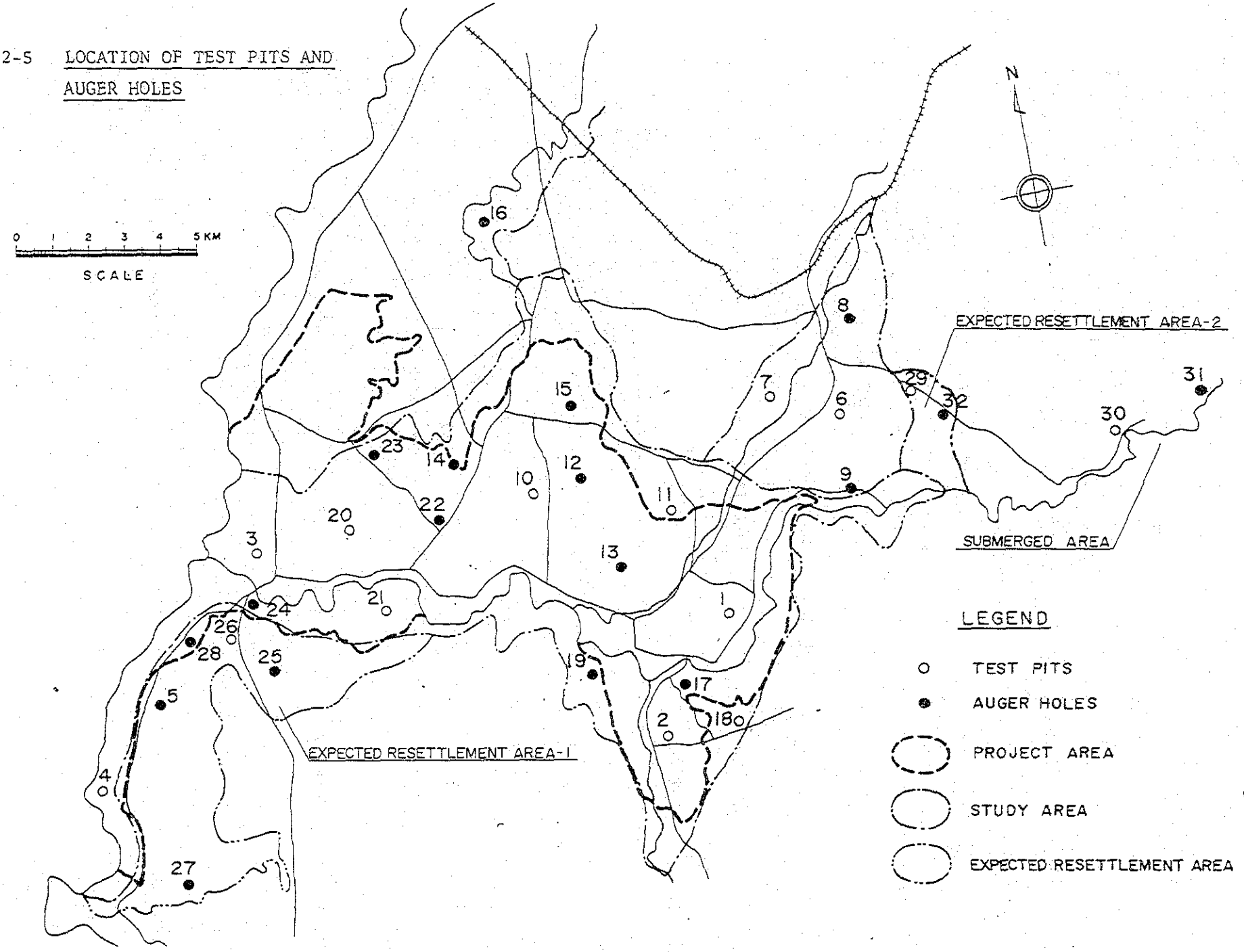
FIG. 3.2-5 LOCATION OF TEST PITS AND AUGER HOLES



Background Information of Sampling Sites

T - 1 Ban Hom, Na Koa, Mae Tha
300m north of Wat Ban Hom
Semi-recent terrace, nearly flat, semi-recent alluvium
Mae Chang series
Class R1 (U2s/R1)
Paddy field,rainfed, (25-30 tang paddy/rai)

T - 2 Ban Kiu Lang, Ban Kiu, Mae Tha
300m east from ARD read
Semi-recent terrace, nearly flat, semi-recent alluvium
Mae Sai series
Class R1 (U2s/R1)
Paddy field, rainfed, not enough water

T - 3 Ban Mae Long, Wang Phrao, Ko Kha
300m north of Wat Mae Long
Semi-recent terrace, nearly flat, semi-recent alluvium
Mae Sai series
Class R1 (U2S/R1)
Paddy field, irrigated by Muang Ban canal but water is not enough, (about 40 tang paddy/rai)

T - 4 Ban Na Saeng, Na Kaeo, Ko Kha
400m from Mae Wang river
Old levee, undulating (3%), semi-recent alluvium
Kamphaeng Saen series
Class U2/R2 (U2s/R2s)
Sugarcane field with scattered banana trees, surrounded by forest.

A - 5 Ban Na Kaes, Na Kaco, Ko Kha
200m east from old Route 1 road
Semi-recent terrace, undulating (complex slope 10%),semi-recent alluvium
Mae Sai series
Paddy field, rainfed

T - 6 Ban Tha Haen, Mae Tha, Mae Tha
500m east from Thanon Mae Tha-Si Chum road
Semi-recent terrace, nearly flat, semi-recent alluvium
Mae Chang series
Class R1 (U3st/R2t)
Paddy field, rainfed, not cultivated last year because of lack in water.

T - 7 Ban Tha Haen, Mae Tha, Mae Tha
About 1.5 km north-east of Wat Tha Haen
Old alluvial terrace, nearly flat, old alluvium
Mae Tha series
Class R1 (U2st/R2t)
Paddy field, rainfed

A - 8 Ban Mae Tha, Mae Tha, Mae Tha
200m south-east of a lumbermill
Semi-recent terrace, nearly flat, semi-recent alluvium
Mae Chang series
Class
Paddy field, rainfed, not cultivated for long (?)

A - 9 Ban Sop Po, Don Fai, Mae Tha
300m west from the Sop Po school
Old levee, simple slope 5% (N S), semi-recent alluvium
Tha Muang/Kamphaeng Saen association
Class U2/R2 (U2st/R2st)
Sugarcane field

T - 10 Ban Pa Muang, Nam Cho, Mae Tha
400m east from the village
Old alluvial ferrace, nearly flat, old alluvium
Mae Rim/Hang Chat/Korat asociation
Class U6/R6 (U6st/R6st)
Paddy field, not cultivated last year because of lack in water supply, low yield

T - 11 Ban Lai Tung, Nam Cho, Mae Tha
500m west of the village
Old alluvial terrace, concave 2%, old alluvium
Hang Chat/Satuk-gravelly vanant association
Class R1(U3st/R2t)
Forest (sparce trees, max 2m high), cultivated several years before(?)
Very hard, compacted soil with cracking on the surface.

A - 12 Ban Hong Ha,
800m south of Wat Hong Ha
rolling (5% S N), old alluvium, Hill
Mae Rim/Hang Chat/Korat asociation
Class U6/R6 (U6st/R6st)
Forest, low trees (2m high), mixed
Severe evasion problem

A - 13 Ban Pa Mak, Na Khot Luang, Mae Tha
50m west from the road
Semi-recent terrace, nearly flat, semi-recent alluvium
Si Satchanai/Mae Tha association
Class U1 (U2t/R3st)
Paddy field, rainfed, abandoned (?)

A - 14 Ban Rong Pa Phung, Nam Cho, Mae Tha
400m north from the village
Old alluvial terrace, gradually slope (2%, convex, E W), old alluvium
Mae Rim/Hang Chat/Korat association
Class U6/R6 (U6st/R6st)
Tabacco field, irrigated

A - 15 Ban Mae Pung, Nam Cho, Mae Tha
300m north-east of the school
Old alluvial terrace, flat, old alluvium
Mae Tha series
Class R1 (U2s/R1)
Beans field next to paddy field, irrigated, intensive cropping area

A - 16 Ban Kluai Luang, Kui Phae, Muang
300m west from the elevated watercourse
Old alluvial terrace, nealy flat slightly concave, old alluvium
Mae Rim/Hang Chat/Korat association
Class U6/R6 (U6st/R6st)
Paddy field, rainfed, surrounded by upland and forest.

A - 17 Ban Na Kwao, Ban Kiu, Mae Tha
500m north of Wat San Doi Noi
Semi-recent terrace, nearly flat slightly concave, semi-recent alluvium
Mae Sai series
Class U2/R2 (U2s/R2s)
Paddy field, rainfed, 30 - 50 tang paddy/rai
Very hard soil surface with cracks.

T - 18 Ban Na Tom, Ban Kiu, Mae Tha
About 1 km east of the village
Old allavial terrace and fans, simple slope (3% S N), old alluvium
Mae Rim series
Class U6/R6 (U6st/R6st)
Shrub, sparse thin trees (1.5m high)

A - 19 That Doi Phra Kan, , Mae Tha
About 1 km south-east of That Doi Phra Kan
Old allavial terrace and fans, complex slope, rolling, old alluvium
Mae Rim/Hang Chat/Korat association
Forest

T - 20 Ban Phak Tut, Nam Cho, Mae Tha
100m north of the village
Old alluvial terrace, flat, old alluvium
Mae Tha series
Class R1 (U3sd/R1)
Paddy field, irrigated by canal but not cultivated in dry season

T - 21 Ban To, Nam Cho, Mae Tha
800m south from the village
Old levee, undulating (convex 1 - 3%), semi-recent alluvium
Si Satchanalai series
Class U1 (U1/R3s)
Sugarcane field surrounded by forest

A - 22 Ban Nam Cho, Nam Cho, Mae Tha
100m north of the village
Old alluvial terrace, flat, old alluvium
Mae Tha series
Class U2/R2 (U2st/R2st)
Peanuts field, irrigated

A - 23 Ban Pa Phai, Nam Cho, Mae Tha
800m north-west from the village
Old alluvial terrace, nearly flat, old alluvium
Mae Rim/Hang Chat/Korat association
Class R1 (U3st/R2t)
Sugarcane field

A - 24 Ban Wang Phrao, Wang Phrao, Ko Kho
300m south from the Route 1 highway
Dissected erosion surface including fans, slightly undulating
(2-3%, S N), Shale, slate and/or phylite
Muak Lek/Li/Ngao association
Class U2/R2 (U2s/R2s)
Sugarcane field surrounded by forest

A - 25 Ban Wang Phrao, Wang Phrao, Ko Kha
About 2 km south from the Route 1 Highway
Dissected erosin surface, including fans, rolling, complex slope, shale, slate and/or phylite
Muak Lek/Li/Ngao association
Class U6/R6 (U6st/R6st)
Forest, considerably dense, mixed trees
Some big stomes and rock outcrop on the surface

T - 26 Isolated
50m west from the Route 1 highway
Dissected erosion surface including fans, rolling (5%, convex, SE NW), shale, slate and/or phylite.
Muak Lek/Li/Ngao association
Closs U6/R6 (U6st/R6st)
Sugarcane field
Many cobbles and stones (2-10cm) paved on the surface, and few rock outcrops.

A - 27 Ban Na Kim, Ban Na Kao, Ko Kha
About 1 km south-east of the village
Dissected erosion surface including fans, rolling, shale, slate and/or phylite.
Muak Lek/Li/Ngao association
Class U6/R6 (U6st/R6st)
Forest

A - 28 Ban Thai Song Kwae, Ban Na Kao, Ko Kha
30m east from the old route 1 road
Class U2/R2 (U2s/R2s)
Paddy field, rainfed, not cultivated for long

T - 29 Isolated
20m south from the road, in the depression area
Old alluvial terrace and fans, slightly undulating, old alluvium
Kue Lom-basic variant
Class U2/R2 (U2st/R2st)
Bush, Pang trees (ø 5-10cm, 203m high), big trees (may be Teak) having been cut
Very hard and compact when dry, strong HCL reaction in the subsoil

T - 30 Ban Mai, Don Phi, Mae Tha
20m east from the village
Old levee, nearly flat, semi-recent alluvium
Kamphaeng Saen series
Class U1 (U1/R3s)
Tobacco field, irrigated by pump, sticky rice was cultivated in wet seasons.

A - 31 Ban Huai Ri, Hua Sua, Mae Tha
50m west from the Mae Chang river
Old levee, slightly sloping towards the river, semi-recent alluvium
Kamphaeng Saen series
Class U1 (U1/R3s)
Tobacco field

A - 32 Isolated
About 1.5 km onrth-west of the Mechanical Center of the Highway Dept, in the depression area
Dissected crosion surface including fans, nearly flat, limestone
Takhli/Lop Buri association
Class R2 (U3st/R2st)
Sparse forest, mainly Nam trees, big trees (may be Teak?) having been cut.

Table 3.2-10 Land Classification Specifications

Classification Characteristics	Upland Field			Paddy Field		
	U 1	U 2	U 3	R 1	R 2	R 3
Soils Texture	SL-friable CL	LS-permeable C LS < 30 cm	Slowly LS- permeable C LS < 60 cm	very slowly CL- permeable C CL < 30 cm	very slowly SL- permeable C. SL < 15 cm L < 30 cm CL > 30 cm	slowly LS- permeable C LS < 15 cm
Depth to Compacted horizon	150 cm	120 cm	90 cm	90 cm	60-90 cm	30 cm
pH (paste)	5.5 - 8.5	5.0 - 8.5	4.5 - 8.5	5.0 - 8.5	4.5 - 8.5	4.0 - 8.5
Salinity $EC \times 10^3$	< 4	< 6	< 8	< 4	< 6	< 8
Exchangeable Sodium, meq/100gm	< 2	< 2	< 3	< 3	< 4	< 4
Water-holding Capacity in 120 cm. depth	15 cm	11 cm	8 cm	not applicable	not applicable	not applicable.
Topography Relief	smooth	wavy	undulating	smooth	wavy	undulating
Slope	< 2%	< 4%	< 6%	< 2%	< 4%	< 4%
Leveling requirement	low	medium	high	low	low	medium
Gravel or rock	few	few	some but tillable	few	few	some but tillable
Rock removal	none	none	some	none	none	some
Trees or brush	slight	moderate	heavy	slight	moderate	heavy
Cover	clearing	clearing	clearing	clearing	clearing	clearing
Drainage Surface	excellent	good	good	good	fair	fair to poor
Sub-sruface	good	good	fair	poor	fair	good
Flood	no	no	occasional	infrequent damaging floods	periodic damaging floods	annual damaging floods

Class 6 is the lands for which the soils do not meet minimum requirements for other land classes.

Table 3.2-11 Result of Soil Analysis (1)

Test Pit No.	Sampling Depth(cm)	Particle Size Hydrometer %				Texture Class	pH H_2O		pH KCl	ECe	Sat.	ECE	ESP	Exchangeable Cations meq/100g				Base Saturation	Organic Matter	Total N	Avail-P Bray II	P-Sorption	Total Extract K	$CaCO_3$ Equivalent	
		2-0.25mm	0.25-0.02mm	0.02-0.002mm	<0.002mm		Paste	1:1	1:1	ms/cm	%	meq/100g	%	Na	Ca-Mg	Ca	K	%	%	%	ppm	ppm	ppm	%	
1	0 - 12	0.7	44.8	31.1	23.4	SiL	6.0	6.2	4.9	0.68	42.2	15	2.8	0.42	8.2	6.5	0.23	59	1.5	0.09	6.1	64	90	0	
	12 - 20	0.8	42.2	26.1	30.9	CL	6.9	7.6	5.8	0.45	53.3	21	2.3	0.48	11	8.1	0.07	55	0.65	0.04	3.5	121	27	0	
	20 - 49	2.4	44.6	24.2	28.8	CL	6.0	6.3	5.0	0.17	53.0	23	< 2	0.27	11	7.8	<0.01	49	0.61	0.03	2.9	83	< 5	0	
	49 - 80	3.2	40.8	27.1	28.9	CL	6.0	6.3	4.9	0.25	50.1	25	< 2	0.42	12	9.1	<0.01	50	0.52	0.03	2.9	-	< 5	0	
	80 -	1.4	26.1	35.2	37.3	SiCL	5.9	6.3	4.8	0.20	57.9	31	< 2	0.29	16	12	<0.01	55	0.83	0.05	0	-	< 5	0	
2	0 - 17	7.2	33.8	36.5	22.5	SiL	6.7	6.8	5.5	0.55	38.5	17	< 2	0.33	9.9	7.1	0.14	61	1.6	0.09	2.9	34	55	0	
	17 - 40	11.0	26.9	33.2	28.9	CL	7.6	7.8	6.2	0.50	49.3	21	2.3	0.48	14	9.4	<0.01	69	0.46	0.02	3.3	68	< 5	0	
	40 - 64	13.6	27.4	29.6	29.4	L	7.7	7.9	6.4	0.58	52.3	20	2.2	0.44	14	6.1	<0.01	72	0.42	0.02	2.4	-	< 5	0	
	64 -	6.7	15.3	30.5	47.5	C	7.7	7.9	6.3	0.92	76.9	28	< 2	0.29	15	12	0.16	-	0.56	0.03	12	-	63	1.01	2/
3	0 - 12	0.6	31.0	41.3	27.1	SiCL	5.1	5.3	4.1	0.45	49.5	19	2.2	0.42	7.3	5.7	0.30	42	1.9	0.10	4.2	139	117	0	
	12 - 20	0.7	30.3	40.8	28.2	SiCL	6.7	6.9	5.6	0.45	48.7	20	3.7	0.75	11	7.8	0.16	60	0.94	0.06	2.9	94	63	0	
	20 - 37	1.4	17.1	40.7	40.8	SiC	7.4	7.8	6.2	0.75	49.2	30	5.3	1.6	17	12	0.12	62	0.70	0.04	2.9	96	47	0	
	37 - 55	2.5	20.0	39.9	37.6	SiCL	7.6	8.0	6.3	1.2	41.0	27	6.7	1.8	16	12	0.07	66	0.70	0.04	4.3	-	27	0	
	55 -	4.9	9.2	39.5	46.4	SiC	7.9	8.2	6.6	1.4	53.3	30	9.3	2.8	19	15	0.04	-	0.59	0.04	2.9	-	16	0.97	2/
4	0 - 10	2.6	53.4	29.0	15.0	SiL	7.3	7.5	6.6	0.50	41.6	22	< 2	<0.10	15	13	1.5	75	3.0	0.13	229	<2.5	586	0	
	10 - 24	1.2	55.3	29.0	14.5	L	6.8	7.2	6.3	0.28	33.9	17	< 2	<0.10	10	8.6	0.65	63	1.4	0.08	161	6.5	254	0	
	24 - 39	0.5	68.5	19.6	11.4	L	6.9	7.4	6.3	0.24	30.5	13	2.1	0.27	8.3	7.0	0.45	69	0.72	0.04	69	12	176	0	
	39 -	0.4	84.1	7.5	8.0	SL	7.1	7.5	6.2	0.25	30.7	6.2	< 2	<0.10	5.3	4.4	0.23	91	0.33	0.01	32	-	90	0	
6	0 - 17	12.4	38.1	34.5	15.0	L	5.7	6.2	4.7	0.28	30.1	12	< 2	0.10	6.2	4.3	0.02	53	0.72	0.04	3.8	51	8	0	
	27 - 32	6.4	29.7	28.1	35.8	CL	6.7	6.9	5.5	0.25	70.1	29	< 2	0.55	20	12	0.02	71	0.26	0.02	4.2	26	8	0	
	32 - 71	7.9	20.1	33.0	39.0	CL	7.5	8.0	6.7	0.52	71.9	29	< 2	0.10	16	13	0.18	-	0.39	0.02	5.8	-	70	1.07	2/
	71 -	9.9	21.1	31.0	38.0	CL	7.7	8.4	6.8	0.42	62.0	32	< 2	0.23	29	25	0.14	-	0.29	0.02	9.6	-	55	2.33	2/
7	0 - 14	5.0	22.2	36.8	36.0	SiCL	5.7	6.4	5.1	0.25	51.8	28	< 2	0.55	17	11	0.07	63	1.4	0.08	3.8	146	27	0	
	14 - 24	6.2	21.8	37.0	35.0	SiCL	6.0	6.4	5.0	0.14	51.5	26	< 2	<0.10	15	11	0.12	58	0.78	0.04	3.8	172	47	0	
	24 - 54	10.6	32.9	33.0	23.5	L	5.1	5.8	4.0	0.09	44.4	17	< 2	0.32	8.6	5.8	<0.01	52	0.59	0.02	3.3	173	< 5	0	
	54 -	12.0	26.6	35.0	26.4	L	4.9	5.3	3.6	0.09	46.5	18	< 2	<0.10	4.9	3.3	<0.01	28	0.19	0.01	3.3	-	< 5	0	
10	0 - 10	20.0	47.0	17.1	15.9	L	6.0	6.3	5.2	0.22	28.0	14	< 2	<0.10	7.7	5.5	0.07	56	1.3	0.06	9.4	82	27	0	
	10 - 24	25.1	46.9	16.8	11.2	SL	6.4	6.8	5.6	0.24	21.7	7.2	< 2	<0.10	5.7	4.3	<0.01	81	1.0	0.05	5.6	40	< 5	0	
	24 - 70	50.2	23.3	12.3	14.2	SL	6.2	6.6	5.6	0.13	27.5	13	< 2	<0.10	5.3	3.0	0.07	42	0.18	0.03	2.9	105	27	0	

Test Pit No.	Sampling Depth (cm)	Particle Size Hydrometer % 2-0.25mm	0.25-0.02mm	0.02-0.002mm	<0.002mm	Texture Class	pH H2O Paste	pH H2O 1:1	pH KCl 1:1	ECe ms/cm	Sat. %	ECE meq/100g	ESP %	Exchangeable Cations meq/100g Na	Ca-Mg	Ca	K	Base Saturation %	Organic Matter %	Total N %	Avail-P Bray II ppm	P-Sorption ppm	Total Extract K ppm	$CaCO_3$ Equivalent %
11	0 - 10	12.4	27.1	25.1	35.4	CL	4.7	5.0	3.8	0.18	47.8	29	< 2	<0.10	14	8.1	0.09	49	1.9	0.08	2.9	131	55	0
	10 - 24	8.7	21.1	21.0	49.2	C	4.4	5.1	3.4	0.09	64.0	38	< 2	0.46	14	11	<0.01	38	1.4	0.05	9.7	220	< 5	0
	24 - 47	9.7	11.6	19.6	58.8	C	4.2	4.6	3.2	0.12	72.8	46	< 2	0.51	20	9.4	0.10	45	0.64	0.03	4.0	186	39	0
	47 -	2.0	1.0	14.6	82.4	C	4.1	4.2	2.9	0.11	105.3	59	< 2	0.84	29	19	0.51	51	0.23	0.04	4.5	-	199	0
18	0 - 10	21.6	29.9	24.8	23.7	L	5.0	5.2	4.1	0.35	37.5	24	< 2	<0.10	11	7.1	0.16	47	2.8	0.12	5.2	123	63	0
	10 - 22	17.2	18.0	26.6	38.2	CL	4.4	4.6	3.5	0.20	25.9	28	< 2	<0.10	9.9	6.3	0.05	36	1.7	0.10	5.7	132	20	0
	22 - 60	19.2	6.8	20.6	53.4	C	4.2	4.8	3.3	0.12	61.6	37	< 2	<0.10	11	7.2	0.02	30	1.3	0.09	3.4	46	8	0
	60 - 75	7.3	6.7	13.0	73.0	C	3.9	4.1	2.9	0.13	77.6	59	< 2	<0.78	16	11	0.29	29	1.0	0.09	3.0	-	113	0
20	0 - 11	7.4	30.6	36.4	25.6	SiL	5.5	5.6	4.4	0.56	40.9	18	< 2	<0.10	8.8	4.1	0.28	51	2.0	0.09	34	113	109	0
	11 - 24	9.0	30.2	36.4	24.4	L	4.9	5.3	3.9	0.25	36.2	15	< 2	<0.10	5.4	3.9	0.02	37	0.79	0.04	6.6	110	8	0
	24 - 50	13.5	31.0	28.9	26.6	SiL	5.0	5.7	3.8	0.11	36.2	14	< 2	<0.10	4.7	2.7	0.05	35	0.47	0.03	3.3	199	20	0
	50 -	9.4	16.6	22.0	52.0	C	5.3	5.9	3.7	0.08	94.1	33	3.6	1.2	9.0	4.3	0.14	31	0.38	0.04	3.3	-	55	0
21	0 - 13	5.4	45.6	26.2	22.8	L	6.6	6.7	5.4	0.58	35.8	18	< 2	0.10	13	8.6	0.29	74	2.3	0.10	15	23	113	0
	13 - 32	5.2	44.3	27.1	23.4	L	6.4	6.5	5.5	0.28	34.4	21	< 2	0.10	14	8.2	0.17	68	1.8	0.07	6.1	31	66	0
	32 -	3.7	31.8	29.5	35.0	CL	6.2	6.5	5.2	0.20	46.8	26	< 2	0.10	14	8.0	0.07	54	0.89	0.05	3.8	-	27	0
26	0 - 5	30.6	30.4	24.0	15.0	L	6.9	7.0	5.9	0.80	37.2	13	< 2	0.10	8.2	5.5	0.19	65	2.0	0.08	8.4	32	74	0
29	0 - 20	3.5	10.3	34.2	52.0	SiC	7.4	7.6	6.4	0.35	77.4	68	< 2	0.10	58	48	0.45	86	4.9	0.19	73	156	176	2.37 2/
	20 - 55	7.6	15.4	23.0	54.0	C	7.6	7.8	6.5	0.40	73.9	65	< 2	0.10	63	37	0.34	97	1.6	0.07	5.2	174	133	2.53 2/
	55 -	14.2	15.6	23.2	47.0	C	7.7	8.1	6.7	0.42	62.0	54	< 2	0.10	-	-	0.09	-	0.83	0.04	4.9	-	35	2.56 2/
30	0 - 11	1.8	26.0	33.2	39.0	SiCL	7.7	7.8	6.8	0.66	34.7	32	< 2	0.10	13	9.7	0.42	42	1.7	0.09	91	25	164	1.10 2/
	11 - 47	1.8	24.7	32.5	41.0	SiC	7.5	7.8	6.7	0.44	60.6	38	< 2	0.10	22	15	0.34	59	0.99	0.05	86	37	133	1.20 2/
	47 - 72	2.5	25.5	31.0	41.0	SiC	7.4	7.9	6.8	0.45	61.8	34	< 2	0.10	23	17	0.30	-	0.92	0.06	68	-	117	2.18 2/
	72 -	3.9	26.9	28.2	41.0	C	7.6	8.0	6.7	0.40	55.8	35	< 2	0.10	21	16	0.34	-	0.68	0.05	21	-	133	2.28 2/

2/ .... The result of exchangeable Calcium and Magnesium will be approximate for soil sample containing carbonate, as ammonium salt will dissoluve free carbonate, 0.1 Hcl is used to removed carbonate before the determination of exchangeable cottons.

Table 3.2-12. Result of Soil Analysis (2)

Auger Hole No.	Sampling Depth (cm)	Texture Class	pH H_2O 1:1	pH Kcl 1:1	EC 1:1 ECx10^3 (ms/cm)	Avail-P Bray II (ppm)	Remarks
5	0 - 10	SL	6.7	5.7	0.13	4.7	
	10 - 50	SCL	6.7	5.4	0.08	3.7	
	50 - 110	SL	6.7	5.1	0.04	6.5	
	110 -	SCL	6.9	5.4	0.11	2.8	
8	0 - 15	CL	5.7	4.3	0.07	5.1	
	15 - 45	CL	5.3	3.6	0.04	3.8	
	45 - 80	C	5.3	3.6	0.05	2.9	
	80 - 90	C	5.3	3.7	0.11	2.9	Gravel=54%
9	0 - 15	SCL	5.8	4.9	0.09	5.9	
	15 - 40	SCL	5.8	4.6	0.17	240	
	40 - 60	SCL	6.9	4.7	0.16	138	
	60 - 85	SCL	5.7	4.6	0.47	120	
12	0 - 10	SL	6.0	4.4	0.03	19	
	10 - 50	SL	5.7	4.2	0.02	8.3	
13	0 - 10	L	5.9	5.0	0.11	3.7	
	10 - 40	SCL	5.4	4.4	0.18	3.7	
	40 - 60	CL	5.6	4.4	0.32	2.9	
	60 -	SCL	6.8	5.6	0.21	6.2	
14	0 - 20	SL	5.7	5.2	0.59	444	Gravel=66%
	20 - 50	SCL	5.5	4.8	0.28	43	Gravel=77%
	50 -	C	4.6	3.6	0.10	4.1	Gravel=71%
15	0 - 10	L	7.8	6.6	0.42	12	
	10 - 60	L	8.2	6.7	0.28	6.6	
	60 - 110	CL	7.8	6.7	0.46	4.3	
16	0 - 10	SL	5.9	4.3	0.06	6.0	
	10 - 20	SL	5.5	4.3	0.04	4.7	
	30 - 45	SL	5.1	4.3	0.19	4.2	
	45 - 60	SCL	5.1	3.8	0.07	3.7	
17	0 - 25	C	6.3	5.0	0.22	11	
	25 - 45	C	6.0	4.7	0.21	4.1	
	45 - 70	C	5.8	4.5	0.16	2.9	
	70 -	C	5.9	4.5	0.15	5.7	
19	0 - 25	SCL	5.4	4.4	0.39	4.0	Gravel=36%

Auger Hole No.	Sampling Depth (cm)	Texture Class	pH H_2O 1:1	pH Kcl 1:1	EC 1:1 $ECx10^3$ (ms/cm)	Avail-P Bray II (ppm)	Remarks
22	0 - 15	L	7.0	5.9	0.18	12	
	15 - 30	SCL	7.3	6.0	0.16	3.7	
	30 - 55	SCL	6.9	5.5	0.14	6.1	
23	0 - 20	CL	5.1	3.9	0.12	4.8	
	20 - 40	CL	4.9	3.6	0.06	4.2	
	40 -	C	5.1	3.4	0.06	2.9	
24	0 - 20	CL	7.0	5.7	0.17	8.9	
	20 - 60	C	6.5	5.3	0.19	3.8	
	60 - 90	C	6.9	5.5	0.14	3.3	
25	0 - 10	CL	7.1	6.0	0.19	5.3	
	10 - 40	C	6.9	5.5	0.14	5.4	
	40 - 60	SCL	7.6	6.3	0.26	13	
27	0 - 2	L	6.9	5.6	0.16	10	Gravel=24%
	2 - 40	CL	7.7	6.2	0.24	4.5	
	40 - 70	L	8.3	6.5	0.21	3.8	
28	0 - 30	CL	7.7	6.5	0.27	5.6	
	30 - 60	CL	7.1	5.8	0.12	6.1	
	60 -	C	6.8	5.3	0.10	3.7	
31	0 - 40	CL	6.6	5.5	0.38	6.5	
	40 - 60	CL	6.3	5.2	0.38	1.8	
	60 -	CL	6.7	5.4	0.24	167	
32	0 - 15	C	6.4	5.3	0.56	4.0	
	15 - 45	C	5.2	3.9	0.49	4.0	
	45 - 90	C	7.2	6.1	0.80	3.0	

Table 3.2-13. Key for Estimating Natural Fertility

(a) Rating of the selected soil test values

CEC	meq/100g soil
High	> 20
Moderately high	15 - 20
Medium	10 - 15
Moderately low	5 - 10
Low	< 5

Organic Matter	weight %
High	> 3.5
Moderately high	2.5 - 3.5
Medium	1.5 - 2.5
Moderately low	1.0 - 1.5
Low	< 1.0

Base Saturation	%
High	> 75
Medium	35 - 75
Low	< 35

Available Phosphorus	P-ppm
High	> 25
Moderately high	15 - 25
Medium	10 - 15
Moderately low	6 - 10
Low	< 6

Very low and very high may be wed if significant for values below 3 and above 45.

(b) Key for estimating the natural fertility of soils mainly suited for paddy rice

C.E.C.	Base Sat.	Org. Matter	Av. Phosphate	Natural Fertility
H-MH	H	H-M	H-M	high
"	H	M-ML	M-ML	moderately high
"	M	M H-M	H-M	moderately high
"	H	ML	M-L	moderate
"	M	M-ML	M-L	moderate
"	L	M	M	moderately low
"	L	ML	M-L	low
M	H	H-M	H	high
"	H	M	M	moderately high
"	H	ML	M-L	moderate
"	M	M	M-L	moderate
"	M	ML	H-M	moderate
"	M	ML	M-L	moderately low
"	L	M	H-M	moderately low
"	L	ML	M-L	low
ML	H	M	H-M	moderately high
"	H	ML	M-L	moderate
"	M	M	H-M	moderate
"	M	ML	M-L	moderately low
"	H	L	M-L	moderately low
"	M	L	M-L	low
"	L	ML	M-L	low
L	H	ML	M	moderately low
"	M-L	L	L	low

(c) Key for estimating the natural fertility of soils mainly suited for upland crops

CEC	Base Sat.	Av. Phosphate	Natural Fertility
H-MH	H	H	high
"	M	H	moderately high
"	L	M	moderately low
"	H	MH-M	moderately high
"	H	L	moderate
"	M	M-L	moderate
M	H	H	high
"	M	H	moderately high
"	L	H	moderately low
"	H	M	moderately high
"	H	L	moderate
"	M	M-ML	moderate
"	M	L	moderately low
"	L	M-L	moderately low
ML	H	H	moderately high
"	M	H	moderate
"	L	H-M	moderately low
"	H	M	moderate
"	M	M-L	moderately low
"	L	L	low
L	H	M	moderately low
"	M-L	M-L	low

Source: Soil Interpretation Handbook for Thailand

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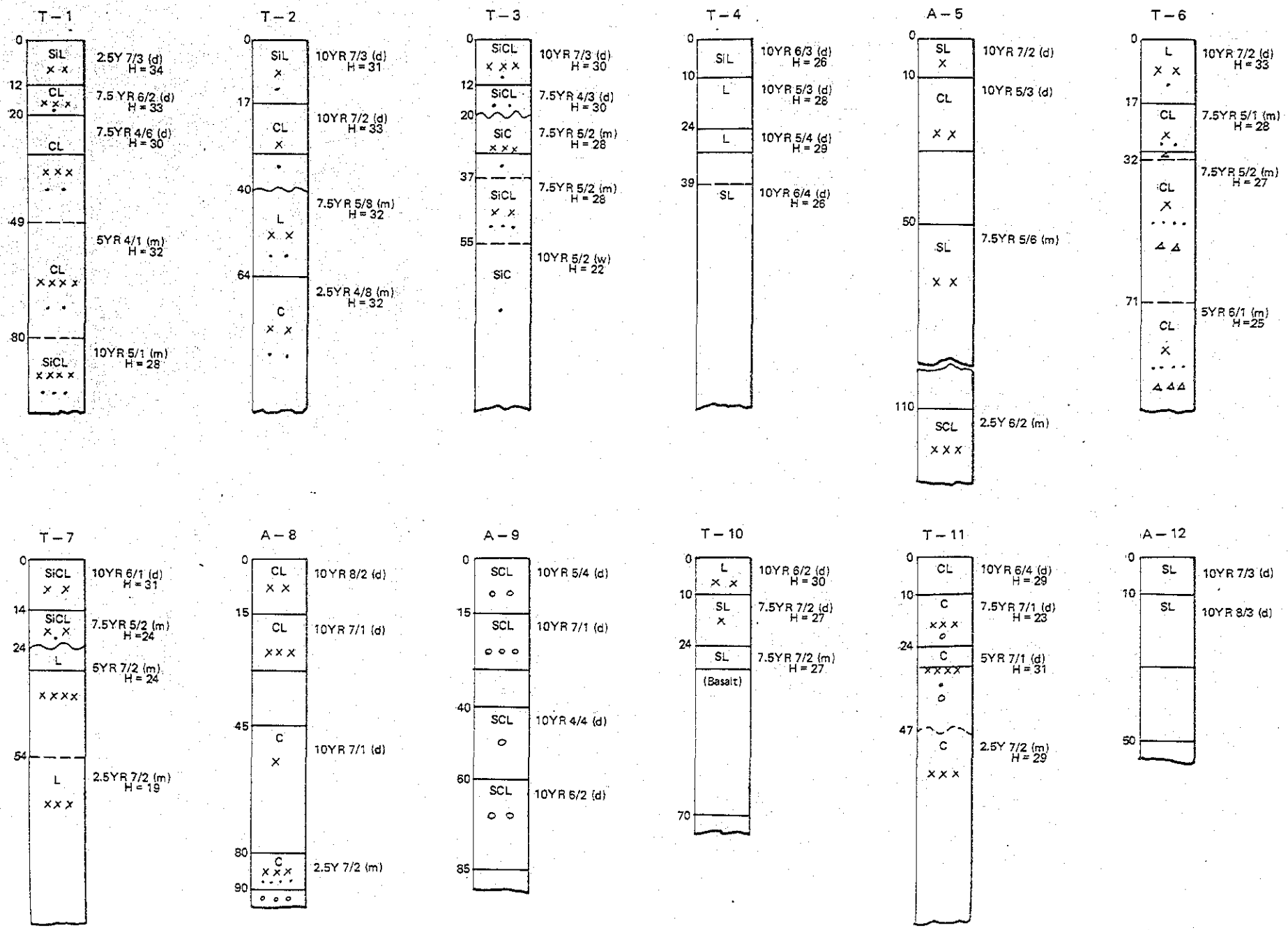
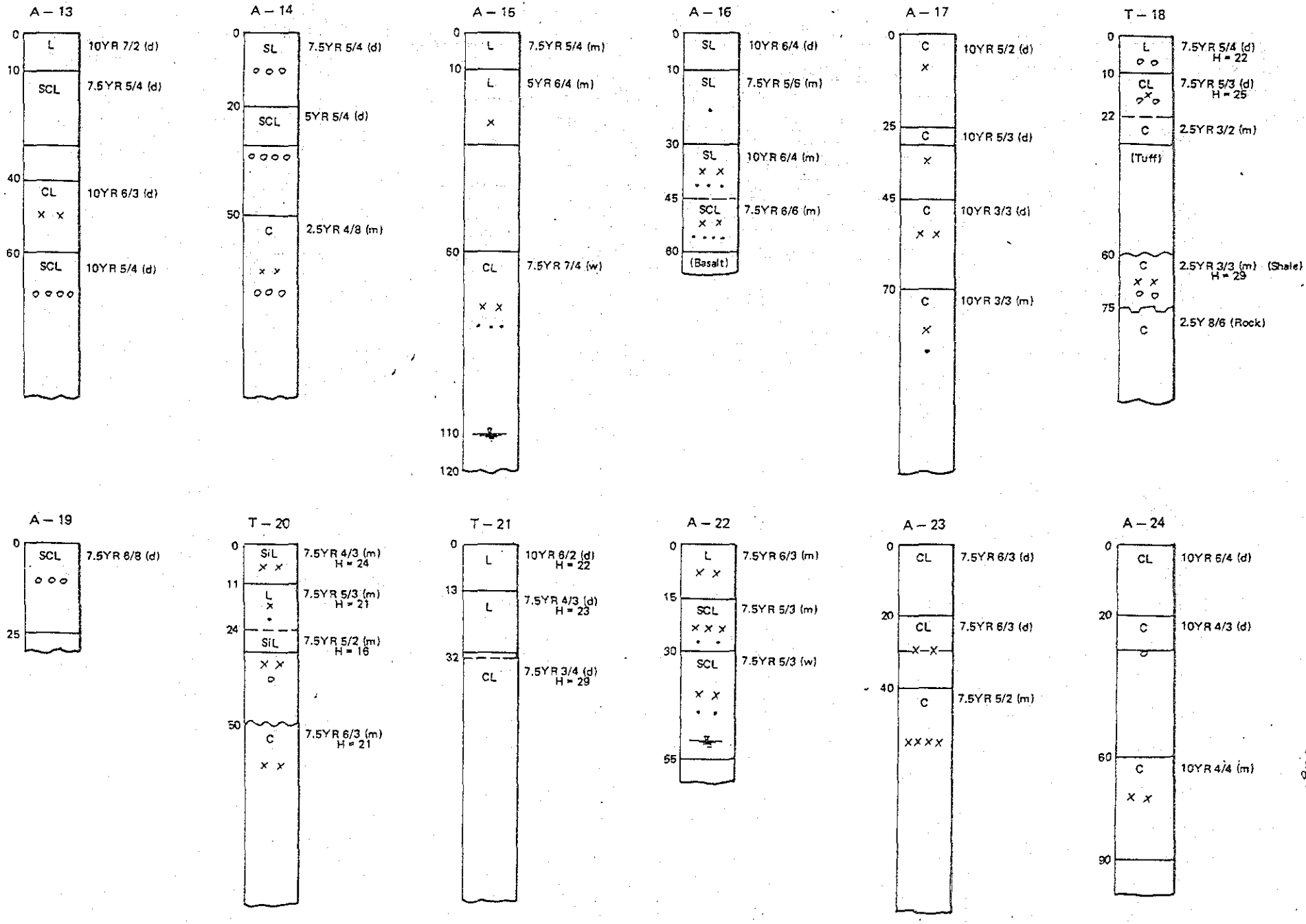
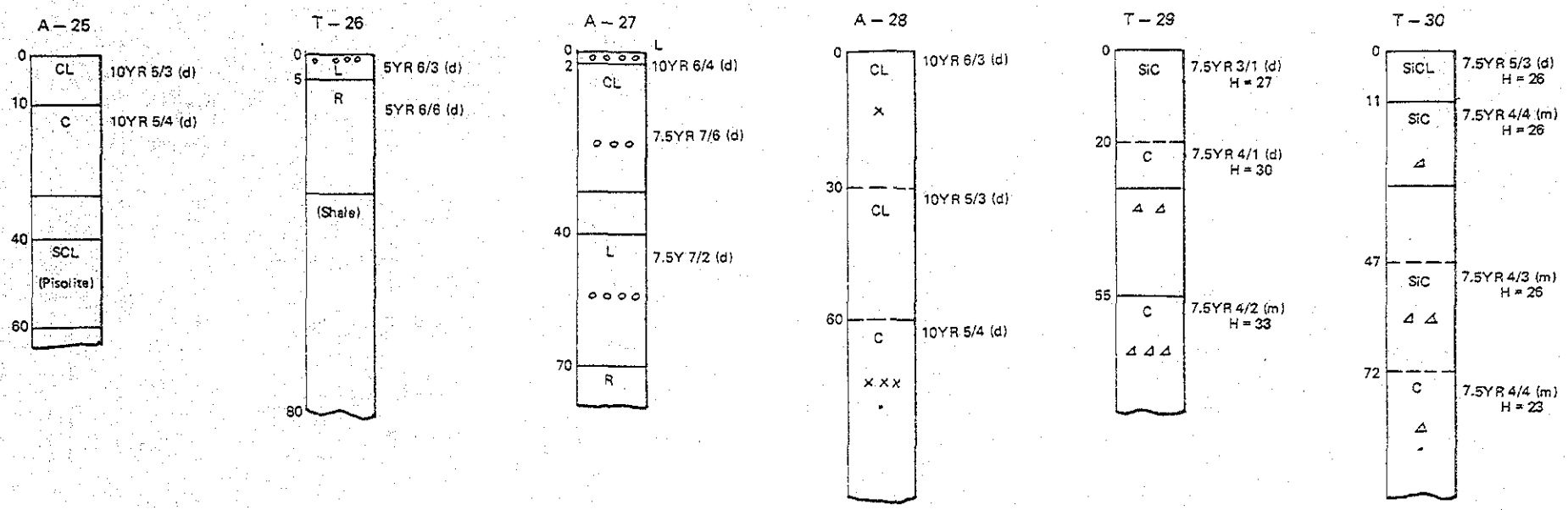
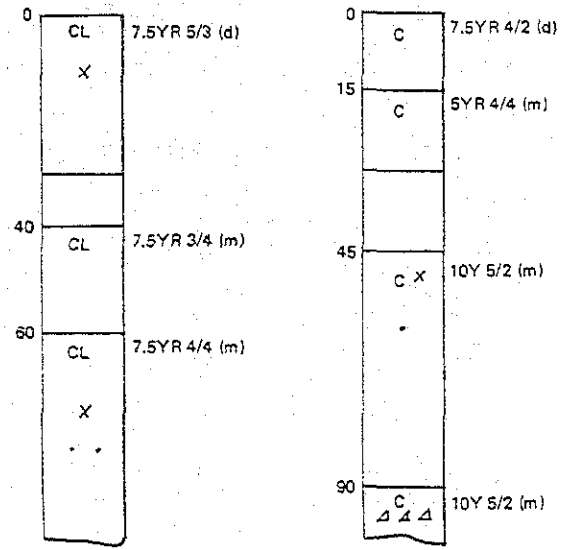
Fig. 3.2-6 (1) Columnar Sections of Soil Profile




A – 13
0
10
40
60
L
SCL
CL
SCL
10YR 7/2 (d)
7.5YR 5/4 (d)
10YR 6/3 (d)
10YR 5/4 (d)
A – 14
0
20
50
SL
SCL
C
7.5YR 5/4 (d)
5YR 5/4 (d)
2.5YR 4/8 (m)
A – 15
0
10
60
110
120
L
L
CL
7.5YR 5/4 (m)
5YR 6/4 (m)
7.5YR 7/4 (w)
A – 16
0
10
30
45
60
SL
SL
SL
SCL
(Basalt)
10YR 6/4 (d)
7.5YR 5/6 (m)
10YR 6/4 (m)
7.5YR 6/6 (m)
A – 17
0
25
45
70
C
C
C
C
10YR 5/2 (d)
10YR 5/3 (d)
10YR 3/3 (d)
10YR 3/3 (m)
T – 18
0
10
22
60
75
L
CL
C
C
C
7.5YR 5/4 (d)
H = 22
7.5YR 5/3 (d)
H = 25
2.5YR 3/2 (m)
(Tuff)
2.5YR 3/3 (m) (Shale)
H = 29
2.5Y 8/6 (Rock)
A – 19
0
25
SCL
7.5YR 6/8 (d)
T – 20
0
11
24
50
SiL
L
SiL
C
7.5YR 4/3 (m)
H = 24
7.5YR 5/3 (m)
H = 21
7.5YR 5/2 (m)
H = 16
7.5YR 6/3 (m)
H = 21
T – 21
0
13
32
L
L
CL
10YR 6/2 (d)
H = 22
7.5YR 4/3 (d)
H = 23
7.5YR 3/4 (d)
H = 29
A – 22
0
15
30
55
L
SCL
SCL
7.5YR 6/3 (m)
7.5YR 5/3 (m)
7.5YR 5/3 (w)
A – 23
0
20
40
CL
CL
C
7.5YR 6/3 (d)
7.5YR 6/3 (d)
7.5YR 5/2 (m)
A – 24
0
20
60
90
CL
C
C
10YR 6/4 (d)
10YR 4/3 (d)
10YR 4/4 (m)





LEGEND

Soil Texture	SL = Sandy loam, L = Loam, CL = Clay loam, SiL = Silty loam, SCL = Sandy clay loam SiCL = Silty clay loam, SC = Sandy clay, SiC = Silty clay, C = Clay, G = Gravelly, R = Parent rock
Mottles and Concretions	XXXX —— predominent, XXX —— many, XX —— common, X —— few X —— Mottles, • —— Concretions, △ —— Lime fragments, ○ —— Gravels
Boundary of Horizons	—— Smooth boundary, ~~~ Wavy boundary, ⌐¬⌐¬ Irregular boundary, adrupt, —— clear, – – – – gradual,
Soil Hardness	H = mm in Yamanaka–Type Soil Hardness Meter Dry : 2 – 24 somewhat hard, 25 – 29 hard, > 30 very hard Moist : 15 – 19 somewhat hard, 20 – 24 hard, > 25 very hard

Table 3.2-14 (1) Seismographical Record (1975 - 1983)

Cordinate of dam site
Latitude 18.19°
Longitude 99.71°

No	Date	Epicenter Latitude	Epicenter Longitude	Magnitude	Distance from dam site	Acceleration
					km	gal
1	May 23,1912	21.000	97.000	8.0	434.5	5.27
2	Dec 3,1930	18.000	96.500	7.3	358.0	4.68
3	Feb 17,1975	17.600	97.900	5.6	211.9	0.62
4	Mar 31,1976	20.510	100.200	3.3	264.0	3.64×10^{-7}
5	May 3,1976	20.300	98.360	3.6	281.6	9.93×10^{-7}
6	May 6,1976	20.300	98.640	3.2	263.3	1.82×10^{-7}
7	May 1,1977	21.170	98.160	4.0	373.9	1.05×10^{-7}
8	May 1,1977	19.950	100.990	4.2	242.2	4.24×10^{-4}
9	Dec 26,1977	18.590	99.910	3.2	49.8	0.96
10	May 5,1978	19.680	99.050	3.2	181.4	6.90×10^{-5}
11	May 11,1978	19.410	98.690	3.5	177.0	4.45×10^{-4}
12	May 25,1978	19.180	99.140	4.0	127.2	0.07
13	May 26,1978	19.200	99.200	4.8	125.9	0.92
14	May 27,1978	19.240	99.140	3.5	133.0	0.008
15	May 29,1978	19.310	99.100	3.5	142.0	0.004
16	Jun 18,1978	19.200	99.200	1.6	125.9	2.12×10^{-6}
17	Jun 20,1978	19.280	99.340	3.5	128.1	0.01
18	Jun 28,1978	21.120	99.130	4.0	332.5	1.00×10^{-6}
19	Jun 29,1978	21.100	99.100	4.0	331.0	1.09×10^{-6}
20	Jul 23,1978	17.050	99.210	3.0	138.6	6.32×10^{-4}
21	Jul 24,1978	17.100	99.200	4.0	134.0	0.05
22	Aug 2,1978	20.500	100.700	5.1	279.8	0.01
23	Aug 2,1978	20.350	100.630	5.4	261.3	0.07
24	Sep 1,1978	19.970	100.540	5.1	218.6	0.08
25	Sep 1,1978	20.400	100.600	4.9	265.2	6.24×10^{-3}
26	Jan 22,1979	20.220	100.400	4.5	238.7	2.48×10^{-3}
27	Mar 18,1979	20.900	102.000	4.5	394.9	2.29×10^{-6}
28	Feb 10,1980	19.400	99.200	4.2	146.2	0.05
29	Sep 10,1980	18.900	99.200	3.6	97.3	0.11
30	Dec 20,1980	18.040	100.200	3.2	57.0	0.57

Table 3.2-14 (2) Seismographical Record (1975 - 1983)

Cordinate of dam site
Latitude 18.19°
Longitude 99.71°

No	Date	Epicenter		Magnitude	Distance from dam site	Acceleration
		Latitude	Longitude			
31	Dec 21,1980	18.030	100.160	3.0	53.2 km	0.47 gal
32	Dec 22,1980	18.030	100.090	4.0	45.9	5.97
33	Dec 22,1980	18.000	100.100	4.0	48.3	5.24
34	Dec 23,1980	18.050	100.160	4.2	52.5	6.06
35	Jan 1,1981	18.000	100.140	3.9	52.3	3.47
36	Jul 22,1981	16.860	98.170	3.0	226.5	6.97×10^{-7}
37	Jun 23,1982	18.100	99.900	4.2	23.4	26.2
38	Apr 15,1983	14.950	99.140	5.3	366.2	1.67×10^{-3}
39	Apr 22,1983	14.952	99.072	5.8	367.4	0.02
40	Apr 22,1983	14.960	99.060	5.2	366.8	9.02×10^{-4}

Fig. 3.2-7 A Seismic Probability Map For Thailand And Neighbouring Countries

Distribution Of Earthquake Epicenters : 1975 - 1981

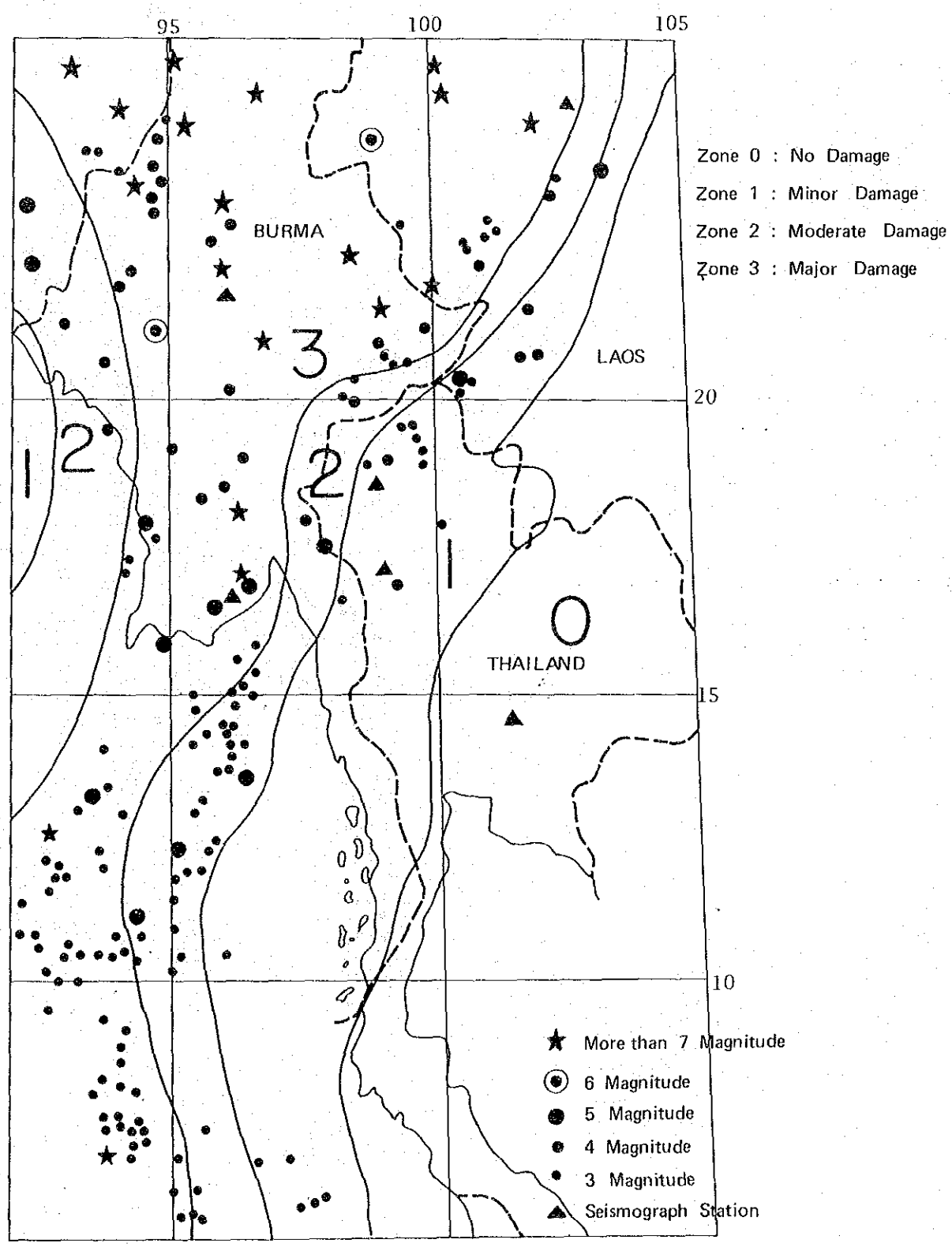


Table 3.3-1 Farm Size and Land Use

Farm Size (rai)	No. of Samples	Total Operated Area (rai)	Operated Area per Household (rai)	Cultivable Land		Non Cultivable Land					
						Fallow Land		Home Stead		Non Cultivable Land	
				Area (rai)	Percentage of Operated Area (%)	Area (rai)	Percentage (%)	Area (rai)	Percentage (%)	Area (rai)	Percentage (%)
under 6	22	99.85	4.54	76.75	76.87	8.75	8.76	14.35	14.37	Null	Null
6 - 10	65	540.69	8.35	387.38	71.38	96.00	17.69	58.51	10.04	0.50	0.09
11 - 15	45	595.65	13.24	396.79	66.62	161.38	27.09	37.48	6.29	Null	Null
16 - 20	16	292.00	18.25	157.75	54.02	117.25	40.16	17.00	5.82	Null	Null
21 and above	12	333.75	27.81	229.75	68.84	90.50	27.12	13.50	4.04	Null	Null
Total	160	1,863.94	11.65	1,248.42	66.98	473.88	25.42	141.14	7.57	0.50	0.03

Note : Average farm size: 1,248.42/160 = 7.8 rai Say 8 rai

Source : Report on Farmers Socio-Economic Study inside Mae Chang Reservoir Project Boundary, Crop Year 1980/81.

Table 3.3-2 Number of Animal for Working by Amphoe

Amphoe	No. of Household	Cattle		Baffaloes	
		head	head/household	head	head/household
Mae Ta	12,326	7,316	0.6	10,809	0.9
Kokha	14,845	1,471	0.1	4,349	0.3
Total:	27,171	8,787	0.3	15,158	0.6

Number of Animal for Working of Project Area

Animal	Household	No. of Animal for Working head
Cattle	5,562	1,669
Buffalo	5,562	3,337
Total:		5,006

Table 3.3-3 Livestock Statistics (1980 ∿ 1982)

Year	Place	Cattle	Buffalo	Swine	Chicken	Duck	Geese
1981	Whole Province	90,412	87,811	70,922	682,041	18,640	
	Mae Ta	20,434	14,213	11,129	72,197	1,339	
	Ko Kha	4,385	7,113	7,364	71,412	1,625	
1982	Whole Province	96,281	93,915	80,649	676,974	24,105	1,329
	Mae Ta	22,729	21,227	16,242	82,694	2,715	100
	Kokha	4,295	7,147	6,492	57,563	849	23
Average	Whole Province	93,347	90,813	75,786	679,508	21,373	1,329
	Mae Ta	21,582	17,720	13,686	77,446	2,027	100
	Kokha	4,340	7,130	6,928	64,488	1,237	23

Source: Lampang Province Office Livestock Section

Table 3.3-4 Number of Cattle and Buffaloes by Age and Sex

Item	Cattle		Buffaloes	
	head	%	head	%
Total	99,463	100.0	105,526	100.0
Cattle of age				
Under 1 year	10,116	10.2	8,975	8.5
1 year and over but less than 2 years [1]	18,437	18.5	21,270	20.2
Male	9,245	9.3	10,587	10.1
Female	9,192	9.2	10,683	10.1
2 years and over [2]	70,910	71.3	75,281	71.3
Male	31,338	31.5	31,178	29.5
for working	28,454	28.6	29,988	28.4
for other	2,884	2.9	1,190	1.1
Female	39,572	39.8	44,103	41.8
for milk production	3,006	3.0	-	-
for working	5,249	5.3	34,337	32.5
for other	31,317	31.5	9,766	9.3

1/ Buffaloes: 3 years 2/ Buffaloes: 3 years and over

Source: 1978 Agri. Census Report THAILAND

3.4-1. Irrigation Conditions

According to the first field survey made in February to March, 1983, the total irrigation area during the dry season is estimated at less than 10% of the Area in the wet season.

Major irrigation facilities in the Area are composed of Mae Pung Canal as one of the Mae Wang Project facilities, Ban Kluai Phae Pumping station by SSIP, Mae Tha Tank in the east and Mae Wa diversion weir in the South. Due to shortage of irrigation water, irrigation in the dry season is practised at extremely limited places adjacent to villages where it is possible to convey water easily.

Those facilities mentioned above were constructed by RID. In addition to such facilities, small scale irrigation structures i.e, concrete or stone masonry weirs, brush dams concrete lining or earthen canals and movable pumps are installed as one of the projects financed by Amphoe or by farmers. In the dry season, upland crops such as tobacco, garlic, groundnut and soybean are mainly planted, on the other hand, paddy fields are cultivated at comparatively low lands along the right bank of the Mae Pung canal, but their area is very limited. The farm ditches are provided so sparsely that most of the fields are irrigated by the plot-to-plot method which brings difficulties of stable water supply in the dry season. Irrigation for tobacco and groundnut is made by gravity flow or pumping with 7-to 10-day intervals, preparing furrows after harvesting of paddy.

The second field survey was carried out during the period of June to July, 1983, in which rainfall was observed only at the end of July. According to local farmers, the coming of this rainy season has been considerably delayed.

In the Project Area, farm practices such as preparation of nursery beds, land soaking and puddling have been carried out as group works by farmers since the middle of May. However, such works are performed only in very limited places where irrigation water is easily obtained.

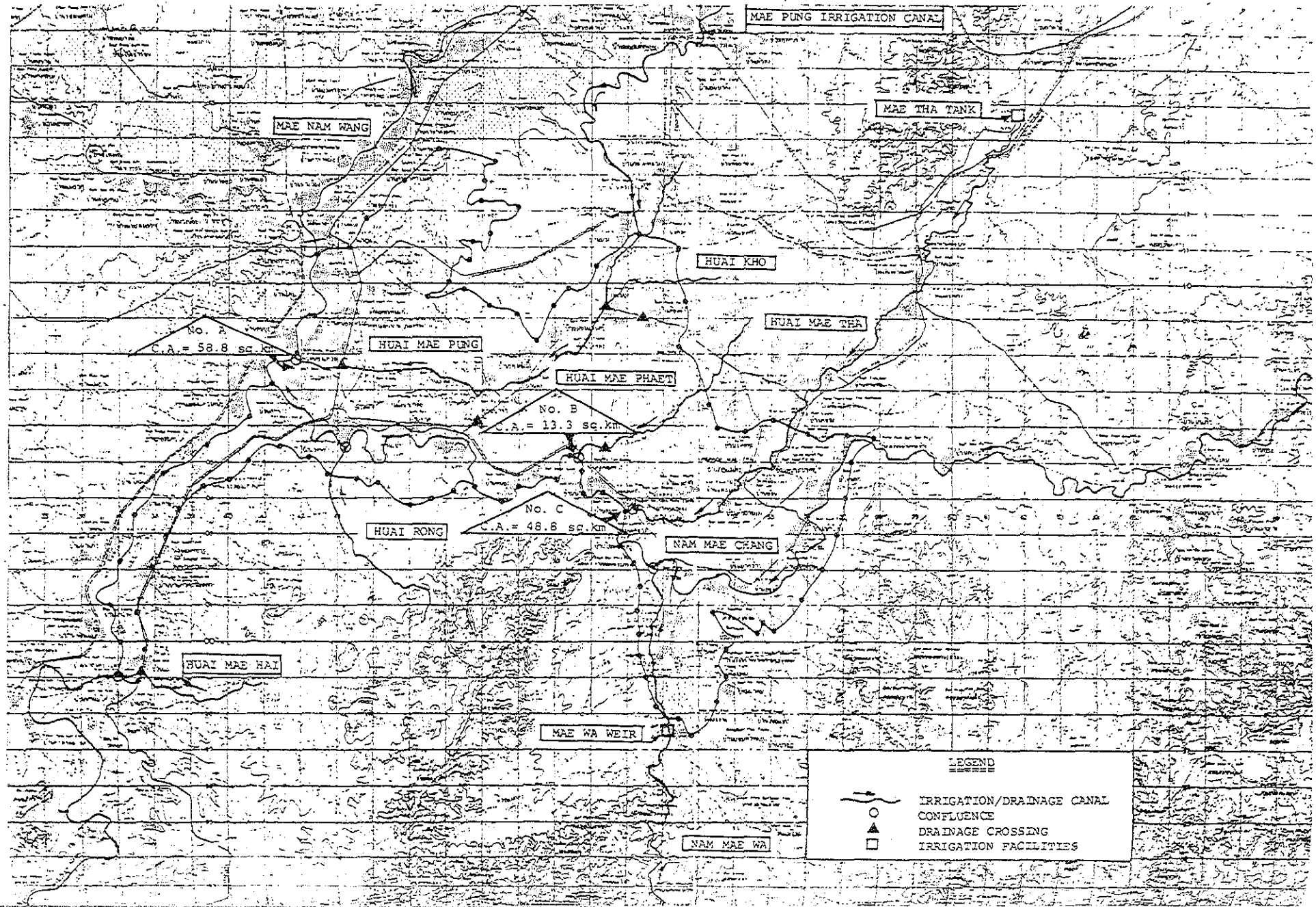
In the rainfed area, now works have been done and nurseries are withering up day by day.

Most of the irrigation water required for the above practices depends upon Mae Chang river water. Due to the small amount of streamflow, farmers have blocked off the river water by construction of brush dams and then lifting up the water by pump for irrigation purposes.

No irrigation water is conveyed into the Mae Pung canal which is one of the major irrigation facilities in the Project Area. This has resulted from a shortage of storage water in Kew Lom dam.

Major crops planted at present is mainly paddy which covers most of the Area. Along the Mae Chang river and hilly areas, sugarcane is under cultivation.

FIG. 3.4-1 PRESENT IRRIGATION/DRAINAGE SYSTEMS



3.4-2. Drainage Conditions

Drainage systems of the Project Area are largely divided into right area and left area bordering the Mae Chang which functions as a main drainage canal.

The right bank area forms comparatively gentle topography with a 1 to 200 slope toward a south-west direction in which streams or "Huai" such as the Huai Mae Pung, Huai Mae Tha and Huai Mae Phaet are developed. The Huai Mae Pung which functions as both irrigation and drainage canals joins the Huai Kho at 1 km downstream of the Mae Pung culvert and flows through the western parts of the Area and empties into the Mae Wang. The Huai Mae Tha is a natural stream originating in the Mae Tha Tank and flows toward a south-east direction and merges with the Mae Chang at Ban Sop Tha. In the middle parts of the Area surrounded by both streams, the Huai Mae Phaet flows in parallel with the said streams and merges with the Mae Chang at Wat Pa Tan Luang.

On the left bank of the Mae Chang, the Huai Mae Thai, Huai Rong, Huai Mae Hai form the alluvial plain and the other streams only develop small paddy fields and their watercourses are short. The above mentioned streams function as drainage canals for the Area and in the dry season become intermittent ones, excluding the Huai Mae Pung. There only exist stagnant water and/or seepage water found in the river bed, where farmers dig shallow wells and lift up water by pump for purposes of irrigation.

The elevation of the river bed of the Mae Chang is around 10 m lower than the services area, therefore, excess water through each Huai is easily drained by gravity even in the rainy season and inundation has not occurred according to the interviews with farmers. In the dry season, as seen along the Mae Pung irrigation canal irrigation is made by the plot-to-plot method and surplus water is returned into the canal. For such re-use of return flows, pipe culverts are installed in the canal.

Concerning the ground water in the dry season, the water of shallow wells is observed at 0.50 to 1.0 m below the ground at the irrigated fields, on the other hand, at 2.50 to 5.0 m at the rainfed fields.

According to the on-foot survey, present drainage systems are meandering and their canal sections are partly insufficient for drainage. In addition to these narrow sections, degenerated or damaged structures such as pipes, box culverts, weirs and bridges are found on the right bank and affect drainage functions.

As shown in the following figure, existing facilities at confluences, No.A (Nam Mae Chang - Nam Mae Wang), No.B (Nam Mae Chang - Huai Mae Phast), No.C (Nam Mae Chang - Huai Mae Tha) has sufficient capacities to drain floods with a five-year return period.

Confluence No.	Catchment Area (km^2)	Existing Capacity (m^3/sec)	Flood (5-year r.p.) (m^3/sec)
No.A	58.8	107	44
No.B	13.3	734	18
No.C	48.8	62	52

Major drainage crossings shown in the figure 3.4-1, Appendix, are not enough to drain floods with the said return period, therefore, rehabilitation works may be required.

The part of Huai Mae Pung running through the low land of the Area has only one meter difference between the field and the bottom of a canal. Once heavy rainfall occurs, low lands will be inundated. To relieve damages from inundation, rehabilitation, i.e., enlargement of canal sections is quite necessary.

3.4-3. On-farm Conditions

The on-farm the Area is not consolidated even in the existing irrigated area, Mae Pung and plot-shapes and scales vary at 0.08 to 0.5 rai on the basis of the survey carried out at Ban Muang San Si. Most of the farm lands are paddly fields and the height of ridges is 20 to 30 cm in the flat irrigation area and around 40 cm in the rainfed area. The width of the ridges is about 30 cm. Irrigation is rainfed and practiced by the plot-to-plot method providing notches at each plot.

At present, Upland crops such as groundnut and tobacco after paddy are irrigated by preparing furrows (width: 1.20 - 2.20 m, height: 0.30 m).

In the rainfed fields during the dry season, soils become rigid and cracks develop. But once irrigation is executed, the fields become muddy.

Year by year, tertiary canals and weirs are rehabilitated by the Amphoe office using concrete. For instance, as seen in Ban Muang San Si, tertiary canals become concrete lined ones, and outlet structures are provided at 300 m intervals on an average. Through such outlets, Main farm ditches without lining convey irrigation water covering 5 to 6 plots which are equivalent to 1.6 rai. No farm roads are provided along the main farm ditches, therefore, transportation of tobacco and garlic products depend upon manpower.

3.4-4. Existing Irrigation Projects

In the Project area there are some existing irrigation projects, namely Mae Wang Irrigation Project, Huai Mae Tha Reservoir Project, Mae Wa Project, Small Scale Irrigation Project (S.S.I.P) and others (see Fig.3.4-2, Appendix) promoted mostly by RID.

1) Mae Wang Irrigation Project

This Project was started in 1953 (B.E. 2480) featured by the construction of Mae Wang Diversion Weir and Mae Wang Left Canal (L=38.4 km) and Mae Wang Right Canal (L=35.3 km) were excavated in 1942 and 1948, respectively. The completion of the Kew Lom Dam in 1973 enabled the said Project to supply stable irrigation water to the fields and its irrigable area reached a total of 91,000 rai (net area; 77,000 rai) in the Mae Wang and Mae Chang Basin. Mae Wang Left Canal (M.W.L.C) has a capacity of 8.0 m^3/sec and its irrigable area in total is 66,000 rai (net 53,000 rai), and supplies water to the Mae Pung Area from the Mae Pung Diversion Weir at the end of M.W.L.C. The Mae Pung Area covers a total acreage of 25,800 rai (net 23,600 rai) in the study area.

The diversion system includes a siphon-structure at the end part, its length is 800 m and slope is 1 : 6,250, and an outlet is facilitated by a 1,000 mm dia pipe., providing a steady discharge rate of 0.64 m^3/sec to the downstream. Mae Pung Main Canal is diverted to Left and Right Canals at Ban Muang. Huai Mae Pung is planned as a waste way in future but at this stage it is utilized as the third main canal and is diverted to the west part of the Mae Pung Area.

The length of the canals is measured on the topographic map of 1:10,000 at 6.7 Km (Left) and 9.5 Km (Right), respectively. The canals are excavated in a clay loam and some parts are observed as rock in the Right canal.

Lateral canals extending from 27 lines of the above main canals, mostly excavated by the water user groups long ago, and divert water to the farm ditches using water from the concrete weirs and temporary earth weirs.

Above mentioned discharge from the outlet of the siphon is not sufficient to irrigate all the Mae Pung area in both wet and dry season. At the same time there are no existing lateral canals in the end parts of the Left and Right Canals. It is, therefore, desirable to have additional supplies of irrigation water and excavation of lateral canals. For the main canals the section area is recognized as sufficient but diversion facilities are now rather damaged.

The Feasibility Report on the Mae Wang - Kew Lom Irrigated Agriculture Development Project of March 1980 referring to the water balance in the Mae Wang Project, said that the shortage of irrigation water would not be solved completely without concrete lined main canals and water supply from the Mae Chang Dam to the Mae Pung Area.

2) Huai Mae Tha Tank Project

The Tank was constructed in 1970 on the Huai Mae Tha, using RID's budget and technical guidance. Major objectives of the Project are supplying irrigation water to the lower basin including a part of the study area during drought periods of wet seasons and domestic water throughout the year. The capacity of the reservoir is insufficient to supply water to the whole lower basin and in the study area utilization is not hopeful enough. In the irrigable area water users utilize many weirs which are mostly made of stones and wooden stakes and earthen canals as their irrigation system. In the dry season, as the discharge from the outlet of the reservoir is limited at about 40 l/sec, it is usable for domestic water in Ban Mae Tha and other villages and irrigation of ten or more hectares. The Project features are as follows;

Project area	14,500 rai
Irrigable area	13,000 rai
Water shed area	43 sq.km
Total storage	2.54 MCM
Available storage	2.30 MCM
Top level	315.20 m (MSL)
Design flood stage	313.20 m (MSL)
Normal water level	312.00 m (MSL)
Low water level	304.00 m (MSL)
Dam height	18.20 m
Length of crest	300 m
Crest width	8.0 m
Slope, Upper	1:3.0
Down	1:2.0
Spill-way Dia	2,500 mm
Outlet Dia	300 mm

3) Mae Wa Project

The Mae Wa Project was completed in 1976 through the endevors of IRO-2 in the area of Ban Bom and Ban Kiew in the lower basin of Huai Mae Wa. The irrigation system is composed of three facilities, namely diversion weir, newly constructed main canal and repaired lateral canals on the left bank of the river. Main project objectives were the combination of the existing eight peoples temporary weirs, the reduction of repairing expense for them and the intaking of water to the fields. The Project features are as follows;

Irrigable area	:	2,500 rai (in wet season) 1,000 rai (in dry season)
Diversion weir	:	W = 32 m H = 2.5 m
Crest level	:	253.50 m (MSL)
Main canal (Left)	:	2,740 m
Canal structures	:	26 places
Lateral canal	:	7.8 km
Canal structures	:	13 places

In the field survey the present irrigable area is estimated at 200 rai at most in the dry season. In addition to this, the Mae Thai Reservoir, has 460,000 m^3 of available storage, was constructed in 1981 and is now supplying irrigation water to an acreage of about 2,000 rai in the wet season in the upper basin of the Nam Mae Wa, about nine km from the Mae Wa Diversion weir.

4) Small Scale Irrigation Project

The agricultural land around Ban Kluai Phae and Ban Kluai Klang often received drought damage even after completion of the Mae Pung Main Canal because of its higher altitude. As a solution to this difficulty the RID constructed an Electric Pumping Project in 1981 as the first step of a Small Scale Irrigation Project in IRO-2, intaking water from the above mentioned canal partly using Japanese Governmental economic aid. The Project features are as follows;

Project area	:	2,400 rai (wet and dry season)
Total pump head	:	16 m
Power of motor	:	35 Kw
Conduit canal	:	528 m (Semicircle, 400 mm)
Main canal	:	1,660 m
Discharge	:	0.350 cms
Operating water level	:	245.80 m (MSL), at the B.P. of the main canal

5) Electric Pumping Projects

The pumping station is located in Ban Sop Po and Ban Nam Thong on the right bank of the Nam Mae Chang. The Projects were constructed in autumn of 1982 by the National Energy Administration (the Ministry of Science, Technology and Energy) and actual operation has started on wet season of 1983.

The main canal is lined with concrete and has already been completed and most lateral canals have been excavated by users, and some mubans have organized water user associations. These facilities are regarded as being temporary by the NEA and the RID, and both sides agreed to remove them according to the progress of the new construction. The Project features are as below;

Ban Sop Po:	Project area	3,150 rai
	Total pump head	25 m
	Power of motor	110 Kw
	Capacity of discharge	15.0 cum per minute
	Pipeline	1.0 Km (ϕ 300 mm)
	Main canal	8.0 Km
Ban Nam Tong :	Project area	3,500 rai

Irrigation facilities are the same as Ban Sop Po Project.

6) Rural Infrastructure Construction Projects

The Projects were started in 1980 organized by the Ministry of Interior through the Changwat Office, the Amphoe Office and the Tambon Office. The objectives of the projects are rural infrastructure development and the supply of employment to farmers in the dry season. The Amphoe Office provides expenses for material costs and labor costs to each Tambon Office, then villages engage themselves in the construction during the dry season.

In Amphoe Mae Tha, 262 small construction projects were completed in four fiscal years and the budget amounts to about 23.0 million baht in total. Most of the project items are concerned with irrigation facilities, such as weir, canal lining with concrete, reservoir and tank. Each project is on a small scale but their role

is recognized as important especially for irrigated agriculture in a limited area.

At the Changwat Committee level, authorities concerned such as RID, the Accelerated Road Department, the Highway Department, the Fishery Department and the Public Welfare Department and so cooperate with each other on the technical aspects.

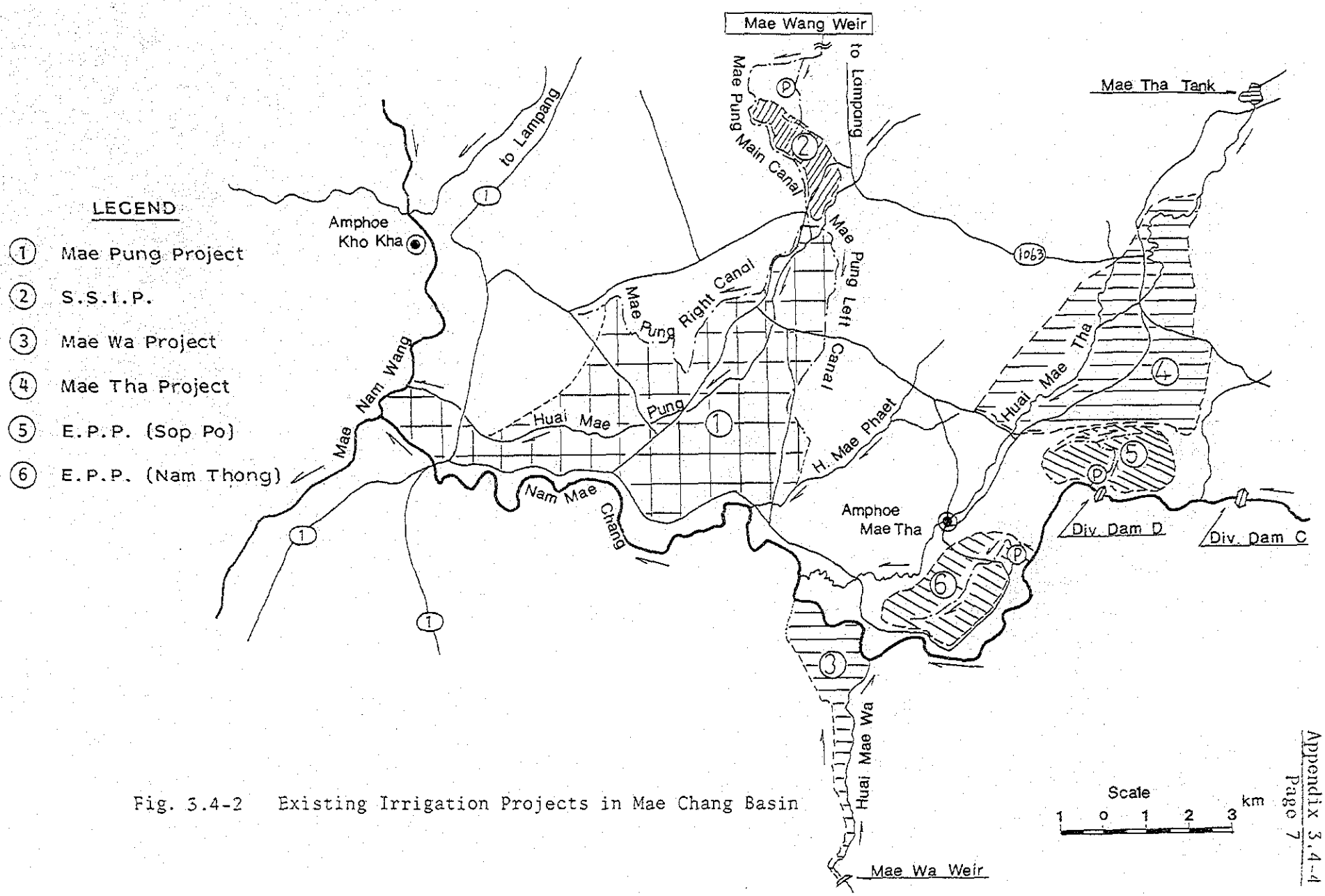


Fig. 3.4-2 Existing Irrigation Projects in Mae Chang Basin

4.1-1 Alternative Case Studies

Alternative case studies for optimum scale of development for the Mae Chang Irrigation Project were discussed preliminarily as reported in Interim Report submitted in June 1983. For reference, the results of the said alternative case studies are summarized hereinafter.

Through the field reconnaissance and the field survey along the Mae Chang Basin, four alternative dam sites in considering maximu scale of dam construction on a geological and topographical basis were selected and studied.

The location of those dam sites are as follows;

Dam site A: Located at about 1.0 km NE from the Ban Don Mung sheet 4945 III 47QNA 916-090.

Dam site B: Located at about 1.0 km downstream from a bridge of the highway route 11 sheet 4945 III 47QNA 658-048.

Dam site C: Located at about 1.5 km upstream from the Ban Sop Po sheet 4945 III 47QNA 615-052.

Dam site D: Located at about 1.5 km downstream from the Ban Sop Po sheet 4945 III 47QNA 580-055.

Note: (1) Refer to sheet 4945 III of topography 1:50,000.

(2) The name of each dam site is designated as A, B, C and D starting from upstream.

(3) Dam site C is the dam site proposed by RID.

Table 4.1-1 COMPARATIVE TABLE ON MAX. SCALE DAM AT ALTERNATIVE DAM SITE

Items		Unit	Dam Site A	Dam Site B	Dam Site C (RID Dam Site)	Dam Site D
Location			Sheet 4945 III 47QNA 716-090 Northeast 1.0 km from Don Mun village	Sheet 4945 III 47QNA 658-048 Downstream 1.0 km from Highway bridge	Sheet 4945 III 47QNA 615-052 Upstream 1.5km Ban Sop Po village	Sheet 4945 III 47QNA 580-055 Downstream 2.0km from Ban Sop Pa village
Geology & Topography			River bed: 60m width sand and gravel Right abutment: Slope 1:1.0 Sandy silt Left abutment: Slope 1:7.0 Basalt is on sandy silt, gravel	River bed: 40m width sand and gravel Right abutment: Slope 1:8.0 Limestone, partly sand stone Left abutment Slope 1:5.0 Basalt is on gravel and hard clay	River bed: 40m width sand and gravel Right abutment: Slope 1:2.0 Terrace 200m width, 20m high from river bed Left abutment Slope 1:2.0 Limestone	River bed: 50m width sand and gravel Right abutment: Slope 1:7.0 Basalt is on silteg or limestone Left abutment Slope 1:6.0 Limestone, partly sandstone and thin shale
Basin	Catchment area	sq.km	403	575	657	696
	Inflow discharge	MCM	80	114	130	138
Reservoir	High water level	m	H.W.L. 283.00	H.W.L. 268.00	H.W.L. 266.00	H.W.L. 263.00
	Full water level	m	F.W.L. 280.17	F.W.L. 264.83	F.W.L. 262.54	F.W.L. 259.68
	Intake water level	m	I.W.L. 270.00	I.W.L. 256.00	I.W.L. 252.50	I.W.L. 248.80
	Dead water level	m	D.W.L. 272.20	D.W.L. 258.20	D.W.L. 255.00	D.W.L. 250.70
	Reservoir area in F.W.L.	m	5.2	10.6	13.5	16.5
	Gross reservoir capacity	MCM	40	63	80	95
	Usable reservoir capacity	MCM	30 (35)	49 (56)	64 (72)	78 (87)
	Usable water depth	m	10.17	8.83	10.04	10.88
Dam	Dam type		Rock-Fill	Earth-Fill	Rock-Fill	Rock-Fill
	Dam crest elevation	m	EL 285.00	EL 270.00	EL 268.00	EL 265.00
	EL of min. Trench excavation	m	EL 250.00	EL 245.00	EL 235.00	EL 230.00
	Dam height	m	35	25	33	35
	Freeboard	m	2.0	2.0	2.0	2.0
	Width of dam crest	m	9.0	9.0	9.0	9.0
	Crest length	m	460	1,500	330	530
	Slope: upstream		1:2-1/2	1:3.0	1:2-1/2	1:2-1/2
	downstream		1:2.0	1:2-1/2	1:2.0	1:2.0
	Dam volume	cu.m	784,000	1,448,000	462,000	670,000
Spillway	Spillway type		Chute (Gateless)	Chute (Gateless)	Chute (Gateless)	Chute (Gateless)
	Designed flood discharge	cu.m/s	1,574	1,943	1,950	1,917
	Spillway discharge capacity	cu.m/s	1,502	1,775	940	1,271
	Crest elevation	m	EL 280.17	EL 264.83	EL 262.54	EL 259.68
	Crest length	m	150	150	70	100
	Max. overflow depth	m	2.83	3.17	3.46	3.32
Intake	Type of intake		Drop inlet	Drop inlet	Drop inlet	Drop inlet
	Max. intake capacity	cu.m/s	10.8	10.8	10.8	10.8
	Guard Gate (1,500x1,500mm)	No.	1	1	1	1
	Service Gate(Dia. 1,500mm)	No.	1	1	1	1

Remarks: Sediment load was estimated by the following data:
(1) Specific sediment load 240 cu.m/sq.km.a
(2) Period to be considered is 100 years.
Value of ( ) is estimated from 50 years period. I.W.L. was estimated from sediment load of 50 years period.

Table 4.1-2 COMPARATIVE TABLE ON DIVERSION DAMS AT ALTERNATIVE DAM SITE

ITEMS			DIVERSION DAM C			DIVERSION DAM D	
Dam type			Rock-Fill	Concrete-gravity	Combination	Rock-fill	Concrete-gravity
Location			sheet 4945 III 47QNA 615-052 Upstream 1.5 km from Ban Sop Po village			sheet 4945 III 47ANA 580-055 Downstream 2.0 km from Ban Sop Pa village	
Basin	Catchment area	sq.km	254			293	
	Inflow discharge	MCM	50			58	
Reservoir	High water level	m	H.W.L. 255.00			H.W.L. 250.00	
	Full water level	m	F.W.L. 254.27			F.W.L. 249.28	
	Intake water level	m	I.W.L. 251.00			I.W.L. 248.00	
	Dead water level	m	D.W.L. 249.50			D.W.L. 246.50	
	Reservoir area in F.W.L.	sq.km	3.5			2.6	
	Gross reservoir capacity	MCM	12			9	
	Usable reservoir capacity	MCM	7			2	
	Usable water depth	m	3.27			1.28	
Dam	Dam crest elevation	m	EL 257.50	EL 257.50	EL.257.50	EL 252.50	EL 252.50
	EL of min. Trench excavation	m	EL 235.00	EL 235.00	EL235.00(EL244.00)	EL 230.00	EL 230.00
	Dam height	m	22.5	22.5	22.5 (13.5)	22.5	22.5
	Freeboard	m	2.5	2.5	2.5	2.5	2.5
	width of dam crest	m	9.0	4.0	4.0 (9.0)	9.0	4.0
	Crest length	m	290	290	90 (200)	340	340
	Slope Upstream		1:2-1/2	Straight	Straight (1:2-1/2)	1:2-1/2	Straight
	Downstream		1:2.0	1:0.7	1:0.7 (1:2.0)	1:2.0	1:0.7
	Dam volume	cu.m	127,000	25,000	8,000 (90,600)	201,000	39,000
Spillway	Spillway type		Gate spillway			Gate spillway	
	Designed flood discharge	cu.m/s	1,950			1,917	
	Crest elevation	m	EL 247.74			EL 247.83	
	Crest length	m	56.9			56.9	
	Max. overflow depth	m	7.26			7.17	
	Radial gate (12.5 x 7.5m)	No.	4			4	
Intake	Max. intake capacity	cu.m/s	10.8			10.8	
	Min. intake capacity	cu.m/s	7.7			7.7	
	Sluice gate (2.0 x 2.0m)	No.	3			3	

Remarks: (1) Figure of ( ) is the case of rock-fill dam

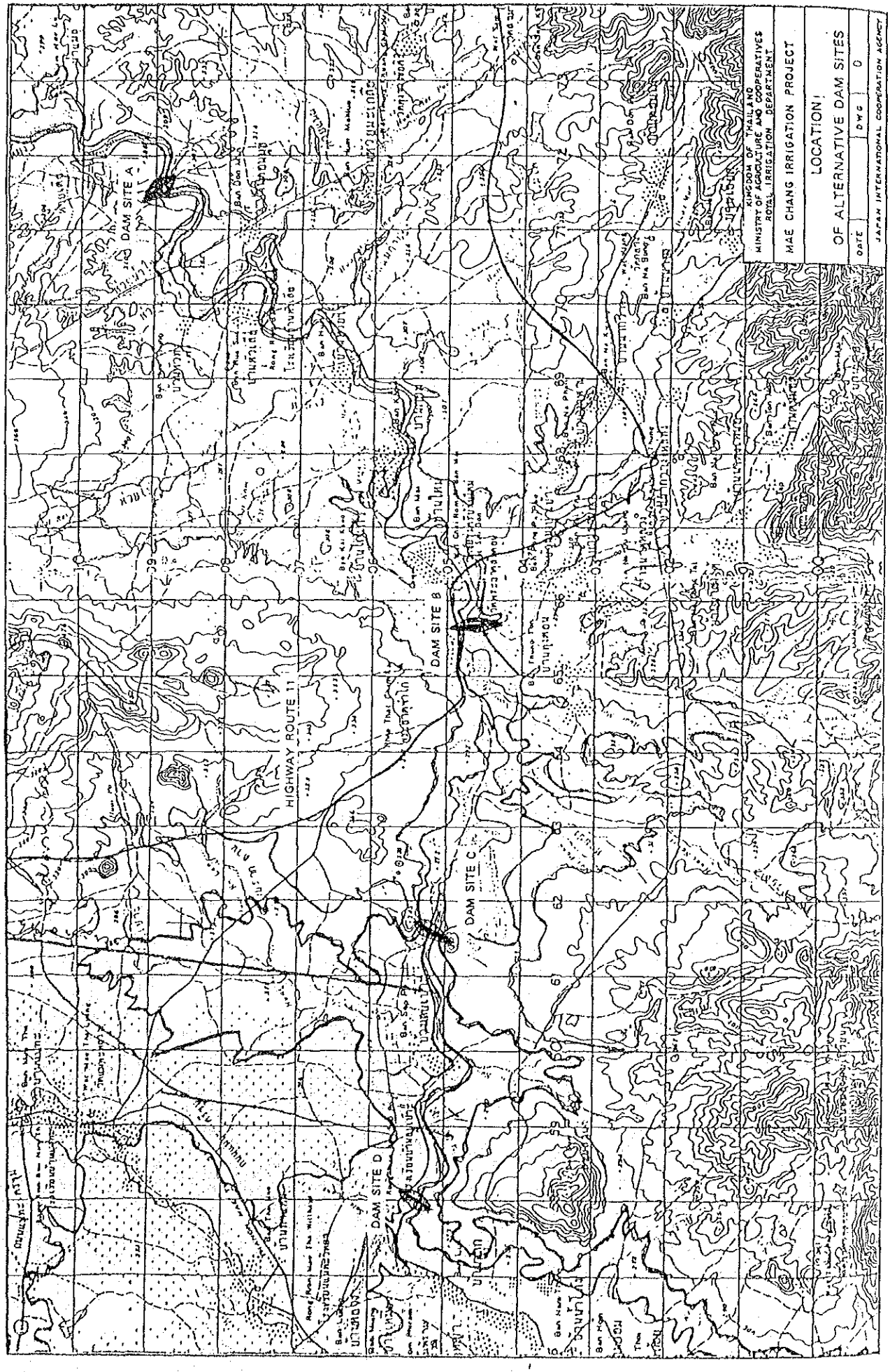
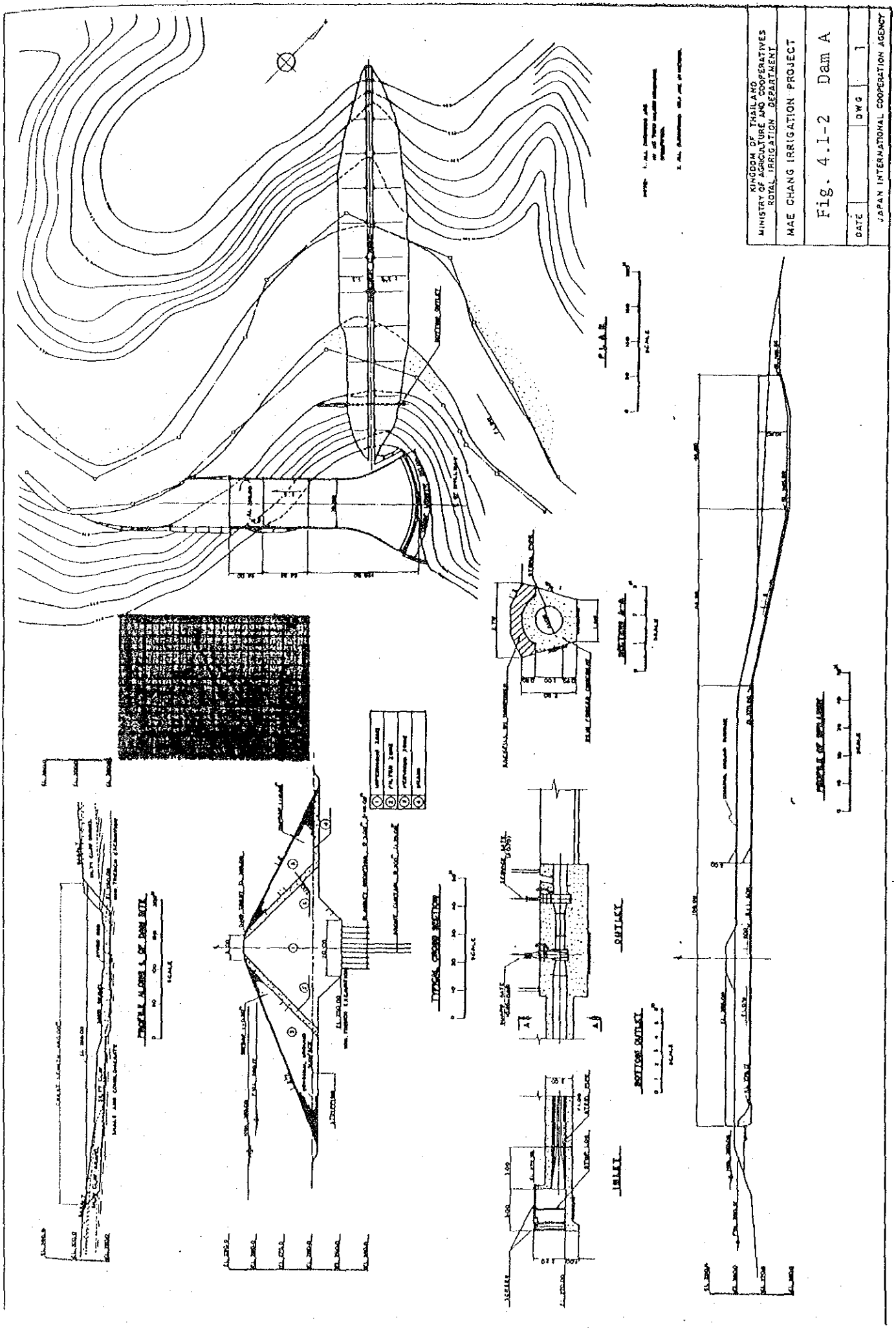
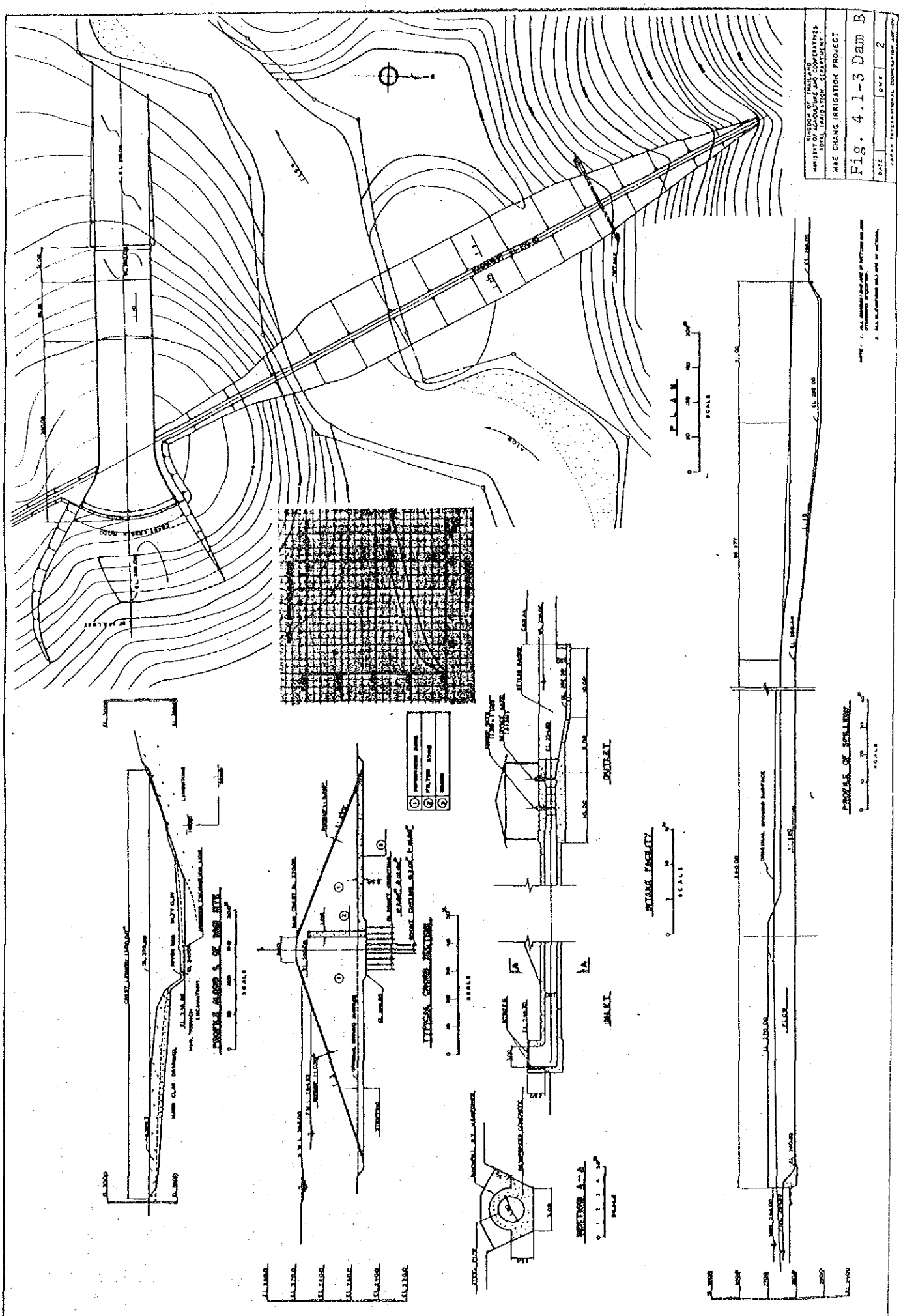
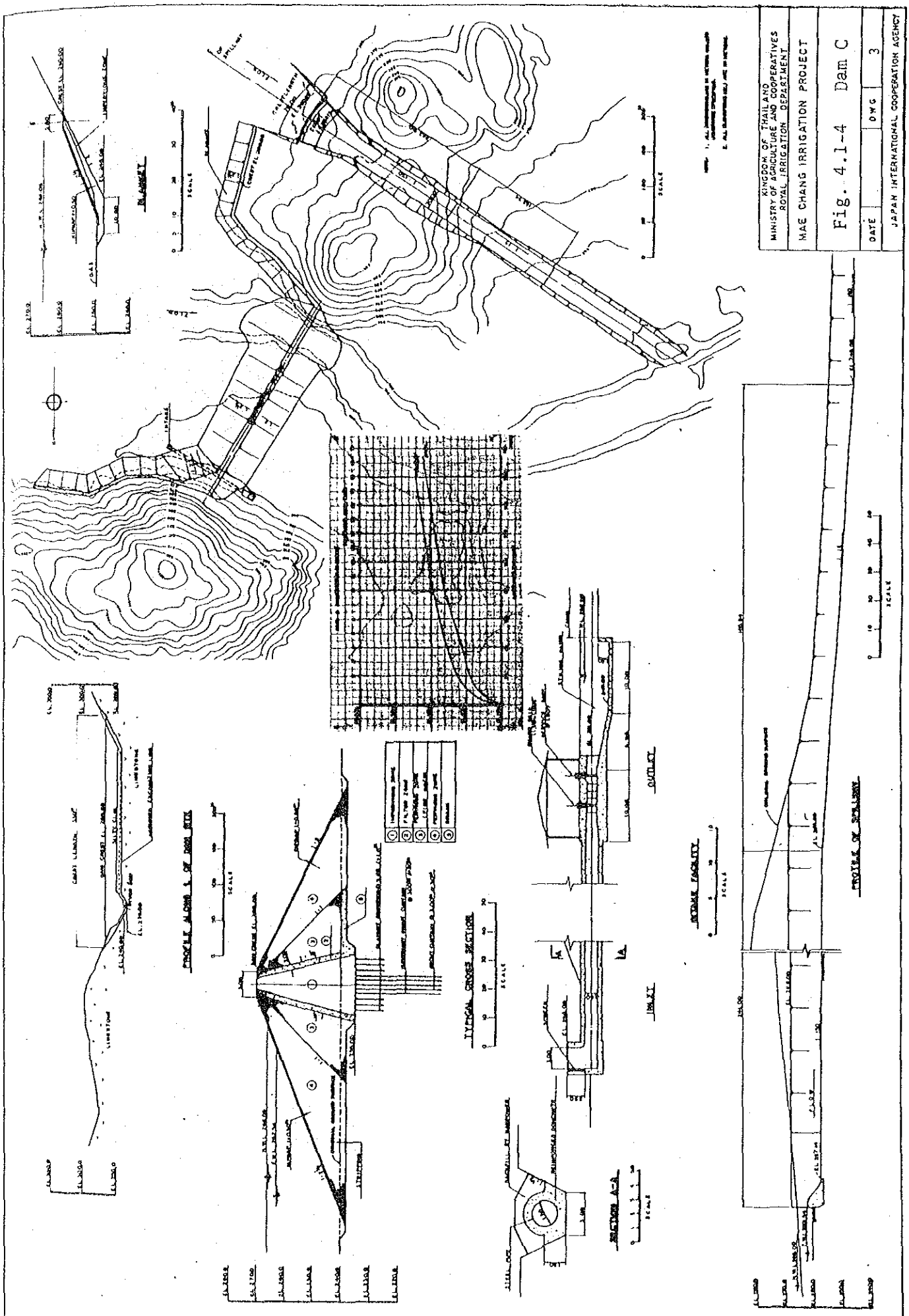


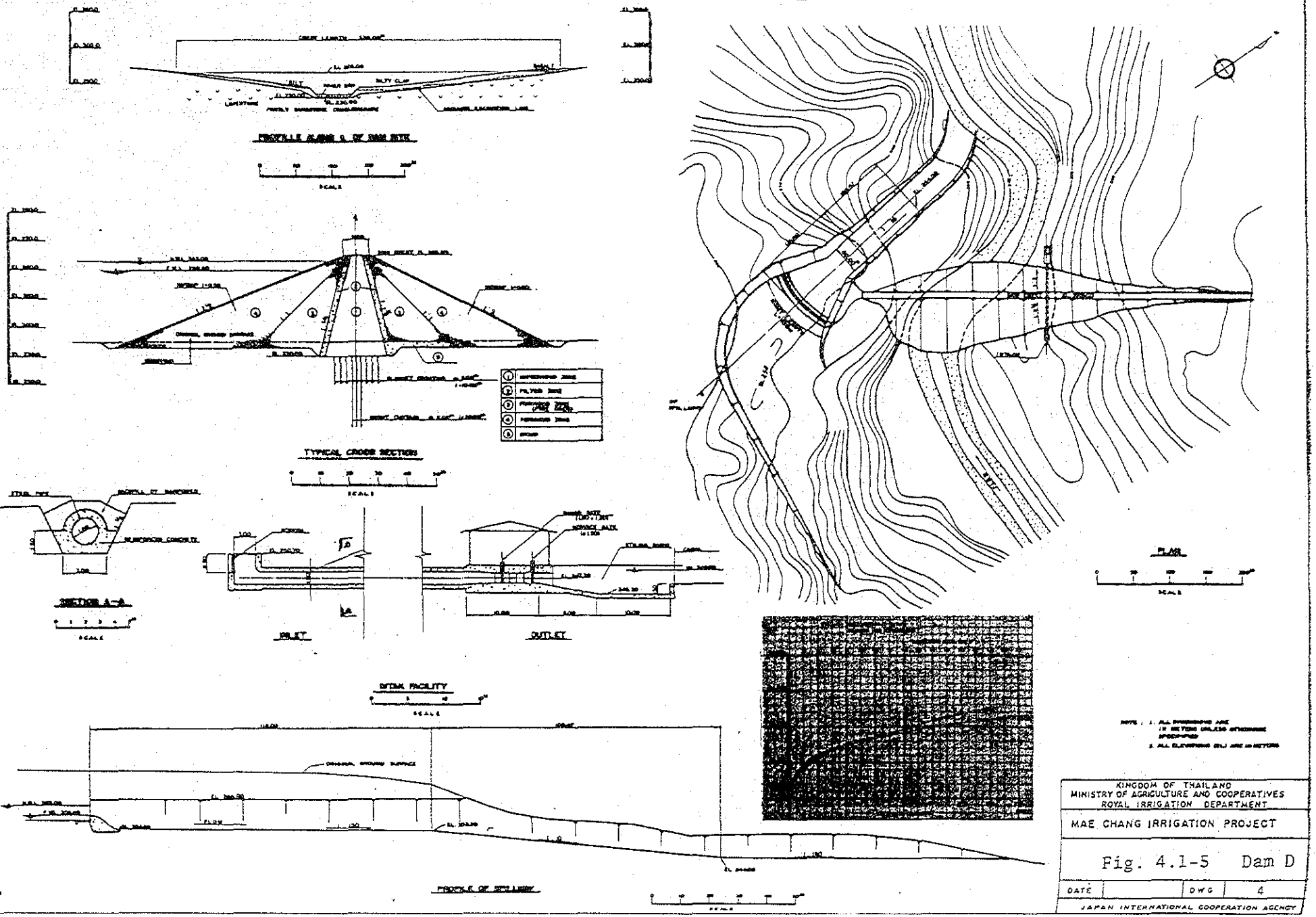
Fig. 4.1-1 LOCATION OF ALTERNATIVE DAM SITES

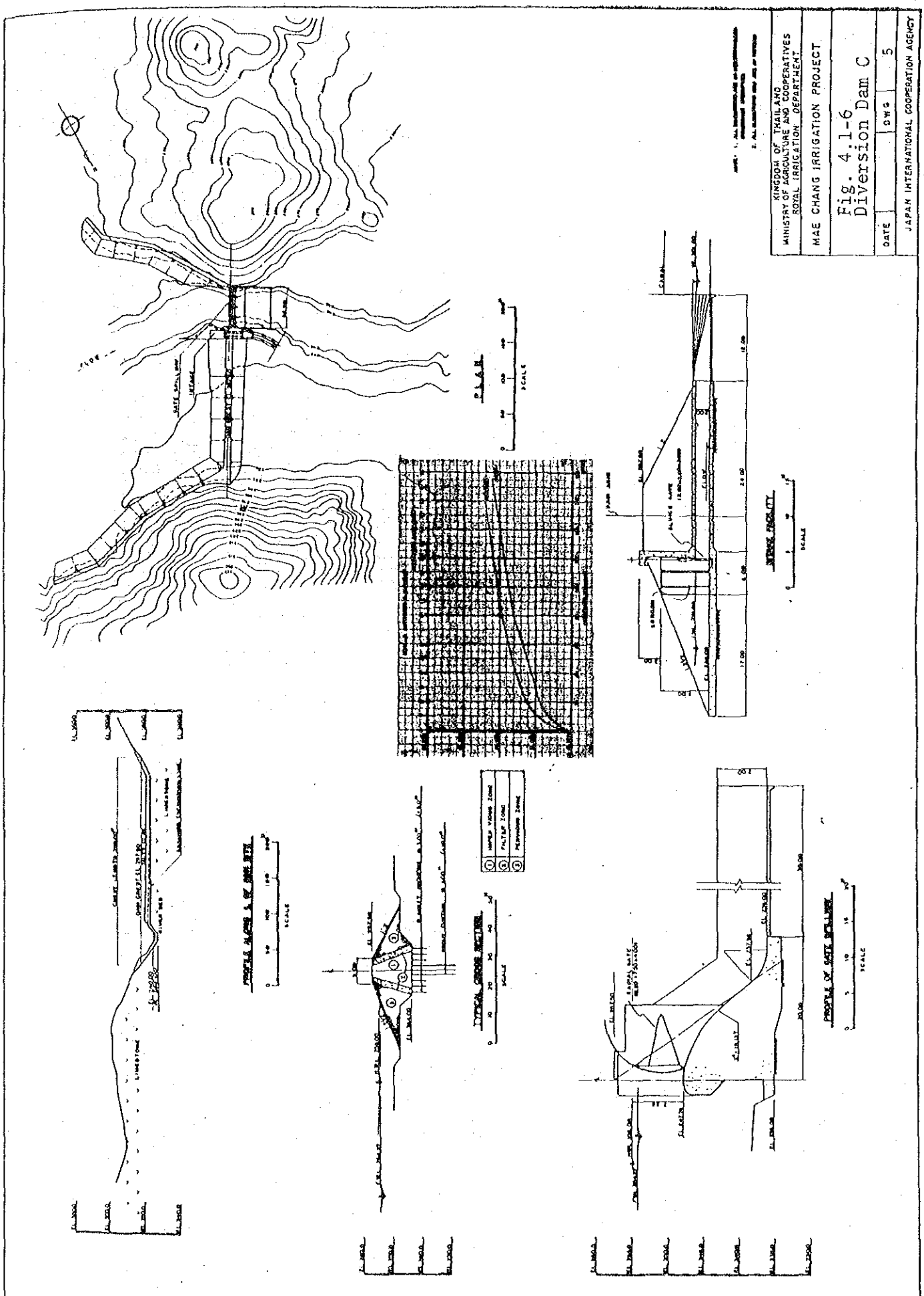
SCALE 1 : 50,000


KINGDOM OF THAILAND
MINISTRY OF AGRICULTURE AND COOPERATIVES
ROYAL IRRIGATION DEPARTMENT
MAE CHANG IRRIGATION PROJECT
Fig. 4.1-2 Dam A
DATE
DWG
1
JAPAN INTERNATIONAL COOPERATION AGENCY


KINGDOM OF THAILAND
MINISTRY OF AGRICULTURE AND COOPERATIVES
ROYAL IRRIGATION DEPARTMENT
MAE CHANG IRRIGATION PROJECT
Fig. 4.1-3 Dam B
DATE
DWG
2
JAPAN INTERNATIONAL COOPERATION AGENCY
SCALE
SECTION A-A
ITYPICAL CROSS SECTION
INTAKE FACILITY
PROFILE OF SPILLWAY


KINGDOM OF THAILAND
MINISTRY OF AGRICULTURE AND COOPERATIVES
ROYAL IRRIGATION DEPARTMENT
MAE CHANG IRRIGATION PROJECT
Fig. 4.1-4 Dam C
DATE
DWG
3
JAPAN INTERNATIONAL COOPERATION AGENCY
PLANNEY
PROFILE ALONG A OF DAM AXIS
TYPICAL CROSS SECTION
OUTLET
INTAKE
SECTION A-A
NORMAL FACILITY
PROFILE OF SPILLWAY


PROFILE ALONG ℄ OF DAM SITE
TYPICAL CROSS SECTIONS
SECTION A-A
INLET
OUTLET
PLAN
SPILLWAY FACILITY
PROFILE OF SPILLWAY
KINGDOM OF THAILAND
MINISTRY OF AGRICULTURE AND COOPERATIVES
ROYAL IRRIGATION DEPARTMENT
MAE CHANG IRRIGATION PROJECT
Fig. 4.1-5 Dam D
DATE
DWG 4
JAPAN INTERNATIONAL COOPERATION AGENCY


KINGDOM OF THAILAND
MINISTRY OF AGRICULTURE AND COOPERATIVES
ROYAL IRRIGATION DEPARTMENT
MAE CHANG IRRIGATION PROJECT
Fig. 4.1-6
Diversion Dam C
DWG
5
JAPAN INTERNATIONAL COOPERATION AGENCY

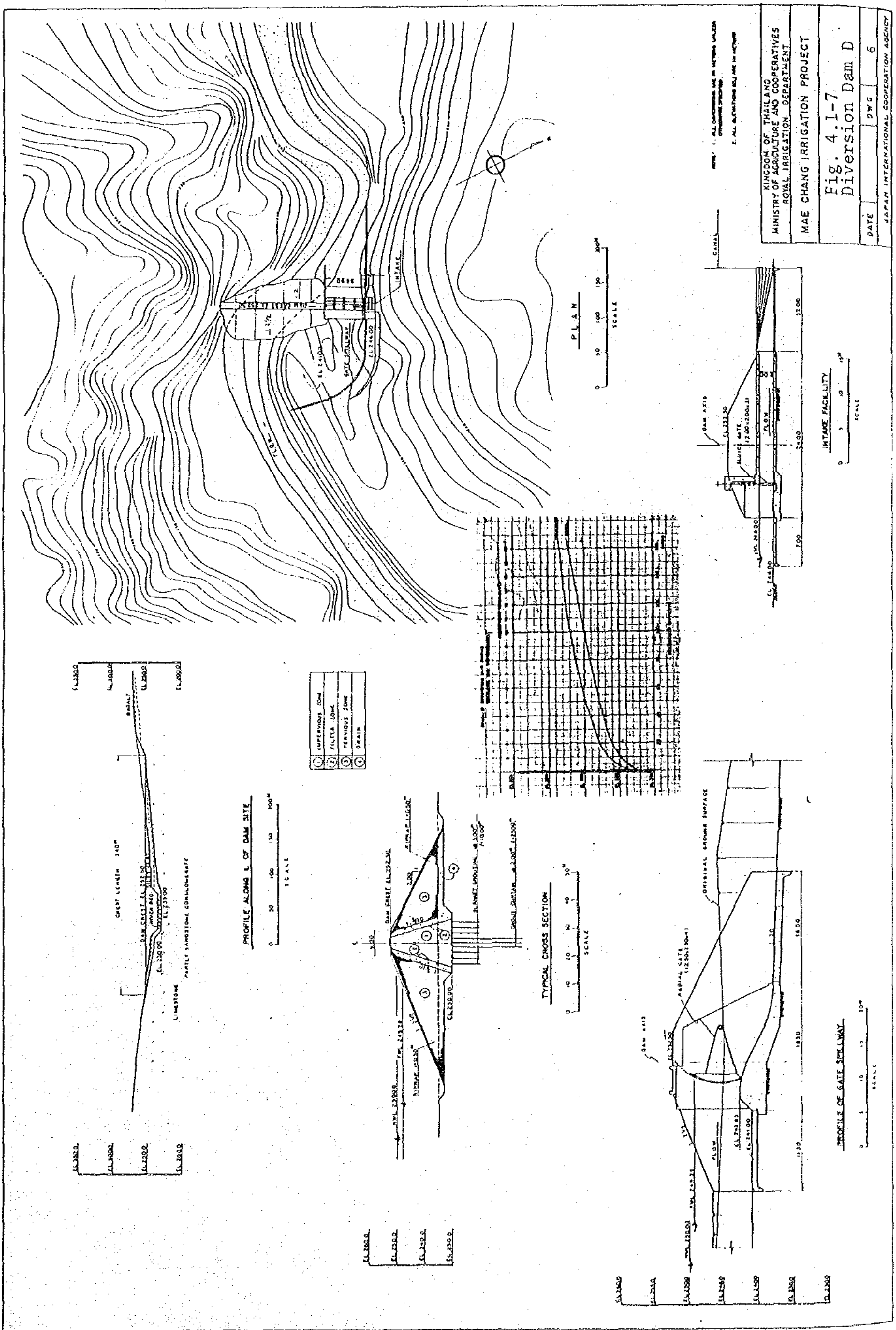

KINGDOM OF THAILAND
MINISTRY OF AGRICULTURE AND COOPERATIVES
ROYAL IRRIGATION DEPARTMENT
MAE CHANG IRRIGATION PROJECT
Fig. 4.1-7
Diversion Dam D
DATE
DWG
6
JAPAN INTERNATIONAL COOPERATION AGENCY
PLAN
SCALE
INTAKE FACILITY
TYPICAL CROSS SECTION
PROFILE ALONG ℄ OF DAM SITE
PROFILE OF GATE SPILLWAY
IMPERVIOUS ZONE
FILTER ZONE
PERVIOUS ZONE
DRAIN

Table 4.1-3 Project Cost Estimate on Alternative Dam Plan

Unit: ฿'000

	Case-1 (Dam A)		Case-2 (Dam B)		Case-3 (Dam C)		Case-4 (Dam D)		Case-5(Dam A & DD-C)		Case-6(Dam A & DD-D)	
	Foreign C	Local C	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC
1. Civil Works	342,470	469,520	482,640	555,830	300,380	305,090	242,680	284,090	394,670	438,760	320,650	392,940
1-1. Pre-Engineering	1,000	9,000	1,000	9,000	1,000	9,000	1,000	9,000	1,000	9,000	1,000	9,000
1-2. Preparation	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500
1-3. Main Dam	139,400	161,000	322,400	317,500	173,000	115,000	128,200	110,200	139,400	161,000	139,400	161,000
1-4. Diversion Dam	-	-	-	-	-	-	-	-	123,400	81,300	63,060	52,870
1-5. Main Canal	149,900	224,900	100,400	150,600	76,210	114,300	66,060	99,100	76,210	114,300	66,060	99,100
1-6. Lateral Canal	33,530	50,310	33,530	50,310	33,530	50,310	33,530	50,310	33,530	50,310	33,530	50,310
1-7. Improvement of Old Facilities	16,140	21,810	22,810	25,920	14,140	13,980	11,390	12,980	18,630	20,350	15,100	18,160
2. Land Acquisition & Compensation	-	22,180	-	498,520	-	631,040	-	417,540	-	84,540	-	24,340
2-1. Reservoir Area	-	9,000	-	269,600	-	338,700	-	233,600	-	50,200	-	13,000
2-2. Resettlement	-	6,700	-	223,400	-	287,300	-	179,300	-	29,300	-	6,700
2-3. Project Area	-	6,480	-	5,520	-	5,040	-	4,640	-	5,040	-	4,640
3. Construction Equipment	6,000	-	6,000	-	6,000	-	6,000	-	6,000	-	6,000	-
4. Project Facilities	900	8,100	900	8,100	900	8,100	900	8,100	900	8,100	900	8,100
5. Project Administration	-	37,560	-	44,470	-	24,410	-	22,730	-	35,100	-	31,440
6. Consulting Services	44,000	49,000	44,000	49,000	44,000	49,000	44,000	49,000	44,000	49,000	44,000	49,000
7. On-Farm Development	50,440	73,100	50,040	73,100	50,440	73,100	50,040	72,520	50,440	73,100	50,040	72,520
Sub-total (1 to 6)	393,370	586,360	533,540	1,155,920	351,280	1,017,640	293,580	781,460	445,570	615,500	371,550	505,820
8. Contingency	39,310	58,640	53,330	115,570	35,100	101,750	29,330	78,130	44,530	61,510	37,130	50,560
Sub-total (1 to 6 & 8)	432,680	645,000	586,870	1,271,490	386,380	1,119,390	322,910	859,590	490,100	677,010	408,680	556,380
9. Price Escalation	131,060	214,730	178,310	334,710	116,870	254,970	98,240	209,540	159,820	221,430	129,410	188,980
Total (1 to 6, 8 & 9)	563,740	859,730	765,180	1,606,200	503,250	1,374,360	421,150	1,069,130	649,920	890,440	538,090	745,360
Total of FC & LC (฿'000)	1,423,470		2,371,380		1,877,610		1,490,280		1,548,360		1,283,450	
($'000)	64,710		104,470		82,720		65,650		68,210		56,540	
Total Irrigation Area	7,310		7,310		7,310		7,252		7,310		7,252	
Cropping Area in Wet S.	(100%)	7,310	(100%)	7,310	(100%)	7,310	(100%)	7,252	(100%)	7,310	(100%)	7,252
Cropping Area in Dry S.	(35%)	2,560	(70%)	5,120	(95%)	6,940	(95%)	6,890	(60%)	4,390	(60%)	4,350
Total Cropping Area	(135%)	9,870	(170%)	12,430	(195%)	14,250	(195%)	14,142	(160%)	11,700	(160%)	11,602
Construction Cost (US$) per ha	8,580		14,290		11,320		9,050		9,330		7,800	
Economic Internal Rate of Return (EIRR %)	9.8		7.3		9.8		11.2		9.9		11.7	

(Cont'd)

	Case-6		Case-6a		Case-6b		Case-6c	
	Foreign C	Local C	FC	LC	FC	LC	FC	LC
1. Civil Works	320,650	392,940	281,920	334,820	275,640	325,400	261,490	304,170
1-1. Pre-Engineering	1,000	9,000	1,000	9,000	1,000	9,000	1,000	9,000
1-2. Preparation	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500
1-3. Main Dam	139,400	161,000	139,400	161,000	139,400	161,000	139,400	161,000
1-4. Diversion Dam	63,060	52,870	63,060	52,870	63,060	52,870	63,060	52,870
1-5. Main Canal	66,060	99,100	29,460	44,190	24,920	37,380	24,280	36,420
1-6. Lateral Canal	33,530	50,310	33,240	49,860	31,800	47,700	18,960	28,440
1-7. Improvement of Old Facilities	15,100	18,160	13,260	15,400	12,960	14,950	12,290	13,940
2. Land Acquisition & Compensation	-	24,340	-	22,900	-	21,300	-	20,700
2-1. Reservoir Area	-	13,000	-	13,000	-	13,000	-	13,000
2-2. Resettlement	-	6,700	-	6,700	-	6,700	-	6,700
2-3. Project Area	-	4,640	-	3,200	-	1,600	-	1,000
3. Construction Equipment	6,000	-	6,000	-	6,000	-	6,000	-
4. Project Facilities	900	8,100	900	8,100	900	8,100	900	8,100
5. Project Administration	-	31,440	-	26,800	-	26,030	-	24,330
6. Consulting Services	44,000	49,000	44,000	49,000	44,000	49,000	44,000	49,000
7. On-farm Development	50,040	72,520	43,740	63,390	42,270	61,260	35,970	52,130
Sub-total (1 to 6)	371,550	505,820	332,820	441,620	326,570	429,830	312,390	406,300
8. Contingency	37,130	50,560	33,250	44,130	32,630	42,970	31,210	40,600
Sub-total (1 to 6 & 8)	408,680	556,380	366,070	485,750	359,200	472,800	343,600	446,900
9. Price Escalation	129,410	188,980	116,330	164,800	114,070	160,410	108,120	149,700
Total (1 to 6, 7 & 9)	538,090	745,360	482,400	650,550	473,270	633,210	451,720	596,600
Total of FC & LC (฿'000)	1,283,450		1,132,950		1,106,480		1,048,320	
($'000)	56,540		49,910		48,740		46,180	
Total Irrigation Area	7,252		6,339		6,126		5,213	
Cropping Area in Wet S.	(100%)	7,252	(100%)	6,339	(100%)	6,126	(100%)	5,213
Cropping Area in Dry S.	(60%)	4,350	(70%)	4,430	(70%)	4,290	(85%)	4,430
Total Croping Area	(160%)	11,602	(170%)	10,769	(170%)	10,416	(185%)	9,643
Constructon Cost (US$) per ha	7,800		7,870		7,960		8,860	
Economic Internal Rate of Return (EIRR %)	11.7		11.6		11.3		10.3	

Table 4.1-4 Farm Land Area to be Compensated

(Unit: rai)

Villages	Dam B			Dam C			Dam D			Dam A.C			Dam A. D.I			Dam A. D.II		
	Paddy	Up-land	Other	Paddy	Up-land	Other	Paddy	Up-land	Other	Paddy	Up-land	Other	Paddy	Up-land	Other	Paddy	Up-land	Othe
Ban Mae Lu	-	-	-	-	-	-	-	-	-	200	200	10	200	200	10	200	200	10
Ban Hua Sue	2,926	1,800	40	2,926	1,800	40	293	180	4	-	-	-	-	-	-	-	-	-
Ban Don Mun	244	192	90	163	128	60	41	32	15	-	-	-	-	-	-	-	-	-
Ban Huai Rai	105	200	10	105	200	10	32	60	3	-	-	-	-	-	-	-	-	-
Ban Huai Maklua	228	161	90	152	107	60	-	-	-	-	-	-	-	-	-	-	-	-
Ban Kom	505	342	17	505	342	17	505	342	17	25	17	1	25	17	1	-	-	-
Ban Mai	393	214	-	491	267	-	491	267	-	98	53	-	98	53	-	-	-	-
Ban Pong Pa Pao	168	21	3	670	83	12	587	73	11	251	31	5	251	31	5	-	-	-
Ban Tung Ton	-	-	-	891	455	30	713	364	24	267	137	9	267	137	9	-	-	-
Ban Sop Po	-	-	-	-	-	-	1,500	1,000	35	-	-	-	1,500	1,000	35	150	100	4
Total	4,569	2,930	250	5,903	3,182	229	4,162	2,318	109	841	438	25	2,341	1,438	60	350	300	14

Table 4.1-5 Number of Family to be Compensated and Resettled

Villages	Compensated						Resettled					
	Dam B	Dam C	Dam D	Dam A.C	Dam A.D.I	Dam A.D.II	Dam B	Dam C	Dam D	Dam A&C	Dam A&D.I	Dam A&D.II
Ban Mae Lu	-	-	-	22	22	22	-	-	-	22	22	22
Ban Hua Sue	450	450	90	-	-	-	450	450	45	-	-	-
Ban Don Mun	90	27	-	-	-	-	90	27	-	-	-	-
Ban Huai Rai	75	75	-	-	-	-	75	75	-	-	-	-
Ban Huai Maklua	-	-	-	-	-	-	-	-	-	-	-	-
Ban Kom	185	185	185	10	10	-	185	185	185	-	-	-
Ban Mai	224	280	280	140	140	-	224	280	280	56	56	-
Ban Pong Pa Pao	-	105	92	26	26	-	-	105	92	26	26	-
Ban Tung Ton	-	206	164	21	21	-	-	206	164	21	21	-
Ban Sop Po	-	-	53	-	53	-	-	-	53	-	53	-
Total	1,024	1,328	864	219	272	22	1,024	1,328	819	125	178	22

Table 4.1-6 Compensation for the Private Properties

Unit: ,000 Baht

	Lands					Houses	Trees	Total	No. of Household
	Paddy	Upland	Other	Homelots	Total				
Dam B	91,360	29,300	1,250	10,240	132,150	122,880	1,536	256,566	1,024
Dam C	118,060	31,820	1,145	13,280	164,305	159,360	1,992	325,657	1,328
Dam D	83,240	23,180	545	8,640	115,605	103,680	1,296	220,581	864
Dam A.C	16,820	4,380	125	2,190	23,515	26,280	329	50,124	219
Dam A.DI	46,820	14,380	300	2,720	64,220	32,640	408	97,268	272
Dam A.D.II	7,000	3,000	70	220	10,290	2,640	33	12,963	22
(Dam A)	(4,000)	(2,000)	(50)	(220)	(6,270)	(2,640)	(33)	(8,943)	(22)

Note: 1) Unit cost: Paddy = 20,000, Upland = 10,000, Other lands = 5,000,
Homelots = 20,000 Baht per rai.
Houses = 120,000 (15 Years old, 80% of a new building),
Trees = 1,500 Baht per household.

2) Excluding wells, graves and other public properties.

Table 4.1-7 Construction Costs of the Resettlement

	No. of Settlers	Area (ha) Divided Area (1.6 ha)	Area of Roads and Canals	Area for Public Use	Total Area	Cost (,000 Baht) Land Clearing	Roads Construction	Irrigation System	Houses	Electricity	School	Wat	Wells	Total
		ha	ha											
Dam B	1,024	1,638.4	163.8	8.0	1,810.2	6,144	90,112	108,544	122,880	10,035	3,000	5,000	525 (35)	346,240
Dam C	1,328	2,124.8	212.5	10.0	2,347.3	7,968	116,864	140,768	159,360	13,014	3,000	5,000	675 (45)	446,647
Dam D	819	1,310.4	131.0	7.0	1,448.4	4,914	72,072	86,814	103,680	8,026	2,000	5,000	420 (28)	280,926
Dam A.C	125	200.0	20.0	4.0	224.0	750	11,000	13,250	26,280	1,225	1,000	2,000	75 (5)	55,580
Dam A.D.I	178	284.8	28.5	4.0	317.3	1,068	15,664	18,868	32,640	1,744	1,000	2,500	90 (6)	73,574
Dam A.D.II	22	35.2	3.5	3.0	41.7	132	1,936	2,332	2,640	216	500	1,500	15 (1)	9,271

Table 4.1-8 Present Benefits from the Affected Villages

Unit: ,000 Baht

	Financial Benefits					Economic Benefits				
	Outputs			Inputs	Benefits	Outputs			Inputs	Benefits
	Crops	Animals	Total			Crops	Animals	Total		
Dam B	14,966	5,385	20,351	1,454	18,897	23,025	7,338	30,363	1,277	29,086
Dam C	17,642	7,882	25,524	1,556	23,968	27,831	10,770	38,601	1,367	37,234
Dam D	12,567	5,466	18,033	1,157	16,876	19,767	7,404	27,171	1,017	26,154
Dam A.C	2,807	781	3,588	328	3,260	4,297	1,085	5,382	288	5,094
Dam A.DI	6,253	926	7,179	348	6,831	10,195	1,287	11,482	306	11,176
Dam A.DII	983	125	1,108	41	1,067	1,579	213	1,792	36	1,756
(Dam A)	(549)	(125)	(674)	(10)	(664)	(888)	(213)	(1,101	(9)	(1,092)

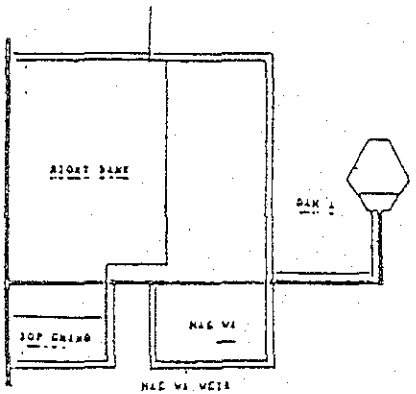
Table 4.1-9 Expected Benefits from the Resettlement

(Unit: ,000 Baht)

	No. of Farm	Financial Benefits					Economic Benefits				
		Outputs			Inputs	Benefits	Outputs			Inputs	Benefits
		Crops	Animals	Total			Crops	Animals	Total		
Dam B	1024	29,276	3,328	32,604	12,411	20,193	40,063	4,608	44,671	10,365	34,306
Dam C	1328	37,968	4,316	42,284	16,095	26,189	51,957	5,976	57,933	13,442	44,491
Dam D	819	23,415	2,662	26,077	9,926	16,151	32,043	3,686	35,729	8,290	27,439
Dam A.C	125	3,574	406	3,980	1,515	2,465	4,891	563	4,328	1,265	3,063
Dam A.DI	178	5,089	579	5,668	2,157	3,511	6,964	801	7,765	1,802	5,963
Dam A.DII	22	629	72	701	267	434	861	99	960	223	737

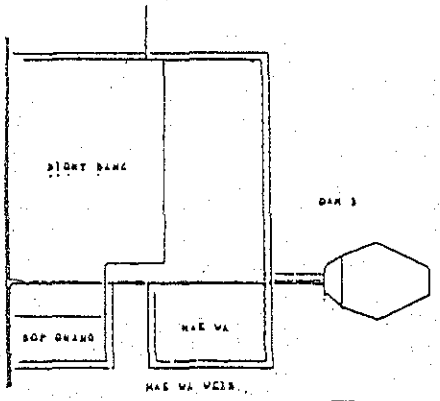
Fig. 4.2-1 ALTERNATIVE PLANS OF MAE CHANG IRRIGATION PROJECT

CASE 1 DAM A



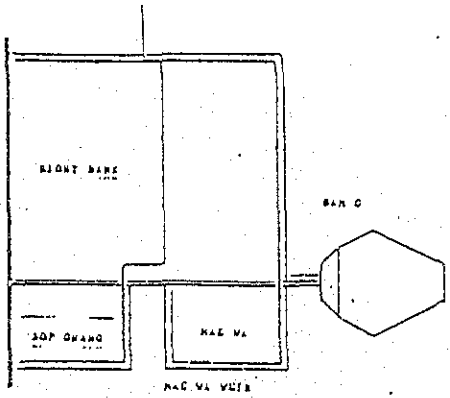
ITEM	AMOUNT
EFFECTIVE RESER. CAPACITY	30 MCM
H.W.L.	265 M
T.W.L.	220 M
CONSTRUCTION COST	1423 MB
IRRIGATION AREA	7310 HA
CROPPING INTENSITY (WET)	100 %
" (DRY)	35 %
CONSTRUCTION COST PER HA	8850 US $
E.I.R.R.	98 %

CASE 2 DAM B



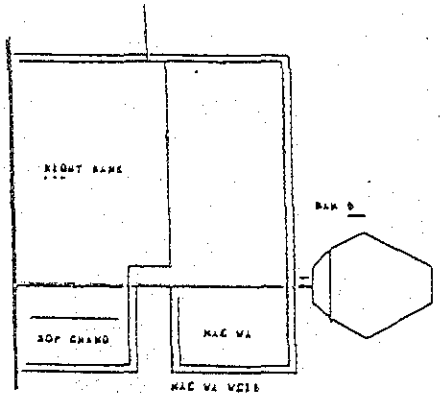
ITEM	AMOUNT
EFFECTIVE RESER. CAPACITY	61 MCM
H.W.L.	268 M
T.W.L.	220 M
CONSTRUCTION COST	2337 MB
IRRIGATION AREA	7310 HA
CROPPING INTENSITY (WET)	100 %
" (DRY)	70 %
CONSTRUCTION COST PER HA	18200 US $
E.I.R.R.	7.3 %

CASE 3 DAM C



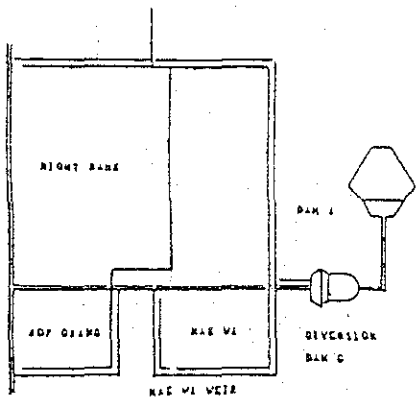
ITEM	AMOUNT
EFFECTIVE RESER. CAPACITY	64 MCM
H.W.L.	265 M
T.W.L.	220 M
CONSTRUCTION COST	2877 MB
IRRIGATION AREA	7310 HA
CROPPING INTENSITY (WET)	100 %
" (DRY)	95 %
CONSTRUCTION COST PER HA	11320 US $
E.I.R.R.	9.8 %

CASE 4 DAM D



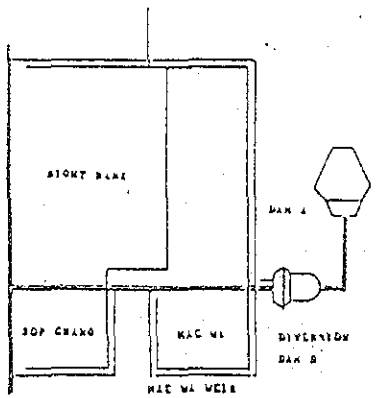
ITEM	AMOUNT
EFFECTIVE RESER. CAPACITY	78 MCM
H.W.L.	263 M
T.W.L.	240 M
CONSTRUCTION COST	2253 MB
IRRIGATION AREA	7253 HA
CROPPING INTENSITY (WET)	100 %
" (DRY)	95 %
CONSTRUCTION COST PER HA	9050 US $
E.I.R.R.	11.2 %

DIV.
CASE 5 DAM A + DAM C



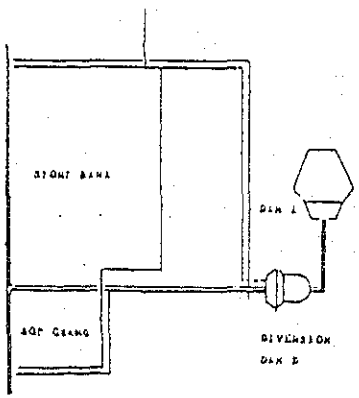
ITEM	AMOUNT
EFFECTIVE RESER. CAPACITY	35 MCM
H.W.L.	DIV. 255 M
T.W.L.	DIV. 220 M
CONSTRUCTION COST	1544 MB
IRRIGATION AREA	7310 HA
CROPPING INTENSITY (WET)	100 %
" (DRY)	80 %
CONSTRUCTION COST PER HA	9330 US $
E.I.R.R.	9.9 %

DIV.
CASE 6 DAM A + DAM D



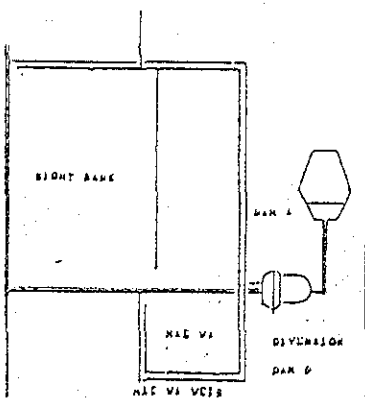
ITEM	AMOUNT
EFFECTIVE RESER. CAPACITY	35 MCM
H.W.L.	DIV. 255 M
T.W.L.	DIV. 240 M
CONSTRUCTION COST	1282 MB
IRRIGATION AREA	7253 HA
CROPPING INTENSITY (WET)	100 %
" (DRY)	80 %
CONSTRUCTION COST PER HA	7800 US $
E.I.R.R.	11.7 %

CASE 6B



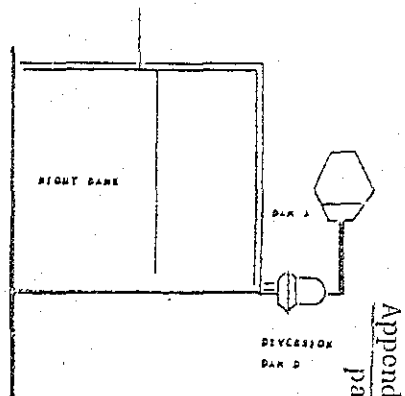
ITEM	AMOUNT
EFFECTIVE RESER. CAPACITY	35 MCM
H.W.L.	DIV. 255 M
T.W.L.	DIV. 240 M
CONSTRUCTION COST	1332 MB
IRRIGATION AREA	6339 HA
CROPPING INTENSITY (WET)	100 %
" (DRY)	80 %
CONSTRUCTION COST PER HA	7800 US $
E.I.R.R.	11.6 %

CASE 6D



ITEM	AMOUNT
EFFECTIVE RESER. CAPACITY	35 MCM
H.W.L.	DIV. 255 M
T.W.L.	DIV. 240 M
CONSTRUCTION COST	1096 MB
IRRIGATION AREA	6212 HA
CROPPING INTENSITY (WET)	100 %
" (DRY)	80 %
CONSTRUCTION COST PER HA	7900 US $
E.I.R.R.	11.3 %

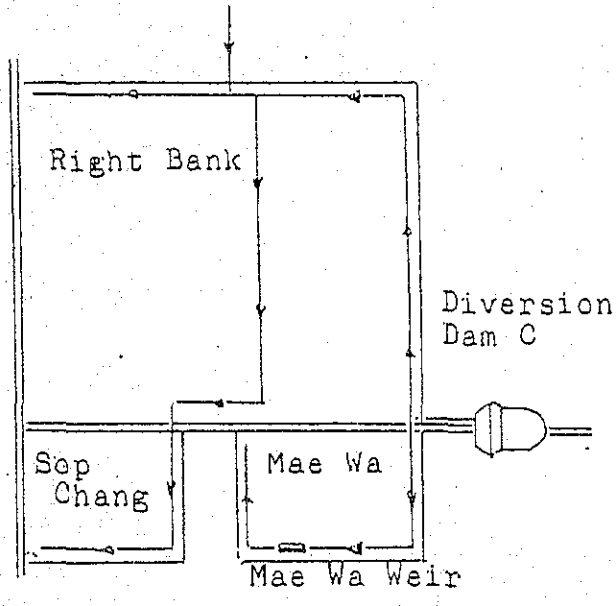
CASE 6C



ITEM	AMOUNT
EFFECTIVE RESER. CAPACITY	35 MCM
H.W.L.	DIV. 255 M
T.W.L.	DIV. 240 M
CONSTRUCTION COST	1096 MB
IRRIGATION AREA	5213 HA
CROPPING INTENSITY (WET)	100 %
" (DRY)	80 %
CONSTRUCTION COST PER HA	8600 US $
E.I.R.R.	10.3 %

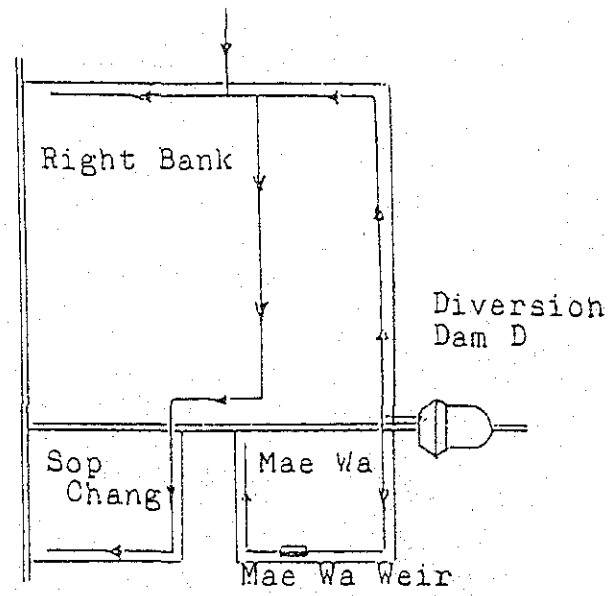
Fig. 4.2-2 ALTERNATIVE PLANS OF MAE CHANG IRRIGATION PROJECT(NO.2)

CASE 7 DIV.DAM C



Efective Reser. Capacity	7 MCM
H.W.L.	255.
I.W.L.	251.
Construction Cost	990 M฿
Irrigation Area	7,210 Ha
Cropping Intensity (wet)	100%
-do- (dry)	0
Construction Cost per Ha	5,970US$
E.I.R.R.	9.2%

CASE 8 DIV.DAM D



Efective Reser. Capacity	2 MCM
H.W.L.	250.
I.W.L.	248.
Construction Cost	233 M฿
Irrigation Area	7,252 Ha
Cropping Intensity (wet)	50%
-do- (dry)	0
Construction Cost per Ha	4,460US$
E.I.R.R.	4.9%

4.2.2. Irrigation Plan

(1) Irrigation Water Requirements

Reference Crop Evapotranspiration (ETo)

Reference crop evapotranspiration (ETo), generally recognized as fairly reliable index in calculating crop water requirements, can be determined by a number of methods, such as the Blaney Criddle, Radiation, Penman and Pan Evaporation.

In this study, ETo is estimated by the modified Penman method which offer the best results minimum possible errors under climatic conditions.

The form of the equation used in the modified Penman method is expressed as:

$$ETo = C\ W\ Rn + (1 - W)\ f(u)\ (ea - ed)$$

Where, Eto = reference crop evapotranspiration in mm/day
W = temperature - related weighting factor
Rn = net radiation in equivalent evaporation in mm/day
f(u) = wind-related function
(ea - ed) = difference between the saturation vapour pressure at mean air temperature and the mean actual vapour pressure of the air, both in mbar
C = adjustment factor to compensate for the effect of day and night weather conditions

Based on the meteorological data observed at Lampang Station, the mean monthly ETo is obtained as shown in Table 4.2-1:

Crop Factor and Consumptive Use

After computation of ETo, consumptive use for each crop can be predicted by applying the appropriate crop coefficient (K).

The K values vary depending upon a growing period of crops and locality. No data on such values, however, are available in the vicinity of the Project Area, so that the following values shown in Table 4.2-2 are selected, taking into account the characteristics of proposed crops, times of planting or sowing and the stage of crop development and climatic conditions prevailing in the Project Area.

The consumptive use for each proposed crop is predicted as shown in Table 4.2-2.

Irrigation Water Requirement

Irrigation water requirements for the proposed cropping pattern are computed on the basis of the consumptive use of crops and additional water supply for nursery bed, land preparation, percolation on paddy fields.

Concerning percolation rate on paddy fields, measurements were made at the following five places in the existing paddy fields by means of portable measuring equipment "Todai - Type Quick Percolation Measurement Equipment". Due to the lack of water, places to be measured were so limited that measurements at the left bank of the Area were not made.

Location No.	Name of Ban	Percolation Rate	Field Conditions
No. A	Ban Muang	1.0 mm/day	Seven-days after transplanting (Lifted water)
No. B	Ban Pa Cham	0.3 mm/day	Two-weeks after transplanting (Rainfed)
No. C	Ban To	0.6 mm/day	One-day after transplanting (Lifted water)
No. D	Ban Pong	1.8 mm/day	Seven-days after transplanting (Lifted water)
No. E	Ban Nan Kao	2.0 mm/day	Seven-days after transplanting (Rainfed)

An average percolation rate for the Project Area is obtained at 1.1 mm per day.

Water requirements in land soaking and preparation for paddy fields are predicted as:

(a) First Irrigation — 140 mm

Top soil saturation depth 150 mm, porosity 50%, soil moisture 35%

	150 mm x 0.50 x 0.65	= 50
Percolation (1.0 mm/day)	1 mm x 25 days	= 25
Standing water	5 mm x 13	= 65

(b) Second Irrigation — 60 mm

Evaporation	5 mm x 12	= 60

Sub-total (a)+(b) — 200 mm

Nursery Bed — 400 mm x 1/15 = 27 = 30 mm

Total — 230 mm

Table 4.2-1 Reference Crop Evapotranspiration (ETo)

Item		Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
T mean (°C)		21.3	23.9	27.4	29.7	28.8	28.0	27.6	27.1	26.6	25.9	24.0	21.4
ea	(1)	25.4	29.6	36.5	31.3	39.6	37.8	37.0	35.9	27.9	33.4	29.8	25.5
RH mean (%)	(2)	72	64	58	59	72	77	78	82	85	84	80	76
ed	(3)=(1)x(2)	18.3	18.9	21.2	18.5	28.5	29.1	28.9	29.4	23.7	28.1	23.8	19.4
	(4)=(1)-(3)	7.1	10.7	15.3	12.8	11.1	8.7	8.1	6.5	4.2	5.3	6.0	6.1
U_2 (km/day)	(5)	67.5	81.8	99.6	120.9	110.2	117.4	124.5	99.6	71.1	56.9	53.4	60.5
f(u)	(6)	0.45	0.49	0.54	0.59	0.57	0.58	0.60	0.54	0.46	0.42	0.42	0.43
J-W lat=250m	(7)	0.29	0.26	0.23	0.21	0.22	0.22	0.22	0.23	0.23	0.24	0.26	0.29
(mm/day)	(8)=(4)x(6)x(7)	0.93	1.36	1.90	1.59	1.39	1.11	1.07	0.81	0.44	0.53	0.66	0.76
Ra lat.=18°N(mm/day)	(9)	11.6	13.0	14.6	15.6	16.1	16.1	16.1	15.8	14.9	13.6	12.0	11.1
n (hr/day)	(10)	8.6	9.6	9.2	9.1	7.7	5.8	4.7	4.5	6.9	7.3	7.9	8.3
N lat.=18°N	(11)	11.2	11.5	12.0	12.6	13.0	13.2	13.1	12.7	12.3	11.7	11.2	10.9
n/N	(12)	0.77	0.83	0.77	0.72	0.59	0.44	0.36	0.35	0.56	0.62	0.71	0.76
= 0.25	(13)	0.48	0.50	0.48	0.46	0.41	0.36	0.30	0.32	0.39	0.42	0.45	0.47
Rns	(14)=(9)x(13)	5.6	6.5	7.0	7.2	6.6	5.8	4.8	5.1	5.8	5.7	5.4	5.2
f(t)	(15)	14.8	15.4	16.1	16.7	16.5	16.3	16.3	16.1	16.1	15.9	15.4	14.8
f(ed)	(16)	0.14	0.12	0.11	0.10	0.10	0.11	0.11	0.11	0.12	0.12	0.12	0.13
f(n/N)	(17)	0.80	0.85	0.80	0.75	0.64	0.51	0.42	0.42	0.60	0.66	0.74	0.79
Rn	(18)=(15)x(16)x(17)	1.66	1.57	1.42	1.25	1.06	0.91	0.75	0.74	1.16	1.26	1.37	1.52
Rn	(19)=(14)-(18)	3.94	4.93	5.58	5.95	5.54	4.89	4.38	4.36	4.64	4.44	4.03	3.68
W	(20)	0.71	0.74	0.77	0.79	0.79	0.79	0.78	0.78	0.77	0.76	0.74	0.71
W.Rn (mm/day)	(21)=(19)x(20)	2.80	3.65	4.30	4.70	4.38	3.81	3.42	3.36	3.57	3.37	2.98	2.61
ETo (mm/day)	(22)=(8)+(21)	3.73	5.01	6.20	6.29	5.77	4.92	4.49	4.17	4.01	3.90	3.64	3.37
C = 0.90													
ETo correction (mm/day)		3.4	4.5	5.6	5.7	5.2	4.4	4.0	3.8	3.6	3.5	3.3	3.0

Note: 1/ Climatic data are on the basis of records at Lampang

Table 4.2-2 Irrigation Water Requirements

Month	Ev	Et	Paddy			Groundnut			Soybeans			Tobacco			Garlic			Sugarcane		
			K	Cu	Tcu	K	Cu	Tcu	K	Cu	Tcu	K	Cu	Tcu	K	Cu	Tcu	K	Cu	Tcu
Jan.	2.7	3.4	-	-	-	0.4	1.4	74	0.7	2.4	74	0.7	2.4	74	0.7	2.4	74	0.85	2.9	90
Feb.	3.8	4.5	-	-	-	0.7	3.2	126	1.0	4.5	126	1.0	4.5	126	0.65	4.5	126	0.65	2.9	82
Mar.	5.0	5.6	-	-	-	1.0	5.6	139	0.8	4.5	139	0.8	4.5	139	0.8	4.5	139	0.6	3.4	104
Apr.	6.6	5.7	-	-	-	0.8	4.6	86	0.5	2.9	59	0.5	2.9	71	0.5	2.9	14	0.5	2.9	86
May	5.1	5.2	-	-	-	0.5	2.6	-	-	-	-	-	-	-	-	-	-	0.6	3.1	97
Jun.	4.9	4.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.8	3.5	106
Jul.	4.2	4.0	1.0	4.0	230	-	-	-	-	-	-	-	-	-	-	-	-	1.0	4.0	124
Aug.	3.8	3.8	1.2	4.6	112	0.4	1.5	23	0.4	1.5	23	-	-	-	-	-	-	1.2	4.6	141
Sep.	3.7	3.6	1.35	4.9	177	0.7	2.5	76	0.7	2.5	76	-	-	-	-	-	-	1.25	4.5	135
Oct.	3.2	3.5	1.2	4.6	174	1.0	3.5	109	1.0	3.5	109	-	-	-	-	-	-	1.2	4.2	130
Nov.	2.9	3.3	1.1	4.0	120	0.8	2.6	79	0.8	2.6	66	-	-	-	-	-	-	1.15	3.8	114
Dec.	2.6	3.0	-	-	-	0.5	1.5	8	-	-	-	0.4	1.2	37	0.4	2.8	37	1.0	3.0	93
Total:																				
1,469.7	1,519.5				813		Wet	295		Wet	274			447			390			1,302
							Dry	425		Dry	368									

Note: 1/ Evaporation observed at Lampang by class A Pan (Refer to "Climatological Data of Thailand (1951 - 80) p.5"
2/ Crop evapotranspiration
3/ Crop factor
4/ Consumptive use = k x ET
5/ Total consumptive use = cu x number of days in an average growing period
(Refer to "Proposed Cropping Pattern")

Irrigation Efficiency

Concerning irrigation efficiency, discussions were made between the Survey Team and RID. The following were selected.

Corps	Field Application Efficiency	Operation Efficiency	Conveyance Efficiency	Overall Irrigation Efficiency
Paddy	0.70	0.90	0.85	0.54
Upland	0.60	0.90	0.85	0.46

Effective Rainfall

Effective rainfall is defined depending upon various computational methods. In this report, two methods were studied, i.e.,

a. Master Plan Study on the Greater Mae Klong River Basin
b. One of the RID methods was studied for comparison

The result shows that the average annual rainfall at the Mae Tha station from 1970 to 1981 is 1,087 mm and the effective rainfall by the Mae Klong method is 790 mm (73% of annual rainfall) and by the RID method is 718 mm (66%).

No large difference appears between the two, therefore, the RID method was selected for this Project's studies.

(a) The Master Plan Study on the Greater Mae Klong River Basin

Crops	Effective Rainfall	E.R. Upper Limit
Paddy	0.75 R	200 mm
Sugarcane	0.75 R	150
Upland Crop	0.75 R	120

Note: R stands for monthly rainfall

(b) RID Method

Monthly Rainfall (R)	Effective Rainfall
0 - 10 mm	0
11 - 100	R x 0.80
101 - 200	R x 0.70
201 - 250	R x 0.60
251 - 300	R x 0.55
301 - up	R x 0.50

Diversion Water Requirement

Diversion water requirements will be calculated by considering effective rainfall and irrigation efficiency as shown below:

$$\text{Div. Water Re.} = \frac{\text{Irri. Water Re. - Effective Rainfall}}{\text{Irrigation Efficiency}}$$

In the period of 1970 to 1981, diversion water requirements by each crop are computed on the monthly basis and their annual values are obtained as the followings:

Table 4.2-3 Diversion Water Requirements

(Unit: mm)

Water Year 1/	Paddy	Groundnut		Soybean		Tobacco	Garlic	Sugarcane
	Rainy	Rainy	Dry	Rainy	Dry	Dry	Dry	Year Round
1970	794	255	737	226	737	767	737	1,281
1971	587	167	552	139	682	853	760	1,254
1972	720	22	654	22	637	717	717	1,270
1973	645	215	674	187	685	857	737	1,334
1974	620	93	636	65	619	699	699	1,254
1975	537	100	754	72	800	971	847	1,289
1976	789	252	654	224	657	828	717	1,415
1977	687	224	561	195	544	654	624	1,340
1978	693	257	754	228	737	817	817	1,530
1979	1,054	370	717	341	700	860	780	1,747
1980	738	107	705	178	731	874	757	1,448
1981	708	150	683	121	683	763	763	1,249
Mean	714	193	673	167	684	805	746	1,368

Note: 1/ April in the year to March in the next year

(2) Irrigable Area

According to the proposed land use mentioned in the previous paragraph, the Project Area cover 45,900 rai (7,349 ha) of cultivated land in net, provided that intake water level is taken at EL 248 m at the proposed diversion dam D (Case 6). On the other hand, in case intake water level is at EL 251 m at the proposed diversion dam C (Case 5), the Project Area covers 50,600 rai (8,095 ha) of cultivated land in net.

The breakdown of irrigable area for each sub-area is summarized as:

Proposed Irrigable Area - Case 5
(Intake Water level EL 250 m)

(Unit: ha)

Item	Right Bank		Mae Wa		Sop Chang		Total	
	Cross 1/	Net 2/	Gross	Net	Gross	Net	Gross	Net
Cultivation Land	6,192	6,006	964	935	1,190	1,154	8,346	8,095
Paddy	5,146	4,992	623	604	911	884	6,680	6,480
Upland	1,046	1,014	341	331	279	270	1,666	1,615
Forest	1,942	-	66	-	127	-	2,135	-
Village	770	-	92	-	133	-	995	-
Others	22	-	8	-	4	-	34	-
Total	8,926	6,006	1,130	935	1,454	1,154	11,510	8,095

(50,600 rai)

Note: 1/ Refer to "Proposed Land Use"
2/ Net Area "Gross Area x 0.97

Table 4.2-4. Proposed Irrigable Area - Case 6
(Intake Water Level EL 248 m)

(Unit: ha)

Item	Right Bank		Mae Wa		Sop Chang		Total	
	Cross[1/]	Net[2/]	Gross	Net	Gross	Net	Gross	Net
Cultivation Land	5,631	5,462	784	761	1,161	1,126	7,576	7,349
Paddy	4,612	4,474	498	483	889	862	5,999	5,819
Upland	1,019	988	286	278	272	264	1,577	1,530
Forest	1,877	-	46	-	127	-	2,050	-
Village	720	-	79	-	133	-	932	-
Others	21	-	8	-	4	-	33	-
Total	8,249	5,462	917	761	1,425	1,126	10,591	7,349

(45,900 rai)

(3) Design Discharge for Irrigation Canal

According to the proposed cropping pattern, the maximum water requirement occurs on the last day of paddy land preparation.

The design discharge of main and lateral irrigation canals is thus determined at 1.30 liter/sec/ha, taking into consideration the weighted average of maximum water requirements on paddy and upland crops and irrigation efficiency.

(4) Upland Field Irrigation Schedules

Infiltration Rate

The infiltration test in the field which are essential for the field irrigation schedules on upland crops have been made for the following five places during the field survey, taking into

consideration the soil classification and conditions of present land use.

No.	Name of Ban	Location	Field Conditions
No.1	Ban Pao	Western part of the Area along the Mae Chang	After harvesting sugar cane cracks are developed
No.2	Ban Pa Cham	Mae Pung Existing irrigated area	After cultivation of paddy irrigation is practiced at adjacent plots
No.3	Ban Pa Muang	Middle parts of the Area	Fallow land: furrows remain no cracks are observed
No.4	Ban Nam Paya	Eastern part of the Area	Rainfed field: no cultivation was made last year due to drought
No.5	Ban Kiu Luang	Southern part of the Area, left bank of the Mae Chang	After harvesting groundnuts fields are kept wet

Most of the fields except No.2 and No.5 are completely under dry conditions showing rigid soil and well-developed cracks. Accordingly, soil sampling and driving an iron cylinder into the soil were extremely difficult. Considering such conditions, infiltration tests were performed keeping the field wet by supplying water 24 hours before, at the same time sampling was made to measure water content of soil.

Infiltration rate was measured by reading of the water depth within the cylinder every 5 to 10 minutes at the initial stage and 30 minutes after one hour. Results of infiltration rate are plotted on a logarithmic paper as shown in Fig.4.2-3, -4.

Depth and Interval of Irrigation Application

Depth and interval of irrigation application is determined in accordance with the following procedure.

- Determination of effective root zone
- Determination of moisture extraction pattern
- Calculation of available moisture of each layer within effective root zone
- Calculation of total available moisture
- Determination of depth and interval of irrigation application

° Depth of Effective Root Zone

The depth of effective root zone will be determined on the basis of field investigations on root zone and soil moisture for each proposed crop over the growing period. However, such investigations were not made due to the limited period of field survey. Therefore, the depth of effective root zone for upland crops is assumed at 50 cm on an average.

° Moisture Extraction Pattern

Consumptive use of soil moisture by crop evapotranspiration will vary depending on the depth of soil.

This consumptive rate of soil moisture is so called "moisture extraction pattern", which will be determined on the basis of the field investigations.

Due to the lack of data concerned, the following pattern was applied.

Depth of Effective Root Zone (cm)	Ratio of Moisture Extraction (%)
0 - 10	40
10 - 20	30
20 - 30	20
30 - 40	10

° Available Moisture in each Layer within Effective Root Zone

Available moisture (A.M) is obtained from the following equation.

$$A.M = \frac{1}{100} \Sigma (Fc - Me)\ Sa \cdot d \quad (mm)$$

Where, Fc: water holding capacity after 24 hours of soil saturation (%)
Me: moisture ratio at wilting point (%)
Sa: apparent specific gravity
d: depth of soil in each layer (mm)

According to soil tests, the following physical properties are obtained.

Real Specific Gravity	(g/cm^3)	2.62
Apparent Specific Gravity	(g/cm^3)	1.32
Porosity	(%)	49.6
Field Capacity	(%)	16.7
Wilting Point	(%)	7.5

In case depth of soil in each layer is 100 mm, A.M becomes 15.2 mm.

° Total Available Moisture (TRAM)

Total available moisture (TRAM) is calculated by the followings:

In the soil layer concerned,

$$\text{Consumed moisture} = \frac{\text{available moisture}}{\text{ratio of moisture extraction}}$$

The layer presenting minimum value obtained from the above equation is the restricting layer of moisture and it's value becomes total available moisture.

$$\text{TRAM} = \frac{15.2}{0.4} = 38 \text{ (mm)}$$

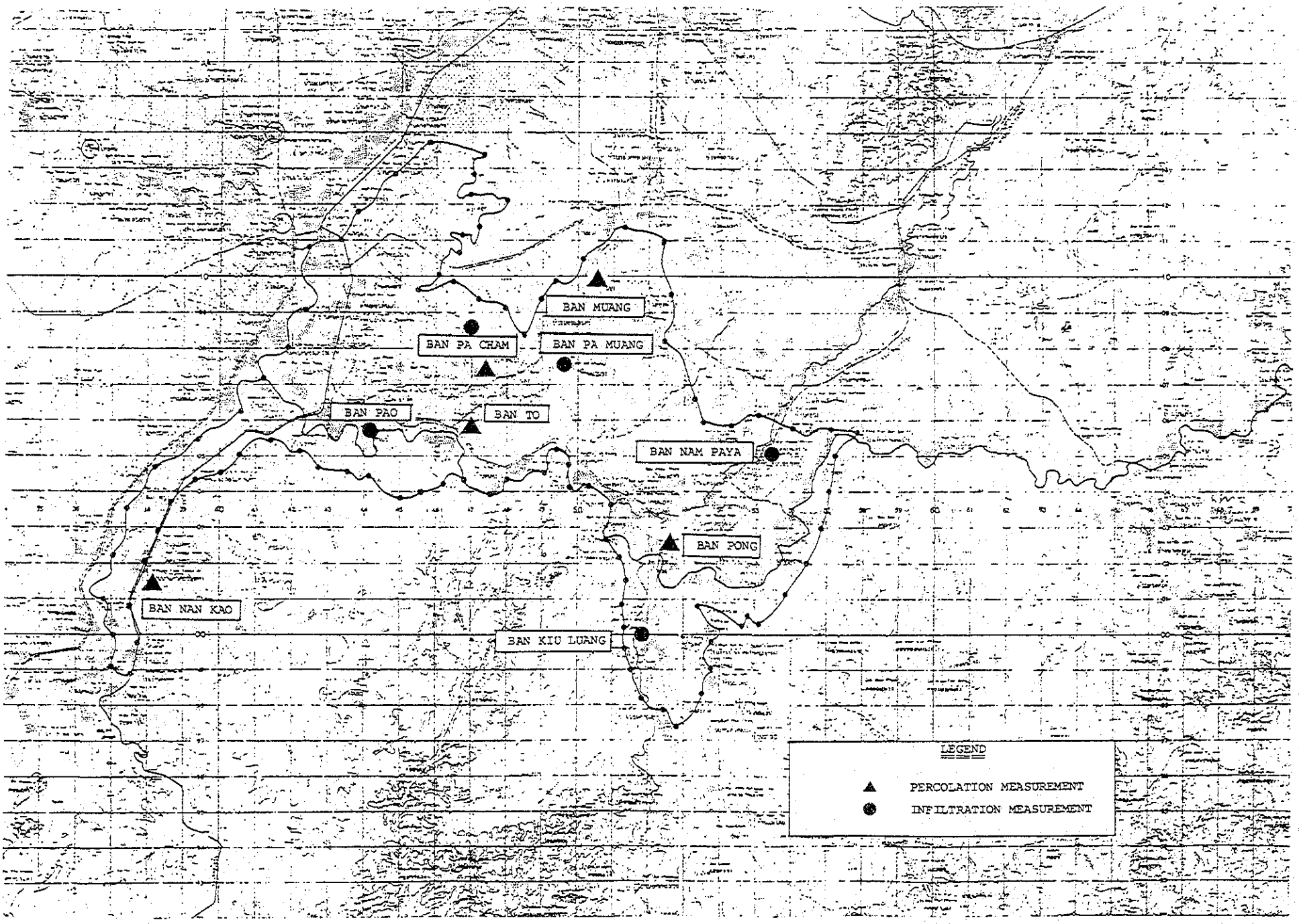
° Interval Irrigation Application

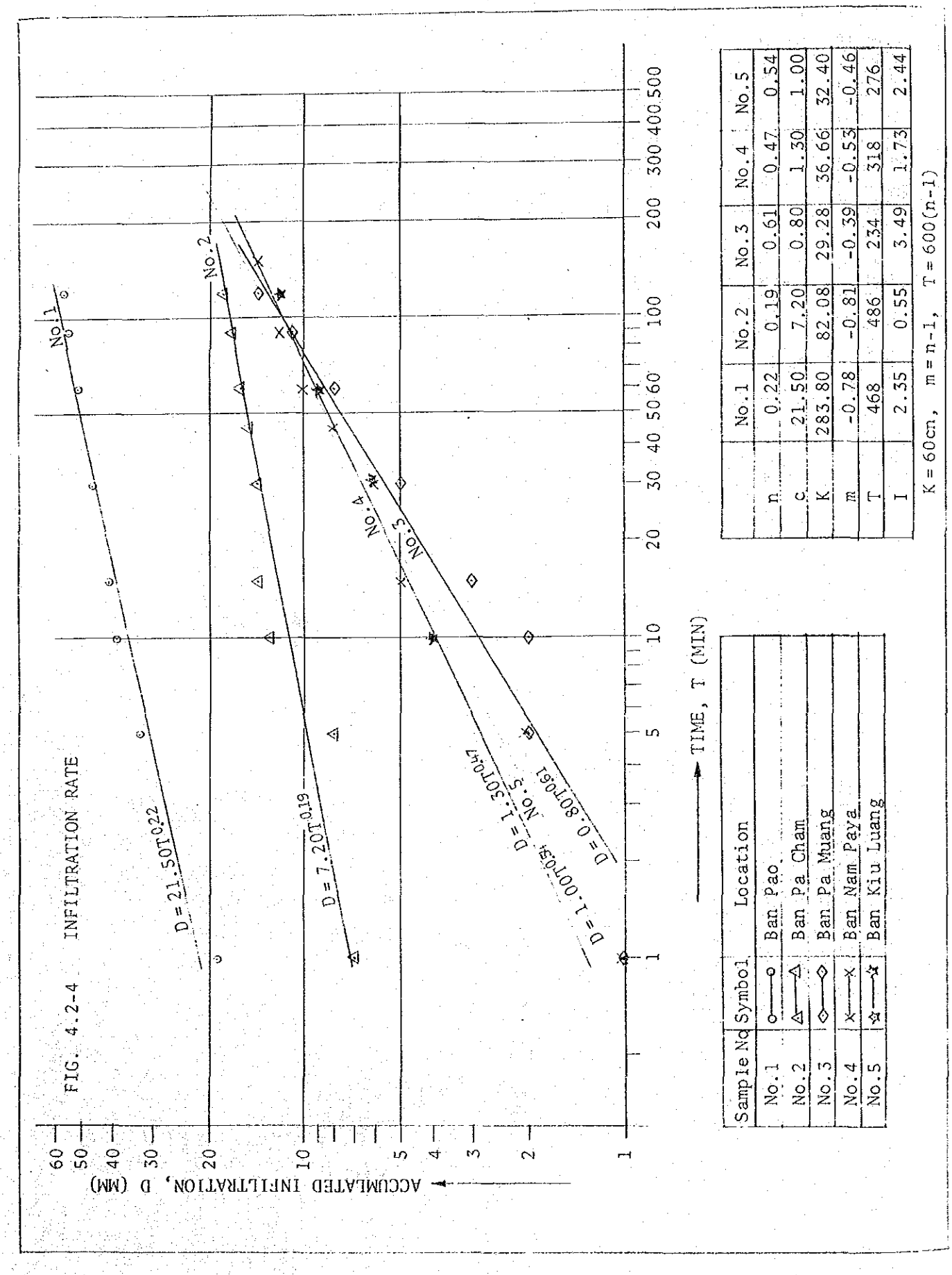
Interval of irrigation application is obtained by dividing TRAM by maximum crop evapotranspiration.

Crop	TRAM (mm)	Maximum Evapotranspiration (mm)	Interval (days)
Groundnut	38	5.6	7
Other Crops	38	4.5	9

For a view point of water management, the same interval of irrigation application is favourable, therefore, 9-day interval is adopted.

FIG. 4.2-3 LOCATION OF PERCOLATION/INFILTRATION MEASUREMENTS





Sample No	Symbol	Location
No.1	o——o	Ban Pao
No.2	△——△	Ban Pa Cham
No.3	◇——◇	Ban Pa Muang
No.4	×——×	Ban Nam Paya
No.5	☆——☆	Ban Kiu Luang

	No.1	No.2	No.3	No.4	No.5
n	0.22	0.19	0.61	0.47	0.54
c	21.50	7.20	0.80	1.30	1.00
K	283.80	82.08	29.28	36.66	32.40
m	-0.78	-0.81	-0.39	-0.53	-0.46
T	468	486	234	318	276
I	2.35	0.55	3.49	1.73	2.44

K = 60cn, m = n-1, T = 600(n-1)

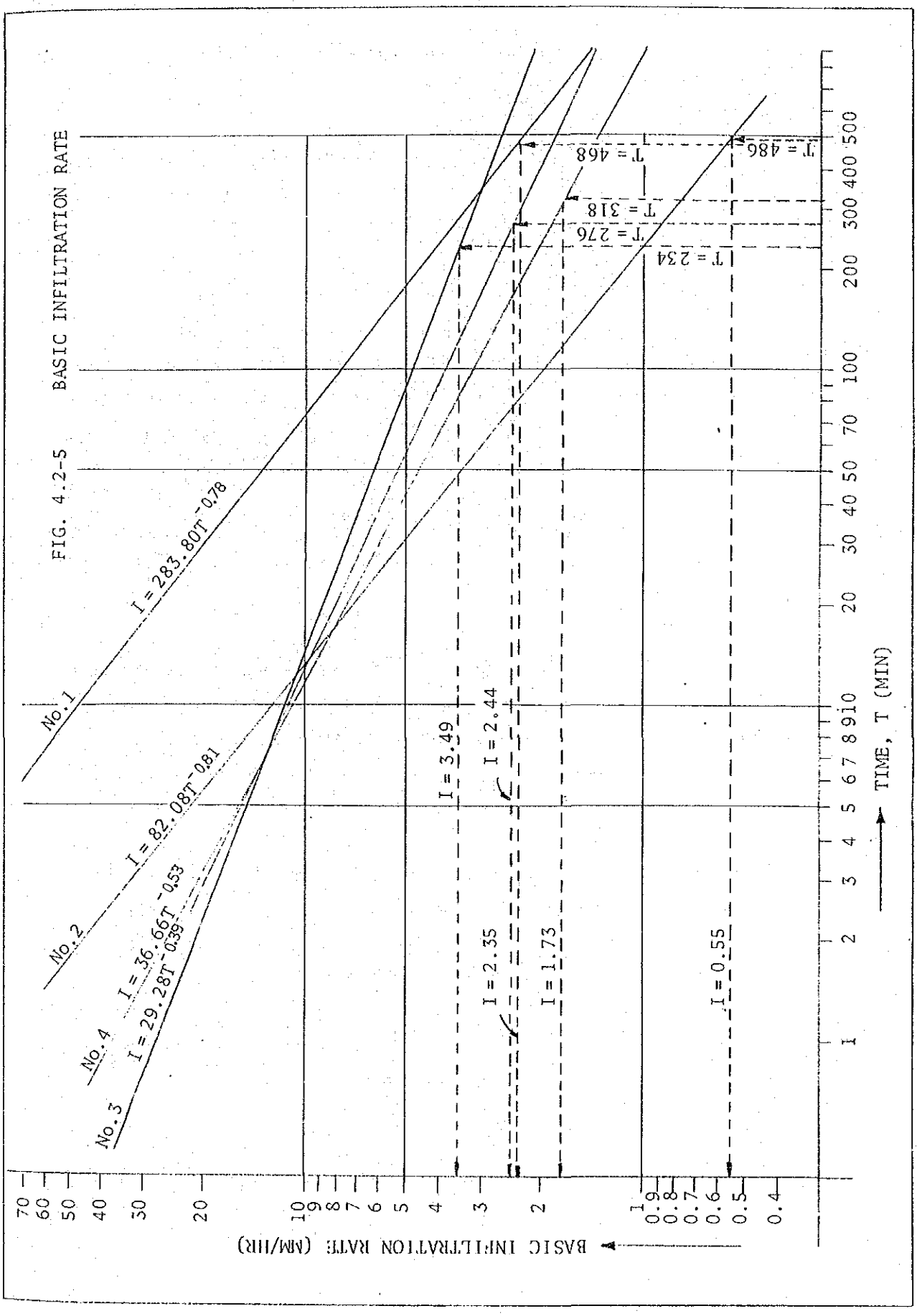


FIG. 4.2-5 BASIC INFILTRATION RATE
No.1 I = 283.80T^-0.78
No.2 I = 82.08T^-0.81
No.4 I = 36.66T^-0.53
No.3 I = 29.28T^-0.39
T = 486
T = 468
T = 318
T = 276
T = 234
I = 3.49
I = 2.44
I = 2.35
I = 1.73
I = 0.55
BASIC INFILTRATION RATE (MM/HR)
TIME, T (MIN)

(5) Water Rights of the Area in the Upstream and Downstream of the Proposed Dam and Diversion Dam

At present, farmers living along the Mae Chang take river water for irrigation and domestic use by means of pumps, brush dams or shallow wells.

With the Project, those people will be affected due to construction of a dam and a diversion dam. In case of alternative plans, dam A and diversion dam C or D, water rights in the upstream of those structures, i.e., upstream of dam A and the section between dam A and dam C or D are estimated, considering population and farm land.

The requirements amount to 10% of the Project water requirements should be accounted for water utilization studies and reservoir capacity.

As for water rights of the downstream section between diversion dam C or D and confluence with the Mae Wang, present irrigation water which is delivered directly by pumps will be conveyed through the newly provided canals with the Project. This means irrigation water will not be necessary for compensation.

Concerning domestic water use, actual amount of water is not definite. Accordingly, as discussed with the RID, minimum river discharge is released through the proposed diversion dam on the basis of observed records of river flows.