Prai Water Supply

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Paper Read Before the Engineering Association of Malaya

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AT the present time Prai does not possess a sufficient water supply and practically all the water required by the railway department and other large users is obtained either by rail or water boat

With the completion of the new wharves at Prai, shipping and other additional demands will have to be met and in order to provide for all these requirements the Prai water supply scheme is now being constructed.

The scheme comprises a masonry dam and storage erservoir at Bukit Serayah, a pipe line to Prai, an elevated storage tank and service mains at the latter place, and is designed to supply 500,000 gallons per day.

Catchment Area

The catchment area is situated on the southern slope of Bukit serayah and has an area of 217 acres.

The surface slopes are steep ; but except for very small areas, are covered with soil. Over a considerable portion of the area small terraces—with dry stone retaining walls—have been constructed by the early spice growers and cultivators. At present the catchment is covered with a growth of coconuts, penang palms, fruit trees and blukar.

No rainfall records for the catchment area are available but we have the following for comparison.:—

Parit Buntai (15 miles distant).	
Mean annual rainfall since 1888	95.7-in.
Bukit Mertajam Village (3 miles distant).	
Mean annual rainfall since 1912	95.3-in.
Pari River Wharves (11 miles distant).	
Mean annual rainfall since 1918	106.3-in.

It is considered that the rainfall at Bukit Serayah is not less than at Parit Buntar, and a mean annual precipitation of 95.7 inches and a minimum of 65 inches have been assumed for the catchment.

In a year of minimum rainfall the total yield from 65 inches would be 319,000,000 gallons, which would give an estimated run-off of 185,000,000 gallons.

Gaugings of the stream at dam site have been taken since December 1920 and a minimum daily flow of 304,000 gallons has been recorded to date. This occurred on 30th August last after about three months of fairly dry weather. The dry weather gaugings always record a larger flow in the mornings than in the afternoons.

The water was submitted to a chemical and physical examination by the institute of medical research, Kuala Lumpur, and was found to be of considerable organic purity and the analysis did not disclose any reason why the water should not be suitable for domestic use.

The oxygen-absorbed figure was low and very little chlorine or free ammonia was present. Only a trace of nitrates was found, and contamination from animal sources is evidently very slight and not of recent origin.

The total solids per 100,000 parts was 6.05. Permanent hardness was 1.95 and temporary hardness nil. The water should therefore by very suitable for boilers. It is very slightly alkaline.

Appendix No. 1 contains the institute's report on this water.

The whole of the catchment area has been acquired and all dwellings are being removed or destroyed in order to avoid the risk of contamination.

Reservoir

The minimum annual run-off available for storage is estimated at 185,000,000 gallons. Evaporation, absorption and other losses are expected to amount to 35,000,000 gallons, leaving a gross available supply of 150,000,000 gallons. Deducting from the last figure the quantity in bottom of reservoir that cannot be drawn off—the nett available supply is 147,000,000 gallons.

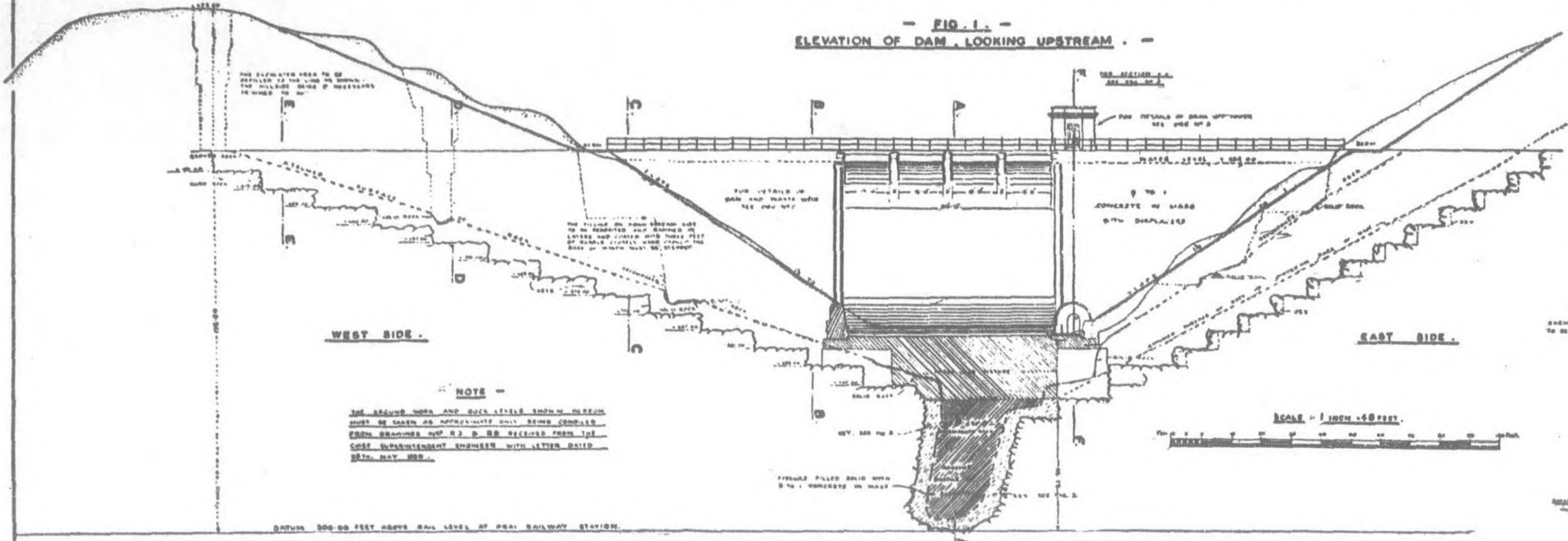
The reservoir has been designed to have a capacity of half this amount and the actual nett capacity of the reservoir when complete will be 72,000,000 gallons.

This is enough for 4½ months supply at the maximum daily draft of 500,000 gallons, and as the rainfall is distributed throughout the year it is considered sufficient.

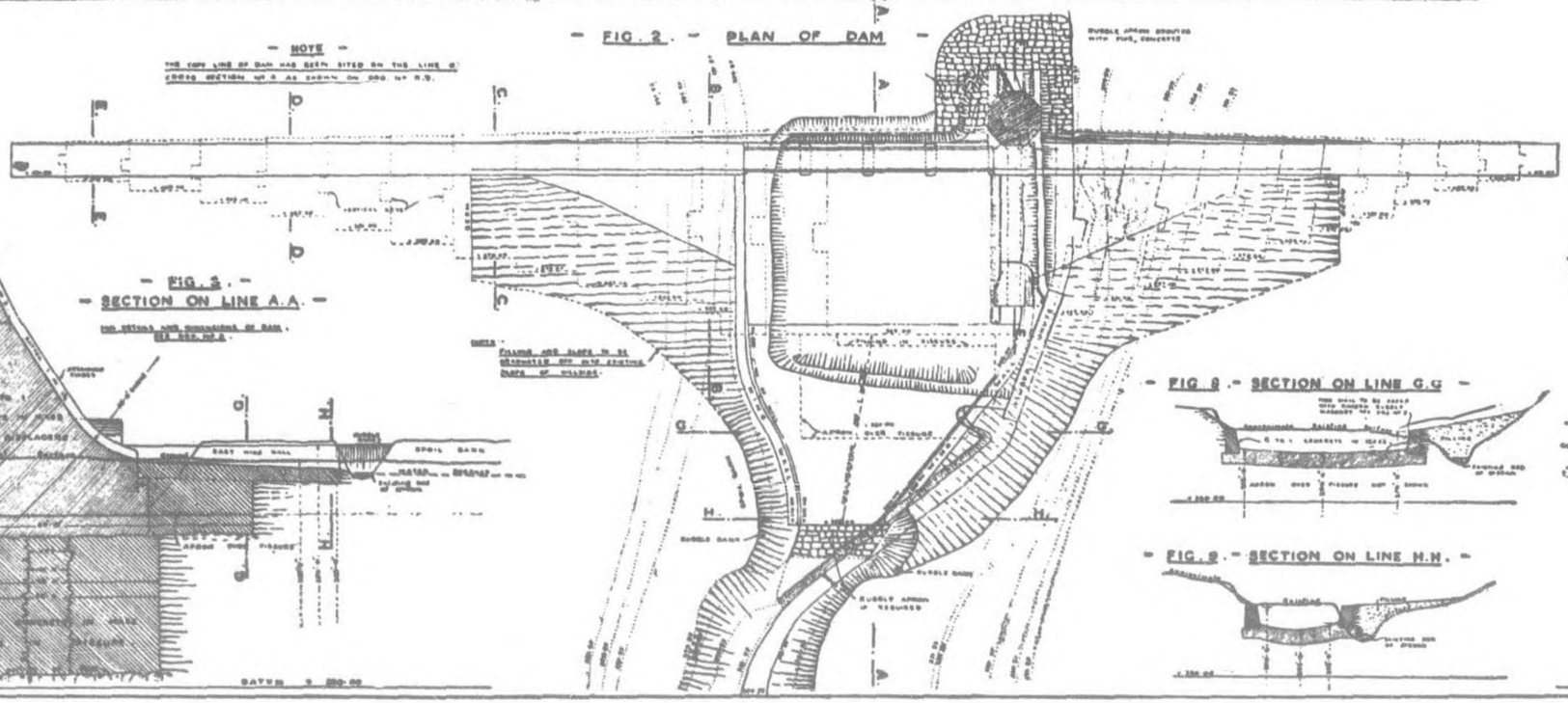
- F.M.S.R. - PRAI WATER SUPPLY . - GENERAL ARRANGEMENT OF DAM - DRAWING No 1 .

- CON: PLAN No 3526. -

- FIG. 1. -
ELEVATION OF DAM, LOOKING UPSTREAM .

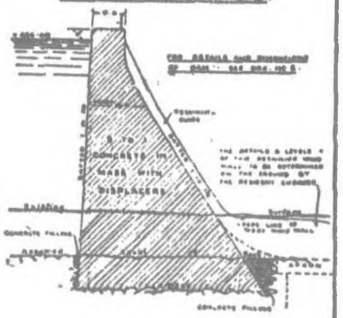


- FIG. 2. - PLAN OF DAM -

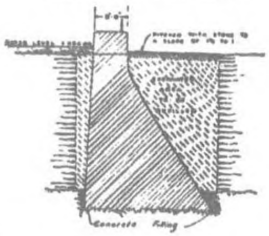


- FIG. 3. -
- SECTION ON LINE A.A. -

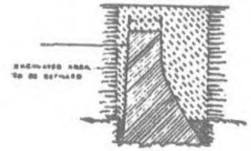
- FIG. 4. -
SECTION ON LINE B.B.



- FIG. 5. -
SECTION ON LINE C.C.



- FIG. 6. -
SECTION ON LINE D.D.



- FIG. 7. -
SECTION ON LINE E.E.

- FIG. 8. - SECTION ON LINE G.G. -

- FIG. 9. - SECTION ON LINE H.H. -

Another factor in determining the capacity of the reservoir was the foundation of the dam on the western side, where the solid rock only rises to about R. L. 424—the level now fixed for the spillway.

The surface area of the reservoir when full will be eleven acres.

The site is situated below the junction of two small streams and between two fairly steep spurs. Below this sites the valley falls very quickly.

The dam is of the gravity type and is to be constructed in cement concrete to the section shown on plan.

The maximum height from toe to spillway level at any section will be about 80-ft., and the maximum available depth of water when reservoir is full will be 55-ft.

The total crest length will be about 450-ft., including a spillway 60-ft. wide. The coping of spillway is 424-ft. above rail level at Prai station.

The calculated maximum pressure on upstream toe when reservoir is empty is 4.99 tons per square foot.

With the reservoir full and overflowing to a depth of one foot over spillway the maximum pressure on down stream toe becomes 5.40 tons per square foot.

The weight of the concrete for these calculations has been taken at 150-lbs. per cubic foot. The concrete specified is a 1 to 5 mix with granite displacers.

The lines of resultant pressures are within the middle third as indicated on the section.

The foundation of the dam is granite, but unfortunately a large fissure about 30 to 40-ft. wide extends across the site and runs approximately parallel to the general direction of the valley. A trial shaft bottomed on rock at about 70-ft. below the surface. The fissure is now being excavated and has reached a depth of about 50-ft. below the original surface. The material filling the fissure is decomposed granite. The government geologist has examined the site. He reports that this extent of softening is not unusual and considers that the decomposition is due to an absence of clay cover and to the chief joints in the granite being parallel to the valley.

A concrete apron over fissure is to be provided on downstream side of dam and will extend far enough away to minimise the risk of erosion at the toe.

A footway 6-ft. wide is to be constructed across the dam with a reinforced concrete gantry over the spillway.

The draw-off tower is to be built of concrete with cast iron lining, and fitted with four 10-in. dia. intake valves at different levels, and a 24-in. sluice valve. A grating and 40-in. flap valve will admit the water to sluice valve. A tunnel through the dam will carry the 10-in. supply main through dam from draw-off pipe. It will also carry the waste water from sluice.

A valve house of dressed granite ashlar with necessary fittings is to be built on top of draw-off tower.

Pipe Line

A 10-in. dia. cast iron main will convey the water from the reservoir to an elevated storage tank at Prai, a distance of 10½ miles, and is calculated to deliver 38,000 gallons per hour or 916,000 gallons per day.

The discharge has been calculated by Kutter's formula with a co-efficient of roughness of .013.

Direct from the 10-in. supply main—at foot of storage tank—a 7-in. cast iron service main leads to the outer end of jetty and is to be fitted with the necessary valves, hydrants, etc. At the outer end of jetty a Glenfield and Kennedy water tower with radial arm is to be fixed for the rapid filling of the water boats.

Service mains are also to be laid for railway and other requirements.

The arrangements of valves at the storage tank will permit of the supply for the 7-in. jetty main being drawn therefrom—whenever required—instead of direct from the 10-in. supply main.

The discharge rates of 7-in. service main at outer end of jetty will be:

(1) Drawing direct from 10-in. main—30,000 gallons per hour =130 tons per hour.

(2) Drawing from storage tank—17,000 gallons per hour=76 tons per hour.

The maximum head on the pipes will be 420-ft. The pipes are of the spigot and socket type with lead joints. They are tested to a pressure of 800-ft. head and receive a coating of Angus Smith composition.

Storage Tank at Prai

The elevated storage tank proposed is to consist of three cast iron tanks capable of being used singly, in pairs, or altogether. The total capacity of the tanks will be 110,000 gallons.

They are to be supported on reinforced concrete columns 50-ft. high. The foundations are to be piled.

Supply of Water to Shipping

Appendix No. 2 gives particulars of the supply of water to shipping at port of Penang. These particulars were obtained from the manager, Penang harbour board, by the chief superintendent engineer.

Construction

Transport.—The site of the reservoir is about four miles from the nearest railway station—Bukit Mertajam—and a fleet of motor lorries provides transport from the railway to foot of approach to site.

Owing to the steepness of the approach to the reservoir site, it has been necessary to provide inclines worked with winding engines. Two double track inclines have been constructed with a winding engine at top of each.

The first incline is 1,100 feet long and rises 200-ft. and the second one is 700-ft. long and rises 165-ft.

A petrol locomotive has been provided for the haulage of materials from top of inclines to the dam site, a distance of about ¾ mile. A second loco of the same type will provide haulage power from the quarry site.

Quarry

A granite quarry is being opened up about half a mile from the dam site. A complete plant, consisting of an Ingersoll-Rand compressor of 528 c.ft. per minute capacity, a Leyner drill sharpener, rock drills, crushers and crane has been obtained. An ample supply of small and large stone is expected from this quarry.

Concrete Plant

Two concrete mixers of 1 c.yd. capacity each will supply the concrete, and two cranes have been provided for work at dam.

It is proposed to build a trestle on downstream side of dam to carry the cranes that will lower the concrete into place, with exception of that required for fissure.

The latter concrete will be mixed by machine alongside of fissure and lowered directly into place from there.

Workshops

The necessary workshops are now being erected. The carpenters' shop will be equipped with saws, planing machines, etc., to deal with the shuttering.

Water Supply

A small gravity supply provides for all construction requirements.

Materials

Stone is obtained from the quarry.

Sand is not obtainable locally in any quantity, and practically all of it will be sea sand brought by tongkangs to Prai and from there delivered by rail to Bukit Mertajam.

Cement is being obtained through the crown agents and is again tested locally by the consulting engineers.

Labor

Most of the labor employed on the works is Chinese. For some special portions of the work other nationalities are employed. The health of the labor force has been causing some anxiety owing to prevalence of malaria, and is receiving special attention.

Estimate

The estimated cost of the works is $2,186,900.

Design, Etc.

The works are being constructed for the F.M.S. railway administration, and are being carried out departmentally by the construction department under the chief resident engineer.

Messrs. Coode, Matthews, Fitzmaurice and Wilson, consulting engineers, designed the works which are being supervised locally by their chief superintendent engineer.

The original location and survey of the reservoir site was made by Mr. H. S. Smail, irrigation engineer, of the P. W. D.

The pipe line was located and surveyed by Mr. John Leggate of the construction department.

Mr. A. T. O'Kelly was in charge of the works until July last, when the author took charge.

In conclusion the author expresses his thanks to Mr. James Brown, chief superintendent engineer of Messrs. Coode, Matthews, Fitzmaurice and Wilson, for the assistance he has given—which includes most of the figures given in this paper.

Also to the Chief Resident Engineer, Mr. F. D. B. Openshaw, for permission to read this paper, for placing departmental papers and records at author's service, and for his assistance in other directions.

Appendix

Institute for Medical Research,

Kuala Lumpur, F.M.S.,

14th April, 1919.

Examination of a sample of water from Bukit Serayah—proposed supply for Prai—received on 1.4.1919.

The sample was contained in two Winchester quart glass bottles labelled "Sample from stream just above site of proposed dam at Bukit Serayah, and about one mile below source, Bukit Mertajam hills. Collected 27.3.1919."

RESULTS OF CHEMICAL AND PHYSICAL EXAMINATION.

Colour—very slightly brownish.
Turbidity—slightly turbid.
Other suspended matter—a little brown.
Reaction—very slightly alkaline.

	parts per 100,000
Free ammonia	0.0012
Albuminoid ammonia	0.0064
Oxygen absorbed in 3 hrs.	0.0490
Chlorine ...	0.20
Nitrates—slight trace.	
Nitrites—nil.	
Total solids	6.05
Hardness, permanent	1.95
"Temporary"—nil.	

REMARKS.—The water is one of considerable organic purity and the analysis does not disclose any reason why the water should not be suitable for domestic use.

The very low total solids should render the water suitable for industrial use.

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