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GROUNDWATER INVESTIGATION ON MIRIVASE ISLAND GULF DISTRICT, PAPUA.

by

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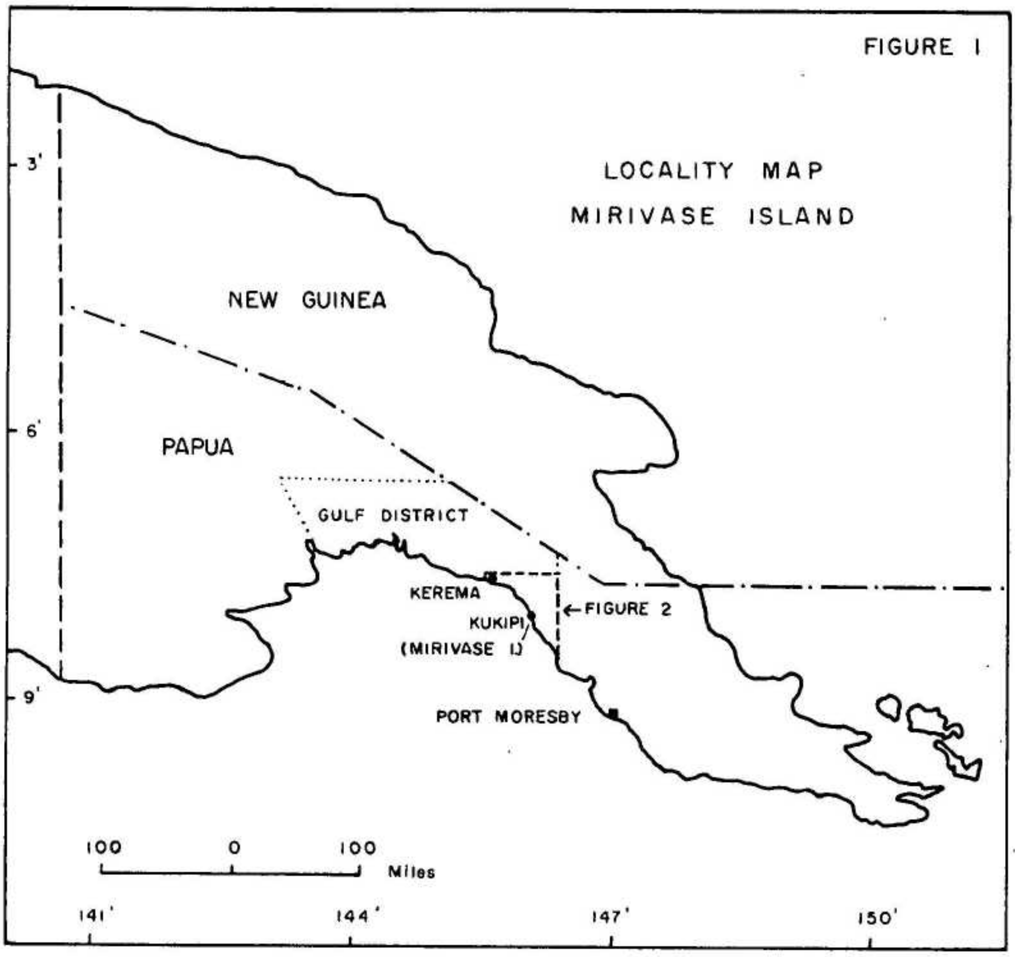
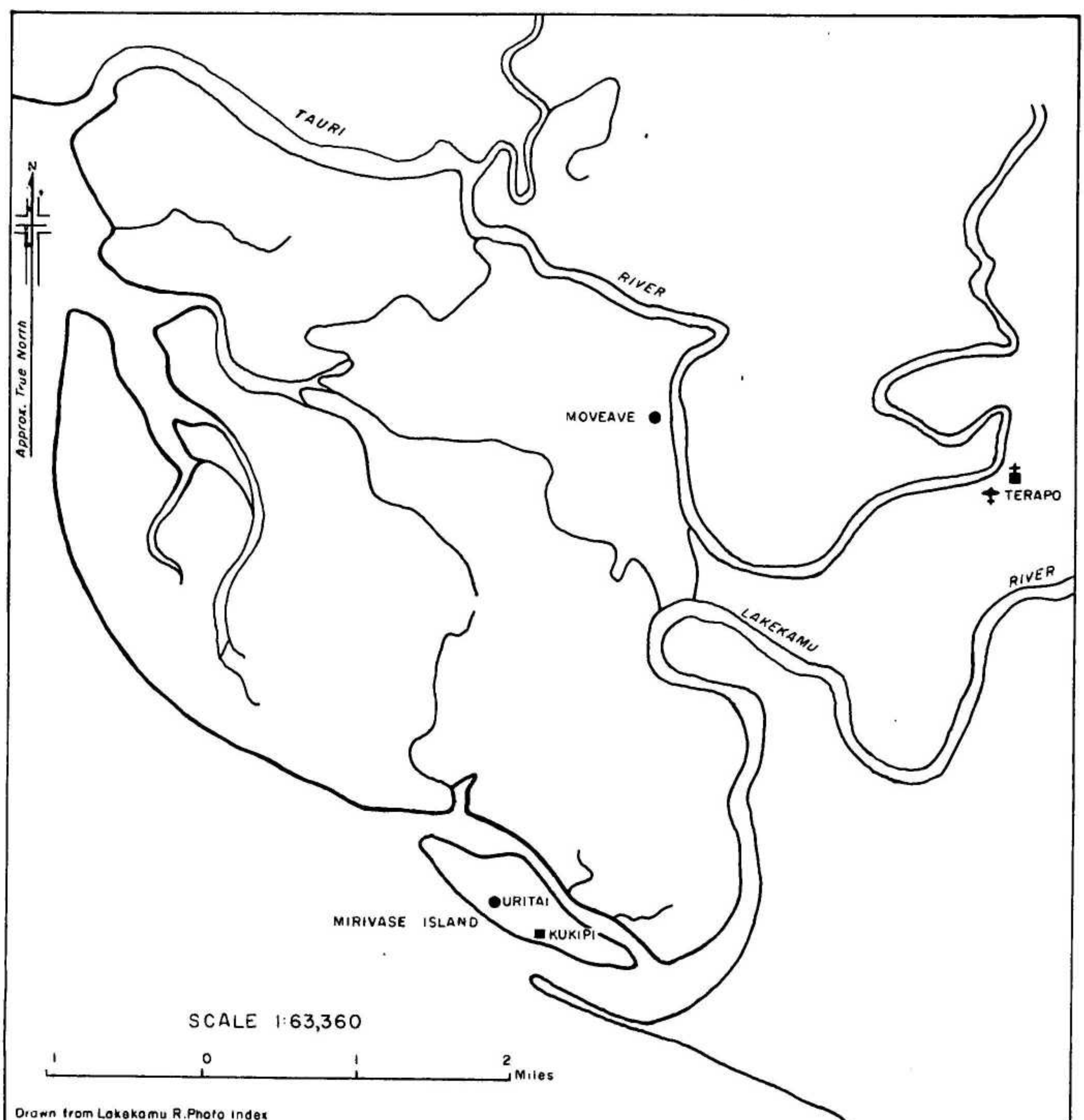


REFERENCE

- ● Native Village
- ■ Patrol Post
- Mission
- Airstrip



GROUNDWATER INVESTIGATION ON MIRIVASE ISLAND GULF DISTRICT, PAPUA

SUMMARY

A hydrological investigation carried out on the sandy island of Mirivase has shown that there is an abundant supply of groundwater on the island. The depth of fresh water probably exceeds 120 feet near the centre of the island and the water table is within four feet of the surface of the ground. The alluvial sand on the island is unconsolidated, very porous and permeable.

An attempt was made to bore a hole with a Banka drill and to drive a spear point into the ground. Drilling operations with the Banka drill were unsuccessful because of continuous caving of the sand, and the spear point yielded on pumping, about one gallon of water per minute. A spear point with a carefully selected mesh size might increase this yield to about three to five gallons per minute. A series of driven wells, properly spaced, and connected to a common pump, would in terms of cost, efficiency and simplicity, be the best method of tapping the underground water on the island.

INTRODUCTION

For sanitary reasons, and as a precautionary measure against the possible spread of endemic diseases from West Irian, the Department of Public Health has undertaken to supply the coastal villages of Papua with groundwater. Up to now, river water has been the main source of water supply to the coastal population.

The staff of the geological office of Port Moresby was requested to investigate the hydrology of the coastal lowlands of Papua and to devise an inexpensive and simple method of getting a groundwater supply. A Banka drill and a spear point meet these requirements. Mirivase Island was selected to carry out an experimental programme as terrain conditions on the island are fairly typical of the coastal lowlands of western Papua.

Mirivase Island is in the Gulf District, about 120 miles north-west of Port Moresby, and is situated in the mouth of Lakekamu River (Figure 1). Kerema, the Gulf District Headquarters, lies about 26 miles north-west of Mirivase Island and Kukipi is the patrol station on the island. Uritai village is situated on the island about half a mile north-west of Kukipi.

Three times a week, a Cessna plane flies from Port Moresby to Terapo mission which is situated on the mainland, on the left bank of the Tauri River, and is three aerial miles from Kukipi. A small boat carries passengers and cargo from Terapo to Kukipi via a narrow channel that links the Tauri River to the Lakekamu River. Kukipi can also be reached once a week by coastal vessels which operate from Port Moresby.

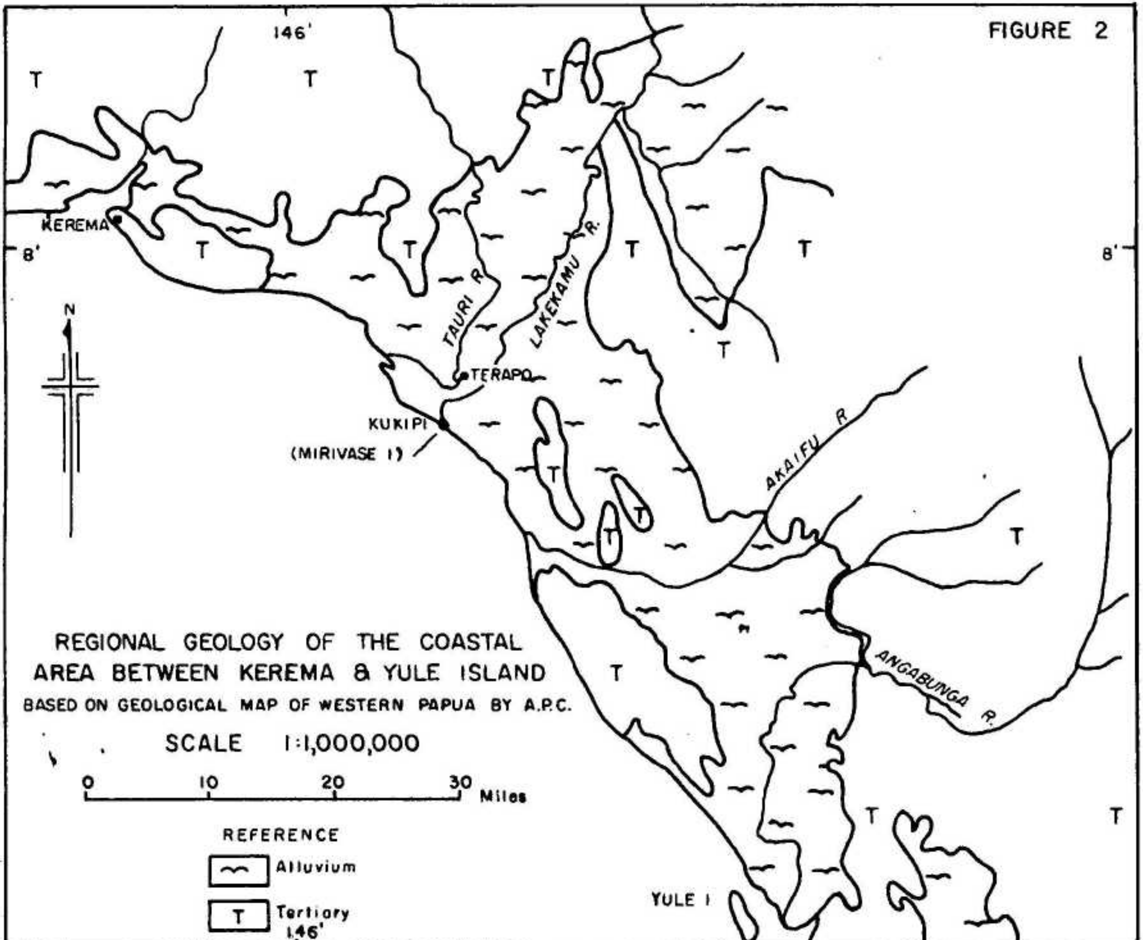
The climate, which is hot and humid, is typical of the coastal lowlands of Papua. The annual rainfall at Kukipi is 40 inches and falls mainly during the north-west monsoonal season.

PHYSIOGRAPHY AND REGIONAL GEOLOGY

The country around Kukipi is low-lying and is flat and swampy in parts. The largest rivers draining the area are the Lakekamu and Tauri Rivers. They rise over widely separated parts of the Owen Stanley Range; as a result the two rivers often flood at different times. Near the coast, the Lakekamu and Tauri rivers flow close to one another and are connected by many water channels. The flow of water in the channels is controlled by the tides and by the difference in the water levels between the two rivers.

The coastal lowlands and Mirivase Island consist of alluvial sands which were deposited by the Lakekamu and Tauri rivers, (see Figure 2). The thickness of the

FIGURE 2



REGIONAL GEOLOGY OF THE COASTAL AREA BETWEEN KEREMA & YULE ISLAND

BASED ON GEOLOGICAL MAP OF WESTERN PAPUA BY A.P.C.

Bureau of Mineral Resources, Geology and Geophysics. *To accompany Record 1965/147.* P/A86 alluvial cover is unknown, but at Terapo the Tauri river bed is littered with large boulders of coral limestone which are probably in place. If this assumption is correct, the thickness of alluvium at Terapo is about 20 feet.

Folded sediments of upper Miocene and Pliocene age crop out as low hills north-east and west of the combined alluvial flats of the Lakekamu and Tauri Rivers. The Tertiary sediments strike north-west.

MIRIVASE ISLAND

TOPOGRAPHY AND GEOLOGY

Mirivase Island is a delta of the Lakekamu River (Figure 1). It is roughly elliptical in shape and is $1\frac{1}{2}$ miles long and about $\frac{1}{4}$ mile wide across its widest part. The longest axis of the island trends north-west. The island is separated from the mainland, on the north side, by a narrow channel, and on the south-east side, the island is partially surrounded by a narrow sand pit.

Mirivase Island consists of unconsolidated alluvium; the material is a fine-grained greywacke sand. A sieve analysis was carried out on sand samples collected at Uritai from a depth ranging from eight feet to ten feet and about 80% by weight of the particles were smaller than 251 microns. (see Appendix 1).

HYDROLOGICAL INVESTIGATION

The sandy island of Mirivase presents similar hydrological problems to sand dunes on the littoral where it is essential to determine the relationship between the fresh water table and sea water. The equilibrium between sea water and fresh water is determined by their difference in density which is about 1/31, where the density of fresh water is taken as unity. Sea water is denser than fresh water. The sea water and the fresh water are, so to speak, in isostatic equilibrium whereby the less the mean specific gravity of a column of water, the higher it will stand. When fresh water and sea water are in equilibrium, fresh water will stand above sea level by a height equal to 1/31st of the depth of fresh water below sea level. Thus, for every foot of fresh water standing above sea level there is 31 feet of fresh water below sea level. On a sandy island, the rain water absorbed by the terrain must eventually flow towards the sea and therefore the lower and upper surfaces of the water table are inclined towards the shores. The resulting shape of the fresh water table standing above sea water is that of a doubly convex lens.

Figure 3 illustrates the relationship between the fresh water table, which is fed by rainfall, and the salt water table related to the sea for a permeable sandy island like Mirivase Island.

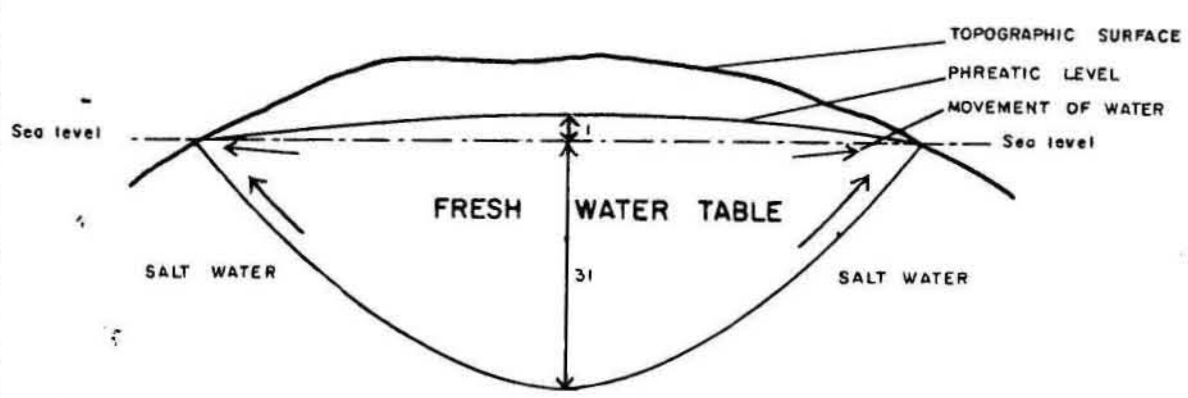


Fig. 3: Schematic representation of fresh water : sea water relationship on a sandy Island.

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A bore site was selected in Uritai village by the medical officer and a topographic survey, using tape, abney level and staff, was carried out from the bore site to the sea shore to determine the height above sea level of the collar of the hole. The height of the collar of the hole was found to be eight feet six inches below ground surface. Thus, the water table was standing four feet above sea level. above sea level, and the water table at the bore site was four feet six inches. Applying the 1/31 relationship, the depth of the fresh water table is about 120 feet at the bore site. In this elementary calculation, the possibility of diffusion reducing the depth of fresh water is ignored. It is also assumed that the water-bearing strata are uniform throughout; this may not be so. On the other hand the salinity of the sea near Mirivase Island is considerably diluted by the inflow of fresh water from the Lakekamu River. This dilution introduces a change in the 1/31 relationship by increasing the denominator of the fraction. It is therefore possible that the thickness of the fresh water lens exceeds 120 feet.

Drilling Operations - The Banka Drill

The Banka drill was devised in Malaya where it is commonly used to sample alluvial tin deposits. The drill is entirely hand operated, and is reported to be capable of operating down to 100 feet depth in fine alluvial deposits. For these reasons and in view of the low cost of the equipment (believed to be about £84), the Banka drill was chosen to bore an experimental hole at Uritai village.

Component parts of the drill

The three main component parts of the Banka drill are:-

1. The drilling tools
2. The casing
3. The platform

1. The drilling tools consist of a handle, detachable drilling rod sections and a sand pump which incorporates a biting shoe. In that order, these items are assembled to constitute the drilling components of the Banka drill.

The handle is T-shaped and is made by welding two steel pipes at right angles to one another. The drilling rods are cylindrical metal tubes 5 to 10 feet long and $1\frac{1}{4}$ inches in diameter. The sand pump is a metallic barrel five feet nine inches long, with perforations on the side near one end of the barrel; the other end of the barrel is fitted with a cutting shoe in which is inserted a clack valve. The drilling tools are assembled with couplings which have tapered male threaded pins and corresponding female threaded box.

2. The casing consists of five-foot-long sections of four-inch diameter pipe made of galvanized iron. For this investigation, one length of casing was modified into a screen by perforating the side of the casing with circular holes about a half inch in diameter which were covered with fine metallic gauze. The casing pipes are assembled with threaded sockets.

3. The platform is four feet square and is made of wood one inch thick. It has a hole in the centre so that it can slide over the casing. The platform is supported on the casing by pipe clamps of sturdy construction. The two sets of pipe clamps are fitted at right angles immediately below the collar of the casing. Photographs of the Banka drill and components appear in Appendix 2.

Setting up and operating the drill

The bore hole is first started with a hand auger. The first length of casing (the one with the perforations) is lowered into the hole and is joined to a length of casing. Great care must be taken to ensure that the casing stands vertically in the hole. The pipe clamps are then fastened to the collar of the second length of casing and the platform is fitted over the pipe clamps. Two operators climb on the platform and the drilling tools are lowered into the casing. The drill is then ready to operate.

The two operators standing on the platform grasp the handle firmly and jerk the drilling tools up and down and at the same time rotate them. As the material is collected in the sand pump, the hole deepens and the casing settles under its own weight and that of the operators. If necessary, more men can stand on the platform to push the casing down the hole. This can also be achieved by rotating the platform with its load of men. After a while, the sand pump becomes filled with sand and the drilling tools must be pulled out of the casing and disconnected to empty the sand pump. The operation is repeated with the successive addition of drilling rods and casing length until the required depth is reached.

Drilling results

The bore hole at Uritai village was intended to be 25 feet deep. Drilling operations went successfully down to 15 feet. A pumping test made at this depth yielded little water. Beyond 15 feet, it was increasingly difficult to cope with sand rising into the casing. An attempt was made to hand-pump the sand out of the hole, but the pump continually discharged a slurry of sand and water; the sand was coming in as fast as it was pumped out. It was found that the gauze on the screen did not did not stand pressures caused by the impact of the drilling rods during drilling operations. Three trials were made with the Banka drill on different sites and all presented the same difficulty of rising sand.

Driving a Spear Point

As the Banka drilling operations were unsuccessful, a spear point, two inches in diameter*, was driven into the ground near the first site; it penetrated to a depth of 18 feet 6 inches. The spear point was connected to three-foot sections of galvanized iron pipes of two inch diameter and one length of piping was fitted with a driving cap. A sledge hammer was used to drive the pipes and the spear point into the ground. Additional lengths of pipes were joined with threaded sockets as the driving depth increased.

During driving operations it was found that the galvanized iron pipe to which was fitted the driving cap did not withstand the blows of the hammer: after a while the pipe bent and bulged out near the point of impact and eventually the pipe had to be rejected. This, in fact, determined the penetration of the spear point. A steel pipe would probably overcome this weakness. A pumping test carried out with a hand-pump yielded about one gallon of water per minute with the spear point eighteen feet six inches below the surface of the ground.

The hand-pump used is a "Dia" pump, which is made in Japan and costs £10. It has a 38 mm (1.55 inches) diameter. Suction pipe, a suction head of 9 metres (29.5 feet), and a capacity of 3.5 cubic metres (124 cubic feet) per hour. It weighs 29 kilogrammes (64 lbs).

Unfortunately, the driven well was not surged for lack of suitable equipment.

CONCLUSIONS

On Mirivase Island, the Banka drill proved inadequate to sink bores because of sand caving, but the drill should perform well in more compacted sediments. It has the advantage of being inexpensive and easy to operate.

Driven wells should be used on Mirivase Island, but the screen for the well points would have to be carefully selected. A driven well with a suitable screen should yield three to five gallons of water per minute, and a series of well points, properly spaced so that there is no interference between cones of depletion, would increase the yield considerably.

* Details of the spear point used are not available in Port Moresby

APPENDIX 1

Results of sieve analysis of sand samples collected at Uritai.

Assay No.	B.S.S. scale	Micron	Weight%
2793	+ 36	422	3.3
	+ 60	251	17.8
	+ 100	152	49.4
	+ 150	104	17.8
	+ 200	76	4.9
	- 200	76	6.8
			100%

Analyst: J. Wise, Assayer, Department of Lands, Surveys & Mines, Port Moresby.

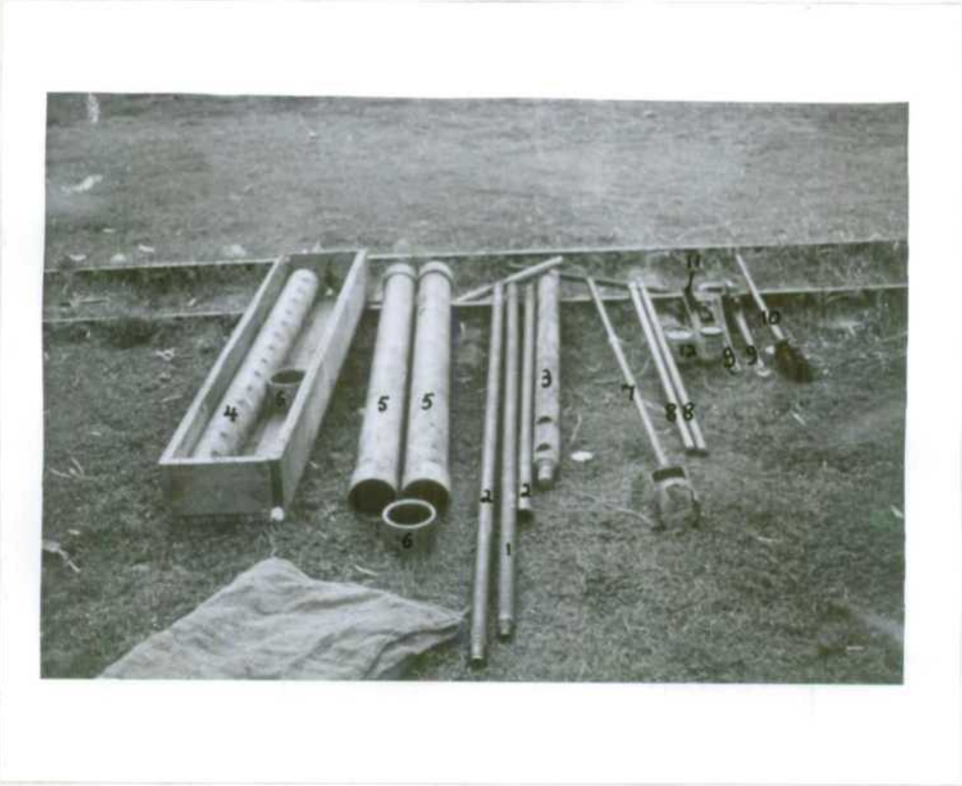
APPENDIX 2

Photographs of the Banka drill.

A. Component parts.

1. Drilling rod handle
2. Drilling rod extension
3. Sand-pump
4. Perforated casing (screen)
5. Casing pipes
6. Casing couplings
7. Hand auger
8. Hand auger rod extension
9. Adjustable spanners
10. Chain tongue
11. Scrubbing brush
12. Grease pot.

B. The drill in operation.



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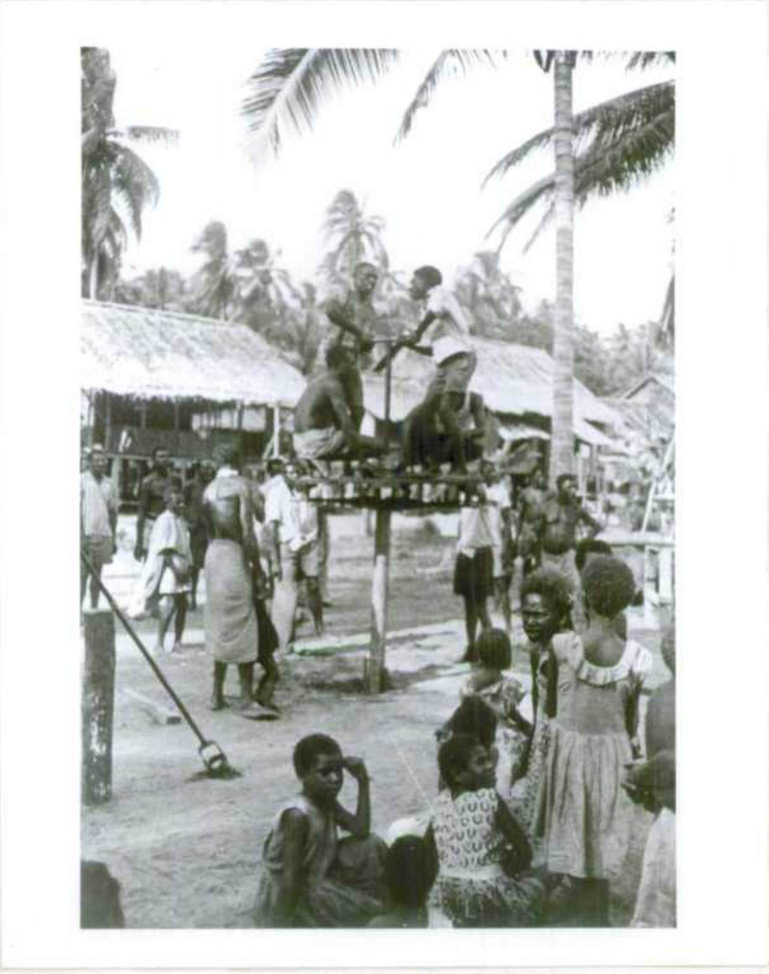

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