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Author(s): Robert I. Money

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## THE HINDIYA BARRAGE, MESOPOTAMIA

Robert I. Money, M.I.C.E.

*[The information in this note supplements and in part corrects the note on the Hindiya Barrage published in 'G.J.,' April 1914, 43, 415; in particular the plan on page 417 of that note is superseded by the plan here published.—ED. 'G.J.']*

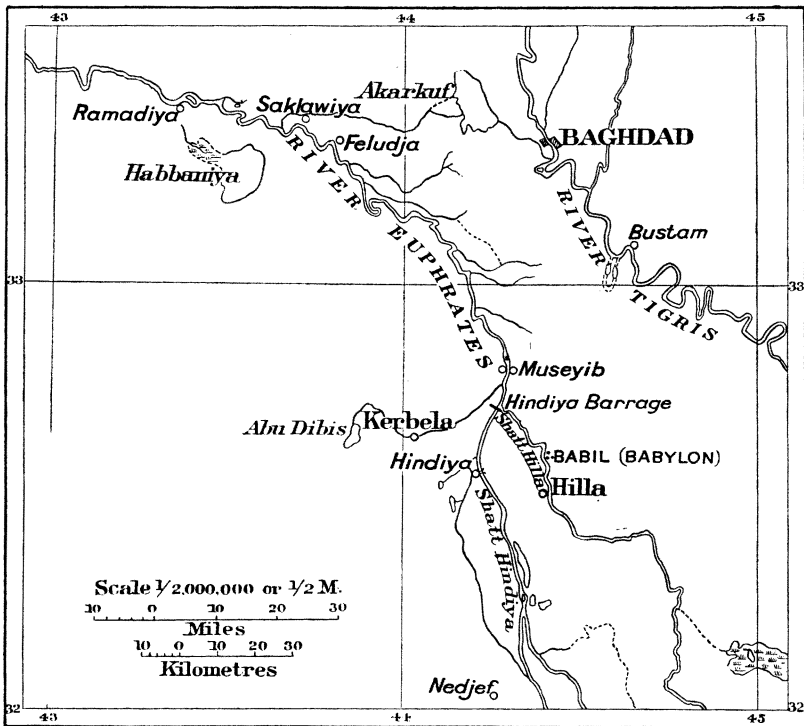
THE annual rainfall at Baghdad over a period of sixteen years gives a maximum of 22·31 inches, a minimum of 1·47 inches, and an average of 6·3 inches. Cultivation is therefore dependent on irrigation. The Euphrates, fed by the melting of the snows on the Taurus, is in flood from March until May, and at Hit has a maximum discharge of 3600 and a minimum of 390 cubic metres per second. The channel of the Euphrates is incapable of containing such a volume, and extensive floods are the result, which reach as far as Baghdad. A strong earthen dam has therefore been built all round this town to protect it from the floods of the Euphrates and also of the Tigris.

A short distance above Feludja on the Euphrates the Saklawiya Canal, constructed in ancient days, leads off and joins the Tigris just below Baghdad. This canal was navigable for steamboats up to about the year 1875, when Midhat Pasha, the Vali of Baghdad, closed the head. It now carries water only during the flood season. The result of the Pasha's action was that a large volume of water, some 750 cubic metres a second, was added to the already overburdened Euphrates channel, and caused immense damage to the country downstream of Feludja.

A day's journey to the south of Baghdad lies the town of Museyib, and four miles south of this town the River Euphrates divides into two, the western arm being known as the Hindiya branch, and the eastern arm as the Hilla branch. The Hindiya branch is said to be the original bed of the Euphrates, and the Hilla branch which flows through Babylon an artificial deviation. Some confusion in the nomenclature exists, for in the time of Alexander the western arm was known as the Pallacopas, and the eastern arm as the Euphrates. The Arabian geographers however reversed this, describing the Euphrates as the western arm flowing to Hindiya and Kufa, while the branch flowing through Babylon and Hilla and Diwaniya was known as the Sura. Western geographers have generally followed the Greek use, and so in modern atlases the river of Babylon or eastern branch is called the Euphrates. On the 1/M. map the two branches are named the Shatt Hilla and the Shatt Hindiya.

The Euphrates flowing past Babylon and Hilla lies at a higher level than the Hindiya branch, and as it was incapable of carrying the extra supply due to the closing of the Saklawiya Canal, the water forced its way down the lower-lying Hindiya branch, swept away the old earth

dams which were built to raise the water-level and so force it into the Hilla branch, scoured out the bed and permanently lowered the water-level at the point where the two rivers branched off. The Hilla branch immediately began to silt up, and as the Hindiya branch provided a straighter and easier course, more and more water continued to pass down it, threatening in the course of time to leave the former dry and to place out of cultivation the large area of land dependent on that river for its irrigation. To remedy this state of affairs the Turkish Government threw a dam across the river at Hindiya, constructed of loose rubble, with a



twenty-metre opening in the middle. As the silting up of the Hilla branch proceeded, more and more water flowed down the Hindiya branch, calling for a modification of the dam to meet the altered conditions. Nothing was done, and it was being gradually swept away, when in 1908 the Turkish Government invited tenders for the construction of a masonry barrage. In the flood of 1909 the Hilla branch was passing 300 and the Hindiya branch 2500 cubic metres per second, while a year later the former, which fifty years previously had discharged 2000, was only passing 150 cubic metres a second.

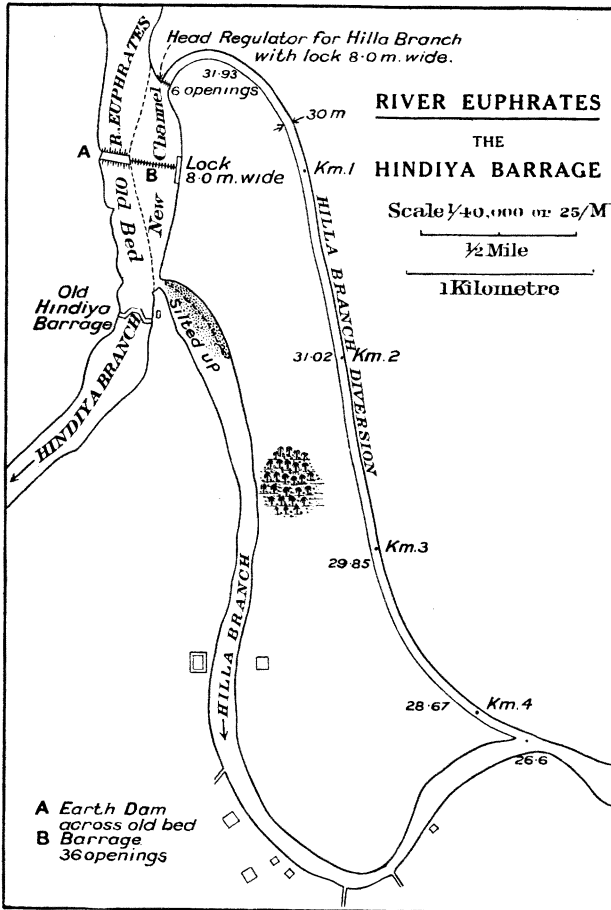
The design of the new barrage, prepared by a French engineer, proposed a structure of reinforced concrete, a bold experiment in such a

climate, where the rapid evaporation and scarcity of experienced labour made difficulties not at that time overcome. The Turkish authorities tried to avoid this difficulty by making the contractor responsible for the design, and stipulating that the work should be maintained for seven years after the date of completion; if it should fail at any time during this period the contractor was not only to forfeit his retention money, but was to repay the Turkish Government all money received from them in payment of work done. The tender was thrown open to the whole world, but no offers were forthcoming. About this time the Sultan Abdul Hamid was deposed, and with the advent of the Young Turk party to power a big programme of Public Works for the development of the country was drawn up. In the forefront of irrigation was that of Mesopotamia, and Sir William Willcocks, who some years previously had visited the country and prepared a scheme in outline, was engaged to make a thorough investigation of the whole question. With a large staff of engineers from Egypt and elsewhere he spent two years surveying a very large area of Mesopotamia, and adding many details to the existing map, besides collecting interesting geographical information. (See his papers in the *Geographical Journal*, vol. 35, p. 1; vol. 40, p. 129; and also Capt. Lyons, vol. 40, p. 501.)

Some escape had to be found for the flood waters of the Euphrates, and not only for those which used to flow down the Saklawiya before it was closed by Midhat Pasha. This was the cause of much anxious thought, until Sir William Willcocks' surveys revealed the existence of two big depressions—Lake Habbaniya, some 20 km. to the south-east of Ramadiya, and another terminating in Lake Abu Dibis, 75 km. still further to the south-east. The Habbaniya depression covers an area of 146 square kms. within the contour 40 metres, while that of Abu Dibis covers some 1200 square kms. within the contour 25 metres. These two together have a sufficient capacity to receive the whole of the excess flood waters of the Euphrates, while the Abu Dibis depression as a possible reservoir in the future is of great potential value. Its capacity below the contour 26 metres is estimated by Sir William Willcocks at 4,000,000,000 cubic metres, with an annual evaporation of 3,000,000,000. During the survey a thick belt of Euphrates River shells was discovered at the level of 25 metres in this Abu Dibis depression, showing that in ancient times it had received the overflow from the Euphrates.

Meanwhile the silting up of the bed of the Hilla branch rapidly proceeded; the town of Hilla saw that in a short time it would be left high and dry, and extensive areas of land had already gone out of cultivation. To remedy this state of affairs, the Turkish Government ordered Sir William Willcocks to proceed with the new barrage at the head of the Hindiya branch, and a new entrance with regulating works to force water down the channel past Hilla. This work he commenced, and at a later date the Turkish Government entered into a contract with Sir J. Jackson,

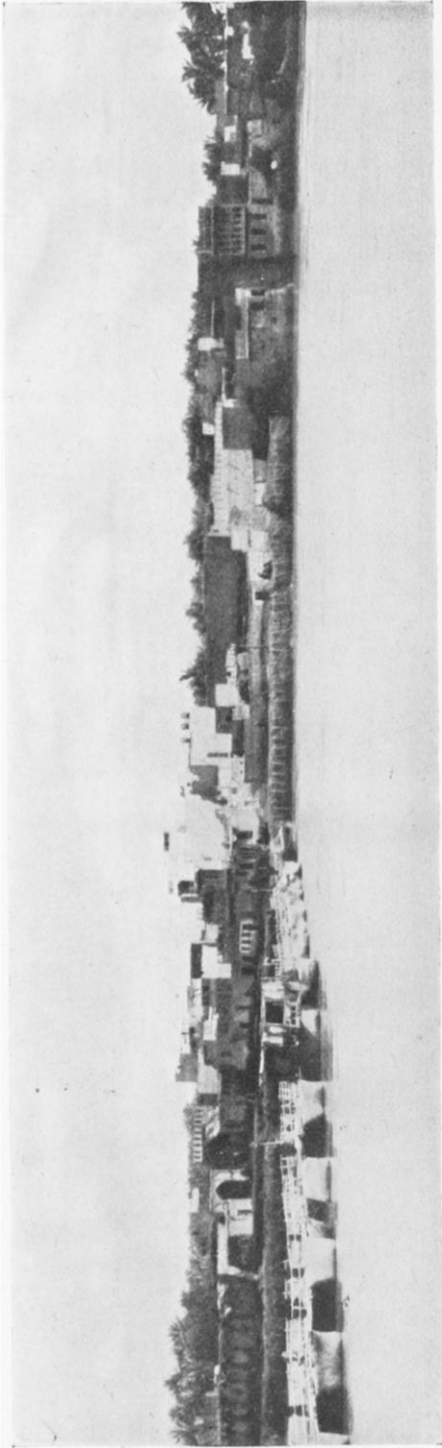
Ltd., of London to complete it. The volume of water flowing in the channel of the river at the proposed site of the work would not allow of the method of construction adopted in Egypt, where the river was diverted to one half while the new work was constructed in the other half of the river-bed, and then sent through the completed part of the barrage while the remaining half was built. Therefore at Hindiya the plan was adopted of building the whole work in the dry to one side of the river, excavating



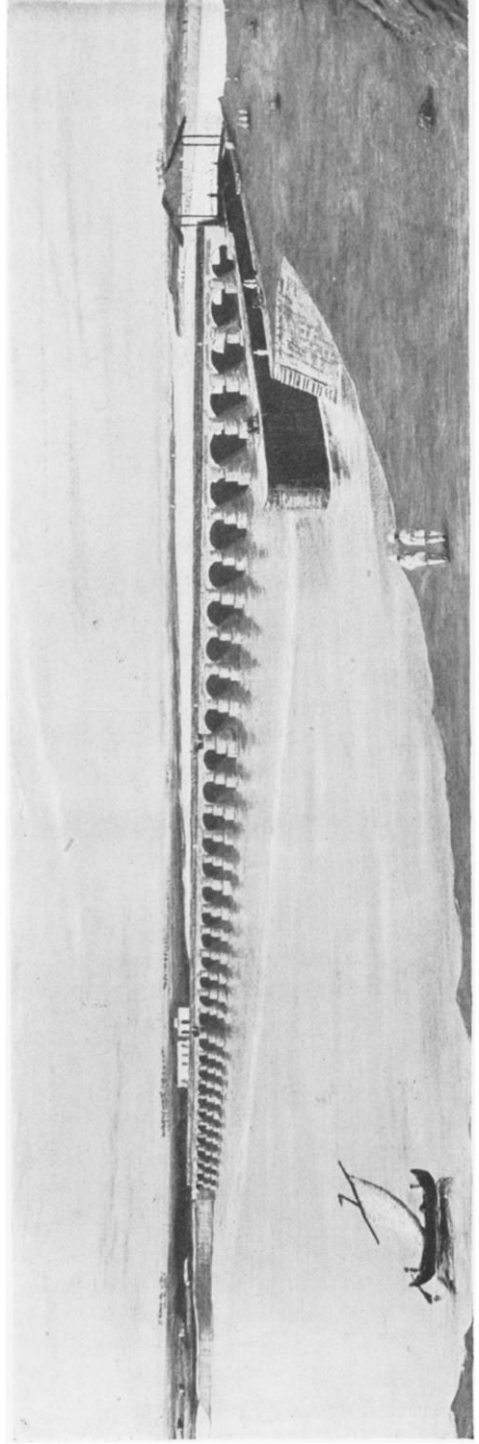
a new channel above and below the barrage, and when the work was completed, cutting the river-bank, diverting the water into the new channel and blocking the old course by building an earthen dam across it (see Fig. 3). Thus a very fine barrage 250 metres long, with thirty-six openings each 5 metres wide, fitted with regulating shutters, was finished shortly before war was declared, and was found uninjured on the British occupation of Baghdad. The barrage as constructed is provided with a double lock, and it was intended on completion of the work to have



REPAIRING BREACH IN OLD BARRAGE, HINDIYA



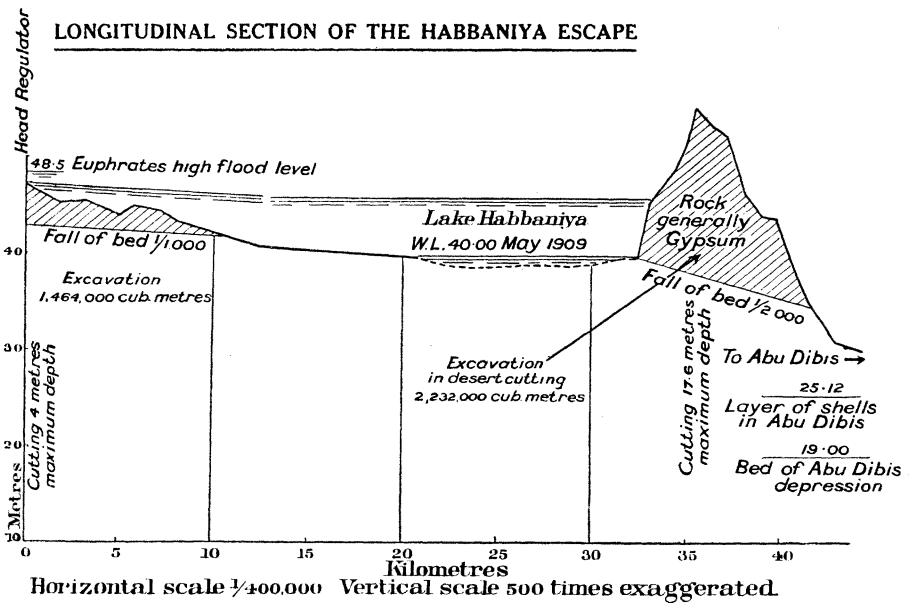
MUSEYIB TOWN AND BRIDGE OF BOATS, EUPHRATES



THE NEW HINDIYA BARRAGE. From sketch lent by Sir John Jackson & Co., Ltd., the Contractors for the work

removed the old barrage, when boats could have continued their journey up-stream. It had been the custom hitherto for goods to be unloaded below the barrage, transported overland and reloaded into other boats for their further passage up-stream. When, on completion of the new barrage, Sir John Jackson's engineers proposed to commence work on the removal of the old one, the Arabs objected, fearing that the new barrage might be unable to perform the duty assigned to it, and "besides," said they, "goods always have been unloaded at the barrage and transported overland, so why should they not continue to do so?" The old barrage has therefore not yet been removed.

The new Hindiya Barrage being constructed above the entrance to the Hilla branch, it became necessary to provide a new channel con-



necting the Euphrates above the barrage with the old channel. As this had silted up very considerably, the new cut was made 30 metres wide in the bed and 4 kilometres long, providing a straighter and more regular course, and being furnished with a regulator at its head. In addition, the river itself was cleaned out and straightened for a distance of some 50 kilometres to Hilla and beyond. The regulator consists of six openings 3 metres in width, fitted with sliding shutters similar to those in the Hindiya Barrage, and when closed will prevent the flood-waters of the Euphrates from passing down the channel. The delight of the inhabitants of Hilla was great when they saw water flowing past their town at a higher level than for many years previously.

The original design provided (1) for cutting a channel some 10 kilometres long and 50 metres wide, connecting the Euphrates at Ramadiya



with Lake Habbaniya, the level of whose bed is 39 metres above sea-level, and involving 1,500,000 cubic metres of excavation; (2) cutting through the ridge to the south-east of Lake Habbaniya and providing a channel some 25 metres in width to discharge the surplus flood-waters into the depression lying between Lakes Habbaniya and Abu Dibis, the level of the bed of the Lake being 19 metres above sea-level. This involves some 2,200,000 cubic metres of excavation.

Later investigations showed that the Lake Habbaniya depression might contain the whole of the excess flood-waters of the Euphrates, and it was proposed to leave in abeyance the work involved in (2) above.

There is therefore in Lake Abu Dibis depression a large storage reserve in case Lake Habbaniya should prove insufficient.

The following tabular statement gives the details :—

*Lake Habbaniya depression.*

Below 40 m.	...	...	...	146 sq. km.	...	164,500,000 cub. m.
,, 43 m.	...	...	...	257	,,	598,500,000 ,,
,, 46 m.	...	...	...	341	,,	1,477,500,000 ,,

The level of flood-water in the depression was in March 1909, 40'0 m., and in May 1910, 46'0 m.

Excavation for the Habbaniya escape was in progress until the war put a stop to all further operations. The latest calculations show that this depression has a sufficient capacity to contain all that is required for the excess waters of the Euphrates' flood. It is therefore proposed to make the Habbaniya Lake a reservoir as well as an escape, the water being fed back to the Euphrates during the low-water season by means of an outlet canal connecting the northern end of the lake with the Euphrates at a point some 40 kilometres below the head of the intake canal at Ramadiya. The proposed new cut connecting Lake Habbaniya with the Abu Dibis depression is not to be proceeded with, but in its place a high-level weir is to be substituted, which will come into operation in the event of abnormal floods.

Plans have been completed for a second barrage at Feludja, to provide perennial irrigation for the country between Feludja and Museyib on the Euphrates and Baghdad and Kut on the Tigris. Sir William Willcocks says that this will be the most effective irrigation work in the country. Presumably it will be the first to be undertaken by the future rulers of Mesopotamia.

## REVIEWS

### EUROPE

**The Passing of the Great Race; or, the Racial Basis of European History.—**

**Madison Grant.** London: G. Bell & Sons. 1917. *Maps.* 8s. 6d. *net.*

THE wrapper of this book states that in it "for the first time the definition of race and the manner in which characteristics are transmitted are clearly stated."