GOVERNMENT OF MALAYSIA
LEMBAGA LETRIK SABAH
(SABAH ELECTRICITY BOARD)

FEASIBILITY STUDY REPORT
ON
TENOM PANGI HYDROELECTRIC POWER DEVELOPMENT PROJECT, PHASE III
(SOOK RESERVOIR)

SUMMARY REPORT

SEPTEMBER 1986

JAPAN INTERNATIONAL COOPERATION AGENCY

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SUMMARY REPORT

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PREFACE

It is with great pleasure that I present this Feasibility Study Report on the Tenom Pangi Hydroelectric Power Development Project, Phase III (Sook Reservoir) to the Government of Malaysia.

This report embodies the result of a field survey which was carried out in the State of Sabah, from June to November, 1985 by a 14-man survey team sent to Malaysia by Japan International Cooperation Agency following the request of the Government of Malaysia to the Government of Japan.

The survey team, headed by Mr. Seiichi Omura, Nippon Koei Co., Ltd., held a series of close discussions with the officials concerned of the Government of Malysia and conducted a wide scope of field survey.

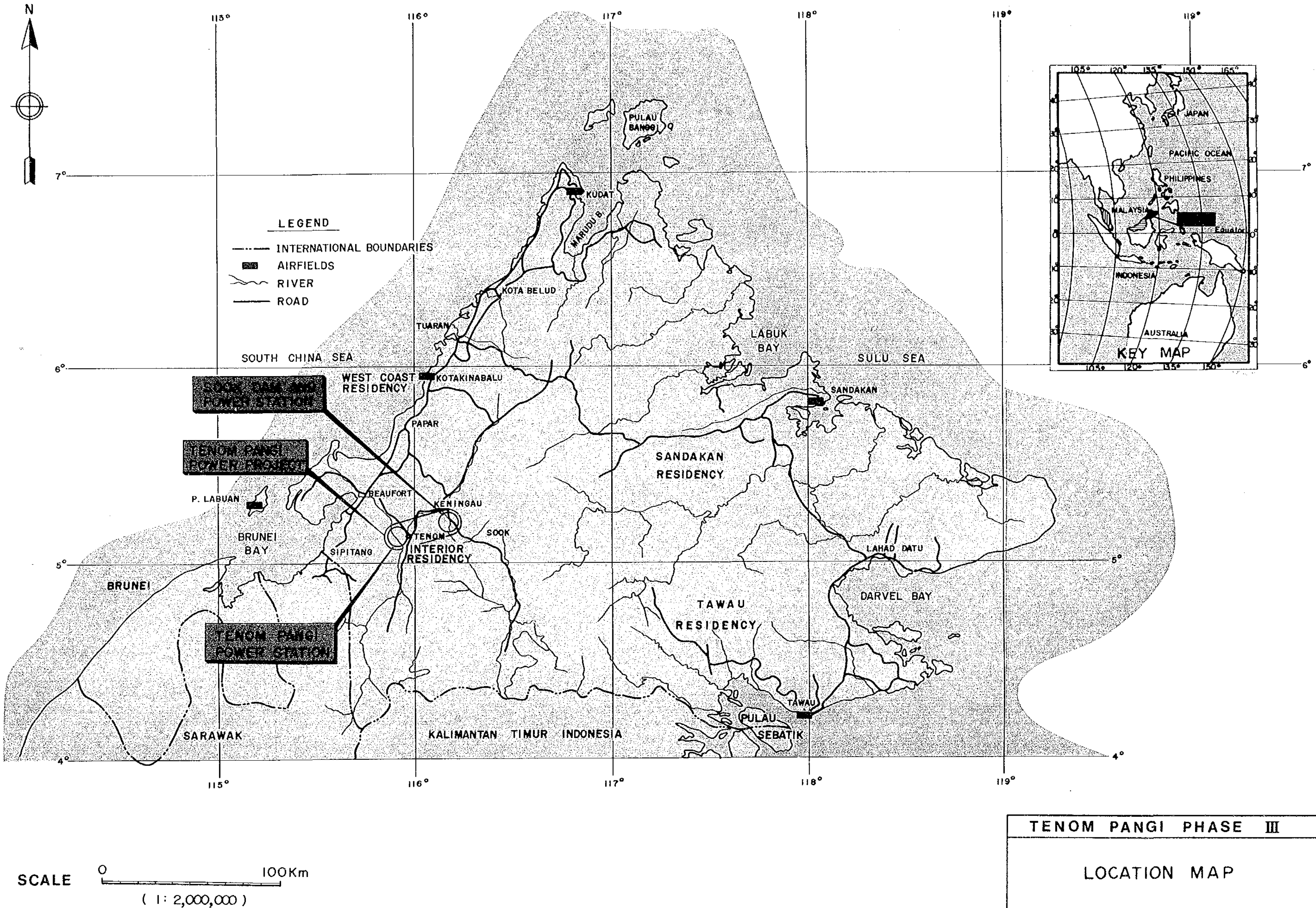
After the team returned to Japan, further studies were made and the present report has been completed.

I hope that this report will be useful as a basic reference for the project and contribute to the promotion of friendly relations between our two countries.

I wish to express my deep appreciation to the officials concerned of the Government of Malaysiea for their close cooperation extended to the team.

September 1986

KEISUKE ARITA
President
Japan International Cooperation Agency



TENOM PANGI PHASE III

LOCATION MAP

SEB / JICA

TENOM PANGI HYDROELECTRIC POWER

DEVELOPMENT PROJECT, PHASE III (SOOK RESERVOIR)

PROJECT BACKGROUND

1. Along with steadily growing economy of Sabah with about 7.2 per cent of annual increase rate for past 10 years from 1975 to 1985, electric power demand of Sabah has increased with an average of more than 12 per cent for the same period. In 1984 the peak demand was 120 MW and energy sold was 503 GWh. The Sabah Electricity Board (SEB) forecasts that the power demand of the whole Sabah will reach at 210 MW in peak demand in 1990 and 520 MW in 2000, of which the demand for west coast area including capital city of Kota Kinabalu, which had been planned to be integrated into one transmission and distribution network in near future, is estimated at 130 MW in 1990 and 300 MW in 2000.

2. In the past years SEB supplied electric power to the consumers by installing various size of diesel generators up to 8,000 KW in unit capacity and 15,000 kW class gas turbine generators. However, in line with the energy policy of the Government of Malaysia of reducing reliance on fossil fuel by the development of other renewable energy resources and in order to meet power demand, SEB constructed the Tenom Pangi hydroelectric power station with an installed capacity of 66 MW. The Tenom Pangi power station is designed as a run-of-river type plant mainly due to its topographical and hydrological reasons. During low flow seasons, therefore, its power generation decreases considerably.

3. The Sook dam and power station is proposed as a supporting facility for the existing Tenom Pangi power station. It is situated at upstream of the Tenom Pangi power station. Storing water in the reservoir and releasing it during low flow seasons, the Sook dam can augment discharge for the downstream Tenom Pangi power station to firm up its power generation.

INVESTIGATION AND STUDY

4. In 1983 the Government of Malaysia requested the Government of Japan the technical cooperation for the implementation of the feasibility study for the Sook Reservoir Project or the Tenom Pangi Project, Phase III. In response to it the Government of Japan decided to extend the technical cooperation for the Project and assigned the Japan International Cooperation Agency (JICA) to carry out the feasibility study of the Project.

   In October 27, 1984, "Scope of Work for Feasibility Study on Tenom Pangi Hydroelectric Power Development Project, Phase III (Sook Reservoir)" was agreed upon between the Economic Planning Unit (EPU) of Prime Minister's Department of the Government of Malaysia and JICA. It was agreed that the work would be implemented by JICA survey team in cooperation with SEB counterpart engineers for about 18-month period from mid-March 1985 to mid-September 1986.

5. According to the agreement, JICA despatched an investigation team to the site in March 1985. Then, from June 1985 to June 1986, JICA team has conducted field investigations, studies and report preparation in full cooperation with SEB counterpart engineers, and the feasibility of the project was examined. The member list of survey team is shown in Table 3.

PROJECT AREA

6. The existing Tenom Pangi power station is located on the Padas River at the upper reach of the "Tenom Gorge", about 100 air km south of Kota Kinabalu. The catchment area at the weir site is 7,815 km^2.

   The proposed Sook damsite is located on the Sook River at about 3 km upstream of the confluence with the Pegalan River which is one of the biggest tributary of the Padas River. The site is 30 air km northeast of the Tenom Pangi power station. The catchment area at the proposed damsite is 1,705 km^2.

7. Average annual rainfall of the Padas River basin is 1,856 mm. The annual mean streamflow is 210 m^3/sec at the Tenom Pangi weir site and 29 m^3/sec at the proposed Sook damsite. The maximum flood observed at the Sook damsite is 410 m^3/sec which was recorded on January 14, 1981. Frequency analysis indicates that 100 and 200 year probable floods are 540 m^3/sec and 610 m^3/sec, respectively. The probable maximum flood at the Sook damsite is estimated at 1,940 m^3/sec.

8. The dam foundation is composed mainly of sandstones of the Crocker Formation intercalated with thin shale layers of one to several meters. The bedrock is more or less disturbed down to the depth of more than 50 m below the ground surface, and especially about 30 m thick zone below the ground surface is badly cracked and pervious. This might have been as a result from a plastic flow caused by foldings. A topographic lineation running in the reservoir area was checked by trench excavation, geophysical prospecting and past earthquake records in Sabah. The study revealed that the lineation might be a fault line created by the past tectonic movement, but no indication is found out that the fault is to be active. Thus, no harmful effect thereby is anticipated. Reference has been made from Geological Survey Department. However, the design of the Sook Dam will take into consideration of possible seismic effect.

9. Sufficient concrete aggregates and dam embankment materials are available in and around the project area. Fluvial deposits of the Pegalan River will be suitable in quality and sufficient in quantity as the material source of concrete aggregates and filter materials. Rock materials will be obtained from the quarry site selected at about 2 km north of the damsite. Impervious core

materials are also obtainable immediately upstream of the damsite.

POWER DEMAND FORECAST

10. Kota Kinabalu being the capital of the state of Sabah is the center of commercial activities in the state. During recent year, construction activity has been very active resulting in an increase of a number of large power consumers. Power demand based on potential consumer records up to 1987 is about 50,000 kW for the whole west coast area, inclusive of about 30,000 kW in the Kota Kinabalu area.

In the east coast area, Tawau is the most active load center. There are many timber or timber-based industries. Construction and quarrying industries and other light industries are also active. Plantations for cocoa, oil palm, rubber, coconut, etc. absorb a lot of labor forces of the area. Reflecting such an active economy, power demand in the area has been also increased.

11. Taking into account such a different trend of the power demand, power demand of west and east coast areas is forecasted separately. System peak demands in both west and east coast areas are summarized as below:1/

(Unit: MW)

Year	West coast area		East coast area		Total	
	High forecast	Low forecast	High forecast	Low forecast	High forecast	Low forecast
1985	82.0	80.0	46.0	45.0	128.0	125.0
1990	137.2	116.5	71.3	63.4	208.5	179.9
1995	220.1	164.2	110.4	89.6	330.5	253.8
2000	353.5	230.9	169.8	127.4	523.3	358.3
2005	519.4	304.0	254.6	172.0	774.0	476.0
2010	695.1	374.3	332.4	216.6	1,027.5	590.9

1/: Based on Survey Team's own forecast.

Installed capacity, generated energy and sold energy at the west and east coast areas in 1985 are as shown below:

		West coast area	East coast area	Total
1.	Installed capacity (MW)	215.1	97.5	312.6
2.	Generated energy (GWh)	487.4	254.6	742.0
3.	Sold energy (GWh)	377.0	194.8	571.8

PLAN FORMULATION

12. In order to determine the development scale of the project, optimization study was made based on the following parameters:

i) high water level

ii) effective storage capacity

iii) installed capacity of the proposed Sook dam and power station

iv) installed capacity (extension only) of the Tenom Pangi power station

As a result of the optimization study, the Tenom Pangi Project, Phase III, is recommended to have the development scale of the project as summarized below:

1) Sook Reservoir and Power Station

(1)	Normal high water level (NHWL):	Eℓ.310 m
(2)	Low water level (LWL):	Eℓ.285 m
(3)	Tail water level (TWL):	Eℓ.250 m
(4)	Effective storage capacity:	550 x $10^6 m^3$
(5)	Rated head:	51 m
(6)	Plant discharge, max:	47.1 m^3/s
(7)	Installed capacity:	20 MW
(8)	Energy output:	Firm 45.5 GWh Dump 6.3 GWh Total 51.8 GWh

2) Tenom Pangi Power Station

(1) Normal high water level (NHWL): Eℓ.173.9 m

(2) Low water level (LWL): Eℓ.170.7 m

(3) Tail water level (TWL): Eℓ. 99.2 m

(4) Effective storage capacity: 4.7 x $10^6 m^3$

(5) Net head: 61.5 m, average

(6) Plant discharge, max:

Extension:	84.9 m^3/s
Existing:	127.3 m^3/s
Total:	212.2 m^3/s

(7) Installed capacity:

Extension:	44 MW
Existing:	66 MW
Total:	110 MW

(8) Energy output:

Extension:	Firm	283.8 GWh
	Dump	- GWh
	Total	283.8 GWh
Existing:	Firm	331.6 GWh
	Dump	184.6 GWh
	Total	516.2 GWh
Total:	Firm	615.4 GWh
	Dump	184.6 GWh
	Total	800.0 GWH

PRELIMINARY DESIGN

13. Comparative study was made to determine damsite, dam axis and dam type. As the results, the damsite in the Sook gorge, upstream dam axis and a rockfill type dam with impervious earth core are selected respectively.

Result of the preliminary design of the Sook dam are as summarized below:

(1) Crest elevation of main dam: Eℓ.314 m

(2) Flood water level (FWL): Eℓ.311.1 m

(3) Normal high water level (NHWL): Eℓ.310 m

(4) Low water level (LWL): Eℓ.285 m

(5) Bottom elevation of dam:	Eℓ.244 m
(6) Type of dam:	Rockfill dam with earth center core
(7) Dam height:	70 m
(8) Width of dam crest:	10 m
(9) Length of dam crest:	345 m
(10) Upstream slope:	1:2.5
(11) Downstream slope:	1:1.9

14. Spillway is located on the left abutment taking an advantage of topographical and geological conditions. It is designed safely to pass 1,000 m^3/s, the outflow of the probable maximum flood, which is calculated after flood routing.

Saddle dams are required to secure the normal high water level at Eℓ. 310.0 m. Length of saddle dams is about 1,500 m in total. Taking into account the geological condition of the foundation and availability of embankment materials, the saddle dam is designed to be of a homogeneous earthfill type.

The Sook power station is of the ground type and is designed to house 2 units of 10 MW installaiton. It is located immediately downstream of the Sook dam.

15. Major structural components for the extension of the Tenom Pangi power station are the construction of a waterway and the power station extension. Intake structure for the extension scheme was already constructed during the implementation of Phases I and II. Headrace tunnel is to be aligned parallel to the existing one. Its diameter is determined at 5.2 m, and its length is about 4,200 m.

Power house is built as an extension of the existing power house so that the existing overhead crane can be used for the extension. The existing assembly bay will also be used for erection of the additional turbines and generators. The units to be newly installed are controlled from the existing control room.

CONSTRUCTION PLAN

16. A construction plan is prepared based on the preliminary design of the project and technical information collected during the field investigation.

Estimated construction periods are 5 years for the Sook dam and power station and 4 years for the extension of Tenom Pangi power station. In addition, another 2.5 years will be needed for preconstruction activities including financial arrangement, supplemental investigation , detailed design, tender and contract procedures. Total implementation periold will therefore be 7.5 years from now.

CONSTRUCTION COST ESTIMATE

17. The project cost is estimated on the basis of the preliminary design, construction plan and schedule, etc. The estimate is made based on the price level of 1985/1986 using the exchange rate of M$2.45 or Yen 200 to 1 US dollar.

Total construction cost excluding price contingency is estimated at US$174,139,000 which consists of US$101,555,000 for the Sook dam and power station and US$72,584,000 for the extension of the Tenom Pangi power station. Including the price contingency, total project implementation cost is estimated at US$243,800,000 which comprises US$142,200,000 for the Sook dam and power station and US$101,600,000 for the Tenom Pangi extension.

Local and foreign currency portions of the project costs are summarized as below:

Project Cost for Sook Dam and Power Station

(Unit: US$)

	Item	Local component	Foreign component	Total
1.	Constructioln cost	29,985,000	38,462,000	68,447,000
2.	Engineering and administration	1,095,000	4,381,000	5,476,000
3.	Compensation	18,400,000	0	18,400,000
4.	Physical contingency	4,948,000	4,284,000	9,232,000
	Sub-total	54,428,000	47,127,000	101,555,000
5.	Price contingency	28,472,000	12,173,000	40,645,000
	Total	82,900,000	59,300,000	142,200,000

Project Cost for Extension of Tenom Pangi Power Station

(Unit: US$)

	Item	Local component	Foreign component	Total
1.	Constructioln cost	20,387,000	40,710,000	61,097,000
2.	Engineering and administration	988,000	3,900,000	4,888,000
3.	Compensation	0	0	0
4.	Physical contingency	2,138,000	4,461,000	6,599,000
	Sub-total	23,513,000	49,071,000	72,584,000
5.	Price contingency	14,487,000	14,529,000	29,016,000
	Total	38,000,000	63,600,000	101,600,000

Construction cost of the existing Tenom Pangi Porject, Phases I and II, is US$138,000,000 in total.

PROJECT EVALUATION

18. Evaluation of the project was made from economic, financial and socio-environmental viewpoints. In view of the stepwise development of the Tenom Pangi project, the evaluation of the project is made from the following two approaches: the first is conducted for an incremental part of the project, i.e Phase III only and the second for an integral case including the Phases I, II and III all together. All the project costs and benefits are estimated at 1985/1986 price level.

19. Economic evaluation is made so as to ascertain the contribution of the project toward the economic development of the nation. In the economic evaluation, the project cost and benefit in financial prices are re-evaluated and converted into the economic values by using the conversion factors for Malaysia. Benefit of the project is accrued from saving the alternative cost of the thermal power plant which is assumed to be a 50 MW class coal-fired thermal plant. Unit power benefit thereby derived is 237 US$/kW for capacity value and 0.026 US$/kWh for energy value. Energy output and 95% dependable power which are used for the project evaluation are summarized as below:

Item	Phase III only			Phases I, II, III		
I. Energy output (GWh)	Firm	Dump	Total	Firm	Dump	Total
1. Sook power station	45.5	6.3	51.8	45.5	6.3	51.8
2. Tenom Pangi (extension)	283.8	-	283.8	283.8	-	283.8
3. Tenom Pangi (existing)	-	-	-	331.6	184.6	516.2
Total:	329.3	6.3	335.6	660.9	190.9	851.8
II. Dependable power (MW)						
1. Sook power station		9.9			9.9	
2. Tenom Pangi (extension)		61.1 1/			61.1 1/	
3. Tenom Pangi (existing)		-			45.0	
Total:		71.0			116.0	

Economic cost-benefit comparison of the project is summarized as below:

Item	Phase III only	Phases I, II and III
1. Capitalized cost (C) : (10^3 US$) 2/	129,104	343,034
2. Capitalized benefit (B) : (10^3 US$) 2/	163,000	432,200
3. Net benefit (B-C) : (10^3 US$)	33,986	89,166
4. Benefit-cost ratio (B/C)	1.26	1.26
5. EIRR : (%)	12.6	13.9

1/: Including increased dependable power generation of 17.1 MW at existing Tenom Pangi power station.

2/: Capitalized to 1989, the project commencement year, based on 10% discount rate and 50 years project life.

As seen in the above table, economic internal rate of return (EIRR) is calculated to be 12.6% for the Phase III only and 13.9% for the integral case of Phases I, II and III, respectively. These economic indices indicate that the proposed project is said to be economically feasible.

20. The project will be implemented by introducing the loans to cover both foreign and local currency portions of the project cost. The financial analysis is based on power tariff as of 1986. Interest rates of 4 % and 8.5 % and repayment periods of 13 years after 7 years grace period and 25 years after 5 years grace period for foreign and local currency portions, respectively, are adopted. The financial statements shown in Tables 1 and 2, indicate that the project will have a loan repayability of the acceptable level under these loan conditions. The financial rate of return (FIRR) was calculated to be 10.8% for the Phase III only and 18.3% for the integral case of Phases I, II and III.

21. The project is also evaluated from socio-environmental viewpoint. Major findings for the evaluation are summarized as below:

1) Resettlement will be required for about 2,200 persons of inhabitants in the proposed reservoir area. This will not be a major constraint to the project if appropriate administrative arrangement is made with close cooperation from other departments and agencies who have plans to develop the surrounding areas.

2) Impact of the project on natural environment will be less important in view that the kinds of vegetation and wildlife found in the reservoir area are of popular natures and widely distributed in other areas. Moreover the area affected by the project is not so large. However, further investigation will be needed to clarify it.

3) The proposed reservoir is reported to have no mineral resources of commercial values according to Geology Survey Department. (after Collenettee 1965).

4) It was confirmed by the field investigation that there would be no specific adverse effect to water uses in the areas downstream of the dam. Contrarily, anticipated are some beneficial effects such as flood control effect by the reservoir, rural electrification around the project area, increase of opportunity for new recreation and sight-seeing spots, etc.

CONCLUSION AND RECOMMENDATION

22. Based on the above findings of the feasibility study, the Tenom Pangi Hydroelectric Power Development Project, Phase III, is now proven to be technically feasible, financially and economically viable and socio-environmentally acceptable.

23. Therefore, early realization of the project is hereby recommended. Implementation of the project is recommended to be carried out in the following manners:-

1) Engineering design including additional field investigation, detailed design, preparation of tender documents, etc., should be started at the beginning of 1987 so that the project can be commissioned by the end of 1993 to meet expected power demand.

2) Proper procedures for gazetting the reservoir area should be taken now so that new development in the areas can be minimized.

3) Plan for resettlement of the families affected by the proposed project should be undertaken by a committee during the Engineering Study.

4) Preparatory works such as construction of access roads, offices and quarters should be started at the beginning of 1989.

5) Main civil works which require five years to be completed, should be commenced in the middle of 1989.

PRINCIPAL FEATURES

24. The principal features of the project are summarized as below:

1) Sook Reservoir and Power Station

(1) Reservoir

•Catchment area:	1,705 km^2
•Annual mean runoff:	29.4 m^3/s
•FWL:	Eℓ.311.1 m
•NHWL:	Eℓ.310.0 m
•LWL:	Eℓ.285.0 m
•TWL:	Eℓ.250.0 m
•Sedimentation surface level:	Eℓ.277.0 m
•Drawdown:	25.0 m
•Gross storage capacity at NHWL:	732 x 10^6 m^3
•Effective storage capacity:	550 x $10^6 m^3$
•Reservoir surface area:	35 km^2

(2) Sook Dam

(a) Main dam:

•Type:	Rockfill dam with center core
•Dam height:	70 m
•Crest elevation:	Eℓ.314.0 m
•Crest length:	345.0 m
•Crest width:	10 m
•Upstream slope:	1:2.5
•Downstream slope:	1:1.9

•Embankment volume

Core:	240,000 m^3
Filter:	190,000 m^3
Rock:	1,300,000 m^3
Total:	1,730,000 m^3

(b) Spillway

•Type:	Gated chuteway with stilling basin
•Gate:	Two roller gates, 11.5 m wide x 7.0 m high each
•Capacity:	1,000 m^3/s at FWL 311.1 m

(c) Diversion system

•Type:	Concrete-lined tunnel diversion
•Section:	5.0 m dia. horseshoe section (two lines)
•Length:	579 m for tunnel No.1 613 m for tunnel No.2
•Design flood:	410 m^3/s

(d) Saddle dam

•Type:	Homogeneous earthfill dam
•Dam height:	12 m
•Crest elevation:	Eℓ.314.0 m
•Crest length:	1,481 m in total
•Crest width:	6 m
•Upstream slope:	1:3.5
•Downstream slope:	1:3.0
•Embankment volume:	370,000 m^3 in total

(3) Waterway and Powerhouse

(a) Intake

•Type:	Horizontal intake with inclined gate shaft
•Gate:	One roller gate, 4.5 m wide x 5.5 m high

(b) Headrace tunnel

•Type:	Concrete-lined pressure tunnel
•Section:	3.9 m dia. circular section (one line)
•Length:	449 m

(c) Surge tank

•Type:	Restricted orifice type
•Dimension:	12 m dia. x 49 m high

(d) Penstock line

•Type:	Surface type with partial tunnel portion
•Dimension:	3.1 m dia. x 139 m long

(e) Powerhouse

•Type:	Surface type
•Dimension:	26.5 m wide x 36.5 m long x 35.5 m high

(4) <u>Generating Equipment</u>

(a) Hydraulic turbine

•Type of turbine:	Vertical shaft Kaplan type
•Gross head:	60 - 35 m
•Rated head:	51 m
•Plant discharge:	47.1 m^3/s
•Installed capacity:	20 MW = 10 MW x 2 units
•Turbine rated speed:	429 rpm (Provisional)

(b) Alternating current generator

•Type of generator:	Three phase vertical shaft synchronous generator
•Capacity:	11.5 MVA x 2 units
•Rated speed:	429 rpm (Provisional)
•Terminal voltage:	11 kV
•Frequency:	50 Hz

(c) Main transformer

•Type	Three phase, 50 Hz, oil immersed self-cooled/forced-oil-circulation with cooling fan
•Rated output	11.5/23 MVA
•Voltage	11/132 kV

(5) Average Annual Energy Output

Firm:	45.5 GWh
Dump (Secondary):	6.3 GWh
Total:	51.8 GWh

(6) Transmission Line

•Voltage:	132 kV
•Number of circuit:	single circuit
•Conductor:	175 mm^2 (Lynx) ACSR
•Length:	10 km to Keningau substation

2) Tenom Pangi Power Station (Extension)

(1) Pondage

•Catchment area:	7,815 km^2
•Annual mean runoff	210 m^3/s
•NHWL:	Eℓ.173.9 m
•LWL:	Eℓ.170.7 m
•TWL:	Eℓ. 99.2 m
•Drawdown:	3.2 m
•Effective storage capacity:	4.7 x 106 m3

(2) Waterway and Power house

(a) Intake for extension

•Type:	Intake with underground settling basin
•Gate:	Three roller gates, 6.0 m wide x 9.0 m high

(b) Tunnel

•Type:	Concrete lined pressure tunnel
•Section:	5.2 m dia. circular section (one line)
•Length:	4,200 m

(c) Surge tank

•Type:	Restricted orifice type
•Dimension:	14 m dia. x 60 m high

(d) Penstock line

•Type:	Tunnel type
•Dimension:	4 m dia. x 220 m long

(e) Powerhouse

•Type:	Surface type
•Dimension:	26.5 m wide x 30.6 m long x 40.5 m high

(3) Generating Equipment

(a) Hydraulic turbine

•Type of turbine:	Vertical shaft Francis type
•Gross head:	74.7 - 71.5 m
•Net head:	63.1 - 59.9 m
•Maximum plant discharge:	
Extension:	84.9 m^3/s
Existing:	127.3 m^3/s
Total:	212.2 m^3/s
•Installed capacity:	
Extension:	44 MW
Existing:	66 MW
Total:	110 MW
•Turbine rated speed:	300 rpm

(b) Alternating current generator

•Type of generator:	Three phase, vertical shaft, semi-umbrella type, synchronous generator
•Capacity:	25 MVA
•Terminal voltage:	11 kV
•Frequency:	50 Hz
•Rated speed:	300 rpm
•Power factor:	0.88 lagging

(c) Main transformer

•Type	Three phase, 50 Hz, oil-immersed, self-cooled/ forced-oil-circulation with cooling fans
•Rated output	12.5/25 MVA
•Voltage	11/132 kV

(d) Average annual energy output

Firm:	283.8 GWh
Dump (Secondary):	-
Total:	283.8 GWh

(4) Penampang Substation

(a) Main transformer

•Type	Three phase, 50 Hz, oil-immersed, self-cooled/ forced-oil-circulation with cooling fans
•Rated output	12/24 MVA
•Voltage	132/66 kV

(b) Static capacitor

•Capacity	40 MVA (Provisional)
•Voltage	66 kV

Table 1 FINANCIAL STATEMENT (SOOK DAM AND POWER STATION + TENOM PANGI EXTENSION - PHASE III ONLY)

(UNIT: 10^3 US$)

No.	Year	Expenditure		Project revenue	OMR costs	Net income	Repayment		Total repayment	Surplus or deficit	Accumulated Surplus or deficit
		Local c.	Foreign c.				Local c.	Foreign c.			
0	1985										
1	1986			0		0	0	0	0	0	0
2	1987			0		0	0	0	0	0	0
3	1988			0		0	0	0	0	0	0
4	1989	4,319	4,601	0		0	367	184	551	-551	-551
5	1990	13,934	10,947	0		0	1,551	621	2,172	-2,172	-2,723
6	1991	12,691	15,477	0		0	2,630	1,241	3,871	-3,871	-6,594
7	1992	27,359	35,514	0		0	4,955	2,661	7,616	-7,616	-14,210
8	1993	19,638	29,659	0		0	6,624	3,847	10,471	-10,471	-24,681
9	1994			24,335	2,610	21,725	7,615	3,847	11,462	10,263	-14,418
10	1995			24,335	2,610	21,725	7,615	3,847	11,462	10,263	-4,155
11	1996			24,335	2,610	21,725	7,615	9,634	17,249	4,476	321
12	1997			24,335	2,610	21,725	7,615	9,634	17,249	4,476	4,797
13	1998			24,335	2,610	21,725	7,615	9,634	17,249	4,476	9,273
14	1999			24,335	2,610	21,725	7,615	9,634	17,249	4,476	13,749
15	2000			24,335	2,610	21,725	7,615	9,634	17,249	4,476	18,225
16	2001			24,335	2,610	21,725	7,615	9,634	17,249	4,476	22,701
17	2002			24,335	2,610	21,725	7,615	9,634	17,249	4,476	27,177
18	2003			24,335	2,610	21,725	7,615	9,634	17,249	4,476	31,653
19	2004			24,335	2,610	21,725	7,615	9,634	17,249	4,476	36,129
20	2005			24,335	2,610	21,725	7,615	9,634	17,249	4,476	40,605
21	2006			24,335	2,610	21,725	7,615	9,634	17,249	4,476	45,081
22	2007			24,335	2,610	21,725	7,615	9,634	17,249	4,476	49,557
23	2008			24,335	2,610	21,725	7,615	9,634	17,249	4,476	54,033
24	2009			24,335	2,610	21,725	7,615		7,615	14,110	68,143
25	2010			24,335	2,610	21,725	7,615		7,615	14,110	82,253
26	2011			24,335	2,610	21,725	7,615		7,615	14,110	96,363
27	2012			24,335	2,610	21,725	7,615		7,615	14,110	110,473
28	2013			24,335	2,610	21,725	7,615		7,615	14,110	124,583
29	2014			24,335	2,610	21,725	7,615		7,615	14,110	138,693
30	2015			24,335	2,610	21,725	7,615		7,615	14,110	152,803
31	2016			24,335	2,610	21,725	7,615		7,615	14,110	166,913
32	2017			24,335	2,610	21,725	7,615		7,615	14,110	181,023
33	2018			24,335	2,610	21,725	7,615		7,615	14,110	195,133
Total:		77,941	96,198	608,375	65,250	543,125	206,502	141,490	347,992	195,133	-

Table 2 FINANCIAL STATEMENT (SOOK DAM AND POWER STATION, TENOM PANGI EXTENSION + TENOM PANGI EXISTING - PHASES I, II, III)

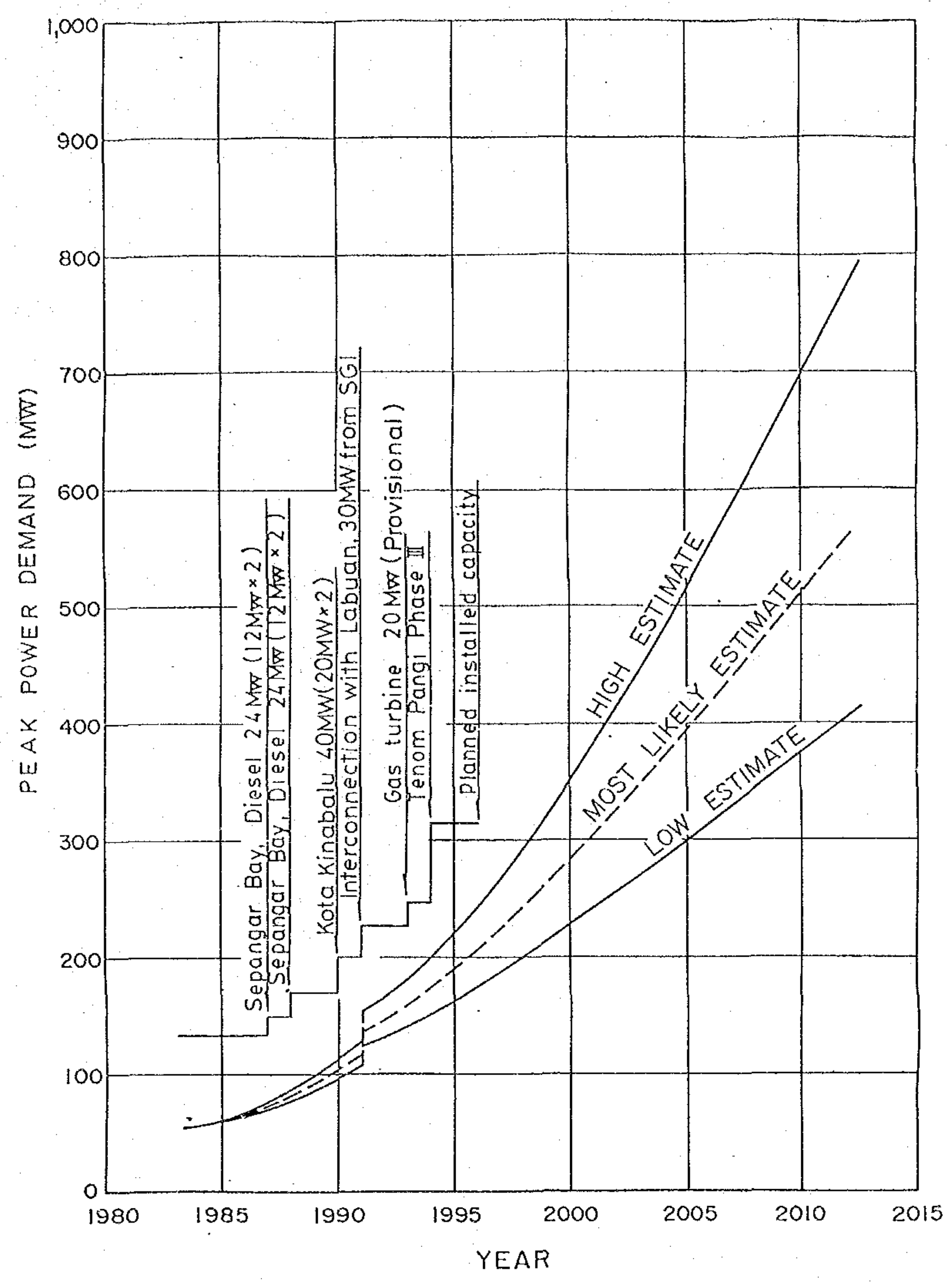
(UNIT: 10^3 US$)

No.	Year	Expenditure		Project revenue	OMR costs	Net income	Repayment		Total repayment	Surplus or deficit	Accumulated Surplus or deficit
		Local c.	Foreign c.				Local c.	Foreign c.			
0	1985	55,890	92,273	23,856	2,070	21,786	5,461	3,691	9,152	12,634	12,634
1	1986			26,162	2,070	24,092	5,461	3,691	9,152	14,940	27,574
2	1987			29,624	2,070	27,554	5,461	9,240	14,701	12,853	40,427
3	1988			31,029	2,070	28,959	5,461	9,240	14,701	14,258	54,685
4	1989	4,319	4,601	31,029	2,070	28,959	5,828	9,424	15,252	13,707	68,392
5	1990	13,934	10,947	31,029	2,070	28,959	7,012	9,861	16,873	12,086	80,478
6	1991	12,691	15,477	31,029	2,070	28,959	8,091	10,481	18,572	10,387	90,865
7	1992	27,359	35,514	31,029	2,070	28,959	10,416	11,901	22,317	6,642	97,507
8	1993	19,638	29,659	31,029	2,070	28,959	12,085	13,087	25,172	3,787	101,294
9	1994			55,365	4,680	50,685	13,076	13,087	26,163	24,522	125,816
10	1995			55,365	4,680	50,685	13,076	13,087	26,163	24,522	150,338
11	1996			55,365	4,680	50,685	13,076	18,874	31,950	18,735	169,073
12	1997			55,365	4,680	50,685	13,076	18,874	31,950	18,735	187,808
13	1998			55,365	4,680	50,685	13,076	18,874	31,950	18,735	206,543
14	1999			55,365	4,680	50,685	13,076	18,874	31,950	18,735	225,278
15	2000			55,365	4,680	50,685	13,076	9,634	22,710	27,975	253,253
16	2001			55,365	4,680	50,685	13,076	9,634	22,710	27,975	281,228
17	2002			55,365	4,680	50,685	13,076	9,634	22,710	27,975	309,203
18	2003			55,365	4,680	50,685	13,076	9,634	22,710	27,975	337,178
19	2004			55,365	4,680	50,685	13,076	9,634	22,710	27,975	365,153
20	2005			55,365	4,680	50,685	13,076	9,634	22,710	27,975	393,128
21	2006			55,365	4,680	50,685	13,076	9,634	22,710	27,975	421,103
22	2007			55,365	4,680	50,685	13,076	9,634	22,710	27,975	449,078
23	2008			55,365	4,680	50,685	13,076	9,634	22,710	27,975	477,053
24	2009			55,365	4,680	50,685	13,076		13,076	37,609	514,662
25	2010			55,365	4,680	50,685	7,615		7,615	43,070	557,732
26	2011			55,365	4,680	50,685	7,615		7,615	43,070	600,802
27	2012			55,365	4,680	50,685	7,615		7,615	43,070	643,872
28	2013			55,365	4,680	50,685	7,615		7,615	43,070	686,942
29	2014			55,365	4,680	50,685	7,615		7,615	43,070	730,012
30	2015			55,365	4,680	50,685	7,615		7,615	43,070	773,082
31	2016			55,365	4,680	50,685	7,615		7,615	43,070	816,152
32	2017			55,365	4,680	50,685	7,615		7,615	43,070	859,222
33	2018			55,365	4,680	50,685	7,615		7,615	43,070	902,292
Total:		133,831	188,471	1,649,941	135,630	1,514,311	343,027	268,992	612,019	902,292	-

Table 3. <u>MEMBER LIST OF SURVEY TEAM</u>

JICA Team			SEB Counterpart	
	Name	Assignment	Name	Assignment
1.	S. Omura	Team leader	1. N.F. Pang	Chief Engineer/Hydro Civil
2.	M. Ogawa	Deputy team leader	2. Amat Aji	Co-team leader
3.	K. Watanabe	Civil engineer (dam)	3. Sahril Jaraei	Civil engineer
4.	A. Katayama	Hydrogist	4. Chu Pui An	Civil engineer
5.	H. Kashiwagi	Sr. Geologist	5. Jokolin Jomini	Mechanical engineer
6.	K. Choshi	Geologist		
7.	M. Kikuchi	Geophysicist		
8.	H. Yoshida	Material engineer	(1) JURUKUR PERUNDING SERVICE SDN. BHD.	Local Contractor for ground surveying
9.	T. Masuda	Aerial surveying engineer		
10.	K. Yamashita	Ground surveying engineer	(2) GROUND ENGINEERING SDN. BHD.	Local Contractor for geological and material investigations and laboratory test
11.	S. Tsukahara	Electrical engineer		
12.	S. Hakoshima	Construction planner		
13.	M. Nishimura	Environmental engineer		
14.	M. Ohashi	Project economist		
15.	T. Ito	Civil engineer		
16.	I. Shimohara	Civil engineer		
17.	Y. Ataka	Electrical engineer		
18.	A. Odatai	Mechanical engineer		
19.	S. Osumi	Architectural engineer		

FIGURE NO. : 1

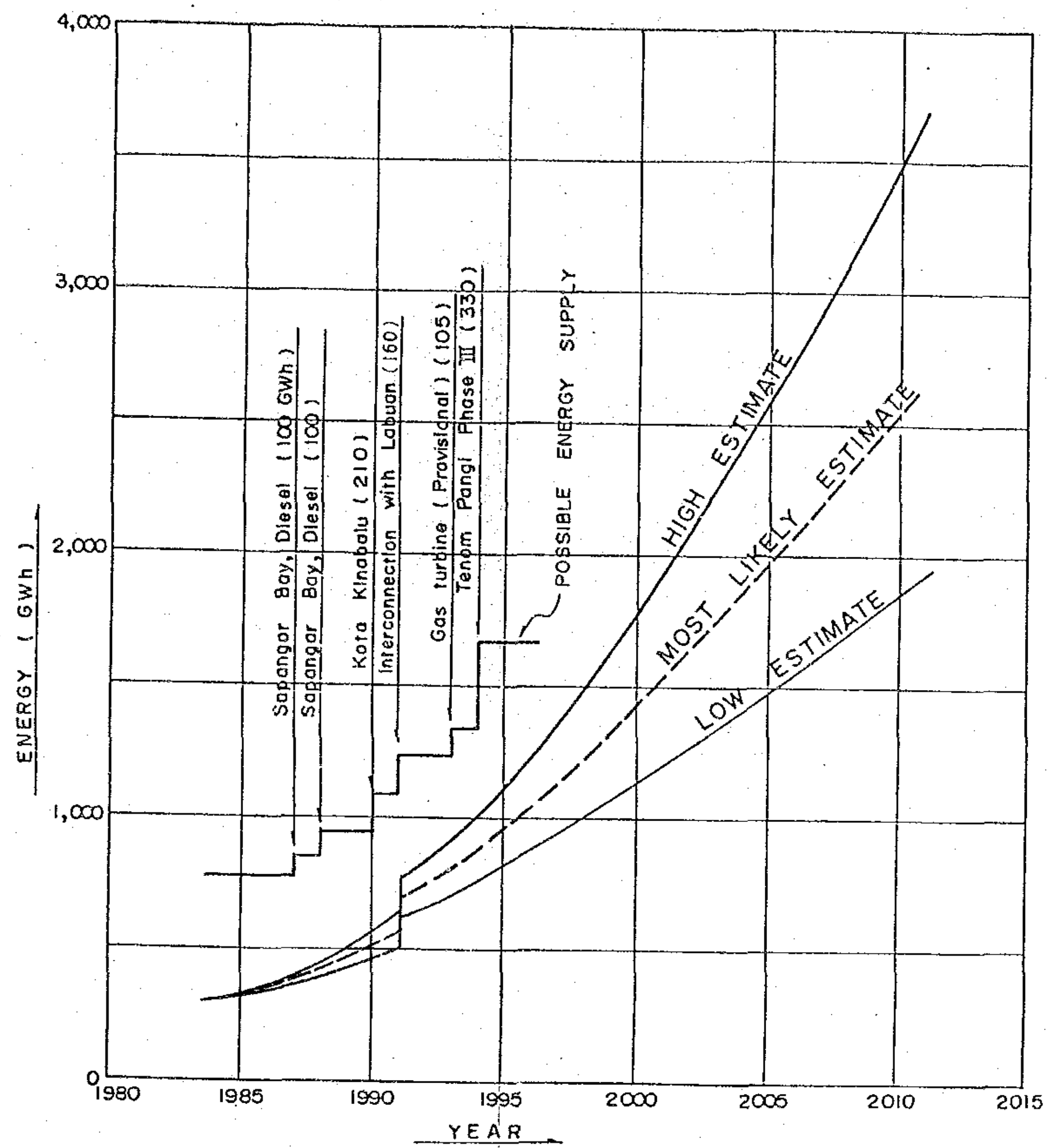


TENOM PANGI PHASE III

PEAK POWER DEMAND
FOR
WEST COAST AREA

SEB / JICA

FIGURE NO. : 2



TENOM PANGI PHASE III

ENERGY DEMAND
FOR
WEST COAST AREA

SEB / JICA

FIG. 3 CONSTRUCTION SCHEDULE OF SOOK DAM PROJECT (1)

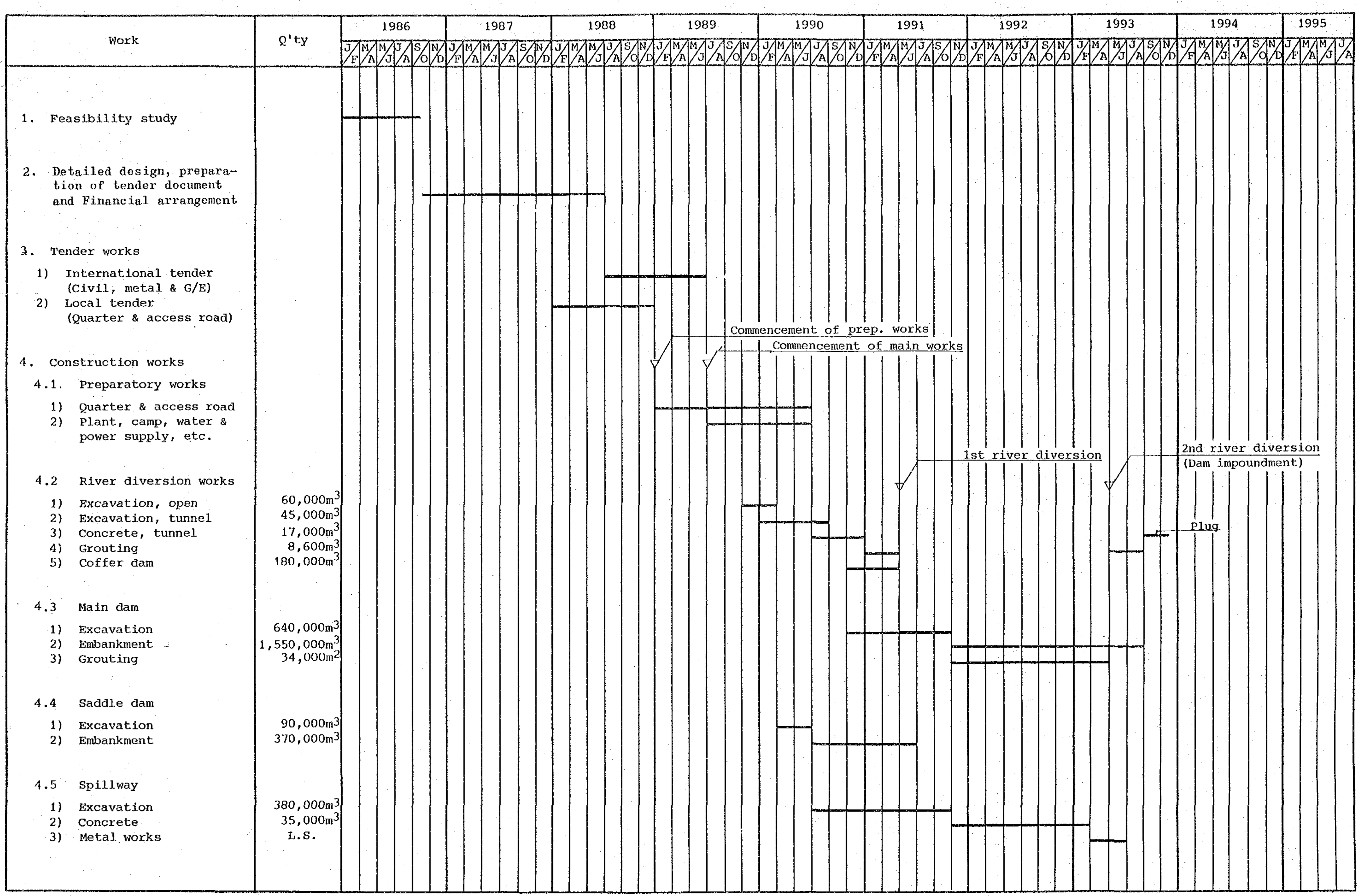


FIG. 3 CONSTRUCTION SCHEDULE OF SOOK DAM PROJECT (2)

Work	Q'ty
4.6 River outlet	
1) Concrete	2,000m^3
2) Metal works	L.S.
4.7 Intake structure	
1) Excavation	53,000m^3
2) Concrete	2,000m^3
3) Metal works	L.S.
4.8 Headrace tunnel	
1) Excavation, tunnel	12,000m^3
2) Concrete, tunnel	3,500m^3
3) Grouting	70t
4.9 Surge tank	
1) Excavation, open	42,000m^3
2) Excavation, shalt	8,500m^3
3) Concrete, shaft with grouting	1,000m^3
4.10 Penstock line	
1) Excavation, open	47,000m^3
2) Excavation, tunnel	1,000m^3
3) Concrete, open	2,000m^3
4) Concrete, tunnel	400m^3
5) Metal works	L.S.
4.11 Powerhouse & Tailrace	
1) Excavation	33,000m^3
2) Concrete	8,500m^3
3) Building works	L.S.
4) Metal works	L.S.
5) Electrical (G/E) works	10MW x 2
4.12 132 kV transmission line	ℓ = 10km

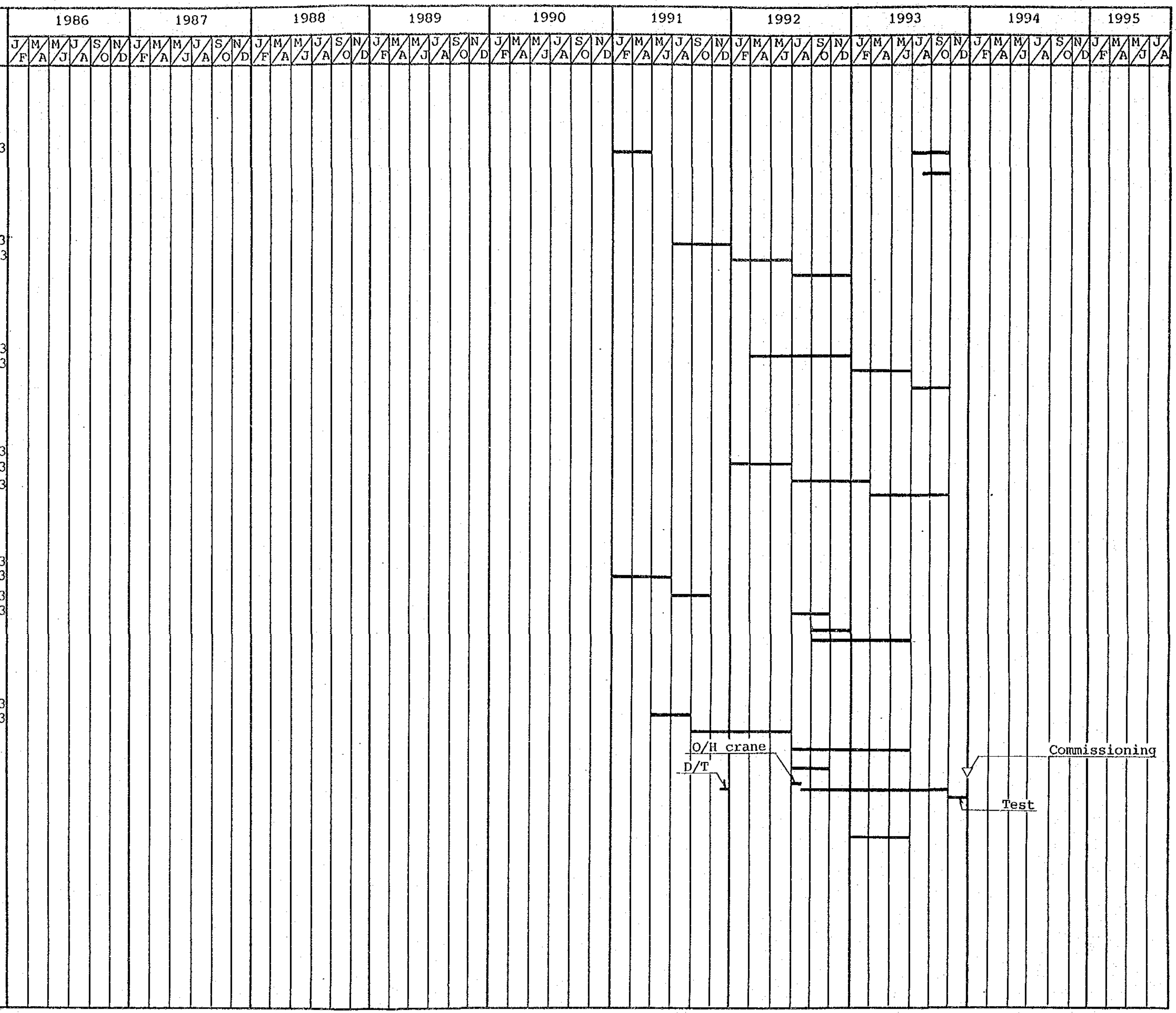
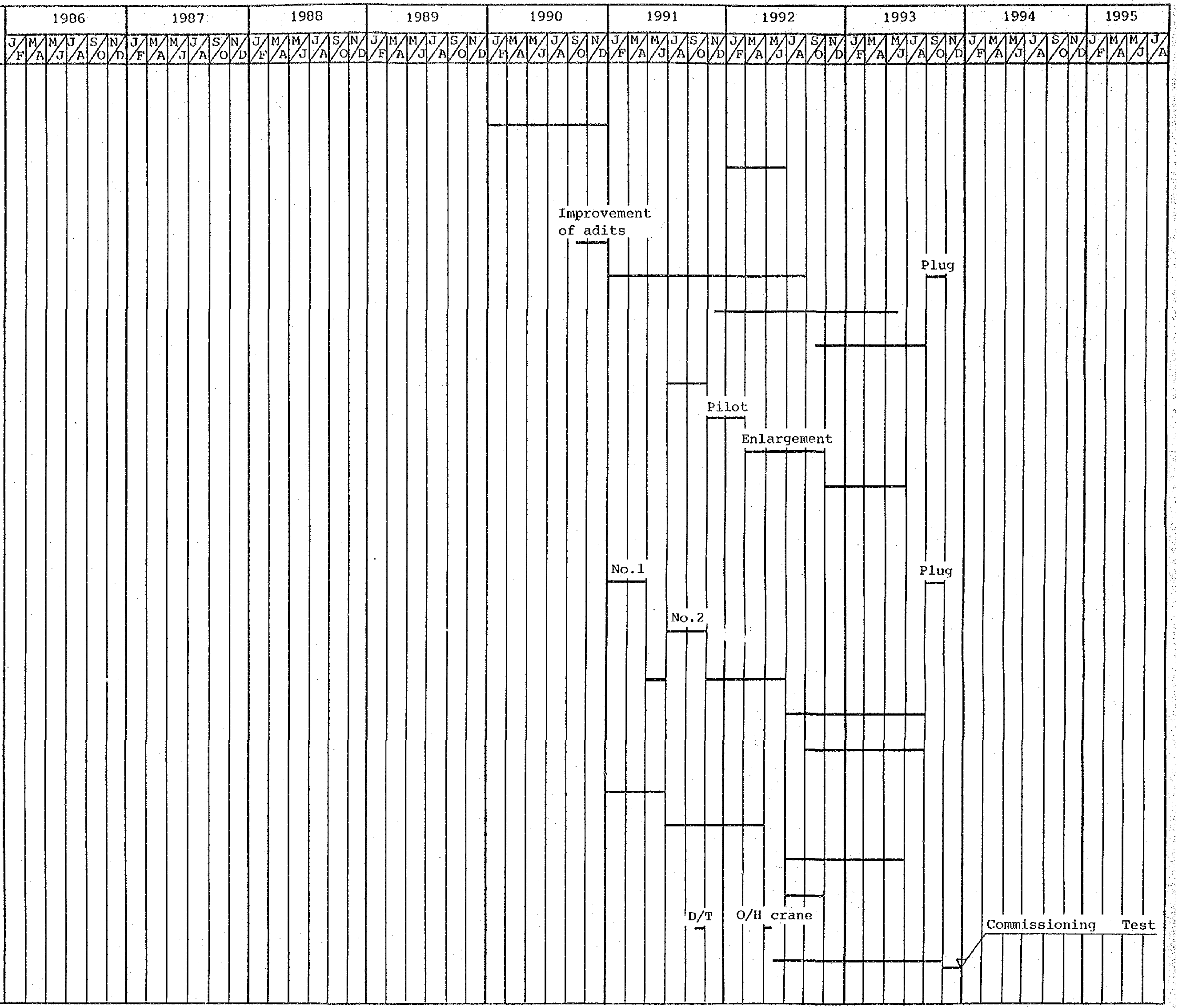
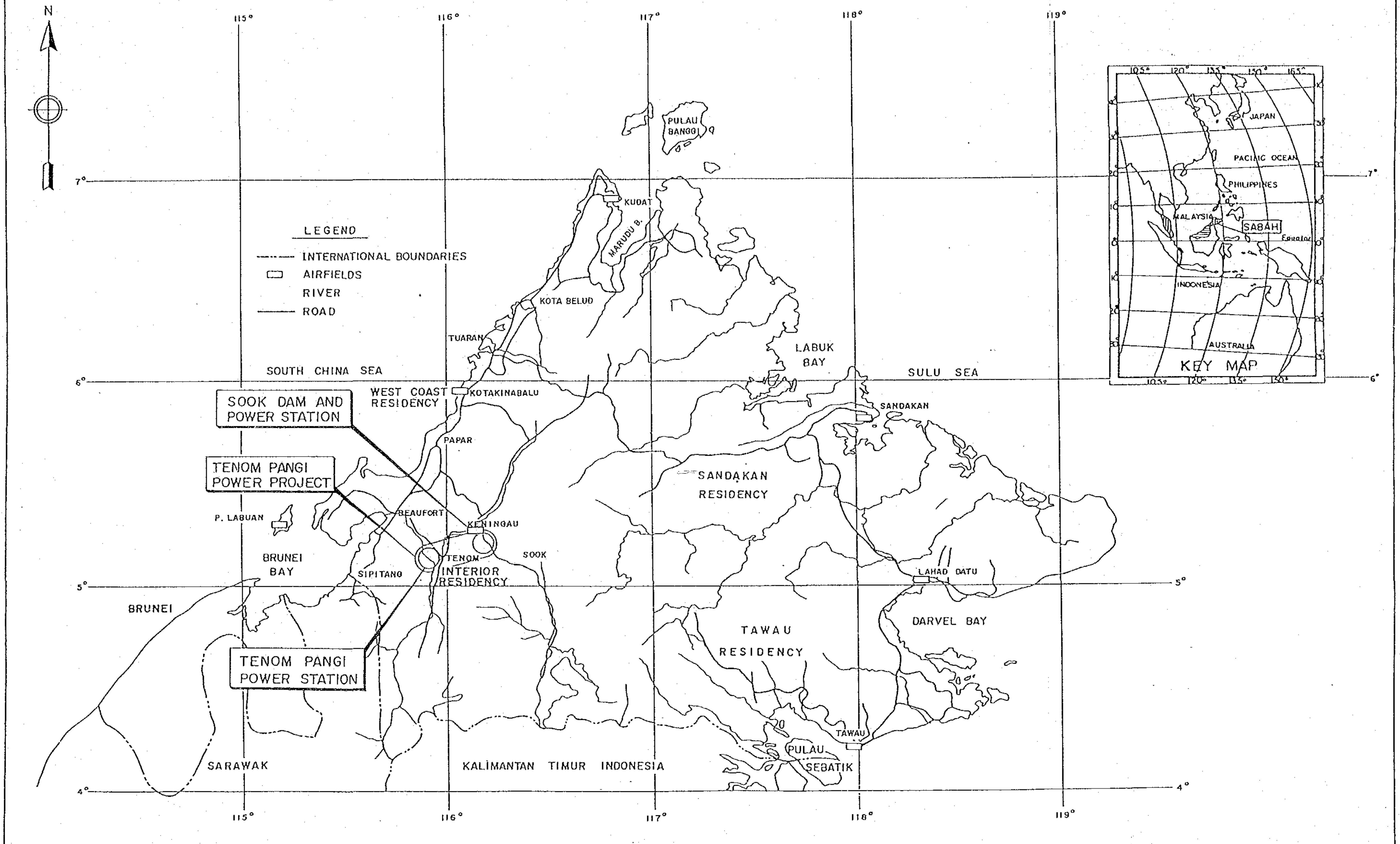


Fig. 4 CONSTRUCTION SCHEDULE OF TENOM PANGI EXTENSION PROJECT

Work	Q'ty
1. Construction works	
1.1 Preparatory works	
1.2 Intake	
1) Metal works	L.S.
1.3 Headrace tunnel	
1) Excavation, tunnel	145,000 m^3
2) Concrete, tunnel	45,000 m^3
3) Grouting	2,100 t
1.4 Surge tank	
1) Excavation, open	40,000 m^3
2) Excavation, shaft	19,000 m^3
3) Concrete, shaft with grouting	5,000 m^3
1.5 Penstock line	
1) Access tunnel	No.1: ℓ=125 m No.2: ℓ=130 m
2) Excavation, tunnel	13,000 m^3
3) Concrete, tunnel	5,000 m^3
4) Metal works	L.S.
1.6 Powerhouse & Tailrace	
1) Excavation	60,000 m^3
2) Concrete	15,000 m^3
3) Building works	L.S.
4) Metal works	L.S.
5) Electrical (G/E) works	22MW x 2



DWG. NO. : 1



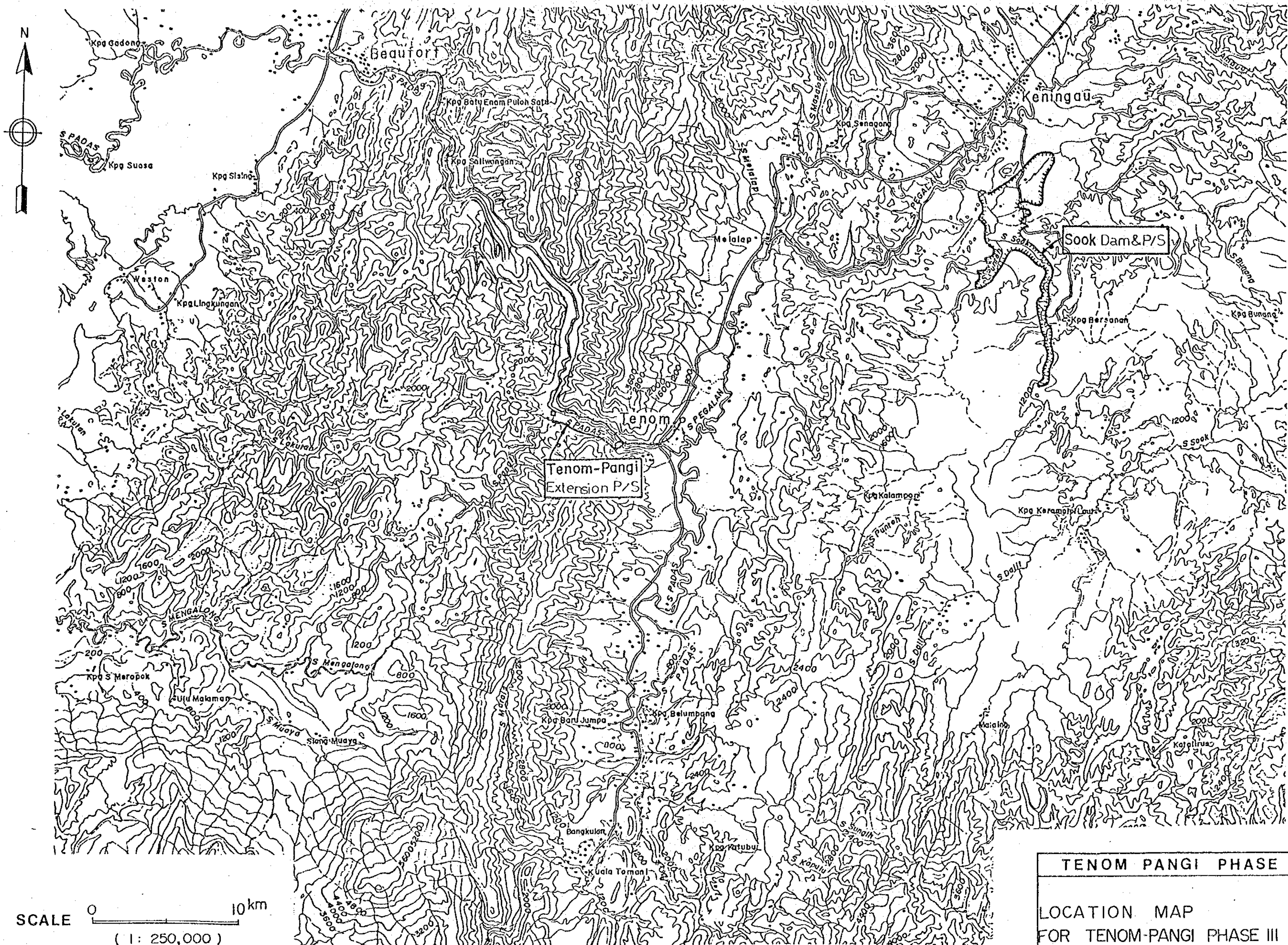
SCALE 0 100Km
(1: 2,000,000)

TENOM PANGI PHASE III

LOCATION MAP

SEB / JICA

DWG. NO. : 2

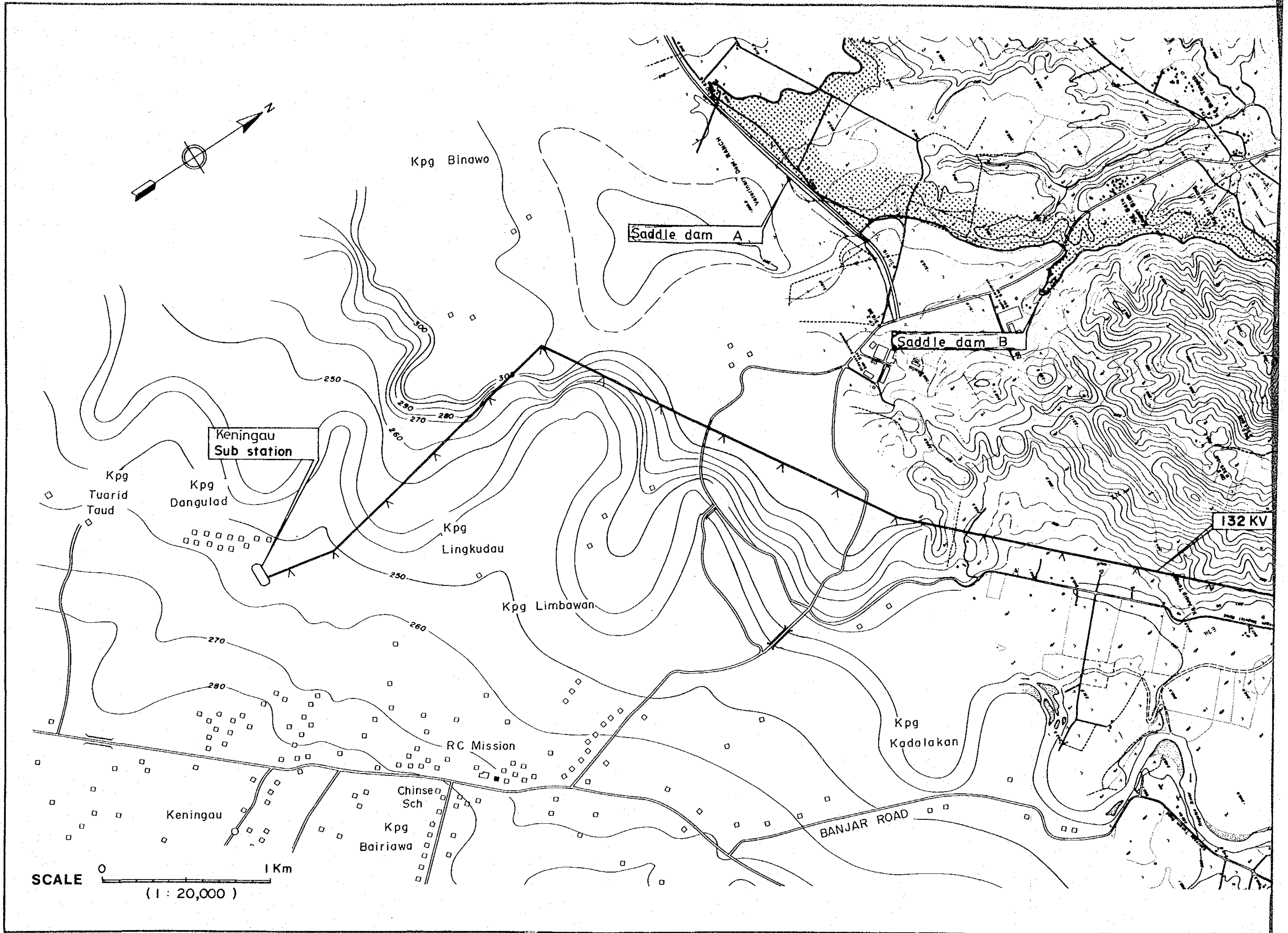


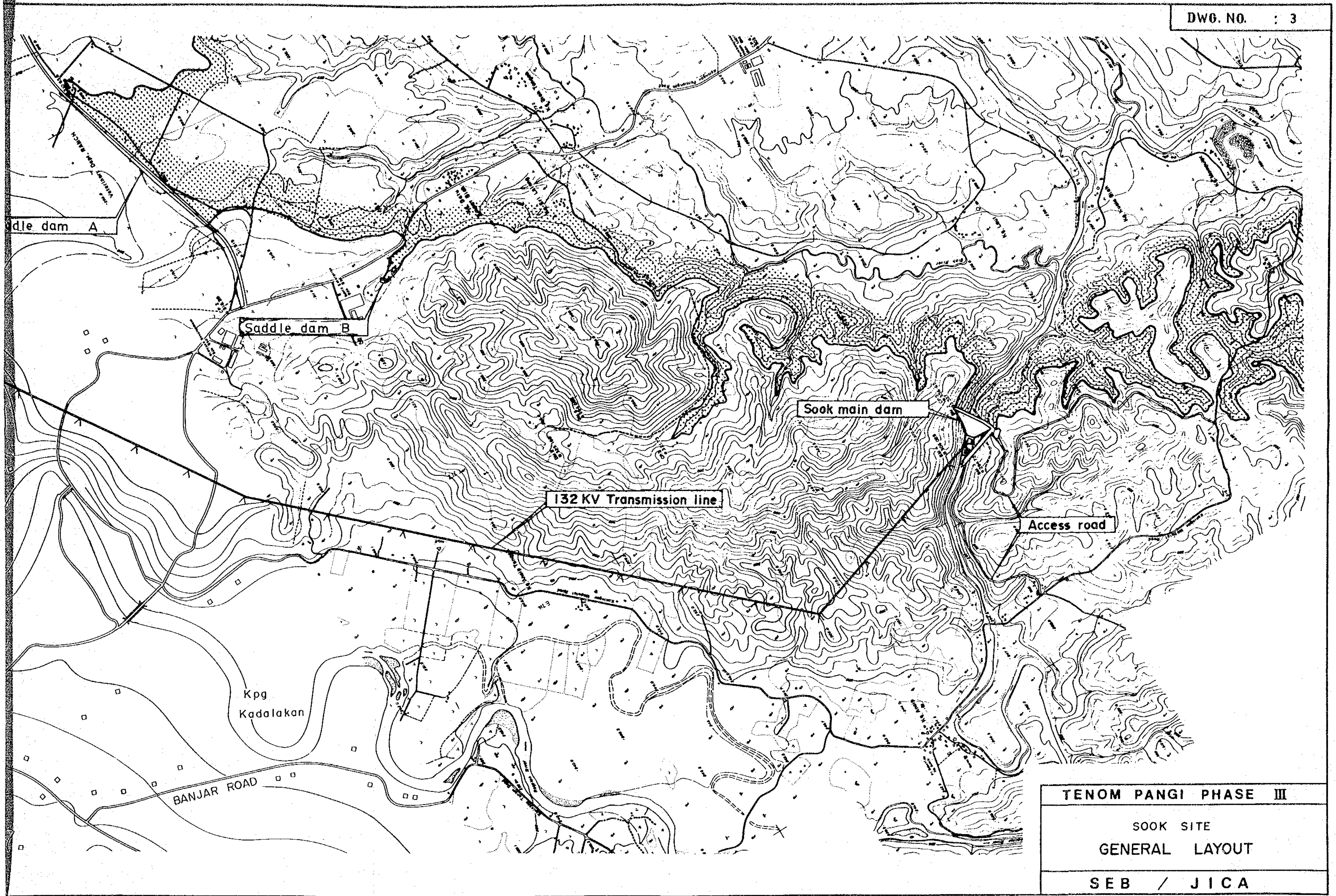
SCALE 0 10 km
(1: 250,000)

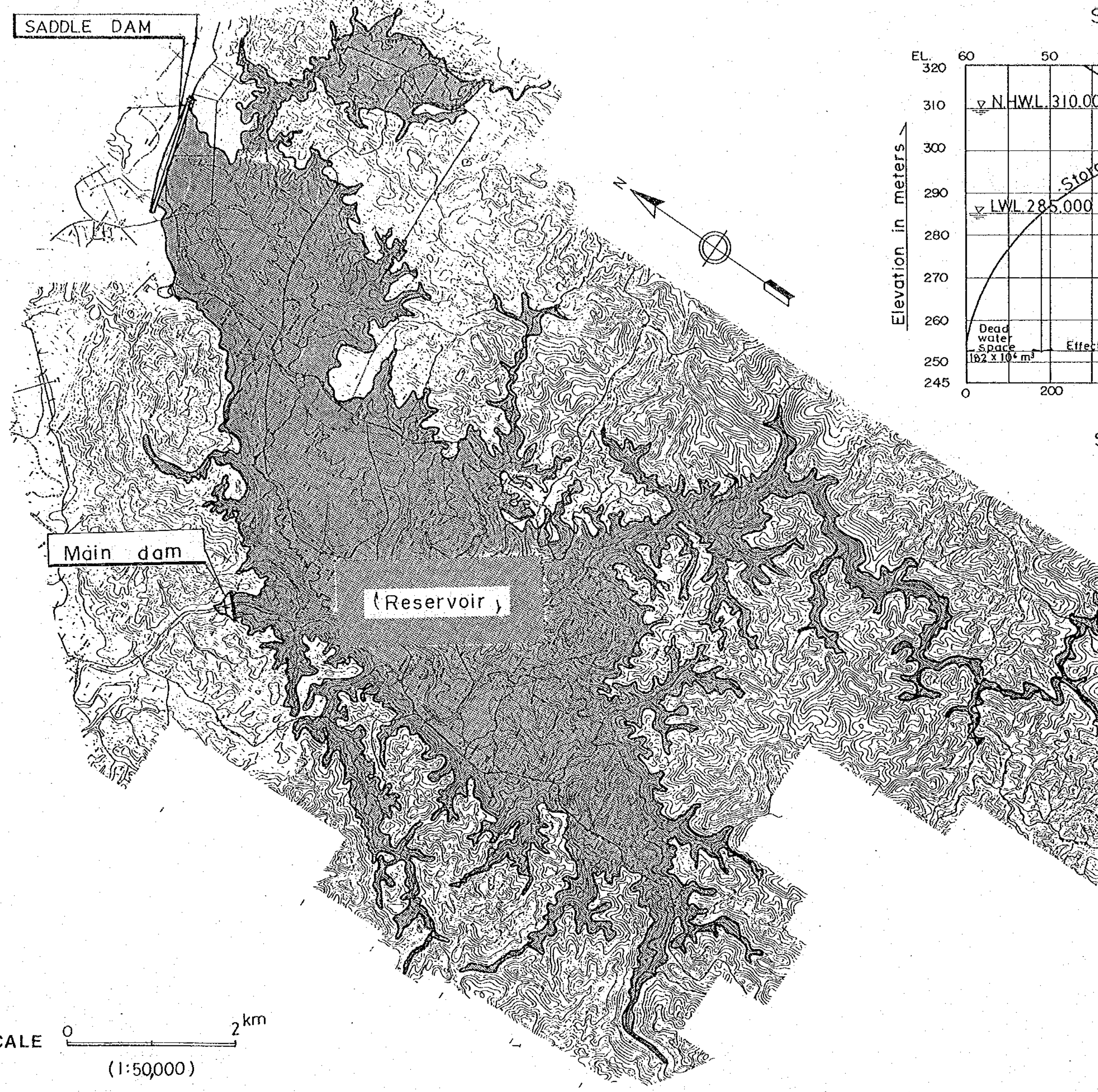
TENOM PANGI PHASE III

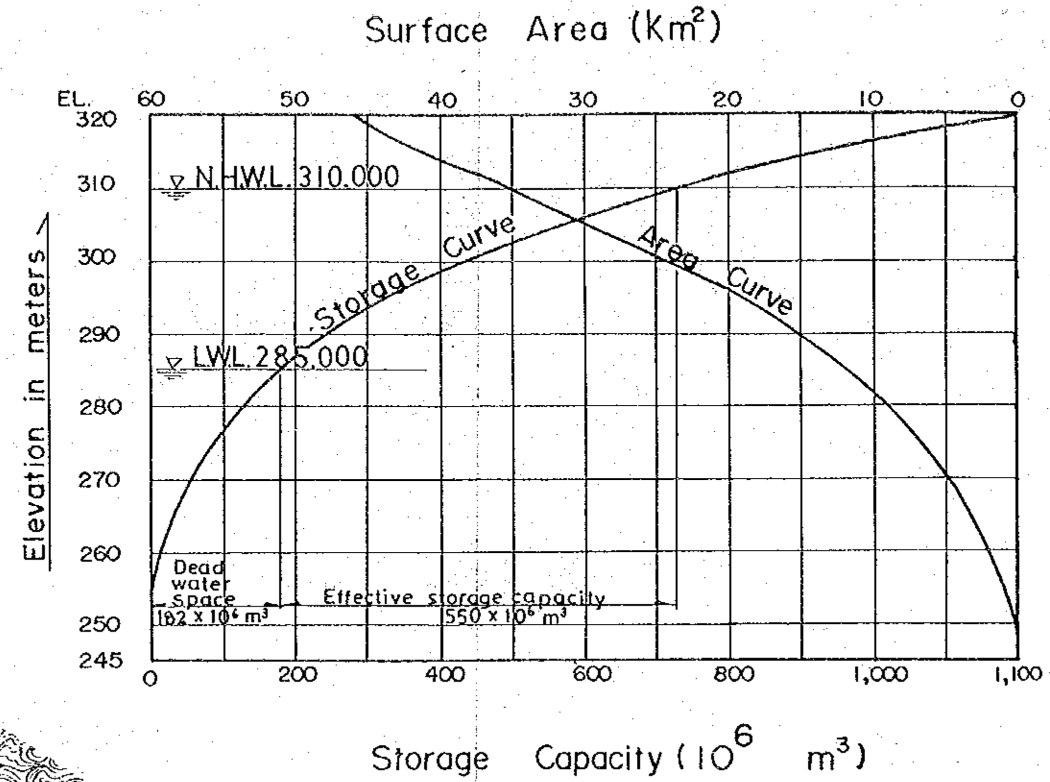
LOCATION MAP
FOR TENOM-PANGI PHASE III PROJECT

SEB / JICA


N
Kpg Binawo
Saddle dam A
Saddle dam B
300
250
290
270
280
260
Keningau
Sub station
Kpg
Tuarid
Taud
Kpg
Dangulad
Kpg
Lingkudau
Kpg Limbawan
132 KV
Kpg
Kadalakan
RC Mission
Chinse
Sch
Keningau
Kpg
Bairiawa
BANJAR ROAD
SCALE
0
1 Km
(1 : 20,000)


DWG. NO. : 3
dle dam A
Saddle dam B
Sook main dam
132 KV Transmission line
Access road
Kpg
Kadalakan
BANJAR ROAD
TENOM PANGI PHASE III
SOOK SITE
GENERAL LAYOUT
SEB / JICA





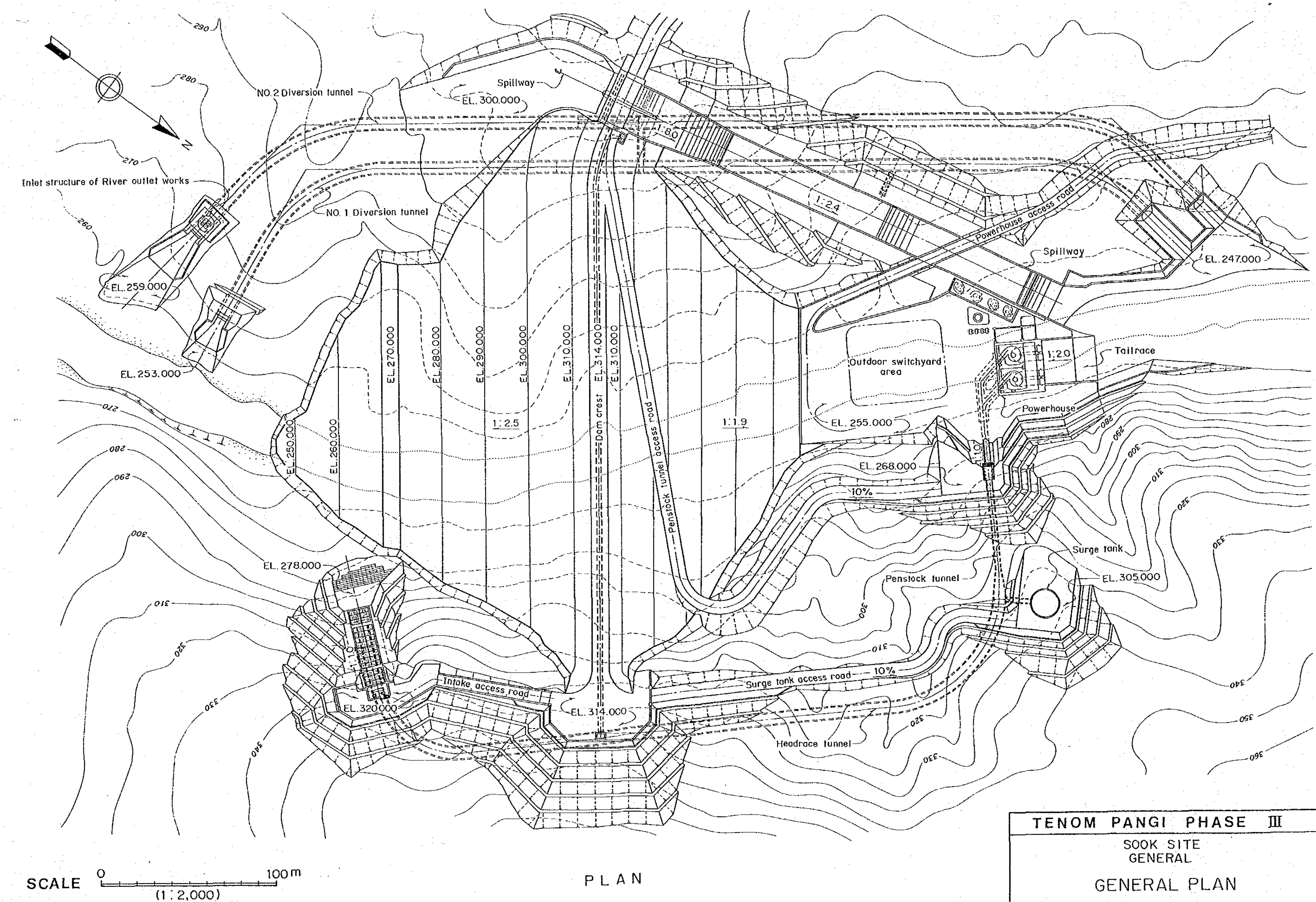
Stage (E.L.)	Area (Km2)	Storage (MCM)
245.0	0	0
250.0	0.03	0.16
260.0	2.71	13.87
270.0	5.23	53.57
280.0	9.32	126.31
285.0	11.54	188.89
290.0	14.75	241.47
300.0	24.26	436.52
310.0	34.81	731.87
320.0	45.90	1,135.44

TENOM PANGI PHASE III

SOOK SITE
RESERVOIR

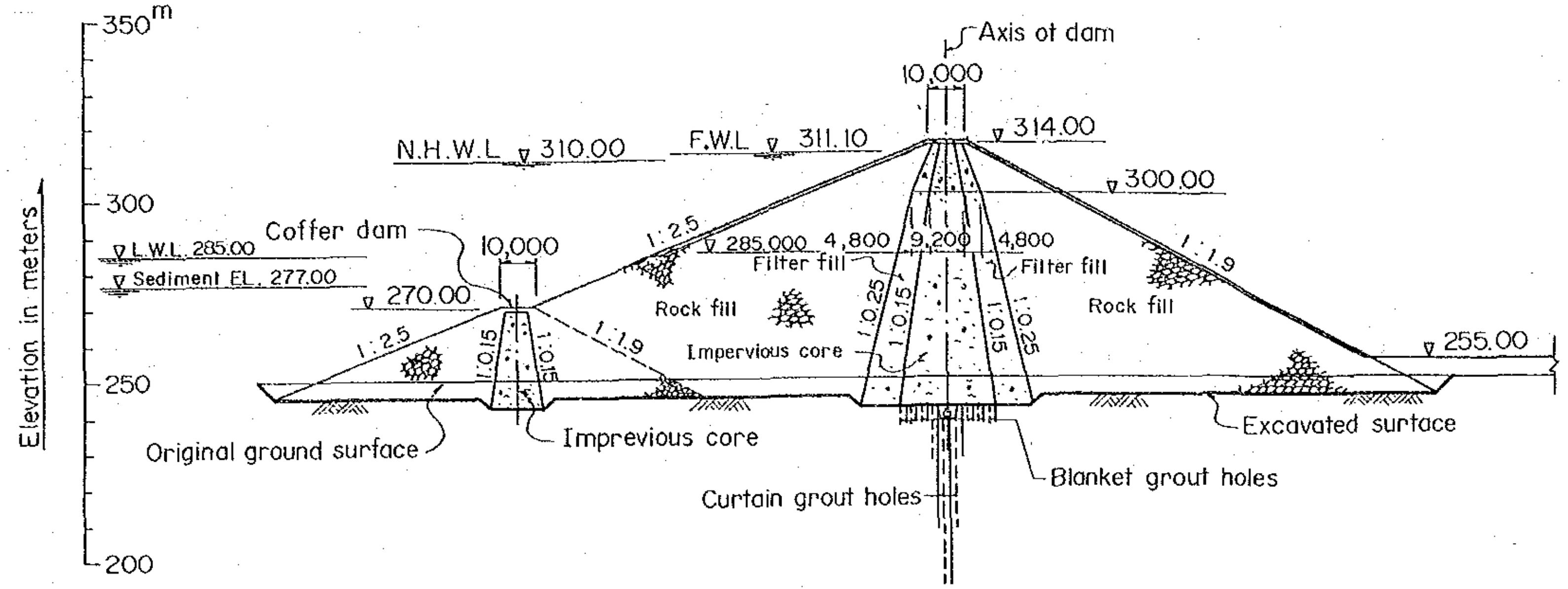
SEB / JICA

DWG. NO. : 5

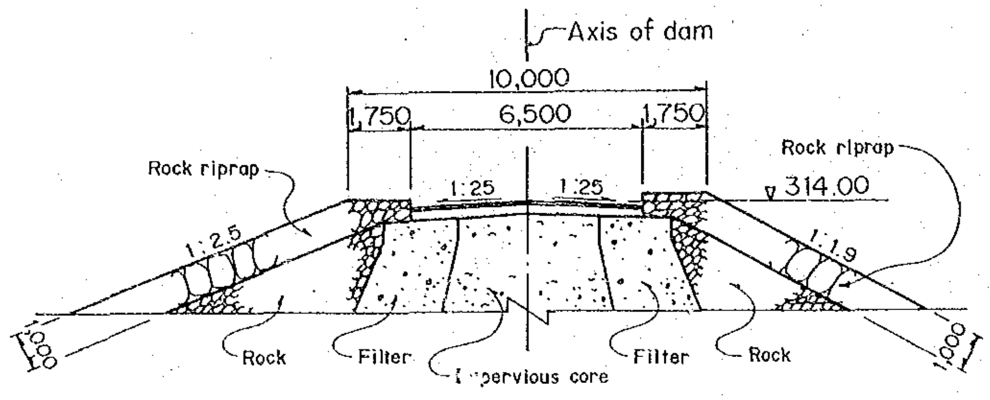


TENOM PANGI PHASE III
SOOK SITE GENERAL
GENERAL PLAN
SEB / JICA

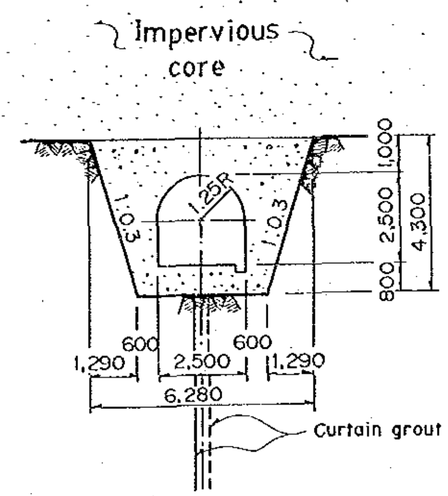
DWG. NO. : 6



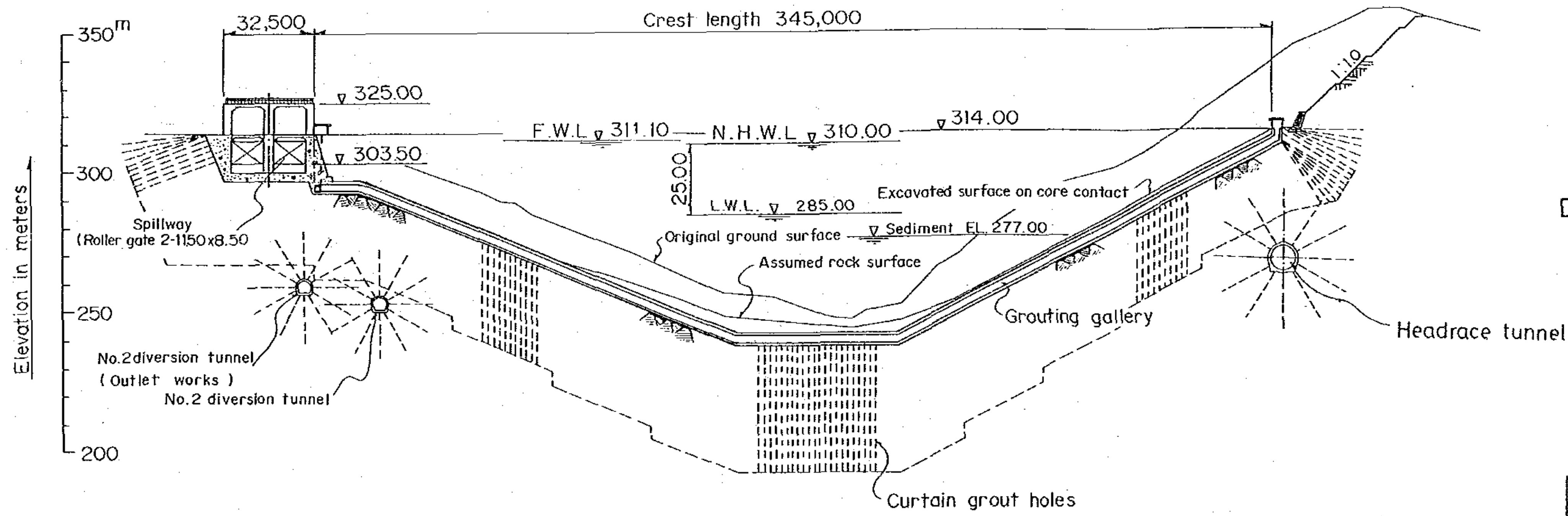
TYPICAL SECTION SCALE A



CREST DETAIL SCALE B



DETAIL OF GALLERY SCALE B



PROFILE SCALE A

SCALE A 0 — 100m (1:2,000)

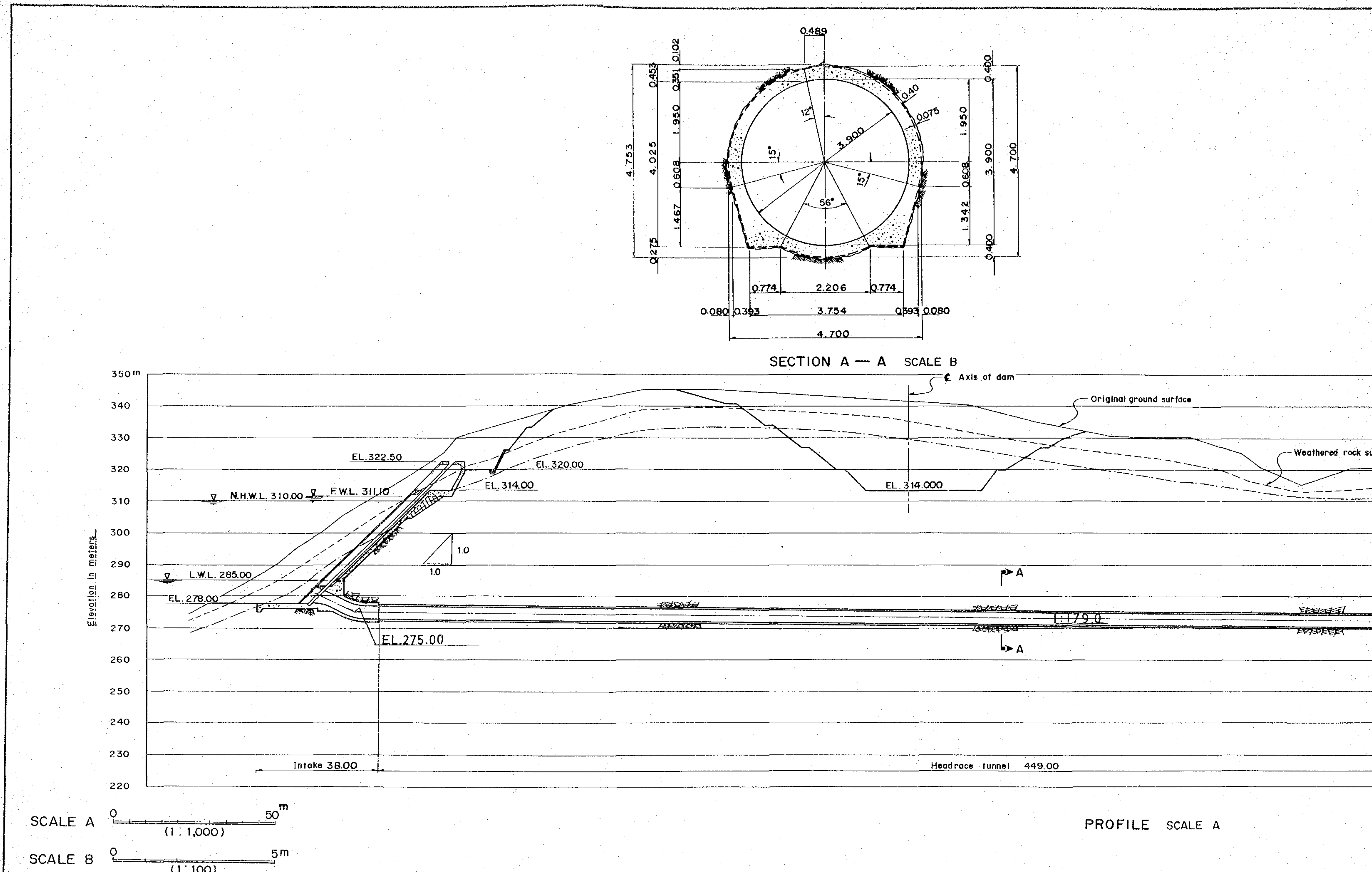
SCALE B 0 — 10m (1:200)

TENOM PANGI PHASE III

SOOK SITE
MAIN DAM

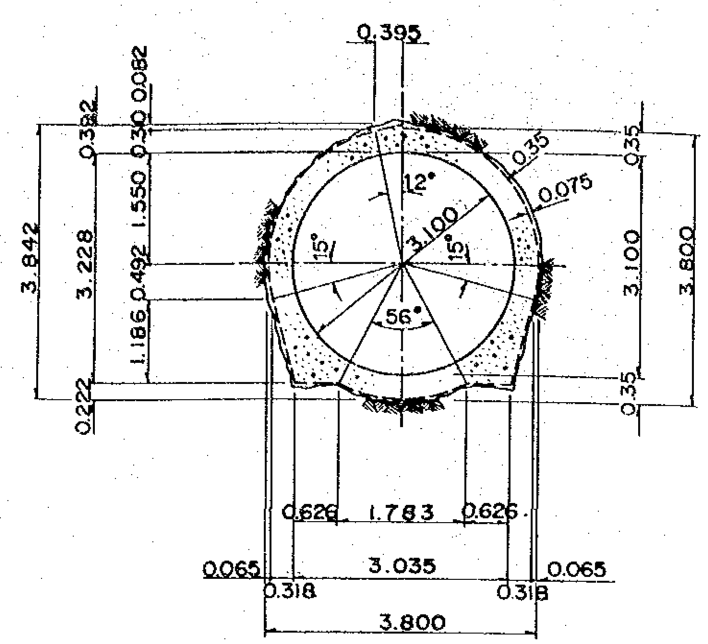
PROFILE, TYPICAL SECTION AND DETAILS

SEB / JICA

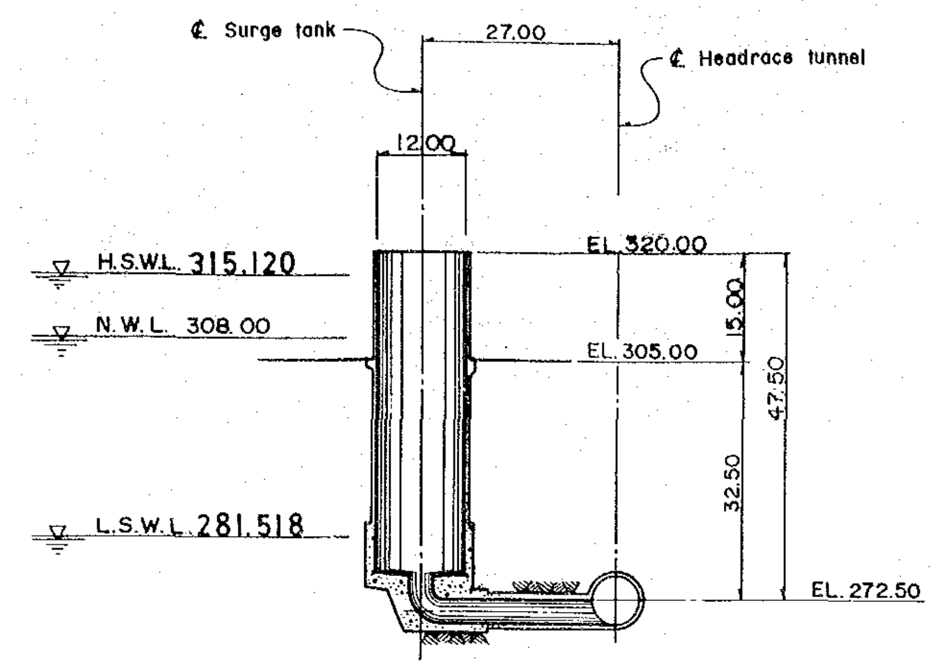


0.489
0.102
0.453
0.351
1.950
4.753
4.025
0.608
1.467
0.275
0.400
0.040
0.075
12°
3.900
15°
15°
56°
1.950
3.900
4.700
0.608
1.342
0.400
0.774
2.206
0.774
0.080
0.393
3.754
0.393
0.080
4.700
SECTION A — A SCALE B
350m
340
330
320
310
300
290
280
270
260
250
240
230
220
Elevation in meters
℄ Axis of dam
Original ground surface
Weathered rock surf
EL. 322.50
EL. 320.00
EL. 314.00
EL. 314.000
N.H.W.L. 310.00
F.W.L. 311.10
1.0
1.0
L.W.L. 285.00
EL. 278.00
A
1:179.0
EL. 275.00
A
Intake 38.00
Headrace tunnel 449.00
SCALE A
0
50m
(1 : 1,000)
SCALE B
0
5m
(1 : 100)
PROFILE SCALE A

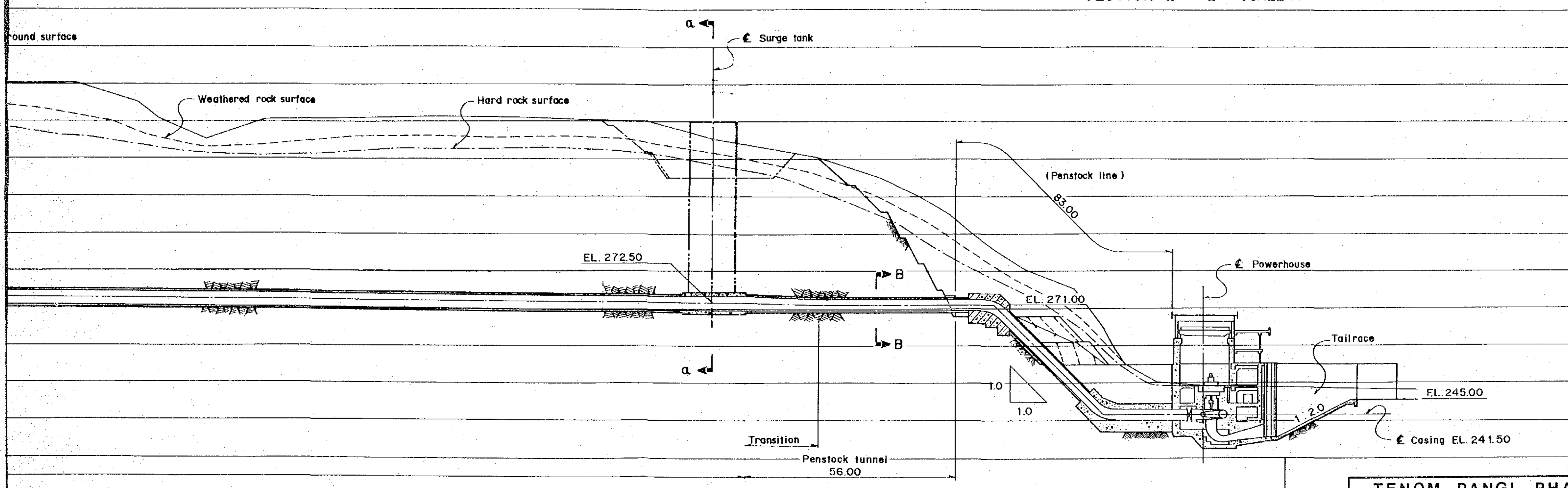
DWG. NO. : 7



SECTION B — B SCALE B



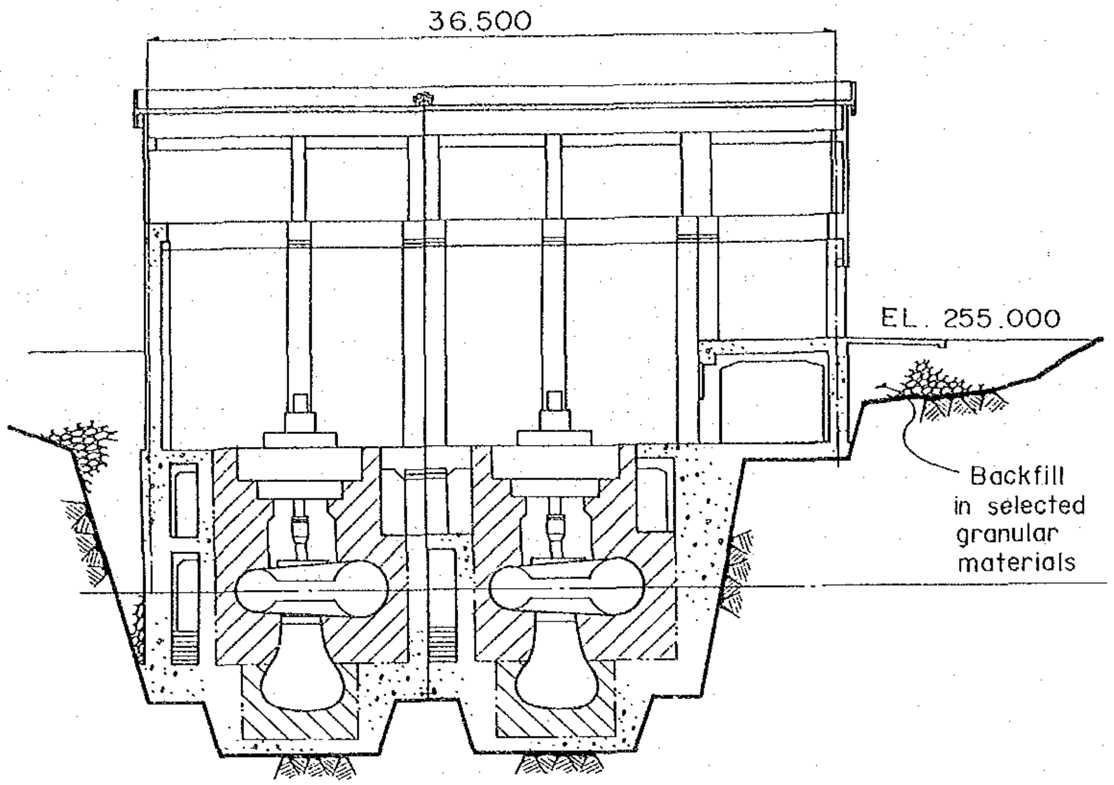
SECTION a — a SCALE A



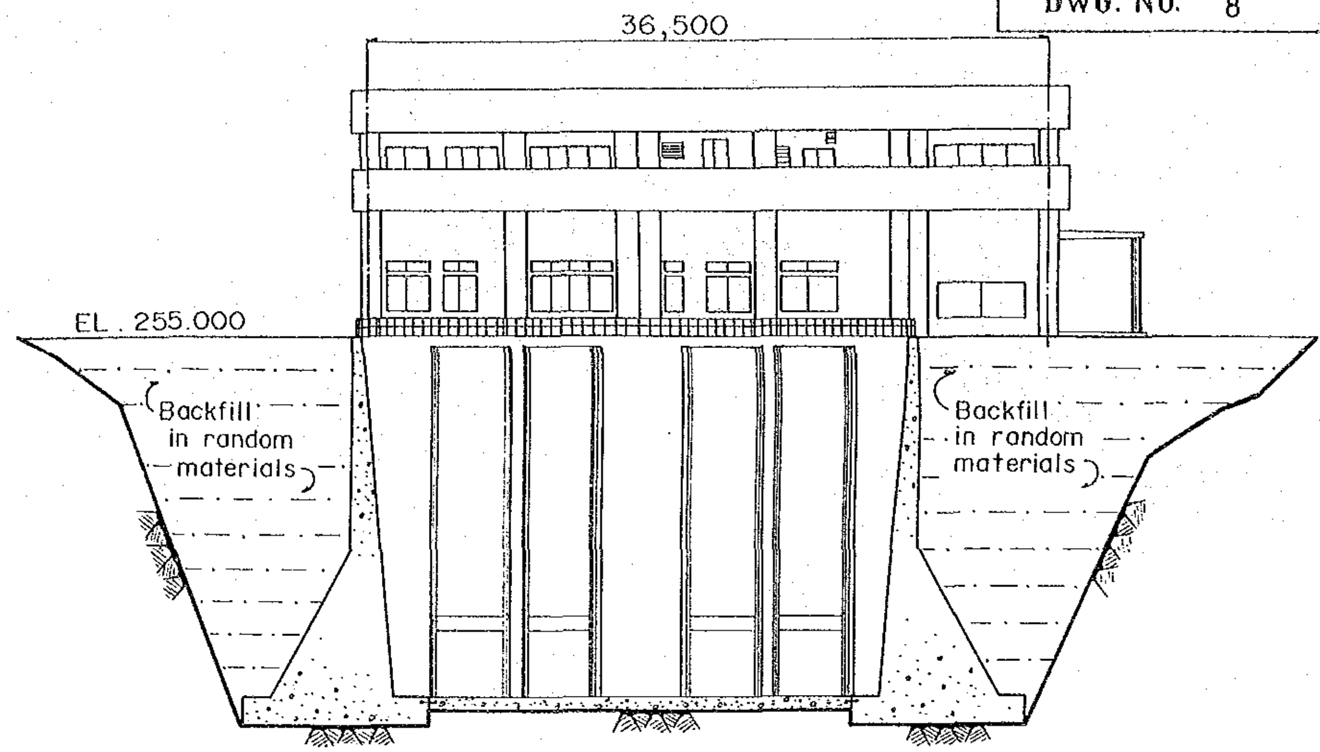
LE SCALE A

TENOM PANGI PHASE III
SOOK SITE WATER WAY
PROFILE AND SECTIONS
SEB / JICA

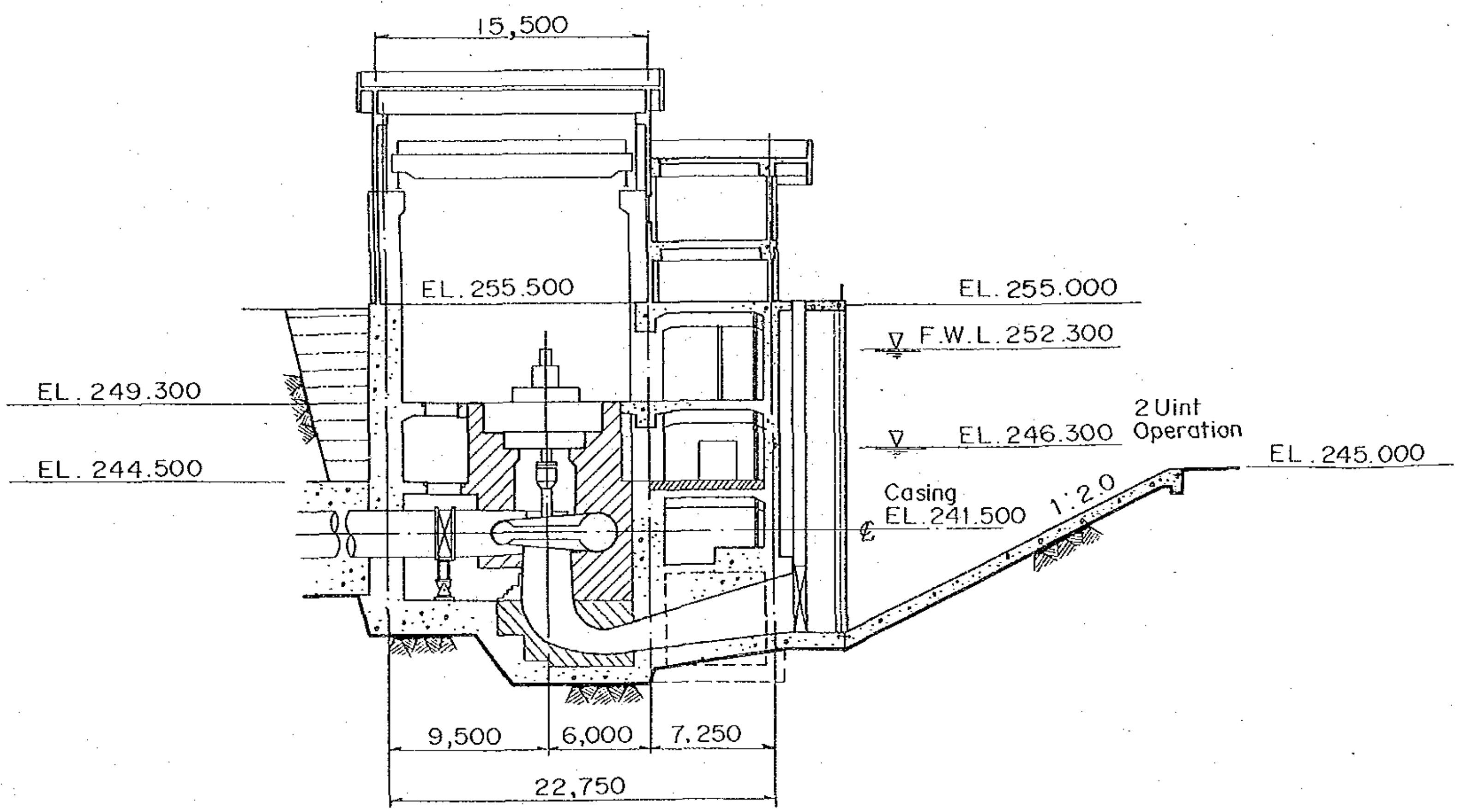
DWG. NO. 8



LONGITUDINAL SECTION (UNIT CENTER)



LONGITUDINAL SECTION (DOWN STREAM FACE)



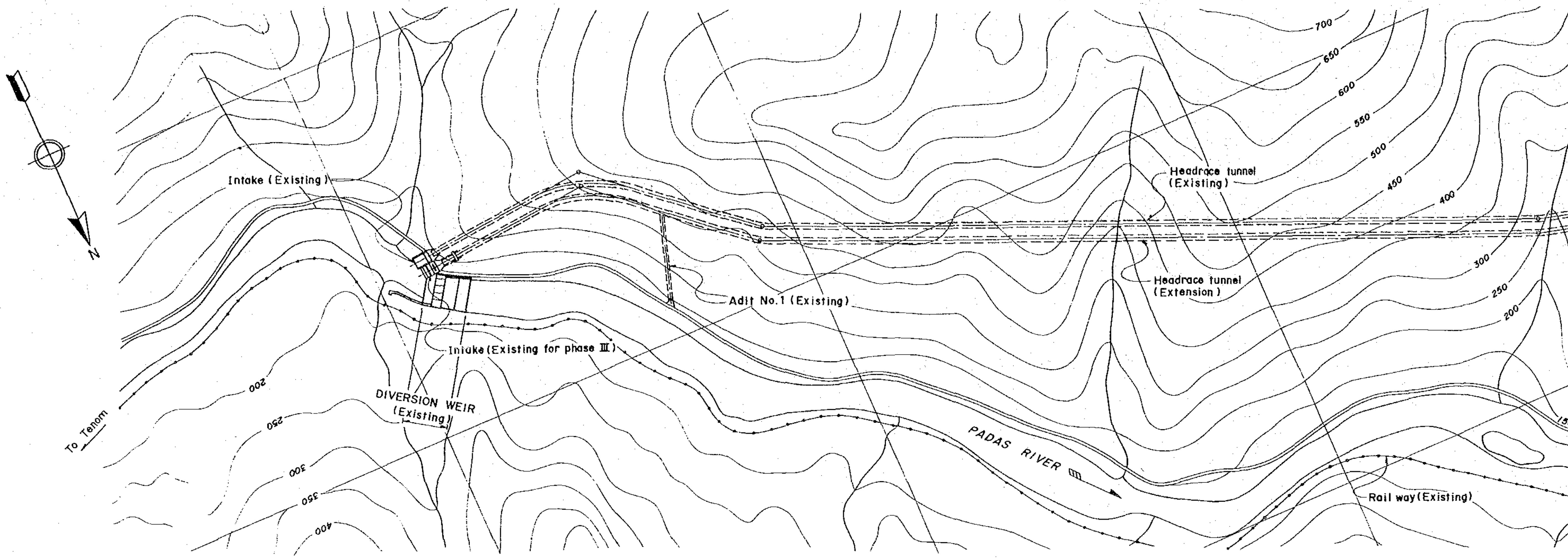
TRANSVERSE SECTION

SCALE 0 20m (1 : 400)

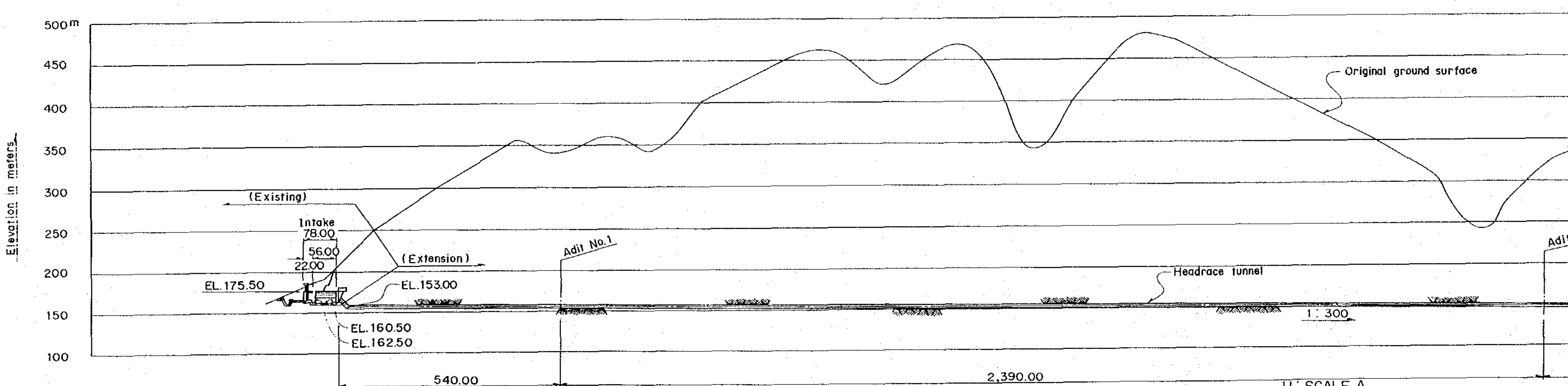
TENOM PANGI PHASE III

SOOK SITE
POWERHOUSE
FLOOR PLAN AND
TRANSVERS SECTION

SEB / JICA



PLAN SCALE A

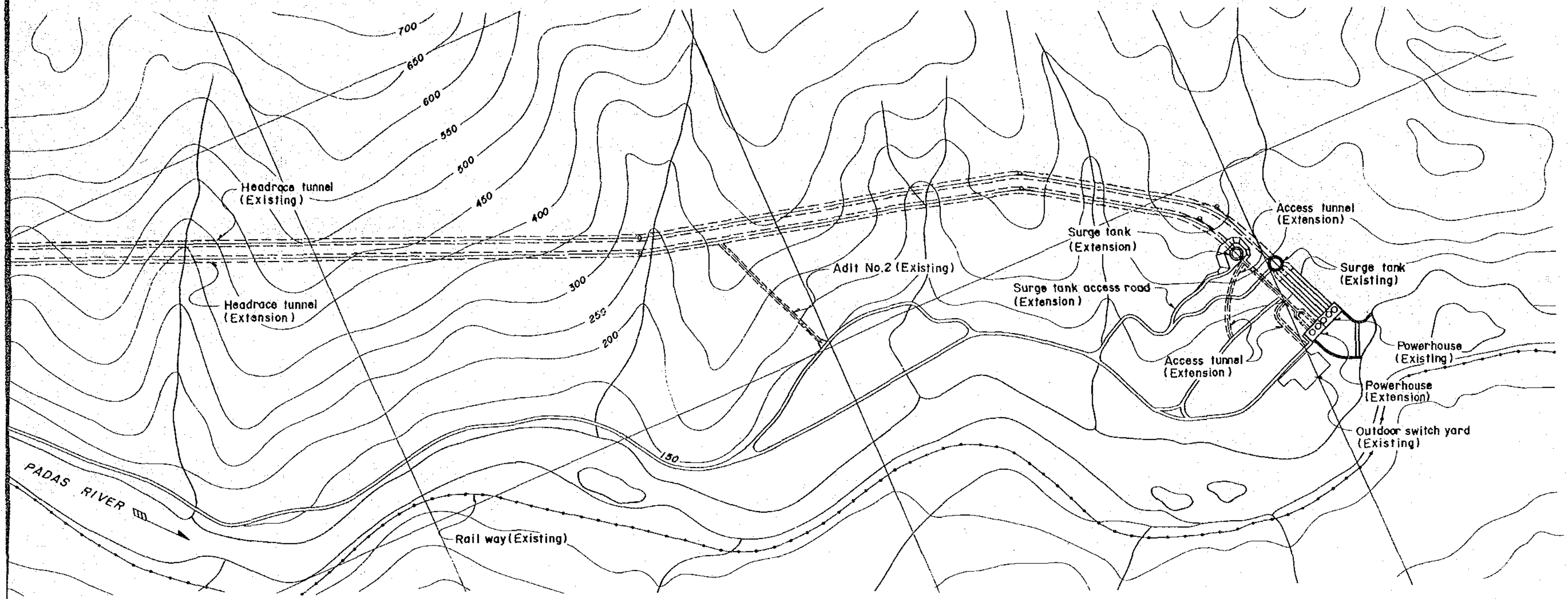


PROFILE H: SCALE A V: SCALE B

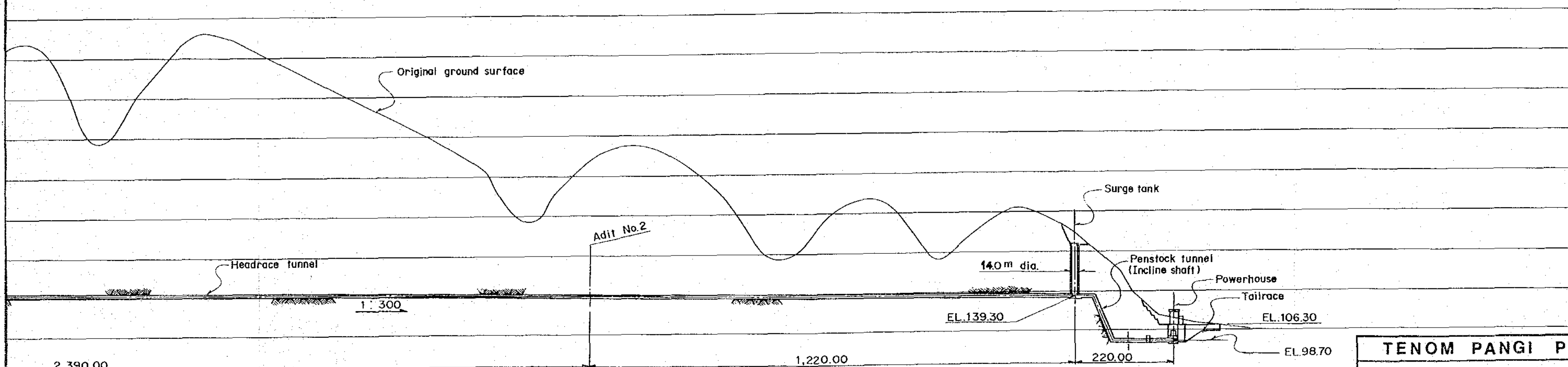
SCALE A 0 500m (1 : 10,000)

SCALE B 0 250m (1 : 5,000)

DWG. NO. : 9

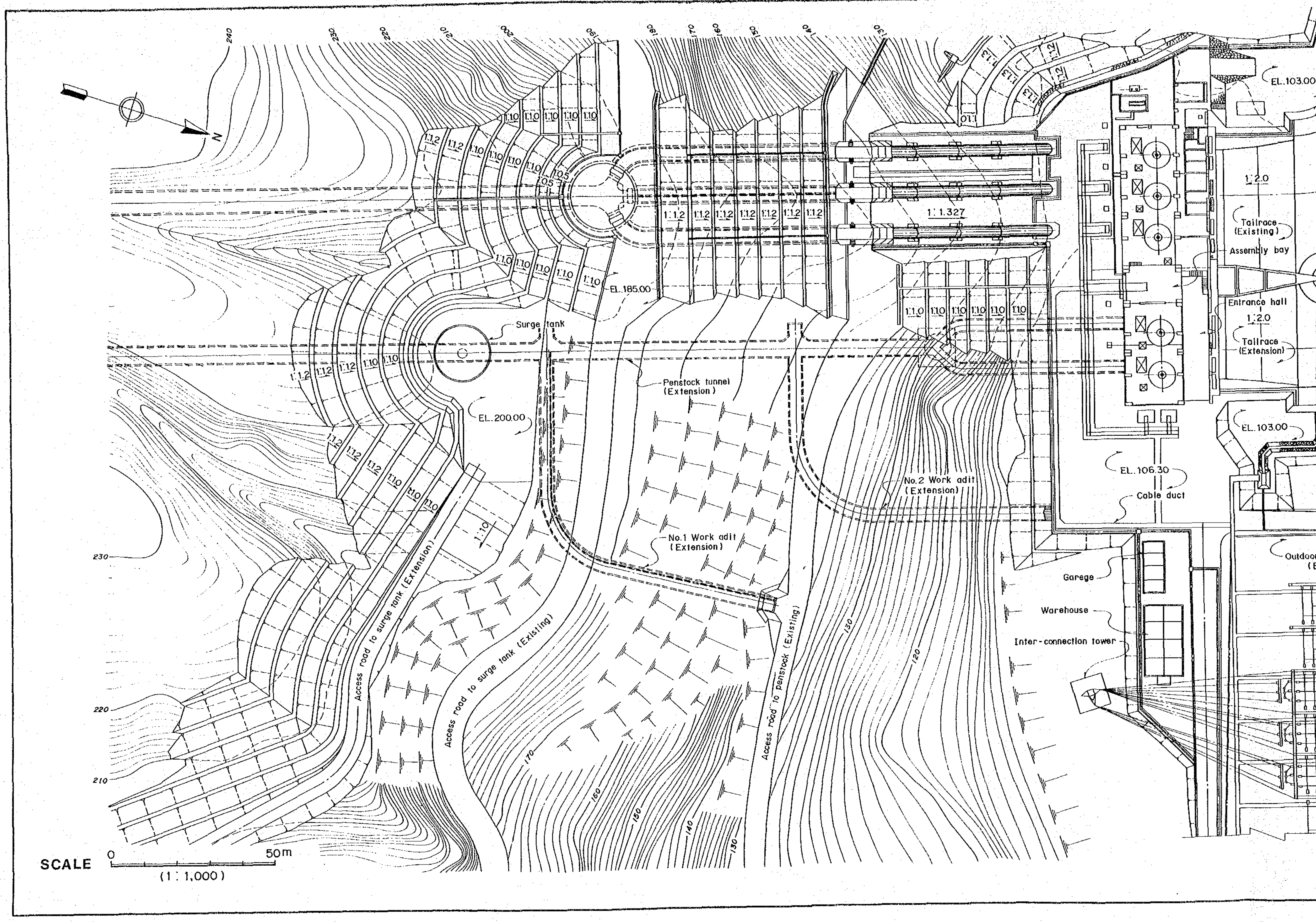


PLAN SCALE A

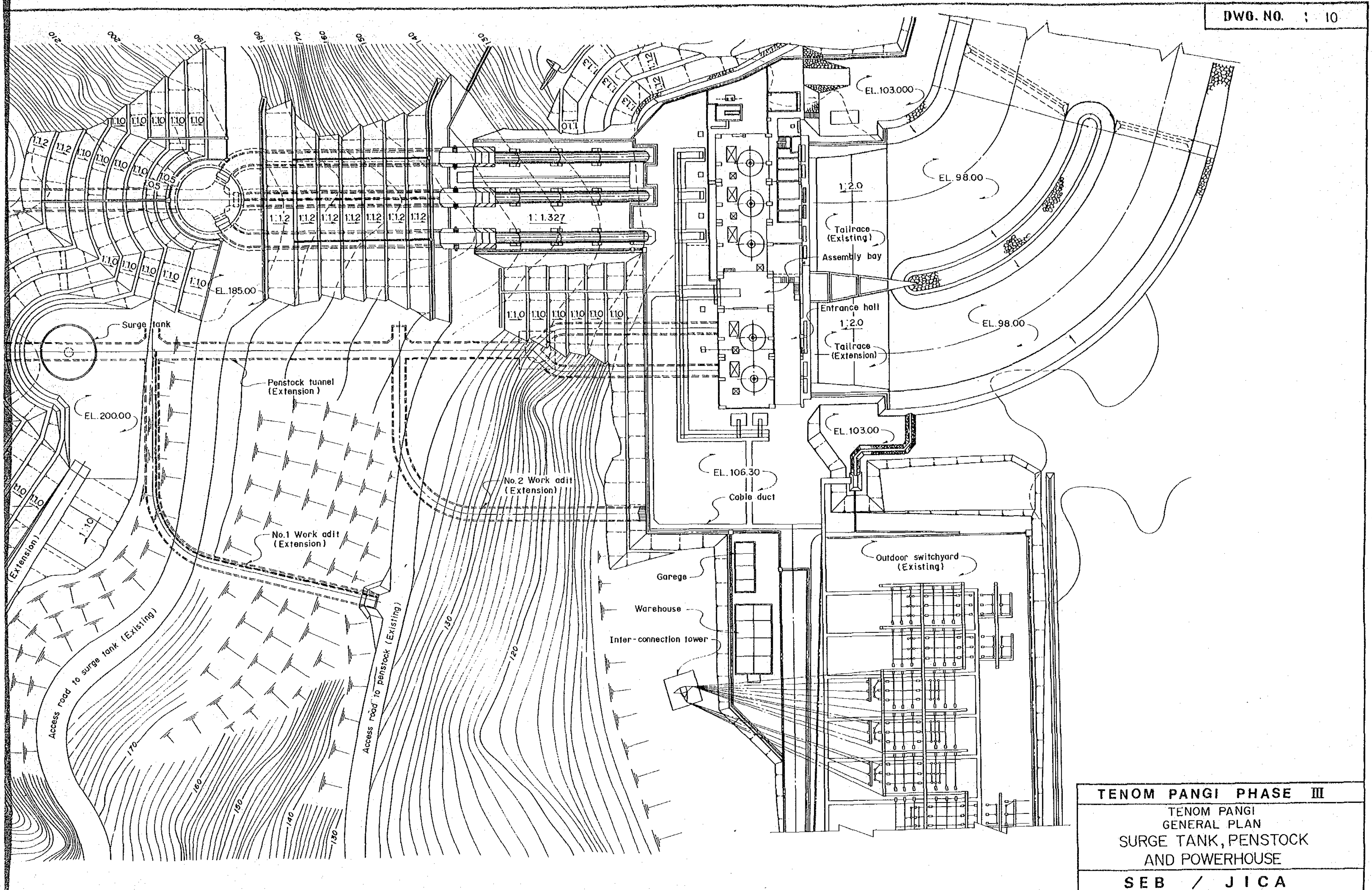


PROFILE H: SCALE A V: SCALE B

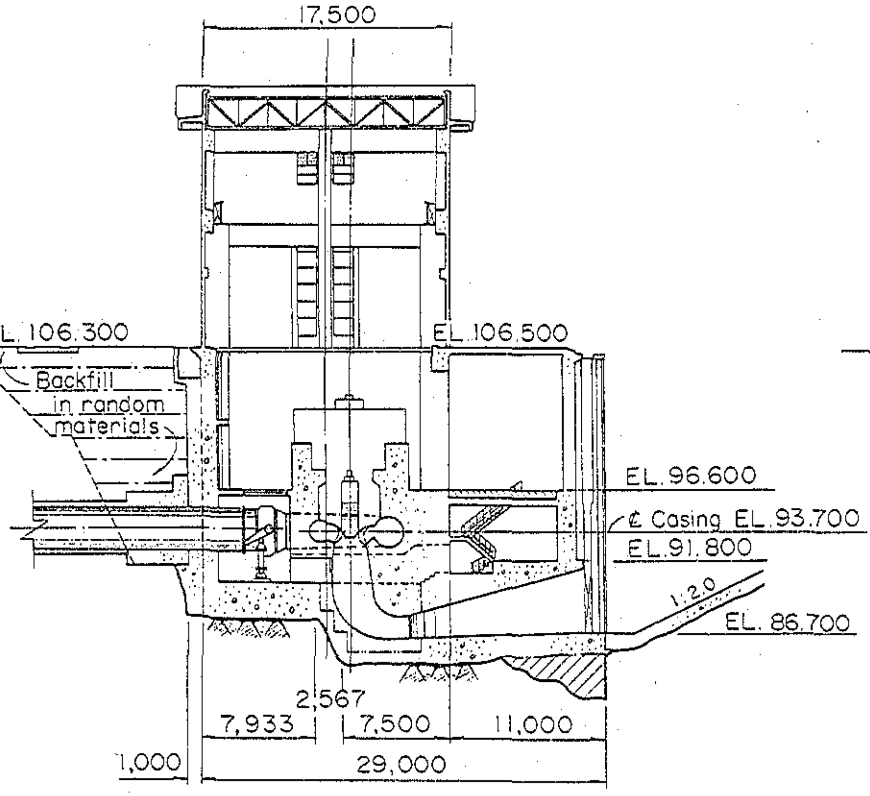
TENOM PANGI PHASE III
TENOM PANGI GENERAL
GENERAL LAYOUT
SEB / JICA



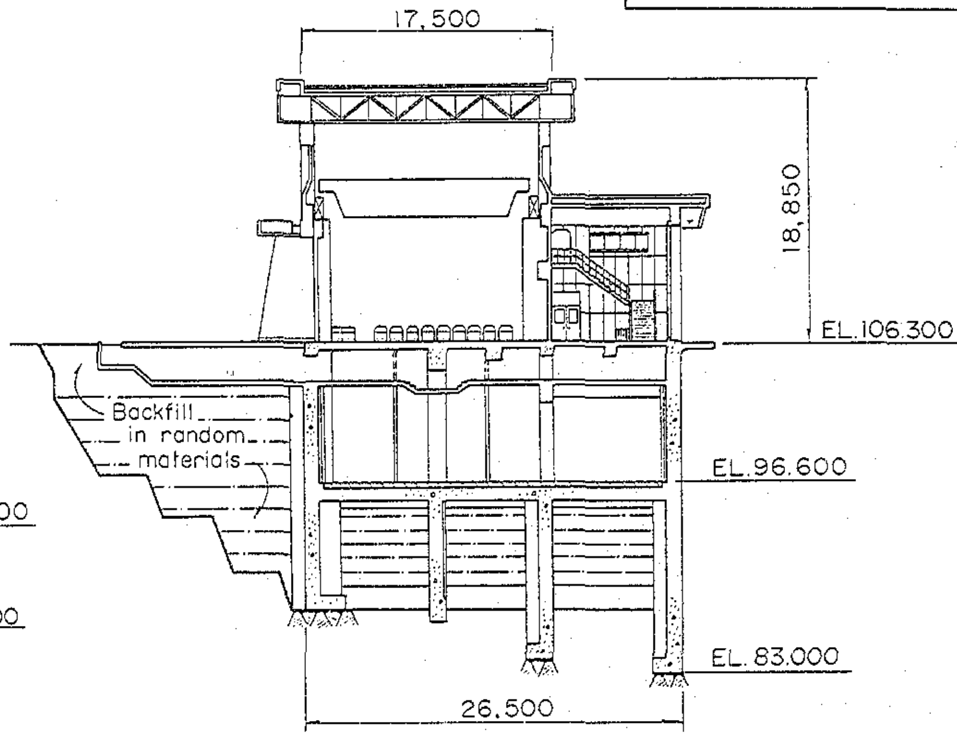
N
Surge tank
EL. 185.00
EL. 200.00
Penstock tunnel (Extension)
No.1 Work adit (Extension)
No.2 Work adit (Extension)
Access road to surge tank (Extension)
Access road to surge tank (Existing)
Access road to penstock (Existing)
1:1.327
EL. 103.00
Tailrace (Existing)
Assembly bay
Entrance hall
Tailrace (Extension)
EL. 106.30
Cable duct
Garege
Warehouse
Inter-connection tower
SCALE
0
50m
(1 : 1,000)


DWG. NO. : 10
EL.103.000
EL. 98.00
1:2.0
Tailrace (Existing)
Assembly bay
Entrance hall
EL. 98.00
1:2.0
Tailrace (Extension)
EL.103.00
EL. 106.30
Cable duct
Outdoor switchyard (Existing)
Garege
Warehouse
Inter-connection tower
1:1.327
EL.185.00
Surge tank
Penstock tunnel (Extension)
EL.200.00
No.2 Work adit (Extension)
No.1 Work adit (Extension)
Access road to surge tank (Existing)
Access road to penstock (Existing)
(Extension)
TENOM PANGI PHASE III
TENOM PANGI
GENERAL PLAN
SURGE TANK, PENSTOCK
AND POWERHOUSE
SEB / JICA

DWG. NO. : 11



Unit center



Assembly bay

SCALE 0 25m (1:500)

TENOM PANGI PHASE III

TENOM PANGI POWERHOUSE

TRANSVERSE SECTIONS

SEB / JICA

JICA