

REPORT

ON THE

COAL MINES OF THE EASTERN OR SYDNEY COAL FIELD OF CAPE BRETON, N.S.

BY

MR. CHARLES ROBB C.E.;

ADDRESSED TO

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MONTREAL, May, 1873.

Instructions.

SIR,—Having in the course of last summer received instructions from you to continue the survey and examination of the Cape Breton Coal Fields, which was commenced in 1870 by the late Mr. Edward Hartley, and having from various circumstances, beyond my control, been prevented proceeding thither until the end of August, I devoted the remainder of the season suitable for field-work to a preliminary survey or general reconnaissance of the principal area occupied by the productive coal measures; and to the collection of materials for an accurate topographical map, and for a report on the various collieries at present in operation in the eastern or Sydney Coal Field.

Map and report.

Geological structure.

In the prosecution of this work I have made many observations and measurements bearing upon the geological structure of the region; but, however useful these may be in the future, they can scarcely be regarded as sufficiently precise or comprehensive to justify any detailed statements on this point upon the present occasion.

Maps, charts and records made use of.

In the preparation of a map upon a sufficiently large scale to form a basis for the determination of the structure of the coal field, I have availed myself, so far as regards the coast lines, of Admiral Bayfield's charts, which at Sydney Harbor and some other points I have verified in many of the minutest details by triangulation and otherwise. For a portion of the coast-line, and also of the interior of the country adjacent thereto, as well as for the contours, and for the course of certain of the coal seams, I am indebted to the records—kindly lent to me by the gentlemen interested—of elaborate surveys made by Professor J. P. Lesley, in 1862 and 1863, for various private companies; and by Mr. B. S. Lyman of Philadelphia, in 1865, for Marshall Bourinot, Esq., of Sydney. I have also to

Acknowledgment of assistance and information.

express my obligations to Messrs. Wm. A. Hendry, Deputy Commissioner of Crown Lands, R. H. Brown, Manager of Sydney Mines, H. Poole, late Manager of Caledonia Mines, E. T. Moseley of Sydney, F. N. Gisborne and A. J. Hill, for access to maps and plans of the various properties in which they are interested, and for much collateral information.

In every instance where advantage has been taken of surveys previously made, I have been careful to verify and connect these, and to fix the positions of the various pits and works, and the crops of the principal seams by bearings and measurements between prominent points. For these purposes also, and for establishing the heights at many points, I have made use of the plans and profiles of the Glasgow and Cape Breton and of the International railways, at present in operation and connecting some of the collieries with Sydney Harbor; also of the projected and surveyed railroad line to Louisbourg.

This map, embracing the whole known area of the productive coal measures in this district, and drawn to a scale of four inches to a mile, is now completed, with the exception of some minor details.

For reasons already stated, and in compliance with your request, I propose to devote the following report to a description of the various collieries now in operation in the eastern Coal Field of Cape Breton, and to the economical considerations suggested in connection with the future development of this most important coal field. On these points some details which were collected by Mr. Hartley, and referred to in your Summary Report for 1870-71, will be embodied with my own observations.*

Without, therefore, on the present occasion entering into any details in regard to the geological structure or topographical features of the region of which this coal-field forms a part, I shall merely give such a slight sketch of these as seems to be necessary in connection with the consideration of the economic questions to be noticed in this Report.

GENERAL REMARKS ON THE EASTERN OR SYDNEY COAL FIELD.

The land area occupied by the productive coal measures in the eastern or Sydney Coal Field may, so far as now known, be estimated at 200 square miles, being about thirty-two miles in length from north-west to south-east, by about six miles in width. It is limited on three sides by the Atlantic Ocean; and towards the south-west by the out-crop of the subjacent Lower Carboniferous rocks. This area forms the southern

Area occupied
by the produc-
tive coal mea-
sures.

* Much information on this subject, in a popular and practical form, is contained in Brown's "Coal Fields of Cape Breton," London, 1871; Rutherford's "Coal Fields of Nova Scotia," Newcastle-upon-Tyne, 1871; Dr. Dawson's "Acadian Geology," London, 1868; and How's "Mineralogy of Nova Scotia," Halifax, 1869.

extremity of an extensive trough or basin, which is for the most part hidden under the waters of the ocean, and which has been corrugated by numerous subordinate folds, bringing the same coal seams repeatedly to the surface along the north-east coast of the Island, under the most favorable conditions and circumstances for their extraction and shipment.

The whole coast is deeply indented by bays and channels approximately coinciding with the axes of these folds, and affording in the sea cliffs numerous natural sections of the strata, and exposures of the coal seams. Some of these bays also constitute excellent harbors, one of which—Sydney Harbor—situated towards the centre of the district, ranks among the finest and most commodious on the Atlantic coast of North America. The cliffs are generally from thirty to eighty feet high, standing perpendicularly and frequently overhanging the sea; and the country inland is of a gently rolling character, the highest altitudes rarely exceeding 150 feet.

Height and character of the country.

Louisbourg Harbour.

Such natural advantages, combined with its highly favorable geographical position, point to this district as probably the most important in the Dominion for the supply of fuel to the numerous steamers navigating the Atlantic. During the few months of winter, when the more northerly harbors are closed or obstructed by ice, a railway only about twenty-two miles in length, will connect many of the collieries with Louisbourg, which is also a fine harbor, and is said to be open and safe throughout the whole year.

Aggregate thickness of coal seams.

The aggregate thickness of coal in workable seams outcropping on the shore, and for the most part exposed in the bays and cliffs, is from forty to fifty feet; the seams vary from three to nine feet in thickness; they generally dip at a very low angle, and appear to be very little affected by faults or disturbances. As the strata all dip seaward, much of the coal will be available in the sub-marine as well as in the land areas. From experience at one of the collieries, to be hereafter described, it has been fully established, that with due caution and care these sub-marine areas may be worked to a large extent.

Sub-marine areas.

Character and quality of the coal.

The coal is of the bituminous or soft variety, with comparatively little diversity in the quality of the different seams; all of which yield a coal exceedingly well adapted for general purposes, while that of some of them is specially applicable to the manufacture of gas. Much of it will compare very favorably with the best English coal. As compared with the Pictou coal, regarding which very full details have been given by Mr. Hartley in the Report of the Geological Survey for 1869, it is characterized on the whole, by a greater proportion of combustible matter, and a smaller proportion of ash; but on the other hand it usually contains a greater amount of sulphur.

COLLIERIES IN OPERATION.

I shall proceed to give some details regarding the condition of the various productive coal mines in this district at the time of my visit, (October, 1872,) and also of those at which works were in progress and expected to be in a condition for raising coal for the market during the present season. For conciseness and to facilitate comparison, I have tabulated such of the more prominent and important features at each colliery as would conveniently admit of this arrangement. Tables.

The first table contains a list of the collieries to which reference is made, with the names of the proprietors and managers, the date of commencement, the extent of the properties, the number of men, horses, and steam-engines employed, the total production, and the amount of capital invested in works. It may be remarked, however, that from various causes, none of the thirteen coal mines enumerated are at present worked to their full capacity.

In the second table a description is given of the various seams worked, analyses of the coal from each seam, and the depth and extent of the workings, &c. Of the series of analyses given in the table, some were made several years ago, and are here compiled from various authentic records, chiefly contained in the works referred to on page Others are taken from examinations more recently made, and not hitherto published, but communicated to me by the proprietors of the various collieries. A series of samples from twelve different collieries, collected by myself last season, and believed to represent the average quality of the coal in each, have been submitted to Dr. B. J. Harrington, Chemist to the Geological Survey, for proximate analysis; the results of which are given in Table II., while his accompanying remarks are introduced under their appropriate headings in the text.

The details given in this Report are to be understood only as relating to those seams which are actually worked on the several areas; and the quantities of coal stated as underlying them are only such as are estimated to exist in these worked seams. Mr. Brown, in his "Coal Fields and Coal Trade of Cape Breton," gives for most of the areas referred to in this Report an estimate of the total amount of coal contained in all the workable seams underlying each.

The method of estimating the quantity of coals in the several areas is as follows: The weight of a cubic foot of water being 62.5 pounds, the average specific gravity of the coal 1.3; the number of superficial feet in an acre, 43,560, and the number of pounds to a gross ton, 2,240. Estimation of quantities.

Then $\frac{62.5 \times 1.3 \times 43,560}{2,240} = 1,580$ tons per acre of one foot thickness. Allowing for irregularities, and for coal which for various reasons is not available, 1,500 tons is assumed as the contents of an acre of coal one foot thick,

which, multiplied by the number of acres in the area, and by the thickness of the seam in feet, gives the total contents.

Bearings.

The bearings given in this Report and in the Table are stated in relation to the magnetic meridian ; the variation of the compass for the year in which the observations were made being 26° 10' West.

I. THE SYDNEY MINES.

Of all the coal mines in Cape Breton the Sydney Mines are not only the first established, but by far the most extensive and important. In 1827 these mines came under the exclusive control of the General Mining Association, a London company, who now hold under lease in the district more than 30,000 acres, which are for the most part underlaid by large workable seams of coal. From 1827 to the present time this company have worked their mines regularly and systematically, and in the most skilful and economical manner. From 1785 to 1827 the Sydney Mines had been worked sometimes by Government, and sometimes by various individuals and companies ; but always in a very desultory and imperfect way. Mr. Richard Brown, the late manager of the General Mining Association, states that the yield of coal from these mines during that period had been 275,000 tons ; only a little more than half what ought to have been produced according to the area over which the workings extended. The total quantity of coal which has been sold from these mines since 1827 is given in Table I.

Operations since 1827.

Yield of the Sydney Mines from 1785-1827.

Seams to which mining operations have been confined.

Although other and important seams crop out within the area owned by the Association, mining operations have been confined to three, known respectively as the Sydney Main seam, the Lloyd's Cove seam, and the Indian Cove seam. Of these the Sydney Main seam is the only one now mined, and is also the one which has been by far the most extensively worked in past years.

The following sections of the Lloyd's Cove and Indian Cove seams are taken from Mr. Brown's elaborate section of the strata at this locality. The former is 728 feet of vertical distance above the main seam, and the latter 460 feet beneath it.

Sections of seams.

LLOYD'S COVE SEAM.		INDIAN COVE SEAM.	
	Ft. In.		Ft. In.
Coal	2 0	Coal.....	0 8
Clay	0 2	Shale.....	0 1
Coal	0 6	Coal.....	4 0
Clay	0 1		
Coal.....	3 6	Total thickness.....	4 9
<hr/>			
Total thickness.....	6 3		

These seams were worked to a small extent a few years ago by the Association, about eighteen acres of the former, and ten acres of the latter

having been partially taken out; but they were abandoned in consequence of their comparatively inferior quality, and the capability of the Main seam to supply all present demands.

The Sydney Main seam is a solid compact seam of from five feet six inches to six feet in thickness, and of nearly homogeneous character throughout. It dips N. 60° E. < 4° 45' or one in twelve. Over an extent of about 1000 acres of the land area, and about 3,200 acres of the sub-marine area belonging to the Association, the seam is five feet nine inches thick. Over 2,154 acres it is four feet thick. Of the land and sub-marine area first named, together 4,200 acres, the coal has been mined over 867 acres only. Over seventy-five acres of this area the pillars have been taken out, while in the remaining 792 acres they are still standing. The sub marine workings have extended over seventy-four acres, with a minimum thickness of eighty fathoms between them and the sea bottom. After deducting the amount of coal extracted as per tabular statement, and that mined previously to 1827, there remains of available coal in this seam 38,300,000 tons.

In addition to the remarks given in the Table, I append the following detailed statements relative to the quality of this coal, as carefully tested and analyzed by Professor Henry How of King's College, Windsor, in 1871.

COMPOSITION OF AVERAGE SAMPLES OF THE WHOLE SEAM OF COAL.

By Medium Coking.		By Fast Coking.	
Moisture.....	3.04	Total volatile matters.....	37.48
Volatile combustible matter...	31.14	Coke.....	62.52
Fixed carbon.....	61.50		100.00
Ash (reddish-brown).....	4.32	Theoretical evaporative power	7.98 lb.
	100.00	By Slow Coking.	
		Total volatile matters.....	29.70
		Coke.....	70.30
			100.00
Coke per cent.....	65.82	Theoretical evaporative power	9.06 lb.
Theoretical evaporative power	8.45		
Mean coke per cent.....	66.21		
Mean theoretical evaporative power.....	8.49		
Ash per cent.....	4.32		
Sulphur per cent.....	1.24		
Specific gravity of average samples.....	1.30		
Calculated weight of one cubic foot, unbroken.....	81.10		
" " " " " broken.....	54.50		
Space for one ton, 2240 lb., on stowage (Economic Weight).....	41.10 cubic feet		

COMPOSITION OF ASH.

Sand and clay.....	29.57
Peroxide of Iron.....	51.33
Alumina.....	4.84
Sulphate of lime.....	10.98
Lime.....	3.05

Magnesia.....	}	0 23
Phosphoric Acid, decided traces.....		
Manganese, traces.....		
Chlorine, traces.....		

100.00

GAS RETURNS.

BY G. BUIST, ESQ., MANAGER OF HALIFAX GAS WORKS.

Gas (average of 4 tests) per ton of 2240 lbs.....	8200 cubic feet.
Coke " " " " " " " " " " " " " "	1295 lb., of good quality.
Illuminating power of gas (average of 6 tests).....	8 candles.

The details above given explain the well known high favor in which this coal has been held for upwards of forty years for domestic use, and also for steam producing by those who have employed it carefully.

The mean theoretical evaporative power, or number of pounds of boiling water which should be evaporated by one pound of coal, 8.49, compares very favorably with the actual power of British coals, as found in the Navy Trials in which I assisted; these were:—

Average of 37 samples from Wales.....	9.05 lb.
" 17 " " Newcastle.....	8.37 lb.
" 28 " " Lancashire.....	7.94 lb.
" 8 " " Scotland.....	7.70 lb.
" 8 " " Derbyshire.....	7.58 lb.

This fact alone would always have been significant as indicating that the Sydney coal should prove a good steam coal; but, since late experiments have shewn that, when burnt in proper furnaces, the bituminous coals have been found to give no smoke, and to have an evaporative power even superior to that of Welsh steam-coals, it is now of the highest importance. It is necessary to draw attention in this connection to the resemblance of the Sydney coal to those bituminous coals which gave these results, in containing a low percentage of ash..... The Director of Naval Construction at Brest reported to the French Minister of Marine (about 1860) "that the steam power of Sydney coal is little inferior to that of Cardiff and equals that of Newcastle coal."

"With respect to the amount of sulphur, I find that, after deducting the harmless sulphur in the sulphate of lime of the ash, there remains but 1.24 per cent., or less than the average in 37 Welsh and 28 Lancashire coals, which is 1.42 in both cases, and in 8 from Scotland which is 1.45, so that this coal will compare favorably in this respect with these from abroad, some of which are highly esteemed for steam purposes."

Remarks by Dr. Harrington.

Dr. Harrington appends the following remarks to the analysis of the sample of Sydney Mines coal analyzed by him:—"A compact coal, breaking with a rather rough fracture. Contains a little mineral charcoal, and has numerous thin leaves of carbonate of lime, running at right angles to the bedding. It contains a good deal of visible pyrites disseminated through it, and gives a reddish-grey ash."

SURFACE WORKS.—The coal is reached by vertical shafts or pits sunk successively further to the dip as the seam becomes exhausted within a convenient distance from the shaft. The first shaft was 200 feet, and the second 300 feet in depth. Both these shafts are now abandoned, and the workings filled with water ; but the coal of the pillars, in those connected with the second shaft, is still available, as well as that in a barrier fifty yards in thickness, which has been left to protect the newer workings.

Now, and for many years back, the coal is brought to the surface by a shaft called the Queen or C Pit. It is 360 feet deep and 1360 yards from the crop of the seam, between which and the shaft, as well as 1100 yards to the dip, most of the available coal has been worked out, to an average breadth of nearly a mile. In this area, however, with the exception of the seventy-five acres above mentioned, nearly all the pillars are still standing.

This colliery is capable of yielding at the rate of upwards of 700 tons per day ; at the time of my visit it was supplying 570 tons per day. Yield.

In connection with the Queen or C pit, which is thirteen feet in diameter, there is a pumping shaft, eleven feet in diameter ; these are both used as downcast shafts, and there is also a separate ventilating or upcast shaft, eight feet in diameter.

The distance of underground haulage from the principal working faces to reach these pits having become so great (now upwards of three quarters of a mile) another set of shafts has been recently commenced 1320 yards further to the dip, which will reach the Main seam at a depth of 630 feet from the surface. These shafts are called the *New Winning*, and are designed chiefly to command the Association's extensive sub-marine area adjacent to the Sydney Mines. Unfortunately in sinking them a great influx of water has been met with at the depth of 300 feet, which the small steam-engines temporarily used for the work have proved inadequate to overcome ; and the operations have in consequence been suspended until the magnificent and powerful pumping engines, designed for the permanent drainage of the mine, can be brought into action. These engines, and the other machinery connected with this colliery, all of which is of the most perfect and substantial description, are the exact counterpart of those which have been recently erected by the General Mining Association at the Foord Pit of the Albion Mines at Pietou, and have been minutely described by Mr. Hartley in his report (Geology of Canada) Report of Progress 1869-70, pp. 87-89. Further recapitulation of details is, therefore, unnecessary, except to note that here the pumps are 20 inches instead of 18 inches in diameter. Underground haulage.
Engines and other machinery.

The machinery at the Queen Pit Colliery consists of a pumping engine of 150 horse-power, 50 inch cylinder and 7 feet stroke, giving 6 feet stroke on the pump, 20 inches in diameter, which makes 13 lifts per Machinery at the Queen Pit.

minute and raises 90 gallons per lift; this is capable of keeping the mine-dry by twelve hours pumping. The steam is supplied to this engine by four plain cylindrical boilers, 7 feet in diameter and 20 feet long, with egg ends. There are four more ready to set up, each 6 feet in diameter and 30 feet long. There is also a winding engine, 32-inch cylinder and 6 feet stroke, 35 lbs. pressure on the boiler, or about 80 nominal horsepower, furnished with steam by three cylindrical boilers, 6 feet in diameter, and 25 feet long, with egg ends. In the same battery are four similarly shaped boilers, 5 feet in diameter, and 25 feet long, for the supply of the underground slope engines. The winding engine is furnished with a 4-inch flat wire rope, working over a 10 feet drum, and is capable of bringing to the surface two *tubs* (as the small underground cars are called) or one ton in less than a minute. The arrangement of shutes, screens, and railway at bank are of the most substantial and perfect description. The screens have thin quarter-inch gratings, and about *one-eighth* of all the coal taken directly from the mine passes through these screens in the shape of *slack*, only a small proportion of which is saleable.

During the winter, when the miners work about half time, and the coal is not immediately required for shipment, it is *banked*. The bank usually contains about 25,000 tons. The coal is drawn by the winding engine while in regular operation up an incline from the bank foot to shutes, by which it is deposited in certain regulated proportions on the screens, along with the coal freshly extracted from the pit. From the effect of atmospheric influences combined with extra handling and moving, *one-fourth* of all the bank coal is in the state of *slack*.

The coal produced at this colliery is conveyed to the loading-ground or wharf at North Sydney by a substantial railway, four miles in length, with self-acting incline at the wharf end, owned of course by the Association. The gauge of this railway is four feet eight and a half inches, with rails of 56 pounds to the yard. The road is equipped with 174 waggons, each capable of containing an English (Newcastle) chaldron, or fifty-three hundred weight, and constructed to open at the bottom; and four locomotives of 16, 17, 27, and 30 tons respectively; the heavier engines draw thirty cars per train, and consume altogether in this service about seventy tons of coal per month.

The wharf is irregular in shape, capable of accommodating and loading eight vessels at a time, drawing from 14 to 22 feet of water. Ample and safe accommodation is afforded in the harbor near the wharf for loading, by means of lighters, vessels of a greater draught. The average amount of coal which the present works and appliances are capable of producing and shipping may be stated to be 550 tons per day, or upwards of 150,000 tons per annum, which will be increased

Railway.

Wharf.

threefold when those at the New Winning are brought into operation.*

There is a good foundry and machine shop, built of brick, attached to this colliery, furnished with several large lathes, planing and screw-cutting machines, boring mill, and all machinery requisite for the construction and repair of steam-engines and of all the implements required about the mines. The foundry engine is of 40 horse-power, with two cylindrical boilers, 6 feet in diameter, and 30 feet long, and an auxiliary boiler, about 3 feet 6 inches in diameter, consuming in all about seventy tons of coal per month. Foundry and machine shop.

UNDERGROUND WORKS.—The style of working which has been adopted in this colliery since the commencement (as in all the others in this district) is what is well known under the name of the *pillar and bord* or *post and stall* system; the only modification introduced having been the enlargement of the pillars as the seam is worked further to the dip. From the bottom of the Queen Pit access is obtained to the dip workings by two slopes, diverging, although nearly on the full dip; one commanding the northern, and the other the southern part of the workings. These inclines or *engine slopes* are over 1000 yards in length each, and are cut seven feet wide for three sets of rails, forming rail or tramways of two feet gauge, with suitable crossing places. The rails are of wrought iron, 32 pounds to the yard; and the slopes are worked by two pairs of horizontal stationery engines, about 30 horse-power each pair, supplied with steam from the boilers on the surface, and drawing the trains of tubs by a wire rope. The tubs or small waggons used in the mine are built for the most part of sheet iron, although some are of wood; they contain on an average $9\frac{1}{2}$ cwt. each, and the train usually consists of about twenty tubs. System of working.

From the main slopes levels are extended on either side in a direction nearly north and south magnetic. These levels are 6 feet wide and $5\frac{1}{2}$ feet high, and are also laid with a similar description of rails, over which the tubs are drawn by horses. The dimensions of the bords and pillars have varied at different parts of the works, the size of the pillars, as already stated, having been increased as the works progressed further to the dip. At present the bords or working-places are $16\frac{1}{2}$ feet wide, driven on the level and parallel to the main roads, and the pillars are left from 30 to 40 yards long by 14 yards wide. The gate roads, 6 feet wide, from the main levels to the working places, are driven about 20° off the true dip, or N. 80° E. There is no regular cleat to this coal seam, but it is found to work best in the direction and manner indicated. The coal is

* This calculation is based on the assumption of a regular yield throughout the whole year. In reality the miners only work about half time in winter, and hence the production during the shipping season is occasionally much greater than the average.

Slack coal

cut in the usual way by holing in the bottom of the seam, shearing in the sides, and bringing down partly by wedges set in a parting, about two feet from the bottom, and partly by blasting with gunpowder. Of all the coal mined at this colliery, probably about 20 per cent, or one-fifth, is in the state of *slack*: and as only a very small proportion of this finds a market (the proportion of large to that of small coal sold being as 23 to 1) most of that made underground is allowed to remain there.

Ventilation.

Ventilation.—The ventilation of this colliery is effected by means of a furnace with 30 square feet area of grate, through which also the exhaust steam from the slope engines is conveyed to the surface. The volume of air set in motion through the workings by this furnace amounts to 28,500 cubic feet per minute. The air is drawn from above through the queen or cage pit shaft and the pumping shaft, down the engine planes, and back through the workings, guided by proper doors and stoppings, to the furnace, from which it is discharged into the upcast shaft, used exclusively for ventilating purposes.

So far as I can learn no faults or troubles have been met with in these workings; but occasionally portions of the roof have fallen in, and have caused disaster and loss of life, such portions being apparently occupied by the spreading roots of erect trees.

Production and
rice

PRODUCTION.—The average annual production of coal for the market from Sydney Mines, for the last fifteen years, is 104,428 tons. It is largely exported to the United States and the neighboring Provinces, chiefly for domestic purposes. The selling price for many years has been \$2.25, per ton with 10 per cent. discount on orders for more than 2,500 tons.

II. LINGAN MINES.

These mines were first opened by the General Mining Association in 1854, upon an extensive and valuable tract of about fourteen square miles, bounded on the east by the shores of Indian Bay and Lingan Basin, and on the west by Sydney Harbor. This tract is underlaid throughout its entire length (six miles) by several very important seams of coal, which will be found to extend in a workable condition under the sub-marine area of ten square miles also leased by the Association.

Forty feet of
good coal.

Eight workable seams have been found and proved on this area, comprising an aggregate thickness of not less than forty feet of good coal, besides several others which have been discovered by boring and trial pits, but whose precise dimensions are unknown. On the present occasion I shall confine myself to a notice of only two of these seams, on which collieries have been established.

The Lingan colliery is situated on the north shore of Indian Bay, about twelve miles from Sydney. The mine is opened by a slope on a seam

eight feet eight inches in thickness, called the Lingan Main seam, dipping N. 32° E. < 12°-16°. At a height of five feet eight inches from the floor of the seam, as will be found mentioned in the description, Table II., a clay parting occurs, which at its out-crop in the cliffs at Indian Bay is only one inch in thickness, but at the working slope, half a mile west, has increased to fifteen inches, and in a further similar distance west attains a thickness of eight feet, splitting the seam into two, the lower portion alone being there worked, and still maintaining its original thickness, whilst the parting forms the roof. Taking the lower bench only of this seam as available for working, the land and sea areas of the seam in the Lingan tract may be estimated to contain 73,800,000 tons of coal, of which, supposing seventy acres to have been partially worked over, there will remain about 73,000,000 tons. Quantity of coal available.

The Lingan mine coal is highly esteemed; and is specially adapted for the manufacture of gas, for which purpose it is largely exported to Boston and New York, and formerly also to Halifax; it is said to yield not less than 9,700 cubic feet of gas per ton. Owing to the occurrence of a pyritous band about two inches in thickness, and fourteen inches from the roof, the coal, after being mined, has to be carefully screened and hand-picked before shipment, to free it from this deleterious ingredient. Pyritous band. This coal is also much esteemed for blacksmiths purposes, and for the quality of its coke.

As regards its character as a steam coal, Professor How remarks:—
 “The ash is very low in all parts of the seam, the average of the whole being only 3·06 per cent. This gives great evaporative power to the coal, and hence, according to late results, it should be valuable for steam purposes. The mean of all my experiments gives for the theoretical evaporative power of the coal 9·19 lbs. as the amount of boiling water which should be evaporated by one pound of coal. This is somewhat above the practical result, even from Welsh steam coals, in our British navy steam trials, which gave the highest weight, viz., 9·05 lbs. As it is now known that bituminous coal can be made to give, without smoke, greater heating power than Welsh steam coals, when their ash is low, a bituminous coal like this of Lingan assumes a new value. . . . I find that the average percentage of ash from fourteen analyses of North of England coal is 3·77, while the Lingan gives only 3·06 per cent., so that, in proper furnaces, it ought to prove a very good steam coal indeed.” Report by Professor How.

Dr. Harrington's remarks on the sample of coal from this mine, submitted by me, are as follows:—“This is a clear, bright coal, and contains a considerable quantity of mineral charcoal, but no visible pyrites. On account of the small amount of ash, as well as of sulphur (as compared with the other coals examined), it may be considered as the best of all the samples of Cape Breton coal which have been submitted to me for Remarks by Dr. Harrington.

analysis. It could scarcely be said to coke, but swelled up into a light porous mass. The ash is of a light grey color, with a slight reddish tint."

Without pausing to notice the earlier workings at Lingan mines, I shall proceed to describe the present state of the colliery.

Slope. **Engine.** **SURFACE WORKS.**—The coal obtained in this mine is brought to the surface by a slope sunk from the crop on the full dip of the seam, and to a length of 704 yards, extending about 66 yards under the sea. This main slope is laid for the most part with a double track railway, two feet gauge, worked by a wire rope connected with the winding engine at the surface, which also raises the water from the levels below the sea to the adit. This is a high pressure engine of 40 horse-power, 28-inch cylinder, and 6 feet stroke, working the pump, and two drums on one shaft. The arrangements are adequate to a production of 300 tons a day.

Railway. From the slope and bank the coal is conveyed to Lingan Harbor, distant about one mile, by a good railway, running straight, and with uniform, descending grade, with self-acting incline 342 yards from the wharf upwards. The railway is 3 feet 6½ inches gauge, laid with T rails, 35 to 65 pounds to the yard. The rolling stock consists of 100 waggons, carrying two tons each; and an English-made saddle-tank locomotive engine of 9 tons weight.

Wharf. The depth of water at the wharf at Lingan Harbor is 16 feet at low, and 20 feet at high, tide, but this depth has to be acquired and maintained by dredging, and the harbor is rather difficult of access for vessels of any considerable draught. The wharf is provided with three shutes, and in conjunction with the railway, as at present equipped, is capable of shipping 600 tons per day, or double the present maximum production of the mine.

Tug-steamer. For harbor and wharf service a small tug-steamer and steam dredging machine are owned by the Association and employed in connection with this colliery. The tug consumes about two tons of coal per day when in full work.

Workings. **UNDERGROUND WORKS.**—These are regulated on the pillar and bord system, as at Sydney mines. As already noted, access is obtained to the underground works by a slope from the crop, provided with a railway, and commanded by a stationary steam-engine at the surface. The slope is 8 feet wide. From it, levels 6 feet wide are extended S.E. and N.W. on the strike of the seam, at distances of 110, 220, 440 and 704 yards respectively from the crop. The first and second levels are about one mile in length, extending to the sea; the first affording a natural drainage to the mine to that depth, the slope being about midway between the sea and the end of the level. The coal to the rise of the first level, and that between the first and second levels, has been for the most part worked out; in the other workings the pillars are still left standing. The dimen-

sions of the pillars vary according to the depth, being 5 yards square at the upper, and 22 yards by 5 yards, at the lower levels. The working places are turned to suit the cleat of the coal, and vary from 5 to 6 yards in width.

The main slope and levels are laid with T rails, 22 pounds per yard; and the gate-roads and working places, with bridge rails, 16 pounds per yard. The number of tubs at present in use is seventy; capacity half a ton each. Six of these are hoisted at once with a single rope, and eight or nine when worked with two ropes; the average number drawn to the surface per day is 700. In the pillar workings the *slack* is left in the mine, in the rooms it is brought to the surface. I may here remark that, although the workings have been extended some distance under the sea, there is no difficulty in draining the mine. Two pumps, 8 inches and 6 inches in diameter respectively, with 4 feet stroke and 16 strokes per minute, fixed in the lower levels, and worked by the stationary engine at the pit head, are found amply sufficient to keep the mine clear of water. Drainage. That portion of the workings belonging to the sub-marine area accumulates only one ton of water per day; an important fact with reference to the practicability of working such areas.

Ventilation.—There is very little gas in this mine except in the deep workings, and by simple precautions all danger from this source is obviated. The air passes down the engine incline and through the workings, and returns by an upcast slope, about 40 or 50 yards to the north, commanded Ventilation. by a furnace with about 30 feet of grate surface, discharging by a shaft 27 feet deep, and chimney, 32 feet high and 9 feet square. The average quantity of air set in motion through the mine is 15,500 cubic feet per minute.

PRODUCTION.—The average annual production of coal at this mine during the last fifteen years has been 29,744 tons; but it is capable, even with the present appliances, of supplying three times that amount if Production and price. required. In the fall of 1866, not less than 8,000 tons were shipped in one month. The selling price has hitherto been \$1.75 per ton, or fifty cents less than the Sydney coal.

BARRASOIS AND BRIDGEPORT MINES.

Although this Report is intended to refer only to such collieries as were actually in operation at the time of my visit, I may here give a brief notice of two other localities where operations have been carried on by the General Mining Association, but which are at present suspended. The first of these is the Barraois Mine, opened on the Lingan Barraois mine. tract, close to the sea shore, and two miles west from Lingan mine, on a seam overlying the Lingan main seam by 457 feet vertical thickness. These workings were instituted for the purpose of securing possession of one of the five square miles sea areas connected with the Lingan tract.

Barrasois seam. The Barrasois seam is ten feet eight inches thick, of which, however, two feet at the height of six feet from the floor consist of a fire-clay parting, probably rendering the lower bench only workable. It dips N. 30° E. < 12°-15°. A pair of slopes, 7 feet by 6 feet, have been driven 374 yards in a direction somewhat to the north of the true dip, in order to reach the sea within the shortest distance; and levels have been driven eighty-eight yards to the east, and forty-four yards to the west of the slope, to win the sea area only. The coal is of excellent quality—best adapted for domestic purposes—but little of it has been mined, and no record seems to have been kept as to quantity or disposal.

Slopes.

Levels.

Quality of the coal.

Bridgeport mine.

Extract from Mr. Brown's "Coal Fields of Cape Breton."

Thickness of the seam.

Railway.

Quality of the Bridgeport coal.

The General Mining Association have also worked to some extent on their Bridgeport tract of two square miles, situated on the south shore of Indian Bay. This mine was in operation for twelve years ending in 1842, when it was abandoned, owing to the reduction in the demand, and want of facilities for shipping. The following brief description of these works is from Mr. Brown's "Coal Fields of Cape Breton," p. 85:—"A level was driven from the outcrop along the strike of the seam, now known as the "Phelan seam." As the level proceeded to the southward pits were sunk at intervals of about a quarter of a mile, from which the coal was raised by horse gins. At the face of the cliff the seam consisted of an upper bed, three feet in thickness, and a lower bed, five feet three inches in thickness, separated by a four-inch layer of shale; but, as the level advanced, the layer of shale gradually increased, until, at the distance of half a mile from the shore, it attained a thickness of 28 feet. Beyond this point it rapidly declined, and, at a trial bore-hole, 300 yards to the dip of the level, it was found to be only fourteen inches thick, the upper bed of coal being three feet six inches, and the lower six feet in thickness. In the first instance the coal was brought out of the level and boated off to vessels at anchor in the open bay; but in 1833 a light railway, two miles in length, was laid from the pit along the sand beach to the harbor, which was adapted only for vessels drawing 11 feet of water when loaded. The Bridgeport is a good domestic fuel, but not equal to the Sydney coal; on the other hand it is more valuable as a gas coal, yielding nearly 10,000 cubic feet of gas per ton. Its constituents by analysis are :

Volatile Matter	33.20
Fixed Carbon	61.39
Ash	5.41

100.00

This is a very valuable tract, as it is underlaid not only by the seam referred to, but by others of great importance, particularly the Ross seam, to be hereafter noticed, lying at a vertical depth of 210 feet below the

Phelan seam. The opening of the International railway, which crosses the area about half a mile inland from the old works, will afford a convenient outlet to an excellent wharf and harbor.

The quantity of coal contained in this tract in the seam which has been partially opened may be estimated at 12,600,000 tons, and the total quantity raised and sold at 156,000 tons.

Quantity of coal in the Bridgeport tract.

III. VICTORIA MINE.

This mine was established in 1867 to work a sub marine area of four square miles on the east side of Sydney Harbor, access to which is obtained from the west end of the Lingan tract of the General Mining Association, where within a breadth not exceeding one mile, measured at right angles to the strike, probably all the coal seams of the district, with an aggregate thickness of over fifty feet of coal, crop out in the cliffs, dipping to the north at an angle of about 40°. These have been fully described by Dr. Dawson in a Report dated August 29th, 1868, a summary of which is given in Mr. Rutherford's "Coal Fields of Nova Scotia," pages 40 and 48. Probably at least six of these seams, representing an aggregate thickness of about thirty-six feet of coal, are of workable dimensions and conditions; and the breadth of the area is such that, with the high dip specified, and provided no faults intervene, all the coal which could be economically extracted from these seams will be included within the area. Most of them will, no doubt, be traced in connection with those found at and in the vicinity of the Lingan and Barraois mines, although in different conditions.

Number and thickness of the seams.

The Victoria Mine is upon a seam which has hitherto been called (from the name of the person who originally worked it) the Ross seam*. It is six feet ten inches thick, but yields in working only five feet six inches of good clean coal, with roof and floor of unexceptionable quality. The quantity of coal within the area in this seam, and to a depth of 4,000 feet, which may, perhaps, be regarded as the limit to which it can be economically worked, is 15,550,000 tons, of which only 55,960 tons have been extracted.

The quality of this coal, as will be seen by the analyses in Table II, is excellent; and this is further corroborated by the fact that, with the exception of the Sydney Mines coal, it has always commanded a higher price than that of any other colliery in the district. It is chiefly used for household and steam purposes, and is not considered good for gas. Dr. Dawson, in giving his analysis of this coal, adds:—"The coke is vesicular and of excellent quality, and leaves very little ash; so that, on

Quality of the Victoria Mine coal.

Coke.

* As there is another important seam of coal in this district, which has been long known as the *Ross seam*, and which cannot be regarded as identical, I propose that the one here referred to should be designated by the name of the *Victoria seam*.

the whole, this may be regarded as one of the finest coals in Cape Breton for any of the uses to which bituminous coal is applied." The slack coal is also excellent for blacksmiths purposes.

Old workings.

The mine is now worked by a slope upon the full dip of the seam N. 30° W. < 38° 30', situated seventy or eighty yards from the sea shore. It was first opened by a slope which was carried down 320 feet, 282 yards to the west of the one now used, and some bords were worked; but having too little cover, and being in danger of invasion by the sea, these workings had to be abandoned. It may be remarked, however, that, although there is a connection between the new and old workings, no perceptible increase of water has been experienced, and the mine suffers little or no inconvenience from this cause.

Engines.

SURFACE WORKS.—The new slope above referred to was opened in 1870, and is worked by two horizontal steam engines, coupled directly to one shaft carrying winding drums, 10 feet in diameter, with wire rope 1½ inches diameter. These engines are of about 120 nominal horse-power, having 22-inch cylinders, and 4 feet 6 inches stroke, with 50 revolutions per minute, and 30 lbs. of steam on the boiler, being of course calculated to work to much greater depths than now attained. The boilers are seven in number, plain cylindrical, 3 feet in diameter and 36 feet long; of which, however, only three are at present required. The tubs, carrying about one ton each, are hoisted two at a time on a species of trolley, cage or carriage, constructed to suit the steep angle of dip, and running on the slope railway; this cage is also in part constructed as a water tub to drain the deep workings. By these arrangements two tubs of coal can be brought to the surface in three minutes, or forty per hour, equal to a production of 500 tons per day, although from various causes the production has hitherto been limited to a maximum of 100 tons per day. The total quantity sold in 1872 was only 20,000 tons.

Boilers.

Daily production.

Pumping machinery.

At the New Works a pair of pumping engines have been erected, although not yet brought into regular operation. They are direct-acting condensing engines of about 50 horse-power, with inverted cylinders, 22-inches in diameter, and 20 inches stroke, working at a reduced speed a plunger pump, 11 inches in diameter and 6 feet stroke; and designed to lift the water the entire height from the lowest workings to the surface. The mine, however, makes very little water in the lower levels, (although under the sea) except what percolates along the coal seam from the old workings. Here a horizontal high pressure engine, cylinder 12 inches in diameter and 4½ feet stroke, geared 3 to 1, works a plunger pump, 8 inches in diameter and 4½ feet stroke, giving 16 strokes per minute, which draws the water (forty gallons per minute) from a depth of 309 feet, and in conjunction with the water tub at the new slope, drains the mine in twelve hours working. There are also a pair of small auxiliary

steam engines, 8-inch cylinder and 16-inch stroke, for hoisting the bank coal, &c. The coal from this mine makes about one fourth *slack*, which is all either sold or used on the works.

No shipping place being available in the immediate vicinity of the mine, the coal is conveyed over a railway to a point three and a half miles higher up the harbor, and immediately within the South Bar, where a commodious wharf has been erected. Both railway and wharf belong exclusively to the company, and were completed only three years ago: no considerable quantity of coal having been previously shipped by the company. The railway is of the usual English, or 4 feet 8½-inch gauge, with T rails, 45 pounds to the yard. It is furnished with thirty-two coal waggons, (and there are ten more in course of construction) each capable of carrying five tons, and opening at the bottom with double doors; also one tank locomotive, 16½ tons in weight, sufficiently powerful to draw eighteen or twenty loaded cars at a fair speed. The wharf is five hundred feet long, with five shutes for loading, and at low tide can accommodate at one time four vessels, drawing 23 feet of water, and two of lighter draught, say 10 feet

The new slope—15 feet by 9 feet, with two tracks, 4 feet 6 inches gauge—is now about 850 feet in depth, measured on the angle of dip, with air courses, 8 feet by 5½ feet, thirty feet distant on each side.

UNDERGROUND WORKS.—The levels are all driven to the west of the slope, as, until a considerable depth is attained, they cannot be extended far in the opposite direction without encroaching on the land area belonging to the General Mining Association. There are three main levels, 7 or 8 feet wide, each about 420 yards in length; the lowest being laid with a substantial railway, 2 feet gauge, with bridge rails, 15 pounds to the yard. All the coal extracted in the upper levels is shot down to the lowest, to be hauled on the railway to the cage at the foot of the engine slope, either directly or on the counterbalance system, as described by Mr. Hartley in his Report (Geology of Canada, 1869, page 93.) The bords extend over 400 square yards, worked out, but the pillars left standing. The size of pillars and bords has varied considerably, and need not here be minutely detailed. The former are generally 23 yards long and 8 yards wide; and the rooms, 6 yards wide, are driven about S. 30° W., the cleat being N. 75° W.

In working this seam the average thickness of good coal taken out is five feet six inches; the lower six inches, being of inferior quality, is left in. A remarkable peculiarity in the mechanical structure of this coal is, that owing to its peculiar toughness and the fact that the cleat runs almost parallel with the direction of the seam, (both being due probably to the compressing forces which have thrown the seam to such an unusually high angle) the coal comes out in long and comparatively thin parallel

Corrugations or
rolls.

blocks, sometimes more than six feet in length. Another noteworthy feature, which may also be connected with, and throw light upon the geological structure, is that three or four heavy rolls or corrugations have been encountered, extending through all the workings to the rise, and dipping at an angle of 30° to the east, rendering it necessary to cut down portions of the roof at the points where they occurred, and in one instance thus admitting water from the old workings. A large mass of very hard tough sandstone intercepted the coal at the end of the lower level, but was found to be of very inconsiderable thickness, and on cutting through it, the seam was seen to have increased to ten or twelve feet in thickness for a certain distance. Similar phenomena have been found to occur in connection with the Block House seam, which will be hereafter more specially referred to.

Sandstone inter-
rupting the
coal.

Gas,

Ventilation.—There is a considerable amount of gas developed in this mine, and in some places to an extent which renders great caution necessary; but naked lights are systematically employed, except in the morning, when some of the rooms have to be examined with a safety lamp; and no accidents have occurred from this cause except such as are directly attributable to carelessness.

Arrangements
for ventilation.

Until very recently no special arrangements for artificial ventilation were employed, but an underground furnace has lately been introduced in the upper end of one of the slopes, thirty feet west of the engine slope, which, by means of two upcast vertical shafts, furnished with chimneys, effectually ventilates the mine.

Production and
price.

PRODUCTION.—The average annual production of this mine during the three years since the railway and wharf were brought into operation, is 14,900 tons. This has been chiefly sold in the British Provinces for domestic and steam purposes. The selling price hitherto has been \$2.00 for large, and ninety cents for *slack*. The *slack* is all sold or otherwise utilized.

IV. INTERNATIONAL MINE AND RAILWAY.

Twenty-two feet
of workable
coal.

The International Coal and Railway Company of New York, acquired in 1863 an area of four square miles, situated about half-way between Sydney Harbor and Cow Bay, about the centre of the Glace Bay basin, and adjoining the Bridgeport area of the General Mining Association. The breadth of this property is not less than three miles in the very heart of the productive coal measures; and it is underlaid by at least four most important seams, with an aggregate thickness of twenty-two feet of workable coal; affording scope for the establishment of several collieries; and as the angle of dip is very moderate, the lowest seam which crops out on the property (the Ross seam), will be reached at 240 yards beneath the crop of the highest. Hitherto mining operations

have been confined to the Harbor seam, being that nearest the centre of the basin, or the highest in the area; its thickness is from five feet six inches to six feet of good coal; and it has been proved to extend entirely across the area, or over two miles at its out-crop. I estimate the quantity of coal contained in this seam on the property, at 5,000,000 tons, of which, only about 340,000 tons have as yet been extracted.

Thickness of
the Harbor
seam.

The quality of this coal is excellent, although hitherto perhaps worked too near the crop; it bears the character of being unusually hard, compact and free from sulphur and shale. It has been chiefly used for the manufacture of gas, for which purpose it has been largely exported to New York, and it is said to yield 10,000 cubic feet of 16-candle gas, and 1,470 lbs. of good coke to the ton. It is also held in high estimation as a steam coal, making a strong, hot fire, and is certified equal to the best West Hartley (North of England) steam coal; although the clinker is somewhat apt to adhere to the furnace bars.

Quality of the
coal.

Gas.

Clinker.

The mine was first opened under the name of the Union Mine, five years before the present company came into possession, by a level driven on the seam from the base of the cliff at the sea shore; at 176 yards inland, this level is connected with a slope, 150 yards in length, to the crop. A second level was also carried south 400 yards at a distance of about eighty yards to the dip from the former, and workings to the rise, to the extent of seven acres, on the pillar and bord system, were carried on systematically and economically, but no pillars extracted. The drainage was effected by means of a horse-power pump which raised the water from the lower level to the sea level. The great obstacle to the success of these operations was the want of a proper shipping place.

Old workings.

On the International Company coming into possession, their attention was first directed to remedying this defect by building, in conjunction with a new colliery on a more extensive and permanent scale, a railway to Sydney Harbor, and a wharf which should at the same time accommodate all the other collieries in the vicinity and along the line. From various causes, however, which it is unnecessary here to detail, it was not until the autumn of 1870, that these works were completed and put into operation. Productive work at the colliery was also suspended during the greater part of 1872, and resumed in September of that year.

Internationals
Company.

Railway and
wharf.

SURFACE WORKS.—The new colliery is situated at the distance of 700 yards from the old slope, or half a mile from the shore. A vertical shaft, 14 feet 6 inches by 6 feet 6 inches, has been sunk 96 feet deep, or 16 feet below the water-level of the seam; and by bratticing off in equal divisions this shaft is used for winding, pumping and ventilating purposes. The arrangements at the pit-head are very complete and substantial. The tubs, each containing half a ton of coal, are raised to the surface at the rate of 1,200 per day by two horizontal high-pressure engines coupled;

Shaft.

Engines.

with 16-inch cylinders, and 3 feet 6-inch stroke. The steam is supplied by two cylindrical boilers, respectively 3 feet and 5 feet in diameter and 25 feet long. The winding drums are 6 feet in diameter, with 1-inch round steel wire rope. The present arrangements are adequate to a production of 600 tons per day; but the actual production at the time of my visit was 200 tons from the pit and 150 tons from the bank.

Daily production.

Buildings.

In connection with the surface works at this colliery there is a good machine and repair shop built of brick, 60 feet by 36 feet, and two engine sheds 40 feet long; the repair shop is provided with all suitable tools, and the motive power is supplied by a horizontal engine, 12-inch cylinder and 2 feet stroke; there is also a turn-table for the railway.

INTERNATIONAL RAILWAY.

International Railway.

From the above described colliery to Sydney Harbour a railway twelve miles in length, and a commodious wharf at the terminus on the harbor, have been constructed by the company, and are now in regular operation. The railway is 4 feet 8½ inches gauge, laid with rails, 56 pounds to the yard, connected by wrought-iron fish-plates, and in every respect built and equipped in the best modern style. The grades are very light not exceeding 1 in 200 with, and 1 in 160 against the traffic. A great part of this railway, as in many similar instances, is ballasted with the *slack*, or small coal from the mine; but although admirably adapted for this purpose, it is to be regretted that a better application has not hitherto been found for such valuable material.

Slack coal used for ballast on the railway.

Cars.

The International railway is stocked at present with 200 cars, opening at the bottom, each capable of carrying five tons of coal, and three English-made tank locomotives, with six wheels coupled, and of 25 tons loaded weight. These engines are each capable of making three trips per day, drawing 35 cars or 175 tons of coal each trip, with an expenditure of 24 bushels, or one ton of coal. At the terminus on Sydney Harbor is a turn-table and engine house, offices, &c.

Locomotives.

Wharf.

The wharf is situated about one and three quarters of a mile from the town of Sydney, and is 1,000 feet in length by 35 feet wide, with three tracks, and seven sets of turn-tables, windlasses, shutes, &c., capable of loading, at low tide, seven vessels at once, with a draught of water up to 30 feet.

System of working.

UNDERGROUND WORKS.—As these have only recently been instituted at the new colliery, and as I have already briefly described the old works there is not much to be recorded respecting the former. The new and old works are connected on one of the levels. The system adopted is to drive level, or nearly level, bords north and south 6 yards wide, with pillars 8 yards wide and 22 yards long, with full rise headways, and incline

horse-roads. There are at present about 200 tubs in the mine, holding half a ton each. The railways underground are of 2 feet 8 inches gauge, mostly laid with strap rails or flat bars, $2\frac{1}{2}$ inches by $\frac{5}{8}$ of an inch. The *slack* made in the mine amounts to about one-fifth of the whole, only a small proportion of which is saleable under present circumstances. Underground railways.

Drainage.—For drainage (below water level) a small direct-acting pump was erected at the bottom of the shaft, supplied with steam from the boilers at the surface. This requires 14 hours pumping per day to drain the mine, but a larger and more perfect (“Cameron Special”) 8-inch pump, worked on the same system, was in readiness and about to be applied at the time of my visit. Drainage.

Ventilation.—The ventilation of this mine hitherto has been attended with no difficulty, and no furnace stoppings, or other special appliances for this purpose have been required, the natural currents of air generated by the arrangement of slopes, shafts, and levels, being found to be adequate for this purpose. Appliances for Ventilation.

PRODUCTION.—The average annual quantity of coal raised and sold from this colliery for the last four years is 27,175 tons. As already stated it has hitherto been chiefly exported to New York, for the manufacture of gas at the Manhattan Gas Company’s works. The selling price delivered free on board at the International wharf, averaged last season \$1.75 per ton. Production and price of the coal.

V. LITTLE GLACE BAY MINES.

These works were commenced in 1858, by Mr. E. P. Archbold, of Sydney, now of Halifax, who leased an area of 1640 acres, or over two and a half square miles, and transferred it in 1861 to the Little Glace Bay Company, chiefly composed of Halifax capitalists, who have worked the mines with little intermission and more or less profitably ever since. For some time previous to the abrogation of the Reciprocity Treaty between the British Provinces and the United States, these operations are said to have been conducted so successfully as to have enabled the directors to pay dividends of 40 per cent. to the shareholders. Since that time, owing to the limitation of the market, the works have not been so vigorously prosecuted, although capable of producing, even with no greater amount of openings and appliances than already exist, nearly double the average annual production hitherto. Dividends of 40 per cent.

This area is situated about sixteen miles from Sydney, adjoining to the east that of the International Company, and is most favorably situated both as regards its position in the coal field and facilities for shipment. It embraces the entire land out-crop of the Hub seam, the central or uppermost and the thickest of the series; and a large proportion of that of the Harbor seam, besides being underlaid, at a maximum depth not

exceeding 700 feet from that last named, by three thick workable seams, and at a somewhat greater depth, not yet determined, by two others of importance. These seams represent an aggregate thickness of not less than 42 feet of good, workable coal.

Forty-two feet
of workable
coal.

Thickness of
the Hub seam

The total thickness of the Hub seam is nine feet ten inches, of which the upper portion, one foot eight inches thick, being of inferior quality is not taken out except in the main level. The land area underlaid by this seam is about 150 acres, of which probably 57 acres have been partially worked out, leaving an available amount of 1,248,000 tons, besides the pillars, none of which have been robbed. The Harbor seam, five feet six inches thick, includes 970 acres, of which, supposing twenty-eight to have been worked out, there will remain 7,820,000 tons besides the pillars. These seams dip, at the point where they are worked, N. 60° E. < 4° 40' or 1 in 12.

Thickness of the
Harbor seam.

Gas.

The coal produced from these seams has been chiefly used for gas and steam; that from the Hub seam being specially adapted for gas, for which purpose it has been for many years used by the Halifax Gas Company, and exported to the United States. It yields nearly 10,000 cubic feet per ton of 15-candle gas, contains an exceedingly small proportion of ash, and makes an excellent coke. The *slack* coal, amounting to about one-fifth of the whole, is much esteemed for blacksmiths uses, and is all saleable. The coal from the Harbor seam is characterized by the presence

Slack.

Ash.

of a somewhat greater proportion of ash, but in other respects is equally good with that of the Hub. The following is an extract from an official report on the quality of these coals, made at Halifax on behalf of the Admiralty:—

H. M. S. "Duncan,"

Halifax, 12th April, 1867.

Description of Coal.	Percentage of Clinker Ash.		Smoke.
	6.79	2.12	
Harbor Vein.	4.28	1.63	Dark brown, and considerable in quantity.
Hub "			Light brown, and considerable in quantity.

Report by
Chief Engineer
Edward O.
Crichton, H.M.
S. "Duncan."

Both of these coals light up quickly, raise steam fast, burn well and cleanly, and generate steam well. They produce a very moderate amount of clinker and ash. The smoke from the Harbor vein coal is considerably more than that from the Hub vein, and much darker. The deposit of soot is considerable in both kinds.

Tested for carbon, the Harbor vein coal contains 83.5 per cent., and the Hub vein 80.9 per cent., and therefore in this respect are nearly equal to Welsh; which is further corroborated by the fact that the average

daily expenditure of Welsh and Glace Bay coal in the lathe-room boiler is as nearly as possible alike, the Harbor vein having slightly the advantage of the Hub vein.

Being similar in their nature to North of England coal, they are not liable to make *smalls* nor *dust*; and would therefore stand trans-shipment without much deterioration.

I am therefore of opinion that both of the coals are well suited for the use of H.M.S. ships, particularly if treated in the same way as ordered by the Admiralty respecting English coals, viz: mixed with Welsh in proper proportions."

(Signed,)

EDWARD O. CRICHTON,
Chief Engineer.

SURFACE WORKS.—The Hub seam was opened for regular working in the first instance by a slope situated 100 yards from the shore at the west side of Little Glace Bay. This slope, which is 12 feet wide by 5 feet high, Slope. with double track railway, is 400 feet in length, driven through the rock at an incline of 1 in 4 to cut the seam 100 feet vertically beneath the surface, and 300 yards from the crop. Levels have been driven on either side Levels. of this slope to win the coal to the rise. Recently a vertical winding shaft, 13 feet by 9 feet, has been sunk to cut the seam 200 yards further to the dip, and 500 yards north from the slope. This shaft is 129 feet deep; it Shafts. is connected by levels with the former workings, and at both points separate shafts have been sunk for pumping and ventilation. For working the slope there are two horizontal high-pressure engines coupled, the combined power of which may be about 30 horse-power. A separate pumping engine Engines of 18 horse-power, originally used at the slope, has been transferred to the new pits to serve both for pumping and winding. The steam for these engines is supplied by four plain cylindrical boilers, 3 feet in diameter Boilers. and 30 feet long. There is a repair shop with a small auxiliary engine at the slope works. A railway one and a third mile in length from the Railway. new pits, and about one mile from the old works, connects this colliery with the harbor at the mouth of Little Glace Bay Brook. It is of the usual English, or 4 feet 3½ inches gauge, laid with rails weighing 45 pounds per yard, and is equipped with 48 waggons, each capable of carrying 4 tons, and one 13-ton locomotive tank engine.

On the Harbor seam the workings have hitherto been reached from the surface by two shafts, 27 feet and 40 feet deep respectively, but the Workings on the Harbor seam. amount of work done at these pits, being so near the crop, has been comparatively limited, and has been almost discontinued so far as the production of coal is concerned. Only one shaft is now in use for pumping purposes, by means of an 18-horse-power steam engine. This colliery is within 60 or 70 yards of the wharf, and the coal produced was loaded

into the vessels direct from the tubs. For more extensive and systematic working on this seam, the company have recently instituted operations; not yet completed, for a new winning, by a set of vertical shafts, 500 yards from the crop and about half a mile from the harbor. These shafts, one for pumping and one for hoisting, at the distance of 100 feet apart, are designed to cut the seam at a depth of 230 feet.

New Shafts.

Harbor.

The harbor, which has been artificially formed at an expense (up to the present date) of £23,000, is safe, accessible and commodious; being protected by two long parallel piers of crib-work, filled with stone. It has an area of at least six acres, and is capable of accommodating 30 or 40 vessels; and there are 800 feet of wharf frontage for vessels drawing up to 17 feet of water; and this depth can be easily increased to 21 feet. The wharf is furnished with shutes, &c., capable of loading four vessels at once, besides four extra shipping berths. The present arrangement at the pits, railway and wharf are adequate to the production and shipment, when in full operation, of not less than 1,009 tons per day of twelve hours, and this quantity could easily be increased if required. A small screw tug steamer, with engine 16-inch cylinder and 4 feet stroke, or about 35 horse-power, is maintained by the Little Glace Bay Company for the accommodation of vessels entering or leaving the harbor; also a small steam dredging machine.

Wharf accom-
modation.

Tug-boat.

UNDERGROUND WORKS.—These works although skilfully and judiciously designed and executed are somewhat varied and irregular in their character, and a detailed description of all their parts is unnecessary. From the new shaft on the Hub seam levels have been driven north 400 yards and south 333 yards. At the old slope, levels have also been extended north and south to connect with the above; the main or horse levels, for a double railway track, are 12 feet, and the water levels 7 feet wide. The coal is extracted on the pillar and bord system; the working rooms being 16 feet wide, and the pillars 12 by 15 feet. The extent to which the workings on this seam are carried may be estimated at 60 acres, although all this area is by no means worked out, and no pillars have been extracted. The coal in the Hub seam is so easily wrought that one man can take out on an average six and a half cubic yards per day, and little or no timbering is required.

Levels.

System of
working.

On the Harbor seam, as already stated, the workings are of very limited extent. From the pumping-shaft a level has been driven to the north 264 yards; and the coal has been worked to the rise from this level, which is eighty yards from the crop. The dimensions of bords and pillars are the same as those in the Hub seam workings. The quality of the water raised from the Harbor seam at this shaft is deserving of notice, being impregnated to an unusual extent with sulphate of iron, which, on exposure to the air, oxydizes and is precipitated in the form of a dense yellow powder (peroxide of iron).

Mineral water.

PRODUCTION.—The coal from the Little Glace Bay colliery is mostly exported to New York, Boston and Halifax, for the manufacture of gas and for other purposes. The average annual sale for the last ten years has been 49,629 tons; and the selling price at the wharf is \$1.75 for round, and \$1.00 for *slack* coal. Production and price of the coal

VI. CALEDONIA MINE.

The property on which this colliery has been opened is situated about sixteen miles from Sydney, adjoining to the east that of the Little Glace Bay Company, and comprises 875 acres of land and 632 acres of sea area, the latter being covered by the waters of Glace Bay and Lake. It is underlaid, within an easily accessible depth, by about five workable coal seams, the united thickness of which may be stated as twenty-four feet of solid coal; and there are other important seams lying at a greater depth. Twenty-four feet of Coal. Operations were commenced here in 1866, and have been continued uninterruptedly ever since by an association of Boston capitalists, under the superintendence of Mr. Henry Poole, a most intelligent and experienced scientific and practical mining engineer and geologist, who has planned and carried out the whole arrangements at this colliery with great skill and success.

The only seam worked on the property is that styled the Phelan seam, dipping N. 27° E. < 5° 45', or 1 in 10, and averaging eight feet three inches in thickness; although, owing to the badness of the roof, eighteen inches of the top coal is not taken out. The area underlaid by this seam on the Caledonia property is about 900 acres, and, deducting the area already worked, the coal which it contains is 6,205,000 tons on land, and 2,940,000 tons under water. The quality of the coal at this mine is such as to render it advantageously applicable to all purposes for which bituminous coal is usually employed. The proportion of ash, however, is in excess of most of the Cape Breton coals, and detracts somewhat from its value as a steam coal. Phelan seam.
Quality of the Coal.

SURFACE WORKS.—A pair of shafts have been sunk to cut the coal, fifty-six yards from the crop, at a depth of 186 feet from the surface, which is eighty feet above the level of the sea. The cage-pit is 11 feet square, and the pumping-shaft 8 feet in diameter. There is also an upcast shaft, 10 feet in diameter and 90 feet deep, with chimney or cupola 30 feet high, situated 330 yards to the rear of the cage-pit. Shafts.

The winding machinery consists of a double-cylinder horizontal high-pressure engine, with 11-inch cylinders and 2 feet stroke, with connected link motion; the crank shaft is geared 1 to 4 with the drum shaft, carrying drums 6 feet in diameter, with flat wire rope 4½ inches by ⅝ of an inch. The cage is constructed to carry two tubs at a time, each containing about half a ton of coal; and the winding machinery is capable of raising Winding machinery.

Pumping
engine.

700 tubs, equal to 350 tons per day of ten hours, although at the time of my visit the mine was only producing at the rate of 145 tons per day. The pumping engine has a single horizontal cylinder, 12 inches in diameter and 2 feet 6 inches stroke, with pumps $7\frac{1}{2}$ and $8\frac{1}{2}$ inches in diameter for the lower and upper lifts respectively, and 4 feet stroke, the lower lift being 120 and the upper 66 feet. The engine speed is geared down to 15 strokes per minute on the pump, or in the ratio of 5 to 1. By these arrangements the mine is kept dry by eight hours pumping per day. Four plain cylindrical boilers, 2 feet 6 inches in diameter and 30 feet long, supply steam at 40 lbs. pressure to both engines. For working the bank a small auxiliary or donkey engine is employed; there is also a 6 horse-power horizontal engine for driving circular saws and other machinery.

Railway.

From the pit head the coal, after passing over the screens, drops into large waggons, by which it is conveyed over a good railway, two and a quarter miles in length, to the wharf at Port Caledonia. For one half of this distance there is an incline of 1 in 78 with, and for a quarter of a mile 1 in 200 against the traffic. The gauge of the railway is 4 feet $8\frac{1}{2}$ inches, and the weight of the rails 41 pounds per yard. The number of coal waggons at present in use is seventy, and the capacity of each, six tons.

Locomotive.

For working the line a 15-ton tank locomotive, by Neilson of Glasgow, with 10-inch cylinders, 20-inch stroke, and four driving wheels coupled, is employed.

Harbor.

The harbor of Port Caledonia, at which the produce of this mine is shipped, is formed by an artificial cut at the east angle of Glace Bay and Lake, with piers of crib-work loaded with stone, 80 feet apart at the mouth, and 120 feet at the wharf or shipping place, and extending 400 yards from the wharf into the sea.

Wharf.

The wharf is provided with three shipping places, two loading shutes, and a steam crane, and is capable of accommodating vessels drawing up to 17 feet of water. A small propeller tug of 45 horse-power, and a steam dredge of about 15 horse-power, are employed in connection with this harbor.

Steam-tug.

are employed in connection with this harbor.

System of
working.

UNDERGROUND WORKS.—These are conducted on the usual pillar and bord system. The levels, 9 feet wide, are extended 570 yards on either side of the pits; and the workings, which have been hitherto for the most part to the rise, extend over a breadth of 240 yards. The bords or working rooms are 6 yards wide; the pillars, of which a few have been extracted, are 20 yards long and 8 yards wide, with crosscuts 6 feet wide and 30 yards apart. The coal has a very distinct and regular cleat by which the direction of the working faces is regulated.*

Cleat.

There is in this mine from one to one and a-half miles of railway under-

* It is worthy of remark as a point of scientific interest that the direction of the cleat here, as in some other instances which have come under my observation in Cape Breton, coincides with that of the joints of the overlying sandstones.

ground, the gauge of which is two feet. The form and weight of rails is : for level roads the T rail 18 pounds per yard ; and for the rooms, the bridge rail, 14 pounds per yard. The number of tubs at present employed is 180. The *slack* coal amounts to one-fifth of the whole, and only a small proportion of it finds a market ; the disposal of the remainder, after ballasting the railroad, &c., becoming a source of expense.

Ventilation.—This mine yields a considerable amount of gas, and its ventilation, which has been carefully attended to, is effected by means of a furnace in connection with the up-cast shaft. As the surface railway passes over a part of the workings, a barrier of 50 yards in width is left for the support of the ground on which it is laid, and the ventilating furnace is placed immediately behind the barrier. The grate surface is 42 square feet, and the average quantity of air set in motion is 25,000 cubic feet. The air passing down by the pumping and winding shafts is split at the pit bottom, passes along by the water level and round by the working faces at the furnace, and is thence discharged by the upcast shaft. To obviate the inconvenience arising from the use of the pumping shaft as a downcast in winter, a headway to the crop is in progress, which will be used for this purpose.

PRODUCTION.—The coal from this mine is principally used for gas and steam purposes, and also largely for lime-burning ; it is said to have yielded at the gas works at Cambridge near Boston, as high as 9,700 to 10,250 cubic feet of 16-candle gas per ton. For all these purposes it is for the most part exported to the New England States, although last year a considerable quantity was consigned to St. John, New Brunswick. The average annual quantity sold for the last four years is 30,647 tons, and the selling price \$1.75 per ton for round, and 75 cents for *slack*.

VII. RESERVE MINE.

This is the name which has been given to a colliery recently opened upon an area lying to the south of and immediately adjoining the Bridgeport tract of the General Mining Association. It is situated ten miles from the town and harbor of Sydney, with which it is connected by the Glasgow and Cape Breton railway, owned by the same company, who have also erected a very commodious and substantial wharf at their terminus at Sydney.

The Reserve area is 640 acres or one square mile in extent, and is underlaid by all the most important coal seams of the district with the exception of the Hub and Harbor seams. The Back Pit, Phelan, and Ross seams, of the thickness respectively of four feet six inches, six feet, and five feet six inches of workable coal, crop out on the property, which has an average general elevation of about 160 feet above the level of the

Slopes.

sea. Works were commenced in May, 1871, by two slopes from the crop of the Phelan seam, dipping N. 58° E. < 5° 20', one of which has already reached a depth of 810 feet measured on the dip, and has produced a very considerable amount of coal for the market, 38,752 tons having been raised and 27,802 tons sold. The success which has attended this and many similar enterprises instituted within the last few years in Cape Breton, both in opening up new collieries and building lines of railway to afford an outlet for their produce, is mainly due to the energy and enterprise of F. N. Gisborne, Esq., the manager of the mine, the results of which are nowhere more strikingly manifested than at this spot, which from being, less than two years ago, in the midst of a trackless wilderness is now converted into the seat of an active and progressive industry.

Quality of the coal.

The Phelan seam, a description of which is given in Table II., is the only one as yet opened on this property, in which it underlies an area of 470 acres, containing about 4,220,000 tons of coal, and the proportion hitherto extracted is comparatively trifling. The top bench, four feet two inches thick, is uniform and of the quality given in the table; the lower part of the seam, two feet thick, is not quite so good, some stone having to be picked out. A marked improvement in the quality is noted, as might be expected, as the seam has been worked further from the surface; hitherto it has been chiefly used for steam producing purposes. The quality and composition of the coal from this mine may be judged by reference to the following analyses and practical tests of average samples; the first made at the Royal School of Mines, London, and the second, at the Manhattan Gas Works, New York.

I.		II.	
Volatile matter.....	36.26	Volatile matter	34.50
Coke	62.74	Fixed carbon.....	59.50
Water.....	1.00	Ash.....	6.00
	100.00		100.00
Carbon.....	77.41	Charge, 2,240 lbs., time, 3 h. 50 m.	
Hydrogen.....	5.47	Maximum yield per ton.....	9,950 feet
Oxygen and nitrogen.....	9.30	Illuminating power at 9,500 ft.	13.17 candles
Sulphur.....	2.47	Coke per ton, 38 bushels.....	1,520 lbs.
Water.....	1.00	Gas purified by one bushel of lime	2,380 feet
Ash.....	4.35		
	100.00		

Note by Dr. Harrington

Dr. Harrington remarks, in reference to the sample of coal from the Reserve Mine, analyzed by him: "This is a bright, tolerably firm coal, breaking with irregular fracture. It contains a few layers of interposed mineral charcoal and thin seams of sulphuret of iron, and gives a reddish-grey ash. Some of the sulphur in this, as well as in most of the other coals, must exist either in an uncombined condition, or else combined with the organic constituents of the coal, judging from the amount of ash."

SURFACE WORKS.—The main slope is worked by an English-made horizontal high-pressure steam engine of about 60 nominal horse-power, of the most improved construction, with 22-inch cylinder and 8 feet 8-inch stroke, geared 1 to 3 with the winding shaft, on which drums, 5 feet 8 inches diameter, are mounted and set in action by friction gearing. The rope is of steel wire, $2\frac{1}{2}$ inches in circumference. Five boilers, 3 feet in diameter and 30 feet long, supply the required steam to this engine, and to a steam pump set in the bottom of the slope; the slope engine also affords power for a machine shop well stocked with tools. From the ground already opened up, these works are adequate to a production of 300 tons per day; but the motive power and other appliances are calculated for a much greater production when the seam is worked further to the dip. Surface works.

UNDERGROUND WORKS.—The principal slope, as already mentioned, has been carried down 810 feet on the full dip of the seam. From this, at the distance of 203 yards from the surface, a level has been driven N. 29° W., or nearly on the course of the seam 333 yards; in the opposite direction this level has been extended 160 yards to meet the eastern slope. Below this, two other levels, twenty-one yards apart, have been commenced, and a few working rooms turned out of each. The area thus worked over amounts to 8,000 square yards, or about one and a half acre, but of course, the pillars are yet untouched. The gauge of the railway under ground is 2 feet $2\frac{1}{2}$ inches; and the capacity of the tubs employed is 24.4 cubic feet. The proportion of *slack* produced is about one-fourth of the whole. As the works hitherto have been mostly near the crop of the seam, no special arrangements for ventilation have been found necessary. Underground works.

PRODUCTION.—At the time of my visit the average daily production from the pit was 165 tons, besides about the same quantity from the bank. The company anticipate shipping at least 80,000 tons from this mine during this year. The coal is conveyed to Sydney over the Glasgow and Cape Breton railway, by a branch about three-quarters of a mile in length from the Reserve mine. As this line has been constructed for the purpose of accommodating several collieries, I shall defer the detailed account of it until some of the adjacent collieries have been described. Production.

VIII. LORWAY AND EMERY MINES.

The mining areas called respectively the Lorway and Emery, the former of two square miles and the latter of one square mile, have recently been combined under one management, and operations on both conducted by an association of English capitalists, styled the Lorway Coal Company of London, under the superintendence of F. N. Gisborne, Esq., of Sydney. These areas adjoin the Reserve mine, and are both traversed by the main line of the Glasgow and Cape Breton railway and its branches. Management.

Seams. This extensive property is underlaid by at least three important workable seams, which have been proved either on or in the immediate vicinity of the areas referred to. The uppermost of these is the Ross seam, from five to six feet thick, underlaying about 200 acres in the Emery area, and containing approximately 1,650,000 tons of coal. The next is the Lorway seam, four feet four inches thick, of excellent coal, about 350 feet below the Ross, and underlying 1,565 acres of the united areas, and containing about 10,000,000 tons. The third, called the Gardiner seam, at an easily accessible depth, with four feet nine inches of coal, will underlie the whole three square miles, containing in the aggregate 13,680,000 tons. Between the Ross and Lorway, and also underlying the Gardiner seam, there is abundant evidence that other seams probably of workable size and good quality, although hitherto undeveloped, will yet be made available.

Quality of the coal. From the three above named seams, although hitherto worked only at the crop, the quality of the coals is such that it may be predicted that they will always command the highest prices. The analyses of the Ross and Gardiner coals are given in the table, and further particulars respecting them will be found in the notices of the mines where they have been worked and tested.

Shafts. **LORWAY MINE.**—Mining operations were commenced by Mr. Gisborne, on the Lorway area, in 1871, by sinking shafts to cut the seam at depths respectively of sixty-six and two hundred and sixty-five feet. The former, which is situated towards the west end of the area; has been brought into successful operation, the workings having developed at the depth stated a seam of uniformly good coal four feet thick, dipping N. 5° 1' E. < 5° 22' or 1 in 10½. The latter called the East pit, where, by boring, the seam is found to have increased to four feet four inches, is not yet completed, its progress being impeded by a great influx of water. The Western pit, 11 feet by 9 feet, bratticed, intended to serve both for rise and dip working, is fully equipped for the production of coal, and has already yielded 1,478 tons chiefly obtained in making the preliminary openings. Levels, 9 feet by 4½ feet, have been driven thirty yards on either side of the shaft N. 85° E., and working places turned 16 feet wide, with pillars 66 feet by 24 feet. The water in this pit is easily drained by a 7-inch steam pump at the bottom, and hitherto no special appliances for ventilation have been required, circulation of air being established by means of an upcast shaft near the crop. The winding engine at this pit is of 12-inch cylinder and 2 feet stroke, with two plain cylindrical boilers 3 feet in diameter and 30 feet long; the speed being reduced by gearing in the proportion of 32 to 72. The winding drums are 6 feet in diameter. The capacity of the tubs is about 9 cwt., the gauge of the underground railway, 2 feet 7½ inches. A short branch, about three hundred yards in length, connects this colliery with the main line of the Glasgow and Cape Breton railway.

Ventilation.

Plant and machinery.

The eastern pits, designed to cut the seam at from 250 to 280 feet from the surface, are now sunk 100 feet. Two small steam engines of 10 and 16 horse-power respectively, are employed for hoisting the material and draining the shaft, the latter being effected by two steam pumps 7 inches diameter and 12 inches stroke. This colliery will connect with the main line of the Glasgow and Cape Breton railway by a short branch 660 yards in length.

EMERY MINE.—On the Emery area mining operations were commenced in the autumn of 1872, by sinking a slope on the Ross seam. I understand that they have been prosecuted with remarkable vigor during the winter; and that such progress has been made as will render this colliery productive during the present year. The coal excavated in sinking the slope is reported to be of excellent quality. It is intended to equip this colliery with machinery and plant the counterpart of those supplied to the Reserve mine, which in general conditions as regards the size, dip and direction of the seam, &c., it greatly resembles. The slope is in immediate proximity to the Reserve branch of the Glasgow and Cape Breton railway.

The combined Lorway and Emery collieries are confidently expected, ^{Anticipated} provided the Lorway East pit can be brought into operation in time, to ^{yield.} yield 80,000 tons of coal this season.

GLASGOW AND CAPE BRETON RAILWAY.

I shall here introduce a slight notice of the Glasgow and Cape Breton railway, a work which has been undertaken and carried out with remarkable vigor in connection with these recent mining operations, and prosecuted chiefly by the same enterprising capitalists by the advice and under the superintendence of Mr. Gisborne.

The construction of this railway and of the fine wharf in connection with it at the terminus on Sydney Harbor is calculated to accommodate those mines which lie at some distance from a port of shipment, or which from various causes would otherwise be debarred from a safe and convenient outlet for their produce, at or near the points where they are situated. With the exception of those on Sydney Harbor all the shipping ports in this coal region are more or less precarious in point of safety, and limited in extent and capacity; and moreover involve a constant and very considerable expenditure in their maintenance. The advantages resulting, therefore, from the construction of the Glasgow and Cape Breton and International railways are of vital importance, not only to the ultimate success of the mines more directly interested, but to the general prosperity of the entire district; a large proportion of which, furthermore, would remain undeveloped but for the facilities thus afforded. The proposed

extension of the Glasgow and Cape Breton railway to Louisbourg will add most materially to the value of this coal field, by furnishing an outlet for its produce throughout the whole year at a point which seems destined at no distant day to be one of the most important coaling stations on the Atlantic seaboard.

Commenced
in June, 1871.

The Glasgow and Cape Breton railway which was only commenced in June, 1871, is now completed and in operation from the town of Sydney to Schooner Pond colliery, a distance of eighteen miles, passing through or connecting by short branches with the Lorway, Emery, Reserve, Haven, Lake, Balmoral and Schooner Pond mining areas. In addition to the main line there are already about three miles of sidings and branches. The road is very substantially built, and is ballasted with rubble and *slack* coal; it is single track, 3 feet gauge, with maximum grades of 1 in 100 against, and 1 in 75 with the traffic. It is laid with T rails, weighing 50 pounds to the yard, with fished joints; and is equipped with three Fairlie-patent double-truck locomotive engines 25 tons loaded weight with 11-inch cylinders, 19-inch stroke, and 3 feet 3 inches wheels coupled; also an ordinary locomotive used for construction. At the time of my visit 200 English made waggons were employed, each containing four tons, and 37 or 38 of these constituted a train; they are fitted with doors opening at the side and with sloping floors to shoot the coals laterally. At the terminus at Sydney commodious and substantial brick station buildings have been erected; also engine houses and work shops fully stocked with tools and machinery for every description of repair and construction which may be required. The cost of the railway thus equipped is about \$20,000 per mile.

Cost of the
railway.

Wharf.

The wharf at the terminus of the railway in the town of Sydney is a handsome and substantial structure 620 feet in length and 40 feet wide, with 36 feet depth of water at high tide at the outer extremity, and standing 24 feet above high tide level on the upper or railway floor, which is furnished with four tracks, seven loading berths with shutes, &c., and four traversing tables for transferring the cars from one track to the other; all of the most improved modern construction, and specially adapted for the speedy and effectual transhipment of the coal. The wharf is built upon very long and stout piles of Baltic timber, creosoted, and suitably strengthened by caps, ties and braces; the superstructure is of Canadian timber of the best quality, strongly framed together and protected by painting. This wharf was built at a cost of about \$20,000.

Cost of the
Wharf.

PRACTICAL TRIALS OF THE COAL.

Steam colliers.

In connection with the business of these new mines and of the Glasgow and Cape Breton Railway two steam colliers were employed during a part

of last season. As having an important bearing upon the economical questions now under consideration, I desire to place upon record the observations, limited and imperfect though they may be, which I had the opportunity of making in regard to the consumption of coal in proportion to the work done both on the railway and on one of the steamers, premising that as they had not yet been brought into systematic operation, little attention had been directed to the economy of fuel.

The Fairlie locomotive engine consumed three tons of coal from the Reserve Mine per day, running sixty miles or three trips to and from the Reserve mine, besides shunting, &c., which might occupy two-thirds of the whole time; drawing thirty-eight cars, each containing four tons of coal. This engine is capable of drawing the load specified up a grade of in 100 at the rate of ten miles per hour, with the regulator valve half open.

The "Joseph Dodds" steam collier, an iron built screw propeller, chartered by the Glasgow and Cape Breton Railway Company, 1,048 tons gross register, drawing from 18 to 19 feet of water when loaded, and with screw propeller 12 feet 6 inches in diameter, carried 1,200 tons of coal from the Reserve mine besides 200 tons for the use of the vessel which steamed at an average speed of eight knots an hour. The engines are of the compound or double cylinder variety, with 30-inch high pressure and 42-inch low pressure cylinders and 3 feet stroke; 65 to 70 revolutions per minute, 75 pounds pressure of steam on the boilers, and surface condensation. This vessel consumed in twenty-four hours eleven and a-half tons of the Cape Breton coal, which was considered equivalent to nine tons of Welsh coal.

The "Joseph Dodds."

IX. GARDINER MINE.

This mine which has been recently opened upon a property belonging to a Montreal company, is situated eight and a-half miles from the town of Sydney and on the south side of Bridgeport or Lingan Basin. The property is two square miles in extent, about half of which is land and half sea area; it is traversed at the distance of little over half a mile from the shore by the line of the International railway, close to which, and at a distance of 132 yards from the east side line of the area, a shaft, 12 feet by 9 feet, has been sunk, intersecting a fine seam of coal, called the Gardiner seam, which crops out towards the western boundary, running parallel with the side lines and thus underlying (provided no faults occur) 510 acres of the land, and 450 acres of the sea area. The seam is four feet nine inches thick of uniformly good coal, and the aggregate amount contained in this seam within the area may be stated at 6,680,000 tons. Other underlying seams probably of workable thickness and at no very great depth are known to exist on this area, but their precise conditions have not

Gardiner mine.

Area.

Four feet nine-inch seam.

Three to four
feet seam.

been ascertained. One which appears at the out-crop to be at least three or four feet thick and of good quality is only thirty-five feet of vertical thickness beneath the Gardiner seam. Another called the Carroll seam, which crops out about two miles from this colliery, will in all probability, from the structure of the field, be found at the depth of about 600 feet; this seam shows at the out-crop six feet of good coal, divided, however, into two benches by a band of shale. Between these two there is every reason to believe that other coal seams will be found. An analysis of coal from the Carroll seam, made by Dr. Dawson, gives :

Six feet seam.

Volatile matter.....	32.8
Fixed carbon.....	61.4
Ash (red).....	5.8
	100.0

The Gardiner seam has been proved by trial pits and borings at the crop for a distance of one mile from the shore of Bridgeport Basin; bearing N. 38° E., with dip S. 52° E. < 5° 12' or 1 in 11. The shaft is sunk about 660 yards (horizontal measurement) to the dip, and cuts the seam at about 162 feet from the surface. It is situated 100 yards south of the railway, and is calculated to serve for a winning of 900 acres.

Valuable seam
beneath those
previously
known.

From the position of this seam in relation to the others in the series, it is obvious that it is one of the lowest in the productive coal measures of this basin; and the developments which have been quite recently, and are now in process of being made with regard to it, are of much interest, and will also tend to enhance the mineral wealth of the district by proving the existence of a valuable seam in addition to and underlying at a moderate depth those previously known. The vertical depth of the Gardiner below the Ross seam, the lowest which had previously been recognized in this part of the field, is from 500 to 600 feet.

This coal seam having been struck at some considerable depth only very recently, and no opportunity having been afforded for more exact personal examination, I append the following extract from a letter lately received from the superintendent, Mr. William Routledge, an experienced and trustworthy authority:—

BRIDGEPORT, C.B., 1st March, 1873.

Letter from
Mr. William
Routledge.

..... We have had our coal fairly tried for steam purposes, and with, I think, very satisfactory results. At present our boiler-power consists of two boilers, each about 3 feet in diameter, one 20 feet and the other 32 feet long, supplying steam to a 12-inch cylinder steam pump with one foot stroke and 70 strokes per minute, and to a hoisting and pumping engine with 10-inch cylinder, 20-inch stroke and 60 strokes per minute. The steam for the steam pump is carried a distance of 200 feet from the boiler, 116 feet of which is down a damp cold shaft, causing a loss of pressure of say 10 per cent. before reaching the pump. The pressure on the boilers is about an average of 40 pounds to the square inch, and the consumption of coal necessary to keep up this pressure for the past week, during very cold weather and with the boilers exposed, was ¼-ton per hour or 6 tons in 24 hours. Considering the weather, and that the coals were not cleaned or dressed, I think this a very moderate consumption for the work done, and during summer it will be little

over half this. I have to inform you that the top portion of the seam for fourteen inches down is a rich gas coal, below which is about half an inch of splent band, then three feet six inches of what I consider a good steam coal, having about three inches of splent at the bottom. The whole seam used for steam purposes makes a bright lively fire, free from sulphur, with very little clinker, and that of such a character as not to stick to the fire-bars. The splent when broken up to about egg size burns freely and does not at all affect the quality of the coal for steam purposes; in fact for our own use, I prefer it mixed among the other coal, as, from the amount of lime in its composition, it will preserve the fire-bars. For gas purposes I have no doubt the whole seam will prove very satisfactory; certainly, for coke making, from samples taken from an open grate, I believe it will be second to none.

(Signed,)

WILLIAM ROUTLEDGE.

The works at this colliery have been skilfully planned and carried out with a view to efficiency and economy. The winding machinery now in process of erection consists of a pair of horizontal high-pressure engines of English manufacture, with 20-inch cylinders and 4 feet stroke, with link motion and all modern improvements applicable to colliery engines. The winding drums, two in number, are 8 feet diameter and 3 feet wide, with a smaller drum for hoisting the bank coal; the pulleys are 7 feet diameter and 3½ inch tread, for round wire rope. The steam will be supplied by four boilers, 3 feet in diameter and 30 feet long. The dimensions of the small pumping and winding engine used in sinking the shaft are given in the superintendent's letter quoted above; and as in this operation an unusual amount of water has been encountered, an additional pump (Cameron's Special) of large capacity, intended for the permanent drainage of the mine, has also been put in operation.

Works and machinery.

The connection with the International Railway will be effected by a short branch into the colliery, with 460 yards of track, and a switch at either end; and the railway company have contracted to deliver the coal from this mine on board the vessels at their wharf at the rate of 30-32 cents per ton. The colliery buildings consist of eighteen double houses for miners, blacksmith's shop, office and store, manager's and foreman's houses, barn and stable for thirty horses, &c.; and the machinery and other arrangements at the pit head are adequate to a production of 80,000 to 100,000 tons annually. From the comparative thinness of the Gardiner and the Lorway seams they will probably be found to be most advantageously worked on the long wall system, by which all the coal is extracted at the first operation. .

X. CLYDE OR ONTARIO MINE.

This mine is opened upon an area owned by associations which have been variously denominated the Ontario and Clyde Companies. It comprises 880 acres of land situated on the coast between Glace Bay and Schooner Pond, and is underlaid throughout its entire length—two and a quarter miles—and at a very moderate depth by two of the most valuable seams

Clyde or Ontario Mine.

of the series, the Phelan and Ross, as well as by others of importance, both above and below these. The situation of this property, both with reference to the quality and direction of the coal seams (which run longitudinally throughout the whole area) and its proximity to a good harbor, combine to render it an extremely valuable one. The development of this colliery has, however, been retarded by want of adequate markets, by litigation and by other causes apart from its merits, and which it is unnecessary here to detail.

Commencement
of operations.

Mining operations were commenced in 1864, but owing to the causes referred to have been prosecuted irregularly and to a very limited extent. The only seam which has been opened is the Phelan, about eight feet thick, of which, however, eighteen inches of the top coal is left in to support the soft shaly roof. After deducting the area of ground worked over, the quantity of coal still available in this seam within the Clyde area is 7,630,000 tons. The coal hitherto raised from it at the Clyde is of the same quality as that at the Caledonia Mine, and has been chiefly used for the manufacture of gas. Dr. Harrington remarks that this is a "bright coal, somewhat brittle and breaking with sharp irregular fracture. A good deal of interposed mineral charcoal. No pyrites could be detected with a magnifying glass, although analysis showed the coal to contain over two per cent. of sulphur. Free burning and with reddish-grey ash."

Quality of the
coal.

Works and
machinery.

The seam is opened by a slope from the crop about 100 yards from the shore of Little Glace Bay and three quarters of a mile from Port Caledonia. The dip of the seam is N. 21° E., at angles varying from 10° at the surface to 5° at lower levels. The slope, which is 14 feet wide, for two tracks, 2 feet gauge, has been driven 160 yards; and levels, 6 feet wide, have been extended on each side, S. 69° E. for a total length of 400 yards, from which the coal has been worked fifty yards towards the crop. The working rooms are turned S. 7° E. with very regular cleat square to the bord direction; both bords and pillars being of equal width, 14 feet; the total breadth of the workings may be about 100 yards. The weight of underground rails is 22 pounds per yard. The slope is worked by a steam engine of 8 horse-power, which also drains the lower level by means of a water car discharging into the upper level and thence into the sea. The workings being on such a limited scale, and so near the surface, no special appliances for ventilation have hitherto been required, and the slope and water level become in turn the intake for air according to the direction of the external currents.

Wharf and
railway.

The quantity of coal yielded by this mine hitherto is inconsiderable, but it is capable of a large production on short notice, should circumstances arise to justify it. There is a small wharf on the property near the slopes, but so exposed as to be practically of little value. A short and light railway has quite recently been constructed—for a great part of the dis-

tance on trestles—to connect the colliery with Port Caledonia. The coal sold from this mine has been chiefly sent to Halifax and Boston for gas making. The price hitherto has been about \$1.75 per ton.

XI. SCHOONER POND MINES.

The mining property on which this colliery is situated is now owned by a London company bearing the above designation, and the operations are conducted under the superintendence of F. N. Gisborne, Esq., of Sydney. It consists of land and sea area in equal proportions, namely, one square mile each, the former adjoining to the south-east, the property of the Clyde Company, and the latter constituting the sea-frontage of that property, and underlaid by all the valuable coal seams known to exist upon it. These run longitudinally through both properties, which are of great length in proportion to their breadth, thus affording an important advantage in rendering the seams accessible over a large area at the least possible depth.

Schooner Pond
mines.

The only coal seam which crops out upon the land area owned by this company, and which has formed the object of mining operations, is the Ross seam, containing here at least six feet in thickness of workable coal, and underlying 105 acres on land and 640 acres under the sea, representing respectively 945,000 and 5,850,000 tons of coal. It will thus be seen that in so far as this seam is concerned, the sea area is by far the most important, and under the circumstances affords promise of very favorable results. In addition to this, however, the whole of the submarine area is underlaid, probably under workable conditions, by the great Phelan seam; and both land and sea areas by the Lorway, Gardiner, and other less developed seams, all of which have already been described.

Quantity of coal
available.

As the thick and fine seam of coal now designated the Ross seam crops out in the sea cliffs on this property, it has attracted attention from a very early period, and has been worked in a rude and imperfect way by various parties. A lease of the land area was obtained from Government in 1862 by Mr. Hugh Ross, and mining operations were commenced in a somewhat more systematic manner under the name of the Acadia Colliery; but owing to the difficulty of shipment they were only conducted on a limited scale and discontinued in 1866, having produced during the three years operations an average of 2,900 tons annually.

Annual produc-
tion.

The present company having acquired the very important sea area in addition to that referred to, commenced operations early in last year, mainly with a view to winning the coal contained in it; and with highly creditable energy have succeeded in the short interval, not only in developing the coal seam in a most satisfactory manner, but in estab-

Railway to
Sydney Harbor.

lishing a permanent and effective outlet for its produce by the construction of a railway connecting the mine with Sydney Harbor.

Quality of the
coal.

The quality of the coal from this seam, analyses of which are given in Table II, compares very favorably with that of any other in the district, and especially for steam and household purposes. As compared with that of the next important overlying seam, it is denser and less tender, and contains a much smaller proportion of ash. Dr. Harrington describes it as: "A compact coal with strongly marked planes of cleat. Lustre not so bright as numbers 1 and 2 (Lingan and Blockhouse). A little mineral charcoal, but no visible pyrites. Ash light reddish-grey. A free burning coal."

Old and new
workings.

The dip of the Ross seam here is N. 23° E. < 7° or 1 in 8. The old workings which are quite near the shore have not extended to a greater depth than the water level, and are so inconsiderable in amount as to require no detailed description. The new works consist of a slope from the crop, 300 yards west from the point where it comes out in the sea cliffs. Owing to the peculiar conformation of the coast, this slope is driven in a direction somewhat west from the full dip, or N. 2° W., so as to hug the shore as closely as possible to the deep, and thus obtain a better cover for the submarine workings. The slope, which is 11 feet wide, had at the time of my visit reached a depth of 310 feet measured on the angle of dip. At 184 feet, levels had been driven connecting on the one hand with the water level of the old works, and on the other for a distance of fifty yards on a course N. 55° W., this being also the direction of the cleat. A temporary suspension of the work of driving the slope had then occurred from inadequacy of the means of draining the water which flowed from the old works, but this has been overcome by the introduction of a good pump, and I am informed that the slope is now down to a depth of 600 feet. Although the work had been so recently commenced, much progress had been made in the erection of the buildings and machinery requisite for carrying on an extensive business, the details of which, however, beyond such as are given in the Table, I am unable to specify.

Buildings and
machinery.

The Glasgow and Cape Breton railway has been extended to this colliery distant, by the railway, eighteen miles from Sydney Harbor. Should no unforeseen contingency occur there seems no reason to doubt that the expectations entertained by the company, of an output of at least 50,000 tons of coal during the present season, will be realized.

XII. BLOCK HOUSE MINE.

Block House
mine

This mine has for many years been justly regarded, from the size and quality of the coal seam and advantageous situation, as one of the most important and valuable in the district, and next to the Sydney mine it

has hitherto proved the most productive. It is situated on the shore of Cow Bay, seventeen miles from the town of Sydney. From a very early period in the history of the Province, coals have been extracted from the Block House seam, where it crops out at the sea shore; but extensive and systematic workings were not commenced till the year 1863, when the mining right to the area on which it occurs was sold by the original lessee, Mr. Marshall Bourinot, to a New York company, by whom the works have been subsequently conducted with little intermission under the superintendence of Mr. Robert Belloni. The property controlled by the company comprises three square miles, 1,280 acres of which are land, and the rest sea area.

The Block House seam, the highest and by far the thickest in the Cow Bay basin, and that on which the operations of the company have hitherto been concentrated, is entirely contained within the limits of this area, occupying a long, narrow and comparatively shallow trough extending east and west, and cut off towards the east by the sea. At the southern out-crop where the works are situated, the dip is N. 20° E. $< 6^{\circ} 39'$ or about 1 in 9; at the opposite side of the basin it dips due S. $< 30^{\circ}$. It has an average thickness of eight feet ten inches, of which one foot is left in to support the roof, and underlies 240 acres of the land area which (taking into account the steep dip on the north side) may be estimated to have contained originally 2,890,000 tons of coal, which, as the seam has been worked to a considerable extent, may now be reduced to 2,120,000 tons including that contained in the pillars. So far as the sea area is concerned it is doubtful if this seam can be relied on for a further supply, but the property is underlaid at a moderate depth by other important seams hitherto untouched, and which will probably be workable under the sea, as well as under the land area.

The Block House seam yields a remarkably fine solid homogeneous coal, free from partings or impurities of any kind, and containing a very moderate proportion of ash. The remarks appended to Dr. Harrington's analysis are as follows:—"A rather bright and compact coal containing a little mineral charcoal and minute veins of sulphuret of iron. A free burning coal. Ash purplish-red." It is almost exclusively used for the manufacture of gas in New York and Boston, and is said to yield 10,500 cubic feet per ton. It constitutes also an excellent steam coal, as may be inferred from the analyses of it in Table II., which is corroborated by practical tests. This seam although undisturbed by faults is characterized by the occurrence of peculiar irregular wedge-shaped masses of shale interrupting its continuity and causing considerable trouble and expense in their removal.*

* A detailed account of these remarkable masses, the occurrence of which may have an important bearing on the identification of the seams, will be found in Mr. Rutherford's Essay "On the Coal Fields of Nova Scotia," page 36. See also page 256, of this Report.

Works and
machinery.

SURFACE WORKS.—The mine is worked in summer by two slopes, called respectively the Belloni and Ingraham slopes, converging to a point at the out-crop of the seam on the sea shore, where a wharf has been constructed which affords very great facilities and advantages for shipment, as the tubs can be emptied directly into the vessels. For operations during the winter a vertical shaft, 80 feet in depth, called the Dawson pit, has been sunk, and at the distance of 600 yards from the wharf, to connect with the Ingraham slope. The so-called Ingraham and Belloni slopes (the former being more properly a level and driven on the water level), are each 10-feet in width for double-track railway, 2 feet 2 inches gauge. The Belloni slope is driven 650 yards in the direction N. 35° W., or about half the angle of dip, from the crop at the wharf to the apex of the basin. They are both worked by the same engine, situated where they meet at the wharf. The engine, which may be rated at 40 horse-power, has a single horizontal high-pressure 15-inch cylinder and 8 feet 8 inches stroke. The winding drums, 5 feet in diameter, are fitted to run loose on the crank shaft, and are set in action as required, each independently of the other, by friction clutches. The tractive power is communicated to the tubs by means of a steel-wire rope, half an inch in diameter, working over a sheave near the bottom of the Dawson pit to draw the tubs inwards. The Belloni slope is worked by similar mechanism connected with the crank-shaft by bevelled gear at the proper angle. The whole arrangements here are exceedingly ingenious and complete; the engine moving continuously, and all the several parts being brought readily into action as required. The engine is supplied with steam from two plain cylindrical boilers 30 inches in diameter and 40 feet long.

Engine.

The Dawson pit, which serves chiefly for banking the coal in winter, is worked as a cage-pit, bringing up one tub or half a ton of coal at a time by an iron wire rope one and a half inches in diameter; it is also used by means of a steel-wire rope, three-quarters of an inch in diameter, passing down the pit, for conveying the motive power to an engine-plane, on the full dip from the bottom of the pit to the lowest part of the basin near to which it crosses the Belloni slope. The engine employed at the pit is of 50 horse-power, having a 16-inch cylinder and 4 feet stroke, with 45 strokes per minute, and 60 pounds pressure on the boilers which are three in number, and of the same dimensions as those at the slopes. This machinery is capable of raising to the bank 500 tons of coal per day, and is also employed for working by means of an endless chain, the trains of tubs which carry the bank coal to the wharf.

Capacity of the
machinery.

The arrangement here referred to, which was originated and put into operation by Mr. H. J. Crandall, now manager of the Victoria Mine, is, like that at the slopes, most ingenious and well worthy of adoption under similar conditions and circumstances. It consists of a common iron chain

with links five-eighths of an inch in diameter, wound round a cylinder or drum set in motion by the engine at the Dawson pit, which is connected with the wharf by a single track incline railway, 570 yards in length with slope of about 1 in 22 and gauge 2 feet 2 inches, the same as the railway under ground. The chain extends to the foot of the slope, and passing over a sheave or pulley fixed there, returns to the winding drum at the top. This endless chain is set parallel to the railway; and its position is so adjusted that the links form a series of couplings by which, in connection with strong catches fixed in the sides of the coal cars, these are taken up or down the slope in obedience to the motion of the chain. The cars, containing about half a ton each, are the ordinary tubs used in the mine with the addition of the catches; they become engaged by simply pushing them under the chain when in motion; and then disengage themselves at the top and bottom, by the simple action of the chain freeing itself from the clutches. This mechanism is capable of delivering four tubs per minute or 120 tons an hour from the bank to the wharf; and the machinery at the Dawson pit, 500 tons per day. The up-cast shaft for ventilation, 6 feet in diameter and 60 feet deep, is situated close to the endless chain railway and half-way between the wharf and the Dawson pit. In connection with the works at this colliery there is a good machine and repair-shop containing two lathes, a planing machine and other tools suitable for both heavy and light work. In the blacksmith's shop are six hearths and a large punching and shearing machine driven by a donkey engine.

As formerly observed, this colliery enjoys the peculiar advantage of shipping direct from the mine tubs into the vessels. This is due both to its situation admitting of the works being placed immediately at the shore, and to the circumstance that the coal is so remarkably free from impurities as to require no sorting or handling after being extracted from the mine. The wharf to which both slopes and pit deliver their produce is now 600 ^{Wharf.} feet in length and somewhat irregular in shape, being in some places 125 feet wide, this great breadth being required in order to give sufficient strength and weight to resist the action of the waves. It is capable of loading four vessels at a time. The depth of water at the extremity of the wharf is 24 feet at high tide, the tide rising and falling here to the extent of four and a-half feet. It is designed to extend the wharf to a length of 1,000 feet from the shore, thereby giving a depth of 30 feet; and additional shipping accommodation for light vessels was in progress at the time of my visit. The wharf is of sufficient width to accommodate several tracks and a very large platform scale, to carry and weigh eight tubs of coal at a time.

With certain winds, and at certain seasons of the year, this part of the coast is so exposed and dangerous as to occasion much trouble, inconvenience and loss; and as the wharf is unprotected by a breakwater, it has frequently been seriously damaged and endangered.

Underground
works.

UNDERGROUND WORKS.—The general arrangement of shafts, slopes and levels having been already indicated, I shall describe briefly the details of the workings under ground, which are constructed on the usual pillar and bord system. In the present instance a peculiar interest is attached to the workings in this mine, which have been chiefly confined to the southern dip, from the circumstance that they have reached the bottom and end of the trough or basin in which the coal seam is deposited.

Levels.

The Ingraham slope has been extended a total length of 1,320 yards from the outlet at the wharf, or 720 yards westward from the bottom of the Dawson pit, which is 80 feet from the surface. The Belloni slope is driven from the same point on half the angle of dip 660 yards, nearly to the axis of the trough, where it meets the engine-slope from the bottom of the Dawson pit, 370 yards in length on the full angle of dip. From this latter slope, in addition to the Ingraham, four other levels are extended east and west 100 yards apart, and from these the bords are worked up to the full rise and nearly to the crop on the south side of the basin. At the distance of about 400 yards from the entrance of the Belloni slope, another called the Henrietta slope is driven on or about the full dip nearly to the bottom of the trough. In the earlier workings the proportions of pillars and bords were somewhat irregular; in those of more recent date the bords are $5\frac{1}{2}$ yards wide, and pillars 20 yards long by $5\frac{1}{2}$ yards wide. The lower levels westward intersect at a very acute angle the axis of the trough, and their extension in a straight line is on the rise of its western end; they will be worked as self-acting inclines, the bords being broken off north and south. There are from five to six miles of railway underground, 2 feet 2 inches gauge, laid with bridge rails weighing from 18 to 24 pounds per yard. The number of tubs used in the mine is 300; capacity 1,000 pounds each.

Underground
railway.

Extent of the
workings.

The workings extend over an area of about fifty acres, but no pillar workings had been instituted until last year, since which time a few have been successfully removed, and this kind of working will doubtless henceforth be followed up with advantage, provided proper attention is paid to ventilation.

Ventilation.

Ventilation.—Little or no gas is developed in this mine, and no special arrangement of lamps, or apparatus for extinguishing fire is requisite. The ventilation is effected by means of a furnace with 42 square feet of grate surface, in connection with the up-cast shaft. The average quantity of air set in motion is about 35,000 cubic feet per minute.

Drainage.—The drainage is effected by two direct-acting steam pumps placed underground, supplied with steam by the boilers at the surface, which raise the water to the Ingraham slope, by which it is discharged into the sea. The quantity of water thus drained from the lower levels is about 250 gallons per minute. The mine water having a powerfully

corrosive action upon the pumps, it is found necessary to line the working barrels with lignum-vitæ.

The following is an analysis of this water, made by Mr. C. Hoffmann, of the Geological Survey Laboratory :

The water when received had a sediment of a yellowish-red color : the supernatant liquid had a brownish-yellow color, an acid reaction and a slightly acid and styptic taste. The sediment when treated with hydrochloric acid is for the most part taken up, the residue consisting of a dirty white coagulum or slime.

The water was filtered and gradually heated : at about 71° C. it became turbid, and as the temperature rose a dense precipitate of a yellowish-red color ensued. After protracted boiling the precipitate was filtered off and washed with boiling water, until the washings gave no reaction with barium chloride : upon treatment with hydrochloric acid it left a dirty white coagulum : the filtrate from the latter gave with barium chloride an immediate precipitate. The filtrate from the precipitate produced by boiling was colorless, and possessed a strong acid reaction, and was found to contain but little more than a trace of iron.

CONSTITUENTS IN 1000 PARTS OF THE WATER.

<i>Suspended matter</i>.....	.1510	consisting of
Ferric oxide.....	.1052	and
Sulphuric acid and organic matter.....	.0458	

The former combined with the ferric oxide as a basic sulphate of iron.

In Solution.

Iron (as persalt).....	.2426
Iron (as protosalt).....	.1168
Manganese.....	.0078
Aluminium.....	.0420
Calcium.....	.1498
Magnesium.....	.0618
Potassium.....	.0134
Sodium.....	.1884
Silica.....	.0116
Sulphuric acid (So ⁴).....	1.4808
Chlorine.....	.4100
Phosphoric acid.....	Traces
Organic matter.....	.2844
Total solid contents.....	3.0094
Total solid contents by direct estimation.....	2.9090
Specific gravity.....	1002.23

PRODUCTION—The productive capability of the mine, as at present Production. opened, may be stated at 1,000 tons per day of twelve hours, which has, as I am informed, been reached on various occasions. At the time of my visit the average shipments amounted to 600 tons—400 direct from the mine and 200 from the bank—with sixty pairs of cutters. The *slack* coal amounts to about one-fourth of the whole ; in summer such as is

made in the mine is stowed there, but in winter it is brought to bank. The average annual quantity sold during the time in which this mine has been in operation, omitting those years in which work has been suspended or irregularly prosecuted, is 64,450 tons, which have been mostly exported to New York and Boston for the manufacture of gas. A large and powerful steam tug is employed in connection with this colliery.

Steam tug.

XIII. GOWRIE MINES.

These mines, which from their first inception to the present date have been owned and controlled by a private firm,—Messrs. Archibald and Co. of North Sydney—furnish a remarkable example of a steady, continuous and regular production amidst all the fluctuations to which the business has been subjected during that time. The area on which the Gowrie mines are situated immediately adjoins to the south that owned by the Block House Company, and like it abuts upon the northern shore of Cow Bay, where a wharf and artificial harbor for the shipment of the coal have been constructed.

Gowrie Mines, area.

The mining area now referred to which was leased to Messrs. Archibald in 1861, is two square miles in extent, and altogether on land; it is underlaid at an easily accessible depth by several workable seams, only one of which, however,—the McAulay seam—has hitherto formed the object of mining operations. This seam underlies that called the Block-House at a vertical depth of about 450 feet; and its thickness varies from four feet eight inches to five feet two inches of good coal, with from two to six inches of coal of inferior quality, left in the mine to support the roof. The floor is of hard sandstone, without underclay, and the seam dips on the south side of the area N. 18° E. < 8°, and on the northern out-crop S. < 40°.

Workings.

The workings on this seam have been hitherto altogether on the southerly dip; and the boundary of the area in that direction has been established so as to include the entire crop of this seam; but it also embraces a large proportion of the coal contained in the northerly dip, and overlies an area of 760 acres, containing originally 5,700,000 tons of coal, of which, supposing 80 acres to have been worked over, about 5,220,000 tons besides that contained in the pillars will still be available.

Quantity of coal available.

After the requisite preliminary works to establish the continuity and quality of the seam, systematic mining operations were commenced here under the superintendence of Mr. Blowers Archibald in 1864, and have been continued ever since without intermission, and with admirable economy and efficiency, at a remarkably regular rate of production. The coal from this mine has a very general application and extensive distribution, having been sold in nearly equal proportions for home consumption, the British American Colonies, West India Islands and United

States, for domestic and steam purposes. The proportion of ash is somewhat objectionable for the latter purpose, but on the other hand its value in this respect is enhanced by the well established fact that it is not apt to form any clinkers. For the manufacture of gas its somewhat high proportion of sulphur is certainly deleterious, although it has been largely used for this purpose. The analysis of average samples from this colliery are given in Table II., and its quality may be further illustrated by the following extracts from letters referring to practical tests on a large scale.

Report of Mr. Sutherland, Chief Engineer of the S.S. "Sweden," on Gowrie coal.

"On the passage from Cow Bay to Liverpool (1869) I have given the Gowrie coal a fair trial, and found that when burning Gowrie coal alone our average steam was little under that obtained from Welsh coal, of average quality, but our consumption about 12 per cent. in excess of Welsh coal. I found on burning an equal mixture of Gowrie and Welsh coal, good steam with little over our usual consumption of Welsh. I believe a ship with proper furnace bars for Gowrie coal could use it with very good results.

I may state that the Gowrie coal forms very little clinker, and consequently is easy on furnace bars; the amount of ash is even less than from Welsh coal, and the specific gravity much the same, being about 41 cubic feet to the ton."

"NORTH SYDNEY, June 21st, 1869.

"We certify that the steamer 'Panther' has been using Gowrie Mines coal almost entirely for the past three years; and that it has been constantly improving in quality during that time.

"We consider it superior to Scotch and Sydney, and almost equal to Welsh for steam purposes; and find that it is particularly easy upon furnace bars.

"(Signed,)

"ROBERT FORBES, Chief Engineer.

"JOHN BARTLETT, Master."

"Office of the New York Gas Light Company,

"New York, January 29th, 1864.

"F. H. ODIORNE, Boston.

"DEAR SIR,—The sample cargoes of Gowrie coal received at the works of the New York Gas Light Company yield about 9,000 feet per ton of 15 candle gas. The coke is of good quality and makes a strong heat. The coal was carbonized by us under very high heats.

"There is a considerable impurity in the coal (slate, &c.,) which may be separated in mining. It is my opinion that this coal, if properly selected before shipment, will yield gas in quantity and quality equal, if not superior, to any coal from Cape Breton.

"(Signed,)

"JOHN H. ADAM, President."

Dr. Harrington's remarks appended to his analysis of the sample of coal from the Gowrie mine are as follows: "Very bright and firm, with marked planes of cleat. A little carbonate of lime, as in No. 3 (Sydney main seam) but in much smaller quantity. But little visible pyrites. Ash reddish-brown. Did not coke."

SURFACE WORKS.—Mining operations at the Gowrie mine, as at the Block House mine, date from a very early period in the history of the province when under French occupation. Passing over these and also

the preliminary works of the present proprietors I shall proceed to describe the state of the colliery at the present time.

At the distance of 900 yards from the shore of the Bay and 450 yards from the crop of the seam a shaft called the Odiorne pit has been sunk to the depth of 205 feet, intersecting the McAulay seam; this is now the principal working pit. There is also another shaft (No. 2) which had been previously in use, situated 300 yards to the south of the former, and on the full rise of the seam from it. This latter shaft, designed exclusively for the crop workings, is connected with a slope to the crop, which served as a travelling way for the men and horses employed in the mines. Both pits are provided with steam engines, the first of 30 horse-power for pumping and winding, and the second of 6 or 8 horse-power for winding only. The Odiorne pit, which is also used as an upcast shaft, is 15 feet by 5½ feet, divided into two compartments 9½ feet and 5½ feet by 6-inch bratticing, the larger division being mounted with slides, &c., as a cage-pit, and the smaller as a pumping shaft.

Machinery.

The engine at this pit has a single horizontal high-pressure 16-inch cylinder, and 3 feet 6 inches stroke, geared down 2½ to 1 on both pumping and winding shafts. The drums 8 feet in diameter and 5 feet long are furnished with flat wire rope, 4 inches by ½ an inch, and the cage is adapted to bring up only one tub at a time, containing 800 pounds of coal. This machinery is capable of hoisting two tubs per minute, and has frequently delivered at the pit-mouth at the rate of 300 tons per day. At the time of my visit the average production at this pit was 250 tons per day, round and *slack*. The pumps, two in number, 10 inches in diameter and 4 feet stroke, lifting a height of 200 feet, and at the rate of 250 gallons per minute, are worked by the same engine by means of the ordinary spear connections, and drain the mine in eight hours pumping, viz., from 6 P.M. till 2 A.M. The steam is supplied to this engine by two cylindrical boilers 5 feet 6 inches in diameter and 26 feet long, with two internal flues, 22 inches diameter, in each.

Drainage.

The arrangements at the bank are very complete and commodious. There are two sets of shutes and screens, those for the pit being distinct from those for the bank coal which is drawn up to the platform by a small steam engine. At the time of my visit the bank might contain about 8,000 tons. Most of the *slack* (which amounts to between one-third and one-fourth of all the coal extracted) is left in the mine; that which is brought to or made at the bank finds a ready sale. About four tons per day of splent and sulphurous coal is picked out and sold to the miners, &c.

Railway.

This colliery is connected with the wharf by a short but substantially built railway 1,100 yards in length with a down grade averaging about 1 in

100 from the pit head, and an incline of about 1 in 15 for 180 yards as it approaches the wharf, enabling the cars to descend by their own gravity and with sufficient impetus to carry them to the end of the wharf without the application of further motive power. The empty cars are drawn back to the pit by horses. The gauge of the railway, which is laid with T rails, 35 pounds to the yard, is 3 feet 7 inches; it is equipped with 84 waggons built at the colliery) each capable of carrying two tons. During last year a new engine shaft (No. 4) 12 feet in diameter was commenced 1512 yards north-west from the Odiorne pit, to cut the seam at the depth of 250 feet from the surface, on the extension of the levels from that pit. The new shaft at the time of my visit had been sunk 86 feet, and the railway graded to connect with that at the present colliery; when these works are completed a locomotive engine will be employed for the haulage of the coal from both pits.

Wharf and Breakwater.—The wharf, which is strongly built of timber on a foundation of crib-work ballasted with stones, is 1,156 feet in length and 24 feet wide, with T piece 230 feet from the water extremity, 175 feet long and 24 feet wide for the protection of vessels lying within that distance from the shore. The wharf is capable of accommodating eight vessels at once, drawing from 10 up to 18 feet of water; it is provided with eight shutles for smaller and two drops with turntables, &c., for larger vessels. As the bay is exposed and dangerous (especially in autumn which is the busiest time for the shipment of coals, and when easterly gales prevail) it has been found necessary to construct a very massive and substantial breakwater for the protection of the wharf and shipping.

This breakwater or pier is about 1,500 feet in length and 48 feet wide, built entirely of strong crib-work very heavily loaded with stone, and has 20 feet depth of water at low tide at its outer extremity. It is situated about 250 yards to the north-east (or seaward) from the wharf; and is made slightly arched or convex outwards, with the deck or upper surface sloping in the same direction at an angle of five degrees. It affords shelter and protection to a large number of vessels, which for such accommodation are required to contribute to its maintenance by small dues or tolls regulated according to the tonnage and time so occupied. Independently of the wharf, the cost of constructing this pier and repairing it, is stated to have been \$60,000.

UNDERGROUND WORKS.—These, which are on the pillar and bord system, have hitherto been altogether confined to the rise of the levels from the bottom of the shafts. At the old shaft (No. II) the breadth of the winning is 150 yards and at the Odiorne pit 300 yards, these works being separated by a barrier of coal. At the old workings, which, as before remarked, are very near the crop, the levels have been driven from the shaft north-east to the shore, 815 yards, and south-west upwards of 600 yards. Here the bords

were 18 feet wide, and the pillars 18 feet by 9 feet, and several of the pillars have been removed. These works were discontinued in 1867, and operations since that date have been limited to that part of the mine commanded by the Odiorne pit.

New workings. The two main levels, 150 yards apart, have been extended 1,000 yards towards the sea and 1,450 yards in the opposite direction, and are connected by self-acting incline gate-roads cut about half across the angle of dip, and coming out in the upper level 500 yards from the shaft. These main roads which are 7 feet wide and 5½ feet high, are laid with rail tracks, two feet gauge, and with T rails, 22 pounds to the yard. The incline roads are worked by a friction-strap and five-eighth inch steel-wire rope; the level roads by horses, of which at the time of my visit twenty were employed in the mine. The direction of the levels is N. 67½ W., and the cleat of the coal being E. and W., the bords or working places are turned due south from the levels, and are driven up 16 yards by 6 yards wide, the pillars being left 16 yards by 7 yards. The coal is holed at or near the bottom of the seam 2 feet in and 9 inches high, and is all wedged down, no blasting being required in this mine owing to the presence of a peculiar cross fracture in the coal in addition to the usual cleat; thus rendering it very easy to work although more liable than is desirable, to break into small pieces. For the bords the rails are of flat iron, 2½ inches by ⅝ inch. There are altogether about four miles of railroad under ground and 150 tubs, each of the capacity of one-third of a ton.

Ventilation.—No explosive gas being generated in the mine no safety lamps are required, and the ventilation hitherto has been attended with no difficulty and requires no special appliances. To assist, however, in promoting the circulation of air, a small furnace, with 18 square feet of grate surface, has been placed 30 feet from the bottom of the cage-pit which acts as an upcast, the pumping compartment being the downcast.

Drainage.—The arrangements for pumping have already been described. Like that at the Block House mine the water is of a highly corrosive character, owing probably to sulphate of iron in solution, rendering it necessary to apply a lining of lignum-vitæ to the pipes and to make the buckets and the working barrels of a mixture of six parts of lead and one of antimony; this alloy although still far from perfect, being found best adapted to resist the corrosive action of the mine water. When made of iron and unprotected, a set of pipes and pumps were rendered useless in four or five days, but when fitted as above described will last three months.

Production and price.—The average annual quantity of coal of both kinds sold at the Gowrie mines during the last nine years in which they have been in regular operation is 42,090 tons; and the greatest deviation from that average during any one year has not exceeded 13,000. For several years

the selling price, loaded on the vessels, has been, for round coal, \$1.75, and for *slack* 90 cents per ton.

GENERAL REMARKS.

One of the most important points connected with the economical working of coal mines, as of all industrial undertakings, is, of course, the cost of production ; and especially the value of the requisite materials and labor. I am not prepared on the present occasion, more especially as there is considerable diversity in the different mines, to give full information upon all the items included under this head. The method of regulating the pay of the miners is very various ; in all cases, however, it depends upon the amount of work done. The following different systems of payment are adopted in different mines, and sometimes a combination of two or more of these in the same mine : by the cubic yard ; by the ton ; and by the lineal yard advance. At the Sydney mines the price paid is 46 cents per ton in whole, and 40 cents in broken coal, filled into the tubs, the *slack* riddled in the mine, and all weighed at the surface. The miners find their own powder and lights. For driving levels, &c., 80 cents per lineal yard is allowed, over and above the rate paid for the coal thus extracted. The average daily work of each miner is three and a half to four tons, and in drifting, two men will advance four and a half feet per day. I am informed that it is not unusual for the men to earn from \$60 to \$80 per month. Ordinary laborers and surface hands are paid, on an average, at the rate of 85 cents per day. The rates at the other mines are regulated in the same proportion, allowing for the different methods of computation, and modifications according to local circumstances. At the smaller establishments, however, the rate of wages is usually from five to ten cents higher than at the Sydney mines, and it has been found necessary of late years, in order to secure the requisite amount of labor, to pay higher prices than had previously ruled ; and with the increased demand this year it is probable that these will require to be still further augmented. During the three or four months of winter, when there is no shipment of coal, it is usual either to reduce the rate of wages or the amount of work done.

Different systems of payment.

Average earnings of the miners.

Reduction of wages or work during winter.

The following estimate of the cost of raising and shipping one ton of coal, including various items of expense in addition to that of the actual mining, is submitted as an approximate average :

Mining expenses, averaging say.....	50 cents per ton.
Wages of putters.....	6 " "
Underground haulage (one horse for every 2,260 tons raised annually).....	5 " "
Timbering.....	4 " "
Engine power, winding.....	2 " "
Firemen to upcast, watchmen, and road cleaners....	2 " "
Overseer and assistants, engineers and firemen at pit mouth.....	3 " "

Expenses of screening and loading coal.....	6 cents per ton.
Expenses of loading bank coal.....	12 " "
Salaries and incidental expenses.....	10 " "
Railway transportation, say 5 miles at 3 cents.....	15 " "
Loading at wharf.....	3 " "
Government Royalty and taxes.....	11 " "
	<hr/>
	1.29
Interest on capital, insurance, wear and tear, agencies, discounts and contingencies, say.....	25 " "
	<hr/>
Total cost per ton free on board.....	1.54

Cost of coal per ton.

The above estimate, from the most reliable data available, is based on a production of 50,000 tons per annum, and must be regarded simply as applicable to the average condition of affairs at the present time, which may be materially modified by various local and incidental causes. Pumping and ventilation are merely questions of increased consumption of coal, and have consequently been omitted in the above statement.

Miners.

It may be estimated that two-thirds of all the mining population of Cape Breton at the present time are Scotch Highlanders or their descendants, who are a very frugal, industrious and deserving race, and make excellent miners. As regards their social condition, every encouragement and facility for its improvement is afforded by the various colliery proprietors, by providing comfortable dwellings, schools, churches, medical attendance, &c., probably on a more liberal and enlightened scale than is usual in most other countries. An increase of this class of population, or of such others as may have been accustomed to work in mines, is greatly to be desired, and for this purpose every encouragement for their immigration should be extended. Owing, to the scarcity and enhanced price of coal in England, and consequent anticipation of increased demand, the past season has been characterized by great activity in developing and rendering available the vast resources of this coal field. But for several years back the coal-mining industry in Cape Breton has been in a languishing condition in consequence of deficient markets, and in fact the mines have been in many instances worked either with little or no profit or at an actual loss, the proprietors merely keeping them in operation in hope of better times. Under these circumstances, and as tending to promote the interests of this most important industry, the following suggestions are offered, referring chiefly to certain objects which it is considered desirable to attain, and which I shall merely indicate without attempting at present to elaborate them.

Condition of the coal trade in Cape Breton.

Utilization of slack coal.

1. UTILIZATION OF *Slack* OR SMALL COAL.—This I conceive to be one of the most important objects which can engage the attention of persons interested in coal mines. At least one-fourth of all the coals mined in this district assumes the form of *slack*, and only a small proportion of

it is saleable even at a less price than it costs to produce it; and in many instances its removal to waste is a source of additional expense. Under these circumstances it seems at all events most desirable that whatever fuel is required on the works or railways, &c., connected with them, which may amount to one-fifteenth of the whole, should be used in this form; and further, that the rest of the *slack* should be either converted into coke, or into a solid fuel by admixture with some other ingredient. It appears to me probable that both these objects could be successfully and economically attained.

2. LONG WALL WORKING.—This system should be adopted for all seams under four feet or four and a half feet in thickness. Many such seams exist in this field, and might be profitably mined, although not perhaps on the pillar and bord system. The long-wall system admits of the introduction of coal-cutting machinery and of the extraction by one operation, of the largest quantity of coal, with the least injury to its quality, and also simplifies the mode of ventilation. System of work-

3. THE EMPLOYMENT OF STEAM COLLIERIES ON AN EXTENSIVE SCALE. Steam colliers.
—This would ensure a greater regularity in the delivery, and a longer continuance of shipment at the time when it is most desirable.

4. COLLECTION OF STATISTICS.—The systematic collection and recording of accurate statistics of all matters connected with the business of coal-mining, including accurate plans and descriptions of underground workings, authentic statements of the results of actual trials on a large scale on railways and steamboats, and in furnaces, gas-works, &c. Such records, which should be accessible in the proper quarter to all persons interested, would prove of incalculable value in connection with the future working of our coal fields. Not only would they be the means of saving an immense amount of useless labor, but they would also prevent the occurrence of many serious accidents involving the sacrifice of life and the loss of much valuable property. In this connection, and respecting the general management and regulation of the coal mines of Nova Scotia, the following remarks by Mr. Rutherford, late Government Inspector of mines for that Province, in his Report for 1866, pp. 69-72, are well worthy of reproduction, and are accordingly appended. Mining records

I have the honor to be, Sir,

Your most obedient servant,

CHARLES ROBB.

TABLE I.
LIST OF COLLIERIES IN OPERATION.
WITH STATISTICS OF LABOUR, MACHINERY, PRODUCTION AND EXPENDITURE.

No.	Year Com- menced	NAME OF MINE.	PROPRIETORS.	PRESIDENT.	MANAGER.	Area sq. Miles.	Miners Houses	Men and Boys	HORSES.		ENGINES.		TOTAL SOLD. Tons.	EXPENDI- TURE ON WORKS. \$.
									Mine. face.	Sur- face.	No.	H.P.		
I.	1827	Sydney Mine	General Mining Association, London.	Col. Scovell.....	Richard H. Brown.	23	250	474	40	24	10	760	3,310,169	400,000
II.	1854	Lingan Mine.....	" "	Col. Scovell.....	Donald Lynk.....	24	357	225	14	11	1	50	487,129	340,000
III.	1868	Victoria Mine.....	Victoria Mining Co., Halifax.....	Wm. J. Frazer....	H. J. Crandall....	4	357	125	3	4	5	220	51,880	150,000
IV.	1868	International Mine...	International Mining Co., N. Y.....	Alfred McKay....	R. Macdonald....	4	12	137	14	16	3	90	191,506	450,000
V.	1862	Little Glace Bay Mine..	Little Glace Bay Co., Halifax.....	Jas. A. Moren....	Henry Mitchell...	2½	50	100	12	4	5	100	514,783	253,000
VI.	1865	Caledonia Mine.....	Caledonia Co., Boston.....	J. H. Converse...	Henry Foote.....	2	46	100	7	4	3	68	130,377	165,000
VII.	1871	Reserve Mine.....	Glasgow & Cape Breton Co., London..	H. L. Micholls...	F. N. Gisborne...	1	247	180	6	4	1	60	27,802	486,400
VIII.	1872	Lorway Mine.....	Lorway Mining Co., London.....	— Underhill.....	F. N. Gisborne....	2	247	65	.....	6	1	30	1,478	80,000
IX.	1871	Gardiner Mine.....	Gardiner Mining Co., Montreal.....	Wm. Gunn.....	Wm. Routledge...	2	20	33	.....	3	3	160	45,000	45,000
X.	1862	Clyde [Ontario] Mine..	Messrs. Campbell & Co., Halifax, &c...	.....	.....	1½	16	21	1	1	1	10	29,854	23,000
XI.	1862	Schooner Pond Mine..	Schooner Pond Co., London.....	H. L. Micholls...	F. N. Gisborne....	2	127	21	6	.....	1	30	10,333	44,800
[XII.]	1860	Block House Mine.....	Block House Co., Halifax.....	Henry Lawson....	Robt. Belloni....	90	300	20	10	4	120	564,802	130,000	
XIII.	1862	Gowrie Mine.....	Archibald & Co., Sydney, C.E.....	.....	E. & C. Archibald..	2	80	100	20	8	1	40	401,020	200,000
						Totals.....	73½	694	1881	148	95	1736	5,721,208.	2,766,400

The miners' houses are for the most part double tenements. The "expenditures," which are for the most part taken from the Reports of the Commissioner of Mines, do not include the value of leases or of real estate. In the case of the Sydney Mines there is no record previous to 1865, since which time the expenditure amounts to about \$200,000. The expenditure for the International and Reserve Mines includes the cost of International Railway and Wharf, and of the Glasgow and Cape Breton Railway and Wharf, with all equipments.

The total quantity of coal remaining in the seams enumerated and described in this Report may be estimated at 261,762,000 tons. It must, however, be understood that there are a number of other seams in the district, which have not yet been worked and are not included in this estimate, and that from these as well as from areas, partly on land and partly sub-marine, likewise omitted, but which are doubtless underlain by some of the seams enumerated, a very large additional quantity of coal can be made available and the total quantity which this coal field is capable of yielding, exclusive of any that may be obtained from seams of a less thickness than four feet, is probably not less than one thousand million tons.

REMARKS

EXTRACTED FROM MR. RUTHERFORD'S REPORT FOR 1866.

With a few exceptions the remarks I am about to make will apply to nearly all the Collieries in the Province; and I have on this account avoided what would have been a mere repetition had I made them in each case. They have reference to pillar working, ventilation, drainage, storing of coal, and plans, under which classification I proceed to give them.

PILLAR WORKING.

The facility with which the coal has been reached in all the districts, as compared with other mining countries in which, from the exhaustion of the seams near the crop, expensive sinkings become necessary to reach the underlying coal, and consequent great skill and carefulness are required in properly opening out the mine; this freedom from an expensive preliminary outlay, instead of enabling an effective winning of a large tract of coal to be made before commencing the regular working thereof, seems to have engendered an indifference to future operations, and allowed the desire for an immediate profit to supersede the necessity of a judicious arrangement of the mode of working. To this cause I attribute the short distance from the crop, to which in most of the mines the workings are confined; and the adoption of a system by which as much of the seam as possible is taken away in the first working and the pillars are reduced to a minimum of strength for the purposes of support. The injudiciousness of this system cannot be too strongly urged. The introduction into the market of coal worked so close to the crop must have operated prejudiciously—and I have reason to believe that it has—to the interests of the mine owner; and the continuance of the scale of pillarage, which has, I think, from the preceding cause been too generally adopted, will be fraught with consequences of a more serious character. For, although with the present limited extent of workings and the absence of pressure in consequence of the proximity of the coal to the surface, the pillars may be sufficient to keep the mine open for ventilation or other purposes, yet if unaltered where the overlying strata are very much thicker and heavier, their inability to support will in no long time be exhibited to the serious detriment of all concerned. For this reason I have felt it my duty to recommend an increased size of pillars as the workings extend to the dip, with a view to their subsequent entire removal. I have also advised the working of the pillars at such a distance from the crop as the quality of the coal will warrant. I am glad to be able to report that this has been effected with success at the Lingan and Gowrie Collieries, and been attended with an additional advantage, to which I will hereafter refer.

This removal of the pillars should commend itself to the managers of mines not only on account of the importance of avoiding a waste of coal, but also because it has the further advantage of lessening the working area of the mine, and consequently reducing the amount of materials required to supply the otherwise rapid extension of roads, and the means of conveyance necessary in widely spread districts.

VENTILATION.

The limited extent of the workings of many of the collieries, and the adoption of the system on which they have been made, have not been without their effect so far as ventilation is concerned. The maintenance of travelling roads through the pillars, and the adoption of any artificial aid, appears to have been thought unnecessary in most cases,—a difference of level as respects the intake and outlet, and the difference of the internal and external temperature, being chiefly relied on to cause the circulation of a current of air.

The freedom from gas of an explosive character—carburetted hydrogen—and the absence of the equally noxious and dangerous non-explosive gas—carbonic acid—have produced an indifference as to the necessity of making provision for a more effective ventilation as the workings become extended. In most of the mines all that is attempted is the conduction of the air into the neighbourhood of the face, and thence allowing it to find its way to the nearest place of outlet. The parts of the mine standing in pillars—as well those immediately behind the working places as those more remote—are thus without any admixture of the air but that which the movements in the mine may occasionally cause to pass into it. A steady and constant current is not to be relied upon under such circumstances, and it therefore frequently happens that the circulation is reversed, and the intake becomes the outlet.

The mere fact of there being at present in most of the mines no deleterious gases requiring to be swept away or reduced to an innocuous mixture, should not be deemed sufficient to render unnecessary the provision of such a quantity of fresh air as is necessary to the healthy pursuit of the occupation of the miner. To effect this, no simpler agent can be employed than the furnace. This, properly constructed, and placed at the bottom of one of the ventilating shafts,—which should be used exclusively for that purpose,—would, with attention to the size of the air-courses and the position of the stoppings, suffice to maintain the steadiness of current and amount of fresh air which are too frequently wanting.

DRAINAGE.

In many instances the exposure of the coal on the faces of the cliffs has induced the opening of the seams to be made by driving an adit or level

from the shore, which has answered the double purpose of being an outlet to the coal and the water made in the mine. The desire to obtain as much coal to the rise as possible, has, in many cases, led to this level being so placed that it is within the reach of the tide, which occasionally flows into the mine. These levels are in many collieries still used as the outlet for the water after being lifted from the dip workings. I am glad to be able to state, however, that in some of these collieries precaution has been taken, by fixing dams, to prevent any unusual rise of the tide extending so far as to overflow into the dip workings. In those mines in which the workings have not yet been made to the dip, I have recommended the adoption of similar means to prevent such a casualty. The quantity of water made in the mines is not large, and, generally speaking, the provisions made for its removal appear to be adequate. One objection that has been made to the working of the pillars is the apprehension of the breakage of the strata setting free a larger quantity of water than could be removed by the present appliances. I have given some attention to this, and am inclined to the opinion that much of the water met with in the dip workings finds its way there from the surface, and that if it were tapped in the upper workings a considerable diminution would be the result. For this additional reason I have advised the removal of the pillars to the rise of the water levels; and it is to the benefit in this respect which has been experienced at Lingan and Gowrie, to which I before alluded.

STORAGE OF COAL.

It may perhaps seem premature to cry "waste" at so early a stage of mining as the very recent development of the mineral resources of this country implies; but, at a time when attention is being directed in England to the exhaustion of her coal supplies, and the consequent necessity of economising them by every available means, it cannot, I think, be considered inopportune to direct attention to a source of waste which may with care, to some extent, be lessened.

In many of the collieries the greater part of the slack made in working is separated from the large coal by riddling, and thrown aside in the mine. The proportion thus taken out varies from 5 to 20 per cent. This slack is seldom removed, and has therefore largely accumulated. It is reasonable to suppose that if it could be sold even at a very small profit, it would not be left in the mine: and it is thus treated to avoid expense of depositing it on the surface, and the combustion that would probably occur if a large quantity were heaped together. By attention to the peculiarity of each seam, and the manner in which the miner performs his work, the proportion of slack made in the ordinary course of working may be reduced, and the loss of merchantable coal from this cause be diminished.

But there is another source of loss to which, inasmuch as it affects the revenue to a much greater extent, I wish to draw attention. I allude to the large stores of coal that are formed during the winter months. The suspension of shipment for a period of from three to four months necessitates the adoption of one of two courses: either the colliery must be stopped, or be continued at work and the coal brought out and stored on the surface. It must be evident that in the former case both employers and workmen would be subject to much inconvenience and loss: the workmen would be obliged to seek other means of employment, and the mine owner would be unprepared to commence operations on an adequate scale when the shipping was resumed. For this reason the latter course is adopted, and the consequence is a deterioration of the coal from exposure and the production of a large proportion of slack both from this cause and from the breakage in putting down and re-lifting. To such an extent does this take place that I have reason to believe that in some instances the produce of large coal from the heap has not much exceeded 50 per cent. When it is remembered that a large percentage has already been taken out in the mine, and that the coal brought to the surface is with respect to size in nearly a merchantable state, the loss of revenue from this cause must be apparent. Impressed with the importance of obviating this as much as possible, I have endeavored to induce the adoption of some means by which this loss may be reduced to a minimum, and I am hopeful that as the interests of the mine owner are seriously affected by so small a yield of saleable coal, they will readily adopt any practicable scheme for realizing so desirable a result. This would, I conceive, be to a considerable extent accomplished by an extension of the power of production by a judicious laying out of the mine, and the formation during the winter of a number of working places, together with the opening of more shafts or other means of bringing the coal to the surface. With such a provision much of the coal might be stored under ground and be raised as required without interrupting the ordinary working of the colliery. The injury to that portion which would be sent out of the mine would also be very much less if suitable erections were made for protecting it from the weather. There are details of arrangement in carrying this out which it is unnecessary to state here; I make the suggestion with the hope of drawing the attention of owners and managers of mines to the importance of devising some means of lessening a loss by which the interests of all are affected.

PLANS.

It is much to be regretted that some system has not been earlier organized by which an accurate representation of the workings would be preserved. In many instances I regret to find no record, either by survey or written description, of the first operations. The coal has been worked

on the principle to which I have alluded, with no intention of returning to those parts of the mine in which operations have ceased. Being thus abandoned, and no care exercised in keeping the workings open, they are closed in many instances by the falling of the roof, and cannot, therefore, be shown on the plans with that degree of accuracy which is desirable. The importance of a knowledge of the position of old workings has been so often and painfully illustrated by the numerous accidents that have occurred in England from the absence of it, that I cannot too earnestly direct the attention of mine owners to a neglect that may hereafter be attended with serious consequences. These workings are generally near the crop, and liable therefore to be filled with water; and as the subsequent operations are not in all cases connected with them, the risk incurred from the ignorance of their position must, I think, be evident.

Most of the collieries have now plans of the workings. Some improvement is desirable in many of them with respect to the mode of showing the workings in different seams; but more especially would I recommend the adoption of one uniform scale for the variety which prevails at present.

I have the honor to be,

Your obedient servant,

JOHN RUTHERFORD,

Inspector of Mines.

To P. S. HAMILTON, Esq.

Chief Commissioner of Mines.