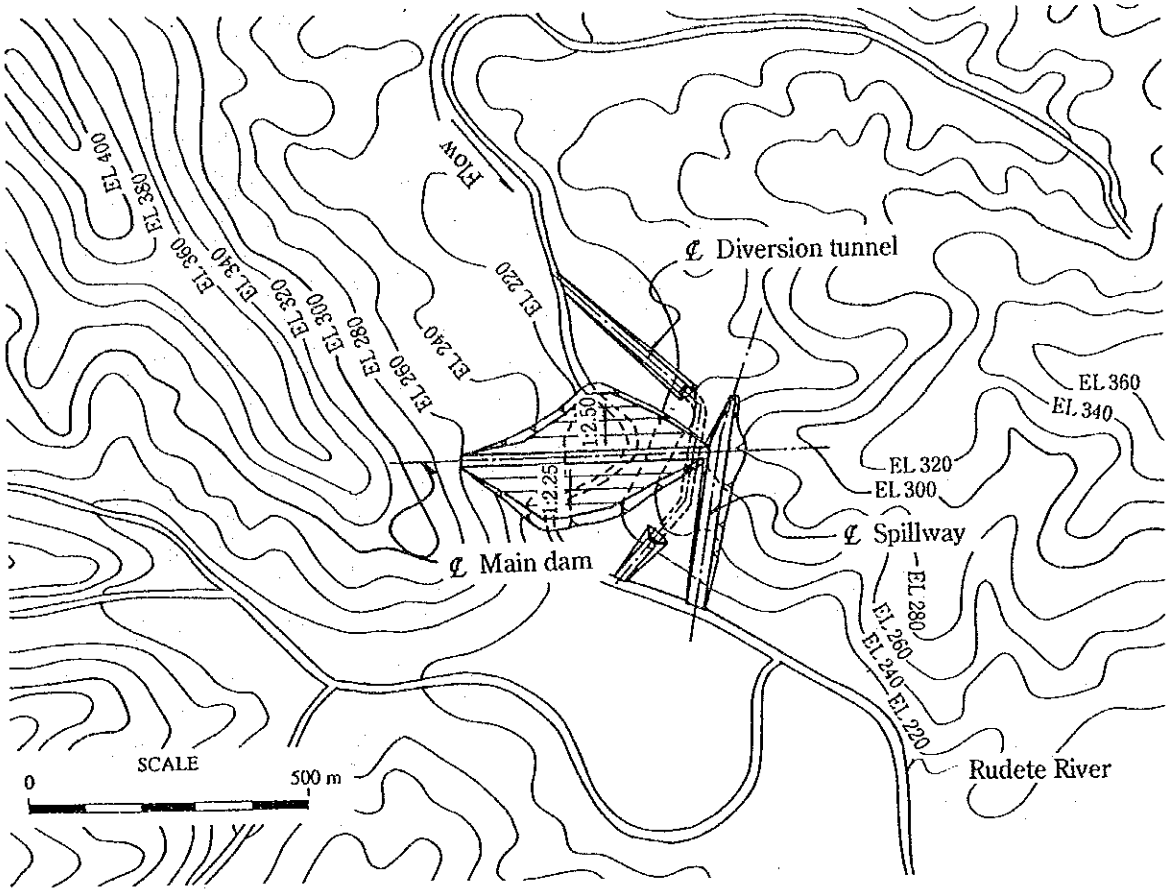
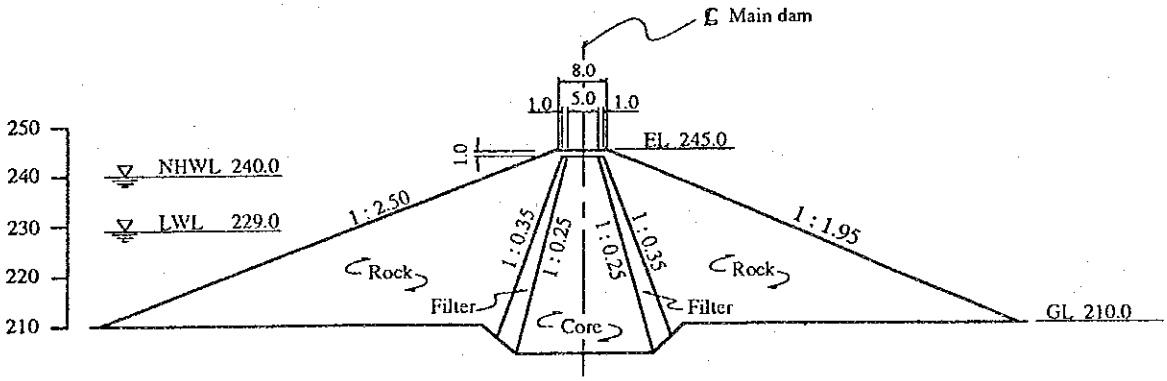
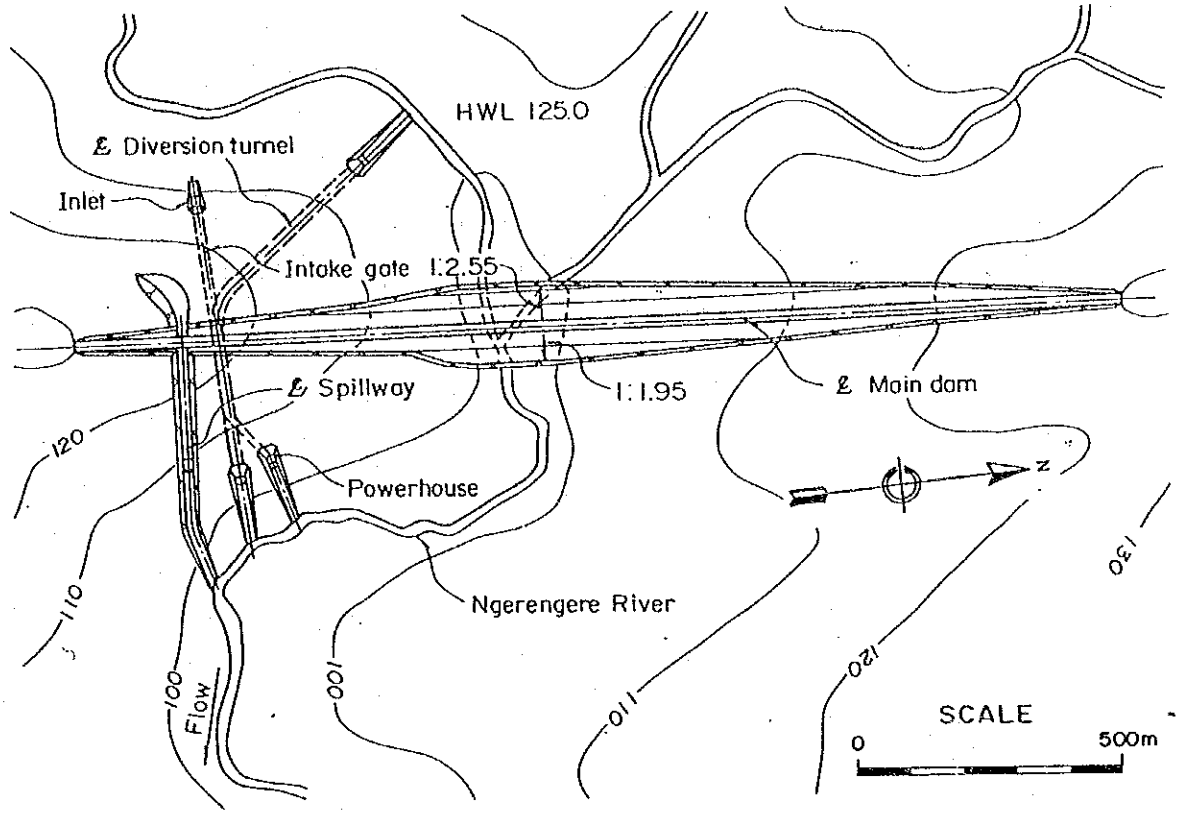


GENERAL PLAN OF RUDETE DAM

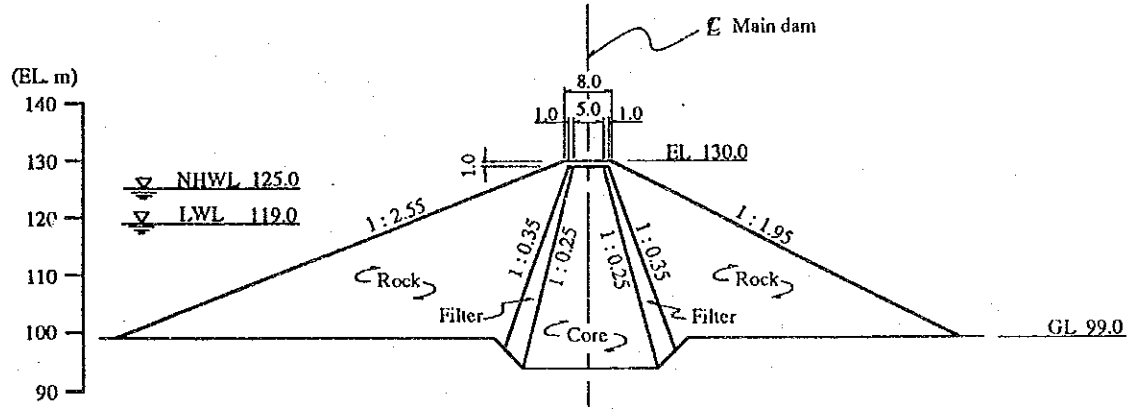


TYPICAL SECTION OF RUDETE DAM

Fig. I.13 GENERAL PLAN OF RUDETE DAM

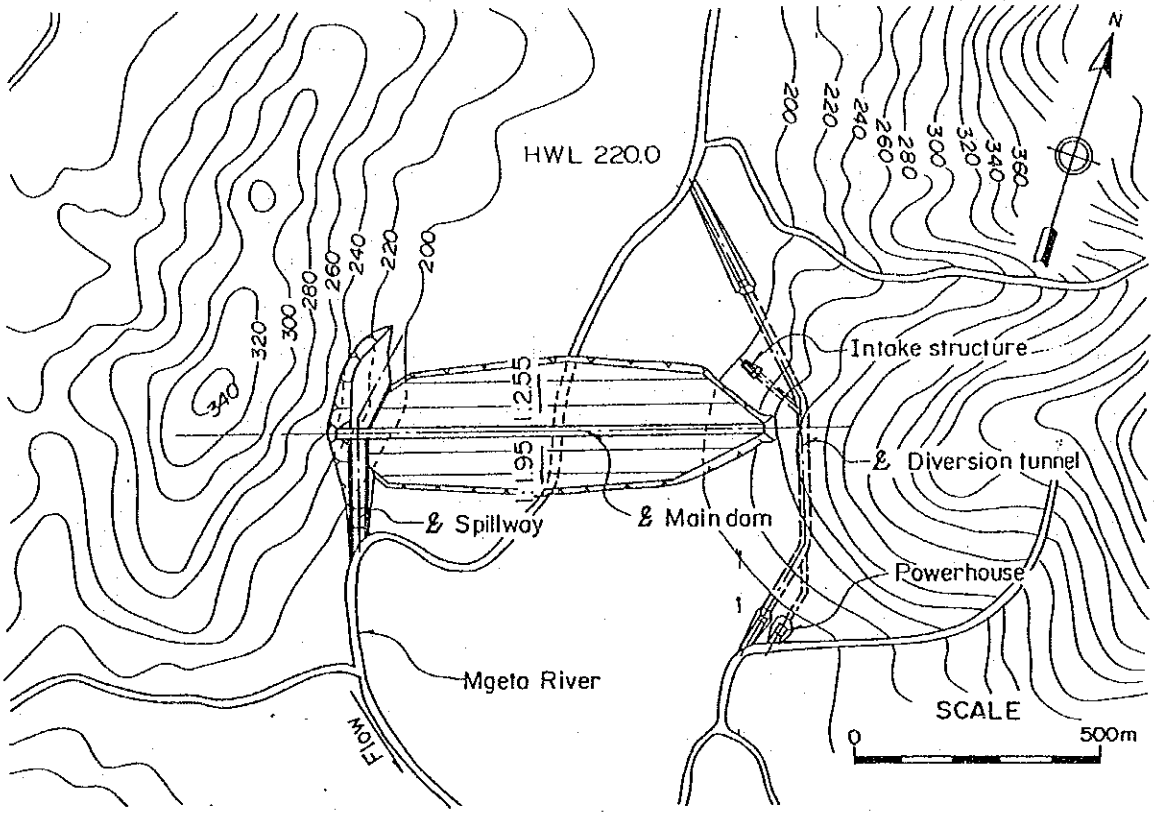


GENERAL PLAN OF NGERENGERE DAM

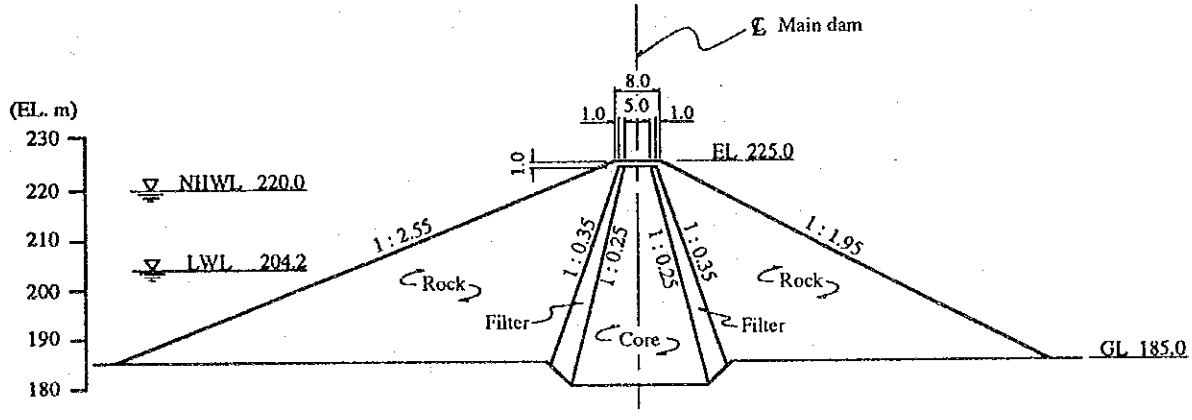


TYPICAL SECTION OF NGERENGERE DAM

Fig. I.14 GENERAL PLAN OF NGERENGERE DAM

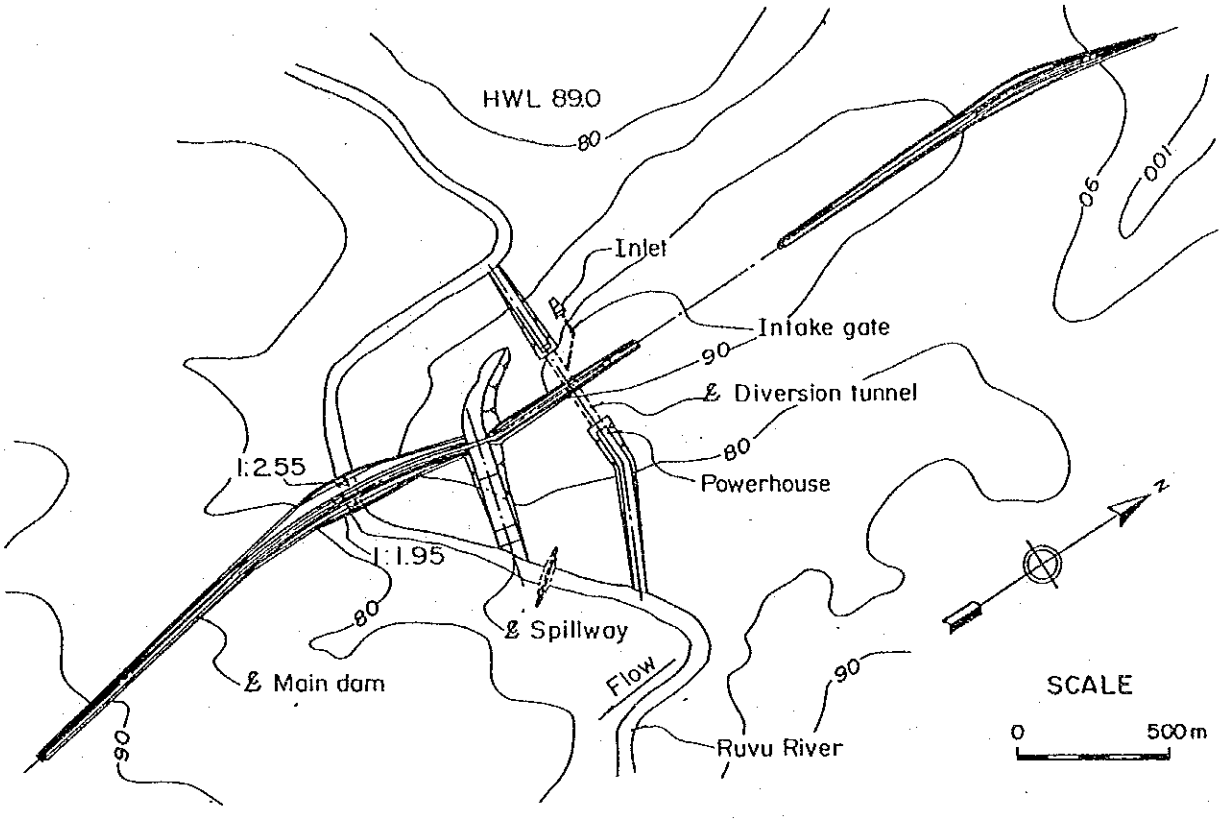


GENERAL PLAN OF MGETA DAM

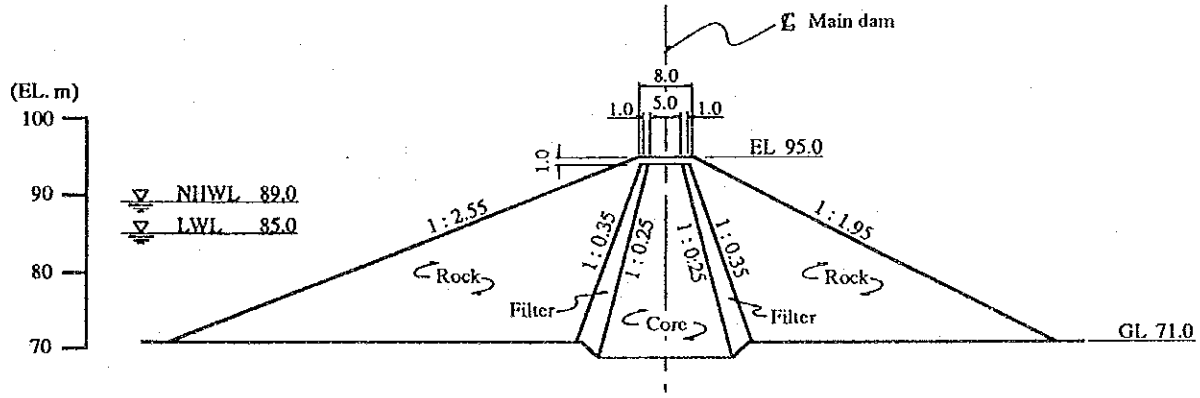


TYPICAL SECTION OF MGETA DAM

Fig. I.15 GENERAL PLAN OF MGETA DAM



GENERAL PLAN OF KIDUNDA DAM



TYPICAL SECTION OF KIDUNDA DAM

Fig. I.16 GENERAL PLAN OF KIDUNDA DAM

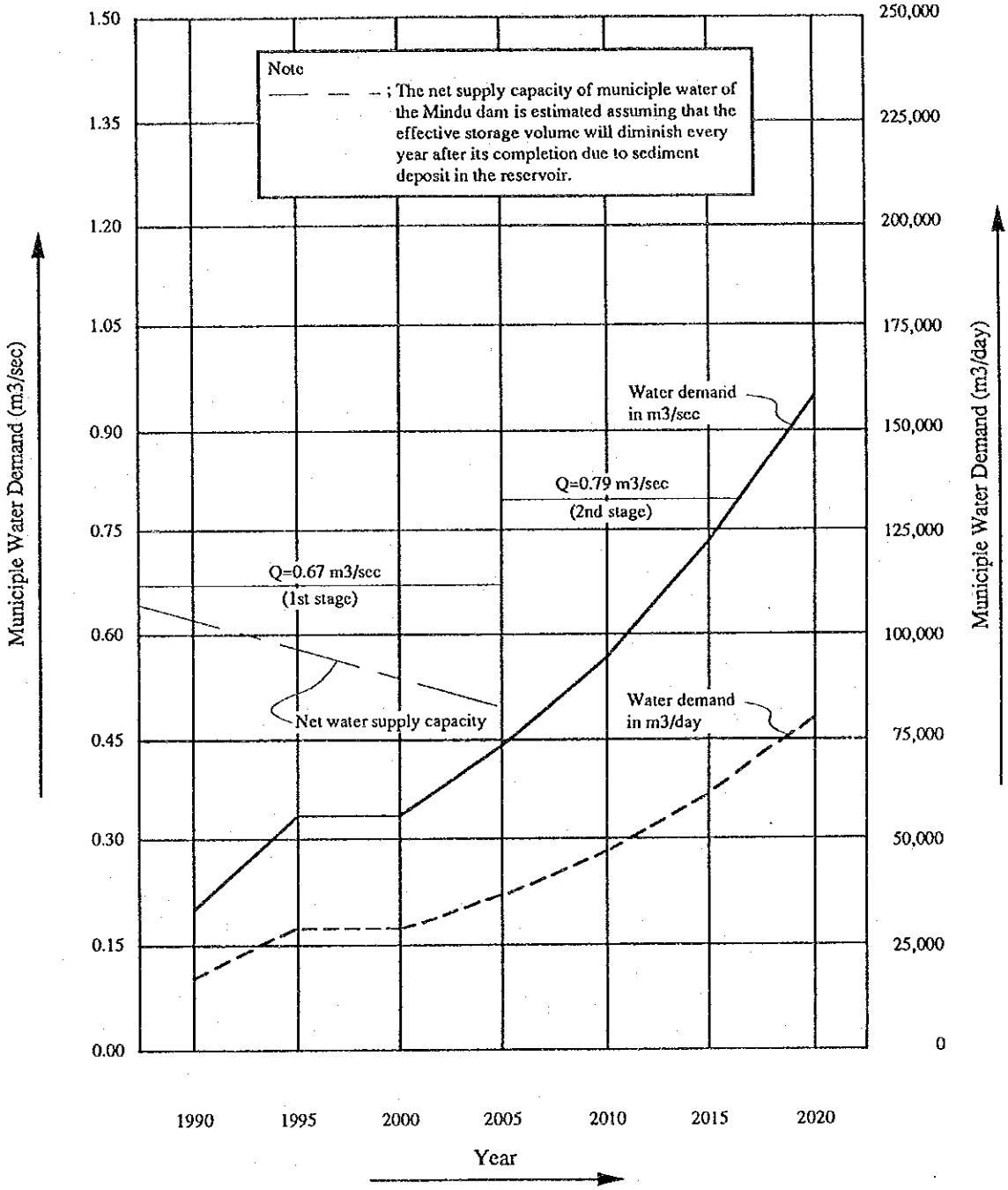


Fig. I.17 MUNICIPAL WATER DEMAND AND WATER SUPPLY FOR MOROGORO MUNICIPALITY

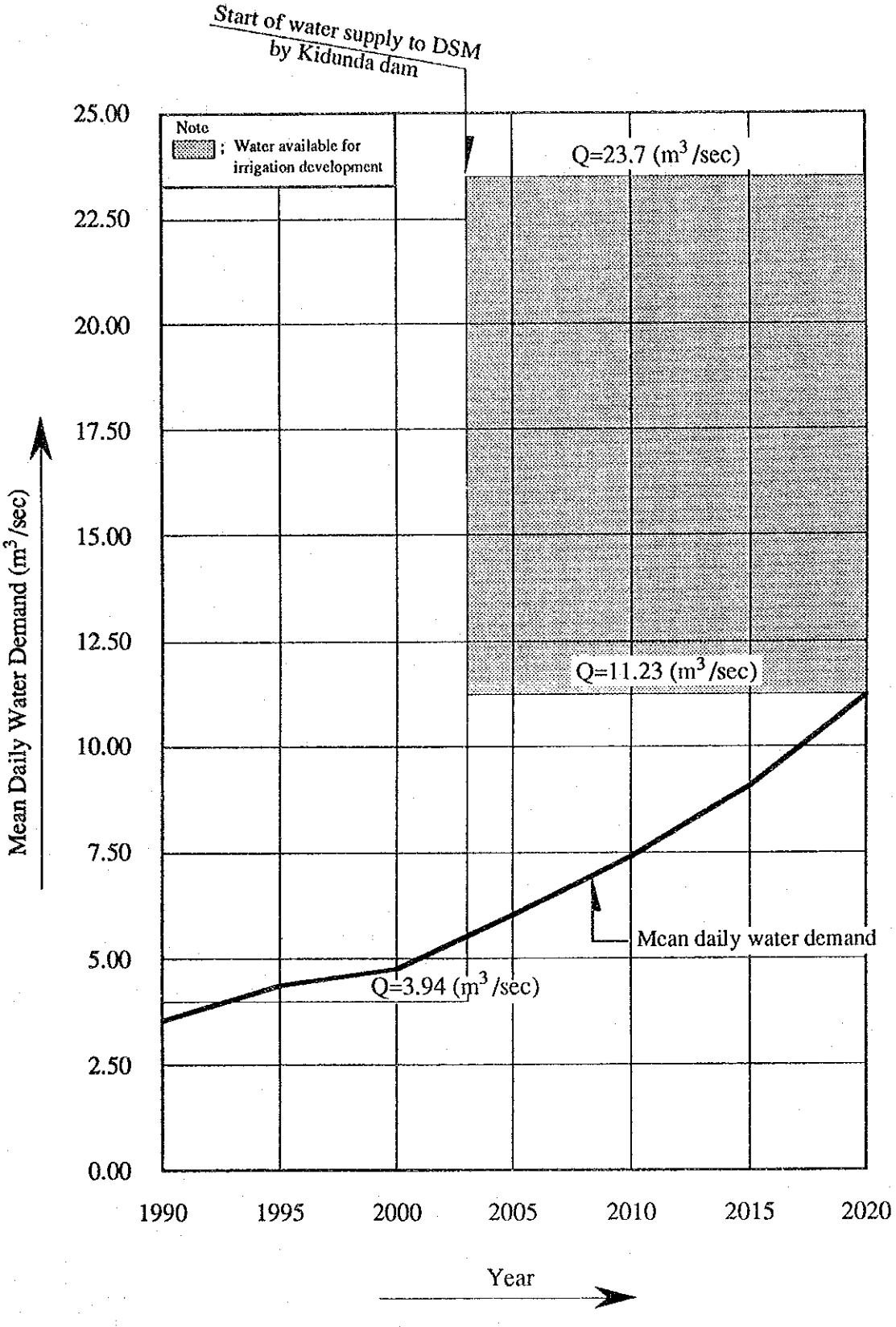


Fig. I.18 MUNICIPAL WATER DEMAND AND WATER SUPPLY FOR DAR ES SALAAM IN CASE OF DEVELOPMET SCENARIO-1

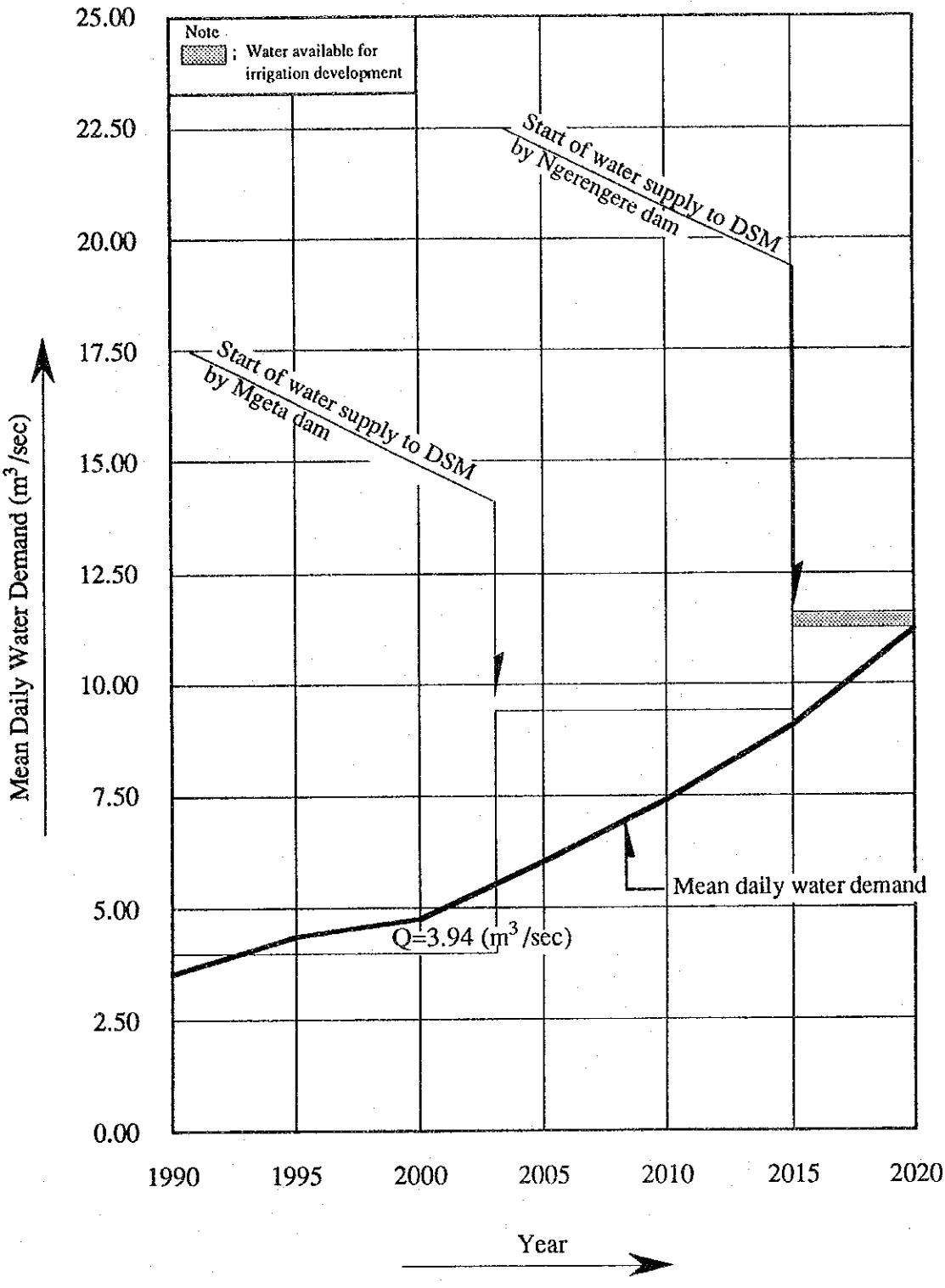
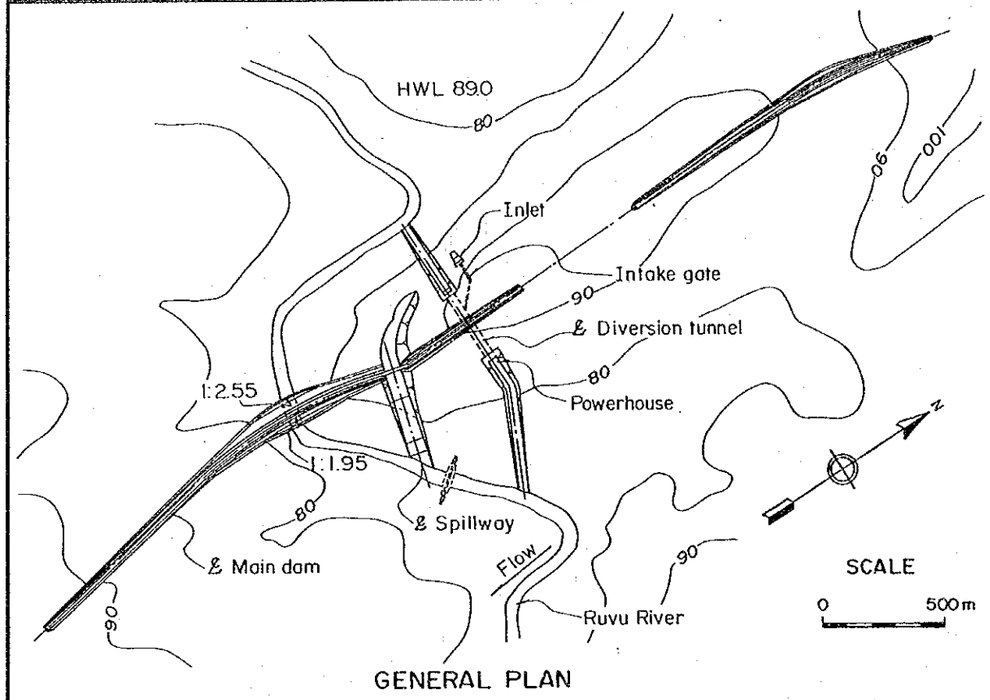
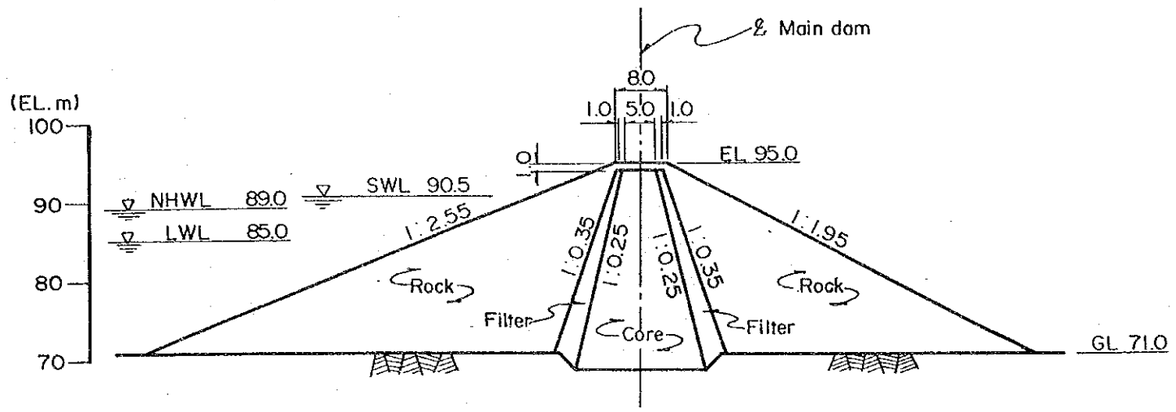


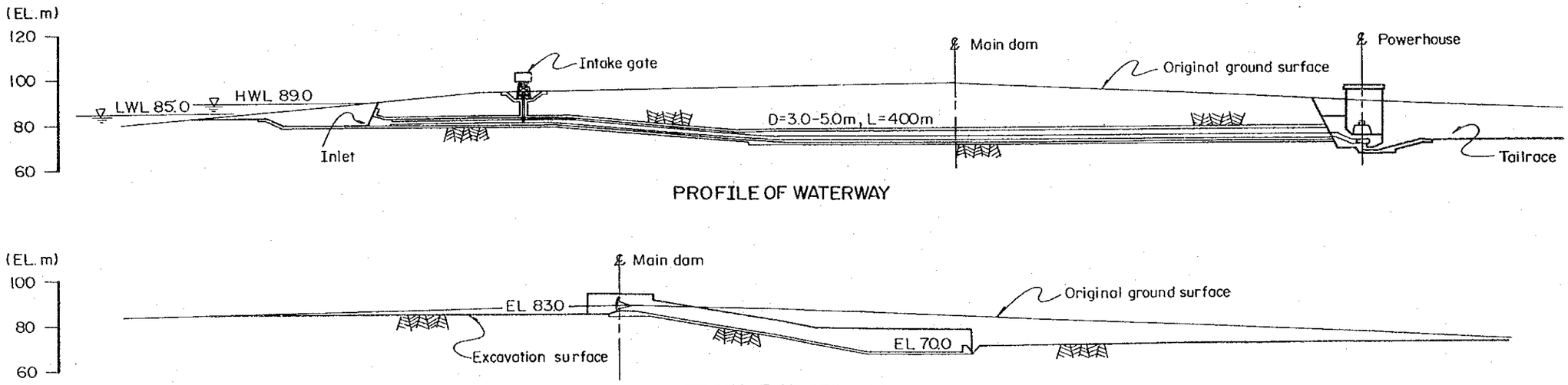
Fig. I.19 MUNICIPAL WATER DEMAND AND WATER SUPPLY FOR DAR ES SALAAM IN CASE OF DEVELOPMET SCENARIO-2



GENERAL PLAN



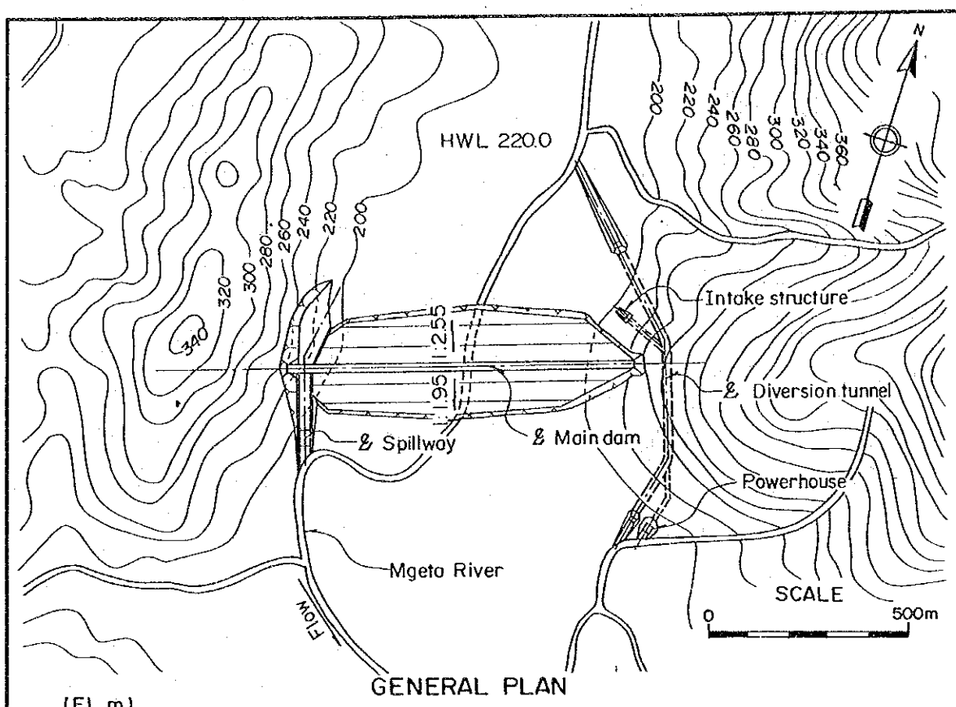
TYPICAL SECTION OF MAIN DAM



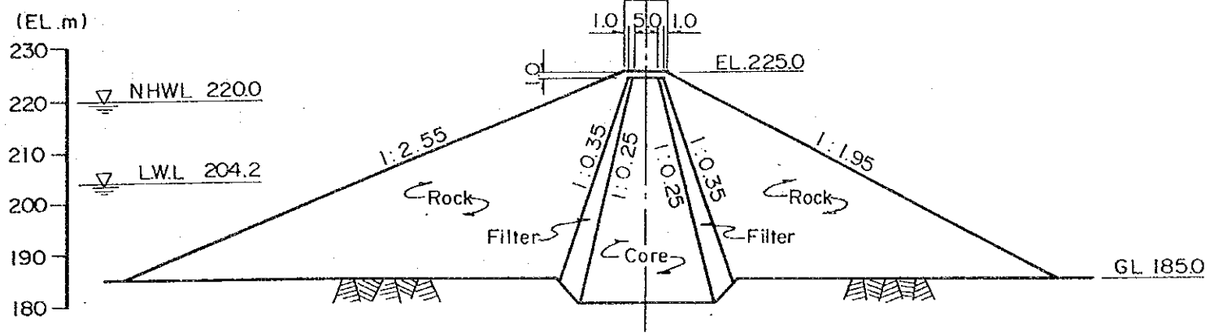
PROFILE OF WATERWAY

PROFILE OF SPILLWAY

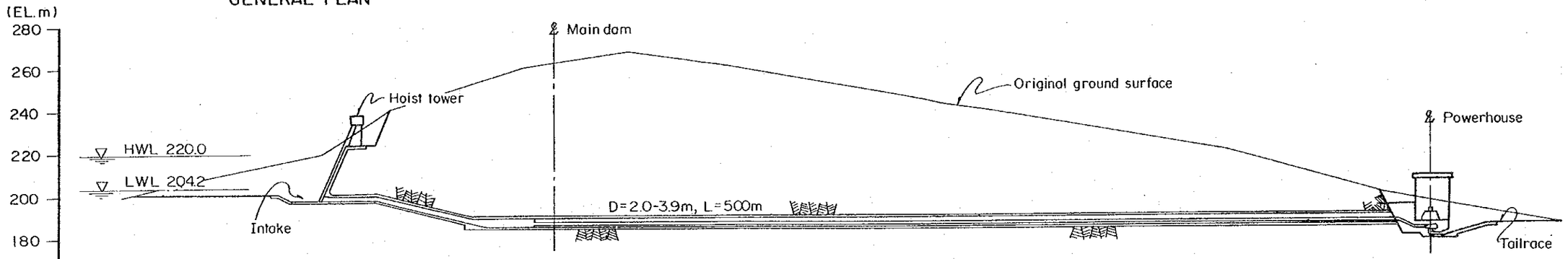
Fig. I.20 LAYOUT PLAN OF KIDUNDA DAM PROJECT



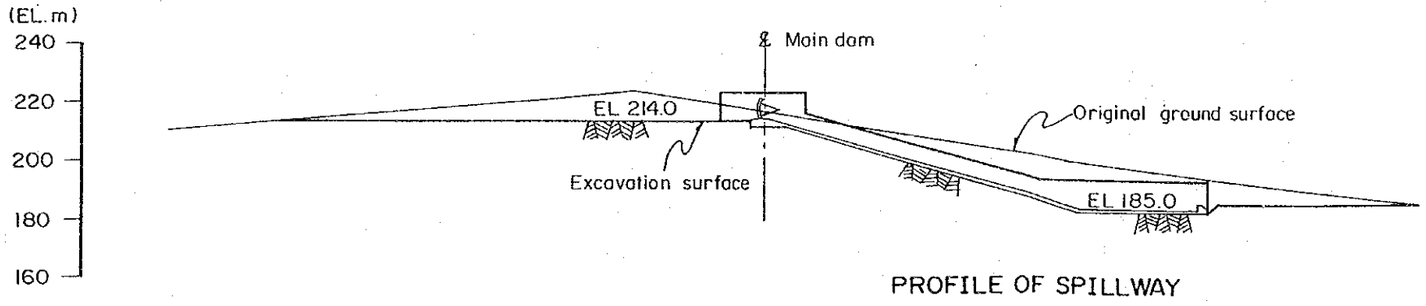
GENERAL PLAN



TYPICAL SECTION OF MAIN DAM

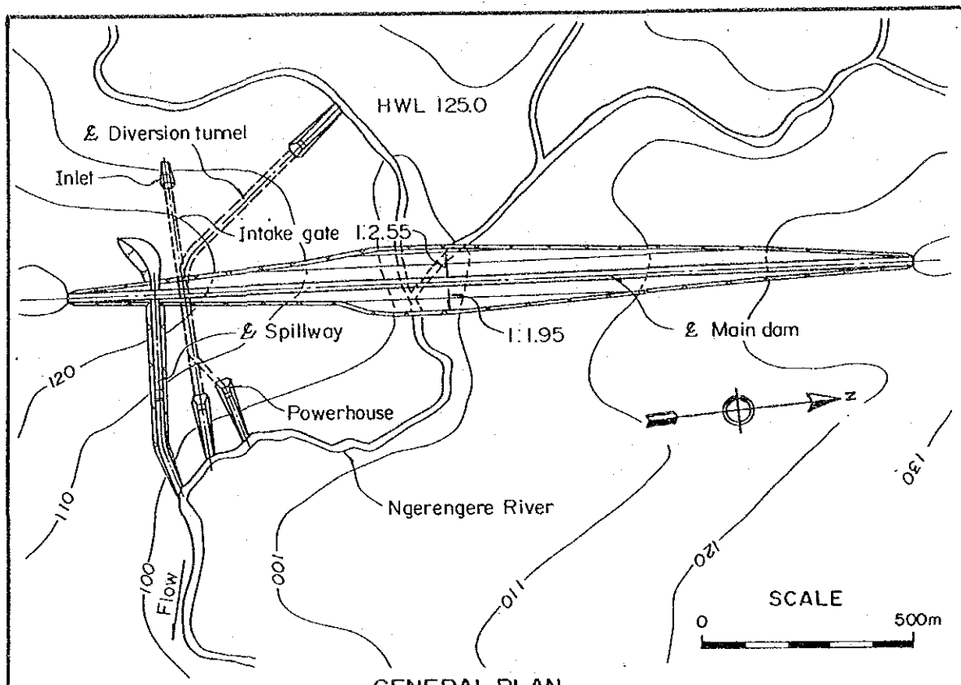


PROFILE OF WATERWAY

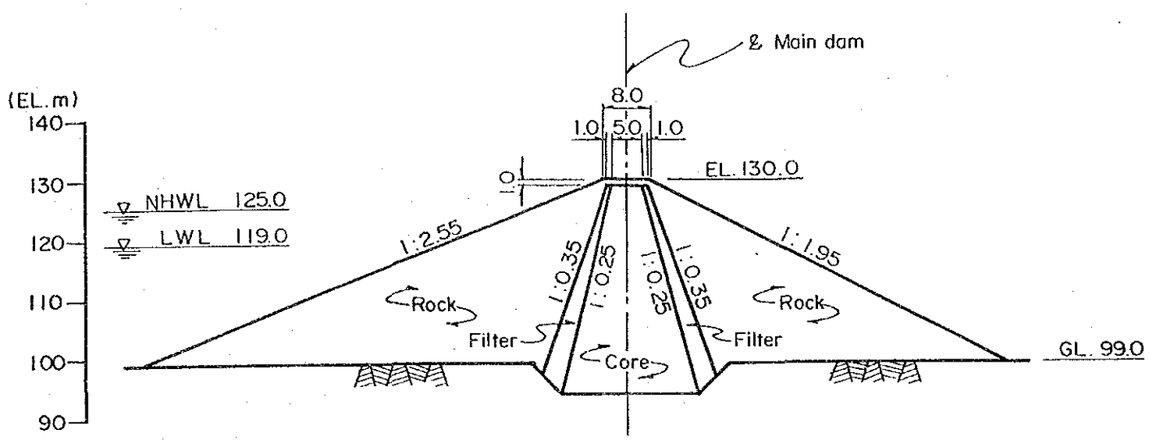


PROFILE OF SPILLWAY

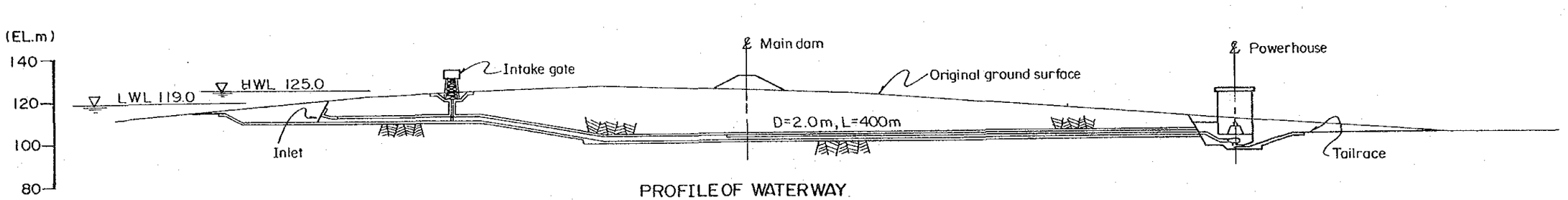
Fig. I.21 LAYOUT PLAN OF MGETA DAM PROJECT



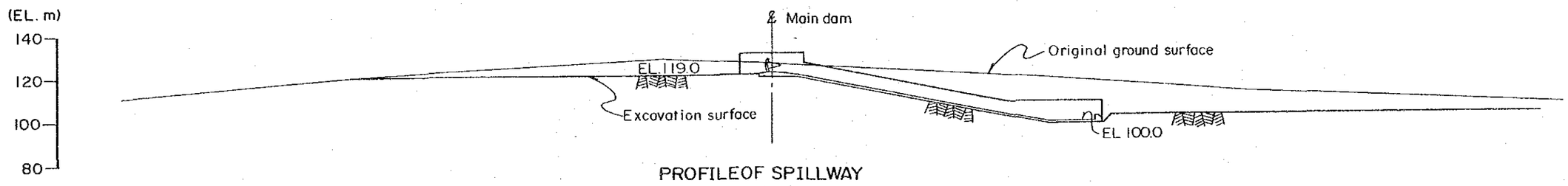
GENERAL PLAN



TYPICAL SECTION OF MAIN DAM



PROFILE OF WATERWAY



PROFILE OF SPILLWAY

Fig. I.22 LAYOUT PLAN OF NGERENGERE DAM PROJECT

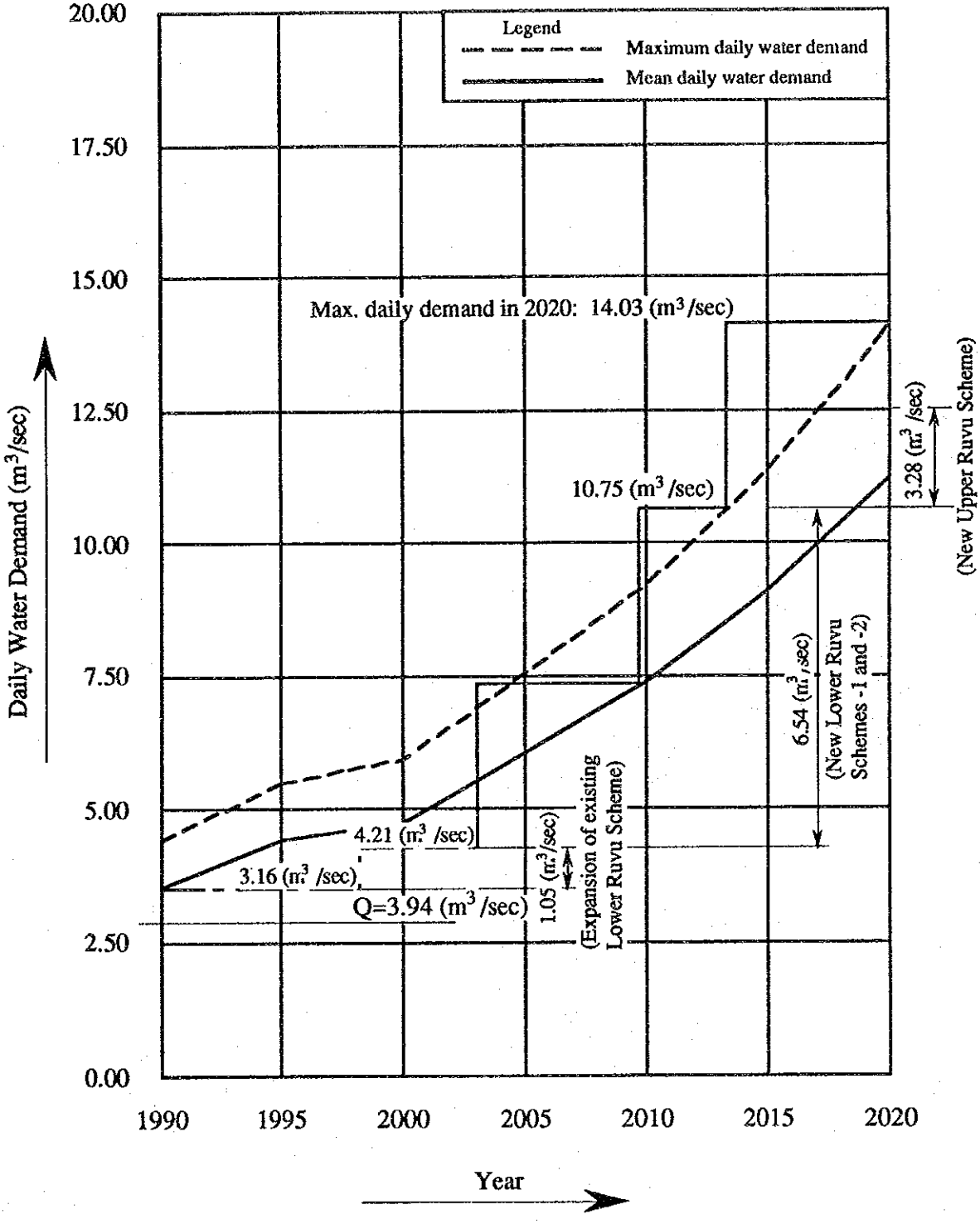


Fig. I.23 EXPANSION PLAN OF WATER CONVEYANCE FACILITY OF DAR ES SALAAM WATER SUPPLY SYSTEM

ATTACHMENT TO APPENDIX - I

PRELIMINARY DESIGN OF WATER CONVEYANCE AND PURIFICATION FACILITY FOR MUNICIPAL WATER SUPPLY TO DAR ES SALAAM

ATTACHMENT TO APPENDIX - I

PLERIMINARY DESIGN OF WATER CONVEYANCE AND PURIFICATION FACILITY FOR MUNICIPAL WATER SUPPLY TO DAR ES SALAAM

AT. 1 General Concept

For the preliminary costing purpose, the major facilities involved in the three (3) new water conveyance projects, namely the New Lower Ruvu - 1, New Lower Ruvu - 2 and New Upper Ruvu Schemes, were designed. The intake structure and transmission pipe main for the New Lower Ruvu Scheme-1 are planned to be newly provided with a total capacity of the New Lower Ruvu Schemes-1 and -2. Therefore, main components of the New Lower Ruvu Scheme-2 comprises treatment plants and booster pumping stations only. A new intake weir is planned to be provided downstream of each of the existing Upper and Lower Ruvu schemes for the new schemes. The capacities of the intake facilities and low lift pumps for each of the water conveyance projects are determined in consideration of the maximum daily demand in the year 2020. The same type of water treatment facility as that of existing Lower Ruvu scheme was referred to in designing that for each of of the water conveyance projects.

The genral alignment of the new water conveyance projects is given in Fig. AT.1. The preliminary design on the main components included in the three (3) water conveyance projects is explained hereunder.

AT. 2 Preliminary Design of Planned Three (3) Water Conveyance Projects

For the preliminary design and rough costing of the main components included in the three (3) new water conveyance projects, the design drawings used for tender of the existing Lower Ruvu scheme and Upper Ruvu scheme were carefully reviewed.

Thus, the water conveyance and purification facilities were preliminarily designed with reference to those existing ones as described below.

(1) Intake weir

The gated weir is planned to be provided downstream of each of existing Lower Ruvu Scheme-1 and Upper Ruvu Scheme. The intake structure for the New Lower Ruvu Scheme-1 is designed to have a total of the intake capacities required for the New Lower Ruvu Scheme - 1 and New Lower Ruvu Scheme - 2. Besides,

the intake structure is designed to have the capacity equivalent to 1.05 times the design capacity of transmission main in consideration of loss and waste in treatment of water for purification. The design capacity for each of the intake structures is summarized below.

No.	Name of Scheme	Intake Capacity (m3/sec)
1.	New Lower Ruvu Scheme-1	6.90
2.	New Lower Ruvu Scheme-2	-
3.	New Upper Ruvu Scheme	3.45

Since the new intake weirs for the new water conveyance projects are to be located downstream of the intake sites of existing Lower Ruvu Scheme and Upper Ruvu Scheme as aforesaid, the river stages at those existing intake sites would become able to be controlled by the new intake weirs. Especially, provision of the new intake weir would contribute to the worse condition of operation of low lift pumps in the existing Lower Ruvu Scheme.

(2) Treatment facilities

The similar type of water purification facility as that of the existing lower Ruvu scheme is planned to be provided for each of the 3 new water supply projects. The capacity of the water treatment facilities are shown below by the new project;

No.	Name of Scheme	Treatment capacity (m3/sec)
1.	New Lower Ruvu Scheme-1	3.45
2.	New Lower Ruvu Scheme-2	3.45
3.	New Upper Ruvu Scheme	3.45

(3) Transmission main

The two lanes of new transmission mains, each for the New Lower Ruvu Schemes-1 & -2 and the New Upper Ruvu Scheme, are planned to be provided along the existing pipelines. In this Study stage, the prestressed concrete pipe was planned to be installed for the both projects. The velocily in the transmission mains is set at 2.2 m in order not to cause the harmful water hammer resulting from the long pipelines so that the diameters of the new transmission mains for the New Lower Ruvu project and New Upper Ruvu project were set to be 1.90 m and 1.35 m, respectively, as shown below;

No.	Name of Scheme	Diameter of transmission main (m)
1.	New Lower Ruvu Scheme-1	1.90
2.	New Lower Ruvu Scheme-2	-
3.	New Upper Ruvu Scheme	1.35

(4) Pumps

For each of the new water conveyance projects, the water conveyed to the treatment plant by the low water pumps is planned to be lifted to reservoir by the booster pumps in two steps taking into account the rather long distance thereto. Thus, the high lift pumping stations will be provided at two locations between the treatment plant and reservoir. The required installed capacity of pump was decided based on discharge and head using the following formula;

$P = 0.163 \times 60 \text{ (sec)} \times Q \times H \times (1+k) / \text{eta (kw)}$

where, Q : discharge (m3/sec)
H : total head (m)
k : allowance (0.1)
eta : pump efficiency (0.85)

No.	Name of Scheme	Raw water pump (kw x unit)	Booster pump (kw x unit)
1.	New Lower Ruvu Scheme-1	400 x 4	2,000 x 6
2.	New Lower Ruvu Scheme-2	400 x 4	2,000 x 6
3.	New Upper Ruvu Scheme	900 x 4	1,900 x 8

(5) Reservoir

The reservoir for the new projects is planned to have a capacity to keep volume equivalent to 10 hours for the conveyance discharge concerning each of the new projects.

The general alignment of the new water conveyance projects is shown in Fig. IAF. 1. The typical cross sections and profiles of transmission mains for the new water conveyance projects are shown in IAF. 2 and IAF. 3, respectively.

AT. 3 Alternative Plan of Water Conveyance Facility

As explained in Attachments to Appendix - K of this Supporting Report, the total present-day construction cost of the three water conveyance projects is estimated to be about 460 million US$. In case of conveying the discharge of 9.3 m^3/sec in one lane of transmission main, its diameter comes to 2.35 m and the total construction cost is estimated at about 430 million US$. Since there is no large difference between the construction costs for the plans of single lane and two lanes of transmission pipes main, the stage-wise development plan for the new water conveyance projects seems to be preferable from the financial viewpoint.

As the alternative plan, it is conceived that the river water is off-taken at the upstream location of existing Morogro Road Bridge to be pumped up to the elevated portion on the left bank side of the Ruvu River. In this case, the lifted water is allowed to transmit to

the Universite reservoir by gravity flow. The approximate alignment of the transmission main is illustrated in Fig. IAF. 1.

It is recommended that the further study on the water conveyance and purification be carried out in detail in next study stage.

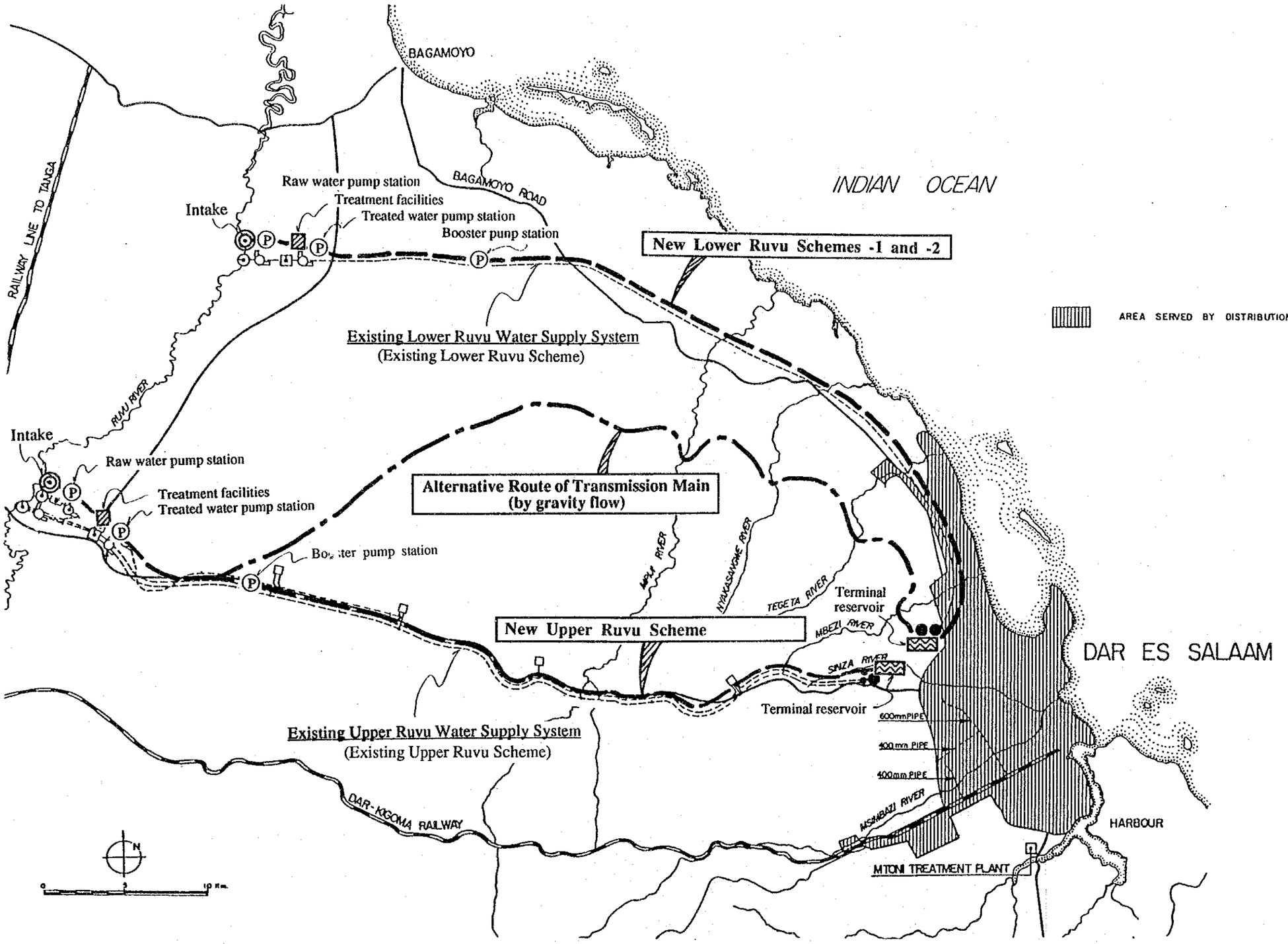
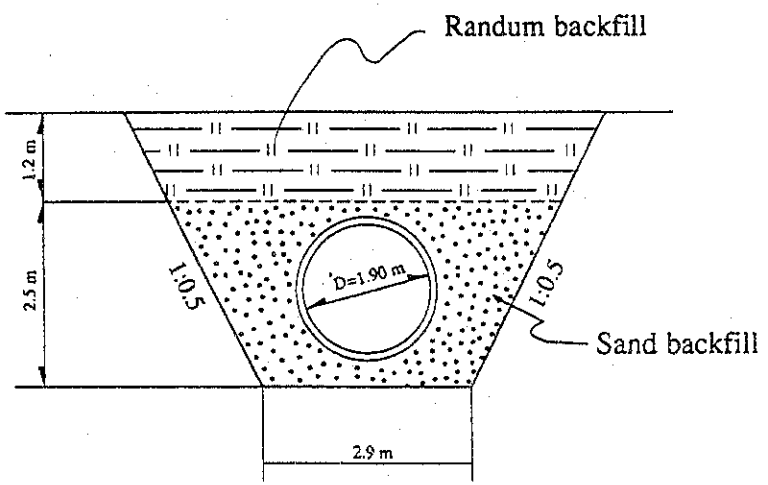
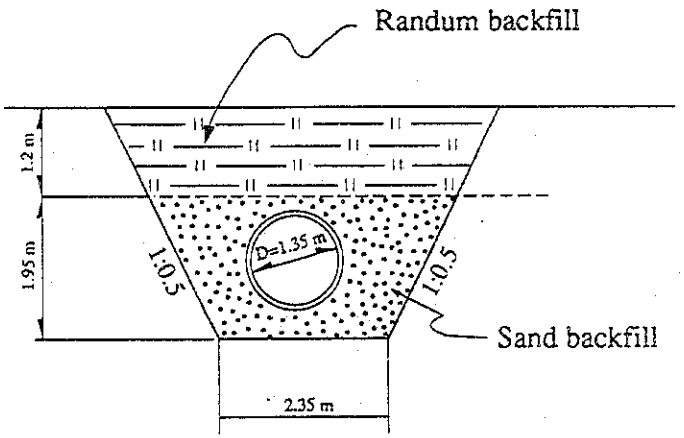


Table IAF.1 LAYOUT PLAN OF NEW WATER CONVEYANCE PROJECT

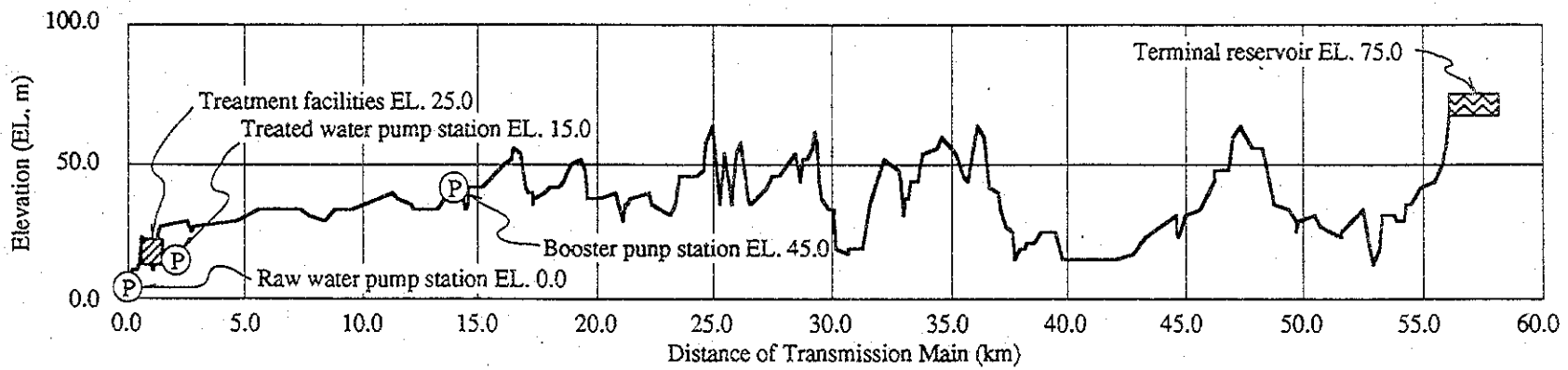


New Lower Ruvu
Transmission Main

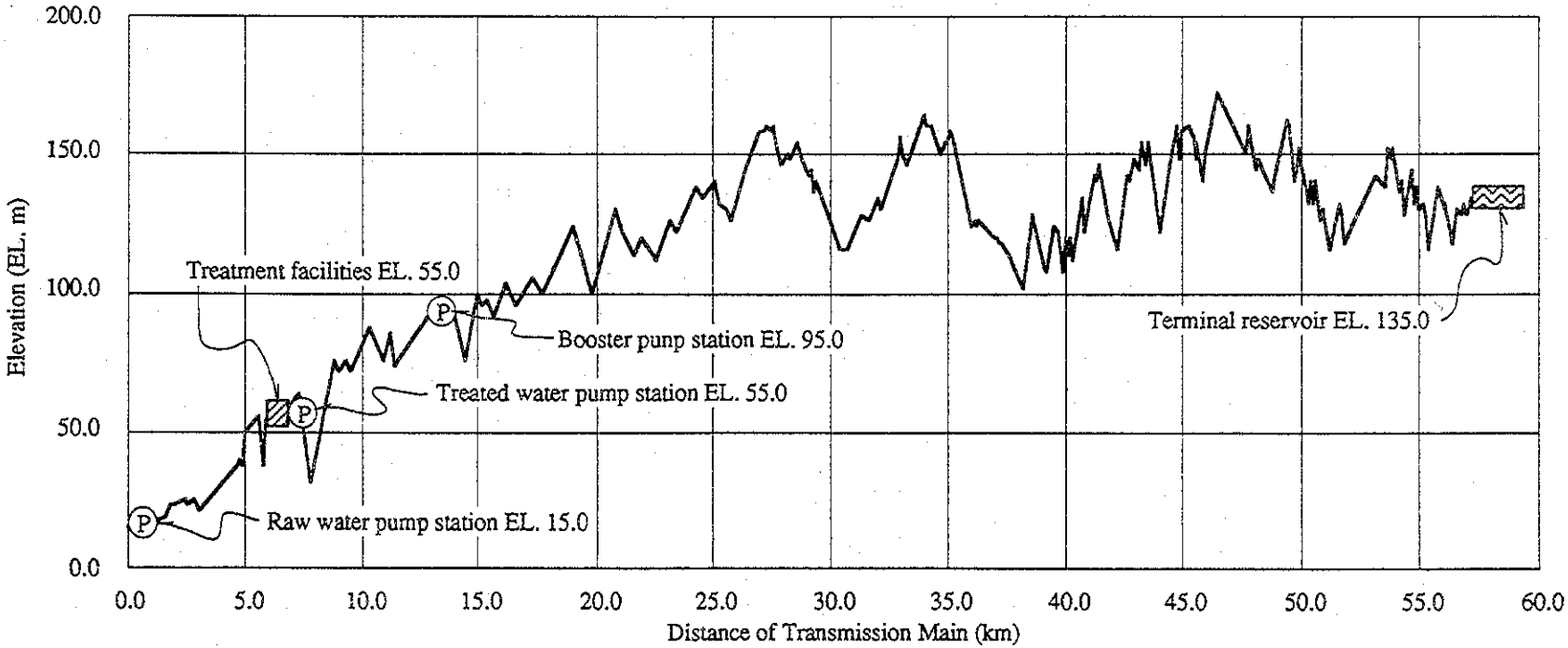


New Upper Ruvu
Transmission Main

Table IAF.2 TYPICAL CROSS SECTION OF NEW LOWER RUVU AND NEW UPPER RUVU TRANSMISSION MAIN



Profile of Lower Ruvu transmission main



Profile of Upper Ruvu transmission main

Table IAF.3 PROFILE OF LOWER RUVU AND UPPER RUVU TRANSMISSION MAIN

APPENDIX-J

ELECTRIC POWER PLANNING

APPENDIX - J

ELECTRIC POWER PLANNING

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APPENDIX - J

ELECTRIC POWER PLANNING

1. EXISTING POWER SUPPLY IN TANZANIA

1.1 Organization of the Power Industries

Tanzania Electric Supply Company Limited (hereinafter referred to as "TANESCO"), the national electric power utility, is responsible for generating, distributing, transmitting and selling electricity in Tanzania. TANESCO is given monopoly in operation of generation, transmission and distribution of electricity in all over the country under the jurisdiction of the Ministry of Water, Energy and Minerals. The organization chart for TANESCO's Outline is shown in Fig. J.1.

TANESCO has two power system, namely, national grid and isolated systems. Most major load centers and power plants have been interconnected by 220 kV and 132 kV transmission lines to form a national grid system. All power plants in the isolated districts which are of diesel generators are operated independently as an isolated system as shown in Fig. J.2.

1.2 Power Generating Facilities

The total installed capacity of generating facilities in Tanzania as of 1991 was 482 MW which consisted of 328 MW of hydropower plant (68.1% of the total) and 154 MW of thermal plant (38.9% of the total). Out of the total capacity, the national grid power system accounts for about 92% thereof and the remaining 7.6% of the total belong to the isolated power system. The existing generating plants in the TANESCO grid system is shown in Table J.1.
The existing generating facilities in Tanzania as of 1991 are summarized below:

	Hydropower		Thermal		Total	
Installed Capacity (MW)						
Grid System	328.220		117.099		445.319	(92.4%)
Isolated System	-		36.631		36.631	(7.6%)
Total	328.220	(68.1%)	153.730	(31.9%)	481.950	(100%)
Available Capacity (MW)						
Grid System	272.000		47.470		319.470	(91.9%)
Isolated System	-		28.250		28.250	(8.1%)
Total	272.000	(78.2%)	75.720	(21.8%)	347.720	(100%)
Energy Generation (MWh)						
Grid System	1,725,000		24,814		1,750,414	(96.0%)
Isolated System	-		73,063		73,063	(4.0%)
Total	1,725,000	(94.6%)	97,877	(5.4%)	1,823,477	(100%)

The historical increase rates of total installed capacity are compared with the growth rates of energy generation as given below:

Year	Installed Capacity		Energy Demand	
	MW	Growth Rate	GWh	Growth Rate
1980	369.8		792.097	
	(298.7)			
1985	481.0	5.40%	1,017.416	5.13%
	(436.2)			
1991	482.0	0.34%	1,823.407	10.21%
	(350.5)			

It is noted from the above table that the increase of installed capacity has not been well coordinated with the growth of energy demand. During the period from 1985 to 1991, the installed capacity was much lower than the growth rate of energy demand. In case no new power plants are developed, the balance of the power demand and supply could not be kept and the power shortage would occur in near future due to the high growth of demand. Moreover, due to the damage and superannuation, the total available capacity of generating plants decreases to about 73% of the total installed capacity including 49% of thermal plants.

1.3 Power Transmission Facilities

Operation of the first 220 kV transmission lines in Tanzania was commenced in 1975 for a section from the Kidatu hydropower station to the Ubungo substation at Dar Es Salaam. This 220 kV transmission system was extended to Iringa, Mbeya and Mwanza and reinforced gradually as a national grid power system. At present, it is interconnected with major power stations and load centers of the country by 132 kV transmission line system. The 132 kV transmission lines were applied to Dar Es Salaam, Morogoro, Hale, Tanga and Moshi system and branch system of the 220 kV system at Shinyanga and Mwanza.

The total lengths of 220 kV and 132 kV transmission lines in 1991 are 1,632 km and 1,282 km respectively, including 38 km long 132 kV submarine cables for the supply to Zanzibar as tabulated in Table J.2. A 66 kV transmission line is applied only for the sections of Kiyung - Arusha and Tanga - Hale lines. 33 kV and 11 kV are used mainly for high tension distribution lines.

2. POWER MARKET

2.1 Present Power Demand in TANESCO

In 1991, the total energy generated in TANESCO was recorded at 1,823,477 MWh, which increased by 11.9% from that in 1990 and 1,461,282 MWh was sold to the consumers including a bulk sale to Zanzibar. The difference between the above values, 362,195 MWh equivalent to 19.9% of the total generated energy, consists of transmission, distribution loads and station use.

The electric power and energy sold by TANESCO in 1991 are summarized as below:

Generated energy (MWh);	1,823,477	
Sold energy (MWh);	1,457,373	(100%)
Domestic	460,313	(31.6%)
Commercial and Industrial	932,651	(64.0%)
Public Lighting	7,580	(0.5%)
Bulk Sales (Zanzibar)	56,829	(3.9%)
Difference (MWh)	366,104	

The above shows that the ratios of sold energy of each consumer class is 31.6% (domestic), 64.0% (commercial and industrial), 0.5% (public lighting) and 3.9% (bulk sales). The difference between the generated and sold ones is calculated at about 20% and it appears to be a high ratio.

2.2 Characteristics of Load

The typical daily load curves and daily load duration curves of the grid system on 21, 22 and 23 June 1991 are shown in Fig. J.3. Monthly peak load curve and monthly energy generation of the grid system in 1991 are also shown in Figs. J.4 and J.5, respectively.

It is seen from these Figures that;

(1) The ratio of peak at night time to that at day time is calculated at 0.90 on Sunday, 0.86 on Saturday and 0.77 on Friday. The pattern of daily load curves is characterized by gradually shifting of the peak load from night time to day time.

(2) The daily load factors are calculated at 0.48 on Sunday, 0.86 on Saturday and 0.90 on weekday.

(3) The seasonalities of monthly energy generation and monthly peak generation in 1991 come to at 0.84 and 0.88, respectively.

2.3 Historical Trend of Power Market in Tanzania

The historical power demands in Tanzania are summarized in Table J.3. The gross energy requirement including that in Zanzibar has increased at an average growth rate of 8.27% per annum during the recent 10 years and 9.72% in the latter half of the period. The Table reveals that the demand growth was very high after 1986. The peak demand in the grid system grew from 176,350 kW to 296,750 kW at an average growth rate of 9.06% per annum during the recent 5 years. The annual load factor was around 65% during the same period.

A historical generation per capita is shown below:

Year	Generation /1 (MWh)	Population (x 10^3)	kWh/capita	Growth (%)
1970	387,967	13,550	28.6	
1975	493,091	15,900	31.0	1.6
1980	778,628	18,670	41.7	6.1
1985	978,150	21,200	46.1	2.0
1987	1,225,514	22,404	54.7	8.9
1988	1,323,198	22,534	58.7	7.4
1989	1,444,900	23,165	62.4	6.2
1990	1,577,270	23,814	66.2	6.2
1991	1,823,477	24,528	74.3	12.2

Note: /1 ; Data exclude sales in Zanzibar but imports at Shinyanga.

As seen in the above table, the per capital energy generation has increased at an annual average growth rate of around 8.28% after 1985, which corresponds to about 76% of the growth rate of total generation.

The historical trends of growth rates of total GDP and total energy generation for the recent 10 years are summarized below:

Year	GDP (%)	Generation (%)
1980		
1981	-0.5	3.89
1982	0.59	0.71
1983	-2.38	3.28
1984	3.38	7.30
1985	2.63	10.66
1986	3.26	12.65
1987	5.09	11.02
1988	4.23	8.27
1989	3.34	9.55
1990	3.50	7.96
1991	3.80	11.92

Judging from the above table, the growth rates of total GDP and generation appear to be well correlated after 1988.

2.4 Electricity Tariff Structure

The current electricity tariff system, which has been enforced from March 1993, is shown in Table J.4. The main features of the tariff system are mentioned below:

(1) There are three kinds of tariff, one is one-part tariff which is charged according to kWh energy consumption with fixed meter service charge except for public lighting. The other is two-part tariff which is charged according to kVA value of demand and kWh energy consumption with fixed meter service.

(2) One-part tariff system is applied to four kinds of customers, "Residential", "Light Commercial", "Light Industrial" where consumption is less than 7,500 kWh per month and "Public Lighting".

(3) Two-part tariff system is applied to kinds of customers "Low Voltage Supply" for general use where consumption is more than 7,500 kW, "Agricultural Consumers" whose consumption is more than 5,000 kWh, "High Voltage Supply" where power is metered at 11 kV and more, "High Voltage Energy Intensive Customers" whose demand is above 5,000 kVA and consumption above 800,000 kWh, "Water Supply Accounts" where consumption is above 10,000 kWh and "Zanzibar Supply".

The first range energy charge, minimum meter service charge and demand charge of each tariff class are summarized as below:

		1st range energy charge Tshs/kWh	Minimum service charge Tshs/meter	1st range demand charge Tshs/kVA
(1)	Residential	6.00	150.00	-
(2)	Light commercial	9.00	350.00	-
(3)	Light industrial	7.00	1,500.00	-
(4)	Low voltage supply	35.50	25,000.00	2,000.00
(5)	Agricultural consumer	24.50	25,000.00	1,500.00
(6)	High voltage supply	29.20	35,000.00	1,765.00
(7)	High voltage supply intensive customers	26.10	60,000.00	1,615.00
(8)	Public lighting	5.90	-	-
(9)	Water supply accounts	21.50	25,000.00	1,400.00
(10)	Zanzibar supply	5.70	-	1,083.57

3 TANESCO'S POWER DEMAND FORECAST

Power demand forecast in whole Tanzania is made and revised every several years by TANESCO referring to the current state of economic activities and also past trend of energy supply. The latest demand forecast for the short-term and long-term up to the year 2020 prepared by TANESCO in 1991 is shown in Fig. J.6.

The latest demand projection of the grid system is summarized below:

	1991	1995	2000	2005	2010	2015	2020
Residential (MWh)	440	598	839	1,119	1,496	1,962	2,539
Commercial (MWh)	156	183	263	300	391	505	647
Industrial (MWh)	751	905	1,212	1,540	2,055	2,739	3,649
Bulk sales (MWh)	57	89	192	378	554	806	1,165
Total consumption (MWh)	1,404	1,175	2,506	3,337	4,496	6,012	8,000
Losses (MWh)	346	416	513	684	921	1,231	1,638
Total generation (MWh)	1,750	2,191	3,019	4,021	5,417	7,243	9,638
Peak load (MW)	297	377	518	690	930	1,243	1,654
Effective load factor	0.673	0.681	0.678	0.675	0.672	0.670	0.669

4 POWER BALANCE

4.1 Power System Development Plan

The long-term development plan of generating facilities for the period up to 2015 was prepared by TANESCO so as to satisfy the forecasted demand. The plan involves two scenarios considering that natural gas may be available in Dar Es Salaam by 1999. One is a hydro-intensive development and the other is a gas turbine-intensive development.

The both development plans are summarized below:

SCENARIO-A (Hydro)

Name of Plant	Type	Installed Capacity (MW)		Commencement of Operation
		Total	Nos. of Units x Capacity of Unit	
Dodoma	D	2.5	1 x 2.5	1994
Mbeya	D	2.5	1 x 2.5	1994
Tabora	D	2.5	1 x 2.5	1994
Pangani Falls (Redevelopment)	H	60.0	3 x 20.0	1995
Lower Kihansi	H	180.0	3 x 60.0	1998
Upper Kihansi	H	45.0	1 x 45.0	1999
Masigira	H	80.0	2 x 40.0	2001
Rumakali	H	204.0	4 x 51.0	2003
Ruhudji	H	255.0	3 x 85.0	2007
Mpanga	H	160.0	2 x 80.0	2011

SCENARIO-B (Gas)

Name of Plant	Type	Installed Capacity (MW)		Commencement of Operation
		Total	Nos. of Units X Capacity of Unit	
Dodoma	D	2.5	1 x 2.5	1994
Mbeya	D	2.5	1 x 2.5	1994
Tabora	D	2.5	1 x 2.5	1994
Pangani Falls (Redevelopment)	H	60.0	3 x 20.0	1995
Lower Kihansi	H	180.0	3 x 60.0	1998
Gas Turbine	G	60.0	2 x 30.0	1999
Gas Turbine	G	100.0	2 x 50.0	2000
Gas Turbine	G	100.0	2 x 50.0	2003
Upper Kihansi	H	45.0	1 x 45.0	2006
Masigira	H	80.0	2 x 40.0	2007
Rumakali	H	204.0	4 x 51.0	2009
Gas Turbine	G	60.0	1 x 60.0	2014
Total				

Note: D; Diesel Plant
H; Hydropower
G; Gas Turbine

In line with the hydropower development plan and load forecast, the expansion plan of transmission line was also prepared by TANESCO as mentioned below:

Project	Voltage	Scheduled Commencement of Operation
Kidatu - Morogoro T/L	220 kV	1993
Morogoro - Dar Es Salaam T/L	220 kV	1994
Singida - Arusha T/L	220 kV	1995
Hale - Tanga T/L	132 kV	1995
Arusha S/S extension	220/132 kV	2003
Mtera - Dodoma - Singida T/L	220 kV	2004
Dar Es Salaam S/S extension	220/132 kV	2008

4.2 Power Balance

The relationship between the demand forecast and power expansion program for the grid power system of TANESCO is shown in Fig. J.6. The Figure shows that:

(1) At present, the national grid power system has no firm surplus supply energy and power capacity. The balance of power supply and demand will be critical from now on.

(2) In case the droughtiest condition prevails over Tanzania in 1996 and 1997, the severe energy shortage would occur in these years and the load shedding would be unavailable.

(3) For increasing of the firm generating capacity, rehabilitation of existing thermal power plant and the implementation of new power development plan are urgently necessary.

5 STUDY ON HYDROPOWER DEVELOPMENT PLANS IN THE RUVU RIVER BASIN

The large head to generate power is exploitable only in the upstream mountainous area of the Ruvu River basin because of the topographic condition, but the available discharge therein is less because of the small catchment area. Thus, it is envisaged that the large-scale hydropower potential is considered very less in the Ruvu River basin. In principal, therefore, the hydropower development is planned utilizing both the head to be created by construction of dam and water to be discharged downstream for the purpose of municipal and irrigation water supply.

As the preliminary planning of hydropower development, the five dam schemes are examined and their basic design data for the hydropower plant are given below:

	Dam scheme	Rated head (m)	Power discharge (m)	Installed capacity (kw)
(1)	Rudete	32.92	2.0	500
(2)	Ngerengere	22.94	2.0	400
(3)	Mkombezi	20.51	0.6	100
(4)	Mgeta	29.70	8.4	2,300
(5)	Kidunda	15.49	32.4	3,900

From the above, the main particulars of water turbine and generator of each scheme are determined as shown below:

(1) Rudete

1. Water turbine
   - Type : Horizontal shaft cross-flow
   - Rated head : 32.97 m
   - Rated output : 520 kW
   - Speed : 375 rpm
2. Generator
   - Type : Horizontal shaft synchronous type, 3-phase
   - Rated output : 620 kVA
   - Rated voltage : 400 V

(2) Ngerengere

1. Water turbine

- Type : Horizontal shaft cross-flow
- Rated head : 22.44 m
- Rated output : 350 kW
- Speed : 300 rpm

2. Generator

- Type : Horizontal shaft synchronous type, 3-phase
- Rated output : 420 kVA
- Rated voltage : 400 V

(3) Mkombezi

1. Water turbine

- Type : Horizontal shaft cross-flow
- Rated head : 20.51 m
- Rated output : 100 kW
- Speed : 500 rpm

2. Generator

- Type : Horizontal shaft synchronous type, 3-phase
- Rated capacity : 115 kVA
- Rated voltage : 400 V

(4) Mgeta

1. Water turbine

- Type : Horizontal shaft Francis
- Rated head : 29.70 m
- Rated output : 2,100 kW
- Speed : 600 rpm

2. Generator

- Type : Horizontal shaft synchronous type, 3-phase
- Rated capacity : 2,500 kVA
- Rated voltage : 6.6 kV

(5) Kidunda

1. Water turbine

- Type : Horizontal shaft S-type tubular
- Rated head : 15.49 m
- Rated output : 4,300 kW
- Speed : 750 rpm

2. Generator

- Type : Horizontal shaft synchronous type, 3-phase
- Rated capacity : 5,200 kVA
- Rated voltage : 6.6 kV

The construction cost of generating facilities is estimated for each scheme at a level of master plan study as below:

(1)	Rudete	US$ 2,000,000	(US$ 4,000/kW)
(2)	Ngerengere	US$ 1,350,000	(US$ 4,100/kW)
(3)	Mkombezi	US$ 780,000	(US$ 8,400/kW)
(4)	Mgeta	US$ 5,000,000	(US$ 2,500/kW)
(5)	Kidunda	US$ 11,000,000	(US$ 2,600/kW)

From the above, it is noted that these costs are too high as compared with other large-scale hydropower station such as Kihansi and that the low development cost per kW is ranked in an order of Mgeta, Kidunda, Rudete, Ngerengere and Mkombezi.

APPENDIX-J

TABLES

Table J.1 EXISTING GENERATING PLANTS IN TANESCO GRID SYSTEM

At January 1992

	Name of Plant	Installed Capacity TOTAL (MW)	Available Capacity (MW)	Commissioning Year of Plant	Breakdown of Installed Capacity (MW)
1. Grid System					
(1) Hydro	Hale	21.000	21.000	1964	2 x 10.500
	Kidatsu	204.000	153.000	1975	4 x 51.000
	Mtera	80.000	80.000	1988	2 x 40.000
	Kituletwa	1.160	0.000	1935	1 x 0.600, 1 x 0.400, 1 x 0.160
	Mbalizi	0.340	0.000	1958	1 x 0.180, 1 x 0.160
	Nyumba ya Mungu	8.000	8.000	1969	2 x 4.000
	Pangani Falls	12.500	10.000	1934	3 x 2.500, 1 x 5.000
	Tosamaganga	1.220	0.000	1851	1 x 0.380, 1 x 0.840
	Sub-Total (Hydro)	328.220	272.000		
(2) Thermal	Arush	2.950	1.000	1956	2 x 0.350, 3 x 0.750
	Zuzu	7.424	2.580		2 x 2.851, 1 x 1.722
	Mbeya			Demolished	
	Iyunga	14.953	8.500	1982	3 x 2.851, 2 x 3.200
	Ubungo	49.367	15.500	1963	3 x 4.410, 1 x 6.137, 2 x 7.500, 1 x 15.000
	Shinyanga	1.640	0.000	1978	2 x 0.500, 1 x 0.640
	New Shingida	0.640	0.000	1983	1 x 0.640
	Mwanza (South)	4.500	1.500	1967	3 x 1.500
	Mwanza (Nya Kato)	18.000	8.000	1978	4 x 4.500
	Musoma	7.350	3.730	1979	2 x 0.500, 1 x 0.350, 8 x 0.750
	Tabora	10.275	6.660	1983	1 x 1.722, 3 x 2.851
	Sub-Total (Thermal)	117.099	47.470		
	Grid System Total	445.319	319.470		

Table J.2 EXISTING TRANSMISSION LINES

Voltage	Section		Length	No. of	Conductor
(kV)	From	To	(km)	Circuit	Type
220	Mbeya	Mufindi	220	1	Bison
220	Mufindi	Iringa	130	1	Bison
220	Mwanza	Shinyanga	139	1	Bison
220	Shinyanga	Singida	220	1	Bison
220	Singida	Dodoma	211	1	Bison
220	Dodoma	Mtera	138	1	Bison
220	Mtera	Iringa	105	1	Bison
220	Iringa	Kidatu	160	1	Bison
220	Kidatu	Morogoro	128	1	Bluejay
220	Morogoro	Ubungo	172	1	Bluejay
132	Musoma	Mwanza	250	1	Wolf
132	Tabora	Shinyanga	203	1	Wolf
132	Morogoro	Chalinze	82	1	Wolf
132	Ilala	Ubungo	11	1	Wolf
132	Zanzibar	Ubungo	41	1	Wolf
132			38	1	Cu 95 sqmm
132	Ubungo	Chalinze	97	1	Wolf
132	Chalinze	Hale	175	1	Wolf
132	Tanga	Hale	60	1	Wolf
132	Hale	Same	200	1	Wolf
132	Same	Kiyungi	50	1	Wolf
132	Kiyungi	Njiro	118	1	Wolf

Table J.3 SUMMARY OF HISTORICAL ENERGY DEMAND

(Unit: MWh)

Year	Sold Energy					Total Generated	Losses
	Public Lighting	Domestic	Commercial & Industrial	Zanzibal	Total		
1970	3,808	61,362	275,970		341,140	393,015	51,875
1975	4,957	86,138	395,250		486,345	557,616	71,271
1980	6,593	155,943	508,727	13,469	684,732	792,097	107,365
1985	4,623	197,829	541,259	39,266	782,977	1,017,415	234,438
1987	4,157	268,878	634,037	48,799	955,871	1,272,448	316,577
1988	4,554	310,972	690,602	54,441	1,060,569	1,377,639	317,070
1989	5,487	330,022	752,477	64,298	1,152,284	1,494,344	342,060
1990	6,934	418,324	826,748	52,011	1,304,017	1,629,242	325,225
1991	7,579	460,313	932,651	56,829	1,457,372	1,823,477	366,105

Table J.4 ELECTRICITY TARIFFS WITH EFFECT FROM MARCH, 1993 BILLINGS (27% increase = 7 US cents per unit) (1/4)

TARIFF NO.1: RESIDENTIAL

Applicable to premises used exclusively for domestic and private residential purposes:

CONSUMPTION RANGE	CHARGING RATES	
0 - 100	0 - 100	Shs. 6.00 per KWH
101 - 7500	0 - 1000	Shs. 7.50 per KWH
	1001 - 2500	Shs. 20.00 per KWH
	2501 - 7500	Shs. 30.00 per KWH
Over - 7500	0 - 1000	Shs. 20.00 per KWH
	1001 - 7500	Shs. 30.00 per KWH
	Over - 7500	Shs. 60.00 per KWH

Service Charge per meter reading period:

0	- 1000	KWH	Shs. 150.00	per meter	
Over	- 1000	KWH	Shs. 650.00	per meter	

TARIFF NO.2: LIGHT COMMERCIAL

Applicable to shops, restaurants, theaters, hotels clubs, harbours, schools, hospitals, airports, lodging houses, group of residential premises with one meter and on premises where similar business or trade is conducted and where consumption is less than 7,500 kilowatt hours per meter reading period:

CONSUMPTION RANGE	CHARGING RATES	
0 - 200	0 - 200	Shs. 9.00 per KWH
201 - 1000	201 - 1000	Shs. 22.50 per KWH
1001 - 2500	0 - 1000	Shs. 22.50 per KWH
	1001 - 2500	Shs. 45.00 per KWH
2501 - 7500	0 - 1000	Shs. 22.50 per KWH
	1001 - 2500	Shs. 45.00 per KWH
	2501 - 7500	Shs. 65.00 per KWH
Over - 7500	0 - 1000	Shs. 22.50 per KWH
	1001 - 2500	Shs. 45.00 per KWH
	2500 - 7500	Shs. 65.00 per KWH
	Over - 7500	Shs. 70.00 per KWH

Service Charge per meter reading period:

0	- 200	KWH	Shs. 350.00	per meter	
Over	- 200	KWH	Shs. 1,500.00	per meter	

Table J.4 ELECTRICITY TARIFFS WITH EFFECT FROM MARCH, 1993 BILLINGS (27% increase = 7 US cents per unit) (2/4)

TEMPORARY SUPPLIES:

Temporary supplies will be given on this tariff.

TARIFF NO.3: LIGHT INDUSTRIAL

Applicable to premises engaged in production of any article/commodity or in Industrial process where the main use of electricity is for motive power, or an electrochemical or electro-thermal process and where the consumption is less than 7,500 kilowatt hours (KWH) per meter reading period:-

CONSUMPTION RANGE	CHARGING RATES	
0 - 1000	0 - 1000	Shs. 7.00 per KWH
1001 - 2500	0 - 1000	Shs. 16.50 per KWH
	1001 - 2500	Shs. 40.00 per KWH
2501 - 7500	0 - 1000	Shs. 16.50 per KWH
	1001 - 2500	Shs. 40.00 per KWH
	2501 - 7500	Shs. 60.00 per KWH
Over - 7500	0 - 1000	Shs. 16.50 per KWH
	1001 - 2500	Shs. 40.00 per KWH
	2500 - 7500	Shs. 60.00 per KWH
	Over - 7500	Shs. 70.00 per KWH

Customer service charge per meter Reading period all consumers — Shs. 1,500.00 per meter

TARIFF NO.4: LOW VOLTAGE SUPPLY

Applicable for general use where the consumption is more than 7,500 kilowatt hours per meter reading period:-

a) Demand charge — Shs. 2,000.00 per kVA of Billing Demand (B.D) per meter reading period.

The kVA Maximum Demand (M.D) indicator shall be reset every meter reading period.

b) Units Charge:-

First 150 times B.D (kVA) units,	Shs.	35.50 per KWH
Next 150 times B.D (kVA) units,	Shs.	31.00 per KWH
Remainder of units,	Shs.	25.00 per KWH

c) Customer service charge per meter reading period — Shs. 25,000.00 per meter

Table J.4 ELECTRICITY TARIFFS WITH EFFECT FROM MARCH, 1993 BILLINGS (27% increase = 7 US cents per unit) (3/4)

TARIFF NO.4A: AGRICULTURAL CONSUMERS

Applicable to Agricultural consumers whose consumption is more than 5,000 units per meter reading period engaged in direct raw farm produce production and/or processing.

a) Demand charge — Shs. 1,500.00 per kVA of Billing Demand (B.D) per meter reading period.

The kVA Maximum Demand (M.D) indicator shall be reset every meter reading period.

b) Units charge:-

First 150 times B.D (kVA) units,	Shs.	24.50 per KWH
Remainder of units,	Shs.	21.50 per KWH

c) Customer service charge per meter reading period. — Shs. 25,000.00 per meter

TARIFF NO.5: HIGH VOLTAGE SUPPLY

Applicable for general use where power is metered at 11 kV and above.

a) Demand charge — Shs. 1,765.00 per kVA of Billing Demand (B.D) per meter reading period.

The kVA Maximum Demand (M.D) indicator shall be reset every meter reading period.

b) Units charge:

First 150 times B.D (kVA) units,	Shs.	29.20 per KWH
Next 150 times B.D (kVA) units,	Shs.	24.00 per KWH
Next 150 times B.D (kVA) units,	Shs.	21.50 per KWH
Remainder of units,	Shs.	16.00 per KWH

c) Customer services charge per meter reading period. — Shs. 35,000.00 per meter

TARIFF NO.5A: HIGH VOLTAGE SUPPLY ENERGY INTENSIVE CUSTOMERS

Applicable to high tension consumers whose demand is above 5,000 kVA and consumption above 800,000 KWH per meter reading period.

a) Demand charge — Shs. 1,615.00 per kVA of Billing Demand (B.D) per meter reading period.

The kVA Maximum Demand (M.D) indicator shall be reset every meter reading period.

b) Units charge:

First 150 times B.D (kVA) units,	Shs.	26.10 per KWH
Next 150 times B.D (kVA) units,	Shs.	24.50 per KWH
Next 150 times B.D (kVA) units	Shs.	21.50 per KWH
Remainder of units,	Shs.	16.00 per KWH

c) Customer service charge per meter reading period. — Shs. 60,000.00 per meter

Table J.4 ELECTRICITY TARIFFS WITH EFFECT FROM MARCH, 1993 BILLINGS (27% increase = 7 US cents per unit) (4/4)

TARIFF NO.6: PUBLIC LIGHTING

Applicable to public lighting and places of worship:

All units	Shs.	5.90 per KWH

TARIFF NO.8: WATER SUPPLY ACCOUNTS

Applicable to all Public Water Supply pumping installations with consumption above 10,000 units per meter reading period.

a)	Maximum Demand charge	Shs.	1,400.00 per kVA of Billing Demand per meter reading period.
	The maximum demand indicator will be reset every meter reading period.		
b)	Units charge:	Shs.	21.50 per KWH
c)	Customer service charge per meter reading period.	Shs.	25,000.00 per meter

TARIFF NO.9: ZANZIBAR SUPPLY

Maximum demand	Shs.	1,083.57 per kVA of Maximum Demand during each meter reading period.

The kVA maximum demand indicator shall be reset every meter reading period.

Unit charge:	Shs.	5.70 per KWH

Maximum Demand readings are taken at Mtoni substation while the units reading are taken at Ubungo substation.

NOTE:

1. Billing Demand (B.D) is the higher of the kVA Maximum Demand (M.D) during the month and 75% of the highest kVA Maximum Demand for the preceding 11 months; provided that during the first year of operation the Billing Demand shall be the higher of the kVA Maximum Demand during the month, and 75% of the highest kVA Maximum Demand recorded commencing from the month the consumer is connected.

2. Meter reading period is the period of time elapsing between any consecutive reading of the meter and/or maximum demand indicator installed by the Company but with exception of their first and last period; each such a period shall be as near to thirty days as possible.

3. These tariffs are applicable only to supply of electricity to consumers with power factor not lower than 0.95 in case of lighting loads or 0.9 in case of other loads, otherwise power factor surcharge shall be applied on the normal charges.

APPENDIX-J

FIGURES

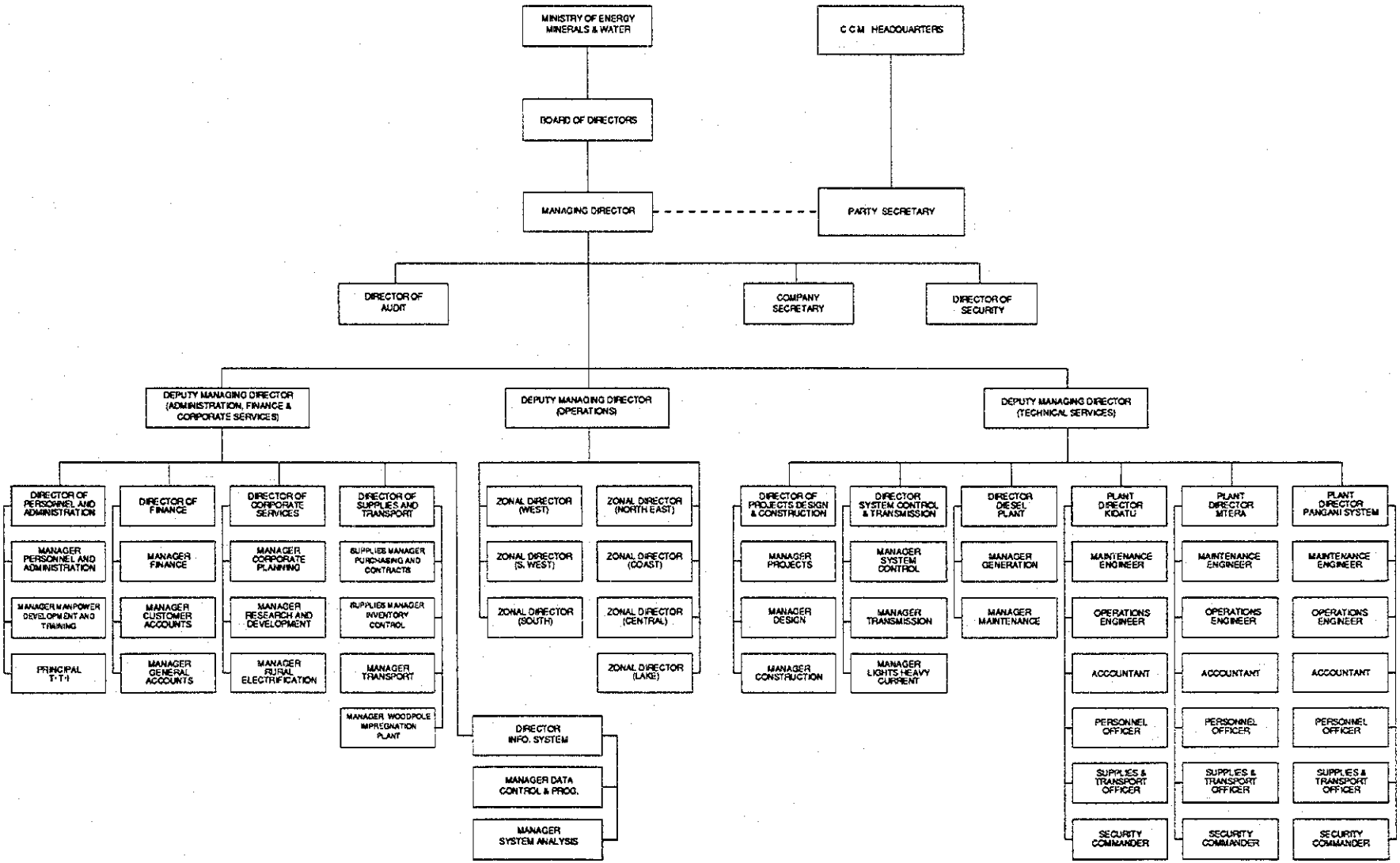


Fig. J.1 ORGANIZATION CHART FOR TANESCO

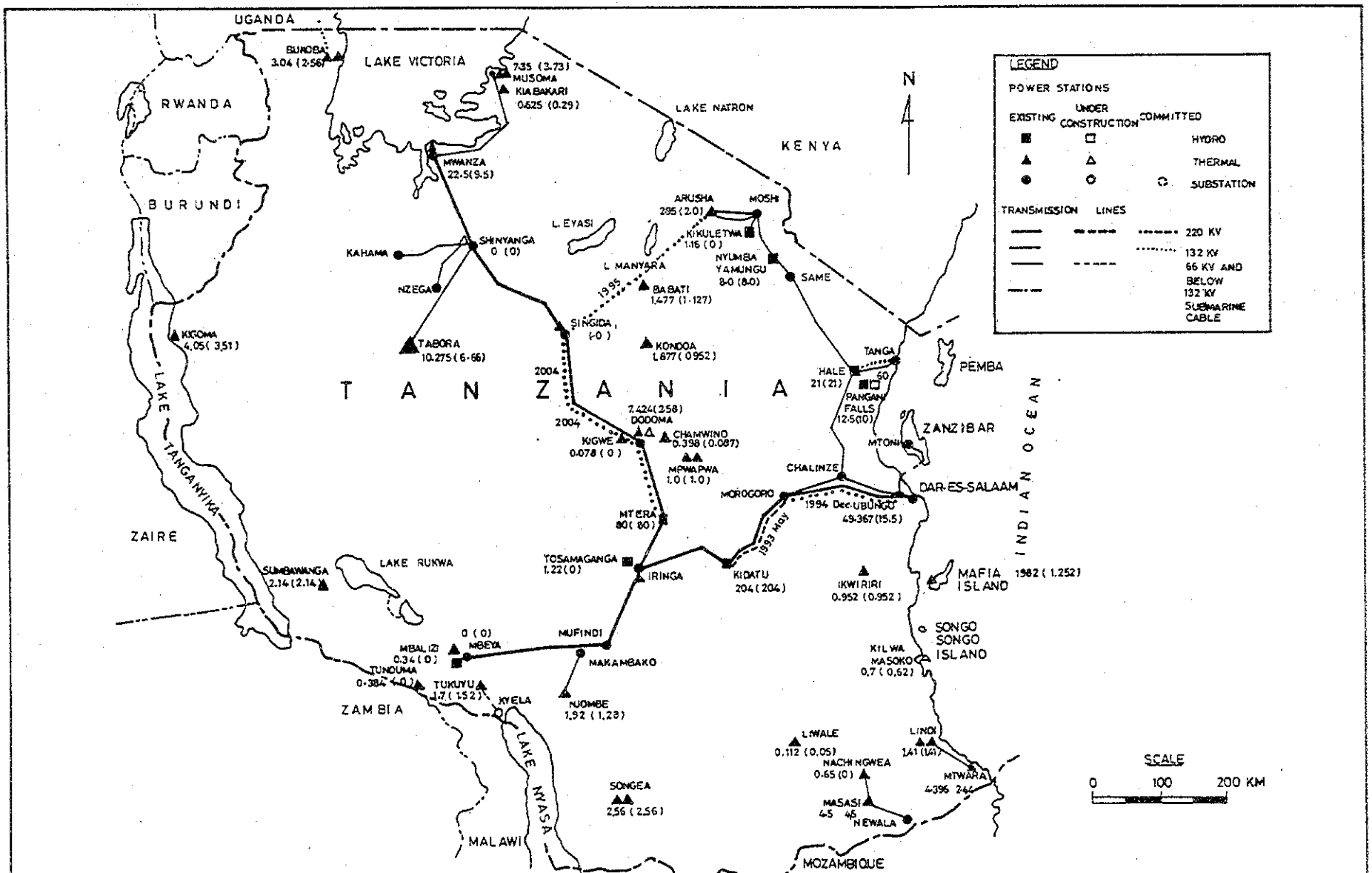
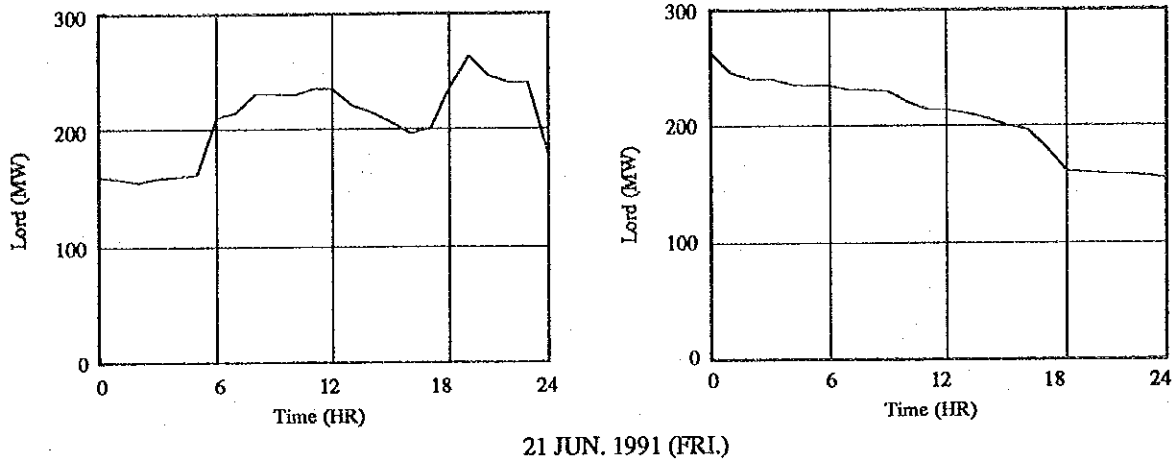
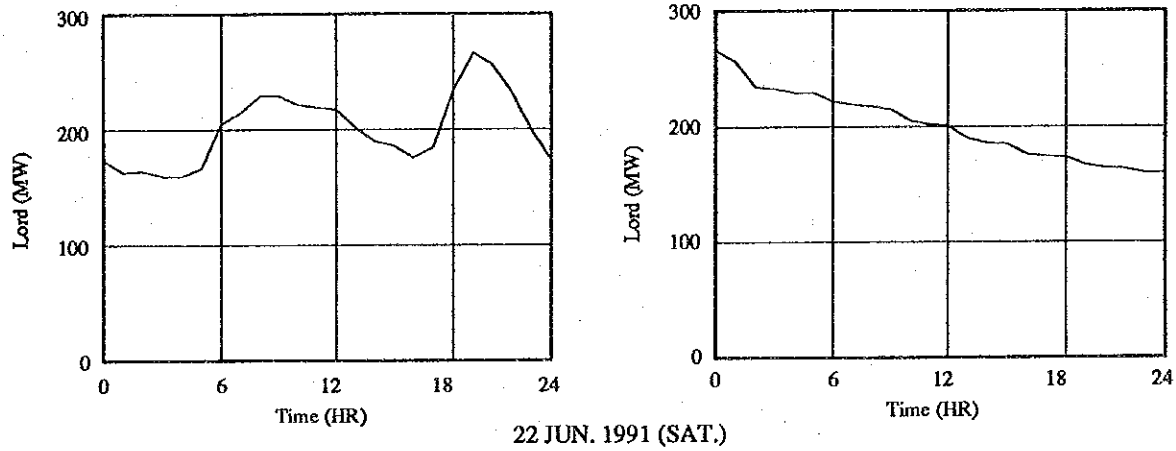


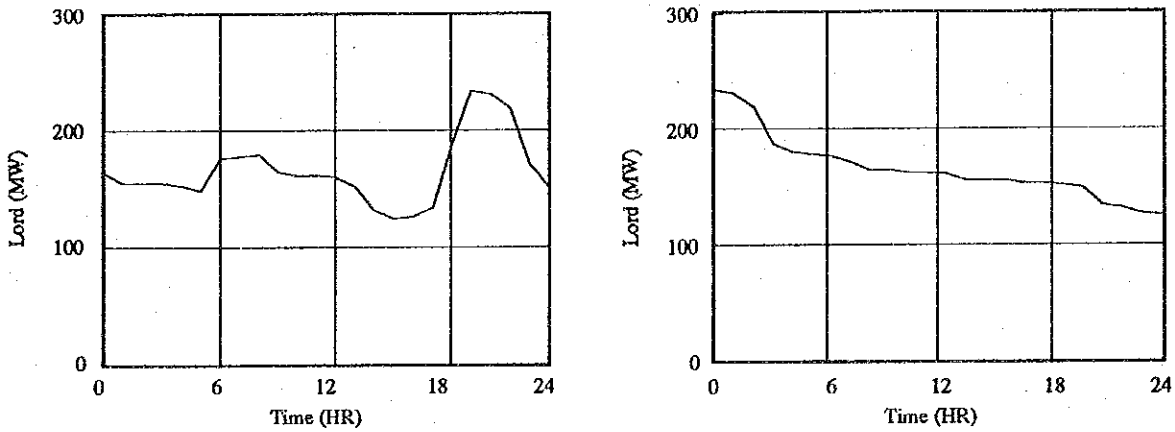
Fig. J.2 EXISTING POWER PLANTS AND TRANSMISSION SYSTEM IN TANZANIA



21 JUN. 1991 (FRI.)



22 JUN. 1991 (SAT.)



23 JUN. 1991 (SUN.)

Fig. J.3 LOAD AND LOAD DURATION CURVE

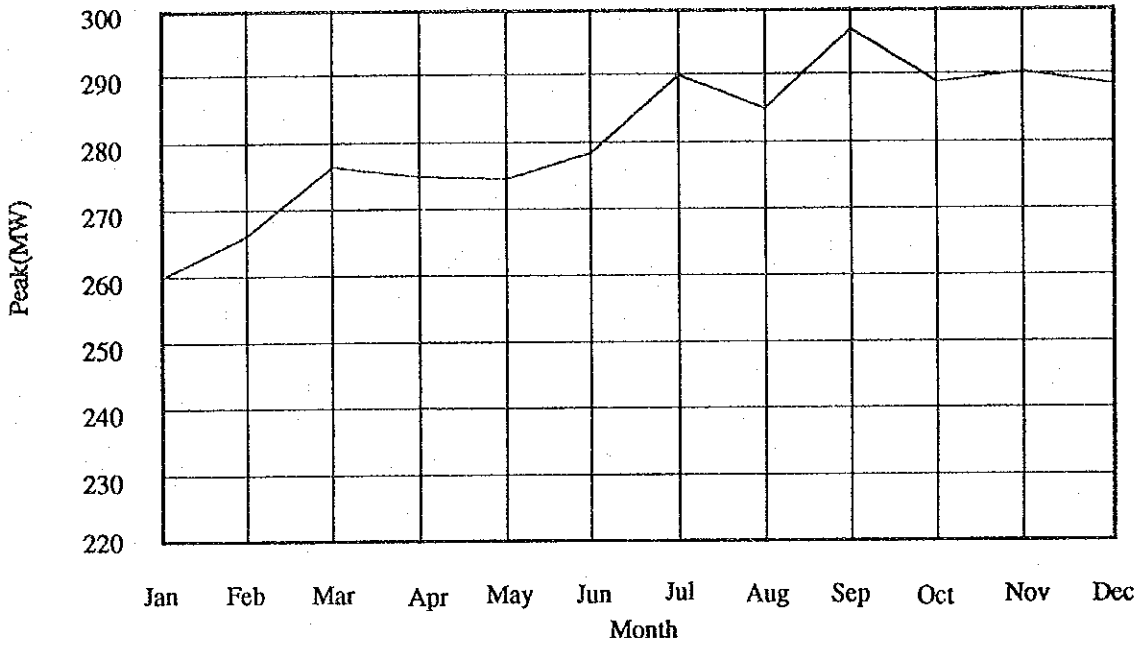


Fig. J.4 MONTHLY PEAK LOAD (1991)

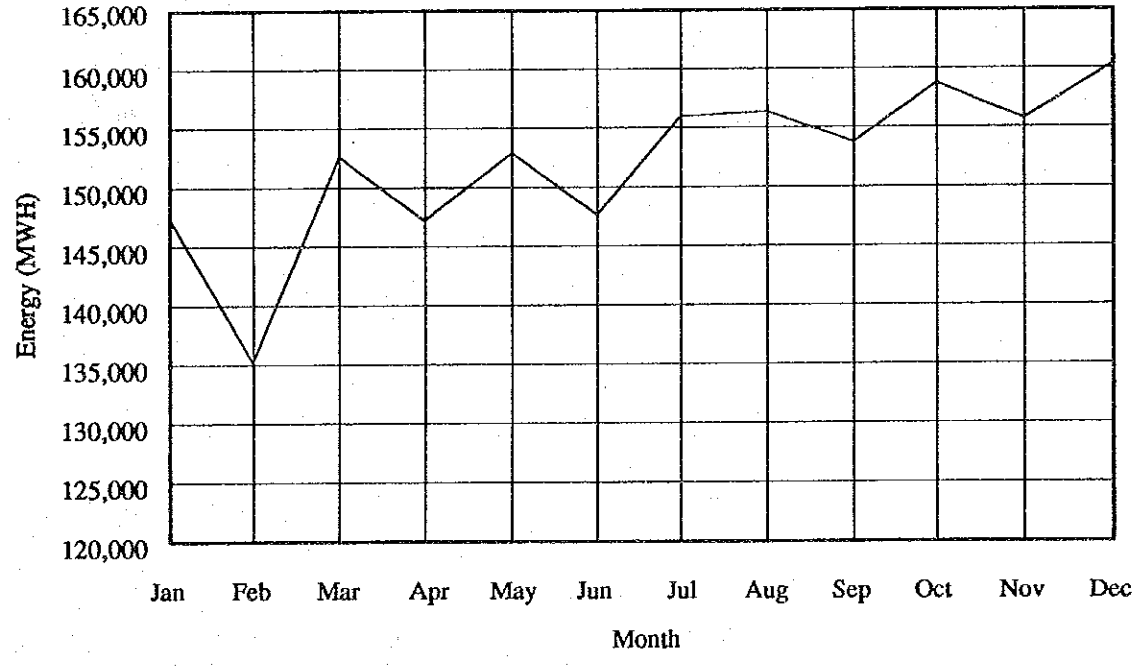
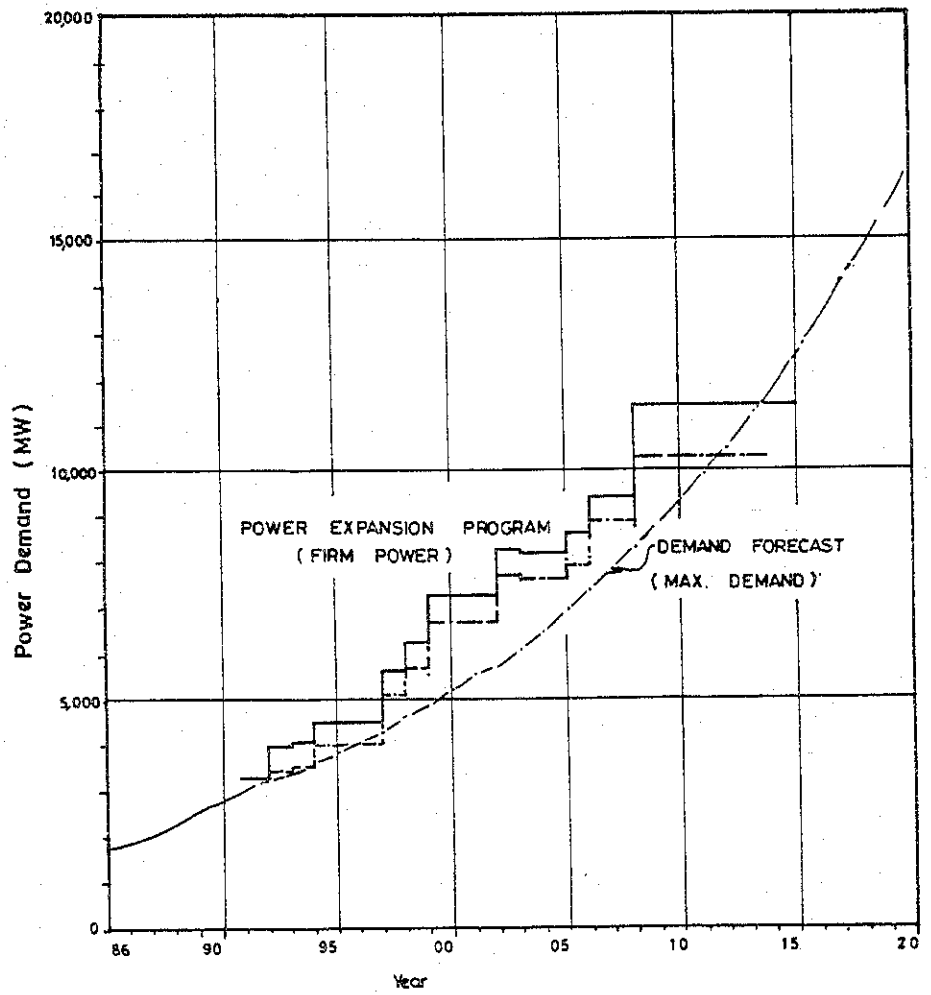
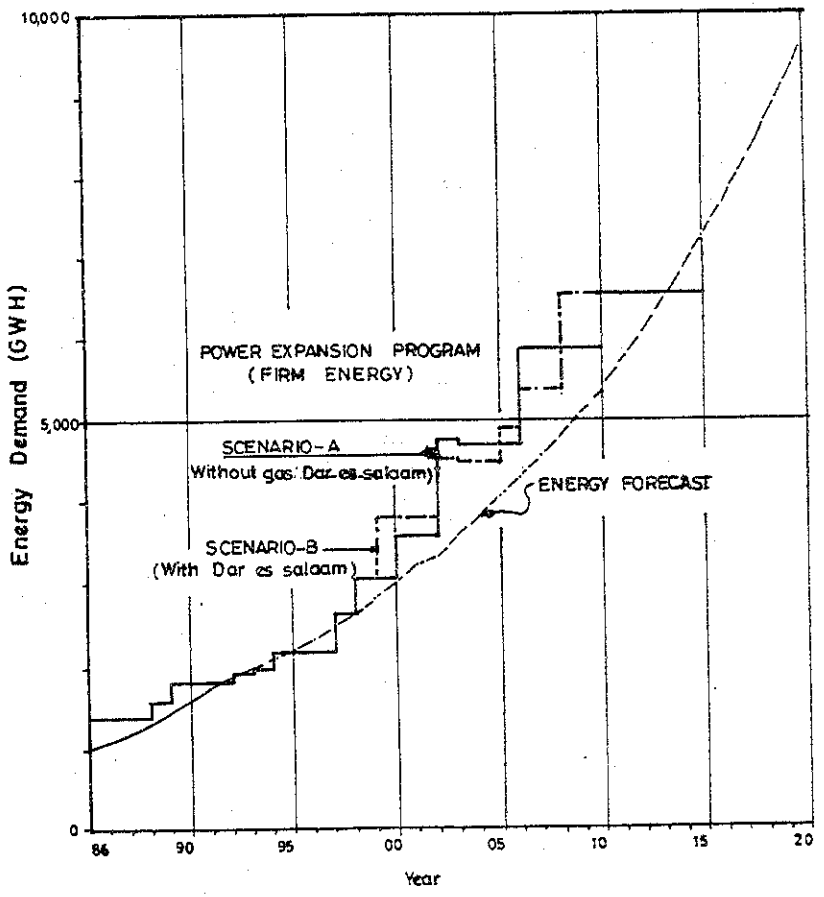


Fig. J.5 MONTHLY ENERGY GENERATION (1991)



POWER DEMAND FORECAST AND BALANCE
(SCENARIO B: GAS IN DAR ES SALAAM IN 1999)



ENERGY DEMAND FORECAST AND BALANCE

Fig. J.6 ELECTRIC POWER DEMAND FORECAST IN TANZANIA

APPENDIX-K

CONSTRUCTION PLANNING AND COST ESTIMATE

APPENDIX - K
CONSTRUCTION PLAN AND COST ESTIMATE FOR DAM PROJECT

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APPENDIX - K

CONSTRUCTION PLAN AND COST ESTIMATE

1. INTRODUCTION

The construction plan and cost estimate were made focusing on the following three dam projects selected for the purpose of coping with the municipal water demand in Dar Es Salaam by 2020;

i) Kidunda dam
ii) Mgeta dam
iii) Ngerengere dam

The succeeding Chapters 2 and 3 describe the construction plan and cost estimate for the above dam projects.

Besides, a preliminary study on the construction plan and cost estimate for the three water conveyance projects, namely the New Lower Ruvu-1, -2 and New Upper Ruvu schemes, was made in the course of the Study as discussed in Chapter 4.

The preliminary study results on those water conveyance projects are summarized in Attachments-K1 to -K3 to this Appendix-K.

2. CONSTRUCTION PLAN AND SCHEDULE FOR THE SELECTED DAM PROJECTS

2.1 Construction Circumstances in the Project Area

2.1.1 Access to the project area

Route A7 road connecting Dar Es Salaam and Morogoro is an asphalt-paved road used as a trunk road. Route B1218 road from Chalinze to Msata is also an asphalt paved road. B1212 road from Dar Es Salaam to Bagamoyo is in poor maintenance condition. The existing local main road and secondary roads which branch off from the main trunk roads are unpaved rural road, and most of these rural roads are not passable during the wet season.

In addition to the trunk road between Dar Es Salaam and Morogoro municipality, two railway lines are available for the transportation purpose. The railway between Dar Es Salaam and Morogoro is operated by the Tanzanian Railway Corporation : 4 days per week for passenger train, 5 to 6 times per day for cargo train.

It is very difficult to access to the middle reach of the Ruvu River, which usually forms the swamp area during the wet season, especially between Mzenga and Kisaki. Great Uhuru Railway is operated by the Tanzania Zambia Railway Authority (TAZARA) and this railway line is situated along the Ruvu River : 3 days per week for passenger train, once a week for cargo train normally. The distances of the TAZARA line from Dar Es Salaam to the respective stations are as follows;

- Dar Es Salaam to Mzenga	:	76 km	1.43 hours
- Dar Es Salaam to Kidunda	:	137 km	3.08 hours
- Dar Es Salaam to Kisaki	:	223 km	5.06 hours

2.1.2 Dar Es Salaam port

The port of Dar Es Salaam is administrated by the Tanzanian Harbor Authorities and the main port through which the export and import goods for Tanzania, Zambia, Malawi, Zimbabwe, Zaire, Rwanda, Burundi and Uganda pass. It is possible to transport and handle equipment and machinery at the port without any problem. On the other hand, heavy equipment and generators are commonly handled by the ship crane. The port of Dar Es Salaam has adequate facilities as shown below;

- 8 general cargo berths (quay length of about 1,100 m)
- 3 container berths (quay length of about 500 m)
- Adequate portal cranes (5 - 7 tons class), yard cranes, forklift tracks, front loaders, tractors and trailers
- 2 shore gantry cranes (35.6 tons each)
- 5 rubber tyred gantry cranes
- 1 rail mounted gantry crane
- 1 floating crane (90 tons)

2.1.3 Inland transportation

There are many transportation companies and forwarders in Dar Es Salaam. The inland transportation from the port to the Project Area including the Dar Es Salaam city area, Coast Region and Morogoro Region are commonly done by road transportation. The transportation costs are also main component of the material costs. The major transportation distances are as follows;

- Dar Es Salaam to Morogoro	:	196 km	(Route A7)
- Dar Es Salaam to Bagamoyo	:	69 km	(Route B1212)
- Dar Es Salaam to Ruvu River bridge	:	61 km	(Route 7)
- Dar Es Salaam to Chalinze	:	109 km	(Route 7)

The transportation by the TAZARA railway line would require the off-loading equipment, trucks and trailers at each station. The frequencies of operation of railway are also limited.

2.1.4 Quarry sites

Existing quarry sites are located at the Kunduchi area, Mikese area and Melela area situated along Route A7 road and B1212 road. As for the sand deposits, the river sands are mainly supplied from the Mfiji, Kifus and Murram areas located along the Route B1212 road. The crusher dust produced by a crushing plant is also used as the sand material. Embankment materials, especially red soil, are supplied from the Kunduchi, Boko and Bunju areas located along Route 1212 road.

As for the middle reach and upper reach of the Ruvu River, the further investigation for quarry sites, river sand deposits and borrow pits is required to be performed in the next study stage. The transportation costs affect the prices of concrete aggregates, sand, embankment/fill materials, since the proposed project sites are located far from the existing quarries. The hauling distances from major cities to the quarries are as follows;

- Dar Es Salaam to Kunduchi quarry site	:	20 km
- Dar Es Salaam to Msolwa quarry site	:	115 km
- Dar Es Salaam to Mikese quarry site	:	145 km
- Dar Es Salaam to Kunduchi and Boko borrow areas	:	20 to 30 km
- Dar Es Salaam to Mpiji River sand pit	:	40 km
- Melela quarry site to Morogoro	:	40 km
		(240 km to DSM)

2.1.5 Access to the proposed dam project sites

The access roads from Dar Es Salaam to each project site are as follows:

i) Kidunda dam project
   a. Dar Es Salaam - Junction at Ngerengere : 120 km
   b. Junction (A7) - Ngerengere - Tunungo - Magogoni - Kiburumo - the dam site : 100 km

ii) Mgeta dam project
   a. Dar Es Salaam - Morogoro : 196 km
   b. Morogoro - Kibungo - Mvuha - Dutumi/Kisaki - the dam site : 142 km

iii) Ngerengere dam project
   a. Dar Es Salaam - Junction at Ngerengere : 120 km
   b. Junction (A7) - Ngerengere - the dam site : 63 km

The above road conditions except main trunk roads are in the condition of poor drainage system and poor maintenance. The traffic is often interrupted during the rainy season. In early stage of the planned construction works, the road improvement works are required to be conducted prior to commencement of the main construction works.

2.2 Construction Plan and Schedule

2.2.1 General

A construction plan of the dam project is prepared on the basis of the preliminary design described in the Appendix-I of this Supporting Report. The construction plan and schedule is prepared to give an outline of possible construction sequence and method, and construction schedule for the following selected three dam projects;

i) Kidunda dam project
ii) Mgeta dam project
iii) Ngerengere dam project

The construction plan and schedule of the dam projects were set up assuming that the construction works be executed by the contractor selected by international competitive tenders, in consideration of a scale of the project construction works.

2.2.2 Basic conditions

The proposed project sites are isolated from the major city and towns. All the construction material and equipment need to be transported from Dar Es Salaam through main trunk road Route 7. Developing quarry sites is required to produce concrete aggregates and filter materials.

In the Study Area, the monthly rainfall is relatively small throughout a year. The construction works may be carried out during the both rainy and dry seasons according to the analysis of workable day. The workable day is estimated taking into account the weather condition (number of rainy days) as well as number of Sunday and national holiday. The number of average workable day per month is estimated as follows and tabulated in Tables K. 1 to K. 5.

- Embankment work for dam
  - Earth (core material) 20 days per month
  - Filter 21 days per month
  - Rock 22 days per month
- Excavation 22 days per month
- Concrete and grouting 22 days per month

2.2.3 Preparatory works and construction facilities

The condition of access roads to the proposed project sites is described in the foregoing Section 2.1. The construction of permanent access road comprises the improvement work of existing rural road and construction of new access road. The permanent access road required for the dam projects is shown below;

		Improvement of existing rural road	Construction of new access road
-	Kidunda dam	90 km	10 km
-	Mgeta dam	130 km	12 km
-	Ngerengere dam	60 km	3 km

The existing unpaved rural road needs to be widened and upgraded to a gravel road for the purpose of transporting during the rainy season. The new access road which connects the rural road and the project site is planned to be constructed to be of a surface dressing road for use as a permanent access road even after completion of the construction works.

The base camp area will be provided at each of the project sites. The base camp area will accommodate temporary buildings including offices, quarters, repair shops, warehouses and labor quarters, stock yard, motor pool, concrete batcher plant, crushing plant, etc.

Water required for the construction and base camp is planned to be taken from the Ruvu River, other tributaries and shallow wells. The raw river water taken for the purpose is planned to be purified for drinking.

Electric power for the construction and base camp is planned to be mainly supplied by diesel generator.

Wireless telecommunication system between each project site and Dar Es Salaam will be provided and the wired telephone facilities will be required within each project site.

2.2.4 Major construction works

Mobilization and access road construction will be first commenced and the preparatory works will be conducted at the early stage of the construction.

River diversion for the construction of main dam is planned to be carried out by the diversion tunnel method. Construction works for the diversion tunnel and cofferdam are commonly the critical path of the construction schedule. A full-face attack method is applied to the tunnel excavation, using drill jumbo, muck loader and dump truck and/or muck car. Especially, the tunnel for Ngerengere dam will be carried out by rail-method for muck hauling in consideration of the tunnel diameter.

As for the concrete lining of tunnel, an arch and then invert method is planned to be applied. Concrete will be transported by agitator truck and placed behind the sliding form using concrete pump car and/or concrete placer.

After diverting the river water, the dam foundation excavation will be carried out using bulldozers with ripper, crawler drills, tractor shovels and dump trucks. The excavated rock material is planned to be used for a random fill and a rockfill as far as they are usable therefor.

Blanket and curtain groutings will be carried out after completion of the foundation excavation. The grout holes will be drilled by rotary boring machines and be injected by grout pumps with grout mixers.

The embankment work will be carried out by a conventional method by using bulldozers, crawler drills, tractor shovels, dump trucks, tamping rollers, vibrating rollers and tire rollers. The earthfill material will be obtained from alluvial deposit located along the main river stretch. The rockfill material will be hauled from the excavated material and a new quarry which is planned to be developed near each dam site. The filter material will be purchased from the existing quarry company or be produced by a crushing plant provided at each dam site.

The spillway structure will be constructed in parallel with the dam embankment work. Available rock materials are used for the rockfill material. Concrete will be produced by a concrete batcher plant and placed by agitator trucks, concrete pumps, concrete buckets with crawler and/or truck cranes.

Immediately after completion of the dam embankment and the installation of spillway gate, the diversion tunnels will be closed by diversion gates located at the tunnel portal. Dam impounding and the works of river outlet facilities will be carried out, following the diversion gate closure.

Such river outlet facilities as the horrow jet valve and the steel pipe are planned to be installed in the diversion tunnel. In succession to the gate closure, intake concrete plug and intake tower structure will also be constructed. Also, steel pipe installation, plug concrete placement and installation of the horrow jet valve are scheduled at the last stage of construction.

Before the diversion gate closure, the substructure and architectural works of powerhouse will be completed and the installation of generating equipment will be done in parallel with construction of the river outlet facilities.

2.3 Construction Schedule

Main construction works of each dam project are estimated to take 4 years. 2 years for pre-feasibility study/feasibility study or the feasibility study and 2 years for detailed design are required as a preconstruction before commencement of the construction. Besides, it would take about one year to impound water in the reservoir after completion of the main construction works. The land acquisition and compensation for the project would need to be settled by the Government one year before commencement of the main dam construction. To cope with the municipal water demand in future, the earliest realization of the Kidunda dam (Development Scenario-1) was assumed as shown in Fig. K.1. The construction schedule for each of the dam projects is shown in Figs. K. 2 to K. 4.

3. COST ESTIMATE FOR THE SELECTED DAM PROJECTS

3.1 Availability of Construction Material and Equipment in the Project Area

Most of construction materials including the local products and imported materials are supplied from the local markets. The material cost was canvassed in Dar Es Salaam during the Study period, especially in the industrial area. The local products are mainly cement, timber, aggregates, sand, nail, wire and structural steel.

While the imported materials are gasoline, diesel, grease, lubricant, bitumen, plywood, reinforcement, structural steel, explosive, detonator, PVC pipe, steel pipe, valve, gate, machinery, electric goods, etc.

Equipment and plant for the construction are owned and provided by the contractors. It is found out through the interview to contractors and transporters that the conventional equipment such as earth-moving equipment, transportation equipment, cranes, etc. are available in Dar Es Salaam. While, in Tanzania, all construction equipment and plant are imported. The special equipment such as boring/grouting equipment, tunneling equipment, concrete plant, asphalt plant, crushing plant, etc. are provided by the contractor for construction.

Tanzania currency (T. Shs.) has been devaluated every year. The foreign exchange rates published by the Bank of Tanzania are shown in Table K.6. The exchange rate in 1993 became more than 200 percent of that in 1990. In the Study, the project costs were expressed in US$ in consideration of the Tanzanian Shilling's devaluation which may take place in future. The unit rates were also based on the converted US Dollar.

The construction material costs and transportation costs increased every year, especially due to the Tanzania shilling devaluation and rise of the fuel price. During the Study period, the material costs increased for the period from May to November 1993 as shown in Table K. 7.

3.2 Basic Assumptions and Procedures Adopted for Cost Estimate

3.2.1 General

The construction costs for the dam projects were estimated on the basis of the preliminary design and work quantities at a level of the master plan. Major unit prices were worked out considering local conditions, availability of materials and equipment and referring to the similar international projects.

Both foreign and local currency portions of the project cost were estimated in US dollar. Assumptions and conditions applied to the cost estimate are as follows:

(1) Price level : Price as of November 1993
(2) Exchange rate : US dollar 1.00 = T. Shs. 460 = Jap. Yen 108
(3) Construction works will be carried out by the contractor selected through an international tender.
(4) Construction costs are divided into direct construction cost and indirect construction cost.

The direct construction cost of the dam project comprises the costs for preparatory works, civil works, metal works and generating equipment. While, the indirect construction cost of the dam project comprises the costs for land acquisition and compensation, administration expenses, engineering services and physical contingency.

3.2.2 Preparatory works

Cost for the preparatory works including temporary buildings, water supply system, electric supply system, telecommunication system, temporary access roads, etc. is estimated at 10 % of the sum of remaining direct construction works.

3.2.3 Civil works

Direct construction cost of civil works is estimated principally on the unit price basis, in which the unit price for each work item is multiplied by the corresponding work quantity to calculate the construction cost therefor. The unit prices include labor, material, equipment and overhead costs.

Table K. 8 shows data on the daily wages for construction, obtained by the Study Team during the Study period.

The local material prices applied for the cost estimate include local net price, inland transportation cost and taxes. The imported materials which are not available in the local markets are estimated assuming the exemption of import duties and taxes. The material cost data are shown in Table K. 9.

The equipment cost is divided into foreign and local portions. The foreign currency portion consists mainly of the costs of depreciation, spare parts and consumable, while the local currency portion includes the cost of mechanic labor, the cost for the repair and maintenance and administration expenses. The costs of equipment required for the project are listed in Table K. 10.

The overhead expenses and profits of the contractor are taken into account in estimating the unit rate of each work item. These expenses were estimated to be 25 percent of the direct cost, including labor cost, material cost and equipment cost.

The unit price for each work item is shown in Tables K. 12 to K. 14.

3.2.4 Metal works and generating equipment

The costs for metal works and generating equipment are estimated with reference to the recent international contract prices of similar works and considering the local conditions.

3.2.5 Land acquisition and compensation cost

The cost of land acquisition and compensation was estimated based on reservoir area and by applying the land value and house compensation cost. The data of the land value and house compensation cost were obtained from the Ministry of Land. The estimated costs for the respective dam projects are summarized below;

Land Acquisition and Compensation Cost for Dam Project

Works	Land Acquisition (US$)	House Compensation (US$)	Total (US$)
Kidunda dam	250,000	1,870,000	2,120,000
Mgeta dam	50,000	-	50,000
Ngerengere	210,000	390,000	600,000

3.2.6 Administration expenses

The administration cost was estimated at 1 % of the direct construction cost and included in local currency portion.

3.2.7 Engineering services

The cost of engineering services for detailed design and construction supervision was estimated at 12 % of the sum of direct construct cost, shared by the foreign currency portion of 85 % and the local currency portion of 15 %. The costs for prefeasibility study and feasibility study are not included in the engineering service cost.

3.2.8 Physical Contingency

The physical contingency is assumed to be 15 % of total cost for both local and foreign currency portions so as to cope with the unforeseenable physical condition. While, the price contingency cost is not included in those project costs, since it is too difficult to forecast accurately the escalation rates of prices during the implementation period.

3.3 Construction Cost

The present-day total construction cost for each of the Kidunda, Mgeta and Ngerengere dam projects was estimated summing up the aforesaid direct and indirect costs as detailed in Tables K. 12 to K. 14. They are summarized below;

No.	Name of Dam Project	Present-day Project Cost (Thousand US$)		
		Foreign Currency	Local Currency	Total
1.	Kidunda Dam (Development Scenario-1)	77,866	23,231	101,097
2.	Mgeta Dam (Development Scenario-2)	85,356	25,246	110,602
3.	Ngerengere Dam (Development Scenario-2)	69,322	21,482	90,804

3.4 Annual Disbursement Schedule

Annual disbursement of each dam project was derived on the basis of the construction schedule shown in Figs. K. 2 to K. 4 and the construction costs of main work items shown in Tables K.12 to K.14. The annual disbursement schedule for each of the Kidunda, Mgeta and Ngerengere dams is shown in Table K. 15.

4. PRELIMINARY EXAMINATION ON CONSTRUCTION PLAN AND COST ESTIMATE FOR WATER CONVEYANCE PROJECT

4.1 Genearl

As discussed in Appendix-I of this Supporting Report, the following three water conveyance projects were preliminarily proposed to be provided in accordance with increase of municipal water demand;

i) New Lower Ruvu-1 scheme
ii) New Lower Ruvu-2 scheme
iii) New Upper Ruvu scheme

The preliminary examination on construction plan and cost estimate for these projects were made based on the major work quantites calculated from the dimensions of main components involved therein.

4.2 Preliminary Construction Plan and Cost Estimate

The new gated weir is planned to be provided downstream of the existing intake gate for each of the New Lower Ruvu scheme-1 and New Upper Ruvu scheme. Mobilization and access road construction will be first commenced, followed by the preparatory works at the early stage of construction.

River diversion works are required for the construction of gated weir. The river diversion is planned to be carried out by the diversion channel method at the left bank. Double steel sheet pile cofferdams will be constructed at the upstream and downstream portions. The excavation

of diversion channel will be made by conventional earth-moving equipment. The steel sheet piles will be driven by using vibrating hammer and diesel hammer with crawler crane.

The construction area enclosed by the cofferdams with steel sheet piles will be dewatered using submergible pumps, and then the foundation excavation will be carried out using backhoe and dump truck. Concrete piles will be driven at the weir foundation by diesel pile hammer.

Concrete placement of weir and intake will be carried out by using agitator truck, concrete pump, concrete bucket handled with crawler crane. Central concrete batcher plant is required to produce concrete for weir, treatment structures, building works, prestressed concrete pipe, etc.

Concrete works for such structures as raw water pump station, clarifiers, filters, treated pump station, water chamber, treated water chamber and buildings, will be performed taking into consideration foundation excavation, installation of treatment equipment, electrical works and architectural works. Concrete aggregate including sand will be purchased from the existing quarries located in the Kunduchi area.

A site factory will be provided to produce prestressed concrete pipes planned to be installed for main intake pipes and new transmission pipes. The concrete pipes will be produced by a procedure of molding, concrete pouring, prestressing and curing. 15 m wide temporary area including access road will be cleared and leveled along the pipe line, in advance of the trench excavation. The pipes will be transported by truck and trailer to the working site and installed in the trench by using truck crane.

As for the New Lower Ruvu-1 and New Upper Ruvu schemes, a temporary factory to produce prestressed concrete pipes would be required at appropriate site located near the pipe line route.

The construction costs, annual disbursement schedules and construction schedules, which were worked out through the preliminary examination, are summarized in Attachments-K1, -K2, -K3 to this Appendix-K, respectively. A total of these three water conveyance project costs was preliminarily estimated at around 460 million US$.

APPENDIX-K

TABLES

Table K.1 WORKABLE DAY IN THE PROJECT AREA

1. Embankment Works - Earth (core)

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Per Year	Per Month
Kidunda	21	18	15	7	19	21	23	25	23	20	21	18	231	19
Duthumi	18	18	16	7	18	22	23	26	24	24	22	17	235	20
Ruvu	21	21	18	9	19	24	24	27	25	19	19	19	245	20
Bagamoyo	21	23	21	10	13	21	23	25	24	20	21	17	239	20

2. Embankment Works - Filter

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Per Year	Per Month
Kidunda	22	20	19	12	22	23	24	27	24	22	23	21	259	22
Duthumi	20	19	18	10	20	23	24	26	25	25	23	18	251	21
Ruvu	21	21	18	9	20	24	24	27	26	19	20	20	249	21
Bagamoyo	22	23	22	12	16	22	24	26	25	22	22	19	255	21

3. Embankment Works - Rock

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Per Year	Per Month
Kidunda	23	21	21	14	23	24	25	27	25	23	23	22	271	23
Duthumi	22	20	20	13	21	24	24	26	25	25	24	19	263	22
Ruvu	22	22	20	11	21	24	24	27	26	20	21	20	258	22
Bagamoyo	23	23	23	14	18	23	24	27	26	23	23	21	268	22

4. Excavation Works

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Per Year	Per Month
Kidunda	23	21	21	14	23	24	25	27	25	23	23	22	271	23
Duthumi	22	20	20	13	21	24	24	26	25	25	24	19	263	22
Ruvu	22	22	20	11	21	24	24	27	26	20	21	20	258	22
Bagamoyo	23	23	23	14	18	23	24	27	26	23	23	21	268	22

5. Concrete and Grouting Works

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Per Year	Per Month
Kidunda	24	21	21	15	23	24	25	27	25	23	24	22	274	23
Duthumi	22	21	21	15	22	24	24	26	25	25	24	20	269	22
Ruvu	23	22	20	12	21	24	24	27	26	21	21	20	261	22
Bagamoyo	23	23	24	14	18	23	24	27	26	23	23	21	269	22

Table K.2 MONTHLY RAINY DAY AND WORKABLE DAY (KIDUNDA)

Monthly Rainy

Rainfall (mm)	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Ave. Less 1	24.7	20.7	17.7	11.0	20.3	24.2	27.8	27.8	25.0	23.8	23.7	22.3
1 - 3	2.7	2.5	5.2	6.8	4.5	2.8	1.8	2.0	2.2	2.5	2.5	4.0
3 - 5	0.7	0.7	1.3	3.2	1.5	0.8	0.3	0.7	0.7	1.0	0.5	1.5
5 - 10	0.7	1.3	2.2	2.2	1.8	1.0	0.7	0.2	1.2	0.8	0.8	1.5
10 - 20	0.7	1.7	2.5	3.7	2.2	0.7	0.2	0.3	0.8	1.2	1.8	1.2
20 - 30	0.3	0.5	0.5	1.3	0.5	0.3	0.2	0.0	0.0	0.7	0.3	0.2
30 - 50	0.7	0.3	1.0	1.3	0.2	0.2	0.0	0.0	0.2	0.8	0.3	0.3
More 50	0.7	0.3	0.7	0.5	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0

Workable Day Earthcore

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Suspended Day Earthfill
Less 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1 - 3	1.3	1.3	2.6	3.4	2.3	1.4	0.9	1.0	1.1	1.3	1.3	2.0	0.5
3 - 5	0.3	0.3	0.7	1.6	0.8	0.4	0.2	0.3	0.3	0.5	0.3	0.8	0.5
5 - 10	0.3	0.7	1.1	1.1	0.9	0.5	0.3	0.1	0.6	0.4	0.4	0.8	0.5
10 - 20	0.7	1.7	2.5	3.7	2.2	0.7	0.2	0.3	0.8	1.2	1.8	1.2	1.0
20 - 30	0.3	0.5	0.5	1.3	0.5	0.3	0.2	0.0	0.0	0.7	0.3	0.2	1.0
30 - 50	1.3	0.7	2.0	2.7	0.3	0.3	0.0	0.0	0.3	1.7	0.7	0.7	2.0
More 50	1.3	0.7	1.3	1.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	2.0
Total	5.5	5.9	10.7	14.8	7.0	3.6	1.8	1.7	3.1	6.1	4.8	5.7	
Sun.,etc.	5	4	5	8	5	5	6	4	4	5	4	7	
Workable day	21	18	15	7	19	21	23	25	23	20	21	18	

Workable Day Filter

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Filter
Less 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1 - 3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3 - 5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5 - 10	0.3	0.7	1.1	1.1	0.9	0.5	0.3	0.1	0.6	0.4	0.4	0.8	0.5
10 - 20	0.7	1.7	2.5	3.7	2.2	0.7	0.2	0.3	0.8	1.2	1.8	1.2	1.0
20 - 30	0.3	0.5	0.5	1.3	0.5	0.3	0.2	0.0	0.0	0.7	0.3	0.2	1.0
30 - 50	1.3	0.7	2.0	2.7	0.3	0.3	0.0	0.0	0.3	1.7	0.7	0.7	2.0
More 50	1.3	0.7	1.3	1.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	2.0
Total	3.9	4.3	7.4	9.8	3.9	1.8	0.7	0.4	1.7	4.3	3.2	2.9	
Sun.,etc.	5	4	5	8	5	5	6	4	4	5	4	7	
Workable day	22	20	19	12	22	23	24	27	24	22	23	21	

Workable Day Rock

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Rock
Less 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1 - 3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3 - 5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5 - 10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10 - 20	0.7	1.7	2.5	3.7	2.2	0.7	0.2	0.3	0.8	1.2	1.8	1.2	1.0
20 - 30	0.3	0.5	0.5	1.3	0.5	0.3	0.2	0.0	0.0	0.7	0.3	0.2	1.0
30 - 50	1.0	0.5	1.5	2.0	0.3	0.3	0.0	0.0	0.3	1.3	0.5	0.5	1.5
More 50	1.0	0.5	1.0	0.8	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	1.5
Total	3.0	3.2	5.5	7.8	3.0	1.3	0.4	0.3	1.1	3.5	2.6	1.9	
Sun.,etc.	5	4	5	8	5	5	6	4	4	5	4	7	
Workable day	23	21	21	14	23	24	25	27	25	23	23	22	

Workable Day Excavation

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Excavation
Less 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1 - 3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3 - 5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5 - 10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10 - 20	0.7	1.7	2.5	3.7	2.2	0.7	0.2	0.3	0.8	1.2	1.8	1.2	1.0
20 - 30	0.3	0.5	0.5	1.3	0.5	0.3	0.2	0.0	0.0	0.7	0.3	0.2	1.0
30 - 50	1.0	0.5	1.5	2.0	0.3	0.3	0.0	0.0	0.3	1.3	0.5	0.5	1.5
More 50	1.0	0.5	1.0	0.8	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	1.5
Total	3.0	3.2	5.5	7.8	3.0	1.3	0.4	0.3	1.1	3.5	2.6	1.9	
Sun.,etc.	5	4	5	8	5	5	6	4	4	5	4	7	
Workable day	23	21	21	14	23	24	25	27	25	23	23	22	

Workable Day Concrete Grouting

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Concrete Grouting
Less 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1 - 3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3 - 5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5 - 10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10 - 20	0.7	1.7	2.5	3.7	2.2	0.7	0.2	0.3	0.8	1.2	1.8	1.2	1.0
20 - 30	0.3	0.5	0.5	1.3	0.5	0.3	0.2	0.0	0.0	0.7	0.3	0.2	1.0
30 - 50	0.7	0.3	1.0	1.3	0.2	0.2	0.0	0.0	0.2	0.8	0.3	0.3	1.0
More 50	0.7	0.3	0.7	0.5	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	1.0
Total	2.4	2.8	4.7	6.8	2.9	1.2	0.4	0.3	1.0	2.9	2.4	1.7	
Sun.,etc.	5	4	5	8	5	5	6	4	4	5	4	7	
Workable day	24	21	21	15	23	24	25	27	25	23	24	22	

Table K.3 MONTHLY RAINY DAY AND WORKABLE DAY (DUTHUMI ESTATE)

Monthly Rainy Day

Rainfall (mm)	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Ave. Less 1	22.7	21.0	19.5	12.1	20.5	25.1	28.0	29.2	27.0	28.1	24.7	23.4
1 - 3	2.2	1.7	2.9	4.7	3.2	2.0	1.5	0.5	1.2	1.2	1.4	2.2
3 - 5	0.7	1.4	0.6	2.3	1.0	0.5	0.3	0.1	0.7	0.5	0.6	0.8
5 - 10	1.7	0.7	2.7	3.5	2.1	1.2	0.6	0.6	0.4	0.5	1.0	0.7
10 - 20	1.6	1.7	2.6	3.2	2.4	0.8	0.4	0.4	0.5	0.4	1.5	1.8
20 - 30	0.6	0.4	1.0	1.6	1.0	0.2	0.1	0.0	0.1	0.2	0.5	0.8
30 - 50	0.8	0.8	0.9	1.6	0.4	0.2	0.1	0.1	0.1	0.1	0.1	1.0
More 50	0.7	0.3	0.8	1.0	0.4	0.0	0.0	0.1	0.0	0.0	0.2	0.3

Workable Day
Earthcore

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Suspended Day Earthfill
Less 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1 - 3	1.1	0.9	1.5	2.4	1.6	1.0	0.8	0.3	0.6	0.6	0.7	1.1	0.5
3 - 5	0.4	0.7	0.3	1.2	0.5	0.3	0.2	0.1	0.4	0.3	0.3	0.4	0.5
5 - 10	0.9	0.4	1.4	1.8	1.1	0.6	0.3	0.3	0.2	0.3	0.5	0.4	0.5
10 - 20	1.6	1.7	2.6	3.2	2.4	0.8	0.4	0.4	0.5	0.4	1.5	1.8	1.0
20 - 30	0.6	0.4	1.0	1.6	1.0	0.2	0.1	0.0	0.1	0.2	0.5	0.8	1.0
30 - 50	1.6	1.6	1.8	3.2	0.8	0.4	0.2	0.2	0.2	0.2	0.2	2.0	2.0
More 50	1.4	0.6	1.6	2.0	0.8	0.0	0.0	0.2	0.0	0.0	0.4	0.6	2.0
Total	7.6	6.3	10.2	15.4	8.2	3.3	2.0	1.5	2.0	2.0	4.1	7.1	
Sun.,etc	5	4	5	8	5	5	6	4	4	5	4	7	
Workable day	18	18	16	7	18	22	23	26	24	24	22	17	

Workable Day
Filter

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Filter
Less 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1 - 3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3 - 5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5 - 10	0.9	0.4	1.4	1.8	1.1	0.6	0.3	0.3	0.2	0.3	0.5	0.4	0.5
10 - 20	1.6	1.7	2.6	3.2	2.4	0.8	0.4	0.4	0.5	0.4	1.5	1.8	1.0
20 - 30	0.6	0.4	1.0	1.6	1.0	0.2	0.1	0.0	0.1	0.2	0.5	0.8	1.0
30 - 50	1.6	1.6	1.8	3.2	0.8	0.4	0.2	0.2	0.2	0.2	0.2	2.0	2.0
More 50	1.4	0.6	1.6	2.0	0.8	0.0	0.0	0.2	0.0	0.0	0.4	0.6	2.0
Total	6.1	4.7	8.4	11.8	6.1	2.0	1.0	1.1	1.0	1.1	3.1	5.6	
Sun.,etc	5	4	5	8	5	5	6	4	4	5	4	7	
Workable day	20	19	18	10	20	23	24	26	25	25	23	18	

Workable Day
Rock

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Rock
Less 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1 - 3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3 - 5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5 - 10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10 - 20	1.6	1.7	2.6	3.2	2.4	0.8	0.4	0.4	0.5	0.4	1.5	1.8	1.0
20 - 30	0.6	0.4	1.0	1.6	1.0	0.2	0.1	0.0	0.1	0.2	0.5	0.8	1.0
30 - 50	1.2	1.2	1.4	2.4	0.6	0.3	0.2	0.2	0.2	0.2	0.2	1.5	1.5
More 50	1.1	0.5	1.2	1.5	0.6	0.0	0.0	0.2	0.0	0.0	0.3	0.5	1.5
Total	4.5	3.8	6.2	8.7	4.6	1.3	0.7	0.8	0.8	0.8	2.5	4.6	
Sun.,etc	5	4	5	8	5	5	6	4	4	5	4	7	
Workable day	22	20	20	13	21	24	24	26	25	25	24	19	

Workable Day
Excavation

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Excavation
Less 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1 - 3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3 - 5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5 - 10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10 - 20	1.6	1.7	2.6	3.2	2.4	0.8	0.4	0.4	0.5	0.4	1.5	1.8	1.0
20 - 30	0.6	0.4	1.0	1.6	1.0	0.2	0.1	0.0	0.1	0.2	0.5	0.8	1.0
30 - 50	1.2	1.2	1.4	2.4	0.6	0.3	0.2	0.2	0.2	0.2	0.2	1.5	1.5
More 50	1.1	0.5	1.2	1.5	0.6	0.0	0.0	0.2	0.0	0.0	0.3	0.5	1.5
Total	4.5	3.8	6.2	8.7	4.6	1.3	0.7	0.8	0.8	0.8	2.5	4.6	
Sun.,etc	5	4	5	8	5	5	6	4	4	5	4	7	
Workable day	22	20	20	13	21	24	24	26	25	25	24	19	

Workable Day
Concrete Grouting

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Concrete Grouting
Less 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1 - 3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3 - 5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5 - 10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10 - 20	1.6	1.7	2.6	3.2	2.4	0.8	0.4	0.4	0.5	0.4	1.5	1.8	1.0
20 - 30	0.6	0.4	1.0	1.6	1.0	0.2	0.1	0.0	0.1	0.2	0.5	0.8	1.0
30 - 50	0.8	0.8	0.9	1.6	0.4	0.2	0.1	0.1	0.1	0.1	0.1	1.0	1.0
More 50	0.7	0.3	0.8	1.0	0.4	0.0	0.0	0.1	0.0	0.0	0.2	0.3	1.0
Total	3.7	3.2	5.3	7.4	4.2	1.2	0.6	0.6	0.7	0.7	2.3	3.9	
Sun.,etc	5	4	5	8	5	5	6	4	4	5	4	7	
Workable day	22	21	21	15	22	24	24	26	25	25	24	20	

Table K.4 MONTHLY RAINY DAY AND WORKABLE DAY (RUVU NATIONAL SERVICE FARM)

Monthly Rainy

Rainfall (mm)	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Ave. Less 1	26.0	25.9	24.0	17.3	23.6	28.3	29.5	30.3	28.9	24.9	23.4	26.9
1 - 3	0.1	0.1	0.3	0.6	0.4	0.3	0.0	0.0	0.1	0.3	0.1	0.1
3 - 5	0.4	0.0	0.0	0.4	0.6	0.0	0.0	0.3	0.6	0.4	0.5	0.4
5 - 10	1.3	0.0	1.1	2.0	1.8	0.6	0.6	0.3	0.3	0.8	1.3	0.1
10 - 20	1.8	1.0	3.1	5.3	2.5	0.6	0.5	0.1	0.1	1.8	3.0	1.5
20 - 30	0.4	0.5	1.3	2.6	1.5	0.1	0.3	0.1	0.0	1.3	0.9	1.4
30 - 50	0.9	0.1	0.6	1.6	0.6	0.1	0.1	0.0	0.0	0.9	0.8	0.3
More 50	0.3	0.4	0.6	0.3	0.0	0.0	0.0	0.0	0.0	0.9	0.1	0.4

Workable Day
Earthcore

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Suspended Day Earthfill
Less 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1 - 3	0.1	0.1	0.1	0.3	0.2	0.1	0.0	0.0	0.1	0.1	0.1	0.1	0.5
3 - 5	0.2	0.0	0.0	0.2	0.3	0.0	0.0	0.1	0.3	0.2	0.3	0.2	0.5
5 - 10	0.6	0.0	0.6	1.0	0.9	0.3	0.3	0.1	0.1	0.4	0.6	0.1	0.5
10 - 20	1.8	1.0	3.1	5.3	2.5	0.6	0.5	0.1	0.1	1.8	3.0	1.5	1.0
20 - 30	0.4	0.5	1.3	2.6	1.5	0.1	0.3	0.1	0.0	1.3	0.9	1.4	1.0
30 - 50	1.8	0.3	1.3	3.3	1.3	0.3	0.3	0.0	0.0	1.8	1.5	0.5	2.0
More 50	0.5	0.8	1.3	0.5	0.0	0.0	0.0	0.0	0.0	1.8	0.3	0.8	2.0
Total	5.4	2.7	7.7	13.2	6.7	1.4	1.4	0.4	0.6	7.4	6.7	4.6	
Sun.,etc	5	4	5	8	5	5	6	4	4	5	4	7	
Workable day	21	21	18	9	19	24	24	27	25	19	19	19	

Workable Day
Filter

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Filter
Less 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1 - 3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3 - 5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5 - 10	0.6	0.0	0.6	1.0	0.9	0.3	0.3	0.1	0.1	0.4	0.6	0.1	0.5
10 - 20	1.8	1.0	3.1	5.3	2.5	0.6	0.5	0.1	0.1	1.8	3.0	1.5	1.0
20 - 30	0.4	0.5	1.3	2.6	1.5	0.1	0.3	0.1	0.0	1.3	0.9	1.4	1.0
30 - 50	1.8	0.3	1.3	3.3	1.3	0.3	0.3	0.0	0.0	1.8	1.5	0.5	2.0
More 50	0.5	0.8	1.3	0.5	0.0	0.0	0.0	0.0	0.0	1.8	0.3	0.8	2.0
Total	5.1	2.6	7.6	12.7	6.2	1.3	1.4	0.3	0.2	7.1	6.3	4.3	
Sun.,etc	5	4	5	8	5	5	6	4	4	5	4	7	
Workable day	21	21	18	9	20	24	24	27	26	19	20	20	

Workable Day
Rock

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Rock
Less 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1 - 3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3 - 5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5 - 10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10 - 20	1.8	1.0	3.1	5.3	2.5	0.6	0.5	0.1	0.1	1.8	3.0	1.5	1.0
20 - 30	0.4	0.5	1.3	2.6	1.5	0.1	0.3	0.1	0.0	1.3	0.9	1.4	1.0
30 - 50	1.3	0.2	0.9	2.4	0.9	0.2	0.2	0.0	0.0	1.3	1.1	0.4	1.5
More 50	0.4	0.6	0.9	0.4	0.0	0.0	0.0	0.0	0.0	1.3	0.2	0.6	1.5
Total	3.9	2.3	6.2	10.7	4.9	0.9	1.0	0.2	0.1	5.7	5.2	3.9	
Sun.,etc	5	4	5	8	5	5	6	4	4	5	4	7	
Workable day	22	22	20	11	21	24	24	27	26	20	21	20	

Workable Day
Excavation

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Excavation
Less 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1 - 3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3 - 5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5 - 10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10 - 20	1.8	1.0	3.1	5.3	2.5	0.6	0.5	0.1	0.1	1.8	3.0	1.5	1.0
20 - 30	0.4	0.5	1.3	2.6	1.5	0.1	0.3	0.1	0.0	1.3	0.9	1.4	1.0
30 - 50	1.3	0.2	0.9	2.4	0.9	0.2	0.2	0.0	0.0	1.3	1.1	0.4	1.5
More 50	0.4	0.6	0.9	0.4	0.0	0.0	0.0	0.0	0.0	1.3	0.2	0.6	1.5
Total	3.9	2.3	6.2	10.7	4.9	0.9	1.0	0.2	0.1	5.7	5.2	3.9	
Sun.,etc	5	4	5	8	5	5	6	4	4	5	4	7	
Workable day	22	22	20	11	21	24	24	27	26	20	21	20	

Workable Day
Concrete Grouting

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Concrete Grouting
Less 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1 - 3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3 - 5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5 - 10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10 - 20	1.8	1.0	3.1	5.3	2.5	0.6	0.5	0.1	0.1	1.8	3.0	1,5	1.0
20 - 30	0.4	0.5	1.3	2.6	1.5	0.1	0.3	0.1	0.0	1.3	0.9	1.4	1.0
30 - 50	0.9	0.1	0.6	1.6	0.6	0.1	0.1	0.0	0.0	0.9	0.8	0.3	1.0
More 50	0.3	0.4	0.6	0.3	0.0	0.0	0.0	0.0	0.0	0.9	0.1	0.4	1.0
Total	3.4	2.0	5.6	9.8	4.6	0.8	0.9	0.2	0.1	4.9	4.8	3.6	
Sun.,etc	5	4	5	8	5	5	6	4	4	5	4	7	
Workable day	23	22	20	12	21	24	24	27	26	21	21	20	

Table K.5 MONTHLY RAINY DAY AND WORKABLE DAY (BAGAMOYO SALT WORKS)

Monthly Rainy

Rainfall (mm)	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Ave. Less 1	25.5	26.4	25.9	16.8	15.3	23.8	28.0	26.9	27.0	24.9	24.2	22.6
1 - 3	1.1	0.3	0.9	1.9	2.9	1.8	0.8	1.3	1.0	1.1	1.1	1.6
3 - 5	0.4	0.3	0.6	1.5	1.6	1.1	0.8	0.8	0.9	1.1	0.3	1.3
5 - 10	1.5	0.5	1.5	2.1	3.6	1.1	0.8	1.9	0.6	1.1	1.5	2.6
10 - 20	1.4	0.3	0.6	4.0	4.5	1.8	0.5	0.3	0.4	1.5	1.1	1.4
20 - 30	0.6	0.1	0.5	2.4	2.1	0.5	0.0	0.0	0.1	0.3	1.1	0.5
30 - 50	0.3	0.3	1.0	1.0	0.5	0.0	0.1	0.0	0.0	0.5	0.4	0.5
More 50	0.3	0.0	0.0	0.4	0.5	0.0	0.1	0.0	0.0	0.5	0.3	0.5

Workable Day
Earthcore

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Suspended Day Earthfill
Less 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1 - 3	0.6	0.1	0.4	0.9	1.4	0.9	0.4	0.6	0.5	0.6	0.6	0.8	0.5
3 - 5	0.2	0.1	0.3	0.8	0.8	0.6	0.4	0.4	0.4	0.6	0.1	0.6	0.5
5 - 10	0.8	0.3	0.8	1.1	1.8	0.6	0.4	0.9	0.3	0.6	0.8	1.3	0.5
10 - 20	1.4	0.3	0.6	4.0	4.5	1.8	0.5	0.3	0.4	1.5	1.1	1.4	1.0
20 - 30	0.6	0.1	0.5	2.4	2.1	0.5	0.0	0.0	0.1	0.3	1.1	0.5	1.0
30 - 50	0.5	0.5	2.0	2.0	1.0	0.0	0.3	0.0	0.0	1.0	0.8	1.0	2.0
More 50	0.5	0.0	0.0	0.8	1.0	0.0	0.3	0.0	0.0	1.0	0.5	1.0	2.0
Total	4.6	1.4	4.6	12.0	12.6	4.4	2.3	2.2	1.7	5.6	5.0	6.6	
Sun.,etc	5	4	5	8	5	5	6	4	4	5	4	7	
Workable day	21	23	21	10	13	21	23	25	24	20	21	17	

Workable Day
Filter

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Filter
Less 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1 - 3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3 - 5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5 - 10	0.8	0.3	0.8	1.1	1.8	0.6	0.4	0.9	0.3	0.6	0.8	1.3	0.5
10 - 20	1.4	0.3	0.6	4.0	4.5	1.8	0.5	0.3	0.4	1.5	1.1	1.4	1.0
20 - 30	0.6	0.1	0.5	2.4	2.1	0.5	0.0	0.0	0.1	0.3	1.1	0.5	1.0
30 - 50	0.5	0.5	2.0	2.0	1.0	0.0	0.3	0.0	0.0	1.0	0.8	1.0	2.0
More 50	0.5	0.0	0.0	0.8	1.0	0.0	0.3	0.0	0.0	1.0	0.5	1.0	2.0
Total	3.8	1.2	3.9	10.3	10.4	2.9	1.5	1.2	0.8	4.4	4.3	5.2	
Sun.,etc	5	4	5	8	5	5	6	4	4	5	4	7	
Workable day	22	23	22	12	16	22	24	26	25	22	22	19	

Workable Day
Rock

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Rock
Less 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1 - 3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3 - 5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5 - 10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10 - 20	1.4	0.3	0.6	4.0	4.5	1.8	0.5	0.3	0.4	1.5	1.1	1.4	1.0
20 - 30	0.6	0.1	0.5	2.4	2.1	0.5	0.0	0.0	0.1	0.3	1.1	0.5	1.0
30 - 50	0.4	0.4	1.5	1.5	0.8	0.0	0.2	0.0	0.0	0.8	0.6	0.8	1.5
More 50	0.4	0.0	0.0	0.6	0.8	0.0	0.2	0.0	0.0	0.8	0.4	0.8	1.5
Total	2.8	0.8	2.6	8.5	8.2	2.3	0.9	0.3	0.5	3.4	3.2	3.5	
Sun.,etc	5	4	5	8	5	5	6	4	4	5	4	7	
Workable day	23	23	23	14	18	23	24	27	26	23	23	21	

Workable Day
Excavation

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Excavation
Less 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1 - 3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3 - 5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5 - 10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10 - 20	1.4	0.3	0.6	4.0	4.5	1.8	0.5	0.3	0.4	1.5	1.1	1.4	1.0
20 - 30	0.6	0.1	0.5	2.4	2.1	0.5	0.0	0.0	0.1	0.3	1.1	0.5	1.0
30 - 50	0.4	0.4	1.5	1.5	0.8	0.0	0.2	0.0	0.0	0.8	0.6	0.8	1.5
More 50	0.4	0.0	0.0	0.6	0.8	0.0	0.2	0.0	0.0	0.8	0.4	0.8	1.5
Total	2.8	0.8	2.6	8.5	8.2	2.3	0.9	0.3	0.5	3.4	3.2	3.5	
Sun.,etc	5	4	5	8	5	5	6	4	4	5	4	7	
Workable day	23	23	23	14	18	23	24	27	26	23	23	21	

Workable Day
Concrete Grouting

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Concrete Grouting
Less 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1 - 3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3 - 5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5 - 10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10 - 20	1.4	0.3	0.6	4.0	4.5	1.8	0.5	0.3	0.4	1.5	1.1	1.4	1.0
20 - 30	0.6	0.1	0.5	2.4	2.1	0.5	0.0	0.0	0.1	0.3	1.1	0.5	1.0
30 - 50	0.3	0.3	1.0	1.0	0.5	0.0	0.1	0.0	0.0	0.5	0.4	0.5	1.0
More 50	0.3	0.0	0.0	0.4	0.5	0.0	0.1	0.0	0.0	0.5	0.3	0.5	1.0
Total	2.6	0.7	2.1	7.8	7.6	2.3	0.7	0.3	0.5	2.8	2.9	2.9	
Sun.,etc	5	4	5	8	5	5	6	4	4	5	4	7	
Workable day	23	23	24	14	18	23	24	27	26	23	23	21	

Table K.6 FOREIGN EXCHANGE RATE (As of 31st December)

Year	Month	Rate Per 1 US$
1984		18.1051
1985		16.4993
1986		51.7189
1987		83.7174
1988		125.0000
1989		192.0000
1990		200.0000
1991		230.0000
1992		340.0000
1993	Jan.	350.0000
"	Feb.	350.0000
"	Mar.	350.0000
"	Apr.	365.0000
"	May	365.0000
"	Jun.	395.0000
"	Jul.	436.5355
"	Aug.	461.0000
"	Sep.	474.3952
"	Oct.	454.4391
"	Nov.	457.2841

Table K.7 COMPARISON OF MATERIAL COSTS IN MAY 1993 AND NOVEMBER 1993

Item	Unit	Price level at May 1993 (T.Shs.)	Price level at Nov.1993 (T.Shs.)
Cement,ex-factory	ton	34,000	43,000
Sand,ex-quarry	m3	1,100	1,100
Aggregate,ex-quarry	m3	6,000	7,400
Crusher-run,ex-quarry	m3	5,000	6,100
Fill material,ex-quarry	m3	700	700
Reinforcement	ton	225,000	248,000
Gasoline	lit	223	233
Diesel	lit	155	185
Lubricant	lit	500	520
Grease	kg	700	950
Timber,hard	m3	110,000	125,000
Timber,soft	m3	75,000	75,000
Plywood	m3	400,000	400,000
Structural steel	ton	350,000	410,000
PVC pipe,3"	m	1,180	1,245
PVC pipe,6"	m	3,300	3,380
PVC pipe,8"	m	6,270	6,530
Concrete block	ea	200	220

Table K.8 LABOR COST (WAGE RATE)

Description	Unit	Foreign Currency (US$)	Local Currency (T.Shs.)
Foreman A,foreign	M.D.	275	-
Foreman B,foreign	M.D.	185	-
Foreman A	M.D.	-	2,000
Mechanic A	M.D.	-	1,300
Mechanic B	M.D.	-	1,000
Electrician A	M.D.	-	1,300
Electrician B	M.D.	-	1,000
Operator A,heavy	M.D.	-	1,800
Operator B,light	M.D.	-	1,500
Assistant operator	M.D.	-	1,000
Plant operator	M.D.	-	1,300
Driver A,dump truck	M.D.	-	1,300
Driver B,ordinary	M.D.	-	1,300
Rigger	M.D.	-	1,200
Carpentor	M.D.	-	1,200
Formworker	M.D.	-	1,200
Concrete worker	M.D.	-	1,200
Driller	M.D.	-	1,300
Tunnel worker	M.D.	-	1,500
Pipe fitter	M.D.	-	1,200
Brick worker	M.D.	-	1,200
Mason	M.D.	-	1,200
Plunber	M.D.	-	1,200
Painter	M.D.	-	1,200
Welder	M.D.	-	1,500
Plasterer	M.D.	-	1,200
Powderman	M.D.	-	1,200
Reinforcing worker	M.D.	-	1,200
Boring worker	M.D.	-	1,500
Grout worker	M.D.	-	1,500
Pavement worker	M.D.	-	1,200
Skilled worker	M.D.	-	1,300
Semi skilled worker	M.D.	-	1,000
Common labor	M.D.	-	800

Table K.9 MATERIAL COST

Description	Unit	Foreign Currency (US$)	Local Currency (T.Shs.)
Gasoline	litre	0.43	46
Light oil	litre	0.39	16
Lubricant	litre	1.13	28
Grease	kg	1.65	228
Heavy oil	litre	0.16	22
Portland cement	ton	60.75	23,650
Bitumen 80/100	kg	0.20	41
Bitumen MC30	litre	0.29	60
Emulsion	litre	0.29	60
Reinforcement	ton	388.10	79,360
Annealed wire	kg	0.79	160
H-shape steel	ton	666.67	21,470
Channel steel	ton	491.39	100,480
Steel plate	ton	641.63	131,200
Nail	kg	0.63	128
Dynamite	kg	5.28	972
ANFO	kg	0.55	100
Detonator	No	2.08	384
Timber,plank	m3	32.60	63,750
Timber,square	m3	54.34	106,250
Timber,log	m3	0.00	78,750
Plywood	m3	869.42	20,000
Sand	m3	18.58	2,550
Aggregate	m3	25.44	5,700
Crusher-run	m3	24.02	5,050
Fill/embank material	m3	18.15	2,350
Boulder	m3	22.50	4,350
Chipping	m3	23.91	5,000
Stone	m3	22.50	4,350
Metal form,300*1500	No	26.48	853
Metal form,150*1500	No	19.86	640
Metal form,100*1500	No	18.33	590

Table K.10 EQUIPMENT COST

Description	Unit	Foreign Currency (US$)	Local Currency (T.Shs.)
Bulldoser,32t	Hr	63.50	7,941
Bulldoser,21t	Hr	44.69	5,589
Bulldozer,11t	Hr	22.35	2,795
Bulldozer/ripper,32t	Hr	1.65	228
Backhoe,0.6m3	Hr	26.26	3,284
Tractor shovel,2.2m3	Hr	33.33	4,169
Dump truck,20t	Hr	39.53	4,773
Dump truck,11t	Hr	15.26	1,842
Crawler drill,10m3/min	Hr	24.63	2,733
Jackhammer	Day	8.32	560
Leg drill	Day	11.09	746
Vibrating roller,10t	Hr	38.84	4,601
Vibrating roller,4t	Hr	12.21	1,446
Tire roller,20t	Hr	15.53	1,681
Tamping roller,13-20t	Hr	20.06	2,172
Rammer	Day	8.36	774
Concrete plant,0.75x2	Hr	100.12	11,112
Agitator truck,3m3	Hr	17.09	2,063
Concrete pump car,50m3/h	Hr	42.93	5,184
Air compressor,13m3/min	Day	125.06	13,538
Diesel generator,200KVA	Day	67.48	6,700
Boring machine,5.5kw	Day	44.44	4,811
Boring machine,11kw	Day	83.13	8,999
Grout pump,7.5kw	Day	38.32	4,253
Grout mixer,200x2	Day	19.75	2,192
Drifter drill	Day	11.34	763
Muck loader,0.35m3	Hr	48.55	5,515
Muck car,3m3	Day	24.71	2,868
Concrete placer,3m3	Day	34.94	3,578

Table K.11 LAND ACQUISITION AND COMPENSATION COSTS

Item No.	Work	Unit	Quantity	Unit Price (T.Shs.)	Amount (T.Shs.)	
Kidunda Dam						
	1. Land acquisition					
	a.Crop land					
	Maise	ha	790	33,000	26,070,000	
	Paddy	ha	190	47,000	8,930,000	
	Millet	ha	700	11,000	7,700,000	
	Cotton	ha	270	35,000	9,450,000	
	Banana	no	3,000	2,100	6,300,000	
	Coconut	no	1,500	6,600	9,900,000	
	Mango	no	2,000	4,200	8,400,000	
	b.Forest					
	Below 10cm dia.	no	1,725,000	10	17,250,000	
	690ha x 10,000m2 x 1/4	no				
	Above 20cm dia.	m3	5,399	2,600	14,037,400	
	17,250no.x 0.313m3					
	c.Others (5%)				5,401,870	
	Total (1)				113,439,270	US$ 246,607 (US$ 250,000)
	2. Compensation					
	a.Brick/block house	no	90	3,500,000	315,000,000	
	b.Mud & wattle house	no	910	600,000	546,000,000	
	Total (2)				861,000,000	US$ 1,871,739 (US$ 1,870,000)
	Total (Kidunda Dam)				974,439,270	(US$ 2,120,000)
Mgeta Dam						
	1. Land acquisition	ha	680	34,000	23,120,000	
	113,439,270 TShs x 1/3,300ha = 34,000/ha					
	2. Compensation				0	
	Total (Mgeta Dam)				23,120,000	(US$ 50,000)
Ngerengere Dam						
	1. Land acquisition	ha	2,830	34,000	96,220,000	(US$ 210,000)
	2. Compensation					
	a.Brick/block house	no	20	3,500,000	70,000,000	
	b.Mud & wattle house	no	180	600,000	108,000,000	
	Total (2)				178,000,000	(US$ 390,000)
	Total (Ngerengeren Dam)				274,220,000	(US$ 600,000)
Lower Ruvu Scheme-1 (including Scheme-2)						
	1. Land acquisition	ha	135	50,000	6,750,000	US$ 14,674 (US$ 20,000)
Upper Ruvu Scheme,						
	1. Land acquisition	ha	135	50,000	6,750,000	US$ 14,674 (US$ 20,000)

Table K.12 BREAKDOWN OF CONSTRUCTION COST FOR KIDUNDA DAM (1/2)

Item No.	Work	Unit	Quantity	Foreign Currency (US$)		Local Currency (US$)		Total (US$)	
				Unit Price	Amount	Unit Price	Amount	Unit Price	Amount
I	Direct Construction Cost								
1.	Preparatory Works (General)	L.S.			5,451,000		1,450,000		6,901,000
2.	Permanent Access Road								
	2.1 Improvement of existing rural road	km	90	70000.00	6,300,000	30000.00	2,700,000	100,000.00	9,000,000
	2.2 Construction of new access road	km	10	105000.00	1,050,000	45000.00	450,000	150,000.00	1,500,000
	(Subtotal-2)				7,350,000		3,150,000		10,500,000
3.	Diversion Tunnel and Intake Tunnel								
	3.1 Excavation at tunnel portals,common	m3	70,000	3.40	238,000	0.90	63,000	4.30	301,000
	3.2 Excavation at tunnel portals,rock	m3	210,000	11.50	2,415,000	2.70	567,000	14.20	2,982,000
	3.3 Tunnel excavation	m3	16,000	59.50	952,000	20.00	320,000	79.50	1,272,000
	3.4 Steel support	ton	62	1173.00	72,726	117.00	7,254	1,290.00	79,980
	3.5 Concrete for tunnel lining	m3	4,100	111.20	455,920	55.90	229,190	167.10	685,110
	3.6 Plug concrete	m3	4,000	85.60	342,400	43.00	172,000	128.60	514,400
	3.7 Reinforcement bar	ton	120	528.90	63,468	137.70	16,524	666.60	79,992
	3.8 Backfill grouting	m3	550	90.60	49,830	23.20	12,760	113.80	62,590
	3.9 Others(5 %)	L.S.			229,467		69,386		298,854
	(Subtotal-3)				4,818,811		1,457,114		6,275,926
4.	Main Dam								
	4.1 Excavation,common	m3	22,000	3.40	74,800	0.90	19,800	4.30	94,600
	4.2 Excavation,rock	m3	67,000	11.50	770,500	2.70	180,900	14.20	951,400
	4.3 Embankment,core	m3	240,000	7.10	1,704,000	1.80	432,000	8.90	2,136,000
	4.4 Embankment,filter	m3	110,000	34.80	3,828,000	16.10	1,771,000	50.90	5,599,000
	4.5 Embankment,rock	m3	420,000	12.60	5,292,000	3.00	1,260,000	15.60	6,552,000
	4.6 Blanket grouting	m	8,900	76.50	680,850	23.00	204,700	99.50	885,550
	4.7 Curtain grouting	m	38,000	96.50	3,667,000	27.00	1,026,000	123.50	4,693,000
	4.8 Crest road	m	4,400	70.00	308,000	30.00	132,000	100.00	440,000
	4.9 1 Measuring apparatus(1%)	L.S.			163,252		50,264		213,516
	4.10 Others(5 %)	L.S.			824,420		253,833		1,078,253
	(Subtotal-4)				17,312,822		5,330,497		22,643,319
5.	Spillway								
	5.1 Excavation,common	m3	65,000	3.40	221,000	0.90	58,500	4.30	279,500
	5.2 Excavation,rock	m3	195,000	11.50	2,242,500	0.70	136,500	12.20	2,379,000
	5.3 Concrete,gravity dam	m3	19,000	107.00	2,033,000	52.00	988,000	159.00	3,021,000
	5.4 Reinforcement bar	ton	790	503.80	398,002	137.70	108,783	641.50	506,785
	5.5 Anchor bar	m	670	11.40	7,638	1.90	1,273	13.30	8,911
	5.6 Spillway bridge	m	52	12600.00	655,200	5400.00	280,800	18,000.00	936,000
	5.7 Others(5 %)	L.S.			277,867		78,693		356,560
	(Subtotal-5)				5,835,207		1,652,549		7,487,756

(Continued)

Table K.12 BREAKDOWN OF CONSTRUCTION COST FOR KIDUNDA DAM (2/2)

Item No.	Work	Unit	Quantity	Foreign Currency (US$)		Local Currency (US$)		Total (US$)	
				Unit Price	Amount	Unit Price	Amount	Unit Price	Amount
6.	Architectural Buildings								
	6.1 Control house	m2	200	540.00	108,000	360.00	72,000	900.00	180,000
	6.2 Valve house	m2	50	540.00	27,000	360.00	18,000	900.00	45,000
	6.3 Gate house	m2	30	540.00	16,200	360.00	10,800	900.00	27,000
	(Subtotal-6)				151,200		100,800		252,000
7.	Metal Work								
	7.1 Diversion gates	ton	52	5830.00	303,160	650.00	33,800	6,480.00	336,960
	7.2 Spillway gate(radial)	ton	300	8330.00	2,499,000	930.00	279,000	9,260.00	2,778,000
	7.3 Intake gate	ton	9	7500.00	67,500	830.00	7,470	8,330.00	74,970
	7.4 Outlet facilities	ton	50	15750.00	787,500	1750.00	87,500	17,500.00	875,000
	7.5 Steel pipes(inc. penstock for hydropower)	ton	146	3300.00	481,800	370.00	54,020	3,670.00	535,820
	(Subtotal-7)				4,138,960		461,790		4,600,750
8.	Powerhouse and Generating Equipment	L.S.			14,908,000		2,352,000		17,260,000
	Total of Direct Construction Cost (I)				59,966,000		15,954,750		75,920,750
II	Land Aquisition and Compensation	L.S.			0		2,120,000		2,120,000
III	Administration Expenses	L.S.			0		759,000		759,000
IV	Engineering Services (Detailed design and supervision)	L.S.			7,744,000		1,367,000		9,111,000
	Total(I to IV)				67,710,000		20,200,750		87,910,750
V	Physical Contengency (15%)	L.S.			10,156,000		3,030,000		13,186,000
	Grand Total				77,866,000		23,230,750		101,096,750

Table K.13 BREAKDOWN OF CONSTRUCTION COST FOR MGETA DAM (1/2)

Item No.	Work	Unit	Quantity	Foreign Currency (US$)		Local Currency (US$)		Total (US$)	
				Unit Price	Amount	Unit Price	Amount	Unit Price	Amount
I	Direct Construction Cost								
1.	Preparatory Works (General)	L.S.			5,959,000		1,775,000		7,734,000
2.	Permanent Access Road								
	2.1 Improvement of existing rural road	km	130	70000.00	9,100,000	30000.00	3,900,000	100000.00	13,000,000
	2.2 Construction of new access road	km	12	105000.00	1,260,000	45000.00	540,000	150000.00	1,800,000
	(Subtotal-2)				10,360,000		4,440,000		14,800,000
3.	Diversion Tunnel and Intake Tunnel								
	3.1 Excavation at tunnel portals,common	m3	11,000	3.40	37,400	0.90	9,900	4.30	47,300
	3.2 Excavation at tunnel portals,rock	m3	32,000	11.50	368,000	2.70	86,400	14.20	454,400
	3.3 Tunnel excavation	m3	15,000	59.50	892,500	20.00	300,000	79.50	1,192,500
	3.4 Steel support	ton	78	1173.00	91,494	117.00	9,126	1290.00	100,620
	3.5 Concrete for tunnel lining	m3	4,600	111.20	511,520	55.90	257,140	167.10	768,660
	3.6 Plug concrete	m3	4,900	85.60	419,440	43.00	210,700	128.60	630,140
	3.7 Reinforcement bar	ton	140	528.90	74,046	137.70	19,278	666.60	93,324
	3.8 Backfill grouting	m3	620	90.60	56,172	23.20	14,384	113.80	70,556
	3.9 Others(5 %)	L.S.			122,529		45,346		167,875
	(Subtotal-3)				2,573,101		952,274		3,525,375
4.	Main Dam								
	4.1 Excavation,common	m3	28,000	3.40	95,200	0.90	25,200	4.30	120,400
	4.2 Excavation,rock	m3	82,000	11.50	943,000	2.70	221,400	14.20	1,164,400
	4.3 Embankment,core	m3	420,000	7.10	2,982,000	1.80	756,000	8.90	3,738,000
	4.4 Embankment,filter	m3	180,000	34.80	6,264,000	16.10	2,898,000	50.90	9,162,000
	4.5 Embankment,rock	m3	1,500,000	12.60	18,900,000	3.00	4,500,000	15.60	23,400,000
	4.6 Blanket grouting	m	4,800	76.50	367,200	23.00	110,400	99.50	477,600
	4.7 Curtain grouting	m	12,000	96.50	1,158,000	27.00	324,000	123.50	1,482,000
	4.8 Crest road	m	800	70.00	56,000	30.00	24,000	100.00	80,000
	4.9 Measuring apparatus(1%)	L.S.			307,654		88,590		396,244
	4.10 Others(5 %)	L.S.			1,553,653		447,380		2,001,032
	(Subtotal-4)				32,626,707		9,394,970		42,021,676
5.	Spillway								
	5.1 Excavation,common	m3	50,000	3.40	170,000	0.90	45,000	4.30	215,000
	5.2 Excavation,rock	m3	150,000	11.50	1,725,000	2.70	405,000	14.20	2,130,000
	5.3 Concrete	m3	10,000	98.50	985,000	49.80	498,000	148.30	1,483,000
	5.4 Reinforcement bar	ton	435	503.80	219,153	137.70	59,900	641.50	279,053
	5.5 Anchor bar	m	400	11.40	4,560	1.90	760	13.30	5,320
	5.6 Spillway bridge	m	20	12600.00	252,000	5400.00	108,000	18000.00	360,000
	5.7 Others(5 %)	L.S.			167,786		55,833		223,619
	(Subtotal-5)				3,523,499		1,172,492		4,695,991

(Continued)

Table K.13 BREAKDOWN OF CONSTRUCTION COST FOR MGETA DAM (2/2)

Item No.	Work	Unit	Quantity	Foreign Currency (US$)		Local Currency (US$)		Total (US$)	
				Unit Price	Amount	Unit Price	Amount	Unit Price	Amount
6.	Architectural Buildings								
	6.1 Control house	m2	200	540.00	108,000	360.00	72,000	900.00	180,000
	6.2 Valve house	m2	50	540.00	27,000	360.00	18,000	900.00	45,000
	6.3 Gate house	m2	30	540.00	16,200	360.00	10,800	900.00	27,000
	(Subtotal-6)				151,200		100,800		252,000
7.	Metal Work								
	7.1 Diversion gates	ton	32	8330.00	266,560	930.00	29,760	9260.00	296,320
	7.2 Spillway gate(radial)	ton	112	7500.00	840,000	830.00	92,960	8330.00	932,960
	7.3 Intake gate	ton	10	8330.00	83,300	930.00	9,300	9260.00	92,600
	7.4 Outlet facilities	ton	19	15750.00	299,250	1750.00	33,250	17500.00	332,500
	7.5 Steel pipes(inc. penstock for hydropower)	ton	87	5830.00	507,210	650.00	56,550	6480.00	563,760
	(Subtotal-7)				1,996,320		221,820		2,218,140
8.	Powerhouse and Generating Equipment	L.S.			8,356,000		1,464,000		9,820,000
	Total of Direct Construction Cost (I)				65,545,826		19,521,356		85,067,182
II	Land Aquisition and Compensation	L.S.			0		50,000		50,000
III	Administration Expenses	L.S.			0		851,000		851,000
IV	Engineering Services (Detailed design and supervision)	L.S.			8,677,000		1,531,000		10,208,000
	Total(I to IV)				74,222,826		21,953,356		96,176,182
V	Physical Contengency (15%)	L.S.			11,133,000		3,293,000		14,426,000
	Grand Total				85,355,826		25,246,356		110,602,182

Table K.14 BREAKDOWN OF CONSTRUCTION COST FOR NGERENGERE DAM (1/2)

Item No.	Work	Unit	Quantity	Foreign Currency (US$)		Local Currency (US$)		Total (US$)	
				Unit Price	Amount	Unit Price	Amount	Unit Price	Amount
I	Direct Construction Cost								
1.	Preparatory Works (General)	L.S.			4,837,000		1,467,000		6,304,000
2.	Permanent Access Road								
	2.1 Improvement of existing rural road	km	60	70000.00	4,200,000	30000.00	1,800,000	100000.00	6,000,000
	2.2 Construction of new access road	km	3	105000.00	315,000	45000.00	135,000	150000.00	450,000
	(Subtotal-2)				4,515,000		1,935,000		6,450,000
3.	Diversion Tunnel and Intake Tunnel								
	3.1 Excavation at tunnel portals,common	m3	5,000	3.40	17,000	0.90	4,500	4.30	21,500
	3.2 Excavation at tunnel portals,rock	m3	14,000	11.50	161,000	2.70	37,800	14.20	198,800
	3.3 Tunnel excavation	m3	6,400	59.50	380,800	20.00	128,000	79.50	508,800
	3.4 Steel support	ton	45	1173.00	52,785	117.00	5,265	1290.00	58,050
	3.5 Concrete for tunnel lining	m3	2,800	111.20	311,360	55.90	156,520	167.10	467,880
	3.6 Plug concrete	m3	1,300	85.60	111,280	43.00	55,900	128.60	167,180
	3.7 Reinforcement bar	ton	80	528.90	42,312	137.70	11,016	666.60	53,328
	3.8 Backfill grouting	m3	390	90.60	35,334	23.20	9,048	113.80	44,382
	3.9 Others(5 %)	L.S.			55,594		20,402		75,996
	(Subtotal-3)				1,167,465		428,451		1,595,916
4.	Main Dam								
	4.1 Excavation,common	m3	58,000	3.40	197,200	0.90	52,200	4.30	249,400
	4.2 Excavation,rock	m3	172,000	11.50	1,978,000	2.70	464,400	14.20	2,442,400
	4.3 Embankment,core	m3	510,000	7.10	3,621,000	1.80	918,000	8.90	4,539,000
	4.4 Embankment,filter	m3	220,000	34.80	7,656,000	16.10	3,542,000	50.90	11,198,000
	4.5 Embankment,rock	m3	1,500,000	12.60	18,900,000	3.00	4,500,000	15.60	23,400,000
	4.6 Blanket grouting	m	8,400	76.50	642,600	23.00	193,200	99.50	835,800
	4.7 Curtain grouting	m	24,000	96.50	2,316,000	27.00	648,000	123.50	2,964,000
	4.8 Crest road	m	2,000	70.00	140,000	30.00	60,000	100.00	200,000
	4.9 Measuring apparatus(1%)	L.S.			354,508		103,778		458,286
	4.10 Others(5 %)	L.S.			1,790,265		524,079		2,314,344
	(Subtotal-4)				37,595,573		11,005,657		48,601,230
5.	Spillway								
	5.1 Excavation,common	m3	13,000	3.40	44,200	0.90	11,700	4.30	55,900
	5.2 Excavation,rock	m3	38,000	11.50	437,000	2.70	102,600	14.20	539,600
	5.3 Concrete	m3	11,000	98.50	1,083,500	49.80	547,800	148.30	1,631,300
	5.4 Reinforcement bar	ton	430	503.80	216,634	137.70	59,211	641.50	275,845
	5.5 Anchor bar	m	670	11.40	7,638	1.90	1,273	13.30	8,911
	5.6 Spillway bridge	m	5	12600.00	63,000	5400.00	27,000	18000.00	90,000
	5.7 Others(5 %)	L.S.			92,599		37,479		130,078
	(Subtotal-5)				1,944,571		787,063		2,731,634

(Continued)

Table K.14 BREAKDOWN OF CONSTRUCTION COST FOR NGERENGERE DAM (2/2)

Item No.	Work	Unit	Quantity	Foreign Currency (US$)		Local Currency (US$)		Total (US$)	
				Unit Price	Amount	Unit Price	Amount	Unit Price	Amount
6.	Architectural Buildings								
	6.1 Control house	m2	200	540.00	108,000	360.00	72,000	900.00	180,000
	6.2 Valve house	m2	50	540.00	27,000	360.00	18,000	900.00	45,000
	6.3 Gate house	m2	30	540.00	16,200	360.00	10,800	900.00	27,000
	(Subtotal-6)				151,200		100,800		252,000
7.	Metal Work								
	7.1 Diversion gates	ton	6	5830.00	34,980	650.00	3,900	6480.00	38,880
	7.2 Spillway gate(radial)	ton	28	8330.00	233,240	930.00	26,040	9260.00	259,280
	7.3 Intake gate	ton	6	7500.00	45,000	830.00	4,980	8330.00	49,980
	7.4 Outlet facilities	ton	13	15750.00	204,750	1750.00	22,750	17500.00	227,500
	7.5 Steel pipes(inc. penstock for hydropower)	ton	26	3300.00	85,800	370.00	9,620	3670.00	95,420
	(Subtotal-7)				603,770		67,290		671,060
8.	Powerhouse and Generating Equipment	L.S.			2,392,000		348,000		2,740,000
	Total of Direct Construction Cost (I)				53,206,579		16,139,262		69,345,840
II	Land Aquisition and Compensation	L.S.			0		600,000		600,000
III	Administration Expenses	L.S.			0		693,000		693,000
IV	Engineering Services (Detailed design and supervision)	L.S.			7,073,000		1,248,000		8,321,000
	Total(I to IV)				60,279,579		18,680,262		78,959,840
V	Physical Contengency (15%)	L.S.			9,042,000		2,802,000		11,844,000
	Grand Total				69,321,579		21,482,262		90,803,840

Table K.15 ANNUAL DISBURSEMENT SCHEDULE FOR DAM PROJECT

Annual disbursement schedule - Kidunda dam (Development Scenario-1)

(Unit : 1,000 US$)

Year	Foreign currency	Local currency	Total
-2nd	1,870	330	2,200
-1st	1,870	2,768	4,638
1st	21,676	6,902	28,578
2nd	20,045	6,987	28,032
3rd	14,427	3,110	17,537
4th	16,978	3,134	20,112
Total	77,866	23,231	101,097

Annual disbursement schedule - Mgeta dam (Development Scenario-2)

(Unit : 1,000 US$)

Year	Foreign currency	Local currency	Total
-2nd	2,095	370	2,465
-1st	2,095	427	2,522
1st	14,841	5,177	20,018
2nd	26,137	8,730	34,867
3rd	31,302	8,926	40,228
4th	8,886	1,616	10,502
Total	85,356	25,246	110,602

Annual disbursement schedule - Ngerengere dam (Development Scenario-2)

(Unit : 1,000 US$)

Year	Foreign currency	Local currency	Total
11th	1,708	301	2,009
12th	1,708	991	2,699
13th	9,625	3,194	12,819
14th	26,019	8,213	34,232
15th	26,881	8,215	35,096
16th	3,381	568	3,949
Total	69,322	21,482	90,804

APPENDIX-K

FIGURES

Fig. K.1 IMPLEMENTATION SCHEDULE OF DAM PROJECT BY DEVELOPMENT SCENARIO

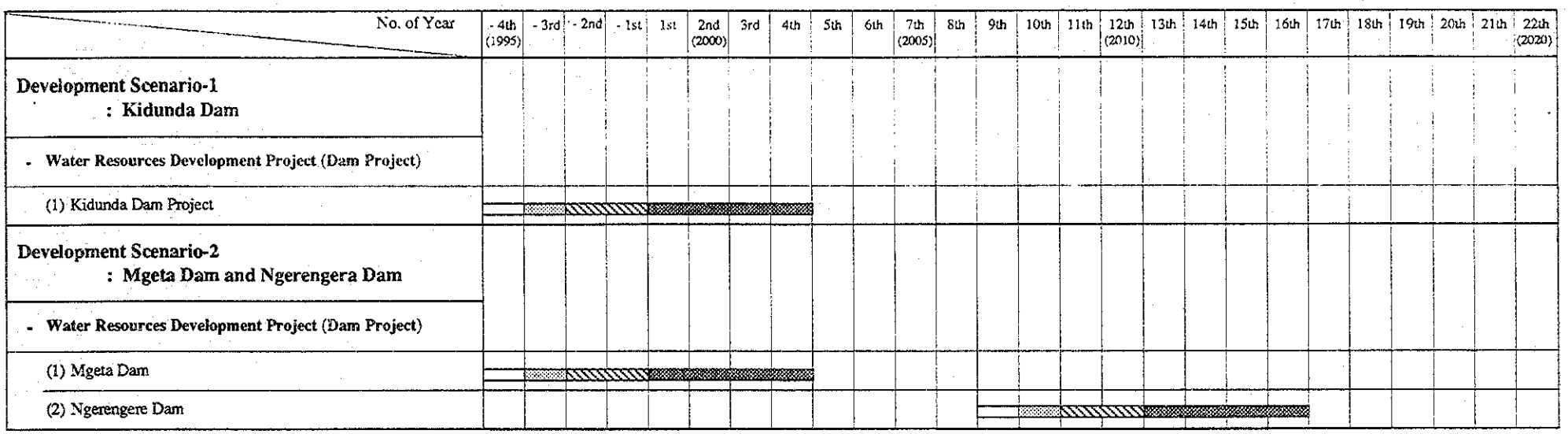


Fig. K.2 CONSTRUCTION SCHEDULE FOR KIDUNDA DAM

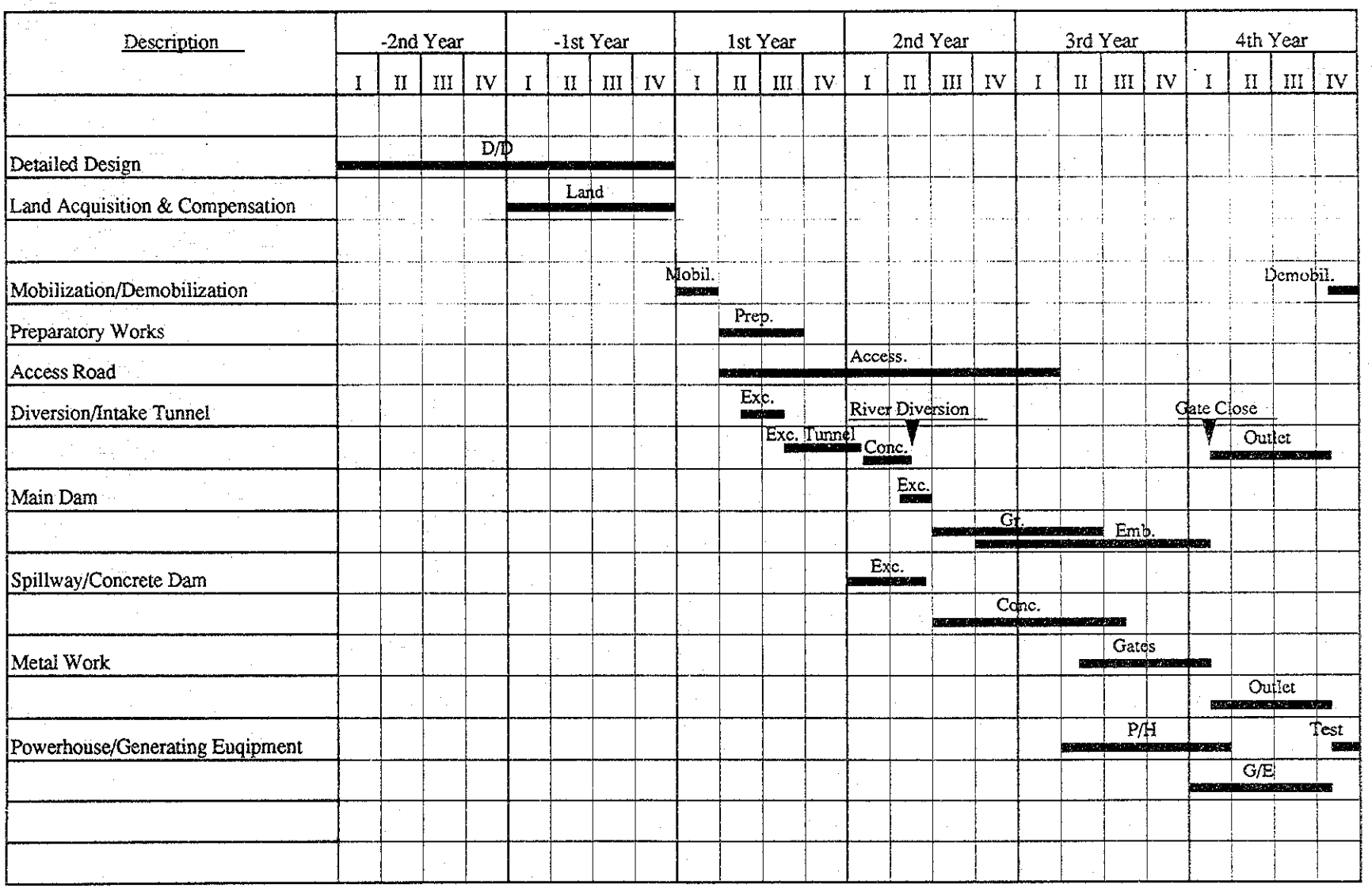


Fig. K.3 CONSTRUCTION SCHEDULE FOR MGETA DAM

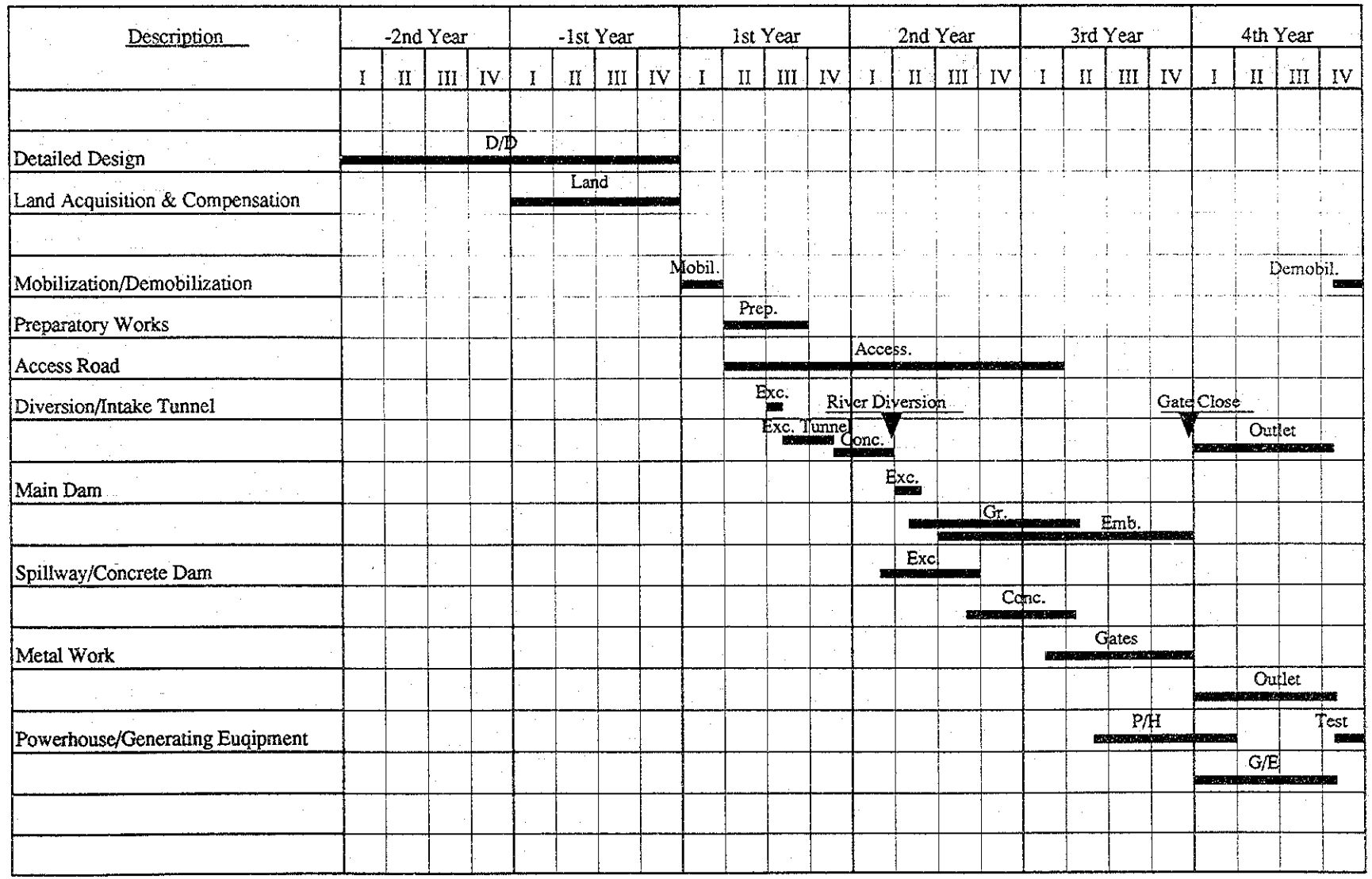
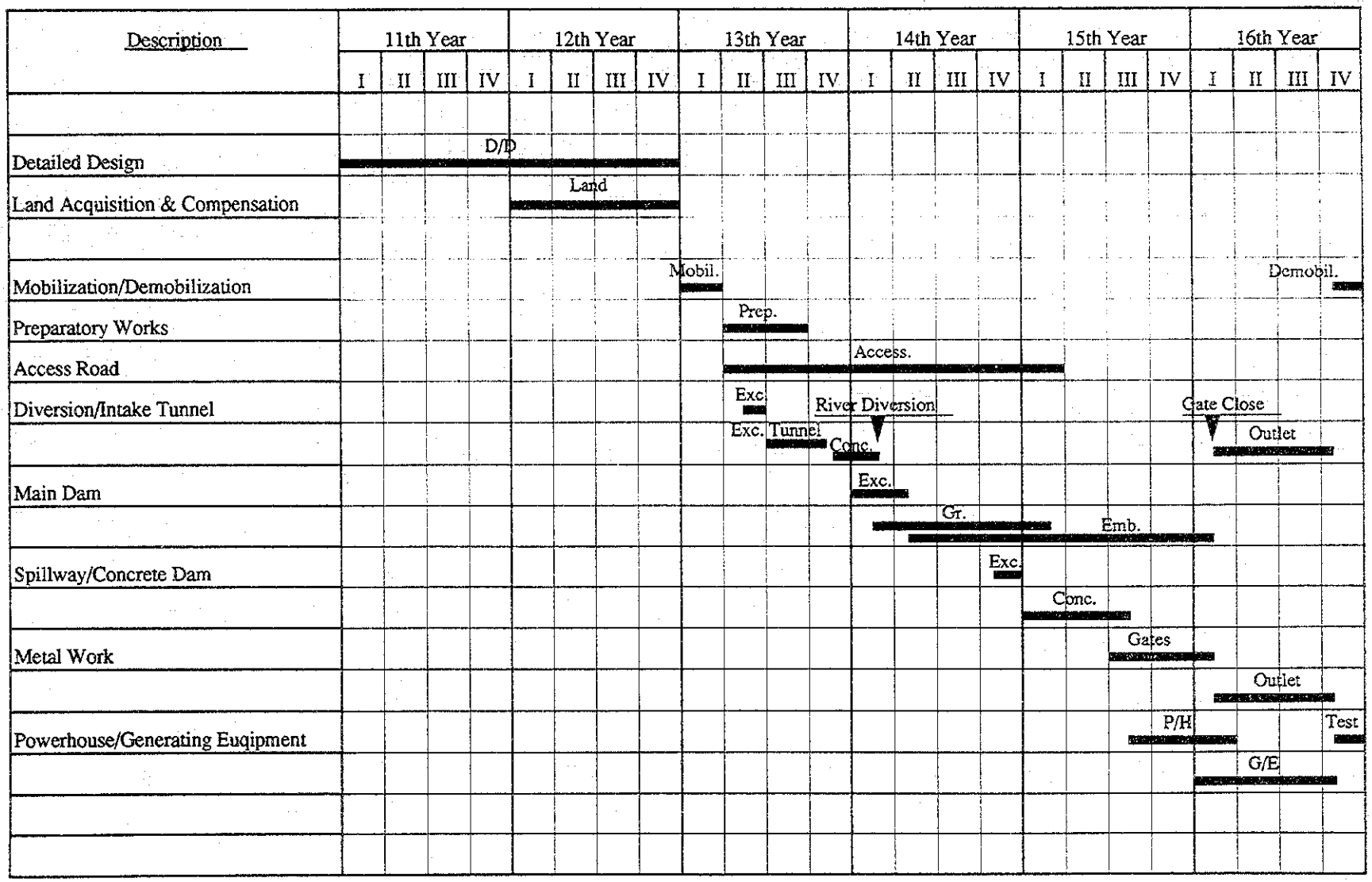


Fig. K.4 CONSTRUCTION SCHEDULE FOR NGERENGERE DAM



ATTACHMENTS TO APPENDIX - K

Attachment-K1 : BREAKDOWN OF CONSTRUCTION COST FOR WATER CONVEYANCE PROJECT

Attachment-K2 : ANNUAL DISBURSEMENT SCHEDULE FOR WATER CONVEYANCE PROJECT

Attachment-K3 : CONSTRUCTION SCHEDULE FOR WATER CONVEYANCE PROJECT

Attachment-K1 : Breakdown of Construction Cost for Water Conveyance Project

Attachment-K1 (1/3) BREAKDOWN OF CONSTRUCTION COST FOR NEW LOWER RUVU SCHEME-1

Item No.	Work	Unit	Quantity	Foreign Currency (US$)		Local Currency (US$)		Total (US$)	
				Unit Price	Amount	Unit Price	Amount	Unit Price	Amount
I	Direct Construction Cost								
1.	Preparatory Works (General)	L.S.			11,860,000		2,727,000		14,587,000
2.	Permanent Access Road								
	2.1 Improvement of existing rural road	km	0	0.00	0	0.00	0	0.00	0
	2.2 Construction of new access road	km	5	105000.00	525,000	45000.00	225,000	150000.00	750,000
	(Subtotal-2)				525,000		225,000		750,000
3.	New Lower Ruvu Intake Weir								
	3.1 Excavation,common	m3	9,300	3.00	27,900	0.60	5,580	3.60	33,480
	3.2 Steel sheet pile	m2	290	150.00	43,500	15.00	4,350	165.00	47,850
	3.3 Concrete pile	m	990	67.30	66,627	34.00	33,660	101.30	100,287
	3.4 Concrete	m3	1,200	107.00	128,400	52.00	62,400	159.00	190,800
	3.5 Reinforcement bar	ton	6	503.80	3,023	137.70	826	641.50	3,849
	3.6 Intake gate	ton	32	7500.00	240,000	830.00	26,560	8330.00	266,560
	3.7 Others(5 %)	L.S.			25,472		6,669		32,141
	(Subtotal-3)				534,922		140,045		674,967
4.	Water supply Facilities								
	4.1 Excavation,common	m3	75,000	3.00	225,000	0.60	45,000	3.60	270,000
	4.2 Embankment	m3	113,000	7.10	802,300	1.80	203,400	8.90	1,005,700
	4.3 Concrete in raw water pump station	m3	860	165.10	141,986	84.80	72,928	249.90	214,914
	4.4 Concrete in clarifires and filters	m3	8,600	165.10	1,419,860	84.80	729,280	249.90	2,149,140
	4.5 Concrete in treated water pumping sta.	m3	440	165.10	72,644	84.80	37,312	249.90	109,956
	4.6 Building works in water chamber	L.S.			145,800		97,200		243,000
	4.7 Building works in treated water chamber	L.S.			842,400		561,600		1,404,000
	4.8 Other building works (admi.,chemi.,storage)	L.S.			1,474,200		982,800		2,457,000
	4.9 Reinforcement bar	ton	600	503.80	302,280	137.70	82,620	641.50	384,900
	4.10 Prestressed concrete pipe,1ntake main,1350mm dia.	m	500	440.00	220,000	110.00	55,000	550.00	275,000
	4.11 Others(5 %)	L.S.			282,324		143,357		425,681
	(Subtotal-4)				5,928,794		3,010,497		8,939,291
5.	Metal and Electrical Works for Water Treatment Facilities								
	5.1 Raw water pumps (400kw x 4 units)	L.S.			964,800		107,200		1,072,000
	5.2 Water treatment facilities(inline mixing)	L.S.			30,690,000		3,410,000		34,100,000
	5.3 Booster pumps (2000kw x 6 units)	L.S.			7,236,000		804,000		8,040,000
	5.4 Others(5 %)	L.S.			1,944,540		216,060		2,160,600
	(Subtotal-5)				40,835,340		4,537,260		45,372,600

(Continued)

Item No.	Work	Unit	Quantity	Foreign Currency (US$)		Local Currency (US$)		Total (US$)	
				Unit Price	Amount	Unit Price	Amount	Unit Price	Amount
6.	New Transmission Main								
	6.1 Excavation	m3	970,000	3.00	2,910,000	0.60	582,000	3.60	3,492,000
	6.2 Backfill,sand	m3	420,000	19.00	7,980,000	5.70	2,394,000	24.70	10,374,000
	6.3 Backfill,random	m3	400,000	2.10	840,000	0.60	240,000	2.70	1,080,000
	6.4 Slab concrete	m3	6,100	69.00	420,900	35.50	216,550	104.50	637,450
	6.5 Reinforcement bar	ton	61	503.80	30,732	137.70	8,400	641.50	39,132
	6.6 Prestressed concrete pipe,1900mm dia.	m	55,000	888.00	48,840,000	222.00	12,210,000	1110.00	61,050,000
	6.7 Others(5 %)	L.S.			3,051,082		782,547		3,833,629
	(Subtotal-6)				64,072,713		16,433,497		80,506,211
7.	Extension of University Reservoir								
	7.1 Excavation	m3	18,000	3.00	54,000	0.60	10,800	3.60	64,800
	7.2 Concrete	m3	46,000	107.00	4,922,000	52.00	2,392,000	159.00	7,314,000
	7.3 Reinforcement bar	ton	2,800	503.80	1,410,640	137.70	385,560	641.50	1,796,200
	7.4 Others(5 %)	L.S.			319,332		139,418		458,750
	(Subtotal-7)				6,705,972		2,927,778		9,633,750
	Total of Direct Construction Cost (I)				130,462,741		30,001,077		160,463,818
II	Land Aquisition and Compensation	L.S.			0		20,000		20,000
III	Administration Expenses	L.S.			0		1,605,000		1,605,000
IV	Engineering Services (Detailed design and supervision)	L.S.			16,367,000		2,888,000		19,255,000
	Total(I to IV)				146,829,741		34,514,077		181,343,818
V	Physical Contengency (15%)	L.S.			22,024,000		5,177,000		27,201,000
	Grand Total				168,853,741		39,691,077		208,544,818

Attachment-K1 (2/3) BREAKDOWN OF CONSTRUCTION COST FOR NEW LOWER RUVU SCHEME-2

Item No.	Work	Unit	Quantity	Foreign Currency (US$)		Local Currency (US$)		Total (US$)	
				Unit Price	Amount	Unit Price	Amount	Unit Price	Amount
I	Direct Construction Cost								
1.	Preparatory Works (General)	L.S.			5,347,000		1,048,000		6,395,000
2.	Permanent Access Road								
	2.1 Improvement of existing rural road	km	0	0.00	0	0.00	0	0.00	0
	2.2 Construction of new access road	km	0	105000.00	0	45000.00	0	150000.00	0
	(Subtotal-2)				0		0		0
3.	New Lower Ruvu Intake Weir								
	3.1 Excavation,common	m3	0	3.00	0	0.60	0	3.60	0
	3.2 Steel sheet pile	m2	0	150.00	0	15.00	0	165.00	0
	3.3 Concrete pile	m	0	67.30	0	34.00	0	101.30	0
	3.4 Concrete	m3	0	107.00	0	52.00	0	159.00	0
	3.5 Reinforcement bar	ton	0	503.80	0	137.70	0	641.50	0
	3.6 Intake gate	ton	0	7500.00	0	830.00	0	8330.00	0
	3.7 Others(5 %)	L.S.			0		0		0
	(Subtotal-3)				0		0		0
4.	Water supply Facilities								
	4.1 Excavation,common	m3	75,000	3.00	225,000	0.60	45,000	3.60	270,000
	4.2 Embankment	m3	113,000	7.10	802,300	1.80	203,400	8.90	1,005,700
	4.3 Concrete in raw water pump station	m3	860	165.10	141,986	84.80	72,928	249.90	214,914
	4.4 Concrete in clarifires and filters	m3	8,600	165.10	1,419,860	84.80	729,280	249.90	2,149,140
	4.5 Concrete in treated water pumping sta.	m3	440	165.10	72,644	84.80	37,312	249.90	109,956
	4.6 Building works in water chamber	L.S.			145,800		97,200		243,000
	4.7 Building works in treated water chamber	L.S.			842,400		561,600		1,404,000
	4.8 Other building works (admi.,chemi.,storage)	L.S.			1,474,200		982,800		2,457,000
	4.9 Reinforcement bar	ton	600	503.80	302,280	137.70	82,620	641.50	384,900
	4.10 Prestressed concrete pipe,1ntake main,1350mm dia.	m	500	440.00	220,000	110.00	55,000	550.00	275,000
	4.11 Others(5 %)	L.S.			282,324		143,357		425,681
	(Subtotal-4)				5,928,794		3,010,497		8,939,291
5.	Metal and Electrical Works for Water Treatment Facilities								
	5.1 Raw water pumps (400kw x 4 units)	L.S.			964,800		107,200		1,072,000
	5.2 Water treatment facilities(inline mixing)	L.S.			30,690,000		3,410,000		34,100,000
	5.3 Booster pumps (2000kw x 6 units)	L.S.			7,236,000		804,000		8,040,000
	5.4 Others(5 %)	L.S.			1,944,540		216,060		2,160,600
	(Subtotal-5)				40,835,340		4,537,260		45,372,600

(Continued)

Item No.	Work	Unit	Quantity	Foreign Currency (US$)		Local Currency (US$)		Total (US$)	
				Unit Price	Amount	Unit Price	Amount	Unit Price	Amount
6.	New Transmission Main								
	6.1 Excavation	m3	0	3.00	0	0.60	0	3.60	0
	6.2 Backfill,sand	m3	0	19.00	0	5.70	0	24.70	0
	6.3 Backfill,random	m3	0	2.10	0	0.60	0	2.70	0
	6.4 Slab concrete	m3	0	69.00	0	35.50	0	104.50	0
	6.5 Reinforcement bar	ton	0	503.80	0	137.70	0	641.50	0
	6.6 Prestressed concrete pipe,1900mm dia.	m	0	888.00	0	222.00	0	1110.00	0
	6.7 Others(5 %)	L.S.			0		0		0
	(Subtotal-6)				0		0		0
7.	Extension of University Reservoir								
	7.1 Excavation	m3	18,000	3.00	54,000	0.60	10,800	3.60	64,800
	7.2 Concrete	m3	46,000	107.00	4,922,000	52.00	2,392,000	159.00	7,314,000
	7.3 Reinforcement bar	ton	2,800	503.80	1,410,640	137.70	385,560	641.50	1,796,200
	7.4 Others(5 %)	L.S.			319,332		139,418		458,750
	(Subtotal-7)				6,705,972		2,927,778		9,633,750
	Total of Direct Construction Cost (I)				58,817,106		11,523,535		70,340,641
II	Land Aquisition and Compensation	L.S.			0		0		0
III	Administration Expenses	L.S.			0		703,000		703,000
IV	Engineering Services (Detailed design and supervision)	L.S.			7,175,000		1,266,000		8,441,000
	Total(I to IV)				65,992,106		13,492,535		79,484,641
V	Physical Contengency (15%)	L.S.			9,899,000		2,024,000		11,923,000
	Grand Total				75,891,106		15,516,535		91,407,641

Attachment-K1 (3/3) BREAKDOWN OF CONSTRUCTION COST FOR NEW UPPER RUVU SCHEME

Item No.	Work	Unit	Quantity	Foreign Currency (US$)		Local Currency (US$)		Total (US$)	
				Unit Price	Amount	Unit Price	Amount	Unit Price	Amount
I	Direct Construction Cost								
1.	Preparatory Works (General)	L.S.			9,190,000		1,999,000		11,189,000
2.	Permanent Access Road								
	2.1 Improvement of existing rural road	km	0	0.00	0	0.00	0	0.00	0
	2.2 Construction of new access road	km	5	105000.00	525,000	45000.00	225,000	150000.00	750,000
	(Subtotal-2)				525,000		225,000		750,000
3.	New Lower Ruvu Intake Weir								
	3.1 Excavation,common	m3	6,200	3.00	18,600	0.60	3,720	3.60	22,320
	3.2 Steel sheet pile	m2	190	150.00	28,500	15.00	2,850	165.00	31,350
	3.3 Concrete pile	m	660	67.30	44,418	34.00	22,440	101.30	66,858
	3.4 Concrete	m3	790	107.00	84,530	52.00	41,080	159.00	125,610
	3.5 Reinforcement bar	ton	4	503.80	2,015	137.70	551	641.50	2,566
	3.6 Intake gate	ton	21	7500.00	157,500	830.00	17,430	8330.00	174,930
	3.7 Others(5 %)	L.S.			16,778		4,404		21,182
	(Subtotal-3)				352,341		92,474		444,816
4.	Water supply Facilities								
	4.1 Excavation,common	m3	75,000	3.00	225,000	0.60	45,000	3.60	270,000
	4.2 Embankment	m3	113,000	7.10	802,300	1.80	203,400	8.90	1,005,700
	4.3 Concrete in raw water pump station	m3	860	165.10	141,986	84.80	72,928	249.90	214,914
	4.4 Concrete in clarifires and filters	m3	8,600	165.10	1,419,860	84.80	729,280	249.90	2,149,140
	4.5 Concrete in treated water pumping sta.	m3	440	165.10	72,644	84.80	37,312	249.90	109,956
	4.6 Building works in water chamber	L.S.			145,800		97,200		243,000
	4.7 Building works in treated water chamber	L.S.			842,400		561,600		1,404,000
	4.8 Other building works (admi.,chemi.,storage)	L.S.			1,474,200		982,800		2,457,000
	4.9 Reinforcement bar	ton	600	503.80	302,280	137.70	82,620	641.50	384,900
	4.10 Prestressed concrete pipe,1ntake main,1350mm dia.	m	6,000	440.00	2,640,000	110.00	660,000	550.00	3,300,000
	4.11 Others(5 %)	L.S.			403,324		173,607		576,931
	(Subtotal-4)				8,469,794		3,645,747		12,115,541
5.	Metal and Electrical Works for Water Treatment Facilities								
	5.1 Raw water pumps (900kw x 4 units)	L.S.			2,170,800		241,200		2,412,000
	5.2 Water treatment facilities(inline mixing)	L.S.			30,690,000		3,410,000		34,100,000
	5.3 Booster pumps (1900kw x 8 units)	L.S.			9,165,600		1,018,400		10,184,000
	5.4 Others(5 %)	L.S.			2,101,320		233,480		2,334,800
	(Subtotal-5)				44,127,720		4,903,080		49,030,800

(Continued)

Item No.	Work	Unit	Quantity	Foreign Currency (US$)		Local Currency (US$)		Total (US$)	
				Unit Price	Amount	Unit Price	Amount	Unit Price	Amount
6.	New Transmission Main								
	6.1 Excavation	m3	630,000	3.00	1,890,000	0.60	378,000	3.60	2,268,000
	6.2 Backfill,sand	m3	260,000	19.00	4,940,000	5.70	1,482,000	24.70	6,422,000
	6.3 Backfill,random	m3	300,000	2.10	630,000	0.60	180,000	2.70	810,000
	6.4 Slab concrete	m3	4,200	69.00	289,800	35.50	149,100	104.50	438,900
	6.5 Reinforcement bar	ton	42	503.80	21,160	137.70	5,783	641.50	26,943
	6.6 Prestressed concrete pipe,1350mm dia.	m	51,000	440.00	22,440,000	110.00	5,610,000	550.00	28,050,000
	6.7 Others(5 %)	L.S.			1,510,548		390,244		1,900,792
	(Subtotal-6)				31,721,508		8,195,128		39,916,635
7.	Extension of University Reservoir								
	7.1 Excavation	m3	18,000	3.00	54,000	0.60	10,800	3.60	64,800
	7.2 Concrete	m3	46,000	107.00	4,922,000	52.00	2,392,000	159.00	7,314,000
	7.3 Reinforcement bar	ton	2,800	503.80	1,410,640	137.70	385,560	641.50	1,796,200
	7.4 Others(5 %)	L.S.			319,332		139,418		458,750
	(Subtotal-7)				6,705,972		2,927,778		9,633,750
	Total of Direct Construction Cost (I)				101,092,334		21,988,207		123,080,541
II	Land Aquisition and Compensation	L.S.			0		20,000		20,000
III	Administration Expenses	L.S.			0		1,231,000		1,231,000
IV	Engineering Services (Detailed design and supervision)	L.S.			12,554,000		2,215,000		14,769,000
	Total(I to IV)				113,646,334		25,454,207		139,100,541
V	Physical Contengency (15%)	L.S.			17,047,000		3,818,000		20,865,000
	Grand Total				130,693,334		29,272,207		159,965,541

Attachment-K2 : Annual Disbursement Schedule for Water Conveyance Project

Attachment-K2 (1/3) **ANNUAL DISBURSEMENT SCHEDULE FOR FOR NEW LOWER RUVU SCHEME - 1**

(Unit : 1,000 US$)

Year	Foreign currency	Local currency	Total
-2nd	1,641	349	1,995
-1st	3,294	720	4,014
1st	10,576	2,390	12,966
2nd	46,341	11,443	57,784
3rd	57,685	12,873	70,558
4th	49,312	11,916	61,228
Total	168,854	39,691	208,545

Attachment-K2 (2/3) **ANNUAL DISBURSEMENT SCHEDULE FOR FOR NEW LOWER RUVU SCHEME - 2**

(Unit : 1,000 US$)

Year	Foreign currency	Local currency	Total
5th	1,733	306	2,039
6th	1,733	306	2,039
7th	9,289	2,423	11,712
8th	31,152	5,277	36,429
9th	31,984	7,205	39,189
Total	75,891	15,517	91,408

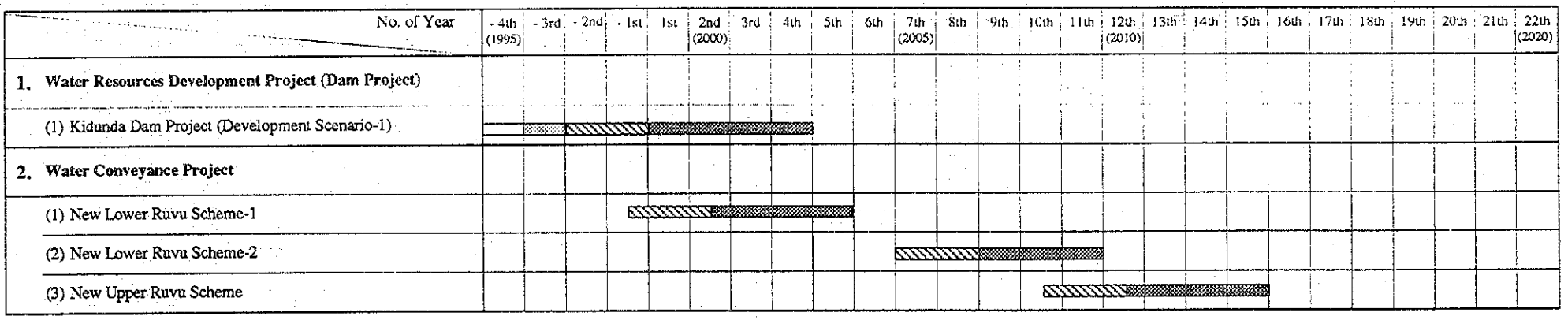
Attachment-K2 (3/3) **ANNUAL DISBURSEMENT SCHEDULE FOR FOR NEW UPPER RUVU SCHEME**

(Unit : 1,000 US$)

Year	Foreign currency	Local currency	Total
8th	1,516	267	1,783
9th	3,032	558	3,590
10th	8,288	1,792	10,080
11th	34,537	8,318	42,855
12th	44,810	9,354	54,164
13th	38,511	8,983	47,494
Total	130,694	29,272	159,966

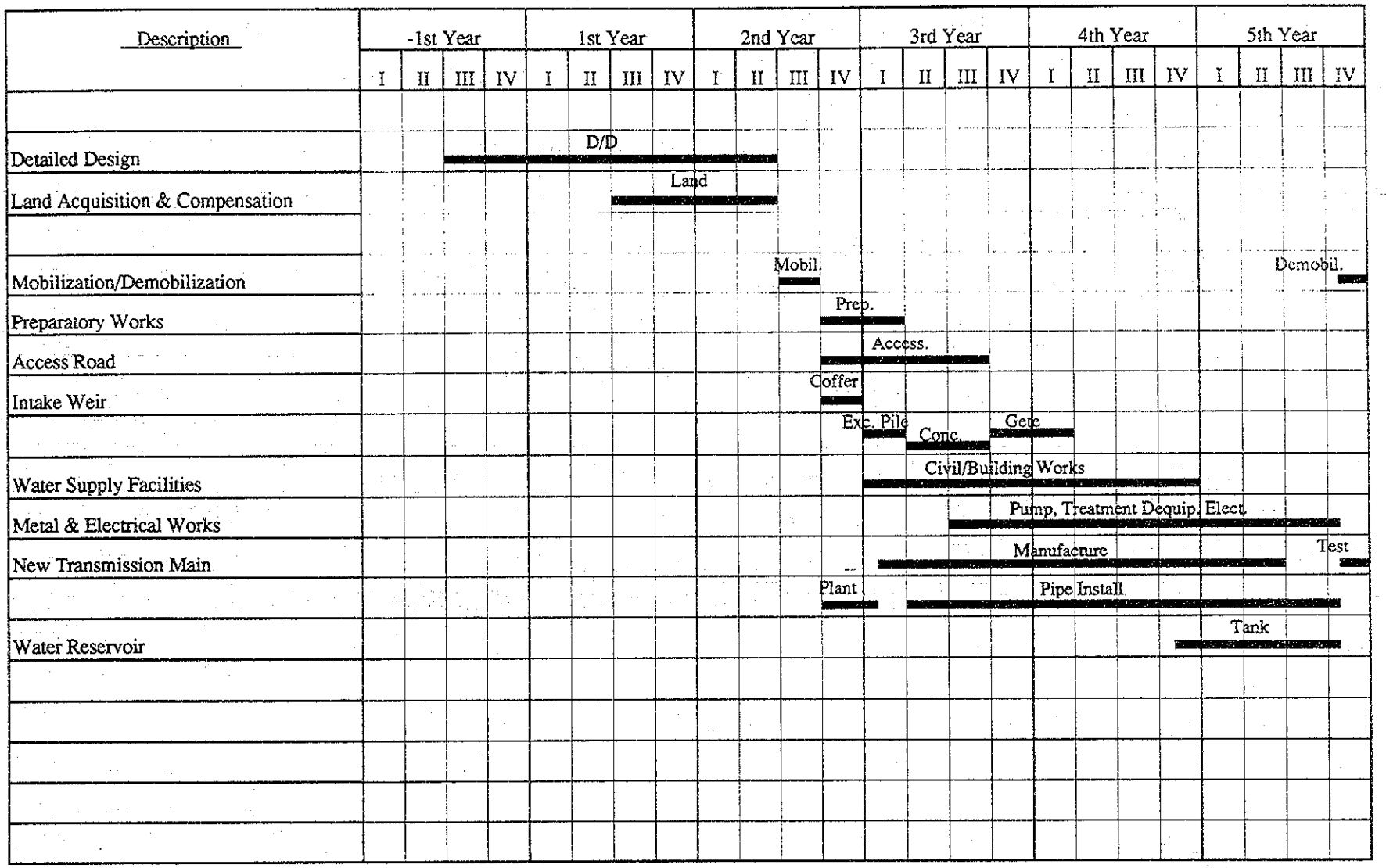
Attachment-K3 : Construction Schedule for Water Conveyance Project

Attachment-K3 (1/4) OVERALL IMPLEMENTATION SCHEDULE OF WATER CONVEYANCE PROJECT

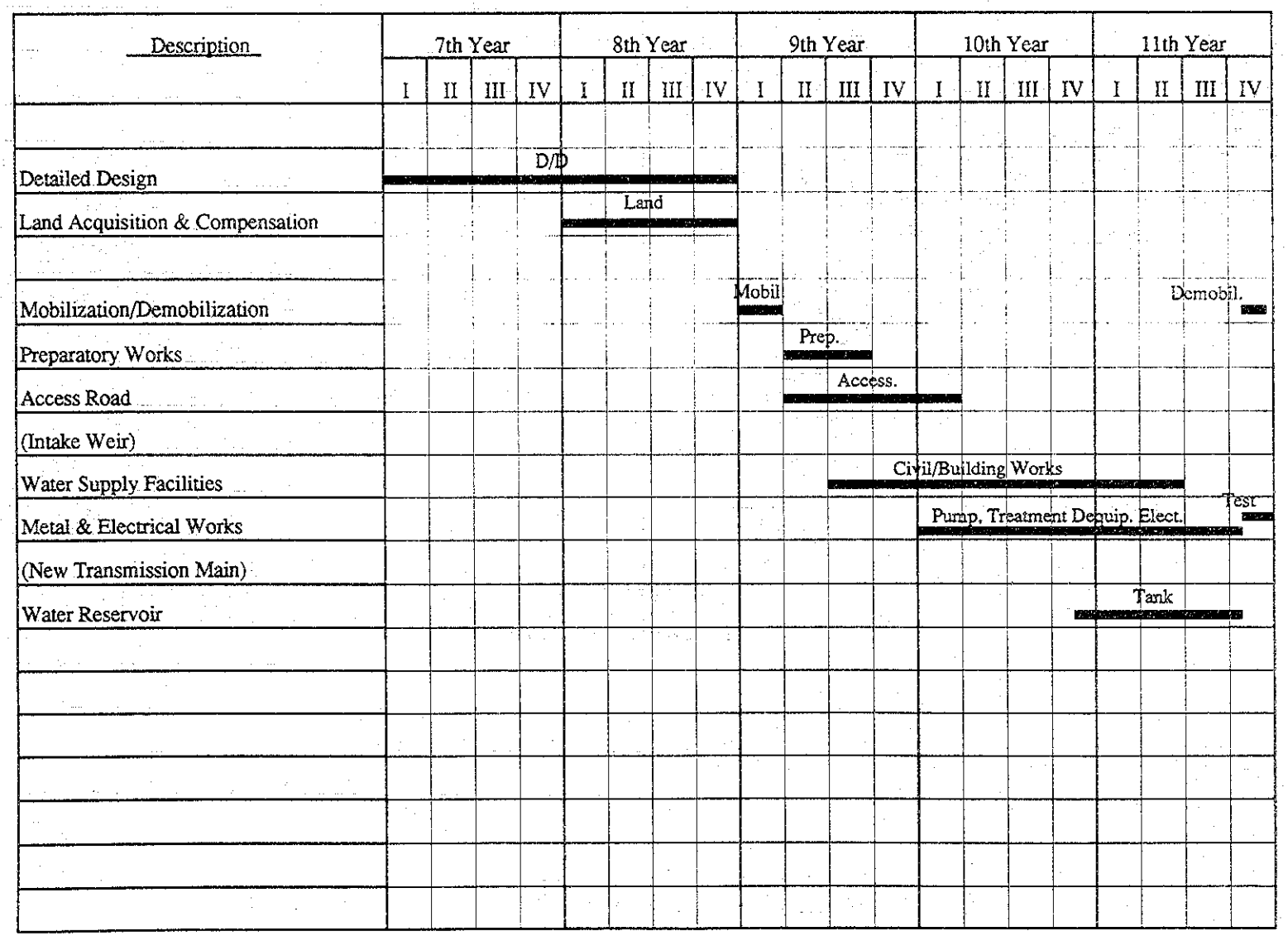


Legend: Pre-Feasibility Study : Feasibility Study : Detailed Design : Construction

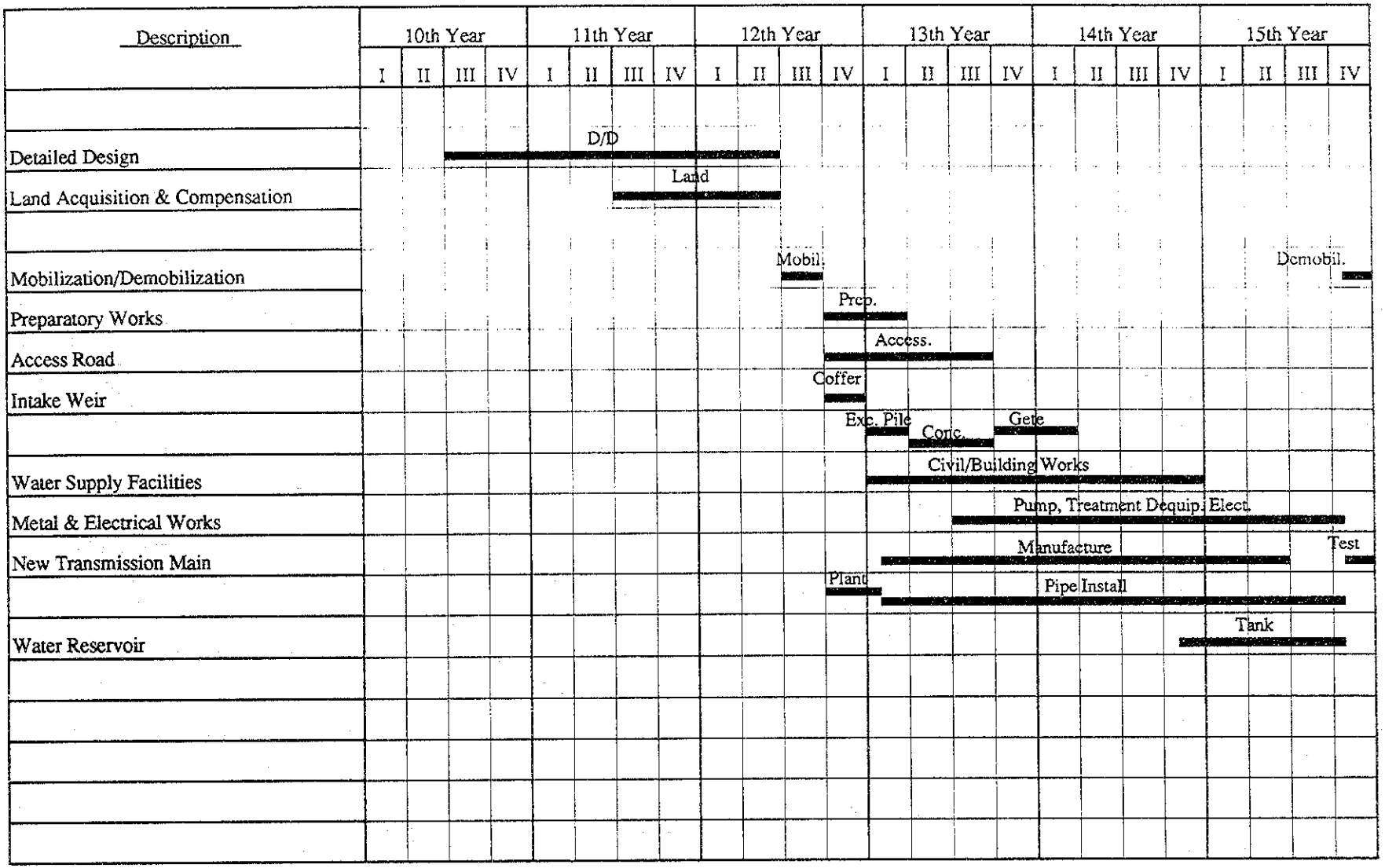
Attachment-K3 (2/4) **CONSTRUCTION SCHEDULE FOR NEW LOWER RUVU SCHEME - 1**



Attachment-K3 (3/4) CONSTRUCTION SCHEDULE FOR NEW LOWER RUVU SCHEME - 2



Attachment-K3 (4/4) **CONSTRUCTION SCHEDULE FOR NEW UPPER RUVU SCHEME**



APPENDIX - L

ECONOMIC EVALUATION ON WATER RESOURCES DEVELOPMENT PLAN

APPENDIX - L
ECONOMIC EVALUATION ON WATER RESOURCES DEVELOPMENT PLAN

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