CHAPTER IX

ECONOMIC AND FINANCIAL ANALYSIS

9.1 Economic Analysis

9.1.1 Benefit

It is generally accepted that the benefit of a hydropower project is measured based on the cost required to produce the equivalent power and energy by the most competitive alternative means. The most likely competitive alternative means in Nepal will be coal-fired thermal plant being widely practiced in India, with unit capacity of 33 MW which is equivalent to the installed capacity of the Kulekhani No.2 Power Station.

The installation cost of a 33 MW coal-fired thermal plant is estimated to be US$700/kW. Annual operation and maintenance cost is considered proportional to the installed capacity and estimated at US$21/kW. A capacity adjustment factor is calculated to be 1.173 as explained in detail below:

(Unit: %)

	Hydro	Thermal
Loss at primary substation	5.0	2.0
Auxiliary power use	0.3	6.0
Forced outage	0.5	5.0
Overhaul	2.0	10.0

Capacity adjustment factor

$$= \frac{(1-0.05)\ (1-0.03)\ (1-0.005)\ (1-0.002)}{(1-0.02)\ (1-0.06)\ (1-0.05)\ \ (1-0.100)} = 1.173$$

The initial investment cost and annual operation and maintenance cost are, therefore, determined to be US$821/kW and US$24.6/kW, respectively, adjusted by the capacity adjustment factor. These values are called as capacity benefit.

Cost proportional to energy output (which is mainly the cost of fuel), is estimated based on the following factors, and its value is estimated at US Mill 35.1/kWh. This value is called as energy benefit.

Coal consumption	0.645 kg/kWh
Cost of coal	US$53/ton
Energy adjustment factor	

$$\frac{(1-0.05)\ (1-0.003)}{(1-0.02)\ (1-0.06)} = 1.028$$

The service life of a coal-fired thermal plant is estimated to be 25 years. On expiration of the service life, the plant has to be replaced and replacement cost is estimated at US$739/kW (90 % of initial investment cost), taking into account the residual value of the old plant.

The estimated unit power benefit is summarized below.

	Capacity benefit	Energy benefit
Investment cost	US$821/kW	-
Replacement cost	US$739/kW	-
Annual O & M cost	US$24.6/kW	-
Fuel cost	-	US mill 35.1/kWh

The annual primary energy of the Kulekhani No.2 Power Station with an installed capacity of 33 MW (which will be consumable in the Greater CNPS), will be 34.7 GWh in 1985/86, 96.4 GWh in 1986/87 and 153,3 GWh after 1987/88.

The power benefit is estimated based on the above basic values, and it is shown below.

Capacity benefit (10^3 US$)

Investment cost	27,090 in 1985/86
Replacement cost	24,390 in intervals of 25 years
Annual O & M cost	810 after 1986/87

Energy benefit (10^3 US$)

Annual fuel cost	1,220 in 1985/86
	3,380 in 1986/87
	5,380 after 1987/88

Besides the primary energy, the Kulekhani No.2 Power Station will produce a secondary energy in the wet season. In this economic analysis, half of the secondary energy is assumed to be exportable to India, and the revenue accrued from the exported energy is counted as a benefit, in addition to the above mentioned benefit. At present, exchange of small power is being made between Nepal and India under the agreement of both governments, at an agreed rate of US mill 20/kWh. The said agreed rate is considered too low in view of present fuel price but it is tentatively used as the unit benefit value for estimating the annual benefit so as to be conservative. The secondary energy of 11.6 GWh/1 is assumed to be sold from 1986/87, in which the primary energy of the Kulekhani No.2 Power Station will be fully consumed in the Greater CNPS. The benefit is, therefore, calculated to be US\$220 x 10^3.

Table 9.1 shows the economic benefit stream for 50 years of economic life.

9.1.2 Economic Cost

The economic cost consists of economic project cost, economic associated facility cost and cost for importing energy from India in the driest year.

The economic project cost was estimated at August 1978 price levels. It consists of the investment cost, replacement cost and O & M cost. The financial costs estimated in CHAPTER VIII include the transfer payment as direct and indirect taxes, compensation cost and price escalation contingency. The transfer payment was estimated to be 5 % of the direct construction cost, engineering service, replacement cost and O & M cost, 30 % of general expenses which includes compensation cost, and 100 % of price escalation contingency. The economic costs of the project were derived by deducting the transfer payment from the financial costs.

The estimated economic investment cost of the project is US\$40.60 x 10^6 as calculated in Table 9.2. The other economic costs are US\$14.29 x 10^6 for the replacement cost and US\$250 x 10^3 for O & M cost.

/1: Half of total secondary energy of 22.1 GWh

The energy of the Kulekhani No.2 Power Station will meet the demand in the Greater CNPS being supplemented by the energy supplied from the diesel plant which is to be newly installed, as mentioned in Paragraph 6.5. It is the facility associated with the project. The economic investment cost, replacement cost and O & M cost are estimated approximately as follows:

Investment cost	US\$380/kW x 2,500 kW = US\$950 x 10^3
Replacement cost	US\$380/kW x 2,500 kW x 0.9 = US\$860 x 10^3
O & M cost	US\$950 x 10^3 x 0.03 = US\$30 x 10^3
Fuel cost	0.29 kg/kWh x US\$0.17/kg = US mill 49/kWh

The service life of a diesel plant is estimated to be 15 years. On expiration of the service life, the plant has to be replaced with the above replacement cost.

It is expected that the demand in the driest year of 12 years cannot be met by the energy generated by the generating facilities in the Greater CNPS, and the energy shortage has to be covered by energy imported from India. The average annual energy shortage for 12 years from 1963 to 1974 is estimated to be 2.4 GWh. The annual cost is, therefore, US\$50 x 10^3 (2.4 GWh x US mill 20/kWh).

Based on the above-mentioned economic cost, the economic cost stream is shown in Table 9.3.

9.1.3 Economic internal rate of return

The economic internal rate of return (EIRR) of the project is estimated to be 14.9 % based on the benefit and cost stream in Tables 9.1 and 9.3, with an evaluation period of 50 years starting in 1981/82.

A sensitivity test of EIRR was made for the following cases:

Case B: Benefit is 10 % less than expected.
Case C: Cost is 20 % larger than expected.
Case D: Combination of Cases B and C.

The results of those calculations are as shown in following table.

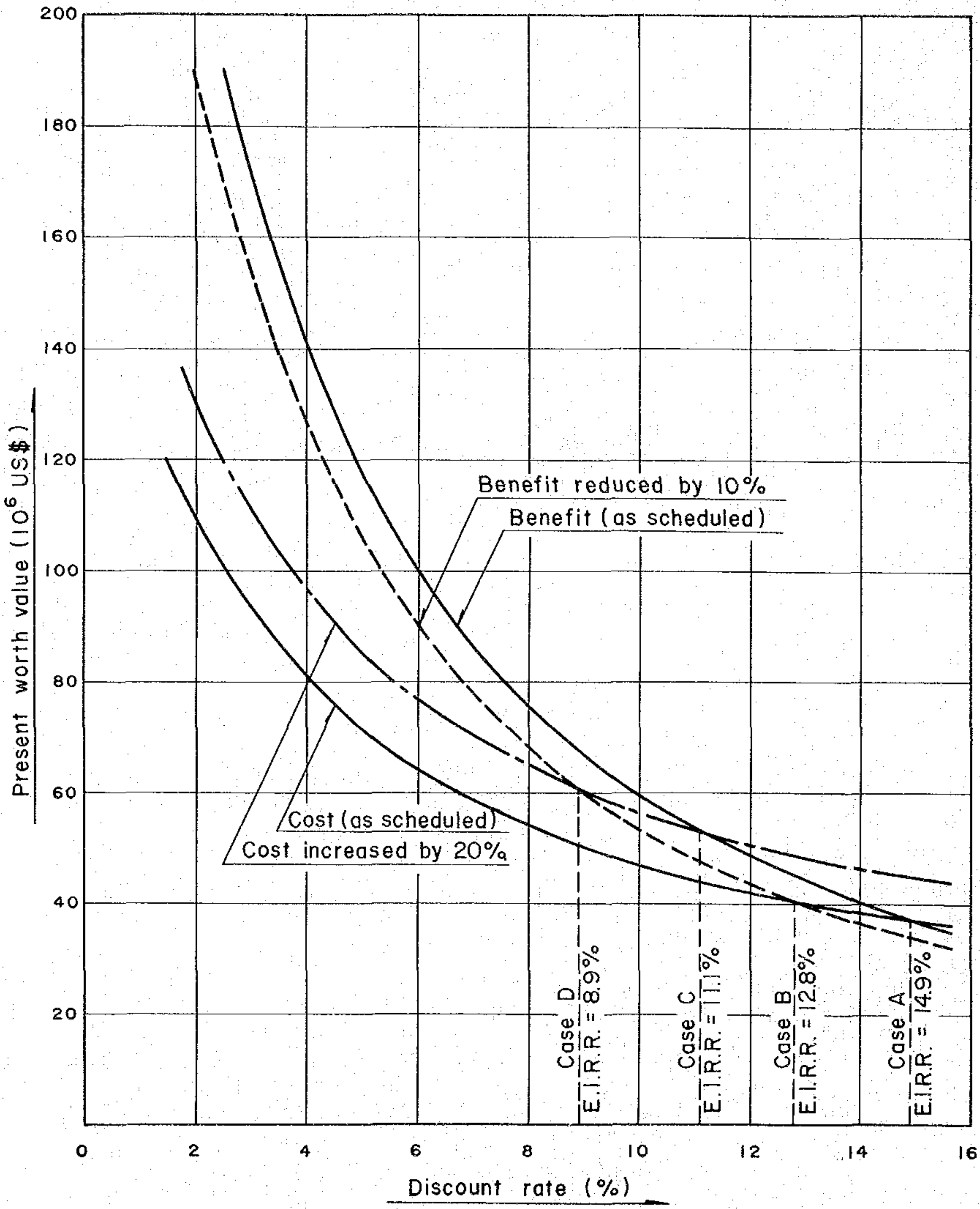

FIG. 9.1 BENEFIT - COST CURVES

Table 9.1 Economic Benefit Stream

(Unit: 10^3US$)

Year in Order	Year	Investment & replacement cost	Fuel cost	O & M cost	Benefit for exported energy	Total
1	1981/82	-	-	-	-	-
2	1982/83	-	-	-	-	-
3	1983/84	-	-	-	-	-
4	1984/85	27,090	-	-	-	27,090
5	1985/86	-	1,220	810	220	2,250
6	1986/87	-	3,380	810	220	4,410
7	1987/88	-	5,380	810	220	6,410
⋮	⋮	⋮	⋮	⋮	⋮	⋮
28	2008/09	-	5,380	810	220	6,410
29	2009/10	24,390	5,380	810	220	30,800
30	2010/11	-	5,380	810	220	6,410
⋮	⋮	⋮	⋮	⋮	⋮	⋮
50	2030/31	-	5,380	810	220	6,410

Table 9.2 Estimated Economic Investment Cost

(Unit: 10^3US$)

	1981/82	1982/83	1983/84	1984/85	Total
Direct construction cost	6,180	10,190	10,270	5,280	31,920
	(6,500)	(10,730)	(10,810)	(5,560)	(33,600)
Engineering services	1,520	1,000	1,000	760	4,280
	(1,600)	(1,050)	(1,050)	(800)	(4,500)
General expenses	250	160	160	130	700
	(550)	(160)	(160)	(130)	(1,000)
Sub-total	7,950	11,350	11,430	6,170	36,900
Physical contingency	800	1,140	1,140	620	3,700
Total	8,750	12,490	12,570	6,790	40,600

Table 9.3 Economic Cost Stream

(Unit: 10^3US$)

Year in Order	Year	Project facilities: Investment & replacement cost	Project facilities: O & M cost	Associated facilities: Investment & replacement cost	Associated facilities: O & M cost	Associated facilities: Fuel cost	Cost for imported energy	Total
1	1981/82	8,750	-	-	-	-	-	8,750
2	1982/83	12,490	-	-	-	-	-	12,490
3	1983/84	12,570	-	-	-	-	-	12,570
4	1984/85	6,790	-	950	-	-	-	7,740
5	1985/86	-	250	-	30	-	50	330
6	1986/87	-	250	-	30	-	50	330
7	1987/88	-	250	-	30	2,030	50	2,360
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
18	1998/99	-	250	-	30	2,030	50	2,360
19	1999/00	-	250	860	30	2,030	50	3,220
20	2000/01	-	250	-	30	2,030	50	2,360
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
33	2013/14	-	250	-	30	2,030	50	2,360
34	2014/15	-	250	860	30	2,030	50	3,220
35	2015/16	-	250	-	30	2,030	50	2,360
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
38	2018/19	-	250	-	30	2,030	50	2,360
39	2019/20	14,290	250	-	30	2,030	50	16,650
40	2020/21	-	250	-	30	2,030	50	2,360
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
50	2030/31	-	250	-	30	2,030	50	2,360

Table 9.4 Results of Sensitivity Test

Case	Description	EIRR
A	As scheduled	14.9 %
B	Benefit reduced by 10 %	12.8 %
C	Cost increased by 20 %	11.1 %
D	B + C	8.9 %

Judging from the values of EIRR, the proposed project is economically justifiable.

9.1.4 Unquantified benefits

In addition to the power benefit which was counted in the economic analysis in the preceding subparagraph, the following benefits are expected to be derived from the Kulekhani No.2 Hydroelectric Project.

(1) The secondary energy eventually generated by new hydropower Station in the future can be utilized as the primary energy by shifting more energy generated at the Kulekhani Project to the dry season.

(2) Runoff in the Rapti river will be augmented in the dry season by the operation of the Kulekhani Project. This may have a potential to be utilized for irrigation and industrial purposes.

The Hetauda area located at the middle reach of the Rapti river was designated as an industrial center by the Government and its irrigable area of about 15,000 ha extends on the right bank of the lower reach of the Rapti river.

(3) The construction of the Kulekhani No.2 Hydroelectric Project will present a definite employment opportunity. The labour required for the construction is estimated to be 1,200 man-years. This will cause an increase in people's income in an area having high unemployment. Furthermore, some of the laborers employed will learn some technics during construction.

(4) The Greater CNPS will require reserved power plants in the future for effective utilization of hydropower plant and for emergency use. The reserved capacity of plants required is considered to be 10 %, at least, of the supply capacity of the system. By installing a new diesel power plant of 2.5 MW the total capacity of the diesel power plants in the Greater CNPS will be 17.1 MW, which corresponds to 12 % of the total capacity of the hydropower plant. Thus, the installation of the diesel power plant will contribute towards reinforcement of the reserved capacity.

9.2 Financial Analysis

9.2.1 Present power rate

The present power tariffs in force in the Nepal Electricity Corporation supply area are US mill 20/kWh to US mill 40/kWh for domestic use, US mill 16/kWh to US mill 20/kWh for industrial use and US mill 16/kWh for commercial use. The average power tariff is estimated to be US mill 25/kWh based on the statement of accounts in 1975/76. /1

According to the statement of accounts, NEC's account has turned to be red since 1974/1975 mainly due to too low power tariffs. In order to make both ends meets, it is necessary for NEC to raise the average power tariff to US mill 36/kWh. Besides, the account is based on the present special condition in Nepal that most of the existing power plants were constructed by foreign aids on a grant or semigrant base and therefore power supply authorities in Nepal are almost free from the liability of capital recovery for the initial investment cost of the power plants.

NEC will have to construct new power plants successively in future to cope with the rapidly increasing power demand. For construction of the new power stations, however, the above special condition will not be excepted, but the construction work will have to be implemented by loan from international financing agencies, which shall be repaid by NEC. The construction work of Kulekhani No.1 Power Station under construction at present is an example of such case. In view of such circumstance, for a sound development of future power project in Nepal, it will be required to review the present power tariff and raise it to a reasonable level.

9.2.2 Financial power cost

For testing the loan repayment capability of the Kulekhani No.2 Hydroelectric Project, the financial power cost is estimated. A financial power cost may be defined as the power rate at a primary substation, which makes the total net revenue from energy sale to be exactly

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/1: Annual Report and Statement of Accounts, 2032-2033, Nepal Electricity Corporation.

the same as the total repayment liability, during the repayment period.

As loan conditions of the Kulekhani No.2 Hydroelectric Project have not been settled yet at the moment, it is tentatively assumed that both the foreign and local currency portions of the initial investment cost will be financed under the same loan conditions of an annual interest rate of 4 per cent and a repayment period of 30 years including 7 years grace period.

The initial investment cost was estimated to be US$48 million as shown in Table 8.1 and the annual disbursement schedule assumed as shown in Table 8.2 the annual O & M cost was estimated to be US$250 x 10^3.

The total annual primary energy supplied from the Kulekhani No.2 Power Station in full consumable stage is 95.1 GWh, as estimated in Paragraph 6.5. The saleable energy at a primary substation is obtained to be 92.2 GWh, deducting 3 % of transmission loss. In addition to the primary energy, a half of the secondary energy, 11.1 GWh, is assumed to be exportable to India at a rate of US mill 20/kWh. The growth of the saleable energy is shown as follows.

Table 9.5 Growth of Saleable Energy

(Unit: GWh)

Year	Primary energy	Secondary energy
1985/86	33.7	11.1
1986/87	91.8	11.1
1987/88	92.2	11.1

Based on the above-mentioned conditions, the financial power cost of the Kulekhani No.2 Power Station is calculated to be US mill 38.4/kWh, and the financial statement is shown in Table 9.6. For the comparison with the present power tariff, the power cost at a distribution end is calculated to be US mill 55.2/kWh, assuming the distribution loss at 15 per cent and the additional cost for administration and distribution service at around US mill 10/kWh.

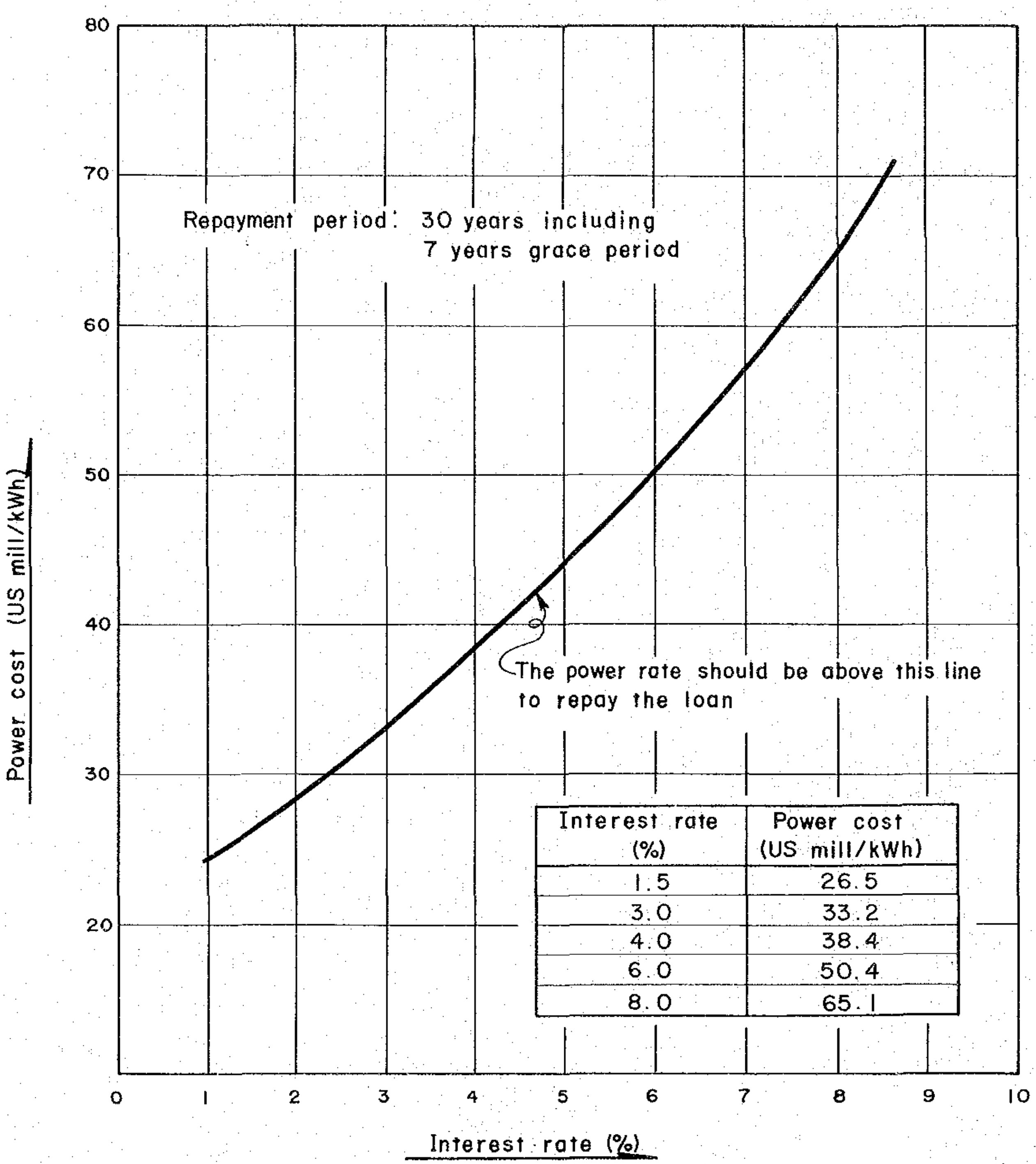
It seems that the Kulekhani No.2 Hydroelectric Project is not financially justifiable as far as it is compared with the present power tariff. However, this is not because the power cost of the Kulekhani No.2 Power Station is too high to be justified financially but solely because the prevailing power tariff of NEC is too low as stated in the preceding paragraph.

In order to clearify this situation, the financial power cost of the coal-fired thermal plant (which is considered as the most economically competitive alternative mean) is calculated under the considerable loan condition corresponding to that of the project. The calculation was made based on the following basic figures and conditions.

Initial investment cost:	US$27.09 million
Fuel cost:	US mill 35.1/kWh
Loan condition	
Annual interest rate:	2.5 %
Repayment period:	20 years including 7 years grace period

The calculated financial power cost of the thermal plant is US mill 68.5/kWh.

Thus, the financial power cost of the Kulekhani No.2 Power Station shows much lower value than that of a coal-fired thermal power plant, and it is financially justifiable as far as the comparison is made with a coal-fired thermal power plant.



Interest rate (%)	Power cost (US mill/kWh)
1.5	26.5
3.0	33.2
4.0	38.4
6.0	50.4
8.0	65.1

FIG.9.2 FINANCIAL POWER COST OF KULEKHAMI NO.2 POWER STATION

Table 9.6 Financial Statement (1)
(Kulekhani No.2 P.S.)

(Unit: 10^3 US$)

Year in order	Year	Investment & replacement (1)	Interest /2 (4 %) (2)	Accumulated /3 loan (3)	Loan /4 repayment (4)	Total /5 debt	Sold energy (GWh) Domestic	Export	Revenue	Annual cost	Annual /6 income	Cash /7 surplus	Accumulated /8 cash surplus
1	1981/82	9,900	-	9,900	-	9,900	-	-	-	-	-	-	-
2	1982/83	14,300	396	24,596	-	24,596	-	-	-	-	-	-	-
3	1983/84	15,300	984	40,880	-	40,880	-	-	-	-	-	-	-
4	1984/85	8,500	1,635	51,015	-	51,015	-	-	-	-	-	-	-
5	1985/86	-	2,041	53,056	-	53,056	33.7	11.1	1,516	250	1,266	1,266	1,266
6	1986/87	-	2,122	55,178	-	55,178	91.8	"	3,747	"	3,477	4,763	4,763
7	1987/88	-	2,207	57,385	-	57,385	92.2	"	3,762	"	3,512	8,275	8,275
8	1988/89	-	2,295	59,680	3,863	55,817	"	"	"	"	"	11,787	7,924
9	1989/90	-	2,233	58,050	"	54,187	"	"	"	"	"	11,436	7,573
10	1990/91	-	2,167	56,354	"	52,491	"	"	"	"	"	11,085	7,222
11	1991/92	-	2,100	54,591	"	50,728	"	"	"	"	"	10,734	6,871
12	1992/93	-	2,029	52,757	"	48,894	"	"	"	"	"	10,383	6,520
13	1993/94	-	1,956	50,850	"	46,987	"	"	"	"	"	10,032	6,169
14	1994/95	-	1,876	48,866	"	45,003	"	"	"	"	"	9,681	5,818
15	1995/96	-	1,800	46,803	"	42,940	"	"	"	"	"	9,330	5,467
16	1996/97	-	1,718	44,658	"	40,795	"	"	"	"	"	8,979	5,116
17	1997/98	-	1,632	42,427	"	38,564	"	"	"	"	"	8,628	4,765
18	1998/99	-	1,543	40,107	"	36,244	"	"	"	"	"	8,277	4,414
19	1999/00	-	1,450	37,694	"	33,831	"	"	"	"	"	7,926	4,063
20	2000/01	-	1,353	35,184	"	31,321	"	"	"	"	"	7,575	3,712
21	2001/02	-	1,253	32,574	"	28,711	"	"	"	"	"	7,224	3,361
22	2002/03	-	1,148	29,859	"	25,996	"	"	"	"	"	6,873	3,010
23	2003/04	-	1,040	27,036	"	23,173	"	"	"	"	"	6,522	2,659
24	2004/05	-	927	24,100	"	20,237	"	"	"	"	"	6,171	2,308
25	2005/06	-	809	21,046	"	17,183	"	"	"	"	"	5,820	1,957
26	2006/07	-	687	17,870	"	14,007	"	"	"	"	"	5,469	1,606
27	2007/08	-	560	14,567	"	10,704	"	"	"	"	"	5,118	1,255
28	2008/09	-	428	11,132	"	7,269	"	"	"	"	"	4,767	904
29	2009/10	-	291	7,560	"	3,697	"	"	"	"	"	4,416	553
30	2010/11	-	148	3,845	3,845	0	"	"	"	"	"	4.065	220

Remarks: Annual interest rate: 4 %
Repayment period: 30 years including 7 years grace period
Power tariff /1: US mill 38.4/kWh for domestic and US mill 20/kWh for export

/1: Financial power cost for 23 years repayment period.
/2: Interest is calculated for (5) of the previous year.
/3: Accumulated loan is calculated as (1) + (2) + (5) of the previous year.
/4: Loan repayment is calculated as 57,385 x 6.73 %. (Capital recovery cost for 23 years at 4 % interest rate)

/5: (3) - (4)
/6: (6) - (7)
/7: (8) + (10) of the previous year.
/8: (9) - (4)

Table 9.7 Financial Statement (2)
(Coal-fired Thermal Power Plant)

(Unit: 10^3 US$)

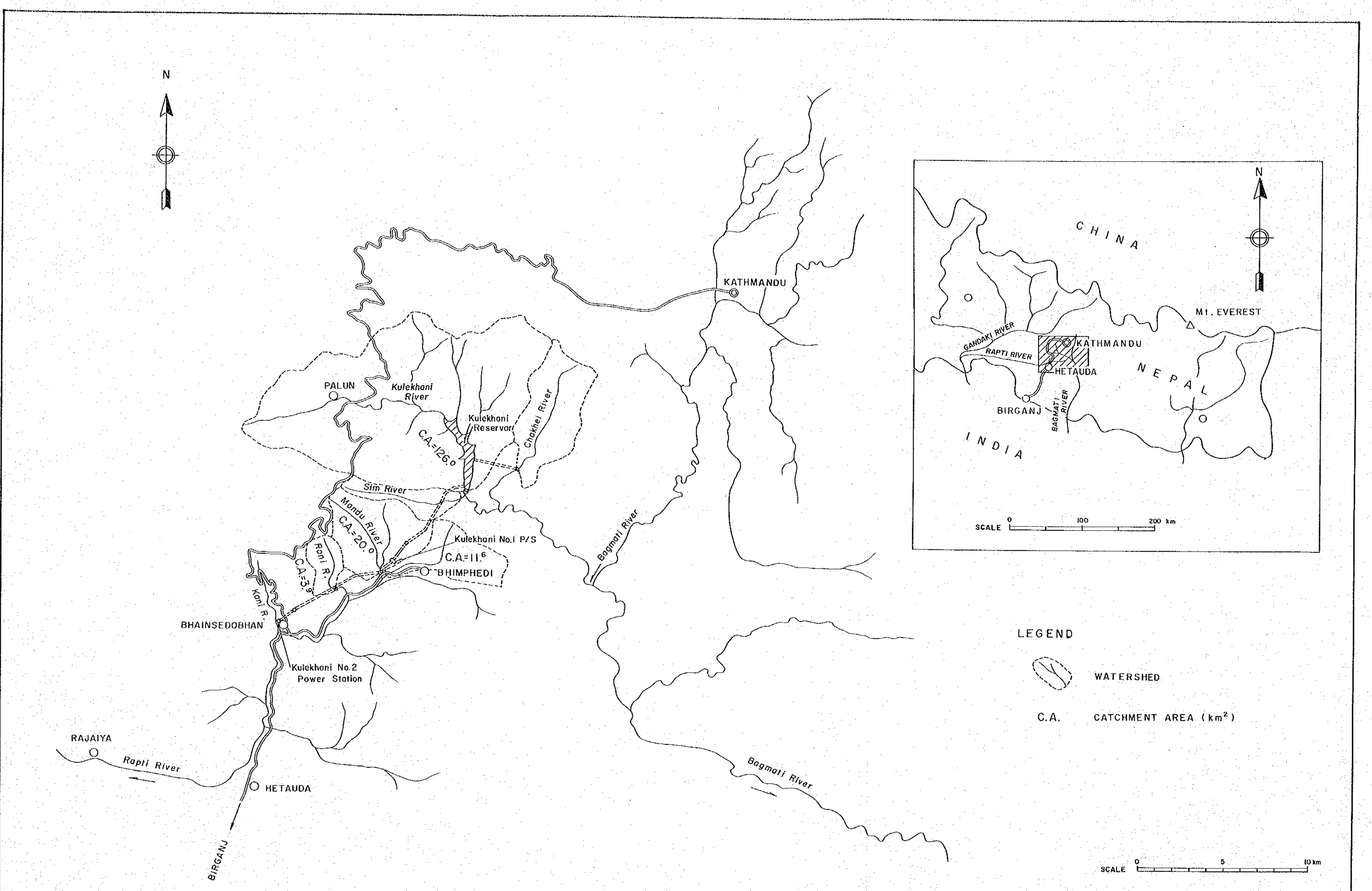
Year in order	Year	Investment (1)	Interest/2 (2.5%) (2)	Accumulated/3 loan (3)	Loan /4 repayment (4)	Total /5 debt (5)	Sold energy (GWh)	Revenue (6)	Annual cost (7)	Annual /6 income (8)	Cash /7 surplus (9)	Accumulated/8 cash surplus (10)
1.	1982/83	-	-	-	-	-	-	-	-	-	-	-
2.	1983/84	-	-	-	-	-	-	-	-	-	-	-
3.	1984/85	27,090	813	27,903	-	27,903	-	-	-	-	-	-
4.	1985/86	-	698	28,601	-	28,601	33.7	2,308	1,990	318	318	318
5.	1986/87	-	715	29,316	-	29,316	91.8	6,288	4,030	2,258	2,576	2,576
6.	1987/88	-	733	30,049	-	30,049	92.2	6,316	4,050	2,266	4,842	4,842
7.	1988/89	-	751	30,800	-	30,800	"	"	"	"	7,108	7,108
8.	1989/90	-	770	31,570	2,805	28,765	"	"	"	"	9,374	6,569
9.	1990/91	-	719	29,484	"	26,679	"	"	"	"	8,835	6,030
10.	1991/92	-	667	27,346	"	24,541	"	"	"	"	8,296	5,491
11.	1992/93	-	614	25,155	"	22,350	"	"	"	"	7,757	4,952
12.	1993/94	-	559	22,909	"	20,104	"	"	"	"	7,218	4,413
13.	1994/95	-	503	20,607	"	17,802	"	"	"	"	6,679	3,874
14.	1995/96	-	445	18,247	"	15,442	"	"	"	"	6,140	3,335
15.	1996/97	-	386	15,828	"	13,023	"	"	"	"	5,601	2,796
16.	1997/98	-	326	13,349	"	10,544	"	"	"	"	5,062	2,257
17.	1998/99	-	264	10,808	"	8,003	"	"	"	"	4,523	1,718
18.	1999/00	-	200	8,203	"	5,398	"	"	"	"	3,984	1,179
19.	2000/01	-	135	5,533	"	2,728	"	"	"	"	3,445	640
20.	2001/02	-	68	2,796	2,796	0	"	"	"	"	2,906	110

Remarks: Annual interest rate: 2.5 %
Repayment period: 20 years including 7 years grace period
Power tariff /1: US mill 68.5/kWh

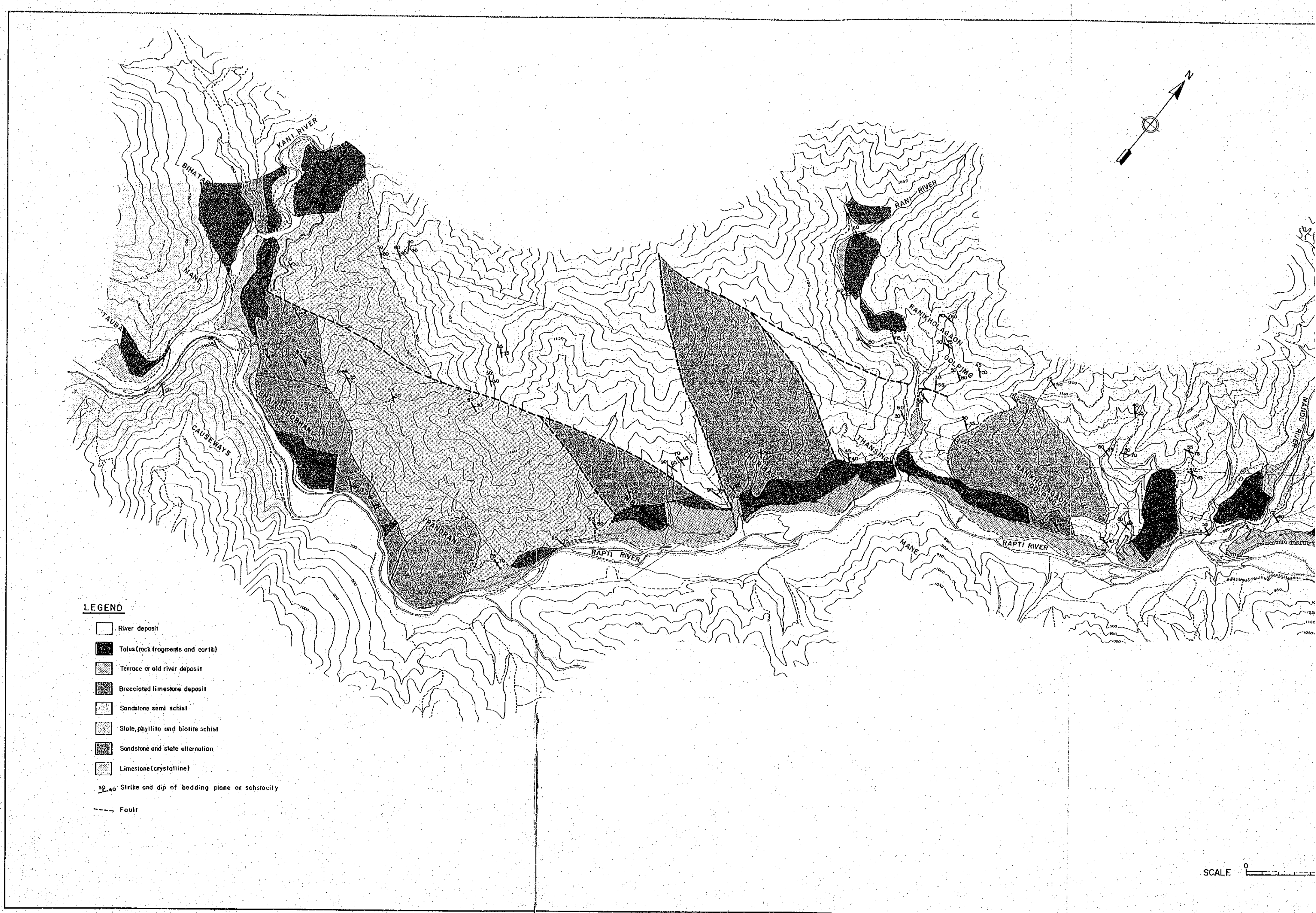
/1: Financial power cost for 13 years repayment period.
/2: Interest is calculated for (5) of the previous year.
/3: Accumulated loan is calculated as (1) + (2) + (5) of the previous year.
/4: Loan repayment is calculated as 30,800 x 9.11 %. (Capital recovery cost for 13 years at 2.5 % interest rate)

/5: (3) - (4)
/6: (6) - (7)
/7: (8) + (10) of the previous year.
/8: (9) - (4)

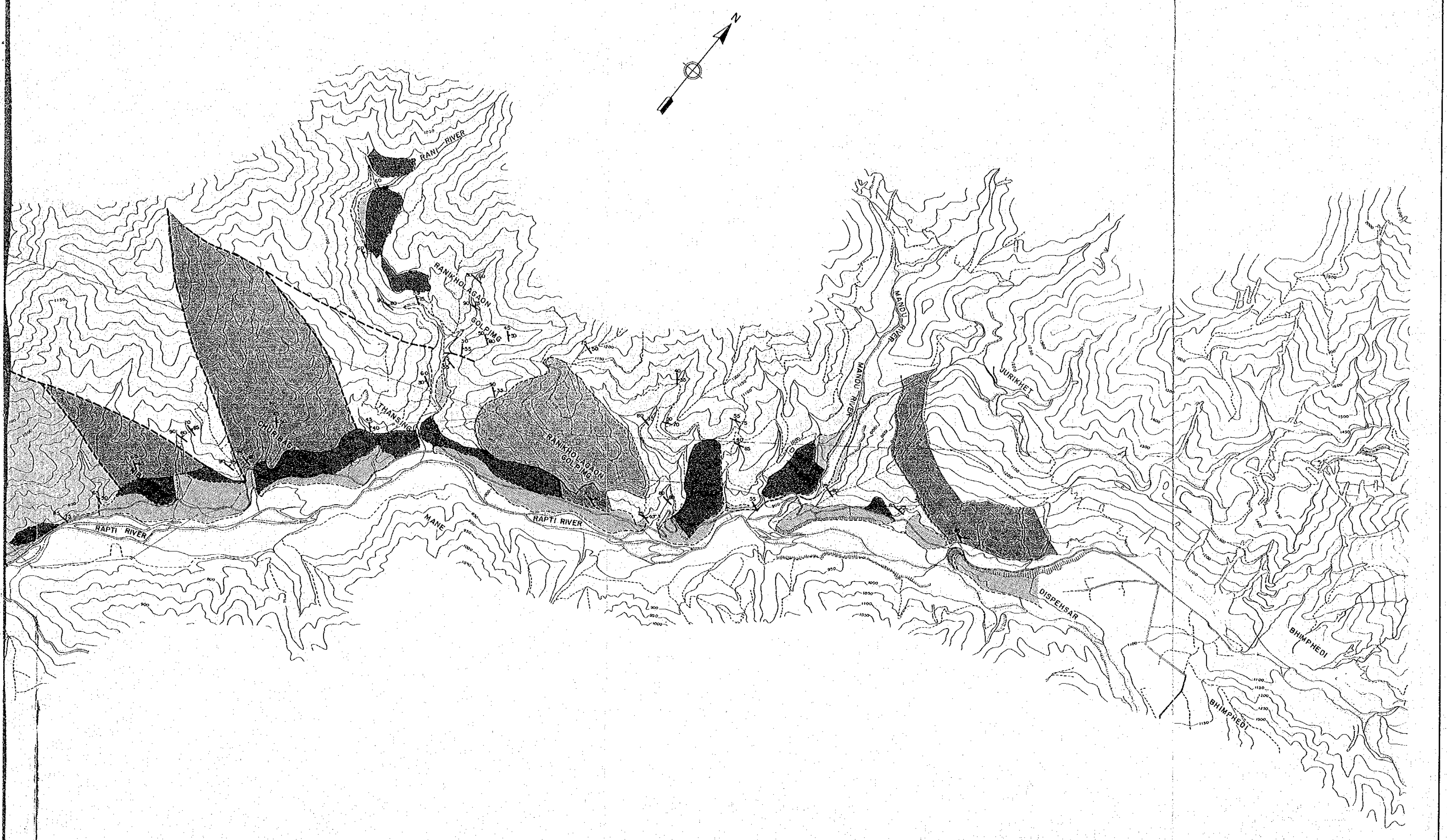
DRAWINGS



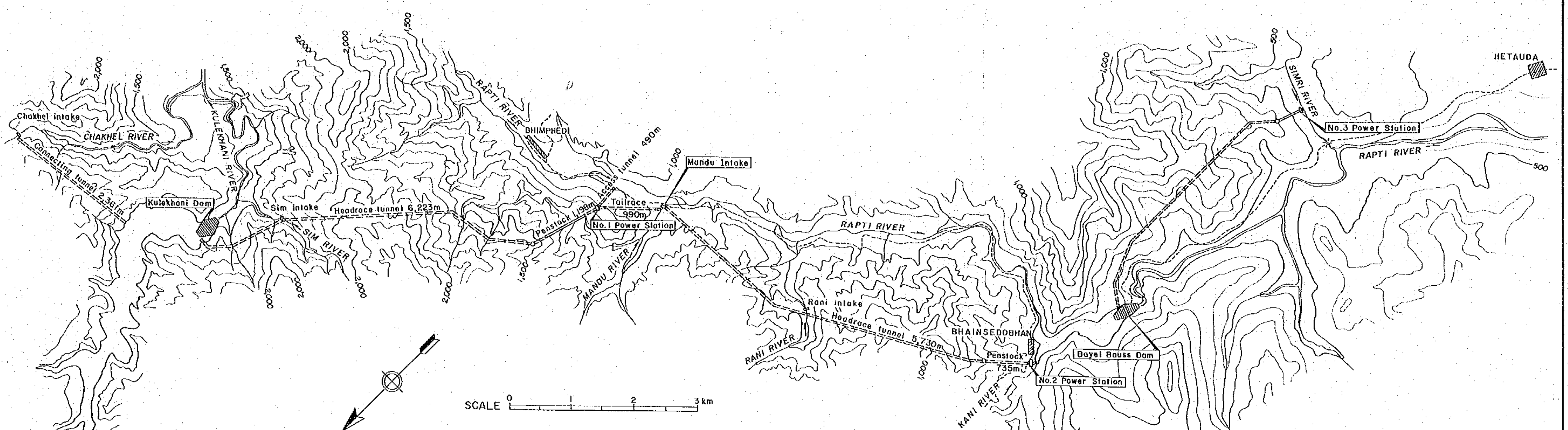
HIS MAJESTY'S GOVERNMENT OF NEPAL	LOCATION MAP	
KULEKHANI NO.2 HYDROELECTRIC PROJECT	DWG. No. 1	JAPAN INTERNATIONAL COOPERATION AGENCY



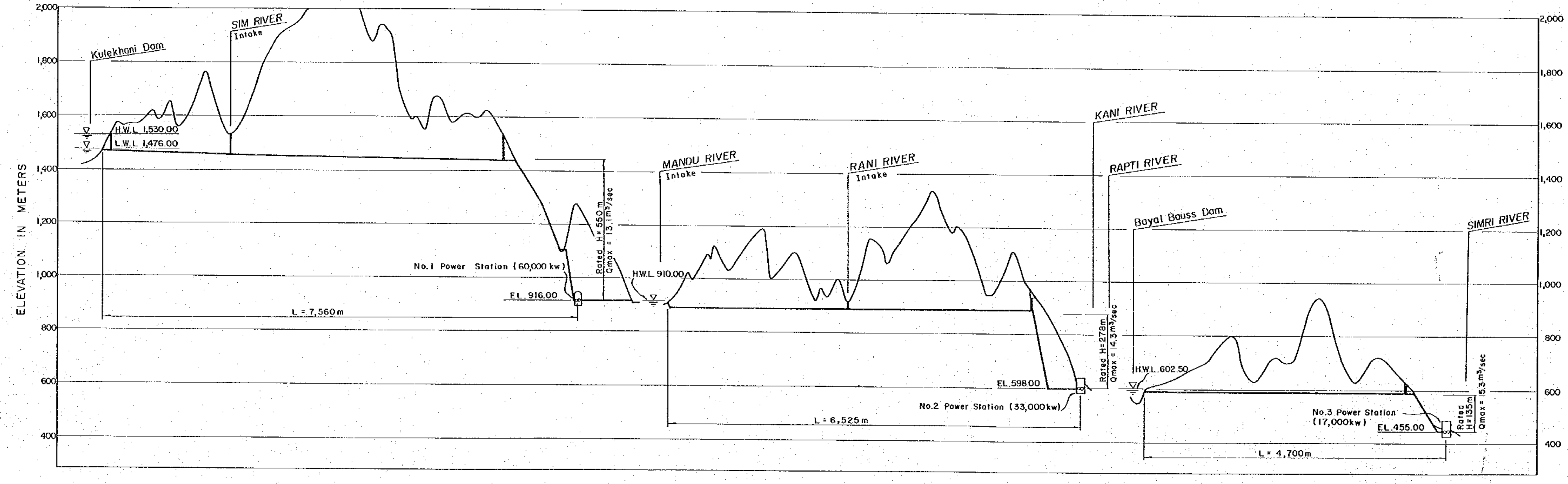
KANI RIVER
BIHATAR
MANE
RANI RIVER
RANIKHOLAGAON
GOLPING
THANSING
CAUSEWAYS
PANDRANG
RAPTI RIVER
MANE
RAPTI RIVER
RANIKHOLAGAON GOLPING
MANDU RIVER
N
LEGEND
River deposit
Talus (rock fragments and earth)
Terrace or old river deposit
Brecciated limestone deposit
Sandstone semi schist
Slate, phyllite and biotite schist
Sandstone and slate alternation
Limestone (crystalline)
Strike and dip of bedding plane or schistocity
Fault
SCALE



HIS MAJESTY'S GOVERNMENT OF NEPAL	GEOLOGICAL MAP IN PROJECT AREA	
KULEKHANI NO.2 HYDROELECTRIC PROJECT	DWG.NO. 2	JAPAN INTERNATIONAL COOPERATION AGENCY

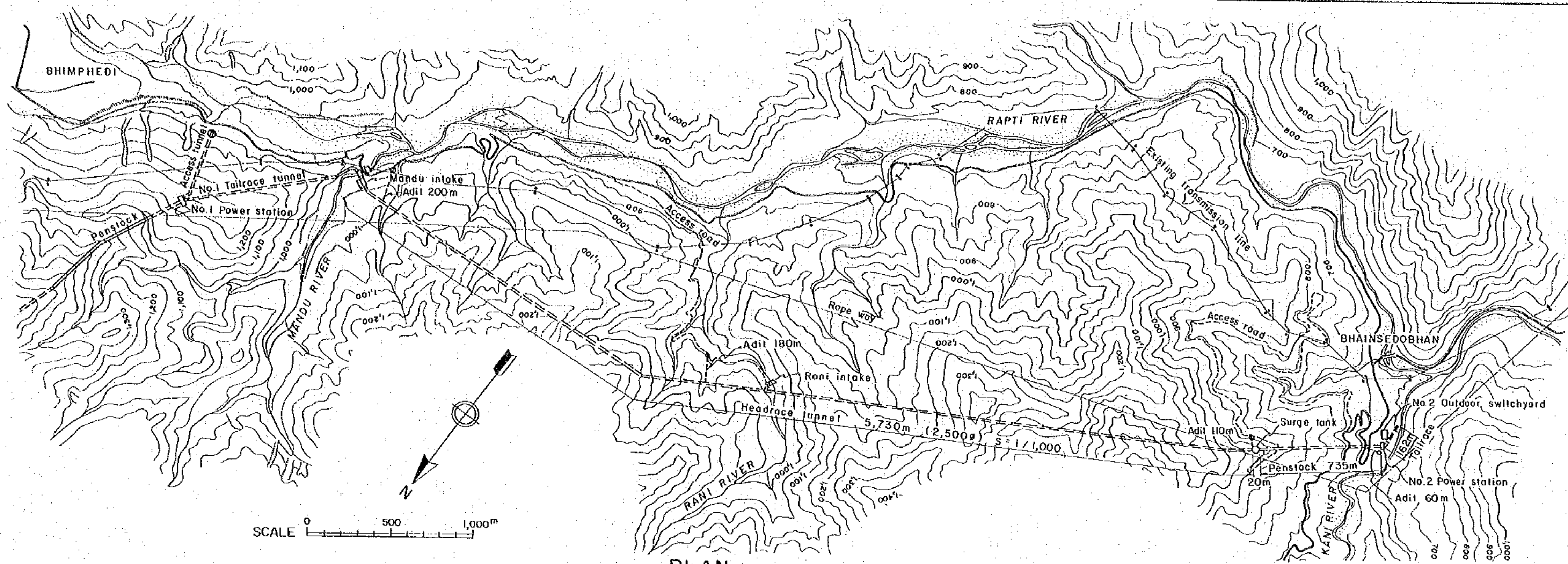


PLAN

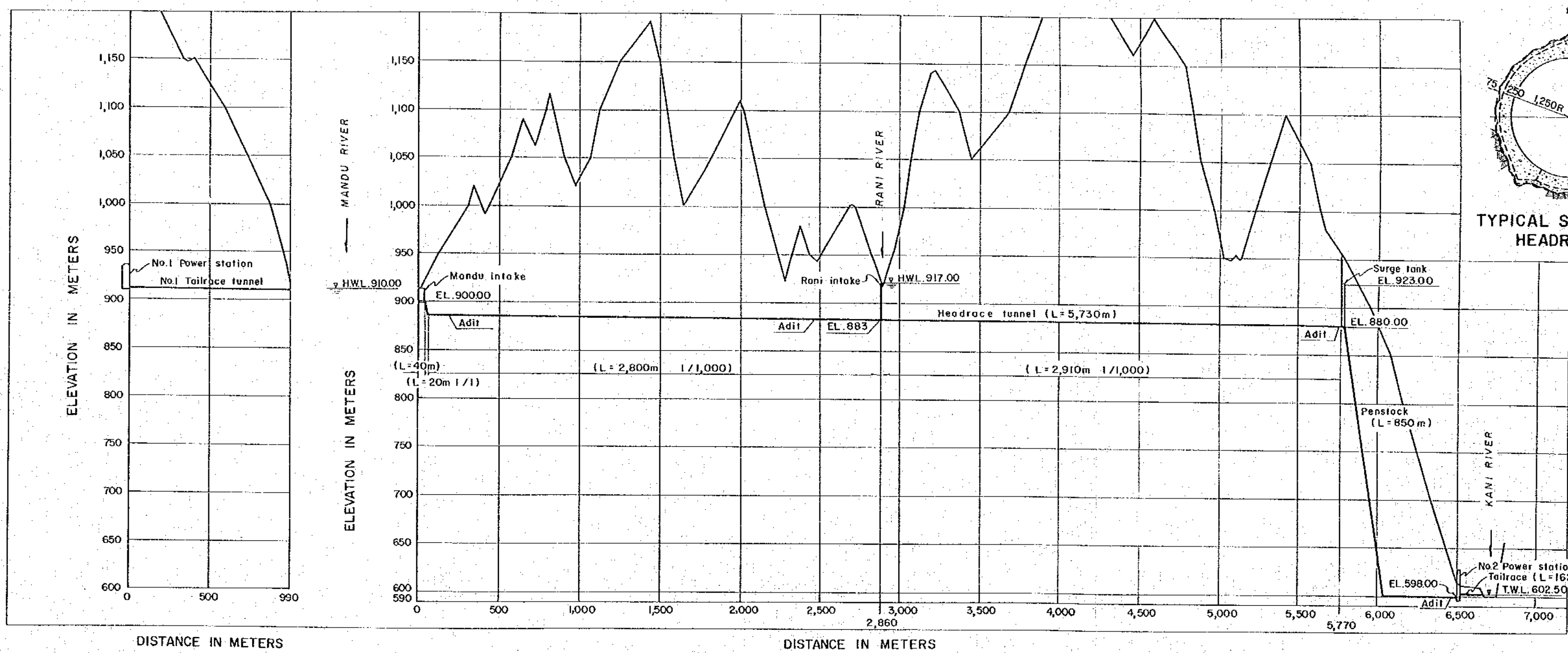


PROFILE

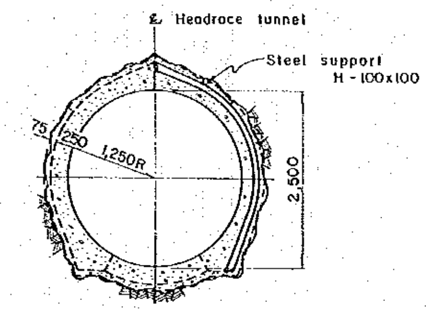
HIS MAJESTY'S GOVERNMENT OF NEPAL	GENERAL LAYOUT (OVERALL KULEKHANI PROJECT)		
KULEKHANI No.2 HYDROELECTRIC PROJECT	DWG. No. 3	JAPAN INTERNATIONAL COOPERATION AGENCY	



PLAN



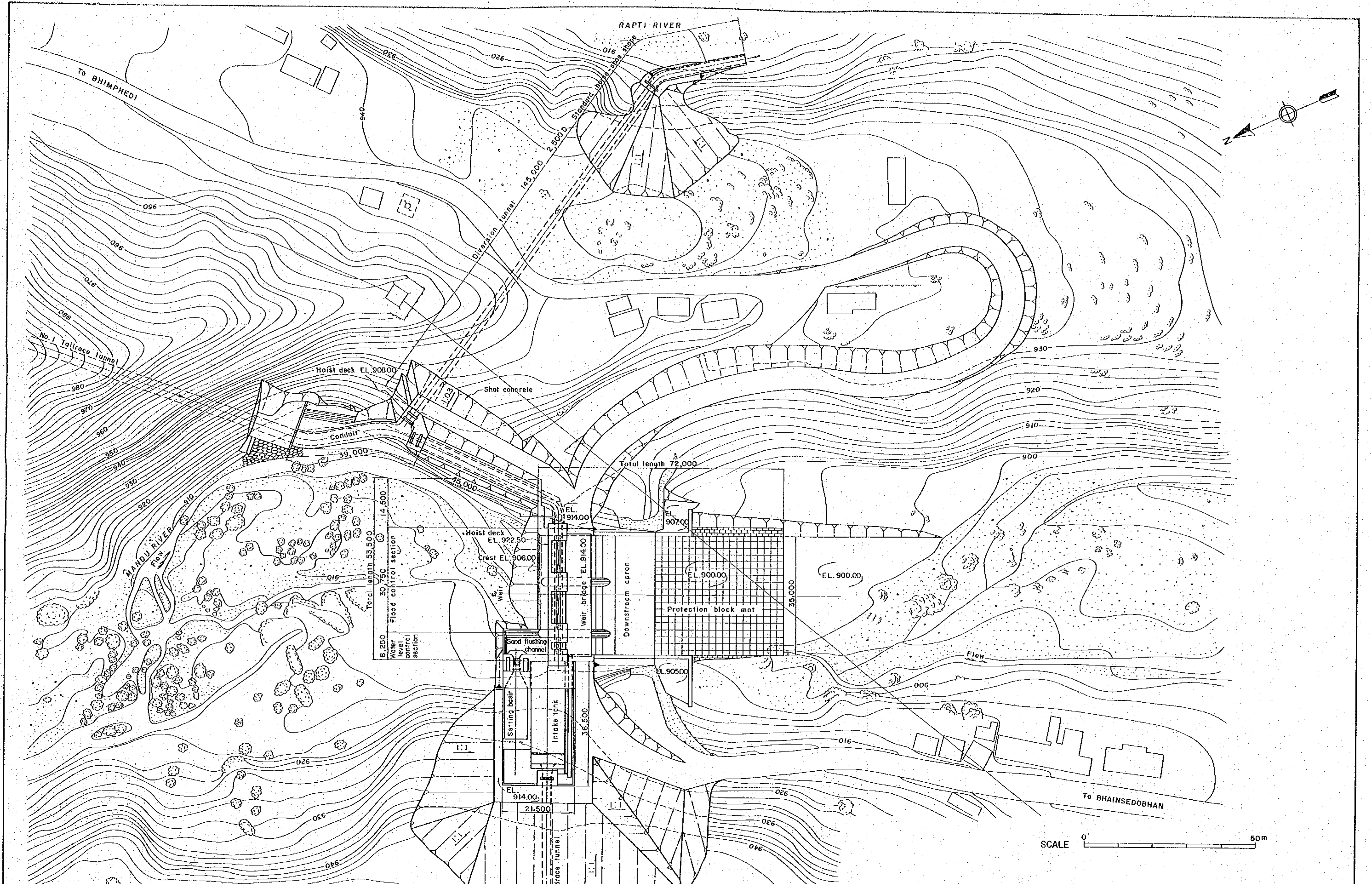
PROFILE



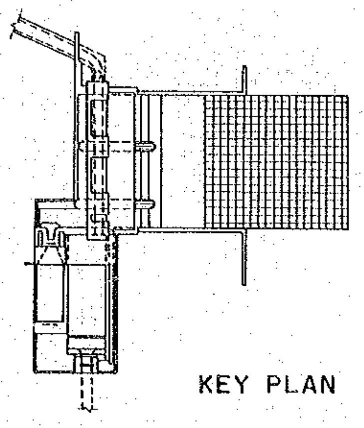
TYPICAL SECTION OF HEADRACE TUNNEL SCALE A

SCALE A 0 5m

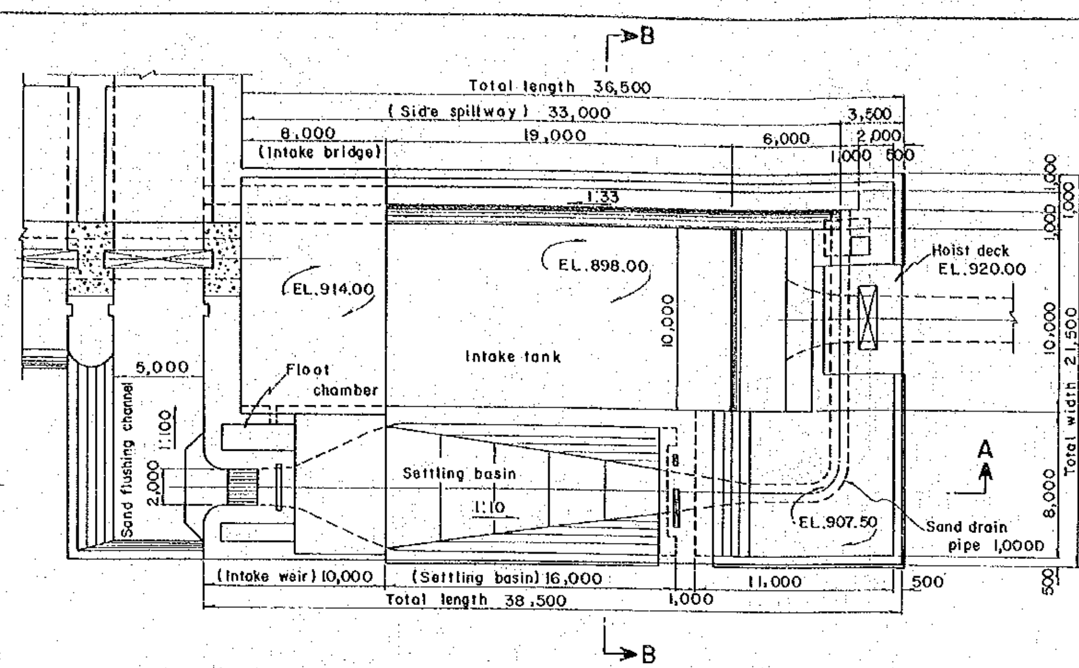
HIS MAJESTY'S GOVERNMENT OF NEPAL	GENERAL LAYOUT	
KULEKHANI No.2 HYDROELECTRIC PROJECT	DWG. No. 4	JAPAN INTERNATIONAL COOPERATION AGENCY



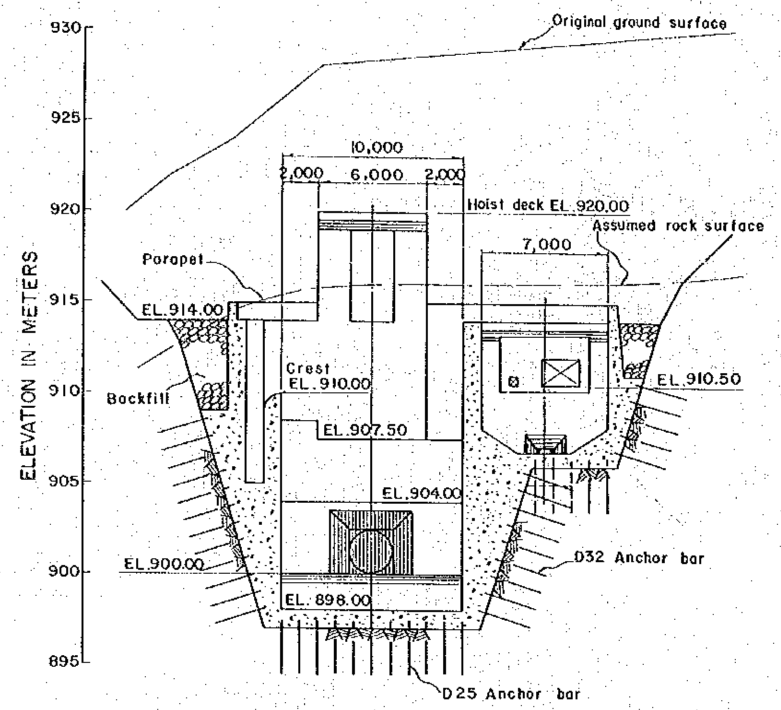
HIS MAJESTY'S GOVERNMENT OF NEPAL	PLAN OF MANDU INTAKE	
KULEKHANI No.2 HYDROELECTRIC PROJECT	DWG. No. 5	JAPAN INTERNATIONAL COOPERATION AGENCY



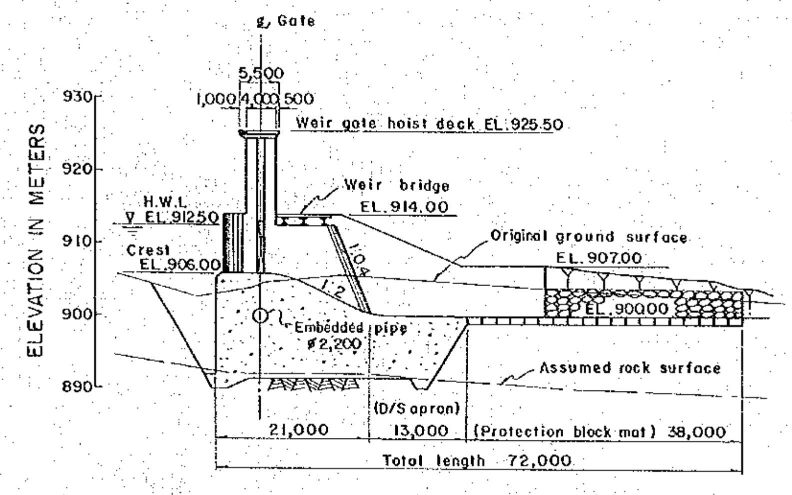
KEY PLAN



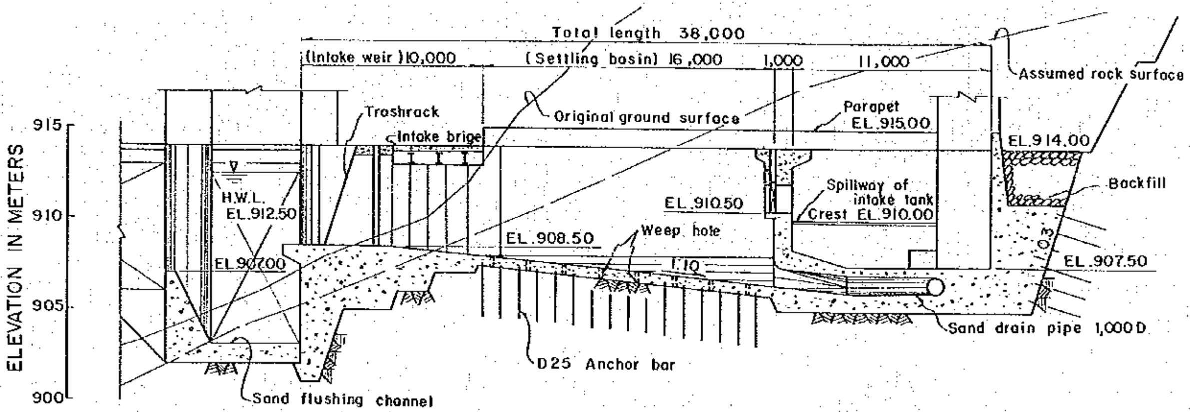
PLAN OF SETTLING BASIN & INTAKE TANK SCALE B



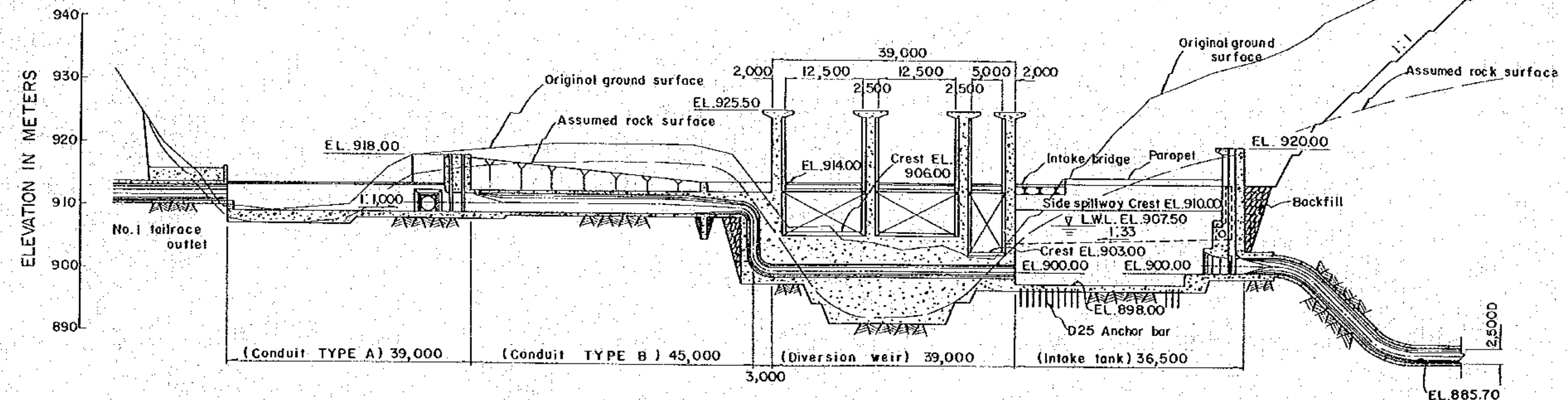
CROSS SECTION OF SETTLING BASIN & INTAKE TANK (B-B) SCALE B



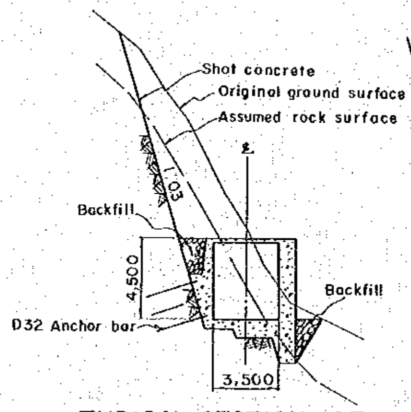
GENERAL PROFILE OF DIVERSION WEIR SCALE A



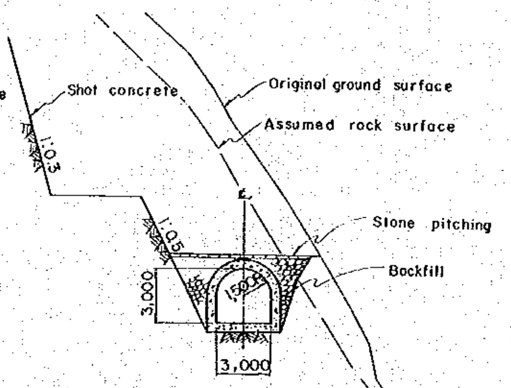
GENERAL PROFILE OF SETTLING BASIN (A-A) SCALE B



GENERAL PROFILE OF INTAKE SCALE A



TYPICAL SECTION OF CONDUIT TYPE A SCALE B

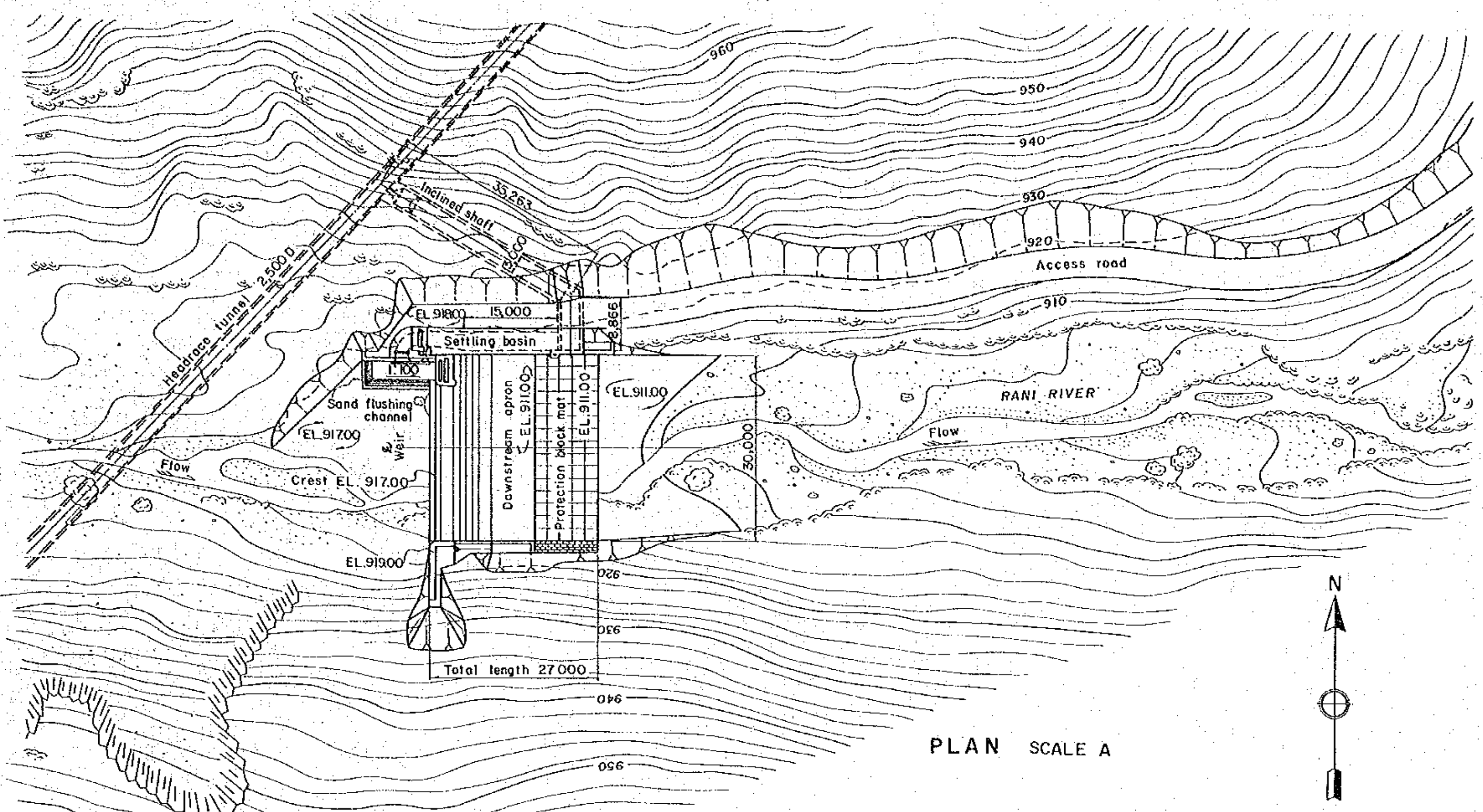


TYPICAL SECTION OF CONDUIT TYPE B SCALE B

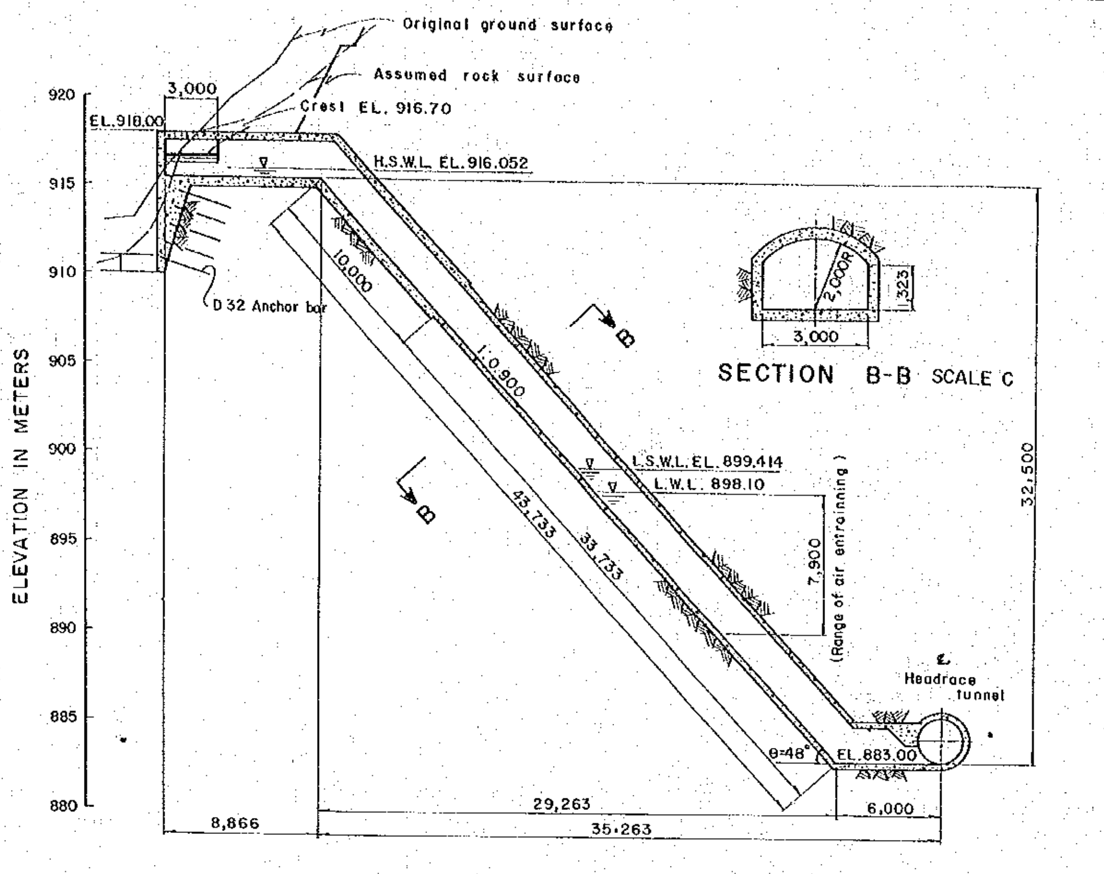
SCALE A 0 — 50m

SCALE B 0 — 10 — 20m

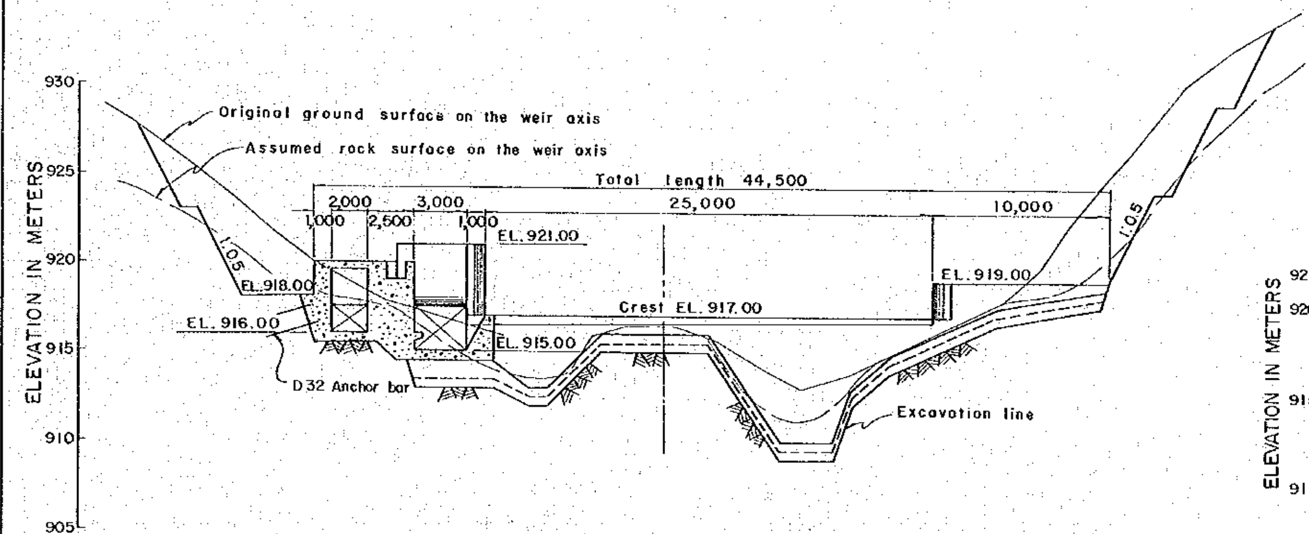
HIS MAJESTY'S GOVERNMENT OF NEPAL	PROFILE OF MANDU DIVERSION WEIR & INTAKE STRUCTURE
KULEKHANI No.2 HYDROELECTRIC PROJECT	DWG. NO. 6 — JAPAN INTERNATIONAL COOPERATION AGENCY



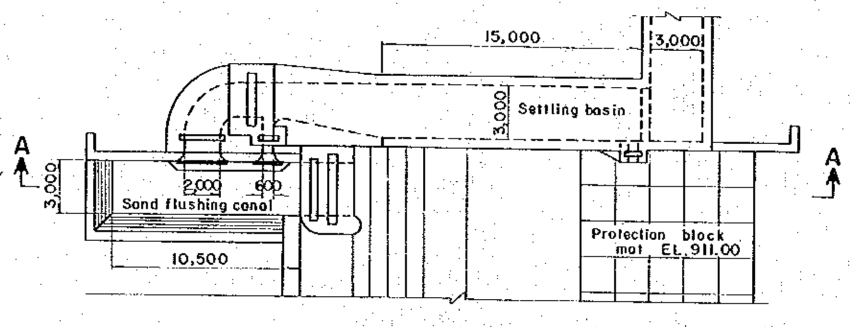
PLAN SCALE A



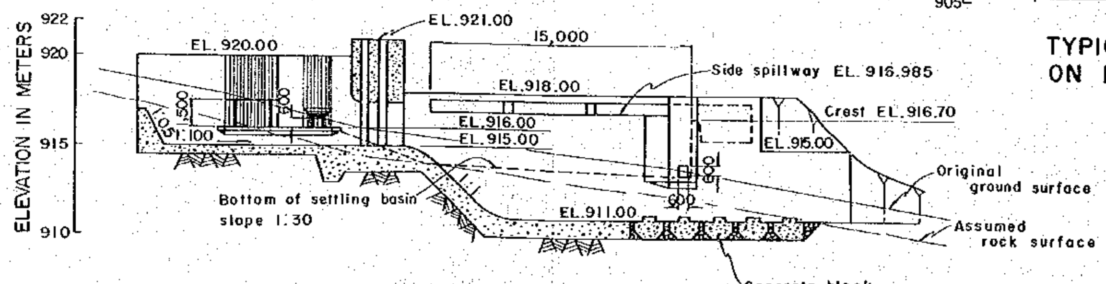
GENERAL PROFILE OF INCLINED SHAFT SCALE B



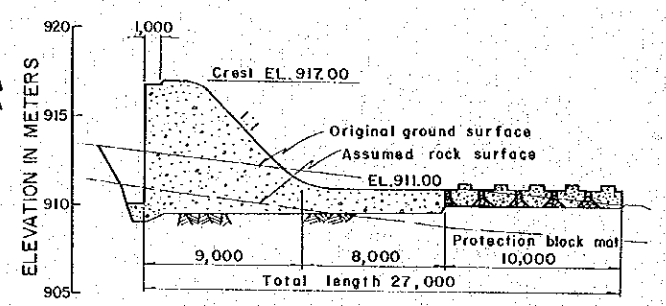
UPSTREAM ELEVATION OF DIVERSION WEIR SCALE B



PLAN OF INLET & SETTLING BASIN SCALE B



SECTION A-A SCALE B

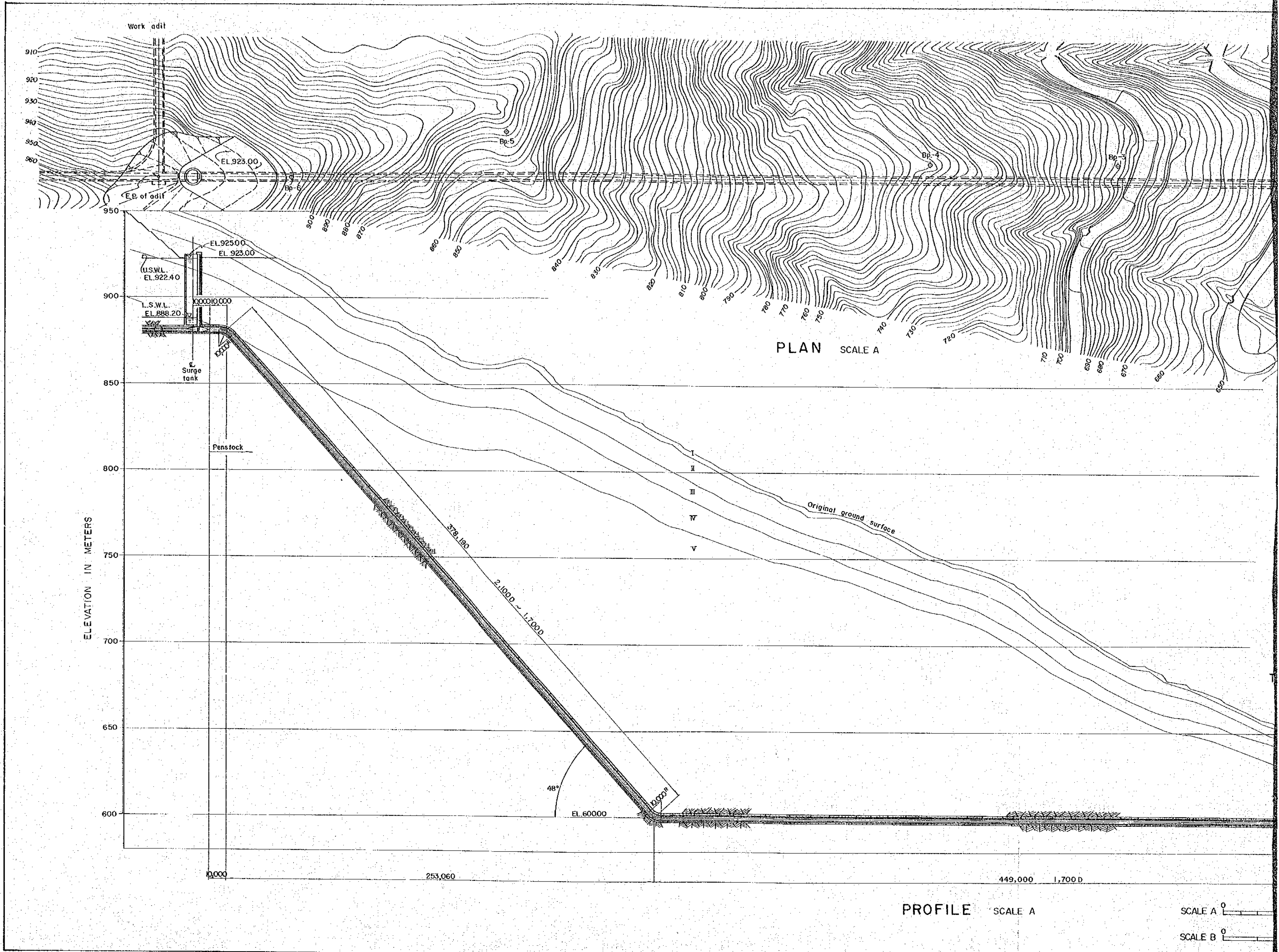


TYPICAL PROFILE OF DIVERSION WEIR ON RIVERBED SCALE B

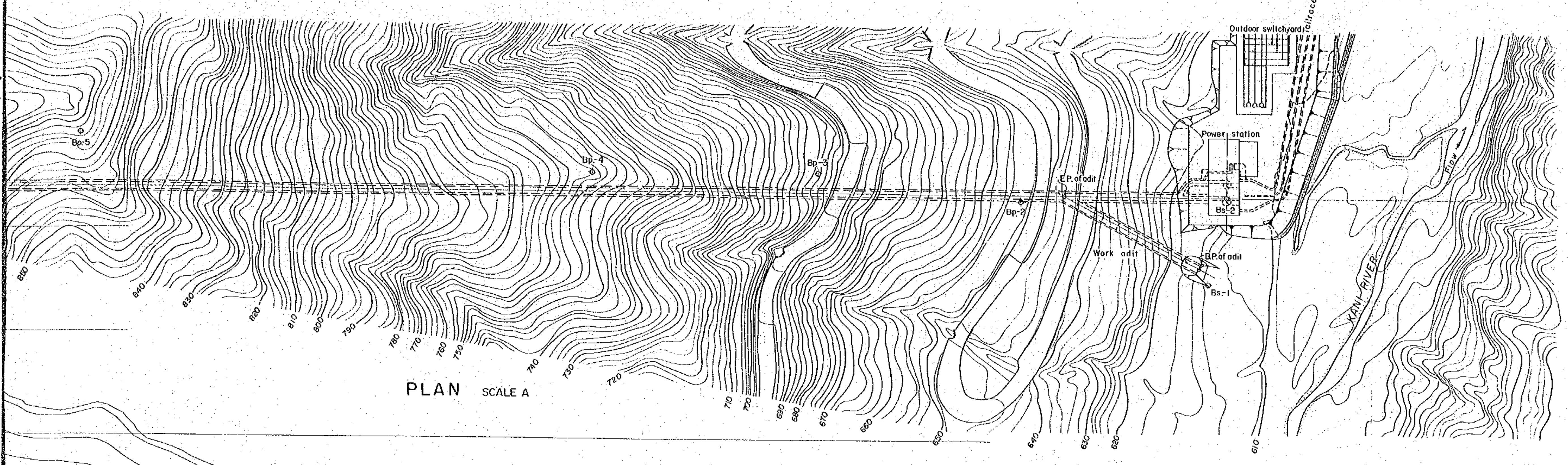
SCALE A 0 — 50m

SCALE B 0 — 10 — 20m

HIS MAJESTY'S GOVERNMENT OF NEPAL	PLAN & PROFILE OF RANI INTAKE	
KULEKHANI No.2 HYDROELECTRIC PROJECT	DWG. No. 7	JAPAN INTERNATIONAL COOPERATION AGENCY



Work adit
E.P. of adit
EL.923.00
Bp-6
Bp-5
Bp-4
Bp-3
PLAN SCALE A
EL.925.00
EL.923.00
U.S.W.L.
EL.922.40
L.S.W.L.
EL.888.20
Surge tank
Penstock
ELEVATION IN METERS
378,190
2,100D ~ 1,700D
Original ground surface
I
II
III
IV
V
48°
EL.600.00
10,000
253,060
449,000
1,700 D
PROFILE SCALE A
SCALE A
SCALE B



PLAN SCALE A

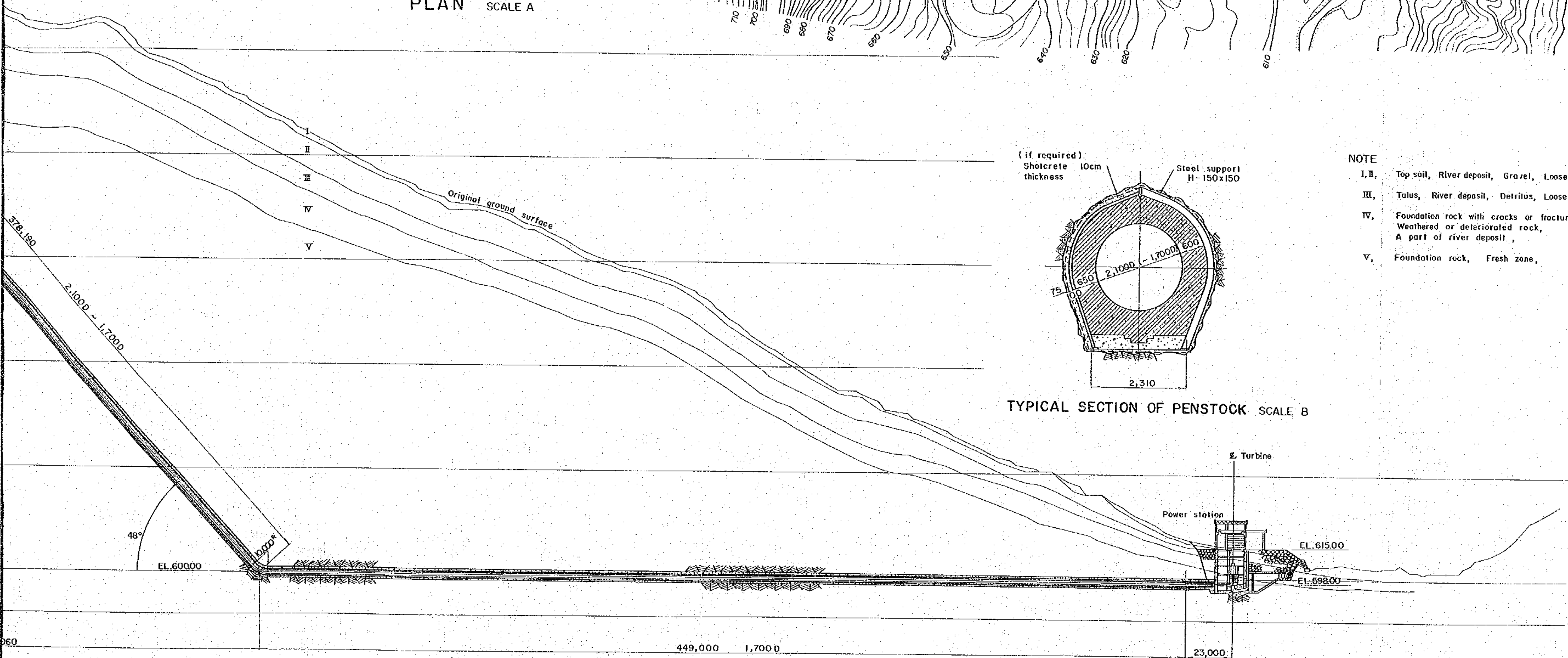
NOTE

I, II, Top soil, River deposit, Gravel, Loose rock,

III, Talus, River deposit, Detritus, Loose rock,

IV, Foundation rock with cracks or fractures, Weathered or deteriorated rock, A part of river deposit,

V, Foundation rock, Fresh zone,



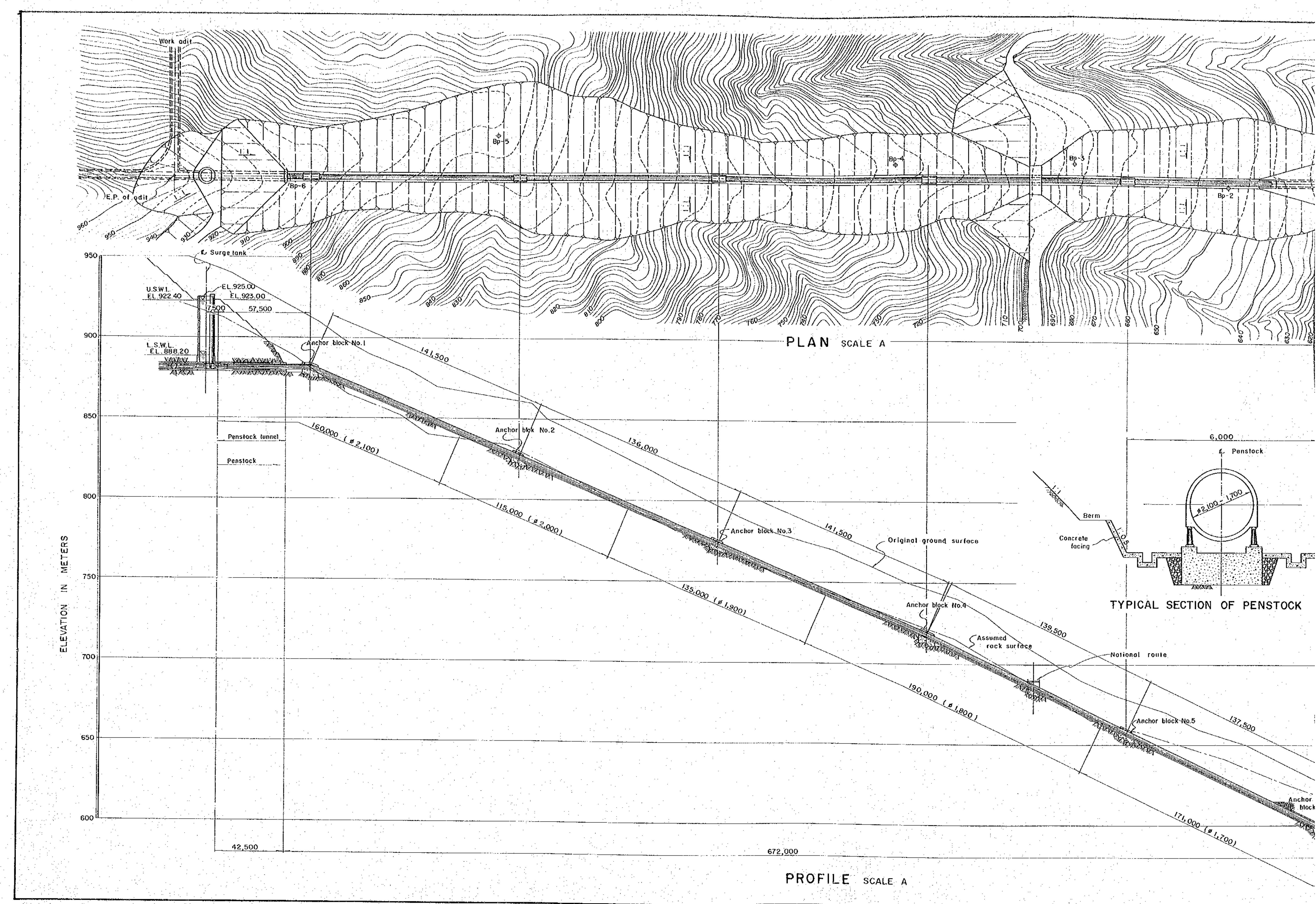
TYPICAL SECTION OF PENSTOCK SCALE B

PROFILE SCALE A

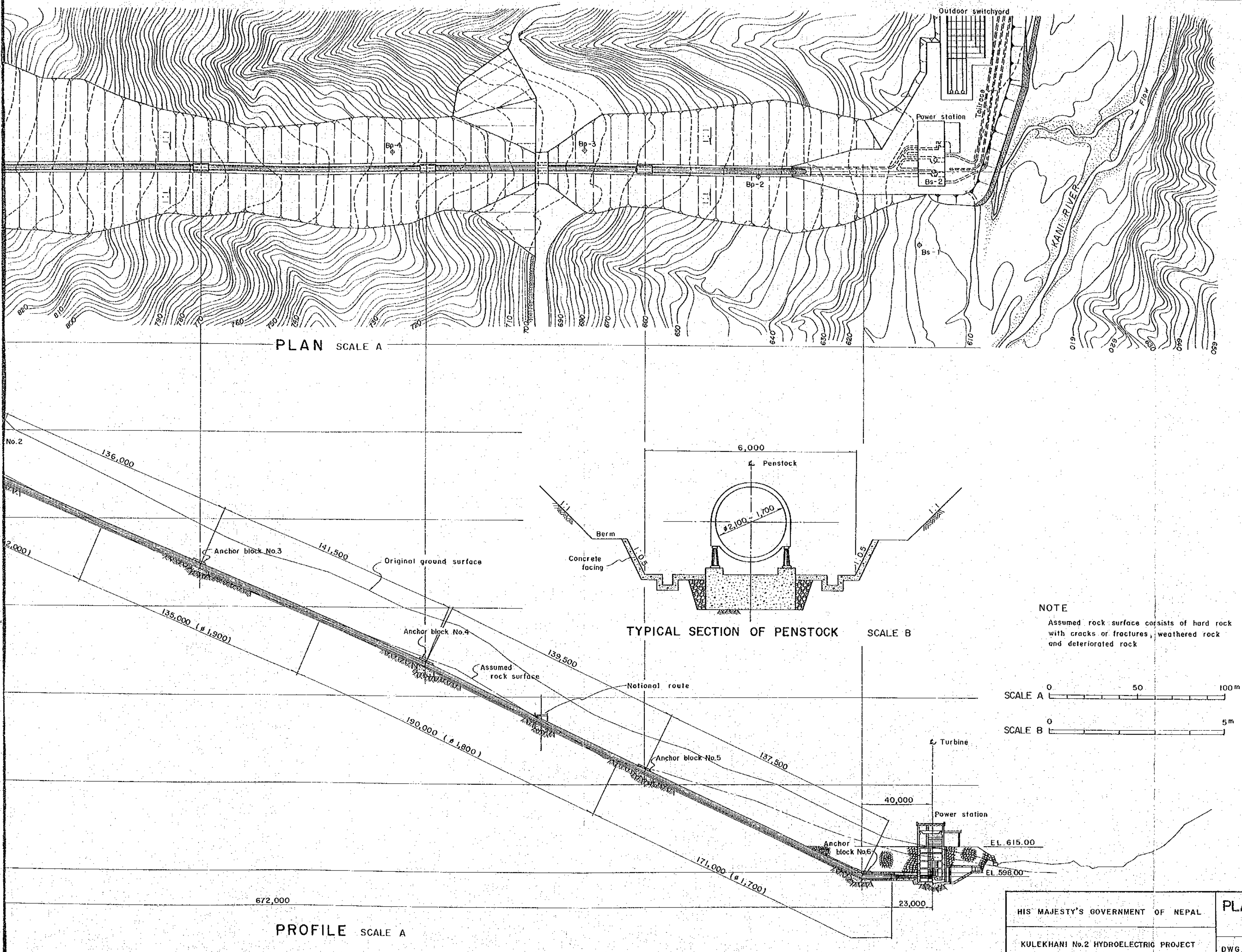
SCALE A 0 50 100m

SCALE B 0 5m

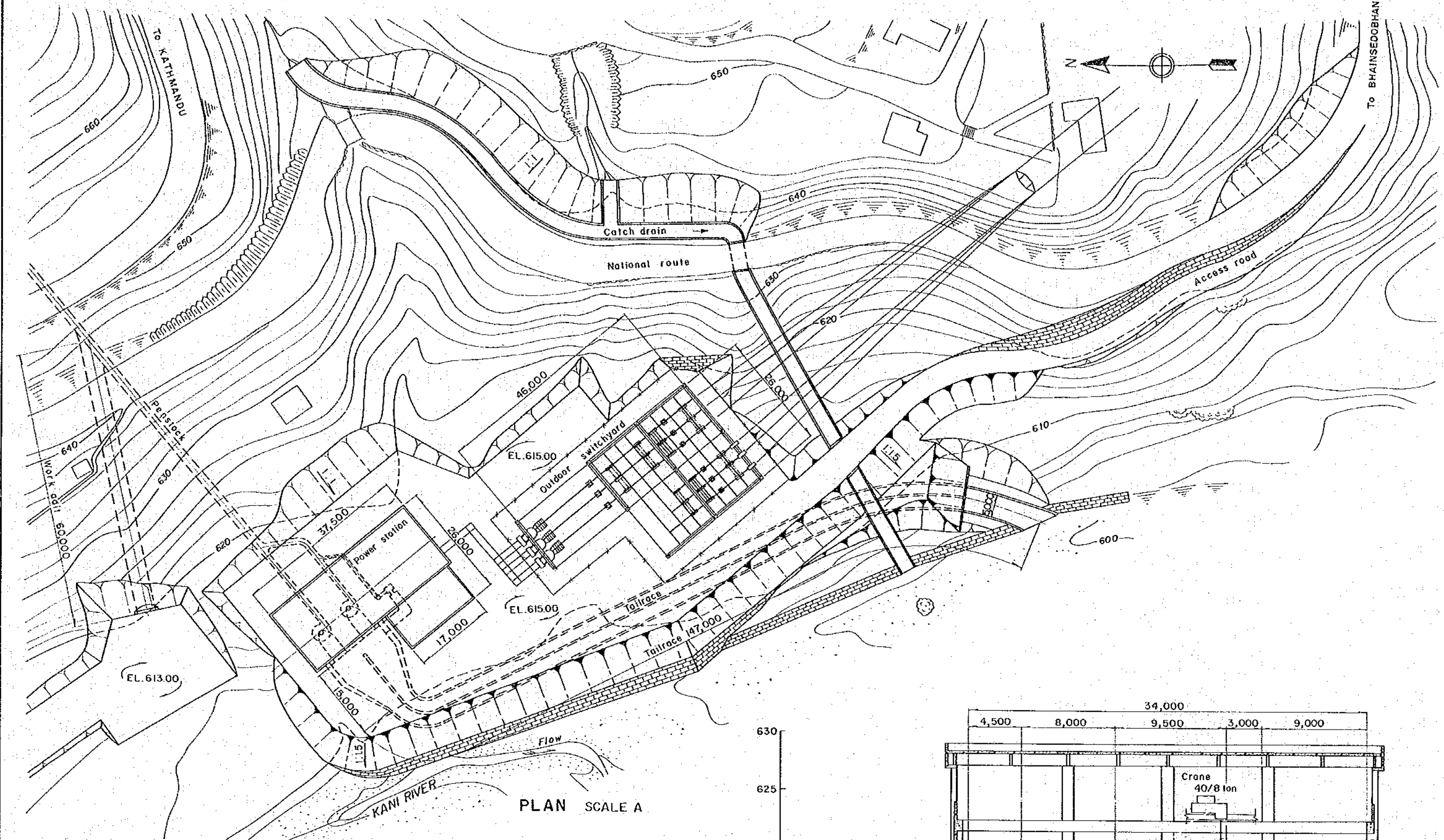
HIS MAJESTY'S GOVERNMENT OF NEPAL	PLAN & PROFILE OF PENSTOCK
KULEKHANI No.2 HYDROELECTRIC PROJECT	DWG. No. 8 — JAPAN INTERNATIONAL COOPERATION AGENCY



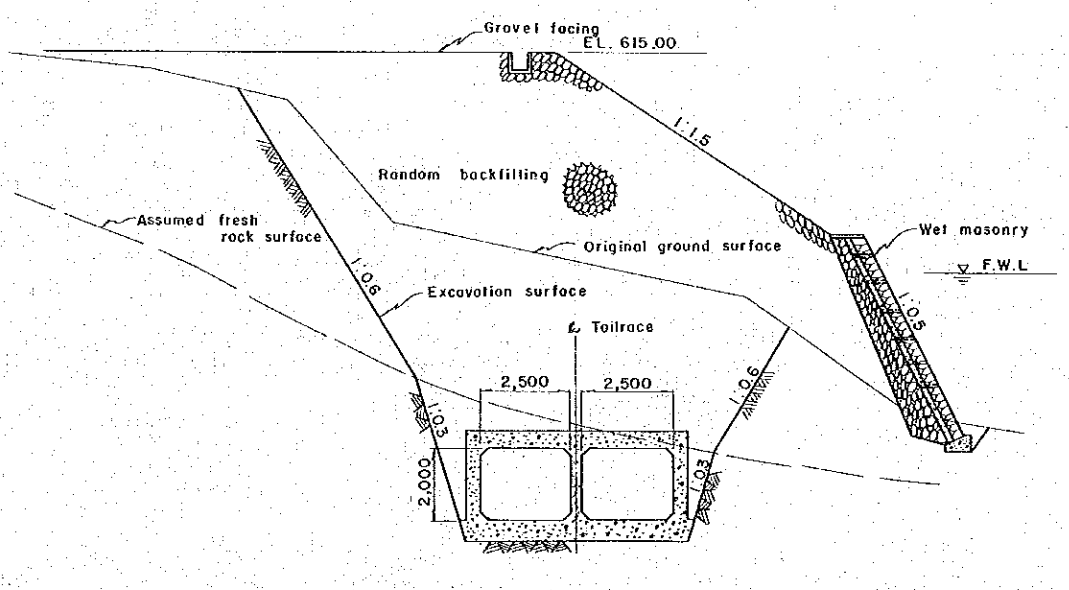
Work adit
E.P. of adit
Bp-6
Bp-5
Bp-4
Bp-3
Bp-2
PLAN SCALE A
℄ Surge tank
U.S.W.L.
EL.922.40
EL.925.00
EL.923.00
7,500
57,500
L.S.W.L.
EL.888.20
Anchor block No.1
141,500
160,000 (ø2,100)
Penstock tunnel
Penstock
Anchor blok No.2
136,000
115,000 (ø2,000)
Anchor block No.3
141,500
Original ground surface
135,000 (ø1,900)
Anchor block No.4
Assumed rock surface
139,500
National route
190,000 (ø1,800)
Anchor block No.5
137,500
171,000 (ø1,700)
Anchor block
42,500
672,000
ELEVATION IN METERS
PROFILE SCALE A
6,000
℄ Penstock
ø2,100 - 1,700
Berm
Concrete facing
TYPICAL SECTION OF PENSTOCK



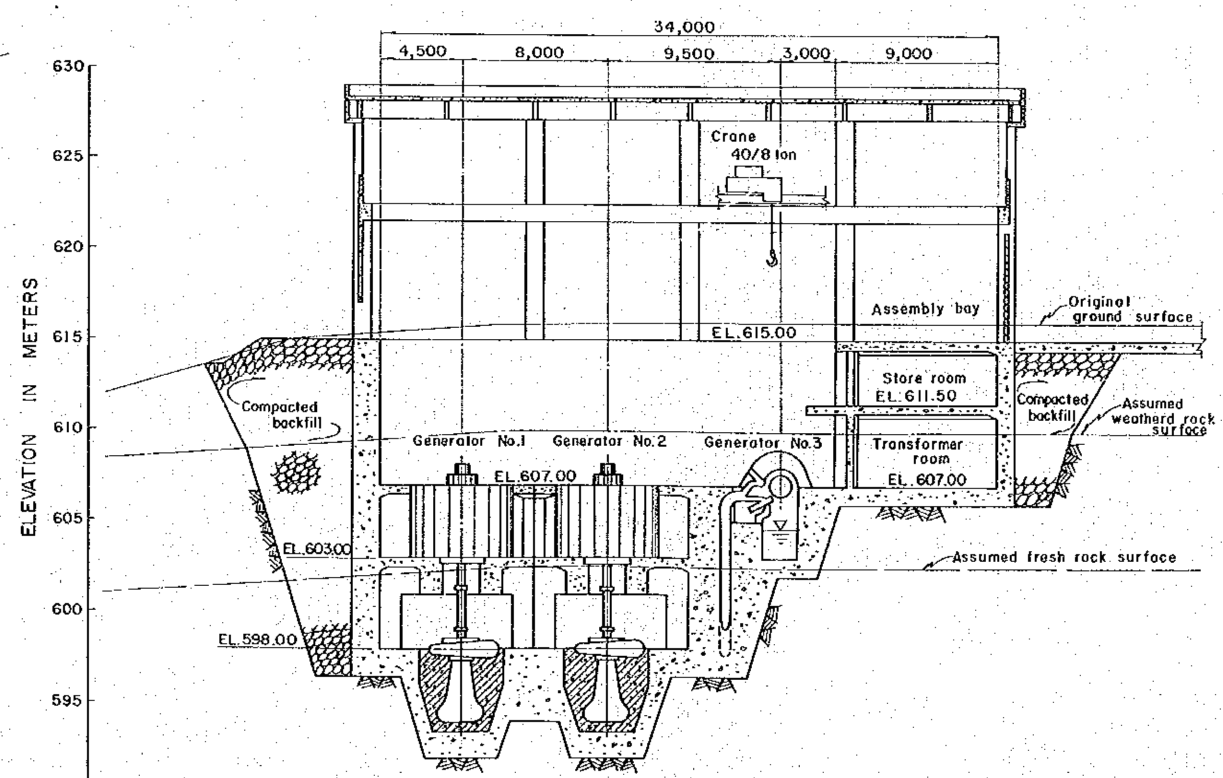
HIS MAJESTY'S GOVERNMENT OF NEPAL	PLAN & PROFILE OF PENSTOCK (ABOVE-GROUND TYPE)	
KULEKHANI No.2 HYDROELECTRIC PROJECT	DWG. No. 9	JAPAN INTERNATIONAL COOPERATION AGENCY



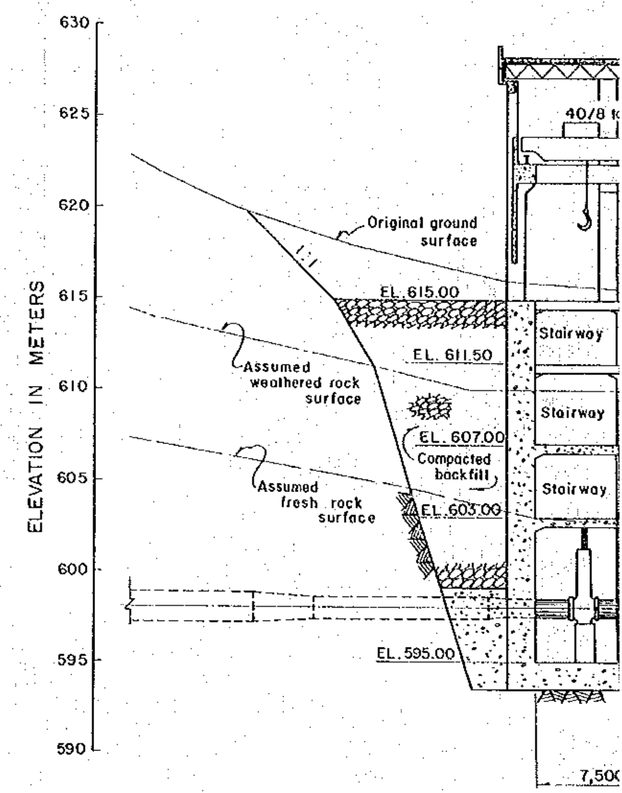
PLAN SCALE A



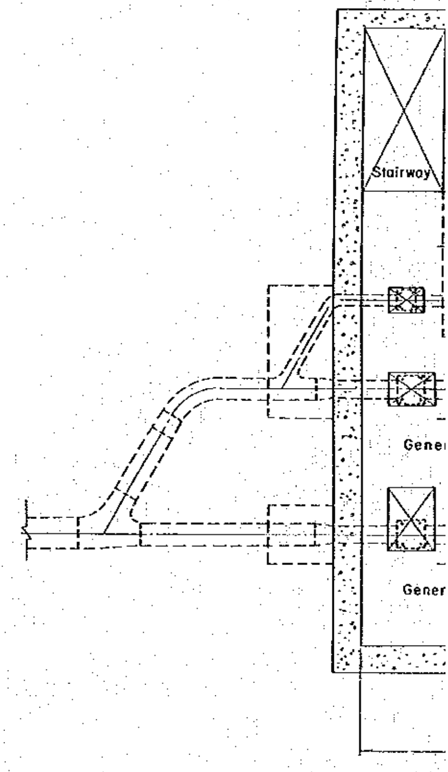
TYPICAL SECTION OF TAILRACE SCALE C



LONGITUDINAL SECTION SCALE B



STAN



PLAN (

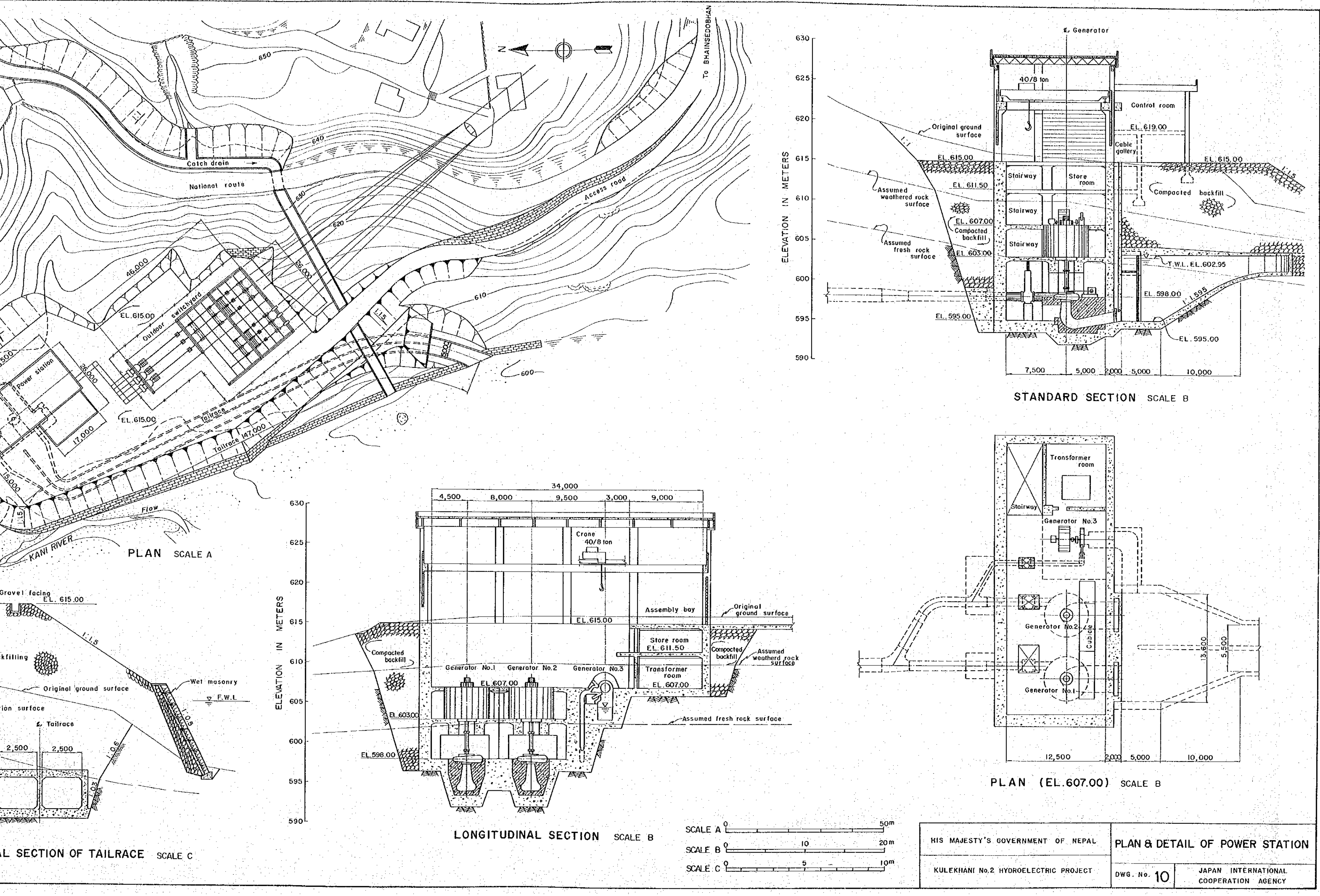
SCALE A 0 50m

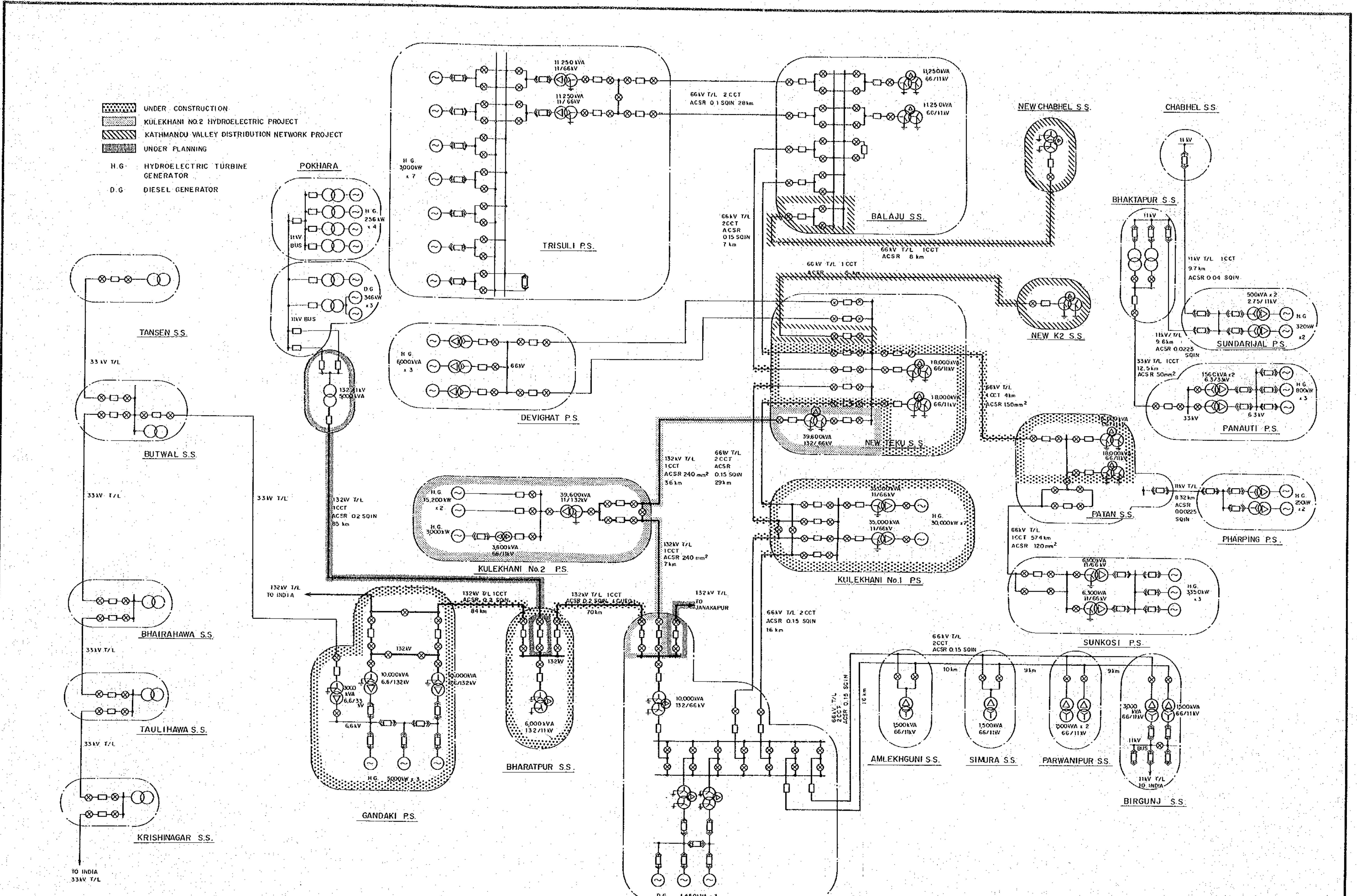
SCALE B 0 10 20m

SCALE C 0 5 10m

HIS MAJESTY'S GOVERNMENT

KULEKHANI No.2 HYDROELECT


To BHAINSEDOBHAN
Catch drain
National route
Access road
Outdoor switchyard
Power station
Tailrace
Tailrace 147,000
Flow
KANI RIVER
PLAN SCALE A
Gravel facing
EL. 615.00
Original ground surface
Wet masonry
F.W.L.
℄ Tailrace
2,500
2,500
AL SECTION OF TAILRACE SCALE C
34,000
4,500
8,000
9,500
3,000
9,000
Crane 40/8 ton
Assembly bay
Original ground surface
EL.615.00
Store room EL. 611.50
Transformer room EL. 607.00
Compacted backfill
Assumed weatherd rock surface
Generator No.1
Generator No.2
Generator No.3
EL.607.00
EL.603.00
EL.598.00
Assumed fresh rock surface
ELEVATION IN METERS
LONGITUDINAL SECTION SCALE B
℄ Generator
40/8 ton
Control room
Original ground surface
EL. 619.00
Cable gallery
EL. 615.00
Stairway
Store room
EL. 611.50
Assumed weathered rock surface
Compacted backfill
EL. 607.00
Assumed fresh rock surface
EL. 603.00
T.W.L. EL. 602.95
EL. 598.00
EL. 595.00
7,500
5,000
2,000
5,000
10,000
STANDARD SECTION SCALE B
Transformer room
Stairway
Generator No.3
Generator No.2
Generator No.1
Cubicle
13,600
5,500
12,500
2,000
5,000
10,000
PLAN (EL.607.00) SCALE B
SCALE A 0 50m
SCALE B 0 10 20m
SCALE C 0 5 10m
HIS MAJESTY'S GOVERNMENT OF NEPAL
KULEKHANI No.2 HYDROELECTRIC PROJECT
PLAN & DETAIL OF POWER STATION
DWG. No. 10
JAPAN INTERNATIONAL COOPERATION AGENCY



HIS MAJESTY'S GOVERNMENT OF NEPAL	NEPAL CNPS POWER TRANSMISSION SYSTEM (132kV, 66kV)	
KULEKHANI No.2 HYDROELECTRIC PROJECT	DWG.No. 11	JAPAN INTERNATIONAL COOPERATION AGENCY

JICA