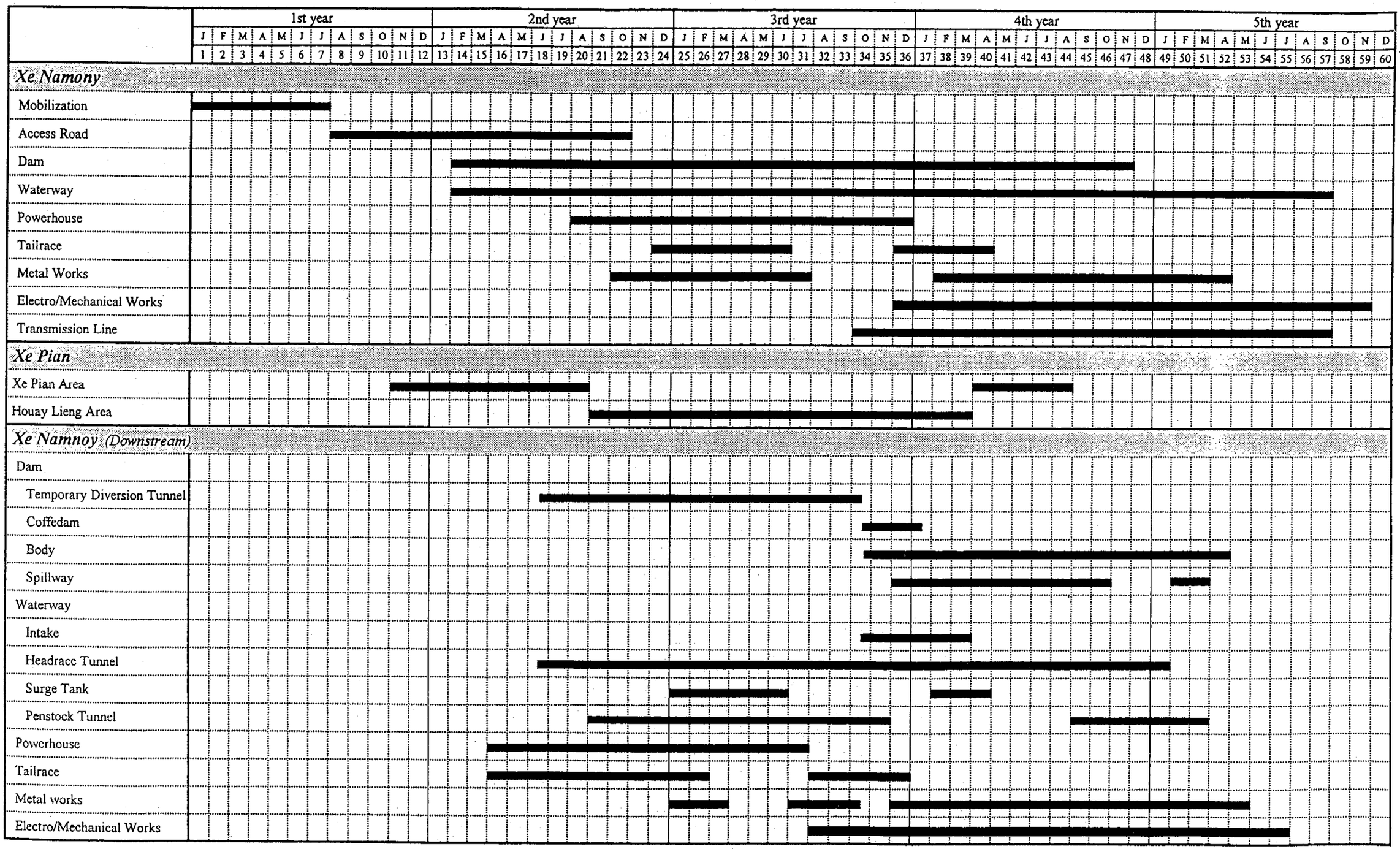
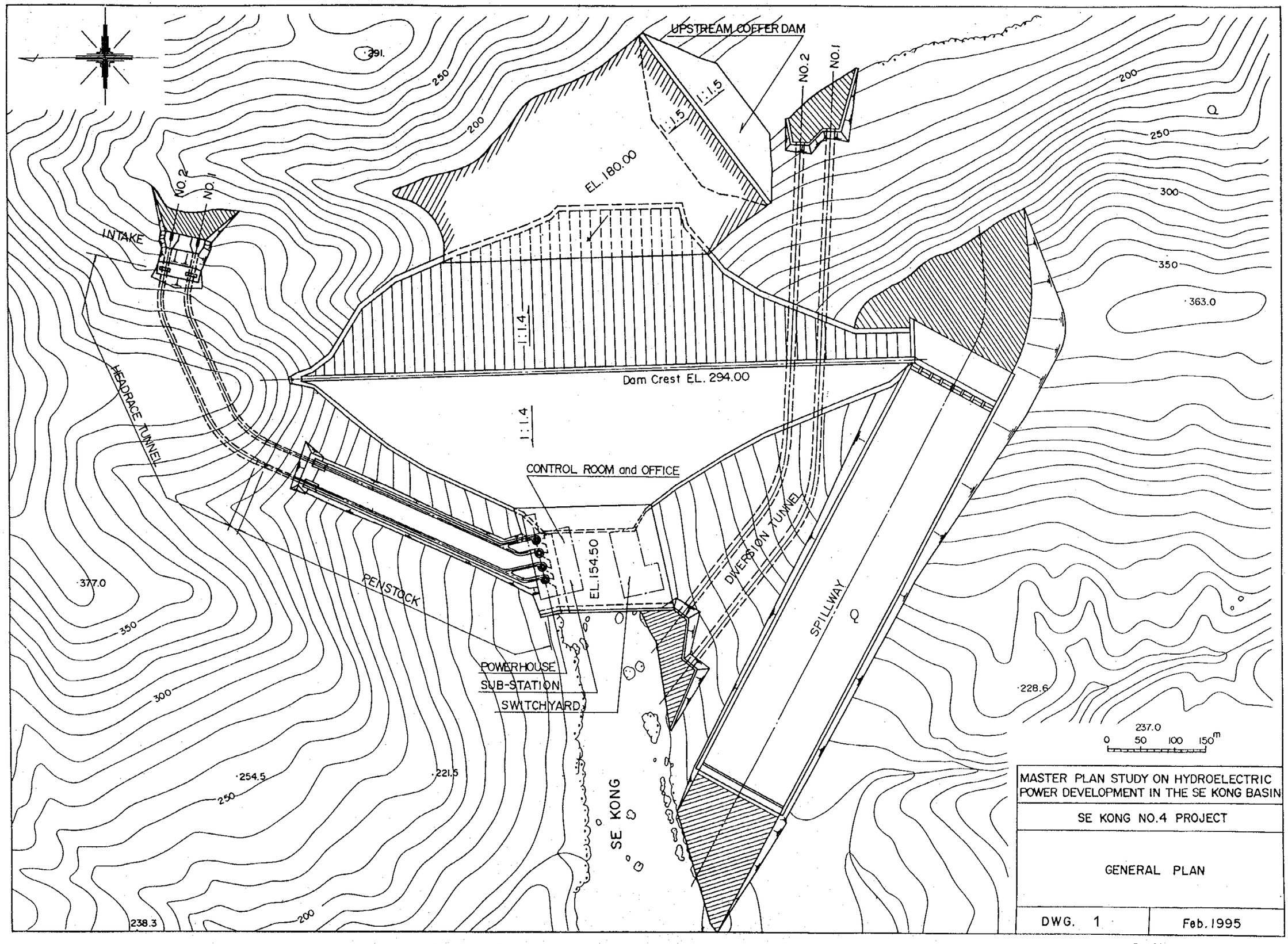
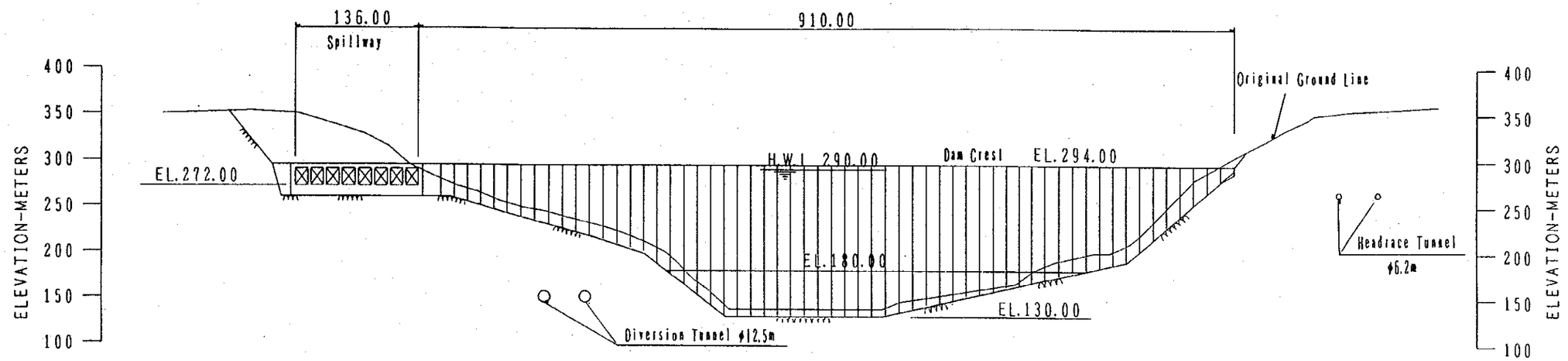
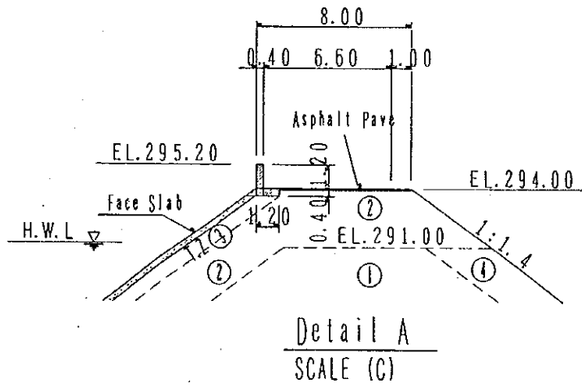
Fig. 5 Construction Schedule of Xe Namnoy Midstream and Downstream Project



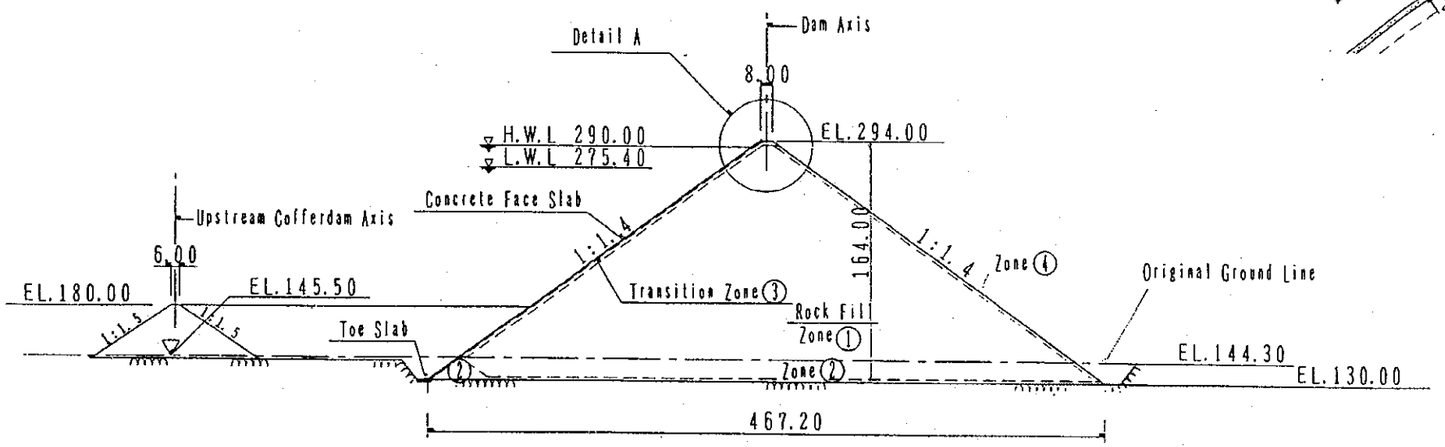

UPSTREAM COFFER DAM
NO.2
NO.1
1:1.5
1:1.5
EL. 180.00
INTAKE
NO.2
NO.1
1:1.4
Dam Crest EL. 294.00
1:1.4
CONTROL ROOM and OFFICE
HEADRACE TUNNEL
EL. 154.50
DIVERSION TUNNEL
PENSTOCK
SPILLWAY
POWERHOUSE
SUB-STATION
SWITCHYARD
SE KONG
377.0
350
300
254.5
250
238.3
200
221.5
228.6
237.0
0 50 100 150m
MASTER PLAN STUDY ON HYDROELECTRIC POWER DEVELOPMENT IN THE SE KONG BASIN
SE KONG NO.4 PROJECT
GENERAL PLAN
DWG. 1
Feb. 1995



ELEVATION ALONG DAM AXIS
SCALE (A)



Detail A
SCALE (C)



SECTION OF CONCRETE FACED ROCKFILL DAM
SCALE (B)

SCALE(A) 0 50 100m
SCALE(B) 0 50 100m
SCALE(C) 0 5 10m

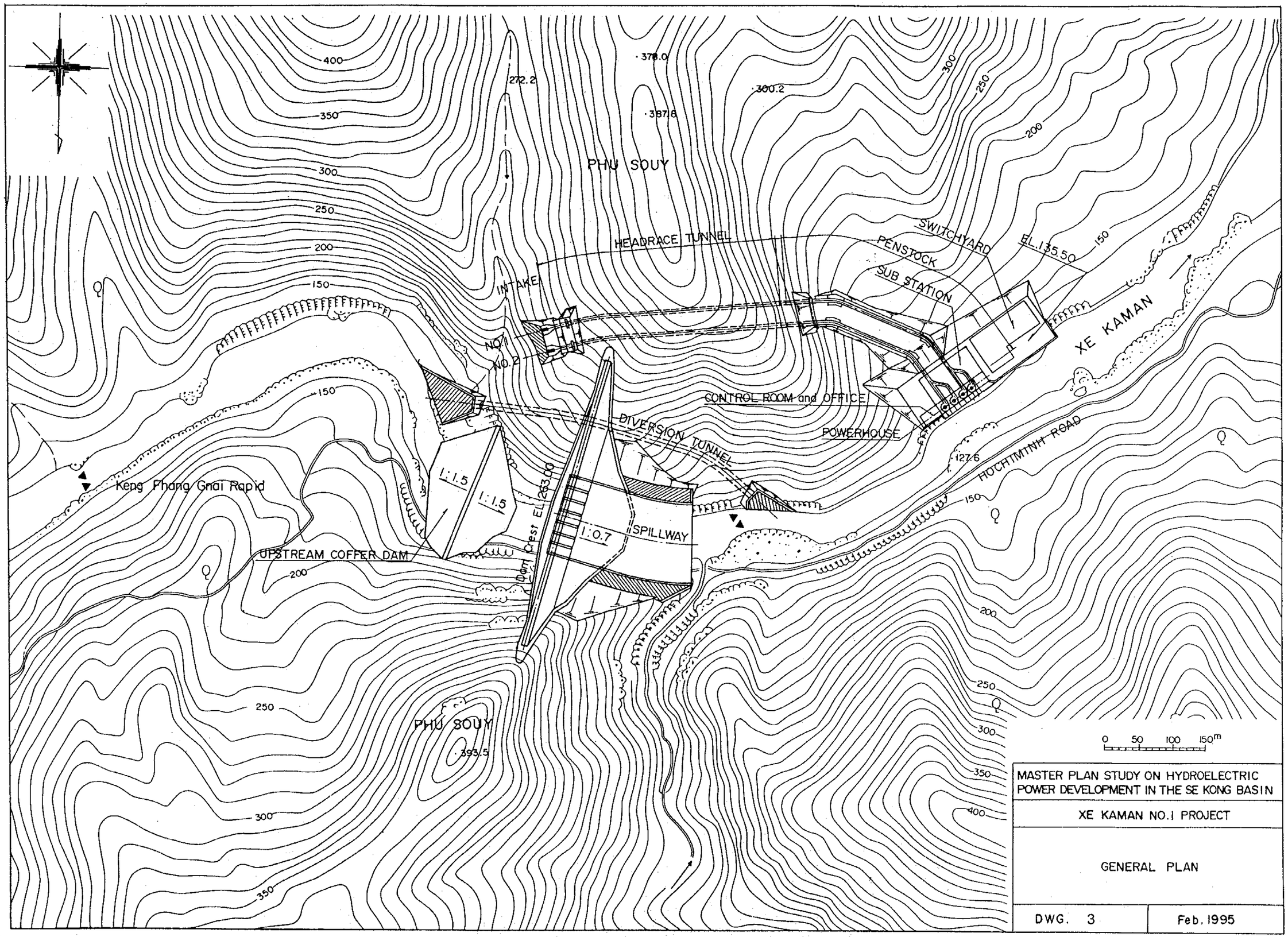
MASTER PLAN STUDY ON HYDROELECTRIC POWER DEVELOPMENT IN THE SE KONG BASIN

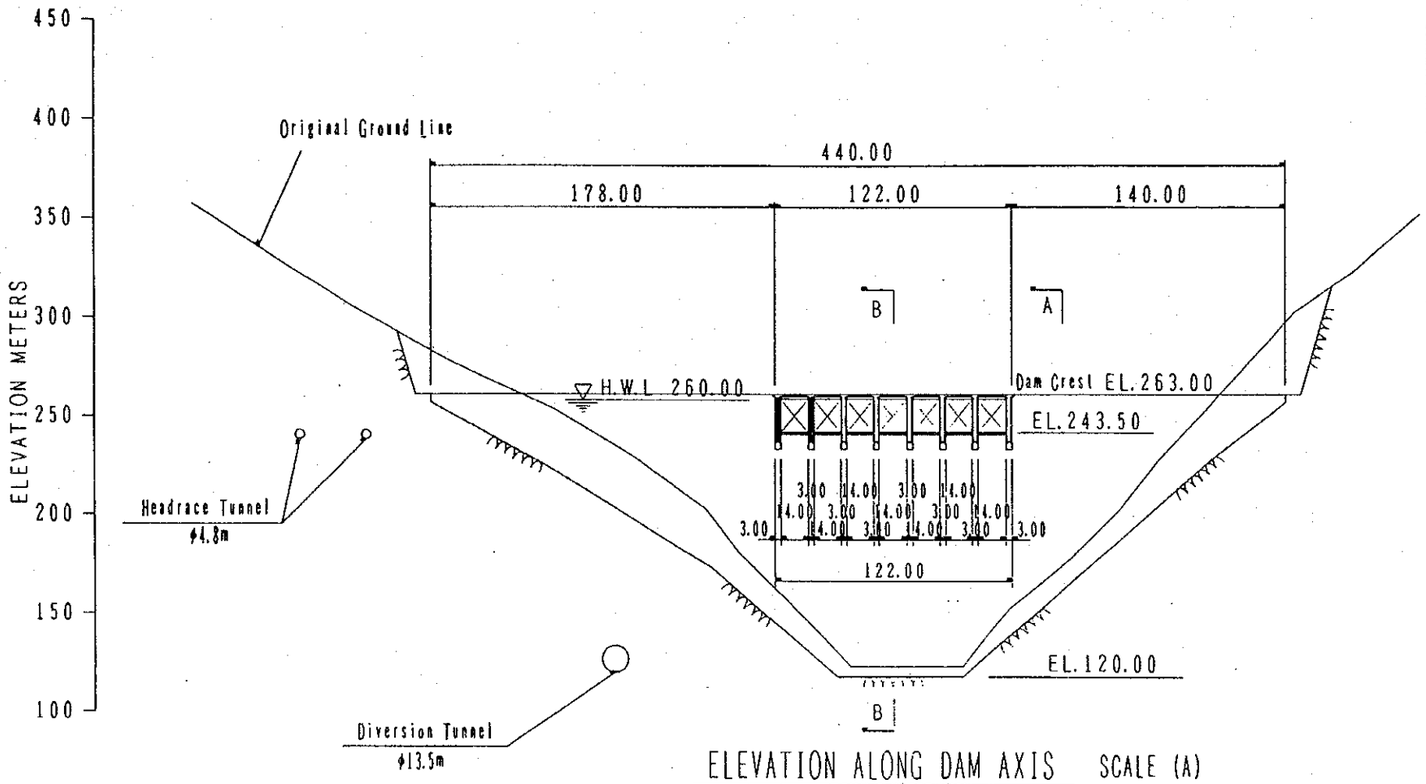
SE KONG NO. 4 PROJECT

DAM

ELEVATION AND SECTIONS

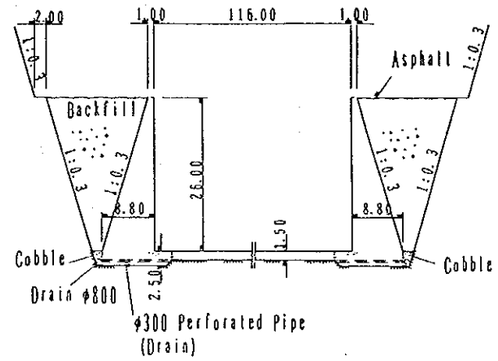
DWG. 2 | Feb. 1995


PHU SOUY
272.2
378.0
300.2
387.8
HEADRACE TUNNEL
PENSTOCK
SWITCHYARD
EL. 135.50
SUB STATION
INTAKE
NO.1
NO.2
XE KAMAN
CONTROL ROOM and OFFICE
POWERHOUSE
DIVERSION TUNNEL
HOCHIMINH ROAD
127.6
Keng Phang Gnai Rapid
1:1.5
1:1.5
1:0.7
SPILLWAY
283.00
UPSTREAM COFFER DAM
PHU SOUY
393.5
400
350
300
250
200
150
0 50 100 150m
MASTER PLAN STUDY ON HYDROELECTRIC POWER DEVELOPMENT IN THE SE KONG BASIN
XE KAMAN NO.1 PROJECT
GENERAL PLAN
DWG. 3
Feb. 1995



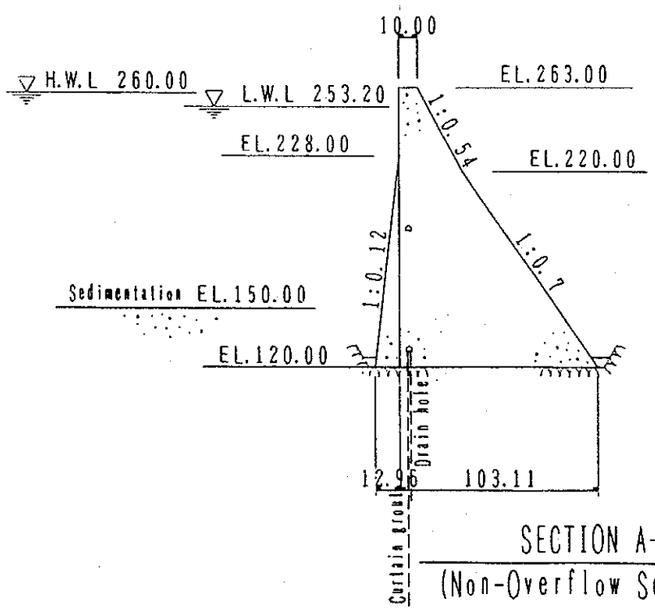
ELEVATION ALONG DAM AXIS SCALE (A)

(Upstream View)



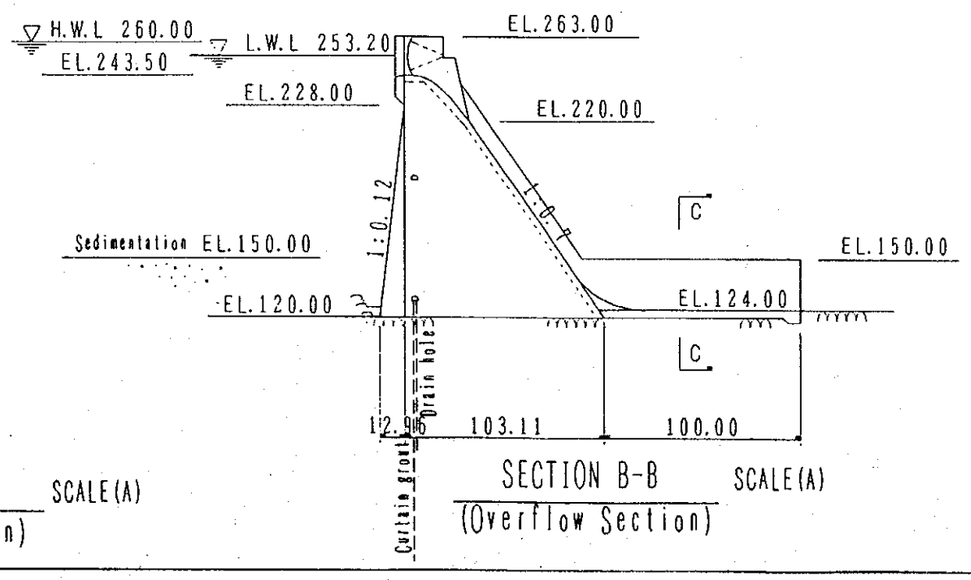
SECTION C-C

SCALE(B)



SECTION A-A SCALE(A)

(Non-Overflow Section)



SECTION B-B SCALE(A)

(Overflow Section)

SCALE(A) 0 50 100 150m

SCALE(B) 0 25 50m

MASTER PLAN STUDY ON HYDROELECTRIC POWER DEVELOPMENT IN THE SE KONG BASIN

XE KAMAN NO. 1 PROJECT

DAM

ELEVATION AND SECTIONS

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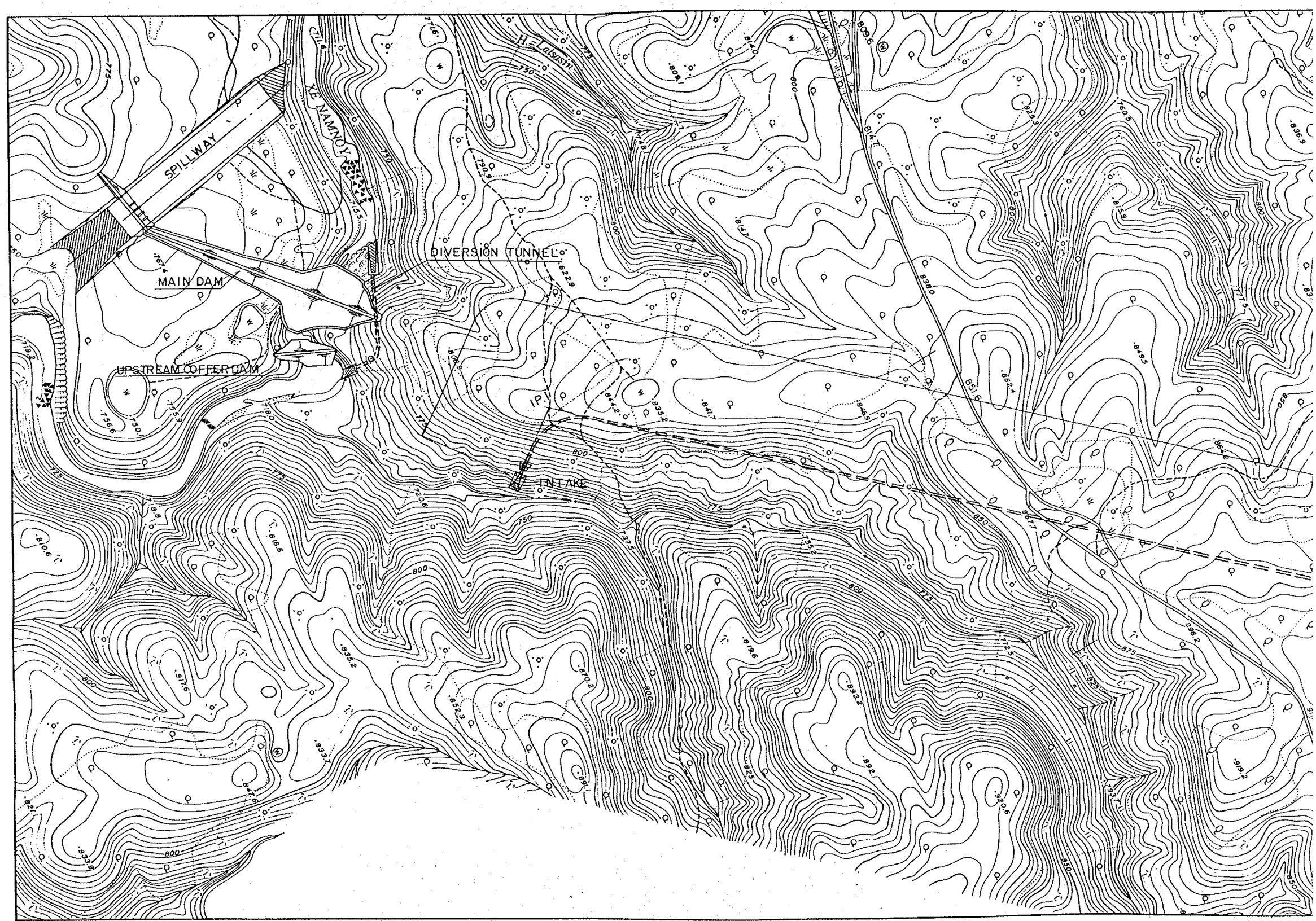
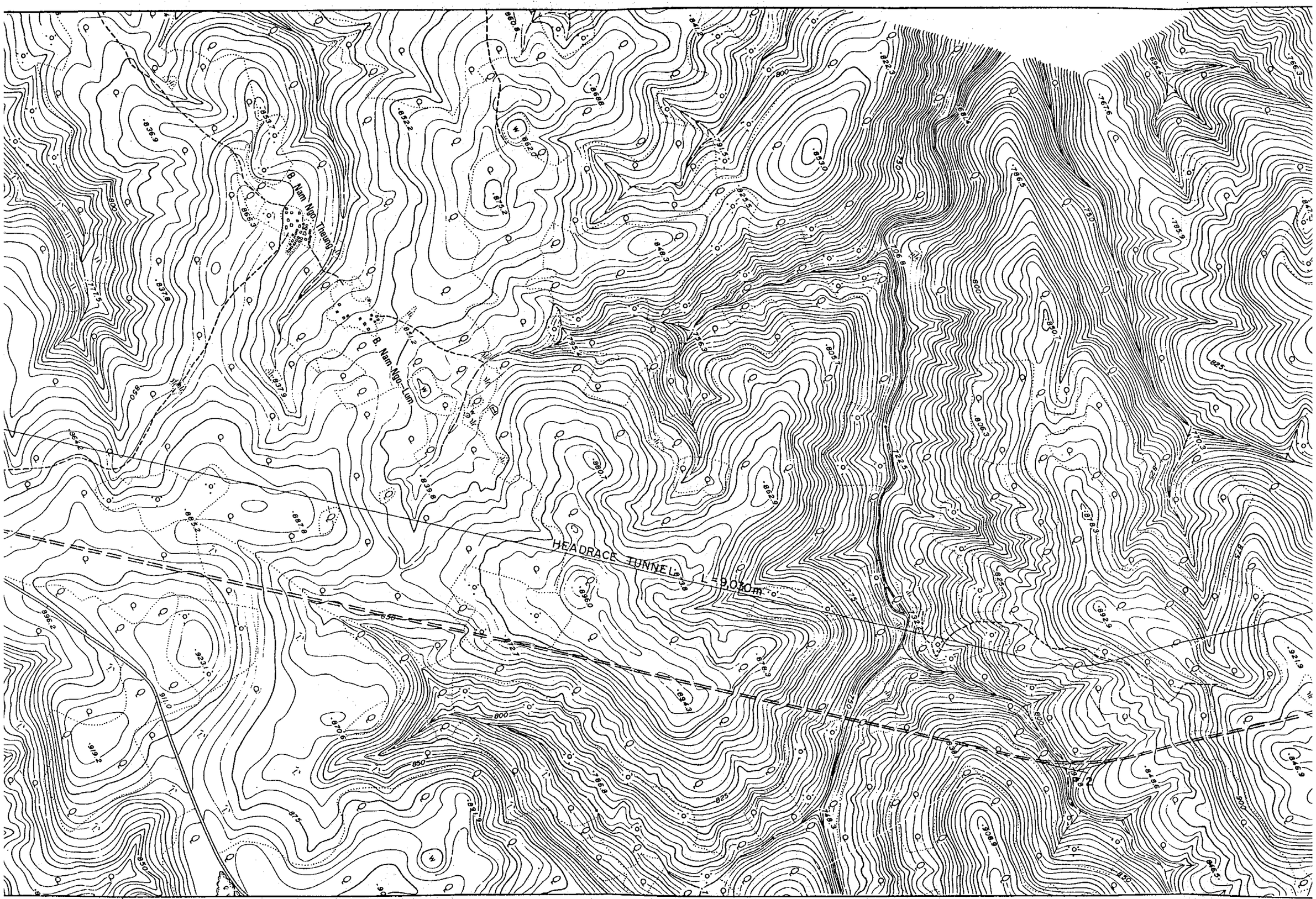
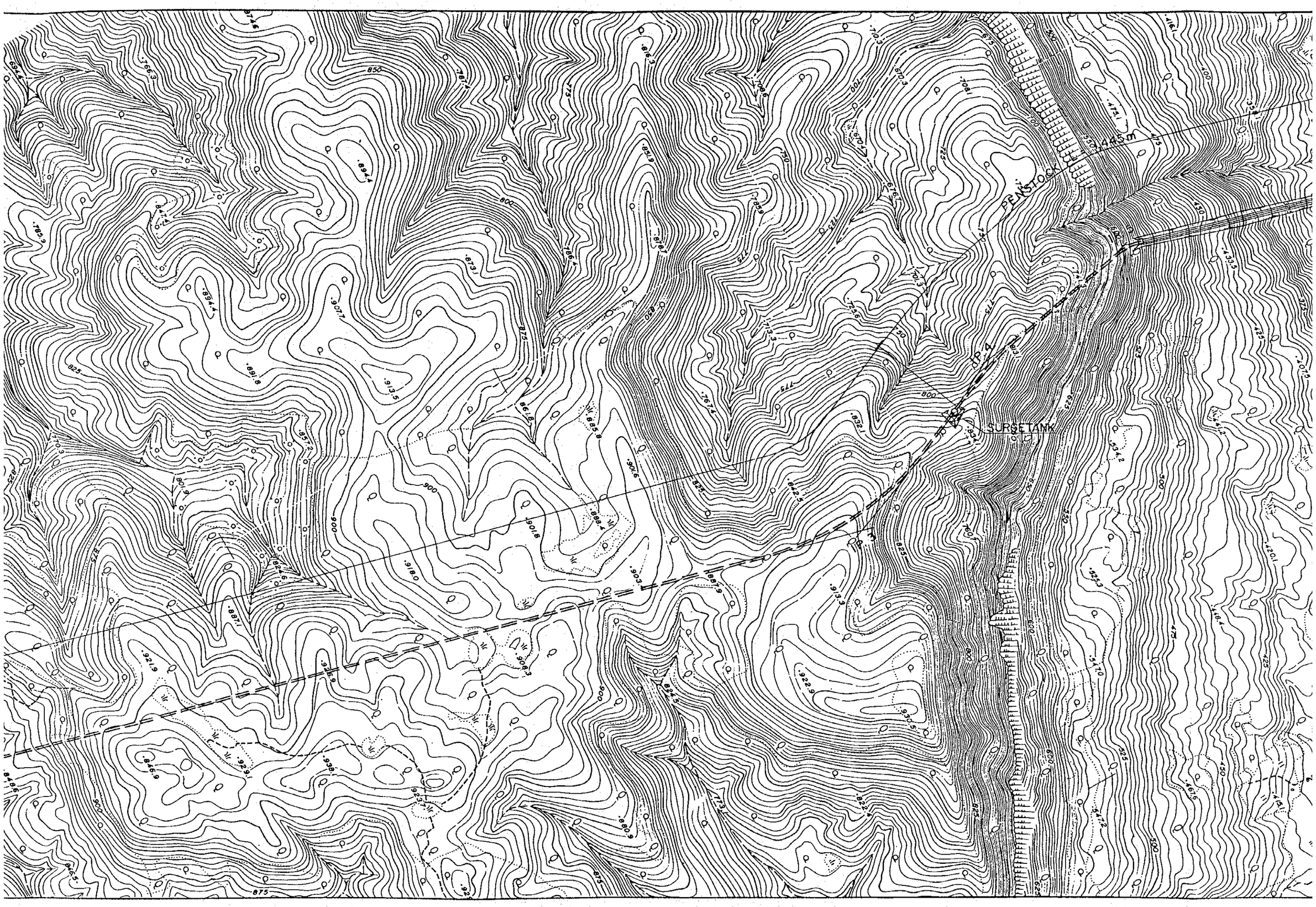
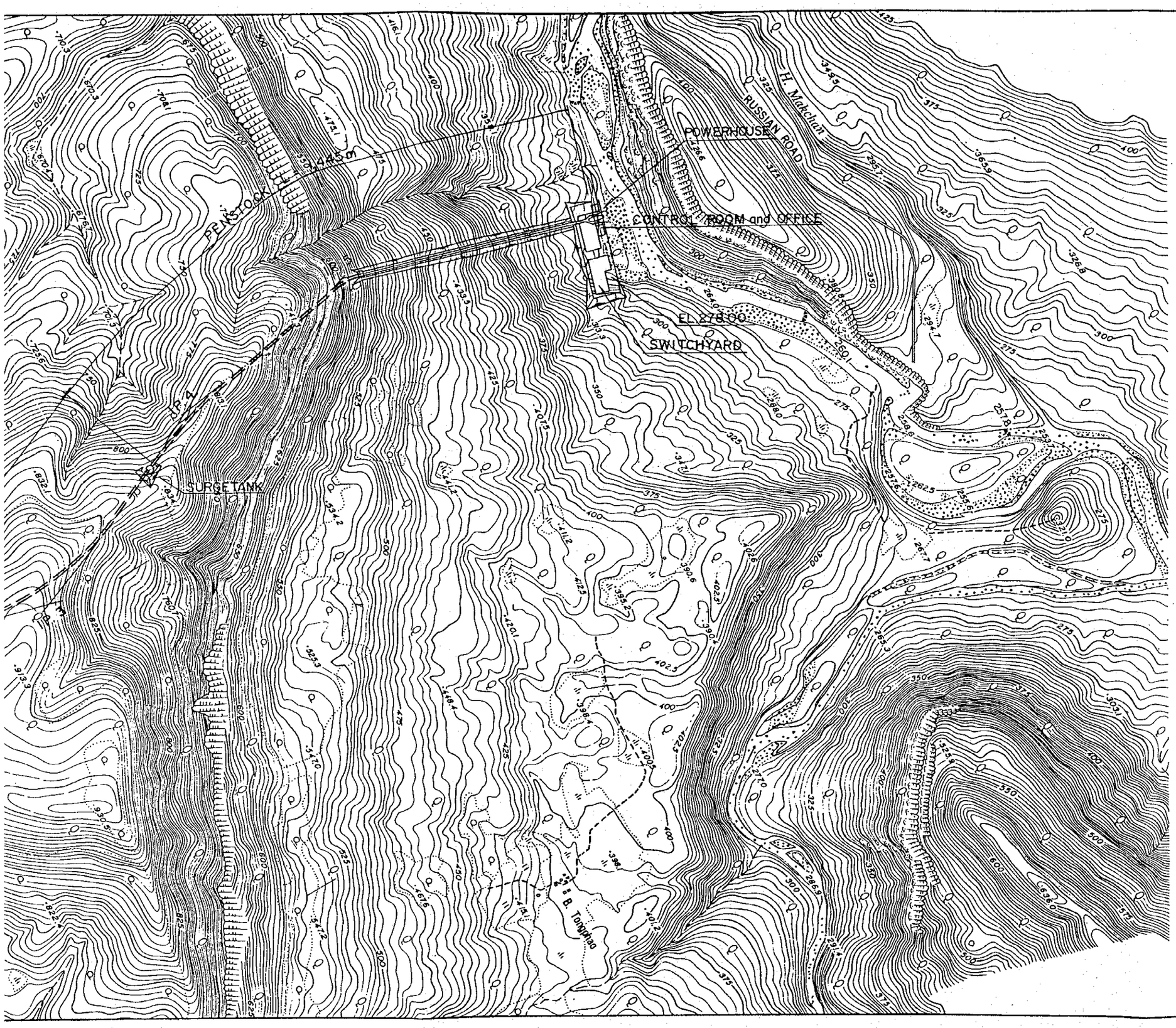

SPILLWAY
XE NAMNOY
H. Latsasin
DIVERSION TUNNEL
MAIN DAM
UPSTREAM COFFERDAM
IP
INTAKE

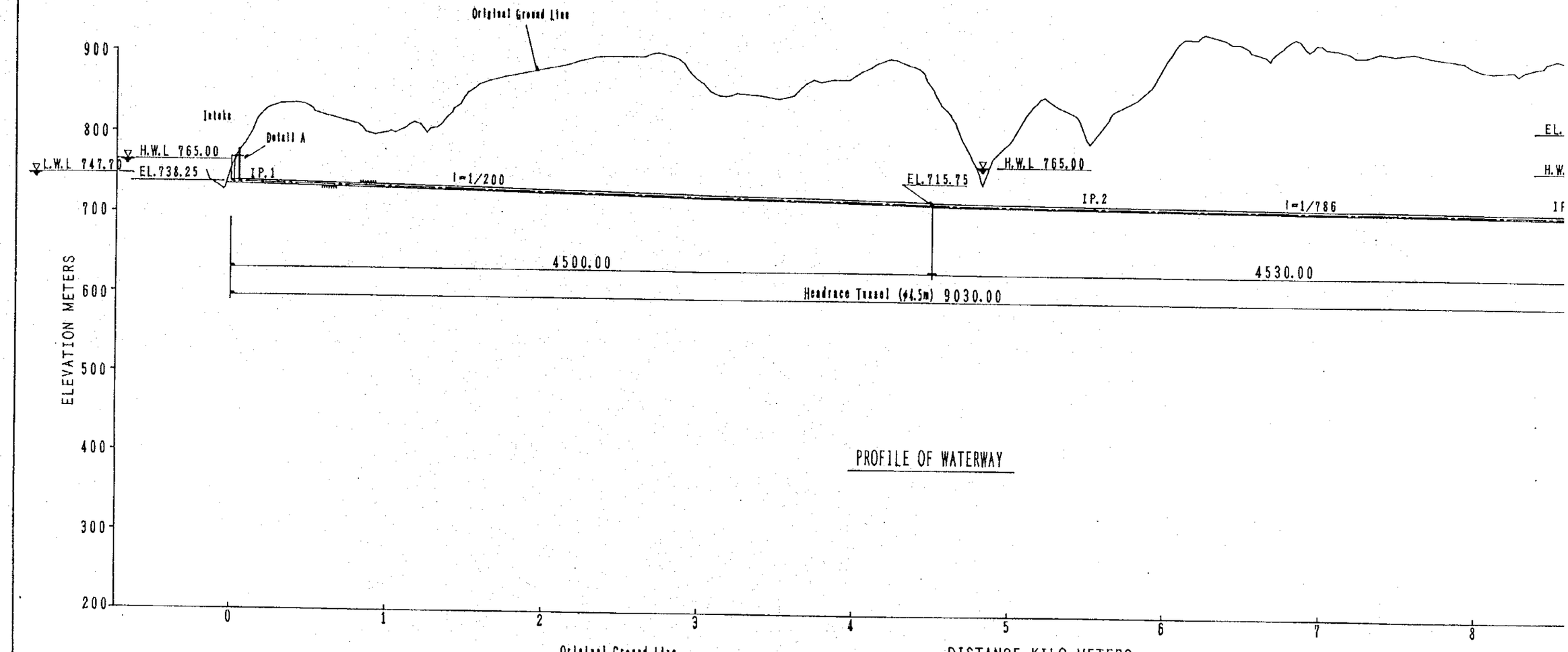

B. Nam Ngo Theung
B. Nam Ngo Lum
HEADRACE TUNNEL
L=9,030m


PENSTOCK
SURGE TANK
P-4

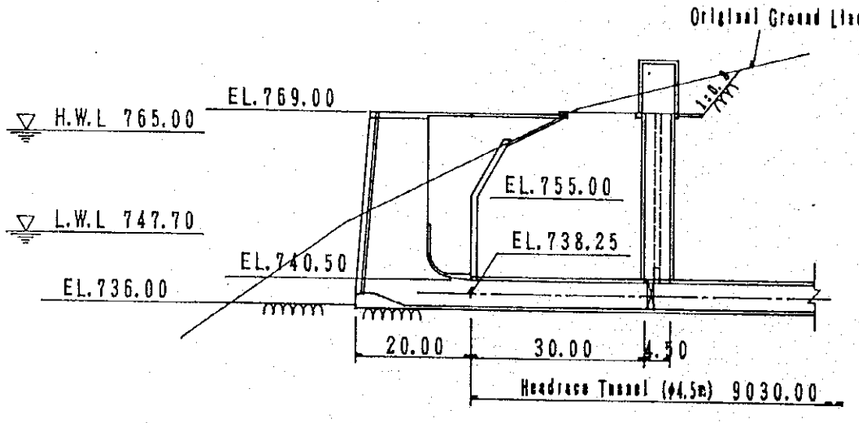


0 100 200 300m

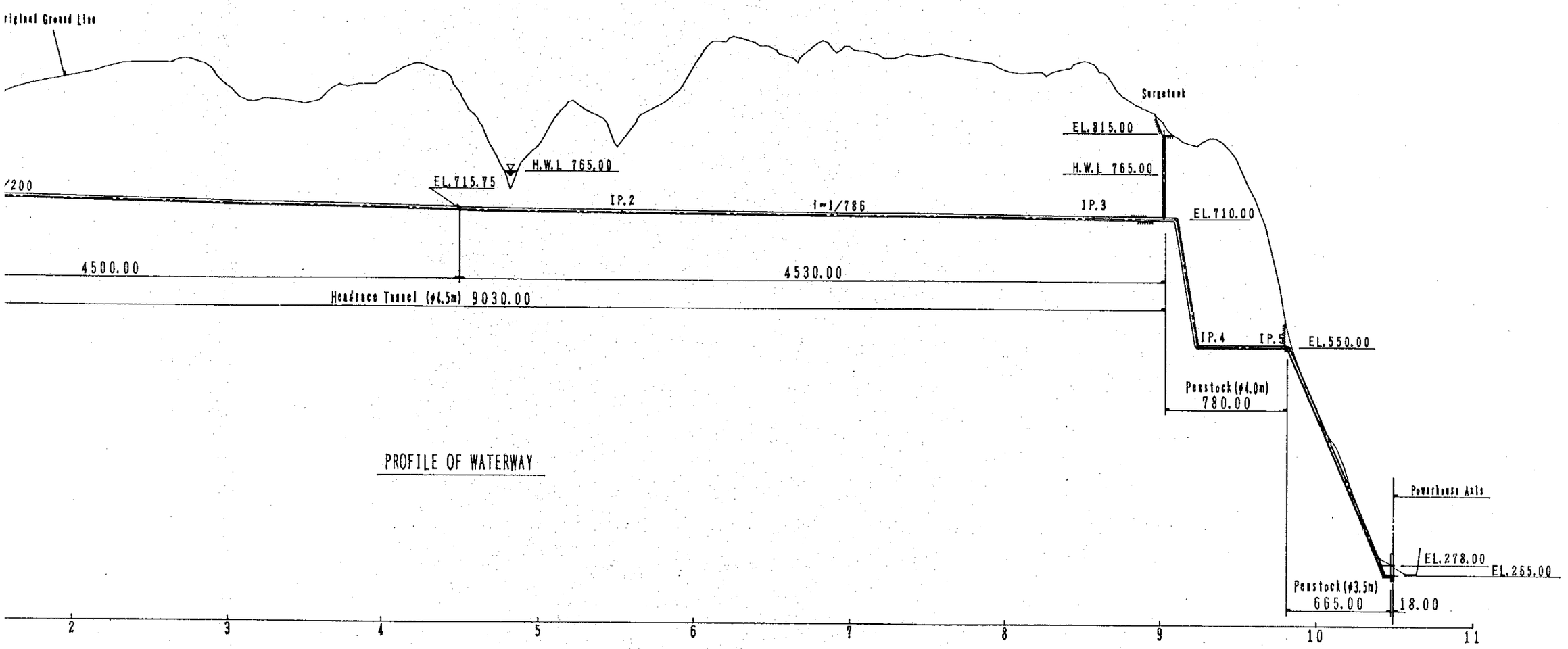
MASTER PLAN STUDY ON HYDROELECTRIC POWER DEVELOPMENT IN THE SE KONG BASIN	
XE NAMNOY MIDSTREAM PROJECT	
GENERAL PLAN	
DWG. 5	Feb. 1995



PROFILE OF WATERWAY



Detail A
SCALE (A)



PROFILE OF WATERWAY

SCALE(A) 0 25 50m

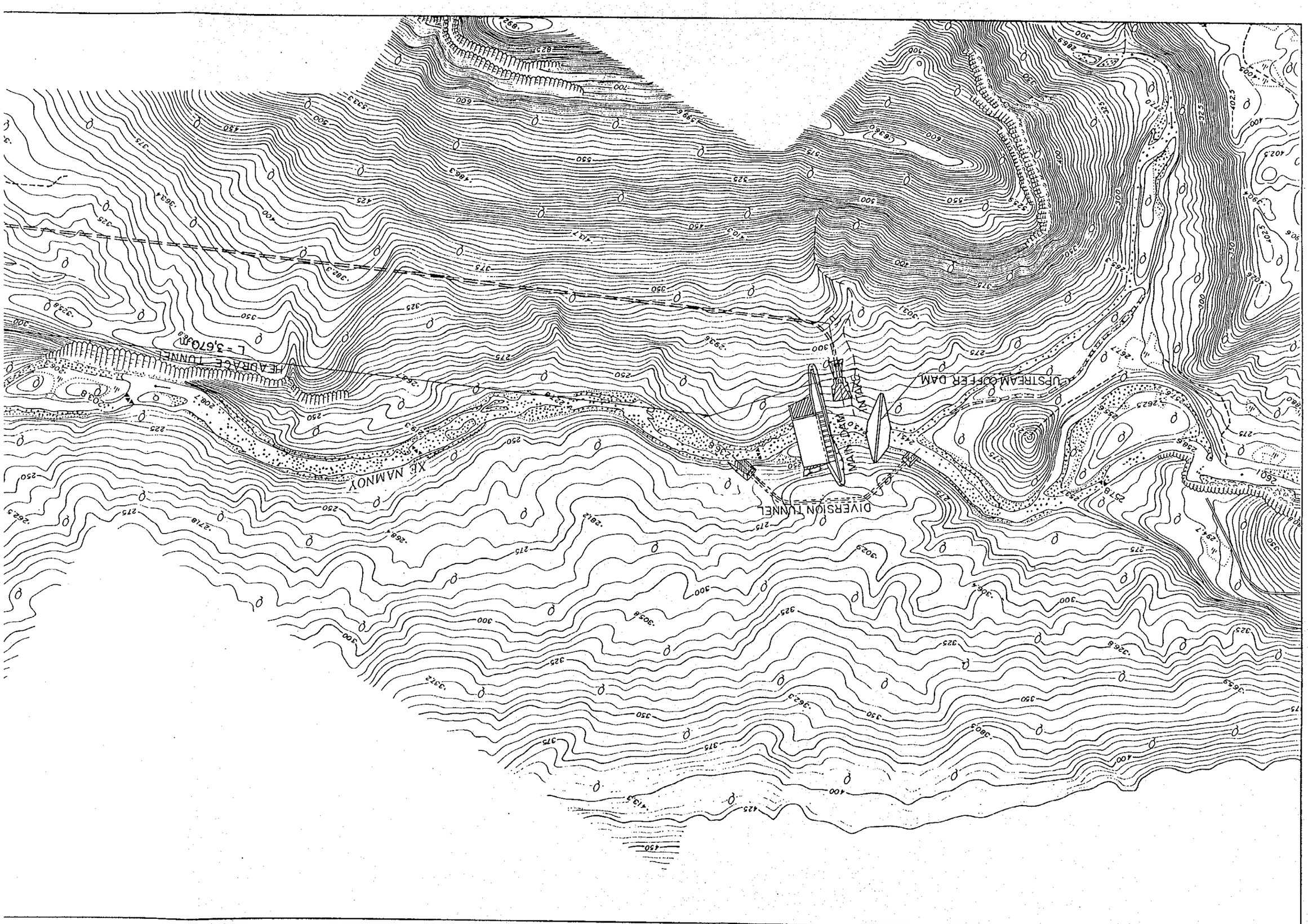
MASTER PLAN STUDY ON HYDROELECTRIC POWER DEVELOPMENT IN THE SE KONG BASIN

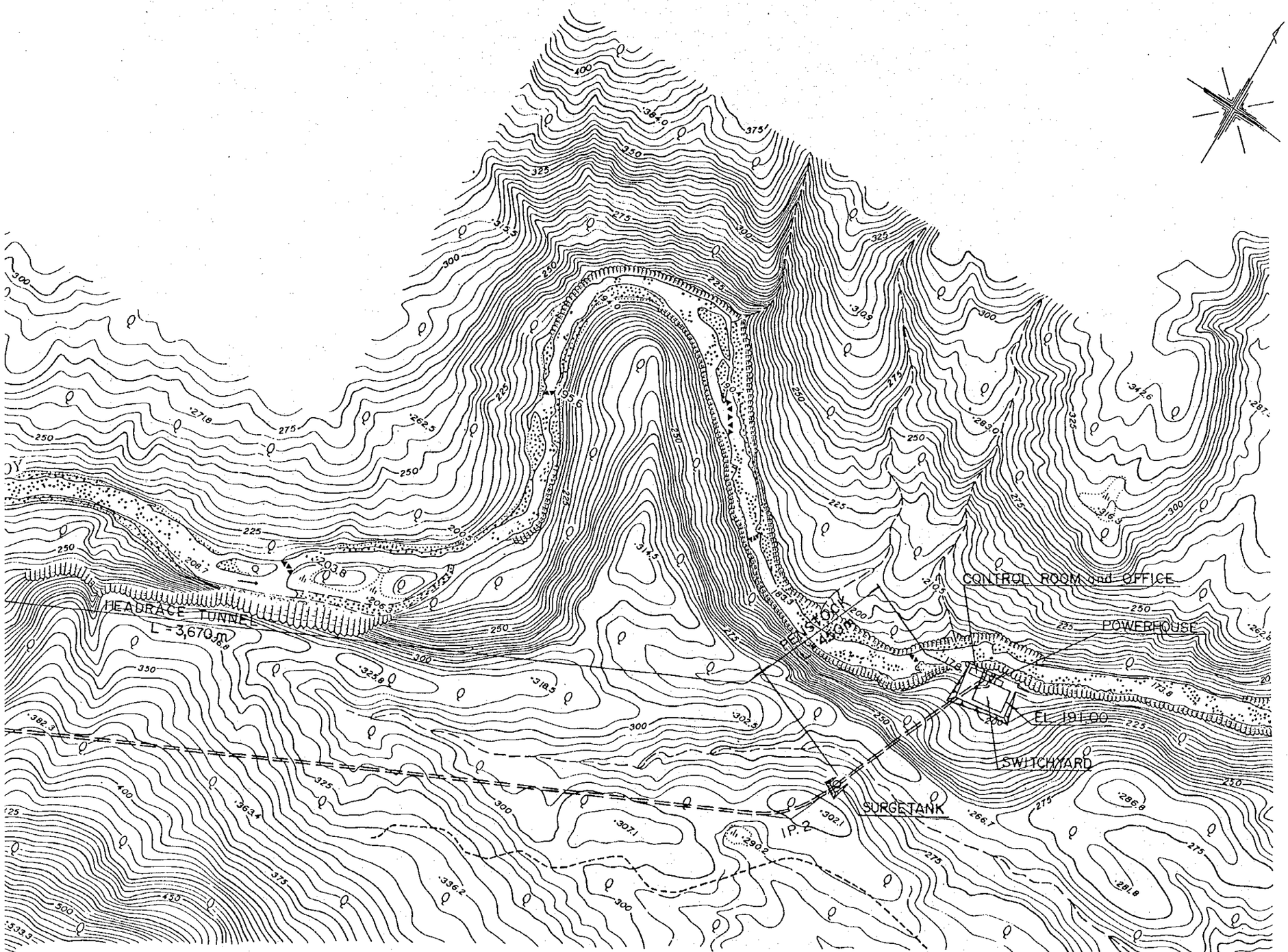
XE NAMNOY MIDSTREAM PROJECT

WATERWAY

PROFILE AND SECTION

DWG. 6 | Feb. 1995


HEADRACE TUNNEL
L = 3,670 ft
XE NAMNOY
UPSTREAM COFFER DAM
MAIN DAM
DIVERSION TUNNEL



MASTER PLAN STUDY HYDROELECTRIC POWER DEVELOPMENT IN THE SE KONG BASIN

XE NAMNOY DOWNSTREAM PROJECT

GENERAL PLAN

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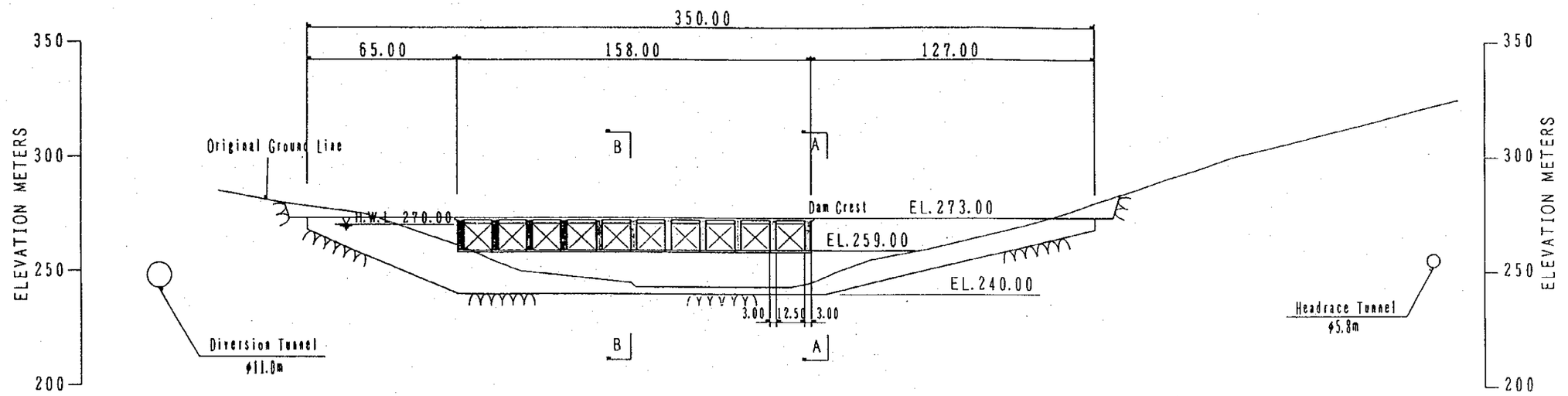
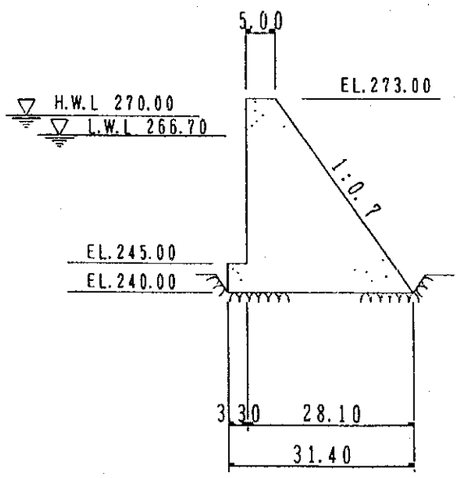


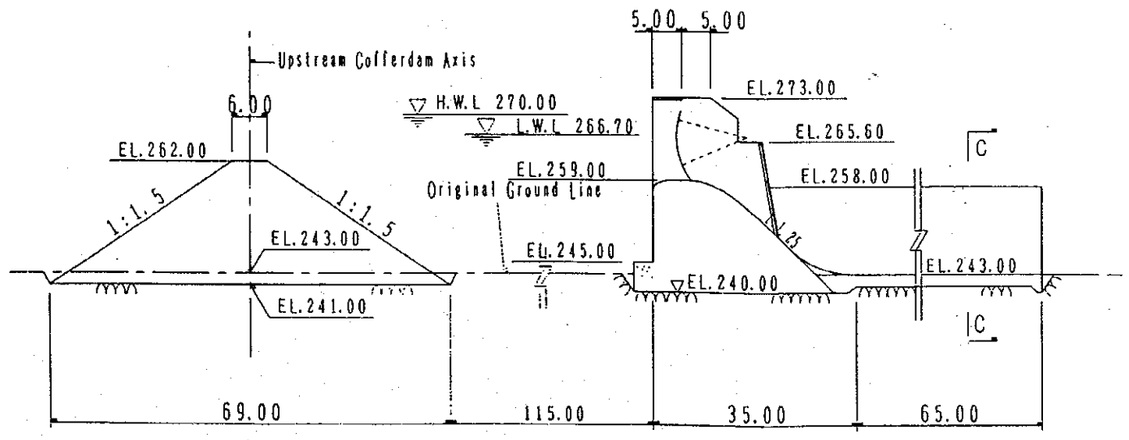
ELEVATION ALONG DAM AXIS SCALE (A)

(Upstream View)



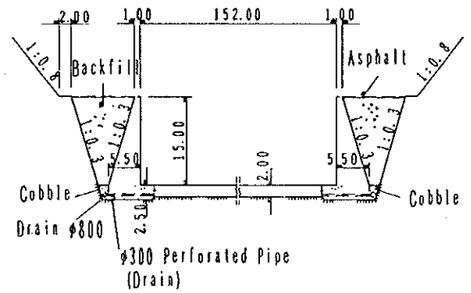
SECTION A-A SCALE(B)

(Non-Overflow Section)



SECTION B-B SCALE(B)

(Overflow Section)



SECTION C-C

SCALE(B)

SCALE(A) 0 50 100m

SCALE(B) 0 25 50m

MASTER PLAN STUDY ON HYDROELECTRIC POWER DEVELOPMENT IN THE SE KONG BASIN

XE NAMNOY DOWNSTREAM PROJECT

DAM

ELEVATION AND SECTIONS

DWG. 8 | Feb. 1995

CONCLUSION AND RECOMMENDATION

CONCLUSION

CONCLUSION

CONCLUSION

1. Hydropower Potential Study in the Se Kong Basin

(1) The Se Kong river is a large tributary of the Mekong River. The river originates in the Annam Ranges which forms the boarder between Laos and Vietnam, flows around southern area of Bolaven Plateau and joins the Mekong River in Cambodia. The Se Kong river has a catchment area of 23,350 km^2 within Laos and is 150 km long which provides abundant hydropower resources including six tributaries.

(2) Hydropower development in the Se Kong basin is planned for two major reasons, (1) to develop an electric power source as a part of the Southern Laos Development Program and the (2) tenable power export to the neighboring countries.

(3) In the hydropower potential study, totally 15 development plans covered 3 plans on Se Kong main stream, 4 plans on Xe Kaman river, 2 plans on Xenamnoy river, 3 plans on Nam Kong river 1 plan on Xe Xou river and 2 plans on small rivers are studied and prepared a development plan inventory.

Out of the inventory, the following three projects are selected as priority development projects.

Se Kong No.4 Project
Xe Kaman No.1 Project
Xe Namnoy Midstream Project including Downstream Project

Pre-feasibility study was carried out for these three projects.

2. Pre-feasibility Study

2.1 Basic Data used in the Pre-feasibility Study

(1) Topographic maps of 1/10,000 scale around the each dam site and a part of reservoir area are prepared and used for the preliminary design.

(2) Meteorological data and hydrological data are preliminary analyzed using the records at the existing stations and or that of the newly installed stations in the study. Monthly

discharge, design flood at the each project sites are analyzed and applied for pre-feasibility design.

(3) Geological investigation such as a seismic prospecting survey, core drilling works were carried out and referred to the dam design.

(4) Preliminary environmental impact survey was carried out at the three selected project areas. Current state of the project areas related natural/social environment was surveyed and compensation costs were roughly estimated. More detailed survey will be required on the Feasibility Study stage.

2.2 Basic Concept for Hydropower Development Plan

(1) Hydropower projects by constructing a medium to large scale hydropower project providing the reservoir which is variances seasonally and one year to the next were selected for the main purpose of power export to the neighboring countries.

(2) Optimum development plan for the each project was selected after case study, which is varied dam height (HWL), effective reservoir capacity and etc. as parameters.

(3) Considering power export to the neighboring countries, a substation is planned at B.Houaykong in the Bolaven Plateau and the transmission line is planned divided into two stage. The first stage of the transmission line is a section from the powerhouse to the substation. the second stage of that is planned from the substation to the substation at Roi Et in Thailand. Allocated transmission line from B. Houaykong substation to the Thai border and independent transmission line from the powerhouse to the Thai border are also studied as comparative studies. Transmission lines to Vietnam and Cambodia are preliminary studied its routes and capacities.

2.3 Se Kong No.4 Project

(1) Se Kong No.4 Project is planned a dam reservoir type providing a concrete facing rockfill dam with 164 m in dam height, 910 m in dam crest length, 1,700 million m^3 in effective reservoir capacity, and a power plant generates 443 MW of installed capacity, 1,816 GWh of annual energy by 137 m of effective head.

The powerhouse is planned at the immediately downstream of the dam. 4 units of Francis turbines/generators (150 MW 2 unit, 71.5 MW 2 units) are planned.

(2) It is conditioned that 30 m^3/s of river retaining flows considered for the turbine size selection.

(3) Geology in the project area is generally satisfactorily. Survey results at present point out no geological problem in the reservoir area. Dam site is underlain by sandstone, shale and esitic tuff. The dam foundation is judged enough in strength, however, more detailed survey will be required for the dam design on the next stage including waterway, powerhouse and etc..

(4) Se Kong No.4 Project has 130 km^2 of reservoir area which is covered by forest. In the reservoir area, there are small villages with 3,500 peoples lying farmland and abandon slash-and burn agriculture. Implementing appropriate measures to alleviate impacts will forestall the occurrence of environmental impacts that will be hinder the project.

(5) Total construction cost of the Se Kong No.4 project is preliminary estimated as follows:

Base (Transmission line cost from the powerhouse to B. Houaykong Substation is included)
US$643,609,000

Case 1 (Addition to the Base, B. Houaykong substation cost and the transmission line cost up to Thai border are included by allocation)
US$693,552,000

Case 2 (Independent transmission line cost from the powerhouse to the Thai border)
US$690,269,000

(6) Total construction period is planned 8 yearrs including preparately work such as construction of access roads.

(7) Result of the economic analysis and financial analysis are shown in 2.6(2), (3)

2.4 Xe Kaman No.1 Project

(1) Xe Kaman No.1 Project is planned a dam reservoir type providing a concrete gravity dam with 143 m in height, 440 m in crest length, 1,270 million m^3 in effective reservoir capacity,

and a power plant generates 256 kW of installed capacity, 1,137 GWh of annual energy by 129.9 m of effective head.

The powerhouse is planned at the immediately downstream of the dam. 4 units of Francis turbine/generators (62 MW 4 units) are planned.

(2) It is conditioned that 20 m^3/s of river retaining flow is considered for the turbine size selection.

(3) Geology in the project area is generally satisfactorily. Survey results at present point out no geological program in the reservoir. Dam site is mainly underlain by sandstone. Shale and conglomerate are partly underlain. The dam foundation is judged enough in strength for the concrete dam, however, more detailed survey will be required for the dam design on the next stage including waterway, powerhouse and etc..

(4) Xe Kaman No.1 Project has 193 km^2 of reservoir area which is covered by forest. In the reservoir area, there are many small villages with 600 peoples lying farmland and abandon slash-and burn agriculture. Implementing appropriate measures to alleviate impacts will forestall the occurrence of environmental impacts that will be hinder the project.

(5) Total construction cost of the Xe Kaman No.4 project is preliminary estimated as follows:

Base (Transmission line cost from the powerhouse to B. Houaykong Substation is included)
US$404,050,000

Case 1 (Addition to the Base, B. Houaykong substation cost and the transmission line cost up to Thai border are included by allocation)
US$432,930,000

Case 2 (Independent transmission line cost from the powerhouse to the Thai border)
US$442,102,000

(6) Total construction period is planned 6 yearrs including preparately work such as construction of access roads.

(7) Result of the economic analysis and financial analysis are shown in 2.6(2), (3)

2.5 Xe Namnoy Project

(1) Xe Namnoy project is planned as two stage development plans of Midstream Project and Downstream Project.

a) Xe Namnoy Midstream Project

Xe Namnoy Midstream Project is planned a dam and waterway type providing a rockfill dam with 60 m in height, 890 m in crest length, 250 m^3 in effective reservoir capacity, and a power plant generates 238 MW of installed capacity, 1,052 GWh of annual energy by 463 m of effective head.

The powerhouse is planned at the right bank of Xe Namnoy river 20 km downstream from the dam. 2 units of Francis turbine/generators (119 MW 2 units) are planned, and a 9.2 km of headrace tunnel is planned between the dam and the powerhouse.
It is condition that 1 m^3/s of river retaining flow is considered to the downstream section of the dam.

b) Xe Namnoy Downstream Project

Xe Namnoy Downstream Project is planned to practical use of generated discharge of the Midstream Project and the discharge of the remaining catchment area effectively. This project is a medium scale and is planned a daily regulating reservoir type..

A concrete gravity dam is planned at immediately downstream of the confluence of H.Katak Tok river with 35 m in height, 350 m in crest length. A powerhouse is planned at the right bank of Xe Namnoy river 4 km downstream from the dam. 2 units of Francis turbine/generators (33.5 MW 2 units) are planned. The power plant generates 67 MW of installed capacity, 332 GWh by 81 m of effective head and 96 m^3/s of maximum discharge. A 3.4 km of headrace tunnel is planned between the dam and the powerhouse.

(2) At the dam site of Xe Namnoy Midstream Project, sandstone, shale and basalt are underlain. Basalt is distributed at lower part than the river bed at the left bank and develops seams overall. This basalt has high permeability so that more detailed survey will

be required including reservoir area. Geology at the waterway and the powerhouse areas are underlain sandstone, shale, and generally satisfactorily.

(3) Total construction cost of the Xe Namnoy Midstream project is preliminary estimated as follows:

Base (Transmission line cost from the powerhouse to B. Houaykong Substation is included)
US$281,807,000

Case 1 (Addition to the Base, B. Houaykong substation cost and the transmission line cost up to Thai border are included by allocation)
US$316,235,000

Case 2 (Indcpendent transmission line cost from the powerhouse to the Thai border)
US$310,686,000

Construction cost of the Xe Namnoy Downstream Project is US$151,400,000.

(4) Construction period of the Xe Namnoy Midstream Project is planned 5 years including preparatory work such as construction of access roads, and the Downstream Project is planned to complete within the period of the Midstream Project.

(5) 1 m^3/s of river retaining flow to the downstream is considered for the Midstream project, but not considered for the downstream Project because there are no village in the section between the dam and the powerhouse.

2.6 Summary of Each Project

Results of the pre-feasibility study for the three selected projects are summarized as follows.

(1) Comparison of Technical Aspect

Items	Se Kong No. 4	Xe Kaman No. 1	Xe Namnoy
Development Plan			
Development type	Dam reservoir type	Dam reservoir type	· Dam reservoir type with Xe Pian diversion (Mid.) · Run of river type with daily regulation
Installed capacity	443 MW	256 MW	· Mid. 238 MW · Down. 67 MW
Annual energy	1,816 GWh	1,137 GWh	· Mid. 1,052 GWh · Down. 332 GWh
Reservoir			· Mid.
Reservoir area	128 km^2	193 km^2	21.8 km^2
Effective reservoir capacit	1,700 x 10^6 m^3	1,270 x 10^6 m^3	250 x 10^6 m^3
Environmental impact			
Reservoir area	The greater part of the area is forest. Small villages and farmers practice slash-and burn agriculture	The greater part of the area is forest. Small villages and farmers practice slash-and burn agriculture	In the Bolaven Plateau. The greater part of area is forest. Small villages and farmers practice slash-and burn agriculture.
Resettled peoples (estimated)	3,500	600	900 (Mid.)
Site characteristic			
Reservoir operation	Stable power can be supplied with large reservoir.	Stable power can be supplied with large reservoir.	As vast differences in flow from dry season to rainy season, special attention on reservoir operation is required (Mid.). Effective regulation is expected using by reservoir operation of Mid. reservoir (Down.).
Access	· National roads to Sekong Town can be available throughout all seasons · No road from B.Phon to the dam site(18 km)	· National roads to Attapu are no good condition in rainy season. No bridge at Xe Namnoy river. · Local road at Attapu no bridge (Se Kong river) · Local road from Attapu to the dam site is very narrow and bad. Not available in rainy season.	· Local road to B.Latsasin is available throughout all seasons. · No road to Down. site.
Geology	· Good, sandstone, shale	· Good, sandstone, shale, conglomerate	· Sandstone, basalt (high permeability). Special attention is required for the basalt distribution.
Transmission line 1/	80 km to B.Houaykong s/s	140 km to B.Houaykong	10 km to B.Houaykong s/s (Mid.) 10 km to Mid. powerhouse

1/ Transmission line shows for base case (Ref. schematic diagram shown in (4)).

(2) Comparison of Economic Analysis Results

(a) Se Kong No.4 Project

Transmission Line up to the Thai Border

Case	Construction Cost	EIRR (%)
Base Case	1,585 $/kW (643.6 M.US$)	10.81
Case 1 (Allocated)	1,704 $/kW (691.6 M.US$)	10.01
Case 2 (Independent)	1,700 $/kW (690.3 M.US$)	10.03

(b) Xe Kaman No.1 Project

Transmission Line up to the Thai Border

Case	Construction Cost	EIRR (%)
Base Case	1,649 $/kW (404.1 M.US$)	11.78
Case 1 (Allocated)	1,780 $/kW (436.2 M.US$)	10.74
Case 2 (Independent)	1,805 $/kW (442.1 M.US$)	10.57

(c) Xe Namnoy Project (Mid + Down)

Transmission Line up to the Thai Border

Case	Construction Cost	EIRR (%)
Base Case	1,464 $/kW (433.2 M.US$)	16.67
Case 1 (Allocated)	1,575 $/kW (466.3 M.US$)	14.89
Case 2 (Independent)	1,561 $/kW (462.1 M.US$)	15.10

(d) Xe Namnoy Project (Midstream)

Transmission Line up to the Thai Border

Case	Construction Cost	EIRR (%)
Base Case	1,225 $/kW (281.8 M.US$)	21.83
Case 1 (Allocated)	1,369 $/kW (314.9 M.US$)	18.18
Case 2 (Independent)	1,351 $/kW (310.7 M.US$)	18.58

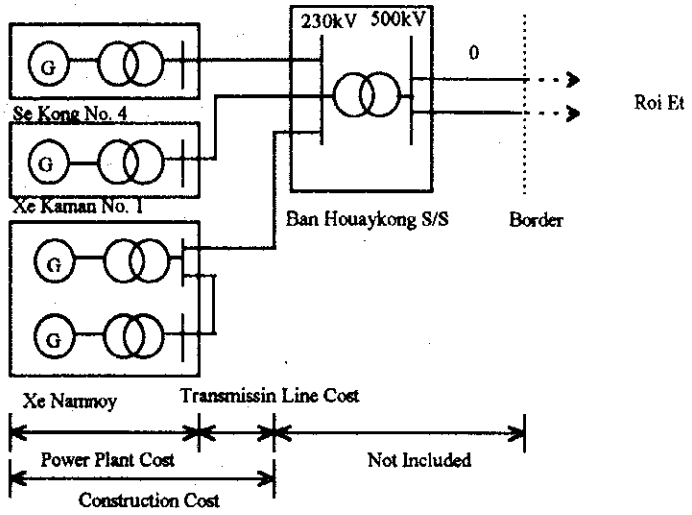
(3) Comparison of Financial Analysis Results

Project Name	Financial Condition a/	Case of T/L Facilitiy b/	Installed Capacity MW	Generation Energy GWh	Salable Energy GWh	Const. Cost M.US$	Unit Cost $/kW	FIRR for Repay. Period c/ %	FIRR for BOT Period e/ %	Averaged DSC f/ Times	Financial Generation Cost $/MWh
Se Kong No.4	A	Base	443	1816	1616	643.61	1,452.8	24.55	-	1.61	56.93
		1				693.55	1,565.6	22.75	-	1.46	61.33
		2				690.27	1,558.2	22.86	-	1.47	61.04
	B	Base				643.61	1,452.8	-9.85	8.03	0.85	78.15
		1				693.55	1,565.6	-19.25	6.88	0.78	83.79
		2				690.27	1,558.2	-18.26	6.96	0.78	83.42
Xe Kaman No.1	A	Base	256	1137	1012	404.05	1,578.3	27.49	-	1.55	54.95
		1				432.93	1,691.1	25.37	-	1.42	58.85
		2				442.10	1,727.0	24.73	-	1.38	60.10
	B	Base				404.05	1,578.3	-13.68	7.97	0.83	74.67
		1				432.93	1,691.1	-31.25	6.83	0.76	79.61
		2				442.10	1,727.0	N/A d/	6.48	0.74	81.19
Xe Namnoy (Mid + Down)	A	Base	305	1384	1232	433.22	1,420.4	37.28	-	1.75	46.51
		1				467.65	1,533.3	34.12	-	1.59	50.19
		2				462.10	1,515.1	34.62	-	1.61	49.60
	B	Base				433.22	1,420.4	-6.58	10.33	0.93	63.06
		1				467.65	1,533.3	-13.31	8.84	0.85	67.64
		2				462.10	1,515.1	-12.06	9.07	0.86	66.90
Xe Namnoy (Midstream)	A	Base	238	1052	936	281.81	1,184.1	43.45	-	2.12	39.86
		1				316.24	1,328.7	38.75	-	1.84	44.71
		2				310.69	1,305.4	39.46	-	1.88	43.92
	B	Base				281.81	1,184.1	2.76	13.60	1.11	54.80
		1				316.24	1,328.7	-3.73	11.15	0.97	60.83
		2				310.69	1,305.4	-2.62	11.51	0.99	59.86

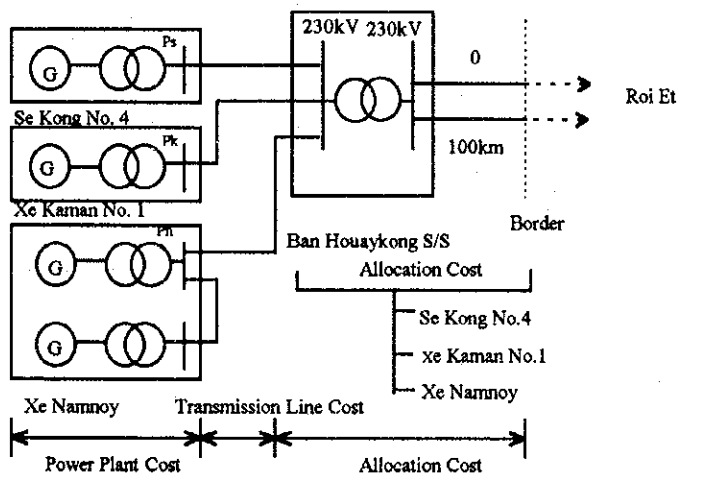
Note: a/ A :Government base B: BOT scheme
b/ 1: Allocated T/L system 2: Independent T/L
c/ Government Base : 25 years BOT scheme : 10 years
d/ N/A means less than -35 %.
e/ 25 years
f/ DSC is the abbreviation for Debt Service Coverage

(4) Schematic Diagram related to Transmission Line

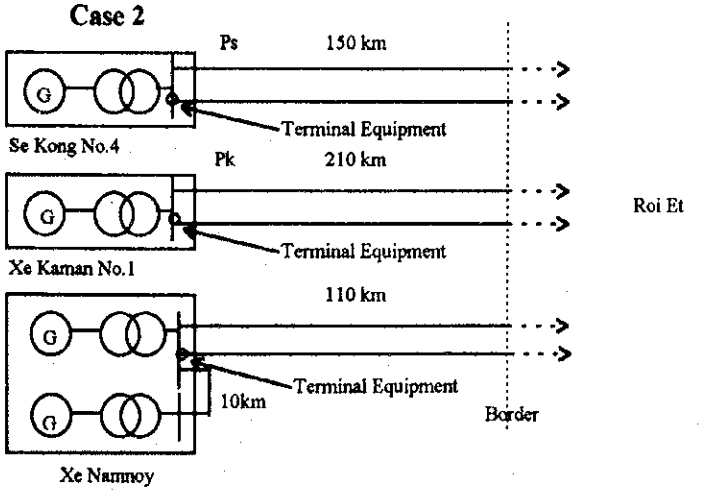
Base



Case 1



Case 2



RECOMMENDATION

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1. Hydropower Potential Study in the Se Kong Basin

(1) Hydropower potential study has been conducted toward clarifying the overall hydropower development potential in the Se Kong basin and preparing a development plan inventory of the basin for selecting several medium to large scale priority projects. Taking these two purposes into account, the hydropower potential was studied so as to provide approximately 60% of plant factor for each project and to maximize the total net benefit (B-C) of the basin.

Although the project locations proposed in this study will remain rational as long as no significant change appears in hydrological conditions from the stand point of potential evaluation, different development scales will be proposed depending on criteria employed such as plant factor and economic evaluation criteria of the projects.

It is important for evaluation of the development plan inventory proposed in this study to understand the basic study policy employed.

(2) The development plan inventory has been established by using existing topographic maps and hydrological and meteorological data in this study. Particularly, availability of the hydrological data observed in the basin is very limited. Therefore, series of the inflow data estimated for each project site are not of accurate actually.

Accumulation of hydrological and meteorological data for a long period is important for development of hydropower projects. Even the observation records of water level and precipitation by the ordinary method, which are relatively easy to be applied, will be so valuable in the future. There are several economical projects in the Se Kong basin other than the three projects studied in the Pre-feasibility Study stage. It is recommended to start meteorological and hydrological investigations for these projects as soon as possible.

(3) The optimum development plans of the priority projects proposed in the Pre-feasibility Study are different from the plans in the development plan inventory. This difference of plans depends on the difference of accuracy of basic data such as topographic maps and discharge data and on the difference of study criteria employed.

By reviewing the difference of each plan, it is understood that no revise is required at this moment on the development plan inventory. However, when a significant change appears

in basic conditions such as accumulation of hydrological and meteorological observation records and topographic maps or implementation of priority projects, it is necessary to revise development plan of related projects in the inventory.

2. Pre-feasibility Study

2.1 Common Items for Each Project

(1) Resulting the pre-feasibility study, three projects; Se Kong No.4, Xe Kaman No.1 and Xe Namnoy Project, selected from the hydropower potential study are promising projects technical and economical points of view. As for financial point of view, they are promising projects in case of official loan conditions. However, the financial condition of BOT development proposed by MIH provides extremely less financial performance than that of official loan case.

It is recommended that the Feasibility Study for the each project be carried out in future continuously.

(2) As the three projects are planned for power export purpose, transmission line systems are affected by the receiving facility of the power import country. Therefore, effective international power system plan including development plans in other basins will be required.

(3) Meteorological/hydrological data are not enough for the each project. Continual observation of river discharge, rain, evaporation and etc. are required. Especially, observation of river discharge at the gauging station of Sekong Town, Attapu Town, B.Hatsaykhao, B.Fangdeng and B.Latsasin will be very important data for the future study.

(4) As for environmental impact and compensation, more detailed surveys are required for the each projects. Especially, the three projects are dam reservoir type development plans, problem of the resettlement of inhabitants, disruption of ecosystem will be occurred. Measures on impacts of the river environment and the river utilization at the downstream area of the dam and powerhouse are also important. Further survey and study will be necessary for the problems.

(5) In the hydropower development plan study, optimum development plan is selected adopting 8 hours of peak power duration to evaluate the value (kW value) of peak supply by the powerplant.

Here, the 8 hours peak duration is referred Thailand's recent daily demand curve. In this case, approximately 50 % of plant factor are obtained.

However, it is considered that a certain extent smaller installed capacity and larger plant factor are profitable for the generating cost of power export. On the other hand, more larger installed capacity has tendency of profitable even higher generating cost as adopting in Nam Ngum Power Station.

At present, it is difficult to select the optimum development plan considering the condition above because the future tariff system of power export is not cleared. Re-examination of the development plan considering the condition is required in future study.

2.2 Se Kong No.4 Project

(1) It is recommended that the following topographic maps be prepared on the Feasibility Study Stage.

Reservoir area : Scale 1/10,000 (all areas except maps prepared by JICA)
Dam area : Scale 1/1,000 (including waterway and powerhouse)

(2) It is recommended that the following geological investigation be carried out on the Feasibility Study Stage.

Location	Seismic prospecting	Test pit	Core drilling
Dam axis	–	–	4 × 100 =400 m
Waterway	–	–	3 × 30 = 90 m
Spillway	–	–	1 × 30 = 30 m
Quarry site	–	–	1 × 50 = 50 m 1 × 100 = 100m
Aggregate	1.5 km	5 × 5 = 25 m	5 × 10 = 50 m
Borrow area	1.5 km	5 × 10 = 50 m	5 × 10 = 50 m
Total	3.0 km	75 m	20 holes 770 m

(3) In the reservoir area extended 128 km^2 and the dam area included related area, more detailed survey of environmental impact and compensation will be required in future.

(4) Prior to the project implementation, it is necessary to construct an access road from B.Nava Nua to the dam site.

2.3 Xe Kaman No.1 Project

(1) It is recommended that the following topographic maps be prepared on the Feasibility Study Stage.

Reservoir area : Scale 1/10,000 (all areas except the maps prepared by JICA)
Dam area : Scale 1/1,000 (including waterway, powerhouse)

(2) It is recommended that the following geological investigation be carried out on the Feasibility Study Stage.

Location	Seismic prospecting	Test pit	Core drilling
Dam axis	–	–	3 × 100 = 300 m
Waterway	–	–	2 × 30 = 60 m 1 × 50 = 50 m
Dam right bank	–	–	1 × 50 = 50 m
Quarry site	–	–	1 × 100 = 100m
Aggregate site	2.0 km	5 × 5 = 25 m	5 × 10 = 50 m
Total	2.0 km	25 m	13 holes 610 m

(3) In the reservoir area extended 193 km^2 and the dam area included related area, more detailed survey of environmental impact and compensation will be required on Feasibility Study Stage.

(4) Prior to the project implementation, it is necessary to construct and improvement as access road from Attapu Town to the dam site.

2.4 Xe Namnoy Project

(1) It is recommended that the following topographic maps be prepared on the Feasibility Study Stage.

Dam site (Mid.) : Scale 1/1,000 (including powerhouse)
Dam site (Down.) : Scale 1/1,000 (including powerhouse)

(2) It is recommended that the following geological investigation be carried out on the Feasibility Study Stage.

	Location	Seismic prospecting	Test pit	Core drilling	
a)	Midstream Project				
	Dam axis	–	–	3 × 30 =	90 m
				2 × 50 =	100 m
				1 × 60 =	60 m
	Dam site (Xe Pian)	–	–	4 × 10 =	40 m
	Waterway	–	–	1 × 50 =	50 m
				2 × 150 =	300 m
	Penstock & powerhouse	1.5 km	–	1 × 50 =	50 m
				1 × 30 =	30 m
	Quarry site	–	–	1 × 50 =	50 m
	Borrow area	1.0 km	10 × 5 = 50 m	3 × 10 =	30 m
b)	Downstream Project				
	Dam axis	–	–	3 × 30 =	90 m
	Waterway & powerhouse site	–	–	1 × 80 =	80 m
				1 × 50 =	50 m
				1 × 20 =	20 m
	Total	2.5 km	50 m	25 holes	1,040 m

Especially, as the basalt lava is distributed at the left bank of Xe Namnoy Midstream Project, a watertightness including dam foundation treatment are worry about its measures and cost estimation. More detailed geological survey will be required in future.

(3) In the reservoir extended 21.8 km^2 and the Midstream dam area including related construction, more detailed survey of environmental impact and compensation will be required in future.

Survey on the river retaining flow at the downstream areas of the Midstream powerhouse and Xe Pian intake dam will be required.

(4) Prior to the project implementation, it is necessary to construct access roads from B.Houaykong to the Downstream Project site, to the Xe Pian intake dam site.