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Les irrigations en Egypte
Documents.

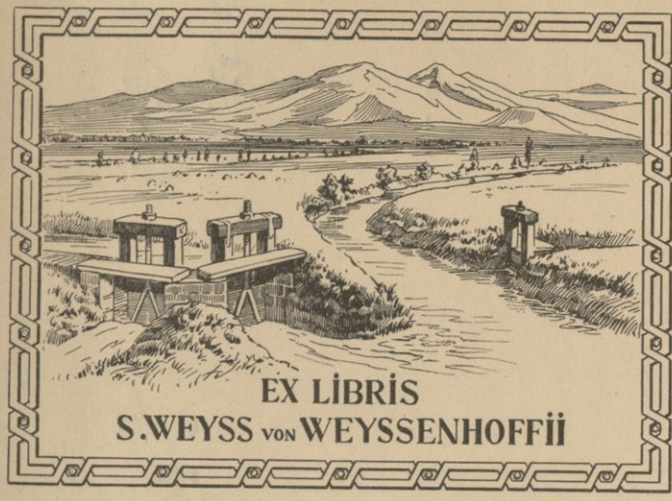
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1885



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J. de Weygandhoff

Les irrigations en Egypte.

Documents.

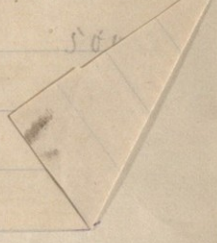
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Provinces	Ingenieurs en chef			Ingenieurs adjoints				Totaux
	1 ^{re} Classe	2 ^e Classe	3 ^e Classe	1 ^{re} Classe	2 ^e Classe	3 ^e Classe	4 ^e Classe	
	360	300	240	180	144	108	60 à 96	
1 ^{re} Inspection				1			2 = 96	372
Igaloubiab		1			3	1	1 = "	936
Charkieb		1		1	3	3	1 = "	1332
Dakablieb		1		2	2	2	2 = "	1356
Canal Ismaïlia	1			3		1	2 = "	1200
2 ^e Inspection				2	5	7	1 = 96	564
Menoufiab	1				5	2	(2=96)(=72)	1560
Igharbiab		1	1	2	4	4	3=96(=84)	2280
3 ^e Inspection				2			3=96(=72)	720
Behera Mahmoudia		1		2	4	4	.....	1668
Iziab			1		2	2	.....	744
Fayoum			1		1	3	.....	708
4 ^e Inspection				4	7	9	.....	288
Beny Snif			1		2	2	1=96, 1=60	900
Minieb			1	1	2	2	.....	924
Assiout	1			4	4	3	4=96, 1=60	2424
Igirgeh		1			2	3	1=96	1008
5 ^e Inspection				1	1			324
Keneb		1		1	2	2	1=96	1080
Esnaab			1	1	2		1=96, 1=72	876
	3	7	6	24	39	36	31	
	1080	2100	1740	4320	5676	3888	2820	21264

5 Inspecteurs à 1000 liv.



NOTE

ON THE

IRRIGATION WORKS OF EGYPT

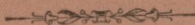
AND THE

IMPROVEMENTS TO BE MADE TO THEM.

BY

COLONEL C.C. SCOTT MONCRIEFF C.S.I.

UNDER SECRETARY OF STATE FOR PUBLIC WORKS.



CAIRO, 1884

PRINTED AT THE BRITANNIA PRESS.

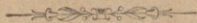
NOTE

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CAIRO, 1884

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NOTE

ON THE

IRRIGATION WORKS OF EGYPT

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IMPROVEMENTS TO BE MADE TO THEM.

1. In writing of the Irrigation of Egypt it must be kept in mind that the country contains two quite distinct forms of agriculture, each requiring its own special form of irrigation.

In Upper Egypt, (except on the tract watered by the Ibrahimieh Canal,) the ancient system prevails.

The country is divided by embankments into a succession of great basins. As the Nile rises in August, these basins fill to a depth of several feet. The water lies in them till October, depositing its fertilizing mud. It is then drawn off, the land is ploughed and sown, and a crop of wheat or beans obtained the following March or April. This system allows of only one crop a year, and valuable subtropical plants, like Sugar Cane and Cotton, cannot be grown.

The Canals of Lower Egypt, and the Ibrahimieh Canal of Upper Egypt, are dug so deep as to take in water at the Lowest Nile. They flow throughout the year, to permit of the cultivation of Rice, Sugar Cane, and Cotton. The lands of Lower Egypt are therefore perpetually under cultivation, and there is no time to flood the fallow fields in the manner practised in Upper Egypt.

For the system of Upper Egypt it is of the most importance to have an abundant flood during High Nile. For the system of Lower Egypt it is of the most importance not to have a very Low Nile.

2. If the Nile flood fails to fill the basins of Upper Egypt the



land cannot be ploughed, and the year is lost to cultivation. The result in this long narrow valley, among a people having no source of wealth but agriculture, must be extreme distress, and if this calamity were to be of frequent occurrence the first duty would be to contrive irrigation works to protect against famine. Fortunately no such works are necessary in Egypt. In the records of 126 years I find the highest Nile gauge at Cairo as follows.

Above	25 * pics or	20.12 metres	5 years
„	24 „	19.58 „	24 „
„	23 „	19.04 „	28 „
„	22 „	18.50 „	21 „
„	21 „	18.23 „	19 „
„	20 „	17.96 „	13 „
„	19 „	17.69 „	11 „
„	18 „	17.42 „	4 „
„	17 „	17.15 „	1 „

126

Above 25 pics is a dangerously high Nile, likely to lead to inundation. Above 23 pics is a good Nile. Above 20 pics is not bad. The present year is one of the eleven between 19 and 20 pics, and some loss of cultivation is anticipated in Upper Egypt. The worst year of the above, 1877, when the Nile rose only to 17 $\frac{3}{4}$ pics, was one of severe famine, and the direct loss of revenue alone amounted to about 2 millions sterling, but as that has only happened once in 125 years, no special provision need be made for its recurrence.

3. The chief improvements to be sought after in the irrigation works of Egypt are somewhat as follows.

1. To obtain every low Nile an abundant supply of water in the Canals of Lower Egypt, thereby ensuring and extending the cotton and rice cultivation.

2. To raise the water level in the Canals during Low Nile, and so diminish what the cultivator has to pay for raising it on to his lands.

* The Arab *pic* is usually .54 metre. But in the Nilometer from 16 to 22 the pics are only half length.

3. To remodel the internal economy of the Canals, so as to enable the *corvée* system to be diminished, if not entirely abolished.

4. To render the Canals of lower Egypt navigable.

5. To secure to the towns of Damietta and Rosetta a sufficient supply of drinking water.

6. To introduce perennial irrigation into the Province of Giseh.

7. To improve the irrigation of the Fayoum, and arrest the deterioration in progress there.

8. To complete and remodel the Ibrahimieh Canal in Upper Egypt, and the irrigation system dependent on it.

9. To construct more Canals in Upper Egypt, like the Ibrahimieh, with a view of obtaining perennial irrigation.

10. Lastly, but not least important, it must never be forgotten that alike in Lower and Upper Egypt, perennial irrigation must be accompanied by drainage, and systematic measures must be taken with this object.

I will take up these improvements in succession, only remarking beforehand that the sums I propose to spend on them are nearly always forecasts rather than estimates, which I have had no time to make. It is therefore quite possible that they may be found inexact. Whenever the promise of funds is made, precise estimates will be framed.

4. The greatest irrigation work in Egypt is the weir or Barrage at the apex of the Delta, built with the objects of raising the level of the Nile waters, and obtaining such control of them as to enable them to be directed as required into three great systems of Canals, watering the western Province of Behera, the Central Provinces of Menoufieh and Gharbieh, and the Eastern Provinces of Kaliubieh, Sharkieh and Dakhalieh.

This work was begun in 1847, and finished in 1862. Soon after, on being put to the test, one portion of it gave way, and such universal distrust followed, that although repaired to some extent it was pronounced, as lately as 18 months ago, by the Public Works Ministry to be a work only useful to prevent the Nile from flowing altogether in the Rosetta Branch and leaving the Damietta dry. This good office it certainly has fulfilled. It was asserted that more could not be expected from the Barrage, and that owing to the defective foundations, any attempt to hold up the water would lead to disaster. One Engineer after another therefore submitted costly projects for rectifying this defect.

5. The flooring of the Barrage is 8 metres above mean sea level. With all the gates open the water surface at extremest low Nile stands about 10.50 metres up stream of the Barrage, and about 10.00 metres below it.

The partial use to which the Barrage was put used to raise this surface to from 11.80 to 12.00 metres above, but never when there was less water in the river than to give 10.70 to 10.80 below. That is, it held up from 1.10 to 1.20 metres of water.

This year a small sum has been spent in stone pitching, and at the time of Low Nile a nearly uniform surface level of 12.90 metres was maintained above, while about 10.70 metres was the surface level below, that is, the Barrage successfully held up from 2.10 to 2.20 metres of water, and the result was most beneficial to the irrigation of Lower Egypt.

6. We have come to the conclusion that the foundations may be trusted. Following a well known Indian system suggested for this very work a few years ago by Mr. John Fowler C.E. Mr. Willcocks has prepared a design for a second or supplementary Barrage, 32 metres downstream of the existing one, by means of which, and generally by strengthening the flooring of the work, we hope successfully to hold up $4\frac{1}{2}$ metres of water, in two drops of $2\frac{1}{4}$ metres each. Thus would be ensured a water surface above the Barrage never lower than 14 metres above Mean Sea level.

7. But this is not enough. I have said that it was intended to have three great systems of Canals starting from the Barrage. The Western Canal, or Rayah Behera, has been dug, but has been greatly neglected; for under the belief that the Barrage would never serve its purpose, a concession was given to the Irrigation Society of Behera to supply water to that Province by means of two immense pumping stations, This concession is to last until 1915, and until then the Government of Egypt is bound to draw water from the Company at a cost of about £42,000 per annum. Holding the views I do about the Barrage I look on this concession as a mistake, but there is said to be much land in Western Behera capable of cultivation if it only had water, so I hope to utilize the Rayah Behera, and the pumps as well. The head of the former will require protective works, and other alterations estimated by Mr. Foster, Inspector of Irrigation, at £43,000, including a syphon to pass under it the surplus water of the Giseh chain of irrigation basins.

The Centre Canal, or Rayah Menoufieh, is a very fine work, and in good working order: but it only waters a portion of the central Delta, being assisted by three important Canals, taking their

water from the Damietta Branch. These Canals must either be connected with the Rayah Menoufieh, or be supplied by another weir.

The Eastern Canal was begun but never completed, and a glance at the map will shew that the Eastern Provinces are watered by a series of Canals taking out of the river at different points between Cairo and Mansourah.

8. From this an interesting question has arisen. Whether should we carry out the original design, and construct a great Eastern Canal, or Rayah Sharkieh, connecting with it the different Canals drawn from the river downward to Mansourah, or should we feed these Canals by means of a new weir or Barrage further down?

9. At first sight the Rayah Sharkieh seems the better project. It involves digging a great Canal from the Eastern end of the Barrage for about 22 miles, passing under the two Branches of the Railway East of Benha, and joining the Bahr Moës a little to the North. It has been said that much, if not all of this work may be done by the *corvée*, which would not place any direct financial burden on Egypt. There seems more symmetry altogether in this plan, and less uncertainty of success than if we built a new weir.

10. On the other hand it involves the excavation of more than $4\frac{1}{2}$ millions of cubic metres of earthwork, part of it more than 5 metres deep. If this were done by contract it would cost £235,000: if by *corvée* it would require the labour of at least 40,000 men for 200 days, a heavy burden on the country, and much of the digging would be below water level, which without the *kurbash* no *corvée* would effect.

This great Canal moreover would take up nearly 400 feddnas of good soil. It would require two railway bridges on the Cairo and Zagazig lines, made to open for navigation, and entailing a fixed establishment of employés. Although it might not often require to be cleared out, we could not hope to do without a certain amount of annual dredging.

Nor would this be the only charge. I have said in para. 7. that the Central Delta is partially watered by three Canals drawn from the Damietta Branch. To connect these with the Rayah Menoufieh, would require the excavation of about 700,000 cub: metres, at an outlay of £35,000, or if done by the *corvée* of about 10,000 men for 100 days.



The alteration, to the Barrage across the head of the Rosetta Branch will be much the same, whichever the system we employ; but if the Rayah Sharkieh is constructed, the Barrage across the Damietta Branch will require costly additional works, not needed if instead we make an entire by new Barrage, further down the river.

11. I do not attach much weight to the argument regarding the danger of trusting the whole irrigation of Lower Egypt to one great weir, but whatever weight this argument possesses is in favour of the conclusion I have adopted that it will be better, as well as more economical, to abandon the scheme of the Rayah Sharkieh, and build a second weir across the Damietta Branch, below the head of the Sahel Canal, and about 4 miles below Benha. An excellent site for this weir exists. The work proposed is merely a dam of 80 openings, each 3 metres wide, separated by masonry piers, and closed by gates or vertical baulks. The whole should rest on a foundation of concrete, overlaid by a cut stone flooring protected up and downstream by a massive apron of rough stone pitching. The utmost limit which it would be required to hold up water on this weir would be 3.5 metres. During High Nile the gates would of course be removed, and the weirs would be entirely submerged. At the right end a lock would be provided for navigation. The estimate of this work is £180,000.

12. With this weir the Canals of Sharkieh on the right, and of Menoufieh and Gharbieh on the left, would have their supply ensured, and it would not be costly or difficult to connect with it, and to enlarge the Canals of Dakhalieh, so as to convey abundant water as far as Damietta. This process would be the same whether the Rayah Sharkieh was made, or the new weir.

The following table shews roughly the cost of these two Projects, and it will be seen that even supposing the whole of the earth work of the first was done by *corvée*, still it would cost £18,265 more than the second, which therefore I do not hesitate to recommend.

	Irrigation scheme with Rayah Sharkieh.	Irrigation Scheme with Benha Barrage.
Completion of Barrage. Damietta Branch	120,000	30,000
Earthwork of Rayah Sharkieh... ..	235,000	... ..
do. of Canals in Menoufieh	35,000	... ..
Price of land. 375 ½ feddans à £30	11,265	... ..
Two Swing Bridges under Railway near Benha ...	50,000	... ..
Regulator and lock for Bahr Moès	12,000	... ..
Masonry works on canals in Menoufieh... ..	35,000	... ..
New Barrage below Benha		180,000
	£498,265	£210,000
	270,000	
	<u>228,265</u>	

*Subtract earthwork if Corvée
was employed*

13. To ensure then a good supply of water to Lower Egypt, during low Nile, which is the first of my projected improvements, it requires the completion of the Barragè, £180,000; the construction of the new Benha weir, £180,000; the connection with this weir of the Canals of the Eastern Provinces, £98,500; and the improvements at the head of the Rayah Behera, £40,000. In all an outlay of £501,500, ~~But I think, without any great hardship, the *corrée* might be required to do about £50,000 worth of this work.~~

14. The second improvement—namely, raising the water level to the surface of the fields in Lower Egypt—depends on the first. With the water level raised by weirs in the river itself it is naturally raised in the canals. But, even without the help of the weirs, a considerable improvement is possible in this direction by experience in water distribution, and the exercise of care and thought, qualities of which I have found in Egypt a deplorable absence. Some idea of what this raising of water level will save the cultivator may be understood from the fact of there being some 2,000 steam pumps employed in Lower Egypt. The owners of these pumps supply water at rates up to £1 per acre, or sometimes they receive as payment one-third of the crop watered. Besides these pumps there are innumerable water-wheels. One wheel waters about five acres, and requires three bullocks and two men to work it. With the recent cattle disease, this is a heavy burden. Even this last summer the arrangements made by Major Ross and Mr. Willcocks have greatly diminished the number of pumps and water-wheels, and with the weirs completed, I hope that two-thirds or three-fourths of them will disappear.

15. No irrigation improvements in Egypt can be considered of much avail while the scandal and the burden of the *corrée* remains. Its operation has often been described, and need not be repeated. The more we go into statistics the more it becomes evident that it is a cruel load on the poor, and that the rich who chiefly benefit, contribute almost nothing towards it.

1/2 About 60,000 men are now steadily at work in Lower Egypt for five months in the year, clearing the canals of silt, receiving no pay or food, and providing their own tools. Hardly is this work finished, than about half of this number is called out to protect the embankments for three months more, during High Nile. Now, by the exercise of engineering skill, a good deal of this labour might be saved, and by the completion of the Nile weirs, I trust all the necessary clearances may be done by half the present numbers. At present certain classes are exempted on the payment of P.E. 120 per

head, but the rich, in most cases, neither pay or send their men. I trust with our weirs completed, we shall be able to say to all: "Either give your personal labour or pay for a substitute," or that this will very soon resolve itself into a labour tax, which Mr. Willcocks estimates at 9 piastres (say two shillings) per acre, with which fund the canals will be properly maintained and unpaid labour will cease in Egypt.

16. Although the improvement and extension of irrigation is of more consequence than navigation, the latter ought not to be neglected in a country devoid of roads. Not only has it been neglected, but it has been deliberately obstructed to force traffic into the State Railway. On the Nile this obstruction, takes the form of tolls charged for passing under bridges. River navigation ought not to cost more than 1-tenth to 1-fifth penny per ton per mile. The tolls alone between Cairo and Alexandria are almost 3-tenths penny. At many places in Lower Egypt the railway bars good navigable canals with bridges, which cannot be opened. The works proposed to the Barrage will have the effect of injuring the navigation on the Rosetta Branch of the Nile for several months each year. The boats must be transferred to the canals, and for this purpose one efficient line of navigation should be made from the Barrage, rejoining the river at Dessouk. This will require a high lift lock at Dessouk, £20,000, the alteration of existing bridges, about £20,000, and a swing opening for a railway bridge, say £15,000. Altogether, perhaps £55,000 to £60,000. For about the same sum, a very useful trunk line of navigation, though not so important as the first, might be made from the Barrage to join the Damietta Branch of the Nile at Samanûd, 12 miles above Mansourah, on the opposite bank, and boats could then cross the Delta from Mansourah to Dessouk, and thence on to Alexandria by the Mahmoudiyeh Canal. A low lift lock (say £12,000) will be needed at the head of the Bahr Moes, to keep up the existing navigation to Zagazig, and for £54,000 a whole system of navigation might be opened up in the province of Dakhalieh and connected with the Nile by a long-proposed lock at Mansourah. In the province of Behera, both for navigation and irrigation, a lock and regulating bridge are urgently required at the junction of the Khatatbeh and Mahmoudieh Canals, and this will cost about £12,000. Other improvements to the bridges on the Khatatbeh Canal, to adapt them to navigation, would cost probably £10,000.

17. The towns of Rosetta and Damietta, situated near mouths of the Nile, are apt to suffer in summer from the sea entering the river and depriving them of their supply of fresh water. The effect of our drawing off increased volumes for irrigation is of course to diminish the supply left in the river, and we may expect the sea water to enter

** These figures will not tally with the ones in the table at the end. When a work is intended partly for navigation and partly for irrigation, the former is debited with only half the cost.*

further within its mouth. The remedy is to bring fresh water to these towns by canals drawn from further up the river. For Damietta, the more important of the two, this will be easily managed at a cost of perhaps £5,000. For Rosetta it is more difficult, and it will be necessary to bring a canal (which may also be used for irrigation) from Atfeh, a distance of 20 miles. This will cost perhaps £20,000, besides £10,000 worth of *corvée* labour.

18. In the province of Gizeh, the irrigation system of Upper Egypt, that is, the basin system, prevails, and although for political reasons it would probably be more important to increase the productive power of the more distant provinces, such as Esneh or Keneh, still, the introduction of sugar-cane and cotton cultivation in lands so close to Cairo as those of Ghizeh, would evidently greatly enhance their value. The effect of holding up the water surface at the Barrage to 14 metres above mean sea level will be felt for some distance above Cairo, so that a constant supply of water, even at Low Nile, could be ensured to the canals of Northern Ghizeh. Mr. Foster estimates that for £20,000 perennial irrigation might be given to about 15,000 acres of land opposite Cairo out of an area of 34,000 commanded. Five shillings an acre would be a small increase to the rental of these lands for the benefit conferred, so that in little more than one year the original cost might be recovered.

19. The Fayoum has been noted during all times for its exceptional fertility, but even more than other provinces it seems to have suffered from neglect, and owing to the physical nature of its surface, it requires, more than the provinces of the Nile Valley, an exercise of engineering skill which has never been bestowed on it. In spite of the fact that the construction of the Ibrahimieh Canal ensures its water supply at all seasons, the desert has largely encroached on the cultivation, while elsewhere this wasted water has soured the land and turned it into swamp. Evidence goes to show that the Fayoum is yearly deteriorating, and wants special measures bestowed on it, and it is a Province well worthy of reclamation. Mr. Forster recommends a yearly outlay of £40,000 for three years which, added to the available *corvée* labour, he believes, would place the irrigation on a sound footing and greatly extend the cultivation. The conditions of the Fayoum are so special that if this grant is given I should like to place the irrigation and the new works under a specially trained engineer from India. But the outlay of £120,000 should be spread over four years at least.

20. The Ibrahimieh Canal is in many respects a very fine and valuable work, but it was made solely to benefit certain estates

now termed the Daira Sanieh, and regardless of the serious injury it inflicted on others.

This injury consists in its having cut off the short canals, employed at intervals of a few miles to convey the muddy waters of the Nile, during flood, to the long chain of basins (containing about 520,000 acres) which lie between the canal and the desert. The strip of perennial irrigation created by the Ibrahimieh Canal lies between the river and these basins. The latter are now fed from the Bahr Yussuf, which itself is supplied from the Ibrahimieh. The water passes from basin to basin to the last, which is 170 miles from Assiout where the water leaves the river.

The result is that the fertilizing mud which is so important for this sort of irrigation is deposited in the upper basins while those lower down get only clear water. To make matters worse the unfortunate owners of these basins are forced to pay one piastre per feddan for the privilege of getting this inferior water. To remedy this state of affairs, Capt. Brown, R.E., Inspector of Irrigation, proposes to build two syphons under the Ibrahimieh Canal, to bring water direct from the Nile, and a series of other works, none in itself very large. These will supply muddy water to the basins, and will at the same time assist in the drainage of the land directly west of the Canal, at present ruined by salt efflorescence, the syphons under the canal acting in a reverse direction during Low Nile. Capt. Brown proposes also to make various works to connect the Ibrahimieh Canal and its western branches with the basins, with the object of allowing a large volume of silt-charged water to be carried forward instead of forming deposits in the Canal bed, which have to be removed by dredging and *corvée* labour. He has not had time to study these works closely, but their cost may be estimated at about £75,500.

21. The dredging of the Ibrahimieh Canal costs more than £40,000 a year. This all takes place above Mellaweh, or within the first 50 miles. The silt clearance from the branches is removed by *corvée*.

The works described above will open out the canal and its Western Branches to the basins, and so carry forward silt. With the same object we propose to make an Escape-Weir from the Canal at Mellaweh, and from the Sahelieh Distributary on its east, back into the river. These will cost about £17,000, and I trust will save more than that amount of dredging within the first two years.



Further down the Canal, Capt. Brown proposes to make an efficient escape channel into the Nile at Abadiéh (mile 134) utilizing an existing work. It will cost about £1,500 to adapt it for this purpose.

22. On the Canal itself some alterations are necessary. Opposite Roda, (mile 56) it passes through an old 9 arched bridge, which blocks all navigation and tends largely to silt deposit. This bridge must be removed and a new one should be substituted for it, with a swing opening for boats. This will cost, perhaps, £10,000. Capt. Brown estimates that £4,500 more are necessary to be spent on various improvements.

23. A most important work is a masonry dam required at Koshesha, the last of the chain of basins alluded to above. Here, every October, an earthen embankment is cut, and the water from these basins is allowed to return to the Nile, and every summer the *corvée* reconstruct this embankment. Should it breach of itself as it has done before now, at an inopportune season, a flood may be sent down the river that imperils Cairo and the whole Cotton crop of the Delta, while the basins above may be emptied of the water necessary to soak the land for the wheat crop. To ensure the country against such a disaster a masonry work is required which will cost about £50,000.

The amount of these improvements to the Ibrahimieh Canal is £158,000. Three points it leaves untouched. The provision of head sluices and lock at Assiout; the navigation of the canal, and the assurance of its supply during Low Nile. The first masonry works on the canal are at Devint, 38 miles below Assiout. Above this point the canal is only a sort of branch of the Nile, scouring out the bed and banks, on one of which is placed the railroad. Captain Brown thinks that with the escape channel above proposed there is no great necessity for regulating works at Assiout. Before determining on this point I should like to see the High Nile of 1885, the floods of this year having been exceptionally low. But I think it desirable to lay aside £60,000 for these head works. If they are not required, the money can well be spent otherwise. With our other improvements navigation will still only be possible as far as mile 105. There is no gate there to the Matai lock, nor to the Magaga lock at mile 123. But these gates would cost little, and if our new escape channels have the desired effect of scouring silt out of the canal bed, there will be plenty of water for boats, and they should be supplied. A tail lock might be built at Beni-Souef, probably for £25,000. But although this would be a convenience, I do not at present recommend the outlay. For a much smaller sum the navigation on the Nile itself might be greatly improved, and as it flows parallel to the Ibrahimieh canal

at the distance of only a few miles, it is not worth while spending much money at present on a second line for boats.

25. A more important improvement would be the assurance of abundant water during Low Nile. I only know of two ways of doing this. We may obtain command of the water by a weir at the canal head, like the Barrage, or we may raise the water by pumps as in the Province of Behera. The Ibrahimieh canal possesses neither of these means of water supply. As the Nile falls, it must fall, and it is only by this costly dredging that it can be kept flowing at all with Low Nile. This question assumes additional importance from the fact that nearly the whole of the great sugar-cane cultivation of the Daïra-Sanieh depends on the Ibrahimieh canal. I think it might be possible to get a contractor to supply below Deirut 2 millions of cubic metres of water per year for £50,000. This would chiefly be of value to the Daïra Sanieh, and part might fairly be charged to it. At the same time it would set free a large volume of water above Deirut which could profitably be expended in introducing perennial irrigation (that is sugar-cane cultivation) into the basins lying to the west of the Ibrahimieh, which would prove a very great boon to the Fayoum. As this would involve a large yearly charge on the Budget, but no great expenditure of capital at once, I make no provision for it in the table at the end of this Report.

26. The other alternative to ensure the supply of the Ibrahimieh canal would be to throw a weir across the Nile below its head, or the head might be moved up-stream to some suitable place for this weir. This question of a second weir is of the greatest importance, and had best be treated in conjunction with my ninth improvement, namely the increased perennial irrigation in Upper Egypt.

27. I believe that even in low Nile, with proper water-distribution as now prevails in Northern India, there is water enough for 400,000 acres of additional cultivation. With such an increase as this the present basin system would disappear over perhaps a million of acres, which would henceforth grow sugar-cane, cotton, or rice, along with the present crops—wheat, beans, clover, or maize. The impression is general that the land assessment of Upper Egypt must be lowered. Assume a general reduction of P.E. 25 per acre, or of £250,000 over a million of acres. This loss might be averted were perennial irrigation given to this area, and 400,000 acres were actually watered at Low Nile, and with this object 2 millions sterling might be profitably spent. Engineers' guesses are often far from the truth, but it is my impression that by throwing a weir across the Nile and making a system of canals from it, the rental of land in Upper Egypt might be increased by at least P.E. 25 per acre, and that this increase

would not cost more than P.E. 250, or £2 10s. per acre. But as the weir itself is the great expense, (perhaps £500,000) and it would cost nearly the same for a large or a small canal system, it would not be worth while pursuing the subject if there was less capital than 1 to 11 millions available, a sum so large that I have not included it in the table. If under certain conditions this capital could be made available it would be advisable to study the project. For the good of Egypt it would probably be best to make the weir at Silsileh, and thence to irrigate the provinces of Esneh, Keneh, and Girzeh. For financial returns it would be best to make the weir in the Girgeh or Assiout provinces, to connect the Ibrahimieh canal with it, and to prolong it, so as to give perennial irrigation on the left bank of the Nile from Assiout to Cairo, including the Fayoum.

28. There remains to consider the subject of drainage. There are, in Egypt, thoughtful people, whose opinion is deserving of respect, who maintain that the perennial irrigation introduced by Mehemet Ali is surely, if slowly, ruining the country. That the constant saturation of soil brings salts to the surface, and that this evil will be much increased if we hold up the water above the Barrage 3 metres higher than the natural surface. They point to the valley of the Wady, near Tel el Kebir, unquestionably ruined by the high level Ismailieh Canal flowing past it to the Saline marshes of Dakhalieh and Garbieh, and to the strip alluded to in para: 20, to the west of the Ibrahimieh Canal. Hitherto nothing on a large scale has been done for the drainage of Egypt. On the contrary the country is divided by a net-work of canals in which during High Nile the water flows at a very high level. Each mesh of this net-work then becomes a shallow tank, from which the water cannot generally run off, washing impurities with it, as from the great Basins of Upper Egypt, but where it has to remain and soak into the ground or evaporate. It should be our object to make an outlet for each of these shallow tanks, sometimes by removing a useless canal crossing the natural slope of the land, sometimes by building a culvert under such banks. In many cases drains must be dug for long distances, and the temptation to obstruct them by embankments, and to make them into a series of troughs from which to pump water must be steadily resisted. This habit of confusing irrigation canals with drains must, if possible, be overcome. With this object kept steadily in view, and a certain amount laid out annually on drainage works, I do not fear raising the water surface by our Nile weirs, and as far as our observation goes, we have reason to



hope that the salt may be washed from the soil and its fertility restored by judicious drainage. The valley of the Wady eastward from Tel el Kebir is, perhaps, the most difficult place to drain in Egypt, as its surface is hardly above that of the sea in the Timsah Lake 30 milles off. Much of this drainage will consist of small works scattered over the country, and carried on year after year. These are more properly works to be executed from the ordinary annual grant than by a special loan fund. For this reason I have only entered £ 100,000 under this heading in the table at the end of this report.

29. As I have said before, (para. 3) this table must not be looked on as a close estimate, but as a forecast. I have been told to frame it to an approximate total of a million sterling. It amounts, therefore, to £ ~~1,000,000~~ ^{1,663,500} *. But it must not be supposed that I consider this as the whole amount, which, if money were forthcoming it would be expedient and profitable to spend on the irrigation works of Egypt. I believe three times this amount might be spent with direct profit. To instance one object alone, my table includes nothing for works in Upper Egypt above Assiout. But in the long Nile valley from that point to Silsileh there is much room for canals. Only, as I have tried to explain in para: 27, it would be no use devising schemes here unless there were a capital available for these alone of at least a million sterling. The minor works necessary to maintain and improve the present system of basin irrigation are best charged to the ordinary annual grant. As regards the amounts proposed year by year, I have stated what I believe could be spent if the money were available, but as little hydraulic work can be done after August, while the Nile is high, the forecast for 1885 could only be utilized if early intimation is received.

30. Lastly it remains to consider the establishment required to carry out these works within the next few years. I can say without hesitation that the time of myself and the four Indian Irrigation Officers under my orders is so fully taken up with our present duties that we should require to be largely helped, and that help must to a considerable extent be obtained from outside Egypt. There is no worse policy than to commit the designing and construction of costly works to an insufficient or incompetent staff. For these particular works there is no such good school as the Indian service, where the conditions of the rivers, the building materials, and the labour, are much the same as here. I recommend the appointment of one officer on £ 1,500 a year, as General Director

* Or if Coria labour be partially employed

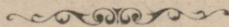
£ 1,083,500

of Works: I propose to commit the completion of the Barrage to Mr. Willcocks, to whose ability and care it is due that, in its incomplete state, it has rendered such good service this season, and with an assistant on the spot, I propose to entrust the Benha weir to him also. But to attend to these duties Mr. Willcocks must be relieved of the charge of the irrigation of the central Delta for which an Irrigation Officer from India, on a salary of £ 1,000 is required. For the Irrigation Works of the Fayoum (as stated in para : 19), and to assist Major Ross, whose duties in the Eastern Provinces are very heavy, I recommend two more officers from India, on salaries not less than £ 800. In all, then, I ask for four more officers from Northern India. For other works I propose to find officers where I can, here or in Europe.

It may be asked why not employ Native Engineers, to which I would merely reply, that as there have been no large Hydraulic Works carried on in Egypt for many years, there are no native engineers gifted with experience enough to warrant their designing or taking charge of large works. But I look to them for constant assistance, and when these works are completed, Egypt should possess some very well trained and capable officers of its own.

(Signed) C. C. SCOTT MONCRIEFF.

Cairo, 7th October, 1884.



List of Proposed Improvements to the Canals of Egypt, with a Forecast of the Outlay, spread over Five Years.

Alluded to in Para.	NAME OF WORK.	PROBABLE EXPENDITURE.					Total Estimate.
		1885.	1886.	1887.	1888.	1889.	
		£	£	£	£	£	
5, 6	Completion of Barrage, Rosetta Branch	30,000	40,000	30,000	20,000	...	120,000
10, 12	"	10,000	15,000	5,000	...	...	30,000
8	Alterations to Head Works, Rayah Behera, and Nikla Syphon	10,000	20,000	13,000	...	...	43,000
11	Construction of New Weir below Benha	40,000	60,000	60,000	20,000	...	180,000
13	Additional water-way, Sahel Canal head	...	5,000	5,000	...	...	10,000
16	Regulating Bridge-head of Bahr Moés	2,000	4,000	...	...	...	6,000
16	Low lift lock into Eastern canals above Benha Weir	3,000	6,000	3,000	...	...	12,000
16	Regulating bridge and lock-head of Mansurah Canal, Mitghamr	...	8,000	4,500	...	...	12,500
16	" Bahia	...	6,000	6,500	...	...	12,500
13	Widening Sahel Canal, Dakhalieh	20,000	20,000	18,000	...	...	58,000
16	Regulating bridge and lock-head of Bahr Soghri, Mansurah	4,000	8,000	...	...	...	12,000
16	Railway Swing Bridge, do. do.	...	15,000	...	...	...	15,000
13	Regulating bridge-head of Om Salâma Canal	...	4,000	2,000	...	...	6,000
16	Lock at Mansurah into the Nile	...	10,000	10,000	...	...	20,000
16	" Dessuk	...	10,000	10,000	...	...	20,000
16	Alterations to bridges on Canals between Barrage and Dessuk	...	10,000	5,000	5,000	...	20,000
16	Railway swing-bridge east of Kafr-Zayat	...	15,000	...	...	...	15,000
16	Lock at Samanûd into the Nile	...	10,000	10,000	...	...	20,000
16	Alterations to bridges on canals between Barrage and Samanûd	...	5,000	10,000	5,000	...	20,000
16	Regulating bridge and lock at Junction of Khatatbeh and Mahmudieh Canals	5,000	7,500	...	...	...	12,500
16	Alteration to bridges, Khatatbeh Canal	...	5,000	5,000	...	...	10,000
17	Conveying water-supply to Rosetta and Damietta	...	15,000	20,000	...	...	35,000
18	Constructing a perennial canal in Gizeh	...	22,000	18,000	...	...	40,000
19	Remodelling and extending irrigation in the Fayoum	10,000	30,000	30,000	30,000	20,000	120,000
20	Bridges and syphons for filling basins west of Ibrahimieh Canal	15,000	30,000	20,000	10,500	...	75,500
21	Escapes at Millâweh and Abadiéh, Ibrahimieh Canal	5,000	10,000	3,500	...	...	18,500
22	New bridge opposite Roda	...	5,000	5,000	...	...	10,000
23	Constructing Masonry Dam at Koshesha	...	25,000	15,000	10,000	...	50,000
24	Regulating bridge and lock-head of Ibrahimieh Canal	...	10,000	25,000	25,000	...	60,000
28	Drainage operations throughout Lower and Upper Egypt	10,000	25,000	25,000	23,000	20,000	100,000
	TOTAL	164,000	455,500	338,000	145,500	40,000	1,163,500

NOTE:—By partial use of the *corvée* this amount may be reduced to £1,083,500. Until detailed estimates are made it is impossible to arrange exactly the order in which the works will be carried out.
C. C. SCOTT-MONCREIFF.



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