TABLES

Table C.3.1 NUMBER OF BORING EXPLORATION

Hole No.	Depth (m)	Laugeon Tests (time)	Remark
No.1	30	5	Left bank
No.2	50	10	Left bank
No.3	30	6	Right bank
No.4	37	5	Right bank
Total	147	26	

Table C.3.2 NUMBER OF TEST PITS

	Hole No.	Depth (m)	Sampling*
Dam Axis	T-1	3.8	D.S
	T-2	3.3	U.D.S
	T-3	4.7	D.S
	T-4	2.0	D.S
	T-5	1.8	U.D.S
	T-6	3.0	D.S
	T-7	3.0	U.D.S
	T-8	3.6	D.S
Upstream	U.T-1	3.8	D.S
	U.T-2	3.4	D.S
	U.T-3	4.5	D.S
	U.T-4	3.0	D.S
	U.T-5	3.3	D.S
	U.T-6	1.9	D.S
Downstream	D.T-1	5.0	D.S
	D.T-2	4.0	D.S
	D.T-3	5.5	D.S
	D.T-4	6.3	D.S
Total		65.9	

Remarks: * D.S Disturbed sample
U.D.S Undisturbed sample

Table C.3.3 SEISMIC EXPLORATION

Exploration Line	Length (m)	Remark
1 line	2,500	Dam axis

Table C.3.4 NUMBER OF LABORATORY TESTS

Test Item	Dam Axis	Upstream	Downstream	Total
Physical Tests				
Specific Gravity	3	0	0	3
Moisture Content	3	1	2	6
Gradation	8	6	4	18
Atterberg Limits	8	6	4	18
Bulk density	3	0	0	3
Mechanical Tests				
Proctor Compaction	-	1	2	3
Unconfined Compression*	3 3	0	0	3 3
Direct Shear	3	1	2	6
Triaxial Compression (UU)	3	1	2	6
Permeability	-	1	2	3

Remarks: * Soil & Rock

Table C.3.5 NUMBER OF CONCRETE AGGREGATE TESTS

Test Item	Quantity	Remark
Abration	3	
Soundness	3	

Table C.4.1 SUMMARY OF LABORATORY TESTS (DAM AXIS)

Sample No.		T-1	T-2	T-3	T-4	T-5	T-6	T-7	T-8
Soil classification		SC	MH	SC	SC	SM	SC	SC	CL
Gradation clay (smaller than 2μ)	%	24.0	47.0	25.6	23.6	25.5	21.5	24.0	38.0
Silt (2-60μ)	%	12.2	11.5	14.2	12.4	15.0	9.5	13.5	20.9
Fine sand (60-200μ)	%	10.3	15.0	9.4	25.5	20.0	7.5	12.5	8.6
Medium sand (200-60μ)	%	16.5	14.5	14.3	22.5	17.0	8.7	15.5	14.0
Coarse sand (600-2.0mm)	%	25.0	11.6	29.4	12.0	14.4	25.3	19.6	13.1
Gravel (2.0mm-19.0mm)	%	12.0	0.4	7.1	4.0	8.1	25.6	14.9	5.4
Cobble (larger than 19mm)	%	0	0	0	0	0	0	0	0
Specific gravity		-	2.710	-	2.706	-	-	2.748	-
Liquid limit	%	45.25	57.7	48.85	39.65	48.50	48.30	49.10	47.30
Plastic limit	%	19.08	24.4	22.48	17.48	19.44	20.30	22.50	21.80
Plastic index	%	26.17	33.3	26.37	22.17	29.06	28.00	26.60	25.50
Moisture content	%	9.37	20.96	13.93	11.79	13.25	7.50	8.88	11.68
Bulk density	g/cm3	-	1.95	-	1.75	-	-	1.83	-
Direct shear cohesin	kg/cm2	-	0.3	-	0	-	-	0	-
Angle of internal frection	ø°	-	34.4	-	36.6	-	-	40.4	
Triaxial compression test cohesin	kg/cm2	-	1.19	-	0.58	-	-	1.18	-
Angle of internal frection	ø°	-	0	-	35.50	-	-	34.3	-
Unconfined compression strength	kg/cm2	-	0.58	-	1.40	-	-	5.05	-

Table C.4.2 SUMMARY OF LABORATORY TESTS (UPSTREAM)

Sample No.		UT-1	UT-2	UT-3	UT-4	UT-5	UT-6
Soil classification		GM	SC	SC	MH	SC	SM
Gradation clay (smaller than 2μ)	%	18.2	23.5	23.8	40.0	30.5	29.5
Silt (2-60μ)	%	9.8	8.5	14.4	20.0	10.0	8.0
Fine sand (60-200μ)	%	9.0	13.0	16.8	15.5	18.0	18.0
Medium sand (200-60μ)	%	8.0	12.5	15.0	11.5	19.0	14.5
Coarse sand (600-2.0 mm)	%	14.3	17.6	21.3	11.5	19.0	26.9
Gravel (2.0mm-19.0mm)	%	40.7	24.9	8.7	1.5	3.5	3.1
Cobble (larger than 19mm)	%	0	0	0	0	0	0
Specific gravity		-	-	-	-	-	-
Liquid limit	%	53.10	47.60	59.77	49.30	42.90	43.10
Plastic limit	%	22.90	20.29	29.95	20.30	18.80	17.60
Plastic index	%	30.20	27.31	29.75	29.00	24.10	25.50
Moisture content	%	11.27	12.05	13.68	21.74	6.74	8.15
Bulk density	g/cm3	-	-	-	1.75	-	-
Direct shear cohesin	kg/cm2	-	0	-	0	-	-
Angle of internal frection	ø°	-	36.2	-	36.6	-	-
Triaxial compression test cohesin	kg/cm2	-	0.45	-	0.58	-	-
Angle of internal frection	ø°	-	17.2	-	35.50	-	-
Unconfined compression strength	kg/cm2	-	-	-	1.40	-	-
Compaction							
Optimum moisture content	%	-	14.6	-	-	-	-
Maximum dry density	g/cm3	-	1.845	-	-	-	-
Permeability	x10-6cm/min	-	3.62	-	-	-	-

Table C.4.3 SUMMARY OF LABORATORY TESTS (DOWNSTREAM)

Sample No.		DT-1	DT-2	DT-3	DT-4
Soil classification		MH	SC	SC	SC
Gradation clay (smaller than 2μ)	%	43.0	18.0	28.5	17.5
Silt (2-60μ)	%	14.5	7.5	16.0	7.5
Fine sand (60-200μ)	%	16.5	18.5	10.5	7.0
Medium sand (200-60μ)	%	13.5	28.5	14.5	4.5
Coarse sand (600-2.0 mm)	%	8.1	21.5	19.5	30.3
Gravel (2.0mm-19.0mm)	%	4.4	6.0	11.0	33.2
Cobble (larger than 19mm)	%	0	0	0	0
Specific gravity		-	-	-	-
Liquid limit	%	57.20	30.75	45.35	44.45
Plastic limit	%	25.31	12.98	21.90	20.63
Plastic index	%	31.89	17.77	23.45	23.82
Moisture content	%	15.79	8.17	16.44	12.91
Bulk density	g/cm3	-	-	-	-
Direct shear cohesin	kg/cm2	-	0	-	0
Angle of internal frection	ϕ^o	-	40.8	-	38.3
Triaxial compression test cohesin	kg/cm2	-	0.14	-	0.07
Angle of internal frection	ϕ^o	-	23.5	-	9.7
Unconfined compression strength	kg/cm2	-	1.03	-	1.03
Compaction					
Optimum moisture content	%	-	11.7	-	12.9
Maximum dry density	g/cm3	-	1.98	-	2.06
Permeability	x10-6cm/min	-	27.6	-	0.547

Table C.4.4 SUMMARY OF ROCK TEST

ELAHERA - KALU GANGA SITE

Specimen No.	Diameter (mm)	Length (mm)	Bulk Density (g/cm3)	Unconfined Compressive Strength (MPa)
No.2 14-52-14-78 (Marble)	54.60	88.15	2.73	62.13
No.3 26-90-27-10 (Garnet Biotite Gneiss)	42.00	91.15	2.74	98.53
No.2 11-60-11-93 (Charnockite)	54.38	126.75	2.83	145.86

Table C.4.5 SUMMARY OF CONCRETE AGGREGATE TESTS

Sample No.	Abrasion Tests and 10% Fines Value				Soundness Tests
	Revolution	Percentage Wear (%)	Uniformity	10% Fines Value	Soundness
1	200	14.9	0.28	40	0.21
	1,000	52.9			
2	200	17.2	0.29	60	0.6
	1,000	59.8			
3	200	15.9	0.30	60	0.6
	1,000	53.8			

FIGURES

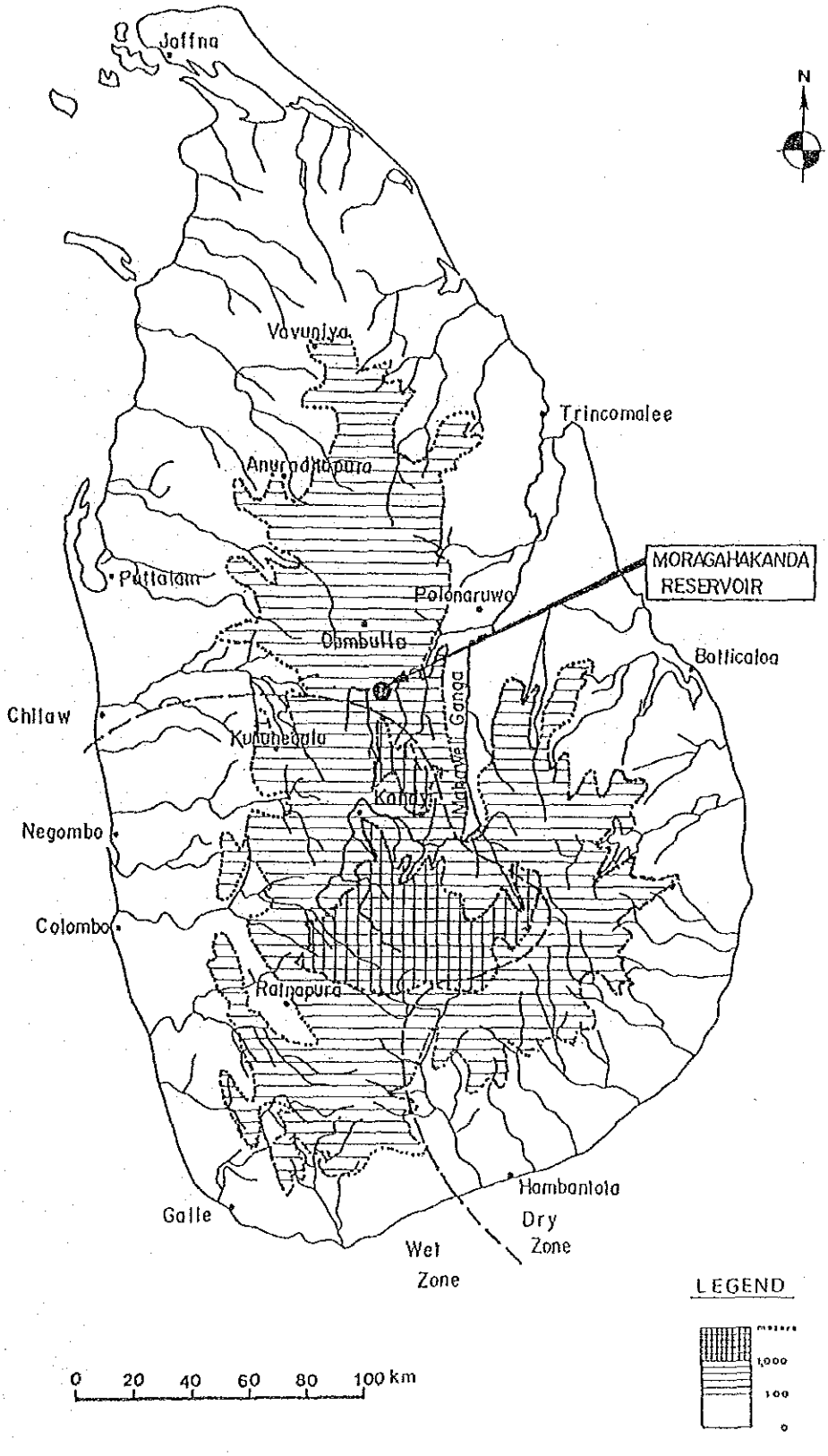

Fig. C.2-1 Physiographic Regions of Sri Lanka

GOVERNMENT OF DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA
MINISTRY OF LANDS, IRRIGATION AND MAHAWELI DEVELOPMENT

THE STUDY ON EXTENSION OF THE MORAGAHAKANDA AGRICULTURAL DEVELOPMENT PROJECT

JAPAN INTERNATIONAL COOPERATION AGENCY

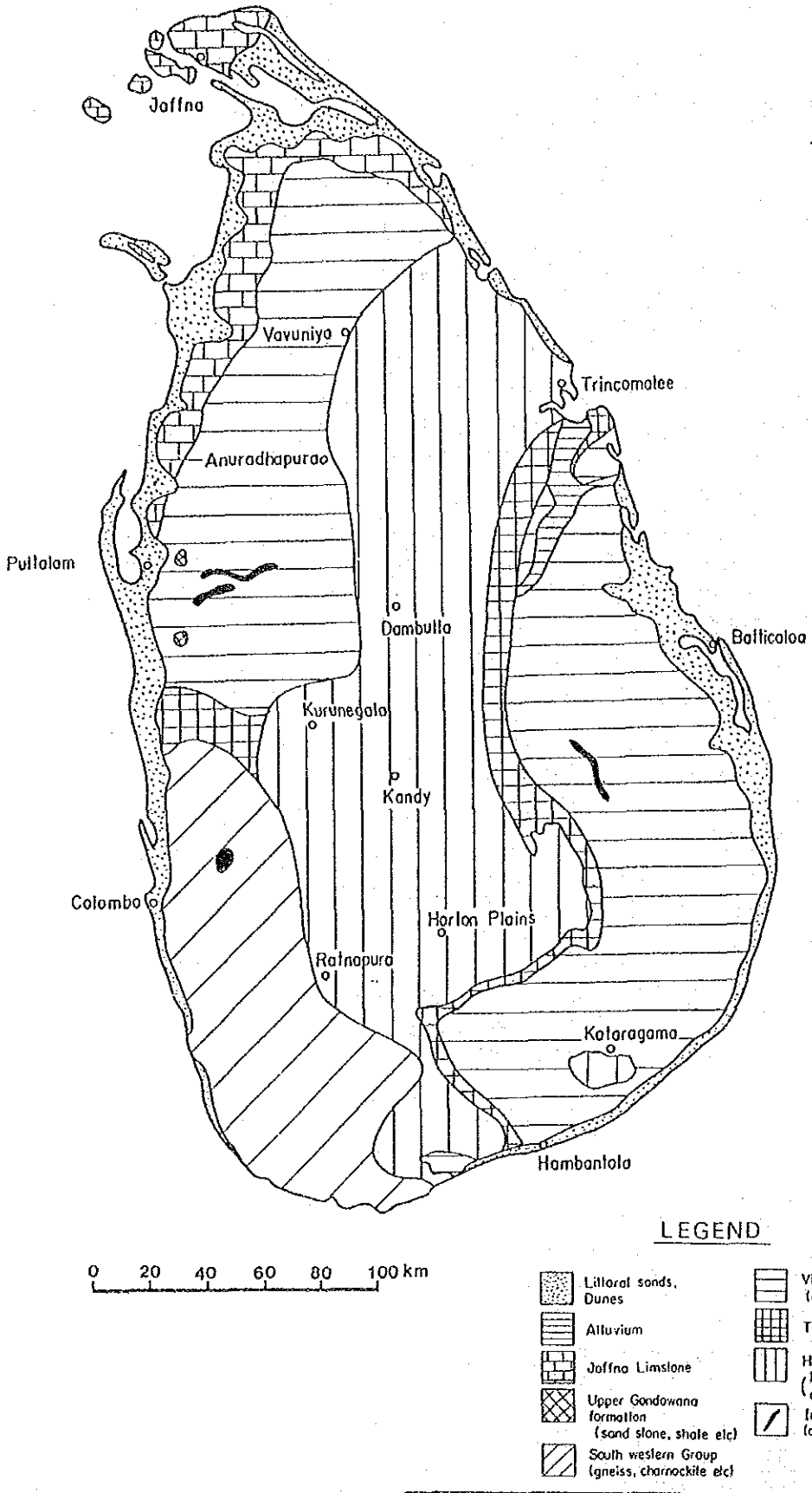

Fig. C.2-2 Geological Map of Sri Lanka

GOVERNMENT OF DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA
MINISTRY OF LANDS, IRRIGATION AND MAHAWELI DEVELOPMENT

THE STUDY ON EXTENSION OF THE MORAGAHAKANDA AGRICULTURAL DEVELOPMENT PROJECT

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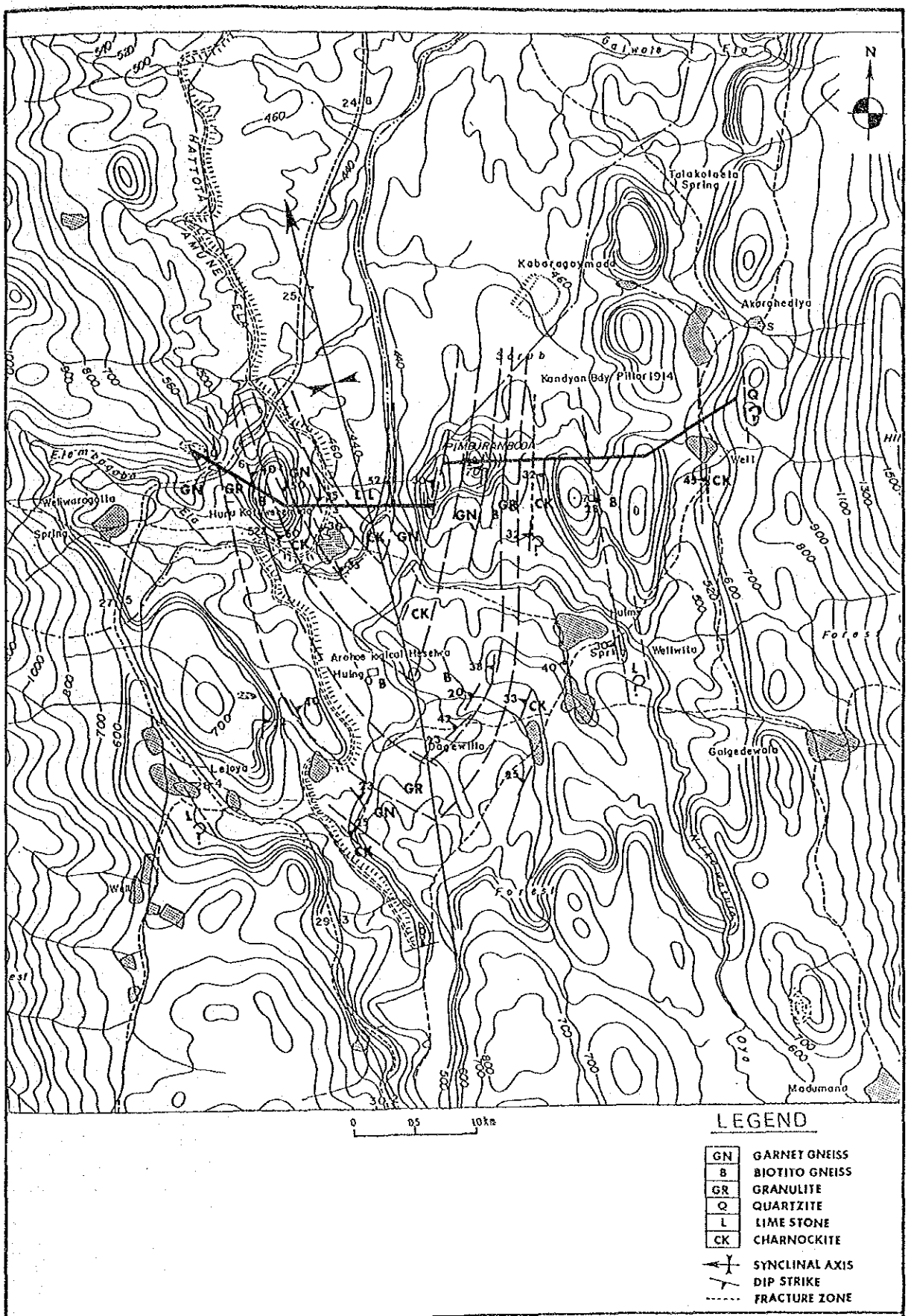

Fig. C.3-1 Geological Map of Kalu Ganga Damsite

GOVERNMENT OF DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA
MINISTRY OF LANDS, IRRIGATION AND MAHAWELI DEVELOPMENT

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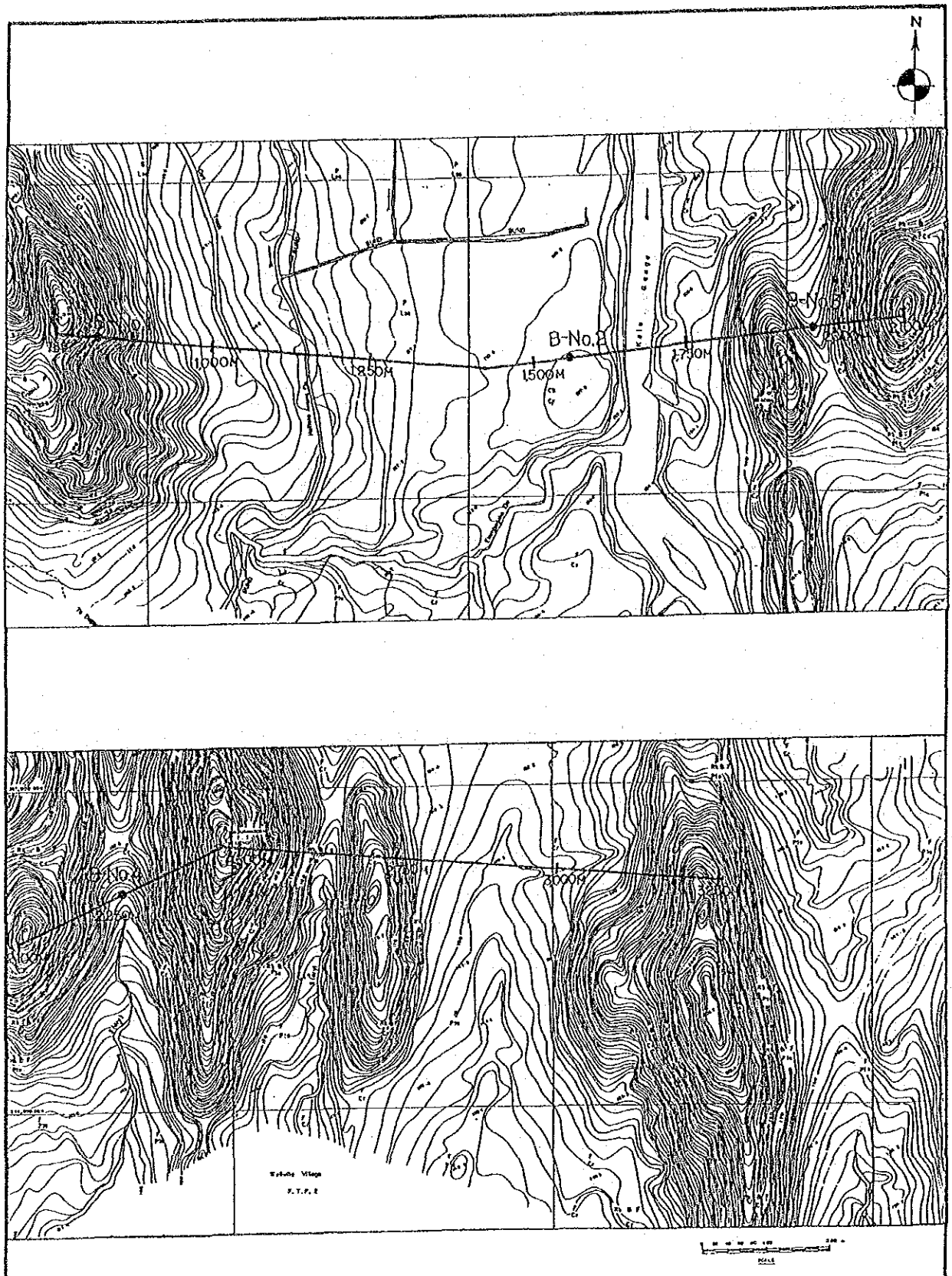

Fig. C.3-2 Location Map of Seismic Exploration

GOVERNMENT OF DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA
MINISTRY OF LANDS, IRRIGATION AND MAHAWELI DEVELOPMENT

THE STUDY ON EXTENSION OF THE MORAGAHAKANDA AGRICULTURAL DEVELOPMENT PROJECT

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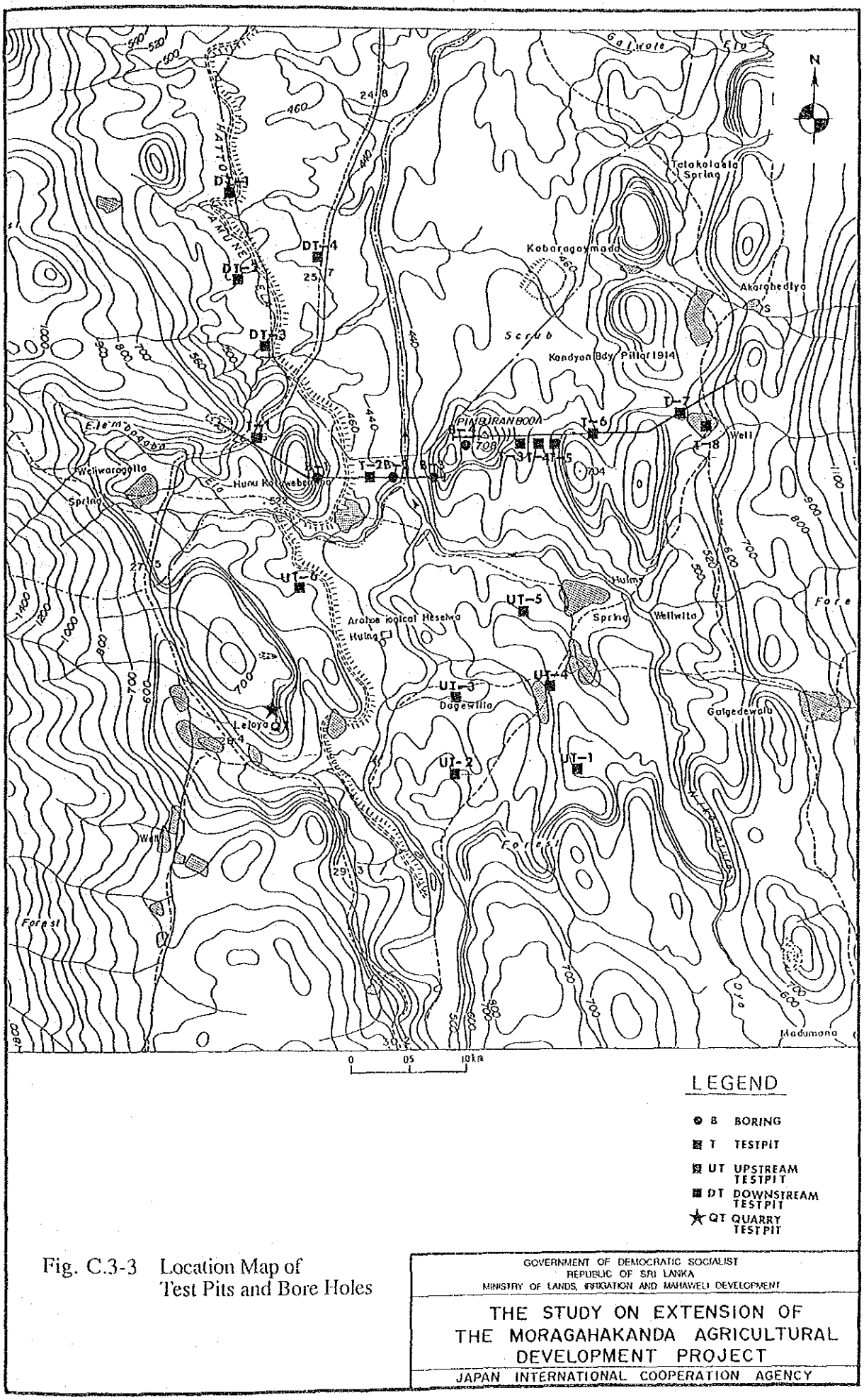

Fig. C.3-3 Location Map of Test Pits and Bore Holes

GOVERNMENT OF DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA
MINISTRY OF LANDS, IRRIGATION AND MAHAWELI DEVELOPMENT

THE STUDY ON EXTENSION OF THE MORAGAHAKANDA AGRICULTURAL DEVELOPMENT PROJECT

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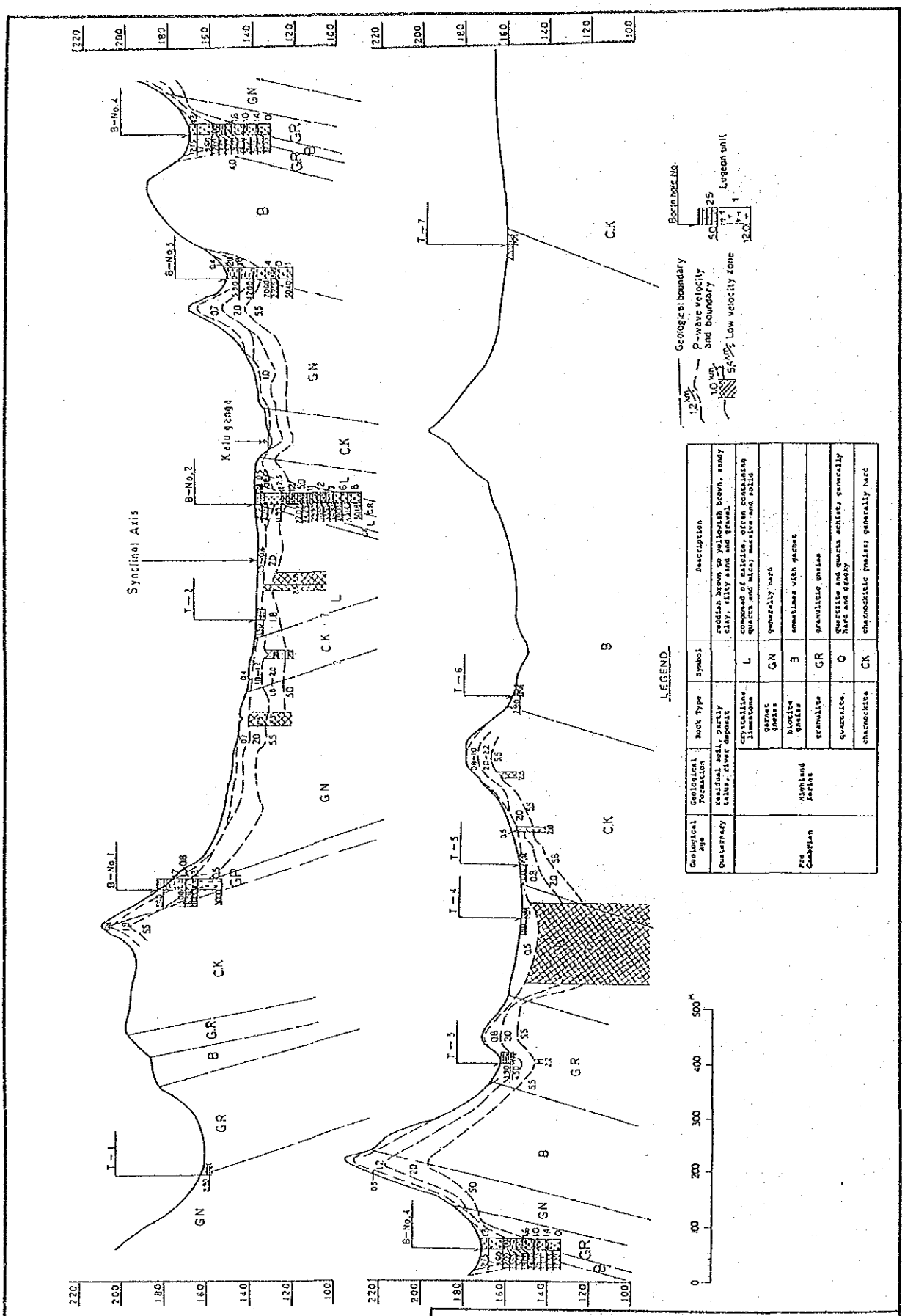

Fig. C.4-1 Geological Profile of Damsite

GOVERNMENT OF DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA
MINISTRY OF LANDS, IRRIGATION AND MAHAWELI DEVELOPMENT

THE STUDY ON EXTENSION OF THE MORAGAHAKANDA AGRICULTURAL DEVELOPMENT PROJECT

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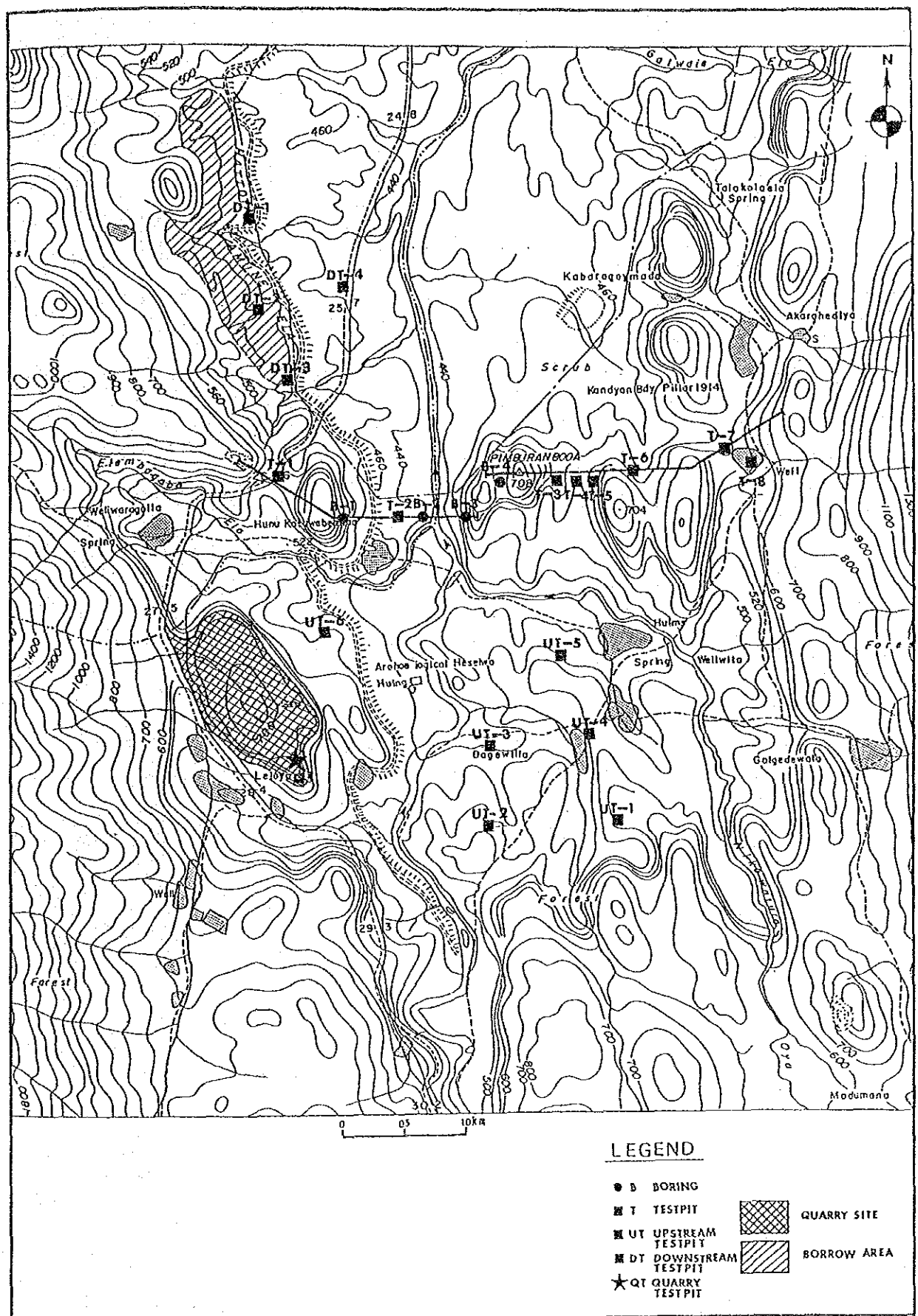

Fig. C.4-2 Location Map of the Proposed Quarry Site and Borrow Area

GOVERNMENT OF DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA
MINISTRY OF LANDS, IRRIGATION AND MAHAWELI DEVELOPMENT

THE STUDY ON EXTENSION OF THE MORAGAHAKANDA AGRICULTURAL DEVELOPMENT PROJECT

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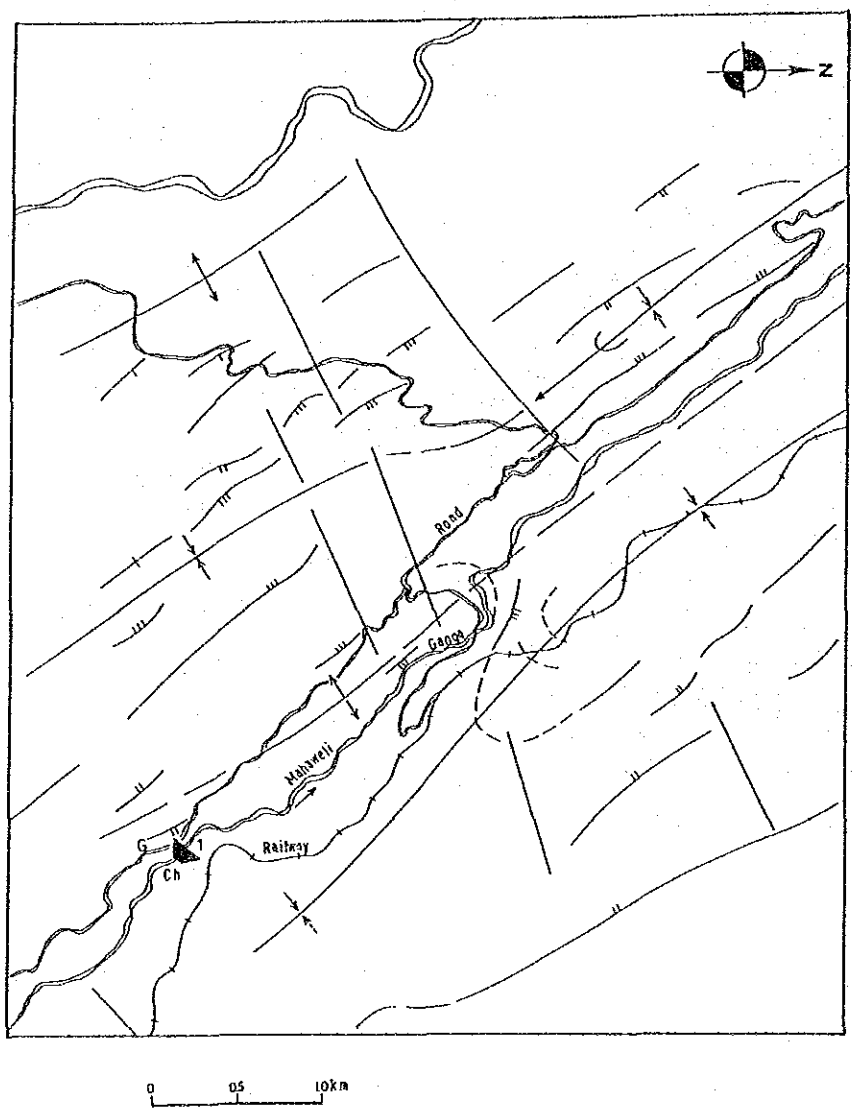

LEGEND

INTERPRETED FROM AERIAL PHOTOS

Synclinal axis with plunge

Surface trace of bedding or Gneissosity with dip

Fractures, Faults or Joints

FIELD OBSERVATIONS

Strike and dip of formation	
Quartzite	Q.
Charnockite	Ch.
Pegmatite	P.
Charnockitic Gneiss	Ch. Gn.
Biotite Gneiss	B. Gn.
Limestone	L.

Fig. C.4-3 Geological Map of Watawala Damsite

GOVERNMENT OF DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA
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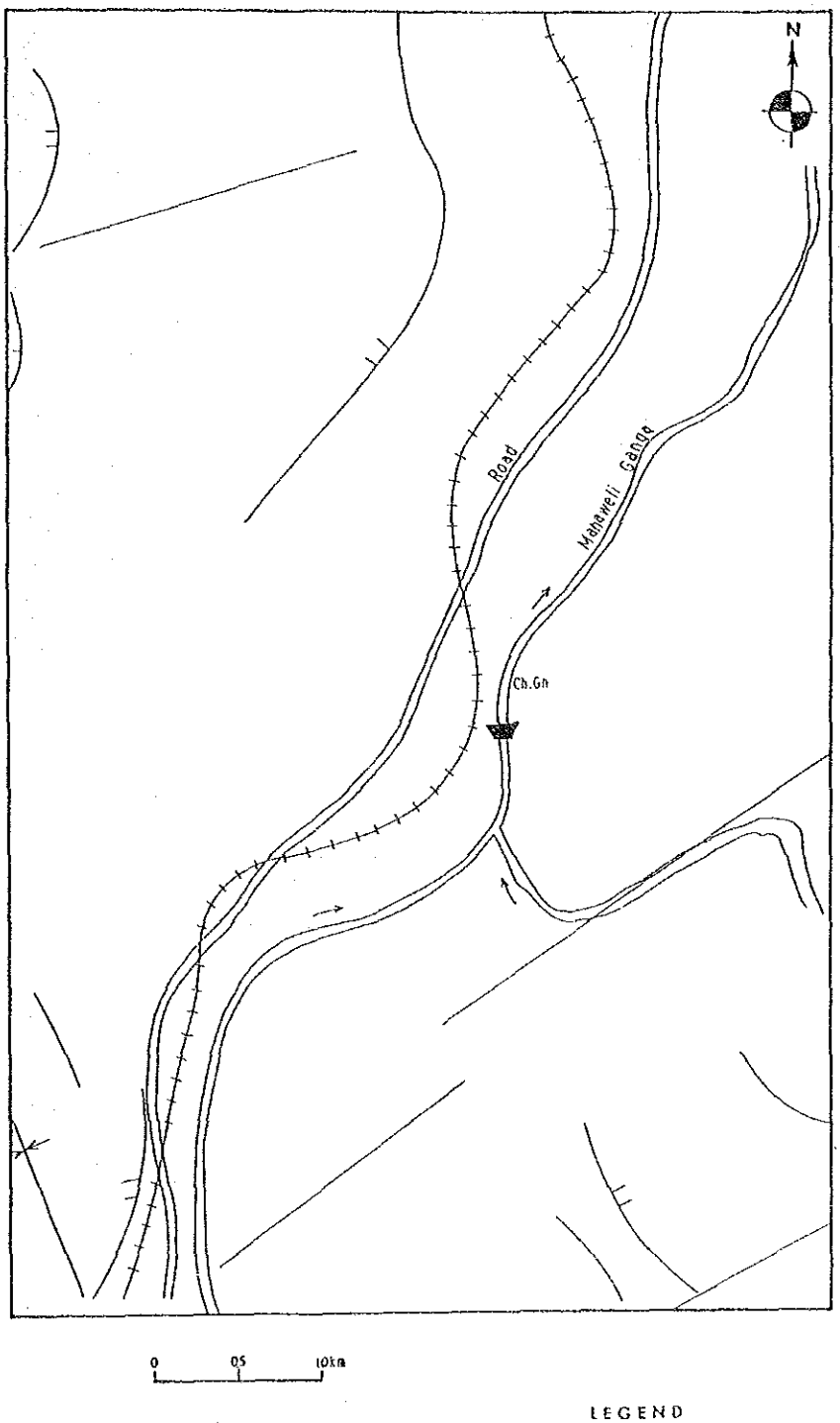
THE STUDY ON EXTENSION OF THE MORAGAHAKANDA AGRICULTURAL DEVELOPMENT PROJECT

JAPAN INTERNATIONAL COOPERATION AGENCY



LEGEND

INTERPRETED FROM AERIAL PHOTOS

Synclinal axis with plunge

Surface trace of bedding or Gneissosity with dip

Fractures, Faults or Joints

FIELD OBSERVATIONS

Strike and dip of formation	
Quartzite	Q.
Charnockite	Ch.
Pegmatite	P.
Charnockitic Gneiss	Ch. Gn.
Biotite Gneiss	B. Gn.
Limestone	L.

Fig. C.4-4 Geological Map of Ulapane Damsite

GOVERNMENT OF DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA
MINISTRY OF LANDS, IRRIGATION AND MAHAWELI DEVELOPMENT

THE STUDY ON EXTENSION OF THE MORAGAHAKANDA AGRICULTURAL DEVELOPMENT PROJECT

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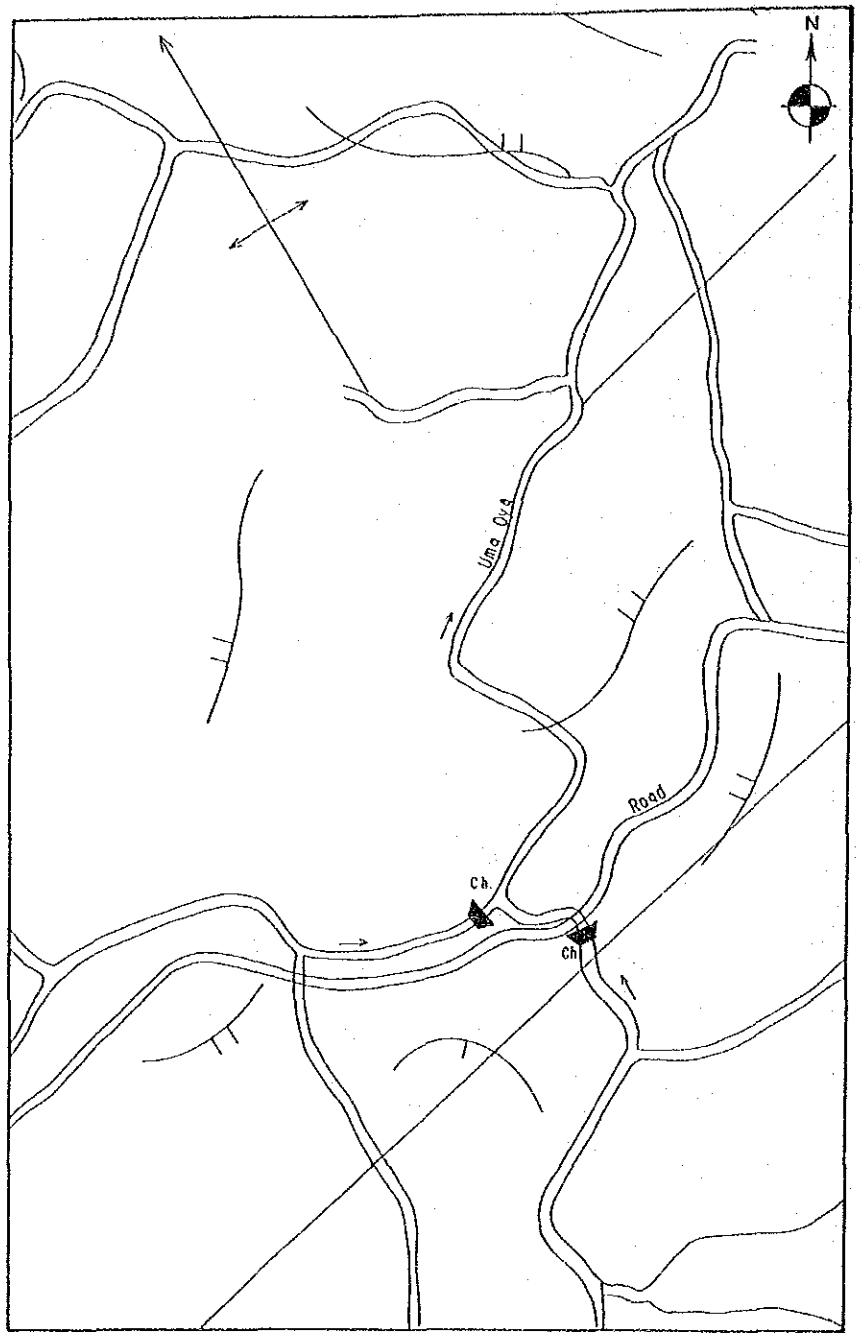

LEGEND

INTERPRETED FROM AERIAL PHOTOS

Synclinal axis with plunge

Surface trace of bedding or Gneissosity with dip

Fractures, Faults or Joints

FIELD OBSERVATIONS

Strike and dip of formation	
Quartzite	Q.
Charnockite	Ch.
Pegmatite	P.
Charnockitic Gneiss	Ch. Gn.
Biotite Gneiss	B. Gn.
Limestone	L.

Fig. C.4-5 Geological Map of Upper Uma Oya Damsite

GOVERNMENT OF DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA
MINISTRY OF LANDS, IRRIGATION AND MAHAWELI DEVELOPMENT

THE STUDY ON EXTENSION OF THE MORAGAHAKANDA AGRICULTURAL DEVELOPMENT PROJECT

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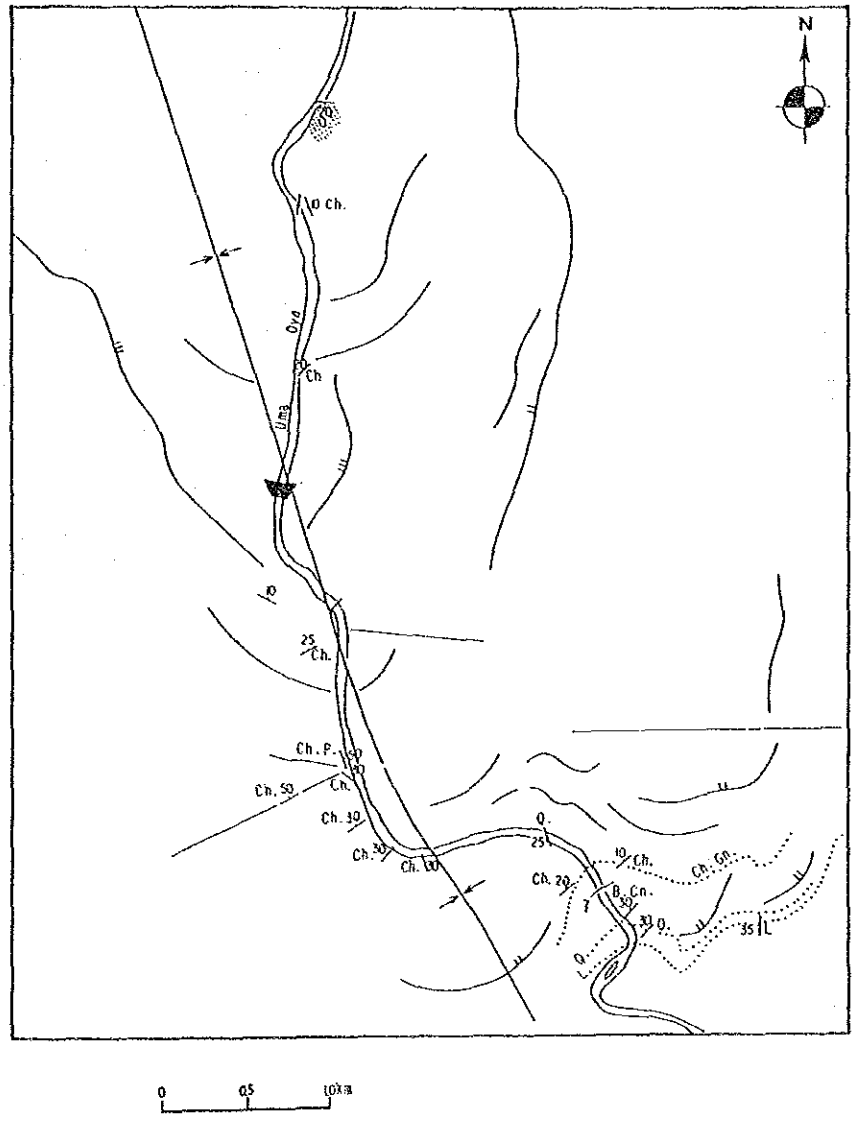

LEGEND

INTERPRETED FROM AERIAL PHOTOS

Synclinal axis with plunge

Surface trace of bedding or Gneissosity with dip

Fractures, Faults or Joints

FIELD OBSERVATIONS

Strike and dip of formation	
Quartzite	Q.
Charnockite	Ch.
Pegmatite	P.
Charnockitic Gneiss	Ch. Gn.
Biotite Gneiss	B. Gn.
Limestone	L.

Fig. C.4-6 Geological Map of Lower Uma Oya Damsite

GOVERNMENT OF DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA
MINISTRY OF LANDS, IRRIGATION AND MAHAWELI DEVELOPMENT

THE STUDY ON EXTENSION OF THE MORAGAHAKANDA AGRICULTURAL DEVELOPMENT PROJECT

JAPAN INTERNATIONAL COOPERATION AGENCY

LEGEND

INTERPRETED FROM AERIAL PHOTOS

Synclinal axis with plunge

Surface trace of bedding or Gneissosity with dip

Fractures, Faults or Joints

FIELD OBSERVATIONS

Strike and dip of formation	
Quartzite	Q.
Charnockite	Ch.
Pegmatite	P.
Charnockitic Gneiss	Ch.Gn.
Biotite Gneiss	B.Gn.
Limestone	L.

Fig. C.4-7 Geological Map of Wewatenna Damsite

GOVERNMENT OF DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA
MINISTRY OF LANDS, IRRIGATION AND MAHAWELI DEVELOPMENT

THE STUDY ON EXTENSION OF THE MORAGAHAKANDA AGRICULTURAL DEVELOPMENT PROJECT

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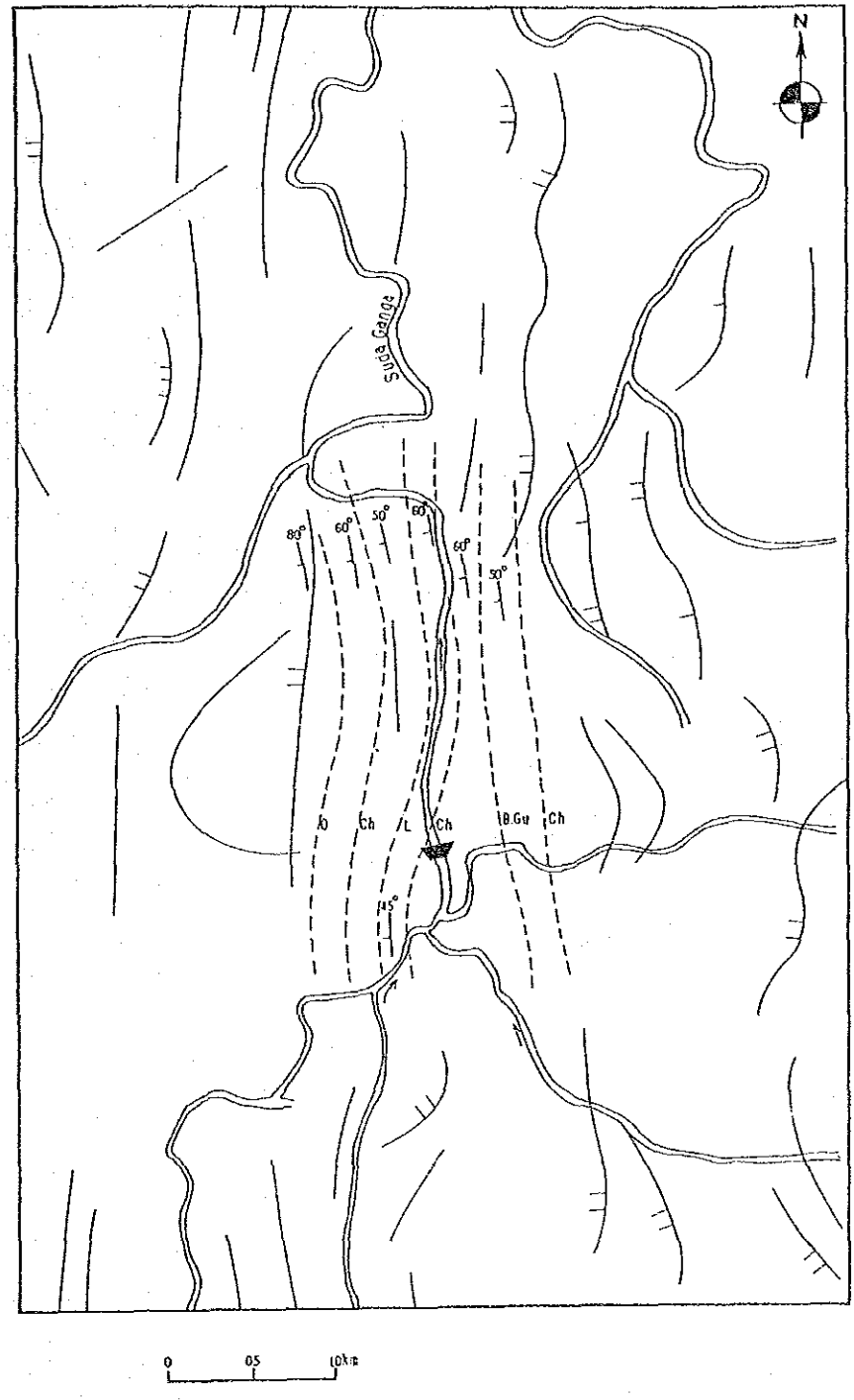

Fig. C.4-8 Geological Map of Sudu Ganga Damsite

GOVERNMENT OF DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA
MINISTRY OF LANDS, IRRIGATION AND MAHAWELI DEVELOPMENT

THE STUDY ON EXTENSION OF THE MORAGAHAKANDA AGRICULTURAL DEVELOPMENT PROJECT

JAPAN INTERNATIONAL COOPERATION AGENCY

GEOLOGICAL RECORD OF BORING HOLE No. 1

ELEVATION	181.5 m	DEPTH OF HOLE	30.07 m
MACHINE		DIAMETER OF HOLE	
DRILLED BY			

PROJECT Moragahakanda

LOCATION Kalu ganga dam axis

DATE OF DRILLING

DEPTH(m)	THICKNESS	COLOR	GEOLOGY	DESCRIPTION
0.70	0.70	Light brown	Topsoil	Pebbley, sandy silt with Humus and plant roots
1.00	0.30	do	Talus deposit	Sand, derived from completely weathered rock (Boulder?)
3.00	2.00	Light brown	Weathered rock	Samples of sand and soil derived from completely weathered rock
6.80				Samples of sand derived from completely weathered rock
				. 6.80 ~ 8.45 m Few Highly weathered rock pieces of garnet sillimanite gr phite gneiss
				. 8.45 ~ 10.00 m Moderately weathered ~ highly weathered, weak, medium grained garnet sillimanite graphite gneiss
				. 10.00 ~ 11.50 m Highly weathered rock and stained joints
			Garnet sillimanite gneiss	. 11.50 ~ 13.00 m Many foliation joins
13.00	10.00	Light brown		
				. 13.00 ~ 14.00 m Core Moderately weathered ~ Highly weathered
				. 14.00 ~ 16.80 m Core Slightly weathered ~ Moderately weathered
			Garnet granulite gneiss	. Highly weathered and broken core from 15.00 ~ 16.20 m fragments are iron stained
16.20	3.20			
				. 16.20 m ~ 17.70 m Slightly weathered, medium grained, very strong garnet biotite gneiss
			Garnet biotite gneiss	. Highly weathered calc silicate at the end of core
18.45	2.25			
				. 18.45 ~ 20.10 m Slightly weathered, very strong, medium grained, garnet granulite gneiss
				. 20.10 ~ 30.07 m Fresh, very strong, medium grained, garnet granulite gneiss
			Garnet granulite gneiss	
30.07	11.62			

ROCK QUALITY DESIGNATION (%) 20 40 60 80

CORE RECOVERY (%) 20 40 60 80

STANDARD PENETRATION TEST (N) 10 20 30 40 50

LUGEON VALUE 17 13 13 1 0.5

WATER TABLE

Fig. C.4-9 (1/4) Geological Record of Boring

GOVERNMENT OF DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA
MINISTRY OF LANDS, IRRIGATION AND MAHAWELI DEVELOPMENT

THE STUDY ON EXTENSION OF THE MORAGAHAKANDA AGRICULTURAL DEVELOPMENT PROJECT

JAPAN INTERNATIONAL COOPERATION AGENCY

GEOLOGICAL RECORD OF BORING HOLE No. 2

PROJECT Moragahakanda

LOCATION Kalu ganga dam axis

DATE OF DRILLING

ELEVATION	137.0 m	DEPTH OF HOLE	50.18 m
MACHINE		DIAMETER OF HOLE	3"
DRILLED BY			

DATE	ELEVATION (m)	DEPTH(m)	THICKNESS	GEOLOGICAL SYMBOL	COLOR	GEOLOGY	DESCRIPTION
		0.30	0.30		Brown	Top soil	Silty clay Humus and plant roots
		2.32	2.02		Reddish brown	Alluvial deposit	Silty clay
		4.25	2.33			Pegmatite	Completely weathered rock fragments containing large feldspar and quartz crystals Pegmatite
	5	5.53			Brown		Completely weathered, weak medium grained garnetferrous charnockite
							. 5.53 ~ 8.50 m Moderately weathered, very strong, medium grained garnetferrous charnockite Highly weathered and fractured through highly weathered and stained foliation joints from 5.53 ~ 5.78, 6.16 ~ 6.54, 6.70 ~ 6.93 fratured upto 8.35 m
	10						. 8.50 ~ 10.00 m Slightly weathered, strong garnet charnockite gneiss
							. 10.00 ~ 11.93 m Slightly weathered to fresh core but some foliation joints show complete weathering and iron stains
		11.93	7.68			Charnockite	
							. 11.93 ~ 13.00 m White gray coarse grained slightly weathered strong crystalline limestone
	15						. 13.00 ~ 15.00 m Slightly weathered to fresh core, highly weathered -Moderately weathered foliation joints with chloritic fillings are present
							. 15.00 ~ 16.30 m Slightly weathered core
							. 16.30 ~ 19.30 m Slightly weathered ~ Moderately weathered strong coarse grained crystalline limestone
	20						. 19.30 ~ 20.10 m Slightly weathered ~ Moderately weathered core Highly sections at 19.30 m, 20.00 ~ 20.10 m
							. 20.10 ~ 22.07 m Slightly weathered, coarse grained, strong impure crystalline limestone..
		22.07	10.14		White gray	Limestone	
					Greenish gray		Fresh, very strong coarse grained Pegmatite
		24.25	2.18				
(2-2)	25						. 24.25 ~ 26.56 m Strong, coarse grained fresh dolomitic marble (crystalline limestone) Core mechanically fractured few cross joints with cavities
							. 26.56 ~ 28.93 m Fresh dolomitic marble
		28.93	4.68		White	Limestone	
	30				Greenish Gray	Charnockite	Very strong Moderately weathered to fresh core
		30.65	1.72				

ROCK QUALITY DESIGNATION (%) 20 40 60 80

CORE RECOVERY (%) 20 40 60 80

STANDARD PENETRATION TEST (N) 10 20 30 40 50

LUGEON VALUE 28 18 11 12 8 11

WATER TABLE 6.95

(2-2)

Fig. C.4-9 (2/4) Geological Record of Boring (2-1)

GOVERNMENT OF DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA
MINISTRY OF LANDS, IRRIGATION AND MAHAWELI DEVELOPMENT

THE STUDY ON EXTENSION OF THE MORAGAHAKANDA AGRICULTURAL DEVELOPMENT PROJECT

JAPAN INTERNATIONAL COOPERATION AGENCY

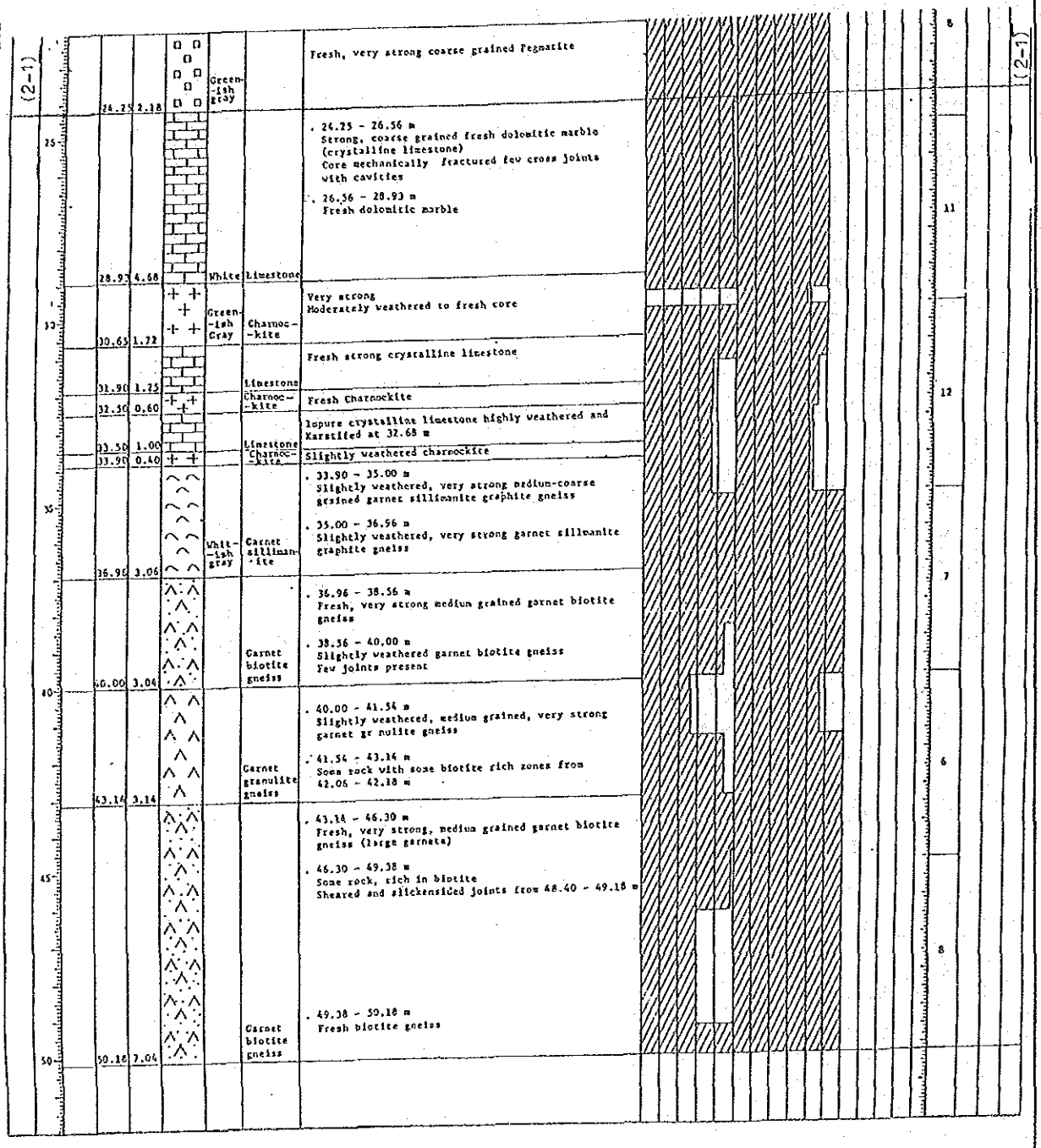

Fig. C.4-9 (2/4) Geological Record of Boring (2-2)

GOVERNMENT OF DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA
MINISTRY OF LANDS, IRRIGATION AND MAHAWELI DEVELOPMENT

THE STUDY ON EXTENSION OF THE MORAGAHAKANDA AGRICULTURAL DEVELOPMENT PROJECT

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GEOLOGICAL RECORD OF BORING HOLE No. 3

PROJECT Moragahakanda

LOCATION Kalu ganga dam axis

DATE OF DRILLING

ELEVATION	147.0 m	DEPTH OF HOLE	30.40 m
MACHINE		DIAMETER OF HOLE	φ
DRILLED BY			

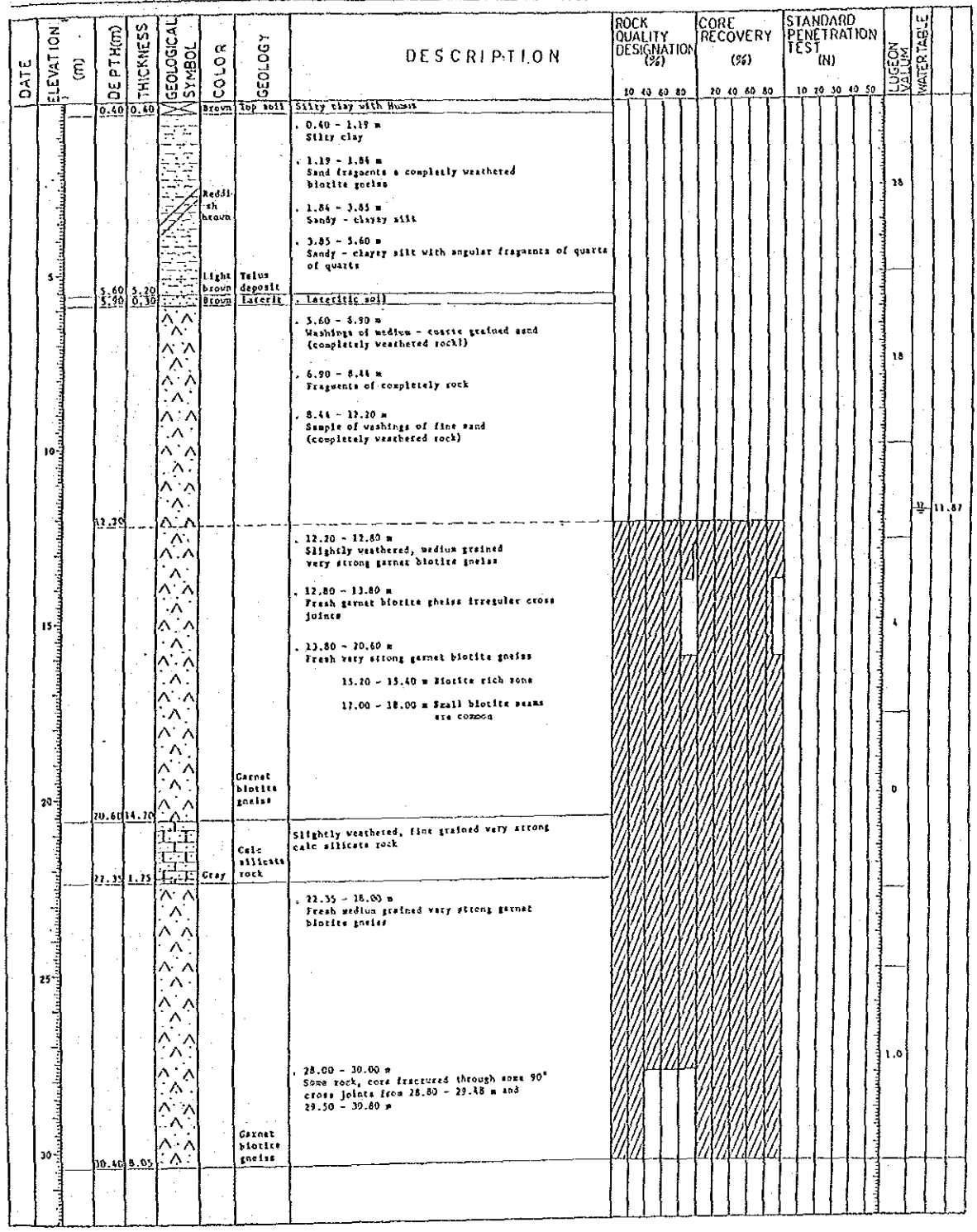

Fig. C.4-9 (3/4) Geological Record of Boring

GOVERNMENT OF DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA
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THE STUDY ON EXTENSION OF THE MORAGAHAKANDA AGRICULTURAL DEVELOPMENT PROJECT

JAPAN INTERNATIONAL COOPERATION AGENCY

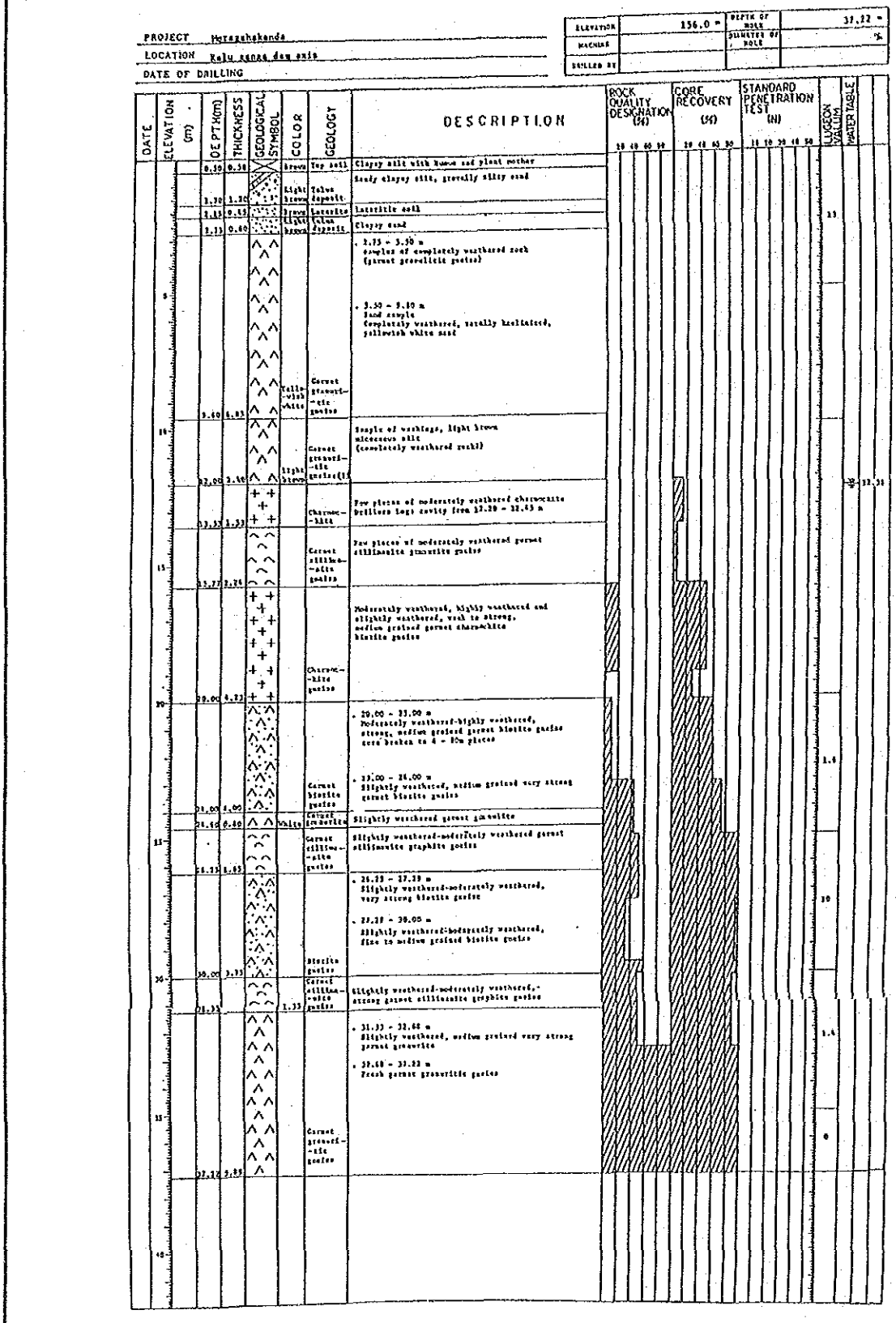

Fig. C.4-9 (4/4) Geological Record of Boring

GOVERNMENT OF DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA
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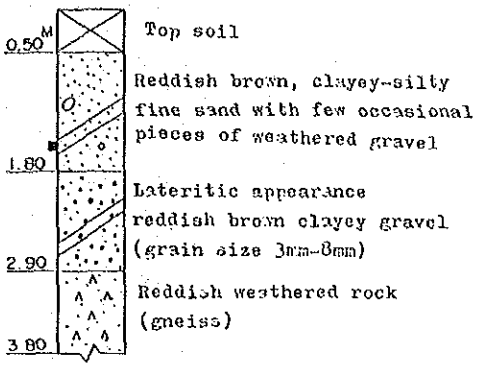
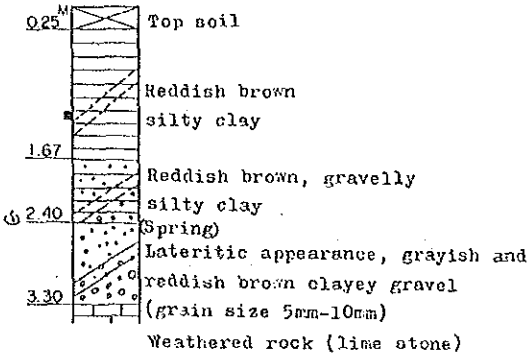
THE STUDY ON EXTENSION OF THE MORAGAHAKANDA AGRICULTURAL DEVELOPMENT PROJECT

JAPAN INTERNATIONAL COOPERATION AGENCY



T-1



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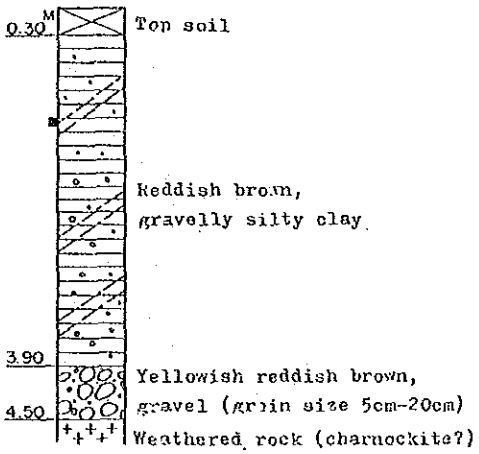

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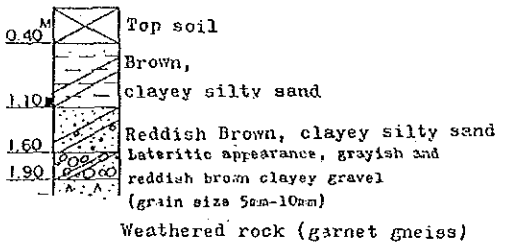

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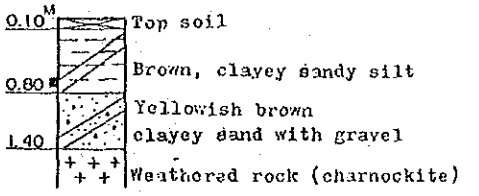

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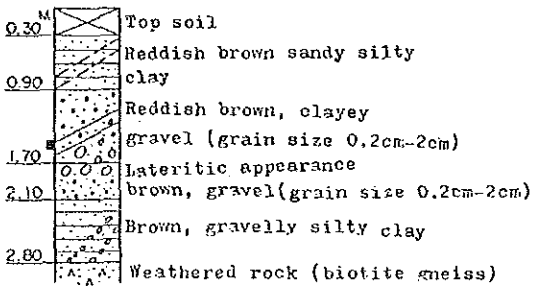


T-6

LEGEND

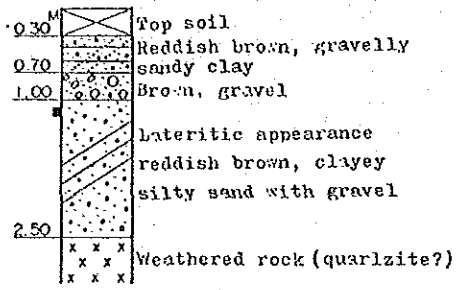
■ SAMPLING

Fig. C.4-10 (1/4) Log of Test Pits

GOVERNMENT OF DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA
MINISTRY OF LANDS, IRRIGATION AND MAHAWELI DEVELOPMENT

THE STUDY ON EXTENSION OF THE MORAGAHAKANDA AGRICULTURAL DEVELOPMENT PROJECT

JAPAN INTERNATIONAL COOPERATION AGENCY



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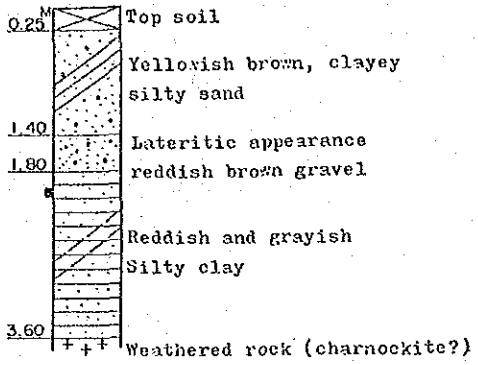


T – 8

LEGEND

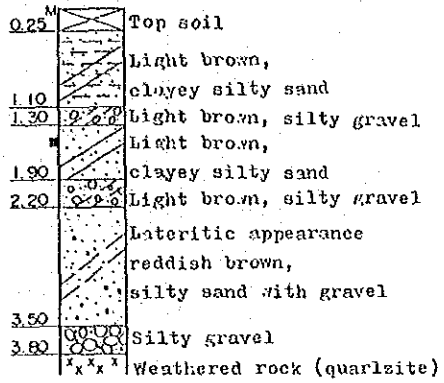
■ SAMPLING

Fig. C.4-10 (2/4) Log of Test Pits

GOVERNMENT OF DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA
MINISTRY OF LANDS, IRRIGATION AND MAHAWELI DEVELOPMENT

THE STUDY ON EXTENSION OF THE MORAGAHAKANDA AGRICULTURAL DEVELOPMENT PROJECT

JAPAN INTERNATIONAL COOPERATION AGENCY



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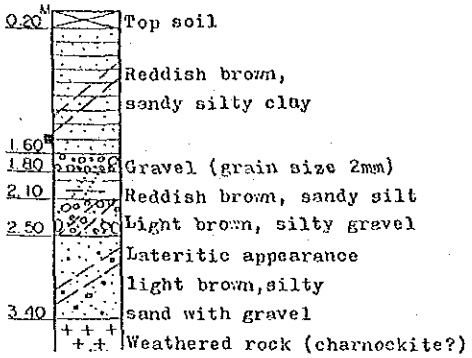

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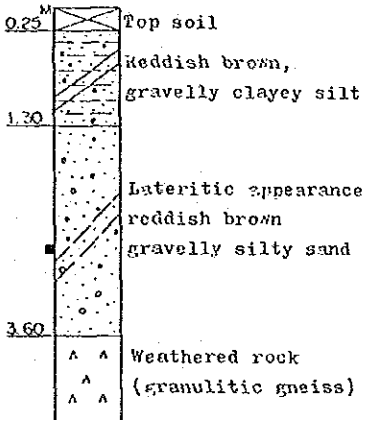

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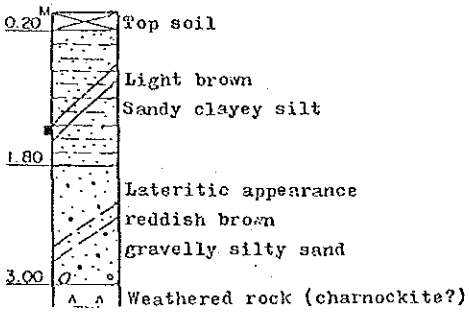

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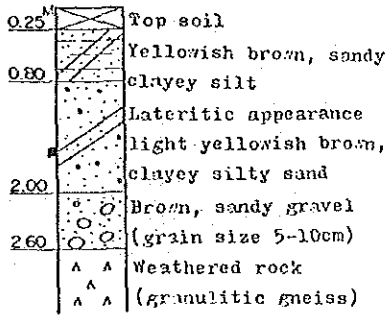

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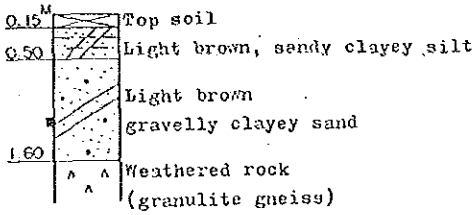


UT – 6

LEGEND

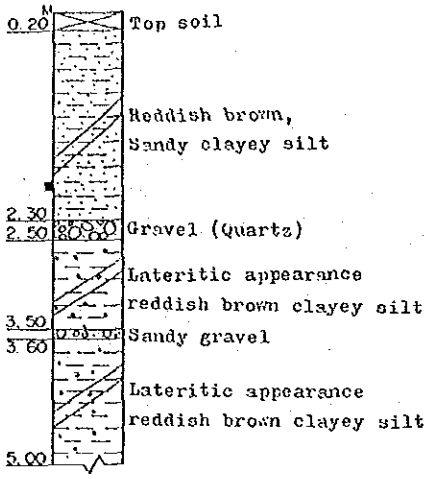
■ SAMPLING

Fig. C.4-10 (3/4) Log of Test Pits

GOVERNMENT OF DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA
MINISTRY OF LANDS, IRRIGATION AND MAHAWELI DEVELOPMENT

THE STUDY ON EXTENSION OF THE MORAGAHAKANDA AGRICULTURAL DEVELOPMENT PROJECT

JAPAN INTERNATIONAL COOPERATION AGENCY



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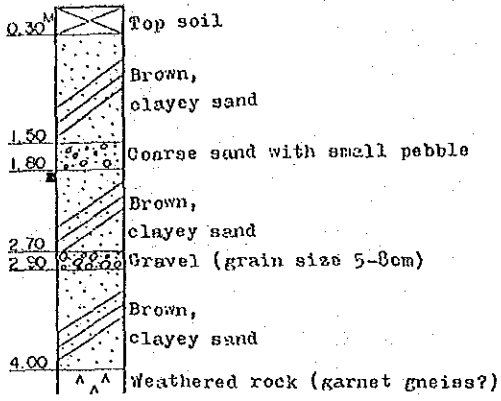

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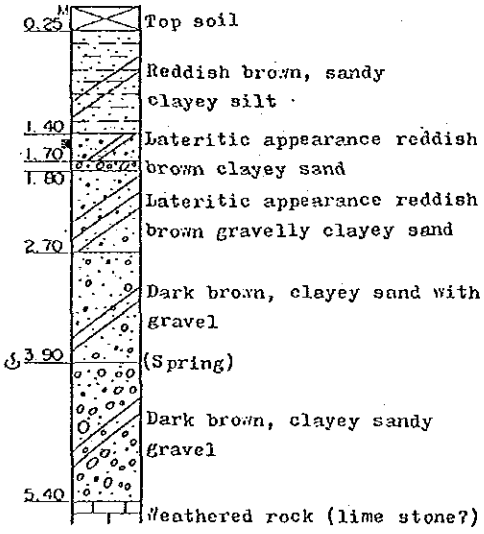

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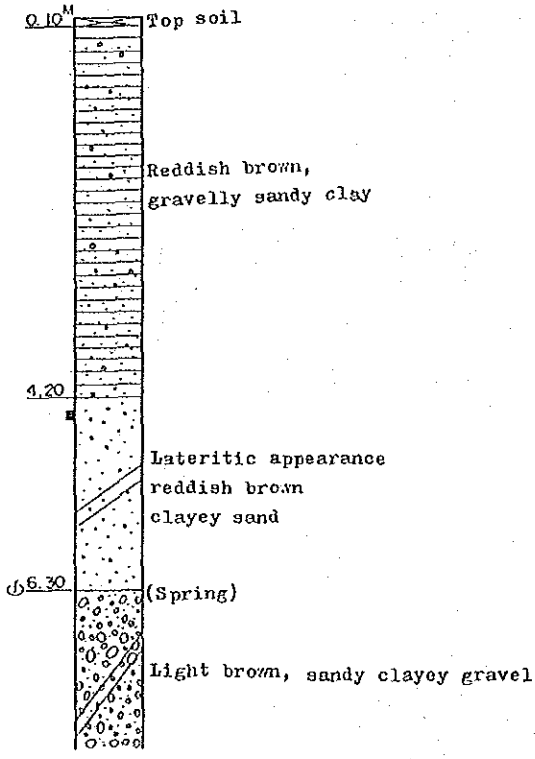

DT – 4

LEGEND

■ SAMPLING

Fig. C.4-10 (4/4) Log of Test Pits

GOVERNMENT OF DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA
MINISTRY OF LANDS, IRRIGATION AND MAHAWELI DEVELOPMENT

THE STUDY ON EXTENSION OF THE MORAGAHAKANDA AGRICULTURAL DEVELOPMENT PROJECT

JAPAN INTERNATIONAL COOPERATION AGENCY

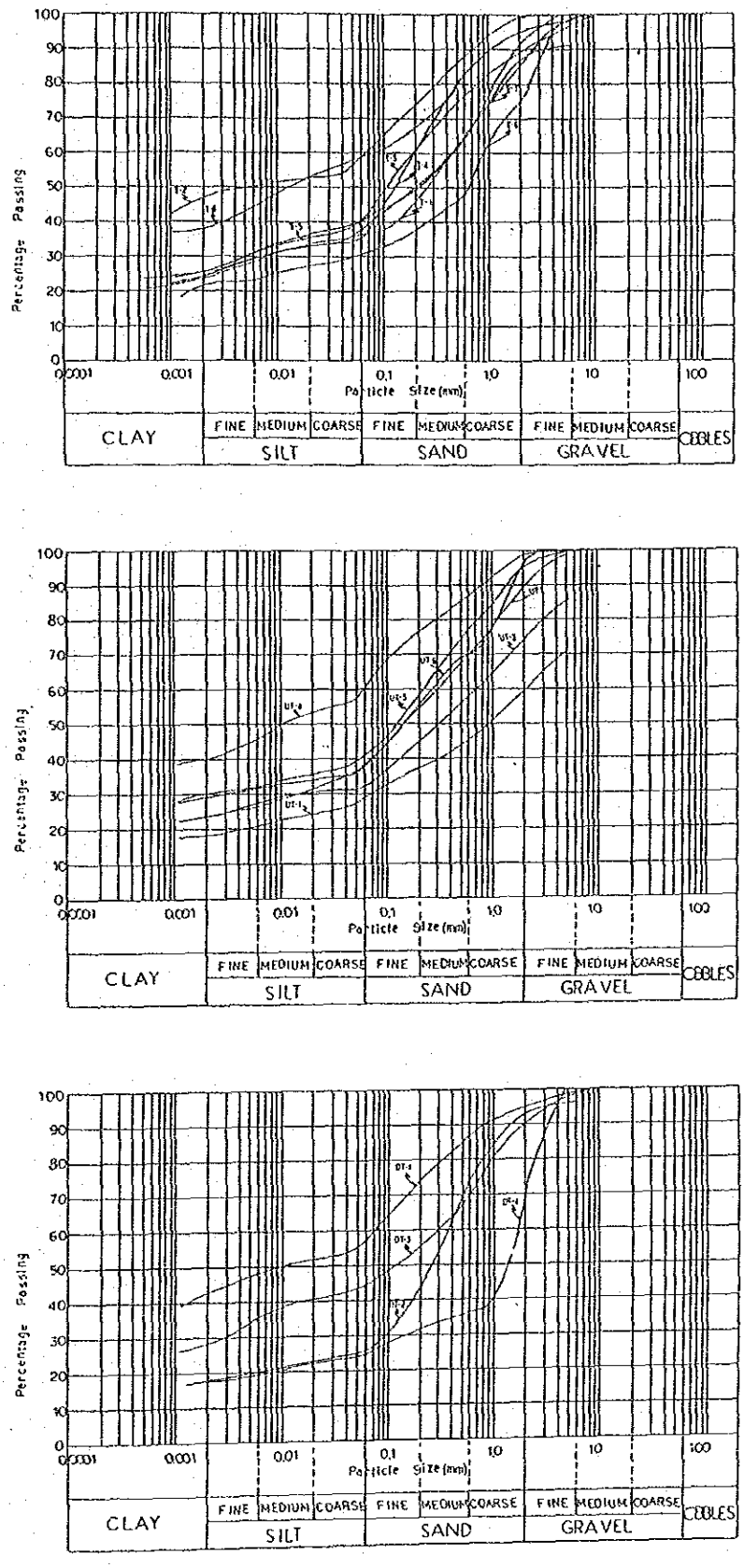

Fig. C-4-11 Gradation Curve

GOVERNMENT OF DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA MINISTRY OF LANDS, IRRIGATION AND MAHAWELI DEVELOPMENT
THE STUDY ON EXTENSION OF THE MORAGAHAKANDA AGRICULTURAL DEVELOPMENT PROJECT
JAPAN INTERNATIONAL COOPERATION AGENCY

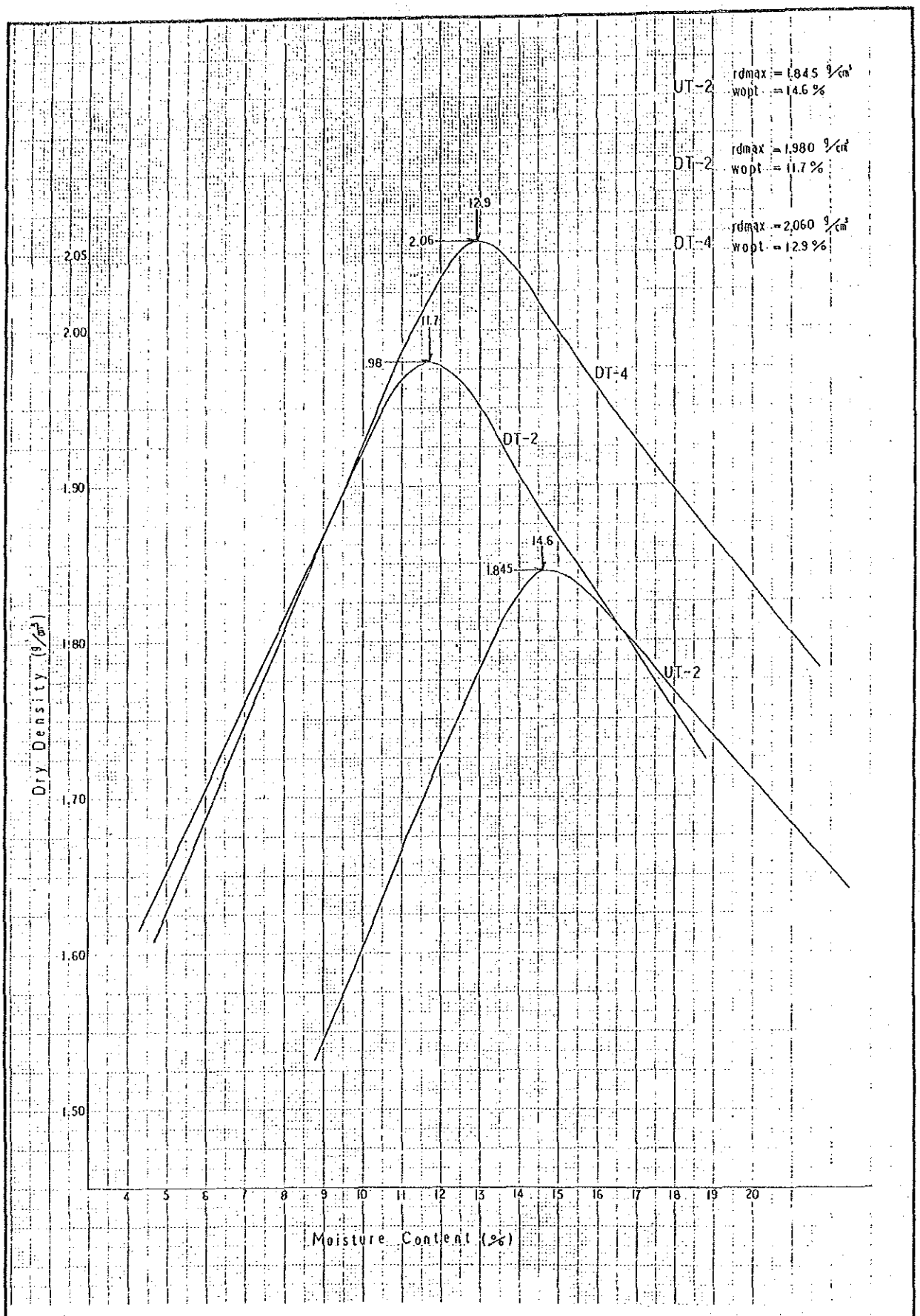

Fig. C-4-12 Compaction Curve

GOVERNMENT OF DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA
MINISTRY OF LANDS, IRRIGATION AND MAHAWELI DEVELOPMENT

THE STUDY ON EXTENSION OF THE MORAGAHAKANDA AGRICULTURAL DEVELOPMENT PROJECT

JAPAN INTERNATIONAL COOPERATION AGENCY

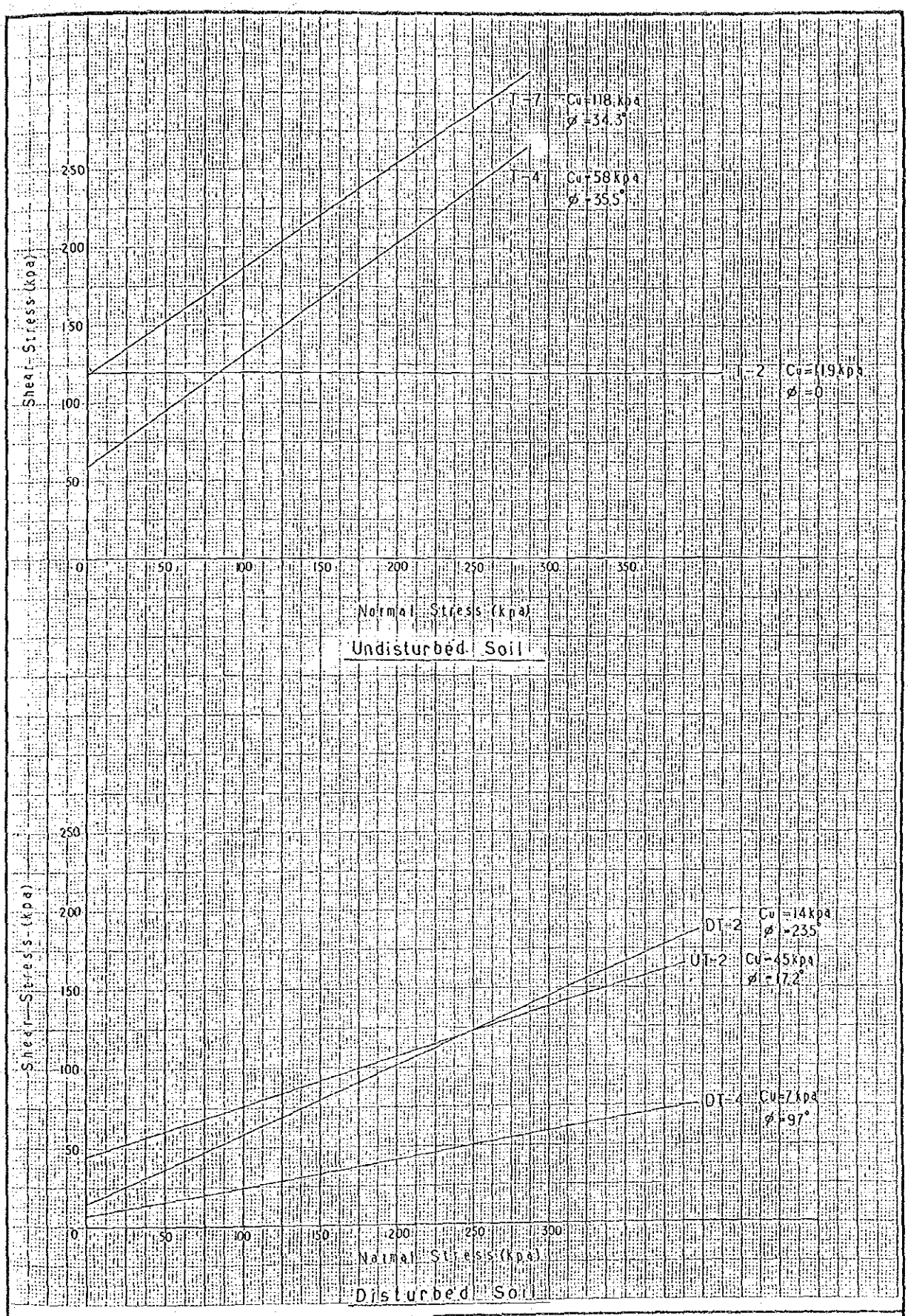

Fig. C-4-13 Soil Shear Strength

GOVERNMENT OF DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA
MINISTRY OF LANDS, IRRIGATION AND MAHAWELI DEVELOPMENT

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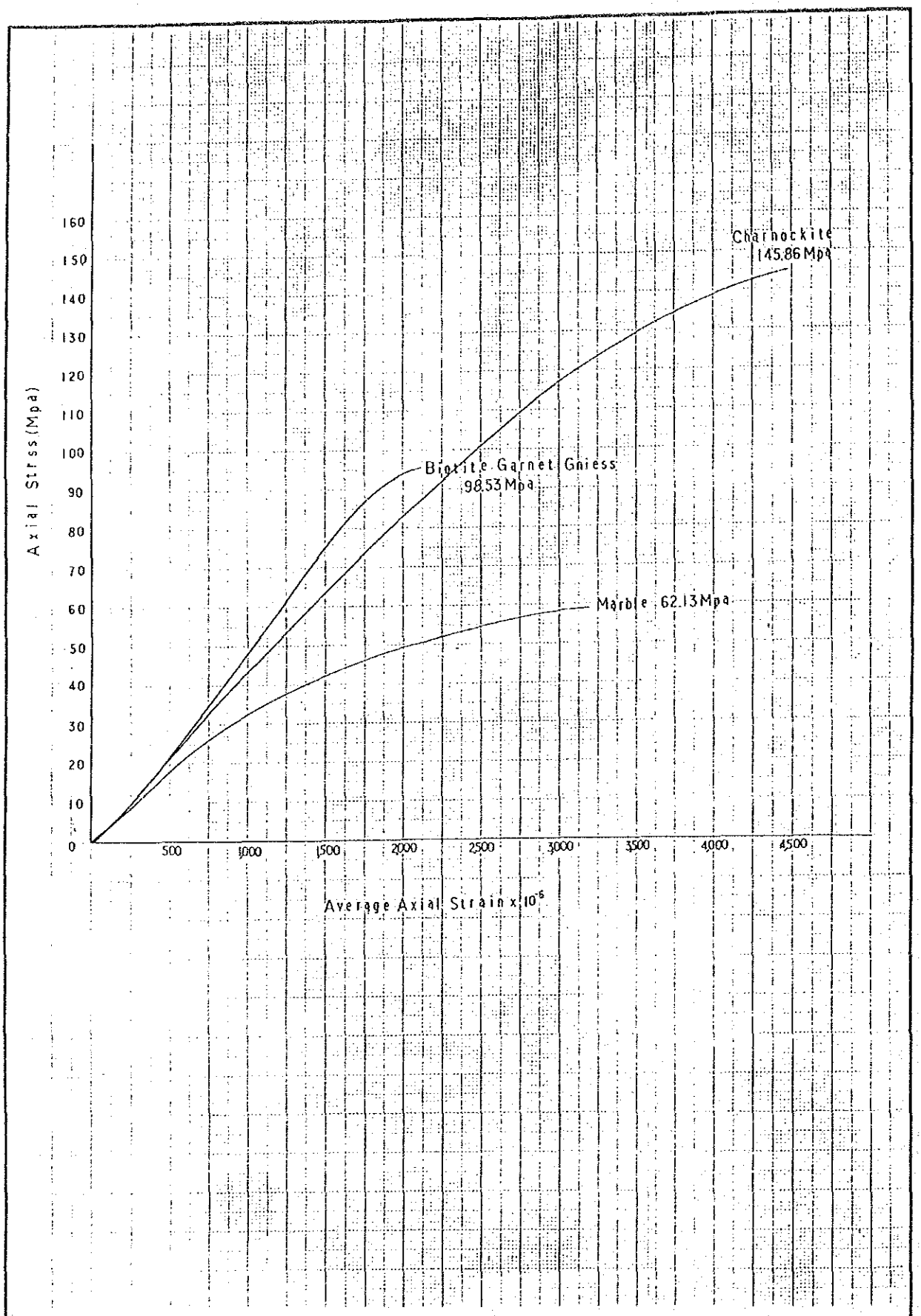

Fig. C-4-14 Rock Shear Strength

GOVERNMENT OF DEMOCRATIC SOCIALIST
REPUBLIC OF SRI LANKA
MINISTRY OF LANDS, IRRIGATION AND MAHAWELI DEVELOPMENT

THE STUDY ON EXTENSION OF
THE MORAGAHAKANDA AGRICULTURAL
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JAPAN INTERNATIONAL COOPERATION AGENCY

ANNEX–D

SOIL AND LAND CLASSIFICATION

ANNEX - D

SOIL AND LAND CLASSIFICATION

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LIST OF TABLES

LIST OF FIGURES

ANNEX-D SOIL AND LAND CLASSIFICATION

D.1 GENERAL

D.1.1 Definition of the Study Area

This ANNEX describes the results of the soil and land classification studies carried out during the Phase-II study. The study also includes inventorization of information on soils that has been generated in previous studies.

The area consists of six (6) Mahaweli Systems and a Zone. Their distribution is shown in Fig. D.1-1 and their names, gross extent and the irrigable areas coming under them are as follows:

(Unit : ha)

System/ Zone	Gross Extent	Proposed Irrigable Area*1
F	5,300	1,900
H	89,200	42,400
IH	7,100	4,700
MH	57,400	26,300*2
I	144,500	61,300*2
M	85,300	25,000
NWDZ (NW-1)	35,600	13,250
Total	424,400	174,850

Remarks; *1 : Refer to ANNEX F.
*2 : Including non-irrigated cashew land.

The Mahaweli System F, in general as defined in FAO/UNDP studies, lie in the northern part of the Mahaweli Ganga basin, and is bordered by the Kalu Ganga on the east, the Kalu Ganga-Elahera canals on the west and Amban Ganga on the north. The Systems H and IH are generally in Kala Oya and Malwatu Oya basins respectively and are to be irrigated with water from the Polgolla diversion of the Mahaweli Ganga. The existing irrigated area of System MH comprises Huruluwewa irrigation scheme. The extension area of System MH (newly developable area) is located at the middle reach of the Yan Oya basin and is bordered by Kahatagasdigiliya village in the west, watershed of the Nelu Oya in the east and Huruluwewa irrigation scheme (existing irrigated area of System MH) in the south. The gross study area of Systems I and M, boundaries of which were defined by FAO/UNDP, are located in the North Central River Basin (NCRB). The NWDZ (NW-1) lies in the Mi-Oya basin as defined in the Transbasin Diversion Study in 1981.

D.1.2 Past Studies With Respect to Soils in the Study Area

The findings of soil and land classification studies in Mahaweli Systems concerned and the NWDZ are presented in the following reports:

(1) A REPORT ON A SURVEY OF THE RESOURCES OF THE KELANI-ARUVI AREA, VOLUME 1, HUNTING SURVEY CO., LTD., CANADA, 1962

(2) A REPORT ON A SURVEY OF THE RESOURCES OF THE MAHAWELI GANGA BASIN, PART 1, HUNTING SURVEY CO., LTD., CANADA, 1963

(3) TRANSBASIN DIVERSION STUDY, SOILS AND LAND SUITABILITY TEXT, MAPS (SCALE: 1/63,300), JOINT VENTURE MAHAWELI TRANSBASIN DIVERSION, 1981

(4) FEASIBILITY STUDY FOR STAGE II (System H) MAHAWELI GANGA DEVELOPMENT PROJECT I, VOLUME III-LAND CLASSIFICATION REPORT AND MAPS (SCALE: 1/10,000), MDB AND SOGREAH, 1972

Classification systems and survey specifications followed in above studies are summarized in Table D.1.1. Some of the recent studies are briefly discussed below:

(1) Transbasin Diversion Study

The semi-detailed soil survey and land classification study for Systems I, J, K, L, M, NWDZ and SEDZ with an observation density of one per 270 ha for the entire survey area of around 12,200 Km^2 were carried out in Transbasin Diversion Study. In this report, the soil maps and land classification maps at a scale of 1:50,000 were produced, and reduced to 1:100,000 for the final presentation which were attached to the reports. The soils have been classified according to the USDA Soil Taxonomy, and the recently developed Sri Lanka classification system. Modified USBR System was applied to land classification.

(2) Irrigation Department Studies

Land Use Division of the Irrigation Department, carried out detailed reconnaissance soil surveys for System H (Kala Oya Basin) in 1968 (Ref. 8), System G in 1978 (Ref. 7), undeveloped area of System D (Ref. 6), and Systems AD, IH and MH. The results for these studies are presented in reconnaissance or semi-detailed soil maps of various scales. Soils classified in these studies are described at series level. The basic concepts for the identification of the soil series are based on the classification systems established in Mahaweli Ganga Development Project (Ref. 10).

(3) JICA Study

JICA conducted soil surveys for undeveloped area of Systems D1 and D2, and entire area of Systems AD and G in 1979. Soil classification categories, applied to

the study was based on the National Classification Systems. Land Classification was made by using great soil group units. Each great soil group has suggested land use specifications, which were used as classification criteria. These criteria were established by land use division, Irrigation Department. The categories of suggested land use were lowland paddy, upland paddy, upland crops able to be grown in the dry zone and perennial crops. These soil studies were inventorized and confirmed in Phase-I (1988).

D.1.3 Objectives and Work Items

The main purposes of this soil study are to identify major soil groups and their distribution, and to examine the land suitability for irrigation farming on the basis of field investigation and the findings of past soil studies mentioned above (the scheme of study is illustrated in Fig. D.1-2). The present report deals with the following study results:

(1) assessment and review of the existing data and information with respect to the soils within the study area,

(2) identification of areas requiring new and supplemental soil surveys as judged from the inventory analysis of available information,

(3) actual soil observation and laboratory analysis for the newly surveyed areas,

(4) identification of major characteristics of the soils for entire study area, and

(5) assessment of land capability of the soil units identified in the study area.

The field-work described in this ANNEX was carried out from February 1988 to September 1988.

D.2 PHYSIOGRAPHY AND SOILS

D.2.1 Procedure of Soil Survey

The physiographic condition of the study area was first examined by using the topographic maps of scale 1/63,360, aerial photos taken in 1981, and existing reconnaissance soil maps in the previous soil reports, in which the land form categories are indicated. The land form categories applied to this report are based on the classification categories established in the Kelani-Aruvi and the Mahaweli Ganga Basin Development Project (Refs. 9 and 10).

According to the assessment of the existing data and information with respect to soils for the study area, entire area of System F was identified as the area to be surveyed newly. Furthermore, existing soil and land classification maps of Systems H and IH should be recompiled and adjusted based on the unified classification system applied to this report. For this study, soil profile and laboratory analysis data collected and attached in Mahaweli Ganga Development Project, Stage II (Ref. 14) are utilizable. The information on soil classification units prepared in the Transbasin Diversion Study for the Systems I, M and the NWDZ are almost available for the compilation of this report (Ref. 12). Therefore, field checking and confirmation within these areas by using the existing semi-detailed soil maps and aerial photos were made during the field survey period.

D.2.2 Physiography

From the physiographic point of view, the land of the study area is classified into the following seven (7) landform categories (details are shown in Table D.2.1):

Land Form Categories	Extent (ha)	Extent (%)
1. Coastal Plain	1,400	0.3
2. Flood Plain	50,700	11.9
3. Bottomland	129,900	30.6
4. Gently Undulating Plain	190,200	44.8
5. Undulating Plain	25,100	5.9
6. Hilly Undulating Plain	5,000	1.2
7. Rock outcrop	17,500	4.1
8. Tanks	4,600	1.2
Total	424,400	100.0

The flood plains are developed on the recent sediments conveyed from the surrounding higher plains, terrace, hills and uplands. These lands mainly extend along the rivers and streams. These land form units cover approximately 12% of the entire survey area.

The gently undulating plain, which constitutes the greater part of the survey area (45%) is developed on the eroded peneplain with an undulating slope of about 3%. Enormous number of tanks shown in the northern part of the survey area have been constructed since the ancient historical period of this country, availing of this unique and typical landform unit in the dry zone area. In this landform unit, surface earth mainly consists of coarse textured soil materials derived from colluvial deposits. The lower parts of the undulating region are called as the bottom lands. They extend to the upper part of the alluvial plains in Systems I, IH, H and NWDZ.

The undulating to hilly undulating plains also occur on the mantled plain, but in these landform units, the gradients of undulating relief are more steep and have higher altitude above the sea level than continuous undulating plain. The gradients of this land form unit range from 6% in the undulating plain to 1% in the hilly land.

The rock knob plain and erosional remnants are scattered over the entire survey area, however, the area of these land form units are relatively small (about 4%). The available soil depth of these lands are generally shallow. They are particularly found around the inselbergs and in areas with many outcrops. The relief of this land form is steeply dissected.

The entire study area is generally flat, comparing with the rest of the country. The slope range distribution is shown in Fig. D.2-1.

D.2.3 Soil Survey

D.2.3.1 Detailed Observation of the Representative Soil Pits in the Study Area

31 soil observation points were selected for the confirmation of the existing soil maps of Systems MH, I and the NWDZ (NW-1). They are:

(Unit : number)

Area	Gross Extent (ha)	Observation Points (No. of Pit)	Objective of the Survey
System MH	57,400	12	field confirmation
System I	144,500	7	field confirmation
NWDZ (NW-1)	35,600	12	filed confirmation
		31	

Following criteria were considered for selecting the suitable observation sites:

- present land use type (paddy, home garden, upland field, etc.),
- soil classification boundary of the great soil group, delineated on one mile one inch topo-map,

- accessibility (northern part of Systems I, MH and M were excluded on account of security problems)

Soil profile descriptions are summarized in Table D.2.2. The drainage condition of each profile was estimated by using the specifications for soil drainage classification in the field (the specifications are shown in Table D.2.3). According to the aerial photo interpretation and the field observation, actual soil classification boundaries are almost similar to the existing soil map boundaries, especially to the maps prepared in TDS. Therefore, there was hardly any need to modify the mapping boundaries.

D.2.3.2 Semi-detailed Soil Survey of System F Area

Total study area of 5,300 ha, which is identified as the area to be surveyed newly by the inventory analysis of existing soil information, was first demarcated (FAO/UNDP definition) on one mile two inch topographic maps. The works, made by present study team, are described below:

(1) Definition of the Study Area

System F lies east of Elahera on the right bank of Amban Ganga. It is bordered on the north by Amban Ganga, east and west approximately by the 150 m contour and on the south by the constriction of the 150m contour at Pimburangoda. The major part of it is drained by Kalu Ganga and the rest by other smaller tributaries of Amban Ganga.

The area north of Galwale Ela, east of Kalu Ganga and of Amban Ganga after the two rivers join comes under the Wasgamuwa Natural Park. Along the periphery of this reserve, a mile wide buffer zone has to be left aside without development. Under the Mahaweli wild life program, there are plans to leave the land north west of Kiri Oya, west of Kalu Ganga and south and south east of Amban Ganga as an elephant corridor to facilitate the movement of elephants from the Wasgamuwa Natural Park to the mountains that lie west of the Kalu Ganga valley. Therefore, the area available for development is limited mostly to the land that lies south of Kiri Oya and west of Kalu Ganga.

(2) Past Studies on Soils of System F

This area has been surveyed at reconnaissance level. Most of the soils present have been described but without maps (Ref. 10). The soils of System F area have developed from residual and alluvial parent material that have originated from rocks of the Khondalite series (Ref. 10).

The dominant rocks of System F area are undifferentiated metasediments, crystalline limestone, charnockites, quartzite and granitic gneiss.

The residual soil formed from in situ rock weathering is less common than those which have formed from weathered material that had been transported over some distance and deposited. The soil profiles of the latter type exhibit a polygenic

horizon sequence with two or more distinct layers. Where weathered material has not been transported out the weathering has been deep. Such soils are of finer texture except when coarse grained pegmatite intrusions have contributed gravel to the profile. Movement of iron and manganese within the profile and development of weak to moderate sub-angular blocky structures are common features of these soils.

Four types of alluvial parent materials have been identified in Mahaweli Ganga Development Project (Ref. 10). They are (1) materials that have been transported from the higher lands, transported short distances and deposited in depressions, (2) leave deposits found in strips along existing river channels, (3) small flood plain deposits and (4) slack water deposits. Followings are the soils identified in the area underlain by Khondalite series geology to which System F area belongs:

Soils derived from residual parent materials

Name of Soil Catena	Series		
	Well Drained	Imperfe tly Drained	Poorly Drained
Alutwewa	Alutwewa	Hambegamuwa	Huratgama
Padavkema	Padavkema	Kithulkote	Huratgama
Handapangala	Handapangala Etiliwewa (shallow phase)	Tellula	Pelessa

Soils derived from alluvial parent materials

Name of Soil Catena	Series		
	Well Drained	Imperfe tly Drained	Poorly Drained
Levee	Mahaweli	-	-
Poor plain	-	Kallar	Mutugalla

Alutwewa soils have originated from coarse grained gneiss or migmatite or gneiss intruded with fine grained pegmatite. They have fine gravel, mainly quartz, in the subsoil. Padavkema soils have originated from fine grained gneiss or migmatite and are gravel free. Handapangala soils originate from coarse grained or migmatite, both intruded with pegmatite, or gneiss intruded with quartzite. They have a heavy concentration of quartz inclusions of coarse gravel pebble and cobble sizes.

Mahaweli soil is deep, stratified and coarse to moderately fine textured with little or no pedogenesis. Kallar soils are deep, fine to medium textured and weekly stratified with little textural variation within profile. They also show little or no signs of pedogenesis. Mutugalla soils differ from Kallar soils, by being poorly drained.

(3) Physiography and Soil

a. Procedure of Soil Survey

Reconnaissance soil survey of 5,300 ha over the System F area was first carried out by using 1:32,000 topographic maps and air-photographs of scale 1:50,000. Semi-detailed soil surveys were conducted by using 1:32,000 topographic map. Field reconnaissance was carried out for entire System F area. During the field survey period, 200 points of field observation and 16 soil pits research were made for the semi-detailed soil survey area.

Soil samples were collected from 9 selected pits of them, and soil characteristics were described by FAO systems.

b. Physiography

Following five main landforms are identified:

1.	Gently undulating plain	3,100 ha	57.5 (%)
2.	Undulating plain	1,300 ha	29.3 (%)
3.	Hilly undulating plain	400 ha	11.5 (%)
4.	Rock out crop	500 ha	1.7 (%)
	Total	5,300 ha	100.0 (%)

Gently undulating plain has slopes less than 4%. It is found mainly in the left bank of Kalu Ganga. The undulating plain lies adjacent to the gently undulating plain. Its steepest slope elements have a gradient of 4% to 8%. The rolling plain occupies the footslopes of the adjacent mountainous landform which lie outside the System F area. Erosional remnants and rock outcrops are scattered within the undulating plain and the rolling plain.

The Kalu Ganga and Amban Ganga stream channels are deeply incised into bedrock. Their channel walls are almost vertical and about 5 m deep. Streams on the left bank of the Kalu Ganga in the southern part (south of Kiri Oya) whether primary, secondary or of higher order have incised and U shaped channels. In the higher order streams, these incisions go down to resistant rock in the upper slopes, but in the slopes down the channel bed consists of alluvial sediments. Other stream channels both the east of Kalu Ganga and the north of Kiri Oya have V shaped (wide or narrow) cross sections. Banks of U shaped channels have finer textured materials, compared to those with V shaped cross section.

c. Soil Survey

c.1 Reconnaissance soil mapping units

Following great soil mapping units were identified within the gross reconnaissance survey area of System F: