APPENDIX 1 UNIT VALUE OF IRRIGATION WATER

For estimating unit value of irrigation water, basic data are quoted from "Feasibility Study on the Matuno River Development Project". Unit value of irrigation water is estimated as follows,

$$Vw = \frac{B - C}{Q \times f}$$

where, Vw; Water value which can be allocated to compensate dam cost (US$)

B ; Present worth of incremental benefit accrued from dry season crops (US$)

C ; Present worth of incremental cost for irrigation including initial investment cost, O&M cost and replacement cost (US$)

Q ; Annual diversion water requirement for irrigating dry season crops (m^3)

F ; Capital Recovery Factor = 8.30 (12% & 50 years)

Note; Discount rate = 12%

To obtain the annual benefit, cropped area and crop production of dry season crops, and incremental labor requirement are assessed as shown in Tables AP1-1 and AP1-2. From these production and requirement, annual benefit is estimated to be 67.7×10^6 US$ as shown in Table AP1-3.

In accordance with the construction schedule, expected irrigation benefits will begin as presented in the following table.

Agricultural Benefit

Year in order	Benefit/1 (%)	Amount (US$ x 1,000)
1	-	-
2	-	-
3	7.8	528
4	23.6	1,598
5	53.0	3,588
6	81.6	5,524
7	95.7	6,479
8	100.0	6,770
9	100.0	6,770
:	:	:
50	100.0	6,770

Note: /1; Page X11-3, Feasibility Study on the Matuno River Development Project, Vol. 2, APPENDIX I Agriculture Component

On the other hand, construction cost for irrigation development is assessed to be 31,600.6 x 10^3 US$. Breakdown of each cost is shown in Table AP1-4.

Annual disbursement schedule of economic construction cost and other costs such as annual operation and maintenance cost, and replacement cost are shown as follows,

Economic cost

1. Annual Disbursement Schedule of Economic Construction Cost

Year in order	Amount (US$ x 1,000)
1	1,068.6
2	3,004.3
3	8,121.6
4	8,476.9
5	7,867.0
6	3,122.2
Total	31,660.6

2. Annual Operation and Maintenance Cost

US$240,000 x 1/2 = US$120,000

3. Replacement Cost

(1) O&M equipment US$0.53 x 10^6 x 1/2 (every 10 years)
(2) Canal gates US$2.00 x 10^6 (every 25 years)

Based on these costs and benefits, present worth of incremental benefit and cost are assessed to be 34,504 x 10^3 US$ and 21,330 x 10^3 US$ respectively. Economic cost and benefit flow and benefit-cost computation are shown in Tables AP1-5 and AP1-6.

To obtain the annual diversion water requirement for irrigating dry season crops, incremental cropped area is estimated as follows,

Incremental Cropped Area for Dry Season Crops

Crops	Cropped area (ha)			Ratio
	Without project	With project	Increment	
HYV paddy	4,570	10,830	6,260	0.58
Corn	420	450	30	0.07
Vegetable	160	400	240	0.60
Peanut	-	1,000	1,000	1.00
Mung bean	-	3,600	3,600	1.00

Taking into account the above cropped area, annual diversion water requirement for irrigating dry season crops is estimated to be 89.55 x 10^6m3. Details are shown in Table AP1-7.

Then, unit value of irrigation water is calculated as follows,

$$Vw = \frac{34,504 \times 103 - 21,330 \times 10^3}{89.55 \times 10^6 \times 8.30} = \underline{\underline{0.02\ US\$/m^3}}$$

Table AP1-1 Cropped Area and Crop Production of Dry Season Crops

Crops	Without project		With project	
	Cropped area (ha)	Production (tons)	Cropped area (ha)	Production (tons)
HYV palay	4,570	17,366	10,830	48,735
Corn	420	462	450	1,575
Root crops	160	960	-	-
Vegetable	-	-	400	4,000
Peanut	-	-	1,000	1,500
Mung bean	-	-	3,600	4,320

Source; Tables IV-6 and IV-7, Feasibility Study on the Matuno River Development Project, Vol. 2, APPENDIX I Agriculture Component.

Table AP1-2 Incremental Labor Requirement

(Unit: M/d)

Item	Without project		With project		Increment	
	For all season	For dry season	For all season	For dry season	For all season	For dry season
Labor requirement	1,707.7	493.2	3,416.9	1,782.0	1,709.2	1,288.8

Source; Tables IV-20 and IV-24, Feasibility Study on the Matuno River Development Project, Vol. 2, APPENDIX 1 Agriculture Component.

Table AP1-3 Incremental Benefit by Dry Season Crops

Crops	Without project			With project			Incremental NPV/1 (₱ x 10^6)	Incremental labor cost (₱ x 10^6)	Benefit (₱ x 10^6)
	NPV/1 (₱/ha)	Cropped area (ha)	Total NPV (₱ x 10^6)	NPV/1 (₱/ha)	Cropped area (ha)	Total NPV (₱ x 10^6)			
HYV palay	5,017	4,570	22.9	5,324	10,830	57.7	34.8		
Corn	1,524	420	0.6	3,641	450	1.6	1.0		
Root crops	33,394	160	5.3		-		-5.3		
Vegetable		-		55,921	400	22.4	22.4		
Peanut		-		5,289	1,000	5.3	5.3		
Mung Beam		-		7,879	3,600	28.4	28.4		
Total		5,150	28.9		16,280	115.4	86.6	18.9/2	67.7

(US$6.77 x 10^6)

Source; Table IV-49, Feasibility Study on the Matuno River Development Project Vol. 2, APPENDIX I Agriculture Component

Notes ; /1: Net Production Value without costing labor

/2: $25.1^{/3} \times \frac{1,288.8^{/4}}{1,709.2} = 18.9$

/3: Incremental economic cost of farm labor for all season crops. See Table IV-49, Feasibility Study on the Matuno River Development Project, Vol. 2

/4: See Table AP1-2

Table AP1-4 Construction Cost for Irrigation Development

Work Item	Amount (US$ x 1,000)	
	Project Cost/1	Economic Cost
1. Pre-Engineering	105.0	101.9
2. Civil Works		
a) Diversion Dam	7,121.0	6,913.6
b) Irrigation System	13,091.0	12,709.7
c) Drainage System	4,128.8	4,008.5
d) Road Networks	2,152.2	2,089.5
e) Hill Development	209.0	202.9
f) On-farm Development	1,741.7	1,741.7
Sub-Total	28,443.7	27,665.9
3. Land Acquisition	698.4	-
4. O&M Equipment	830.0	805.8
5. Administration & Engineering	3,537.0	3,537.0
6. Training	70.0	70.0
Total (1 - 6)	33,684.1	32,180.6
7. Physical Contingency	3,368.4	3,218.1
Total (1 - 7)	37,052.5	35,398.7
Economic Cost		31,660.6/2

/1; Source: Table-6, Feasibility Study on the Matuno River Development Project, Volume I Main Report.

/2; 35,398.7 (1 x 0.53 + 0.82 x 0.40 + 0.52 x 0.07)/3

/3; Page 6-2 of Feasibility Study on the Matuno River Development Project, Volume I Main Report.

Table AP1-5 Economic Cost and Benefit Flow

(Unit: US$ x 1,000)

Year in Order	Cost				Benefit
	Capital	O&M	Replace	Total	
1	1,069			1,069	
2	3,004			3,004	
3	8,122	24		8,146	528
4	8,477	48		8,525	1,598
5	7,867	72		7,939	3,588
6	3,122	96		3,218	5,524
7		120		120	6,479
8		120		120	6,770
9		120		120	6,770
10		120		120	6,770
11		120		120	6,770
12		120		120	6,770
13		120		120	6,770
14		120		120	6,770
15		120		120	6,770
16		120	265	385	6,770
⋮		120		120	6,770
⋮		120		120	6,770
26		120	265	385	6,770
⋮		120		120	6,770
⋮		120		120	6,770
31		120	2,000	2,120	6,770
⋮		120		120	6,770
⋮		120		120	6,770
36		120	265	385	6,770
⋮		120		120	6,770
⋮		120		120	6,770
46		120	265	385	6,770
⋮		120		120	6,770
⋮		120		120	6,770
50		120		120	6,770

Table AP1-6 Benefit-Cost Computation

(Unit: US$ x 1,000)

Year in Order	Discount Factor 12%	Cost Total	Present Worth	Benefit	Present Worth
1	0.893	1,069	954.6		
2	0.797	3,004	2,394.2		
3	0.712	8,146	5,800.0	528	375.9
4	0.636	8,525	5,421.9	1,598	1,016.3
5	0.567	7,939	4,501.4	3,588	2,034.4
6	0.507	3,218	1,631.5	5,524	2,800.7
7	0.452	120	54.2	6,479	2,928.5
8	0.404	120	48.5	6,770	2,735.1
9	0.361	120	43.3	6,770	2,444.0
10	0.321	120	38.5	6,770	2,173.2
11	0.287	120	34.4	6,770	1,943.0
12	0.257	120	30.8	6,770	1,740.0
13	0.229	120	27.5	6,770	1,550.3
14	0.205	120	24.6	6,770	1,387.9
15	0.183	120	22.0	6,770	1,238.9
16	0.163	385	62.8	6,770	1,103.5
17	0.146	120	17.5	6,770	988.4
18	0.130	120	15.6	6,770	880.1
19	0.116	120	13.9	6,770	785.3
20	0.104	120	12.5	6,770	704.1
21	0.093	120	11.2	6,770	629.6
22	0.083	120	10.0	6,770	561.9
23	0.074	120	8.9	6,770	501.0
24	0.066	120	7.9	6,770	446.8
25	0.059	120	7.1	6,770	399.4
26	0.053	385	20.4	6,770	358.8
27	0.047	120	5.6	6,770	318.2
28	0.042	120	5.0	6,770	284.3
29	0.037	120	4.4	6,770	250.5
30	0.033	120	4.0	6,770	233.4
31	0.030	2,120	63.6	6,770	203.1

(To be continued)

(Continuation)

Year in Order	Discount Factor 12%	Cost Total	Present Worth	Benefit	Present Worth
32	0.027	120	3.2	6,770	182.8
33	0.024	120	2.9	6,770	162.5
34	0.021	120	2.5	6,770	142.2
35	0.019	120	2.3	6,770	128.6
36	0.017	385	6.5	6,770	115.1
37	0.015	120	1.8	6,770	101.6
38	0.013	120	1.6	6,770	88.0
39	0.012	120	1.4	6,770	81.2
40	0.011	120	1.3	6,770	74.5
41	0.0096	120	1.2	6,770	65.0
42	0.0086	120	1.0	6,770	58.2
43	0.0076	120	0.9	6,770	51.5
44	0.0068	120	0.8	6,770	46.0
45	0.0061	120	0.7	6,770	41.3
46	0.0054	385	2.1	6,770	36.6
47	0.0049	120	0.6	6,770	33.2
48	0.0043	120	0.5	6,770	29.1
49	0.0039	120	0.5	6,770	26.4
50	0.0035	120	0.4	6,770	23.7
Total			21,330		34,504

Table AP1-7 Incremental Diversion Water Requirement of Dry Season Crops/2

(Unit: m^3/s)

YR	Crop/1	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1957	2	5.53	2.85	0.98	-	-	-	-	-	-	4.77	5.09	5.75	24.97
	3	-	2.34	2.62	1.67	-	-	-	-	-	-	-	-	6.63
	5	0.13	0.23	0.17	0.13	0.06	-	-	-	-	-	-	0.70	1.42
	6	0.18	0.66	0.71	0.64	0.32	-	-	-	-	-	-	1.57	4.08
	7	0.01	0.03	0.03	0.02	0.02	-	-	-	-	-	-	0.07	0.18
Total		5.85	6.11	4.51	2.46	0.40	-	-	-	-	4.77	5.09	8.09	37.28
1958	2	5.53	2.63	0.57	-	-	-	-	-	-	4.92	4.25	6.00	23.90
	3	-	1.95	4.10	2.50	-	-	-	-	-	-	-	-	8.55
	5	0.14	0.21	0.26	0.19	0.02	-	-	-	-	-	-	0.71	1.53
	6	0.23	0.56	1.12	0.87	0.13	-	-	-	-	-	-	1.61	4.52
	7	0.01	0.02	0.04	0.03	-	-	-	-	-	-	-	0.07	0.17
Total		5.91	5.37	6.09	3.59	0.15	-	-	-	-	4.92	4.25	8.39	38.67
1959	2	5.53	2.55	0.32	-	-	-	-	-	-	5.77	3.33	3.29	20.79
	3	-	1.99	2.27	3.02	-	-	-	-	-	-	-	-	7.28
	5	0.14	0.21	0.14	0.22	-	-	-	-	-	-	-	0.68	1.39
	6	0.25	0.57	0.61	1.01	-	-	-	-	-	-	-	1.48	3.92
	7	0.01	0.02	0.02	0.04	-	-	-	-	-	-	-	0.07	0.16
Total		5.93	5.34	3.36	4.29	-	-	-	-	-	5.77	3.33	5.52	33.54
1960	2	5.53	1.84	0.98							4.54	6.25	5.79	24.93
	3	-	-	4.44	0.57	-	-	-	-	-	-	-	-	5.01
	5	0.15	-	0.29	0.06	-	-	-	-	-	-	-	0.71	1.21
	6	0.28	-	1.21	0.34	-	-	-	-	-	-	-	1.64	3.47
	7	0.01	-	0.04	0.01	0.01	-	-	-	-	-	-	0.07	0.14
Total		5.97	1.84	6.96	0.98	0.01	-	-	-	-	4.54	6.25	8.21	34.76
1961	2	5.53	2.84	0.66							3.60	3.61	1.14	17.38
	3	-	2.34	1.17	1.68	-	-	-	-	-	-	-	-	5.19
	5	0.16	0.23	0.07	0.13	0.08	-	-	-	-	-	-	0.47	1.14
	6	0.33	0.66	0.30	0.64	-	-	-	-	-	-	-	0.61	2.54
	7	0.01	0.03	0.01	0.02	0.01	-	-	-	-	-	-	0.04	0.12
Total		6.03	6.10	2.21	2.47	0.09	-	-	-	-	3.60	3.61	2.26	26.37
1962	2	5.53	2.85	0.32	-	-	-	-	-	-	5.83	4.81	5.50	24.84
	3	-	2.34	2.59	1.51	0.16	-	-	-	-	-	-	-	6.60
	5	0.14	0.23	0.16	0.12	0.14	-	-	-	-	-	-	0.73	1.52
	6	0.27	0.66	0.70	0.60	0.45	-	-	-	-	-	-	1.70	4.38
	7	0.01	0.03	0.03	0.02	0.01	-	-	-	-	-	-	0.07	0.17
Total		5.95	6.11	3.80	2.25	0.76	-	-	-	-	5.83	4.81	8.00	37.51

(To be continued)

Notes: /1 Crop; 2: Dry Paddy, 3: Mung Bean, 5: Vegetable, 6: Peanut, 7: Dry Corn

/2 Calculated as difference between D.W.R of with and without project.

(Continuation)

		Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1963	2	5.53	2.24	0.98	-	-	-	-	-	-	4.94	5.66	2.40	21.75
	3	-	1.93	2.87	4.58	0.06	-	-	-	-	-	-	-	9.44
	5	0.14	0.20	0.18	0.32	0.13	-	-	-	-	-	-	0.53	1.50
	6	0.25	0.55	0.78	1.45	0.11	-	-	-	-	-	-	0.89	4.03
	7	0.01	0.02	0.03	0.05	-	-	-	-	-	-	-	0.05	0.16
Total		5.93	4.94	4.84	6.40	0.30	-	-	-	-	4.94	5.66	3.87	36.88
1964	2	5.53	2.77	0.66	-	-	-	-	-	-	5.81	0.42	0.72	15.91
	3	-	2.29	4.22	3.66	-	-	-	-	-	-	-	-	10.17
	5	0.16	0.23	0.27	0.26	-	-	-	-	-	-	-	0.46	1.38
	6	0.32	0.65	1.15	1.19	-	-	-	-	-	-	-	0.56	3.87
	7	0.01	0.03	0.04	0.04	-	-	-	-	-	-	-	0.04	0.16
Total		6.02	5.97	6.34	5.15	0.00	-	-	-	-	5.81	0.42	1.78	31.49
1965	2	5.53	2.56	0.32	-	-	-	-	-	-	5.83	2.56	5.03	21.83
	3	-	2.09	3.48	1.80	-	-	-	-	-	-	-	-	7.37
	5	0.13	0.22	0.22	0.14	0.08	-	-	-	-	-	-	0.65	1.44
	6	0.18	0.59	0.95	0.68	-	-	-	-	-	-	-	1.39	3.79
	7	0.01	0.02	0.04	0.02	-	-	-	-	-	-	-	0.07	0.16
Total		5.85	5.48	5.01	2.64	0.08	-	-	-	-	5.83	2.56	7.14	34.59
1966	2	5.53	2.85	0.98	-	-	-	-	-	1.68	3.00	1.39	4.44	19.87
	3	-	2.34	3.13	1.85	-	-	-	-	-	-	-	-	7.32
	5	0.14	0.23	0.20	0.14	-	-	-	-	-	-	-	0.68	1.39
	6	0.24	0.66	0.85	0.69	-	-	-	-	-	-	-	1.50	3.94
	7	0.01	0.03	0.03	0.02	-	-	-	-	-	-	-	0.07	0.16
Total		5.92	6.11	5.19	2.70	0.00	-	-	-	1.68	3.00	1.39	6.69	32.68
1967	2	5.39	2.23	0.85	-	-	-	-	-	-	5.83	-	-	14.30
	3	-	1.95	4.14	1.48	-	-	-	-	-	-	-	-	7.57
	5	0.11	0.21	0.26	0.12	-	-	-	-	-	-	-	0.41	1.11
	6	0.12	0.56	1.13	0.59	-	-	-	-	-	-	-	0.39	2.79
	7	0.01	0.02	0.04	0.02	-	-	-	-	-	-	-	0.03	0.12
Total		5.63	4.97	6.42	2.21	-	-	-	-	-	5.83	-	0.83	25.89
1968	2	5.53	2.85	0.98	-	-	-	-	-	-	4.70	5.58	5.82	25.46
	3	-	2.34	4.54	0.10	-	-	-	-	-	-	-	-	6.98
	5	0.11	0.23	0.29	0.02	0.09	0.05	-	-	-	-	-	0.70	1.49
	6	0.14	0.66	1.24	0.21	-	-	-	-	-	-	-	1.57	3.82
	7	0.01	0.03	0.04	0.01	-	-	-	-	-	-	-	0.07	0.16
Total		5.79	6.11	7.09	0.34	0.09	0.05	-	-	-	4.70	5.58	8.16	37.91
1969	2	5.53	2.81	0.98	-	-	-	-	-	0.27	2.89	4.67	4.77	21.92
	3	-	2.31	3.90	3.47	-	-	-	-	-	-	-	-	9.68
	5	0.16	0.23	0.25	0.25	0.13	0.11	-	-	-	-	-	0.64	1.77
	6	0.34	0.66	1.06	1.14	-	-	-	-	-	-	-	1.33	4.53
	7	0.01	0.03	0.04	0.04	-	-	-	-	-	-	-	0.06	0.18
Total		6.04	6.04	6.23	4.90	0.13	0.11	-	-	0.27	2.89	4.67	6.80	38.08

(To be continued)

(Continuation)

		Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1970	2	5.53	2.65	0.32	-	-	-	-	-	0.76	2.18	1.06	-	12.50
	3	-	1.98	2.63	2.36	-	-	-	-	-	-	-	-	6.97
	5	0.11	0.21	0.17	0.18	0.07	-	-	-	-	-	-	0.55	1.29
	6	0.14	0.56	0.71	0.83	0.19	-	-	-	-	-	-	0.94	3.37
	7	0.01	0.02	0.03	0.03	0.01	-	-	-	-	-	-	0.05	0.15
Total		5.79	5.42	3.86	3.40	0.27	-	-	-	0.76	2.18	1.06	1.54	24.28
1971	2	5.53	2.55	0.98	-	-	-	-	-	-	5.83	2.32	2.20	19.41
	3	-	1.11	3.41	4.30	-	-	-	-	-	-	-	-	8.82
	5	0.10	0.15	0.22	0.31	-	0.05	-	-	-	-	-	0.53	1.36
	6	0.07	0.32	0.93	1.37	-	-	-	-	-	-	-	0.86	3.55
	7	-	0.02	0.03	0.05	-	-	-	-	-	-	-	0.05	0.15
Total		5.70	4.15	5.57	6.03	-	0.05	-	-	-	5.83	2.32	3.64	33.29
1972	2	5.53	2.75	0.98	-	-	-	-	-	-	5.83	3.08	6.11	24.28
	3	-	2.27	3.87	0.26	0.39	-	-	-	-	-	-	-	6.79
	5	0.07	0.23	0.25	0.04	0.16	0.10	-	-	-	-	-	0.71	1.56
	6	-	0.64	1.06	0.25	0.29	-	-	-	-	-	-	1.64	3.88
	7	-	0.03	0.04	0.01	0.01	-	-	-	-	-	-	0.07	0.16
Total		5.60	5.92	6.20	0.56	0.85	0.10	-	-	-	5.83	3.08	8.53	36.67
1973	2	5.53	2.85	0.98	-	-	-	-	-	1.39	3.46	3.48	6.39	24.08
	3	-	2.34	4.54	3.95	1.10	-	-	-	-	-	-	-	11.93
	5	0.16	0.23	0.29	0.28	0.20	0.08	-	-	-	-	-	0.73	1.97
	6	0.34	0.66	1.24	1.27	0.38	-	-	-	-	-	-	1.70	5.59
	7	0.01	0.03	0.04	0.04	0.01	-	-	-	-	-	-	0.07	0.20
Total		6.04	6.11	7.09	5.54	1.69	0.08	-	-	1.39	3.46	3.48	8.89	43.77
1974	2	5.53	2.73	0.98	-	-	-	-	-	1.51	2.52	2.07	3.34	18.68
	3	-	2.27	4.40	3.27	-	-	-	-	-	-	-	-	9.94
	5	0.15	0.23	0.28	0.24	0.11	0.02	-	-	-	-	-	0.62	1.65
	6	0.29	0.64	1.20	1.09	0.16	-	-	-	-	-	-	1.22	4.60
	7	0.01	0.03	0.04	0.04	-	-	-	-	-	-	-	0.06	0.18
Total		5.98	5.90	6.90	4.64	0.27	0.02	-	-	1.51	2.52	2.07	5.24	35.05
1975	2	5.53	2.76	0.98	-	-	-	-	-	0.88	3.85	3.21	1.85	19.06
	3	-	2.28	4.18	2.09	-	-	-	-	-	-	-	-	8.55
	5	0.16	0.23	0.27	0.16	0.08	0.08	-	-	-	-	-	0.52	1.50
	6	0.34	0.65	1.14	0.76	0.09	-	-	-	-	-	-	0.81	3.79
	7	0.01	0.03	0.04	0.03	-	-	-	-	-	-	-	0.05	0.16
Total		6.04	5.95	6.61	3.04	0.17	0.08	-	-	0.88	3.85	3.21	3.23	33.06
1976	2	5.53	2.85	0.98	-	-	-	-	-	-	3.74	4.85	5.50	23.45
	3	-	2.34	2.82	4.33	-	-	-	-	-	-	-	-	9.49
	5	0.04	0.23	0.18	0.31	-	-	-	-	-	-	-	0.73	1.49
	6	-	0.66	0.76	1.38	-	-	-	-	-	-	-	1.70	4.50
	7	-	0.03	0.03	0.05	0.02	-	-	-	-	-	-	0.07	0.20
Total		5.57	6.11	4.77	6.07	0.02	-	-	-	-	3.74	4.85	8.00	39.13
Average														$m^3/s.$ month 34.55

$Q = 34.55 \times 30 \times 24 \times 3,600 = 89.55 \times 10^6 m^3$

APPENDIX 2 ENERGY VALUE

Energy value to be applied in this study of damsites screening is estimated based on the alternative coal-fired thermal power plant cost (Isabela Power Plant 100,000 kW).

Followings are the operating characteristics of the alternative coal-fired thermal power plant,

Item	Value/1
Initial investment	1,200 US$/kW
Economic life	30 years
Heating value of fuel	12,000 BTU/Lb
Heat efficiency	37%
Fuel cost	45 US$/ton
Fixed O&M	10 US$/kW/year
Capacity factor	70%

/1: Source; NAPOCOR

Based on the above conditions, fuel cost per kWh is calculated as follows,

$$\text{Fuel cost/kWh} = 0.045\ \$/\text{kg} \times 0.454\ \text{kg/Lb} \times \frac{3{,}413\ \text{BUT/kWh}}{12{,}000\ \text{BUT/Lb} \times 0.37}$$

$$= 0.016\ \text{US\$/kWh}$$

Adjustment factors to be applied to the above costs are assessed to take into account different performances between hydropower and coal-fired thermal plant. These adjustment factors for kW value and kWh value are estimated by the following difference of the loss rates.

kW adjustment factor

	Loss Rate (%)			
	Transmission	Forced outage	Maintenance	Station use
Coal-fired	2.0	10.0	14.0	9.0
Hydropower	3.0	2.0	-	0.3

Therefore, the adjustment factor for kWh value is calculated as follows,

$$\text{Adjustment factor for kWh} = \frac{(1-0.03)(1-0.003)}{(1-0.02)(1-0.09)}$$
$$= 1.084$$

In addition to these assumptions and conditions, construction period of coal-fired thermal plant and discount rate are assumed as follows,

Construction period		3 years
Annual investment rate	1st year	30%
	2nd year	40%
	3rd year	30%
Discount rate		12%

Based on these assumptions, costs and annual energy output are assessed for estimating energy value as follows,

Investment cost

1st and 3rd year ------ 1,200 $ x 30% x 1.373 = 494 $

2nd year ---------- 1,200 $ x 40% x 1.373 = 659 $

Fixed O&M cost and fuel cost

Fixed O&M cost -------- 10 $/yr x 1.373 = 13.73$/yr

Fuel cost ---------- 0.016 $/kWh x 6,132 kWh/yr x 1,084

= 106.35 $/yr

Total = 120 $/yr

Annual energy output ------- 1 kW x 24 hrs x 365 days x 0.7

= 6,132 kWh/yr

By applying the above costs and annual energy, energy value is assessed to be 0.06 $/kWh under the discount rate of 12%. Cost and energy stream are shown in Table AP2-1.

Table AP2-1 Cost and Energy Stream

Year	Cost (US$)		Energy output (kWh)
	Investment	O&M, Fuel	
1	494		0
2	659	0	0
3	494	0	0
4	0	120	6,132
5	0	120	6,132
6	0	120	6,132
7	0	120	6,132
8	0	120	6,132
9	0	120	6,132
10	0	120	6,132
11	0	120	6,132
12	0	120	6,132
13	0	120	6,132
14	0	120	6,132
15	0	120	6,132
16	0	120	6,132
17	0	120	6,132
18	0	120	6,132
19	0	120	6,132
20	0	120	6,132
21	0	120	6,132
22	0	120	6,132
23	0	120	6,132
24	0	120	6,132
25	0	120	6,132
26	0	120	6,132
27	0	120	6,132
28	0	120	6,132
29	0	120	6,132
30	0	120	6,132

Discount rate	Cost	Energy	Energy value
12%	1,996 US$	34,666 kWh	0.06 $/kWh

Attachment A. List of Collected Data

Ref. No.	Title	Author	Date of issue
DA-101	Topographical Maps, Chico River No. IV Hydroelectric Power Development Project, Scale 1:5,000, 8 sheets	NAPOCOR	
DA-102	Topographical Maps, Diduyon River Hydroelectric Project, Scale 1:10,000, 6 sheets	NAPOCOR	
DA-103	Topographical Maps, Matuno River Irrigation Project, Scale 1:4,000, 18 sheets	NIA	
DA-104	Topographical Maps, Conwap Damsite of Casecnan Transbasin Diversion Project, Scale 1:4,000, 1 sheet	NIA	
DA-105	Reference Materials and Labor Costs	NAPOCOR	Oct.1985

Attachment B. List of Collected Project Reports

Ref. No.	Title	Author	Date of issue
DA-201	Feasibility Study Chico IV Hydropower Project in the Chico River, Luzon	LAHMAYER	May 1981
DA-202	Feasibility Study on Diduyon Hydroelectric Development Project	JICA	Dec.1980
DA-203	Casecnan Transbasin Diversion Project Feasibility Study	ELC	Jan.1983
DA-204	Feasibility Study on the Matuno River Development Project	JICA	Feb.1984
DA-205	Magat River Project Feasibility Report	USBR & USAID	Jun.1973
DA-206	Binongan Hydroelectric Project Feasibility Study	SHAWINIGAN	Apr.1985
DA-207	Technical Pre-Feasibility Study of the Hydroelectric Development in the Chico River	LAHMEYER	Jun.1973
DA-208	Magat River Multipurpose Project, Stage II, Project Design Report	ECI	Sep.1976
DA-209	Cagayan River Flood Control Basin-Wide Study	PHILTECH	Jul.1981

Attachment C. List of Collected Publications

Ref. No.	Title	Author	Date of issue
DA-301	Equipment Guidebook	ACEL	Sep.1982
DA-302	Geotechnical Problems and Practice of Dam Engineering (Dam Engineering in Philippines)	Eduado P. Abesamis	1982
DA-303	Magat Dam (Pamphlet)	NIA	
DA-304	Magat Resettlement Program (Pamphlet)	NIA	
DA-305	Inauguration of Magat Dam (Pamphlet)	NIA	

ANNEX WB

WATER DEMAND AND SUPPLY BALANCE

ANNEX WB

Table of Contents

List of Tables

List of Figures

I CONDITION AND PROCEDURE

1.1 Condition of Balance Study

1.1.1 Balance Point and Basin Model

The water demand and supply balance study is performed at the selected balance points in the Cagayan river basin. The 48 of balance points are determined considering the following sites:

a) Intake sites of the national irrigation system ---------- 24 sites
b) Intake sites of municipal water ---------- 16 sites
c) Sites of 20 dam candidates and the existing Magat dam ------ 21 sites
d) Estuary and confluences of the main stream and tributaries ---------- 9 sites

Some of the above sites are the same balance points.

The Cagayan river basin, of which the drainage area is 27,281 km^2, is divided into 48 subbasins at the above mentioned balance points for the purpose of the balance study. The divided subbasins are shown in Fig. 1.1, and those drainage areas are listed in Table 1.1.

Fig. 1.2 gives the basin model for the water balance study. All the study elements are included in this basin model, which are above mentioned 48 balance points and 48 divided subbasins, 48 intakes of the communal irrigation systems, and the return flow of irrigation diversion water and the transbasin diversion arrows.

1.1.2 Runoff from Subbasin

The naturalized river runoff from each of the divided 48 subbasins is applied to the water balance study. This runoff is estimated by multiplying the basin area and the annual rainfall ratios to the generated runoff studied in the streamflow analysis of the hydrological study. Table

1.1 shows the subbasins for water balance study and the corresponding subbasins for the streamflow analysis, and the area and the rainfall ratios.

The estimated runoff from the subbasin is 10-day mean naturalized one for 22 years from 1963 to 1984. The monthly mean runoff is summarized in Table 1.2.

The Casecnan Transbasin Diversion Project is scheduled to complete its construction in 1995 and the water in the Casecnan basin (1,150 km^2) is transferred out of the Cagayan basin from 1995. However, the Casecnan reservoir should release downstream the dam some water as the river maintenance flow. The maintenance flow is assumed to be 5.3 m^3/s, which is discussed in 1.1.4 in detail.

1.1.3 Water Demand

The water demand in the Cagayan river basin comprises the irrigation water demand and the municipal water demand. The irrigation water demand is composed of demand for the national irrigation system and that for the communal irrigation system. The municipal water demand includes the domestic, service/public and industrial water demands. These demands are projected in each sectoral study.

Table 1.3 summarizes the monthly mean diversion water requirements of the national irrigation system in the years of 1985, 1990, 1995, 2000 and 2005. The projected municipal water requirement is listed in Table 1.4.

Two types of the cropping patterns, Pattern A and Pattern B, are used in order to estimate the irrigation water demand for national systems.

1.1.4 River Maintenance Flow

In determining the river maintenance flow of a river, the following aspects are to be considered to maintain the function of river such as (a) navigation, (b) fishing, (c) picturesque scenery, (d) salt water

intrusion, (e) clogging of river mouth, (f) riparian structures, (g) groundwater table, (h) flora and fauna, and (i) river water quality.

Among these items, (a), (e) and (g) are deemed not to be significant with regard to the Cagayan river.

In order to maintain the function such as (c), (f), (h) and (i), the maintenance flow is assumed on the basis of the specific discharge of 0.0046 $m^3/s/km^2$, which is figured out as an average of the n-th lowest discharges during n-years at water level gauges over the basin as shown in Table 1.5.

Another critical point in the lower reach of the Cagayan river is the site of the Magapit pumping station which may be affected by the salt water intrusion in low streamflow condition. Then, the following matters are examined and the river maintenance flow is determined to be 140 m^3/s at this pumping station:

a) The above mentioned specific discharge of 0.0046 $m^3/s/km^2$ induces the discharge of 124 m^3/s at the pumping station with the drainage area of 27,003 km^2. On the other hand, the 1/5 probable annual minimum runoff is 140 m^3/s at the pumping station according to the water balance study under the condition of the present (1985) demand level. The bigger runoff of 140 m^3/s is, then, taken for the following salt water intrusion study.

b) In case of the discharge of 140 m^3/s, the salt water reaches up to EL-3.5 m at the pumping station, which is 1.0 m lower than the intake sill of the Magapit pumping station (Ref. IR-213, -214). Then, the river maintenance flow is determined to be 140 m^3/s at the pumping station.

The river maintenance flow at the Magat damsite and the Siffu diversion damsite is zero, since both structures are designed to operate without releasing the maintenance flow.

The applied river maintenance flow is summarized for each of the balance points in Table 1.6.

1.1.5 Return Flow

The return flow from sectors is assumed as follows:

a)	Irrigation scheme	:	30%
b)	Hydropower scheme	:	100%
c)	Municipal water supply scheme	:	40%

The return flow of the communal irrigation system and the municipal water supply is assumed to return just downstream the balance point where the demand water is taken. The return flow of the national irrigation system is returned as indicated in Fig. 1.2.

1.1.6 Magat Dam

The effective storage volume of the Magat reservoir is 820 million cubic meters according to the study report for THE MASTER PLAN STUDY ON THE IMPROVEMENT PROJECT OF THE O & M OF MAGAT RIVER INTEGRATED IRRIGATION SYSTEM. The evaporation from the reservoir surface and the seepage loss are assumed to amount 30 million cubic meters a year.

1.2 Procedure of Balance Study

The water demand and supply balance study is performed in order (a) to project the water deficit under the present basin runoff and the future water demand conditions and (b) to examine the required storage volumes of the deficit supply dams.

The water deficit estimated is the balance of the lesser present river runoff and bigger future water demand as a sum of the irrigation water, municipal water and the river maintenance flow. The present river runoff includes the water released from the existing Magat reservoir, of which the effective storage volume is 820 million cubic meters. The future water

demand is provided by summing the irrigation water, municipal water and the river maintenance flow for each of the years of 1985, 1990, 1995, 2000 and 2005. The water deficit estimation for the demand years of 1985, 1990, 1995, 2000 and 2005 suggests the occurrence time and the amount of the deficit.

In order to supply the water against the water deficit estimated above, some water supply dams are to be planned and the required storage volumes are examined.

After determining the proposed deficit supply dams in the dam planning sector, the water deficit estimation is carried out again with the proposed dams to confirm the water supply at the interested balance points.

II PROJECTED WATER DEFICIT

2.1 Deficit without Proposed Dams

2.1.1 Deficit Calculation

The water deficit in the present basin runoff condition is estimated without proposed dams but with the Magat dam. The naturalized 10-day mean runoff for 22 years from 1963 to 1984 and 5 water demand conditions in 1985, 1990, 1995, 2000 and 2005 are applied to this estimation. The result of the estimation is given in Table 2.1, and the 1/5 probable annual water deficit is summarized in Table 2.2.

2.1.2 Deficit Evaluation

Here, the water deficit estimated in 2.1.1 is evaluated from the standpoint of necessity of the deficit supply dam development. According to Table 2.2, the deficits appear at the following 21 points among the 48 balance points:

Balance Point	River	Relating irrigation scheme
6	Dabubu river	Dabubu river IP
7	Upper Cagayan river	
8	Madalan, Sinalugan river	Gappal IP
9	Upper Cagayan river	
11	Magat river	Matuno IP (Bayombong)
13	Magat river	Magat RIS
21	Chico river	
22	Chico river	
23	Chico river	Chico RIS
26	Chico river	Chico RIS (Chico West)
27	Chico river	
30	Mallig river	Chico Mallig IP
31	Mallig river	Mallig RIS

32	Siffu-Mallig river	
33	Tumauini river	Tumauini IS
34	Pinacanauan river	San Pablo-Cabagan IS
42	Paranan river	Baggao IS (Paranan)
44	Zinundungan river	Zinundungan RIS and Extension IP
46	Dummon river	Dummon RIS
47	Cagayan river	CIADP (Lower Cagayan)
48	Cagayan river	

The followings are the evaluations of the deficits at each of the balance points. The deficit evaluated is mainly that for the projected demand in the year of 2005.

The balance point 6 is the intake site of the Dabubu irrigation scheme. The water demand is composed of irrigation water requirement and the river maintenance flow of 0.6 m^3/s. The 1/5 probable annual deficit amounts to 2 million cubic meters for 2005 demand condition as shown in Table 2.2. The maximum 10-day deficit is 0.54 m^3/s, which continues for 30 days in June as seen in Table 2.3. On the other hand, the irrigation requirement is 1.21 m^3/s at the same time. Then, the above deficit of 0.54 m^3/s is considered to be big and should be supplied by a certain supply dam.

The balance point 7 is located on the main river course of the upper Cagayan river. The water demand is composed of the municipal water of 1.08 m^3/s and the river maintenance flow of 25.7 m^3/s. The 1/5 probable annual deficit is estimated to be 6 million cubic meters in Table 2.2. According to Table 2.3, this deficit continues for 30 days, however the deficit for 20 days is less than 6% of the demand water and considered to be negligible. And the deficit of 4.17 m^3/s for the remaining 10 days, which is 16% of the demand, is judged to be bearable because of its duration of 10 days. Then, the deficit supply dam is not discussed for this balance point.

The balance point 8 is an assembly of intakes for the Gappal irrigation scheme. The demand includes the irrigation water demand and the river maintenance flow of 0.6 m^3/s. The 1/5 probable annual water deficit is estimated to be 75 million cubic meters as shown in Table 2.2, which is rather big amount. Moreover, this deficit continues for about 8 months in Table 2.3. Then, the deficit supply dam is recommended for this Gappal irrigation scheme.

The balance point 9 is situated on the Cagayan river just upstream the junction of the main river and the Magat river. The water demands are municipal water of 1.17 m^3/s and the river maintenance flow of 30.5 m^3/s. The 1/5 probable annual deficit is 11 million cubic meters in Table 2.2. This deficit continues for 40 days, however, almost all the 10-day deficit is less than 10% of the demand, and considered to be small. And, the maximum deficit of 6.32 m^3/s continues for only 10 days. Therefore, the deficit at this point is judged not to be supplied.

The balance point 11 is the intake site of the Matuno irrigation scheme (Bayombong). The water demands are the above irrigation water requirement, the municipal water of 0.29 m^3/s and the river maintenance flow of 7.8 m^3/s. The 1/5 probable annual deficit is estimated to be 87 million cubic meters as shown in Table 2.2. And, the deficit continues more than 2 months. Then, the deficit water supply scheme is to be examined.

The balance point 13 is the site of the existing Magat dam. The water demand is composed of the irrigation water requirement for Magat RIS and deficit supply for Siffu RIS and the municipal water of 1.26 m^3/s. The 1/5 probable annual deficit amounts to 146 million cubic meters as shown in Table 2.2, though the Magat reservoir functions with the effective storage volume of 820 million cubic meters. Then, besides tbe existing Magat dam, the additional water supply dams are expected in order to supplement the supply capacity of the Magat dam.

The balance point 21 is the site of the screened Chico No. 2 dam on the Chico river. The water requirements are the municipal water of 0.15 m^3/s and the maintenance flow of 3.3 m^3/s. The 1/5 probable annual deficit is estimated to be 2 million cubic meters as shown in Table 2.2. This deficit continues for 40 days in Table 2.3 and the maximum one is 1.43 m^3/s which is considered to be big comparing with the demand. However, the dam is conditioned not to be planned on the Chico river due to social circumstances. Then, the above deficit is not supplied.

The balance point 22 is the site of the screened Chico No. 4 dam. The water demand is the river maintenance flow of 6.5 m^3/s. The 1/5 probable annual deficit is 3 million cubic meters as shown in Table 2.2. This deficit continues for 40 days and the maximum deficit is big one of 2.05 m^3/s as seen in Table 2.3. Nevertheless, the deficit supply dam is decided not to be considered for this point from the same reason as that at Point 21.

The balance point 23 is the intake site of the Chico RIS. The water demand includes the irrigation water requirement and the river maintenance flow of 9.0 m^3/s. The 1/5 probable annual deficit is estimated to be 139 million cubic meters and the deficit continues more than 4 months, as shown in Table 2.2 and 2.3. Then, the deficit supply scheme is to be planned for the Chico RIS without relying on the dam on the Chico river.

The balance point 26 is the intake site of the Chico West irrigation scheme. The water demand includes the irrigation water requirement, the municipal water of 0.64 m^3/s, and the river maintenance flow of 15.0 m^3/s. The 1/5 probable annual deficit is 20 million cubic meters as shown in Table 2.2. But, the deficit appears at intervals as seen in Table 2.3, which will be diminished by the return flow of the irrigation water for the Chico RIS supplied from a dam being planned on the Mallig river. Then, a water supply scheme is not examined for the deficit at this balance point.

The balance point 27 is located on the Chico river just upstream the junction with the main river. The water demands are the municipal water of 0.24 m^3/s and the river maintenance flow of 20.9 m^3/s. The 1/5 probable

annual water deficit amounts to 6 million cubic meters as seen in Table 2.2. This deficit continues for 30 days and the maximum 10-day deficit is 3.85 m^3/s. However, the above deficit will be diminished by the same return flow as that at Point 26. Then the deficit supply is not studied for this point.

The balance point 30 is the intake site of the Chico Mallig irrigation scheme. This point is also the screened Mallig No. 2 damsite. The water demands are the above irrigation demand and the river maintenance flow of 1.7 m^3/s. The 1/5 probable annual deficit is so big to be 650 million cubic meters as shown in Table 2.2. Then, the water supply dam is necessary to be studied for the full development of the Chico Mallig irrigation scheme.

The balance point 31 is the intake site of the Mallig RIS. The water demands at this point are the irrigation water requirement and the maintenance flow of 2.1 m^3/s. The 1/5 probable annual deficit is computed to be 55 million cubic meters as shown in Table 2.2. In order to supply water for this water deficit, a certain dam scheme is to be examined.

The balance point 32 is situated on the Siffu Mallig river just upstream the junction with the main river. The water demand here is composed of the municipal water of 0.71 m^3/s and the river maintenance flow of 9.3 m^3/s. The 1/5 probable annual deficit is estimated to be 8 million cubic meters in Table 2.2. This deficit will be, however, reduced by the additional return flow of the irrigation water supplied from a dam which is studied on the Mallig river. Then, the additional water supply dam is not taken for the deficit supply at this point.

The balance point 33 is the intake site of the Tumauini irrigation scheme. The water demand includes the irrigation water and the river maintenance flow of 0.8 m^3/s. The 1/5 probable annual deficit is 5 million cubic meters as seen in Table 2.2. This deficit is considered to be big, then a water supply scheme is examined for this Tumauini irrigation scheme.

The balance point 34 is the intake site of the San Pablo-Cabagan irrigation scheme. The water requirement at this point includes the irrigation water demand and the maintenance flow of 0.6 m^3/s. The 1/5 probable annual deficit is estimated to be 10 million cubic meters as seen in Table 2.2. This rather big deficit requires a water supply dam.

The balance point 42 is the intake site of the Baggao irrigation scheme (Paranan). The water demands are the irrigation water and the river maintenance flow of 0.3 m^3/s. The 1/5 probable annual deficit is 14 million cubic meters in Table 2.2. This deficit continues 3 months with the maximum deficit of 1.66 m^3/s as seen in Table 2.3. Therefore, a supply dam is to be planned.

The balance point 44 is the intake site of the Zinundungan irrigation scheme. The water requirement at this point is composed of the above irrigation water and the river maintenance flow of 0.7 m^3/s. The 1/5 probable annual deficit is estimated to be 38 million cubic meters as given in Table 2.2. This deficit continues for 3 months with the maximum value of 4.54 m^3/s. Then, the deficit supply dam is examined.

The balance point 46 is the intake site of the Dummon irrigation scheme. The water demands here are the above irrigation water and the river maintenance flow of 0.9 m^3/s. The 1/5 probable annual deficit is 25 million cubic meters as shown in Table 2.2, and this deficit continues for about 4 months. Then, this deficit is considered to be supplied by a certain dam.

The balance point 47 is the intake site of the CIADP (Lower Cagayan). The water requirement includes the irrigation water demand, the municipal water of 0.6 m^3/s, and the river maintenance flow of 140 m^3/s. According to Table 2.2, the 1/5 probable annual water deficit is 37 million cubic meters. This deficit will be, however, reduced to be zero by water releases from the proposed dams for the irrigation schemes. Then, the water supply scheme is not discussed for this point.

The balance point 48 is the estuary of the Cagayan river. The river maintenance flow of 140 m^3/s should be retained at this point. But, Table 2.2 suggests the 1/5 probable annual deficit of 34 million cubic meters for the maintenance flow of 140 m^3/s. This deficit will be also reduced like the deficit at point 47. Then, the deficit supply is not examined for this point.

2.1.3 Required Dam Development

According to the results of the deficit calculation and evaluation in the previous sections, the water deficit supply is required at the following 12 balance points:

Balance Point	Irrigation Scheme	Annual Deficit /* (MCM)
6	Dabubu River IP	2
8	Gappal IP	75
11	Matuno IP (Bayombong)	87
13	Magat RIS	146
23	Chico RIS	139
30	Chico Mallig IP	650
31	Mallig RIS	55
33	Tumauini IS	5
34	San Pablo-Cabagan IS	10
42	Baggao IS (Paranan)	14
44	Zinundungan RIS and Extension IP	38
46	Dummon RIS	25

Note, /*: 1/5 probable annual deficit for demand in 2005

On the other hand, the possible candidates of damsites in the Cagayan basin are discussed in the dam planning sector, which are,

Dam	Drainage Area (km2)	Annual Average Natural Runoff (m^3/s)
Casecnan	1,150	61.3
Cagayan No. 1	2,364	129.6
Cagayan No. 2	1,631	89.3
Diduyon	477	21.2
Addalam (A)	864	37.8
Gappal (Sta. Maria, Calaocan, Colorado)	122	4.3
Ilagan No. 1	1,350	47.9
Disabungan	652	36.2
Matuno No. 1	550	36.0
Alimit No. 1 (A)	559	31.4
Siffu No. 1 (A)	656	34.9
Mallig No. 2	362	16.9
Chico No. 2	720	46.4
Chico No. 4	1,410	86.3
Pinukpuk	856	51.3
Pinacanauan	119	10.3
Paranan	64	4.5
Zinundungan	161	9.1
Dummon	112	4.7

Among the above candidates, 6 dams -- Casecnan dam, Cagayan No. 1 dam, Diduyon dam, Chico No. 2 dam, Chico No. 4 dam and Pinukpuk dam -- are not accepted as the water supply dams from the following reasons:

a) The Casecnan Transbasin Diversion Project is envisioned as a multipurpose project with irrigation in the Central Luzon basin and power generation. The detailed design works of this project are now ongoing. Then, it is very difficult to add the purpose of water supply to the Cagayan basin in this project stage.

b) The Cagayan No. 1 damsite is located in the limestone area. According to detailed geological investigations, long term water storage may not be bearable at this site. Then, the Cagayan No. 1 dam does not have a

function of water supply.

c) The Diduyon Project is of the hydropower purpose and the feasibility study is completed. Through the potential damsite screening studies for the Cagayan basin, this dam is manifested to be highly effective as the hydropower purpose dam owing to large head and not effective for other purposes such as water supply and flood control.

d) The remaining 3 dams -- Chico No. 2 dam, Chico No. 4 dam and Pinukpuk dam -- are situated in the Chico river basin. Water resources development plan is deliberated not to be introduced in this Chico river basin due to its social circumstances.

The 9 small dams selected in the dam planning sector are also candidates as water supply dams. They are Liwan Norte, Santor, Maglatac 1, San Francisco, Bagong, Linglingay, Bello, Santo Niño and San Vicente.

Considering the points and amounts of deficits and the available water supply dam candidates, the following combinations of water deficit and supply are selected:

Deficit Supplied Balance Point		Supply Dam
6	(Dabubu River IP)	Santo Niño
8	(Gappal IP)	Gappal (Sta Maria, Calaocan, Colorado)
11	(Matuno IP-Bayombong)	Matuno No.1
13	(Magat RIS)	Matuno No.1, Alimit No.1(A), Siffu No.1(A)
23, 30, 31	(Chico RIS, Chico Mallig IP, Mallig RIS)	Mallig No.2
33	(Tumauini IS)	San Vicente
34	(San Pablo-Cabagan IS)	Pinacanauan
42	(Baggao IS-Paranan)	Paranan
44	(Zinundungan RIS and Extension IP)	Zinundungan
46	(Dummon RIS)	Dummon

The annual deficits at the balance point 6 and 33 are 2 and 5 million cubic meters and then supplied by the small dams. The deficits at the balance point 8, 11, 34, 42, 44, 46 are supplied from the possible and nearest dams. The deficit at the balance point 13 is supplied from one or some of the possible 3 dams mentioned above. The deficit at the balance point 23 is covered by the supply from the Mallig No. 2 dam, since no water resources development is considered in the Chico river basin. Judging from the amount of annual deficit at point 23, 30, 31 and the available river runoff at the Mallig No. 2 damsite, the transbasin diversion tunnel is required from the Chico river to the Mallig river.

2.2 Deficit with Proposed Dams

2.2.1 Deficit Calculation

The water balance calculation is made with the proposed 12 dams and the existing Magat dam for the water demand in 2005. The proposed 12 dams are Santo Niño, Sta. Maria, Calaocan, Colorado, Matuno No. 1, Alimit No. 1 (A), Siffu No. 1 (A), Mallig No. 2, San Vicente, Paranan, Zinundungan, and Dummon dams. The 1/5 probable annual water deficit with the above dams is given in Table 2.4.

2.2.2 Deficit Evaluation

According to Table 2.4, the water deficits still remain at 5 balance points, point 7, 9, 21, 22, and 34. However, all the above deficits are decided not to be supplied as discussed in 2.1.2. Then, the water deficit to be supplied is verified to be supplemented.

III REQUIRED STORAGE OF DEFICIT SUPPLY DAM

3.1 Dams Required

The 13 numbers of deficit supply dams for the projected water demand in 2005 are selected in the previous clause. These dams are 11 large dams -- Santa Maria, Calaocan, Colorado, Matuno No. 1, Alimit No. 1 (A), Siffu No. 1 (A), Mallig No. 2, Pinacanauan, Paranau, Zinundungan, and Dummon dams -- , and 2 small dams -- Santo Niño and San Vicente dams.

Following this selection, the required storage volumes of the selected dams are computed. These selected dams are grouped into 2 -- dams not relating to the Magat dam and dams relating to the Magat dam -- in this computation. The reason of this grouping is that the existing Magat reservoir is required to cede a certain space to flood control and to supplement the deficit for irrigation, and these requirements are subrogated by the combination of 3 dams, Matuno No. 1, Alimit No. 1 (A) and Siffu No. 1 (A) dams.

The Mallig No. 2 dam scheme includes the transbasin tunnel to divert the river runoff in the Chico river to the Mallig river. The required storage capacity of the Mallig No. 2 dam relates to the discharge capacity of this tunnel. In order to determine the tunnel capacity by economical comparison, the relation is examined between the tunnel capacity and the storage volume of the Mallig No. 2 dam. This examination is illustrated in Fig. 3.1. The economical comparison is conducted and described in the dam planning sector. Consequently, the maximum discharge capacity of the diversion tunnel is 30 m^3/s.

3.2 Required Storage of Dams not Relating to Magat Dam

3.2.1 Storage for Alternative Cropping Pattern

The required storage volumes of the following dams are computed for the alternative cropping patterns, pattern-A and pattern-B, and the irrigation area in 2005.

Dam	Required Storage (MCM)	
	Pattern-A	Pattern-B
Santa Maria	18.1	16.2
Calaocan	41.0	28.6
Colorado	58.4	42.1
Matuno No.1/1	61.1	44.3
Mallig No. 2	545.0	487.0
Pinacanauan/2	12.9	-
Paranan	18.1	10.1
Zinundungan	53.1	34.7
Dummon	24.1	14.2
Santo Niño	2.0	1.5
San Vicente	6.9	4.3

Notes; /1: The required storage volumes are estimated to supply municipal water and water to Matuno IP (Bayombong).

/2: Pinacanauan dam is not included in this master plan, and the required storage is estimated for reference.

3.2.2 Storage for Alternative Irrigation Area

The required storage volumes of the following dams are estimated for the alternative irrigation areas and the cropping pattern-A.

Dam	Case 1 Irrigation Area (ha)	(%)	Storage (MCM)	Case 2 Irrigation Area (ha)	(%)	Storage (MCM)	Case 3 Irrigation Area (ha)	(%)	Storage (MCM)
Santa Maria/1	968	(22)	18.1	-	-	-	-	-	-
Calaocan/1	1,232	(28)	41.0	880	(20)	18.5	-	-	-
Colorado/1	2,200	(50)	58.4	2,200	(50)	58.4	2,200	(50)	58.4
Matuno No. 1	11,590	(100)	61.1	8,113	(70)	30.0			
Mallig No. 2	52,111	(100)	545.0	36,478	(70)	307.0	26,056	(50)	192.0
Paranan	1,263	(100)	18.1	884	(70)	9.2	632	(50)	4.2
Zinundungan	3,510	(100)	53.1	2,457	(70)	27.6	1,755	(50)	13.3
Dummon	2,070	(100)	24.1	1,449	(70)	10.7	1,035	(50)	5.6
Santo Niño	1,000	(100)	2.0	700	(70)	0.5	500	(50)	0.1
San Vicente	1,687	(100)	6.9	1,300	(77)	3.8	1,000	(59)	2.1

Note: /1; These 3 dams contribute to supply water for Gappal Irrigation scheme, of which the service area is 4,400 ha. The case study is conducted combining these dams.

3.3 Required Storage of Dams Relating to Magat Dam

The water supply capability of the Magat dam is examined in order to confirm the function of this dam. Through this examination, the Magat reservoir is manifested to be insufficient to supply irrigation water to whole Magat RIS and Siffu RIS and municipal water under the water demand condition in 2005. The required storage of the Magat dam is estimated to be 884 million cubic meters for full supply with 80% dependability and then the shortage volume is 94 million cubic meters (884 MCM-790 MCM).

Meanwhile, the reservoir space of the Magat dam, which is provided for irrigation and municipal water supplies and hydropower generation, is attempted to be ceded to flood control purpose.

In order to supplement the shortage of the storage and to compensate the ceded space of the Magat dam, Matuno No. 1, Alimit No. 1 (A) and Siffu No. 1 (A) dams are taken for candidates. Matuno No. 1 and Alimit No. 1 (A) damsites are located upstream the Magat dam. Siffu No. 1 (A) damsite is

situated just upstream the intake for Siffu RIS.

The hydrologically maximum storage volumes of the Matuno No. 1 and Alimit No. 1 (A) dams are computed. The hydrologically maximum volume is defined as the volume with which the reservoir does not carry over its storable space at 80% dependability. The maximum storage volume of Siffu No. 1 (A) dam is determined under the condition that this dam supplies the irrigation water for the whole Siffu RIS. The above computation results are summarized as follows:

Matuno No. 1 dam	Maximum storage	210 MCM
Alimit No. 1 (A) dam		156 MCM
Siffu No. 1 (A) dam		93 MCM

Next, the storage volumes of the above 3 dams and the corresponding saving storage of Magat dam are estimated in order to relate the storages of the 3 dams and Magat dam. The examined relations are shown below.

Dam	Ratio to Irrigation Demand	Required Storage (MCM)	Saving Storage of Magat dam (MCM)
Matuno No. 1	10% of MARIS	80	19
	14% "	117	56
	20% "	210	149
Alimit No. 1 (A)	10% of MARIS	45	45
	15% "	102	102
	18% "	156	156
Siffu No. 1 (A)	70% of SIFRIS	52	12
	100% "	93	41

Fig. 3.2 illustrates the above results.

Table 1.1 Subbasins for Water Balance Study and Streamflow Analysis

Serial No.	/1 Subbasin	Drainage Area (km²)	/2 Sub-basin	Area Ratio	Rainfall Ratio	/2 Sub-basin	Area Ratio	Rainfall Ratio	/2 Sub-basin	Area Ratio	Rainfall Ratio
1	UC-1	1,150	1								
2	UC-2	481	2								
3	UC-3	733	3								
4	UC-4	477	7								
5	UC-5	387	8								
6	UC-6A	141	4	141/298	3250/2900						
7	UC-6B	843	4	157/298	2585/2900	5			6		
8	UC-7	1,370	9			11					
9	UC-8A	122	10	122/1051	2170/2060						
10	UC-8B	929	12	929/1051	2045/2060						
11	UC-9	247	21								
12	M-1	1,143	13			14			16	231/1228	
13	M-2	550	15								
14	M-3	1,891	16	997/1228		17			19		
15	M-4	559	18								
16	M-5	970	20								
17	I-1	1,350	22			23					
18	I-2	215	24								
19	I-3	652	25								
20	I-4	915	26								
21	S-1	656	28								
22	S-2	7	29	7/408							
23	S-3	362	30								
24	S-4	100	31	100/589							
25	S-5	890	29	401/408		31	489/589				
26	C-1	720	40			41					
27	C-2	690	42			43					
28	C-3	541	44			45	169/612	2540/2200			
29	C-4	856	46								
30	C-5	463	45	443/612	2070/2200	47	20/366	2100/1900			
31	C-6	1,281	47	346/366	1890/1900	48			49		
32	LC-1	209	27								
33	LC-2	170	32	170/225	4025/3530						
34	LC-3	129	34	129/327	4290/3690						
35	LC-4A	445	36	445/657	4200/3880						
36	LC-4B	212	36	212/657	3210/3880						
37	LC-5	1,219	32	55/225	2000/3530	33			34	198/327	3300/3690
			35			37	135/1042				
38	LC-6	193	37	193/1042	2200/2000						
39	LC-7	567	37	567/1042	1930/2000						
40	LC-8	111	38	111/969	4030/3100						
41	LC-9A	64	38	64/969	3500/3100						
42	LC-9B	6	38	6/969	3500/3100						
43	LC-10	1,008	38	788/969	2935/3100	37	147/1042		39		
44	LC-11	161	52	161/393	2900/2500						
45	LC-12A	112	51	112/417	2100/2000						
46	LC-12B	88	51	88/417	2100/2000						
47	LC-13	618	50			51	217/417	1910/2000	52	232/393	2220/2500
48	LC-14	278	53								

Note: /1; Subbasin for water balance study (UC = Upper Cagayan, M = Magat, I = Ilagan, S = Siffu-Mallig, C = Chico, LC = Lower Cagayan)

/2; Subbasin for streamflow analysis

Table 1.2 Monthly Mean Runoff from Subbasin

(Unit: m^3/s)

Subbasin	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual Mean
UC-1	42.5	28.2	20.1	18.3	36.4	63.3	58.4	64.1	68.7	103.2	134.4	96.3	61.3
UC-2	19.4	12.9	9.2	8.4	16.6	28.9	26.6	29.2	31.4	47.1	61.3	43.9	28.0
UC-3	27.9	18.5	13.2	12.0	23.9	41.6	38.3	42.1	45.1	67.8	88.2	63.2	40.3
UC-4	14.7	9.8	7.0	6.3	12.6	21.9	20.2	22.2	23.8	35.7	46.4	33.3	21.2
UC-5	11.5	7.6	5.4	5.0	9.8	17.1	15.8	17.3	18.6	27.9	36.3	26.0	16.6
UC-6A	5.1	3.4	2.4	2.2	4.4	7.6	7.1	7.7	8.3	12.5	16.2	11.6	7.4
UC-6B	24.7	16.3	11.7	10.6	21.0	36.7	33.7	37.1	39.8	59.7	77.9	55.7	35.6
UC-7	32.2	21.3	15.2	13.8	27.5	47.9	44.1	48.5	52.0	77.9	101.6	72.7	46.4
UC-8A	3.0	2.0	1.4	1.3	2.5	4.4	4.1	4.5	4.8	7.2	9.4	6.7	4.3
UC-8B	21.3	14.1	10.1	9.2	18.3	31.7	29.2	32.1	34.4	51.7	67.3	48.2	30.7
UC-9	6.3	4.8	3.4	2.8	4.2	7.0	6.8	7.4	8.1	11.9	15.9	12.2	7.6
M-1	36.1	22.9	21.1	25.6	53.2	66.6	69.4	78.7	81.4	85.4	81.4	56.2	57.7
M-2	22.9	14.8	13.4	16.2	33.8	42.2	44.1	50.0	51.6	54.2	51.7	35.7	36.0
M-3	66.0	42.6	38.7	46.8	97.6	121.8	127.2	144.2	148.9	156.3	149.1	102.9	103.9
M-4	19.9	12.9	11.7	14.1	29.5	36.8	38.4	43.5	45.0	47.2	45.0	31.1	31.4
M-5	22.0	14.2	12.9	15.6	32.6	40.6	42.4	48.1	49.7	52.2	49.7	34.3	34.6
I-1	39.9	30.3	21.2	17.7	26.4	44.5	43.1	47.0	50.9	75.3	100.8	77.3	47.9
I-2	6.3	4.8	3.3	2.8	4.1	7.0	6.8	7.4	8.0	11.9	15.9	12.2	7.5
I-3	30.1	22.9	16.0	13.4	19.9	33.6	32.5	35.5	38.5	56.9	76.1	58.4	36.2
I-4	43.4	32.9	23.1	19.3	28.7	48.3	46.8	51.2	55.4	82.0	109.7	84.1	52.2
S-1	22.2	14.3	13.0	15.8	32.8	41.0	42.8	48.5	50.1	52.6	50.2	34.6	34.9
S-2	0.2	0.1	0.1	0.1	0.2	0.3	0.3	0.3	0.3	0.4	0.3	0.2	0.2
S-3	10.8	6.9	6.3	7.6	15.9	19.9	20.7	23.5	24.3	25.5	24.3	16.8	16.9
S-4	2.1	1.4	1.3	1.5	3.2	4.0	4.2	4.7	4.9	5.1	4.9	3.4	3.4
S-5	19.3	12.4	11.3	13.7	28.4	35.5	37.0	42.0	43.4	45.6	43.5	30.0	30.3
C-1	16.0	11.0	7.7	14.8	46.7	64.2	85.2	81.1	81.1	65.9	52.0	28.6	46.4
C-2	13.7	9.5	6.6	12.7	40.2	55.3	73.3	69.8	69.9	56.7	44.8	24.6	39.9
C-3	11.3	7.8	5.4	10.5	33.0	45.3	60.2	57.3	57.4	46.6	36.7	20.2	32.8
C-4	24.3	15.1	11.0	16.1	40.4	58.9	63.5	79.0	67.4	85.5	95.9	56.0	51.3
C-5	6.6	4.5	3.2	6.0	18.8	25.8	34.0	32.7	32.5	26.9	21.7	12.0	18.8
C-6	29.5	18.4	13.3	19.4	48.9	71.4	76.9	95.8	81.5	103.7	116.2	67.8	62.2
LC-1	6.6	4.2	2.7	2.8	6.1	10.1	14.4	19.0	17.4	23.0	27.8	15.2	12.5
LC-2	7.3	4.7	3.0	3.1	6.7	11.2	15.9	21.0	19.3	25.4	30.8	16.8	13.8
LC-3	6.0	3.8	2.4	2.5	5.5	9.0	12.8	17.0	15.6	20.6	24.9	13.6	11.2
LC-4A	20.1	12.8	8.1	8.4	18.4	30.5	43.3	57.5	52.7	69.5	84.1	45.9	37.8
LC-4B	7.3	4.6	3.0	3.1	6.7	11.1	15.8	20.9	19.2	25.3	30.6	16.7	13.7
LC-5	30.2	19.1	12.4	13.3	29.5	48.2	66.4	87.5	79.6	104.8	125.9	69.2	57.4
LC-6	3.9	2.4	1.8	2.6	6.5	9.5	10.2	12.7	10.8	13.7	15.4	9.0	8.2
LC-7	10.1	6.2	4.6	6.7	16.7	24.4	26.3	32.7	27.9	35.4	39.6	23.2	21.2
LC-8	4.8	3.1	2.0	2.0	4.4	7.3	10.4	13.8	12.6	16.6	20.1	11.0	9.0
LC-9A	2.4	1.5	1.0	1.0	2.2	3.7	5.2	6.9	6.3	8.3	10.1	5.5	4.5
LC-9B	0.2	0.1	0.1	0.1	0.2	0.3	0.5	0.6	0.6	0.8	0.9	0.5	0.4
LC-10	29.0	18.4	11.9	13.1	29.6	47.7	64.4	84.5	76.6	100.5	120.3	66.2	55.4
LC-11	4.3	2.7	1.9	2.9	7.1	10.4	11.2	14.0	11.9	15.1	16.9	9.9	9.1
LC-12A	2.5	1.6	1.0	1.1	2.3	3.8	5.4	7.2	6.6	8.7	10.6	5.8	4.7
LC-12B	2.0	1.3	0.8	0.8	1.8	3.0	4.3	5.7	5.2	6.9	8.3	4.5	3.7
LC-13	12.4	7.8	5.4	7.1	17.3	26.0	30.4	38.7	33.8	43.5	50.0	28.5	25.2
LC-14	5.9	3.7	2.7	3.9	9.8	14.2	15.3	19.1	16.3	20.7	23.2	13.5	12.4

Table 1.3 Diversion Water Requirement of National Irrigation System

(1) National Irrigation System and Balance Point

Balance Point	System Name
6	Dabubu River IP
8	Gappal IP
10	Matuno IP (Manamtam)
11	Matuno IP (Bayombong)
13	Magat RIS
15	Lulutan IP
18	Ilagan IP, Tumauini IS (Ilagan)
23	Chico RIS
26	Chico RIS (Chico West)
29	Siffu RIS
30	Chico Mallig IP
31	Mallig RIS
33	Tumauini IS
34	San Pablo - Cabagan IS
35	Pinacanauan RIS
36	Tuguegarao IP
37	Solana - Tuguegarao IS, Alcala - Amulung West IS
38	CIADP (Iguig)
39	CIADP (Alcala-Amulung)
40	Baggao IS (Pared)
42	Baggao IS (Paranan)
44	Zinundungan RIS, Zinundungan Extension IP
46	Dummon RIS
47	CIADP (Lower Cagayan)

(2) Requirement in 1985 (m^3/s)

Balance Point	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
6	-	-	-	-	-	-	-	-	-	-	-	-
8	-	-	-	-	-	-	-	-	-	-	-	-
10	-	-	-	-	-	-	-	-	-	-	-	-
11	-	-	-	-	-	-	-	-	-	-	-	-
13	65.07	73.24	14.80	32.19	101.98	71.56	87.84	37.63	0.00	0.00	46.01	37.09
15	-	-	-	-	-	-	-	-	-	-	-	-
18	-	-	-	-	-	-	-	-	-	-	-	-
23	9.13	10.33	11.65	1.85	0.00	0.00	4.59	7.57	11.37	8.69	6.90	7.74
26	1.45	1.69	1.91	0.29	0.00	0.00	0.52	0.87	1.35	1.06	0.86	0.86
29	8.75	9.85	1.99	4.45	14.08	9.88	12.13	5.20	0.00	0.00	6.19	4.99
30	-	-	-	-	-	-	-	-	-	-	-	-
31	1.20	1.56	0.18	0.27	1.63	1.45	1.66	1.40	1.19	0.15	0.77	0.64
33	1.46	1.90	2.20	0.33	1.87	1.67	1.91	1.61	1.37	0.17	0.94	0.79
34	0.06	0.08	0.09	0.01	0.08	0.08	0.07	0.06	0.06	0.01	0.04	0.04
35	0.38	0.45	0.51	0.08	0.39	0.38	0.36	0.30	0.28	0.03	0.22	0.26
36	-	-	-	-	-	-	-	-	-	-	-	-
37	1.24	1.50	1.69	0.26	0.00	0.00	0.00	0.00	0.00	0.00	0.74	0.85
38	0.52	0.62	0.70	0.11	0.55	0.53	0.51	0.42	0.40	0.05	0.31	0.35
39	1.53	1.84	2.07	0.32	1.55	1.51	1.45	1.20	1.13	0.14	0.91	1.04
40	0.58	0.70	0.79	0.12	0.61	0.60	0.57	0.48	0.45	0.05	0.35	0.40
42	0.79	0.95	1.07	0.17	1.13	1.10	1.06	0.88	0.83	0.10	0.47	0.54
44	2.12	2.64	2.99	0.44	2.16	2.01	2.00	1.72	1.69	0.21	1.35	1.41
46	1.19	1.88	2.31	0.38	2.01	1.89	1.96	1.62	1.20	0.14	0.94	0.74
47	0.05	0.08	0.10	0.02	0.38	0.36	0.37	0.30	0.23	0.03	0.04	0.03

(to be continued)

(Continuation)

(3) Requirement in 1990 (m^3/s)

Balance Point	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
6	-	-	-	-	-	-	-	-	-	-	-	-
8	-	-	-	-	-	-	-	-	-	-	-	-
10	-	-	-	-	-	-	-	-	-	-	-	-
11	-	-	-	-	-	-	-	-	-	-	-	-
13	117.84	118.74	84.29	55.75	111.00	98.31	142.29	74.11	41.17	29.95	48.87	90.91
15	-	-	-	-	-	-	-	-	-	-	-	-
18	-	-	-	-	-	-	-	-	-	-	-	-
23	23.60	28.43	12.99	0.00	8.66	27.08	22.25	18.88	7.19	0.00	5.52	20.07
26	1.99	2.47	1.14	0.00	0.73	2.19	1.81	1.59	0.63	0.00	0.49	1.69
29	13.68	15.97	16.70	5.50	5.22	14.90	16.90	8.22	7.42	4.79	3.43	11.79
30	-	-	-	-	-	-	-	-	-	-	-	-
31	1.36	1.78	0.84	0.00	1.11	3.25	3.10	2.66	0.92	0.00	0.35	1.03
33	1.46	1.90	2.20	0.33	1.87	1.67	1.91	1.61	1.37	0.17	0.94	0.79
34	1.84	2.22	1.02	0.00	1.35	4.23	3.48	2.95	1.12	0.00	0.43	1.57
35	1.57	1.78	1.79	0.15	1.60	1.56	1.50	0.97	0.32	0.26	0.11	1.21
36	-	-	-	-	-	-	-	-	-	-	-	-
37	1.24	1.50	1.69	0.26	0.00	0.00	0.00	0.00	0.00	0.00	0.74	0.85
38	1.01	1.15	1.15	0.10	1.03	1.01	0.97	0.63	0.05	0.00	0.00	0.74
39	3.08	3.48	3.50	0.30	3.14	3.05	2.93	1.90	0.16	0.00	0.00	2.24
40	0.58	0.70	0.79	0.12	0.61	0.60	0.57	0.48	0.45	0.05	0.35	0.40
42	0.79	0.95	1.07	0.17	1.13	1.10	1.06	0.88	0.83	0.10	0.47	0.54
44	2.21	2.58	2.61	0.21	2.20	2.05	2.03	1.36	0.12	0.00	0.00	1.63
46	1.19	1.88	2.31	0.38	2.01	1.89	1.96	1.62	1.20	0.14	0.94	0.74
47	9.63	14.08	15.52	1.41	15.20	14.31	14.79	9.57	0.62	0.00	0.00	8.52

(4) Requirement in 1995 (m^3/s)

Balance Point	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
6	0.66	0.91	1.09	0.14	0.81	0.56	0.73	0.46	0.21	0.13	0.06	0.59
8	-	-	-	-	-	-	-	-	-	-	-	-
10	-	-	-	-	-	-	-	-	-	-	-	-
11	-	-	-	-	-	-	-	-	-	-	-	-
13	117.84	118.74	84.29	55.75	111.00	98.31	142.29	74.11	41.17	29.95	48.87	90.91
15	-	-	-	-	-	-	-	-	-	-	-	-
18	-	-	-	-	-	-	-	-	-	-	-	-
23	23.60	28.43	12.99	0.00	8.66	27.08	22.25	18.88	7.19	0.00	5.52	20.07
26	1.99	2.47	1.14	0.00	0.73	2.19	1.81	1.59	0.63	0.00	0.49	1.69
29	13.68	15.97	16.70	5.50	5.22	14.90	16.90	8.22	7.42	4.79	3.43	11.79
30	38.25	44.19	44.76	4.36	38.41	36.93	35.95	23.25	7.88	6.39	2.93	29.44
31	1.36	1.78	0.84	0.00	1.11	3.25	3.10	2.66	0.92	0.00	0.35	1.03
33	1.46	1.90	2.20	0.33	1.87	1.67	1.91	1.61	1.37	0.17	0.94	0.79
34	1.84	2.22	1.02	0.00	1.35	4.23	3.48	2.95	1.12	0.00	0.43	1.57
35	1.57	1.78	1.79	0.15	1.60	1.56	1.50	0.97	0.32	0.26	0.11	1.21
36	-	-	-	-	-	-	-	-	-	-	-	-
37	3.71	4.19	4.22	0.36	3.78	3.67	3.53	2.29	0.74	0.61	0.26	2.86
38	1.01	1.15	1.15	0.10	1.03	1.01	0.97	0.63	0.05	0.00	0.00	0.74
39	3.08	3.48	3.50	0.30	3.14	3.05	2.93	1.90	0.16	0.00	0.00	2.24
40	0.58	0.70	0.79	0.12	0.61	0.60	0.57	0.48	0.45	0.05	0.35	0.40
42	0.79	0.95	1.07	0.17	1.13	1.10	1.06	0.88	0.83	0.10	0.47	0.54
44	2.21	2.58	2.61	0.21	2.20	2.05	2.03	1.36	0.12	0.00	0.00	1.63
46	1.19	1.88	2.31	0.38	2.01	1.89	1.96	1.62	1.20	0.14	0.94	0.74
47	9.63	14.08	15.52	1.41	15.20	14.31	14.79	9.57	0.62	0.00	0.00	8.52

(to be continued)

(Continuation)

(5) Requirement in 2000 (m^3/s)

Balance Point	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
6	0.66	0.91	1.09	0.14	0.81	0.56	0.73	0.46	0.21	0.13	0.06	0.59
8	3.58	4.55	5.26	0.54	4.37	3.16	3.94	2.51	1.01	0.66	0.24	3.06
10	-	-	-	-	-	-	-	-	-	-	-	-
11	-	-	-	-	-	-	-	-	-	-	-	-
13	117.84	118.74	84.29	55.75	111.00	98.31	142.29	74.11	41.17	29.95	48.87	90.91
15	2.55	3.17	3.63	0.34	3.12	2.28	2.81	1.80	0.70	0.46	0.15	2.16
18	0.90	1.93	2.64	0.56	1.13	0.54	0.98	0.55	0.48	0.30	0.27	1.02
23	23.60	28.43	12.99	0.00	8.66	27.08	22.25	18.88	7.19	0.00	5.52	20.07
26	1.99	2.47	1.14	0.00	0.73	2.19	1.81	1.59	0.63	0.00	0.49	1.69
29	13.68	15.97	16.70	5.50	5.22	14.90	16.90	8.22	7.42	4.79	3.43	11.79
30	38.25	44.19	44.76	4.36	38.41	36.93	35.95	23.25	7.88	6.39	2.93	29.44
31	1.36	1.78	0.84	0.00	1.11	3.25	3.10	2.66	0.92	0.00	0.35	1.03
33	1.46	1.90	2.20	0.33	1.87	1.67	1.91	1.61	1.37	0.17	0.94	0.79
34	1.84	2.22	1.02	0.00	1.35	4.23	3.48	2.95	1.12	0.00	0.43	1.57
35	1.57	1.78	1.79	0.15	1.60	1.56	1.50	0.97	0.32	0.26	0.11	1.21
36	0.88	1.33	1.46	0.32	0.69	0.52	0.67	0.42	0.25	0.19	0.15	0.65
37	10.15	12.32	12.69	1.58	9.83	9.16	9.24	5.94	2.22	1.77	0.94	7.75
38	1.01	1.15	1.15	0.10	1.03	1.01	0.97	0.63	0.05	0.00	0.00	0.74
39	3.08	3.48	3.50	0.30	3.14	3.05	2.93	1.90	0.16	0.00	0.00	2.24
40	0.58	0.70	0.79	0.12	0.61	0.60	0.57	0.48	0.45	0.05	0.35	0.40
42	0.79	0.95	1.07	0.17	1.13	1.10	1.06	0.88	0.83	0.10	0.47	0.54
44	2.21	2.58	2.61	0.21	2.20	2.05	2.03	1.36	0.12	0.00	0.00	1.63
46	1.19	1.88	2.31	0.38	2.01	1.89	1.96	1.62	1.20	0.14	0.94	0.74
47	9.63	14.08	15.52	1.41	15.20	14.31	14.79	9.57	0.62	0.00	0.00	8.52

(6) Requirement in 2005 (m^3/s)

Balance Point	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
6	0.66	0.91	1.09	0.14	0.81	0.56	0.73	0.46	0.21	0.13	0.06	0.59
8	3.58	4.55	5.26	0.54	4.37	3.16	3.94	2.51	1.01	0.66	0.24	3.06
10	1.08	1.28	1.36	0.13	1.17	1.21	1.14	0.91	0.27	0.22	0.14	1.02
11	11.47	13.57	14.34	1.35	12.39	12.82	12.10	9.65	2.87	2.32	1.44	10.78
13	117.84	118.74	84.29	55.75	111.00	98.31	142.29	74.11	41.17	29.95	48.87	90.91
15	2.55	3.17	3.63	0.34	3.12	2.28	2.81	1.80	0.70	0.46	0.15	2.16
18	3.55	5.17	5.99	9.84	4.10	3.19	4.02	2.55	0.63	0.30	0.27	2.91
23	23.60	28.43	12.99	0.00	8.66	27.08	22.25	18.88	7.19	0.00	5.52	20.07
26	1.99	2.47	1.14	0.00	0.73	2.19	1.81	1.59	0.63	0.00	0.49	1.69
29	13.68	15.97	16.70	5.50	5.22	14.90	16.90	8.22	7.42	4.79	3.43	11.79
30	38.25	44.19	44.76	4.36	38.41	36.93	35.95	23.25	7.88	6.39	2.93	29.44
31	1.36	1.78	0.84	0.00	1.11	3.25	3.10	2.66	0.92	0.00	0.35	1.03
33	0.99	1.21	1.25	0.11	1.84	1.65	1.89	1.24	0.87	0.70	0.22	0.82
34	1.84	2.22	1.02	0.00	1.35	4.23	3.48	2.95	1.12	0.00	0.43	1.57
35	1.57	1.78	1.79	0.15	1.60	1.56	1.50	0.97	0.32	0.26	0.11	1.21
36	0.88	1.33	1.46	0.32	0.69	0.52	0.67	0.42	0.25	0.19	0.15	0.65
37	10.15	12.32	12.69	1.58	9.83	9.16	9.24	5.94	2.22	1.77	0.94	7.75
38	1.01	1.15	1.15	0.10	1.03	1.01	0.97	0.63	0.05	0.00	0.00	0.74
39	3.08	3.48	3.50	0.30	3.14	3.05	2.93	1.90	0.16	0.00	0.00	2.24
40	0.63	0.71	0.72	0.06	0.73	0.71	0.68	0.44	0.14	0.12	0.05	0.49
42	1.65	1.87	1.88	0.16	1.69	1.64	1.58	1.02	0.33	0.27	0.12	1.28
44	4.16	4.95	5.04	0.45	4.10	3.77	3.76	2.53	0.55	0.36	0.17	3.13
46	1.83	2.68	2.95	0.27	2.89	2.72	2.82	1.82	0.52	0.31	0.13	1.67
47	9.63	14.08	15.52	1.41	15.20	14.31	14.79	9.57	0.62	0.00	0.00	8.52

Table 1.4 Projected Municipal Water Requirement

Balance Point	Block No.	Requirement (m^3/s)							
		1985	1990	1995	2000	2005	2010	2015	2020
3	Block 1	0.13	0.18	0.24	0.40	0.61	0.87	1.22	1.69
7	Block 4, 5	0.28	0.37	0.48	0.75	1.08	1.50	1.96	2.66
9	Block 6, 8	0.27	0.36	0.48	0.79	1.17	1.69	2.23	3.03
11	Block 2	0.08	0.10	0.13	0.20	0.29	0.42	0.59	0.89
12	Block 10	0.12	0.15	0.18	0.25	0.34	0.44	0.56	0.74
13	Block 3	0.25	0.35	0.48	0.81	1.26	1.79	2.48	3.36
14	Block 9	0.17	0.22	0.29	0.45	0.66	0.91	1.44	1.97
19	Block 7	0.15	0.20	0.26	0.43	0.66	0.93	1.23	1.70
21	Block 11	0.08	0.09	0.10	0.12	0.15	0.18	0.22	0.28
25	Block 16	0.03	0.04	0.04	0.05	0.05	0.06	0.07	0.07
26	Block 15	0.13	0.17	0.24	0.40	0.64	0.93	1.24	1.55
27	Block 19	0.09	0.11	0.13	0.18	0.24	0.30	0.39	0.50
32	Block 12	0.15	0.20	0.27	0.46	0.71	1.00	1.32	1.83
37	Block 13, 14, 17	0.26	0.34	0.44	0.67	0.95	1.28	1.67	2.22
38	Block 18	0.15	0.19	0.23	0.33	0.44	0.57	0.72	0.94
47	Block 20	0.18	0.23	0.29	0.43	0.60	0.79	1.02	1.36

Table 1.6 River Maintenance Flow

Balance Point	Drainage Area(km^2)	Maintenance Flow (m^3/s)	Balance Point	Drainage Area(km^2)	Maintenance Flow (m^3/s)	Balance Point	Drainage Area(km^2)	Maintenance Flow (m^3/s)
1	1,150	5.3	17	652	3.0	33	170	0.8
2	1,631	7.5	18	2,217	10.2	34	129	0.6
3	2,364	10.9	19	3,132	14.4	35	445	2.0
4	477	2.2	20	15,334	70.5	36	657	3.0
5	864	4.0	21	720	3.3	37	19,524	89.8
6	141	0.6	22	1,410	6.5	38	19,717	90.7
7	5,582	25.7	23	1,951	9.0	39	20,284	93.3
8	122	0.6	24	1,951	0.0	40	111	0.5
9	6,633	30.5	25	856	3.9	41	64	0.3
10	550	2.5	26	3,270	15.0	42	70	0.3
11	1,693	7.8	27	4,551	20.9	43	21,473	98.8
12	559	2.6	28	656	3.0	44	161	0.7
13	4,143	0.0	29	663	0.0	45	112	0.5
14	5,113	4.5	30	362	1.7	46	200	0.9
15	11,993	55.2	31	462	2.1	47	27,003	140.0
16	1,350	6.2	32	2,015	9.3	48	27,281	140.0

Table 1.5 N-th Lowest Discharge

Gauging Station	Drainage Area (km^2)	Sample Size (Nos)	N-th Minimum (m^3/s)	Specific Discharge ($m^3/s/km^2$)	Remarks
(1) Upper Cagayan					
Palattao	6,626	11	23	0.0035	
Pangal	4,244	13	14	0.0033	
Guinalvin	921	8	3	0.0033	
(2) Magat					
Oscariz	4,150	5	20	0.0048	
Hapid	606	7	6	0.0099	
Bante	558	20	4	0.0072	
Bato	1,649	12	2	0.0012	
(3) Ilagan					
Malalam	3,123	5	30	0.0096	
(4) Lower Cagayan					
Calaoagan	308	5	1.1	0.0036	
Calantac	907	6	3	0.0033	
Larion Alto	655	18	2	0.0031	
Antagan	170	7	0.09	0.0005	* too small
(5) Upper Chico					
Ampawilen	751	14	2	0.0027	
Taed	391	13	0.10	0.00026	* too small
Supang	57	8	0.02	0.00035	* too small
(6) Lower Chico					
Escolta	655	9	5	0.0076	
Pinukpuk	856	5	2	0.0023	

Average excluding stations marked with "*" 0.0046

Table 2.1 Annual Water Deficit at Balance Point Demand in 1985

	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
1	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
3	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
4	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
5	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
6	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
7	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
8	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
9	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
10	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.	0.
11	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
12	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
13	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
14	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
15	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
16	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	4.	15.
17	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
18	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
19	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
20	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
21	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	7.
22	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	2.	3.	3.	1.	2.	3.
23	20.	23.	1.	36.	16.	0.	18.	0.	0.	5.	38.	11.	0.	13.	27.	35.	57.	40.	39.	44.	31.	56.
24	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
25	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
26	8.	10.	0.	9.	3.	0.	6.	0.	0.	0.	11.	2.	0.	0.	9.	15.	13.	15.	15.	15.	8.	11.
27	2.	4.	0.	0.	0.	0.	2.	0.	0.	0.	2.	0.	0.	0.	0.	4.	2.	6.	4.	4.	2.	2.
28	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
29	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
30	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
31	1.	0.	0.	0.	0.	0.	2.	1.	0.	0.	1.	1.	0.	0.	0.	2.	0.	0.	0.	0.	3.	2.
32	6.	3.	0.	3.	0.	0.	7.	1.	0.	0.	3.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
33	7.	3.	0.	0.	0.	3.	0.	1.	0.	0.	4.	0.	0.	1.	5.	7.	2.	7.	4.	7.	16.	8.
34	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
35	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
36	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
37	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
38	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	10.
39	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	10.
40	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	10.
41	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	3.	3.
42	6.	3.	0.	2.	1.	3.	6.	1.	2.	0.	4.	2.	2.	2.	4.	5.	4.	5.	3.	6.	12.	6.
43	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	11.
44	14.	12.	0.	10.	6.	10.	16.	11.	5.	3.	16.	10.	4.	6.	9.	14.	14.	10.	10.	11.	16.	9.
45	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.	1.
46	17.	11.	0.	11.	4.	10.	17.	5.	5.	0.	14.	8.	6.	9.	12.	15.	11.	16.	10.	14.	28.	13.
47	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	2.	34.
48	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	31.

(MCM)

(to be continued)

(Continuation)

Demand in 1990

	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
1	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
3	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
4	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
5	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
6	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
7	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
8	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.	12.	1.	0.
9	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
10	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	2.	16.	4.	0.
11	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
12	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
13	0.	0.	0.	0.	0.	0.	33.	0.	0.	0.	28.	0.	27.	0.	0.	0.	0.	0.	0.	0.	38.	0.
14	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
15	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
16	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	3.
17	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
18	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
19	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
20	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
21	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
22	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	2.	3.	3.	1.	2.	3.
23	60.	65.	10.	116.	47.	14.	56.	15.	0.	26.	121.	31.	2.	71.	93.	120.	147.	139.	97.	132.	147.	146.
24	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
25	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
26	8.	13.	0.	13.	3.	0.	7.	0.	0.	0.	19.	2.	0.	0.	7.	20.	12.	15.	15.	18.	17.	13.
27	2.	4.	0.	0.	0.	0.	1.	0.	0.	0.	2.	0.	0.	0.	0.	3.	2.	6.	4.	3.	2.	1.
28	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
29	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
30	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
31	0.	0.	0.	0.	0.	0.	7.	1.	0.	0.	0.	0.	3.	0.	0.	1.	0.	2.	0.	0.	13.	1.
32	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.	0.	0.	0.	0.	0.	0.
33	7.	3.	1.	3.	0.	1.	7.	1.	0.	0.	4.	0.	0.	1.	5.	7.	2.	7.	4.	7.	16.	8.
34	7.	3.	0.	2.	0.	1.	8.	3.	2.	0.	6.	6.	6.	1.	2.	10.	10.	14.	5.	16.	31.	9.
35	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	5.	4.
36	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	4.	3.
37	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.
38	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.
39	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
40	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	3.	3.
41	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
42	6.	3.	1.	2.	1.	3.	6.	1.	2.	0.	4.	2.	2.	2.	4.	5.	4.	5.	3.	6.	12.	6.
43	6.	3.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.
44	11.	12.	3.	9.	5.	9.	15.	10.	4.	2.	15.	9.	3.	5.	8.	13.	13.	9.	9.	10.	16.	8.
45	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.	1.
46	17.	11.	4.	11.	4.	10.	17.	5.	5.	0.	14.	8.	6.	9.	12.	15.	11.	16.	10.	14.	28.	13.
47	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	2.	0.	60.	36.
48	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.	0.	53.	31.

(MCM)

(to be continued)

(Continuation)

Demand in 1995

	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
1	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
3	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
4	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
5	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
6	0.	0.	0.	0.	0.	1.	2.	1.	0.	0.	0.	0.	0.	0.	0.	4.	1.	2.	2.	4.	5.	2.
7	0.	0.	0.	0.	0.	0.	1.	0.	0.	0.	0.	0.	0.	0.	0.	2.	0.	0.	0.	4.	23.	5.
8	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	2.	0.	0.	0.	5.	27.	8.
9	0.	0.	0.	0.	0.	0.	1.	0.	0.	0.	0.	0.	0.	0.	0.	2.	0.	0.	0.	5.	27.	8.
10	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
11	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
12	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
13	0.	0.	0.	0.	0.	0.	33.	0.	0.	0.	28.	0.	27.	0.	0.	0.	0.	0.	0.	0.	38.	0.
14	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
15	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	2.	4.
16	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
17	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
18	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
19	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
20	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
21	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
22	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	2.	3.	3.	2.	2.	3.
23	60.	65.	10.	116.	47.	14.	58.	15.	0.	26.	121.	31.	2.	71.	93.	120.	147.	139.	97.	132.	147.	146.
24	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
25	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
26	8.	13.	0.	14.	3.	0.	7.	0.	0.	0.	20.	2.	0.	0.	7.	21.	12.	16.	15.	19.	18.	13.
27	2.	5.	0.	1.	0.	0.	2.	0.	0.	0.	2.	0.	0.	0.	0.	5.	2.	7.	5.	5.	4.	2.
28	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
29	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
30	488.	421.	491.	458.	548.	518.	674.	491.	400.	472.	623.	655.	650.	481.	555.	622.	517.	567.	448.	525.	845.	463.
31	30.	22.	26.	44.	28.	33.	68.	42.	16.	33.	45.	53.	60.	29.	46.	55.	30.	47.	27.	29.	81.	31.
32	4.	0.	0.	2.	0.	4.	9.	5.	0.	0.	7.	7.	1.	0.	1.	8.	4.	0.	2.	0.	5.	3.
33	7.	3.	1.	3.	0.	3.	7.	1.	0.	0.	4.	0.	0.	1.	5.	7.	2.	7.	4.	7.	16.	8.
34	7.	3.	2.	2.	0.	1.	8.	3.	2.	0.	6.	6.	6.	1.	2.	10.	10.	14.	5.	16.	31.	9.
35	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	5.	4.
36	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	4.	3.
37	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	4.
38	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	6.
39	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	7.
40	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	3.	3.
41	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
42	6.	3.	1.	2.	1.	3.	6.	1.	2.	0.	4.	2.	2.	2.	4.	5.	4.	5.	3.	6.	12.	6.
43	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	6.
44	11.	12.	3.	9.	5.	9.	15.	10.	4.	2.	15.	9.	3.	5.	8.	13.	13.	9.	9.	10.	16.	8.
45	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.	1.
46	17.	11.	4.	11.	4.	10.	17.	5.	5.	0.	14.	8.	6.	9.	12.	15.	11.	16.	10.	14.	28.	13.
47	0.	0.	0.	0.	0.	0.	8.	0.	0.	0.	0.	0.	0.	0.	0.	8.	3.	0.	11.	0.	105.	58.
48	0.	0.	0.	0.	0.	0.	7.	0.	0.	0.	0.	0.	0.	0.	0.	7.	2.	0.	10.	0.	98.	51.

(MCM)

(to be continued)

(Continuation)

Demand in 2000

	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
1	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
3	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
4	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
5	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
6	0.	0.	0.	0.	0.	1.	2.	1.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
7	0.	0.	0.	0.	0.	0.	2.	0.	0.	0.	0.	0.	0.	0.	0.	4.	1.	2.	2.	4.	5.	2.
8	30.	23.	44.	49.	40.	55.	67.	49.	11.	26.	46.	44.	41.	36.	67.	77.	47.	78.	53.	75.	87.	40.
9	0.	0.	0.	0.	0.	0.	4.	0.	0.	0.	0.	0.	0.	0.	0.	7.	0.	2.	0.	7.	42.	12.
10	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
11	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
12	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
13	0.	0.	0.	0.	0.	0.	66.	0.	0.	0.	56.	0.	53.	0.	0.	0.	0.	0.	0.	0.	0.	0.
14	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	76.	0.
15	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
16	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	12.	6.
17	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
18	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
19	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
20	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
21	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	2.	3.	0.	0.	0.	2.
22	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	3.	5.	3.	2.	2.	3.
23	60.	65.	10.	116.	47.	14.	58.	15.	0.	26.	121.	31.	2.	71.	93.	120.	147.	139.	97.	132.	147.	146.
24	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
25	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
26	8.	14.	0.	15.	3.	0.	8.	0.	0.	0.	21.	2.	0.	0.	8.	22.	13.	16.	16.	20.	19.	13.
27	2.	5.	0.	1.	0.	0.	2.	0.	0.	0.	2.	0.	0.	0.	0.	5.	2.	7.	5.	5.	4.	2.
28	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
29	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
30	488.	421.	491.	458.	548.	518.	674.	491.	400.	472.	623.	655.	650.	481.	555.	622.	517.	567.	448.	525.	845.	463.
31	30.	22.	26.	44.	28.	33.	68.	42.	16.	33.	45.	53.	60.	29.	46.	55.	30.	47.	27.	29.	81.	31.
32	5.	0.	0.	2.	0.	4.	9.	6.	0.	0.	8.	7.	1.	0.	2.	8.	4.	0.	3.	0.	5.	3.
33	7.	3.	1.	3.	0.	3.	7.	1.	0.	0.	4.	0.	0.	1.	5.	7.	2.	7.	4.	7.	16.	8.
34	7.	3.	2.	2.	0.	1.	6.	3.	2.	0.	6.	6.	6.	1.	2.	10.	10.	14.	5.	16.	31.	9.
35	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	5.	4.
36	3.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	11.	10.
37	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	37.	22.
38	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	37.	25.
39	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	49.	30.
40	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	3.	3.
41	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
42	6.	3.	1.	2.	1.	3.	6.	1.	2.	0.	4.	2.	2.	2.	4.	5.	4.	5.	3.	6.	12.	6.
43	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	32.	22.
44	11.	12.	3.	9.	5.	9.	15.	10.	4.	2.	15.	9.	3.	5.	8.	13.	13.	9.	9.	10.	16.	8.
45	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.	1.
46	18.	12.	4.	11.	4.	11.	18.	6.	6.	0.	15.	9.	7.	9.	13.	16.	12.	17.	11.	15.	30.	14.
47	0.	0.	0.	0.	0.	0.	24.	0.	0.	0.	0.	0.	0.	0.	0.	26.	17.	0.	25.	8.	187.	109.
48	0.	0.	0.	0.	0.	0.	21.	0.	0.	0.	0.	0.	0.	0.	0.	23.	16.	0.	24.	7.	176.	97.

(MCM)

(to be continued)

(Continuation)

Demand in 2005

	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
1	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
3	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
4	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
5	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
6	0.	0.	0.	0.	0.	1.	2.	1.	0.	0.	0.	0.	0.	0.	0.	4.	1.	2.	2.	4.	5.	2.
7	0.	0.	0.	0.	0.	0.	3.	0.	0.	0.	0.	0.	0.	0.	0.	6.	0.	2.	0.	6.	35.	9.
8	30.	23.	44.	49.	40.	55.	67.	48.	11.	26.	46.	44.	41.	36.	67.	77.	47.	78.	53.	75.	87.	40.
9	0.	0.	0.	0.	0.	0.	7.	0.	0.	0.	0.	0.	0.	0.	0.	11.	0.	3.	0.	11.	52.	15.
10	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
11	41.	5.	0.	24.	17.	26.	133.	43.	0.	4.	83.	65.	63.	29.	31.	91.	32.	28.	33.	1.	152.	87.
12	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
13	0.	0.	0.	0.	0.	0.	193.	0.	0.	0.	159.	0.	146.	0.	0.	0.	0.	0.	0.	0.	220.	0.
14	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
15	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	23.	9.
16	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
17	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
18	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	2.	9.	8.
19	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	3.	2.
20	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	5.	4.
21	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	2.	3.	3.	2.	2.	3.
22	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	3.	5.	4.	2.	3.	5.
23	61.	65.	10.	117.	47.	14.	58.	15.	0.	26.	121.	31.	2.	72.	93.	120.	147.	139.	98.	132.	147.	146.
24	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
25	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
26	9.	15.	0.	16.	3.	0.	9.	0.	0.	0.	22.	2.	0.	1.	9.	23.	14.	17.	17.	21.	20.	14.
27	3.	5.	0.	1.	0.	0.	2.	0.	0.	0.	3.	0.	0.	0.	0.	6.	2.	7.	6.	6.	5.	2.
28	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
29	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
30	488.	421.	491.	458.	548.	518.	674.	491.	400.	472.	623.	655.	650.	481.	555.	622.	517.	567.	448.	525.	845.	463.
31	30.	22.	26.	44.	28.	33.	68.	42.	16.	33.	45.	53.	60.	29.	46.	55.	30.	47.	27.	29.	81.	31.
32	6.	0.	0.	2.	0.	4.	11.	6.	0.	0.	9.	8.	1.	0.	2.	9.	4.	0.	3.	0.	7.	3.
33	5.	2.	1.	0.	0.	2.	3.	0.	0.	0.	1.	0.	0.	0.	2.	5.	1.	6.	2.	4.	14.	4.
34	7.	3.	2.	2.	0.	1.	8.	3.	2.	0.	6.	6.	6.	1.	2.	10.	10.	14.	5.	16.	31.	9.
35	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	5.	4.
36	3.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	11.	10.
37	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	70.	36.
38	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	72.	38.
39	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	2.	0.	82.	45.
40	2.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	5.	2.
41	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
42	13.	9.	4.	9.	4.	10.	15.	5.	5.	1.	12.	7.	6.	7.	10.	14.	10.	12.	9.	15.	22.	13.
43	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	65.	39.
44	33.	36.	14.	28.	24.	37.	38.	35.	22.	18.	39.	33.	16.	21.	30.	37.	42.	30.	27.	31.	44.	24.
45	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.	1.
46	24.	20.	8.	17.	8.	18.	28.	10.	11.	1.	23.	18.	12.	17.	18.	25.	19.	25.	17.	24.	42.	20.
47	0.	0.	0.	0.	0.	0.	37.	0.	0.	0.	0.	0.	0.	0.	0.	45.	23.	0.	33.	17.	234.	143.
48	0.	0.	0.	0.	0.	0.	34.	0.	0.	0.	0.	0.	0.	0.	0.	41.	22.	0.	30.	14.	222.	131.

(MCM)

Table 2.2 1/5 Probable Annual Water Deficit at Balance Point

(Present condition)

Unit: $x10^6m^3$/year

Balance Point	Annual Deficit 1985 Demand	1990 Demand	1995 Demand	2000 Demand	2005 Demand
1					
2					
3					
4					
5					
6			2 (80)	2 (80)	2 (80)
7			2 (78)	5 (78)	6 (78)
8				75 (82)	75 (82)
9			2 (78)	7 (78)	11 (78)
10					
11					87 (84)
12					
13		27 (75)	27 (75)	53 (75)	146 (75)
14					
15					
16					
17					
18					
19					
20					
21	2 (83)	2 (83)	2 (83)	2 (83)	2 (83)
22	3 (83)	3 (83)	3 (83)	3 (83)	3 (83)
23	40 (80)	139 (80)	139 (80)	139 (80)	139 (80)
24					
25					
26	15 (78)	17 (83)	18 (83)	19 (83)	20 (83)
27	4 (78)	4 (78)	5 (78)	5 (78)	6 (78)
28					
29					
30			650 (75)	650 (75)	650 (75)
31	2 (78)	2 (80)	55 (78)	55 (78)	55 (78)
32			7 (74)	7 (74)	8 (74)
33	7 (78)	7 (78)	7 (78)	7 (78)	5 (78)
34		10 (78)	10 (78)	10 (78)	10 (78)
35					
36					
37					
38					
39					
40					
41					
42	6 (63)	6 (63)	6 (63)	6 (63)	14 (78)
43					
44	14 (78)	13 (78)	13 (78)	13 (78)	38 (69)
45					
46	16 (80)	16 (80)	16 (80)	17 (80)	25 (80)
47			8 (78)	25 (81)	37 (69)
48			7 (78)	23 (78)	34 (69)

Note; Figures in parentheses are the years when 1/5 probable deficits occur.

Table 2.3 Ten Days Mean Deficit in the Year with 1/5 Probability
(2005 demand condition)

(Unit: m^3/s)

Point		6	7	8	9	11	13	21	22	23	26	27	30
Year		1980	1978	1982	1978	1984	1975	1983	1983	1980	1983	1978	1975
Jan.	1	0.	0.	2.77	0.	8.10	6.48	0.	0.	2.79	0.	0.	30.78
	2	0.	0.	3.20	0.	9.68	6.48	0.	0.	7.74	0.	0.	11.78
	3	0.	0.	3.56	0.	12.96	6.48	0.	0.	11.83	0.	0.	24.18
Feb.	1	0.	0.	4.35	0.	15.67	6.53	0.	0.	16.71	0.	0.	37.95
	2	0.	0.	4.45	0.	16.57	6.53	0.	0.	20.90	0.	0.	37.25
	3	0.	0.	4.34	0.	14.16	6.53	0.	0.	19.11	0.	0.	36.85
Mar.	1	0.	0.	5.51	0.	12.71	4.64	0.	0.	9.03	0.	1.08	38.16
	2	0.19	0.	5.58	0.	0.	4.64	0.	0.	13.32	3.75	1.38	39.36
	3	0.40	0.	5.64	0.	8.96	4.64	1.43	2.05	14.82	5.94	3.85	40.66
Apr.	1	0.	0.	0.41	0.	0.	3.07	0.32	0.43	0.48	0.	0.	1.84
	2	0.	0.	0.41	0.	0.	3.07	0.32	0.43	0.68	0.	0.	2.64
	3	0.	0.	0.28	0.	0.	3.07	0.42	0.53	0.68	0.	0.	3.24
May	1	0.06	0.	4.55	0.	0.	6.11	0.	0.	2.81	4.79	0.	34.65
	2	0.11	0.	4.45	0.	0.	6.11	0.	0.	0.	2.96	0.	35.35
	3	0.	0.	4.35	0.	0.	6.11	0.	0.	0.	0.	0.	34.45
June	1	0.43	0.	3.61	0.	0.	5.41	0.	0.	0.	0.	0.	27.79
	2	0.54	0.	1.86	0.	0.	5.41	0.	0.	15.63	0.	0.	33.09
	3	0.54	0.	2.23	0.63	0.	5.41	0.	0.	22.40	1.99	0.	33.89
July	1	0.	1.26	6.14	2.88	0.	7.83	0.	0.	0.	3.24	0.	52.77
	2	0.	1.66	6.17	3.28	0.	7.83	0.	0.	0.	0.	0.	49.47
	3	0.	4.17	6.36	6.32	0.	7.83	0.	0.	0.	0.	0.	52.57
Aug.	1	0.	0.	1.93	0.	0.	4.08	0.	0.	0.	0.	0.	15.33
	2	0.08	0.	1.50	0.	0.	4.08	0.	0.	0.	0.	0.	16.63
	3	0.39	0.	0.	0.	0.	4.08	0.	0.	0.	0.	0.	16.03
Sept.	1	0.	0.	0.	0.	0.	2.26	0.	0.	0.	0.	0.	0.
	2	0.	0.	0.	0.	0.	2.26	0.	0.	0.	0.	0.	1.39
	3	0.	0.	0.	0.	0.	2.26	0.	0.	0.	0.	0.	5.29
Oct.	1	0.	0.	0.	0.	0.	1.65	0.	0.	0.	0.	0.	1.42
	2	0.	0.	0.	0.	0.	1.65	0.	0.	0.	0.	0.	0.
	3	0.	0.	0.	0.	0.	1.65	0.	0.	0.	0.	0.	0.
Nov.	1	0.	0.	0.	0.	0.	2.69	0.	0.	0.	0.	0.	0.
	2	0.	0.	0.	0.	0.	2.69	0.	0.	0.	0.	0.	0.
	3	0.	0.	0.	0.	0.	2.69	0.	0.	0.	0.	0.	3.49
Dec.	1	0.	0.	0.	0.	0.	5.00	0.	0.	0.	0.	0.	14.24
	2	0.	0.	0.19	0.	0.	5.00	0.	0.	0.	0.	0.	0.
	3	0.	0.	2.01	0.	0.	5.00	0.	0.	0.	0.	0.	8.85

Point		31	32	33	34	42	44	46	47	48
Year		1978	1974	1978	1978	1978	1969	1980	1969	1969
Jan.	1	2.53	0.	0.	0.	0.11	3.27	0.	0.	0.
	2	2.72	0.	0.	0.	0.48	3.32	0.	0.	0.
	3	2.89	0.	0.	0.	0.89	3.51	0.81	0.	0.
Feb.	1	3.15	0.	0.	0.35	1.08	3.09	2.07	0.	0.
	2	3.23	0.	0.	0.54	1.18	3.13	1.92	0.	0.
	3	3.00	0.	0.	0.26	1.05	2.71	1.92	0.	0.
Mar.	1	2.32	0.	0.	0.	1.43	4.35	2.49	10.40	8.63
	2	2.35	0.	0.25	0.07	1.51	4.35	2.74	0.	0.
	3	2.51	0.	0.69	0.44	1.66	4.54	1.23	32.00	30.43
Apr.	1	1.57	1.42	0.	0.	0.	0.	0.07	0.	0.
	2	1.57	0.	0.	0.	0.	0.	0.12	0.	0.
	3	0.	1.82	0.	0.	0.	0.	0.37	0.	0.
May	1	2.54	1.73	1.25	0.79	1.46	3.73	2.68	0.	0.
	2	2.69	1.92	1.25	0.84	1.48	1.35	0.	0.	0.
	3	0.	2.74	0.	0.	0.	3.20	0.	0.	0.
June	1	2.57	0.	0.	0.	0.	0.	3.66	0.	0.
	2	2.65	0.	0.25	3.11	1.22	0.	4.16	0.	0.
	3	5.32	0.	0.42	3.20	1.29	2.44	4.32	0.	0.
July	1	5.25	0.	1.09	2.24	1.06	0.	0.	0.	0.
	2	3.99	0.	0.	0.	0.	0.	0.	0.	0.
	3	2.11	0.	0.	0.	0.	0.	0.	0.	0.
Aug.	1	2.40	0.	0.	0.	0.	0.	0.	0.	0.
	2	2.90	0.	0.	0.	0.	0.	0.	0.	0.
	3	0.	0.	0.	0.	0.	0.82	0.	0.	0.
Sept.	1	0.	0.	0.	0.	0.	0.	0.	0.	0.
	2	0.	0.	0.	0.	0.	0.	0.	0.	0.
	3	0.	0.	0.	0.	0.	0.	0.	0.	0.
Oct.	1	0.	0.	0.	0.	0.	0.	0.	0.	0.
	2	0.	0.	0.	0.	0.	0.	0.	0.	0.
	3	0.	0.	0.	0.	0.	0.	0.	0.	0.
Nov.	1	0.	0.	0.	0.	0.	0.	0.	0.	0.
	2	0.	0.	0.	0.	0.	0.	0.	0.	0.
	3	0.	0.	0.	0.	0.	0.	0.	0.	0.
Dec.	1	0.89	0.	0.	0.	0.	0.	0.	0.	0.
	2	1.11	0.	0.	0.	0.	0.	0.	0.	0.
	3	0.45	0.	0.	0.	0.	0.	0.	0.	0.

Table 2.4 1/5 Probable Annual Water Deficit with and without Dams in 2005

Unit:x10^{6}m^3/year

	Balance Point	Annual Deficit for Demand in 2005	
		with Magat Dam only	with Dams
1			
2			
3			
4			
5			
6	Dabubu River IP	2	
7	(Main River at junction of Diadi River)	6	6
8	Gappal IP	75	
9	(Main River at junction of Magat River)	11	9
10	Matuno IP(Manamtam)		
11	Matuno IP(Bayombong)	87	
12			
13	Magat RIS	146	
14			
15	Lulutan IP		
16			
17			
18	Ilagan IP, Tumauini IS (Ilagan)		
19			
20			
21	(Chico No.2 Damsite)	2	2
22	(Chico No.4 Damsite)	3	3
23	Chico RIS	139	
24			
25			
26	Chico RIS (Chico West)	20	
27		6	
28			
29	Siffu RIS		
30	Chico Mallig IP	650	
31	Mallig RIS	55	
32		8	
33	Tumauini IS	5	
34	San Pablo-Cabagan IS	10	10
35	Pinacanauan RIS		
36	Tuguegarao IP		
37	Solana-Tuguegarao IS Alcala-Amulung West IS		
38	CIADP(Iguig)		
39	CIADP(Alcala-Amulung)		
40	Baggao IS (Pared)		
41			
42	Baggao IS (Paranan)	14	
43			
44	Zinundungan RIS and Extension IP	38	
45			
46	Dummon RIS	25	
47	CIADP (Lower Cagayan)	37	
48		34	

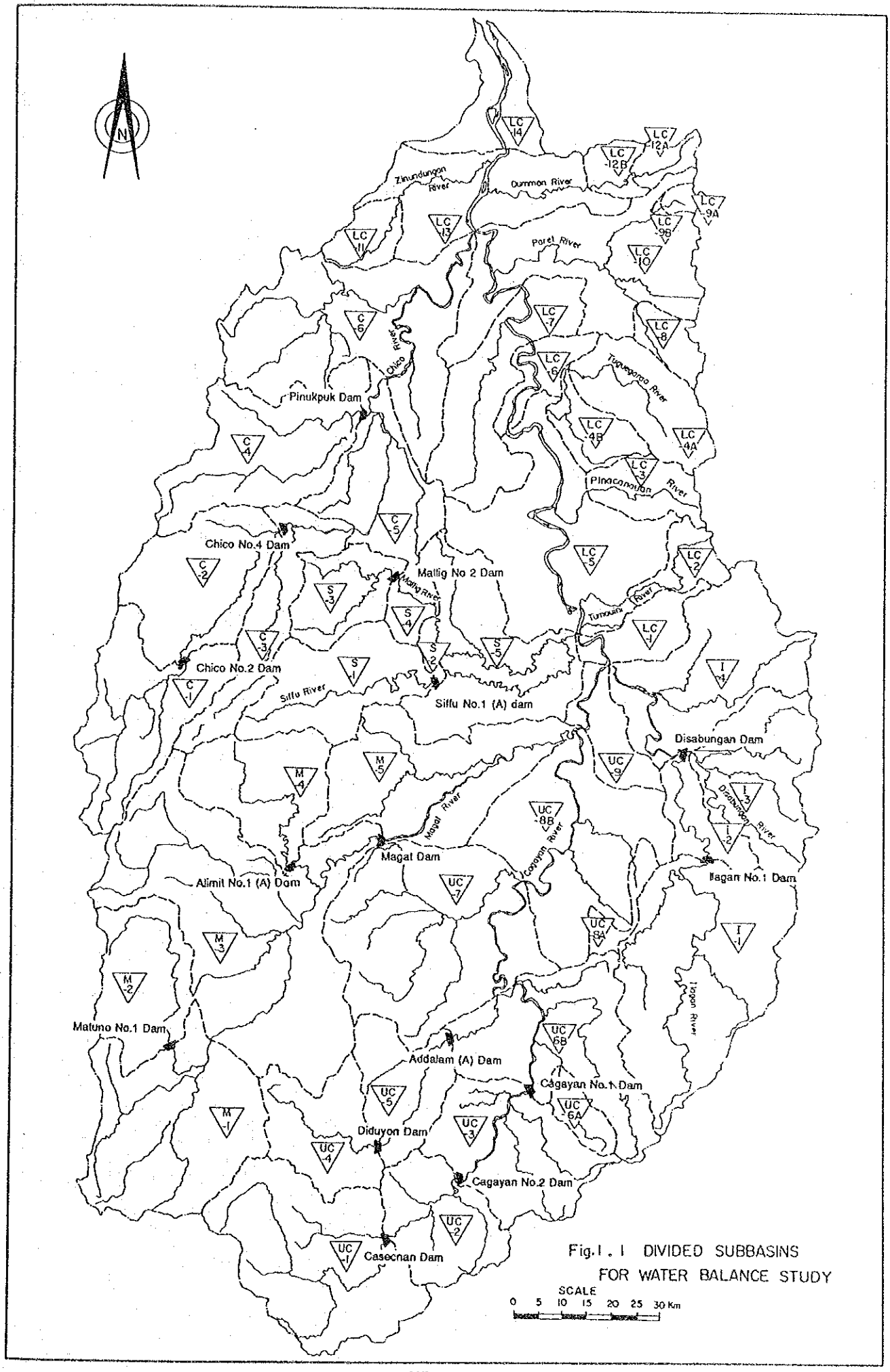

Fig.I.1 DIVIDED SUBBASINS FOR WATER BALANCE STUDY

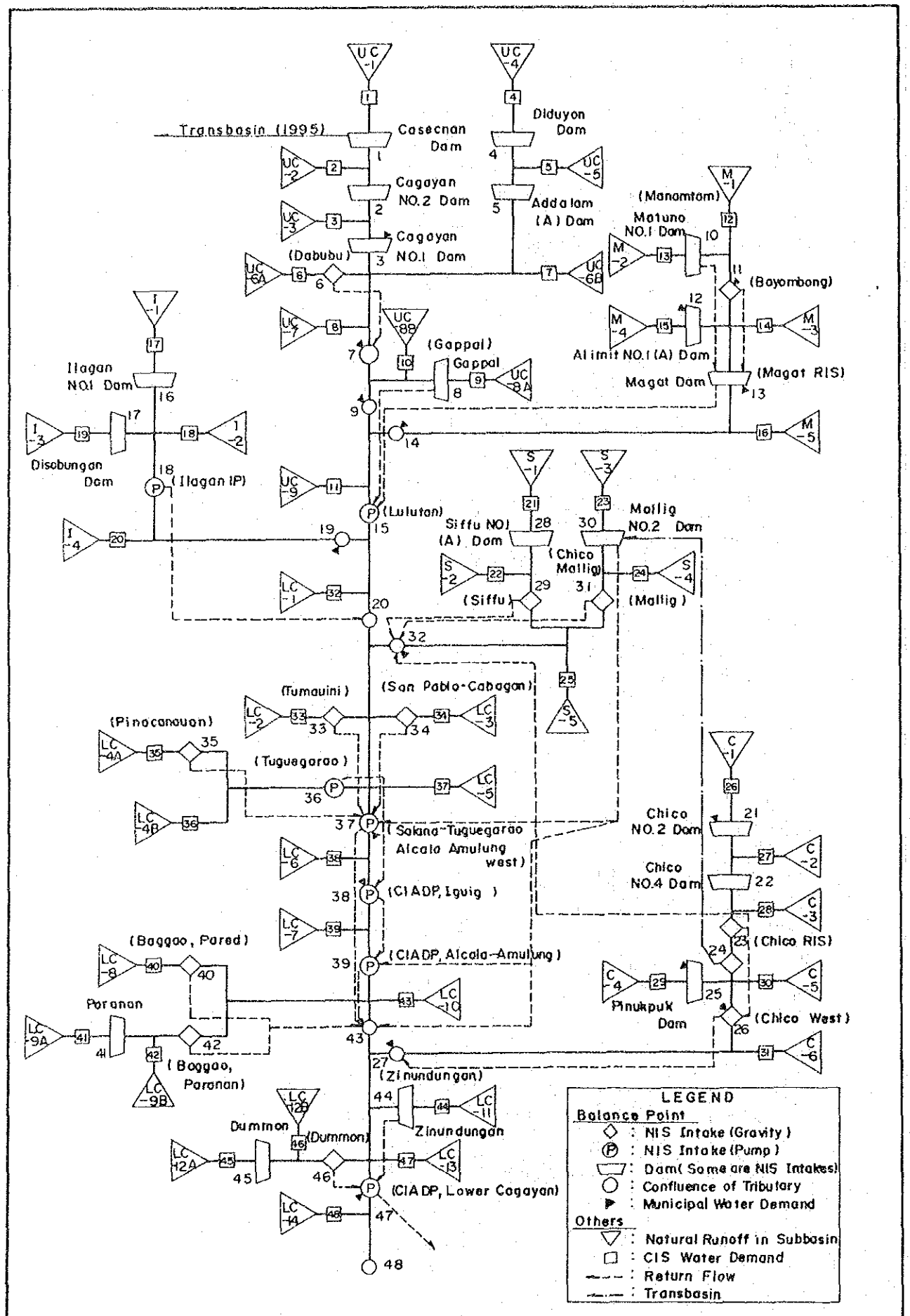

Fig. 1.2 **BASIN MODEL FOR WATER BALANCE STUDY**

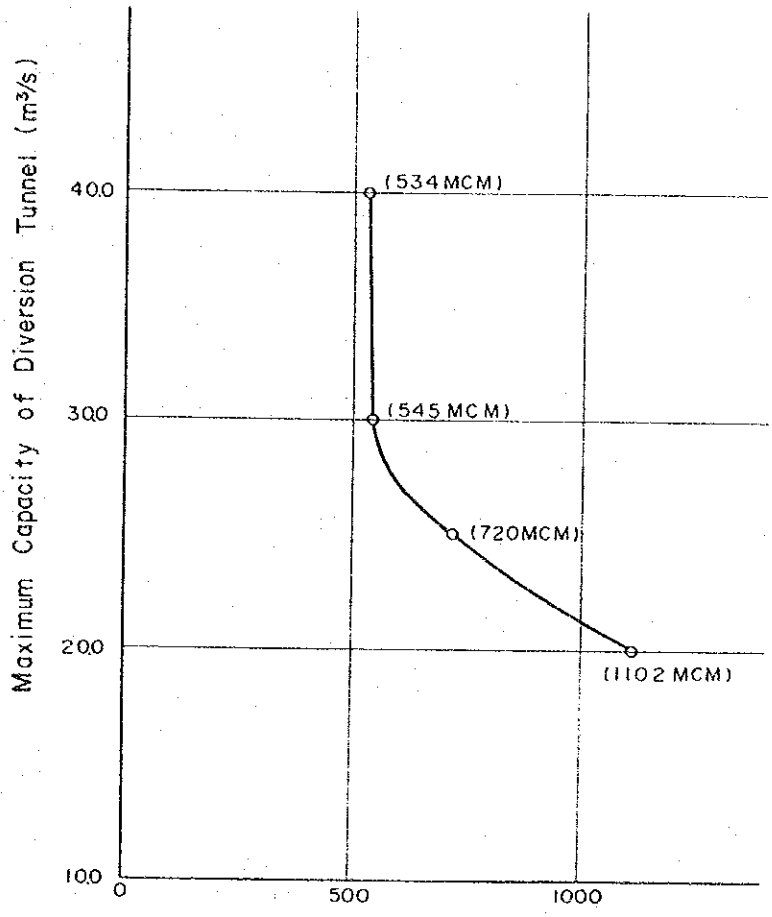

Fig. 3.1 RELATIONSHIP BETWEEN TUNNEL CAPACITY AND STORAGE OF MALLIG NO. 2 DAM

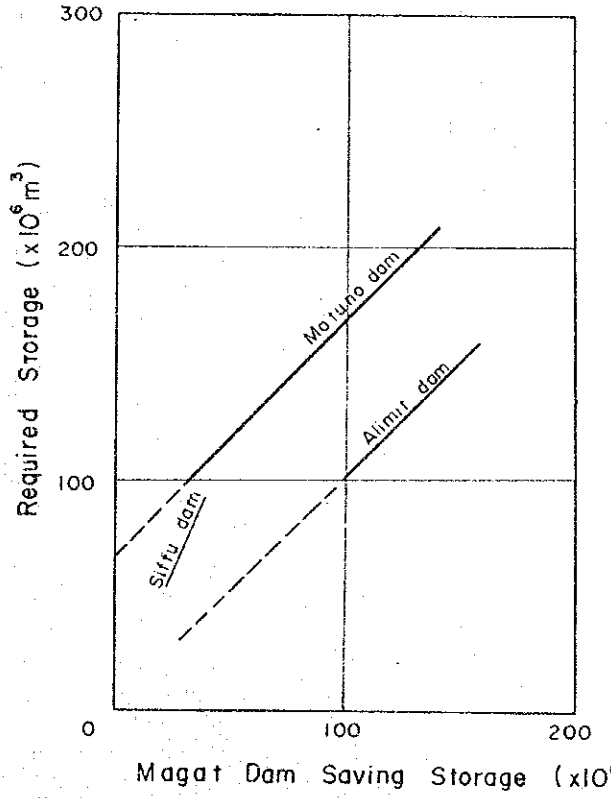

Fig. 3.2 RELATIONSHIP BETWEEN REQUIRED STORAGES OF 3 DAMS AND MAGAT DAM SAVING STORAGE

ANNEX EN

ENVIRONMENT

ANNEX EN

Table of Contents

List of Tables

List of Figures

List of Attachment

I GENERAL

1.1 Objectives of the Environmental Impact Assessment

In general, almost all development projects bring impacts, more or less, on the environment in and around the project areas. Environmental Impact Assessment (EIA) is one of the useful tools to forecast and evaluate negative effects/problems caused by the implementation and operation of the projects.

The purpose of the Cagayan river basin Water Resources Development Study is to prepare a Master Plan for water resources development of the Cagayan river basin. The Master Plan involves various kinds of schemes related to the water resources development, such as dam construction, river improvement, and agriculture development. Therefore, the EIA is conducted in this Master Plan Study as an attempt to clarify whether the proposed project may cause adverse effects on the environment of the project area.

The study level of EIA depends on the study stage of the project, in other words, the specification level of the project. Since the study stage of the proposed Project is a master plan level, a lot of alternative schemes shall be considered in the Master Plan Study. Consequently, the EIA in this Master Plan Study should present available information through the environmental viewpoint for screening of alternatives which are proposed by the sectoral study. Moreover, the result of the EIA should orient a regular environmental study of the next stage.

From this context, the objectives of the EIA in this Master Plan Study are summarized as follows;

(1) To present available information for screening of schemes through execution of the EIA; and

(2) To orient and recommend further environmental study.

1.2 Guideline for Environmental Impact Assessment in the Philippines

1.2.1 Background of EIA in the Philippines

The EIA system in the Philippines is institutionalized by the Government of the Philippines, pursuant to following Presidential Decrees and Proclamation:

- Presidential Decree No. 1121 (1977)
  CREATING THE NATIONAL ENVIRONMENTAL PROTECTION COUNCIL

- Presidential Decree No. 1151 (1977)
  PHILIPPINE ENVIRONMENTAL POLICY

- Presidential Decree No. 1586 (1978)
  ESTABLISHING AN ENVIRONMENT IMPACT STATEMENT SYSTEM INCLUDING OTHER ENVIRONMENTAL MANAGEMENT RELATED MEASURES AND FOR OTHER PURPOSES

- Proclamation No. 2146 (1981)
  PROCLAIMING CERTAIN AREAS AND TYPES OF PROJECTS AS ENVIRONMENTALLY CRITICAL AND WITHIN THE SCOPE OF THE ENVIRONMENTAL IMPACT STATEMENT SYSTEM ESTABLISHED UNDER PRESIDENTIAL DECREE NO. 1586

Pursuant to these Presidential Decrees and Proclamation, the Philippine Environmental Impact Statement System was established. Thus, projects planned by any government agency or private firm, which fall within the definition of an Environmentally Critical Project, or which will be located within an Environmentally Critical Area, shall be requested to prepare the regular EIA which is included in the Feasibility Study Reports in order to obtain an Environmental Compliance Certificate (ECC) issued by the National Environmental Protection Council (NEPC).

1.2.2 Guideline for Environmental Impact Assessment of the Department of Public Works and Highways

Pursuant to Presidential Decree No. 1186 in relation to Section 4 of P.D. No.1151 and Proclamation No. 2146, the Ministry of Public Works and Highways (MPWH) promulgated Ministry Order No. 72, Series of 1982, known as the DPWH Guideline for EIA.

This guideline shall apply to projects planned by DPWH, which are categorized as Environmentally Critical Projects, or which will be located within the Environmentally Critical Areas. The EIA of the proposed project should be conducted in accordance with the guideline of DPWH, because the guideline is officially approved, and has been applied for all projects which are planned by DPWH. The definition of the Environmentally Critical Projects and Areas of DPWH are as follows:

(1) Environmentally Critical Projects

(a) Major dam - a dam with a structure height of more than 15 meters and/or a volume of storage exceeding 50 million cubic meters built across a watercourse to confine/impound/keep back or regulate flowing water,

(b) Major power plants, whether fossil-fueled, nuclear-fueled, hydroelectric, or geothermal,

(c) Major reclamation projects - refers to any large scale activity which will involve the filling or draining of an area larger than one hectare along foreshore areas, marshes, swamps, lakes and rivers,

(d) Major roads and bridges - roads and bridges which will traverse a highly developed urban area, and significantly affect traffic flow.

(2) Environmentally Critical Areas

(a) All areas declared by law as national parks, watershed reserves, wildlife preserves and sanctuaries;

(b) Areas set aside as aesthetic potential tourist spots;

(c) Areas which constitute the habitat for any endangered or threatened species of indigenous Philippine wildlife (flora and fauna);

(d) Areas of unique historic, archaeological or scientific interest;

(e) Areas which are traditionally occupied by cultural communities or tribes;

(f) Areas frequently visited and/or hard-hit by natural calamities (geological hazards, floods, typhoons, volcanic activity, etc.);

(g) Areas with critical slopes;

(h) Areas classified as prime agricultural lands;

(i) Recharge areas of acquifers;

(j) Water bodies characterized by one or any combination of the following conditions;

a) tapped for domestic purpose
b) within the controlled and/or protected areas declared by appropriate authorities
c) which support wildlife and fishery activities

(k) Mangrove areas characterized by one or any combination of the following conditions;

a) with primary pristine and dense young growth
b) adjoining mouth of major river system
c) near or adjacent to traditional productive fry or fishing grounds
d) which act as natural buffers against shore erosion strong winds and storm floods
e) on which people are dependent for their livelihood

(l) Coral reefs characterized by one or any combination of the following conditions;

a) with 50% and above live coralling cover
b) spawning and nursery grounds for fish
c) which act as natural breakwater of coastline

1.3 Outline of the Cagayan River Basin Water Resources Development Project

The Cagayan River Basin Water Resources Development Study has been carried out under the implementing agreement on the technical cooperation between the Japan International Cooperation Agency (JICA) and the Department of Public Works and Highways (DPWH) in the Republic of the Philippines.

The objective of the proposed Project is to formulate the Master Plan for the Cagayan River Basin Water Resources Development, taking into consideration its flood control, irrigation and drainage, and hydropower development. The Master Plan shall include a comprehensive long-term development plan to be materialized within a period of around twenty years. The study area is located in the northern part of Luzon Island and covers all the Cagayan river basin with a watershed area of approximately 27,300 km^2.

1.4 Scope of Work

1.4.1 Schemes Environmental Impact thereof are to be assessed

As mentioned earlier in Section 1.3, the Study proposes various regional development schemes which will sustain the economic policy of the Government of the Philippines during the target period of around 20 years. The water requirement by the proposed schemes enunciates the water demand to be met by the water resources development plan. Accordingly, the Study also proposes various water resources development schemes as well. The principal schemes proposed are dams, river improvement works and, agriculture development works. The EIA focuses on the study of the environmental impacts entailed by these proposed schemes in the light of the adopted guidelines mentioned in the Section 1.2. The following schemes are selected for objectives of the EIA.

(1) Dam Construction ..... 14 major dam schemes
(2) River Improvement ..... levee, retarding basin, cut-off channel
(3) Agriculture Development .... irrigation development, livestock farming development

1.4.2 Aspects of the Environmental Impact Assessment

The aspects of the EIA for the proposed Project are selected through the guideline for EIA and traits of the schemes of the Project.

In general, EIA comprises the natural environment, social environment and economic activities. However, since detailed studies are to be conducted in the relevant sectoral studies, following 3 aspects are not discussed in this section;

. Climate, Natural Calamities
(geologic hazards, floods, typhoons, volcanic activity, earthquakes, tsunami, storm surges, etc.)

. Compensation and Resettlement

. Economic Activities

(agriculture, forestry, fishery, industry, mining, etc.)

The aspects to be assessed on view of the guideline of the DPWH are listed in Table 1.1 for each contemplated project. Among the aspects shown on the Table, Air, Noise and Vibration Hazard, and Offensive Odor are omitted, because it is considered that any scheme of the Project may not cause serious problems on the environment with regard to these aspects, although a slight impact is unavoidable for short period of the implementation thereof. Subsequently, following 6 aspects were encompassed in the EIA for the Project;

(1) Land
(2) Water
(3) Fauna and Flora
(4) Aesthetic or Academic Potential Sports
(5) Cultural Communities or Tribes
(6) Public Health

1.4.3 Methods of the Environmental Study

The objectives of the Environmental Study are to present available information for screening of schemes, and to orient and recommend further environmental study by conducting the EIA related to the proposed Project.

In principle, the analysis of the EIA was conducted by using existing data and the field reconnaissance, because its study level was considered enough for attainment of the objectives. However, further detailed EIA may be needed for scheme to obtain the Environment Compliance Certificate issued by NEPC.

In order to achieve the objectives mentioned above, following a train of study was carried out; and the work flow of the Environmental Study is shown on Fig. 1.1.

(1) Determination of environmental aspects related to the Proposed Project in accordance with the Guidelines for EIA in the Philippines,

(2) Data collection related to each environmental aspect,

(3) Carrying out a field reconnaissance,

(4) Grasp and description of the existing environmental conditions in the Project area,

(5) Execution of EIA for the proposed Project,

(6) Summarization of EIA and recommendation of the further study.

II DESCRIPTION ON THE ENVIRONMENT IN THE CAGAYAN RIVER BASIN

2.1 Land

2.1.1 Land Use

The total land area of the Basin is 27,300 km^2, occupied by forest areas, which is about 11,500 km^2 or 42%, grasslands, about 11,100 km^2 or 40%, agricultural areas, about 4,600 km^2 or 17%, wetland and built-up areas, about 80 km^2. (Refer to Table 2.1) It should be noted that the share of agricultural land of 17% is lesser than the national average of 29%. While the share of grassland, 41% is significantly larger than the national average of 27%.

The Cagayan river basin is primarily an agricultural region. About 1.6 million or 85% of the total population in the rural area are engaged in agricultural activities.

Paddy is the main crop in the Study area. The cultivated land for paddy shares almost half of the total agricultural land. Land for diversified crop and pasture land follow the paddy. Rice and corn are the primary crops which are generally grown along the Cagayan river and at the coastal plains of the basin.

2.1.2 Slope

The areas with less than 18% slope are mainly utilized for agricultural lands, and with 18-30% are mainly for pasture lands. Almost all hilly or mountainous areas with more than 30% slope in the Cagayan river basin are covered primarily grass lands due to deforestation and subsequent destruction of the bushes and secondary vegetations by Kaingerous. In these conditions, soil erosion exposing the rocks and limestone under the grassland has taken place, because grasslands have lower water and soil holding capacity than woodlands due to shorter and less extensive root system. Moreover, the dry season, grasses have a tendency to die and dry out leaving the top soil vulnerable to the first

heavy rain.

2.1.3 Watershed and Forest Reserves

Watershed and forest reserves serve special functions for the ecological life of the basin. Forest areas in the basin should be maintained from wanton destruction by commercial logging activities, shifting cultivation and forest fires. Selective logging, afforestation and, government forest surveillance are policies and programs that the government can undertake for the watershed and forest protection. In this regard, forest conservation measures are being undertaken by the Bureau of Forest Development (BFD) through its reforestation program. Thus, the BFD has identified 20 forest reserves and 3 watershed forest reserves in the Basin. (Refer to Table 2.2, Fig. 3.6)

2.1.4 Land Use Regulatory Measures

The following is a summary on policies and laws concerning land use in the Philippines which will serve as references guide in land use planning.

(1) P.D. 815 - Restrict the conversion of prime agricultural lands for other uses.

(2) P.D. 705 - The Forestry Reform Code of the Philippines was promulgated by the Republic of the Philippines on 19 May 1975. This code defines the functions and responsibilities of the Bureau of Forest Development. It answers all views of forest resources management, utilization, demarcation, protection, enforcement and rehabilitation. This code has several instructions concerning forest policies and the following policies have been adopted:

The multiple uses of forests lands shall be oriented to the development and progress requirements of the country, the advancement of science and technology and the public welfare:

Land classification and survey shall be systematized and hastened:

The establishment of wood-processing plants shall be encouraged and rationalized, and the protection, development and rehabilitation of forest lands shall be emphasized so as to ensure their continuity in production condition.

Section 54. No forest lands 50% in slope or over may be utilized for pasture purposes.

(3) P.D. 331 - The documents stipulated that all public forests be developed, managed and utilized on a sustained yield basis with the assistance of technically, trained and Registered Foresters. As emphasized, it seeks the help of technical personnel to carry out logging practices as well as silvicultural aspects. It seeks to harmonize the productivity and stability of the nation's forest ecosystems.

Implementing guidelines, rules and regulations on forest occupancy serve the purpose of requiring concerning terms of reference in forest occupancy. Strict compliance of the rules and written in the whole context of the agreement.

(4) P.D. 953 - This decree requires every person who owns land adjoining a river or creek, to plan trees extending at least 5 meters on his land adjoining the edge of the bank of the river or creeks, except when such land, due to its permanent improvement, can not be planted with trees. Likewise, every holder of a license agreement, lease, license or permit from the government, involving occupancy and utilization of forest or grazing land with a river or creek therein shall plant trees extending at last 20 meters from each edge of the bank of river or creek.

(5) L.O.I. 423 - This letter of instruction brought a new massive approach towards forest ecosystem management. It directed the creation of a Presidential Council for Forest Ecosystem Management (PROFEM) to

"formulate programs, rules, guidelines, regulations and policies that will maintain and enhance the country's forest ecosystem and further prevent its destructions". It supports the initial thrust of forest ecosystem management, which involves reforestation, afforestation, agro-forestation, establishment of communal forests, family orchards and recreational parks.

(6) L.O.I. 145 - Directed the Presidential Committee on Wood Industries Development to work out and submit a program at promoting the development of industrial forest plantation and tree farms in the Republic of the Philippines. This move has the primary objectives of introducing agro-forestry program and the production of raw materials for wood based industries including the rehabilitation of critical watershed that are resettled.

(7) L.O.I. 409 - Was issued to execute officials of the Department of Natural Resources and Bureau of Forest Development to determine the performance of forest concessionaires and their adherence to forest regulations and policies.

(8) L.O.I 525 - Was issued to expedite the implementation of the government agro-forestry development pilot project under Proclamation No. 1632. The Secretary of Natural Resources is authorized to use funds from the Department to compensate the value of improvement of the various ranchers and small settlers within the agro-forestry development pilot project. It exempts displaced settlers and ranchers from the payment of application fees, registration fees and other requirements for the registration of their land patents or pasture application.

2.2 Water

2.2.1 Waterbodies

Per NEPC definition, waterbodies considered as environmentally critical areas shall refer to waters which are tapped for domestic purposes within the controlled and/or protected areas declared by the appropriate authorities and which support wildlife and fishery activities. This shall cover all fresh surface waterbodies which are class AA, A, B and C, and marine estuarine waters which are class SB and SC as the National Pollution Control Commission (NPCC) Classification. The Table 2.3, 2.4 shows the classification of fresh surface water and its best usage. However, those environmentally critical waterbodies are not designated in the Cagayan river basin.

2.2.2 Water Quality

The results of water quality test at the gauging stations on the Cagayan river basin furnished by the National Water Resource Council (NWRC) as observed in June, July, September and November 1985 are tabulated on Table 2.5, 2.6, and location are also shown on Fig. 2.1. According, likewise, to the water quality criteria set by NPCC as shown on Table 2.3, water in the Cagayan river basin is judged to be usable for irrigation, municipal and industrial purposes though calcium concentration is little high.

While, there are several mining operations in the Basin, such as Batong Buhay Gold Mines, Inc., Gonzaga Lime Plant, Caschrome Inc. and other mining and quarry operations. (Refer to Table 2.7) Few years ago, one of those mining operations, Batong Buhay Gold Mines, Inc., caused severe environmental problems to the local residents particularly those within the municipalities of Tabuk, Rizal, Conner and adjoining areas by its tailings disposal to the Pasil river, one of tributaries of the Chico river. At present, the concentration of water quality shows normal conditions through the result of water quality analysis conducted by the National Irrigation Administration (NIA). (Refer to Table 2.8) And now, no serious

environmental problems are reported in the Basin.

2.2.3 Acquifers

Based on the NEPC map on acquifers, there are medium yield acquifers which are located on the western portion of the Cagayan Province, and northern and western part of the Isabela Province. However, no recharged areas of acquifers for ground water sources replenishment are designated, and any kind of problems related to ground subsidence are not reported in the Cagayan river basin.

2.2.4 Navigation

No information is available concerning inland navigation in the Cagayan river. However, it is known that some parts of the Cagayan river are being used for navigation to provide better accessibility mainly due to lack of roads and bridges, transport vehicles, or the poor condition of the roads specially along the interior portions of the Cagayan basin.

2.3 Fauna and Flora

2.3.1 Vegetation

The vegetation of the Cagayan river basin, is a part of the tropical rainforest biome, represents a vast storehouse of biological resources which makes it an abundant genetic pool. So, the basin has provided various kind of fundamental materials for human being. But, uncontrolled logging and inadequate cultivation of the forest land brought serious environmental problems such as topsoil erosion, deterioration of wildlife habitats and wood resources.

In the present land use condition of the Cagayan basin of 27,300 km^2, forest area occupies about 11,500 km^2 or 42.0%. This condition means that the Cagayan river basin still has a large amount of forest resources. However, wide spreaded grassland areas usually located on hilly lands are one evidence of past excessive logging without consideration of the forest

regeneration.

In this regard, 3 watershed forest reserves and 21 forest reserves were designated in order to preserve forest resources as already mentioned 2.1.3. Moreover, there are 16 existing reforestation projects in the Region II. It embrances the provinces of Cagayan, Isabela, Ifugao, Quirino and Nueva Vizcaya, and the entire area of the projects covers about 1,100 km^2. Afforestations of those projects are aimed to bring about utilization of idle land which have been unproductive for, any years, protection of watershed, minimized soil erosion caused by destructive logging and shifting cultivation practices. Total approximate area of 300 km^2 plantation of different tree species was established by 1985. Now, these forest protection practices show a steady progress of watershed conservation in the Basin.

While, in the Cagayan river basin, there are no so wide and important Mangrove areas. Only common sea-coast vegetation can be found at the river mouth areas near Aparri.

2.3.2 Wildlife

In general, the wildlife depends on the condition of its habitats especially vegetation. It has been reported many kinds of wildlife, such as insects, amphibians, reptiles, birds and mammals in the Basin because of distribution of wide tropical rainforests. At present, however, very few available data do not allow to prepare sufficient inventories of wildlife species.

According to the existing reports, some fish, birds and animals can be seen in the basin. The indigenous fish found in the Cagayan river and its tributaries are mudfish, catfish, goby and mullet. Some freshwater fish which were introduced several years ago have adopted well to their habitats and now grow abundantly. The most common fish are carp, milkfish and tilapia. Species known to migrate up the Cagayan river system to live a part of their life cycle and then return to ocean or estuary to spawn are eel, mullet and shrimp. The Cagayan river is one of river systems which

abounds eel fry of elvers in the Philippines. As for eel and shrimp, commercial culture methods have been established, but mullet is now under difficult conditions in the Cagayan river.

Mullets mean the fish belonging to the family of Mugilidae, and about twenty species of mullets identified in the Philippines. In the Cagayan river, four species of mullets called local name "Ludong", can be seen. Once, the Cagayan river was abundant source of mullets. But the number of mullets have been diminished by uncontrolled fishing, because mullets are economically very important for the local people. Thus, in June 6, 1982, the Fisheries Administrative Order No. 139 was promulgated by the Minister of Natural Resources (MNR) for protection and conservation of mullets in all inland waters of the Philippines, subject to "ESTABLISHING A CLOSED SEASON OF FIVE YEARS TO CATCH OR TAKE, SELL, POSSESS AND TRANSPORT MULLETS IN ALL THE INLAND WATERS OF THE PHILIPPINES".

While, ecological investigation and development of artificial spawning methods of mullets have been carrying out by the study team consisted with MNR and the Bureau of Fishery and Aquatic Resources (BFAR) from 1979 to 1981 in the upstream area of the Cagayan river. The study team reported some ecological information about mullets, but there were no remarkable progress related to the implementation of the induced-spawning of mullets. A brief ecological description of mullets is as follows:

- Mullet fry abounds in coastal shallow waters near estuaries and river mouth areas during milkfish fry season (April-July),

- Mullets, maybe, start upstream migration during the beginning of rainy season (May-June),

- Mullets on young stage usually feed on plankton, while adults feed on algae and decayed organic matters on bottom and surface,

- Habitat of mullet is rather deep, clean, clear and unpolluted water body,

- Flooded and swift currents conditions of the Cagayan river hasten downstream migration of mullet spawners,

- Mullets on spawning stage are usually caught during September to November.

Other terrestial fauna in the Basin consist of deer, wild pig, monkey and bat. Actually, most of these wildlife species are found in the deep forest of mountainous areas of the basin. But some of them, can be seen at grasslands and agricultural areas. The most common bird species are imperial pigeon, quail, kingfisher, ricebird and wild duck. The list of common wildlife in the basin is shown on Table 2.9.

2.3.3 Endangered Species

Wildlife habitats and niches are containers of wildlife populations available with many of the natural elements such as forests and water courses performing a variety of functions for survival and propagation. Destructive operations, pushing a large number of wildlife species to the brink of extinction.

At present, 24 species, 11 birds, 8 mammals and 5 reptiles, were designated as the rare and threatened Wildlife in the Philippines. Following 5 species of them can be seen in the Cagayan river basin:

Bird

- Philippine Eagle (Pithecophage jefferyi)
- Rufous Hornbill (Buceros hydrocorax)
- Blue-napped Parrot (Tanygnathus lucionensis)
- Bleeding-heart Pigeon (Gallicolumba luzonica)

Mammal

- Philippine Dear (Cervus philippinus)

The list of rare and threatened Philippine wildlife is shown on Table 2.10.

2.3.4 Wildlife Conservation

Wildlife management, which calls for conservation and protection, is a part of land use management. Up to the recent years, protection of wildlife has been given the least importance in natural resources conservation, probably because the role that it plays in the environment is not properly understood. However, at present, protection and conservation of wildlife becomes a nationwide concern.

In the Philippines, there are four major causes of wildlife habitat destruction:

- Overlogging, logging out or clear cutting of forests,
- Conversion of prime wildlife habitats into agricultural land or fishfarm,
- Shifting cultivation practiced by marginal-income families and cultural minorities,
- Inadequate and uncommitted wildlife protection.

The first three causes show difficulties of a wildlife management that short term benefits from human operations conflict with the long term value of wildlife diversity. The last cause is a result primarily of insufficient funding to bear the costs involved in wildlife protection.

Under these conditions, National Parks (NP), Game Refuges and Bird Sanctuaries (GRBS) has been established for the sake of adequate wildlife protection by the government of the Philippines. Pursuant to specific enactments, 60 National Parks and 12 Game and Refuge and Bird Sanctuaries were reserved for purpose of parks and wildlife by 1982. National Parks comprise an estimated area about 4,300 km^2, while GRBS encompass an estimated area about 11,900 km^2 in the Philippines.

In the Cagayan river basin, there are following three National Parks and one Game and Bird Sanctuary. The total area of those designated areas are about 9,926 hectares.

National Park

- Callao Cave National Park (192 Has)
- Balbalasang-Balbalan National Park (1,338 Has)
- Fuyot Spring National Park (819 Has)

Game Refuge and Bird Sanctuary

- Magapit Game Refuge and Bird Sanctuary (7,577 Has)

The list of National Parks and Game Refuge and Bird Sanctuary in the Cagayan river basin, and those location map are shown on Table 2.11, Fig. 3.5.

2.4 Aesthetic or Academic Potential Spots

2.4.1 Tourist Spots

In Region II, particularly the provinces of Cagayan, Ifugao and Nueva Vizcaya offer some notable tourist attractions. Callao Caves Resort and Park, Penablanca; Punta Lakay-lakay rock formation, Claveria; Mapaso Hot Springs, Gattaran, are all in Cagayan. Ifugao (Banaue) Rice Terraces one of the world's wonders is located in Ifugao. While Nueva Vizcaya is noted for the Salinas Hot Spring, Bambang; Malico Plateau and Balangabank Rice Terraces, a replica of the rice terraces in Banawe.

Of the tourist attractions mentioned above, the following are located in the Cagayan river basin:

(a) Callao Caves Resort and Park

It is located in Penablanca, Cagayan at $121^{o}49'$ north latitude, $17^{o}42'$ east latitude and has an area of 250.6 hectares. Likewise, officially declared as national park per Presidential Proclamation No. 827 on July 16,

1935. It has seven chambers, which bats and red billed Kalaw bird for whom the cave has been named, once made this their home. One of its features is a chapel found in the second chamber, where a large round hole in the roof through which sunlight serves as spotlight in the stone altar. A natural garden is also found in one of the chambers. Six permanent furnished cottages and one dormitory were constructed on a mound right across the entrance. These are for rent for tourists and visitors in its effort to promote the place. From 1981-1985, it had registered a total of 151,485 tourists, 94% are domestic while only 6% are foreign tourists.

(b) Ifugao (Banaue) Rice Terraces

The centuries old rice terraces believed to have been carved by hardly mountain farmers more than 2,000 years ago. Rice terraces are not that unique Philippine practices, because rice terraces culture is practices to date in Indonesia and Japan. But due to its magnitude and perfection, this tourist spot is believed to be incomparable with those of other countries. In rises majestically to an altitude of about 1,524 meters above sea level and encompassing 4,000 sq. miles, these terraces encircle mountains that are thousands of feet high. It depicts Ifugaos longstruggle for survival and eventual conquest of a harsh circumstance. Here, man fought against nature and succeeded in converting barren stone mountains into arable ledges where rice can grow.

(c) Mapaso Hot Spring

It is located in Gattaran, Cagayan and famous for its black and metallic bed hissing with sulfuric water. It can be reached by cars, buses and jeeps in one hour from Tuguegarao.

(d) Salinas Hot Spring

It is found in Bambang, Nueva Vizcaya. Likewise, near Salinas Forest and Deer Refuge. What makes it unique is this hot spring looks like tall white mountains.

(e) Malico Plateau

Malico Plateau which is 1,222 meters above sea level is noted for its temperature similar to Baguio, summer capital of the Philippines. Due to its temperature and scenic attraction, many visitors have visited this place especially during the months of March and April.

Although, there are tourists spots in Region II, there are no areas considered as critical areas set aside as aesthetic potential tourist spots as declared and reserved by the Philippine Tourism Authority of the Ministry of Tourism. As such, Region II is not included in the Tourism Investment Priorities Plan (TIPP) which refers to the annual listing of tourism activities to be encouraged and given priority, and also refer to the tourism facilities required to supply the needs of foreign tourists and travellers that can be established with incentives. In the determination of tourism investment project sites, it is necessary to consider policies of the government with respect to the preservation of the national environment and maintenance of ecological balance. In this reason, tourist zones within the priority provinces which have been declared as national parks, national wildlife sanctuaries are not open for tourism superstructure development such as constructing modern hotels and other facilities which may disturb or destroy the environment. However, this does not mean that the establishment of similar facilities in other areas such as the provinces that comprise the Cagayan river basin which are not included in the TIPP will be disapproved or discouraged, provided that they do not apply for government incentives or government financial assistance.

2.4.2 Historical, Scientific and Archaeological Sites

The Cagayan Province, one of the provinces of the basin, has a very rich and dramatic history. To the trained eye the soil surface easily yields and array of stone tools, fossilized bones and other materials which record the geologic background and prehistoric cultural part of Cagayan. Research made by the National Museum and field researchers of the Cagayan Museum have revealed vast archaeological assets. Due to its richness in prehistoric wealth, the whole province has been declared as an

archaeological nets as per Presidential Decree (P.D.) 1109. By virtue of such P.D. areas where indication of archaeological treasures are found have been declared as archaeological reservations and placed under the control and supervision of the National Museum. Based on previous study, the Isabela Province has likewise some archaeological sites. However, in the Basin, no major archaeological site has so far been located. Some sites though outside the Basin.

Likewise, as shown in the map of the National Environmental Protection Council (NEPC) on critical areas of historical, scientific and archaeological sites, it has indicated the following as critical areas:

(1) Kalinga Apayao/Cagayan Valley Archaeological Reservation

This area is specifically located on the east flank of the Pangul anticline and near the south nose of another big, North South trending anticline, the Cabalwan. To the west beyond the Pangul anticline is the plateau of Tabuk through which the Chico river cuts its way to the sea. The barangays nearest to the site are Nabbutuan and Pallao, Solana, Cagayan only 2.5 kms to the east; and Macutay, Rizal, Kalinga-Apayao, to the South-east.

As found by previous workers of the National Museum, they have verified the occurrence of two utilized flake scraps. They were retrieved in-situ, embedded in fine argillanceous sandstone bed which otherwise would be sandstone. There was also the recovery of elephant bone fossils, almost intact and in-situ in a tuffaceous claystone, member of the same formation but much lower than the bed containing the flake tools by 4.5 meter bed thickness; it would mean that the two flake scrapes and the elephant fossil are separated by roughly 7,500 years.

The findings tend to affirm the belief that man (tool maker, probably Home erectus) and Pleistocene mammal existed in the Philippines particularly in the plain of Cagayan valley as early as Mid-Pleistocene or during the Ice Age when land bridges, now submerged, connected Luzon with mainland Asia.

(2) Ifugao Rice Terraces (Banaue)

It is considered as Cultural Treasure, and its description is on 2.4.1.

(3) Kiangan War Memorial (Bantayog sa Kiangan), Kiangan, Ifugao

This is considered as a national shrine, in honor of the Filipinos who fought in World War II. It is located infront of the Ifugao Museum. No other information is available on this historical site.

The above mentioned historical, cultural and archaeological sites may be considered as potential tourist spots, particularly the famous Ifugao Rice Terraces.

2.5 Cultural Tribes

Before the Spaniards invaded the Cagayan river basin, there were already organized into well defined tribes, each occupying separate fortified places. These were the Negritos, Orags, and Ibanags in the Cagayan river valley, the Igorots, Ifugaos, Tingians and Kalingas in the western mountains, and the Ilongots in the southern area of the Basin, the present provinces of Nueva Vizcaya and Quirino. Up to this time there are number of them, either living the foothills, mountains or lowlands. Settlement areas for national minorities were established by the Presidential Assistance for National Minorities (PANAMIN) within the provinces of Cagayan and Isabela. The distribution of respective cultural minorities in the basin is shown on Table 2.12.

Total 26 settlement areas are located in the Cagayan river basin. In the Cagayan Province, there are 14 settlement areas, wherein prodominantly composed of Aetas (Negritos), Tinguians, Igorots and Kalingas. Their population range from 105 to 1085 people (1985), and settlement areas from 150-900 hectares. While, there are three settlement areas in the Isabela Province, composed of Dumagats/Aetas, whose population ranges from 271 to

1023. Both settlement areas are located in the Cagayan river basin. The Ifugao Province has two settlement areas, namely, Payawan with 1500 Ifugaos and Pugal with 610 Ifugaos. The areas they occupied are all ancestral lands of National Cultural Communities identified in Section 1 of P.D. No. 410 and settlements by the then PANAMIN, now Office of Muslim Affairs and Cultural Communities (OMACC) for national minorities. The settlement areas of the basin is shown on Table 2.13, and location of respective settlement areas is shown on Fig. 2.2.

The following description of major or well-known ethnic groups in the Cagayan river basin is an informative attempt at disclosing the lifestyles of these people, economy, domestic affairs and pertinent indigenous culture.

(1) NEGRITOS

The Negritos are sometimes called Aeta, Agta, Dumagat, Dyango and Paranan. Basically, their sources of livelihood are hunting, fishing and barter economy. Hunting activities are done during dry season with bows and arrows. While fishing is done in streams and rivers usually with bare hands.

Most of the groups have long been in contact with Filipinos living close to their semi-nomadic settlements. Their contacts have exposed them to their economic relations such that resin and timber gathered from forest are sold to Christians in the lowlands. Baskets, winnous, mats and hammocks woven by this people are used for bartering purposes with outsiders. The political life is simple, where the father assumes the role of governor of family affairs while the elder men control over affairs which are usually of adjudicative nature. Everyone is considered equal and usually no one is appointed chief.

(2) IFUGAOS

These group of people are living in the province of Ifugao located in the Central Cordillera Mountains have been also called "Ifugaws" or "Ipugaws", which means "from the earth". Several groups of them are Banaue, Mayayaw, Kiangan, Hungduan, Lagawe, Potia and Lamut groups. Rice is the major crop which is cultivated in swidden or in rice terraces. Other crops are sugarcane, sweet potato, beans, corn, jam and several other vegetables.

They live in small local clusters of scattered homesteads and sometimes into hamlets of two dozens or so houses. Two kinds of housing, namely, "abong" (hut) which is a temporary dwelling, and the "bale" (house) which is considered to be an architectural ingenuity of the Ifugaos as housebuilders because the whole building is set up without nails and very minimal rattan lashings. The Ifugaos practice polytheism with their dieties divided into classes according to their functions. Their dieties are not adorned or loved but feared. One of the practices of religious significance is headhunting. A head is hunted and taken to mean a gained social status determinant of the person who took it. It is believed that there will be an increased in land fertility, hence more food and yield.

(3) ILONGOTS

This group are found in the southern Sierra Madre and Caraballo Mountains. Further divided into groups with their own dialect and customs. Along the upper water of the Cagayan river is the Italon group which is short of Mongol mixture, the second group is Egongut who lives in the Tabaya river while the primitive Abaka group inhabits the Conwap river. Fishing and hunting are their main occupation. Fish are caught in traps as well as nets with small fish, crabs and crayfish. While wild pigs and deer are common catch from hunting. Sudden farming is used in cultivating camote, upland rice, gabi, bananas, corn, and sugarcane. Other occupation are basketry and trading of forest products such as rattan, honey, beenwax for their necessities such as salt, cloth, brasswire, pots and steels.

The social organization is called alipian consisting of about eleven of more houses, each alipian is under the control of a chief or head called beganganat who assumes the position of a leader by virtue of age or ability. Headhunting is likewise practised, usually coincides with the blooming of the Arbor del Fuego (Flame Tree). Heads taken are considered as trophies and are hang from the rafters of the houses. They are also polytheists, for them there are two gods, Cain and Abal, who are the creators and guardian lords of all things. They likewise, pay homage to the sun, moon and stars, fire and anitos.

(4) KALINGAS

This group has the most ethnic diversity with several minorities who intermingled in physical type, language and culture. They are divided into "north" and "south" and sometimes "east". Wet rice cultivation from the Bontoc area was introduced by them and resulted in an observable gradient from south to north. The title of "Peacocks of the Philippines" was attributed to their distinctive stress on ceremonial costumes. In a way assert their sence of superiority over their drab fellows in the adjacent Christian lowlands. The northern Kalingas are less traditional than the southern Kalingas. Hunting is their main economic pursuit in the mountains. Sometimes by means of rifles or traps for catching game, with rituals aimed to ensure that traps will catch their prey.

The Kalingas are shifting cultivators. Rice is supplementered with yam, banana and vegetables such as beans and cabbages. They are also noted for manufacturing of spears and headaxes which people from surrounding mountain areas trade for or buy from them. Weaving cloth is an occupation of the south Kalinga women, while the north Kalinga women find it easier clothing material from them. The society they line in is characterized by "warrior instincts". Warrior chiefs carry weight in group decisions but membership in this class does not guarantee a position of community leadership. Additional qualification of shelt in arbitrary disputes and sufficient wealth are needed. The dominant leader are called pangat. The Kalingas believe that everything that happen to them is the working of the spirits (anito or alon).

(5) IBANGAS

This group of people used to occupy the main Cagayan plain with to their expansion up the valleys or their assimilation into the modern Ibanag's milieu are specifically found in the provinces of Cagayan, Isabela, along the banks of the Cagayan river, and the northern crail of Luzon. Before the Spaniards arrived, Ibanags are already cultivating wet rice on the lower Cagayan river flats and dry rice on the hills. Today, Ibanags are agricultural workers, who grew rice as the main staple, but due to state control on the tobacco monopoly they were forced to substitute corn. They depend on the annual overflowing of the Cagayan river instead of using fertilizers or soil nutrients. Whatever remained of the ancient Ibanag beliefs have been deeply immersed with Catholicism. Today the Ibanags are more of a linguistic group rather than an isolated cultural group.

The preceding ethnographic profile was presented mainly to provide an overview of the life and culture of ethnic communities within the vicinity of the proposed projects especially those who in the course of project implementation may be adversely affected. In places where future relocation and resettlement would be deemed necessary the information provided are hoped to serve as basis in the consideration of the group of people who will have to move. With regard to construction of major dams, the usual response of those affected tribes has been persistent opposition and resistance. For these communities and culture took years to develop and to solidity. It is imperative therefore, to search for all alternative sites should be exhausted. Likewise, assess the implication of any change so as to minimize disruptions and to maximize benefits.

2.6 Public Health

2.6.1 Health Status

The health status of the Region II has improved due to the implementation of health programs of the Ministry of Health through the Regional Health Office No. 2. The 1985 figures of vital indices showed a decrease in total births, total deaths and infant deaths with minimal increase in maternal and foetal deaths as shown on Table 2.14. The crude birth rate had declined by 4% from 23.96 in 1984 to 23.0 in 1985. Likewise, the crude death had decreased by 8.7%. The infant mortality rate has decreased by 18.5%, while maternal death rate in 1985 was 0.65 or a slight increased from 1984.

Primary health needs in the Region II are served by a total of 603 health centers including 118 hospitals. Of the figure about 61% of 366 are Barangay Health Stations (BHS) for a total of 2,668 barangays. A total of 1,915 bed capacity of government hospitals, giving a bed population ration of 1:1309, while bed population ratio of private hospitals is 1:2267. (Refer to Table 2.15)

2.6.2 Water Borne and Vector Transmitted Disease

Similar to any part of the country, enteric, metabolic and respiratory diseases are prevalent human diseases in the Region II. The following discussion, however, will deal on the water borne and vector transmitted diseases. Cholera, typhoid and para typhoid fever, dysentery and diarrhea are water borne diseases, while malaria, schistosomiasis and filariasis are vector transmitted diseases.

Based on 1980-1983 health statistics of the four mentioned water borne diseases, diarrhea has the highest cases, morbidity and mortality rates. (Refer to Table 2.16) Spread of these diseases can be due to improper sewage and solid waste disposal, inadequate or absence of treatment of domestic water supply, lack of health education and unsanitary practices of the inhabitants and inadequate health facilities and services. While,

disease outbreaks, especially typhoid fever, often accompany flood conditions when contaminated river enters drinking water supplies.

With regard to vector transmitted diseases, the most prevalent is malaria. Three types of malaria are found in the Region II, namely, falciparum, tertian and mixture type of falciparum and tertian. Falciparum malaria is caused by plasmodium falciparum and had about 62-65% occurrences while tertian is caused by plasmodium vivax had about 30-32% occurrences. The mixture type had only 3%. The number of persons afflicted with this disease varies as seasonal changes. It has a peak during rainy season from July-October. Due to its geographical location, the Cagayan River Basin is malaria endermic area.

One of the health improvement programs is the Malaria Control Program. Primary health care is the approach used in the effective implementation of the different activities of this program. The community participated inhouse spraying of DDT, clearing of streams and the seeding of larvivarous fish in streams, broochs, and ponds which are the breeding places of anopheles mosquitoes. The evidence indicates that schistasomiasis is virtually absent in the Region II. Oncomelania sp., the snail vector of schistosomiasis is not known to occur, but surveillance will maintained in order to prevent its introduction and subsequent spreading. (Refer to Table 2.17)