

(If there are more than one request, it is kindly requested to prepare answers by each project).

1. Details of the request for the Japanese grant aid.

1. Name of the project to which Japanese grant aid is requested.

Hurga and Nur El din Pumped Irrigation Schemes

2. Purpose of the project.

Feasibility study for Grouping and Extension of Hurga and Nur El Din Schemes.

3. Details of the project.

a) grouping and moderning two schemes, totalling 21,800 feddans.

b) Installation of one pumping station (Electrical)

c) Extension into new area, totalling 18000 feddans.

4. Total amount required for the project. (If possible it is kindly requested to explain the details or the basis of the estimated amount Thirty Nile million U.S. million.

a) Rehabilitation and grouping of existing schemes: at the rate of U.S.\$ 800 per feddaan = 17,440 mill \$

b) Extension at the rate of \$ 1200 per feddan = 21.600

Total = 390.4 Mill

+ Cost of study two million U.S dollars i.e 0.5% of total cost.

5. Name of authorities in charge of requesting the Japanese grant aid.

Ministry of Irrigation.

6. Name of authorities which operates the project after the implementation of the grant aid.

7. Effect of the project on population, stratum of society and area.

Restoration of abandoned agricultural lands; increase of number of farmers; increase of farmers income; improvement of social infrastructures.

8. Effect of the project on the dwellers in the region. provision of farming employment, staff employment, Rehabilitation of immigrants from the region.

9. Time desired for executing the grant aid for the project.

Oct. 1988 to March 1990.

10. Existence of aid for the project by other countries international organizations. (In case such request is made, it is kindly requested to explain its outline).

Nil

11. Priority of the project among the projects listed in the priority list for Japanese grant aid.

12. Progress of preparatory work necessary for the implementation of the project such as construction site and so on.

Existing pump sites could be utilized for preparatory activities.

13. Prospect of the project management after the implementation of the grant aid (It is kindly requested to mention the measures necessary for the project management such as the staff, budget and so on).

Available Ministry of Irrigation and Sudan Gezira Board's staff will manage the project. Appropriate budget for running will be made available by G.O.S

14. Past records of the aid by other countries/international organizations to the similar projects. Existence of duplication or supplementary relations between the project and the aid by other countries/international organizations to the similar projects.

15. Necessity of the Japanese technical cooperation to the project. (In case it is necessary; it is kindly requested to explain its outline.)

Enabling evaluation of the projects economic viability and preparing necessary appraisals for procurement of finance.

16. Other information such as maps; reference material. Available detailed topographical maps for existing schemes; Available detailed topographical maps and soil data for new area.

11. Back ground information of the project. In case the project composes part of the plans such as the national development plan. It is kindly requested to answer to the following questions.

1. Name of the development plan.

Nile Waters Study ; Master plan; 1979.

2. Purpose and details of the development plan.

Planning the future development of the Nile and its tributaries for irrigation, water storage; hydro-electric power and water conservation projects.

3. Expected time and the term for executing the development plan.

Years 1990 to 2010

4. Position of the project in the development plan.

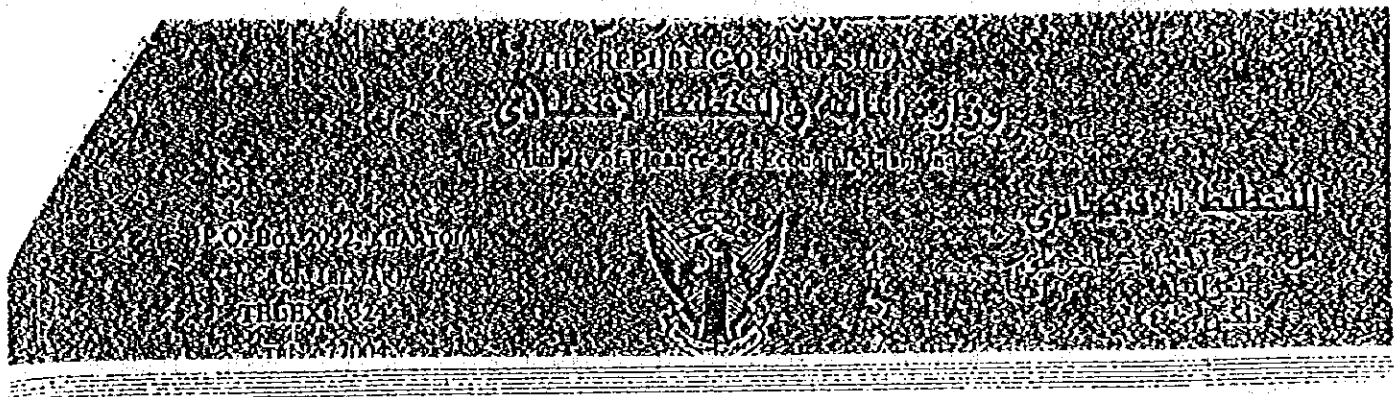
First programme of development i.e rehabilitation projects.

5. Existence of aid; including technical cooperation and so on; by other countries/international organizations to the development plan. (In case such aid is made; it is kindly requested to explain its outline).

Nil;

6. Other information.

.../Fathia



Khartoum: 5th. January 1988

Ref. MFEP/Janan/T.A/57

الخطوط من :
التمرة :
الوانق :

Embassy of Japan
Khartoum.

Dear Sir,

Subject:- Japan's Development Survey
for 1989/90.


With reference to your Embassy's letter No; JE-264-88 concerning the above mentioned subject, please find enclosed herewith the proposals for the;

1. New White-Nile Bridge.
2. Industry Development Survey (cement industry).
3. Resources survey (Iron ore deposit).
4. Hurga and Nur El-Din Pump-Irrigation Schemes.
5. Semi-Arid Forest Management Plan.
6. Shelter-Belt Project for Railroad in Central Sudan.

Thank you very much for your cooperation.

Best regards...

Sincerely yours,


Mohamed Saïd Abdalla
For/ First Undersecretary for Planning
Ministry of Finance & Economic Planning



.../Fathia

SUMMARY

- 1) Name of Project : Gezira Rehabilitation Project as part
in immediate stage HURGA and NUR-ED-DDP
Pumping Stations
- 2) Sector of the Project : Irrigation
- 3) Name of Coordinating
Organization : Gezira Rehabilitation Project
Management Unit (RPMU)
- 4) Name of Implementation
Organization : Ministry of Irrigation
- 5) Requesting Agency : Ministry of Finance, Economic and
Planning
- 6) Proposed Source of
Assistance : Government of Japan
- 7) Total Amount of Request : ¥ 1.5 Billion

1. BACKGROUND AND OBJECTIVES OF PROJECT

Agriculture is the principal sector supporting Sudanese economy. Agriculture accounts for about 40% of GDP and nearly 95% of the total value of all commodity exports come from agriculture.

The Government of the Democratic Republic of the Sudan has launched the Third Three Years Investment Program (83/84 - 85/86) aiming at recovering recent recession and maintaining stable growth of the national economy. The sectorial program in agriculture gives priority to (i) rehabilitation of existing projects, (ii) completion of ongoing projects and (iii) implementation of new projects.

The Hugra - Nur ed Din Grouping Irrigation Project is one of the main components of the Gezira Rehabilitation and Modernization Project which is defined as one of the top priority rehabilitation projects.

The Hugra pumping irrigation scheme and Nur ed Din pumping irrigation scheme were separately established in the early 1950s as private cotton growing schemes with net irrigation areas of about 12,300 feddans (about 4,900 ha) and about 9,500 feddans (about 3,800 ha), respectively. In 1960s, all pumping irrigation schemes with pump diameters bigger than 6 inches on the White Nile and the Blue Nile were nationalized including these two schemes, and came under the direct administration of the Agrarian Reform Corporation on the Blue Nile. Later, in 1970s management of these two schemes were further transferred to Sudan Gezira Board (SGB) with a view to modernizing the pump irrigation systems and introducing modern management techniques. At the same time, pumping stations of these schemes became under control of Ministry of Irrigation.

Currently, the pumping facilities, constructed in early 1950s, have been completely deteriorated, so that crop irrigation stopped from 1985. Local farmers ^{70% or 73%} have now lost their source of cash crops such as cotton and groundnuts and only raise sorghum under rainfed condition.

To solve these problems drastically by renovation of pumping facility, the Government has taken up the Project as one of the top priority projects of rehabilitation of existing project.

2. PROJECT AREA

The Project area is located to the right bank of the Blue Nile about 30 km southeast of Wad Hedari in Central Province, and extends between the Dinder river and the Rahad river which are tributaries of the Blue Nile. The existing Hurga and Nar ed Din pumping stations are situated on the right bank of the Blue Nile.

Climate of the project area is defined as the northern light-rainfall zone with an average annual rainfall varying 0 mm to 400 mm. It is broadly divided into three seasons, the dry winter, dry summer and wet summer. The dry winter lasts three months from December to February which is characterized by low temperature and low humidity. The wet summer, from July to September where more than 80% of the annual rainfall occurs with high temperature and relatively high humidity, while the dry summer from March to November (excluding July, August and September) is characterized by high temperature and low humidity.

The soils in the project area are classified into Pellic Verisols which are sidely known as black cotton soils in Sudan. The soils are suitable for many kinds of crops but needs fertilization especially with nitrogen and phosphorous.

Irrigation water will be taken from the Blue Nile. The water level of the Blue Nile fluctuates seasonally ranging about 10m at existing Hurga pumping station site.

3. REHABILITATION PLAN

In order to achieve stable production of exportable crops and increase of farm income by increasing crop yield, the following should be considered for project formulation.

- 1) It is inevitable for the Project to renovate existing pumping stations.

ii) The maximum use of existing canal networks is essential with maintenance work.

iv) The main and major canals should be modified for continuous irrigation with night storage in minor canals.

v) The use of electrically driven motors would save both the capital and the operation cost of pumping facilities.

The basic idea of rehabilitation pump station is shown in following attachment 3) - 6).

4. REQUIRED FACILITY AND EQUIPMENT FOR REHABILITATION OF THE EXISTING PUMPING STATION.

EQUIPMENT LIST (PUMPING STATION)

Equipment/Pumping station	HURGA PUMPING STATION	NUR EDDIN PUMPING STATION
1. Main Pump		
Type	Vertical type double Suction Volute Pump	Vertical type Double Suction Volute Pump
Rating	90m ³ /min x 23.5m x 750m ³ x 450kw	60m ³ /min x 24m x 1000m ³ x 310kw
Q'ty	3 sets	3 sets
2. Main Motor		
Type	Vertical Wound Rotor Induction Motor	Vertical Wound Rotor Induction Motor
Rating	450kw x 8P, 3300V x 50Hz	310kw x 6P, 3300V x 50Hz 500V
Starting Method	Starting Resistor	Starting Resistor
Q'ty	3 sets	3 sets
3. Suction Valve		
Type	Manually Operated Butterfly Valve	Manually Operated Butterfly Valve
Nominal Dia.	800 mm	600 mm
Q'ty	3 sets	3 sets
4. Discharge Valve		
Type	Manually Operated Butterfly Valve	Manually Operated Butterfly Valve
Nominal Dia	700 mm	500 mm
Q'ty	3 sets	3 sets

Equipment/Pumping station	MURGA PUMPING STATION	NUR EDDIN PUMPING STATION
5. Check Valve		
Nominal Dia.	500 mm	500 mm
Q'ty	3 sets	3 sets
6. Auxiliary Equipment		
	Vacuum Pump x 1 set	Vacuum Pump x 1 set
	Sealing Pump x 1 set	Sealing Pump x 1 set
	Sump Pump x 2 sets	Sump Pump x 2 sets
	Other Materials x 1 lot	Other materials x 1 lot
7. Pipe		
Material	STEEL PIPE	STEEL PIPE
Nominal Dia	800mm 700mm	600mm 500mm
8. Switchgear		
Type	Indoor Use Metal Enclosed Self Standing	Indoor Use Metal Enclosed Self Standing
	High Tension Incoming Panel x 1 cubicle	High Tension Incoming Panel x 1 cubicle
	High Tension Starter Panel x 3 cubicles	High Tension Starter Panel x 3 cubicles
	Low tension TR & Low Voltage Panel x 1 cubicle	Low tension Power Supply Panel x 1 cubicle
	D.C. Panel x 1 cubicle	D.C. Panel x 1 cubicle
	Aux. Relay Panel x 2 cubicles	Aux. Relay Panel x 2 cubicles
9. Power and Control Cables	1 lot	1 lot

EQUIPMENT LIST (SUBSTATION)

1. 22KV SWITCHGEAR

Type : Outdoor Use Metal Enclosed Self Standing
Incoming Section Panel x 1 cubicle
Receiving Section Panel x 1 cubicle

2. Main Transformer

Capacity: -4,000 KVA, 3 ϕ 22/3.3 KV
Q'ty : 1 unit

3. 3KV Switchgear

Type : Outdoor Use Metal Enclosed Self Standing
Incoming Section Panel x 1 cubicle
Receiving Section Panel x 1 cubicle

4. Cables

5. Power Transmission Line between Substation and Pumping Stations

(1) Conductor

(2) Concrete Pole

12m x 190 ϕ ----- 45 sets

5. Implementation Schedule

Activity	1988			1989			1990					
	JAN	APR	JULY	OCT	JAN	APR	JULY	OCT	JAN	APR	JULY	OCT
Gezira Rehabilitation Project as part in immediate stage	Request	B/D	E/N	D/D	Contract	Project execution						Taking over
(1) Rehabilitation of HURCA Pumping Station					Design & Manufacturing		Transportation		Replacement & Installation			Commissioning
(2) Rehabilitation of Nur-Ed-Din Pumping Station					Design & Manufacturing		Transportation		Replacement & Installation			Commissioning
(3) SUBSTATION					Design & Manufacturing		Transportation		Installation			Commissioning
(4) Modification of the Civil work and the erection <i>X 1</i>						?						
(5) Maintenance & Training												

Remarks) E/N : Exchange of Note

6. PROJECT COST ESTIMATION

The cost estimation for the Required Facility and Equipment including replacement of the existing equipment, modification of the Civil work and the erection and installation of the new equipment in order to implement the "Cezira Rehabilitation Project as part in immediate stage HURGA and NUR-ED-DIN pumping station" is as follows;

1. HUGRA PUMPING STATION

- 1) Require Facility and Equipment cost ; Y 450 Million
 - 2) Placement of the existing equipment
and Installation cost ; Y 50 Million
 - 3) Modification of the civil work and
the erection cost ; Y 170 Million
-
- Item 1. Total. Y 670 Million

2. NUR-ED-DIN PUMPING STATION

- 1) Require Facility and Equipment cost ; Y 310 Million
 - 2) Placement of the existing equipment
and Installation cost ; Y 30 Million
 - 3) Modification of the civil work and
the erection cost ; Y 140 Million
-
- Item 2. Total. Y 480 Million

3. SUBSTATION

- 1) Require Facility and Equipment cost ; Y 100 Million
 - 2) Installation cost ; Y 30 Million
 - 3) Civil work and erection cost ; Y 100 Million
-
- Item 3. Total. Y 230 Million

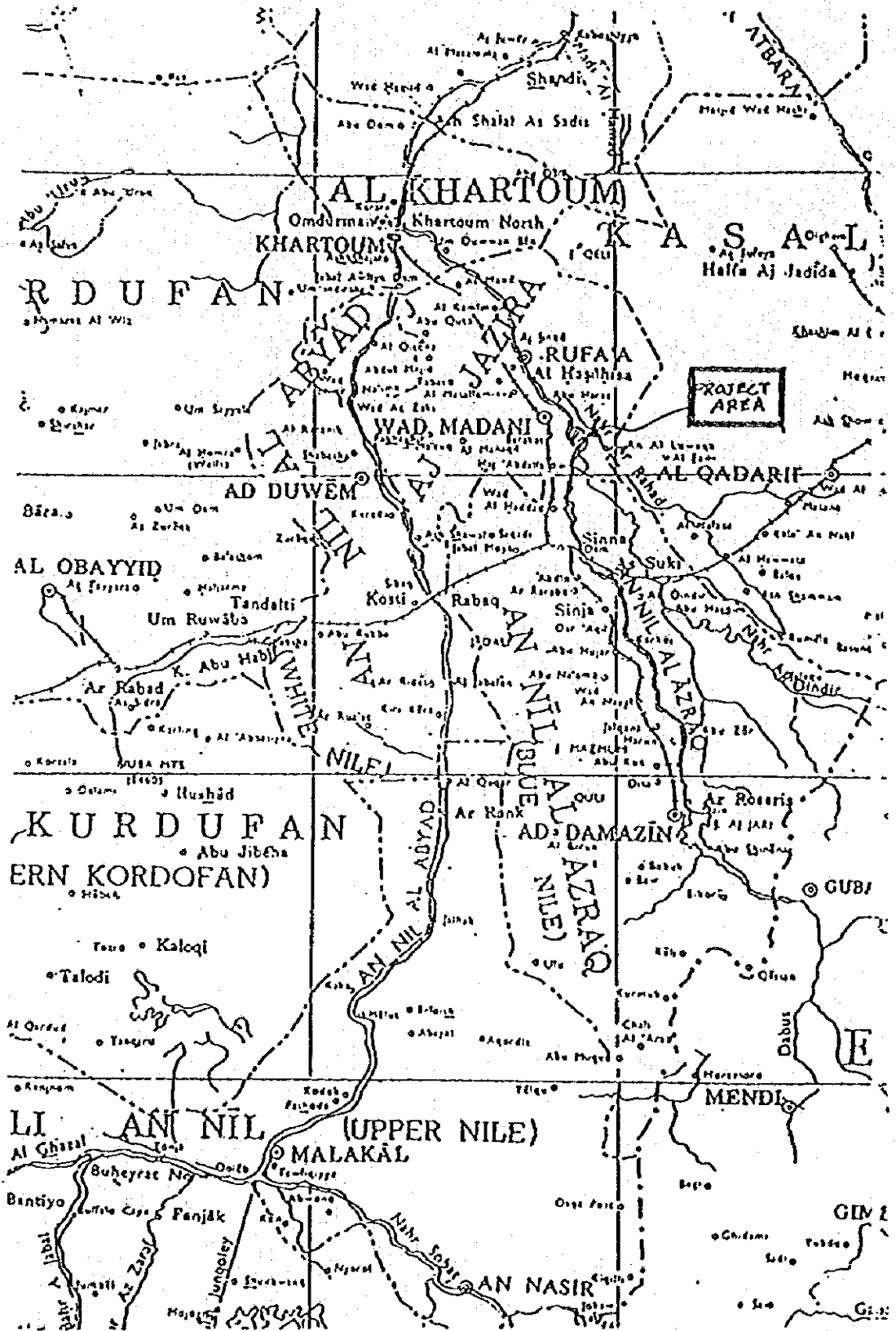
4. ENGINEERING FEE ; Y 120 Million

GRAND TOTAL (ITEM 1+2+3+4) Y 1.5 Billion.

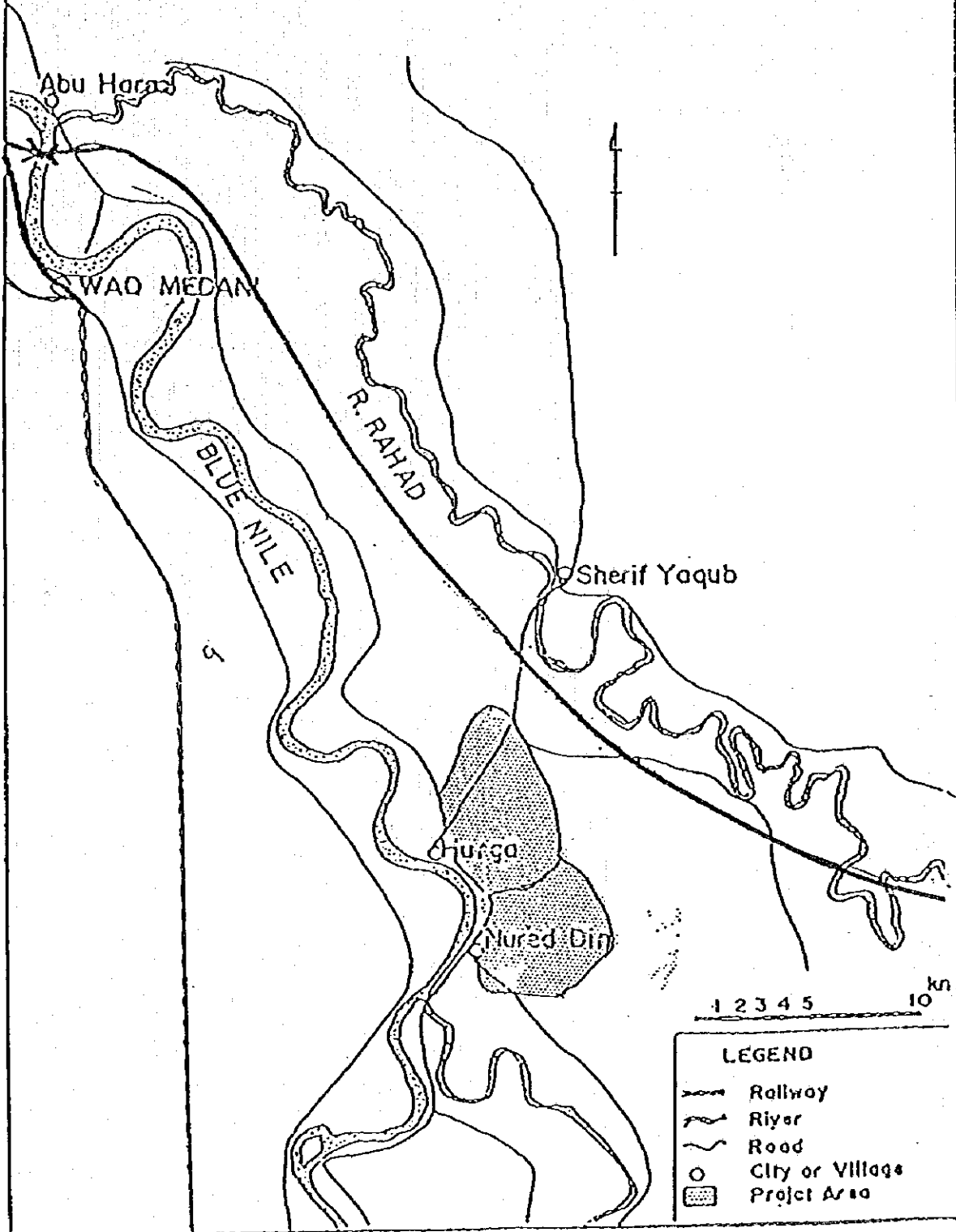
Remarks; Import duty and any taxes in Sudan is not included above estimation.

ATTACHMENTS

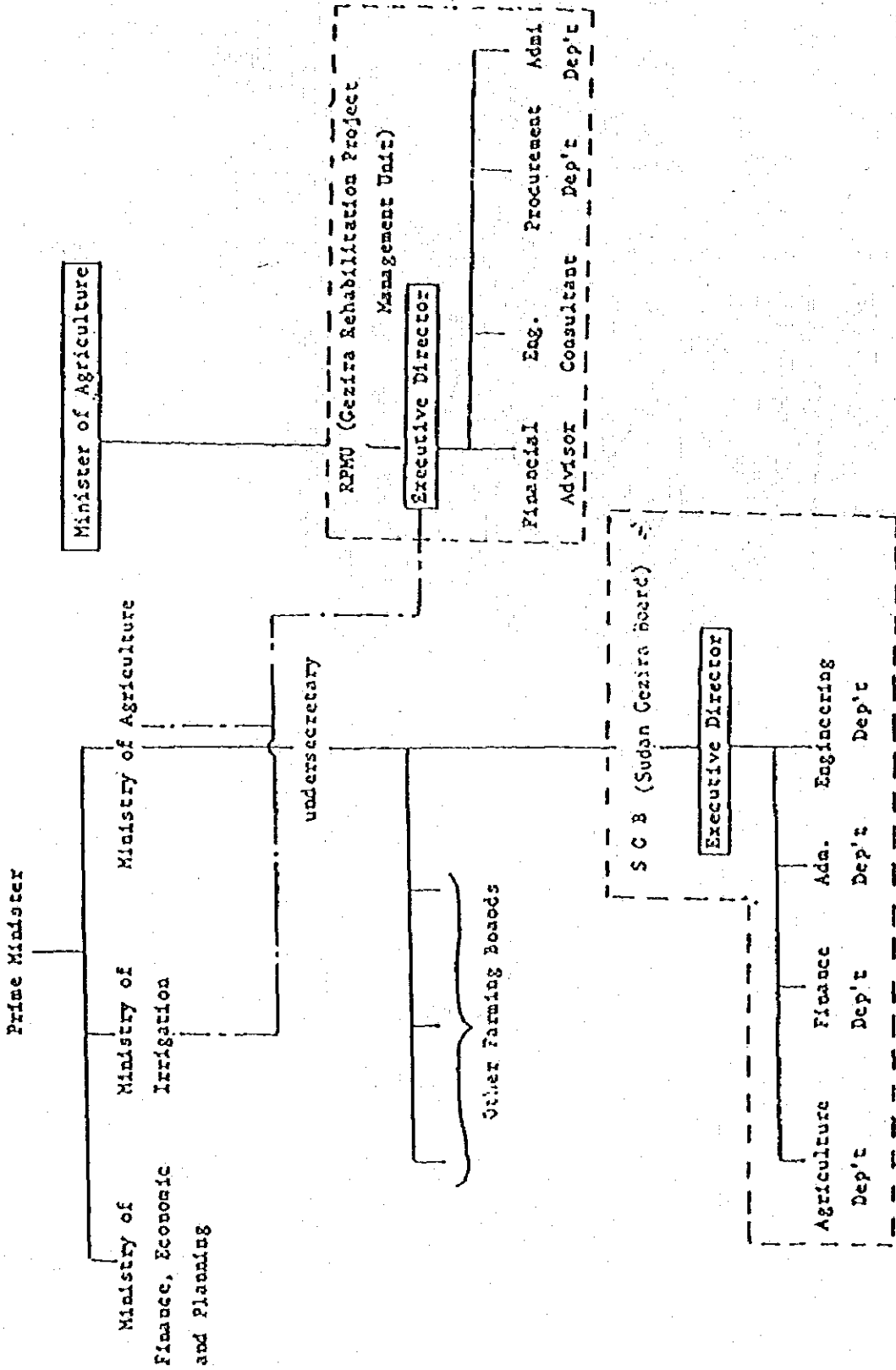
1) PROJECT AREA



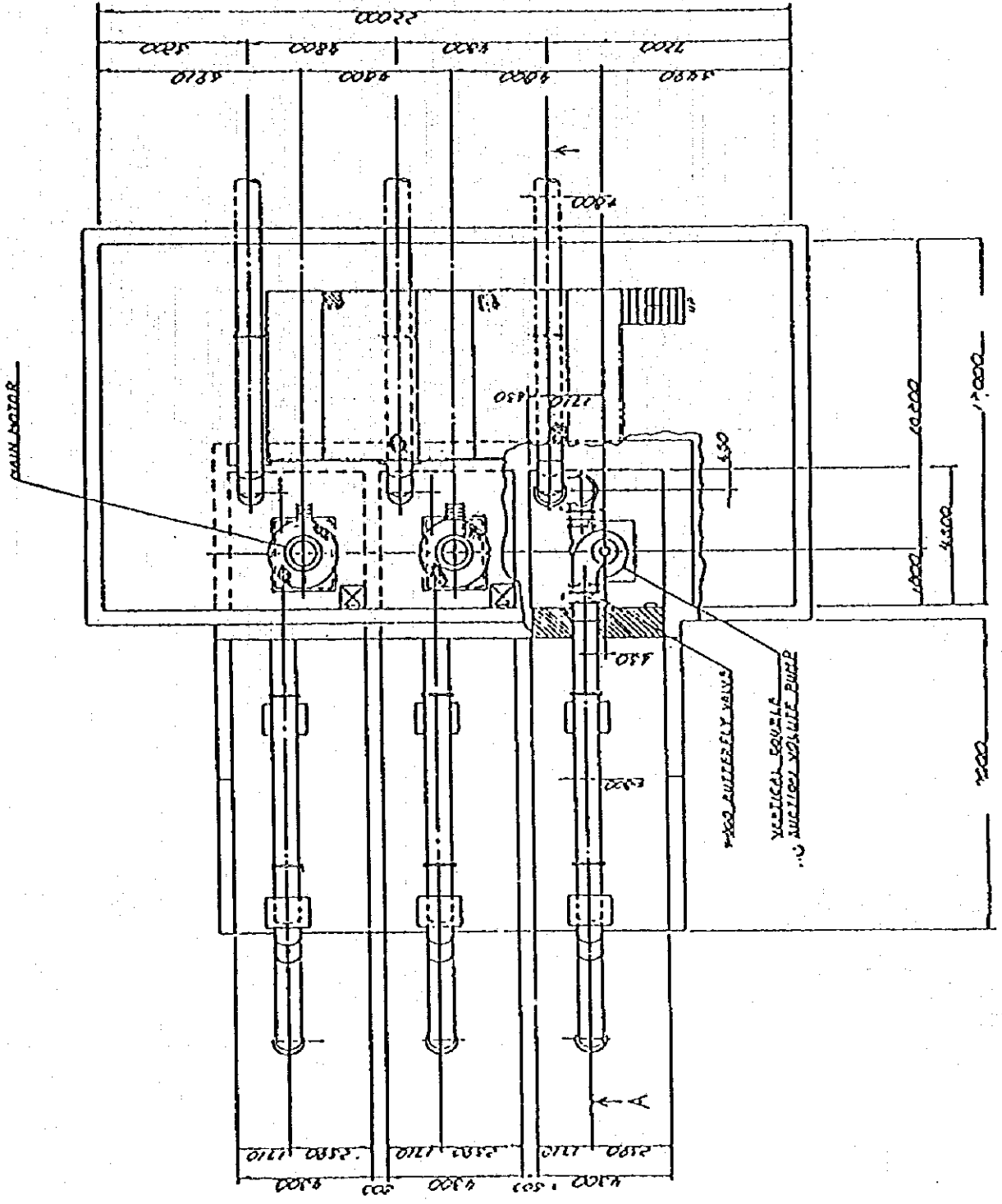
1) LOCATION MAP



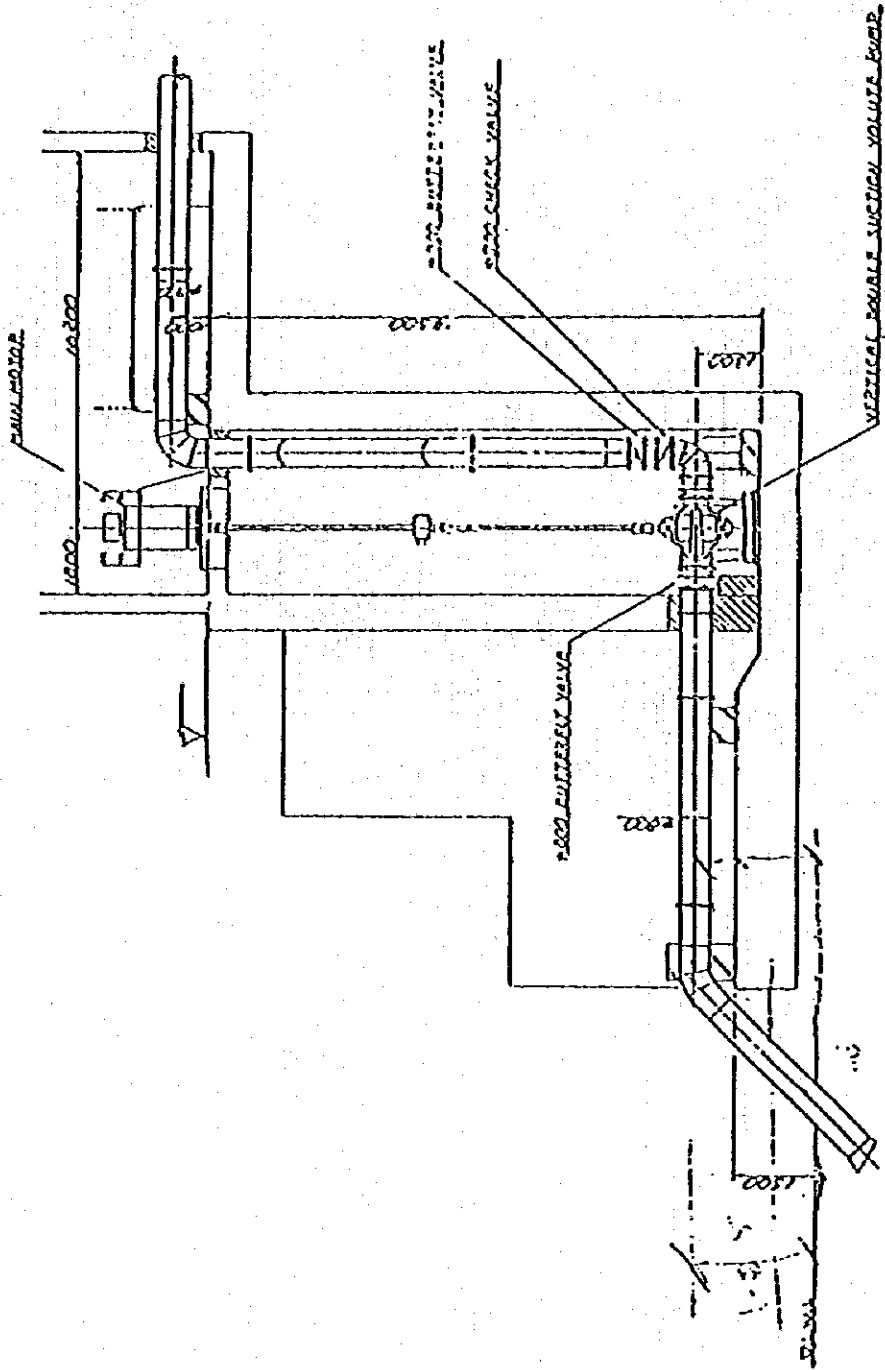
2) ORGANIZATION CHART



3) HURGA PUMPING STATION (GENERAL ARRANGEMENT)

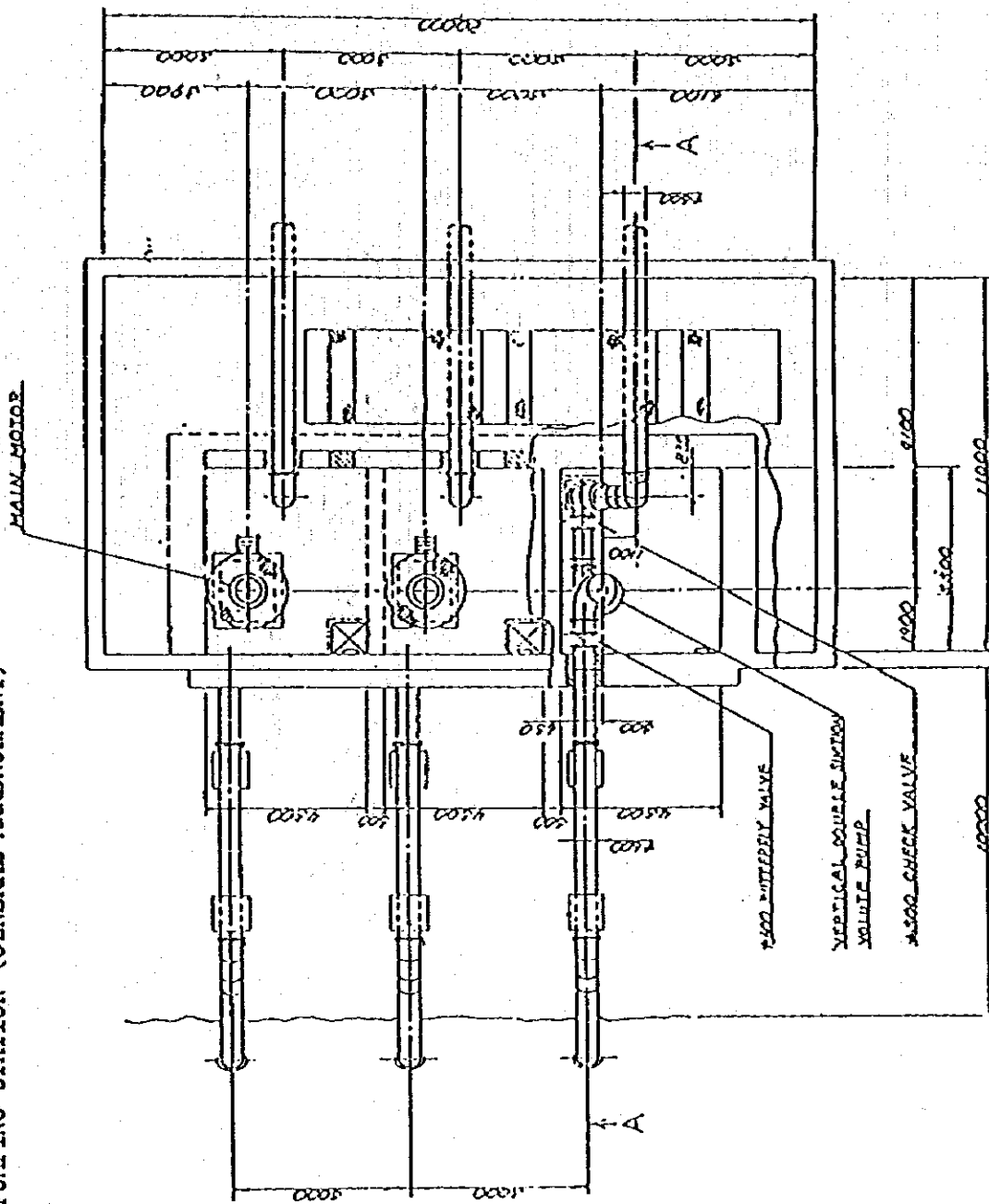


4) HURGA PUMPING STATION (SECTIONAL VIEW)

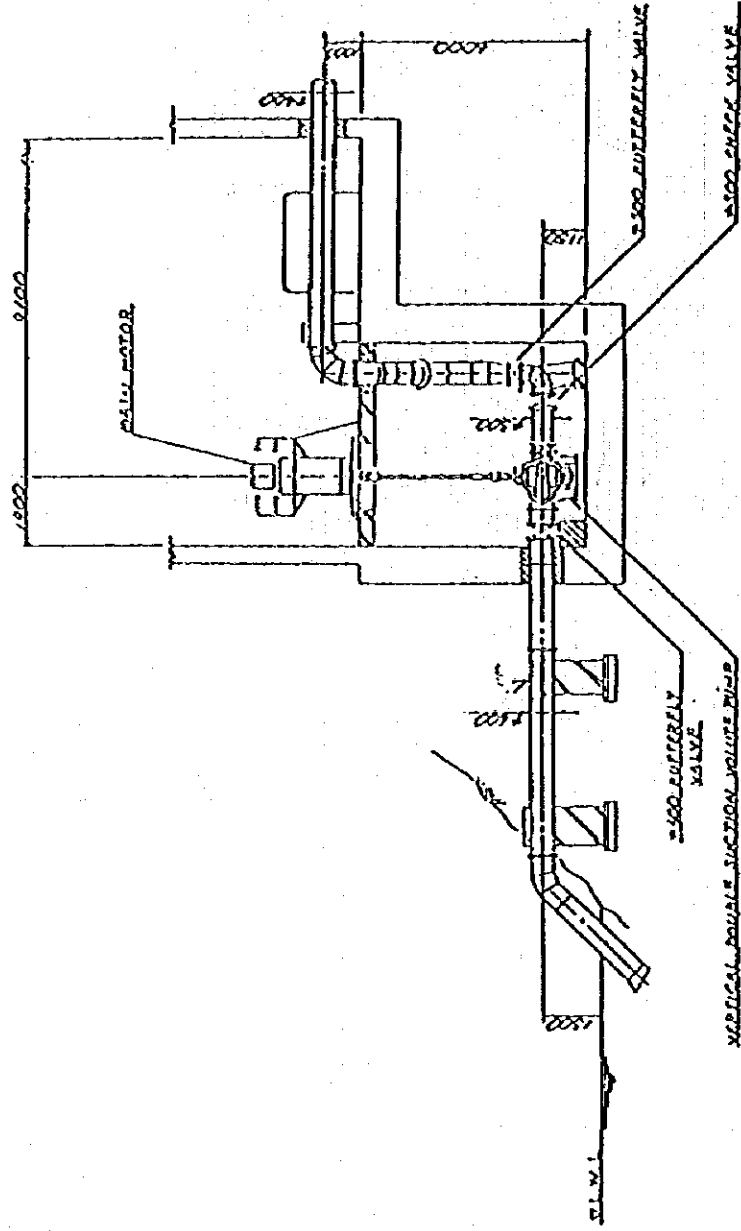


SECTION A-A

5) NUR ED-DIN PUMPING STATION (GENERAL ARRANGEMENT)



6) NUR ED-DIN PUMPING STATION (SECTIONAL VIEW)



HURQA & HUR ED DEIN BLOCKS, 106, 107

GEZIRA SCHEME.

--: RENOVATION ESTIMATES.

ITEM:	UNIT :	QUANTITY :	RATE :	AMOUNT :	TOTAL :
:	:	:	L.S :	L.S :	L.S :
1. Preliminaries,	Sum	Prov.		200,000	200,000
2. Field surveys and Design	F	40,000	2.50	100,000	100,000
3. <u>EARTHWORK:-</u>					
Construct new Feeder					
Canal to pick up existing					
main canals.					
a) Fill by Scraper.	M3	1,000,000	6.00	6,000,000	
b) Excavation by Drag					
: lime.	M3	1,500,000	2.00	3,000,000	
c) Remodelling of existing					
: canals.		750,000	2.50	1,875,000	<u>10,875,000</u>
4. <u>WATER CONTROL STRUCTURES</u>					
a) Remodelling of existing					
: structures (Minor).	No.	40	15000	600,000	
b) Construction of new					
: structures (Minor).	No.	45	15000	675,000	
c) Traffic bridges.	No.	4	200,000	800,000	<u>2,075,000</u>
5. <u>FIELD CHANNELS</u>					
a) New A/XX	No.	250	750	187,500	
b) Remodelling of existing					
: A/XX.	No.	300	500	150,000	<u>337,500</u>
<u>DRAINAGE :-</u>					
1- <u>EARTHWORK</u> 1-					
a) Excavate Protection					
: Drain.	M3	750,000	2.00	1,500,000	
b) Collector Drains.	M3	1,200,000	2.00	2,400,000	
2- <u>STRUCTURES</u> :-					
a) Drain crossings.	No.	30	10,000	300,000	
b) Drain out-falls.	No.	15	8000	120,000	<u>4,320,000</u>
<u>BUILDINGS</u> :-					
Pump Colony.	Sum	Prov.		1,500,000	
Water Control	No.	60	45,000	2,700,000	
Management buildings	Sum	Prov.		1,500,000	<u>5,700,000</u>
<u>PUMPS AND PUMPING STATION:-</u>					
1- Electro - Mechanical					
: Equipment.					
a) Supply, deliver, erect					
: and test five units each					
: 4.5 M3/Sec.	No.	5	2,000,000	10,000,000	

IRRIGA & PUR TO DEEM BLOCKS

ITEM	DESCRIPTION	UNIT	QUANTIT	RATE	AMOUNT	TOTAL
:	:	:	:	L.S	L.S	L.S
:	:	:	:	:	:	:
:	b) Customs and Transport	:	:	:	:	:
:	40% of (a)	Sum	:	800,000	800,000	:
:	12-- Construct pump house	:	:	:	:	:
:	to accomodate the above	:	:	:	:	:
:	pumping unite.	Sum	:	:	14,000,000	:
:	Transmission line and	:	:	:	:	:
:	sub-station	Sum	:	:	5,000,000	19,800,000
:	TOTAL	:	:	:	:	43,407,000
:	10% CONTINGENCIES	:	:	:	:	4,340,000
:	GRAND TOTAL	:	:	:	:	47,748,000
:	<u>-(Say Forty Eight Million)-</u>	:	:	:	:	:
:	:	:	:	:	:	:
:	(Only Forty Eight Million Sudanese Pounds)	:	:	:	:	:

Osman/Abu Bakr//

7. Implementing Organization

Project implementing agency will be the Ministry of Irrigation, coordinating by RPMU (Cozira Rehabilitation Project Management Unit) headed by the Minister of Agriculture and Natural Resources for financing and relation with other governmental organizations concerned. The organization chart is shown in attachments 2.

11

EXECUTIVE SUMMARY

S.1 INTRODUCTION

In July 1988, the Ministry of Finance and Economic Planning (MFEP) of the Government of Sudan signed a Contract Agreement with Sir Alexander Gibb & Partners (working in association with Hunting Technical Services and Newtech) to carry out the Blue Nile Pump Schemes Modernization study. The commencement of the study was delayed by the severe flooding in Sudan in August and September 1988 and an initial reconnaissance was eventually carried out in mid October 1988, with the start of the soil survey and data collection in November 1988. The objective of the project is to group and modernize some 60 existing irrigation schemes on the Blue Nile, including implementation of;

- new electrically driven pumping stations
- new link canals and irrigation distribution and drainage systems where necessary
- rehabilitation of the existing irrigation and drainage network to provide efficient water distribution
- improved water management techniques
- revitalised agricultural and cropping systems with increased farmer involvement.

The Project Preparation Unit (PPU) of the MFEP selected four representative groups for more detailed study; Kassab and Busata on the east bank of the Nile and Wad Hashim and Nayra on the west bank.

S.2 THE STUDY AREA

S.2.1 Physical Characteristics

The study area is located in the central clay plain of Sudan between latitudes 12° 50' and 14° 20' N. On the east bank of the Blue Nile, the area extends from 80 km north of Sennar to 130 km south, whilst on the west bank, there are no schemes north of Sennar, the area extending for about 82 km from Sennar to the south. The area is bounded on the east by the Rahad and Dinder Rivers, whilst to the west of the Blue Nile, the area generally extends across the level plain to the more steeply rising land beyond.

The climate of the study area is of tropical continental type, governed by the movement of the boundary between the northerly and southerly winds. Rainfall increases southwards from about 400 mm per year at Wad Medani in the north to over 600 mm at the southern extremity.

There are only a few isolated rock outcrops in the vicinity of the study area. In general, the deep surface soils are part of the Blue Nile alluvial fan, which falls at an average slope of between 1 in 5000 and 1 in 10000 in the general direction of the river. Away from the river, the land is generally flat but significant level changes occur as the result of old water courses and flood channels. Small undrained basins occur in some areas within the flatter lands. While the majority of soils are clays, areas of sandier soils are not uncommon.

S.2.2 Existing Irrigation

There are 62 Government owned pump irrigated schemes within the study area, including some which have been incorporated into adjacent schemes and others which have been abandoned. The original area of the schemes administered by the BNASA is 262,405 feddans. Two schemes, Hurga and Nur Ed Din, administered by the Sudan Gezira Board, cover some 22,275 feddans, giving a total of 284,680 feddans for the study area.

A thorough survey of the pumps and pumpstations indicates that the situation has deteriorated over the years and that a large number of pumps are now either inoperative or performing very much below their design requirements. This is reflected in the net cultivated areas in Table S.1 which indicate that only 115,000 feddans out of the 285,000 feddans of original scheme areas are currently cultivated, a cropping intensity of 40% compared to the planned cropping pattern of 60%. For individual schemes, the intensity varies from zero to over 70%.

At present, BNASA aims to provide all its active tenants, i.e. those currently growing cotton, with necessary mechanisation services and farm inputs for the cotton crop together with cash advances to cover the costs of hired labour. BNASA also buys all harvested cotton. The tenants on the other hand assume full responsibility for growing sorghum, which is their subsistence crop. Private sector companies provide mechanisation services for land preparation for the sorghum crop.

Accurate population figures for the study area are not available, but in the 1983 census the population of the Sennar area was given as 283,000 with an average annual growth of 3% and an average family size of 6 persons. This is thought to be an underestimate. In the four representative groups of Wad Hashim, Kassab, Busata and Nayra, the population is currently estimated at 47,000 permanent residents.

The area of the Blue Nile Pump Schemes is already substantially electrified with a significant coverage of the study area by 33kV overhead distribution lines.

S.3 PLANNING CONSIDERATIONS

S.3.1 Grouping of Schemes

One of the principal measures to be taken on the Blue Nile is to reduce the very large number of schemes by grouping them into a much smaller number of more easily administered units. Apart from the improved administration there would be economies of scale in infrastructure. The land is generally flat and the grouping can be arranged by pumping from a very reduced number of stations and by constructing link canals to join up a number of smaller schemes, each at present provided with its own pumping station.

Constructing pump stations on the Blue Nile, capable of providing water throughout the year, is expensive and even the smaller pump stations incur very considerable costs for dewatering during construction. With the wide variety of pumping duties and variation in sites, no general rules could be made, but in those cases where the option of one or several pumpsites appeared viable, comparisons of capital and operational costs were carried out to determine whether there were significant differences.

The location of suitable sites for pumping presents one of the main problems along the Blue Nile, particularly since pumping from lowest river level is necessary in

order to provide an assured water supply. The first step to be taken was therefore to locate such sites and a comprehensive survey of possible sites was carried out as part of the field work. In the event, the availability of suitable sites has been a limiting factor in the determination of a number of groups.

The second factor in grouping the schemes is the topography. In a number of instances, there are old river courses, oxbow lakes and seasonal rivers (khor) which influence the grouping either because the schemes either side are physically distant or because these features would be costly to cross with a link canal. This cost, the additional water losses associated with long link canals and the water management requirements were considered in relation to the construction, operation and management costs of additional pump stations.

Existing development was a third factor affecting the selection of the groups. The presence of the two groups currently being implemented, the Meina canal (feeding the Rahad scheme), the Suki Agricultural Corporation canal and the Sennar Sugar Corporation Canal influenced the choice of the groups, as crossing those canals would also be costly and potentially disruptive.

The make up and areas of the groups are given in Table S.1 and are shown on Figure 3.3.

S.3.2 Extension Areas

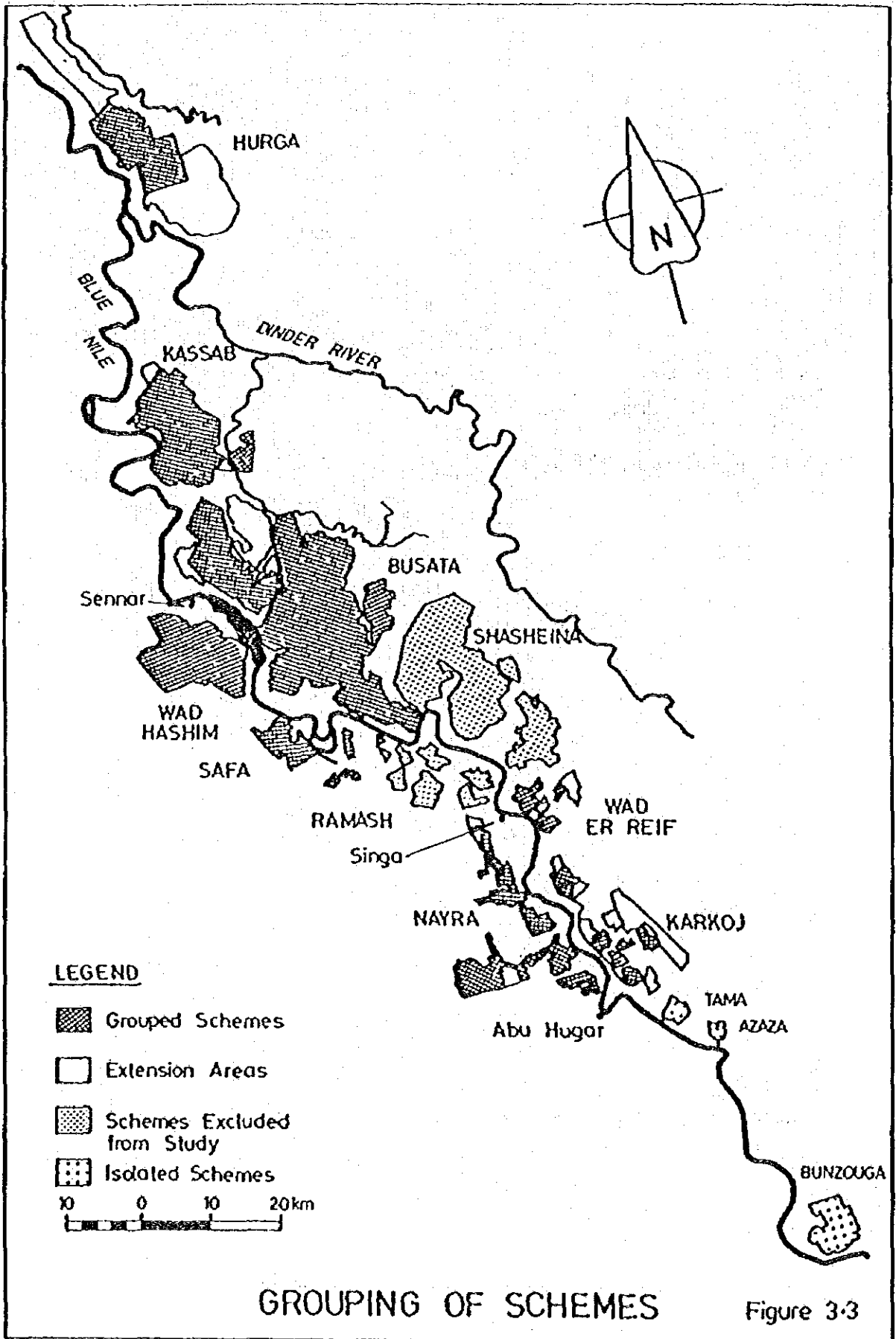
There is significant potential for extension of the pump schemes in certain areas, both between the existing schemes, as infilling, and outside them. The project's aim is to concentrate on modernizing and rehabilitating the existing schemes. The potential for extension has therefore generally been limited to those areas which lie adjacent to the existing schemes and logically could be developed as part of them, rather than developing large extensions out of all proportion to the existing schemes. Such development could possibly prejudice future development plans when more water becomes available following the heightening of Roseires Dam.

One or two small areas have been incorporated within the existing proposals as a rationalisation process (most notably in the Wad Hashim area). However, more major extensions have been considered based on the soils, topography and ease of command. These are possible within the Nayra, Hurga, Kassab, Wad Er Reif and Karkoj groups.

Potential extension areas amount to 68 360 foddans.

S.3.3 Health Aspects

The main health threats within the irrigation schemes are malaria, schistosomiasis (bilharzia) and diarrhoeal diseases. It is important that plans for modernization, rehabilitation and extension of the irrigation areas should take into account the potential health hazards in order to minimise any adverse effects.



Blue Nile Pump Schemes

TABLE S.1 - GROUPING OF SCHEMES

GROUP NAME	SCHEMES INCLUDED	ORIGINAL SCHEME	CULTIVATED 1987/88	CURRENT DEVELOPED FEEDDANS
-- WEST BANK --				
Wad Hashim	Wad Hashim North and South, Mayirno North, Awsat and South	23590	12535	23200
Safa	Dar Es Shifa, Marafa, Safa Abdeen, Islah, Abdeen, Wad El Abati, Faltahen, Um Shoka	9420	5411	9420
Ramash	Wad Raba'a, Berro, Shallal, Munrani, Dakhla, Ramash, Dabkara, Manshia, Wad El Gezouli, Kawkab	15570	4083	15570
Mayra	Mayra, Um Marih, Layouna, Seiro	16800	6152	18700
-- EAST BANK --				
Hurga	Hurga, Nur Ed Din	22275	7425	19830
Kassab	Bersi, Gadein, Assar, Wad El Abbas Gheresli, Shambata, Khafrat, Kassab North, Gadein and South	56675	23026	46100
Busata	Amara, Reweina, Abulla North and South, Hegeirat, Um Durraba, Massara, Busata, Tereira Koofa	59475	28697	59475
Shasheina/Suki	Suki, Shasheina, Wad Salmon North and South	52000	20826	52600
Wad Er Reif	Wad Er Reif, Wad El For, Meina	5650	2055	4720
Karkoj	Furhana, Abu Usha, Karkoj, Zumurka	10900	1685	6700

Separate Schemes (not viable for grouping)				
Tana		1500	nll	1500
Azaza		1950	1000	1350
Bunzouga		10875	1780	10875
Totals		284680	114675	270040

S.4 AGRICULTURAL DEVELOPMENT

S.4.1 Soils and Land Classification

The soils and land classification studies of the Blue Nile Pump Schemes Modernization study were carried out with the aim of providing a technical framework to the modernizing and regrouping of the pump schemes. Surveys were conducted within the existing schemes; in schemes that were under consideration for extension; in areas proposed for new development, and in former agricultural lands requiring reclamation.

The investigations were made at two levels of survey. The first, along the Blue Nile from Bunzouga northwards to near Wad Medani, was a regional study, examining the existing pump schemes and the lands around them. Secondly, more detailed traverses were made in a number of representative groups of pump schemes. At both levels of survey, soils were evaluated for their land suitability for irrigated agriculture, within the conditions of the proposed pump scheme groupings, and according to the United States Bureau of Reclamation (USBR) 1953 system, modified to suit Sudanese conditions. Classes 2, 3, 4 and 6 (respectively moderately suitable, marginally suitable, special use, and permanently unsuitable) were identified in the study area.

S.4.2 Crop Options

Cotton and groundnuts were selected to be the major cash crops in the 'with project' situation. These two crops give by far the best economic returns for crops on large areas. Vegetables would have a minor role to play as cash crops; they would also be grown to some extent for subsistence. Sorghum would continue to be grown largely as a subsistence crop on a significant proportion of the tenants' land. It is believed that such a mix of cash and subsistence crops would be attractive to farmers in the context of their being given greater freedom to select the crops grown in the future.

Cotton is the main cash crop grown in the Sudan and cotton production technology is well known to irrigation scheme tenants. Modern, adequately financed and well managed schemes, such as Rahad, have average yield levels of seed cotton of around 6 or 7 kantars/ld (850 or 990 kg/ld). These have been high enough to sustain an acceptable level of financial viability for the tenants. Cotton is a crop that is well adapted to the soil and climatic conditions prevailing in the Blue Nile Pump Schemes area.

Sorghum is mainly grown in the Sudan as a rainfed crop, either traditionally on a subsistence basis around villages or in large government sponsored, mechanised schemes. In the Blue Nile Pump Schemes area, irrigated sorghum is grown primarily for the subsistence of irrigation scheme tenants, their families and their hired labour.

Current yields for irrigated sorghum are around 450 kg/leddan, reflecting not only the shortcomings of inputs and husbandry but, more important, the inadequate irrigation, so that a proportion of the area is effectively only rainfed. With adequate irrigation and inputs, yields would be expected to rise to more than double this figure.

Groundnuts are grown as a major rotational crop on a number of irrigation schemes, eg. Gezira, Managil and Rahad. Yields commonly obtained of 600 to 1200 kg/ld (unshelled weight) are usually high enough to give an adequate return to tenant farmers on these schemes. Sale of groundnut hay, a valuable livestock feedstuff, provides a useful supplementary income.

Vegetable crops would be included in the project but only as a minor crop. Not all vegetables would be marketed fresh, part of the produce, eg. of tomatoes and onions, would be dried immediately after harvest prior to sale.

S.4.3 Crop Rotations

The present standard Blue Nile rotation results in a cropping intensity of approximately 66%, with 33% cotton and 33% sorghum. Given the twin objectives for the project of intensification and diversification, the Consultants studied different rotation options that would omit the fallow in order to raise cropping intensity to 100% and include a major role for groundnuts and a minor role for vegetables as additional cash crops. The options would, however, retain cotton as the principal cash crop and sorghum as the farmers' food staple.

From the viewpoint of maximizing returns to new investment in irrigation, it is clear that a 2 course rotation, along Rahad lines, or a 3 course rotation along Managil lines, would yield the greatest benefits, in terms of both financial returns to farmers and foreign exchange earnings for the nation. Rotations with 4 or more courses including fodder crops and/or a fallow would yield much lower benefits.

For the purpose of financial and economic analyses of the project, it was decided to examine in detail both a 2 course and a 3 course rotation. These rotations would be adapted for agroclimatic conditions in the Blue Nile Pumps Schemes area.

S.4.4 Cropping Practices

The cropping practices proposed for field crops are based on ARC recommendations which cover the Blue Nile area and on farming operations currently undertaken at Rahad.

The number of irrigations applied would be increased to 10 for cotton and 4 for sorghum. For vegetables and groundnuts, 8 and 6 irrigations would be applied respectively. In dry periods, frequency of irrigation would normally be once every 2 weeks, except for vegetable crops in early stages of growth which require more frequent watering, typically once or twice per week. During rainy months, some irrigation would be needed but irrigation frequency would be extended.

Expected crop yields with project at full development are:

- cotton (seed cotton)	7 kantars/ld (990 kg/ld)
- sorghum (threshed grain)	1000 kg/ld
- vegetables (fresh produce)	5000 kg/ld
- groundnuts (unshelled)	800 kg/ld

To ensure that higher crop yields are obtained after modernization of the Blue Nile Pump schemes, there will be a need for government to provide agricultural support services in the fields of research, extension and crop protection.

S.4.5 Livestock

Livestock owners are primarily scheme tenants, cotton pickers and pastoralists. Animals are mostly herded communally, close to villages and graze natural pasture and crop residues.

To develop livestock production in the study area effectively, the following general proposals would have to be considered:

- a proper survey of livestock population, movement and management practice within the whole of the study area should be carried out; the authorities concerned should cooperate in this.
- the introduction of fodder crops in limited areas within the schemes would have to be considered; these crops could be grown in areas of low suitability for irrigated field crops.
- positive policies towards recognition and development of the livestock sector in the Study Area should be adopted by the BNASA and by any proposed organization which may replace it.
- existing veterinary offices, range and pasture administration offices, and the Veterinary Research Laboratory should be strengthened;
- the Livestock and Meat Marketing Corporation (LMMC) should be provided with more facilities to cover all the markets and monitor livestock movements in the study area.

S.4.6 Forestry

There are three main options possible for forestry development in the study area. These are:

- partially irrigated woodlots in areas unsuitable for irrigated field crop production within and adjacent to irrigation schemes;
- fully irrigated plantations for the production of poles (and/or fodder) on a commercial basis on land suitable for irrigated field crop production;
- shelterbelts, windbreaks and canal side plantations.

Taking a broader view of forestry activities in the Blue Nile area as a whole, it needs to be emphasized that the better conservation and effective rehabilitation of remaining sun forest and dry land forest should play the major role in the future provision of forest products for the Blue Nile, Gezira and Khartoum demand area as a whole. The development of occasionally irrigated woodlots and, even if viable, of fully irrigated commercial forests, can at best only play a minor role in meeting the demand for forest products in the long term.

S.5 PROJECT WORKS

S.5.1 Description

The project works comprise the grouping of the pump schemes into eight viable groups with one, or sometimes two, pumpstations serving each group. The works include the construction of storage reservoirs close to each pumpstation; link canals to join the main canals of each scheme in the group; booster pumpstations where required to achieve command; remodelling of the existing canal system, including de-siltation of canals and drains and provision of new control structures; installation of power lines and substations to connect the pumpstations to the existing grid and improvement of communications (the roads and radio telephone network).

S.5.2 Water Demands

Gross water consumption for all groups, including Shashelna/Suki and Ramash, 'without project' is estimated at around 300 million m^3 per year on the present performance and cropping pattern. With the intensification of cropping and provision of pumps which provide the required water, this figure would rise to 960 million m^3 per year without extension areas or 1210 million m^3 per year with extensions. The estimated incremental monthly water requirements are given in Table S.2.

Table S.2 - Incremental Water Requirements
(million m^3)

	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Jan	Tot
Without extension areas	85	30	74	28	115	126	90	61	52	661
With extension areas	106	39	111	39	160	175	127	85	72	914

These figures lie within the 1140 million m^3 /year allowed for in the Roseires Dam Heightening report for additional irrigation on the Blue Nile.

S.5.3 Pumping Stations

The new pumping stations should be capable of pumping from the lowest river levels and should be electrically powered. The area of the Blue Nile pump schemes is already substantially electrified and is capable with moderate extensions of providing all necessary electrical power for electrically driven pumpsets at the proposed new river intakes and booster pumping stations.

Various types and configurations of pumps have been considered. These are as follows:

- submersible pumps
- Inclined (down the bank) pumps
- vertical wet well pumps
- vertical dry well pumps.

Having carefully considered the various alternatives the vertical wet well installation is proposed as the most reliable type capable of being easily maintained within the capabilities of the facilities and staff likely to be available.

The most economical form of drive would be by electric motor coupled directly to the pump and fed by the NEC grid supply. The supply voltage for motors below 375 kW would be 415 V with 3.3 kV for motors above 400 kW. It is accepted that 3.3 kV is not a standard NEC supply voltage and each pumping station would be provided with its own substation supplied from the NEC 33 kV or 11 kV supply.

S.5.4 Link Canals

A major factor affecting the link canals design was the limitation of pumping from the river to 18 hours/day due to restrictions in the power supply from the grid. An intermittent water supply to the minor canals would impose almost impossible management demands on the groups, with their much longer lengths of canal between pumping station and field than on the individual schemes. During the six hour shut off, canals would drain down, unless all gates were immediately closed, and even then canal losses would be significant. Once pumping started, there would be a considerable delay before the furthest canals were operating at full supply level. With storage in the major or minor canals, these difficulties would be inherent. For ease of water management therefore, a continuous 24-hour flow to each scheme within the group is desirable and there is a need to store 6 hours supply of irrigation water. It was concluded that the optimum solution was to provide a storage reservoir at the head of each link canal. This minimises the size and cost of the link canals and structures and also has the important added advantage of removal of a large proportion of the silt load before water enters the link canal and irrigation system generally.

Standard Ministry of Irrigation roller sluice gated canal control structures have been used, as they are proven in use, make good use of local materials and the masonry structures have a lower foreign exchange cost.

The reservoirs are located as near as possible to the upstream end of the canal and designed to be able to operate either on or off line. This will enable them to trap as much silt as possible during the main irrigation season. Each reservoir can then be drained for annual desilting when irrigation demand is low, i.e. during the first six months of each year.

S.5.5 Distribution System

The distribution systems are generally in a very poor state of repair. There is a backlog of silt clearance, weed clearance and bank maintenance. Structure control gates are rusted, broken and inoperable and masonry work is in need of repair, road crossing pipework is damaged and there are virtually no water level gauges.

It is therefore planned to remodel all canals and replace all structures, as almost none are in good working order at present.

S.5.6 Electrification

Electrical loads at the study pumping stations are shown in Annexe J, total peak load amounting to approximately 15 MW (excluding extension areas) and 21 MW (including all extension areas). Estimates of future non-study loads in the area served by the Sennar, Mina Sharif and Hag Abdulla substations for 1998 amount to approximately 73 MW against a present load of about 30 MW.

S.6 INSTITUTIONAL FRAMEWORK

S.6.1 Institutional Options

Institutional options that were considered:

1. Maintain and strengthen the BNASA - the corporate option.
2. Provide central management and services through a limited liability company.
3. Provide management and services through farmer co-operatives at each group - the co-operative option.
4. Provide services through existing agencies and the private sector to groups of independent tenant farmers which have flexibility of choice as to their own organisation and internal management.

S.6.2 Proposed Institutional Arrangements

The proposed institutional arrangements involve a number of organizations, namely the Farmers' Union, the MOI, ABS, MOANR, the Private Sector and a Project Planning Coordination Committee (and Unit).

Farmers Groups

Individually defined, transferable and assignable tenancies should be issued to the farmers. The period of the lease should be not less than 30 years with a right of renewal. Each sitting tenant-at-will would be granted a tenancy over a 15 feddan holding divided into three 5 feddan irrigated plots (hawasha). If farmers have plots in three contiguous Abu Ishreen, these three irrigation units would together constitute a Group of 18 farmers with a total area of 270 feddan. These Groups would be registered by the Farmers' Unions in the name of a Group Leader, elected by the Group members under Union supervision.

The Farmers' Unions

No change in the present structure or procedures of the existing Farmers' Unions is envisaged. It is recommended, however, that the Unions be encouraged to

undertake more responsibility in the the affairs of their members. The Farmers' Unions will be responsible for the general organization and management of the farmers as a whole. In conjunction with other line agencies, they will be involved in crop resource planning, water supplies, credit, mechanisation, transport and marketing and water charges.

Water

The operation and maintenance of the irrigation system from the pumping source to the field outlet into the Abu Ishreen would be the responsibility of the Ministry of Irrigation. MOI should appoint an Irrigation Manager for the Blue Nile Pump Schemes to whom both the Mechanical and Civil Divisions would be directly answerable. Full infrastructural needs and required staff should be supplied, including housing and transport, so that such deficiencies may not be cited as reasons for poor performance.

Extension

Extension services for the modernized Blue Nile Pump Schemes are would be made available by MOANR through the Regional Director of Extension. Each Irrigation group would be served by one or two Extension Sub Units depending on the number of tenants in the group. A total of 12 Sub Units would be needed. These would be located in large villages and controlled from 3 Extension Units, in Sennar, Singa and Suki Towns.

Crop Protection

The entire crop protection operation would be the responsibility of the Crop Protection Department of MOANR who would appoint a Project Entomologist to manage this aspect. Such supervisory functions as were previously undertaken by the Corporation would be transferred to the Department including such staff or other infrastructure as may be necessary.

Mechanisation

Consideration should be given to the possibility of a management buy-out of new BNASA workshop facilities with the financial support of the Sudan Agricultural Bank. Funds would need to be allocated for initial technical assistance particularly in the field of financial control and resource management.

Agricultural Research

ARC's Sennar Research Station is well placed to support the technical development of irrigated cropping in the Blue Nile area. Six key research topics for on farm trials have been identified:

- variety trials for selected field crops, i.e. cotton, groundnuts and sorghum;
- crop fertilisation requirements of selected field crops;
- crop water requirements and farm level water management;
- Insect pest and weed control;
- crop rotations and introduction of new field and fodder crops;
- Introduction of export quality horticultural crops.

Costs are based at January 1989 price levels with foreign exchange costs expressed in U.S. \$ and local costs in Sudanese pounds. Totals are expressed in U.S. \$ at the official exchange rate of U.S. \$ = LS 4.5.

S.8 ECONOMIC AND FINANCIAL ANALYSIS

S.8.1 Economic and Financial Assumptions

The analyses have been carried out in three stages.

1. Economic evaluation techniques are used to compare the 'with' and 'without project' case to rank the individual groups in terms of their economic rates of return.
2. The economic ranking exercise is then used to assist in defining a specific development plan for the whole project area. The development plan provides a phased programme of development for the groups including extension areas over a period of about 18 years. The most favourable groups in terms of their economic rates of return, technical suitability and physical location are included in the first 5 year period of the development plan.
3. Finally, an economic rate is calculated for the complete development plan which includes all costs such as transmission and institutional costs which cannot be conveniently attributed to individual groups.

The financial evaluation follows the same procedure and derives financial rates of return for the individual groups and the development plan as a whole.

A revised foreign exchange market system was announced in October 1988. Two main exchange rate regimes were established; an official rate of exchange at LS 4.5 = US\$ 1.0 and a commercial market rate of LS 12.0 = US\$ 1.0. The study has assumed a free market equilibrium rate at LS 10.0 = US\$ 1.0. This premium is reflected in the economic pricing of goods and services by reducing the value of the domestic currency component in market prices by a standard conversion factor (SFC) of 0.45.

Long term commodity prices used in the analysis are shown in Table S.5.

Table S.5 - Commodity Prices (1995)

	CIF Value (U.S. \$/t)	Farmgate Economic	Price (LS/t) Financial
Cotton	1833	4043	3141
Groundnuts:		1632	1228
- oil	788		
- meal	192		
Sorghum	93	440	770
Vegetables	N.A	432	960

TABLE S.3
Summary of Capital Costs (US\$ x 1,000)

GROUP	PUMP STATIONS	LINK CANALS	IRRIGATION & DRAINAGE	INFRA-STRUCTURE	TOTAL		
					FOREIGN	LOCAL (LSx1000)	GRAND
WAD NASHIM	6,895	5,305	2,677	1,158	11,137	22,039	16,035
SAFA	5,534	6,601	1,079	652	9,292	20,585	13,866
NAYRA							
Without extension	8,434	7,476	2,121	1,057	12,870	27,983	19,088
With extension	10,502	7,684	3,054	1,238	15,468	31,543	22,478
HURGA							
Without extension	4,306	3,527	2,271	1,710	8,114	16,647	11,814
With extension	9,814	5,017	9,892	3,455	19,450	39,278	28,178
KASSAB							
Without extension	6,890	15,834	5,242	2,359	20,043	46,270	30,326
With extension	7,860	16,423	8,158	3,017	23,476	53,918	35,458
BUSATA	12,089	12,038	6,815	4,475	24,167	50,630	35,418
WAD ER REIF							
Without extension	2,638	599	541	255	2,802	5,540	4,033
With extension	3,246	1,056	961	348	3,903	7,686	5,611
KARKOJ							
Without extension	4,642	5,198	768	2,036	8,206	19,970	12,644
With extension	7,076	6,731	4,051	2,699	13,574	31,422	20,557
SEPARATE SCHEMES							
Tama	1,640	594	172	97	1,669	3,756	2,504
Azara	1,651	586	155	90	1,654	3,726	2,482
Bunzouga	3,795	1,493	1,246	556	4,926	9,736	7,089
TOTALS							
Without extension	58,515	59,251	23,087	14,445	104,879	226,882	155,298
With extension	70,103	63,528	38,260	17,785	128,716	274,319	189,676
TWO STAGE DEVT. OPTION							
Kassab - Stage 1	7,068	16,362	5,242	2,359	20,456	47,589	31,032
Stage 2	749	70	2,916	720	3,048	6,331	4,655
Hurga - Stage 1	4,189	4,505	2,271	1,710	8,599	18,342	12,675
Stage 2	6,839	628	7,621	1,745	11,822	22,549	16,833

Exchange Rate 1 US\$ = LS 4.5

Three sensitivity tests have been carried out to determine if the initial ranking is affected by the following changes:

- (1) decline in the future price of cotton by 25%
- (2) decrease in cropping intensities to 66% by omitting groundnut production
- (3) slower build of benefits over a 6 year period

Even under the pessimistic assumptions concerning reduced cotton price, decreased-cropping intensities or slower build up of benefits, the rates of return for all the groups remain attractive. The decline in the cotton price has the most significant effect on the ERRs. This is to be expected as about 70% of net agricultural benefits are derived from cotton.

The financial evaluation follows the same methodology and assumptions used for the economic evaluation except that the analyses are undertaken in terms of market prices for project costs and benefits which include all duties and taxes. The financial rates of return for the individual groups are significantly lower than the economic rates of return. This is mainly due to inclusion of taxes and duties paid by the farmers which reduce their crop incomes in the financial analyses. However, the ranking of the groups remains unaffected.

S.8.3 Farm Budgets

An average farm budget for a 15 feddan holding based on a standard cropping pattern is set out in Table S.7. This indicates that with the modernization programme, tenants will have a considerably increased income compared with their present income. For the standard cropping pattern a tenant can expect an average net farm income of over LS 12,600 per 15 feddan holding. This is after deducting all crop growing costs, water charges, credit costs and other costs.

Table S.7 - Net Farm Income from an Average Irrigated Holding
At Full Development

With Project:	LS
Crop Income (1)	19778
Less	
Water Charges	1932
Credit Costs	2348
Labour-hired	2631
Other Costs	245
Total deductions	7156
Net farm income	12622
Without Project:	
Net Farm Income	1319
Net Incremental Income	11303

(1) Net of all input costs including taxes etc.

S.8.4 Development Plan Options

Based on the project ranking, three options have been considered which have an even rate of development, without undue peaks in either financial or construction resources. These options are:

- Option A Selecting the alternative within each group of 'with' or 'without extension' depending on which has the highest economic rate of return, and ranking the groups thus selected strictly by highest rate of return. This results in a mixture of groups, some with extension areas and others without, and a peak development rate of 15,500 feddans per year.
- Option B Selecting the 'with extension' alternative in all cases, where this is available and ranking by highest economic rate of return. The development rate peaks at 17,500 feddans per year.
- Option C As for Option B above but with the Hurga and Kassab groups, which have large potential extension areas and fall early in the programme, developing their extensions after the development of all other areas. There is thus a two stage development for the Hurga and Kassab groups. Some minor adjustment was also made to the programming of the Karkoj group to maintain the peak of development within the 17,500 feddans per year. This latter group would be constructed all in one stage as it falls late in the development plan.

Economic and financial rates of return have been calculated for each development plan option assuming a time horizon of 35 years. Costs and benefits associated with each group are phased by project year, the last group commencing construction in Project Year 15 for Options A and C and Year 16 for Option B. The results summarised in Table S.8.

Table S.8 - Development Plan Options
Economic and Financial Rates of Return

	ERR%	FRR%
Option A	34	20
Option B	35	20
Option C	33	18

S.9 THE DEVELOPMENT PLAN

S.9.1 Recommended Programme

The three options considered do not result in widely different rates of return. Option A covers a net area of modernization, rehabilitation and new development of almost 229,000 feddans, whilst Options B and C cover slightly over 270,000 feddans. Options B and C, as expected, result in slightly lower rates of return.

Recommended Development Programme

Project Year

GROUP	AREA (teddon)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
HURGA	19,830	Stage 1 No Extension																			
BUSATA	59,475	Stage 1 No Extension																			
KASSAB	46,100	Stage 1 No Extension																			
BUNZOUGA	10,875	Stage 1 No Extension																			
WAD HASHIM	23,200	Stage 1 No Extension																			
WAD ER REIF	6,620	With Extension																			
NAYRA	22,400	With Extension																			
SAFA	9,240	With Extension																			
TAMA	1,500	With Extension																			
KARKOJ	20,270	With Extension																			
AZAZA	1,350	With Extension																			
HURGA	35,690	Stage 2 Extension added																			
KASSAB	13,500	Stage 2 Extension added																			
TOTAL		270,230																			

S.9.2 Institutional Aspects

An effective institutional structure is a fundamental requirement to the success of the project. However, whatever solution is adopted, the following conclusions will apply.

1. The supply of irrigation water should remain under the control of the MOI for the foreseeable future and adequate funds should be provided to enable them to perform this function. Hence the groups will not be entirely privatised.
2. Changes are necessary to the existing BNASA organization and it must be assumed that it will be phased out as the involvement of the private sector increases. The question is at what rate and in which way this will be achieved. It should be possible to re-deploy many of the existing staff within the administrative framework of the Project.
3. Although the new groups are likely to be operated by the private sector, some residual body will be required to administer the schemes that have not yet been modernized.
4. A strong and effective project planning and coordination unit must be established to oversee the implementation of the project.

S.9.3 Implementation

The study to date has been undertaken generally to feasibility level, with some additional survey work and investigations for the four representative groups of Busata, Kassab, Wad Hashim and Nayra. These groups are the subject of specific, more detailed reports (Volumes 3 and 4).

However, the information available is not considered adequate for the preparation of final designs and tender documents. Additional topographical surveys will be required for all the groups of the development programme, including the representative areas, though the surveys of Hurga, Busata and Kassab, with their extension areas, could be completed as a first stage. This could be accomplished either by normal ground survey methods or by aerial survey. In view of the extensive areas to be covered the latter course would be preferable.

Once this information is available, tender documents can be prepared in the normal way. It has been assumed that the survey work and document preparation would be completed during the first project year for each group.

5. 収集資料リスト

1. 地形図 (1/20,000, 1/10,000)
2. The four year salvation, recovery and development programe
(1988/89 - 1991/92)
3. Agricultural situation and outlook
4. Sudanow
5. Blue Nile Pump Schemes Modernization Study (Draft)

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|-----------|---|---|
| Volume 1 | - | Executive Summary |
| Volume 2 | - | Main Report |
| Volume 3 | - | Representative Group Reports
(i) Busata
(ii) Kassab |
| Volume 4 | - | Representative Group Reports
(iii) Wad Hashim
(iv) Nayra |
| Volume 5 | - | Annex A - Soils and Land Classification
Annex B - Agriculture |
| Volume 6 | - | Annex C - Mechanisation
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Annex F - Agro-economica |
| Volume 7 | - | Annex G - Pumping Stations
Annex H - Link Canals
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