Table G.3.2 ESTIMATE OF POWER BENEFIT

Scheme	Dependable P. Power		Firm		Secondary		Total
	Peak Power (MW)	Benefit (US10^3)	Energy (GWh)	Benefit (US10^3)	Energy (GWh)	Benefit (US10^3)	Benefit (US10^3)
1. Watawala	15.9	1,480	31	2,090	18	540	4,110
2. Ulapane	40.6	3,780	75	5,060	16	480	9,320
3. Caledonia	44.0	4,090	70	4,720	65	1,940	10,750
4. Talawakele	204.0	18,980	364	24,530	310	9,240	52,750
5. Kotmale Extension	39.0	3,630	209	14,090	-150	-4,470	13,250
6. Upper Uma Oya (Scheme-1000)	128.9	11,990	201	13,550	141	4,200	29,740
7. Lower Uma Oya (Scheme 500)	96.0	8,930	192	12,940	118	3,520	25,390
8. Wewatenna	19.7	1,830	36	2,430	33	980	5,240
9. Sudu Ganga	23.8	2,210	74	4,990	48	1,430	8,630

Remark: * shows only incremental values.

Table G.3.3 ESTIMATE OF INCREMENTAL BENEFIT

Scheme	95% Dependable Discharge (m3/s)	Firm Discharge After Regulation (m3/s)	Incremental Firm Discharge (m3/s)	Total Net Head m	Incremental Firm Energy (10^3 GWh)	Incre-mental Benefit (US10^3)
1. Watawala	0.5	2.3	1.8	415	37.5	1,410
2. Ulapane	1.7	9.5	7.8	306	119.9	4,510
3. Caledonia	1.7	6.7	5.0	507	127.3	4,790
4. Talawakele	-	-	-	-	-	-
5. Kotmale Extension	29.8	16.8	13.0	300	203.6	7,660
6. Upper Uma Oya	-	4.9	7.9	78	30.9	2,080 <1
(Scheme -1000)	-	1.5	1.5	38	4.4	130 <2
						2,210 <3
7. Lower Uma Oya	-	1.2	1.2	78	7.2	490 <1
(Scheme -500)	-	3.0	3.0	38	8.8	260 <2
						750 <3
8. Wewatenna	-	-	-	-	-	-
9. Sudu Ganga	1.8	4.1	2.3	110	19.5	730

Remarks: <1 Incremental benefit for Randenigala
<2 Incremental benefit for Rantembe
<3 Total incremental benefit

Table G.3.4 SUMMARY OF COST ESTIMATE AND ECONOMIC COST OF PROPOSED HYDROPOWER SCHEMES (1/2)

(Unit: US$10^3)

Item	Watawala	Ulapane	Caledonia	Talawakele	Kotmale Extension
1. Construction Cost					
(1) Direct Cost					
General items	3,300	3,300	5,400	12,800	9,900
Diversion tunnel/canal	1,400	2,300	-	-	-
Main dam	10,000	23,600	42,600	4,000	141,000
Spillway	-	4,100	-	-	19,600
Tributary intake (1)	-	-	4,800	9,300	-
Tributary intake (2)	-	-	-	-	-
Intake	200	300	900	1,700	-
Headrace tunnel	3,100	20,100	9,400	47,200	-
Surge tank	500	1,200	1,300	3,600	-
Penstock	200	200	1,000	3,600	-
Powerhouse	1,700	4,400	21,700	26,000	-
Hydromech. works	2,600	6,100	3,100	9,800	7,500
Electrical works	9,600	18,500	13,900	41,200	-
Sub-total	32,600	84,100	104,100	159,200	178,000
(2) Indirect Cost	11,600	32,900	52,300	56,600	58,600
(3) Total Const.Cost	44,200	117,000	156,400	215,700	236,600
2. Allocated Const. Cost	44,200	117,000	97,800 <1 101,900 <2	274,300 <1 270,200 <2	236,600
3. Economic Cost	42,800	112,000	94,400 <1 98,300 <2	264,700 <1 260,700 <2	228,300
4. Annual Cost	4,400	11,400	9,600 <1 10,000 <2	26,900 <1 26,500 <2	23,200

Remarks: <1: Case 1 (not including incremental benefit)
<2: Case 2 (including incremental benefit)

Table G.3.4 SUMMARY OF COST ESTIMATE AND ECONOMIC COST OF PROPOSED HYDROPOWER SCHEMES (2/2)

(Unit: US$10^3)

Item	Upper Uma Oya Scheme-1000	Lower Uma Oya Scheme-500	Wewatenna	Sudu Ganga
1. Construction Cost				
(1) Direct Cost				
General items	5,000	4,400	3,900	3,900
Diversion tunnel/canal	2,200	2,900	2,700	2,900
Main dam	36,400	17,400	27,800	15,600
Spillway	3,300	-	3,800	3,500
Tributary intake (1)	13,900	11,600	-	-
Tributary intake (2)	11,600	-	-	-
Intake	300	400	200	200
Headrace tunnel	49,200	67,700	6,200	-
Surge tank	1,800	800	1,300	-
Penstock	3,300	4,800	100	-
Powerhouse	8,300	7,500	2,500	4,100
Hydromech. works	23,400	30,100	3,400	5,200
Electrical works	27,300	23,700	11,400	24,800
Sub-total	186,000	171,300	63,300	60,200
(2) Indirect Cost	63,100	57,200	22,200	22,900
(3) Total Const.Cost	249,100	228,500	85,500	83,100
2. Allocated Const. Cost	249,100	228,500	85,500	83,100
3. Economic Cost	240,000	220,500	82,500	80,800
4. Annual Cost	24,400	22,400	8,400	8,200

Table G.3.5 INDEPENDENT ECONOMIC EVALUATION OF HYDROPOWER SCHEMES (1) WITHOUT INCREMENTAL (CASE 1)

	Construction Cost (US$10^3)	Annual Energy (GWh)	Unit Const. Cost (US$/kWh)	Annual* Economic Cost (US$10^3)	Annual Benefit (US$10^3)	Annual Net Benefit (US$10^3)	Benefit-Cost Ratio	Ranking
(1) Watawela	44,200	49	0.90	4,400	4,110	-290	0.93	6
(2) Ulapane	117,000	91	1.29	11,400	9,320	-2,080	0.82	7
(3) Caledonia	156,400	135	1.16	9,600	10,750	1,150	1.12	4
(4) Talawakele	215,700	674	0.32	26,900	52,750	25,850	1.96	1
(5) Kotmale Extension	236,600	59	4.01	23,200	13,250	-9,950	0.57	9
(6) Upper Uma Oya (Scheme - 1000)	249,100	342	0.72	24,400	29,740	5,340	1.22	2
(7) Lower Uma Oya (Scheme - 500)	228,500	310	0.74	22,400	25,390	2,990	1.13	3
(8) Wewatenna	85,500	69	1.24	8,400	5,240	-3,160	0.62	8
(9) Sudu Ganga	83,100	122	0.68	8,200	8,630	430	1.05	5

Remarks: Discount rate = 10%.

Table G.3.6 INDEPENDENT ECONOMIC EVALUATION OF HYDROPOWER SCHEMES (2) WITH INCREMENTAL (CASE 2)

	Construction Cost (US$10^3)	Annual Energy (GWh)	Unit Const. Cost (US$/kWh)	Annual* Economic Cost (US$10^3)	Annual Benefit (US$10^3)	Annual Net Benefit (US$10^3)	Benefit-Cost Ratio	Ranking
(1) Watawela	44,200	87	0.51	4,400	5,520	1,120	1.25	4
(2) Ulapane	117,000	211	0.55	11,400	13,830	2,430	1.21	5
(3) Caledonia	101,900	262	0.48	10,000	15,540	5,540	1.55	2
(4) Talawakele	270,200	674	0.40	26,500	52,750	26,250	1.99	1
(5) Kotmale Extension	236,600	263	0.90	23,200	20,910	-2,290	0.90	8
(6) Upper Uma Oya (Scheme - 1000)	249,100	373	0.67	24,400	31,950	7,550	1.31	3
(7) Lower Uma Oya (Scheme - 500)	228,500	314	0.73	22,400	26,140	3,740	1.17	6
(8) Wewatenna	85,500	69	1.24	8,400	5,240	-3,160	0.62	9
(9) Sudu Ganga	83,100	142	0.59	8,200	9,360	1,160	1.14	7

Remarks: Discount rate = 10%.

FIGURES

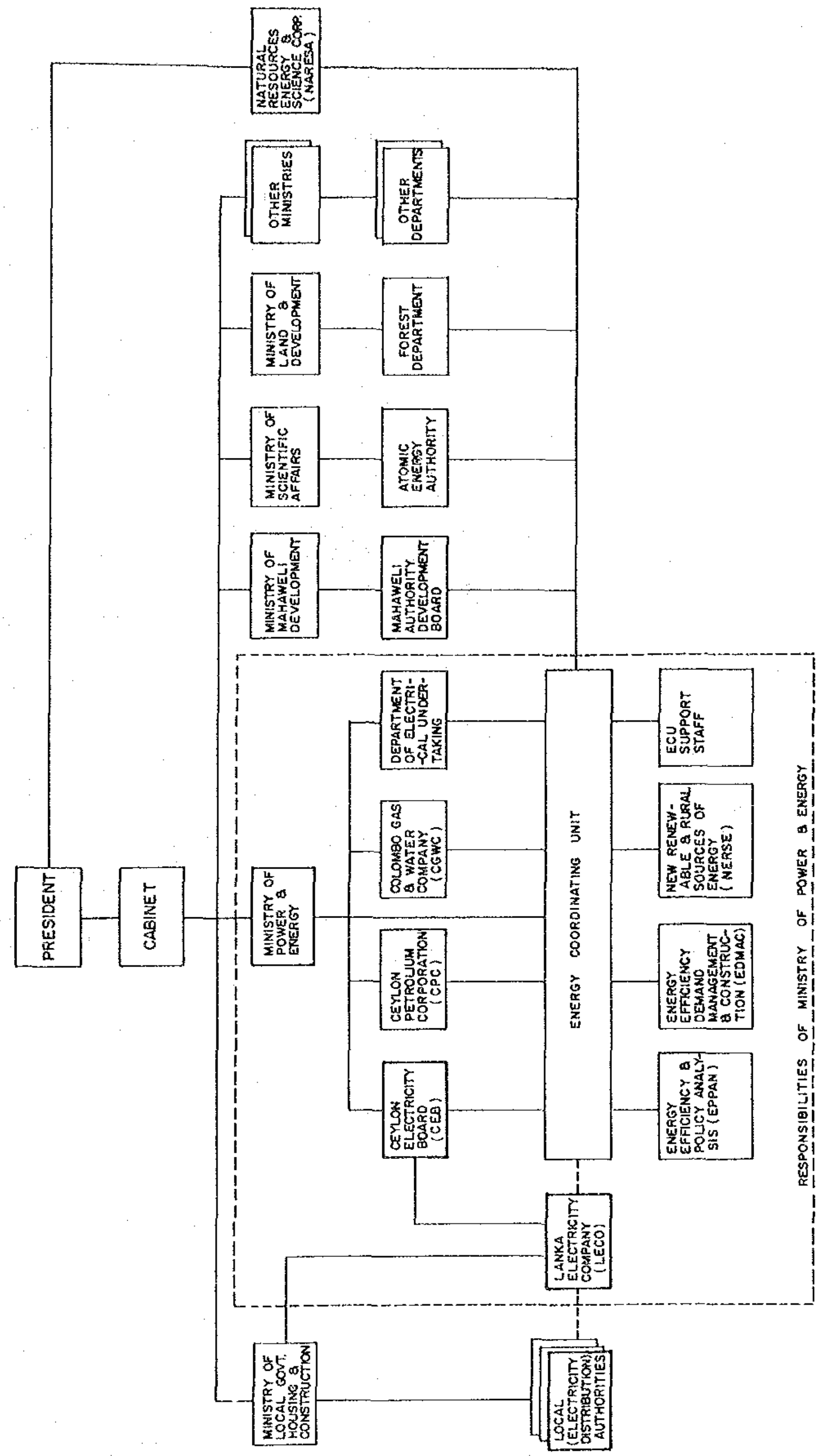

Fig. G.1-1 Organization Chart of Energy Sector

GOVERNMENT OF DEMOCRATIC SOCIALIST
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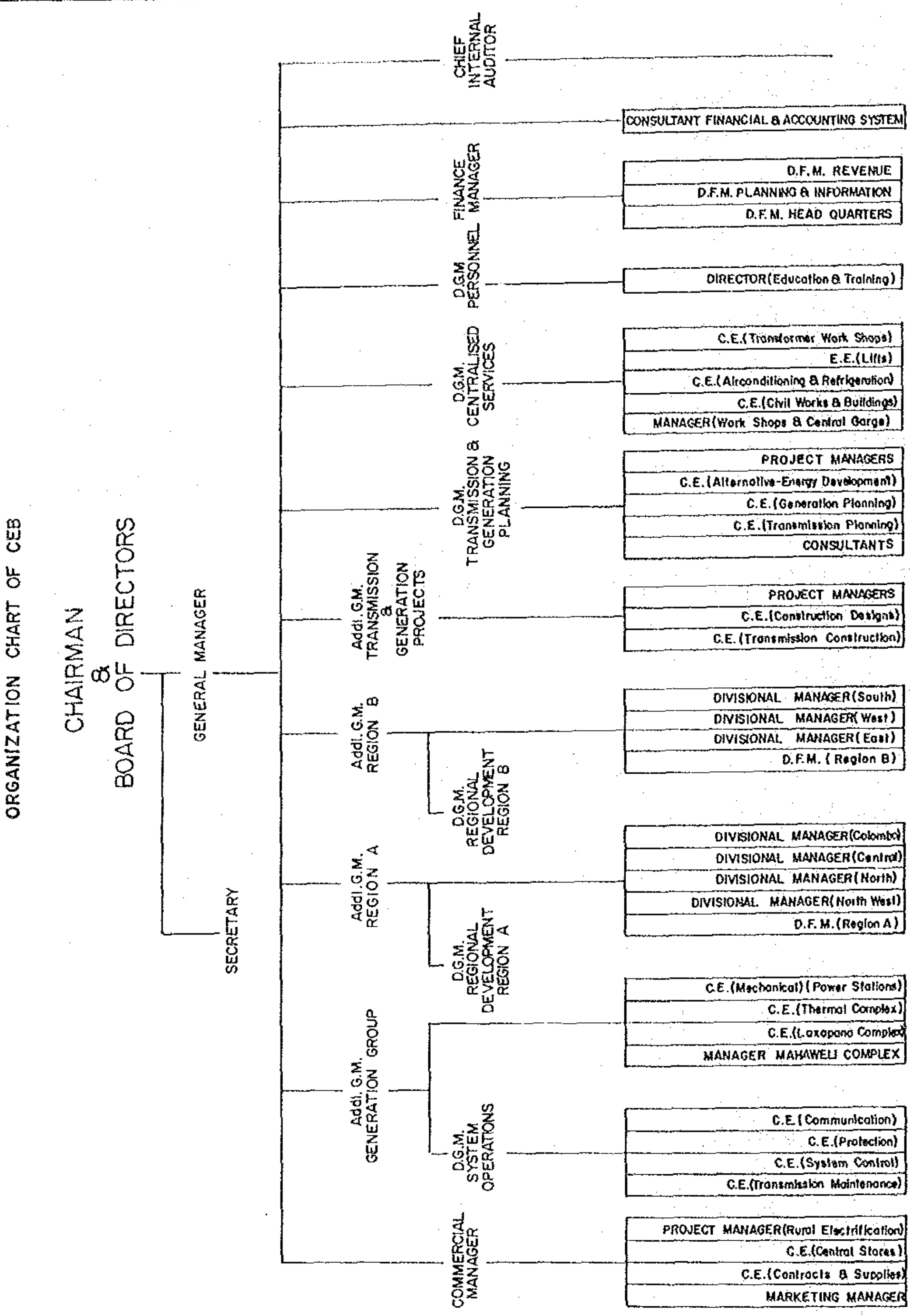

Fig. G.1-2 Organization Chart of CEB

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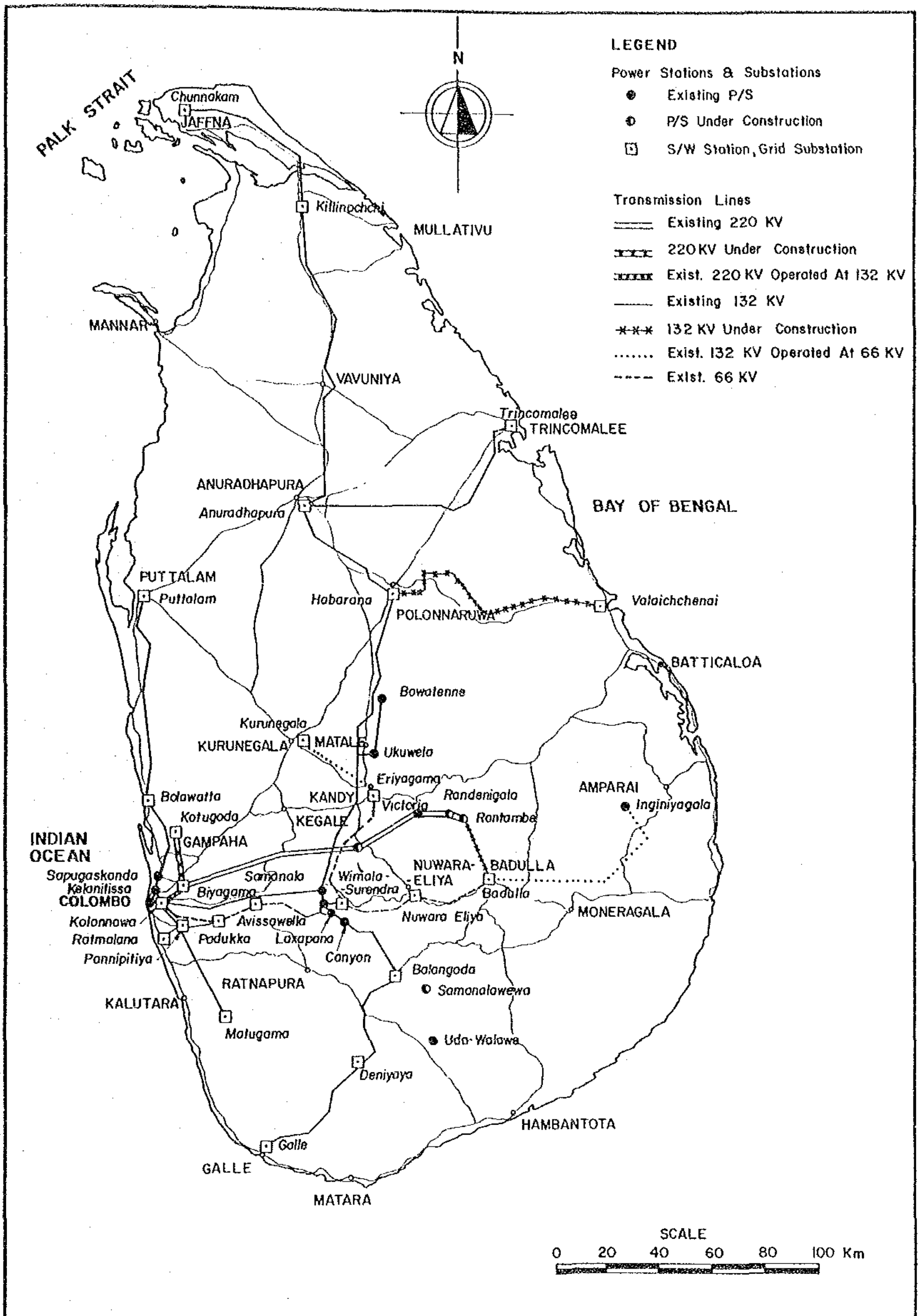

Fig. G.1-3 Transmission Network in Sri Lanka

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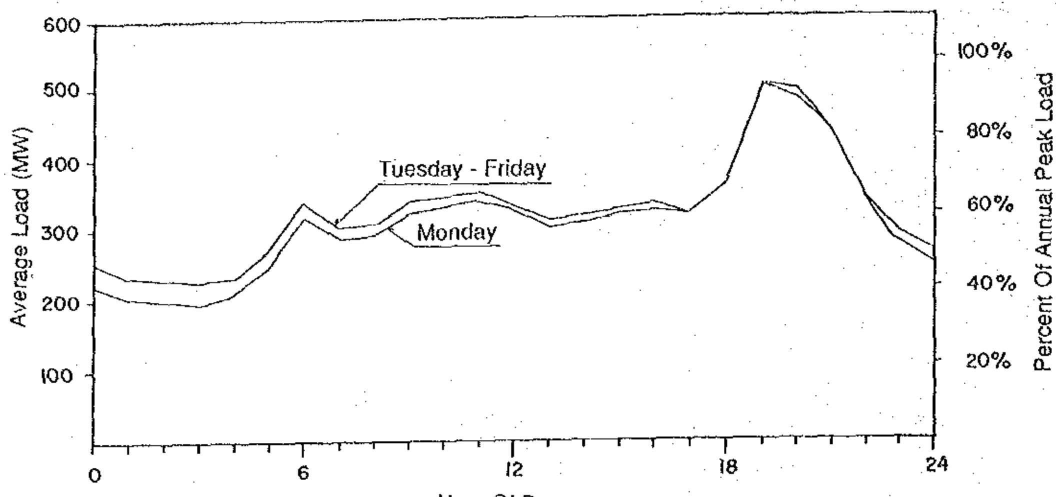
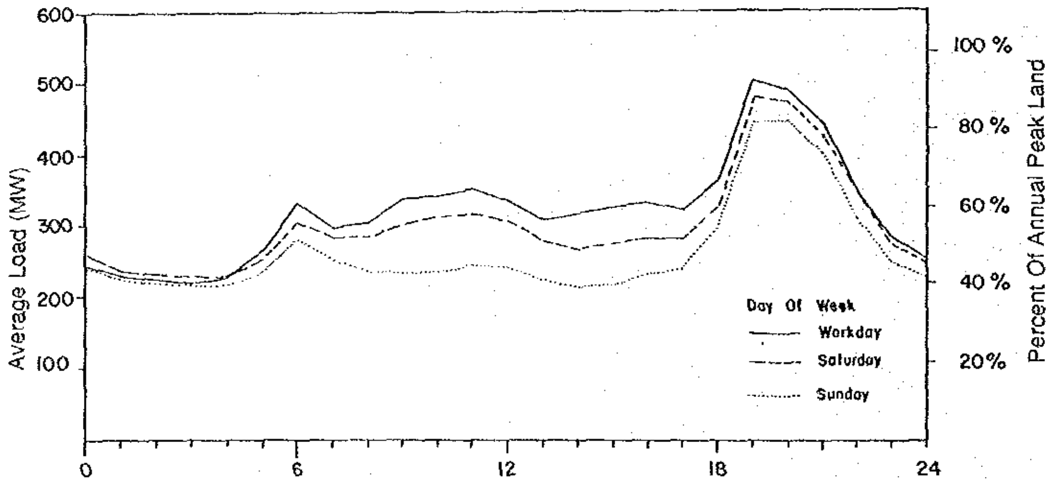


Weekdays December 1986



December 1986

Fig. G.1-4 Daily Load Curves

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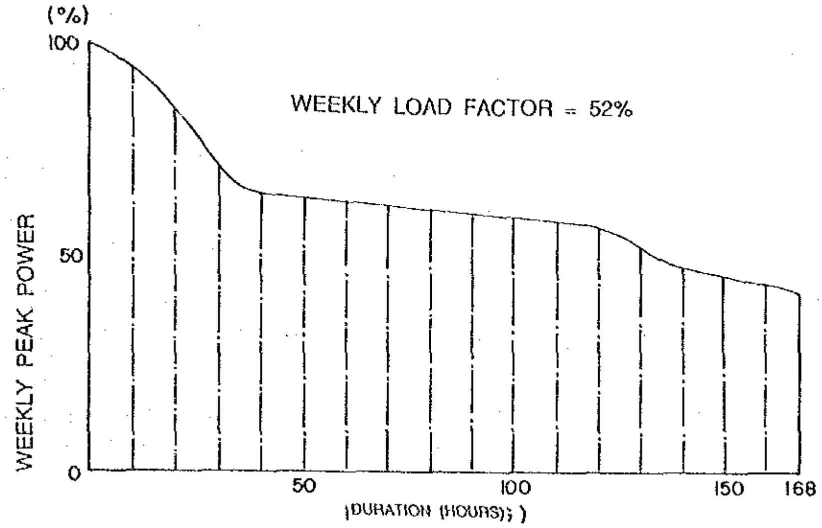
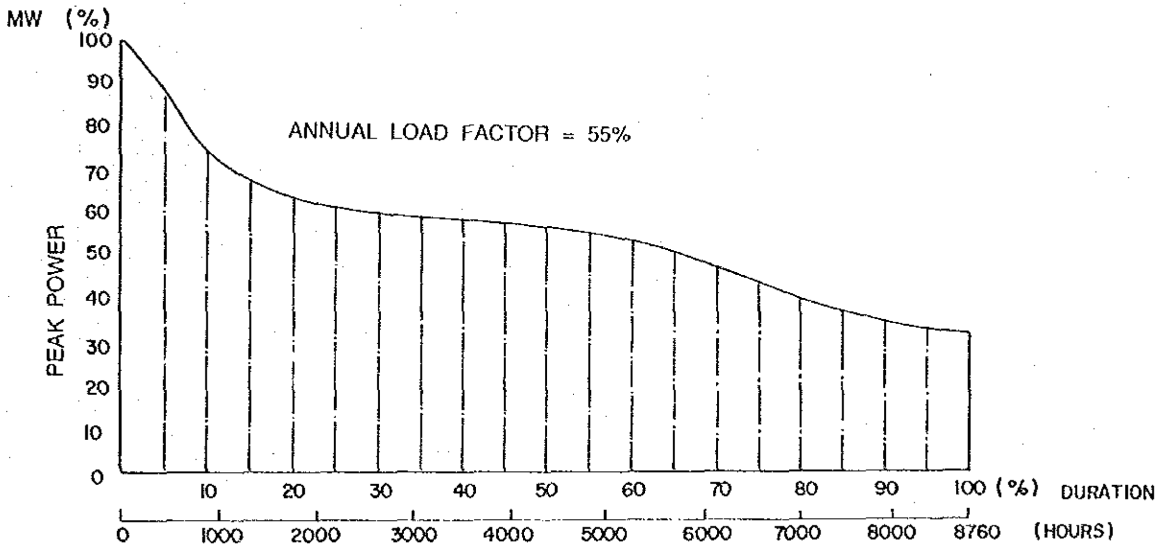
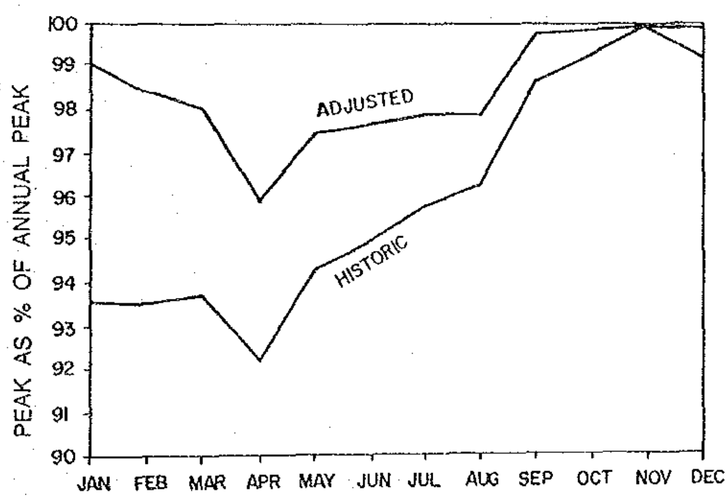


Weekly Load Duration Curve (1)



Annual Load Duration Curve (2)



Monthly Peak Load Variation (3)

Fig. G.1-5 Load Duration and Variation Curves

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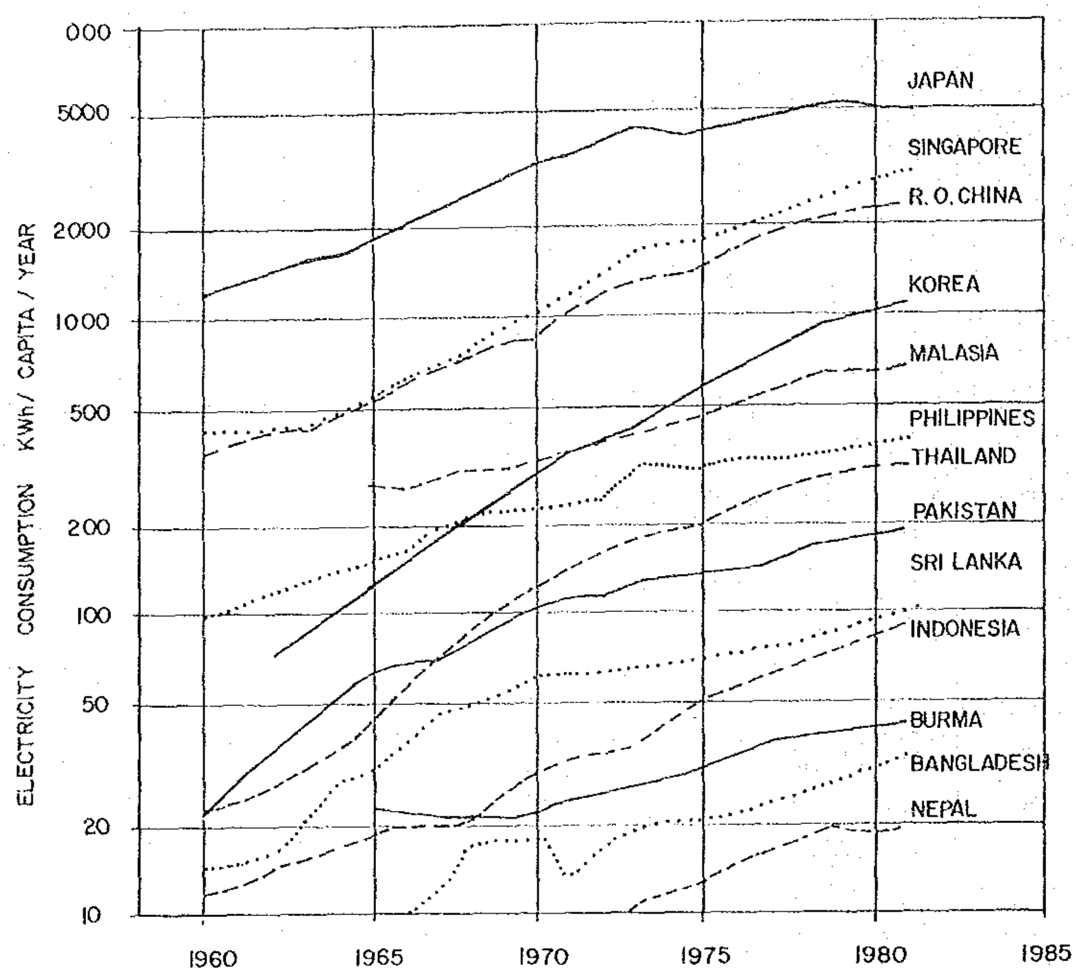

Fig. G.1-6 Comparison of Per Capita Energy Consumption with Other Asian Countries

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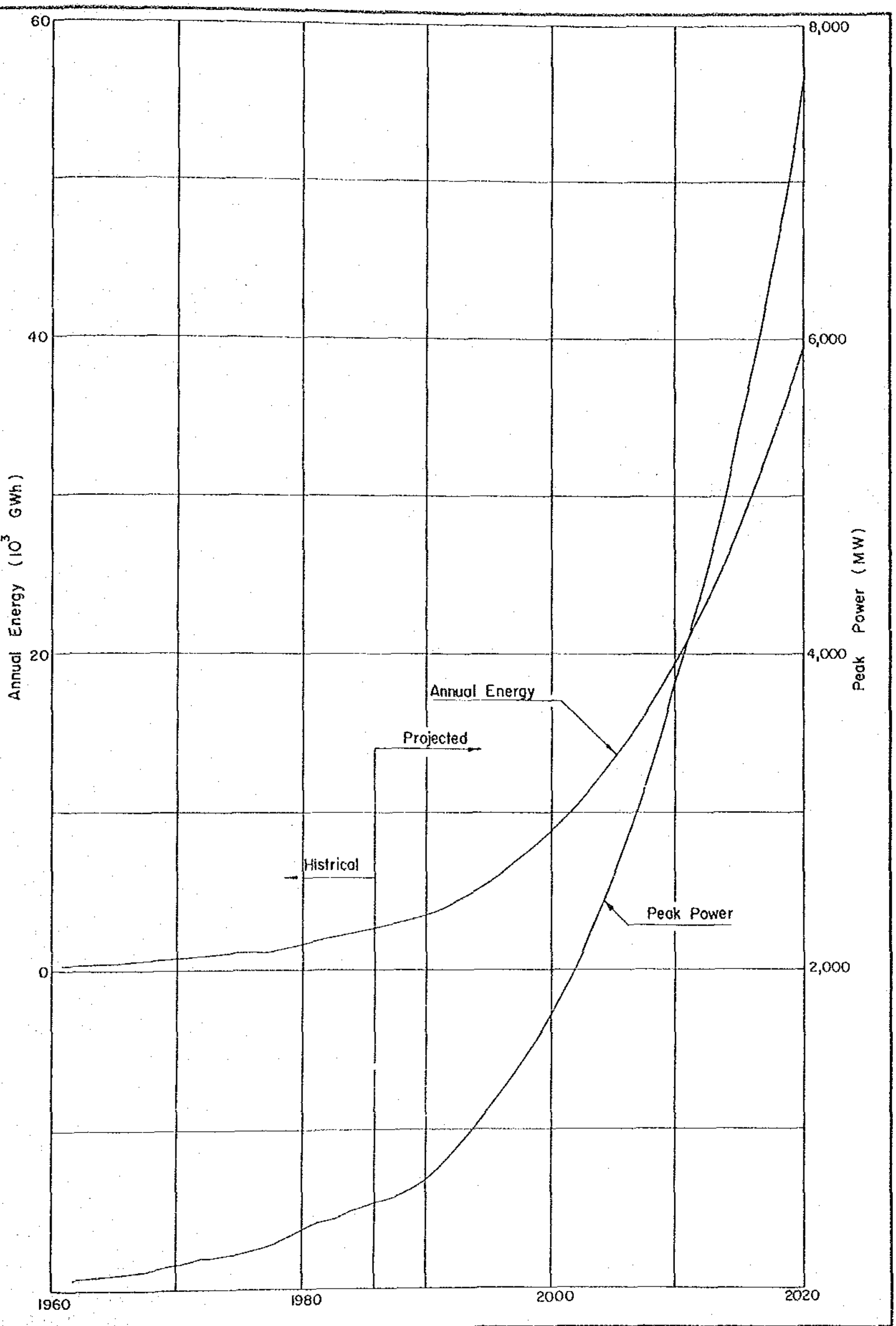

Fig. G.1-7 Historical and Projected Power and Annual Energy Demand

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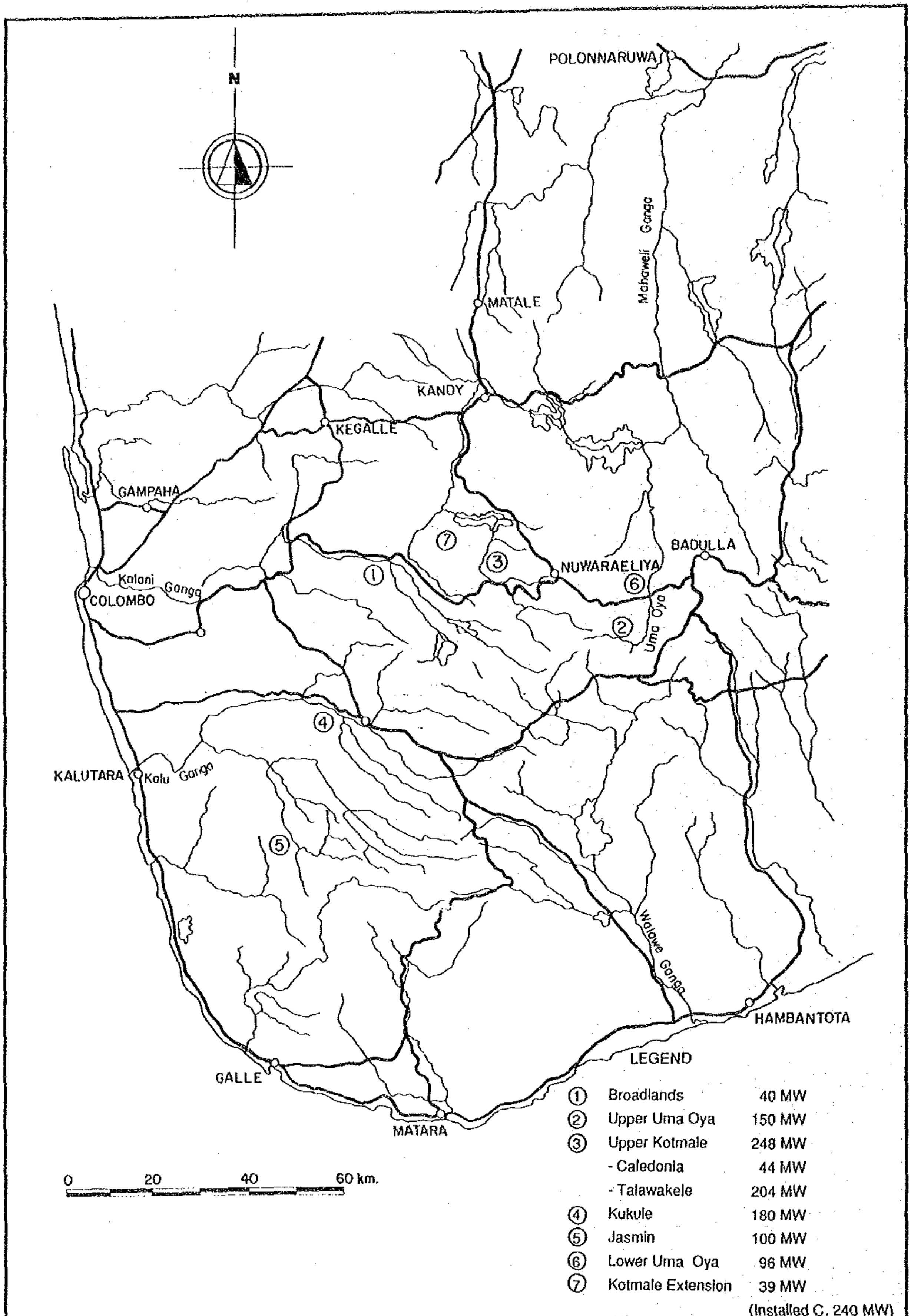

Fig. G.2-1 Proposed Hydropower Schemes by CEB

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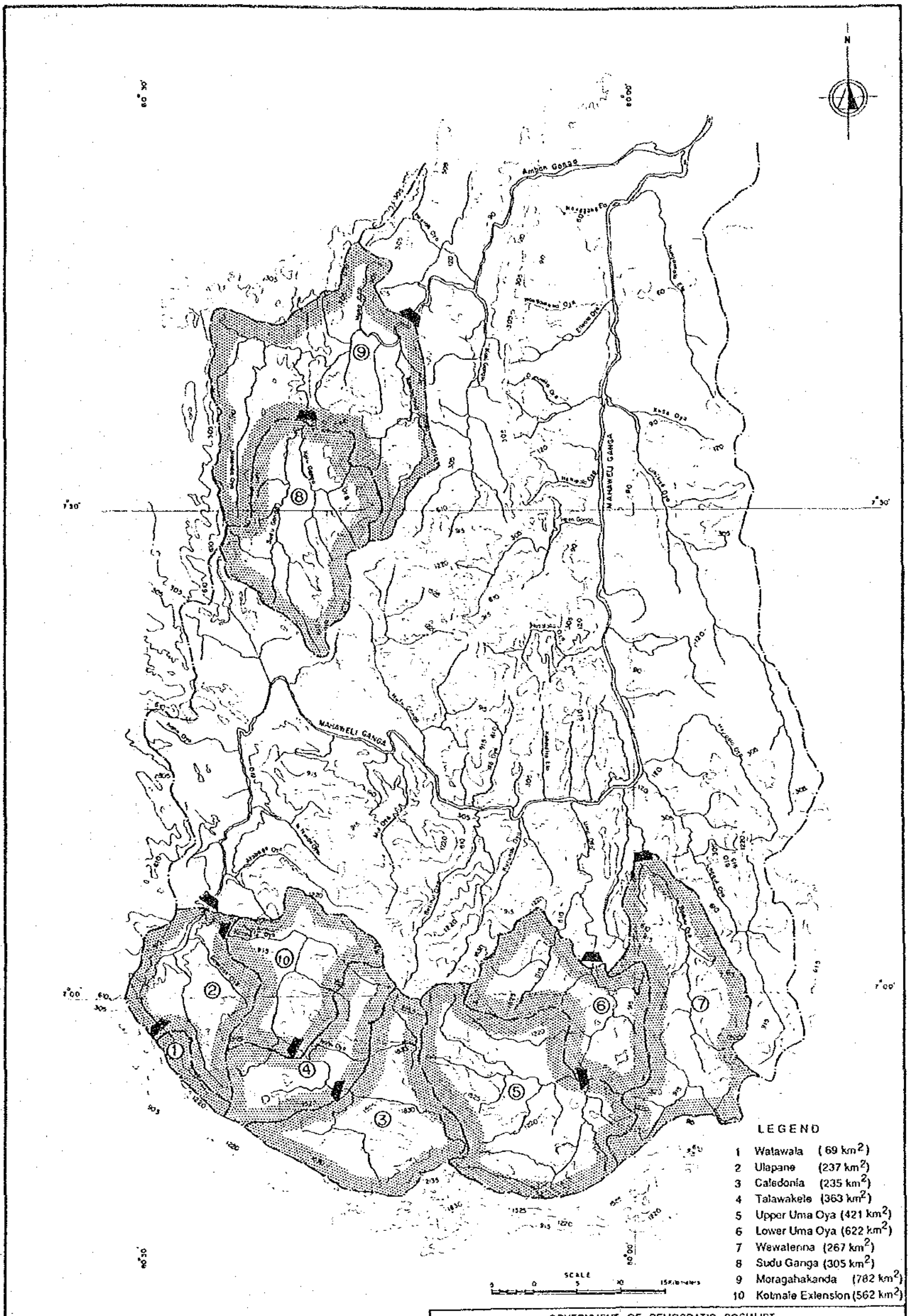

Fig. G.2-2 Catchment Boundary for Proposed Hydropower Schemes

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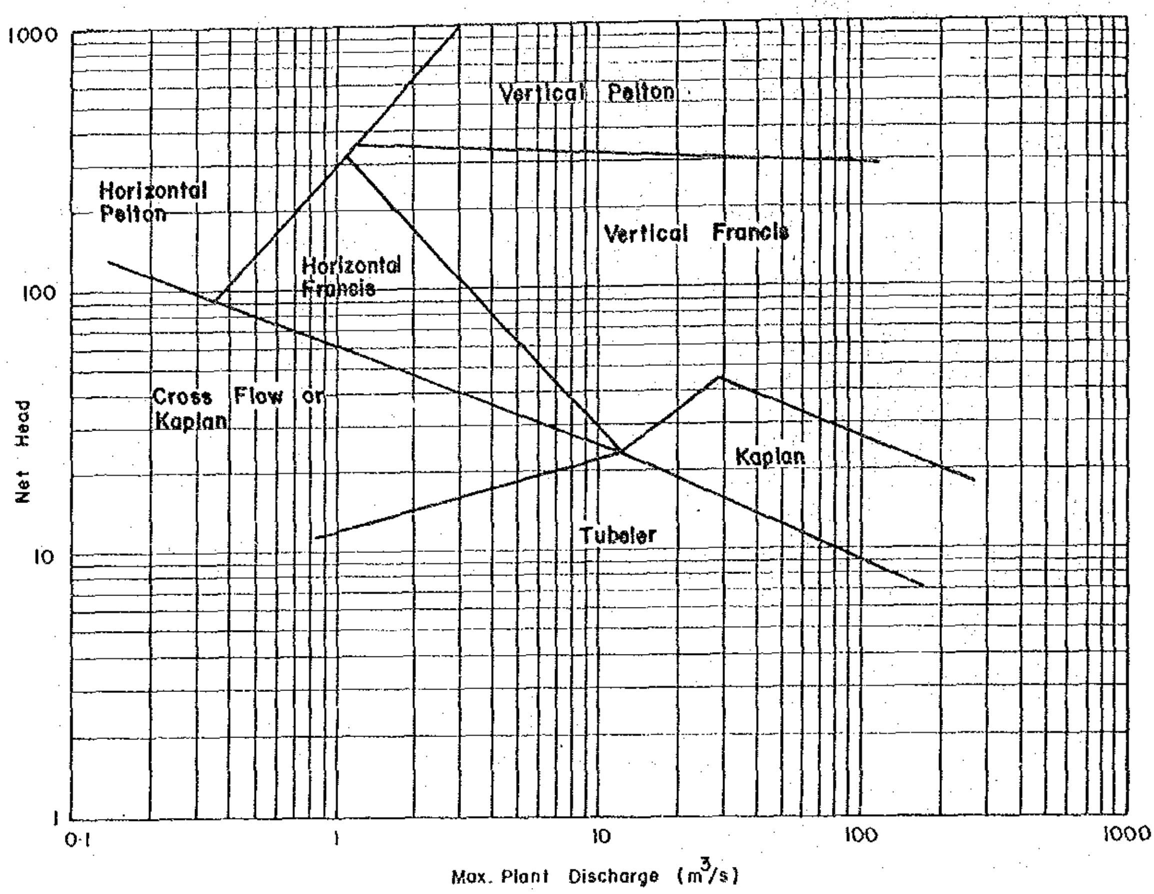

NOTE

This diagram was prepared, based on the data of the actually installed plants in the world. The number of plants used for the diagram are more than four hundred

Fig. G.2-3 Type of Turbine

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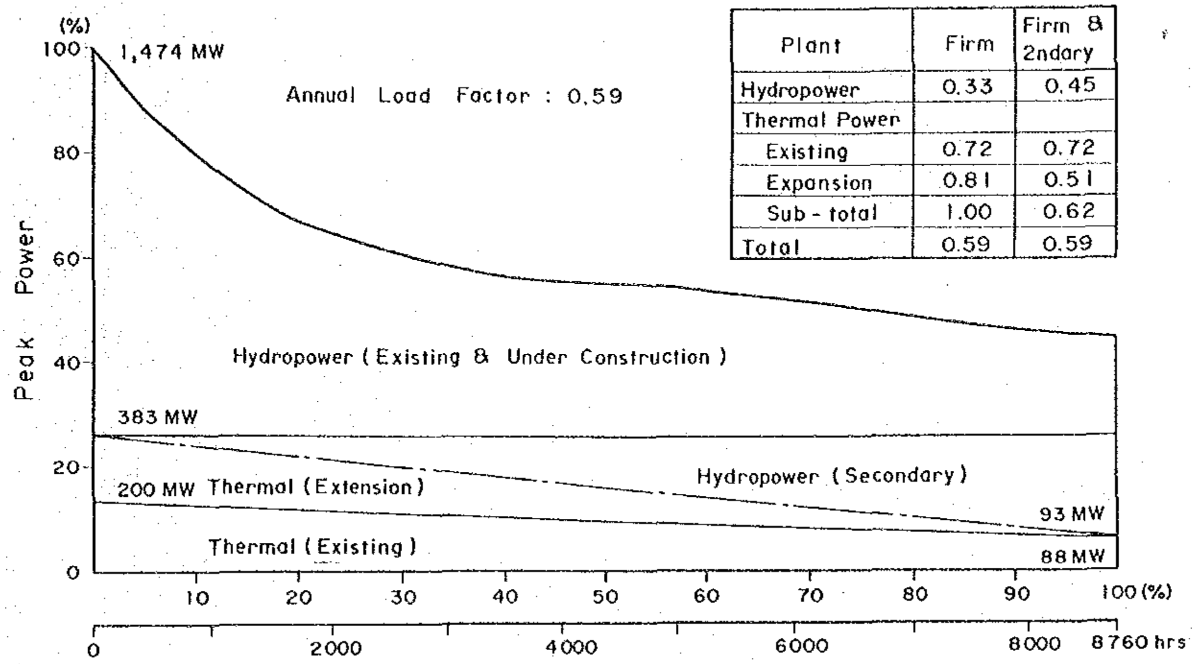
PLANT FACTOR

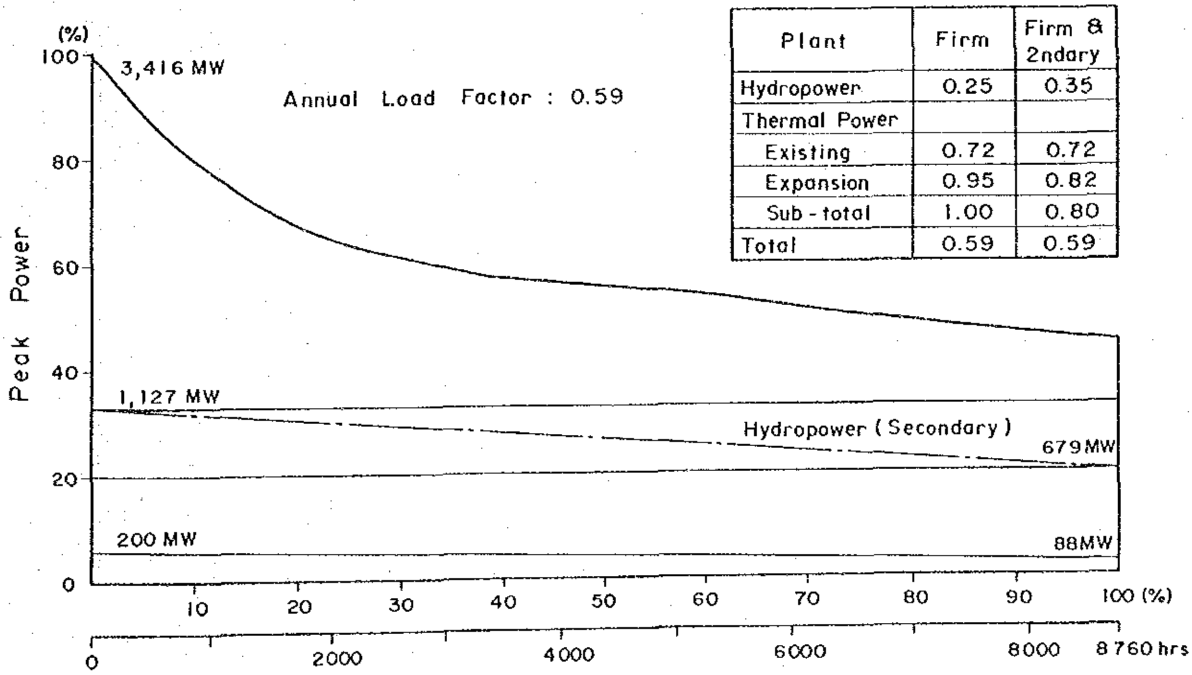
Plant	Firm	Firm & 2ndary
Hydropower	0.33	0.45
Thermal Power		
Existing	0.72	0.72
Expansion	0.81	0.51
Sub - total	1.00	0.62
Total	0.59	0.59



Annual Load Duration Curve (1)

PLANT FACTOR

Plant	Firm	Firm & 2ndary
Hydropower	0.25	0.35
Thermal Power		
Existing	0.72	0.72
Expansion	0.95	0.82
Sub - total	1.00	0.80
Total	0.59	0.59



Annual Load Duration Curve (2)

Fig. G.2-4 Load Sharing on Annual Load Duration Curve

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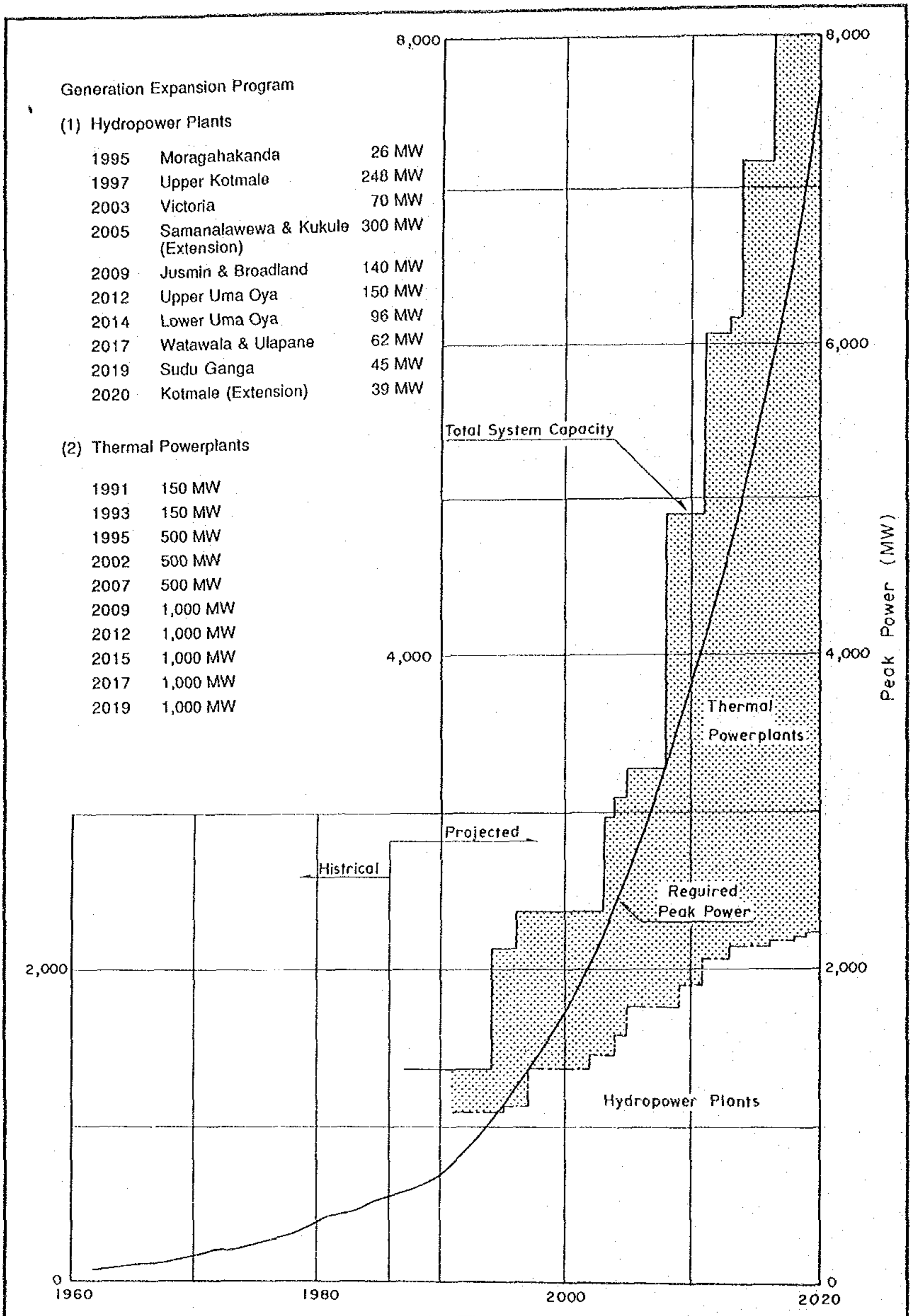

Fig. G.2-5 Long-Term System Generation Expansion Plan (Tentative)

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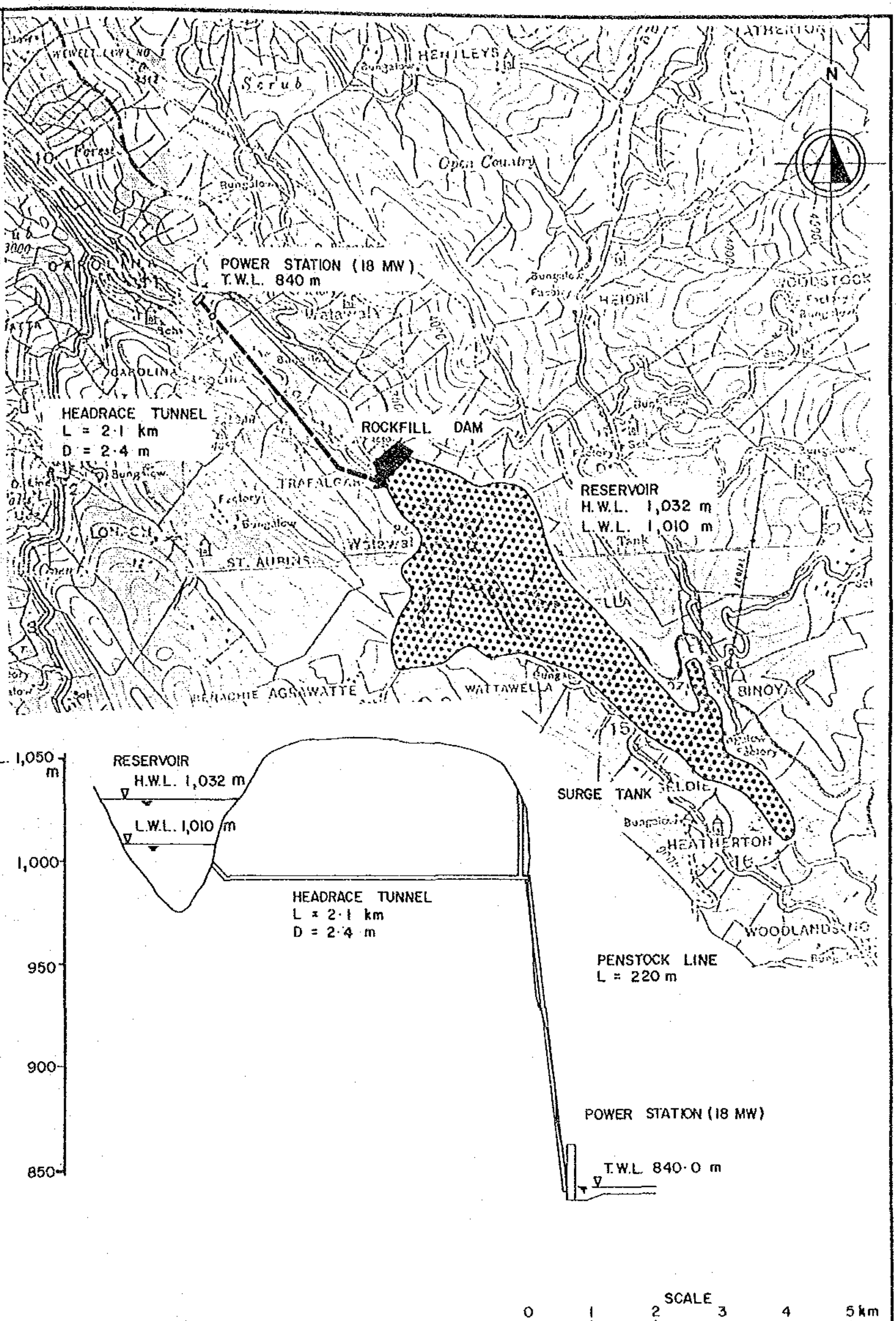

Fig. G.2-6 Watawala Hydropower Scheme

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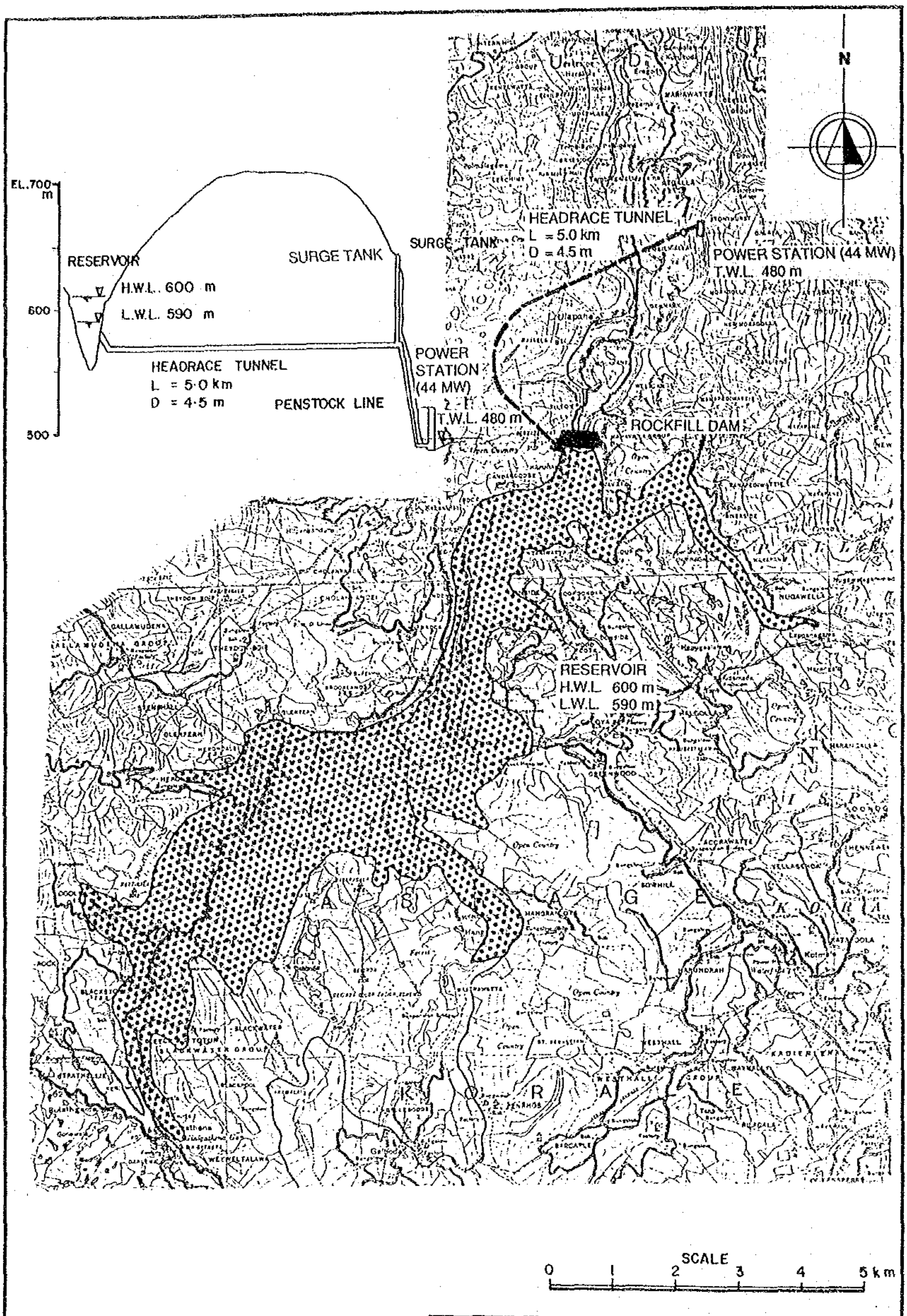

Fig. G.2-7 Ulapane Hydropower Scheme

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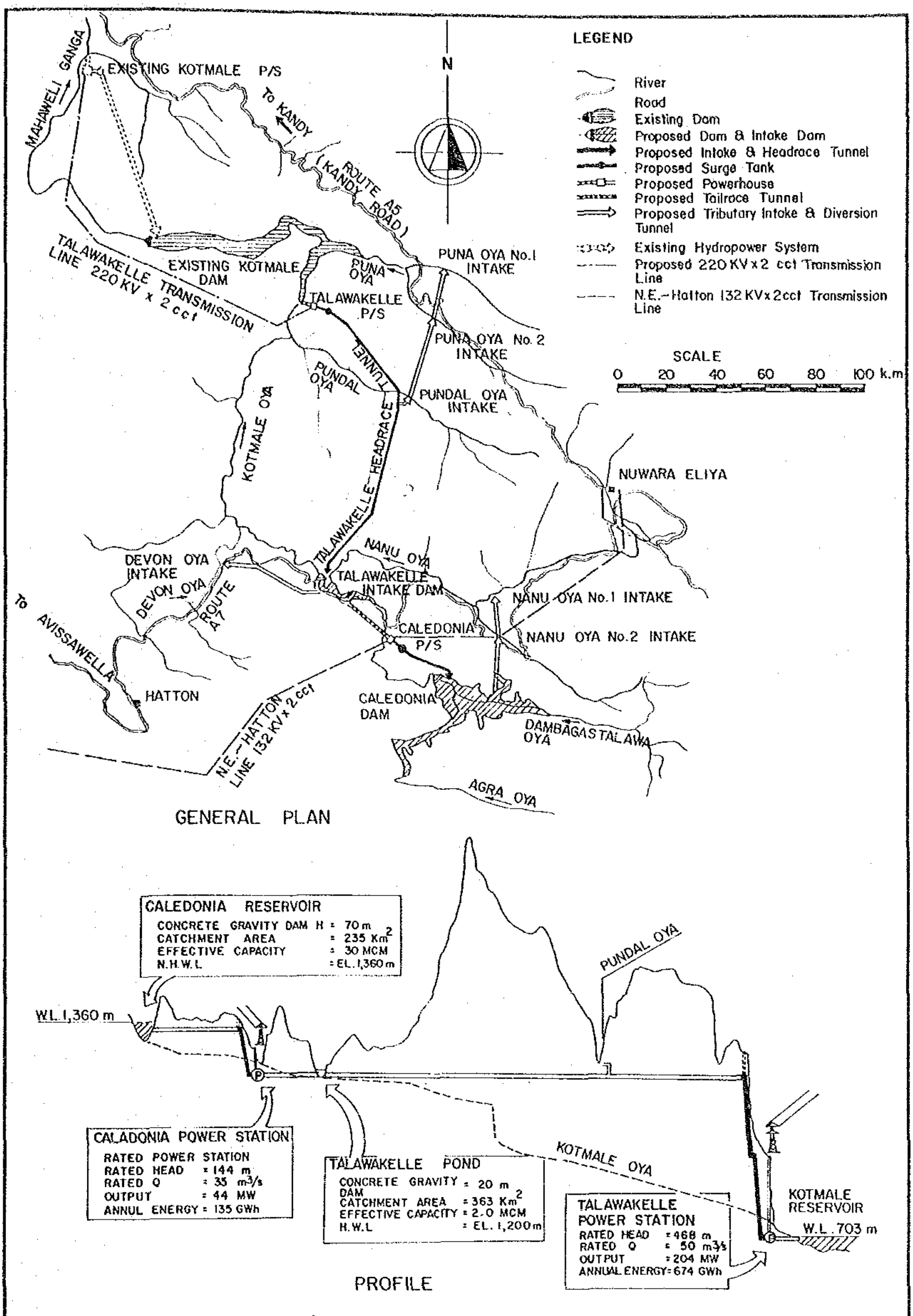

Fig. G.2-8 Upper Kotmale Hydropower Scheme

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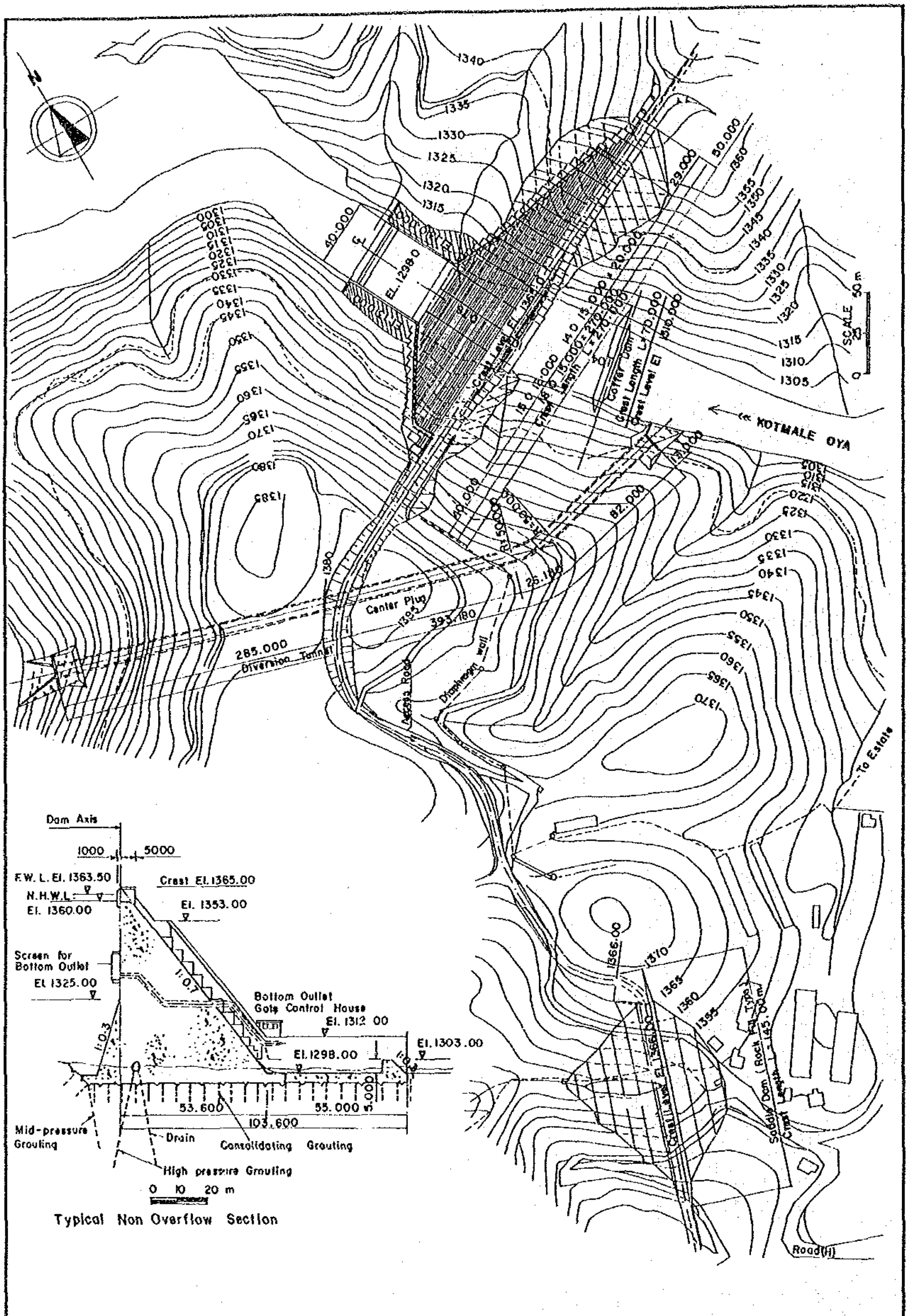

Fig. G.2-9 Caledonia Hydropower Scheme

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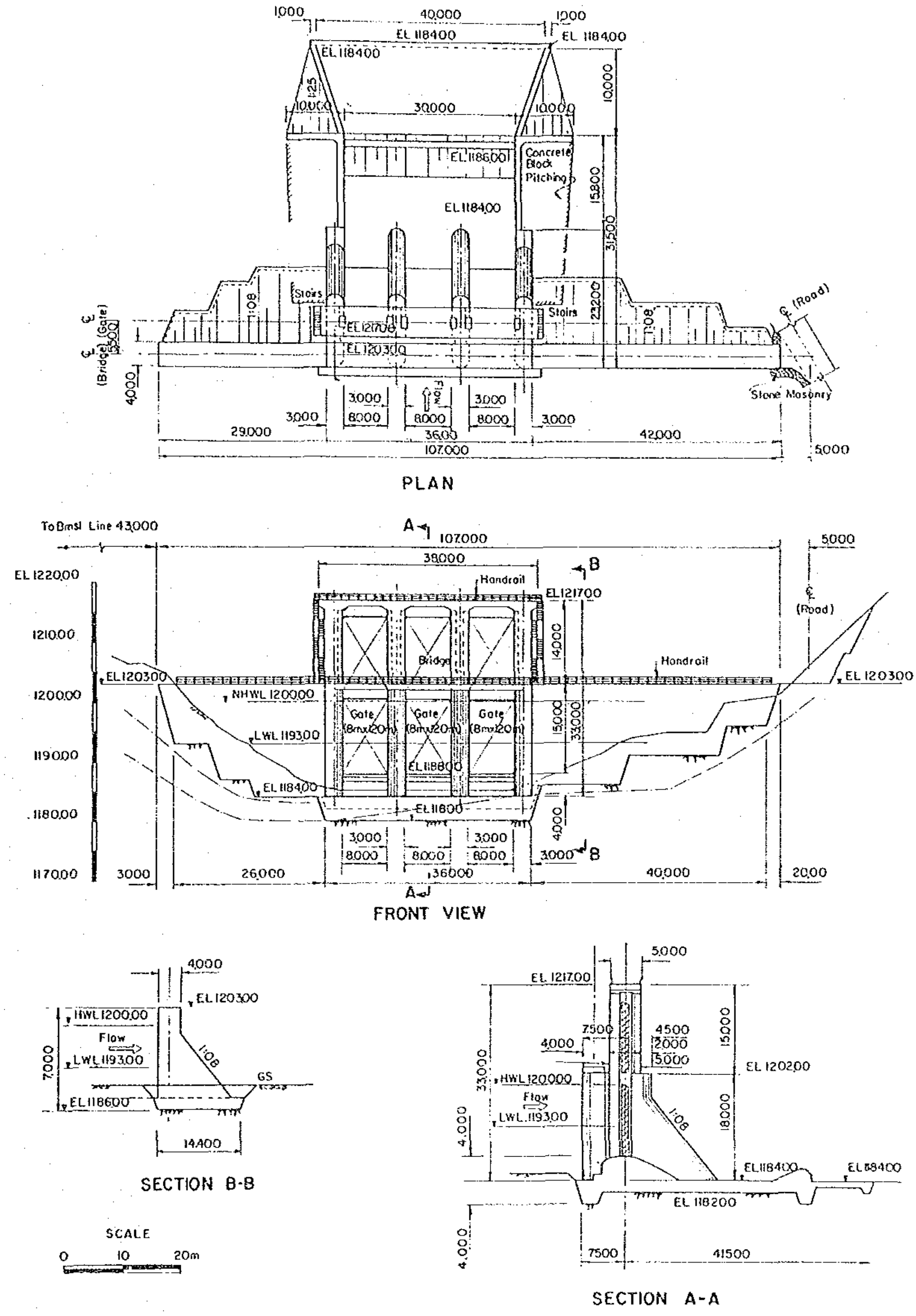

Fig. G.2-10 Talawakele Hydropower Scheme

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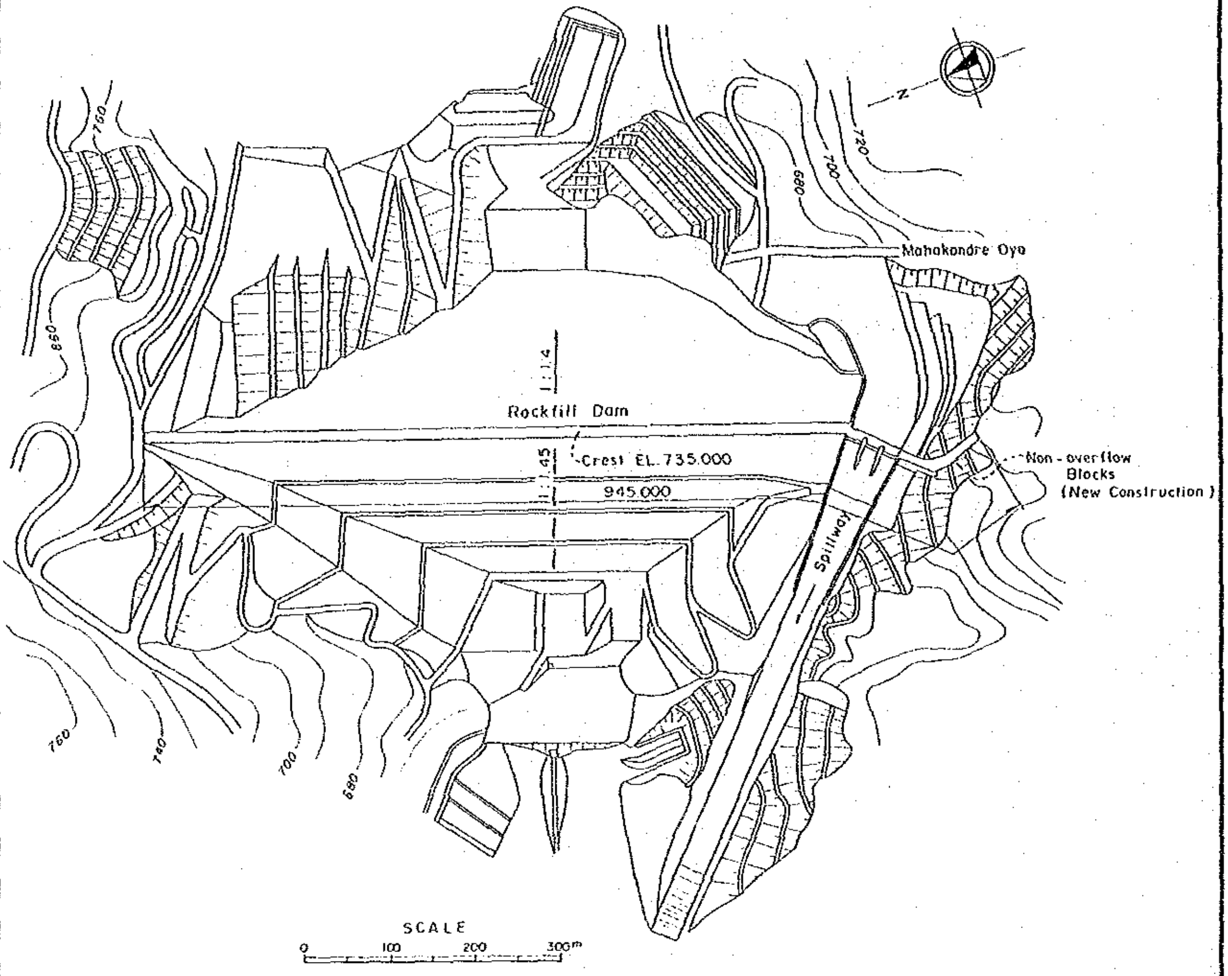
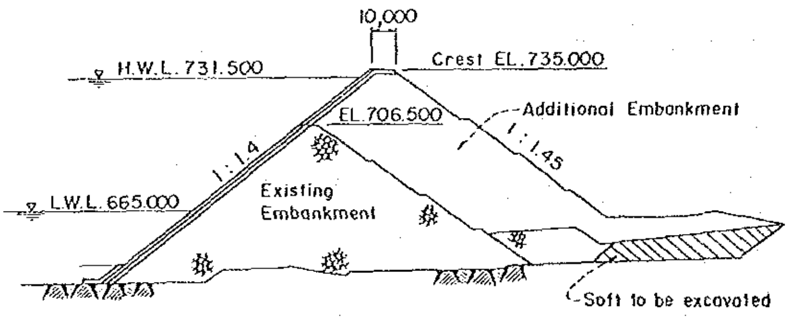


GENERAL PLAN OF DAM



TYPICAL SECTION OF DAM

SCALE
0 100m

Fig. G.2-11 Kotmale Extension Scheme

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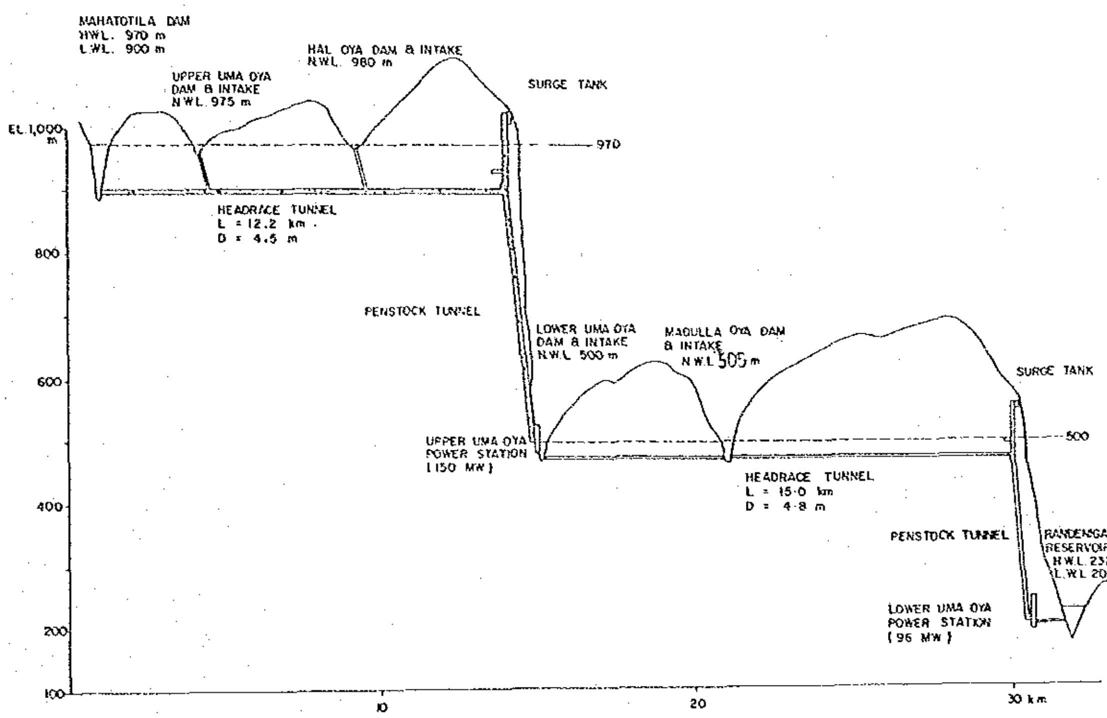

Fig. G.2-12 Uma Oya Hydropower Scheme

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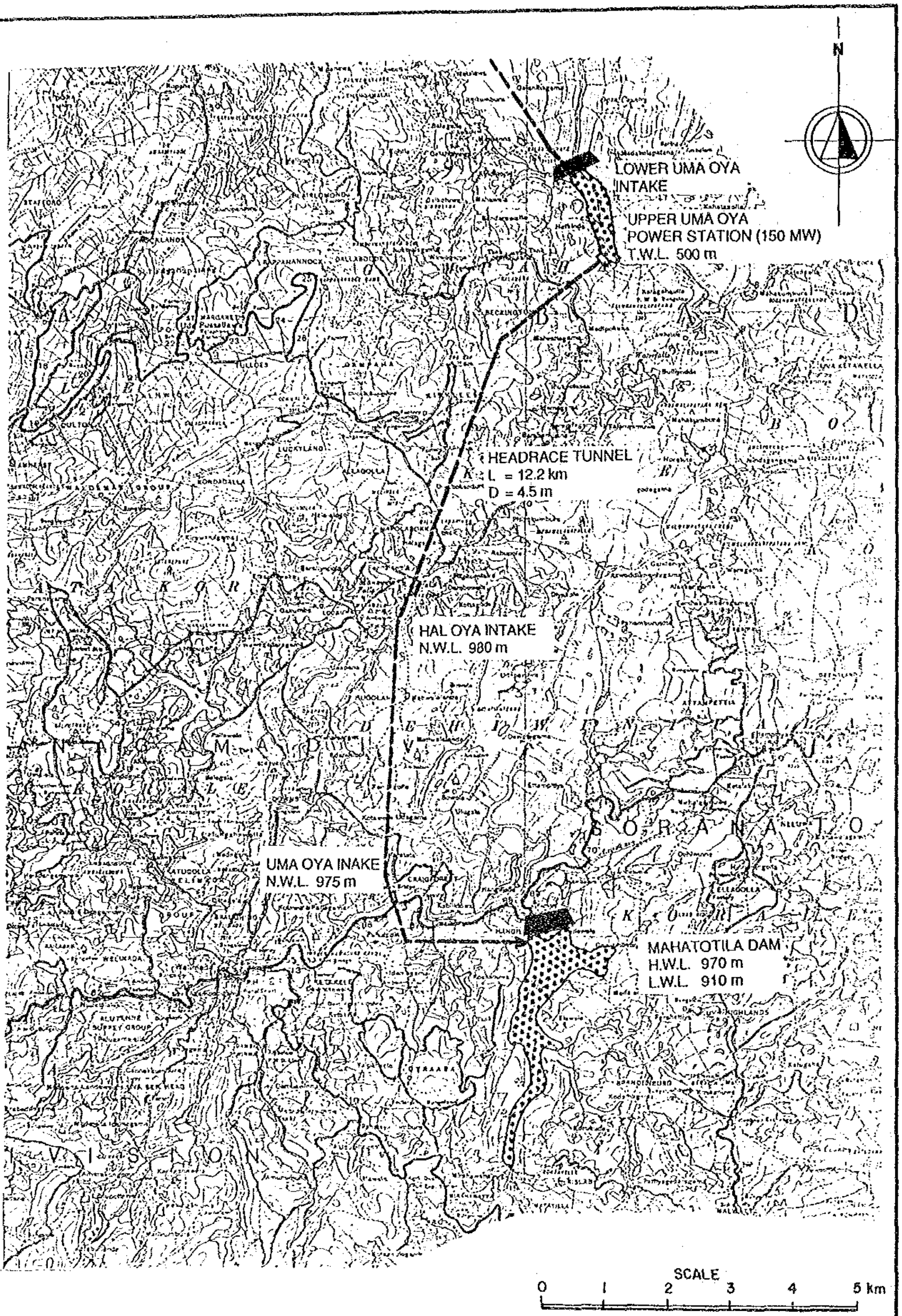

Fig. G.2-13 Upper Uma Oya Hydropower Scheme (Scheme-1000)

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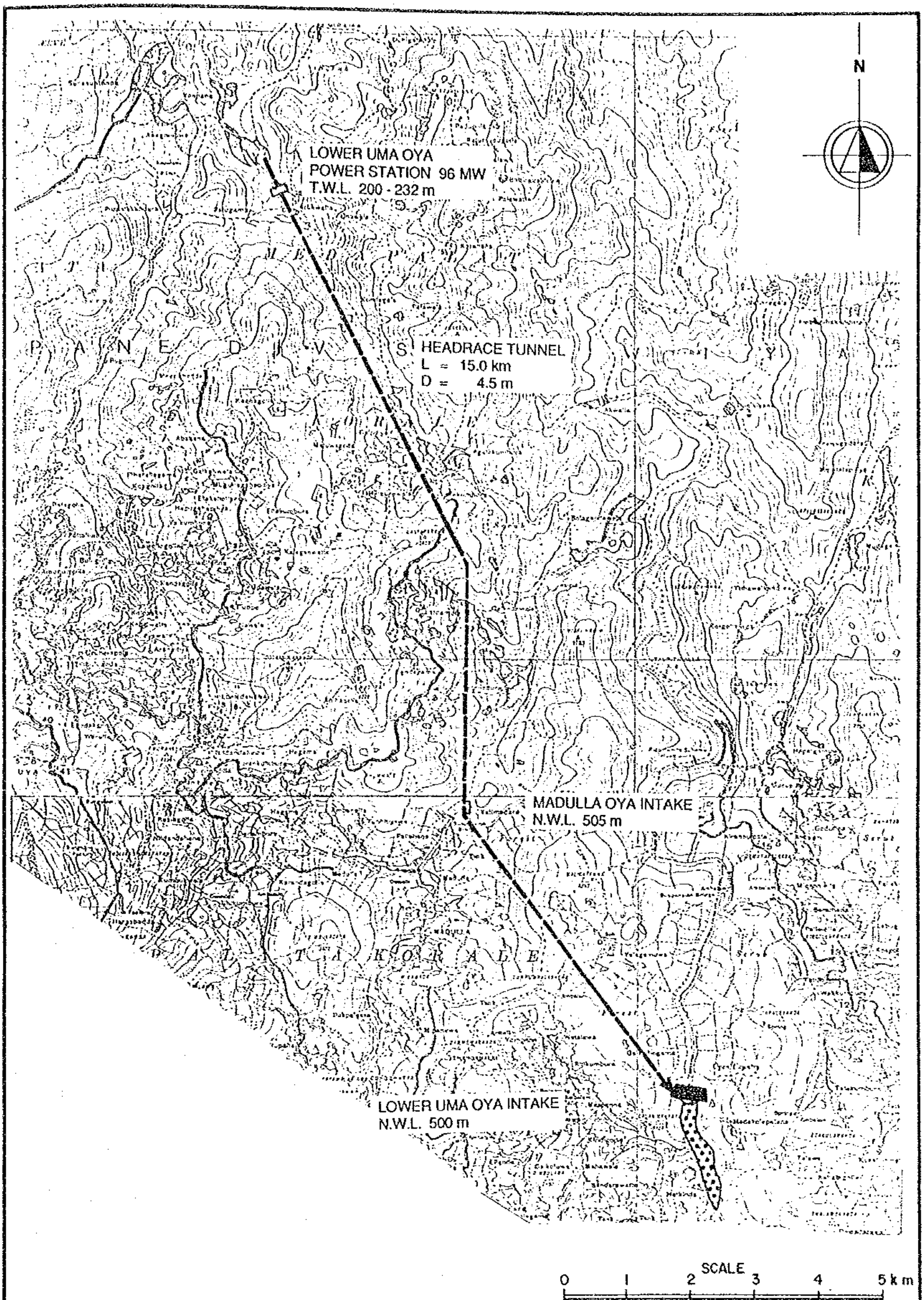

Fig. G.2-14 Lower Uma Oya Hydropower Scheme (Scheme-500)

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THE STUDY ON EXTENSION OF THE MORAGAHAKANDA AGRICULTURAL DEVELOPMENT PROJECT

JAPAN INTERNATIONAL COOPERATION AGENCY

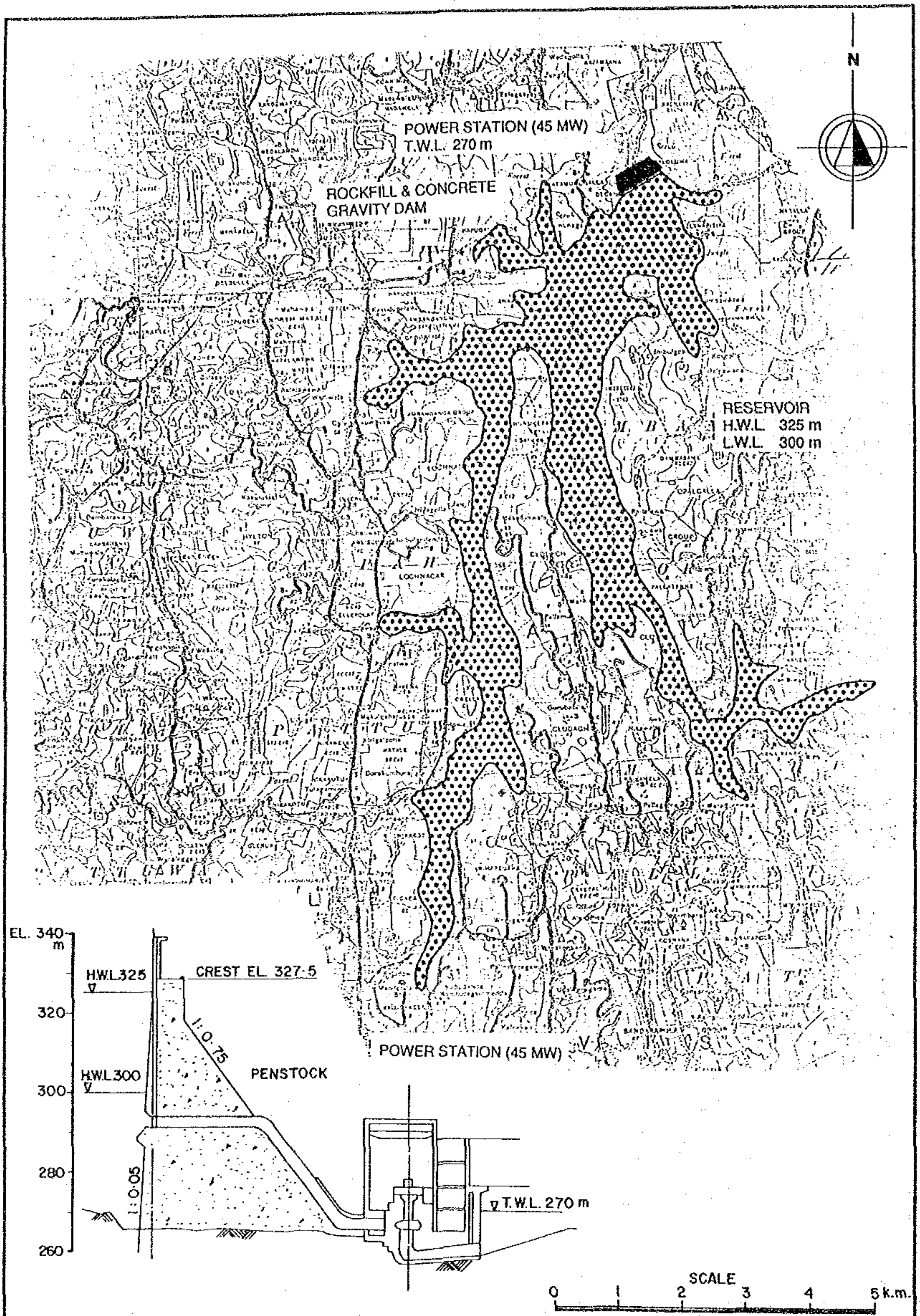

Fig. G.2-15 Sudu Ganga
Hydropower Scheme

GOVERNMENT OF DEMOCRATIC SOCIALIST
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ANNEX-H

CONVEYANCE SYSTEM

ANNEX - H

CONVEYANCE SYSTEM

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ANNEX-H CONVEYANCE SYSTEM

H.1 GENERAL

In the 1960s, to attain self-sufficiency in foodstuff, increase job opportunities and eliminate the shortage of electric power, the GOSL has promoted the Mahaweli Ganga Development Project, which aims to develop the potential arable land in the central and north-central parts of Sri Lanka by supplying water diverted from the Mahaweli Ganga and its tributaries which are blessed with abundant water resources. In 1968, a master plan for the Mahaweli Ganga Development prepared with the assistance of UNDP/FAO comprised irrigation development of about 365,000 ha and hydropower development of 500 MW in capacity. Based on the master plan, the Government has been proceeding with development in the Mahaweli Ganga basin since 1968.

However, since the implementation period of the master plan was over 30 years and expected project benefits could not be anticipated in the earliest time, in 1977 the Government revised the master plan to accelerate the Mahaweli Development Programme for yielding the quickest return to the nation. The revised plan, which is called the Accelerated Mahaweli Development Programme (AMDP), involves (1) irrigation development of about 204,000 ha with 8 irrigation systems, from A to D, G, H, IH and MH, and (2) hydropower development schemes of about 470 MW in installed capacity through the construction of 5 dams: Kotmale, Victoria, Randenigala, Moragahakanda and Maduru Oya dams.

Since 1978 the Government has commenced the implementation of the hydropower generation and irrigation development projects in the Mahaweli Ganga basin as recommended in the AMDP in 1977. As of 1987, the Government had almost completed four multi-purpose dams on the Mahaweli Ganga and one multi-purpose dam on the Maduru Oya with a hydropower generating capacity of 611 MW and irrigation development area of about 130,000 ha in total irrigated with water of the Mahaweli Ganga, the Amban Ganga and local catchment according to the AMDP.

In the hydropower development sector, the GOSL obtained a good result which exceeds the sector target of 470 MW in the AMDP. On the other hand, irrigation development has taken slower movement, irrigation systems covering only about 130,000 ha have been or are being implemented, which corresponds to about 65% of the sector target.

Under these situations, the GOSL intends to promote irrigation development based on the following basic concepts:

- to exploit the most effective use of the water resources in the Mahaweli river system for irrigation development considering the required water distribution to irrigation systems and hydropower generation,

- to maximize the irrigation area with available water and to increase crop intensity in the existing irrigation areas, and

- to work out a proper implementation programme for irrigation development considering the present difficulties in implementation, socio-economic conditions, development priorities, etc.

In 1978/1979, the GOSL carried out the Implementation Strategy Study (ISS) on the Mahaweli Development Programme to formulate an optimum development strategy and policy.

In 1980-1980, the GOSL carried out the Transbasin Diversion Study (TDS) covering potential irrigation area in the SEDZ, NWDZ and NCRB. All possible conveyance systems between the Mahaweli Ganga and the SEDZ, NWDZ, and NCRB were studied and compared.

H.2 TRANSBASIN CONVEYANCE SYSTEM

H.2.1 General

There are several transbasin diversion plans from the Mahaweli Ganga to the NCRB and NWDZ which were studied by UNDP/FAO, subsequently in the ISS and TDS. The increase of Polgolla diversion to the Amban Ganga will decrease hydropower generation at the existing hydropower stations on the Mahaweli main stream. However, this increased diversion policy will save losses of energy consumption at a pump station which will be necessary to irrigate the NCRB area. In order to establish an overall development plan, all the possible conveyance systems should be studied duly in consideration comprehensive overall benefits for the long term development.

In 1981/84, the TDS made alternative studies based on UNDP/FAO and ISS (NEDECO) solutions. In this study, the recommended plan in the TDS was adopted basically and added one alternative transbasin conveyance system to the NCRB area. According to the ISS and the TDS solutions, energy consumption at proposed pump stations would be about 1,400 GWh for the ISS solution being equivalent to about 62% of total energy consumption in 1987 in Sri Lanka, about 440 GWh to about 20% for the TDS solution.

As seen in Table H.2.1 abstracted from the TDS, there is a clear trend that due to the heavy energy consumption at the pump station, the economic viability was greatly effected. Therefore, it is noted that an optimum solution for the transbasin diversion should be a plan how to minimize the energy consumption at the pump station, how to keep electric energy generation on the Mahaweli Ganga main stream, and at the same time how to keep the irrigated agriculture to the maximum extent. Since the pumping energy consumption of the alternatives recommended in the ISS and the TDS is so large compared to the annual energy consumption and generation capacity in Sri Lanka, a combined gravity system and pump plan was added in this study in order to minimize energy consumption at a proposed pump station which would serve the NCRB area.

In the following Sections, possible alternatives for transbasin conveyance system to the NCRB and NWDZ are studied referring to the results of the previous studies.

H.2.2 Conveyance System to NCRB Area

H.2.2.1 General

In order to irrigate the NCRB area, there is only a way to select either the increase of Polgolla diversion resulting in decrease of power generation or pumping up of surplus water after the hydropower generation on the Mahaweli main stream, or combination of these. Followings are three alternatives.

Case A : New Alternative Plan (See Fig. H.2-1)

Minipe - Minipe New LB canal - Minneriya tank - Minneriya pump station - NCP canal - NCRB area

Case B : Electrowatt (TDS) Solution modified
(See Fig. H.2-2)

Minipe - Minipe LB canal - Hettipola Oya (Pump Station) - Kalu Ganga dam - Elahera anicut - NCP canal - NCRB area

Case C : UNDP/FAO (ISS) Solution revised by NEDECO
(See Fig. H.2-3)

Minipe - Minipe LB canal - Angamedilla - Kaudulla - Kantalai Angamedilla - Angamedilla underground pump station - NCP canal - NCRB area

H.2.2.2 New Alternative Plan (Case-A)

Gravity transbasin conveyance system from the Minipe anicut (crest El. 114.0 m) to the Minneriya tank (FSL. El. 93.6m) was selected, in order to minimize pumping energy consumption and to keep hydropower generation on the main stream of the Mahaweli Ganga. Conveyance system is shown on Fig. H.2.1. Diverted water from the Minipe anicut will be supplied through a newly proposed Minipe LB canal being parallel to the existing Minipe LB canal at the initial section, then crossing the Wasgamuwa National Park, and once stored in the Minneriya tank. Water could be used to irrigate the existing System D1 including the expansion areas of the on-going Moragahakanda project. Irrigation water originally supplied from the on-going Moragahakanda project will be replaced and utilized for irrigation of the NCRB areas.

As described in ANNEX-I, there is still possible diversion water at the Minneriya tank, even after replaced the irrigation water in System D1 and its expansion area. This water can be pumped up to the NCP canal at the Minneriya tank. Depending on the selected future plan, possible pumping up water with a static head of about 45-53 m was estimated at 650-760 MCM, which will be able to irrigate about 30,000 ha in the NCRB area.

From the Elahera anicut located at the downstream of the Moragahakanda dam, a newly proposed concrete lined canal was planned to be located generally parallel to the existing Elahera - Minneriya canal. The canal alignment between Elahera to the Kiri Oya was chosen along the foot of the hills forming the western slope of the Amban Ganga valley. A number of sections of deep-cut and tunnel are required. The NCP canal proposed by NEDECO (high level NCP canal) was basically adopted in this study with a minor modification of route alignment and the canal route are presented in DRAWINGS. Diverted water at Elahera to the NCRB area will be augmented at the place after crossing the Kiri Oya, by pumping water from the Mahaweli Ganga at the proposed Minneriya pump station.

TDS recommended to provide the Kiri Oya reservoir as a level crossing for Kiri Oya valley. However, runoff in this catchment have been used as water sources for the Minneriya tank for a long time, moreover. Since the Kiri Oya dam will be approximately 40 m high dam, the canal detour case with a small upper regulation pond for the Minneriya pump station is the most economical solution based on the preliminary cost comparison. Instead of the Kiri Oya level crossing, the detoured canal route was adopted as the NCP canal route.

H.2.2.3 TDS's Solution (Case-B)

In TDS, water diverted at Minipe will be pumped at Hettipola into the paralleled Kalu Ganga valley, and to feed to Elahera and the NCP canal originally proposed by UNDP/FAO. The Minipe-Hettipola canal from the Minipe anicut to the proposed Hettipola pump station was planned to have the same alignment of the initial section as originally proposed by UNDP/FAO. The static pumping head will be about 80 m instead of 61m which was proposed in the TDS, since pumped water will be once regulated in the proposed Kalu Ganga reservoir. In order to utilize available water resources adjacent to the development area, the Kalu Ganga dam was proposed to feed irrigation water to the NCRB areas. The conveyance system is shown on Fig. H.2-2.

The pump station will be located near the proposed lower regulating pond at Hettipola. Pumping water through the proposed penstocks with approximately 500 m in length, will be delivered to a high-level canal leading to the transbasin diversion tunnel through the Sudu Ganga ridge between the valleys of the Mahaweli Ganga and Kalu Ganga. Diverted water will be once impounded in the proposed Kalu Ganga dam. Regulated water will be delivered to the Elahera anicut and to the NCRB area through the NCP canal as same as Case A.

If this plan would be adopted, the pumping energy consumption will be so huge compared to the total energy consumption in Sri Lanka, but no disturbance to the Wasgamuwa National Park will be expected.

H.2.2.4 UNDP/FAO solution as Revised by NEDECO (Case-C)

The Minipe LB 2 canal was originally proposed by UNDP/FAO and revised in ISS. The canal would extend from Minipe to the existing Kantalai tank. An underground pump station would be required to feed water to the NCP canal. The route of Case C conveyance system is shown on Fig. H.2-3.

The existing Minipe LB canal being under-rehabilitation will be utilized as the initial section of the UNDP/FAO conveyance canal, and be enlarged in order to supply the additional flow to the NCRB area. The later section of the Minipe LB 2 canal should pass through the Wasgamuwa National Park as same as Case A conveyance route.

An underground pump station with a static head of about 65 m was planned at Wewala located near the outlet of the proposed Angamedilla syphon, and would lift water from the Minipe-Angamedilla conveyance canal to the NCP canal. Due to the topographic conditions of the site, it was planned to construct an underground pump station, an 5 km long supply tunnel, surge chamber and delivery shaft.

The NCP canal route for Case C is the same as described in Case A and B. The Minipe LB 2 canal originally recommended by UNDP/FAO was planned to serve a part of System D1. Irrigation water diverted from Minipe to a part of System D1 could replace water originally diverted from Elahera. Therefore, the water originally supplied to a part of System D1 will be conveyed to the NCRB area through the NCP canal. In this case, pumping energy could be saved in comparison with Case B.

H.2.3 Conveyance System to NWDZ Area

In TDS, six alternative conveyance routes from the Mahaweli Ganga to NWDZ were studied. Among these six routes, it was concluded that irrigation water to NWDZ would be diverted through the existing Ukuwela power station and discharged into the Sudu Ganga, then into the Bowatenna reservoir. From the Bowatenna reservoir, water will be supplied through a second irrigation tunnel, being parallel to the existing irrigation tunnel.

Once water diverted into the upper Dambullu Oya near the Lenadora village, the following three possible routes to the Mi Oya valley where NWDZ exists were studied: (1) from an anicut on the Dambullu Oya at Lenadora, westward across into the upper Mi Oya valley, (2) from Dambullu tank to the Siyambalangamuwa Oya valley, with a second canal from this valley to the proposed Galgamuwa tank, at the head of the Mi Oya right bank irrigation area (NW1), and (3) from Kalawewa, utilizing the System H left bank canal to the existing Mahakatnoruwa tank in the Siyambalangamuwa Oya valley and finally to the Galgamuwa tank.

Among the above three routes, Kalawewa - Mahakatnoruwa - Galgamuwa tanks route was selected. In this study, due to the limitation of available water as studied in TDS and ANNEX-I, the TDS's recommending route to the NWDZ was adopted as the NWDZ conveyance system as shown on Fig. H.2-1.

In order to serve the NWDZ area under the fixed Polgolla diversion policy, no additional water will be taken from the Mahaweli Ganga at Polgolla. Rather, water originally used in Systems D and G will be replaced by the inflows of the Kalu Ganga, a tributary of the Amban Ganga, and released from Bowatenna to the NWDZ area. This will be affected the on-going Moragahakanda project and the existing Bowatenna hydropower station due to decreased available water. This fact should be carefully studied in the water balance and comprehensive economic comparison.

Brief explanation of adopted conveyance route in the study is given below:

(i) Polgolla diversion water to Kalawewa tank

Diverted water through the Ukuwela power station (38 MW) will be once impounded in the Bowatenna reservoir. From the Bowatenna, water through 40 MW hydropower station will be released to the Moragahakanda dam, then to Systems D and G as well as to the NCRB area. In order to increase diversion water, a second diversion tunnel parallel to the existing irrigation tunnel to Dambullu Oya valley is required to supply additional water to Systems H, MH and IH, and to the NWDZ. And released water will be once impounded in the Dambullu Oya tank, then the Kalawewa tank.

(ii) Kalawewa tank to Galgamuwa tank

The Kalawewa tank is one of key tanks to serve irrigation water to Systems H, IH, MH and the NWDZ areas. Water diverted at Polgolla through Bowatenna to the Dambullu Oya would once be stored and regulated at

Kalawewa tank. The Kalawewa LB canal connected to the Mahakatnoruwa tank will be enlarged in order to supply additional irrigation water to the NWDZ area. However during the construction, special attention should be given to the construction method, because this canal is the existing canal which supply water to Kalawewa left bank area throughout the year.

H.3 SCREENING OF CONVEYANCE SYSTEM

H.3.1 General

The design capacities of transbasin conveyance canals and pump were fixed, through the water balance simulation runs by changing their capacities of respective channels. The results of the water balance simulation runs are presented in Tables H.3.1 and H.3.2, and principal features of transbasin system are summarised in Tables H.3.4 and H.3.5. The details are described in ANNEX-I.

Based on the above principal features of the systems, the design and cost estimate for respective cases were carried out , and the summary of construction costs is shown in Tables H.3.6 to H.3.9. The details are described in ANNEX-J.

In the following Sections, the economic comparisons are made for respective alternative transbasin conveyance systems and development plans.

H.3.2 Comparison of Transbasin Conveyance System

The comparison of three alternative transbasin conveyance plans and irrigable areas in the NCRB and NWDZ areas under the present Polgolla diversion policy of 875 MCM was carried out based on the results of water balance simulation described in ANNEX-I, and costs and benefits in ANNEXES-E and J.

All conveyance systems were evaluated under the condition that the irrigation schemes of AMDP should be given first priority to supply water within an allowable water deficit as a base case for the comparison. As shown in Table H.3.1, total area of 323,750 ha including the irrigation area of AMDP can be irrigated within the allowable deficit. And decreased hydropower generation at the existing power stations was considered as a negative benefit. Table H.3.1 shows the results of a water balance in case of the present Polgolla diversion of 875 MCM. The summary is shown below:

	Unit	Alternative Plan			Present Condition
		Case A145	Case B151	Case C145	Case D
1. Combination of Irrigation Area		AMDP NCRB NWDZ	AMDP NCRB NWDZ	AMDP NCRB NWDZ	AMDP - -
2. Irrigation Area*	ha	323,750	323,750	323,750	200,300
3. Pump Station					
- Pumping volume	MCM	761	1,515	896	-
- Energy consumption	GWh	146	498	219	-
4. Energy Output					
- Existing hydropower	GWh	2,138	2,020	2,017	2,264
- Proposed hydropower	GWh	1,808	1,824	1,824	-
- Total	GWh	3,946	3,844	3,841	2,264

Remark: * Including 20,000 ha of non-irrigated cashew land.

Annual equivalent costs of construction for respective cases were calculated at a discount rate of 8% per annum. Hydropower benefit was valued on the basis of the production costs of alternative thermal stations, as detailed in ANNEX-G. Energy consumption at pumping stations was valued at a mean value of firm and secondary energy on the assumption that pump operation would be restricted to use off-peak energy output, referring to the results of water balance studies. Table H.3.12 shows the results of the studies, and following table shows the summary of the comparison of these cases:

	Unit	Alternative Plan		
		Case A145	Case B151	Case C145
1. Total Irrigation Area*1	ha	323,750	323,750	323,750
2. Annual Benefits	US$10^6	155.6	149.8	149.7
3. Annual Costs*2	US$10^6	135.6	176.2	151.1
4. Economic Comparison				
- B/C	-	1.15	0.85	0.99
- B-C	US$10^6	20.0	-26.4	-1.4

Remarks: *1 Including 20,000 ha of non-irrigatred cashew land.
*2 A discount rate of 8% was applied.
No consideration was given to the implementation schedule and the built-up period of the scheme.

As seen in the above table, there is a clear trend that due to the heavy energy consumption at the pump station, the economic viability was greatly affected. Therefore, it is noted that an optimum solution for the transbasin diversion should be a plan how to minimize the energy consumption at the pump station, and at the same time how to keep the irrigated agriculture to the maximum extent. Case B shows the negative benefit, and Case C shows the marginal benefit at a discount rate of 8%. Therefore, Case A was selected as an optimum transbasin conveyance system to supply water to the NCRB area among three alternatives.

In TDS (refer to Table 6.1 of Main Report, Ref. 27), it was also noted that there was very clear trend similar to the above figures as shown in Table H.2.1.

H.3.3 Screening of Agricultural Land Development Plan

As discussed in preceding Section, Case A proposed in this study was selected as an optimum transbasin conveyance plan in terms of B-C and B/C. Moreover, each two alternative development plan with Case A conveyance system were studied under the present Polgolla diversion of 875 MCM and possible alternative diversion of 1,280 MCM adopted in the Moragahakanda Project in 1979 (Ref. 8). Table H.3.2 presents the results of water balance simulation runs, and the summary is presented below:

	Unit	Present Policy 875 MCM		Alternative Policy 1,280 MCM	
		A118	A145	A209	A242
1. Combination of Irrigation Area		AMDP NCRB -	AMDP NCRB NWDZ	AMDP NCRB -	AMDP NCRB NWDZ
2. Irrigation Area*	ha	310,500	323,750	310,500	323,750
3. Pump Station					
- Pumping volume	MCM	560	761	249	262
- Energy consumption	GWh	108	146	67	64
4. Energy Output					
- Existing hydropower	GWh	2,221	2,138	1,967	1,998
- Proposed hydropower	GWh	1,818	1,808	1,866	1,868
- Total	GWh	4,039	3,946	3,833	3,866

Remark: * Including 20,000 ha of non-irrigated cashew land.

By adopting the same procedures described in the preceding Section, the economic comparison of the above cases was carried out on the basis of the results of the water balance studies. Table H.3.13 shows the results of the studies and the following shows the summary of the comparison:

	Unit	Present Policy 875 MCM		Alternative Policy 1,280 MCM	
		A118	A145	A209	A242
1. Total Irrigation Area*1	ha	310,500	323,750	310,500	323,750
2. Annual Benefit	US$$10^6$	147.5	154.7	133.7	147.4
3. Annual Costs*2	US$$10^6$	122.1	135.6	113.3	126.3
4. Economic Comparison					
- B/C	-	1.21	1.14	1.18	1.17
- B-C	US$$10^6$	25.4	19.1	20.4	21.1

Remarks: *1 Including 20,000 ha of non-irrigated cashew land.
*2 A discount rate of 8% was adopted.
No consideration was given to the implementation schedule and the built-up period of the schemes.

As seen in the above table, the development plan of the NCRB, Case A118, shows the most economical plan in terms of B-C and B/C among four alternatives. There is a trend that reduced energy output on the Mahaweli main stream, i.e. the existing hydropower stations under the AMDP, gives rather substantial effect to the comparison as discussed in Section 2.1. This trend is clearly seen in the development of the NWDZ, due to available head to be utilized in hydropower generation. If a value of fossil fuel would increase, it will show a much clearer trend. Contrary to this, if a value of agricultural product would be higher than increase of fossil fuel value, the above trend will be less. Therefore, it is recommended that the present Polgolla diversion might be kept for the time being, and at the final stage of the development in the NCRB area, the Polgolla diversion policy should be reassessed.