Preliminary Report on Electrification, Grouping, Extension and Modification of the Pumping Schemes on the Blue and White Niles

compiled and written by

MOHAMED ABDEL-KARIM ASAKIR

(*Asst. Under-Secretary, Ministry of Irrigation & E.P.*)

Acknowledgement

The writer wishes to acknowledge gratefully the invaluable assistance rendered by the following engineers of the Ministry:

MOHAMED SALIH EL-NAYAL *(asst. chief mech. engineer)*
MOHAMED EL-AMIN A/GADIR *(asst. div. engineer)*
IBRAHIM HAMAD SALIH *(divisional engineer)*

and a group of engineers working on the schemes

MINISTRY OF IRRIGATION AND ELECTRIC POWER

Printed by
KHARTOUM UNIVERSITY PRESS
P.O. Box 321, Khartoum
Democratic Republic of the Sudan
August 1972

Contents

Preliminary Report on Electrification, Grouping, Extension and Modification of the Pumping Schemes on the Blue and White Niles

INTRODUCTION

In 1931 the Sudan Government started the development of the livelihood schemes on Kawa. The main livelihood schemes developed then were Dueim, Fatisa, Hashaba and Um Gar with a gross area of nearly 21,000 feddans irrigated by pumps from the White Nile. Later this was followed by the development of Wad Nimir, Shabasha, Wakara and Abger pumping schemes with a total area of 6,700 feddans. The construction of Gebel Aulia Dam in 1937 provided low lifting heads during the period of irrigation of cotton, dura and wheat, which encouraged the private sector to invest their capital in development of pumping schemes on the White Nile. All the livelihood schemes were then administered by the White Nile Board which was established in 1943. In 1970 the administration of these schemes came under the Agrarian Reform Corporation which was established in 1968. The development on the Blue Nile began some 20 years after development on the White Nile, partly because hydrological conditions are not favourable owing to the high and variable pumping heads on the Blue Nile. The major development of the pumping schemes took place between 1950 and 1957 when cotton prices were high. It is now estimated that the total area under pump irrigation on the Blue Nile is one third of the total area of the pumping schemes.

In 1964 (October Revolution) the people raised the banner of nationalization and agrarian reform. Since then, the owners, scared of their schemes being nationalized, took no interest in keeping up or improving the condition of these schemes. When the Government began the nationalization of pumping schemes on the White and Blue Niles in 1968, most of the production elements were found to be in very bad condition. The May Revolutionary Government nationalized all schemes with pump diameters bigger than 6 inches. Now the pumping schemes which come under the direct administration of the Agrarian Reform Corporation on the White and Blue

Niles are nearly 250 schemes, ranging in size from as small as 180 feddans net cultivable area to 30,000 feddans.

I PUMPS AND PUMP SCHEMES

Most of the pump schemes were not designed according to normal engineering practice and were hurriedly constructed. As a result of this the foundations of the engines and pumps are badly built and, consequently, most of the engines are not properly erected. A big number of the engines and pumps are exposed to the sun and dust with no pump house or shed to protect them. In some of the large schemes like El Ghazala scheme, even the overhead cranes were not installed for handling the very heavy engines and pumps which need repair or overhauling. All the pumps in the existing schemes are built in such a way that the water can only be pumped at levels very much higher than the minimum river levels, and even with the normal pumping levels the efficiency is very much reduced due to the positioning of the pumps which are usually built 4 metres or more above the normal water level. A large number of the engines and pumps in the schemes are of different make and some of them are now out of production. The majority of the engines work for 24 hours during the peak water demand, and in most of the schemes there is no standby. The diameter of the suction and delivery pipes is usually smaller than the engine power, thus giving less water than originally designed for. Not only that but in some of the schemes the speed of the engines is reduced to cope with the size of the pump.

II STAFF AND OPERATION

The personnel operating, repairing and overhauling the engines and pumps are hardly skilled. There are no workshops or equipment for proper maintenance or overhauling of the engines. There is hardly any service offered to the labourers and mechanics working in the pumping stations, and most of them are not given housing. This makes it very difficult for any man, skilled or unskilled, to attend to his engine and detect the faults at the time when they occur. Therefore, it was inevitable that major defects should have occurred, and in many engines the crank shafts were broken due to the negligence of operating staff. Spare parts are only bought whenever any of the engines or pumps is out of order or broken. All these factors reduce the lifespan of the engines and pumps, increase the cost of

repairs and overhauls and also increase the fuel and grease consumption. There is no record to show the history of the engines or the consumption of fuel and grease in any of the pumping stations, which means that the staff have to be oriented and properly trained to be able to run the engines efficiently and to keep good records. There are no stores or storekeepers to control the distribution of fuel and spare parts. Whenever spare parts are bought from the market or ordered from abroad and received by the engineer in-charge they are handed to the head engine drivers who take them straight for the repair or overhaul of the engines and pumps. This makes it impossible to control the use of spare parts. Not only that, but due to the acute shortage of engineers and efficient mechanics, it is the head drivers of the engines who decide on whether to change any part of the engine. Thus the cost of maintenance and overhaul is further increased.

III IRRIGATION SYSTEM

There is no system of irrigation, and the pumping hours mainly depend on the agricultural inspector of the individual scheme. Due to the lack of personnel and a system of water control in the field, the irrigation water is misused, thus causing difficulties and a rise in cost of production. The lack of telephones and efficient communications makes the water control very difficult and it is normal that wash-out of canal banks takes place, thus further increasing the production cost. The canalization of a large number of the schemes is not executed according to normal engineering practice, and what has been executed is different from the proposed layout of canalization for some schemes. There are no maps for a lot of the schemes, neither in the offices of the Survey Department nor elsewhere. In a number of the existing pump schemes only two-thirds of the area is developed, thus upsetting the rotation.

For the above reasons and facts and to avoid collapse of the pump schemes it has become obvious that a lot of changes and improvements have to take place in the existing pumping schemes. The following reformation and improvements are suggested:

1 *Electrification of the pumping schemes*

The installation of three turbines out of seven as a first stage on the Roseires Dam, each generating a maximum of 30,000 kilowatts

will provide electrical energy which has to be utilised either on agriculture or in industry or both. Since the generation of electricity from Roseires Dam was started in July 1971 the importance of finding immediate resources for its use has become a necessity. It is wisely thought to use some of the energy in electrifying the existing pumping schemes on the Blue and White Niles. Besides increasing the efficiency and reducing operation costs, the use of electrically-driven motors will save hard currency, i.e. the cost of fuel and lubricant. The spare parts used in electrically-driven motor pumps are less than those used for diesel engines. The total cost of fuel, lubricants and spare parts now used in the existing pumping schemes is estimated at a million pounds approximately.

2 *Grouping of the schemes*

It is also thought that the grouping of the existing schemes according to their proximity to one another, will reduce the operation costs and improve the pumping sites, which will be selected according to engineering practice. The grouping will of course reduce the number of the pumping stations and also the number of stand-by units, thus reducing the capital cost when changing to electrically-driven motors.

3 *Extension to the existing schemes*

There are undeveloped areas, lying in between or adjacent to the existing schemes which will be developed. The development of such areas will increase the areas of the grouped schemes so that they will be of fairly sizable areas, i.e. whenever possible an area of about 50,000 feddans is deemed suitable.

4 *Modification of the available power according to the actual requirements*

The available power on the existing schemes is usually in excess of that required for the water duties. Therefore when changing to elecrically-driven motor pumps, the power required has to be calculated according to the irrigation factors and duties. The maximum water use per day on the available cultivable area is known as the peak gross factor. The highest peak factor for the areas on the Blue and White Niles is taken as 30 cubic metres per day per cropped feddan. When considering the electrification it has been considered

that two-thirds of the available land is being irrigated. Consideration has also been made for 100% irrigation.

5 *Modification of canalization*

The main and major canals will be designed and modified for continuous watering with night storage in minor canals. The canals and field outlet pipes will be designed in accordance with the Ministry of Irrigation technical notes and normal engineering practice.

The electrification, grouping and extension of the Blue Nile pumping schemes will be given priority to the White Nile pumping schemes.

6 *Proper location of the pumping stations*

The existing pump sites for a large number of the schemes are vulnerable to both bank erosion and desilting of the intakes. The inlet channels of some of the pumping schemes on the White Nile are objectionably long reaching five kilometres or more. The selection of these sites was not according to engineering practice and some of the pumping stations are in danger of being eroded. Some of the pumps are being repaired very frequently due to the heavy deposition of sand. When carrying out the electrification, grouping and extension, necessary engineering requirements will be satisfied including proper selection of sites.

Blue Nile Pumping Schemes

LOCATION OF SCHEMES, AREAS AND PUMP DATA

The existing pump schemes on the Blue Nile cover a strip of approximately 40 kilometres north of Sennar and 120 kilometres south of Sennar. The total number of schemes on both sides of the Blue Nile which come under the direct administration of the Agrarian Reform Corporation is 62 with areas ranging from as small as 180 feddans gross to 30,000 feddans. The number of schemes on the east bank is 32 and that on the west bank is 30. The gross area of the existing schemes is nearly 282,000 feddans, and the proposed area of extensions is approximately 97,000 feddans.

General information on these schemes is given in the following tables:

Table I*: showing all the schemes on the east bank of the Blue Nile with their respective cotton areas, number and make of engines, horse-power and the estimated future lifespan of each engine.

Table II: showing all schemes on the west bank of the Blue Nile with their respective areas, number and make of engines, h.p. and the estimated future lifetime of each engine.

Table III: showing the schemes, with their full supply levels and the maximum and minimum static heads.

Electrification

In order to draw a suitable plan of electrification of the pumping schemes that would cope with the Five-Year Plan, we have to give priority to the schemes lying within the existing 33 kV. overhead transmission lines between Sennar and Singa and those which will be constructed for El Suki and Rahad projects.

The survey on the existing pumping stations of the Blue Nile showed that the engines can be categorized according to their condition into three parts:

(i) Engines which are obsolete and need immediate replacement.

(ii) Engines which cannot be efficiently operated after the end of the Five-Year Plan (1974/75).

*For all tables *see* Appendices p. 23

(iii) Engines which can be operated economically and efficiently after the end of the Five-Year Plan (74/75).

Table IV shows the schemes which lie within the existing 33 kV. overhead transmission lines and those which will be constructed on the east and west banks of the Blue Nile. The scrap and obsolete engines are also indicated. It is intended that the engines and pumps which are in good condition will be transferred to the pumping stations according to the plan and priority of electrification. Hence the good engines and pumps of the Blue Nile will be transferred to the pumping stations on the White Nile according to a certain priority. This procedure of work will have the following advantages:

(i) Electrification may be done in stages in phase with the Five-Year Plan.

(ii) The diesel-driven engines and pumps in the existing pumping stations will be utilized fully, i.e. the engines which are in good condition will be transferred to the sites on the White Nile where their diesel engines need replacement, thereby improving the irrigation conditions of the diesel-driven pumping schemes on the White Nile.

(iii) Besides distributing the capital investment over a number of years, the planning in such a manner will increase the efficiency of the pumping schemes and decrease the cost of operation, bringing therefore a decrease in the irrigation cost.

The required working power per feddan of cropped area is calculated in accordance with the following formula:

$$\text{h.p.} = \frac{Q\ H}{75\ M}$$

where: 'Q' is the discharge in litres per second per cropped feddan; 'H' is the total head in metres under which the pump will work; and 'M' is the efficiency of the electrical motor/pump sets (taken as 80%).

According to normal engineering practice, the peak crop factor is taken as 30 cubic metres per cropped feddan per day. Normally two-thirds of the available area is being irrigated, and the pumps operate for 18 hours per day. It is envisaged that the intensity of cropping and hence irrigation will be increased to 100%.

As most of the schemes lie upstream of Sennar Dam, the fluctuation of the river is reduced to a minimum and the total head under which the pumps will work is estimated as 14.5 metres on the average. According to the above:

$$Q = \frac{30 \times 10}{18 \times 60 \times 60} = 0.46 \text{ litres/sec.}$$

$$\text{Power required per cropped feddan} = \frac{0.46 \times 14.5}{75 \times 0.8} = 0.11 \text{ h.p.}$$

This figure is considered as an average value and will have to be adjusted when assessing more closely the required capacity of the individual schemes. Therefore the electrification of the existing diesel-driven pumps would entail not only the installation of another type of pump, but a complete revision of the design criteria for each individual scheme, with the result of providing the most adequate motor and pump sets to match the necessary head and discharge requirements for the proper irrigation of the associate fields.

Grouping and extension of the schemes

The grouping of the Blue Nile pumping schemes has been proposed in such a way that 56 of the existing schemes are grouped into 11 schemes. There are another 6 isolated schemes that cannot be grouped (*see* Table VI), and it is suggested that the extensions to these schemes be dealt with when preparing the final report. Table V shows the grouping of the schemes with the proposed extension and available h.p.

Most of the probable areas proposed for extensions to the existing schemes were mainly proposed by their owners before nationalization. The total proposed area of extensions is approximately 97,000 feddans.

Considering that the horse-power required per cropped feddan is 0.110, the total horse-power of each of the electrified schemes with their extensions included is tabulated as shown opposite.

Thus the total h.p. required for ⅔ cropping is nearly 26,600 and for 100% cropping, 39,900 h.p. It is worth noting that the total

Item	Scheme	Gross area	Cropped area	h.p. cropped area x 0.11
1	Hurga Group	51570	34380	3781.8
2	Kassab Group	55180	36787	4046.6
3	El Hegeirat Group	22180	14787	1626.6
4	Busata Group	47045	31363	3449.9
5	Shasheina Group	42000	28000	3080.0
6	Wad Salam Group	33650	22433	2467.6
7	Karkog Group	9550	6366	700.3
8	El Nayra Group	31440	20960	2305.6
9	El Rammash Group	29070	19380	2131.8
10	El Safa Group	17420	11613	1277.4
11	Wad Hashim Group	23589	15726	1729.9
	TOTAL	362694	241795	26597.5

power available now on the existing schemes of the Blue Nile is equivalent to 31,880 h.p. and the gross area is nearly 282,000.

In pump irrigation, the efficient use and number of pumps in each scheme should be carefully considered. Whenever possible a minimum of four pumps working for 18 hours per day is thought to be the best arrangement; because it will be possible to achieve the same output from three of the pumps working for 24 hours per day, and therefore no separate standby is needed.

Suitable sites for pump stations

The requirements which have to be satisfied in the location of a satisfactory pump station site may be summarized as follows:

(i) There should be sufficient depth of water adjacent to the river bank at low river so that siltation of the inlet channels is reduced to a minimum.

(ii) The bank slope should be as steep as possible so as to keep to a minimum the length of intake and delivery piping.

(iii) The ground level at the pump station sites should be as high as possible so as to minimise the risk of flooding at high river.

The availability of suitable pump station sites on the Blue Nile is affected by the following factors:

(a) Meandering of the river channel: the location of the pump houses and intakes in relation to the meander pattern is important, since both desilting of intakes, and the protection of river banks

can become expensive items in the operating costs of a pump station. While the low rate of lateral erosion taking place at low water levels creates the usual zones of erosion, it is the flood erosion which is the more serious factor. The high river flood erosion operates in two directions: first the maximum current tends to leave the concave area of meander and the point of maximum erosion moves downstream causing increased turbulance; secondly the rise in water levels leads to saturation of the river bank. When the flood quickly subsides, the bank collapses due to the internal pore water pressure, which is no longer balanced by the external hydrostatic pressure.

Hence the proposed pump station sites will be chosen upstream of the point of maximum erosion since it may be expected to shorten the length of bank protections.

(b) The extent of the eroded lands between the river bank and the high clay plain is a major factor when considering the capital cost. A canal embankment is generally limited to two or three metres above ground level or the irrigation supply has to be conveyed through a rising main from the pump house on the river bank to the canal head.

(c) The operation schedule of Sennar Dam greatly affects the pump station sites, and the reservoir backwater reduces the lifting head and increases the depth of water at the pump intakes, thus reducing the risk of drawing sand. The high reservoir level has also the effect of reducing the length of the inlet channels and in some cases the inlet channels may be eliminated.

Estimated cost

In order to evaluate the cost of electrification of the existing pump schemes the following points have to be taken into consideration:

(a) Capital cost invested to install the electrical motor and pump sets.
(b) Cost of the electrical overhead transmission lines.
(c) Cost of modifying and grouping the existing schemes to be irrigated from the proposed new electrical pumps.
(d) Cost of developing the areas in between or adjacent to the existing schemes.

(a) The cost of installation of electrical motor/pump sets is based on technical literature, engineering practice and the experience of the Ministry of Irrigation & E.P.

(b) The cost of electrical transmission lines is taken from the C.E.W.C. report in which the cost of transmission lines and feeders on the Blue Nile is estimated as LS.900,000 for an area of 350,000 feddans.
(c) The cost of modification of the existing schemes to be irrigated by electrically-driven motor/pump sets, consists mainly of preliminary survey, design, setting out and excavation of the main canals to feed the existing schemes, building of head regulators, modification of the existing regulators, excavation of drains, building of crossings, building of houses and workshops, and establishing telephones and transport. It is also necessary to estimate the cost of the mechanical equipment and surveying instruments required for the electrified schemes.

Considering the above information, the capital cost required to irrigate one feddan of the existing area by electrically-driven motor/pump sets is estimated as shown in the following table:

Item	Description	Cost of feddan ⅔ cropping	Cost of feddan 100% cropping
1	Cost of motor/pump sets including taxes, freight, erection & testing	3.750	4.250
2	Construction of the pump house inlet channel and delivery basin	1.750	2.000
3	Preliminaries, survey, design and setting out	0.150	0.150
4	Excavation of main canal to feed the existing schemes	3.000	3.250
5	Building of cross regulators and head regulators to feed the existing schemes	1.250	1.500
6	Modification of the existing canals		0.750
7	Modification of the cross regulators across the existing canals	0.500	1.500
8	Excavation of drains and crossings for the existing schemes	1.000	1.000
9	Buiiding of houses for engineers, staff operating the engines and personnel working in water control	2.250	2.500
10	Establishment of telephone system	0.250	0.250
11	Workshops & workshop equipment	0.200	0.200
12	Transport and water supply	0.500	1.000
13	Establishment of offices	0.100	0.100
	TOTAL	14.700	18.450
	Add for contingencies	.300	.550
	TOTAL COST	15.000	10.000

(d) The cost of developing the areas in between or adjacent to the existing schemes estimates is based on the experience, technical reports and engineering practice of the Ministry of Irrigation and E.P. The estimated cost required to irrigate one feddan by electrical motors and pumps is shown in the following table:

Item	Description	Cost of feddan ⅔ cropping	Cost of feddan 100 % cropping
1	Cost of motor/pump sets including taxes, freight, erection & testing	3.750	4.250
2	Cost of construction of the pumping station	1.750	2.000
3	Preliminaries, survey, design & setting out	0.550	0.550
4	Excavation of the main canals to feed the extension	2.700	3.250
5	Building of cross regulators and head regulators	1.250	1.500
6	Excavation of minor canal, Abu XXs & Abu VIs	1.000	1.250
7	Structures on minor canals	2.000	2.250
8	Excavation of drains & building of crossings	1.000	1.000
9	Building of houses for engineers and other staff	2.500	2.500
10	Establishment of telephone system	0.250	0.250
11	Workshops & workshop equipment	0.200	0.200
12	Transport & water supply	1.000	1.000
13	Establishment of offices	0.100	0.100
	TOTAL	18.050	20.100
	Add for contingencies	.350	.900
	TOTAL	18.400	21.000
	Cost of transmission lines	2.600	2.600
	GRAND TOTAL	21.000	23.600

Considering the above facts and figures the total cost of each electrified scheme is tabulated as shown opposite.

It is essential to mention that the present report suggests no fixed condition of capital investment with respect to phasing and time. A wide and flexible form is provided in carrying out the electrification, grouping and extension, whereby any capital investment at any time may be objectively utilized.

(A) *Estimated cost for ⅔ cropping*

Item	Scheme	Cost of modification of existing area LS. m/ms	Cost of developing the extensions LS. m/ms	Total cost LS. m/ms
1	El Hurga Group	333,550.000	552,000.000	875,550.000
2	Kassab Group	722,700.000	128,800.000	951,500.000
3	El Hegeirat Group	272,700.000	73,600.000	346,300.000
4	Busata Group	675,675.000	36.800.000	712,474.000
5	Shasheina Group	630,000.000	–	630,000.000
6	Wad Salman Group	234,750.000	331,200.000	565,950.000
7	El Nayra Group	252,000.000	269,376.000	521,376.000
8	El Ramash Group	233,550.000	248,400.000	481,950.000
9	El Safa Group	141,300.000	147,200.000	288,500.000
10	Wad Hashim Group	353,835.000	–	353,835.000
11	Karkoug Group	143,250.000	–	143,250.000
	Cost of modifyng the isolated schemes (*see* Table VI)	245,925.000	–	245,925.000
	TOTAL COST	4,239,235.000	1,787,376.000	6,016,610.000
	Say			6,000,000.000
	Local currency	LS.	3,180,000.000m/ms	
	Foreign currency	LS.	2,820,000.000m/ms	

(B) *Estimated cost for 100% cropping*

Item	Scheme	Cost of modification of existing area LS. m/ms	Cost of developing the extensions LS. m/ms	Total cost LS. m/ms
1	El Hurga Group	409,830.000	630,000.000	1,039,830.000
2	Kassab Group	915,420.000	147.000.000	1,062,420.000
3	El Hegeirat Group	345,420.000	84,000.000	429,420.000
4	Busata Group	855,855.000	42,000.000	897,855.000
5	Shasheina Group	798,000.000	–	798,000.000
6	Wad Salman Group	297,350.000	378,000.000	675,350.000
7	El Nayra Group	319,200.000	307,440.000	626,640.000
8	El Ramash Group	295,830.000	283,500.000	579,330.000
9	El Safa Group	178,980.000	168,000.000	346,980.000
10	Wad Hashim Group	448,191.000	–	448,191.000
11	Karkoug Group	181,450.000	–	181,450.000
12	Cost of modifying the isolated schemes	482,505.000		482,505.000
	TOTAL COST	5,528,031.000	2,039,940.000	7,567,971.000
	Say			7,600,000.000
	Local currency	LS.	4,030,000,000m/ms	
	Foreign currency	LS.	3,570,000,000m/ms	

White Nile Pumping Schemes

LOCATION OF SCHEMES, AREAS AND PUMP DATA

The existing pump schemes on the White Nile cover a strip of approximately 380 kilometres south of Gebel Aulia. The total number of schemes on both sides of the White Nile which come under the direct administration of the Agrarian Reform Corporation is 186 with areas ranging from as small as 200 feddans gross to 18,600 feddans. The number of schemes on the east bank is 89 and of those on the west bank is 97. The gross area of the existing schemes is nearly 418,900 feddans, and the proposed area of extensions is approximately 284,000 feddans.

General information on these schemes is given in the following tables:

Table VII* showing all the schemes in Dueim and Kosti regions on both east and west banks, with their respective cotton areas, number and make of engines, horse-power and the estimated life-span of each engine.

Table VIII showing the schemes, with their full supply levels, and the maximum and minimum static heads.

Electrification

As previously mentioned the electrification on the Blue Nile schemes will precede that of the White Nile schemes and the latter will make use of the engines released therefrom.

The survey on the existing pumping stations of the White Nile showed that the engines can be categorized according to their condition into three parts, viz:

(i) Engines which are obsolete and need immediate replacement.
(ii) Engines which cannot be efficiently operated after the end of the Five-Year Plan (1974/75).
(iii) Engines which can be operated economically and efficiently after the end of the Five-Year Plan (74/75).

The required working power per feddan of cropped area is calculated in accordance with the following formula:

$$\text{h.p.} = \frac{Q\ H}{75\ M}$$

*Appendices p. 35

where: 'Q' is the discharge in litres per second per cropped feddan; 'H' is the total head in metres under which the pump will work; and 'M' is the efficiency of the electrical motor/pump sets (taken as 80%).

As most of the schemes lie upstream of Gebel Aulia Dam, the fluctuation of the river is reduced to a minimum and the total head under which the pump will work is estimated as 4.00 metres The working hours per day per pump are taken as 18 hours.

$$Q = \frac{30 \times 10^3}{18 \times 60 \times 60} = 0.46 \text{ litres/sec.}$$

$$\text{Power required per cropped feddan} = \frac{0.46 \times 4}{75 \times 0.8} = 0.031 \text{ h.p.}$$

This figure is considered as an average value and will have to be adjusted when assessing more closely the required capacity of the individual schemes. Therefore the electrification of the existing diesel-driven pumps would entail not only the installation of another type of drive but a complete revision of the design criteria for the individual schemes, with the result of providing the most adequate motor and pump sets to match the necessary head and discharge requirements for the proper irrigation of the associate fields.

Grouping and extension of the schemes

The grouping of the White Nile pumping schemes has been proposed in such a way that 169 of the existing schemes are grouped into 29 schemes. There are another 10 isolated schemes that cannot be grouped (*see* Table XI), and it is suggested that the extensions to these schemes be dealt with when preparing the final report. Table IX shows the grouping of the schemes with the proposed extension and available h.p.

The probable areas of extensions to the existing schemes were mainly proposed by the owners before nationalization. The total proposed area of extensions is approximately 284,000 feddans.

Considering that the horse-power required per cropped feddan is 0.031 the total horse-power of each of the electrified schemes with their extensions included is tabulated as follows:

Item	Scheme	Gross area	Cropped area	h.p. croppe l area x 0.031
1	Malaha	37,724	25,149	779.62
2	El Firdoos	30,059	20,039	621.21
3	El Bahaga	32,649	21,766	674.75
4	Dumo	7,300	4,867	150.89
5	Naifer	36,784	24,523	760.81
6	Goba	24,080	16,053	497.64
7	Birkat El Agab	23,300	15,533	481.52
8	A/Khadra	24,880	16,587	514.20
9	Bandit	10,850	7,233	224.22
10	El Shur	5,927	3,951	122.48
11	El Sulha	6,726	4,484	139.00
12	Guli	11,940	7,960	246.76
13	El Tagawa	33,398	22,265	690.22
14	El Gazala	9,590	6,393	198.18
15	El Entisar	18,585	12,390	384.07
16	El Naeim	26,445	17,630	546.53
17	El Rida	42,515	28,343	878.63
18	Um Galala	34,000	22,657	702.68
19	El Busham	20,800	13,867	429.88
20	Wimer	12,855	8,570	265.67
21	Abger	37,143	24,762	767.62
22	Dueim	43,920	29,280	907.68
23	Um Takal	26,381	17,587	545.20
24	El Fitooh	28,563	19,042	590.30
25	Um Gar	18,845	12,563	389.45
26	Wakara	7,398	11,597	359.51
27	Fatisa	7,744	5,163	160.05
28	A/Heibeir	14,635	9,757	302.47
29	Hassan Alob	25,689	17,126	530.91
	TOTAL	670,689	447,147	13861.57

Thus the total h.p. required for ⅔ cropping is nearly 13,900 and for 100% cropping, 20,850 h.p. It is worth noting that the total power available now on the existing schemes of the White Nile is equivalent to 28,260 h.p. and the gross area is approximately 418,900 feddans.

In pump irrigation, the efficient use and number of pumps in each scheme should be carefully considered. Whenever possible a minimum of four pumps working for 18 hours per day is thought to be the best arrangement; because it will be possible to achieve the same output from three of the pumps working for 24 hours per day, and therefore no separate standby is needed.

Location of pump station sites

The same measures that are to be taken for the proper location of

pump station sites on the Blue Nile will be applied here. Sufficient depth of water adjacent to the river bank at low level, steepness of bank slope and high ground level at pump station site, are usually the main requirements.

Estimated cost

In order to evaluate the cost of electrification of the existing pumping schemes the following points have to be taken into consideration:

(a) Capital cost invested to install the electrical motor and pump sets.
(b) Cost of the electrical overhead transmission lines.
(c) Cost of modifying and grouping the existing schemes to be irrigated from the proposed electrical pumps.
(d) Cost of developing the areas in between or adjacent to the existing schemes.

(a) The cost of installation of electrical motor/pump sets is based on technical literature, engineering practice and the experience of the Ministry of Irrigation & E.P.

(b) The cost of the electrical transmission lines is taken from the C.E.W.C. report in which the cost of transmission lines and feeders on the Blue Nile is estimated as LS.900,000 for an area of 350,000 feddans.

(c) The cost of modification of the existing schemes to be irrigated by electrically-driven motor/pump sets consists mainly of preliminary survey, design, setting out and excavation of the main canals to feed the existing schemes, building of head regulators, modification of the existing regulators, excavation of drains, building of crossings, building of houses and workshops, and establishing telephones and transport. It is also necessary to estimate the cost of the mechanical equipment and surveying instruments required for the electrically-driven pump schemes.

Considering the above information the capital cost required to irrigate one feddan of the existing area by electrical pumps is estimated as shown in table (c) on next page.

(d) Cost of developing the areas in between or adjacent to the existing schemes estimates, is based on the experience, technical reports and engineering practice of the Ministry of Irrigation & E.P. The estimated cost required to irrigate one feddan by electrical motor pumps is summarised in table (d) on next page.

Item	Description	Cost of feddan ⅔ cropping	Cost of feddan 100% cropping
	Table (c)		
1	Cost of the motor/pump sets including taxes, freight, erection and testing	1.500	2.000
2	Construction of the pump house inlet channel and delivery basin	1 000	1 250
3	Preliminaries, survey, design and setting out	0.150	0 150
4	Excavation of main canals to feed the existing schemes	3 000	3.250
5	Building of cross regulators and head regulators to feed the existing schemes	1 .250	1 500
6	Modification of the existing canals		0.750
7	Modification of the cross regulators across the existing canals	0.500	1.500
8	Excavation of drains and crossings for the existing schemes	1.000	1.000
9	Building of houses for the engineers, staff operating the engines and personnel working in water control	2 250	2.500
10	Establishment of telephone system	0.250	0.250
11	Workshops & workshop equipment	0 200	0.200
12	Transport and water supply	0 500	1.000
13	Establishment of offices	0.100	0.100
	TOTAL	11.700	15.450
	Add for contingencies	0.300	0.550
	TOTAL	12.000	16.000
	Cost of transmission lines	1.300	1.300
	GRAND TOTAL	13.300	17.300
	Table (d)		
1	Cost of motor/pump sets including taxes, freight, erection and testing	1.500	2.000
2	Cost of construction of the pumping station	1.000	1.250
3	Preliminaries, survey, design and setting out	0.550	0.550
4	Excavation of main canals to feed the extensions	2.700	3.250
5	Building of cross regulators and head regulators	1.250	1.500
6	Excavation of main canals, Abu XXs and Abu VIs	1.000	1.250
7	Structures on minor canals	2.000	2.250
8	Excavation of drains & building of crossings	1.000	1.000
9	Buildings for engineers and other staff	2.500	2.500
10	Establishment of telephone system	0.250	0.250
11	Workshops and workshop equipment	0.200	0.200
12	Transport and water supply	1.000	1.000
13	Establishment of offices	0.100	0.100
	TOTAL	15.050	17.100
	Add for contingencies	.350	.900
	TOTAL COST	15.400	18.000
	Cost of transmission lines	1.300	1.300
	GRAND TOTAL	16.700	19.300

Considering the above facts the total cost of each electrified scheme is tabulated as follows:

(A) *For ⅔ cropping*

Item	Scheme	Cost of modification of existing area LS. m/ms	Cost of developing the extensions LS. m/ms	Total cost LS. m/ms
1	El Shor Group	59,124.000	15,400.000	74,524.000
2	El Sulha Group	26,700.000	69,300.000	96,012.000
3	Gulli Group	125,820.000	23,100.000	148,920.000
4	El Tagwa Group	115,716.000	365,827.000	481,543.000
5	El Gazala Group	115,080.000	–	115,080.000
6	El Intisar Group	79,020.000	184,800.000	263,820.000
7	El Naeim Group	245,340.000	92,400.000	337,740.000
8	El Rida Group	90,180.000	539,000.000	629,180.000
9	Um Galala Group	288,000.000	154,000.000	442,000.000
10	El Bushara Group	93,600.000	200,200.000	293,800.000
11	El Mellaha Group	374,688.000	100,100.000	474,788.000
12	El Firdos Group	48,708.000	400,400.000	449,108.000
13	El Bahga Group	139,788.000	323,400.000	463,188.000
14	Dimo Group	39,600.000	61,600.000	101,200.000
15	Naifre Group	141,408.000	385,000.000	526,408.000
16	Eoda Group	288,960.000	–	288,960.000
17	Birkat El Agab Group	279,600.000	–	279,600.000
18	Abu Khadra Group	209,220.000	114,653.000	323,873.000
19	Bandit Group	73,200.000	73,150.000	146,350.000
20	Nimir Group	132,180.000	28,336.000	160,516.000
21	Abger Group	304,116.000	181,720.000	485,836.000
22	Dueim Group	298,020.000	293,909.000	591,929.000
23	Wakara Group	182,952.000	33,110.000	216,062.000
24	Um Takal Group	160,092.000	200,816.000	360,908.000
25	El Futuh Group	195,264.000	189,281.400	384,545.400
26	Um Garr Group	195,060.000	39,886.000	234,946.000
27	El Fatisa Group	86,448.000	8,316.000	94,764.000
28	Abu Hibeira Group	96,420.000	101,640.000	198,060.000
29	Hassan Aloub	158,268.000	192,500.000	350,768.000
	TOTAL	4642,584.000	4371,844.400	9014,428.400
	Electrification of isolated schemes (*see* Table XI)	466,776.000		466,776.000
	GRAND TOTAL	5109,360.000	4371,844.400	9,481,204.400
	Say			9,500,000.000
	Local currency LS.		5,035.000 m/ms	
	Foreign currency LS.		4,465.000 m/ms	

(B) *For 100% cropping*

Item	Scheme	Cost of modification of existing area L.S. m/ms	Cost of developing the extensions L.S. m/ms	Total cost L.S. m/ms
1	El Shor Group	78,832,000	18,000,000	96,832,000
2	El Sulha Group	35,616,000	81,000,000	116,616,000
3	Gulli Group	167,760,000	27,000,000	194,760,000
4	El Tagwa Group	154,288,000	427,590,000	581,878,000
5	El Ghazala Group	153,440,000	—	153,440,000
6	El Intisar Group	105,360,000	216,000,000	321,360,000
7	El Naeim Group	327,120,000	108,000,000	435,120,000
8	El Rida Group	120,240,000	630,000,000	750,240,000
9	Um Galala Group	384,000,000	180,000,000	564,000,000
10	El Shara Group	124,800,000	234,000,000	358,800,000
11	El Mellaha Group	499,584,000	117,000,000	616,584,000
12	El Firdos Group	64,944,000	468,000,000	532,944,000
13	El Bahga Group	186,384,000	378,000,000	564,384,000
14	Dimo Group	52,800,000	32,000,000	84,800,000
15	Naifre Group	188,544,000	450,000,000	638,544,000
16	Goda Group	385,280,000	—	385,280,000
17	Birkat El Agab Group	372,800,000	—	372,800,000
18	Abu Khadra Group	278,960,000	134,010,000	412,970,000
19	Baudit Group	97,600,000	85,500,000	183,100,000
20	Nimer Group	176,240,000	33,120,000	209,360,000
21	Abger Group	405,488,000	212,400,000	617,888,000
22	Dueim Group	397,360,000	343,530,000	740,890,000
23	Wakara Group	243,936,000	38,700,000	282,636,000
24	Um Takkal Group	213,456,000	234,720,000	448,176,000
25	El Futuh Group	260,352,000	221,238,000	481,590,000
26	Um Garr Group	260,080,000	46,620,000	306,700,000
27	El Fatisa Group	115,264,000	9,720,000	124,984,000
28	Abu Hebeira Group	128,560,000	118,800,000	247,360,000
29	Hassan Aloub Group	211,024,000	225,000,000	436,024,000
30	Electrification of isolated schemes	622,368,000	—	622,368,000
	GRAND TOTAL	6,812,480,000	5,069,948,000	11,882,428,000
	Say			12,000,000,000
	Local currency	L.S.	6,360,000,000m/ms	
	Foreign currency	L.S.	5,640,000,000m/ms	

Conclusion

Irrigation is a vital factor for any agricultural scheme and without water there is no agriculture. The availability of irrigation water at all times according to proper scientific methods will not only give better and increased production of crops, but also will decrease the running and operation costs of the schemes. As mentioned at the beginning of this report, the existing pumping stations are small, scattered, old and not designed according to normal engineering practice, thus they are not satisfying the field water requirements and hence the efficiency of irrigation is reduced and the cost of operation and running of the schemes is increased. The proposed electrification, grouping and extension of the existing schemes will definitely provide the radical solution for the existing everlasting problems and the irrigation water will then be supplied according to a proper system based on normal scientific methods. Besides increasing the efficiency of irrigation, the grouping and electrification will also increase the cropping area by about 30 %. With the increase in overall efficiency the running costs will decrease, thus decreasing the cost of production of crops. The increase in the cropping area to 30% will increase the tenancies by the same proportion thus giving a wider social life to the inhabitants of the area. It has been proposed to intensify the cultivation in the pumping schemes on the Blue and White Nile to 100% cropping, a factor, which if effected, will add to the many and great advantages of the project of electrification. Besides the economic returns, the intensification will give chances to more families in the locality to own tenancies. In a report submitted by an entomologist in Kosti region, it has been proposed to reduce the tenancy to 9 feddans instead of 15 feddans, thus increasing the tenancies to more than 60%. He suggested that 3 feddans be for cotton, 3 feddans dura and 3 feddans fodder for animals. By analysing the returns from the 15 feddans with the existing rotation, and the returns from the 9 feddans proposed tenancy, a conclusion may be reached that the income of the tenant will be nearly doubled. Thus the intensification for the proposed electrically-driven pump schemes will increase the national income and give a better life to more families. If an economic appraisal is done, the benefits and returns of the proposed project of electrification can be further demonstrated in figures.

APPENDICES

TABLE I
BLUE NILE—EAST BANK (Sennar Region)

Item	Pumping station	Engine make and type	h.p.	Pump size inches	Life in years	Cotton area fds
1	Bonzoga	Grossley-PCQ8	530	27x27	7	3625
		Grossley-PCQ8	530	27x27	7	
2	El Azaza	B/Stone-EV5	225	18x16	5	650
		Bohn & Kh-XR18V	90	14x14	5	
3	Tama	Deutz-A4M428	—	14x14	5	500
		Deutz-A4M428	—	—	5	
4	Zumorka	Skoda-65160	90	14x12	5	400
		Deutz-A4M428	97	14x14	5	
5	Abu Asha	Tangye-LL-10	95	14x12	5	450
		Deutz-A6M517	73	—	5	
6	Farhana	Ruston-9XHR	67	7x7	5	202
		Ruston-9XHR	67	7x7	5	
7	Wad El Reif	Bohn & Kh-KR185	150	16x16	5	800
		B/Stone-EV3	135	14x12	5	
		National-NAV	55	12x10		
8	Maina	Tangye-KL-9B	42	10x8	5	550
		Wilson-MP 11	57/60	12x10	5	
		Deutz-A4M428	99	16x16	5	
9	Wad El For	B/Stone-EV3	135	16x14	5	400
10	Wad Salman South	Deutz-A4M428	135	14x14	7	400
		Bohn & Kh-KR18V	90	14x14	7	
11	Wad Salman North	Crossley-QVD8	400	24x24	7	2800
		Crossley-QVD8	500	24x24	7	
		Tangye-JLD10	134	16x14	7	
		Tangye-JLD10	134	16x14	7	
12	Shasheina	Ruston-6VEB	360	24x24	7	7000
		Ruston-6VEB	360	24x24	7	
		Ruston-6VEB	360	24x24	7	
		Ruston-6VEB	360	24x24	7	
13	El Suki	Ruston-6VEB	360	26x24	7	7000
		Ruston-6VEB	360	26x24	7	
		Ruston-6VEB	360	26x24	7	
		Ruston-6VEB	360	26x24	7	
14	Tireira El Koofa	—	—	—		300
15	Busata	Ruston-5VEB	300	30x24	7	4510
		Ruston-5VEB	300	30x24	7	
		Ruston-5VEB	300	30x24	7	
		Ruston-7VEB	1320	36x36	7	
16	Masarra	Keller-S111ba	720	36x36	7	10005
		Keller-S111ba	720	36x36	7	
		Keller-S111ba	720	48x48	7	
		Ruston-5VEK/3	2610	24x24	7	
17	Um Durraba	Dorman-6LB111	96	12x12	2	200

Item	Pumping station	Engine make and type	h. p.	Pump size inches	Life in years	Cotton area fds
18	El Hegeirat	Ruston-4VEB	240	24x24	7	3120
		B/Stone-EV5	705	18x18	7	
		Ruston-4VEB	240	24x24	7	
19	Abulla South	Ruston-8HR	49	10x8	7	240
		Crossley HD10	40	—	2	
		Ruston-8HR	138	10x8	5	
20	Abulla North	L/B.Stone-EV3	135	14x14	7	450
		Ruston-6XHR	36	6x6	5	
		Ruston-9XHR	238	10x10	5	
21	Rewiena	Tangye-LL-10	95	18x16	5	600
		Tangye-KL-10	80	12x12	5	
22	Amara	Tangye-JL-10	67	12x12	5	400
		Tangye-JL-10	67	12x12	5	
		National-PBSE	164	6x6	5	
23	Kassab South	National-NAX	77		–	800
		Tangye-LL-10	174	14x14	5	
24	Kassab Galiyeen	Tangye-LL-10	95	12x12	5	450
		Ruston-6HR	36	10x10	5	
		Ruston-5XHR	153	8x8	5	
25	Kassab North	Ruston-6VEB	360	24x24	7	5000
		Ruston-6VEB	360	24x24	7	
		Ruston-6VEB	1080	24x24	7	
26	Grisisly	National-R4A4	223	14x12	–	500
		National-R4A4	223	16x14	1	
27	Khayrat	National-F4A4	342	18x16	7	3840
		National-F4A4	342	18x16	7	
		Mirless —	570	26x24	7	
28	Wad El Abbas	Ruston —	500	24x24	7	2845
		Ruston-6VEB	360	18x16	7	
		Ruston-6VEB	360	18x16	7	
29	Assar	National-F4A4	325	28x20	1	1500
		National-F4A4	380	24x20	5	
30	Gadeen	Ruston-VEB/X	450	24x22	7	2860
		Ruston-VEB/X	450	24x22	7	

TABLE II

BLUE NILE—WEST BANK (Sennar Region)

Item	Pumping station	Engine make and type	h. p.	Pump size inches	Life in years	Cotton area fds
1	Abdel Kareim	Ruston-6XHR	36	8x8	2	120
		B/Stone-OP1	24	8x8	2	
2	Kara	National-PBSE	30	6x6	2	120
		Wilson-PM	40	—	–	
3	Wad Hashim North	National-F4A4	342	24x24	5	2850
		Bohn & Kh.-KR185	180	18x16	5	
		Bohn & Kh.-KR185	180	18x16	5	
		National-F4A4	342	20x18	5	
4	Wad Hashim South	Buda-6DC1879	180	16x16	2	1205
		Buda-6DC1879	180	16x16	2	
5	Mayirno North	Tangye-KL-10	80	12x10	5	600
		Tangye-JL-10	67	8x8	5	
		Tangye-LL-10	95	16x16	5	
6	Mayirno(Mid)	Allen-Blost Inj	240	20x18	2	2000
		Tangye-JLD-10	134	16x14	5	
		Tangye-LL-10	95	16x14	5	
7	Mayirno South	Tangye-JLD-10	134	16x16	5	1200
		Tangye-JLD-10	134	16x16	1	
		Allen —	240	20x20	2	
8	El Marafa	Bohn & Khl-KB18V	90	16x16	5	450
		Ruston —	—	14x14	2	
		Allen —	—	14x14	5	
9	Dar El Shifa	Tangye-LL-10	95	16x16	5	600
		Ruston-6XHR	36	10x8	5	
		National NAN	66	14x12	–	
10	El Safa Abdeen	Deutz-A4N517	—	8x8	5	120
		Wilson-PM10	45/49	8x8	5	
11	Islah	National-MAX	77	14x12	–	300
12	Abdeen Elagouz	Ruston-9XHR	67	12x10	5	400
		Tangye-LL-10	95	14x12	5	
13	Wad El Abati	National-NAN	66	12x10		400
		Ruston-7XHR	42	10x8	5	
14	El Falaheen	Ruston-9XHR	67	14x14	5	420
15	Um Shoka	Mirrless-TL4	210	16x14	5	420
		National-SB	42	10x8	1	
		National-DNA	28	—	–	
16	Wad Rabaa	Wilson-AM12	164/70	10x8	5	250
		Tangye-HL-9B	42	8x8	5	
17	El Barno	Ruston-9XHR	67	12x12	5	450
		Ruston-9XHR	67	12x12	5	
18	El Shalal	National-NAN	66	10x10	–	650
		National-NAN	66	10x10	–	
		Deutz-A6M517	90	10x10	5	
19	Humrani	Deutz-MJH438	40	—		120

Item	Pumping station	Engine make and type	h. p.	Pump size inches	Life in years	Cotton area fds
20	El Ramash	Ruston-5VCBX	210	20x20	2	1620
		Bohn & Kh-KR128	270		1	
		Ruston-6VCB	150	20x16	5	
21	El Dabkora	Lister B/S-EV3	125	14x14	5	400
		Tangye-JL-9B	67	14x14	5	
		National-NAV	55	—	—	
22	El Manshia	B/Stone-EV3	135	14x14	5	225
23	Wadel Gazoli	B/Stone-EV3	135	14x14	5	450
24	El Kawkab	Ruston-7XHR	42	10x8	2	400
		National —	99	14x12	2	
25	El Naira	Ruston-9XHR	67	12x10	5	1000
		Ruston-9XHR	66	12x10	10	
		B/Stone-EV4	180	16x14	5	
26	Um Marih	B/Stone-EV6	270	22x22	5	1500
		B/Stone-EV4	180	14x12	5	
27	Layuna	Crossley-QVD8	400	24x24	5	2500
		Crossley-QVD8	330	24x24	5	
		Crossley-PCQ8	530	27x27	5	
28	El Tofeikia	—	—	—	—	—
29	El Dakhla	Ruston-6VEB	360	18x16	7	120
30	El Maggag					

TABLE III
BLUE NILE—EAST BANK

Item	Scheme	F.S.L.	*River level*		*Static head*	
			Maximum	Minimum	Maximum	Minimum
1	Bunzuga	415.81	437.83	429.48	22.33	13.98
2	El Azaza Raway	441.30	421.96	416.13	25.17	19.34
3	Tama	440.02	421.94	416.05	23.97	18.08
4	Zumorks	439.86	421.93	416.00	23.86	17.93
5	Abu Asha	437.17	421.91	415.96	21.21	15.26
6	Furhana	435.10	421.91	415.93	19.17	13.19
7	Wad El Reif	433.26	421.90	415.88	17.38	11.36
8	Maina	433.02	421.90	415.88	17.14	11.12
9	Wad el Fur	431.75	421.89	415.85	15.90	9.86
10	Wad Salman South	431.30	421.88	415.83	15.47	9.42
11	Wad Salman North	431.58	421.88	415.83	15.75	9.70
12	Shasheina	428.50	421.85	415.75	12.75	6.65
13	El Suki	427.22	421.82	415.70	11.52	5.40
14	Tireira Al Kofa	427.55	421.82	415.69	11.86	5.73
15	Busata	427.55	421.80	415.63	11.92	5.75
16	Masara	426.05	421.80	415.63	10.42	4.25
17	Um Doraba	426.35	421.80	415.63	10.72	4.55
18	El Higeirat	429.35	421.75	415.57	13.78	7.60
19	Abulla South	425.87	421.74	415.56	10.31	4.13
20	Abulla North	426.07	421.73	415.56	10.51	4.34
21	Rewina	425.99	421.72	415.54	10.45	4.27
22	El Amara	425.17	421.72	415.52	9.65	3.45
23	Kassab South	425.13	421.70	415.51	9.62	3.43
24	Kassab Mid	425.20	421.70	415.51	9.69	3.50
25	Kassab North	424.61	421.70	415.51	9.10	2.91
26	El Khayrat	418.34	408.54	402.42	15.92	9.50
27	Girisli	417.66	408.95	402.50	15.16	8.71
28	Wad El Abbas	417.66	408.79	402.38	15.28	8.87
29	Assar	416.61	408.30	402.00	14.61	8.31
30	Gadeen	416.94	407.85	401.61	15.33	9.09
31	El Hurga	411.30	401.85	395.30	16.00	9.45
32	Nur El Din	411.30	401.65	395.18	16.18	9 65

BLUE NILE—WEST BANK

Item	Scheme	F.S.L.	River level		Static head	
			Maximum	Minimum	Maximum	Minimum
1	Abdel Karim	422.24	421.70	415.50	6.74	0.54
2	Kara	424.71	421.70	415.50	9.21	3.01
3	Wad Hashim North	428.61	421.71	415.53	13.08	6.90
4	Wad Hashim South	428.33	421.71	415.53	12.80	6.22
5	Mayrno North	430.19	421.75	415.57	14.62	8.44
6	Mayrno Mid	430.05	421.75	415.57	14.48	8.30
7	Mayrno South	430.89	421.75	415.57	15.32	9.14
8	El Marafa	431.20	421.77	415.60	15.60	9.43
9	Dar El Shifa	425.59	421.77	415.60	9.69	3.82
10	El Safa Abdeen	426.70	421.78	415.63	11.07	4.92
11	Islam	426.25	421.79	415.64	10.61	4.46
12	Abdeen El Agos	430.26	421.80	415.64	14.62	8.46
13	Wadel Abbati	431.00	421.81	415.66	15.34	9.19
14	El Falaheen	430.79	421.82	415.68	15.11	89.7
15	Um Shoka	427.65	421.83	415.69	11.96	5.82
16	Wad Rabaa	427.67	421.84	415.75	11.92	5.83
17	El Barno	429.23	421.85	415.75	13.48	7.38
18	El Shallal	429.10	421.86	415.76	13.34	7.24
19	Humrani	427.97	412.87	415.76	12.21	6.10
20	El Dakhla	428.37	421.92	415.76	12.61	6.45
21	El Ramash	428.75	421.88	415.76	12.99	6.87
22	El Dabkara	430.82	421.89	415.84	14.98	8.93
23	El Manshia	429.92	421.90	415.84	14.08	8.02
24	Wad El Gozoli	431.36	421.91	415.85	15.51	9.45
25	El Kokab	431.56	421.92	415.85	15.71	9.64
26	El Nyra	441.96	421.93	415.94	16.02	10.03
27	Um Marih	441.98	421.94	415.95	16.03	10.04
28	El Layona	437.86	421.95	415.97	11.89	6.91
29	Seiro	434.50	421.96	415.97	18.53	12.54

TABLE IV

Schemes which lie between Sennar and Shasheina and downstream of the Dam

BLUE NILE—EAST BANK

Item	Scheme	No. of engines	Make & type	Life in years	h.p.
1	Kassab North	3	Ruston 6VEB	7	1080
2	Kassab Galiyeen	1	Tangye LL-10	5	95
		1	Ruston 6HR	5	36
		1	Ruston 5XHR	5	22
3	Kassab South	1	Tangye LL-10	5	95
4	El Amara	1	Tangye JL-10	5	134
		1	National PBSE	5	30
5	Reweina	1	Tangye LL-10	5	95
		1	Tangye KL-10	5	80
7	Abulla North	1	L/B/Stone EV3	7	135
		1	Ruston 6XHR	5	36
		1	Ruston 9XHR	5	67
7	Abulla South	2	Ruston SHR	6	98
		1	Grossley HD-10	2	40
8	El Hegeirat	2	Ruston 4XEB	7	480
		1	L/B/Stone EV5	7	225
9	Um Durraba	1	Dorman 6 LB111	2	96
10	El Massara	3	Koller S11BA	7	2160
		1	Ruston 5 VEBX/3	7	450
11	El Busata	3	Ruston 5VEB	7	900
		1	Ruston 7 VEB	7	420
12	Tereiva El Koofa				
13	El Suki	4	Ruston 6 VEB	7	1440
14	Shasheina	4	Ruston 6 VEB	7	1440
15	Girisly	1	National R4A4	1	223
16	El Khayrat	2	National F4A4	5	684
		1	Mirrless F6	7	570
17	Wad El Abbass	1	Ruston VEBX	5	450
		3	Ruston VCB	5	630
18	Assar	1	National F4A4	1	425
		1	National FRA4	5	380
19	Gadeen	2	Ruston VEBX	7	900
	TOTAL	50			13816

Scrap and obsolete engines in schemes which lie between Sennar and Shasheina and downstream of the Dam

Item	Scheme	No. of engines	Make & type	h.p.
1	Kassab South	1	National NAX	77
2	Girisly	1	National R4A4	223
	TOTAL	2		300

Scrap and obsolete engines in schemes which lie between Sennar and Singa

1	Kara	1	Wilson PM	40
2	El Marafa'a	1	Ruston	—
		1	Allen	—
3	Dar El Shifa	1	National NAW	66
4	El Safa Abdeen	1	Wilson PM10	45
5	El Islah	1	National MAX	77
6	Abdeen El Agose	1	Tangye LL-10	95
7	Wad El Abati	1	National NAW	66
8	Um Shoka	1	National DNA	28
9	Wad Raba'a	1	Wilson AM12	64
10	El Shallal	2	National NAW	132
11	Hormrani	1	Deuts MJH 438	40
12	El Dabkara	1	National NAB	55
	TOTAL	14		708

TABLE V

Scheme grouping (Sennar Region)

BLUE NILE—EAST BANK

Group 1: *Hurga Group*

Item	Scheme	Exist. area	Propd. exten.	Total area	No. of engines	h.p.	Life in years
1	El Hurga	12555	15000	27555	3	1800	7-7-7
2	Norel Din	9015	15000	24015	3	1350	7-7-7

Group 2: *Kassab Group*

1	Kassab N.	15000	2500	17500	3	1080	7-7-7
2	Girisly	1500	—	1500	1	223	1
3	El Khayrat	11505	—	11505	3	1254	5-5-7
4	Wad El Abbas	8535	—	8535	4	1080	5-5-5-5
5	Assar	4500	4500	9000	2	705	1-5
6	Gadeen	7140	—	7140	2	900	7-5
	TOTAL	48180	7000	55180	15	5242	

Group 3: *El Hegeirat Group*

1	El Hegierat	9360	3000	12360	3	705	7-7-7
2	Abulla South	720	—	720	3	138	7-2-5
3	Abulla North	1350	—	1350	3	238	7-5-5
4	El Amara	1200	—	1200	3	164	5-5-5
5	Reweina	1800	—	1800	2	175	5-5
6	Kassab South	2400	—	2400	2	172	0-5
7	Kassab Gal.	1350	1000	2350	3	153	5-5-5
	TOTAL	18180	4000	22180	19	1745	

Group 4: *Busata Group*

1	Tereira Koofa	900	—	900			
2	El Busata	13530	—	13530	4	2610	7-7-7-7
3	El Masarra	30015	—	30015	1	96	2
4	Um Durraba	600	2000	2600	4	1320	7-7-7-7
	TOTAL	45045	2000	47045	9	4026	

Group 5: *Shasheina Group*

1	El Suki	21000	—	21000	4	1440	7-7-7-7
2	Shasheina	21000	—	21000	4	1440	7-7-7-7
	TOTAL	42000	—	42000	8	2880	

Item	Scheme	Exist. area	Propd. exten.	Total area	No. of engines	h.p.	Life in years
Group 6: Wad Salman Group							
1	Wad Salman N.	8400	—	8400	4	1168	7–7–7–7
2	Wad Salman S.	1600	5000	6600	2	90	7–7–7–7
3	Wad El For	1600	3000	4600	1	135	5
4	Maina	1650	3000	4650	3	102	5–5–5
5	Wad El Reif	2400	7000	9400	3	340	5–5–5
	TOTAL	15650	18000	33650	13	1835	
Group 7: Karkog Group							
1	Zumorka	1200	—	1200	2	187	5–5
2	Abu Asha	1350	—	1350	2	168	5–5
3	Karkog	7000	—	7000	–	—	—
	TOTAL	9550	—	9550	4	355	

Scheme grouping (Sennar Region)
BLUE NILE—WEST BANK

Item	Scheme	Exist. area	Propd. exten.	Total area	No. of engines	h.p.	Life in years
Group 1: El Nayra Group							
1	Sairo	1800	—	1800	2	250	5–5
2	El Layona	7500	7800	15300	3	x260	5–5–5
3	Um Marrib	4500	6840	11340	2	450	5–5–5
4	El Nayra	3000	—	3000	3	313	5–10–5
	TOTAL	16800	14640	31440	10	2273	
Group 2: El Ramash Group							
1	El Kawkab	1200	3000	4200	2	141	2–2
2	Wad El Gezouli	1350	3000	4350	1	135	5
3	El Manashia	900	—	900	1	135	5
4	El Dbakara	1200	—	1200	3	247	5–5–0
5	El Ramash	4860	4500	9360	3	420	2–1–5
6	El Dakhla	360	—	360	—	—	
7	Humrani	450	—	450	1	40	0
8	El Shalla!	1950	3000	4950	3	222	0–0 5
9	El Barno	1350	—	1350	2	134	5–5
10	Wad Raba's	1950	—	1950	2	106	5–5
	TOTAL	15570	13500	29070	18	1580	
Group 3: El Safa Group							
1	Um Shoka	1350	—	1350	3	280	5–1–0
2	El Fallaheen	1260	1000	2260	1	67	5
3	Wad El Abati	1200	2000	3200	2	108	0–5
4	Abdeen El Agos	1200	2000	3200	2	162	5–0
5	El Islah	900	1000	1900	1	77	0
6	El Safa Abdeen	360	—	360	2	49	5–50
7	Dar El Shifa	1800	—	1800	3	197	5–50
8	El Marafa	1350	2000	3350	3	90	5–0–0
	TOTAL	9420	8000	17420	17	1030	
Group 4: Wad Hashim Group							
1	Mayirno South	3600	—	3600	3	508	5–x–2
2	Mayirno Awsat	6000	—	6000	4	603	2–5–5–5
3	Mayirno North	1800	—	1800	3	242	5–5–5
4	Wad Hashim S.	3615	—	3615	2	360	2–2
5	Wad Hashim N.	8574	—	8574	4	1044	5–5–5–5
	TOTAL	23589	—	2389	16	2757	

TABLE VI

Cost of electrification of isolated schemes

BLUE NILE

Item	Scheme	Gross area	Cost of modification	
			⅓ cropping	100% cropping
1	Abdel Karim	360	5,400,000	6,840,000
2	Kara	360	5,400,000	6,840,000
3	Bonzoga	10875	163,125,000	206,625,000
4	El Azaza	1950	29,250,000	37,050,000
5	Tama	1500	22,500,000	28,500,000
6	Farhana	1350	20,250,000	25,650,000
	TOTAL	16395	245,925,000	311,505,000

TABLE VII

WHITE NILE—EAST BANK (Kosti Region)

Item	Pumping station	Engine make and type	h.p.	Pump size inches	Life in years	Cotton area fds
1	Dabat Alali (S.B.)	Deutz-A6M517	88	18x16	5	750
		Deutz-A6M517	88	10x8	5	
2	Majak	Skoda —	—	10x8	1	—
		Deutz-MJH436	—	8x8	–	
3	Gawandeet	B/Stone-R.P.	37	10x8	2	200
4	Lalbur	National-B.S.E.	22	10x8	5	400
		National-B.S.E.	22	10x8	5	
		Skoda-6x-110	90	14x14	2	
5	Bandid	Tangye-LIG	42/46	10x8	5	350
		B/Stone- S.P.	50	12x12	5	
6	Khor Agayz	National-B.S.E.	22	10x8	2	200
		Tangye -E.W.H.	24	8x8	2	
7	Faywar South	National-R.B.	35	10x8	5	860
	Faywar North	National-NAV	55	12x10	–	200
		B/Stone-T.P.	77	16x14	5	
8	Abu Khadra	Ruston-6VEB	360	24x24	5	400
		Ruston-6VEB	360	24x24	5	
9	Magara	M.W.M. R.H.S526V	105	18x16	2	685
		Robson-C.H.W.	70	14x12	2	
		Robson-C.H.W.	40	12x10	2	
10	El Geigar	S.K.L.-4NAD24	77	18x18	5	1000
		National-NAY	65	12x12	–	
		Ruston-7HXR	42	12x10	5	
11	Birkat El Agab	Ruston-6VEB	360	24x24	5	4380
		Ruston-6VEB	360	24x24	5	
		Ruston-6VEB	480	36x36	5	
12	Tayba	B/Stone-EV3	135	20x20	2	750
		Crossley HH10	46	10x8	2	
13	El Remeila South	B/Stone-EV3	90	16x16	5	750
		Tangye-GL9B	34/37	10x8	5	
		Tangye-JL-10	73	12x12	2	
14	El Remaila North	S.K.M.-3NVD18	42	10x8	5	150
		Tangye-GL-9B	34	10x8	2	
15	Hamadauk	Ruston-9XHR	67	16x16	5	720
		Ruston-7XHR	42	12x10	5	
16	Goz Fami (El Taysha)	Ruston-CHT	50	10x10	2	550
		Skoda-HB6	—	14x14	2	
17	Goda	B/Stone-EV5	225	24x24	5	4130
		B/Stone-EV5	225	24x24	5	
		B/Stone-EV5	225	24x24	5	
18	El Adl	Ruston-8HR	49	10x8	2	200
19	Muna	Deutz-NJH438	40	10x10	–	330
		National-MAK	77	14x14	–	
20	El Gana'a	N.A.N.-W3V175/22A	78/85	14x14	2	500
		Ruston-9XHR	67	14x12	5	

Item	Pumping station	Engine make and type	h.p.	Pump size inches	Life in years	Cotton area fds
21	El Alegaya	Tangye-GL-89B	34/37	10x8	2	300
		Ruston-8HR	49	14x14	2	
22	El Warrad	National-R.B.	35	10x8	5	300
		Crossley-1HH9	43	12x12	5	
23	Dabat Bosin	National-NAX	77	14x14	–	400
		National-NAX	55	10x10	–	
24	El Magabi	B/Stone-T.P.	77	16x14	5	500
		B/Stone-S.P.	50	14x12	5	
25	El Naara	National-R.B.	35	8x8	5	300
		Ruston-7XHR	42	14x14	2	
26	Abu Ramad	Ruston-6XHR	36	8x8	5	150
		Deutz-NAH220	22	8x6	2	
		Tangye-DWH3	20	8x6	5	
27	El Furat	B/Stone-E.H	50	12x10	5	300
28	El Makhalief	Ruston-5HR	26	6x6	5	68
		B/Stone-JP1	14	5x5	5	
		National-O.B.S.E.	22	6x6	2	
29	Mahd El Sharief	Ruston-6XHR	36	8x8	10	400
		Ruston-6XHR	36	8x8	10	
		Ruston-6XHR	49	12x10	15	
30	El Gebelein	Wilson —	33/36	8x6	1	—
		Deutz —	30	8x8	–	
31	Musran El Sabaha	Deutz- MAX320	25	—	2	150
32	Musran El Sabaha	Ruston-7XHR	42	10x10	2	250
33	Musran El Taysha	Deutz-MJH436	30	10x8	–	150
34	Aradeeb El Gabelien	Skoda-6S-110	90	14x14	5	270
		Petter-FH	40	10x8	5	
35	Naifr	Skoda-6S-275	390	24x24	5	2040
		Skoda-6S-275	390	24x24	5	
		Skoda-6S-275	390	24x24	5	
36	Marwa	Deutz-A4M517	58	14x14	5	400
		Herford-BS	40	14x12	5	
37	Taksaboon	Deutz-A4M517	58	14x14	5	550
		Deutz-A4M528	—	24x22	10	
38	Tabat	Pett r-FH	40	10x8	5	300
		B/Stone-OP1	24	6x6	5	
39	Dimo	National-NAV	55	10x8		400
		E.K.M.-3NVD21/2	65	14x12	5	
40	Islah	National-NAV	50	12x10	–	300
41	Sharrad	B/Stone-S.P.	50	14x14	2	400
		B/Stone-T.P.	77	16x16	2	
42	El Amal	Tangye-IL-9B	50	12x10	2	200
43	El Aradeeb	Tangye-JI-10	67	14x12	2	340
		Tangye-IL-9B	50	12x10	2	
44	El Zeaif	Ruston-8HR	49	12x10	2	300
		Herford-A/S	30	10x10	2	
45	El Bahaga	Ruston-8HR	49	14x12	5	400
		Ruston-7XHR	42	10x8	2	

Item	Pumping station	Engine make and type	h.p.	Pump size inches	Life in years	Cotton area fds
46	El Hudaib South	Deutz-NAH320	26	6x6	5	68
		Crossley-HH7	25	6x6	5	
47	El Hudaib North	National-BBSE	30	10x8	2	200
48	El Abyad	B/Stone-S.P.	50	14x12	5	375
49	El Makh. Abu Zeid	Ruston-8HR	49	12x10	2	200
50	Khor Agwal	Ruston-8HR	49	14x14	5	500
51	El Omara	B/Stone-R.P.	37	12x12	2	200
52	Hilat Abbas	Ruston-6HE	36	8x8	2	150
		B/Stone-OP1	34	10x8	7	
53	Rabak	Deutz-MAH320	26	10x10	7	150
		Deutz-MAH916	16	6x6	2	
54	Zainooba	B/Stone-R.P.	34	10x8	7	490
		Electric —	80		7	
55	El Firdos	Deutz-A6J517	90	14x14	5	515
		Tangye-GL9B	34	—	5	
56	Hagar Ass. East	Petter-FH	40	12x10	5	348
		Crossley-HDH	55	14x12	2	
57	Hagar Ass. West	Ruston-5WHR	22	—	5	100
		Ruston-5WHR	22	6x6	5	
58	El Gezira Aba	Ruston-9XHR	67	14x14	10	2600
		Crossley-0123	80	14x14	7	
		Ruston-6VCB	150	20x20	7	
		B/Stone-EV5	225	30x30	5	
		Lister —	74.4	14x14	2	
		Deutz-A6M517	90	14x14	5	
		Deutz-MJH436	30	8x8	–	
59	El Debeibat	Deutz-MAH320	26	12x10	7	400
		B/Stone-R.P.	37	8x8	2	
		B/Stone-T.P.	77	16x16	2	
60	El Marabee	National-NAV	55	12x12		264
		B/Stone-T.P.	70	12x12	1	
61	Fudat El Garnouk	B/Stone-O.P.	24	8x8	1	70
62	El Abassiya	B/Stone-O.P.1	24	6x6	2	85
		B/Stone-O.P.1	24	6x6	5	
		B/Stone-O.P.1	24	6x6	5	
63	Sheikan	Ruston-10HRC	156	18x18	2	—
		Ruston-10HRC	156	18x18	5	
		Bohn & Kh-KR28V	300	24x24	5	
64	Um Barad	Tangye-GL9B	34	10x8	2	
		Ruston-7HR	—	10x8	2	
65	El Malaha	Sulzer-Obsolete	150	18x18	–	6102
		Ruston-10HRC	156	18x18	2	
		Ruston-10HRC	156	18x18	2	
66	Sharg El Gasir	Ruston-9HRC	767	14x14	5	1000
		Ruston-10HRC	156	18x18	2	
67	El Tayif	Tangye-LI-10	95	20x20	5	1040
68	El Shawal	Ruston-10HRC	156	20x18	5	1512
		Ruston -10HRC	156	20x18	2	
69	El Dakhla	B/Stone-R.P.	37	12x12	5	300

WHITE NILE—WEST BANK (Kosti Region)

Item	Pumping station	Engine make and type	h.p.	Pump size inches	Life in years	Cotton area fds
1	El Shor Haifa (East Bank)	B/Stone R.P.	34	10x8	5	400
		B/Stone R.P.	34	12x10	5	
2	El Shor	Ruston-8HR	49	14x10	5	685
		Petter-FH	40	12x12	2	
		Ruston-9HR	58	16x16	5	
3	El Shor Goba	Petter-FH	40	10x8	5	420
		Petter-FH	40	10x10	5	
4	El Bayaha	Ruston-5WHR	22	8x6	2	68
5	Rawdat El Mukhtar	Deutz-MAH916	16	6x6	10	76
		Deutz-MAH220	22	6x6	10	
6	El Genaiga	Ruston-7XHR	42	10x10	10	230
7	Kashoma	National-0.B.S.E.	22	6x6	2	72
8	Abu Agarib	Slavia —	15	6x6	10	72
9	El Sulha	Deutz-MJH438	40	14x14		215
10	El Safa	Wilson-P.M9	40/44	—	1	200
11	El Tagadom	Deutz-MAH320	26	8x8	5	150
12	El Karama	B/Stone-EH1	50	14x14	10	400
		National-S.P.	42	12x10	10	
		Deutz-MAH914	11	4x4	5	
		B/Stone —	10	4x4	5	
13	Wad Shamam	B/Stone-OP2	24	8x8	5	500
		B/Stone-EH1	50	14x14	–	
		B/Stone-OP1	24	8x8	5	
14	El Bidaya	Deutz -MAH436	30	6x5	–	65
15	Golli	Ruston-10HRC	156	22x22	5	1360
		Sulzer-38RP25	150	18x18	2	
16	Um Ganeen	Ruston-9XHR	67	14x12	2	520
		B/Stone-SP.	50	14x12	2	
17	Abu Muhar	Ruston-7XHR	42	10x8	5	
		Ruston-9XHR	67	14x12	5	
		Ruston-7XHR	42	10x8	5	
18	El Fashashoya	Deutz-MIH438	40	12x10	10	410
		B/Stone-S.P.	50	12x10	1	
		B/Stone-S.P.	50	12x10	5	
19	El Gabal	Ruston-6XHR	36	12x12	5	215
20	El Taweela	Sulzer-38RKP25	150	18x18	1	860
		Ruston-10HRC	156	18x18	5	
21	Mahd El Nimir	Ruston-7XHR	42	12x10	5	228
22	Abu Girba	National-P.S.	30	8x8	2	305
		National-P.S.	30	8x8	5	
23	El Tagwa	Ruston-8HR	49	14x14	2	400
		Ruston -6HR	36	8x8	10	
24	El Salam	Deutz-HAH916	16	6x6	2	68
		Deutz-MAH220	22	6x6	5	

Item	Pumping station	Engine make and type	h.p.	Pump size inches	Life in years	Cotton area fds
25	El Abassyia	Tangye-IL9B	50	10x8	2	150
26	Um Hani	Ruston-6VCB	150	24x24	5	4000
		Ruston-6VCB	150	24x24	5	
		Ruston-6VCB	150	24x24	5	
		Ruston —			1	
27	El Regeiga (S.W.)	B/Stone-RP	37	10x8	5	330
28	El Regeiga South	Bohn & Kh-KR184	45	12x10	5	395
		Wilson-PM8	33/36	8x6	2	
29	El Gazala	VEB.-8DV136	300	30x24	10	2355
		VEB.-8DV136	300	30x24	10	
		VEB.-8DV136	300	30x24	10	
30	Um Hayaya	Ruston-8HR	49	12x10	5	45
		Crossley-HH10	46	12x10	5	
31	El Zelait	Crossley-QVD5	250	24x24	5	4500
		Crossley-QVD5	250	24x24	5	
		Crossley-QVD5	250	24x24	5	
		Crossley-QVD5	250	24x24	5	
32	El Shawal	Crossley-HH10	75	14x14	5	400
33	El Rideis	Ruston-7XHR	42	8x8	5	300
34	El Intisar	Tangye-IL-9B	50/55	12x12	2	350
35	El Sirour	Tangye-JL-10	67/73	14x12	1	300
36	El Sa'ada	Crossley-HH10	46	12x12	2	400
		B/Stone-OP1	24	6x6	5	
37	Jori	Ruston-8HR	49	14x12	2	445
38	Um Habab	E.K.M.-2NVD18	25	10x8	5	535
		E.K.M.-2NVD21/2	65	14x14	5	
		Wilson-PM	40	—	1	
39	Zamzam	B/Stone-OP2	24	12x10	5	585
		Ruston-9XHR	67	14x12	10	
40a	El Arak	Ruston-9XHR	67	16x14	5	515
40b	El Naeem	Deutz-A6M428	–	24x24	10	3000
		A6M428	—	26x26	10	
41	Um Dalgam	Ruston-5VCB	125	18x18	5	1230
42	El Debeikraya	Ruston-8XHR	—	12x10	5	300
43	El Aradeeb	Wilson-PM.	40	12x10	2	200
44	El Resheidi	Ruston-9XHR	67	10x10	5	400
45	El Gala'a	Deutz-6S-110	90	14x14	2	405
46	Um Irig	Ruston-8HR	49	12x10	5	400
		Ruston-7XHR	42	10x8	5	
47	Dabat El Tor	Ruston-CHX2	170	18x16	2	1300
		B/Stone-TP	77	18x14	2	
48	El Hida	Ruston-9XHR	67	12x12	10	375
49	Dakhla	B/Stone-R.P.	37	12x12	5	300
50	Um Galala	Ruston-4VEB	240	24x24	10	5000
		Ruston-4VEB	240	24x24	10	
		Ruston-4VEB	240	24x24	10	
		Ruston-4VEB	240	24x24	10	

Item	Pumping station	Engine make and type	h.p.	Pump size inches	Life in years	Cotton area fds
51	Karshawal	B/Stone-S.P.	50	—	2	—
52	El Kiwaik	Ruston-5VEB	300	24x24	5	3000
		Ruston-5VEB	300	24x24	5	
53	El Bir Kadok	Ruston-9XHR	67	14x14	5	550
		Herford-LVM140	12	—	1	
54	El Bushara	Deutz-4-S110	49	14x12	2	1000
		B/Stone-EV2	90	16x14	5	
55	Dakana	B/Stone-T.P.	77	16x14	2	550
		B/Stone-S.P.	50	12x10	2	
56	Lilo Amara	B/Stone-S.P.	50	10x8	2	1050

TABLE VII *(continued)*
WHITE NILE — WEST BANK (Dueim Region)

Item	Pumping station	Engine make and type	h.p.	Pump size inches	Life in years	Cotton area fds
1	Mabrouka	B/Stone-S.P.	37	10x10	2	504
		B/Stone-S.P.	50	12x12	1	
		B/Stone-S.P.	50	14x14	1	
2	Talha	National-NAV	55	14x14	—	420
		Ruston-HR	55	12x12	10	
3	Um Arda	B/Stone-S.P.	50	14x14	10	440
		Glander		10x10	2	
4	Irler	Mirless-TL4	210	20x20	1	3354
		Masohimen-6DV136	225	24x24	10	
5	Shatawi	Mirless-TL4	210	20x20	10	144
		Deutz-MJH438	40	10x8		
		Deutz-MCH320	26	8x8	1	
6	Nimer	Merceies-M204B	100	14x14	7	340
		Deutz				
7	Bara	B/Stone-BP33333	37	12x10	1	428
		Skoda-6-S110	90	10x10	7	
8	El Ekhalid	Ruston-H.R.	36	10x10	2	316
		Petter F.-FH	40	10x10	2	
9	Wasim	Deutz-MAH916	16	6x6	5	88
10	Eraifat	Herford-A-S	30	10x10	1	280
		Skoda-4S-110	60	10x10	7	
11	Mabrouk	Deutz-MAH320	26	10x10	5	288
		B/Stone-R.P.	37	10x10	5	
12	Khanger	Skoda-6S110	90	14x14	2	1568
		Skoda-6S110	60	14x14	2	
		Deutz-A6M517	90	20x20	10	
13	Khanger Booster	Petter F.-F.H.	40	12x12	1	
		National-S.P.	42	16x16	1	
14	Goz El Baid	Skoda-6S110	90	14x14	7	496
		B/Stone-EHI	50	14x12	10	
15	Rahwat	B/Stone-EV2	90	18x16	7	1556
		B/Stone-EV2	90	18x16	7	
16	Rahawat Booster(A)	B/Stone-T.P.	70	16x14	1	
		B/Stone-T.P.	70	16x14	1	
17	Rahawat Booster(B)	B/Stone-EHP	50	14x12	1	
		B/Stone-O.P.	22	10x8	1	
18	El Watun	(will be watered from El Gardood) (one B/stone engine transferred to El Ain)				308
19	El Eitilaf	Skoda-4S110	60	12x12	5	500
		E.K.M.-3NVD	65	12x12	2	

Item	Pumping station	Engine make and type	h.p.	Pump size inches	Life in years	Cotton area fds
20	Salati	B/Stone-S.P.	50	16x16	1	304
		B/Stone-S.P.	50	14x14	1	
21	El Ain	Tangye-JL-10	67	14x14	2	1672
		L.B/Stone-EV4	180	16x16	7	
		L.B/Stone-EV2	90	16x16	7	
22	Insaf	Ruston-H.R.	42	10x10	1	304
		National-S.P.	42	12x10	1	
23	Rawdan	Ruston-H.R.	42	14x14	5	496
		Ruston-H.R.	42	10x10	5	
		Ruston-H.R.	42	10x10	5	
24	Um Takkal	National-NAX	77	14x12	–	676
		National-NAX	77	14x12	–	
		Mirless-T14	162	20x20	5	
		Mirless-T14	210	18x16	5	
25	Magam	B/Stone-T.P.	77	14x14	1	950
			77	16x16	1	
26	Abu Gimri	B/Stone-EH1	50	10x10	1	442
		B/Stone-T.P.	77	16x16	5	
		B/Stone-S.P.	50	12x12	5	
27	Minidreeb	L.B/Stone-TVP	154	16x14	5	1600
		B/Stone-EV5	225	26x26	10	
28	Mahala (A)	B/Stone-R.P.	34	10x10	1	400
	(B)	B/Stone-R.P.	34	10x10	1	
		B/Stone-S.P.	50	14x14	5	
29	Atshan	B/Stone-T.P.	77	16x16	7	400
30	Firdos	B/Stone-T.P.	77	16x16	5	275
		B/Stone-R.P.	37	10x10	5	
31	Rahama (A)	B/Stone-S.P.	50	12x12	1	1254
	(B)	Skoda-6S110	90	14x14	7	
		Skoda-6S110	90	14x14	7	
		Skoda-6S110	90	14x14	10	
32	Gamer El Gardod	P.Fielding-F.H.	40	12x10	1	820
	(A)	P.Fielding-F.H.	40	12x10	1	
	(B)	P.Fielding-F.H.2	80	16x14	7	
	(B)	P.Fielding-F.H.2	80	16x14	7	
33	Hiafa	B/Stone-S.P.	50	14x14	7	500
		Ruston -H.R.	40	10x10	7	
34	Fitoh	Ruston-H.R.	40	10x10	5	524
		Skoda-6S110	90	14x14	5	
35	Salam	B/Stone-S.P.	50	14x14	5	380
		Crossley-1HH8	35	12x12	7	
36	Mona	Ruston		10x10	1	304
37	Gardod El Hag	B/Stone-OP1	24	8x8	1	260

Item	Pumping station	Engine make and type	h.p.	Pump size inches	Life in years	Cotton area fds
38	El Falah	B/Stone -OP1	24	8x8	5	144
		Ruston-2YWAMK2	25	6x6	5	
39	Bojo	National-R.B.	35	10x8	7	160
40	Taif	Ruston-H.R.	40	10x10	5	540
		Ruston-H.R.	66	14x14	7	
41	El Bushara	Tangye-JL-10	67	14x14	5	816
		Tangye-JL-10	67	14x14	5	
		B/Stone-R.P.	37	10x10	5	
		Tangye-LL93	55	14x14	2	
42	Shabasha West	Deutz-MAN320	26	10x10	2	440
		Ruston-8HR	49	12x10	10	
		Ruston-8HR	49	12x10	10	
43	El Hilal	Ruston-7HR	40	10x8	5	250
		Deutz	26	8x8	5	
44	El Tagwa	(All engines transferred to Minidreeb)				620

WHITE NILE—EAST BANK (Dueim Region)

Item	Pumping station		Engine make and type	h.p.	Pump size inches	Life in years	Cotton area fds
1	Wad Diwiw		Tangye-JL-10	67	16x16	5	504
			Skoda-4S-160	90	14x14	2	
2	Hassan Alob	(A)	Tangye	120	16x16	1	630
		(B)	Tangye-LL-10	95	16x14	5	
3	Konoz	(A)	Sulzer 38RB 25	150	22x22	7	1000
		(B)	Vicker P.	100	14x14	1	
			Crossley-QVD3	150	20x20	10	
4	Abu Hindi	(A)	Ruston-HRC	155	22x22	1	1000
		(B)	Ruston-HRC	155	22x22	7	
5	Mashkor El Kawa		B/Stone-EH1	50	14x14	7	400
			Skoda-6S-110	90	12x12	7	
6	Abu Hibiera		B/Stone-S.P.	50	10x10	5	300
			Deutz MIH438	40	10x10	5	
7	Nazaha		Crossley-0120	53	14x14	1	412
			Ruston-HR	42	12x12	7	
8	Fatih		Deutz MAH320	26	6x6	5	208
			R.A.Lister				
			Crossley		10x10	1	
9	Arkiz		National-PBSE	30	8x8	1	144
			National-PBSE	22	8x8	1	
10	Wad El Nogomi	(A)	Tangye-IL9B	50	14x14	5	408
		(B)	Crossley-0120	53	14x14	1	
			P. Fielding-FH2	80	16x16	–	
11	Dobasi		Ruston	75	14x14	–	420
			Skoda	90	14x14	7	
			Crossley	65	12x12	1	
12	Mongara		Skoda-4S-110	80	12x12	1	300
			B/Stone-OP1	24	8x8	5	
			Skoda-4S-110	60	12x12	7	
13	Basatin		Crossley-1HH7	27	8x8	1	120
			Skoda	45	8x8	5	
14	Gamalab	(A)	Ruston-HR	66	14x12	7	400
		(B)	Ruston-HR	66	14x12	7	
		(C)	Ruston-HR	66	20x18	7	
15	Wad Nimir		Ruston-YDA	32	16x16	10	876
			Ruston-YDA	32	16x16	10	
			Ruston-YDA	32	16x16	10	
			Ruston-6FR6	—	14x12	10	
16	Wad Nimir Booster		Ruston-Lister	10	10x10	5	
			Ruston-Lister	10	10x10	5	
			Ruston-Lister	10	10x10	5	

Item	Pumping station	Engine make and type	h.p.	Pump size inches	Life in years	Cotton area fds
17	Abger	Ruston-3VCB	75	30x30	10	3348
		Ruston-3VCB	75	30x30	10	
		Ruston-3VCB	75	30x30	10	
		Ruston-3VCB	75	30x30	10	
		Ruston-3VCB	75	30x30	10	
18	Shabasha	Ruston-5VPH	54	24x24	7	1458
		Ruston-5VPH	54	24x24	7	
19	Wakara	Ruston-5VPH	54	24x24	7	1548
		Ruston-5VPH	54	24x24	7	
		Ruston-5VPH	54	24x24	7	
20	Um Gerr	Allen-5S30B	195	30x30	5	3318
		Allen-5S30B	195	30x30	5	
		Allen-5S30B	195	30x30	5	
		Allen-5S30B	195	30x30	5	
21	Dueim	Ruston-3VCB	75	24x24	7	710
		Ruston-3VCB	75	24x24	7	
		Ruston-3VCB	75	24x24	7	
22	Fatisa	Allen-5S30B	195	30x30	5	1665
		Allen-5S30B	195	30x30	5	
		Allen-5S30B	195	30x30	5	
23	Hashaba	Allen-5S30B	195	30x30	5	2593
		Allen-5S30B	195	30x30	5	
		Allen-5S30B	195	30x30	5	
		Allen-5S30B	195	30x30	5	
		Allen-5S30B	195	30x30	5	

TABLE VIII

WHITE NILE—EAST BANK (Kosti Region)

Item	Scheme	F.S.L.	River level		Static head	
			Maximum	Minimum	Maximum	Minimum
1	Dabat Allali	387.48	379.52	377.82	9.66	7.96
2	Gawandit	386.39	379.42	377.75	8.64	6.97
3	Latbur	387.20	379.39	377.72	9.48	7.48
4	Bandid	7.67	379.36	377.71	9.96	8.31
5	Khor El Aggiz	5.80	379.33	377.69	8.11	6.47
6	Faywar South	5.98	379.30	377.68	8.30	6.68
7	Faywar North	5.83	379.27	377.66	8.17	6.56
8	Abu Khadra	7.89	379.24	377.65	10.24	8.68
9	Magara	7.48	379.21	377.63	9.85	8.27
10	El Gelgar	7.48	379.18	377.62	9.86	8.30
11	Birkat El Agab	387.02	379.16	377.59	9.43	7.86
12	Abu Ramad	385.69	378.72	377.30	8.39	6.97
13	El Furat	5.48	378.69	377.28	8.20	6.79
14	El Makhaleif	5.07	378.66	377.26	7.81	6.41
15	Meheir El Sharif(N)	385.03	378.63	377.24	7.79	6.40
16	Meheir El Sharif (S)	5.11	378.60	377.23	7.88	6.51
17	Naif	384.68	378.42	377.12	7.56	6.26
18	Marwa	382.55	378.39	377.10	5.45	4.16
19	Taksaboon	382.95	378.36	377.08	5.87	4.59
20	Tabat	385.43	378.33	377.06	8.37	7.10
21	Dimo	383.34	378.30	377.05	6.29	5.04
22	Islah	385.59	378.27	377.03	8.56	7.32
23	Sharrat	385.22	378.24	377.01	8.21	6.98
24	El Amal	384.70	378.21	376.99	7.80	6.58
25	El Arabeeh	384.90	378.18	376.97	7.93	6.72
26	El Zeif	384.83	378.15	376.96	7.87	6.68
27	El Bahgar	384.23	378.12	376.94	7.29	6.11
28	El Hideib(S)	384.23	378.09	376.92	7.31	6.14
29	El Hideib (N)	384.23	378.06	376.06	7.33	6.17
30	El Abeid	383.47	378.03	376.88	6.59	5.44
31	El Makhada	383.78	378.00	376.86	6.92	5.78
32	Khor Agwal	382.94	377.97	376.85	6.09	4.97
33	El Umara	384.68	377.94	376.83	7.85	6.74
34	Hillat Abbas	384.25	377.91	376.82	7.43	6.34
35	Rabak	384.35	377.89	376.80	7.55	6.46
36	Zeinoba	381.56	377.88	376.80	4.76	3.68
37	El Firdos	381.25	377.87	376.79	4.46	3.38
38	Hagar Asslaya(W)	379.04	377.85	376.77	2.27	1.19
39	Hagar Asslaya(E)	381.45	377.84	376.76	4.69	3.61
40	El Gezira Aba	380.54	377.83	376.75	3.79	2.71
41	El Dibeibat	381.41	377.82	376.74	4.67	3.59
42	El Marab'e	381.19	377.81	376.73	4.46	3.38
43	Tadat El Garnoug	379.01	377.80	377.80	2.30	1.21
44	Sheikan	380.87	377.78	376.69	4.18	3.09
45	El M'alaha	381.19	377.77	376.67	4.52	3.42
46	Sharg El Gasir	380.64	377.76	376.66	3.98	2.88
47	El Taif	380.69	377.75	376.65	4.04	2.94
48	El Shawal	380.33	377.75	376.65	3.65	2.58

WHITE NILE—WEST BANK (Kosti Region)

Item	Scheme	F.S.L.	River level		Static head	
			Maximum	Minimum	Maximum	Minimum
1	El Bayaha	379.82	377.59	376.90	2.92	2.23
2	El Gineiga	379.30	377.59	377.40	1.90	1.71
3	Kisheima	379.98	377.60	376.48	3.50	2.38
4	Abu Agarib	379.22	377.60	376.88	2.34	1.62
5	El Sulha	379.35	377.60	377.40	1.95	1.75
6	El Safa	380.33	377.60	377.40	2.93	2.73
7	El Tagadum	379.71	377.60	377.30	2.41	2.11
8	El Karama	379.71	377.60	377.30	2.01	2.11
9	Wad Shamam	380.33	377.60	377.30	3.03	2.73
10	El Bidaya	379.70	377.59	376.90	2.80	2.11
11	Golli	380.70	377.55	376.65	4.05	3.15
12	Um Ganeem	380.70	377.77	376.67	4.03	2.93
13	Abu Mehhar	380.40	377.79	376.69	3.71	2.61
14	El Galal	380.12	377.81	376.73	3.39	2.31
15	El Tawila	381.000	377.84	376.76	4.24	3.16
16	Mahad el Nimir	380.92	377.86	376.78	4.14	3.06
17	El Tagwa	381.56	377.88	376.80	4.76	3.68
18	El Salam	381.56	377.89	376.82	4.74	3.67
19	El Abasiea West	379.19	378.00	376.86	2.33	1.19
20	Um Hani	381.35	378.00	376.86	4.49	3.35
21	El Gazala	380.19	378.00	376.86	3.33	2.19
22	Um Hayaya	382.51	378.12	376.94	5.57	4.39
23	El Zileit	385.40	378.24	377.01	7.39	7.16
24	El Shawa	382.80	377.75	376.80	6.00	5.05
25	El Radeis	380.40	377.97	376.99	3.41	2.43
26	El Intisar	379.27	377.97	376.99	2.28	1.30
27	El Sirour	381.38	377.96	376.99	4.39	3.41
28	El Saada	379.84	377.97	376.99	2.82	1.87
29	Gori	379.43	377.97	376.99	2.44	1.46
30	Zamzum	383.84	378.98	377.45	6.38	4.86
31	El Arak	383.84	378.98	377.46	6.38	4.86
32	El Naiem	383.84	378.98	377.46	6.38	4.86
33	Um Dilgam	383.35	378.98	377.46	5.89	4.37
34	El Dibeikrya	383.15	378.98	377.46	5.69	4.17
35	El Aradeeb	382.80	380.74	379.74	3.06	2.06
36	El Rashidi	382.58	379.10	377.55	5.03	3.48
37	El Gala'a	382.60	379.10	377.55	5.05	3.50
38	Um Irig	384.31	379.13	377.57	6.74	5.18
39	Dabat el Tor	383.85	379.13	377.57	6.28	4.72
40	El Rida	382.71	379.18	377.62	5.09	3.53
41	El Dakhla	380.33	377.60	377.40	2.93	2.73
42	Um Galala	383.58	379.18	377.62	5.96	4.40
43	El Kiwik	383.61	379.24	377.65	5.96	4.37
44	El Birkadok	382.39	379.24	377.65	5.74	3.15
45	El Bushra	383.49	379.24	377.65	5.84	4.25

TABLE VIII *(continued)*

WHITE NILE—WEST BANK (Dueim Region)

Item	Scheme	F.S.L.	*River level*		*Static head*	
			Maximum	Minimum	Maximum	Minimum
1	Mabrouka	379.49	377.33	375.88	3.61	2.16
2	Talha	379.24	377.34	376.89	2.35	1.98
3	Um Area	378.68	377.34	376.24	3.44	1.34
4	Goz El Nogara	379.56	377.24	376.53	3.03	2.32
5	Shatawi	378.79	377.52	374.52	1.27	1.27
6	Nimir	378.42	377.18	—	—	1.24
7	Bars	380.04	377.15	375.70	4.34	2.89
8	El Ikhailed	378.11	377.11	373.76	4.55	1.11
9	El Waseem	378.26	377.20	—	—	1.06
10	Ireifab	378.42	377.18	—	—	1.24
11	Mabrouk	378.37	377.18	—	—	1.19
12	Khanger	378.68	377.30	—	—	1.32
13	Goz el Baid	378.49	377.18	376.48	2.01	1.31
14	Rahawat	379.29	377.46	—	—	1.83
15	El Watan	379.46	377.54	376.15	3.31	1.92
16	El Etilaf	379.24	377.79	376.81	2.43	1.45
17	Salati	379.27	377.27	375.47	4.21	2.41
18	El Amin	279.53	377.25	375.65	3 88	2.28
19	Insaf	379.02	377.43	376.70	2 32	1.59
20	Rawda	379.68	377.48	377.21	2.47	2.20
21	Um Takal	379.47	377.49	375.97	3.50	1.98
22	El Magam	379.45	377.29	376.49	2.96	2.16
23	Abu Gumri	379.24	377.41	376.42	2.82	1.83
24	Mineidrib	379.94	377.42	374.97	4.97	2.52
25	Mahala	379.70	377.40	375.96	3.74	2.30
26	Atshan	379.28	377.49	375.14	4.14	1.19
27	Firdos	379.26	377.42	375.16	4.10	1.84
28	Rahama	379.30	377.40	376.72	2.58	1.90
29	Gammar el Gardod	379.46	377.54	376.15	3.31	1.92
30	Hayafa	379.66	377.58	376.65	3.01	2 08
31	El Fitoh	379.40	377.57	376.24	3.16	1.83
32	El Salam	378.87	377.54	376.20	2 67	1.23
33	Munna	379.10	377.52	376.25	2.85	1.58
34	Gardod El Hag	379.73	377.67	376.82	2 91	2.06
35	El Falah	379.21	377 65	376.73	2 48	1.56
36	Bojo	379 09	377.66	377.10	1.99	1.43
37	El Taif	379.42	377.66	376.64	2.78	1.76
38	El Bushra	378 80	377 18	—	—	1.62
39	Shabasha (West)	377.85	377 35	374.97	2.88	0.50
40	El Tagwa	379.30	377 40	376.72	2.58	1.90
41	Um Gur	379.89	377.78	373.78	5.9*	2.11
42	Abger	378.56				
43	Shabasha	379.50				
44	Wakara	379 61				
45	El Dueim	379.37				

WHITE NILE—EAST BANK (Dueim Region)

Item	Scheme	F.S.L.	*River level*		*Static head*	
			Maximum	Minimum	Maximum	Minimum
1	Wad Diwiw	378.15	376.77	374.96	3.19	1.38
2	Hassan Allob	379.18	377.34	373.16	6 02	1.84
3	Kinoz	379.13	377.47	373.27	5.36	1.66
4	Abu Hindi	379.48	377.64	373.34	6.14	1.84
5	Mash Kor El Kawa	383.78	380.17	379.61	4.17	3.61
6	Abu Hibeira	379.86	376.10	375.65	4.21	3.76
7	El Nazaha	384.76	377.24	376.42	8.31	7.52
8	El Fatih	384.76	377.24	376.49	8.27	7.52
9	Arkiz	382.47	377.20	377.10	5.37	5.27
10	Wad El Nigomi	380.64	377.11	376.31	4.33	3.53
11	Dubbasi	379.57	377.32	375.66	3.91	2.25
12	El Mungata	379.57	377.14	376.44	3.13	2.43
13	El Basatein	380.04	377.25	372.35	7.69	2.79
14	El Gammalab	380.04	377.25	372.85	7.19	2.79
15	El Fatisa	380.16	—	—	—	—
16	El Hashaba	380.32	—	—	—	—

TABLE IX

Scheme grouping (Dueim Region)

WHITE NILE—EAST BANK

Group 1: *El Fatisa Group*

Item	Scheme	Exist. area	Prop. exten.	Total area	No. of engines	h.p.	Life in years
1	Fatisa	4995	—	4995	3	585	5–5–5
2	Gamalbab	1659	360	2049	3	198	7–7–7
3	Basateen	529	180	700	2	72	1–5
	TOTAL	7204	540	7744	8	855	

Group 2: *Abu Hibeira Group*

1	Dubasi	1450	550	2000	3	230	7–1–1
2	Wad El Nigomi	1842	1650	3492	3	183	5–1–0–0
3	Arkiz	570	1750	2320	2	52	1–2–0–0
4	Fatih	920	1150	2070	3	81	5–5–1
5	Nazaha	1648	800	2448	2	90	1–7
6	Abu Hibeira	1605	700	2305	2	90	5–5
	TOTAL	8035	6600	14635	15	731	5–5

Group 3: *Hassan Alloub Group*

1	Abu Hindi	3178	4600	7778	2	310	1–7
2	El Kunuz	4914	5600	10514	3	400	10–1–7
3	Hassan Alloub	2127	2050	4177	2	215	1–5
4	Wad Diwiw	2970	250	3220	2	157	5–2
	TOTAL	13189	12500	25689	9	1082	

Scheme grouping (Dueim Region)

WHITE NILE—WEST BANK

Group 1: *Nimir Group*

Item	Scheme	Exit. area	Propd. exten.	Total area	No. of engines	h.p.	Life in years
1	Ash Shatwi	594	530	1124	3	236	10–1–2–0–0
2	El Ekhaild	975	300	1275	2	76	2–2
3	El Bara	1500	—	1500	2	127	1–7
4	El Waseem	264	—	264	1	16	5
5	Nimir	1401	—	1401	1	100	7
6	El Ereifab	1057	1010	2067	2	90	1–7
7	El Bushra	4300	—	4300	4	226	5–5–5–2
8	El Mabrouk	924	—	924	2	63	5–5
	TOTAL	11015	1840	12855	17	934	

Group 2: *Abger Group*

1	El Rahwat	6164	2200	8364	2	180	7–7
2	Wad Nimir	2628	—	2628	4	130	10–10–10–10
3	Abger	10044	—	10044	4	300	10–10–10–10
4	Gos El bied	1607	—	1607	2	140	7–10
5	El Khanger	4900	9600	14500	3	240	2–2–10
	TOTAL	25343	11800	37143	15	990	

Group 3: *Dueim Group*

1	Shabsha	5586	2295	7881	4	312	7–7–7–7–7
2	Gos El Nagara	9200	3550	12750	4	854	1–10–2–2
3	Shabasha West	2000	—	2000	3	124	2–10–10
4	Um Arda	1540	—	1540	2	150	2–10
5	Talha	1799	3340	5139	2	110	200–10
6	Mabrouka	2580	9900	12480	3	137	2–1–1
7	Dueim	2130	—	2130	3	225	7–7–7
	TOTAL	24835	19085	43920	21	1912	

Group 4: *Wakara Group*

1	El Eitilaf	1500	—	1500	2	115	5–2
2	Salati	912	350	1262	2	150	1–1
3	El Aien	7200	1800	9000	3	337	7–7–3
4	Insaf	990	—	990	2	84	1–1
5	Wakara	4644	—	4644	3	162	7–7–7
	TOTAL	15246	12150	17396	12	636	

Item	Scheme	Exist. area	Propd. exten.	Total area	No. of engines	h.p.	Life in years
Group 5: Um Takal Group							
1	El Roda	2005	1020	3025	3	126	5–5–5
2	Um Takal	3300	2800	6100	4	526	0–0–5–5
3	El Magam	3166	2670	5836	3	204	1–1–1
4	Abu Gimri	970	2200	3170	2	127	5–5
5	El Minadreeb	3900	4350	8250	2	90	1–7
	TOTAL	13341	13040	26381	14	1073	
Group 6: El Futuh Group							
1	El Mahala	1440	—	1440	3	118	1–1–5
2	Elatshan	1400	2131	3531	1	77	7
3	Fardous	760	1200	1950	2	114	5–5
4	El Rahma	3685	—	3685	4	320	1–7–7–10
5	El Tagwa	1900	—	1900	—	—	—
6	Gamer El Gardoud	2700	—	2700	4	240	1–1–7–7
7	Hayafa	2080	7710	9790	2	90	7–7
8	El Futuh	2307					
	TOTAL	16272	12272	28563	18	1059	
Group 7: Um Garr Group							
1	Um Garr	9954	—	9954	4	780	5–5–5–5
2	Muna	1052	—	1052	1	48	1
3	El Salam	1091	—	1091	2	85	5–7
4	Gardoud El Hag	1028	—	1028	2	61	1–1
5	El Falah	523	1800	2323	2	69	5–5
6	Bogo	530	180	710	1	35	7
7	El Tayff	2077	610	2687	2	106	5–7
	TOTAL	16255	2590	18845	14	1184	
Group 8: El Rida Group							
1	Dabat El Tour	3900	35000	39000	2	247	2–2
2	Um Irig	1200	—	1200	2	91	5–5
3	El Rida	1200	—	1200	1	67	10
4	El Gala	1215	—	1200	1	67	10
4	El Gala	1215	—	1215	1	90	2
	TOTAL	7515	35000	42515	6	495	

Item	Scheme	Exist. area	Propd. exten.	Total area	No. of engines.	h.p.	Life in years
Group 9: Um Galala Group							
1	Um Galala	15000	—	15000	4	960	10–10–10–10
2	El Kiwake	9000	10000	19000	2	600	5–5
Group 10: El Bushara Group							
1	Bushara	3000	3000	6000	2	130	5–2
2	Wad Dakona	1650	5000	6650	2	127	2–2
3	Lilo Amara	3150	5000	8150	2	127	5–2
	TOTAL	7800	13000	20800	6	384	

TABLE X

Scheme grouping (Kosti Region)

WHITE NILE – EAST BANK

Group 1: El Mellaha Group

Item	Scheme	Exist. area	Propd. exten.	Total area	No. of engines	h.p.	Life in years
1	Shawal	4596	1500	6096	2	312	5–2
2	Taif	3120	—	3120	1	95	5
3	Gasir East	3000	—	3000	2	223	5–2
4	Mellaha	18306	5000	23306	3	462	2–2–0
5	Debaibat	1200	—	1200	3	140	7–2–2
6	Marrabeh	792	—	792	2	125	1–2
7	Fodat Elgarnok	210	—	210	2	48	2–1
	TOTAL	31224	6500	37724	15	1405	

Group 2: El Firdos Group

1	Hagar Assallaya	1044	25000	26044	2	95	5–2
2	Firdos	1545	—	1545	2	124	5–5
3	Zenuba	1470	1000	2470			
	TOTAL	4059	26000	30059	4	219	

Group 3: El Bahga Group

1	Rabak	450	—	450	2	42	7–2
2	Hillat Abbas	450	2000	2450	2	70	7–2
3	El Omra'	600	—	600	1	37	2
4	Khor Agwa	1500	2000	3500	1	49	5
5	El Mokada A/Z	800	—	800	1	49	2
6	El Abied	825	—	825	1	50	5
7	El Hidaib North	800	—	800	1	30	2
8	El Hidaib South	204	—	204	2	51	5–5
9	El Bahga	1200	—	1200	2	91	5–2
10	El Ze'i	900	—	900	2	79	2–2
11	Aradeeb	1020	—	1020	2	137	2–2
12	El Amal	800	—	800	1	50	2
13	Shorat	1200	17000	18200	2	127	2–2
14	El Islah	900	—	900	1	50	Obsolete
	TOTAL	11549	21000	32649	21	912	

Item	Scheme	Exist. area	Propd. exten.	Total area	No. of engines	h.p.	Life in years
Group 4: Dimo Group							
1	Dimo	1200	4000	5200	2	120	5–0
2	Masran El Sababal	1200	—	1200	1	42	2
3	Masran Basalla	1200	—	1200	1	42	2
4	Masran El Taysha	450	—	450	1	30	Obsolete
	TOTAL	3300	4000	7300	5	217	

Group 5: Naifre Group

1	Tabat	900	—	900	2	64	5–5
2	Naifre	6120	25000	31120	3	1170	5–5–5
3	Aradeeb El Gab	510	510	510	2	130	5–5
4	El Morwa	1200	—	1200	2	98	5–5
5	Tackspoon	1650	—	1650	2	58	10–5
6	Mohdi El Sherif	450	—	450	3	121	15–10–10
7	Mohdi El Sherif	750	—	750	—	—	
8	El Makhlif	204	—	204	3	62	5–5–2
	TOTAL	11784	25000	36784	17	1703	

Group 6: Goda Group

1	El Furat	900	—	900	1	50	5
2	Abu Ramad	450	—	450	3	78	5–5–2
3	El Magabi	1500	—	1500	2	127	5–5
4	El Adara	900	—	900	2	77	5–2
5	El Worad	900	—	900	2	78	5–5
6	Dabat Besin	1200	—	1200	2	132	0–0
7	El Alagaya	900	—	900	2	83	2–2
8	El Guna'a	1500	—	1500	2	145	5–2
9	Muna	990	—	990	2	117	0–0
10	El Adl	800	—	800	1	49	2
11	Goda	13390	—	12390	3	675	5–5–5
12	Goz Fami	1650	—	1650	2	50	2–2
	TOTAL	24080	—	24080	24	1661	

Group 7: Birkat El Agab Group

1	Hamdouk	2160	—	2160	2	109	5–5
2	El Remila (N)	450	—	450	2	176	5–2
3	El Remila (S)	2250	—	2250	3	197	5–5–2
4	Tayba	2450	—	2450	2	181	2–2
5	Birkat El Agab	12990	—	12990	3	1200	5–5–5
6	El Geiger	3000	—	3000	3	184	5–50
	TOTAL	23300	—	23300	15	1947	

Item	Scheme	Exist. area	Propd. extent.	Total area	No. of engines	h.p.	Life in years
Group 8: Abu Khadra							
1	Abu Khadra	12000	6000	18000	2	720	5–5
2	Mangra	2055	1445	4500	3	215	2–2–2
3	Fawar North	800	—	800	2	132	5–0
4	Fawar South	2580	—	2580	1	35	5
	TOTAL	17435	7445	24880	8	1102	
Group 9: Bandit Group							
1	Khor Agaiz	800	—	800	2	46	2–2
2	Bandit	1050	—	1050	2	92	5–5
3	Gaandit	800	—	800	1	37	2
4	Latbior	1200	2000	3200	3	134	5–2–2
5	Dabat Alali	2250	2750	5000	2	176	5–5
	TOTAL	6100	4750	10800	10	485	

Scheme grouping (Kosti Region)
WHITE NILE—WEST BANK

Group 1: El Shur Group

Item	Scheme	Exist area	Propd. exten.	Total area	No. of engines	h.p.	Life in years
1	El Shur Hvafa	1200	——	1200	2	68	5–5
5	El Shur Aba	1955	500	2455	3	1475	5–2
3	El Shur Goba	1500	500	2000	2	80	5–5
4	El Biaiba	272	—	272	1	22	2
	TOTAL	4927	1000	5927	8	317	
Group 2: Silha Group							
1	El Ginaiga	690	3000	3690	1	42	10
2	El Sulha	900	1500	2400	1	40	Obsolete
3	Abu Agarib	216	—	216	1	15	10
4	Kashoma	216	—	216	1	22	2
5	Abu Hasheim	204	—	204			
	TOTAL	2226	4500	6726	4	119	
Group 3: Gulli Group							
1	El Dakhla	1500	500	2000	3	88	
2	Wad Shaman Tag	3345	—	3150	4	124	5–5–5–5
3	Karama & Bidaya				5	143	10–10
4	Gulli, Figarab	4080	1000	5080	2	306	5–5
5	UmGaniem	1560	—	1560	2	117	
	TOTAL	10485	1500	11790	16	778	
Group 4: El Tagwa Group							
1	Abu Mohar Fasha Shoia	3435	3000	6435	6	291	10–5–5
2	El Galal	645	255	900	1	36	5
3	El Tawiyla	2580	6000	8580	2	306	5–1
4	Mahd El Nimir	684	—	684	1	42	5
5	Abugirba Tagwa	2115	2500	4515	4	145	10–5–2–2
6	El Salam	184	12000	12184	2	38	5–2
	TOTAL	9643	23755	33298	16	858	

Item	Scheme	Exist. area	Propd. exten.	Total area	No. of engines	h.p.	Life in years
Group 5 : Gazola Group							
1	Um Hiya	1350	—	1350	2	95	5–5
2	El Gazala	6085	—	6065	3	900	10–10–10
3	Rigeiga Gedida	340	—	340	–	—	
4	Regeiga North	1185	—	1185	–	—	
5	Regeiga South	450	—	450	2	78	5–2
	TOTAL	9590	—	9590	7	1073	
Group 6: El Intisar Group							
1	El Shana	1200	—	1200	1	75	5
2	El Rideis	900	—	900	1	42	5
3	El Intisar	1050	—	1050	1	50	2
4	El Sarour	900	—	900	1	67	1
5	El Sa'ada	1200	—	1200	2	70	5–2
6	Gori	1335	12000	1335	1	49	2
	TOTAL	6585	12000	18585	7	353	
Group 7: El Naiem Group							
1	El Naim	12300	5000	17300	2	460	10–10
2	Zamzam, Arak and Um Habab	1605	1000	2605	6	291	10–5–5
3	Um Dalgani	3690	—	3690	1	125	5–5–1
4	Dibkraia	900	—	900	1	—	
5	Arad'eeb	750	—	750	1	40	2
6	Rashidi	1200	—	1200	1	67	5
	TOTAL	20445	6000	26445	12	983	

TABLE XI

Cost of electrificiation of isolated schemes

WHITE NILE

Item	Scheme	Gross area	Cost of electrification	
			⅓ cropping	100% cropping
1	Baraka	450	5,400,000	7,200,000
2	El Birkadok	1,650	19,800,000	26,400,000
3	El Arak	1,545	18,540,000	24,720,000
4	El Zeleit	13,500	162,000,000	216,000,000
5	Um Hani	12,000	144,000,000	192,000,000
6	Rowdat El Mukhtar	228	2,756,000	3,648,000
7	El Abbasiya	225	2,700,000	3,600,000
8	El Gezira Aba	7,800	93,600,000	124,800,000
9	Asalaya West	300	3,600,000	4,800,000
10	Mashkor El Kawa	1,200	14,400,000	19,200,000
	TOTAL	38,898	466,776,000	622,368,000