The Korat soils in this unit are similar to the regular Korat soils already described except that it is common for them to contain laterite concretions at a depth as a shallow as 60 cm. The Phon Phi Sai soils in this unit are similar to the Phon Phi Sai soils which will be described later.

d) Roi Et Series (Re)

The Roi Et series consists of somewhat poorly drained, light colored sandy or loamy soils formed in old alluvium of the nearly level and gently undulating low and middle terraces.

Soil profile of Roi Et series is as follows:

Ap - - - The surface horizon is distinctly mottled, grayish brown or light grayish brown, sandy loam or fine sandy loam. The mottles are strong brown and strong yellowish brown, mostly along old root channels. When dry, this layer is light gray. The organic matter content is commonly less than one percent. Its thickness ranges from 15 to 20 cm.

A2 - - - The upper subsoil is light brownish gray or pinkish gray, sandy loam or fine sandy loam with distinct mottles of strong brown and yellowish brown. This layer is commonly 15 to 30 cm thick.

B2tg - - - The lower subsoil is a pinkish gray, light brownish gray or light grayish brown, sandy clay loam or clay loam, distinctly mottled with strong brown and yellowish red. This layer commonly contains laterite concretions at depth more than 50 cm.

The range in pH of these soils is commonly from 4.5 to 5.5, but subsoil layers are alkaline in some places.

e) Nam Phong Series (Ng)

The Nam Phong series consist of excessively drained light colored, sandy soils formed in old alluvium on undulating or rolling parts of low and middle terraces. There are large areas of these soils in northern and south-western parts of the basin.

Soils profile of Nam Phong series is as follows:

A1 - - - The surface horizon is grayish brown or light brownish gray and or loamy sand about 15 cm thick. In some forest areas this horizon is dark grayish brown. Organic matter content is usually low.

C1 - - - The subsoil is light brown, yellowish brown or pinkish brown, almost single grained sand or loamy sand 45 to 65 cm thick.

C2 - - - Below a depth of 80 cm the texture is commonly loamy sand or sandy loam; however, this layer may be as shallow as 60 cm.

The range in pH is commonly 4.5 to 6.0 with values in the surface sometimes slightly higher.

f) Phon Phi Sai Series (Pp)

The Phon Phi Sai series consists of moderately well and somewhat poorly drained loamy soils that are shallow to laterite. These soils are on gently undulating to rolling edges of middle terraces.

Soil profile of Phon Phi Sai series is as follows:

A1 or Ap - - - The surface layer is a dark brown or grayish brown sandy loam or loam 15 to 20 cm thick. It has an organic matter content of less than one percent.

B2t - - - The subsoil is a yellowish red, reddish brown or brown sandy clay loam or clay loam with variable amounts of laterite concretions. This layer of laterite concretions is embedded in clay loam, sandy clay or clay. This layer is multicolored, containing shades of red and yellow. Below a depth of about one meter there is light gray sandy clay or clay. The pH values usually ranges between 4.5 and 5.5, but the values for the surface layer a sometimes higher.

g) Roi Et/On Association (Re/On)

This unit is composed of soils of the Roi Et series and the On series that occur side by side.

Soils of the Roi Et / On association are on the flat parts of low terraces. They are associated with soils of the Roi Et and On series.

The soils of this unit are underlain by layers of laterite commonly at a depth less than one meter; however, the laterite layer has a wavy surface, and in some places is at the surface. Where the laterite layer begins at a depth greater than 50 cm, the soils belong to the Roi Et series. Where the laterite layer begins between 10 and 50 cm the soils belong to the On series.

h) Roi Et/Phen Association (Re/Pn)

This unit is composed of soils of the Roi Et series and the Phen series that occur side by side on gently undulating topography. The Roi Et soils are on the lower parts and the Phen soils on the higher parts.

The Roi Et soils can be differentiated from Phen soils by considering the depth to unconsolidated laterite in nodules and the physiographic position. Where the laterite concretion layer begins at a depth greater than 50 cm, the soils belong to the Roi Et series. Where the unconsolidated laterite layer begins at a depth less than 50 cm, the soils belong to the Phen series. Soils of this unit are associated with soils of the Korat and Phon Phi Sai series.

i) Ubon Series (Ub)

Soils of the Ubon series have mottled, light colored sandy profiles. They are developed in old alluvium on the higher parts of low and middle terraces. All of these soils have been used for paddy rice and have "inverted gley" that is common in such soils.

Soil profile of Ubon series is as follows:

Ap - - - The surface layer is a distinctly mottled, gray or light grayish brown loamy sand or sand. It has an organic matter content often less than 0.5 percent. Its thickness ranges from 15 to 20 cm.

A2 - - - The upper subsoil is a distinctly mottled pinkish gray loamy sandy or sand, more than 50 cm thick.

B2t - - - The lower subsoil is a pinkish gray to pale brown sandy loam. It is faintly mottled with brownish yellow and strong brown. This layer is usually more than one meter thick.

The pH values are variable but usually range from 5.0 to 6.0.

j) Buntharik Series (Bt)

The Buntharik soils consist of somewhat poorly to moderately well drained soils formed in sandy residuum and colluvium on the undulating and rolling footslopes of hills underlain by sandstone. Slope gradients range between two and six percent.

Soil profile of Buntharik series is as follows:

A1 - - - The surface layer is very dark grayish brown or dark brown loamy sand or coarse sandy loam, 10 to 20 cm thick. Ap horizons are grayish brown in areas cultivated to upland crops. This layer contains about one percent of organic matter.

A2 - - - The upper subsoil is very pale brown loamy sand or sandy loam about 15 to 30 cm thick.

B2t - - -The lower subsoils is grayish brown, pale brown or very pale brown sandy clay loam or sandy clay, distinctly mottled with shades of gray, yellow, and red.

R - - - Sandstone bedrock is usually deeper than two meters, but may be a shallow as one meter.

These soils have pH values which usually range between 5.0 and 5.5 for surface layers and between 4.5 and 5.0 for subsoils.

k) Phen Series (Pn)

The Phen series consists of somewhat poorly drained sandy or loamy soils that contain unconsolidated laterite in a clay matrix at a depth of less than 50 cm. They are in shallow depressions, formed in clayey old alluvium on the lower slopes of middle terraces.

Soil profile of Phen series is as follows:

Apg - - - The surface soil is a distinctly mottled grey or grayish brown loamy sand or sandy loam, about 15 cm thick. In some places this layer contains numerous fine laterite concretions.

B2tg - - - The upper subsoil consists of laterite concretions embedded in a gray to light gray clay loam or clay. It has prominent multicolored mottles. In the lower part of the layer, it is usually dense and is difficult to penetrate with an auger. Thickness ranges from 20 cm to one meter or more.

Cg - - - The lower subsoil is prominently mottled gray clay, one meter or more thick.

The Phen soils range in pH values from 4.5 to 5.5.

l) Chok Chai Series (Ci)

The Chok Chai series consists of red, well drained soils on residuum or colluvium from basalt and andesite. They occupy on undulating to gently rolling topography of the strath terrace or lava plateau.

A large area containing Chok Chai soils is in the southern part of the basin. The Chok Chai soils are surrounded by soils of the Korat series.

Soil profile of Chok Chai series is as follows:

Ap or Al - - - The surface layer is a dark brown to dark reddish brown clay loam or clay. Thickness ranges from 15 to 25 cm.

B2t - - - The subsoil is a red or dark red clay, one meter or more thick. These soils may also have A3 or Bl horizons. Soil pH values generally range from 6.0 to 7.0 but subsoils have lower values.

m) Alluvial Complex (Ac)

The areas surveyed as Alluvial Complex consist of the Kalasin and Phimai soils in the low parts and Chiang Mai series on the somewhat higher river levees. These soils are so intermingled that they cannot be shown separately on the map.

n) Roi Et Series, loamy phase (Re-1)

Soils mapped in this phase have finer textures throughout than those in Roi Et series, otherwise they are very similar. The texture to a depth of 20 to 40 cm is loam, or in some places, clay loam. The lower subsoil texture is clay loam or clay.

o) On Series (On)

The On series consists of poorly drained, light colored sandy or loamy soils formed in old alluvium of the flat and nearly flat low terraces.

Soil profile of On series is as follows:

Ap or Apg - - - The surface horizon is distinctly mottled, grayish brown loamy sand or sandy loam, 10 to 20 cm thick.

Btg - - - The subsoil is light gray or pinkish gray sandy clay loam, clay loam or clay, prominently mottled with shades of yellowish, brownish, and reddish colors.

Laterite layer - - - This layer is multicolored in shades of red, yellow, and gray. It contains many dark brown, irregularly shaped, hard concretions and semi-consolidated or consolidated laterites. Thickness of the layer ranges from a few centimeters to more than one meter. Material below the laterite is light gray clay with mainly yellowish brown and red mottles and contains scattered laterite concretions.
The soils of the On series have a range in pH values from 5.0 to 6.5. In places the laterite layer may have pH value as high as 8.0.

p) Sakon Series (Sk)

The Sakon series consists of moderately well and somewhat poorly drained sandy or loamy soils that contain consolidated laterite at depths less than 50 cm. They are on nearly level to gently sloping parts of the low and middle terraces.

Soil profile of Sakon series is as follows:
Al or Ap - - - The surface layer is a grayish brown fine sandy loam or loamy fine sand about 15 cm thick.

B2t - - - The subsoil is a pinkish gray or light brownish gray loam or fine sandy clay loam, mottled dark reddish brown and strong brown in the low part. This layer contains variable amounts of laterite concretions, and in the lower part contains more than 50 percent of laterite concretions. The range in thickness is from 5 to 45 cm.
The common range in pH values is from 4.5 to 6.0 but surface layer are sometimes higher.

CHAPTER II. LAND CLASSIFICATION

Land classification of the basin is done based on soil map (scale 1 : 50,000) of the Department of Land Development (DLD) in 1990. The map illustrates land suitability for economic crops in the form of "land unit". Definition and suggestions of each land unit according to Land Classification System of the DLD are described in Table C-1:

The following land class groups of the basin were identified.

LAND CLASS GROUPS

Land Class Group	Area (ha)	Area (rai)	Area (%)
L_1	3,614	22,519	0.7
L_2	176,536	1,103,345	36.0
L_4	19,157	119,732	3.9
L_5	25,880	161,751	5.0
L_6	46,700	291,875	9.5
L_7	58,700	366,877	12.0
L_8	86,967	543,539	17.8
L_{10}	3,615	22,595	0.7
L_{12}	18,723	117,021	3.8
L_{13}	50,607	316,294	10.3
Total	490,499	3,065,620	100.0

The results of land classification study show that most of the area in the basin is suitable for paddy rice (36 percent of the total area). Precaution is that during the growing period of rice, water shortage at certain stages of growth may be encountered. Suitable area for upland crops account for 44.6 percent but the area that most suitable to upland crops covers only 5.3 percent. For the remaining areas are those of sandy soil with very poor fertility. In some area, especially that of Land Class Group 8, which occupies 17.8 percent of the total area, should be developed for growing rice.

The land classification map covering the basin is given in Figure C-2.

TABLE C- 1 LAND CLASSIFICATION SYSTEM

Land Class Group	Land Unit	Definition	Suggested Management
L_1	2, 4, 6, 7, 15, $7d_3$	Suitable for paddy rice; in area where water resource exists, annual crops or vegetables can be grown in the dry season.	Apply fertilizer and maintain soil fertility
L_2	17, 18, 22, 24, 25, 59, $17d_3$, $17d_3c$, 17/25, $18d_3$, $18d_3c$, $18/22d_3$, $22d_3$, $22/22d_3$, $22/24$, $22d_3/24d_3$, 22/25, $22d_3/25$, $22/22d_3/25$, $24d_3$, $24d_3/25$, 7hi, 17hi, 18hi, 21, 22hi, 25hi, 22/22hi, 25/25hi	Suitable for paddy rice with a risk of water shortage when rainfall is erratic as soils in most area are sandy and some area is high steep.	Water reservoir is needed for use if shortage or when land use is changed to more suitable operation.
L_3	7sa, 18sa, 22sa	Moderately suitable to paddy rice as salinity is the problem.	Sufficient quantity of water reservoir is indispensable, preventive measures and soil improvement program before and after growing are necessary.
L_4	15/38, 17/40, 21/38, 22/40, 25/56b, 59/60	Suitable for paddy rice, upland crops and pasture.	Exploit the land as describe by land suitability
L_5	29, 29B, 31, 31B, 33, 35, 35B, 36, 36B, 38, 55, 55B, 56, 56B, 29/29B	Suitable for upland crops and vegetables.	Apply fertilizer and maintain soil fertility; in some area, land should be used with soil and water conservation measures.
L_6	40, 40B, 40/56, 40B/56B	Suitable for upland crops and vegetables although soils are sandy and fertility is low in nature.	Organic fertilizer and cover crops should be used; organic fertilizer should be used strictly as recommended (rate, time) so as to reduce metricuts loss.
L_7	41, 41b, $41d_3$, $41d_3b$, 41B, 41Bb, $41d_3B$, 41C, 44, 44b, $44d_3$, 44B, 40/41, 40b/41b, 40B/41B, 41/41b, $41/41d_3$, $41b/41d_3b$, $41d_3/41d_3b$, $41d_3b/56b$, 41Bb/41B, 44/44b	Moderately suitable for upland crops or suitable for pasture as soils are very sandy with very low fertility.	Organic fertilizer is necessary to improve soil characteristics, otherwise use the land according to its suitability.
L_8	35b, 40b, $40d_3b$, 56b, 56Bb, 40/40b, 40b/49b, 40b/56b, 56/56b, 56Bb/56B	Suitable for upland crops, however, lands are currently renovate for growing rice.	Land should be used according to land suitability and land should be fertilized.
L_9	40sa	Suitable or moderately suitable for certain crops as soils are saline or potentially saline.	Soils should be planted to saline tolerant cultivars, protective and solving measures of saline soils should be devised.
L_{10}	56C, 40C/56C	Suitable for fruits and trees.	Fertilizer should be applied simultaneously with soil and water conservations measures.
L_{11}	48E	Moderately suitable for fruit and trees as land is high steep.	Soil and water conservation measures are necessary and should be exercized simultaneously with fertilizer application.
L_{12}	46, 46b, 46B, 46Bb, 47, 47B, 47C, 48, 48B, 48Bb, 48C, 48Cb, 48D, 49, 49b, 49B, 49Bb, 49C, 48/48b, 48/56, 48b/56b, 48B/56B, 48Bb/56Bb, 48C/56, 48C/48Cb, 49/49b, 49/56, 49b/56b, 49B/56B, 49Bb/56Bb. 49C/56C	Suitable or moderately suitable for fruits and trees as soil contains gravel or having layer of rock in subsoil.	Planting should be well prepared and organic and inorganic fertilizers should be applied with measures of soil and water conservations.
L_{13}	62, RD, 40/RL, 41B/RL, 41C/RL, 47C/RL, 48/RL, 48B/RL, 48C/RL, 48D/RL, 48E/RL, 48/56/RL, 48B/56B/RL, 48B/48C/RL, 48C/56C/RL,48C/48D/RL, 48D/56D/RL, 48D/48E/RL, 49B/56B/RL, 56C/RL, 56C/48D/RL	High mountainous areas, rolling topography with rock outcrops or soil mixed with irregular hilly areas having rock outcrops, unsuitable for economic crops.	Land should be preserved as watershed area or forest; in natural forest areas having encroachments, they should be reforested.
L_{14}		Other areas such as water resources, housing area, industrial plant, rock outcrop area.	Measures should be exercised to prevent their impact on environment and other natural resources.

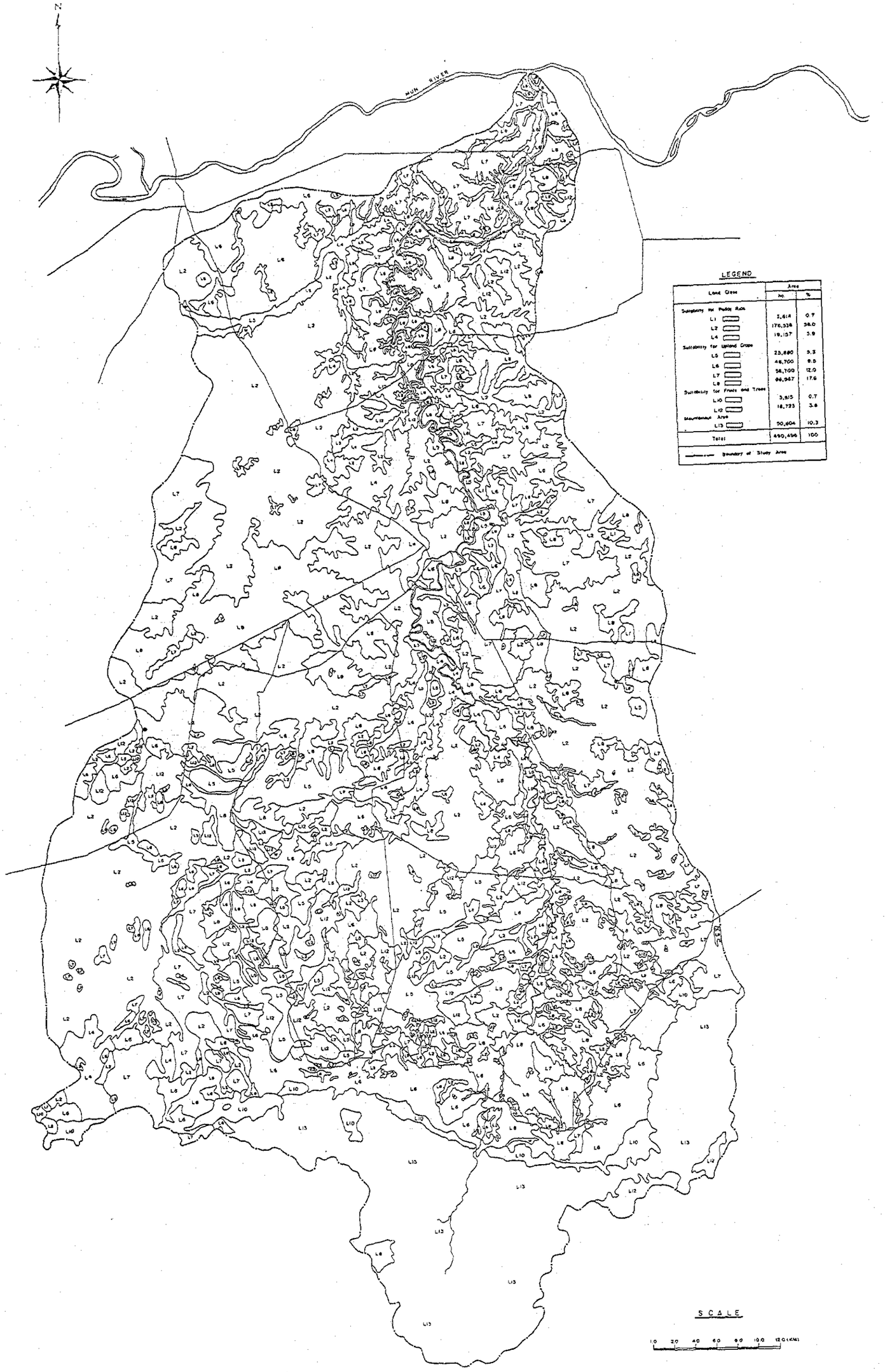


FIGURE C-2 LAND CLASSIFICATION IN THE BASIN

CHAPTER III. LAND USE

The total area of the basin is about 490,500 ha (3,065,600 rai). This area is classified according to land use based on data from current land use map (1:100,000) of the Department of Land Development (1988), the agricultural reports of 1989 and 1990 on land use for wet and dry season crops of Provincial Agricultural Extension Office and from survey conducted.

The pattern of land utilization is closely related with landform patterns and soil-type distribution. Paddy field is mostly confined to alluvial plain of the Lam Dom Yai river and low terraces. Upland crop fields mainly extend on the middle terraces, while mixed orchard and vegetable are generally located in nearby the housing in the village areas. The present land use of the Lam Dom Yai basin is as follows:

PRESENT LAND USE

Category	Area		
	(ha)	(rai)	(%)
Paddy field	200,822	1,255,137	40.9
Upland field	53,707	335,669	10.9
Sub-total	254,529	1,590,806	51.9
Forest	171,153	1,069,706	34.9
Residential area	23,565	147,281	4.8
Public & Other Area	41,252	257,825	8.4
Sub-total	235,970	1,474,812	48.1
Total	490,499	3,065,618	100.0

The major types of agricultural land use are paddy, upland crops (include orchard and vegetables), fallow land (include pasture) and forest. Those areas accounted for about 86 percent of the total. Paddy field occupies 40.9 percent of the area. When wet and dry season rices are compared, the dry season rice accounted for only 0.2 percent of the total paddy field. The agricultural reports in 1989 and 1990 on land use for the basin show only some changes in land use patterns. This indicates that the land use has already been stabilized to a medium to high degree in the area. Due to low productivity of

soil, shifting cultivation for upland crops such as kenaf, cassava, etc. was found in some areas. Although several kinds of crops have been grown in the past five years, rice has still been the main crop upto the present.

The forest area in the basin occupy about 35 percent which is high as compared to the total area. Most of the forest is the National reserved forest, however, most of them have been changed exploitedly. The forest area also includes wild life sanctuary and National Park which is located on the south of the basin. The following information on forest area was taken from report by the Regional Forest Office.

The forest area in the area can be identified as follows:

National Reserved Forest

- Non Hang Rang Raeng forest
- Huai Tong Wed Left Bank forest
- Huai Mae Non forest
- Son Dong Tui forest
- Dong Na-Kae forest
- Huai Ka-Yung Right Bank forest
- Lam Dom Yai Left Bank forest
- Khoa Pra Wi-han forest
- Lam Dom Yai Right Bank forest

Wild Life Sanctuary Area

- Yod Dom

National Park

- Phu Jong Na-yoi

Observations and analysis of information from Landsat data (1988) and National reserved forest (1988) revealed that 73 percent of Nation reserved forest is degraded forest and has been used for agricultural purposes, for example, for paddy field, upland crops such as cassava and kenaf, etc. Farmers who farm in these areas do not hold any land titles or deeds. Forest areas which are in good condition are Khoa Pra Wi-han, Lam Dom Yai Left Bank (southern part), Yod Dom Wild Life Sanctuary area and Phu Jong Na-yoi National Park. For the Lam Dom Yai Right Bank, the Royal Forest Department has conveyed

authority to the Agricultural Land Reform Office to reform the land for farmers.

The details of current land use map of the basin are shown in Figure C-3.

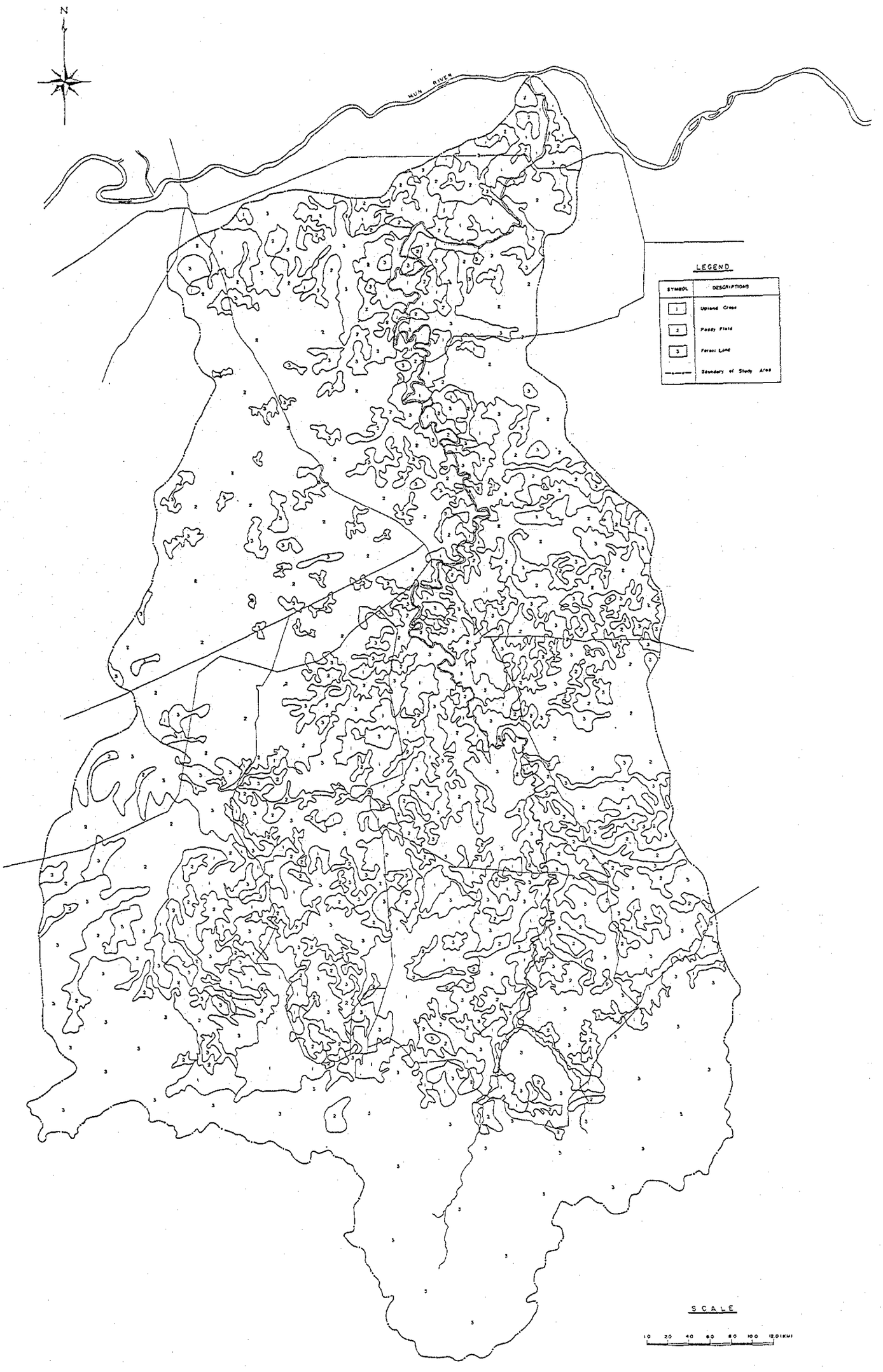


FIGURE C-3 LAND USE MAP IN THE BASIN

PART-II (FEASIBILITY STUDY)

CHAPTER IV. SOIL

4. 1 Soil Classification

The Soil Survey Report of the Department of Land Development (DLD) reveals that Ubon Ratchathani province is occupied by 30 soil series, of which 24 soil series appear in the Lam Dom Yai basin. The 12 soil series in the Study Area can be grouped into following seven soil sub-groups;

- Oxic Paleustult (Kt)
- Aeric Paleaquult (Re, Re-1)
- Ustoxic Quartzipsamment (Ng)
- Typic Plinthustult (Pp)
- Aquic Quartzipsamment (Ub)
- Typic Plinthaquult (Pn)
- Oxic Plinthaquult (On)

Source: Guide Line to Soil Series and Classification of Thailand, DLD (1981)

Distributions of each soil series in the area are as follows;

DISTRIBUTION OF EACH SOIL SERIES

(Unit: ha)

Soil Classification	Plan A - 1			Plan B - 1
	Left Bank	Right Bank	Total	(Right Bank)
1. Korat (Kt)	10,930	13,670	24,600	15,200
2. Korat - Phon Phisai Asso. (Kt/Pp)	-	12,630	12,630	17,730
3. Roi Et - On Association (Re/On)	-	860	860	7,560
4. Roi Et (Re)	2,520	2,620	5,140	4,210
5. Roi Et - Phen Asso. (Re/Pn)	100	1,740	1,840	1,890
6. Nam Phong (Ng)	-	3,560	3,560	4,240
7. Phon Phisai (Pp)	2,220	180	2,400	200
8. Phen (Pn)	1,260	240	1,500	260
9. Alluvial Complex (Ac)	1,610	-	1,610	-
10. Ubon (Ub)	-	640	640	890
11. Roi Et, loamy phase (Re-1)	170	200	450	300
12. On (On)	-	270	270	410
Total	18,810	36,690	55,500	52,890

The distribution of identified soil series mentioned above are shown in Figure C-4 (Soil Map). The soil map was complied on the basis of the detailed reconnaissance soil map (1 : 100,000) prepared by DLD and has been confirmed through field observations in November, 1991.

4. 2 Soil Characteristics

Most of these soil series are characterized by sandy, loam and loamy sand soils. The soil texture is high in sand and silt. The soil pH is around 4.5 - 6.0. The soil fertility and organic matter are low.

The major soil series in the area are as follows;

- Korat Series (Kt)
- Korat - Phon Phisai Association (Kt/Pp)
- Roi Et Series (Re)
- Roi Et - On Association (Re/On)
- Nam Phong Series (Ng)
- Phon Phisai Series (Pp)
- Phen Series (Pn)
- Alluvial Complex Series (Ac)
- Ubon Series (Ub)
- Roi Et, Series Loamy Phase (Re-1)
- On Series (On)

The characteristic of these soil series are referred to the descriptions mentioned in Part I.

4. 3 Soil Survey and Investigation

1) Soil Investigation

Soil samples were taken at selected nine sites (from 5 major soil series) for physico-chemical analysis. 27 samples (3 layers of each soil series) were analyzed at RID laboratory. The results of soil analysis are given in Table C-2 . The sampling of each layer was done at excavated pit sites. The sampling sites are indicated in Figure C-4 of soil map.

The results of soil analysis are summarized as follows;

Soil Reaction (pH, 1 : 5 soil : water suspension)

Range : 5.3 - 6.2 (soil surface)

Interpretation : preferred range for rice cultivation

Particle Size Distribution

Result : from sandy loam to loam

Interpretation : good drainage but not suitable for rice cultivation

Electro Conductivity

Range : less than two (EC $\times 10^3$: mmho)

Interpretation : no salinity problem will be anticipated

Total Nitrogen (%)

Range : 0.01 - 0.05

Interpretation : medium but normally suitable for rice cultivation

Available Phosphorus (ppm)

Range : 0.13 - 17

Interpretation : normally low in available P content

Total Potassium (ppm)

Range : 18 - 141 for surface soil
8.2 - 176 for subsoil

Interpretation : medium concentration but normally suitable for rice cultivation

Exchangeable Cation (meq/100g soil)

Sodium

Range : 0.10 - 0.40

Interpretation : negligible for sodium effect

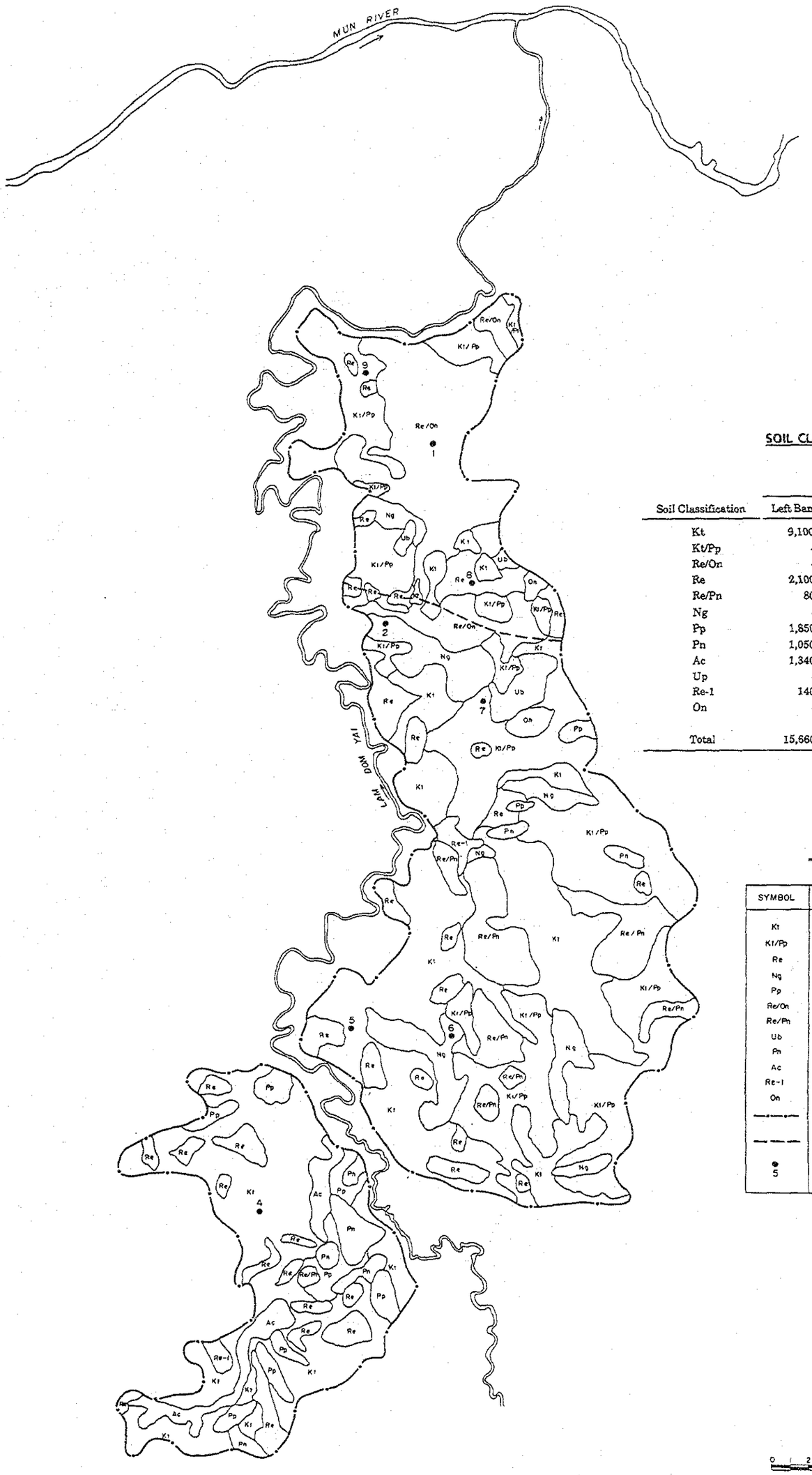
Potassium

Range : 0.01 - 0.31

Interpretation : normally suitable for rice cultivation

TABLE C-2 RESULTS OF SOIL CHEMICAL ANALYSIS

Soil Map Soymbol	Pit No.	Depth (cm)	Particle Size (%)			Soil Texture	pH		EC×10³ (mmho)	Total-C (%)	Total-N (%)	C/N Ratio	Avail.P (ppm)	Total K (ppm)	Active Fe (%)	Exchangeable Cation (meq/100 g)			
			Sand	Silt	Clay		1:1	1:5								Na	Ca+Mg	Ca	K
Re/On	1	0-15	68.0	24.5	7.5	SL	5.9	6.2	0.11	0.38	0.04	9.5	17.00	141.0	0.16	0.40	0.31	0.16	0.31
		15-40	58.6	24.4	17.0	SL	4.8	5.2	0.08	0.16	0.02	8.0	3.80	35.0	0.35	0.40	0.31	0.10	0.05
		40-61	64.0	20.0	16.0	SL	5.1	5.4	0.05	0.09	0.01	9.0	0.47	36.0	0.39	0.20	0.21	0.10	0.03
Ng	2	0-10	65.6	24.4	10.0	SL	4.8	5.3	0.05	0.46	0.03	15.0	10.00	109.0	0.88	0.20	0.31	0.10	0.09
		10-20	59.0	16.0	25.0	SCL	4.8	5.3	0.06	0.41	0.03	14.0	0.54	129.0	0.68	0.30	0.21	0.05	0.17
		20-75	26.0	17.0	57.0	C	5.1	5.5	0.06	0.45	0.04	11.0	0.20	176.0	0.94	0.30	0.16	0.10	0.13
	6	0-11	80.0	16.7	3.3	LS	5.2	5.5	0.02	0.27	0.02	13.0	3.50	27.0	0.05	0.10	0.10	0.05	0.03
		11-30	80.0	16.7	3.3	LS	5.3	5.8	0.02	0.12	0.01	12.0	2.80	26.0	0.01	0.10	0.10	0.05	0.03
		30-58	82.0	13.7	4.3	LS	7.1	7.3	0.08	0.04	0.01	4.0	0.53	17.0	0.14	0.30	0.36	0.10	0.07
Re	3	0-15	51.6	39.4	9.0	L	5.2	5.3	0.04	0.27	0.02	13.0	4.00	18.0	0.55	0.20	0.21	0.05	0.02
		15-45	51.0	31.0	18.0	L	5.0	5.5	0.02	0.13	0.01	13.0	0.20	36.0	0.78	0.10	0.10	0.05	0.01
		45-65	54.0	27.0	19.0	SL	5.0	5.3	0.03	0.08	0.01	8.0	0.13	27.0	1.00	0.10	0.21	0.10	0.02
	8	0-15	50.0	43.4	6.6	SL	5.2	5.7	0.03	0.18	0.02	9.0	1.10	18.0	0.54	0.20	0.10	0.05	0.01
		15-30	40.4	42.0	17.6	L	6.0	7.3	0.04	0.13	0.02	6.5	0.27	37.0	0.25	0.20	0.21	0.10	0.04
		30-58	38.4	42.0	19.6	L	6.4	7.8	0.06	0.20	0.02	10.0	0.13	43.0	0.18	0.40	0.21	0.10	0.03
Kt	4	0-12	70.6	17.4	12.0	SL	5.3	5.9	0.04	0.65	0.05	13.0	2.70	18.0	0.19	0.20	0.21	0.10	0.02
		12-45	65.6	13.4	21.0	SCL	5.3	5.8	0.02	0.25	0.02	12.0	2.80	9.0	0.48	0.10	0.10	0.05	0.01
		45-100	67.4	14.0	18.6	SL	5.0	5.4	0.05	0.21	0.02	10.0	0.74	8.6	0.21	0.20	0.31	0.10	0.02
	5	0-15	71.8	22.2	6.0	SL	5.3	5.6	0.04	0.91	0.04	23.0	5.00	18.0	0.04	0.20	0.16	0.05	0.02
		15-40	73.8	19.2	7.0	SL	5.2	5.8	0.20	0.17	0.02	8.5	3.50	17.0	0.14	1.30	0.42	0.10	0.05
		40-100	73.0	17.0	10.0	SL	4.8	5.3	0.03	0.09	0.01	9.0	3.10	8.2	0.28	0.10	0.21	0.05	0.02
Kt/Pp	7	0-15	67.2	29.5	3.3	SL	5.2	5.4	0.07	0.09	0.01	19.0	4.60	27.0	0.04	0.30	0.31	0.10	0.03
		15-35	64.4	26.0	9.6	SL	4.6	5.0	0.03	0.12	0.01	12.0	3.60	27.0	0.43	0.10	0.21	0.10	0.01
		35-70	60.4	26.0	13.6	SL	4.9	5.2	0.03	0.11	0.01	11.0	2.50	27.0	0.15	0.10	0.16	0.05	0.04
	9	0-15	69.5	26.7	3.8	SL	5.0	5.3	0.03	0.16	0.01	16.0	2.30	27.0	0.18	0.10	0.21	0.10	0.01
		15-50	70.0	20.4	9.6	SL	4.5	4.9	0.05	0.11	0.01	11.0	0.20	24.0	0.46	0.20	0.31	0.10	0.01
		50-90	69.0	19.0	12.0	SL	4.9	5.4	0.03	0.06	0.01	6.0	0.27	27.0	0.81	0.20	0.10	0.05	0.01



SOIL CLASSIFICATION

(unit: ha)

Soil Classification	Plan A-1 Left Bank	Plan A-1 Right Bank	Plan A-1 Total	Plan B-1
Kt	9,100	14,850	23,950	15,200
Kt/Pp	-	13,710	13,710	17,730
Re/On	-	930	930	7,560
Re	2,100	2,850	4,950	4,210
Re/Pn	80	1,890	1,970	1,890
Ng	-	3,870	3,870	4,240
Pp	1,850	200	2,050	200
Pn	1,050	260	1,310	260
Ac	1,340	-	1,340	-
Up	-	690	690	890
Re-1	140	300	440	300
On	-	290	290	410
Total	15,660	39,840	55,500	52,890

LEGEND

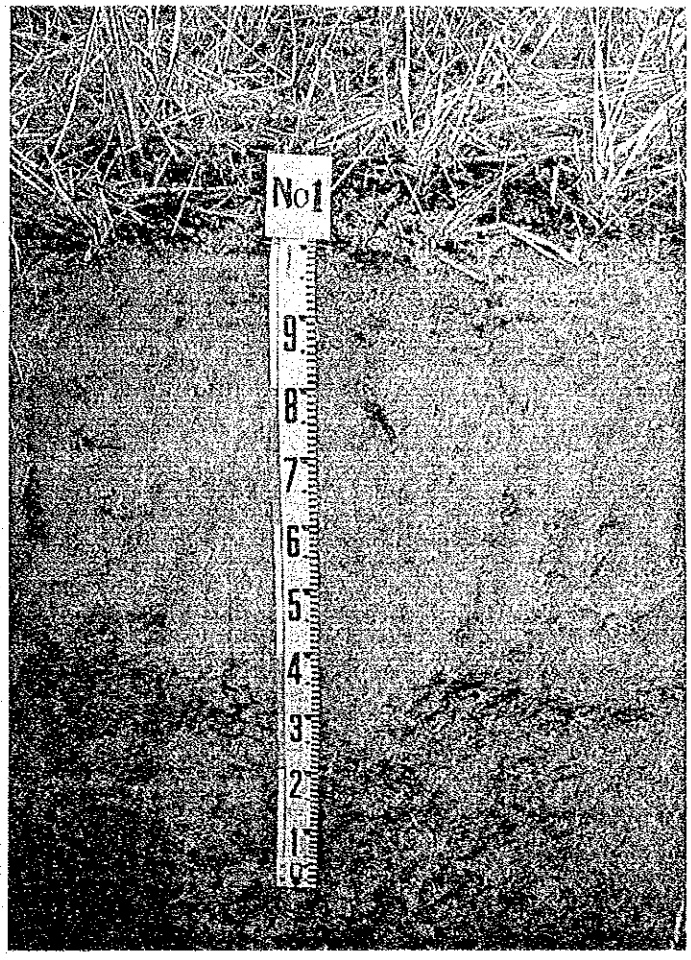
SYMBOL	SOIL CLASSIFICATION
Kt	Korat
Kt/Pp	Korat- Phon Phisai Asso
Re	Roi Et
Ng	Nam Phong
Pp	Phon Phisai
Re/On	Roi Et-On Association
Re/Pn	Roi Et-Phen Asso
Ub	Ubon
Pn	Phen
Ac	Alluvial Complex
Re-1	Roi Et, loamy Phase
On	On
—·—·—	Boundary of Study Area
— — —	Boundary of Alternative Plan
● 5	Soil Survey Point

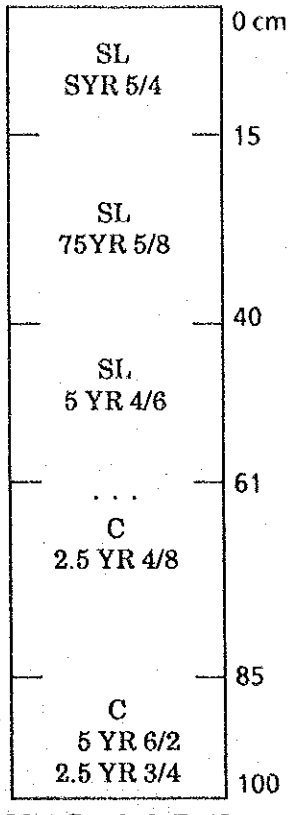
SCALE

0 1 2 3 4 5 6 7 8 9 10 Km

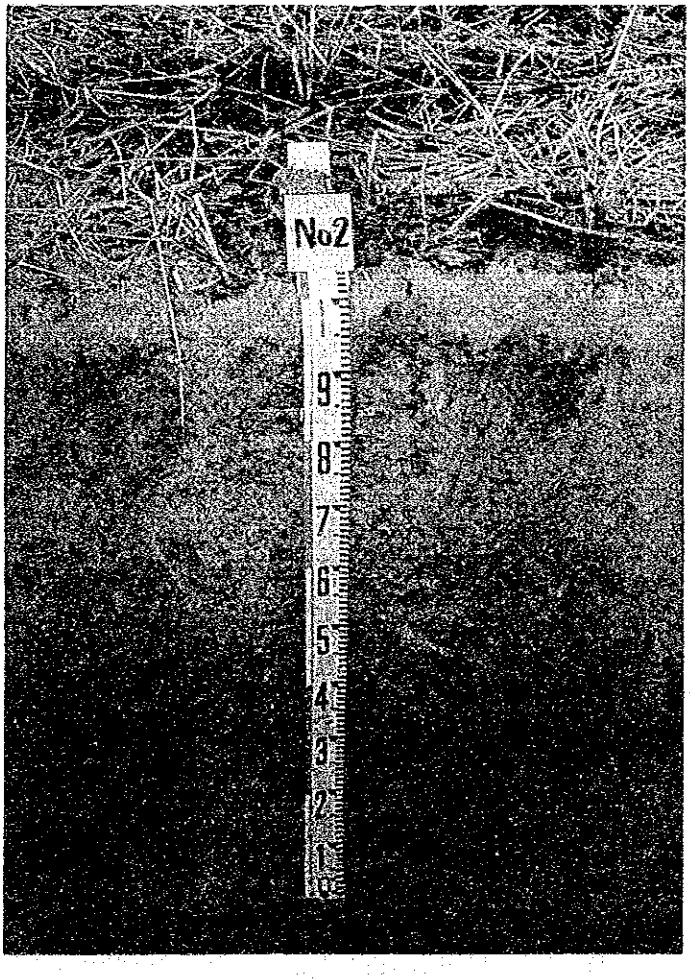
FIGURE C-4 SOIL MAP IN STUDY AREA

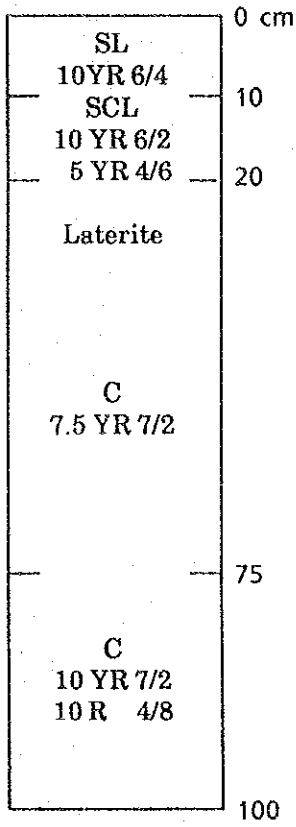
FIGURE C-5 SOIL COLUMNAR SECTION





Map Symbol :Re/On
Pit No. : 1





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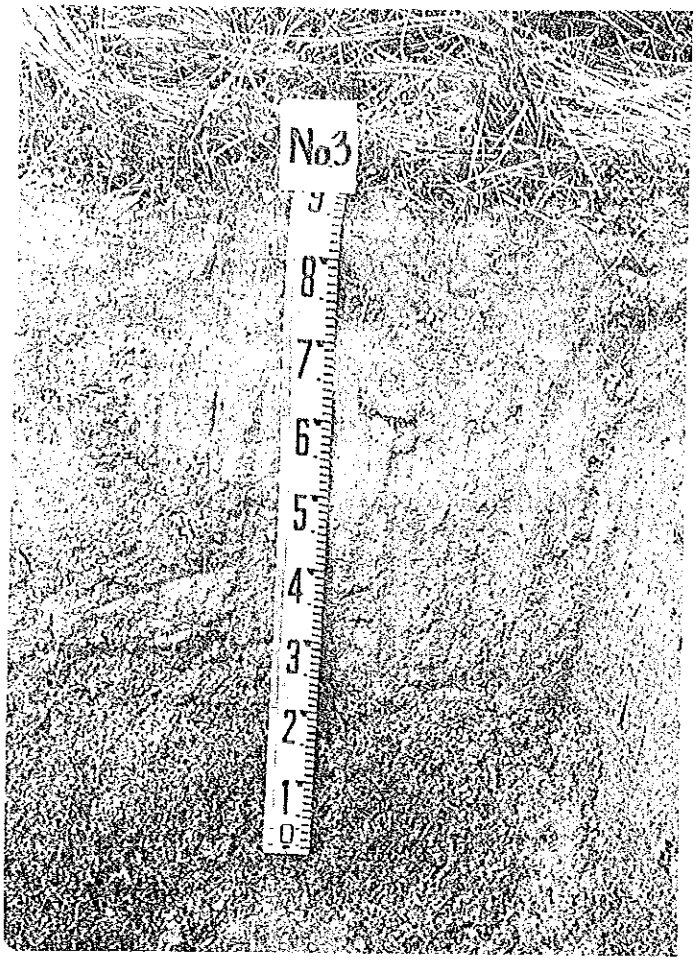

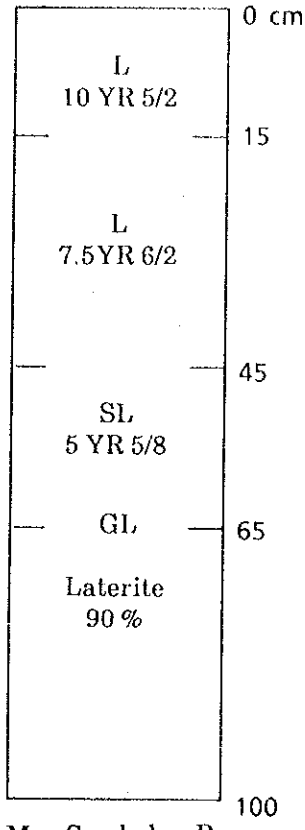

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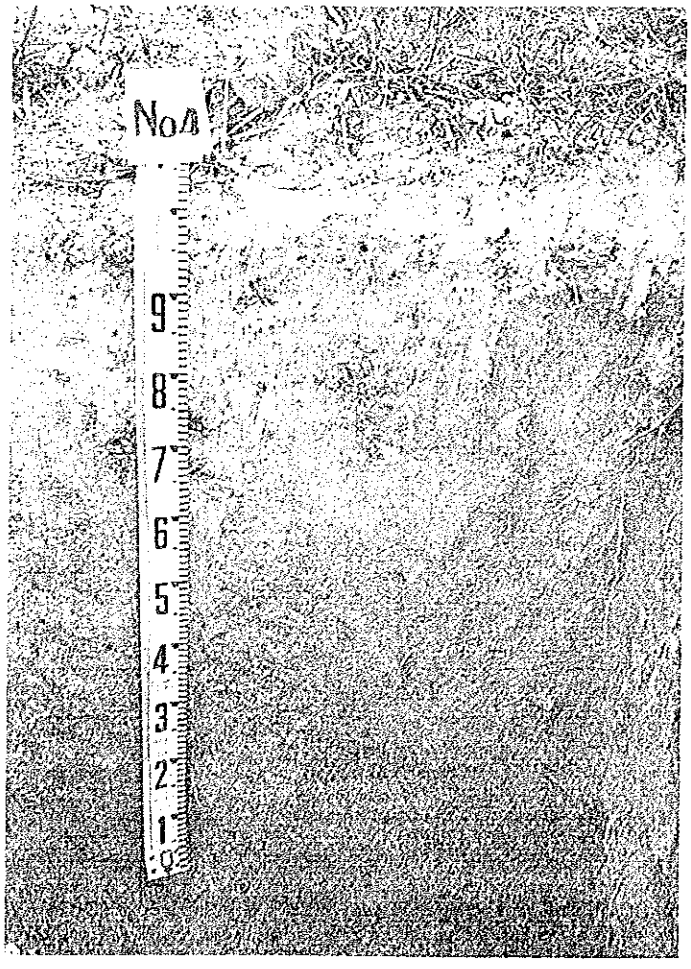
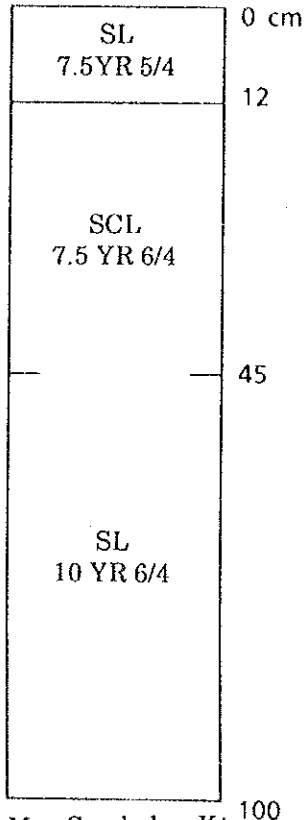
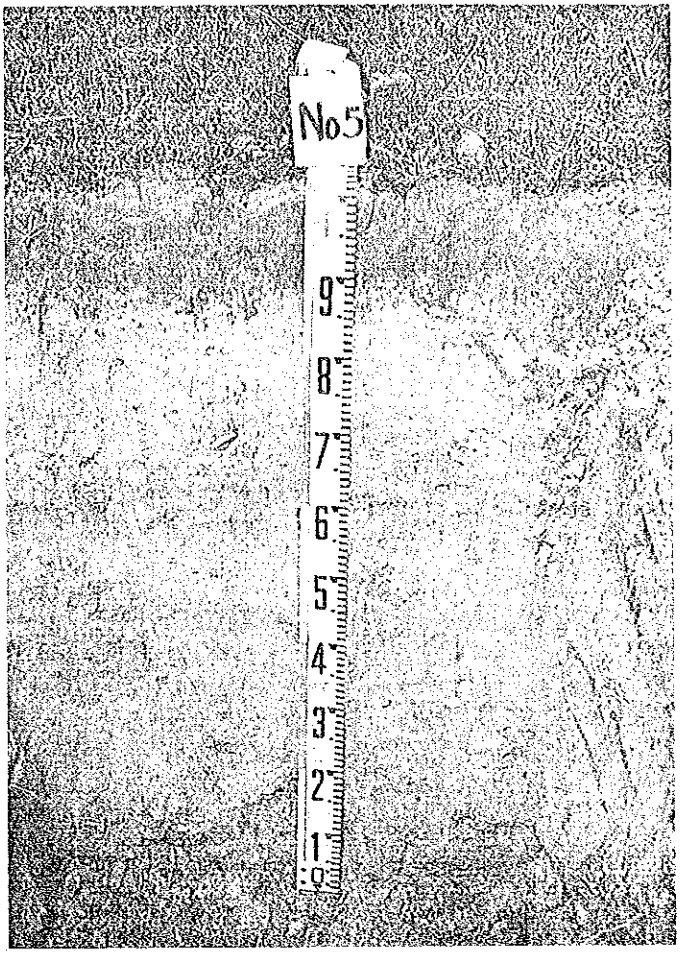
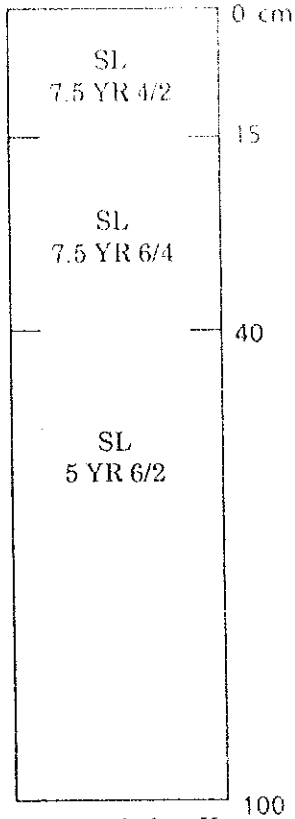




Map Symbol : Kt
Pit No. : 4





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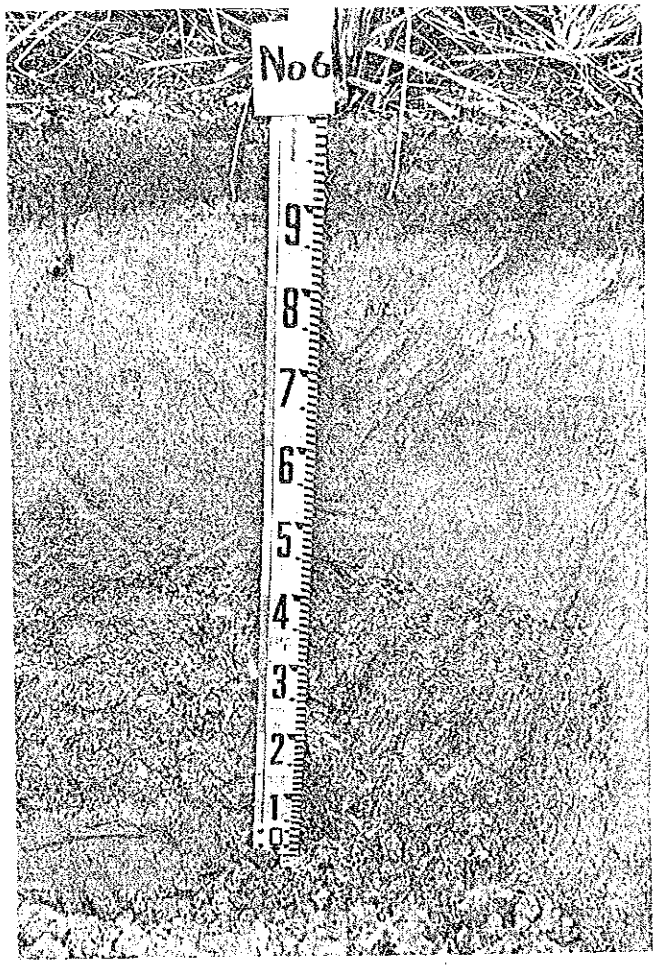
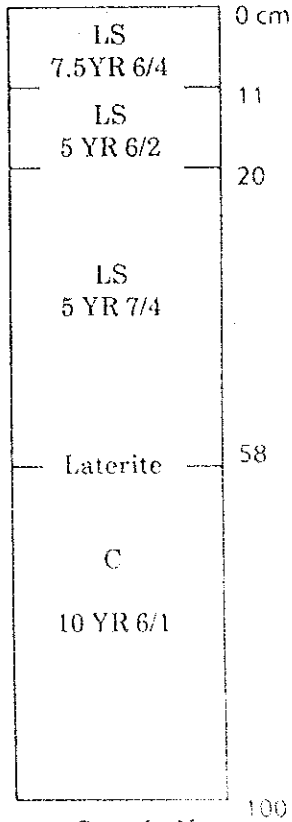
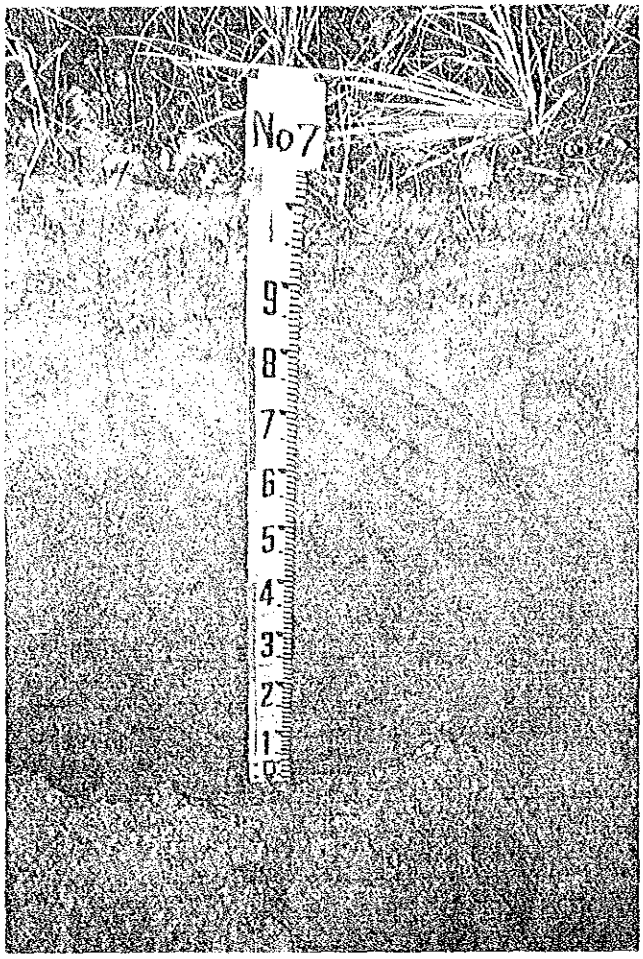
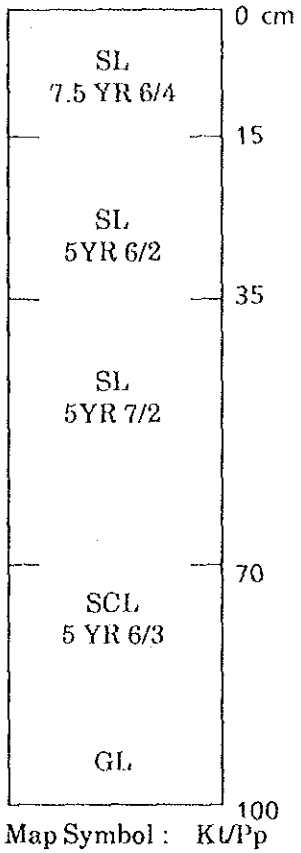


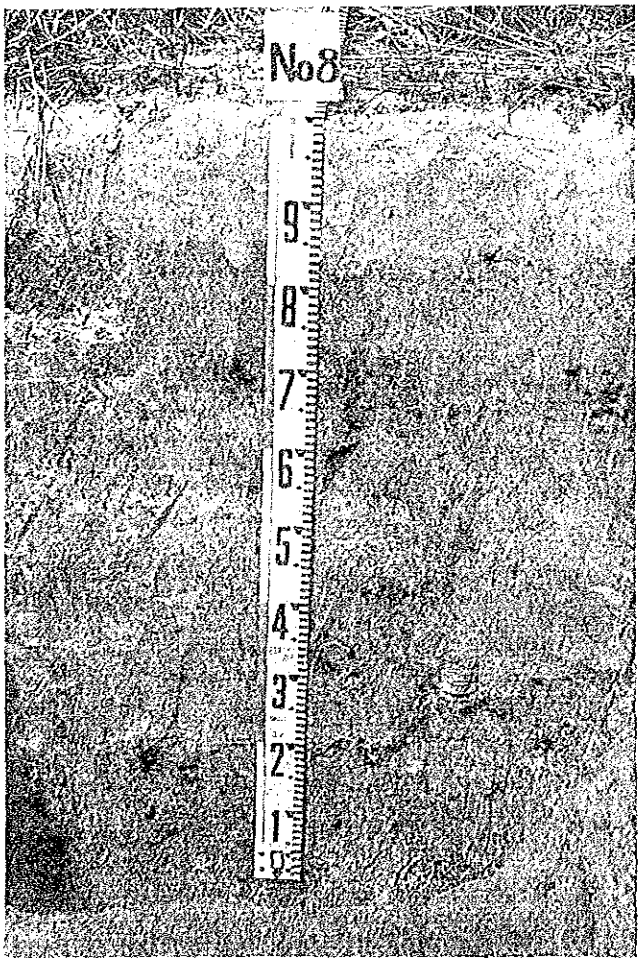


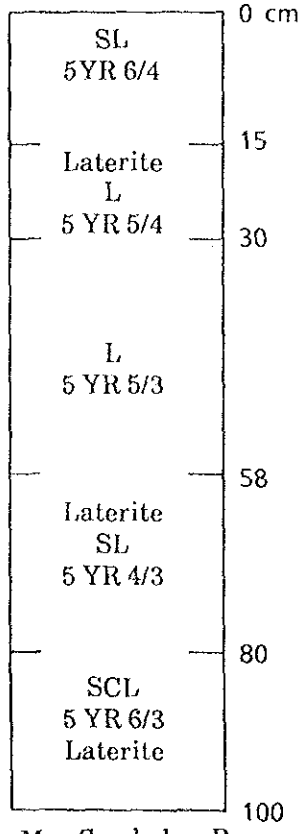
May Symol : Ng
Pit No. : 6



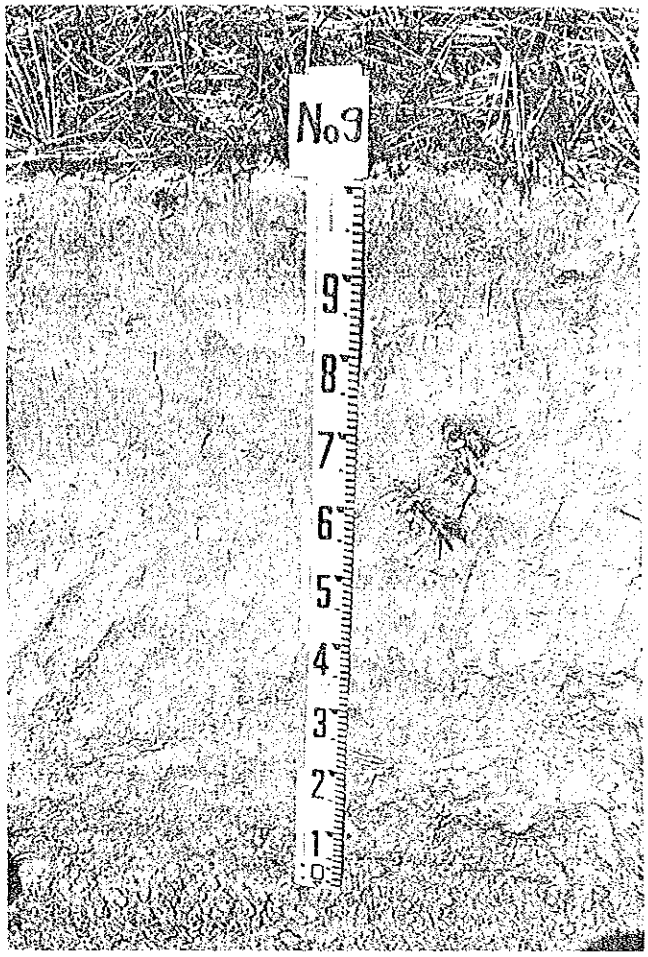


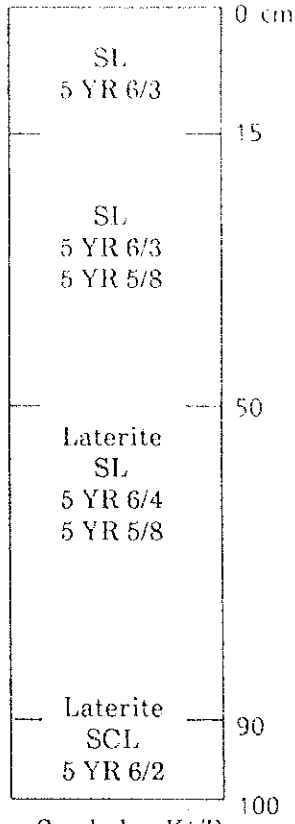
Map Symbol : KU/Pp
Pit No. : 7





Map Symbol : Re
Pit No. : 8





Map Symbol : Kt/Pp
Pit No. : 9

Legend

1. Color

   Munsell's soil color name Hue V alue/Chroma

   Example : 5 YR 6/3

2. Texture

   S - Sand/y

   Si - Silt/y

   C - Clay

   L - Loam

   Example : SL - Sandy Loam

3. Rate of gravel content

   · - 5 %

   · · - 5~15 %

   · · · - 15~40 %

4. Groundwater level - GL

CHAPTER V. LAND CLASSIFICATION

Land classification of the Study Area is done based on soil group map (scale 1 : 50,000) of Ubon Ratchathani Province prepared by the DLD (1990). The land classification map illustrates land suitability for economic crops in the form of "land unit". In this report, land unit is regrouped as land class using the capital letter L following by number as follows;

L_1 - L_4	-	suitable for paddy rice
L_5 - L_8	-	suitable for upland crops
L_9	-	suitable for certain crops as soil is saline
L_{10} - L_{12}	-	suitable for fruits and trees
L_{13}	-	mountainous area
L_{14}	-	suitable for purposes other than agriculture

Area covered, definition and suggestions of each land class in the Study Area according to Land Classification System of the DLD are shown in Table C-3 and Figure C-6.

Most of the soils in the Study Area are suitable for paddy rice. These soils occupy about 50 percent of the total area. The second to these soils are of suitable for upland crops. Appropriate management of soils in each land class is suggested as follows:

L_1 : apply fertilizer and maintain soil fertility,

L_2 : water supply is needed for use if shortage or when land use is changed to more suitable operation,

L_4 : exploit the land as described by land suitability

L_5 : apply fertilizer and maintain soil fertility; in some area, land should be used with soil and water conservation measures,

L_6 : organic fertilizer and cover crops should be used; inorganic fertilizer should be used strictly as recommended (rate, time) so as to reduce nutrients loss,

L_7 : organic fertilizer is necessary to improve soil characteristics, otherwise use the land according to its suitability,

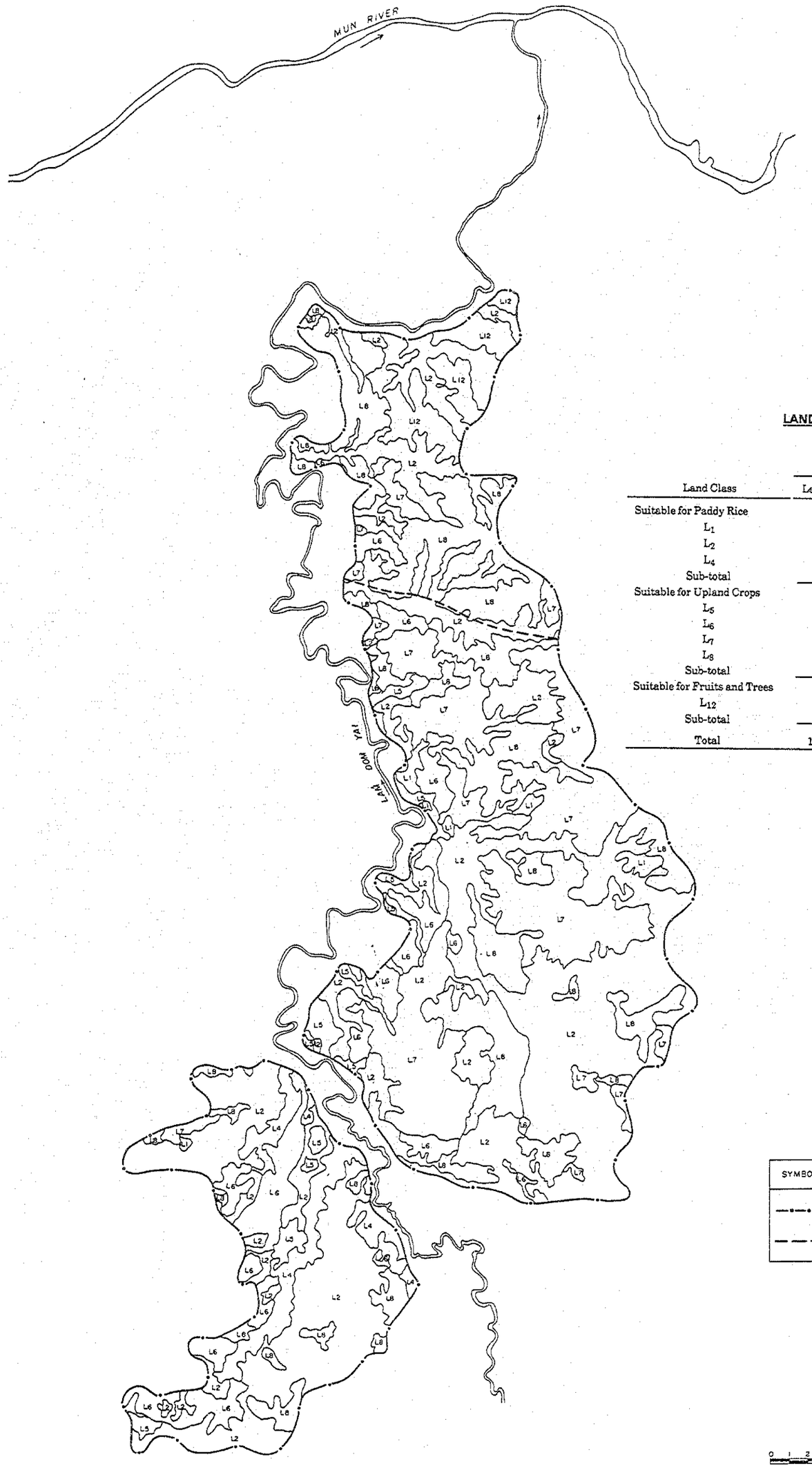
L_8 : land should be used according to land suitability and land should be fertilized, and

L_{12} : planting should be well prepared and organic and inorganic fertilizers should be applied with measures of soil and water conservations

TABLE C-3 LAND CLASSIFICATION IN STUDY AREA

(Unit: ha)

Land Class	Plan A-1			Plan B-1
	Left Bank	Right Bank	Total	(Right Bank)
Suitable for Paddy Rice				
L_1 suitable for paddy rice; in area where water resources exists, annual crops or vegetables can be grown in the dry season	10	500	510	540
L_2 suitable for paddy rice with a risk of water shortage when rainfall is erratic as soils in most area are sandy and some area is high steep	7,520	13,790	21,310	19,300
L_4 suitable for paddy rice, upland crops and pasture	4,010	-	4,010	40
Sub-total	11,540	14,290	25,830	19,880
Suitable for Upland Crops				
L_5 suitable for upland crops and vegetables	910	900	1,810	980
L_6 suitable for upland crops and vegetables although soils are sand and fertility is low in nature	4,940	2,700	7,640	3,260
L_7 moderately suitable for upland crops or suitable for pasture as soils are very sandy with very low fertility	110	11,450	11,560	13,200
L_8 suitable for upland crops, however, lands are currently renovate for growing rice	1,310	7,350	8,660	13,240
Sub-total	7,270	22,400	29,670	30,680
Suitable for Fruits and Trees				
L_{12} suitable or moderately suitable for fruits and trees as soil contains gravel or having layer of rock in subsoil	-	-	-	2,330
Sub-total	-	-	-	2,330
Total	18,810	36,690	55,500	52,890



LAND CLASSIFICATION

(unit: ha)

Land Class	Plan A-1			Plan B-1
	Left Bank	Right Bank	Total	
Suitable for Paddy Rice				
L_1	10	540	550	540
L_2	6,260	14,970	21,230	19,300
L_4	3,340	-	3,340	40
Sub-total	9,610	15,510	25,120	19,880
Suitable for Upland Crops				
L_5	760	980	1,740	980
L_6	4,110	2,930	7,040	3,260
L_7	90	12,440	12,530	13,200
L_8	1,090	7,980	9,070	13,240
Sub-total	6,050	24,330	30,380	30,680
Suitable for Fruits and Trees				
L_{12}	-	-	-	2,330
Sub-total	-	-	-	2,330
Total	15,660	39,840	55,500	52,890

FIGURE C-6 LAND CLASSIFICATION MAP IN STUDY AREA

CHAPTER VI. LAND USE

The present land use in the Study Area, of which total area is estimated at 71,700 ha was categorized as shown below, according to the following land use data relating to the Study Area; i) Current Land Use Map (1:100,000 in scale) prepared by the Department of Land Development (DLD) (1988), ii) Agricultural Reports of 1989 and 1990 on Land Use for Wet and Dry Season Crops prepared by Provincial Agricultural Extension Office, and iii) through field survey.

PRESENT LAND USE

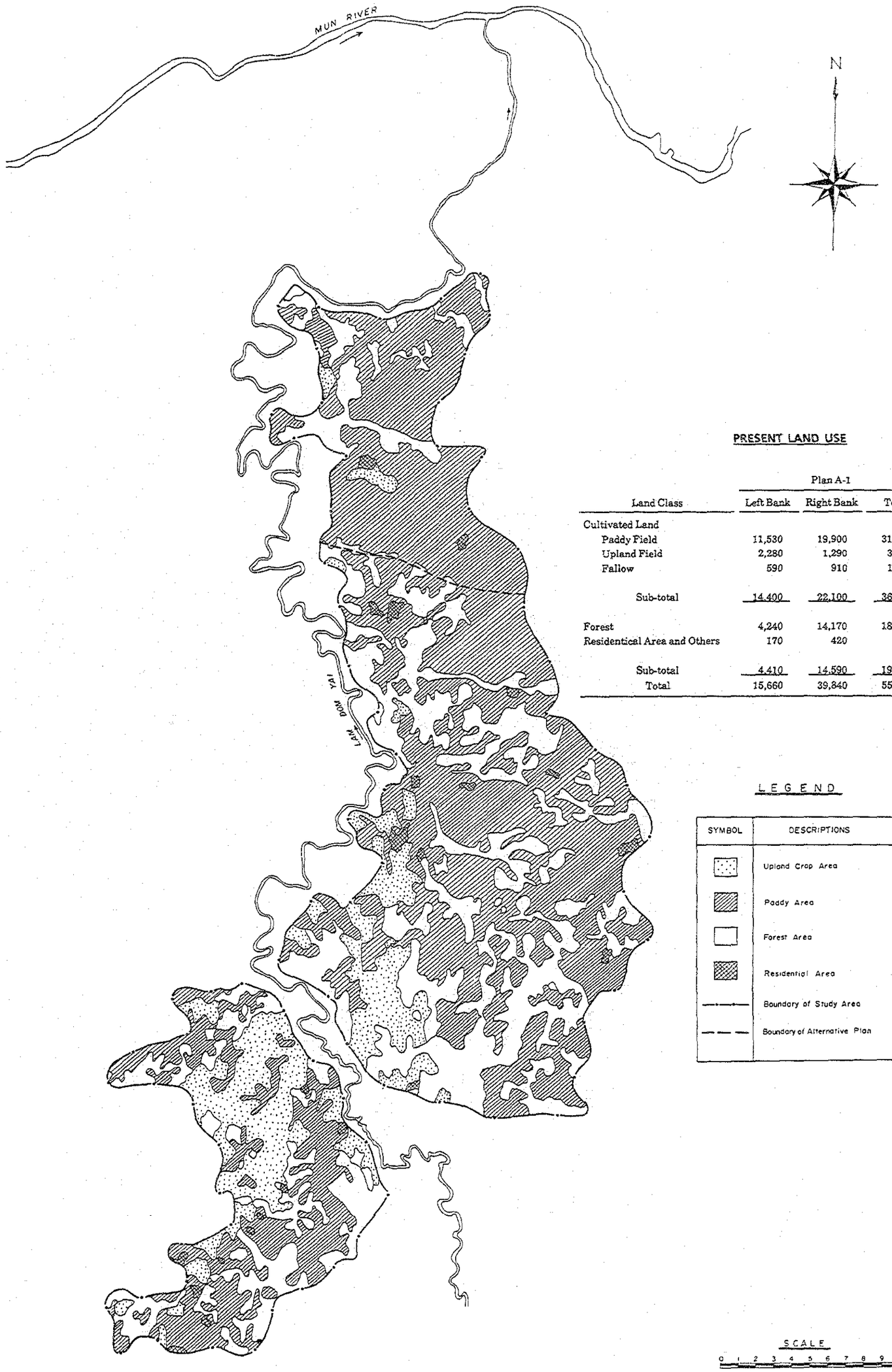
Land Category	Left Bank Area (ha)	Right Bank Area (ha)	Total (ha)
Paddy Field	11,530	29,830	41,360
Upland Field	2,280	1,510	3,790
Fallow	590	4,580	5,170
Forest	4,240	16,450	20,690
Residential Area and Other	170	520	690
Total	18,810	52,890	71,700

It was found out through field survey that the above-mentioned forest area was deciduous forest and had been utilized for cultivation land, mostly for paddy field, by illegally occupied local people at present. The forest land encompasses a part of the following national reserved forest.

- Huai Mae Non Forest
- Dong Na-Kae Forest
- Lam Dom Yai Left Bank Forest
- Lam Dom Yai Right Bank Forest

The report published by the Royal Forest Department (1988) indicates that real forest area is only three percent in the Dong Na-Kae Forest and 45 percent in Lam Dom Yai Left Bank Forest, respectively. A part of Lam Dom Yai Right Bank Forest in the Study Area is under land appropriation procedure for agricultural purposes by the Agricultural Land Reform Office (ALRO).

Figure C-7 indicates the present land use map in the Study Area.



PRESENT LAND USE

(unit: ha)

Land Class	Plan A-1 Left Bank	Plan A-1 Right Bank	Plan A-1 Total	Plan B-1
Cultivated Land				
Paddy Field	11,530	19,900	31,430	29,830
Upland Field	2,280	1,290	3,570	1,510
Fallow	590	910	1,500	4,580
Sub-total	14,400	22,100	36,500	35,920
Forest	4,240	14,170	18,410	16,450
Residentical Area and Others	170	420	590	520
Sub-total	4,410	14,590	19,000	21,410
Total	15,660	39,840	55,500	51,890

FIGURE C-7 LAND USE MAP IN STUDY AREA

ANNEX D. GEOLOGY AND CONSTRUCTION MATERIALS

ANNEX D. GEOLOGY AND CONSTRUCTION MATERIALS

Page

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GROUNDWATER, GEOLOGY AND EMBANKMENT MATERIALS

PART - II (FEASIBILITY STUDY)

GEOLOGY AND MATERIALS

LIST OF TABLES

LIST OF FIGURES

PART - I (OVERALL BASIN STUDY)

CHAPTER I. GROUNDWATER

1.1 Groundwater Condition

The project area is situated in a south-eastern part of the Khorat Plateau. As shown in Figure 2-5, the aquifers in the area are classified according to their rock types and water-bearing characteristics from younger to older, namely, Alluvial aquifer, Basalt, Upper Khorat aquifer, Middle Khorat aquifer and Lower Khorat aquifer*1.

Alluvial aquifer consists of unconsolidated deposits such as terrace and flood plane. The aquifer is limited in aerial extent and less than 50 m thick. According to the reports by RID*2 in permeability tests at the dam-sites, coefficient of permeability is less than 5×10^{-3} cm/sec.

The Upper Khorat aquifer is composed of shale, siltstone and sandstone of the Maha Sarakam and Khok Kuruat Formations. The formations are distributed widely in the Study Area, and 90 percent of the existing wells are located in the formations. Groundwater of the aquifer is variable in both quantity and quality and many wells produce water of high electric conductivity. According to above mentioned reports, coefficient of permeability is less than 5×10^{-4} cm/sec.

The Middle and Lower Khorat aquifers consist of sandstone, conglomerate and siltstone and are distributed in the mountainous area. However, no wells exist in the area where the aquifers are distributed.

As shown in Figure 2-5, groundwater is basically recharged by rainfall in mountain lands, and flows from south to north through alluvial deposits and basement rocks. Hydraulic gradient is nearly same with the land surface, and the groundwater table ranges in depth from 0.6 to 16.4 m. Water flow directions are generally from mountain land to the Lam Dom Yai and from south to north along the river. Most wells in the area are non flowing artesian.

Note: *1: Vachi Namnarong, 1985, Review on Groundwater in the Northeastern Thailand
*2: RID. 1987 to 1991, Geological Investigation Reports in Ubon Ratchathanee and Sisaket Provinces

The existing well inventory is shown in Table D-1, and distributions of well depth, yield and specific capacity are illustrated in Figure D-1. As shown in Figure D-1, more than 90 percent of the well depth is less than 40 m deep, and 182.9 m in maximum depth. The well yield ranges from 0.68 to 32.6 cu.m/hr, however, average yield is only 4.76 cu.m/hr (1.32 ℓ/sec). Average specific capacity in the area is 0.52 cu.m/hr/m (0.14 ℓ/sec/m), and this means that one well is expected to yield 0.14 ℓ/sec in drawdown of one meter of water table.

1. 2 Groundwater Quality

Field water quality tests of selected 94 existing wells were performed for Electric Conductivity (EC), Hydrogen-ion Concentration (pH) and Temperature (°C) by using a portable kit.

The results of the tests are shown in Table D-1, Figure D-2 and Figure 2-6.

Acceptable upper value for irrigation with most crops and most soils authorized by U. S. Salinity Laboratory is 250 μS/cm, and pH value in Drinking Water Standard of Thailand is 6.5 - 9.2.

As shown in Figure D-2, EC values of 77 percent of the investigated wells exceed acceptable upper value, and pH values of 14.4 percent. The distribution of EC exceeding acceptable limit covers the area of more than 50 percent, mostly in two areas: one is distributed in eastern mountainous area bounded by the Lam Dom Noi basin, and consisting of the Phuphan Formation: another is distributed in western hilly area bounded by the Huai Khayung basin, and consisting of the Maha-Sarakham Formation. The high value of EC probably results from the geology in the area. The temperature of the groundwater ranges from 27.5 to 31.1°C and is suitable for rice crops.

CHAPTER II. TOPOGRAPHY AND GEOLOGY

2.1 Topography

The Study Area is situated in a part of the Khorat Plateau which comprises an area of about 170,000 sq.km, approximately one-third of the total area 514,000 sq.km of the whole country. A general feature of the Khorat Plateu is the shallow saucer-shaped basin tilted slightly to the southeast, and the Study Area is situated at the south-east edge of the saucer.

The altitude of the northern border of the basin is about 130 m above mean sea level (mamsl). To the south along the Lam Dom Yai, the altitude the increases gently, and averages about 500 mamsl at the Phanom Dong Rek, however, altitudes extend up to 700 mamsl in places. Owing to the geological structure of the area, the Phanom Dong Rek forms a steep northward-facing escarpment.

The surface of the basin, except the perimeter of the Phanom Dong Rek, consists of gently rolling hills and monotonous plains. The Lam Dom Yai rises in the south escarpment and flows to north throughout the basin.

It is apparent from aero-photographs and topographic maps that the Lam Dom Yai and its tributaries have changed their courses back and forth across the basin. Many of these ancient meanders may be recognized from air by their topographic expression and vegetation. The meanders have formed thick deposits of sand, silt and clay. These areas are called flood plane and heavily cultivated by rich soils, and in places by swamps. The bed rock forms low ridges, where the soil is less fertile, more sandy and less contributive to rice cultivation.

2.2 Geology

The north-eastern Thailand known as the Khorat Plateau is principally built up of very thick sedimentary Khorat Group dating from the Upper Triassic onwards and forming the bedrock series, and various Quaternary deposits covering up the major part of the plateau. Rocks of the

Khorat Group are predominantly sandstone, siltstone, shale and conglomerate. The Khorat Group is divided into nine formations, and the area consists of five formations from older to younger namely, the Phra Wiham, Sao-Khua, Phuphan, Khok Kruat and Maha-Sarakham Formations, and described their stratigraphy as shown in Table D-4. Figure 2-7 Geological Map in the Study Area is taken and modified from the geological maps and various reports[*1]. The stratigraphy of each formation is as follows;

Phra Wiham Formation (Jpw)

It is distributed only in the limited area bounded to the south by the border of Kampuchea, and consists of mostly massive sandstone intercalated by pebble layer.

Sao Khua Formation (Jsk)

The formation is also distributed in the limited areas in the rugged mountainous land called Phanom Dong Rek along the Thai-Kampuchean border, and is composed of micaceous sandstone, siltstone, shale and conglomerate.

Phu Phan Formation (Kpp)

Major part of the Phanom Dong Rek is formed by the formation and bounded to the north by the Khok Kruat formation. Many proposed and constructed dams by RID are located on/around the boundary between the two formations. The formation consists of mostly sandstone with shale and conglomerate, and dips gently to the north and is overlain by the Khok Kruat formation.

Khok Kruat Formation (Kkk)

The formation covers approximately 60 percent of the basin with few outcrops. The terrain founded within the area includes rolling hills, monotonous plane and nearly level river floors, and is bounded to the south by the escarpment of the Phanom Dong Rek consisting of the Phra Wiham, Sao Khua and Phuphan Formation. The Lam Dom Yai and its tributaries form a tree-like river system which means that the geology is composed of nearly flat and homogeneous rocks. The formation consists mostly of fine to medium sandstone and siltstone, and strikes NW to W and dips 5 to 10°N. The surface of the rocks in the rolling hills and monotonous planes is covered by residual soils

originated from the basement rocks, and unconsolidated deposits in river courses, flood planes and slopes.

Maha Sarakham Formation (KTms)

The formation is distributed in the west of the Lam Dom Yai and forms mostly rolling hills and nearly level floors describing a tree-like and parallel river systems. The Lam Dom Yai flows the boundary between the Khok Kuruat and Maha Sarakham formations.

The geology consists mostly of sandstone, siltstone, shale and rock salt, and dips NW to W. The detail geological structure, however, is unknown because of less informations. Residual soils are distributed on the surface of the basement rocks as same with the Khok Kuruat formation. EC measured during the field investigation indicates high values in this area presumably because of affection of the rock salt. Unconsolidated deposits also overlie the formation in river courses, flood plane and slopes of hills.

Basalt (Bs)

Two bodies of basalt flow exist in the upper stream of the Lam Dom Yai, and a crusher plant is operated in the body of Amphoe Nam Yun. The rock is olivine and nepheline basalt and hard.

Quaternary Deposits (Qa)

Flood plane, talus and terrace deposits are widely distributed along river courses and slopes of hills in the areas mostly of the Khok Kuruat and Maha Sarakham formations. The deposits are unconsolidated and consist of sand, silt and clay. The soils heavily cover the basement rocks and less than 30 meters in maximum thickness. The beds are generally alternating and soft.

Note: *1: DMR, Geological Map of Thailand 1 : 250,000, 1985
DMR, Geological Map of Thailand 1 : 500,000, 1983
Vig Sethaput, Histrical Activities on Geology and Mineral Resources Development of Northeastern Thailand, 1985
RID, Geological Investigation Reports in Ubonratchathanee and Sisaket Provinces, 1983 to 1991

2.3 Dam-Site Geology

The area which includes preliminary selected dam-sites is monotonous plane broken by gently rolling hills. The altitude of the area is between 130 and 180 mamsl level.

Basement rocks in the area are covered by lateritic soils, residual soil and talus in hilly land, and by flood plain deposits and recent river deposits in drainages. The outcrops of the base rock, therefore, are very poor except D-23 dam-site. The thickness of unconsolidated beds is mainly presumed from the test pits, geographical survey and existing data.

It is difficult to assess the excavation line for dam foundation in this stage because of pack of data, and exact excavation depth should be decided after detail investigations. In this report, however, the depth is presumed by the data gotten by the survey so as to provide data for dam planning and cost estimation.

1) D-23 Lam Dom Yai (M)

Geography

The dam-site is situated in the upperstream of the Lam Dom Yai meandering throughout rolling hills, and forms narrow flood plane and steep river banks. Gradients of the slopes of the slopes of the hills around the dam-site are about 1/50 at the right bank and about 1/80 at the left bank.

Geology

The area consists of the Khok Kruat formation, residual soils, talus deposits and flood plane deposits as shown in Figure D-4.

The Khok Kruat formation composing of slightly hard sandstone intercalated by siltstone is exposed on the river floor and left bank around the dam-site. On the riverbed, alternation beds of siltstone and fine to medium grained sandstone are observed. It seems that the sandstone is impermeable, however, the thin siltstone bed is well jointed and has high permeability.

Talus deposits, two to five meters thick, is distributed in the foot of rolling hills, and composed of fine to silty sand.

Flood plane deposits distributing along the river consist of fine sand and are presumably one to four meters.

The excavation line of the dam foundation will be max. seven meters.

2) D-24 Lam Som

Geography

The dam area is composed of gently sloping hills and a nearly level river floor. The Lam Som, flowing gently west to east, forms wide flood plane reaching about 500 m wide near the dam-site, and a number of swamps presents on the flood plane. Slopes near the dam-site have gradients of about 1/80 at both banks, and the land is almost cultivated.

Geology

No bed rock crops out, because it is covered by unconsolidated layers, such as residual soils, hard laterite, talus deposits and flood plane deposits. In the test pits of P-2 and P-3, however, completely to slightly weathered alternation beds of sandstone and siltstone were observed, and the bed belongs to the Maha-Sarakhm formation.

Residual soils regarded as the Maha-Sarakham formation in origin consist of fine to silty sand, silt and clay. The soils, one to three meters thick, overlie the original formation, and expose around the top of rolling hills and in the test pits.

Hard laterite, less than 1.5 meters thick, overlies residual soils, and is distributed around the top of rolling hills.

Talus, one to three meters thick, is composed of sand, silt and clay, and distributed in the slopes of rolling hills.

Flood plane deposits, one to three meters thick, are found widespread along the Lam Som and consist of loose sand, silt and clay.

The rocks are presumably permeable and the excavation line of the dam foundation will be more than three meters deep.

3) D-25 Huai Ari

Geography

Terrain found within the dam area includes gently sloping alluvial surface and a nearly level valley floor. The Huai Ari flowing from west to east forms wide flood plane reaching about 700 m wide around the dam axis. The river meanders in a small radius with a gradient of about 1/650. Old river courses are recognized on the plane from aero-photographs interpretation, and some swamps utilizing for irrigation present on them. The gently sloping alluvial surface have gradients of about 1/100 at the left bank, and about 1/50 at the right bank.

The land around the dam-site is almost cultivated except forests along the river. The farming land consists of sandy to silty soil.

Geology

The geology in the dam area is composed of basement rock, residual soils, talus and flood plane deposits as shown in Figure D-6. With the adverse conditions of heavy cover of unconsolidated sediments, it is difficult to assess the rock quality of the dam foundation. In the tests pits, however, highly weathered fine to silty and permeable sandstone intercalated by mudstone was observed. The permeable sandstone is a member of the Maha-Sarakham formation.

Residual soils originated from the Maha-Sarakham formation, one to two meters thick, is observed on the flat land of rolling hills, and consists of sand, silt and mud. Lateritic soils, about one meter thick, are found in the test pits and river banks covered by talus deposits.

Talus, overlying the Maha-Sarakham formation, is distributed on the slopes of the rolling hills, and consists of fine to silty sand from the observation of the test pits. The talus deposit is loose and presumably two to three meters thick.

Lateritic soils, which are underlain by talus and about one meter thick, found in the test pits and river banks.

Flood plane deposits, which are found widespread along the Huai Ari, consist of sand, silt and clay. the deposits, presumably two to four meters thick, are loose and partly permeable.

The excavation line of the dam foundation is presumably more than five meters deep near the river floor.

4) D-28 Lam Dom Yai (L)

Geography

The dam-site is situated in the halfway up of the Lam Dom Yai river meandering from east to west around the dam-site and forming wide flood plane. Old river courses are recognized by aero-photographs interpretation, and swamps utilizing for irrigation present in places. The slopes of the rolling hills have gradients of 1/30 at the right abutment and 1/15 at the left abutment.

Geology

The area consists of the Khok Kruat formation, residual soils, talus and flood plane deposits. The Khok Kruat formation in the dam-site is covered by thick soils, therefore, the evaluation of rock quality is difficult. From the observation of the test pits and residual soils, however, it seems that the formation is composed of fine to silty sandstone intercalated by siltstone and conglomerale. The highly weathered layer of the basement rock is presumably two to three meters thick and permeable.

Residual soils, three seven to three meters thick, overlie highly weathered rock and consist of fine sand, silt and clay.

Talus, about three meters in maximum thickness, is distributed in the foot of rolling hills, and composed of sand, silt and clay.

Flood plane deposits distributed widely along the river, have been accumulated by the transportation of the river, and consist of loose sediments such as fine sand, silt and clay. The deposits are presumably five to ten meters thick.

The excavation line of the dam foundation is presumably more than five meters deep around the river floor.

5) D-29 Huai Fang Deang (L)

The dam has two rivers, namely Huai Fang Deang and its tributary called Huai Dam Rong, and the dam length reaches more than 2,000 m. The area is mostly composed of very gentle sloping hills and nearly level river floors.

As shown in Figure D-8, no basement rock crops out because of heavily covered unconsolidated layers, and estimated excavation line will be less than five meters deep.

6) J-1 Lam Som (L)

The dam area is mostly composed of gently sloping hills and nearly level river floor, and in places, relatively steep sloping hills. The Lam Som around the dam site meanders back and forth and forms wide flood plane.

No basement rock crops out, because it is covered by heavy unconsolidated sediments, such as residual soils, talus deposits and flood plane deposits. These deposits are presumably more than five meters thick.

7) J-7 Huai Bon

Terrain found within the dam area includes alluvial surface and nearly level flood plane. The Huai Bon flows west to east with a gentle gradient, and the flood plane around the dam axis is about 400 m wide.

The area is composed of the Khok Kruat formation, residual soils originated from rock formation, talus deposits and flood plane deposits as shown in Figure D-10. The Khok Kruat formation, however, crops out neither the river floor nor the test pits because of heavy covers of unconsolidated sediments.

Unconsolidated sediments including residual soils are two to six meters deep and excavation line is presumably about seven meters deep near the river.

CHAPTER 3. EMBANKMENT MATERIALS

Test pits were dug at the dam-sites of D-23, D-24, D-25, D-28, D-29 and J-7 for the observation and confirmation of embankment materials, especially of impervious materials. The locations of the pits are shown in Figure D-4 ~ D-10 Geological Map in Each Dam-Site, and descriptions of the test pits in Fiure.D-3. Typical soil samples were collected from the pits and analyzed the physical properties in the laboratory of RID. The items and numbers of the laboratory tests are shown in Table D-2. Results of the laboratory tests are shown in Table D-3.

The soil samples collected in each dam-site consist of residual soils originated from basement rocks, talus deposits, terrace deposits, recent river deposits, etc. In the field investigations and observations of the test pits, residual soils distributed in rolling hills are more adequate for impervious materials. As shown in Table 2-4, the coefficient of permeability is less than 10^{-5} cm/sec, and low natural water moisture and optimum water moisture indicate that the soils are appropriate for the construction work.

In other unconsolidated deposits, impervious soils are found in alternating pervious beds such as fine to medium sand, and it seems that quality control for core materials is difficult. Those deposits, therefore, are more suitable for semi-pervious or pervious materials.

The presence of impervious materials was revealed by the field investigation and observation of test pits, however, detail survey of materials should be conducted for the volume and locations by using accurate maps.

Hard rocks appropriate to dam embankment could not be found in the dam areas and their perimeters, however, two basalt bodies are distributed in the basin as shown in Figure 2-5 Geological Maps in the Area. In the body of Amphoe Num Yun, a crusher plant is operated by a private company, and the rock quality is adequate to riprap materials and coarse aggregate of concrete. Fine aggregate for drain and concrete can obtain from the Mun river.

TABLE D-1 EXISTING WELL INVENTORY

(Water quality investigated in July,1991)

WELL NO.	WELL STRUCTURE					WATER QUALITY		
	DEPTH (m)	SWL (m)	YIELD (m3/hr)	DRAW DOWN (m)	SPECIFIC CAPACITY (m3/hr/m)	pH	EC (μ S/cm)	Temp. (°C)
UB0001	30.5	5.2	6.8	6.1	1.11	6.9	232	30.6
UB0002	24.4	6.7	1.8	12.2	0.15	7.2	603	29.9
UB0003	30.5	5.0	15.6	8.1	1.92			
UB0003	182.9	5.8	4.1	6.4	0.64			
UB0005	61.0	3.6	3.4	42.1	0.08			
UB0006	30.5	5.1	10.3	20.0	0.52			
UB0007	47.9	7.3	5.5	14.3	0.38			
UB0008	53.4	3.8	5.9	21.7	0.27			
UB0009	48.8	1.5	2.0	4.6	0.43			
UB0010	30.5	5.4	4.8	21.8	0.22	7.8	323	30.2
UB0011	30.5	3.7	3.3	23.3	0.14			
UB0015	30.5	3.0	32.6	11.3	2.88			
UB0015	30.5	6.1	2.3	19.5	0.12			
UB0016	30.5	4.6	6.8	13.7	0.50	7.2	407	29.7
UB0016	45.7	7.9	7.5	11.5	0.65			
UB0017	24.4	6.2	7.1	13.9	0.51			
UB0018	42.7	9.1	1.1	28.6	0.04			
UB0026	18.3	5.8	2.3	6.1	0.38			
UB0027	33.5	6.7	1.4	22.2	0.06			
UB0028	62.5	6.6	5.5	7.6	0.72			
UB0028	30.5	6.4	3.2	16.8	0.19			
UB0029	45.7	5.5	4.2	37.2	0.11	6.4	662	28.0
UB0030	62.5	3.1	5.4	5.4	1.00	7.2	412	28.1
UB0031	27.4	6.7	2.3	16.2	0.14	6.1	119	29.2
UB0032	61.0	2.6	6.6	7.4	0.89			
UB0033	30.5	4.0	3.0	10.4	0.29	7.2	604	29.6
UB0034	30.5	2.7	5.4	4.9	1.10	6.0	162	30.2
UB0035	21.3	3.0	4.1	6.4	0.64	6.7	235	29.9
UB0041	45.7	13.7	2.3	20.4	0.11			
UB0042	45.7	5.5	4.0	17.0	0.24	7.1	1910	29.9
UB0042	30.5	7.9	1.8	15.5	0.12	7.1	483	29.8
UB0043	30.5	4.6	6.9	10.4	0.66			
UB0043	30.5	3.6	4.8	24.1	0.20			
UB0044	30.5	4.3	7.1	14.0	0.51	7.2	2500	29.7
UB0044	42.7	4.6	1.4	22.9	0.06			
UB0045	30.5	7.0	7.2	8.4	0.86			
UB0046	30.5	6.7	6.9	7.8	0.88			
UB0084	30.5	9.8	4.8	17.7	0.27	7.1	607	29.9
UB0086	30.5	4.6	9.0	16.6	0.54			
UB0086	61.0	6.7	1.1	23.2	0.05			
UB0087	45.7	9.4	4.0	17.0	0.24			
UB0088	42.7	7.6	5.4	12.7	0.42			
UB0093	36.6	5.1	32.5	13.5	2.14	7.0	604	30.1
UB0143	42.7	7.7	3.0	19.8	0.15	7.3	550	27.5
UB0144	30.5	2.0	6.9	10.8	0.64	7.2	488	28.6
UB0144-1						6.9	253	27.8
UB0145	29.0	8.1	28.5	8.3	3.43			
UB0146	30.5	7.1	8.1	19.3	0.42	5.8	57	28.9
UB0147	42.7	7.2	3.4	19.9	0.17			
UB0274	36.6	9.1	2.3	12.2	0.19	7.2	450	27.5
UB0275	46.7	8.1	7.2	22.5	0.32			
UB0276	45.7	6.7	5.6	10.5	0.53			
UB0278	30.5	4.6	7.1	6.3	1.13			
UB0279	39.6	5.3	6.2	9.7	0.64	6.8	253	29.7

TABLE D-1 EXISTING WELL INVENTORY

(Water quality investigated in July,1991)

WELL NO.	WELL STRUCTURE					WATER QUALITY		
	DEPTH (m)	SWL (m)	YIELD (m3/hr)	DRAW DOWN (m)	SPECIFIC CAPACITY (m3/hr/m)	pH	EC (μ S/cm)	Temp. (°C)
UB0281	39.6	5.8	4.8	9.1	0.53	7.9	407	30.1
UB0282	36.6	6.7	2.6	8.6	0.31	7.1	610	30.1
UB0284	24.4	2.4	7.1	5.0	1.42			
UB0285	30.5	5.2	4.2	4.2	0.29	7.1	471	29.6
UB0286	36.6	3.4	2.9	20.1	0.14			
UB0287	45.7	4.0	1.9	25.3	0.08			
UB0291	30.5	4.8	3.6	18.4	0.20			
UB0292	30.5	4.0	11.9	8.0	1.49			
UB0294	30.5	5.3	11.4	10.6	1.08	6.8	503	30.3
UB0295	24.4	6.9	10.6	10.2	1.04			
UB0296	30.5	7.5	11.1	9.1	1.22	6.7	292	28.7
UB0297	30.5	11.0	3.6	15.1	0.24			
UB0298	30.5	9.8	6.3	10.0	0.63			
UB0299	30.5	6.9	5.0	15.2	0.33			
UB0301	30.5	8.3	5.0	19.8	0.25			
UB0349	30.5	6.5	6.0	9.2	0.65	7.6	560	30.3
UB0350	36.6	5.2	2.6	9.3	0.27	7.8	1170	30.4
UB0351	30.5	6.6	5.0	13.2	0.38			
UB0352	30.5	4.6	2.0	13.1	0.15			
UB0353	36.6	8.8	1.4	20.1	0.07	6.4	161	30.1
UB0355	41.2	9.3	2.6	20.2	0.13			
UB0357	27.4	4.3	2.7	2.7	0.19			
UB0358	30.5	8.2	5.7	8.5	0.67	7.3	508	29.7
UB0367	30.5	7.6	11.0	9.4	1.17			
UB0376	24.4	5.5	1.6	12.8	0.12	6.6	271	29.5
UB0406	45.7	4.9	2.3	24.1	0.10	7.1	263	29.2
UB0407	30.5	5.5	5.0	17.9	0.28	7.3	505	28.8
UB0408	30.5	7.9	2.7	17.7	0.15			
UB0409	30.5	8.0	4.2	14.8	0.28			
UB0410	30.5	7.0	2.8	11.3	0.25			
UB0411	30.5	8.2	2.5	13.1	0.19			
UB0412	57.9	6.4	1.4	38.1	0.04			
UB0413	30.5	7.6	3.2	15.2	0.21			
UB0414	30.5	4.5	6.2	7.5	0.83	6.8	602	29.2
UB0415	30.5	6.2	3.4	14.8	0.23	5.9	126	28.4
UB0416	30.5	4.9	11.0	8.1	1.36			
UB0417	30.5	7.1	5.7	17.0	0.34			
UB0418	30.5	5.5	4.1	20.8	0.20	7.3	1560	30.1
UB0419	45.7	9.6	3.6	17.5	0.20	7.1	1060	29.7
UB0420	30.5	6.2	5.0	18.7	0.27	7.2	602	30.4
UB0421	30.5	4.3	3.9	19.7	0.20	7.6	488	29.4
UB0422	30.5	5.6	9.0	10.0	0.90			
UB0444	30.5	8.5	1.8	15.8	0.11	8.0	704	29.2
UB0446	61.0	8.5	5.0			8.0		
UB0448	27.4	5.4	11.9	6.3	1.89	8.4		
UB0453	33.5	12.0	5.5	16.1	0.34	8.0		
UB0455	30.5	4.9	2.0	14.9	0.13			
UB0456	30.5	7.6	4.5	15.8	0.28			
UB0457	51.8	9.1	1.1	36.6	0.03			
UB0458	39.6	7.0	0.9	29.6	0.03			
UB0460	39.6	5.5	1.8	21.6	0.08	7.5	348	29.3
UB0461	24.4	4.6	8.0	15.1	0.53	6.4	208	30.0

TABLE D-1 EXISTING WELL INVENTORY

(Water quality investigated in July,1991)

WELL NO.	WELL STRUCTURE					WATER QUALITY		
	DEPTH (m)	SWL (m)	YIELD (m3/hr)	DRAW DOWN (m)	SPECIFIC CAPACITY (m3/hr/m)	pH	EC (μ S/cm)	Temp. (°C)
UB0462	30.5	6.2	12.0	6.7	1.79	7.3	126	28.6
UB0462	30.5	6.2	12.0	6.7	1.79			
UB0463	24.4	5.7	8.0	13.3	0.60			
UB0464	30.5	7.8	9.0	14.2	0.63	6.6		
UB0464	30.5	7.8	9.0	14.2	0.63			
UB0465	30.5	5.3	5.1	13.2	0.39			
UB0465	30.5	5.3	5.1	13.2	0.39	7.1		
UB0466	30.5	1.9	14.3	8.5	1.68	7.4		
UB0466	30.5	1.9	14.3	8.5	1.68			
UB0467	30.5	4.6	12.0	12.1	0.99	7.0	299	29.7
UB0467	30.5	4.6	12.0	12.1	0.99	7.8		
UB0468	27.4	5.8	10.3	11.7	0.88	6.5	265	29.9
UB0468	27.4	5.8	10.3	11.7	0.88	6.6		
UB0469	30.5	9.1	1.4	12.2	0.11	6.4	283	30.2
UB0470	30.5	4.8	5.5	14.3	0.38	6.9		
UB0470	30.5	4.8	5.5	14.3	0.38			
UB0500	30.5	8.0	0.7	8.9	0.08	7.0	442	30.5
UB0501	27.4	4.1	13.5	6.2	2.18			
UB0502	30.5	4.6	1.4	19.8	0.07	5.9	117	29.5
UB0505	18.3	0.6	5.4	6.1	0.89			
UB0506	39.6	5.5	6.8	6.7	1.01			
UB0507	24.4	7.5	4.4	11.8	0.37			
UB0509	24.4	4.6	5.7	7.6	0.75			
UB0510	18.3	1.8	5.7	8.8	0.65			
UB0511	24.4	3.9	5.8	9.8	0.59			
UB0524	24.4	4.1	2.0	15.6	0.13			
UB0525	24.4	3.0	6.0	5.3	1.13			
UB0527	21.3	6.1	2.0	9.4	0.21	7.0	609	30.3
UB0528	30.5	5.2	5.4	9.1	0.59	7.1	503	29.5
UB0529	30.5	6.1	0.9	21.3	0.04			
UB0541	24.4	2.1	4.2	10.1	0.42	6.5	305	29.4
UB0542	24.4	6.1	2.0	9.1	0.22	8.4		
UB0543	24.4	6.1	3.0	6.1	0.49			
UB0544	30.5	4.6	5.0	13.7	0.36	7.7		
UB0546	27.4	4.9	6.4	6.1	1.05	7.1	505	29.6
UB0572	24.4	4.6	4.1	13.7	0.30			
UB0573	30.5	1.8	6.0	11.9	0.50	5.7	47	29.1
UB0574	24.4	6.1	3.8	9.8	0.39	7.0	276	28.5
UB0575	24.4	4.9	4.3	8.8	0.49	7.1	433	30.3
UB0576	30.5	7.3	5.3	14.0	0.38			
UB0577	30.5	7.0	1.4	15.8	0.09	7.2	650	30.6
UB0578	30.5	6.1	1.1	16.8	0.06			
UB0579	35.1	7.6	1.9	18.3	0.10	7.3	2700	30.5
UB0580	41.2	7.6	4.5	19.8	0.23			
UB0582	30.5	3.0	8.7	6.1	1.43	7.3		
UB0583	30.5	7.6	3.9	12.2	0.32	7.7		
UB0584	33.5	6.1	4.8	7.0	0.68	8.7		
UB0585	30.5	3.0	1.1	23.2	0.05			
UB0586	30.5	3.0	6.8	4.6	1.48	7.4	505	29.3
UB0588	30.5	5.5	4.8	9.1	0.53	7.4	707	29.4
UB0589	30.5	7.3	11.0	11.0	0.10	7.7		
UB0590	24.4	1.5	2.9	4.6	0.63	8.1		

TABLE D-1 EXISTING WELL INVENTORY

(Water quality investigated in July,1991)

WELL NO.	WELL STRUCTURE					WATER QUALITY		
	DEPTH (m)	SWL (m)	YIELD (m3/hr)	DRAW DOWN (m)	SPECIFIC CAPACITY (m3/hr/m)	pH	EC (μ S/cm)	Temp. (°C)
UB0591	24.4	7.6	2.0	15.2	0.13	8.2		
UB0592	27.4	6.1	1.1	21.3	0.05	8.1		
UB0593	24.4	7.6	3.4	13.7	0.25	8.3		
UB0594	24.4	1.5	6.8	7.0	0.97	6.9	227	28.7
UB0595	41.2	12.2	1.4	18.3	0.08			
UB0596	42.7	11.6	1.1	22.0	0.05	7.2	360	29.7
UB0602	24.4	1.5	4.8	10.7	0.45	6.3	506	29.7
UB0609	22.9	2.4	6.8	7.6	0.89	6.9	556	29.5
UB0623	24.4	6.1	6.3	6.1	1.03			
UB0624	30.5	1.2	5.0	4.9	1.02	6.5	112	30.4
UB0625	30.5	6.1	3.6	13.7	0.26	7.5	223	29.4
UB0649	36.6	8.2	1.4	16.2	0.09			
UB0652	24.4	3.0	3.4	6.1	0.56			
UB0653	30.5	2.1	6.4	8.5	0.75			
UB0654	24.4	4.3	3.4	6.1	0.56			
UB0655	24.4	1.2	4.4	11.0	0.40			
UB0656	30.5	6.1	1.4	18.3	0.08			
UB0657	30.5	9.1	2.5	13.7	0.18	7.3	486	30.5
UB0658	30.5	8.5	2.8	14.3	0.20	7.6		
UB0659	42.7	9.1	1.1	18.3	0.06	7.5		
UB0661	24.4	4.6	5.3	6.1	0.87	7.1	600	29.2
UB0662	30.5	7.0	3.2	8.2	0.39			
UB0664	30.5	6.1	1.4	16.8	0.08			
UB0665	24.4	6.1	2.7	10.7	0.25	6.7	127	30.6
UB0666	30.5	4.6	1.1	13.7	0.08			
UB0675	30.5	3.0	4.5	6.1	0.74	6.1	123	29.8
UB0678	30.5	6.1	2.3	17.7	0.13			
UB0679	30.5	1.5	4.5	4.6	0.98			
UB0680	30.5	7.6	4.5	8.2	0.55	7.5		
UB0699	30.5	10.7	5.0	11.3	0.44	7.1	603	29.9
UB0707	24.4	1.5	6.8	6.1	1.11			
UB0710	24.4	4.6	4.5	4.6	0.98	7.3	471	29.5
UB0711	30.5	6.1	4.1	10.7	0.38	7.2	509	30.1
UB0712	30.5	6.1	3.4	9.1	0.37			
UB0713	30.5	3.0	1.1	13.7	0.08	6.9	141	30.1
UB0714	27.4	4.6	2.3	15.2	0.15	7.6	455	30.4
UB0718	30.5	6.7	1.1	22.0	0.05	6.8	504	29.9
UB0718	30.5	1.5	4.5	6.1	0.74			
UB0720	30.5	3.0	2.0	12.2	0.16			
UB0765	24.4	7.6	1.1	10.7	0.10			
UB0766	30.5	2.7	5.4	6.4	0.84			
UB0776	30.5	1.5	4.8	3.0	1.60	7.9		
UB0777	30.5	3.0	4.1	4.6	0.89	7.4	286	28.1
UB0779	15.2	2.4	3.4	3.6	0.94	7.6		
UB0780	30.5	2.4	3.4	21.9	0.16			
UB0827	30.5	3.0	4.1	7.3	0.56	6.5	275	29.2
UB0833	51.8	5.2	4.1	13.1	0.31			
UB0834	30.5	1.5	6.4	4.0	1.60	7.1	550	29.1
UB0835	30.5	7.0	4.5	7.6	0.59	6.4	128	31.1
UB0836	30.5	4.6	4.5	7.6	0.59	6.5	126	28.0
UB0837	30.5	3.0	3.4	9.1	0.37			
UB0895	53.4	8.2	2.3	31.4	0.07	7.1	389	28.6

TABLE D-1 EXISTING WELL INVENTORY

(Water quality investigated in July,1991)

WELL NO.	WELL STRUCTURE					WATER QUALITY		
	DEPTH (m)	SWL (m)	YIELD (m3/hr)	DRAW DOWN (m)	SPECIFIC CAPACITY (m3/hr/m)	pH	EC (μ S/cm)	Temp. (°C)
UB0896	54.9	6.1	2.3	41.2	0.06			
UB0897	30.5	1.5	6.8	4.6	1.48			
UB0898	24.4	3.0	5.4	6.7	0.80	6.6	345	28.7
UB0899	30.5	5.2	5.9	5.5	1.07	6.3	286	29.0
UB0900	30.5	3.0	5.2	9.1	0.57			
UB0949	48.8	7.9	3.4	28.6	0.12			
UB0951	36.6	3.0	2.3	3.0	0.77	7.0	164	29.3
UB0952	45.7	9.1	1.1	29.0	0.04			
UB0953	30.5	5.2	3.0	15.2	0.20			
UB0954	24.4	4.6	1.8	13.1	0.89			
UB0955	30.5	4.3	4.1	7.0	0.58			
UB0957	30.5	4.3	5.4	4.6	1.17			
UB1002	30.5	6.7	2.7	15.8	0.17	6.9	443	29.9
UB1003	36.6	4.9	3.6	18.9	0.19	7.0	367	30.8
UB1006	36.6	5.5	7.3	20.4	0.36			
UB1007	36.6	8.6	4.5	9.1	0.49			
UB1008	30.5	4.3	2.3	20.1	0.11			
UB1009	30.5	5.5	4.5	16.2	0.28			
UB1010	30.5	3.6	2.7	23.8	0.11			
UB1012	36.6	7.6	2.3	21.3	0.11			
UB1013	30.5	4.9	3.8	18.6	0.20	6.9	387	29.7
UB1014	30.5	5.2	2.3	19.2	0.12			
UB1015	30.5	1.8	9.1	5.5	1.65			
UB1016	30.5	3.6	5.7	5.5	1.04			
UB1017	30.5	7.6	4.5	8.5	0.53	7.0	344	30.3
UB1018	36.6	4.9	1.4	25.0	0.06			
UB1019	30.5	7.6	2.3	16.8	0.14	6.9	445	30.6
UB1020	30.5	3.0	5.2	8.5	0.61			
UB1030	30.5	4.6	3.4	14.6	0.23			
UB1031	30.5	6.7	4.1	7.6	0.54			
UB1032	48.9	8.5	1.4	32.9	0.04			
UB1033	30.5	16.4	1.4	17.4	0.08	6.7	998	28.4
UB1034	36.6	6.1	1.8	24.4	0.07			
UB1067	36.6	4.6	6.8	6.1	1.11			
UB1071	36.6	1.5	4.1	14.3	0.29	6.9	182	29.7
UB1072	36.6	4.9	4.5	8.8	0.51			
UB1073	36.6	5.2	2.9	19.8	0.15			
UB1075	24.4	3.0	5.2	4.6	1.13			
UB1076	36.6	5.8	4.5	6.4	0.70			
UB1077	30.5	6.7	5.2	7.6	0.68	7.0	213	27.6
UB1078	30.5	5.5	3.4	13.4	0.25			
UB1079	36.6	3.0	4.1	19.2	0.21	7.2	505	29.2
UB1086	36.6	5.5	2.3	22.9	0.10	6.7	351	30.3
UB1091	30.5	1.5	7.9	3.6	2.19			
UB1094	30.5	7.9	3.4	12.8	0.26			
UB1095	36.6	6.4	4.5	19.8	0.23			
UB1096	54.9							
UB1098	36.6	3.6	4.5	17.1	0.26	7.1	600	29.9
UB1099	30.5	6.1	1.1	17.1	0.06			
K0587	24.4	4.5	7.8	9.1	0.86	5.3		
K0588	18.3	4.6	1.1	12.2	0.09			
K0622	18.3	7.0	0.7	3.6	0.10			

TABLE D-1 EXISTING WELL INVENTORY

(Water quality investigated in July,1991)

WELL NO.	WELL STRUCTURE					WATER QUALITY		
	DEPTH (m)	SWL (m)	YIELD (m3/hr)	DRAW DOWN (m)	SPECIFIC CAPACITY (m3/hr/m)	pH	EC (μ S/cm)	Temp. (°C)
K0692	21.3	3.9	5.5	7.3	0.76	8.1		
K0710	24.4	3.6	6.5	9.8	0.67	7.0		
K0711	24.4	5.8	4.5	9.7	0.46	7.3		
K0753	30.5	7.1	4.2	2.2	0.60	6.7		
K0835	18.3	4.9	3.4	9.4	0.36			
K0836	18.3	2.8	4.8	1.8	1.71			
K0838	30.5	1.1	4.8	9.2	0.52	8.1		
K0847	18.3	3.1	2.2	9.0	0.24			
K0978	30.5	5.5	7.2	8.8	0.82			
K0984	30.5	4.3	1.1	20.1	0.06			
K1006	24.4	3.2	7.2	7.8	0.92			
K1011	27.4	6.5	6.0	7.1	0.84			
K1056	18.3	2.4	2.3	8.5	0.27			
K1061	24.4	5.2	1.4	13.1	0.10			
K1062	30.5	5.2	2.3	19.2	0.12			
K1071	36.6	6.4	2.7	19.8	0.14			
K1106	30.5	8.5	4.8	8.2	0.56			
K1107	30.5	7.0	5.9	3.0	0.84			
K1108	30.5	9.8	3.9	4.0	0.39			
K1109	36.6	6.4	5.2	4.6	0.82			
CC0485	30.5	8.5	2.0	13.4	0.15	7.9		
CC0489	36.6	6.1	2.3	21.3	0.11	8.4		
CC0490	15.2	3.8	9.0	1.9	2.36	7.0		
R0521	36.6	2.4	7.5	10.8	0.69	6.8		
R0525	36.6	6.4	7.8	4.4	1.22	7.4		
R0538	18.3	1.8	8.7	9.5	0.92	8.5		
R0620	24.4	4.0	3.4	18.3	0.18	7.7		
R0621	24.4	4.3	1.8	5.9	0.30	8.0		
R0622	24.4	2.6	1.9	3.1	0.62	8.5		
R0867	36.6	7.6	1.6	24.4	0.06			
R0868	30.5	5.5	3.2	15.8	0.20	7.7		
R0869	30.5	1.5	4.1	2.7	1.51			
R0872	30.5	1.5	4.1	9.6	0.43			
R1037	30.5	4.0	5.5	19.2	0.29			
R1038	30.5	1.8	1.1	22.0	0.05			
R1039	30.5	3.0	1.6	20.1	0.08			
MG0528	30.5	7.6	1.1	21.3	0.05	7.2		
MG0529	24.4	5.4	2.4	15.5	0.15	8.1		
MG0530	30.5	10.0	1.9	10.9	0.17	8.2		
MG0531	42.7	9.4	1.4	19.5	0.07			
MG0471	30.5	1.7	4.8	6.9	0.70	7.6		
MG0548	30.5	1.2	2.3	23.2	0.10			
SB0551	36.6	4.6	1.1	9.4	0.12			
SB0623	27.4	3.0	2.3	9.8	0.23			
SB0624	24.4	3.0	1.6	13.1	0.12			
SB0626	30.5	4.3	2.7	14.0	0.19			
SB0627	30.5	3.0	3.6	10.7	0.34			
AV.	32.50	5.46	4.76	13.11	0.52	7.17	477.81	29.55
MAX	182.9	16.4	32.6	42.1	3.43	8.7	2700	31.1
MIN	15.2	0.6	0.68	1.8	0.03	6.3	47	27.5

TABLE D-2 LIST OF SOIL LABORATORY TEST

ITEMS	SPECIFIC GRAVITY	MOISTURE CONTENTS	ATTERBERG L.L. P.L.	GRADATION	COMPACTION	PERMEA-BIILITY	IDENTIFI-CATION
SAMPLE NO.							
P-23 P-1	○	○	○	○			CL
P-2	○	○	○	○	○	○	SM
P-24 P-1(1)	○	○	○	○			CL
P-1(2)	○	○	○	○			CL
P-2	○	○	○	○	○	○	CH
P-3	○	○	○	○	○	○	ML
P-25 P-1	○	○	○	○			ML
P-2	○	○	○	○			CL
P-3	○	○	○	○			CL
P-4(1)	○	○	○	○	○	○	MH
P-4(2)	○	○	○	○	○	○	CL
P-28 P-1(1)	○	○	○	○	○	○	CL
P-1(2)	○	○	○	○			CL
P-2(1)	○	○	○	○	○	○	SM
P-2(2)	○	○	○	○	○	○	SM-SC
P-3(1)	○	○	○	○			GM-GC
P-3(2)	○	○	○	○			SC
P-3(3)	○	○	○	○	○	○	SC
P-29 P-2	○	○	○	○	○	○	SC
J-7 P-1	○	○	○	○			CL
P-2	○	○	○	○			SM
P-3	○	○	○	○	○	○	CL

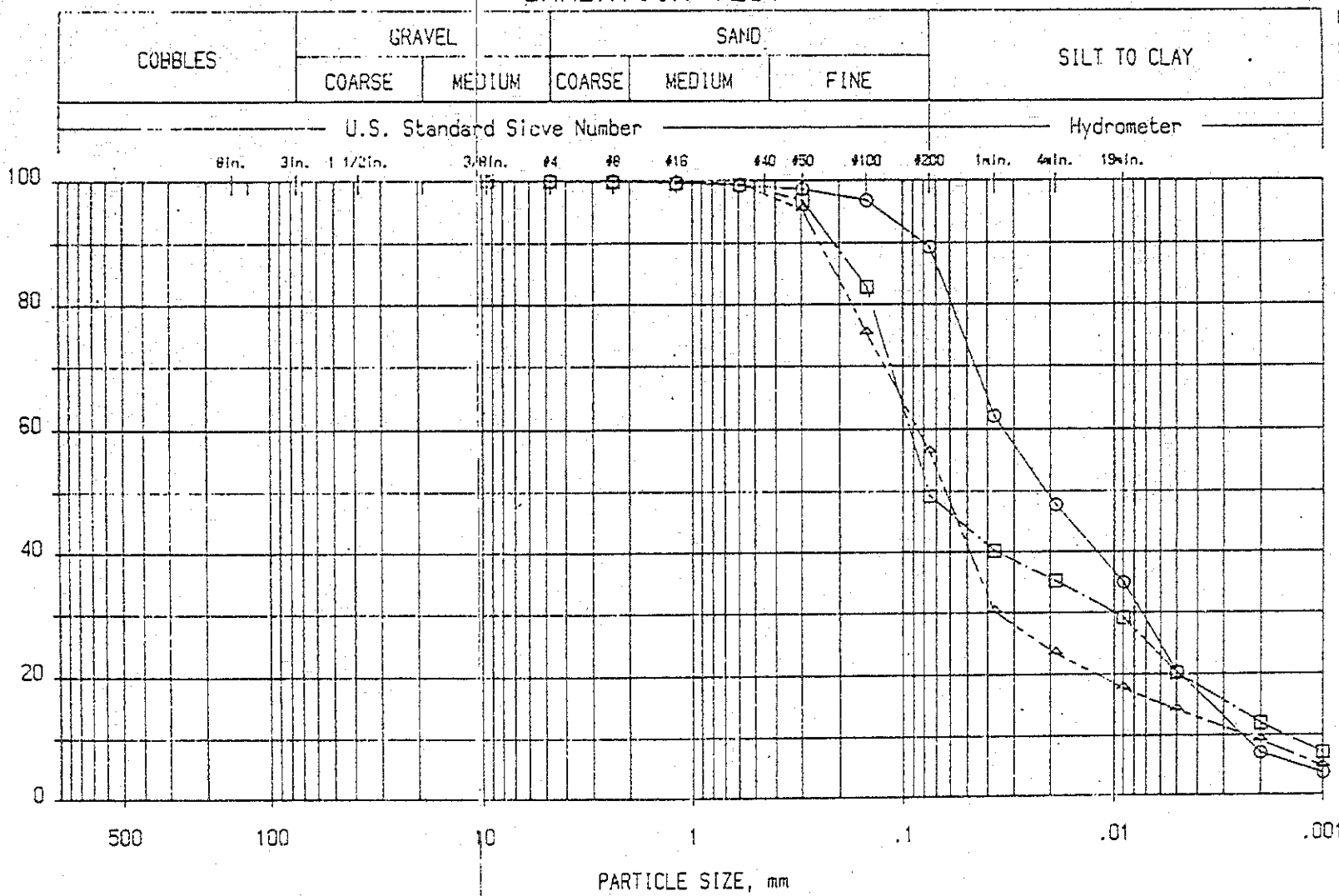
1) ○; Test items requested by JICA Team
2) Tested by Soil Engineering Division, RID

TABLE D－3 RESULT OF SOIL TEST

Soil Classification	:	CL, CL-ML, SM, SC, SM-C
Max. Grain Size (mm)	:	20
Grain Size - 200 # (%)	:	20.0 ~ 82.5
Uniformity Coefficient (UC)	:	10 ~ 583
Max. Dry Density (t/cu.m)	:	1.7 ~ 2.0
Natural Water Contents (%)	:	10.6 ~ 20.3
Plastic Limit (%)	:	12.4 ~ 25.0
Plasticity Index (%)	:	4.6 ~ 22.0
Opt. Water Contents (%)	:	9.3 ~ 17.1
Wn - Wopt (%)	:	+2.9 ~ -5.0
Permeability Coefficient (cm/sec)	:	1.4×10^{-7} ~ 1.9×10^{-8}
Specific Gravity	:	2.61 ~ 2.78

GRADATION TEST

Royal Irrigation Department
Research and Laboratory Division
Soil Engineering Branch



Project DOM-YAI (2nd)
Memo 161/34
Checked by PAIBOON
Date: 17/07/34

Sample No.		Boring No.	Depth (m.)	L.L.	P.L.	P.I.	CLASS	Gs	Wn, %	
⊙	1	D23-P1		29.10	17.90	11.20	CL	2.69	18.6	
⊡	2	D23-P2		----------	Non-Plastic	----------	SM	2.68	11.0	
▽	3	D24-P1(1)	1.20 M.	25.80	16.00	9.80	CL	2.71	16.9	