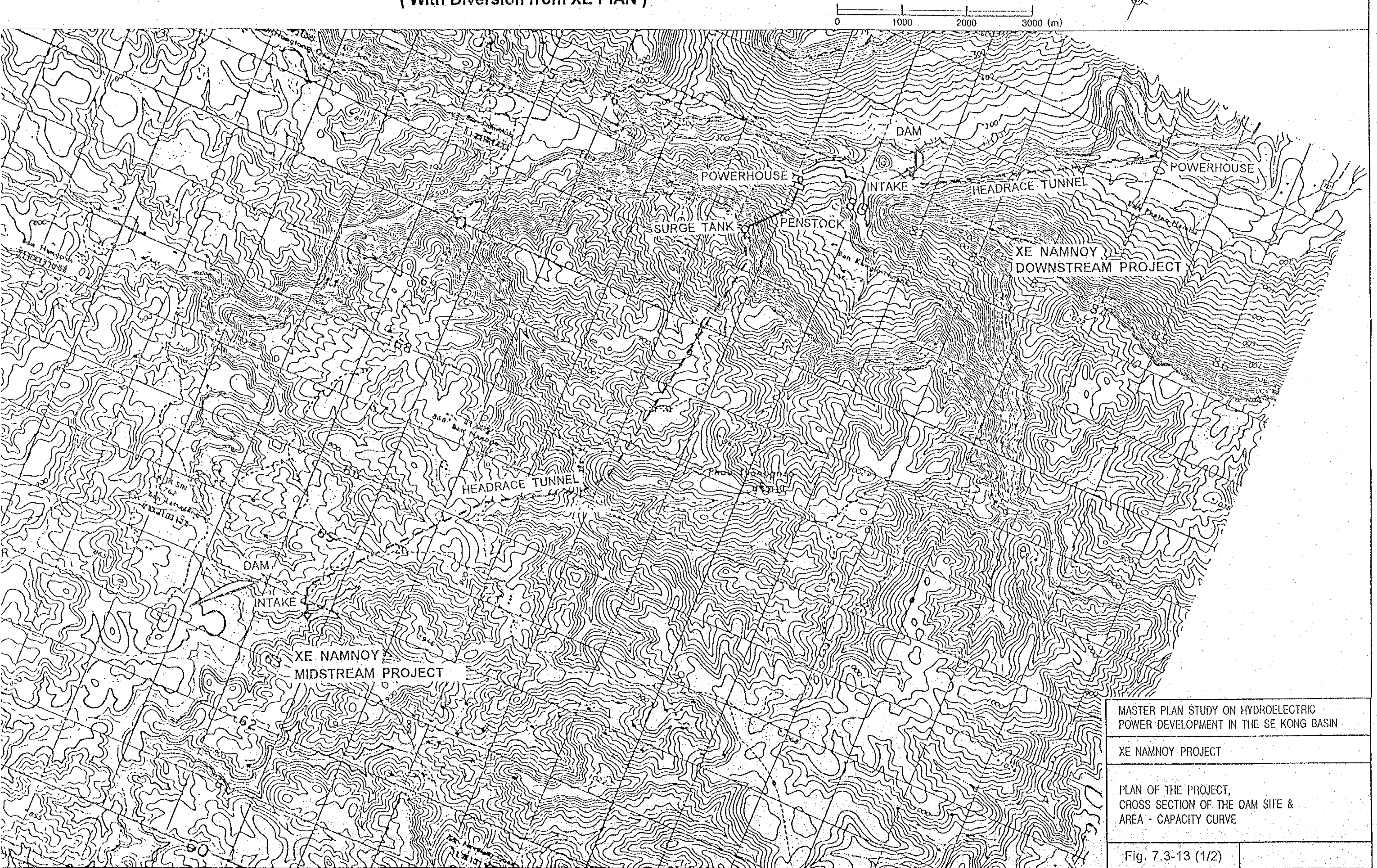
PLAN OF XE NAMNOY PROJECT

(With Diversion from XE PIAN)

0 1000

PLAN OF XE NAMNOY PROJECT

(With Diversion from XE PIAN)



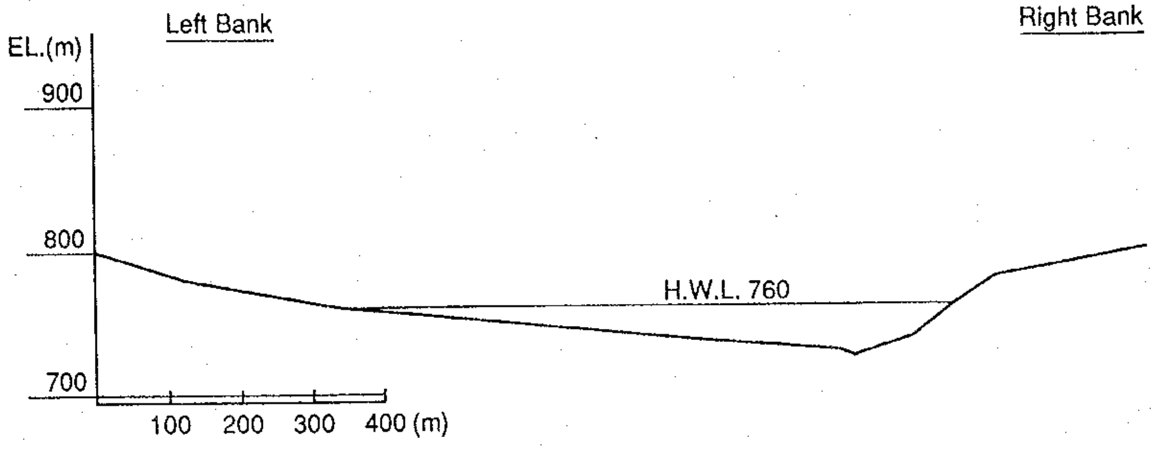
MASTER PLAN STUDY ON HYDROELECTRIC POWER DEVELOPMENT IN THE SE KONG BASIN

XE NAMNOY PROJECT

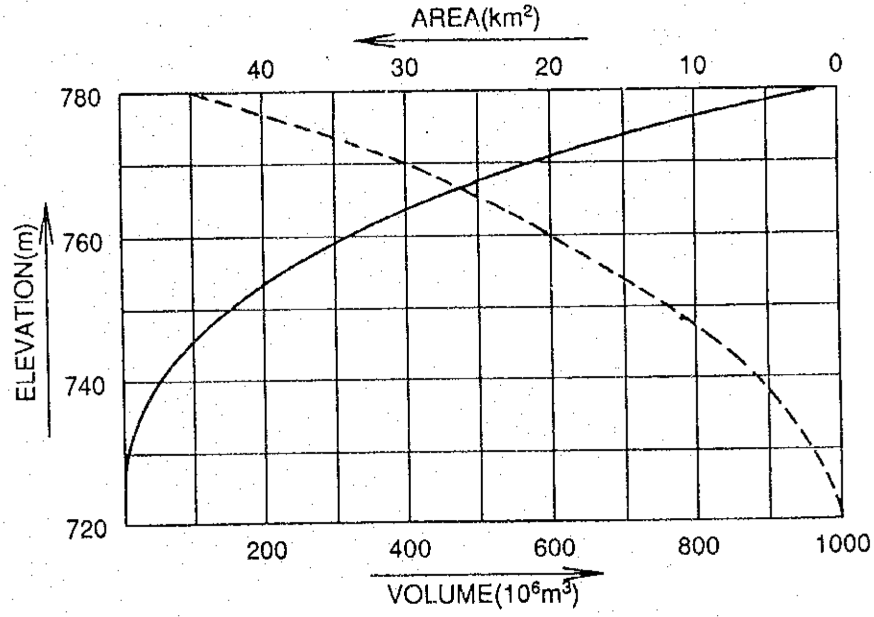
PLAN OF THE PROJECT, CROSS SECTION OF THE DAM SITE & AREA - CAPACITY CURVE

Fig. 7.3-13 (1/2)

CROSS SECTION AT THE DAM SITE



AREA AND CAPACITY CURVE



ELEVATION (m)	AREA (Km^2)	VOLUME (10^6m^3)
780	44.78	975
760	20.38	323
740	5.94	59
720	0.00	0

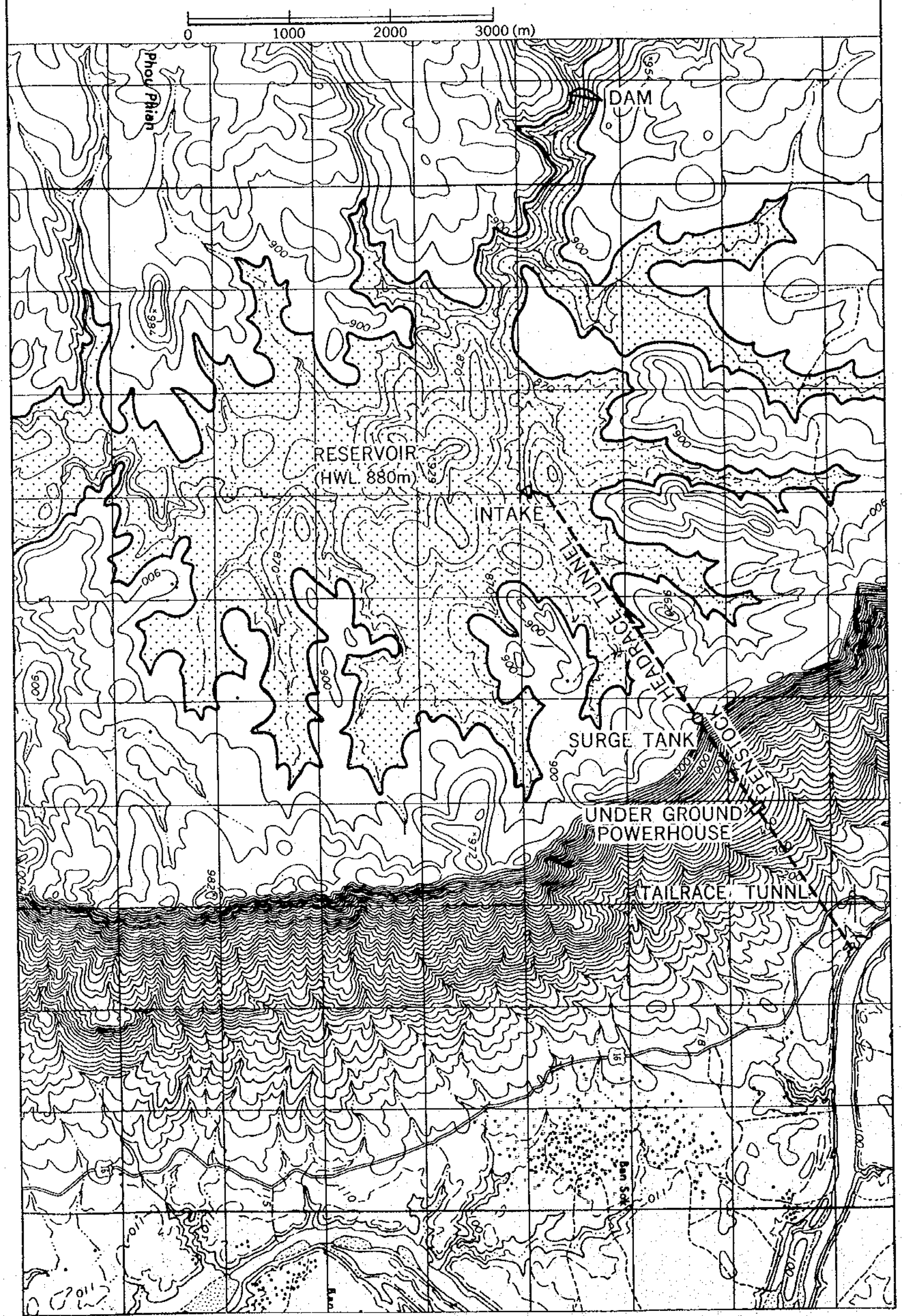
MASTER PLAN STUDY ON HYDROELECTRIC POWER DEVELOPMENT IN THE SE KONG BASIN

XE NAMNOY MIDSTREAM PROJECT

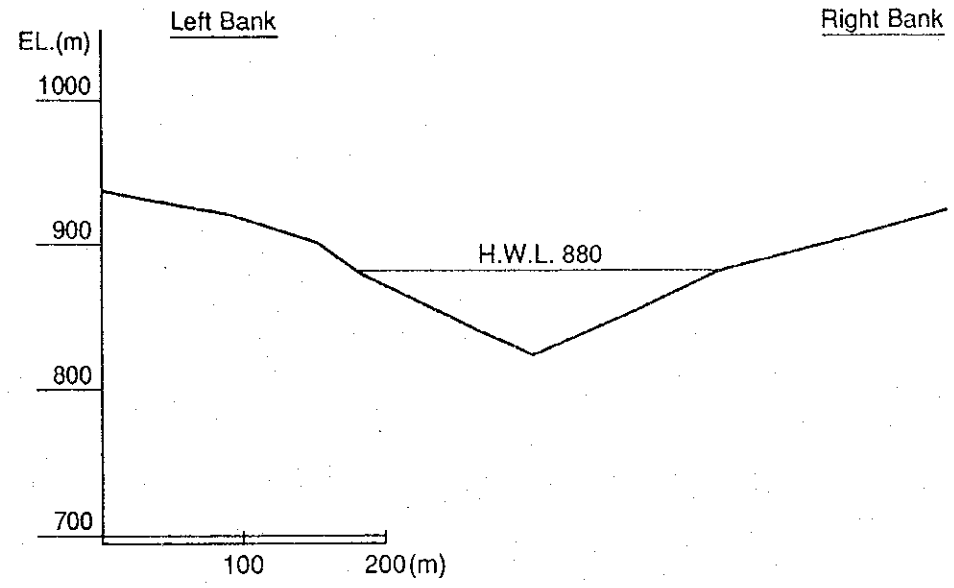
CROSS SECTION OF THE DAM SITE & AREA-CAPACITY CURVE

Fig. 7.3-13 (2/2)

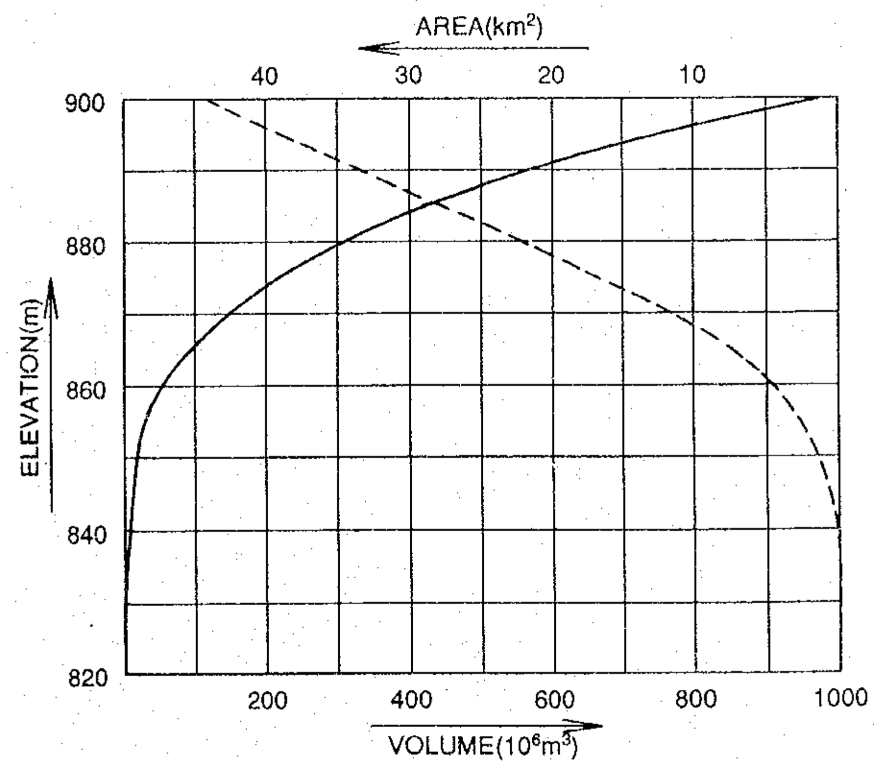
PLAN OF H. KATAK TOK PROJECT



CROSS SECTION AT THE DAM SITE



AREA AND CAPACITY CURVE



ELEVATION (m)	AREA (Km²)	VOLUME (10⁶m³)
900	43.13	975
880	22.63	317
860	4.26	48
840	0.31	2
825	0.00	0

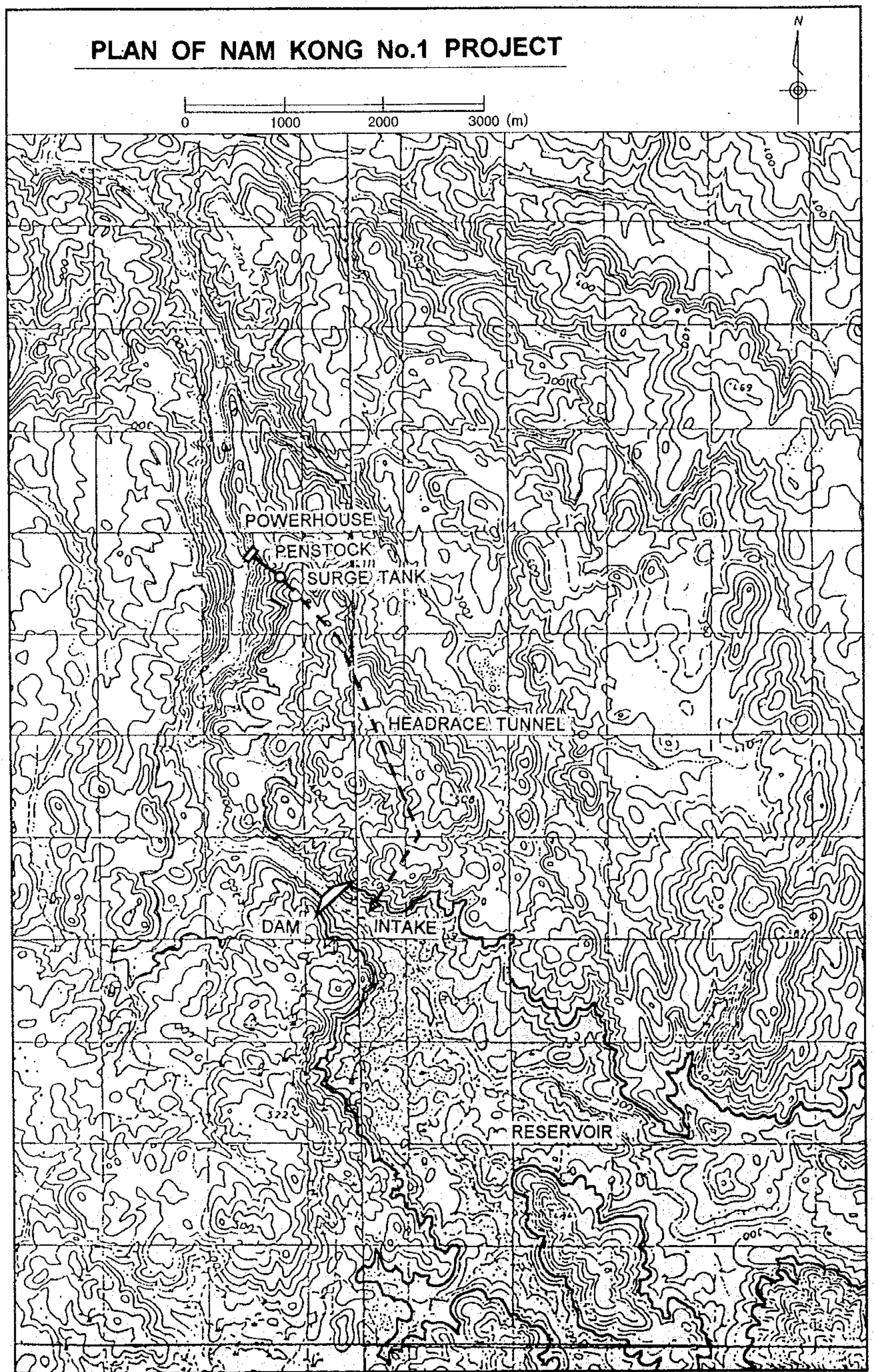
MASTER PLAN STUDY ON HYDROELECTRIC POWER DEVELOPMENT IN THE SE KONG BASIN

H. KATAK TOK PROJECT

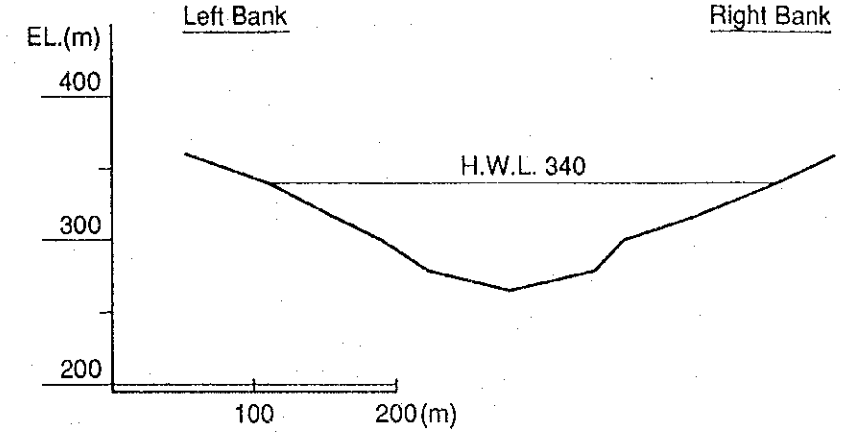
CROSS SECTION OF THE DAM SITE & AREA-CAPACITY CURVE

Fig. 7.3-14

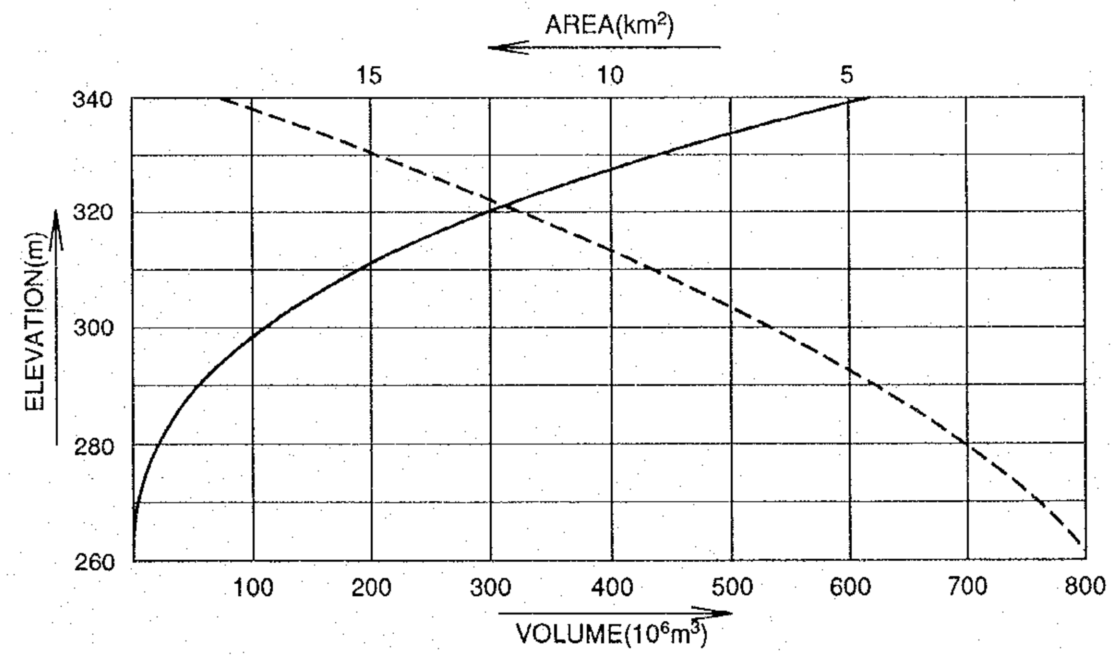
PLAN OF NAM KONG No.1 PROJECT



CROSS SECTION AT THE DAM SITE



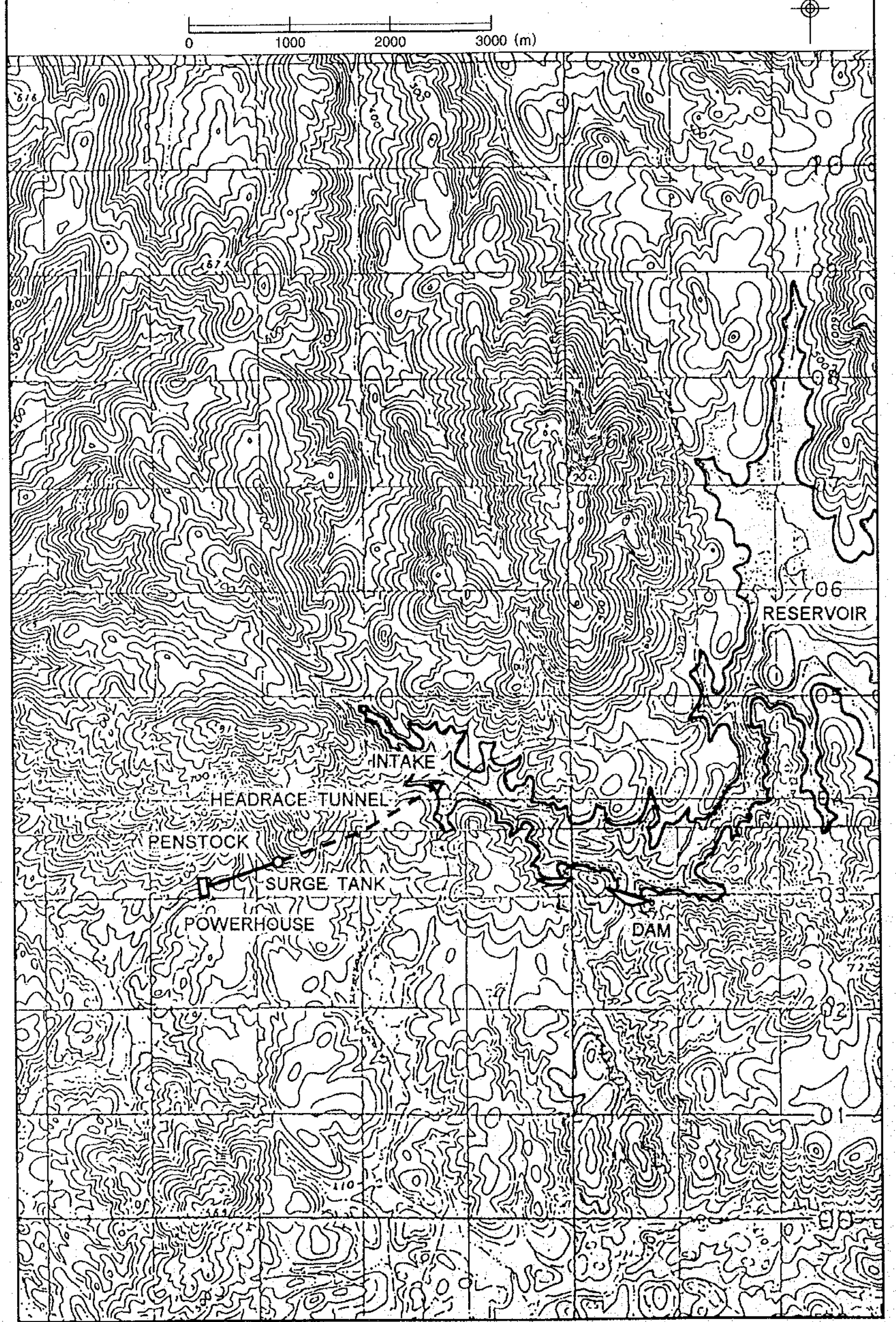
AREA AND CAPACITY CURVE



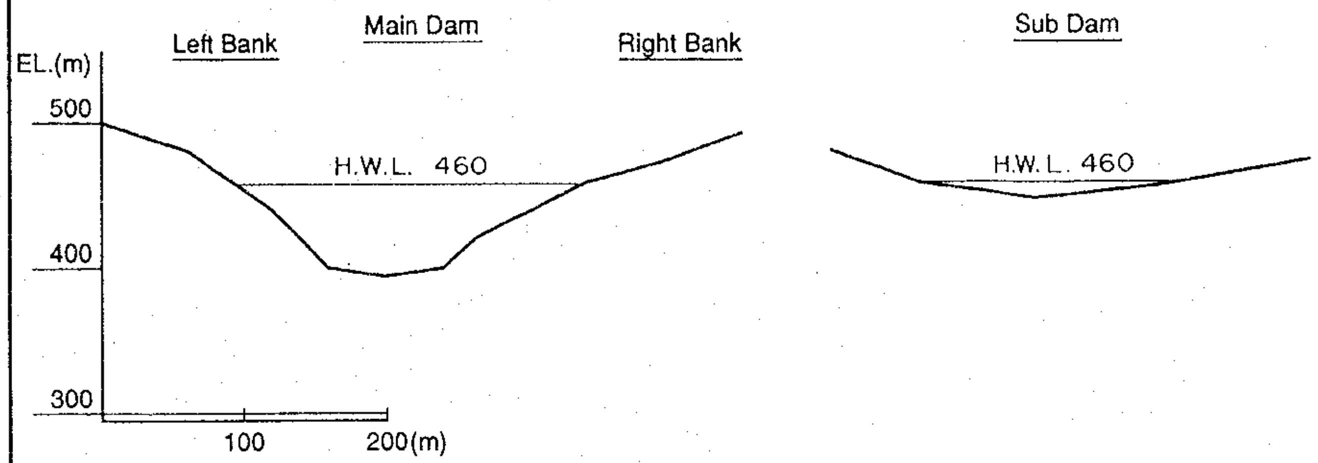
ELEVATION (m)	AREA (Km²)	VOLUME (10⁶m³)
340	18.33	612
320	12.27	306
300	7.05	113
280	2.42	18
265	0.00	0

MASTER PLAN STUDY ON HYDROELECTRIC POWER DEVELOPMENT IN THE SE KONG BASIN
NAM KONG NO. 1 PROJECT
PLAN OF THE PROJECT, CROSS SECTION OF THE DAM SITE & AREA - CAPACITY CURVE
Fig. 7.3-15

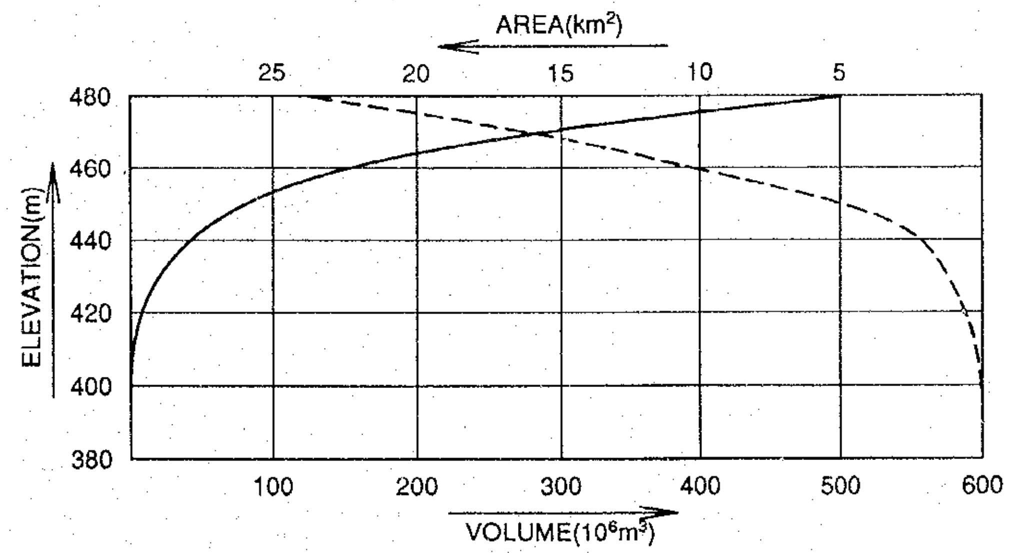
PLAN OF NAM KONG No.2 PROJECT



CROSS SECTION AT THE DAM SITE



AREA AND CAPACITY CURVE



ELEVATION (m)	AREA (Km^2)	VOLUME (10^6m^3)
480	24.05	521
460	10.91	171
440	2.35	38
420	0.70	8
400	0.08	2
398	0.00	0

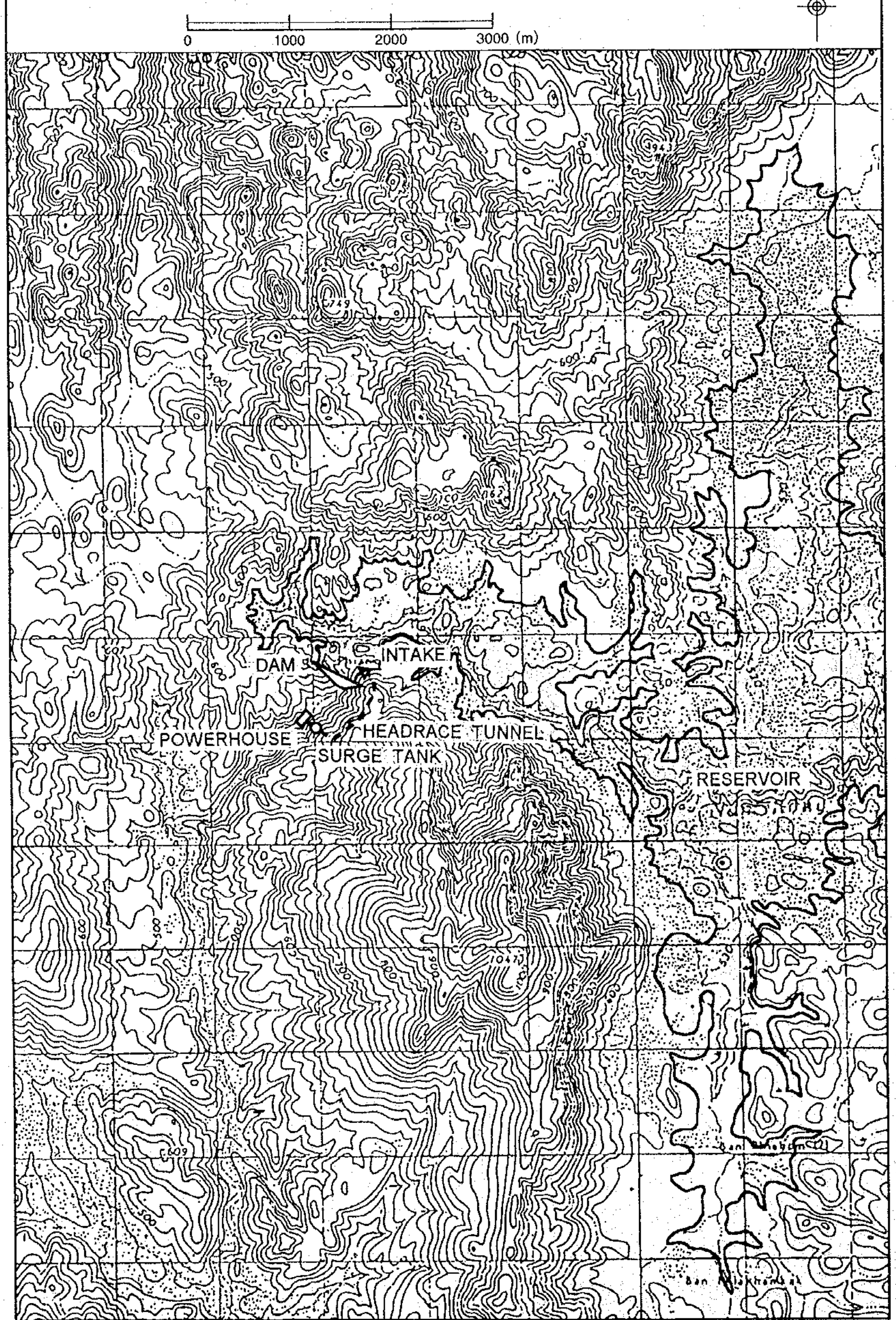
MASTER PLAN STUDY ON HYDROELECTRIC POWER DEVELOPMENT IN THE SE KONG BASIN

NAM KONG NO. 2 PROJECT

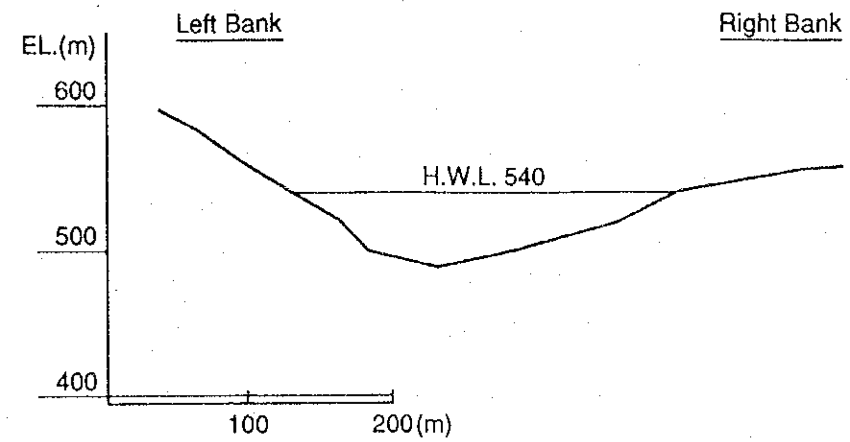
CROSS SECTION OF THE DAM SITE & AREA-CAPACITY CURVE

Fig. 7.3-16

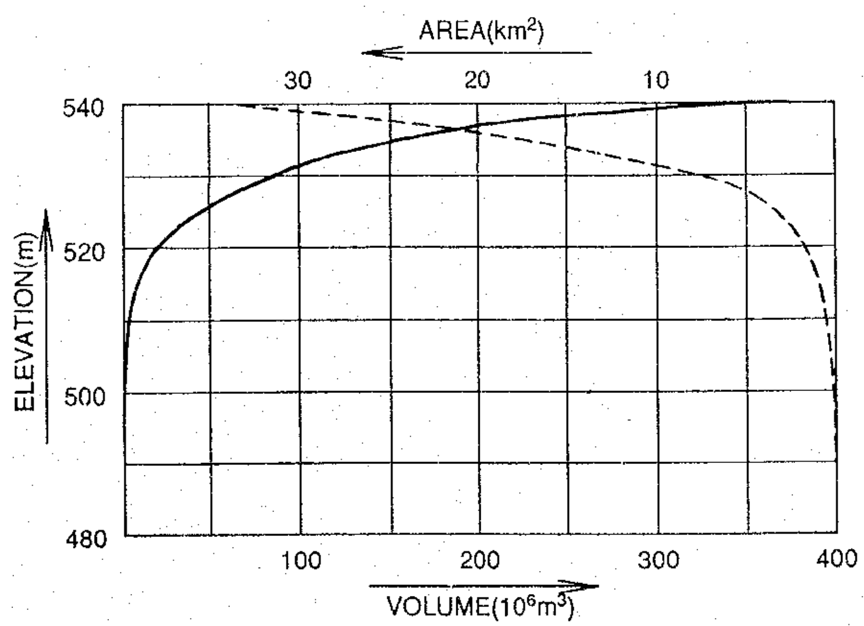
PLAN OF NAM KONG No.3 PROJECT



CROSS SECTION AT THE DAM SITE



AREA AND CAPACITY CURVE



ELEVATION (m)	AREA (Km²)	VOLUME (10^6m^3)
540	34.36	377
520	1.63	17
500	0.03	0
490	0.00	0

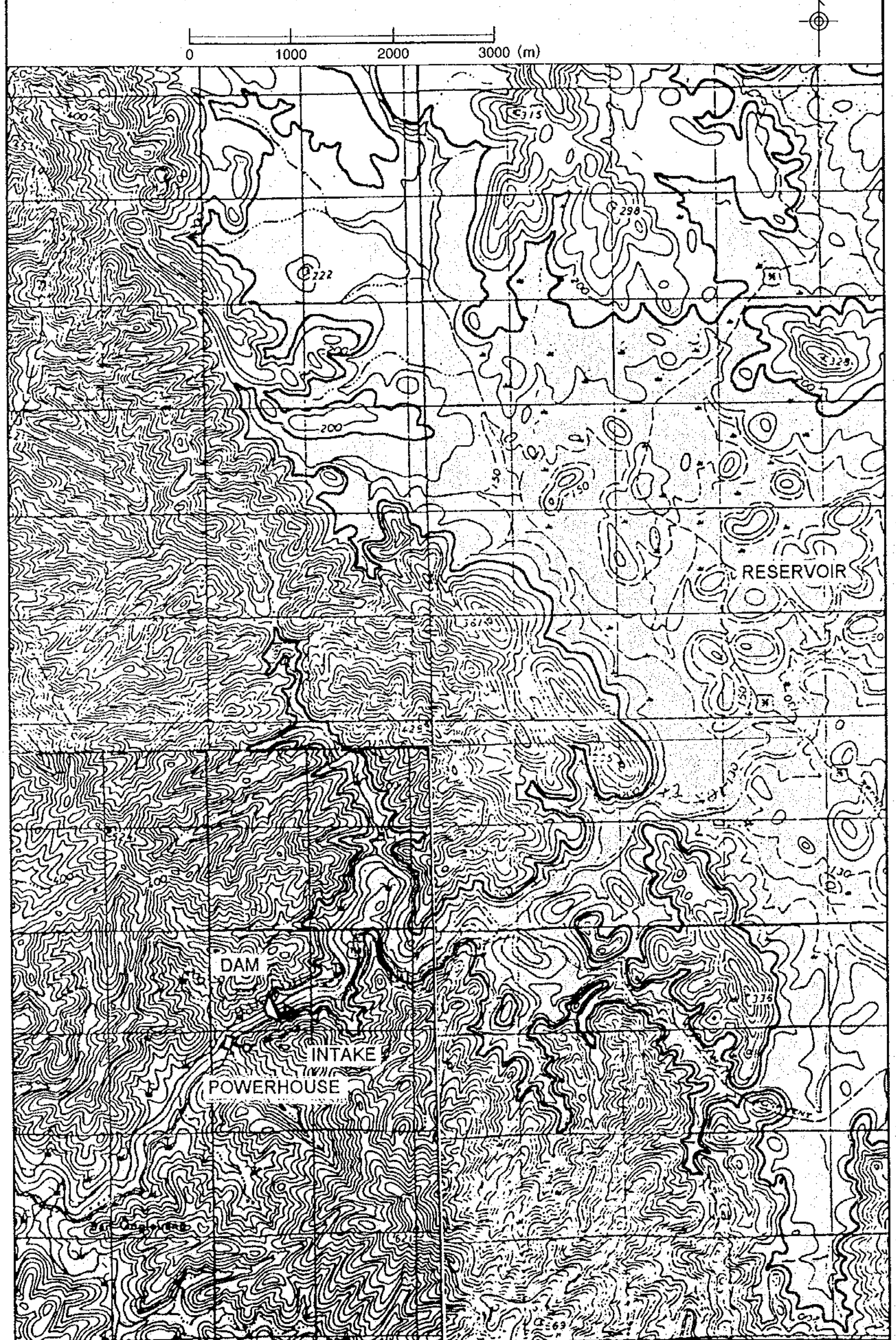
MASTER PLAN STUDY ON HYDROELECTRIC POWER DEVELOPMENT IN THE SE KONG BASIN

NAM KONG NO. 3 PROJECT

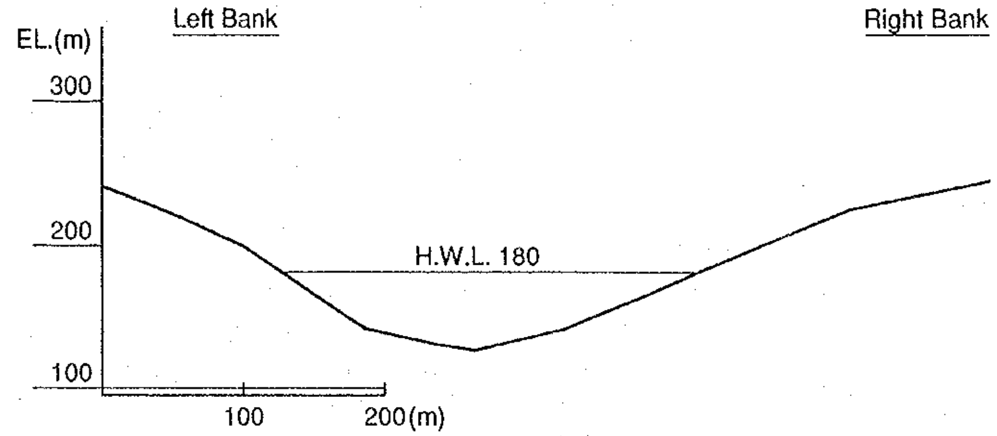
CROSS SECTION OF THE DAM SITE & AREA-CAPACITY CURVE

Fig. 7.3 - 17

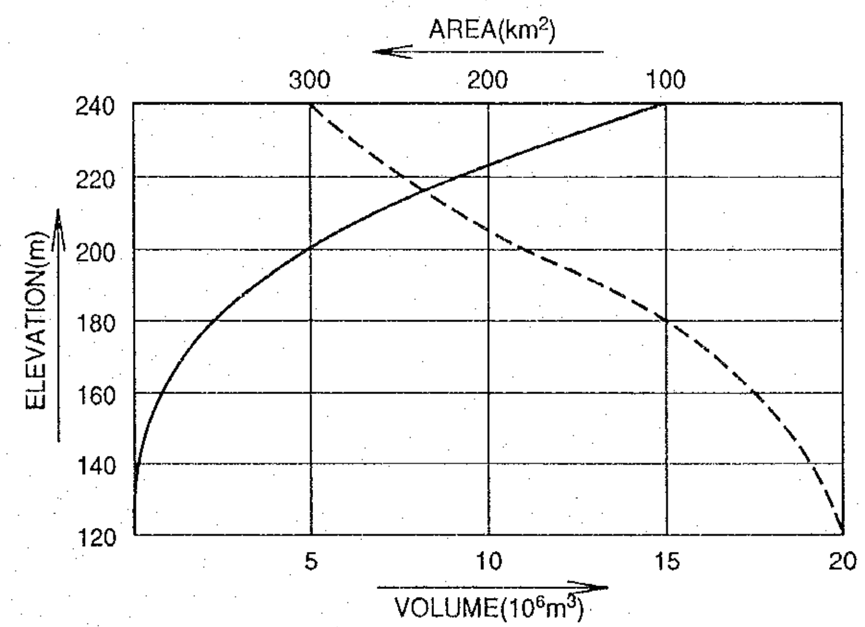
PLAN OF XE XOU PROJECT



CROSS SECTION AT THE DAM SITE



AREA AND CAPACITY CURVE



ELEVATION (m)	AREA (Km^2)	VOLUME (10^6m^3)
240	304.18	14,891
220	248.55	9,365
200	177.50	5,104
180	100.11	2,328
160	51.55	811
140	14.77	148
120	0.00	0

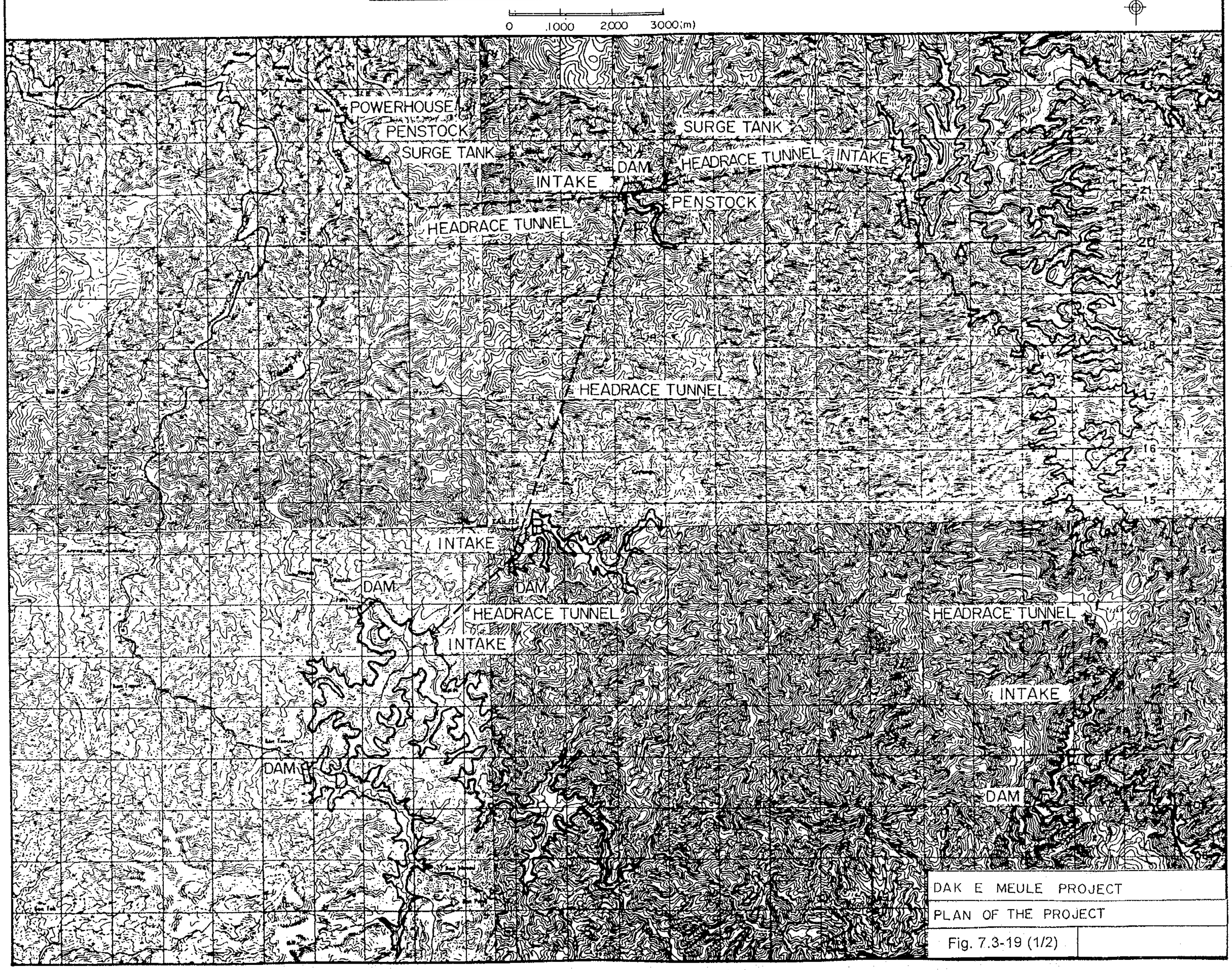
MASTER PLAN STUDY ON HYDROELECTRIC POWER DEVELOPMENT IN THE SE KONG BASIN

XE XOU PROJECT

PLAN OF THE PROJECT,
CROSS SECTION OF THE DAM SITE &
AREA - CAPACITY CURVE

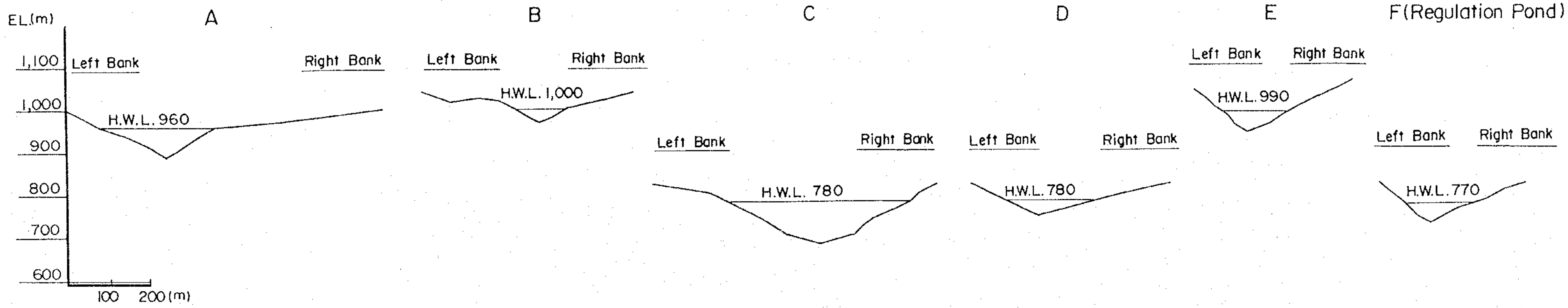
Fig. 7.3-18

PLAN OF DAK E MEULE PROJECT

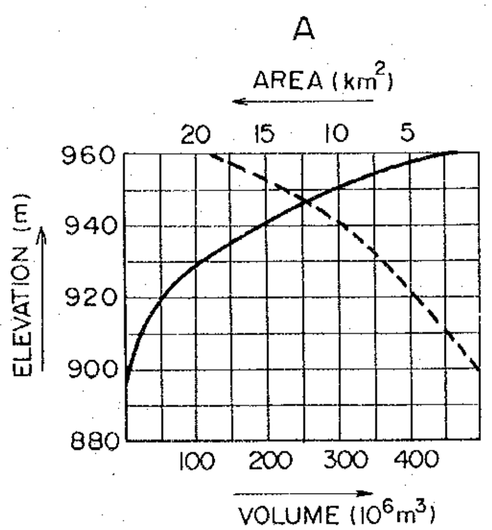


DAK E MEULE PROJECT	
PLAN OF THE PROJECT	
Fig. 7.3-19 (1/2)	

CROSS SECTION AT THE DAM SITE

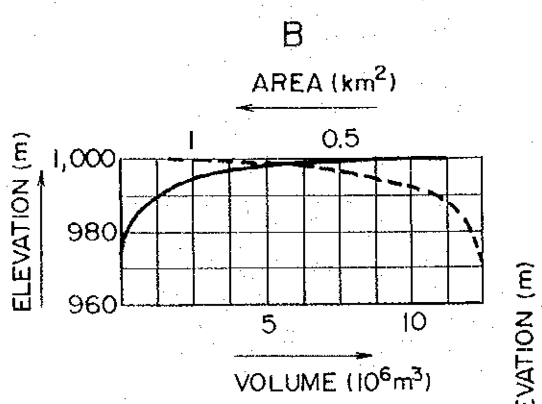


AREA AND CAPACITY CURVE



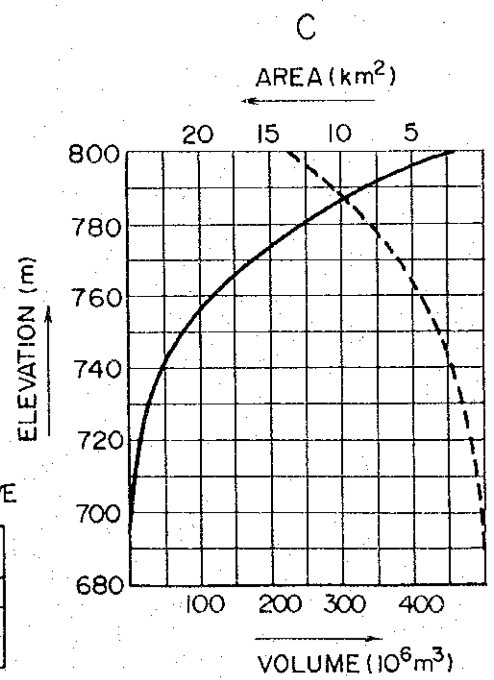
DAK E MEULE A AREA-VOLUME CURVE

ELEVATION (m)	AREA (km2)	VOLUME (10⁶m³)
960	18.23	470
940	9.69	190
920	4.41	50
900	0.36	2
890	0.00	0



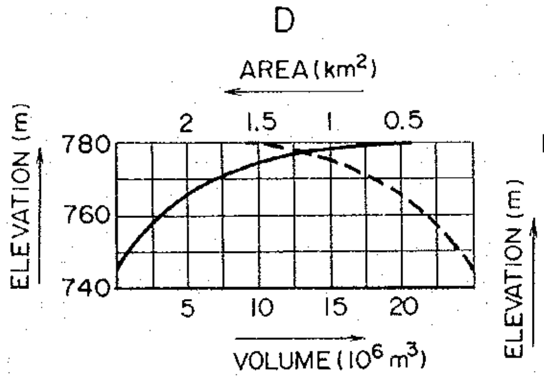
DAK E MEULE B AREA-VOLUME CURVE

ELEVATION (m)	AREA (km2)	VOLUME (10⁶m³)
1,000	1.08	11
980	0.04	0
970	0.00	0



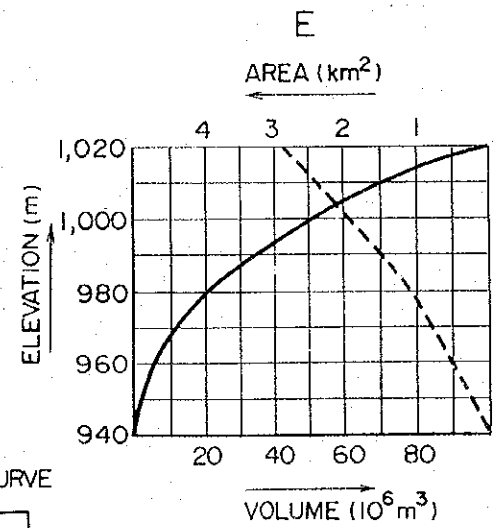
DAK E MEULE C AREA-VOLUME CURVE

ELEVATION (m)	AREA (km2)	VOLUME (10⁶m³)
800	13.71	463
780	8.18	244
760	4.49	118
740	2.25	50
720	1.05	17
700	0.34	3
680	0.00	0



DAK E MEULE D AREA-VOLUME CURVE

ELEVATION (m)	AREA (km2)	VOLUME (10⁶m³)
780	1.55	22
760	0.35	3
745	0.00	0



DAK E MEULE E AREA-VOLUME CURVE

ELEVATION (m)	AREA (km2)	VOLUME (10⁶m³)
1,020	2.90	99
1,000	1.90	51
980	1.08	21
960	0.51	5
940	0.00	0

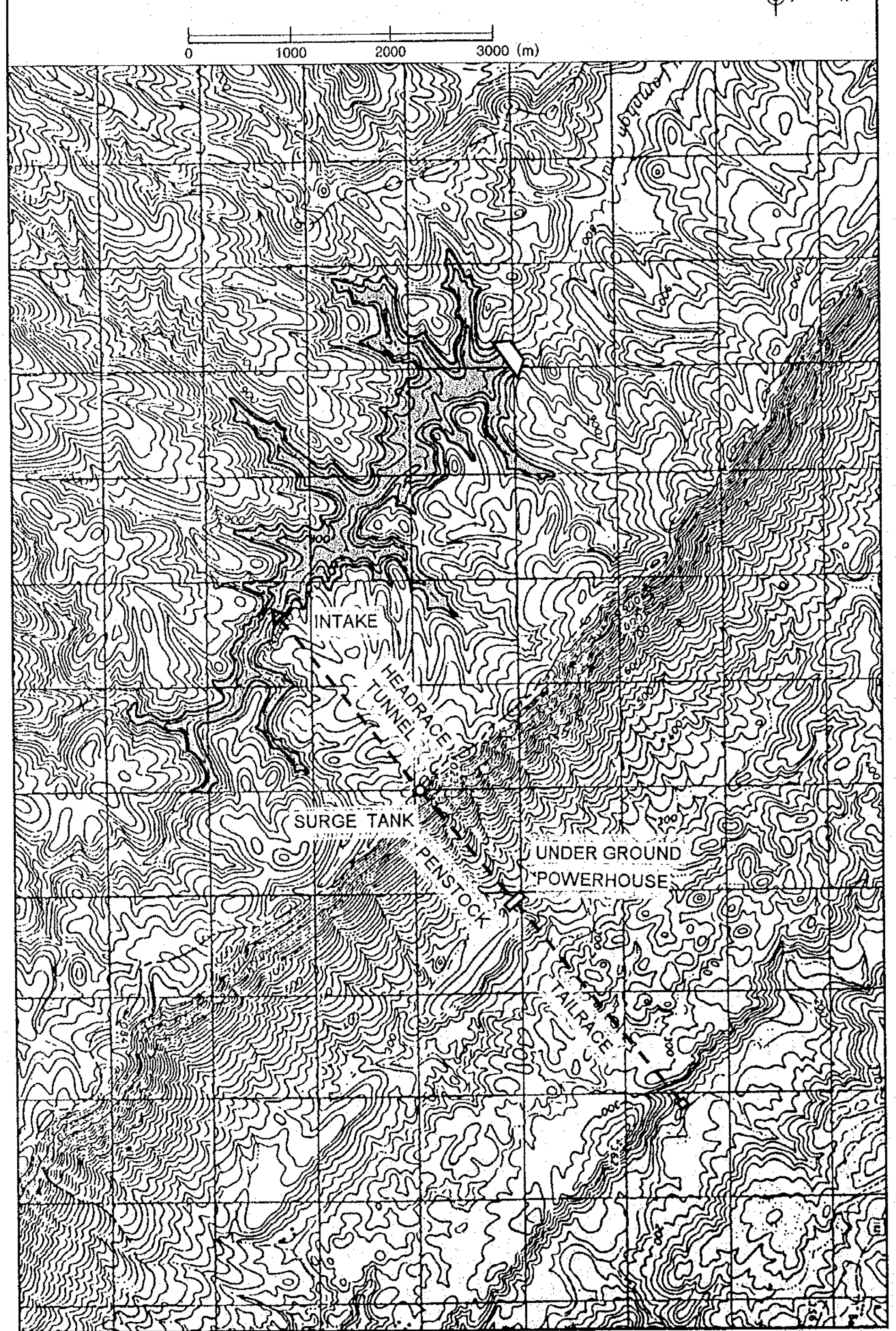
MASTER PLAN STUDY ON HYDROELECTRIC POWER DEVELOPMENT IN THE SE KONG BASIN

DAK E MEULE PROJECT

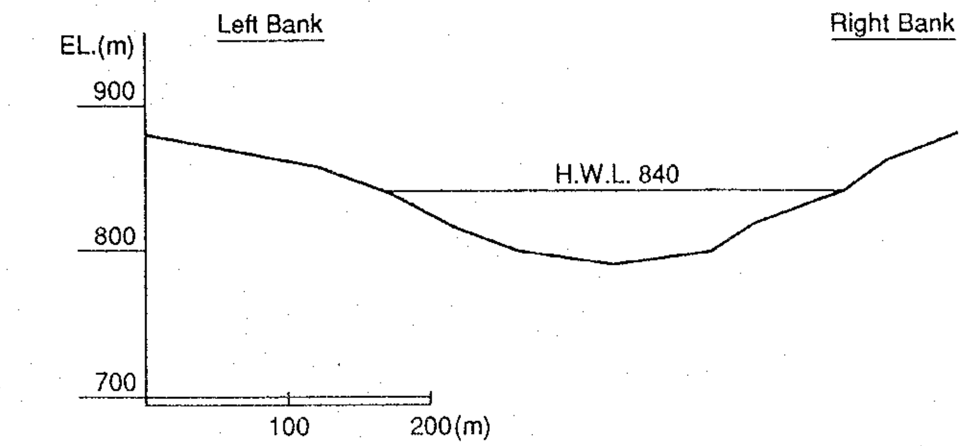
CROSS SECTION OF THE DAM SITE & AREA - CAPACITY CURVE

FIG. 7.3-19 (2/2)

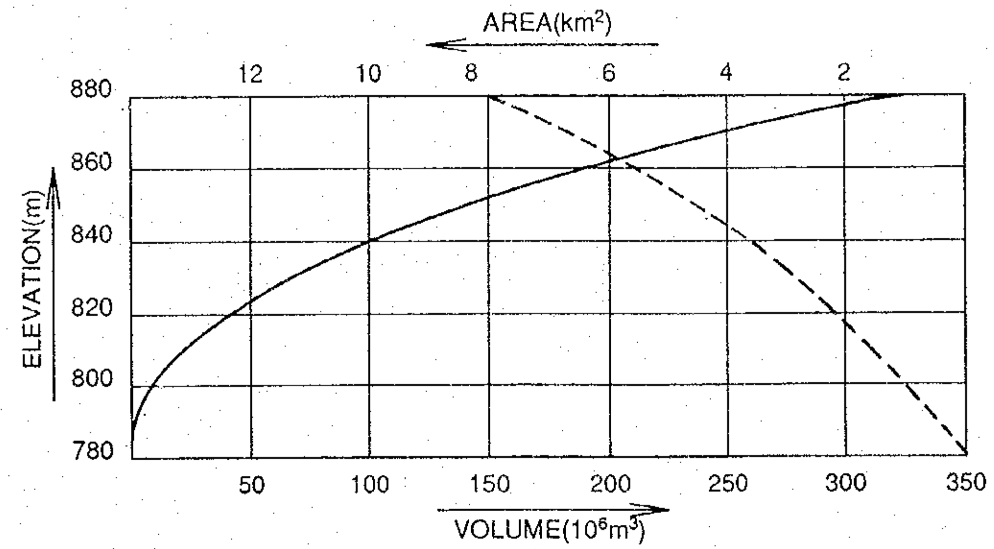
PLAN OF H LAMPHAN GNAI PROJECT



CROSS SECTION AT THE DAM SITE



AREA AND CAPACITY CURVE



ELEVATION (m)	AREA (Km^2)	VOLUME (10^6m^3)
880	8.08	325
860	5.49	190
840	3.53	99
820	2.23	42
800	1.12	8
785	0.00	0

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

H. LAMPHAN GNAI PROJECT

CROSS SECTION OF THE DAM SITE & AREA-CAPACITY CURVE

Fig. 7.3-20

7.4 Selection of Projects for Pre-feasibility Study

In this section, priority projects, on which the pre- feasibility studies are carried out as the second stage of this study, are selected from the development plan inventory for the Se Kong River basin produced in 7.3.

7.4.1 Selection of Candidates for Priority Project

Table 7.4-1 shows the results of project ranking of the 15 projects listed in the development plan inventory study by the following project indicators for project evaluation;

(a) Development scale in installed capacity (MW)
(b) Annual energy generation (GWh)
(c) Total construction cost including transmission lines excluding interest during construction)
(d) Net benefit (B-C)
(e) Cost benefit ratio (B/C)
(f) Unit energy cost (US$/kWh)
(g) Unit construction cost (M.US$/ kW)

Table 7.4-1 also shows the total score of ranking numbers for the combination of ranks of economic indicators (d) to (g), and for the combination of adding indicator (b) to the previous combination, respectively. According to **Table 7.4-1**, the following five development projects are potential candidates for selection as priority projects.

- Se Kong No.4 Project
- Xe Kaman No.1 Project
- Xe Kaman No.3 Project
- Xe Namnoy Project (Midstream and Downstream)
- Houay Katak Tok Project

At this stage, the priority projects for the Pre-feasibility Study are selected from the five projects above. Features of each project are shown in **Table 7.4-2**.

7.4.2 Characteristics of Each Candidate Project

Prior to the selection of the priority projects, the characteristics of the five candidate projects selected in 7.4.1 are evaluated from overall viewpoints.

The indicators in relation to the selection of the priority projects are shown in **Table 7.4-2** for the five candidate projects. The characteristics of each project are examined based on **Table 7.4-2** and the information and data presently available.

(1) Se Kong No. 4 Project

According to **Table 7.4-2**, the B/C of the Se Kong No. 4 project ranks 5th. However, its B-C is ranked 3rd because it is the largest in development scale. On the other hand, as this project requires more investment funding than the other candidates, the procurement of such funds could present problems. Also, of all the candidates, as both the unit energy cost and unit construction cost rank 5th respectively, this project provides relatively expensive energy in proportion among the candidates.

However, if construction costs could be reduced, it would be a rather promising project as it includes a large reservoir which would enable a stable electricity supply. The major part of the construction costs are consumed by the cost of the dam construction. Investigations of the topographic and geological conditions are, therefore, most important to improve the accuracy of the said construction costs.

Considering the topography at the dam site, according to the 1/50,000 topography map, construction of a development plan with a 300m HWL is possible. However, the upper elevation area of the dam axis ridge shows gentle terrain on both banks of the river, so that it might be expected that the scale of dam becomes larger than that estimated by the 1/50,000 maps. In this regard, a study with more accurate topographic maps is required.

Regarding the geological conditions, it is expected that there is no problem with the foundation rock of the riverbed. However, limestone distributions are found in some parts of the dam site, providing the possibility of problems in the watertight integrity of the reservoir. This must be confirmed by geological investigation.

Also, according to information received, there is a coal deposit in the planned reservoir area for which a survey will be conducted. As the accuracy of this information cannot be confirmed at this stage, it is, therefore, necessary to monitor the progress of that survey.

Regarding the river flow data, no data is available at the dam site. The river flow of the Se Kong River's mainstream is, however, being observed at the Attapu gauging station and data for the past approximately five years are available at that station. The river inflow at the dam site can be estimated to a certain accuracy by using these data and the observation data at the Xe Namnoy River.

Regarding the environmental effects, a large area of 145 km^2 would be flooded by a project with a 300m HWL. However, as there is only a relatively small population in the planned reservoir area, the effects on the social environment would not be serious if appropriate mitigation measures are taken. Further environmental research is required, however, on the potential effects on the natural environment.

Regarding the access road to the project site, an existing road does lead to an area relatively near the site. A new, approximately 18 km long road would be required for the construction works of the project and, as the terrain is flat, no problems are presented in this regard.

Of the five candidate projects, next to the Xe Namnoy Project, the Se Kong No.4 Project has the second advantage for the construction of transmission lines.

(2) Xe Kaman No. 1 Project

According to **Table 7.4-2**, the Xe Kaman No. 1 project ranks 3rd in B/C and the best in B-C. This project is a dam type incorporating a large scale reservoir similar to the Se Kong No.4 project. Its capacity scale ranks 3rd, next to the Se Kong No.4 project. Both unit energy cost and unit construction cost per KW rank 4th to provide a better performance than that of the Se Kong No.4 Project.

If construction costs can be reduced, however, it would be a rather promising project as it includes a large reservoir which would enable stable electricity supply. The major part of the construction costs are consumed by the cost of the dam construction.

Also for this project, if the construction cost of the dam can be reduced, it will be a promising project as it includes a large reservoir. Investigations of the topographic and geological conditions are, therefore, important to improve the accuracy of the construction cost in order to confirm its economic viability.

This plan provides better conditions than the Se Kong No. 4 project with regard to the topography and geology of the dam site, and no serious problem has been reported for the time being. However, a limestone distribution near the upstream edge of the reservoir could possibly cause a problem in the watertight integrity of the reservoir.

As there is insufficient river flow data available on the Xe Kaman river at this time, it is necessary to carry out continuous discharge observation to improve the accuracy of the flow estimation for the dam site. Currently, the water levels are being observed at the Ban Foungdeng station situated between the dam site and Attapu township, and it is important both to continue this observation and to carry out discharge measurement with a current meter.

Regarding the affects on the environment, the inundation area is wide at approximately 220 km^2. However, as the population within the planned reservoir area is smaller than that of the Se Kong No. 4 project, the project may not provide so serious impact on the social environment. Further environmental research is required, however, on the potential effects on the natural environment.

Regarding an access road to the project site, the Xe Kaman No.1 Project has a disadvantage in comparison with the Se Kong No. 4 project. There is a road able to handle vehicles to the dam site, but this road can only be used in the dry season, and requires improvement. The road connecting Sekong and Attapu township is also in bad condition. In particular, a new large bridge is required across the Xe Namnoy River. In this regard, as there are plans to improve this road through financial aid provided by ADB, such road development costs are not included in the construction cost in this study. However, future movements in this matter should be observed.

For the construction of transmission line, this project provides less advantage the others following the Xe Kaman No. 3 project which is in worst condition.

(3) Xe Kaman No. 3 Project

The Xe Kaman No. 3 project is proposed as a daily regulation type. As seen in **Table 7.4-2**, its development scale of 79 MW ranks the lowest of the five candidate projects. Its B-C also ranks 5th, which is again the smallest. Although its B/C ranks 2nd, this project, a daily regulation type, is evaluated as a power plant for peak power supply by daily regulation. When this project is equally evaluated in balance with other reservoir type projects, its B/C falls below 1.0. On the other hand, its unit energy cost and construction cost per KW rank 2nd. In this regard, it is a relatively economical project.

There is a problem, however, in the estimation of the discharge data at the project site because there is no flow data available at the vicinity of the site at present. It is possible that the planned power generation cannot be attained when the inflow volume in the dry season is less than that estimated in this study. In this case, the power generation capacity would decrease in the dry season and the exporting electricity price would be set low, which is even more disadvantageous in terms of the economic viability of the project. In this regard, a river flow survey over a reasonably long period is very necessary.

Concerning the environmental effect of the project, the river flow reduction between the dam site and outlet site would represent a problem. There would be almost no problem, however, with the environment overall due to its small development scale.

Regarding an access road and transmission line, this project presents the worst conditions. There are no roads to the project site at the present and an entirely new road exceeding 130 km would be required. Accordingly, the topographical and geological investigations required for the study at the level of the Pre-feasibility Study are practically impossible due to lack of access.

(4) Xe Namnoy Project

The Xe Namnoy project, is a combined project of the Xe Namnoy Midstream project, which is a dam and waterway type incorporating a reservoir with a storage capacity for annual flow regulation, and the Xe Namnoy Downstream project, which is also a dam and waterway type, but is a daily regulation type without a large scale reservoir.

As **Table 7.4-2** shows, as a combined project, its B/C ranks 3rd and its B-C ranks 2nd among the five candidate projects. The development scale of 255 MW is equivalent to the Xe Kaman No.1 project and ranks 3rd. The unit energy cost and construction cost per KW also rank 3rd. This project is superior to the Se Kong No.4 project and Xe Kaman No.1 project in terms of economic viability.

It should be noted that the economic viability of the Xe Namnoy Project depends heavily on whether the site is able to provide an adequate reservoir storage capacity for annual flow regulation because, according to the previous hydrological survey, there is a great difference in the river flow volume between the dry season and the rainy season. Since the topography around the dam and reservoir of the Midstream Project is gentle, it is difficult to accurately estimate the reservoir capacity with 1/50,000 scale topographic maps. Therefore, the development of precise topographic maps covering the entire reservoir area are required.

Regarding the geological conditions of the dam site, basalt distributions are observed in and around the reservoir area of the Midstream Project. Considering the formation process of the Bolaven Plateau, it is very possible that there is a large permeable formation in and under this basalt. Therefore, geological investigation is required to confirm the watertight integrity of the reservoir. There would be no remarkable problems related to the downstream project site.

Regarding the river flow at the dam site, observations of the water level are being carried out at the dam site of the Midstream Project using the water level staff gauge and recorder installed by JICA in 1991, and the necessary data is now being accumulated. It is possible to acquire reasonably accurate discharge data with the existing water level data once the rating curves are clarified by discharge measurements in the rainy season.

Regarding the effect on the environment, the inundation area of the Midstream Project will be approximately 20 km^2. This is about 1/10th those of the Se Kong No.4 and Xe Kaman No.1 Projects. As the population in the reservoir area is also relatively small, no major problem would be provided to the social environment. Although it is expected that there would be no problems with the natural environment thus far, further environmental research is required.

Regarding an access road to the planned site, a road available for vehicles leads to the dam site of the Midstream Project. Although this road does require repair work, it is in relatively good condition. There is no road at this time to the powerhouse site of Midstream Project or to the dam and powerhouse site of the Downstream Project. However, as the distance from the nearest existing road is relatively short, the construction of a new road is not seen as a problem.

Similar to the Se Kong No.4 project, this project's location also provides relatively good conditions for the construction of a transmission line among the five projects.

(5) Houay Katak Tok Project

As shown in **Table 7.4-2**, the Houay Katak Tok project ranks top in terms of B/C. However, its B-C ranks only 4th because its development scale of 105 MW is small in comparison with the other projects. However, as its unit energy cost and construction cost per KW also rank the best, this project is the most superior in terms of economic viability.

This project is planned as a dam and waterway type. However, as this is a development in a river basin with a small catchment area, the reservoir is not overly large. With the inflow volume being small and accordingly, the required storage capacity of the reservoir also small, there is no problem in acquiring the reservoir capacity.

Regarding the site geology, the aerial and literaturel surveys show no serious problems. The dam construction cost would not greatly affect the economic viability of the project because they are relatively small in proportion to the overall construction costs. However, since the project is a high head power generation plan with an available head of approximately 800m, the construction cost of the waterway structures such as the headrace tunnel, penstock, powerhouse, and tailrace tunnel, represent a large portion of the total construction cost, providing the optimum layout and design of these structures is an important factor for the project.

Regarding the flow at the dam site, although there is information that discharge observations have been started recently, the data presently available is quite inadequate. Since the catchment area is small, the local conditions of topography, geology, and climate would greatly effect the river flow and it is possible that the flow resume of the Houay Katak Tok river differs from that of the neighboring Xe Namnoy river. Therefore, the development plan requires certain changes in accord with the results of further discharge observations. It is, therefore, necessary to carry out long-term discharge observations on the Houay Katak Tok river simultaneously with the discharge observation of the Xe Namnoy River.

Regarding the effect on the environment, the inundation area will be approximately 20 km^2, equivalent to that of Xe Namnoy Midstream Project. The environmental effect might be less than that of the Se Kong No.4 and Xe Kaman No.1 projects. As there are only very few villages within the planned reservoir area, there will be very little adverse affect upon the social environment. Also, there would be no major problem with the natural environment. However, further environmental research is required.

The access road to the project site starts at the site of Xe Namnoy Midstream Project. There is no road at present (July 1993) and a new road will be required. For the powerhouse site, the road connecting Sekong and Attapu township is available as an access road. However, it is necessary to construct a new, rather large bridge across the Xe Namnoy River.

The conditions for a transmission line are very similar to those of the Xe Namnoy project.

7.4.3 Selection of Projects for Pre-feasibility Study

In this section, the development projects on which the pre-feasibility studies are carried out in the second stage of this study are selected from the five candidates, considering the characteristics of each candidate project described in 7.4.3.

(1) Development Projects not to be selected

For the following reasons, the Xe Kaman No.3 and Houay Katak Tok Projects are not selected as objectives of the pre-feasibility studies;

a) Xe Kaman No.3 Project

The Xe Kaman No.3 Project is planned as a daily flow regulation type. As this project is evaluated as a power plant for peak power supply and as it has no reservoir for annual regulation, its operation range is limited. Very especially in the dry season, its dependability is greatly decreased. Considering electricity not only as an export item but also for domestic supply in Laos, it is important to develop a reservoir type project able to provide a reliable power supply to the area.

Also, considering the situation of available basic data, especially data related to discharge which requires long-term observation, there are many uncertainties in the project for hydropower planning study.

Taking the above into account, it is difficult to select this project for pre-feasibility study. However, as the Xe Kaman No.3 Project has potential to be a promising project for future development, it is necessary that hydrological investigation be initiated as soon as possible.

b) Houay Katak Tok Project

According to the findings of the current study carried out based on 1/50,000 scale topographic maps, this project does provide the highest economic performance. At present, however, the availability of discharge data is very limited and a great deal of time would be required to collect the discharge data necessary to accurately confirm the economic viability of the project. Also, geological and topographical investigation works are required for the design of the waterway tunnel under the condition of a high head and high pressure and an underground powerhouse in addition to the design of the dam. It is difficult, however, to carry out these investigations in the limited time allotted to this study due to the problem of accessibility to the site.

Taking the above into account, it is considered too early to carry out a Pre-feasibility Study in this study. However, as the Houay Katak Tok Project shows a potential of being a promising project for future development, it is necessary that the preparation of an access road and hydrological investigations are started as soon as possible.

(2) Development Projects to be Selected

Of the five candidate development projects described in 7.4.3, the following three, although they all have certain advantages and disadvantages, show wide potential as priority development projects. It is considered appropriate that Pre-feasibility Study be carried out on these projects, after considering their characteristics and situations of the basic data for the study.

Accordingly, Pre-feasibility Studies are carried out on the three development projects shown below.

- Se Kong No.4 Project
- Xe Kaman No. 1 Project
- Xe Namnoy Project (Midstream and Downstream Projects)

In the Pre-feasibility Study, field investigations such as topographic surveys, geological investigations, hydrological surveys and environmental surveys will be carried out for the three selected projects. The operation planning and optimum development plan of each project will then be studied considering the conditions of the projects including the power demand and power system expansion plan of the related area. Following this, studies at the pre-feasibility level including project design, estimation of project cost, economic evaluation, and financial analysis are performed, based on the data obtained from the above surveys.

Table 7.4-1 Ranking of Development Project

No.	Project	(4-7) Total Point Rank	(4-7) Total Point	(2,4-7) Total Point Rank	(2,4-7) Total Point	(1) Installed Capacity	(2) Annual Energy	(3) Const Cost	(4) B-C	(5) B/C	(6) Energy Cost	(7) Const. Cost/KW
						Number of Ranking						
1	Se Kong No.3	8	33	8	35	2	2	14	8	8	8	9
2	Se Kong No.4	5	21	4	22	1	1	15	3	6	6	6
3	Se Kong No.5	7	28	7	33	5	5	13	6	7	7	8
4	Xe Kaman No.1	4	13	3	17	3	4	12	1	3	5	4
5	Xe Kaman No.2	15	60	15	72	12	12	8	15	15	15	15
6	Xe Kaman No.3	2	11	4	22	11	11	2	5	2	2	2
7	Xe Kaman No.4	12	48	11	55	7	7	11	14	11	12	11
8	Xe Namnoy *	2	11	1	14	3	3	10	2	3	3	3
9	H.Katak Tok	1	7	2	15	8	8	4	4	1	1	1
10	Nam Kong No.1	8	33	9	42	8	9	7	9	8	9	7
11	Nam Kong No.2	11	47	12	60	14	13	3	11	12	11	13
12	Nam Kong No.3	14	54	14	69	15	15	1	12	14	14	14
13	Xe Xou	13	50	13	63	13	13	5	13	12	13	12
14	Dak E Meule **	10	40	10	46	6	6	9	10	10	10	10
15	H.Lamphan Gnai	5	21	6	31	10	10	6	7	5	4	5

* The Xe Namnoy project includes the midstream and downstream projects.

** The Dak E Meule project includes the upstream and midstream projects.

Table 7.4-2 Profile of Candidate Projects

Description	Unit	Se Kong No. 4	Xe Kaman No. 1	Xe Kaman No. 3	Xe Namnoy			Houay Katak Tok
					Midstream	Downstream	Total	
Hydrology								
Catchment Area	km^2	5,400	3,800	655	(529+220) 749	1252+220-199) 1,273	-	199
Annual Inflow Volume	10^6m^3	6,444	4,177	758	1,151	2,209	-	299
Average Inflow	m^3/s	204	132	24	36	70	-	9
Project Structure								
Dam Height × Crest Length	m	155 × 880	170 × 410	30 × 150	50 × 920	30 × 230	-	65 × 260
Tunnel Length	m	--	--	5,000	9,350	3,500	12,850	6,000
Open Channel Length	m	--	--	--	1,400	--	1,400	--
Penstock Length	m	870	580	950	1,390	220	1,610	900
Reservoir								
High Water Level	m	300	280	790	760	280	-	880
Low Water Level	m	291	276	788	741	278	-	869
Gross Storage Capacity	10^6m^3	7,776	16,208	1.5	323	16	-	316
Effective Storage Capacity	10^6m^3	1,287	833	Daily Regulation	255	Daily Regulation	-	142
Regulation Ratio	%	20	20	--	22	--	-	47
Regulated Firm Flow	m^3/s	144	93	6.0	25.0	33.4	-	8.4
Power Generation Plan								
Tail Water Level	m	160	118	380	280	200	-	100
Maximum Gross Head	m	145	162	410	480	80	560	780
Net Head	m	140	159	385	446	74	520	730
Maximum Discharge	m^3/s	288	186	24	50	100	-	16.7
Installed Capacity	MW	346	255	79	192	63	255	105
Peak Power Duration	Hours	12	12	6	12	6	12	12
Firm Peak Capacity[2)]	MW	331	250	79	186	63 (42)[3)]	228	104
Annual Energy	GWH	1,925	1,354	441	1,161	338	1,499	550
Plant Factor	%	63	61	63	69	61	67	60
Project Economy								
Construction Cost[1)]	$10^6\$$	754.9	520.7	118.5	313.6	116.0	429.6	137.6
Net Benefit (B-C)[2)]	$10^6\$$	17.6	29.6	12.1	23.2	8.9 (1.3)[3)]	24.5	15.7
Benefit Cost Ratio (B/C)[2)]	--	1.21	1.52	1.93	1.67	1.70 (1.11)[3)]	1.52	2.03
Energy Cost	¢/kWh	4.31	4.23	2.95	2.97	3.78	3.15	2.75
Construction Cost per kW	$/kW	2,182	2,045	1,491	1,637	1,828	1,685	1,312

1) Including transmission line cost and excluding interest during construction.
2) Calculated applying the peak power duration corresponding to each project.
3) Figures evaluated with the condition of 12 hours peak power duration.