THE PRACTICAL WORK OF STARTING A GREAT ENGINEERING ENTERPRISE.

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Having been requested by the University Engineering Society to communicate a paper on some engineering subject, Mr. E. M. de Burgh, M. Inst. C.E., Acting-Chief Engineer for Rivers, Water Supply, and Drainage, while regretting that pressure of business would not admit of his writing a paper, offered to give a brief address on "The Practical Work of Starting a Great Engineering Enterprise," and this address was given in the Geological Hall of the University on the 8th July, 1908, and was illustrated by a number of lantern views, prepared by Mr. Degotardi, of the Department of Public Works. The following synopsis of the address is prepared partly from shorthand notes taken at the time, and some figures have been introduced which the time at Mr. de Burgh's disposal prevented him laying before the meeting:—

Mr. de Burgh regretted that he had not had time to write a scientific paper, but had no doubt that the members of the Engineering Society would be able to obtain any amount of technical detail with regard to the works on which he was going to speak from other sources or at a future date. He chose the subject, as he thought it might be of interest to them to hear an account of the business details that occupy an engineer's time, and cause him the greatest anxiety in the initial stages of a great work. Seeing the position which he occupied in the Public Service of the State, those present would probably expect to hear a great deal about the irrigation scheme generally known under the name "Barren Jack," but officially known as the "Northern Murrumbidgee Irrigation Scheme," and if they were at first surprised to hear a great deal about a railway, and very little about a dam, they would probably, by the time he concluded his remarks, understand why such prominence was given to the subject of the railway.

It might be supposed by some, at all events by the junior members of the Engineering Society, who were present that when such a great scheme as the Northern Murrumbidgee Irrigation Scheme is authorised by Parliament the engineers who have investigated it, and on whom the work of construction devolves, would be ready to the utmost detail to start the work, and that, given the necessary authority, everything would proceed immediately upon fixed lines, and, as it were, automatically. That, however, is not the case in the actual practice of the profession. Large sums of money cannot be expended on work which is not yet authorised, and while a great deal of information must be collected in order to obtain the sanction of Parliament to the scheme, no Government, nor private company, would allow their engineers to expend large sums of money on an investigation of all the details of a scheme which might never be authorised by the Legislature. In the United Kingdom large engineering proposals are usually referred to a Parliamentary Committee, and, after investigation, form the subject of a Bill presented to Parliament. The promoters of a scheme must judge, taking into account the likelihood of the scheme passing, what sum they are prepared to spend upon the investigation of it, and the Minister for Public Works, New South Wales, and the engineers acting under his direction, occupy a similar position with regard to the Standing Parliamentary Committee on Public Works who, in this State, take the place of the Parliamentary Committees in the United Kingdom.

In submitting the Murrumbidgee Northern Irrigation Scheme to the Public Works Committee, there were certain matters on which the engineers required absolutely definite information.

First, the quantity of water which could be stored at Barren Jack.

Second, the area of land that could be watered from that storage.

Third, the quantity of water required at varying periods of the year for the irrigation of that land.

And last, sufficient detailed surveys were required to enable fairly accurate estimates to be formed of the cost of the proposed works.

The Northern Murrumbidgee Irrigation Scheme had been talked about for many years. Successive Governments had considered it, but no definite action had been taken, and it was not until the present Minister for Public Works (the Hon. C. A. Lee) came into office that a scheme was formulated, and sent on for inquiry to the Parliamentary Standing Committee. The engineers at that time had the necessary con-

FIG. 1.

tours to enable the capacity of the reservoir to be calculated, and they had a fair amount of information with regard to the area of land which could be irrigated. They had also preliminary surveys at the site of the dam fairly sufficient to enable a preliminary estimate to be formed, but not in such detail as to absolutely fix any exact spot in the gorge of the Murrumbidgee as the best possible for the site of the dam. The scheme was worked up under great pressure, owing to the limited time, and from the day that submission was made to the Committee the number of side issues which arose during their inquiry taxed the energy of the staff to the utmost, and absolutely precluded work being done on the engineering details of the scheme during the period of inquiry. Even at this stage no large expenditure could be incurred, as the passing of the scheme was quite problematical.

One of the most important matters which had to be considered as bearing closely upon the cost of the Barren Jack dam was the question of access to the site of the dam itself. Barren Jack is situated about 30 miles from Bowning station, on the main southern railway line. Bowning is distant 196 miles by rail from Sydney, and all material required for the work would have to be hauled from Bowning, or some adjacent point, on the main southern line, to the dam site. When the estimate for the dam was prepared, of course one of the first things ascertained was the quantity and class of masonry or concrete to be used, and from that was deduced the quantity of cement required. This quantity was fixed at 48,000 tons. Assuming that this cement could be purchased at, say, 9s. a cask at Portland or Granville, and taking, roughly, 5½ casks to the ton. it will be seen that this cement alone is worth £132,000 at the works, whence it had to be hauled to Bowning, and conveyed over the intervening 30 miles of road to the dam site. The cost of the cement could be estimated, making due allowance for fluctuation in the market, and an arrangement as to freight to Bowning could be made with the Government railways, but with regard to its conveyance from the railway to the site of the dam there was no time to go into niceties. It might be practicable and economical to build a railway line for its conveyance, but what the class of line would be, what practicable route could be found for it, and even what the length of such route would be, were matters there was no time to investigate. Some assumption had to be made. however, and this was taken at 8d. per ton mile by traction engine, or £1 per ton for the 30 miles, amounting to £48,000 from Bowning to the works. The Departmental engineers had experience of the use of traction engines for this class of traffic in connection with the Cataract Dam, and in making the above assumption they were

acting upon experience in traction engine haulage. But in traction engine haulage everything depends upon the road. That from Bowning to Barren Jack follows the Main Southern-road for a distance of about nine miles. with a good metal surface, but a very heavy grade at Conroy's Gap. Leaving the main road at the 9-Mile, the remainder of the distance to the Murrumbidgee is along an uncleared road, over which it would be absolutely impossible to operate traction engines. Further, on approaching the Murrumbidgee, the road dips into the valley, which will be inundated by the impounded water, so that unless the existing route were departed from it would be impossible to utilise this line of conveyance after water was stored, owing to the construction of the lower portion of the dam. A rough estimate was accordingly made for the diversion of the road from Makoolama over Lucas's Gap, so as to approach the dam site from the mountains above it, instead of via the valley. For this work and the improvement of the surface of the road £12,000 was allowed, while another £12,000 was put down for maintenance, so that, taking the haulage at 8d. per ton mile and these two items of £12,000 each, a sum of no less than £72,000 was reached for the conveyance of cement from Bowning to Barren Jack alone, and it was on these rough figures that the estimate placed before the Parliamentary Committee was based.

On October 13th, 1906, the Works Committee passed the Northern Murrumbidgee Irrigation Scheme, and it appeared more than likely that Parliament would sanction it. The pressue of work caused by investigating the many issues raised during the inquiry being relieved, the engineers naturally turned to the consideration of the various items of the estimate, and to a consideration of their position as to immediately putting the work in hand should it be passed. The first item on which attention was concentrated was the problem of getting this large quantity of cement out to the dam site. It has been stated that the existing road approached the dam site through the submerged area, and this will frequently be found to be the case, the road in approach to the site of the proposed dam at Wyangala, on the Lachlan River, being almost precisely similar in location to that at Barren Jack, and to divert the road so as to avoid the flooded area necessitated the landing of the cement at a point some 800ft. above the proposed dam site, from which height it would be necessary to lower the cement by ropeways or some other special means, as it was out of the question to obtain a trafficable gradient down the side of the mountain. The problem of constructing a suitable traction engine road for the sum of £12,000, and maintaining it during wet weather for another £12,000, became much more serious on closer investigation

than it had appeared when hastily considered among a vast number of other items in making up the estimate for the dam; and another matter, viz., the supply of firewood for the engines upon the works began to assume greater importance the more it was investigated, it being seen that if the road were the only means available for conveying the large quantity of wood, possibly some 60 tons a day, required at the works, the cost of this fuel would mount up very rapidly as the length of haulage increased. The alternative to road haulage by means of traction engine was, of course, a railway, and directly the Standing Committee had passed the work surveyors were detailed to investigate the possible routes for a line.

At the outset it was urged as imperative that the line should be of the standard gauge, so as to enable the trucks conveying the cement to travel through to Barren Jack without trans-shipment, and preliminary surveys were accordingly based on a gradient of 1 in 30, with a minimum curve of five-chain radius. Trial surveys were made from Bowning via Conroy's Gap, from Bowning via Black Range, and from Emu Flat, all of which lines left the existing road at Makoolama, and climbed thence over Lucas's Gap to a point above the dam site, and every one of them, taken on the five-chain radius basis above, appeared absolutely prohibitive in cost if the haulage were to be kept within or near the sum set down for it.

On the 23rd December, 1906, Parliament passed the Northern Murrumbidgee Irrigation Bill, and the Minister for Works issued a terse order to the engineers to start the work, and there was not a peg in the ground on any line that appeared to offer a practical solution of the difficult question of hauling this cement.

While these investigations in connection with the railway line had been proceeding, detailed surveys at the site of the dam itself had been pushed on, with the result that it was decided to adopt a site half a mile further down the river than that which had been taken in the preliminary investigations. This moving of the site added to the difficulty of conveying the cement, as access to the dam was no longer possible from the point 800ft. above it, which had up to that time been considered the terminus for the road or possible railway. It being seen that it was impossible to adhere to curves of a five-chain radius, and at the same time keep the cost of construction within reasonable limits, it was decided to adopt a gauge of 2ft., and a minimum curve radius of 1½ chain, or 99ft. It was seen clearly that to set the cost of trans-shipping the cement against the cost of constructing a standard line was absurd, for the whole of the cement might readily

be trans-shipped at 4d. to 6d. a ton, making a total trans-shipping cost of £800 to £1,200; while not only would this sum be insufficient to pay the difference in cost of a mile of construction in the more difficult country, but the five-chain curves rendered the adoption of the most suitable route practically impossible.

By March, 1907, Mr. C. R. Cunningham, who was in charge of the survey, located a line from Goondah Siding, at the 202-Mile peg on the Great Southern Railway. down Carroll's Creek to the dam site itself, obviating the necessity for the terminus being 800ft. above the work— a line which, it may be stated, is absolutely impracticable without the 1½-chain curves, as, even if tunnelling were resorted to in order to admit of the use of five-chain curves, the portion of the line at Carroll's Creek would be so shortened that the necessary gradients could not be obtained. It was estimated that this line could be constructed at such a price as would enable the cement to be delivered at a cost reasonably approximating to the sum allowed in the preliminary estimate, and that, in addition to the haulage of the cement, great advantage would accrue from the tapping of large areas of timber suitable for firewood by the line, while a certain proportion of the running charges would be repaid by the revenue to be derived from passenger and general goods traffic in connection with the large population which would be resident at Barren Jack during the construction of the works.

On the 13th March, 1907, or about 18 months ago, the Minister for Works authorised the construction of the railway, and the following is a brief description of the class of line and rolling-stock which it was decided to adopt:—

Gauge, 2ft.; rails, British standard, 30lb.; sleepers, hardwood, 8 x 4, 5ft. long, 2ft. centres; minimum curve, 99ft., compensated to a gradient of 1 in 30 against a load and 1 in 25 with the load.

Rolling-stock: Krauss locomotives, 4ft. wheel base, burning coal, 6ft. 7in. wide over frame; weight, 11½ tons in steam. Trucks, bogie stock; length, 16 and 20 feet over all. weight, 3 tons 5cwt.; net load, 10 tons. Hauling power of locomotives, three of these trucks loaded, equal to approximately 40 tons, exclusive of engine, up a 1 in 30 grade. Wheels of the rolling-stock are cast steel, and the whole of the stock is built very low, in order to obtain stability.

Length of line, 26 miles, approximately. Westinghouse brakes are used throughout.

Orders for the rails and fastenings required, and which could not be obtained in Australia, were cabled to Europe, as well as orders for three of the Krauss type of locomotive, which it had been decided to use.

It is hardly necessary to state that, as this line was the key to the situation at Barren Jack, and as the Government were extremely anxious that a prompt start should be made with the work, the construction of the line could not wait for such preliminaries as the resumption of the land required, and an immediate start on the formation was absolutely necessary. A depot was established at Goondah Siding, and a temporary camp erected, the formation being cut up into small contracts, and tenders locally invited for lengths of one mile to three miles. A start had hardly been made before trouble was encountered in connection with the sleepers. While the timber at the Goondah end of the line is very poor, there is a large quantity of stringy bark and mixed hardwood available at the Barren Jack end, from a point about 14 miles from Goondah, and, as it was intended to use any solid timber that could be obtained, and to accept round-backed sleepers, it was anticipated that, on account of their small size, they could be procured for about a shilling each. The owners of the land on which the timber was available, however, demanded a royalty, which would have resulted in an addition of 75 per cent. to the cost of the sleepers, and instead of obtaining them locally it was found necessary to bring about 40,000 from the Newcastle district, and the greater part of the balance, another 40,000, from different stations along the Southern Line, with a result that the sleepers actually cost 1s. 6d. each. Against this it may be stated that the sleepers were of much better class than it was originally intended to use, and, no doubt, the additional cost will be repaid in the extra life of the better timber.

At the time the line started there was only one 2ft. gauge locomotive available, and, pending the arrival of those ordered from Europe, it was necessary to use this engine, which had been in continuous use for the previous three years at Cataract, and which, to quote from the report of the Engineer-in-Charge, had the disadvantage of dropping pieces of the mechanism along the road. However, this engine was better than none, and directly the first consignment of rails arrived from Europe the plate-laying was rapidly pushed out from Goondah. With regard to the formation, the country over the first 18 miles presents no sepcial difficulties. It cannot by any means be called flat, as gradients of 1 in 30 and three-chain curves are necessary to avoid heavy works; but, compared with the country at the Barren Jack end, it is comparatively easy. The average contract price for the formation and side drains along this 18 miles of country was £110 per mile, exclusive, of course, of waterways and bridges. In the heavy side cutting in rock formation down Carroll's Creek, the cost of formation amounted to £1,690 per mile. The total