

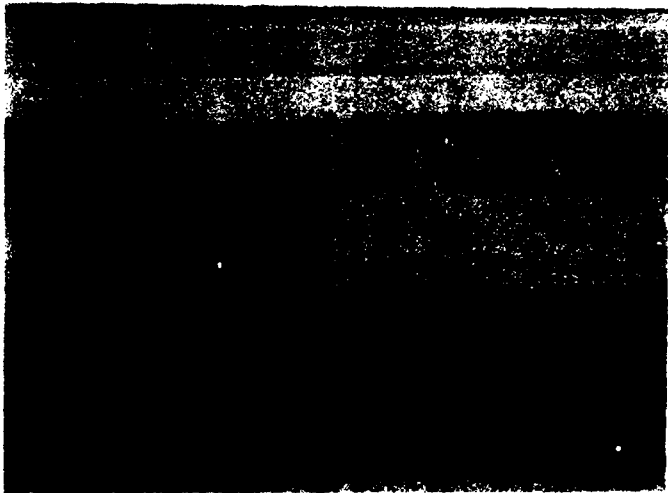


REPUBLIC OF THE SUDAN

RURAL WATER AND DEVELOPMENT CORPORATION

The NAFIR

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BOOKLET NO.

8

BY

SHAWGI IBRAHIM ASA'AD
(CHIEF SURFACE WATER ENGINEER)

JANUARY 1969

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THE HAFIR

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RURAL WATER & DEVELOPMENT CORPORATION

1. Introduction :

The construction of hafirs had started in the Sudan in 1946 by the Soil Conservation Section. The aim of such hafirs was to provide water in order to develop the lands for agriculture, pasture, and forestry. During the period 1946-1956, some 300 hafirs and 11 small earth embankments had been executed which provided 8,705,000 M³. of water.

After 1956, the responsibility for developing the rural areas through provision of water and proper land use had been shouldered by the Land Use and Rural Water Department, which was able to execute 196 hafirs and 13 dams of a total capacity of 9,374,000 M³ within 10 years. By the end of 1966, it was evident that the Land Use and Rural Water Department was unable to cope with the great demand for water and the repeated cries of thirst that rose from all parts of the country. Consequently, the Government reconsidered this acute problem and amalgamated all technical units working in the field of rural development into one organization which was named the Rural Water and Development Corporation.

During the last two working seasons, 91 hafirs and 3 small dams executed in the field of surface water with a total capacity of 7,296,000 M³.

II. Hafirs :

1. The hafir is by definition (from the Arabic hufra) a small depression where water accumulates during the wet season. The volume of water thus stored is used for domestic purposes or to water the animals

2. The conventional hafirs are usually excavated in areas which soil conditions are favourable, being sufficiently impervious to cut down the seepage losses to minimum.
3. Hafirs usually have the shape of an inverted frustum of a pyramid whose base is rectangular in section for practical purposes. However, other shapes are being also adopted such as semi-circular, circular, or square.
4. The hafirs are mechanically excavated. The excavation team usually consists of the following units.
 1. No.4 scrapers of 10-16 cubic yard capacity.
 2. No.1 Bulldozer
 3. No.1 ripper
 4. Fuel tanks, trailers and tractors with other service and transport fleet.
5. The dimensions of the base vary according to the local conditions of the site. Different ratios of base dimensions i.e. 1:2, 1:3, 1:4, are used. The longer sides are cut in steps at a gradient of 1:1½ or 1:2 depending on the nature of the soil while the shorter sides are cut at a gradient of 1:4 to facilitate the movement of machinery in and out the hafir.
6. The depth of hafir usually varies between 3-8 mts. In deciding the depth of a hafir, soil structure and composition allowing, a compromise is made between easy movement of excavating machines in shallow hafirs and low evaporation loss in deep hafirs.
7. Hafirs are excavated in different capacities varying from 5,000- 150,000 M³. Twin hafirs have been adopted for large capacities to facilitate cleaning and desilting during rectification, and to reduce the area exposed for evaporation by means of pumping from one hafir to the other as the water level drops.
8. A silt trap is installed at the inlet to reduce the amount of silt entering the hafir. Water usually enters the hafir through a single or multiple inlet pipeline of asbestos, concrete, or steel. It is drawn through another pipeline located at the opposite side which ends at a closed concrete or masonry well fitted with a simple hand pump feeding the distributing

troughs from which water is drawn free of charge.

9. The water stored in the hafir is protected by an earth embankment made of the spoil of excavation and varies in height according to hafir capacity and ground level. This embankment is fenced by barbed wire to prevent any direct access to the stored water.
10. Hafirs are generally free from debris which is prevented from entering by means of a trash placed on top of the inlet well. As water enters it is usually turbid, however; after some time its turbidity may fall down to about 60-100 p.p.m. where it is drawn for consumption at this condition.
11. In big water points (over 50,000 M3 capacity) near large settlements, small purification plants are constructed. Generally speaking, due attention is paid to provide water of sufficient quantity at low cost.
12. The selection of a hafir site is usually governed by the suitability of the site topographically, and geologically as well as by the water potentiality of the feeding source. Need and the land capabilities having been decided, the capacity of hafir is based on the availability of water at the site. This can be assessed by estimating the surface flow of the feeding source or by adopting an adequate runoff coefficient. In both cases hydrological data concerning the duration and frequencies of floods are necessary. Where the water supply is adequate, the main deciding factor for the capacity of a hafir is the water requirements. The standard per capita estimate of daily water consumption in rural areas is as follows :

Human	4	gallons
Horses, mules, donkeys	5	"
Cattle	6	"
Sheep & Goats	2	"

Camels drink 12-18 gallons at a time and usually water every 2-5 days in hot weather and about 10 days in cold weather.

13. The suitability of the hafir site is ensured by digging test pits and determining the profile which is impervious enough to keep the possible seepage losses within the permissible limit.

The initial cost of construction varies according to the respective capacity and types of catchment. It ranges from 600 mm to 300 mm for 10,000 M³ and over 50,000 M³ capacity respectively.

considering the other expenditure of operation and maintenance during the estimated life period of the hafir (20 years) cost of useful water ranges between 100% - 200% per metre cube for 50,000 M³, 10,000 M³ respectively.

14. Types of hafirs :

Hafirs vary in type according to the nature of the catchment which may be classified as follows :

1. Khor catchment :

In this type, the hafir is fed from a natural water course, water is conveyed to the hafir either by an excavated canal or by daming the water course to raise its water level. In the latter case, the spillway has to be carefully designed to avoid any damage that might result due to under estimation of the maximum discharge of the water course.

2. Jebel catchment :

The hafir in this type is fed by the direct surface runoff from small hills and plinths, where no reliable water course exists at the site.

The concept of such type is based on the fact that the surface runoff in hills and plinth is considerably higher, and losses are relatively small. Water is collected through a drain canal or system of canals which in turn deliver water to a collecting canal ending at the hafir. Silting problems are more noticeable in such types of catchment which calls for frequent desilting. However, it is still considered one of the best and most efficient methods to provide water where there are hills in rural areas. Topographic conditions may call for construction of drops to reduce the steepness of canals or to provide spill-

way to take care of any excess flow as to runoff coefficient is based on experience.

3. Self catchment hafir :

In this type, the catchment is either from natural depression where water accumulates during the wet season or from areas with mild slopes, which calls for an artificial drainage system.

III. Small Dams :

Small dams constitute one of the means to provide water supply in rural areas.

17 dams, of varying capacity from 300,000 to 2,000,000 M³; and height from 3-8 mts. had been built in the Sudan so far. Most of the dams built are of earth, few are in masonry. Investigation of dams requires careful and detailed studies of hydrology, geology and topography of the site together with the land use and soil conservation aspects. Failure of some of the early built dams was mainly attributed to improper design based on insufficient data. Though dams provide more water than hafirs, yet they have the disadvantage of being more liable to pollution which if not adequately prevented, it may lead to fatal results. Purification plants are being executed to improve the quality of water.

IV. Alternative new Methods :

Provision of water in sandy areas where conventional hafirs are difficult to make takes a different shape, primitive methods which are still in use are cultivation of water melons in wide patches of lands and using it during summer time as a water source. Storing rain water in tebeldi trees (Baobab) is another method. These trees of 1.0 - 3.0 mts. diameter are hollowed and filled with water annually during rains. A tree can store 3.0 - 10 M³ of water. These methods are temporary, however; and do not provide drinking water for the whole year.

In natural depressions with shallow depth of clay soil, hafirs can also be excavated and provided with relatively high embankments 4-5 mts. to allow overground storage, which may attain partially by pumping.

Lining of hafirs in sandy areas have also been attempted. Different types of lining materials were used i.e. asphalt, clay, and P.V.C. membrane. The latter gave initially the best results. However, the membrane had been attacked by termites, thus discarded. At present experiments are being conducted on butyl rubber and polythene sheeting for lining hafirs in sandy areas.

The United Nation Special Fund Project in Northern Kordofan Province investigated the drinking water problem in the crisis area. According to their recommendation, wells, boreholes, hafirs and large reservoir will in many places provide the best solution where natural conditions are favourable. But beyond the limits of these solutions, the small polyethelene village tank with its own small catchment to collect and store the rain water. (Reference is invited to DOS-SUD/A-42 July 1965 prepared for F.A.O.).

The design consideration which apply to these polyethelene village tanks are as under :

1. They should give the fullest possible stimulus to the indigenous skills and aptitudes of the people.
2. They should make the smallest possible call on the services of professional or craft trained people.
3. They should make the maximum possible use of materials found on the spot.
4. They should make the minimum use of materials requiring to be transported to the site or bought for cash; especially imported materials requiring foreign exchange.
5. They should be economical compared to other provisional resources in present use.
6. There should be a minimum of mechanical plant especially that which has to be bought from abroad with foreign exchange and that needing a lot of expert care and maintenance.

Six prototype tanks were built before the rainy season of 1964 in the experimental yard near El Obeid, they are :

1.	Pillared roof	230	M ³	capacity
2.	Bottle tank	5	"	"
3.	Multiple inter connected beehive	100	"	"
4.	Cris-cross honey comb	20	"	"
5.	Multiple separate beehive	30	"	"
6.	Sand bed	10	"	"

The basic elements in all the prototypes are an artificial catchment apron to collect the rain water and a tank to store it, covered over so as to control evaporation. To these basic a filter bed through which the water passes on its way into the storage tank to be lifted out by the consumer.

Three types of catchment aprons were used.

1. Earth, dressed with oil base materials.
2. An earth formation covered with a membrane which might be black polythene, P.V.C. or (Butyle) artificial rubber.
3. A plain earth apron, compacted by spraying catchment with oil based products gave very good runoff coefficient and the plain earth gave a fair runoff coefficient.

To make the water tanks impervious, polythene sheets and mud slurry were used as a "sandwich"; several layers of five gauge polythene membrane, with about 5 mm of mud slurry between each layer. Each layer of membrane $\frac{3}{2000}$ of an inch thick is laid so that each overlies the junction between the layer below, with mud slurry in between. Thus making a total thickness of about 2 cms. The risk of seepage through successive layers is small; there is safety in numbers. The mud layers are part of the seal. The construction material is formed by filling sand and cement in 1:6 proportion in polythene bags which take sausage shapes

Ten village tanks have been constructed in 1965/66 season in Iyal Bakheit area.

Though **Doxiades** Associates, who were carrying out the experiments, have recommended the use of the village tank, it has been found that their use is not practical for the following reasons:

1. The polythene sheeting used was susceptible to termites. The test made at Semeih experimental hafir showed that the termites had severely damaged the buried membrane. Their recommendations to treat the soil with insecticides around the tank is deemed too dangerous, as the insecticides which are known to date are very liable ~~mix~~ with the stored water.

2. The structure designed for village tanks is of a closed nature; no allowance being made for maintenance. Thus any small damage to the tank will involve major work.
3. The initial cost per cubic metre reaches 10-12 pounds in practice against the estimated cost of one pound per metre cube.

A P P E N D I C E S:

(A) Tables :

1. Existing hafirs in Kordofan Province.
2. Existing hafirs in Darfur Province.
3. Existing hafirs in Kassala Province.
4. Existing hafirs in Blue Nile Province.
5. Existing hafirs in Upper Nile Province.
6. Dimensions of hafirs.
7. Summary of execution programme of hafirs and dams from season 47/48 - 67/68.

(B) Drawings :

1. Hafirs and dams executed in the Sudan.
2. Typical plan of a hafir.
3. Standard arrangement of inlet and outlet works in a hafir.
4. Standard outlet well and water distribution system
5. Standard arrangement for distribution troughs.
6. Barbed wire fence in hafir :
 - (i) Standard single gate
 - (ii) Standard for corner post .
7. Typical jebel catchment hafir
8. Typical self catchment hafir.

(C) Photos :

1. Camp of an investigation team
2. Hafir under excavation.
3. A complete hafir ready for receiving water
4. Desilting of an old hafir
5. Spillway of Abu Gidad Dam
6. Abu Gidad Dam.

TABLE No. (1)

EXISTING HAFIRS & DAMS IN KORDOFAN PROVINCE

Ser. No.	Hafir No.	Name of Hafir	Co-ordinates		Capacity	Rural Comm.	Season of Cons.	REMARKS
			Lat.	Long.				
1	1A	Ahmed	12° 44'	30° 53'	12,000	E. Kord.	47/48	
2	1B	Geona	12 41	30 55	12,000	"	"	
3	25	El Edayat	12 42	30 51	10,305	"	48/49	
4	26	Inderaba	12 41	30 43	15,424	"	"	
5	27	Karashona	12 15	31 01	4,297	E. Jebel	"	
6	28	Khor Er Tina	12 15	30 47	6,526	"	"	
7	29	Sherak	11 56	30 45	9,248	"	"	
8	30	Jubeilat	11 52	30 50	8,573	"	"	
9	31	Kiweikaya	11 53	30 48	6,190	"	"	
10	32	Umm Mahahir	11 23	30 58	11,897	"	"	
11	33	Fattat	11 21	31 16	6,182	"	"	
12	34	Umm Saga'a	11 18	31 16	5,513	"	"	
13	35	Sahal	11 14	31 22	9,512	"	"	
14	36	Widai	11 14	31 25	6,497	"	"	
15	37	Abu Tuleih	11 01	31 35	4,416	"	"	
16	38	Ban Gedid	10 59	31 44	5,681	"	"	
17	39	Shewat (Gurun)	11 31	31 27	8,585	"	"	
18	40	Shambora (Abu Gereis)	11 45	31 40	8,069	"	"	
19	41	Surat	12 00	31 52	8,831	"	"	
20	42	Megeinis (Jebel)	11 56	32 07	8,401	"	"	
21	43	" (K. Beida)	11 55	32 07	21,594	"	"	
22	44	Sinat	10 46	31 10	5,198	"	"	
23	45	Bint El Kalb	10 47	30 54	8,771	"	"	
24	46	Umm Zarzura	10 47	31 03	8,182	"	"	
25	47	Hadaba	10 26	30 55	10,451	"	"	
26	48	Hireidan	10 30	30 29	5,365	"	"	
27	49	Umm Dual	10 39	30 31	7,279	"	"	
28	50	Berdab	10 46	30 29	9,110	"	"	
29	51	Kuk	10 49	30 37	4,668	"	"	
30	52	Tash	11 12	29 47	9,088	"	"	
31	53	El Arak	11 27	28 55	6,377	Meseriya	"	
32	54	Umm Sha'ara (Moga)	11 28	28 43	8,129	"	"	
33	55	" Sha'ara (A wahid)	11 25	28 42	8,057	"	"	
34	56	Durungas (Tureiga)	11 15	28 49	9,008	"	"	
35	57	Umm Gunguma	11 09	28 51	5,817	"	"	

EXISTING HAFIRS & DAMS IN KORDOFAN PROVINCE

Serial No.	Hafir No.	Name of Hafir	Co-ordinates	Capacity M3	Rural Council	Season of Construction	REMARKS
36	58	El Malsm (Hidayda)	11 35 28 51	8,088	Messeri	48/49	Hafir
37	59	Melleis	11 40 28 55	8,275	"	"	"
38	60	Abu Regina	11 48 28 57	7,916	"	"	"
39	61	Umm Kireisha	11 52 29 05	6,888	"	"	"
40	62	Malawlaw	11 30 29 35	6,892	N. Jebels	"	"
41	63	Beida	11 39 29 39	8,892	"	"	"
42	64	Domaya	11 41 29 59	5,639	"	"	"
43	65	Talwadi	11 38 29 59	9,533	"	"	"
44	66	Widai	11 33 29 59	7,144	"	"	"
45	67	Rigl El Marsfeen	11 32 29 51	7,037	"	"	"
46	68	Andur (Khashm El Kalb)	11 37 30 10	5,111	"	"	"
47	69	Teital	12 05 30 10	6,706	"	"	"
48	70	Safafir	12 09 30 24	8,343	"	"	"
49	71	Layuna	12 19 30 14	6,063	"	"	"
50	72	Birka	12 33 30 06	6,112	Bederiya	"	"
51	73	Nabag	12 35 29 55	6,591	N. Jebel	"	"
52	114	Forest Nursery	12 42 30 51	21,455	E. Kordofan	50/51	"
53	115	Dabkar (No. 5C.R)	12 37 31 02	12,289	"	"	"
54	116	Murrat (No. 4C.R)	12 35 31 25	12,422	E. Jebels	"	"
55	117	Tabaadiya	11 52 30 23	9,643	"	"	"
56	118	Abu Dom (No. 3C.R)	12 29 31 36	10,722	"	"	"
57	119	Feid El Awag	11 23 29 33	7,087	S. Jebels	"	"
58	120	Seisaban (No. 2C.R)	12 17 31 42	12,289	E. "	"	"
59	121	Nabagaya	11 13 29 33	6,876	S. "	"	"
60	122	Mogren	11 10 29 32	8,877	"	"	"
61	123	Umm Heiran	11 28 31 07	8,746	E. "	"	"
62	124	" Dam	11 07 29 25	9,787	S. "	"	"
63	125	Karaba	11 28 31 23	8,726	E. "	"	"
64	126	Fungus	11 02 29 54	8,845	S. "	"	"
65	127	Sahaba	11 02 31 14	8,778	E. "	"	"
66	128	Mashag El Beida	11 16 29 50	9,890	S. "	"	"
67	129	Umm Hassan	10 55 31 05	9,357	E. "	"	"
68	130	El Bukhas	11 15 29 57	9,200	S. "	"	"
69	131	Habas El Gidad	10 55 31 11	9,256	E. "	"	"

EXISTING HAFIRS AND DAMS IN KORDOFAN PROVINCE

Ser No.	Hafir No.	Name of Hafir	Co-ordinates		Capacity M3	Rural Council	Season of construction	REMARKS
			Lat.	Long.				
70	132	Umm Seneina	11 26	29 57	6,880	S. Jebels	50/51	
71	133	Gedeid	10 59	31 46	25,590	E. "	"	
72	134	Lado	10 35	30 06	9,527	E. "	"	
73	135	Garada	10 25	30 20	9,735	E. "	"	
74	137	Abu Feids	10 24	30 34	10,085	E. "	"	
75	139	Arians	10 21	30 36	9,172	E. "	"	
76	141	Morung	10 40	31 02	9,675	E. "	"	
77	143	Rigl El Hamir	10 49	30 56	10,003	E. "	"	
78	146	Tebeldi	10 56	30 46	8,532	E. "	"	
79	146	Khor Esh Shai	10 50	30 44	7,110	E. "	"	
80	148	Karandal	11 08	30 45	9,874	E. "	"	
81	149	J. Lubia	11 17	30 53	6,280	E. "	"	
82	151	Murrat	11 20	30 46	3,154	E. "	"	
83	153	Hagar El Abyad	11 33	30 45	9,891	E. "	"	
84	155	Harhar	11 43	30 44	9,936	E. "	"	
85	156	Gherega (Rereig)	11 48	30 45	9,710	E. "	"	
86	158	J. Sahaba	12 02	30 31	9,240	E. "	"	
87	160	Tabaldiya						
		(No. 6C.R)	12 34	30 41	8,908	E. Kord.	"	
88	162	Sangala (No. 7C.R)	12 24	30 12	10,839	N. Jebels	"	
89	163	Seisaban (" 8C.R)	12 25	29 57	11,805	"	"	
90	165	Umm Alwan (" 9C.R)	12 13	29 39	12,488	"	"	
91	166	Sinut (No. 10C.R)	12 10	20 02	9,753	Masiriya	"	
92	168	Maya'a (No. 11C.R)	12 03	28 47	7,942	"	"	
93	169	Dabkar (No. 5C.R)	12 37	31 02	8,460	E. Kord.	51/52	
94	170	Baraka	12 30	31 17	6,110	E. Jebels	"	
95	171	Layuna	12 19	30 14	12,960	N. "	"	
96	172	Murrat (No. 4C.R)	12 35	31 21	9,390	E. "	"	
97	173	Safir	12 09	30 25	13,450	N. "	"	
98	174	Abu Dom (No. 3C.R)	12 26	31 34	8,120	E. "	"	
99	175	Feid	12 12	30 05	11,000	N. "	"	
100	176	Seisaban (No. 2C.R)	12 17	31 42	8,220	E. "	"	
101	177	Umm Geras	12 09	31 22	7,840	"	"	
102	178	Habila	11 55	30 08	11,980	E. "	"	
103	179	Tagur	12 10	31 27	8,300	E. "	"	
104	180	Shag El Afzar	11 49	29 58	12,850	N. "	"	
105	181	Uzban	11 55	29 52	5,400	"	"	
106	183	Fayo	11 49	30 03	11,730	"	"	

EXISTING HAFIRS AND DAMS IN KORDOFAN PROVINCE

Ser. No.	Hafir No.	Name of Hafir	Co-ordinates		Elev. city	Rural Council	Season of Conc.	REMARKS
			Lat.	Long.				
107	184	Andur No.2	11 37	30 10	12,060	N. Jebels	51/52	
108	185	Gadalla	11 10	51 53	6,980	E. Jebels	"	
109	186	Talwadi No.2	11 38	29 59	13,710	N. "	"	
110	197	Yoi	10 40	31 54	6,800	E. "	"	
111	188	Idd Ed Dam	10 53	31 39	14,300	E. "	"	
112	189	Rigl El Marfaeen No.2	11 32	29 57	12,230	N. "	"	
113	190	Kau Nyara	10 38	31 34	7,570	E. "	"	
114	191	Saragia	11 17	31 40	6,500	E. "	"	
115	192	Tash No.2	11 12	29 47	9,960	S. "	"	
116	193	Abu Nuwara	11 14	31 31	7,380	E. "	"	
117	194	Umm Zoga Medeibi	11 22	31 28	6,750	E. "	"	
118	195	" Dam No.2	11 07	29 25	12,250	S. "	"	
119	196	Dabat El Bakhas	11 23	31 20	7,460	E. Jebels	"	
120	197	Tagatu	12 19	30 46	7,050	E. Kord.	"	
121	198	Khor El Afin	12 15	30 38	7,440	"	"	
122	199	Abu Zaida	12 26	30 48	7,490	"	"	
123	200	Tabaldiya (No.6 CRW)	12 36	30 41	8,840	"	"	
124	201	" (No.6 CRW)	12 36	30 41	8,820	"	"	
125	202	Gardud El Arak	12 32	30 30	7,050	"	"	
126	205	Sangals (No.7 CRW)	12 24	30 12	9,130	N. Jebels	"	
127	206	" " 7 SW)	12 24	30 12	9,160	"	"	
128	208	Seisaban No.8 CR	12 25	29 57	9,360	"	"	
129	210	Umm Alwan (No.9 CR)	12 13	29 39	9,060	"	"	
130	211	" " No.2	12 13	29 39	6,090	"	"	
131	214	Sinut No.10 C.R.	12 10	29 02	7,270	Mestriya	"	
132	215	" " "	12 10	29 02	7,920	"	"	
133	218	Maya'a No. 11 CR	12 03	28 47	10,210	"	"	
134	222	Semeih village	12 42	30 51	43,030	E. Kord.	"	
135	227	Forest Nursery	12 42	30 52	19,630	"	"	
136	309	Semeih village (No.2)	12 44	30 55	60,000	"	53/54	
137	360	El Ginei	11 43	30 11	15,000	N. Jebels	56/57	
138	361	Gabr Ed dar	11 48	30 15	15,000	"	"	
139	362	Shag Rz Zaraf	11 54	30 08	15,000	"	"	
140	363	Malabak	11 57	30 26	15,000	"	"	
141	364	Kulbaba	10 40	29 20	12,927	Mestriya	"	

EXISTING HAFIRS AND DAMS IN KORDOFAN PROVINCE

Ser. No.	Hafir No.	Name of Hafir	Co-ordinates		Capacity	Rural Council	Season of Construction	Remarks
			Lat	Long	M3			
142	365	Ed Dibeikir	10 23	29 09	12341	Miseriya	56/57	
143	366	Umm Manteig	10 10	28 59	15000	"	"	
144	367	Kibieu	10 06	28 47	15000	"	"	
145	368	Umm Irig	10 13	28 45	15000	"	"	
146	369	Feid El Aggal	10 23	28 45	15000	"	"	
147	370	Umm Shagg	10 33	28 38	15000	"	"	
148	371	Abu Indrab	10 47	28 41	15000	"	"	
149	372	Nabagaya	11 07	28 56	15000	"	"	
150	373	Liko	11 15	28 31	15000	"	"	
151	374	Tasbareib	11 35	28 35	15000	"	"	
152	377	El Mazrub	13 54	29 19	9031	Dar Hamid	"	
153	410	Nawa	12 52	30 31	10000	E. Kordofan	"	
154	411	Tebaldiya	12 40	30 45	15000	"	"	
155	412	Qoz Bushara	12 37	30 46	14000	"	"	
156	413	Dibeillo	12 20	30 34	24000	"	"	
157	414	Umm Qufufu	12 13	30 34	18000	"	"	
158	415	Malabbak	12 02	30 36	18000	N. Jebels	"	
159	416	Mabsut	12 17	31 01	14500	E. "	"	
160	417	Umm Bertabu	11 37	30 45	18000	E. "	"	
161	418	Abu Gereis	11 42	31 41	15000	" "	"	
162	419	Gereid	10 49	31 47	15000	" "	"	
163	420	Kau	10 38	31 30	16000	" "	"	
164	421	Umm Sharan	10 41	29 54	16000	S. "	"	
165	422	El Hamra Site(1)	10 54	29 49	16000	" "	"	
166	423	Debeibat	11 11	29 54	15000	" "	"	
167	424	Magda J. Kilga 2nd	11 33	29 41	18000	N "	"	
168	425	Darwir Rasak	11 41	29 39	15000	" "	"	
169	426	Umm Sereiha	12 29	29 14	14500	Hamar J.	"	
170	427	Rahad Es Silik	12 38	28 32	15000	" "	"	
171	428	Dindinna	12 19	28 41	17500	" "	"	
172	429	El Yei	10 28	29 17	15000	Meseriya	"	
173	430	Butri 3	11 26	31 05	15000	E. Jebels	"	
174	431	Semeih	12 44	30 54	18000	E. Kordofan	"	
175	432	Aradeiba (Miri Bara 2)	11 13	29 34	25000	S. Jebels	"	
176	433	Mashagga Hamra 2	10 54	29 54	15000	" "	"	

Ser- No.:	Haf- No.:	Name of hafir	Co-ordinates : Lat. : Long.:	Capa- city M3	Rural Council	Season of Con- :struct- :tion :	REMARKS
177	434	Umm Kheir(Katla 3)	11 42 29 44	17000	Meseriya	57/58	
178	435	Zereiga	10 43 29 34	13000	"	"	
179	436	Gereif	10 46 29 23	14500	"	"	
180	437	Umm Qarn	10 44 29 13	14500	"	"	
181	438	Shagg Narmas	10 45 29 11	15000	"	"	
182	439	Kabba	10 57 28 18	15000	"	"	
183	440	Rahad En Nabag	12 24 29 49	14500	N.Jebels	"	
184	465	Shagg El Higlig	11 50 29 40	12609	"	58/59	
185	466	Abu Dahasha	11 40 29 50	18381	"	"	
186	467	Kalataya	11 29 29 40	19523	"	"	
187	468	El Battaya	11 32 29 00	12694	Meseriya	"	
188	469	Abu Dumu	11 52 29 13	11617	"	"	
189	470	Ishishat	11 35 28 50	13817	"	"	
190	471	Debbat Abeid	11 21 28 51	12468	"	"	
191	472	Atash	11 13 28 50	11545	"	"	
192	473	Hambul	11 05 29 00	9395	"	"	
193	474	Segali	11 01 29 06	10363	"	"	
194	475	El Kadi	11 14 29 33	12053	S.Jebels	"	
195	476	Et Tomat	11 01 29 49	18869	"	"	
196	477	Debkar(Shalango)	10 38 29 43	18543	"	"	
197	478	Shat Es Siffaya	10 45 29 40	17255	"	"	
198	479	Ayad	10 33 30 17	10881	E. "	"	
199	480	Berdab(Taledi)	10 50 30 37	20215	"	"	
200	481	Dambale	10 45 30 40	12130	"	"	
201	482	Bint El Kalb	10 25 31 15	16219	"	"	
202	483	Dabdeb	10 57 31 04	13517	"	"	
203	484	Indameina	11 29 31 04	16442	"	"	
204	485	Abu Udam	11 34 30 53	16028	"	"	
205	486	Efeizir	11 57 31 46	11146	"	"	
206	487	Sewalig	11 54 31 48	17850	"	"	
207	489	Kobi	12 31 30 14	30000	Bederiya	61/62	
208	490	Abu Sinun	13 20 30 14	15000	"	"	
209	491	Taleshi	13 31 30 00	15000	"	"	
210	542	Shigeila	13 51 29 39	8000	Dar Hamid	"	Replaced by hafir No.627
211	543	Guleit	13 43 29 24	4000	"	"	

EXISTING HAFIRS & DAMS IN KORDOFAN PROVINCE

Ser. No.:	Hafir No.:	Name of hafir	Co-ordinates		Capacity	Rural Council	Season
:	:	:	Lat.	Long.	M3	:	of construction
212	544	Sunta Salatiya	14 11	28 53	5000	Kababish	61/62
213	545	El Hufra	14 04	28 51	4000	"	"
214	546	Has-has	14 02	29 09	3000	"	"
215	547	Hufirat El arab	14 03	29 08	4000	"	"
216	548	Ban Gedid	14 10	29 22	4000	"	"
217	549	Sunta En Nila	14 24	29 35	6000	"	"
218	550	Sunta Umm Qussal	14 14	29 41	8000	"	"
219	551	Maya'a	14 27	29 54	4000	"	"
220	552	Rahad Ed Dabib	14 28	29 56	8000	"	"
221	553	Mashaga	14 34	30 02	8000	"	"
222	554	Hamadiya	14 25	30 08	5000	"	"
223	555	Muffennikh	14 32	30 30	10000	"	"
224	556	Mekheirig	14 48	30 22	5000	"	"
225	557	Eteishana	15 00	30 34	2000	"	"
226	558	Tingari	14 57	30 20	4000	"	"
227	559	Abu Sunta	14 51	30 04	8000	"	"
228	560	Tinni Well Field	14 32	29 27	2330	"	"
229	561	Ghalmi Bara	14 29	29 05	4000	"	"
230	562	Sodari	14 25	29 05	40000	"	"
231	587	Umm Iubiya	11 13	30 55	84000	E. Jebels	63/64
232	588	Tosi	10 49	30 50	53000	"	"
233	589	Habila	11 55	30 01	12500	N. "	"
234	609	Mazrub	13 54	29 19	40000	Dar Hamid	65/66
235	610	Hemrat Esheik (Weir)	14 35½	27 58½	101000	Kababish	"
236	611	Umm Badir (Weir)	14 13½	27 57½	80000	"	"
237	622	El Odaya	12 25	30 01	10000	Bederiya	66/67
238	623	Umm Arada	12 55	30 09	60000	"	"
239	624	El Eteifih	11 20	29 10	10000	Meseriya	"
240	625	El Ein	13 00	30 10	50000	Bederiya	"
241	626	Birka Kabira	12 23	30 05	13400	"	"
242	627	Shegeila	13 51	29 39	20000	Dar Hamid	"

Replacement of hafir No. 542

EXISTING HAFIRS & DAMS IN KORDOFAN PROVINCE

Ser. No.:	Hafir No.:	Name	Co-ordinates		Capacity	Rural Council	Season of Construction	REMARKS
			Lat.	Long				
243	628	Sunta Umm Qusea	14 14	29 41	15000	Kababish	66/67	
244	629	Rohad Ed Dabib	14 28	29 56	20000	"	"	
245	630	El Mazrub	13 54	29 19	40000	Dar Hamid	"	
246	643	Miri Bara (Dam)	11 03	29 35	600000	S. Jebels	67/68	75% of work is done
247	644	El Fungus	11 00	29 58	19800	"	"	
248	645	El Afin	10 56	29 50	19900	"	"	
249	646	Kululu	10 51	29 51	19900	"	"	
250	647	Fama	10 37	29 38	19900	"	"	
251	648	Shat Es Siffaya	10 43	29 45	19900	"	"	
252	649	Telwadi (Dam)	11 38	29 59	1091900	N.	"	
253	650	El Widay	11 23	29 59	20400	"	"	
254	651	Teital	12 05	30 10	20600	"	"	
255	652	El Bugulti	12 26	29 55	21000	"	"	
256	653	El Faye	11 47	30 03	87200	"	"	
257	654	Kortala	12 04	30 22	94000	"	"	Capacity 33200 outside storage 54000
258	655	Muaddir	12 43	30 00	23300	Bederiya	67/68	Capacity 42400 outside storage 51600 more
259	656	Ereidibe	12 43	30 23	20000	"	"	
260	657	Umm Shidaira Elkharta	12 56	30 10	31200	"	"	Capacity partially over-ground storage 11,200
261	658	Kwikaya	12 36	30 25	25800	"	"	Capacity 20000 partially overground storage 5800

EXISTING HAFIRS & DAMS IN KORDOFAN PROVINCE

Ser. No.	Hafir No.	Name	Co-ordinates : Lat. : Long.	Capacity : M3	Rural Council	Season : of Con- : struc- : tion	REMARKS
262	659	El Temeid	12 55 30 13	67300	Bederiya	67/68	Capacity 20000 partially over ground storage 47300 ms.
263	660	El Mashaga Ez Zarga	13 00 29 57	23000	"	"	Capacity 30000 partially over ground storage upto 220000
264	661	En Niela	13 25 30 05	26000	"	"	Capacity 20000 outside storage 6000
265	662	Umm Sumeima	13 10 29 30	19200	"	"	
266	663	Abu Ga'ud	13 09 29 46	20100	"	"	
267	664	Umm Higlig	13 21 30 03	19600	"	"	
268	665	Bint El Kalib	10 48 30 55	18700	E!Jebels	"	
269	666	Morong	10 36 31 55	19900	"	"	
270	667	Umm Hassan	10 50 31 05	20100	"	"	Capacity 18100 outside storage 2000.
271	668	Es Senaf	10 47 31 13	19600	"	"	
272	669	Bir Ayad	10 46 31 57	19500	"	"	
273	670	Dama'a	10 53 30 45	19800	"	"	
274	671	Umm Sineina	10 41 30 45	18900	"	"	
275	672	El Beida	10 31 30 45	44400	"	"	
276	673	Battatat	11 21 31 16	20900	"	"	
277	674	Umm Saga'a	11 18 31 16	20500	"	"	
278	675	Es Sahal	11 14 31 22	68200	"	"	Capacity 21900. Outside storage 48300 M3
279	676	Bukhas	11 23 31 20	23200	"	"	Capacity 2000. Outside storage 3000 M3
280	677	Umm Heitan	11 28 31 07	20500	"	"	
281	678	Tugur	12 10 31 27	20600	"	"	

TABLE NO. 2

EXISTING HAFIRS AND DAMS IN DARFUR PROVINCE

Ser. No.	Hafir No.	Name of Hafir	Co-ordinates	Capacity M3	Rural Council	Season of construction	REMARKS
1A		Mellit	14° 08' 25" N 33° 00' 00" E	931000	N. Darfur	47/48	
1	203	Abu Buati	10° 54' 26" N 36° 00' 00" E	5427	S. "	51/52	
2	204	Umm Dubban	10° 54' 26" N 22° 00' 00" E	10977	"	"	
3	207	Silwachi El Rimeila	10° 48' 26" N 24° 00' 00" E	10591	"	"	
4	209	Malemm	10° 21' 26" N 38° 00' 00" E	8294	"	"	
5	212	Daha el Gamus	10° 15' 26" N 39° 00' 00" E	5033	"	"	
6	213	Martenda	10° 30' 26" N 28° 00' 00" E	6708	"	"	
7	216	El Feid Bagga	10° 38' 26" N 18° 00' 00" E	10170	"	"	
8	217	Habl El Tarar	10° 45' 26" N 38° 00' 00" E	4009	"	"	
9	219	Niyalis	10° 54' 25" N 58° 00' 00" E	9013	"	"	
10	220	Wakila	10° 54' 26" N 11° 00' 00" E	4573	"	"	
11	221	Kariu	11° 08' 26" N 20° 00' 00" E	5310	"	"	
12	223	Serereiha	11° 12' 25" N 59° 00' 00" E	6622	"	"	
13	224	Tishbara	10° 54' 26" N 43° 00' 00" E	4057	"	"	
14	225	Umm Higara	10° 51' 26" N 48° 00' 00" E	1844	"	"	
15	226	Mahfura	10° 50' 26" N 53° 00' 00" E	1749	"	"	
16	330	Markangia	11° 03' 25" N 33° 00' 00" E	8078	"	"	
17	331	Mashallokha (Buta)	10° 56' 25" N 23° 00' 00" E	7462	"	"	
18	332	Angana (Buta)	10° 59' 25" N 03° 00' 00" E	8948	"	"	
19	333	Talong	10° 42' 24" N 49° 00' 00" E	5223	"	"	
20	334	El Akab	10° 38' 24" N 57° 00' 00" E	10163	"	"	
21	335	Ras El Fil	10° 33' 24" N 57° 00' 00" E	6888	"	"	
22	336	Heneiga	10° 43' 25" N 03° 00' 00" E	6395	"	"	
23	337	Shaggag	10° 41' 25" N 12° 00' 00" E	7043	"	"	
24	338	Debardora	10° 29' 25" N 11° 00' 00" E	6779	"	"	
25	339	Abu Wereiga	10° 31' 25" N 18° 00' 00" E	8496	"	"	
26	340	Tuefra	10° 37' 25" N 25° 00' 00" E	12577	"	"	
27	341	Aggreb	10° 43' 25" N 30° 00' 00" E	10705	"	54/55	
28	342	An Nugra	10° 37' 25" N 36° 00' 00" E	7792	"	"	
29	343	Aradeib el Hamra	10° 45' 25" N 36° 00' 00" E	7573	"	"	
30	344	Keika	10° 36' 25" N 40° 00' 00" E	12036	"	"	
31	345	Mishagga	10° 43' 25" N 38° 00' 00" E	8174	"	"	

EXISTING HAFIRS AND DAMS IN DARFUR PROVINCE

Ser No.	Hafir No.	Name of Hafir	Co-ordinates		Capacity M ³	Rural Council	Season of Con-	REMARKS
			Lat.	Long.				
32	346	Misheifir	10° 35'	25° 46'	9803	S. Darfur	54/55	
33	347	Sibeir 'B'	10° 38'	25° 57'	4838	"	"	
34	348	El Feid Abu Nila	10° 36'	26° 12'	7030	"	"	
35	349	Umm Ruba	10° 36'	26° 13'	9594	"	"	
36	350	Abu Tisha	10° 22'	26° 30'	12282	"	"	
37	351	Nyamis	10° 15'	26° 36'	9394	"	"	
38	352	Qardud es Salala	10° 08'	26° 37'	11379	"	"	
39	353	Tamagis	9° 56'	26° 51'	7972	"	"	
40	354	Umm Durdeiga	10° 09'	26° 43'	13307	"	"	
41	355	Koo Angato	10° 08'	26° 46'	17417	"	"	
42	356	Kallaba	10° 02'	26° 50'	12902	"	"	
43	357	Umm Agaga	10° 02'	26° 55'	13334	"	"	
44	358	El Fau Duano	10° 05'	26° 58'	10592	"	"	
45	359	Mireir El Ebeyed	10° 00'	27° 13'	9177	"	"	
46	386	Mutba	13° 36'	25° 46'	45000	Fasher	56/57	
47	387	Kulkul bridge	13° 38'	25° 41'	25000	"	"	
48	388	Umm Dam	13° 35'	25° 54'	30000	"	"	
49	389	Tawila	13° 30'	24° 51'	300000	"	"	
50	390	Migabila	14° 05'	25° 13'	300000	"	"	
51	391	Bir Nahla	14° 01'	25° 20'	60000	"	"	
52	392	Azagarfa	13° 53'	25° 25'	300000	"	"	
53	393	Jebel Ma'alla	14° 04'	22° 47'	300000	Masalit	"	
54	394	Traco Masonry	13° 44'	25° 43'	60000	Fasher	"	
55	395	Matakero	14° 52'	23° 54'	1200000	N. Darfur	"	
56	396	Jebel Darma	15° 15'	23° 30'	120000	"	"	
57	397	Sireiba Masonry	15° 00'	23° 34'	375000	"	"	
58	398A	Wadi Bassau	15° 01'	22° 57'	Washed out Re-const.	"	"	
					61/62			
59	401	Gadid Ras El Fil	12° 30'	25° 44'	480000	Fasher	57/58	
60	488	Turtur hafir	13° 57'	23° 25'	43000	N. Darfur	58/59	
61	489	Abugudad Dam	14° 07'	23° 14'	1500000	"	"	
62	512	Zallut Garrash	14° 21'	23° 32'	30000	"	59/60	
63	513	Guhr Marafein	14° 09'	23° 23'	30000	"	"	
64	514	Hillaliya Dam	15° 01'	23° 10'	1500000	"	"	

EXISTING HAFIRS AND DAMS IN DARFUR PROVINCE

Ser. No.	Hafir No.	Name of Hafir	Co-ordinates			Capacity	Rural Council	Season of Construction	REMARKS
			Long.	Lat.	City				
65	515	Mandara	13 54	23 15		30000	N. Darfur	59/60	
66	516	Hillilat Dam	14 20	22 43		500000	Masalit	"	
67	517	Gumeiza	13 45	23 09		30000	"	"	
68	518	Tori	13 26	22 17		30000	"	"	
69	519	Shingle Tubaya	13 01	25 15		Embankment	Fasher	"	
70	520	Wada'a Dam	12 50	25 45		77000	"	"	
71	521	Umm Kutkut	12 26	26 20		30000	"	"	
72	563B	Wadi Bassau Dam	15 01	22 57		680000	N. Darfur	61-62	
73	564	Wadi El Ku9	13 24	25 31		30000	Fasher	"	
74	565	Wadi Erigi	14 00	24 15		40000	N. Darfur	"	
75	566	Wadi Tilfu	14 24	23 32		20000	"	"	
76	567	Wadi Anabagi	14 40	23 51		40000	"	"	
77	582	Karingu	13 21	25 02		31000	Fasher	63/64	
78	583	Fasha'ar	13 39	25 30		63000	"	"	
79	584	Tamad Dehish	13 17	25 11		36000	"	"	
80	585	Lunya	13 43	25 25		32000	"	"	
81	612	Hashaba	13 47	23 10		30000	Masalit	66-67	
82	613	Dohat Kasha	13 44	23 03		40000	"	"	
83	614	Mahabas	13 30	22 47		40000	"	"	
84	615	Saliema	13 29	22 59		25000	"	"	
85	616	Rosi	13 24	22 51		60000	"	"	
86	617	Beir Gadah	14 22	22 55		30000	"	"	
87	618	Sassa	14 54	22 46		30000	N. Darfur	"	
88	619	Gheibeshat	13 24	24 57		15000	Fasher	"	
89	620	Fashar "Twin"	13 39	25 29		60000	"	"	
90	621	Wadi Golu	13 32	25 19		250000	"	"	
91	679	Karfu (Dam)	14 45	23 39		1955000	N. Darfur	67-68	
92	680	Rahad Um Sunina	13 45	23 37		35000	"	"	
93	681	Rahad Simu	13 41	23 59		45000	"	"	
94	682	Wadi Gussa	13 38	23 32		25000	"	"	
95	683	Rahad El Gadid	13 43	23 19		30000	"	"	
96	684	Lunya - "Twin"	13 43	25 31		35000	Fasher	"	
97	685	Wadi El Ku 'Twin'	13 14	25 31		28000	"	"	
98	686	Gereiwid El Bash	13 16	25 25		35000	"	"	
99	687	Tugur Tarni	13 20	24 55		40000	"	"	
100	688	Ragabat Wad El Naem	13 45	27 22		30000	E. Darfur	"	

TABLE No. 3

EXISTING HAFIRS AND DAMS IN KASSALA PROVINCE

Ser. No.	Hafir No.	Name of Hafir	Co-ordinates Lat : Long.	Capacity MB	Rural Council	Season of Construction	REMARKS
1	1	Lake Smith (Ghadamaliya)	14° 02' 35" 02	160000	N. Gedaref	47-48	
2	21	Tab El Mara	13 34 34 28	6725	"	"	
3	22	Tab Ez Zaraf	13 33 34 27	7472	"	"	
4	23	Kaffai	13 22 35 49	14650	S. Gedaref	"	
5	24	Kassab	13 51 35 26	5550	"	"	
6	74	Kobri No.1	14 03 35 05	7751	N "	49-50	
7	75	Kobri No.2	14 03 35 05	7998	"	"	
8	76	Leya	14 07 35 06	3131	"	"	
9	77	Camp No.4	13 59 34 52	13902	"	"	
10	78	Camp No.4	13 59 34 53	14374	"	"	
11	79	Abu Sa'ana	14 31 34 40	25888	"	"	
12	80	Abu Qanafid	14 50 34 40	12 730	"	"	
13	82	Abu Garad	15 03 34 40	11626	"	"	
14	83	Wad Gigi	15 25 35 07	25173	"	"	
15	84	El Hasheib	15 05 35 19	24333	"	"	
16	86	Shasheina	13 52 35 35	11340	S. Gedaref	"	
17	87	Khor Saydeen	13 33 35 21	81566	"	"	
18	90	Sagia Sanga'at	13 41 35 23	6113	"	"	
19	91	Beya	13 25 35 00	9243	Gola En Nahal	"	
20	92	Beya	13 25 35 00	9481	"	"	
21	95	Umm Burush	13 17 34 58	7289	"	"	
22	97	Jebel Marafa'a	13 19 34 50	6034	"	"	
23	99	Ban	13 25 34 55	8989	"	"	
24	100	Ban	13 25 34 55	9240	"	"	
25	102	Qurein	13 32 34 48	11541	"	"	
26	103	Kartot	13 37 34 49	6152	"	"	
27	105	El Gir	13 40 35 04	14000	"	"	
28	106	Khor Queisher	13 41 35 02	16324	"	"	
29	108	Wad Dafta	13 44 35 18	8933	S. Gedaref	"	
30	109	Wad Dafta	13 44 35 18	11062	"	"	
31	228	Jebel El Atash	13 58 34 32	12600	"	"	
32	310	Wadi Atshan	15 34 34 56	26619	"	"	
33	311	Wad Gigi No.2	15 17 35 04	15688	"	"	

EXISTING HAFIRS AND DAMS IN KASSALA PROVINCE

Ser. No.	Hafir No.	Name of Hafir	Co-ordinates		Capacity	Rural Council	Season of construction	REMARKS
			Lat.	Long.				
34	312	Wadi Musran	15° 15'	35° 19'	16977	N. Gadaref	54-55	
35	313	Jebel Nawasil	14 54	35 28	11564	"	"	
36	314	" Kasamor	14 36	35 28	31150	"	"	
37	315	" Mganis	14 34	35 13	5217	"	"	
38	316	" Surug Mahmoud	14 51	34 58	22775	"	"	
39	317	Wadi Abu Qanatif No.2	14 51	34 36	22795	"	"	
40	318	Khor Abu Garad No.2	15 04	34 32	15191	"	"	
41	319	Jebel Mundara	15 00	34 23	10733	"	"	
42	320	" Ghur	14 49	34 20	8190	"	"	
43	321	" Geraia	14 40	34 16	7694	"	"	
44	322	J. Ummat Rumeila	14 10	34 41	10871	"	"	
45	323	J. Karadis	14 11	35 22	9070	"	"	
46	324	El Mahal	13 43	35 28	28035	"	"	
47	325	J. El Humra	13 39	35 33	9745	"	"	
48	326	J. Beila	13 41	34 51	29569	Qala En Nahal	"	
49	327	J. Qelbi	13 37	34 44	29517	"	"	
50	328	J. Kartot	13 36	34 49	10781	"	"	
51	329	J. Umm Masam	13 29	34 43	10710	"	"	
52	375	Khor Mogran	13 49	35 01	20000	S. Gedaref	55/56	
53	376	El Galaba	13 55	34 59	15000	"	"	
54	382	Matna	13 46	35 05	20012	"	"	
55	383	Abu Muruwa	13 53	35 09	20012	"	"	
56	384	Gum Huriya	13 51	35 05	50000	"	"	
57	385	Et Taraf	14 11	35 04	20012	N. Gedaref	56/57	
58	403	J. El Arid	13 33	34 48	15000	Qala En Nahal	57/58	
59	404	J. El Asama	13 16 40	34 52	15000	"	"	
60	405	Khor Abu Hamir	13 31	34 56	15000	"	"	
61	406	El Ban Gadid	13 30 30	34 48	15000	"	"	
62	407	Qureisha(Hafir)	13 42 30	35 56	15000	S. Gedaref	"	
63	408	Qureosja(Dam)	13 42 30	35 56	23800	"	"	
64	409	Abu Qulut(Dam)	13 40	35 33 30	102137	"	"	
65	490	Ghadambaliya	14 02	35 02	25000	N. Gedaref	"	
66	491	Camp 8	13 58	35 05	20000	S. "	"	
67	492	Khor Singida	14 06	35 03	20000	N. "	"	
68	493	Wad Daul	14 08	34 56	20000	N. "	"	

EXISTING HAFIRS AND DAMS IN KASSALA PROVINCE •

Ser. No.	Hafir No.	Name of Hafir	Co-ordinates : Lat. : Long		Capacity : M3	Rural Council	Season of construction	REMARKS
69	494	Ummat Rawabi	14 06	34 44	20000	N. Gedaref	59/60	
70	495	El Faw	14 07	34 17	30000	"	"	
71	496	Abu Rahama	13 56	34 33	8000	"	"	
72	497	J. Heleiba	13 36	34 43	10000	Qala En Nahal	"	
73	498	Gala El Bagar	13 10	34 59	18000	"	"	
74	499	J. Utash	13 18	35 09	16000	"	"	
75	500	Wad Wadeida	13 27	35 06	10000	"	"	
76	501	Qongoleisa	13 38	35 08	10000	S. Gedaref	"	
77	502	Kaffai	13 21	35 49	20000	"	"	
78	503	Kanin 1	13 18	35 50	20000	"	"	
79	504	Kanin 2	13 18	35 51	45000	"	"	
80	505	Umm Trimbi	13 50	34 45	15000	"	"	
81	506	J. Quleya	13 52	34 55	12000	"	"	
82	507	Wad Rawyan	15 43	34 51	20000	N. "	"	
83	508	Wad Rahad	15 34	34 30	20000	"	"	
84	509	Esh Shugui	15 17	34 13	30000	"	"	
85	510	Esh Shubeika	15 17	33 48	15,000	"	"	
86	511	W. Hamad	15 43	34 00	30000	"	"	
87	532	K. Salatna	13 25	34 30	35000	"	60/61	
88	533	K. Queishir	13 45	35 01	10000	S "	"	
89	534	Umm Beleil	13 26	35 20	15000	Qal En Nahal	"	
90	535	W. Fartog	13 25	35 17	16000	"	"	
91	536	Mayass	13 47	34 35	15000	N. Gedaref	"	
92	537	Camp 5	13 55	34 48	15000	"	"	
93	538	Er Rawashda	14 11	35 34	25000	"	"	
94	581	Wad Yousif	13 45	35 56		"	62/63	Post-poned
95	586	Dalasa (Dam)	14 00	35 26 20	160000	"	63/64	
96	638	Beila	13 30	34 49	30000	Qal En Nahal	66/67	
97	639	Bulbi	13 37	34 49	25000	"	"	
98	640	Essuki	14 25	34 40	35000	N. Gedaref	"	
99	641	Umm Kanda	13 20	34 34	30000	"	"	
100	642	Doka	13 30	35 45	40000	S. "	"	
101	699	Ban	13 25	34 55	35000	Qal En Nahal	67/68	

EXISTING HAFIRS AND DAMS IN KASSALA PROVINCE

Ser. No.	Hafir No.	Name of Hafir	Co-ordinates		Capacity	Rural Council	Season of construction	REMARKS
			Long	Lat.				
102	700	Balca	13 23	34 57	35000	Qal En Nalal	67/68	
103	701	El Arid	13 23	34 48	25000	"	"	
104	702	El Baniya	14 10	34 21	25000	N.Gedaref	"	
105	703	Rashid Embankment	13 30	35 59	120000	S.	"	"
106	704	Simsim	13 12	35 12½	110000	Qal En Nahal	"	"
107	705	Es Sunut	13 09	35 19	40000	"	"	"

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TABLE No.4

EXISTING HAFIRS AND DAMS IN BLUE NILE PROVINCE

Ser. No.	HAF-ir No.	Name of Hafir	Co-ordinates : : Lat : Long		Capacity : : city : M3	Rural Council :	Season of construction :	REMARKS
1	2	J. Moya (Fangugu)	13° 22'	33° 18'	54000	Sennar	47/48	
2	3	J. Dali East	12° 51'	33° 24'	47114	Abu Hugar	"	
3	4	J. " West	12° 51'	33° 24'	24000	" "	"	
4	5	J. Mazmum	12° 15'	33° 32'	32900	" "	"	
5	20	Umm Faraneb	13° 19'	34° 25'	11700	Ruffa'a E	"	
6	81	J. Bozi	12° 27'	33° 30'	16081	Abu Hugar	49/50	
7	85	Abu Ureif	12° 24'	33° 14'	26475	"	"	
8	110	Kabusa	13° 18'	34° 33'	17564	Ruffa'a E	"	
9	111	J. Abu Gurud	12° 25'	33° 19'	16733	Abu Hugar	"	
10	112	Wad El Egeila	13° 21'	34° 24'	22561	Ruffa'a	"	
11	113	Butana (sh. En. Nur)	13° 18'	34° 29'	9407	"	"	
12	164	Gerabin	12° 07'	33° 51'	19901	Abu Hugar	50/51	
13	167	J. Terru	12° 33'	33° 10'	17252	" "	"	
14	182	J. Megeinis	11° 55'	32° 07'	20030	Kosti	51/52	
15	229	J. Moya East	13° 28'	33° 22'	21266	Sennar	52 /53	
16	2 30	J. " N.W.	13° 28'	33° 19'	21033	"	"	
17	231	J. Roru	11° 52'	33° 39'	15906	Kurmuk	"	
18	232	J. Gammam	11° 50'	33° 33'	14930	"	"	
19	233	J. Sagadi	13° 36'	33° 09'	6896	Sennar	"	
20	234	J. Duhum	13° 32'	32° 55'	10048	"	"	
21	235	J. Gulbi	11° 45'	33° 28'	45961	Kurmuk	"	
22	236	J. Dud	13° 24'	33° 07'	11265	Sennar	"	
23	237	J. Fangugu No. 2	13° 22'	33° 18'	11802	"	"	
24	238	J. Umm Gidyan E.	13° 15'	33° 07'	3977	"	"	
25	239	" " W	13° 14'	33° 04'	5368	"	"	
26	240	J. Girewa S.	11° 52'	33° 32'	18136	Kurmuk	"	
27	241	J. Geifrat	12° 55'	33° 19'	14194	Abu Hugar	"	
28	242	J. Gireiwa N.W.	11° 50'	33° 31'	19359	Kurmuk	"	
29	243	J. Dali	12° 53'	33° 25'	27831	Abu Hugar	"	
30	244	J. Buk	11° 35'	33° 53'	18463	Kurmuk	"	
31	245	J. Meleisa	12° 55'	33° 14'	6950	Abu Hugar	"	
32	246	J. Kodi	12° 57'	32° 59'	15099	Kosti	"	
33	2 47	J. Agadi	11° 48'	34° 04'	16687	Kurmuk	"	

Ser:	Haf-:		: Co-ordinates :		Capa-	Rural :	Season :	REMARKS
No.:	ir :		Lat. :	Long. :	city	Council:	of Con-:	
:	No.:		:	:	K3	:	struc-	
:	:		:	:	:	:	tion :	
34	248	J.Ahmarein	12 41	33 05	17656	Kosti	52 / 53	
35	249	J. Neyfr	12 40	32 50	9666	"	"	
36	250	J.Bogis	11 36	34 09	16479	Kurmuk	"	
37	251	K.El Tuleih (B.S.)	11 30	33 52	10178	"	"	
38	252	K.Kukur	11 26	33 54	1781	"	"	
39	253	J. Silak	11 08	33 44	8450	"	"	
40	254	J.Danderu	11 03	34 04	17163	"	"	
41	255	J. Malkan	10 50	33 40	8878	"	"	
42	256	J. Ulu	10 42	33 30	17172	"	"	
43	259	J. Kardos	12 33	34 21	24387	Roseiris	"	
44	262	J, Oka lma	12 31	34 19	16466	"	"	
45	264	J.Gerri	11 48	34 36	19672	"	"	
46	269	K. Es Sureifa	11 30	34 45	40642	"	"	
47	272	J. But	11 25	33 25	10000	Kurmuk	"	
48	273	K. Humra	11 37	34 47	11355	Roseiris	"	
49	274	Abu Ushush	11 24	33 27	10000	Kurmuk	"	
50	275	J. Werkat	12 07	33 43	25000	Abu Hugar	"	
51	276	J. Mazmun	12 15	33 32	32900	" "	"	
52	277	J.Gerabin No.2	12 07	33 51	26040	" "	"	
53	278	J.Fashar	11 52	33 35	16091	Kurmuk	"	
54	279	J. Ahmar	11 27	33 45	16050	"	"	
55	280	J.Silak No.2	11 08	33 42	12029	"	"	
56	281	J.Mudda	11 04	33 42	15376	"	"	
57	282	J.Gerawid	10 49	33 25	23148	"	"	
58	378	J.Dali S.C. No.1	12 45	33 30	5000	Abu Hugar	56/57	
59	379	" " No.2	12 49	33 30	5000	" "	"	
60	380	" " No.3	12 47	33 34	5000	" "	"	
61	381	" " No.4	12 54	33 35	5000	" "	"	
62	441	K.Jana	11 33 30	33 59 30	12000	Kurmuk	58/59	
63	442	J.Qargada	11 39	34 18	15000	"	"	
64	443	J.Balmut	11 21 30	33 48	15000	"	"	
65	444	J. Mugum	11 12	34 03	10000	"	"	
66	445	J. Dali	11 15 30	34 06 30	12000	"	"	
67	446	J. Bangas	11 30	34 12	8000	"	"	
68	447	J.Tor Nasy	10 52	34 20	15000	"	"	
69	448	J.Qabgu	11 03 30	34 29 30	9000	"	"	
70	450	K.Tunja	10 29 30	33 44 30	15000	"	"	

EXISTING HAFIRS & DAMS IN BLUE NILE PROVINCE

Ser. No.	Hafir No.	Name of Hafir	Co-ordinates		Capacity	Rural Council	Season of construction	REMARKS
			Lat	Long.				
71	451	Umm Dardaga	13 29	34 19	15000	Rufa'a E	58/59	
72	452	J. Dia	12 41	30 33 58	8000	Abu Hugar	"	
73	453	J. Abdel	12 42	34 03	12000	"	"	
74	454	J. Biyut North	13 26	32 54 30	5000	Kosti	"	
75	455	Khor Sidra	12 35	32 22	8000	"	"	
76	456	Sagadi	13 33	33 11	8000	Sennar	"	
77	457	Ubeyda	12 43	30 33 59	10000	Abu Hugar	"	
78	458	Nuri	12 57	33 03 30	8000	Kosti	"	
79	459	J. Mir	13 25	32 57	5000	"	"	
80	460	Umm Agareib No.1	12 19	31 58	20000	"	"	
81	461	" " No.2	12 19	31 58	20000	"	"	
82	462	Huabnis	13 09	32 14	9000	"	"	
83	463	Sha'anya	13 18	34 31	15000	Rufa'a E.	"	
84	464	Bozi	12 28	33 28 30	15000	Abu Hugar	"	
85	522	J. Dali North	12 52	33 23	10000	"	60/61	
86	523	J. Dali No.5 (MCPS)	12 53	30 33 30 30	10000	"	"	
87	524	" " " 6 "	12 49	33 37	10890	"	"	
88	525	" " " 7 "	12 40	30 33 38 30	10890	"	"	
89	526	" " " 8 "	12 42	30 33 31	10350	"	"	
90	527	Mazmun No.1	12 12	30 33 46	10350	"	"	
91	528	" No.2	12 11	30 33 40 30	11400	"	"	
92	529	" " 3	12 21	30 33 38 30	10350	"	"	
93	530	" " 4	12 15	30 33 43	11400	"	"	
94	531	J. Gifrat	12 55	30 33 18	8000	"	"	
95	574	Tebeitab9	10 59	33 26	17433	Kurmuk	62/63	
96	575	Damigo	10 07	34 05	15000	"	"	
97	576	Maghafa	11 04	33 54	25000	"	"	
98	577	Erbal	11 17	33 45	14000	"	"	
99	578	Madir	11 36	33 26	10000	"	"	
100	579	Bafei	11 11	33 48	14000	"	"	
101	580	Sedak	11 29	33 44	15000	"	"	
102	590	J. Meirak	11 20	34 11	40000	"	64/65	
103	591	J. Mufwa	10 28	34 02	40000	"	"	
104	592	J. Danderu	11 03	34 04	20000	"	"	
105	593	J. Mafr	11 26	33 50	30000	"	"	

EXISTING HAFIRS & DAMS IN BLUE NILE PROVINCE

Ser. No.:	Hafir No.:	Name of Hafir	Co-ordinates:		Capacity:	Rural Council:	Season of Construction:	REMARKS
:	:	:	Lat.:	Long.:	M3	:	ion	:
106	594	J. El Teen	11 17	33 53	15000	Kurmuk	64/65	
107	595	J. Ahmar	11 26	33 44	60000	"	"	
108	596	J. Keilgo	11 34	34 19	30000	"	"	
109	597	J. Weigo	11 39	34 12	60000	"	"	
110	598	Umm Kaweika	13 00	32 16	25000	Kosti	65/66	
111	599	Grada (Idd)	13 12	32 20	25000	"	"	
112	600	Abu Hamra	13 10	32 14	18000	"	"	
113	601	Umm Gudur	12 50	32 19	20000	"	"	
114	602	Udeid Hamad	12 36	32 06	20000	"	"	
115	603	Er Rua'at	12 20	32 16	20000	"	"	
116	604	J. Idrat	12 36	33 03	25000	"	"	
117	605	J. El Teibon	12 20	33 02	25000	"	"	
118	606	Mazmun (Twin	12 15	33 32	100000	Abu Hugar	"	
119	607	Umm Shahwan	11 50	34 41	60000	Roseiris	"	
120	608	Mazambagha	11 32	34 49	2 5000	"	"	
121	631	Wirkat	12 07	33 43	50000	Abu Hugar	66/67	
122	632	Buk	11 35	33 53	50000	Kurmuk	"	
123	633	Bulli	12 41	33 05	50000	Kosti	"	
124	634	Dereisa	13 10	32 16	20000	"	"	
125	635	J. Moya	13 22	33 18	100000	Sennar	"	
126	636	Umm Gidian	13 14	33 07	50000	"	"	
127	637	El Henew	15 08	32 24	(Piped Water Supply Scheme)	Ed Dueim	"	
128	689	Abu Ureif	12 48	33 14	27000	Abu Hugar	67/68	
129	690	El Dali	12 50	33 24	70000	" "	"	
130	691	Abu Rawag	12 43	33 37	40000	" "	"	
131	692	Bozi	12 19	33 59	33000	" "	"	
132	693	Wl Terro	12 19	33 10	27000	Kosti	"	
133	694	Migawir	12 24	33 23	27000	Abu Hugar	"	
134	695	Chali	10 09	34 04	33000	Kurmuk	"	
135	696	Adola	10 27	34 07	27000	"	"	
136	697	El Kurmuk	10 2 0	34 14	75000	"	"	
137	698	Umm Ramta (J. Afu)	14 50	32 16	150000	N.W. Nile	"	

TABLE No. 5

EXISTING HAFIRS & DAMS IN UPPER NILE PROVINCE

Ser. No.	Hafir No.	Name of hafir	Co-ordinates		Capacity	Rural Council	Season of construction	REMARKS
			Lat.	Long.				
1	6	Uam Dilwis	12° 06'	33° 08'	44195	Renk	47-48	
2	7	Abu Shanab	12° 05'	33° 05'	6450	"	"	
3	8	Girbanat	12° 00'	33° 06'	6790	"	"	
4	9	Wad Batta	11° 56'	33° 02'	8980	"	"	
5	10	Rom	11° 47'	32° 52'	6450	"	"	
6	11	Renk-Guli(Khor Duleib)	11° 42'	33° 01'	6000	"	"	
7	12	Willit	11° 40'	32° 56'	5225	"	"	
8	13	Chimade	11° 32'	32° 59'	6470	"	"	
9	14	Donglei	11° 23'	33° 07'	14000	"	"	
10	15	Ugra villa ge	11° 17'	33° 06'	6050	"	"	
110	16	K. Ugra (Fachoch)	11° 11'	33° 06'	6180	"	"	
12	17	Manafiock(Western)	10° 32'	32° 59'	6800	"	"	
13	18	Zarzura	10° 32'	33° 17'	20000	"	"	
14	19	Ban Uga	10° 22'	33° 19'	6800	"	"	
15	88	Warrawa	11° 07'	33° 09'	5512	"	49-50	
16	89	Fabong	10° 58'	33° 09'	6159	"	"	
17	93	Tibna	10° 50'	33° 10'	4843	"	"	
18	94	Meding	10° 42'	33° 04'	7273	"	"	
19	96	Fariak	10° 32'	32° 32'	6321	"	"	
20	98	Nyek	10° 29'	32° 39'	7512	"	"	
21	101	Paloich(Kitiloit)	10° 27'	32° 33'	10284	"	"	
22	104	Mongador	10° 26'	32° 26'	9065	"	"	
23	107	Loweir	10° 33'	32° 16'	8568	"	"	
24	136	Momo	10° 36'	32° 00'	9752	Shilluk	50-51	
25	138	Roar	10° 27'	32° 00'	7623	"	"	
26	140	Agoic	10° 18'	31° 59'	11830	"	"	
27	142	Widokoki	10° 11'	31° 47'	8967	"	"	
28	144	Fama	10° 04'	31° 56'	10796	"	"	
29	147	Akoka	9° 44'	32° 10'	9199	Sobat	"	
30	150	Akonowing	9° 42'	32° 21'	11164	"	"	
31	152	Wankar	9° 47'	32° 22'	10101	"	"	
32	154	Loye	9° 39'	32° 27'	9348	"	"	
33	157	Balagat	10° 14'	32° 40'	6230	Kenk	"	
34	159	Daraful	10° 21'	32° 43'	736	"	"	

EXISTING HAFIRS & DAMS IN UPPER NILE PROVINCE

Ser. No.	Hafir No.	Name of Hafir	Co-ordinates		Capacity	Rural Council	Season of Construction	REMARKS
			Lat	Long				
35	161	Ayan	10 27	32 38	6543	Renk	50-51	
36	257	Khor Marafeen	10 41	33 12	8956	"	52-53	
37	258	Banjeila	10 24	33 08	7825	"	"	
38	260	Warawet	10 20	32 56	9553	"	"	
39	261	Leweng	10 23	32 38	12826	"	"	
40	263	Paloich(Kitiloit)	10 27	32 32	7861	"	"	
41	265	Tir	10 32	32 28	7851	"	"	
42	266	Miakol	10 35	32 39	7981	"	"	
43	267	Aturak	10 41	32 40	8781	"	"	
44	268	Dow	10 29	32 44	10000	"	"	
45	270	Kolochetta (Makwech)	10 24	32 52	10000	"	"	
46	271	Wahfat	10 31	32 55	10000	"	"	
47	283	Gobkwero	9 35	32 07	9564	Sobat	53-54	
48	284	Wabnit	9 27	32 08	9600	"	"	
49	285	Wanatong	9 20	32 25	8417	"	"	
50	286	Wanamong	9 15	32 27	8996	"	"	
51	287	Dual Bay	9 12	32 30	9861	"	"	
52	288	Rom	9 08	32 43	8449	E.Nuer	"	
53	289	Ditchin	9 07	32 50	8949	"	"	
54	290	Joen	9 03	32 40	8783	"	"	
55	291	Mangagual	01	32 40	8732	"	"	
56	292	Nabula	10 01	30 20	10364	W.Nuer	"	
57	293	Nagdjar (F.N. HAFIR)	9 27	31 45	13750	Sobat	"	
58	294	Gob Na m	10 07	29 55	9110	W.Nuer	"	
59	295	Biem Darlong	10 05	30 00	9377	"	"	
60	296	Myawing	10 01	30 00	8503	"	"	
61	297	Robchoek	10 00	29 58	7825	"	"	
62	298	Lewin	9 55	30 08	8354	"	"	
63	299	Riagnom	9 55	30 01	8955	"	"	
64	300	Bulyor	9 47	29 58	8833	"	"	
65	301	Nabuk	9 50	30 06	9218	"	"	
66	302	Lili	9 44	30 15	12650	"	"	
67	303	Bamadol	9 48	30 10	11168	"	"	
68	304	Ling	9 53	30 11	13721	"	"	
69	305	El Araish (Dam)	9 38	30 53	20000	Shilluk	"	

EXISTING HAFIRS & DAMS IN UPPER NILE PROVINCE

Ser. No.	Hafir No.	Hafir Name	Co-ordinates Lat. : Long.	Capacity M ³	Rural Council	Season of construction	REMARKS
70	306	Hafir No. 14	9° 32' 31" 23'	12664	Shilluk	53-54	
71	307	" " 10	9° 35' 31" 32'	10056	"	"	
72	308	" " 7	9° 48' 31" 51'	12010	"	"	
73	568	Liapker	10° 29' 32" 3 9'	19450	Renk	62-63	
74	569	Gabek	10° 29' 30" 32° 25' 30"	20000	"	"	
75	570	Owang Agodo	9° 46' 30" 31° 48' 30"	25000	Shilluk	"	
76	571	Nyigir Otego	9° 54' 31° 29'	17200	"	"	
77	572	Oriang	10° 38' 32" 09'	7000	Renk	"	
78	573	Gerbanat	12° 00' 33" 06'	20600	"	"	

TABLE No. 6.

DIMENSIONS OF HAFIRS HAVING CAPACITIES BETWEEN 5,000 AND 60,000 CUBIC METRES AND DEPTHS VARYING FROM 3.0 TO 10 METRES.

FAIRLY SANDY SOILS

Sides 1:2, End Ramps 1:4

$$l = 2W$$

Bottom length twice the bottom width.

The table attached shows the top and bottom Dimensions of Hafirs of different capacities in cubic metres for depth varying from 3 to 10 metres at 50 cm. intervals.

The dimensions in metres and centimetres are indicated by the following fraction.

$$\frac{L \times W}{l \times w} \quad \text{where}$$

L = The top length

W = The top width

l = The bottom length

w = The bottom width.

The capacity of the hafir at any depth can be easily derived by the integration method. Consider an infinitesimal layer of water of depth d , located at a depth d from the bottom as shown in figures below :-

$d v = da \times \Delta d$

$da = \text{length} \times \text{width}$

$= (2w + 8d)(w + 4d)$

$d v = (2w^2 + 16wd + 32d^2) \Delta d$

$d = D$

$\therefore V = \int_0^D (2w^2 + 16wd + 32d^2) \Delta d$

$d = 0$

$= \left[2w^2 d + 8wd^2 + \frac{32}{3} d^3 + C \right]_0^D$

at $d = 0, V = 0 \therefore C = 0$

$\therefore V = 2w^2 d + 8wd^2 + \frac{32}{3} d^3 \quad (1)$

The Hafirs is usually reversed truncated pyramid whose base is rectangular in shape having the bottom length twice the bottom width, and sides slopes are 1:2, where the slopes of the end ramps are 1:4.

The bottom width of the hafir is obtained by solving equation (1) which gives :

$$w = \frac{\sqrt{18VD - 48 D^4 - 12 D^2}}{6D} \quad (2)$$

Other dimensions can be obtained by substituting in these equations.

$$L = 2 W + 8 D$$

$$W = w + 4 D$$

$$L = 2 w$$

The minimum bottom width allowed is 15.0

Capacity in M ³	5,000	6,000	7,000	8,000
	Top Dimensions Bottom Dimen - sions	Top Dimensions Bottom Dimen - sions	Top Dimensions Bottom Dimen - sions	Top Dimensions Bottom Dimen - sions
3.00	<u>69.32 x 34.66</u> 45.32 x 22.66	<u>74.86 x 37.43</u> 50.86 x 25.43	<u>79.96 x 39.98</u> 50.96 x 27.98	<u>84.70 x 42.35</u> 60.70 x 30.35
3.50	<u>66.83 x 33.47</u> 38.83 x 19.47	<u>71.99 x 36.00</u> 43.99 x 22.00	<u>76.72 x 38.36</u> 48.72 x 24.36	<u>81.12 x 40.56</u> 53.12 x 26.56
4.00	<u>65.13 x 32.57</u> 33.13 x 16.57	<u>69.99 x 34.99</u> 37.99 x 18.99	<u>74.43 x 37.22</u> 42.43 x 21.22	<u>78.57 x 39.28</u> 46.57 x 23.28
4.50		<u>68.58 x 34.29</u> 32.58 x 16.29	<u>72.80 x 36.40</u> 36.80 x 18.40	<u>76.71 x 38.36</u> 40.71 x 20.36
5.00			<u>71.64 x 35.82</u> 31.64 x 15.82	<u>75.37 x 37.69</u> 35.37 x 17.69
5.50				<u>74.42 x 37.21</u> 30.42 x 15.21
6.00				
6.50				
7.00				
7.50				
8.00				
8.50				
9.00				
9.50				
10.00				

Capacity in M ³	9,000	10,000	12,000	14,000
	<u>Top Dimensions</u> <u>Bottom Dimen -</u> <u>sions</u>	<u>Top Dimensions</u> <u>Bottom Dimen -</u> <u>sions</u>	<u>Top Dimensions</u> <u>Bottom Dimensions</u>	<u>Top Dimensions</u> <u>Bottom Dimen -</u> <u>sions</u>
3.00	<u>89.15 x 44.57</u> <u>65.15 x 32.57</u>	<u>93.36 x 46.68</u> <u>69.36 x 34.68</u>	<u>101.17 x 50.59</u> <u>77.17 x 38.59</u>	<u>108.36 x 54.18</u> <u>84.36 x 42.18</u>
3.50	<u>85.26 x 42.63</u> <u>57.26 x 28.63</u>	<u>89.16 x 44.58</u> <u>61.16 x 30.58</u>	<u>96.41 x 48.21</u> <u>68.41 x 34.21</u>	<u>103.08 x 51.54</u> <u>75.08 x 37.54</u>
4.00	<u>82.44 x 41.22</u> <u>50.44 x 25.22</u>	<u>86.11 x 43.05</u> <u>54.11 x 27.05</u>	<u>92.91 x 46.45</u> <u>60.91 x 30.45</u>	<u>99.15 x 49.58</u> <u>67.15 x 33.58</u>
4.50	<u>80.39 x 40.19</u> <u>44.39 x 22.19</u>	<u>83.85 x 41.93</u> <u>47.85 x 23.93</u>	<u>90.29 x 45.14</u> <u>54.29 x 27.14</u>	<u>96.19 x 48.10</u> <u>60.19 x 30.10</u>
5.00	<u>78.87 x 39.44</u> <u>38.87 x 19.44</u>	<u>82.18 x 41.09</u> <u>42.18 x 21.09</u>	<u>88.31 x 44.16</u> <u>48.31 x 24.16</u>	<u>93.93 x 46.97</u> <u>53.93 x 26.97</u>
5.50	<u>77.78 x 38.89</u> <u>33.78 x 16.89</u>	<u>80.95 x 40.47</u> <u>36.95 x 18.47</u>	<u>86.82 x 43.41</u> <u>42.82 x 21.41</u>	<u>92.21 x 46.11</u> <u>48.21 x 24.11</u>
6.00		<u>80.05 x 40.02</u> <u>32.05 x 16.02</u>	<u>85.71 x 42.85</u> <u>37.71 x 18.85</u>	<u>90.89 x 45.45</u> <u>42.89 x 21.45</u>
6.50			<u>84.88 x 42.44</u> <u>32.88 x 16.44</u>	<u>89.89 x 44.95</u> <u>37.89 x 18.95</u>
7.00				<u>89.14 x 44.57</u> <u>33.14 x 16.57</u>
7.50				
8.00				
8.50				
9.00				
9.50				
10.00				

Capacity in M	15,000	16,000	18,000	20,000
	Top Dimensions Bottom Dimensions	Top Dimensions Bottom Dimensions	Top Dimensions Bottom Dimensions	Top Dimensions Bottom Dimensions
3.00	$\frac{111.76 \times 55.88}{87.76 \times 43.88}$	$\frac{115.04 \times 57.52}{91.04 \times 45.52}$	$\frac{121.33 \times 60.66}{97.33 \times 48.66}$	$\frac{127.26 \times 63.63}{103.26 \times 51.63}$
3.50	$\frac{106.23 \times 53.11}{78.23 \times 39.11}$	$\frac{109.27 \times 54.64}{81.27 \times 40.64}$	$\frac{115.10 \times 57.55}{87.10 \times 43.55}$	$\frac{120.60 \times 60.30}{92.60 \times 46.30}$
4.00	$\frac{102.11 \times 51.05}{70.11 \times 35.05}$	$\frac{104.96 \times 52.48}{72.96 \times 36.48}$	$\frac{110.41 \times 55.21}{78.41 \times 39.21}$	$\frac{115.57 \times 57.79}{83.57 \times 41.79}$
4.50	$\frac{98.99 \times 49.49}{62.99 \times 31.49}$	$\frac{101.68 \times 50.84}{65.68 \times 32.84}$	$\frac{106.83 \times 53.42}{70.83 \times 35.42}$	$\frac{111.71 \times 55.85}{75.71 \times 37.85}$
5.00	$\frac{96.59 \times 48.30}{56.59 \times 28.30}$	$\frac{99.16 \times 49.58}{59.16 \times 29.58}$	$\frac{104.06 \times 52.03}{64.06 \times 32.03}$	$\frac{108.69 \times 54.35}{68.69 \times 34.35}$
5.50	$\frac{94.75 \times 47.38}{50.75 \times 25.38}$	$\frac{97.21 \times 47.61}{53.21 \times 26.61}$	$\frac{101.90 \times 50.95}{57.90 \times 28.95}$	$\frac{106.33 \times 53.17}{62.33 \times 31.17}$
6.00	$\frac{93.34 \times 46.67}{45.34 \times 22.67}$	$\frac{95.70 \times 47.85}{47.70 \times 23.85}$	$\frac{100.21 \times 50.11}{52.21 \times 26.11}$	$\frac{104.47 \times 52.23}{56.47 \times 28.23}$
6.50	$\frac{92.25 \times 46.13}{40.25 \times 20.13}$	$\frac{94.54 \times 47.27}{42.54 \times 21.27}$	$\frac{98.89 \times 49.45}{46.89 \times 23.45}$	$\frac{103.00 \times 51.50}{51.00 \times 25.50}$
7.00	$\frac{91.43 \times 45.72}{35.43 \times 17.72}$	$\frac{93.65 \times 46.83}{37.65 \times 18.83}$	$\frac{97.87 \times 48.93}{41.87 \times 20.93}$	$\frac{101.84 \times 50.92}{45.84 \times 22.92}$
7.50	$\frac{90.83 \times 45.41}{30.83 \times 15.41}$	$\frac{92.98 \times 46.49}{32.98 \times 16.49}$	$\frac{97.08 \times 48.54}{37.08 \times 18.54}$	$\frac{100.95 \times 50.47}{40.95 \times 20.47}$
8.00			$\frac{96.49 \times 48.24}{32.49 \times 16.24}$	$\frac{100.25 \times 50.13}{36.25 \times 18.13}$
8.50				$\frac{99.73 \times 49.87}{31.73 \times 15.87}$

Capacity in M ³	25,000	30,000	35,000	40,000
V. D.	Top Dimensions Bottom dimensions.	Top Dimensions bottom Dimensions	Top Dimensions Bottom Dimensions	Top Dimensions Bottom Dimensions
3.00	<u>140.91 x 70.46</u> 116.91 x 58.46	<u>153.25 x 76.63</u> 129.25 x 64.63	<u>164.60 x 82.30</u> 140.60 x 70.30	<u>175.16 x 87.58</u> 151.16 x 75.58
3.50	<u>133.24 x 66.62</u> 105.24 x 52.62	<u>144.68 x 72.34</u> 116.68 x 58.34	<u>155.18 x 77.59</u> 127.18 x 63.59	<u>164.98 x 82.49</u> 136.98 x 68.49
4.00	<u>127.42 x 63.71</u> 95.42 x 47.71	<u>138.12 x 69.06</u> 106.12 x 53.06	<u>147.98 x 73.99</u> 115.98 x 57.99	<u>157.14 x 78.57</u> 125.14 x 62.57
4.50	<u>122.89 x 61.45</u> 86.89 x 43.45	<u>133.00 x 66.50</u> 97.00 x 48.50	<u>142.26 x 71.13</u> 106.26 x 53.13	<u>150.92 x 75.46</u> 114.92 x 57.46
5.00	<u>119.33 x 59.67</u> 79.33 x 39.67	<u>128.93 x 64.47</u> 88.93 x 44.47	<u>137.78 x 68.89</u> 97.78 x 48.89	<u>145.98 x 72.99</u> 105.98 x 52.99
5.50	<u>116.49 x 58.25</u> 72.49 x 36.25	<u>125.67 x 62.84</u> 81.67 x 40.84	<u>134.08 x 67.04</u> 90.08 x 45.04	<u>141.90 x 70.95</u> 97.90 x 48.95
6.00	<u>114.23 x 57.12</u> 66.23 x 33.12	<u>123.04 x 61.52</u> 75.04 x 37.52	<u>131.10 x 65.55</u> 83.10 x 41.55	<u>138.62 x 69.31</u> 90.62 x 45.31
6.50	<u>112.41 x 56.21</u> 60.41 x 30.21	<u>120.89 x 60.45</u> 68.89 x 34.45	<u>128.70 x 64.35</u> 76.70 x 38.35	<u>135.92 x 67.96</u> 83.92 x 41.96
7.00	<u>110.95 x 55.48</u> 54.95 x 27.48	<u>119.16 x 59.58</u> 63.16 x 31.58	<u>126.68 x 63.34</u> 70.68 x 35.34	<u>133.68 x 66.84</u> 77.68 x 38.84
7.50	<u>109.79 x 54.90</u> 49.79 x 24.90	<u>117.75 x 58.88</u> 57.75 x 28.88	<u>125.06 x 62.53</u> 65.06 x 32.53	<u>131.82 x 65.91</u> 71.82 x 35.91
8.00	<u>108.87 x 54.43</u> 44.87 x 22.43	<u>116.61 x 58.30</u> 52.61 x 26.30	<u>123.70 x 61.85</u> 59.70 x 29.85	<u>130.28 x 65.14</u> 66.28 x 33.14
8.50	<u>108.14 x 54.07</u> 40.14 x 20.07	<u>115.69 x 57.85</u> 47.69 x 23.85	<u>122.60 x 61.30</u> 54.60 x 27.30	<u>129.00 x 64.50</u> 61.00 x 30.50
9.00	<u>107.58 x 53.79</u> 35.58 x 17.79	<u>114.96 x 57.48</u> 42.96 x 21.48	<u>121.70 x 60.85</u> 49.70 x 24.85	<u>127.98 x 63.99</u> 55.98 x 27.99
9.50		<u>114.38 x 57.19</u> 38.38 x 19.19	<u>120.98 x 60.49</u> 44.98 x 22.49	<u>127.10 x 63.55</u> 51.10 x 25.55
10.00		<u>113.93 x 56.97</u> 33.93 x 16.97	<u>120.42 x 60.21</u> 40.42 x 20.21	<u>126.42 x 63.21</u> 46.42 x 23.21

Capacity in M ³	45,000	50,000	55,000	60,000
	<u>Top Dimensions</u> <u>Bottom Dimen -</u> <u>sions</u>	<u>Top Dimensions</u> <u>Bottom Dimen -</u> <u>sions</u>	<u>Top Dimensions</u> <u>Bottom Dimen -</u> <u>sions</u>	<u>Top Dimensions</u> <u>Bottom Dimen -</u> <u>sions</u>
3.00	<u>185.06 x 92.53</u> <u>161.06 x 80.53</u>	<u>194.44 x 97.22</u> <u>170.44 x 85.22</u>	<u>203.32 x 101.66</u> <u>179.32 x 89.66</u>	<u>211.86 x 105.93</u> <u>187.86 x 93.93</u>
3.50	<u>174.16 x 87.08</u> <u>146.16 x 73.08</u>	<u>182.84 x 91.42</u> <u>154.84 x 77.42</u>	<u>191.10 x 95.55</u> <u>163.10 x 81.55</u>	<u>199.00 x 99.50</u> <u>171.00 x 85.50</u>
4.00	<u>165.74 x 82.87</u> <u>133.74 x 66.87</u>	<u>173.86 x 86.93</u> <u>141.86 x 70.93</u>	<u>181.60 x 90.80</u> <u>149.60 x 74.80</u>	<u>188.98 x 94.49</u> <u>156.98 x 78.49</u>
4.50	<u>159.04 x 79.52</u> <u>123.04 x 61.52</u>	<u>166.70 x 83.35</u> <u>120.96 x 65.35</u>	<u>174.00 x 87.00</u> <u>138.00 x 69.00</u>	<u>180.74 x 90.37</u> <u>144.74 x 72.37</u>
5.00	<u>153.64 x 76.82</u> <u>113.64 x 56.82</u>	<u>160.96 x 80.48</u> <u>120.96 x 60.48</u>	<u>167.90 x 83.95</u> <u>127.90 x 63.95</u>	<u>174.50 x 87.25</u> <u>134.50 x 67.25</u>
5.50	<u>149.32 x 74.66</u> <u>105.32 x 52.66</u>	<u>156.22 x 78.11</u> <u>112.22 x 56.11</u>	<u>162.82 x 81.41</u> <u>118.82 x 59.41</u>	<u>169.14 x 84.57</u> <u>125.14 x 62.57</u>
6.00	<u>145.90 x 72.85</u> <u>97.90 x 48.85</u>	<u>152.36 x 76.18</u> <u>104.36 x 52.18</u>	<u>158.66 x 79.33</u> <u>110.66 x 55.33</u>	<u>164.72 x 82.36</u> <u>116.72 x 58.36</u>
6.50	<u>142.72 x 71.36</u> <u>90.72 x 45.36</u>	<u>149.12 x 74.56</u> <u>97.12 x 48.56</u>	<u>155.42 x 77.71</u> <u>103.42 x 51.71</u>	<u>161.04 x 80.52</u> <u>109.04 x 54.52</u>
7.00	<u>140.24 x 70.12</u> <u>84.24 x 42.12</u>	<u>146.42 x 73.21</u> <u>90.42 x 45.21</u>	<u>152.30 x 76.15</u> <u>96.30 x 48.15</u>	<u>157.94 x 78.97</u> <u>101.94 x 50.97</u>
7.50	<u>138.16 x 69.08</u> <u>78.16 x 39.08</u>	<u>144.16 x 72.08</u> <u>84.16 x 42.08</u>	<u>149.86 x 74.93</u> <u>89.86 x 44.93</u>	<u>155.30 x 77.65</u> <u>95.30 x 47.65</u>
8.00	<u>136.44 x 68.22</u> <u>72.44 x 36.22</u>	<u>142.28 x 71.14</u> <u>78.28 x 39.14</u>	<u>147.80 x 73.90</u> <u>83.80 x 41.90</u>	<u>153.08 x 76.54</u> <u>89.08 x 44.54</u>
8.50	<u>135.02 x 67.51</u> <u>67.02 x 33.51</u>	<u>140.68 x 70.34</u> <u>72.68 x 36.34</u>	<u>146.04 x 73.02</u> <u>78.04 x 39.02</u>	<u>151.20 x 75.60</u> <u>83.20 x 41.60</u>
9.00	<u>133.82 x 66.91</u> <u>61.82 x 30.91</u>	<u>139.34 x 69.67</u> <u>67.34 x 33.67</u>	<u>144.58 x 72.29</u> <u>72.58 x 36.29</u>	<u>149.58 x 74.79</u> <u>77.58 x 38.79</u>
9.50	<u>132.82 x 66.41</u> <u>56.82 x 28.41</u>	<u>138.22 x 69.11</u> <u>62.22 x 31.11</u>	<u>143.34 x 71.67</u> <u>67.34 x 33.67</u>	<u>148.22 x 73.11</u> <u>72.22 x 36.11</u>
10.00	<u>132.02 x 66.01</u> <u>52.02 x 26.01</u>	<u>137.00 x 68.50</u> <u>57.00 x 28.50</u>	<u>142.32 x 71.16</u> <u>62.32 x 31.16</u>	<u>147.08 x 73.54</u> <u>67.08 x 33.54</u>

TABLE 7

SUMMARY OF EXECUTION PROGRAMME OF HAFIRS & DAMS FROM SEASON
1947/48 - 1967/68

Work- ing Sea- son	Kordofan		Darfur		Kassala		Blue Nile		Upper Nile		Bahr El Gazal		Equat- oria		Khar- toum		T O T A L			
	N	C	N	C	N	C	N	C	N	C	N	C	N	C	N	C	Hafirs		Dams	
																	N	C	N	C
47/48	2	24	1	931	5	194	5	189	14	150							26	557	1	931
48/49	49	386	-	-	-	-	-	-	-	-	-	-	-	-	-	-	49	386	-	-
49/50	-	-	-	-	25	364	6	109	9	66	-	-	-	-	-	-	40	539	-	-
50/51	41	410	-	-	-	-	2	37	12	109	-	-	-	-	-	-	55	556	-	-
51/52	44	457	15	93	1	13	-	-	-	-	-	-	-	-	-	-	60	563	-	-
52/53	-	-	-	-	-	-	37	572	11	102	-	-	-	-	-	-	48	674	-	-
53/54	1	60	-	-	-	-	6	109	26	268	-	-	-	-	-	-	32	417	1	20
54/55	-	-	30	284	20	329	-	-	-	-	-	-	-	-	-	-	50	613	-	-
55/56	16	229	-	-	2	35	-	-	-	-	-	-	-	-	-	-	18	264	-	-
56/57	-	-	12	3115	4	110	4	20	-	-	-	-	-	-	-	-	11	230	9	3015
57/58	31	492	2	680	7	416	-	-	-	-	-	-	-	-	-	-	36	567	4	1021
58/59	23	334	2	1543	1	25	23	269	-	-	-	-	-	-	-	-	48	671	1	1500
59/60	-	-	9	2257	21	409	-	-	-	-	-	-	-	-	-	-	27	589	3	2077
60/61	-	-	-	-	8	139	9	96	-	-	-	-	-	-	-	-	17	235	-	2
61/62	24	206	5	810	-	-	-	-	-	-	-	-	-	-	-	-	28	336	1	680

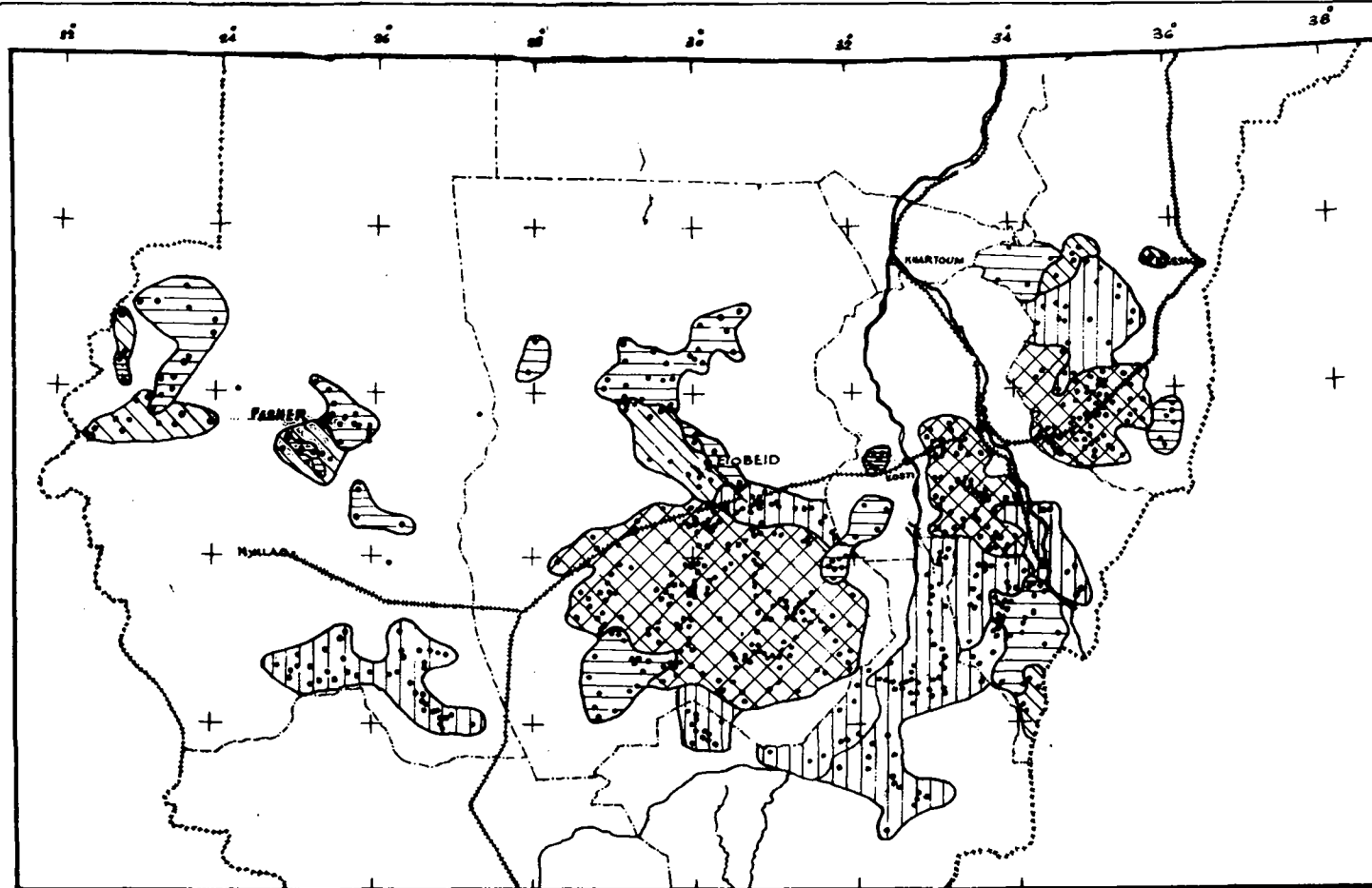
TABLE 7

Work- ing sea- son	Kordofan		Darfur		Kassala		Blue Nile		Upper Nile		Bahr : El :Gazal		Equat- :oria :		Khar- :toun :		T O T		A L	
	N	C	N	C	N	C	N	C	N	C	N	C	N	C	N	C	N	C	N	C
62/63	-	-	-	-	-	-	7	115	6	109	-	-	-	-	-	-	13	224	1	-
63/64	3	262	4	162	1	160	-	-	-	-	-	-	-	-	-	-	7	424	1	160
64/65	-	-	-	-	-	-	8	295	-	-	-	-	-	-	-	-	8	295	-	-
65/66	3	221	-	-	-	-	11	363	-	-	-	-	-	-	-	-	12	403	2	181
66/67	9	989	10	580	5	160	7	320	-	-	-	-	-	-	-	-	31	2049	-	-
67/67	30	2105	10	2253	7	390	10	509	-	-	-	-	-	-	-	-	61	2702	2	2555
TOTAL	283	6175	100	12708	107	2744	135	3003	78	804							677	13294	25	12140





NOTE :

N = Number of projects
 C = Capacity of project in 1000 M³
 H = Hafir

1. Execution from 47/48-56/57 Made by Soil Conservation Department
2. " " 57/58-65/66 Made by Land Use and Rural Water Department
3. " " 66/67- and on made by Rural Water & Development Corporation.



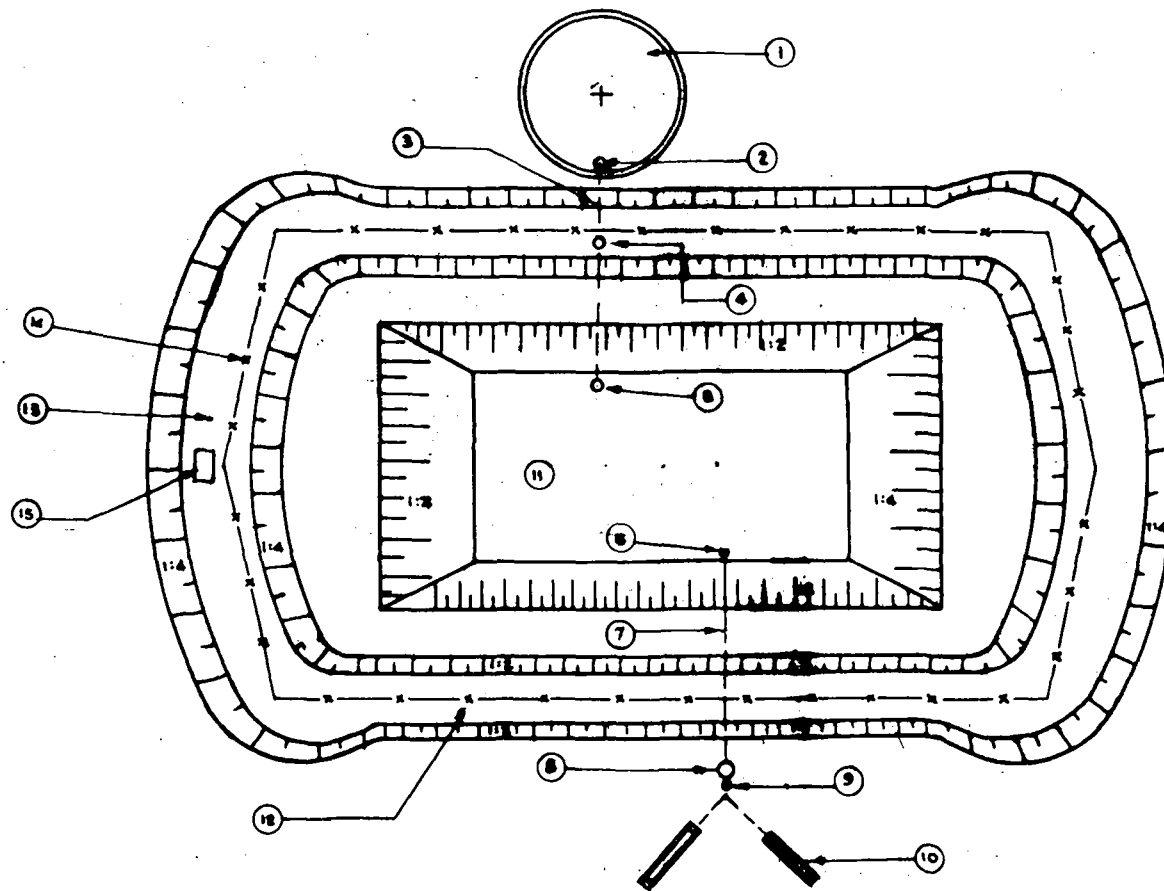
HAFIRS & DAMS EXECUTED IN THE SUDAN.

- 
Hafir excavated by Conservation Dept.
- 
Hafirs excavated by L.U. & R.W.D. Dept.
- 
Hafirs excavated by R.W. & Dev. C.
- 
Hafirs excavated by Conservation, L.U. & R.W.D. & R.W. & Dev. Corporation.

SCALE :- 1:8,000,000

FIG. 1

TYPICAL HAFIR



1. STILLING BOWL
2. INLET WELL
3. INLET PIPE LINE
4. SLUICE VALVE TO CONTROL INFLOW.
5. ENERGY DISSIPATOR
6. FLANGED STRAINER FOR OUT-LET PIPE LINE
7. OUT LET PIPE LINE
8. OUTLET WELL
9. HAND PUMP
10. DISTRIBUTING TROUGHS
11. HAFIR
12. LONG EMBANKMENTS OF HAFIR
13. END RAMPS OF HAFIR
14. BARBED WIRE FENCE
15. GUARD HUT.

FIG. 2

STANDARD ARRANGEMENT FOR INLET & OULET WORKS IN A HAFIR

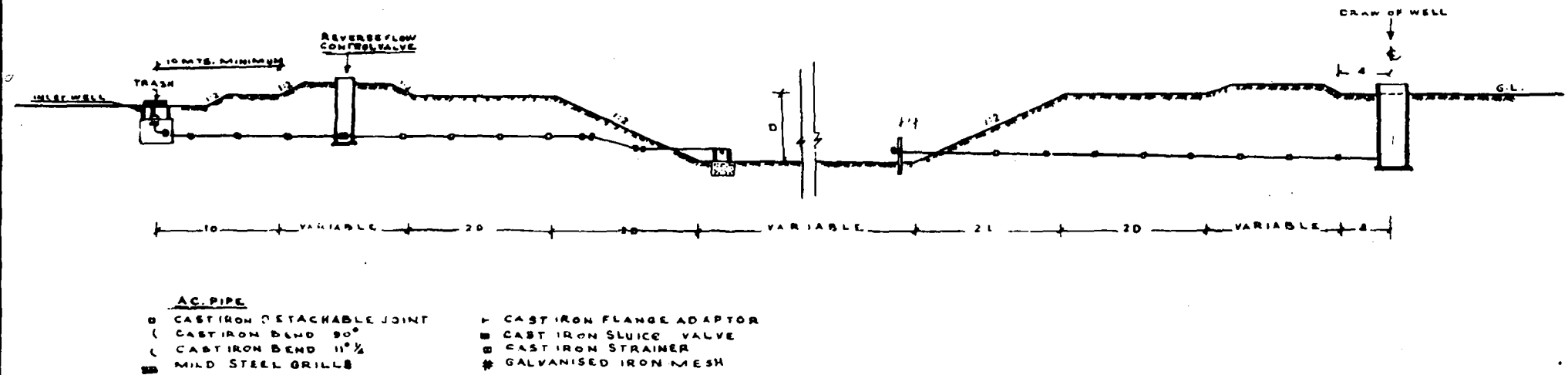


FIG. 3.

STANDARD OUTLET PIPE LINE, AND DISTRIBUTION SYSTEM

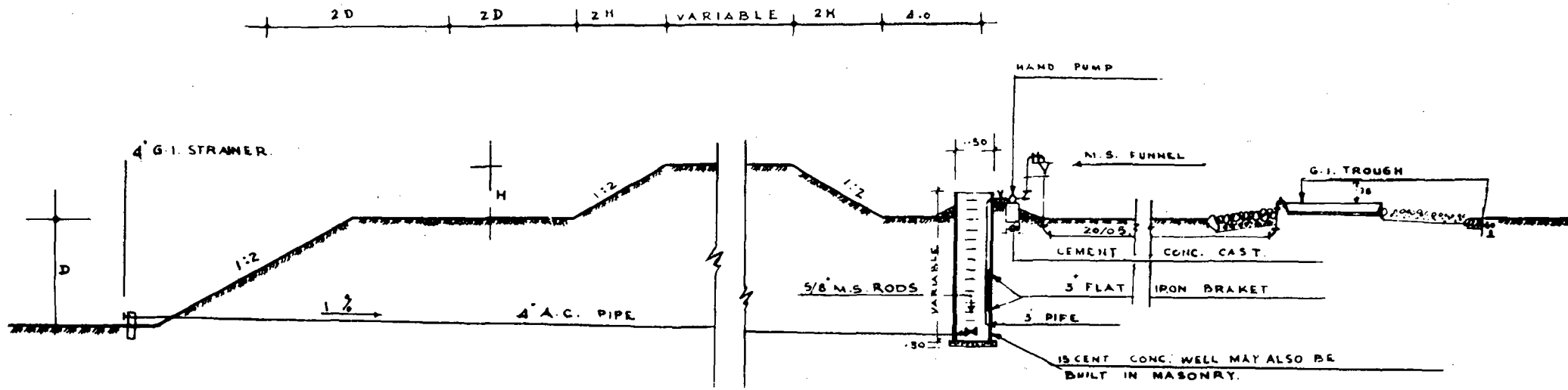
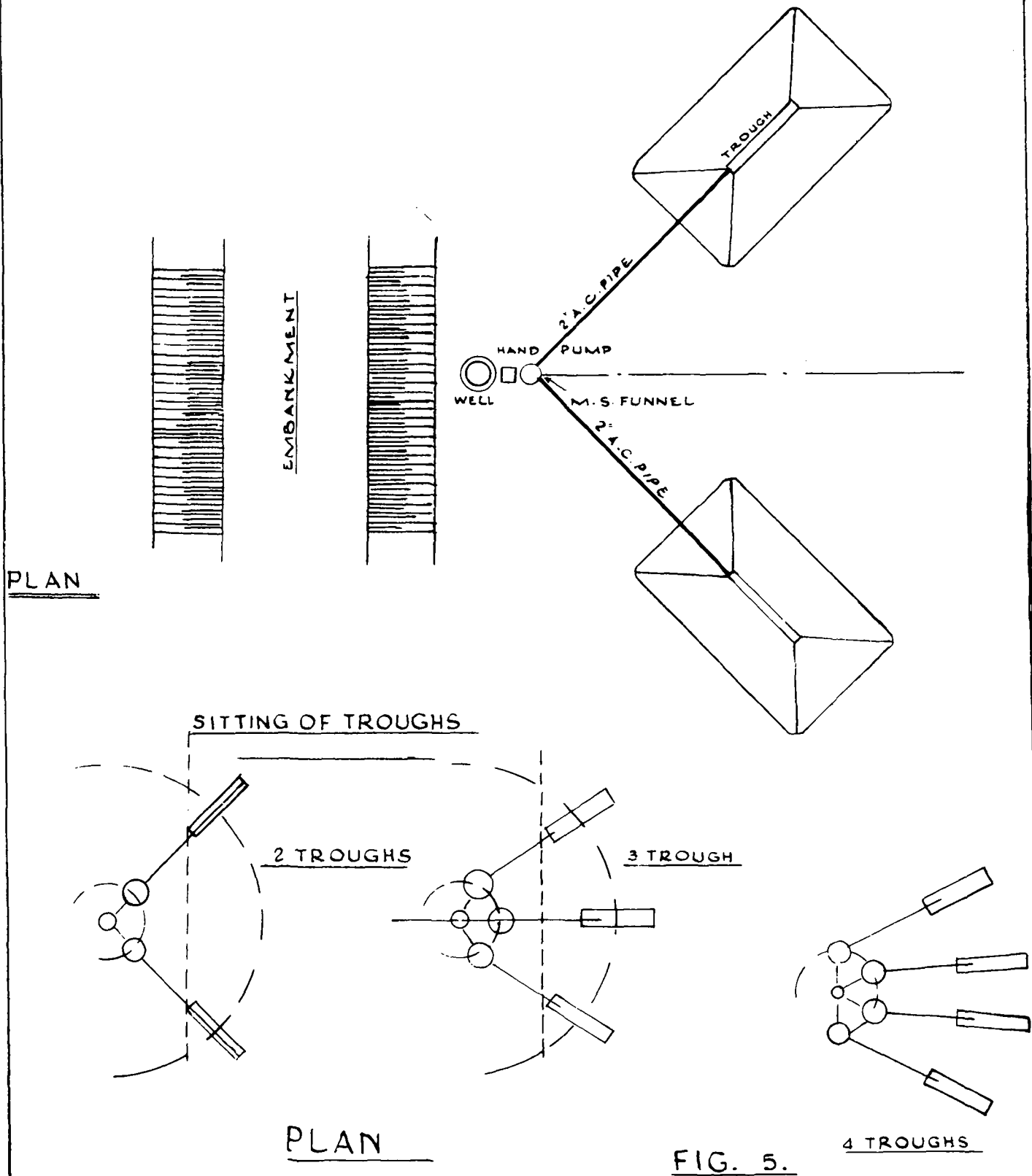
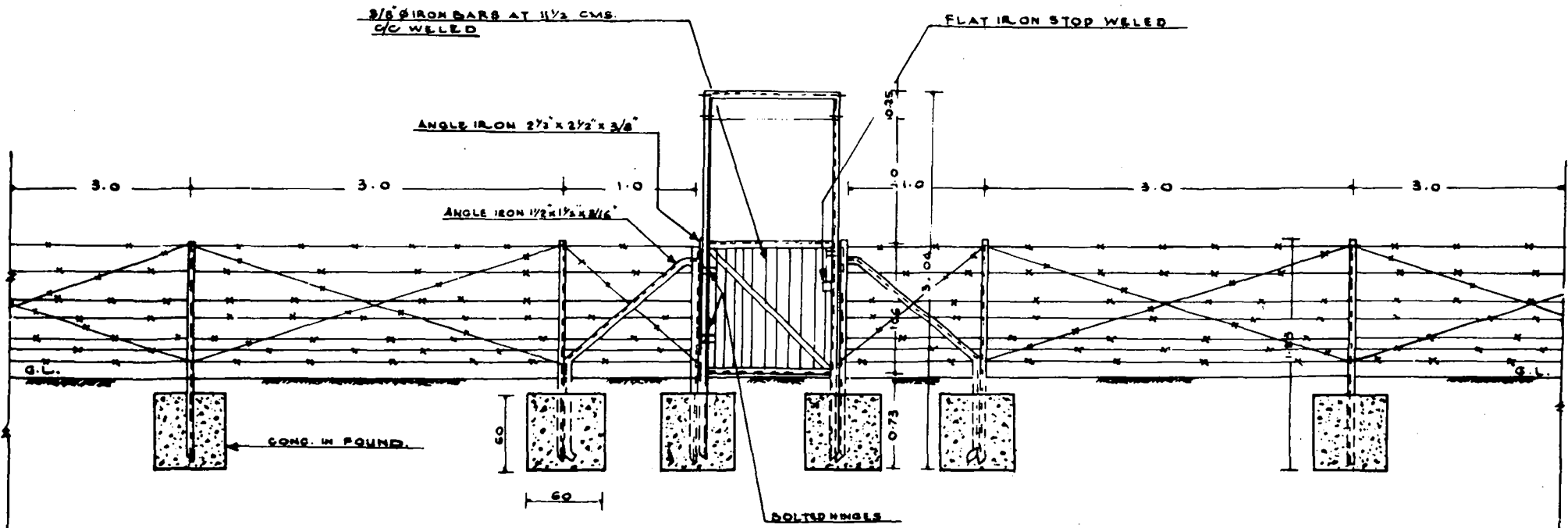


FIG. 4.

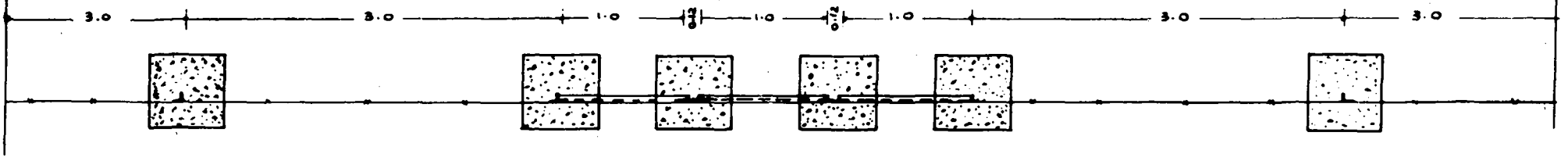
STANDARD ARRANGEMENT FOR DISTRIBUTING TROUGHS



BARBED WIRE FENCE IN HAFIR
A) STANDARD SINGLE GATE



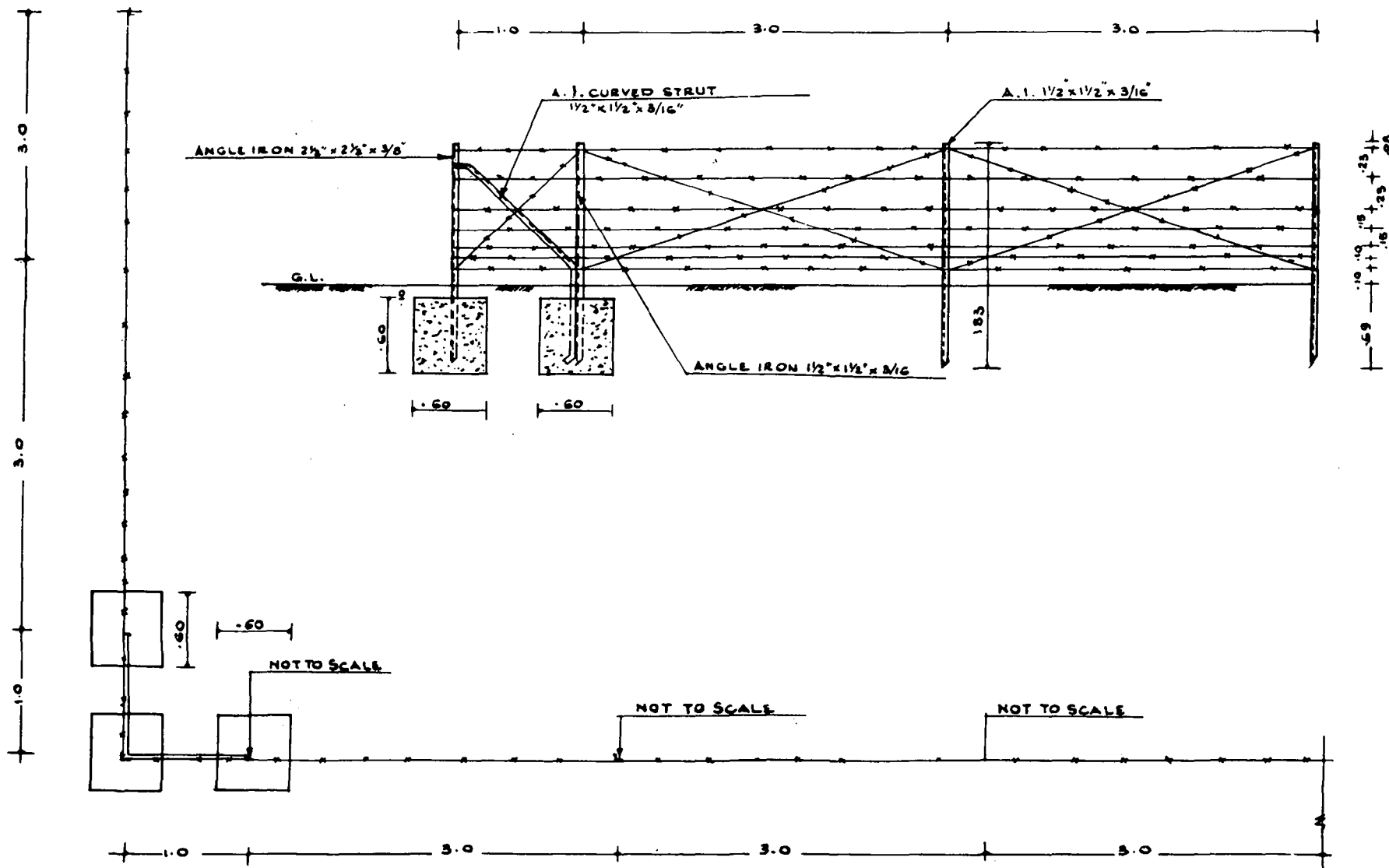
SECTION ELEVATION



PLAN

FIG. 6.

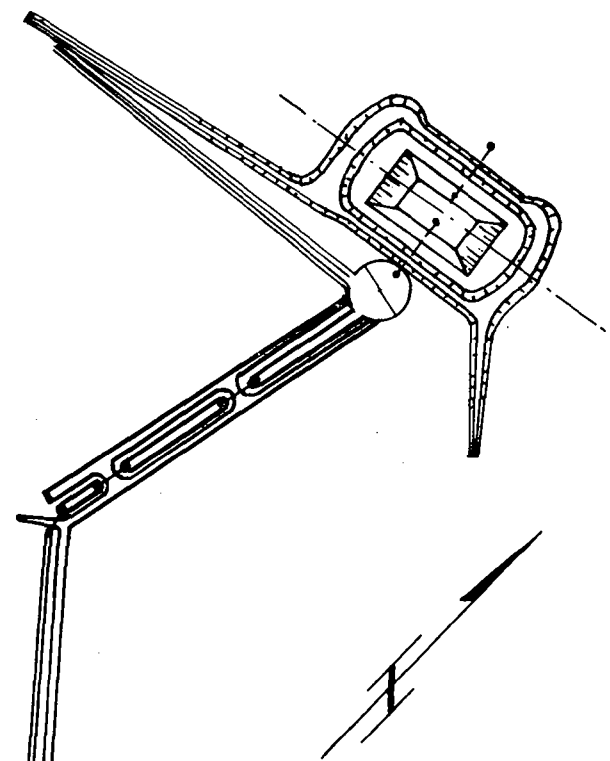
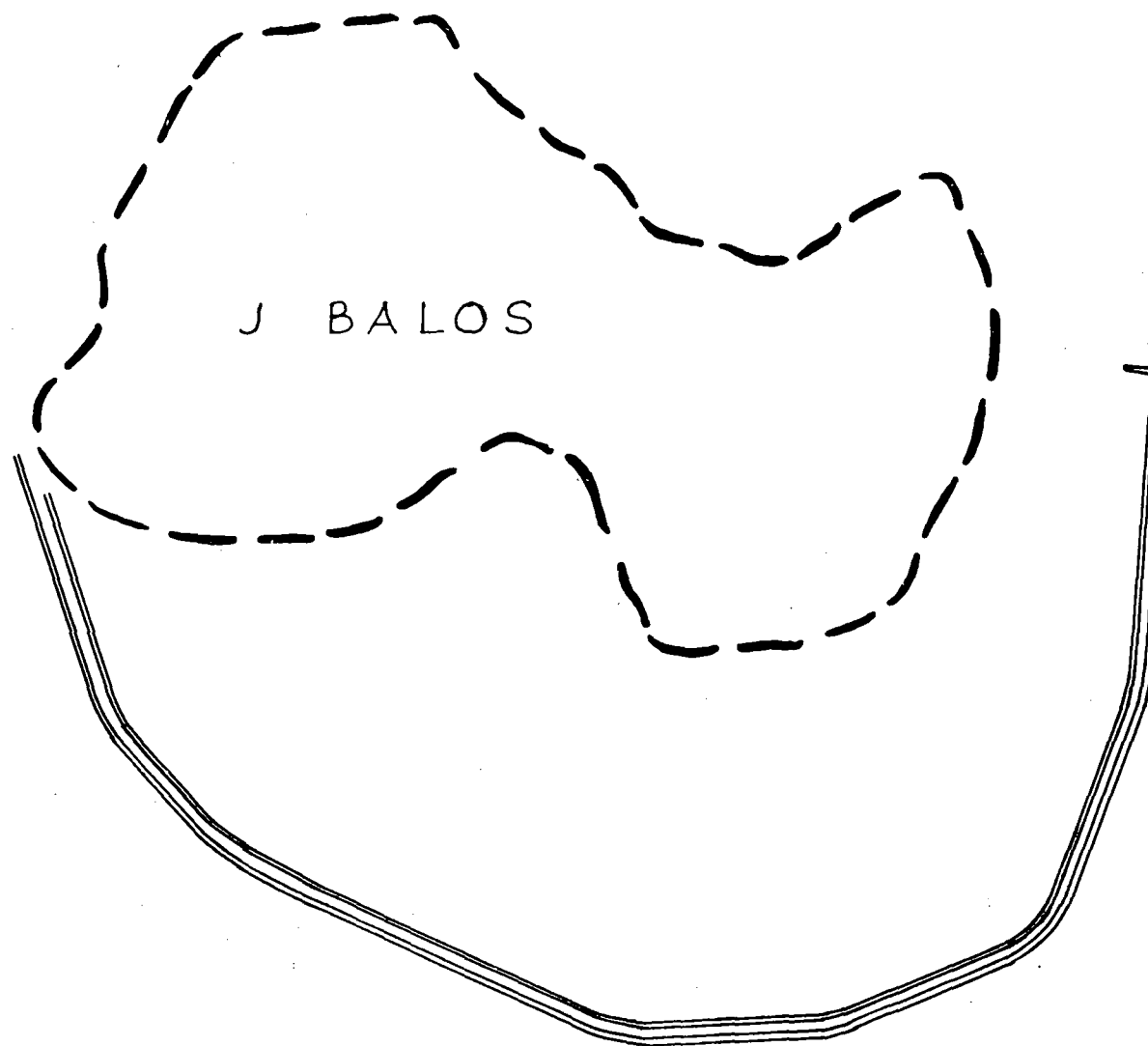
(B) BARBED WIRE FENCE
STANDARD FOR CORNER POST.



PLAN

FIG.(6)

TYPICAL JEBEL CATCHMENT HAFIR

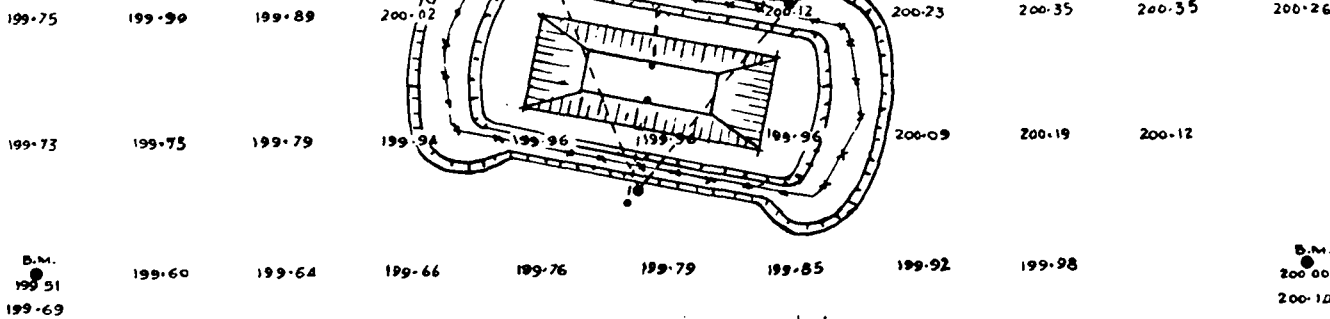
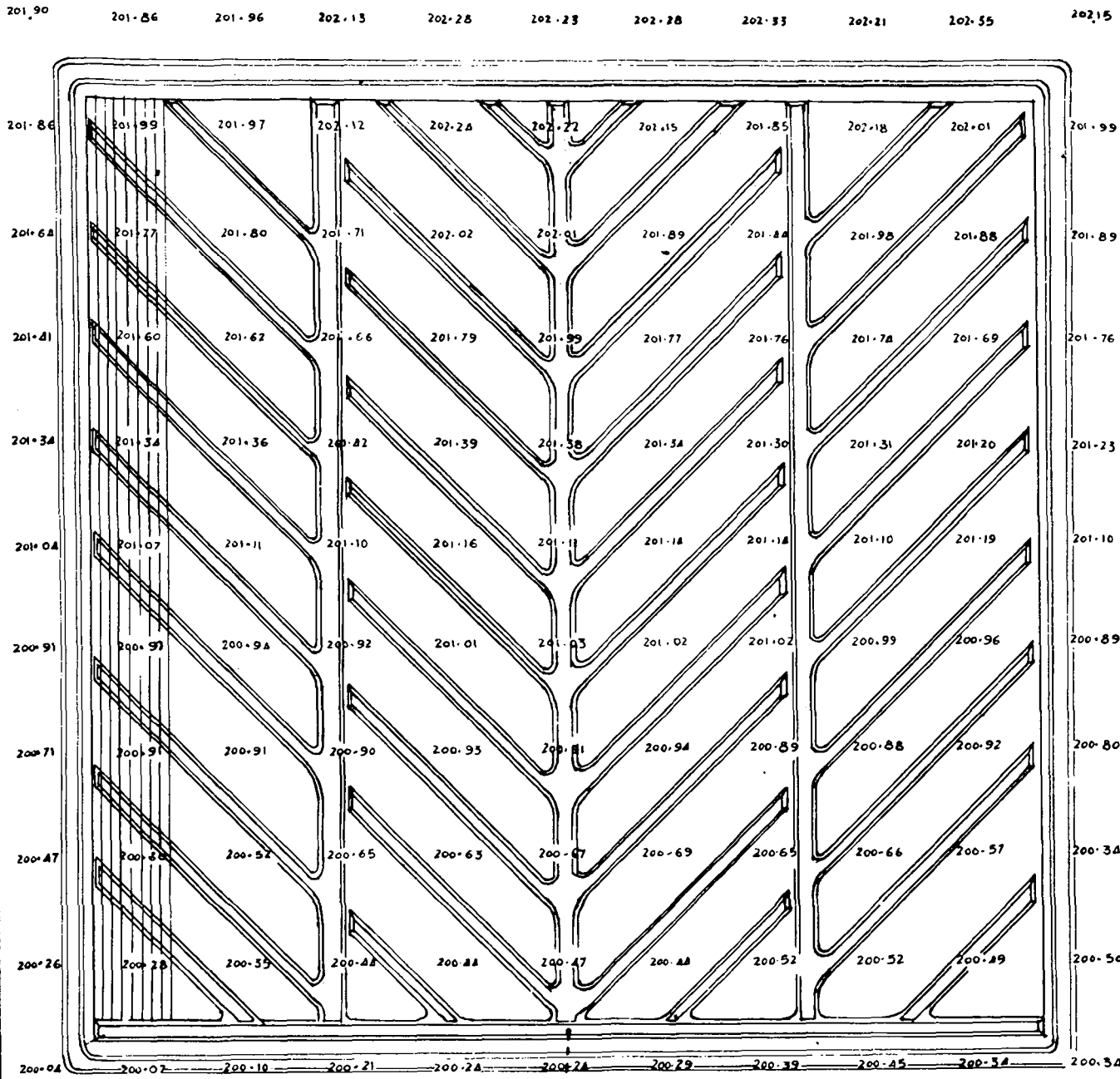


PLAN

SCALE 1:6,000

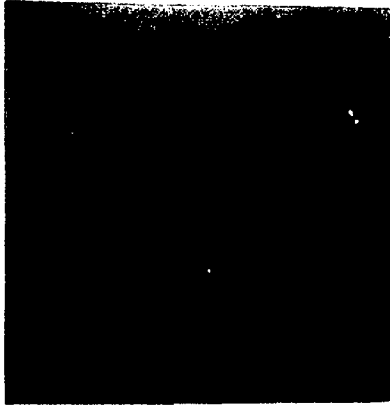
FIG. 7

TYPICAL SELF-CATCHMENT HAFIR



PLAN

FIG. 8



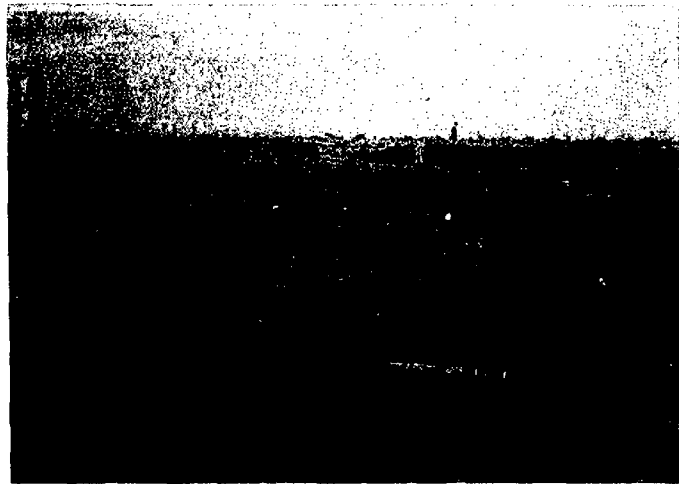
Camp of an investigation team



Hafir under excavation



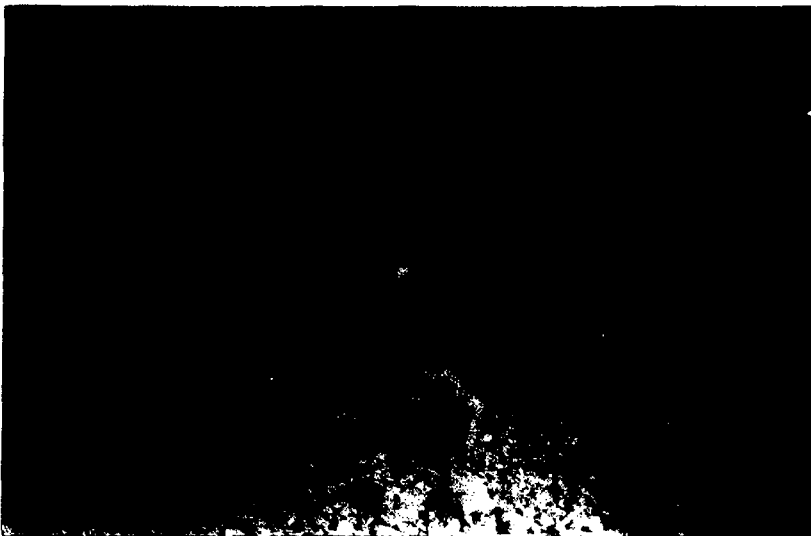
A complete hafir ready for receiving water



Desilting of an old hafir



Abu Gidad Dam



Spillway of Abu Gidad Dam

LIST OF CORPORATION'S PUBLICATIONS

<u>Book No</u>	<u>D e s c r i p t i o n</u>
1	Organisation & internal regulations (Arabic & English) - out of print
2	Anti Thirst Campaign - First 1966/67 programme (A r a b i c)
3	Water & Development in the Sudan by M.K. Shawki - Director General (Arabic & English)
4	Anti-Thirst Campaign - Second 1967/68 programme (Arabic & English)
5	Water Pumps - by Abdel Bagi Omer Attāya Director of Water & Mech. Engineer Salah Abdo (A r a b i c)
6	Rural Water & Development Corporation in the balance (1) (A r a b i c)
7	Water Provision in the Sudan by Hamid Abu Zied - (B.Sc. Agric. Economics) (Arabic & English)
8	The Hafir - by Shawgi Ibrahim Asa'ad Chief Surface Water Engineer (E n g l i s h)
-	Annual Report - 1966/67 (A r a b i c)
-	The role of rural water in social & Economical development in the Sudan, by M.K. Shawki (A r a b i c)
3	Introducing Rural Water & Development in the Sudan (2nd. Edition) (Arabic & English)

Under Printing

1	Anti-Thirst Campaign 1968/69 program (Arabic)
2	Rural Water & Development Corporation in the balance (2) (Arabic)
3	Annual Report 1967/68 (Arabic)