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No. 2

Cement Materials at Flowery Gully

BY

W. H. TWELVETREES, Government Geologist

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The Honourable Sir NEIL ELLIOTT LEWIS, K.C.M.G.
Minister for Mines for Tasmania

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Introduction.

Among other localities in Tasmania which have been deemed suitable for the establishment of Portland Cement Works it has been necessary to examine that of Flowery Gully, between Beaconsfield and Winkleigh. Beds of limestone are extensively developed on Adams' Hill, where the ground rises from the valley of Johnston's Creek. The latter is a tributary of Middle Arm Creek, which it joins at the south end of the gorge of the Cabbage Tree Hill. Being between 7 and 8 miles from a deep-water port at Beauty Point, the position is attractive for works if the raw materials exist in company with the other necessary conditions. In considering the suitability of the locality, the following points will be discussed:—

1. The occurrences of limestone and its suitability for cement-making.
2. The occurrences of shale and clay and their suitability for cement-making.
3. The manufacturing problem.
4. The source of a supply of gypsum.
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I.—Occurrences of Limestone.

A strip of limestone country, 1 mile long by ⅜-mile wide, occupies Adams' Hill, extending from the foot of the hill at Johnston's Creek in a south-easterly direction as far as the Rookery Road. The exposures terminate just a little south of the junction of that road with the main road to Winkleigh. The strike of the limestone is a few degrees east of south, and its dip is east of north. The older ferruginous strata on Dr. L. G. Thompson's 24 acres must therefore underlie the limestone basin. The exposures of the limestone at the north-west end of the belt are at Quigley's quarry at the northern boundary of Dr. Thompson's 29 acres (A. E. Thomas), and just below the road going up Adams' Hill on the 500 acres in the names of Evans, Thompson, and Douglas, known locally as the Bank property. The road ascending the hill between the 82 acres in the name of A. Douglas, and the 113 acres in the name of F. N. Beams, traverses the length of the belt and has limestone on each side of it, the bulk being on the 113 acres. Along the south-west side line of this property is a thin covering of waste from denuded Permo-Carbonifeous beds.

The limestone is a bluish-grey, compact rock, veined with calcite, and near Mr. Beams' house possessing a subterranean cave channel known as the Winkleigh caves. These used to be resorted to by visitors: they have, however, been left to themselves and the depredations of tourists, and have now no particularly spectacular characteristics. The surface outcrops of the limestone occur as a series of rocky knobs at irregular intervals.

The beds belong to the Gordon River and Chudleigh series, which are judged to be of Silurian age. Their trend does not assist in attempting to connect them with the limestone near Beaconsfield, on the east side of the Cabbage Tree Hill, but both doubtless belong to what was at one time one and the same basin of sedimentation.

The limestone area on A. Douglas' property is well timbered, that on Beams' farm is all cleared land.

The rock has been quarried for lime-burning on Beams' land, where a kiln was operated by Mr. Lutwyche, but is now abandoned; and Quigley's lime quarry has also been worked on the south boundary of the Bank property.

All authorities agree that to warrant the erecting of a cement plant, the quantities of raw material available should be sufficient to enable work to be carried on for at least 20 or 25 years. In making a rough calculation of the tonnage of limestone to be worked here, the stone at Quigley's and that on Douglas' may be left out as reserves for the future, and the estimate be confined to the limestone on Beams' farm, and more particularly to the hill rising from Lutwyche's quarry. Taking the block of ground between this quarry and the Winkleigh Road as the mainstay of the proposed enterprise, with a maximum of about 270 feet elevation above the quarry floor, its mean thickness for an area approximately of 6 acres would be about 100 feet. Its content at 168 lb. per cubic foot would be 2,160,000 tons, less, say, 720,000 tons for cavities, waste, and shrinkage; or net about 1,440,000 tons. This, at a consumption rate of 30,000 tons per annum, would last 48 years.

Samples of this limestone were taken on the present visit, and have been analysed in the Geological Survey laboratory by the Government Assayer (Mr. W. D. Reid), with the following results:—

	From Lutwyche's Quarry.	From Caves.	From Quigley's Quarry.	Average.
Calcium carbonate	95·40	95·65	94·75	95·26
Magnesium carbonate...	1·22	0·83	1·17	1·07
Iron and alumina	1·79	1·70	2·81	2·10
Silica	1·44	1·61	0·98	1·34
Moisture	0·13	0·18	0·20	0·17
	99·98	99·97	99·91	...

Previous samples were assayed by Mr. H. J. Colbourn, the Agricultural Chemist, at Hobart, as follows:—

	Main Outcrop.	Outcrop at Face.	Outcrop overlying Caves.
Calcium carbonate	95·45	94·00	93·72
Iron oxide and alumina ...	1·65	3·15	0·55
Insoluble matter	1·85	0·98	5·53
Moisture	1·05	1·87	0·20
	100·00	100·00	100·00

A limestone with 75 per cent. carbonate of lime and 20 per cent. iron, alumina, &c., would be an ideal rock, and no admixture with clay or shale would be needed, but stone of this perfect composition is seldom or never found in nature, hence the proportions of lime and alumina have to be adjusted according to the nature of the limestone and clayey material used.

The Flowery Gully rock is a high-grade limestone perfectly suitable for the manufacture of Portland cement when mixed with clay or shale of proper composition. Its hardness does not exceed that of an ordinary crystalline or sub-crystalline limestone. A report has spread that it is too hard for cement manufacture, but this opinion must have been based on experience with the English wet process of manufacture, in which the soft and moist materials (chalk and marl and mud) are ground and mixed wet. The question of hardness is purely one of crushing cost, and there would seem to be no difficulty whatever in crushing and pulverising the limestone at Flowery Gully. Its position on the scale of hardness does not exceed 3 and this degree of hardness does not offer the slightest obstacle to a crusher of the Gates type in reducing to a size fit for the grinding plant (ball or tube mills), in which the mixed materials have to be further ground in separate stages to a fine powder. To any maker in the habit of treating only soft limes and marls the high-grade limestones seem hard, and from his point of view are undesirable in that respect; but as a matter of fact they are being used satisfactorily for cement-making all over the world. The Flowery Gully rock is a somewhat pure, dry limestone, but is not siliceous nor really hard. In the early days of the industry, the crushing and grinding machinery was not so perfect as now, and there was difficulty in reducing the so-called "hard" limestones economically, but this disadvantage no longer exists.

The general composition of the rock in question is satisfactory. There only remains for the manufacturer to blend with it such proportions of clay or shale as will produce a cement of the composition aimed at, *i.e.*, a mixture with an average composition of 75 per cent. carbonate of lime, 15 per cent. silica, and 5 or 6 per cent. alumina and iron.

II.—Occurrences of Shale and Clay.

The clay and shale deposits of Flowery Gully are not all in one place and are of different kinds.

1. There is the general overburden of the limestone, a few feet thick, derived from the gradual weathering and decomposition of the underlying rock. It is mixed in places with the sheddings of soil from the adjacent ironstone and slates, and must vary a good deal in composition in different parts of the area.

2. There is the overburden of the slate and sandstone on A. Douglas' property on Adams' Hill.

3. There is an alluvial, somewhat sandy, clay on the floor of the valley of Johnston's Creek. How far this descends is uncertain.

4. On the Bank property is a considerable area of Permo-Carboniferous mudstone shales. Some of these contain pebbles; some are fossiliferous and rather calcareous. Similar shales occur up the hill on McKercher's property (formerly Ellis').

The composition of the clay or shale ingredient is as important as that of limestone in cement-making. This is obvious when one realises that the deficiencies of the limestone in silica and alumina have to be made good by the addition of the clayey material. Whether clay or shale is used matters very little. Shale being soft, is easily ground. A frequent drawback to alluvial clays is their irregular composition. They also often have a large organic content.

Clays used for Portland cement generally have a silica percentage ranging from 55 per cent. to 70 per cent., the higher percentages being the more desirable. The iron and alumina should be about one-third of the silica percentage, or at most it should not exceed one-half.

The selection of clay on a cement property devolves on the consulting engineer or works chemist, and the soundness of the cement will largely depend upon his choice and judgment. On the present visit samples of clay were taken from the following places and analysed by the Government Assayer as under:—

	Overburden near Beams' House.	Road Quarry, Adams' Hill.	Alluvial, Quigley's Flat.
Silica	68·56	77·74	79·04
Iron and alumina...	23·38	17·08	13·38
Lime	0·45	0·58	0·52
Magnesia	2·38	2·32	2·17
Loss on ignition ...	5·24	2·14	4·72
	100·01	99·86	99·83

The high silica content rules out Nos. 2 and 3. The clay from the overburden lying on the limestone in the road-bank opposite Beams' house is the only material of approximately correct constitution. The quantity of this, however, does not appear to be sufficient for manufacturing on a large scale. As regards quantities, the shales on the Bank property are more promising, but no samples were taken on this occasion, as the few exposures seen were pebbly or too calcareous. If works are contemplated, prospecting on that property should be directed towards the locating of beds of suitable material. The present report does not aim at being other than a preliminary description of the proposition, stating what is to be seen at present, and pointing out what lies before those who are disposed to embark on the undertaking. Owners of limestone properties are often too prone to forget the important *role* played by alumina (as contained in clay and shale) in cement manufacture. The limestone exposures are so obvious; the clay, on the other hand, has to be sought and proved, and the right kind of clay is not always easy to discover. But the one is as essential as the other.

III.—The Manufacturing Problem.

Portland cement is a mixture of limestone and clay or shale, ground fine and burned in a kiln to a stage of incipient fusion. The calcined mixture is then ground as fine as flour, when it becomes the Portland cement of commerce. A little gypsum is added to the mixture to retard the setting. The average composition of the cement mixture is approximately 75 per cent. of carbonate of lime, 14 per cent. or 15 per cent. silica, and 5 per cent. to 7 per cent. alumina and iron oxide. It is evident that this composition can be obtained by using various proportions of various classes of raw materials, lime, silica, alumina and iron being the essential ingredients. The usual proportion of shale or clay used is one part to three of high-grade limestone, the ratio between the silica on the one hand and the alumina and iron on the other being from 2·5 or 3·and 3·5 or even 4 to 1. It is not always easy to find clay or shale with approximately this composition and otherwise suitable.

Both the physical and chemical characters of the raw materials have to be studied and controlled by the works chemist. He has to see that the raw materials are of such a nature that when mixed in certain proportions they are suitable for the manufacture, and he regulates the blending from the different quarries accordingly. Besides this, he controls by analysis the quality of the finished product. In doing this, the soundness, tensile and compressive strength, rate of setting, and specific gravity have to be determined, before allowing the cement to be placed on the market.

For a plant producing 500 to 600 tons of cement per week (26,000 to 30,000 tons per annum), the following quantities of material and coal ought to be available annually:—

30,000 tons of limestone.
10,000 tons of clay or shale.
500 tons of gypsum.
20,000 tons of coal.

IV.—Gypsum.

For the annual production of 30,000 tons of cement, from 500 to 600 tons of gypsum would have to be imported, as no economic deposits of this mineral have as yet been ascertained to exist in Tasmania. Inquiry in the other States will be necessary as to the source whence it could be best obtained. Probably supplies would come from South Australia, where the present price is approximately 17s. 6d. per ton at Port Adelaide. The freight and charges would bring the cost at Flowery Gully to between 40s. and 45s. per ton.

V.—Extraction and Manufacture.

(*a*)—Quarrying and Preparing the Stone for Burning.

The quarries of limestone and shale will be laid out so as to admit of direct connection by tramway between the working faces and the rock-breaker. For the shale, if worked on the Bank property, an ordinary horse tramway will most likely be sufficient. The problem of the transport of the limestone from the quarries on the hillside would probably be solved by installing an endless-rope haulage. The principle of this method is that of an endless rope running round a drum at the loading and discharging terminals respectively, and travelling continuously in one direction. Or, for the upper benches when the work on them predominates, the desirability may have to be considered of conveying the stone to the tramway bins on the level ground by aerial ropeway with automatic release buckets, and driven by electric motor. This system of transport is peculiarly adapted to quick carriage with small or moderate loads; but it would not be applicable to quarries on the floor at Lutwyche's workings.

The raw materials are suitable for the dry method of manufacture, and it is assumed that this will be the process adopted.

The stone will be passed through a rock-breaker of the Gates gyratory type, which is preferable to the jaw stone-breaker when the duty required is considerable. The material will be crushed to 2-inch size. The term "Gates" originates from the works of that name in Chicago, but is applied nowadays to any gyratory type of machine rather than to the particular make turned out by that company. The action is that of a cone which works on an eccentric and approaches and recedes alternately from the walls of the enclosing shell. This subjects the stone to powerful squeezes, and at last breaks it. It is without the excessive vibration of the jaw stone-breaker, and crushes to a 2-inch size very evenly. Modifications of the original type are in the market, retaining, however, the essential gyratory action.

It is, however, now accepted as good practice to adhere as closely as possible to the principle of crushing the raw materials in stages by separate machines, and in many works the jaw stone-breaker is used as the first crusher, reducing the stone to 5 or 6 inch sizes.

The limestone at Flowery Gully, by analysis, does not contain more than 0·2 per cent. of moisture, and as about 1 per cent. or a little over is allowable in the dry process of manufacture, it would not seem necessary to instal a drying plant for this rock, if the stocks are kept protected from the weather. But it may be necessary to have driers for the shale and clay. These are essentially rotating drums, through which hot air from the kiln, or generated by separate furnaces, is caused to pass.

After crushing and drying, the limestone and shale are automatically weighed and mixed in the proper proportions, and are then ready to be ground to a powder. Several types of grinders for this stage of the manufacture are in use at different works, but those which are most favoured are the ball and tube mills—the former for the first grinding, the latter for the second. Tube mills are hollow steel cylinders, 6 or 7 yards long and 4 or 5 feet in diameter. They are half-filled with quartz or flint pebbles, and as the tube rotates the pebbles rise on the sides, and, falling again, grind the mixture till the desired degree of fineness is reached.

Ball mills are rotating cylinders or drums stepped inside and provided with steel balls which fall from one step to another as the drum rotates, and grind the material to the fineness of grit.

The product prepared in this way for the kiln has been reduced to a size which admits of the bulk passing through a 180-mesh screen.

(b)—Burning the Mixture.

The old upright kiln has given place in modern practice to the continuous rotary kiln, an English invention (Ransome), improved and first successfully used by Americans about 28 years ago. This is a hollow steel cylinder lined with firebrick, or sometimes and partially with cement clinker bricks, 6 to 9 inches thick. It is usually 6 to 8 feet in diameter and from 60 to over 100 feet long. Up to recent years the standard length was 60 feet, but it has been found that the duty of the kiln is increased by increasing the length. Works have been provided with 150 feet kilns, 10 feet in diameter, but this extreme length is considered in the trade as being the limit of efficiency; 120 or 125 feet in length and 6 to 8 feet in diameter are considered normal dimensions for modern plants. F. B. Peck, in a paper on the "Cement Belt in Pennsylvania" (Economic Geology, 1908, page 69), states that actual experience has shown the average producing capacity of rotary kilns in barrels of cement per day is as follows:—

60-feet kiln	200 barrels.
100-feet kiln	400 barrels.
120-feet kiln	500 barrels.
150-feet kiln	750 barrels.

It is obvious that a long kiln will permit much of the heat to be saved which could not be utilised in a shorter kiln.

A screw conveyor feeds the raw mixture into the upper end of the cylinder at a rate which is controlled by the kiln operator, who regulates the speed according to circumstances: this varies from one revolution in one minute to one in ten. The cylinder is usually driven by a variable-speed motor. The cylinder is slightly inclined ($\frac{3}{8}$ or $\frac{5}{8}$ inch to the foot). Under the influence of gravity and the rotation of the cylinder, the material slowly travels down the latter, and in the lower part of its passage is reduced to a state of semi-fusion by the heat from pulverised coal, which is blown by hot-air blast into the lower end. The temperature in the fire zone is between 2600 and 3000 degrees Fahr.

The partly-fused product, consisting of chemically combined lime, silica, alumina, and iron, drops out at the discharge end in the form of lumps and nodules of white or red hot "cement clinker," having a temperature of about 2000 degrees Fahr.

The introduction of the rotary continuous kiln gave an immense impetus to the growth of the cement industry throughout the world, and no modern cement plant is without it.

A kiln will run for six months before renewals of the lining are necessary.

(c)—Cooling the Clinker.

The hot clinker falls from the kiln into an inclined rotating cooler drum, the air current passing through the drum being the cooling agent. It is taken by a conveyor to the clinker store, where it remains for some weeks before adding the gypsum and subjecting it to a final grinding.

(d)—Adding the Gypsum.

Gypsum (sulphate of lime) has to be added to the clinker in small proportions as the latter passes to the grinding mill, in order to retard the setting of the cement, which otherwise proceeds too quickly. Between 1 per cent. and 2 per cent. is usually added; 3 per cent. appears to be the limit of usefulness, as when more than that proportion is used, it is said to impair the strength of the cement. After being crushed in a stone-breaker the crude gypsum is in some mills shovelled into elevators conveying it to the grinding mill bins, or in others it is served automatically to the clinker as the latter enters the mill.

(e)—Grinding the Clinker.

This is effected in ball and tube mills, the latter being used for the final fine grinding. The product is as fine as flour, between 80 and 90 per cent. of it passing a 200-mesh sieve. It seems to be established that powdered clinker coarser than 180-mesh size (180 holes per lineal inch) is deficient in the cementing property.

(f)—Storage of the Cement.

The product is usually taken from the final tube mills by conveyors, and is then elevated to the hoppers in the storage house, where it remains until it has been analysed and subjected to the necessary tests. After this has been done it is drawn from the bins and delivered by means of conveyors and elevators to automatic bagging-machines, and is then ready for market. It may be mentioned, however, that it is not taken from the bins until it has remained in them for some weeks or months to ripen. Certain chemical reactions may supervene, and have to be watched.

VI.—Fuel.

It may be expected that coal will be the fuel used for kilns and boiler furnaces, and will have to be brought from a distance. Petroleum and producer gas have been sometimes used for burning, but the general practice is to employ coal. Where coal is too costly, the use of producer gas has to be considered, but Bleininger insists that it is never to be employed if it is at all possible to use coal, the percentage of heat losses being about 15 per cent. in favour of direct firing.(1).

The best coal for cement-making is that with a fixed carbon content ranging between 50 and 60 per cent., volatile matter between 30 and 40 per cent., and the less ash the better. A proportion of the ash always remains behind in the cement, and there should be no excess of ash if possible; but the ash may amount to as much as 15 per cent. without offering any difficulty, provided that it contains no particular constituent that would affect the proportions of the raw materials mixture. The fixed carbon percentage should not be high enough to make the coal anthracitic, for such coal (like powdered charcoal) is difficult of ignition. The Tasmanian East Coast coal is quite suitable for the manufacture of Portland cement.

Coal for the kilns may be received at the works as it is hewn from the seam or as slack. If it is lump coal, it has to be crushed by jaw stone-breaker or gyratory crusher, but if it is slack it is taken straight to the drier.

All the coal when dried is reduced to powder in ball or tube mills till 90 or 95 per cent. of it will pass through

(1) "Manufacture of Hydraulic Cements," by A. V. Bleininger. Ohio Geol. Sur. Bulletin, 1904, p. 298.

a 100-mesh sieve. The finer it is ground the quicker it will ignite, and even a poor coal can be used in the kiln if it is ground very fine. The drying and grinding are very important efficiency factors in burning.

The powdered coal is passed in a screw conveyor to bins in front of the kilns, and thence drawn and blown into the kilns with hot-air blast.

The coal actually consumed in the kilns is only a part of the aggregate consumption for all fuel and power requirements. The purely kiln consumption has been reduced in recent practice, but usually figures out at about 30 per cent. of the clinker produced. But in making the necessary calculations the various power and works requirements must be taken into account. Eckel states:

> "Every barrel (380 lb.) of Portland cement implies that at least 200 to 300 lb. of coal have been used in the power plant and the kilns."(2).

This is equivalent to 15 cwt. of coal for every ton of cement, but for an annual production of 30,000 tons of cement, allow roughly 20,000 tons of coal.

The Public Works Department of New South Wales, in calculating the quantity of coal required for their proposed State works, estimates that to produce 30,000 tons of cement it will need 20,000 tons of coal for the kilns and works plant.

The Tasmanian coal companies do not sell slack, and ordinary coal brought from Mt. Nicholas to Launceston and thence by boat to Beauty Point will not cost less than 25s. per ton at Flowery Gully. Slack coal from New South Wales will probably cost about 22s. per ton delivered at works site; or the small "duff" coal separated in Newcastle might approximate to 18s. or 19s. per ton. Evidence was given before the New South Wales Public Works Commission to the effect that the very fine coal ("duff"), resulting from double-screening, could be obtained cheaply at Newcastle, and would be suitable for cement works. Enquiries made by the writer show that the coal in question is screened through ½-inch and ⅛-inch apertures. It averages about 16 per cent ash. The Wickham and Bullock Island Coal Co. Ltd., Neath Colliery, has continuously separated the duff for years, and has been supplying it to brick kilns of a semi-Hoffman type. The cost, f.o.b. Newcastle, would be about 4s. 6d. per ton. No

(2) "Portland Cement Materials and Industry in the United States," by E. C. Eckel. United States Geol. Sur. Bulletin No. 522, 1913, p. 66.

instance could be learned of its use in the manufacture of cement, and some tests would be necessary before its quality could be accepted as suitable.

While in the district it was suggested to the writer that, there being so much timber in the neighbourhood, charcoal might be used instead of coal, but, as mentioned above, powdered charcoal is not easy to ignite unless the kiln conditions are incandescent.

VII.—Works Site.

The country at the foot of the hill in the valley of Johnston's Creek is level, and a permanent stream flows through it. The works would probably be on that flat, and on the 500 acres of Evans, Thompson, and Douglas. The limestone would be taken to the kiln by tramway from Lutwyche's quarry, and perhaps by aerial ropeway from the higher benches. The conveying of this material to the works would involve a transport of about a quarter of a mile or a little over. The clay and shale transport will probably be about the same distance. The transport route from Lutwyche's face is a singularly level and easy one. There is plenty of room on this flat available for all the buildings required in connection with the works and port railway, storage sheds for farmers' freights, &c.

VIII.—Transport to Shipping Port.

No serious difficulties exist in the way of establishing a good line of communication with Beauty Point. The distance will be nearly 8 miles, approximately. A steam tramway for over 3 miles of this, connecting the port of Beauty Point with Beaconsfield, is already in working order, and for the remainder of the distance the engineering work will meet with no obstacles. On the Beaconsfield side of the gorge the extension of the present tramway would necessitate some arrangement with private owners of land, but after passing through the gorge the line could be carried parallel with the road on the east side of Johnston's Creek valley, where it would be on Crown land, and would not interfere with private property before approaching the south end of the valley. There, probably, the owners would welcome facilities for conveying their produce to port or market. With sundry freight revenues from this line the transport charge for the cement to Beauty Point would probably not exceed 2s. per ton.

IX.—Cost of Erection of Works.

There is nothing in the existing conditions which would make the cost of works at Flowery Gully greater than that of similar cement works elsewhere in Australia. In 1914, Mr. E. J. Morston reported on the Flowery Gully property, and estimated that cement works with a capacity of 500 tons per week could be erected for about £40,000 with suitable buildings, plus power plant for same, approximately £10,000; in all £50,000.

Mr. F. Oakden reported to the New South Wales Government in 1912 on the cost of erection of State cement works at Homebush near Sydney, with a capacity of 600 tons per week (30,000 tons per annum), which he estimated would be £37,000, exclusive of railway sidings, earthworks, &c.

Mr. L. Janicke, in the same year, reporting to the New South Wales Government on the cost of proposed works of similar capacity at the Homebush site, furnished an estimate of £41,000; while the New South Wales Public Works Department estimated from £58,000 to £93,000 for works with two plant units at various places in that State.

In reporting for the Tasmanian Portland Cement, Lime, Brick, and Coal Company Ltd., Ida Bay, in 1914, Mr. A. J. Willcoxson estimated the cost of a 30,000-ton plant at £33,000, exclusive of tramways and coal mine equipment.

It will be seen from these figures that the installation of a modern cement-making plant is no light matter, even if restricted to one unit of plant. It is considered the best practice to have two kilns and two units, so as to avoid stoppage if anything happens to the kiln. The works can be laid out, according to expert evidence, so as to allow the addition of a second unit without interference with the first, and at a cost of not more than 60 per cent. of that of the first installation.

For Flowery Gully the plant power would be electric, which is the accepted practice in all modern works. The power required for manufacturing by the dry process is usually reckoned as from one to one and a half horse-power per barrel of cement, *i.e.*, from 600 to 800 horse-power for the proposed Flowery Gully works. If the power is derived from the State hydro-electric installation, the power fuel consumption will be considerably reduced.

In England, however, steam power still has its advocates.

X.—Cost of Manufacture.

In the present state of trade and labour no reliable estimates can be framed of manufacturing cost, and the following must only serve to give a quite approximate idea of what may be expected:—

	£
30,000 tons of limestone, quarrying, handling, and transporting to works, at 3s. 6d. per ton	5250
10,000 tons of clay or shale, quarrying, handling, and transporting to works, at 2s. 6d. per ton	1250
500 tons of gypsum, delivered to works, at 45s. per ton	1125
20,000 tons of coal for kiln and power, at 23s. per ton	23,000
Total	£30,625

Roughly, therefore, it may be said that the materials and fuel will cost about £1 per ton of cement. Possibly the clay extraction may not exceed 2s. per ton, but the difference will not materially affect the total, as the governing factor in the calculation is the cost of the coal. As mentioned above, the coal item can be advantageously modified only by the eventual utilisation of the hydro-electric current.

The manufacturing cost (labour, administration, repairs, bagging, and depreciation of plant) will fluctuate according to the varying current conditions, but good Australian authorities estimate it for cement works on this scale as ranging between 18s. and 23s. per ton. Taking 22s. under this head, the total cost will be brought to £2 2s. per ton at Flowery Gully and probably £2 4s. or £2 5s. at Beauty Point.

A comparison of this estimate with the estimated costs of other proposed sites in Tasmania and Australia shows the following figures:—

At Ida Bay, in Tasmania, the cost of extraction and manufacture has been estimated as probably being £2 per ton.

At Carlos Gap, in New South Wales, at site, £1 8s. 8d. per ton.

At Newcastle, at works site, £1 12s. 2½d. to £1 17s. 8½d. per ton.

At Homebush, near Sydney, £2 1s. 6½d. per ton, at works site.

It may be mentioned that in the New South Wales estimates the coal item figures at 3s. 6d. per ton of coal at Carlos Gap and 14s. 1d. per ton at Homebush.

XI.-Markets.

Supposing all the requirements of manufacture are satisfied, the chances of success depend largely on markets and distribution. Competition has to be faced, and prices will be found to be governed by slight advantages of position which one works possesses over another. One is either nearer a port or the port is nearer a market, or railway freights are higher, or fuel has to be transported over a greater distance, or the consumption of the product within a given radius is not adequate, or a score of conditions may exist which will give one proposition a pull over another. Notwithstanding that the cement may be manufactured profitably, the factors which bring about success are exceedingly complex.

According to returns supplied to the Secretary for Mines by various public bodies (Hobart Marine Board, Launceston Municipality, Burnie and Table Cape Marine Board, Tasmanian Government Railways), their consumption of Portland cement has been for the past five years at the rate of 3300 tons per annum; if we add an equal tonnage for the requirements of private builders and contractors, the aggregate yearly consumption will be, allowing for increased consumption after the war, within 10,000 tons per annum. Thus it appears that Tasmania cannot hope to consume in the immediate future more than one-third of the output of the proposed works, and would have to depend upon the mainland for taking the balance. It is easily seen, therefore how vitally important it is, when starting this industry in Tasmania, that the works should be in the best possible position for coping with outside competition. The scale of output estimated in this report is at the rate of 500 tons per week more or less, which is that of a moderate-sized one-unit plant. If the capacity of plant were limited to 300 tons per week, which is a small output for cement works, the proportion which would have to be exported to the other States might then be only about one-third of the total production instead of two-thirds, but the unit cost of production would be higher and competition more difficult to meet.

The limited demand in Tasmania operates disadvantageously in deciding upon the size of the plant to be installed, for to obtain the very highest degree of efficiency at the minimum cost, a large installation is requisite, with a capacity of, say, 2000 or 3000 tons per week. The present markets, however, would not justify a larger plant capacity than 500 or 600 tons per week, which means a single-unit plant.

XII.—Conclusion.

In the pre-war period the cement industry throughout the world was developing at a rapid rate. The material is indispensable for the constructional engineer and builder in satisfying the multiform needs of modern life, and new uses are being found for it nearly every day. There is every reason for believing that an increasing consumption may be relied on as a certainty.

Australia at present cannot meet its requirements from its own factories, but is compelled to import from abroad to supply the deficiency. This state of things will no doubt eventually be remedied by an enlarged Australian output, and unquestionably it is desirable that Tasmania should, if possible, assist in contributing to the augmented production. The position at Flowery Gully is perhaps such that immediate advantage cannot be taken of the deposits there, but with the expansion of the hydro-electric scheme of distribution, and perhaps a railway connecting the Government system of lines with Beauty Point, increased facilities for the supply of power and fuel may by and by considerably improve the working conditions. It is plain, however, that the starting of cement works is not a thing to be entered upon with a light heart, but requires for success the most careful consideration of both materials and site, as well as the command and application of high technique and practical experience. Year by year the requirements of the trade in respect of quality of product grow more exacting, and the highest training and practical knowledge on the part of those who control the manufacture are necessary to cope with the ever-increasing demands.

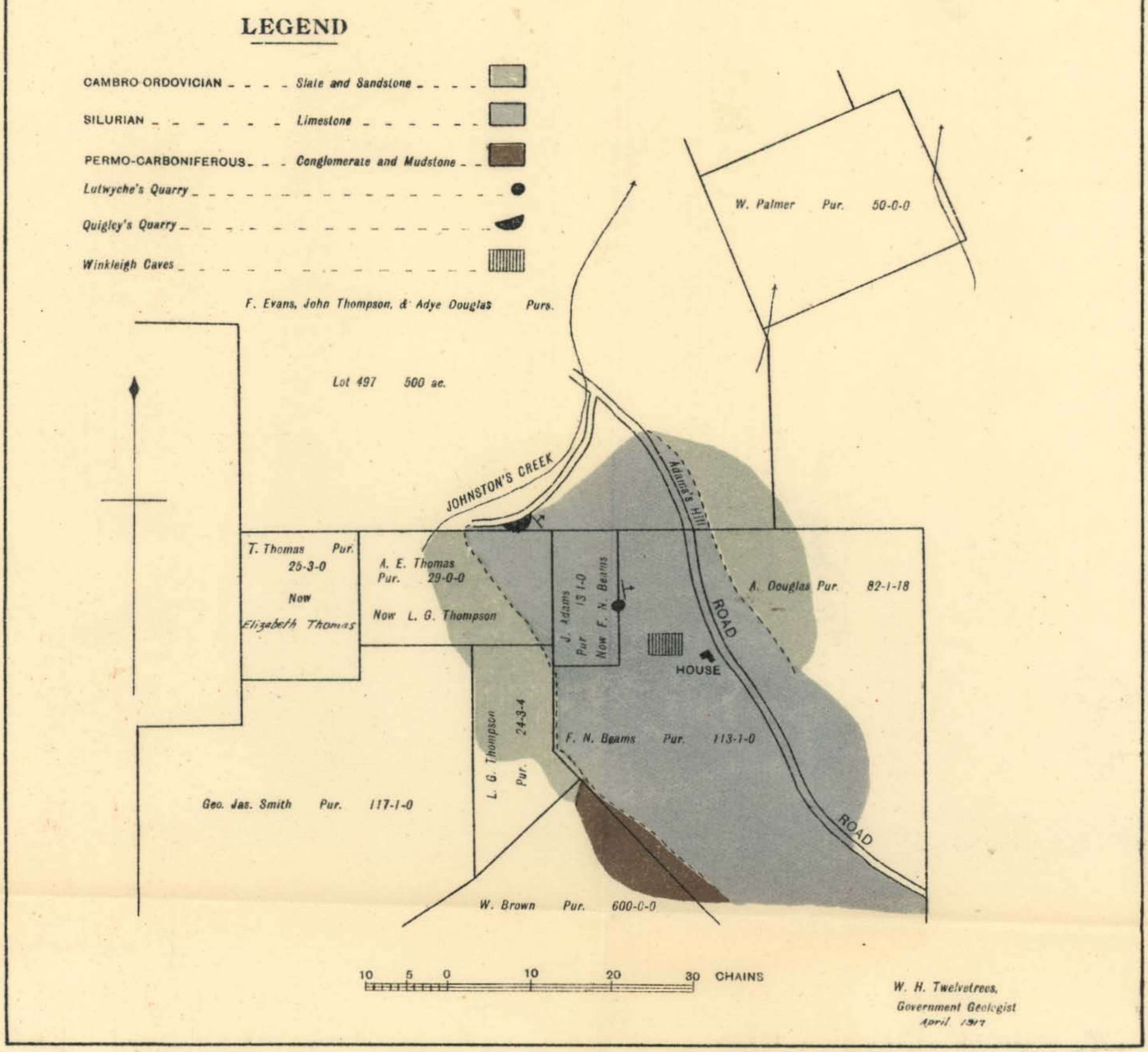
Given the materials and a favourable site, the installation of Portland cement works in Tasmania is an attractive proposition. At several places in the island are large deposits of high-grade limestone, and the question of selection of site is for the most part a pure matter of business insight and judgment. The use of cement has already become one of the great factors in the material progress of civilised life, and there can be no doubt that the establishment of the industry in Tasmania is destined ere long to be an accomplished fact. It seems worth while taking some risk in achieving this.

W. H. TWELVETREES, Government Geologist.

Launceston, 5th April, 1917.

GEOLOGICAL MAP OF

LIMESTONE AREA AT FLOWERY GULLY



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