THE KINGDOM OF THAILAND

FEASIBILITY REPORT

ON

THE MAE WANG - KEW LOM IRRIGATED AGRICULTURE DEVELOPMENT PROJECT

(ANNEX)

MARCH 1980

JAPAN INTERNATIONAL COOPERATION AGENCY

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Status of Hydro-Meteorological Observation

Item	Station	Code Number	Available Period	Note
Rainfall	Lampang	16013	1952 - 1978	No record period included
	Ko Kha	16032	1953 - 1978	- do -
	Mae Tha	16052	1952 - 1978	
	Hang Chat	16062	1953 - 1978	- do -
	Chae Hom	16022	1953 - 1978	- do -
	Wang Nua	16112	1956 - 1978	- do -
	Sop Prap	16042	1954 - 1978	
River Discharge	Chae Hom	W16	1971 - 1977	
	Kew Lom	W10	1962 - 1967	
	"	W10A	1966 - 1977	
	Ratsada Phisek Bridge	W1	1952 - 1966	
	Kittikhachon II Bridge	W1A	1967 - 1978	
	Ko Kha Bridge	W5A	1963 - 1974	
	Ban Sop Po	W15	1969 - 1978	
Meteorological Data	Lampang		1951 - 1975	

Data source: Rainfall and River Discharge are RID
Meteorological Data are provided by Meteorological Department

Lampang Climatological Summaries

Period 1951 - 1975

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Year
Temperature (°C)													
Mean	21.5	24.1	27.5	29.8	28.9	28.0	27.6	27.1	26.6	25.9	24.1	21.5	26.0
Mean Max.	30.1	33.2	35.8	37.0	34.9	32.8	32.2	31.7	31.5	31.2	30.5	29.4	32.5
Mean Min.	13.5	15.1	18.7	22.3	23.9	24.0	23.7	23.4	23.0	21.7	18.4	14.7	20.2
Relative Humidity (%)													
Mean	66.0	61.1	55.0	56.0	69.0	75.0	75.0	79.0	81.0	80.0	77.0	73.0	71.0
Mean Max.	95.9	92.1	86.9	85.7	91.1	93.2	92.9	95.1	96.6	97.2	97.0	96.6	93.4
Mean Min.	42.3	34.1	31.6	35.6	50.8	60.4	62.4	65.9	67.8	64.9	56.7	49.8	51.9
Dew Point (°C)													
Mean	15.1	15.4	16.6	19.7	22.7	23.4	23.2	23.6	23.7	22.7	20.0	16.6	20.3
Evaporation (mm)													
Mean - Piche	66.4	86.8	122.5	121.2	86.8	64.3	62.3	49.1	38.9	41.3	43.7	51.8	835.1
Wind (Knots)													
Prevailing Wind	N.S	S	S	S	S	SW	SW	S	S	NE	NE	NE	-
Mean Wind Speed	2.3	2.6	3.0	3.7	3.5	4.0	3.9	3.4	2.2	1.9	1.7	1.9	-
Cloudiness (0-8)													
Mean	2.7	2.2	2.4	3.4	5.4	6.4	6.8	6.9	6.3	5.2	4.0	3.4	4.6
Rainfall (mm)													
Mean	6.4	6.2	28.9	63.2	152.6	137.6	131.3	215.7	210.8	122.0	26.6	5.7	1,107.0
Mean rainy days	1.4	0.9	3.1	6.2	13.9	15.9	17.7	20.3	18.4	12.0	3.7	1.7	115.2

Data source: Meteorological Department

Monthly Rainfall, Amphoe Muang Lampang (16013)

Unit: mm

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1952	***	***	***	48.8	58.0	103.0	108.8	193.2	174.6	85.6	15.9	0.0	***
1953	24.5	2.1	0.0	27.0	65.0	165.6	162.8	228.5	281.7	55.8	20.9	***	***
1954	***	***	***	10.4	123.7	60.7	28.6	229.3	194.0	229.3	10.3	0.0	***
1955	0.0	18.6	0.0	43.0	147.7	288.9	83.7	292.5	116.9	43.9	14.7	25.0	1,074.9
1956	0.0	0.0	0.9	113.2	161.4	66.5	156.1	211.1	224.0	63.4	14.7	0.0	1,011.3
1957	0.0	3.8	22.7	48.8	80.0	119.7	94.0	106.4	183.6	88.2	0.9	0.0	748.1
1958	36.8	0.0	95.8	32.4	69.1	193.3	67.4	160.5	138.4	92.7	13.0	0.0	899.4
1959	0.1	0.0	3.4	108.9	318.6	121.8	155.1	235.2	219.5	85.1	0.0	0.0	1,247.7
1960	16.3	0.0	16.3	0.6	115.4	131.4	194.8	274.2	258.1	101.7	46.7	1.9	1,157.4
1961	0.4	2.4	36.6	58.6	239.1	103.8	56.1	317.7	201.9	179.7	24.5	2.4	1,223.2
1962	4.3	0.0	0.9	19.2	89.1	70.7	144.3	246.3	238.2	120.1	0.0	1.4	934.5
1963	0.0	2.0	6.1	58.8	24.1	196.8	140.2	192.4	183.1	170.2	55.2	1.2	1,030.1
1964	0.0	1.4	0.0	42.3	184.5	79.5	148.4	126.9	272.9	152.5	1.5	1.2	1,011.1
1965	0.0	56.5	35.3	55.6	98.7	142.5	59.4	222.2	119.5	140.5	23.1	1.8	955.1
1966	12.6	0.2	7.8	1.0	288.1	123.5	130.7	235.9	170.6	115.0	26.8	9.7	1,121.9
1967	0.2	0.0	0.4	48.2	114.9	103.9	104.7	189.8	242.6	49.0	47.2	1.4	902.3
1968	0.0	1.5	6.4	136.1	151.3	203.9	77.9	131.4	125.1	85.8	13.9	0.0	933.3
1969	3.8	0.0	12.2	126.4	168.5	129.2	82.2	193.7	305.0	52.3	0.0	2.5	1,075.8
1970	0.0	11.6	51.0	75.0	250.2	230.4	109.2	316.6	323.4	100.1	10.7	28.2	1,506.4
1971	0.0	8.8	25.2	40.7	224.1	102.6	332.2	204.9	216.1	154.5	2.0	20.0	1,331.1
1972	3.2	0.0	31.9	111.4	81.2	108.9	107.9	215.9	139.5	196.0	93.5	14.9	1,104.3
1973	0.0	0.1	56.5	24.3	151.7	90.8	241.5	212.3	306.2	92.2	49.2	0.0	1,224.8
1974	0.0	0.0	37.6	236.5	154.5	136.1	135.5	180.9	326.2	62.8	134.4	5.9	1,410.4
1975	59.7	6.1	24.2	23.2	142.6	119.6	207.7	413.4	179.9	257.1	25.4	7.9	1,466.8
1976	0.0	13.8	0.0	19.9	120.2	40.3	62.0	169.3	193.1	92.6	14.7	2.1	728.0
1977	69.0	0.0	12.3	119.4	127.7	11.3	131.4	323.8	282.8	175.6	3.4	29.7	1,286.4
1978	17.9	15.7	0.0	15.0	202.3	66.7	213.0	130.5	206.7	86.4	0.0	0.0	954.2
Mean	10.0	5.8	19.3	60.9	146.4	122.6	130.9	220.5	215.7	115.9	24.5	6.0	1,097.4

Annual Rainfall of Each Stations

Unit: mm

Year	Lampang	Hang Chat	Ko Kha	Mae Tha	Sop Prap	Chae Hom
1952	-	-	-	-	-	-
53	-	1,454.0	-	1,313.1	-	1,754.5
54	-	1,023.7	1,463.8	935.7	742.9	1,419.7
55	1,074.9	1,181.7	1,486.5	1,103.3	881.4	1,634.0
56	1,011.3	1,145.2	-	1,117.5	1,100.4	1,360.1
57	748.1	854.4	656.3	1,116.5	865.2	1,348.0
58	899.4	905.2	841.2	957.7	868.9	947.6
59	1,247.7	900.8	1,215.2	1,441.3	1,034.0	944.5
1960	1,157.4	1,546.7	1,145.2	1,114.1	1,240.2	848.1
61	1,223.2	1,161.1	1,235.3	988.5	1,288.7	1,051.3
62	934.5	1,301.8	1,063.6	1,033.9	1,045.4	1,000.4
63	1,030.1	1,208.7	-	1,091.6	1,090.1	970.5
64	1,011.1	900.4	996.3	1,238.5	1,235.3	851.2
65	955.1	735.5	964.8	978.7	839.9	810.2
66	1,121.9	-	916.7	965.0	1,135.3	593.6
67	902.3	-	1,021.3	1,012.0	1,034.7	1,200.1
68	933.3	666.3	860.8	1,142.0	815.2	714.8
69	1,075.8	1,262.5	1,091.2	1,278.0	1,427.1	849.5
1970	1,506.4	1,564.2	1,306.5	1,275.8	1,144.1	1,143.8
71	1,331.1	1,289.3	1,193.8	1,095.9	1,085.8	1,043.0
72	1,104.3	929.6	1,118.7	1,000.7	1,032.2	958.0
73	1,224.8	1,400.7	1,111.1	1,333.1	1,176.3	1,070.4
74	1,410.4	1,191.5	1,507.3	1,106.0	1,332.7	-
75	1,466.8	1,871.1	1,337.0	1,390.1	1,820.5	951.9
76	728.0	1,233.9	930.4	820.7	1,045.9	768.5
77	1,286.4	1,170.0	1,215.1	1,092.7	906.3	880.0
78	954.2	1,018.2	-	992.0	1,224.4	697.6
Mean	1,097.4	1,163.2	1,121.7	1,112.9	1,096.5	1,032.5

Data source: RID Hydrology Section

Rainy Days in Lampang Station

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Year
1952	-	-	-	3	7	14	18	17	18	15	2	0	94
53	3	1	0	2	6	12	14	21	14	11	3	-	86
54	-	-	-	2	11	9	9	20	16	11	1	0	79
55	0	1	0	7	11	19	15	23	19	7	3	2	107
56	0	0	1	8	20	12	19	16	20	8	3	0	107
57	0	1	5	2	8	14	14	20	17	7	2	0	90
58	3	0	3	4	10	15	19	19	17	16	3	0	109
59	1	0	2	8	20	18	24	20	21	6	0	0	120
1960	5	0	2	1	13	14	16	20	19	20	8	2	120
61	1	2	3	6	15	24	18	19	25	18	5	1	137
62	2	0	1	5	14	20	17	20	19	16	0	2	116
63	0	1	3	8	7	16	20	19	18	14	4	2	112
64	0	1	0	7	16	12	19	16	22	13	3	3	112
65	0	2	3	4	6	21	15	18	15	17	5	1	107
66	3	1	2	1	21	17	16	22	15	14	5	3	120
67	1	0	1	10	15	13	15	18	22	10	6	1	112
68	0	2	3	11	15	15	17	16	12	13	1	0	105
69	2	0	1	7	14	17	17	21	17	2	0	1	99
1970	0	1	2	10	13	21	15	22	19	11	5	7	126
71	0	1	6	10	15	14	19	20	16	12	3	3	119
72	2	0	2	11	8	9	15	21	16	11	10	2	107
73	0	1	6	3	22	18	22	26	20	11	3	0	132
74	0	0	6	10	18	12	19	15	24	12	7	1	124
75	9	1	1	2	16	15	22	24	19	13	4	1	120
76	0	1	0	6	15	14	16	23	18	18	6	3	120
77	4	0	1	7	20	7	22	18	15	14	2	4	114
78	5	6	0	5	15	10	18	16	19	10	0	0	104
Mean	2	1	2	6	14	15	17	20	18	12	3	2	112

Data source: RID Hydrological Section

ANNEX 1-1
Table 1-1-6

Correlation Coefficient of Annual Rainfall in Each Stations

	Lampang	Mae Tha	Ko Kha	Sop Prap	Hang Chat	Chae Hom	Wang Nua
Lampang	-	0.57	0.78	0.54	0.60	0.03	0.16
Mae Tha	-	-	0.23	0.47	0.38	0.19	0.22
Ko Kha	-	-	-	0.29	0.48	0.46	0.10
Sop Prap	-	-	-	-	0.70	-0.27	0.37
Hang Chat	-	-	-	-	-	0.20	0.21
Chae Hom	-	-	-	-	-	-	0.03

Monthly River Discharge (W1, W1A)

Unit: MCM

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1952	***	***	***	***	***	***	***	110.6	389.4	93.3	60.2	49.9	***
53	27.9	21.9	14.0	14.5	50.7	37.3	23.8	91.8	270.9	102.0	59.7	33.1	747.8
54	13.1	8.0	8.9	***	***	40.1	5.5	75.2	125.8	191.9	38.5	25.3	***
55	10.3	4.5	4.1	1.4	1.3	24.3	4.5	273.5	303.8	78.0	10.0	5.0	720.8
56	2.0	1.7	1.1	6.8	58.8	22.8	77.6	231.9	279.8	47.7	22.8	8.2	761.1
57	3.1	2.6	1.9	4.2	9.0	39.6	3.9	63.8	198.7	120.9	19.7	5.9	473.3
58	4.3	2.0	1.0	1.8	5.0	9.1	12.6	48.6	86.8	54.8	12.1	3.9	242.1
59	1.6	1.3	0.1	0.4	43.3	15.7	36.2	94.5	231.8	54.3	12.3	7.2	498.7
1960	3.2	3.8	1.0	0.3	4.7	7.5	48.3	130.2	218.4	156.9	36.3	42.5	653.1
61	9.2	1.9	0.8	2.7	51.3	66.0	16.9	222.8	360.2	221.6	65.4	28.3	1,047.0
62	12.2	6.6	6.6	3.1	15.4	4.4	10.1	55.3	98.8	211.6	27.4	10.8	462.4
63	4.8	2.8	2.9	3.0	2.4	26.3	30.4	192.1	121.1	225.6	157.5	29.3	798.2
64	7.2	3.6	3.1	2.4	16.9	15.2	36.6	15.8	198.9	239.7	52.1	20.1	611.6
65	5.9	3.0	2.9	2.1	4.7	10.2	2.8	56.1	91.5	103.7	55.6	12.8	351.1
66	2.9	1.9	1.6	0.8	25.7	16.4	5.3	90.7	154.4	30.5	18.0	6.8	355.0
67	2.0	1.6	1.4	2.2	11.2	7.0	3.7	24.6	295.7	87.5	21.9	11.3	470.4
68	1.4	0.0	0.4	4.0	13.6	25.9	9.7	58.6	88.9	56.0	16.4	7.3	282.3
69	1.3	0.2	0.0	0.8	5.9	31.4	9.1	111.4	63.3	64.0	22.1	5.2	314.8
1970	0.8	0.3	0.0	4.7	68.4	154.7	80.4	358.0	257.1	91.4	43.0	44.4	1,103.5
71	11.2	3.8	2.1	1.6	11.7	8.1	102.4	300.1	237.2	188.2	48.3	17.8	932.3
72	8.7	2.5	1.9	11.7	3.1	2.0	1.5	52.3	132.5	120.8	73.1	38.3	448.4
73	9.9	7.1	8.9	23.5	20.8	9.4	85.4	483.2	430.2	153.9	40.6	25.7	1,298.6
74	12.6	2.3	6.4	13.7	39.5	44.9	41.8	163.4	131.5	16.8	112.7	11.6	597.2
75	46.5	4.6	5.3	9.0	7.6	40.7	41.6	208.8	223.1	127.9	49.6	26.2	790.9
76	10.6	5.0	7.3	10.2	10.7	12.5	13.7	86.7	79.9	15.3	79.6	21.4	303.0
77	21.7	7.1	8.7	10.0	16.3	15.1	16.8	41.3	174.8	122.5	60.5	43.7	538.4
78	17.3	14.1	12.7	15.5	23.0	18.7	133.3	164.7	139.9	96.7	27.1	11.2	674.2
Mean	9.7	4.4	4.1	6.0	20.8	27.1	32.8	139.1	199.4	113.8	46.0	20.5	619.0

Note: The data of 1952 to 1966 indicate at W1 Station. The data of 1967 to 1978 indicate at W1A Station.

Monthly River Discharge (W10, W10A)

Unit: MCM

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1962	***	***	***	6.6	20.8	8.5	17.1	59.0	89.7	193.4	31.7	18.2	***
63	11.9	8.2	7.3	3.5	2.3	18.4	36.6	152.7	100.1	206.6	136.9	32.2	716.6
64	18.8	11.2	8.8	8.0	23.7	23.3	53.1	26.4	176.3	205.5	57.7	30.9	643.5
65	21.0	14.4	11.7	5.9	8.9	18.2	7.7	54.7	91.3	118.0	50.4	18.5	420.7
66	9.6	5.7	3.8	2.2	40.2	22.1	13.9	94.5	150.8	46.3	29.8	15.3	434.2
67	9.0	4.6	3.3	4.1	16.0	12.7	10.3	42.1	262.2	92.4	28.6	12.2	497.6
68	8.1	5.4	4.7	9.9	20.2	29.9	20.0	67.7	91.9	54.3	21.2	16.4	349.7
69	7.9	4.5	2.7	2.9	12.6	34.3	22.5	107.7	51.8	55.1	28.9	16.1	347.0
1970	10.3	5.8	4.1	9.2	60.6	110.1	74.0	266.6	187.1	67.3	38.9	42.1	876.1
71	19.1	9.8	8.5	8.8	19.6	15.0	93.5	240.3	191.6	153.2	45.4	22.9	827.8
72	19.1	10.0	8.3	17.5	9.9	9.7	8.4	120.1	106.4	86.0	64.0	23.1	482.5
73	7.5	10.3	16.9	12.1	28.8	49.2	110.6	486.6	452.2	206.0	77.4	42.0	1,499.6
74	25.9	23.5	23.3	22.5	44.9	47.5	51.6	131.9	137.6	64.9	122.2	34.1	729.9
75	61.2	24.8	26.0	21.1	24.3	74.9	91.9	389.1	335.2	198.8	79.7	42.9	1,369.9
76	29.5	26.1	15.6	12.5	23.5	19.9	17.6	52.3	136.9	139.5	84.2	31.7	589.3
77	35.3	13.5	15.1	15.3	40.9	10.1	27.4	62.2	166.2	170.2	72.1	40.4	668.8
78	21.4	16.5	12.5	16.2	34.0	20.9	159.3	165.8	131.7	83.8	36.7	17.7	716.5
Mean	19.7	12.1	10.8	10.5	25.4	30.9	48.0	148.2	168.2	126.0	59.2	26.9	698.1

Note: 1962 - Nov. in 1967 indicate at W10, Dec. in 1967 - Jul. in 1972 indicate at W10A
Aug. in 1972 - 1978 are estimated from outflow of Dam

Monthly River Discharge (W16)

Unit: MCM

1971	***	***	***	***	***	6.4	33.7	147.2	79.9	61.0	16.4	9.5	***
72	5.4	2.8	2.1	4.5	3.0	6.2	1.7	51.8	43.6	36.6	28.2	11.7	197.6
73	5.1	2.2	2.8	1.5	6.5	11.1	29.0	227.6	164.0	60.5	21.5	11.4	543.3
74	6.8	3.9	3.4	3.1	9.7	11.9	13.3	55.9	64.1	26.6	43.5	9.5	251.9
75	15.4	3.8	3.4	3.7	3.5	20.1	27.1	147.2	146.9	83.5	27.4	14.7	496.7
76	6.2	3.8	2.5	2.2	6.3	8.0	5.4	20.5	61.5	60.6	33.3	9.3	219.5
77	10.6	2.6	2.1	4.7	15.4	2.9	9.8	25.0	63.2	72.3	23.0	9.2	240.5
Mean	8.3	3.2	2.7	3.3	7.4	9.5	17.1	96.5	89.0	57.3	27.6	10.8	324.9

Monthly River Discharge (W5A)

Unit: MCM

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1963	***	***	***	***	***	7.1	47.9	314.3	230.8	350.6	284.9	72.8	***
64	41.1	39.5	21.3	11.8	42.3	33.2	91.0	41.6	371.7	413.8	93.9	47.9	1,249.2
65	30.7	32.7	40.4	20.8	18.8	20.7	10.0	89.9	150.5	154.4	106.1	42.7	717.8
66	44.4	43.7	20.9	5.4	62.2	56.4	19.3	196.5	316.0	68.3	52.9	21.8	907.9
67	35.9	25.9	26.2	10.0	23.1	13.8	7.3	38.0	482.0	112.8	25.8	17.8	818.6
68	22.2	27.8	4.1	9.2	21.2	32.3	15.1	59.1	80.2	64.8	23.7	16.1	375.8
69	17.6	8.3	14.8	2.9	7.8	42.4	26.4	153.5	181.4	129.9	53.0	20.3	658.3
1970	7.1	13.0	8.1	12.8	105.7	255.7	121.0	710.2	532.2	166.2	49.9	56.3	2,038.4
71	20.8	8.8	10.2	7.1	27.3	15.8	183.8	536.0	368.5	306.5	58.8	25.5	1,569.1
72	18.5	10.5	12.5	20.7	5.8	5.1	2.0	73.2	130.1	139.4	96.6	40.2	554.5
73	13.1	11.9	13.1	25.5	23.3	14.5	117.7	619.0	709.9	***	52.4	18.4	***
74	4.7	2.2	2.9	15.2	58.6	54.0	49.5	205.5	285.6	***	***	***	***
Mean	23.3	20.4	15.9	12.9	36.0	45.9	57.6	253.1	319.9	190.7	81.6	34.5	987.7

Monthly River Discharge (W15)

Unit: MCM

1969	***	***	***	1.1	6.2	***	***	***	***	***	5.5	2.1	***
70	1.4	1.1	0.8	0.8	10.3	39.6	22.3	102.2	93.1	24.5	6.5	4.6	307.1
71	1.6	0.9	0.5	0.1	5.1	6.6	33.1	79.1	47.9	78.3	4.9	2.5	260.6
72	1.5	0.8	0.6	3.3	1.5	3.1	2.3	47.8	16.3	40.4	7.2	2.8	127.6
73	1.5	1.0	0.9	0.6	3.9	9.7	11.0	62.9	114.7	52.0	8.3	3.6	270.3
74	2.2	1.6	1.5	5.5	9.8	11.5	4.8	68.1	56.5	13.8	41.3	2.8	219.2
75	2.2	0.5	0.2	0.1	0.4	1.1	24.7	60.6	91.8	47.6	5.4	0.1	234.7
76	0.5	0.3	0.1	0.0	0.5	2.1	7.4	23.5	41.9	22.6	5.5	0.4	104.9
77	0.3	0.0	0.0	0.0	0.6	0.5	0.0	3.6	89.4	27.1	4.0	0.4	126.0
78	0.0	0.0	0.0	***	***	***	***	***	***	***	***	***	***
Mean	1.2	0.7	0.5	1.3	4.3	9.3	13.2	56.0	68.9	38.3	9.9	2.2	206.3

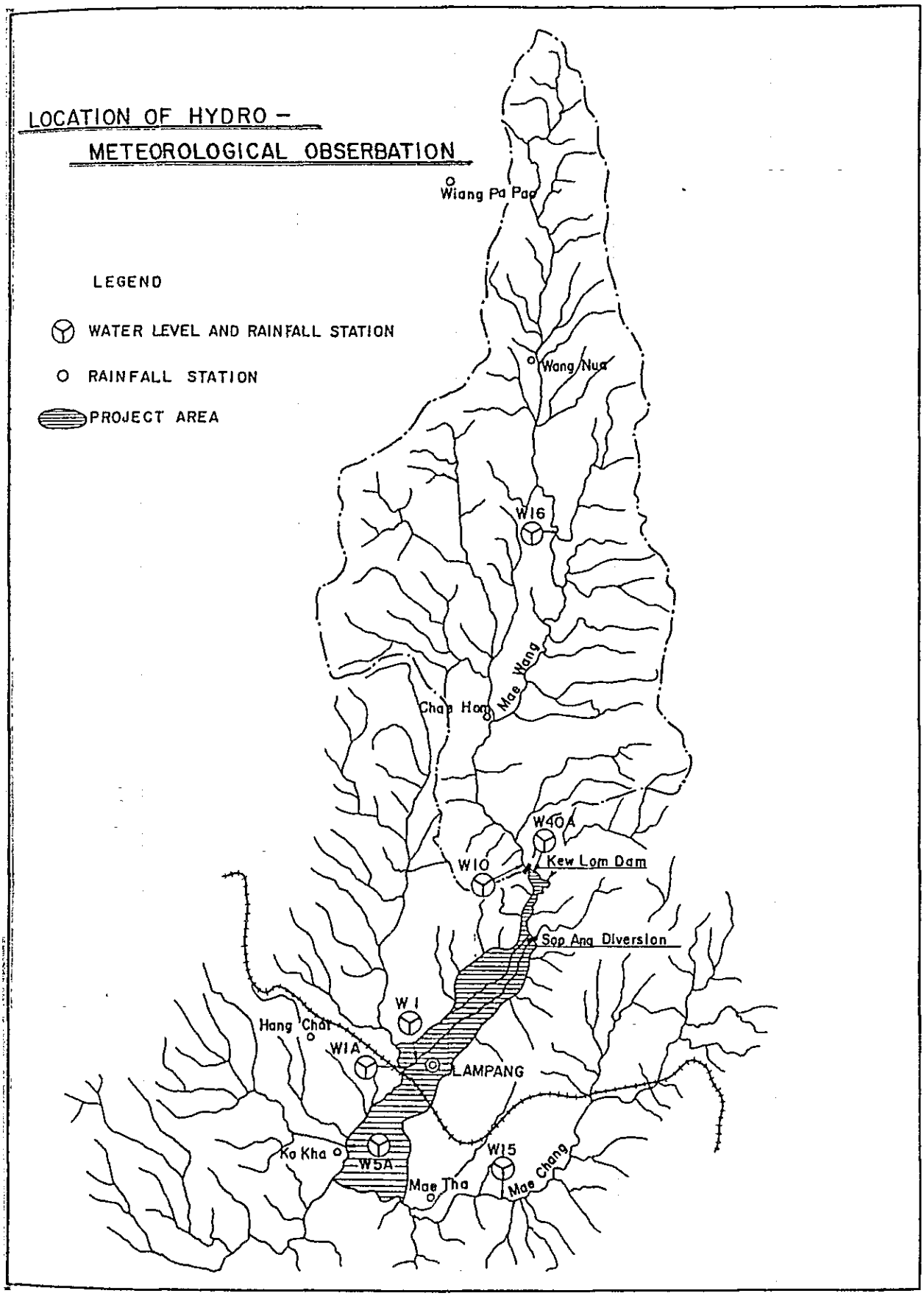
ANNEX 1-1
Table 1-1-12

Monthly Diversion Water at Sop Ang

Unit: MCM

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1968	-	-	-	8.4	15.3	16.4	20.7	26.3	26.9	30.8	18.5	10.8	-
69	9.5	5.1	3.1	3.9	6.0	19.0	25.5	26.8	22.6	24.9	14.5	12.4	173.3
1970	11.2	5.8	4.5	5.5	2.1	15.0	24.4	8.6	20.5	21.1	16.9	6.4	142.0
71	11.8	9.0	8.8	10.0	11.1	16.1	24.4	23.2	18.0	21.5	20.6	9.2	183.7
72	15.6	12.7	13.3	12.6	9.7	13.1	30.8	23.1	27.0	29.2	18.0	7.9	213.0
73	19.3	10.7	13.4	17.7	19.2	14.2	21.4	25.6	9.6	19.5	11.0	9.5	191.1
74	10.5	15.9	15.9	15.6	15.2	18.7	22.1	21.1	18.1	20.0	17.6	6.9	197.6
75	4.5	10.6	12.6	10.4	13.3	18.0	22.1	22.7	12.8	16.2	7.1	4.0	154.3
76	18.6	14.8	15.0	11.7	11.8	17.9	18.9	19.7	14.9	17.4	12.5	12.0	185.2
77	14.1	10.8	10.8	10.1	11.5	15.2	21.8	19.6	10.0	25.2	17.9	8.8	175.8
78	13.5	14.7	14.3	15.1	9.8	18.1	18.3	20.2	18.7	22.3	14.3	14.0	193.3
79	19.5	13.4	14.6	13.2	6.2	12.0	-	-	-	-	-	-	-
Mean	13.5	11.2	11.5	11.1	11.7	16.1	22.8	22.8	18.1	22.6	15.4	9.3	186.1

Data source: RID Hydrological Section


LOCATION OF HYDRO - METEOROLOGICAL OBSERBATION
LEGEND
WATER LEVEL AND RAINFALL STATION
RAINFALL STATION
PROJECT AREA
Wiang Pa Pao
Wang Nua
W16
Mae Wang
Chae Hom
W40A
W10
Kew Lom Dam
Sop Ang Diversion
W1
Hang Chat
W1A
LAMPANG
Ko Kha
W5A
Mae Tha
W15
Mae Chang

ANNEX 1-2. Soil and Land Classification

Soil and Land Classification

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Soil and Land Classification

1.2.1. Geology and landform

Along the rivercourses of the Wang river flowing in the center of the Lampang basin and its tributaries, the semi-recent terraces and old levees which are composed of the recent and semi-recent alluvium as parent materials are formed and flood plains are found in the upperstream area of the Wang river. The semi-recent terraces develop at the back of the old levees and the terraces or fans, being composed of the old alluvium are formed in the area elevating about 240-250 m adjacent to the semi-recent terraces. The expansion area in the right bank of the Wang river, the downstream area and the Mae Pung area in the southern part of the left bank are occupied by terraces composed of old alluvium. And the soils of the semi-recent alluvium are distributed in the low-lying area within the expansion area (Kew Lom Stage I area). In the most upstream area on the right bank - around the Kew Lom Dam site, the colluvium belong to Lampang Group-Triassic[1/] is distributed, forming the dissected erosion surface and hills (Map 1-2-2).

1.2.2 Characteristics of major soils

The soils of flood plain (650 ha, 7.7 %) are composed of Tha Muang/Sanphaya association. Tha Muang soils are formed from recent alluvium. They have moderately well to well drained fine sandy loam or silty loam. The soil reaction is medium to slightly acid (PH 6.0 - 6.5). Sanphaya soils are formed from river alluvium and occur on slightly lower parts than Tha Muang Series. The soil texture is loam to silt loam in the surface soils and loam to silty clay loam or clay loam in the subsoils. The soil reaction is medium to silghtly acid (PH 6.5 - 5.5), but in some location, PH values are strongly or very strongly acid (PH 5.0 - 4.5) in deeper subsoils. Tha Muang soils are well suited for upland crops while Sanphaya soils are moderately sutied. Tha Muang soils generally not suited for paddy production, while the Sanphaya soils are moderately well

1/ Marine and nonmarine sandstone, shale and limestone folded-Triassic by F.R. Moorman, 1972

suited.

The soils of semi-recent terrace (5,340 ha, 30.3 %) are composed of Mae Sai Series (Low Humic Grey Soil) and Hang Dong Series (Low Humic Grey Soil to Hydromorphic Non Calcie Brown Soil). Mae Sai Series are formed from alluvium and occur on semi-recent terraces. Relief is flat to almost flat and drainage is poor. The soil texture is silty clay loam, clay loam or silt loam in the surface soils and clay to silty clay in the subsoils. The soil reaction in the surface soils ranges from slightly to strongly acid (PH 6.0 - 5.0) becoming almost neutral to alkaline (PH 6.5 - 8.0) in the subsoils.

Hang Dong Series occur on between alluvial plains and terraces. Topography is flat to gently sloping with local areas vary gently undulating. Drainage is somewhat poorly to moderately well drained. The soil textures of the surface soils is loam to clay loam and the subsoils is clay loam. The soil reaction ranges from slightly acid to almost neutral (PH 5.5 - 6.5) in the surface soil and usually increased in the subsoils (PH 6.5 - 8.0). Both of soil series are well suited for paddy production and yields are fairly high.

Kampang Saen Series (Non Calcic Brown Soil) and Si Satchanalai Series are main soils on the old levees (2,160 ha, 12.1 %) Kampaeng Saen soils are formed from semi-recent alluvium. The soil texture is loam or clay loam in the surface soils overlying clay loam subsoils and well drained soil. The soil reaction ranges from slightly to medium acid (PH 6.0 - 6.5) in the surface soils and neutral to alkaline (PH 7.0 - 8.0) in the subsoils. These soils are mainly used for residential areas and upland fields including orchard.

Si Satchanalai soils are developed from alluvium on nearly level to undulating old levees. They are very deep and moderately well drained soil. The soil texture is silt loam or silty caly in the surface soils and silty clay loam to clay in the subsoils. The soil reaction is medium acid to neutral (PH 5.5 - 7.0) in the surface soils becoming slightly acid to mildly alkaline (PH 6.0 - 8.0)

in the subsoils.

The soils on old terraces (8,730 ha, 49.0 %) are composed of about 14 of soil series that are formed from old alluvium and occur each soil series itself or as an association. Main soil series are as follows:

Roi Et Series (Low Humic Grey Soil)

They are very deep, poorly drained loam, sandy loam or loamy sand in the surface soils and sandy clay, loam or clay loam in the subsoils. The soil reaction in the surface soils ranges from medium to slightly acid (PH 6.5 - 5.5) and decreasing very strongly to strong acid (PH 4.5 - 5.5) in the subsoils.

Hang Chat Series (Red Yellow Podzolic Soil)

They are very deep, well drained soil and soil texture is sandy loam in the surface soils and clay loam, clay or sandy clay in the sbusoils. The soil reaction is neutral to medium acid (PH 7.0 - 5.5) in the surface soils and becomes very strongly to strong acid (PH 4.5 - 5.5) in the subsoils. These soil are moderately suited for upland crops and are generally not suited for paddy field because of their high portion.

Mae Rim Series (Red Yellow Podzolic Soil)

They are formed from old gravelly and strong alluvium on dissected old terraces. They are very deep, gravelly, well drained. The soil texture is sandy loam or loamy sand in the surface soils and sandy clay loam, clay loam or sandy clay in the subsoils. The soil reaction ranges from very strongly to medium acid (PH 4.5 - 6.0) in the surface soils and PH value usually decrease with depth. These soil are generally not suited for paddy production.

Satuk Series (Red Yellow Podzolic Soil)

They are deep soils, sandy loam in the surface soils and sandy clay loam or clay loam in the subsoils. The soil reaction is medium to slightly acid (PH 5.5 - 6.5) in the surface soils and becomes very strongly to strongly acid (PH 4.5 - 5.5) in the subsoils. These soils are moderately suited for upland crops and generally not suited for paddy production.

Lampang Series (Low Humic Grey Soil)

They are very deep, poorly drained loam or clay loam surface soils. The subsoils are clay loam, silty clay loam or light clay. The soil reaction is medium to slightly acid (PH 5.5 - 6.5) in the surface soils becoming very strongly or strongly acid (PH 4.5 - 5.5) in the subsoils. They are moderately suitable for paddy production. The characteristics of major soils are illustrated in Table 1-2-1 and Map 1-2-1.

1.2.3. Soils in the sample areas

Soil survey mainly by auger boring observation, was carried out for the selected five (5) areas as the sample areas for land consolidation scheme. (Figure 1-2-1) Intensity of the auger boring observation is one boring per four hectares (at 200 m intervals) and the aerophoto maps at the scale of 1/4,000 and the topo-maps at the scale of 1/10,000 were used as the base map. Furthermore, reference was made to detailed reconnaissance soil map of Changwat Lampang (Land Survey Division, Land Development Department) for the study.

The boring tests were carried out at 275 points in total (Sample area No.1 = 67 points, No.2 = 59, No.3 = 47, No.4 = 48 and No.5 =54). (Refer to Figure 1-2-2) At each boring point, the survey was made on depth, texture, color, color mottles, PH as well as total 550 soil samples were collected from the surface and subsoils for analysis on soil reaction and available phosphorous.

Test pit survay on paddy field could not make during the field survay period because the whole paddy field had been flooded for the cultivation of wet season paddy. Therefore, the test pit survay was made at the representative sites selected from fallow paddy fields and upland fields in every sample area. Totaled 22 soil samples for analysis were collected from 6 test pits and soil analysis was entrusted to the Soil Chemistry and Physics Laboratory. RID.

During the field survey, interview survey was carried out with those farmers cultivating lands where the boring tests were carried out with those farmers cultivating lands where the boring tests were carried out, so that information could be collected on their present cropping patterns, farming practices, yield of crops, water condition, etc. for clarifying the actual status of farm management in the Project area.

The soil series occurring in the respective sample area are summarized as below. They are distributed on the sample areas in the form of soil series itself or an association.

Sample Area	Soil Series and Variant	Parent Materials
No.1	Kampaeng Saen	Semi-recent alluvium
	Si Satchanalai	- " -
	Satuk	Old alluvium
	Mae Rim	- " -
	Hang Chat	- " -
	Korat	- " -
No.2	Hang Dong	Semi-recent alluvium
	Kamphaeng Saen	- " -
	Kew Lom	Old alluvium
	Hang Chat	- " -
	Satuk gravelly variant	- " -

Sample Area	Soil Series and Variant	Parent Materials
No.3	Hang Dong	Semi-recent alluvium
	Korat	Old alluvium
No.4	Mae Sai	Semi-recent alluvium
	Roi Et	Old alluvium
	San Sai	- " -
No.5	San Sai	Old alluvium
	Mae Rim	- " -
	Hang Chat	- " -
	Korat	- " -

The shematic cross section of sample areas are shown in Figure 1-2-3. As shown in Figure 1-2-3, three of sample areas are situated on very gentle slope, except the Sample area No.1 and No.2 having slightly uneven to undulating relief. Figure 1-2-4 shows the relationship of soil texture between the surface and the subsoils.

In general, the soil texture of the surface horizon is moderately fine textured soil in all sample areas, particularly clay loam or sandy clay loam dominate. As a general tendency, moderlately fine textured soils are dominant in the surface soils in the Sample area No.1, No.2 and No.4 locating on the right bank of the Wang river, but the subsoils vary to fine textured soils, particularly clay soils dominate with depth.

On the other hand, the soils in the Sample area No.3 and No.5 on the left bank of the river are characterized by their moderately fine textured soils distributing throughout the horizon.

In Sample area No.4, the surface soils through the subsoils, clay soils are dominant and the Sample area No.1, loam soils are found in the surface soils at about 30 % of the survey points. In general, moderately fine textured soils tend to occur in the lower horizon

than the upper horizon within 50 cm depth from the surface.

In Sample area No.3, No.4 and No.5, however, changing range of the soil texture is small as compared with that in Sample area No.1 and No.2, in other words, the clay soils in Sample area No.4 and the sandy clay loam and clay loam in Sample area No.3 and No.5 are the dominant soil textures at 50 cm below the surface.

In comparing the soil textures at 50 cm below the surface in the double cropping paddy field of the Sample area No.3 with those of Sample area No.5 (Figure 1-2-4), 95 % of the paddy fields surveyed in No.3 and 74 % in No.5 show moderatelycoarse to moderately fine textured soils (sandy loam, loam, clay loam, sandy clay loam and silty clay loam). The occurance of these soil textures in the Sample area No.3 and No.5 seems to be one of the reasons why the double cropping system is prevailed in the above two sample areas in comparison with other three sample areas.

In Sample area No.5, on the other hand, 63 % of the paddy fields used for the single cropping of wet season paddy have textured soils with clay or silt clay, and in Sample area No.3, 81 % of the paddy fields used for the single cropping of wet season paddy have clay loam or sandy loam whithin 50 cm from the surface.

The tendency of the soil textures at 207 boring sites of the paddy fields revealed that 50 % of the total has fine textured soil and 45.9 % has moderately fine textured soil at 50 cm below the surface. From these facts, it appears that the paddy fields in the project area have slow to moderate permeability and also a relatively good water holding capacity. Furthermore, Mn/Fe concretions and mottles occur in solum throughout the sample areas and from their point of view, the downward movement of the percolation water is suggested.

However, when the study is made on each sample area, the soil texture at 50 cm below the surface is sandy loam at boring points

No.15 and 47 in Sample area No.3, and boring points No.31, 32, 40 and 50 in Sample area No.5, and the soils at these boring points are presumed to have moderately rapid or rapid permeability. Besides the above points, the interview survey shows that the soils at the boring points No.6, 7, 13, 21, 23, 24, 36 and 37 in Sample area No.3, and at the boring points No.4, 21 and 42 in Sample area No.5 appear to have a relatively high permeability in due consideration of one or two days water retaining period at these points.

The followings are the summary of the soil textures of surface soils and subsoils in the paddy fields where the different cropping patterns are practiced, respectively.

	Surface Soil Texture	Subsoil Texture
Field used for 2 paddy a year	Moderately fine	fine
Field used for double cropping	Moderately fine	Moderately fine
Field used for wet season paddy	Moderately fine	fine

Since the respective sample areas are situated on the areas of the semi-recent terrace, old levee, old alluvium terrace or located on their transitional areas, there occur the concentrated layers of pisolite, limestone fragments, gravels, etc. in the areas. Pisolite is rounded iron concretions of various size and sometimes clustered pisolitic concretions (a kind of hardended laterite block) of medium to large gravel size are found in the subsoils. The soils having pisolite are more frequent occurred on the old alluvium terrace. The occurrences of these concentrated layers prevented the soil auger from penetrating in some points. The points where the impenetrable layers exist within 100 cm from the surface are found by four points in Sample area No.1, five points in No.2 and one point in No.5. Furthermore, the points with impenetrable layers existing within the depth of 150 cm from the surface are found by six points in Sample area No.1, tenpoints in No.2, three points in No.4 and three points in No.5, respectively.

The major materials of the respective impenetrable layers are gravels in Sample area No.1, limestone fragments in Sample area No.2, pisolite in Sample area No.4, and gravels in Sample area No.5.

It is considered that in Sample area No.1 and No.2 located in the expansion area, the presence of the impenetrable layers in the terraces including its surroundings, indicates distribution of old alluvium (Mae Rim Series) or Colluvium (Takli series).

In the area extending with elevation ranging from 234 to 240 m at the eastern edge of Sample area No.5 (boring point No.20, 21, 31, 32, 41 and 42), the gravel layer with Quartz, Shist, Quarzite, Slate and Sand stone as major materials occur below 25 cm from the surface. The areas with such gravel layers may be unsuitable for land consolidation.

Table 1-2-4 shows the result of PH measurement. The soil reaction varies by every auger boring site. Generally, in terms of surface soil reaction, Sample area No.2, No.3 and No.5 are slightly acid (PH 6.1 - 6.4 in average), Sample area No.1 is medium acid (PH 6.0 in average) and Sample area No.4 has neutral reaction (PH 6.6 in average). While, in terms of reaction of subsoil, Sample area No.3 and No.4 have neutral reaction (PH 6.8 to 7.0 in average), Sample area No.5 is slightly acid (PH 6.4 in average) and Sample area No.1 and No.2 are medium acid (PH 5.9 and 5.8, respectively).

Table 1-2-5 shows number of soils having similar range of soil reaction and this table indicates the status of soil reaction in the surface soils and subsoils, respectively. Figure 1-2-6 shows the number of subsoils having similar PH range for the surface foils or different PH range from the surface soils. As shown in this figure, the number of sites occurring acid soils (< HP 6.5) in both surface and subsoils, are 46 (among 67 sites) in Sample area No.1, 36 (among 59 sites) in No.2, 12 (among 47 sites) in No.3, 11 (among 47 sites) in No.4 and 20 (among 54 sites) in No.5, Among these

sites, both of the surface and subsoils ranged as the strong acid soil (< PH 5.5) are 17 in Sample area No.1 and 12 in No.2, respectively. These strong acid soils are mainly distributed on shrub areas or upland fields located on surrounding the sample areas.

While, soils having neutral and alkaline reaction in both surface and subsoils are 11 in Sample area No.1, 10 in No.2, 18 in No.3 25 in No.4 and 10 in No.5, among these sites, one of No.1, two of No.2, four of No.4 and one of No.5 have alkaline reaction.

From the result of PH measurement, it seems that the acid soils widly distribute on the surface soils of Sample area No.1, No.2 and No.5.

While the surface soils having neutral and alkaline reaction tend to distribute mostly on semi-recent alluvium where Sample area No.3 and No.4 are situated on. On the other hand, acid soil is dominant in the subsoils of Sample area No.1 and No.2, while Sample area No.3, No.4 and No.5 are abundant in the neutral and alkaline soils.

Alkaline soils above PH 7.4 are found at limited parts in Sample area No.2, No.3 and No.4 and in these parts the possibility of occurrence of iron, manganese and zinc deficiency are will be expected.

Result of analysis on available phophorus in the soils are as shown in Table 1-2-4. Table 1-2-5 shows number of sites having similar raiting of available phosphorus and number of subsoils having similar or diferrent raiting of available phosphorus in the surface soils are shown in Figure 1-2-7.

10 ppm of available phosphorus in the soils is suggested as moderately at low content in Thailand[3/]. The soils having below 10 ppm occur at 23 in Sample area No.1, 38 in No.2, 16 in No.3, 11 in No.4 and 15 in No.5. While, the soils having above 10 ppm through

3/ refer to Reference No.2

the surface and subsoils are 19 in Sample area No.1, 10 in No.2, 22 in No.3, 18 in No.4, 21 in No.5, and remaining sites have either the surface or subsoils occurring below 10 ppm. The available phosphorus in soils between 15 to 50 cm below the surface which is considered as less influences soils from the applied phosphorus fertilizers are below 10 ppm in average throughout the sample areas.

The surface soils having above 15 ppm occur at 25 in Sample area No.1, 13 in No.2, 11 in No.3, 12 in No.4, 23 in No.5. Among these sites, particularly sites having above 45 ppm are found six in Sample area No.1. and No.2. three in No.3. four in No.4 and five in No.5. These sites having high value occur at a limited sites and the highest value of each areas are as follows;

Sample area

No.1-14 (WP[4/] + garlic field)	:	274 ppm (surface soil)/386 ppm (subsoil)
No.2-9 (WP. + DP[5/])	:	131 ppm/106 ppm
No.3-33 (orchard)	:	1,336 ppm/157 ppm
No.4-44 (residential area)	:	946 ppm/409 ppm
No.5-4 (WP. + Tobacco)	:	66 ppm/19 ppm

Generally, orchard, upland field and paddy field used for two paddy a year have high value than other fields.

From the result mentioned above, it is hardly to difinit as the soils which are rich in available phosphorus, although there are some higher value sites in at limited parts. In general, the soils having relatively high available phosphorus tend to occur on Sample area No.3, 4 and 5 than other two areas.

The quantities of available phosphorus in the paddy fields with various cropping patterns prevailed in Sample area No.5 where double cropping system on the paddy field is prevailed than other sample areas are as follows;

4/ WP: wet season paddy

5/ DP: dry season paddy

	Surface soil (ppm)	Subsoil (ppm)
Wet season paddy field	8.2	9.8
Wet season paddy + Dry season Tobacco	21.9	12.3
Wet season paddy + Dry season Tobacco + Vegetables	20.4	9.6
Wet season paddy + Garlic	10.5	7.9

As shown above, the paddy fields with the dry season upland crops have higher available phosphorus value than that of the wet season paddy fields and the paddy fields with the dry season tobacco have high value in particular. This fact appears due to influences from heavy applied phosphorus fertilizers to tobacco.

Diagramatic representations of the soil profiles are shown in Figure 1-2-8, The patterns and distribution of mottles suggest that there have been a downward movement of water in every pit. The surface soils, in general, are dark brown or brown sandy loam, loam, silty clay loam, and light brown, grayish brown, dark reddish brown, light yellowish brown and grayish brown clay loam, sandy clay loam and clay are dominant in the subsoils. Main mottling color are yellowish brown, strong brown, brownish yellow and yellowish red.

As mentioned above, medium and moderately fine textured soils dominate in every test pit, however, clay particles increase with depth as shown in Fig. 1-2-9. While proportion of sand and silt particles in the soils of Sample area No.3 are greater than that of other.

Many limestone fragments were found at below 55 cm from the surface in the test pit No.2-1 (4-6 cm in diameter), this occurrence may due to Takhli series originated from limestone. At the test pit No.5-1, ϕ 1-3 cm gravels at 0-8 cm depth and ϕ 5-6 cm gravels at 8-16 cm depth are found, and become to gravel layer from 16 cm depth.

These gravles are mainly composed of Quartz shist, Ouartzite, Slate, Sanstone and Argillicous quartzite. The results of soil analysis are shown in Table 1-2-6 and summary of result is as follows; the soil reaction of surface soils are slightly to medium acid except in test pit No.2-32 having mildly alkaline reaction, however, the reaction of subsoils are neutral in test pit No.4-1, mildly alkaline in No.2-32 and No.3-1, and strong acid in No.1-1.

Electric conductivity (EC) values of the subsoils are higher than the surface soils except in test pit No.3-1, however, almost of those values are below 1m mhos/cm. EC values of 1.0 to 7.5 m mhos/cm are found at the depth of below 25 cm in test pit No.3-1 and these high EC values may due to sodium ion. Cation exchange capacity (CEO) are increase with depth, however, they have medium or moderately high CEC value which is below 20 meq/100g excepting that test pit No.4-1 has high values between 24 to 43 m mhos/cm through the profile and soil of 0 to 65 cm in test pit No.3-1 have low CEC values (7.7-8.9 meq/100g). Main composition of exchangeable cation are magnesium and calcium, however, soils below 25 cm from the surface in test pit No.3-1 have extraordinary high exchangeable sodium and exchangeable sodium percentage are also high as 22 to 36 percent. And also these horizons have cation exchange capacity of 5.4 to 7.5 meq/100g. From these chemical characteristics, these soils appear to be saline-alkali-soil by the classification of US. Salinity Laboratory[6/]. Further study on this origin of this soils will be necessary in the future.

Base saturation percentage is medium value as 45 to 71 % except for test pit No.2-32 and No.3-1. The content of organic matter is moderately low value as 1.1 to 3.1 % except 4.3% in the surface soil of No.2-32, especially the subsoils are poor in organic matter less than 1 %. And also these soils have low value of nitrogen and exchangeable potasium.

Available phosphorus of most soils are less than 9.2 ppm except for 10 ppm in 15-80 cm horizon of test pit No.2-32, 20 ppm in 0-10 cm horizon of NO.2-1, and 14 ppm in 0-8 cm horizon of No.5-1.

6/ refer to Reference No.5

From the result of evaluation on chemical characteristics, these soils seem to be moderately fertile soils.

Following present the summary of the results of the above surveys and studies.

In sample area No.1 and No.2, topographically these exist the landscape with slightly higher parts and isolated mounds; moreover, in terms of soils, the occurrences of gravels, limestone fragments and pisolite layers are confirmed around 100 cm below the surface. Therefore, a careful study on these matters should be required for implementing the land consolidation in these areas.

In Sample area No.5, since gravel soils are distributed under shallow surface soils at the eastern corner of the area, further detailed survey on the matter should be carried out before implementing the land consolidation works.

The effective depth of soils are, in general, deep thoughout the sample areas, and replacement of surface soils in land levelling will not be necessary in terms of civil works, In most cases of land levelling, however, the surface soils are taken away and the subsoils less fertile than the surface soils are newly provided for cropping. Therefore, the present production level can hardly be maintained in these areas with new top soils for two or three years, unless much more organic matters as well as fertilizers are applied to increase the soil fertility.

According to the results of interview survey, the paddy fields in Sample area No.2, No.4 and those located along the northern boundary of the Sample area No.5 are found wet even in harvesting time of November and December. Since these wet paddy fields even in the dry season appear to result from poor drainage in the areas concerned, it is considered necessary to provide adequate drainage facilities in the areas in future.

1.2.4. Land classification

The RID conducted the land classification for the Mae Wang Basin of about 88,000 ha (550,000 rai) including the MK-IADP area in 1972, and the results were published in the report.

Reviewing of the relevant data and report in the course of this study revealed that about 900 ha of the area were left unsurveyed around the expansion area. Consequently, a supplemental survey was made during the field survey to cover the said unsurveyed area, and the land classification map was compiled for the MK-IADP.

The land classification classes employed by RID can be summarized as follows;

Class U1	:	Land best suitable for upland irrigation crops
Class U2	:	Land less suitable for upland irrigation crops with one or more limitation in the soil, topography or drainage characteristics
Class U3	:	Land of distinctly restricted suitability for upland crops because of extreme limitations in the soils, topography or drainage characteristics
Class U2/R2	:	Land suitable for either upland crops or rice production with some limitation
Class R1	:	Land best suited for rice production
Class R2	:	Land adopted for rice production but with one or more limitations
Class R3	:	Land distinctly restricted for rice production because of exterme limitations
Class 6	:	Lands unsuitable for the production of crops

Land classification classified above are groups of soils made only according to degree of hazard or limitation and give no indication of kind of limitation. For this purpose the soils within each class are grouped according to kinds of dominant limitations for irrigated agriculture. The kinds of limitation which present in the study area and symbols are as follows.

s = Soil limitation in the root zone
t = Topographic limitation
d = Impeded drainage

Carrying out the semi-detailed land classification for the Mae Wang Project, the RID has prepared the specifications as shown in Table 1-2-7. Furthermore, the classes and sub-classes have been grouped into as follows.

Land Class & Sub-class

U1	U1/R3s,	U2t/R3st,	U1/R2s,	U2t/R2st
U2	U2s/R2s,	U2st/R3st		
U3	U3s/R3s,	U3st/R3st,	U3s/R6s,	U3st/R6st
U2/R2	U2s/R2s,	U2st/R2st		
R1	U3sd/R1, U2sd/R1,	U3st/R2t, U2s/R1,	U2st/R2t, U3st/R2st	
R2	U3s/R2s,	U3st/R2st,	U6s/R2s,	U6st/R2st
R3	U6s/R3s,	U6st/R3st		
U6/R6	U6s/R6s,	U6st/R6st		

The land class-groupwise acreages for 22,700 ha in the MK-IADP area are shown in Table 1-2-8.

In terms of land class group, the lands classified as upland fields (U1-3 group) total 3,120 ha, occupying 13.7 % of the total acreage, the lands classified as paddy field total 8,400 ha, occupying 37.0 % of the same and the land classified as U2/R2 (land suitable for either upland crops or paddy production) total 4,040 ha, occupying 17.8 % of the total acreage of the area. On the other hand,

according to the data on present situation of land use, acreage of paddy fields totaled in 12,300 ha and upland fields are 2,250 ha. In comparison with the acreage of lands classified as paddy field group, it appears that most parts of the lands classified as U2/R2 group are used as paddy fields.

Out of 6,773 ha of the present arable lands in the zones No.3 to No.7, 6,324 ha, about 93.3 % of the above, have been used for paddy production, while the lands classified as paddy fields in the relevant zones total 4,399 ha. The difference of 1,925 ha between the two is presumed to include those lands converted to paddy fields from the lands providing good condition for water use, being selected among the lands in U2/R2 group which occupied 24.4 % (1,650 ha) of the total arable land of the said area and those lands classified as upland field of 724 ha. Under the circumstances, further reclamation of paddy fields will not be expected in the said area.

On the other hand, in the zone No.12 there are 1,353 ha of lands classified as paddy fields, while the existing paddy fields are 1,351 ha in total, and furthermore, there are the lands of 2,519 ha in U1-U3 group and U2/R2 group, while the existing upland fields are 1,590 ha in total. Therefore, the zone No.12 is considered to have a room enough to develop the lands in U2/R2 group into the paddy fields in future.

REFERENCES

1) Report of on land classification of Mae Wang Project. LCPR LCR. 18 RID. 1972

2) Soil Interpretation Handbook for Thailand. Soil Survey Division. Department of Land Development. MOAC.

3) Soil Survey Handbood for Thailand. Soil Survey Divesion. Department of Land Development. MOAC.

4) Key to Soil Series of Thailand. Soil Survey Division. Department of Land Development. MOAC.

5) Diagnosis and Improvement of Saline and Alkali Soils. USDA. Handbook. 60

6) The Soil of The Kingdom of Thailand, Explanatory Text of The General Soil Map. F.R. Moormann & S. Rojanasoonthon. Report SSR-72A. 1972

7) Geology of Thailand. Department of Mineral Resources. Thailand 1969

Acreage of Mapping Unit in The Project Area

RECENT ALLUVIUM FLOOD PLAIN	650	(3.7%)
2 Tha Muang	99	
3 Alluvial soil, poorly drained	96	
5 Tha Muang/Sanphaya Assn.	445	
SEMI RECENT ALLUVIUM-SEMI RECENT TERRACES	5,340	(30.3%)
6 Mae Sai	2,774	
7 Hang Dong	1,292	
9 Phan	84	
12 Lap Lae	159	
14 Mai Sai/Hang Dong	1,031	
SEMI RECENT ALLUVIUM-OLD LEVEE	2,160	(12.1%)
21 Kamphaeng Saen	1,188	
23 Si Satchanalai	128	
25 Kamphaeng Saen/Si Satchanalai Assn	844	
COMBINED UNIT OF RECENT, SEMI RECENT AND OLD ALLUVIUM	480	(2.7%)
28 Si Satchanalai/Mae Tha Assn.	480	
OLD ALLUVIUM-OLD ALLUVIUM TERRACE AND FANS	8,730	(49.0%)
32 Lampang	570	
33 Lampang, basic variant	164	
35 Roi Et	630	
36 San Sai	982	
37 Tha Tum	55	
38 On	32	
39 Mae Tha	702	
40 Roi Et/San Sai Assn.	303	
42 Lampang/Lampang, basic variant, Assn.	206	
48 Korat	189	
50 Satuk	55	
51 Hang Chat	206	
52 Kue Lom	242	
55 Mae Rim	116	
61 Hang Chat/Satuk, gravelly variant, Assn.	521	
62 Kue Lom/Hang Chat Assn.	122	
65 Hang Chat/Satuk/San Patong Assn.	48	
66 Mae Rim/Hang Chat/Satuk Assn.	217	
68 Mae Rim/Hang Chat/Korat Assn.	2,615	
69 Mae Rim/Korat/Satuk Assn.	194	
72 Mae Taeng/Hang Chat/Satuk Assn.	34	
75 Hang Chat/Satuk/Korat Assn.	527	
COLLUVIUM	440	(2.5%)
82 Bang Chong/Muak Lek/Li Assn.	405	
98 Takli	35	
Total	17,800 ha.	1)

Note: 1) excluding residential area of 4,000 ha and others of 900 ha in the whole project area of 22,700 ha.

Data Source: Detailed Reconnaissance Soil Map of Lampang Province.
Soil Survey Division, Department of Land Development. MOAC

Land Use of Boring Test Sites

	Sample Area No.				
	No.1	No.2	No.3	No.4	No.5
PADDY FIELD					
1) Wet season paddy	1	10	21	33	8
2) Two paddy a year	42	13	1	-	-
3) Double cropping	8	2	20	2	38
4) One paddy & two upland crops	-	-	-	-	8
UPLAND FIELD	8	6	-	-	-
ORCHARD	-	5	-	3	-
SHRUB	8	12	3	4	-
SHRUB mixed with small paddy field	-	1	-	-	-
SHRUB mixed with small upland field	-	5	-	-	-
WASTE LAND	-	-	-	1	-
VILLAGE & RESIDENTIAL AREA	-	5	2	5	-
Number of boring by area	67	59	47	48	54
Total of boring					275

Fluctuation of Soil Texture by the Depth

Sample Area		LS	SL	L	SiL	CL	ScL	SicL	SC	SiC	C	Impene-trable	No. of boring
No.1	Surface soil	0	5	20	0	22	6	4	1	0	9	0	67
	at 50cm depth	0	0	0	0	16	15	1	1	0	34	0	
	100cm depth	0	0	0	0	7	6	0	4	0	46	4	
	150cm depth	0	0	0	0	2	3	0	11	0	45	6	
No.2	surface soil	0	7	2	0	30	6	4	0	3	7	0	59
	at 50cm depth	0	0	0	0	7	4	0	2	4	42	0	
	100cm depth	0	0	0	0	1	0	1	7	1	44	5	
	150cm depth	0	0	0	0	0	0	1	5	2	41	10	
No.3	surface soil	0	9	3	0	21	13	0	0	0	1	0	47
	at 50cm depth	0	6	0	0	13	23	0	0	0	5	0	
	100cm depth	0	4	0	0	7	20	0	3	0	3	0	
	150cm depth	0	3	0	0	3	19	0	11	0	11	0	
No.4	surface soil	0	8	0	0	9	2	0	0	7	22	0	48
	at 50cm depth	0	3	0	0	2	5	0	1	0	37	0	
	100cm depth	1	1	0	0	0	3	0	5	0	38	0	
	150cm depth	0	1	0	0	0	3	0	7	0	34	3	
No.5	surface soil	0	9	2	0	7	27	0	4	3	2	0	54
	at 50cm depth	0	3	1	0	4	29	0	11	0	6	0	
	100cm depth	0	3	0	0	7	17	0	21	0	5	1	
	150cm depth	0	1	0	0	0	5	0	39	0	6	3	

Result of Analysis of PH and Available Phosphrus

No.	pH I	pH II	P ppm I	P ppm II
Sample Area No. 1				
1.	5.7	6.3	147	36
2.	6.3	5.8	37	7.5
3.	5.2	5.1	8.4	10
4.	6.0	5.7	4.7	2.1
5.	6.4	6.6	8.2	3.7
6.	4.6	4.5	9.2	7.6
7.	6.7	6.8	52	18
8.	6.3	6.5	25	12
9.	5.5	4.8	5.5	2.9
10.	5.4	4.8	2.8	3.0
11.	6.2	6.3	5.0	4.8
13.	5.9	5.9	10	4.9
14.	6.6	6.9	274	386
15.	6.4	6.3	21	7.5
16.	6.3	6.5	26	6.6
17.	6.0	6.1	13	4.0
18.	6.7	6.5	29	16
19.	5.5	5.6	35	39
21.	5.9	5.7	8.8	6.3
22.	6.6	6.5	31	19
23.	6.5	6.6	27	5.5
24.	6.4	6.7	17	4.7
25.	6.9	6.9	13	15
26.	6.4	5.6	12	2.1
27.	6.0	6.8	6.7	3.4
28.	5.0	4.9	2.4	3.7
30.	6.4	5.5	6.5	2.0
31.	6.6	6.7	74	12
32.	7.0	6.5	19	5.6
33.	6.2	6.4	10	7.6
34.	6.6	6.8	11	3.5
35.	6.4	6.5	4.9	3.6
36.	6.0	5.8	14	2.8
37.	5.5	5.3	8.3	9.3
38.	4.7	4.6	10	6.6
39.	6.3	5.8	56	27
40.	7.0	7.3	7.3	12
41.	6.9	6.9	15	4.7
42.	6.3	5.9	12	6.5
43.	5.5	5.0	2.9	3.2
44.	6.0	6.2	6.3	3.8
45.	6.7	6.7	35	14
46.	6.6	7.0	31	9.0
47.	6.2	6.7	10	5.6
48.	6.3	6.0	3.1	2.1
49.	6.1	5.4	12	6.5
50.	7.5	7.2	15	3.1
51.	6.5	6.5	17	5.5
52.	6.5	6.5	46	40
53.	6.8	7.2	16	2.0
54.	6.4	5.6	5.9	4.0
55.	6.2	5.8	5.8	2.8
56.	5.4	5.9	5.2	3.9
57.	5.3	4.9	5.4	5.4
58.	5.1	4.7	16	14
59.	5.2	4.8	7.4	13
60.	4.8	4.8	4.6	5.5
61.	5.7	5.2	6.4	5.4
62.	5.5	5.1	11	15
63.	6.5	6.2	30	10
64.	5.4	6.6	2.7	2.1
65.	5.5	5.1	23	10
66.	5.5	5.0	3.5	11
67.	4.4	4.4	14	11
68.	4.9	4.7	3.7	2.7
69.	6.1	6.7	21	11
70.	6.3	5.1	17	12
Sample Area No. 2				
1.	5.9	7.0	4.6	3.8
2.	6.5	7.3	15	11
3.	5.5	4.8	4.9	9.2
4.	7.4	7.2	10	15
5.	6.0	6.1	6.7	4.6
6.	6.6	6.0	11	4.6
7.	6.3	5.7	121	6.6
8.	5.6	5.3	4.0	3.9
9.	7.1	7.2	131	106
10.	5.6	5.0	8.1	4.6
11.	6.2	5.2	4.7	7.4
12.	6.3	5.1	6.3	3.7
13.	7.5	7.3	16	6.4
14.	7.1	6.2	89	5.4
15.	7.2	7.0	127	21
16.	5.8	5.2	5.6	6.0
17.	4.9	5.0	4.9	3.8
18.	6.8	5.9	13	3.7
19.	6.0	5.4	5.5	4.9
20.	5.7	5.0	8.1	4.6
21.	6.3	5.9	9.0	7.7
22.	7.5	7.3	31	14
23.	6.1	5.0	47	4.5
24.	6.4	5.5	6.5	3.6
25.	5.9	5.8	4.9	3.6
26.	5.8	5.2	5.6	8.1
27.	6.5	6.2	16	31
28.	6.3	5.6	14	4.9
29.	6.9	5.3	7.7	8.5
30.	5.8	5.5	4.7	4.7
31.	6.0	5.2	4.1	4.2
32.	7.5	7.7	8.2	6.1
33.	6.8	6.4	15	13
34.	6.7	6.0	5.7	7.5
35.	7.3	7.3	8.6	8.7
36.	5.1	5.1	4.6	2.8
37.	5.1	4.8	7.6	4.7
38.	5.6	5.2	9.3	4.2
39.	6.5	5.7	6.6	4.0
40.	6.4	6.7	6.6	4.7
41.	5.4	4.9	7.7	5.3
42.	5.1	5.0	3.7	4.6
43.	5.0	5.1	9.2	9.4
44.	7.5	7.4	15	17
45.	6.7	6.1	56	24
46.	5.5	5.3	4.7	5.7
47.	5.6	4.7	5.0	3.9
48.	4.9	4.9	4.7	4.6
49.	6.2	7.2	13	12
50.	5.6	5.3	11	4.7
51.	7.3	7.5	15	16
52.	6.3	6.6	23	7.4
53.	6.1	5.5	9.5	9.2
54.	5.5	5.0	5.7	2.3
55.	4.6	4.6	8.4	15
56.	5.0	4.8	4.7	4.1
57.	5.7	4.8	6.5	5.7
58.	6.6	6.3	6.6	9.5
59.	6.2	6.6	18	8.4
Sample Area No. 3				
1.	6.7	7.4	11	10
2.	7.0	7.4	2.5	2.0
3.	7.3	7.8	16	28
4.	7.9	7.8	5.4	3.2
5.	6.6	7.5	1.9	2.7
6.	5.7	6.3	3.1	14
7.	6.8	7.3	23	21
8.	6.4	7.0	613	73
9.	6.6	6.9	11	11
10.	6.7	7.9	7.2	3.7
11.	6.6	6.2	7.5	30
12.	6.7	7.7	6.4	13
13.	6.1	6.8	6.1	3.7
14.	6.5	6.1	10	12
15.	7.1	6.9	17	13
16.	5.9	5.7	1.9	2.7
17.	6.0	6.2	10	13
18.	6.6	6.8	3.2	3.7
19.	8.1	8.4	9.3	8.5
20.	6.9	6.8	4.0	4.7
21.	5.9	6.6	19	10
22.	6.1	6.3	9.5	13
23.	6.9	6.5	9.5	12
24.	6.5	6.8	25	15
25.	6.4	6.7	4.3	2.4
26.	6.4	6.7	13	11
27.	7.4	8.9	2.8	8.3
28.	6.0	6.8	10	11
29.	6.1	5.8	2.4	4.7
30.	6.2	6.2	4.8	4.0
31.	6.5	6.6	12	10
32.	8.0	7.8	1336	157
33.	6.2	6.6	17	13
34.	6.0	6.8	13	8.8
35.	6.6	7.9	12	12
36.	6.6	6.5	12	2.9
37.	5.8	6.5	106	221
38.	6.1	5.3	15	5.9
39.	6.5	6.8	11	11
40.	6.0	6.7	2.6	3.3
41.	6.8	6.7	23	13
42.	5.8	6.2	13	10
43.	5.0	5.0	11	12
44.	6.5	6.6	15	5.6
45.	6.0	6.7	13	12
46.	5.2	5.8	3.7	4.5
47.	5.8	7.7	3.8	3.6
Sample Area No. 4				
2.	6.7	7.0	4.7	3.3
3.	7.0	8.0	9.5	14
4.	6.6	7.2	8.5	9.3
5.	6.7	7.6	16	9.8
6.	6.6	7.7	49	1.9
7.	6.9	7.1	12	10
8.	7.3	7.1	14	28
9.	7.5	7.3	8.1	16
10.	6.6	6.6	11	2.0
11.	7.5	7.0	233	2.5
12.	5.8	6.2	13	10
13.	7.4	7.9	28	16
14.	7.1	7.4	3.8	2.9
15.	6.4	6.3	22	3.1
16.	5.6	7.1	13	3.4
17.	7.1	6.7	15	17
18.	6.7	6.8	15	17
19.	6.0	6.6	2.8	3.8
20.	6.3	6.8	3.5	16
21.	6.1	6.4	34	15
22.	7.4	-	426	-
23.	6.8	7.3	1.9	2.0
24.	6.7	6.7	3.0	3.6
25.	6.8	7.1	11	12
26.	6.7	7.1	2.9	7.6
27.	6.9	6.9	16	14
28.	6.8	7.1	11	13
29.	5.7	6.3	8.6	15
30.	6.0	7.3	3.8	2.7
31.	6.4	6.5	11	2.0
32.	6.2	6.9	16	3.0
33.	6.2	6.9	2.0	2.0
34.	6.6	7.0	3.4	12
35.	6.8	7.4	10	4.8
36.	6.6	7.0	2.1	2.1
37.	4.6	6.7	11	15
38.	6.2	6.3	13	12
39.	6.3	6.5	8.6	12
40.	5.7	6.6	2.0	6.7
41.	6.5	6.9	14	14
42.	6.2	6.2	2.4	2.0
43.	6.5	7.2	10	8.2
44.	6.6	7.3	946	409
45.	5.4	6.0	213	211
46.	7.1	7.2	10	8.1
47.	6.6	6.4	9.6	11
48.	5.6	6.5	21	29
49.	5.6	6.2	31	5.6
Sample Area No. 5				
2.	5.4	5.6	23	13
3.	6.3	7.5	29	8.1
4.	6.8	6.7	66	19
5.	6.9	7.0	3.1	2.4
6.	7.3	6.9	9.3	8.8
7.	6.5	5.7	27	11
8.	6.7	6.6	30	3.7
9.	6.3	5.7	21	8.1
10.	6.3	7.4	61	24
11.	6.1	6.8	9.5	18
12.	6.6	6.8	9.3	16
13.	6.9	6.6	14	15
14.	6.0	6.2	23	7.4
15.	5.6	5.3	3.9	13
16.	6.0	6.6	15	18
17.	6.4	6.7	20	14
18.	6.2	7.0	32	16
19.	6.0	5.5	4.6	7.4
20.	5.4	5.8	14	4.9
21.	5.8	6.7	18	16
22.	6.8	6.8	8.5	9.1
23.	6.7	6.9	9.3	11
24.	6.9	6.5	7.3	7.3
25.	6.7	6.6	11	9.3
26.	5.7	5.7	16	16
27.	7.2	6.3	2.8	8.1
28.	6.0	6.3	13	14
29.	6.5	6.8	11	6.5
30.	6.2	7.2	33	19
31.	5.8	6.7	18	19
32.	5.1	6.4	16	15
33.	6.5	6.6	21	11
34.	5.3	4.9	3.3	2.8
35.	6.0	6.9	7.3	6.6
36.	6.8	6.9	10	7.1
37.	4.7	6.2	14	18
38.	5.9	6.6	9.2	16
39.	6.5	6.6	61	10
40.	5.9	6.9	47	7.5
41.	5.4	5.3	7.3	9.1
42.	6.8	6.5	4.4	4.6
43.	6.3	5.4	14	6.4
44.	6.6	6.3	11	6.4
45.	6.5	7.2	3.3	4.0
46.	5.9	5.8	4.8	6.0
47.	6.0	6.7	23	9.3
48.	6.0	7.0	11	13
49.	6.4	5.9	16	13
50.	6.3	7.5	57	10
51.	5.2	4.9	6.4	7.3
52.	6.6	6.2	7.5	6.5
53.	6.0	5.8	26	23
54.	5.7	6.5	9.3	19
55.	6.2	6.5	9.2	3.1

Remarks: No.: boring site number
pH 1 : 1 soil-water mixture
P ppm. available phosphorus (P ppm) by Bray II Method
I : surface soil (0-15/20 cm.)
II: subsoil (15/20-50 cm.)
The analysis was conducted by Soil Chemistry and

Summary of Measurement of PH and Available Phosphorus

	Sample Area	No.1 Surface soil	No.1 Sub-soil	No.2 Surface soil	No.2 Sub-soil	No.3 Surface soil	No.3 Sub-soil	No.4 Surface soil	No.4 Sub-soil	No.5 Surface soil	No.5 Sub-soil
PH	<4.5	1	1	-	-	-	-	-	-	-	-
	4.5 - 5.0	5	12	5	14	1	1	1	-	1	2
	5.1 - 5.5	14	8	7	14	1	1	1	-	6	4
	5.6 - 6.0	9	13	15	10	11	3	8	1	16	8
	6.1 - 6.5	24	15	15	5	14	9	11	11	16	11
	6.6 - 7.3	13	18	12	13	16	21	23	29	15	26
	7.3 - 7.8	1	-	5	3	1	8	3	4	-	3
	>7.9	-	-	-	-	3	4	-	2	-	-
Avail. P ppm	<3	4	10	-	2	6	5	10	9	2	2
	3 - 6	12	23	20	30	8	12	3	7	5	5
	6 - 10	11	11	20	15	7	3	6	5	14	20
	10 - 15	15	15	6	5	15	21	16	12	10	14
	15 - 25	9	3	7	5	8	1	5	8	12	13
	25 - 45	10	4	-	1	-	2	3	4	6	-
	>45	6	1	6	1	3	3	4	2	5	-
	Number of Samples	67		59		47		48		54	

Data source: Report on Soil Analysis, Mae Wang-Kew Lom Project, Lab. No.51/2522.
Soil Chemistry and Physics Laboratory Research and Laboratory Division RID.

Result of Soil Analysis

Sample Area	Field Site No.	Depth	Particle Size Hydrometer Sand (%)	Silt (%)	Clay (%) <2	Text. Class Lab. Hyd.	pH Water Pasto	pH Water 1:1	pH KCl 1:1	Elect. Cond. ECx10³	Sat. % S.P.	CEC NH4 Ext. meq./100g.	ESP NH4 Ext.	Exchange Cations meq./100g. Na	Ca+Mg	Ca	K	Base Saturation (%)	Org. Mat. % O.M.	Total N (%)	Phosphorus P Sorpt. (ppm.)	Phosphorus P Avail. (Bray II) (ppm.)
Area No.1	(1)	0- 15	48.6	30.8	20.6	L	6.2	6.0	4.9	0.32	29.6	14	<2	0.10	8.8	6.5	0.10	64	1.9	0.12	76	2.6
		15- 39	40.6	28.8	30.6	CL	5.4	5.4	4.0	<0.20	36.2	14	<2	0.10	6.9	5.4	0.10	61	0.85	0.05	148	2.9
		39- 59	37.6	28.0	34.4	CL	5.1	5.2	3.7	<0.20	10.5	16	<2	0.10	7.0	5.3	0.10	56	0.69	0.06	176	2.7
		53-100	33.6	27.0	39.4	CL+	5.3	5.3	3.7	<0.20	46.6	18	<2	0.10	9.3	6.9	0.10	53	0.51	0.05	202	4.5
Area No.2	(32)	0- 11	20.0	45.4	34.6	CL,SICL	7.3	7.5	6.6	0.65	64.2	22	<2	0.38	31	29	0.10	-	4.3	0.19	183	8.2 1/
		11- 15	39.0	35.4	25.6	L+	7.6	7.7	6.7	0.50	42.2	14	<2	<0.10	31	28	0.10	-	2.0	0.13	107	6.1 1/
		15- 80	46.2	25.8	28.0	SCL	7.7	7.9	6.8	0.42	40.4	21	<2	0.40	27	26	0.10	-	1.1	0.07	114	10 1/
	(1)	0- 10	60.4	22.2	17.4	SL+	6.3	6.5	5.5	0.30	25.4	17	<2	<0.10	11	8.1	0.14	66	2.8	0.16	42	20
		10- 25	58.0	20.2	21.8	SCL-	5.8	6.1	5.1	<0.20	31.6	15	<2	<0.10	9.9	7.4	0.10	67	2.0	0.10	74	5.6
		25- 55	49.0	13.2	37.8	SC	6.1	6.1	5.1	<0.20	49.7	19	<2	<0.10	12	9.5	0.10	64	0.96	0.08	142	3.9
		55-100	34.0	13.0	53.0	C	7.6	7.7	6.6	0.25	71.0	31	<2	0.38	50	42	0.10	-	0.66	0.06	135	2.9 1/
Area No.3	(1)	0- 15	48.4	34.2	17.4	L	5.5	5.7	4.1	0.29	24.0	8.9	5.6	0.50	6.2	4.1	0.10	76	1.1	0.07	60	3.7
		15- 25	58.8	29.7	12.0	SL	6.4	7.1	5.1	1.0	19.1	7.7	6.5	0.50	5.8	3.4	0.10	83	0.45	0.04	57	3.7
		25- 65	51.4	32.2	16.4	L	6.9	7.6	6.0	5.4	23.4	7.8	22	1.8	5.8	4.0	0.21	-	0.50	0.03	48	3.7
		65-110	45.2	27.4	26.4	SCL-	7.6	7.9	6.5	1.4*	41.1	15	42	6.3	7.5	4.6	0.14	93	0.21	0.04	29	3.8
		110-180	40.8	25.0	34.2	CL	7.6	8.1	6.6	7.5	50.5	21	36	7.6	7.0	3.9	0.10	70	0.28	0.03	43	3.9
Area No.4	(1)	0- 10	10.4	39.2	50.4	C-	5.6	5.7	4.3	0.42	52.6	24	3.0	0.72	14	10	<0.10	62	2.1	0.16	209	3.8
		10- 22	8.8	38.6	52.6	C-	6.0	6.2	4.8	<0.20	52.2	33	<2	0.48	15	11	<0.10	47	1.8	0.12	179	3.4
		22-100	7.8	29.0	63.2	C	6.2	6.7	4.8	0.42	58.9	43	3.1	1.3	19	12	0.16	48	1.1	0.09	208	2.8
Area No.5	(1)	0- 8	48.8	30.6	20.6	L	5.8	5.5	4.6	0.57	36.1	15	2.7	0.41	8.3	6.5	<0.10	59	3.1	0.21	145	14
		8- 16	53.8	27.0	19.2	SL+	6.3	6.5	5.0	0.36	26.0	14	2.3	0.32	8.0	6.3	<0.10	60	0.64	0.11	119	9.2
		16- 55	2/	2/	2/	2/	2/	2/	2/	2/	2/	17	4.7	0.80	11	8.4	0.22	71	1.0	0.09	89	3.7

NOTE: * Lab. Sample No. 5388 saturation extract dilution ratio 1'9 has EC x 10^3 - 1.4
1/ Lime is found in the sample by qualitative determination
2/ Out of sample to complete determination

Sample Area	Field Site No	Depth	pH Paste	pH 1:1	Sat. % SP.	Elect. Cond. (ECx10^3)	Saturation Extract Soluble Cations Na (meq/ℓ)	Ca+Mg (meq/ℓ)	Ca (meq/ℓ)	K (meq/ℓ)	Soluble Anions CO_3 (meq/ℓ)	HCO_3 (meq/ℓ)	SO_4 (meq/ℓ)	Cl (meq/ℓ)	Sod. Adsorp. Ratio SAR.	C.E.C. (19) (meq/100g)	E.S.P. (20a)	Goluble Salt
Area No.3	(1)	25- 65	6.9	7.6	23.4	5.4	46	8.8	6.0	0.10	0	1.1	54	7.2	22	7.8	22	0.10
		15-110	7.6	7.9	41.1	1.4*	110	23	15	<0.05	0.27	2.0	137	10	32	15	42	0.41
		110-180	7.6	8.1	50.5	7.5	90	4.4	2.7	<0.05	0.45	2.2	79	7.6	61	21	36	0.32

*Lab. Sample No.5388 saturation extract dilution ratio 1:9 has ECx10^3=1.4

DATA SOURCES: Report on soil analysis. Mae Wang-Kew Lom Project.
Soil Chemistry and Physics Laboratory. RID. (Lab. No.51/2522)

Specification for Semi-detailed Land Classification

Classification Characteristics	Upland			Rice-land		
	U-1	U-2	U-3	R-1	R-2	R-3
Soil Texture	SL-fri.CL	CLLS-p.C LS 30cm	LS - sp.C LS 60cm	CL-vsp.C CL 30cm	SL-vsp.C SL 15cm L 30cm CL 30cm	LS-sp.C LS 15cm
Depth to compacted horizon	150 cm	120 cm	90 cm	90 cm	60-90cm	30 cm
pH	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 x 10^3	4	6	8	4	6	8
Exchangeable Sodium meg/100gm	2	2	3	3	4	4
Water-holding capacity in 120cm depth	15 cm	11 cm	8 cm	not applicable	not applicable	not applicable
Topography	smooth	wavy	undulating	smooth	wavy	undulating
slope	2%	4%	6%	2%	4%	4%
Levelling 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-surface	good	good	fair	poor	fair	good
Flood	no	no	occasional	infrequent	periodic	annual

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

Acreage of Land Class Group

Land Class Group	Acreage (ha)	%
U1	2,290	10.1
U2	690	3.0
U3	140	0.6
Upland field sub-total	3,120	13.7
R1	7,290	32.1
R2	170	0.7
R3	940	4.2
Paddy field sub-total	8,400	37.0
U2/R2	4,040	17.8
U6/R6	2,240	9.9
Village & residential area	4,000	17.6
Others	900	4.0
Total	22,700	100.0

Note: Land Classification Classes by RID.

Class U1: Land best suitable for upland irrigation crops.

Class U2: Land less suitable for upland irrigation crops with one or more limitation in the soil, topography or drainage characteristics.

Class U3: Land of distinctly restricted suitability for upland crops because of extreme limitation in the soils, topography or drainage characteristics.

Class U2/R2: Land suitable for either upland crops or rice production with some limitation.

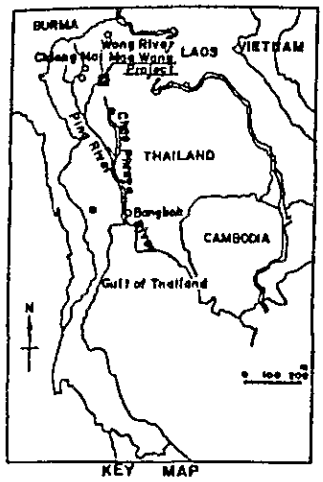
Class R1: Land best suited for rice production.

Class R2: Land adopted for rice production but with one or more limitations.

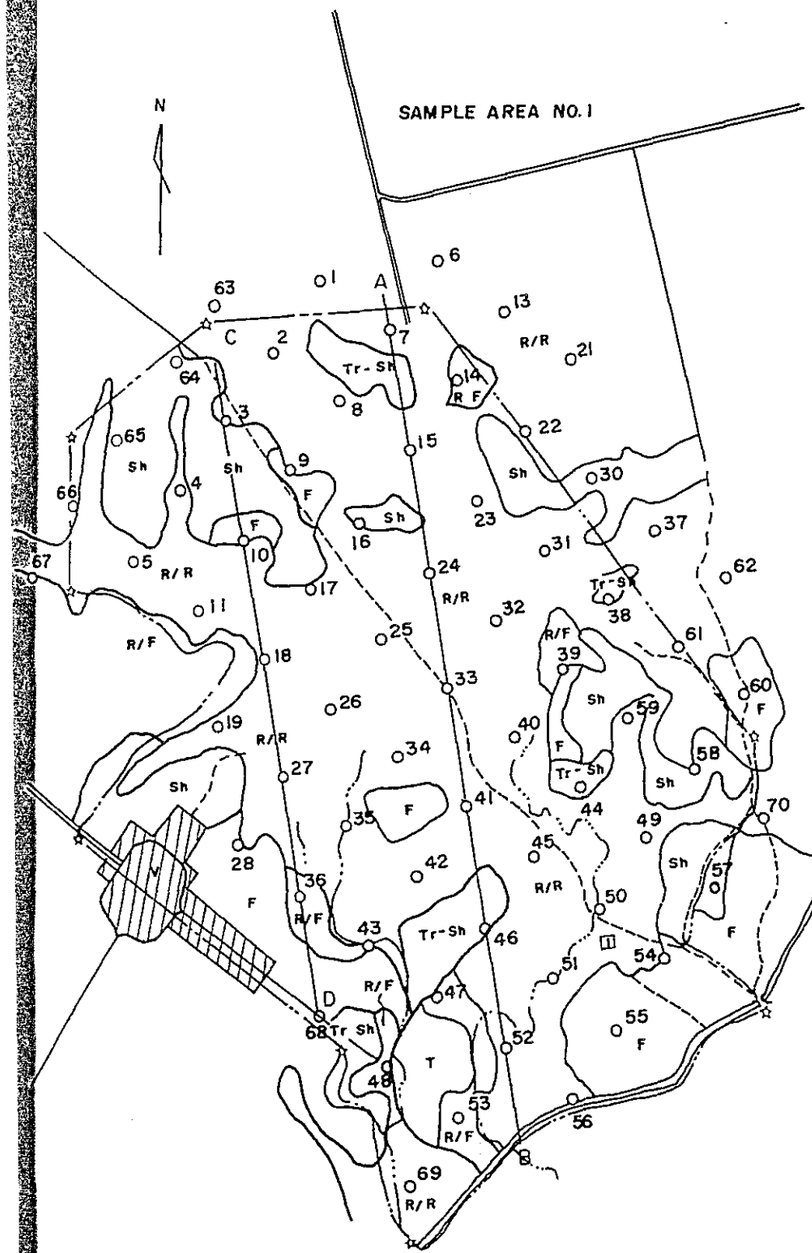
Class R3: Land distinctly restricted for rice production because of extreme limitations

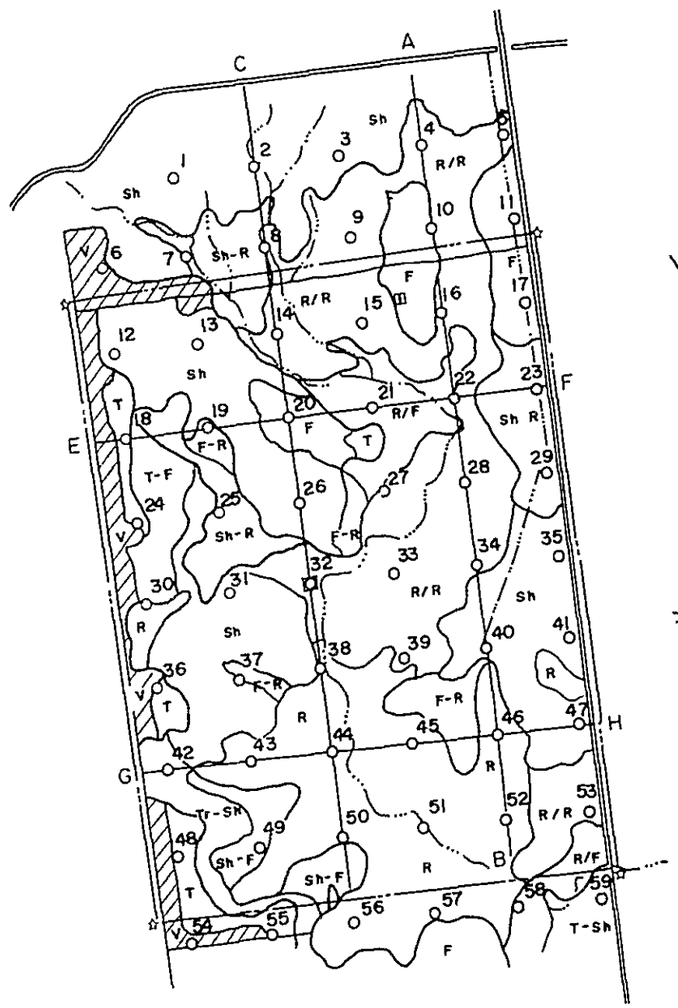
Class 6: Land unsuitable for the production of crops.

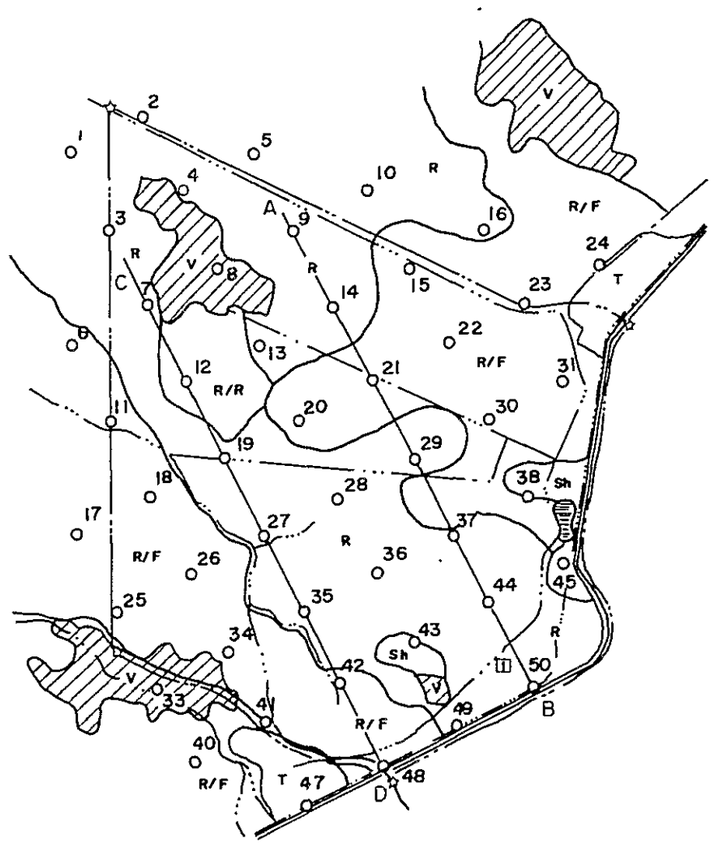
LOCATION OF SAMPLE AREA



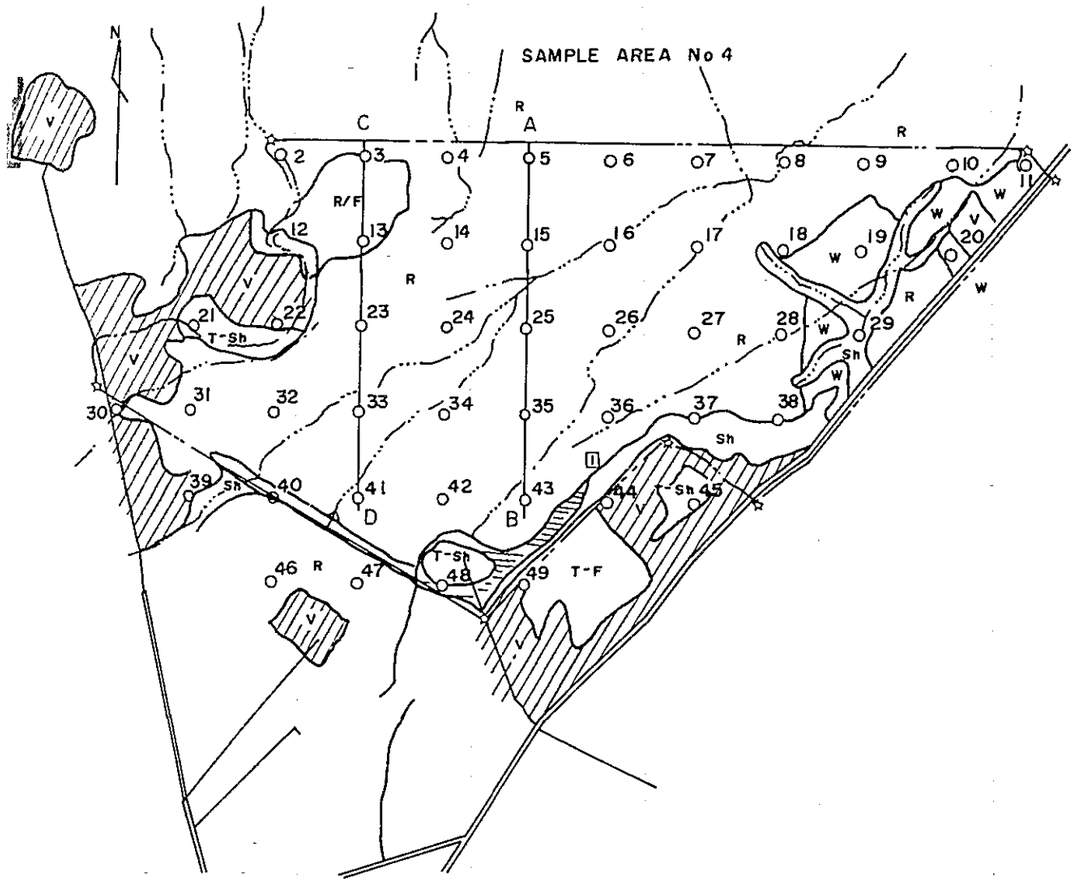
MAP SHOWING LAND USE AND LOCATION OF BORING SITES IN THE SAMPLE AREAS

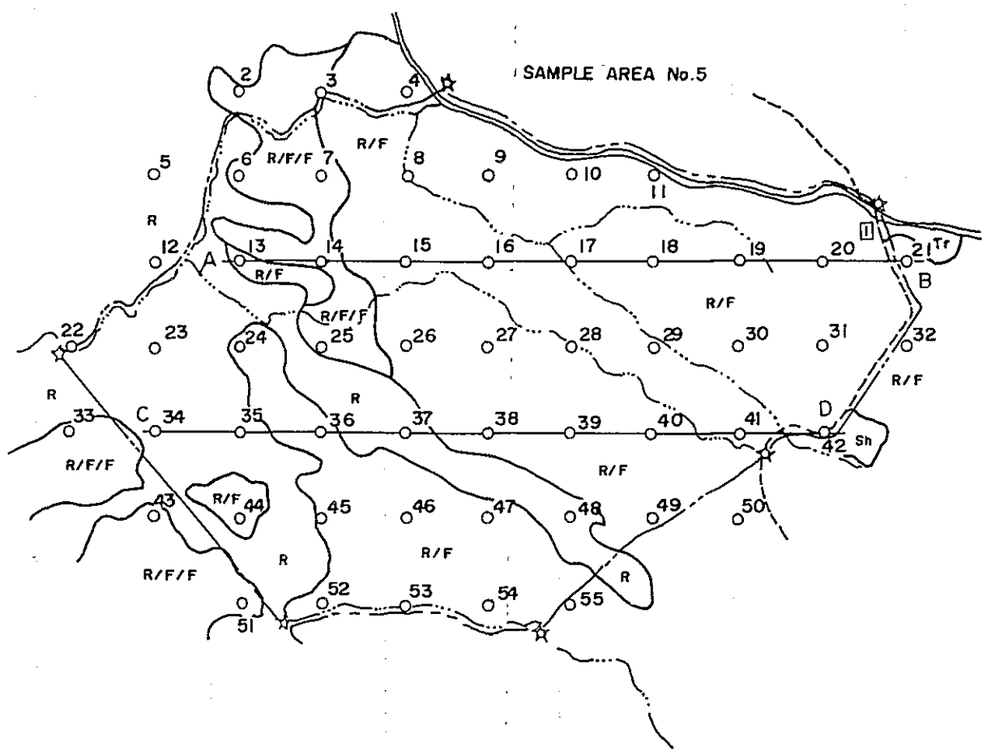






MAP SHOWING LAND USE AND LOCATION OF BORING SITES IN THE SAMPLE AREAS





LEGEND

PADDY FIELD
- R; Area of wet season paddy
- R/R; Area of 2 Paddy a year
- R/F; Double cropping area
- R/F/F Area of wet season paddy + 2 upland crops

UPLAND FIELD (F)
- F-R; Area mixed with upland field and paddy field

ORCHARD (T)
- T-F; Orchard mixed with upland field
- T-Sh; Orchard with shrub

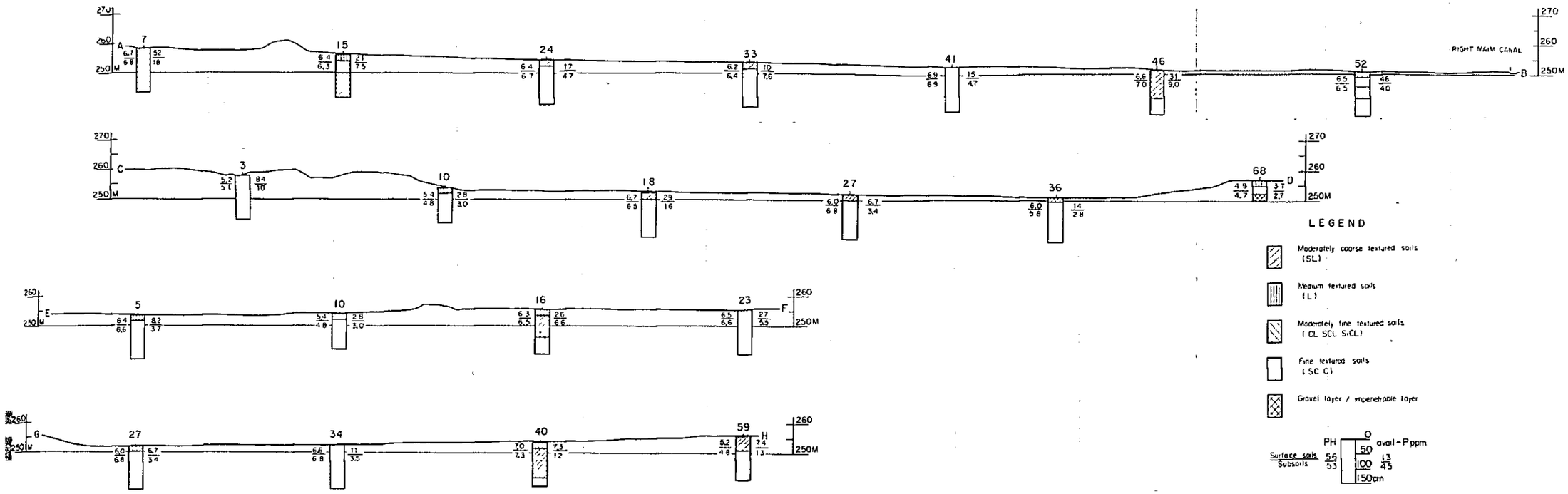
SHRUB (Sh)
- Sh-R; Shrub mixed with small paddy field
- Sh-F; Shrub mixed with small upland field

FOREST (Tr)
- Tr-Sh; Complex area of tree and shrub

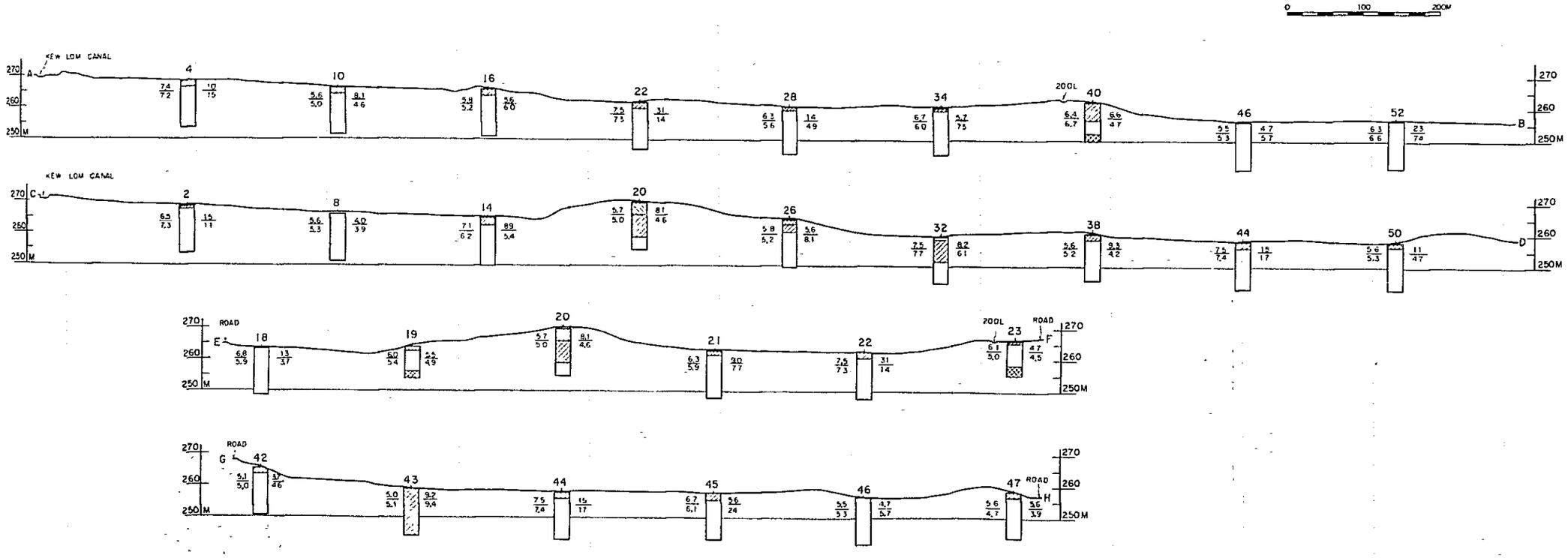
- V — Village and residential area
- W — Waste land
- Pond
- Boundary of sample Area
- Irrigation canal, ditch & natural stream
- Road
- Test pit site
- O15 — Boring test site

CROSS SECTION OF SAMPLE AREAS

SAMPLE AREA NO.1

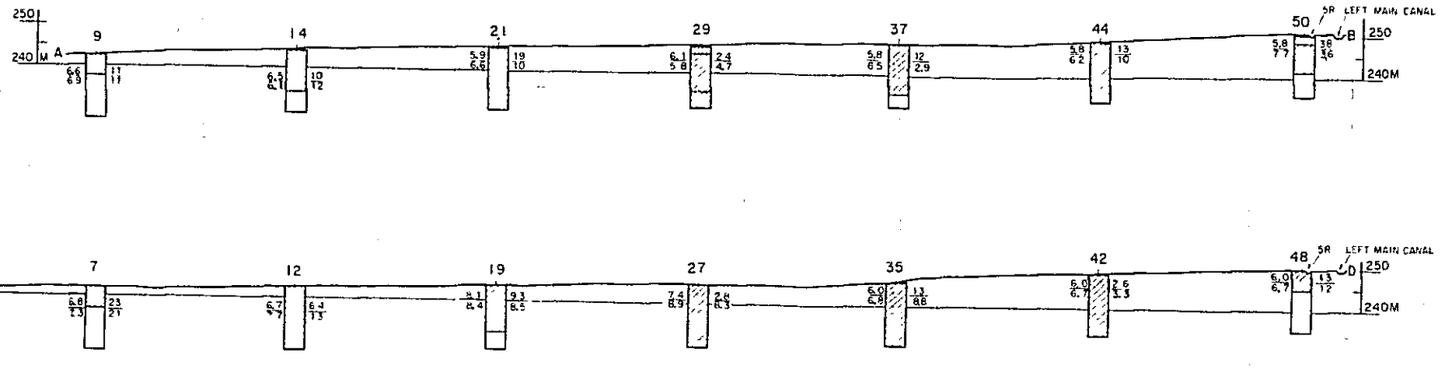


SAMPLE AREA NO.2

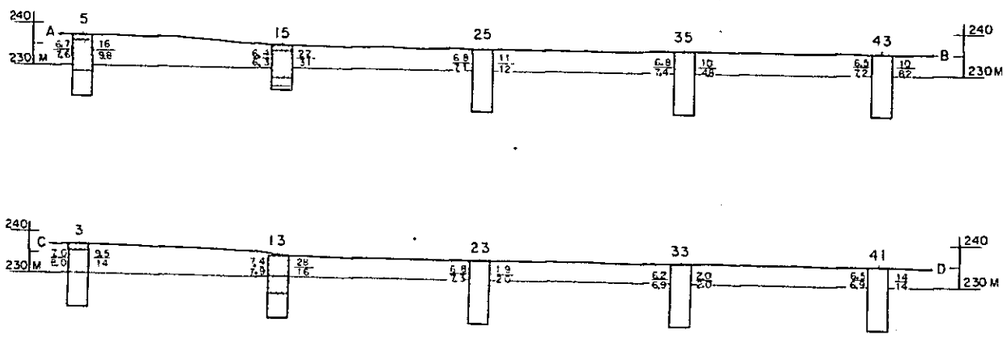


CROSS SECTION OF SAMPLE AREAS

SAMPLE AREA NO.3



SAMPLE AREA NO.4



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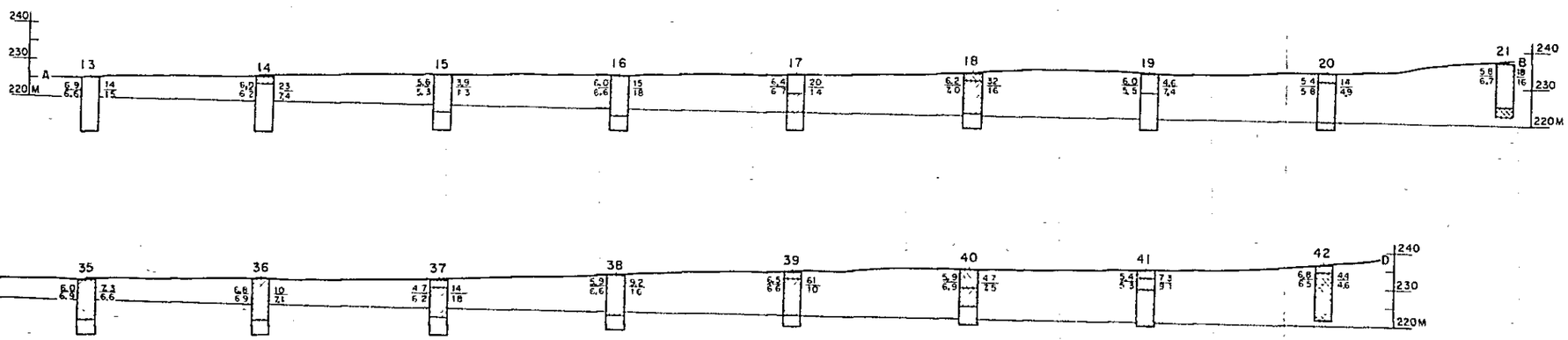


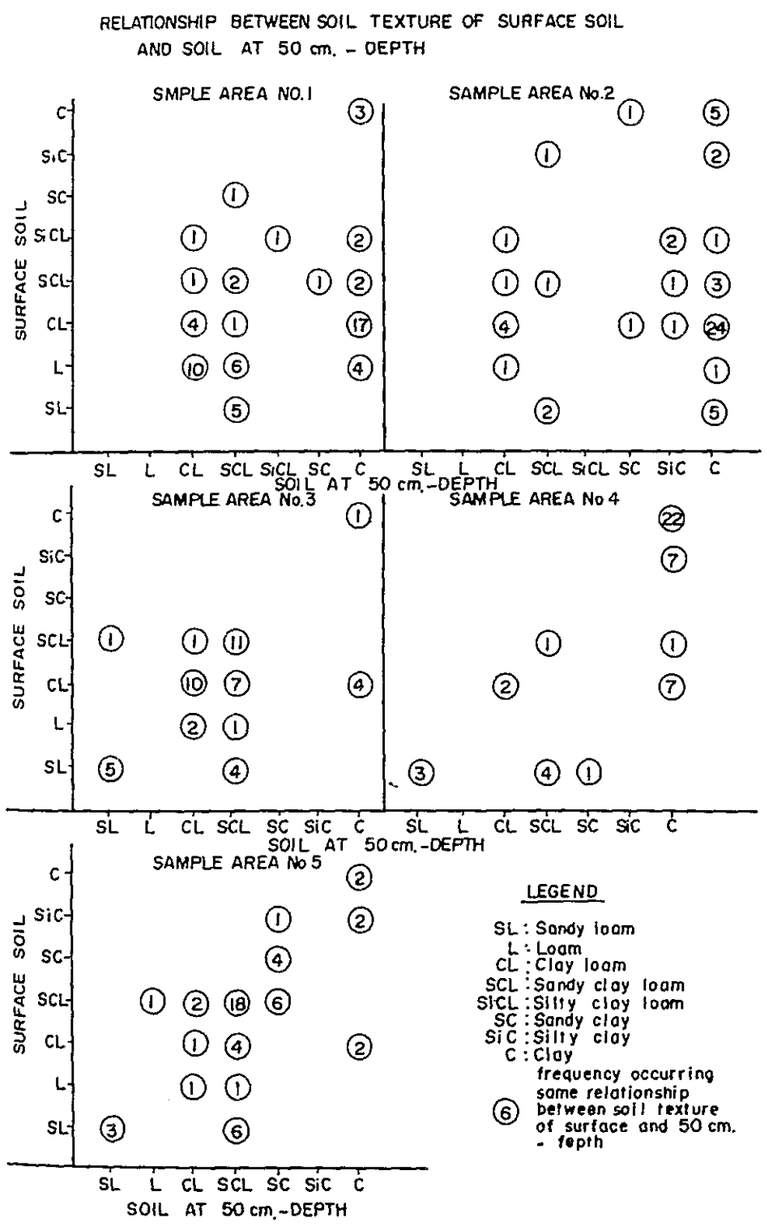
LEGEND

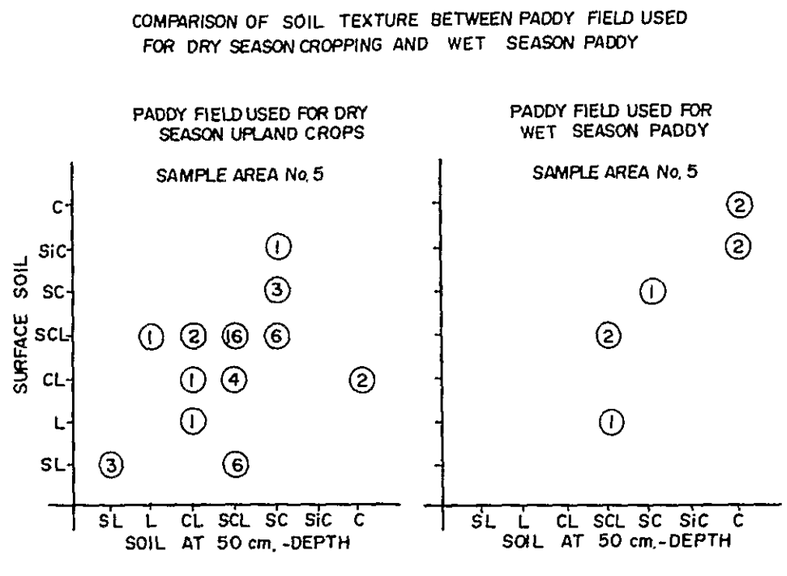
- Moderately coarse textured soils (SL)
- Medium textured soils (L)
- Moderately fine textured soils (CL SCL SiCL)
- Fine textured soils (SC C)
- Gravel layer / impenetrable layer

PH 0 / 50 / 100 / 150cm — avail-P ppm.
Surface soils 5.6 / 13
Subsoils 5.3 / 45

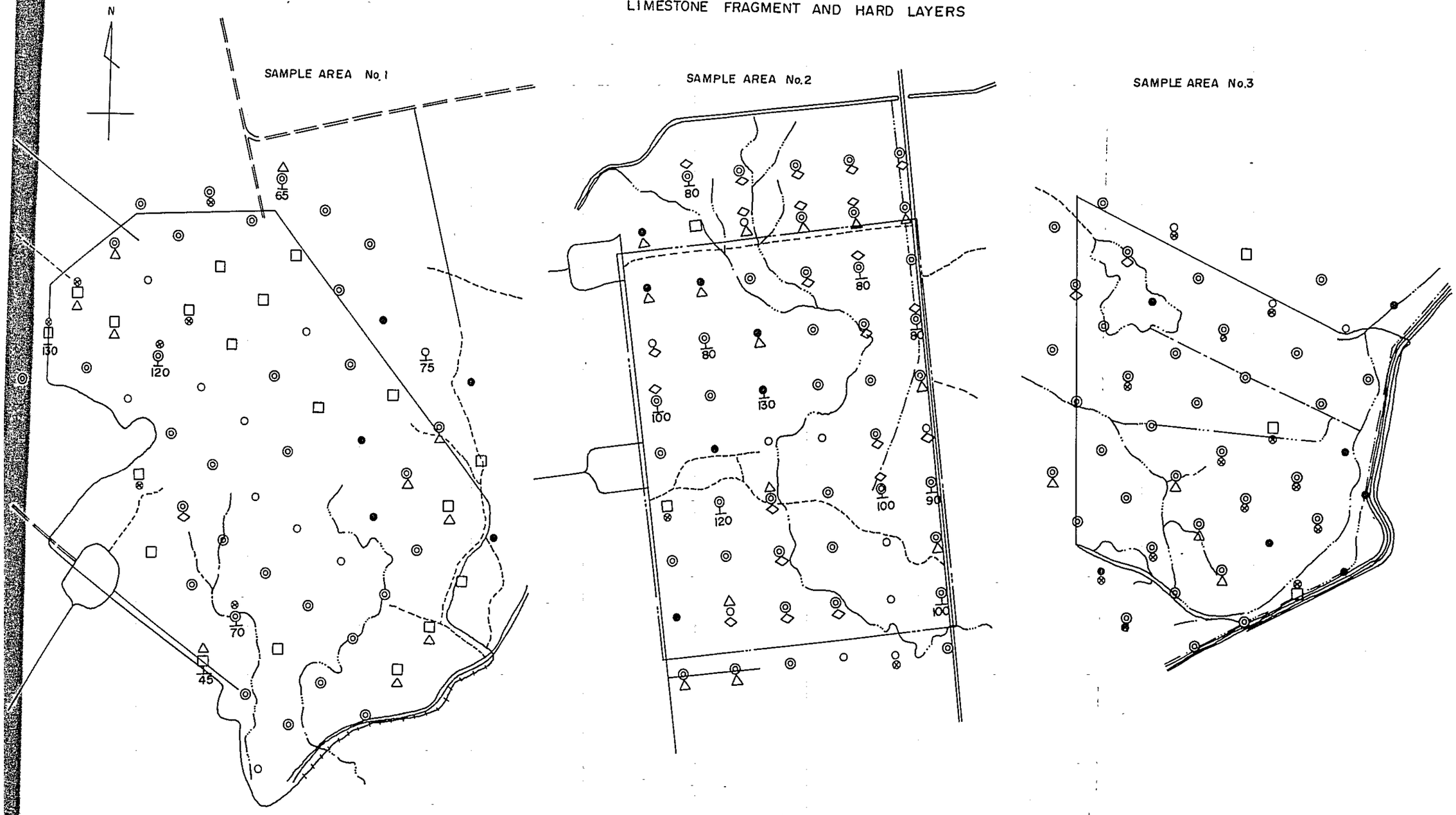
0 — 100 — 200M

RELATIONSHIP BETWEEN SOIL TEXTURE OF SURFACE SOIL AND SUBSOIL



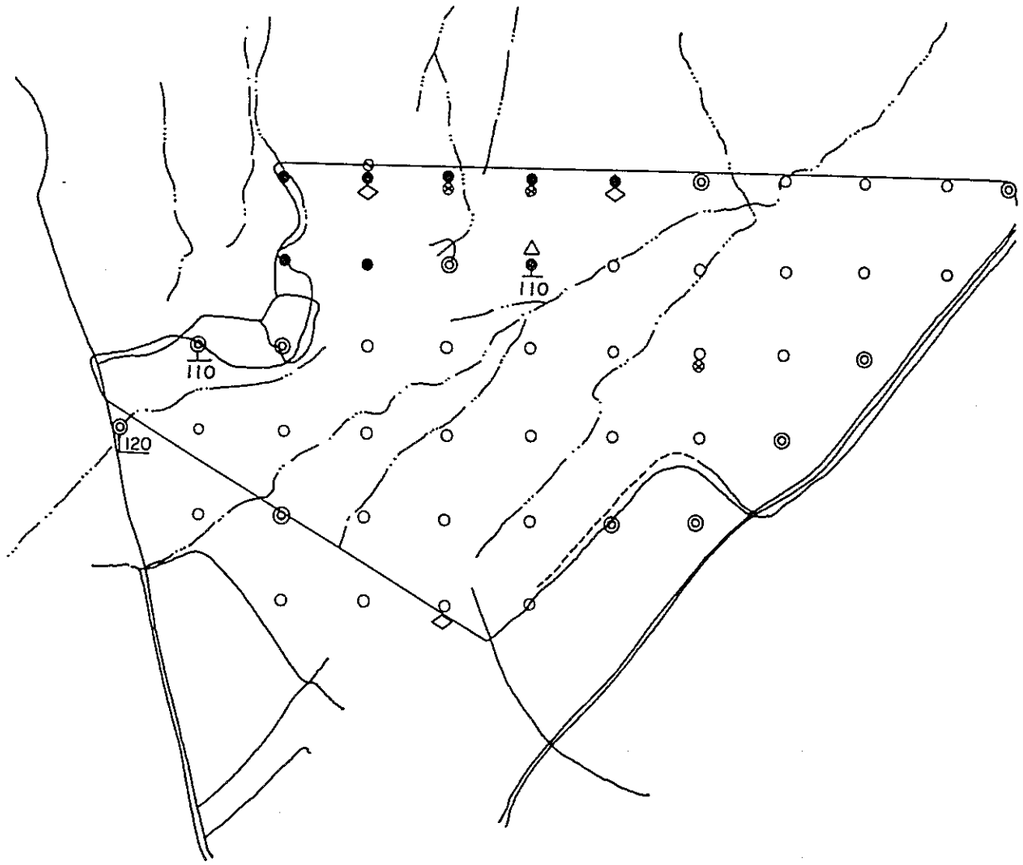


MAP SHOWING SOIL TEXTURE OF SURFACE SOIL AND OCCURRENCE OF GRAVEL, PISOLITE, LIMESTONE FRAGMENT AND HARD LAYERS

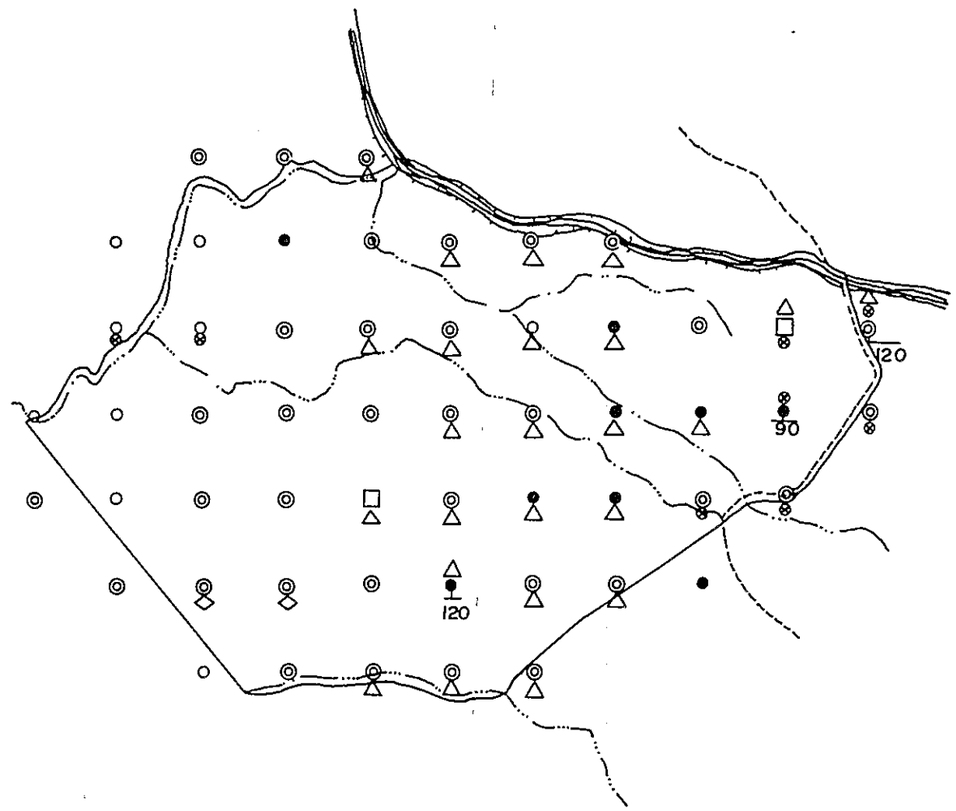


MAP SHOWING SOIL TEXTURE OF SURFACE SOIL AND OCCURRENCE OF GRAVEL, PISOLITE, LIMESTONE FRAGMENT AND HARD LAYERS

SAMPLE AREA No. 4



SAMPLE AREA No. 5

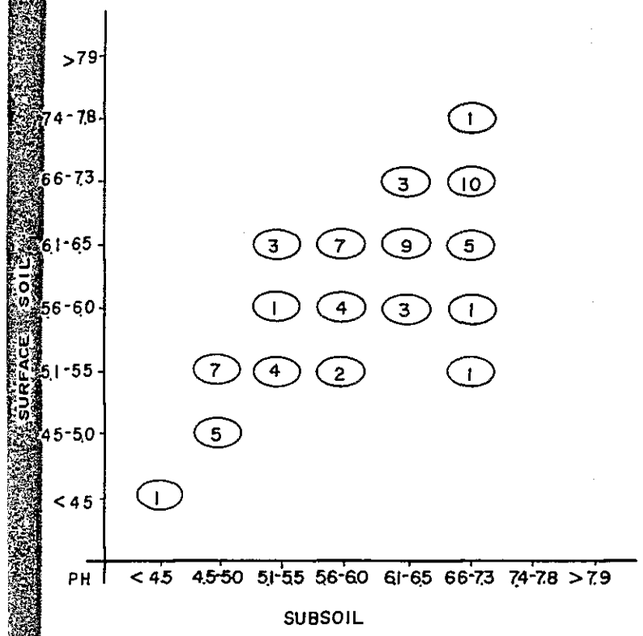


LEGEND

- Moderately coarse textured soils (sandy loam)
- Medium textured soils (loam)
- Moderately fine textured soil s(clay loam.) sandy clay loam, silty clay loam)
- Fine textured soi ls (sandy clay, silty clay, clay)
- Gravel
- Pisolite
- Lime stone fragment
- 120 — hard pan/hard layer & position (cm.)

STATUS OF PH IN THE SAMPLE AREAS

SAMPLE AREA No. 1



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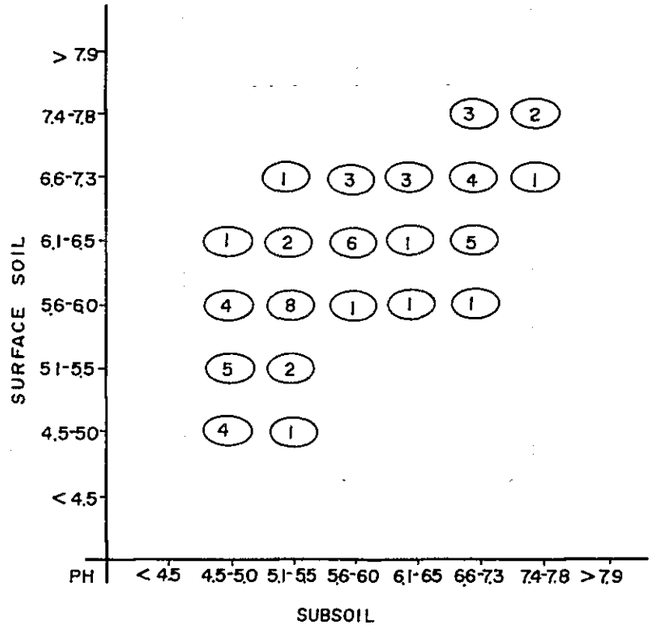

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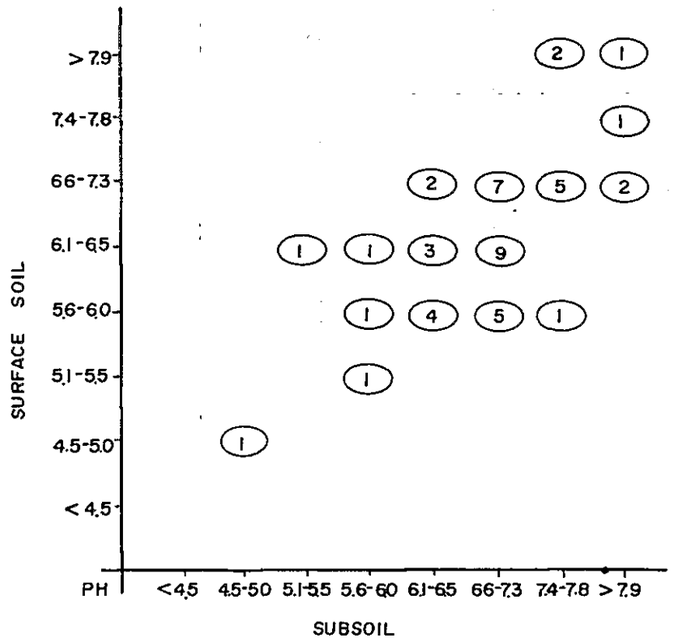
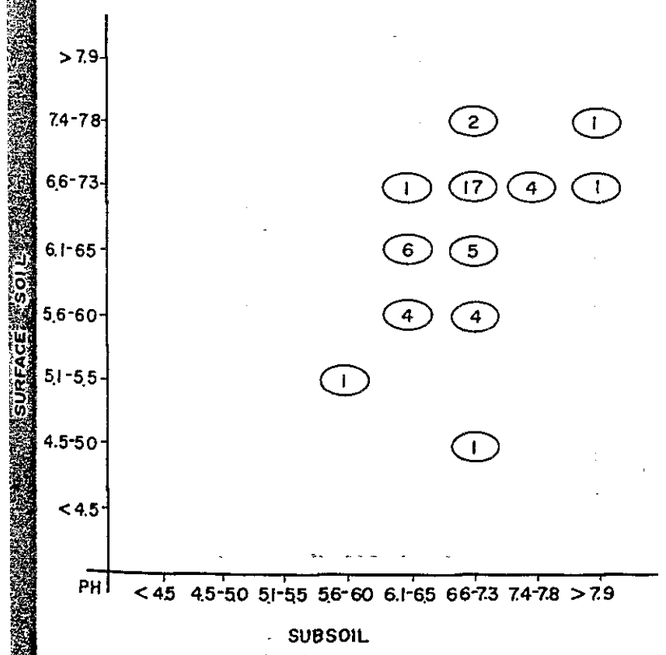


SAMPLE AREA No. 4



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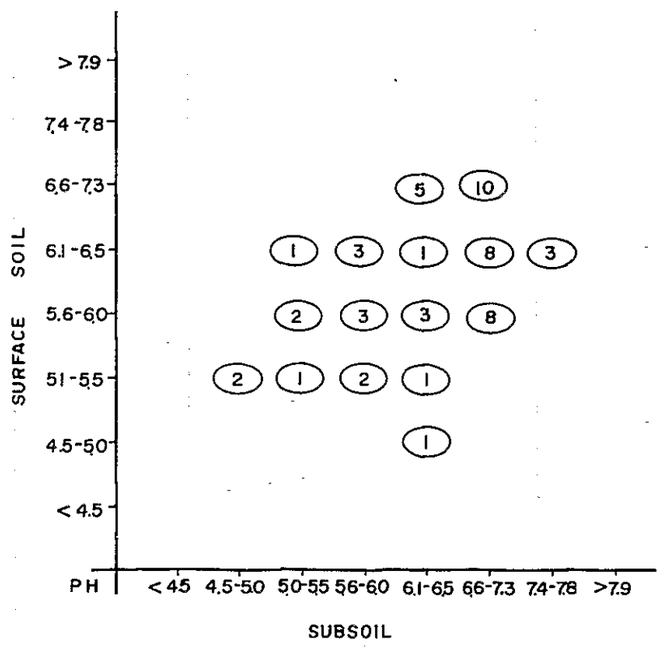
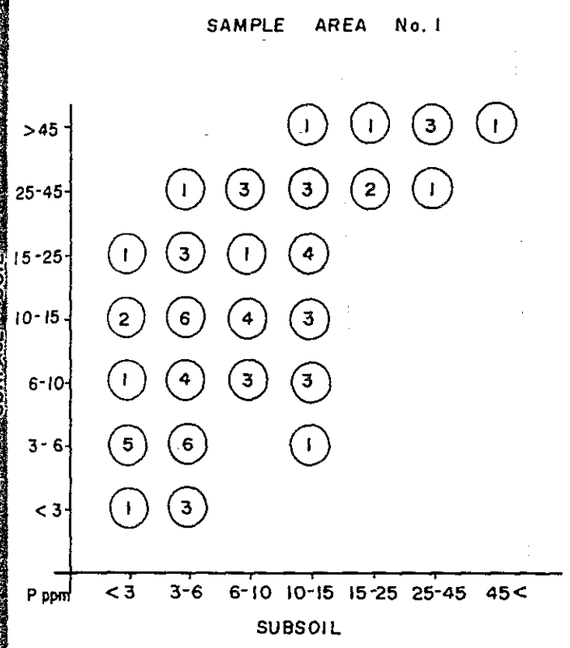


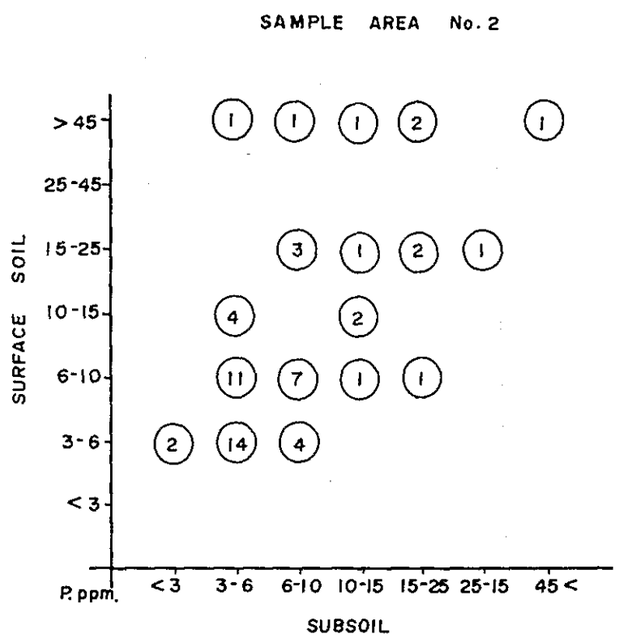
Degree of Acidity and Alkalinity:

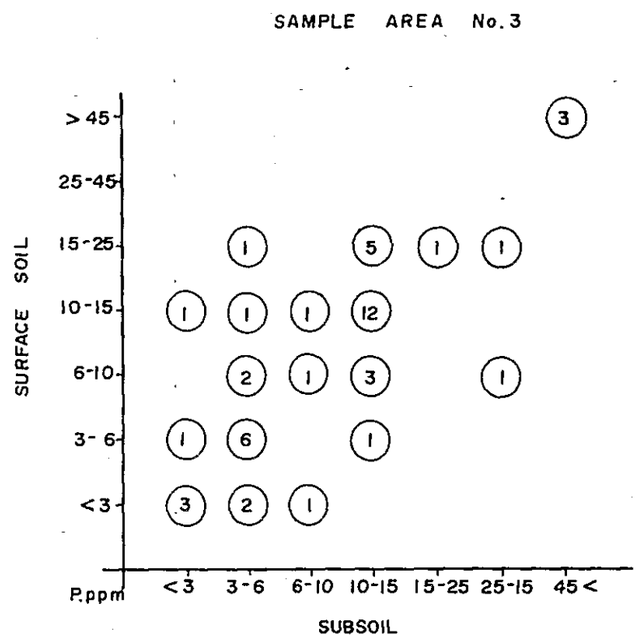
< 4.5	Extremely acid
4.5 - 5.0	Very strong acid
5.1 - 5.5	Strong acid
5.6 - 6.0	Medium acid
6.1 - 6.5	Slightly acid
6.6 - 7.3	Neutral
7.4 - 7.8	Mildly alkaline
7.9 - 8.4	Moderalely alkaline
8.5 - 9.0	Strong alkaline

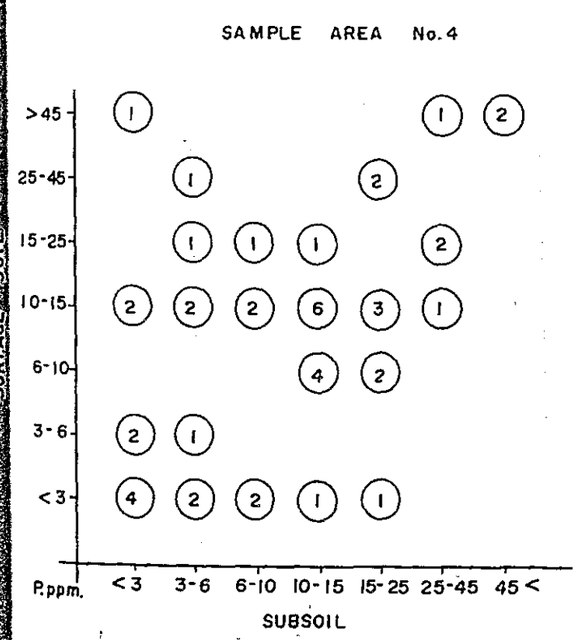
(3) frequency occurring same range of PH between surface soil and subsoil

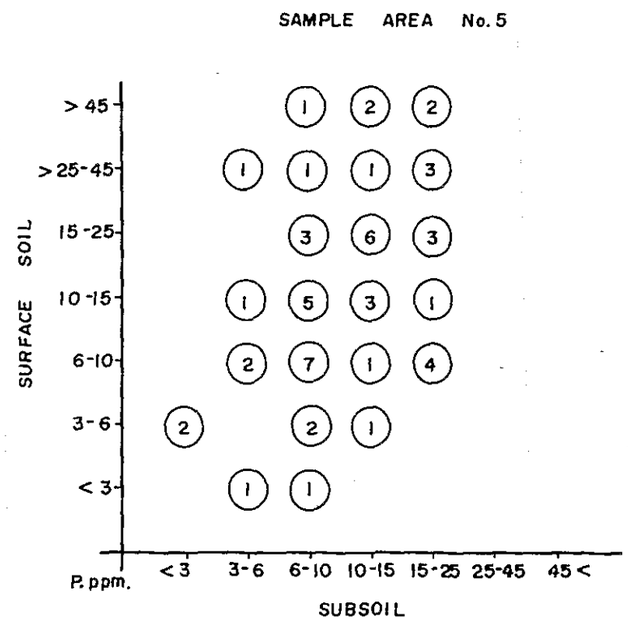
STATUS OF AVAILABLE PHOSPHORUS IN THE SAMPLE AREAS









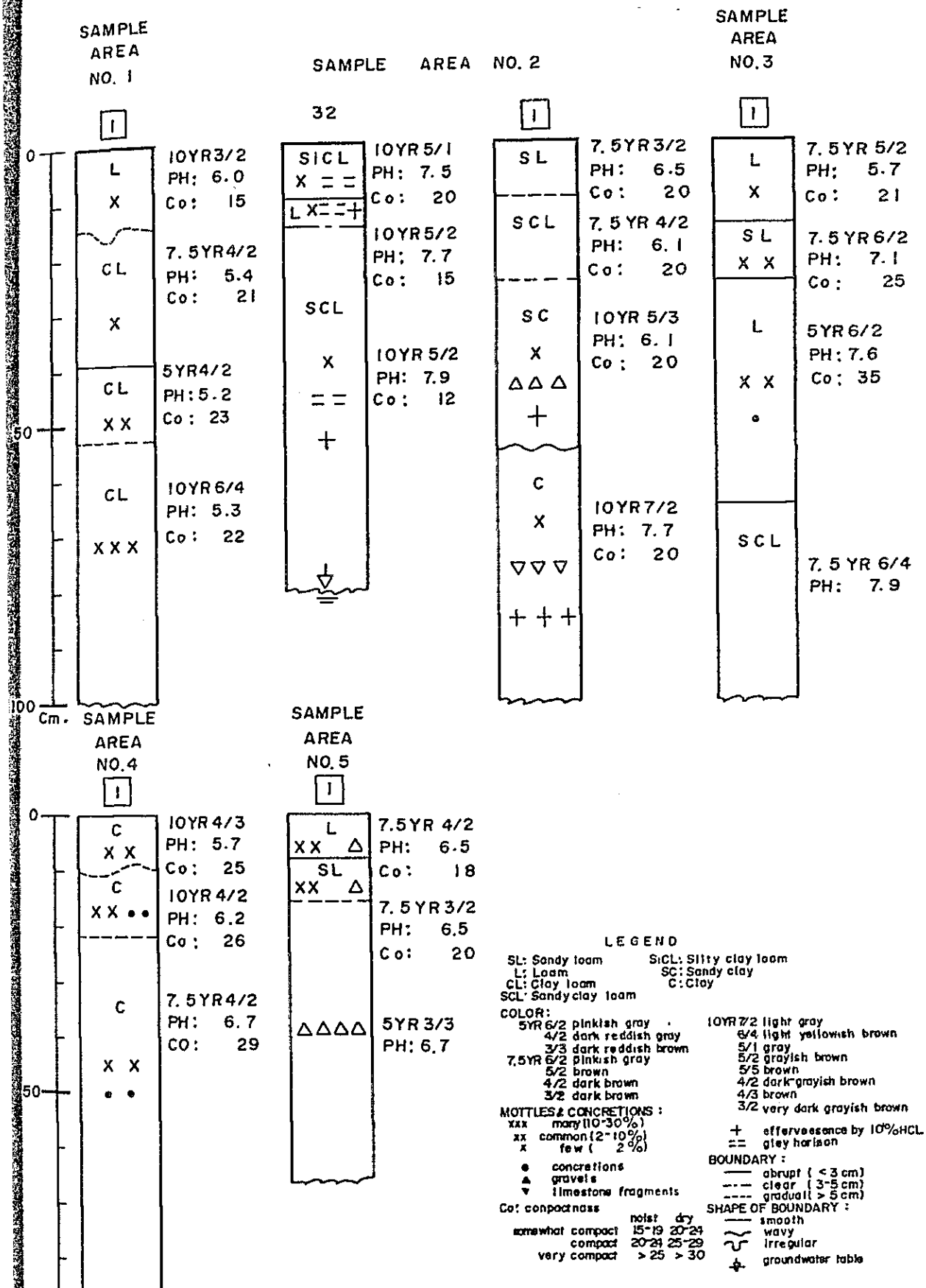


Rating of available phosphorus (P. ppm)
(after Soil Interpretation Handbook
for Thailand 1973.)

>45	Very high
25-45	High
15-25	Moderately high
10-15	Medium
6-10	Moderately low
3-6	Low
<3	Very low

(5) frequency occurring same rating of available Phosphorus between surface soil and subsoil

DIAGRAMATIC REPRESENTATIONS OF SOIL PROFILES



LEGEND

SL: Sandy loam
L: Loam
CL: Clay loam
SCL: Sandy clay loam
SiCL: Silty clay loam
SC: Sandy clay
C: Clay

COLOR:
5YR 6/2 pinkish gray
4/2 dark reddish gray
3/3 dark reddish brown
7.5YR 6/2 pinkish gray
5/2 brown
4/2 dark brown
3/2 dark brown
10YR 7/2 light gray
6/4 light yellowish brown
5/1 gray
5/2 grayish brown
5/5 brown
4/2 dark grayish brown
4/3 brown
3/2 very dark grayish brown

MOTTLES & CONCRETIONS :
xxx many (10-30%)
xx common (2-10%)
x few (2%)
● concretions
▲ gravels
▼ limestone fragments

+ effervescence by 10%HCL
== gley horizon

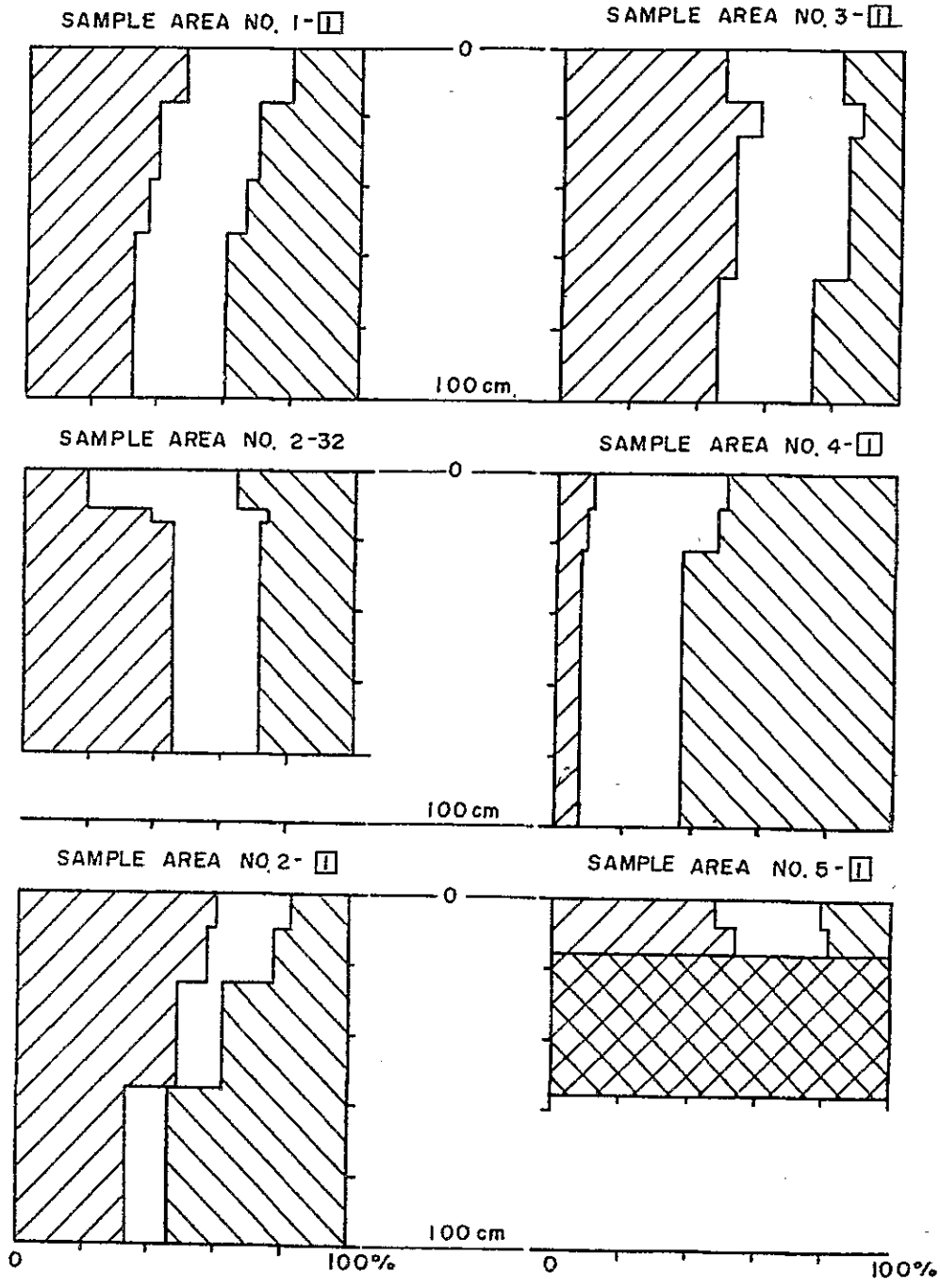
BOUNDARY :
—— abrupt (< 3 cm)
– – – clear (3-5 cm)
- - - - gradual (> 5 cm)

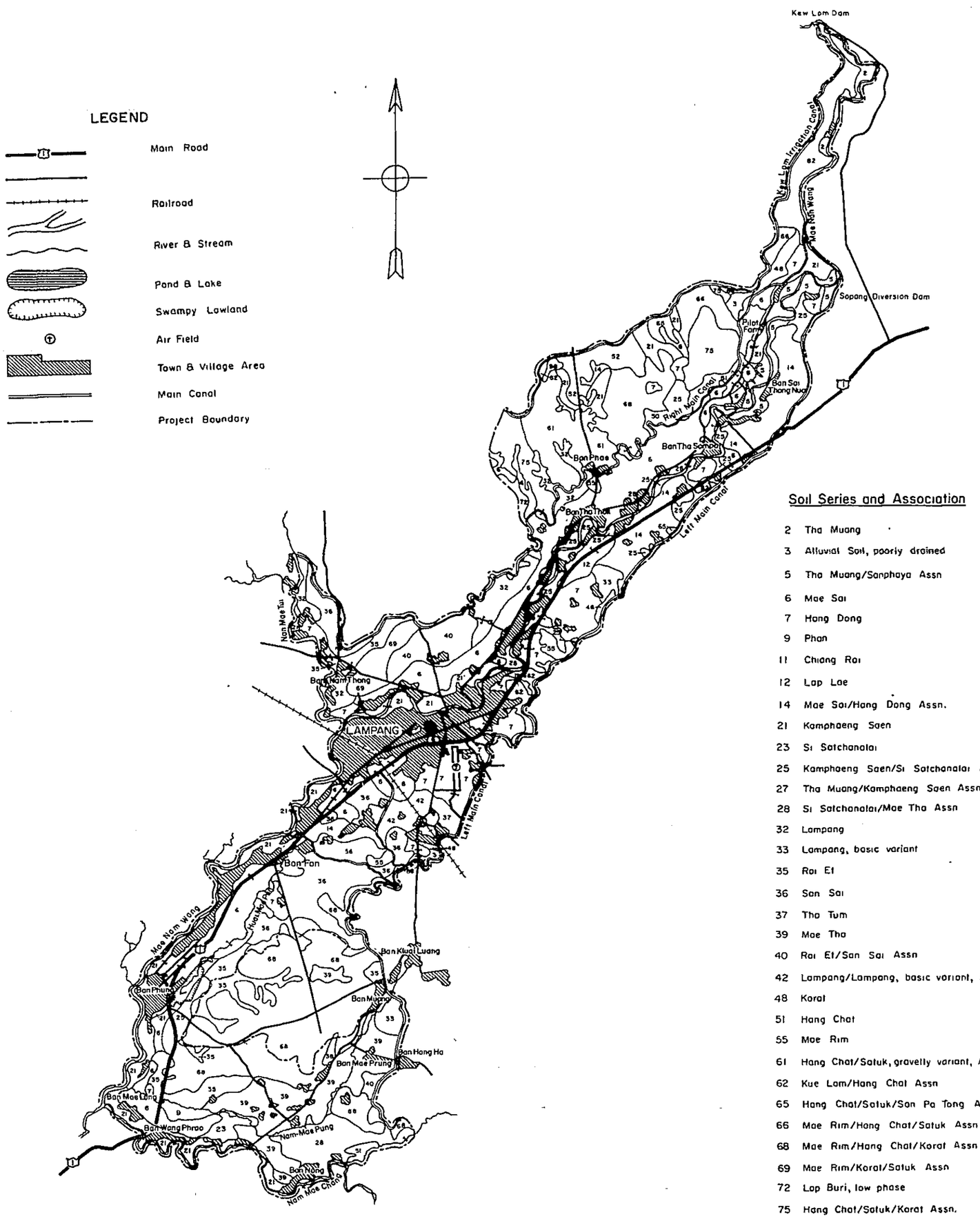
SHAPE OF BOUNDARY :
—— smooth
~~~ wavy
∿∿ irregular
groundwater table

Co: conpactness

| | moist | dry |
|---|---|---|
| somewhat compact | 15-19 | 20-24 |
| compact | 20-24 | 25-29 |
| very compact | > 25 | > 30 |
~~~

PROPORTION OF PARTICLE SIZE OF TEST PITS





KINGDOM OF THAILAND
MINISTRY OF AGRICULTURE AND COOPERATIVES
ROYAL IRRIGATION DEPARTMENT

THE MAE WANG – KEW LOW IRRIGATED AGRICULTURAL DEVELOPMENT PROJECT

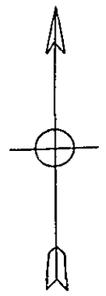
SOIL MAP OF THE PROJECT AREA

JAPAN INTERNATIONAL COOPERATION AGENCY

S – 4

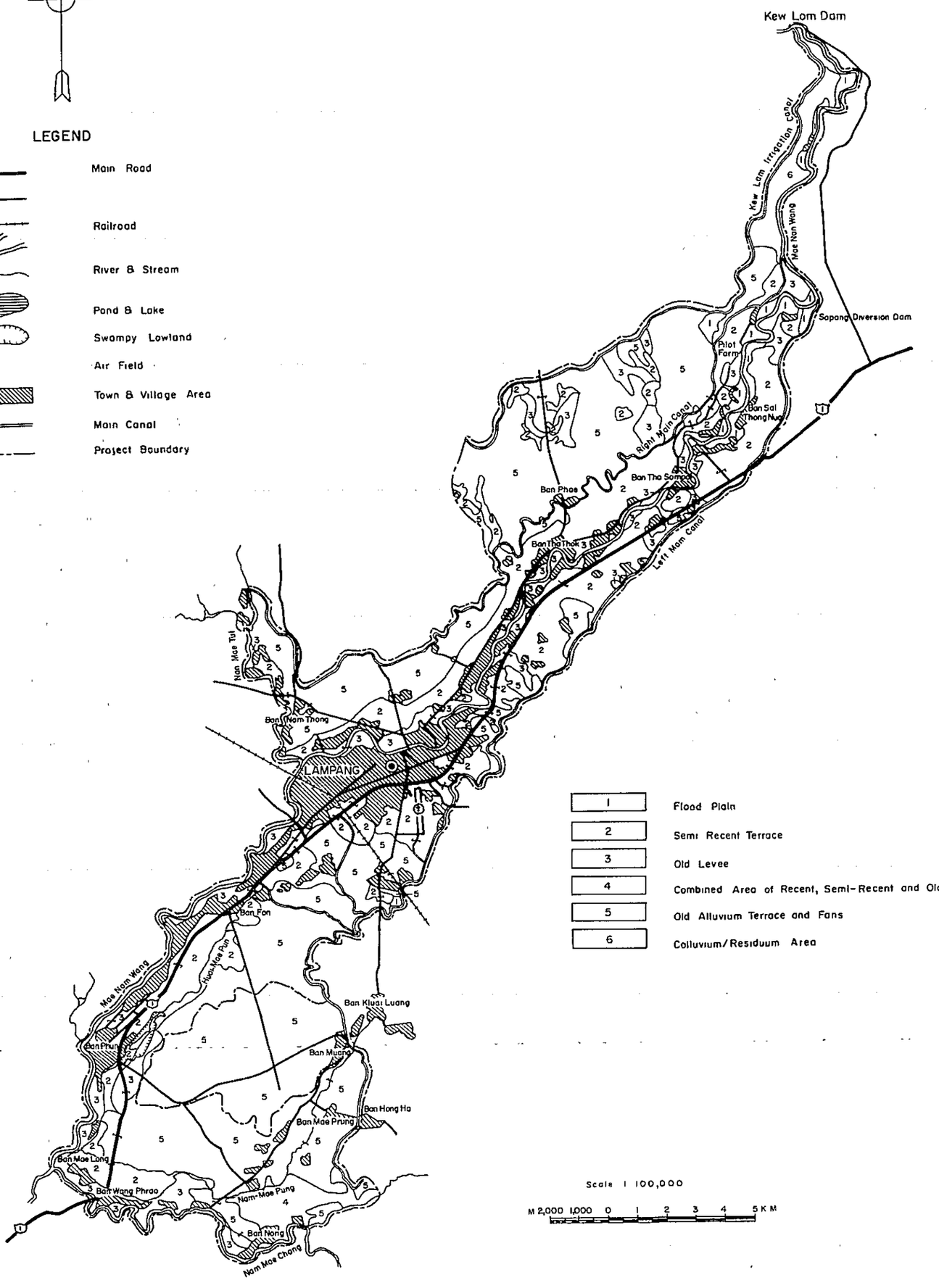
Data Source: Detailed Reconnaissance Soil Map of Lampang Province Soil Survey Division, Department of Land Development Ministry of Agriculture and Cooperative

MAP SHOWING LANDFORM IN THE PROJECT AREA

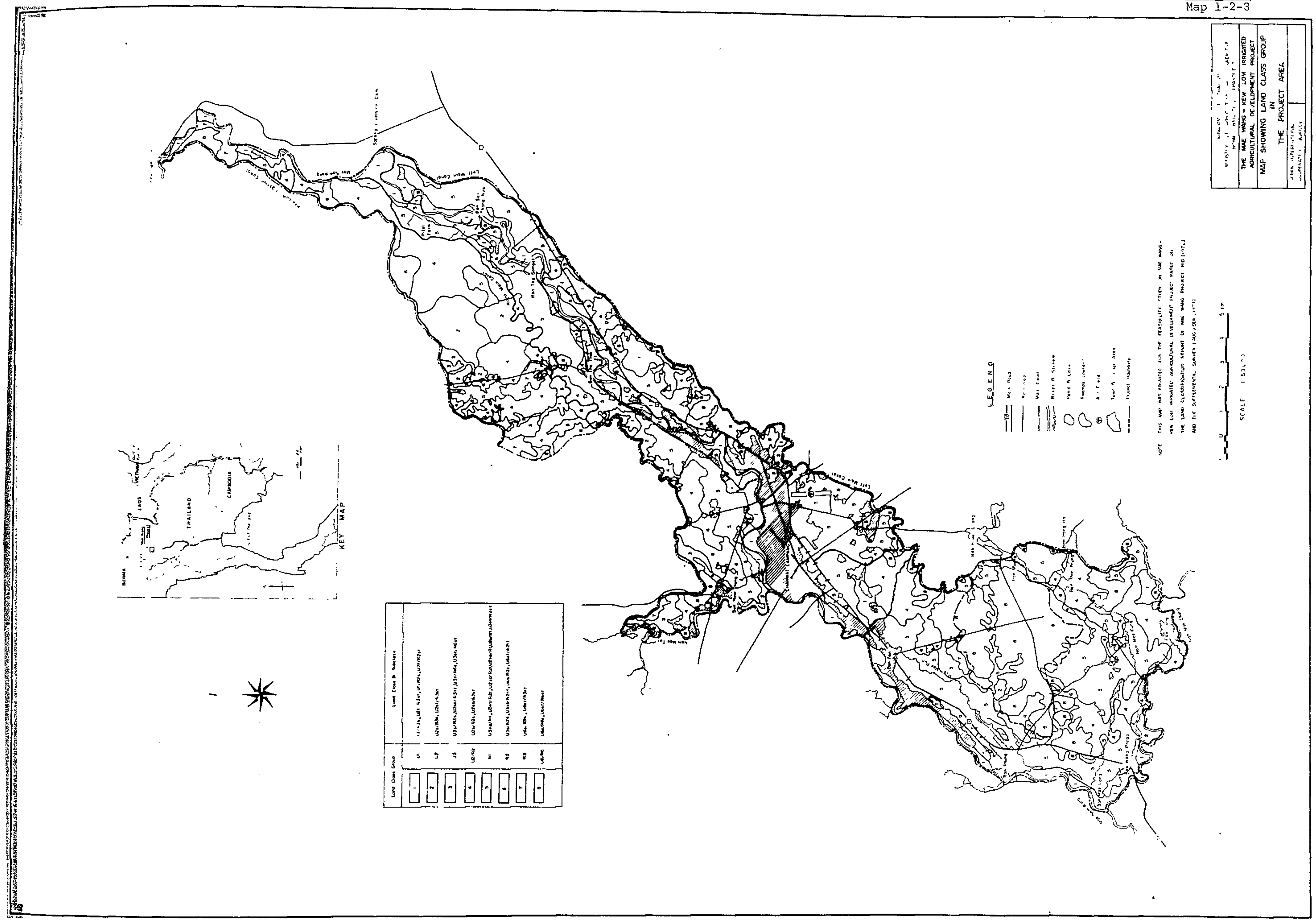


LEGEND

- Main Road
- Railroad
- River & Stream
- Pond & Lake
- Swampy Lowland
- Air Field
- Town & Village Area
- Main Canal
- Project Boundary



Data Source Detailed Reconnaissance Soil Map of Lampang Province Soil Survey Division, Department of Land Development Ministry of Agriculture and Cooperatives


THE MAE WANG - KEW LOM IRRIGATED
AGRICULTURAL DEVELOPMENT PROJECT
MAP SHOWING LAND CLASS GROUP
IN
THE PROJECT AREA
LEGEND
KEY MAP
THAILAND
LAOS
CAMBODIA
BURMA
SCALE

ANNEX 1-3. Agriculture

Table of Contents

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Agriculture

1.3.1. Present situation of agricultural extension services

The agricultural extension services in Thailand had been rendered under administration of several departments of MOAC as nucleus of the activities, aiming at upgrading the welfare of about 30 million farming population throughout the nation. The Department of Agricultural Extension was established in 1966 as one of the departments of MOAC so as to render integrated services for improving the farming techniques and farm management.

The Department of Agricultural Extension (DAE) consists of Nine (9) divisions as shown in Figure 1-3-3 of Annex 1-3 (as of 1979), and has six regional offices, Changwat office for 72 Changwats, and Amphoe office for 686 Amphoes as its sub-organization throughout the country.

The on-going National Agricultural Extension Project has been executing very attentive and scrupulous services to the farmers by providing the extension agents stationing in every Tambon.

The extension agents, stationing in every Tambon, have been rendering services to the farmers through contact farmers who have been selected among farmers, at one for 10 farmers, guidance to the farmers.

Outlines of the National Agricultural Extension Project (NAEP)

The National Agricultural Extension Project was launched in 1977 under the World Bank aid. This project, a five year development plan between 1977 and 1981, has been promoted by the DAE as main executing body aiming at,

1. Strengthening extension services for farming techniques of the major crop, in other words, improvement of extension method according to the so-called advanced technique,

2. Increasing in extension staff,

3. Training extension staff for upgrading quality of staff,

4. Improving the conditions for extension activities (power-up of mobility, supply with extension materials, and treatment of staff concerned) for the target of providing one extension agent to 1,000 farmers for five million farmers 72 Changwats throughout the nation.

This project includes two stages, the first and the second stage.

Changwat Lampang, where MK-IADP is located, is included in the first stage of the NAEP, and the extension agents in Changwat Lampang has been increased to 127 covering the whole Changwat area, and from 1980 and onward the plan will be implemented to smoothen the extension activities by providing North Regional Training Centre (Chieng Mai), Provincial Training Centres (every Changwat), District Training Centre (every Amphoe), sub-district Centre (Office for extension agents), vehicles, office equipment and supplies, and farm inputs such as seeds, fertilizers, agri-chemicals, etc.

The extension agents have had a weekly meeting at Amphoe extension office to review the activities performed in the last week and discuss the programme for the coming week. At the Changwat and Amphoe levels, the extension authorities concerned have had a fortnightly meeting with Changwat pest control office, irrigation office, and cooperative office.

Duty of extension agents

The extension agents are those officials who directly contact with farmers to render services to the farmers in respect to farming techniques, farming management and other services concerned with agriculture.

The major works imposed on the extension agents belonging to offices in Changwat Lampang are specified as follows;

1. to diffuse the knowledges and techniques of agriculture and farming,
2. to introduce the profitable and intensive farm management under irrigated agriculture,
3. to assist the farmers concerned in over coming technical difficulties to be encountered in exercising modernized farming,
4. to cooperate with local research institutes in seeking solutions of the problems the farmers face, and
5. to cooperate with local agri-related organizations such as agricultural cooperatives, agri-industries, educational and welfare organizations, for accomplishing the purposes.

Extension agents in the country are required to be qualified as college graduates, MOAC's institution graduates, or sucessful applicant for the examination under the National Personnel Authority.

1.3.2. Situation of agricultural cooperatives

The agricultural cooperatives in Thailand has been a mono-functioning cooperative for rendering the crediting services to the member farmers since 1916, and still keeping its traditional function. The cooperative is organized on the collective responsibility and under the unlimited partnership. A qualification is strictly required to become the member of the cooperative, and such a condition has prevented the cooperative from being organized by the whole village farmers under unification of the villages.

In 1959, the cooperative introduced the system of crediting for the production materials, and since the latter half of 1960s, many small-scale crediting cooperatives have been merged to form larger-scale cooperatives which have render various services on top of the

crediting service. Since 1970, the merger for larger-scale cooperative has been progressed and the cooperative has been turned into the limited responsibility system in its crediting service together with generalization of service items including purchase of input materials, sales of farm products, giving technical guidance, etc.

In term of agricultural crediting by cooperatives, the crediting service has been promoted by BAAC, established in 1966, and other financing organizations. The following table shows the agricultural financing status as of 1970 by BAAC and major commercial banks.

Trend of Agricultural Financing by Major Banks

(Unit: Million Baht)

Name of Bank	1970		1972		1974		1976	
	Amount	Growth Rate	Amount	Growth Rate	Amount	Growth Rate	Amount	Growth Rate
Bangkok Bank	93.15	1.0	89.74	1.0	173.53	1.9	1,084.27	11.6
Krunthai Bank	1.90	1.0	4.26	2.2	4.50	2.4	386.75	203.6
Thai Farmers' Bank	6.69	1.0	24.92	3.7	43.14	6.4	98.93	14.8
BAAC	920.17	1.0	1,213.99	1.3	1,926.95	2.1	3,518.63	3.8
Toatl	1,021.91	1.0	1,332.91	1.3	2,142.12	2.1	5,025.58	4.9

Many farmers, however, have still depended their operation funds and living funds before harvesting upon unorganized financing sources. The national tendency in farmers' crediting in 1976 revealed that the relatives and merchants occupied a greater part of money lenders, excepting BAAC, in terms of debt amounts by lenders.

Cultivated Area Classified by Type of Land Tenure*/

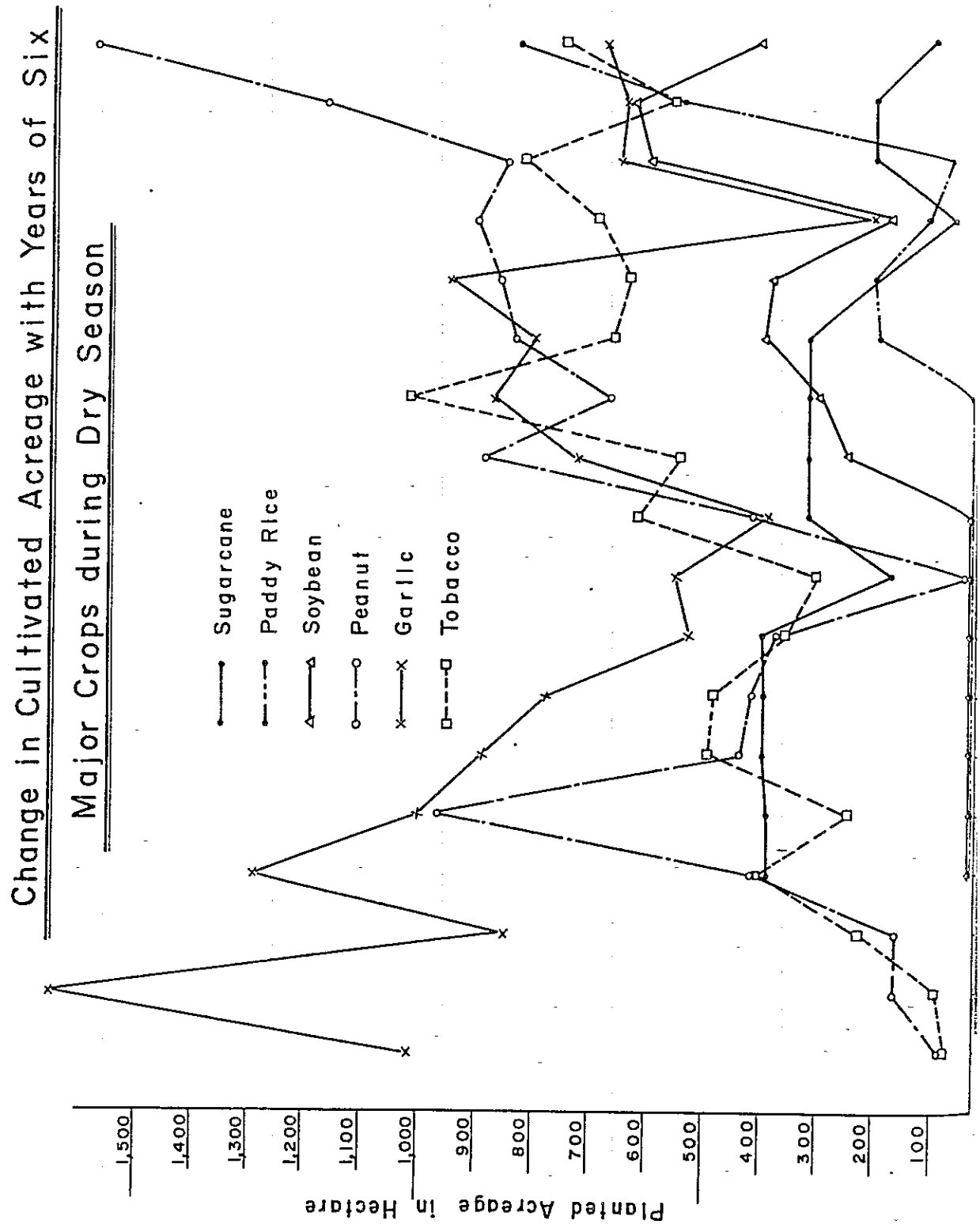
Amphor	Owner farmers			Partial-tenant farmers			Landlords			Total		
	Area			Area			Area			Area		
	ha	%	H	ha	%	H	ha	%	H	ha	%	H
Muang Lampang	20,435	87.5	16,243	429	1.8	655	2,503	10.7	1,057	23,367	100.0	17,955
Mae Tha	15,505	98.7	11,187	72	0.4	95	138	0.9	99	15,715	100.0	11,381
Ko Kha	14,055	97.0	8,914	137	0.9	135	297	2.1	198	14,489	100.0	9,247
Total	49,995	93.3	36,344	638	1.2	885	2,938	5.5	1,354	53,571	100.0	38,583

Area of Actually Cultivated land per Household, Classified by Type of Farmer*/

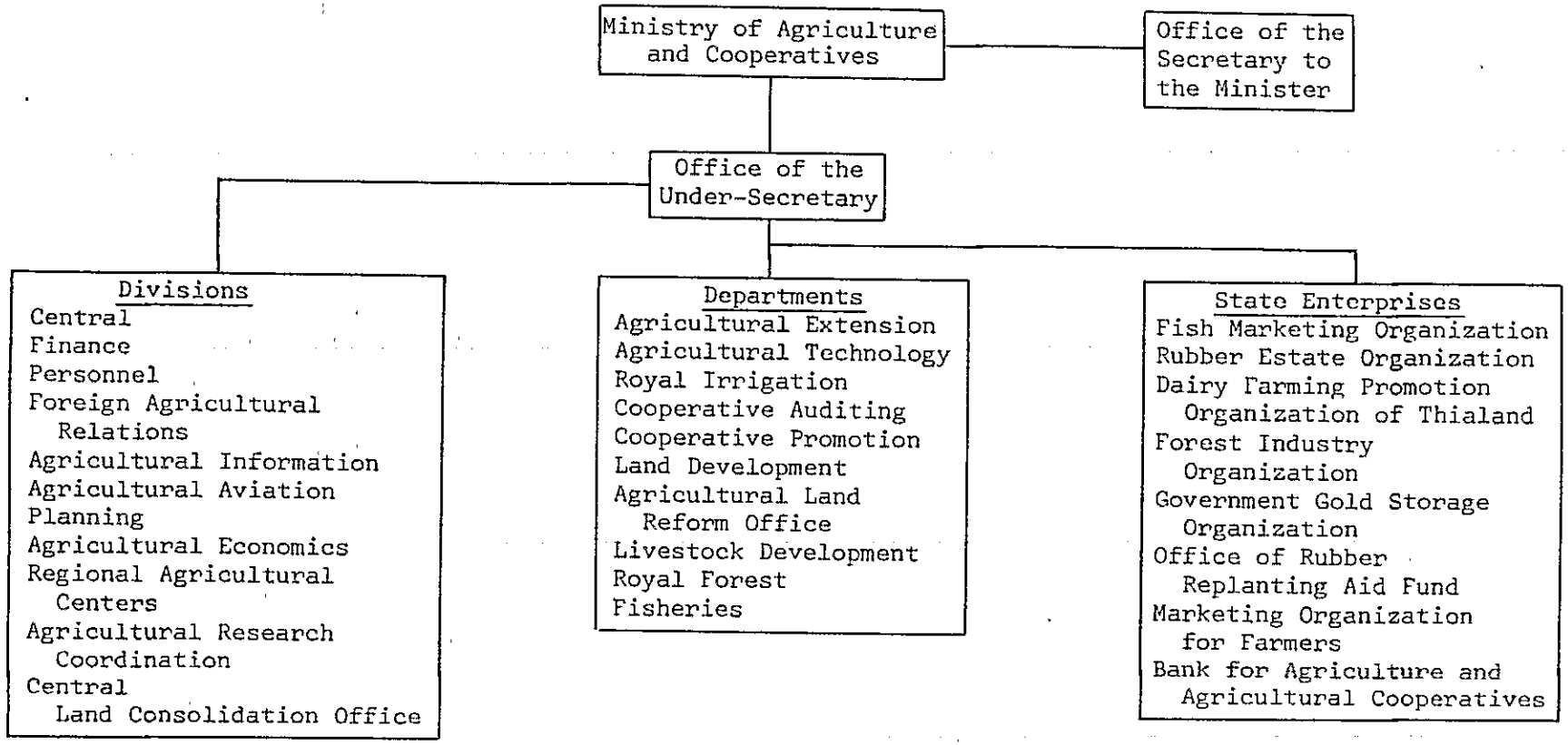
Amphor	Owner farmers			Partial-tenant farmers			Pure-tenant farmers			Total		
		Area			Area			Area			Area	
	H	ha	ha/H	H	ha	ha/H	H	ha	ha/H	H	ha	ha/H
Muang Lampang	16,243	20,435	1.26	655	1,186	1.81	624	975	1.56	17,522	22,595	1.29
Mae Tha	11,187	15,505	1.39	95	145	1.53	58	72	1.24	11,340	15,722	1.39
Ko Kha	8,914	14,055	1.58	135	301	2.23	95	123	1.29	9,144	14,479	1.58
Total	36,344	49,995	1.38	885	1,632	1.84	777	1,170	1.51	38,006	52,796	1.39

Data Source: * --- "Agricultural Land Tenure, Crop Year 1976 - 1977, Lampang Province No.75"
Department of Land Development, MOAC

Note: H = Household

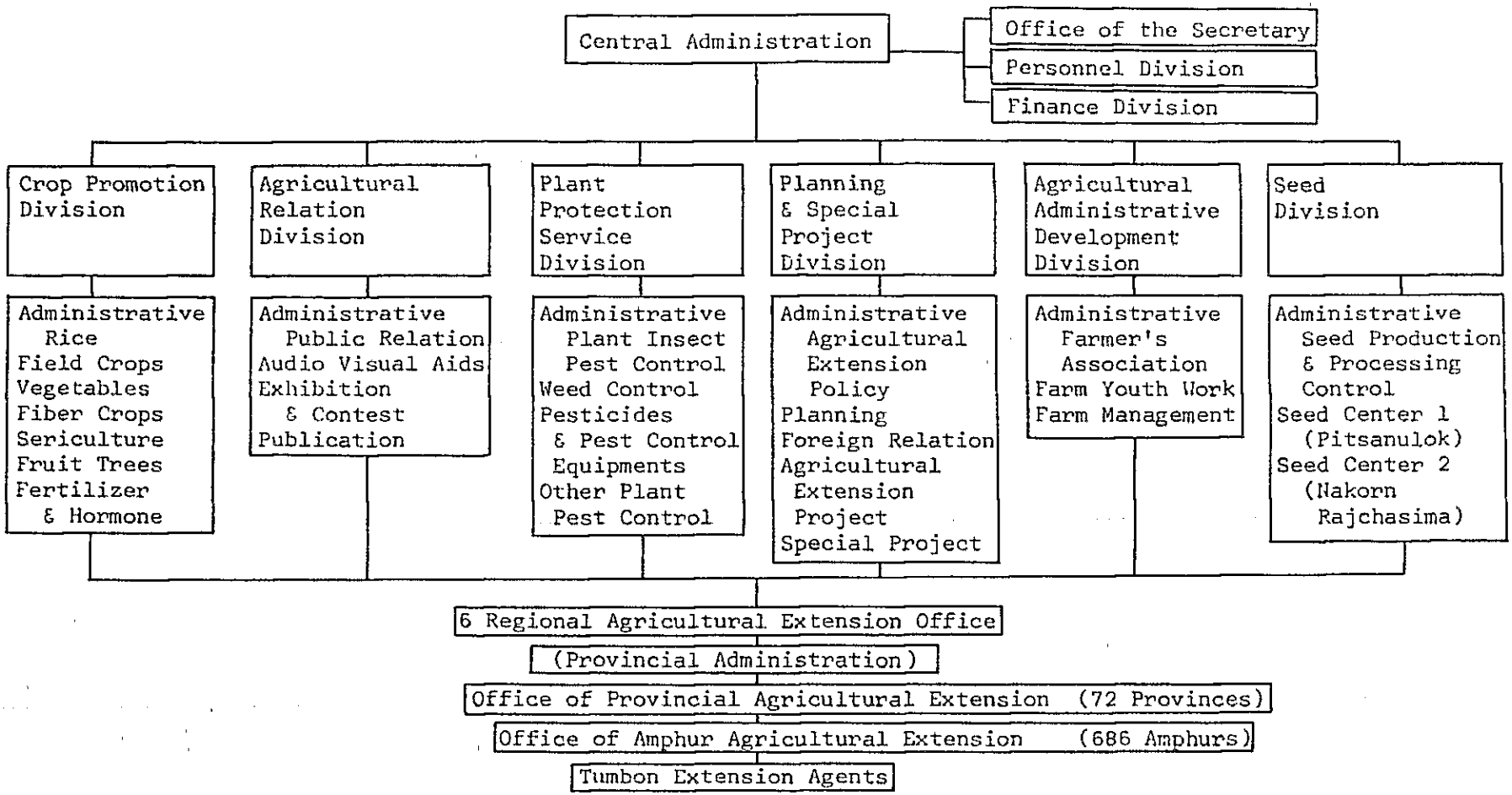

Change in Cultivated Acreage with Years of Six
Major Crops during Dry Season
Sugarcane
Paddy Rice
Soybean
Peanut
Garlic
Tobacco
Planted Acreage in Hectare
1,500
1,400
1,300
1,200
1,100
1,000
900
800
700
600
500
400
300
200
100

Organization of MOAC



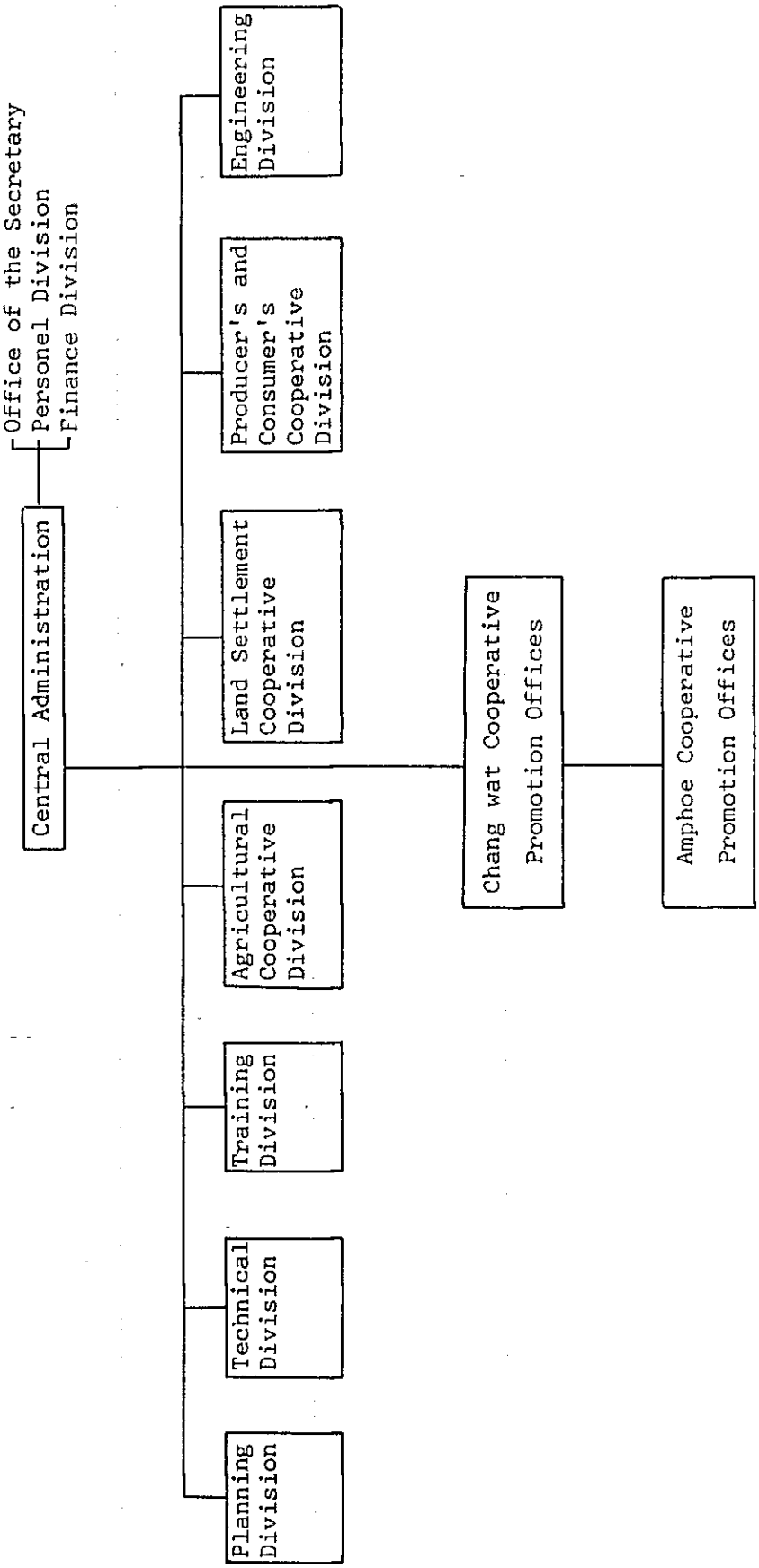
Source: National Institute of Development Administration 1979.

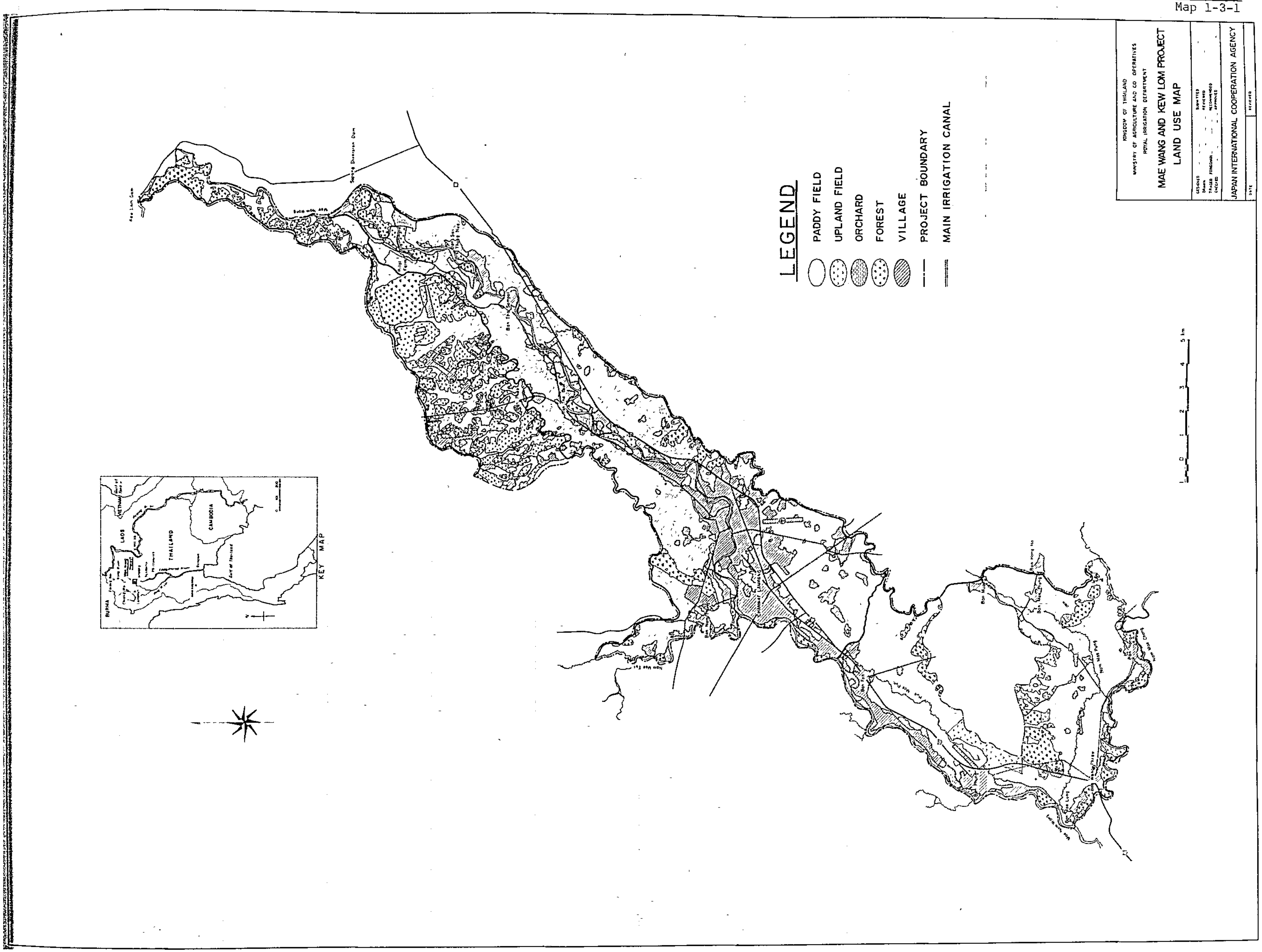
Organization of Department of Agricultural Extension, MOAC



Source: National Institute of Development Administration, 1976

Organization of Department of Cooperative Promotion MOAC




KINGDOM OF THAILAND
MINISTRY OF AGRICULTURE AND CO OPERATIVES
ROYAL IRRIGATION DEPARTMENT
MAE WANG AND KEW LOM PROJECT
LAND USE MAP
JAPAN INTERNATIONAL COOPERATION AGENCY
LEGEND
PADDY FIELD
UPLAND FIELD
ORCHARD
FOREST
VILLAGE
PROJECT BOUNDARY
MAIN IRRIGATION CANAL
THAILAND
CAMBODIA
LAOS
BURMA
KEY MAP

ANNEX 1-4. Present Irrigation, Drainage and O & M Systems

Present Irrigation, Drainage and O & M Systems

Existing Canal Length and Conditions

Name or No. of Canal	Length km	Conditions: Earth Canal km	Conditions: Concrete Lined Canal km	Remarks
Mae Wang Left Main Canal	38,450	38,450	-	
No.1 Lateral	2,760	2,760	-	
No.2 "	2,440	2,440	-	
No.3 "	1,090	1,090	-	
No.4 "	2,180	-	2,180	
No.5 "	3,140	-	3,140	
No.6 "	2,360	2,360	-	
No.7 "	0.618	0.613	-	
No.8 "	0.748	0.748	-	
No.9 "	2,040	-	2,040	
No.10 "	4,580	-	4,580	
Sub-total	60,406	48,466	11,940	
Mae Wang Right Main Canal	38,770	38,770	-	
No.1 Lateral	3,080	-	3,080	
No.2 "	1,350	-	1,350	
No.2-1 "	0.977	-	0.977	
No.3 "	1,957	-	1,957	
No.1R-3L "	1,050	-	1,050	Sub lateral
No.4 "	1,770	-	1,770	
No.4-1 "	1,185	-	1,185	
No.5 "	3,220	-	3,220	
No.6 "	2,520	2,520	-	
No.7 "	2,537	-	2,537	
No.8 "	2,300	-	2,300	
No.9 "	2,877	2,877	-	
No.10 "	1,290	-	1,290	
No.10-1 "	2,050	-	2,050	
Sub-total	66,933	44,167	22,766	

-continued-

Existing Canal Length and Conditions (cont')

Name or No. of Canal	Length	Conditions		Remarks
		Earth Canal	Concrete Lined Canal	
	m	m	m	
Mae Pung Main Canal	8,040	8,040	-	
No.1 Lateral	*	-	-	
No.2 "	*	-	-	
No.3 "	*	-	-	
No.4 "	4,500	-	4,500	
Mae Pung Right	9,600	9,600	-	
" Left	6,520	6,520	-	
Sub-total	28,660	24,160	4,500	
Total	155,999	116,793	39,206	
Kew Lom Main Canal	23,800	18,800**	5,000**	
10.4L	1,620	-	1,620	
11.2L	1,050	-	1,050	
11.2L-0.1R	0.750	-	0.750	Sub Lateral
14.5L	2,700	-	2,700	
15.2L	3,970	-	3,970	
15.2L-2.4L	1,450	-	1,450	Sub Lateral
16.6L	3,950	-	3,950	
16.6L-0.5L	1,270	-	1,270	Sub Lateral
18.3L	3,880	-	3,880	
18.3L-1.4L	1,270	-	1,270	Sub Lateral
18.3L-1.4L-0.5L	1,450	-	1,450	"
20.0L	1,440	-	1,440	
23.0L	2,830	-	2,830	
23.0L-2.0R	1,440	-	1,440	Sub Lateral
23,0L-2.1R	1,500	-	1,500	"
23.0L-2.1R-0.5L	1,725	-	1,725	"
23.3L	2,950	-	2,950	
23.8L	2,474	-	2,474	
23.8L-0.5L	3,850	-	3,850	Sub Lateral
Sub-total	65,349	18,800	46,549	
Grand Total	221,348	135,593	85,755	

* Those lateral canals are regarded as farmditch

** Assumed length

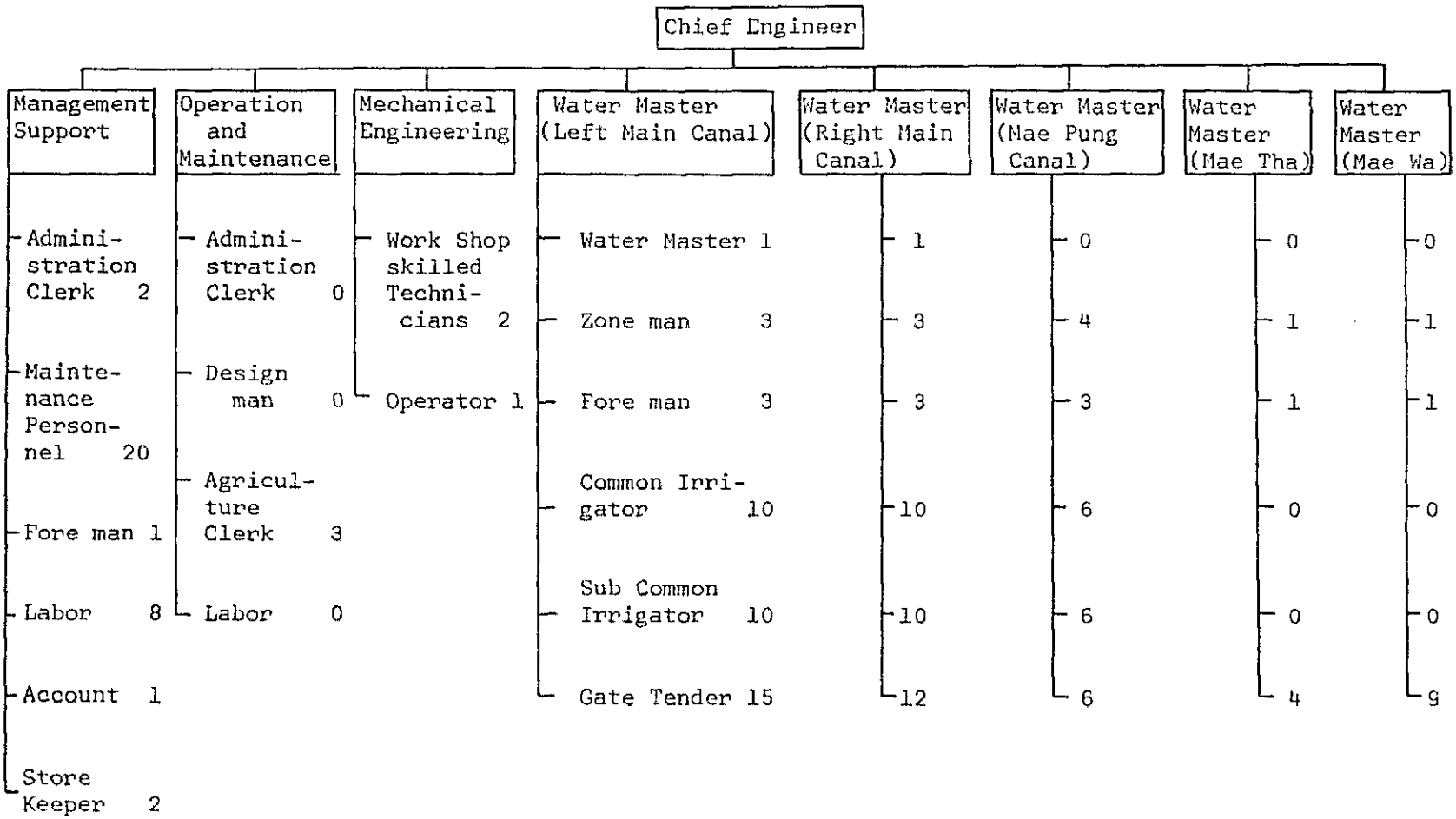
List of Structures

Canal Name	Structure	Improvement		Total
		Completed place	Incompleted place	place
Left Main Canal	Siphon	4	0	4
	Diversion	5	6	11
	Drop	1	0	1
	Bridge	12	19	31
Sub-total		22	25	47
Right Main Canal	Siphon	2	0	2
	Diversion	10	2	12
	Drop	1	0	1
	Bridge	4	20	24
Sub-total		17	22	39
Mae Pung Canal	Culvert	1	0	1
	Diversion	2	3	5
	Bridge	0	1	1
Sub-total		3	4	7
Kew Lom Main Canal	Aqueduct	1	0	1
	Diversion	10	0	10
	Bridge	4	0	4
Sub-total		15	0	15
Grand Total		57	51	108

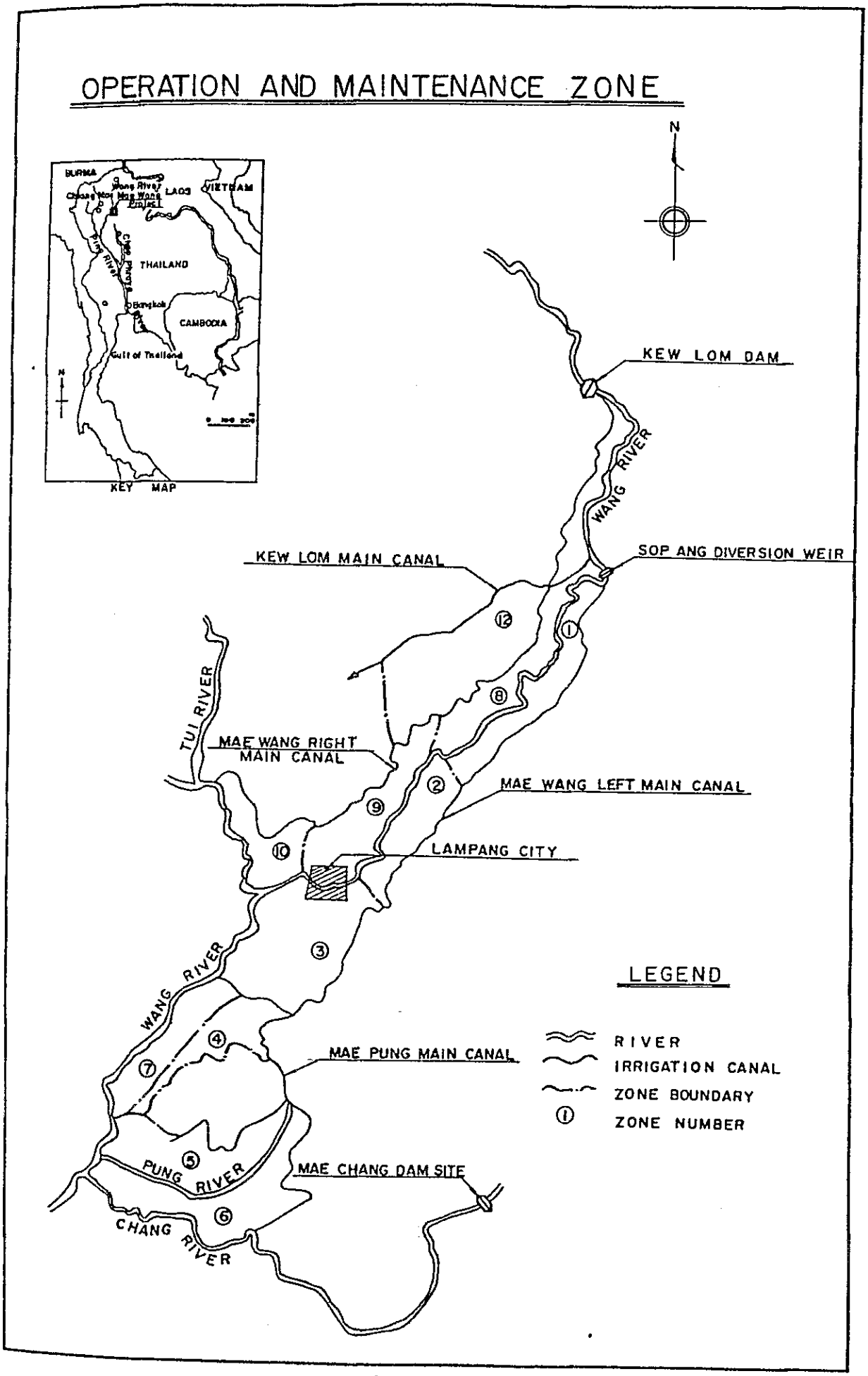
Note: Spillway and scouring sluice are fixed with each siphon.
Check gate in the main canal is fixed with each diversion work.

ANNEX 1-4
Figure 1-4-1

Organization of Mae Wang Operation and Maintenance Office



Note: Figures show the number of persons.


OPERATION AND MAINTENANCE ZONE
N
BURMA
LAOS
VIETNAM
THAILAND
CAMBODIA
Gulf of Thailand
KEY MAP
KEW LOM DAM
WANG RIVER
KEW LOM MAIN CANAL
SOP ANG DIVERSION WEIR
TUI RIVER
MAE WANG RIGHT MAIN CANAL
MAE WANG LEFT MAIN CANAL
LAMPANG CITY
WANG RIVER
MAE PUNG MAIN CANAL
PUNG RIVER
MAE CHANG DAM SITE
CHANG RIVER
LEGEND
RIVER
IRRIGATION CANAL
ZONE BOUNDARY
ZONE NUMBER

ANNEX 2. PROPOSED CROPPING PATTERN AND LAND USE

PROPOSED CROPPING PATTERN AND LAND USE

List of Tables

List of Figures

Present and Proposed Cropping Patterns (Project Area as a Whole)

Unit: ha

Crops	Present			Proposed		
	Wet Season	Dry Season	Total	Wet Season	Dry Season	Total
1. Paddy	12,300	472	12,772	13,400	4,740	18,140
2. Peanut	401	1,275	1,676	330	3,100	3,430
3. Tobacco	95	704	799	340	850	1,190
4. Soybean	144	462	606	255	800	1,055
5. Chilli	174	35	209	230	560	790
6. Garlic	0	531	531	0	1,500	1,500
7. Sugarcane	200	200	200	200	200	200
8. Pineapple	100	100	100	100	100	100
9. Vegetable	346	371	717	295	600	895
10. Orchard	250	250	250	250	250	250
	14,010	4,400	17,860	15,400	12,700	27,550

Cropping Intensity: Present --- $\frac{17,860\text{ha}}{14,010} \times 100 \fallingdotseq 127\%$, Proposed --- $\frac{27,550}{15,400} \times 100 = 179\%$

Present Cropping Pattern and Acreage

A. Wet Season

No. of Zone	Rice	Peanut	Tobacco	Soybean	Chilli	Pineapple	Sugarcane	Vegetables	Orchard	Total
1	1,015	-	-	-	50	10	-	7	90	1,172
2	843	-	-	-	-	20	-	28	0	891
3	1,775	-	-	-	-	-	-	11	10	1,796
4	623	10	5	-	-	-	-	46	0	684
5	1,383	25	13	-	-	-	50	37	0	1,508
6	1,607	-	5	-	-	-	50	16	0	1,678
7	936	25	13	25	30	-	-	68	10	1,107
8	900	-	-	30	30	-	-	-	70	1,030
9	1,240	-	-	-	-	-	-	14	56	1,310
10	627	-	-	-	20	-	-	22	14	683
12	1,351	341	59	89	44	70	100	97	0	2,151
Total	12,300	401	95	144	174	100	200	346	250	14,010

ANNEX 2
Table 2-3

Present Cropping Pattern and Acreage

B. Dry Season

No. of Zone	Rice	Peanut	Tobacco	Soybean	Chilli	Garlic	Sugarcane	Pineapple	Vegetables	Orchard	Total
1	42	91	141	-	-	21	-	10	-	90	395
2	29	88	12	-	-	46	-	20	31	0	226
3	32	123	182	173	-	103	-	-	-	10	623
4	-	103	129	6	-	33	-	-	31	0	302
5	57	123	124	-	4	16	50	-	31	0	405
6	86	95	25	9	6	23	50	-	-	0	294
7	49	25	-	66	6	15	-	-	62	10	233
8	20	91	37	98	-	15	-	-	62	70	393
9	31	119	12	35	3	92	-	-	48	56	396
10	-	115	42	17	-	36	-	-	13	14	237
12	126	302	-	58	16	131	100	70	93	0	896
Total	472	1,275	704	462	35	531	200	100	371	250	4,400

ANNEX 2
Table 2-4

Proposed Cropping Pattern and Acreage

A. Wet Season

No. of Zone	Rice	Peanut	Tobacco	Soybean	Chilli	Pineapple	Sugarcane	Vegetables	Orchard	Total
1	1,015	-	-	-	50	10	-	7	90	1,172
2	843	-	-	-	-	20	-	28	-	891
3	1,775	-	-	-	-	-	-	11	10	1,796
4	623	10	10	-	-	-	-	41	-	684
5	1,383	25	25	-	-	-	50	25	-	1,508
6	1,607	-	10	-	-	-	50	11	-	1,678
7	936	25	25	25	30	-	-	56	10	1,107
8	900	-	-	30	30	-	-	-	70	1,030
9	1,240	-	-	-	-	-	-	14	56	1,310
10	627	-	-	-	20	-	-	22	14	683
12	2,451	270	270	200	100	70	100	80	-	3,541
Total	13,400	330	340	255	230	100	200	295	250	15,400

ANNEX 2
Table 2-5

Proposed Cropping Pattern and Acreage

B. Dry Season

No. of Zone	Rice	Peanut	Tobacco	Soybean	Chilli	Garlic	Sugarcane	Pineapple	Vegetables	Orchard	Total
1	419	220	170	-	-	60	-	10	-	90	969
2	292	215	15	-	-	130	-	20	50	-	722
3	321	300	220	300	-	290	-	-	-	10	1,441
4	-	250	155	10	-	94	-	-	50	-	559
5	576	300	150	-	60	45	50	-	50	-	1,231
6	865	230	30	15	100	66	50	-	-	-	1,356
7	492	60	-	115	100	43	-	-	100	10	920
8	203	220	45	170	-	42	-	-	100	70	850
9	315	290	15	60	50	260	-	-	78	56	1,124
10	-	280	50	30	-	100	-	-	22	14	496
12	1,257	735	-	100	250	370	100	70	150	-	3,032
Total	4,740	3,100	850	800	560	1,500	200	100	600	250	12,700

ANNEX 2
Table 2-6

Present Land Use for Each Zone

Unit: hectare

No. of Zone	Rice Field	Upland	Orchard	Sub-total	Forest	Village	Others	Total
1	1,015	67	90	1,172	117	222	121	1,632
2	843 (66)	48 (0)	0 (0)	891 (66)	174 (0)	576 (81)	54 (0)	1,695 (147)
3	1,775 (889)	11 (11)	10 (6)	1,796 (906)	50 (0)	1,001 (930)	90 (52)	2,937 (1,888)
4	623	61	0	684	176	44	10	914
5	1,383	125	0	1,508	378	124	45	2,055
6	1,607	71	0	1,678	258	208	112	2,256
7	936	161	10	1,107	25	581	197	1,910
8	900	60	70	1,030	154	281	67	1,532
9	1,240 (99)	14 (3)	56 (0)	1,310 (107)	118 (17)	541 (258)	53 (20)	2,022 (429)
10	627 (222)	42 (30)	14 (6)	683 (258)	73 (0)	239 (166)	31 (15)	1,026 (439)
12	1,351	1,590	0	2,941	1,477	183	120	4,721
Total	12,300 (1,276)	2,250 (49)	250 (12)	14,800 (1,337)	3,000 (17)	4,000 (1,462)	900 (87)	22,700 (2,903)

Note: Figures in the parentheses indicate the Lampang City Planning Area

ANNEX 2
Table 2-7

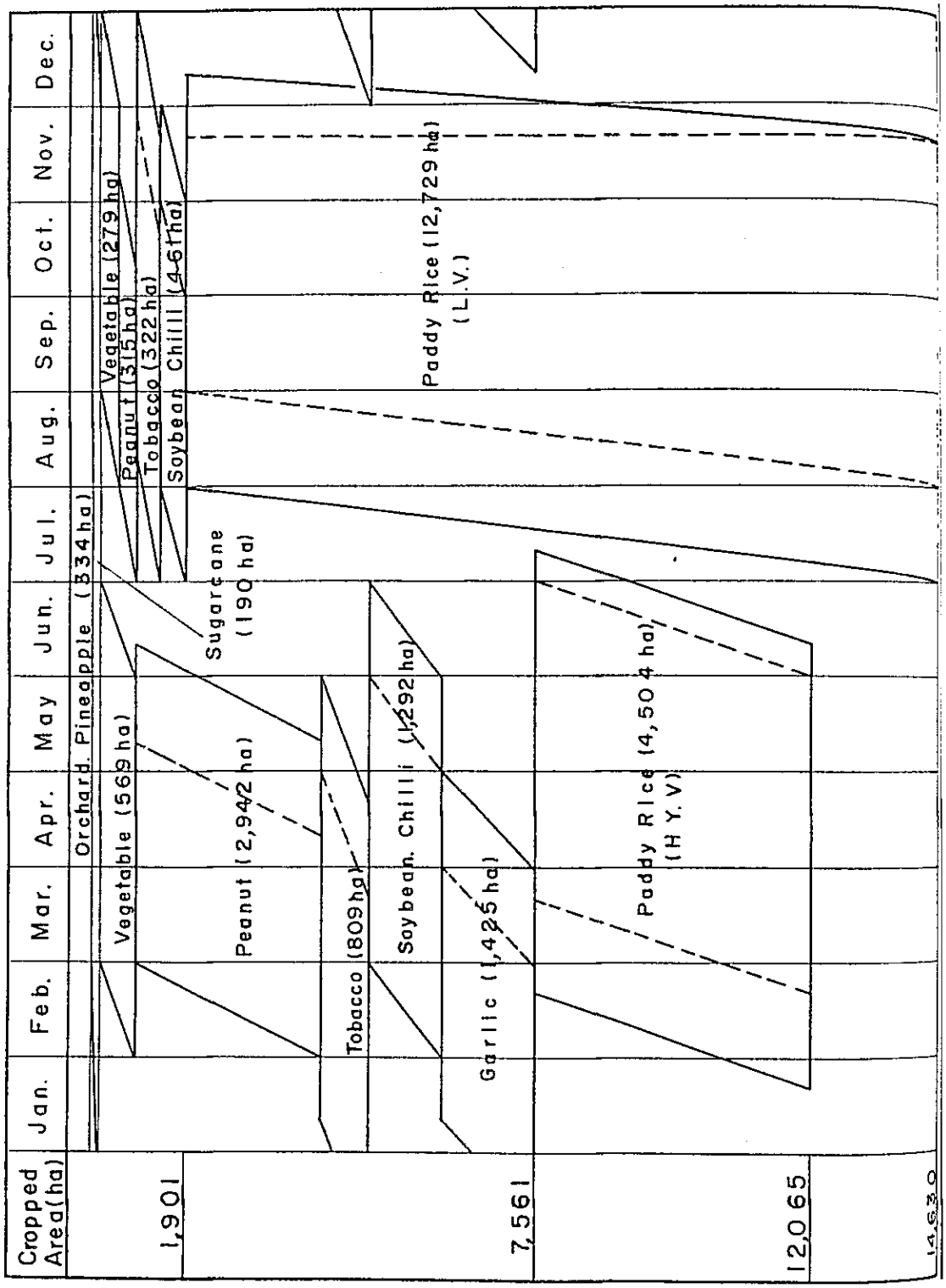
Proposed Land Use for Each Zone

Unit: hectare

No. of Zone	Rice Field	Upland	Orchard	Sub-total	Forest	Village	Others	Total
1	1,015	67	90	1,172	117	222	121	1,632
2	843 (66)	48 (0)	0 (0)	891 (66)	174 (0)	576 (81)	54 (0)	1,695 (147)
3	1,775 (889)	11 (11)	10 (6)	1,796 (906)	50 (0)	1,001 (930)	90 (52)	2,937 (1,888)
4	623	61	0	684	176	44	10	914
5	1,383	125	0	1,508	378	124	45	2,055
6	1,607	71	0	1,678	258	208	112	2,256
7	936	161	10	1,107	25	581	197	1,910
8	900	60	70	1,030	154	281	67	1,532
9	1,240 (99)	14 (8)	56 (0)	1,310 (107)	118 (17)	541 (285)	53 (20)	2,022 (429)
10	627 (222)	42 (30)	14 (6)	683 (258)	73 (0)	239 (166)	31 (15)	1,026 (439)
12	2,451	1,090	0	3,541	877	183	120	4,721
Total	13,400 (1,276)	1,750 (49)	250 (12)	15,400 (1,337)	2,400 (17)	4,000 (1,462)	900 (87)	22,700 (2,903)

Note: Figures in the parentheses indicate the Lampang City Planning Area.

PROPOSED CROPS CALENDAR



ANNEX 3. IRRIGATION AND DRAINAGE SCHEME

ANNEX 3. IRRIGATION AND DRAINAGE SCHEME

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ANNEX 3-1. Irrigation Scheme

Irrigation Scheme

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Irrigation Scheme

3.1.1. Water resources

(1) Present conditions

The water resources of the Project depends upon the Kew Lom Dam located about 14 km upstream of the Sop Ang Diversion Dam. The Kew Lom Dam is the concrete gravity type dam constructed in 1972, providing 110 MCM storage capacity. The dimensions are shown as follows:

Kew Lom Reservoir

Catchment area	2,700 km^2
Maximum operating water elevation	285 MSL
Minimum operating water elevation	272 MSL
Surface area: water elevation at 285 MSL	16 km^2
Surface area: water elevation at 272 MSL	2 km^2
Capacity: water elevation at 285 MSL	112 MCM
Capacity: water elevation at 272 MSL	10 MCM
Dam type	Concrete gravity
Dam crest elevation	286.5 MSL
Spillway type	Gauged dam-flow with elevated flip
Spillway elevation	277.4 MSL
Maximum spillway discharge, water elevation	285 MSL

The annual runoff measured at Kew Lom Dam site ranges from 310 MCM to 1,500 MCM, as compared with which the reservoir capacity is small. That is because the reservoir capacity was forced to be designed small with lower embankment due to social constraints with submergency of a town in the upstream, although a large capacity reservoir with high embankment would be available in terms of topography, geology and dam engineering. The RID has planned to construct the Kew Kor Mah Dam upstream of the Kew Lom Dam for the development of another water resources.

The Kew Lom Main Canal, which is now under construction, was so designed with canal capacity of 25.0 m^3/sec as to meet the irrigation demands for the Kew Lom area of about 19,000 ha including Kew Lom Stage I, II the beneficial area on the Mae Wang Right Bank, and the proposed Kew Lom Stage III area to be benefited by planned Kew Kor Mah Dam, extending west of the Tui River.

The Kew Kor Mah Dam, when completed, is planned to release the monthly average 11 MCM water to the Kew Lom Dam. According to the present operation rule of the Kew Lom Dam, however, the Dam usually releases the water by 12.00 m^3/sec to the Wang River and in case the pool elevation exceeds the spillway crest elevation of 277.4 MSL, the spillway gates are operated according to the operation rule taking into account the stability of dam body as well as expected flood damages in the downstream areas.

Therefore, the Kew Lom Dam has presently made ineffective discharge in considerable amount, but will allow the more effective water utilization to be available by controlling the said ineffective discharge from the Dam.

The Sop Ang Diversion Dam diverting the irrigation water to the Mae Wang Left Main Canal, has such a small residual catchment area that the necessary amount of water to the canal has been supplied from the Kew Lom Dam.

(2) Future planning in the Wang River Basin

The existing irrigation water source in the MK-IADP area depends on the Kew Lom Dam and the intake facilities are the Kew Lom Dam and the Sop Ang Diversion Dam.

The irrigated areas by these facilities extend on both the left and the right banks of the Wang River and another irrigated area is the Kew Lom area which is supplied with water conveyed through the Kew Lom canal. A plan has been made to develop the irrigated agriculture in the Lampang area and its surroundings in the Wang River

basin, and another four dams, besides the Kew Lom Dam, are planned to be constructed for the purpose. (By Kew Lom Project Feasibility Report, Volumes I and II by ECI).

The outline of these dam construction schemes and their related irrigable areas are shown as follows:

Name of Dam Site	Reservoir Capacity (MCM)	Irrigable Area (ha)
Kew Kor Mah	260	43,200 (270,000 rai) *1)
Kew Lom (existing)	112	21,300 (113,300 rai) *2)
Mae Tui	135	7,800 (49,000 rai)
Mae Yao	68	4,300 (27,000 rai)
Mae Chang	175	15,800 (99,000 rai)

*1) -- Kew Kor Mah = Chae Hom + Mae Wang + Kew Lom

43,200 = 10,400 + 14,080 + 18,720

(270,000) = (65,000) (88,000) (117,000) ( ): rai

11 MCM per month can be released to Kew Lom Dam.

*2) -- The area will be included in the irrigable areas by Kew Kor Mah Dam, when the dam is completed.

The general map concerning these dam construction schemes is shown in Fig. 3-1-1.

Among the above projects now under contemplation, those which will concern the MK-IADP are the Kew Kor Mah Dam Project and the Mae Chang Dam Project.

Kew Kor Mah Dam Project

The Kew Kor Mah Dam, as mentioned previously, will be constructed in the upstream of the Kew Lom Dam, and about 43,000 ha of the areas including the Project Area, will be irrigated by two dams, the existing Kew Lom Dam and the proposed Kew Kor Mah, in future.

Mae Chang Dam Project

The proposed Mae Chang Dam will command the areas around the Mae Tha area, and the RID has been working out the construction programme of this dam. As a part of the beneficial areas under this project, the Mae Pung area involved in the MK-IADP is included. The proposed dimensions of the Mae Chang Dam are illustrated as follows:

Catchment area	1,100 km^2
Capacity at the Maximum Retention Level	135 MCM
Capacity at the Minimum Storage	25 MCM
Effective Capacity	110 MCM
Crest Elevation	268 MSL
Maximum Retention Elevation	265.5 MSL
Minimum Storage Elevation	256.0 MSL
Dam Height	28.0 m
Commandable Area	100,000 rai (16,000 ha)

Source: General Descriptions of the Project prepared by RID, 1975.

3.1.2. Irrigation scheme

(1) Irrigable areas

For making the irrigation scheme of the Project, it is required to clarify the relationship between the irrigation water requirement estimated on the proposed land use and the available amount of water to be released from the Kew Lom Dam.

The MK-IADP include the Kew Lom Stage I (Kew Lom Extension) area, Mae Wang area and Mae Pung area as major project area, and in addition to the above three areas, the Kew Lom Stage II area can be taken into consideration on the following basis for the water balance study.

According to the ECI's Feasibility Study Report, the total beneficial area covered by Kew Lom Dam was estimated at about 21,300 ha (133,300 rai) containing the Mae Wang area, Mae Pung area and Kew Lom extension area.

Therefore, there is a partial difference in the beneficial areas between the estimation made by ECI and that made by the current study of MK-IADP.

However, the total irrigable area of the MK-IADP and Kew Lom Stage II in consideration of cropping intensity will have almost the same acreage as commandable area of Kew Lom Dam by the ECI's estimation.

The irrigable area available on the basis of the above estimation is tabulated in Table 3-1-1.

(2) Diversion water requirements

(a) Basic concept for estimating diversion water requirements

The diversion water requirements will be estimated by the following formula:

- Net Water Requirements = Crop Consumptive Use + Percolation + Water Requirements for Field Preparation (land preparation, etc.)
- Field Water Requirements = Net Water Requirements - Effective Rainfall + Field Losses
- Diversion Water Requirements = Field Water Requirements + Conveyance and Operation Losses

(b) Crop consumptive use (Cu)

Crop consumptive use can be obtained by multiplying evapotranspiration by crop factors (K) which varies with the respective crop growths.

Evapotranspiration

The estimate of evapotranspiration can be made by either computing/using the observation values of Pan-evaporation or applying meteorological data to the empirical formula. The evapotranspiration employed in this study was obtained by the Penman method. The meteoro-

logical data required for computation, such as temperature, wind velocity, etc. were obtained from the records observed at Lampang station for 25 years (1951-1975).

The estimated evapotranspiration for the Project is illustrated as follows:

Evapotranspiration (ET)

Month	mm/day	mm/month
January	2.70	83.7
February	3.42	95.8
March	4.29	133.0
April	4.99	149.0
May	4.54	140.7
June	3.83	114.9
July	3.52	109.1
August	3.21	99.5
September	3.32	99.6
October	3.26	101.1
November	2.79	83.7
December	2.50	77.5
Total or Average	3.53	1,288.3

The above estimated evapotranspiration found that the maximum value appears by 4.99 mm/day in April, while the minimum value by 2.50 mm/day in December. The annual evapotranspiration reaches 1,288 mm, which is as much as 1.5 times of 835 mm of the annual evaporation.

Crop factor (K)

The crop factors of each crop in varying with their growing stages are adopted as follows:

Crop Factors (K)

Month	LV	HLY	Sugarcane	Upland Crops	Vegetable Orchard
1st	1.0	1.0	0.6	0.4	0.7
2nd	1.0	1.25	0.8	0.7	0.7
3rd	1.2	1.35	1.0	1.0	0.7
4th	1.35	1.3	1.2	0.8	0.7
5th	1.3	1.1	1.25	0.5	
6th	1.2		1.2		
7th	1.1		1.15		
8th			1.0		
9th			0.85		
10th			0.65		
11th			0.6		
12th			0.5		

Note: Above factors are based on the actual measurements by Irrigated Agricultural Section, RID in 1979.

The consumptive use of proposed crops for the Project, which was derived from Crop factors and evapotranspiration was on the basis of 10-day unit (Table 3-1-2). The said results show that the maximum consumptive use appears by 7.69 mm/day in the second decade of April for the dry season paddy cropping and by 5.27 mm/day in the second decade of September for the wet season of paddy cropping.

(c) Percolation

Percolation varies largely with the soil feature of the farm lands. According to the soil survey carried out for the Project, the soils in the Area generally are clayey soils with comparatively small percolation rate.

Percolation for the Project was determined by measurements carried out at eight selected points as shown in Fig. 3-1-2. The results obtained from the measurement are shown below.

Test Site No.	Surface Soil Texture	Percolation Rate * (mm/day)	Period (1979)
1	SL	1.0	20 Sep - 4 Oct.
2	SiCL	0.6	-ditto-
3	CL-L	0.6	-ditto-
4	SL	2.6	5 Sep. - 30 Sep.
5	SL	0.5	9 Sep. - 15 Sep.
6	SL - L	0.4	9 Sep. - 18 Sep.
7	SL	0.3	9 Sep. - 17 Sep.
8	SCL - CL	3.6	9 Sep. - 15 Sep.
Mean		1.1	

Note: * --- Percolation rate is the average of the values obtained by two measurements at every site.

The results revealed that most of the soils in the Area, except for those in the sites No. 4 and 8, have small percolation rate ranging from 0.3-1.0 mm/day. It must be, however, noted that the above values are obtained by a short-period observation and may have some errors.

The percolation value was eventually determined by 1.0 mm/day for the both dry and wet seasons based on the measurement data and the results employed in other project studies in the country.

(d) Water requirements for other preparatory works (land preparation, etc.)

Water requirements for land preparation in paddy cropping and those for preparatory works in upland cropping should be considered in addition to crop consumptive use in any croppings. The crop-wise general water requirements are shown as follows:

Crop	Additional Water Requirements (mm)
Paddy	200
Sugarcane	50
Upland	40

The land preparation is determined to take 30 days according to the proposed cropping pattern and the farming practices currently

exercised. The water should be applied for 90 days for preparatory works of sugarcane cropping, for 40 days for tobacco cropping, and for 30 days for other upland cropping.

(e) Effective rainfall

The Master Plan Study on the Greater Mae Klong River Basin (under JICA) has carried out the analysis that the effective rainfall in the basin has been simulated by the tank model method using observation records kept at 21 gauging station. Hence, the relationship between the rainfall and the effective rainfall was found out as follows. The results which are shown below are almost equal to the effective rainfall computed by RID.

Crops	Effective Rainfall	Upper Limit (mm)	
		One Month	10-Days
Paddy	0.75 R	200	70
Sugarcane	0.75 R	150	50
Upland	0.75 R	120	40

Note: R -- Rainfall (mm)

The monthly effective rainfall estimated using the records observed at Lampang Station for 27 years (1952-1978) is shown in Tables 3-1-3 and -4. The tables revealed that the diversion water requirements for the wet season paddy cropping were largely affected by effected rainfall. Thereby, the probable effective rainfall, which is necessary for computing the diversion water requirements, is shown below.

Unit: mm

Probable Year	Paddy Field		Upland Fields	
	Jul-Nov.	Annual	Jul-Nov.	Annual
1/2	458.8	726.3	361.7	579.4
1/5	389.4	627.2	319.5	512.7
1/10	356.3	577.5	299.4	480.7
1/20	330.5	537.4	283.7	455.6

Note: The details are shown in Table 3-1-5.

It was learned from the above that the year of 1967 has fallen near under the 10-year probable rainfall year. In this study, the water requirements are estimated on the decade (10-day) basis. Then, the decade basis probable rainfalls in July and August, when much more water is required are estimated as follows:

Unit: mm

		Paddy Fields			Upland Fields		
		1/2	1/5	1/10	1/2	1/5	1/10
Jul.	1	18.2	7.6	4.3	18.3	8.6	4.9
	2	20.7	8.7	4.9	20.1	9.6	5.4
	3	33.7	17.5	10.9	29.4	17.9	12.1
Aug.	1	30.7	17.3	11.6	24.4	12.4	8.7
	2	46.0	26.9	17.6	30.2	19.3	15.3
	3	47.0	27.3	20.6	33.4	22.6	18.5

Note: The details are shown in Table 3-1-6.

(f) Losses

(1) Field loss

A part of irrigation water to be supplied to the fields will become losses as horizontal and vertical percolation in the fields, or surface runoff. Therefore, the field water requirements should be estimated by the following equation:

$$FWR = \frac{NWR - ER}{Ef}$$

Where,

FWR: Field water requirements
NWR: Net water requirements
ER: Effective rainfall
Ef: Field efficiency

The field efficiency varies with different irrigation method and field conditions, and this study adopted 0.7 for paddy fields and 0.60 for upland field.

(2) Conveyance loss and operational loss

Some water losses take place while the water is conveyed through the main and lateral canals. The conveyance loss varies with different structures of the canals concerned.

The operational loss, which varies with operation method to be adopted in case of raining, can be considered as almost zero in the dry season.

In taking these water losses, the diversion water requirements to be required at the diversion site can be computed by the following equations:

$$DWR = \frac{FWR}{Ec \times Eo} = \frac{NWR - ER}{Ef \times Ec \times Eo}$$

Where,

DWR: Diversion water requirements
FWR: Field water requirements
NWR: Net water requirements
ER : Effective rainfall
Ef : Field efficiency
Ec : Conveyance efficiency
Eo : Operation efficiency

In this study, the conveyance efficiency adopted 0.90 for concrete-lined canals and the operation efficiency adopts 0.95.

(g) Diversion water requirements

According to the aforesaid various conditions and the proposed cropping pattern illustrated in Fig. 3-1-3, the diversion water requirements were estimated on the 10-day basis for 26 years (1953-1978).

From the above results, the crop-wise diversion water requirements necessary in 1967 when the 10-year probable rainfall took place, are listed in Tables 3-1-8, -9, and -10, respective. The tables show that the maximum diversion water requirements are necessary for paddy cropping in either the dry season and the wet season by 1.9 l/s/ha and 1.6 l/s/ha, respectively.

The crop-wise diversion water requirements by seasons can be illustrated as follows:

Diversion Water Requirements in 1967

Unit: mm

	Rice	Peanuts	Tobacco	Soybean Chilli	Garlic	Vegetable Fruits	Sugar cane	Weighted Average*
Dry	1,386	431	570	472	464	757	1,223	557
Wet	835	102	173	128	-	214	268	189

* -- Acreages of each upland crop which are used in the computation of the requirements are shown below.

Unit: ha

	Peanuts	Tobacco	Soybean Chilli	Garlic	Vegetable Fruits	Sugarcane
Dry	3,076	902	1,410	1,395	1,476	490
Wet	307	317	451	-	822	490

(h) Estimation of water requirements for designing facilities

The canals for the Project should be designed based on the unit water requirements in 1967 when the effective rainfall corresponds to the 10-year probable rainfall.

In this estimation, the effective rainfall in the wet season is taken into consideration but that in the dry season is not. This is because it is impossible to take rainfall with certain probability in the dry season into consideration due to an extremely little rainfall and unstable rainfall pattern in the dry season. For upland cropping in the Area, since the kinds of crops to be grown are abundant and water requirements and cropping were determined by weighted average of the respective upland crops. The results of computation are shown in Table 3-1-1.

(3) Water balance computation

(a) Basic concept

Water balance computation was carried out to clarify the relationship between diversion water requirements obtained by estimation based on the zone-wise proposed land use and the water amount to be released from the Kew Lom Dam. The water balance study for the Project was conducted in taking into account the future water resources planning including the existing Kew Lom Dam. The Project related water resources now under contemplation include the Kew Kor Mah Dam and the Mae Chang Dam as mentioned previously.

The proposed Kew Kor Mah Dam to be constructed upstream the Kew Lom Dam will stably supply the water to the Kew Lom Dam, so as to expand the irrigable areas in the Wang River Basin including this Project Area by more effective water utilization. The Kew Lom Dam will be a main water resource for the Project before completion of Kew Kor Mah Dam. The Mae Chang Dam is planned to command the Mae Pung area as a part of its whole irrigable area as described in this annex. However, at present, the Mae Pung area has been supplied with irrigation water by the Kew Lom Dam through the Mae Wang Left Main canal and the Mae Pung canal which are linked. Therefore, before completion of the Mae Chang Dam, the Kew Lom Dam will be a water resource of the Mae Pung area.

Subsequently, the water balance computation for the Kew Lom Dam as a water resource was carried out in the case study of (1) the case of including the Mae Pung area, and (2) the case of excluding the Mae Pung area. The detailed water balance computation for a dam requires to perform a simulation analysis to cover a considerably long term. Thereby, in the current study, the simulation analysis on the 10-day basis was carried out for the recent 26 years (1953-1978).

(b) Runoff discharge at dam site

The water balance computation for the Kew Lom Dam required to obtain the runoff discharge at dam site on the 10-day basis for 26 years (1953-1978). The runoff discharge observation at dam site has been carried out since 1962, and the water released from the Dam and the storage water surface level have been observed since 1972 when the Kew Lom Dam was completed. The runoff discharge data covering the period between 1962 and 1972 were taken from the observation records and the data covering the period after 1972 were computed based on the water released from the Dam and the storage water surface level. The runoff discharge data for 1953-1961, for which the observation records are unavailable, were to be estimated.

The observation records available for the Wang River discharge cover a comparatively short period from 1969 and onward, except for the records kept at Kittikhachon II Bridge at Lampang city. Accordingly, the runoff discharge at the dam site was estimated using the values observed at the said bridge point. The monthly mean runoff discharges at these two points 1962 through 1972, before completion of the Dam, are shown in Figure 3-1-4, which illustrates that in a greater part of the year, except for August, September and October in the wet season, more runoff discharge took place at the dam site than that at the Kittikhachon bridge and the difference between the two became remarkable in the dry season. It is considered that operation of the Sop Ang Diversion Dam at the downstream would affect to the discharges. The observation of the diversion water amount at the Sop Ang site was started in 1968 in Table 1-1-12 and the amount of water diverted averages at 142 to 213 MCM per annum and annual fluctuation range in the amount is very small.

The annual mean runoff discharges at Kittikhachon and at the dam site, in taking the annual diversion water into account are almost the same in their orders, 217 mm and 200 mm, respectively.

Furthermore, a very close correlationship is found between the decade basis runoff discharges at Kittikhachon site and at the dam site in a period 1968 through 1971, before completion of dam, taking into consideration the annual diversion water (Figure 3-1-5). The runoff discharges at dam site for 1953 to 1961 were estimated based on the correlationship found between them. The water diverted at the Sop Ang site for the period was estimated using the monthly average amount of water diverted 1968 through 1978. The estimated runoff discharges based on various studies and computations are shown in Table 3-1-12.

(c) Flow discharge at Sop Ang Diversion Dam site

The discharge at Sop Ang site are obtained by the discharge water released from the Dam plus the runoff from the residual catchment area. The residual catchment area covers only small area of 245 km^2, the runoff discharge from which was computed using the specific discharge at the dam site. Hence, the daily mean runoff discharge from residual catchment area ranges from 0.9 to 15.5 MCM and the annual mean is as small as 58.0 MCM.

(d) Evaporation

The observation data are not available on evaporation from the water surface in the reservoir. Therefore, the Piche-evaporation records kept at the Lampang observation station were adopted in this study (Table 1-1-2).

(e) Water balance computation

In the Project Area, the Kew Lom Canal, to which the water is diverted from the Kew Lom Dam, has irrigated the Mae Wang Right Bank, Kew Lom Stage I and II areas, and the Mae Wang Left canal, to which the water is diverted from the Sop Ang Diversion Dam, has irrigated the Mae Wang Left Bank area and the Mae Pung area.

The annual diversion water requirements on an average are shown in the following table by the respective areas:

Water Resources	Diversion Water Requirement (MCM)
Kew Lom Dam	
Mae Wang Right	33.3
Kew Lom Stage I	41.4
Kew Lom Stage II	28.5
Sub-total	103.2
Sop Ang Diversion	
Mae Wang Left	67.1
Mae Pung	43.3
Sub-total	110.5
Total	213.7

The water balance computation was proceeded as follows:

- o The case study was conducted for the following cases:
  - (1) The case including the Mae Pung area, and,
  - (2) The case excluding the Mae Pung area.

Operation of the spillway gates has been presently performed according to the operation rule set up on the basis of the stored water level and the rainfall at the upstream of the Dam. During the irrigation period, the Sop Ang Diversion Dam presently has a responsible discharge by 12 m^3/s.

The water balance study revealed that the dam operation according to the above rule has caused a considerable shortage in irrigation water supply in the dry season due to a large amount of ineffective discharge (Figure 3-1-6).

In order to improve the situation, following modifications to the present operation rule are necessary for securing the ample amount of water for irrigation.

(i) The responsible discharge from the dam should be released in the amount indicated in Table 3-1-13 in taking into account the fact that the runoff discharge from the residual catchment area of the Sop Ang Diversion Dam is little expected, in considering water demand of the Mae Wang Left Bank area and the Mae Pung area. The water level in the reservoir should be kept at full water level in December before transplanting the dry season paddy.

(ii) The ineffective discharge from dam should be possibly minimized, particularly in the dry season, except for the responsible discharge, although the specific operation rule of the spillway gates for flooding period will not be set up.

The water balance computation was made on the above rule and the results are illustrated in Figure 3-1-7 to -9. As the results of the study, the average total runoff discharge at the dam site is 663 MCM, and this amount of water is estimated at three times of the annual average diversion water requirements of 214 MCM.

The water shortage takes place in the following particular years:

Year	Inflow (MCM)	Diversion Water Requirements (MCM)		Amount in Short (MCM)	
		Case-1	Case-2	Case-1	Case-2
1965	421	216	172	13	0
1967	501	241	193	34	14
1972	483	196	155	16	0

Note: The above table carries those years with short supply over 10 MCM.

Ordinarily, the water shortage takes place in July when the land preparation is carried out in paddy field (Table 3-1-14). The causes of the water shortage in the respective drought years will be considered as follows:

- In 1965 and 1972, the total annual runoff discharges were 421 MCM and 483 MCM which are almost equivalent to that of the annual average, but the runoff discharges in July were as small as 7.7 MCM and 8.5 MCM, respectively, which are less than 9.5 MCM of the 10-year probable runoff in July. The effective rainfall took place in July, 1965 is equivalent to that with 10-year return period (Table 3-1-15).

- The year of 1967 met the severest water shortage in 26 years. The total annual runoff discharge in 1967 was 501 MCM which is almost at the normal level, but the dry season of that year (November to following April) had 66.1 MCM of runoff discharge which approximate to 66.4 MCM of the 10-year probable runoff discharge. The total effective annual rainfall of that year in the Project Area was 554 mm, which is almost equivalent to that with the 10-year return period.

The above study found that the water shortages have taken place in those drought years with the 10-year return period. However, the water shortage taking place in the above scale will be avoided when the effective water utilization is realized by systematic operation of two dams of the Kew Lom and the Kew Kor Mah to be constructed at the upstream of the Kew Lom Dam.

3.1.3. Physical planning for irrigation

(1) Necessity of irrigation canal improvement

The annual O & M costs expended by the Mae Wang O & M Office are detailed below. The said costs cover the services rendered for the Mae Wang left and right main irrigation canals Fiscal 1975 through 1979.

(Unit: ฿1,000)

Fiscal Year	Canal Improvement	Canal Repair	Office Expense	Total
1975	2,475	930	2,881	6,286
1976	2,975	492	2,965	6,432
1977	4,000	1,068	3,171	8,239
1978	4,140	1,075	3,744	8,959
1979	4,710	546	4,396	9,652
Average	3,660	822	3,431	7,914

The annual average cost spent for repairing the canals amounted to about ฿822,000, and was estimated to total about one million Baht, when including the repair works for the Mae Pung left and right main canals. A total O & M cost to be required during n-years of facilities life can be obtained by the following equation in assuming the annual price escalation rate to be six percent.

$$\text{Total O \& M cost} = (\text{O \& M cost for the first year}) \times \frac{1 - r^n}{1 - r}$$

In taking the durable period of earth canals and concrete canals by 15 years and 30 years, respectively, the total investment for O & M for 30 years was estimated as follows:

Canal Type	Repair/Rehabilitation Cost	O & M Cost	Total
Earth canal	71,119/1	79,058	150,177
Concrete canal	121,473	12,290/2	133,763
Difference	(-)50,354	66,768	16,414

NOTE: /1 -- The repair cost for the earth canal contains the cost for the first repair and that for rehabilitation at 16th year. The said repair and rehabilitation cost was estimated by the following equation:

R/R cost (฿71,119) = {Earth work cost (฿24,370) + Rehabilitation cost for structures (฿22,379)} + {Earth work cost (฿24,370)}

/2 -- The O & M cost for concrete canal was estimated at about one million Baht for every O & M service to be made once for every five years after completion of the Project, and the equation employed for this estimation is shown below.

$$O \& M = 1{,}000\ (1.06^{4} + 1.06^{9} + 1.06^{14} + 1.06^{19} + 1.06^{24})$$

(฿12,290)

The above comparison clarified that the concrete canals are advantageous to the earth canals not only in the annual O & M cost by saving about 550,000 Baht but also in facilitating the O & M works by efficiently supplying the water to the downstream areas.

(2) Improvement plan for the irrigation canals in the Mae Pung area

There would be water shortages rarely taking place, except specific drought years, in the Kew Lom area, when the Kew Lom Dam can supply the water to meet the requirements of the Mae Pung area of 4.492 m^3/sec.

The comparative study was made on the construction costs for both cases of the Mae Pung area to be commanded by the Kew Lom Dam and by the proposed Mae Chang Dam.

In the former case, it would be designed that the Mae Wang Left Main Canal is widened, and the Mae Pung Main Canal and the 1.20 km long culvert are totally improved, while in the latter, the original plan would be adopted. The following table shows the canal dimensions, design discharge, increase in facilities lots for the works for the both cases.

Portions (km)	Original			Alternative			Increase in Canal Lots
	Discharge (m^3/s)	Bottom Width (m)	Water Depth (m)	Discharge (m^3/s)	Bottom Width (m)	Water Depth (m)	(m)
0 - 9 + 200	8.02	2.70	2.07	12.96	3.50	2.45	1.93
9+200 - 14+600	7.11	2.70	1.97	12.05	3.50	2.38	2.02
14+600 - 23+500	5.67	2.70	1.80	10.61	3.00	2.31	1.81
23+500 - 27+650	5.14	2.70	1.62	10.08	3.00	2.22	2.09
27+650 - 33+890	3.88	2.10	1.56	8.82	3.00	2.11	2.55
33+890 - 35+590	1.74	1.90	1.09	6.69	2.70	1.78	2.87
35+590 - 36+990	1.42	1.90	1.01	6.36	2.70	1.74	3.01
36+990 - 39+500	1.08	1.20	1.03	6.02	2.70	1.70	3.53
39+500 - 40+700	-	-	-	4.94	2.00	2.00	-

The expected canal lots increase would be about 9.0 ha (56 rai), for which the acquisition cost would be about 560,000 Baht. On the other hand, the RID's estimation for the Mae Chang Dam construction cost was about 560,000,000 Baht on the basis of 1980 unit price.

The irrigable areas in the original plan (the Mae Chang Dam Project) was estimated at about 16,000 ha (100,000 rai), of which the Mae Pung area (3,200 ha or 20,000 rai) occupies about 20 percent. The allotment of the Mae Chang Dam construction cost to the Mae Pang area was estimated at 112,000,000 Baht. The construction costs to be required for the canal works illustrated as above, are broken down for the respective cases as follows:

(Unit: ฿1,000)

Canal Name	Cost for Original Plan	Cost for Alternative	Difference
Mae Wang Left Canal	50,767	74,368	23,601
Mae Pung Main Canal	7,756	13,588	5,832
Culvert	-	10,173	10,173
Mae Pung Link Canal	1,960	-	1,960
Cost for Land Acquisition	250	560	310
Sub-total	60,733	98,689	37,956
Cost Relating to Dam Construction	112,000	-	112,000
Total	172,733	98,689	74,044

As shown above, the construction cost for the original plan exceeds that for the alternative plan by about 74 million Baht, but the original plan (Mae Chang Dam Project) prepared by the Government has been adopted in this study in terms of development of the Chang River Basin, easy water management and more effective development of the MK-IADP. The internal rate of return of this case was estimated at 25.3 percent, which proves the plan to be economically feasible.

(3) Determination of design discharge for the respective canals

The design discharge for the canals can be determined by the following equations:

$$Q = q_p A_p + q_u \cdot A_u$$

Where, Q: Design discharge (m^3/s)
q_p: Unit water requirement in the paddy field ($m^3/s/ha$)
A_p: Irrigation area of paddy field (ha)
q_u: Unit water requirement in the upland field ($m^3/s/ha$)
A_u: Irrigation area of upland field (ha)

Unit water requirement in the paddy field

As mentioned in the main report, the computation shall be made the concept of "constant flow" during the land preparation period, and the equation for computing the unit water requirement in the paddy field can be shown as follows:

$$q_p = \frac{Dt}{8{\cdot}64 \cdot Ec \cdot \{1 - e^{-(Dt/Ds)N}\}}$$

The value of Dt should be the wet season paddy water requirement which can maximize the cropping acreage of the paddy.

Crop consumptive use in the 3rd decade of July	4.52 mm/day
Effective rainfall in the 3rd decade of July	1.26 mm/day
Dt	3.26 mm/day

Water requirements for land preparation Ds = 200 mm
Number of day for land preparation N = 30 days
Irrigation efficiency Ec = 0.60

Consequently, the following can be derived from the above:

$$q_p = \frac{0.00326}{8.64 \times 0.60 \times \{1 - e^{-(3.26/200) \times 30}\}}$$

$$= 0.00163 \ m^3/s/ha$$

Unit water requirement in the upland field

The unit water requirement in the upland field can be obtained by the following equation:

$$q_u = \frac{d \times 10^{-3} \times 10^4}{86{,}400 \times Ec}$$

Where, d: Daily water requirement in the upland field (mm/day)
Ec: Irrigation efficiency

The daily water requirement in the upland field in the 3rd decade of July was obtained by weighted average of consumption for the cropping acreage of the respective crops.

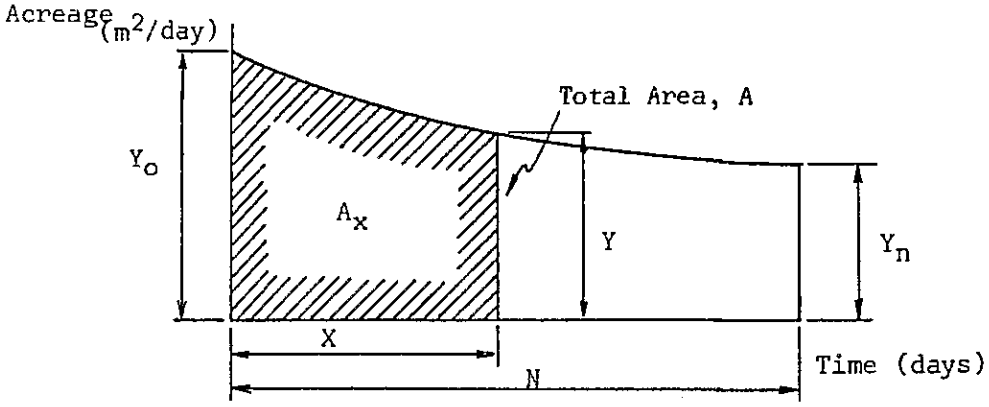
Water requirement	2.79
Effective rainfall	1.26
d	1.53 mm/day
Irrigation efficiency	0.51

Therefore,

$$q_u = \frac{1.53}{8{,}640 \times 0.51} = 0.0035 \ m^3/s/ha$$

Determination of canal capacity based on "constant flow" concept during the land preparation

Under the condition that the relationship between time, X and the rate of land development Y, is a curve, $Y = f(X)$, starting from $Y = Y_o$, when $X = 0$, and ending at $Y = Y^N$, when $X = N$ with an enclosed area of A as shown in the following figure, the discharges required for puddling the field and for the transplanted rice at the time, X, will be:



$Qs = Y \cdot Ds$

$Qt = A_x \cdot Dt = Dt \int_o^X Ydx$

and the total of Qs and Qt will be:

$$Q = YDs + Dt \int_o^X Ydx \quad \text{---------- (1)}$$

In order to supply a constant discharge through the whole period of land preparation under the most economical condition for the determination of canal or pump capacity;
let Q = constant, and differential Equation (1); therefore,

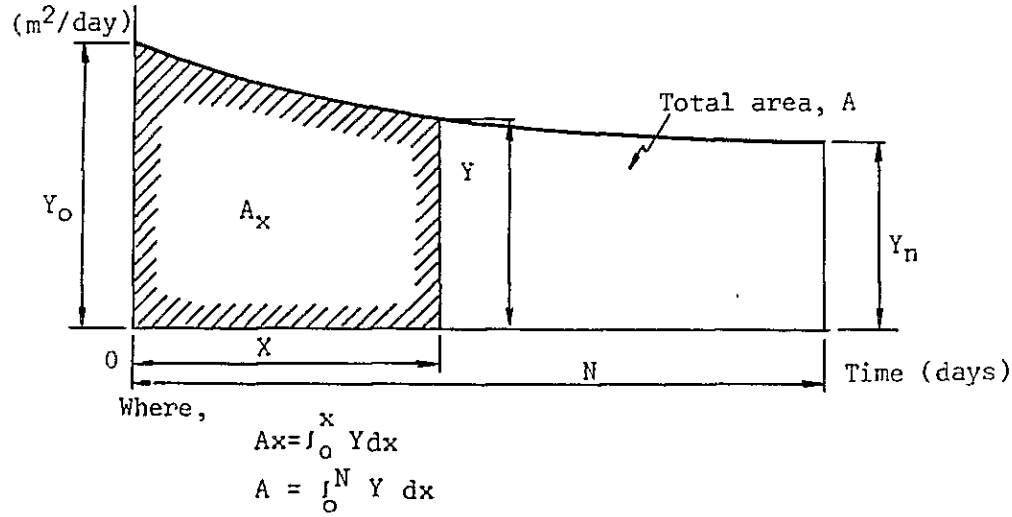
$$O = Ds \cdot \frac{dY}{dX} + Dt \cdot Y$$

or

$$\frac{dY}{dX} = - \frac{Dt}{Ds} Y \quad \text{----------} \quad (2)$$

The above differential Equation (2) is a condition that (Qs + Qt) is always equal to a constant discharge. Its solution will be:

$$\int \frac{dY}{Y} = - \frac{Dt}{Ds} \int dx + C$$



Where,

$$Ax = \int_o^x Y dx$$

$$A = \int_o^N Y \, dx$$

Above figure, schematic diagram for proposed water use in land preparation.

or

$$\log Y = \frac{Dt}{Ds} X + C$$

$$Y = e^{(C - \frac{Dt.X}{Ds})} = e^{C} . e^{-(Dt/Ds).X}$$

Where,

e = the best of natural logarithm = 2.718282

The constant e^C can be evaluated from the condition that y = yo at X = 0, giving,

$$Y = Y_o e^{-(Dt/Ds).X} \quad \text{---------- (3)}$$

Because,

$$A = \int_o^N Y dx$$

$$A = Yo \int_o^N e^{-(Dt/Ds).X} dx = Yo \left[\frac{e^{-(Dt/Ds)X}}{-(Dt/Ds)} \right]_0^N$$

$$A = Yo \; \frac{e^{-(Dt/Ds)N} - 1}{-(Dt/Ds)}$$

$$Yo = \frac{ADt}{Ds(1 - e^{-(Dt/Ds)N})} \quad \text{---------- (4)}$$

If the value of Yo is substituted into Equation (3), one obtains;

$$Y = \frac{A.Dt.e^{-(Dt/Ds)X}}{Ds(1 - e^{-(Dt/Ds)N})} \quad \text{---------- (5)}$$

The discharge, Q, is constant for the entire period of land preparation; therefore, it is convenient to evaluate Q at X = N. Equations (1) and (5) will be as follows:

$$Q = Y_N \cdot Ds + A \cdot Dt$$

and,

$$Y_N = \frac{A.Dt.e^{-(Dt/Ds)N}}{Ds\,(1 - e^{-(Dt/Ds)N})} \quad \text{---------- (6)}$$

Therefore,

$$Q = \frac{A.Dt.e^{-(Dt/Ds)N}}{1 - e^{-(Dt/Ds)_N}} + A.Dt$$

$$= \frac{ADt}{1 - e^{-(Dt/Ds)_N}}$$

If the conveyance loss of the canal is considered, the discharge, Q, will be:

Final Formulas:

If the conveyance efficiency, Ec, is applied to Equation (7), one obtains the finally modified formula,

$$Q(\text{in } m^3/\text{day}) = \frac{ADt}{Ec\{1 - e^{-(Dt/Ds)N}\}} \quad \text{---------- (8)}$$

$$Q(\text{in cms}) = \frac{ANDt}{8.64\ Ec\{1 - e^{-(Dt/Ds)N}\}} \quad \text{---------- (9)}$$

Where,
- A_N = Area in hectares
- Ec = Decimals instead of percent
- Q = Canal or pump capacity (maximum discharge)
- A = Area in m^2 to be irrigated
- Dt = Water requirement in meters per day in the transplanted rice field
- Ds = Puddling water requirement in meters required for soaking the field
- N = Period of land preparation, in number of days, for the entire area, A.
- T = Number of seconds in one day, and

In rotational irrigation, Dt will be Dr/Pr in which Dr is the depth of water for each application of rotational irrigation and Pr is the rotational interval in days.

(4) Capacities and other dimensions of the main canals

Name of Canal	Portion	Capacity (m^3/s)	Slope	Bottom Width (m)	Water Depth (m)	Velocity (m/s)
Mae Wang Left Main Canal	0 - 9,200	8.019	1/6,000	2.70	1.67	0.919
	9,200 - 14,600	7.108	"	"	1.57	0.892
	14,600 - 23,500	5.666	"	"	1.40	0.840
	23,500 - 27,650	5.136	1/5,000	"	1.27	0.874
	27,650 - 33,890	3.878	"	2.10	1.21	0.821
	33,890 - 38,400	0.697	1/1,000	1.20	0.40	0.955
Mae Wang Right Main Canal	3,372 - 11,800	3.973	1/4,000	2.10	1.16	0.898
	11,800 - 21,868	3.299	"	"	1.05	0.853
	21,868 - 28,700	2.514	"	1.90	0.95	0.798
	28,700 - 31,600	0.969	"	1.20	0.69	0.631
	31,600 - 38,658	0.643	"	"	0.56	0.566
Mae Pung Main Canal	0 - 1,700	1.743	1/4,000	1.90	0.79	0.721
	1,700 - 3,100	1.418	"	"	0.71	0.680
	3,100 - 5,608	1.075	"	1.20	0.73	0.684
Mae Pung Right Canal	0 - 2,800	2.298	1/4,000	1.90	0.91	0.778
	2,800 - 8,300	1.355	"	"	0.69	0.672
	8,300 - 12,300	0.815	"	0.80	0.80	0.600
Mae Pung Left Canal	0 - 3,000	2.644	1/3,000	1.90	0.90	0.911
	3,000 - 4,500	1.927	"	"	0.76	0.645
	4,500 - 6,520	0.209	1/2,500	0.50*	0.40	0.550

* --- Embankment slope should be designed by 1.0.

Proposed Cropping Pattern and Irrigable Area
for Water Balance Study

Unit: ha

Season	Name of Tract	Zone	Rice	Peanuts	Tobacco	Soybean Chilli	Garlic	Sugarcane	Vegetable Orchard Pineapple	Total
Wet	Mae Wang Left	1,2,3,4,7	4,829	33	33	97	-	-	263	5,255
	Mae Wang Right	8, 9, 10	2,573	-	-	75	-	-	163	2,811
	Mae Pung	5, 6	2,781	23	33	-	-	93	33	2,963
	Kew Lom I	12	2,279	251	251	279	-	93	139	3,292
	Kew Lom II	-	2,656	-	-	-	-	304	224	3,184
	Total		15,118	307	317	451	-	490	822	17,505
Dry	Mae Wang Left	1,2,3,4,7	1,417	972	521	488	574	-	316	4,288
	Mae Wang Right	8,9,10	482	735	102	289	374	-	316	2,298
	Mae Pung	5,6	1,340	493	167	163	103	93	47	2,406
	Kew Lom I	12	1,169	684	-	326	344	93	205	2,821
	Kew Lom II	-	-	192	112	144	-	304	592	1,344
	Total		4,408	3,076	902	1,410	1,395	490	1,476	13,157

Note: (1) The irrigable area is multiplied by 0.93 deduct 7% of public land after land consolidation.
(2) The irrigable area in Kew Lom II are estimated by the ECI Feasibility Report.
(3) The ratio of wet to dry season crops in project area assumed at 80% tentatively.
(4) The ratio of Kew Lom II is 42% by the ECI Feasibility Report.

Consumptive Use for Each Crops

Unit: mm/day

Month	Rice		Upland Crop					
	H.Y.V.	L.V.	Peanut	Tobacco	Soybean or Chilli	Garlic	Vegitable or Fruits	Sugarcane
Jan. 1				1.27		1.22	1.89	1.39
2				1.44		1.43	1.89	1.69
3	3.70			1.69		1.80	1.89	2.00
Feb. 1	4.40		1.37	2.62	1.37	2.82	2.39	2.86
2	4.45		1.37	2.93	1.37	3.12	2.39	3.08
3	4.63		1.56	3.13	1.41	3.19	2.39	3.28
Mar. 1	5.86		2.31	3.99	2.14	3.29	3.00	4.35
2	6.22		2.90	3.84	2.58	1.92	3.00	4.56
3	6.48		3.62	3.13	3.21	0.83	3.00	4.78
Apr. 1	7.55		4.56	2.44	4.34	0.01	3.49	5.77
2	7.69		3.81	1.47	4.73		3.49	5.88
3	7.65		2.18	0.60	4.56		3.49	5.99
May 1	6.97		0.62		3.22		3.18	5.51
2	6.81				1.88		3.18	5.49
3	6.50				0.75		3.18	5.46
Jun. 1	4.47						2.68	4.55
2	3.17						2.68	4.45
3	1.78						2.68	4.35
Jul. 1		4.52	1.41	1.41	1.41		2.46	3.88
2		4.52	1.41	1.41	1.41		2.46	3.75
3		4.52	1.62	1.41	1.49		2.46	3.61
Aug. 1		4.21	1.75	1.48	1.63		2.25	3.13
2		4.33	2.22	1.69	1.94		2.25	2.96
3		4.56	2.73	1.98	2.45		2.25	2.77
Sep. 1		5.03	3.01	2.51	2.90		2.32	2.69
2		5.27	2.52	2.81	3.13		2.32	2.55
3		5.41	1.45	3.01	3.04		2.32	2.41
Oct. 1		5.30	0.45	3.03	2.39		2.28	2.13
2		5.18		2.92	1.43		2.28	1.83
3		5.03		2.37	0.63		2.28	1.52
Nov. 1		4.28		1.36	0.01		1.95	1.15
2		4.15		0.82			1.95	1.13
3		0.24		0.34			1.95	1.10
Dec. 1				0.27			1.75	1.00
2				1.00		1.00	1.75	1.00
3				1.02		1.00	1.75	1.12

Note: Consumptive use for Rice crops are including percolation 1.00 mm/day.

Monthly Effective Rainfall for Paddy Rice

Unit: mm

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1952	***	***	***	36.6	43.5	77.2	81.6	144.9	130.9	64.2	11.9	0.0	***
1953	18.4	1.6	0.0	20.3	48.8	119.0	98.7	149.3	177.9	41.8	15.7	0.0	691.4
1954	0.0	1.1	10.0	7.8	92.8	45.5	21.4	147.8	96.2	102.1	7.7	0.0	532.6
1955	0.0	13.9	0.0	32.2	110.8	112.9	62.8	168.7	87.7	32.9	11.0	18.7	651.7
1956	0.0	0.0	0.7	82.4	110.5	49.9	117.1	157.1	152.6	47.5	11.0	0.0	728.8
1957	0.0	2.8	17.0	36.6	55.6	89.8	70.5	79.8	124.4	66.1	0.7	0.0	543.5
1958	27.6	0.0	71.8	24.3	51.8	145.0	50.5	120.4	103.8	69.5	9.7	0.0	674.5
1959	0.1	0.0	2.5	81.7	191.4	91.3	116.3	112.1	116.3	63.8	0.0	0.0	775.6
1960	12.2	0.0	12.2	0.4	86.5	98.5	115.7	177.9	168.9	76.3	35.0	1.4	785.2
1961	0.3	1.8	27.4	43.9	141.8	77.8	42.1	180.1	145.0	122.8	18.4	1.8	803.4
1962	3.2	0.0	0.7	14.4	66.8	53.0	84.8	123.8	163.5	90.1	0.0	1.0	601.4
1963	0.0	1.5	4.6	44.1	18.1	117.8	105.1	144.3	137.3	127.6	41.4	0.9	742.8
1964	0.0	1.0	0.0	31.7	138.4	59.6	111.3	80.2	184.0	102.5	1.1	0.9	710.8
1965	0.0	42.4	26.5	41.7	73.1	105.2	44.5	128.3	89.6	105.4	17.3	1.3	675.5
1966	9.4	0.1	5.8	0.8	199.5	84.6	89.7	165.1	127.9	86.2	20.1	7.3	796.7
1967	0.1	0.0	0.3	36.1	86.2	77.9	78.5	91.4	120.8	36.7	35.4	1.0	564.7
1968	0.0	1.1	4.8	102.1	113.5	136.8	58.4	98.5	93.8	64.3	10.4	0.0	683.9
1969	2.8	0.0	9.1	94.8	126.4	96.9	61.6	129.9	172.4	39.2	0.0	1.9	735.2
1970	0.0	8.7	38.3	56.2	167.7	159.0	81.9	134.0	186.7	75.1	8.0	21.1	936.8
1971	0.0	6.6	18.9	30.5	154.9	76.9	186.9	140.8	162.1	115.9	1.5	15.0	910.1
1972	2.4	0.0	23.9	83.5	60.9	81.7	80.9	161.9	104.6	119.8	70.1	11.2	801.0
1973	0.0	0.1	42.4	18.2	113.8	68.1	168.0	128.5	171.4	69.1	36.9	0.0	816.5
1974	0.0	0.0	28.2	89.0	115.8	102.1	88.5	102.3	203.9	47.1	100.8	4.4	882.2
1975	44.8	4.6	18.1	17.4	106.9	89.7	155.8	187.6	133.7	146.4	19.0	5.9	930.1
1976	0.0	10.3	0.0	14.9	90.1	30.2	46.5	127.0	132.2	69.4	11.0	1.6	533.4
1977	51.7	0.0	9.2	89.5	95.8	8.5	98.5	157.8	152.6	131.7	2.5	22.3	820.2
1978	13.4	11.8	0.0	11.2	117.5	50.0	129.5	96.8	154.0	64.8	0.0	0.0	649.1

Note: Upper limit (10 days) are 70 mm.

Monthly Effective Rainfall for Upland Crops

Unit: mm

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1952	***	***	***	36.6	43.5	77.2	72.2	110.3	113.4	61.6	11.9	0.0	***
1953	18.4	1.6	0.0	20.3	48.8	89.0	69.7	99.9	122.3	41.8	15.7	0.0	527.4
1954	0.0	1.1	10.0	7.8	75.0	45.5	21.4	103.1	67.2	73.1	7.7	0.0	412.1
1955	0.0	13.9	0.0	32.2	100.5	83.9	54.9	116.2	87.7	32.9	11.0	18.7	552.2
1956	0.0	0.0	0.7	53.4	81.5	49.9	93.6	112.6	98.9	47.5	11.0	0.0	549.1
1957	0.0	2.8	17.0	36.6	41.0	61.5	70.5	79.8	95.4	66.1	0.7	0.0	471.6
1958	27.6	0.0	71.8	24.3	43.8	118.7	50.5	94.0	99.9	69.5	9.7	0.0	610.0
1959	0.1	0.0	2.5	65.1	123.0	84.6	98.1	83.1	87.3	53.4	0.0	0.0	597.3
1960	12.2	0.0	12.2	0.4	70.0	76.3	86.7	119.9	110.9	76.3	35.0	1.4	601.5
1961	0.3	1.8	27.4	43.9	103.1	77.8	42.1	122.1	94.1	93.8	18.4	1.8	626.8
1962	3.2	0.0	0.7	14.4	63.3	53.0	55.8	94.8	105.5	80.5	0.0	1.0	472.3
1963	0.0	1.5	4.6	44.1	18.1	88.8	85.4	122.9	123.0	84.3	41.0	0.9	614.7
1964	0.0	1.0	0.0	31.7	120.6	59.6	92.9	51.2	123.0	73.5	1.1	0.9	555.7
1965	0.0	41.0	26.5	41.7	44.1	76.2	44.5	88.8	79.6	105.4	17.3	1.3	566.6
1966	9.4	0.1	5.8	0.8	123.0	55.6	66.8	123.0	110.0	86.2	20.1	7.3	608.2
1967	0.1	0.0	0.3	36.1	86.2	63.3	70.9	62.4	91.8	36.7	35.4	1.0	484.5
1968	0.0	1.1	4.8	82.7	93.9	107.8	58.4	89.8	82.9	64.3	10.4	0.0	596.2
1969	2.8	0.0	9.1	80.2	86.5	96.9	61.6	100.9	123.0	39.2	0.0	1.9	602.3
1970	0.0	8.7	38.3	54.2	111.6	103.1	79.8	105.0	123.0	65.2	8.0	21.1	718.2
1971	0.0	6.6	18.9	30.5	96.9	55.8	123.0	101.5	115.1	86.9	1.5	15.0	651.8
1972	2.4	0.0	23.9	72.1	60.9	81.7	57.8	123.0	101.4	87.8	70.1	11.2	692.3
1973	0.0	0.1	42.4	18.2	103.4	65.4	123.0	94.1	117.1	54.6	36.9	0.0	655.2
1974	0.0	0.0	28.2	60.0	92.5	95.6	59.5	73.3	123.0	47.1	80.4	4.4	664.2
1975	44.8	4.6	18.1	17.4	90.9	71.1	109.8	123.0	104.7	106.6	19.0	5.9	716.1
1976	0.0	10.3	0.0	14.9	73.9	30.2	46.5	101.4	103.2	69.4	11.0	1.6	462.6
1977	41.0	0.0	9.2	62.4	88.5	8.5	92.1	103.6	118.0	121.7	2.5	22.3	669.9
1978	13.4	11.8	0.0	11.2	83.6	50.0	100.5	67.8	117.0	64.8	0.0	0.0	520.3

Note: Upper limit are weighted average 41 mm/10 days.
Sugarcane 490ha x 50mm + others 8,259ha x 40mm/8,749ha = 41 mm (10 days)

ANNEX 3-1
Table 3-1-5

Return Period of Monthly Effective Rainfall in Wet Season

Unit: mm

	Jul.	Aug.	Sep.	Oct.	Jul.-Nov.	Annual
Rice						
1/2	83.7	131.2	139.5	76.3	458.8	726.3
1/5	56.3	107.2	112.4	53.1	389.4	627.2
1/10	45.0	96.4	98.8	43.0	356.3	577.5
1/20	37.1	88.4	87.8	35.7	330.5	537.4
1/50	29.4	80.1	75.8	28.3	303.2	493.4
Upland						
1/2	72.0	96.6	104.0	67.6	361.7	579.4
1/5	52.1	80.0	91.0	50.7	319.5	512.7
1/10	42.6	72.5	84.9	43.0	299.4	480.7
1/20	35.2	66.9	80.2	37.2	283.7	455.6
1/50	27.3	61.0	75.2	31.3	266.9	428.8

Station: Lampang 1952 - 1978

Return Period of Ten Days Effective Rainfall in Wet Season

Unit: mm

	Jul.			Aug.			Sep.			Oct.		
	1	2	3	1	2	3	1	2	3	1	2	3
Rice												
1/2	18.2	20.7	33.7	30.7	46.0	47.0	41.3	40.9	41.3	31.3	19.1	19.8
1/5	7.6	8.7	17.5	17.3	26.9	27.3	23.1	25.9	26.5	16.7	9.1	8.8
1/10	4.3	4.9	10.9	11.6	17.6	20.6	17.0	20.4	21.0	11.2	5.5	5.0
1/20	2.3	2.6	6.3	7.5	10.3	16.3	13.2	16.7	17.4	7.4	3.1	2.6
1/50	0.6	0.6	1.9	3.3	2.4	12.5	10.0	13.4	14.0	3.8	1.0	0.4
Upland												
1/2	18.3	20.1	29.4	24.4	30.2	33.4	32.5	33.1	33.0	25.2	19.2	19.6
1/5	8.6	9.6	17.9	12.4	19.3	22.6	20.3	24.0	24.7	15.3	9.5	9.4
1/10	4.9	5.4	12.1	8.7	15.3	18.5	15.9	20.3	21.2	11.8	5.7	5.4
1/20	2.3	2.4	7.4	6.5	12.6	15.6	13.0	17.7	18.7	9.5	3.1	2.6
1/50	0.0	0.0	2.2	4.7	10.1	12.9	10.4	15.1	16.3	7.5	0.6	0.0

Station: Lampang 1952 - 1978

Effective Rainfall for Each Crops in 1967

Month		Rainfall (mm)	Paddy Effective (mm)	Paddy Rainfall (mm/day)	Sugarcane Effective (mm)	Sugarcane Rainfall (mm/day)	Upland Effective (mm)	Upland Rainfall (mm/day)
Jan.	1							
	2	0.2	0.1	0.01	0.1	0.01	0.1	0.01
	3							
Feb.	1							
	2							
	3							
Mar.	1							
	2	0.4	0.3	0.03	0.3	0.03	0.3	0.03
	3							
Apr.	1							
	2	24.9	18.7	1.87	18.7	1.87	18.7	1.87
	3	23.3	17.5	1.75	17.5	1.75	17.5	1.75
May	1	52.9	39.7	3.97	39.7	3.97	39.7	3.97
	2	28.3	21.2	2.12	21.2	2.12	21.2	2.12
	3	33.7	25.3	2.30	25.3	2.30	25.3	2.30
Jun.	1	74.1	55.6	5.56	50.0	5.00	40.0	4.00
	2	18.3	13.7	1.37	13.7	1.37	13.7	1.37
	3	11.5	8.6	0.86	8.6	0.86	8.6	0.86
Jul.	1	21.3	16.0	1.60	16.0	1.60	16.0	1.60
	2	64.8	48.6	4.86	48.6	4.86	40.0	4.00
	3	18.6	13.9	1.26	13.9	1.26	13.9	1.26
Aug.	1	19.1	14.3	1.43	14.3	1.43	14.3	1.43
	2	9.5	7.1	0.71	7.1	0.71	7.1	0.71
	3	161.2	70.0	6.36	50.0	4.55	40.0	3.64
Sep.	1	22.1	16.6	1.66	16.6	1.66	16.6	1.66
	2	45.7	34.3	3.43	34.3	3.43	34.3	3.47
	3	174.8	70.0	7.00	50.0	5.00	40.0	4.00
Oct.	1	14.9	11.2	1.12	11.2	1.12	11.2	1.12
	2	26.1	19.6	1.96	19.6	1.96	19.6	1.96
	3	8.0	6.0	0.55	6.0	0.55	6.0	0.55
Nov.	1	16.2	12.1	1.21	12.1	1.21	12.1	1.21
	2	23.3	17.5	1.75	17.5	1.75	17.5	1.75
	3	7.7	5.8	0.58	5.8	0.58	5.8	0.58
Dec.	1	1.4	1.0	0.10	1.0	0.10	1.0	0.10
	2							
	3							
Total		902.3			519.1		480.5	

Note: Effective Rainfall = 0.75 x Rainfall

Upper limit of effective rainfall are 70 mm for Paddy, 50mm for Sugarcane and 40mm for Upland.

Diversion Water Requirement for Paddy Rice in 1967

		Effective Rainfall	H.Y.V. Net Water Requirement		H.Y.V. Diversion Water Requirement			L.V. Net Water Requirement		L.V. Diversion Water Requirement		
		(mm/day)	(mm/day)	(ℓ/s/ha)	(mm/day)	(mm)	(ℓ/s/ha)	(mm/day)	(ℓ/s/ha)	(mm/day)	(mm)	(ℓ/s/ha)
Jan.	1	0.00										
	2	0.01	0.62	0.072	1.03	10.3	0.120					
	3	0.00	6.95	0.809	11.58	127.4	1.340					
Feb.	1	0.00	8.53	0.987	14.22	142.2	1.645					
	2	0.00	9.93	1.149	16.55	165.5	1.915					
	3	0.00	4.63	0.535	7.72	61.8	0.892					
Mar.	1	0.00	5.86	0.678	9.77	97.7	1.130					
	2	0.03	6.19	0.716	10.32	103.2	1.193					
	3	0.00	6.48	0.750	10.80	118.8	1.250					
Apr.	1	0.00	7.55	0.874	12.58	125.8	1.457					
	2	1.87	5.82	0.674	9.70	97.0	1.123					
	3	1.75	5.90	0.683	9.83	98.3	1.138					
May	1	3.97	3.00	0.347	5.00	50.0	0.578					
	2	2.12	4.68	0.542	7.80	78.0	0.903					
	3	2.30	4.20	0.486	7.00	77.0	0.810					
Jun.	1	5.56	0.00	0.000	0.00	0.0	0.000					
	2	1.37	1.49	0.172	2.48	24.8	0.287					
	3	0.86	0.46	0.053	0.77	7.7	0.088					
Jul.	1	1.60						6.17	0.714	10.28	102.8	1.190
	2	4.86						4.73	0.547	7.88	78.8	0.912
	3	1.26						8.35	0.967	13.92	153.1	1.612
Aug.	1	1.43						3.35	0.388	5.58	55.8	0.647
	2	0.71						3.62	0.419	6.03	60.3	0.698
	3	6.36						0.00	0.000	0.00	0.0	0.000
Sep.	1	1.66						3.37	0.390	5.62	56.2	0.650
	2	3.43						1.85	0.214	3.08	30.8	0.357
	3	7.00						0.00	0.000	0.00	0.0	0.000
Oct.	1	1.12						4.19	0.485	6.98	69.8	0.808
	2	1.96						3.22	0.373	5.37	53.7	0.622
	3	0.55						4.48	0.519	7.47	82.2	0.865
Nov.	1	1.21						3.07	0.355	5.12	51.2	0.592
	2	1.75						2.40	0.278	4.00	40.0	0.463
	3	0.58						0.00	0.000	0.00	0.0	0.000
Dec.	1	0.10										
	2	0.00										
	3	0.00										

Note: (1) Effective Rainfall (See Table 3-1-7)
(2) Diversion Water Requirement: Net Water Requirement/Irrigation Efficiency (0.60).

Diversion Water Requirement for Upland Crops in 1967

		Effective Rainfall	Peanuts					Tobacco					Soybean and Chili				
			Net Water Requirement		Diversion Water Requirement			Net Water Requirement		Diversion Water Requirement			Net Water Requirement		Diversion Water Requirement		
		(mm/day)	(mm/day)	(ℓ/s/ha)	(mm/day)	(mm)	(ℓ/s/ha)	(mm/day)	(ℓ/s/ha)	(mm/day)	(mm)	(ℓ/s/ha)	(mm/day)	(ℓ/s/ha)	(mm/day)	(mm)	(ℓ/s/ha)
Jan.	1	0.00						2.08	0.241	4.08	10.8	0.473					
	2	0.01						1.42	0.164	2.78	27.8	0.322					
	3	0.00						1.67	0.193	3.27	36.0	0.378					
Feb.	1	0.00	1.59	0.184	3.12	31.2	0.361	2.61	0.302	5.12	51.2	0.592	1.59	0.184	3.12	31.2	0.361
	2	0.00	2.06	0.238	4.04	40.4	0.467	2.92	0.338	5.73	57.3	0.663	2.06	0.238	4.04	40.4	0.467
	3	0.00	2.64	0.305	5.18	41.4	0.598	3.10	0.359	6.08	48.6	0.704	2.53	0.922	4.96	39.7	1.808
Mar.	1	0.00	2.41	0.279	4.73	47.3	0.547	3.97	0.459	7.78	77.8	0.900	2.27	0.263	4.45	44.5	0.516
	2	0.03	2.87	0.332	5.63	56.3	0.651	3.82	0.442	7.49	74.9	0.867	2.55	0.295	5.00	50.0	0.578
	3	0.00	3.62	0.419	7.10	78.1	0.822	3.15	0.365	6.18	68.0	0.716	3.21	0.371	6.29	69.2	0.727
Apr.	1	0.00	4.56	0.528	8.94	89.4	1.035	2.45	0.284	4.80	48.0	0.557	4.34	0.502	8.51	85.1	0.984
	2	1.87	1.94	0.225	3.80	38.0	0.441	0.00	0.000	0.00	0.0	0.000	2.86	0.331	5.61	56.1	0.649
	3	1.75	0.43	0.050	0.84	8.4	0.098	0.00	0.000	0.00	0.0	0.000	2.82	0.326	5.53	55.3	0.639
May	1	3.97	0.00	0.000	0.00	0.0	0.000						0.00	0.000	0.00	0.0	0.000
	2	2.12											0.00	0.000	0.00	0.0	0.000
	3	2.30											0.00	0.000	0.00	0.0	0.000
Jun.	1	4.00															
	2	1.37															
	3	0.86															
Jul.	1	1.60	0.75	0.087	1.47	14.7	0.171	0.59	0.068	1.57	15.7	0.133	0.75	0.087	1.47	14.7	0.171
	2	4.00	0.00	0.000	0.00	0.0	0.000	0.00	0.000	0.00	0.0	0.000	0.00	0.000	0.00	0.0	0.000
	3	1.26	1.09	0.126	2.14	23.5	0.247	0.73	0.084	1.43	15.7	0.165	0.99	0.115	1.94	21.3	0.225
Aug.	1	1.43	0.40	0.046	0.78	7.8	0.090	0.67	0.078	1.31	13.1	0.153	0.28	0.032	1.82	18.2	0.063
	2	0.71	1.50	0.174	2.94	29.4	0.341	0.98	0.113	1.92	19.2	0.222	1.23	0.142	2.41	24.1	0.278
	3	3.64	0.00	0.000	0.00	0.0	0.000	0.00	0.000	0.00	0.0	0.000	0.00	0.000	0.00	0.0	0.000
Sep.	1	1.66	1.36	0.157	2.67	26.7	0.308	0.85	0.098	1.67	16.7	0.192	1.24	0.144	2.43	24.3	0.282
	2	3.43	0.00	0.000	0.00	0.0	0.000	0.00	0.000	0.00	0.0	0.000	0.00	0.000	0.00	0.0	0.000
	3	4.00	0.00	0.000	0.00	0.0	0.000	0.00	0.000	0.00	0.0	0.000	0.00	0.000	0.00	0.0	0.000
Oct.	1	1.12	0.00	0.000	0.00	0.0	0.000	1.92	0.222	3.77	31.7	0.435	1.28	0.148	2.51	25.1	0.290
	2	1.96						0.96	0.111	1.88	18.8	0.218	0.00	0.000	0.00	0.0	0.000
	3	0.55						1.83	0.212	3.59	39.5	0.416	0.03	0.000	0.06	0.7	0.000
Nov.	1	1.21						0.15	0.017	0.29	2.9	0.033	0.00	0.000	0.00	0.0	0.000
	2	1.75						0.00	0.000	0.00	0.0	0.000					
	3	0.58						0.00	0.000	0.00	0.0	0.000					
Dec.	1	0.10						0.98	0.113	1.92	19.2	0.222					
	2	0.00						0.35	0.041	0.69	6.9	0.080					
	3	0.00						0.63	0.073	1.24	13.6	0.143					

Note: (1) Effective Rainfall (See Table 3-1-7)

(2) Diversion Water Requirement = Net Water Requirement/Irrigation Efficiency (0.51)

Diversion Water Requirement for Upland Crops in 1967

		Effective Rainfall	Garlic					Vegetable or Fruits					Sugarcane				
			Net Water Requirement		Diversion Water Requirement			Net Water Requirement		Diversion Water Requirement			Net Water Requirement		Diversion Water Requirement		
		(mm/day)	(mm/day)	(ℓ/s/ha)	(mm/day)	(mm)	(ℓ/s/ha)	(mm/day)	(ℓ/s/ha)	(mm/day)	(mm)	(ℓ/s/ha)	(mm/day)	(ℓ/s/ha)	(mm/day)	(mm)	(ℓ/s/ha)
Jan.	1	0.00	2.26	0.262	4.43	44.3	0.514	1.61	0.186	3.16	31.6	0.365	1.92	0.222	3.76	37.6	0.435
	2	0.01	1.43	0.166	2.80	28.0	0.325	1.87	0.216	3.67	36.7	0.424	2.19	0.253	4.29	42.9	0.496
	3	0.00	1.80	0.208	3.53	38.8	0.408	1.89	0.219	3.71	40.8	0.429	2.51	0.291	4.92	54.1	0.571
Feb.	1	0.00	2.82	0.326	5.53	55.3	0.639	2.39	0.277	4.69	46.9	0.543	1.91	0.221	3.75	37.5	0.433
	2	0.00	3.12	0.361	6.12	61.2	0.708	2.39	0.277	4.69	46.9	0.543	3.08	0.356	6.04	60.4	0.698
	3	0.00	3.19	0.369	6.25	50.0	0.724	2.39	0.277	4.69	37.5	0.543	3.28	0.380	6.43	51.4	0.745
Mar.	1	0.00	3.29	0.381	6.45	64.5	0.747	3.00	0.347	5.88	58.8	0.680	4.35	0.503	8.53	85.3	0.986
	2	0.03	1.92	0.222	3.76	37.6	0.435	2.97	0.344	5.82	58.2	0.675	4.53	0.524	8.88	88.8	1.027
	3	0.00	0.75	0.087	1.47	16.2	0.171	3.00	0.347	5.88	64.7	0.680	4.78	0.553	9.37	103.1	1.084
Apr.	1	0.00	0.01	0.000	0.02	0.2	0.000	3.49	0.404	6.84	68.4	0.792	5.77	0.668	11.31	113.1	1.310
	2	1.87						1.63	0.189	3.20	32.0	0.371	4.01	0.464	7.86	78.6	0.910
	3	1.75						1.75	0.203	3.43	34.3	0.399	4.24	0.491	8.31	83.1	0.963
May	1	3.97						0.00	0.000	0.00	0.0	0.000	1.54	0.178	3.02	30.2	0.349
	2	2.12						1.06	0.123	2.08	20.8	0.241	3.36	0.389	6.59	65.9	0.763
	3	2.30						0.88	0.102	1.73	19.0	0.200	3.16	0.366	6.20	68.2	0.718
Jun.	1	4.00						0.00	0.000	0.00	0.0	0.000	0.00	0.000	0.00	0.0	0.000
	2	1.37						1.31	0.152	2.57	25.7	0.298	3.08	0.356	6.04	60.4	0.698
	3	0.86						1.82	0.211	3.57	35.7	0.414	3.48	0.403	6.82	68.2	0.790
Jul.	1	1.60						0.87	0.101	1.71	17.1	0.198	2.28	0.264	4.47	44.7	0.518
	2	4.00						0.00	0.000	0.00	0.0	0.000	0.00	0.000	0.00	0.0	0.000
	3	1.26						1.20	0.139	2.35	25.9	0.273	2.34	0.271	4.59	50.5	0.531
Aug.	1	1.43						0.81	0.938	1.59	15.9	1.839	1.70	0.197	3.33	33.3	0.386
	2	0.71						1.53	0.177	3.00	30.0	0.347	2.25	0.260	4.41	44.1	0.510
	3	3.64						0.00	0.000	0.00	0.0	0.000	0.00	0.000	0.00	0.0	0.000
Sep.	1	1.66						0.67	0.078	1.31	13.1	0.153	1.04	0.120	2.04	20.4	0.235
	2	3.43						0.00	0.000	0.00	0.0	0.000	0.00	0.000	0.00	0.0	0.000
	3	4.00						0.00	0.000	0.00	0.0	0.000	0.00	0.000	0.00	0.0	0.000
Oct.	1	1.12						1.16	0.134	2.27	22.7	0.263	1.01	0.117	1.98	19.8	0.229
	2	1.96						0.32	0.037	0.63	6.3	0.073	0.00	0.000	0.00	0.0	0.000
	3	0.55						1.74	0.201	3.41	37.5	0.394	0.97	0.112	1.90	20.9	0.220
Nov.	1	1.21						0.74	0.086	1.45	14.5	0.169	0.41	0.047	0.80	8.0	0.092
	2	1.75						0.21	0.024	0.41	4.1	0.047	0.35	0.041	0.69	6.9	0.080
	3	0.58						1.38	0.160	2.71	27.1	0.314	1.00	0.116	1.96	19.6	0.227
Dec.	1	0.10	0.12	0.014	0.24	2.4	0.027	1.64	0.190	3.22	32.2	0.373	1.42	0.164	2.78	27.8	0.322
	2	0.00	1.42	0.164	2.78	27.8	0.322	1.75	0.203	3.43	34.3	2.512	1.59	0.184	3.12	31.2	0.361
	3	0.00	1.75	0.203	3.43	37.7	0.398	1.51	0.175	2.96	32.6	0.343	1.64	0.190	3.22	35.4	0.373

Note. (1) Effective Rainfall (See Table 3-1-7)

(2) Diversion Water Requirement = Net Water Requirement/Irrigation Efficiency (0.51)

Water Requirement of Paddy Rice and Upland Crops in 1967

Month		Rainfall (mm)	Paddy Rice: Effective Rainfall (mm)	Paddy Rice: Effective Rainfall (mm/day) (1)	Paddy Rice: N.W.R. (mm/day) (2)	Paddy Rice: W.R. (mm/day)	Upland Field: Effective Rainfall (mm)	Upland Field: Effective Rainfall (mm/day) (1)	Upland Field: N.W.R. (mm/day) (2)	Upland Field: W.R. (mm/day)
Jan.	1								2.41	2.41
	2								1.51	1.51
	3				3.70	3.70			1.82	1.82
Feb.	1				4.42	4.42			2.68	2.68
	2				4.45	4.45			2.78	2.78
	3				4.63	4.63			2.90	2.90
Mar.	1				5.86	5.86			2.78	2.78
	2				6.22	6.22			2.82	2.82
	3				6.48	6.48			2.91	2.91
Apr.	1				7.55	7.55			4.11	4.11
	2				7.69	7.69			3.71	3.71
	3				7.65	7.65			2.78	2.78
May	1				6.97	6.97			1.86	1.86
	2				6.81	6.81			2.66	2.66
	3				6.50	6.50			2.01	2.01
Jun.	1				4.47	4.47			3.01	3.01
	2				3.17	3.17			2.99	2.99
	3				1.78	1.78			2.95	2.95
Jul.	1	21.3	16.0	1.60	4.52	2.92	16.0	1.60	2.71	1.11
	2	64.8	48.6	4.86	4.52	0.0	41.0	4.10	2.69	0.0
	3	18.6	13.9	1.26	4.52	3.26	13.9	1.26	2.79	1.53
Aug.	1	19.1	14.3	1.43	4.21	2.78	14.3	1.43	2.14	0.71
	2	9.5	7.1	0.71	4.33	3.62	7.1	0.71	2.15	1.44
	3	161.2	70.0	6.36	4.56	0.0	41.0	3.73	2.38	0.0
Sep.	1	22.1	16.6	1.66	5.03	3.37	16.6	1.66	2.64	0.98
	2	45.7	34.3	3.43	5.27	1.84	34.3	3.43	2.66	0.0
	3	174.8	70.0	7.00	5.41	0.0	41.0	4.10	2.48	0.0
Oct.	1	14.9	11.2	1.12	5.30	4.18	11.2	1.12	2.12	1.00
	2	26.1	19.6	1.96	5.18	3.22	19.6	1.96	2.11	0.15
	3	8.0	6.0	0.55	5.03	4.48	6.0	0.55	1.71	1.16
Nov.	1	16.2	12.1	1.21	4.28	3.07	12.1	1.21	1.74	0.53
	2	23.3	17.5	1.75	4.15	2.40	17.5	1.75	1.58	0.0
	3	7.7	5.8	0.58	0.24	0.0	5.8	0.58	1.44	0.86
Dec.	1								1.33	
	2								2.16	
	3								2.18	

Note: N.W.R. = Net Water Requirement. N.W.R. in Paddy Field are shown in Table 3-1-2.

N.W.R. in Upland Field are weighted average.

W.R. = Water Requirement = (2) - (1)

Upper limit of Effective Rainfall in Upland Field are weighted acreage 41mm/days

ANNEX 3-1
Table 3-1-12

Monthly Run-off at Kew Lom Dam Site

Unit: MCM

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1953	30.10	23.64	17.55	17.72	46.61	39.56	34.20	87.50	224.04	95.26	56.41	30.84	703.43
1954	18.50	12.80	13.90	16.65	32.75	41.74	19 87	74.44	110.39	165.61	39.90	24.79	571.34
1955	16.35	9.99	9.92	7.59	7.95	29.40	19.05	229.70	249.74	76.45	17.56	8.88	682.58
1956	9.85	7.81	7.57	11.77	52.34	28.20	76.32	197.84	231.01	52.68	27.55	11.19	714.73
1957	10.70	8.54	8.18	9.79	13.91	38.61	18.62	65.51	167.49	110.00	25.15	9.60	486.10
1958	11.60	8.10	7.70	7.90	10.92	17.46	25.41	53.68	79.88	59.62	19.17	8.05	309.49
1959	9.48	7.47	6.81	6.78	40.80	22.64	44.08	89.57	193.39	57.88	19.40	10.60	508.90
1960	10.79	9.50	7.52	6.68	10.56	16.20	53.33	117.50	179.59	138.21	38.15	38.25	626.28
1961	15.44	7.99	7.32	8.61	47.03	62.01	28.76	190.01	294.52	189.57	60.94	27.09	939.29
1962	17.80	11.72	11.90	6.65	20.84	8.49	17.06	58.99	89.68	193.45	31.67	18.19	486.44
1963	11.89	8.18	7.31	3.47	2.29	18.42	36.56	152.67	100.14	206.58	136.86	32.23	716.60
1964	18.76	11.16	8.83	7.96	23.66	23.31	53.06	26.39	176.26	205.46	57.72	30.91	643.48
1965	21.03	14.41	11 69	5.86	8.86	18.17	7.74	54.72	91.33	117.98	50.37	18.52	420.68
1966	9.61	5.74	3.82	2.19	40.19	22.06	13.90	94.46	150.85	46.29	29.84	15.30	434.25
1967	9.04	4.57	3.30	4.07	16.01	12.73	10.30	42.11	262.22	92.45	28.60	12.20	497.60
1968	8.14	5.43	4.68	9.88	20.17	29.89	20.03	67.70	91.90	54.35	21.16	16.41	349.74
1969	7.86	4.47	2.74	2.89	12.63	34.26	22.49	107.72	51.84	55.13	28.90	16.07	347.00
1970	10.25	5.75	4.09	9.21	60.65	110.07	74.05	266.63	187.14	67.31	38.88	42.10	876.12
1971	19.09	9.81	8.55	8.78	19.60	15.02	93.47	240.28	191.64	153.19	45.45	22.94	827.36
1972	19.13	9.98	8.31	17.49	9.89	9.72	8.39	120.04	106.35	85.98	63.89	22.92	482.09
1973	7.53	10.76	17.85	12.94	29.29	49.69	110.68	486.58	452.11	205.96	77.30	41.87	1,502.56
1974	25.67	23.63	23.77	23.44	45.79	47.98	52.15	131.95	137.52	64.86	122.10	33.97	732.83
1975	60.96	24.69	26.08	21.61	25.08	75.36	92.41	389.07	335.11	198.78	79.56	42.75	1,371.46
1976	29.25	26.08	16.02	13.38	24.36	20.55	18.02	52.57	137.10	139.44	84.09	31.55	592.41
1977	35.05	13.63	15.65	16.25	41.74	10.84	27.96	62.58	166.17	170.11	71.99	40.24	672.21
1978	21.20	16.68	13.13	17.13	34.71	21.58	159.26	165.68	131.66	83.77	36.57	17.60	716.97
Mean	17.88	11.64	10.55	10.64	26.89	31.69	43.74	139.46	176.50	118.71	50.35	24.04	662.04

Water Release Programme from Kew Lom Dam

Unit: cu.m/s

Month	Excepting Mae Pung D.W.R.	Excepting Mae Pung Water Release	Including Mae Pung D.W.R.	Including Mae Pung Water Release	Month	Excepting Mae Pung D.W.R.	Excepting Mae Pung Water Release	Including Mae Pung D.W.R.	Including Mae Pung Water Release
Jan. 1	0.7	2.0	0.9	1.0	Jul. 1	5.7	8.0	9.0	12.0
2	1.6	2.0	2.9	3.0	2	6.8	8.0	10.7	12.0
3	1.9	2.0	3.4	3.5	3	8.0	8.0	12.6	12.0
Feb. 1	2.9	3.5	5.0	5.0	Aug. 1	4.0	5.0	6.4	6.5
2	3.4	3.5	5.9	6.0	2	3.7	5.0	5.7	6.5
3	2.7	3.5	4.3	4.3	3	3.8	5.0	6.0	6.5
Mar. 1	3.0	3.5	5.0	5.0	Sep. 1	4.2	5.0	6.6	6.5
2	3.1	3.5	5.1	5.1	2	4.4	5.0	6.9	6.5
3	3.1	3.5	5.2	5.3	3	4.6	5.0	7.1	6.5
Apr. 1	3.5	4.0	6.0	6.0	Oct. 1	4.4	5.0	7.0	6.5
2	3.3	4.0	5.7	6.0	2	4.3	5.0	6.8	6.5
3	2.9	4.0	5.1	5.1	3	4.2	5.0	6.5	6.5
May 1	2.2	3.0	4.1	4.1	Nov. 1	3.6	4.0	5.6	5.5
2	2.0	3.0	3.7	3.7	2	3.5	4.0	5.4	5.5
3	1.8	3.0	3.4	3.4	3	0.2	4.0	0.4	5.5
Jun. 1	1.2	2.0	2.3	1.0	Dec. 1	0.2	2.0	0.3	0.6
2	0.8	2.0	1.4	1.0	2	0.4	2.0	0.5	0.6
3	0.4	2.0	0.7	1.0	3	0.4	2.0	0.6	0.6

Note: D.W.R. = Diversion Water Requirements in case of no Effective Rainfall.

Water Shortage List of Special Years in July

Year	July	Inflow (MCM)	Effective*1) Rainfall (mm)	Diversion Requirement (MCM)	July Shortage (A) (MCM)	Annual Shortage (B) (MCM)	Ratio (A)/(B) (%)
1965	1	2.3	1.8	18.2	0.0		
	2	1.6	2.1	21.6	0.0		
	3	3.8	40.6	15.6	7.8		
	Total	7.7	44.5	55.4	7.8	13.4	58
1967	1	2.1	16.0	15.9 (13.0)	0.0 (0.0)		
	2	4.4	48.6	12.0 (9.8)	5.9 (0.0)		
	3	3.8	13.9	23.9 (19.6)	19.8 (7.7)		
	Total	10.3	78.5	51.8 (42.4)	25.7 (7.7)	34.4 (14.0)	75 (55)
1972	1	3.5	6.7	17.4	0.0		
	2	2.4	64.1	10.7	0.0		
	3	2.6	10.0	25.2	15.7		
	Total	8.5	80.8	53.3	15.7	15.7	100

Note: *1) Weighted Averaged Effective Rainfall.

( ): In case of excepting Mae Pung.

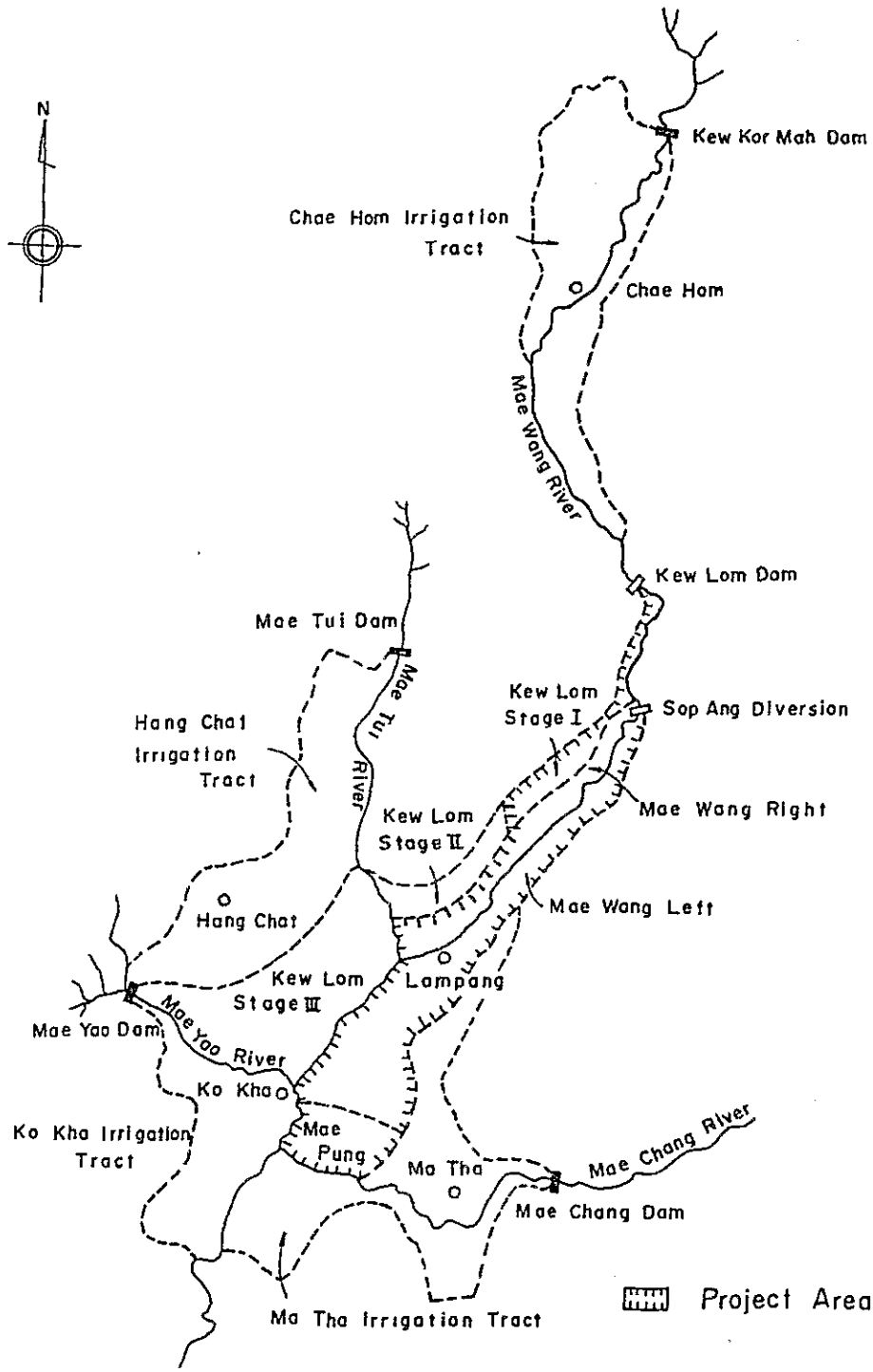
Return Period of Run-off Discharge at Kew Lom Dam Site

Unit: MCM

Probable Year	Nov.-Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Annual
Minimum								
1/2	128.4	22.1	22.1	31.9	103.3	138.3	116.2	616.3
1/5	82.7	12.2	12.7	14.4	53.4	89.8	72.3	442.6
1/10	64.6	8.5	10.1	9.5	39.5	74.7	53.9	381.5
1/20	51.9	5.9	8.6	6.7	31.7	65.5	40.7	341.9
1/50	39.8	3.5	7.4	4.6	25.6	57.9	27.7	306.6
1/100	32.9	2.2	6.9	3.6	22.6	53.9	20.0	287.4
Maximum								
1/2	128.4	22.1	22.1	31.9	103.3	138.3	116.2	616.3
1/5	193.4	37.1	42.6	71.3	214.1	231.7	174.8	905.2
1/10	237.8	47.7	61.7	108.5	318.6	311.1	212.9	1,125.9
1/20	281.2	58.3	84.7	153.5	444.7	400.5	249.0	1,357.8
1/50	338.7	72.8	121.7	227.0	649.6	536.5	295.4	1,687.6
1/100	383.0	84.2	155.6	294.7	838.0	654.7	330.3	1,957.8

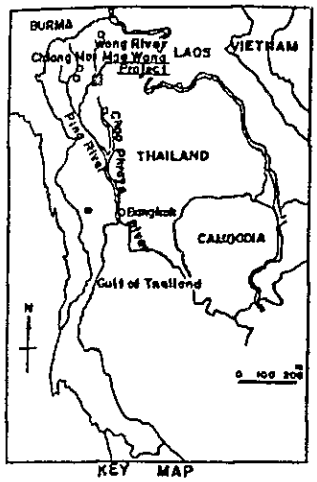
Note: Measuring periods are 17 years from 1962 to 1978.

LOCATION MAP OF PROJECT AREAS IN THE MAE WANG BASIN

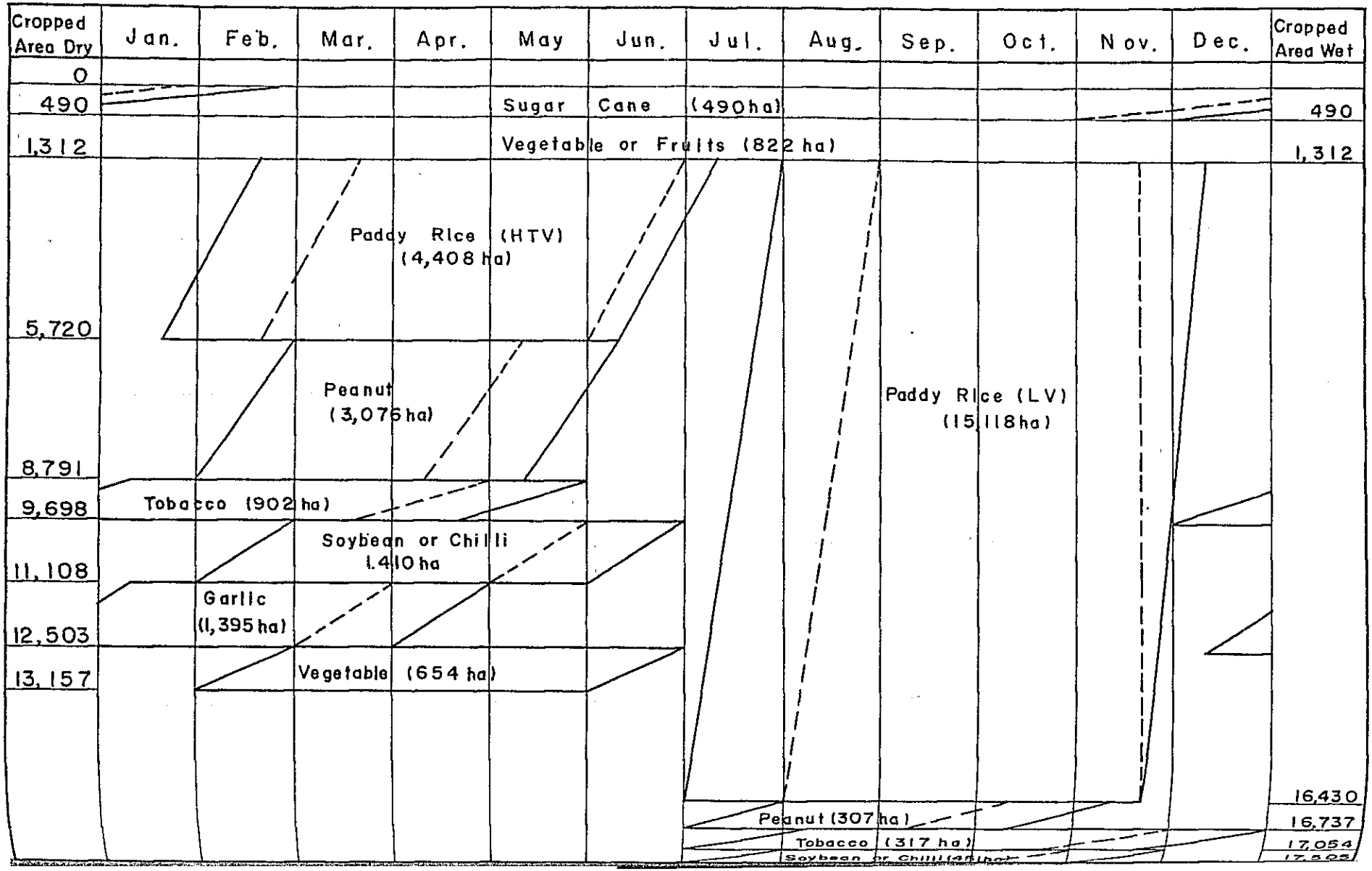


Source : Kew Lom Project Feasibility Report, Volume II by ECI (Dec. 1967)

MEASURING SITE OF PERCOLATION

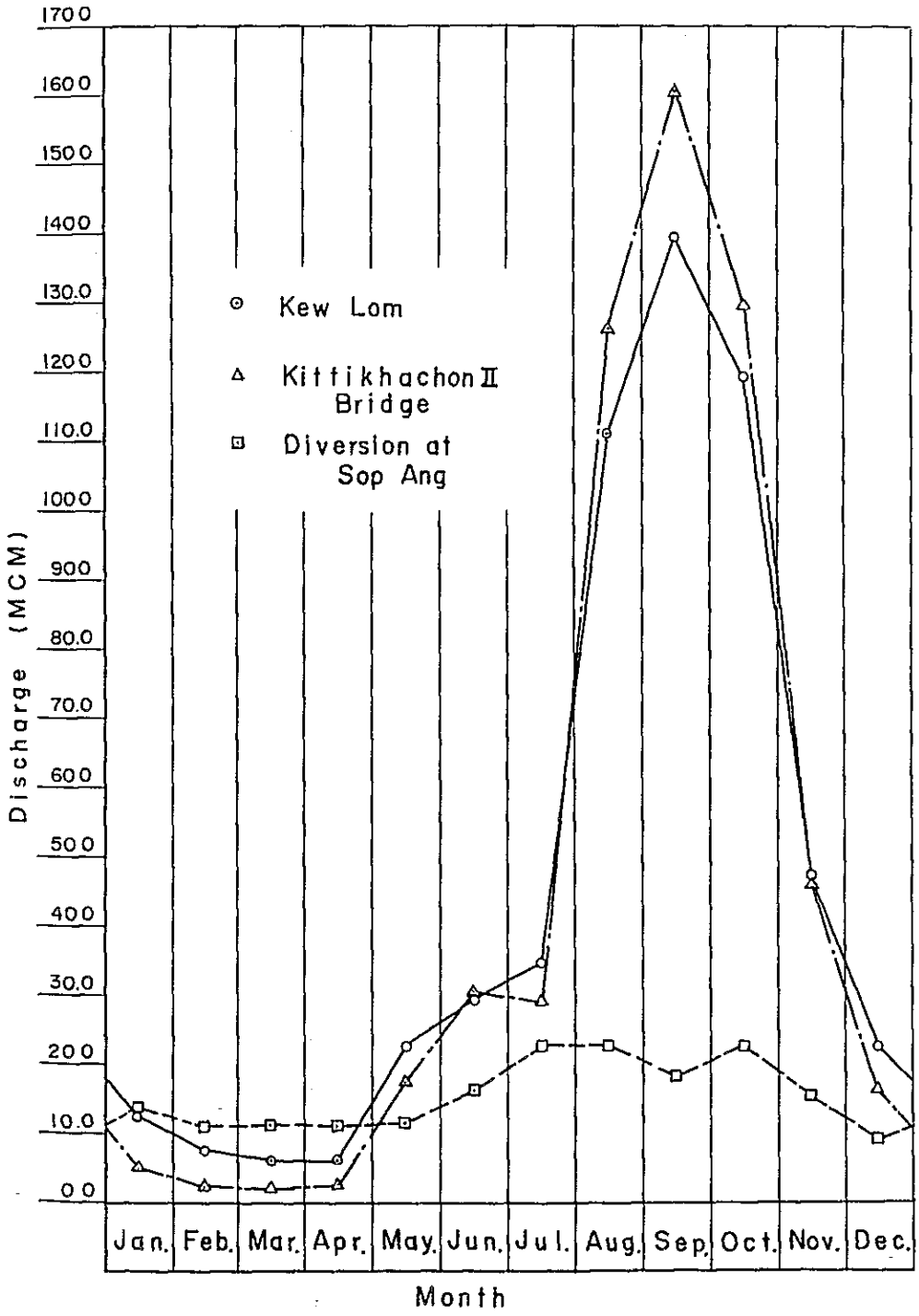


PROPOSED CROPS CALENDAR



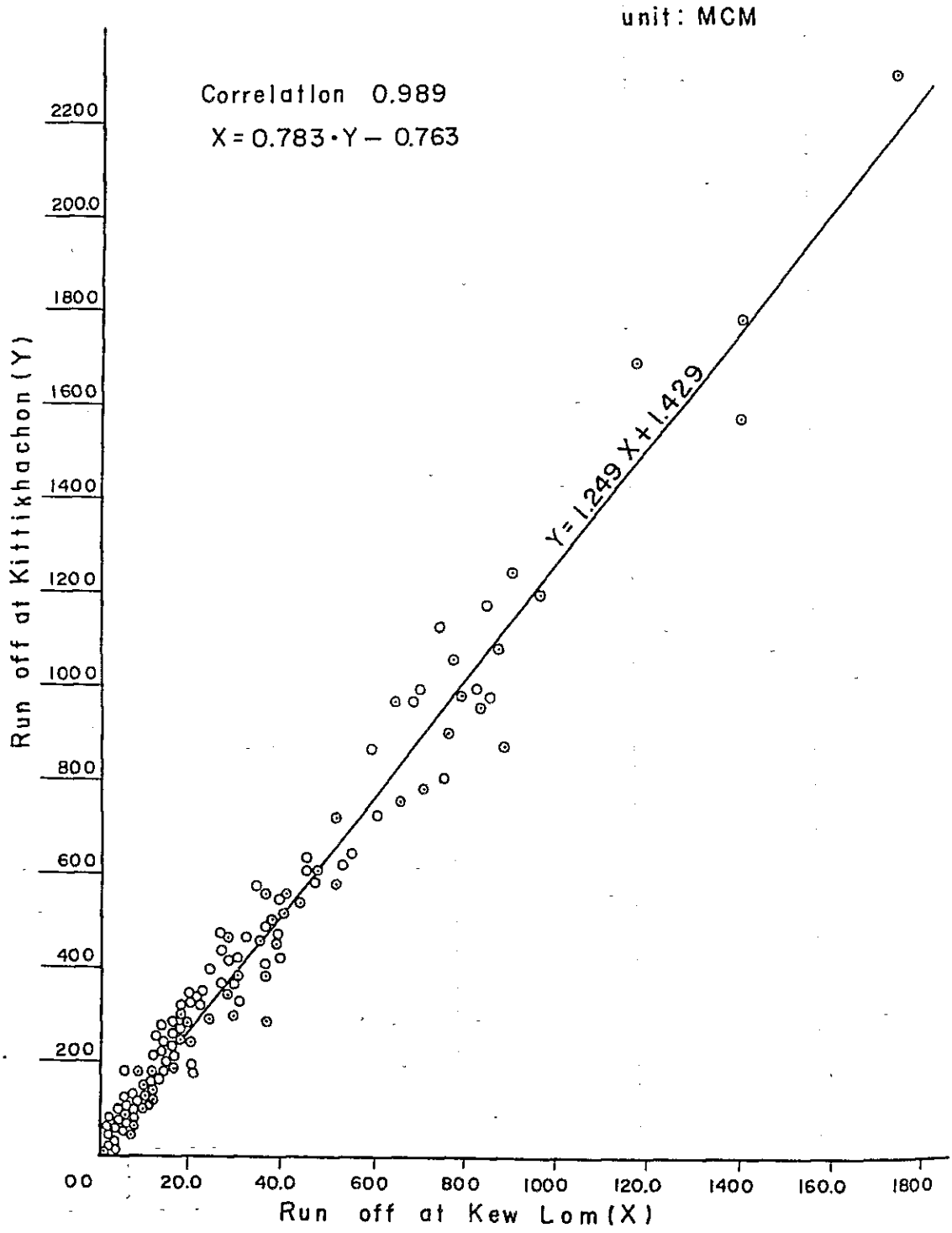
ANNEX 3-1
Figure 3-1-3

Monthly Mean River Discharge at Kew Lom Dam, Sop Ang and Kittikhachon



note : 1962 - 1971

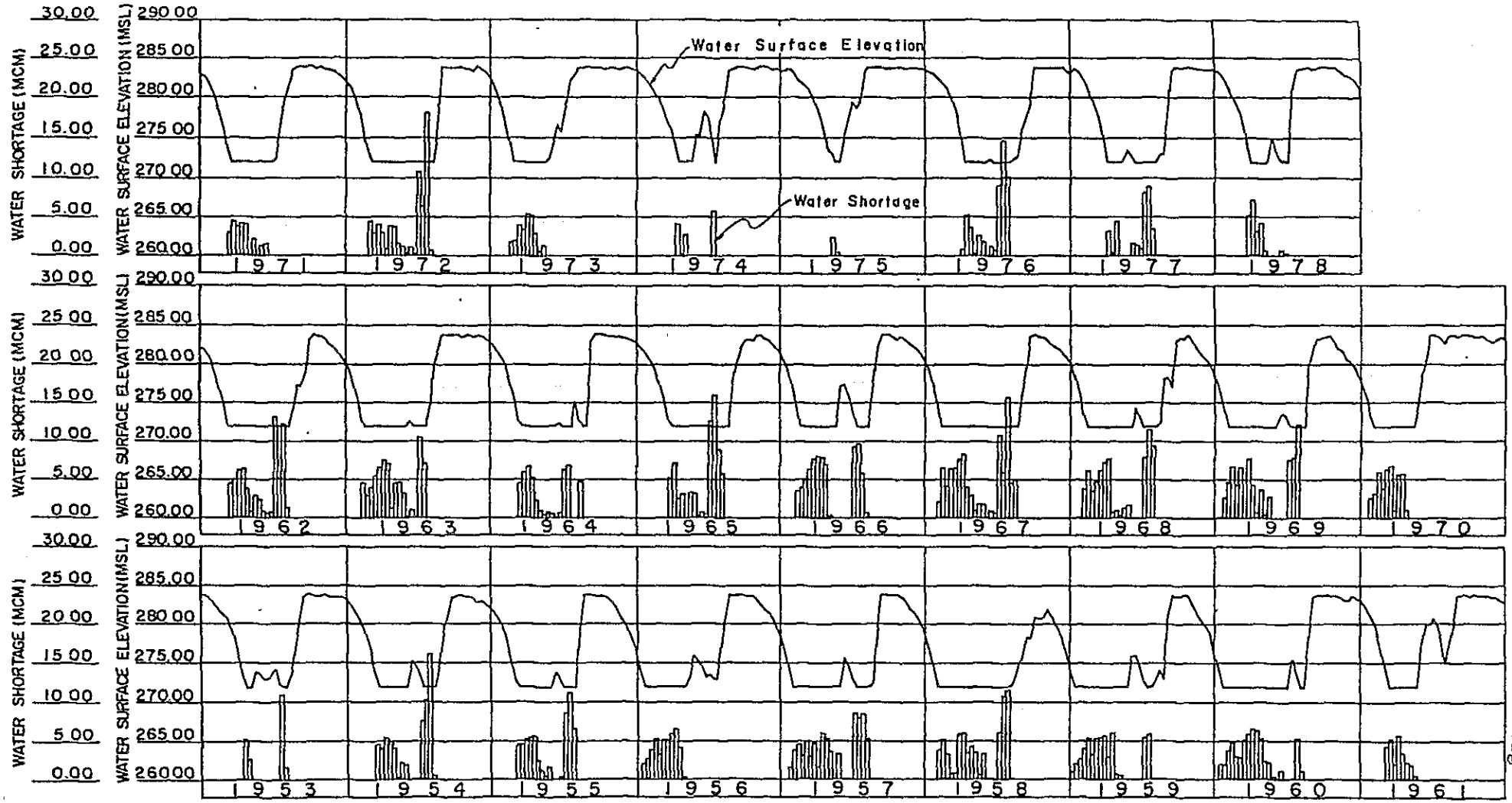
Correlation of Run-off Discharge Between Kew Lom and Kittikhachon



note : Period 1968 − 1971

Water shortage and Water surface elevation of Dam (Excepting Mae Pung)

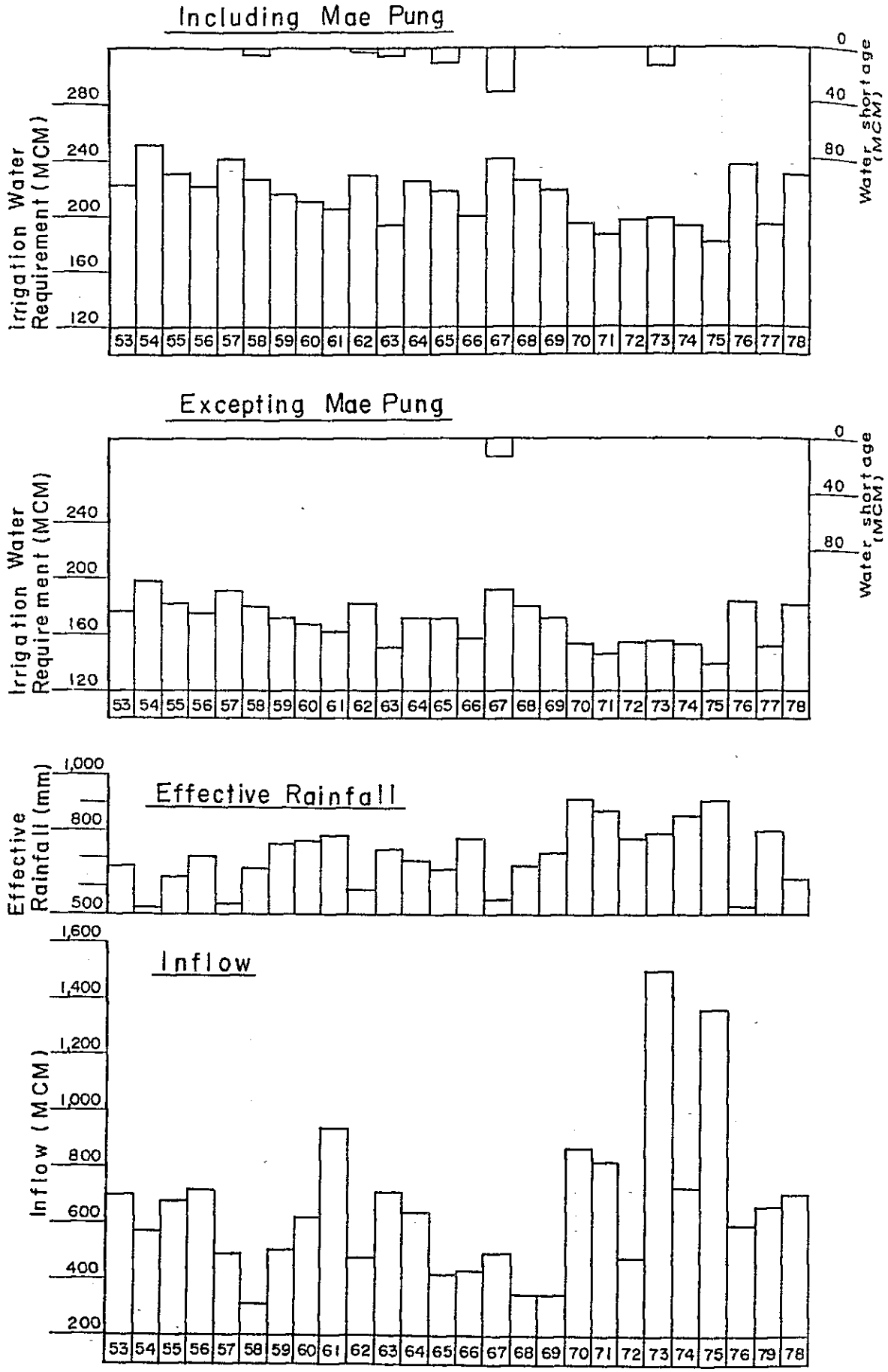
(In Case of Original Operation Rule)



note : Maximum operating water elevation 285 MSL
Minimum operating water elevation 272 MSL
The present operation rule is applied to releasing water from dam

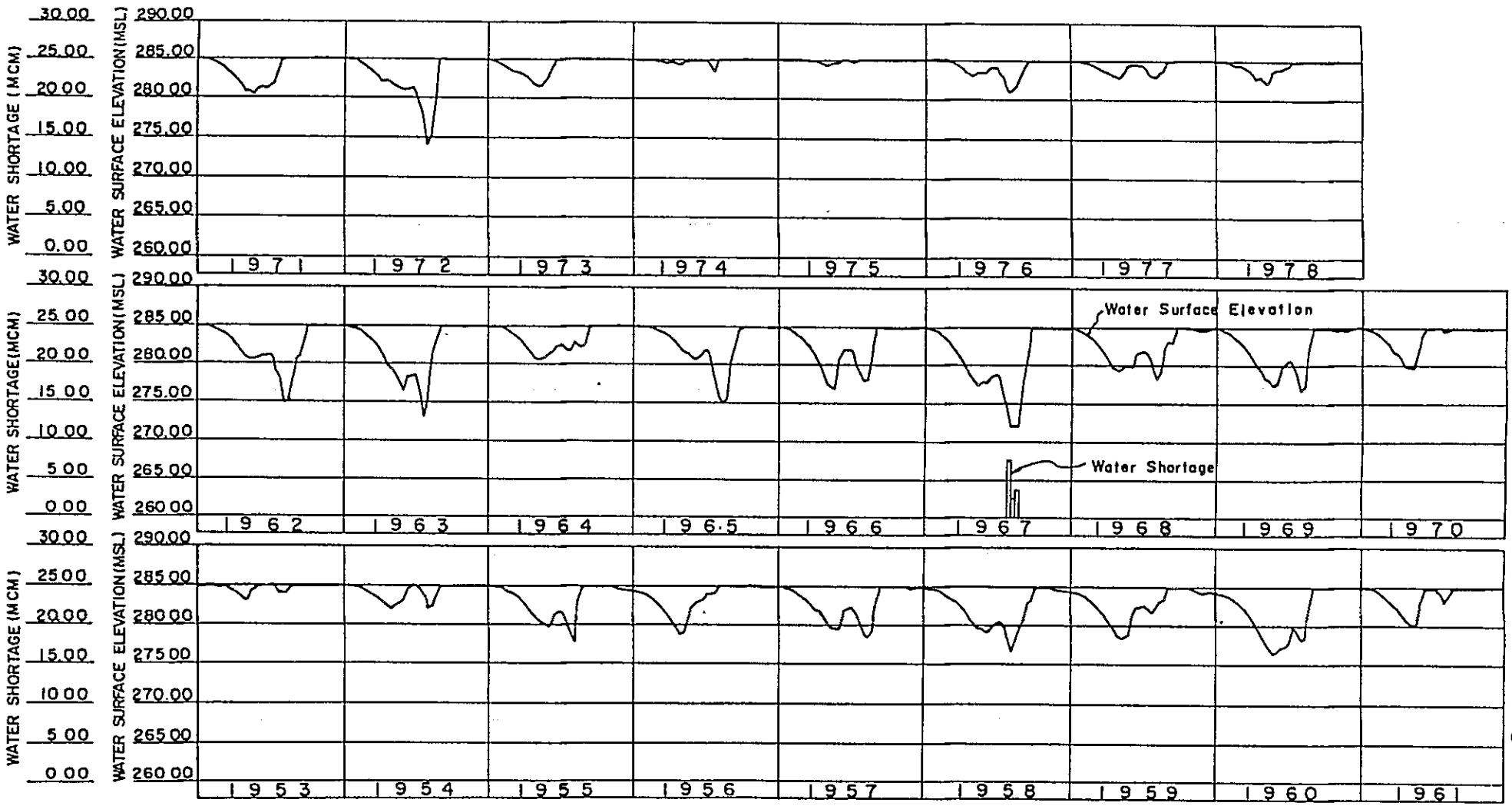
ANNEX 3-1
Figure 3-1-6

Summary of Water Balance for Kew Lom Reservoir



Water shortage and Water surface elevation of Dam (Excepting Mae Pung)

(In Case of Revised Operation Rule)

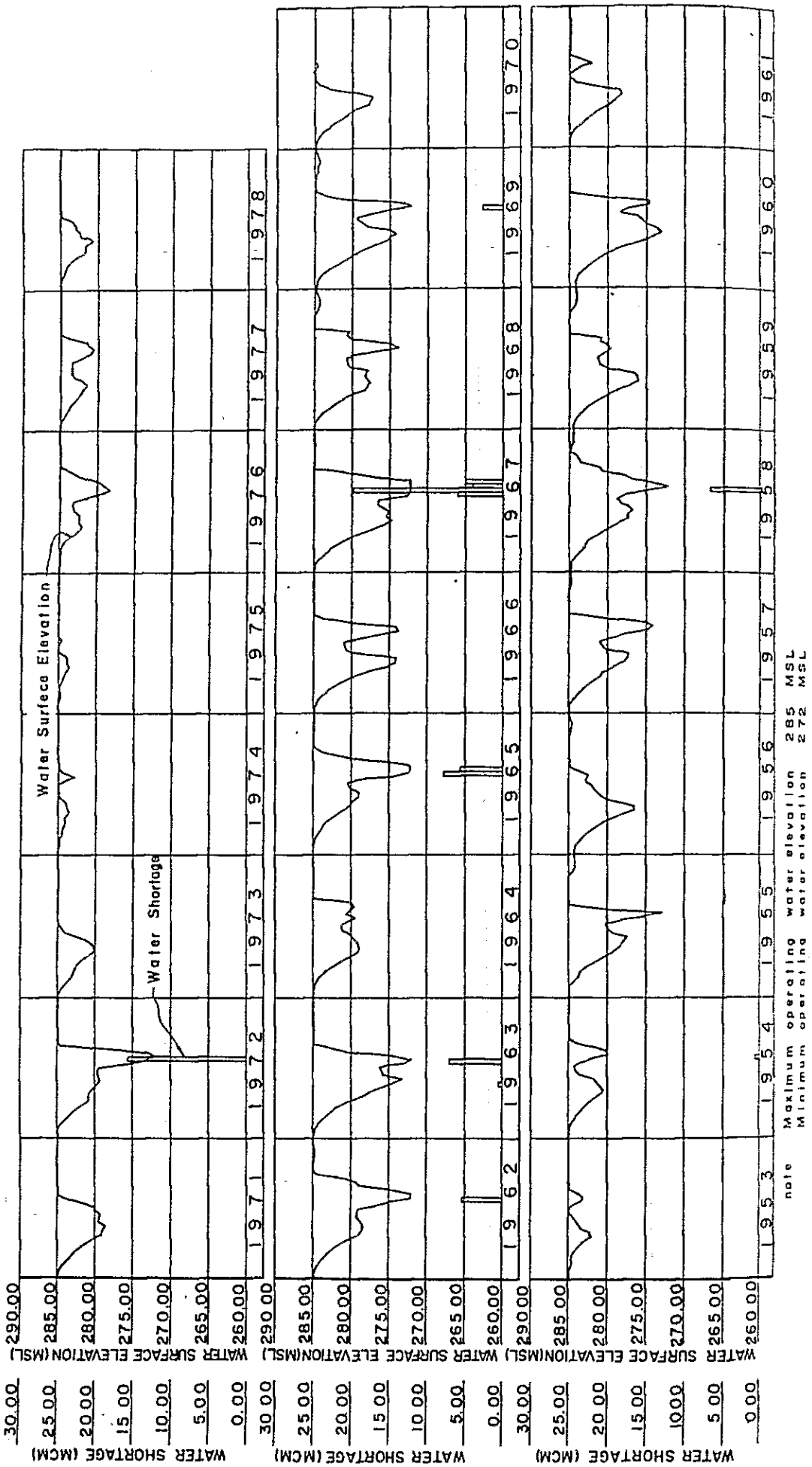


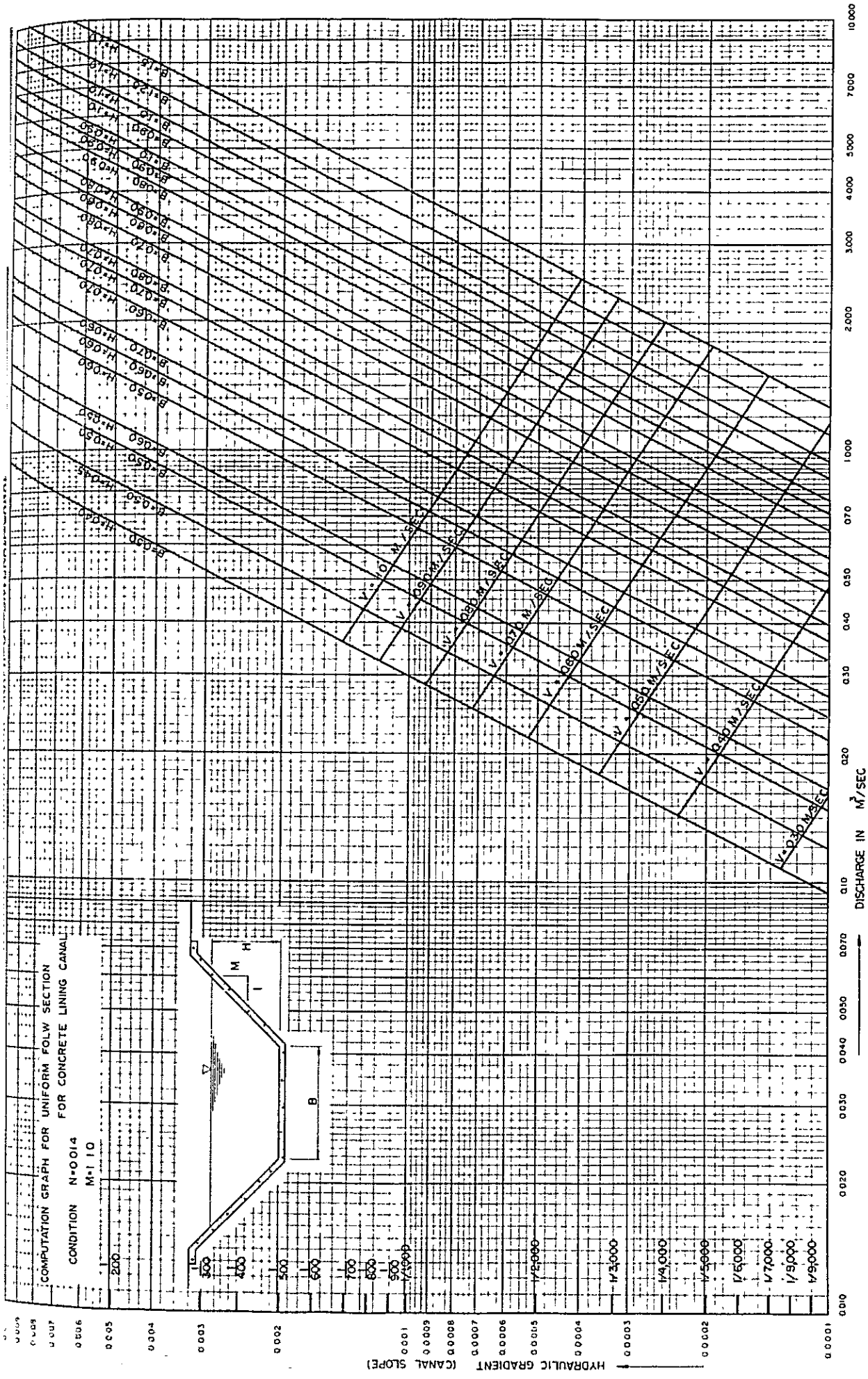
note : Maximum operating water elevation 285MSL
Minimum operating water elevation 272MSL

ANNEX 3-1
Figure 3-1-8

Water shortage and Water surface elevation of Dam (Including Mae Pung)

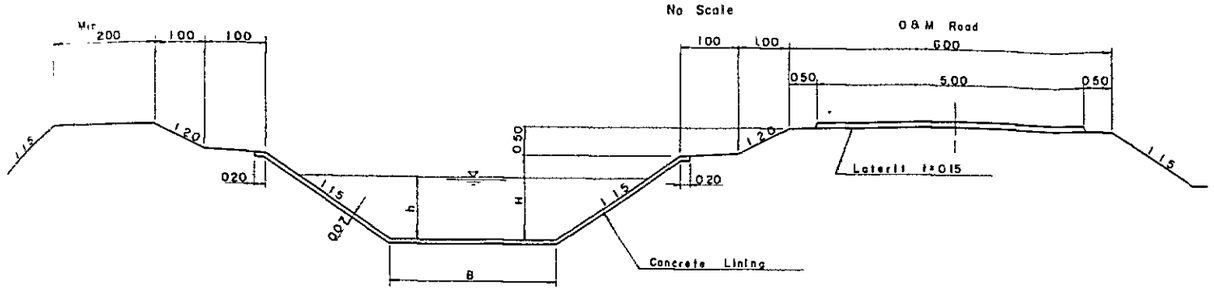
(In Case of Revised Operation Rule)




COMPUTATION GRAPH FOR UNIFORM FOLW SECTION
FOR CONCRETE LINING CANAL
CONDITION N=0.014
M=1.10
DISCHARGE IN M³/SEC
HYDRAULIC GRADIENT (CANAL SLOPE)

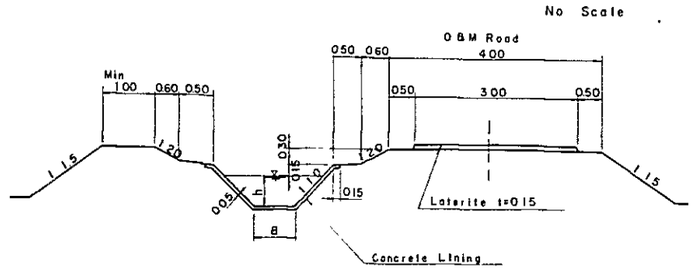
TYPICAL CROSS SECTION OF MAIN CANAL

No Scale



TYPICAL CROSS SECTION OF LATERAL CANAL

No Scale



DIMENSION TABLE OF MAIN CANAL

Name of Canal	Length (km)	Discharge (m^3/s)	Slope I	h (m)	B (m)	H (m)
Mae Wang Left Canal	9 20	8 02	1/6,000	1 67	2 70	2 07
	5 40	7 11	1/6,000	1.57	2 70	1 97
	8 90	5.67	1/6,000	1 40	2 70	1 80
	4 15	5 14	1/5,000	1 27	2 70	1 62
	6 24	3 88	1/5,000	1 21	2 10	1 56
	4 51	0 70	1/1,000	0 40	1 20	0 65
	(38 40)					
Mae Wang Right Canal	8 43	3 97	1/4,000	1 16	2 10	1 51
	10 07	3 30	1/4,000	1 05	2 10	1.40
	6 83	2.51	1/4,000	0 95	1 90	1 25
	2 90	0 97	1/4,000	0 69	1 20	0 94
	7 06	0 64	1/4,000	0.56	1.20	0 81
	(35 29)					
Mae Pung Main Canal	1 70	1.74	1/4,000	0 79	1.90	1 09
	1 40	1 42	1/4,000	0 71	1 90	1 01
	2 51	1 08	1/4,000	0 73	1 20	1 03
	(5 61)					
Mae Pung Left Canal	3 00	2.64	1/3,000	0 90	1 90	1 20
	1 50	1 93	1/3,000	0 76	1 90	1 06
	2 02	0 30	1/2,500	0 40	0 50	0 55
	(6 52)					
Mae Pung Right Canal	2 80	2 30	1/4,000	0 91	1 90	1 21
	5.50	1 36	1/4,000	0 69	1 90	0 99
	4.00	0.82	1/4,000	0 80	0.80	0 95
	(12.30)					
Link Canal	2 00	4 94	1/4,000	1 20	2 10	1 55

DIMENSION TABLE OF LATERAL CANAL

Name of Main Canal	Lateral No	Length (km)	Discharge (m^3/s)	Slope I	h (m)	B (m)
Mae Wang Left Canal	ML 1R	2 50	0 43	1/5,000	0 70	0 60
	ML 2R	1 55	0 37	1/3,000	0.60	0 50
	ML 3R	0 40	0 15	1/4,000	0 40	0 50
	ML3-1R	0 55	0 14	1/4,000	0 40	0 50
	ML 6R	2 20	0 21	1/2,000	0 40	0 50
	ML9R-1R	1 60	0 39	1/1,500	0 50	0 50
	ML10R-1R	1 40	0 16	1/3,000	0 40	0 50
	ML10R-1L	3 30	0 28	1/1,000	0 40	0 50
	ML10R-2L	1 40	0 37	1/1,000	0 45	0 50
	ML11L	3 00	0 75	1/1,500	0 60	0 70
	ML11L	3.00	0 38	1/2,000	0 50	0 60
	ML11L-1R	1.70	0 16	1/4,000	0 40	0 50
Mae Wang Right Canal	MR4L-1L	1 40	0 20	1/2,000	0 40	0 50
	MR 6 L	2 30	0 14	1/1,500	0 40	0 50
	MR7L-1L	1 40	0 20	1/2,000	0 40	0 50
	MR8L-1R	1 90	0 29	1/2,500	0 50	0 50
	MR8L-1RL	1 10	0 20	1/2,000	0 40	0 50
	MR8L-1L	2 00	0 46	1/2,000	0 60	0 60
	MR8L-2L	1 20	0 19	1/2,500	0 40	0 50
	MR 9 L	2 90	0 35	1/2,000	0.50	0 60
	MR9L-1R	1 10	0 20	1/2,000	0 40	0 50
	MR10L	1 29	0 24	Enlargement to exsisting Canal		
	MR10-1L	2 05	0 22			
Mae Pung Main Canal	MP1 R	2 50	0 35	1/2,000	0 50	0.60
	MP2 R	2 00	0 37	1/2,000	0 50	0 60
	MR3R	2 80	0 51	1/1,000	0 50	0.60
	MP4 R	4 50	0 64	1/4,000	0 70	0.80
	MP4 R	3 00	0 30	1/1,500	0 45	0.50
	MP4 R	2.70	0 14	1/4,000	0 40	0.50
	MP4R-1R	1 60	0 21	1/2,000	0 40	0 50

Name of Main Canal	Lateral No	Length (km)	Discharge (m^3/s)	Slope I	h (m)	B (m)
Mae Pung Left Canal	MPL1R	1 10	0.23	1/2,000	0 40	0 50
	MPL2R	1 10	0.23	1/2,000	0 40	0 50
	MPL3R	3 00	1 56	1/2,000	0 90	0 90
	MPL3R	3 00	1 09	1/2,500	0 80	0 90
	MPL3R	4 00	0 62	1/1,500	0 60	0 60
	MPL3R-1L	1 55	0 24	1/2,000	0 40	0 50
Mae Purg Right Canal	MPR1L	3 00	0 80	1/2,500	0 70	0 70
	MPR1L	1 70	0 29	1/1,500	0 45	0 50
	MPR2L	1 60	0 28	1/1,000	0.40	0 50
	MPR3L	2 50	0 26	1/1,500	0 40	0 50
	MPR4L	1 90	0 22	1/2,000	0 40	0 50
	MPR5L	1 30	0 28	1/1,000	0 40	0 50
	MPR6L	1 20	0 31	1/1,500	0 45	0 50

KINGDOM OF THAILAND
MINISTRY OF AGRICULTURE AND CO OPERATIVES
ROYAL IRRIGATION DEPARTMENT

MAE WANG AND KEW LOM PROJECT
TYPICAL SECTIONS OF
MAIN AND LATERAL CANAL

DESIGNED	SUBMITTED
DRAWN	REVIEWED
TRACED PONGCHAN	RECOMMENDED
CHECKED	APPROVED

JAPAN INTERNATIONAL COOPERATION AGENCY

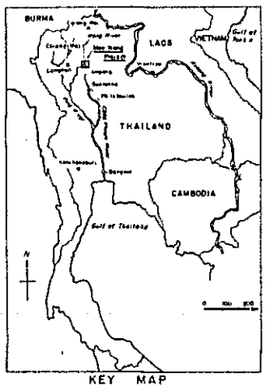
DATE	REVIEWED

MAIN CANAL

NAME OF CANAL	LENGTH (km)		
	COMPLETED	CONSTRUCTION	TOTAL
MAE WANG LEFT CANAL	—	38.4	38.4
MAE WANG RIGHT CANAL	—	35.3	35.3
MAE PUNG MAIN CANAL	—	5.6	5.6
MAE PUNG LEFT CANAL	—	6.5	6.5
MAE PUNG RIGHT CANAL	—	12.3	12.3
KEW LOM CANAL	23.8	—	23.8
LINK CANAL	—	2.0	2.0
TOTAL	23.8	100.1	123.9

LATERAL CANAL

ZONE NO	NUMBER OF ROUTES	LENGTH (km)		
		COMPLETED	CONSTRUCTION	TOTAL
1	5	2.2	5.0	7.2
2	2	3.1	2.2	5.3
3	6	6.6	7.7	14.3
4	5	4.5	14.6	19.1
5	6	—	13.2	13.2
6	4	—	13.8	13.8
7	2	—	7.7	7.7
8	7	8.2	1.4	9.6
9	9	8.1	9.9	18.0
10	4	—	7.3	7.3
12	19	41.6	—	41.6
TOTAL	69	74.3	82.8	157.1



KEY MAP

LEGEND

- PROJECT or ZONE BOUNDARY
- COMPLETED MAIN CANAL
- MAIN CANAL TO BE CONSTRUCTED
- COMPLETED LATERAL CANAL
- LATERAL CANAL TO BE CONSTRUCTED

KINGDOM OF THAILAND
MINISTRY OF AGRICULTURE AND CO OPERATIVES
ROYAL IRRIGATION DEPARTMENT

MAE WANG AND KEW LOM PROJECT
PROPOSED IRRIGATION SYSTEM

DESIGNED — SUBMITTED
DRAWN — REVIEWED
TRACED JONGCHAI — RECOMMENDED
CHECKED — APPROVED

JAPAN INTERNATIONAL COOPERATION AGENCY

DATE | REVIEWED

ANNEX 3-1
Map 3-1-1