CHAPTER 7 CONSTRUCTION OF SOUTHWARD DIVERSION

7.1 Diversion Discharge

From the Chapter 5, the peak flood in Khlong Wa after construction of flood control dam and Phru Phli Khwai retarding basin is reduced to 118 cms. and it is closed to the existing capacity at the end of Khlong Wa. If the diversion channel D.6 divert runoff from Khlong Rian about 50 cms. to Khlong Wa, the runoff in Khlong Wa will increase to 168 cms. that is exceeded the existing capacity at the end of Khlong Wa.

In order to control runoff at the end of Khlong Wa to fit the existing capacity, the excess runoff will be diverted to Khlong U-Taphao or another basin. The southward diversion line will divert runoff from Khlong Wa to upstream retarding basin of Khlong U-Taphao located upper the highway No. 43. The southward diversion will be diverting runoff about 50 cms. from Khlong Wa to Khlong U-Taphao.

7.2 Routes, Profile and Cross-section

The southward diversion will start from Khlong Wa about Km. 5+000, the lines will pass Ban Khlong Wa and many houses. This line will cross the 2 highway namely, Highway No. 4 and Highway No. 43 and one railway line (Hat Yai - Padang Besa).

The field survey for selected southward diversion line selection was done and the alignment is changed due to existing village located. The final selected are 2 existing small steams and village road in Ban Phru Sub-district municipality, the routes and profile shown in Fig. 7.2-1 and Fig. 7.2-2 respectively.

7.3 Diversion Channel and Appurtenant Structures

The main features of Southward diversion line will be open channel and tunnel, as follow:

- 0+000 - 1+000	Open channel	slope 1:1,000
- 1+000 - 1+900	Open and close box culvert 4.00 x 4.00	slope 1:400
- 1+900 - 2+700	Tunnel ϕ 4.50 m.	slope 1:400
- 2+700 - 3+000	Open and close box culvert 4.00 x 4.00	slope 1:400
- 3+000 - 3+650	Open channel	slope 1:1,000

7.4 Construction Cost

(1) Tunnel	diameter	4.50	m.
	length	900	m.
	unit cost	0.106	mB/m.
	Total Cost	95.4	mB.

(2) Box culvert size 4.00 x 4.00 m.
length 1,200 m.
unit cost 0.05 mB/m.
Total Cost 60 mB.

(3) Open Channel
length 1,650 m.
unit cost 0.005 mB/m.
Total Cost 8.25 mB.

(4) Total Budget

The construction cost (not include Land Acquisition)

- Tunnel	=	95.40	mB.
- Box culvert	=	60.00	mB.
- Open channel	=	8.25	mB.
		163.65	mB.
Say	=	165	mB.

7.5 Comparison Cost with improvement of existing Khlong Wa

From Chapter 5, the total cost for improvement of existing Khlong Wa is 29 mB. but the southward diversion cost in item 7.4 is 165 mB (not included Land Acquisition).

So, the southward diversion line is unappropriated for construction due to expensive cost.

CHAPTER 8 NON STRUCTURAL MEASURES

8.1 Flood Risk Map in Khlong Wa Flood Plain

From modeling study, the water level in flood plain of Khlong Wa basin for various flood return periods are calculated. Figure 3.2-1 in Appendix B shows the boundary of flood plain in 5 years, 25 years return periods and flood in year 2000. The 5 years return period boundary is considered as the flood risk water level in Khlong Wa basin

8.2 Flood Warning System of Khlong Wa

The bed slope of Khlong Wa is very steep, the velocity range is between 1.12 m/s to 3.76 m/s. The peak runoff flows from Na Mom district to Hat Yai Municipality, distance around 11+690 km. take time about 2.90 hrs. To 0.86 hr. Or average 2 hrs.

Hence, the flood warning system in Khlong Wa basin is ineffective due to time limitation. In case of flash flood, only broadcasting by village radio tower can be done for people around risk area. It should be operated especially on rainy season or heavy rain.

Table 3.1-1 Characteristic of Identified Flood Control Dam

Item No.	Name	Catchment Area sq.km	Location of Dam Site				Water Surface		Volume of Reservoir MCM.	Dam Charecteristic		
			Co-ordinate	Sheet No.	Latitude	Longitude	Elev. m.msl.	Area sq.km		Crest m.msl.	Length m.	Height m.
1	Khlong Ban Phli Khwai Dam	7.125	726 - 716	5122 IV	6° - 58' - 42.39"	100° - 33' - 44.27"	20.00	0.631	0.499	22.00	500	4.00
2	Upper Khlong Muang Dam	10.375	744 - 728	5122 IV	6° - 59' - 21.85"	100° - 34' - 45.05"	40.00	0.508	1.518	42.00	700	12.00
3	Lower Khlong Muang 1 Dam	12.350	738 - 715	5122 IV	6° - 58' - 38.48"	100° - 34' - 24.25"	20.00	0.235	0.118	22.00	500	3.10
4	Lower Khlong Muang 2 Dam	20.600	735 - 712	5122 IV	6° - 58' - 29.67"	100° - 34' - 16.77"	20.00	0.661	0.442	22.00	830	3.50
5	Upper Khlong Ban Sae Dam	5.450	758 - 694	5122 IV	6° - 57' - 29.67"	100° - 35' - 29.25"	40.00	0.254	0.447	43.00	600	8.00
6	Lower Khlong Ban Sae Dam	5.850	755 - 695	5122 IV	6° - 57' - 33.91"	100° - 35' - 19.18"	40.00	0.499	1.271	43.00	750	10.50
7	Lower Khlong Ko Wao Dam	4.625	744 - 684	5122 IV	6° - 56' - 57.39"	100° - 34' - 43.75"	40.00	0.200	0.456	42.00	180	9.50
8	Upper Khlong Ko Wao Dam	3.175	756 - 675	5122 IV	6° - 56' - 26.74"	100° - 35' - 24.38"	65.00	0.365	2.385	68.00	680	20.50
9	Lower Khlong Wa Dam	27.800	736 - 674	5122 IV	6° - 56' - 24.46"	100° - 34' - 16.77"	40.00	0.645	1.494	43.00	300	10.50
10	Khlong Hin Dam Dam	4.850	753 - 666	5122 IV	6° - 55' - 58.37"	100° - 35' - 13.65"	70.00	0.384	3.222	73.00	350	24.00
11	Khlong Ba Dam	1.150	750 - 663	5122 IV	6° - 55' - 47.78"	100° - 35' - 03.90"	70.00	0.087	0.626	73.00	180	20.00
12	Upper Khlong Wa Dam	18.600	733 - 658	5122 IV	6° - 55' - 31.63"	100° - 34' - 07.67"	70.00	0.828	8.159	73.00	850	30.00
							75.00	1.061	12.882	78.00	980	35.00
							80.00	1.522	19.341	83.00	1,100	40.00

Remarks.

1. Location and Elevation base on Topographic map with scale of 1:50,000 in Map Series No. L 7017, Sheet No. 5122 IV by Royal Thai Survey Department

2. Normal Freeboard used 3.00 meters and used 2.00 meters for small catchment area or near village.

Table 3.1-2 Flood Peak and Volume of Flood in 7 day

Item No.	Name	Catchment Area sq.km	5 Yrs.		10 Yrs.		15 Yrs.		25 Yrs.		50 Yrs.		100 Yrs.		200 Yrs.		500 Yrs.		Yr. 2000	
			Q_{peaks} cms.	Acc. Vol. MCM.	Q_{peaks} cms.	Acc. Vol. MCM.	Q_{peaks} cms.	Acc. Vol. MCM.	Q_{peaks} cms.	Acc. Vol. MCM.	Q_{peaks} cms.	Acc. Vol. MCM.	Q_{peaks} cms.	Acc. Vol. MCM.	Q_{peaks} cms.	Acc. Vol. MCM.	Q_{peaks} cms.	Acc. Vol. MCM.	Q_{peaks} cms.	Acc. Vol. MCM.
1	Khlong Ban Phli Khwai Dam	7.125	6.943	0.926	10.342	1.290	12.679	1.523	15.370	1.815	19.175	2.233	23.133	2.665	26.944	3.105	31.970	3.705	30.079	3.469
2	Upper Khlong Muang Dam	10.375	10.111	1.348	15.059	1.879	18.462	2.231	22.382	2.644	27.931	3.251	33.685	3.880	39.234	4.521	46.552	5.395	43.799	5.051
3	Lower Khlong Muang 1 Dam	12.350	12.035	1.605	17.926	2.236	21.976	2.656	26.642	3.147	33.236	3.870	40.097	4.618	46.703	5.381	55.414	6.422	52.137	6.013
4	Lower Khlong Muang 2 Dam	20.600	20.075	2.677	29.901	3.730	36.657	4.430	44.439	5.249	55.438	6.456	66.883	7.704	77.901	8.976	92.431	10.712	86.966	10.030
5	Upper Khlong Ban Sae Dam	5.450	5.311	0.708	7.911	0.987	9.698	1.172	11.757	1.389	14.667	1.708	17.695	2.038	20.610	2.375	24.454	2.834	23.008	2.653
6	Lower Khlong Ban Sae Dam	5.850	5.701	0.760	8.491	1.059	10.410	1.258	12.620	1.491	15.743	1.833	18.994	2.188	22.122	2.549	26.249	3.042	24.697	2.848
7	Lower Khlong Ko Wao Dam	4.625	4.507	0.601	6.713	0.838	8.230	0.995	9.977	1.178	12.447	1.449	15.016	1.730	17.490	2.015	20.752	2.405	19.525	2.252
8	Upper Khlong Ko Wao Dam	3.175	3.094	0.413	4.608	0.575	5.650	0.683	6.849	0.809	8.544	0.995	10.308	1.187	12.007	1.383	14.246	1.651	13.404	1.546
9	Lower Khlong Wa Dam	27.800	27.092	3.613	40.352	5.034	49.469	5.978	59.972	7.084	74.814	8.712	90.260	10.396	105.128	12.114	124.738	14.456	117.361	13.535
10	Khlong Hin Dam Dam	4.850	4.726	0.630	7.040	0.878	8.630	1.043	10.463	1.236	13.052	1.520	15.747	1.814	18.341	2.113	21.762	2.522	20.475	2.361
11	Khlong Ba Dam	1.150	1.121	0.149	1.669	0.208	2.046	0.247	2.481	0.293	3.095	0.360	3.734	0.430	4.349	0.501	5.160	0.598	4.855	0.560
12	Upper Khlong Wa Dam	18.600	18.126	2.417	26.998	3.368	33.098	4.000	40.125	4.739	50.056	5.829	60.390	6.956	70.337	8.105	83.457	9.672	78.522	9.056

Table 3.3-1 Summary of reservoir Routing in Upper Khlong Wa Dam

Return Period	$Q_{peak\ (cms.)}$	Crest length	Case 1		Case 2		Case 3	
		m	Qoutflow-cms.	H - m.	Qoutflow-cms.	H - m.	Qoutflow-cms.	H - m.
100 Yrs	60.39	15	19.513	0.83	34.831	1.222	35.957	1.248
		20	22.094	0.744	37.234	1.054	38.064	1.07
		25	24.261	0.683	39.139	0.939	39.32	0.942
Year 2000	78.522	15	45.123	1.408	46.858	1.489	48.287	1.519
		20	47.764	1.245	49.963	1.283	50.536	1.292
		25	51.303	1.125	52.601	1.144	52.629	1.144
25 Yrs	40.125	20	0.273	0.044	22.706	0.758	24.836	0.805
50 Yrs	50.056	20	9.337	0.419	30.291	0.919	31.181	0.937
100 Yrs	60.390	20	22.094	0.744	37.234	1.054	38.064	1.070
200 Yrs	70.337	20	38.438	1.077	44.133	1.181	44.864	1.194
500 Yrs	83.457	20	52.33	1.323	53.605	1.344	54.331	1.356
Yrs. 2000	78.522	20	47.764	1.245	49.963	1.283	50.536	1.292

Table 6.3-1 Hydraulic Design of Tunnel for the Diversion Scheme No. 1

Km.	Diameter (m)	Longitudinal Slope (1:LS)	Flow Velocity (m/s)	Design Discharge (cms.)	Invert Elevation (m.msl.)
10+312					+4.356
	4.5	1 : 600	2.94	45	
8+980					+2.136
	4.6	1 : 600	2.99	50	
8+520					+1.369
	4.6	1 : 600	2.99	50	
7+580					-0.198
	5.0	1 : 700	2.92	55	
6+900					-0.773
	5.0	1 : 700	2.92	55	
6+510					-1.330
	6.5	1 : 1,400	2.46	80	
5+850					-1.802
	6.5	1 : 1,400	2.46	80	
4+980					-2.423
	6.5	1 : 1,000	2.9	95	
4+400					-3.003
	6.5	1 : 1,000	2.9	95	
3+700					-3.703

Note - The tunnel inside surface is concrete-lined.

- The manning : n is 0.015
- Diameter Length

(m.)	(m.)
4.5	1,332
4.6	1,400
5.0	1,070
6.5	2,810
Total length	6,612

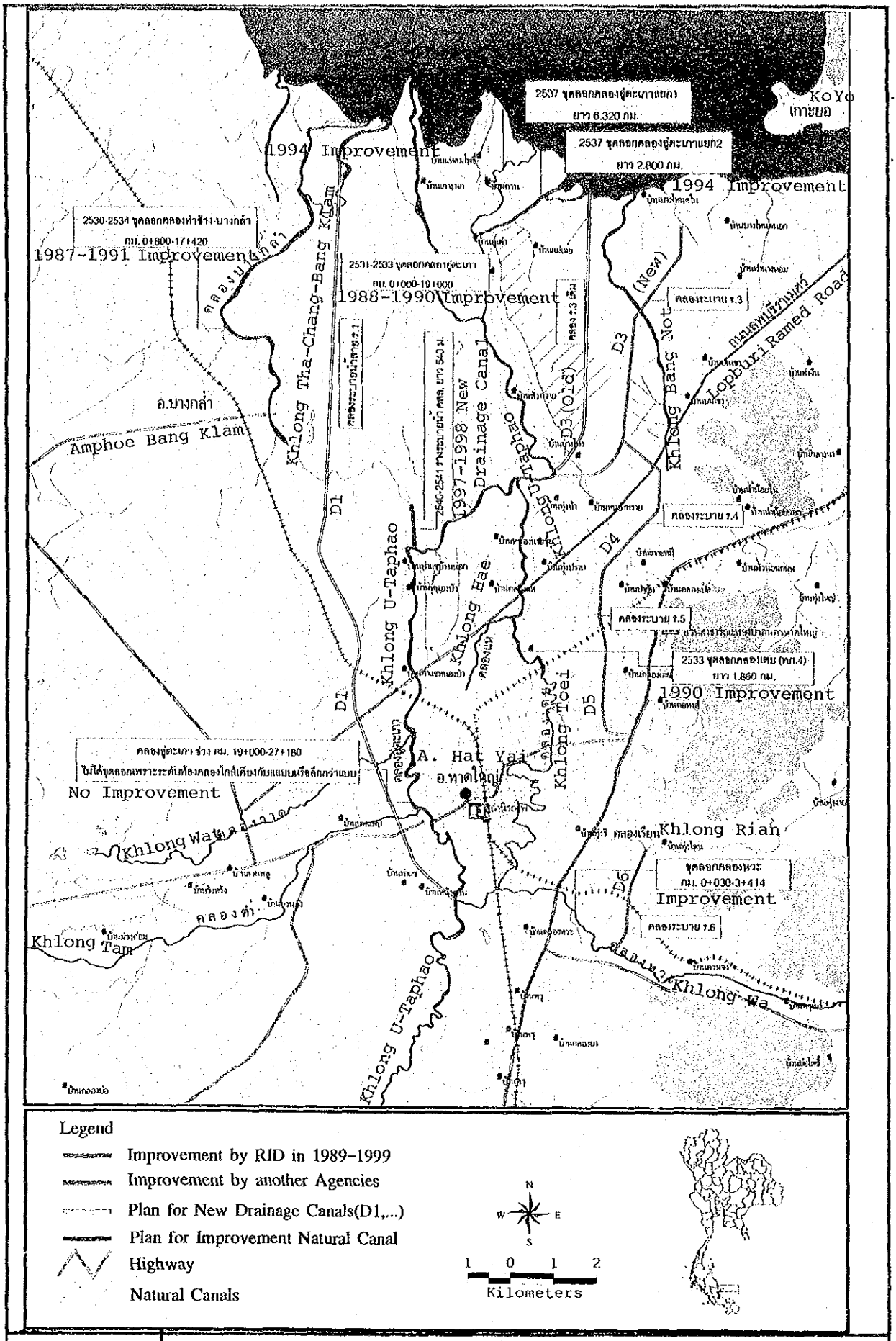


Fig. 1.1-1 Drainage Canals for Flood Mitigation Plan

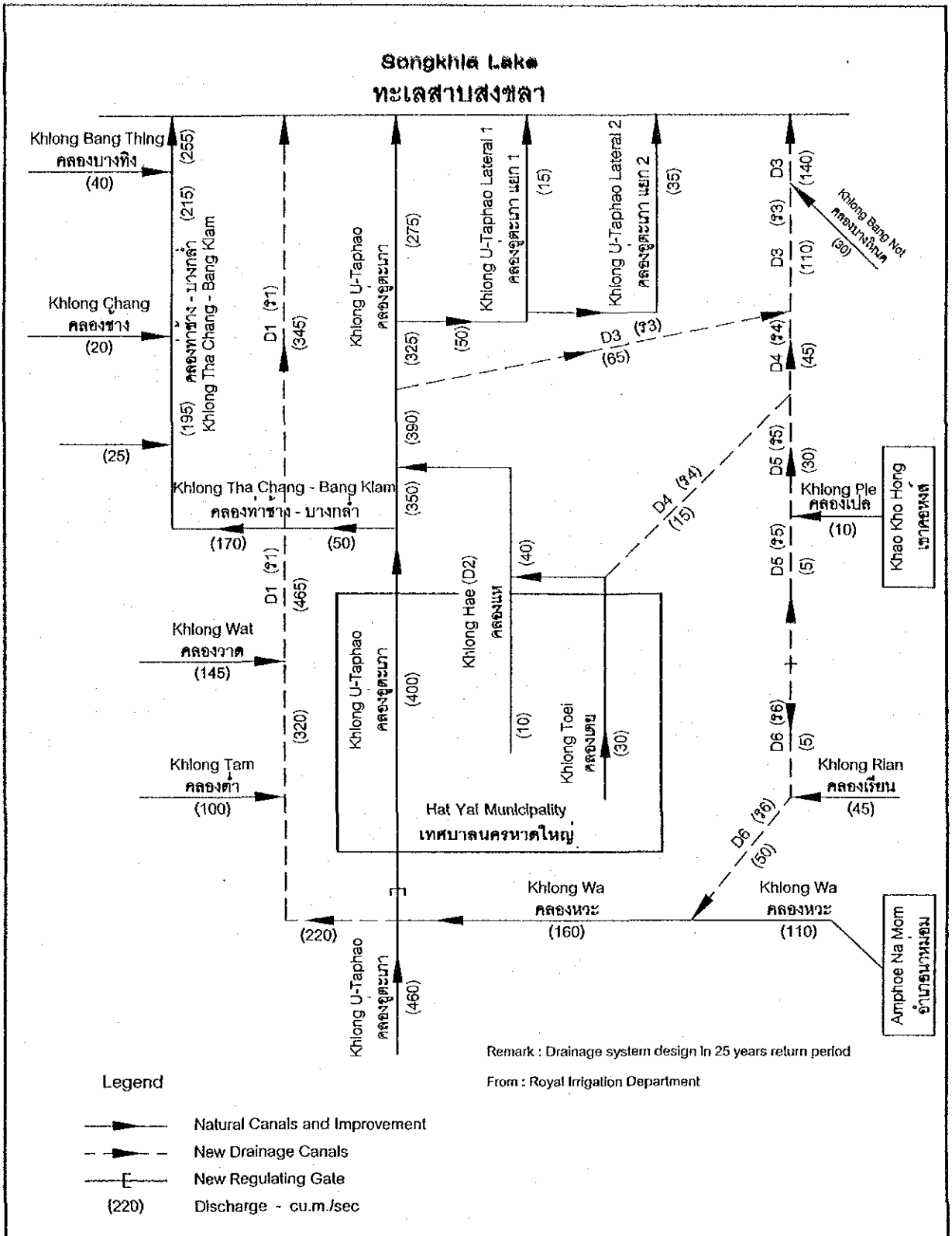


Figure 1.1-2	Schematic Diagram for Drainage System in The Flood Mitigation Plan for Hat Yai Municipality

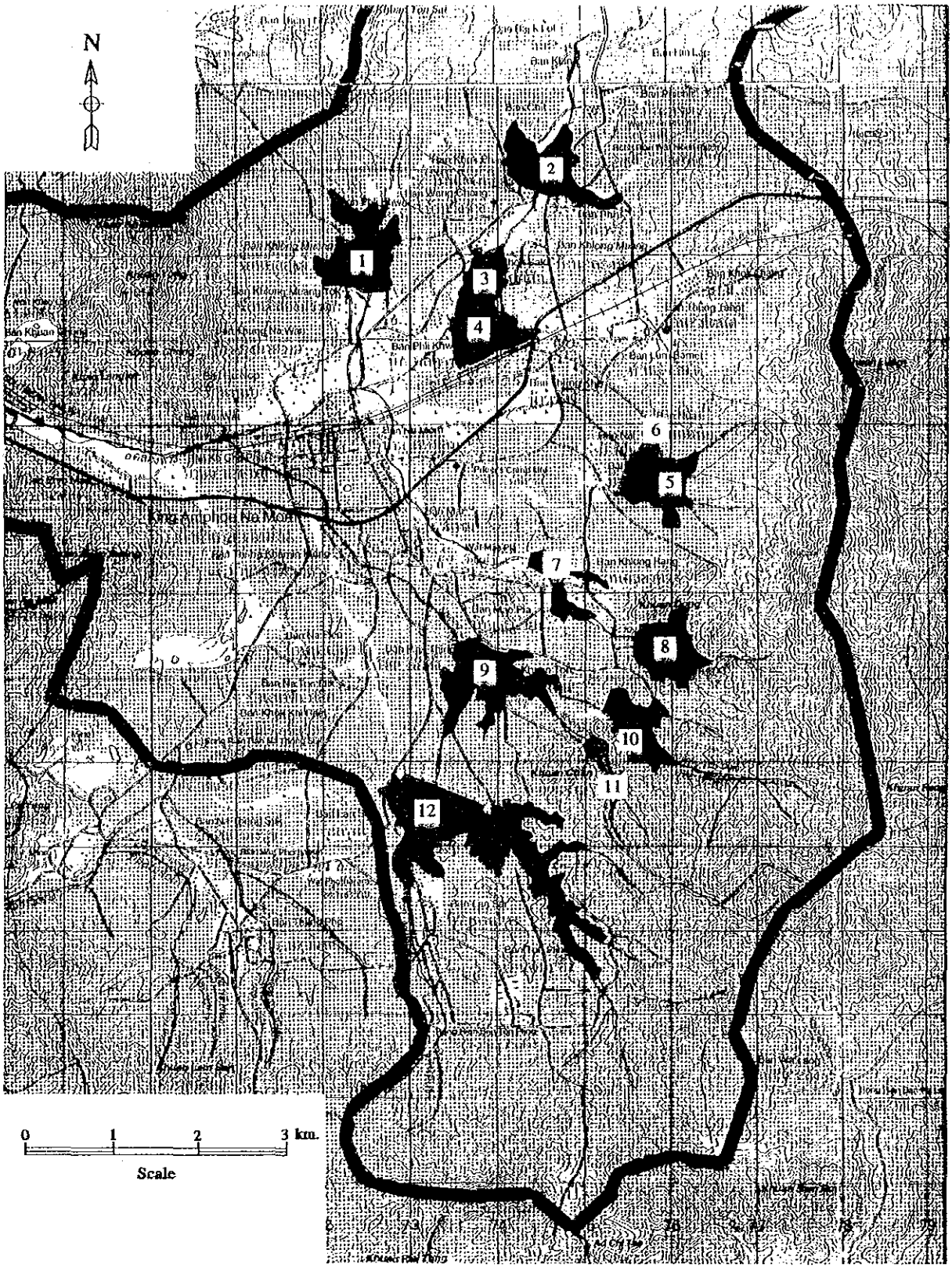


Fig. 3.1-1	Location of Identified Flood Control Dam

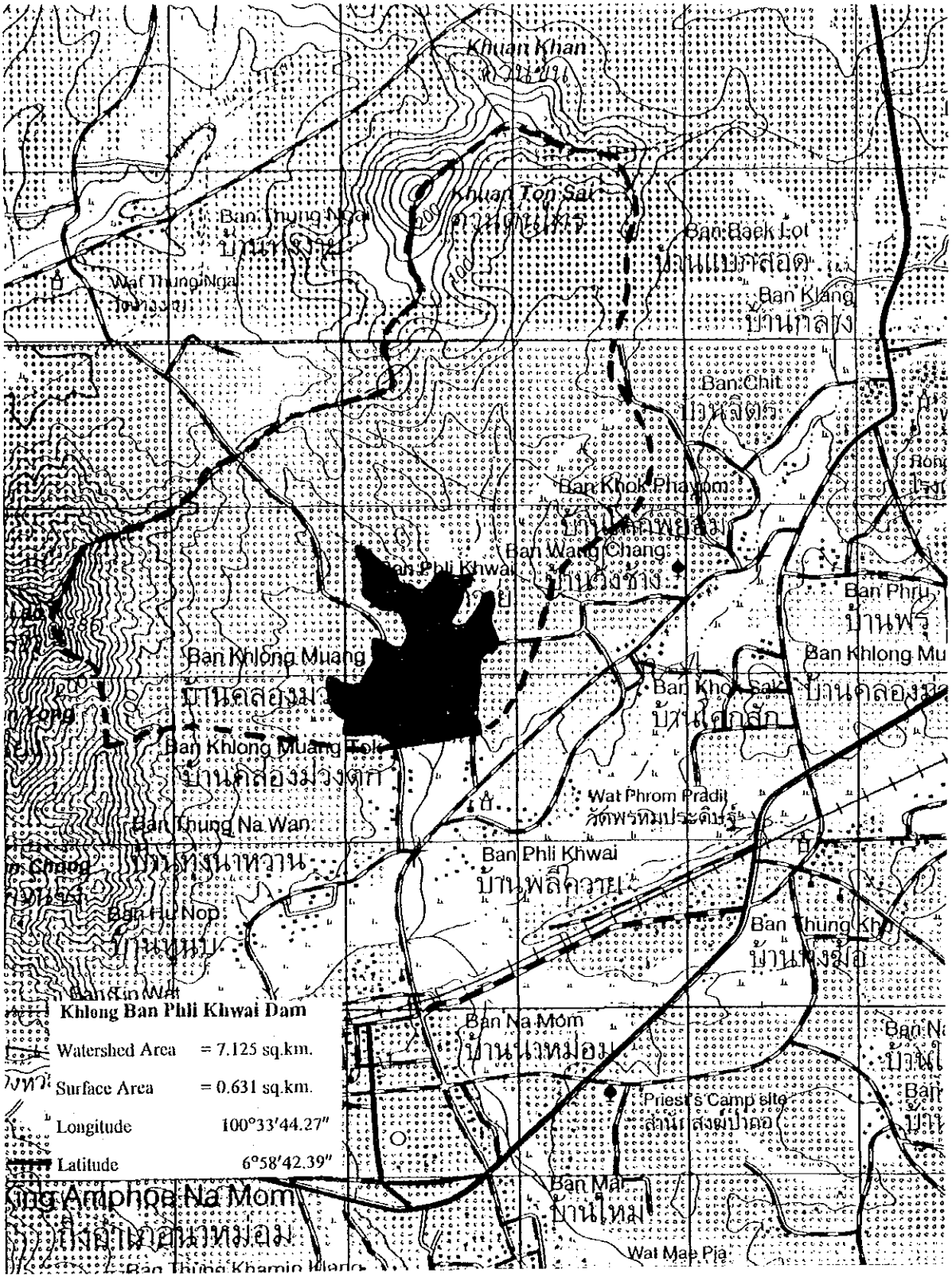
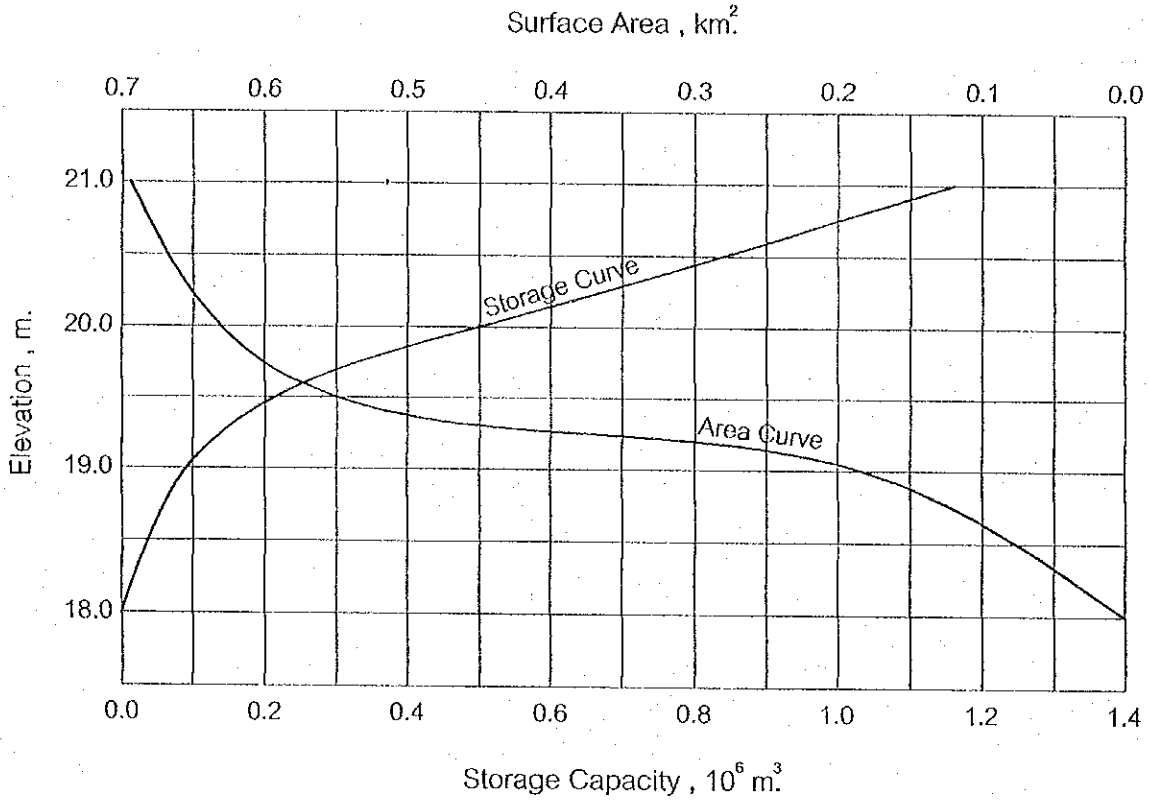


Fig. 3.1–2	Location of Flood Control Dam No.1: Khlong Ban Phli Khwai Dam



Elev. (m.)	Area (km^2.)	Capacity (10^6 m^3.)
18.00	0	0
19.00	0.184	0.092
20.00	0.631	0.499
21.00	0.694	1.161

Fig. 3.1-3	Area - Capacity of Khlong Ban Phli Khwai Dam

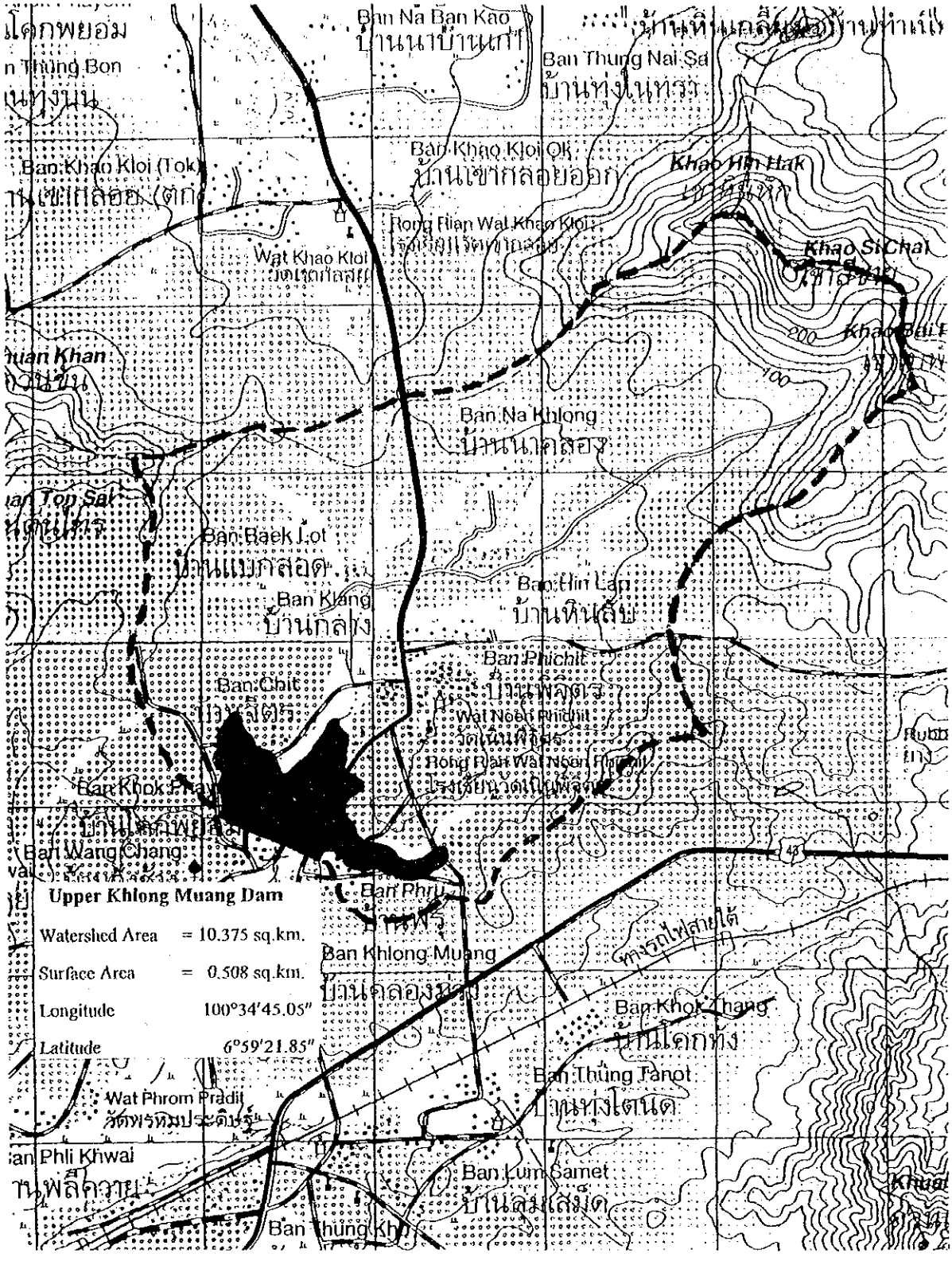
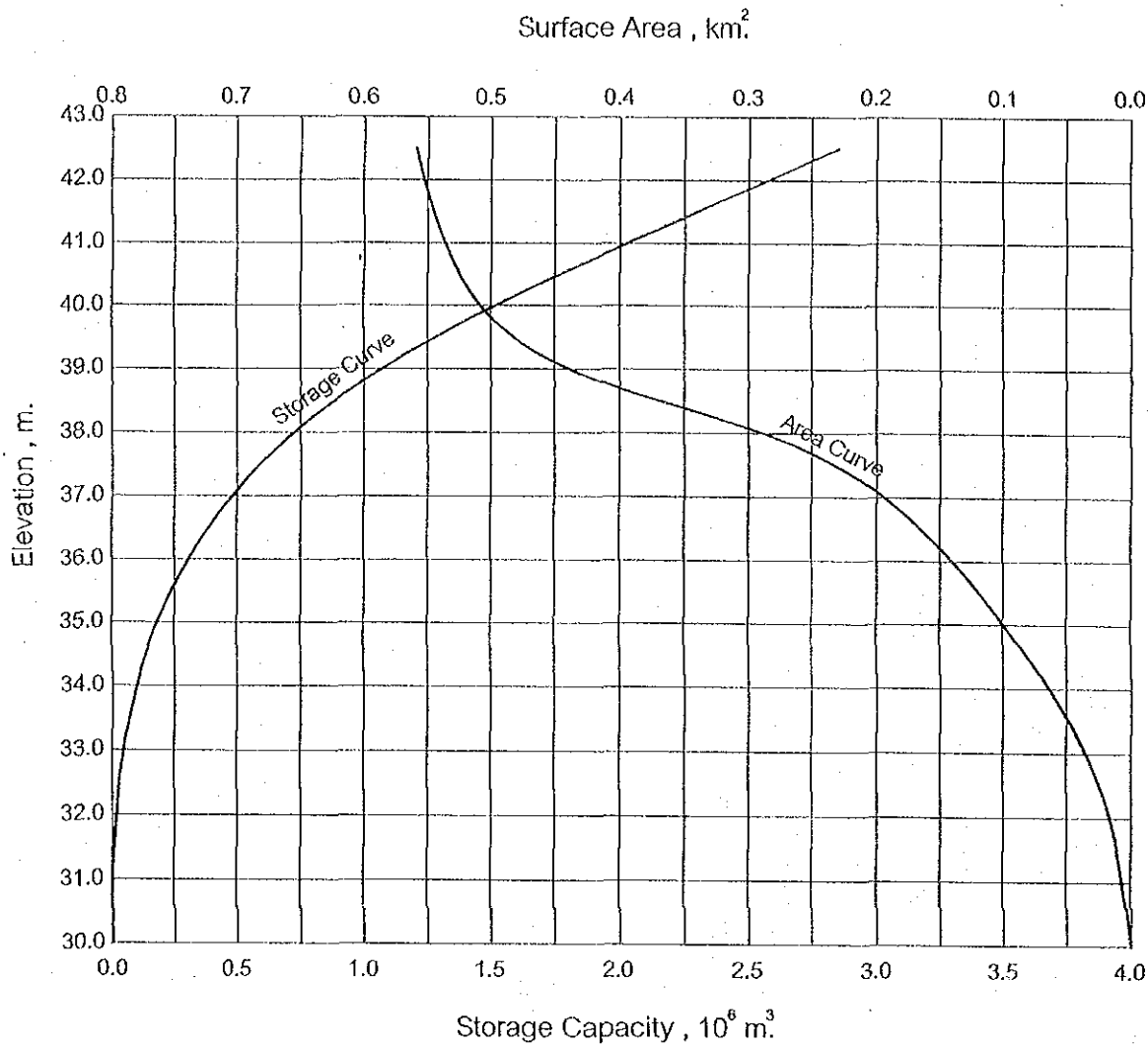


Fig. 3.1-4	Location of Flood Control Dam No.2: Upper Khlong Muang Dam



Elev. (m.)	Area (km^2)	Capacity ($10^6 m^3$)
30.00	0	0
32.50	0.024	0.029
35.00	0.099	0.182
37.50	0.231	0.594
40.00	0.508	1.518
42.50	0.559	2.852

Fig. 3.1-5	Area - Capacity of Upper Khlong Muang Dam

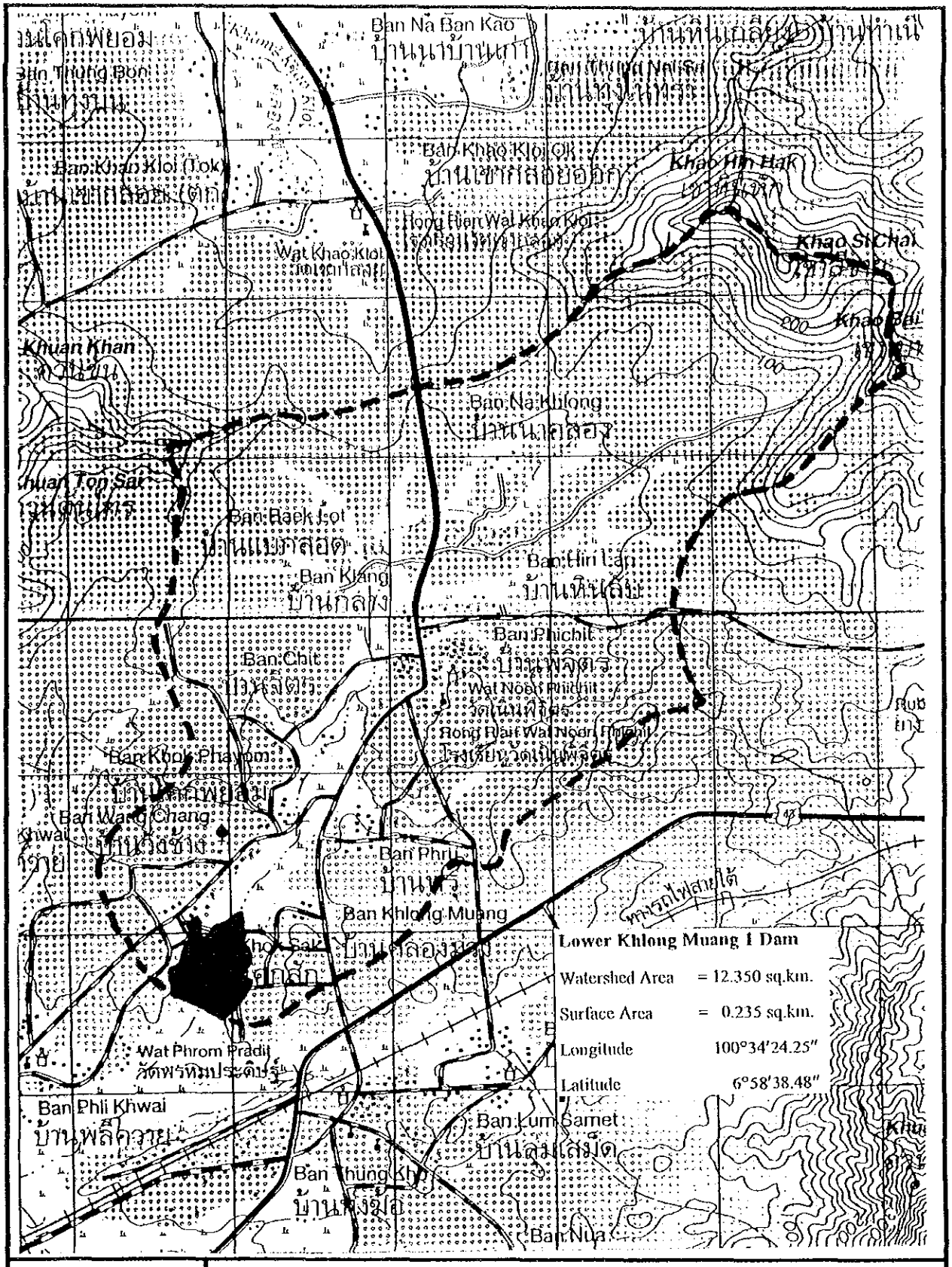
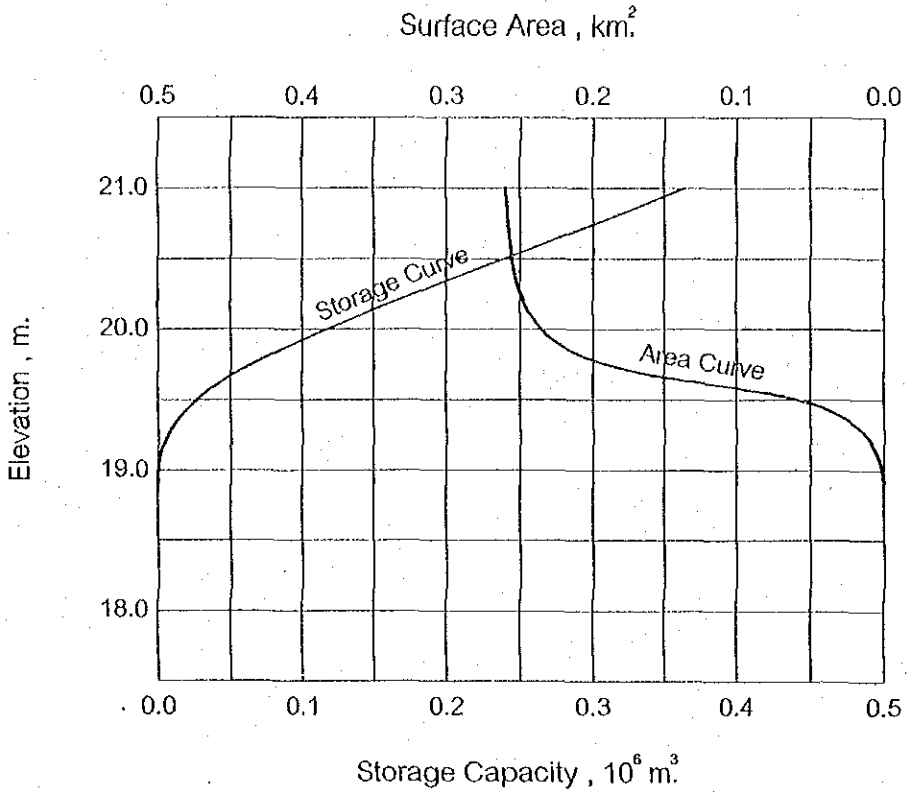


Fig. 3.1-6	Location of Flood Control Dam No.3: Lower Khlong Muang 1 Dam



Elev. (m.)	Area (km^2)	Capacity ($10^6 m^3$)
18.90	0	0
19.00	0.001	0.001
20.00	0.235	0.118
21.00	0.259	0.365

Fig. 3.1-7	Area - Capacity of Lower Khlong Muang 1 Dam

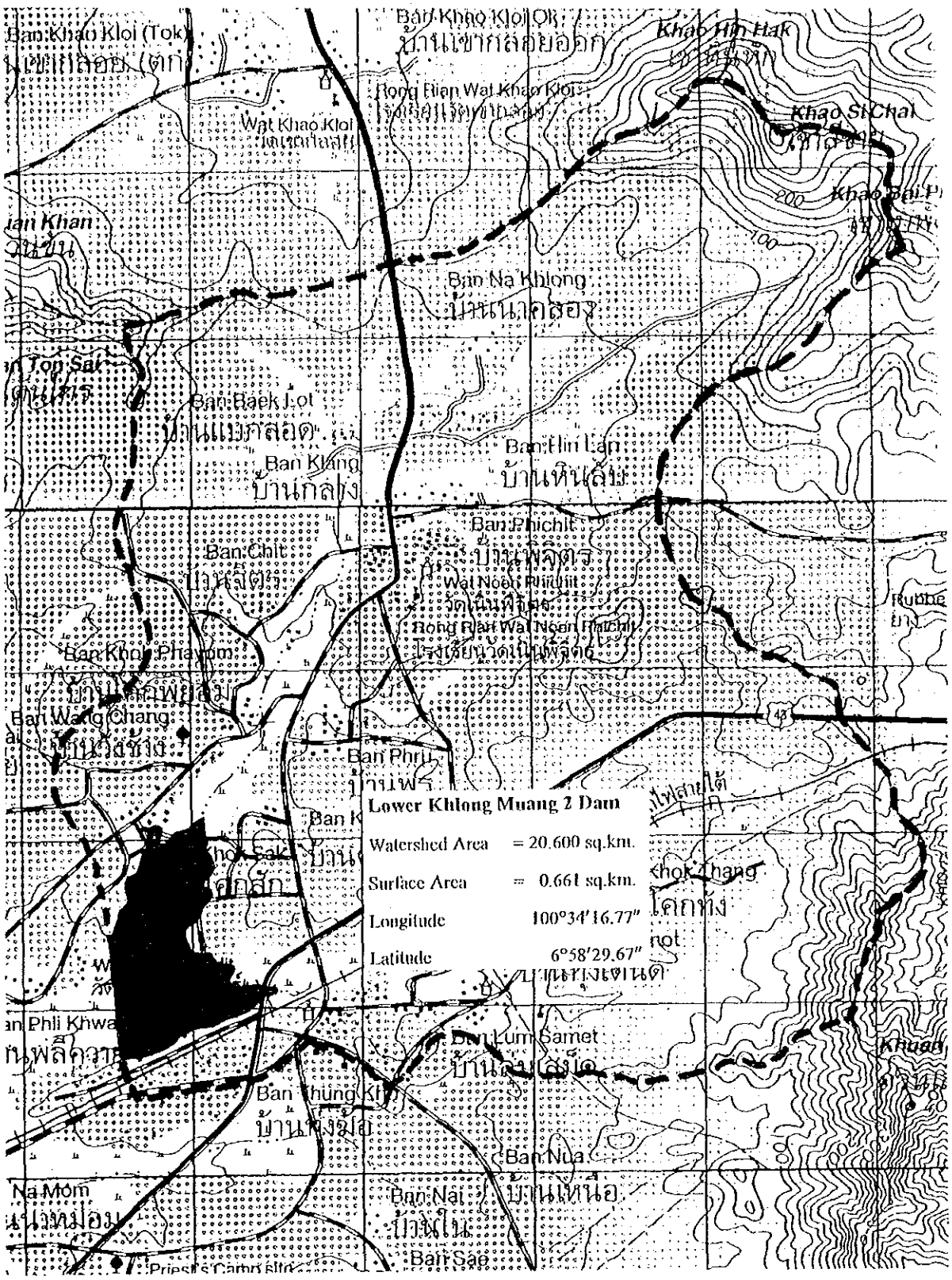
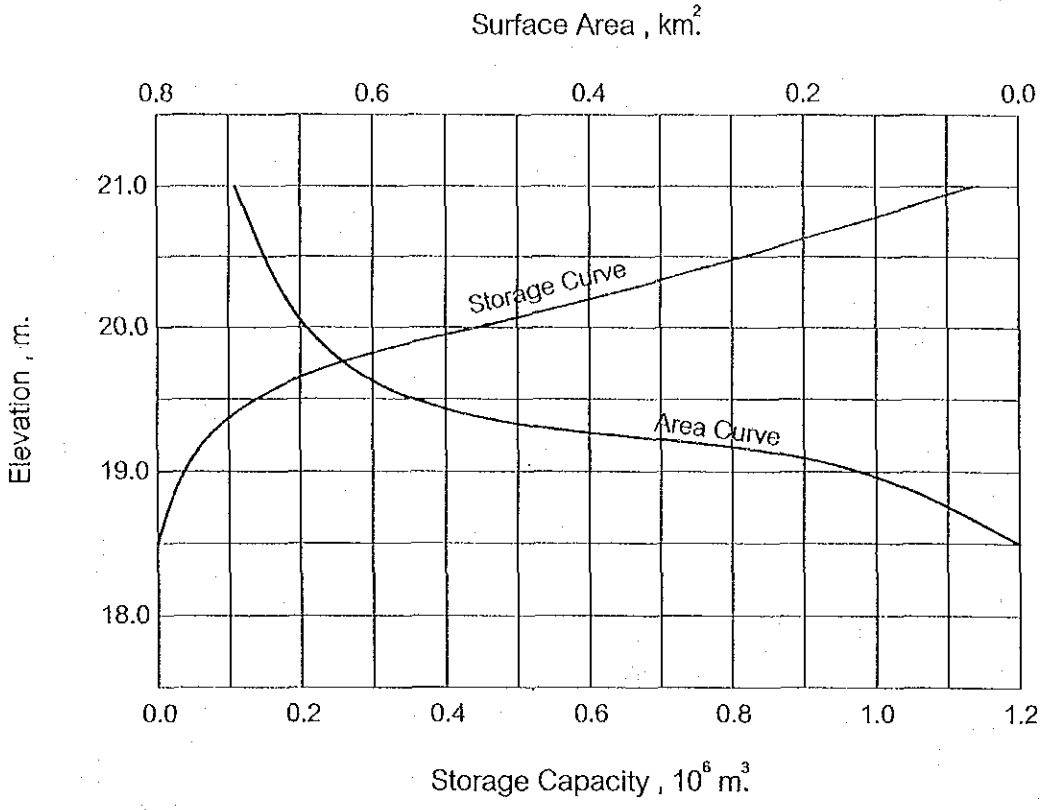


Fig. 3.1-8	Location of Flood Control Dam No.4: Lower Khlong Muang 2 Dam



Elev. (m.)	Area (km^2.)	Capacity (10^6 m^3.)
18.50	0	0
19.00	0.148	0.037
20.00	0.661	0.442
21.00	0.727	1.136

Fig. 3.1-9	Area - Capacity of Lower Khlong Muang 2 Dam

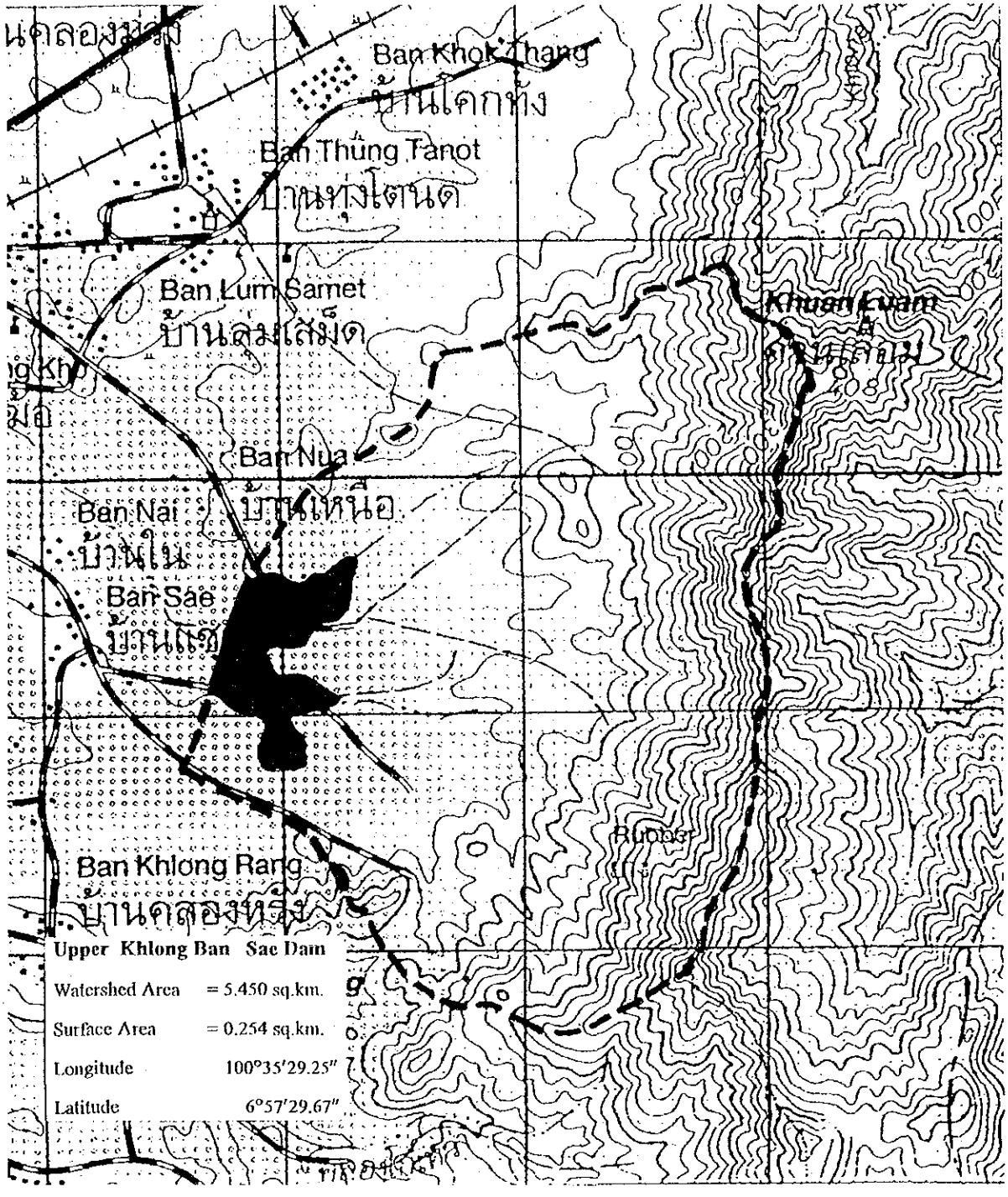
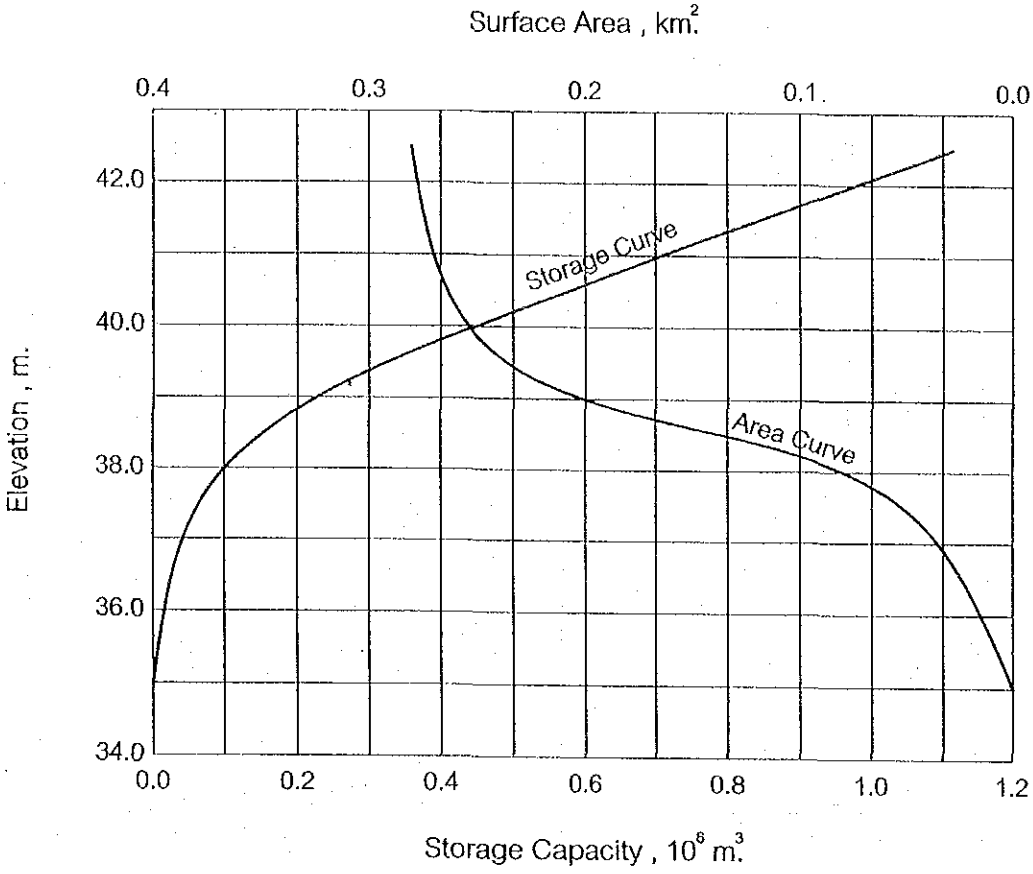


Fig. 3.1–10	Location of Flood Control Dam No.5: Upper Khlong Ban Sae Dam



Elev. (m.)	Area ($km.^2$)	Capacity (10^6 $m.^3$)
35.00	0	0
37.50	0.052	0.065
40.00	0.254	0.447
42.50	0.280	1.114

Fig. 3.1-11	Area - Capacity of Upper Khlong Ban Sae Dam

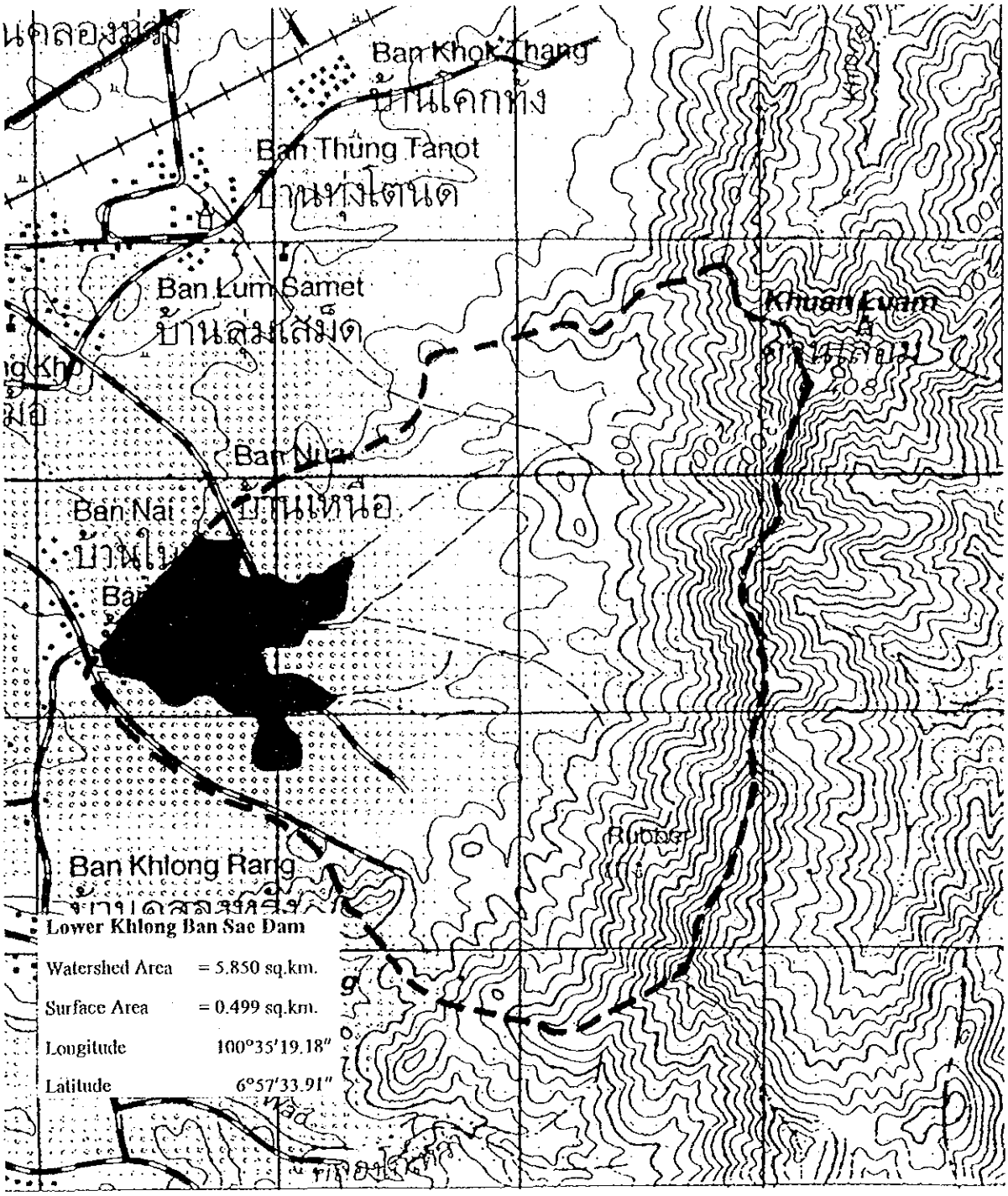
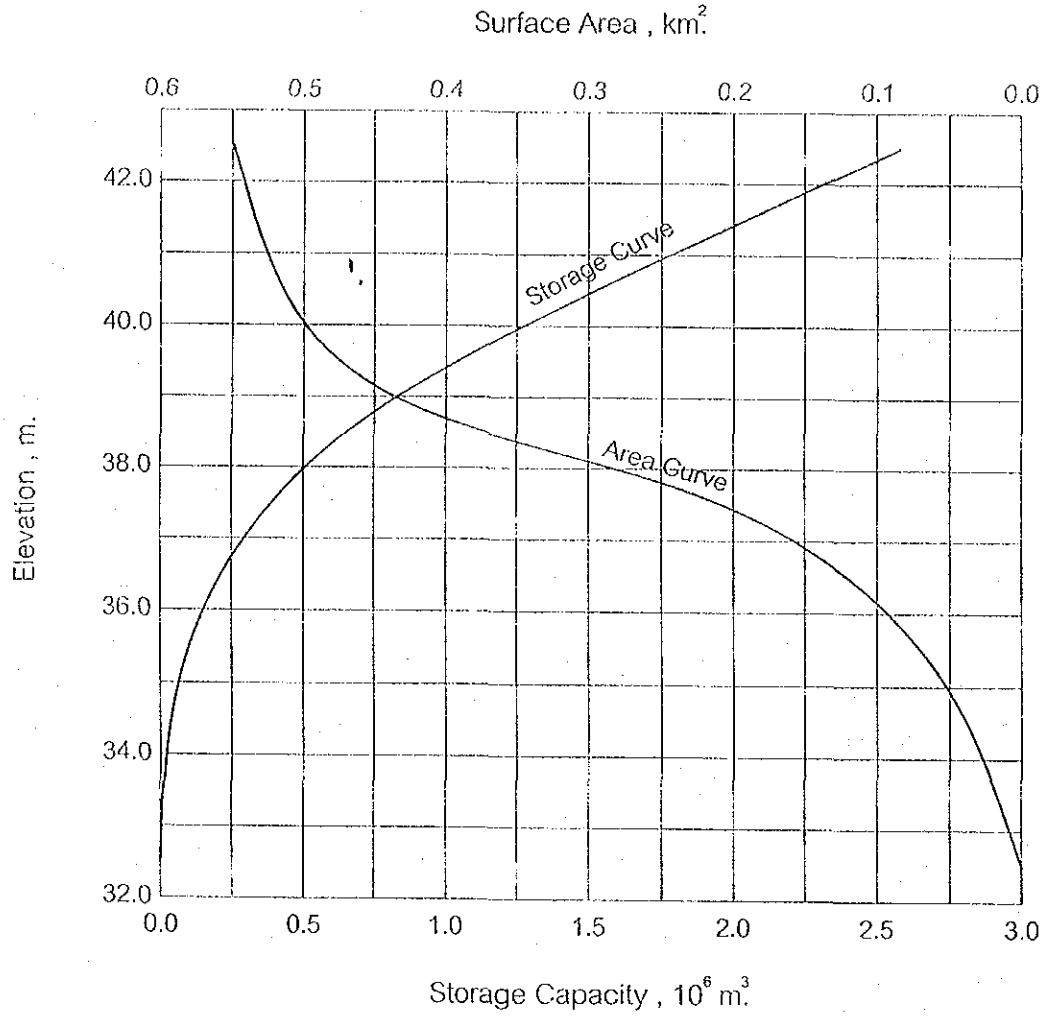


Fig. 3.1-12	Location of Flood Control Dam No.6: Lower Khlong Ban Sae Dam



Elev. (m.)	Area (km^2)	Capacity ($10^6 m^3$)
32.50	0	0
35.00	0.052	0.065
37.50	0.207	0.388
40.00	0.499	1.271
42.50	0.549	2.580

Fig. 3.1-13	Area - Capacity of Lower Khlong Ban Sae Dam

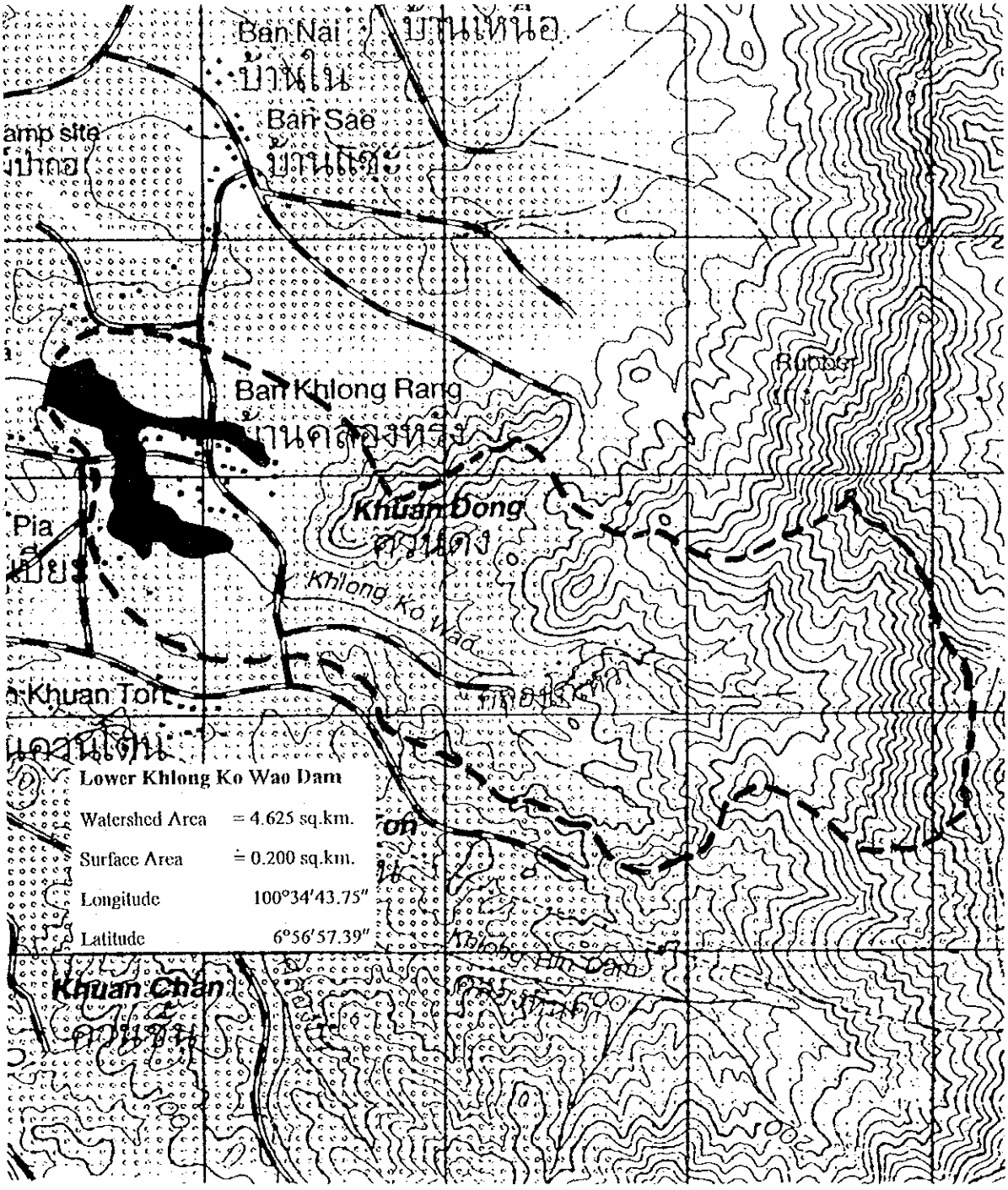
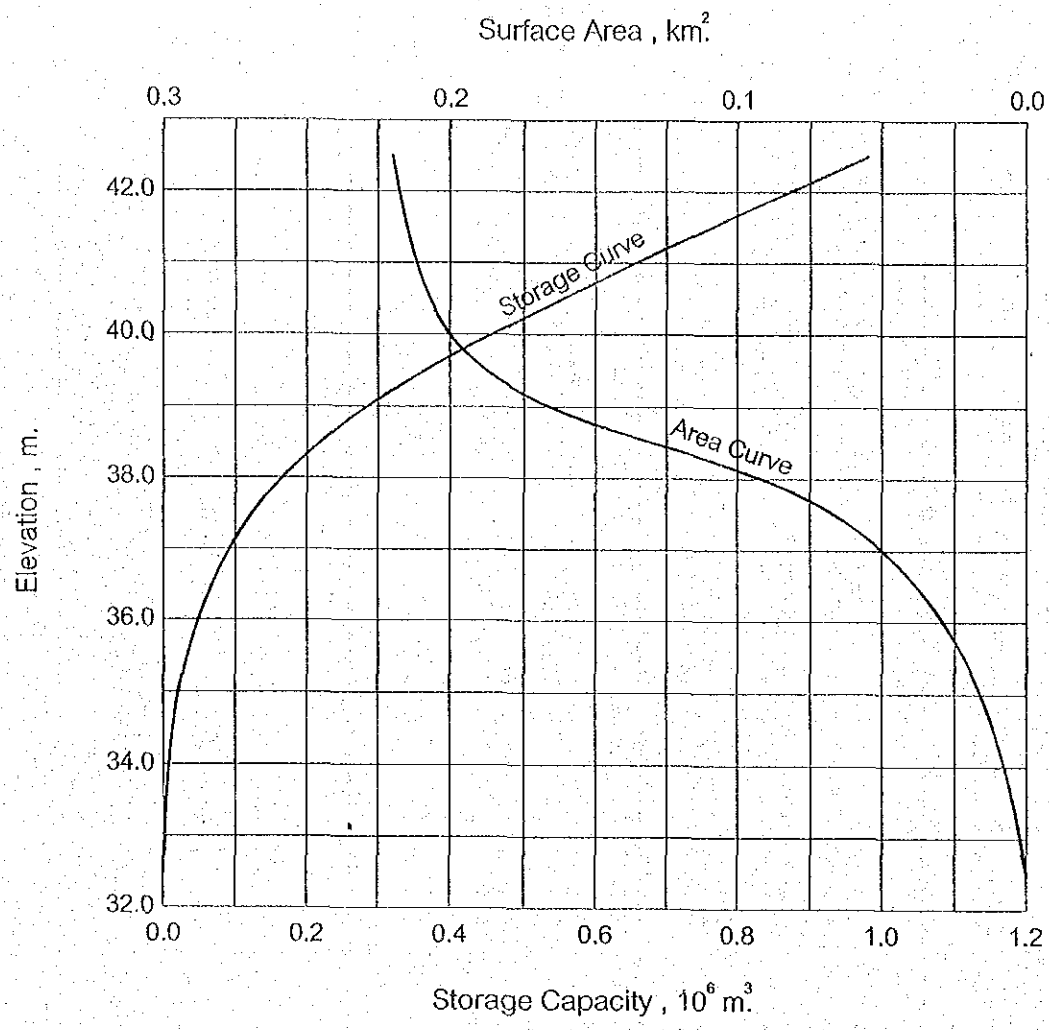


Fig. 3.1-14	Location of Flood Control Dam No.7: Lower Khlong Ko Wao Dam



Elev. (m.)	Area (km^2.)	Capacity (10^6 m^3.)
32.50	0	0
35.00	0.016	0.021
37.50	0.066	0.124
40.00	0.200	0.456
42.50	0.220	0.981

Fig. 3.1-15 Area - Capacity of Lower Khlong Ko Wao Dam

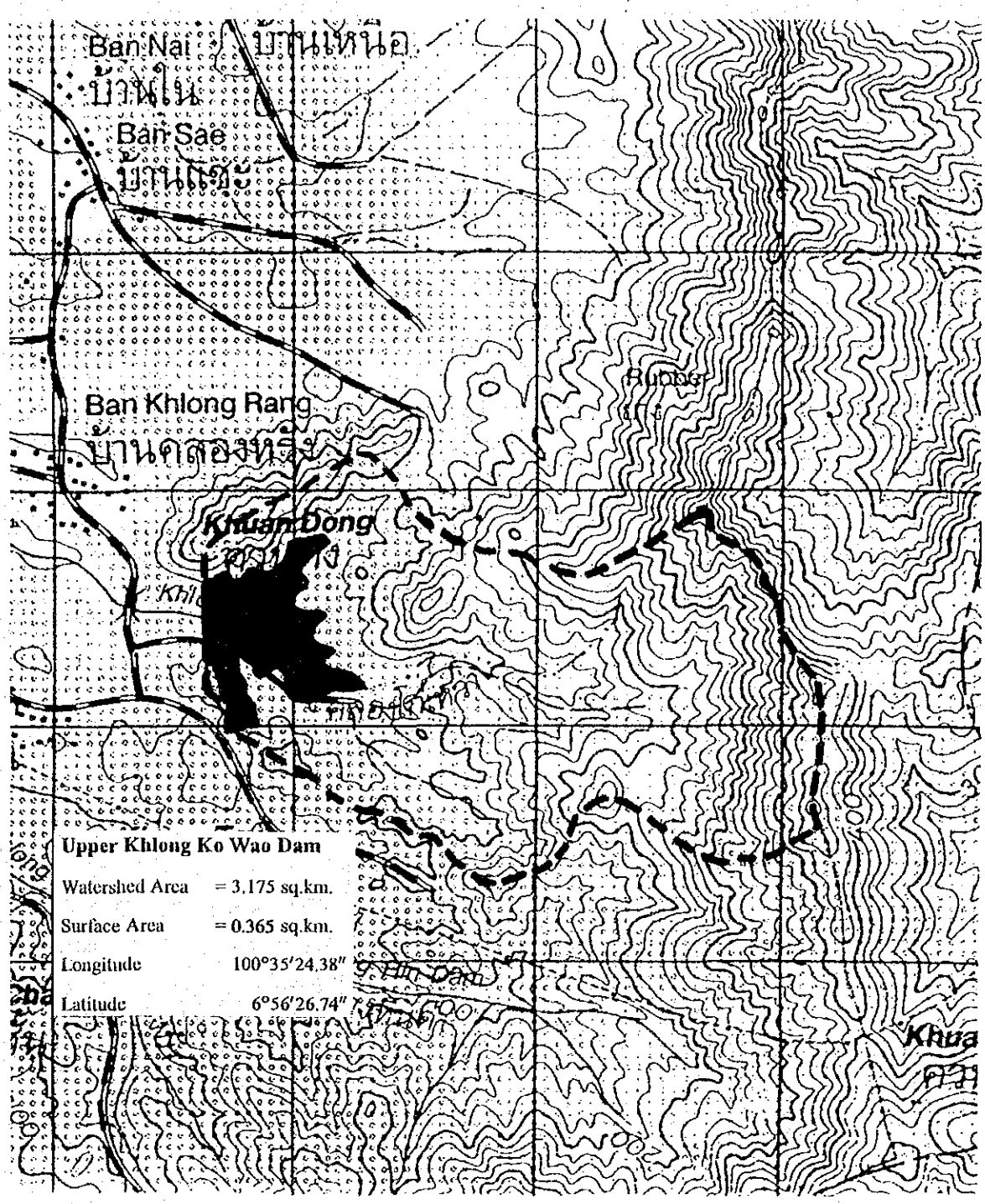
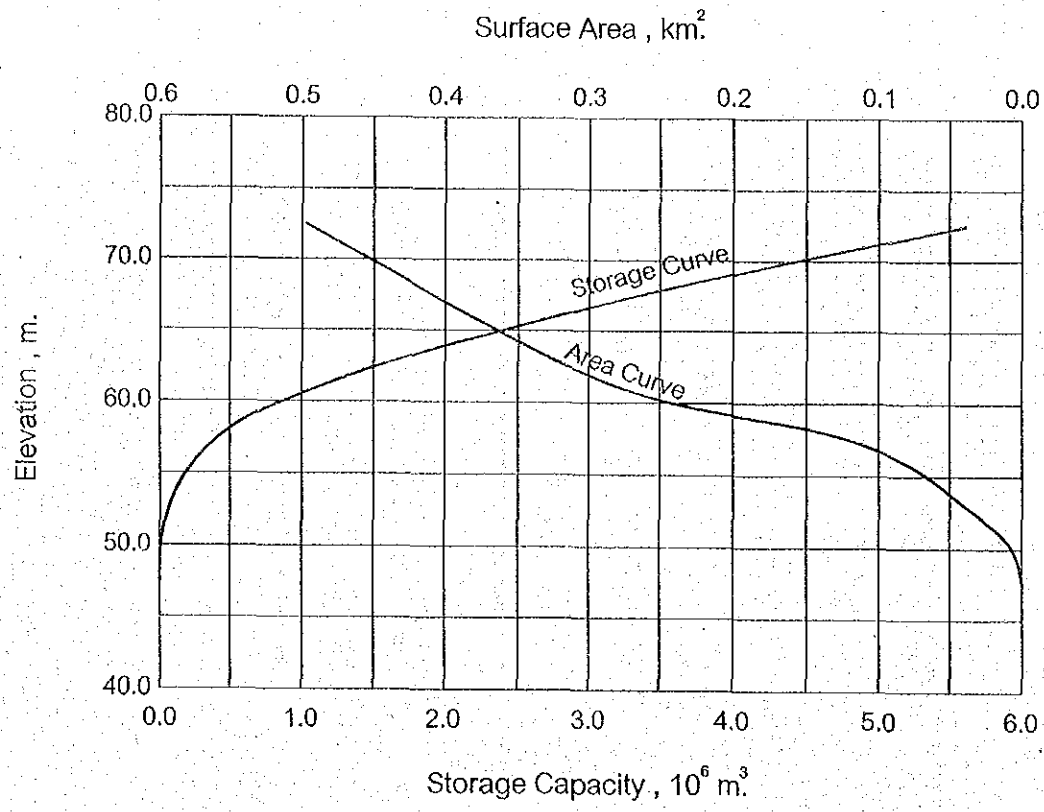


Fig. 3.1–16	Location of Flood Control Dam No.8: Upper Khlong Ko Wao Dam



Elev. (m.)	Area (km^2)	Capacity ($10^6 m^3$)
47.50	0	0
50.00	0.007	0.009
52.50	0.033	0.059
55.00	0.066	0.182
57.50	0.120	0.415
60.00	0.242	0.868
65.00	0.365	2.385
70.00	0.452	4.426
72.50	0.497	5.612

Fig. 3.1-17 Area - Capacity of Upper Khlong Ko Wao Dam

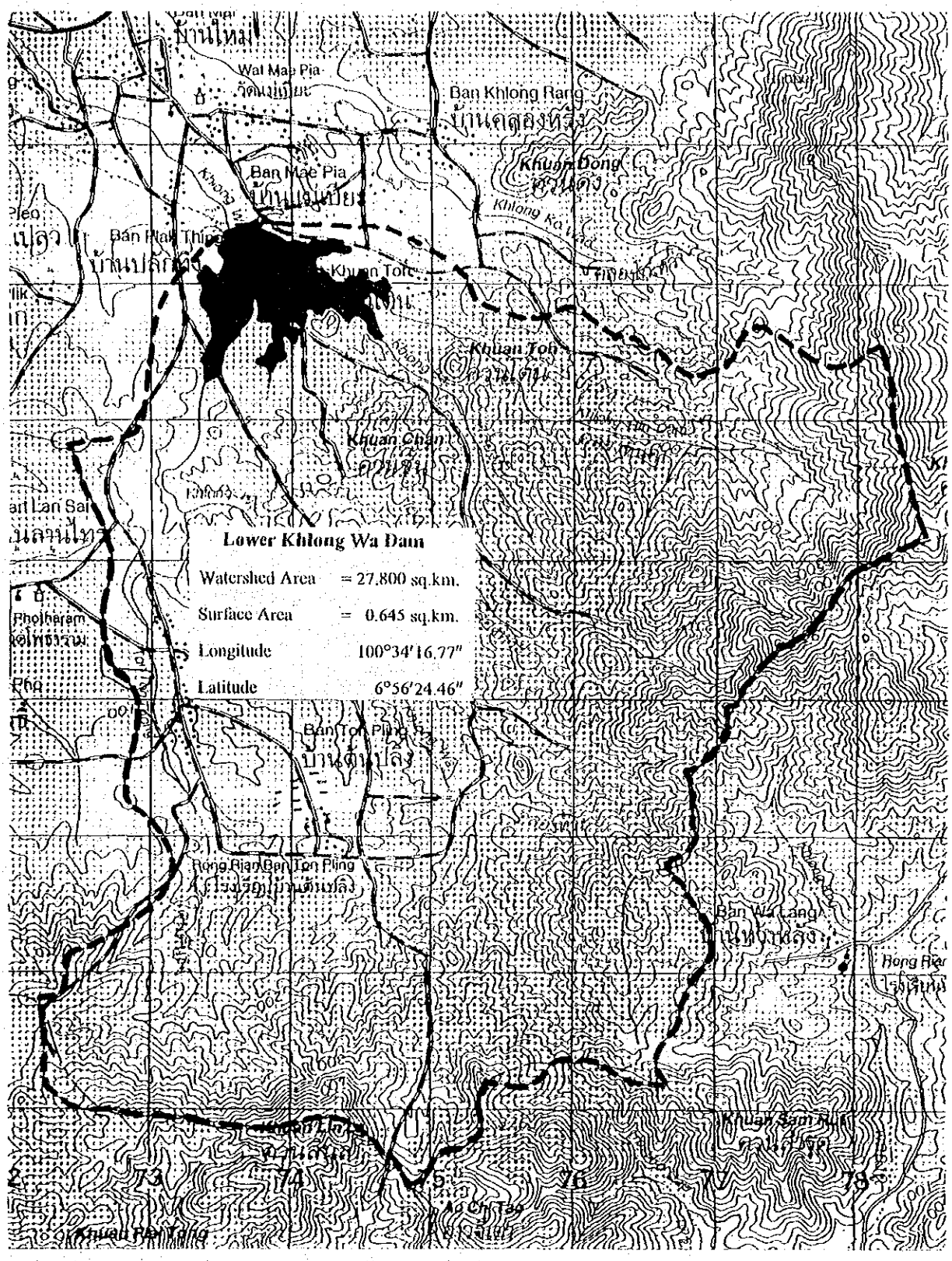
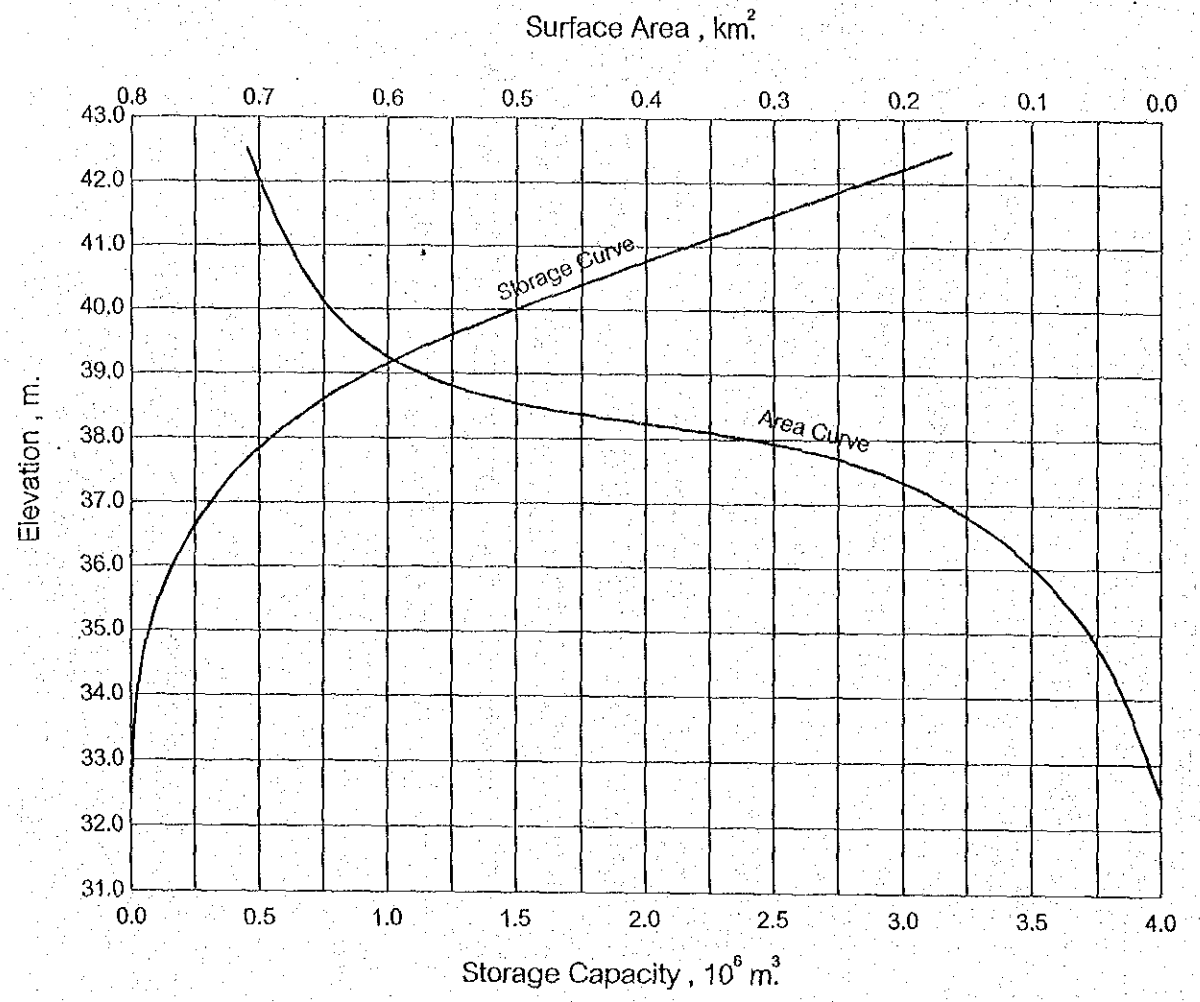


Fig. 3.1–18	Location of Flood Control Dam No.9: Lower Khlong Wa Dam



Elev. (m.)	Area (km^2.)	Capacity (10^6 m^3.)
32.50	0	0
35.00	0.056	0.071
37.50	0.219	0.415
40.00	0.645	1.494
42.50	0.709	3.186

Fig. 3.1-19 Area - Capacity of Lower Khlong Wa Dam

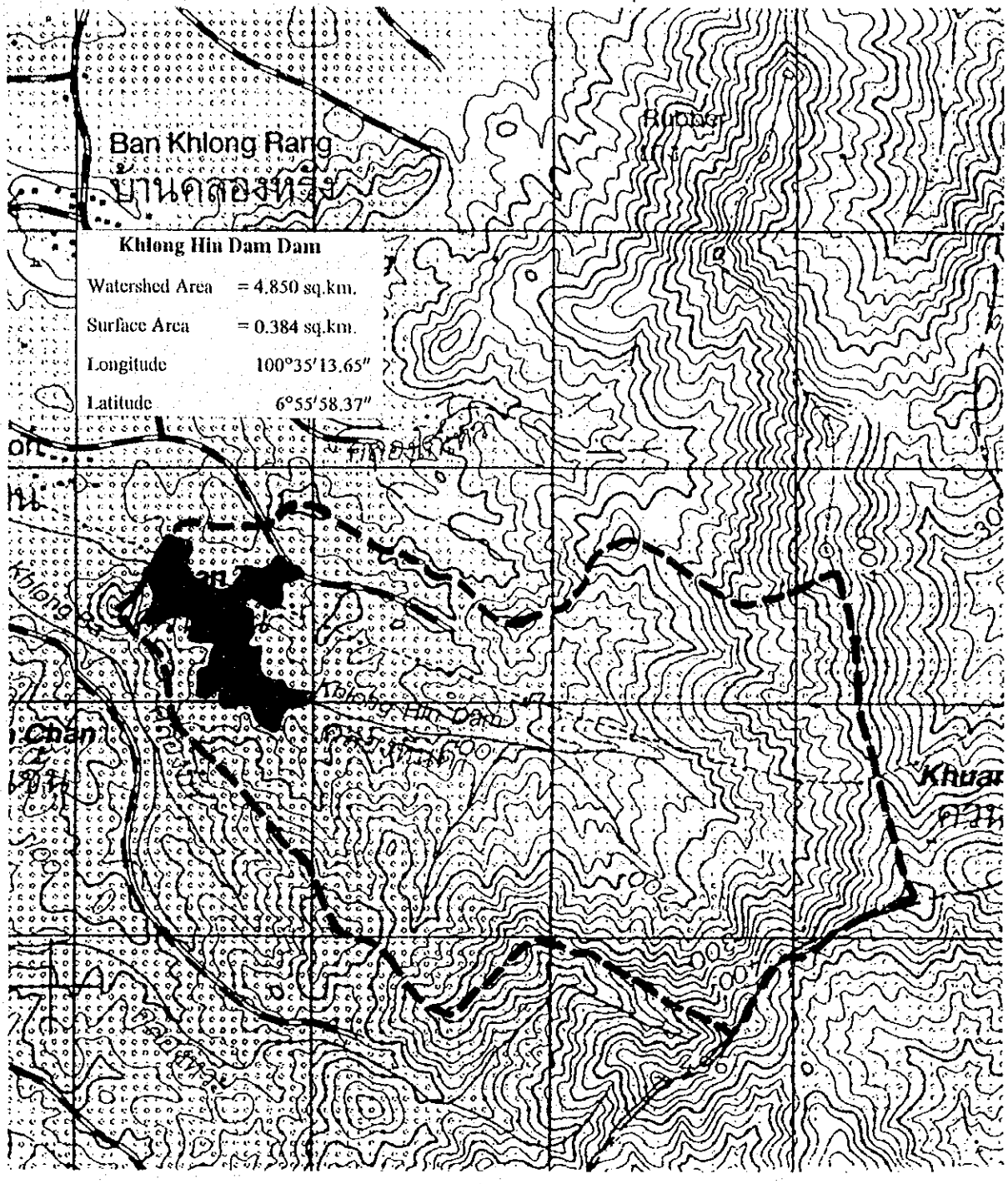
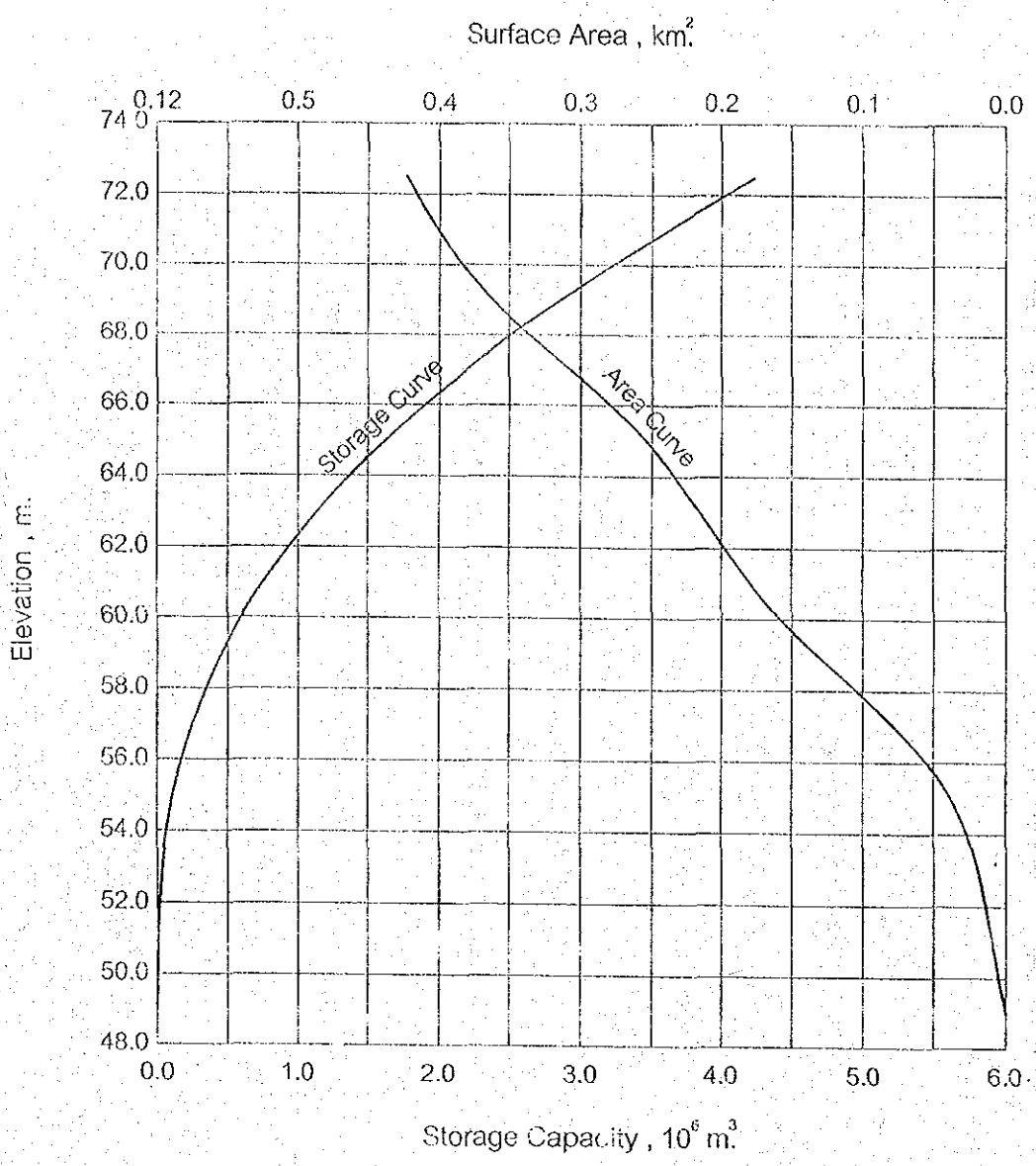


Fig. 3.1-20	Location of Flood Control Dam No.10: Khlong Hin Dam Dam



Elev. (m.)	Area (km^2)	Capacity ($10^6 m^3$)
49.00	0	0
50.00	0.005	0.002
55.00	0.038	0.108
60.00	0.158	0.596
65.00	0.254	1.626
70.00	0.384	3.222
72.50	0.423	4.230

Fig. 3.1-21 Area - Capacity of Khlong Hin Dam Dam

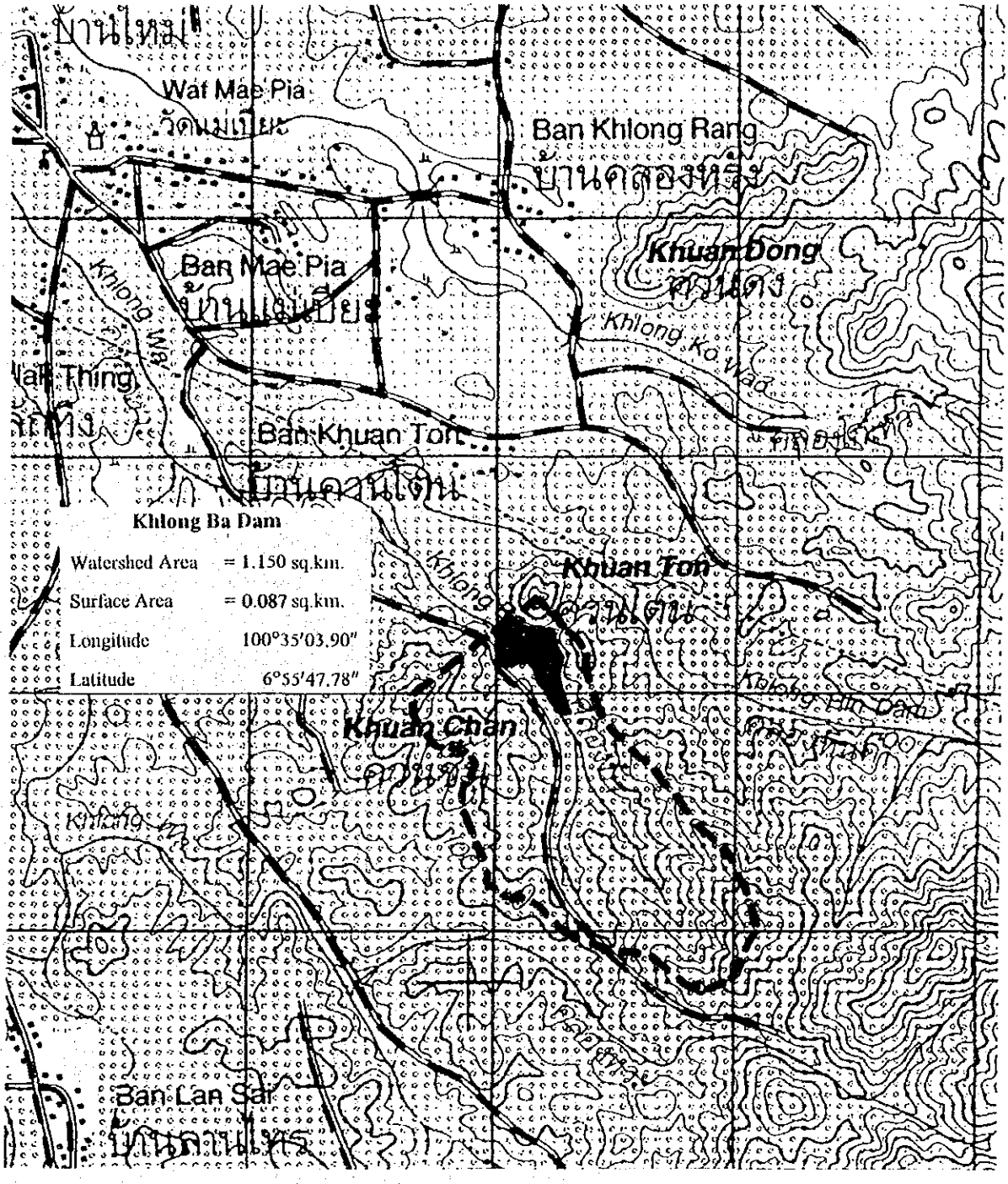
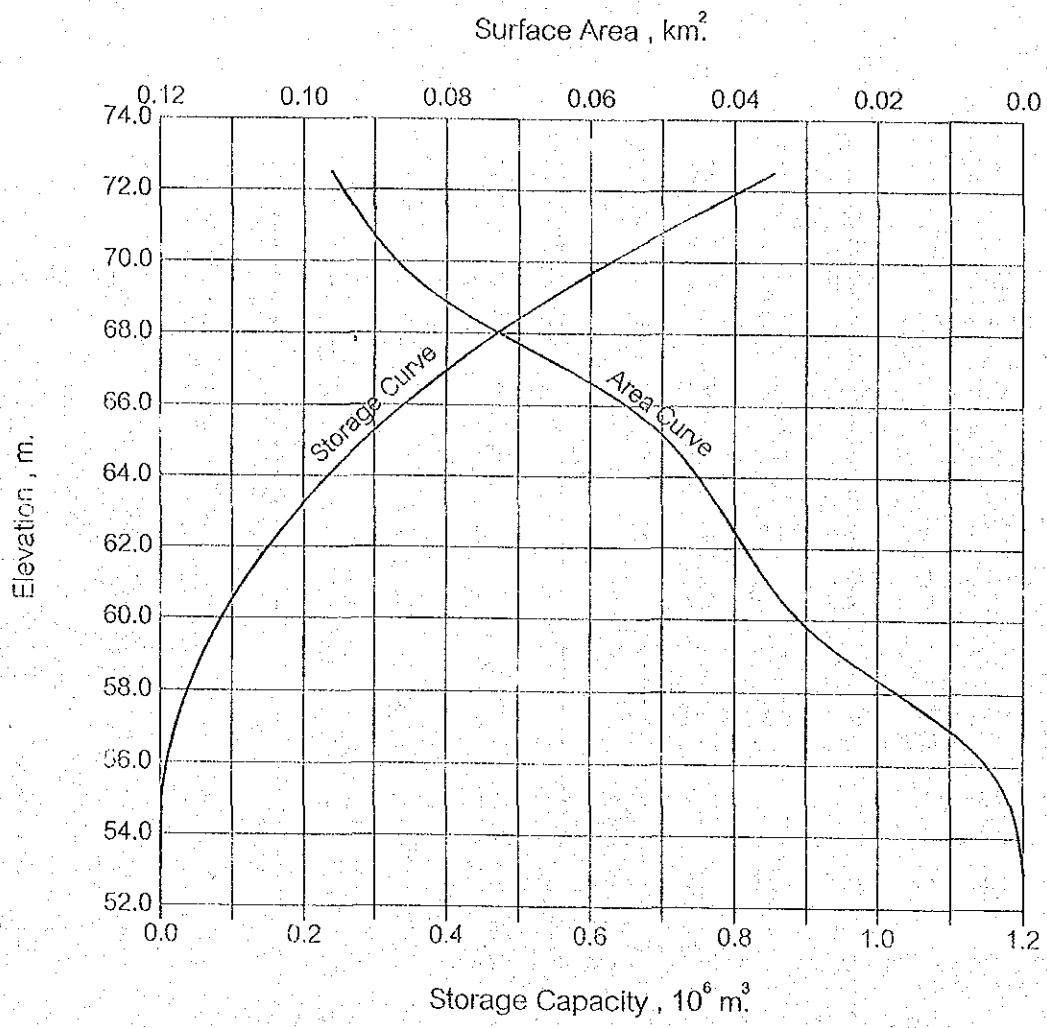


Fig. 3.1-22	Location of Flood Control Dam No.11: Khlong Ba Dam



Elev. (m.)	Area (km^2)	Capacity ($10^6 m^3$)
53.00	0	0
55.00	0.002	0.002
60.00	0.031	0.085
65.00	0.049	0.285
70.00	0.087	0.626

Fig. 3.1-23 Area - Capacity of Khlong Ba Dam

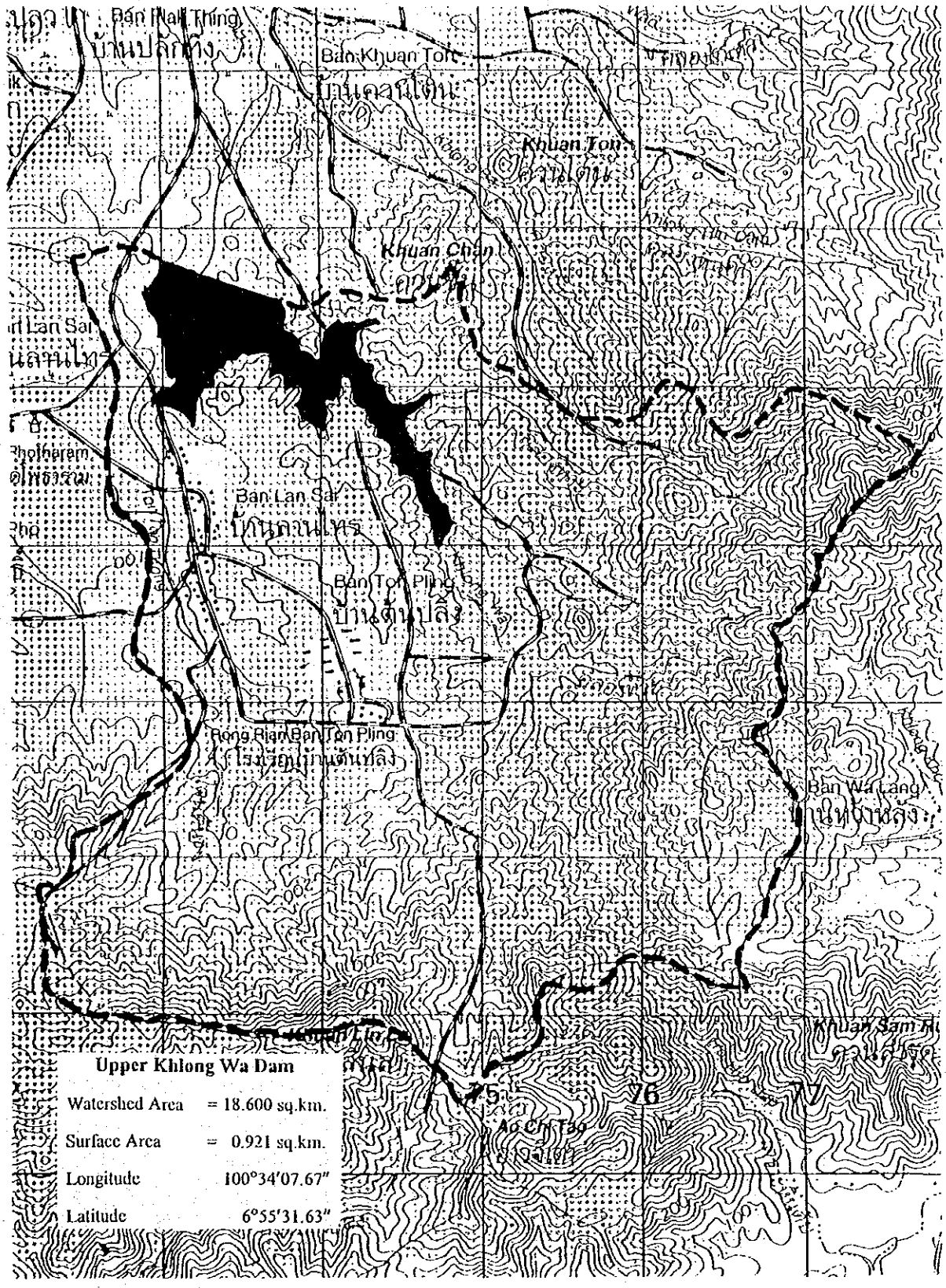
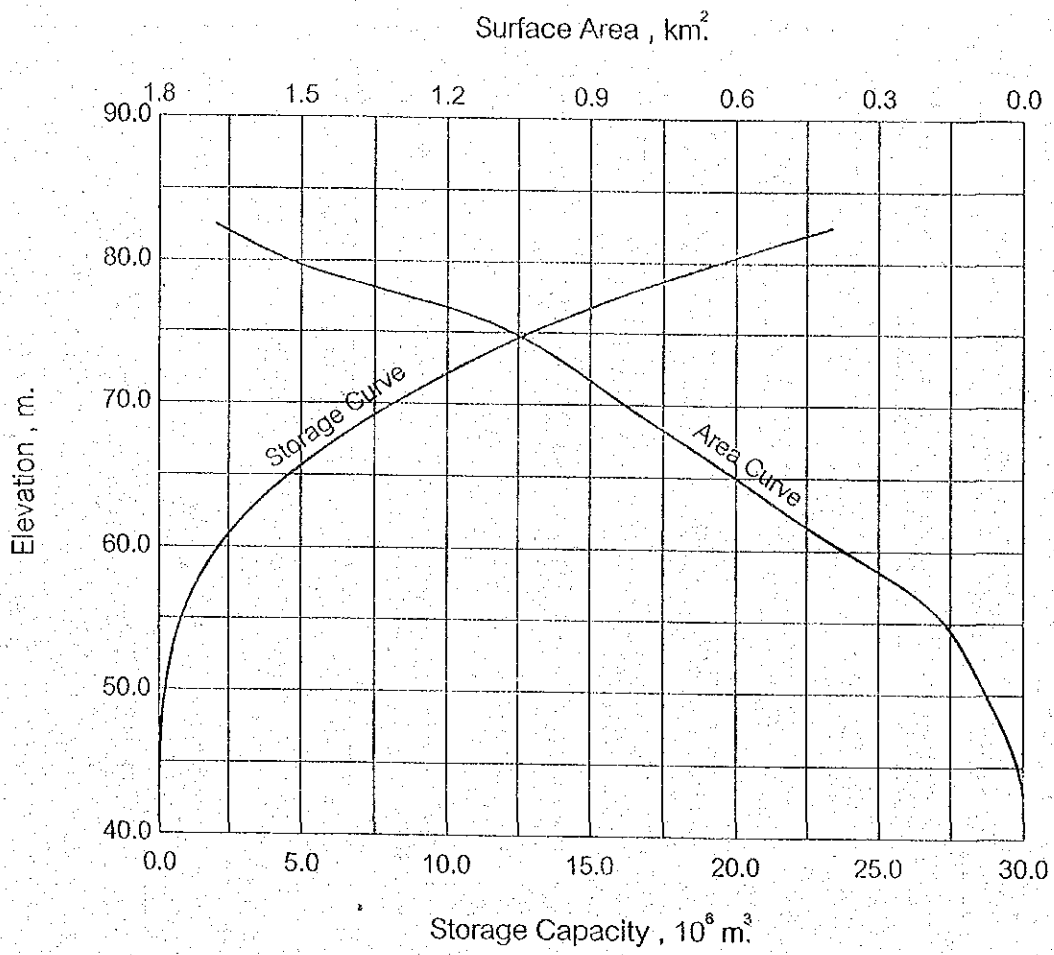


Fig. 3.1-24	Location of Flood Control Dam No.12: Upper Khlong Wa Dam



Elev. (m.)	Area (km^2)	Capacity ($10^6 m^3$)
43.00	0	0
45.00	0.012	0.012
50.00	0.075	0.229
55.00	0.162	0.824
60.00	0.372	2.159
65.00	0.600	4.588
70.00	0.828	8.159
75.00	1.061	12.882
80.00	1.522	19.341
82.50	1.675	23.337

Fig. 3.1-25 Area - Capacity of Upper Khlong Wa Dam

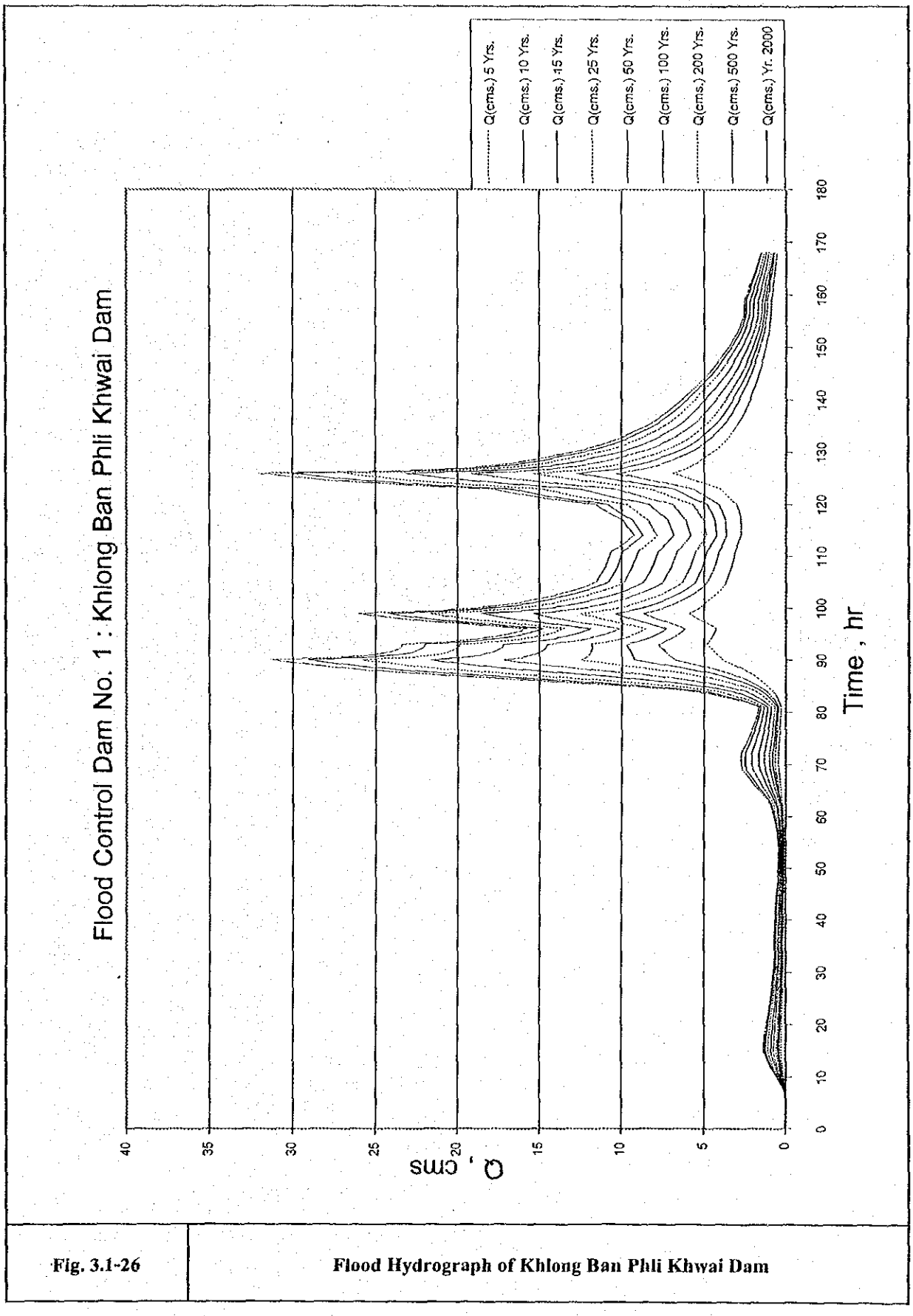


Fig. 3.1-26 **Flood Hydrograph of Khlong Ban Phli Khwai Dam**

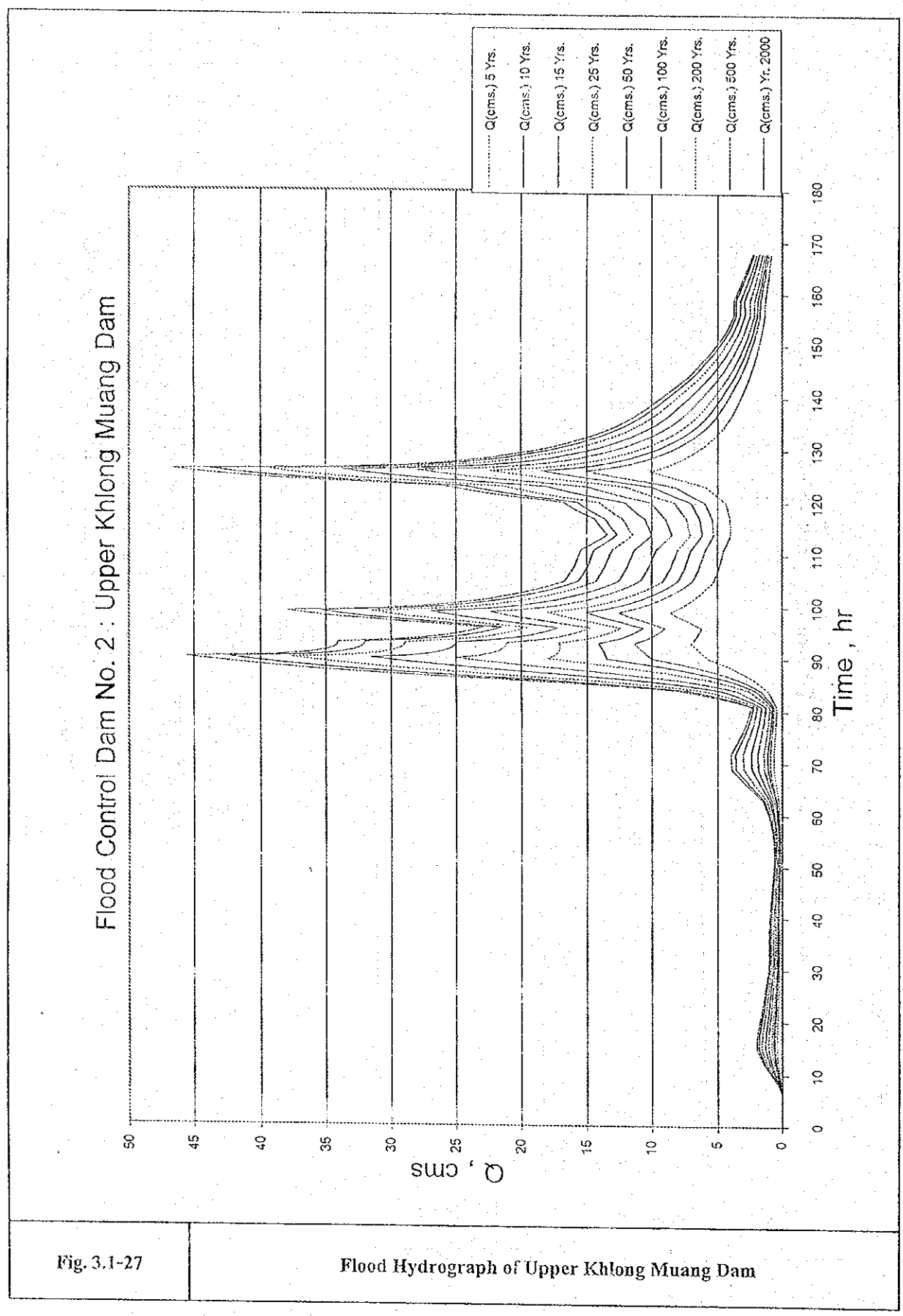


Fig. 3.1-27 Flood Hydrograph of Upper Khlong Muang Dam

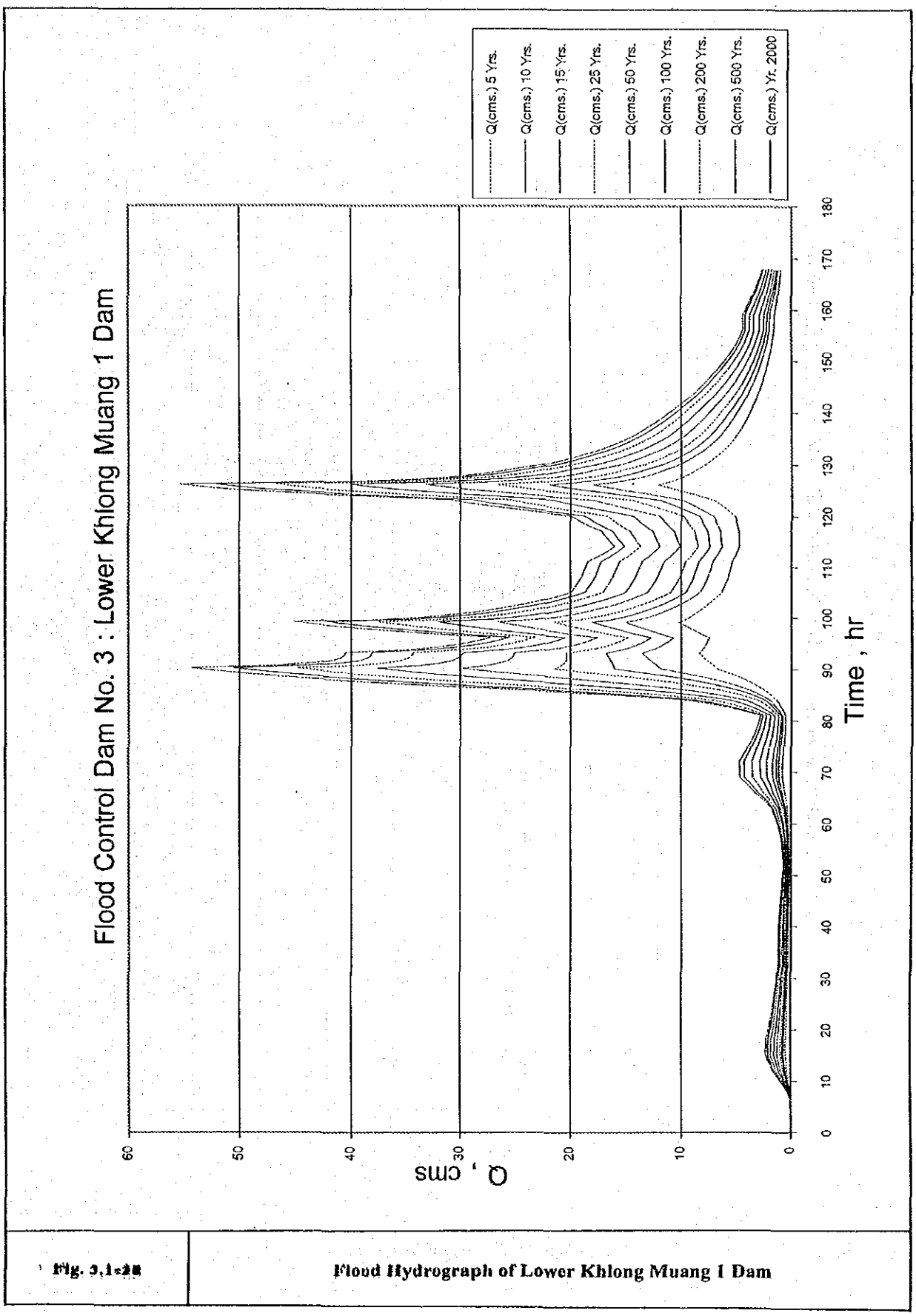


Fig. 3.1-28 Flood Hydrograph of Lower Khlong Muang 1 Dam

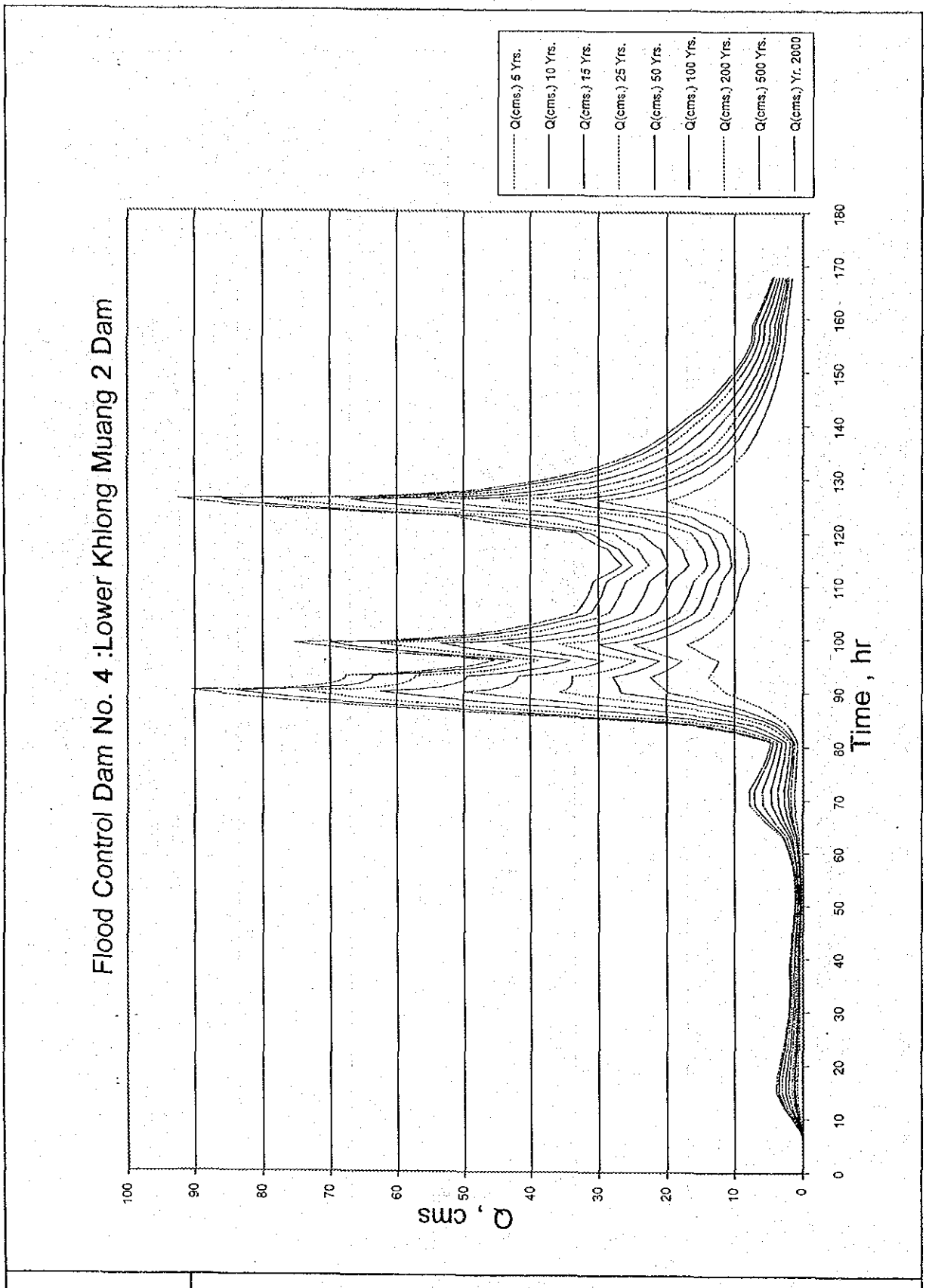


Fig. 3.1-29 **Flood Hydrograph of Lower Khlong Muang 2 Dam**

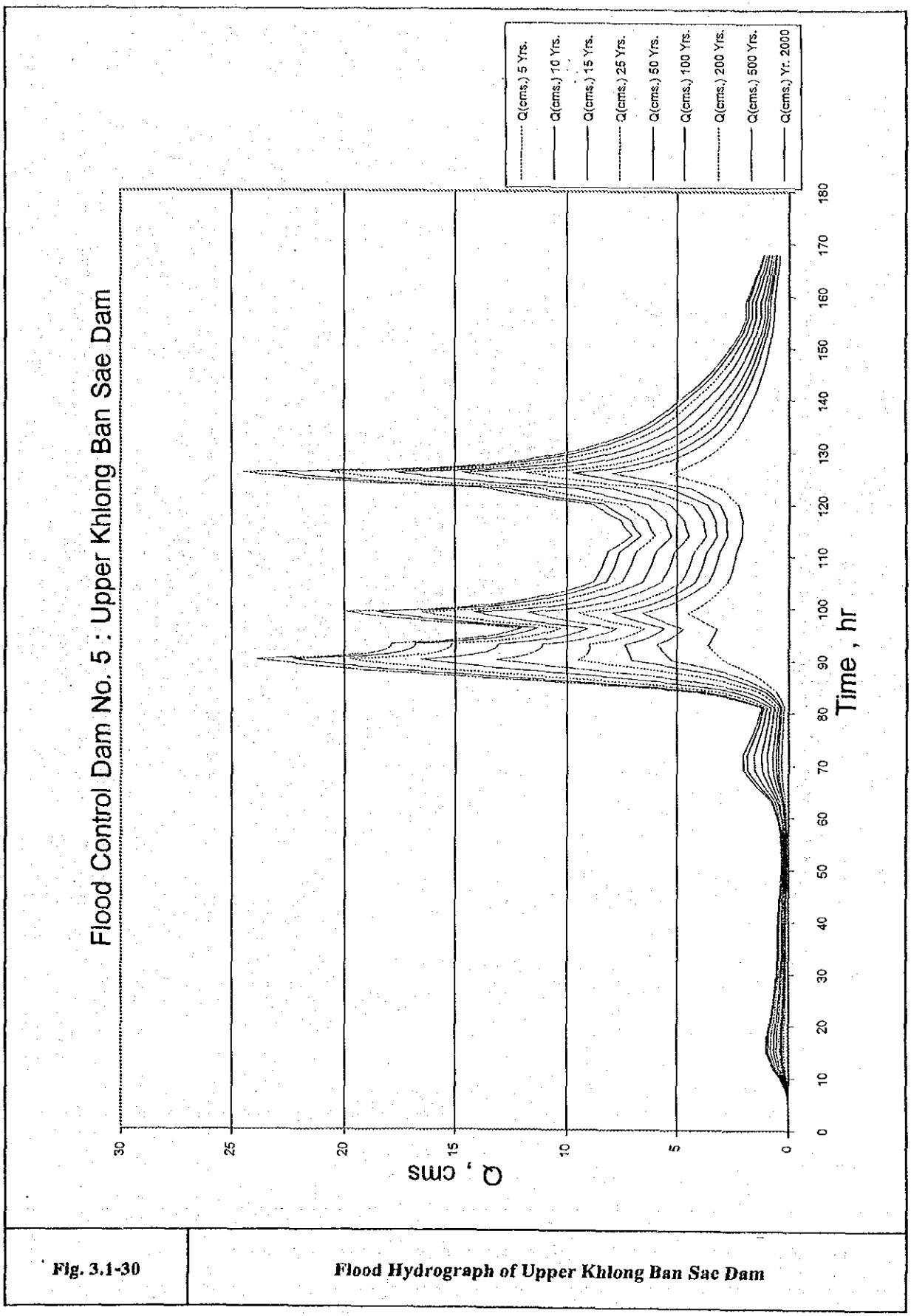


Fig. 3.1-30 **Flood Hydrograph of Upper Khlong Ban Sae Dam**

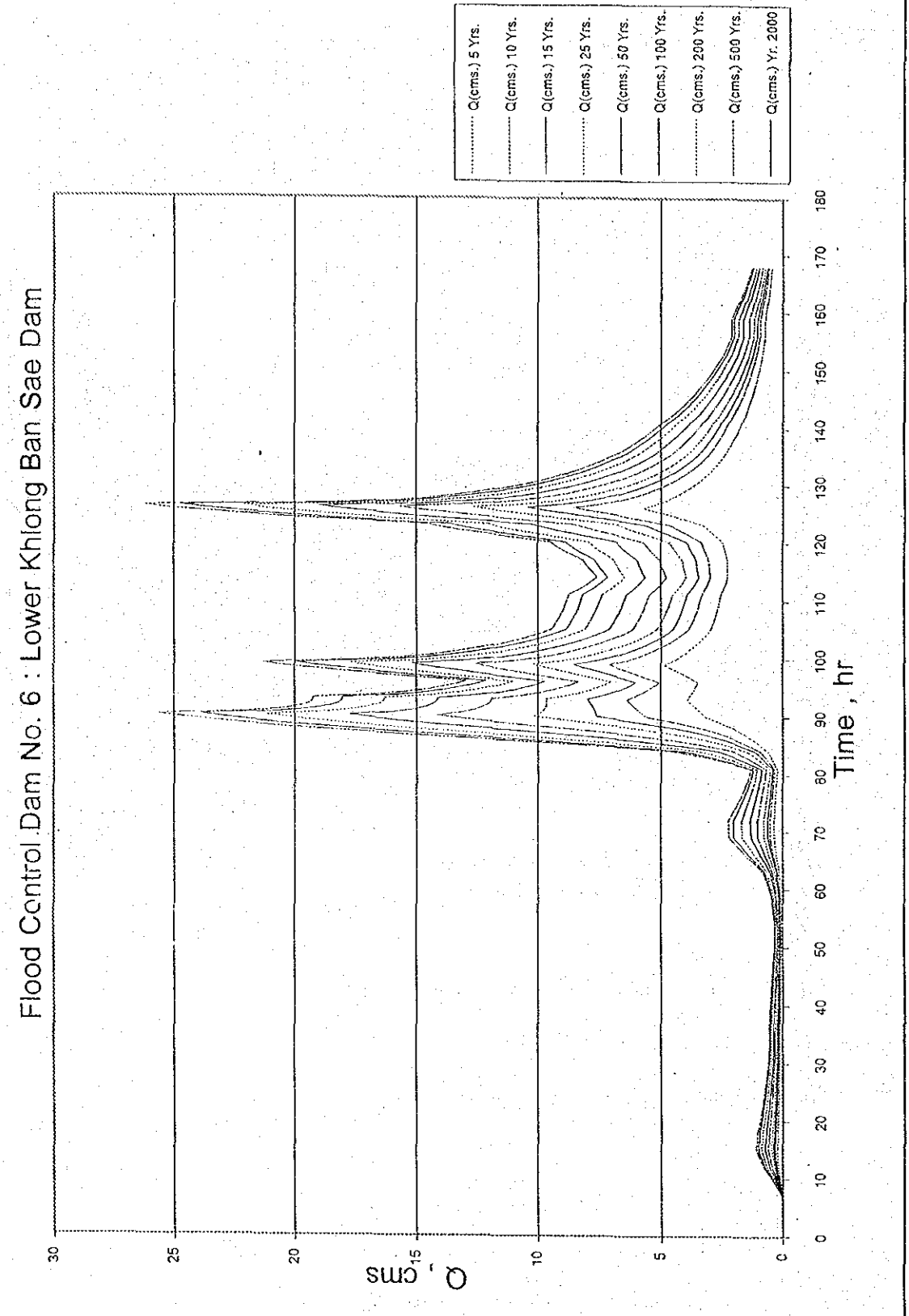


Fig. 3.1-31 **Flood Hydrograph of Lower Khlong Ban Sae Dam**

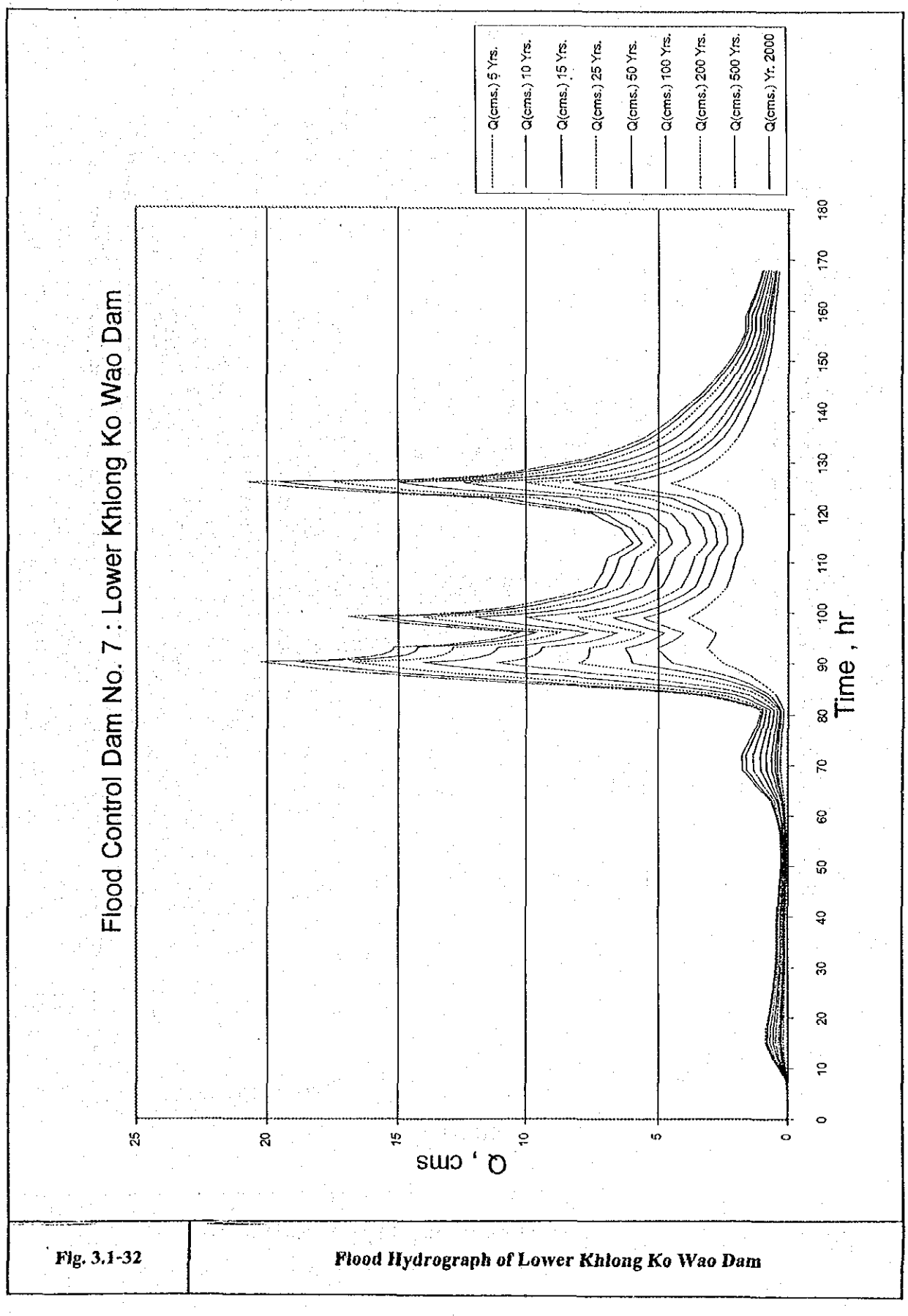


Fig. 3.1-32 ***Flood Hydrograph of Lower Khlong Ko Wao Dam***

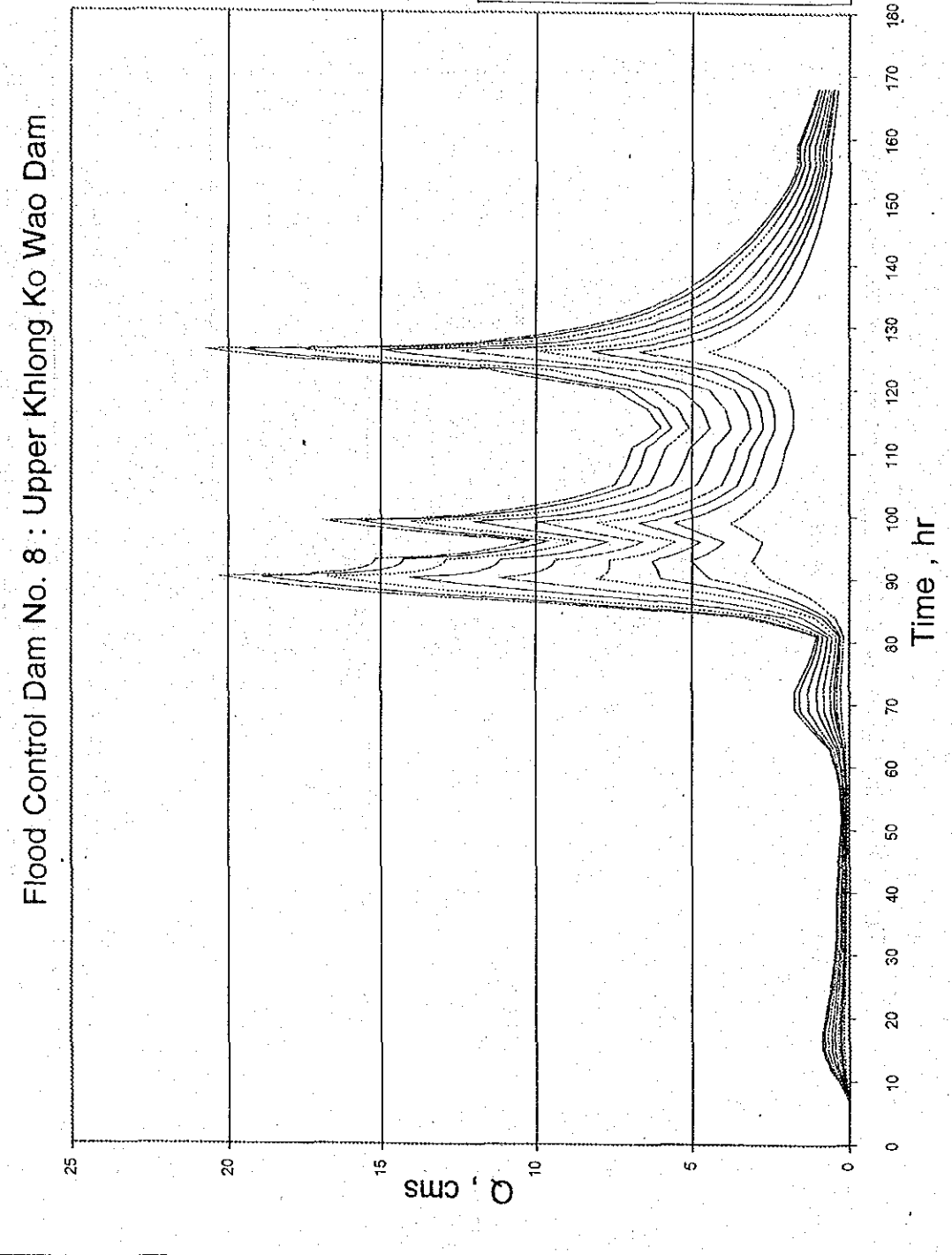


Fig. 3.1-33	Flood Hydrograph of Upper Khlong Ko Wao Dam

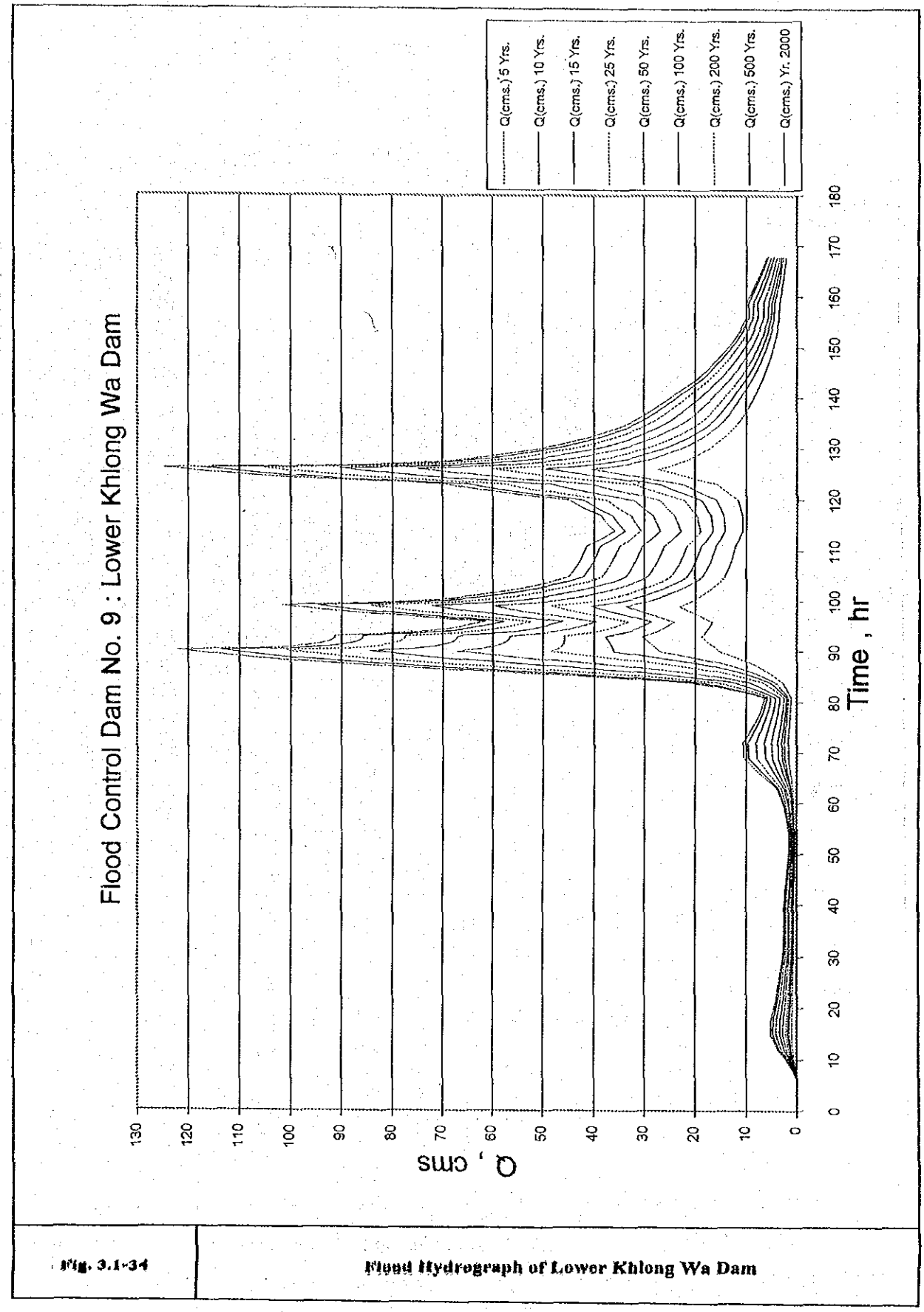


Fig. 3.1-34 **Flood Hydrograph of Lower Khlong Wa Dam**

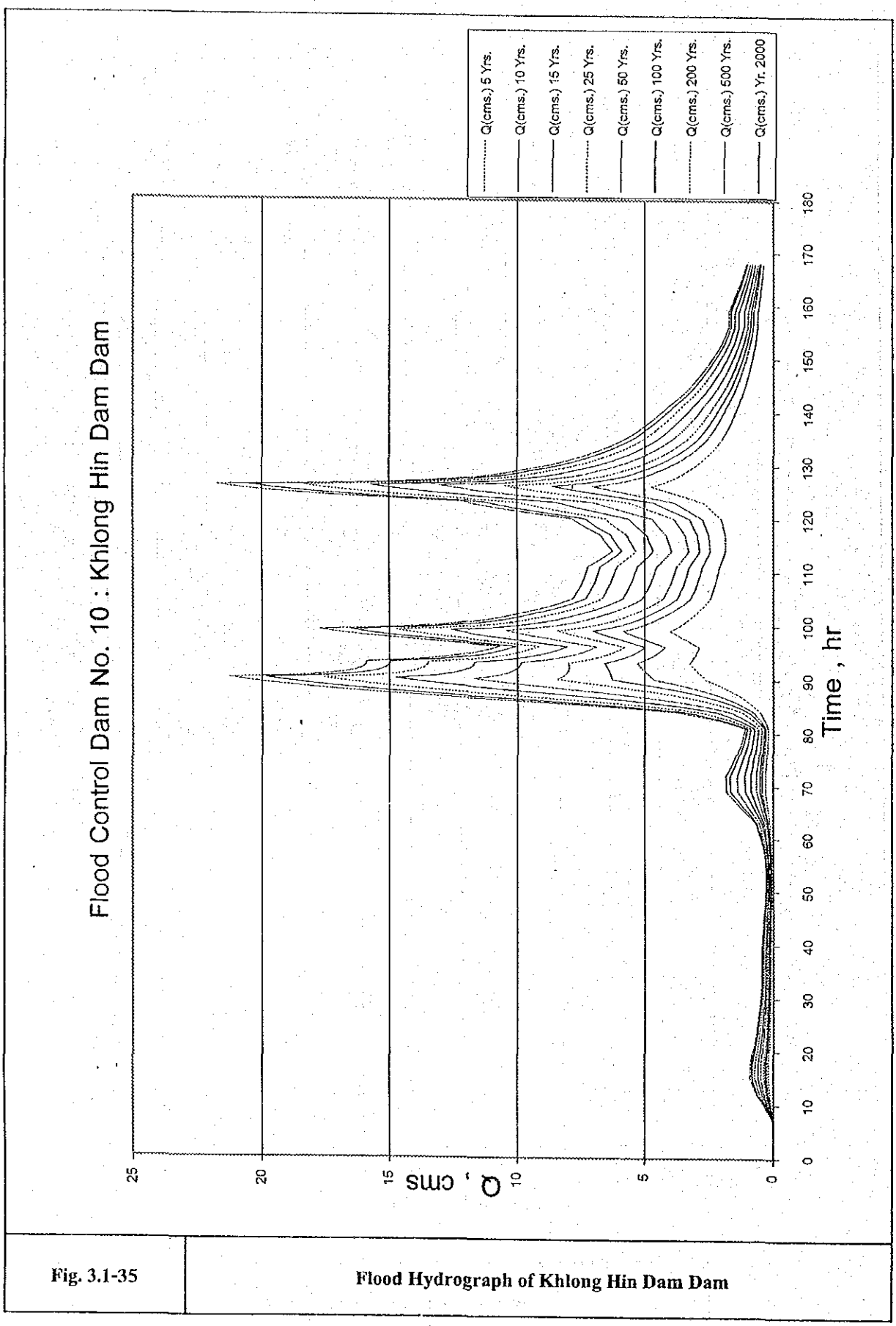


Fig. 3.1-35	**Flood Hydrograph of Khlong Hin Dam Dam**

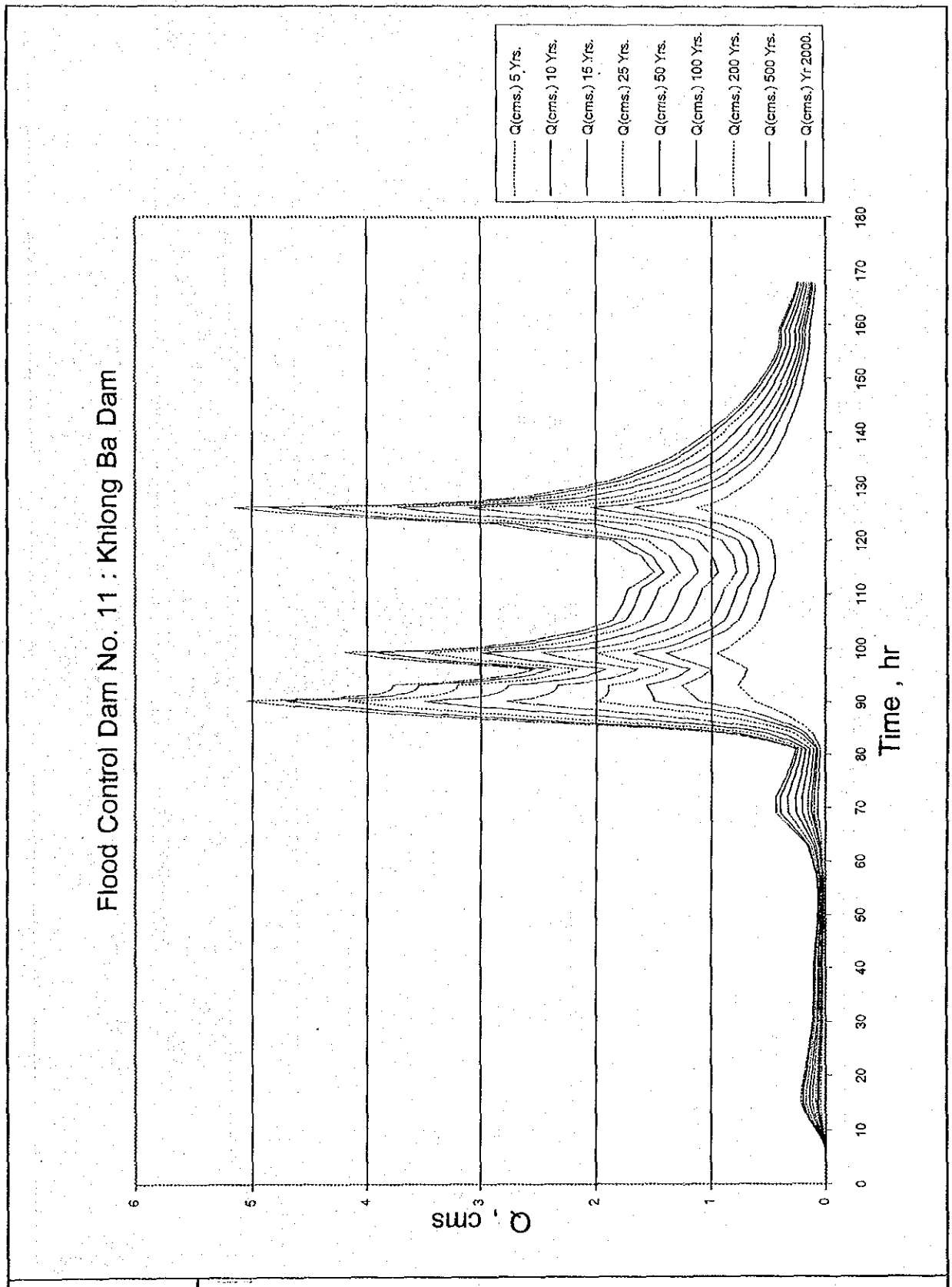


Fig. 3.1-36 **Flood Hydrograph of Khlong Ba Dam**

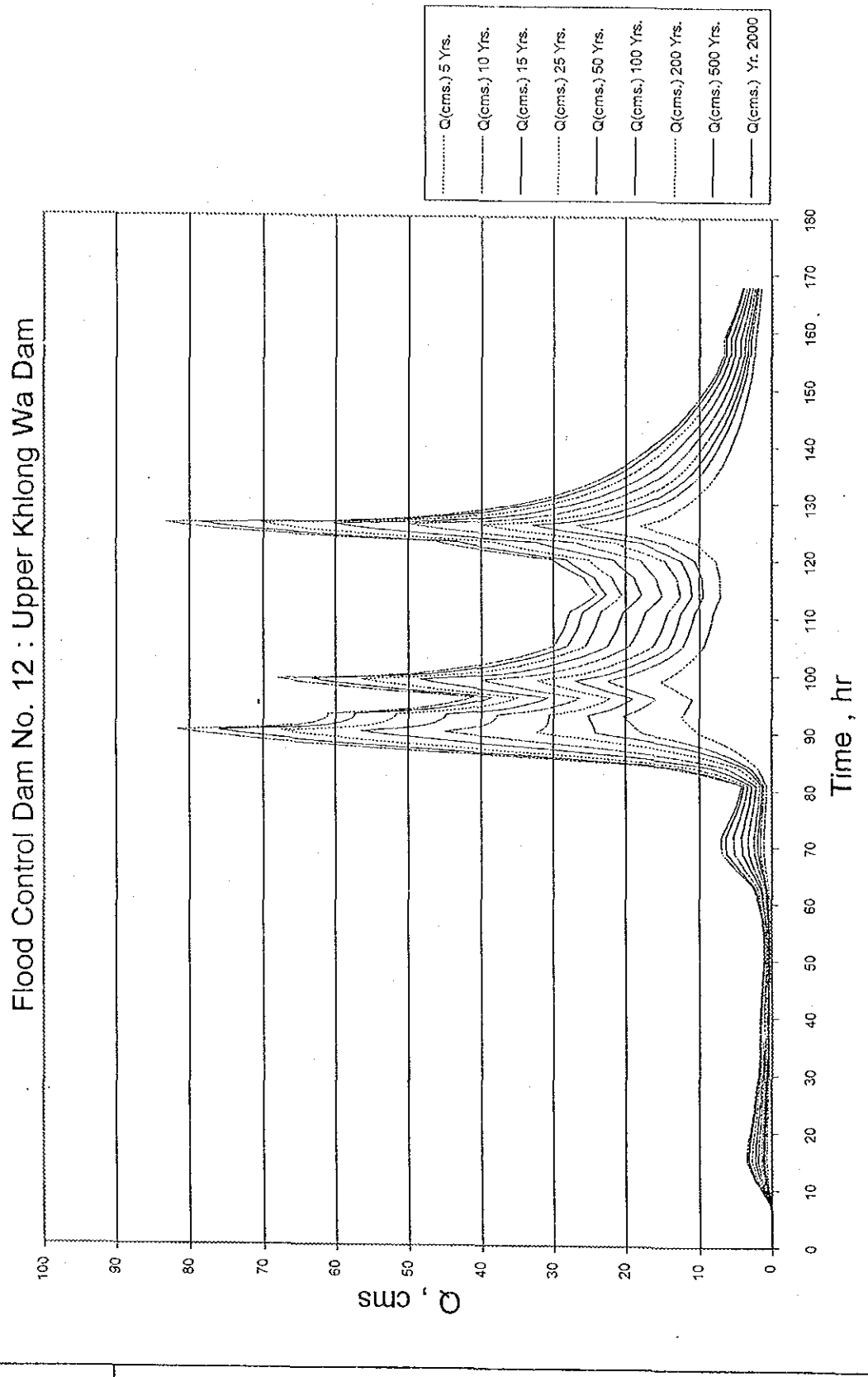
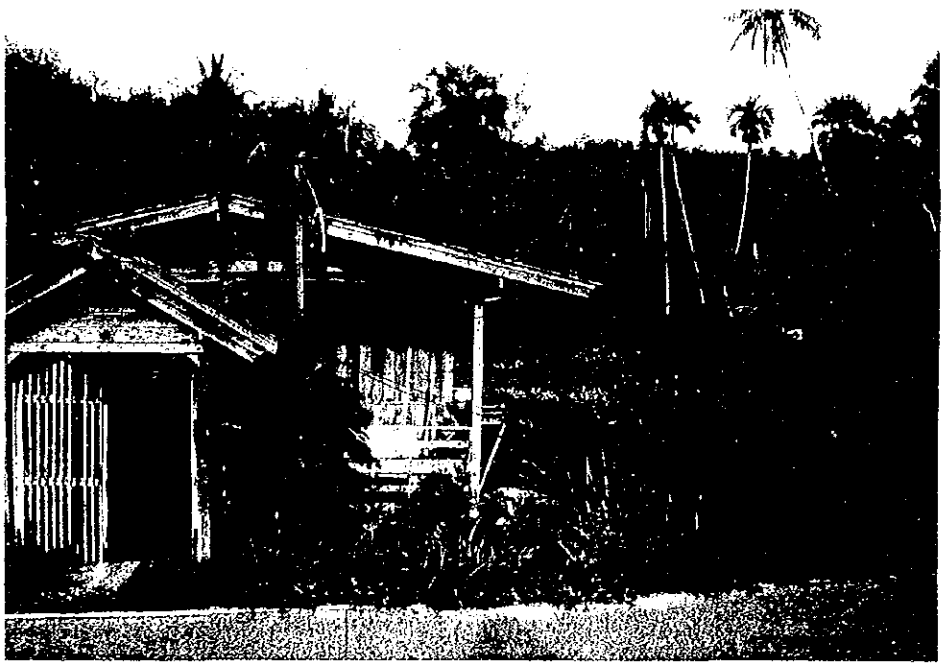


Fig. 3.1-37	Flood Hydrograph of Upper Khlong Wa Dam

The Reservoir is in Village



The House is in Reservoir

Fig. 3.1-38	Photograph Shown Problem in The Reservoir

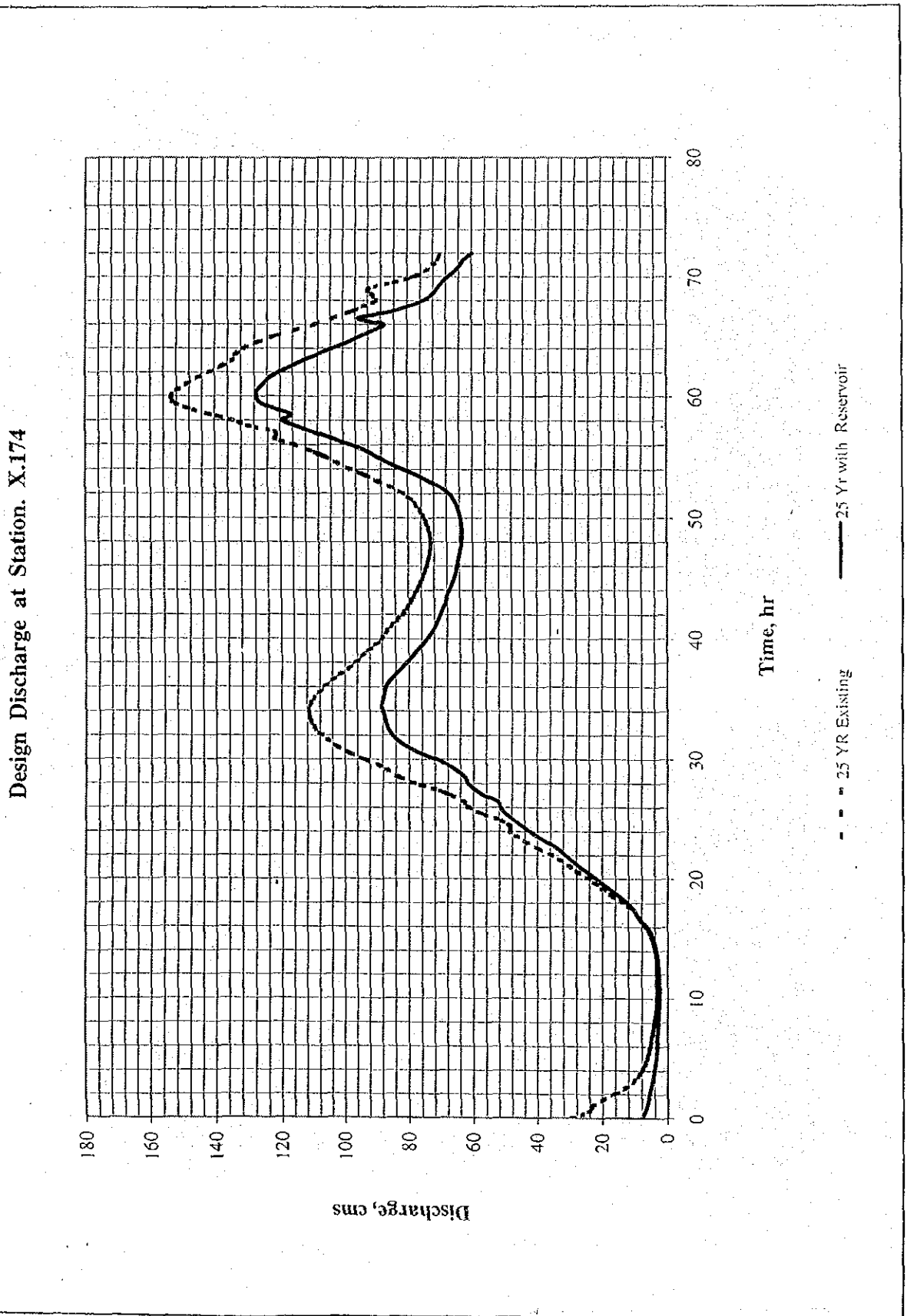


Fig. 3.2-1	Discharge Hydrographs at Station X.174 for Existing and with reservoir Condition

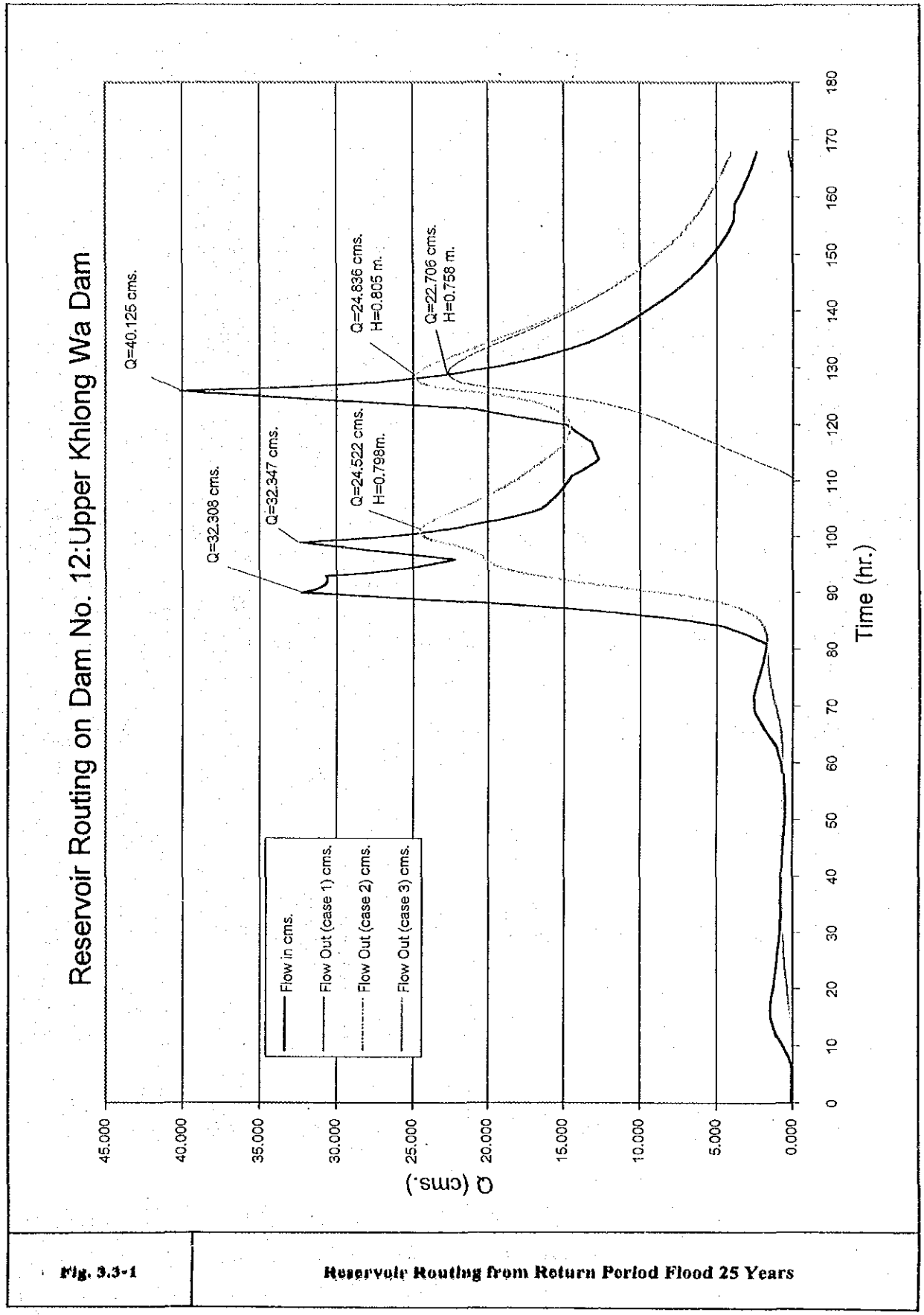


Fig. 3.3-1 **Reservoir Routing from Return Period Flood 25 Years**

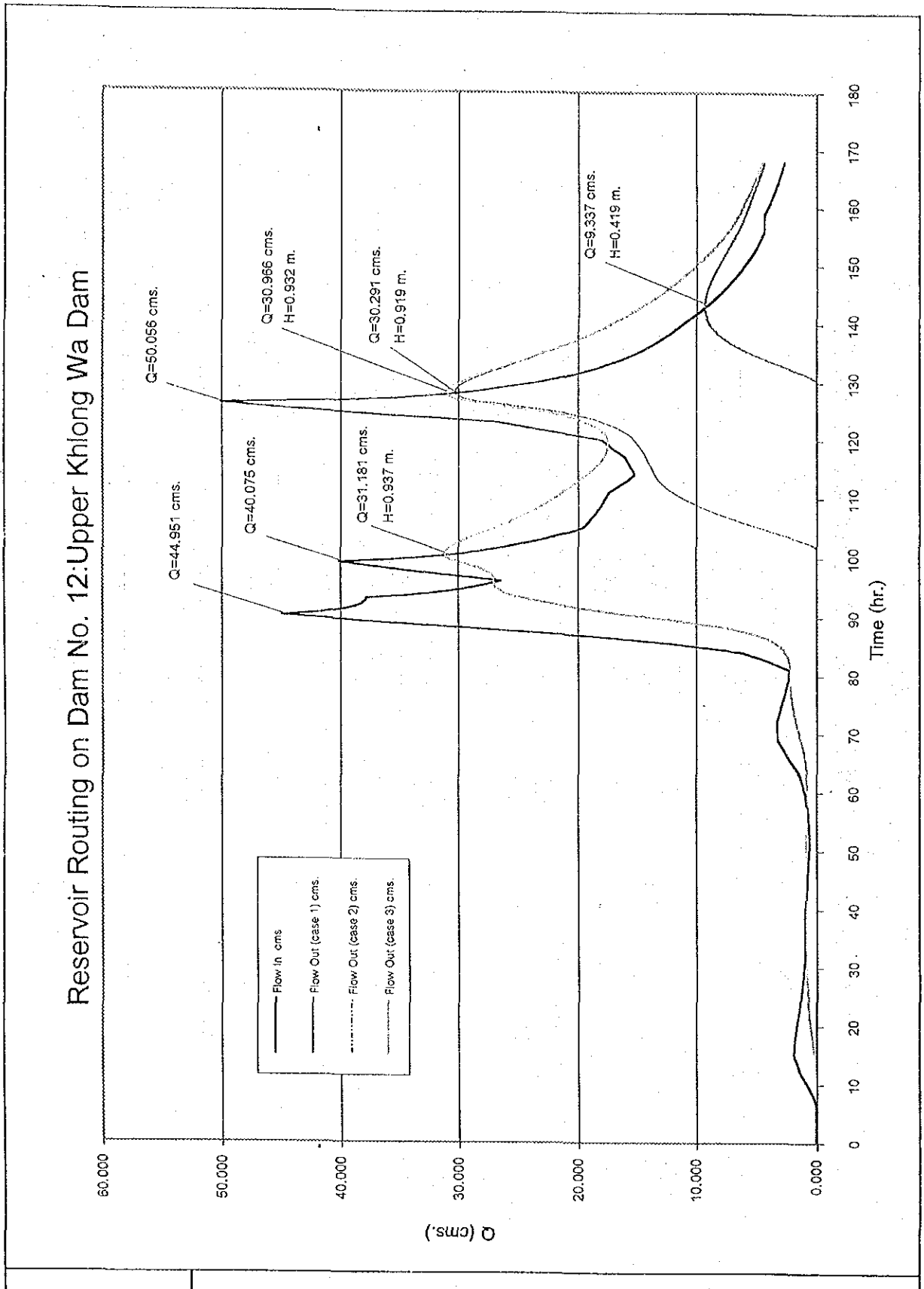


Fig. 3.3-2	Reservoir Routing from Return Period Flood 50 Years

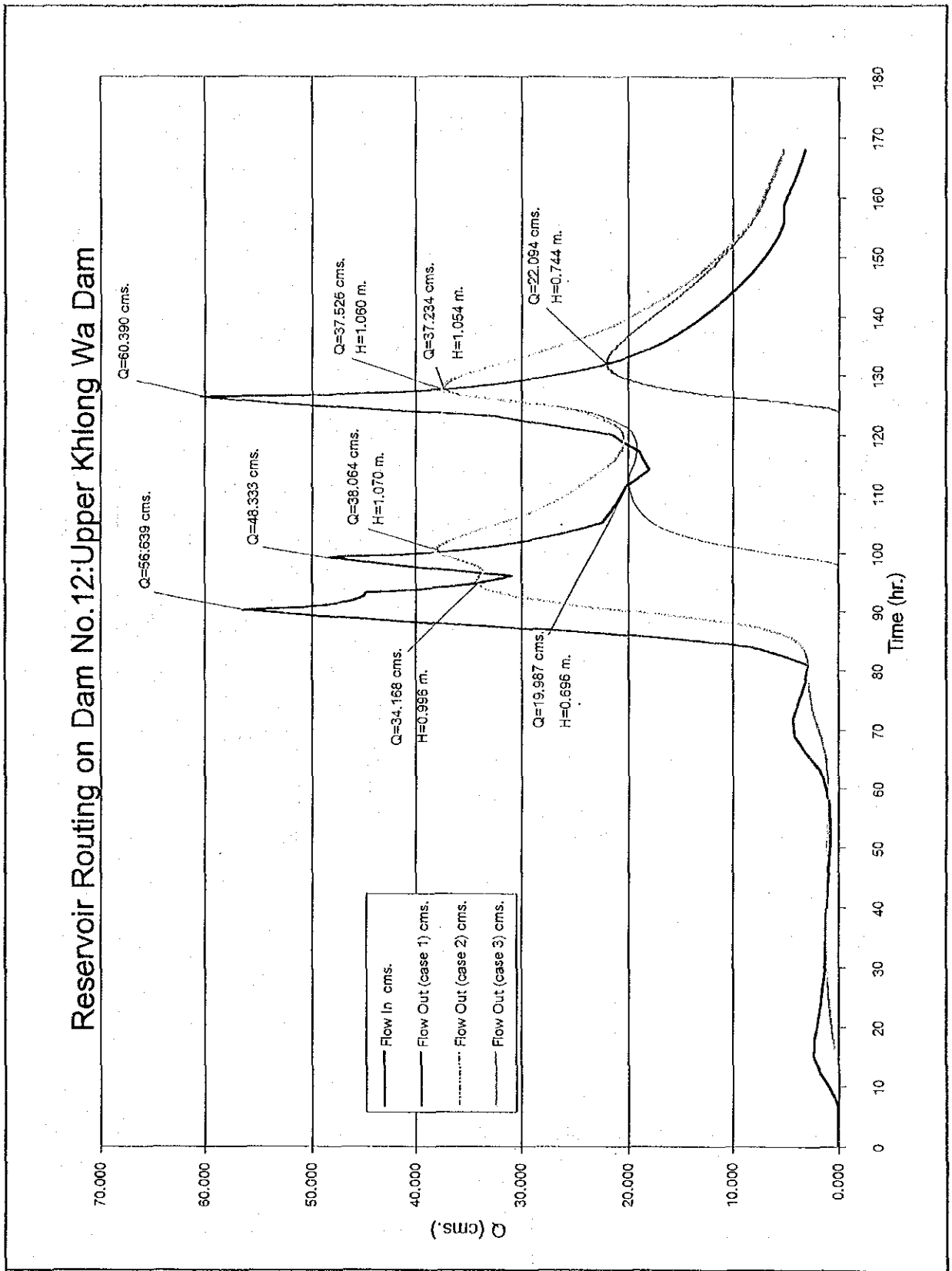


Fig. 3.3-3 **Reservoir Routing from Return Period Flood 100 Years**

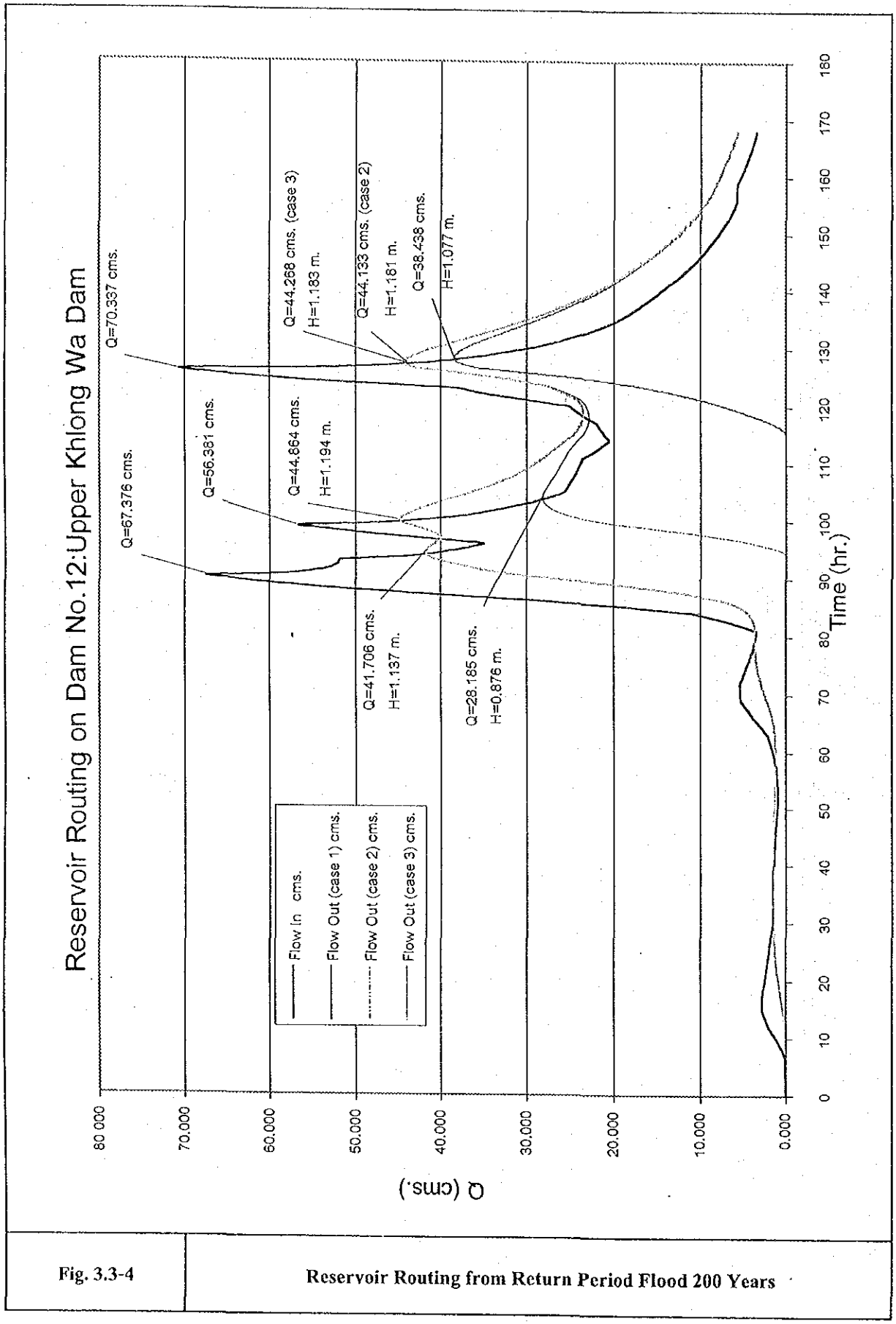


Fig. 3.3-4	**Reservoir Routing from Return Period Flood 200 Years**

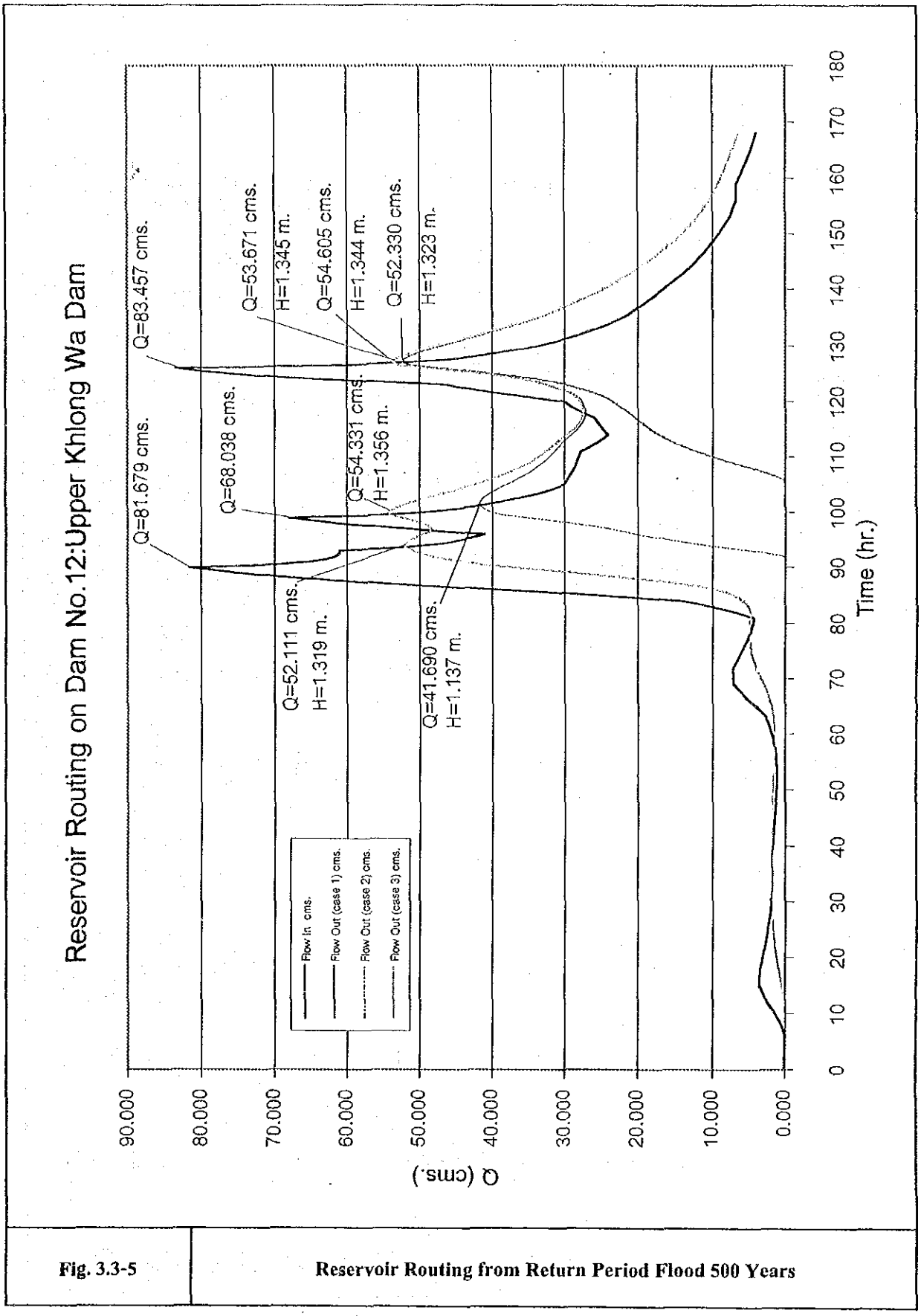


Fig. 3.3-5 **Reservoir Routing from Return Period Flood 500 Years**

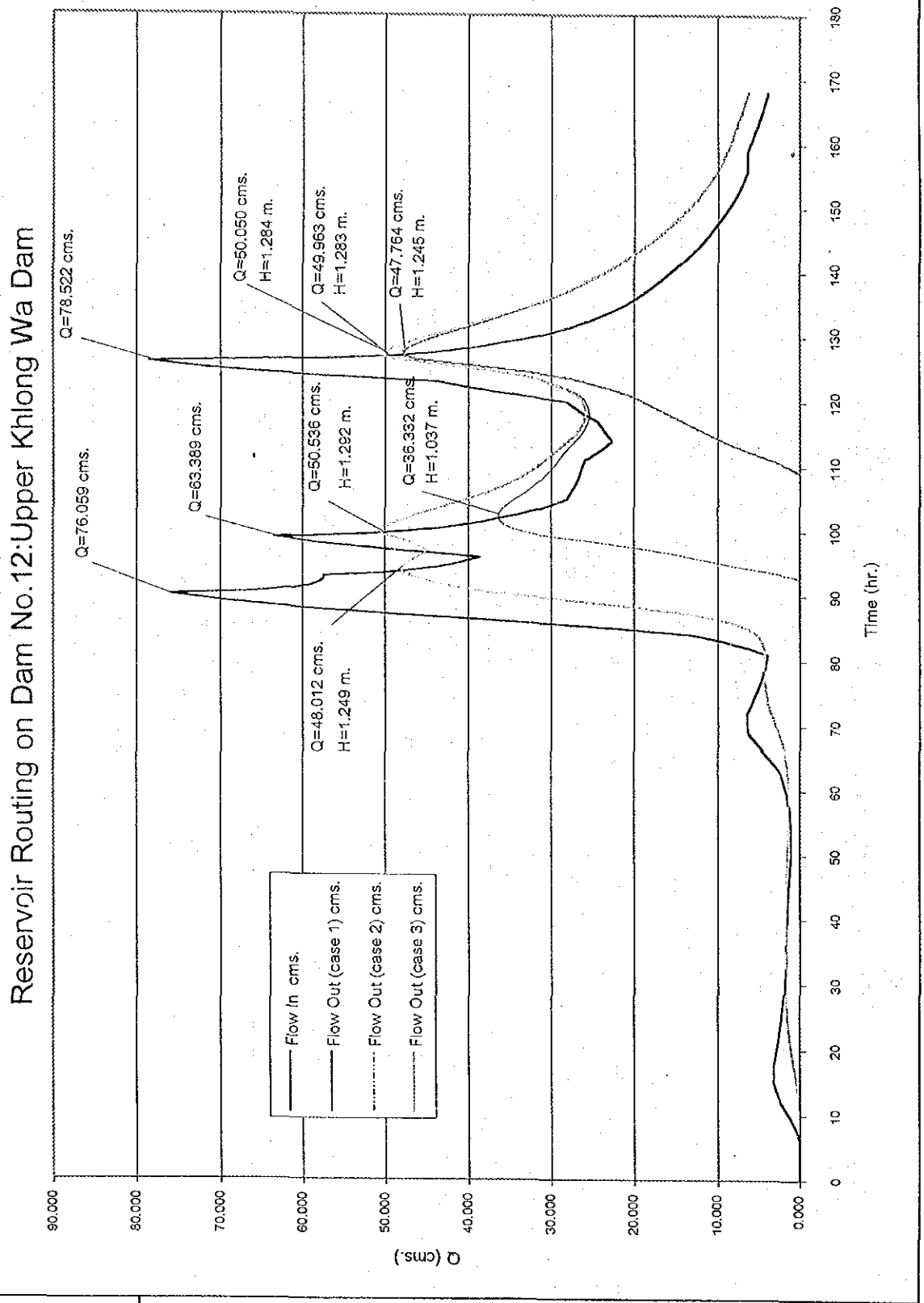
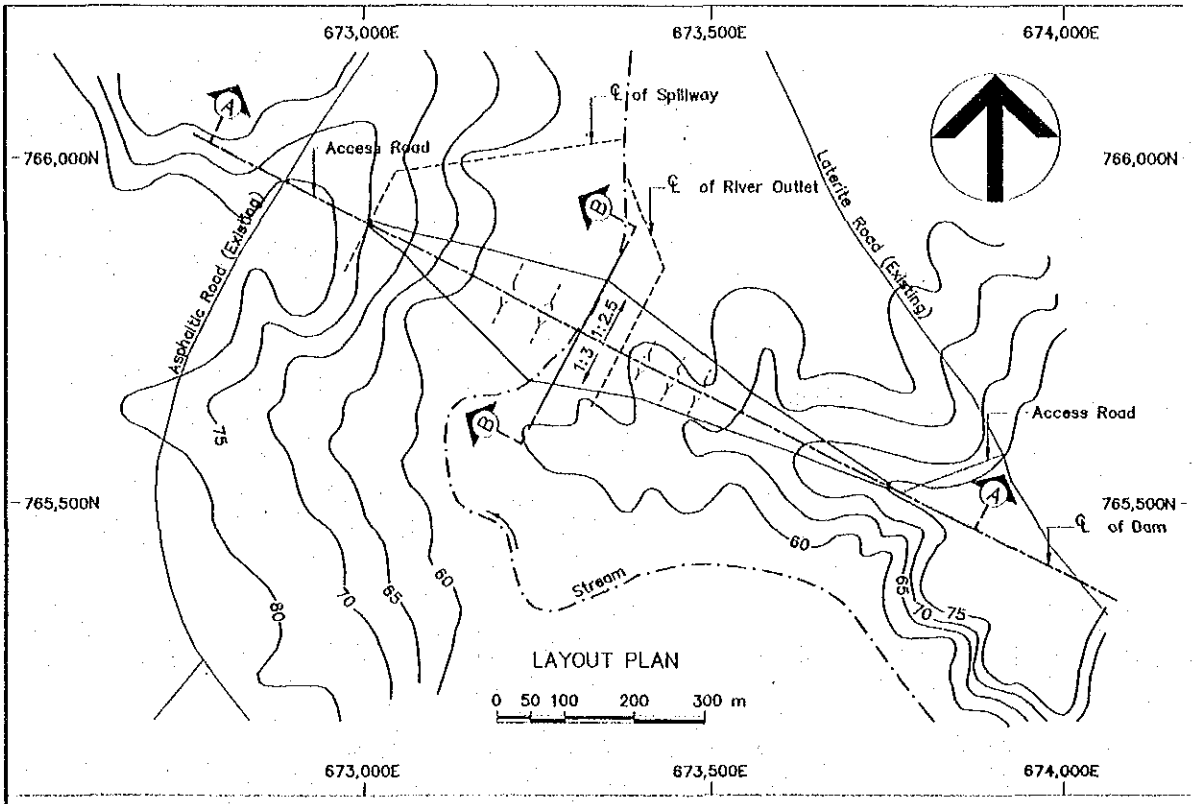
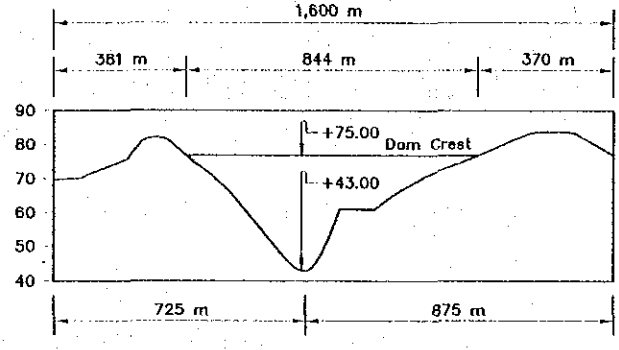
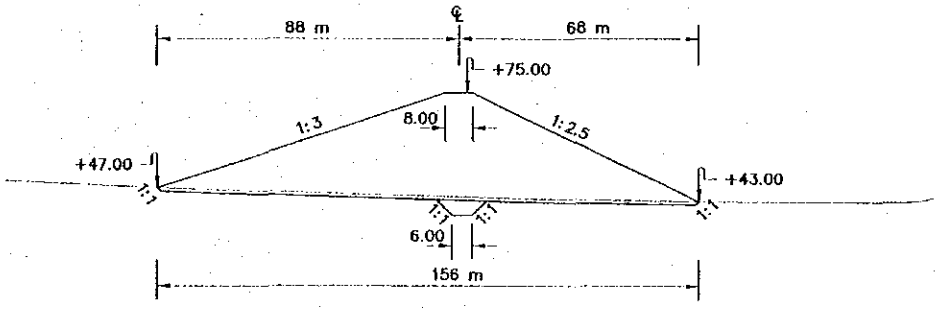


Fig. 3.3-6	Reservoir Routing from Return Period Flood Year 2000





SECTION (A) – (A)



SECTION (B) – (B)

Fig. 3.4–1	LAYOUT PLAN OF UPPER KHONG WA DAM