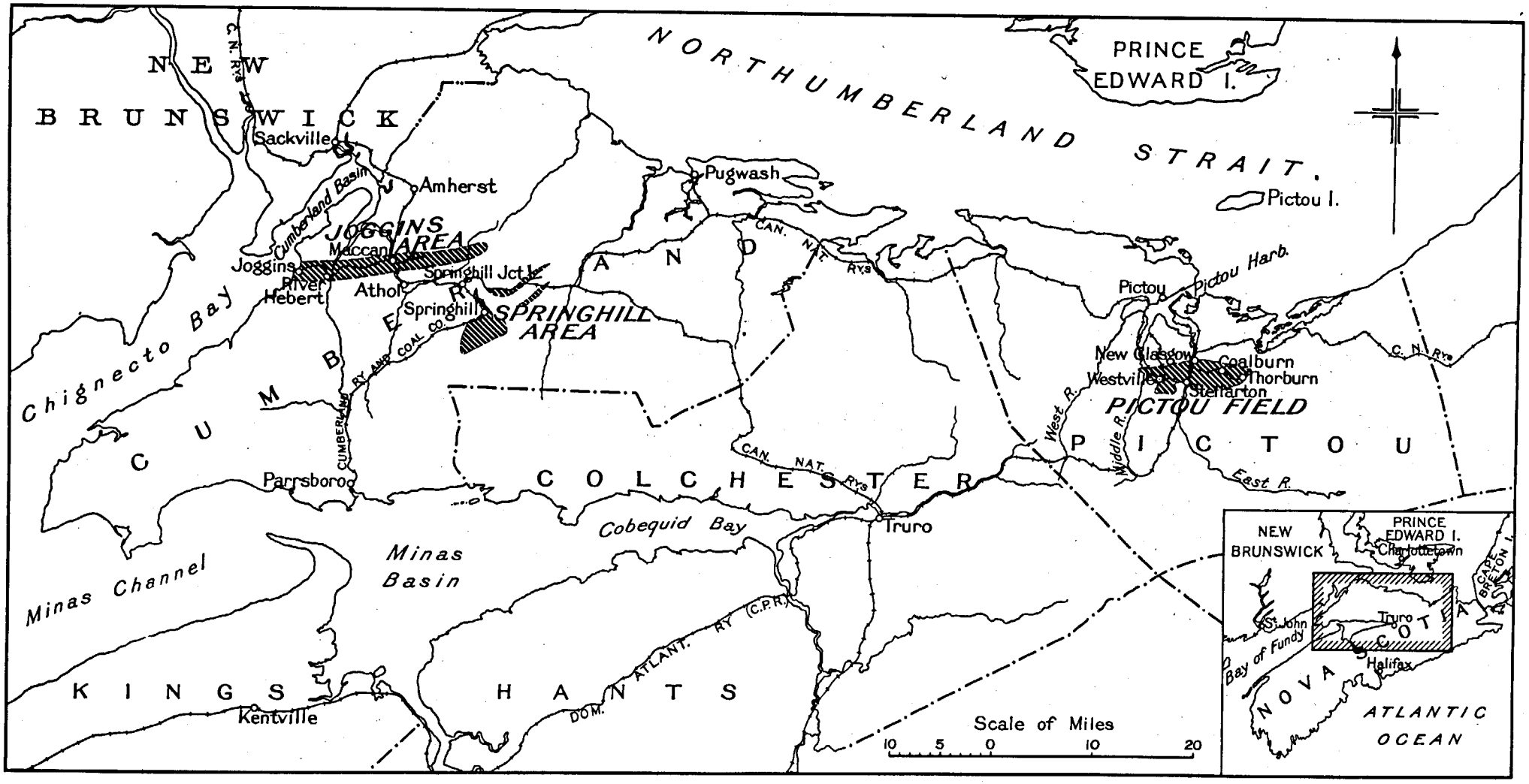

Fig. 1 - Map of Nova Scotia Showing the Pictou County Coalfield

the Albion mine, the Allan Shaft mine and the Acadia No. 7 mine. At the Allan mine where work was still in the development stage, the seam was 12-feet thick with about 8 feet of coal suitable for extraction. At No. 7 Acadia mine the seam averaged 9 feet in thickness and contained a band of so-called 'splint' varying from 18 to 24 inches in thickness and situated about 3½ feet from the roof. This band of bony coal contained approximately 16 to 23 per cent ash, and was marketed locally as refuse coal. The seam, as mined at the Albion colliery, was very similar in structure to that mined at Acadia No. 7 mine.

(e) The Third Seam: This seam lies from 75 to 106 feet below the Cage seam, and averages approximately 12 feet in thickness, varying from 6 feet to somewhat over 16 feet. As mined at the Albion colliery, the coal contains no distinct partings but there is an apparent abundance of discontinuous irregular bands of shale and also of pyrites in the form of sulphur balls and streaks. A new opening on the Third seam, to be located at Acadia No. 7 mine, was being planned in 1937.

(f) The Purvis Seam: This seam lies from 27 to 133 feet below the Third seam and averages about 4 feet in thickness. This seam is not being mined.

(g) The Fleming seam; This seam, separated from the Purvis seam by strata varying from 77 to 145 feet in thickness, is considered to be merely the top part of the McGregor seam, being separated from the main body of the seam by a 5-foot stratum. The seam is approximately 4 feet thick. It contains no distinct partings but is apparently abundantly adulterated with sulphur balls and streaks. This seam was mined in the McGregor colliery, operation being suspended during July 1937. Evidently much of the Fleming seam coal cannot be extracted because in the past the McGregor seam was worked prior to the Fleming.

(h) The McGregor Seam: This seam, which, as stated above, is separated from the Fleming by a 5-foot stratum, varies from 8 to 21 feet in thickness. There are no distinct partings but sulphur balls and streaks and discontinuous bands of shale are present.

If the concealed seams below the McGregor are included, then there are apparently sixteen or seventeen coal seams in all. Early observations on the underlying seams, based on coal outcrops, have been corroborated by more recent diamond-drill records. According to this information, the nine underlying seams vary in thickness from 3 feet 2 inches to 21 feet 9 inches, but up to the present no mining has been attempted in any of these seams.

Thorbun (Vale) District

This area contains a series of coal seams bent into a synclinal basin, along a northeasterly axis, measuring about three miles across from crop to crop of the lowest seam. As mentioned above, this series of seams is believed to be a higher series than those contained in the Stellarton district, and is separated from the latter by about 1,600 feet of barren strata. The seams in the Thorburn district, in descending order, are as follows:-

(a) Captain Seam: This seam probably underlies the greater part of the northern Marsh Pit basin, where it contains about 3 feet of coal.

(b) The Millrace Seam: This seam, which lies approximately 23 feet below the Captain, shows about 3 feet of coal.

(c) The George Mackay seam: This seam lies about 64 feet below the Millrace and has been traced, more or less continuously on each side of the basin. On the average, the seam is about 3 feet 6 inches in thickness, allowing a 24 inch extraction of coal. This seam, as worked at the Milford mine, contains a band of 'splint' about 6 to 8 inches from the floor. There is also a band of inferior coal 8 to 18 inches in thickness near the roof.

(d) The Six-Foot (Vale) Seam: This seam lies about 607 feet below the George MacKay. It varies in thickness from 3 to 8 feet but where mined at the Acadia No. 3 mine averaged about 4½ feet. There were no distinct partings, but there was a substantial quantity of pyrite occurring as balls, lenses and streaks. A small mine, Acadia No. 8, was opened on an outcrop of this seam in June 1937. At this mine the seam was about 5½ feet thick.

(e) The McBean or Eight-Foot Seam: This seam lies about 700 feet below the Six-Foot and was mined for a time at Acadia No. 3 mine. At the mine the seam was approximately 8 feet thick and appeared to increase in thickness to the northward.

Below the McBean there are several small seams of unimportance, all being less than two feet in thickness.

Chapter II

DESCRIPTION OF THE MINES

Since the Physical and Chemical Survey generally has been limited to regularly operating collieries, the investigation of the Pictou County coalfield has been confined to the seams being mined in the areas, or districts, described in Chapter I. The various mines operated in the three districts in the Pictou County coalfield are described below.

WESTVILLE DISTRICT

Intercolonial Coal Company Limited

Coal has been mined in the Westville district since its discovery in 1854, when mining operations were commenced by the Black Diamond Company on the Main seam. At present, that is, at the date of this report, only the one company, the Intercolonial, operates in the Westville district. This company operates the Drummond mines working both the Main and Second seams. The Main seam is worked through Drummond No. 1 and No. 5 mines, whereas the Second seam is worked through Drummond No. 2 mine.

Drummond No. 1 Mine (Main seam)

When visited in 1937, the seam at this mine was entered by a slope, which was 4,200 feet long with a cover of 1,280 feet, the course being S.77° E. The mining was conducted entirely by the room and pillar method, there having been twenty-five rooms and three headways in operation. The coal was extracted by hand-pick mining.

The mine was damp and the passages were free of coal dust, but, as is usual in this district, the mine was quite gassy. The average quantity of air in circulation was about 26,000 cubic feet per minute.

Horse haulage was used on the levels, whereas a steam hoist brought the coal to the surface on the single-track slope at the rate of twelve one-ton boxes per trip.

The mine had an average daily output of 275 gross (long) tons, with a total output for 1936 of 60,475 tons. Based on the employment of 190 men (surface and underground), the mine yielded on a one-shift day 1.45 long tons per man per day.

Bankhead--Drummond No. 1 Mine

The bankhead (see Figure 2), which was used at one and the same time for both No. 1 and No. 2 mines, contained one revolving tipple capable of handling two mine boxes. The coal or rock, after weighing, was discharged by means of the revolving tipple into a 4-ton hopper from which the coal or rock was removed by means of a steel plate conveyor belt. The rock was by-passed at the end of the conveyor by means of a rotary valve to the stone and refuse hopper cars.

The coal passed from the conveyor onto a double-decked shaker screen. The top deck of the screen was fitted with two $2\frac{1}{2}$ inch round-hole plate screens, each 4 feet wide and 5 feet long, whereas the bottom deck was equipped at the feed end with a plate 4 feet long and at the discharge end with a 1 inch wire mesh screen 6 feet in length. When a 1 inch lump coal was required the 1 to $2\frac{1}{2}$ inch size was by-passed to the $+2\frac{1}{2}$ inch lump picking belt; otherwise the 1 to $2\frac{1}{2}$ inch coal was recombined with the 0 to 1 inch coal. The lump coal remaining on the $2\frac{1}{2}$ inch screen passed over a picking belt of the steel plate conveyor type, whereas the 0 to $2\frac{1}{2}$ inch slack passed over a separate picking belt similar in design to the first and running parallel to it. Four men were employed in picking on the lump coal belt and two men on the slack belt, all the refuse being thrown down a chute into the stone and refuse hopper car. In order to produce the commercial mixture of crushed lump and slack referred to below, which represents most of the mine output, the hand-picked lump coal was crushed in a double-roll crusher, usually set at 3 inches, and then remixed with the slack.

For commercial purposes, the following grades of coal were being prepared:-

1. Run-of-mine
2. Crushed lump and slack mixture
3. Crushed lump
4. Lump, +1 inch or $+2\frac{1}{2}$ inch
5. Slack, 0 to 1 inch or 0 to $2\frac{1}{2}$ inch.

Drummond No. 5 Mine (Main seam)

The seam at this mine was entered by a slope which, in 1937, was 1,700 feet long with a cover of 600 feet, the course being N.72°E. The mining was entirely room and pillar and hand-pick, with ten rooms and three headways in operation.

The mine was damp and gassy, and the passages were relatively free from coal dust. The average quantity of air in circulation was 18,000 cubic feet a minute.

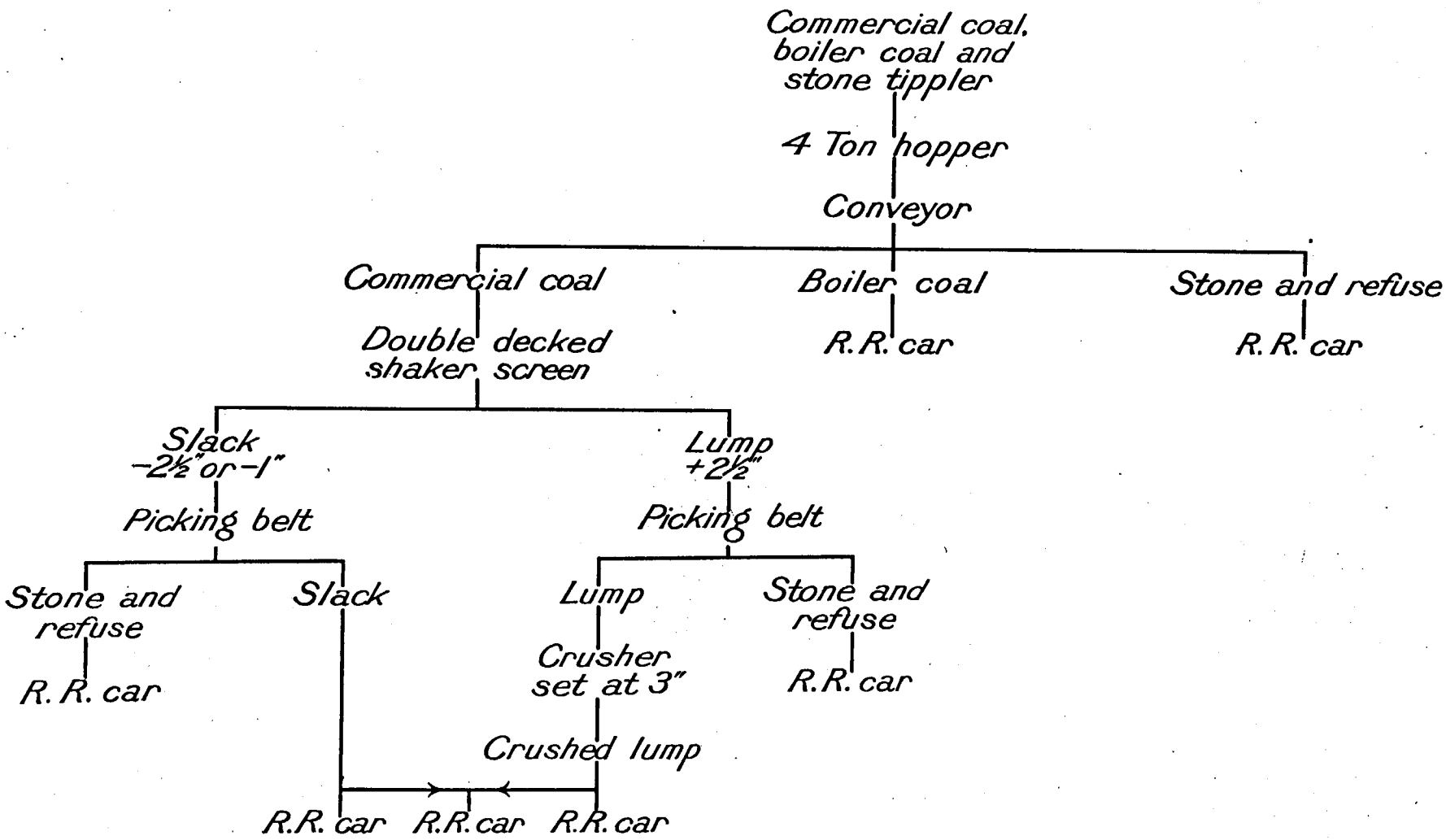

Fig. 2 - Flow-sheet of Bankhead or Tipple at Drummond No. 1 and No. 2 Mines

Horse haulage was used on the levels, whereas a steam-operated hoist brought the coal to the surface on the single-track slope at the rate of seven one-ton boxes per trip.

This mine, which was nearly worked out at the time of sampling, had an average daily output of 90 gross tons, with a total output for 1936 of 23,844 gross tons. Based on the employment of 83 men (surface and underground), the mine yielded 1.08 gross tons per man per day.

Bankhead--Drummond No. 5 mine

Because it was expected that the mine would be closed down within a short time, the bankhead was allowed to remain in a decrepit condition. The tipple house contained only an end dump tipple from which the coal was discharged by means of a chute into hopper cars. No preparation was attempted, only run-of-mine coal being loaded.

Drummond No. 2 Mine (Second seam)

The seam at this mine was entered by a slope 4,400 feet long with a cover of 1,500 feet. The course of the slope for the first 1,767 feet was S.77°, then swinging to N.74° for the remainder. The mining was entirely advancing longwall and development, with six working walls ranging from 200 to 380 ft. in length. The coal was undercut by a Siskol header equipped with a 5-foot rod.

The mine was damp in some places and dry in others. The passages were kept free from coal dust, some rock dusting, however, being necessary. The mine was quite gassy and required an average circulation of 37,500 cubic feet per minute.

Horse haulage was used on the levels, whereas a steam hoist brought the coal to the surface on the single-track slope at the rate of 14 one-ton boxes per trip.

The mine had an average daily (one-shift) output of 850 gross tons, with a total output of 71,150 gross tons for 1936. Based on the employment of 171 men (surface and underground), the mine yielded 4.97 long tons per man per day.

Bankhead--Drummond No. 2 Mine

As the openings of No. 1 and No. 2 mines were situated within a few feet of each other, the same bankhead was used for both mines. The bankhead is described above under Drummond No. 1 mine. Although it was the usual practice to mix the coal from the two mines as they came over the tipple, the coal from each mine was segregated, when necessary, for certain orders.

STELLARTON DISTRICT

Acadia Coal Company Limited

Coal was first discovered in the Pictou field in 1798 when prospecting was carried on along the banks of the East river in the Stellarton district. The Acadia Coal Company Limited, formed in 1886 by the amalgamation of three operating companies, is today the only organization mining coal in the Stellarton district. This company operates four mines: the Allan Shaft, Albion, McGregor and Acadia No. 7, all in the vicinity of the town of Stellarton.

Allan Shaft Mine (working Foord, Cage and Four-Foot Seams)

This mine, operated mainly on the Foord or Main seam, was entered by a shaft 1,200 feet deep. From the bottom of the shaft the 1,200-foot level runs in a northeast direction. The 1,500-foot level runs in a southeast course, with sinkings from the 1,500 to the 1,700-foot level. The Foord seam in this mine was being worked both by longwall and by room and pillar. There were two long walls, one slightly over 100 feet long and the other 300 feet long, with a daily extraction of approximately 700 tons from the two walls. Ten rooms were worked and no pillars extracted. Mining was very irregular, due to fires and the presence of inferior coal. The occurrence of inferior coal was very troublesome and in some cases after a wall had been worked for a month or so it had to be abandoned because of the sudden appearance of this poorer grade of coal. The coal was machine-mined, using radial cutters. No undercutting was done because of the danger of sparking when sulphur balls are struck. No powder was used in mining the walls, Holman and Elie compressed air picks being preferred. In some of the rooms, coal bursters were employed, but their use was not very extensive.

The Cage and Four-Foot seams were in the development stage, two headways being driven in preparation for a long wall. The output of the Four-Foot seam was expected to be in the neighbourhood of 125 tons per day.

The mine was very dry and dusty, necessitating the use of rock dusting. Ventillation was effected by means of a steam-operated suction fan passing 90,000 cubic feet of air per minute.

Haulage on the levels was effected by means of compressed air, using the main and tail system, with 35 cars per trip, each car containing approximately 2,650 pounds of coal. An electrically-operated hoist hauled the cars from the 1,500 to the 1,200-foot level. Hoisting up the shaft to the surface was by means of a single-drum double-rope 1,200 h.p. steam-operated hoist.

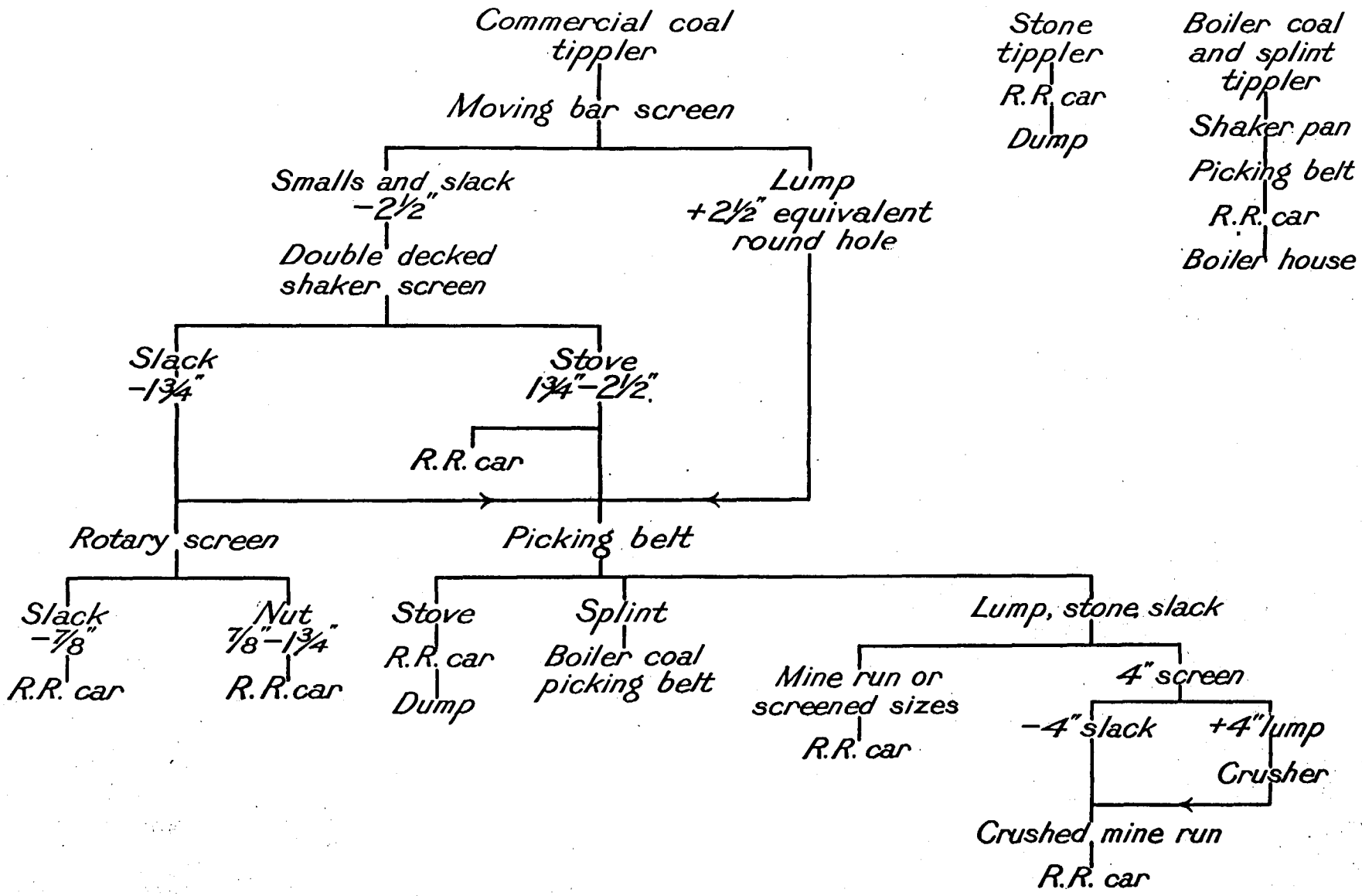

Fig. 3 - Flow-sheet of Bankhead or Tipple at Allan Shaft Mine.

The mine had an average daily output of 613 long tons (mainly from the Foord seam), working two 8-hour shifts per day. Based on the employment of 517 men (surface and underground), the mine yielded 1.18 long tons per man per day.

Bankhead--Allan Shaft Mine

In addition to the three seams worked at this mine, the bankhead handled the Cage seam coal brought by truck from the Acadia No. 7 mine. The bankhead (see figure 3) contained three rotary tipples, one for stone, one for boiler coal, and one for commercial coal. The stone was dumped directly into hopper cars and conveyed to the dump.

The inferior coal for use as boiler fuel passed by means of a shaker distributor onto a steel plate conveyor-type picking belt, 5 feet wide and 55 feet long, and was usually discharged into cars immediately below. The normal procedure was to run the boiler coal, plus the so-called 'splint' (bony coal) from the commercial coal picking table, directly to cars for conveyance to the power plant where all the coal was crushed. This plant, which consumed approximately 250 tons of this coal and 'splint' a day, producing 3/4 to 1 million k.w. hours per month, was equipped with ten mechanically-stokered Stirling boilers, eight of which were in constant use.

The commercial coal passed over a moving bar screen with $1\frac{1}{4}$ by 9 inch openings, the lump passing down a chute to the picking table. A gate at the end of this chute enabled the lump to be held back, so that the small coal and lump were separated on the belt, thus facilitating picking. The coal which passed through the bar screen dropped onto a double-decked shaker screen, the upper deck of which was equipped with the following screens from feed to discharge end:- (1) one lip screen, 6 feet long by 5 feet wide, the slots being 3 inch long and $1\frac{1}{2}$ inch wide at the base; and (2) one round-hole plate screen with 1-3/4 inch openings, 3 feet long by 5 feet wide. The coal retained on this deck was called 'stove coal', and it could either be by-passed directly to cars or could continue on to the picking belt to be mixed with the lump coal. The small coal passing the screen dropped onto the lower deck, equipped with a steel plate, from which the coal was either delivered to a belt conveyor carrying the coal to a revolving screen, or was passed onto the picking belt with the lump to produce run-of-mine. When nut coal was required, the slack was classified by the revolving screen, which was fitted with a 7/8 inch wire-mesh screen, rotating at 16 r.p.m., the slack and nut being collected separately in hoppers from which the railroad cars were loaded.

The coal which was passed over the steel conveyor-type picking belt (55 feet in length) was either lump, lump and stove, or run-of-mine. The so-called 'splint' (bony coal) was thrown onto the boiler coal belt, whereas the stone was discarded by means of a chute to a hopper car.

The handpicked lump or run-of-mine coal could either be loaded immediately into cars or be conducted by means of a steel belt conveyor, running at right angles to the picking belt, to a single roll Jeffrey crusher (100 tons per hour capacity) preceded by a 4-inch round-hole shaker screen. When railway coal was prepared, the crusher was set at 6 inch if the coal was to be water-borne, and at 5 inch when rail shipments were required. These were the specifications by the Canadian National Railways. The crushed lump was re-mixed with the coal passing the 4-inch screen and loaded together into either hopper or box cars. For box car loading, a Christie loader was employed.

The following sizes of coal could be produced:-

1. Lump coal -- +2½ inch (approximate round-hole screen)
2. Crushed lump -- through 5 or 6 inch screen
3. Stove coal -- 1-3/4 to 2-1/2 inch (approximate round-hole screen)
4. Nut coal -- 7/8 inch (square-hole) to 1-3/4 inch (round-hole screen)
5. Slack -- 0 to 7/8 inch (square-hole screen)
6. Run-of-mine
7. Run-of-mine containing crushed lump.

Albion Mine (working Third and Cage seams)

This mine has been operating on the Cage and Third seams since the latter part of the nineteenth century. About one-third of the total output from the Cage seam was, in 1937, being raised through this mine, that is, about 100 tons per day. At this time, the total output from the Third seam came from the Albion mine.

The mine was entered by a slope which had a northeast course, with a maximum cover of approximately 1,200 feet. The Third seam was being worked both longwall and by room and pillar, there being one wall 200 feet in length off the 5th west level, and 11 rooms off the 6th east level, in addition to development work. The coal was machine-mined, using a Mavor and Coalson cutter with a 5 foot rod on the wall, and a radial cutter with a 6-foot cut in the room and pillar work. All the underground machinery, including haulage on the levels, was operated by compressed air. The coal was hauled up the main slope, which was a distance of 4,500 feet to the bottom landing, by means of a double-drum electrically-operated hoist, bringing to the surface

15 one- (long) ton capacity boxes per trip. The Cage seam was being worked by the room and pillar method, eight rooms being in operation in 1937. The coal was machine-mined, using compressed air operated radial cutters which make a 6-foot cut.

The mine was extremely dry and dusty, necessitating the use of fairly large quantities of rock dust. It was also quite gassy, and several areas were on fire.

Bankhead -- Albion Mine

The bankhead at this mine received the coal from four seams, but only from three at one time, that is, the coal from the Third seam, the Cage seam, and either the McGregor or Fleming seam. Coal from these two last named seams was brought to the central preparation house from the McGregor mine situated a few hundred feet from the Albion mine.

The preparation building contained three rotary tipples, one for the coal from the Albion mine (Cage and Third seams), one for the coal from the McGregor mine (McGregor or Fleming seam), and one for the so-called 'splint' or inferior bony coal, this latter being placed, for convenience, between the two coal tipples. There were three other tipples situated on a lower floor, two for domestic coal for local sales, and one for stone. The domestic coal was dumped into hoppers without preparation, and the stone was dumped into cars for disposal on the refuse pile.

The treatment of the coals from the three main tipples handling the commercial coal and 'splint' may be described as follows. The coals from the respective mines were dumped onto moving bar screens with $1\frac{1}{4}$ by 9 inch openings, separating the lump from the smaller coal and slack. In preparing run-of-mine coal, a gate at the end of the screen could be used to hold back the coal passing through the bar screen, so that the lump and smaller coal passed over the picking belt separately, thus facilitating the picking. When lump was required, it was collected by by-passing the smaller coal. The material passing through the bar screen fell onto a double-decked shaker screen, the upper deck of which was equipped with two 1-3/4 inch round-hole plate screens 6 feet wide by $11\frac{1}{2}$ feet long. The lower deck contained a solid plate with a by-pass valve which could be used for dropping the 1-3/4 inch slack to a conveyor to be delivered to the revolving or rotary screen used for preparing nut coal. The coal retained on the 1-3/4 inch screen could be either by-passed for loading as 'stove' coal, or could be sent over the main picking belt with the mine-run coal, or over the special 'stove' picking belt which also handled screened crushed lump prepared for 'stove' size. The lump, with or without the 'stove'

and nut slack (in the first case, run-of-mine), passed onto a steel plate conveyor-type picking belt. The stone was discarded by means of a chute to the stone cars, whereas the so-called 'splint' was thrown onto the 'splint' picking belt which was situated between the belts for the Albion and McGregor coals.

The run-of-mine coal or hand-picked lump could be either loaded into cars by means of a flexible discharge end of the picking belt, or could be conveyed by a belt running at right angles to the picking belt to a single-roll Jefferey crusher preceded by a 4-inch round-hole shaker screen. The material passing the screen was conveyed either to the revolving screen for the preparation of nut and slack or could pass on to the crushed lump picking belt. The lump retained on the screen was passed through the crusher which, for the preparation of railway coal, was set at 6 inches. The crushed lump was delivered to a picking belt and then loaded to cars with or without the slack. When an increased quantity of 'stove' coal was required, the crusher was set at 2 inches and the crushed lump was conveyed to a 3/4 inch shaker screen, the oversize passed over the 'stove' picking belt. The slack was delivered either to the revolving screen or directly to cars, or was mixed with crushed lump for railway use. For the preparation of nut coal, the slack (1-3/4 inch or smaller) was delivered to an inclined rotary screen equipped with a 7/8 inch wire mesh screen, resulting in the production of 7/8 to 1-3/4 inch nut and 0 to 7/8 inch slack.

The so-called 'splint' or inferior coal, which was dumped by the centre main tipple onto a shaker conveyor, passed over a steel conveyor-type picking belt situated, as has been already stated, between the Albion and McGregor picking belts. Here the stone was removed, the 'splint' from the commercial coals added, and the combined product delivered to cars for the boiler house.

The grades of coal that could be produced at this mine were as follows:-

1. Lump -- +2 inch or +3 inch (round-hole)
2. Crushed lump
3. Stove -- 1-3/4 to 2 or 3 inch (round-hole)
4. Nut coal -- 7/8 (square-hole) to 1-3/4 inch (round-hole)
5. Stove from crushed lump -- 3/4 to 2 inch (round-hole)
6. Nut slack -- 0 to 1-3/4 inch
7. Slack -- 0 to 3/4 or 7/8 inch
8. Run-of-mine -- with or without crushed lump

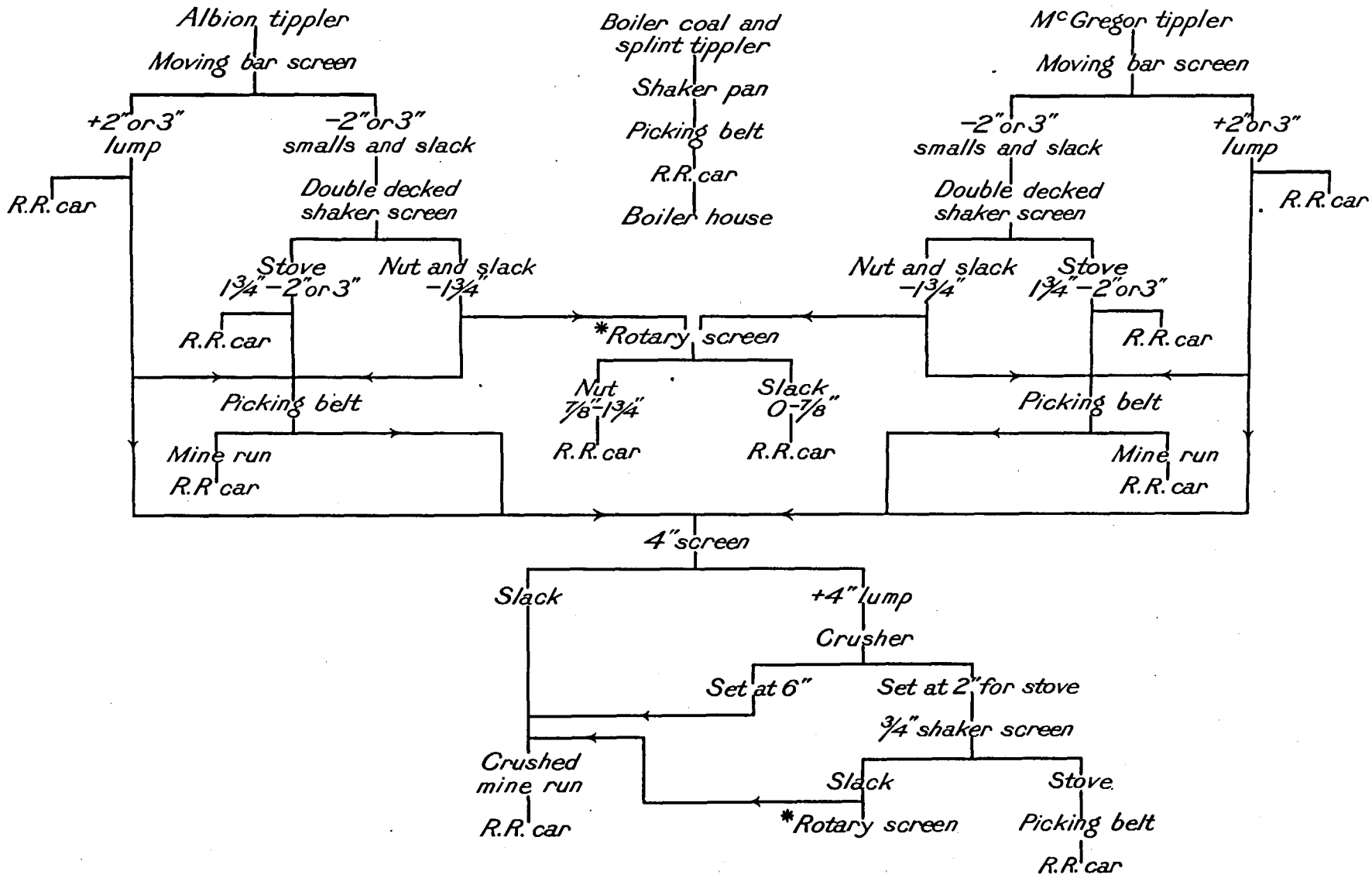

Fig. 4 - Flow-sheet of Bankhead or Tipple at Albion Mine.

Acadia No. 7 Mine (Cage seam)

This mine was opened in 1936 on that portion of the Cage seam which was not available to the Albion mine. The seam at this mine was entered by a slope which, in 1937, was 1,200 feet long, with a dip of 24 degrees, and a cover of about 400 feet at the face. There was one 230-foot long wall, machine-mined, using a radial cutter. Development coal was obtained from the levels, sinkings and airways. All the machinery in the mine was operated by compressed air.

The mine was free from gas, allowing shot firing. The levels were quite damp, the water being pumped into the Albion mine, from whence it was pumped to the surface. Ventillation was effected by means of an electrically-driven fan, delivering 10,000 cubic feet of air per minute.

The coal was hoisted to the surface by a single-rope electric hoist hauling three cars per trip, each car having a capacity of approximately 1,800 pounds.

The mine, during 1937, had an average daily output of approximately 200 tons, which accounted for about two-thirds of the total output from the Cage seam. Based on the employment of a total of 93 men, the mine yielded 1.93 tons of coal per man per day.

Bankhead--Acadia No. 7 Mine

The bankhead was very simple, consisting of two end dump tipples which discharged the coal into a bin with an 80-ton capacity. The coal was then discharged into trucks and delivered to the Allan shaft mine, a distance of about two and a half miles, where it was dumped into a small hopper at ground level. From this it was conveyed by means of a scraper conveyor into a bin on the tipple floor. Here, the coal was loaded into mine cars and sent over the tipple and thus through the preparation plant previously described. It was intimated that the above method of handling the coal would be continued, as the mine was some distance from the railway sidings and also because economic factors did not warrant expenditures on a suitable bankhead with proper preparation equipment.

As the coal from this mine was mixed with the Allan mine coals. the grades of coal prepared are the same as those listed for that mine.

McGregor Mine (McGregor and Fleming seams)

This mine operated on both the McGregor and Fleming seams alternately. The mine, situated near the Albion bankhead, was entered by a slope which, in 1937, had a length of 4,800 ft. to the bottom landing, with a cover, at this point, of approximately 1,300 feet. The McGregor seam was being worked by the longwall method, the two walls in operation being 140 and 200 feet long respectively. A certain amount of development work was going on. Mavor and Coalson cutting machines with 5-foot rods were used. All the underground machinery, including haulage on the levels, was operated by compressed air. The coal was hauled up the main slope by means of a double-drum electric hoist, there being twelve one-ton (long) boxes per trip.

When the Fleming seam was in operation, it was worked both longwall and room and pillar. The final operations, in July 1937, were confined to two walls between No. 6 and No. 7 East levels.

The mine was gassy, dry and dusty, with several areas on fire. Rock dusting was employed extensively.

Bankhead

The Albion bankhead handled all the coal from the McGregor mine (see Figure 4). Reference to the description of the Albion bankhead shows that, although the McGregor coal was prepared at the Albion bankhead, provision was made for handling this coal separately. The McGregor mine contributed approximately 400 tons per day to the output of the Albion bankhead.

THORBURN (VALE) DISTRICT

Greenwood Coal Company Limited

Milford Mine (George McKay seam)

This mine, operating on the George McKay seam, is situated at Coalburn, about four miles southeast of New Glasgow, on leases Nos. 816 and 117 of the Acadia Coal Company Limited.

The seam at this mine, which has been operating since 1915, was entered by a slope 900 feet long with a dip of 11 degrees. The main level, in 1937, was 2,500 feet long. Advance longwall machine mining was employed in this mine, two walls, one 430 feet long and the other 170 feet long, being worked. No conveyors were employed; the coal being loaded into the mine boxes by hand. The coal was hoisted to the surface on a single track by means of a single-drum electric hoist which hauled seven 1,200-pound capacity cars per trip.

The mine was damp and the passages were free from coal dust. Although the mine was quite free from gas, electric lamps were used.

The mine had an average daily output of 250 tons, with a total output for 1936 of 43,227 long tons. Based on the employment of 143 men (surface and underground), the mine yielded 1.75 tons per man per day.

Bankhead -- Milford Mine

The bankhead, which was of all-wood construction, contained the commercial coal tipple and screening equipment. The coal was discharged from an end dump tipple onto a double-decked shaking screen, the upper deck of which was fitted with a 1-inch round-hole plate screen, 4 feet wide by 8 feet long. The lower deck was equipped with a 3/4-inch square-mesh screen, 4 feet by 8 feet. The slack coal (-3/4 inch) was loaded directly to hopper cars. The lump (+3/4 inch) passed over a steel plate conveyor-type picking belt approximately 40 feet in length. The coal was picked by four men, all the large lumps being broken to facilitate removal of stone, bone and inferior coal. The refuse was thrown onto the floor and subsequently carted to the eight-ton refuse bin. The cleaned lump could either be loaded into cars or be diverted into the three-ton domestic bin. When preparing mine-run coal, a steel plate was placed on the 3/4 inch wire mesh screen. The upper deck of the shaking screen, fitted with the 1-inch screen, served to separate the large lumps from the smaller sizes, thus facilitating picking.

The various sizes of coal produced at this mine during 1936 were as follows:

1. Run-of-mine
2. Lump (+3/4 inch square-hole)
3. Slack (-3/4 inch square-hole)

The total quantity of refuse, that is, that brought to the surface as such and that picked from the belt, amounted to approximately 14 per cent of the total raised.

Acadia Coal Company Limited

Acadia No. 3 Mine (Six-Foot seam)

This mine, which operated on the Six-Foot seam, was situated at Thorburn, and at the time of sampling in 1937 was almost worked out. The mine was closed down in 1938.

The seam was entered by a slope 2,400 feet long, with a dip starting at 25 degrees and decreasing to zero at the 2,400

foot level, after which the seam dips the other way. Mining was conducted by the room and pillar method, and at the time of sampling two rooms were in operation and nine pillars were being extracted. All the mining was done by hand picks. Haulage on the levels was electrical, and the coal was raised to the surface on the double-tracked slope by means of an electric hoist, five 13.6 cwt. cars being drawn per trip.

The mine was practically free from gas, and powder was used quite freely. Ventillation was effected by means of an electric fan supplying 35,000 cubic feet of air per minuted.

The mine had an average daily output, during 1936, of 273 long tons, and based on the employment of a total of 160 men the mine yielded 1.71 long tons per man per day.

Bankhead -- Acadia No. 3 Mine

The bankhead was equipped with three tipples, one revolving type and two end dump type. One of the end dump tipples was used for domestic coal for local sales, whereas the other handled the stone. The commercial coal passed over the revolving tipple and was dumped into a scale pan for weighing. The coal was then discharged onto a shaker screen, the feed end of which was fitted with a 1-1/4 by 3/4 inch slotted screen, 4 by 4 feet. The discharge end of the screen was constructed of bars, 1-1/4 inch square in cross-section and set 1-1/2 inch apart. This arrangement separated the slack from the lump and facilitated picking. The picking belt was a steel plate conveyor approximately 4 feet wide and 40 feet long. The rejected material was thrown into a refuse hopper of five-ton capacity. The hand-picked coal was crushed by means of a single-roll Jeffrey crusher set at 6 inches, the slack coal also passing through the crusher. The resultant crushed run-of-mine coal was loaded directly to hopper cars, there being no facilities for loading box cars.

The only grade of coal produced at this mine was crushed run-of-mine.

Acadia No. 8 Mine (Six-Foot seam)

This mine, which was situated about 3,000 feet west of No. 3 slope, was opened in June 1937 and operated for a few months in order to obtain a certain amount of coal from the Six-Foot seam, which was not available from No. 3 mine.

The mine was entered by a slope which, in August 1937, was 160 feet long. No levels were driven, the mining operation consisting of four rooms off the west side of the slope in addition to the development work on the slope.

The coal was hoisted to the surface on a single track by means of a gasoline engine, one 13.6 cwt. capacity car being hauled per trip.

Bankhead--Acadia No. 8 Mine

The bankhead consisted of an end dump tipple which discharged the coal into a 2½ ton chute. The coal was then loaded into trucks and taken to No. 3 mine, where it was placed in mine cars and sent over the No. 3 tipple.

The output of the mine was approximately 50 tons per day, employing eight men.

Chapter III

PHYSICAL AND CHEMICAL CHARACTERISTICS OF THE COALS FROM PICTOU COUNTY COALFIELD

The samples of coal from this field, reported in this publication, were taken under the supervision of an officer of the Division of Fuels, namely: E. Swartzman, during the summer of 1937.

Approximately 2,500 pounds of coal, representative of a day's output, was collected from each seam at the tipple. In those cases where the same seam was being worked in more than one mine, samples were collected from the various mines in proportion to their output from the seam, one composite sample for each seam being made for the investigation. Each sample was mixed, coned and quartered, one-half being used for the study of the physical and chemical characteristics of the coal, the other half being reserved for special investigation.

The data obtained from each seam studied in the three districts of the Pictou coalfield are presented in the following sets of tables, as listed below:-

Physical tests:
- Table I - Screen analyses, bulk density and apparent specific gravity.
- Table II - Size stability.
- Table III - Grindability.

Chemical Analyses:
- Table IV - Proximate analyes, calorific value and ash fusibility.
- Table V - Ultimate analyses.
- Table VI - Sulphur forms and fusain.
- Table VII - Chemical analysis of ash.

Washing tests:
- Table VIII- Float and sink data on 1½ inch slack--ash and sulphur.
- Table IX - Chemical analyses and fusibility of ash of float and sink portions of 1½ inch slack
- Table X - Chemical analyses, sulphur forms and fusain of raw coal, clean coal and refuse.
- Table XI - Screen and chemical analyses of sizes prepared from 1½ inch slack, and analyses of the clean coal and refuse of these sizes after washing at a selected gravity.
- Figures 5, 6, 7, 8, 9, 10, 11, 12, 13 and 14 - Washability curves re ash and sulphur.

Coking tests:

Table XII - Physical properties of by-product cokes as indicated by the 'swelling index' test; and caking index.

A full discussion of the significance of all the tests employed in this investigation is presented in the Appendix of this report.

WESTVILLE DISTRICT
MAIN SEAM
DRUMMOND NO. 1 AND NO. 5 MINES, INTERNATIONAL COAL COMPANY LIMITED
WESTVILLE, NOVA SCOTIA

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TABLE I. Screen Analyses, Bulk Density and Apparent Specific Gravity

Screen sizes *	Screen analyses: As received % By weight	As received % Cumulative	As mined % By weight	As mined % Cumulative	Bulk density --- lb. per cu. ft.	Apparent specific gravity	Void %	Ash %
Plus 4 "	31.6	31.6	31.8	31.8	.....	....	....	10.7
2 " - 4 "	18.5	50.1	19.0	50.8	41.50	1.34	50.3	12.3
1½" - 2 "	5.9	56.0	6.0	56.8	42.50	1.34	49.2	10.8
1 " - 1½"	7.7	63.7	8.2	65.0	43.50	1.35	48.4	11.9
3/4" - 1 "	4.9	68.6	4.9	69.9	43.75	1.35	48.2	13.1
1/2" - 3/4"	6.6	75.2	6.6	76.5	44.00	1.34	47.4	12.1
1/4" - 1/2"	8.2	83.4	8.2	84.7	44.00	1.32	46.7	12.2
1/8" - 1/4"	5.7	89.1	4.9	89.6	43.25	1.33	48.0	15.0
No. 48 - 1/8"	7.7	96.8	8.5	98.1)	50.50	1.32	38.8	(17.7
0 " - No. 48	3.2	100.0	1.9	100.0)				(18.6
Mine run		100.0		100.0	55.50	1.34	33.7	12.6
0 " - 4 "		68.4		68.2	56.00	1.34	33.1	13.9
1/8" - 4 "		57.5		57.8	52.75	1.34	37.0	13.7
3/4" - 4 "		37.0		38.1	46.00	1.35	45.5	12.6
0 " - 3/4"		31.4		30.1	53.00	1.32	36.3	16.1
0 " - 1½"		44.0		43.2	55.00	1.33	33.9	15.2
0 " - 1/8"		10.9		10.4	50.50	1.32	38.8	18.0

	As mined	As received
Average size of run-of-mine coal.....in.	2.98	2.94
Size stability during handling from mine to Ottawa.....%		99

* In this and subsequent tables, all screens 1/8" and larger are round-hole screens. No. 48 is Tyler 48-mesh with nominal aperture of 0.295 mm.

MAIN SEAM -- DRUMMOND NO. 1 AND NO. 5 MINES

TABLE II. Size stability

Screen sizes	Screen analyses before and after drop-shatter test									
	Single sizes				Mixed sizes					
	2 - 3 inch		3 - 4 inch		3/4 - 4 inch			0 - 4 inch		
	Before test %	After 2 drops %	Before test %	After 2 drops %	Before test %	After 2 drops %	After 4 drops %	Before test %	After 2 drops %	After 4 drops %
3 " - 4 "			100.0	52.7	20.5	15.0	8.7	11.1	9.3	9.3
2 " - 3 "	100.0	66.5		21.4	29.5	24.2	22.5	15.9	14.4	11.8
1½" - 2 "		13.0		8.2	15.9	15.8	16.7	8.6	7.6	7.2
1 " - 1½"		8.5		3.5	20.8	17.9	17.1	11.3	16.0	15.2
3/4" - 1 "		2.5		4.0	13.3	13.8	14.2	7.2	8.4	9.3
1/2" - 3/4"		3.5		3.0		6.2	8.3	9.6	10.5	10.1
0 " - 1/2"		6.0		7.2		7.1	12.5	36.3	33.8	37.1
Average size..in.	2.50	2.06	3.50	2.64	1.11	1.81	1.58	1.28	1.23	1.16
Size stability..%		82		75		86	75		97	91

TABLE III. Grindability *

Screen size of coal tested	Hardgrove index	
	Old	New
0" - 4 "	79	84
0" - 3/4"	79	82
0" - 1/8"	77	80

* See Appendix.

MAIN SEAM -- DRUMMOND NO. 1 AND NO. 5 MINES

TABLE IV. Proximate Analyses, Calorific Value and Fusibility of Ash

Screen sizes	Moisture (as rec'd) %	Dry basis: Ash %	Dry basis: Volatile matter %	Dry basis: Fixed carbon %	Dry basis: Sulphur %	Dry basis: Calorific value Btu/lb.	Initial deformation °F.	Softening temperature °F.	Fluid temperature °F.	Melting range °F.	Softening interval °F.	Flow interval °F.
Plus 4 "	2.3	10.7	26.9	62.4	0.7	.....	2210	2310	2430	220	100	120
2 " - 4 "	2.0	12.3	27.0	60.7	1.3	.....	2190	2250	2300	110	60	50
1½" - 2 "	2.0	10.8	26.8	62.4	0.9	.....	2250	2360	2420	170	110	60
1 " - 1½"	2.0	11.9	26.7	61.4	0.9	.....	2240	2340	2390	150	100	50
3/4" - 1 "	1.9	13.1	26.5	60.4	1.0	.....	2250	2300	2360	110	50	60
1/2" - 3/4"	1.9	12.1	26.8	61.1	1.1	.....	2200	2300	2450	250	100	150
1/4" - 1/2"	1.9	12.2	26.3	61.5	1.0	.....	2300	2390	2500	200	90	110
1/8" - 1/4"	1.9	15.0	25.9	59.1	1.2	.....	2300	2390	2500	200	90	110
No. 48 - 1/8"	1.9	17.7	25.9	56.4	1.3	.....	2320	2400	2450	130	80	50
0 " - No. 48	1.7	18.6	26.1	55.3	1.5	.....	2200	2300	2400	200	100	100
Mine run	1.1	12.6	27.1	60.3	1.2	13,155	2210	2300	2450	240	90	150
0 " - 4 "	1.8	13.9	26.6	59.5	1.0	13,040	2240	2300	2400	160	60	100
1/8" - 4 "	2.1	13.7	26.5	59.8	1.0	13,055	2250	2350	2470	220	100	120
3/4" - 4 "	1.9	12.6	26.9	60.5	0.9	13,240	2260	2300	2330	70	40	30
0 " - 3/4"	2.2	16.1	26.5	57.4	1.2	12,625	2270	2350	2420	150	80	70
0 " - 1½"	2.0	15.2	26.4	58.4	1.1	12,710	2260	2310	2350	90	50	40
0 " - 1/8"	2.1	18.0	26.1	55.9	1.3	12,310	2250	2340	2400	150	90	60

TABLE V. Ultimate Analyses (Dry Basis)

Sample	Carbon %	Hydrogen %	Sulphur %	Nitrogen %	Oxygen %	Ash %
1/8" - 4 "	74.3	4.5	1.0	2.1	4.4	13.7
0 " - 1/8"	69.9	4.4	1.3	2.0	4.4	18.0

TABLE VI. Sulphur Forms and Fusain

Screen sizes	Total sulphur	Sulphate sulphur		Pyritic sulphur		Organic sulphur		Fusain
	% of coal	% of coal	% of sulphur	% of coal	% of sulphur	% of coal	% of sulphur	% of pure coal
Mine run	1.22	0.00	0.0	0.58	47.5	0.64	52.5	....
0 " - 4 "	....	....	...	....	....	....	....	3.05
1/8" - 4 "	....	....	...	....	....	....	....	3.16
3/4" - 4 "	....	....	...	....	....	....	....	3.18
0 " - 3/4"	....	....	...	....	....	....	....	3.64
0 " - 1/8"	....	....	...	....	....	....	....	3.47
0 " - 1/8"	....	....	...	....	....	....	....	4.77

TABLE VII. Chemical Analyses of Ash ≠

Screen sizes	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	Na_2O	K_2O	TiO_2	P_2O_5	SO_3	Total
1/8" - 4 " %	58.4	22.9	7.0	4.0	1.1	0.2	1.6	0.8	0.3	4.0	100.3
0 " - 1/8" %	47.6	23.0	6.5	9.7	1.1	0.0	1.4	0.6	0.4	9.3	99.6

≠ Analysis made in chemical laboratory, Division of Metallic Minerals, under the direction of J.A. Fournier, Chief Chemist.

MAIN SEAM -- DRUMMOND NO. 1 AND NO. 5 MINES

TABLE VIII. Float and Sink Data on 1½" Slack - Ash and Sulphur

Specific gravity		Weight	Ash	Sulphur	Cumulative Floats			Cumulative Sinks			±.10 specific gravity distribution	
Sinks	Floats	%	%	%	Weight %	Ash %	Sulphur %	Weight %	Ash %	Sulphur %	Gravity	Calculated ordinate
											1.35	91.0
	1.30	23.4	5.3	0.8	23.4	5.3	0.8	100.0	15.1	1.2	1.40	63.4
1.30	1.40	59.3	10.4	0.8	82.7	9.0	0.8	76.6	18.1	1.3	1.45	14.4
1.40	1.50	4.1	19.9	1.6	86.8	9.5	0.9	17.3	44.1	2.7	1.55	5.3
1.50	1.60	1.9	24.5	1.4	88.7	9.8	0.9	13.2	52.3	3.0	1.65	3.2
1.60		11.3	57.0	3.3	100.0	15.1	1.2	11.3	57.0	3.3	1.75	2.7
Curve No. 4			2	2	1,2,4	1	1	3	3	3	5	5

TABLE IX. Chemical Analysis and Fusibility of Ash on Float and Sink Portions of 1½" Slack (Dry Basis)

Specific gravity		Ash	Volatile matter	Fixed carbon	Coking properties	Sulphur	Initial deformation	Softening point	Fluid temperature	Melting range	Softening interval	Flow interval
Sinks	Floats	%	%	%		%	°F.	°F.	°F.	°F.	°F.	°F.
	1.30	5.4	27.5	67.1	Good	0.8	2450	2550	2660	210	100	110
1.30	1.40	10.6	26.7	62.7	Good	0.8	2470	2570	2780	310	100	210
1.40	1.50	20.1	25.9	54.0	Fair	1.6	2040	2140	2200	160	100	60
1.50	1.60	24.8	26.6	48.6	Poor	1.4	2090	2160	2220	130	70	60
1.60		57.8	20.7	21.5	Non-agglomerating	3.3	2350	2420	2500	150	70	80

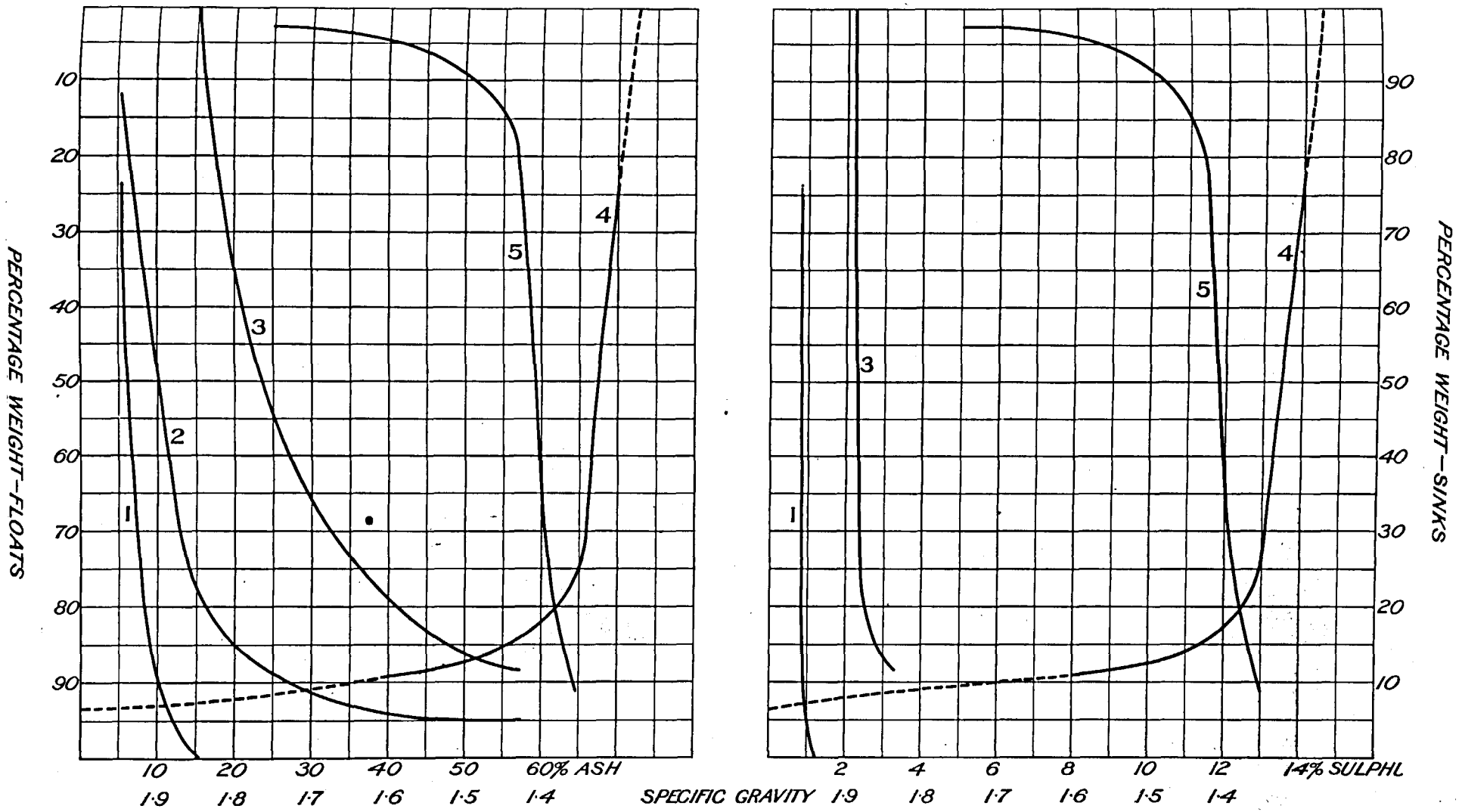

Fig. 5 - Washability Curves for Main Seam--Drummond No. 1 and No. 5 Mines

Curve 1 - Cumulative coal-ash or sulphur percentage (float).
Curve 2 - Actual ash or sulphur percentage.
Curve 3 - Cumulative slate-ash or sulphur percentage (sink).
Curve 4 - Specific gravity.
Curve 5 - ±.10 specific gravity distribution.

MAIN SEAM -- DRUMMOND NO. 1 AND NO. 5 MINES

TABLE X. Chemical Analyses and Fusain of Raw Coal, Clean Coal and Refuse

	Raw Coal	Clean coal Floats 1.50	Refuse Sinks 1.50
Weight.....%	100.0	88.0	12.0
Proximate analysis (dry basis)--			
Ash.....%	15.2	9.9	50.8
Volatile matter.....%	26.4	26.5	21.3
Fixed carbon.....%	58.4	63.6	27.9
Sulphur.....%	1.1	0.9	3.1
Calorific value.....B.t.u./lb.	12,710	13,785	....
Fusion point of ash.....°F.	2310	2540	2400
Melting range of ash.....°F.	90	170	160
Coking properties.....	Good	Good	Slightly agglomerating
Fusain in pure coal.....%	3.47	2.99	8.42

TABLE XI. Screen and Chemical Analyses of Sizes Prepared From 1½" Slack, and Analyses of the Clean Coal and Refuse of These Sizes After Washing at a Selected Gravity of 1.50

Screen sizes	Weight %	Cumulative weight %	Ash %	Sulphur %	F.P.A. °F.	Floats Weight %	Floats Ash %	Floats Sul. %	Floats F.P.A. °F.	Sinks Weight %	Sinks Ash %	Sinks Sul. %	Sinks F.P.A. °F.
3/4" - 1½"	28.6	28.6	12.5	1.0	2320	88.6	10.2	0.8	2580	11.4	48.6	3.2	2220
1/8" - 3/4"	46.6	75.2	13.0	1.1	2380	87.7	9.4	0.9	2560	12.3	56.5	3.3	2340
0 " - 1/8"	24.8	100.0	18.0	1.3	2340	80.7	7.9	1.0	24.0	19.3	57.4	2.4	2400

MAIN SEAM -- DRUMMOND NO. 1 AND NO. 5 MINES

TABLE XII. Physical Properties Of By-product Cokes As Indicated By The 'Swelling Index' Test

	1½ inch slack	
	As received	After washing
Volatile matter at 600°C. (dry)...%	20.2	21.8
Swelling index.....	495	459
Section--Coke classification chart.	IX	IX
Specific volatile index.....	170.5	179.2
Section--Coal classification chart(	E Parabituminous	F Orthobituminous
Ash per cent in coal (dry basis)..%	15.2	9.9
Physical properties of coke:		
Size on wharf (% on 3 in.....	70.0	65.0
Size on wharf (Breeze: % -1/2 in.	3.0	2.0
Shatter test. (Index: % on 2 in..	65.0	65.0
Shatter test. (Breeze: % -1/2 in.	4.0	4.0
Abrasion test (Index: % on 1½ in.	90.0	90.0
Abrasion test (Dust: % -1/16 in..	2.5	2.5
Density (App. specific gravity...	1.1	0.95
Density (Pounds per cubic foot...	31.0	28.0
Transverse shrinkage.....	Good	Good
Appearance of natural surface....	Steel grey, slightly irregular	
Shape.....	Blocky, slightly triangular	
Strength.....	Tough to hard	
Cross fracture.....	Small amount, slightly steppy	
Longitudinal fracture.....	Small amount	
Cell fracture.....	Small	Small to medium
Sponge.....	Small amount	
Pebbly seam.....	None	
Remarks.....	This coal should result in the production of a fairly good domestic by-product coke.	Washing should improve the resultant coke, both physically and chemically.

Caking Properties

	Caking index by Gray's method
Run-of-mine sample.....	49

WESTVILLE DISTRICT
SECOND SEAM
DRUMMOND NO. 2 MINE, INTERCOLONIAL COAL COMPANY LIMITED
WESTVILLE, NOVA SCOTIA

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TABLE I. Screen Analyses, Bulk Density and Apparent Specific Gravity

Screen sizes *	Screen analyses: As received % By weight	As received % Cumulative	As mined % By weight	As mined % Cumulative	Bulk density lb. per cu. ft.	Apparent specific gravity	Void %	Ash %
Plus 4 "	47.3	47.3	51.0	51.0	.....	....	....	21.1
2 " - 4 "	16.2	63.5	19.3	70.3	46.00	1.42	48.2	21.5
1½" - 2 "	4.5	68.0	4.8	75.1	45.50	1.40	48.0	21.3
1 " - 1½"	7.4	75.4	6.4	81.5	46.00	1.45	49.2	21.0
3/4" - 1 "	3.8	79.2	3.2	84.7	45.25	1.44	49.7	21.1
1/2" - 3/4"	4.6	83.8	4.0	88.7	45.00	1.42	49.3	21.1
1/4" - 1/2"	5.5	89.3	2.0	90.7	46.00	1.42	48.2	19.6
1/8" - 1/4"	3.8	93.1	2.8	93.5	45.50	1.42	48.7	19.1
No. 48 - 1/8"	4.9	98.0	4.7	98.2	51.75	1.38	40.0	20.0
0 " - No. 48	2.0	100.0	1.8	100.0				19.0
Mine run		100.0		100.0	73.00	1.42	11.8	20.9ø
0 " - 4 "		52.7		49.0	60.00	1.42	32.4	20.8ø
1/8" - 4 "		45.8		42.5	56.00	1.43	37.3	21.1
3/4" - 4 "		31.9		33.7	51.25	1.44	43.0	21.5
0 " - 3/4"		20.8		15.3	54.50	1.42	38.6	20.5
0 " - 1½"		32.0		24.9	57.75	1.42	35.0	20.7
0 " - 1/8"		6.8		6.5	51.75	1.38	40.0	19.8

	As mined	As received
Average size of run-of-mine coal.....in.	4.20	3.83
Size stability during handling from mine to Ottawa.....%		91

* In this and subsequent tables, all screens 1/8" and larger are round-hole screens. No. 48 is Tyler 48-mesh with nominal aperture of 0.295 mm.

ø Ash percentages calculated from those of individual screen sizes.

SECOND SEAM -- DRUMMOND NO. 2 MINE

TABLE II. Size Stability

Screen sizes	Screen analyses before and after drop-shatter test									
	Single sizes				Mixed sizes					
	2 - 3 inch		3 - 4 inch		3/4 - 4 inch			0 - 4 inch		
	Before test %	After 2 drops %	Before test %	After 2 drops %	Before test %	After 2 drops %	After 4 drops %	Before test %	After 2 drops %	After 4 drops %
3 " - 4 "			100.0	56.5	24.5	21.3	17.5	14.8	12.9	12.9
2 " - 3 "	100.0	74.0		23.0	26.3	22.5	22.5	15.9	16.7	13.4
1½" - 2 "		11.0		7.5	14.1	13.3	13.8	8.5	7.9	8.8
1 " - 1½"		6.5		3.5	23.2	22.1	19.1	14.0	10.4	10.8
3/4" - 1 "		3.5		3.5	11.9	12.5	12.9	7.2	7.9	8.3
1/2" - 3/4"		1.5		2.0		4.2	6.3	8.7	8.3	8.8
0 " - 1/2"		3.5		4.0		4.1	7.9	30.9	35.9	37.0
Average size..in.	2.50	2.17	3.50	2.78	2.16	1.96	1.83	1.42	1.34	1.28
Size stability..%		87		80		91	85		94	90

TABLE III. Grindability

Screen size of coal tested	Hardgrove index	
	Old	New
0" - 4 "	73	78
0" - 3/4"	71	77
0" - 1/8"	73	77

SECOND SEAM -- DRUMMOND NO. 2 MINE

TABLE IV. Proximate Analyses, Calorific Value and Fusibility of Ash

Screen sizes	Moisture (as recd) %	Dry basis: Ash %	Volatile matter %	Fixed carbon %	Sulphur %	Calorific value Btu/lb.	Initial deformation °F.	Softening temperature °F.	Fluid temperature °F.	Melting range °F.	Softening interval °F.	Flow interval °F.
Plus 4 "	1.7	21.1	23.0	55.9	1.5	.....	2650	2710	2780	130	60	70
2 " - 4 "	1.5	21.5	23.4	55.1	1.5	.....	2540	2600	2680	140	60	80
1½" - 2 "	1.5	21.3	24.0	54.7	1.4	.....	2530	2620	2710	180	90	90
1 " - 1½"	1.5	21.0	23.8	55.2	1.6	.....	2550	2600	2630	80	50	30
3/4" - 1 "	1.5	21.1	23.8	55.1	1.4	.....	2540	2580	2620	80	40	40
1/2" - 3/4"	1.4	21.1	23.8	55.1	1.3	.....	2600	2640	2675	75	40	35
1/4" - 1/2"	1.3	19.6	23.5	56.9	1.4	.....	2480	2530	2620	140	50	90
1/8" - 1/4"	1.2	19.1	24.4	56.5	1.4	.....	2500	2550	2650	150	50	100
No. 48 - 1/8"	1.2	20.0	24.3	55.7	1.5	.....	2300	2380	2430	130	80	50
0 " - No. 48	1.4	19.0	24.6	56.4	1.5	.....	2300	2360	2400	100	60	40
Mine run ≠	1.6	20.9	23.9	55.2	1.5	11,800	2460	2520	2610	150	60	90
0 " - 4 " ≠	1.4	20.8	24.0	55.2	1.6	11,880	2480	2570	2620	140	90	50
1/8" - 4 "	1.2	21.0	23.4	55.6	1.7	11,845	2550	2600	2650	100	50	50
3/4" - 4 "	1.4	21.5	23.4	55.1	1.4	11,780	2600	2690	2750	150	90	60
0 " - 3/4"	1.4	20.5	24.0	55.5	1.6	11,780	2400	2450	2500	100	50	50
0 " - 1½"	1.6	20.7	24.1	55.2	1.6	11,815	2400	2490	2600	200	90	110
0 " - 1/8"	1.2	19.8	24.4	55.8	1.4	11,975	2240	2360	2450	210	100	110

≠ The determined ash percentages of these composited samples were found to be greater than those calculated from the individual screen sizes. The calculated ash and moisture percentages were employed in Table IV, and the other constituents of the composited samples re-calculated so as to conform to these, except that for the run-of-mine sample the sulphur--like the moisture and ash--was calculated from the individual screen sizes.

TABLE V. Ultimate Analyses (Dry Basis)

Screen sizes	Carbon	Hydrogen	Sulphur	Nitrogen	Oxygen	Ash
1/8" - 4 " %	67.8	4.3	1.7	1.8	3.4	21.0
0 " - 1/8" %	69.0	4.3	1.4	1.9	3.6	19.8

SECOND SEAM --- DRUMMOND NO. 2 MINE

TABLE VI. Sulphur Forms and Fusain

Screen sizes	Total sulphur	Sulphate sulphur		Pyritic sulphur		Organic sulphur		Fusain
	% of coal	% of coal	% of sulphur	% of coal	% of sulphur	% of coal	% of sulphur	% of pure coal
0 " - 4 "	1.55	0.02	1.0	0.71	46.1	0.82	52.9	4.76
1/8" - 4 "	1.66	0.02	1.1	0.89	53.7	0.75	45.2	4.28
3/4" - 4 "	1.41	0.02	1.3	0.71	50.4	0.68	48.3	3.75
0 " - 3/4"	1.55	0.03	1.7	0.86	55.7	0.66	42.6	6.42
0 " - 1½"	1.56	0.03	1.9	0.81	51.9	0.72	46.2	5.76
0 " - 1/8"	1.33	0.05	3.5	0.68	51.4	0.60	45.1	11.86

TABLE VII. Chemical Analyses of Ash ✓

Screen sizes	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	Na_2O	K_2O	TiO_2	P_2O_5	SO_3	Total
1/8" - 4 " %	52.1	29.2	6.9	2.5	1.2	1.5	1.9	0.6	0.4	3.6	99.9
0 " - 1/8" %	48.6	26.3	6.5	6.8	1.2	1.1	1.7	0.7	0.4	6.4	99.7

✓ Analysis made in chemical laboratory, Division of Metallic Minerals, under the direction of J.A. Fournier, Chief Chemist.

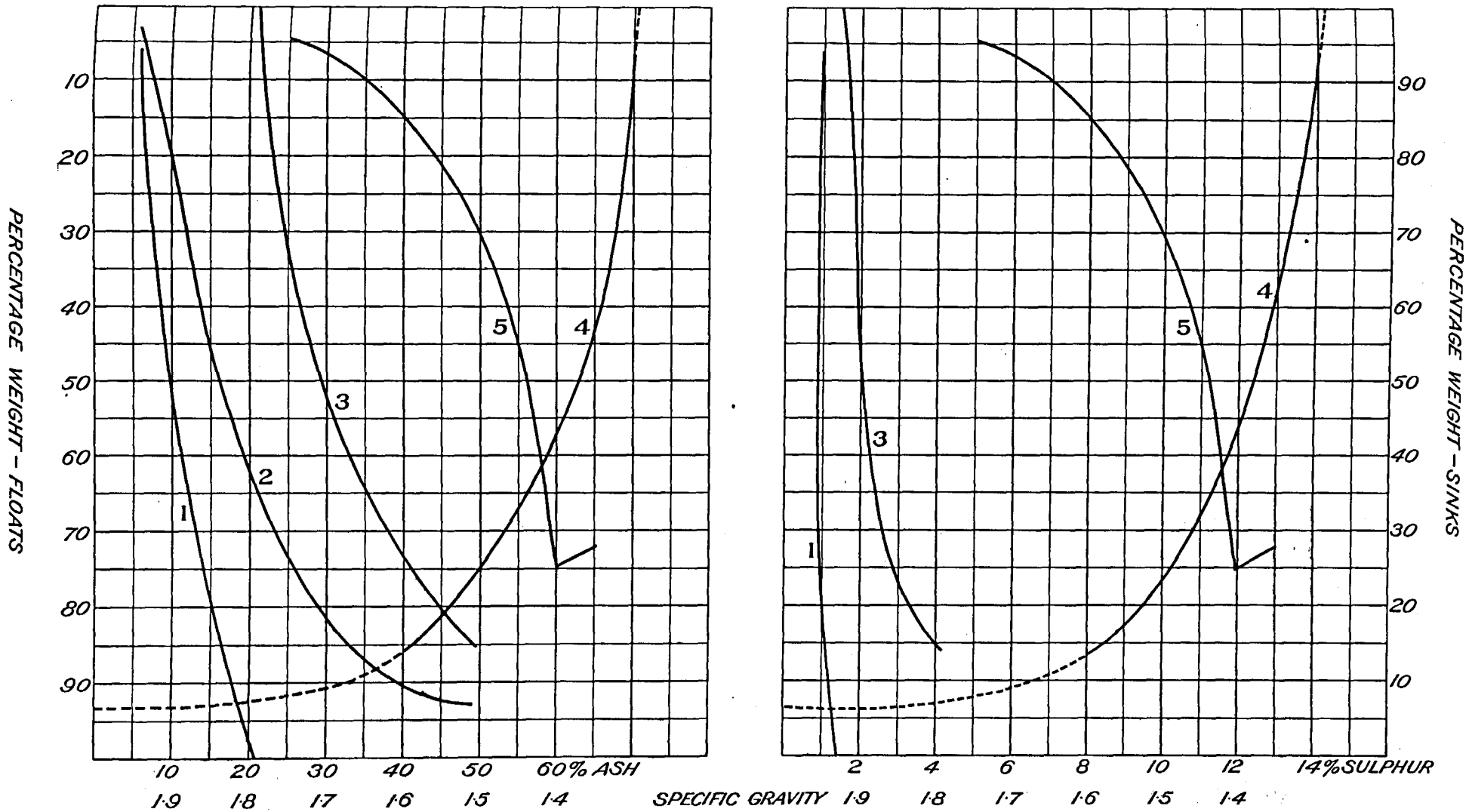

Fig. 6 - Washability Curves for Second (Scott) Seam--Drummond No. 2 Mine

Curve 1 - Cumulative coal-ash or sulphur percentage (float).
Curve 2 - Actual ash or sulphur percentage.
Curve 3 - Cumulative slate-ash or sulphur percentage (sink).
Curve 4 - Specific gravity.
Curve 5 - ±.10 specific gravity distribution

SECOND SEAM -- DRUMMOND NO. 2 MINE

TABLE VIII. Float And Sink Data On 1½" Slack - Ash and Sulphur

Specific gravity		Weight	Ash	Sulphur	Cumulative						±.10 Specific gravity distribution	
					Floats			Sinks				
Sinks	Floats	%	%	%	Weight %	Ash %	Sulphur %	Weight %	Ash %	Sulphur %	Gravity	Calculated ordinate
											1.35	72.2
	1.30	6.0	5.8	1.0	6.0	5.8	1.0	100.0	20.6	1.5	1.40	74.8
1.30	1.40	51.0	12.3	0.9	57.0	11.6	0.9	94.0	21.5	1.5	1.45	41.2
1.40	1.50	19.0	22.0	1.3	76.0	14.2	1.0	43.0	32.4	2.2	1.55	24.1
1.50	1.60	10.1	29.9	1.3	86.1	16.1	1.0	24.0	40.7	3.0	1.65	10.4
1.60		13.9	48.5	4.2	100.0	20.6	1.5	13.9	48.5	4.2	1.75	4.3
Curve No. 4			2	2	1,2,4	1	1	3	3	3	5	5

TABLE IX. Chemical Analysis And Fusibility Of Ash On Float And Sink Portions of 1½" Slack (Dry Basis)

Specific gravity		Ash	Volatile matter	Fixed carbon	Coking properties	Sulphur	Initial deformation	Softening point	Fluid temperature	Melting range	Softening interval	Flow interval
Sinks	Floats	%	%	%		%	°F.	°F.	°F.	°F.	°F.	°F.
	1.30	5.9	27.0	67.1	Good	1.0	2250	2300	2350	100	50	50
1.30	1.40	12.4	25.4	62.2	Good	0.9	2700	2850+	+	150+	150+	+
1.40	1.50	22.3	23.2	54.5	Poor to fair	1.3	2650	2850+	+	200+	200+	+
1.50	1.60	30.3	22.8	46.9	Poor	1.3	2600	2850+	+	250+	250+	+
1.60		49.1	20.1	30.8	Agglomerating	4.2	2200	2270	2300	100	70	30

SECOND SEAM -- DRUMMOND NO. 2 MINE

TABLE X. Chemical Analyses, Fusain and Sulphur Forms of Raw Coal, Clean Coal and Refuse

---	Raw coal	Clean coal Floats 1.60	Refuse Sinks 1.60
Weight.....%	100.0	85.9	14.1
Proximate analysis (dry basis)--			
Ash.....%	20.7	15.3	46.2
Volatile matter.....%	24.1	24.5	21.1
Fixed carbon.....%	55.2	60.2	32.7
Sulphur.....%	1.6	1.2	3.4
Calorific value.....B.t.u./lb.	11,815	12,850	....
Fusion point of ash.....°F.	2490	2710	2340
Melting range of ash.....°F.	200	190	210
Coking properties.....	Good	Good	Agglomerating
Fusain in pure coal.....%	5.76	3.08	18.91
Sulphur forms--as percentage of total sulphur:			
Sulphate sulphur.....%	1.9	0.8	1.5
Pyritic sulphur.....%	51.9	42.3	12.2
Organic sulphur.....%	46.2	56.9	86.3

TABLE XI. Screen and Chemical Analyses of Sizes Prepared From 1½" Slack, and Analyses of the Clean Coal and Refuse of These Sizes After Washing at a Selected Gravity of 1.60

Screen sizes	Weight	Cumulative weight	Ash	Sul-phur	F.P.A.	Floats				Sinks			
						Weight	Ash	Sul.	F.P.A.	Weight	Ash	Sul.	F.P.A.
	%	%	%	%	°F.	%	%	%	°F.	%	%	%	°F.
3/4" - 1½"	35.1	35.1	21.1	1.5	2590	87.6	18.4	1.2	2720	12.4	53.5	5.2	2160
1/8" - 3/4"	43.6	78.7	19.6	1.4	2560	85.3	15.5	1.2	2735	14.7	51.2	3.6	2300
0 " - 1/8"	21.3	100.0	19.8	1.4	2340	83.0	12.4	1.1	2670	17.0	54.2	2.9	2380

SECOND SEAM -- DRUMMOND NO. 2 MINE

TABLE XII. Physical Properties Of By-Product Cokes As Indicated By The 'Swelling Index' Test

	$1\frac{1}{2}$ inch slack	
	As received	After washing
Volatile matter at 600°C. (dry)...%	18.3	19.3
Swelling index.....	-27	104
Section--Coke classification chart.	Border XIII & X	Border X & XI
Specific volatile index.....	172.9	179.5
Section--Coal classification chart(	E Parabituminous	G Orthobituminous
Ash per cent in coal (dry basis)..%	20.7	15.3
Physical properties of coke:		
Size on wharf (% on 3 in.....	70.0	75.0
Size on wharf (Breeze: % -1/2 in.	3.0	3.0
Shatter test. (Index: % on 2 in..	70.0	70.0
Shatter test. (Breeze: % -1/2 in.	7.0	5.0
Abrasion test (Index: % on $1\frac{1}{2}$ in.	75.0	80.0
Abrasion test (Dust: % -1/16 in..	7.0	5.0
Density (App. specific gravity...	1.1	1.0
Density (Pounds per cubic foot...	28.0	30.0
Transverse shrinkage.....	Good	Fair to good
Appearance of natural surface...(	Dull grey, granular	Dull to steel grey
Shape.....	Blocky, irregular	
Strength.....	Friable	Tough to friable
Cross fracture.....(	Small amount, irregular	Small amount, slightly steppy
Longitudinal fracture.....	Small amount	
Cell structure.....	Very little	Irregular
Sponge.....(	Granular ends	Very little sponge, slightly granular
Pebbly seam.....	Very pebbly	Some pebbliness
Remarks.....	This coal will produce a poor coke from both a production & consumption viewpoint.	Washing material improves the by-product coke, but not sufficiently to be classed as a satisfactory domestic or metallurgical product.

Caking Properties

	Caking index by Gray's method
Run of mine sample.....	36

STELLARTON DISTRICT
FOORD (MAIN) SEAM
ALLAN SHAFT MINE, ACADIA COAL COMPANY LIMITED
STELLARTON, NOVA SCOTIA

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TABLE I. Screen Analyses, Bulk Density and Apparent Specific Gravity

Screen sizes *	Screen analyses: As received % By weight	As received % Cumulative	As mined % By weight	As mined % Cumulative	Bulk density --- lb. per cu. ft.	Apparent specific gravity	Void %	Ash %
Plus 4 "	29.7	29.7	32.8	32.8	.....	....	....	15.8
2 " - 4 "	18.7	48.4	13.7	46.5	43.00	1.39	50.5	17.2
1½" - 2 "	5.6	54.0	6.3	52.8	44.25	1.40	49.4	16.3
1 " - 1½"	9.7	63.7	9.6	62.4	44.25	1.39	49.1	16.5
3/4" - 1 "	5.9	69.6	6.2	68.6	44.00	1.37	48.6	16.5
1/2" - 3/4"	6.6	76.2	7.5	76.1	44.00	1.35	47.9	16.0
1/4" - 1/2"	7.8	84.0	8.6	84.7	44.00	1.33	47.0	15.2
1/8" - 1/4"	5.6	89.6	6.1	90.8	44.00	1.33	47.0	14.6
No. 48 - 1/8"	7.3	96.9	7.0	97.8)	48.00	1.27	39.6	(13.2
0 " - No. 48	3.1	100.0	2.2	100.0)				(13.6
Mine run		100.0		100.0	60.00	1.35	28.9	15.9ø
0 " - 4 "		70.3		67.2	55.75	1.34	33.4	15.9ø
1/8" - 4 "		59.9		58.0	52.00	1.37	39.2	16.3ø
3/4" - 4 "		39.9		35.8	49.50	1.39	43.0	16.8ø
0 " - 3/4"		30.4		31.4	52.00	1.32	37.0	15.3
0 " - 1½"		46.0		47.2	55.00	1.32	33.3	15.5
0 " - 1/8"		10.4		9.2	48.00	1.27	39.6	13.4

	As mined	As received
Average size of run-of-mine coal.....in.	2.93	2.85
Size stability during handling from mine to Ottawa.....%		98

* In this and subsequent tables, all screens 1/8" and larger are round-hole screens. No. 48 is Tyler 48-mesh with nominal aperture of 0.295 mm.

ø Ash percentages calculated from those of individual screen sizes.

FOORD SEAM -- ALLAN SHAFT MINE

TABLE II. Size Stability

Screen sizes	Screen analyses before and after drop-shatter test									
	Single sizes				Mixed sizes					
	2 - 3 inch		3 - 4 inch		3/4 - 4 inch			0 - 4 inch		
	Before test %	After 2 drops %	Before test %	After 2 drops %	Before test %	After 2 drops %	After 4 drops %	Before test %	After 2 drops %	After 4 drops %
3 " - 4 "			100.0	58.5	20.3	17.9	13.3	11.5	9.2	5.8
2 " - 3 "	100.0	70.0		14.4	26.6	22.1	22.5	15.1	14.2	15.8
1½" - 2 "		10.5		8.0	14.0	13.3	11.7	8.0	7.5	6.2
1 " - 1½"		8.0		7.5	24.3	19.6	19.2	13.8	10.8	10.8
3/4" - 1 "		3.5		3.5	14.8	15.8	13.8	8.4	9.2	9.2
1/2" - 3/4"		2.5		2.5		4.6	7.5	9.4	9.2	10.0
0 " - 1/2"		5.5		5.6		6.7	12.0	33.8	39.9	42.2
Average size..in.	2.50	2.10	3.50	2.70	2.06	1.84	1.67	1.30	1.17	1.07
Size stability..%		84		77		90	81		90	83

TABLE III. Grindability

Screen size of coal tested	Hardgrove index	
	Old	New
0" - 4 "	72	76
0" - 3/4"	74	78
0" - 1/8"	87	91

FOORD SEAM -- ALLAN SHAFT MINE

TABLE IV. Proximate Analyses, Calorific Value and Fusibility of Ash

Screen sizes	Moisture (as recd) %	Dry basis: Ash %	Volatile matter %	Fixed carbon %	Sulphur %	Calorific value Btu/lb.	Initial deformation °F.	Softening temperature °F.	Fluid temperature °F.	Melting range °F.	Softening interval. °F.	Flow interval. °F.
Plus 4 "	1.7	15.8	29.1	55.1	0.7	.....	2450	2505	2580	130	55	75
2 " - 4 "	1.5	17.2	28.5	54.3	0.8	.....	2640	2700	2775	135	60	75
1½" - 2 "	1.4	16.3	26.9	56.8	0.8	.....	2770	2850	2850+	80+	80	+
1 " - 1½"	1.5	16.5	27.6	55.9	0.6	.....	2680	2810	2850+	170+	130	40+
3/4" - 1 "	1.5	16.5	27.6	55.9	0.8	.....	2600	2720	2800	200	120	80
1/2" - 3/4"	1.4	16.0	27.7	56.3	0.8	.....	2610	2780	2820	210	170	40
1/4" - 1/2"	1.3	15.2	27.9	56.9	0.8	.....	2610	2800	2840	230	190	40
1/8" - 1/4"	1.3	14.6	28.0	57.4	0.7	.....	2600	2710	2800	200	110	90
No. 48 - 1/8"	1.3	13.2	28.2	58.6	0.7	.....	2450	2560	2680	230	110	120
0 " - No. 48	1.1	13.6	26.3	60.1	0.8	.....	2200	2360	2400	200	160	40
Mine run ≠	1.5	15.9	27.9	56.2	0.7	12,950	2700	2780	2835	135	80	55
0 " - 4 " ≠	1.4	15.9	27.8	56.3	0.7	12,950	2520	2630	2740	220	110	110
1/8" - 4 " ≠	1.4	16.3	28.0	55.7	0.9	12,850	2570	2800	2850	280	230	50
3/4" - 4 " ≠	1.5	16.8	27.6	55.6	0.8	12,710	2740	2840	2850+	110+	100	10+
0 " - 3/4"	1.5	15.3	27.8	56.9	0.8	12,930	2520	2620	2720	200	100	100
0 " - 1½"	1.6	15.5	28.0	56.5	0.7	12,920	2520	2610	2700	180	90	90
0 " - 1/8"	1.6	13.4	27.7	58.9	0.8	13,320	2270	2470	2560	290	200	90

≠ The determined ash percentages of these composited samples were found to be greater than those calculated from the individual screen sizes. The calculated ash and moisture percentages were employed in Table IV (and the ash in Table V), and the other constituents of the composited samples re-calculated so as to conform to these.

TABLE V. Ultimate Analyses (Dry Basis)

Screen sizes	Carbon	Hydrogen	Sulphur	Nitrogen	Oxygen	Ash
1/8" - 4 " %	72.3	4.8	0.9	2.0	3.7	16.3
0 " - 1/8" %	75.2	4.8	0.8	2.0	3.8	13.4

FOORD SEAM -- ALLAN SHAFT MINE

TABLE VI. Sulphur Forms and Fusain

Screen sizes	Total sulphur	Sulphate sulphur		Pyritic sulphur		Organic sulphur		Fusain
	% of coal	% of coal	% of sulphur	% of coal	% of sulphur	% of coal	% of sulphur	% of pure coal
Mine run	0.71	0.00	0.0	0.17	23.9	0.54	76.1	....
0 " - 4 "	....	....	...	....	....	....	....	3.26
1/8" - 4 "	....	....	...	....	....	....	....	3.42
3/4" - 4 "	....	....	...	....	....	....	....	3.36
0 " - 3/4"	....	....	...	....	....	....	....	3.94
0 " - 1½"	....	....	...	....	....	....	....	3.68
0 " - 1/8"	....	....	...	....	....	....	....	4.82

TABLE VII. Chemical Analyses of Ash ✓

Screen sizes	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	Na_2O	K_2O	TiO_2	P_2O_5	SO_3	Total
1/8" - 4 " %	54.9	29.0	6.4	1.6	1.4	1.2	2.5	0.7	0.3	1.6	99.6
0 " - 1/8" %	51.8	26.3	5.9	4.6	1.6	1.6	2.1	0.6	0.6	3.9	99.0

✓ Analysis made in chemical laboratory, Division of Metallic Minerals, under the direction of J.A. Fournier, Chief Chemist.

FOORD SEAM -- ALLAN SHAFT MINE

TABLE VIII. Float And Sink Data On 1½" Slack - Ash and Sulphur

Specific gravity		Weight	Ash	Sulphur	Cumulative						±.10 specific gravity distribution	
					Floats			Sinks				
Sinks	Floats	%	%	%	Weight %	Ash %	Sulphur %	Weight %	Ash %	Sulphur %	Gravity	Calculated ordinate
											1.35	90.6
	1.30	7.1	4.6	0.8	7.1	4.6	0.8	100.0	15.4	0.8	1.40	87.4
1.30	1.40	72.3	12.1	0.6	79.4	11.4	0.6	92.9	16.2	0.8	1.45	33.6
1.40	1.50	12.3	22.7	0.8	91.7	12.9	0.6	20.6	30.7	1.2	1.55	7.1
1.50	1.60	2.1	29.2	0.8	93.8	13.3	0.7	8.3	42.6	1.8	1.65	2.1
1.60		6.2	47.2	2.2	100.0	15.4	0.8	6.2	47.2	2.2	1.75	1.4
Curve No. 4			2	2	1,2,4	1	1	3	3	3	5	5

TABLE IX. Chemical Analysis and Fusibility of Ash On Float And Sink Portions of 1½" Slack (Dry Basis)

Specific gravity		Ash	Volatile matter	Fixed carbon	Coking properties	Sulphur	Initial deformation	Softening point	Fluid temperature	Melting range	Softening interval	Flow interval
Sinks	Floats	%	%	%		%	°F.	°F.	°F.	°F.	°F.	°F.
	1.30	4.6	30.3	65.1	Good	0.8	2550	2700	2780	230	150	80
1.30	1.40	12.3	28.9	58.8	Good	0.6	2850+	+	+	+	+	+
1.40	1.50	23.0	25.8	51.2	Fair	0.8	2830	2850+	+	20+	+	+
1.50	1.60	29.5	24.8	45.7	Poor	0.9	2500	2630	2740	240	130	110
1.60		47.7	21.6	30.7	Slightly agglomerating	2.2	2050	2230	2300	250	180	70

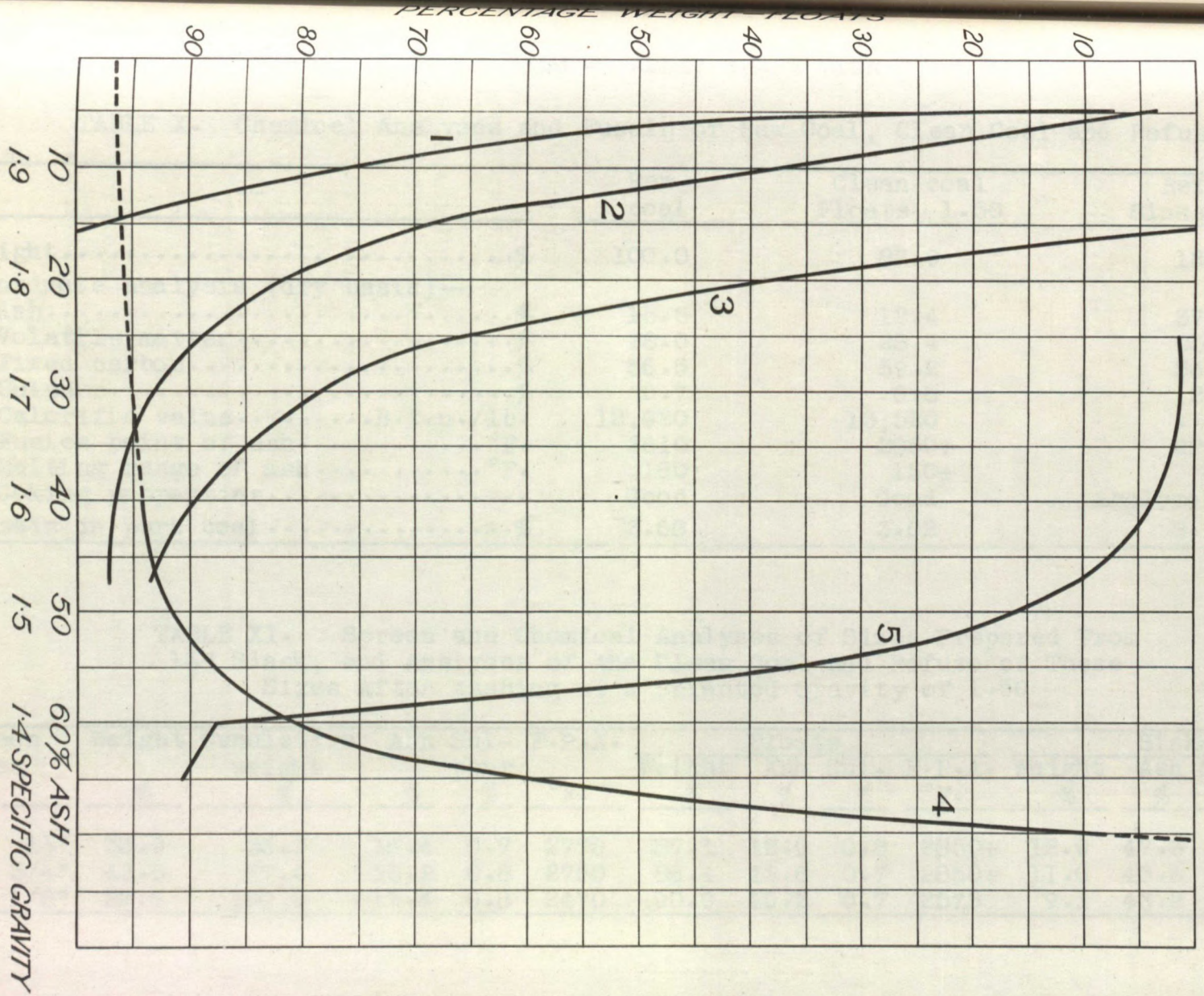

Fig. 7 - Washability Curves for Foord Seam--Allan Shaft Mine

Curve 1 - Cumulative coal-ash percentage (float).
Curve 2 - Actual ash percentage.
Curve 3 - Cumulative slate-ash percentage (sink).
Curve 4 - Specific gravity.
Curve 5 - ±.10 specific gravity distribution.

FOORD SEAM -- ALLAN SHAFT MINE

TABLE X. Chemical Analyses and Fusain of Raw Coal, Clean Coal and Refuse

---	Raw coal	Clean coal Floats 1.50	Refuse Sinks 1.50
Weight.....%	100.0	87.9	12.1
Proximate analysis (dry basis)--			
Ash.....%	15.5	12.4	37.9
Volatile matter.....%	28.0	28.4	25.9
Fixed carbon.....%	56.5	59.2	36.2
Sulphur.....%	0.7	0.8	2.2
Calorific value.....B.t.u./lb.	12,920	13,520	....
Fusion point of ash.....°F.	2610	2850+	2200
Melting range of ash.....°F.	180	150+	85
Coking properties.....	Good	Good	Agglomerating
Fusain in pure coal.....%	3.68	3.02	8.38

TABLE XI. Screen and Chemical Analyses of Sizes Prepared From 1½" Slack, and Analyses of the Clean Coal and Refuse of These Sizes After Washing at a Selected Gravity of 1.50

Screen sizes	Weight	Cumulative weight	Ash	Sul-phur	F.P.A.	Floats				Sinks			
						Weight	Ash	Sul.	F.P.A.	Weight	Ash	Sul.	F.P.A.
	%	%	%	%	°F.	%	%	%	°F.	%	%	%	°F.
3/4" - 1½"	33.9	33.9	16.4	0.7	2770	87.1	12.9	0.8	2850+	12.9	47.3	2.0	2140
1/8" - 3/4"	43.5	77.4	15.2	0.8	2750	88.4	12.6	0.7	2850+	11.6	43.6	1.4	2300
0 " - 1/8"	22.6	100.0	13.4	0.8	2470	90.9	10.2	0.7	2575	9.1	43.2	1.1	2300

FOORD SEAM -- ALLAN SHAFT MINE

TABLE XII. Physical Properties of By-product Cokes as Indicated By The 'Swelling Index' Test

	1½ inch slack	
	As received	After washing
Volatile matter at 600°C. (dry)...%	22.3	23.1
Swelling index.....	269	238
Section--Coke classification chart.	IX near XI	IX near XI
Specific volatile index.....	178.1	181.4
Section--Coal classification chart(	F orthobituminous	F orthobituminous
Ash per cent in coal (dry basis)..%	15.5	12.4
Physical properties of coke:		
Size on wharf (% on 3 in.....	55.0	55.0
(Breeze: % -1/2 in.	4.0	4.0
Shatter test. (Index: % on 2 in..	60.0	60.0
(Breeze: % -1/2 in.	5.0	5.0
Abrasion test (Index: % on 1½ in.	90.0	90.0
(Dust: % -1/16 in..	2.5	2.5
Density (App. specific gravity...	1.1	1.0
(Pounds per cubic foot...	30.0	29.0
Transverse shrinkage.....	Good to fair	Good
Appearance of natural surface....	Steel grey, irregular	
Shape.....	Blocky, square	Blocky, slightly triangular
Strength.....	Tough to hard	
Cross fracture.....	Small amount, slightly steppy	
Longitudinal fracture.....	Small amount	
Cell structure.....	Irregular	Small to medium
Sponge.....	Small amount	
Pebbly seam.....	None	
Remarks.....	Physically this coal should produce only a fair by-product coke	Very little improvement, physically due to washing

Caking Properties

	Caking index by Gray's method
Run-of-mine sample.....	46

STELLARTON DISTRICT
CAGE (DEEP) SEAM
ALLAN SHAFT, ALBION AND ACADIA NO. 7 MINES, ACADIA COAL COMPANY LIMITED
STELLARTON, NOVA SCOTIA

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TABLE I. Screen Analyses, Bulk Density and Apparent Specific Gravity

Screen sizes *	Screen analyses: As received % By weight	As received % Cumulative	As mined % By weight	As mined % Cumulative	Bulk density --- lb. per cu. ft.	Apparent specific gravity	Void %	Ash %
Plus 4 "	26.4	26.4	29.0	29.0	.....	....	....	14.2
2 " - 4 "	16.6	43.0	14.3	43.3	42.75	1.35	49.4	14.5
1½" - 2 "	6.8	49.8	6.5	49.8	42.75	1.38	50.4	13.9
1 " - 1½"	12.4	62.2	10.1	59.9	42.75	1.37	50.0	13.5
3/4" - 1 "	7.8	70.0	6.6	66.5	42.50	1.36	50.0	12.8
1/2" - 3/4"	9.0	79.0	8.9	75.4	42.75	1.33	48.6	12.3
1/4" - 1/2"	9.1	88.1	9.8	85.2	42.50	1.32	48.5	12.1
1/8" - 1/4"	4.9	93.0	7.6	92.8	42.50	1.31	48.1	12.4
No. 48 - 1/8"	5.1	98.1	5.4	98.2)	48.00	1.29	40.4	(13.0
0 " - No. 48	1.9	100.0	1.8	100.0)				(16.9
Mine run		100.0		100.0	54.75	1.35	35.1	13.1
0 " - 4 "		73.6		71.0	53.75	1.34	35.8	14.1
1/8" - 4 "		66.6		63.8	51.50	1.37	39.8	14.4
3/4" - 4 "		43.6		37.5	46.75	1.37	45.3	14.5
0 " - 3/4"		30.0		33.5	49.75	1.32	39.7	13.6
0 " - 1½"		50.2		50.2	51.50	1.33	37.6	13.5
0 " - 1/8"		7.0		7.2	48.00	1.29	40.4	13.7

	As mined	As received
Average size of run-of-mine coal.....in.	2.90	2.82
Size stability during handling from mine to Ottawa.....%		97

* In this and subsequent tables, all screens 1/8" and larger are round-hole screens. No. 48 is Tyler 48-mesh with nominal aperture of 0.295 mm.

CAGE SEAM -- ALLAN SHAFT, ALBION AND ACADIA NO. 7 MINES

TABLE II. Size Stability

Screen sizes	Screen analyses before and after drop-shatter test									
	Single sizes				Mixed sizes					
	2 - 3 inch		3 - 4 inch		3/4 - 4 inch			0 - 4 inch		
	Before test %	After 2 drops %	Before test %	After 2 drops %	Before test %	After 2 drops %	After 4 drops %	Before test %	After 2 drops %	After 4 drops %
3 " - 4 "			100.0	60.0	14.0	12.9	8.7	8.3	5.8	2.9
2 " - 3 "	100.0	68.5		15.0	24.1	21.7	22.1	14.3	15.4	16.7
1½" - 2 "		14.0		6.5	15.6	12.5	12.5	9.2	8.8	9.2
1 " - 1½"		8.0		5.0	28.4	24.1	22.1	16.8	12.5	12.1
3/4" - 1 "		3.0		3.0	17.9	16.7	16.2	10.6	9.6	9.2
1/2" - 3/4"		2.5		4.0		6.7	8.4	12.2	12.1	12.0
0 " - 1/2"		4.0		6.5		5.4	10.0	28.6	35.8	37.9
Average size..in.	2.50	2.11	3.50	2.72	1.88	1.72	1.57	1.26	1.12	1.08
Size stability..%		84		78		91	84		91	86

TABLE III. Grindability

Screen size of coal tested	Hardgrove index	
	Old	New
0" - 4 "	56	58
0" - 3/4"	58	61
0" - 1/8"	59	62

CAGE SEAM -- ALLAN SHAFT, ALBION AND ACADIA NO. 7 MINES

TABLE IV. Proximate Analyses, Calorific Value and Fusibility of Ash

Screen sizes	Moisture (as recd) %	Dry basis: Ash %	Dry basis: Volatile matter %	Dry basis: Fixed carbon %	Dry basis: Sulphur %	Dry basis: Calorific value Btu/lb.	Initial deformation °F.	Softening temperature °F.	Fluid temperature °F.	Melting range °F.	Softening interval °F.	Flow interval °F.
Plus 4 "	2.6	14.2	29.2	56.6	1.4	.....	2400	2535	2640	240	135	105
2 " - 4 "	2.6	14.5	29.9	55.6	1.5	.....	2150	2490	2600	450	340	110
1½" - 2 "	2.4	13.9	30.3	55.8	1.3	.....	2180	2400	2500	320	220	100
1 " - 1½"	2.4	13.5	30.1	56.4	1.6	.....	2200	2380	2500	300	180	120
3/4" - 1 "	2.3	12.8	30.1	57.1	1.4	.....	2340	2550	2610	270	210	60
1/2" - 3/4"	2.3	12.3	29.7	58.0	1.3	.....	2300	2540	2600	300	240	60
1/4" - 1/2"	2.3	12.1	30.0	57.9	1.4	.....	2400	2520	2620	220	120	100
1/8" - 1/4"	2.2	12.4	29.8	57.8	1.4	.....	2150	2430	2530	380	280	100
No. 48 - 1/8"	2.2	13.0	29.8	57.2	1.4	.....	2100	2230	2400	300	130	170
0 " - No. 48	2.1	16.9	26.8	56.3	1.8	.....	2040	2150	2250	210	110	100
Mine run	2.4	13.1	29.9	57.0	1.5	12,810	2210	2450	2570	360	240	120
0 " - 4 "	2.2	14.1	30.0	55.9	1.5	12,705	2210	2460	2590	380	250	130
1/8" - 4 "	2.3	14.4	29.7	55.9	1.7	12,710	2200	2450	2530	330	250	80
3/4" - 4 "	2.2	14.5	29.7	55.8	1.5	12,605	2260	2470	2600	340	210	130
0 " - 3/4"	2.4	13.6	30.2	56.2	1.5	12,810	2200	2350	2450	250	150	100
0 " - 1½"	2.3	13.5	29.6	56.9	1.7	12,700	2150	2300	2400	250	150	100
0 " - 1/8"	2.1	13.7	29.6	56.7	1.5	12,640	2150	2220	2300	150	70	80

TABLE V. Ultimate Analyses (dry basis)

Screen sizes	Carbon	Hydrogen	Sulphur	Nitrogen	Oxygen	Ash
1/8" - 4 " %	72.5	4.4	1.7	1.9	5.1	14.4
0 " - 1/8" %	73.0	4.6	1.5	1.9	5.3	13.7

TABLE VI. Sulphur Forms and Fusain

Screen sizes	Total sulphur	Sulphate sulphur		Pyritic sulphur		Organic sulphur		Fusain
	% of coal	% of coal	% of sulphur	% of coal	% of sulphur	% of coal	% of sulphur	% of pure coal
Mine run	1.49	0.05	3.6	0.66	44.1	0.78	52.3	....
0 " - 4 "	....	....	...	....	....	....	....	5.77
1/8" - 4 "	....	....	...	....	....	....	....	5.62
3/4" - 4 "	....	....	...	....	....	....	....	5.54
0 " - 3/4"	....	....	...	....	....	....	....	6.84
0 " - 1½"	....	....	...	....	....	....	....	6.56
0 " - 1/8"	....	....	...	....	....	....	....	11.27

TABLE VII. Chemical Analyses of Ash ✓

Screen sizes	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	Na_2O	K_2O	TiO_2	P_2O_5	SO_3	Total
1/8" - 4 " %	53.1	24.1	13.3	2.0	1.2	1.1	1.6	0.8	0.4	2.2	99.8
0 " - 1/8" %	46.9	21.6	12.5	6.1	2.3	0.1	2.2	0.6	0.5	7.5	100.3

✓ Analysis made in chemical laboratory, Division of Metallic Minerals, under the direction of J.A. Fournier, Chief Chemist.

CAGE SEAM -- ALLAN SHAFT, ALBION AND ACADIA NO. 7 MINES

TABLE VIII. Float And Sink Data On 1½" Slack - Ash and Sulphur

Specific gravity		Weight	Ash	Sulphur	Cumulative						±.10 specific gravity distribution	
					Floats			Sinks				
Sinks	Floats	%	%	%	Weight %	Ash %	Sulphur %	Weight %	Ash %	Sulphur %	Gravity	Calculated ordinate
											1.35	90.2
	1.30	5.7	5.3	1.2	5.7	5.3	1.2	100.0	12.9	1.3	1.40	88.8
1.30	1.40	73.5	10.0	1.1	79.2	9.7	1.1	94.3	13.3	1.3	1.45	32.9
1.40	1.50	12.7	19.5	1.4	91.9	11.0	1.1	20.8	25.0	2.0	1.55	8.4
1.50	1.60	2.8	23.6	1.5	94.7	11.4	1.2	8.1	33.6	2.9	1.65	2.9
1.60		5.3	38.9	3.7	100.0	12.9	1.3	5.3	38.9	3.7	1.75	1.2
Curve No. 4			2	2	1,2,4	1	1	3	3	3	5	5

TABLE IX. Chemical Analysis And Fusibility Of Ash On Float And Sink Portions Of 1½" Slack (Dry Basis)

Specific gravity		Ash	Volatile matter	Fixed carbon	Coking properties	Sulphur	Initial deformation	Softening point	Fluid temperature	Melting range	Softening interval	Flow interval
Sinks	Floats	%	%	%		%	°F.	°F.	°F.	°F.	°F.	°F.
	1130	5.4	30.9	63.7	Good	1.2	2350	2420	2650	300	70	230
1.30	1.40	10.2	30.3	59.5	Fair	1.1	2500	2630	2710	210	130	80
1.40	1.50	19.8	28.2	52.0	Poor	1.4	2550	2660	2740	190	110	80
1.50	1.60	24.1	26.3	49.6	Agglomerating	1.5	2400	2500	2620	220	100	120
1.60		39.9	23.8	36.3	Non-agglomerating	3.8	2030	2110	2170	140	80	60

CAGE SEAM -- ALLAN SHAFT, ALBION AND ACADIA NO. 7 MINES

TABLE X. Chemical Analyses And Fusain of Raw Coal, Clean Coal and Refuse

---	Raw coal	Clean coal Floats 1.60	Refuse Sinks 1.60
Weight.....%	100.0	93.9	6.1
Proximate analysis (dry basis)--			
Ash.....%	13.5	11.5	38.3
Volatile matter.....%	29.6	30.2	25.6
Fixed carbon.....%	56.9	58.3	36.1
Sulphur.....%	1.7	1.2	5.4
Calorific value.....B.t.u./lb.	12,700	13,185	....
Fusion point of ash.....°F	2300	2680	2000
Melting range of ash.....°F	250	320	190
Coking properties.....	Poor	Fair	Slightly agglomerating
Fusain in pure coal.....%	6.56	5.78	18.67

TABLE XI. Screen and Chemical Analyses of Sizes Prepared From 1½" Slack, and Analyses of the Clean Coal and Refuse of These Sizes After Washing at a Selected Gravity of 1.60

Screen sizes	Weight %	Cumulative weight %	Ash %	Sulphur %	F.P.A. °F.	Floats Weight %	Floats Ash %	Floats Sul. %	Floats F.P.A. °F.	Sinks Weight %	Sinks Ash %	Sinks Sul. %	Sinks F.P.A. °F.
3/4" - 1½"	40.2	40.2	13.2	1.5	2450	95.3	13.1	1.4	2700	4.7	45.6	4.0	2290
1/8" - 3/4"	45.8	86.0	12.3	1.4	2500	96.8	11.6	1.2	2750	3.2	49.3	9.5	2060
0 " - 1/8"	14.0	100.0	13.7	1.5	2220	79.8	10.0	1.1	2630	20.2	30.4	3.1	1930

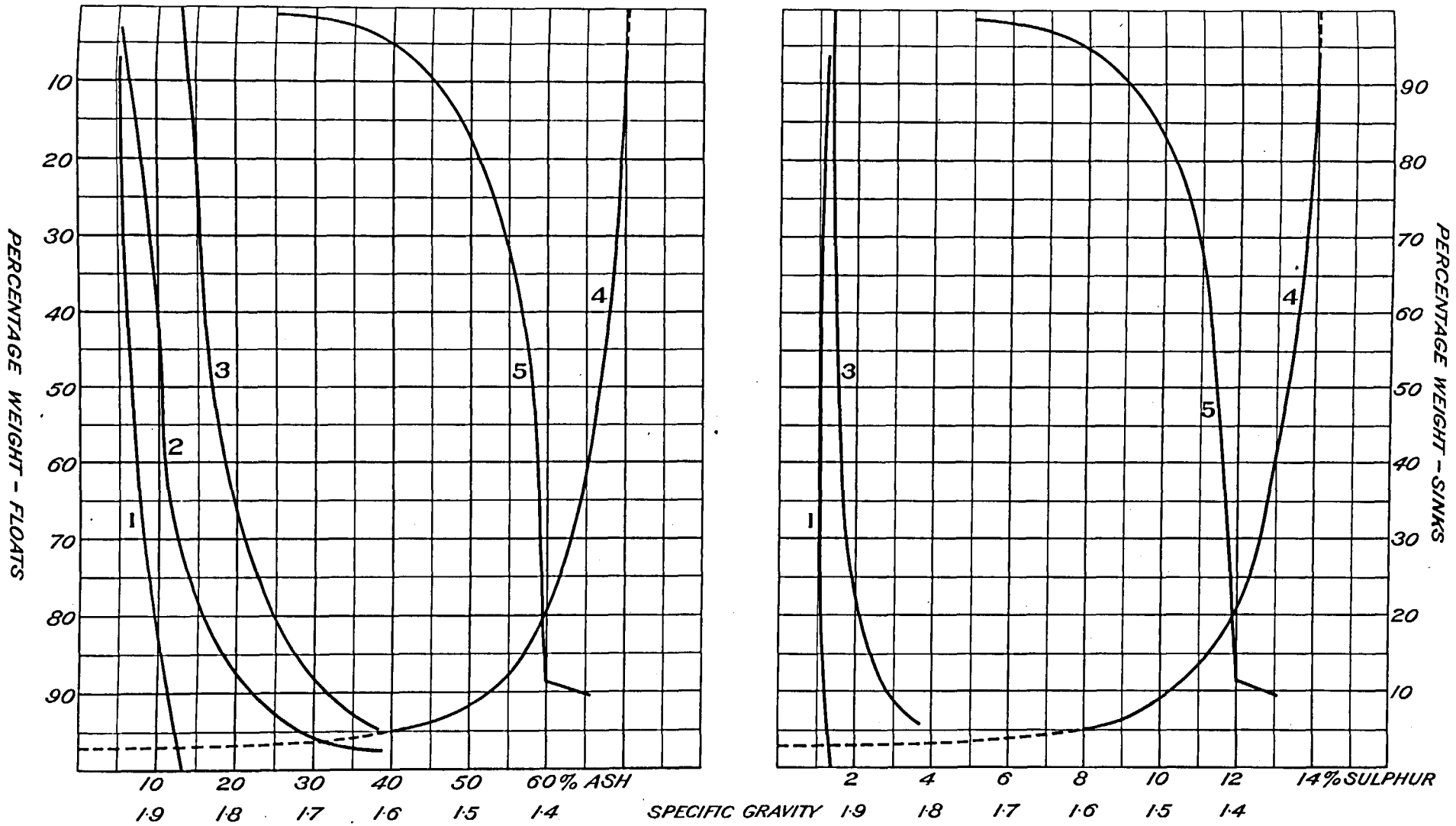

Fig. 8 - Washability Curves for Cage Seam--Allan Shaft, Albion and Acadia No. 7 Mines.

Curve 1 - Cumulative coal-ash or sulphur percentage (float).
Curve 2 - Actual ash or sulphur percentage.
Curve 3 - Cumulative slate-ash or sulphur percentage (sink).
Curve 4 - Specific gravity.
Curve 5 - ±.10 specific gravity distribution.

CAGE SEAM -- ALLAN SHAFT, ALBION AND ACADIA NO. 7 MINES

TABLE XII. Physical Properties Of By-Product Cokes As Indicated By The 'Swelling Index' Test

	1½ inch slack	
	As received	After washing
Volatile matter at 600°C. (dry)...%	23.3	23.3
Swelling index.....	-215	-258
Section--Coke classification chart.	XIII	XIII
Specific volatile index.....	158.2	163.2
Section--Coal classification chart	C Subbituminous	D Parabituminous
Ash, per cent in coal (dry basis).%	13.5	11.5
Physical properties of coke--		
Size on wharf (% on 3 in.....	....	....
(Breeze: % -1/2 in.	....	....
Shatter test. (Index: % on 2 in..	....	....
(Breeze: % -1/2 in.	....	....
Abrasion test (Index: % on 1½ in.	....	....
(Dust: % -1/16 in..	....	....
Density (App. specific gravity...	....	....
(Pounds per cubic foot...	....	....
Transverse shrinkage.....	Good	
Appearance of natural surface....	....	
Shape.....	....	
Strength.....	....	
Cross fracture.....	....	
Longitudinal fracture.....	....	
Cell structure.....	....	
Sponge.....	....	
Pebbly seam.....	All pebbly	
Remarks.....	Practically non-coking	No improvement due to washing

Caking Properties

	Caking index by Gray's method
Run-of-mine sample.....	25

STELLARTON DISTRICT
THIRD SEAM
ALBION AND ACADIA NO. 7 MINES, ACADIA COAL COMPANY LIMITED
STELLARTON, NOVA SCOTIA

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TABLE I. Screen Analyses, Bulk Density and Apparent Specific Gravity

Screen sizes *	Screen analyses: As received, % By weight	As received, % Cumulative	As mined, % By weight	As mined, % Cumulative	Bulk density --- lb. per cu. ft.	Apparent specific gravity	Void %	Ash %
Plus 4 "	18.7	18.7	26.0	26.0	.....	....	....	11.5
2 " - 4 "	9.4	28.1	10.4	36.4	41.00	1.35	51.4	12.6
1½" - 2 "	4.1	32.2	4.8	41.2	41.75	1.35	50.5	13.6
1 " - 1½"	11.6	43.8	8.6	49.8	41.75	1.35	50.5	15.9
3/4" - 1 "	7.8	51.6	7.2	57.0	41.75	1.34	50.2	13.3
1/2" - 3/4"	11.0	62.6	11.0	68.0	41.75	1.31	49.0	12.6
1/4" - 1/2"	14.7	77.3	12.6	80.6	42.00	1.29	47.9	11.9
1/8" - 1/4"	9.2	86.5	7.9	88.5	41.50	1.29	48.5	12.1
No. 48 - 1/8"	9.8	96.3	8.6	97.1)	48.00	1.28	40.0	(12.4
0 " - No. 48	3.7	100.0	2.9	100.0)				(12.5
Mine run		100.0		100.0	55.00	1.34	34.4	15.0
0 " - 4 "		81.3		74.0	54.00	1.34	35.6	12.6
1/8" - 4 "		67.8		62.5	49.75	1.35	41.0	12.4
3/4" - 4 "		32.9		31.0	45.00	1.35	46.7	13.9
0 " - 3/4"		48.4		43.0	51.00	1.30	37.2	12.4
0 " - 1½"		67.8		58.8	53.00	1.32	35.8	12.7
0 " - 1/8"		13.5		11.5	48.00	1.28	40.0	12.2

	As mined	As received
Average size of run-of-mine coal.....in.	2.53	2.03
Size stability during handling from mine to Ottawa.....%		80

* In this and subsequent tables, all screens 1/8" and larger are round-hole screens. No. 48 is Tyler 48-mesh with nominal aperture of 0.295 mm.

TABLE II. Size Stability

Screen sizes	Screen analyses before and after drop-shatter test									
	Single sizes				Mixed sizes					
	2 - 3 inch		3 - 4 inch		3/4 - 4 inch			0 - 4 inch		
	Before test %	After 2 drops %	Before test %	After 2 drops %	Before test %	After 2 drops %	After 4 drops %	Before test %	After 2 drops %	After 4 drops %
3 " - 4 "			100.0	42.0	11.9	7.9	5.4	4.8	3.8	2.9
2 " - 3 "	100.0	55.0		20.0	16.7	15.0	13.3	6.8	6.7	6.2
1½" - 2 "		9.5		9.0	12.5	9.2	6.7	5.0	5.8	4.2
1 " - 1½"		11.5		9.0	35.3	27.5	24.2	14.3	12.9	13.3
3/4" - 1 "		6.5		5.0	23.6	20.0	20.0	9.6	8.7	8.7
1/2" - 3/4"		6.5		5.5		10.0	13.3	13.5	12.5	12.9
0 " - 1/2"		11.0		9.5		10.4	17.1	46.0	49.6	51.8
Average size..in.	2.50	1.81	3.50	2.34	1.70	1.42	1.24	0.88	0.83	0.77
Size stability..%		72		67		84	73		95	88

TABLE III. Grindability

Screen size of coal tested	Hardgrove index	
	Old	New
0" - 4 "	64	66
0" - 3/4"	65	68
0" - 1/8"	72	75

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TABLE IV. Proximate Analyses, Calorific Value and Fusibility of Ash

Screen sizes	Moisture (as recd) %	Dry basis: Ash %	Dry basis: Volatile matter %	Dry basis: Fixed carbon %	Dry basis: Sulphur %	Dry basis: Calorific value Btu/lb.	Initial deformation °F.	Softening temperature °F.	Fluid temperature °F.	Melting range °F.	Softening interval °F.	Flow interval °F.
Plus 4 "	1.8	11.5	28.3	60.2	1.1	.....	2520	2680	2815	295	160	135
2 " - 4 "	1.5	12.6	28.8	58.6	1.1	.....	2150	2450	2590	440	300	140
1½" - 2 "	1.6	13.6	28.8	57.6	1.4	.....	2250	2430	2570	320	180	140
1 " - 1½"	1.6	15.9	28.6	55.5	2.1	.....	2000	2150	2400	400	150	250
3/4" - 1 "	1.5	13.3	28.8	57.9	1.2	.....	2150	2430	2500	350	280	70
1/2" - 3/4"	1.7	12.6	28.6	58.8	1.5	.....	2270	2470	2610	340	200	140
1/4" - 1/2"	1.7	11.9	28.5	59.6	1.5	.....	2250	2500	2590	340	250	90
1/8" - 1/4"	1.6	12.1	28.7	59.2	1.3	.....	2250	2640	2700	450	390	60
No. 48 - 1/8"	1.4	12.4	28.5	59.1	1.5	.....	2240	2355	2500	260	115	145
0 " - No. 48	1.4	12.5	27.1	60.4	1.3	.....	2150	2250	2370	220	100	120
Mine run	1.9	13.0	28.3	58.7	1.4	13,120	2360	2530	2630	270	170	100
0 " - 4 "	1.8	12.6	28.6	58.8	1.3	13,200	2420	2510	2600	180	90	90
1/8" - 4 "	1.8	12.4	28.7	58.9	1.4	13,205	2260	2530	2620	360	270	90
3/4" - 4 "	1.6	13.9	28.3	57.8	1.8	12,965	2090	2275	2400	310	185	125
0 " - 3/4"	1.6	12.4	29.0	58.6	1.5	13,190	2210	2380	2500	290	170	120
0 " - 1½"	1.9	12.7	28.4	58.9	1.4	13,095	2150	2280	2450	300	130	170
0 " - 1/8"	1.6	12.2	27.8	60.0	1.4	13,180	2240	2310	2470	230	70	160

TABLE V. Ultimate Analyses (Dry Basis)

Screen sizes	Carbon	Hydrogen	Sulphur	Nitrogen	Oxygen	Ash
1/8" - 4 " %	74.9	4.8	1.4	1.8	4.7	12.4
0 " - 1/8" %	75.0	4.6	1.4	1.8	5.0	12.2

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TABLE VI. Sulphur Forms and Fusain

Screen sizes	Total sulphur	Sulphate sulphur		Pyritic sulphur		Organic sulphur		Fusain
	% of coal	% of coal	% of sulphur	% of coal	% of sulphur	% of coal	% of sulphur	% of pure coal
Mine run	1.33	0.00	0.0	0.44	33.1	0.89	66.9	....
0 " - 4 "	....	....	...	....	....	....	....	6.10
1/8" - 4 "	....	....	...	....	....	....	....	5.95
3/4" - 4 "	....	....	...	....	....	....	....	5.89
0 " - 3/4"	....	....	...	....	....	....	....	6.74
0 " - 1½"	....	....	...	....	....	....	....	6.10
0 " - 1/8"	....	....	...	....	....	....	....	9.79

TABLE VII. Chemical Analyses of Ash ✓

Screen sizes	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	Na_2O	K_2O	TiO_2	P_2O_5	SO_3	Total
1/8" - 4 " %	57.1	22.7	12.7	0.8	1.3	Trace	1.8	0.7	0.3	2.3	99.7
0 " - 1/8" %	51.6	23.9	10.8	4.4	1.5	0.2	1.8	0.6	0.4	4.7	99.9

✓ Analysis made in chemical laboratory, Division of Metallic Minerals, under the direction of J.A. Fournier, Chief Chemist.

THIRD SEAM -- ALBION AND ACADIA NO. 7 MINES

TABLE VIII. Float And Sink Data On 1½" Slack - Ash and Sulphur

Specific gravity		Weight	Ash	Sulphur	Cumulative						±.10 specific gravity distribution	
					Floats			Sinks				
Sinks	Floats	%	%	%	Weight %	Ash %	Sulphur %	Weight %	Ash %	Sulphur %	Gravity	Calculated ordinate
											1.35	93.3
	1.30	21.0	5.1	1.5	21.0	5.1	1.5	100.0	12.5	1.6	1.40	74.3
1.30	1.40	62.9	10.5	1.0	83.9	9.1	1.1	79.0	14.5	1.6	1.45	17.6
1.40	1.50	8.8	20.0	1.0	92.7	10.2	1.1	16.1	30.0	4.0	1.55	5.4
1.50	1.60	1.5	23.7	1.3	94.2	10.4	1.1	7.3	42.0	7.6	1.65	1.2
1.60		5.8	46.7	9.3	100.0	12.5	1.6	5.8	46.7	9.3	1.75	0.8
Curve No. 4			2	2	1,2,4	1	1	3	3	3	5	5

TABLE IX. Chemical Analysis And Fusibility Of Ash On Float And Sink Portions of 1½" Slack (Dry Basis)

Specific gravity		Ash	Volatile matter	Fixed carbon	Coking properties	Sulphur	Initial deformation	Softening point	Fluid temperature	Melting range	Softening interval	Flow interval
Sinks	Floats	%	%	%		%	°F.	°F.	°F.	°F.	°F.	°F.
	1.30	5.1	30.0	64.9	Good	1.5	2440	2600	2750	310	160	150
1.30	1.40	10.6	28.6	60.8	Good	1.0	2550	2710	2810	260	160	100
1.40	1.50	20.2	26.9	52.9	Fair to poor	1.0	2670	2820	2850+	180+	150	30+
1.50	1.60	24.0	26.1	49.9	Poor	1.3	2500	2615	2720	220	115	105
1.60		47.1	24.9	28.0	Non-agglomerating	9.4	1850	1950	2150	300	100	200

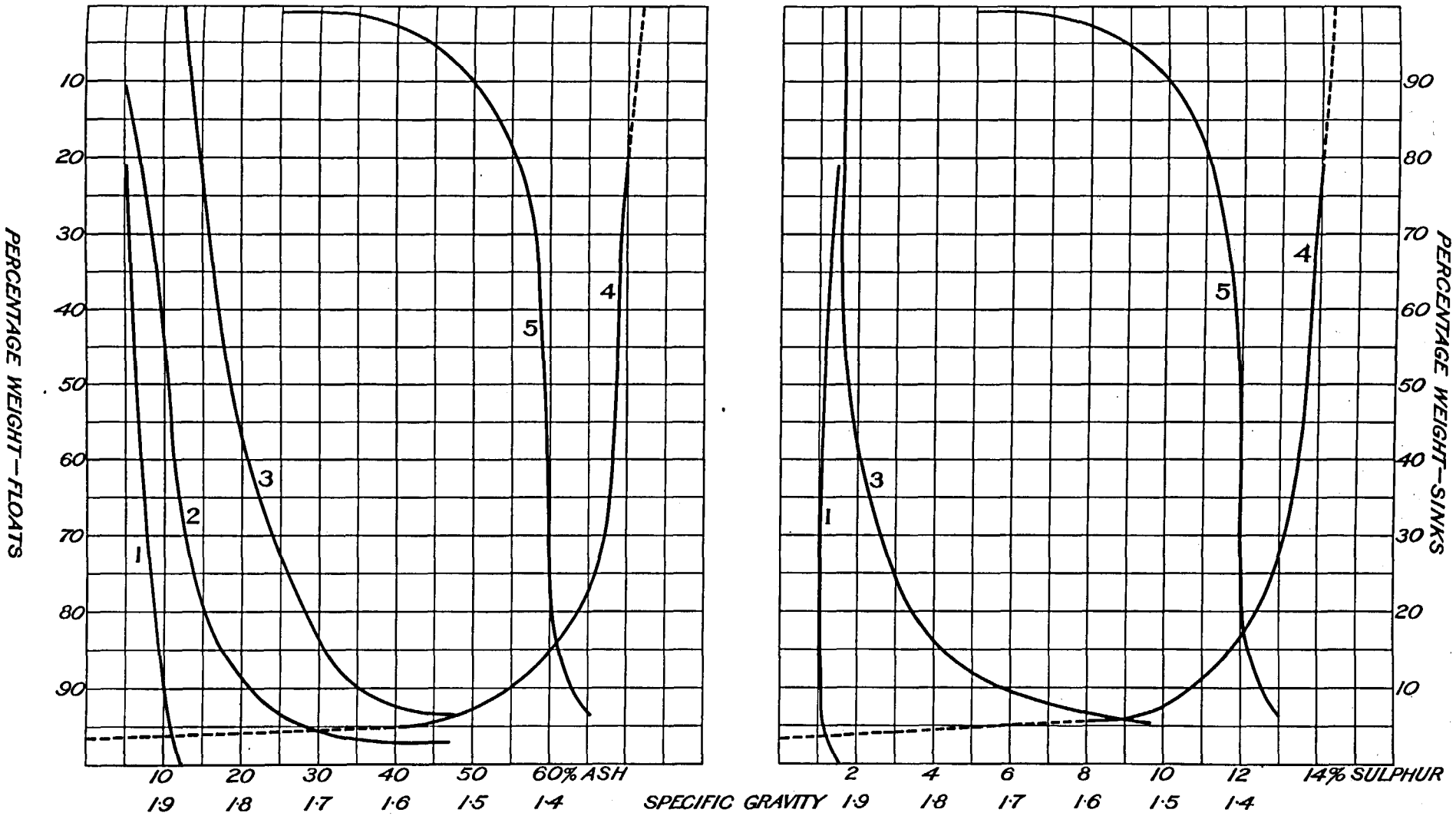

Fig. 9 - Washability Curves for Third Seam--Albion and Acadia No. 7 Mines

Curve 1 - Cumulative coal-ash or sulphur percentage (float)
Curve 2 - Actual ash or sulphur percentage.
Curve 3 - Cumulative slate-ash or sulphur percentage (sink)
Curve 4 - Specific gravity.
Curve 5 - ±.10 specific gravity distribution.

TABLE X. Chemical Analyses and Fusain of Raw Coal, Clean Coal and Refuse

---	Raw coal	Clean coal Floats 1.50	Refuse Sinks 1.50
Weight.....%	100.0	93.2	6.8
Proximate analysis (dry basis)--			
Ash.....%	12.7	10.3	40.2
Volatile matter.....%	28.4	28.7	24.6
Fixed carbon.....%	58.9	61.0	35.2
Sulphur.....%	1.4	1.1	4.0
Calorific value.....B.t.u./lb.	13,095	13,585	....
Fusion point of ash.....°F.	2280	2630	2080
Melting range of ash.....°F.	300	250	230
Coking properties.....	Good	Good	Slightly agglomerating
Fusain in pure coal.....%	6.10	5.97	11.25

TABLE XI. Screen and Chemical Analyses of Sizes Prepared From 1½" Slack, and Analyses of the Clean Coal and Refuse of These Sizes After Washing at a Selected Gravity of 1.50

Screen sizes	Weight %	Cumulative weight %	Ash %	Sul-phur %	F.P.A. °F.	Floats Weight %	Floats Ash %	Floats Sul. %	Floats F.P.A. °F.	Sinks Weight %	Sinks Ash %	Sinks Sul. %	Sinks F.P.A. °F.
3/4" - 1½"	28.6	28.6	14.9	1.7	2260	92.2	12.0	1.0	2620	7.8	39.2	5.5	2030
1/8" - 3/4"	51.5	80.1	12.0	1.5	2530	95.0	10.1	1.1	2730	5.0	44.7	6.2	2005
0 " - 1/8"	19.9	100.0	12.2	1.4	2310	93.2	9.2	1.2	2700	6.8	42.9	4.0	2100

THIRD SEAM -- ALBION AND ACADIA NO. 7 MINES

TABLE XII. Physical Properties of By-product Cokes As Indicated By The 'Swelling Index' Test

	1½ inch slack	
	As received	After washing
Volatile matter at 600°C. (dry)...%	23.0	23.4
Swelling index.....	-196	-85
Section--Coke classification chart.	XIII opposite X	XIII opposite X
Specific volatile index.....	168.4	171.8
Section--Coal classification chart(	E parabituminous	E parabituminous
Ash, per cent in coal (dry basis).%	12.7	10.3
Physical properties of coke:		
Size on wharf (% on 3 in.....	40.0	40.0
(Breeze: % -1/2 in.	3.0	3.0
Shatter test. (Index: % on 2 in..	50.0	50.0
(Breeze: % -1/2 in.	7.0	5.0
Abrasion test (Index: % on 1½ in.	70.0	70.0
(Dust: % -1/16 in..	7.0	7.0
Density (App. specific gravity...	1.0	1.0
(Pounds per cubic foot...	27.0	27.0
Transverse shrinkage.....	Good	Good
Appearance of natural surface....	Dull grey, granular	
Shape.....	Blocky, irregular	
Strength.....	Friable	
Cross fracture.....(	Small to medium amount, irregular	
Longitudinal fracture.....	Small to medium amount	
Cell structure.....	Very little to none	
Sponge.....	Granular ends	
Pebbly seam.....	Very pebbly	
Remarks.....	Very poor by-product coke	Practically no improvement due to washing

Caking Properties

	Caking index by Gray's method
Run-of-mine sample.....	44

STELLARTON DISTRICT
FOUR-FOOT SEAM
ALLAN SHAFT MINE, ACADIA COAL COMPANY LIMITED
STELLARTON, NOVA SCOTIA

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TABLE I. Screen Analyses, Bulk Density and Apparent Specific Gravity

Screen sizes *	Screen analyses: As received % By weight	Screen analyses: As received % Cumulative	Screen analyses: As mined % By weight	Screen analyses: As mined % Cumulative	Bulk density --- lb. per cu. ft.	Apparent specific gravity	Void %	Ash %
Plus 4 "	17.0	17.0	26.4	26.4	.....	....	....	15.5
2 " - 4 "	14.9	31.9	13.9	40.3	43.25	1.35	48.8	18.5
1½" - 2 "	4.7	36.6	5.8	46.1	43.50	1.39	49.9	17.8
1 " - 1½"	10.4	47.0	8.5	54.6	43.00	1.37	49.8	17.1
3/4" - 1 "	7.3	54.3	6.4	61.0	43.50	1.34	48.0	14.9
1/2" - 3/4"	9.5	63.8	9.0	70.0	42.25	1.34	49.5	14.6
1/4" - 1/2"	12.4	76.2	9.5	79.5	42.50	1.32	48.5	13.1
1/8" - 1/4"	9.3	85.5	8.5	88.0	41.75	1.32	49.4	12.2
No. 48 - 1/8"	11.3	96.8	9.6	97.6)	45.50	1.32	44.9	(11.7
0 " - No. 48	3.2	100.0	2.4	100.0)				(14.7
Mine run		100.0		100.0	56.25	1.36	33.8	15.1
0 " - 4 "		83.0		73.6	56.25	1.35	33.3	14.8
1/8" - 4 "		68.5		61.6	50.50	1.36	40.6	15.4
3/4" - 4 "		37.3		34.6	45.25	1.37	47.1	16.8
0 " - 3/4"		45.7		39.0	50.50	1.32	38.8	13.2
0 " - 1½"		63.4		53.9	53.00	1.32	35.8	14.3
0 " - 1/8"		14.5		12.0	45.50	1.32	44.9	12.4

	As mined	As received
Average size of run-of-mine coal.....in.	2.51	1.96
Size stability during handling from mine to Ottawa.....%		78

* In this and subsequent tables, all screens 1/8" and larger are round-hole screens. No. 48 is Tyler 48-mesh with nominal aperture of 0.295 mm.

FOUR-FOOT SEAM -- ALLAN SHAFT MINE

TABLE II. Size Stability

Screen sizes	Screen analyses before and after drop-shatter test									
	Single sizes				Mixed sizes					
	2 - 3 inch		3 - 4 inch		3/4 - 4 inch			0 - 4 inch		
	Before test %	After 2 drops %	Before test %	After 2 drops %	Before test %	After 2 drops %	After 4 drops %	Before test %	After 2 drops %	After 4 drops %
3 " - 4 "			100.0	51.0	12.9	11.3	11.3	5.8	4.2	4.2
2 " - 3 "	100.0	65.0		23.0	27.1	23.3	19.6	12.2	12.5	11.7
1½" - 2 "		14.0		6.5	12.6	10.8	10.8	5.7	5.8	5.4
1 " - 1½"		8.5		6.0	27.9	21.7	18.3	12.5	8.3	7.9
3/4" - 1 "		3.0		4.0	19.5	18.3	18.3	8.8	8.3	7.5
1/2" - 3/4"		4.0		2.5		6.7	8.3	11.4	10.8	11.2
0 " - 1/2"		5.5		7.0		7.9	13.4	43.6	50.1	52.1
Average size..in.	2.50	2.04	3.50	2.62	1.87	1.66	1.55	1.00	0.92	0.88
Size stability..%		82		75		89	83		91	88

TABLE III. Grindability

Screen size of coal tested	Hardgrove index	
	Old	New
0" - 4 "	78	81
0" - 3/4"	78	81
0" - 1/8"	79	81

FOUR-FOOT SEAM -- ALLAN SHAFT MINE

TABLE IV. Proximate Analyses, Calorific Value and Fusibility of Ash

Screen sizes	Moisture (as recd) %	Dry basis: Ash %	Dry basis: Volatile matter %	Dry basis: Fixed carbon %	Dry basis: Sulphur %	Dry basis: Calorific value Btu/lb.	Initial deformation °F.	Softening temperature °F.	Fluid temperature °F.	Melting range °F.	Softening interval °F.	Flow interval °F.
Plus 4 "	1.4	15.5	28.8	55.7	1.0	.....	2550	2740	2820	270	190	80
2 " - 4 "	1.4	18.5	28.2	53.3	1.3	.....	2350	2580	2700	350	230	120
1½" - 2 "	1.1	17.8	29.5	52.7	1.2	.....	2150	2230	2400	250	80	170
1 " - 1½"	1.4	17.1	29.1	53.8	1.3	.....	2300	2400	2600	300	100	200
3/4" - 1 "	1.4	14.9	28.9	56.2	1.4	.....	2300	2450	2700	400	150	250
1/2" - 3/4"	1.4	14.6	29.3	56.1	1.5	.....	2275	2400	2610	335	125	210
1/4" - 1/2"	1.4	13.1	29.8	57.1	1.2	.....	2250	2320	2520	270	70	200
1/8" - 1/4"	1.4	12.2	30.2	57.6	1.2	.....	2000	2240	2305	305	240	65
No. 48 - 1/8"	1.2	11.7	30.1	58.2	1.1	.....	2020	2270	2315	295	250	45
0 " - No. 48	1.2	14.7	28.5	56.8	1.0	.....	2100	2160	2200	100	60	40
Mine run	1.4	15.1	29.4	55.5	1.4	12,785	2250	2350	2560	310	100	210
0 " - 4 "	1.3	14.8	29.6	55.6	1.6	12,870	2150	2250	2320	170	100	70
1/8" - 4 "	1.3	15.4	29.4	55.2	1.4	12,860	2240	2360	2500	260	120	140
3/4" - 4 "	1.3	16.8	29.0	54.2	1.3	12,580	2260	2510	2600	340	250	90
0 " - 3/4"	1.3	13.2	29.8	57.0	1.2	13,180	2200	2300	2430	230	100	130
0 " - 1½"	1.3	14.3	29.9	55.8	1.3	12,940	2200	2300	2415	215	100	115
0 " - 1/8"	1.3	12.4	30.2	57.4	1.1	13,195	2160	2250	2280	120	90	30

TABLE V. Ultimate Analyses (Dry Basis)

Screen sizes	Carbon	Hydrogen	Sulphur	Nitrogen	Oxygen	Ash
1/8" - 4 " %	72.2	4.7	1.4	1.8	4.5	15.4
0 " - 1/8" %	74.9	4.9	1.1	1.8	4.9	12.4

FOUR-FOOT SEAM -- ALLAN SHAFT MINE

TABLE VI. Sulphur Forms and Fusain

Screen sizes	Total sulphur	Sulphate sulphur		Pyritic sulphur		Organic sulphur		Fusain
	% of coal	% of coal	% of sulphur	% of coal	% of sulphur	% of coal	% of sulphur	% of pure coal
Mine run	1.36	0.02	1.1	0.66	48.9	0.68	50.0	....
0 " - 4 "	....	....	...	....	....	....	....	5.76
1/8" - 4 "	....	....	...	....	....	....	....	4.82
3/4" - 4 "	....	....	...	....	....	....	....	4.64
0 " - 3/4"	....	....	...	....	....	....	....	7.46
0 " - 1½"	....	....	...	....	....	....	....	6.85
0 " - 1/8"	....	....	...	....	....	....	....	10.98

TABLE VII. Chemical Analyses of Ash ✓

Screen sizes	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	Na_2O	K_2O	TiO_2	P_2O_5	SO_3	Total
1/8" - 4 " %	55.3	21.9	9.9	4.5	1.1	nil	1.5	0.7	0.2	5.3	100.4
0 " - 1/8" %	41.9	16.6	8.7	15.3	1.9	nil	1.1	0.5	0.2	14.0	100.2

✓ Analysis made in chemical laboratory, Division of Metallic Minerals, under the direction of J.A. Fournier, Chief Chemist.

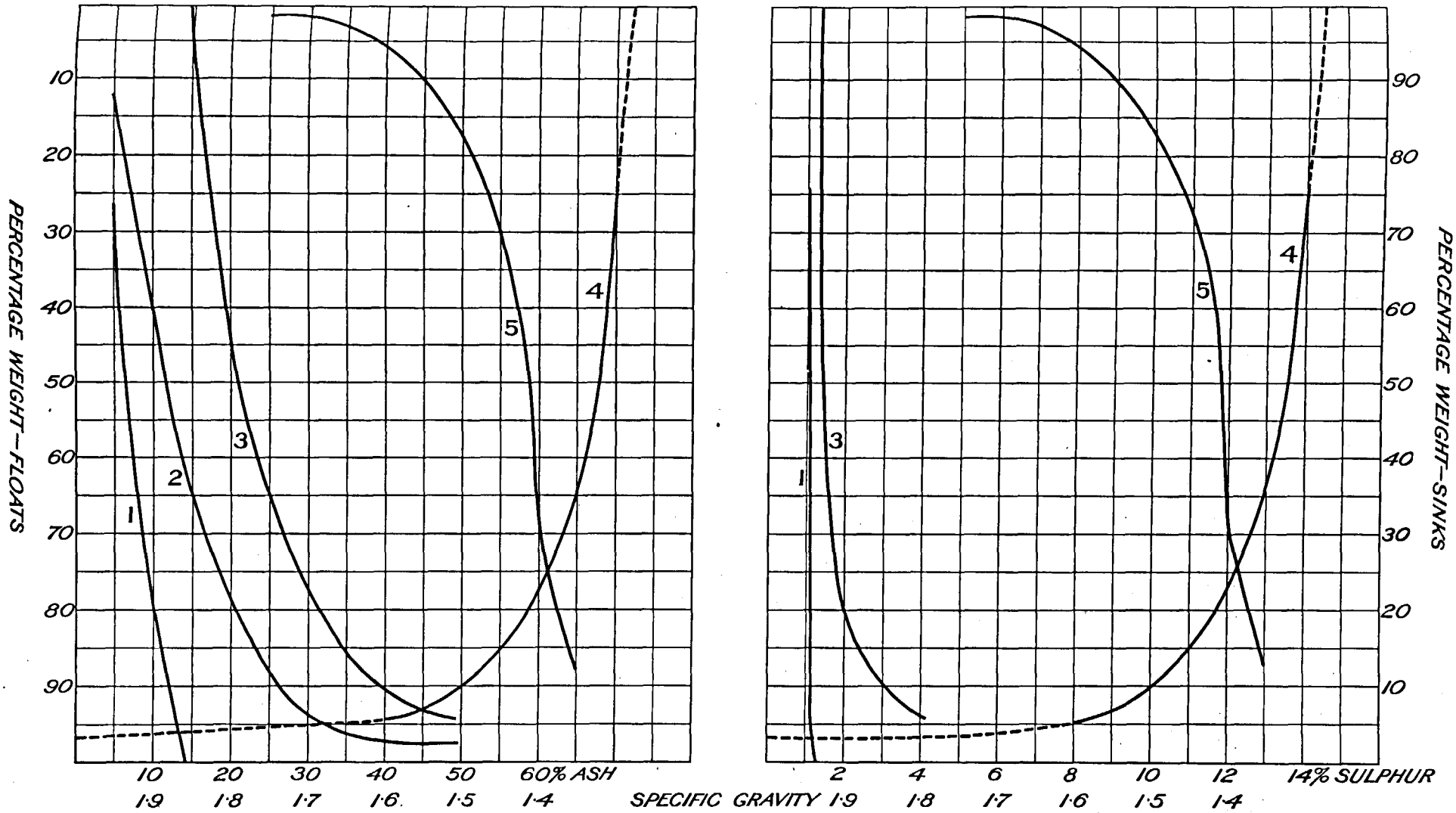

Fig. 10 - Washability Curves for Four-Foot Seam--Allan Shaft Mine

Curve 1 - Cumulative coal-ash or sulphur percentage (float)
Curve 2 - Actual ash or sulphur percentage.
Curve 3 - Cumulative slate-ash or sulphur percentage (sink)
Curve 4 - Specific gravity.
Curve 5 - ±.10 specific gravity distribution.

TABLE VIII. Float and Sink Data on 1½" Slack - Ash and Sulphur

Specific gravity		Weight	Ash	Sulphur	Cumulative						±.10 specific gravity distribution	
					Floats			Sinks				
Sinks	Floats	%	%	%	Weight %	Ash %	Sulphur %	Weight %	Ash %	Sulphur %	Gravity	Calculated ordinate
											1.35	87.6
	1.30	24.0	4.9	1.0	24.0	4.9	1.0	100.0	14.5	1.3	1.40	68.4
1.30	1.40	52.0	11.9	1.1	76.0	9.7	1.1	76.0	17.5	1.3	1.45	29.9
1.40	1.50	14.4	22.2	1.0	90.4	11.7	1.1	24.0	29.6	1.8	1.55	9.8
1.50	1.60	3.8	27.5	1.5	94.2	12.3	1.1	9.6	40.7	3.1	1.65	2.4
1.60		5.8	49.3	4.1	100.0	14.5	1.3	5.8	49.3	4.1	1.75	1.3
Curve No. 4			2	2	1,2,4	1	1	3	3	3	5	5

TABLE IX. Chemical Analysis and Fusibility of Ash on Float and Sink Portions of 1½" Slack (Dry Basis)

Specific gravity		Ash	Volatile matter	Fixed carbon	Coking properties	Sulphur	Initial deformation	Softening point	Fluid temperature	Melting range	Softening interval	Flow interval
Sinks	Floats	%	%	%		%	°F.	°F.	°F.	°F.	°F.	°F.
	1.30	5.0	31.6	63.4	Good	1.0	2450	2690	2770	320	240	80
1.30	1.40	12.0	29.8	58.2	Good	1.1	2630	2850+	2850+	220+	220+	+
1.40	1.50	22.6	27.2	50.2	Fair	1.0	2690	2770	2850	160	80	80
1.50	1.60	28.1	26.9	45.0	Poor	1.6	2450	2600	2740	290	150	140
1.60		49.8	28.0	22.2	Slightly agglomerating	4.1	1950	2040	2110	160	90	70

FOUR-FOOT SEAM -- ALLAN SHAFT MINE

TABLE X. Chemical Analyses and Fusain of Raw Coal, Clean Coal and Refuse

---	Raw coal	Clean coal Floats 1.60	Refuse Sinks 1.60
Weight.....%	100.0	92.0	8.0
Proximate analysis (dry basis)--			
Ash.....%	14.3	11.5	45.6
Volatile matter.....%	29.9	29.6	32.4
Fixed carbon.....%	55.8	58.9	22.0
Sulphur.....%	1.3	1.1	2.5
Calorific value.....B.t.u./lb.	12,940	13,485	....
Fusion point of ash.....°F.	2300	2720	2000
Melting range of ash.....°F.	215	280	110
Coking properties.....	Good	Good	Slightly agglomerating
Fusain in pure coal.....%	6.85	5.94	16.46

TABLE XI. Screen and Chemical Analyses of Sizes Prepared From 1½" Slack, and Analyses of the Clean Coal and Refuse of These Sizes After Washing at a Selected Gravity of 1.60

Screen sizes	Weight %	Cumulative weight %	Ash %	Sulphur %	F.P.A. °F.	Floats Weight %	Floats Ash %	Floats Sul. %	Floats F.P.A. °F.	Sinks Weight %	Sinks Ash %	Sinks Sul. %	Sinks F.P.A. °F.
3/4" - 1½"	27.9	27.9	16.2	1.3	2420	92.2	13.7	1.1	2720	7.8	52.2	4.5	2050
1/8" - 3/4"	49.2	77.1	13.3	1.3	2320	94.8	11.1	1.0	2710	5.2	50.0	4.3	2020
0 " - 1/8"	22.9	100.0	12.4	1.1	2250	82.6	7.6	1.0	2700	17.4	32.8	1.4	2270

FOUR-FOOT SEAM -- ALLAN SHAFT MINE

TABLE XII. Physical Properties Of By-Product Cokes As Indicated By The 'Swelling Index" Test

	$1\frac{1}{2}$ inch slack	
	As received	After washing
Volatile matter at 600°C. (dry)...%	24.2	25.1
Swelling index.....	360	438
Section--Coke classification chart.	IX near XIII	VII near IX
Specific volatile index.....	170.7	168.2
Section--Coal classification chart(	E parabituminous	E parabituminous
Ash per cent in coal (dry basis)..%	14.3	11.5
Physical properties of coke:		
Size on wharf (% on 3 in.....	70.0	70.0
Size on wharf (Breeze: % -1/2 in.	3.0	4.0
Shatter test. (Index: % on 2 in..	65.0	70.0
Shatter test. (Breeze: % -1/2 in.	4.0	3.0
Abrasion test (Index: % on $1\frac{1}{2}$ in.	90.0	95.0
Abrasion test (Dust: % -1/16 in..	2.5	2.5
Density (Apparent specific gravity	0.95	0.95
Density (Pounds per cubic foot...	26.0	26.0
Transverse shrinkage.....	Good	
Appearance of natural surface....	Steel grey, irregular	
Shape.....	Slightly triangular, fairly blocky	Slightly triangular, blocky
Strength.....	Tough to hard	
Cross fracture.....	Medium amount, slightly steppy	Small to medium amount, slightly steppy
Longitudinal fracture.....	Medium amount	
Cell structure.....	Small to medium	
Sponge.....	Small amount	
Pebbly seam.....	None	
Remarks.....	This coal should result in the production of a fairly good by-product coke.	Washing indicates a definite improvement in the coking properties.

Caking Properties

	Caking index by Gray's method
Run-of-mine sample.....	49

STELLARTON DISTRICT
FLEMING SEAM
McGREGOR MINE, ACADIA COAL COMPANY LIMITED
STELLARTON, NOVA SCOTIA

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TABLE I. Screen Analyses, Bulk Density and Apparent Specific Gravity

Screen sizes *	Screen analyses: As received % By weight	As received % Cumulative	As mined % By weight	As mined % Cumulative	Bulk density --- lb. per cu. ft.	Apparent specific gravity	Void %	Ash %
Plus 4 "	35.8	35.8	36.8	36.8	.....	....	....	16.8
2 " - 4 "	14.3	50.1	15.2	52.0	44.00	1.37	48.6	16.1
1½" - 2 "	3.6	53.7	4.2	56.2	43.75	1.40	50.0	16.6
1 " - 1½"	7.9	61.6	7.5	63.7	44.00	1.36	48.2	15.7
3/4" - 1 "	5.8	67.4	5.9	69.6	44.25	1.34	47.2	15.0
1/2" - 3/4"	8.4	75.8	8.8	78.4	44.50	1.31	45.7	13.6
1/4" - 1/2"	10.6	86.4	9.2	87.6	44.00	1.29	45.4	12.9
1/8" - 1/4"	6.3	92.7	5.8	93.4	43.75	1.24	43.6	13.0
No. 48 - 1/8"	5.7	98.4	5.2	98.6	46.50	1.26	41.0	14.1
0 " - No. 48	1.6	100.0	1.4	100.0				14.6
Mine run		100.0		100.0	55.75	1.36	34.9	14.4
0 " - 4 "		64.2		63.2	54.25	1.35	35.7	13.9
1/8" - 4 "		56.9		56.6	51.50	1.36	39.8	14.9
3/4" - 4 "		31.6		32.8	47.75	1.37	44.2	16.4
0 " - 3/4"		32.6		30.4	47.75	1.29	40.8	13.8
0 " - 1½"		46.3		43.8	51.75	1.30	36.3	13.9
0 " - 1/8"		7.3		6.6	46.50	1.26	41.0	14.0

	As mined	As received
Average size of run-of-mine coal.....in.	3.35	3.21
Size stability during handling from mine to Ottawa.....%		96

* In this and subsequent tables, all screens 1/8" and larger are round-hole screens. No. 48 is Tyler 48-mesh with nominal aperture of 0.295 mm.

FLEMING SEAM -- McGREGOR MINE

TABLE II. Size Stability

Screen sizes	Screen analyses before and after drop-shatter test									
	Single sizes				Mixed sizes					
	2 - 3 inch		3 - 4 inch		3/4 - 4 inch			0 - 4 inch		
	Before test %	After 2 drops %	Before test %	After 2 drops %	Before test %	After 2 drops %	After 4 drops %	Before test %	After 2 drops %	After 4 drops %
3 " - 4 "			100.0	54.5	19.3	17.9	14.2	10.5	10.0	7.1
2 " - 3 "	100.0	66.5		14.0	26.0	17.9	15.0	12.8	10.8	10.4
1½" - 2 "		8.5		4.0	11.4	10.8	10.4	5.6	5.8	6.7
1 " - 1½"		7.0		6.5	25.0	17.9	15.8	12.3	10.4	9.6
3/4" - 1 "		4.0		4.0	18.3	15.8	16.6	9.0	8.7	9.2
1/2" - 3/4"		4.5		6.0		9.2	11.3	13.1	12.5	12.9
0 " - 1/2"		9.5		11.0		10.5	17.7	36.7	41.8	44.1
Average size..in.	2.50	1.99	3.50	2.51	2.00	1.71	1.50	1.19	1.11	1.01
Size stability..%		80		72		86	75		93	85

TABLE III. Grindability

Screen size of coal tested	Hardgrove index Old	New
0" - 4 "	69	72
0" - 3/4"	70	73
0" - 1/8"	70	74

FLEMING SEAM -- McGREGOR MINE

TABLE IV. Proximate Analyses, Calorific Value and Fusibility of Ash

Screen sizes	Moisture (as recd) %	Dry basis: Ash %	Dry basis: Volatile matter %	Dry basis: Fixed carbon %	Dry basis: Sulphur %	Dry basis: Calorific value Btu/lb.	Initial deformation °F.	Softening temperature °F.	Fluid temperature °F.	Melting range °F.	Softening interval °F.	Flow interval °F.
Plus 4 "	1.7	16.8	27.6	55.6	1.6	.....	2360	2500	2600	240	140	100
2 " - 4 "	1.8	16.1	27.6	56.3	1.2	.....	2340	2510	2610	270	170	100
1½" - 2 "	1.8	16.6	27.3	56.1	1.1	.....	2380	2580	2660	280	200	80
1 " - 1½"	1.7	15.7	27.5	56.8	1.3	.....	2250	2430	2500	250	180	70
3/4" - 1 "	1.7	15.0	27.5	57.5	1.3	.....	2300	2450	2500	200	150	50
1/2" - 3/4"	1.7	13.6	27.7	58.7	1.3	.....	2360	2500	2600	240	140	100
1/4" - 1/2"	1.8	12.9	27.5	59.6	1.1	.....	2400	2550	2640	240	150	90
1/8" - 1/4"	1.7	13.0	27.8	59.2	1.1	.....	2300	2680	2770	470	380	90
No. 48 - 1/8"	1.6	14.1	27.7	58.2	1.1	.....	2200	2490	2600	400	290	110
0 " - No. 48	1.1	14.6	24.1	61.3	0.8	.....	2230	2350	2400	170	120	50
Mine run	1.7	14.4	27.6	58.0	1.2	12,965	2240	2500	2610	370	260	110
0 " - 4 "	1.7	13.9	27.8	58.3	1.1	13,010	2260	2550	2650	390	290	100
1/8" - 4 "	1.6	14.9	28.0	57.1	1.3	12,900	2200	2400	2440	240	200	40
3/4" - 4 "	1.6	16.4	27.5	56.1	1.3	12,640	2200	2450	2480	280	250	30
0 " - 3/4"	1.6	13.8	27.4	58.8	1.1	13,045	2250	2470	2510	260	220	40
0 " - 1½"	1.7	13.9	27.6	58.5	1.2	13,085	2340	2500	2580	240	160	80
0 " - 1/8"	1.3	14.0	26.8	59.2	1.0	12,920	2300	2380	2490	190	80	110

TABLE V. Ultimate Analyses (Dry Basis)

Screen sizes	Carbon	Hydrogen	Sulphur	Nitrogen	Oxygen	Ash
1/8" - 4 " %	72.8	4.8	1.3	1.6	4.6	14.9
0 " - 1/8" %	74.1	4.7	1.0	1.5	4.7	14.0

FLEMING SEAM -- McGREGOR MINE

TABLE VI. Sulphur Forms and Fusain

Screen sizes	Total sulphur	Sulphate sulphur		Pyritic sulphur		Organic sulphur		Fusain
	% of coal	% of coal	% of sulphur	% of coal	% of sulphur	% of coal	% of sulphur	% of pure coal
Mine run	1.18	0.00	0.0	0.41	34.7	0.77	65.3	....
0 " - 4 "	....	....	...	....	....	....	....	5.84
1/8" - 4 "	....	....	...	....	....	....	....	5.12
3/4" - 4 "	....	....	...	....	....	....	....	4.96
0 " - 3/4"	....	....	...	....	....	....	....	6.73
0 " - 1½"	....	....	...	....	....	....	....	6.24
0 " - 1/8"	....	....	...	....	....	....	....	10.86

TABLE VII. Chemical Analyses of Ash ✓

Screen sizes	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	Na_2O	K_2O	TiO_2	P_2O_5	SO_3	Total
1/8" - 4 " %	50.7	26.1	14.1	2.3	1.2	Trace	1.9	0.6	0.3	2.7	99.9
0 " - 1/8" %	48.8	25.1	10.1	5.8	1.4	0.5	1.7	0.5	0.4	6.1	100.4

✓ Analysis made in chemical laboratory, Division of Metallic Minerals, under the direction of J.A. Fournier, Chief Chemist.

FLEMING SEAM -- McGREGOR MINE

TABLE VIII. Float and Sink Data on 1½" Slack - Ash and Sulphur

Specific gravity		Weight	Ash	Sulphur	Cumulative						±.10 specific gravity distribution	
					Floats			Sinks				
Sinks	Floats	%	%	%	Weight %	Ash %	Sulphur %	Weight %	Ash %	Sulphur %	Gravity	Calculated ordinate
											1.35	92.8
	1.30	2.8	7.6	1.0	2.8	7.6	1.0	100.0	13.8	1.0	1.40	93.6
1.30	1.40	83.4	11.3	0.9	86.2	11.2	0.9	97.2	13.9	1.0	1.45	20.9
1.40	1.50	8.3	21.9	1.3	94.5	12.1	0.9	13.8	29.8	1.7	1.55	5.7
1.50	1.60	1.6	26.7	1.5	96.1	12.4	0.9	5.5	41.7	2.3	1.65	2.0
1.60		3.9	47.9	2.7	100.0	13.8	1.0	3.9	47.9	2.7	1.75	0.9
Curve No. 4			2	2	1,2,4	1	1	3	3	3	5	5

TABLE IX. Chemical Analysis and Fusibility of Ash on Float and Sink Portions of 1½" Slack (Dry Basis)

Specific gravity		Ash	Volatile matter	Fixed carbon	Coking properties	Sulphur	Initial deformation	Softening point	Fluid temperature	Melting range	Softening interval	Flow interval
Sinks	Floats	%	%			%	°F.	°F.	°F.	°F.	°F.	°F.
	1.30	7.7	28.3	64.0	Good	1.0	2440	2760	2850+	410+	320	90+
1.30	1.40	11.5	28.1	60.4	Good	0.9	2460	2740	2780	320	280	40
1.40	1.50	22.3	26.9	50.8	Fair	1.3	2050	2440	2480	430	390	40
1.50	1.60	27.1	26.7	46.2	Fair	1.5	2400	2690	2790	390	290	100
1.60		48.7	23.2	28.1	Non-agglomerating	2.7	2000	2170	2250	250	170	80

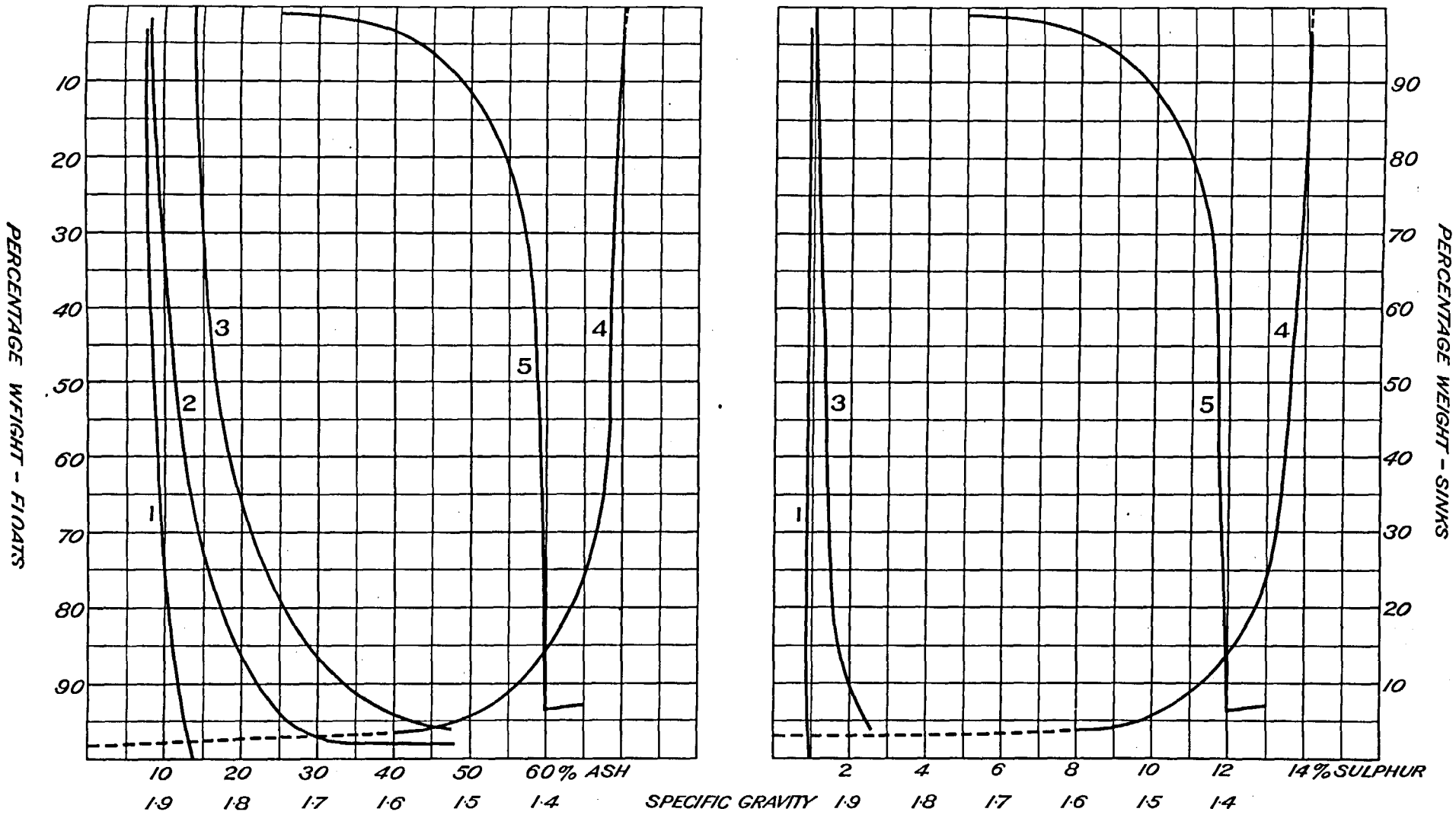

Fig. 11 - Washability Curves for Fleming Seam--McGregor Mine

Curve 1 - Cumulative coal-ash or sulphur percentage (float).
Curve 2 - Actual ash or sulphur percentage.
Curve 3 - Cumulative slate-ash or sulphur percentage (sink).
Curve 4 - Specific gravity.
Curve 5 - ±.10 specific gravity distribution.

TABLE X. Chemical Analyses and Fusain of Raw Coal, Clean Coal and Refuse

---	Raw coal	Clean coal Floats 1.60	Refuse Sinks 1.60
Weight.....%	100.0	93.6	6.4
Proximate analysis (dry basis)--			
Ash.....%	13.9	12.5	40.5
Volatile matter.....%	27.6	27.5	25.8
Fixed carbon.....%	58.5	60.0	33.7
Sulphur.....%	1.2	1.0	3.6
Calorific value.....B.t.u./lb.	13,085	13,280	....
Fusion point of ash.....°F.	2500	2750	2080
Melting range of ash.....°F.	240	120	145
Coking properties.....	Fair	Good	Agglomerating
Fusain in pure coal.....%	6.24	5.32	15.68

TABLE XI. Screen and Chemical Analyses of Sizes Prepared From 1½" Slack, and Analyses of the Clean Coal and Refuse of These Sizes After Washing at a Selected Gravity of 1.60

Screen sizes	Weight %	Cumulative weight %	Ash %	Sul-phur %	F.P.A. °F.	Floats Weight %	Floats Ash %	Floats Sul. %	Floats F.P.A. °F.	Sinks Weight %	Sinks Ash %	Sinks Sul. %	Sinks F.P.A. °F.
3/4" - 1½"	29.6	29.6	15.3	1.3	2440	91.4	13.8	1.0	2780	8.6	45.9	5.7	2080
1/8" - 3/4"	54.7	84.3	13.2	1.1	2560	96.4	12.3	0.9	2800	3.6	47.3	6.9	2080
0 " - 1/8"	15.7	100.0	14.0	1.0	2380	92.1	11.3	0.9	2820	7.9	23.4	1.4	2160

FLEMING SEAM -- McGREGOR MINE

TABLE XII. Physical Properties of By-Product Cokes As Indicated By The 'Swelling Index' Test

	1½ inch slack	
	As received	After washing
Volatile matter at 600°C. (dry)...%	25.3	23.3
Swelling index.....	-86	43
Section--Coke classification chart.	XIII	X
Specific volatile index.....	165.5	165.8
Section--Coal classification chart.	Parabituminous	Parabituminous
Ash per cent in coal (dry basis)..%	13.9	12.5
Physical properties of coke:		
Size on wharf (% on 3 in.....	60.0	70.0
Size on wharf (Breeze: % -1/2 in.	4.0	4.0
Shatter test. (Index: % on 2 in..	40.0	65.0
Shatter test. (Breeze: % -1/2 in.	12.0	8.0
Abrasion test (Index: % on 1½ in.	60.0	70.0
Abrasion test (Dust: % -1/16 in..	8.0	7.0
Density (App. specific gravity...	1.00	0.95
Density (Pounds per cubic foot...	27.0	26.0
Transverse shrinkage.....	Good	Fair to good
Appearance of natural surface....	Dull grey, granular	Dull, granular
Shape.....	Blocky, irregular	
Strength.....	Friable	Tough to friable
Cross fracture.....	Small to medium amount, irregular	Small amount, steppy
Longitudinal fracture.....	Small to medium amount	Small amount
Cell structure.....	Very little	Small to medium
Sponge.....	Granular ends	
Pebbly seam.....	Very pebbly	Slightly pebbly
Remarks.....	This coal is practically non-coking, making a very poor by-product coke.	Washing improved the coking quality but not sufficiently to allow for the production of satisfactory by-product coke.

Caking Properties

	Caking index by Gray's method
Run-of-mine sample.....	35

STELLARTON DISTRICT
McGREGOR SEAM
McGREGOR MINE, ACADIA COAL COMPANY LIMITED
STELLARTON, NOVA SCOTIA

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TABLE I. Screen Analyses, Bulk Density and Apparent Specific Gravity

Screen sizes *	Screen analyses: As received, % By weight	Screen analyses: As received, % Cumulative	Screen analyses: As mined, % By weight	Screen analyses: As mined, % Cumulative	Bulk density --- lb. per cu. ft.	Apparent specific gravity	Void %	Ash %
Plus 4 "	14.7	14.7	20.7	20.7	.....	....	....	14.6
2 " - 4 "	8.6	23.3	8.2	28.9	44.00	1.36	48.2	21.2
1½" - 2 "	4.3	27.6	4.5	33.4	44.00	1.38	49.0	18.5
1 " - 1½"	9.4	37.0	8.7	42.1	44.00	1.36	48.2	16.7
3/4" - 1 "	7.6	44.6	6.8	48.9	44.00	1.36	48.2	16.3
1/2" - 3/4"	10.6	55.2	9.3	58.2	44.00	1.37	48.6	15.1
1/4" - 1/2"	15.3	70.5	15.0	73.2	44.00	1.32	46.6	14.4
1/8" - 1/4"	11.4	81.9	11.2	84.4	42.50	1.29	47.3	14.6
No. 48 - 1/8"	13.7	95.6	11.9	96.3)	51.00	1.27	35.8	(14.7
0 " - No. 48	4.4	100.0	3.7	100.0)				(14.6
Mine run		100.0		100.0	59.00	1.36	30.6	16.7
0 " - 4 "		85.3		79.3	58.50	1.35	30.7	15.9
1/8" - 4 "		67.2		63.7	51.50	1.36	39.4	17.3
3/4" - 4 "		29.9		28.2	46.50	1.37	45.7	16.9
0 " - 3/4"		55.4		51.1	53.00	1.30	34.7	14.7
0 " - 1½"		72.4		66.6	55.00	1.33	33.8	15.8
0 " - 1/8"		18.1		15.6	51.00	1.27	35.8	14.4

	As mined	As received
Average size of run-of-mine coal.....in.	2.13	1.73
Size stability during handling from mine to Ottawa.....%		81

* In this and subsequent tables, all screens 1/8" and larger are round-hole screens. No. 48 is Tyler 48-mesh with nominal aperture of 0.295 mm.

McGREGOR SEAM -- McGREGOR MINE

TABLE II. Size Stability

Screen sizes	Screen analyses before and after drop-shatter test									
	Single sizes				Mixed sizes					
	2 - 3 inch		3 - 4 inch		3/4 - 4 inch			0 - 4 inch		
	Before test %	After 2 drops %	Before test %	After 2 drops %	Before test %	After 2 drops %	After 4 drops %	Before test %	After 2 drops %	After 4 drops %
3 " - 4 "			100.0	54.0	8.7	7.5	6.2	3.3	3.3	3.3
2 " - 3 "	100.0	68.0		16.0	20.1	17.9	14.6	7.0	6.7	5.8
1½" - 2 "		9.0		5.0	14.4	10.9	10.4	4.8	3.7	3.7
1 " - 1½"		7.5		8.0	31.4	24.2	23.7	11.0	10.0	8.8
3/4" - 1 "		3.0		4.0	25.4	23.7	20.4	8.9	5.8	6.2
1/2" - 3/4"		4.5		4.0		7.9	11.8	12.4	10.0	10.0
0 " - 1/2"		8.0		9.0		7.9	12.9	52.6	60.5	62.2
Average size..in.	2.50	2.03	3.50	2.56	1.68	1.48	1.35	0.78	0.71	0.67
Size stability..%		81		73		88	80		91	86

TABLE III. Grindability

Screen size of coal tested	Hardgrove index	
	Old	New
0" - 4 "	60	64
0" - 3/4"	65	68
0" - 1/8"	60	63

TABLE IV. Proximate Analyses, Calorific Value and Fusibility of Ash

Screen sizes	Moisture (as recd) %	Dry basis: Ash %	Volatile matter %	Fixed carbon %	Sulphur %	Calorific value Btu/lb.	Initial deformation °F.	Softening temperature °F.	Fluid temperature °F.	Melting range °F.	Softening interval °F.	Flow interval. °F.
Plus 4 "	2.0	14.6	27.6	57.8	1.3	.....	2210	2570	2670	460	360	100
2 " - 4 "	1.7	21.2	27.3	51.5	2.0	.....	2120	2250	2550	430	130	300
1½" - 2 "	1.7	18.5	27.6	53.9	1.3	.....	2550	2670	2780	230	120	110
1 " - 1½"	1.7	16.7	27.4	55.9	1.2	.....	2680	2750	2780	100	70	30
3/4" - 1 "	1.7	16.3	26.9	56.8	1.2	.....	2700	2800	2850	150	100	50
1/2" - 3/4"	1.7	15.1	27.3	57.6	1.2	.....	2650	2800	2850	200	150	50
1/4" - 1/2"	1.8	14.4	27.9	57.7	1.2	.....	2680	2750	2800	120	70	50
1/8" - 1/4"	1.7	14.6	27.7	57.7	1.2	.....	2600	2680	2750	150	80	70
No. 48 - 1/8"	1.6	14.7	28.2	57.1	1.2	.....	2500	2620	2710	210	120	90
0 " - No. 48	1.5	14.6	27.4	58.0	1.1	.....	2450	2525	2620	170	75	95
Mine run	1.9	16.7	27.6	55.7	1.3	12,510	2600	2755	2780	180	155	25
0 " - 4 "	1.7	15.9	27.8	56.3	1.2	12,595	2650	2745	2800	150	95	55
1/8" - 4 "	1.7	17.3	27.1	55.6	1.3	12,410	2420	2590	2640	220	170	50
3/4" - 4 "	1.7	16.9	27.4	55.7	1.2	12,470	2410	2590	2630	220	180	40
0 " - 3/4"	1.7	14.6	27.8	57.6	1.2	12,745	2500	2605	2690	190	105	85
0 " - 1½"	1.8	15.8	28.0	56.2	1.2	12,575	2420	2520	2640	220	100	120
0 " - 1/8"	1.7	14.4	27.6	58.0	1.2	12,820	2420	2580	2620	200	160	40

TABLE V. Ultimate Analyses (Dry Basis)

Screen sizes	Carbon	Hydrogen	Sulphur	Nitrogen	Oxygen	Ash
1/8" - 4 " %	70.8	4.6	1.3	1.8	4.2	17.3
0 " - 1/8" %	73.2	4.6	1.2	1.8	4.8	14.4

McGREGOR SEAM -- McGREGOR MINE

TABLE VI. Sulphur Forms and Fusain

Screen sizes	Total sulphur	Sulphate sulphur		Pyritic sulphur		Organic sulphur		Fusain
	% of coal	% of coal	% of sulphur	% of coal	% of sulphur	% of coal	% of sulphur	% of pure coal
Mine run	1.24	0.00	0.0	0.47	37.9	0.77	62.1	....
0 " - 4 "	....	....	...	....	....	....	....	6.06
1/8" - 4 "	....	....	...	....	....	....	....	5.74
3/4" - 4 "	....	....	...	....	....	....	....	5.36
0 " - 3/4"	....	....	....	....	....	....	....	7.02
0 " - 1½"	....	....	...	....	....	....	....	6.94
0 " - 1/8"	....	....	...	....	....	....	....	11.64

TABLE VII. Chemical Analyses of Ash ✓

Screen sizes	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	Na_2O	K_2O	TiO_2	P_2O_5	SO_3	Total
1/8" - 4 " %	52.4	28.6	11.1	0.9	1.7	0.2	2.7	0.7	0.2	1.5	100.0
0 " - 1/8" %	52.0	26.9	11.4	2.0	1.6	nil	3.0	0.7	0.2	2.5	100.3

✓ Analysis made in chemical laboratory, Division of Metallic Minerals, under the direction of J.A. Fournier, Chief Chemist.

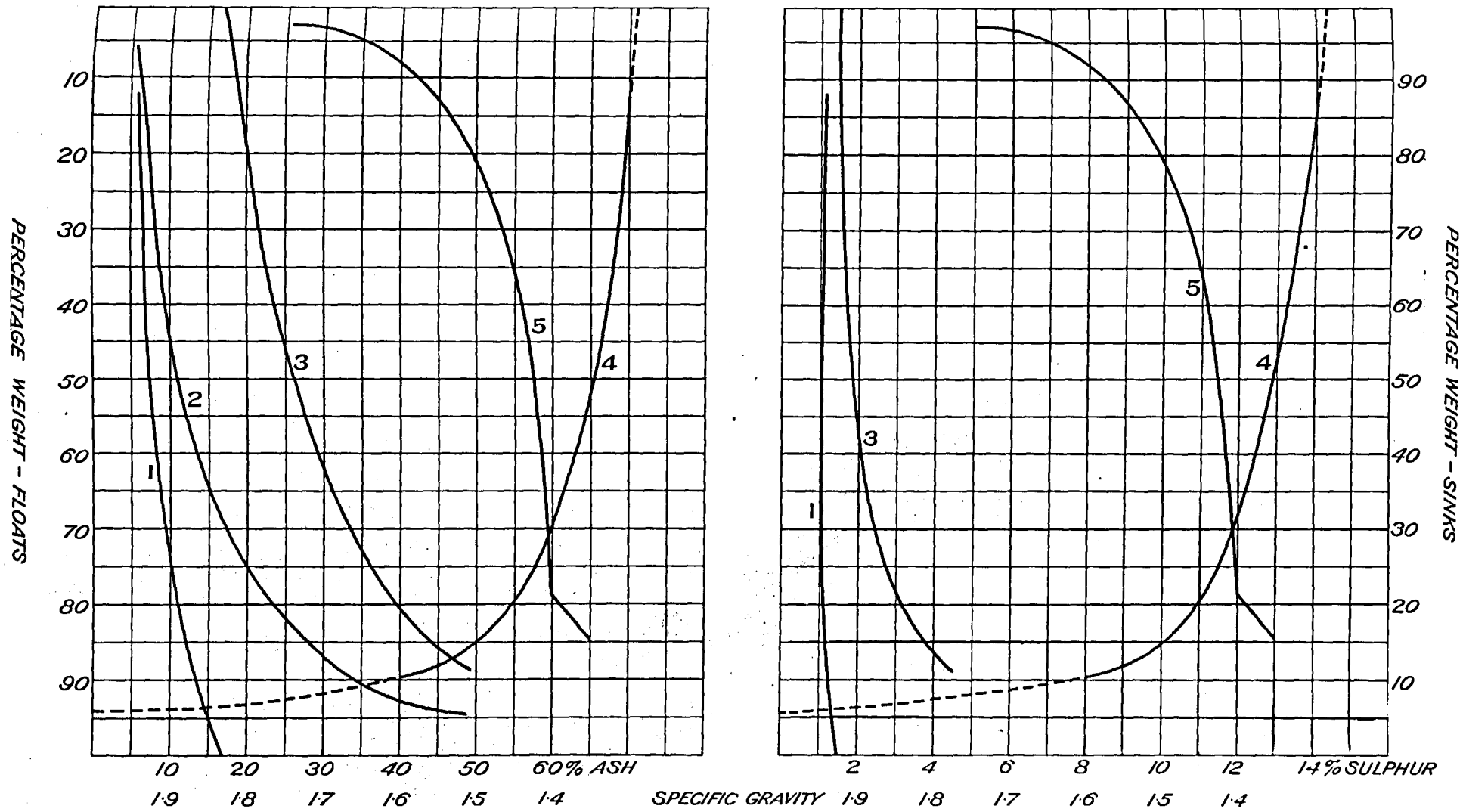

Fig. 12 - Washability Curves for McGregor Seam--McGregor Mine.

Curve 1 - Cumulative coal-ash or sulphur percentage (float).
Curve 2 - Actual ash or sulphur percentage.
Curve 3 - Cumulative slate-ash or sulphur percentage (sink).
Curve 4 - Specific gravity.
Curve 5 - ±.10 specific gravity distribution.

TABLE VIII. Float and Sink Data on 1½" Slack - Ash and Sulphur

Specific gravity		Weight	Ash	Sulphur	Cumulative						±.10 specific gravity distribution	
					Floats			Sinks				
Sinks	Floats	%	%	%	Weight %	Ash %	Sulphur %	Weight %	Ash %	Sulphur %	Gravity	Calculated ordinate
											1.35	84.6
	1.30	11.7	5.6	1.1	11.7	5.6	1.1	100.0	16.9	1.5	1.40	78.4
1.30	1.40	56.2	10.2	1.0	67.9	9.4	1.0	88.3	18.4	1.5	1.45	37.7
1.40	1.50	17.5	22.9	1.3	85.4	12.2	1.1	32.1	32.7	2.4	1.55	12.2
1.50	1.60	3.6	29.2	1.3	89.0	12.9	1.1	14.6	44.5	3.7	1.65	4.9
1.60		11.0	49.5	4.5	100.0	16.9	1.5	11.0	49.5	4.5	1.75	2.9
Curve No. 4			2	2	1,2,4	1	1	3	3	3	5	5

TABLE IX. Chemical Analysis and Fusibility of Ash on Float and Sink Portions of 1½" Slack (Dry Basis)

Specific gravity		Ash	Volatile matter	Fixed carbon	Coking properties	Sulphur	Initial deformation	Softening point	Fluid temperature	Melting range	Softening interval	Flow interval
Sinks	Floats	%	%	%		%	°F.	°F.	°F.	°F.	°F.	°F.
	1.30	5.6	28.8	65.6	Good	1.1	2560	2680	2720	160	120	40
1.30	1.40	10.4	28.6	61.0	Good to fair	1.0	2560	2700	2750	190	140	50
1.40	1.50	23.2	27.3	49.5	Fair to poor	1.3	2450	2610	2640	190	160	30
1.50	1.60	29.7	25.4	44.9	Poor	1.3	2740	2850+	2850+	110+	110+	+
1.60		50.2	20.9	28.9	Slightly agglomerating	4.5	2040	2140	2245	205	100	105

McGREGOR SEAM -- McGREGOR MINE

TABLE X. Chemical Analyses and Fusain of Raw Coal, Clean Coal and Refuse

---	Raw coal	Clean coal Floats 1.60	Refuse Sinks 1.60
Weight.....%	100.0	89.0	11.0
Proximate analysis (dry basis)--			
Ash.....%	15.8	12.3	46.7
Volatile matter.....%	28.0	27.9	21.2
Fixed carbon.....%	56.2	59.8	32.1
Sulphur.....%	1.2	1.2	2.3
Calorific value.....B.t.u./lb.	12,575	13,170	....
Fusion point of ash.....°F.	2520	2800	2570
Melting range of ash.....°F.	220	200	200
Coking properties.....	Good	Good	Slightly agglomerating
Fusain in pure coal.....%	6.94	6.02	17.96

TABLE XI. Screen and Chemical Analyses of Sizes Prepared From 1½" Slack, and Analyses of the Clean Coal and Refuse of These Sizes After Washing at a Selected Gravity of 1.60

Screen sizes	Weight %	Cumulative weight %	Ash %	Sul-phur %	F.P.A. °F.	Floats Weight %	Floats Ash %	Floats Sul. %	Floats F.P.A. °F.	Sinks Weight %	Sinks Ash %	Sinks Sul. %	Sinks F.P.A. °F.
3/4" - 1½"	23.5	23.5	16.5	1.2	2800	87.4	13.4	1.1	2750	12.6	53.6	1.8	2580
1/8" - 3/4"	51.5	75.0	14.6	1.2	2750	94.0	12.1	1.0	2830	6.0	53.4	3.4	2080
0 " - 1/8"	25.0	100.0	14.4	1.2	2580	81.1	10.9	1.0	2850	18.9	31.0	1.6	2260

McGREGOR SEAM -- McGREGOR MINE

TABLE XII. Physical Properties Of By-product Cokes As Indicated By The 'Swelling Index' Test

	1½ inch slack	
	As received	After washing
Volatile matter at 600°C. (dry)...%	22.5	22.9
Swelling index.....	-155	-87
Section--Coke classification chart.	XIII	XIII
Specific volatile index.....	167.4	169.1
Section--Coal classification chart(	E parabituminous	E parabituminous
Ash per cent in coal (dry basis)...	15.8	12.3
Physical properties of coke:		
Size on wharf (% on 3 in.....	....	....
(Breeze: % -1/2 in.	....	....
Shatter test. (Index: % on 2 in..	....	....
(Breeze: % -1/2 in.	....	....
Abrasion test (Index: % on 1½ in.	....	....
(Dust: % -1/16 in..	....	....
Density (App. specific gravity...	....	....
(Pounds per cubic foot...	....	....
Transverse shrinkage.....	Good	
Appearance of natural surface....	Dull grey	
Shape.....	Granular	
Strength.....	....	
Cross fracture.....	....	
Longitudinal fracture.....	....	
Cell structure.....	....	
Sponge.....	....	
Pebbly seam.....	Pebbly to non-coking	
Remarks.....	This coal is practically non-coking.	Practically no improvement on washing

Caking Properties

	Caking index by Gray's method
Run-of-mine sample.....	36

THORBURN DISTRICT
GEORGE McKAY SEAM
MILFORD MINE, GREENWOOD COAL COMPANY LIMITED
COALBURN, NOVA SCOTIA

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TABLE I. Screen Analyses, Bulk Density and Apparent Specific Gravity

Screen sizes *	Screen analyses: As received % By weight	As received % Cumulative	As mined % By weight	As mined % Cumulative	Bulk density --- lb. per cu. ft.	Apparent specific gravity	Void %	Ash %
Plus 4 "	29.9	29.9	30.0	30.0	.....	....	....	15.2
2 " - 4 "	18.9	48.8	20.1	50.1	39.50	1.38	54.2	15.1
1½" - 2 "	5.6	54.4	7.3	57.4	40.50	1.38	53.0	15.0
1 " - 1½"	8.4	62.8	9.4	66.8	41.00	1.39	52.8	16.7
3/4" - 1 "	6.4	69.2	5.9	72.7	44.00	1.38	49.0	15.1
1/2" - 3/4"	7.7	76.9	6.9	79.6	45.25	1.38	47.5	16.0
1/4" - 1/2"	9.8	86.7	8.9	88.5	44.25	1.38	48.6	15.1
1/8" - 1/4"	5.3	92.0	4.8	93.3	44.00	1.38	49.0	16.8
No. 48 - 1/8"	5.5	97.5	5.0	98.3)	51.00	1.37	40.4	20.5
0 " - No. 48	2.5	100.0	1.7	100.0)				22.9
Mine run		100.0		100.0	53.50	1.38	37.9	16.9
0 " - 4 "		70.1		70.0	50.25	1.38	41.7	16.6
1/8" - 4 "		62.1		63.3	48.75	1.38	43.4	16.2
3/4" - 4 "		39.3		42.7	44.00	1.38	49.0	16.0
0 " - 3/4"		30.8		27.3	51.50	1.38	40.2	17.9
0 " - 1½"		45.6		42.6	52.00	1.38	39.6	17.6
0 " - 1/8"		8.0		6.7	51.00	1.37	40.4	20.0

	As mined	As received
Average size of run-of-mine coal.....in.	2.94	2.87
Size stability during handling from mine to Ottawa.....%		98

* In this and subsequent tables, all screens 1/8" and larger are round-hole screens. No. 48 is Tyler 48-mesh with nominal aperture of 0.295 mm.

GEORGE McKAY SEAM -- MILFORD MINE

TABLE II. Size Stability

Screen sizes	Screen analyses before and after drop-shatter test									
	Single sizes				Mixed sizes					
	2 - 3 inch		3 - 4 inch		3/4 - 4 inch			0 - 4 inch		
	Before test %	After 2 drops %	Before test %	After 2 drops %	Before test %	After 2 drops %	After 4 drops %	Before test %	After 2 drops %	After 4 drops %
3 " - 4 "			100.0	58.0	19.3	14.2	12.5	12.8	8.7	7.1
2 " - 3 "	100.0	62.0		18.5	28.8	25.8	18.3	17.1	15.0	13.3
1½" - 2 "		15.0		5.0	14.2	12.1	12.1	8.0	9.2	8.8
1 " - 1½"		10.0		5.5	21.4	19.6	20.4	12.0	20.4	18.8
3/4" - 1 "		4.0		3.5	16.3	14.6	16.3	9.1	10.4	10.8
1/2" - 3/4"		3.5		3.0		6.7	7.9	11.0	11.3	12.0
0 " - 1/2"		5.5		6.5		7.0	12.5	30.0	25.0	29.2
Average size..in.	2.50	2.01	3.50	2.72	2.06	1.79	1.59	1.39	1.32	1.21
Size stability..%		80		78		87	77		95	88

TABLE III. Grindability

Screen size of coal tested	Hardgrove index Old	New
0" - 4 "	60	62
0" - 3/4"	57	59
0" - 1/8"	64	67

GEORGE McKAY SEAM -- MILFORD MINE

TABLE IV. Proximate Analyses, Calorific Value and Fusibility of Ash

Screen sizes	Moisture (as recd) %	Dry basis: Ash %	Volatile matter %	Fixed carbon %	Sulphur %	Calorific value Btu/lb.	Initial deformation °F.	Softening temperature °F.	Fluid temperature °F.	Melting range °F.	Softening interval °F.	Flow interval °F.
Plus 4 "	4.1	15.2	30.6	54.2	0.8	.....	2600	2820	2850+	250+	220	30+
2 " - 4 "	3.6	15.1	31.4	53.5	0.9	.....	2500	2600	2700	200	100	100
1½" - 2 "	3.7	15.0	31.5	53.5	0.9	.....	2360	2460	2600	240	100	140
1 " - 1½"	3.6	16.7	30.1	53.2	0.9	.....	2510	2620	2700	190	110	80
3/4" - 1 "	3.4	15.1	30.7	54.2	0.9	.....	2510	2600	2690	180	90	90
1/2" - 3/4"	3.4	16.0	31.1	52.9	1.0	.....	2510	2600	2680	170	90	80
1/4" - 1/2"	3.4	15.1	29.8	55.1	1.0	.....	2500	2610	2710	210	110	100
1/8" - 1/4"	3.2	16.8	29.7	53.5	1.0	.....	2500	2620	2730	230	120	110
No. 48 - 1-8"	3.5	20.5	27.4	52.1	1.3	.....	2360	2450	2560	200	90	110
0 " - No. 48	1.6	22.9	23.5	53.6	1.3	.....	2250	2360	2470	220	110	110
Mine run	3.9	16.9	29.3	53.8	0.9	12,180	2470	2750	2850+	380+	280	100+
0 " - 4 "	3.6	16.6	29.8	53.6	0.9	12,230	2500	2750	2850+	350+	250	100+
1/8" - 4 "	3.5	16.2	30.0	53.8	0.9	12,330	2500	2800	2850+	350+	300	50+
3/4" - 4 "	3.4	16.0	29.8	54.2	0.9	12,290	2500	2750	2850+	350+	250	100+
0 " - 3/4"	3.4	17.9	28.2	53.9	1.1	12,035	2480	2600	2785	305	120	185
0 " - 1½"	3.9	17.6	28.3	54.1	1.1	12,085	2350	2480	2540	190	130	60
0 " - 1/8"	2.9	20.0	26.1	53.9	1.2	11,570	2200	2300	2360	160	100	60

TABLE V. Ultimate Analyses (Dry Basis)

Screen sizes	Carbon	Hydrogen	Sulphur	Nitrogen	Oxygen	Ash
1/8" - 4 " %	70.5	4.9	0.9	1.9	5.6	16.2
0 " - 1/8" %	67.4	4.5	1.2	1.6	5.3	20.0

GEORGE McKAY SEAM -- MILFORD MINE

TABLE VI. Sulphur Forms and Fusain

Screen sizes	Total sulphur	Sulphate sulphur		Pyritic sulphur		Organic sulphur		Fusain
	% of coal	% of coal	% of sulphur	% of coal	% of sulphur	% of coal	% of sulphur	% of pure coal
Mine run	0.87	0.01	1.3	0.40	45.1	0.46	52.8	....
0 " - 4 "	0.91	Trace	Trace	0.48	52.7	0.43	47.3	4.69
1/8" - 4 "	0.83	Trace	Trace	0.40	48.2	0.43	51.8	4.50
3/4" - 4 "	0.83	Trace	Trace	0.39	47.0	0.44	53.0	3.78
0 " - 3/4"	1.06	0.02	1.9	0.61	57.6	0.43	40.5	6.37
0 " - 1½"	1.03	0.01	1.0	0.56	54.4	0.46	44.6	5.72
0 " - 1/8"	1.16	0.04	3.5	0.71	61.2	0.41	35.3	10.23

TABLE VII. Chemical Analyses of Ash ≠

Screen sizes	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	Na_2O	K_2O	TiO_2	P_2O_5	SO_3	Total
1/8" - 4 "	55.4	27.8	5.6	2.2	1.3	1.4	3.2	0.8	0.1	2.3	100.1
0 " - 1/8"	51.6	25.6	7.2	7.1	1.4	1.2	2.1	0.6	0.1	3.2	100.1

≠ Analysis made in chemical laboratory, Division of Metallic Minerals, under the direction of J.A. Fournier, Chief Chemist.

GEORGE McKAY SEAM -- MILFORD MINE

TABLE VIII. Float and Sink Data on 1½" Slack - Ash and Sulphur

Specific gravity		Weight	Ash	Sulphur	Cumulative						±.10 specific gravity distribution	
					Floats			Sinks				
Sinks	Floats	%	%	%	Weight %	Ash %	Sulphur %	Weight %	Ash %	Sulphur %	Gravity	Calculated ordinate
											1.35	83.2
	1.30	5.5	3.8	0.6	5.5	3.8	0.6	100.0	16.3	1.1	1.40	83.8
1.30	1.40	64.4	10.2	0.8	69.9	9.7	0.7	94.5	17.1	1.2	1.45	31.0
1.40	1.50	15.2	21.1	1.3	85.1	11.7	0.8	30.1	31.7	2.1	1.55	13.8
1.50	1.60	4.9	27.6	2.5	90.0	12.6	0.9	14.9	42.6	2.9	1.65	6.0
1.60		10.0	49.8	3.0	100.0	16.3	1.1	10.0	49.8	3.0	1.75	2.9
Curve No. 4			2	2	1,2,4	1	1	3	3	3	5	5

TABLE IX. Chemical Analysis And Fusibility of Ash on Float and Sink Portions of 1½" Slack (Dry Basis)

Specific gravity		Ash	Volatile matter	Fixed carbon	Coking properties	Sulphur	Initial deformation	Softening point	Fluid temperature	Melting range	Softening interval	Flow interval
Sinks	Floats	%	%	%		%	°F.	°F.	°F.	°F.	°F.	°F.
	1.30	3.9	33.1	63.0	Poor to fair	0.7	2350	2450	2500	150	100	50
1.30	1.40	10.6	31.6	57.8	Poor	0.8	2630	2720	2750	120	90	30
1.40	1.50	21.6	22.5	52.9	Agglomerating to poor	1.3	2570	2670	2700	130	100	30
1.50	1.60	28.1	25.3	46.6	Agglomerating	2.6	2150	2250	2360	210	100	110
1.60		50.6	19.9	29.5	Non-agglomerating	3.1	2150	2250	2350	200	100	100

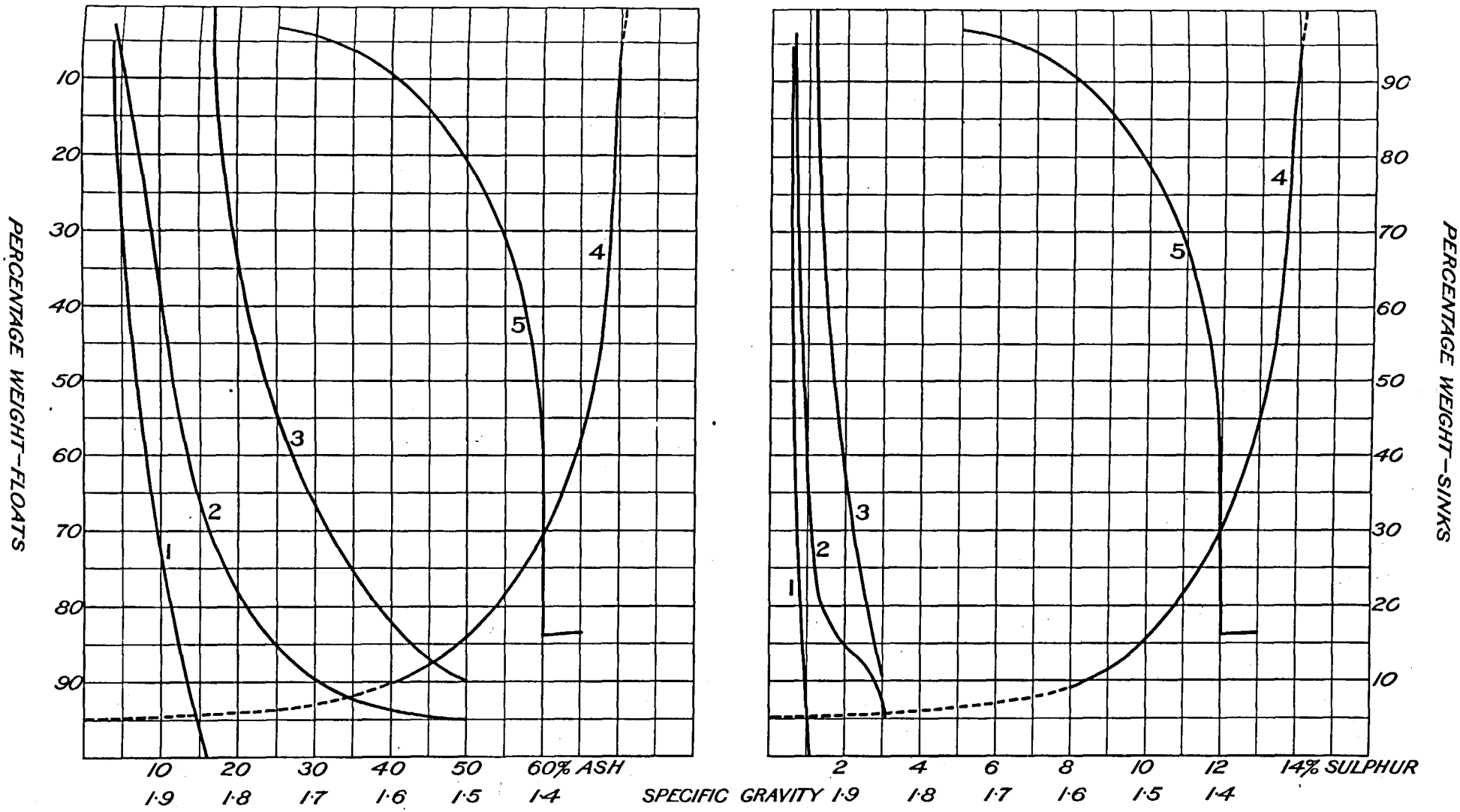

Fig. 13 - Washability Curves for George McKay Seam--Milford Mine

Curve 1 - Cumulative coal-ash or sulphur percentage (float).
Curve 2 - Actual ash or sulphur percentage.
Curve 3 - Cumulative slate-ash or sulphur percentage (sink).
Curve 4 - Specific gravity.
Curve 5 - ±.10 specific gravity distribution.

TABLE X. Chemical Analyses, Fusain and Sulphur Forms of Raw Coal, Clean Coal and Refuse

---	Raw coal	Clean coal Floats 1.60	Refuse Sinks 1.60
Weight.....%	100.0	84.3	15.7
Proximate analysis (dry basis)--			
Ash.....%	17.6	13.0	48.1
Volatile matter.....%	28.3	31.4	20.0
Fixed carbon.....%	54.1	55.6	31.9
Sulphur.....%	1.1	0.8	2.4
Calorific value.....B.t.u./lb.	12,085	12,765	....
Fusion point of ash.....°F.	2480	2500	2280
Melting range of ash.....°F.	190	140	100
Coking properties.....	Poor	Poor	Non-agglomerating
Fusain in pure coal.....%	5.72	2.75	18.00
Sulphur forms--as percentage of total sulphur:			
Sulphate sulphur.....%	1.0	0.6	2.2
Pyritic sulphur.....%	54.4	38.9	86.8
Organic sulphur.....%	44.6	60.5	11.0

TABLE XI. Screen and Chemical Analyses of Sizes Prepared From 1½" Slack, and Analyses of the Clean Coal and Refuse of These Sizes After Washing at a Selected Gravity of 1.60

Screen sizes	Weight	Cumulative weight	Ash	Sul-phur	F.P.A.	Floats				Sinks			
						Weight	Ash	Sul.	F.P.A.	Weight	Ash	Sul.	F.P.A.
	%	%	%	%	°F.	%	%	%	°F.	%	%	%	°F.
3/4" - 1½"	32.5	32.5	15.7	0.9	2610	93.6	13.8	0.8	2780	6.4	60.2	1.5	2430
1/8" - 3/4"	50.0	82.5	16.0	1.0	2610	89.2	13.0	0.9	2700	10.8	50.4	2.9	2350
0 " - 1/8"	17.5	100.0	20.0	1.2	2300	70.1	12.3	0.9	2460	29.9	37.7	2.2	2330

GEORGE McKAY SEAM -- MILFORD MINE

TABLE XII. Physical Properties Of By-product Cokes As Indicated By The 'Swelling Index' Test

	$1\frac{1}{2}$ inch slack	
	As received	After washing
Volatile matter at 600°C. (dry)...%	22.2	24.2
Swelling index.....	-180	-227
Section--Coke classification chart.	XIII	XIII
Specific volatile index.....	159.2	155.9
Section--Coal classification chart(	Border of C & D subbituminous	Border of C & D subbituminous
Ash per cent in coal (dry basis)..%	17.6	13.0
Physical properties of coke:		
Size on wharf (% on 3 in.....	....	....
(Breeze: % -1/2 in.	....	....
Shatter test. (Index: % on 2 in..	....	....
(Breeze: % -1/2 in.	....	....
Abrasion test (Index: % on $1\frac{1}{2}$ in.	....	....
(Dust: % -1/16 in..	....	....
Density (App. specific gravity...	....	....
(Pounds per cubic foot...	....	....
Transverse shrinkage.....	Good	
Appearance of natural surface....	Steel grey, granular	
Shape.....	Irregular	
Strength.....	Very fragile	
Cross fracture.....	Large amount	
Longitudinal fracture.....	Large amount	
Cell structure.....	Very little or none	
Sponge.....	Granular ends	
Pebbly seam.....	Very pebbly	
Remarks.....	This coal is practically non-coking.	Washing does not improve the coking properties.

Caking Properties

	Caking index by Gray's method
Run-of-mine sample.....	12

THORBURN DISTRICT
SIX-FOOT SEAM
ACADIA NO. 3 AND NO. 8 MINES, ACADIA COAL COMPANY LIMITED
THORBURN, NOVA SCOTIA

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TABLE I. Screen Analyses, Bulk Density and Apparent Specific Gravity

Screen sizes *	Screen analyses: As received % By weight	As received % Cumulative	As mined % By weight	As mined % Cumulative	Bulk density --- lb. per cu. ft.	Apparent specific gravity	Void %	Ash %
Plus 4 "	15.3	15.3	30.1	30.1	.....	....	....	19.2
2 " - 4 "	21.8	37.1	18.7	48.8	42.00	1.37	50.9	18.9
1½" - 2 "	8.5	45.6	6.5	55.3	42.50	1.37	50.3	20.0
1 " - 1½"	12.6	58.2	9.8	65.1	43.25	1.41	50.9	19.6
3/4" - 1 "	8.3	66.5	6.9	72.0	43.75	1.39	49.6	18.1
1/2" - 3/4"	9.6	76.1	8.6	80.6	44.00	1.38	48.9	18.1
1/4" - 1/2"	10.4	86.5	7.9	88.5	44.00	1.38	48.9	17.1
1/8" - 1/4"	5.9	92.4	5.0	93.5	44.00	1.37	48.6	18.6
No. 48 - 1/8"	5.4	97.8	4.7	98.2	48.00	1.36	43.5	22.9
0 " - No. 48	2.2	100.0	1.8	100.0				22.7
Mine run		100.0		100.0	53.00	1.38	38.5	18.6
0 " - 4 "		84.7		69.9	51.00	1.37	40.4	19.3
1/8" - 4 "		77.1		63.4	48.25	1.38	44.0	18.8
3/4" - 4 "		51.2		41.9	43.75	1.38	49.2	19.2ø
0 " - 3/4"		33.5		28.0	50.25	1.37	41.2	20.8
0 " - 1½"		34.4		44.7	52.50	1.38	39.1	19.7
0 " - 1/8"		7.6		6.5	48.00	1.36	43.5	22.4

	As mined	As received
Average size of run-of-mine coal.....in.	3.06	2.22
Size stability during handling from mine to Ottawa.....%		73

* In this and subsequent tables, all screens 1/8" and larger are round-hole screens. No. 48 is Tyler 48-mesh with nominal aperture of 0.295 mm.

ø Ash percentage calculated from those of individual screen sizes.

SIX-FOOT SEAM -- ACADIA NO. 3 AND NO. 8 MINES

TABLE II. Size Stability

Screen sizes	Screen analyses before and after drop-shatter test									
	Single sizes				Mixed sizes					
	2 - 3 inch		3 - 4 inch		3/4 - 4 inch			0 - 4 inch		
	Before test %	After 2 drops %	Before test %	After 2 drops %	Before test %	After 2 drops %	After 4 drops %	Before test %	After 2 drops %	After 4 drops %
3 " - 4 "			100.0	48.0	15.8	12.9	12.5	9.6	6.7	3.8
2 " - 3 "	100.0	65.0		19.0	26.8	22.1	18.3	16.2	17.1	17.5
1½" - 2 "		12.0		9.0	16.6	13.8	12.9	10.0	8.7	8.7
1 " - 1½"		8.0		9.5	24.6	23.3	21.7	14.9	17.1	16.3
3/4" - 1 "		4.5		4.0	16.2	15.0	15.0	9.8	11.3	10.4
1/2" - 3/4"		4.0		4.0		6.2	8.3	11.3	11.3	12.1
0 " - 1/2"		6.5		6.5		6.7	11.3	28.2	27.8	31.2
Average size..in.	2.50	2.02	3.50	2.51	1.96	1.73	1.60	1.33	1.27	1.17
Size stability..%		81		72		88	82		96	88

TABLE III. Grindability

Screen size of coal tested	Hardgrove index	
	Old	New
0" - 4 "	57	60
0" - 3/4"	55	57
0" - 1/8"	64	67

SIX-FOOT SEAM -- ACADIA NO. 3 AND NO. 8 MINES

TABLE IV. Proximate Analyses, Calorific Value and Fusibility Of Ash

Screen sizes	Moisture (as recd) %	Dry Basis: Ash %	Dry Basis: Volatile matter %	Dry Basis: Fixed carbon %	Dry Basis: Sulphur %	Dry Basis: Calorific value Btu/lb.	Initial deformation °F.	Softening temperature °F.	Fluid temperature °F.	Melting range °F.	Softening interval °F.	Flow interval °F.
Plus 4 "	3.2	19.2	28.6	52.2	1.2	.....	2660	2770	2800	140	110	30
2 " - 4 "	2.7	18.9	29.2	51.9	0.8	.....	2720	2800	2840	120	80	40
1½" - 2 "	2.6	20.0	29.2	50.8	0.6	.....	2500	2600	2680	180	100	80
1 " - 1½"	2.5	19.6	29.1	51.3	0.6	.....	2720	2820	2850	130	100	30
3/4" - 1 "	2.3	18.1	29.1	52.8	0.7	.....	2780	2830	2850+	70+	50	20+
1/2" - 3/4"	2.7	18.1	29.4	52.5	0.7	.....	2760	2800	2850+	90+	40	50+
1/4" - 1/2"	2.6	17.1	29.3	53.6	0.7	.....	2720	2790	2850	130	70	60
1/8" - 1/4"	2.4	18.6	28.4	53.0	0.9	.....	2650	2750	2800	150	100	50
No. 48 - 1/8"	2.2	22.9	26.7	50.4	0.9	.....	2500	2650	2770	270	150	120
0 " - No. 48	1.0	22.7	21.0	56.3	1.2	.....	2340	2420	2470	130	80	50
Mine run	3.1	18.6	28.6	52.8	0.7	11,915	2720	2780	2820	100	60	40
0 " - 4 "	2.7	19.3	29.0	51.7	0.7	11,850	2450	2640	2720	270	190	80
1/8" - 4 "	2.9	18.8	28.8	52.4	0.7	11,865	2700	2750	2810	110	50	60
3/4" - 4 "	2.8	19.2	28.7	52.1	0.8	11,765	2450	2500	2560	110	50	60
0 " - 3/4"	2.7	20.8	27.5	51.7	0.8	11,525	2560	2640	2740	180	80	100
0 " - 1½"	2.8	19.7	28.2	52.1	0.7	11,735	2600	2720	2760	160	120	40
0 " - 1/8"	2.3	22.4	24.7	52.9	1.0	11,200	2320	2400	2460	140	80	60

TABLE V. Ultimate Analyses (Dry Basis)

Screen sizes	Carbon	Hydrogen	Sulphur	Nitrogen	Oxygen	Ash
1/8" - 4 "	67.8	4.7	0.7	1.8	6.2	18.8
0 " - 1/8"	65.3	4.7	1.0	1.5	5.1	22.4

SIX-FOOT SEAM -- ACADIA NO. 3 AND NO. 8 MINES

TABLE VI. Sulphur Forms and Fusain

Screen sizes	Total sulphur	Sulphate sulphur		Pyritic sulphur		Organic sulphur		Fusain
	% of coal	% of coal	% of sulphur	% of coal	% of sulphur	% of coal	% of sulphur	% of pure coal
Mine run	0.70	Trace	Trace	0.25	35.7	0.45	64.3	....
0 " - 4 "	0.65	Trace	Trace	0.23	35.4	0.42	64.6	4.52
1/8" - 4 "	0.71	Trace	Trace	0.26	36.6	0.45	63.4	4.38
3/4" - 4 "	0.77	Trace	Trace	0.27	35.1	0.50	64.9	3.64
0 " - 3/4"	0.82	Trace	Trace	0.40	48.8	0.42	51.2	6.22
0 " - 1½"	0.69	Trace	Trace	0.26	37.7	0.43	62.3	5.41
0 " - 1/8"	1.01	0.02	2.0	0.50	49.5	0.49	48.5	11.26

TABLE VII. Chemical Analyses of Ash ✓

Screen sizes	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	Na_2O	K_2O	TiO_2	P_2O_5	MnO	SO_3	Total
1/8" - 4 " %	59.1	27.5	4.2	2.4	0.7	0.9	2.1	1.0	0.1	0.2	1.8	100.0
0 " - 1/8" %	49.1	27.1	6.0	7.1	0.6	0.8	2.3	0.6	0.1	0.3	5.3	99.3

✓ Analysis made in chemical laboratory, Division of Metallic Minerals, under the direction of J.A. Fournier, Chief Chemist.

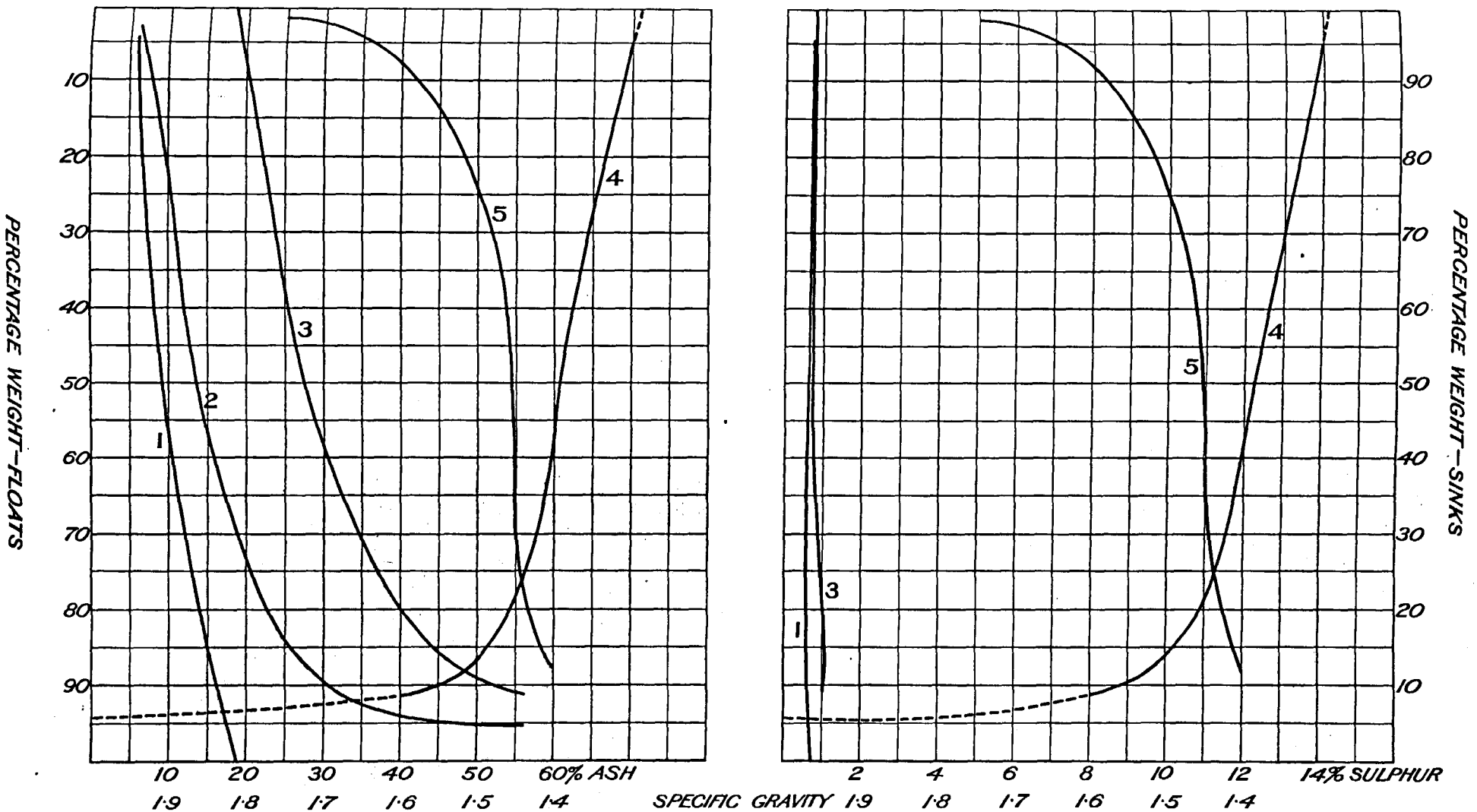


Fig. 14 - Washability Curves for Six-Foot Seam--Acadia No. 3 and No. 8 Mines

Curve 1 - Cumulative coal-ash or sulphur percentage (float).
Curve 2 - Actual ash or sulphur percentage.
Curve 3 - Cumulative slate-ash or sulphur percentage (sink).
Curve 4 - Specific gravity.
Curve 5 - ±.10 specific gravity distribution.

TABLE VIII. Float and Sink Data on 1½" Slack - Ash and Sulphur

Specific gravity		Weight	Ash	Sulphur	Cumulative						±.10 specific gravity distribution	
					Floats			Sinks				
Sinks	Floats	%	%	%	Weight %	Ash %	Sulphur %	Weight %	Ash %	Sulphur %	Gravity	Calculated ordinate
											1.35	83.2
	1.30	4.5	5.9	0.7	4.5	5.9	0.7	100.0	18.5	0.7	1.40	88.1
1.30	1.40	52.6	11.1	0.6	57.1	10.8	0.6	95.5	19.0	0.7	1.45	65.8
1.40	1.50	30.5	20.7	0.6	87.6	14.2	0.6	42.9	28.7	0.7	1.55	14.3
1.50	1.60	3.5	29.4	1.3	91.1	14.8	0.6	12.4	48.4	1.1	1.65	3.2
1.60		8.9	55.9	1.0	100.0	18.5	0.7	8.9	55.9	1.0	1.75	1.6
Curve No. 4			2	2	1,2,4	1	1	3	3	3	5	5

TABLE IX. Chemical Analysis and Fusibility of Ash On Float and Sink Portions of 1½" Slack (Dry Basis)

Specific gravity		Ash	Volatile matter	Fixed carbon	Coking properties	Sulphur	Initial deformation	Softening point	Fluid temperature	Melting range	Softening interval	Flow interval
Sinks	Floats	%	%	%		%	°F.	°F.	°F.	°F.	°F.	°F.
	1.30	6.0	32.5	61.5	Poor	0.7	2320	2390	2410	90	70	20
1.30	1.40	11.4	32.1	56.5	Poor	0.7	2550	2640	2680	130	90	40
1.40	1.50	21.2	28.5	50.3	Poor	0.6	2750	2850+	2850+	100+	+	+
1.50	1.60	29.9	25.9	44.2	Agglomerating	1.4	2300	2420	2560	260	120	140
1.60		56.8	17.8	25.4	Non-agglomerating	1.0	2550	2710	2850+	300+	160	140+

SIX-FOOT SEAM -- ACADIA NO. 3 AND NO. 8 MINES

TABLE X. Chemical Analyses, Fusain and Sulphur Forms of Raw Coal, Clean Coal and Refuse

---	Raw coal	Clean coal Floats 1.60	Refuse Sinks 1.60
Weight.....%	100.0	91.6	8.4
Proximate analysis (dry basis)--			
Ash.....%	19.7	15.9	62.5
Volatile matter.....%	28.2	30.8	17.0
Fixed carbon.....%	52.1	53.3	20.5
Sulphur.....%	0.7	0.6	0.8
Calorific value.....B.t.u./lb.	11,735	12,360	....
Fusion point of ash.....°F.	2720	2850+	2680
Melting range of ash.....°F.	160	+	170
Coking properties.....	Poor	Poor	Non-agglomerating
Fusain in pure coal.....%	5.41	2.54	17.46
Sulphur forms--as percentage of total sulphur:			
Sulphate sulphur.....%	Trace	Trace	2.8
Pyritic sulphur.....%	37.7	30.0	71.9
Organic sulphur.....%	62.3	70.0	25.3

TABLE XI. Screen and Chemical Analyses of Sizes Prepared From 1½" Slack and Analyses of the Clean Coal and Refuse of These Sizes After Washing at a Selected Gravity of 1.60

Screen sizes	Weight	Cumulative weight	Ash	Sul-phur	F.P.A.	Floats				Sinks			
						Weight	Ash	Sul.	F.P.A.	Weight	Ash	Sul.	F.P.A.
	%	%	%	%	°F.	%	%	%	°F.	%	%	%	°F.
3/4" - 1½"	38.4	38.4	19.0	0.7	2820	92.1	17.3	0.6	2830	7.9	52.6	0.5	2480
1/8" - 3/4"	47.6	86.0	18.1	0.7	2780	90.6	14.5	0.7	2850+	9.4	68.3	0.6	2850+
0 " - 1/8"	14.0	100.0	22.4	1.0	2400	76.3	12.2	0.8	2680	23.7	55.9	1.8	2550

SIX-FOOT SEAM -- ACADIA NO. 3 AND NO. 8 MINES

TABLE XII. Physical Properties Of By-Product Cokes As Indicated By The 'Swelling Index' Test

	1½ inch slack	
	As received	After washing
Volatile matter at 600°C. (dry)...%	23.0	24.1
Swelling index.....	-344	-166
Section--Coke classification chart.	XIII	XIII
Specific volatile index.....	158.0	157.6
Section--Coal classification chart.	Border of C & D subbituminous to parabituminous	Border of C & D subbituminous to parabituminous
Ash per cent in coal (dry basis)..%	19.7	15.9
Physical properties of coke:		
Size on wharf % on 3 in.....	....	....
Size on wharf Breeze: % -1/2 in.	....	....
Shatter test. Index: % on 2 in..	....	....
Shatter test. Breeze: % -1/2 in.	....	....
Abrasion test Index: % on 1½ in.	....	....
Abrasion test Dust: % -1/16 in..	....	....
Density App. specific gravity...	....	....
Density Pounds per cubic foot...	....	....
Transverse shrinkage.....	Good	
Appearance of natural surface....	Steel grey, granular	
Shape.....	Irregular	
Strength.....	Very fragile	
Cross fracture.....	Large amount	
Longitudinal fracture.....	Large amount	
Cell structure.....	Very little or none	
Sponge.....	Granular ends	
Pebbly seam.....	Very pebbly	
Remarks.....	This coal is practically non-coking.	Washing does not improve the coking properties.

Caking Properties

	Caking index by Gray's method
Run-of-mine sample.....	12

Chapter IV

SUMMARY AND DISCUSSION OF RESULTS

Although the ten coal seams studied in the Pictou County coalfield occur in two different coal measures, they may be compared on the basis of their physical and chemical characteristics; because, in the first place, they are of the same age and, secondly, there is sufficient evidence to indicate that the two districts are related geologically.

Physical Properties

Size Distribution

The size distributions of the run-of-mine samples are shown in Table I under the respective seam designations. Figure 15 represents graphically, on a cumulative basis, the screen analyses of the coals 'as mined'. The average particle size of the coals 'as received', calculated from the screen analyses in accordance with the method referred to in the Appendix and as shown below, indicates the difference in size between the products of the various seams in the three districts.

Generally speaking, the greater the average size of run-of-mine coal the smaller is the proportion of fine sizes produced and the greater is the quantity of large lump. This is also clearly shown in the following table.

District	Seam	Average particle size inches	+4 in. lump %	1½ in. slack %	-1/8 in. fines %	Dust -48 mesh %
Westville.	Second.....	3.83	47.3	32.0	6.8	2.0
Stellarton	Fleming.....	3.21	35.8	46.3	7.3	1.6
Westville.	Main.....	2.94	31.6	44.0	10.9	3.2
Thorburn..	George McKay	2.87	29.9	45.6	8.0	2.5
Stellarton	Foord.....	2.85	29.7	46.0	10.4	3.1
Stellarton	Cage.....	2.82	26.4	50.2	7.0	1.9
Thorburn..	Six-Foot....	2.22	15.3	34.4	7.6	2.2
Stellarton	Third.....	2.03	18.7	67.8	13.5	3.7
Stellarton	Four-Foot...	1.96	17.0	63.4	14.5	3.2
Stellarton	McGregor....	1.73	14.7	72.4	18.1	4.4

As judged by the quantity of 1½ inch slack present in the run-of-mine coal, in only three cases can the coals be considered to be very friable in comparison to the others, namely: the McGregor seam, Third seam and Four-Foot seam coals, all in the Stellarton district.

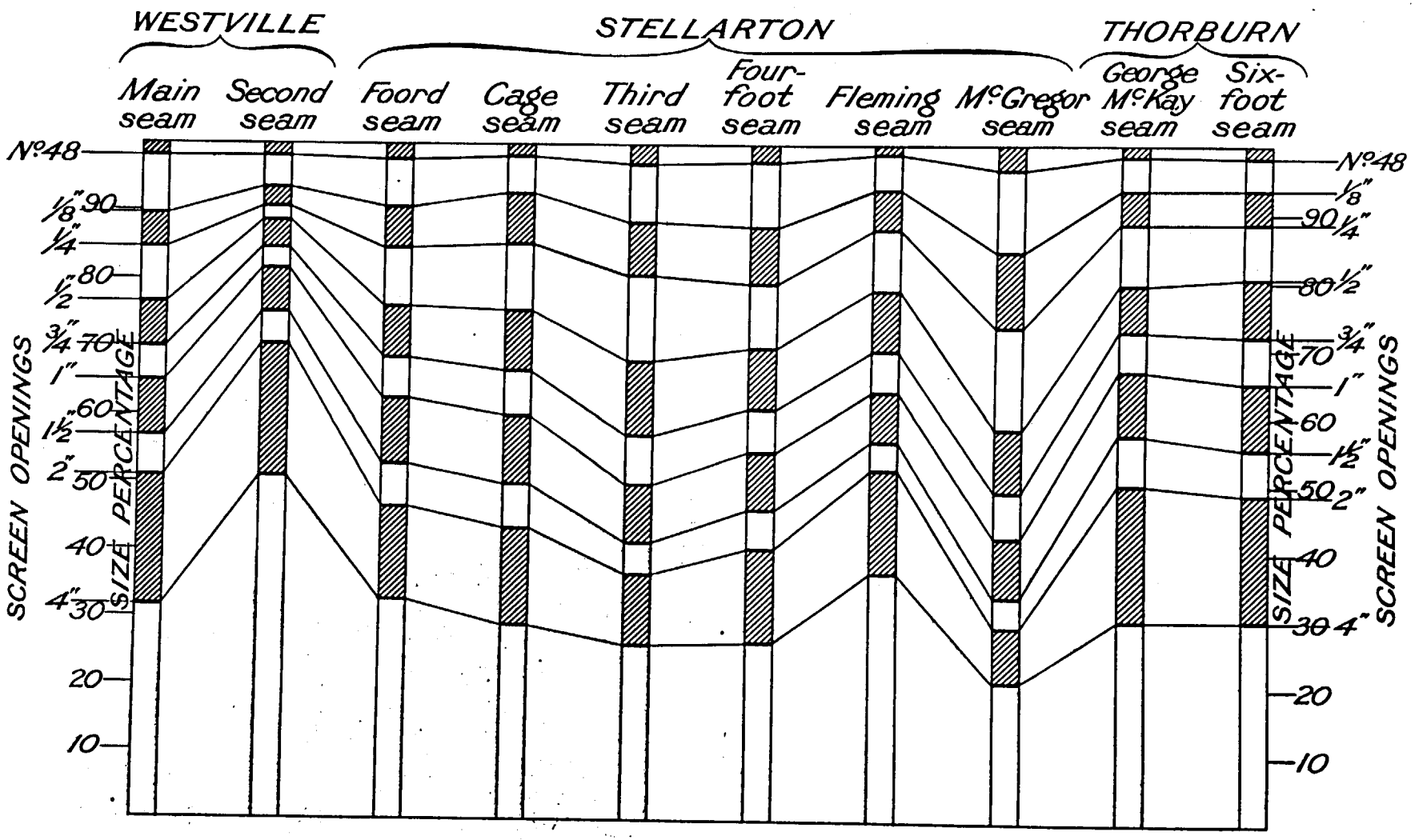


Fig. 15 - Comparative Screen Analyses (as received)

The quantity of fines, that is material passing a 1/8 inch screen, and of dust, that is material passing a 48 mesh screen, varies considerably from seam to seam, and the variation is only roughly proportional to the average particle size of the coal as mined.

Density

The apparent specific gravity, bulk density and 'void' for each of the various sizes passing the 4-inch screen from the ten coal seams are shown in Table I under the respective seam designations. The following table gives the minimum and maximum values obtained for these characteristics.

Seam	Apparent specific gravity	Bulk density lb. / cu.ft.	Void %	Ash %
Main.....	1.32-1.35	41.50-44.00	46.7-50.3	10.7-15.0
Second.....	1.40-1.45	45.00-46.00	48.0-49.7	19.1-21.5
Foord.....	1.33-1.40	43.00-44.25	47.0-50.5	14.6-17.2
Cage.....	1.31-1.38	42.50-42.75	48.1-50.4	12.1-14.5
Third.....	1.29-1.35	41.00-42.00	47.9-50.5	11.9-15.9
Four-Foot....	1.32-1.37	41.75-43.50	48.8-49.9	12.2-18.5
Fleming.....	1.24-1.40	43.75-44.50	43.6-50.0	12.9-16.6
McGregor.....	1.29-1.38	42.50-44.00	46.6-49.0	14.4-21.2
George McKay.	1.37-1.39	39.50-45.25	47.5-54.2	15.0-16.8
Six-Foot.....	1.37-1.41	42.00-44.00	48.6-50.9	17.1-20.0

The above results indicate some variation in density characteristics for the various sizes of the same coal and substantial variation in the corresponding sizes of the different coals. Broadly speaking for coal in general, it may be said that the apparent specific gravity increases mainly with an increase in ash, whereas the bulk density is influenced not only by the ash content but also by the size and shape of the particles. However, when the ash is fairly high, as in the case of the coal from the Pictou coalfield, the high-ash coals show definitely not only higher apparent gravity but also higher bulk density.

'Void', which is the volume of free space between the particles of coal, depends upon the apparent gravity of the coal as well as on the bulk density, thus implying the influence of size, shape, total moisture and ash. It should be noted that the smaller individual sizes usually show a lower void than the larger lump sizes. Where there is a mixture of large and small coal the percentage of void is lower than for the corresponding sizes. Except in the case of the very fine coal, the smaller mixed sizes, as in the case of the single sizes, show a lower void than the larger sizes.

Size Stability (by Drop-shatter Tests)

The size degradation, after a standardized amount of handling, of the various sizes and size mixtures of the ten coals is shown in Table II under the respective seam designations. Shatter tests on the 2 to 3 inch and the 3 to 4 inch sizes were made in order to obtain a comparison of the relative size stability of the coals. The following table summarizes these data.

District	Seam	Size Stability Per Cent (After 2 Drops)	
		2 - 3 inch coal	3 - 4 inch coal
Westville.	Main.....	82	75
	Second.....	87	80
Stellarton	Foord.....	84	77
	Cage.....	84	78
	Third.....	72	67
	Four-Foot...	82	75
	Fleming.....	80	72
	McGregor....	81	73
Thorburn..	George McKay	80	78
	Six-Foot....	81	72

The above values indicate that, based on the calculated average particle size of the coal before and after the standard shatter test for either of the sizes tested, the Third seam, Stellarton, coal is the least stable, and the Second seam, Westville, coal is the most stable. It should be noted that the 2 to 3 inch size of the other coals is fairly uniform insofar as its stability to handling is concerned. The stabilities of mixed sizes, after 4 drops, are shown below.

District	Seam	Size Stability Per Cent (After 4 drops)	
		3/4 - 4 in. coal	0 - 4 inch coal
Westville.	Main.....	75	91
	Second.....	85	90
Stellarton	Foord.....	81	83
	Cage.....	84	86
	Third.....	73	88
	Four-Foot...	83	88
	Fleming.....	75	85
	McGregor....	80	86
Thorburn..	George McKay	77	88
	Six-Foot....	82	88

As is to be expected, the Third seam coal, when the lump sizes without the fines (that is, the 3/4 - 4 inch coal) are tested, exhibits the lowest size stability. In addition, it may be noted that four drops of the mixed 3/4 - 4 inch lumps of this coal do not affect the size stability of the mixture to any greater degree than two drops of the individual 2 to 3 inch size. This result indicates the cushioning effect of the small lump sizes. The results of the shatter tests on the 0 to 4 inch mixtures show to even a greater extent the cushioning effect of the small lumps and fines. The size stabilities of the various 0 to 4 inch coal mixtures tend to be uniformly high.

Grindability

The Hardgrove indices of grindability for three size mixtures of the Pictou county coals are shown in Table III under the respective seam designations. The table below, giving the Hardgrove indices (new) of the 0 to 3/4 inch slack, shows that there is a substantial variation in the grindability characteristics of the different seams. The higher figures represent greater amenability to grinding, and it will be noted that those coals with the lowest moisture content are generally the most easily pulverized. The influence of moisture on the ease of grinding is praticularly noticeable in the case of the George McKay seam coal, where the Hardgrove index has dropped to 59. There is a tendency for the low-ash coals to be the most readily ground. This tendency is more marked in the different sizes of the same coal than it is in the different coals. Only the coals from the Main, Second, Foord and Four-Foot seams may be considered as fuels which can be ground with relative ease. The other coals, either by reason of their high moisture and/or ash contents or due to the inherent structure of the coal, cannot be considered as very amenable to grinding, as judged by the Hardgrove test.

District	Seam	Hardgrove Grindability Index 0 - 3/4 inch slack	Moisture %	Ash %
Westville...	Main.....	82	2.2	16.1
	Second.....	77	1.4	20.5
Stellarton..	Foord.....	78	1.5	15.3
	Cage.....	61	2.4	13.6
	Third.....	68	1.6	12.4
	Four-Foot...	81	1.3	13.2
	Fleming.....	73	1.6	13.8
	McGregor....	68	1.7	14.6
Thorburn....	George McKay	59	3.4	17.9
	Six-Foot....	57	2.7	20.8

Chemical Properties

Proximate Analyses

The proximate analyses of the various screened sizes and composites of the screen sizes for the Pictou County coals are shown in Table IV under the respective seam designations. As the values obtained for the run-of-mine composites may be considered to be representative, these results are used for comparative purposes as shown below.

It should be noted that the ash contents are fairly high, ranging from 12.6% for the Main seam coal to 20.9% for the Second seam coal, both being Westville coals. It should also be noted that on the average the Stellarton district coals are lower in ash than are the coals from the other two districts.

District	Seam	Proximate analyses			
		Moisture as received	Dry basis		
			Volatile matter	Fixed carbon	Ash
Westville.	Main.....%	1.1	27.1	60.3	12.6
	Second.....%	1.6	23.9	55.2	20.9
Stellarton	Foord.....%	1.5	27.9	56.2	15.9
	Cage.....%	2.4	29.9	57.0	13.1
	Third.....%	1.9	28.3	58.7	13.0
	Four-Foot.....%	1.4	29.4	55.5	15.1
	Fleming.....%	1.7	27.6	58.0	14.4
	McGregor.....%	1.9	27.6	55.7	16.7
Thorburn..	George McKay....%	3.9	29.3	53.8	16.9
	Six-Foot.....%	3.1	28.6	52.8	18.6

Generally speaking, the larger the coal the higher is the ash content, but it should be noted that in most cases there is not a very great variation in ash content from size to size. The table below, which shows the ash contents of a composite of lumps and of a composite of fines, indicates the uniformity in ash content of the various sizes for each coal and also shows that in only three cases do the fines contain more ash than the lump sizes.

District	Seam	Ash (Dry Basis) 3/4 - 4 inch coal	Ash (Dry Basis) 0 - 1/8 inch coal
Westville.	Main.....%	12.6	18.0
	Second.....%	21.5	19.8
Stellarton	Foord.....%	16.8	13.4
	Cage.....%	14.5	13.7
	Third.....%	13.9	12.2
	Four-Foot.....%	16.8	12.4
	Fleming.....%	16.4	14.0
	McGregor.....%	16.9	14.4
Thorburn..	George McKay....%	16.0	20.0
	Six-Foot.....%	19.2	22.4

The moisture contens of the Westville and Stellarton districts coals are uniformly low, ranging from 1.1 to 2.4 per cent for the run-of-mine size, whereas the coals from the Thorburn district exhibit comparatively higher moisture contents.

On the dry, ash-free basis, the proximate analyses of the 0 to 4 inch coals from the ten seams are as follows:-

District	Seam	Volatile matter	Fixed carbon
Westville.	Main.....%	31.0	69.0
	Second.....%	30.2	69.8
Stellarton	Foord.....%	33.2	66.8
	Cage.....%	34.4	65.6
	Third.....%	32.5	67.5
	Four-Foot.....%	34.6	65.4
	Fleming.....%	32.2	67.8
	McGregor.....%	33.1	66.9
Thorburn..	George McKay....%	35.3	64.7
	Six-Foot.....%	35.1	64.9

The change in the volatile matter contents of the coals from district to district is noteworthy, there being an increase from west to east. In this connection, it should be noted that the Thorburn district coals, which have the highest volatile matter, are the youngest. These coals do not occur in either the Stellarton or Westville districts, the measures in which they occur having been eroded. The difference between the volatile matter contents of the Westville and Stellarton coals indicates that none of the seams in the one district are repeated in the other, as has been suggested from a geological study of the districts.

Calorific Value

The calorific values of the various composites of screened sizes are shown in Table IV referred to above. Calculated to the dry, ash-free basis, these values are as follows.

Seam	Calorific Value--B.t.u./lb. (Dry, ash-free Basis)						
	0 - 4 inch	1/8 - 4 inch	3/4 - 4 inch	0 - 3/4 inch	0 - 1½ inch	0 - 1/8 inch	Average
Westville							
Main.....	15,145	15,125	15,150	15,190	14,990	15,010	15,100
Second.....	15,000	14,995	15,005	14,815	14,900	14,930	14,940
Stellarton							
Foord.....	15,400	15,350	15,275	15,265	15,290	15,380	15,325
Cage.....	14,790	14,850	14,740	14,825	14,680	14,645	14,755
Third.....	15,105	15,075	15,060	15,055	15,000	15,010	15,050
Four-Foot...	15,105	15,200	15,120	15,185	15,100	15,060	15,130
Fleming.....	15,110	15,160	15,120	15,135	15,195	15,025	15,125
McGregor....	14,975	15,005	15,005	14,925	14,935	14,975	14,970
Thorburn							
George McKay	14,665	14,715	14,630	14,660	14,665	14,460	14,630
Six-Foot....	14,685	14,610	14,560	14,550	14,615	14,430	14,575

The average values for the ten coals indicate that the Thorburn district coals are lower in calorific value than the coals from the other two districts. It should also be noted that the Foord seam coal in the Stellarton district exhibits the highest heating value on the dry, ash-free basis, whereas the Cage seam coal shows the lowest heating value.

The average calorific values for the run-of-mine composites of the above coals are as follows:

District	Seam	Calorific Value (B.t.u./lb.)			Moisture	Ash, dry basis
		As received	Dry basis	Dry, ash-free basis	%	%
Westville.	Main.....	13,010	13,155	15,050	1.1	12.6
	Second.....	11,610	11,800	14,920	1.6	20.9
Stellarton	Foord.....	12,755	12,950	15,400	1.5	15.9
	Cage.....	12,500	12,810	14,740	2.4	13.1
	Third.....	12,870	13,120	15,080	1.9	13.0
	Four-Foot...	12,605	12,785	15,050	1.4	15.1
	Fleming.....	12,745	12,965	15,140	1.7	14.4
	McGregor....	12,270	12,510	14,980	1.9	16.7
Thorburn..	George McKay	11,705	12,180	14,650	3.9	16.9
	Six-Foot....	11,545	11,915	14,640	3.1	18.6

The above data confirm the observation made above, that the Thorburn district coals are lower in heat value than the coals from the other districts. This difference must be constitutional, as it cannot be accounted for by a difference in either the quantity or quality of the mineral matter associated with the coal.

Ultimate Analyses

The ultimate analyses, that is the carbon, hydrogen, sulphur, nitrogen and oxygen contents of the coals from the Pictou coalfield, are shown in Table V under the respective seam designations. In order to correlate these data, the values obtained for the composites of screen sizes passing a 4-inch round-hole screen and retained on a 1/8-inch screen are shown in the following table.

District and Seam	Ultimate analyses (dry basis)					
	Carbon	Hydrogen	Sulphur	Nitrogen	Oxygen	Ash
Westville						
Main.....%	74.3	4.5	1.0	2.1	4.4	13.7
Second.....%	67.8	4.3	1.7	1.8	3.4	21.0
Stellarton						
Foord.....%	72.3	4.8	0.9	2.0	3.7	16.3
Cage.....%	72.5	4.4	1.7	1.9	5.1	14.4
Third.....%	74.9	4.8	1.4	1.8	4.7	12.4
Four-Foot.....%	72.2	4.7	1.4	1.8	4.5	15.4
Fleming.....%	72.8	4.8	1.3	1.6	4.6	14.9
McGregor.....%	70.8	4.6	1.3	1.8	4.2	17.3
Thorburn						
George McKay..%	70.5	4.9	0.9	1.9	5.6	16.2
Six-Foot.....%	67.8	4.7	0.7	1.8	6.2	18.8

For comparative purposes, the ultimate analyses on the dry, ash-and-sulphur-free basis are more indicative of the quality of the pure coal material, as shown below.

District	Seam	Ultimate analyses (dry, ash-and-sulphur-free basis)			
		Carbon	Hydrogen	Nitrogen	Oxygen
Westville.	Main.....%	87.1	5.3	2.5	5.1
	Second.....%	87.7	5.6	2.3	4.4
Stellarton	Foord.....%	87.3	5.8	2.4	4.5
	Cage.....%	86.4	5.2	2.3	6.1
	Third.....%	86.9	5.6	2.1	5.4
	Four-Foot.....%	86.8	5.6	2.2	5.4
	Fleming.....%	86.9	5.7	1.9	5.5
	McGregor.....%	87.0	5.7	2.2	5.1
Thorburn..	George McKay..%	85.0	5.9	2.3	6.8
	Six-Foot.....%	84.2	5.8	2.2	7.8

These values show the same trend as do the results of the proximate analyses and calorific values. The Thorburn district coals are lowest in carbon and highest in hydrogen and oxygen. The Westville district coals have the highest carbon and lowest oxygen, although the difference between these coals and those from the Stellarton district is not very marked.

It should be noted that the sulphur for all these coal is generally low, ranging from 0.7 to 1.7 per cent.

Fusibility of Ash

The fusibilities of ash, which include the temperature of initial deformation, the softening temperature and fluid temperature, as determined by the gas furnace method in a reducing atmosphere, are shown in Table IV under the respective seam designations. The temperature intervals between the above empirical points are also shown in Table IV. For comparative purposes, the results obtained on the composite samples of mine-run of each coal are shown below.

	Ash Fusibility					
	Initial deformation °F.	Softening temperature °F.	Fluid temperature °F..	Melting range °F.	Softening interval °F.	Flow interval °F.
Westville						
Main.....	2210	2300	2450	240	90	150
Second.....	2460	2520	2610	150	60	90
Stellarton						
Foord.....	2700	2780	2835	135	80	55
Cage.....	2210	2450	2570	360	240	120
Third.....	2360	2530	2630	270	170	100
Four-Foot...	2250	2350	2560	310	100	210
Fleming.....	2240	2500	2610	370	260	110
McGregor....	2600	2755	2780	180	155	25
Thorburn.						
George McKay	2470	2750	2850+	380+	280	100+
Six-Foot....	2720	2780	2820	100	60	40

There is apparently an appreciable variation in the softening temperatures of the ashes of the various seams, ranging from a low of 2300°F. to a high of 2780°F. This would indicate that there is quite a variation in the constitution of the mineral matter associated with the different coals. Reference to Table IV shows that in most cases the ash of the fines has a lower softening temperature than that of the lump sizes. In those coals where the softening temperature of the ash is low to medium, the fusibility of the ash is fairly uniform for all

the sizes with the exception of the fines. Where the coals exhibit a high softening temperature of ash, the fusibility tends to decrease with a decrease in the size of the coal. It should be noted that the Thorburn district coals examined showed a higher softening temperature of ash than the coals from the other districts, with the exception of the Foord and McGregor seam coals.

Chemical Analyses of the Ash

Table VII for each of the Pictou coals shows the chemical analyses of the ashes. For comparative purposes and in studying the relationship of the various ash components, the four-component system, SiO_2-Al_2O_3-Fe_2O_3-CaO, has been found to yield the most valuable information. The ash analyses of the 1/8 to 4 inch composites of the ten coals are presented in the following table, calculated on the four-component basis.

	Ash Analyses					Softening temperature of ash
	SiO_2 %	Al_2O_3 %	Fe_2O_3 %	CaO %	SiO_2+ Al_2O_3 %	°F.
Westville						
Main.....	63.3	24.8	7.6	4.3	88.1	2350
Second.....	57.4	32.2	7.6	2.8	89.6	2600
Stellarton						
Foord.....	59.7	31.6	6.9	1.8	91.3	2800
Cage.....	57.4	26.0	14.4	2.2	83.4	2450
Third.....	61.2	24.3	13.6	0.9	85.5	2530
Four-Foot.....	60.4	23.9	10.8	4.9	84.3	2360
Fleming.....	54.4	28.0	15.1	2.5	82.4	2400
McGregor.....	56.3	30.8	11.9	1.0	87.1	2640
Thorburn						
George McKay....	60.9	30.5	6.2	2.4	91.4	2800
Six-Foot.....	63.4	29.5	4.5	2.6	92.9	2750

It will be noted that, although all the coal ashes contain more than 80 per cent total SiO_2 and Al_2O_3, they vary from 82.4 to 92.9 per cent. The softening temperatures of the ashes vary roughly with the total amount of refractory constituents, the higher the SiO_2+Al_2O_3 compenents the higher the ash softening temperature. This effect is tempered by the influence of the relative proportions of lime and iron oxide, as for instance in the case of the Main seam coal ash. In this ash there is 88.1 per cent total SiO_2+Al_2O_3, but because the lime content is relatively high, namely: 4.3 per cent, the softening temperature of the ash has dropped rather low to 2350°F.

Sulphur Forms

The distribution of the forms in which the sulphur occurs in the coals, that is, the sulphate, pyritic and organic sulphur, is shown in Table VI under the respective seam designations. The comparative results for the composites of screen sizes making up mine-run coals are shown below.

District	Seam	Sulphur Forms			
		Total sulphur	Sulphate sulphur	Pyritic sulphur	Organic sulphur
		As Percentage of Coal			
Westville.	Main.....%	1.22	0.00	0.58	0.64
	*Second.....%	1.55	0.02	0.71	0.82
Stellarton	Foord.....%	0.71	0.00	0.17	0.54
	Cage.....%	1.49	0.05	0.66	0.78
	Third.....%	1.33	0.00	0.44	0.89
	Four-Foot....%	1.36	0.02	0.66	0.68
	Fleming.....%	1.18	0.00	0.41	0.77
	McGregor.....%	1.24	0.00	0.47	0.77
Thorburn..	George McKay.%	0.87	0.01	0.40	0.46
	Six-Foot.....%	0.70	Trace	0.25	0.45
		As Percentage of Total Sulphur			
Westville.	Main.....%	100.0	0.0	47.5	52.5
	*Second.....%	100.0	1.0	46.1	52.9
Stellarton	Foord.....%	100.0	0.0	23.9	76.1
	Cage.....%	100.0	3.6	44.1	52.3
	Third.....%	100.0	0.0	33.1	66.9
	Four-Foot....%	100.0	1.1	48.9	50.0
	Fleming.....%	100.0	0.0	34.7	65.3
	McGregor.....%	100.0	0.0	37.9	62.1
Thorburn..	George McKay.%	100.0	1.3	45.9	52.8
	Six-Foot.....%	100.0	Trace	35.7	64.3

* Analyses on 0 to 4 inch composite of screen sizes.

Generally, in low sulphur coals, the proportion of pyritic sulphur is quite low. Sulphur over and above 0.7 to 0.8 per cent is mainly due to the presence of pyrite. The coals in the Pictou coalfield are considered as medium to low sulphur fuels, and it will be noted that their pyritic sulphur contents are fairly low, ranging from 0.17% to 0.66% as a percentage of the total coal. The organic sulphur is more uniform, ranging from 0.45 to 0.89 per cent.

Fusain

The distribution of fusain in the ten coals studied is also shown in Table VI. The following summary indicates the distribution of the fusain in the different (composite) sizes of these coals.

District	Seam	Fusain as Per Cent of Pure Coal		
		Composite 0 - 4 in.	Composite 1/8 - 4 in.	Composite 0 - 1/8 in.
Westville.	Main.....	3.05	3.16	4.77
	Second.....	4.76	4.28	11.86
Stellarton	Foord.....	3.26	3.42	4.82
	Cage.....	5.77	5.62	11.27
	Third.....	6.10	5.95	9.79
	Four-Foot...	5.76	4.82	10.98
	Fleming.....	5.84	5.12	10.86
	McGregor....	6.06	5.74	11.64
Thorburn..	George McKay	4.69	4.50	10.23
	Six-Foot....	4.52	4.38	11.26

The fusain contents of all the coals but two are uniformly high, ranging from 4.52 to 6.10 per cent for the 0 to 4 inch composites. There is an appreciable concentration of fusain in the fines of all the coals, with the exception of the Main and Foord seam coals. It should be noted that these latter have the lowest fusain content, namely: 3.05 and 3.26 per cent in the 0 to 4 inch coal, and show only a proportionately small increase in the fines.

Classification By Rank

The ranks of the coals in the Pictou coal area, according to both the S.V.I. (Specific Volatile Index) and the A.S.T.M. (American Society for Testing Materials) systems of classification, are shown in Table XII under the respective seam designations. The S.V.I. classification is considered specially suitable for use in the by-product coking industry, and that designated as A.S.T.M. is the general classification recently adopted (internationally) for the scientific classification of North American coals. The table below is a comparison of the rank of these coals by the two systems of classification.

	S.V.I.	S.V.I. Classification ($1\frac{1}{2}$ in. slack) Group	A.S.T.M. Classification ($1\frac{1}{2}$ in. slack)
Westville			
Main.....	179.2	F : Orthobituminous	Medium Vol. Bit.
Second.....	179.5	G : Orthobituminous	Medium Vol. Bit.
Stellarton			
Foord.....	181.4	F : Orthobituminous	High Vol. A Bit.
Cage.....	163.2	D : Parabituminous	High Vol. A Bit.
Third.....	171.8	E : Parabituminous	High Vol. A Bit.
Four-Foot...	168.2	E : Parabituminous	High Vol. A Bit.
Fleming.....	165.8	E : Parabituminous	High Vol. A Bit.
McGregor....	169.1	E : Parabituminous	High Vol. A Bit.
Thorburn			
George McKay	155.9	C & D: Sub to Parabituminous	High Vol. A Bit.
Six-Foot....	157.6	C & D: Sub to Parabituminous	High Vol. A Bit.

According to the S.V.I. classification, the coals vary in rank from borderline sub- to parabituminous coals to orthobituminous. The Westville coals are highest in rank and those in the Thorburn district are lowest in rank, bordering on the subbituminous. All the Stellarton coals, with the exception of the Foord seam coal, are parabituminous gas coals, whereas the Foord coal is a natural by-product coking orthobituminous coal. This is in accordance with the various chemical and physical characteristics of the four coals discussed above.

According to the A.S.T.M. method of classification, the coals are either medium volatile bituminous or high volatile A bituminous. This classification does not appear to separate the coals as completely as the S.V.I. classification. However, examination of the moist mineral-matter-free calorific values of the coals upon which the A.S.T.M. classification is dependent would indicate a far greater difference between the coals than is evident from their position in the table.

Washing Characteristics

Laboratory washing tests on the coals from the ten seams in the Pictou County coalfield were conducted in the standard manner on the $1\frac{1}{2}$ inch slack, as described in the Appendix. The results obtained are reported in a series of tables and curves shown in Chapter III.

Float and Sink Data

The data obtained by the float and sink tests with respect to ash and sulphur are given in Table VIII under the respective seam designations. The inherent ash and sulphur contents, as indicated by the analyses of the fractions floating at a specific gravity of 1.30, are as follows.

District	Seam	Inherent Ash and sulphur		Coal recovery at 1.30 specific gravity	Ash in unwashed coal
		Ash %	Sulphur %	Per cent of total	Per cent
Westville.	Main.....	5.3	0.8	23.4	15.2
	Second.....	5.8	1.0	6.0	20.7
Stellarton	Foord.....	4.6	0.8	7.1	15.5
	Cage.....	5.3	1.2	5.7	13.5
	Third.....	5.1	1.5	21.0	12.7
	Four-Foot...	4.9	1.0	24.0	14.3
	Fleming.....	7.6	1.0	2.8	13.9
	McGregor....	5.6	1.1	11.7	15.8
Thorburn..	George McKay	3.8	0.6	5.5	17.6
	Six-Foot....	5.9	0.7	4.5	19.7

The inherent ash contents of the ten coals are fairly high and more or less uniform, whereas the inherent sulphur is low. The yield of relatively pure coal is comparatively low, a condition usually associated with high inherent ash.

The complete chemical analyses and ash fusibilities of the fractions separated at the various gravities are shown in Tables VIII and IX under the respective seam designations. In all cases, the heavier the material, that is, the higher the mineral matter, the lower are the volatile matter and fixed carbon. In addition, the coking properties of the fractions, as judged by the volatile matter button obtained at 950°C., decrease fairly rapidly with increase of gravity of separation. A study of the ash fusibility results indicates that in all cases, with the exception of the coal from the Six-Foot seam, the inherent ash has a substantially higher softening temperature than the extraneous material represented in the coal sinking at a specific gravity of 1.60. In the case of the Six-Foot seam coal, this condition is apparently reversed.

Washing at Selected Gravity

Simple wet washing, as indicated by the ±0.10 specific gravity distribution curves, was effected for all the coals by separation at a specific gravity of 1.60 in the case of seven of the coals, and at 1.50 in the case of the remaining three coals.

The results of washing the 1½ inch slacks at the selected gravities are presented in Table X which shows the analyses of the clean coal and refuse fractions. The table below shows the ash contents of the ten coals before and after washi together with the quantity of clean coal reclaimed.

District	Seam	Ash content		Clean Coa
		Raw coal	Clean coal	Reclaimed
Westville...	Main.....%	15.2	9.9	88.0
	Second.....%	20.7	15.3	85.9
Stellarton..	Foord.....%	15.5	12.4	87.9
	Cage.....%	13.5	11.5	93.9
	Third.....%	12.7	10.3	93.2
	Four-Foot.....%	14.3	11.5	92.0
	Fleming.....%	13.9	12.5	93.6
	McGregor.....%	15.8	12.3	89.0
Thorburn....	George McKay..%	17.6	13.0	84.3
	Six-Foot.....%	19.7	15.9	91.6

It should be noted that, in all cases, the ash reduction was not very great, irrespective of the quantity of ash present in the raw coal. This is due to the fact that the inherent ash is high and that there is a large high-ash middlings fraction. Very little reduction in sulphur content was obtaine because the sulphur content in the raw coal is relatively low and present to a large degree in the organic form.

Table X, showing the fusain contents of the clean coal, refuse and unwashed coal for each seam, indicates that, although there is always some concentration of this material in the refuse, in most cases the reduction in the clean coal has not been very high, except in the case of the Thorburn coals.

Table XI presents in detail the results obtained by washing various screened sizes of the ten coals at the selected gravities. Generally speaking, the finer sizes show a greater ash reduction with an attendant greater loss as refuse than do the coarser sizes of the 1½ inch slack. However, it should be noted that fines, material passing a 1/8 inch screen, are not readily cleaned by ordinary dry or wet washing processes, so that the results indicate only those which may be obtained by some process like froth flotation.

Coking Properties

The coking properties of the coals from the Pictou area, as indicated by laboratory tests, are shown in Table XII under the respective seam designations.

Swelling Index Test

The results of the swelling index test, which serves to predict the physical properties of the by-product coke made from a given coal, are given in Table XII. The table below presents the comparative pertinent data on the washed coals.

	Volatile matter at 600° C. (Dry Basis) %	Swelling index	Remarks	S.V.I.	Gray caking index.
Westville					
Main.....	21.8	459	Fair to good coke	179.2	49
Second.....	19.3	104	Poor coke	179.5	36
Stellarton					
Foord.....	23.1	238	Fair coke	181.4	46
Cage.....	23.3	-258	Practically non-coking	163.2	25
Third.....	23.4	-85	Very poor coke	171.8	44
Four-Foot...	25.1	438	Fair to good coke	168.2	49
Fleming.....	23.3	43	Practically non-coking	165.8	35
McGregor....	22.9	-87		169.1	36
Thorburn					
George McKay	24.2	-227	Practically non-coking	155.9	12
Six-Foot....	24.1	-166		157.6	12

The coals from this area vary substantially insofar as their amenability to by-product coke manufacture in standard by-product ovens is concerned. Amongst the ten coals there are only two, the Main seam coal in the Westville district and the Four-Foot seam coal in the Stellarton district, which, after washing, may be considered as suitable for by-product use when charged alone. The Foord seam coal would result in only a fair coke, but it may be satisfactory when blended with other suitable coals. Most of the other coals are either poorly coking or practically non-coking.

Caking Index (Gray Method)

This test, which at present is of doubtful value for Canadian coals, is included because it is felt that it may be shown to be related in some way to the reaction of fuels in combustion equipment. The results of the tests on coal samples

from the ten seams in the Pictou coalfield are shown in Table XII and in the table above for comparison. It will be noted that the caking index appears to decrease with a decrease in rank as indicated by the Specific Volatile Index.

Appendix

DESCRIPTION AND SIGNIFICANCE OF TESTS EMPLOYED IN PHYSICAL AND CHEMICAL SURVEY OF COALS FROM CANADIAN COLLIERIES (BUREAU OF MINES - MEMORANDUM SERIES)

The various tests described herein were employed at the Fuel Research Laboratories for studying the chemical and physical characteristics of (ton-lot) samples of coal from Canadian collieries. The data obtained by these tests have served for making a comparative scientific and economic evaluation of the coals examined.

Tests For Physical Properties

Size Distribution By Screen Analysis

The size distribution of the (run-of-mine) coal samples was determined, with slight modifications where necessary, according to the Tentative Method of Test for Screen Analysis of Coal, A.S.T.M. Designation D 410-35T, as described in the A.S.T.M. publication "Standards on Coal and Coke" prepared by Committee D-5, October 1938. Screens from the following series were used:-

1. Round-hole screens:- Plate screens with 4, 3, 2, $1\frac{1}{2}$, 1, 3/4, 1/2, 1/4 and 1/8 inch diameter openings; and
2. Sieves:- Wire-cloth Tyler sieves with square openings of 10, 20, 48, 60 and 100 meshes to the linear inch. The nearest equivalent A.S.T.M. designations for the above sieves are respectively: 1680, 840, 297, 250 and 149 microns (A.S.T.M. Designation E-11)

It is becoming increasingly evident that the performance of mechanical stokers, gas producers, and other coal burning appliances are dependent not only on the average and 'absolute' size of the fuel used but also on the size distribution or range of sizes, and fuel technologists are conducting considerable research on this subject. Bennett(1) has shown how the problem can be attacked by studying the physical nature of the process of breakage of coal and by making use of Rosin and Rammler's law, which governs the distribution of size in the material obtained in the course of its mining and subsequent breakage. Since the application to coal of that law is still a subject of discussion, the 'size distribution' and 'absolute size' constants have not been generally utilized. However, in order to compare the screen analyses of the different physical and chemical survey samples, the average size of the coal has been calculated according to the method used by Smith(2)(5),

where the percentage weight of each screen size is multiplied by its respective average screen hole diameter in inches, the sum total being the average (particle) size of the coal.

Density

Apparent specific gravity, or 'lump' density, equals the weight of unit volume of the solid fuel as a lump, including cracks and fissures, ash and moisture. This physical property was determined by a modification of the A.S.T.M. method for coke as outlined under A.S.T.M. Designation D 167-24. The modified apparatus and procedure, as developed by the Fuel Research Laboratories, has been reported in R.I.C.S. No. 35(3), as yet unpublished.

Bulk density equals the weight of the dry, or wet, fuel contained in a unit volume of packing space. This physical characteristic was determined according to the Standard Method of Test For Cubic Foot Weight of Crushed Bituminous Coal, A.S.T.M. Designation D 291-29.

The bulk density is a characteristic of coal which has a bearing upon the filling of such spaces as bunkers, freight cars, coke oven chambers, etc., and upon the storage of a given number of heat units within a given volume. The bulk density of a coal depends upon various factors such as: apparent specific gravity, particle size distribution, shape of particles, moisture content, thickness of bed, relation between mean particle size and dimensions of layer, duration of storage, and mode of packing (height of fuel, shaking, stamping, etc.). Hence, as pointed out by Rosin(4), it is evident that bulk density is not a "property of substance and is no exact characteristic" but a resultant of various factors.

The bulk density of a coal will be equal to its lump density (apparent specific gravity) if the interspaces between the grains become so small that they are completely filled by the adherent water retained by the capillary forces acting in the minute interspaces.

'Void' is the interspace volume between the coal particles. It is calculated as a percentage from:

$$1 - \left(\frac{\text{bulk density}}{62.5 \times \text{apparent specific gravity}} \right) \times 100$$

and is highest for a bed consisting of particles of equal size. It increases, however, inversely with the volume factor.

The relations between particle size, moisture, bulk density and 'void' are of great significance, especially for

carbonization, on account of their influence on packing, heat transfer and formation of the plastic layer. These relations are also fundamental in considering the following:- the dewatering of coal by drainage, shaking or centrifuging; the preparation of coal-oil mixtures; the dust-proofing of coal by oil spraying; the pitch consumption in briquetting; and the determination of the most economical compromise between the viscosity of a coal-oil mixture and the velocity of the reaction in the hydrogenation of coal.

Size Stability (and Friability)

Coal is a brittle heterogeneous material containing cracks and fissures. When a brittle material such as this, which varies in strength, is subjected to forces large enough to cause fracture, it breaks up into smaller pieces of varying sizes. This readiness of coal to break into smaller pieces is termed 'friability', which is a complex physical characteristic implying size degradation. The antonym of 'friability', as applied to coal, is 'size stability', and this may be considered to be a measure of the handling properties or resistance to breakage of the coal, either as an aggregate of lumps of the same size, or as a mixture of sizes. In the physical and chemical survey reports the term 'size stability' rather than 'friability' has been employed.

Methods for determining the comparative handling properties of coal were devised and tested at the Fuel Research Laboratories in connection with the programme of the "Coal Friability" Sub-committee of the American Society for Testing Materials(5). The Drop Shatter Test for Coal, which is an A.S.T.M. Tentative Standard(6), has been used in this investigation for determining the comparative size stability (and friability) of certain sizes and mixtures of sizes. Friability per cent is 100 - size stability per cent.

Grindability

The grindability, or ease of pulverizing a material, is not a single physical property but is a composite factor dependent upon a combination of such properties as strength, brittleness, hardness, etc. This factor was determined by the Tentative Method of Test for Grindability of Coal by the Hardgrove-machine Method, A.S.T.M. Designation D 409-37T. The method gives a measure of the relative grindability of any coal in comparison with a standard coal chosen as 100 grindability. The coal chosen as a standard is a low volatile run-of-mine product from Jerome mine, Upper Kittanning bed, Somerset county,

Pennsylvania. The method is based on Rittinger's law(7), which states "The work done in pulverizing is proportional to the new surface produced". A sized sample receives a definite amount of grinding energy in a miniature pulverizer and the new surface is determined by sieving, greater resistance to grinding being indicated by lower values.

Grindability figures refer only to any given or constant grinding system and cannot be generalized to include other systems. Inasmuch as the term 'grindability' implies a combination of a group of physical properties and technical factors, the latter prevailing to a marked extent, no absolute scale of grindability for all grinding machines can be established. According to Rosin(4), "certain relations exist between particle size, power consumption and throughput, but they are greatly modified and completely masked by the machine factor, 99 per cent of the power consumption in pulverizers not being utilized for disintegration".

Some of the factors, other than 'grindability', that influence industrial capacity of pulverizers are moisture and size of coal. According to an article "Factors in Economical Grinding and Pulverizing"(8), when mills of any type are operated without air-drying of the coal "the effect of the surface moisture becomes important, as increase in moisture decreases the output disproportionately. The general effect is to cause clogging of the fine material and prevent its removal by the air current so that the efficiency of the mill is lowered.". The effect varies with different types of mills, being greatest with slow-speed mills of the ball-mill type and smallest with the impact or beater pulverizers. Increasing the size of the feed normally tends to decrease the output and the efficiency of pulverizers.

Tests For Chemical (and Physico-chemical) Properties

The various screened sizes of coal and the so-called 'composites' (re-assembled screened sizes) were subjected to chemical and physico-chemical analyses, as outlined below.

Proximate Analyses

According to Bone(10), "the usefulness of any given coal for a particular purpose depends largely upon the yield of combustible 'volatile' matter expelled when it is carbonized under certain specified conditions and upon the character of the resulting carbonaceous residue. From a properly conducted laboratory test (ordinarily known as 'proximate analysis') much

valuable information may be gained respecting the economic value of a given coal". A.S.T.M. Designation D 121-30, Standard Definitions of Terms Relating to Coal and Coke, defines proximate analysis as the determination, by prescribed methods, of moisture, volatile matter, fixed carbon and ash.

The American Society for Testing Materials has devised standard methods for proximate analysis, which are published as Standard Methods of Laboratory Sampling and Analysis of Coal and Coke, under A.S.T.M. Designation D 271-37. The Fuel Research Laboratories, however, for various reasons, have retained slight modifications of these methods of analysis, but they do not vary to any great degree from the standards adopted by the A.S.T.M.

Moisture-- For determining the moisture of a coal, that is the moisture retained after sufficient drying to allow for crushing and grinding, one-gram quantities of the finely pulverized coal were dried for 105 minutes in small metal capsules. The drying was effected in a suitably constructed oven heated with toluene vapour at a temperature of between 105 and 108° C., with a current of preheated and dried carbon dioxide sweeping over the coal samples. The A.S.T.M. standard specifies air instead of CO_2, otherwise the method used corresponds to the published standard.

In the survey, only the moisture, as determined above, has been included, although the influence of surface or extraneous moisture on the use of coal for various purposes is of real importance. As this extraneous moisture is, however, dependent upon many factors such as storage, drainage, change of atmospheric conditions, etc., a study of the surface moisture of the seam samples in a general survey would not be of any significance.

Ash-- The ash was determined according to the standard method described under A.S.T.M. Designation D 271-37. One gram of the finely pulverized coal is ignited in an electric muffle at a controlled temperature between 700 and 750° C. The residual incombustible matter, which is a complex mixture of compounds resulting from the dehydration and ignition of the inorganic impurities present in the coal, is reported as ash.

Volatile Matter-- The volatile matter of the coal was determined according to the A.S.T.M. method Designation D 271-37, with the exception that a Chaddock gas burner was employed in preference to either a Meker burner or a vertical electric furnace. The method consists of placing one gram of the sample in a covered platinum crucible and heating it over the Chaddock burner for a period of exactly seven minutes, the flame being so regulated as to give a temperature of 950° C. ±20° C. The loss of weight minus the moisture equals the volatile matter.

Fixed Carbon-- The fixed carbon, which is that material remaining after the evolution of the moisture and volatile matter exclusive of ash, is calculated as follows:
100 - (moisture + ash + volatile matter) = percentage of fixed carbon

Ultimate Analyses

In A.S.T.M. Designation D 121-30, ultimate analysis is defined as the "determination of carbon and hydrogen in the material, as found in the gaseous products of its complete combustion, the determination of sulphur, nitrogen and ash in the material as a whole, and the estimation of oxygen by difference".

Total Sulphur-- The total sulphur content of the coals was determined according to the Eschka method as described under A.S.T.M. Designation D 271-37, with the exception that the sample was ignited at 700 to 750°C. instead of at the specified 800°C. ±25°C. with the Eschka mixture. The sulphates were then leached out and determined gravimetrically by precipitation with $BaSO_4$, as specified.

Carbon and Hydrogen-- The determination of carbon and hydrogen was made by a procedure corresponding to A.S.T.M. Designation D 271-37, using an electrically-heated combustion furnace.

Nitrogen-- The Kjeldahl-Gunning method, as recommended under A.S.T.M. Designation D 271-37, was employed for determining the nitrogen in the coals.

Oxygen-- As there is no satisfactory direct method for determining oxygen, it was estimated by subtracting the sum of the percentages of hydrogen, carbon, nitrogen, sulphur and ash from 100. This result is, of course, affected by any errors incurred in the other determinations.

Calorific Value

The gross calorific value of coal, according to A.S.T.M. Designation D 407-35T, is "the heat produced by combustion of unit quantity, at constant volume, in an oxygen bomb calorimeter under specified conditions". This value was determined with the Emerson bomb according to the method described under A.S.T.M. Designation D 271-37.

The calorific value of a coal is an important factor in its evaluation for steam raising purposes, as well as for the determination of its rank. The purchase of coal on a heat value

basis for steam raising has generally given satisfaction, and as aptly stated by Grumell(10) "the knowledge and experience acquired by systematic evaluation leads to better control of subsequent fuel deliveries and, in most cases, to more efficient performance in the boiler plant". The average calorific value of a coal seam, calculated to the dry ash-free (or mineral-matter-free) basis, can be generally used as a check on commercial determinations. It should be noted, however, that calorific value alone is not entirely sufficient for comparative purposes, as the satisfactory use of a coal often depends upon other factors as well, such as: moisture, ash, volatile matter, coking properties, size, friability, and possibly the melting point of ash.

Fusibility of Ash

The fusibility of the ashes of the coals was determined by the standard method outlined in A.S.T.M. Designation D 271-37, using a modified Remmey fusion test furnace heated with acetylene and oxygen. By means of this method, three different physical states of the ash cone under the influence of increasing temperatures are recorded.

1. The Initial Deformation Temperature--the temperature at which the apex of the cone begins to round or bend;

2. The Softening Temperature--the temperature at which the cone fuses down to a spherical shape; and

3. The Fluid Temperature--the temperature at which the ash becomes fluid and spreads out over the plaque in a flat layer.

The ranges in temperature between these points have been defined as follows:

a) Softening Interval--the range in temperature between the initial deformation and softening temperature;

b) Fluid Interval--the range in temperature between the softening and fluid temperatures; and

c) Melting Range--the range in temperature between the initial deformation and fluid temperatures.

Selvig and Fieldner(11) have arbitrarily sub-divided the range of ash softening temperatures into three groups, as follows:

Class 1: Refractory ashes, softening above 2600°F.

Class 2: Ashes of medium fusibility, softening between 2200 and 2600°F.; and

Class 3: Easily fusible ashes, softening below 2200°F.

The relationship of ash fusibility to clinker formation has been studied for many years, and it is conceded that the tendency to form clinker is not definitely related to the softening temperature of the ash. The present status of the problem has been stated by Nicholls and Selvig(12) in discussing the results of their work. They conclude that "no simple measure of the nature of the ash, such as its fusibility determined by an arbitrary method, can be expected to predict closely, relative values of troubles resulting from a complex ash passing through a set of conditions in which the temperature, time of exposure to that temperature, and travel of the ash are undefined, uncertain and dependent on factors that are also variable". Recent investigations conducted at the Fuel Research Laboratories(13) corroborate the above general statement.

Chemical Analysis of the Ash

The mineral matter in coal is composed mainly of compounds of silica, alumina, lime and iron, with smaller quantities of magnesia, titanium, phosphorus and alkali compounds. According to Thiessen et al(14), "the minerals comprizing the inorganic matter in coals are pyrite, calcite, kaolinite, detrital clay and silica".

Chemical analyses of the ash, however, show only the simple constituents present without indicating the manner in which they exist in the coal as minerals. In such analyses, the following compounds are usually determined and reported: SiO_2, Al_2O_3, Fe_2O_3, CaO, MnO, MgO, Na_2O, K_2O, TiO_2, P_2O_5 and SO_3. These analyses, which were conducted in the chemical laboratory of the Division of Metallic Minerals of the Bureau of Mines, were made with certain modifications according to the methods outlined in the Third Edition of "Methods Of The Chemists Of The United States Steel Corporation For The Sampling And Analysis Of Coal, Coke And By-products" published by Carnegie Steel Company, Pittsburgh, Pennsylvania, and in "Methods For The Quantitative Analysis Of Coal Ash"--Physical and Chemical Survey of the National Coal Resources No. 28, Department of Scientific and Industrial Research, England.

Sulphur Forms

The sulphur in coal occurs in two principal forms, depending upon its origin, these being termed inorganic and organic.

The inorganic sulphur appears in two forms known as sulphate sulphur and pyritic sulphur. The organic sulphur is composed of resinic and humic sulphur which, for all practical purposes, may be considered as total organic sulphur. Powell's[15] methods for determining quantitatively these sulphur forms were employed, with slight modifications, for these determinations.

Sulphate sulphur was determined by treating the pulverized coal with 3 per cent hydrochloric acid for 40 hours at 60°C., and estimating the sulphur in the filtrate by precipitation with $BaCl_2$.

Pyritic sulphur was determined by digesting the pulverized coal with 1.12 sp. gr. nitric acid for 96 hours at room temperature, the oxidized pyrite plus the original sulphate being determined by precipitation with barium chloride, the pyritic sulphur being calculated by subtracting the percentage of sulphate sulphur from the total inorganic sulphur.

Organic sulphur was estimated by subtracting the total inorganic sulphur from the total sulphur.

Information with respect to the distribution of the forms of sulphur is useful, inasmuch as it indicates the degree to which the sulphur content of a coal may be reduced by washing processes.

Fusain

The importance of fusain with respect to its influence on the spontaneous combustion of coal, and its effect on the coking properties, necessitates a study of its quantitative distribution between the various coal sizes. The method adopted with certain modifications for this determination was that of Heathcoat[16]. This method takes advantage of the fact that, in bituminous coals, fusain is more resistant to oxidation than the other coal constituents. Hence, after oxidizing the insoluble humic material to an alkali-soluble humic substance, the more resistant fusain is collected by filtration, dried and ignited, and reported as "per cent dry ash-free fusain in dry ash-free coal".

A great deal of information with respect to coal washing may be obtained by studying the distribution of fusain in conjunction with the distribution of the forms of sulphur. Inasmuch as fusain is usually very porous in structure, it is often loaded with pyrite, and by reason of its friable nature it is usually concentrated in the fine coal dust. Elimination of fusain loaded with pyrite, by screening may result in a far

greater reduction in the total sulphur content of the coal than would be obtained by a washing process.

The influence of fusain on coke structure is well known. Mott and Wheeler(17) have shown that the addition of this constituent in moderate amounts (usually about three per cent) to by-product oven charges of good coking coals permits the production of a 'blockier' and stronger coke of larger size. For coals with poor caking strength, however, the addition of fusain results in a weaker and sootier coke, and its removal from the charge is usually considered to be beneficial.

The influence of fusain on spontaneous combustion of stored coals is rather uncertain. Experiments by Stopes and Wheeler(18) led them to consider it improbable that fusain had a preponderating influence in promoting the actual ignition of the coal after self-heating had begun. They, however, considered it possible that "the rapid absorption of oxygen by fusain at low temperatures might be attended by a sufficient evolution of heat to raise appreciably the temperature of the main mass of the coal, thereby causing the most inflammable ingredient, vitrain, to react more rapidly with oxygen".

Classification Of Coal By Rank

A committee of the American Society for Testing Materials (A.S.T.M.) has been studying various methods of coal classification for a number of years and has recently published standard specifications* for classification of coals both by rank and by grade. Prior to this, the Fuel Research Laboratories of the Canadian Bureau of Mines employed the 'specific volatile index'(19) method of coal classification, and as this method serves to classify coals for specific purposes, the two methods have been used for the coals reported herewith.

A.S.T.M. Classification By Rank (Designation D 388-38)

This method classifies coals by rank according to their fixed carbon and calorific values calculated to the mineral-matter-free basis. The higher rank coals are classified by fixed carbon on the dry basis, whereas the lower rank coals are classified by the B.t.u. per pound value on the moist basis. Agglomerating and weathering properties are used to differentiate between certain adjacent groups.

* See A.S.T.M. Designations D 388-38 and D 389-38 in reference (6), also "Report on the A.S.T.M. Standard Specifications For Classification of Coals by Rank and by Grade and Their Application to Canadian Coals" N.R.C. No. 814--National Research Council of Canada.

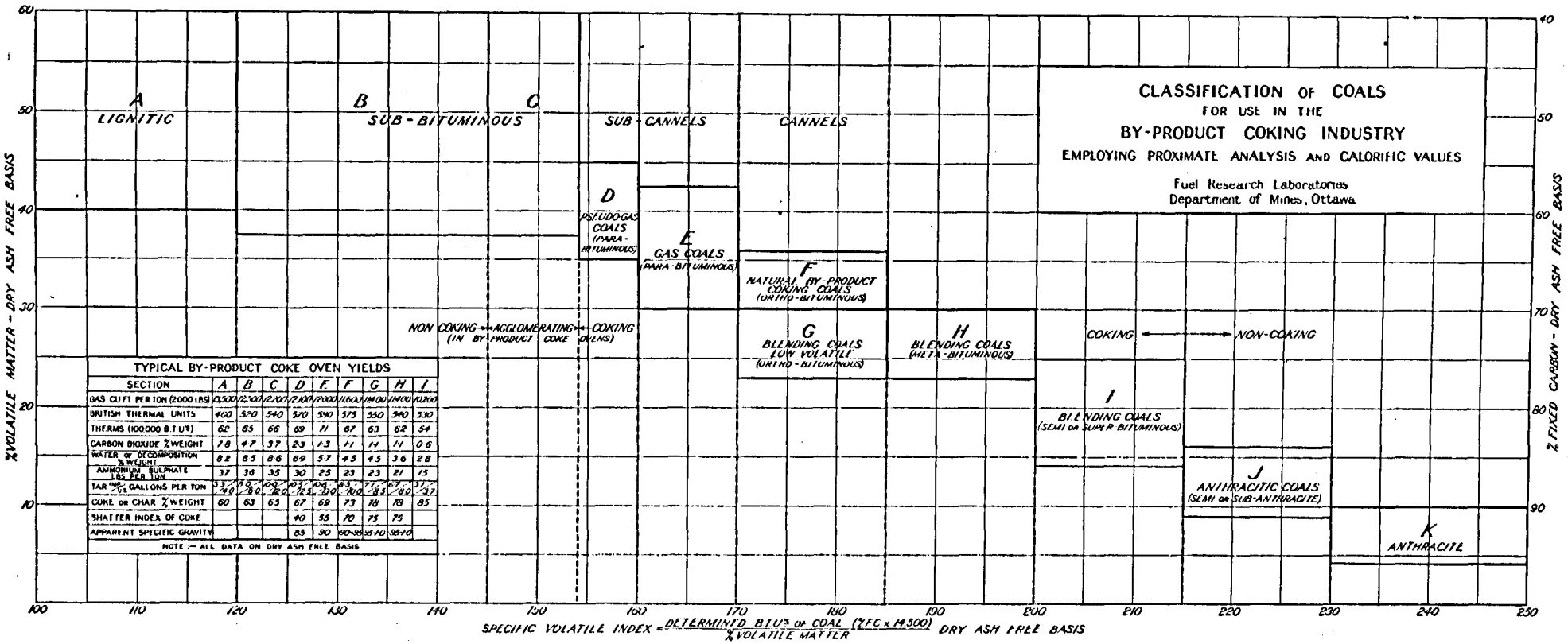

CLASSIFICATION OF COALS
FOR USE IN THE
BY-PRODUCT COKING INDUSTRY
EMPLOYING PROXIMATE ANALYSIS AND CALORIFIC VALUES
Fuel Research Laboratories
Department of Mines, Ottawa
A
LIGNITIC
B
SUB-BITUMINOUS
C
SUB-CANNELS
CANNELS
D
PSEUDO GAS COALS (PARA-BITUMINOUS)
E
GAS COALS (PARA-BITUMINOUS)
F
NATURAL BY-PRODUCT COKING COALS (ORTHO-BITUMINOUS)
G
BLENDING COALS LOW VOLATILE (ORTHO-BITUMINOUS)
H
BLENDING COALS (META-BITUMINOUS)
I
BLENDING COALS (SEMI OR SUPER BITUMINOUS)
J
ANTHRACITIC COALS (SEMI OR SUB-ANTHRACITE)
K
ANTHRACITE
NON COKING ← AGGLOMERATING → COKING (IN BY-PRODUCT COKE OVENS)
COKING ← → NON-COKING
% VOLATILE MATTER - DRY ASH FREE BASIS
% FIXED CARBON - DRY ASH FREE BASIS
SPECIFIC VOLATILE INDEX = DETERMINED BTU'S OF COAL (%FC x 14,500) / % VOLATILE MATTER DRY ASH FREE BASIS
TYPICAL BY-PRODUCT COKE OVEN YIELDS
SECTION A B C D E F G H I
GAS CU FT PER TON (2000 LBS) 13,500 12,500 12,200 12,100 12,000 11,600 11,400 11,400 10,200
BRITISH THERMAL UNITS 400 520 540 570 590 575 550 540 530
THERMS (100,000 B.T.U'S) 62 65 66 69 71 67 63 62 54
CARBON DIOXIDE % WEIGHT 7.8 4.7 3.7 2.3 1.3 1.1 1.4 1.1 0.6
WATER OR DECOMPOSITION % WEIGHT 8.2 8.5 8.6 8.9 5.7 4.5 4.5 3.6 2.8
AMMONIUM SULPHATE LBS PER TON 37 36 35 30 23 23 23 21 15
TAR IMP. U.S. GALLONS PER TON 3.3/4.0 4.0/6.0 6.0/7.20 6.5/7.25 6.5/8.0 6.5/10.0 7.1/8.2 6.7/8.0 3.7/3.7
COKE OR CHAR % WEIGHT 60 63 63 67 69 73 78 78 85
SHATTER INDEX OF COKE 40 55 70 75 75
APPARENT SPECIFIC GRAVITY 85 90 90-95 95-1.0 95-1.0
NOTE — ALL DATA ON DRY ASH FREE BASIS

Chart I

A.S.T.M. Classification By Rank - As Per Designation D 388-38

Classes and Groups	Limits of Fixed Carbon (F.C.) and B.t.u. (mineral-matter-free basis) and Requisite Physical Properties
I. Anthracitic class	
1. Meta-anthracite group	Dry F.C., 98 per cent or more.
2. Anthracite group.....	Dry F.C., 98 to 92 per cent.
3. Semi-anthracite group	Dry F.C., 92 to 86 per cent, non-agglomerating.
II. Bituminous class	
1. Low volatile group...	Dry F.C., 86 to 78 per cent.
2. Medium volatile group	Dry F.C., 78 to 69 per cent.
3. High volatile A group	Dry F.C., less than 69 per cent and moist B.t.u. 14,000 or more
4. High volatile B group	Moist B.t.u., 14,000 to 13,000.
5. High volatile C group	Moist B.t.u., 13,000 to 11,000, either agglomerating or non-weathering.
III. Subbituminous class	
1. Subbituminous A group	Moist B.t.u., 13,000 to 11,000, both weathering and non-agglomerating.
2. Subbituminous B group	Moist B.t.u., 11,000 to 9,500.
3. Subbituminous C group	Moist B.t.u., 9,500 to 8,300.
IV. Lignitic class	
1. Lignite group.....	Moist B.t.u., less than 8,300 (consolidated)
2. Brown coal group.....	Moist B.t.u., less than 8,300 (unconsolidated)

Specific Volatile Index (S.V.I.) Classification

This method is based on the heating value of the volatile matter, the values or indices obtained arranging coals in increasing value from peats to anthracites according to their rank. The index is calculated according to the following formula:-

$$\frac{\text{Determined B.t.u.} - (14{,}500 \times \text{weight of fixed carbon})}{\text{Per cent of volatile matter}} = \text{S.V.I.}$$

For ordinary purposes, the index is calculated on the dry, or dry ash-free, basis, but when the ash content is over 10 per cent and the sulphur over 1.5 per cent the calculation is made on the 'unit coal basis' (A.S.T.M. Designation D 388-38T).

In accordance with this classification, coals are arbitrarily divided into the following groups.

	'Unit Coal' S.V.I. Limits	Volatile Matter Range Per cent
Brown lignites...	82 - 99	40 - 70
Black lignites...	99 - 125	36 - 55
Sub-bituminous...	125 - 160	35 - 50
Para-bituminous..	160 - 175	28 - 45
Ortho-bituminous.	175 - 190	21 - 35
Meta-bituminous..	190 - 210	21 - 28
Semi-bituminous..	210 - 230	14 - 24
Semi-anthracite..	230 - 255	9 - 16
Anthracites.....	255 - 300	3 - 10

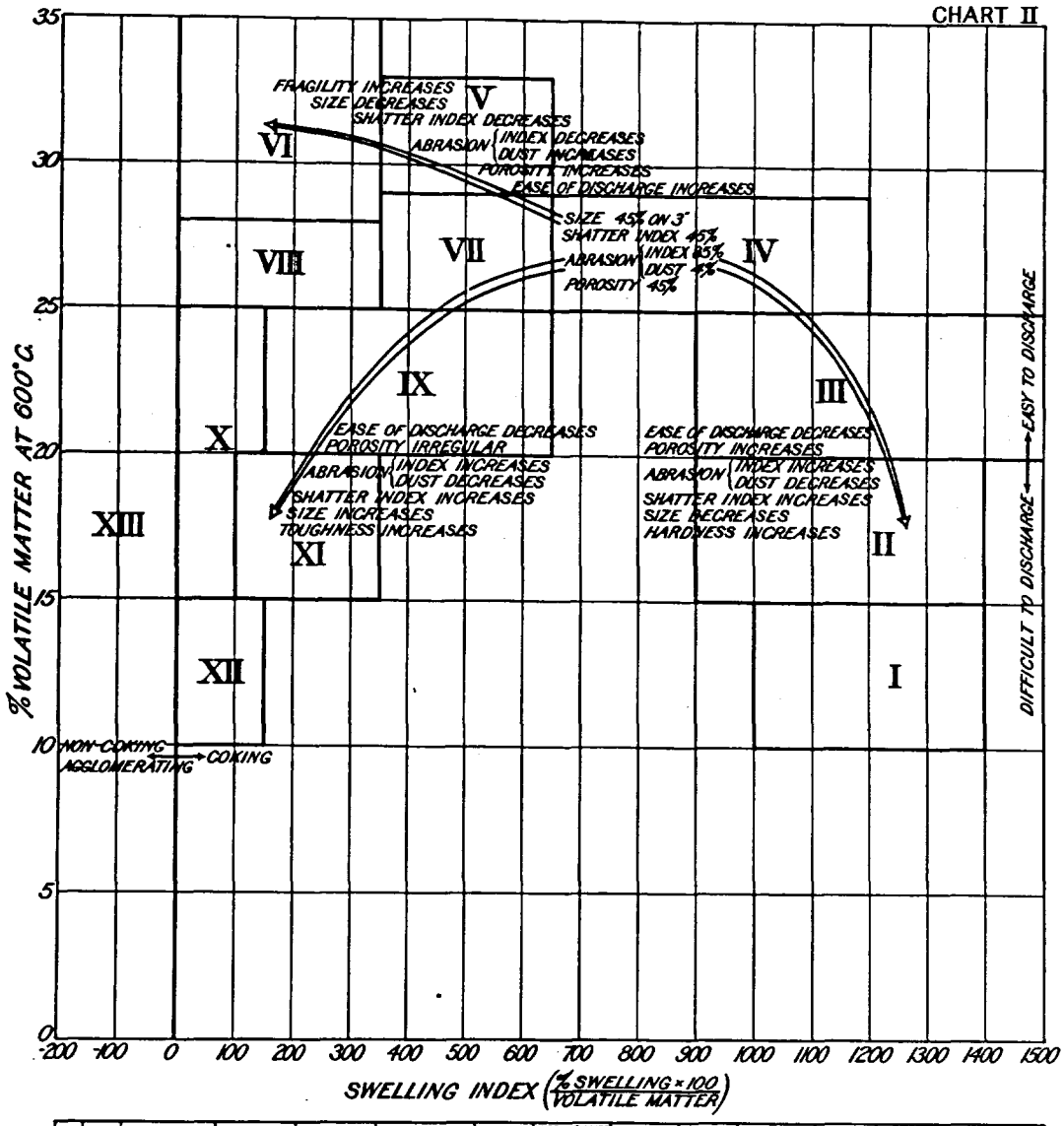
By noting the position of a coal on a chart, as per Chart I, according to its S.V.I. and volatile matter, it is possible to predict with a fair degree of accuracy the characteristics of the coal with respect to its behavious in a by-product coke oven and the approximate yield of by-products to be expected. These characteristics are indicated in the table inserted in the lower left hand corner of Chart I, in which, it is to be noted, the data are on the dry ash-free basis.

Coking Properties

Swelling Index Test

In order to predict the physical properties of the (by-product) coke made from any given coal, a laboratory test was developed at the Fuel Research Laboratories of the Canadian Bureau of Mines and was published by the Mines Branch(20). This test consists of determining the volatile matter and the percentage swelling of the coke button at a temperature of 600°C. From these data, the swelling index is calculated and, by the aid of a coke classification chart, shown as Chart II, the coal is located in a particular group. The various groups are arbitrarily delimited according to the known physical properties of the cokes made from coals in these groups.

In addition to the use of this test for the by-product coke industry, its value is indicated in other fields. From a paper given at the A.I.M.E. meeting in 1937 by H.F. Hebley, viz: "Economics of Preparing Coal For Steam Generation" and reviewed in the Iron And Coal Trades Review (February 11, 1938, p. 277), the author may be quoted in part as follows:- "With coal of a highly-coking nature, the swelling characteristics often have a great influence on the ability of a stoker to maintain its load ..... When the use of underfeed stokers is considered, the



SECTION	ASH%	SIZE ON WHARF % ON 3"	SIZE ON WHARF BREEZE	SHATTER INDEX	SHATTER BREEZE	ABRASION INDEX	ABRASION DUST	DENSITY APP. S.G.	DENSITY LB. C.F.	TRANSVERSE SHRINKAGE	APPEARANCE OF NATURAL SURFACE	SHAPE	STRENGTH	CROSS FRACTURE	LONGITUDINAL FRACTURE	CELL STRUCTURE	SPONGE	PEBBLY SEAM
I		POCAHONTAS TYPE BLENDING COALS								NIL			HARD				VERY LITTLE	NONE
II		25-40	2.5-1.0	65-55	3.0-2.0	85-25	3.5 2.0	85-95	24-26	FAIR*	STEEL GREY AND SMOOTH	SQUARE	HARD	MEDIUM TO LARGE AMOUNT STRAIGHT	SMALL TO MEDIUM AMOUNT	DENSE	VERY LITTLE	NONE
III		30-45	2.5-1.0	50-65	3.0-2.0	85-95	3.5-2.0	.90-1.0	25-28	FAIR TO GOOD	STEEL GREY AND SMOOTH	SQUARE	HARD	MEDIUM AMOUNT, SQUARE	SMALL TO MEDIUM AMOUNT	DENSE	VERY LITTLE	NONE
IV		40-50	3.0-2.0	45-55	3.0-2.0	80-90	5.0-3.0	1.0-1.1	26-29	GOOD	STEEL GREY, FAIRLY SMOOTH	SLIGHTLY TRIANGULAR	HARD	MEDIUM AMOUNT, STEPPY	MEDIUM AMOUNT	DENSE	VERY LITTLE	NONE
V		30-50	4.0-2.0	40-50	6.0 4.0	75-85	5.0-3.0	1.0-0.9	26-29	GOOD	STEEL GREY, IRREGULAR	TRIANGULAR, FINGERY	FRAGILE	MEDIUM TO LARGE AMOUNT STEPPY	MEDIUM TO LARGE AMOUNT	MEDIUM	SMALL TO MEDIUM AMOUNT	NONE
VI		30-50	2.0-5.0	25-40	6.0-4.0	55-80	7.0-3.0	85-0.9	25	VERY GOOD	STEEL GREY, IRREGULAR	TRIANGULAR VERY FINGERY	VERY FRAGILE	MEDIUM TO LARGE AMOUNT STEPPY	LARGE AMOUNT	MEDIUM TO LARGE	MEDIUM AMOUNT	NONE
VII	0-5	40-50	4.0	55-70	3.0	90-95	2.5-5.0	.83	23.5	GOOD	STEEL GREY, IRREGULAR	BLOCKY, SLIGHTLY TRIANGULAR	HARD TO FRAGILE	SMALL TO MEDIUM, SLIGHTLY STEPPY	MEDIUM TO SMALL AMOUNT	MEDIUM TO SMALL	SMALL AMOUNT	NONE
	5-10	50-70	4.0	55-70	3.0	90-95	2.5-5.0	.83-.95	23.5-25	"	"	"	"	"	"	"	"	"
	10-15	70-50	5.0	55-70	3.0	90-95	2.5-5.0	.95	26	"	"	"	"	"	"	"	"	"
VIII		50-70	2.0-5.0	45-65	4.0-5.0	80-80	2.5-7.0	.85-.95	24-26	GOOD	STEEL GREY, IRREGULAR	SLIGHTLY TRIANGULAR AND FINGERY	HARD TO FRAGILE, FRIABLE	MEDIUM AMOUNT, SLIGHTLY STEPPY	MEDIUM AMOUNT	MEDIUM, IRREGULAR	SMALL AMOUNT	NONE
IX	0-5	45-55	4.0	70	3.0	93	2.5	.80-.86	22-25	GOOD	STEEL GREY, SLIGHTLY IRREGULAR	BLOCKY, SLIGHTLY TRIANGULAR	TOUGH TO HARD	SMALL TO MEDIUM, SLIGHTLY STEPPY	SMALL TO MEDIUM AMOUNT	SMALL TO MEDIUM	SMALL AMOUNT	NONE
	5-10	55-80	2.0	70-80	3.0-5.0	.90	2.5	.98-1.1	25-31.5	"	"	"	"	"	"	"	"	"
	10-15	80-55	2.0-4.0	70-80	3.0-5.0	.90	2.5	1.1-.92	31.5-25	"	"	"	"	"	"	"	"	"
X		70-80	3.0-5.0	65-80	10.0-5.0	70-80	10.0-7.0	.95-1.1	26-30	FAIR TO GOOD	DULL, GRANULAR	BLOCKY, IRREGULAR	TOUGH, FRIABLE	SMALL AMOUNT, SLIGHTLY STEPPY	SMALL AMOUNT	SMALL TO MEDIUM	GRANULAR ENDS	PEBBLY
XI		70-80	3.0	70-80	5.0	85-90	3.0-4.0	1.0-1.1	30-31	FAIR	DULL TO STEEL GREY, IRREGULAR	BLOCKY, SQUARE	TOUGH	SMALL AMOUNT, VERY SLIGHTLY STEPPY	SMALL AMOUNT	IRREGULAR	VERY LITTLE	NONE
XII		80	3.0	80	5.0	85	4.0	1.0-1.1	30-31	FAIR TO POOR	DULL GREY, IRREGULAR	BLOCKY, IRREGULAR	TOUGH, FRIABLE	VERY SMALL AMOUNT, IRREGULAR	VERY LITTLE	IRREGULAR	VERY LITTLE	NONE
XIII		25-70	4.0-3.0	30-70	20.0-5.0	50-80	15.0-5.0	.85-1.1	23.5-28	GOOD	DULL GREY, GRANULAR	BLOCKY, IRREGULAR	FRIABLE	SMALL TO MED. AMOUNT, IRREGULAR	SMALL TO MEDIUM AMOUNT	VERY LITTLE TO NONE	GRANULAR ENDS	PEBBLY TO NON COKING

*DIFFICULT TO DISCHARGE

Chart 2. Classification for By-product Cokes according to their physical properties, employing Volatile Matter and "Swelling Index" at 600° C. of the coal.

rate of combustion has a pronounced effect on the character of the coke produced during the operation of the stoker..... Some coals form hard dense coke masses, which fracture and break up much less readily than others. Other coals contract somewhat after initial coking, thereby causing fissures through the coke masses." It is obvious, therefore, that the evaluation of this swelling and coking property is very important in determining the suitability of coals for stoker use as well as for coke manufacture.

Caking Index

It has been shown that those coals which are recognized as falling within the best coke-producing class are more capable of withstanding a higher mixture of inert material and still yield a carbonized residue of definite crushing strength than are the inferior coals. This phenomenon of 'caking' or 'agglutination' has been thoroughly studied, and methods have been developed for the determination of the caking index. While these tests are of uncertain value for the purpose of assessing a wide range of coals in their application to the production of by-product coke, a knowledge of the caking index is of importance when it is desired to mix inert carbonaceous material, or non-coking coal, with coking coals.

The method developed by Gray(21), in which 25-gramme mixtures of coal and sand in varying proportion are carbonized in crucibles at 950° C., has been adopted as a standard at the Fuel Research Laboratories. The ratio of sand to coal, which on carbonization will form a sufficiently strong button to support a weight of 500 grammes, is designated as the 'caking index'. The higher the caking index, the greater the caking properties.

According to Malleis(22), the agglutinating value test has generally been found to have value for special investigation such as detecting deterioration of coking properties of coal due to storage, but it seems to have little value as a reliable index of the probable caking or coking properties of a coal.

Laboratory Washing Tests

Coal washing, generally speaking, depends on the difference in the specific gravities of the coal and refuse, and this difference has been used in the laboratory for many years by means of float-and-sink tests, to differentiate between these materials. By the successive separation of a coal at various gravities, washability curves may be constructed which will in-

dicate for any given coal the theoretical ash content and yield of both clean coal and refuse obtainable at any chosen gravity.

The data obtained from such tests on 1½ inch slack, the details of which are shown in a series of tables in Chapter IV, were plotted according to the method outlined by Campbell(23) of the American Rheolaveur Corporation. To these was added the 'specific gravity distribution' curve as suggested by Bird(24) of the Battelle Memorial Institute. The curves, as constructed, contain the following information:

Curve 1, the cumulative float ash per cent curve, represents the variation of the ash.

Curve 2, the variation in ash per cent of the material with variation in gravity at which the separation is made.

Curve 3, the cumulative sink per cent according to the recovery as in Curve 1.

Curve 4, the variation in recovery according to the specific gravity.

Curve 5, the ±.10 specific gravity distribution curve, represents a measure of the comparative difficulty of separation according to specific gravity at the selected point of separation.

According to Bird, the degree of difficulty of wet washing a coal may be predicted from the specific gravity distribution curve, and its application to standard processes is summarized in the following table.

±.10 Curve Per cent	Degree of Difficulty	Preparation
0 - 7	Simple.....	Almost any process: high tonnage
7 - 10	Moderately difficult.	Efficient process: high tonnage
10 - 15	Difficult.....	Efficient process: medium tonnage
15 - 20	Very difficult.....	Efficient process: low tonnage
20 - 25	Exceedingly difficult	Very efficient process: low tonnage
Above 25	Formidable.....	Limited to a few exceptionally efficient processes

For the study of an ordinary bituminous coal, 10 per cent on the curve is used, and the specific gravity representing this point is usually selected for the washing of a composite sample, the clean coal and refuse fractions of which are studied

for their various properties. If a horizontal line is drawn from this point on Curve 4 (specific gravity curve), the points at which it cuts the other lines represent the following:

Curve 1, the average ash per cent of the separated coal;

Curve 2, the actual ash per cent of the heaviest piece of material left in the coal, and likewise the lightest piece of material in the refuse; and

Curve 3, the average ash per cent of the refuse extracted.

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