2. STORAGE FUNCTIONNAL METHOD

[Storage Functional Method]

This method is used for estimating the river runoff in this area by using rainfall as outlined in the following:

The method is used in estimating the amount of rainfall which directly constitutes the river runoff without being evaporated or infiltrated into the ground, while the tank model is used in calculating the portion of rainfall which is evaporated or infiltrated into the ground, assuming the ground as a tank for the above portion.

In case of the storage functional method, river runoff is calculated according to the following equation:

(Storage Functional Method)

$$r - q = ds/dt$$

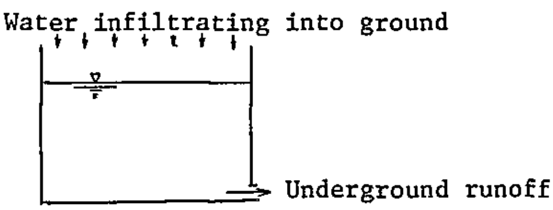
$$s = k.q^{p}$$

where,

- r: Average rainfall in the river basin
- q: Height of runoff (mm/day)
- s: Unit storage height (mm)
- k·p: Constant

The tank model is illustrated in the following diagram:

(Tank Model)



* T. Kimura: Applied Hydrorlgy: New Civil Design Data Book (July 1969 by Morikita Publishing Co.)

Fig. A.1 Chronological Graph of Runoff shows a comparison of river runoff calculated according to this method with observed runoff. Evaporation from Kaptai reservoir and ground surface is estimated according to the Hammon method in this study.

Fig. A-1 CHRONOLOGICAL GRAPH of RUNOFF

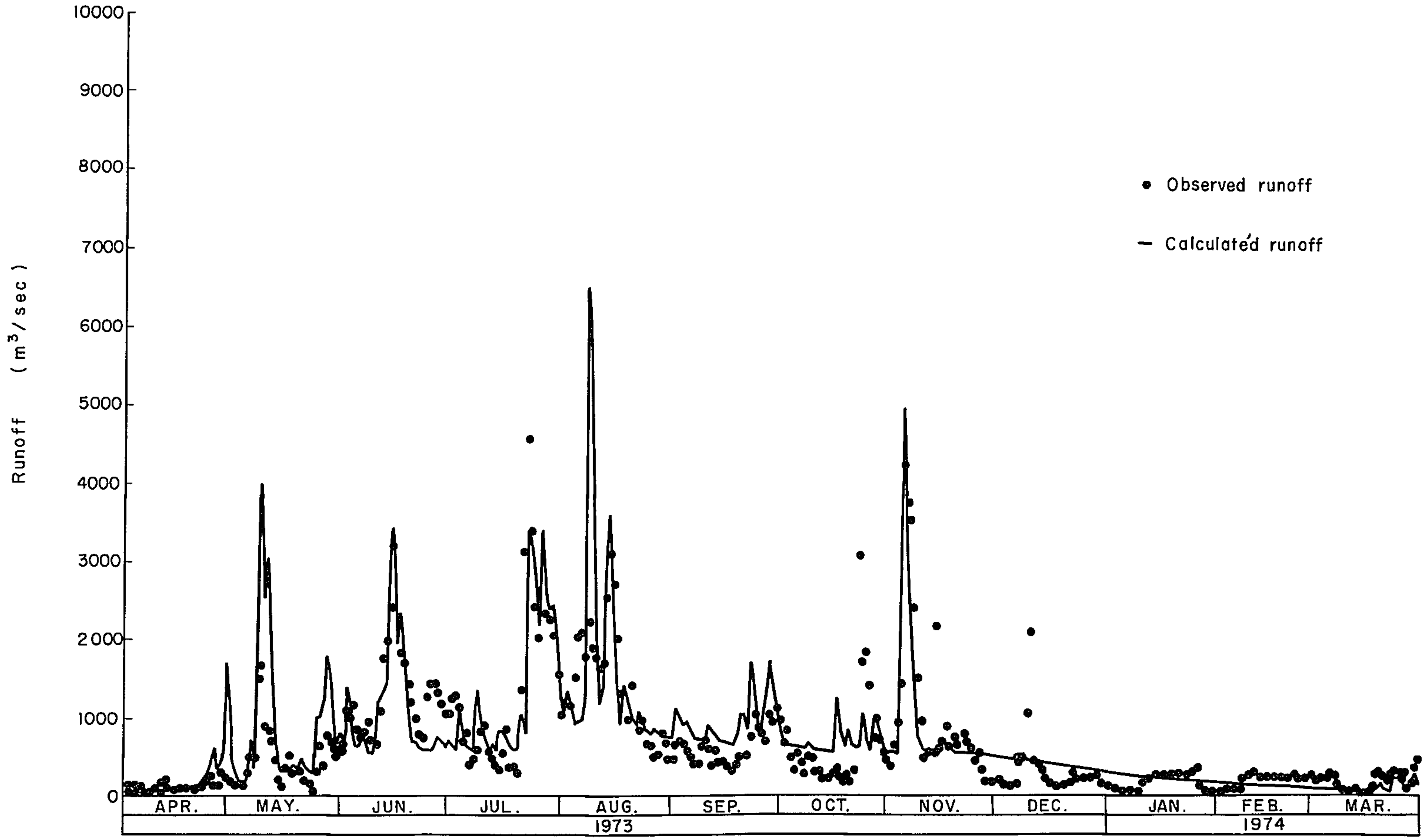
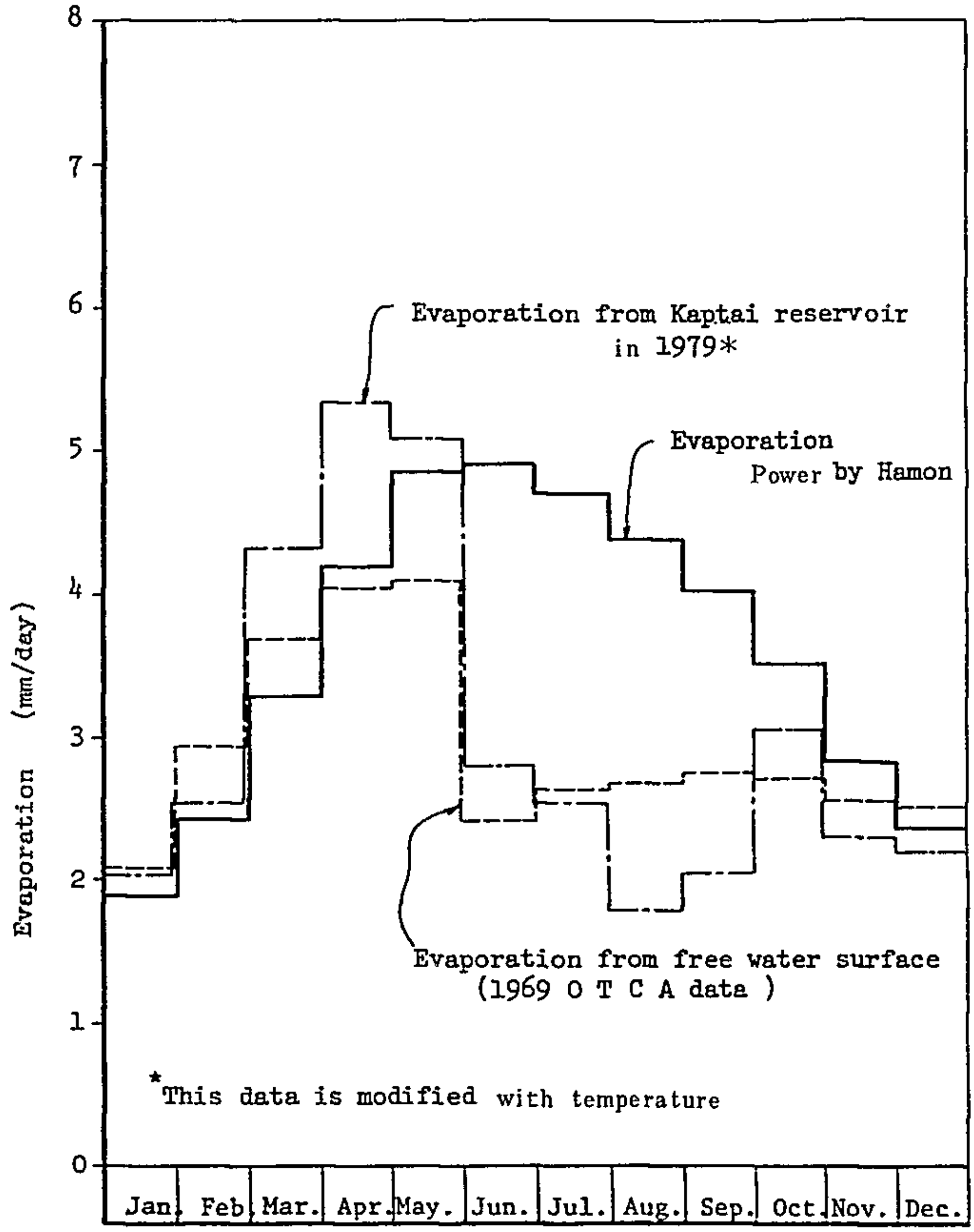


Fig. A.2 Comparison of Evaporations



3. LIST OF RUNOFF AND DISCHARGE IN EACH CASE

List of Runoff and Discharge in each case

(Case 1: 3 units operated, without upper limit of water level)

(x $10^7 m^3$)

Year	Description	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1973	Runoff	22.5	21.5	30.0	27.3	127.0	323.0	348.0	389.0	151.0	175.0	282.0	83.5	1979.8
	Turbine discharge	74.5	107.0	113.0	102.0	142.0	148.0	79.8	136.0	46.0	78.1	125.0	110.0	1261.4
	Spillway discharge	0	0.2	0	0	62.4	175.0	130.0	111.0	1.3	54.8	158.0	25.7	718.4
1974	Runoff	46.7	47.8	53.1	68.4	102.0	414.0	502.0	316.0	352.0	202.0	64.4	43.7	2212.1
	Turbine discharge	98.7	129.0	131.0	131.0	143.0	147.0	142.0	96.7	124.0	117.0	58.0	93.3	1410.7
	Spillway discharge	0	4.1	5.2	12.7	36.2	267.0	223.0	76.8	124.0	43.7	6.4	2.4	801.4
1975	Runoff	54.8	36.1	36.7	41.8	65.1	167.0	471.0	256.0	267.0	260.0	128.0	45.0	1828.5
	Turbine discharge	107.0	121.0	120.0	115.0	132.0	128.0	75.1	77.3	117.0	108.0	97.9	97.0	1295.3
	Spillway discharge	0	0.6	0	1.9	10.2	38.2	260.0	36.8	45.6	110.0	29.9	0	533.2
1976	Runoff	32.5	45.8	32.1	54.9	106.0	890.0	811.0	391.0	216.0	100.0	68.8	40.7	2788.8
	Turbine discharge	84.5	122.0	115.0	121.0	137.0	143.0	134.7	132.0	72.2	32.1	60.8	91.1	1244.9
	Spillway discharge	0	12.7	0	9.3	44.3	74.3	538.0	118.0	40.8	28.2	9.6	0	1543.9
1977	Runoff	33.3	41.3	17.0	138.0	195.0	278.0	287.0	328.0	207.0	67.6	36.7	19.7	1648.6
	Turbine discharge	85.1	121.0	99.9	136.0	153.0	128.0	90.3	100.0	83.3	21.2	36.7	70.6	1125.1
	Spilway discharge	0.2	5.7	0	77.0	119.0	150.0	60.3	86.0	20.3	3.8	0	1.2	523.5
1978	Runoff	23.7	18.6	18.7	16.8	152.0	499.0	304.0	250.0	376.0	118.0	229.0	34.5	2040.3
	Turbine discharge	75.7	104.0	102.0	91.8	131.0	149.0	110.1	63.4	120.0	76.4	108.0	86.5	1217.9
	Spillway discharge	0	0	0	0	99.2	350.0	57.0	44.2	152.0	0	120.0	0	822.4
1979	Runoff	30.5	25.6	31.3	25.9	32.2	63.9	441.0	299.0	280.0	58.7	36.6	33.2	1357.9
	Turbine discharge	82.5	111.0	114.0	101.0	109.0	60.3	55.8	73.6	97.9	23.2	29.8	83.8	941.9
	Spillway discharge	0	0.2	0	0	0.9	3.6	264.0	67.0	78.2	0	0.7	1.4	416.0
Average	Runoff	34.9	33.8	31.3	53.3	111.3	376.4	452.0	318.4	264.1	140.2	120.8	42.9	1979.4
	Turbine discharge	86.9	116.4	113.6	114.0	135.3	129.0	98.2	97.0	94.3	65.1	73.7	90.3	1213.8
	Spillway discharge	0	3.4	0.7	14.4	53.2	246.7	218.9	77.1	66.0	34.4	46.4	4.4	765.6

List of Runoff and Discharge in each case

(Case 2: 5 units operated, without upper limit of water level)

($\times 10^7 m^3$)

Year	Description	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1973	Runoff	22.5	21.5	30.0	27.3	127.0	323.0	348.0	389.0	151.0	175.0	282.0	83.5	1979.8
	Turbine discharge	74.5	107.0	113.0	102.0	187.0	234.0	119.0	199.0	47.2	101.0	173.0	121.0	1577.7
	Spillway discharge	0	0	0	0	17.1	88.8	93.1	47.9	0	31.7	109.0	14.5	402.1
1974	Runoff	46.7	47.8	53.1	68.4	102.0	414.0	502.0	316.0	352.0	202.0	64.4	43.7	2212.1
	Turbine discharge	98.7	133.0	136.0	141.0	176.0	737.0	227.0	133.0	184.0	150.0	64.4	95.7	1775.8
	Spillway discharge	0	0	0	2.6	2.9	177.0	138.0	40.0	63.7	11.1	0	0	435.3
1975	Runoff	54.8	36.1	36.7	41.8	65.1	167.0	471.0	256.0	267.0	260.0	128.0	45.0	1828.5
	Turbine discharge	107.0	122.0	120.0	117.0	143.0	166.0	123.3	102.0	154.0	160.0	119.0	97.0	1530.3
	Spillway discharge	0	0	0	0	0	0.5	209.0	12.4	8.6	58.5	9.2	0	298.2
1976	Runoff	32.5	45.8	32.1	54.9	106.0	890.0	811.0	391.0	216.0	100.0	68.8	40.7	2788.8
	Turbine discharge	84.5	134.0	115.0	130.0	174.0	234.0	230.0	188.0	102.0	39.1	67.0	91.1	1586.7
	Spillway discharge	0	0	0	0	3.8	656.0	444.0	62.3	11.4	21.2	3.4	0	1202.1
1977	Runoff	33.3	41.3	17.0	138.0	195.0	278.0	287.0	328.0	207.0	67.6	36.7	19.7	1648.6
	Turbine discharge	85.3	127.0	99.9	184.0	223.0	173.0	114.3	140.0	101.0	24.8	36.0	71.7	1380.0
	Spilway discharge	0	0	0	28.5	49.5	105.0	36.8	45.7	2.8	0.3	0	0	268.6
1978	Runoff	23.7	18.6	18.7	16.8	152.0	499.0	304.0	250.0	376.0	118.0	229.0	34.5	2040.3
	Turbine discharge	75.7	104.0	102.0	91.8	183.0	254.0	150.6	92.9	181.0	76.4	161.0	86.5	1558.9
	Spillway discharge	0	0	0	0	47.0	245.0	16.5	14.7	90.7	0	67.5	0	481.4
1979	Runoff	30.5	25.6	31.3	25.9	32.2	63.9	441.0	299.0	280.0	58.7	36.6	33.2	1357.9
	Turbine discharge	82.5	111.0	114.0	101.0	110.0	63.9	83.2	103.0	128.0	23.2	30.5	85.1	1035.4
	Spillway discharge	0	0	0	0	0	0	237.0	37.6	47.9	0	0	0	322.5
Average	Runoff	34.9	33.8	31.3	53.3	111.3	376.4	452.0	318.4	264.1	140.2	120.8	42.9	1979.4
	Turbine discharge	86.9	119.7	114.3	123.8	170.9	194.6	149.6	136.8	128.1	82.0	93.0	92.5	1492.2
	Spillway discharge	0	0	0	4.4	17.2	181.8	167.8	37.2	32.2	17.5	27.0	2.1	487.2

List of Runoff and Discharge in each case

(Case 3: 5 units operated, with upper limit of water level)

(x $10^7 m^3$)

Year	Description	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1973	Runoff	22.5	21.5	30.0	27.3	127.0	323.0	348.0	389.0	151.0	175.0	282.0	83.5	1979.8
	Turbine discharge	74.5	107.0	113.0	102.0	204.0	241.0	200.3	265.0	122.0	112.0	233.0	157.0	1930.8
	Spillway discharge	0	0	0	0	0	0	0	0	0	5.9	43.1	0	49.0
1974	Runoff	46.7	47.8	53.1	68.4	102.0	414.0	502.0	316.0	352.0	202.0	64.4	43.7	2212.1
	Turbine discharge	98.7	133.0	136.0	143.0	177.0	262.0	269.9	257.0	232.0	161.0	64.4	95.7	2029.7
	Spillway discharge	0	0	0	0	0	0	4.0	58.4	120.0	0	0	0	182.4
1975	Runoff	54.8	36.1	36.7	41.8	65.1	167.0	471.0	256.0	267.0	260.0	128.0	45.0	1828.5
	Turbine discharge	107.0	122.0	120.0	117.0	143.0	167.0	139.1	262.0	207.0	196.0	128.0	97.0	1805.1
	Spillway discharge	0	0	0	0	0	0	0	0	1.2	22.2	0	0	23.4
1976	Runoff	32.5	45.8	32.1	54.9	106.0	890.0	811.0	391.0	216.0	100.0	68.8	40.7	2788.8
	Turbine discharge	84.5	134.0	115.0	130.0	181.0	224.0	255.9	256.0	175.0	60.3	70.4	91.9	1778.0
	Spillway discharge	0	0	0	0	0	282.0	554.0	135.0	39.8	0	0	0	1010.8
1977	Runoff	33.3	41.3	17.0	138.0	195.0	278.0	287.0	328.0	207.0	67.6	36.7	19.7	1648.6
	Turbine discharge	85.3	127.0	99.9	213.0	240.0	217.0	231.9	173.0	128.0	25.1	36.7	71.7	1648.6
	Spilway discharge	0	0	0	0	0	0	0	0	0	0	0	0	0
1978	Runoff	23.7	18.6	18.7	16.8	152.0	499.0	304.0	250.0	376.0	118.0	229.0	34.5	2040.3
	Turbine discharge	75.7	104.0	102.0	91.8	184.0	264.0	270.9	268.0	217.0	76.4	222.0	86.5	1962.3
	Spillway discharge	0	0	0	0	0	0	0	0	71.4	0	6.6	0	78.0
1979	Runoff	30.5	25.6	31.3	25.9	32.2	63.9	441.0	299.0	280.0	58.7	36.6	33.2	1357.9
	Turbine discharge	82.5	111.0	114.0	101.0	110.0	63.9	272.7	180.0	184.0	23.2	30.5	85.1	1357.9
	Spillway discharge	0	0	0	0	0	0	0	0	0	0	0	0	0
Average	Runoff	34.9	33.8	31.3	53.3	111.3	376.4	452.0	318.4	264.1	140.2	120.8	42.9	1979.4
	Turbine discharge	86.9	119.7	114.3	128.3	177.0	205.6	234.4	237.3	180.7	93.4	112.1	97.8	1787.5
	Spillway discharge	0	0	0	0	0	40.3	79.7	27.6	33.2	4.0	7.1	0	191.9

List of Runoff and Discharge in each case

(Case 4: 3 units operated, with upper limit of water level)

($x\ 10^7 m^3$)

Year	Description	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1973	Runoff	22.5	21.5	30.0	27.3	127.0	323.0	348.0	389.0	151.0	175.0	282.0	83.5	1979.8
	Turbine discharge	74.5	107.0	113.0	102.0	149.0	149.0	208.4	146.0	139.0	84.7	130.0	136.0	1538.6
	Spillway discharge	0	0	0	0	0	68.8	57.4	157.0	12.6	27.4	118.0	0	441.2
1974	Runoff	46.7	47.8	53.1	68.1	102.0	414.0	502.0	316.0	352.0	202.0	64.4	43.7	2212.1
	Turbine discharge	98.7	129.0	138.0	145.0	154.0	149.0	150.3	144.0	139.0	138.0	70.6	102.0	1557.6
	Spillway discharge	0	0	0	0	0	68.8	192.0	171.0	213.0	9.7	0	0	335.1
1975	Runoff	54.8	36.1	36.7	41.8	65.1	167.0	471.0	256.0	267.0	260.0	128.0	45.0	1828.5
	Turbine discharge	107.0	121.0	120.0	117.0	135.0	144.0	97.4	145.0	139.0	139.0	132.0	97.0	1493.4
	Spillway discharge	0	0	0	0	0	3.8	57.8	70.5	128.0	75.0	0	0	335.1
1976	Runoff	32.5	45.8	32.1	54.9	106.0	890.0	811.0	391.0	216.0	100.0	68.8	40.7	2788.8
	Turbine discharge	84.5	134.0	115.0	124.0	149.0	143.0	142.4	144.0	134.0	60.3	60.7	101.0	1391.9
	Spillway discharge	0	0	0	0	0	402.0	667.0	247.0	80.6	0	0	0	1396.9
1977	Runoff	33.3	41.3	17.0	138.0	195.0	278.0	287.0	328.0	207.0	67.6	36.7	19.7	1648.6
	Turbine discharge	85.3	127.0	99.9	145.0	154.0	149.0	151.0	144.0	132.0	26.0	36.7	71.7	1321.6
	Spilway discharge	0	0	0	0	0	30.6	47.4	174.0	75.0	0	0	0	327.0
1978	Runoff	23.7	18.6	18.7	16.8	152.0	499.0	304.0	250.0	376.0	118.0	229.0	34.5	2040.3
	Turbine discharge	75.7	104.0	102.0	91.8	131.0	148.0	144.8	144.0	139.0	76.4	130.0	125.0	1411.7
	Spillway discharge	0	0	0	0	0	92.6	134.0	105.0	237.0	0	60.0	0	628.6
1979	Runoff	30.5	25.6	31.3	25.9	32.2	63.9	441.0	299.0	280.0	58.7	36.6	33.2	1357.9
	Turbine discharge	82.5	111.0	114.0	101.0	110.0	63.0	153.9	151.0	139.0	23.2	30.5	85.1	1164.2
	Spillway discharge	0	0	0	0	0	0	34.4	43.3	116.0	0	0	0	193.7
Average	Runoff	34.9	33.8	31.3	53.3	111.3	376.4	452.0	318.4	264.1	140.2	120.8	42.9	1979.4
	Turbine discharge	86.9	119.0	114.6	118.0	140.3	135.0	149.7	145.4	137.3	78.2	84.4	102.5	1411.3
	Spillway discharge	0	0	0	0	0	95.2	170.0	138.3	123.2	16.0	25.4	0	568.1

4. GENERATED ELECTRIC ENERGY OF KAPTAI HYDRO-POWER STATION

Generated Electric Energy in Kaptai Hydro-Power Station

(Case 1: 3 units operated without upper limit of water level)

($x10^6$ kWh)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1973	49.4	68.9	68.1	56.1	68.3	66.4	40.7	81.2	29.7	52.2	87.6	76.0	744.6
1974	66.0	82.7	78.3	71.6	69.1	65.8	70.8	58.4	81.0	80.4	38.1	64.3	826.5
1975	71.7	77.8	72.0	62.8	64.1	57.7	39.0	45.6	77.1	73.5	68.2	67.0	776.5
1976	56.4	78.2	68.9	65.3	65.7	63.8	67.6	80.4	46.0	19.0	40.4	62.7	714.4
1977	56.8	77.9	60.1	73.9	73.5	57.6	45.5	61.3	53.7	12.5	21.5	47.8	642.1
1978	50.1	67.2	61.2	50.5	62.8	66.6	56.2	37.8	79.1	51.7	76.0	59.6	718.8
1979	55.0	71.6	68.9	55.5	53.2	27.0	26.2	45.7	63.5	14.7	18.1	57.6	557.0
Average	57.9	74.9	68.2	62.2	65.2	57.8	49.6	58.6	61.4	43.4	50.0	62.1	711.1

Genarated Electric Energy in Kaptai Hydro-Power Station
(Case 2: 3 units operated without upper limit of water level)

(x 10^6 kWh)

Year	Description	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1973	Existing (3 units)	49.4	68.9	68.1	56.1	68.3	66.4	40.7	81.2	29.7	52.3	87.9	76.1	745.1
	Extension (2 units)	0	0	0	0	21.7	38.6	19.7	37.8	0.6	15.7	32.7	7.9	174.0
	Total	49.4	68.9	68.1	56.1	90.0	105.0	60.4	119.0	30.3	68.0	120.6	83.3	919.1
1974	Existing (3 units)	66.0	82.8	78.3	71.6	69.1	65.8	70.8	58.5	81.4	80.7	38.2	64.4	827.6
	Extension (2 units)	0	1.3	2.4	5.4	16.1	40.7	42.6	22.3	38.8	21.3	4.4	1.3	196.1
	Total	66.0	84.2	80.7	77.0	85.2	106.0	113.4	80.8	120.0	102.0	42.6	65.7	1,023.7
1975	Existing (3 units)	71.7	77.8	72.0	62.8	64.1	57.7	39.0	45.6	77.3	73.8	68.4	67.0	777.2
	Extension (2 units)	0	0.3	0	0.9	4.7	17.0	26.2	14.3	24.3	35.3	13.9	0	136.9
	Total	71.7	78.1	72.0	63.7	68.8	74.7	65.2	59.9	101.6	109.1	82.3	67.0	914.1
1976	Existing (3 units)	56.4	78.4	68.9	65.3	65.7	63.8	67.6	80.5	46.1	19.0	40.4	62.7	714.8
	Extension (2 units)	0	7.3	0	4.6	17.5	41.1	46.0	34.6	18.6	4.9	4.2	0	178.8
	Total	56.4	85.7	68.9	69.9	83.2	104.9	113.6	115.1	64.7	23.9	44.6	62.7	893.6
1977	Existing (3 units)	56.8	78.1	60.1	73.9	73.5	57.6	45.5	61.3	53.9	12.5	21.5	47.8	642.5
	Extension (2 units)	0	2.9	0	26.7	33.4	20.0	12.0	24.7	10.9	2.4	0	0.7	133.7
	Total	56.8	81.0	60.1	100.6	106.9	77.6	57.5	86.0	64.8	14.9	21.5	48.5	776.2
1978	Existing (3 units)	50.1	67.2	61.2	50.5	62.8	66.6	56.2	37.9	79.4	51.7	76.3	59.6	719.5
	Extension (2 units)	0	0	0	0	24.3	47.1	21.4	17.6	40.1	0	37.1	0	187.6
	Total	50.1	67.2	61.2	50.5	87.1	113.7	77.6	55.5	119.5	51.7	113.4	59.6	907.1
1979	Existing (3 units)	55.0	71.6	68.9	55.5	53.2	27.0	26.2	45.7	63.7	14.7	18.1	57.6	557.2
	Extension (2 units)	0	0	0	0	0.4	1.6	12.7	18.0	19.3	0	0.3	0.9	53.2
	Total	55.0	71.6	68.9	55.5	53.6	28.6	38.9	63.7	83.0	14.7	18.4	58.5	610.4
Aver-age	Existing (3 units)	57.9	75.0	68.2	62.2	65.2	57.8	49.4	58.7	61.6	43.5	50.1	62.2	711.8
	Extension (2 units)	0	1.7	0.3	5.4	16.9	29.4	25.8	24.2	21.8	11.4	13.2	1.4	151.5
	Total	57.9	76.7	68.5	67.6	82.1	87.2	75.2	82.9	83.4	54.9	63.3	63.6	863.3

Generated Electric Energy in Kaptai Hydro-Power Station
(Case 3: 5 units operated with upper limit of water level)

(x 10^6 kWh)

Year	Description	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1973	Existing (3 units)	49.4	68.9	68.1	56.1	69.8	70.3	61.8	96.9	53.8	53.1	94.7	82.6	825.5
	Extension (2 units)	0	0	0	0	29.1	44.5	45.0	74.7	26.4	23.5	73.0	26.1	342.3
	Total	49.4	68.9	68.1	56.1	98.9	114.8	106.8	171.6	80.2	76.6	167.7	108.7	1167.8
1974	Existing (3 units)	66.0	82.8	78.3	71.6	69.1	72.3	94.5	98.2	90.2	81.4	38.2	64.4	909.0
	Extension (2 units)	0	1.3	2.4	7.0	16.3	55.3	72.9	75.7	68.0	28.5	4.4	1.3	333.1
	Total	66.0	84.1	80.7	78.6	85.4	127.6	167.4	173.9	158.2	109.0	42.6	65.7	1242.1
1975	Existing (3 units)	71.7	77.8	72.0	62.8	64.1	57.7	46.1	98.0	89.4	85.2	68.8	67.0	860.6
	Extension (2 units)	0	0.3	0	0.9	4.7	17.3	35.5	75.5	48.0	51.4	20.3	0	253.9
	Total	71.7	78.1	72.0	63.7	68.8	75.0	81.6	173.5	137.4	136.6	89.1	67.0	1114.5
1976	Existing (3 units)	56.4	78.4	68.9	65.3	65.7	83.8	98.2	98.2	71.3	25.8	40.4	62.7	815.1
	Extension (2 units)	0	7.3	0	4.6	21.1	56.5	75.7	75.7	46.4	13.4	6.6	0	307.3
	Total	56.4	85.7	68.9	69.9	86.8	140.3	173.9	173.9	117.7	39.2	47.0	62.7	1122.4
1977	Existing (3 units)	56.8	78.1	60.1	77.5	75.5	65.3	71.5	65.6	57.8	12.7	21.5	47.8	690.2
	Extension (2 units)	0	2.9	0	39.8	43.1	36.4	49.8	42.2	24.4	2.4	0	0.7	241.7
	Total	56.8	81.0	60.1	117.3	118.6	101.7	121.3	107.8	82.2	15.1	21.5	48.5	931.9
1978	Existing (3 units)	50.1	67.2	61.2	50.5	66.4	82.5	96.4	97.6	86.8	51.7	91.5	59.6	861.5
	Extension (2 units)	0	0	0	0	26.1	63.6	74.4	75.2	57.0	0	68.2	0	364.5
	Total	50.1	67.2	61.2	50.5	92.5	146.1	170.8	172.8	143.8	51.7	159.7	59.6	1226.0
1979	Existing (3 units)	55.0	71.6	68.9	55.5	53.2	27.0	90.7	64.4	80.0	14.7	18.1	57.6	656.7
	Extension (2 units)	0	0	0	0	0.4	1.6	70.0	47.4	41.8	0	0.4	0.9	162.5
	Total	55.0	71.6	68.9	55.5	53.6	28.6	160.7	111.8	121.8	14.7	18.5	58.5	819.2
Average	Existing (3 units)	57.9	75.0	68.3	62.7	66.3	65.6	79.9	88.4	75.6	46.4	53.3	63.1	802.5
	Extension (2 units)	0	1.7	0.3	7.5	20.1	39.3	60.5	66.6	44.6	17.0	24.7	4.1	286.4
	Total	57.9	76.7	68.6	70.2	86.4	104.9	140.4	155.0	120.2	63.4	78.0	67.2	1088.9

Generated Electric Energy in Kaptai Hydro-Power Station

(Case 4: 3 units operated with upper limit of water level)

($x10^6$ kWh)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1973	49.4	68.9	68.2	56.1	75.1	78.6	90.1	97.6	94.6	57.2	94.2	97.5	927.5
1974	66.0	82.8	82.3	79.9	76.1	78.6	97.1	97.8	94.6	97.7	47.5	70.7	971.1
1975	71.7	78.0	72.2	63.8	65.5	66.3	54.9	97.8	94.6	97.7	93.8	67.0	923.3
1976	56.4	86.4	68.9	67.3	73.8	87.7	97.8	97.8	91.0	40.3	40.4	69.6	877.4
1977	56.9	81.5	60.1	83.9	88.4	88.8	97.3	97.8	90.0	15.7	21.5	48.6	830.5
1978	50.1	67.2	61.2	50.5	65.7	88.2	97.7	97.8	94.6	51.5	94.2	87.7	906.8
1979	55.0	71.7	68.9	55.5	53.6	28.2	93.4	96.5	94.3	14.7	18.6	58.5	708.9
Average	57.9	76.6	68.8	65.3	71.2	73.8	89.8	97.6	93.4	53.6	58.6	71.4	878.0

5. PLANS

(1) GENERAL LAYOUT

(2) GENERAL PLAN

(3) PROFILE of WATERWAY NO. 4

(4) PROFILE of WATERWAY NO. 5

(5) INTAKE PLAN

(6) INTAKE SECTION

(7) POWERHOUSE FLOOR PLAN EL.49.00

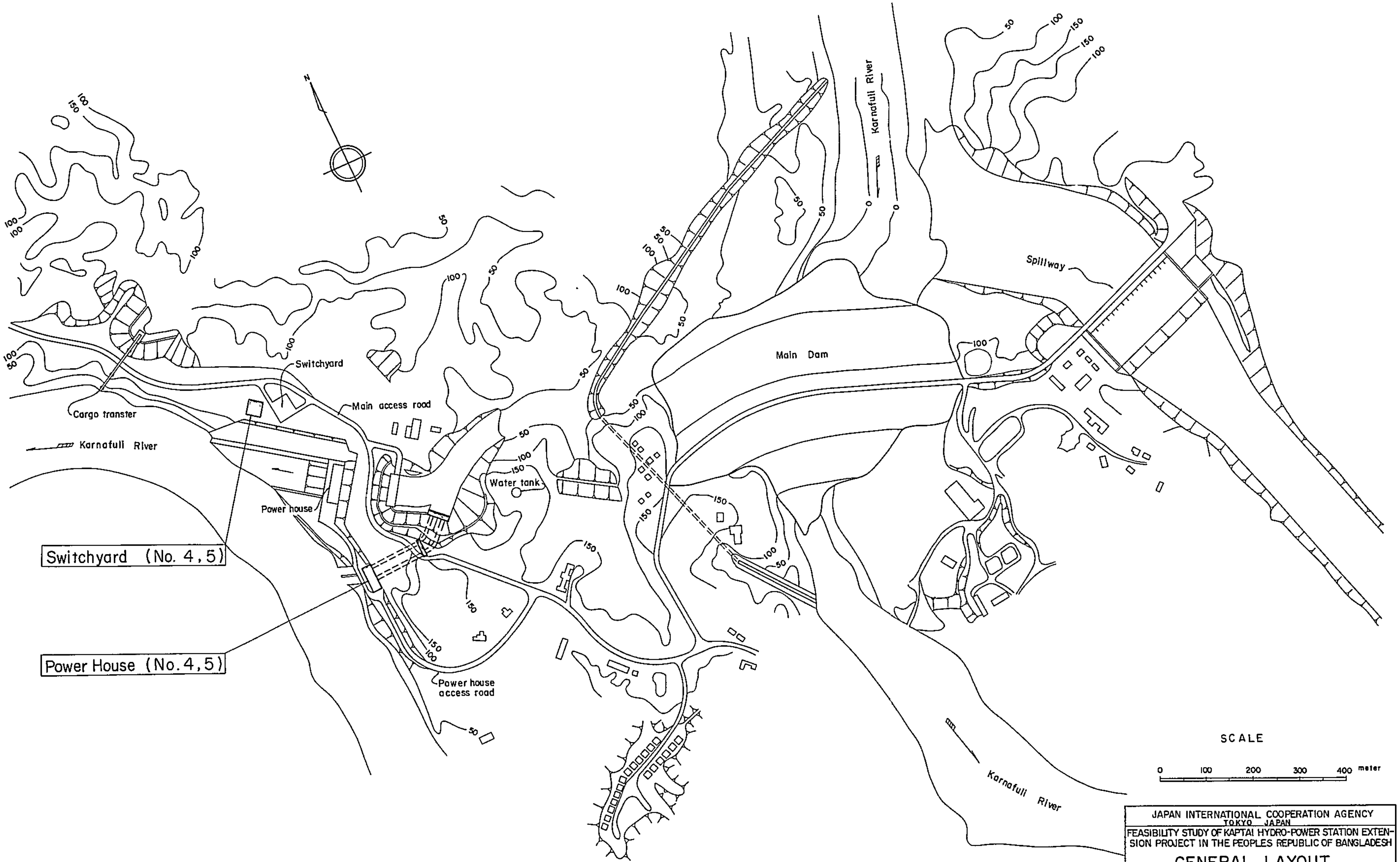
(8) POWERHOUSE FLOOR PLAN EL.22.50

(9) POWERHOUSE FLOOR PLAN EL. 5.00

(10) POWERHOUSE TRANSVERSE SECTION

(11) POWERHOUSE LONGITUDINAL SECTION

(12) POWERHOUSE DOWNSTREAM ELEVATION



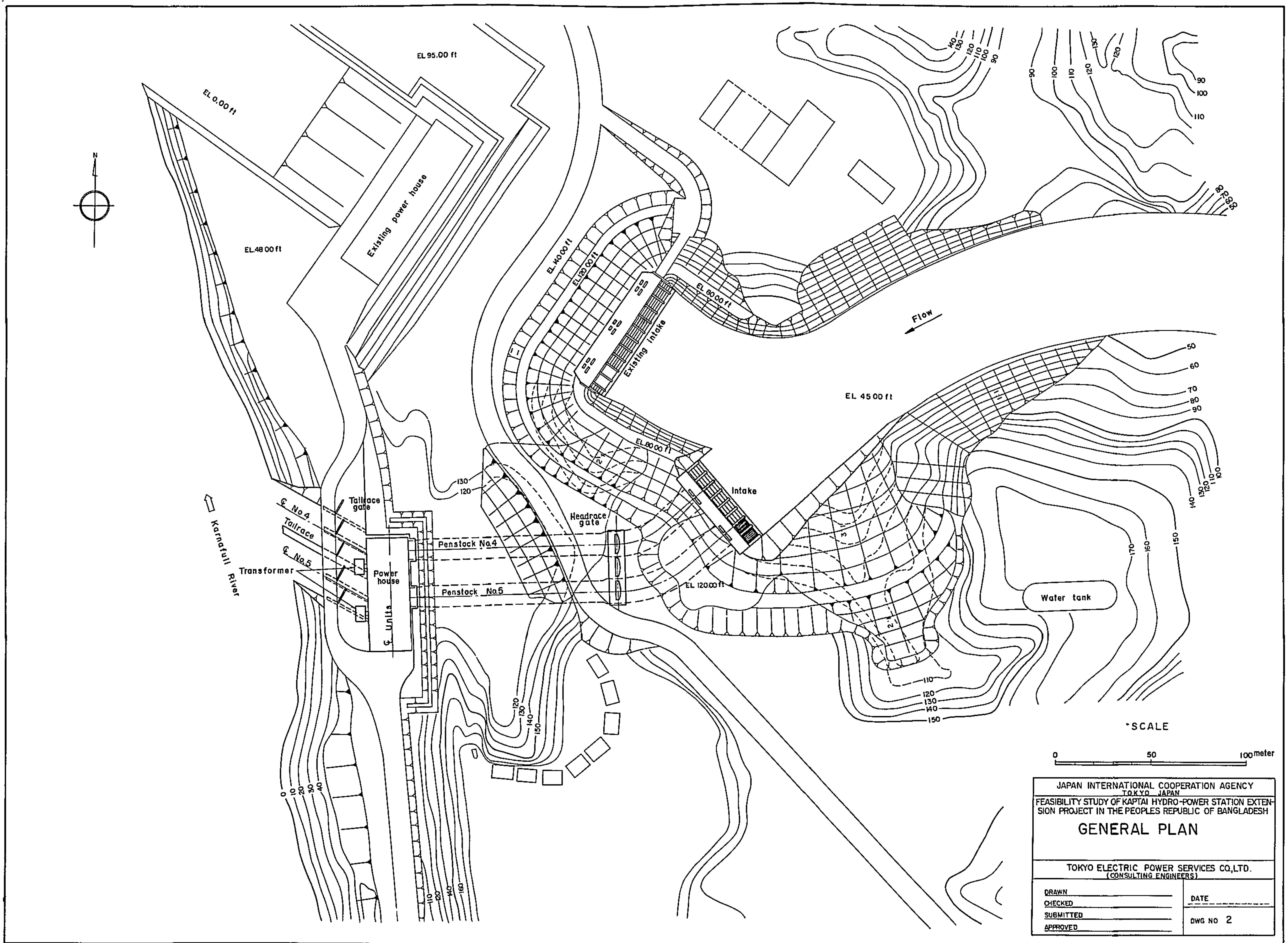
JAPAN INTERNATIONAL COOPERATION AGENCY
TOKYO JAPAN

FEASIBILITY STUDY OF KAPTAI HYDRO-POWER STATION EXTENSION PROJECT IN THE PEOPLES REPUBLIC OF BANGLADESH

GENERAL LAYOUT

TOKYO ELECTRIC POWER SERVICES CO., LTD
(CONSULTING ENGINEERS)

DRAWN	DATE
CHECKED	
SUBMITTED	DWG. NO 1
APPROVED	



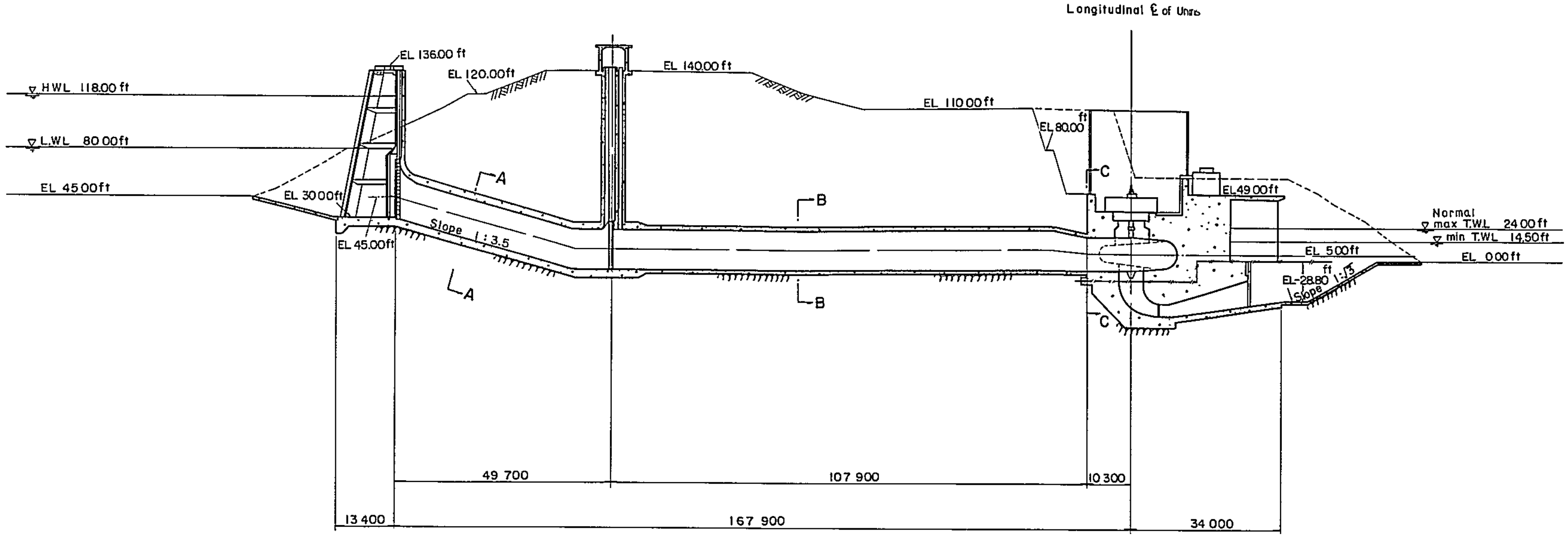
JAPAN INTERNATIONAL COOPERATION AGENCY
TOKYO JAPAN

FEASIBILITY STUDY OF KAPTAI HYDRO-POWER STATION EXTENSION PROJECT IN THE PEOPLES REPUBLIC OF BANGLADESH

GENERAL PLAN

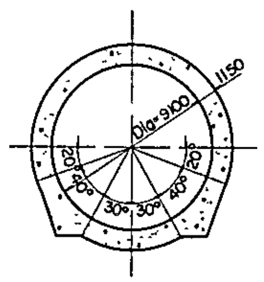
TOKYO ELECTRIC POWER SERVICES CO.,LTD.
(CONSULTING ENGINEERS)

DRAWN	DATE
CHECKED	
SUBMITTED	DWG NO 2
APPROVED	

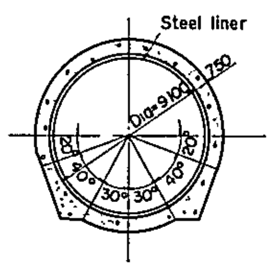


SCALE

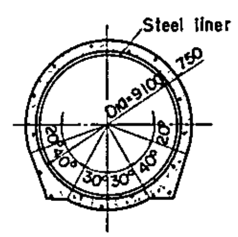
0 20 40 60 meter



SECTION A-A



SECTION B-B

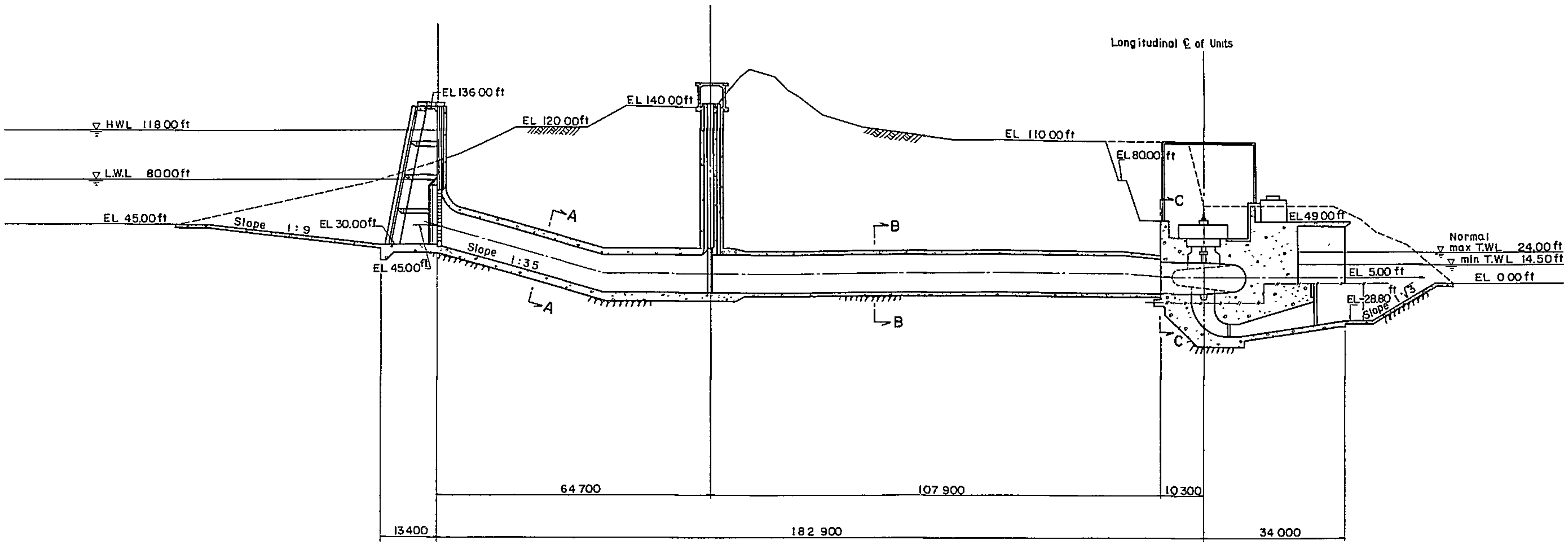


SECTION C-C

SCALE

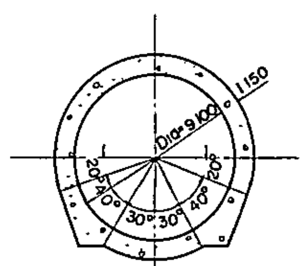
0 5 10 15 meter

JAPAN INTERNATIONAL COOPERATION AGENCY TOKYO JAPAN
FEASIBILITY STUDY OF KAPTAI HYDRO-POWER STATION EXTENSION PROJECT IN THE PEOPLES REPUBLIC OF BANGLADESH
PROFILE OF WATERWAY NO.4
TOKYO ELECTRIC POWER SERVICES CO.,LTD. (CONSULTING ENGINEERS)
DRAWN CHECKED SUBMITTED APPROVED
DATE DWG. NO. 3

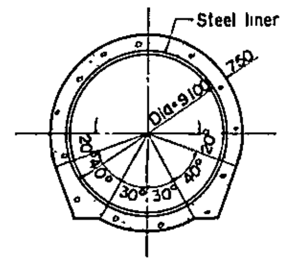


SCALE

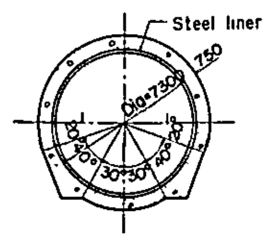
0 20 40 60 meter



SECTION A-A



SECTION B-B



SECTION C-C

SCALE

0 5 10 15 meter

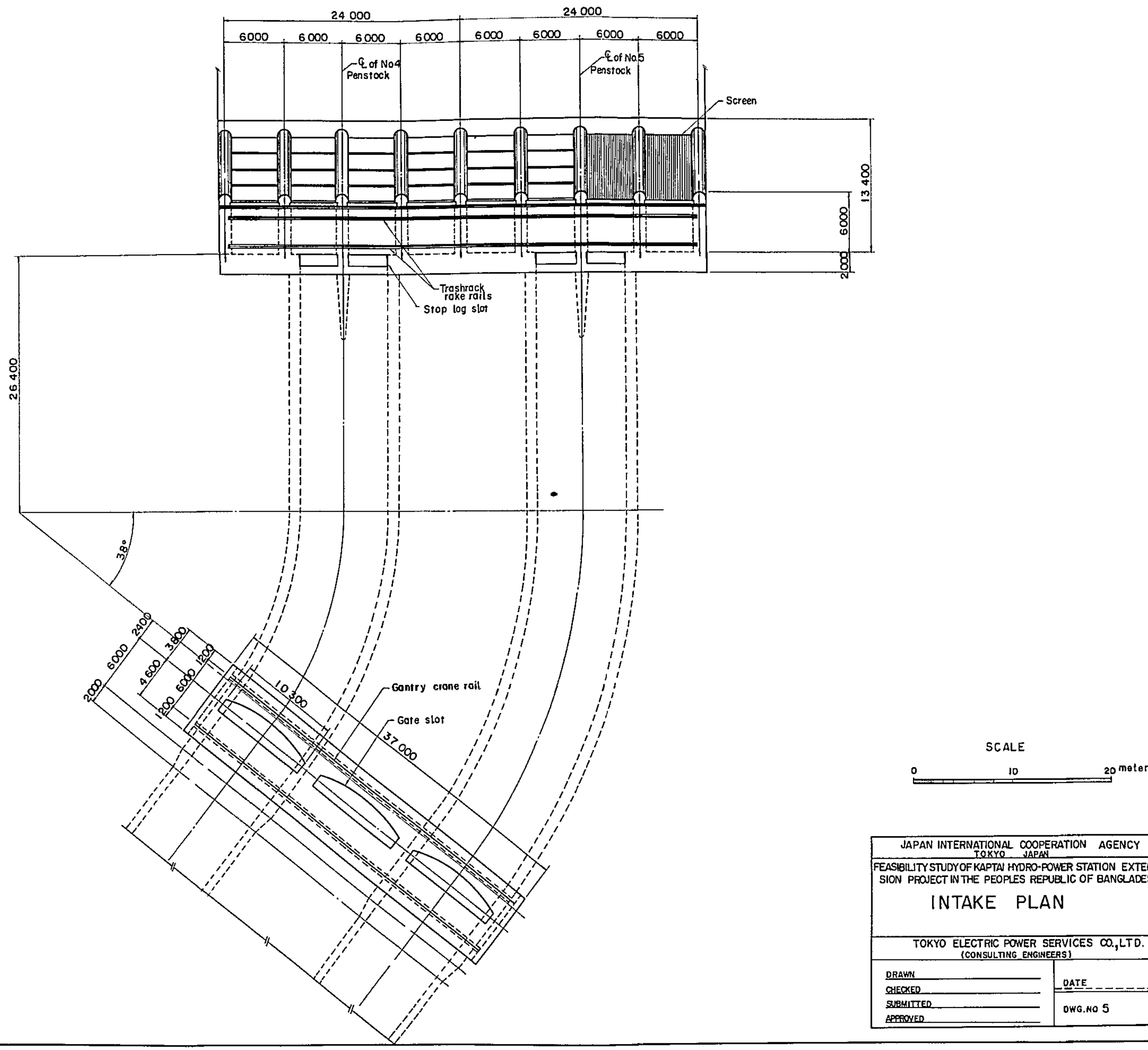
JAPAN INTERNATIONAL COOPERATION AGENCY
TOKYO JAPAN

FEASIBILITY STUDY OF KAPTAI HYDRO-POWER STATION EXTENSION PROJECT IN THE PEOPLES REPUBLIC OF BANGLADESH

PROFILE OF WATERWAY NO. 5

TOKYO ELECTRIC POWER SERVICES CO., LTD.
(CONSULTING ENGINEERS)

DRAWN CHECKED SUBMITTED APPROVED	DATE DWG. NO. 4



JAPAN INTERNATIONAL COOPERATION AGENCY
TOKYO JAPAN

FEASIBILITY STUDY OF KAPTAI HYDRO-POWER STATION EXTENSION PROJECT IN THE PEOPLES REPUBLIC OF BANGLADESH

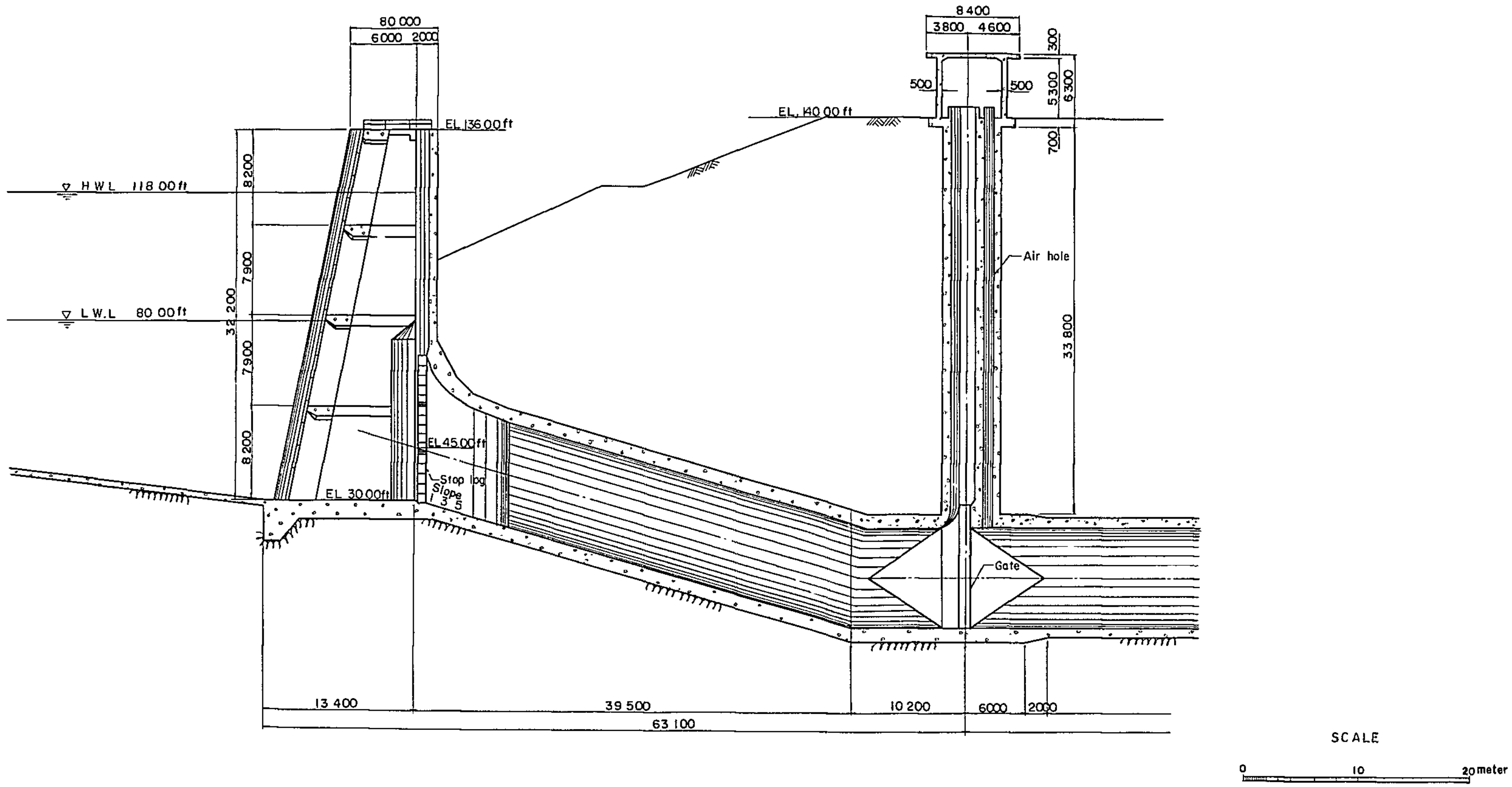
INTAKE PLAN

TOKYO ELECTRIC POWER SERVICES CO.,LTD.
(CONSULTING ENGINEERS)

DRAWN
CHECKED
SUBMITTED
APPROVED

DATE

DWG.NO 5



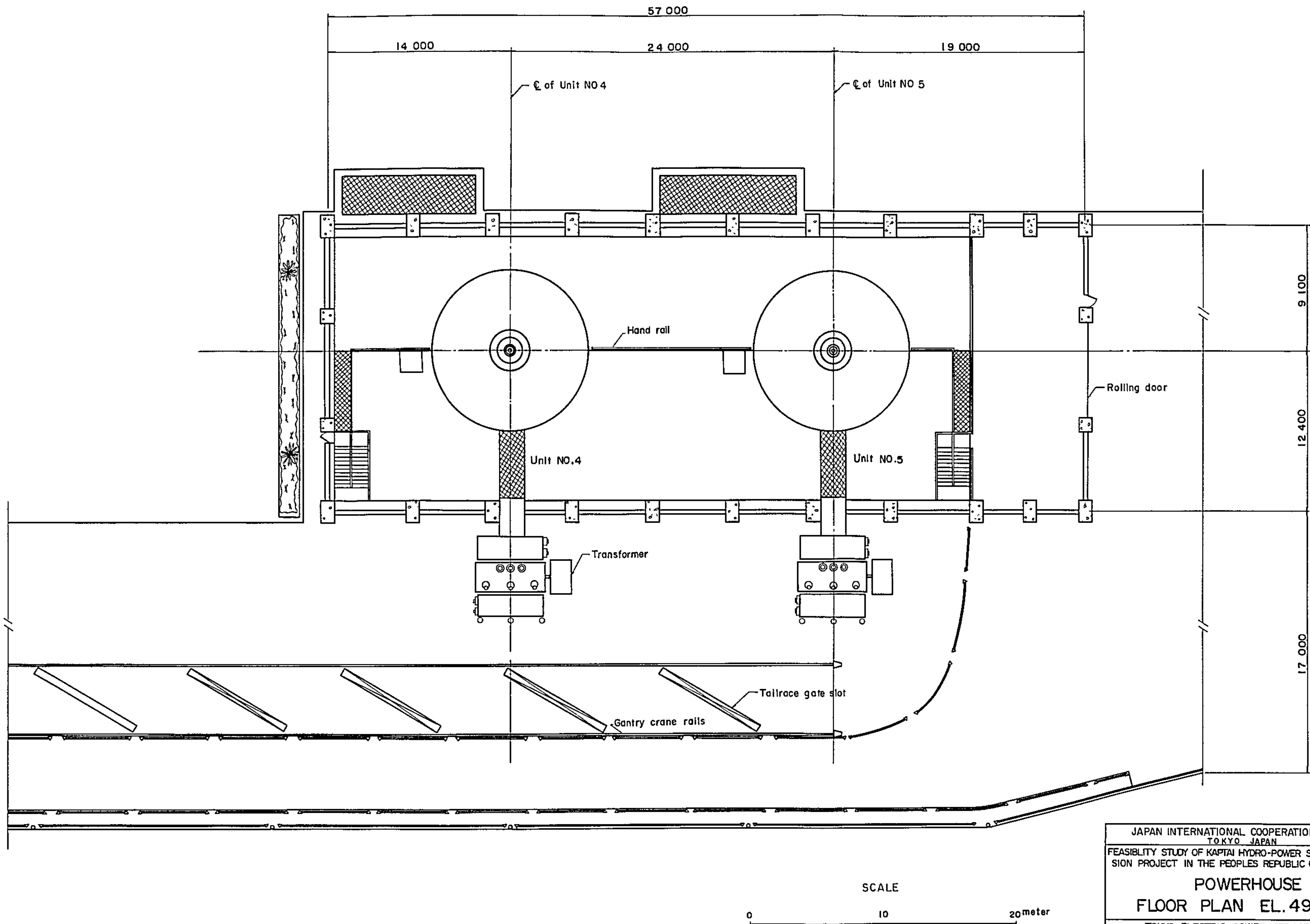
JAPAN INTERNATIONAL COOPERATION AGENCY
TOKYO JAPAN

FEASIBILITY STUDY OF KAPTAI HYDRO-POWER STATION EXTENSION PROJECT IN THE PEOPLES REPUBLIC OF BANGLADESH

INTAKE SECTION (LONGITUDNAL)

TOKYO ELECTRIC POWER SERVICES CO., LTD.
(CONSULTING ENGINEERS)

DRAWN	DATE
CHECKED	
SUBMITTED	DWG NO. 6
APPROVED	



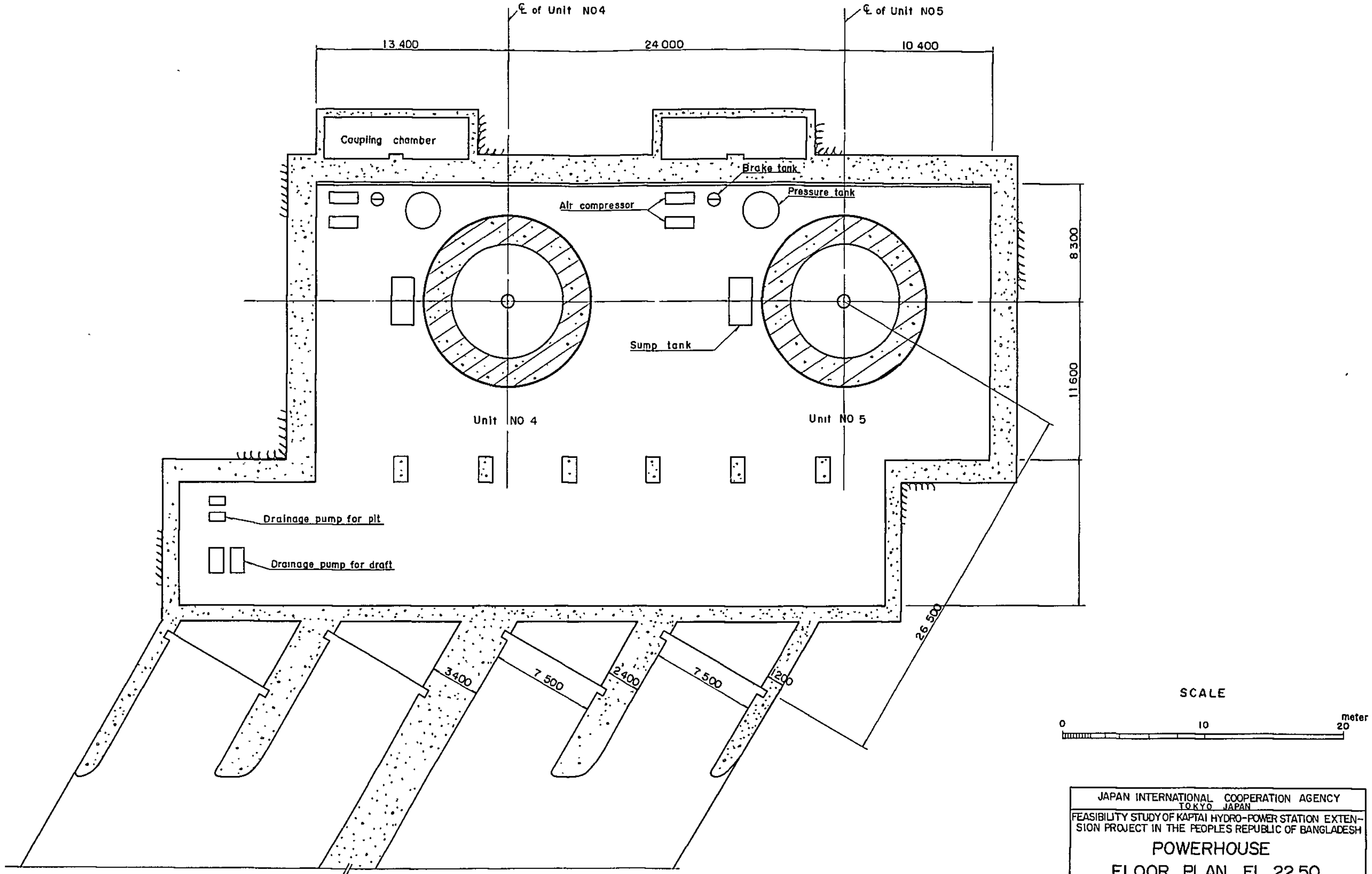
JAPAN INTERNATIONAL COOPERATION AGENCY
TOKYO JAPAN

FEASIBLITY STUDY OF KAPTAI HYDRO-POWER STATION EXTENSION PROJECT IN THE PEOPLES REPUBLIC OF BANGLADESH

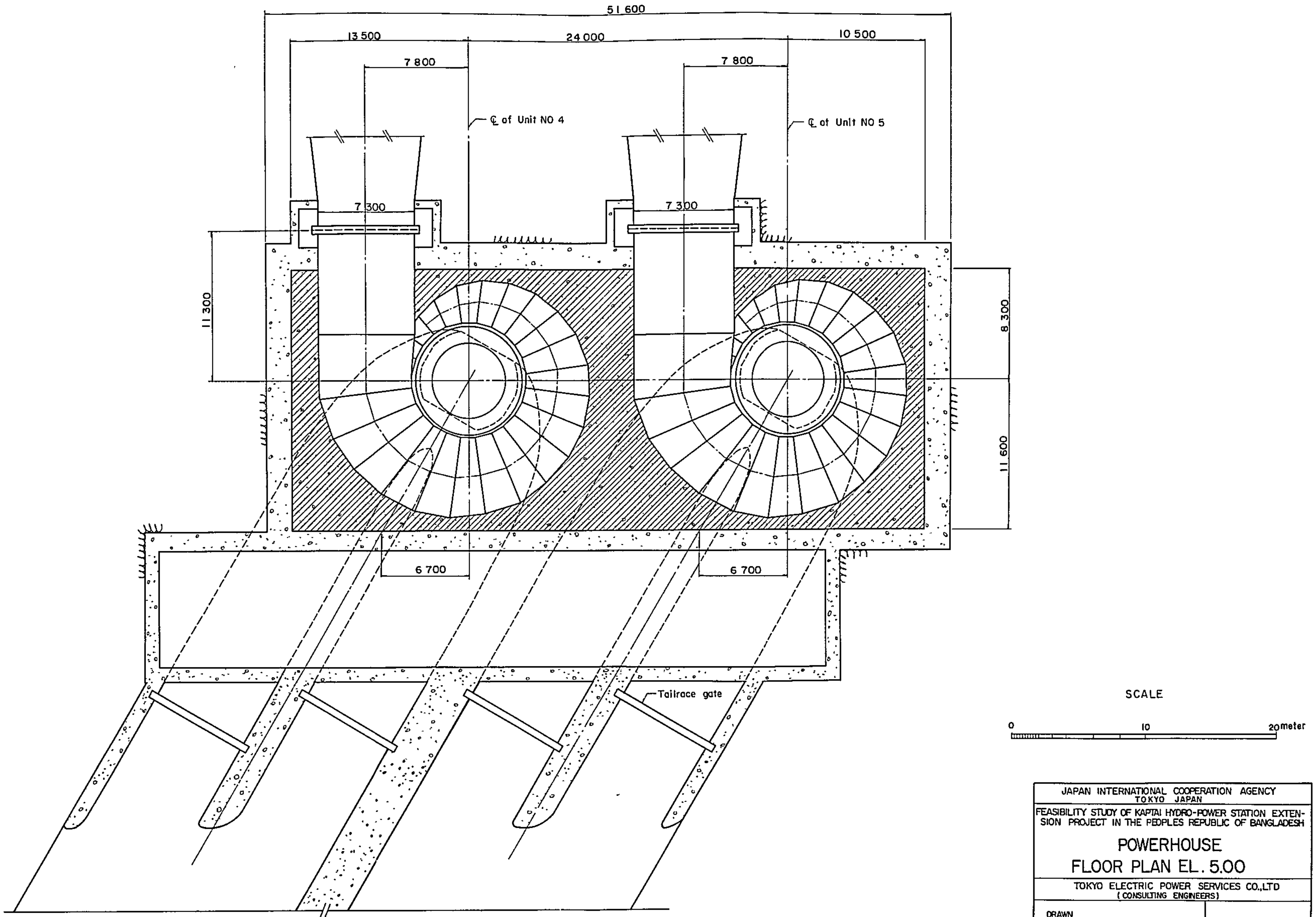
POWERHOUSE FLOOR PLAN EL. 49.00

TOKYO ELECTRIC POWER SERVICES CO., LTD.
(CONSULTING ENGINEERS)

DRAWN
CHECKED
SUBMITTED
APPROVED
DATE
DWG. NO. 7



JAPAN INTERNATIONAL COOPERATION AGENCY TOKYO JAPAN
FEASIBILITY STUDY OF KAPTAI HYDRO-POWER STATION EXTENSION PROJECT IN THE PEOPLES REPUBLIC OF BANGLADESH
POWERHOUSE FLOOR PLAN EL. 22.50
TOKYO ELECTRIC POWER SERVICES CO.,LTD (CONSULTING ENGINEERS)
DRAWN CHECKED SUBMITTED APPROVED
DATE DWG NO. 8



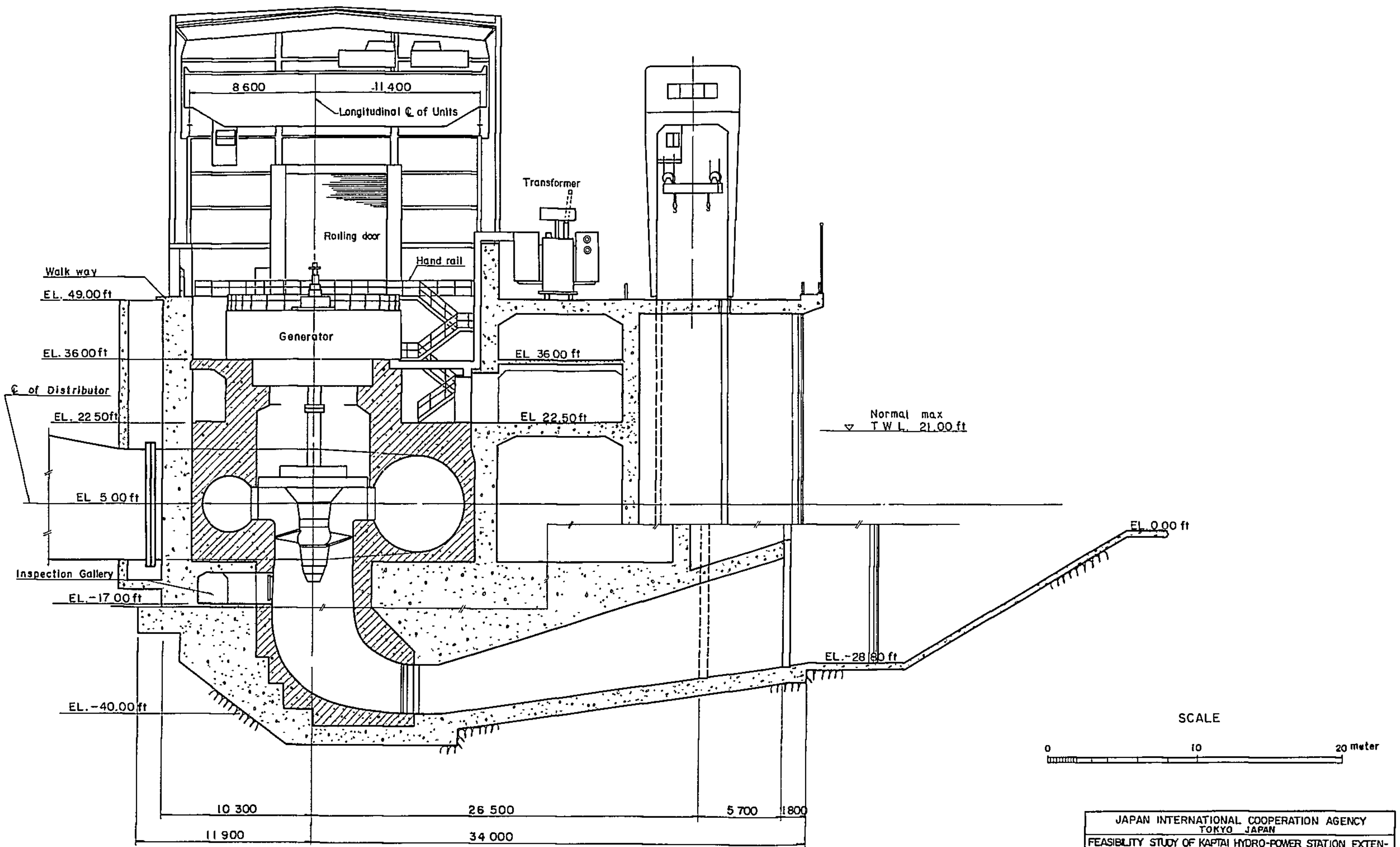
JAPAN INTERNATIONAL COOPERATION AGENCY
TOKYO JAPAN

FEASIBILITY STUDY OF KAPTAI HYDRO-POWER STATION EXTENSION PROJECT IN THE PEOPLES REPUBLIC OF BANGLADESH

POWERHOUSE
FLOOR PLAN EL. 5.00

TOKYO ELECTRIC POWER SERVICES CO.,LTD
(CONSULTING ENGINEERS)

DRAWN	DATE
CHECKED	
SUBMITTED	DWG. NO. 9
APPROVED	



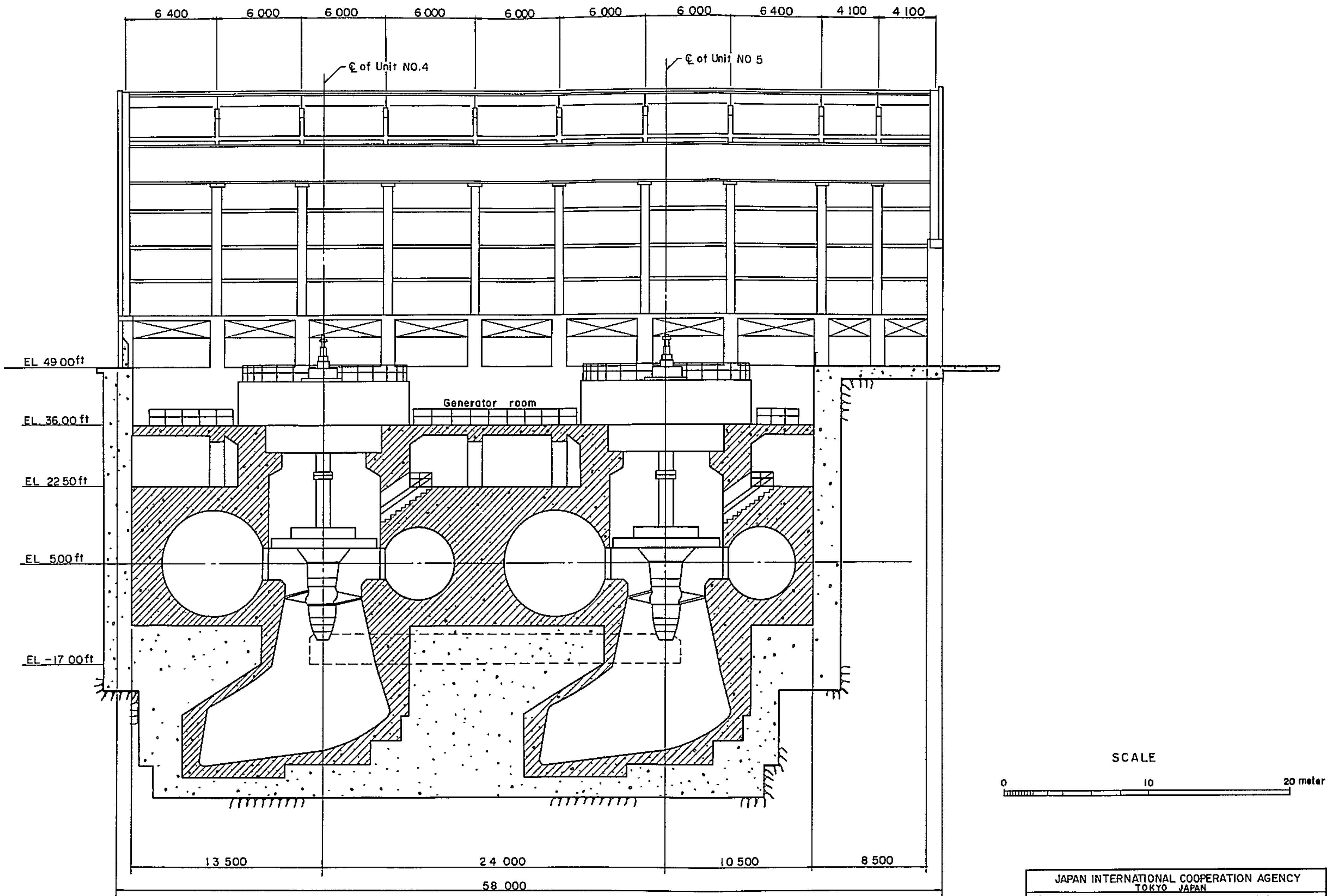
JAPAN INTERNATIONAL COOPERATION AGENCY
TOKYO JAPAN

FEASIBILITY STUDY OF KAPTAI HYDRO-POWER STATION EXTENSION PROJECT IN THE PEOPLES REPUBLIC OF BANGLADESH

POWERHOUSE TRANSVERSE SECTION

TOKYO ELECTRIC POWER SERVICES CO., LTD.
(CONSULTING ENGINEERS)

DRAWN	DATE
CHECKED	
SUBMITTED	DWG NO 10
APPROVED	



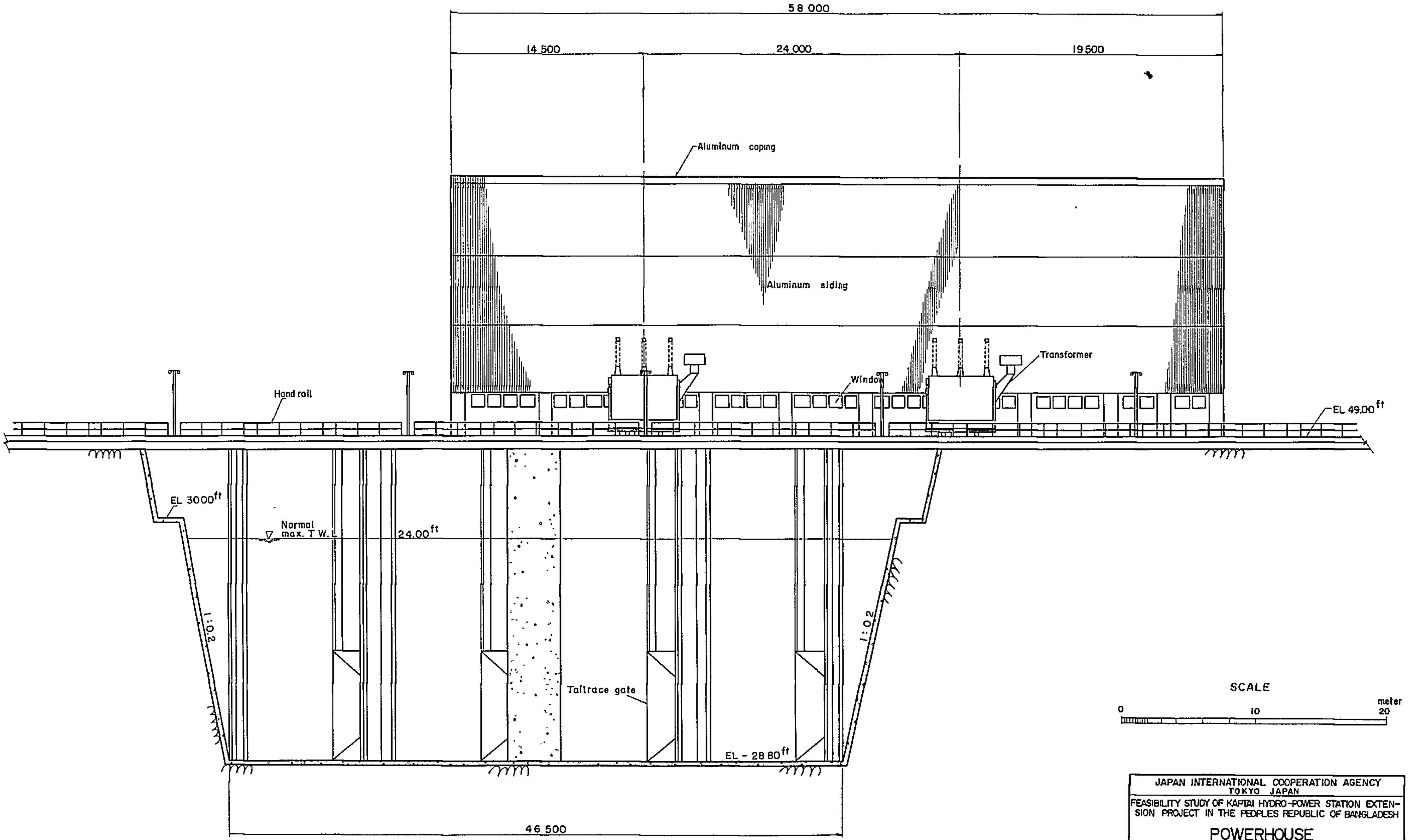
JAPAN INTERNATIONAL COOPERATION AGENCY
TOKYO JAPAN

FEASIBILITY STUDY OF KAPTAI HYDRO-POWER STATION EXTENSION PROJECT IN THE PEOPLES REPUBLIC OF BANGLADESH

POWERHOUSE LONGITUDINAL SECTION

TOKYO ELECTRIC POWER SERVICES CO.,LTD
(CONSULTING ENGINEERS)

DRAWN	DATE
CHECKED	
SUPMITTED	DWG. NO. 11
APPROVED	



DOWNSTREAM ELEVATION

JAPAN INTERNATIONAL COOPERATION AGENCY
TOKYO JAPAN

FEASIBILITY STUDY OF KAPTAI HYDRO-POWER STATION EXTENSION PROJECT IN THE PEOPLES REPUBLIC OF BANGLADESH

POWERHOUSE
DOWNSTREAM ELEVATION

TOKYO ELECTRIC POWER SERVICES CO., LTD.
(CONSULTING ENGINEERS)

DRAWN	DATE
CHECKED	
SUBMITTED	DWG. NO. 12
APPROVED	

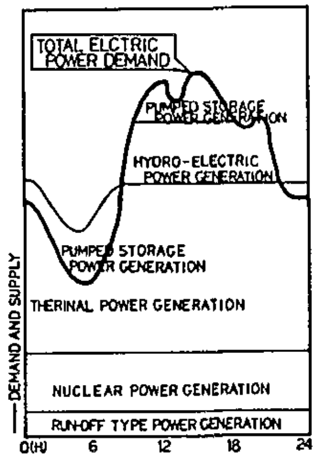
6. FEASIBILITY OF KAPTAI HYDRO-POWER EXTENSION PROJECT BY PUNPED STORAGE POWER PLANT

Feasibility of Kaptai Hydro-Power Extension
Project by Pumped Storage Power Plant

1. Regarding the Pumped Storage Power Plant

Generally, electricity tends to be consumed more in the daytime than in midnight during a day, and, sometimes, electric power consumption in midnight becomes half of that in the daytime. (See Fig. 1)

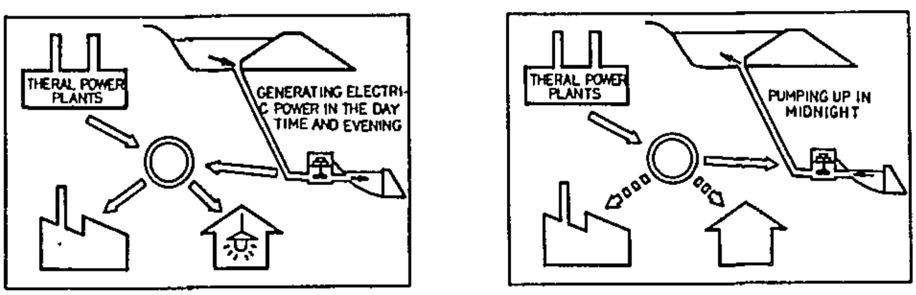
Fig. 1



In case of a pumped storage power plant, water is pumped up into an upper dam by making use of surplus electric power in midnight, etc. as electric power source, and the water stored in this way is used for power generation in the daytime and evening when demand of electric power is large.

This is a reasonable system of combinedly utilizing thermal and hydro-power plants to meet the electric power demand fluctuating largely in a day or a week. Illustrates in Fig. 2 how the pumped storage power plant is operated among the entire electric power generating plants.

Fig. 2



Generally speaking, there is about 20 to 30% of loss between energy used for pumping up and energy generated by pumped up water. Therefore, it is necessary to effectively operate a pumped-up power plant in view of both utilizing surplus electric power and power supply in peak hours in compliance with electric power demand.

2. Problematical Points in Case of Adopting Pumped Storage Power Plant for Kaptai Hydro-Power Extension Project

When a pumped storage power plant is adopted for the Kaptai Hydro-Power Extension Project, it should be studied if electric power for pumping up is available while taking into account the electric power demand and particularly a pattern of fluctuation in demand in consuming areas.

2-1 Load Factor in Chittagong Area*

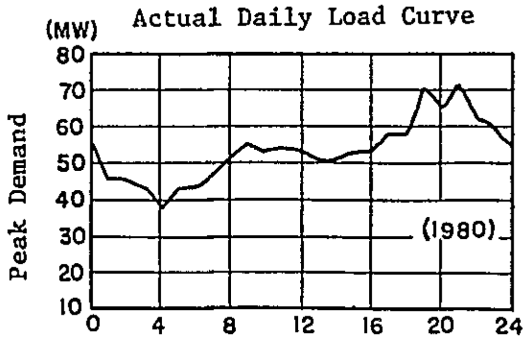
The load factor in Chittagong area is about 74% at present, and electric power demand does not fluctuate so largely.

Fig.3 and Fig.4 show the load curve in the Chittagong area.

The load factor is expected to show a similar trend in the future, and it is estimated that the load factor in 1993 will be about 76% as shown in the daily load curve in Fig. 4.

Fig. 3

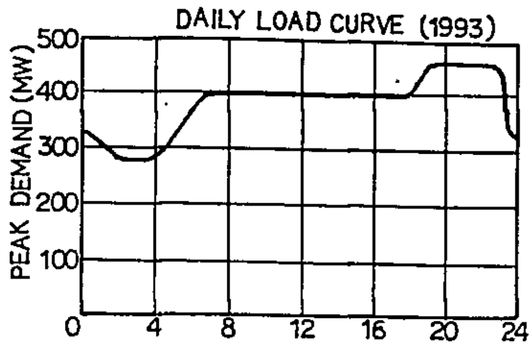
Actual Daily Load Curve



---

* Load factor = (Daily average electric power ÷ Daily maximum electric power) x 100

Fig. 4



In principle, a pumped storage power plant is adopted in many cases when the load factor is about 40% or less in view of economical stand point. However, judging from the electric power demand forecast in this district, this high load factor is estimated to be maintained at least until 1995, and it can be said that adoption of a pumped storage power plant for the Kaptai Hydro-Power Extension Project is inappropriate.

2-2 Pumping-up Power Source

Generally, surplus electric power source from other thermal power plants, etc. is utilized for pumping-up power source. In case a 100 MW pumped storage power plant is extended at the Kaptai Hydro-Power Station, surplus electric power required for pumping up at this power plant is not available in the Chittagong District in the foreseeable future.

2-3 Transmission System

As transmission line connecting the Chittagong District and other districts, there is now only one 132 kV transmission system of around 40 MW capacity between Chittagong and Dacca. Therefore, this transmission system does not have a sufficient capacity to supply pumping up power source from the Dacca District.

2-4 Reregulating Reservoir

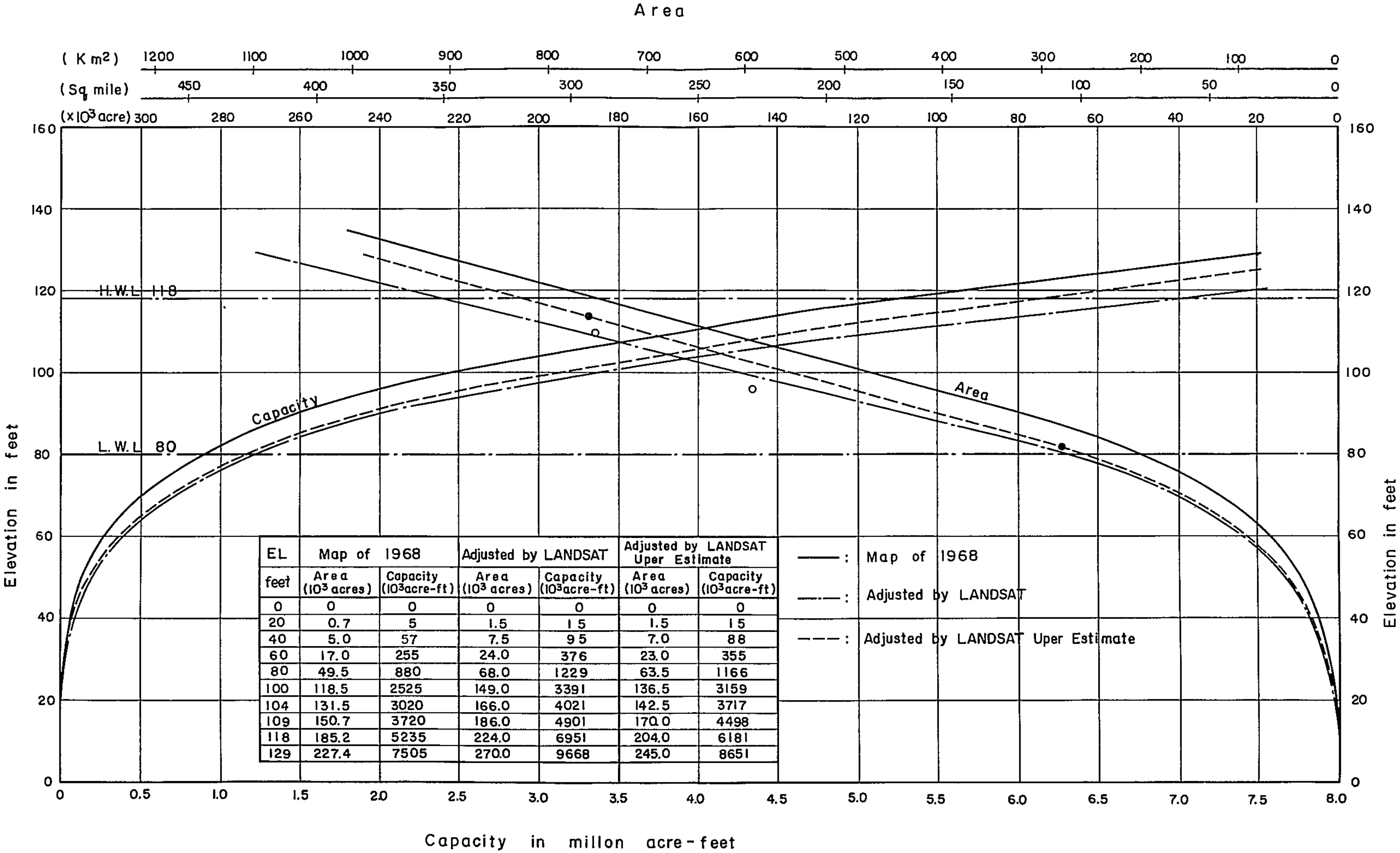
As a matter of fact, water is not discharged from the dam and the power station during pumping-up operation. Therefore, it is necessary to construct a reservoir, so-called a reregulating reservoir downstream from the power station not only for storing pumping-up water but also for navigation and irrigation in the downstream area.

However, the river slope is gentle as ($i \fallingdotseq 1/10,000$) in the downstream area from the Kaptai Hydro-Power Station, and the land form is comparatively flat. As a result, it is very difficult to construct a reservoir in this area.

3. Summary

Judging from the above stand points, it can be said that there is almost no feasibility for the execution of the Kaptai Hydro-Power Extension Project by pumped-up power generation system until about 1995 when a pattern of electric power demand and supply similar to the present one is estimated to continue.

Fig. - 5 Area and Capacity Curves of Karnaful Reservoir



EL	Map of 1968		Adjusted by LANDSAT		Adjusted by LANDSAT Uper Estimate	
feet	Area (10^3 acres)	Capacity (10^3 acre-ft)	Area (10^3 acres)	Capacity (10^3 acre-ft)	Area (10^3 acres)	Capacity (10^3 acre-ft)
0	0	0	0	0	0	0
20	0.7	5	1.5	15	1.5	15
40	5.0	57	7.5	95	7.0	88
60	17.0	255	24.0	376	23.0	355
80	49.5	880	68.0	1229	63.5	1166
100	118.5	2525	149.0	3391	136.5	3159
104	131.5	3020	166.0	4021	142.5	3717
109	150.7	3720	186.0	4901	170.0	4498
118	185.2	5235	224.0	6951	204.0	6181
129	227.4	7505	270.0	9668	245.0	8651

JICA