The requirement of hydropower generation for Kota Kinabalu and Keningau is estimated to be 224 MW in the year 2000 as shown in Table 47. The requirement for the Sabah grid system development is estimated to be 586 MW in the year 2000 as shown in Table 48.

The hydropower development plan for Kota Kinabalu, shown in Table 49, is recommended as the most realistic plan for Sabah. The development plan for the Sabah grid system, shown in Table 50, is proposed as an alternative plan. Table 53 shows the recommended hydropower development plan for the case under the condition of lower economic growth. Table 51 shows the power demand of major power stations for the case of lower economic growth.

Fig. 28 shows the recommended power balance program at Kota Kinabalu and the other major power stations in Sabah.

The location of the proposed hydropower sites, alternative sites and routes of transmission lines are shown in Fig. 30.

The alternative combination of hydropower development and the optimum development scale depend on the required ratio of hydropower portion to the total power demand.

In this study, the two foregoing alternative hydropower requirement is proposed to make the hydropower portion larger as practically as possible based on the present energy policy which emphasizes saving fossil oil.

In the screening process the other cases having lower hydropower portion of 20 to 50% were also preliminarily studied changing the combination of sites, demand centers, route of transmission line as listed in Tables 54 and 56.

4.3.3 Hydropower development plans in Sarawak

Two alternative hydropower development plans are formulated for the State of Sarawak. One is for the largest demand center, Kuching, in which projected maximum power demand is 142 MW in 1990 and 295 MW in 2000. The other one is for Kuching, Sarikei, Sibu, Bintulu and Miri in which projected maximum power demand is 245 MW in 1990 and 558 MW in 2000. If the energy-intensive project is commissioned for Bintulu the maximum power demand is increased to 736 MW in 1990 and 1,054 MW in 2000. In the latter case, the demand centers are isolated each other, and therefore a grid system of transmission line is required to connect these demand centers.

The requirement of hydropower generation including reserved capacity is estimated for Kuching to be 190 MW in the year 2000 after completion of the Batang Ai hydropower station.

The upper Batang Ai, Batang Sekrang and Konowit (identified as KONO 110 in Ref. 2) hydropower schemes shown in Table 52 are recommended for Kuching power demand to bridge the commission of the large scale development.

If the energy-intensive industries is commissioned in Bintulu, the Pelagus (Raja 284) scheme with 770 MW should be constructed taking into account a power transmission line grid system through the State of Sarawak.

Table 53 shows the recommended hydropower development plan for the case under the condition of lower economic growth.

Fig. 29 shows the recommended power balance program at Kuching and the other major power stations in Sarawak.

The location of the proposed hydropower sites, alternative sites and routes of transmission lines are shown in Fig. 31.

In the screening process the other cases, which exclude the demand of energy-intensive industries in Bintulu but intend to supply to Kuching, Sibu, Bintulu and Miri, were also preliminarily studied changing the demand of hydropower portion, combination of sites, demand centers, route of transmission line as listed in Table 57.

Though the investment efficiency of these alternatives is estimated to be better than that of the recommended plan, these combination is not proposed because the accessibility to these sites is extremely bad and uncertainties are involved in the timing to bridge the commission of the energy intensive industries in Bintulu.

The hydropower potential of the Song upper and Song lower sites, which are located upstream and downstream of Song town in the Rajang river respectively (see Fig. 31), is roughly estimated. The potential installed capacity is estimated around 300 to 440 MW as shown in Table 85. The high power potential of the two sites is very attractive but implementation of these sites would be practically not feasible because most residents lived in the river plane along the Rajang river will be submerged completely.

4.3.4 Features of hydropower projects

The major technical features of the proposed hydropower projects in Sabah and Sarawak are roughtly estimated and presented in Tables 77 to 84, which compile gross storage, active storage, full supply level, reservoir surface area, dam height, installed capacity, annual energy, rated head and breakdown of the project cost. The values which are not available are kept as blank.

4.4 Economic Benefit of Hydropower Development

4.4.1 Methodology

Economic benefit to be derived from power generation by the proposed hydropower projects is estimated based on the least-costly alternative power facilities cost criteria. As the alternatives, the following power plants are considered and economic comparison is made based on the price levels at the end of 1980.

Alternatives	Unit Capacity (MW)
Diesel	8 & 12
Gas turbine	22
Oil-fired thermal	60
Coal-fired thermal	60

For the proposed hydropower projects in Sabah and Sarawak, gas turbine plant of 22 MW unit capacity is selected based on the results of the economic comparison, taking into account the projected total power demand in Sabah and Sarawak, type and unit capacity of the power plants planned by SEB and SESCO and other relevant matters.

4.4.2 Economic power benefit

(1) Power (kW) value

On the basis of the economic construction cost of 22 MW gas turbine plant, annual equivalent cost required for producing the anticipated power is estimated with the following assumptions:

- Economic construction cost M$440/kW
- Construction period 2 years
- Economic life 15 years
- Salvage value 10%
- Insurance (% of construction cost) 0.6%
- Fixed O&M (% of construction cost) 3.5%

The annual equivalent cost per kW is estimated at M$61.3 at 8% discount rate.

For the calculation of the kW value, adjustment factor of hydropower to the thermal power is calculated at 1.24 as shown in Table 58.

The kW value is estimated at M$76.0.

(2) Energy (kWh) value

The annual equivalent cost required for generating the projected energy is the sum of fuel cost and variable O&M cost of the 22 MW gas turbine plant, which is calculated at M$0.145/kWh with the following assumptions:

- Fuel consumption 0.299 lit/kWh
- Oil price M$75.5/barrel (US$34/barrel)
- Variable O&M (% of fuel cost) 2.25%

For the calculation of the kWh value, adjustment factor of hydropower to the thermal power is calculated at 1.028 as shown in Table 58. The kWh value is estimated at M$0.149/kWh.

(3) Economic power benefit

The total power benefit of each hydropower project is estimated for each discount rate as follows:

Total annual power benefit = Installed capacity x kW value
+ Annual generated energy x kWh value

The annual equivalent of economic benefit at 8% discount rate for each hydropower project is shown in the Sectoral Report, Vol. 17, Public Expenditure and Beneficial and Adverse Effects.

5. BENEFICIAL AND ADVERSE EFFECTS DUE TO WATER SOURCE AND HYDROPOWER DEVELOPMENT

5.1 Parameters Showing Beneficial and Adverse Effects due to Water Source and Hydropower Development

The beneficial and adverse effects due to the alternative water source development for water demand and supply balance programs and hydropower development are evaluated from the standpoint of national economic development, environmental quality and social well-being as set out below:

1) National economic development

   a) economic benefit

   b) economic cost

   c) economic internal rate of return

2) Environmental quality

   a) beneficial effect; safe river maintenance flow period

   b) adverse effect; possible reduction in kind of fish immediately downstream of dams and barrages (number of sites)

3) Social well-being

   a) beneficial effect;

      · safe water supply period

      · drought damage ratio

   b) adverse effect;

      · number of people to be removed for construction of water source and hydropower facilities

      · land compensation and resettlement

The beneficial and adverse effects on all the sectors are evaluated for the whole Malaysia in the Main Report, Vol. 2. It is evaluated by State basis in the State Reports (Vols. 9 & 10) and the detailed evaluation is made for each sector by project basis in the Sectoral Report, Public Expenditure and Beneficial and Adverse Effects. In this chapter the calculation procedure and results of the effects due to water source development and hydropower development are independently presented.

5.2 National Economic Development

The beneficial and adverse effects of the alternatives on the national economic development account are calculated as the annual equivalent of economic benefits and costs, assuming a discount rate of 8% for an evaluation period of 50 years between 1981 and 2030.

The prices of internationally traded goods and services are estimated based on the World Bank projection to 1990, or the international market price in December, 1980. The prices of locally traded goods and services are the normalized price in December, 1980. The transfer payments such as tax and local contractors' profit are deducted from all prices. The ratio of transfer payment to the financial cost is assumed to be 20% of financial cost referring to the ratio of tax revenued to GDP at purchasers' price in 1980 in 4MP.

The supply capacity required for multipurpose development scheme is allocated to domestic and industrial water supply and irrigation water supply in proportion to the demand.

The domestic and industrial water supply benefit is estimated based on the least-costly alternative facilities cost criteria. A construction schedule of dams to meet the required supply capacity which is allocated to domestic and industrial water supply is prepared, assuming the least costly dams among those which are not proposed for the alternative. The cost of the above-mentioned dams and the proposed intake, conveyance, treatment and distribution system is regarded as the benefit of domestic and industrial water supply without drought damage.

So far as the hydrological condition in the record period from 10 to 16 years is assumed, all water deficit can be met by Alternative B1 in the Basins with the river utilization of more than 10%. On the other hand, there may be a certain water deficit in the cases of Alternatives B2 and B2.

There should be established a rule for the emergency operation against the drought in which both the rate of water withdrawal and rate of river maintenance flow should be sustained as much as possible and the river flow should be kept not below the essential river maintenance flow. Herein a simplified rule is assumed that water withdrawal for use continues until the river flow lowers to the essential river maintenance flow after the water withdrawal and thereafter the water withdrawal is reduced so that river flow no longer lowers. Consequently the reduction in supply for domestic and industrial water demand and irrigation water demand was calculated through the recorded period for Alternatives B2 and B3, allowing low flow after the water withdrawal to be equal to the essential river maintenance flow. The reduction in benefit was calculated assuming that it is proportional to the reduction in the supply. The drought damage ratio is estimated in Section 5.3.2 for this purpose.

The economic internal rate of return (EIRR) is calculated as the discount rate with which the present worth of benefit equals to that of cost.

All the results for the national economic development account are compiled in the Main Report (Vol. 2), the State Reports and the Sectoral Report (Public Expenditure and Beneficial and Adverse Effects).

The benefit of the hydropower development is described in Chapter 4.

5.3 Environmental Quality and Social Well-being

5.3.1 Safe river maintenance flow period

The river maintenance flow is the requisite for the conservation of river environment and adequate water use. The effect on the river maintenance flow is evaluated by the safe river maintenance flow period defined as follows:

The period when the desirable river minimum maintenance flow (the daily mean discharge with the probability of exceedence of 97%, Q97%) is sustained under the most severe drought ever recorded (1/N), provided 100% water supply is gualanteed.

The calculation model of the safe river maintenance flow period is shown in Table 59. The safe river maintenance flow is calculated for the both conditions before (without structural measures) and after (with structural measures) the structural measures of water source facilities are provided. The results of the alternatives B1 - B3 are shown in Table 60 for the years 1990 and 2000. The results of the recommended plan are shown in Table 62 for the years 1990 and 2000. The value with structural measures are compared with the value without structural measures under 1/N drought level to show the rate of improvement. Table 61 shows the values without structural measures under different drought level, 1/N, 2/N and 3/N for the 47 Basins. The results of recommended plan under the lower economic growth are presented in Table 63 for the years 1990 and 2000.

5.3.2 Safe water supply period and drought damage ratio

The safe water supply period is defined as follows:

The period when water supply is gualanteed 100% but the river minimum maintenance flow is reduced to the essential minimum maintenance flow (the daily mean discharge with the probability of exceedence of 99%, Q99%) under the most sever drought ever recorded (1/N).

The drought damage ratio is defined as follows:

The ratio of total amount of water shortage in N years to the total amount of development water including river minimum maintenance flow (Q97%) and withdrawal of all the sectors in N years in percent, provided alternative structural measures are given.

The calculation model of the safe water supply period and the drought damage ratio is shown in Table 59.

The safe water supply period is estimated for the both conditions before (without structural measures) and after (with structural measures) the structural measures of water source facilities are provided. The results of the alternatives B1 - B3 are shown in Table 60 for the years 1990 and 2000. The results of the recommended plan are shown in Table 62 for the years 1990 and 2000. The value with structural measures is compared with the value without structural measures under 1/N drought level to show the rate of improvement. Table 61 shows the values without structural measures under different drought level, 1/N, 2/N and 3/N for the 47 Basins. The results of recommended plan under the lower economic growth are presented in Table 63 for the years 1990 and 2000.

The drought damage ratio is estimated for the case with structural measures and the results of alternatives B1 - B3 are shown in Table 64. Table 65 shows the results with recommended plans under the both target and lower economic growth in the years 1990 and 2000.

5.3.3 Resettlement and effects on aqua-ecology

The number of people to be removed for the purpose of construction of proposed water source and hydropower development facilities is calculated as adverse effect.

If a dam or a barrage is constructed, some species of fish would disappear within a certain length of river stretch immediately downstream of the dam reflecting an adverse effect on ecological system, though such adverse effect could be compensated by possible cage culture in the created reservoir. The number of dam or barrage sites is counted as the adverse effect.

These results are compiled in the Main Report, the State Reports and the Sectoral Report, Public Expenditure and Beneficial and Adverse Effects.

The land compensation and resettlement cost is accounted for the project cost. Table 66 shows the standard land compensation and resettlement cost used in this study.

5.4 Number of Proposed Facilities and Manpower Requirement

The number of proposed water source facilities (i.e. dams) and hydropower projects (dams) is counted as of the commission year of the facilities and is compiled by alternative and the period of Malaysia Plan from 5MP (1986 - 1990) to 7MP (1996 - 2000) as listed in Table 67.

The manpower, which is required for construction, operation and maintenance of the proposed facilities is also counted in terms of the number of the required staff. The results are compiled in Malaysia Plan by alternative or recommended plan as shown in Tables 68 and 69 for water source facilities and in Table 70 for hydropower dams.

The grade of government staff is classified into 4 from A to D based on the information of the Government of Malaysia. The number of staff required for a project is assumed as follows:

Grade	Construction	Operation and Maintenance
(i) Water source facilities (dams)		
A; Engineer	1	1
B; Technical assistant	1	1
C; Technician	2	1
D; Others	3	4
Total	7	7
(ii) Hydropower dams		
A; Engineer	1	1
B; Technical assistant	2	2
C; Technician	2	1
D; Others	3	4
Total	8	8

REFERENCES

1. VEN TE CHOW (Editor-in-Chief), HANDBOOK OF APPLIED HYDROLOGY, MacGraw-Hill, 1964, PP8.28-8.29

2. SESCO, MASTER PLAN FOR POWER SYSTEM DEVELOPMENT, German Agency for Technical Cooperation Ltd. (SAMA Consortium), April, 1981, Vols. 1 - 4

Remarks; The other reports referred in Phase III study are compiled in the Sectoral Report, Water Resources Engineering, Part 2.

TABLES

Table 1 SIMULATION PERIOD OF WATER BALANCE BY BASIN

	Basin	Simulation Period	Simulation Period in Years
201	Pensiangan	1968 - 1977	10
202	Serudong	1968 - 1977	10
203	Kalabakan	1968 - 1977	10
204	Brantian	1968 - 1977	10
205	Umas Umas	1968 - 1977	10
206	Merutai Besar	1968 - 1977	10
207	Tawau	1968 - 1977	10
208	Kalumpang	1968 - 1977	10
209	Silibukan	1968 - 1977	10
210	Segama	1968 - 1977	10
211	Kinabatangan	1968 - 1977	10
212	Segaliud	1964 - 1977	14
213	Labuk	1964 - 1977	14
214	Sugut	1964 - 1977	14
215	Paitan	1964 - 1977	14
216	Bengkoka	1965 - 1977	13
217	Bongan	1965 - 1977	13
218	Kadamaian	1965 - 1977	13
219	Tuaran	1965 - 1977	13
220	Putatan	1965 - 1977	13
221	Papar	1965 - 1977	13
222	Kimanis	1965 - 1977	13
223	Membakut	1965 - 1977	13
224	Padas	1968 - 1977	10
225	Labuan	1965 - 1977	13
226	Lakutan	1965 - 1977	13
227	Lawas	1965 - 1977	13
228	Trusan	1965 - 1977	13
229	Limbang	1966 - 1980	15
230	Baram	1966 - 1980	15
231	Miri	1967 - 1979	13
232	Sibuti	1967 - 1979	13
233	Niah	1967 - 1979	13
234	Buai	1967 - 1979	13
235	Similajau	1967 - 1979	13
236	Kemena	1967 - 1979	13
237	Tatau	1967 - 1979	13
238	Balingian	1967 - 1979	13
239	Mukah	1967 - 1979	13
240	Oya	1967 - 1979	13
241	Rajang	1967 - 1979	13
242	Kerian	1964 - 1979	16
243	Saribas	1964 - 1979	16
244	Lupar	1964 - 1979	16
245	Sadong	1964 - 1979	16
246	Sarawak	1970 - 1979	10
247	Kayan	1970 - 1979	10

Table 2 STANDARD DIRECT COST FOR DAMS AND BARRAGES

(A) Dam

Assumptions

1)	Dam type	Rockfill dam
2)	Typical cross section	Slope of upstream and downstream: 4
		Foundation excavation: 10 - 30 m depending on height of dam
		Crest width: 10 m
		Free board : 3.0 m

Direct cost

Unit cost	Volume of dam
US$20/m^3:	2 million m^3 or larger
US$25/m^3:	between 0.5 and 2 million m^3
US$30/m^3:	0.5 million m^3 or less

(US$1.00 = M$2.22)

Direct unit cost includes those of dam, spillway, diversion, intake and other appurtnant structures.

The unit cost was based on the actual construction cost of some dams in Nepal, Jordan, Indonesia and Malaysia from 1978 to 1980.

(B) Barrage/Weir

M$1,450/m per m^3/s of 100-year maximum discharge capacity.

Table 3 STANDARD DIRECT COST FOR TUNNELS

Assumptions

1)	Type	Pressure or free flow tunnel with concrete lining
2)	Typical cross section	Circular type with lining thickness of 0.12 D (diameter) Flow velocity was assumed at 2 m/sec.
3)	Unit cost	Unit cost was expressed as construction cost per meter length of tunnel for some selected flow capacities. The unit cost was estimated as a sum of excavation and concrete lining cost. Excavation cost = US$40/$m^3$ Concrete lining = US$100/$m^3$ These costs were also based on the actual construction cost of the dam projects referred in dam cost estimate.

Direct cost

Flow capacity		Q (m^3/s)	5	10	20	30
Dia		D (m)	1.78	2.52	3.57	4.37
Excavation per meter		E (m^3/m)	4.64	8.69	17.84	26.71
Concrete per meter		C (m^3/m)	1.47	3.70	7.83	11.71
Cost:	Excavation	(US$/m)	185.6	347.6	713.6	1,068.4
	Concrete	(US$/m)	147.0	370.0	783.0	1,171.0
Total unit direct cost		(US$/m)	332.6	717.6	1,496.6	2,239.4

Table 4 STANDARD DIRECT COST FOR OPEN CANALS

Assumptions

1) Type — Open canal with side lining

2) Typical cross section
- Side slope : 1 : 2.5
- Bottom : 3 h (h: design depth)
- Allowance : 1.0 - 1.5 m
- Flow velocity: 1.0 m/sec

3) Unit cost

Unit cost was expressed as construction cost per meter length for some selected flow capacity.

The unit cost was estimated as a sum of excavation and lining cost.

Excavation : US$5/$m^3$
Lining : US$80/$m^3$

Direct cost

Flow capacity	Q (m^3/s)	5	10	20	30
Depth	H (m)	0.95	1.35	1.9	2.3
Allowance	F (m)	1.0	1.0	1.2	1.5
Excavation	E (m^3/m)	15	23	42	62
Concrete	C (m^3/m)	1.53	2.18	3.07	3.72
Cost: Excavation	(US$/m)	75	115	210	310
Concrete	(US$/m)	122.4	134.4	245.6	297.6
Total unit direct cost	(US$/m)	197.4	289.4	455.6	607.6

Table 5 STANDARD DIRECT COST FOR PIPELINES

(A) Pipeline with large diameter

Assumptions

1)	Type	Steel pipeline
2)	Cross section	Flow velocity: 2 m/sec Thickness : minimum 8 mm
3)	Unit cost	Unit cost was expressed as construction cost per meter length for some selected flow capacities. Unit cost of materials per weight was estimated at US$5,400/ton which included steel material, erection and civil foundation cost.

Direct cost

Discharge	Q	(m^3/sec)	1	2	3	5	10
Dia	D	(m)	0.80	1.13	1.38	1.78	2.52
Thickness	T	(mm)	8	10	10	10	12
Weight	W	(kg/m)	159	280	342	446	740
Cost per meter		(US$/m)	859	1,512	1,847	2,408	3,996

(B) Pipeline with small diameter

Direct cost

Discharge	Q	(m^3/sec)	0.1	0.3	0.5	0.7	0.9	1.0
Velocity	V	(m/sec)	1.0	1.0	1.0	1.0	1.0	1.0
Diameter	D	(m)	0.36	0.62	0.80	0.94	1.07	1.12
Cost per meter		(US$/m)	180	340	470	585	700	740

(C) Sub-marine pipeline

Direct cost

Discharge	Q	(m^3/sec)	0.1	0.3	0.5	0.7
Velocity	V	(m/sec)	1.0	1.0	1.0	1.0
Diameter	D	(m)	0.36	0.62	0.80	0.94
Cost per meter		(US$/m)	650	920	1,060	1,130

Table 6 STANDARD DIRECT COST FOR PUMP STATIONS AND ACCESS AND RELOCATION ROADS

(A) Pump station

Assumptions

1) Type — Horizontal double suction volute pump

2) Unit cost — Unit cost was expressed as construction cost for some selected combination of suction head and discharge.

The pump cost included pump, motor and base structures.

Civil cost was assumed 100% of the pump cost.

Direct cost

Discharge	Q (m^3/min)	50	50	50	100	100	100	200	200
Head	H (m)	20	40	90	20	40	90	20	40
Motor capacity	(kW)	230	550	1,250	480	980	2,200	1,100	1,850
Pump cost	(US$10^3)	75	110	190	165	215	470	340	595
Civil cost	(US$10^3)	75	110	190	165	215	470	340	595
Total cost	(US$10^3)	150	220	380	330	430	940	680	1,190

O&M cost

Energy: M$10/kWh

Maintenance including operators: 1% of the total construction cost/year

(B) Single lane access road and Relocation road

Assumptions

1) Type — Single lane rural class

Direct cost

Access road including pavement : M$300,000/km

Pavement only : M$100,000/km

2) Relocation road : M$300,000 - M$800,000/km

Table 7 BASIN DIVISION AND CATCHMENT AREA

Sabah				Sarawak			
No.	Basin	Catchment Area(km^2)	Effective Area(km^2)	No.	Basin	Catchment Area(km^2)	Effective Area(km^2)
201	Pensiangan	5,971	5,971	227	Lawas	1,080	977
202	Serudong	1,308	1,155	228	Trusan	2,768	2,598
203	Kalabakan	1,371	1,288	229	Limbang	3,920	3,865
204	Brantian	741	678	230	Baram	22,325	21,822
205	Umas Umas	553	408	231	Miri	788	263
206	Merutai Besar	558	473	232	Sibuti	935	790
207	Tawau	888	683	233	Niah	1,345	1,117
208	Kalumpang	2,792	2,284	234	Buai	1,440	1,242
209	Silibukan	2,714	2,154	235	Similajau	1,268	935
210	Segama	5,558	4,787	236	Kemena	6,000	5,745
211	Kinabatangan	16,755	15,752	237	Tatau	5,150	4,790
212	Segaliud	2,335	1,632	238	Balingian	2,518	1,548
213	Labuk	6,829	5,969	239	Mukah	2,625	1,486
214	Sugut	3,094	2,826	240	Oya	2,005	1,277
215	Paitan	1,474	1,086	241	Rajang	51,053	46,035
216	Bengkoka	1,866	1,463	242	Kerian	1,675	849
217	Bongan	2,126	1,823	243	Saribas	1,900	799
218	Kadamaian	1,336	1,171	244	Lupar	6,813	5,209
219	Tuaran	1,247	1,139	245	Sadong	3,645	2,935
220	Putatan	629	494	246	Sarawak	3,358	2,152
221	Papar	805	785	247	Kayan	1,838	1,549
222	Kimanis	607	547				
223	Membakut	736	338				
224	Padas	9,180	8,475				
225	Labuan	86	46				
226	Lakutan	1,291	1,173				
Total of Sabah		72,850	64,600	Total of Sarawak		124,449	107,983

Table 8 MINIMUM RIVER MAINTENANCE FLOW IN EFFECTIVE AREA

Basin No.	Effective Catchment Area (km^2)	Balance Point (km)	Q97%		Q99%	
			$m^3/s/100\ km^2$	m^3/s	$m^3/s/100\ km^2$	m^3/s
201	5,971	0	1.27	75.9	1.16	69.0
202	1,155	11	0.894	10.3	0.813	9.4
203	1,288	13	0.965	12.4	0.877	11.3
204	678	10	0.874	5.9	0.795	5.4
205	408	5	0.819	3.3	0.745	3.0
206	473	5	0.884	4.2	0.802	3.8
207	683	10	1.05	7.2	0.958	6.5
208	2,284	5	1.03	23.5	0.934	21.3
209	2,154	5	1.41	30.4	1.28	27.6
210	4,787	35	1.32	63.2	1.20	57.4
211	15,752	52	0.474	74.7	0.243	38.3
212	1,632	8	1.38	22.5	0.743	12.1
213	5,969	15	1.44	86.0	0.779	46.5
214	2,826	35	1.43	40.4	0.775	21.9
215	1,086	10	1.59	17.3	0.857	9.3
216	1,463	4	0.468	6.8	0.298	4.4
217	1,823	1	0.424	7.7	0.270	4.9
218	1,171	5	0.626	7.3	0.398	4.7
219	1,139	6	0.688	7.8	0.449	5.1
220	494	3	0.591	2.9	0.355	1.8
221	785	3	0.614	4.8	0.368	2.9
222	547	3	0.586	3.2	0.351	1.9
223	338	12	0.571	1.9	0.342	1.2
224	8,475	27	0.675	57.2	0.597	50.6
225	46	Ave.2	0.673	0.3	0.403	0.2
226	1,173	5	0.517	6.1	0.311	3.6
227	977	5	0.800	7.8	0.480	4.7
228	2,598	15	0.550	14.3	0.330	8.6
229	3,865	6	1.84	71.1	1.46	56.4
230	21,822	63	1.78	388	1.41	308
231	263	20	0.676	1.8	0.451	1.2
232	790	15	0.574	4.5	0.383	3.0
233	1,117	12	0.548	6.1	0.365	4.1
234	1,242	31	0.683	8.5	0.455	5.7
235	935	3	0.849	7.9	0.566	5.3
236	5,745	21	1,08	62.0	0.723	41.5
237	4,790	19	1.08	51.7	0.721	34.5
238	1,548	46	1.05	16.3	0.698	10.8
239	1,486	40	1,08	16.0	0.721	10.7
240	1,277	25	0.846	10.8	0.564	7.2
241	46,035	15	3.06	1,409	2.79	1,284
242	849	26	1.10	9.3	0.82	7.0
243	799	39	1.05	8.4	0.80	6.4
244	5,209	36	1.08	56.3	0.82	42.7
245	2,935	81	1.13	33.2	0.86	25.2
246	2,152	35	1,69	36.4	1.40	30.1
247	1,549	11	2.07	32.1	1.70	26.3

Remarks; Q97%, 99% = The daily discharge with the probability of exceedance of 97% and 99% respectively

Table 9 NUMBERING OF STATES

State No.	Name of State	State No.	Name of State
1	Perlis	7	Melaka
2	Kedah	8	Johor
3	Pulau Pinang	9	Pahang
4	Perak	10	Trengganu
5	Selangor	11	Kelantan
6	Negeri Sembilan	12	Sabah
		13	Sarawak

Table 10 NUMBERING OF PROSPECTIVE CITIES

Sabah		Sarawak	
City/Town	City No.	City/Town	City No.
Tawau	C201	Limbang	C212
Semporna	C202	Marudi	C213
Lahad Datu	C203	Miri	C214
Sandakan	C204	Bintulu	C215
Ranau	C205	Sibu	C216
Kudat	C206	Sarikei	C217
Kota Belud	C207	Serian	C218
Kota Kinabalu	C208	Kuching	C219
Papar	C209		
Keningau	C210		
Labuan	C211		

Table 11 NUMBERING OF DISTRICTS

Sabah			Sarawak		
District No.	Name	Residency	District No.	Name	Division
D201	Pensiangan	Interior	D224	Lawak	Fifth
D202	Tawau	Tawau	D225	Limbang	"
D203	Semporna	"	D226	Baram	Fourth
D204	Lahad Datu	"	D227	Miri	"
D205	Kinabatangan	Sandakan	D228	Bintulu	"
D206	Sandakan	"	D229	Mukah	Third
D207	Labuk & Sugut	"	D230	Oya Dalat	"
D208	Pitas	West Coast	D231	Sibu	"
D209	Kudat	"	D232	Kanowit	"
D210	Kota Marudu	"	D233	Belaga	Seventh
D211	Kota Belud	"	D234	Kapit	"
D212	Ranau	"	D235	Song	"
D213	Tuaran	"	D236	Matu & Daro	Sixth
D214	Kota Kinabalu	"	D237	Binatang	"
D215	Penampang	"	D238	Sarikei	"
D216	Papar	"	D239	Julau	"
D217	Tambunan	Interior	D240	Kalaka	Second
D218	Keningau	"	D241	Saribas	"
D219	Kuala Penyu	"	D242	Lubok Antu	"
D220	Beaufort	"	D243	Simanggang	"
D221	Tenom	"	D244	Simunjam	First
D222	Sipitang	"	D245	Serian	"
D223	Labuan	Labuan	D246	Kuching	"
			D247	Bau	"
			D248	Lundu	"

Table 12 MEAN ANNUAL RAINFALL AND RUNOFF BY BASIN IN SABAH AND SARAWAK

Basin No.	Catchment Area (km^2)	Mean Annual Rainfall (mm)	Mean Annual Runoff Depth (mm)	Mean Annual Rainfall (10^6 m^3)	Mean Annual Runoff (10^6 m^3)
201	5,971	2,491	1,492	14,870	8,906
202	1,308	2,093	1,051	2,740	1,375
203	1,371	2,168	1,134	2,970	1,555
204	741	2,071	1,027	1,530	761
205	553	2,013	962	1,110	532
206	558	2,080	1,036	1,160	578
207	888	2,262	1,238	2,010	1,099
208	2,792	2,233	1,206	6,230	3,367
209	2,714	2,639	1,655	7,160	4,493
210	5,558	2,549	1,556	14,170	8,647
211	16,755	2,660	1,332	44,570	22,324
212	2,335	3,161	2,275	7,380	5,313
213	6,829	3,272	2,388	22,340	16,306
214	3,094	3,255	2,371	10,070	7,335
215	1,474	3,506	2,625	5,170	3,869
216	1,866	2,700	1,268	5,040	2,366
217	2,126	2,582	1,151	5,490	2,446
218	1,336	3,130	1,695	4,180	2,265
219	1,247	3,023	1,952	3,770	2,434
220	629	3,126	1,831	1,970	1,152
221	805	3,190	1,897	2,570	1,527
222	607	3,106	1,812	1,890	1,100
223	736	3,064	1,769	2,260	1,302
224	9,180	2,110	1,027	19,370	9,432
225	86	3,376	2,093	290	180
226	1,291	2,900	1,602	3,740	2,068
227	1,080	3,762	2,479	4,060	2,677
228	2,768	2,999	1,703	8,300	4,713
229	3,920	3,884	2,699	15,230	10,581
230	22,325	3,794	2,607	84,700	58,205
231	788	2,976	1,646	2,350	1,297
232	935	2,745	1,399	2,570	1,308
233	1,345	2,681	1,333	3,610	1,793
234	1,440	2,993	1,661	4,310	2,392
235	1,268	3,378	2,068	4,280	2,622
236	6,000	3,918	2,640	23,510	15,837
237	5,150	3,912	2,632	20,150	13,554
238	2,518	3,830	2,548	9,640	6,417
239	2,625	3,914	2,632	10,270	6,910
240	2,005	3,369	2,060	6,750	4,131
241	51,053	3,991	2,492	203,750	127,201
242	1,675	3,637	2,227	6,090	3,731
243	1,900	3,547	2,139	6,740	4,065
244	6,813	3,612	2,204	24,610	15,013
245	3,645	3,716	2,306	12,540	8,404
246	3,358	4,193	2,730	14,080	9,167
247	1,838	4,793	3,334	8,810	6,128

Table 13 HYDROLOGIC WATER BALANCE AMONG RAINFALL, EVAPOTRANSPIRATION, DEEP PERCOLATION AND SURFACE RUNOFF BY BASIN

Unit: 10^9 m^3/y

Basin No.	Name of Basin	Catchment* Area (km^2)	Rain-fall	Evapotrans-piration	Deep Per-colation**	Surface Runoff
201	Pensiangan	5,971	14.87	5.44	0.52	8.91
202	Serudong	1,308	2.74	1.24	0.12	1.38
203	Kalaban	1,371	2.97	1.26	0.15	1.56
204	Brantian	741	1.53	0.68	0.09	0.76
205	Umas Umas	553	1.11	0.50	0.08	0.53
206	Merutai Besar	558	1.16	0.49	0.09	0.58
207	Tawau	888	2.01	0.66	0.25	1.10
208	Kalumpang	2,792	6.23	2.38	0.48	3.37
209	Silibukan	2,714	7.16	1.86	0.81	4.49
210	Segama	5,558	14.17	4.32	1.20	8.65
211	Kinabatangan	16,755	44.57	19.62	2.63	22.32
212	Segaliud	2,335	7.38	1.75	0.32	5.31
213	Labuk	6,829	22.34	4.53	1.50	16.31
214	Sugut	3,094	10.07	2.19	0.54	7.34
215	Paitan	1,474	5.17	0.68	0.62	3.87
216	Bengkoka	1,866	5.04	2.37	0.30	2.37
217	Bongan	2,126	5.49	2.59	0.45	2.45
218	Kadamajan	1,336	4.18	1.66	0.25	2.27
219	Tuaran	1,247	3.77	1.15	0.19	2.43
220	Putatan	629	1.97	0.63	0.19	1.15
221	Papar	805	2.57	0.93	0.11	1.53
222	Kimanis	607	1.89	0.64	0.15	1.10
223	Membakut	736	2.26	0.63	0.33	1.30
224	Padas	9,180	19.37	8.67	1.27	9.43
225	Labuan	86	0.29	0.07	0.04	0.18
226	Lakutan	1,291	3.74	0.59	1.08	2.07
227	Lawas	1,080	4.06	1.18	0.20	2.68
228	Trusan	2,768	8.30	3.22	0.37	4.71
229	Limbang	3,920	15.23	3.82	0.83	10.58
230	Baram	22,325	84.70	22.82	3.67	58.21
231	Miri	788	2.35	0.65	0.40	1.30
232	Sibuti	935	2.57	1.06	0.20	1.31
233	Niah	1,345	3.61	1.63	0.19	1.79
234	Buai	1,440	4.31	1.67	0.25	2.39
235	Similajau	1,268	4.28	1.40	0.26	2.62
236	Kemena	6,000	23.51	6.84	0.83	15.84
237	Tatau	5,150	20.15	5.57	1.03	13.55
238	Balingian	2,518	9.64	2.02	1.20	6.42
239	Mukah	2,625	10.27	2.13	1.23	6.91
240	Oya	2,005	6.75	1.90	0.72	4.13
241	Rajang	51,053	203.75	65.56	10.99	127.20
242	Kerian	1,675	6.09	1.69	0.67	3.73
243	Saribas	1,900	6.74	1.76	0.91	4.07
244	Lupar	6,813	24.61	7.16	2.44	15.01
245	Sadong	3,645	12.54	2.64	1.50	8.40
246	Sarawak	3,358	14.08	3.22	1.69	9.17
247	Kayan	1,838	8.81	1.93	0.75	6.13

Remarks; * Total catchment area of effective and ineffective area
** denotes groundwater recharge.

Table 14 RIVER UTILIZATION RATIO BY BASIN IN 1990 AND 2000 UNDER THE CONDITION OF TARGET ECONOMIC GROWTH

Basin No.	Name of Basin	Surface Rounoff in Effective Area (1) (10^6 m^3/y)	1990 Source Demand (10^6 m^3/y) D&I	Irriga-tion	Total (2)	Ratio (2)/(1) (%)	2000 Source Demand (10^6 m^3/y) D&I	Irriga-tion	Total (3)	Ratio (3)/(1) (%)*
201	Pensiangan	8,906	0.3	0	0.3	0	0.6	0	0.6	0
202	Serudong	1,214	0.7	0	0.7	0	1.1	0	1.1	0.1
203	Kalabakan	1,460	0.8	0	0.8	0	1.4	0	1.4	0
204	Brantian	696	0.4	0	0.4	0	0.8	0	0.8	0.1
205	Umas Umas	393	0.3	0	0.3	0	0.6	0	0.6	0.1
206	Merutai Besar	490	0.3	0	0.3	0	0.7	0	0.7	0.1
207	Tawau	846	9.0	0	9.0	1.1	27.3	0	27.3	3.2
208	Kalumpang	2,754	3.9	0	3.9	0.1	8.3	0	8.3	0.3
209	Silibukan	3,566	4.2	0	4.2	0.1	15.1	0	15.1	0.4
210	Segama	7,447	1.0	0	1.0	0	1.7	0	1.7	0
211	Kinabatangan	20,988	1.3	0	1.3	0	2.4	0	2.4	0
212	Segaliud	3,714	16.7	0	16.7	0.4	53.1	0	53.1	1.4
213	Labuk	14,253	2.6	30	32.6	0.2	6.3	56	62.3	0.4
214	Sugut	6,699	0.6	13	13.6	0.2	1.0	13	14.0	0.2
215	Paitan	2,850	0.3	0	0.3	0	0.4	0	0.4	0
216	Bengkoka	1,855	0.9	20	20.9	1.1	1.4	22	23.4	1.3
217	Bongan	2,097	4.0	76	80.0	3.8	11.6	76.	87.6	4.2
218	Kadamaian	1,985	2.5	126	128.5	6.5	6.0	135	141.0	7.1
219	Tuaran	2,224	4.9	43	47.9	2.2	5.3	43	48.3	2.2
220	Putatan	905	24.1	37	61.1	6.8	64.2	37	101.2	11.2
221	Papar	1,489	3.4	45	48.4	3.3	7.7	45	52.7	3.5
222	Kimanis	991	0.4	31	31.4	3.2	0.6	31	31.6	3.2
223	Membakut	598	1.1	16	17.1	2.9	2.0	16	18.0	3.0
224	Padas	8,708	6.1	117	123.1	1.4	13.4	150	163.4	1.9
225	Labuan	96	12.4	0	12.4	12.9	23.8	0	23.8	24.8
226	Lakutan	1,879	0.9	15	15.9	0.8	1.7	15	16.7	0.9
227	Lawas	2,422	0.5	5	5.5	0.2	0.8	5	5.8	0.2
228	Trusan	4,424	0.5	6	6.5	0.1	0.8	17	17.8	0.4
229	Limbang	10,432	2.3	31	33.3	0.3	4.5	78	82.5	0.8
230	Baram	56,893	3.5	28	31.5	0	9.2	78	97.2	0.2
231	Miri	433	14.1	2	16.1	3.7	52.1	2	54.1	12.5
232	Sibuti	1,105	0.6	11	11.6	1.0	0.9	11	11.9	1.1
233	Niah	1,489	0.8	0	0.8	0	1.5	0	1.5	0.1
234	Buai	2,063	0.9	0	0.9	0	1.5	0	1.5	0
235	Similajau	1,934	0.3	0	0.3	0	0.4	0	0.4	0
236	Kemena	15,167	16.9	14	30.9	0.2	27.2	38	65.2	0.4
237	Tatau	12,607	0.6	3	3.6	0	1.1	3	4.1	0
238	Balingian	3,944	0.6	0	0.6	0	1.0	4	5.0	0.1
239	Mukah	3,911	1.6	6	7.6	0.2	2.6	6	8.6	0.2
240	Oya	2,631	0.8	4	4.8	0.2	1.4	7	8.4	0.3
241	Rajang	114,699	29.1	13	42.1	0	64.6	52	116.6	0.1
242	Kerian	1,891	1.6	0	1.6	0	3.0	0	3.0	0.2
243	Saribas	1,709	1.5	2	3.5	0.2	2.8	2	4.8	0.3
244	Lupar	11,481	4.6	20	24.6	0.2	7.0	85	92.0	0.8
245	Sadong	6,768	4.2	16	20.2	0.3	8.3	37	45.3	0.7
246	Sarawak	5,875	37.4	29	66.4	1.1	80.1	45	125.1	2.1
247	Kayan	5,164	1.3	6	7.3	0.1	1.9	12	13.9	0.3

Remarks; *: The ratio of less than 0.1% is assumed to be zero.

Table 15 RIVER UTILIZATION RATIO BY BASIN IN 1990 AND 2000 UNDER THE CONDITION OF LOWER ECONOMIC GROWTH

Basin No.	Name of Basin	Surface Rounoff in Effective Area (1) (10^6 m^3/y)	1990 Source Demand (10^6 m^3/y) D&I	Irriga-tion	Total (2)	Ratio (2)/(1) (%)	2000 Source Demand (10^6 m^3/y) D&I	Irriga-tion	Total (3)	Ratio (3)/(1) (%)*
201	Pensiangan	8,906	0.3	0	0.3	0	0.6	0	0.6	0
202	Serudong	1,214	0.6	0	0.6	0	1.1	0	1.1	0.1
203	Kalabakan	1,460	0.7	0	0.7	0	1.5	0	1.5	0.1
204	Brantian	696	0.3	0	0.3	0	0.8	0	0.8	0.1
205	Umas Umas	393	0.3	0	0.3	0.1	0.6	0	0.6	0.2
206	Merutai Besar	490	0.3	0	0.3	0.1	0.7	0	0.7	0.1
207	Tawau	846	8.2	0	8.2	1.0	16.2	0	16.2	1.9
208	Kalumpang	2,754	3.7	0	3.7	0.1	7.6	0	7.6	0.3
209	Silibukan	3,566	3.7	0	3.7	0.1	8.9	0	8.9	0.2
210	Segama	7,447	0.9	0	0.9	0	1.6	0	1.6	0
211	Kinabatangan	20,988	1.2	0	1.2	0	2.3	0	2.3	0
212	Segaliud	3,714	14.9	0	14.9	0.4	28.7	0	28.7	0.8
213	Labuk	14,253	2.2	30	32.2	0.2	4.3	56	60.3	0.4
214	Sugut	6,699	0.6	13	13.6	0.2	0.8	13	13.8	0.2
215	Paitan	2,850	0.2	0	0.2	0	0.2	0	0.2	0
216	Bengkoka	1,855	0.8	20	20.8	1.1	1.2	22	23.2	1.3
217	Bongan	2,097	3.6	76	79.6	3.8	7.5	76	81.5	3.9
218	Kadamaian	1,985	2.1	126	128.1	6.5	3.9	135	138.9	7.0
219	Tuaran	2,224	4.1	43	47.1	2.1	4.6	43	47.6	2.1
220	Putatan	905	22.8	37	59.8	6.6	44.8	37	81.8	9.0
221	Papar	1,489	3.1	45	48.1	3.2	5.5	45	50.5	3.4
222	Kimanis	991	0.4	31	31.4	3.2	0.6	31	31.6	3.2
223	Membakut	598	1.1	16	17.1	2.9	1.9	16	17.9	3.0
224	Padas	8,708	5.6	117	122.6	1.4	11.1	150	161.1	1.9
225	Labuan	96	11.5	0	11.5	12.0	19.6	0	19.6	20.4
226	Lakutan	1,879	0.8	15	15.8	0.8	1.6	15	16.6	0.9
227	Lawas	2,422	0.6	5	5.6	0	0.6	5	5.6	0
228	Trusan	4,424	0.5	6	6.5	0.1	0.8	17	17.8	0.4
229	Limbang	10,432	2.0	31	33.0	0.3	3.7	78	81.7	0.8
230	Baram	56,893	3.3	28	31.3	0.1	6.3	78	84.3	0.1
231	Miri	433	12.5	2	14.5	3.3	26.6	2	28.6	6.6
232	Sibuti	1,105	0.6	11	11.6	1.0	1.1	11	12.1	1.1
233	Niah	1,489	0.9	0	0.9	0.1	1.6	0	1.6	0.1
234	Buai	2,063	0.8	0	0.8	0	1.7	0	1.7	0.1
235	Similajau	1,934	0.3	0	0.3	0	0.4	0	0.4	0
236	Kemena	15,167	12.3	14	26.3	0.2	19.7	38	57.7	0.4
237	Tatau	12,607	0.6	3	3.6	0	1.1	3	4.1	0
238	Balingian	3,944	0.6	0	0.6	0	1.0	4	5.0	0.1
239	Mukah	3,911	1.4	6	7.4	0.2	2.7	6	8.7	0.2
240	Oya	2,631	0.8	4	4.8	0.2	1.3	7	8.3	0.3
241	Rajang	114,699	27.5	13	40.5	0	50.8	52	102.8	0.1
242	Kerian	1,891	1.5	0	1.5	0.1	2.4	0	2.4	0.1
243	Saribas	1,709	1.4	2	3.4	0.2	2.3	2	4.3	0.3
244	Lupar	11,481	4.5	20	24.5	0.2	5.7	85	90.7	0.8
245	Sadong	6,768	3.7	16	19.7	0.3	7.1	37	44.1	0.7
246	Sarawak	5,875	34.8	29	63.8	1.1	61.0	45	106.0	0.8
247	Kayan	5,164	1.2	6	7.2	0.1	1.8	12	13.8	0.3

Remarks; *: The ratio of less than 0.1% is assumed to be zero.

Table 16 RIVER UTILIZATION RATIO IN SPECIFIED AREA IN 1990 AND 2000 UNDER THE CONDITION OF TARGET ECONOMIC GROWTH

Basin No.	Name of Town or Irrigation Scheme of Sub-basin	Effective Catchment Area of Sub-basin (km^2)	Surface Runoff (1) (10^6 m^3/y)	1990 Source Demand (10^6 m^3/y) D&I	Irriga-tion	Total (2)	Ratio (2)/(1) (%)	2000 Source Demand (10^6 m^3/y) D&I	Irriga-tion	Total (3)	Ratio (3)/(1) (%)
207	C201 Tawau	83	103	8.0	0	8.0	7.8	25.8	0	25.8	25.0
208	C202 Semporna	66	80	0.8	0	0.8	1.0	2.6	0	2.6	3.3
209	C203 Lahad Datu	110	162	3.5	0	3.5	2.2	14.1	0	14.1	8.7
212	C204 Sandakan	36	82	14.8	0	14.8	18.0	50.1	0	50.1	61.1
213	C205 Ranau	144	344	0.8	9	9.8	2.8	3.6	9	12.6	3.7
216	Bengkoka Irrigation	751	952	0.3	20	20.3	2.1	0.7	22	22.7	2.4
217	C206 Kudat	70	80	2.2	0	2.2	2.8	8.1	0	8.1	10.1
217	Minor Irrigation	1,050	1,209	2.0	52	54.0	4.5	3.3	52	55.3	4.6
218	C207 Kota Belud & Irrigat.	813	1,378	0.9	126	126.9	9.2	3.7	135	138.7	10.1
219	Minor Irrigation	750	1,464	1.3	43	44.3	3.0	2.0	43	45.0	3.1
220	C208 Kota Kinabalu	195	357	23.1	37	60.1	16.8	62.3	37	99.3	27.8
221	C209 Papar	770	1,461	2.2	45	47.2	3.2	5.9	45	50.9	3.5
224	C210 Keningou & Minor Irr.	1,935	1,825/2	1.0	110	111.0	6.1	3.6	147	150.6	8.3
224	Tambuan & Minor Irr.	570	538/2	0.7	23	23.7	4.4	1.5	45	46.5	8.6
225	C211 Labuan	46/1	96	12.4	0	12.4	12.9	23.8	0	23.8	24.8
229	C212 Limbang	3,865/1	10,432	1.8	31	32.8	0.3	3.8	78	81.8	0.8
230	C213 Marudi	21,822/1	56,893	1.5	28	29.5	0.1	5.7	78	83.7	0.1
231	C214 Miri	150	247	13.4	0	13.4	5.4	51.4	0	51.4	20.8
236	C215 Bintulu	147	304/3	16.1	0	16.1	5.3	25.9	0	25.9	8.5
241	C216 Sibu	40,035/1	114,699	17.1	13	30.1	0	42.6	52	94.6	0.1
241	C217 Sarikei	94	209/4	3.3	0	3.3	1.6	9.0	0	9.0	4.3
245	C218 Serian	2,935/1	6,768	0.5	16	16.5	0.8	2.2	37	39.2	0.6
246	C219 Kuching	735	2,006	31.3	0	31.3	1.6	69.8	0	69.8	3.5
246	Major Irrigation	353	964	0	21	21.0	2.3	0	21	21.0	2.3

Remarks; /1: Basin effective area,
/2: Estimated using discharge record of Tenom Lama,
/3: Discharge in the Sibiu river estimated using discharge record of Basin 235,
/4: Estimated using discharge record of Basin 242,
D&I: Domestic and Industrial Water Supply

Table 17 RIVER UTILIZATION RATIO IN SPECIFIED AREA IN 1990 AND 2000 UNDER THE CONDITION OF LOWER ECONOMIC GROWTH

Basin No.	Name of Town or Irrigation Scheme of Sub-basin	Effective Catchment Area of Sub-basin (km^2)	Surface Runoff (1) (10^6 m^3/y)	1990 Source Demand (10^6 m^3/y) D&I	1990 Irriga-tion	1990 Total (2)	1990 Ratio (2)/(1) (%)	2000 Source Demand (10^6 m^3/y) D&I	2000 Irriga-tion	2000 Total (3)	2000 Ratio (3)/(1) (%)
207	C201 Tawau	83	103	7.2	0	7.2	7.0	14.6	0	14.6	14.2
208	C202 Semporna	66	80	0.7	0	0.7	0.9	1.5	0	1.5	1.9
209	C203 Lahad Datu	110	162	3.1	0	3.1	1.9	7.8	0	7.8	4.8
212	C204 Sandakan	36	82	13.3	0	13.3	16.2	26.1	0	26.1	31.8
213	C205 Ranau	144	344	0.8	9	9.8	2.8	2.0	9	11.0	3.2
216	Bengkoka Irrigation	751	952	0.3	20	20.3	2.1	0.6	22	22.6	2.4
217	C206 Kudat	70	80	1.9	0	1.9	2.4	4.4	0	4.4	5.5
217	Minor Irrigation	1,050	1,209	2.2	52	54.2	4.5	2.7	52	54.7	4.5
218	C207 Kota Belud & Irrigat.	813	1,378	0.9	126	126.9	9.2	2.0	135	137.0	9.9
219	Minor Irrigation	750	1,464	1.3	43	44.3	3.0	1.8	43	44.8	3.1
220	C208 Kota Kinabalu	195	357	21.8	37	58.8	16.5	43.0	37	80.0	22.4
221	C209 Paper	770	1,461	2.1	45	47.1	3.2	3.7	45	48.7	3.3
224	C210 Keningou & Minor Irr.	1,935	1,825/2	1.0	110	111.0	6.1	2.3	147	149.3	8.2
224	Tambuan & Minor Irr.	570	538/2	0.7	23	23.7	4.4	1.5	45	46.5	8.6
225	C211 Labuan	46/1	96	11.2	0	11.2	11.7	19.1	0	19.1	19.9
229	C212 Limbang	3,865/1	10,432	1.6	31	32.6	0.3	2.9	78	80.9	0.8
230	C213 Marudi	21,822/1	56,893	1.4	28	29.4	0.1	2.8	78	80.8	0.1
231	C214 Miri	150	247	12.0	0	12.0	4.9	25.7	0	25.7	10.4
236	C215 Bintulu	147	304/3	11.6	14	25.6	8.4	18.5	38	56.5	18.6
241	C216 Sibu	40,035/1	114,699	16.2	13	29.2	0	32.7	52	84.7	0.1
241	C217 Sarikei	94	209/4	3.0	0	3.0	1.4	6.4	0	6.4	3.1
245	C218 Serian	2,935/1	6,768	0.4	16	16.4	0.2	1.5	37	38.5	0.6
246	C219 Kuching	735	2,006	29.1	0	29.1	1.5	50.6	0	50.6	2.5
246	Major Irrigation	353	964	0	21	21.0	2.3	0	21	21.0	2.3

Remarks; /1: Basin effective area

/2: Estimated using discharge record of Tenom Lama

/3: Discharge in the Sibiu river estimated using discharge record of Basin 235

/4: Estimated using discharge record of Basin 242

D&I: Domestic and Industrial Water Supply

Table 18 ANNUAL DEFICIT BY SUB-BASIN IN 1990 AND 2000 UNDER THE CONDITION OF TARGET ECONOMIC GROWTH

Unit: 10^6 m^3/y

Basin No.	Name of Sub-Basin	Drought Level 1/N Deficit	Year	2/N Deficit	Year	3/N Dificit	Year	4/N Dificit	Year	5/N Deficit	Year
1990											
207	Tawau	7.8	1973	1.5	1969	1.4	1968	0.8	1971	0.6	1977
218	Kadamaian	51.1	1973	31.4	1969	7.6	1966	3.8	1970	3.7	1975
219	Tuaran	9.9	1969	2.3	1975	1.8	1973	1.4	1967	1.3	1968
220	Moyog	14.0	1973	8.7	1969	6.8	1966	4.8	1968	4.0	1965
221	*Papar	12.1	1973	1.8	1969	1.4	1976	0.6	1968	0.5	1965
231	Miri	3.3	1976	2.4	1977	1.9	1973	0.8	1974	0.4	1972
2000											
207	Tawau	15.3	1973	7.9	1969	5.6	1972	5.5	1971	5.1	1968
218	Kadamaian	54.5	1973	34.6	1969	8.9	1966	4.9	1975	4.8	1970
219	Tuaran	10.0	1969	2.3	1975	1.8	1973	1.4	1967	1.3	1968
220	Moyog	23.7	1973	16.7	1969	12.4	1968	11.2	1965	10.6	1966
221	*Papar	12.4	1973	1.9	1969	1.4	1976	0.7	1968	0.5	1965
231	Miri	13.2	1976	9.8	1977	8.2	1973	7.5	1974	4.9	1975

Remarks; *: be subject to interbasin water transfer

Table 19 ANNUAL DEFICIT BY SUB-BASIN IN 1990 AND 2000 UNDER THE CONDITION OF LOWER ECONOMIC GROWTH

Unit: 10^6 m^3/y

Basin No.	Name of Sub-Basin	Drought Level 1/N Deficit	Year	2/N Deficit	Year	3/N Deficit	Year	4/N Deficit	Year	5/N Deficit	Year
1990											
207	Tawau	7.5	1973	1.3	1969	1.3	1968	0.6	1971	0.6	1977
218	Kadamaian	51.1	1973	31.4	1969	7.6	1966	3.7	1970	3.7	1975
219	Tuaran	12.3	1969	3.5	1973	2.9	1975	2.4	1967	2.1	1968
220	Moyog	13.5	1973	8.4	1969	6.6	1966	4.5	1968	3.8	1965
221	*Papar	12.9	1973	1.8	1969	1.3	1976	0.6	1968	0.5	1965
231	Miri	3.1	1976	2.2	1977	1.8	1973	0.8	1974	0.3	1972
2000											
207	Tawau	10.5	1973	3.5	1969	2.4	1968	2.1	1971	1.6	1972
218	Kadamaian	53.6	1973	33.8	1969	8.6	1966	4.7	1975	4.5	1970
219	Tuaran	13.0	1969	4.1	1973	3.1	1975	2.7	1967	2.3	1968
220	Moyog	17.7	1973	11.7	1969	8.2	1966	7.0	1968	6.3	1965
221	*Papar	12.1	1973	1.9	1969	1.4	1976	0.7	1968	0.5	1965
231	Miri	5.6	1976	4.3	1977	3.3	1973	2.5	1974	1.2	1972

Remarks; *: be subject to interbasin water transfer

Table 20 LIST OF EXISTING AND PLANNED DAMS IN SABAH

Name	Basin No./ River	Purpose/ Year of Commission	Organi-zation	Catchment Area (km^2)	Active Storage Capacity (10^6 m^3)	Net Supply Capacity (10^3 m^3/d)
EXISTING						
Kudat rain storage reservoir	217, Bongan	WS	PWD	-	2.73	4.55 (1MGD)
UNDER CONSTRUCTION						
Timbangan dam	208, Kalumpang	WS/end 1983	PWD	27.7	0.82	9.12 (2MGD)
Sepagaya dam	209, Silibukan	WS/mid 1984	PWD	23.2	1.91	9.12
Tenom weir	224, Padas	HY: 66MW/1984	SEB	7,815	4.7	Run-of-river
UNDER DETAILED DESIGN						
Bukit Kuda dam	225, Labuan	WS	PWD	0.2	3.64	
Kerupang dam	225, Labuan	WS	PWD	0.5	0.28	12.29(2.7MGD) by 3 dams
Pagar dam	225, Labuan	WS	PWD	0.8	0.36	
UNDER PLANNING						
Balat dam	211, Kinabatangan	FM, HY: 34MW	(DID)	10,730	5,000	-
Meliau dam	213, Labuk	WS	PWD	58	18	-
Sook dam	224, Padas	HY: 35MW	SEB	1,770	400	-
Papar dam	221, Papar	HY: 45MW	SEB	350	-	-

Remarks; WS: Domestic and industrial water supply
FM: Flood mitigation
HY: Hydropower

Table 21 LIST OF EXISTING AND PLANNED DAMS IN SARAWAK

Name	Basin No./ River	Purpose/ Year of Commission	Organi-zation	Catchment Area (km^2)	Active Storage Capacity (10^6 m^3)	Net Supply Capacity (10^3 m^3/d)
EXISTING						
Two dams under Matang scheme	246, Sarawak	WS	Kuching Water Baord	2.0	0.41 (gross)	9.12 (2MGD)
UNDER CONSTRUCTION						
Batang Ai dam	244, Lupar	HY: 92MW/ 1985	SESCO	1,200	750	Guaranteed outflow 94 m^3/s
Sika reservoir	236, Kemena	WS/1983	PWD	-	1.55 (gorss)	38.6 (8.5 MGD) at 1st stage
UNDER PLANNING						
Pelagus dam (Raja 284)	241, Rajang	HY: 770MW/ 1990	SESCO	20,919	1,200	-
Bakun dam (Balu 037)	241, Rajang (Balui)	HY: 2,580MW/ 1994	SESCO	14,764	16,200	-

Remarks; WS: Domestic and industrial water supply
HY: Hydropower

Table 22 WATER SOURCE DEVELOPMENT PLANS FOR SABAH AND SARAWAK FOR ALTERNATIVE B1

(1) DAM

Basin No.	Name of Facilities	Purpose	Catchment Area (km^2)	Active Storage Capacity (10^6m^3)	Net Supply Capacity ($10^6m^3/y$)	Construction Cost (M10^6)	Construction Period
SABAH							
207	Tawau dam	WS	38	7	21	89	1987-1991
213	Meliau dam	WS	58	17	48	150	1986-1990
217	Milau dam	WS	70	5	12	8	1987-1991
218	Wariu dam	IR,WS	123	25	65	269	1985-1989
221	Papar dam	IR,WS	353	25	58	71	1985-1989
SARAWAK							
231	Miri dam	WS	33	5	20	15	1985-1989

(2) DIVERSION FACILITIES

Basin No.	Diversion Facilities	Purpose	Basin Transfer (Basin No.)	Diversion Discharge Capacity (m^3/s)	Construction Cost (M10^6)	Construction Period
SABAH						
213	Meliau diversion	WS	213 to 212 (Sandakan)			
	- Pipeline-1	WS		0.3	133	1983-1987
	- Pipeline-2	WS		0.6	223	1986-1990
	- Pipeline-3	WS		0.6	223	1991-1995
217	Milau diversion	WS	217 to 217 (Kudat)	0.4	15	1983-1987
221	Paper diversion	WS	221 to 220 (Kota Kinabalu)	2	41	1985-1989
224	Padas diversion	WS	224 to 225 (Labuan)			
	- Pipeline-1	WS		0.3	153	1983-1987
	- Pipeline-2	WS		0.3	153	

Remarks; IR : Irrigation, WS : Water supply
Construction cost is the financial cost at 1980 constant price.

Table 23 WATER SOURCE DEVELOPMENT PLANS FOR SABAH AND SARAWAK FOR ALTERNATIVE B2

(1) DAM

Basin No.	Name of Facilities	Purpose	Catchment Area (km^2)	Active Storage Capacity (10^6m^3)	Net Supply Capacity ($10^6m^3/y$)	Construction Cost (M10^6)	Construction Period
SABAH							
207	Tawau dam	WS	38	4	12	57	1987-1991
213	Meliau dam	WS	58	17	48	150	1986-1990
217	Milau dam	WS	70	5	12	8	1987-1991
218	Wariu dam	IR, WS	123	17	42	179	1985-1989
221	Papar dam	IR, WS	353	15	35	67	1985-1989
SARAWAK							
231	Miri dam	WS	33	4	15	13	1985-1989

(2) DIVERSION FACILITIES

Basin No.	Diversion Facilities	Purpose	Basin Transfer (Basin No.)	Diversion Discharge Capacity (m^3/s)	Construction Cost (M10^6)	Construction Period
SABAH						
213	Meliau diversion	WS	213 to 212 (Sandakan)			
	- Pipeline-1	WS		0.3	133	1983-1987
	- Pipeline-2	WS		0.6	223	1986-1990
	- Pipeline-3	WS		0.6	223	1991-1995
217	Milau diversion	WS	217 to 217 (Kudat)	0.4	15	1983-1987
221	Papar diversion	WS	221 to 220 (Kota Kinabalu)	2	41	1985-1989
224	Padas diversion	WS	224 to 225 (Labuan)			
	- Pipeline-1	WS		0.3	153	1983-1987
	- Pipeline-2	WS		0.3	153	1988-1992

Remarks; IR : Irrigation, WS : Water supply

Table 24 WATER SOURCE DEVELOPMENT PLANS FOR SABAH AND SARAWAK FOR ALTERNATIVE B3

(1) DAM

Basin No.	Name of Facilities	Purpose	Catchment Area (km^2)	Active Storage Capacity (10^6m^3)	Net Supply Capacity ($10^6m^3/y$)	Construction Cost (M10^6)	Construction Period
SABAH							
213	Meliau dam	WS	58	17	48	150	1986-1990
217	Milau dam	WS	70	5	12	8	1987-1991
218	Wariu dam	IR, WS	123	8	10	64	1985-1989
221	Papar dam	IR, WS	353	15	35	67	1985-1989
SARAWAK							
231	Miri dam	WS	33	3	13	12	1985-1989

(2) DIVERSION FACILITIES

Basin No.	Diversion Facilities	Purpose	Basin Transfer (Basin No.)	Diversion Discharge Capacity (m^3/s)	Construction Cost (M10^6)	Construction Period
SABAH						
206	Melotai Kanan diversion (pipeline)	WS	206 to 207 (Tawau)	0.3	29	1987-1991
213	Meliau diversion	WS	213 to 212 (Sandakan)			
	- Pipeline-1	WS		0.3	133	1983-1987
	- Pipeline-2	WS		0.6	223	1986-1990
	- Pipeline-3	WS		0.6	223	1991-1995
217	Milau diversion	WS	217 to 217 (Kudat)	0.4	15	1983-1987
221	Papar diversion	WS	221 to 220 (Kota Kinabalu)	2	41	1985-1989
224	Padas diversion	WS	224 to 225 (Labuan)			
	- Pipeline-1	WS		0.3	153	1983-1987
	- Pipeline-2	WS		0.3	153	1988-1992

Remarks; IR : Irrigation, WS : Water supply

Table 25 DROUGHT LEVEL AND CORRESPONDING RECURRENCE INTERVAL

Unit: Year

Simulation Period (N Year)	Drought Level (m/N)	Plotting-position Formula for Recurrence Interval (T)		
		Hazen 2N/(2m-1)	Weibull (or Tomas) (N + 1)/m	Gringorten (N+0.12)/(m-0.44)
N = 10	1/10	20.0	11.0	18.1
	2/10	6.7	5.5	6.5
	3/10	4.0	3.7	4.0
	4/10	2.9	2.8	2.8
N = 13	1/13	26.0	14.0	23.4
	2/13	8.7	7.0	8.4
	3/13	5.2	4.7	5.1
	4/13	3.7	3.5	3.7
N = 14	1/14	28.0	15.0	25.2
	2/14	9.3	7.5	9.1
	3/14	5.6	5.0	5.5
	4/14	4.0	3.8	4.0
N = 16	1/16	32.0	17.0	28.8
	2/16	10.7	8.5	10.3
	3/16	6.4	5.7	6.3
	4/16	4.6	4.2	4.5
	5/16	3.6	3.4	3.5

Remarks; N = Total number of items (record period);
m = Order number of items arranged in descending magnitude, thus m = 1 for the largest item;
Probability $P(X > x) = 1/T$

Source; Ref. 1

Table 26 RECOMMENDED WATER DEMAND AND SUPPLY BALANCE PROGRAM FOR TAWAU

Unit: 10^6 m^3/y

Storage/Diversion Facilities	Location of Facilities	Year of Commission	Net Supply Capacity/ Required Supply Capacity 1990	2000
Tawau Dam	Tawau river	1992	-	20.9
Required Supply			-	16.8
Balance			-	+4.1

Remarks; The required supply capacity is 1.1 times of estimated water deficit under 1/10 drought. No structural measures required until 1992.

Table 27 RECOMMENDED WATER DEMAND AND SUPPLY BALANCE PROGRAM FOR SANDAKAN

Unit: 10^6 m^3/y

Storage/Diversion Facilities	Location of Facilities	Year of Commission	Net Supply Capacity/ Required Supply Capacity 1990	2000
Existing Supply			8.0	8.0
Meliau Dam	Meliau river			
Meliau Diversion				
Pipeline-1		1988	8.3	8.3
Pipeline-2		1991		20.0
Pipeline-3		1996		20.0
Total Supply			16.3	56.3
Required Supply			16.3	55.1
Balance			0	+0.9

Remarks; The required supply capacity is 1.1 times of estimated water demand.

Table 28 RECOMMENDED WATER DEMAND AND SUPPLY BALANCE PROGRAM FOR KUDAT

Unit: 10^6 m^3/y

Storage/Diversion Facilities	Location of Facilities	Year of Commission	Net Supply Capacity/ Required Supply Capacity 1990	2000
Milau Diversion (Pipeline)	Milau river	1985	3.8	-
Milau Dam	Milau river	1992	-	12.3
Existing Supply (Rain storage: 1 MGD)			(1.6)	(1.6)
Total Supply			5.4	13.9
Required Supply			2.4	8.9
Balance			+3.0	+17.4

Remarks; The required supply capacity is 1.1 times of estimated water demand.

Table 29 RECOMMENDED WATER DEMAND AND SUPPLY BALANCE PROGRAM FOR IRRIGATION MINOR SCHEMES IN BASIN 218

Unit: 10^6 m^3/y

Storage/Diversion Facilities	Location of Facilities	Year of Commission	Net Supply Capacity/ Required Supply Capacity 1990	2000
Wariu Dam	Wariu river	1990	10.3	10.3
Required Supply			9.1	10.3
Balance			+1.2	0

Remarks; The required supply capacity is 1.2 times of estimated water deficit under 3/13 drought.

Table 30 RECOMMENDED WATER DEMAND AND SUPPLY BALANCE PROGRAM FOR KOTA KINABALU, TUARAN AND PAPAR AREA

Unit: 10^6 m^3/y

Storage/Diversion Facilities	Location of Facilities	Year of Commission	Net Supply Capacity/ Required Supply Capacity 1990	2000
Existing Supply and Diversion from the Tuaran river to Kota Kinabalu		U/C: 1984-85	17.0	17.0
Water Diversion from the Papar river to Kota Kinabalu and Papar dam		1990	35.0	35.0
Total Supply			52.0	52.0
Required Supply			30.0	52.0
Balance			+22.0	0

Remarks; The required supply capacity of Basin 221 is 1.2 times of estimated water deficit under 3/13 drought and 1.1 times of demand of Kota Kinabalu.

Table 31 RECOMMENDED WATER DEMAND AND SUPPLY BALANCE PROGRAM FOR LABUAN

Unit: 10^6 m^3/y

Storage/Diversion Facilities	Location of Facilities	Year of Commission	Net Supply Capacity Required Supply Capacity 1990	2000
Existing Supply (Groundwater)			1.8	1.8
3 Dams under		D/D 1985	4.5	4.5
Padas Diversion	from Beanfort to Labuan			
Submarine stage 1		1988	10.0	10.0
Pipeline stage 2		1993		10.0
Total Supply			16.3	26.3
Required Supply			13.6	26.2
Balance			+2.7	+0.1

Remarks; The required supply capacity is 1.1 times of estimated water demand.

Table 32 RECOMMENDED WATER DEMAND AND SUPPLY BALANCE PROGRAM FOR MIRI

Unit: 10^6 m^3/y

Storage/Diversion Facilities	Location of Facilities	Year of Commission	Net Supply Capacity/ Required Supply Capacity 1990	2000
Liku Dam	Liku river	1990	20.0	20.0
Required Supply			3.6	14.5
Balance			+16.4	+5.5

Remarks; The required supply capacity is 1.1 times of estimated water deficit under 1/13 drought.

Table 33 RECOMMENDED WATER SOURCE DEVELOPMENT PLANS FOR SABAH AND SARAWAK

(1) DAM

Basin No.	Name of Facilities	Purpose	Catchment Area (km^2)	Active Storage Capacity (10^6m^3)	Reservoir Surface Area (km^2)	Net Supply Capacity ($10^6m^3/y$)	Construction Cost (M10^6)	Construction Period
SABAH								
207	Tawau dam	WS	38	7	0.5	21	89	1987-1991
213	Meliau dam	WS	58	17	0.9	48	150	1986-1990
217	Milau dam	WS	70	5	6	12	8	1987-1991
218	Wariu dam	IR, WS	123	8	0.3	10	64	1985-1989
220	Papar dam	HR,IR,WS	353	15	3	35	67*	1985-1989
SARAWAK								
231	Miri dam	WS	33	5	3	20	15	1985-1989

(2) DIVERSION FACILITIES

Basin No.	Diversion Facilites	Purpose	Basin Transfer (Basin No.)	Diversion Discharge Capacity (m^3/s)	Construction Cost (M10^6)	Construction Period
SABAH						
213	Meliau diversion	WS	213 to 212 (Sandakan)			
	- Pipeline-1	WS		0.3	133	1983-1987
	- Pipeline-2	WS		0.6	223	1986-1990
	- Pipeline-3	WS		0.6	223	1991-1995
217	Milau diversion	WS	217 to 217 (Kudat)	0.4	15	1983-1987
221	Papar diversion	WS	221 to 220 (Kota Kinabalu)	2	41	1985-1989
224	Padas diversion	WS	224 to 225 (Labuan)			
	- Pipeline-1	WS		0.3	153	1983-1987
	- Pipeline-2	WS		0.3	153	1988-1992

Remarks; IR : Irrigation, WS : Watery Supply, HY : Hydropower
* : Cost for hydropower generation is borne by the hydropower development.
Construction cost is the financial cost at 1980 constant price.

Table 34 RECOMMENDED WATER SOURCE DEVELOPMENT PLANS FOR SABAH AND SARAWAK UNDER THE CONDITION OF LOWER ECONOMIC GROWTH

(1) DAM

Basin No.	Name of Facilities	Purpose	Catchment Area (km^2)	Active Storage Capacity (10^6m^3)	Net Supply Capacity ($10^6m^3/y$)	Construction Cost (M10^6)	Construction Period
SABAH							
207	Tawau dam	WS	38	3.7	13.2	59	1987-1991
213	Meliau dam	WS	58	7	28	87	1988-1992
218	Wariu dam	IR, WS	123	8	10	64	1985-1989
221	Papar dam	IR,WS,HY	353	20	33	61*	1985-1989
SARAWAK							
231	Miri dam	WS	33	1.2	7.6	10	1985-1989

(2) DIVERSION FACILITIES

Basin No.	Diversion Facilities	Purpose	Basin Transfer (Basin No.)	Diversion Discharge Capacity (m^3/s)	Construction Cost (M10^6)	Construction Period
SABAH						
213	Meliau diversion	WS	213 to 212 (Sandakan)			
	- Pipeline-1	WS		0.3	133	1983-1987
	- Pipeline-2	WS		0.6	223	1988-1992
217	Miliau diversion	WS	217 to 217 (Kudat)	0.1	15	1983-1987
220	Papar diversion	WS	220 to 219 (Kota Kinabalu)	1	25	1985-1989
224	Padas diversion	WS	224 to 225 (Labuan)			
	- Pipeline-1	WS		0.4	214	1983-1987

Remarks; IR : Irrigation, WS : Water Supply, HY : Hydropower
*: Cost for hydropower generation is borne by the hydropower development.
Construction cost is the financial cost at 1980 constant price.

Table 35 POTENTIAL HYDROPOWER SITES STUDIES BY SEB IN SABAH

Name of Site	Name of River	Installed Capacity (MW)	Energy Output (GWh/y)
Tenom Pangi	Padas	66	464
Sook	Padas	35	220
Rayok	Padas	65	-
Lower Halogilat	Padas	144	990
Upper Halogilat	Padas	98	-
Papar	Papar	45	171
Moyong	Moyong	7	-
Tamparuli	Tuaran	35	-
Balat	Kinabatangan	34	342
Deramakot	Kinabatangan	78	387
Milian	Milian	50	236
Kuamut	Kuamut	46	241
Total		703	3,051

Source; SEB

Table 36 MAJOR FEATURES OF RAJANG RIVER HYDROPOWER DEVELOPMENT IN SARAWAK

Project		Pelagus (Raja 284)	Bakun (Balu 037)	Muru 040	Bela 010
Name of River		Rajang	Belui	Murum	Belaga
Mean Discharge	m^3/s	2,000	1,560	310	230
Mean Net Head	m	39	159	291	112
Max. Active Storage Volume	$10^9 \times m^3$	3.0	27.1	6.0	6.8
Reservoir Area	km^2	330	730	210	390
Installed Capacity	MW	770	2,580	940	260
Energy	GWh	5,600	18,100	6,600	1,800
Capital Cost	$10^6 \times$ M$	1,480	2,690	1,080	730
Energy Cost	M$/kWh	4.1	2.3	2.3	5.3
Proposed Year of Commission	1st stage	1990	1995	2004	2009
	2nd stage	-	2001	-	-

Remarks; data on June, 1982

Source; Ref. 2

Table 37 POTENTIAL HYDROPOWER SITES IN SABAH, CATCHMENT AREA ≧ 1,000 km²

Name of Dam	Basin No. Located	Catchment Area (km^2)	Annual Firm Discharge ($10^6m^3/y$)	Dam Height (m)	Installed Capacity (MW)	Annual Energy (GWh)
Pensiangan	201	5,106	6,242	156	374	1,640
Sapulut	201	2,594	3,496	148	200	874
Kuamut-2	211	2,686	3,511	72	95	416
Kuamut-3	211	1,971	2,554	78	*75	*329
Kuamut-4	211	1,408	400	84	*13	*56
Pinangah	211	1,205	1,390	40	20	88
Milian-1	211	3,390	2,230	38	*31	*135
Milian-2	211	1,262	1,510	130	*75	*330
Padas-1	224	1,935	1,652	162	**233	**1,020
Padas-2	224	1,171	1,179	186	85	372
Pangi No.2	224	8,000	3,560	-	90	547
Lower Halogilat	224	8,200	3,649	75	*144	*999
Sook & Tenom Pangi extension	224	1,770	-	60	84	309
Pegalan-1	224	1,283	923	101	36	155
Sub-total without *					1,217	5,421
Sub-total with *					338	1,849
Total					1,555	7,270

Table 38 POTENTIAL HYDROPOWER SITES IN SABAH, CATCHMENT AREA 500 - 999 km²

Name of Dam	Basin No. Located	Catchment Area (km^2)	Annual Firm Discharge ($10^6m^3/y$)	Dam Height (m)	Installed Capacity (MW)	Annual Energy (GWh)
Sibungo	201	530	683	143	*38	*165
Segama-2	210	671	769	93	27	120
Kuamut-5	211	945	1,203	117	54	236
Labau	211	977	1,158	156	70	305
Mirali-1	214	685	1,547	101	60	262
Bengkoka-1	216	515	574	85	19	81
Tuaran-1	219	711	1,345	108	56	244
Tuaran-2	219	568	814	93	*29	*126
Maligan	224	575	581	133	*30	*130
Telekosang-1	224	821	831	168	**124	**680
Telekosang-2	224	624	623	140	*34	*147
Sub-total without *					410	1,928
Sub-total with *					131	568
Total					541	2,496

Remarks; (1) The dam sites with * are submerged if the sites without * are constructed.
(2) ** combination with pressure tunnels.

Table 39 POTENTIAL HYDROPOWER SITES IN SABAH, CATCHMENT AREA < 500 km^2 (1/2)

Name of Dam	Basin No. Located	Catchment Area (km^2)	Annual Firm Discharge ($10^6 m^3/y$)	Dam Height (m)	Installed Capacity (MW)	Annual Energy (GWh)
Sumatalun	201	384	466	104	*19	*81
Tagul	201	449	631	142	*35	*151
Serudong	202	441	376	204	30	130
Kalabatan-3	203	278	279	57	*6	*26
Kalabatan-2	203	295	239	144	13	52
Kalabatan-1	203	310	91	38	1	6
Brantian-1	204	478	427	78	13	55
Brantian-2	204	436	410	98	*15	*67
Brantian-3	204	120	115	83	4	16
Umas-Umas-2	205	171	159	127	*8	*34
Umas-Umas-1	205	208	172	82	5	24
Merotai-1	206	192	133	33	2	7
Merotai-2	206	86	37	23	0	1
Tawau	207	38	35	69	1	4
Kinabutan	207	23	26	67	1	3
Balung-1	207	47	50	66	1	5
Balung-2	207	20	11	12	0	0
Danum	210	257	319	89	11	47
Kuamut-6	211	381	482	236	*44	*194
Imbak	211	360	456	75	13	57
Sinoa	211	171	186	27	2	8
Tongod	211	216	73	47	1	6
Pingas	211	264	304	79	9	40
Babakong	212	36	44	11	*0	1
Moynod	213	99	137	18	1	4
Kolombuon-1	215	34	77	87	3	11
Nibang	216	55	67	62	*2	*7
Bengkoka-2	216	347	310	148	*18	*77
Bengkoka-3	216	170	193	168	13	55
Bandau	217	101	115	125	6	24
Langkon	217	41	44	71	1	5
Kinaran-2	217	38	39	147	2	10
Tuaran	217	87	89	120	4	18
Penataran	218	40	59	131	3	13
Kadamaian	218	139	189	81	6	25
Wariu	218	123	145	178	*10	*44
Tuaran-3	219	451	690	101	27	116
Tuaran-4	219	213	415	137	22	96
Tuaran-5	219	120	234	163	15	65
Tuaran-6	219	98	170	136	9	39

Remarks; The installed capacity of less than 1 MW is assumed to be 0.

Table 40 POTENTIAL HYDROPOWER SITES IN SABAH, CATCHMENT AREA < 500 km^2 (2/2)

Name of Dam	Basin No. Located	Catchment Area (km^2)	Annual Firm Discharge ($10^6 m^3/y$)	Dam Height (m)	Installed Capacity (MW)	Annual Energy (GWh)
Moyog-1	220	114	132	63	3	14
Moyog-2	220	53	86	89	3	13
Tempangoa	220	19	33	72	1	4
Gramatoi	221	83	137	93	5	21
Papar-1	221	353	260	53	**30	**131
Mandalipau	221	101	163	95	6	26
Papar-3	221	221	254	79	*8	*33
Puas	222	44	66	62	2	7
Papar-2	221	288	336	73	9	41
Bongawan	222	40	49	46	1	4
Kimanis	222	63	95	72	3	11
Besanon-1	222	61	107	62	*3	*11
Besanon-2	222	47	76	64	2	8
Membakut-1	223	164	185	26	2	7
Membakut-2	223	128	173	37	*2	*10
Membakut-3	223	57	90	126	4	19
Membakut-4	223	37	56	78	2	7
Sub-total without *					292	1,255
Sub-total with *					198	859
Total					490	2,114

Remarks; The installed capacity of less than 1 MW is assumed to be 0.

The dam sites with * are submarged if the site without * are constructed.

**: combination with pressure tunnels.

Table 41 FUTURE POWER DEMAND IN SABAH PROJECTED BY SEB

Year	Energy (GWh)	Max. Power (MW)	Power Factor (%)
1965	44.8	10.6	48.2
1970	87.9	20.0	50.2
1975	197.6	40.2	56.1
1979	359.1	69.2	58.1
1980	386.1	79.0	55.8
1985	761.0	162.0	56.5
1990	1,636.0	344.0	58.2
1995	3,094.0	620.0	59.2
2000	5,257.0	1,035.0	61.2

Remarks; The values were revised by SEB on June, 1982.

Table 42 FUTURE POWER DEMAND IN SARAWAK PROJECTED BY SESCO

	Minimum Forecase (1)			Maximum Forecast (2)		
Year	Energy (GWh)	Max. Power (MW)	Load Factor (%)	Energy (GWh)	Max. Power (MW)	Load Factor (%)
1975	176	37	57.4	-	-	-
1979	318	69	54.4	-	-	-
1980	361	74	55.7	361	74	55.7
1985	812	160	57.9	3,164	475	76.0
1990	1,413	274	58.9	4,776	749	72.8
1995	2,243	425	60.3	5,608	900	71.1
2000	3,260	600	62.0	6,623	1,075	70.3

Remarks; (1) Normal growth of the existing stations
(2) Minimum forecast plus the following project in Bintulu
- Aluminium smelter
- Iron ore direct reduction plant
- Electric arc steel plant

Source; Ref. 2 (Vol. II, Annex 3/2)

Table 43 FUTURE POWER DEMAND OF MAJOR POWER STATIONS IN SABAH

Station	Power Demand (MW)				
	1979	1985	1990	1995	2000
Kota Kinabalu	37	73	148	276	460
Sandakan	16.5	31	54	100	168
Tawau	9.5	19	36	67	112
Labuan	5.1	21	69	127	213
Lahad Datu	2.2	5	9	17	28
Kudat	1.3	3	5	9.3	16
*Keningau	1	3	5.1	9.5	16
Total	72.6	155	326.1	604.8	1,013

Remarks; The values were revised by SEB on June, 1982.
*: Keningau station, which trends to grow in the same pace as Kudat station, is included.

Table 44 FUTURE POWER DEMAND OF MAJOR STATIONS IN SARAWAK

Station	Power Demand (MW)				
	1979	1985	1990	1995	2000
Kuching	38.9	85	142	213	295
Sibu	12.6	24	40	67	101
Miri	8.2	18	32	52	78
Bintulu	2.0	11	26	47	69
Sarikei	1.3	3	5	9	15
Energy-intensive Project /1	-	328	491	495	496
Total	63	469	736	883	1,054

Remarks; /1: Aluminium smelter, iron ore, direct reduction plant, electric arc steel plant, deepwater port, Urea/ammonia plant.

Table 45 SELECTED HYDROPOWER SITES FOR ALTERNATIVE STUDIES IN SABAH

Name of Dam	Basin No. Located	Catchment Area (km^2)	Installed Capacity (MW)	Annual Energy (Gwh)
Pensiangan	201	5,106	374	1,640
Sapulut	201	2,594	200	874
Sibungo	201	530	38	165
Tagul	201	449	35	151
Serudong	202	441	30	130
Kuamut-2	211	2,686	95	416
Kuamut-3	211	1,971	75	329
Kuamut-5	211	945	54	236
Kuamut-6	211	381	44	194
Milian-1	211	3,390	31	135
Milian-2	211	1,262	75	330
Labau	211	977	70	305
Mirali-1	214	685	60	262
Tuaran-1	219	711	56	244
Papar-1	221	353	30	131
Padas-1	224	1,935	233	1,020
Padas-2	224	1,171	85	372
Telekosang-1	224	821	124	680
Telekosang-2	224	624	34	147
Lower Hulogilat	224	8,200	144	999
Pangi No.2	224	8,000	90	547
Sook & Tenom Pangi extension	224	1,770	84	309
Pegalan-1	224	1,283	36	155
Maligan	224	575	36	130
Kinabatangan (Balat)	211	10,730	34	149

Table 46 SELECTED HYDROPOWER SITES FOR ALTERNATIVE STUDIES IN SARAWAK

Name of Dam	Basin No. Located	Catchment Area (km^2)	Installed Capacity (MW)	Annual Energy (Gwh)
Pelagus (Raja-284)	241	20,919	770	5,600
Bakun (Balu-037)	241	14,764	2,580	18,100
Bela-010	241	2,883	260	1,800
Muru-040	241	2,883	940	6,600
Muru-008	241	3,111	435	1,294
Lina-013	241	2,531	426	2,486
Kati-051	241	1,539	315	1,377
Kati-010	241	2,987	187	1,290
Bele-020	241	575	73	149
Tuto-125	230	2,380	85	283
Limb-136	229	1,980	98	568
Trus-101	229	1,649	48	184
Upper Batang Ai	244	360	48	225
Batang Sekrarg	244	440	46	210
Konowit (Kono-110)	241	1,250	110	485

Table 47 ASSUMED HYDROPOWER DEVELOPMENT PROGRAM FOR KOTA KINABALU

Station	Maximum Power Demand (MW)											
	1990				1995				2000			
		Diesel*	Hydro			Diesel*	Hydro			Diesel*	Hydro	
	Total Demand	OP & Plan	Existing**	*** New	Total Demand	OP & Plan	Existing**	*** New	Total Demand	OP & Plan	Existing**	*** New
Kota Kinabalu & Keningau	148	139	110	+110	276	139	110	-27	460	139	110	-211
	5	3	0	-	10	3	0	-	16	3	0	-
Total	153	142	110	+99	286	142	110	-34	476	142	110	-224

Remarks; *: In operation and expansion program up to 1985 by SEB.
**: After Tenom Pangi and Sook.
***: Plus means surplus capacity and minus means requirement of hydropower development

Table 48 ASSUMED HYDROPOWER DEVELOPMENT PROGRAM FOR SABAH TRANSMISSION LINE GRID SYSTEM

Station	Maximum Power Demand (MW)											
	1990				1995				2000			
		Diesel*	Hydro			Diesel*	Hydro			Diesel*	Hydro	
	Total Demand	OP & Plan	Existing**	*** New	Total Demand	OP & Plan	Existing**	*** New	Total Demand	OP & Plan	Existing**	*** New
Kota Kinabalu & Keningau	148	139	110	+110	276	139	110	-27	460	139	110	-211
	5	3	0	-	10	3	0	-	16	3	0	-
Labuan	69	28	0	-	127	28	0	-	213	28	0	-
Tawau	36	45	0	-	67	45	0	-	112	45	0	-
Sandakan	54	58	0	-	100	58	0	-	168	58	0	-
Total	312	273	110	+71	580	273	110	-197	969	273	110	-586

Remarks; *: In operation and expansion program up to 1985 by SEB.
**: After Tenom Pangi and Sook.
***: Plus means surplus capacity and minus means requirement of hydropower development.

Table 49 RECOMMENDED HYDROPOWER DEVELOPMENT PLAN FOR KOTA KINABALU

Basin No.	Name	Catchment Area (km^2)	Active Storage Capacity (10^6 m^3)	Surface Area (km^2)	Installed Capacity (MW)	Annual Energy Output (GWh)	Purpose	Construction Cost (M10^6)	Date of Commission
224	Tenom Pangi Stage III								
	- Sook dam & power	1,770	480	27	40	172	HY	150	1990
	- Pangi extension	(7,815)	-	-	44	137	HY	150	1990
221	Papar multi-purpose	353	147	5	30	130	HY,IR,WS	180/1	1990
224	Pangi No.2	(8,000)	-	2	90/3	547	HY	290/2	1994
224	Upper Padas	1,893	300	9	170	742	HY	870	1996

Remarks; IR: Irrigation, WS: Water Supply, HY: Hydropower
Construction cost: Financial cost at 1980 constant price.
/1: M$67 x 10^6 for D&I water supply deducted
/2: Cost for railway relocation not included
/3: After Tenon Pangi, Stage III

Table 50 ALTERNATIVE HYDROPOWER DEVELOPMENT PLAN FOR SABAH TRANSMISSION LINE GRID SYSTEM

Name	Catchment Area (km^2)	Active Storage Capacity ($10^6 m^3$)	Installed Capacity (MW)	Annual Energy Output (GWh)	Construction Cost (M10^6)	Date of Commission
Tenom Pangi Stage III (Sook)						
(Sook & Pangi extenstion)	1,770	480	84	309	300	1990
Papar Multipurpose	353	147	30	130	180/1	1990
Pangi No. 2	(8,000)	-	90/3	547	290/2	1994
Pensiangan	5,106	4,342	370	1,639	1,070/4	1996
Sapulut & Pensiangan extension	2,594	2,865	230	1,007	460	1999

Remarks; /1: M$67 x 10^6 for D&I water supply deducted.
/2: Cost for railway relocation not included.
/3: After Tenom Pangi, Stage III.
/4: Cost of transmission system to Tawau, Labuan & Sandakan included.

Table 51 ESTIMATED FUTURE POWER DEMAND OF MAJOR POWER STATIONS IN SABAH UNDER THE CONDITION OF LOWER ECONOMIC GROWTH

Station	Maximum Power Demand (MW)			
	1985	1990	1995	2000
Kota Kinabalu	70	109	178	268
Sandakan	30	40	64	98
Tawau	18	30	43	65
Labuan	20	51	82	124
Lahad datu	4.8	6.7	11	16
Kudat	2.9	3.7	6	9.3
Keningau	2.9	3.8	6.1	9.3
Total	149	244	390	590

Table 52 RECOMMENDED HYDROPOWER DEVELOPMENT PLAN FOR KUCHING

Basin No.	Name	Catchment Area (km^2)	Active Storage Capacity (10^6 m^3)	Surface Area (km^2)	Installed Capacity (MW)	Annual Energy Output (GWh)	Purpose	Construction Cost (M10^6)	Date of Commission
241	Konowit	1,250	1,180	71	110	485	HY	510	1990
244	Batang Sekrang	440	450	15	46	210	HY	310	1996
244	Upper Batang Ai	360	340	8	48	225	HY	460	1998

Remarks; HY: Hydropower,
Construction cost: Financial cost at 1980 constant price.

Table 53 RECOMMENDED HYDROPOWER DEVELOPMENT PLAN FOR KOTAKINABALU AND KUCHING IN SABAH AND SARAWAK UNDER THE CONDITION OF LOWER ECONOMIC GROWTH

Basin No.	Project	Catchment Area (km^2)	Active Storage Capacity (10^6 m^3)	Surface Area (km^2)	Installed Capacity (MW)	Annual Energy Output (GWh)	Purpose	Construction Cost (M10^6)	Date of Commission
Sabah (KOTA KINABALU)									
224	Tenom Pangi Stage III								
	- Sook dam & power	1,770	480	27	40	172	HY	150	1990
	- Pangi extension	(7,815)	-	-	44	137	HY	150	1990
221	Papar multi-purpose	353	147	5	30	130	HY,IR,WS	180/1	1990
224	Pangi No.2	(8,000)	-	2	90/3	547	HY	290/2	1994
Total		(17,938)	627	34	204	986		770	
Sarawak (KUCHING)									
244	Batang Sekrang	440	450	15	46	210	HY	310	1996

Remarks; Construction cost: Financial cost at 1980 constant price
IR: Irrigation, WS: Water Supply, HY: Hydropower
/1: M$67 x 10^6 for D&I water supply deducted
/2: Cost for railway relocation not included
/3: After Tenom Pangi, Stage III

Table 54 ALTERNATIVE COMBINATION OF HYDROPOWER DEVELOPMENT PLANS IN SABAH (1/3)

Name of Dam (With Basin No.)	Catch-ment Area (km^2)	Installed Capacity (MW)	Annual Energy (GWh)	Transmission Line to Demand Center (km)	Project Cost ($M\$10^6$) Dam	Power Facility	Trans-mission Line	Total Cost
*Alternative H1-1								
Sook (224)	1,770	35	153	60(to Pangi)	118.0	52.3	17.2	188
Pensiangan (224)	5,106	110	482	150(to Pangi) 231(to Tawau)	190.0	174.8	57.2 115.9	538
Kuamut-2 (211)	2,686	46	202	165(to Sandakan) 133 (to Lahad Datu)	179.9	102.6	54.3 52.3	389
Extension of Transmission Line				186(K/K to Kudat)			53.2	
Expansion of Tenom Pangi		44				47.5		
	Total	235 MW						
Alternative H1-2								
Pensiangan (224)	5,106	195	853	150(to Pangi) 231(to Tawau)	448.8	279.5	71.5 115.8	916
Kuamut-2 (211)	2,686	46	202	165(to Sandakan) 133(to Lahad Datu)	179.9	102.6	54.3 52.3	389
Extension of Transmission Line				186(K/K to Kudat)			53.2	
	Total	241 MW						
Alternative H1-3								
Sook (224)	1,770	35	153	60(to Pangi)	118.0	52.3	17.2	188
Padas-1 (224)	1,935	59	258	55(to Pangi)	432.6	77.8	16.5	527
Bengkoka-1 (216)	515	9	40	120(to Kudat)	207.5	19.1	41.5	268
Sapulut (224)	2,594	48	212	200(to Tawau)	144.8	99.9	91.2	336
Kuamut-2 (211)	2,686	46	202	165(to Sandakan) 133(to Lahad Datu)	179.9	102.6	54.3 52.3	389
Expansion of Tenom Pangi		44				47.5		
	Total	241 MW						

Remarks; *: The optimum scheme in alternative H1.

Table 55 ALTERNATIVE COMBINATION OF HYDROPOWER DEVELOPMENT PLANS IN SABAH (2/3)

Name of Dam (With Basin No.)	Catchment Area (km^2)	Installed Capacity (MW)	Annual Energy (GWh)	Transmission Line to Demand Center (km)	Project Cost (M10^6$) Dam	Power Facility	Transmission Line	Total Cost
*Alternative H2-1								
Sook-1 (224)	1,770	35	153	60(to Pangi)	118.0	52.3	17.2	188
Kuamut-2 (211)	2,686	46	202	165(to Sandakan) 133(to Lahad Datu) 125(to Tawau)	179.9	102.6	54.3 52.3 71.5	461
Expansion of Tenom Pangi		44				47.5		
Extension of Transmission Line				186(K/K to Kudat)			53.2	
	Total	125 MW						
Alternative H2-2								
Padas-1 (224)	1,935	68	298	55(to Pangi) 267(to Tawau)	533.7	91.3	16.5 136.4	778
Segama-2 (210)	670	23	100	76(to Lahad Datu)	263.5	38.8	27.9	330
Extension of Transmission Line				186(K/K to Kudat) 165(Lahad Datu to Sandakan)			53.2 70.8	
Expansion of Tenom Pangi		44				47.5		
	Total	135 MW						
Alternative H2-3								
Padas-1 (224)	1,935	68	298	55(to Pangi)	533.7	91.3	16.5	643
Kuamut-2 (211)	2,686	46	202	165(to Sandakan) 133(to Lahad Datu) 125(to Tawau)	179.9	102.6	54.3 52.3 71.5	460
Extension of Transmission Line				186(K/K to Kudat)			53.2	
Expansion of Tenom Pangi		44				47.5		
	Total	158 MW						

Table 56 ALTERNATIVE COMBINATION OF HYDROPOWER DEVELOPMENT PLANS IN SABAH (3/3)

Name of Dam (With Basin No.)	Catchment Area (km^2)	Installed Capacity (MW)	Annual Energy (GWh)	Transmission Line to Demand Center (km)	Project Cost ($M\$10^6$) Dam	Power Facility	Transmission Line	Total Cost
*Alternative H3								
Sook-1 (224)	1,770	35	153	60(to Pangi)	118.0	52.3	17.2	188
Pensiangan (201)	5,106	240	1,053	150(to Pangi) 35(to Sapulut)	724.4	260.0	50.5	1,035
Sapulut (201)	2,594	48	212	120(to Kuamut-2)	144.8	52.8	48.0	246
Kuamut-2	2,686	46	202	165(to Sandakan) 133(to Lahad Datu) 125(to Tawau)	179.9	102.6	178.1	461
Balat (212)	10,730	34	149	-	-	-	-	-
Expansion of Tenom Pangi	-	44	-	-	-	47.5	-	-
Extension of Transmission Line				186(K/K to Kudat)			53.2	
	Total	447 MW						

Remarks; *: The optimum scheme in alternative H2 & H3

Table 57 ALTERNATIVE COMBINATION OF HYDROPOWER DEVELOPMENT PLANS IN SARAWAK

Name of Dam	Catchment Area (km^2)	Installed Capacity (MW)	Annual Firm Energy (GWh)	Transmission Line to Demand Center (km)	Project Cost (M10^6$) Dam & Power Facilities	Trans-mission Line	Total Cost
*Alternative H1-1							
Muru-008	3,111	435	1,294	223 (to Miri)	679.0	63.7	
				378 (to Sibu)		108.1	
				184 (Sibu to Butang Ai)		52.6	
						Total	903
Alternative H1-2							
Lina-013	2,531	426	2,486	223 (to Miri)	739.0	65.7	
				378 (to Sibu)		108.1	
				184 (Sibu to Butang Ai)		52.6	
						Total	963
*Alternative H2-1							
Bela-010	2,883	219	1,517	223 (to Miri)	425.0	63.7	
				378 (to Sibu)		108.1	
				184 (Sibu to Butang Ai)		52.6	
						Total	650
Alternative H2-2							
Muru-008	3,111	211	981	223 (to Miri)	532.0	63.7	
				378 (to Sibu)		108.1	
				184 (Sibu to Butang Ai)		52.6	
						Total	756
*Alternative H3-1							
Kati 051	1,539	315	1,377	88 (to Sarikei)	952.0	35.2	987
Bele 020	575	73	149	130 (to Bintulu)	274.0	52.0	326
Tuto 125	2,380	85	283	160 (to Miri)	353.0	48.0	401
						Total	1,714
Alternative H3-2							
Kati 052	1,539	315	1,377	88 (to Sarikei)	1,057.0	35.2	1,092
Bela 010	2,883	143	957	95 (to Bintulu)	469.0	38.0	534
Limb 136	1,980	98	568	160 (to Miri)	400.0	48.0	448
						Total	2,074
*Alternative H4-1							
Kati 051	1,539	185	792	88 (to Sarikei)	500.0	35.2	535
Bele 020	575	73	149	130 (to Bintulu)	274.0	52.0	326
Trus 101	1,649	48	184	203 (to Miri)	331.0	60.9	392
						Total	1,253
Alternative H4-2							
Kati 010	2,987	187	1,290	88 (to Sarikei)	584.0	35.2	619
Bele 020	575	73	149	130 (to Bintulu)	274.0	52.0	326
Trus 101	1,649	48	184	203 (to Miri)	331.0	60.9	392
						Total	1,337

Remarks; *: The optimum scheme in each alternative combination.

Source; Ref. 2

Table 58 ADJUSTMENT FACTOR FOR KW AND KWH VALUE

(1) Power (kW) Adjustment Factor:

Loss Factor	Hydropower (%)	Oil-fired (%)
Transmission loss	4.0	2.0
Forced outage	0.5	5.0
Station service	0.3	5.0
Overhaul and inspection	2.0	15.0

$$\text{Adjustment Factor} = \frac{(1-0.04)(1-0.005)(1-0.003)(1-0.02)}{(1-0.02)(1-0.05)(1-0.05)(1-0.15)} = 1.241$$

(2) Energy (kWh) Adjustment Factor:

Loss Factor	Hydropower (%)	Oil-fired (%)
Transmission loss	4.0	2.0
Station service	0.3	5.0

$$\text{Adjustment Factor} = \frac{(1-0.04)(1-0.003)}{(1-0.02)(1-0.05)} = 1.028$$

Table 59 DEFINITION OF SAFE RIVER MAINTENANCE FLOW PERIOD, SAFE WATER SUPPLY PERIOD AND DROUGHT DAMAGE RATIO

Description	Alternative			
	B1	B2	-	B3
Drought Level	1/N	2/N	3/N	4/N
Deficit under Q97% maintenance flow ($10^6 m^3/y$)	DA1	DA2	DA3	DA4
Deficit under Q99% maintenance flow ($10^6 m^3/y$)	DB1	DB2	DB3	DB4
Period of Deficit under Q97% maintenance flow (days/y)	PA1	PA2	PA3	PA4
Period of Deficit under Q99% maintenance flow (days/y)	PB1	PB2	PB3	PB4
Shortage in 1/N drought under Q97% maintenance flow ($10^6 m^3/y$)	SA1=0	SA2= DA1-DA2	SA3= DA1-DA3	SA4= DA1-DA4
Shortage in 1/N drought under Q99% maintenance flow ($10^6 m^3/y$)	SB1=0	SB2= DB1-DB2	SB3= DB1-DB3	SB4= DB1-DB4
Damage period of shortage in 1/N drought under Q97% (days/y)	PDA1=0	PDA2= SA2/C	PDA3= SA3/C	PDA4= SA4/C
Damage period of shortage in 1/N drought under Q99% (days/y)	PDB1=0	PDB2= SB2/C	PDB3= SB3/C	PDB4= SB4/C
* Safe river maintenance flow period in 1/N drought (days/y)	365	365- PDA2	365- PDA3	365- PDA4
* Safe water supply period in 1/N drought (days/y)	365	365- PDB2	365- PDB3	365- PDB4
Shortage in N years under Q97% maintenance flow ($10^6 m^3$)	TS1=0	TS2=SA2	TS3=SA3 +(DA2-DA3)	TS4=SA4 +(DA2-DA3) +(DA3-DA4)
* Drought damage ratio in N years (%)	R1=0	R2= TS2/TDW	R3= TS3/TDW	R4= TS4/TDW

in which; $C = DA1/PA1$, $N = 10 - 16$ (years),

$$TDW = \sum_{i=1}^{N} (Q97\% \text{ maintenance flow} + \text{withdrawal})i$$

Table 60 SAFE WATER SUPPLY PERIOD AND SAFE RIVER MAINTENANCE FLOW PERIOD WITH/WITHOUT ALTERNATIVE STRUCTURAL MEASURES IN 1990 AND 2000

Unit: days

1990

Basin No.	Basin Name	Safe Water Supply Period B1	B2	B3	without Structures (1/N)	Safe River Maintenance Flow Period B1	B2	B3	without Structures (1/N)
SABAH									
207	Tawau	365	297	271	260	365	285	261	254
218	Kadamaian	365	358	301	270	365	325	295	260
221	Papar	365	356	351	330	365	350	340	301
SARAWAK									
231	Miri	365	365	350	319	365	349	319	309

Unit: days

2000

Basin No.	Basin Name	Safe Water Supply Period B1	B2	B3	without Structures (1/N)	Safe River Maintenance Flow Period B1	B2	B3	without Sturctures (1/N)
SABAH									
207	Tawau	365	295	268	254	365	282	255	244
218	Kadamaian	365	358	298	265	365	325	290	260
221	Papar	365	357	350	330	365	331	330	296
SARAWAK									
231	Miri	365	365	345	298	365	329	310	278

Remarks; N = 10 - 16,

'B1, B2 and B3' mean the condition after the alternative water source facilities are implemented, and 'without structures' means natural flow condition.

Table 61 SAFE WATER SUPPLY PERIOD AND SAFE RIVER MAINTENANCE FLOW PERIOD WITHOUT STRUCTURAL MEASURES IN 2000

Unit: days

Basin No.	Safe Water Supply Period			Safe River Maintenance Flow Period		
	1/N	2/N	3/N	1/N	2/N	3/N
201	260	335	345	254	335	350
202	260	335	345	254	335	350
203	260	335	345	254	335	350
204	260	335	345	254	335	350
205	260	335	345	254	335	350
206	260	335	345	254	335	350
207	254	335	350	244	335	350
208	260	335	345	254	335	350
209	260	335	345	254	335	350
210	260	335	345	254	335	350
211	350	334	365	310	325	355
212	325	316	365	285	305	355
213	330	321	365	285	305	355
214	330	326	365	285	305	355
215	330	326	365	285	305	355
216	265	296	360	260	281	347
217	285	327	365	270	296	352
218	265	291	295	260	281	300
219	312	360	360	296	339	345
220	301	316	331	280	311	321
221	330	349	350	296	320	329
222	335	349	360	361	326	350
223	335	344	360	306	326	340
224	276	335	354	276	330	339
225	137	102	215	97	132	210
226	335	360	365	316	342	350
227	340	360	365	322	350	355
228	335	360	365	322	350	355
229	345	360	360	364	355	355
230	345	360	360	329	355	355
231	298	309	314	278	299	309
232	340	360	360	319	329	350
233	345	360	365	319	329	350
234	345	360	365	319	329	350
235	345	360	365	319	329	350
236	340	344	360	314	319	350
237	345	360	365	359	334	350
238	345	360	365	319	334	350
239	345	354	365	319	334	350
240	345	354	365	319	334	350
241	355	360	360	325	360	360
242	339	349	365	309	350	329
243	339	349	365	309	350	329
244	334	344	365	304	324	350
245	324	339	365	299	329	350
246	345	355	355	335	349	350
247	360	360	365	340	349	360

Remarks; N = 10 - 16 (see Table 1)

Table 62 SAFE WATER SUPPLY PERIOD AND SAFE RIVER MAINTENANCE FLOW PERIOD WITH/WITHOUT RECOMMENDED STRUCTURAL MEASURES IN 1990 AND 2000

Unit: days

1990

Basin No.	Basin Name	Safe Water Supply Period		Safe River Maintenance Flow Period	
		with Structures	without Structures	with Structures	without Structures
SABAH					
207	Tawau	365	260	365	254
218	Kadamaian	301	270	295	260
221	Papar	351	330	340	301
SARAWAK					
231	Miri	365	319	365	309

Unit: days

2000

Basin No.	Basin Name	Safe Water Supply Period		Safe River Maintenance Flow Period	
		with Structures	without Structures	with Structures	without Structures
SABAH					
207	Tawau	365	254	365	244
218	Kadamaian	298	265	290	260
221	Papar	350	330	330	296
SARAWAK					
231	Miri	365	298	365	278

Remarks; 'With structures' means the condition after the recommended water source facilities are implemented, and 'without structures' means the natural flow condition both under the 1/N drought.

Table 63 SAFE WATER SUPPLY PERIOD AND SAFE RIVER MAINTENANCE FLOW WITH/WITHOUT RECOMMENDED STRUCTURAL MEASURES IN 1990 AND 2000 UNDER THE CONDITION OF LOWER ECONOMIC GROWTH

Unit: days

1990

Basin No.	Basin Name	Safe Water Supply Period		Safe River Maintenance Flow Period	
		with Structures	without Structures	with Structures	without Structures
SABAH					
207	Tawau	365	271	365	259
218	Kadamaian	301	272	295	260
221	Papar	352	331	341	303
SARAWAK					
231	Miri	365	319	365	310

Unit: days

2000

Basin No.	Basin Name	Safe Water Supply Period		Safe River Maintenance Flow Period	
		with Structures	without Structures	with Structures	without Structures
SABAH					
207	Tawau	365	260	365	252
218	Kadmaian	298	265	292	261
221	Papar	351	330	331	296
SARAWAK					
231	Miri	365	303	365	288

Table 64 DROUGHT DAMAGE RATIO WITH ALTERNATIVE WATER SOURCE FACILITIES IN 1990 AND 2000

Unit: Percentage

Basin No.	Basin Name	1990 B1	1990 B2	1990 B3	2000 B1	2000 B2	2000 B3
SABAH							
207	Tawau	0	1.76	2.32	0	1.37	2.29
218	Kadamaian	0	0.56	2.26	0	0.55	2.28
221	Papar	0	0.45	0.57	0	0.42	0.55
SARAWAK							
231	Miri	0	0.15	0.87	0	0.31	0.80

Remarks; The condition under the 1/N drought.

Table 65 DROUGHT DAMAGE RATIO WITH RECOMMENDED WATER SOURCE FACILITIES IN 1990 AND 2000

Unit: Percentage

Basin No.	Basin Name	1990 Target Economic Growth	1990 Lower Economic Growth	2000 Target Economic Growth	2000 Lower Economic Growth
SABAH					
207	Tawau	0	0	0	0
218	Kadamaian	2.26	2.26	2.28	2.26
221	Papar	0.57	0.58	0.55	0.54
SARAWAK					
231	Miri	0	0	0	0

Remarks; The condition under the 1/N drought.

Table 66 STANDARD COMPENSATION AND RESETTLEMENT COST

Unit: $M\$10^6/km^2$

(A) Compensation on Land

Irrigated paddy	2.5	Urban area class S	100
Rainfed paddy	1.5	Urban area class A	10
Tree crop field class A	1.5	Urban area class B	5
Tree crop field class B	1.0	Village area class A	5
Free crop field calss C	0.5	Village area class B	1
Forest class A	0.5		
Forest class B	0.1		

(B) Resettlement

Urban	M$30,000/household
Rural	M$10,000/household

Remarks; S = very good access; A = good access;
B = poor access; C = very poor access

Table 67 NUMBER OF PROPOSED WATER SOURCE FACILITIES AND HYDROPOWER DAMS IN SABAH AND SARAWAK

(A) Number of Proposed Dams

Unit: number of sites

	5MP	6MP	7MP	Total
The State of Sabah				
Alternative B1	2	3	0	5
Alternative B2	2	2	0	4
Alternative B3	2	2	0	4
Recommended Plan	2	3	0	5
Recommended, Lower Case	2	2	0	4
The State of Sarawak				
Alternative B1	1	0	0	1
Alternative B2	1	0	0	1
Alternative B3	1	0	0	1
Recommended Plan	1	0	0	1
Recommended, Lower Case	1	0	0	1

(B) Number of Proposed Hydropower Dams

Unit: number of sites

	5MP	6MP	7MP	Total
The State of Sabah				
Recommended Plan	3	1	1	5
Recommended, Lower Case	3	1	0	4
The Stage of Sarawak				
Recommended Plan	1	0	2	3
Recommended, Lower Case	0	0	1	1

Remarks; The number is counted as of commission year.

Table 68 MANPOWER REQUIREMENT FOR WATER SOURCE FACILITIES, ALTERNATIVE B1 AND RECOMMENDED PLAN

Construction

Unit: number of staff

	4MP	5MP	6MP	7MP
Grade A: Engineer	0	3	3	0
B: Technical Assistant	0	3	3	0
C: Technician	0	6	6	0
D: Others	0	9	9	0
Total Govt. Staff	0	21	21	0

O & M

	4MP	5MP	6MP	7MP
Grade A: Engineer	0	3	6	6
B: Technical Assistant	0	3	6	6
C: Technician	0	3	6	6
D: Others	0	12	24	24
Total Govt. Staff	0	21	42	42

Construction & O&M

	4MP	5MP	6MP	7MP
Grade A: Engineer	0	6	9	5
B: Technical Assistant	0	6	9	6
C: Technician	0	9	12	6
D: Others	0	21	33	24
Total Govt. Staff	0	42	63	42

Remarks; O&M: Operation and maintenance

Table 69 MANPOWER REQUIREMENT FOR WATER SOURCE FACILITIES, ALTERNATIVES B2 & B3 AND RECOMMENDED PLAN UNDER THE CONDITION OF LOWER ECONOMIC GROWTH

Construction

Unit: number of staff

	4MP	5MP	6MP	7MP
Grade A: Engineer	0	3	2	0
B: Technical Assistant	0	3	2	0
C: Technican	0	6	4	0
D: Others	0	9	6	0
Total Govt. Staff	0	21	14	0

O & M

	4MP	5MP	6MP	7MP
Grade A: Engineer	0	3	5	5
B: Technical Assistant	0	3	5	5
C: Technician	0	3	5	5
D: Others	0	12	20	20
Total Govt. Staff	0	21	35	35

Construction & O&M

	4MP	5MP	6MP	7MP
Grade A: Engineer	0	6	7	5
B: Technical Assistant	0	6	7	5
C: Technician	0	9	9	5
D: Others	0	21	26	20
Total Govt. Staff	0	42	49	35

Remarks; O&M: Operation and maintenance.

Table 70 MANPOWER REQUIREMENT FOR RECOMMENDED HYDROPOWER DAMS

(A) Recommended Plan

Unit: number of staff

Construction

	4MP	5MP	6MP	7MP
Grade A: Engineer	0	4	1	3
B: Technical Assistant	0	8	2	6
C: Technician	0	8	2	6
D: Others	0	12	3	9
Total Govt. Staff	0	32	8	24

O & M

	4MP	5MP	6MP	7MP
Grade A: Engineer	0	4	5	8
B: Technical Assistant	0	8	10	16
C: Technician	0	4	5	8
D: Others	0	16	20	32
Total Govt. Staff	0	32	40	64

Construction & O&M

	4MP	5MP	6MP	7MP
Grade A: Engineer	0	8	6	11
B: Technical Assistant	0	16	12	22
C: Technician	0	12	7	14
D: Others	0	28	23	41
Total Govt. Staff	0	64	48	88

(B) Recommended Plan Under Lower Economic Growth

Construction

	4MP	5MP	6MP	7MP
Grade A: Engineer	0	3	1	0
B: Technical Assistant	0	6	2	0
C: Technician	0	6	2	0
D: Others	0	9	3	0
Total Govt. Staff	0	24	8	0

O & M

	4MP	5MP	6MP	7MP
Grade A: Engineer	0	3	4	4
B: Technical Assistant	0	6	8	8
C: Technician	0	3	4	4
D: Others	0	12	16	16
Total Govt. Staff	0	24	32	32

Construction & O&M

	4MP	5MP	6MP	7MP
Grade A: Engineer	0	6	5	4
B: Technical Assistant	0	12	10	8
C: Technician	0	9	6	4
D: Others	0	21	19	16
Total Govt. Staff	0	48	40	32

Remarks; O&M: Operation and maintenance

Table 71 FEATURES OF DAM (1/6)

The State of Sabah
Basin No. : 207
Name of Dam: Tawau

Catchment Area (km^2) : 37.6
Annual Discharge (10^6 m^3/y): 46.5
Purpose: WS to Tawau

Features		Maximum Scale	Alternative * 1/10	2/10	3/10
Net supply capacity	(10^6 m^3/y):	28.1	21.0	12.0	--
Active storage	(10^6 m^3) :	22.8	7.1	3.5	
Gross storage	(10^6 m^3) :	24.3	8.6	5.0	
Reservoir surface area	(km^2) :		0.5	0.4	
Dam volume	(10^6 m^3) :		0.93	0.59	
Potential annual energy	(MWh) :	-			
Project Cost ($M\$10^6$)					
Dam	:		62.0	39.7	
Engineering & administration	:		6.2	4.0	
Land & resettlement	:		0.1	0	
Physical contingency	:		20.5	13.1	
Total dam project cost	:		88.7	56.8	--

Remarks; *: For recommended plan

Table 72 FEATURES OF DAM (2/6)

The State of Sabah
Basin No. : 213
Name of Dam: Meliau

Catchment Area (km^2) : 58.0
Annual Discharge (10^6 m^3/y): 132.0
Purpose: WS to Sandakan

Features		Maximum Scale	Alternative * 1/N	2/N	3/N
Net supply capacity	(10^6 m^3/y):		48.0	48.0	48.0
Active storage	(10^6 m^3) :		16.7		
Gross storage	(10^6 m^3) :		19.0		
Reservoir surface area	(km^2) :		0.9		
Dam volume	(10^6 m^3) :		1.56		
Potential annual energy	(MWh) :		-		
Project Cost ($M\$10^6$)					
Dam	:		104.7	104.7	104.7
Engineering & administration	:		10.5	10.5	10.5
Land & resettlement	:		0.1	0.1	0.1
Physical contingency	:		34.6	34.6	34.6
Total dam project cost	:		149.8	149.8	149.8

Remarks; *: For recommended plan

Table 73 FEATURES OF DAM (3/6)

The State of Sabah
Basin No. : 217
Name of Dam: Milau

Catchment Area (km^2) : 70
Annual Discharge (10^6 m^3/y): 80.6
Purpose: WS to Kudat

Features		Maximum Scale	Alternative *1/N	2/N	4/N
Net supply capacity	(10^6 m^3/y):		12.3	12.3	12.3
Active storage	(10^6 m^3) :		5.3		
Gross storage	(10^6 m^3) :		8.0		
Reservoir surface area	(km^2) :		5.6		
Dam volume	(10^6 m^3) :		0.04		
Potential annual energy	(MWh) :		-		
Project Cost (M10^6$)					
Dam	:		3.1	3.1	3.1
Engineering & administration	:		0.3	0.3	0.3
Land & resettlement	:		3.0	3.0	3.0
Physical contingency	:		1.9	1.9	1.9
Total dam project cost	:		8.3	8.3	8.3

Remarks; *: For recommended plan

Table 74 FEATURES OF DAM (4/6)

The State of Sabah
Basin No. : 218
Name of Dam: Wariu

Catchment Area (km^2) : 123
Annual Discharge (10^6 m^3/y): 208
Purpose: IR,WA

Features		Maximum Scale	Alternative 1/13	2/13	*3/13
Net supply capacity	(10^6 m^3/y):	157.6	65.4	41.5	10.3
Active storage	(10^6 m^3) :	146.4	24.5	17.0	7.8
Gross storage	(10^6 m^3) :	151.4	29.4	21.4	12.8
Reservoir surface area	(km^2) :		0.6	0.4	0.3
Dam volume	(10^6 m^3) :	177.6	3.55	1.86	0.66
Potential annual energy	(MWh) :	0.1	-	-	-
Project Cost (M10^6$)					
Dam	:		187.3	124.9	44.4
Engineering & administration	:		19.6	12.4	4.4
Land & resettlement	:		0.2	0.1	0.1
Physical contingency	:		62.2	41.2	14.7
Total dam project cost	:		269.3	178.7	63.6

Remarks; *: For recommended plan

Table 75 FEATURES OF DAM (5/6)

The State of Sabah
Basin No. : 220
Name of Dam: Papar

Catchment Area (km^2) : 353
Annual Discharge (10^6 m^3/y): 646
Purpose: IR, WS

Features		Maximum Scale	Alternative 1/N	2/N	*3/N
Net supply capacity	(10^6 m^3/y):		58.0	35.0	35.0
Active storage	(10^6 m^3) :		25.5	15.0	15.0
Gross storage	(10^6 m^3) :		39.5	30.0	30.0
Reservoir surface area	(km^2) :		2.9	2.6	2.6
Dam volume	(10^6 m^3) :		0.74	0.65	0.65
Potential annual energy	(MWh) :	See Table 79			
Project Cost (M10^6$)					
Dam	:		49.5	46.3	46.3
Engineering & administration	:		4.9	4.6	4.6
Land & resettlement	:		0.6	0.6	0.6
Physical contingency	:		16.3	15.2	15.2
Total dam project cost	:		71.3	66.7	66.7

Remarks; *: For recommended plan

Table 76 FEATURES OF DAM (6/6)

The State of Sarawak
Basin No. : 231
Name of Dam: Liku

Catchment Area (km^2) : 33
Annual Discharge (10^6 m^3/y): 54
Purpose: WS to Miri

Features		Maximum Scale	Alternative * 1/13	2/13	3/13
Net supply capacity	(10^6 m^3/y):	41.8	20.0	15.0	13.0
Active storage	(10^6 m^3) :	37.8	5.3	3.6	2.8
Gross storage	(10^6 m^3) :	39.1	6.6	4.9	4.1
Reservoir surface area	(km^2) :		2.9	2.7	2.6
Dam volume	(10^6 m^3) :		0.13	0.11	0.10
Potential annual energy	(MWh) :	-	-	-	-
Project Cost (M10^6$)					
Dam	:		10.1	8.8	8.1
Engineering & administration	:		1.0	0.9	0.8
Land & resettlement	:		0.4	0.3	0.3
Physical contingency	:		3.4	3.0	2.8
Total dam project cost	:		14.9	12.9	11.9

Remarks; *: For recommended plan

Table 77 FEATURES OF HYDROPOWER PROJECT (1/8)

Basin No. : 201 Catchment Area (km^2) : 2,594
Name of Dam: Sapulut Annual Discharge (10^6 m^3/y): 3,870
Purpose : HY

	Description	Unit	Features
Principal Features :	Gross storage	(10^6 m^3)	6,285.7
	Active storage	(10^6 m^3)	2,865.0
	Average outflow	(m^3/sec)	104.8
	Full supply level	(m)	347.0
	Dam crest elevation	(m)	350.0
	Reservoir surface area	(km^2)	83.0
	Dam volume	(10^6 m^3)	4.7
	Dam height	(m)	117.0
	Installed capacity	(MW)	150.0
	Annual energy	(GWh)	657.0
	Rated head	(m)	
Project Cost (M10^6):	Dam		233.0
	Generating equipment		85.6
	TL & SS		
	Land & resettlement dam		
	Land & resettlement TL & SS		
	Physical contingency		93.0
	Total Project Cost		411.6

Table 78 FEATURES OF HYDROPOWER PROJECT (2/8)

Basin No. : 201 Catchment Area (km^2) : 5,106
Name of Dam: Pensiangan Annual Discharge (10^6 m^3/y): 7,618
Purpose : HY

	Description	Unit	Features
Principal Features :	Gross storage	(10^6 m^3)	6,152.4
	Active storage	(10^6 m^3)	4,342.4
	Average outflow	(m^3/sec)	197.9
	Full supply level	(m)	233.0
	Dam crest elevation	(m)	236.0
	Reservoir surface area	(km^2)	135.0
	Dam volume	(10^6 m^3)	10.0
	Dam height	(m)	155.4
	Installed capacity	(MW)	374.4
	Annual energy	(GWh)	1,640.0
	Rated head	(m)	120.7
Project Cost (M10^6):	Dam		496.7
	Generating equipment		165.0
	TL & SS		206.0
	Land & resettlement dam		
	Land & resettlement TL & SS		
	Physical contingency		203.3
	Total Project Cost		1,070.0

Table 79 FEATURES OF HYDROPOWER PROJECT (3/8)

Basin No. : 221
Name of Dam: Papar
Purpose : HY, WS
Catchment Area (km^2) : 353
Annual Discharge (10^6 m^3/y): 670

	Description	Unit	Features
Principal Features :	Gross storage	(10^6 m^3)	174.2
	Active storage	(10^6 m^3)	108.5
	Average outflow	(m^3/sec)	14.0
	Full supply level	(m)	190.0
	Dam crest elevation	(m)	193.0
	Reservoir surface area	(km^2)	5.0
	Dam volume	(10^6 m^3)	
	Dam height	(m)	79.0
	Installed capacity	(MW)	30.0
	Annual energy	(GWh)	131.4
	Rated head	(m)	143.7
Project Cost (M10^6):	Dam & pressure tunnel		180.0
	Generating equipment		11.1
	TL & SS		
	Land & resettlement dam		
	Land & resettlement TL & SS		
	Physical contingency		56.3
	Total Project Cost		247.4

Table 80 FEATURES OF HYDROPOWER PROJECT (4/8)

Basin No. : 224
Name of Dam: Sook
Purpose : HY
Catchment Area (km^2) : 1,770
Annual Discharge (10^6 m^3/y): 1,746

	Description	Unit	Features
Principal Features :	Gross storage	(10^6 m^3)	480.0
	Active storage	(10^6 m^3)	398.0
	Average outflow	(m^3/sec)	43.2
	Full supply level	(m)	304.9
	Dam crest elevation	(m)	307.9
	Reservoir surface area	(km^2)	23.0
	Dam volume	(10^6 m^3)	1.19
	Dam height	(m)	61.0
	Installed capacity	(MW)	40.0
	Annual energy	(GWh)	175.2
	Rated head	(m)	37.4
Project Cost (M10^6):	Dam		50.0
	Generating equipment		41.0
	TL & SS		
	Land & resettlement dam		23.0
	Land & resettlement TL & SS		
	Physical contingency		36.0
	Total Project Cost		150.0

Table 81 FEATURES OF HYDROPOWER PROJECT (5/8)

Basin No. : 224 Catchment Area (km^2) : 1,893
Name of Dam: Upper Padas Annual Discharge (10^6 m^3/y): 1,944
Purpose : HY

	Description	Unit	Features
Principal Features :	Gross storage	(10^6 m^3)	500.0
	Active storage	(10^6 m^3)	300.0
	Average outflow	(m^3/sec)	43.1
	Full supply level	(m)	492.0
	Dam crest elevation	(m)	493.0
	Reservoir surface area	(km^2)	9.4
	Dam volume	(10^6 m^3)	6.5
	Dam height	(m)	120.0
	Installed capacity	(MW)	170.0
	Annual energy	(GWh)	742.0
	Rated head	(m)	250.5
Project Cost (M$$10^6$):	Dam & pressure tunnel		591.1
	Generating equipment		70.5
	TL & SS		29.0
	Land & resettlement dam		
	Land & resettlement TL & SS		
	Physical contingency		177.4
	Total Project Cost		868.0

Table 82 FEATURES OF HYDROPOWER PROJECT (6/8)

Basin No. : 244 Catchment Area (km^2) : 1,250
Name of Dam: Konowit Annual Discharge (10^6 m^3/y): 2,755
Purpose : HY

	Description	Unit	Features
Principal Features :	Gross storage	(10^6 m^3)	1,657.0
	Active storage	(10^6 m^3)	1,175.0
	Average outflow	(m^3/sec)	
	Full supply level	(m)	
	Dam crest elevation	(m)	
	Reservoir surface area	(km^2)	
	Dam volume	(10^6 m^3)	3.0
	Dam height	(m)	83.0
	Installed capacity	(MW)	110.0
	Annual energy	(GWh)	485.0
	Rated head	(m)	67.0
Project Cost (M$$10^6$):	Dam		194.0
	Generating equipment		109.0
	TL & SS		51.0
	Land & resettlement dam		2.0
	Land & resettlement TL & SS		30.0
	Physical contingency		116.0
	Total Project Cost		502.0

Table 83 FEATURES OF HYDROPOWER PROJECT (7/8)

Basin No. : 244 Catchment Area (km^2) : 440
Name of Dam: Batang Sekrang Annual Discharge (10^6 m^3/y): 970
Purpose :

	Description	Unit	Features
Principal Features :	Gross storage	(10^6 m^3)	636.0
	Active storage	(10^6 m^3)	451.0
	Average outflow	(m^3/sec)	
	Full supply level	(m)	162.0
	Dam crest elevation	(m)	165.0
	Reservoir surface area	(km^2)	
	Dam volume	(10^6 m^3)	2.6
	Dam height	(m)	95.0
	Installed capacity	(MW)	46.0
	Annual energy	(GWh)	210.0
	Rated head	(m)	70.0
Project Cost (M10^6):	Dam		160.0
	Generating equipment		25.0
	TL & SS		44.0
	Land & resettlement dam		2.0
	Land & resettlement TL & SS		8.0
	Physical contingency		71.0
	Total Project Cost		310.0

Table 84 FEATURES OF HYDROPOWER PROJECT (8/8)

Basin No. : 244 Catchment Area (km^2) : 360
Name of Dam: Upper Batang Ai Annual Discharge (10^6 m^3/y): 793
Purpose :

	Description	Unit	Features
Principal Features :	Gross storage	(10^6 m^3)	461.0
	Active storage	(10^6 m^3)	340.0
	Average outflow	(m^3/sec)	
	Full supply level	(m)	220.0
	Dam crest elevation	(m)	223.0
	Reservoir surface area	(km^2)	
	Dam volume	(10^6 m^3)	4.2
	Dam height	(m)	113.0
	Installed capacity	(MW)	48.0
	Annual energy	(GWh)	225.0
	Rated head	(m)	90.0
Project Cost (M10^6):	Dam		255.0
	Generating equipment		26.0
	TL & SS		44.0
	Land & resettlement dam		2.0
	Land & resettlement TL & SS		24.0
	Physical contingency		105.0
	Total Project Cost		456.0

Table 85 HYDROPOWER POTENTIAL AT SONG UPPER AND LOWER SITES IN SARAWAK

Site	Catchment Area (km^2)	Annual Inflow ($10^6 m^3/y$)	F.S.L (m)	Rated Head (m)	Installed Capacity (MW) *	Annual Energy (GWh)
Song Upper	35,200	87,700	122 (400')	89	3,870	16,900
			137 (450')**	101	4,400	19,300
Song Lower	38,600	96,300	91.5 (300')	77	3,080	13,500
			107 (350')**	65	3,670	16,100

Remarks; * : 12 hours of daily operation
**: Physical maximum scale