

ANNEX-H

MINI-HYDROPOWER DEVELOPMENT

ANNEX - H

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1. MINI-HYDROPOWER DEVELOPMENT PLAN

1.1 General

As clarified in ANNEX-A "Selection of the High Priority Project", two sites of No.1 and No.2, and a combination of site No.1 and No.2 from 110 potential sites which NIA contemplated, were selected for the feasibility study of the mini-hydropower development project.

The site No.1 is located in the Tabuk Supply Canal No.1 within the Chico River Irrigation System. It is near Bulanao town in Kalinga Apayao province. The site has easy access and relatively short distance of 2.5 km from Tabuk sub-station.

The site No.2 is located in the Main Supply Canal within the Chico River Irrigation System. It is 2 km west from Agbannawag town in Kalinga Apayao province and accessible from the national and provincial roads. The distance is about 18.5 km from Tabuk sub-station.

The location of the sites is shown in Fig. 1.1.

The basic concept of the mini-hydropower development projects at the sites is:

- (i) to generate economic electric power and
- (ii) to sell all the electric power generated to NAPOCOR through the existing Tabuk sub-station.

1.2 Optimum Development Plan

In order to determine the optimum scale of the mini-hydropower development plan at the sites No.1 and No.2, the least construction cost per kWh to each site was examined for four alternative discharges with consideration of fluctuation in canal discharges (Duration curve at Site No.1 and No.2 is illustrated in Figs. 1.2 and 1.3).

As a result, the optimum scale of the installed capacity of plant was decided at 700 kW for Site No.1 and 770 kW for Site No.2 as shown in Table 1.1.

1.3 Basic Design Concept of Electrical Equipment and Intake Facilities

Basic design concept of electrical equipment and intake facilities is as follows:

- 1) Water turbine is to be designed as horizontal Francis Single flow turbine which has a simple structure and can control discharge from irrigation canal without quick fluctuation.
- 2) Electromotive operating system without pressure oil supply system will be adopted for guide vane control mechanism.
- 3) No inlet valve will be adopted from economical viewpoint.
- 4) Generator having a synchronous type will be taken to prevent occurrence of voltage drop on transmission line and large shock to power system when generators are parallel into power system.

5) Penstock made from welding thickness.

1.4 Mini-Hydropower Development Plan

1.4.1 Arrangement of Power Distribution System

The generated electric power by the mini-hydropower plant at No.1 and No.2 sites was planned to be sent to Tabuk sub-station via 13.8 kV transmission line to be installed by NIA, and can be consumed in the service area of KALCO and Tuguegarao through NAPOCOR's 69 kV transmission line. The arrangement of power system is shown on Fig. 1.4.

The plan of the mini-hydropower developments at the sites No.1 and No.2 is outlined as follows:

1.4.2 Features of the Mini-hydropower Plants

(i) Maximum discharge

The maximum discharge is determined from economical viewpoint by estimating annual possible power generation in consideration of fluctuation in discharge. Duration curve has been prepared on the basis of monthly average canal discharge from 1984 to 1987 as shown in Fig. 1.2 for site No.1 and Fig. 1.3 for site No.2. As a study result, maximum discharge has been determined to be 4 m³/sec at site No.1 and 12 m³/sec at site No.2, respectively.

(ii) Efficiency of water turbine, generator and transformer

An efficiency of water turbine, generator, increaser and transformer is designed as follows:

Water turbine	:	85% for site No.1 84% for site No.2
Generator	:	95% for sites No.1 & No.2
Increaser	:	96% for site No.2

(iii) Effective height of drop

An effective of height of drop is estimated to be 22.10 m at site No.1 and 8.55 m at site No.2 taking into consideration the head loss.

(iv) Estimation of expected output

An expected output is estimated by the following formula:

$$P = 9.8 \times H \times Q \times Et \times Eg \times Ei$$

where, H : height of drop (m)
Q : discharge (m³/sec)
Et : turbine efficiency
Eg : generator efficiency
Ei : increaser efficiency

The output is estimated as 700 kW for No.1 site and 770 kW for No.2 site.

(v) Estimation of generated energy

The generated energy expressed in kWh is determined by generated output (P) times power operation hours (hr).

Annual possible power generation has been obtained from the following formula.

$$\text{Annual possible power generation} = P \times E \times 24 \times 365$$

where, P : output corresponding to the maximum discharge
E : annual water utilization factor (0.75) = annual discharge available/maximum discharge x 365 (see Figs. 1.2 and 1.3).

The estimated generated energy is 4,511 MWh for No.1 site and 5,062 MWh for No.2 site.

1.4.3 Specification of Mini-hydropower Plants

(i) Water turbine

		Site No.1	Site No.2
Type		HF-1RS	HF-1RS
Effective head	(m)	22.1	8.55
Discharge	(m ³ /sec)	4.0	12.0
Output	(kW)	736	845
Speed	(rpm)	600	165

Note: HF-1RS: Horizontal shaft Fransis type one runner

Speed governor is direct current motor operated with electronic type governor.

Level governor is applied to control the output corresponding to discharge fluctuation.

(ii) Generator

Type : Synchronous generator with salient pole revolving field type.

		Site No.1	Site No.2
Output	(kVA)	778	855
Output	(kW)	700	770
Speed	(rpm)	600	900
Power factor	0.9	0.9	
Voltage	(kV)	3.3	3.3
Frequency	(Hz)	60	60
Increaser ratio		N/A	5.5
No. of pole		12	8

Before parallel into power system, generator terminal voltage can be constantly controlled by automatic voltage regulator and after parallel into power system, the power factor can be constantly controlled by automatic power factor controller.

(iii) Switchgear for generating equipment

The panels of indoor type are provided for generator control, protection, power distribution and battery and battery charger and 3.3 kV indoor cubicles for generator switchgear are provided.

(iv) 13.8 kV outdoor switchgear

The switchgear for connecting generator to 13.8 kV transmission line comprises with main transformer, circuit breaker, disconnecting switch, potential transformer, current transformer and lightning arrester.

(v) Lifting device

Motor operated monorail hoist having 5 ton in capacity is provided on ceiling in power house is installed for installation and maintenance of water turbine and generator.

(vi) 69 kV/13.8 kV switchgear at Tabuk sub-station

The switchgear comprises main transformer, disconnecting switch, lightning arrester, potential and current transformers, gas circuit breaker and metering outfit.

(vii) Transformer

Transformer is applied to oil immersed natural air cooled outdoor use type with no-voltage tap changer on high tension side.

The specification is as follows:

		Site No.1	Site No.2	Combination
Rated capacity	(kVA)	800	900	1,600
Rated frequency	(Hz)	60	60	60
No. of phase		3	3	3
Connection		Yd1	Yd1	Yd1
Rated voltage 1st	(kV)	3.3	3.3	13.8
Rated voltage 2nd	(kV)	13.8	13.8	66
Tap voltage	(kV)	F14.5-F13.8- R13.2-F12.5- F12.0	F14.5-F13.8- R13.2-F12.5- F12.0	F72-F69- R-66-F63- F60
Cooling		ONAN	ONAN	ONAN

Note: Yd1 means delta-star connection.
ONAN means oil immersed natural air cooled

1.4.4 Arrangement of Mini-hydropower Plants

- (i) Arrangement of mini-hydropower plant for No.1 and No.2 sites comprised with plan and profile is shown on Fig. 1.5 for No.1

site and Fig. 1.6 for No.2 site. These drawings show power house, penstock, intake facilities, tailrace and existing irrigation facilities.

(ii) Arrangement of Tabuk sub-station

The transmitted electricity is received to 13.8 kV switchgear and transformed to 69 kV voltage level by transformer and connected to 69 kV bus of the existing switchgear.

The arrangement of equipments is shown on Fig. 1.7.

(ix) Arrangement of 13.8 kV transmission line

The transmission line is installed between No.2 site and Tabuk sub-station and is branched on the midpoint of 2.5 km from Tabuk sub-station for No.1 site. The transmission line is 18.5 km in total route length and installed passing along Chico Main Diversion Canal with 16 km in length and crossing on 2.5 km pasture. The route of transmission line is shown on Fig. 1.8.

2. COST ESTIMATE

2.1 Project Cost

The construction cost comprises installation cost of water turbine, generator, increaser, transformer, switchgear, battery and battery charger, 69 kV sub-station, 13.8 kV transmission line, metal works and civil works of their installation, engineering and administration cost and contingency.

The engineering and administration cost is assumed as 15% of the direct cost and the contingency is estimated as 10% of both the direct cost and the engineering and administration cost.

All prices are expressed in constant 1988 price, and a standard conversion of US\$1.00 = Peso 21 = Yen 135. The estimated construction cost is shown on Table 2.1.

2.2 Operation and Maintenance Cost

The operation and maintenance cost is assumed to be 1.5% of the project cost.

2.3 Fund Requirement

The fund requirement for implementation of each of the project was estimated based on the price escalation factor and the implementation schedule, as shown in Table 2.1.

3. PROJECT EVALUATION

To confirm the project assessment, the economic and financial analysis was carried out for Site No.1, Site No.2 and a combination of Site No.1 and No.2 plan.

3.1 Precondition

Following preconditions are applied on the analysis.

- 1) The economic useful life of the project is 35 years.
- 2) All prices are expressed in 1988 constant price.
- 3) The exchange rate of US\$1.00 = Peso 21 = Yen 135.
- 4) A standard conversion factor of 0.83 is applied to local cost necessary for civil works.
- 5) The construction of each of the projects will be done for two years.
- 6) The construction cost is disbursed to 60% of the total construction cost in the first year and 40% in the second year.
- 7) Benefit and O&M cost will occur in the third year.

3.2 Economic Analysis

3.2.1 Economic Cost

The cost is composed of economic capital cost and operation and maintenance cost.

a) Economic construction cost

The economic cost was estimated by the applying conversion factor of standard conversion rate (0.83) to local currency portion of the construction cost. The economic cost is shown below:

	(Unit: 10 ³ US\$)
Site No. 1	2,348
Site No. 2	2,853
Combination	4,858

b) Operation and maintenance cost

The economic operation and maintenance cost was estimated taking account of standard conversion rate of the financial annual operation and maintenance cost as shown below:

	(Unit: 10 ³ US\$)
Site No. 1	38
Site No. 2	46
Combination	79

3.2.2 Benefit

The power benefit of each of the prospective power development project is estimated as the saving cost by supplying electric energy from mini-hydropower plant instead of supply from alternative diesel power plant which has equivalent power output. Capacity value is not considered in this case because dependable capacity is nearing zero in case of 90% period. The benefit is calculated by the following formula:

$$CB = Q_f \times C_f \times kWh \times AF$$

where, CB : benefit
Q_f : fuel consumption rate (lit/kWh) = 0.2844
C_f : fuel cost (US\$/lit) = 0.3
AF : adjustment factor for energy = 1.01

3.2.3 Economic Analysis

The economic analysis was carried out by economic internal rate of return (EIRR) as shown in Table 2.2. The study result is as follows:

(Unit: US\$1,000)

	Site No.1	Site No.2	Combination
Economic capital cost	2,348	2,853	4,858
Benefit	389	436	825
O&M cost	38	46	79
EIRR (%)	13.7	12.5	14.0

3.2.4 Sensitivity Analysis

The sensitivity analysis was carried out with following 3 cases:

- Case-A : Increasing of 10% cost
- Case-B : Decreasing of 10% benefit
- Case-C : Combined with Case-A and Case-B

The results of sensitivity analysis are shown below:

(Unit: %)

	Site No.1	Site No.2	Combination
Case A	12.3	11.2	12.6
Case B	12.2	11.1	12.5
Case C	10.9	9.9	11.2

3.3 Financial Analysis

The repayment capacity for the capital cost (fund requirement) of the project was examined by a preparing cash flow statement for each of the mini-hydropower development project.

On the basis of fund requirements, cash flow statements were prepared under assumption of the following conditions:

- i) The foreign currency portion will be financed by the Government through a financing institution at an assumed interest rate of 2.7% per annum for a repayment period of 30 years including a grace period of 10 years.
- ii) The local currency portion will be financed by the Government from its own resources with no interest and 25 years repayment period and
- iii) The revenue depends on the sale of the annual energy generated by the mini-hydropower plant at a rate of 0.0486 US\$/kWh. The annual energy to be sold is estimated to be 95% of the generated energy. The cash flow statements for each project are shown in Table 3.1.

Table 1.1 STUDY OF OPTIMUM DEVELOPMENT PLAN

Item	Site No. 1				Site No. 2			
	Case 1	Case 2	Case 3	Case 4	Case 1	Case 2	Case 3	Case 4
Net Head (m)	22.1	22.1	22.1	22.1	8.55	8.55	8.55	8.55
Discharge (m ³ /s)	3.5	3.75	4.0	4.5	10.0	11.0	12.0	12.5
Output (kW)	612	656	700	787	642	706	770	802
Annual Energy (1,000 kWh)	4,284.16	4,402.44	4,510.80	4,642.56	4,487.04	4,790.16	5,061.67	5,092.92
Construction Cost* (1,000 US\$)	2,403.70	2,477.06	2,516.39	2,699.13	2,899.34	2,974.93	3,072.10	3,123.32
Cost per kWh (US\$)	0.561	0.563	0.558	0.581	0.646	0.621	0.607	0.613
Priority	2	3	1	4	4	3	1	2

Remark : * = not including price contingency

Table 2.1 COST ESTIMATE

Item	(Unit: 1,000 US\$)								
	Site No. 1			Site No. 2			Combination		
	FC	LC	Total	FC	LC	Total	FC	LC	Total
(1) Generating Equipment									
- Water turbine	496	-	496	646	-	646	1,142	-	1,142
- Generator	323	-	323	280	-	280	603	-	603
- Increaser	N/A	-	0	108	-	108	N/A	-	0
- Indoor switchgear	200	-	200	200	-	200	400	-	400
- DC supply	46	-	46	46	-	46	92	-	92
- Transformer	29	-	29	32	-	32	61	-	61
- Outdoor switchgear	67	-	67	67	-	67	133	-	133
(1) Sub-total:	1,161	-	1,161	1,378	-	1,378	2,539	-	2,539
(2) 13.8 kV T/L & 69 kV Sub-station									
- Transformer	40	-	40	43	-	43	63	-	63
- 69 kV & 13.8 kV sub-station	251	-	251	251	-	251	251	-	251
- 13.8 kV T/L	11	14	25	70	89	160	81	103	185
(2) Sub-total:	302	14	316	365	89	454	396	103	499
(3) Penstock	-	60	60	-	63	63	-	123	123
(4) Intake Gate	-	26	26	-	26	26	-	51	51
(5) Civil Work	-	427	427	-	507	507	-	934	934
(6) Sub-total of (1) to (5)	1,463	526	1,989	1,743	685	2,429	2,935	1,212	4,147
(7) Engineering and Administration Cost	219	79	298	262	103	364	440	182	622
(8) Sub-total of (6) to (7)	1,682	605	2,288	2,005	788	2,793	3,376	1,393	4,769
(9) Contingency	168	61	229	200	79	279	338	139	477
(10) Project Cost (8) to (9)	1,850	666	2,516	2,205	867	3,072	3,713	1,533	5,246
(11) Price Contingency*									
1st year	114	84	198	136	109	245	228	193	421
2nd year	117	88	205	139	115	254	234	203	437
(11) Sub-total	231	172	403	275	224	499	462	396	858
(1,000 Peso)	(4,851)	(3,614)	(8,465)	(5,768)	(4,703)	(10,471)	(9,712)	(8,317)	(18,018)
(12) Fund Requirement**									
1st year	1,224	484	1,708	1,459	630	2,089	2,456	1,113	3,569
2nd year	857	354	1,211	1,021	461	1,482	1,719	816	2,535
(12) Sub-total	2,081	388	2,469	2,480	1,091	3,571	4,175	1,929	6,104
(1,000 Peso)	(43,698)	(8,148)	(51,846)	(52,082)	(22,911)	(74,993)	(93,975)	(40,502)	(134,477)

Remarks:

- * = Price contingency was taken into account on the basis of an annual escalation rate of 10% for the local currency portion and 5% for the foreign currency portion
- ** = Fund requirement consists of 60% of total fund requirement in the 1st year of implementation year and 40% in the 2nd year

Table 2.2 ECONOMIC COSTS AND BENEFITS FLOW

SITE NO.1

Year	(Unit : thousands US \$)			Total	Benefit
	Capital Cost	O. & M. Cost	Benefit		
1	1,409	0	1,409	0	0
2	939	0	939	38	389
3	0	38	38	38	389
4	0	38	38	38	389
5	0	38	38	38	389
6	0	38	38	38	389
7	0	38	38	38	389
8	0	38	38	38	389
9	0	38	38	38	389
10	0	38	38	38	389
11	0	38	38	38	389
12	0	38	38	38	389
13	0	38	38	38	389
14	0	38	38	38	389
15	0	38	38	38	389
16	0	38	38	38	389
17	0	38	38	38	389
18	0	38	38	38	389
19	0	38	38	38	389
20	0	38	38	38	389
21	0	38	38	38	389
22	0	38	38	38	389
23	0	38	38	38	389
24	0	38	38	38	389
25	0	38	38	38	389
26	0	38	38	38	389
27	0	38	38	38	389
28	0	38	38	38	389
29	0	38	38	38	389
30	0	38	38	38	389
31	0	38	38	38	389
32	0	38	38	38	389
33	0	38	38	38	389
34	0	38	38	38	389
35	0	38	38	38	389
36	0	38	38	38	389
37	0	38	38	38	389

SITE NO.2

Year	(Unit : thousands US \$)			Total	Benefit
	Capital Cost	O. & M. Cost	Benefit		
1	1,712	0	1,712	0	0
2	1,141	0	1,141	46	436
3	0	46	46	46	436
4	0	46	46	46	436
5	0	46	46	46	436
6	0	46	46	46	436
7	0	46	46	46	436
8	0	46	46	46	436
9	0	46	46	46	436
10	0	46	46	46	436
11	0	46	46	46	436
12	0	46	46	46	436
13	0	46	46	46	436
14	0	46	46	46	436
15	0	46	46	46	436
16	0	46	46	46	436
17	0	46	46	46	436
18	0	46	46	46	436
19	0	46	46	46	436
20	0	46	46	46	436
21	0	46	46	46	436
22	0	46	46	46	436
23	0	46	46	46	436
24	0	46	46	46	436
25	0	46	46	46	436
26	0	46	46	46	436
27	0	46	46	46	436
28	0	46	46	46	436
29	0	46	46	46	436
30	0	46	46	46	436
31	0	46	46	46	436
32	0	46	46	46	436
33	0	46	46	46	436
34	0	46	46	46	436
35	0	46	46	46	436
36	0	46	46	46	436
37	0	46	46	46	436

COMBINATION

Year	(Unit : thousands US \$)			Total	Benefit
	Capital Cost	O. & M. Cost	Benefit		
1	2,915	0	2,915	0	0
2	1,943	0	1,943	79	825
3	0	79	79	79	825
4	0	79	79	79	825
5	0	79	79	79	825
6	0	79	79	79	825
7	0	79	79	79	825
8	0	79	79	79	825
9	0	79	79	79	825
10	0	79	79	79	825
11	0	79	79	79	825
12	0	79	79	79	825
13	0	79	79	79	825
14	0	79	79	79	825
15	0	79	79	79	825
16	0	79	79	79	825
17	0	79	79	79	825
18	0	79	79	79	825
19	0	79	79	79	825
20	0	79	79	79	825
21	0	79	79	79	825
22	0	79	79	79	825
23	0	79	79	79	825
24	0	79	79	79	825
25	0	79	79	79	825
26	0	79	79	79	825
27	0	79	79	79	825
28	0	79	79	79	825
29	0	79	79	79	825
30	0	79	79	79	825
31	0	79	79	79	825
32	0	79	79	79	825
33	0	79	79	79	825
34	0	79	79	79	825
35	0	79	79	79	825
36	0	79	79	79	825
37	0	79	79	79	825

Discount Rate (%)	Cost		B/C	B-C
	Benefit	Cost		
13.0	2,309	2,206	1.05	102.86
13.1	2,289	2,202	1.04	86.58
13.2	2,268	2,198	1.03	70.55
13.3	2,248	2,193	1.02	54.77
13.4	2,228	2,189	1.02	39.24
13.5	2,209	2,185	1.01	23.96
13.6	2,189	2,180	1.00	8.91
13.7	2,170	2,176	1.00	-5.91
13.8	2,152	2,172	0.99	-20.50
13.9	2,133	2,168	0.98	-34.86
14.0	2,115	2,164	0.98	-49.00
14.1	2,097	2,160	0.97	-62.92
14.2	2,079	2,156	0.96	-76.64
14.3	2,061	2,152	0.96	-90.14
14.4	2,044	2,148	0.95	-103.44
14.5	2,027	2,144	0.95	-116.54

Discount Rate (%)	Cost		B/C	B-C
	Benefit	Cost		
12.0	2,843	2,737	1.04	105.76
12.1	2,816	2,731	1.03	84.72
12.2	2,790	2,726	1.02	64.02
12.3	2,764	2,720	1.02	43.67
12.4	2,738	2,714	1.01	23.65
12.5	2,713	2,709	1.00	3.96
12.6	2,688	2,703	0.99	-15.42
12.7	2,663	2,698	0.98	-34.48
12.8	2,639	2,692	0.98	-53.23
12.9	2,615	2,687	0.97	-71.68
13.0	2,591	2,681	0.97	-89.83
13.1	2,568	2,676	0.96	-107.69
13.2	2,545	2,670	0.95	-125.27
13.3	2,523	2,665	0.95	-142.57
13.4	2,500	2,660	0.94	-159.59
13.5	2,478	2,655	0.93	-176.34

Discount Rate (%)	Cost		B/C	B-C
	Benefit	Cost		
13.5	4,687	4,523	1.04	163.88
13.6	4,646	4,514	1.03	131.74
13.7	4,606	4,506	1.02	100.10
13.8	4,566	4,497	1.02	68.95
13.9	4,527	4,488	1.01	38.27
14.0	4,488	4,480	1.00	8.06
14.1	4,450	4,471	1.00	-21.66
14.2	4,412	4,463	0.99	-50.98
14.3	4,375	4,454	0.98	-79.83
14.4	4,338	4,446	0.98	-108.24
14.5	4,302	4,438	0.97	-136.23
14.6	4,266	4,430	0.96	-163.80
14.7	4,230	4,421	0.96	-190.95
14.8	4,196	4,413	0.95	-217.70
14.9	4,161	4,405	0.94	-244.06
15.0	4,127	4,397	0.94	-270.02

Table 3.1 (1/3) CASH FLOW STATEMENT (SITE NO. 1)

(Unit: 1,000 US \$)

Year in	Capital Cost		Loan Repayment		O & M Cost		Cash Outflow		Cash Inflow		Balance Accumulation
	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	
Order											
1	1,224	484	33	0	0	0	1,741	1,224	484	0	1,708
2	857	354	56	0	0	0	1,267	857	354	0	1,211
3	0	0	56	0	38	0	94	0	0	208	114
4	0	0	56	0	38	34	128	0	0	208	81
5	0	0	56	0	38	34	128	0	0	208	105
6	0	0	56	0	38	34	128	0	0	208	186
7	0	0	56	0	38	34	128	0	0	208	267
8	0	0	56	0	38	34	128	0	0	208	347
9	0	0	56	0	38	34	128	0	0	208	428
10	0	0	56	0	38	34	128	0	0	208	508
11	0	0	53	104	38	34	229	0	0	208	589
12	0	0	51	104	38	34	226	0	0	208	568
13	0	0	48	104	38	34	223	0	0	208	550
14	0	0	45	104	38	34	221	0	0	208	535
15	0	0	42	104	38	34	218	0	0	208	523
16	0	0	39	104	38	34	215	0	0	208	513
17	0	0	37	104	38	34	212	0	0	208	507
18	0	0	34	104	38	34	209	0	0	208	503
19	0	0	31	104	38	34	206	0	0	208	502
20	0	0	28	104	38	34	204	0	0	208	504
21	0	0	25	104	38	34	201	0	0	208	508
22	0	0	22	104	38	34	198	0	0	208	516
23	0	0	20	104	38	34	195	0	0	208	526
24	0	0	17	104	38	34	192	0	0	208	539
25	0	0	14	104	38	34	190	0	0	208	555
26	0	0	11	104	38	34	187	0	0	208	574
27	0	0	8	104	38	34	184	0	0	208	595
28	0	0	6	104	38	34	181	0	0	208	619
29	0	0	3	104	38	34	178	0	0	208	646
30	0	0	0	104	38	34	142	0	0	208	676
											743

Remarks: FC = Foreign Currency, LC = Local Currency
 Condition of Loan Repayment; Interest 2.7%
 Foreign Currency 0.0%
 Local Currency 0.0%
 Repayment Period 30 years (including grace period)
 25 years

Table 3.1 (2/3) CASH FLOW STATEMENT (SITE NO. 2)

(Unit: 1,000 US \$)

Year in	Capital Cost		Loan Repayment		Cash Outflow		O & M		Total		Cash Inflow		Balance Accumulation	
	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC		
Order			Interest Principal		Principal		Cost							
1	1,459	630	39	0	0	0	0	0	2,128	1,459	630	0	2,089	-39
2	1,201	461	72	0	0	0	46	0	1,734	1,201	461	0	1,662	-72
3	0	0	72	0	0	0	46	0	118	0	0	234	234	116
4	0	0	72	0	44	44	46	0	161	0	0	234	234	72
5	0	0	72	0	44	44	46	0	161	0	0	234	234	72
6	0	0	72	0	44	44	46	0	161	0	0	234	234	72
7	0	0	72	0	44	44	46	0	161	0	0	234	234	72
8	0	0	72	0	44	44	46	0	161	0	0	234	234	72
9	0	0	72	0	44	44	46	0	161	0	0	234	234	72
10	0	0	72	0	44	44	46	0	161	0	0	234	234	72
11	0	0	68	133	44	44	46	0	291	0	0	234	234	-57
12	0	0	65	133	44	44	46	0	287	0	0	234	234	-54
13	0	0	61	133	44	44	46	0	284	0	0	234	234	-50
14	0	0	57	133	44	44	46	0	280	0	0	234	234	-46
15	0	0	54	133	44	44	46	0	277	0	0	234	234	-43
16	0	0	50	133	44	44	46	0	273	0	0	234	234	-39
17	0	0	47	133	44	44	46	0	269	0	0	234	234	-36
18	0	0	43	133	44	44	46	0	266	0	0	234	234	-32
19	0	0	40	133	44	44	46	0	262	0	0	234	234	-28
20	0	0	36	133	44	44	46	0	259	0	0	234	234	-25
21	0	0	32	133	44	44	46	0	255	0	0	234	234	-21
22	0	0	29	133	44	44	46	0	251	0	0	234	234	-18
23	0	0	25	133	44	44	46	0	248	0	0	234	234	-14
24	0	0	22	133	44	44	46	0	244	0	0	234	234	-10
25	0	0	18	133	44	44	46	0	241	0	0	234	234	-7
26	0	0	14	133	44	44	46	0	237	0	0	234	234	-3
27	0	0	11	133	44	44	46	0	233	0	0	234	234	0
28	0	0	7	133	44	44	46	0	230	0	0	234	234	4
29	0	0	4	133	44	44	46	0	226	0	0	234	234	7
30	0	0	0	133	0	0	46	0	179	0	0	234	234	55

Remarks: FC = Foreign Currency, LC = Local Currency
 Condition of Loan Repayment: Interest 2.7%
 Foreign Currency 0.0%
 Local Currency 0.0%
 Repayment Period 30 years (including grace period)
 25 years

Table 3.1 (3/3) CASH FLOW STATEMENT (COMBINATION)

(Unit: 1,000 US \$)

Year in Order	Capital Cost		Loan Repayment		Cash Outflow		O & M		Total		Cash Inflow		Balance Accumulation	
	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC
1	2,456	1,113	66	0	0	0	3,635	2,456	1,113	0	3,569	-66	-66	
2	1,719	816	113	0	0	0	2,648	1,719	816	0	2,535	-113	-179	
3	0	0	113	0	0	79	191	0	0	0	442	251	72	
4	0	0	113	0	77	79	268	0	0	0	442	174	245	
5	0	0	113	0	77	79	268	0	0	0	442	174	419	
6	0	0	113	0	77	79	268	0	0	0	442	174	592	
7	0	0	113	0	77	79	268	0	0	0	442	174	766	
8	0	0	113	0	77	79	268	0	0	0	442	174	939	
9	0	0	113	0	77	79	268	0	0	0	442	174	1,113	
10	0	0	113	0	77	79	268	0	0	0	442	174	1,286	
11	0	0	107	209	77	79	472	0	0	0	442	442	1,257	
12	0	0	101	209	77	79	466	0	0	0	442	442	1,233	
13	0	0	96	209	77	79	460	0	0	0	442	442	1,214	
14	0	0	90	209	77	79	455	0	0	0	442	442	1,202	
15	0	0	85	209	77	79	449	0	0	0	442	442	1,195	
16	0	0	79	209	77	79	443	0	0	0	442	442	1,193	
17	0	0	73	209	77	79	438	0	0	0	442	442	1,197	
18	0	0	68	209	77	79	432	0	0	0	442	442	1,207	
19	0	0	62	209	77	79	426	0	0	0	442	442	1,223	
20	0	0	56	209	77	79	421	0	0	0	442	442	1,244	
21	0	0	51	209	77	79	415	0	0	0	442	442	1,271	
22	0	0	45	209	77	79	410	0	0	0	442	442	1,303	
23	0	0	39	209	77	79	404	0	0	0	442	442	1,341	
24	0	0	34	209	77	79	398	0	0	0	442	442	1,385	
25	0	0	28	209	77	79	393	0	0	0	442	442	1,434	
26	0	0	23	209	77	79	387	0	0	0	442	442	1,489	
27	0	0	17	209	77	79	381	0	0	0	442	442	1,550	
28	0	0	11	209	77	79	376	0	0	0	442	442	1,616	
29	0	0	6	209	77	79	370	0	0	0	442	442	1,688	
30	0	0	0	209	0	79	287	0	0	0	442	442	1,842	

Remarks: FC = Foreign Currency, LC = Local Currency
 Condition of Loan Repayment: Interest 2.7%
 Foreign Currency 0.0%
 Local Currency 0.0%
 Repayment Period 30 years (including grace period)
 25 years

Fig. 1.1 LOCATION OF MINI-HYDRO SITES NO.1 AND NO.2

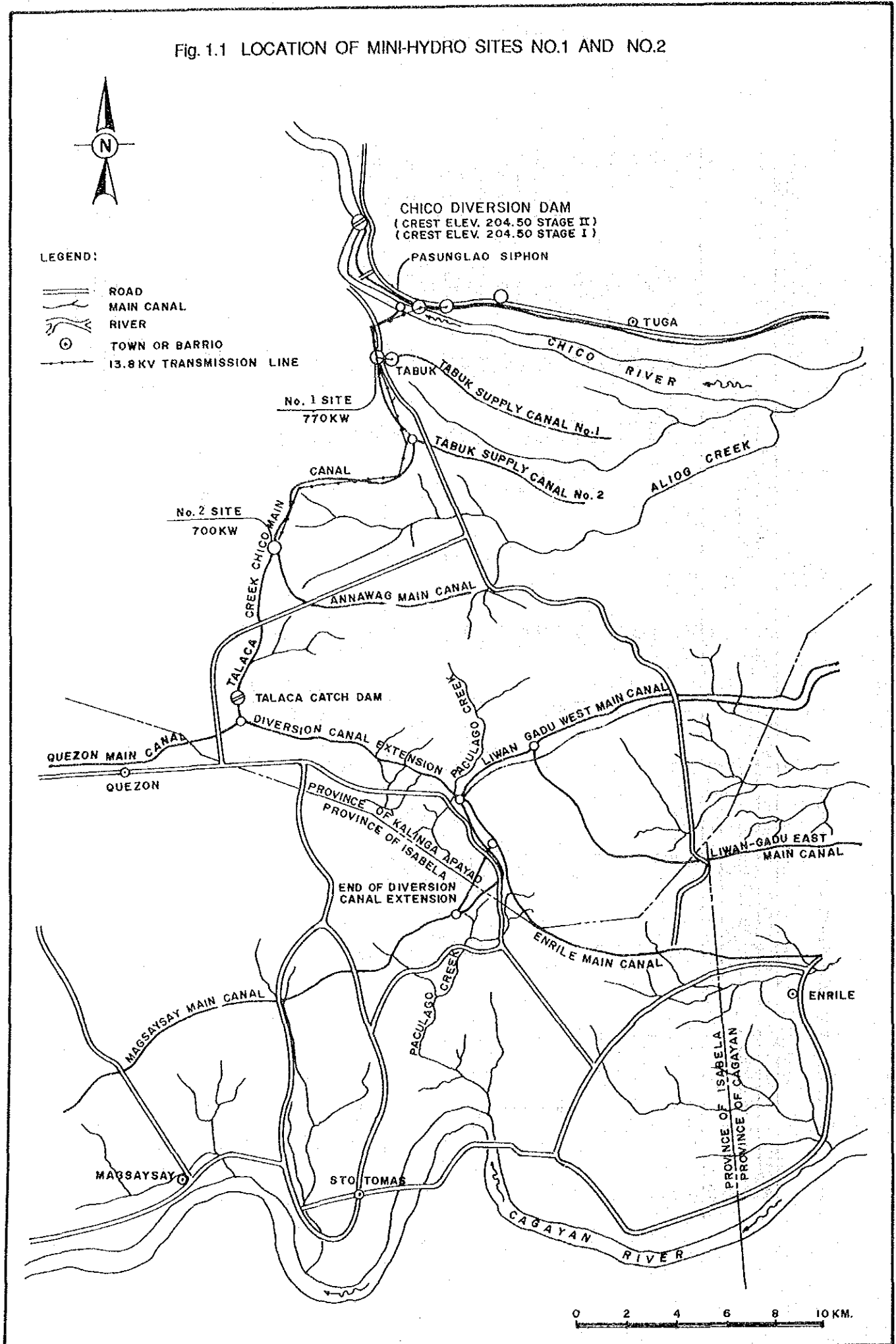


Fig. 1.2 DURATION CURVE AT CHICO MC. TABUK SUPPLY CANAL NO.1 (SITE NO.1)

From the data during 1984 to 1987

	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC
Q max.(m ³ /s)	3.951	5.491	5.175	4.725	3.160	2.346	2.151	4.424	4.951	5.927	2.913	2.622
Q min (")	2.760	3.720	2.559	2.188	0.518	0	0	1.793	2.986	2.498	2.148	2.155
Q ave.(")	3.240	4.637	3.933	3.423	1.960	1.326	1.829	3.469	4.233	4.346	2.530	2.388

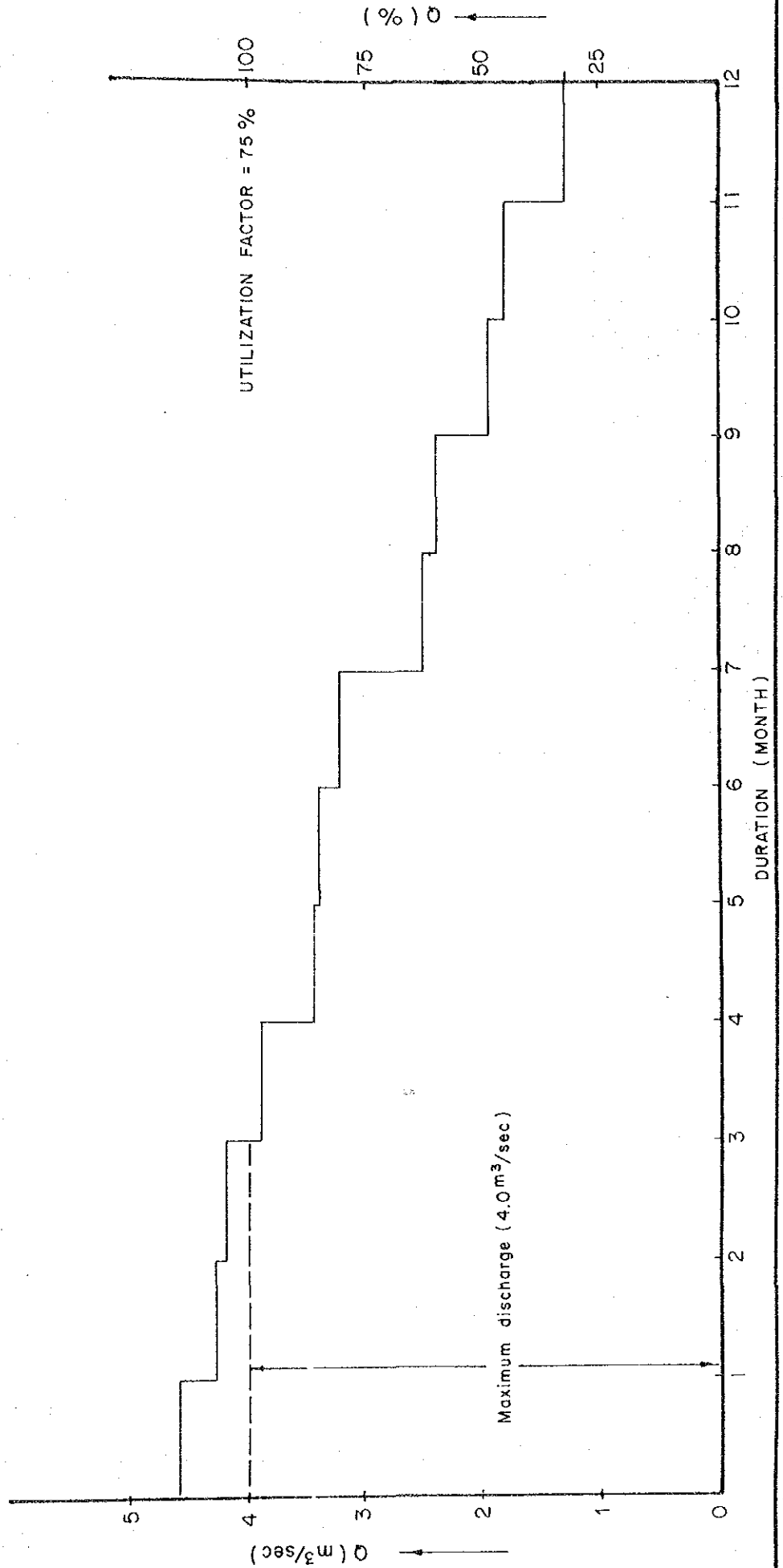


Fig. 1.3 DURATION CURVE AT CHICO MDC. END OF MDC SPILL WAY STA.22+317 (SITE NO.2)

From the data during 1984 to 1987

	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC
Q max (m ³ /s)	15.202	15.237	12.736	11.835	7.901	2.844	9.997	14.109	14.547	14.629	10.267	9.537
Q min (")	9.038	10.349	10.815	5.702	0.806	0	0	12.032	7.828	9.052	9.158	8.402
Q ave (")	11.322	12.932	11.741	9.341	3.356	1.635	8.615	12.290	12.041	12.509	9.712	8.969

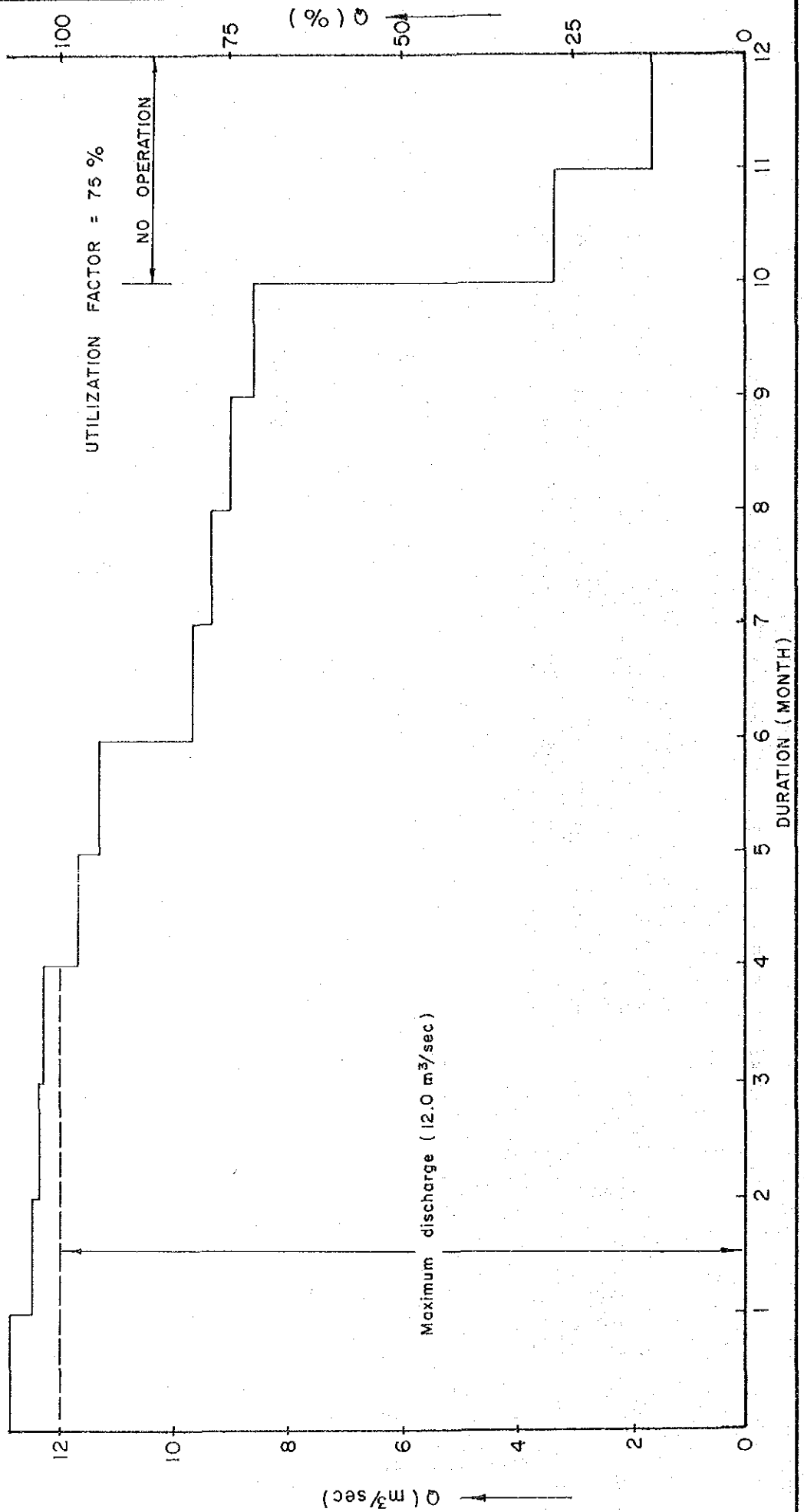
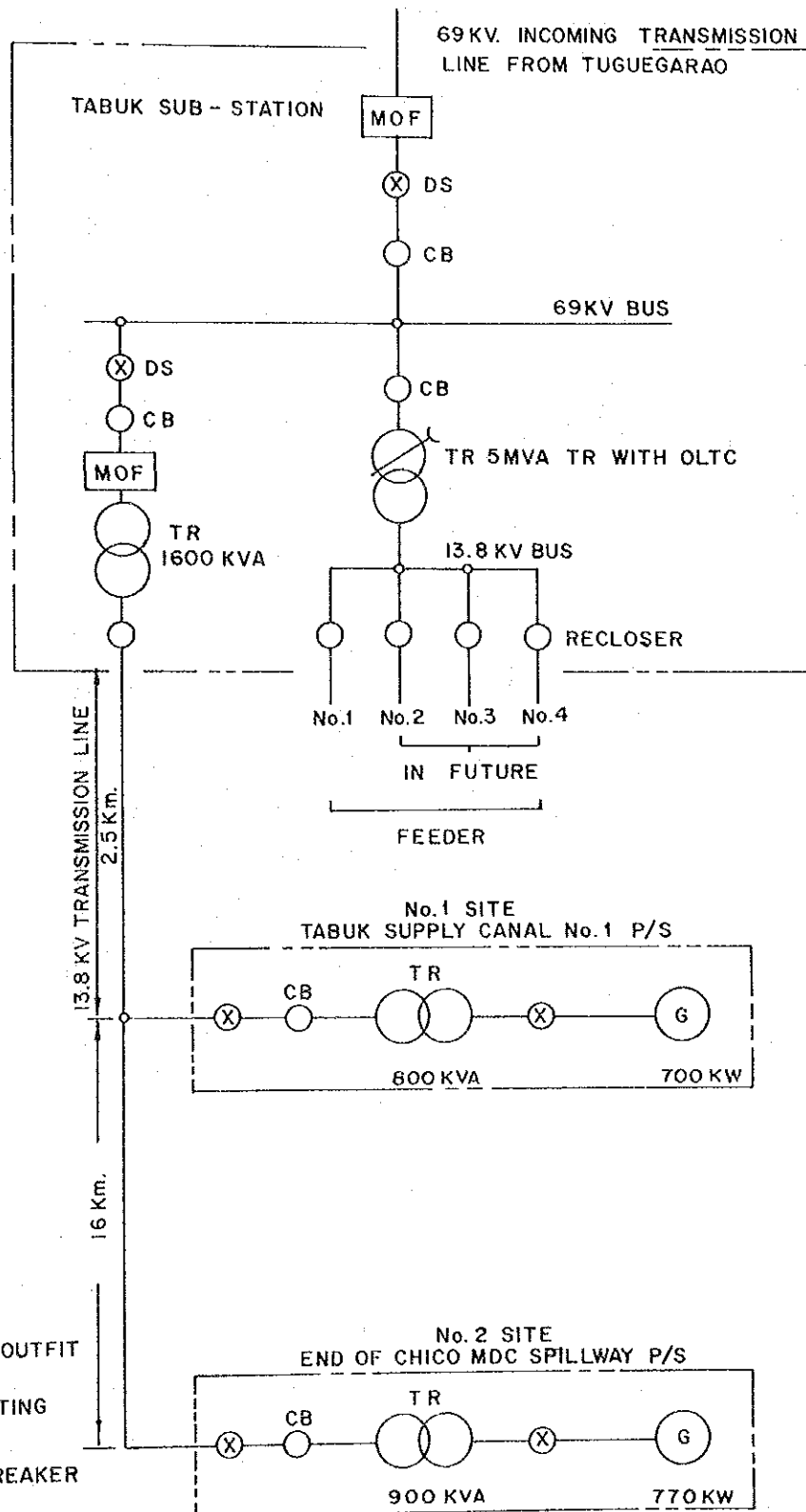


Fig.1.4 SINGLE LINE DIAGRAM FOR MINI-HYDRO SYSTEM IN CHICO RIS



LEGEND:

- MOF = METERING OUTFIT
- DS = DISCONNECTING SWITCH
- CB = CIRCUIT BREAKER
- TR = TRANSFORMER
- G = HYDRO-GENERATOR

Fig. 1.5 GENERAL LAYOUT AND PROFILE OF NO.1 SITE

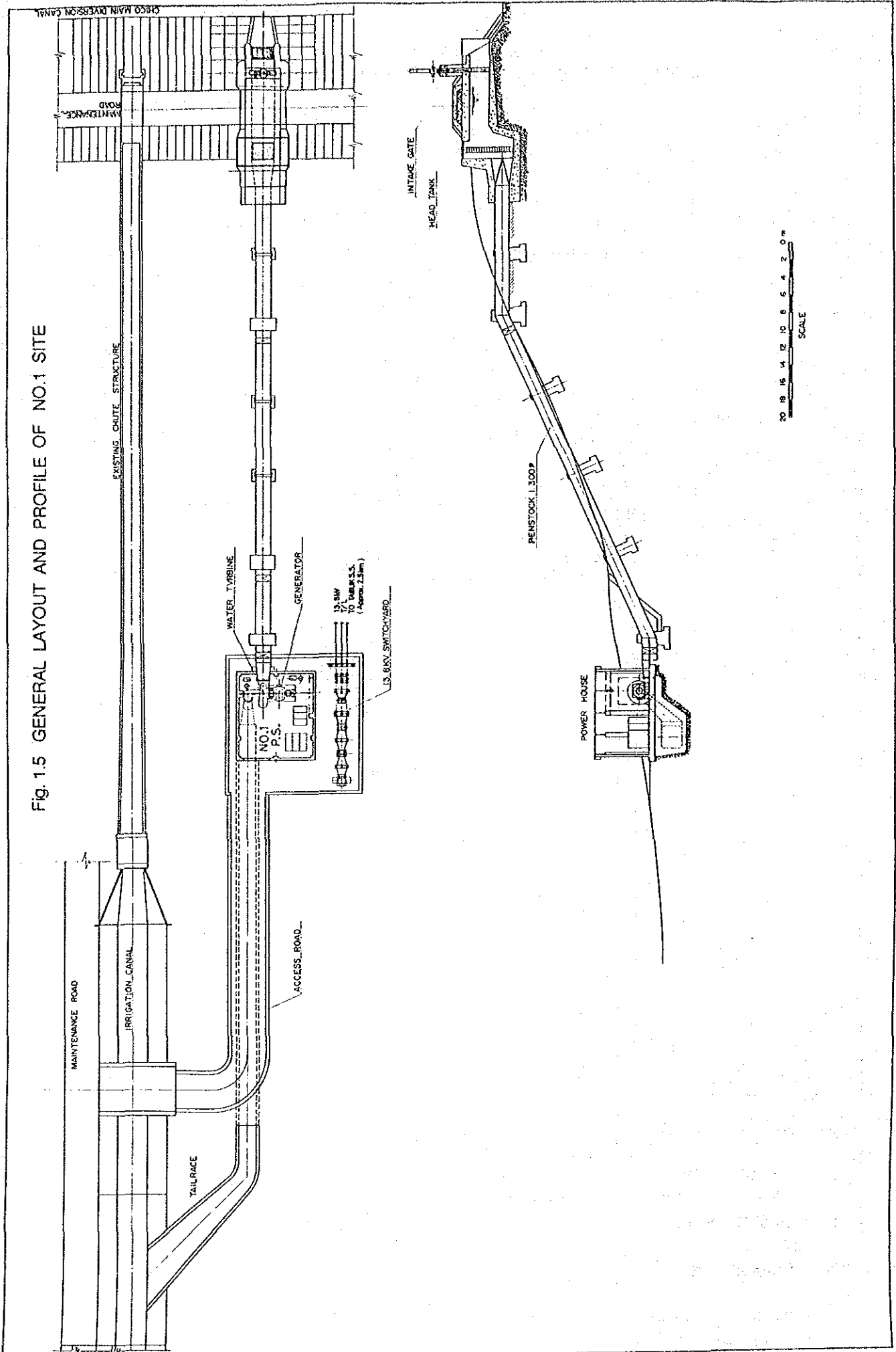


Fig. 1.6 GENERAL LAYOUT AND PROFILE OF NO.2 SITE

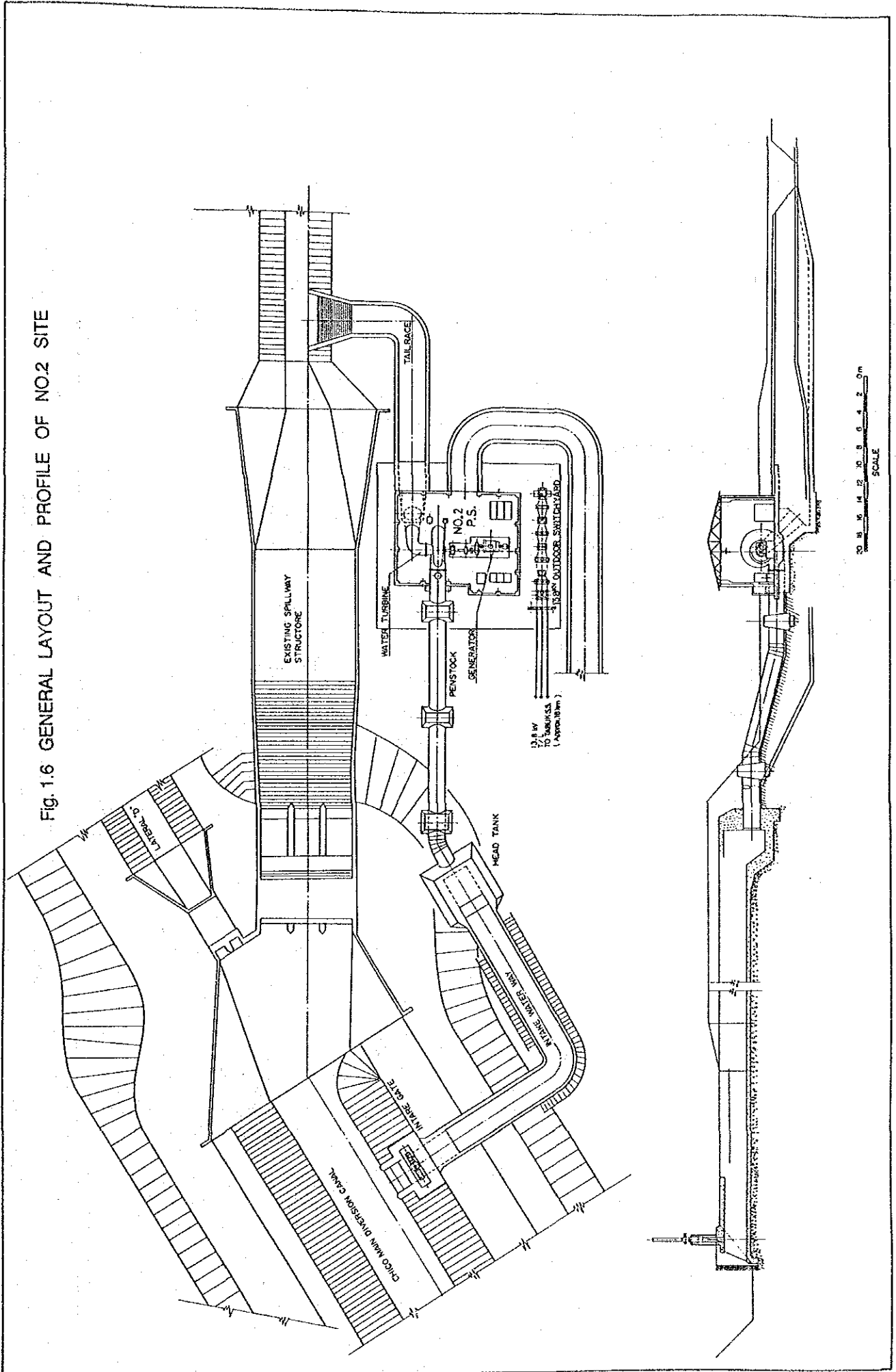
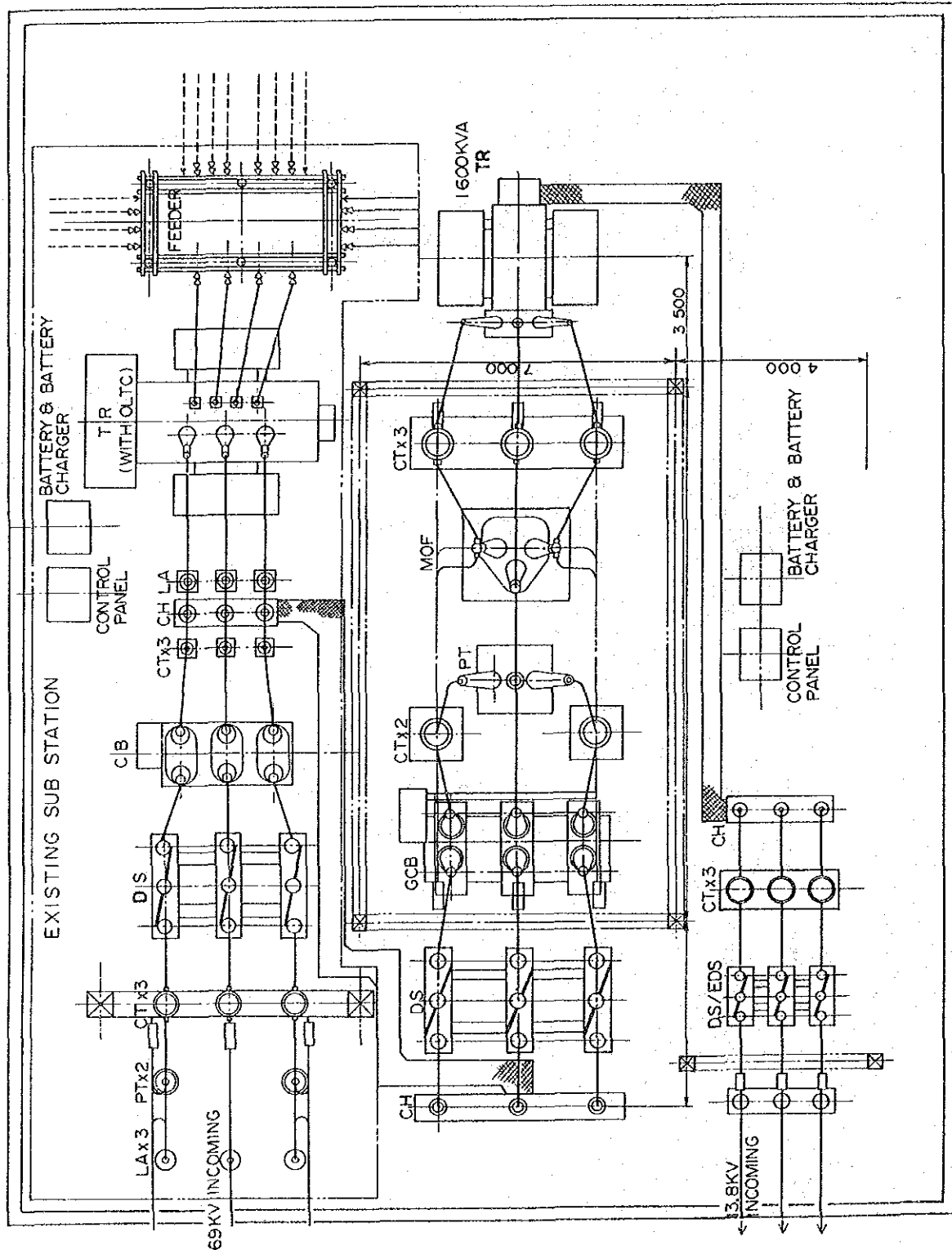


Fig. 1.7 ARRANGEMENT OF EQUIPMENT FOR TABUK SUB-STATION



LEGEND

- LA : LINE ARRESTER
- PT : POTENTIAL TRANSFORMER
- DS : DISCONNECTING SWITCH
- CB : CIRCUIT BREAKER
- CH : CABLE HEAD
- MOF : METERING OUTFIT
- ES : EARTHING DISCONNECTING SWITCH
- GCB : GASCIRCUIT BREAKER

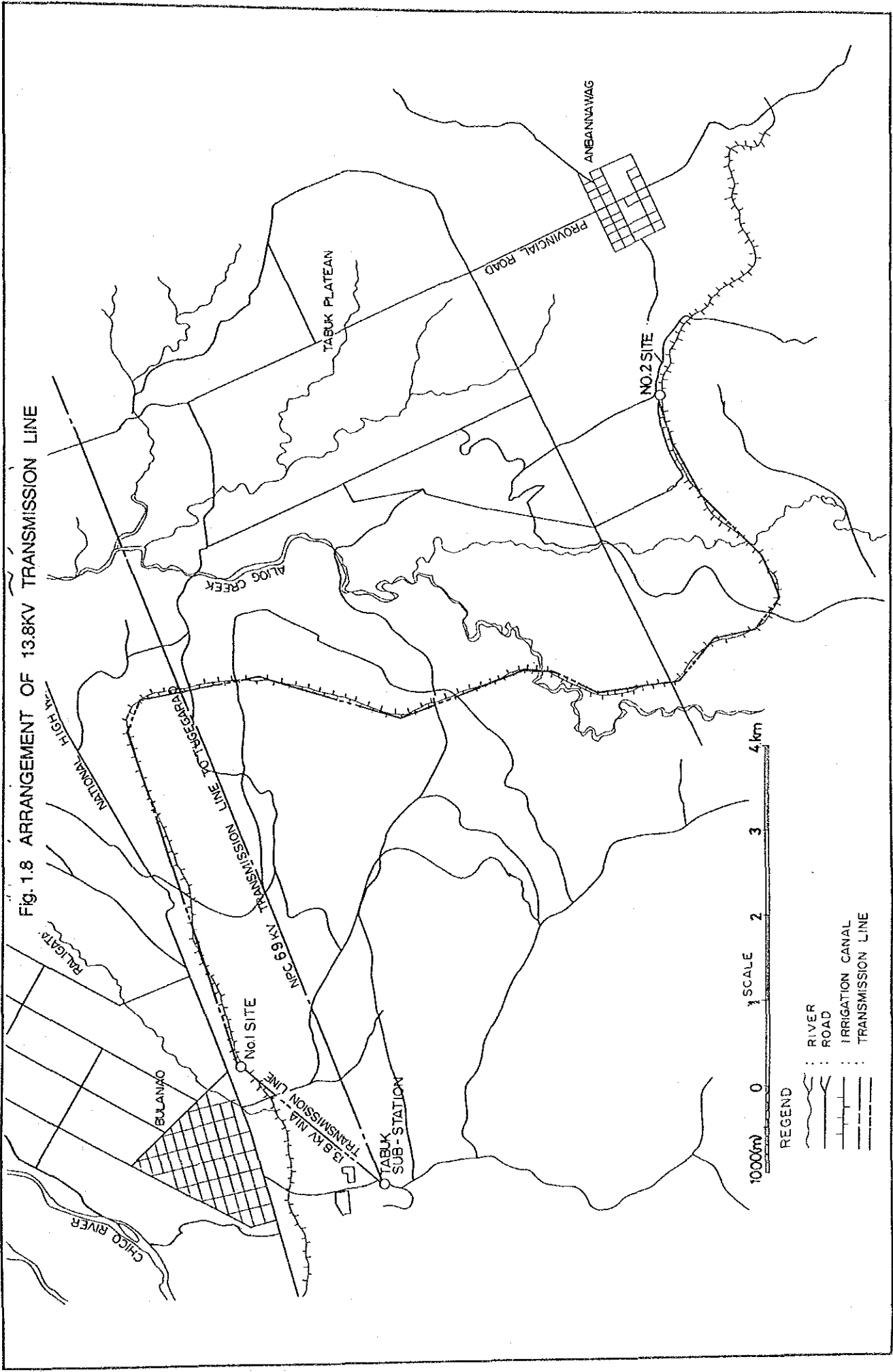


Fig. 1.8 ARRANGEMENT OF 13.8KV TRANSMISSION LINE

JICA