FIG. II-5

GEOLOGICAL CROSS SECTION OF SITE C (DOWN STREAM)

Drilled 1979 & 1982

S = 1:100

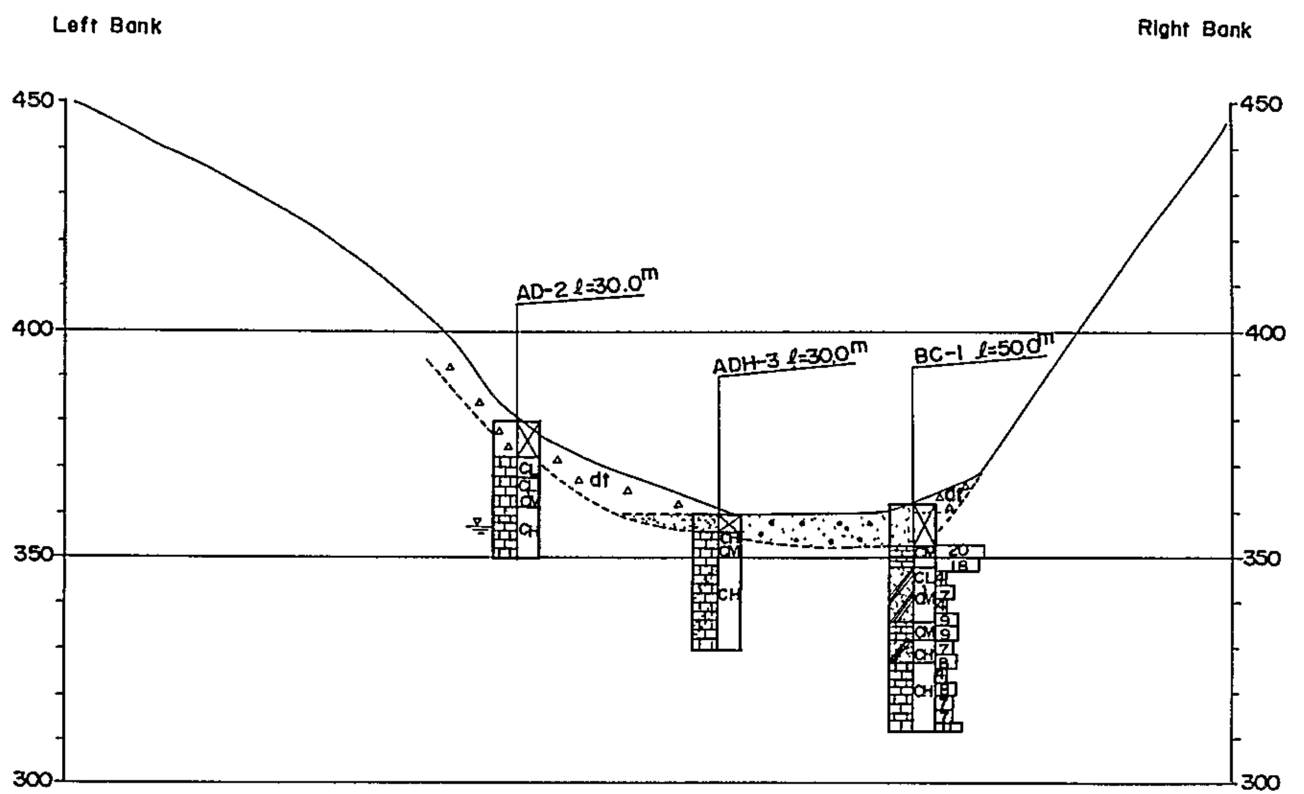
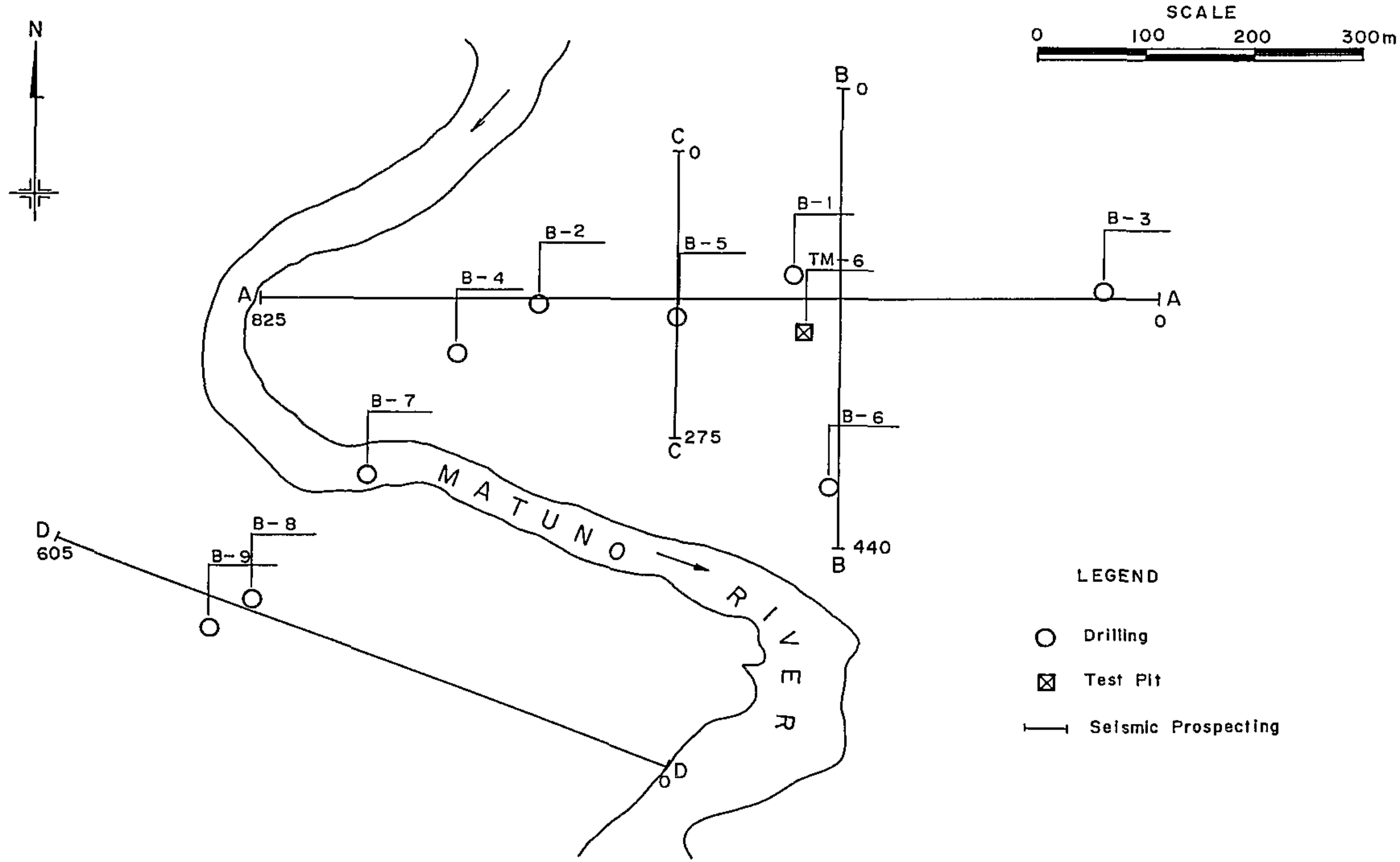


FIG. II-6

GEOLOGICAL MAP OF SITE B2

FIG. II-7

LOCATION MAP OF INVESTIGATION AT SITE B2



BORE HOLE LOG FOR SITE B2

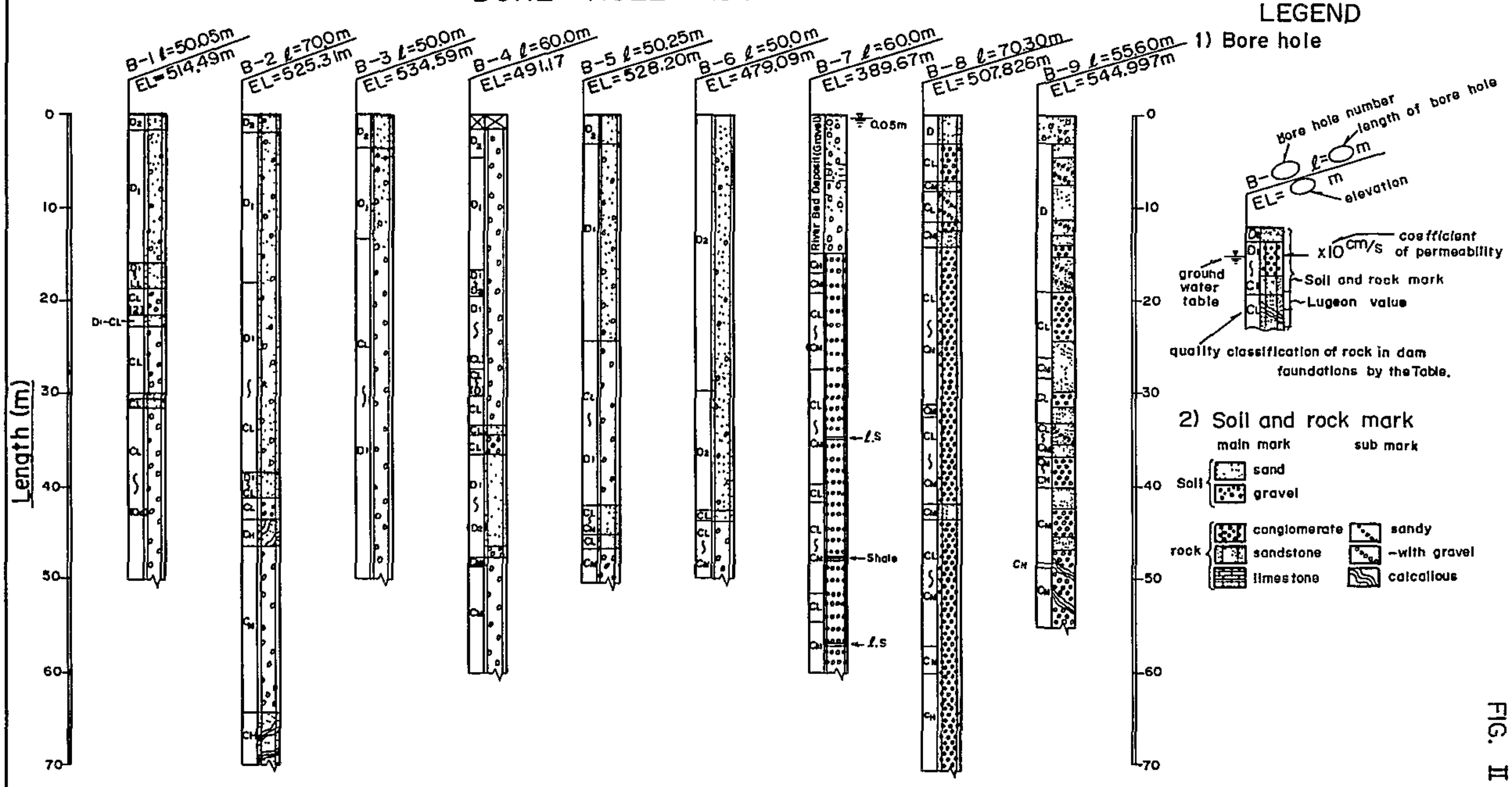


FIG. II-8

GEOLOGICAL CROSS SECTION OF SITE B2

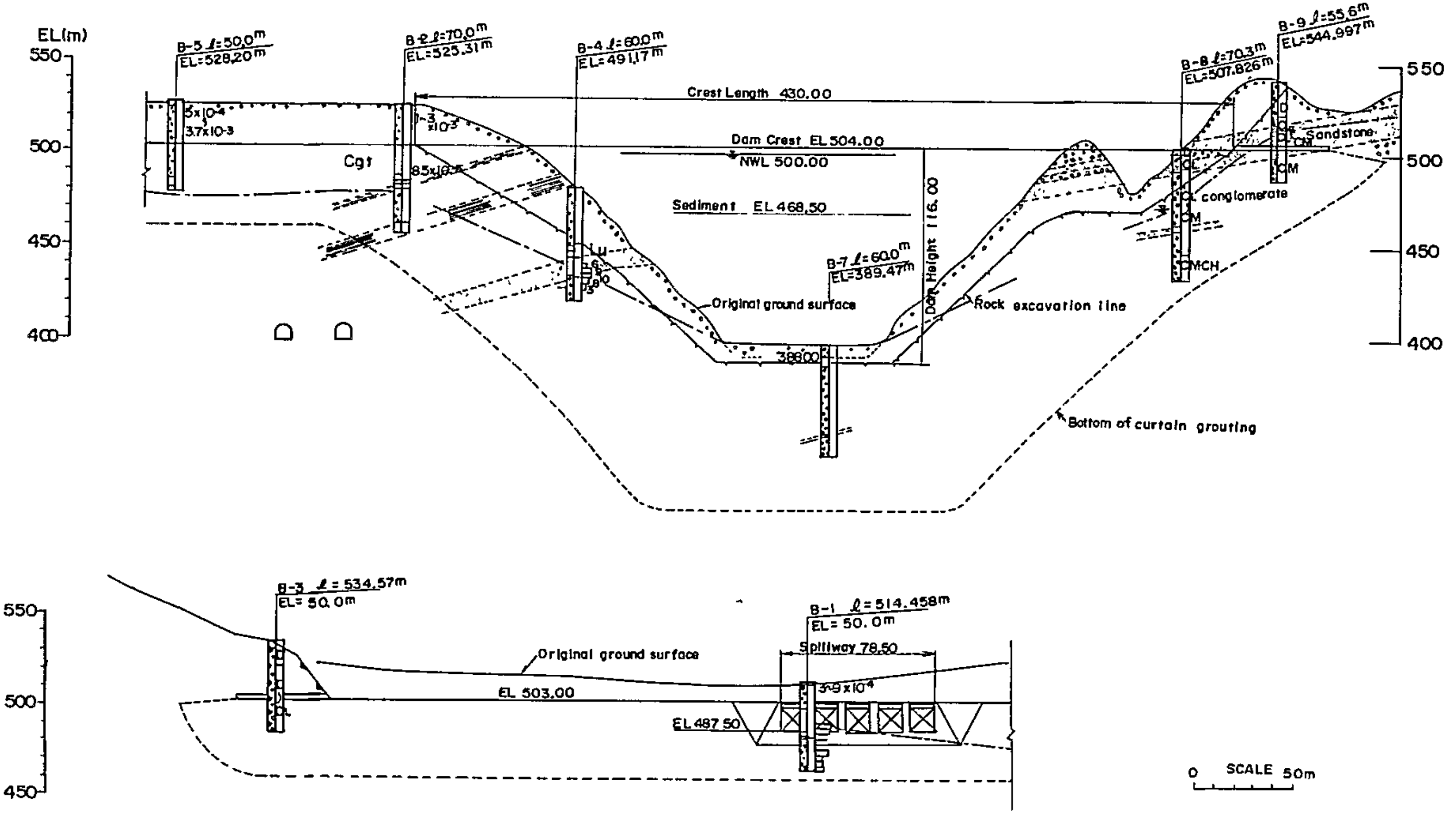


FIG. II - 9

RESULTS OF PERMEABILITY TEST AT SITE B2

Hole No. / Depth (m)	B - 1	B - 2	B - 4	B - 5	B - 7	B - 8	B - 9
	K						
0 - 3	$3\text{-}9 \times 10^{-4}$						2.62×10^{-3} cm/sec
- 6	cm/sec			K		6.7m	2.16×10^{-4}
- 9		$1\text{-}2 \times 10^{-3}$		3.7×10^{-3}	1.05×10^{-2}	9Lu	3.39×10^{-4}
-12		cm/sec		5.0×10^{-4}	1.65×10^{-2}	9.7 14	7.51×10^{-4}
-15				cm/sec	cm/sec	12.7	1.24×10^{-4}
-18					20m 19 Lu		5.09×10^{-4}
-21							
-24					25m 20		4.60×10^{-4}
-27	17 Lu				23		25m 11 Lu
-30	14				30m		28m 11
-33	-				22		31m 10
-36	12	8.5×10^{-5}			35m		34m 15
-39	12	cm/sec			40m 24		37m 11
-42	13	9 Lu	6 Lu	18 Lu	26		40m 10
-45	7	7	9	10	45m		43m 11
-48	7		10	-	29		46m 10
-51	8	10	8	12	50m		49m 7
-54		17	3		55m 28		52m
-59		34			60m 31		
-62		13					
-65		16					
-68		6					

Lu: Lugeon Value
K: Permeability Coefficient (cm/sec)

FIG II-11

DISTRIBUTION CHART OF LUGEON VALUE SITE B2

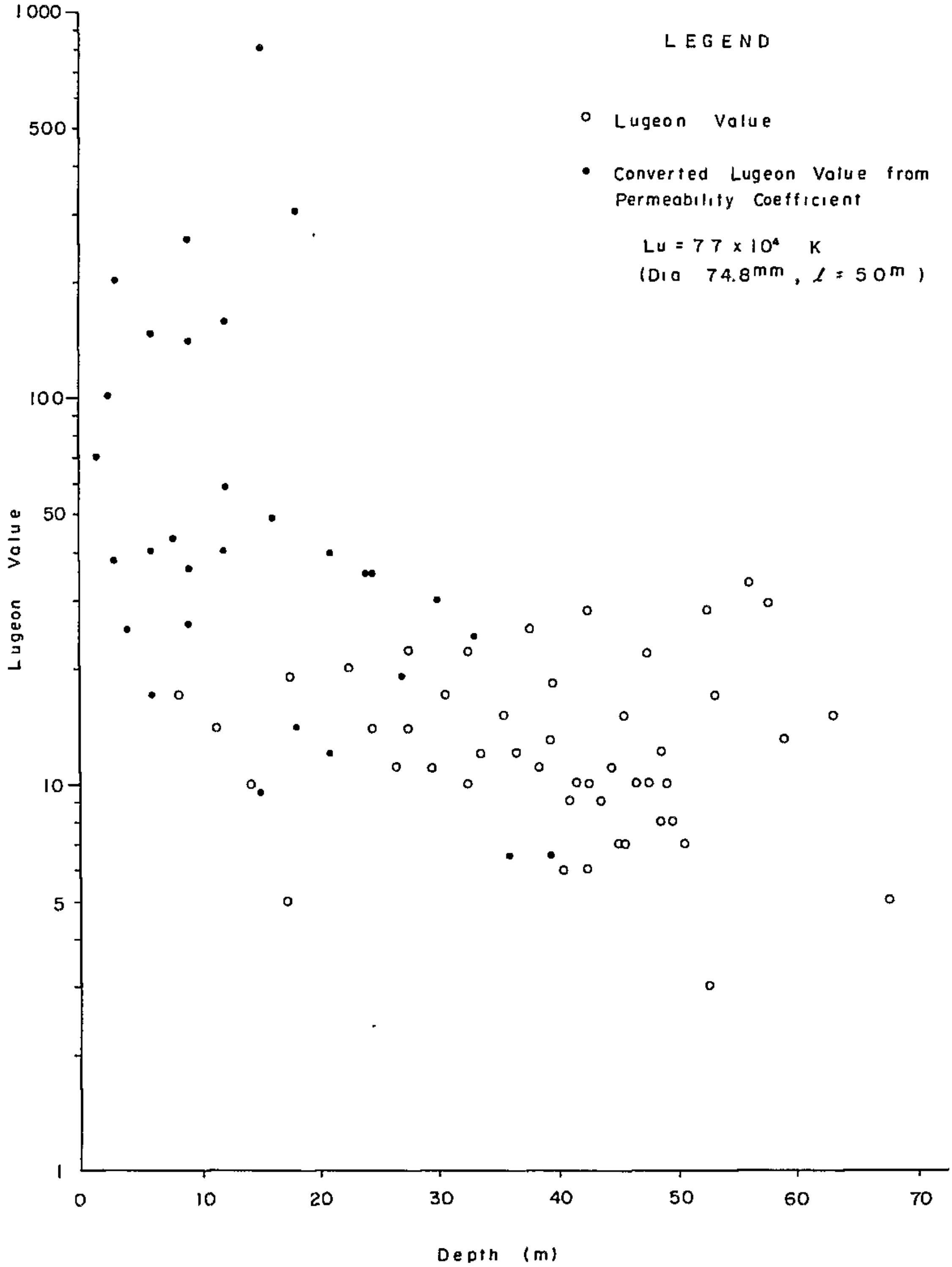


FIG. II-12

VELOCITY LAYER SECTION BY SEISMIC PROSPECTING

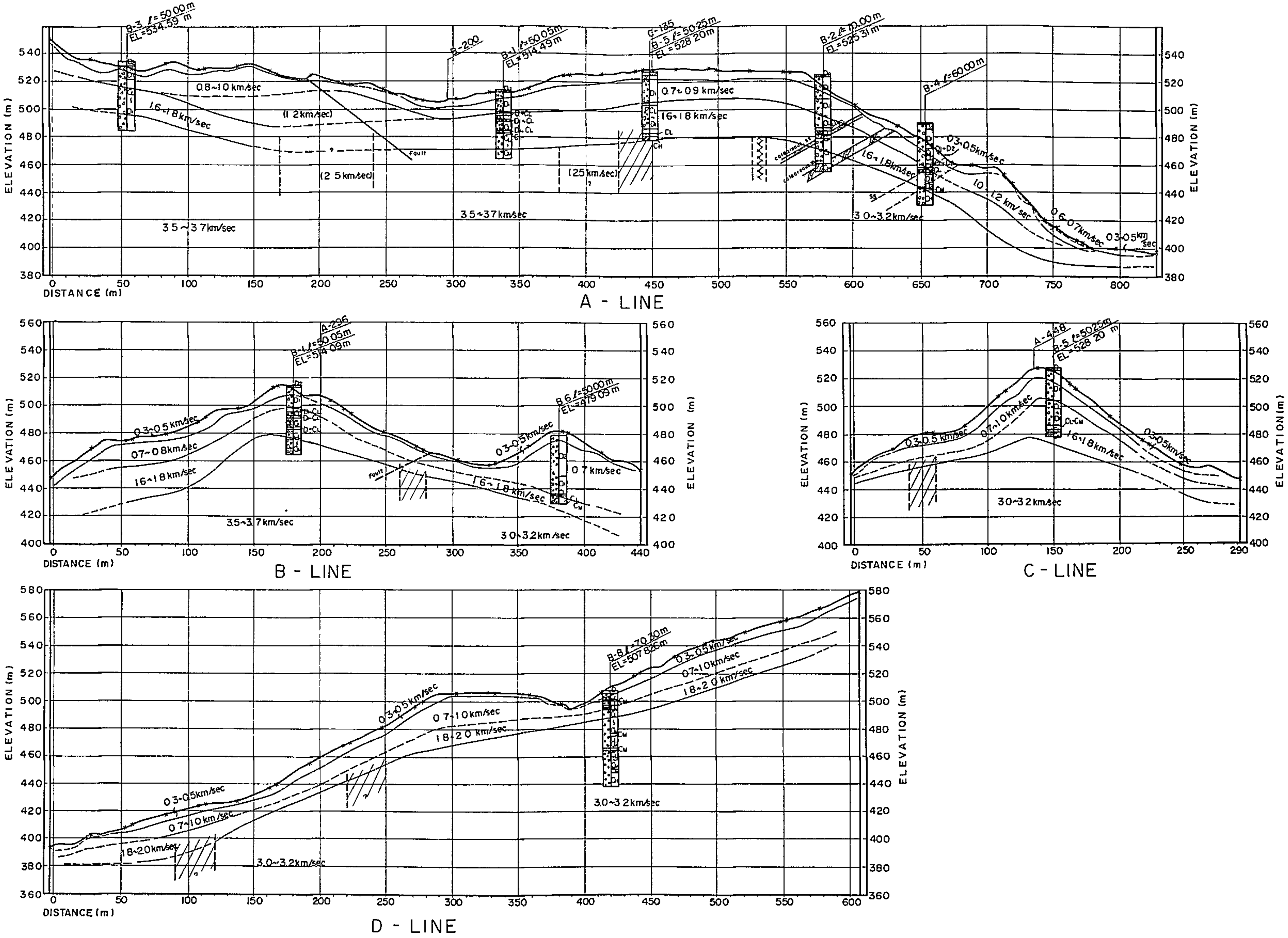
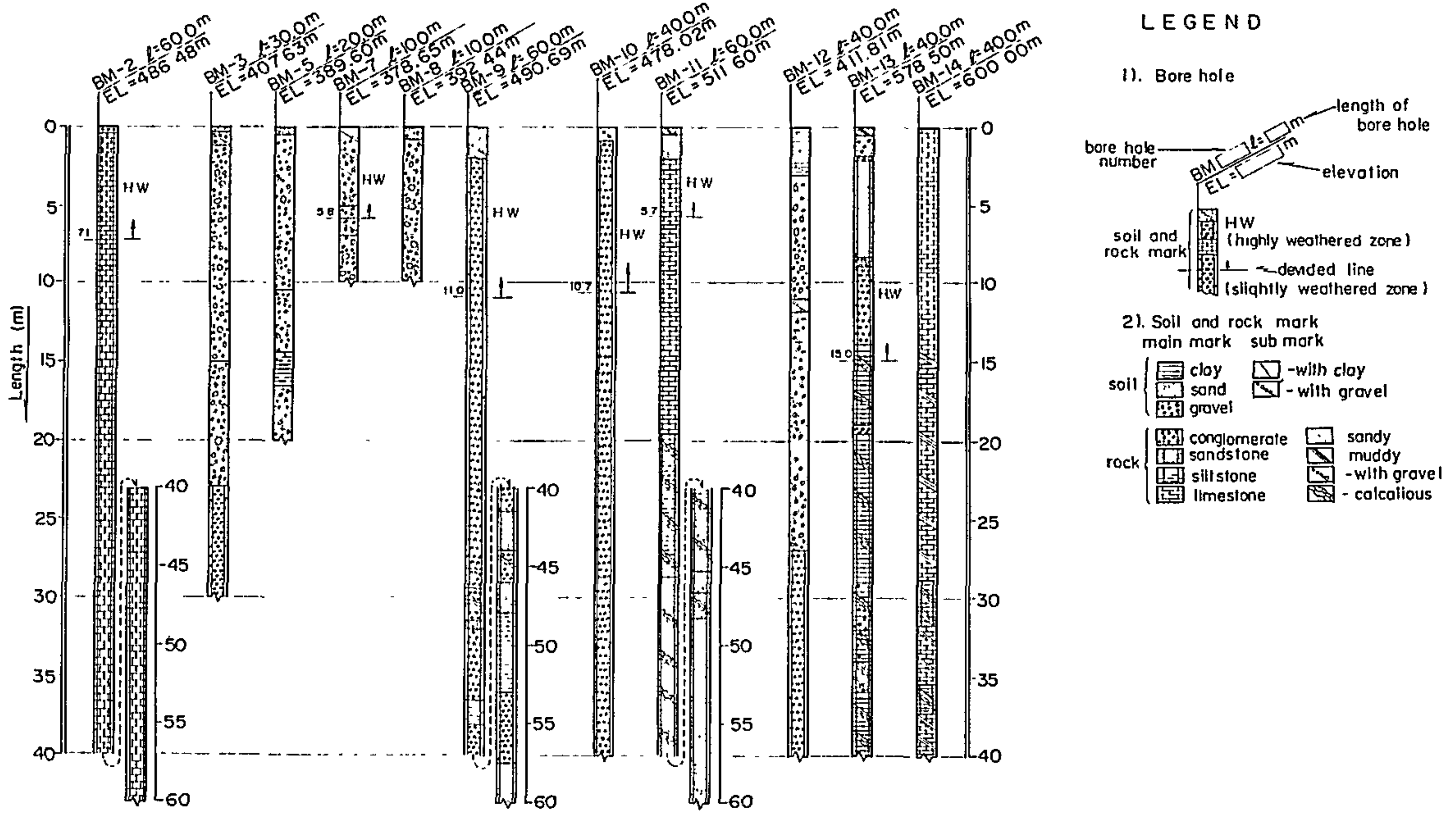


FIG. II - 13

BORE HORE LOG FOR IMPERVIOUS MATERIAL BORROW AREA



LOCATION MAP OF BORROW AND QUARRY SITE

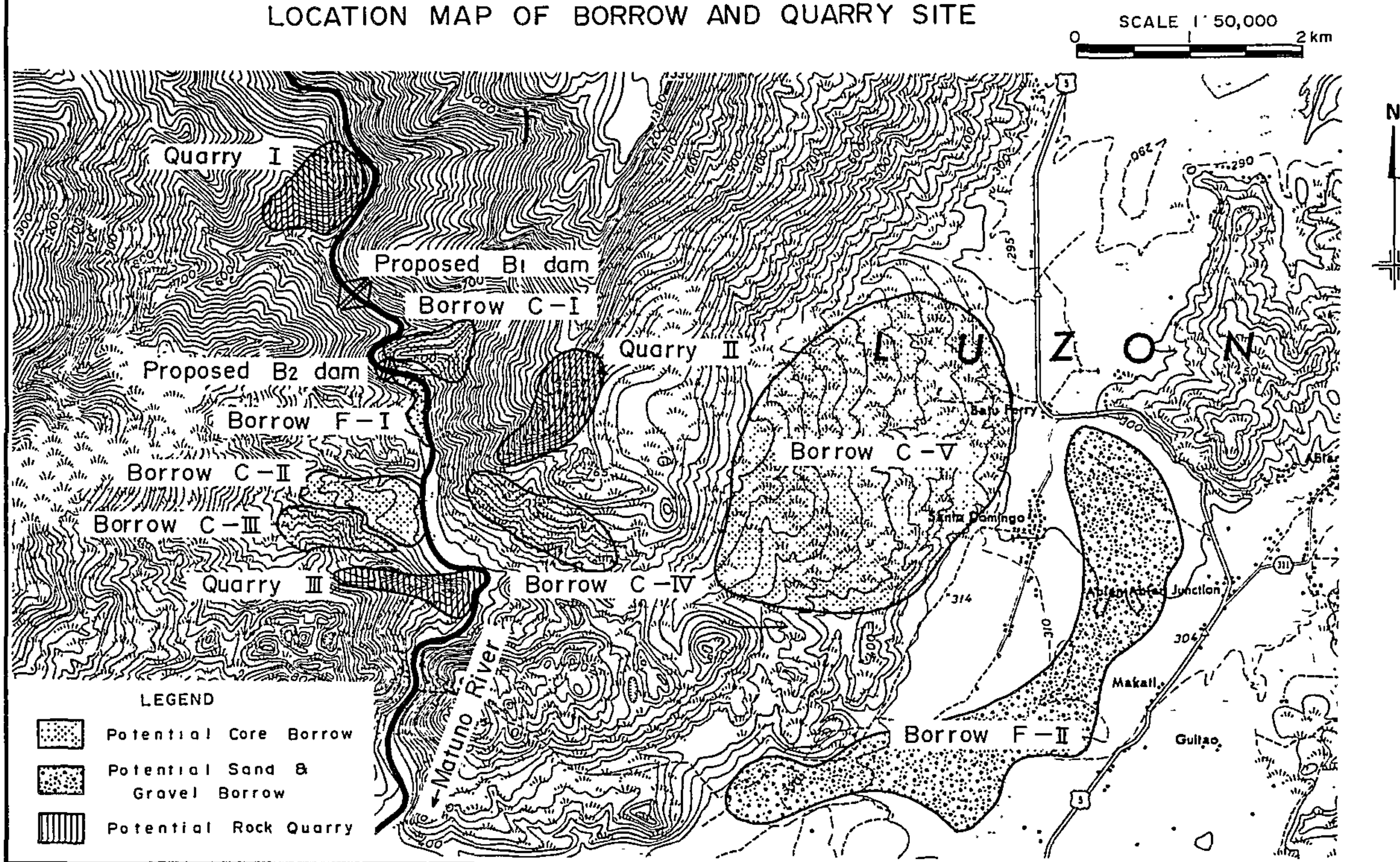


FIG. II-14

FIG. II-15

EXCAVATION PLAN OF PROPOSED IMPERVIOUS BORROW AREA (C-III)

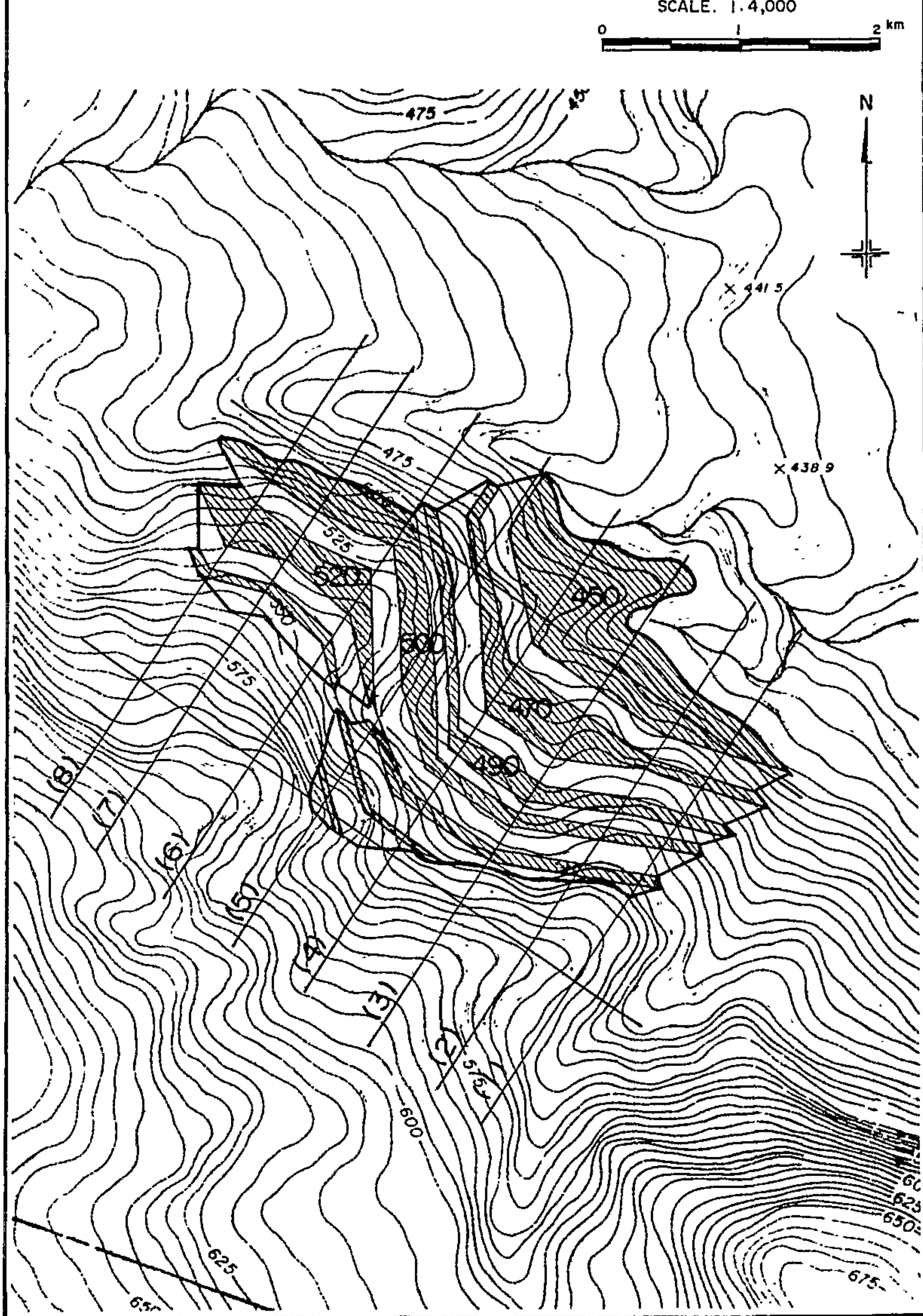
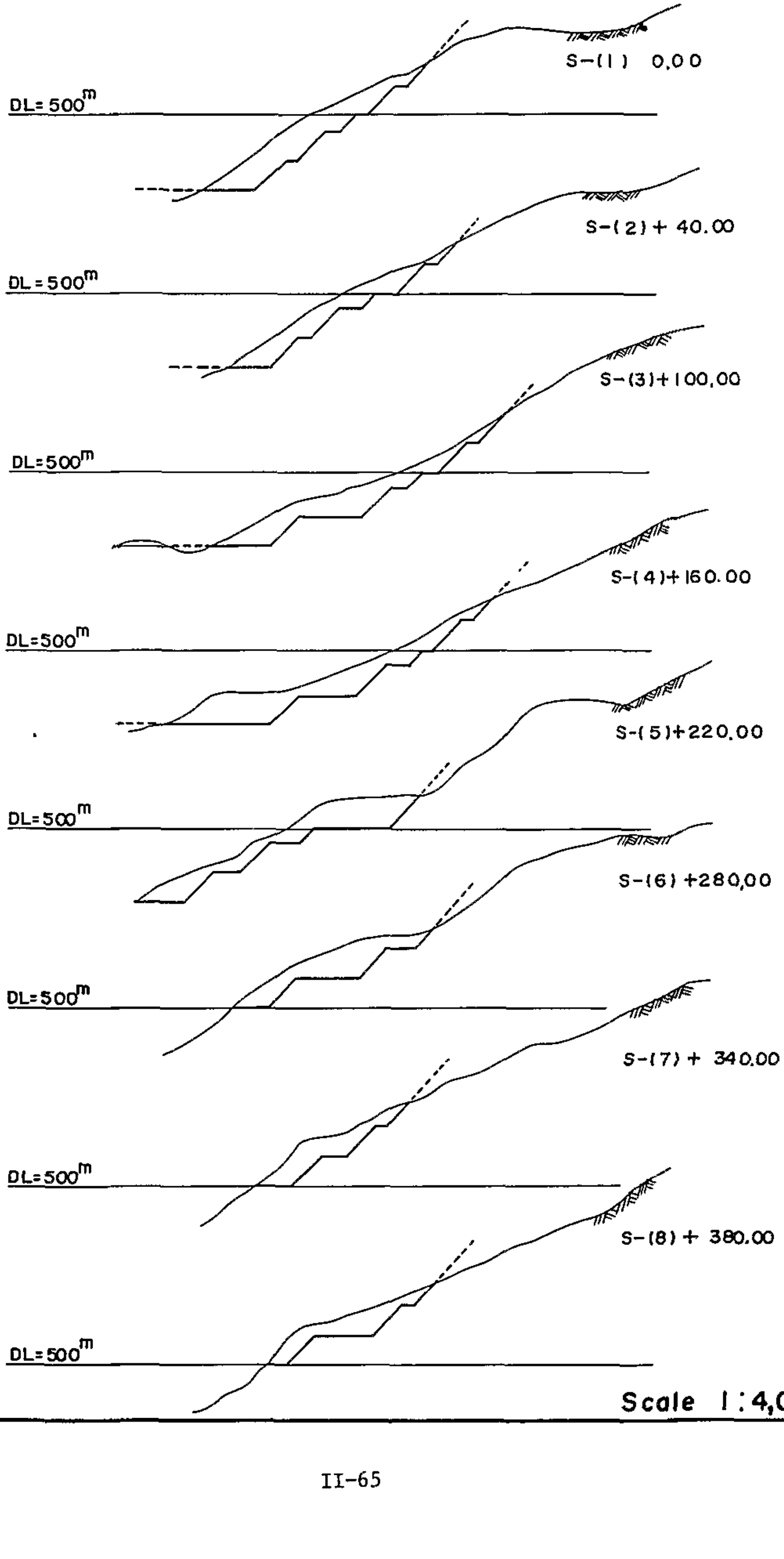


FIG. II-16

EXCAVATION RROFILE FOR IMPERVIOUS MATERIAL BORROW AREA



Scale 1:4,000

EXCAVATION PLAN OF PROPOSED QUARRY SITE

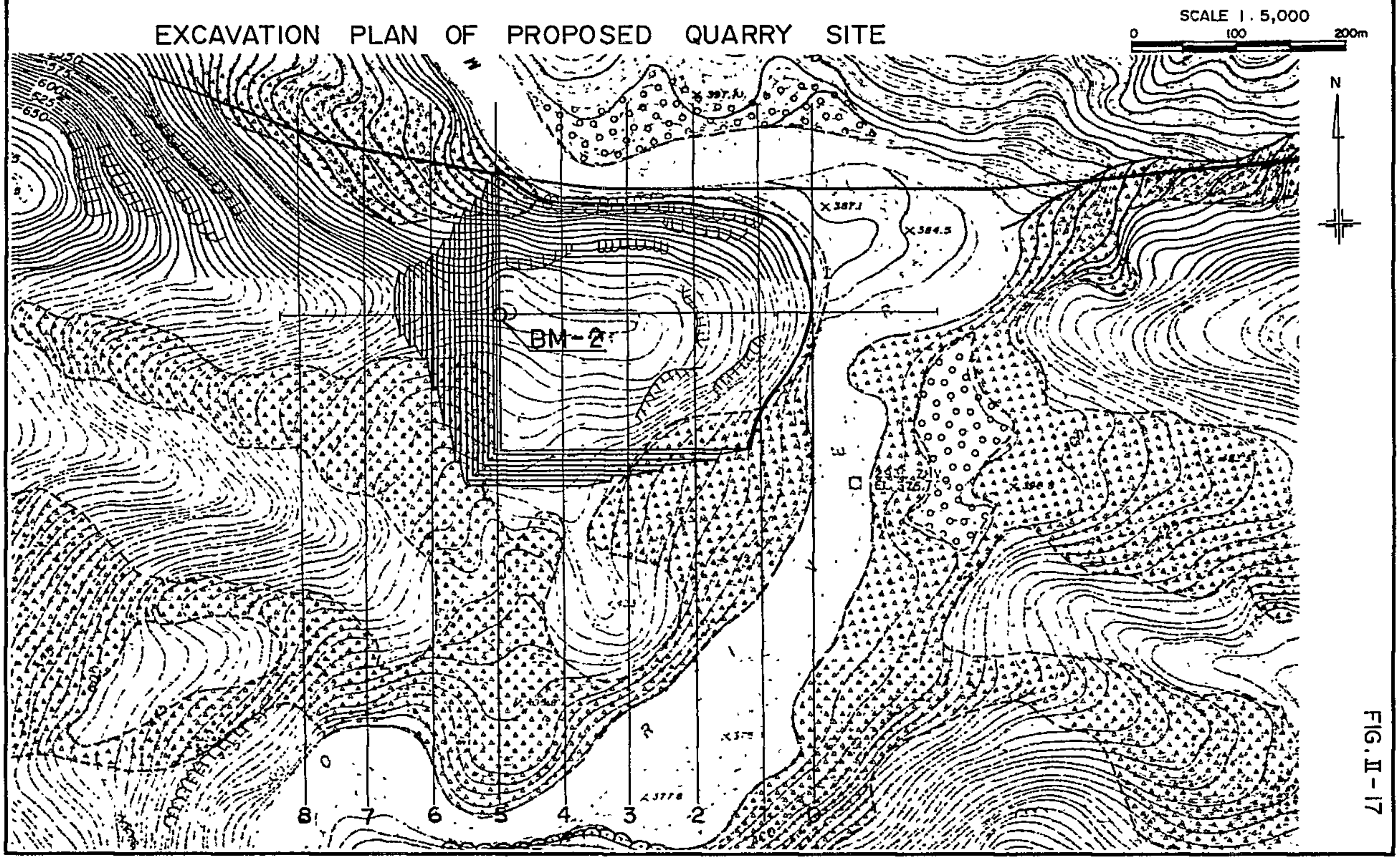


FIG. II-17

FIG. II - 18

EXCAVATION PROFILE FOR PERVIOUS MATERIAL QUARRY SITE

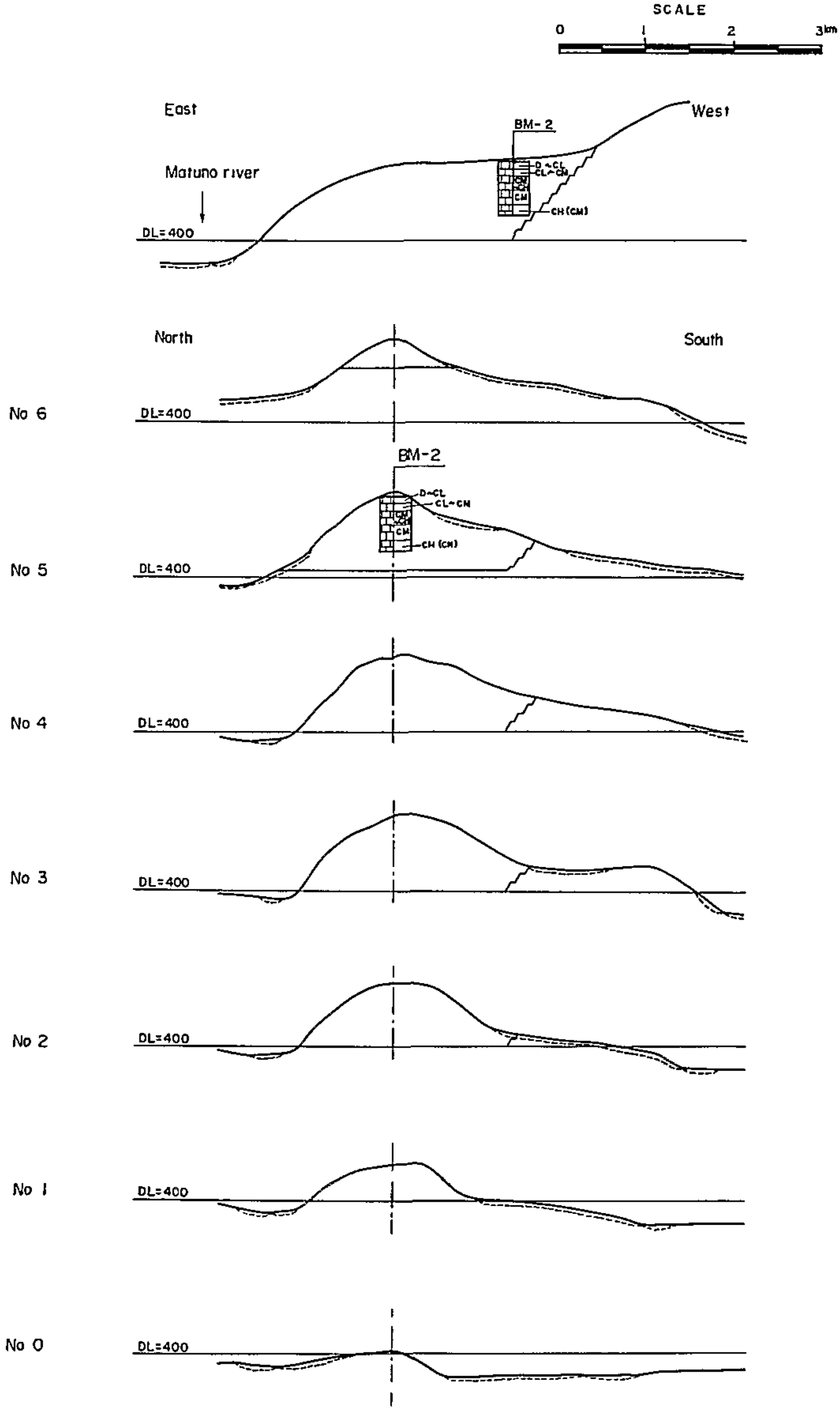


FIG. II - 19

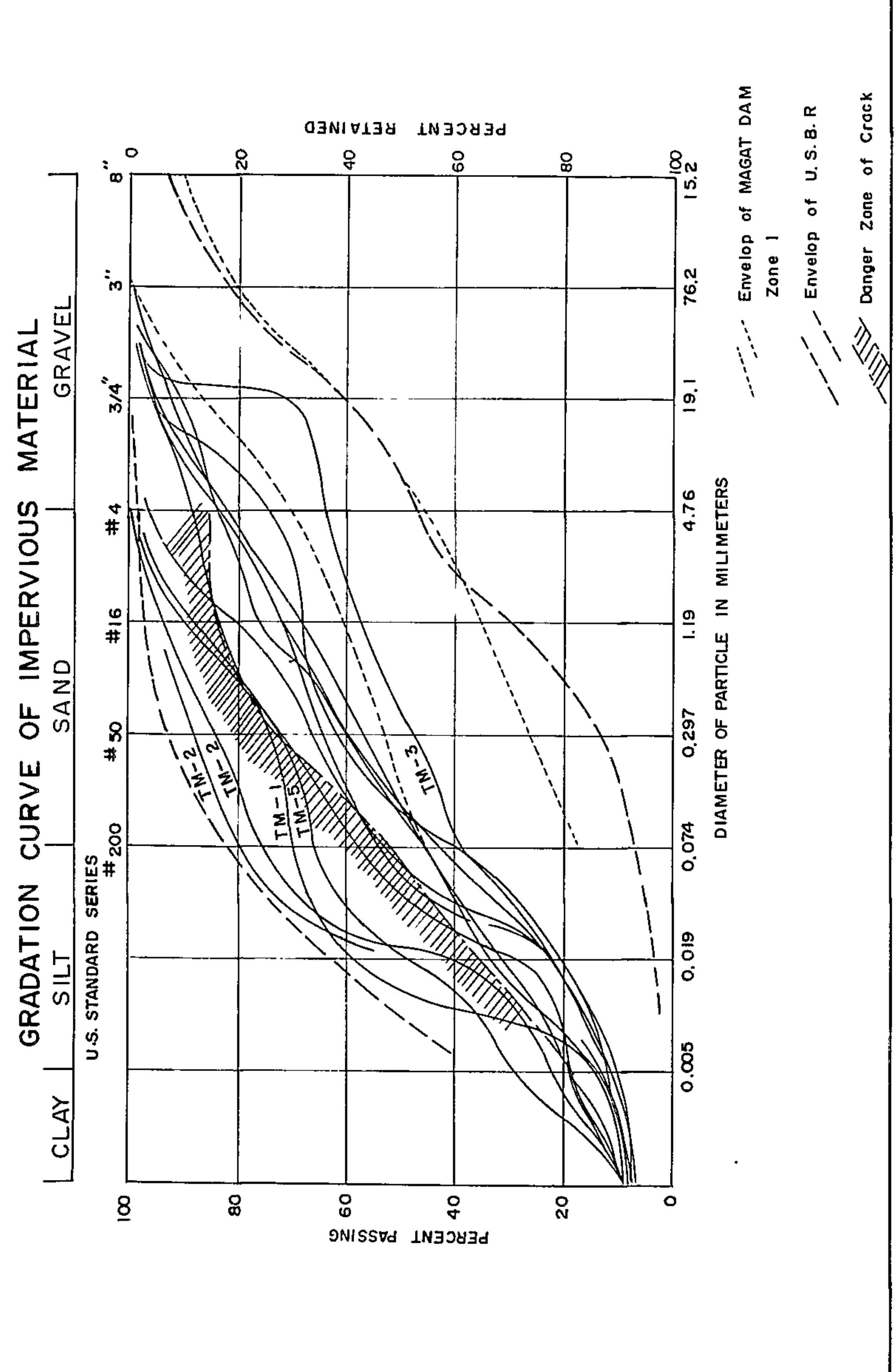
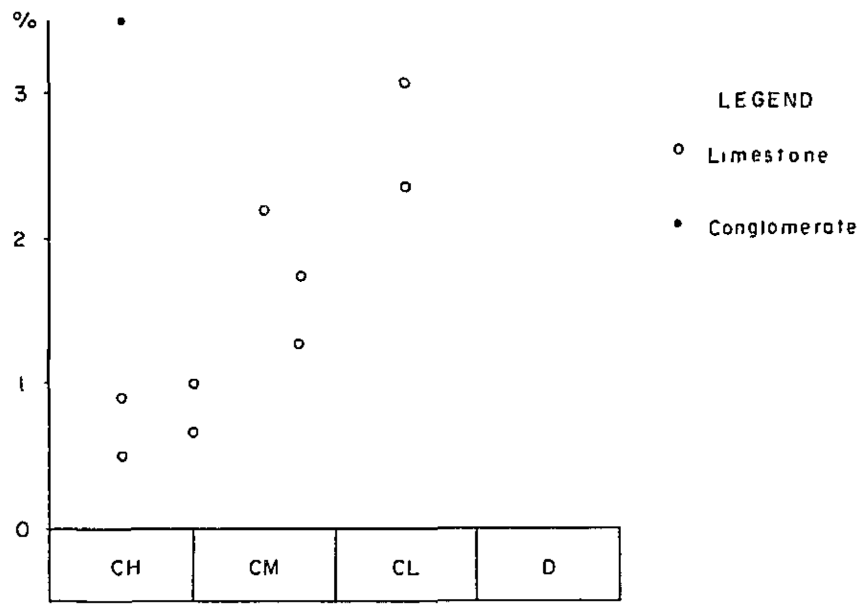

GRADATION CURVE OF IMPERVIOUS MATERIAL
CLAY
SILT
SAND
GRAVEL
U.S. STANDARD SERIES
#200
#50
#16
#4
3/4"
3"
8"
PERCENT PASSING
PERCENT RETAINED
0.005
0.019
0.074
0.297
1.19
4.76
19.1
76.2
15.2
DIAMETER OF PARTICLE IN MILIMETERS
TM-1
TM-2
TM-2
TM-3
TM-5
Envelop of MAGAT DAM Zone 1
Envelop of U.S.B.R
Danger Zone of Crack

FIG. II - 20
FIG II - 21

COEFFICIENT OF WATER ABSORPTION~ROCK CLASSIFICATION



ULTRASONIC VELOCITY~ROCK CLASSIFICATION

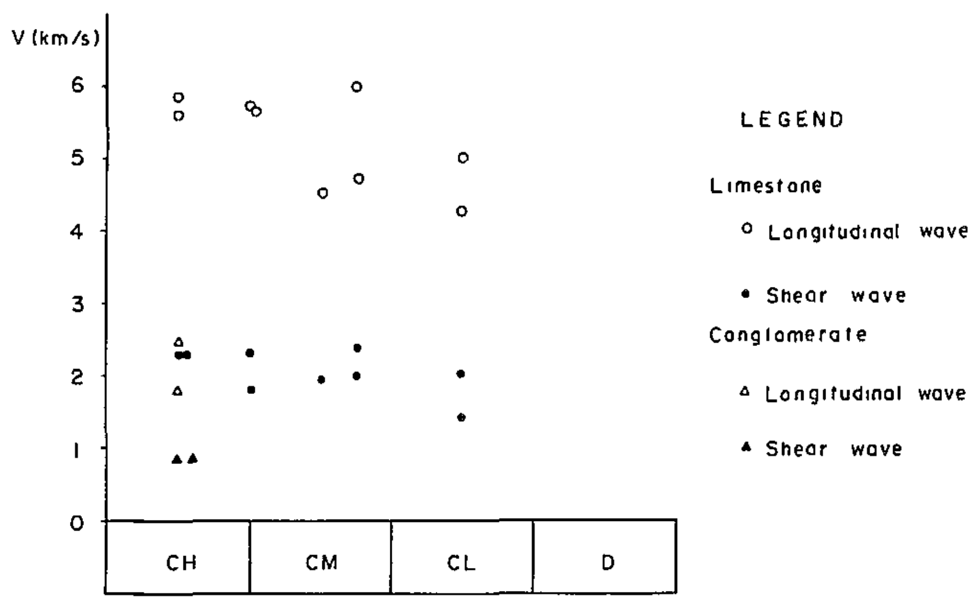
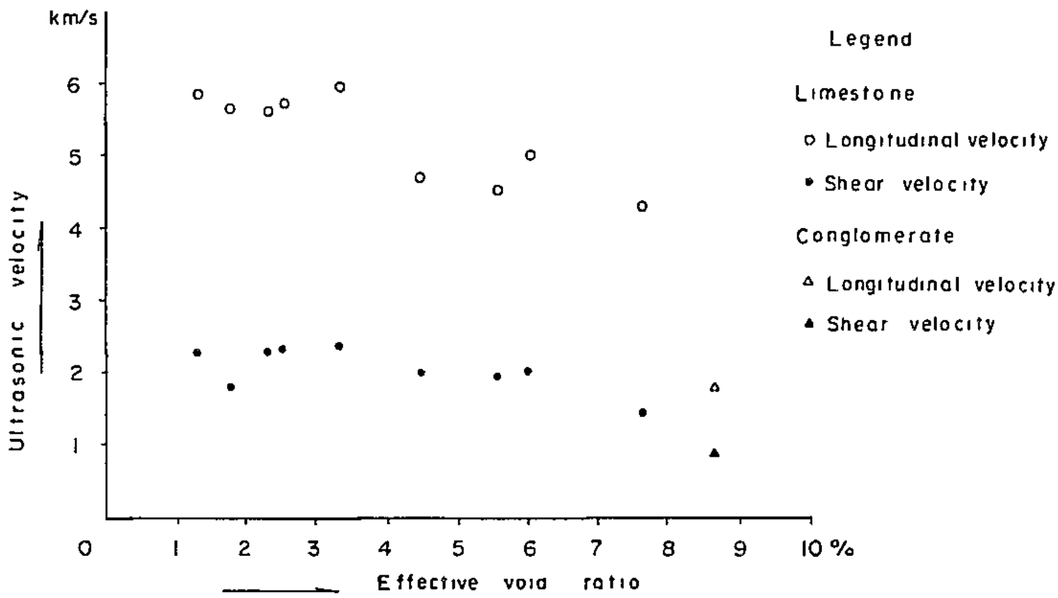


FIG. II - 22
FIG. II - 23

ULTRASONIC VELOCITY ~ EFFECTIVE VOID RATIO



UNCONFINED COMPRESSIVE STRENGTH ~ ROCK CLASSIFICATION

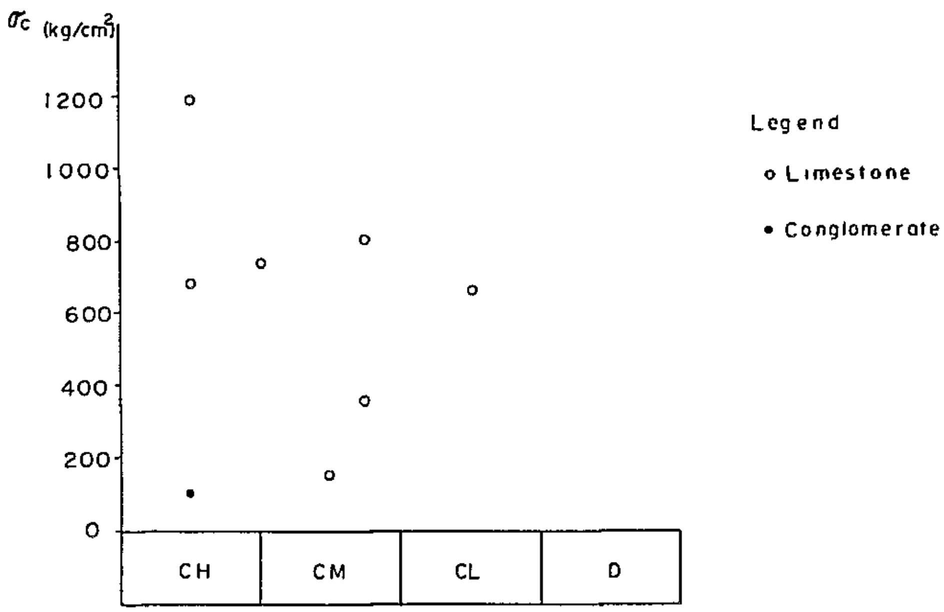
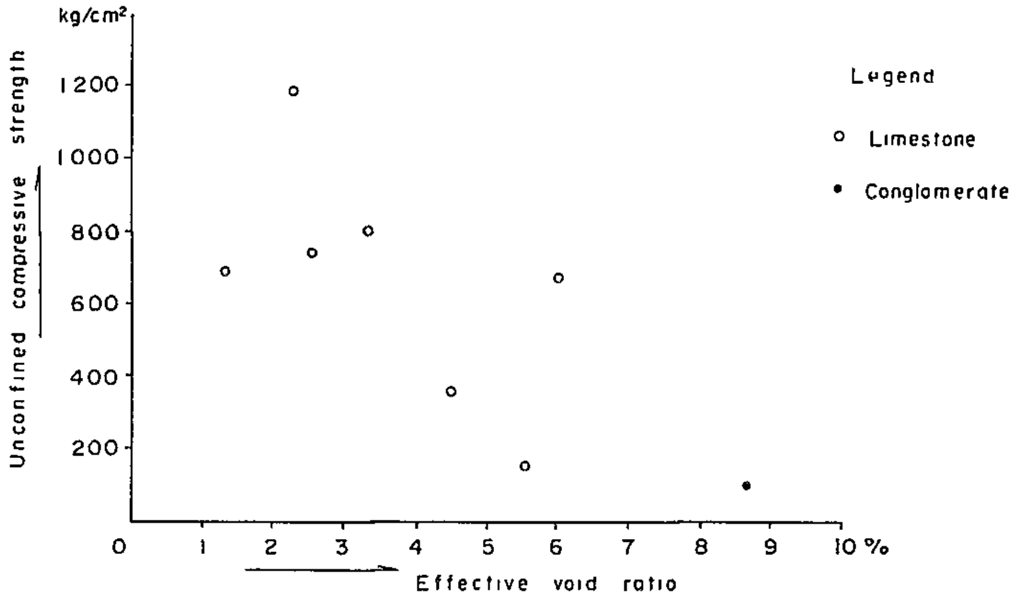
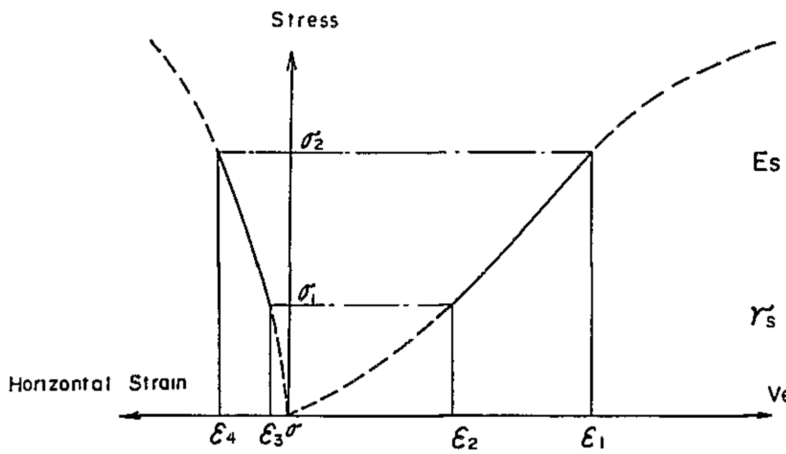


FIG. II - 24
FIG. II - 25

UNCONFINED COMPRESSIVE STRENGTH~EFFECTIVE VOID RATIO



RELATION BETWEEN STRESS AND STRAIN



$$Es = \frac{\sigma_2 - \sigma_1}{\varepsilon_1 - \varepsilon_2} \ (kg/cm^2)$$

$$\gamma_s = \frac{\varepsilon_4 - \varepsilon_3}{\varepsilon_1 - \varepsilon_2}$$

FIG. II - 26

LOCATION MAP OF BORING FOR IRRIGATION SERVICE AREA

SCALE 1 100,000

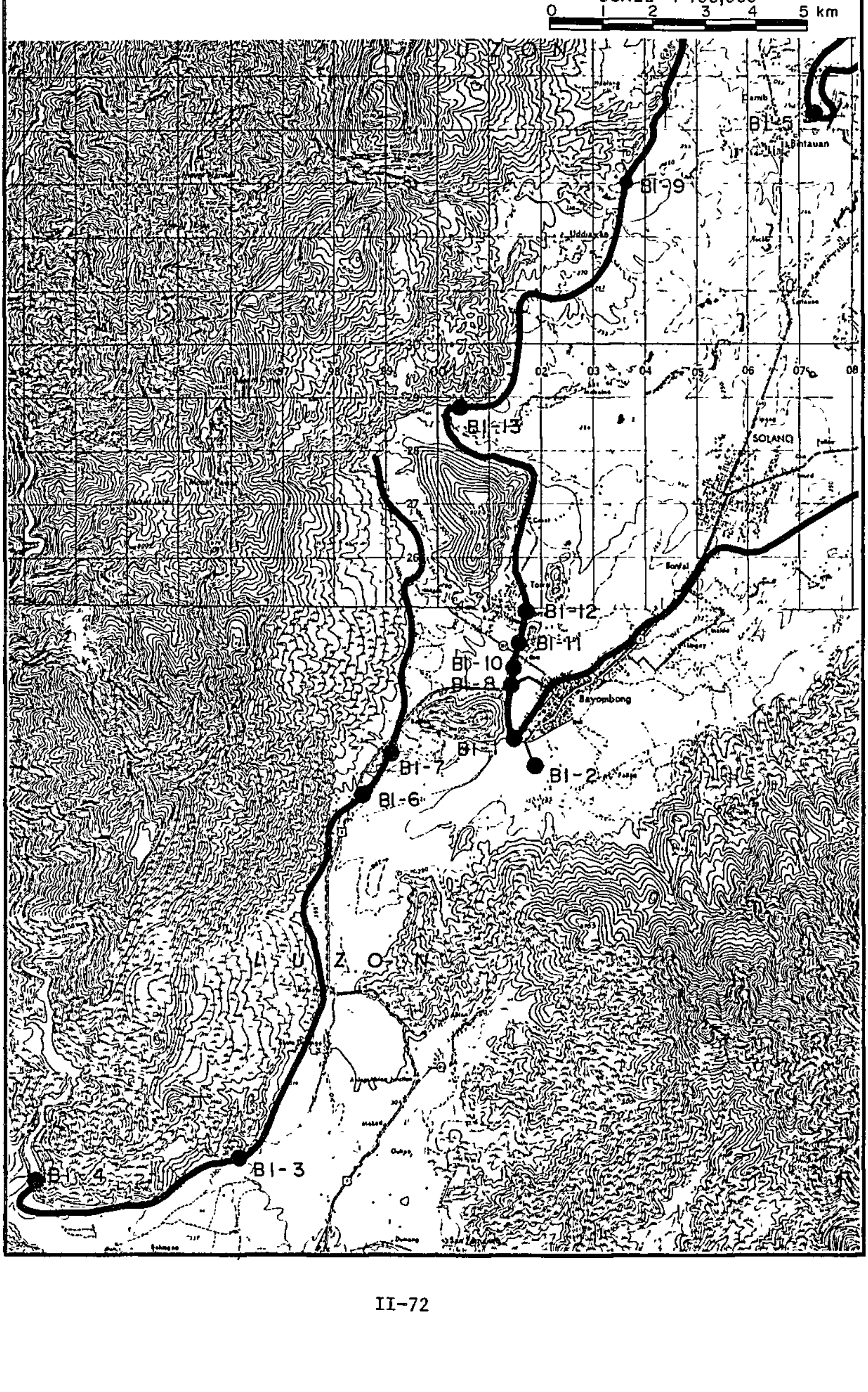
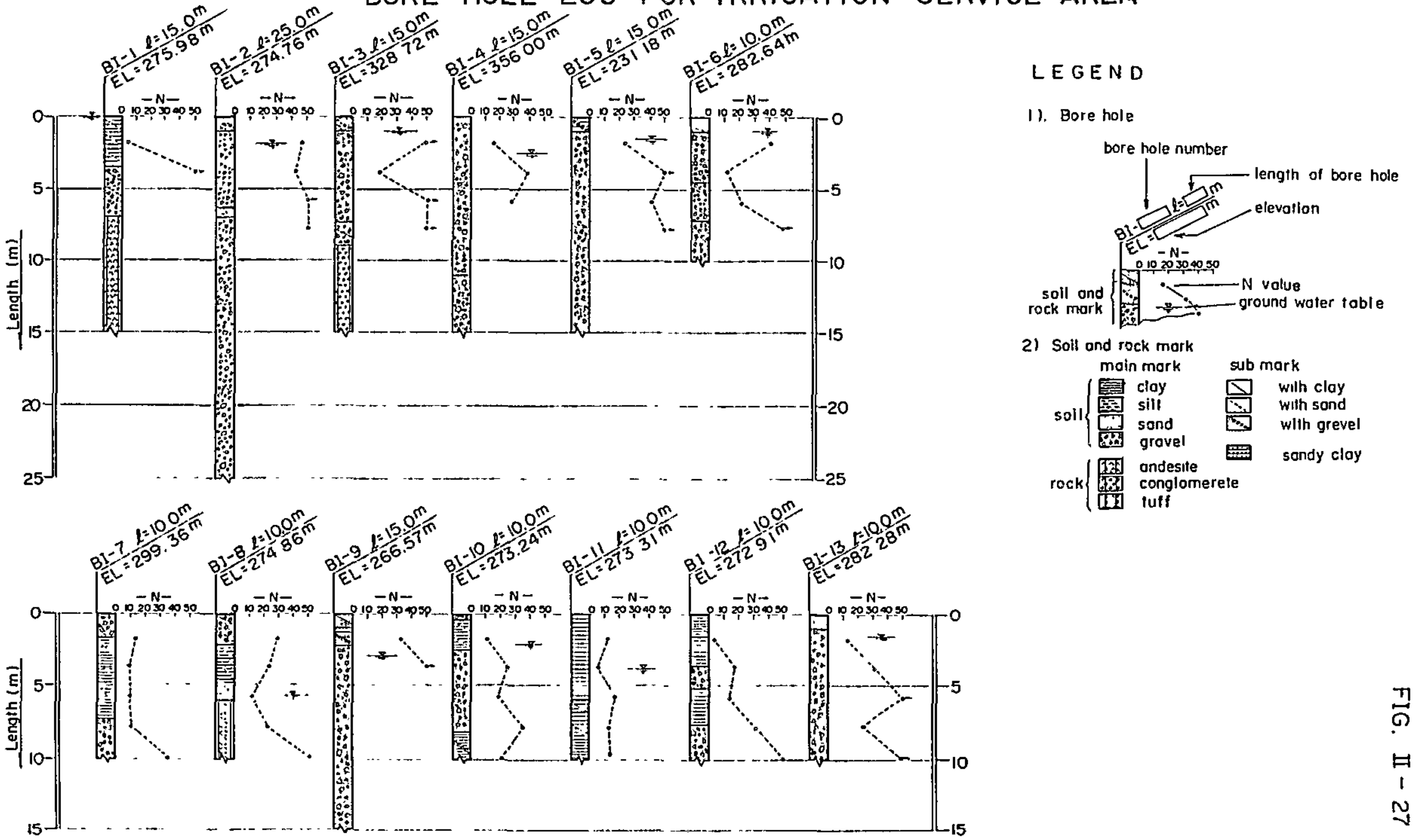


FIG. II - 27

BORE HOLE LOG FOR IRRIGATION SERVICE AREA



CONTOUR LINE OF BEDROCK AT COLOCOL INTAKE

FIG. II-28

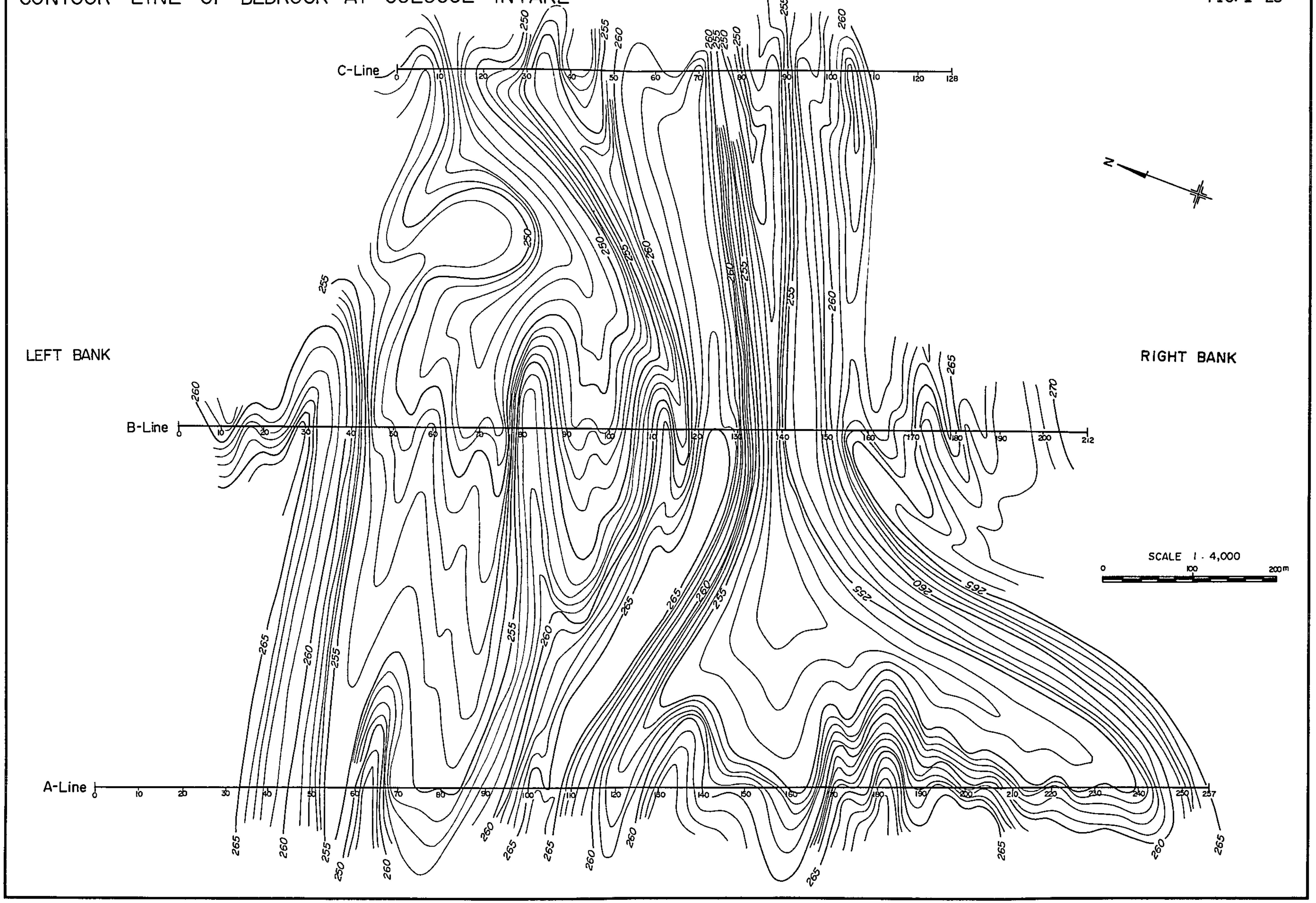
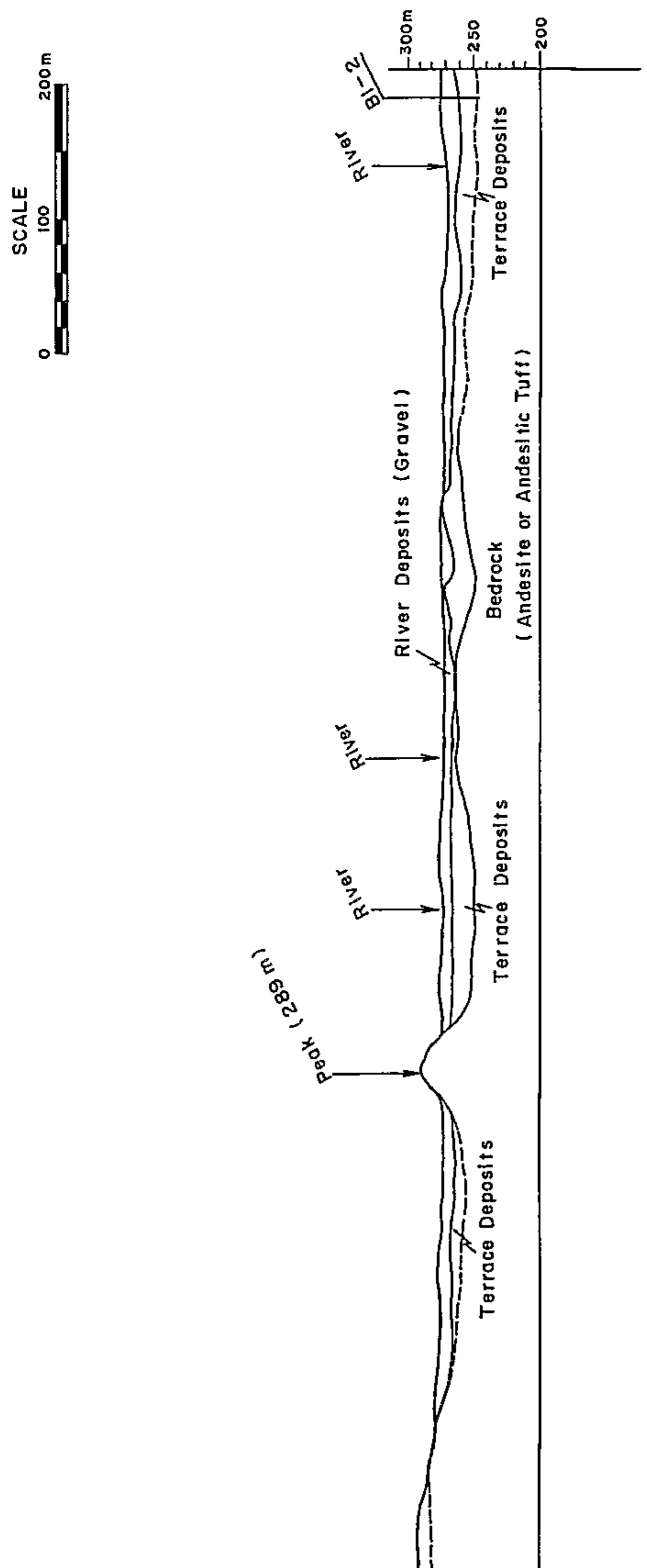


FIG. II - 29

GEOLOGICAL PROFILE AT MAGAT DIVERSION DAM



GEOLOGY ALONG PROPOSED IRRIGATION CANAL

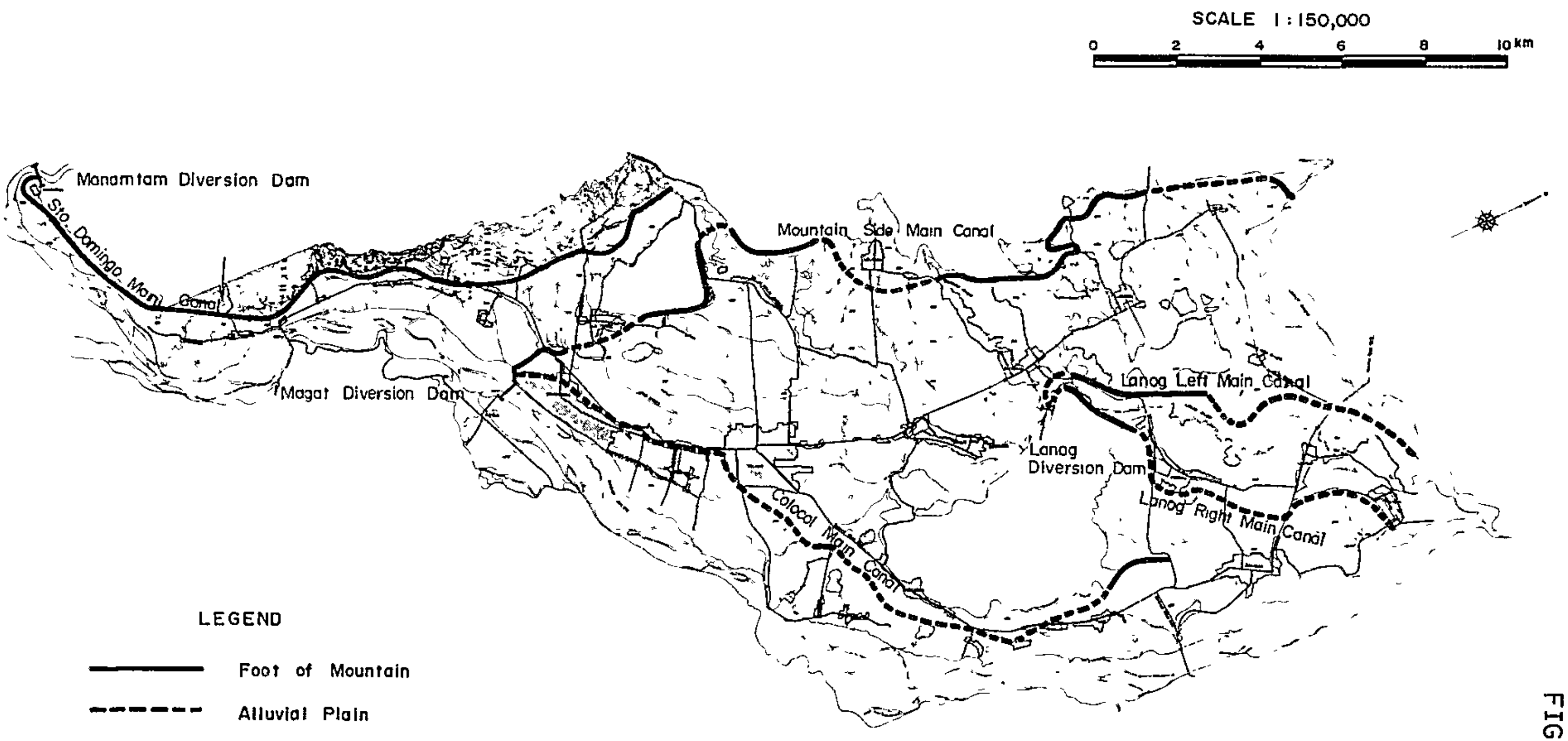


FIG. II-30

APPENDIX I - III

SOIL AND LAND CLASSIFICATION

APPENDIX I-III

SOIL AND LAND CLASSIFICATION

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LIST OF FIGURES

APPENDIX I-III

SOIL AND LAND CLASSIFICATION

1. GENERAL

During the feasibility study period, soil and land use surveys were carried out in the field and additional research was undertaken in the NIA office and in the home office of the Consultant in Japan. Soil analysis was conducted by the Soils and Water Laboratory Services, Research and Development Department, NIA.

The survey was based on data obtained from the following sources:

- Soil Survey of Nueva Vizcaya Province, Bureau of Soil, 1963
- Feasibility Land Classification and Soil Survey of Matuno River Irrigation Project, NIA, 1980
- The Maps of Soil, Land Use and Land Classification (1:50,000), NIA, 1980
- Aerial Photographs (1:10,000), NIA

Based on land use maps and aerial photographs, the present land use status has been checked in the field to up-date and improve the preciseness of the same. According to the results of this survey, the Project area has been re-classified--low area: 5 blocks and hill area: 1 block.

2. PRESENT LAND USE

The total Project area is 20,600ha, and comprises 19,300ha of lowland paddy extending from the left bank of the Magat River, and 1,300ha of upland area at the southwest end.

As shown in TABLE III-1, total arable land in the low land area is 13,040ha (67%); 11,050ha (57%) of paddy field, 1,890ha (10%) of diversified crops including corn and 100ha (0.5%) of orchard. Non-arable land is made up of 4,215ha (22%) of intermittent hilly area, 1,440ha (7%) of residential area and 605ha (4%)of right of way.

Irrigated paddy field is 9,505ha (86%) but, due to the shortage of irrgation water, most of the area is cropped only once a year during the rainy season and irrigated rotationally every other year. Diversified crop fields are predominately planted with non-irrigated low yield corn.

Arable land is divided into six (6) blocks as shown in FIG. III-1. The present level of agricultural development in each block can be interpreted as follows.

Block 1

Water supply in the Bagabag, Sta. Lusia and Pieza areas is severely lacking although the areas partially include paddy fields which utilize surplus water from upstream. The said areas mainly consist of rainfed paddy and corn fields.

Block 2

Although paddy fields in the Bintawan and Villaverde areas are irrigated by creeks from the foot of the mountain, water supply is inadequate resulting in low cropping intensity.

Block 3

Bayombong and Solano are the most advanced irrigated paddy areas and are under the service of the Colocol Communal Irrigation System.

Block 4

This block includes the areas of Manamtam, Sto. Domingo and La Torre. Although at present paddy fields of the former two areas have an adequate irrigation water supply while those of the latter do not, in future these areas may be covered by one unified irrigation system.

Block 5

The banks of the Magat, Lamut and Lanog rivers are suitable for diversified crops.

Block 6

Upland area is comprised of 70ha of paddy field, 110ha of diversified crops, 115ha of orchard and 845ha of natural grass. The majority of the area forms extensive pasture land while the remaining portion is comprised of high slopes, 140ha of gravelly land and 20ha of residential area. Orchards located in Magsaysay produce coconut, citrus and mango.

Present land use of the cultivated area in each of the above mentioned blocks is presented in TABLE III-2, while a present land use map is given in FIG.III-2.

3. SOIL CLASSIFICATION

The project area has 5 soil series, namely, Prenza, Bago, Maligaya, San Manuel and Guimbaloan. This group of soils has very similar profile characteristics such as horizontal thickness, texture, color and mineralogy.

3.1 Soil Series

Soils of the Prenza, Bago and Maligaya series are members of the fine, mixed isohyperthermic family of Aeric Tropaquepts, which consist of alluvial deposits. The topography is nearly flat to flat. The soil is moderately deep to deep and poorly drained. The "A" horizon is mainly grayish brown, dark grayish brown to brown clay loam; "B" horizon is moderately brown to dark brown clay to silty clay with slight iron manganese concretions and gravel; "C" horizon is stratified concretionary clay and clay loam mixed with gravel.

Solum thickness in these areas ranges from a depth of 100-150 cm. The "A" horizon in the first 10-25cm has a Hue value of 10 YR and chromas of 3 or less clay loam, slightly sticky, slightly plastic and friable; "B" horizon is mottled gray and brown clay loam, silty clay loam, clay and silty clay with few to many gravels; "C" horizon colors are similar to "B" but also include reddish gray, while the structure is weak.

The soil reaction is a little acidic with an average value of 6.5; CEC is quite high and the base saturation is also relatively high with an average value of 80% in the first 20cm depth. The organic matter content is high averaging 4%; exchangeable potassium is slightly low but within the adequancy range and the phosphorus level is also considered adequate.

The San Manuel soil series is a member of the fine loamy family, having a moderate depth and well drained soil. It is a recent alluvial deposit along river flows adjacent to upland and mountain areas. "A" horizon is light brownish gray to dark brown clay loam to very fine sandy loam; "B" horizon is very dark grayish brown, grayish brown, brown to strong brown clay, clay loam, sandy clay loam, very fine sandy loam to fine sandy loam. "C" horizon is dark brown to strong brown silty clay to silty clayey loam with gravel. Solum thickness ranges from 100-150cm. The topography is flat to slightly undulating.

The Guimbaloan soil series is a member of the loamy to clayey family, which consists of volcanic tuff or limestone. It is a residual soil with undulating to steep slope topography and good surface drainage.

A detailed physical and chemical characterization of the representative soil series based on analysis of soil samples tabulated in TABLE III-3 are as follows.

Prenza Series

Ap1 - 0-16cm, brown black (10YR 5/3) moist; fine sandy clay loam; no mottles; subangular blocky structure; diffused wavy horizon boundary

Ap2 - 16-37cm, dark brown (10YR 3/3) moist; fine sandy clay loam; few fine distinct clear yellowish brown (10YR 7/6) mottles; subangular blocky structure; diffused wavy horizon boundary

B1 - 37-43cm, dull yellow; fine clay; common fine distinct clear yellowish brown (10YR 5/2) moist; brown (10YR 5/8) mottles; angular blocky structure; diffused smooth horizon boundary

B2 - 43-66cm, grayish yellow brown (10YR 5/2) moist; coarse sandy clay loam; common fine distinct clear yellowish brown (10YR 5/8) mottles; angular blocky structures; diffused smooth horizon boundary

B3 - 66-85cm, dull yellowish brown (10YR 4/3), moist; sandy clay loam; common medium distinct clear dark yellowish brown (10YR 3/6) mottles; angular blocky structure; diffused irregular horizon boundary

C - 85-150cm, dark brown (10YR 3/4) moist; fine sandy clay; angular blocky structure.

Bago Series

Ap1 - 0-23cm, gray (10YR 5/1) moist; clay loam, common fine distinct clear strong brown (7.5YR 5/6) mottles; moderately weak subangular structure; clear smooth horizon boundary

B1 - 23-55cm, dark gray (10YR 4/1) moist; sandy clay loam; no mottles; moderately strong medium angular blocky structure; diffused wave horizon boundary

B2 - 55-117cm, grayish brown (10YR 5/2) moist; sandy clay loam; common fine distinct clear yellowish brown (10YR 5/6) mottles; moderately strong medium angular blocky structure

Maligaya Series

Ap1 - 0-12cm, gray (N 4/0) moist; clay loam; few fine distinct clear strong bright brown (7.5YR 5/6) mottles; weak subangular blocky structure; no concretions; abrupt wavy horizon boundary

Ap2 - 12-31cm, brownish black (10YR 3/1) moist; clay; no mottles; weak subangular blocky structure; diffused wavy horizon boundary

B1 - 31-49cm, brownish black (10YR 3/1) moist; clay; no mottles; angular blocky structure; diffused irregular horizon

B2 - 49-65cm, dark gray (N 3/0) moist; clay; no mottles; weak subangular blocky structure; diffused smooth horizon boundary

B3 - 65-101cm, grayish yellow brown (10YR 5/2) moist; clay; no mottles; weak subangular blocky structure; diffused smooth horizon boundary

C - 101-150cm, grayish yellow brown (10YR 4/2)moist; clay no mottles; weak granular structure

<u>San Manuel Series</u>

Ap - 0-20cm, grayish yellow brown (10YR 5/2) moist; sandy clay loam; common fine distinct clear bright brown (7.5YR 5/6) mottles; moderately weak angular to subangular blocky structure; smooth clear horizon boundary

B1 - 20-49cm, grayish yellow brown (10YR5/2) moist; clay loam; few fine distinct clear strong bright brown (7.5YR 5/8) mottles; moderately strong angular to subangular blocky structure; gradual smooth horizon boundary

B2 - 49-75cm, dull reddish brown (10YR 4/3) moist; fine sandy clay loam; few fine faint diffused strong bright brown (7.5YR 5/6) mottles; moderately weak subangular blocky structure; gradual smooth horizon boundary

B3 - 75-100cm, brown black (10YR 3/2)moist; sandy clay loam; few fine faint diffused brown (10YR 5/3) mottles; moderately weak and subangular blocky breaking into granular structure

C - below 100cm, gravel and stones

Guimbaloan Series

A1 - 0-29cm, brownish black (10YR 2/2)moist; silty loam; common fine distinct clear gray (10YR 5/1) mottles; good medium granular structure; diffused wavy horizon boundary

A2 - 29-58cm, brown black (10YR 3/1) moist; clay; few fine distinct clear bright reddish brown (5YR 5/8) mottles; poor granular structure; diffused smooth horizon boundary

B1 - 58-80cm, grayish yellow brown (10YR 5/2) moist; clay; few fine distinct clear bright brown (5YR 5/8) mottles; angular blocky structure; diffused smooth horizon boundary

B2 - 80-100cm, yellowish gray (2,5YR 4/1) moist; clay; common medium distinct clear orange (7.5YR 6/6) mottles; angular blocky structure

3.2 Soil Type

The above mentioned five soil series found in the Project area are further classified into seven soil types as follows:

i) Prenza Series
- Prenza clay loam

ii) Bago Series
- Bago sandy clay loam

iii) Maligaya Series
- Maligaya clay loam

iv) San Manuel Series
- San Manuel silty loam
- San Manuel sandy loam

v) Guimbaloan Series
- Guimbaloan clay loam
- Guimbaloan gravelly clay loam

The soil map based on the above soil series is shown in FIG. III-3, and the area of each soil series is tabulated in TABLE III-4.

3.3 Chemical Conditions

As shown in TABLE III-3 the soils in the Project area are a little acidic, with the pH averages ranging from 5.2-7.8. On the average, the calcation exchange capacity (CEC) of the soils is relatively high. The average base saturation is high giving the soils a high productivity rate. The average organic matter content of the soil is also quite high.

On the whole, the average phosphorous content of the soils is moderately adequate. The potassium content of soils on the average is below adequacy level but above marginal level. The micro-nutrient (copper, iron, manganese and zinc) status of the soil adequately meets the requirements of rice cultivation. Overall, the soils in the Project area have a high productive potential for rice production.

4. LAND CLASSIFICATION

FIG. III-4 depicts the special distribution of land classes based on suitability for irrigated rice and diversified crops, while the area of each land class is tabulated in TABLE III-5.

The Project area was first grouped into two land classes: arable land and nonarable land. Arable land was further subclassed into rice, dual class, and diversified crop lands. The chief criteria applied for land suitablity classification were physical soil characteristics, physiographic position, flood hazards, potential crop productivity, drainage characteristics and future cost of development. Whether the land is best suited for rice or for diversified crops (upland crops) was judged primarily by the drainage characteristics of the soil.

Land categorized as rice land was further divided into subclasses based on such physical factors as soil depth, slope, fertility status and flood hazards. Lands considered highly suitable for irrigated rice with slight or no deficiencies of the above mentioned factors were classified as 1R; those with moderate physical limitations, considered moderately suitable for irrigated rice were classed as 2R; and those with severe but rectifiable deficiencies and thus considered as having limited suitability for irrigated rice were designated as 3R.

In the same manner, 1R (2), 2R (2) lands are categorized as highly or moderately suitable for irrigated rice and moderately suitable for irrigated diversified crops due to possible poor drainage or flooding. In these areas, however, high productivity is possible with appropriate countermeasures. Irrigated diversified crop lands with a slight flood hazard were classed as 2; and irrigated diversified crop lands with flood problems and coarse textures were classed as 3.

Those lands which do not categorically belong to the above mentioned types were classed 4Or, 4P and 4F, for orchard, pasture and dendro forest, respectively. Non-arable lands were categorized into class 6, including rivers, creeks and hilly areas and class M consisting of residential and built-up areas in addition to right of way.

5. PROPOSED LAND USE PLAN

Tha land use plan of the Project area was made by categorizing the lowland area into 5 blocks and the upland area into 1 block with due consideration of soil types, land classes and irrigation development plan as shown in FIG. III-1. The content of this block-wised land utilization plan is given below. Based on the plan, the proposed land use map has been prepared as shown in FIG. III-5.

Block 1

Most of the area is suited for paddy cultivation, but there are some corn lands which are highly productivive. Therefore, about 14% of the block's land area has been planned as rotation area with wet paddy and dry corn crops, while the remaining area is designated for double paddy and partial mung bean cultivation.

Block 2

In accordance with the irrigation development plan of the western hillside, the land use plan envisions upgrading of the current low paddy crop intensity and consequent improvement of productivity.

Block 3

Almost all of the area is currently under the command of Colocol CIS, and thus has an adequate supply of irrigation water. Farmers in this area are achieving comparatively high levels of agricultural production. This block can be considered as the production center of paddy from a view point of land utilization, and also as a center of post harvest operation.

Block 4

Block 4 is currently divided into 2 different areas, namely, Manamtan and Sto. Domingo, both high in crop production and intensity, and La Torre with low crop yield and intensity. In the land utilization plan, rehabilitation and implementation of irrigation systems and also strengthening of agricultural support systems has been planned throughout the area to increase agricultural production.

Block 5

Block 5 is located in various places along the left bank of the Magat River, the right bank of the Lamut River, and both right and left banks of the Lanog River. Most of the land belongs to land classes 1R (2), 2 and 3. However, the eastern portion of National Highway No.5 which joins Bayombong to Solano presently utilizes surplus water from Colocol CIS for paddy cultivation. This area is about 330 ha. The remaining area is scattered and planned as an upland crop development area to be planted with such crops as corn, vegetables and peanuts and provided with upland irrigation facilities.

With the implementation of irrigation facilities in the entire lowland area, the present right of way hectarage of 770ha will increase to an estimated 1,030ha.

Block 6

In planning land utilization of the Project's upland area, there were various factors to be considered such as socio-economic conditions, adjustment to regional development plans, etc. The utilization plan has also been studied in consideration of the versatility of natural conditions.

In the upland area, 1,300ha (90%) of land is non-cultivated, either used extensively for grazing or left fallow. With consideration of land conservation and watershed cultivation including the development of domestic water resources, about 100ha of this land is suited for dendro-forest development. About 500ha are covered by gently undulating slopes suitable for grazing cows and carabaos. Upon Project completion lowland open fields in the Project area will be minimized due to the expansion of high intensity cropping. Therefore, it is necessary to ensure provision of adequate grazing land, preferably by improvement of pastures in the hilly areas scattered throughout the Project as well as on the western hillside.

About 500ha of upland, including the existing orchards, are not suited for pasture due to undulation and inclination. This area could be considered for tree-farming development, such as mango, coffee, citrus fruit and cashew. The tree-farming development plan will aid efficiency of watershed and land conservation. Moreover, this plan may support farmers' income and expansion of employment opportunity to employ the expected labor surplus.

The proposed areas for different land classes under the Project are tabulated in TABLE III-6, while the proposed block-wise area for each land class is tabulated in TABLE III-7. In addition, the proposed land use plan for different crops is tablulated in TABLE III-8.

TABLE III-1

PRESENT LAND USE

Unit: ha

Land Use	Lowland Area	Upland Area	Total
Cultivated			
Paddy	11,050	70	11,120
(irrigated)	(9,505)	(30)	(9,535)
(rainfed)	(1,545)	(40)	(1,585)
Corn 1/	1,890	110	2,000
Orchard	100	115	215
Sub-Total	13,040	295	13,335
Pasture (natural)	-	845	845
Non-arable land			
Class 6	4,215	140	4,355
Residential area	1,440	20	1,460
Right of way	605	-	605
Sub-Total	6,260	160	6,420
Total	19,300	1,300	20,600

1/ Includes some vegetables and root crops

TABLE III-2

PRESENT BLOCK-WISE LAND USE OF CULTIVATED AREA

Land Use	Block 1	Block 2	Block 3	Block 4	Block 5	Sub-total	Block 6	Total
Paddy rice								
Pr 1/	1,320	110	10	105	-	1,545	40	1,585
Pr I (1) 2/	730	1,330	-	-	-	2,060	-	2,060
Pr I (A) 3/	360	1,990	-	380	-	2,750	30	2,780
Pr I (2) 4/	765	-	3,020	580	330	4,695	-	4,695
Sub-total	4,925	3,430	3,030	1,065	330	11,050	70	11,120
Diversified crops								
rainfed 5/	215	130	-	35	1,510	1,890	110	2,000
Orchard	20	20	10	-	50	100	115	215
Total	3,430	3,580	3,040	1,100	1,800	13,040	295	13,335

Note: Block 1 - 5 are low land area, Block 6 is upland area

1/ rainfed paddy with cropping intensity of 70 - 100%
2/ irrigated paddy with cropping intensity of Below 100%
3/ -do- with cropping intensity of 100 - 150%
4/ -do- with cropping intensity of 150 - 200%
5/ wet corn single crop cultivated 80%
" " fallow 20%

ANALYSIS OF SOIL SAMPLES

Soil Series	Site No.	Depth cm	Sand %	Silt %	Clay %	Text. Class	Moisture Tensions % Tension in bars 1/10	1/3	3	10	RAM %	pH (1:1)	EC mmho /cm	Avail. P_2O_5 ppm	Org. Carbon %	Org. Matter %	Ex. Cations me/100g Ca	Mg	K	Na	CEC me /100g
SAN MANUEL	5	0- 20	35	45	20	L	43.1	33.1	19.9	12.7	14.7	7.2	0.62	8.2	2.35	4.04	27.30	2.82	0.29	0.58	34.29
		20- 49	32	44	24	L	41.8	34.0	20.3	14.4	16.3	7.5	0.19	5.7	1.01	1.74	34.53	3.65	0.31	0.63	36.53
		49- 75	36	43	21	L	38.7	39.8	18.4	12.2	12.7	7.1	0.07				25.67	3.00	0.30	0.55	34.47
		75-100	38	34	28	CL	38.4	30.1	20.2	15.2	10.9	7.0	0.08				29.46	5.66	0.47	0.50	39.31
GUIMBALAON	8	0- 16	30	23	47	C		37.3		18.2		4.9	0.12	3.6	3.6	5.78	31.05	7.00	0.75	0.50	
		16- 42	22	15	63	C		39.9		18.2		5.2	0.05	4.6	2.1	3.60	38.00	4.36	0.24	0.51	
		42- 68	24	16	60	C		38.5		18.1		5.2	0.08				42.00	9.94	0.13	0.66	
		68- 80	23	22	55	C		35.8		17.4		5.7	0.19				48.32	9.78	0.19	0.65	
		80-100	41	30	29	CL		30.2		14.3		5.7	0.05				46.13	9.19	0.16	0.62	
GUIMBALAON	26	0- 26	23	32	45	C		38.5		18.8		7.6	0.38	5.8	3.03	5.21	77.44	0.59	0.23	0.17	
		26- 43	34	26	40	CL		35.1		15.6		7.9	0.25	4.6	1.27	2.13	65.26	0.84	0.17	0.15	
		43- 60	38	22	40	CL		34.6		15.6		8.0	0.25				61.65	0.68	0.17	0.12	
		60- 78	35	19	46	C		37.7		18.5		7.8	0.19				67.57	1.30	0.25	0.14	
		78-100	40	21	39	Cl		31.0		14.8		7.8	0.19				63.98	0.46	0.20	0.18	
PRENZA	38	0- 16	51	29	20	L	28.2	22.7	14.6	9.9	9.9	5.1	0.10	1.1	1.43	2.46	9.41	2.73	0.22	0.12	14.79
		16- 37	42	24	34	CL	35.6	26.2	20.1	15.5	9.0	5.4	0.05	1.1	1.05	1.81	14.03	3.47	0.44	0.13	23.98
		37- 43	39	24	37	CL	38.9	30.2	20.5	17.0	10.1	5.7	0.03				14.09	5.51	0.26	0.19	26.23
		43- 66	48	20	32	SCL	39.4	30.0	20.5	16.7	9.7	5.8	0.05				17.56	4.16	0.46	0.36	30.06
		66- 85	52	18	30	SCL	38.5	29.1	21.0	16.2	8.3	6.3	0.03				17.01	4.10	0.33	0.33	31.25
		85-150	52	18	30	SCL	37.0	29.0	19.7	15.8	10.2	6.2	0.03				19.51	6.83	0.39	0.37	31.38
PRENZA	47	0- 20	43	31	26	L	37.0	31.0	19.0	12.8	15.6	6.9	0.20	6.8	2.04	3.51	15.96	2.01	1.29	0.23	23.17
		20- 50	30	30	40	C	43.3	32.5	22.4	17.8	10.0	6.9	0.09		1.26	2.17	21.47	4.93	1.04	0.30	31.46
		50-100	27	30	43	C	45.7	38.3	28.6	20.5	12.1	6.8	0.08				23.49	31.13			38.62
		100-210	34	34	32	CL	42.5	34.2	22.7	16.6	13.2	6.8	0.07				21.16	28.09			32.69
MALIGAYA	62	0- 11	32	32	36	CL	40.6	32.0	20.6	15.7	12.6	5.9	0.41	1.1	2.62	4.51					45.86
		11- 33	28	24	48	C	40.6	35.8	25.8	20.0	11.8	6.7	0.13	0.9	1.58	2.72	21.68	3.26	0.51	0.44	30.04
		33- 62	68	13	19	SL	24.5	19.5	15.6	12.1	4.7	6.8	0.09				13.89	3.97	0.15	0.41	23.16
		62-120	67	15	18	SL	22.8	19.7	14.8	10.8	6.5	7.0	0.07				13.56	4.73	0.15	0.40	26.66
MALIGAYA	114	0- 12	33	28	39	CL	42.7	28.9	23.3	19.6	5.1	5.6	0.55	3.0	2.56	4.51	29.59	3.51	0.31	0.46	38.56
		12- 31	28	29	43	C	42.0	34.1	24.4	20.6	10.7	6.9	0.31	22.1	1.82	3.13	36.70	2.59		0.49	45.84
		31- 49	27	29	44	C	44.2	38.3	27.0	21.5	14.8	6.9	0.19				36.10	3.24	0.80	0.56	47.12
		49- 65	24	30	46	C	47.1	38.1	26.5	17.3	14.2	6.8	0.16				37.25	3.37	1.20	0.56	48.32
		65-101	23	31	46	C	51.2	43.3	29.4	22.8	16.7	6.9	0.12				36.84	2.96	0.93	0.48	48.68
		101-150	22	31	47	C	49.6	40.1	30.7	22.7	10.6	6.8	0.08				34.77	4.30	0.69	0.47	46.06

ANALYSIS OF SOIL SAMPLES

Soil Series	Site No.	Depth cm	Sand %	Silt %	Clay %	Text. Class	Moisture Tensions % Tension in bars 1/10	1/3	3	10	RAM %	pH (1:1)	EC mmho /cm	Avail. P_2O_5 ppm	Org. Carbon %	Org. Matter %	Ex. Cations me/100g Ca	Mg	K	Na	CEC me /100g
MALIGAYA	119	0- 9	35	50	15	SiL		26.3		12.4		7.8	0.84	4.6	1.80	3.09	60.13	4.90	0.30	1.36	
		9- 29	21	48	31	CL		30.5		14.6		7.8	0.60	4.6	1.61	2.78	47.29	6.83	0.35	0.88	
		29- 58	18	36	46	C		38.7		18.8		7.5	0.52				43.91	8.03	0.31	0.95	
		58- 80	18	28	54	C		37.6		18.3		7.5	0.64				43.82	8.00	0.43	1.01	
		80-103	19	21	60	C		39.1		18.6		7.4	0.56				68.26	9.04	0.34	1.02	
BAGO	169	0- 23	44	28	28	CL	32.9	26.3	15.1	9.2	14.0	4.7	0.11	2.1	1.45	2.49	4.81	2.22	1.32	4.81	11.46
		23- 55	48	22	30	SCL	26.9	21.6	15.3	12.9	7.7	5.6	0.04	1.4	1.08	1.86	6.57	5.09	0.23	6.57	13.43
		55-117	47	19	34	SCL	32.9	26.6	17.5	13.0	10.9	6.5	0.03				9.79	4.74	0.41	9.79	17.49
		117-150	59	15	26	SCL	30.4	23.6	16.9	13.2	7.6	6.5	0.04				8.22	6.69	0.42	8.22	15.40
SAN MANUEL	181	0- 16	35	54	11	SiCL	38.7	21.1	13.4	8.2	6.4	7.3	0.33	3.0	1.30	2.24	31.53	0.77	0.37	0.35	25.65
		16- 28	35	53	12	SiL	39.6	20.7	14.0	8.1	5.5	7.4	0.24	1.8	1.16	2.00	32.07	0.59	0.26	0.41	24.37
		28- 45	64	23	8	SL	18.2	10.5	6.8	5.1	4.2	7.3	0.24				18.59	2.70	0.26	0.25	16.55
		45- 89	97	1	2	S	2.1	1.8	1.5	1.0	0.7	6.9	0.04				5.52	0.88	0.12	0.11	5.88
		89-102	30	51	19	SiL	35.3	29.1	18.7	11.5	13.6	7.2	0.09				22.59	2.38	0.33	0.45	31.08
		102-113	44	38	18	L	30.4	24.2	15.4	9.5	10.8	7.1	0.08				21.05	1.67	0.21	0.39	26.35
		113-138	82	13	5	LS	9.6	7.5	5.3	4.3	3.3	7.0	0.08				13.09	0.68	0.15	0.26	14.61
		138-150	95	2	3	S	2.1	1.9	1.8	1.6	0.6	6.8	0.03				6.04	1.85	0.09	0.18	15.02
BAGO	210	0- 18	47	29	24	L	28.7	23.0	13.0	10.2	9.7	5.9	0.10	16.1	1.44	2.48	8.56	2.34	1.12	0.24	14.61
		18- 40	42	27	31	CL	29.1	22.3	16.0	12.4	6.9	5.8	0.09	14.2	1.10	1.89	10.77	0.70	0.63	0.24	16.67
		40- 68	40	26	34	CL	31.8	25.0	19.8	16.1	5.8	6.0	0.05				12.07	2.31	0.51	0.14	21.33
		68-114	40	27	33	CL	35.6	28.0	20.1	16.9	8.7	6.2	0.04				11.68	5.38	0.92	0.12	23.91
		114-150	53	21	26	SCL	31.0	24.6	15.2	10.0	11.3	6.4	0.04				11.73	4.01	0.67	0.13	19.26

TABLE III-4

SOIL TYPES AND AREA

A. Lowland Area	Area (ha)	Percentage
1. Prenza clay loam	3,060	16
2. Bago sandy clay loam	2,920	15
3. Maligaya clay loam	5,115	27
4. San Manuel silty loam	1,600	8
5. San Manuel sandy loam	950	5
6. Guimbalaon clay loam	-	-
7. Guimbalaon gravelly clay loam	4,215	22
8. Miscellaneous land 1/	1,440	8
Total	19,300	100

B. Upland Area	Area (ha)	Percentage
6. Guimbalaon clay loam	650	50
7. Guimbalaon gravelly clay loam	630	48
8. Miscellaneous land 1/	20	2
Total	1,300	100

1/ Residential and Built-up Area

TABLE III-5

PRESENT LAND CLASSES

Unit: ha

Land Class	Lowland Area	Upland Area	Total
Arable	13,040	1,140	14,180
1R	9,625	-	9,625
2R	895	-	895
3R	-	30	30
Sub-total	10,520	30	30
1R (2)	1,360	40	1,400
2R (2)	135	-	135
Sub-total	1,495	40	1,535
2	795	-	795
3	130	110	240
Sub-total	925	110	1,035
4 Or	100	115	215
4 P	-	845	845
4 F	-	-	-
Non-arable	6,260	160	6,420
Class 6	4,215	140	4,355
M-land	1,440	20	1,460
Right of way	605	-	605
Total	19,300	1,300	20,600

PROPOSED AREA FOR LAND CLASSES

Unit: ha

Land Class	Lowland Area	Upland Area	Total
Arable	12,780	1,280	14,060
1R	9,510	-	9,510
2R	860	-	860
3R	-	30	30
Sub-total	10,370 1/	30	10,400
1R (2)	1,320	40	1,360
2R (2)	130	-	130
Sub-total	1,450 1/	40	1,490
2	740	-	740
3	120	110	230
Sub-total	860 1/	110	970
4 Or	100	500 2/	600
4 P	-	500 3/	500
4 F	-	100 3/	100
Non-arable	6,520	20	6,540
Class 6	4,110	-	4,110
M-land	1,440	20	1,460
Right of ways	970	-	970
Total	19,300	1,300	20,600

Note:

1/ Total 12,680ha included in the proposed Project area for lowland development

2/ 400ha included in the proposed Project area for hill area development

3/ 600ha included in the proposed Project area for hill area development

TABLE III-7

PROPOSED BLOCK-WISE LAND CLASSIFICATION OF ARABLE LAND

Land class	Block 1	Block 2	Block 3	Block 4	Block 5	Sub-total	Block 6	Total
1R	3,030	3,005	3,030	445	-	9,510	-	9,510
2R	260	535	-	65	-	860	-	860
3R	-	-	-	-	-	-	30	30
1R (2)	-	-	-	470	850	1,320	40	1,360
2R (2)	-	-	-	110	20	130	-	130
2	-	-	-	-	740	740	-	740
3	-	-	-	-	120	120	110	230
4 Or	20	20	10	-	50	100	500	600
4 P	-	-	-	-	-	-	500	500
4F	-	-	-	-	-	-	100	100
Total	3,310	3,560	3,040	1,090	1,780	12,780	1,280	14,060

TABLE III-8

PROPOSED LAND USE

Unit: ha

Land Use	Lowland Area	Upland Area	Total
Cultivated Land			
Paddy			
(irrigated)	10,830 1/	30	10,860
(rainfed)	-	40	40
(upland dry farming)	-	110	110
Paddy - Corn	450 1/	-	450
Corn - Peanut	1,000 1/	-	1,000
Corn - Vegetable	400 1/	-	400
Orchard	100	500 2/	600
Pasture	-	500 3/	500
Tree-farming	-	100 3/	100
Sub-total	12,780	1,280	14,060
Non-arable Land			
Class 6	4,110		4,110
Residential area	1,440	20	1,460
Right of way	970		970
Sub-total	6,520	20	6,540
Total	19,300	1,300	20,600

Note:

1/ Total 12,680ha included in the proposed Project area for lowland development

2/ 400ha included in the proposed Project area for hill area development

3/ 600ha included in the proposed Project area for hill area development

LAND USE BLOCK

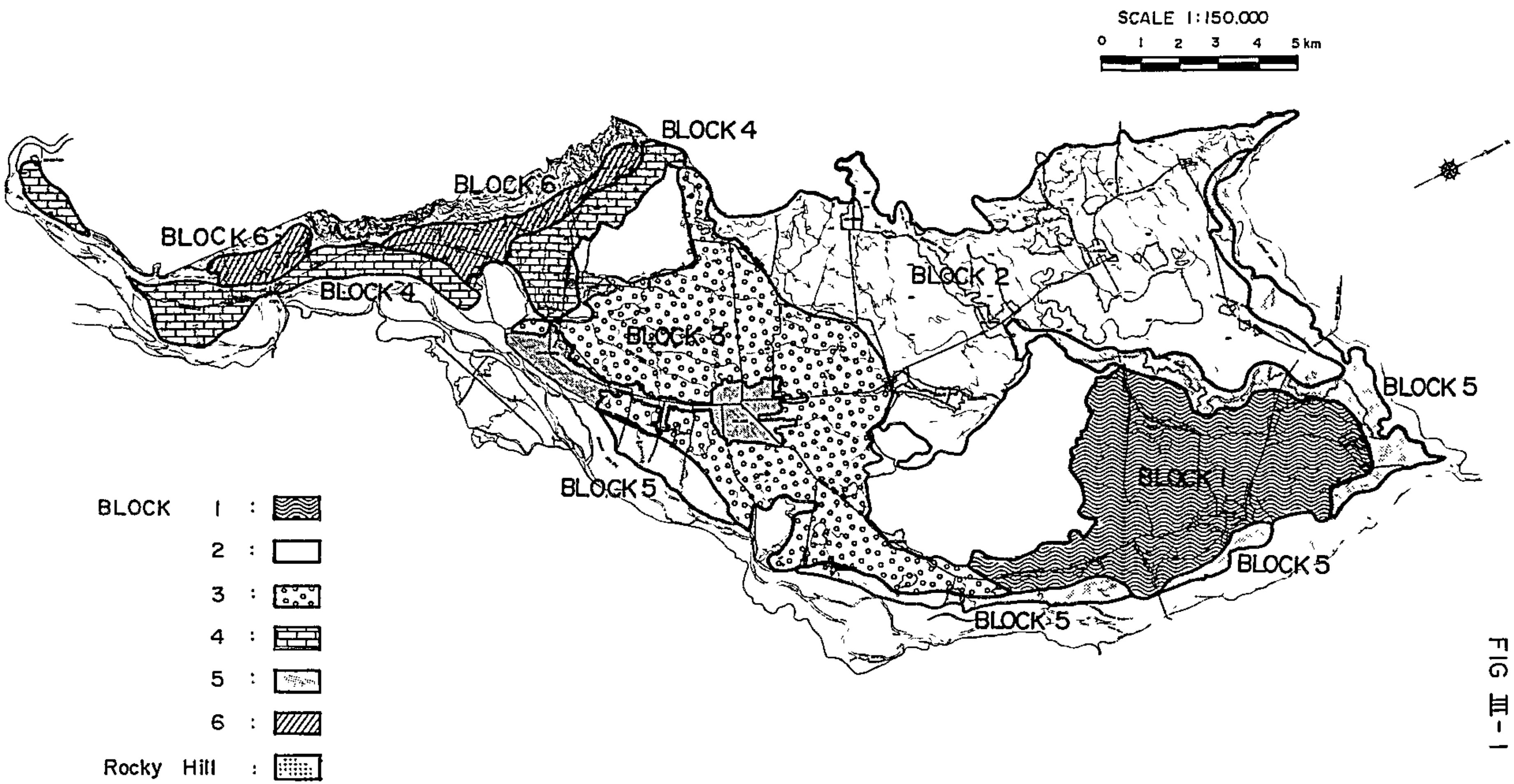
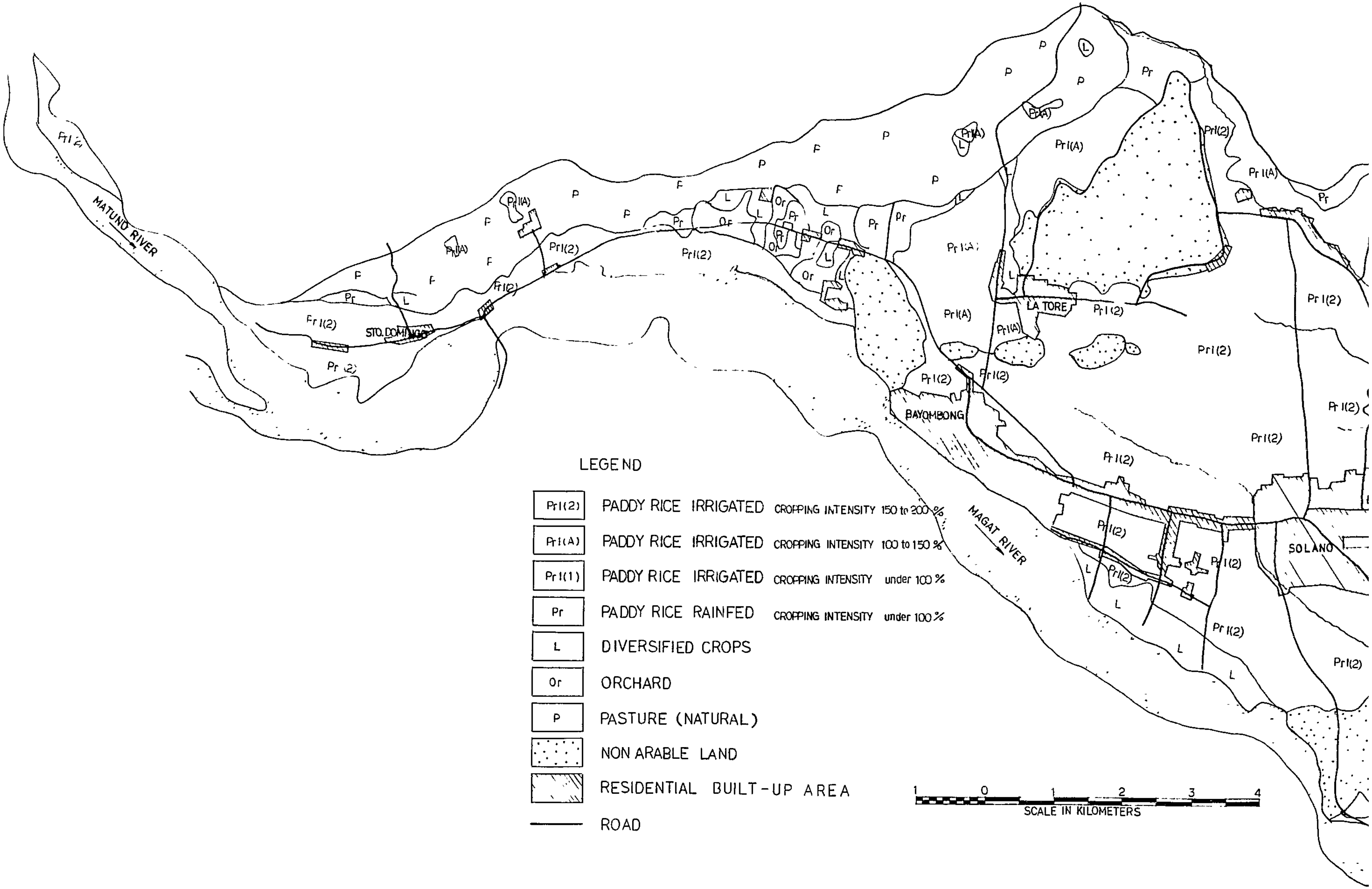
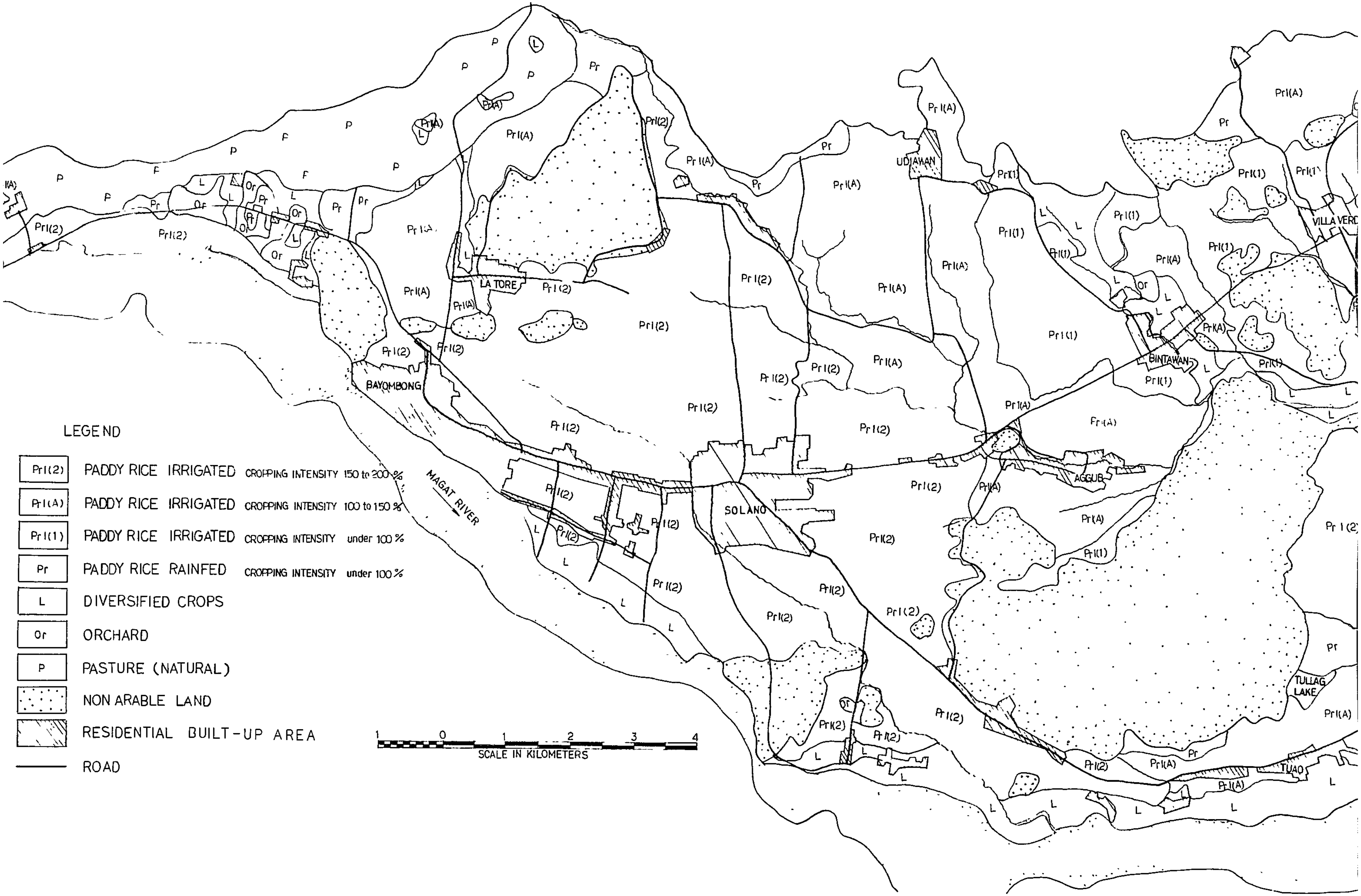


FIG III-1

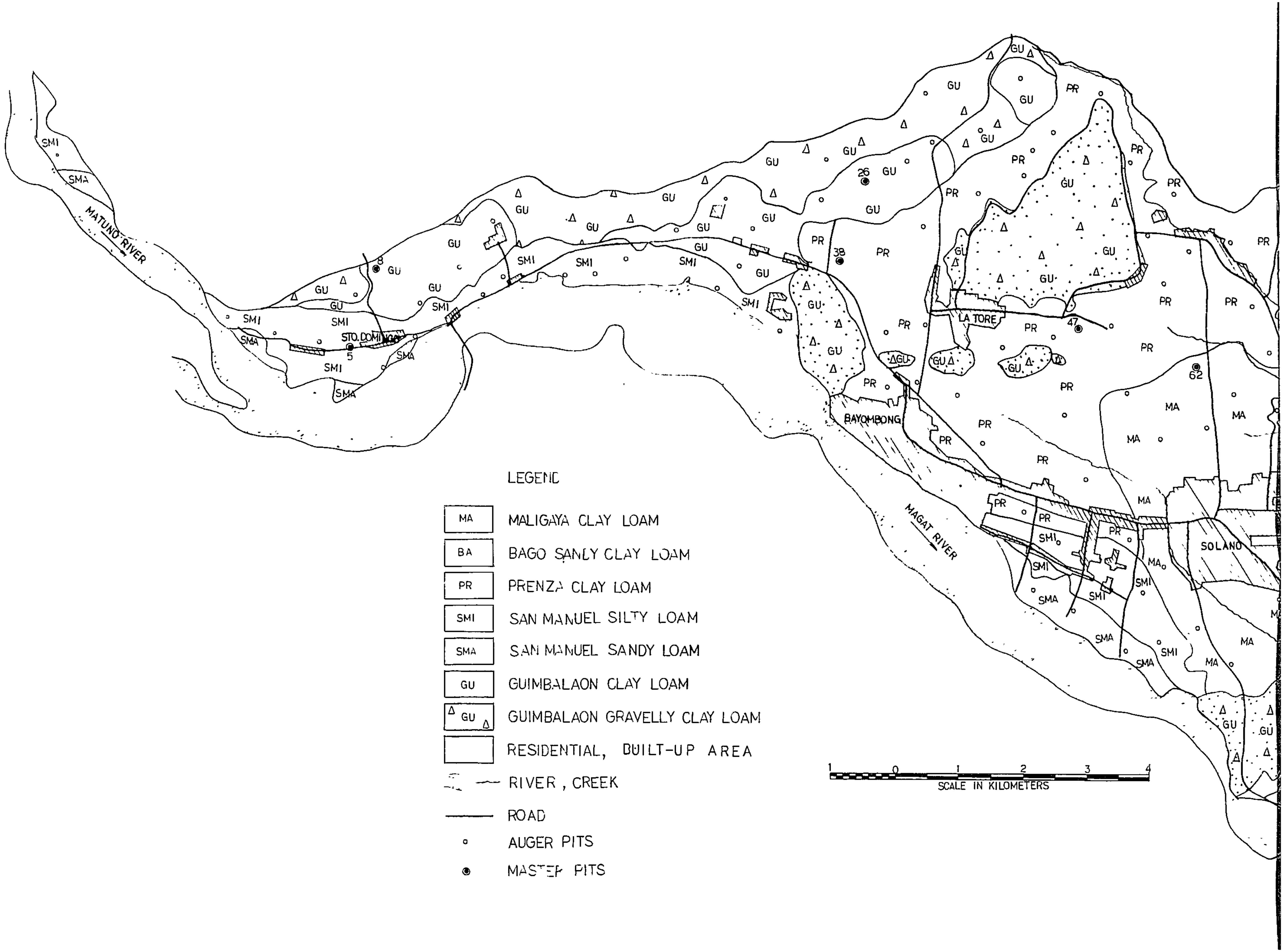

MATUNO RIVER
MAGAT RIVER
STO. DOMINGO
LA TORE
BAYOMBONG
SOLANO
LEGEND
Pr I(2) PADDY RICE IRRIGATED CROPPING INTENSITY 150 to 200 %
Pr I(A) PADDY RICE IRRIGATED CROPPING INTENSITY 100 to 150 %
Pr I(1) PADDY RICE IRRIGATED CROPPING INTENSITY under 100 %
Pr PADDY RICE RAINFED CROPPING INTENSITY under 100 %
L DIVERSIFIED CROPS
Or ORCHARD
P PASTURE (NATURAL)
NON ARABLE LAND
RESIDENTIAL BUILT-UP AREA
ROAD
1 0 1 2 3 4
SCALE IN KILOMETERS

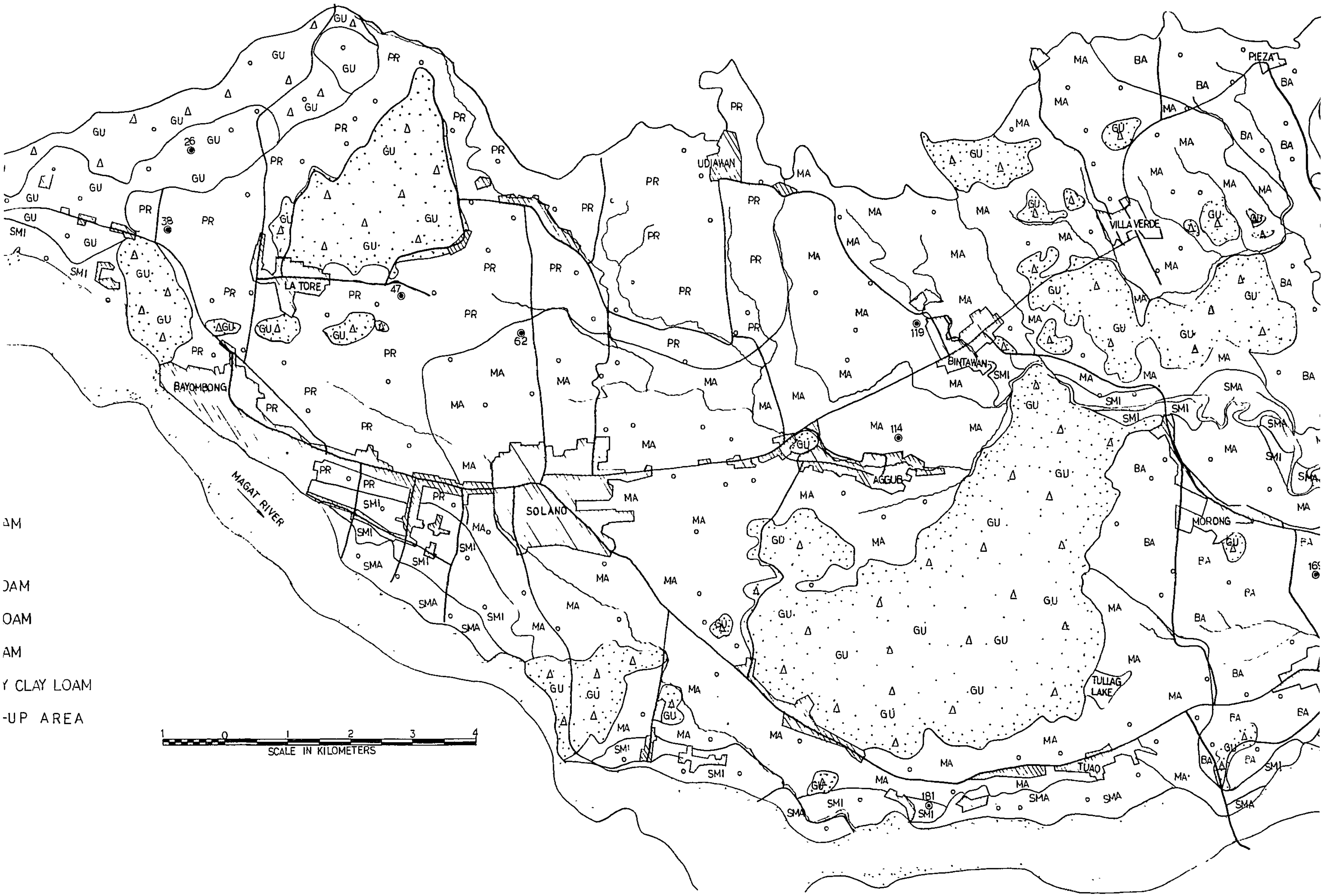


LEGEND
PrI(2) PADDY RICE IRRIGATED CROPPING INTENSITY 150 to 200 %
PrI(A) PADDY RICE IRRIGATED CROPPING INTENSITY 100 to 150 %
PrI(1) PADDY RICE IRRIGATED CROPPING INTENSITY under 100 %
Pr PADDY RICE RAINFED CROPPING INTENSITY under 100 %
L DIVERSIFIED CROPS
Or ORCHARD
P PASTURE (NATURAL)
NON ARABLE LAND
RESIDENTIAL BUILT-UP AREA
ROAD
1 0 1 2 3 4
SCALE IN KILOMETERS
MAGAT RIVER
BAYOMBONG
LA TORE
SOLANO
UDIAWAN
BINTAWAN
AGGUB
VILLA VERD
TULLAG LAKE
TUAO

FIG. III - 2

PRESENT LAND USE MAP


MATUNO RIVER
STO. DOMINGO
BAYOMBONG
LA TORE
SOLANO
MAGAT RIVER
LEGEND
MA MALIGAYA CLAY LOAM
BA BAGO SANDY CLAY LOAM
PR PRENZA CLAY LOAM
SMI SAN MANUEL SILTY LOAM
SMA SAN MANUEL SANDY LOAM
GU GUIMBALAON CLAY LOAM
GU GUIMBALAON GRAVELLY CLAY LOAM
RESIDENTIAL, BUILT-UP AREA
RIVER, CREEK
ROAD
AUGER PITS
MASTER PITS
SCALE IN KILOMETERS
1 0 1 2 3 4


AM
OAM
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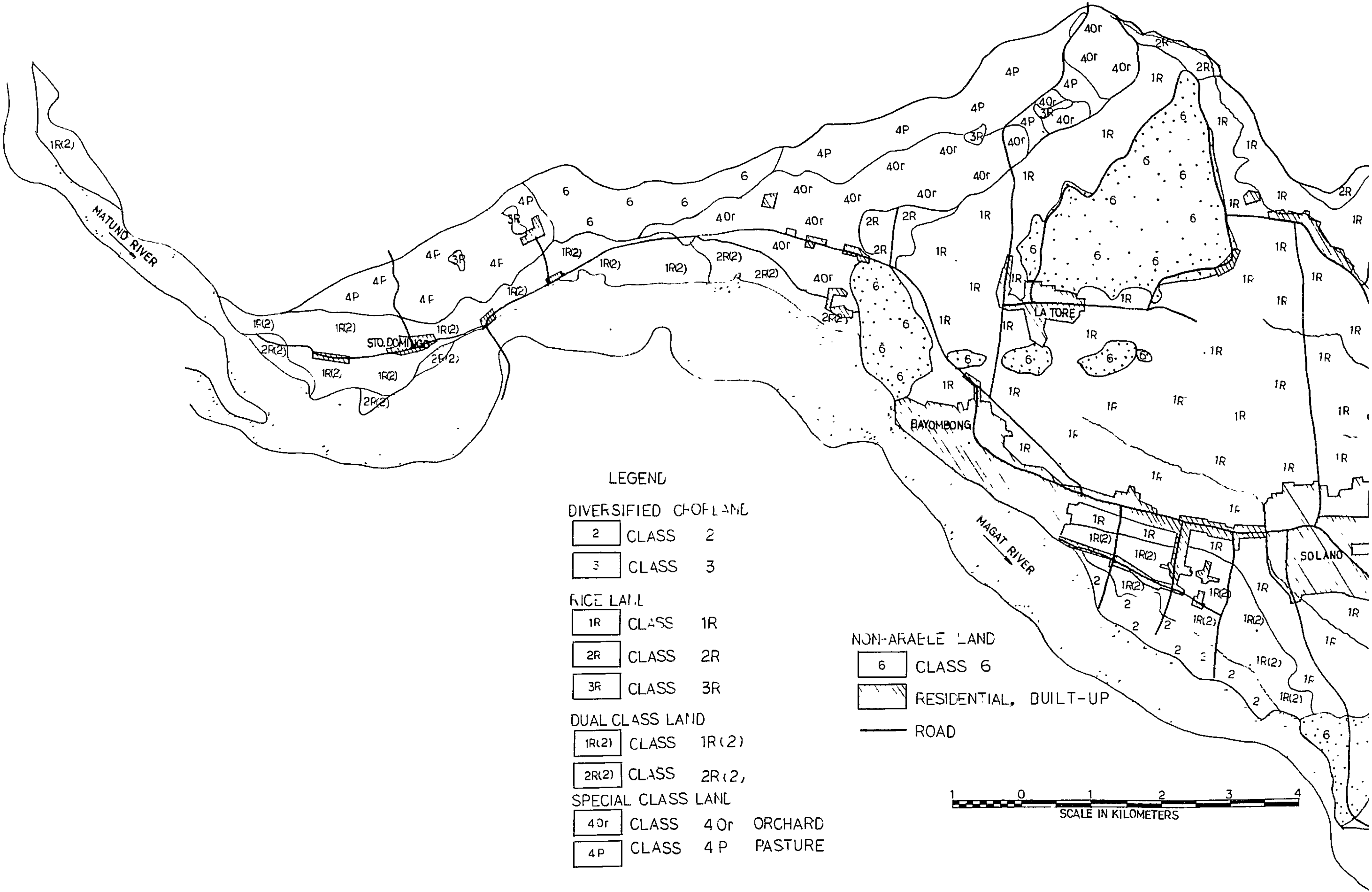
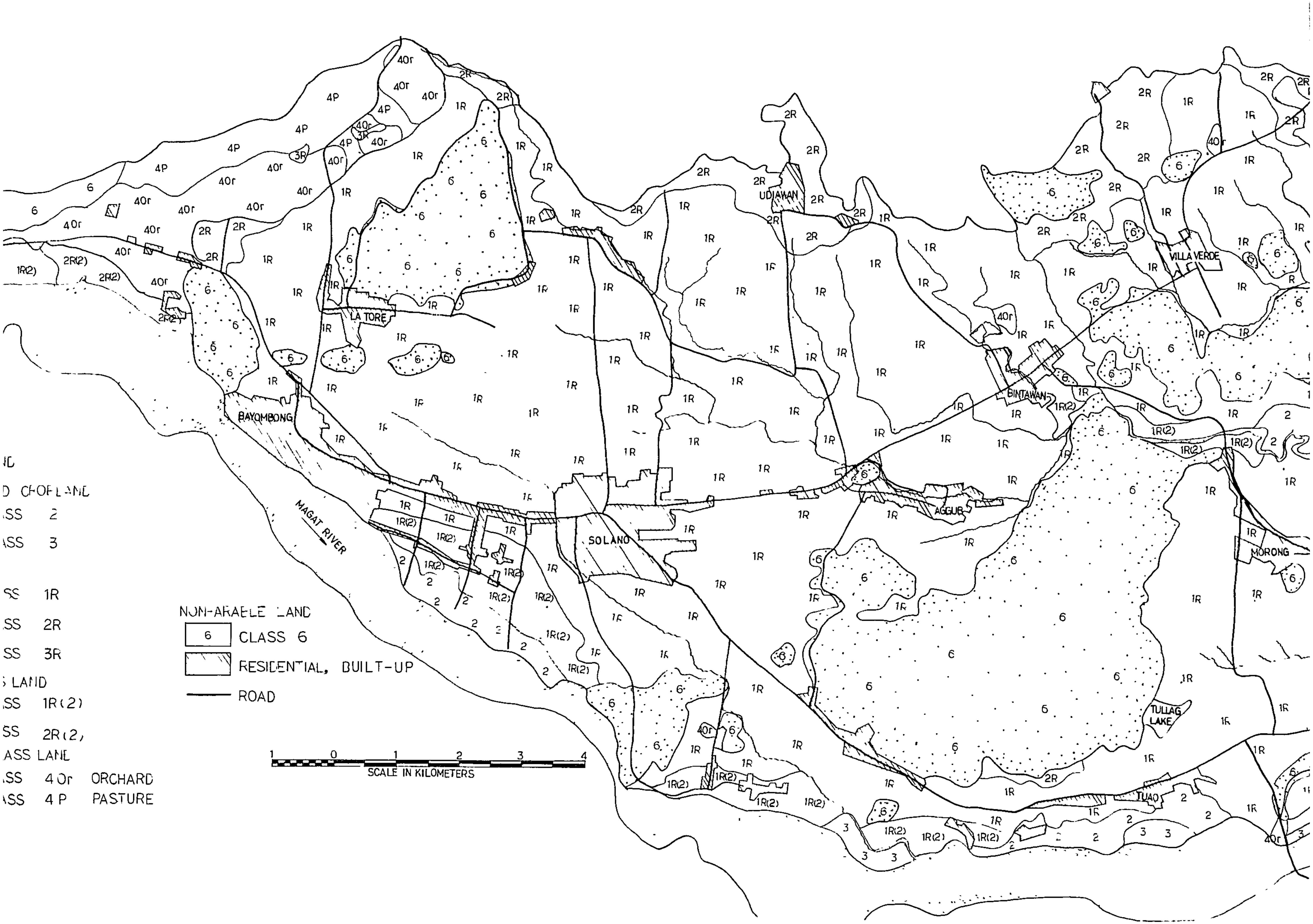
AM
Y CLAY LOAM
-UP AREA
1 0 1 2 3 4
SCALE IN KILOMETERS
MAGAT RIVER
BAYOMBONG
LA TORE
SOLANO
UDIAWAN
BINTAWAN
AGGUB
VILLA VERDE
PIEZA
MORONG
TUAO
TULLAG LAKE
GU
PR
MA
BA
SMI
SMA
FA
26
38
47
62
114
119
181

FIG. III - 3

SOIL MAP



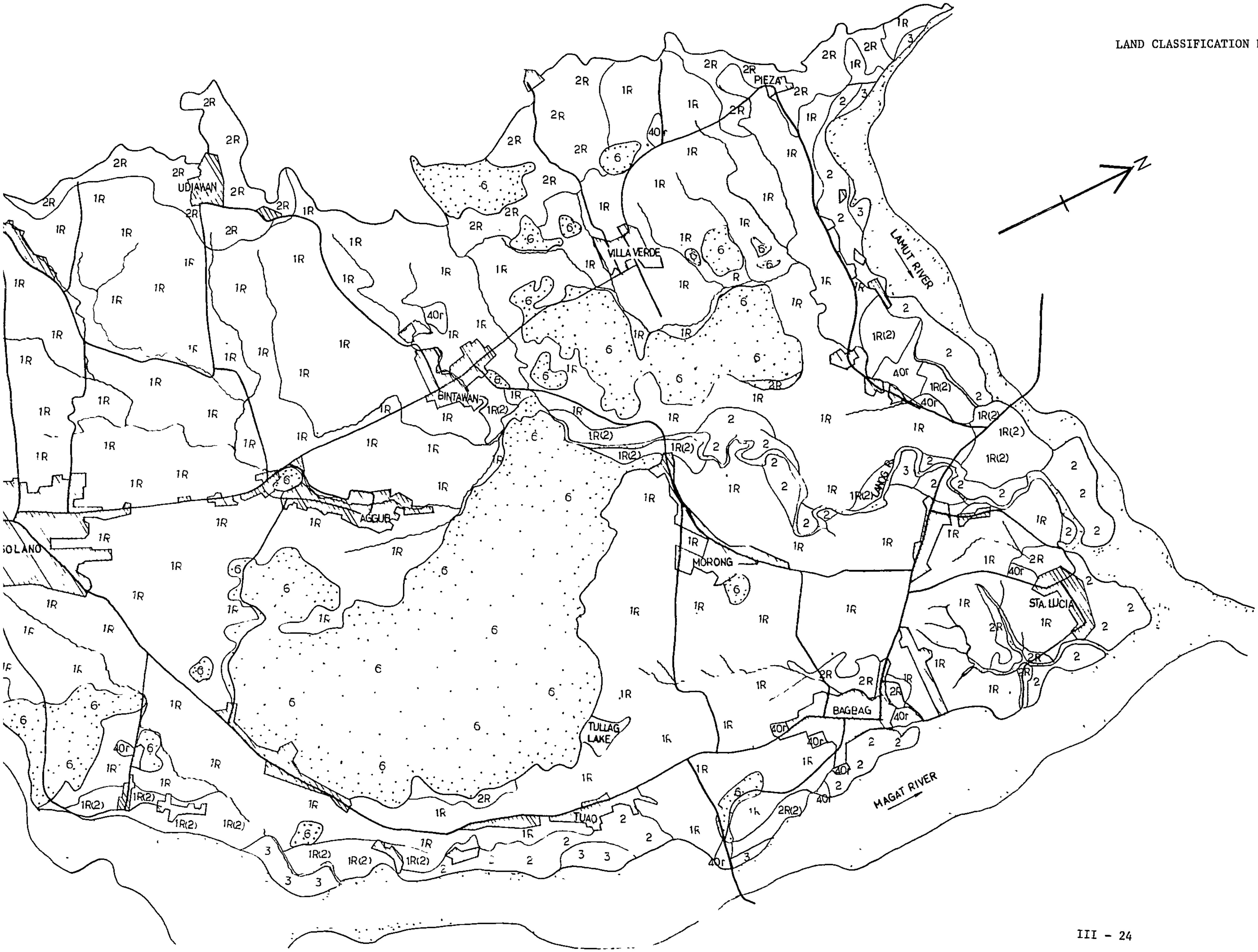
MATUNO RIVER
STO. DOMINGO
BAYOMBONG
LA TORE
MAGAT RIVER
SOLANO
LEGEND
DIVERSIFIED CROPLAND
2 CLASS 2
3 CLASS 3
RICE LAND
1R CLASS 1R
2R CLASS 2R
3R CLASS 3R
DUAL CLASS LAND
1R(2) CLASS 1R(2)
2R(2) CLASS 2R(2)
SPECIAL CLASS LAND
4Or CLASS 4Or ORCHARD
4P CLASS 4P PASTURE
NON-ARABLE LAND
6 CLASS 6
RESIDENTIAL, BUILT-UP
ROAD
1 0 1 2 3 4
SCALE IN KILOMETERS

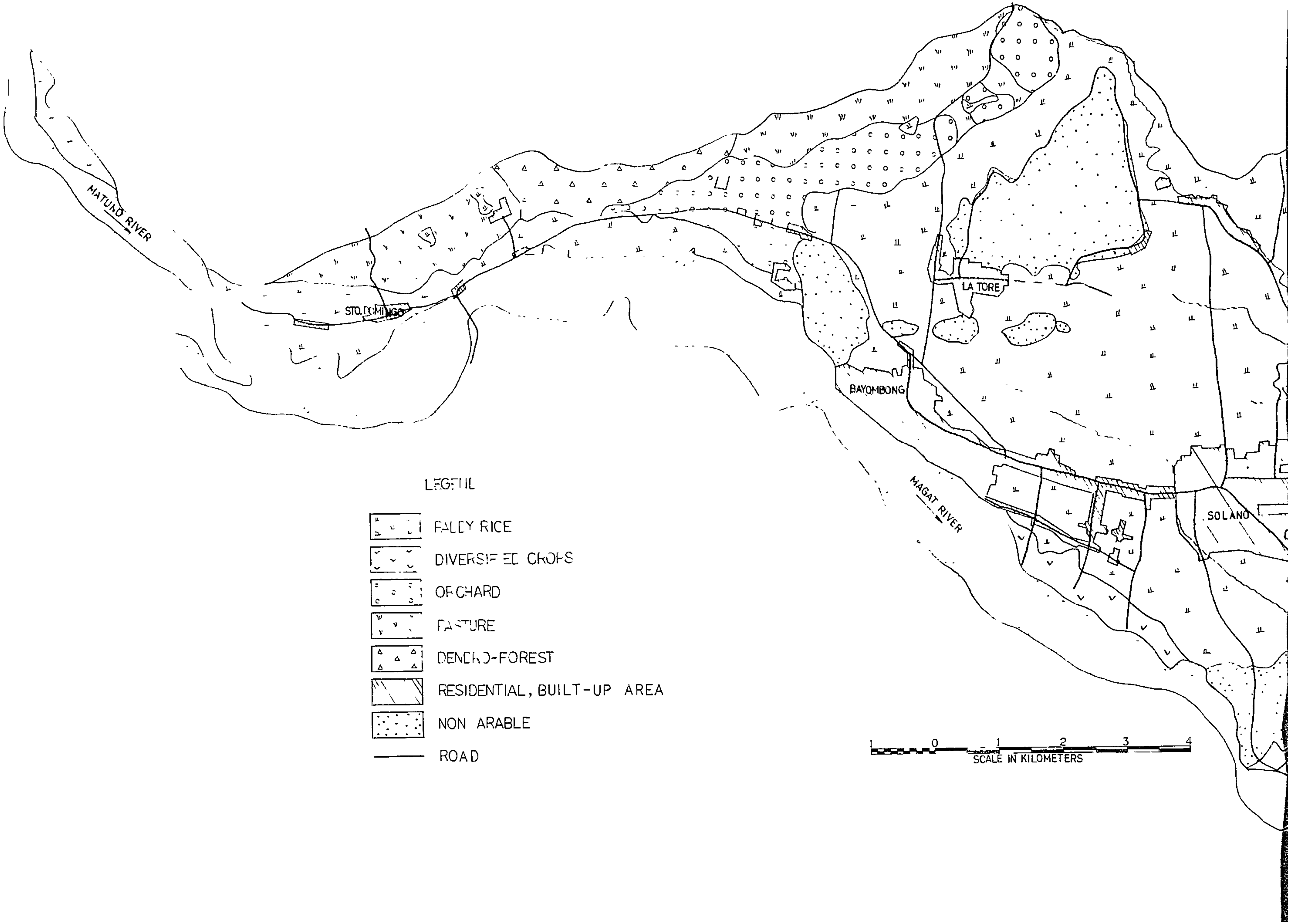


BAYOMBONG
LA TORE
UDIAWAN
VILLA VERDE
BINTAWAN
AGGUB
SOLANO
MORONG
TULLAG LAKE
TUAO
MAGAT RIVER
SS 2
SS 3
SS 1R
SS 2R
SS 3R
SS 1R(2)
SS 2R(2)
ASS 4 0r ORCHARD
ASS 4 P PASTURE
NON-ARABLE LAND
6 CLASS 6
RESIDENTIAL, BUILT-UP
ROAD
SCALE IN KILOMETERS

FIG. III - 4

LAND CLASSIFICATION MAP




MATUNO RIVER
STO. DOMINGO
LA TORE
BAYOMBONG
MAGAT RIVER
SOLANO
LEGEND
PADDY RICE
DIVERSIFIED CROPS
ORCHARD
PASTURE
DENDRO-FOREST
RESIDENTIAL, BUILT-UP AREA
NON ARABLE
ROAD
1 0 1 2 3 4
SCALE IN KILOMETERS

UDIAWAN
PIEZA
VILLA VERDE
LA TORE
GINTAWAN
BAYOMBONG
AGGUB
MAGAT RIVER
SOLANO
MORONG
BAGBA
TULLAG LAKE
TUAO
1 0 1 2 3 4
SCALE IN KILOMETERS

FIG. III - 5

PROPOSED LAND USE MAP

APPENDIX I - IV

AGRICULTURE AND AGRO-ECONOMY

ANNEX I-IV

AGRICULTURE AND AGRO-ECONOMY

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AGRICULTURE AND AGRO-ECONOMY

1. PRESENT CROPPING PATTERN AND CROP PRODUCTION

1.1 Cropping Pattern

Major crops grown in the Project area are traditional and high yielding varieties (HYV) of paddy and both white and yellow corn as summarized in FIG. IV-1. Several kinds of vegetables and root crops are grown on a small scale mostly along the riverside. However, some leafy vegetables, tomatoes, eggplant and other vegetables are also grown in patches in dual class land, while beans are sometimes cultivated along the dikes of paddy field. Monorice cropping is prevalent, involving about one half of the cultivated area. Corn/corn and corn/vegetable cropping patterns are prominent in areas in Block 1 and 5 respectivelry, (see FIG. IV-2 and TABLE VI-1) and are concentrated mainly along the riverside.

Double cropping of HYA paddy is carried out in Blocks 1 to 4 as shown in TABLE IV-2 involving about 1,900ha of land where irrigation facilities have been established. On the other hand, double cropping of paddy with local varieties/HYV is cultivated in about 2,610ha.

Except in Block No. 2 (Bintawan - Villaverde) where transplanting of HYV takes place as early as June-July, transplanting of both local and HYV wet season paddy rice is spread over a three month period starting from mid-August and continuing until mid-November. Harvesting of paddy transplanted in June-July takes place from September until late October. Harvesting of paddy transplanted during the later part of the wet season starts in November and ends in April.

HYV dry season paddy which depend on local water supply are transplanted from early December up to the second week of January in areas under Block No. 2 and part of Block No. 4. Most dry season paddy is transplanted over a three month period from March until May. Corn planting commences in early May and is completed after one and a half months. After harvesting the wet season crops about 60% of the cultivated area located in the Pieza-Sta. Lucia of Block No. 1, is left fallow throughout the dry season.

Some farmers also grow vegetables along the riverside during the dry season. The area where this cropping pattern is practiced is limited to about 160ha, however, due to the necessity of a stable water supply. Vegetable crops are mostly grown on diversified land located along the Magat, Lamut and Lanog rivers.

Cropping intensity in each Block ranges from 109.5% in Block No. 5 to 174.7% in Block No. 3, while the average cropping intensity throughout the Project area is about 134.7%

1.2 Crop Yield

As shown in TABLE IV-1, the lowest average yield of paddy for local varieties (1.4t/ha) was found in Block No. 2 and the highest yield, 2.96t/ha, in Block No. 3 and 5. During the wet season HYV yield is 1.8 to 2.7t/ha whereas during the dry season the average yield is about 3.5 t/ha. Both wet and dry season corn yield an average of 0.9 t/ha.

2. PROPOSED CROPPING PATTERN AND CROPPING INTENSITY

2.1 Proposed Cropping Pattern

With the introduction of irrigation, a major change in the cropping pattern will be effected. The proposed cropping pattern depicted in FIG. IV - 3, TABLE IV - 4 and TABLE IV - 5, was arrived at after consideration of such factors as the characteristics of recommended rice varieties, proposed land use, and soil and climatic characteristics. The overriding consideration, however, was the availability of water.

The seasonal calendar for dry paddy is land soaking and land preparation, including transplanting from mid-October to mid-December, transplanting from mid-September to mid-November and harvesting from mid-January to mid-March. The dry season paddy is harvested during the period of lowest rainfall from January to March. To expand the wet season cultivated area, the cropping calendar takes advantage of the available water supply in May for land soaking and land preparation. Land soaking and land preparation for wet season cropping begins in May, trans-planting begins the 3rd week of May to the end of July, and harvesting takes place from August to the end of October.

The proposed cropping pattern provides a 90-day fallow period between each cropping season. This period will allow irrigators' associations sufficient time to maintain and rehabilitate irrigation systems and farmers sufficient time to complete threshing, drying, packing and storing of the harvest before commencing the wet season crop. During this period, one third of the area will be planted with mung beans, the growth period of which is about 70 days. The mung bean is a promising leguminous crop, high in protein, the use of which will increase soil fertility by providing synthetic nitrogen and organic materials to the soil. Harvest of the wet season crop takes place during a period of substantial rainfall. Drying of the harvest, could thus be a problem and mechanical dryers should therefore be made available in the Project area.

Due to the soil condition, about 1,850ha in the Project area has been classified as dual crop area and diversified crop area where farmers traditionally plant mainly corn and some wet paddy during the wet season. In the latter area, 1,400ha will be planted with corn and 450ha will be used for paddy rotated with dry season corn. On consideration of the available water supply, a projected 1,000ha of the Project area will be planted with peanuts and 400ha with vegetables during the dry season.

2.2 Cropping Intensity

The cropping intensity of 135% in the Project area without Project implementation is shown in TABLE IV-3. This figure was derived from the total cropping hectarage of 17,560ha against the arable area of 13,040ha which will increase to 227% or 29,060ha of cropping area to 12,780ha of arable land. A substantial increase in cropping intensity is projected under the Project for the paddy area which will increase from the existing 143% to 233% under the Project, while diversified cropping will increase from 97.7% at present to 200%.

3. ANTICIPATED YIELD AND PRODUCTION

At present the Project area is characterized by local palay and HYV palay cultivation with a cropping intensity of 143% and an average yield of 2.4 t/ha. With the Project however, shortage of irrigation water especially during the dry season will be alleviated and cropping intensity increased to 233% including mung bean cultivation with an average yield of 4.25 t/ha as shown in TABLE IV-6 and IV-7.

Paddy cultivated area will increase from 10,745ha to 11,280ha during the wet season and from 4,570ha to 10,830ha during the dry season. The change in corn production will on the other hand, be very minimal as summarized in TABLE IV-8. However, a significant shift in the cropping system will occur with the introduction of the diversified crops (mango and peanut) totalling 4,600ha every year and redistribution of paddy and corn cultivation into different land blocks (see TABLE IV-9).

The importance of corn production particularly yellow corn as animal feed is emphasized by the Ministry of Agriculture under the Maisagana Program. However, in general practice, corn cultivation in the Project area is mostly dependant on rainfed water supplies and this, coupled with insufficient management, results in a low average crop yield of 0.9t/ha.

In the Project area, there is a large diversified crop area distributed mostly along the river banks which will be suitable for corn cultivation with improvement and provision of irrigation facilities and the introduction of package practices. In Sta. Lucia located in the northen part of the Project area, there is a corn demonstration farm of the Ministry of Agriculture presently under the management of the Maisagana program. Corn cultivators in its vicinity are experiencing higher corn yeilds. The Ministry of Agriculture reports that the potential yield of corn in the Project municipalities can be categorized into three areas; (1) low potential area: 1 - 2t/ha, (2) medium potential area: 3-4t/ha, and (3) high potential area: 4-5t/ha. Therefore, a corn yield of 3.0 MT/ha during the wet season and 3.5 MT/ha during the during the dry season is considered a feasible target yield for the Project.

Mung bean cultivation in the Project area is not extensive. However, farmers have been familiar with the same for many years and the mung bean itself has a high local as well as commercial market value. In recent years, the Ministry of Agriculture has successfully bred some improved varieties with short growth duration, high yield potential and photo-insensitivity. With optimum crop care, these varieties will have a yield potential of 1.5t/ha.

The demand for peanuts in the Philippines has been increasing rapidly. The import of peanuts as animal feed in particular has greatly increased since 1973. The Bureau of Plant Industry of the Ministry of Agriculture has designated 44% of the entire nation's peanut production as the target for Region II in its National Legumes Production and Development Program as shown in TABLE IV-10. With adequate irrigation facilities and suitable farm management, a target yield of 1.5t/ha in the diversified crop area of the Project is considered feasible.

4. ANIMAL HUSBANDRY

Carabao and cattle are considered the most important major livestock in the whole Project area. The carabao is used mainly as a draft animal while cattle are important as a source of meat. The carabao population of 1980 is estimated at about 9,514 in the Project area, out of a total population of 12,471 in the Project municipalities. The potential use of carabao for farm operation in the Project area is estimated at 80% while machines as 4-wheel and 2-wheel tractors will be used for the remaining 20%. In Bambang and Bayombong municipalities, which have the largest pasture area, the cattle population is as high as 75% of the Project municipalities. Livestock and poultry production in

Project municipalities and the province are given in TABLE IV - 11 and TABLE IV -12.

Bayombong municipality reported that the annual growth rate of the carabao population is about 5%. However increase of carabao within the province was not high during the period from 1976 to 1980, the annual growth rate recorded during this time being only 1.73%. During the same period, the cattle population decrease by about 33%.

To realize the government's goal to increase meat production, the Bureau of Animal Industry launched the Animal Dispersal Program. This program includes carabao, cattle, goat and swine. As of 1980, about 700 animals have been given to farmers and animal raisers as shown in TABLE IV-13, the number of these animals tripling within 3 years.

5. FISHERY AND AQUATIC RESOURCES

Inland water resources of Nueva Vizcaya can be classified into three types: rivers, fishponds and paddy fields. The largest of these resources is the Magat River which is the main source of fish. The Magat River extends from Bambang down to Diadi covering approximately 50ha with an estimated annual fish production of 7 metric tons as shown in TABLE IV-14.

In the province, there are about 58ha devoted to freshwater fishponds owned by 141 fishpond operators as shown in TABLE N-17. In addition, 29.5ha of marshes and lakes are also used for freshwater fishponds by different government agencies as shown in TABLE IV-15. The Bureau of Fisheries and Aquatic Resources operates about 2.5ha in the Polloc Freshwater Fish Farm to produce fingerlings for distribution to agricultural cooperatives and Fishery Association members.

The Bureau of Fisheries and Aquatic Resources in cooperation with the Ministry of Agriculture is promoting the Rice-Fish Culture Program. As of 1982, about 10ha have been devoted to this program in the province as shown in TABLE IV-16.

6. PRESENT FARM LABOR CONDITIONS

6.1 Human Resources

In the Project area, which has 13,040ha of arable land in the lowe portion, there are an estimated 9,357 farm households with a total farm population of 49,503. The average size of farm household is calculated at about 5.29 persons as shown in TABLE IV-19. The potential labor force of the average farm family is estimated at 0.64 persons in the 15 to 19 year age group considered to have a 50% labor rate, and 2.05 persons in the 20 to 59 year age group, considered to have a full labor force rate. Those over 60 years of age, also considered to have only a 50% labor force rate, are estimated at 0.25 persons per household (TABLE-18). The total labor force of one farm household therefore is calculated at 2.5 persons as also shown in TABLE IV-19.

The number of potential working days in one year per farm laborer is estimated at 240 days by the World Bank. In the Project area therefore approximately 5,407,900 man-days per year have been estimated with the available labor force being distributed over a 12 month period and allowing for a 5% accident and illness rate. From the total hectarage of different crops throughout the year determined by the present cropping pattern and its intensity, the total man-day requirement in the peak months of April and October is estimated at about 221,000 and 245,400 man-days respectively. The balance of the labor force in these peak months, which is tabulated in TABLE IV-20 and FIG. IV-4 is +223,500 or 50.3% in April, +214,000 or 46.6% in October indicating a surplus potential labor force. In the meantime during the slack season from May to August about 80 to 90% of the potential farm labor force remains untapped.

6.2 Animal Labor

In the Project area, carabaos are generally used as draft animals the total number of which was estimated at about 9,514 in 1980. Within this total number 70% are working carabao while 30% are calf or non-functional carabao.

A higher percentage of farmers use animals for farm cultivation, while only about 20% of farm operations are mechanized employing mainly 4-wheeel and 2-wheel tractors. Animals are also used for hauling inputs and farm products. Considering the general number of draft animals available for land preparation, inter-tillage and hauling of farm products, and the average 240 working days per year per animal with a 5% default ratio, the monthly draft animal labor potential is estimated at about 126,500 days. In addition, available farm equipment is estimated at one fourth of the animal labor potential in the Project area.

The results shown in FIG. IV-5 reveal a large surplus in carabao even excluding the potential labor of farm machines. TABLE IV-21 shows the labor balance for carabao alone, from which the higher demand for animal labor in September and October is evident. During this peak period however, there is still a surplus potential labor force of 49% in September and 43.3% in October of carabao, without the inclusion of mechanized equipment potential.

7. FUTURE FARM LABOR CONDITION

7.1 Projection of Farm Household Population

According to statistics, the annual population growth rate in the Project municipalities from 1975 to 1980 varied from 0.1% in Villaverde municipality to 2.76% in Bayombong municipality, while the average of 5 municipalities was 2.12%. Particularly in Villaverde municipality, this trend is due to migration of the population caused by agricultural and socio-economic conditions. Implementation of the Project will help to check further outflow of labor by increasing employment opportunities. Therefore, the annual population growth rate of 2.12% is expected to continue in future.

Population projection and projection of the farm household population calculated with the assumed annual growth rate of 2.12% are shown in TABLE IV-22 and TABLE IV-23.

7.2 Projection of Total Number of Carabao

The increase in the number of carabao in the Project area from 1976 to 1980 was 1.73% per year. This trend seems likely to continue in future. Projection of carabao as draft animals and potential use of equipment are key points for planning the future implementation of farm mechanization.

7.3 Farm Labor Balance

(1) Human Resources

In the Project, the proposed cropping area is 29,060ha, 12,680ha of which is irrigable, and 100ha of which is non-irrigable. The cropping intensity will increase from the present 135% to 227%. On the basis of the proposed cropping pattern and the projected farm household size, the balance of manual labor was calculated as shown in TABLE IV-24, FIG. IV-6 and FIG. IV-8.

Upon completion of the Project about 85% of the available labor force will be engaged in farm operation in the peak month of February. (This ratio is in comparsion with the area without the Project at 41.5% in peak month of October.) Therefore, with Project implementation the employment opportunities for those engaged in farming will be more than doubled.

(2) Animal Labor

The potential for farm machinery in the Project area is estimated at 32,000 days per month converted to animal labor. However, animal labor is considered only in terms of carabao engaged in such tasks as land preparation, inter-tillage and hauling work while the animal labor balance was calculated on the basis of the estimated annual growth rate of 1.73%. During the peak month of February, surplus rate of animal labor was 24.6% as shown in TABLE IV-25, FIG. IV-7 and FIG. IV-9. Furthermore, this percentage coupled with an assumption of zero percent annual growth rate for the present carabao population indicates as much as 7.4% surplus.

8. ON FARM REQUIREMENT

8.1 General

Land preparation, cultivation of crops, threshing or shelling, and hauling can be improved and/or shortened by increased use of draft animals. Post harvest operations such as drying and milling can only be increased by the provision of appropriate dryers, etc.

8.2 Carabao

Regional statistics estimate the annual growth rate of carabao in the Project area at about 5%. However, results of field analysis show that the annual growth rate of carabao from 1975 to 1980 is only 1.73%. With the implementation of the Project, the growth rate of the carabao population is expected to be reduced even further with the conversion of grazing spaces into paddy land due to the objective to maximize land occupancy with crops.

At present the total number of available carabao is 9,514 head. This however, together with mechanization of tillage operation appear more than sufficient to satisfy the estimated on-farm requirement in the Project area. Even should the annual growth rate of carabao be reduced to zero, as projected for the final stage of the Project on the basis of anticipated crop intensity, the number of carabao will be fully adequate for farm operation.

8.3 Rice Dryer

Untimely and inadequate drying reduce the quality of rice. Sun drying is the common practice in the Project area. At harvest time the average moisture content of palay grains is about 16 to 20%. If the weather is fair and sunny the harvested palay is usually left in the field for a day or two to cure under the sun before threshing. The threshed palay grains are again dried under the sun taking an average of 2 days to reduce the moisture content to the desired level of 14%. If harvesting falls during rainy periods, a considerable amount of spoilage occurs. For harvesting and threshing large amounts of palay, sun-drying alone can not adequately ensure consistent good quality. Therefore a mechanical dryer must be made available as a supplement to the sun-drying method, to be used especially during rainy days of the harvest period. Mechanical dryers vary in size and specification. However, the most practical and economical local dryer for small size farms is the so-called 'Batch dryer', independently developed by IRRI and UPLB. The drying capacity is 2 t/load for 6 to 8 hours time, depending on the initial moisture content. The advantages of this type of dryer are: simple design, compact size and portability, low horse power requirement, ease of operation and fast drying rate. Detailed machine specifications of the IRRI-designed dryer are shown in TABLE IV -26. IRRI placed the total cost of manufacture at ₱5,200/unit.

It is recommended that this type of dryer be used for at least 50% of the projected total palay harvest in the Project area. Based on the same, at 2t/load, 2 loads/day, the Project area will require about 100 units. Because of its simple design, this machine can also be readily manufactured locally.

9. POST HARVEST FACILITIES

9.1 General Facilities

Post harvest activities commence immediately after harvesting and conclude with purchase of the product. This includes such activities as threshing, drying, milling, storage, transportation and marketing.

Mechanical threshers in the area consist mainly of portable threshers, both foot driven and machine driven. The five Project municipalities have a total of 104 rice threshers, both hold-on and throw-in types, with a combined capacity of 4,542 cavans/hr or 1,816.8t/day as tabulated in TABLE IV-27. Present annual rice production in the Project area is about 36,554t while that for Project municipalities is about 74,070t. The number of threshers are thus more than adequate for present production.

As indicated in TABLE IV-29 processing facilities for both rice and corn include mills, the cono-type, kiskisan-type, centrifugal-type and rubber roll-type, and corn grinders all owned by the private sector. The number of rice mills in the area is 111 with a total capacity of about 963 cavans/hr. There are also 22 corn mills with a combined capacity of about 90 cavans/hr. The total capital value of privately owned rice and corn mills is estimated at ₱3.4 million. Considering the 200-day milling season, these facilities are sufficient to mill the total present production in the Project area and its project municipalities.

Although sun-drying is the usual practice, because of its low production cost and resultant flavor it is not a dependable method during rainy season. The National Food Authority has only one mechanical rice drier located in Bambang with a capacity of 50 cavans/hr and therefore there is a need to increase mechanical drying facilities in order to meet present demand.

Another post harvest facility in the area is warehouses as summarized in TABLE IV-28. There are reportedly 40 warehouse units operated both by the NFA and the private sector in the Project municipalities with a combined capacity of 157,085 cavans. Of these 12 are in Solano and 4 in Villaverde. The remaining units are located in the three Project municipalities. Assuming that 50% of the total annual rice and corn production in the area needs warehousing, these facilities could provide storage for only about 10% of production even after excluding farmer's personal stock. It is therefore necessary to increase warehouse facilities.

9.2 Marketing Facilities

The NFA provides incentives to farmers by subsidizing the transportation of farm products to NFA buying stations. The farmers' associations (Samahang Nayon) play a major role in the procurement and marketing program of NFA by acting as marketing agents for farmer-members and NFA, this guarantees efficiency under the area covered. NFA provides a better price for farm products processed through the farmer's associations while farmers sell their products to middlemen at lower prices.

As of July 31, 1982, NFA reported that there are three mobile buying units and one permanent unit in Nueva Vizcaya. Supervision of procurement in these stations is handled by two Farm Leaders and Rice Grain Classifiers in coordination with the Municipal Development

Officer. One of these facilities is located in Bayombong. In addition, NFA has established 274 retail and wholesale outlets for grains, involving about 229 persons. Solano has the most units while Villaverde has only 9. Total estimated value of these units is ₱4.75 million, details of which are given in TABLE IV - 30.

The National Food Authority is responsible for stabilization of grain prices and prices of grain products both on-farm and at the consumer level. Buying activities are limited to about 10% of the total market volume. This percentage may vary however, depending on several factors as indicated in TABLE IV - 31. In the Project area, NFA procurement ranged from 4 to 9% of the marketable surplus.

10. OPTIMUM POST HARVEST FACILITY SIZE

The estimated deficit or surplus of different post harvest facilities (TABLE IV-32) after implementation of the Project is itemized below:

(1) Thresher

Threshing capacity within the Project area is currently estimated at 908.4t/day. Estimated production after Project implementation is 93,855t for both dry and wet seasons. Given an estimated threshing period of 120 days (60 days following each harvest), a threshing capacity of 782t/day will be necessary. At 908.4t/day, present threshing capacity in the Project area is accordingly sufficient for envisaged yields under the Project.

(2) Rice Mills

Rice mill capacity is just sufficient to process current rice production in the Project area, and will therefore not be adequate for the handling of the increases in rice yield envisaged under the Project. This will necessitate an increase in rice mill capacity of approximately 1.5 times the current capacity. Accordingly, capital investment from the private sector as well as a strengthening of the agricultural support system by NIA are required to ensure adequate rice mill capacity for future increases in yield.

(3) Corn Grinders

Present potential corn grinding capacity in the Project area greatly exceeds current requirements by approximately 68%. Nevertheless, projected yield increases under the Project will slightly exceed current corn grinder capacity. The anticipated shortage in capacity however, is only 0.5cavans/hr, which may be adequately compensated for by improving existing facilities and enhancing operation effeciency.

(4) Warehouses

The least developed area of post harvest facilities is warehousing. Assuming that warehouse capacity should be equivalent to 50% of production for purposes of price and quality control as well as for pest control, the current warehouse capacity of 3,900t represents only 1/5 of what is needed to accommodate present grain production. With projected yield increases under the Project, it will be necessary to expand current capacity 12 fold.

(5) Grain Drying System

Drying of the grain after harvesting and threshing will particularly pose problems for the wet season crop. With projected yield increases under the Project, a corresponding expansion of mechanical drier facilities will also be necessary. However, as the cost for operating mechanical drier systems will have a subsequent effect on the farmers' net income, consideration should also be given to expansion of solar drying platforms with group operation.

(6) Transportation

Potential transport capacity in the Project area has been estimated from the assumptions listed on the following page and is based on numbers and types of vehicles registered at the Bureau of Land Transportation in Bayombong.

- Total estimated transport capacity in Project municipalities: 650t
- Annual number of operating days per vehicle: 240 days
- Operation and loading efficiency: 80%
- Percentage of vehicles actually within Project area for each Project municipality: 70%
- Number of trips per day: (60% of total vehicles x 2 trips) + (40% of total vehicles x 1 trip)

Based on the above, potential transport capacity within the Project area is estimated at 14,000t.

The balance between current transport capacity and anticipated transport requirements for farm products during the Project is estimated on the basis of the following assumptions:

- total production of agricultural products under the Project: 111,322t
- amount of products transported within Project area: 111,322t x 2 times = 222,644t
- amount of products transported outside Project area: 111,322t - 20,000t (consumption within Project area) = 91,322t
- ratio of total amount transported within Project area to required amount of agricultural products: 10 : 9

The total amount of agricultural products transported at full development of the Project 5 years after completion is estimated at 314,000t. The total amount transported for all commodities at that time is estimated at 349,000t as opposed to a present farm vehicle capacity of 210,000t within the Project area. Thus additional capacity required with the Project is 70,000t/yr or 365t/day This is the equivalent of approximately 90 additional 4 ton trucks.

11. PROPOSED AGRICULTURAL EXTENSION SYSTEM

11.1 General

Although farmers in the Project area are accustomed to paddy cultivation, the projected shift from mono-cropping paddy cultivation to multi-cropping double paddy cultivation with supplementary mung bean cultivation will likely entail some major adjustments for the farmers concerned in terms of working habits and management practices. In the Project area, there are local discrepancies in the technical level of traditional crop production practises affected by the distribution of irrigation water. The Project is designed to increase crop productivity and rectify these discrepancies through implementation of a unified irrigation system over the entire area and improvement of institutional aspects. Improvement of farmers' production techniques and strengthening of facilities, social systems and supporting institutions is essential to obtain maximum value from capital invested. Therefore, the "Pilot Farm" which coincides with Project development, and its implementation schedule should be designed for versatility and effectiveness.

To assist the farmers during pre-Project implementation, a pilot demonstration farm with a new cropping system will be established. The said pilot farm will be the center of training and learning activities in all phases of the cropping system program and will include group-oriented farming activities.

11.2 Objectives and Systems of the Pilot Farm

The chief objective of the pilot farm is demonstrate to farmers the basic practices involved in, or associated with the new cropping system. A further objective is to teach and train farmers in the dynamics of group-oriented farming activities. Finally, the pilot farm is to serve as a test site for application of recent agricultural technology which will further contribute to general recommendations for the new cropping system.

Two types of facilities, permanent and temporary adaptable to the farmers' technical level and the implementation stage of the Project, will be constructed. Management, however, will be most important for the pilot farm of this Project due to the urgent need to achieve uniformity in the farmers' technical level within the subjected period.

11.3 Size of Pilot Farm

Hectarage of the pilot farm depends on a number of variables. The basic guideline is that it should be neither so large as to render it unmanageable, nor so small as to be unrealistic or atypical of actual farm situations. 50ha appears to be the ideal size for this purpose. This proposed size should be titled by 25 to 30 individual farmers.

11.4 Management System and Training Function

Under the Project, all farmers will participate in the pilot farm training program. To satisfy the above stated objectives of the pilot farm, there will also be several different management systems.

(1) Rotational Pilot Farm System

The pilot farm will train participants through both seminars and practical training programs, extending this service throughout the vicinity by use of demonstrations. In the case of permanent pilot farm facilities, however, it would be too difficult to extend and demonstrate the modern tehniques over the entire Project area, The permanent facilities would rather form a fixed center. The ideal solution for this situation would be the temporary establishment of a mobile pilot farm system. This system could be operational for some period of the cropping season, for example, and move to new areas according to a priority sequence based on extension blocks in the Project area. In this system the extension center for permanent facilities would actually form more of an extension line, the mobile center rotating from one site to the next after given periods of time.

(2) Extension Sub-Center System

In the extension block, some extension sub-centers will be established to conduct small scale demonstration plots. Training programs in the sub-centers will use seminars and the system of training and visting (T&V system). The latter will function to spread the establishment of extension stations.

(3) Combined Sub-Center and Rotational System

This system will unify and coordinate the above mentioned systems for effectiveness by facilitating extension of both into new locations. By rotational shifting of the total system from block to block, the entire Project area will be covered.

In all of these systems, the participating farmers should be trained as nucleus leaders for their areas. These same farmers will provide continuity in the transmission of the new techniques once the pilot farm has been relocated elsewhere.

11.5 Selection of Pilot Farm

The pilot farm site must be selected for maximum effectiveness as a center. The criteria upon which the selection of this site is based are:

i) accessibility to major roadways (national or provincial);
ii) proximity to a community of farmers;
iii) accessibility to a dependable water source that can be tapped for irrigation;
iv) representativeness of the site in terms of soil characteristics and other features;
v) willingness of farmers involved to work cooperatively with the pilot farm set-up;
vi) composition of small owner-tilled or lease-tilled farmers; and,
vii) non-regulatation of prolonged inundation.

11.6 Technical Staff

The technical staff of one pilot farm unit will be composed of: one agronomist with a strong background in rice cultivation and soil management; one agricultural engineer with good theoretical knowledge of farm mechanization and post harvest operation; and one agricultural economist with good theoretical and practical background in farm management and a working knowledge of sociology. Administratively, the technical staff will be under the direct supervision and coordination of the project Manager.

12. PRODUCTION PRACTICES FOR IRRIGATED RICE

Crop yield depends on the combined effect of many environmental and management factors involved in each stage of the crop's development. The use of a potentially high yielding rice or corn variety, for instance, does not guarantee high yield unless supported and complemented by other contributing factors, such as fertilizer, and weed and pest control. Hence, it is essential that these factors be considered and applied as a complete technological system if high rice yields are to be achieved.

12.1 Rice Varieties

The first step in such a system is the selection of the HYV to be adopted in the area. The search for superior rice varieties in the Philippines, as elsewhere, is a continuing effort by research centers, principally the International Rice Research Institute (IRRI), University of the Philippines at Los Baños (UPLB), Bureau of Plant Industry (BPI) and the Philippine Atomic Energy Commission (PAEC). The current Philippine Seed Board recommended rice varieties, together with their main agronomic characteristics are shown in TABLE IV - 33.

It may be noted that, although all these varieties have high yield potentials, their agronomic characteristics differ widely, particularly their reactions to common pests and diseases. In rice growing areas where a serious disease is known to prevail, a variety resistant to that particular disease should be used.

No definite recommendation can be made at this point as to the variety to be grown in the Project area. Changes are expected to take place by the time the Project is implemented. Radically new varieties may be developed in the future that could replace the present recommended varieties. The listing and characterization of the present Phil-Seed Board recommended varieties merely underscores the wide wide variation in characteristics, and illustrates that selection will depend on the conditions prevailing in the area.

12.2 Methods of Planting

There are 2 methods of planting rice: the traditional Philippine method of transplanting and the direct seeding method. No less than 95% of both irrigated and rainfed paddy lands in the Philippines are planted by the former method. Preference of one over the other is governed by circumstances prevailing in the area.

One big advantage of direct seeding over the transplanting method however, is the elimination of the cost of raising the seedlings and transplanting. In addition, the maturity of the crop is hastened by about 5 to 7 days. Its disadvantages are: 1) it requires better control of water in the field during seeding time and at the early stage of plant growth; 2) requires more seeds than the transplanting method and 3) requires more thorough weed control at the early stages of plant growth.

The transplanting method on the other hand, allows for the growth of healthy seedlings, requires less seed and permits better weed control, especially if planted in straight rows. Its marked disadvantage is that it entails additional labor costs for raising the seedlings in a seed bed nursery and transplanting.

12.3 Raising Rice Seedlings

If the transplanting method is to be used, it is essential that the seedlings be properly raised.

High rice yield, both under rainfed and irrigated conditions, is dependant on the use of healthy seedlings for transplanting. There are two general methods of raising seedlings for transplanting: the wet-bed method and the dapog method. The wet-bed method however, is widely practiced in the country. The advantages of the wet-bed method over the dapog are: 1) less seed is needed 2) seedlings are easier to transplant 3) the number of seedlings transplanted per hill can be regulated, and 4) it does not require precise water control at planting. The disadvantages, on the other hand, are that the seedbed occupies part of the field and that the method requires more labor in seedbed care.

The dapog method is more commonly practiced in southern Luzon. Seedlings raised by this method can be transplanted 10 to 14 days after sowing, hence the time required in the nursery is reduced. The other advantages of this method over the wet-bed method are: 1) wider choice of seedbed location 2) elimination of root or stem injury to seedlings 3) elimination of pulling of seedlings and 4) hastening of maturity by 5 to 7 days. Its disadvantages are: However, 1) a larger amount of seed is required 2) seedlings are short 3) number of seedlings per hill can not be controlled and 4) more precise water regulation is required at planting.

The use of the wet-bed method is recommended in the Project area for first 2 or 3 years of Project implementation. However, the dapog method should also be introduced into the Project area on a demonstration scale in the first year of implementation to acquaint the farmers with the method. As each method has its own merits and demerits, the farmers themselves will have to select which to practice in the years following their exposure to both methods.

12.4 Land Preparation

A major prerequisite for successful rice cultivation is good land preparation. Irrigated rice requires an adequately prepared, leveled, and inundated field to provide a soil surface that is weed free, to make manual transplanting easier, to permit uniform distribution of irrigation water, fertilizer and pesticides, and to prevent or minimize water seepage from the field.

If land preparation is not uniform, rice plants will develop unevenly, causing differences in plant growth and maturity which in turn influences rice quality. Furthermore if organic matter is not well decomposed at the time of transplanting, the transplanted seedlings are likely to be affected by toxics releasd from decomposition of aerobic organic matter. For these reasons, land preparation theoretically should commence at least 2 weeks before transplanting.

The first step is to flood the field with water 5 to 7 days before plowing. Plowing can be accomplished either by an animal or hand tractor-drawn mold board plow or by a hand tractor with a rotavator attachment. On the average, it takes 2 days to finish plowing one hectare using a 7 HP hand tractor or 6 - 7 days/ha using a carabao-drawn plow. The field is left inundated for another 5 - 7 days before the first harrowing. The field should be kept flooded from plowing time until transplanting to conserve nitrogen released by organic matter during decomposition. In the meantime, the dikes should be cleaned, repaired, and lined with mud to effectively hold water in the paddy fields. It takes another 2 days to accomplish the first harrowing using the hand tractor or 5 - 6 days using the carabao-drawn combtooth harrow. This operation breaks the clods, incorporates the weeds into the soil, and partially floods the field. The sequency and rate of farm operations and the waiting period between operations in the Project area for both carabao-drawn implements and hand tractor-drawn implements are shown in the TABLE IV -34.

12.5 Transplanting Methods

There are two methods of transplanting: the random or traditional method and the straight-row method. The straight-row transplanting method is strongly advocated over the traditional random transplanting method as it provides superior weed control, inadequate control of which is still a major cause of reduced rice yield. Straight row planting affords indirect weed control by allowing the use of convenient and more efficient mechanical, hand-pushed rotary weeders. In addition it allows for the recommended optimum distance between rows, another factor contributing to higher yields.

Immediately before transplanting a wooden marker is passed along and across the field to mark off the cross-sections (or hills) where the seedlings are to be transplanted. The recommended distance between hills for moderately high tilling varieties is 20cm x 20cm and 25cm x

25cm for high tilling varieties. The recommended ratio of seedlings to plants per hill is 2 - 3 for wet-bed seedlings and 5 - 7 for dapog seedlings. Excess water is removed from the field before transplanting up to the third day after transplanting. This allows for rapid recovery and establishment of the transplanted seedlings. After this period, irrigation water is gradually applied to suppress the germination of weed seeds and to conserve soil nitrogen.

12.6 Fertilization

The response of irrigated rice to application of fertilizer depends on a number of factors, such as soil characteristics and fertility level, type of fertilizer, season of planting, timing and distribution of fertilizer.

HYV rice varieties are generally responsive to fertilization, especially in the dry season due to increased exposure to solar rays. For this reason, the recommended fertilizer rate is always higher for the dry season crop than the wet-season crop. Although there is limited data on fertilizer application and soil at present, the following fertilizer rates can be recommended for preliminary use in the Project area:

Cropping	Nutrient (kg/ha) N	P[1/]	K[1/]	Type of Fertilizer Complete[2/] 14-14-14	Urea	Ammonium Sulfate
					bags	
Wet season	81	60	52	8	1.5	or 3
Dry season	87	72	52	10	1	or 2

1/ These rates are in the form of $P_2 O_5$ and $K_2 O$, respectively.
2/ 15-15-15 formulation can also be used.

There are three stages in the growth of the rice plant when nitrogen is most needed: 1) the early vegetative stage - nitrogen supplied by basal application, 2) the active tillering stage-nitrogen supplied by first top-dressing, and 3) the panicle initiation stage-nitrogen supplied by the second top-dressing. The recommended staggered application of nitrogen fertilizer is based upon the above three stages.

For basal application it is recommended that 8 or 10 bags (50kgs) of nitrogen be applied during final harrowing and leveling. The balance of the fertilizer either in the form of urea or ammonium sulfate should be applied in two stages; half of the urea or ammonium sulfate to be applied in the first top-dressing at the most active tillering stage (about 20 - 25 days after transplanting) and the other half in the second top dressing at the panicle initiation stage (about 20 - 25 days before heading). To minimize loss of nitrogen and at the same time to maximize fertilizer efficiency, side-dressed fertilizer should also be incorporated into the soil where possible.

12.7 Weed Control

Weed proliferation can reduce rice yield by as much as 60%. To control the spread of weeds in irrigated paddy, chemicals (herbicides), a mechanical hand-pushed rotary weeder, manual weeding, or a combination of all three may be used.

A number of commonly used effective paddy herbicides in either granular or sprayable form are available in the market. TABLES IV - 35 and IV - 36 show the recommended herbicides in granular and sprayable types respectively. The granular type is preferred over the sprayable type for irrigated paddy conditions as it is easier to apply and does not require extra equipment. The recommended time of application and depth of irrigation water in the field must be folowed in order for the herbicide to be effective. If the granular type is not available, the sprayable type may be used. Since the effectiveness of the latter depends on spray coverage, the volume of solution and nozzle discharge, however, it is always advisable to get the assistance of knowledgeable extension technicians or BPI pest control officers in the locality.

If pre-emergence herbicide is not used mechanical weeding must be carried out as early as 15 - 20 days after transplanting. For ease of operation, the field should have a water depth of 2 - 3cm. A push-type rotary is passed between the rows of transplanted rice, once along and once across the rows. The assumption here, as strongly advocated in this report, is that rice seedlings are planted in straight rows.

Although some of the rice plants will be bent by side-sweeping of the rotary weeder, they will soon recover. Irrigation water is again applied at a depth of 5cm to suppress the growth of whatever weeds remain.

12.8 Pest and Disease Management

The following insect pests may endanger rice production:

(a) Green leaf hopper	- (Nephotettix impicticeps)
	- (N. apicales)
(b) Brown plant hopper	- (Nilaparvata lugens)
(c) Rice stemborers	- (Tryporyza innotata)
	- (T. incertulas)
	- (Chilo suppressalis)
	- (Sesamia inferens)
(d) Rice leaf folders	- (Cnaphalocroccis medinalis)
(e) Rice whorl maggot	- (Hydrellia philippina)
(f) Mole cricket	- (Gryllotalpa africana)
(g) Army worm	- (Pseudaletia separata)

The crop damage caused by these pests can be avoided or minimized by (1), planting resistant rice varieties and (2) timely application of appropriate agricultural chemicals, either spray or granular, broadcasted in 3 - 5cm of paddy water. Pest management is capsulized in TABLE IV - 37. TABLES IV -38 and IV - 39 list some of the recommended granular and sprayable insecticides for transplanted paddy. It is suggested that in the control of a specific pest the choice be matched to a specific insecticide only effective against the same pest. This will safeguard and maintain the ecological balance of the area. Likewise, it will also reduce contamination of the environment, development of insecticide tolerance in insects, and offer lower risks to humans, livestock and fish in the surrounding area. Insecticides used should also be selected for low residual effects and application of the same should occur only when economically necessary. Observation at IRRI, for example, indicated that a population distribution of 25 - 50 plant hoppers per hill during the latter half of the crop period will not cause significant loss in rice yield. Besides the above consideration, steps should be taken to monitor contamination of the environment, to develop cultural methods of pest control, to breed varieties resistant to pests and diseases and to develop urgently required bio-control measures.

12.9 Rat Control

Rats are one of the most destructive crop pests, particularily of rice and corn crops. More than 90% of rats caught in lowland and upland rice fields are rice field rats (Rattus rattus umbriventer K).

The period after harvest and before planting is the best time to implement rat control. During this period the vegetation which provides food and shelter for rats is minimal and the rat population is correspondingly low. Due to food shortage in the fields at this time, rats may be easily baited and trapped. A rat control program during the peak in rat population which usually coincides with harvest time on the other hand, although it may reduce the population will not protect the harvest. Rat control programs must be continued throughout the year. To this end, the following program is recommended:

(a) Cut weeds along dikes and canal banks and adjacent uncropped areas several weeks before transplanting, and during the early stages of crop growth. Practice sustained baiting, using rodenticides such as Ratoxin, Warfarin, Tomarin, Diphacin, Fumarin and Diphacinone.

(b) Mix the rodenticide with the bait material so that the poison concentration is around 0.25%. Possible bait includes rice, corn, toasted coconut and dried fish or snails.

(c) Immediately after transplanting or seeding select 5 -6 baiting stations for every ha of rice land to be protected. The stations must be at least 50m apart for good coverage.

(d) Make bait containers from available materials such as coconut husks, bamboo sections, tin cans, wooden boxes, banana stalks and cardboard. The containers can be placed along dikes or supported above the water level in the paddy.

Other good locations include dike inter-sections, canal banks and old threshing mounds.

(e) Begin baiting after transplanting. Put 5 - 6 tablespoons of bait in each container. After 3 days, check the containers. If all the the bait at baiting station has been consumed increase the number of containers at a single station to 3 and check again after 3 - 4 days. If all the baits in the containers are gone, increase the number of containers again. Maintain approximately 6 tablespoons of bait in each container.

(f) Continue to check the bait containers twice a week if the bait in each container is consumed. Anticipate increases in bait consumption to ensure that the containers are always supplied with bait. Otherwise, the rats may feed on the rice plants. The bait consumption usually rises rapidly during the period 3 - 8 weeks after transplanting when rats are moving into the paddies. Bait consumption then gradually levels off or declines dropping significantly at the heading stage due to low rat population.

(g) Replace wet or moldy baits regularly.

(h) During grain development, the few remaining rats may prefer rice grains to bait material. Changing or using different bait materials helps further reduce the rat population. Remove traps 2 - 3 weeks before harvest.

(i) At the above suggested rate, the total bait consumption will usually be about 40 - 50kg/ha costing approximately ₱50.

For additional information on rat control or for assistance in obtaining rat control materials and in making bait containers, a BPI pest control officer or a rice extension technologist assigned in the area should be consulted.

12.10 Water Management

There are 2 general management practices in irrigated paddy production: (1) continuous flooding or submergence, and (2) intermittent irrigation. Results from numerous studies on methods of irrigation vary widely. Both methods and variations on the same have advantages and disadvantages. In considering action of all factors involved in each general method, the continuous flooding method has been recommended for the Project area due to the following advantages:

i) sustains plant growth and yield even under conditions of low fertilizer application,

ii) requires less labor for water management,

iii) prevents physical damage to plants and helps eliminate growth of certain weeds, and

iv) assures efficiency of granular systemic pesticides and pre-emergence herbicides.

For better irrigation water economy, the following general guidelines on water depth are recommended:

i) The field should be covered with 1 - 2cm of water at transplanting.

ii) Water should be increased from 3 - 4cm after transplanting up to the onset of vegetative growth.

iii) Water depth should be as shallow as possible (2-3cm) at the tillering stage.

iv) The field should be kept well inundated at the formation stage with a water depth of 4 - 5cm.

v) Water should be gradually withdrawn from the field after full flowering until completely drained at about 2-3 weeks before harvest (Philippine Recommendations for Rice, 1977).

12.11 Zinc-deficiency Problem

Although Project area data lacks information on the adequacy of the average zinc content of the soil, induced deficiency of this micro nutrient may occur when the farming system is changed to intensive rice production.

The availability of zinc in the soil is a direct function of the soil's PH level. When the soil is inundated for paddy cultivation, the PH level of the soil rises. This rise decreases the solubility of zinc and hence its availability. The high organic matter content of the soil in the Project areas may also induce zinc deficiency.

Should a zinc-deficiency arise in the Project area corrective measures must be taken. The cheapest and most convenient method of rectifying zinc deficiency is to apply zinc-carrying materials to the soil. The most common are zinc oxide (ZnO) and zinc sulfate ($ZnSO_4$). If the deficiency is not severe, dipping rice seedlings in a 2% suspension of zinc oxide (ZnO) in water before transplanting may be sufficient. If a severe deficiency occurs application of 10 - 20kg/ha of zinc sulfate ($ZnSO_4$) may be required.

Zinc deficiency is characterized by rusty brown discoloration of the old leaves and chlorosis at the base of younger leaves, while the first visible symptom of the same is the appearance of interveinal chlorosis at the base of emerging leaves. These indications appear 2-4 weeks after transplanting. If deficiency is not severe, the symptom will disappear in 6 - 8 weeks and plants may recover although maturity will be delayed. (Source: Philippine Recommendation for Rice, 1977).

12.12 Harvesting, Threshing and Drying

Timely harvesting of rice plants is crucial for 2 reasons:

(a) To avoid losses in the field and (2) to prevent damage to the rice grains and thus to the quality of the rice. Under normal conditions, the average estimated loss due to untimely harvesting ranges from 5 - 10%. Rice must be harvested as soon as the crop reaches maturity, indicated by the golden yellow color of the grains.

(b) Untimely threshing and drying are also causes of unnecessary losses which can run as high as 10% likewise affecting the quality of palay grains. When humidity levels and weather conditions at harvest time are good, threshing should occur immediately after harvest. It is important to dry the palay soon after threshing to maintain palay quality. Either sun-drying or artificial dryers (if available in the locality) may be used.

13. PRODUCTION PRACTICES FOR MUNG BEANS

In order to increase the farmer's income, the Project's cropping system includes 3,600ha of mung bean cultivation after harvesting the dry season paddy and before land preparation for wet season paddy.

13.1 Mung Bean Varieties

There are three outstanding new mung varieties bred and one selected variety. The new varieties have wide regional adaptability, early and uniform maturity, resistance to pod shattering, large green seeds and high carbohydrate and protein content.

TABLE IV - 40 supplied by the Seed Certification Laboratory, Production Division of the Bureau of Plant Industry, shows the complete list of recommended mung bean varieties and their important characteristics.

13.2 Cultural Methods

(1) Land Preparation

Successful production of mung beans depends largely on thorough land preparation. Plowing the field two to three times followed by one rotavation or pegtooth harrowing will render the soil ideal for seed germination. A weed-free field is especially important as the mung bean is sensitive to early weed competition.

(2) Seed Inoculation

The mung bean, like other legume crops, utilizes free nitrogen from the air with the aid of nitrogen-fixing bacteria in the roots. The development of nodules in the roots indicates the presence of the bacteria. These bacteria can be employed to cross-inoculate other legumes like cowpeas, snapbeans, peanuts and others excluding soybean.

If mung beans are grown in a certain area for the first time, plant foliage may be pale in color and stunted. This indicates a nitorogen deficiency in the soil and a low or nonexistant nitrogen-fixing bacteria density necessitating artificial introduction of the organism.

The cheapest way of making the bacteria available in the soil is by inoculating the seed. A pure inoculant culture can be obtained from the Bureau of Soils. Before inoculation the seeds should be sprinkled with molasses diluted in water to moisten the seed coat. After inoculation, the seeds are placed in a tin or glass container. In order to achieve an even distribution of inoculum on the seeds, the container should be rotated slowly. Bacterial suspension in molasses should be used so that the inoculum will adhere to the seed coat, provide ready food to the bacteria and protect the bacteria from the heat of the sun after seeding during dry months. The inoculated seed should be air-dried or spread under a shaded place before planting. The inoculated seed should not be dried in the open sunlight however, because the bacteria may be destroyed.

(3) Planting and Spacing

Mung beans can be planted by various methods; the hill, row drill and broadcast method. For best results, the row drill method should be employed in the Project area.

(a) Row drill method - this method of planting consists of a definite distance between rows but no specific distance between plants. The seeds are drilled thinly in the row. This method cuts down the cost of labor as compared to hill planting. Mung bean varieties such as MG50-10A and BPI Glabrous 3 are best suited for this method due to their short height.

When using the mechanized seed drill planter, the rows should be adjusted to 50cm apart. Likewise, the seed spout opening should be adjusted to distribute 25 - 30 seeds/m row, equivalent to 30 - 35kg rate of seeding/ha. If the viability of seeds has dropped below 85%, the seed rate/ha should be adjusted accordingly. A final stand at harvest time of 20 - 25 plants/m may be expected. If all inputs in production are properly supplied and weather and environmental conditions are favorable, the expected yield should not be less than 1.5t/ha.

In the case of MD15-12, known as the "Super Mung" the distance between the rows should be 70cm, with a seed spout rate of 15 - 20 seeds/m along the row, equal to a seeding rate of 20 -25kg/ha. The projected final stand at harvest time with the above conditions is 10 - 14 plants/m/row.

Mung beans may also be planted by hand drilling. The seeding rates are 30 - 35kg/ha for the MG50-10A and BPI Glabrous 3, and 20 - 25kg/ha for the MD15-2.

(b) Row hill method - this method requires a specific distance between the hills and between rows. It requires fewer planting materials but despite extra labor input, results in a lower yield than the drill method. For MG50-10A and BPI Glabrous 3, seeding is 3 - 4 seeds/hill at a distance of 10 - 15cm amounting to 20 -25kg/ha for a 50cm distance between the rows. For MD15-2, the rows will be 70cm apart, and the hills 10 - 15cm, with 3 - 4 seeds/hill, requiring 15 - 20kg of seeds/ha.

(c) Broadcast method - this method requires less labor. The seeds are simply broadcast in the field and a pegtooth harrow passed over the same lengthwise and crosswise. When using "lithao" to make furrows, the lithao is first passed over the field lengthwise and crosswise.

For MG50-10A and BPI Glabrous 3, the rate of seeding required is 50 - 60kg/ha and 35 - 40kg/ha for MD15-2. Modified broadcast cultivation is made possible by use of the lithao. The disadvantages of this method are difficult weed control, overgrowth, and excessive seeding rate. The use of effective pre-emergence herbicide and growth regulators may overcome these problems.