FROME DAM, MOORINA, TASMANIA.

(Paper read before the Sydney University Engineering Society, on June 16th, 1910.)

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Construction and Costs.

1. *General Description.*—The Frome Dam was built by the Pioneer Tin Mining Co., Ltd., whose mine is situated at Bradshaw's Creek on the North East Coast of Tasmania, thirty-two miles from Scottsdale, the nearest railway town, and seventy-two miles from Launceston. The surrounding country is of an undulating character with occasional button grass flats.

The mine is an alluvial tin proposition, the drift being broken down by hydraulic giants, and lifted to the surface by centrifugal pumps mounted on barges, where the tin is recovered in tail races.

The dam was built as the first step in its Hydro-Electric Scheme, a brief outline of which is as follows:—

Six chains below the Dam the water is picked up by a race 1 mile 45 chains in length, at the lower end of which the water drops through a 36in. pipe column (434 feet vertically) to the Power Station, where it is used to drive Impulse Turbines direct coupled to Generator Sets. The tail water from the turbines is led through another race 3 miles in length to a point where it picks up the old race and continues into the mine for use through the nozzles and in the tail races. From the Power Station to the mine the Electricity is transmitted in a direct line four miles in length at a pressure of six thousand volts, where it is used direct for driving pump motors, lighting, etc.

The Dam is 6 miles distant from the mine in rough myrtle forest country, 770 feet above the mine floor level and 1080 feet approximately above sea level. The Embankment is located at the lower end of the Frome Flats, at a point where the river passes through a gorge, six chains below which it drops 300 feet in a succession of waterfalls. These Flats, separated by a low bar of granite, as seen in the sketch have been worked for the last thirty-two years and over two thousand tons of alluvial tin have been won from them.

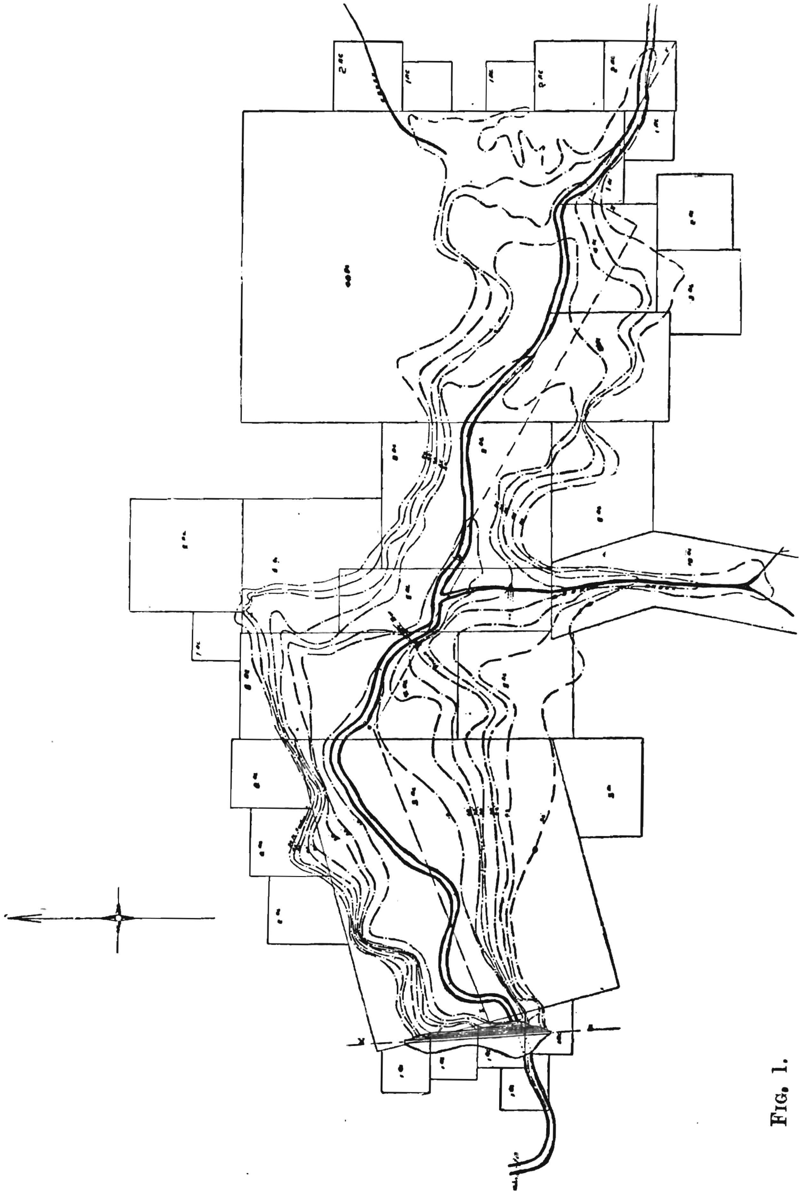

FIG. 1.

When full the Dam covers some 82 acres of ground, with a mean depth of 16.3 feet and contains 400,000,000 gallons. Its length is approximately three quarters of a mile, with an average width of 870 feet.

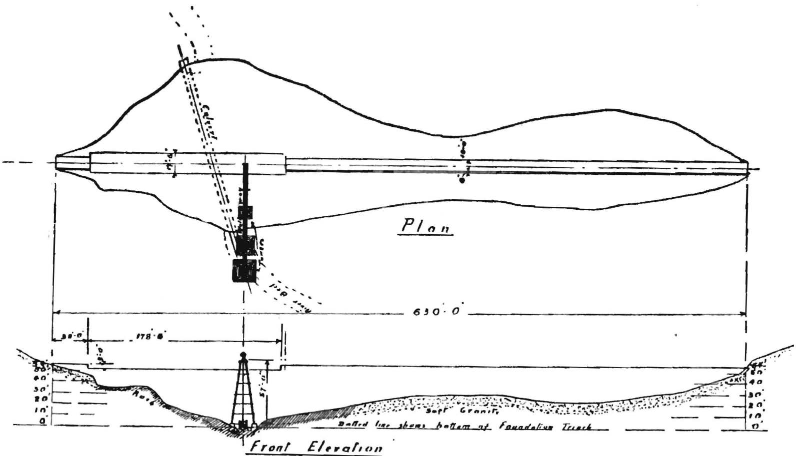

Fig. 2.

The present watershed is five square miles, but by tapping one higher up the total catchment area will be increased to ten square miles. The annual rainfall of the lower watershed is about 45 inches, and of the upper 72 inches.

Three miles above the Frome Flats the river takes its rise in the Emu Flats, which have been worked for tin for an equal period of time and have given nearly as good results. Owing to the country in the immediate neighbourhod of these upper flats becoming denuded of timber by fires, etc., the ground no longer holds the water as before, and the river fluctuates very rapidly in volume. In exceptionally dry seasons its volume has been down as low as five Tasmanian Sluice Heads (1 Tasmanian Sluicehead equals 24 cubic feet per minute), but in better years it may be taken as averaging 30 T.S.H. with occasional floods of 1,000 to 1,500 T.S.H.

As originally proposed the Embankment was to have had a maximum height of 54 feet with a 4 feet bye-wash, that is a water depth of 50 feet. This was to have been constructed of earth with a clay puddle wall; inside batter 2 to 1, outside batter 1½ to 1, contents 66,000 cubic yards. Subsequently this plan was discarded on account of its unreliability and the scarcity of good material. The next scheme was to build a rock-filled body with an outside apron of clay, which, however, was finally abandoned in favour of a concrete facing wall. The width of the bank at the top was to be 10 feet, length 630 feet, inside slope 1 to 1, outside slope $1\frac{1}{2}$ to 1; the inside slope dry-walled, the outside slope being left rough. The thickness of the facing wall was 3 feet 6 inches at the bottom, decreasing to 18 inches at the 14 feet level, and from that point to 6 inches at the top. The final quantities then stood as follows:—

Rock Filling................33,000 cubic yards
Dry Wall on Inside Slope......2,670 square yards

Concrete Facing Wall:
  Foundations................429 cubic yards
  Wall Proper...............857 „ „

The outlet for the water was to be through a concrete culvert laid in the old river bed 2 feet 6 inches in diameter and 198 feet long.

2. *Surveying.*—Contours for the Dam were run out by means of centre lines and cross sections, the surveys being plotted and areas taken thereform.

After the surface stripping had been completed the centre line of the Embankment was set out and 50 feet cross sections made. The quantities were calculated by the method of mean areas with prismoidal corrections substracted.

3. *Scrubbing.*—85 acres were scrubbed and cleared of all timber up to nine inches in diameter for an average price of 32s. 6d. per acre. This included some very dense bush as well as the clearer patches on the old workings. The work was started by a small gang in January, 1907, and continued intermittently; the scrubbing finished in February, 1908, and the burning off in November of the same year.

4. *Cleaning and Scrubbing Embankment Site, an Area of Five Acres.*—This was a heavy item; not only was there dense scrub to begin with, but many big trees were included which had to be grubbed, sawn up, split and burnt. The wood being green burnt badly, and no bullocks were available for par-buckling. The work was far enough advanced, however, by the 1st December, 1907, to start sluicing off the top soil.

5. *Removing Loose Top Soil.*—This was done by hydraulic sluicing. On the South side there was already one old race three miles long and of 5 sluice heads capacity, which only needed repairing and cleaning out to be ready for use. On the Northern side there was an old race of 3.5 sluice heads capacity, only partially completed and a fair amount of work was needed to bring it on to the embankment site.

For the former a two inch nozzle was used, and for the latter a one and a half inch, with a column pressure of from 40 to 60 feet. Where the slope was steep and rocks numerous the soil was removed by ground sluicings, the total amount being 6,650 cubic yards, with an average height of face 3 feet.

The ground was for the most part very stony and towards the end considerable difficulty was experienced in getting the tailings away, owing to the small quantity of water in the river.

The cost of removing over all was 7.76d. per cubic yard, but for the actual sluicing time and including current stores it varied from 3d. to 8d., according to the nature of the ground. Duty of No. 1 Nozzle (2in.) varied from 14.3 to 1, to 30.8 to 1. Duty of No. 2 Nozzle (1½in.) was 17.2 to 1.

Subsequently a further 800 cubic yards were stripped by hand where the ground laid bare was deemed unsatisfactory. This left about half the area with a rock bottom, the remainder being of a soft granite formation, which extended to an unknown depth, two shafts having failed to bottom it in the Northern end at 35 feet.

6. *Cleaning-out River Bed.*—In former days the river bed, where the embankment crossed it, had been worked for tin, the river being diverted through a side race; a bar of rock shot out and the drainage was kept under by means of a water wheel and Californian pump. It had been worked thus to a maximum depth of 10 feet below the present river level, and then had been allowed to fill up again with rock and sand. In ignorance of these facts it was at first attempted to clean the river out by lowering the channel at the head of the falls and snagging the river in front of the embankment site and divert it through in lowering the bed by two feet, but owing to the presence of numerous rocks amongst the drift, it was impossible to gauge the remaining depth of the wash, and it was decided to dam the river upwards to the embankment site. This plan succeeded a channel shot out and flumed along the sides. A small hydraulic elevator (1¾in. nozzle) was installed at the bottom end of the portion to be excavated, and by means of a flexible joint was gradually lowered into a sump hole below the true bottom. The drift and stones were then barrowed out clear of the workings. In this manner some 500 cubic yards were removed, or a total of about 700 cubic yards. Cuttings were also made at both ends where the river deviated from the straight line required by the culvert.

7. *Culvert.*—As soon as the excavation was completed rubble concrete foundations were put in, the width of which was 6 feet 6 inches and the length 250 feet, while the depth varied from 8 to 2 feet. The finished level was brought up to within 6 inches of the bottom of the Culvert, and lay at a grade of 1 in 120.

The concrete was mixed in the proportions of 1 : 2½ : 5., the sand been screened through a ⅛ inch mesh and the metal broken to 2 inch size. With these proportions 1.3 batches equalled 1 cubic yard in place, neglecting the proportion of rubble. In the wet concrete large rubble stones were placed, forming about 50 per cent. of the total bulk. In all 254 cubic yards of foundations were laid before the culvert itself was started.

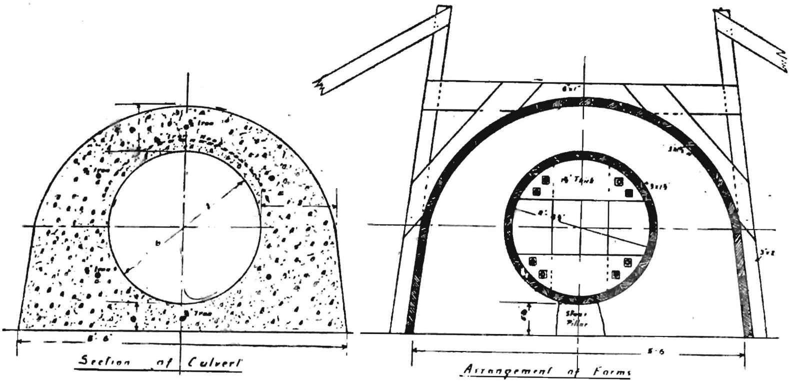

FIG. 3.

The culvert was made of circular section 2 feet 6 inches diameter, length 198 feet, and on the inlet side an iron pipe, 12ft long, ½ inch thick, flanged one end, was built in, the flanged end projecting just beyond the concrete.

Inasmuch as the culvert would be covered with about 10 feet of rock within ten days of completion and taking into consideration the shocks of large rocks rolling down on top of it, the sizes were made larger than those necessary for normal conditions, being 12 inches at crown and 15 inches at haunches. In addition four semi-hoops, 4 feet long, of ½ inch rod iron, were built into each 12 feet length in the centre portion, and six tie rods ½ inch diameter by 2 feet were used for tying the 12 feet lengths together. The mixture was made 1: 2: 4, of a wet quaking consistency, being stronger and less porous than that used for the foundations.

The metal (granite) was broken to pass through a 1¼ inch ring. It was spalled in a quarry 150 feet distant and wheeled to the knapping heap. Average cost per cubic yard of the metal:—

	s.
Spalling and Wheeling	3.53
Knapping	7.64
General (popping, shifting plats, etc.)	1.08
Total	12.255

The rock was exceedingly hard, and all the men unused to the work. The sand was sieved from wet river drift, containing a large proportion of gravel. ⅜in. mesh sieves were used in the first place, altered later to ¼ inch mesh.

	s.
Average cost of sieving per cubic yard	3.58
Cartage	2.39
Total	5.97

The brand of cement used was English Portland.

Cost per Batch.	Foundations.	Culvert.
	s.	s.
Forms		5.74
Sand	2.08	1.59
Metal	8.58	6.78
Cement and M.P. Stores ..	23.55	28.00
Mixing and Placing	7.70	5.59
General	6.19	5.58
Administration	2.82	1.75
Totals	50.92	55.03

Note, Cost of one cask of cement landed on works, 23/6.

8. *Quarries.*—The first quarry was No. 3, at the extreme northern end of the embankment, the level of its floor being 44 feet above the datum mark. The site was scrubbed and cleared and the surface soil stripped down to bed-rock by ground sluicing. A cut was then made into the face and a tramway laid.

A double cylinder winch was installed, and as more room was obtained, shear legs were erected over the truck road close up to the face. A half-inch wire rope from the winch barrel, passing through double and treble blocks, hung from the shear legs, was used to lift rocks to $3\frac{1}{2}$ tons in weight slung with $\frac{5}{8}$ and $\frac{1}{2}$ inch chains. In the first instance three derrick legs were used, but latterly two legs were found to be sufficient with four $\frac{5}{8}$ inch wire rope guys.

The tramway was 3 feet 6 inches gauge, Government railway 40lb. rails being used. The trucks were of the platform end tipping type, built on the works, and were tipped over a stout timber bumper at the dump head fastened back to sleepers by a $\frac{3}{4}$ inch chain.

The rock face had a maximum height of 30 feet, but as the quarry extended into the hill the quality of the rock deteriorated and soft bands frequently occurred, until finally it had to be abandoned.

Powder in long jumper holes was mostly used in the breaking-down, gelignite being almost entirely reserved for popping. The loose dirt broken was run off by hand sluicing.

No. 2 quarry was started shortly after No. 3, on the northern bank of the river, and immediately behind the embankment. Two faces were opened up and worked simultaneously for some time. The lower, 12 feet above datum level, was used to cover the culvert; the higher, 20 feet above datum, worked straight