Democratic Socialist Republic of Sri Lanka
The Ministry of Mahaweli Development

FEASIBILITY REPORT
ON
THE MORAGAHAKANDA AGRICULTURAL DEVELOPMENT PROJECT

VOLUME I
MAIN REPORT

OCTOBER 1979

JAPAN INTERNATIONAL COOPERATION AGENCY

Democratic Socialist Republic of Sri Lanka
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P R E F A C E

The government of the Democratic Socialist Republic of Sri Lanka, having given top priority to the Mahaweli Ganga Development Program for attaining self-sufficiency in food production, for the elimination of unemployment and promotion of economic development, requested the government of Japan for cooperation in one of the five major projects of the Mahaweli Ganga Development Program.

Following the above request, the Japan International Cooperation Agency (JICA) dispatched for 46 days from 12th June, 1978, a 9 men Preliminary Survey Team on Mahaweli River Basin Agricultural Development headed by Director Akira Arimatsu, of the JICA.

Based on the findings and observation of the Preliminary Survey Team, the JICA dispatched for 145 days from 17th October, 1978, a 15 men Feasibility Study Team on the Moragahakanda Agricultural Development Project headed by Director Toshio Sakai, of the Japan Engineering Consultants Co., Ltd.

The Team conducted necessary technical and economic feasibility studies in Sri Lanka. After their return to Japan, the Team made a further study and has completed this feasibility report on the Moragahakanda Agricultural Development Project.

I hope this report will contribute to further development of the economy of Sri Lanka, and also to the promotion of friendly relations between Sri Lanka and Japan.

I wish to express my gratitude to the Government of Sri Lanka and its officials concerned for their close cooperation extended to the Team.

October, 1979

Shinsaku HOGEN
President
JAPAN INTERNATIONAL COOPERATION AGENCY

LETTER OF TRANSMITTAL

October, 1979

Mr. Shinsaku HOGEN
President
Japan International Cooperation Agency
TOKYO, Japan

Feasibility Report on the Moragahakanda
Agricultural Development Project, Sri Lanka

Dear Sir;

We have the pleasure to submit herewith the Feasibility Study Report on the Moragahakanda Agricultural Development Project, which is a final product of our study which lasted for nearly one year: the field survey, from October 1978 to February 1979, and the ensuing home work which has been carried on since immediately upon our return to Japan.

In the meanwhile, the salient features identified during the field survey and the basic orientation of the study were stipulated in the Field Report (February 1979); Interim Report was submitted in May 1979, at mid-term of our home work, and the Draft Report, in September 1979. Both were presented to and commented upon by the both Governments. These comments have been duly incorporated in the present Report which comprise three volumes: Vol. I (Main Report). Vol. II (Moragahakanda Dam and Power Station), and Vol. III (Downstream Development.)

Upon conclusion of our assignment, we are very happy to say that this project is technically feasible and economically sound. It is our sincere hope that it should proceed to the next stage of the detailed survey and designing so that it would be implemented at the earliest possible point of time.

- to be continued -

Finally, we wish to express our sincere-most appreciation and gratitude to the personnel of your Agency, the Embassy of Japan in Sri Lanka, and the officials concerned of the Government of Sri Lanka for the courtesies and cooperation liberally afforded us during our field survey and home work. Our particular thanks are due to the chairman and the members of the Advisory Group for their unchanging interest shown towards our study and for providing us with many valuable suggestions at each stage of its entire course.

Very truly yours,

Toshio SAKAI
Leader

Feasibility Study Team on the
Moragahakanda Agricultural Development
Project
(Director and Head of the Water
Resources Dept.,
Japan Engineering Consultants Co., Ltd.)

SUMMARY AND CONCLUSIONS

Background

1. The Democratic Socialist Republic of Sri Lanka has its place among the countries of the world on a tropical Island in the Indian Ocean. Her land space is approximately 65,500 km^2, about 80 per cent of which is being used as farmland. About 80 per cent of her total population now estimated at around 14 million are rural. Sri Lanka can be divided into two broad regions; the wet zone located in the southeest and south central highlands where rainfall is distributed rather evenly throughout the year and averages 75 to 200" (1,900 - 5,000 mm); and the dry zone in the northern and eastern parts of the country where rainfall between 35 to 75" (900 - 1,900 mm) is annually limited during the northeast monsoon in October - March. Wet zone accounts for about two-thirds of the total area presently under permanent cultivation including the entire area planted to the important export crops like tea and rubber, most of that under coconut and nearly one-half of paddy and other croplands. Another 2 million ha has the potential for cultivation in the dry zone but only through systematic supply of irrigation water.

2. The Government of Sri Lanka gives top priority to the implementation of the Mahaweli Development Program with a view to simultaneously solve two major problems confronting the nation, that are, food shortage and unemployment. Inspite of a weighty position which agriculture occupies in Sri Lankan national economy by contributing 30 per cent of GNP, foreign exchange amounting to 4,000 million repees (267 million US$) a year is being spent for importing rice, wheat flour, sugar and other main food items. Not less than 250,000 are estimated to join a pool of over a million unemployed every year.

Mahaweli Development Scheme

3. The Mahaweli Ganga which originates in the wet zone highlands is the longest and the biggest river in Sri Lanka with a total length of 330 km; its 10,500 km^2 - wide basin holds rich water resources which can be made available for irrigating the dry zone and generating hydroelectric power. The Master Plan of the Mahaweli development was prepared by the joint efforts of the UNDP/FAO Team and the Sri Lankan engineers during 1965 and

1968. It envisaged development of 360,000 ha of the dry zone through irrigation and generation of 500MW hydropower over a period of 30 years by constructing a group of dams and reservoirs in the Mahaweli basin. Since 1970, Polgolla-Bowatenne Diversions Project has been completed as a first stage.

4. The present Government, being eager to speed up the Mahaweli Ganga development, selected five major projects out of those included in the Master Plan, and decided to complete them over the next six years with international cooperation, in the name of the "Accelerated Mahaweli Development Program."

Moragahakanda Agricultural Development Project

5. Moragahakanda Agricultural Development Project is one of the five major projects coming under the umbrella of the "Accelerated Mahaweli Development Program" and its feasibility study was undertaken by the Government of Japan at the request of the Government of Sri Lanka. It is projected to build a storage dam on the Amban Ganga, a tributary of the Mahaweli Ganga, in view of raising agricultural productivity in its downstream through the irrigated agricultural development, thus helping attain food self-sufficiency in the country, and also of generating hydropower in response to an increasing national demand, and combinedly provide gainful employment opportunities to the unemployed.

6. The Scope of Work which was agreed upon between the two Governments in October 1978 specifies that the area to be covered by the Feasibility Study Team would consist of about 56,000 ha, including both the existing land and the newly reclaimable land in Systems G, D1, D2 and A/D, in the downstream of the existing anicuts at Elahera and Angamedilla in the Amban Ganga basin. It has, however, been acknowledged that most of these areas would be made adequately irrigable after the completion of other projects in the Mahaweli basin and then the storage water of the Moragahakanda dam should be diverted for irrigation of the NCP Area. As a result of the Field Survey, the total area to be irrigated has been identified as about 62,200 ha. While the land for new reclamation has dwindled down considerably, the land which has been

put under cultivation by the existing farmers beyond the area under specification has been found much larger than expected and the necessity of improving irrigation in such area has been acknowledged.

7. The Moragahakanda reservoir inflows consist of not only the own runoff of the Amban Ganga but also the Manaweli water which, after being diverted at Polgolla would split a portion of it for System H irrigation at Bowatenne, before reaching the Moragahakanda site. The Team's study has been carried out on the understanding that no major alterations would be made with the Government rules concerning these diversions as was confirmed in a course of discussions which took place in early February and late May 1979. The keynote of these diversion rules is that the Mahaweli water may be diverted upto 56.6 m^3/sec provided that the minimum of 4.25m^3/sec is guaranteed as the release water to the mahaweli Ganga downstream reaches.

8. As a result of water balance computations, the effective storage capacity to meet the downstream irrigation requirements has been identified as 606 million cubic meters, with the high water level of 188 meters in elevation and a tentative benefit/cost calculation resulted at a very high net benefit. A number of alternative plans have been compared to find out the best scale of hydropower development to the basic irrigation water requirements and a stage development of the powerstation has also been studied in a condition that the North Central Province Canal would be constructed in the near future. Eventually the optimal scale has been decided the Moragahakanda Reservoir to have its high water level at 195 meters in elevation and the effective storage capacity of 686 million cubic meters, and the installation of generating equipment to be 26 MW at the first stage and to become 52 MW in the near future.

9. The main dam on the Amban Ganga, as well as the second saddle dam, will be of rockfill type, and the first saddle dam, of concrete gravity type. Their maximum height will be 72m, 42m and 62.5m, and their crest length 490m, 490m and 396m, respectively. The maximum discharge capacity of the spillway has been designed at 3,400 m^3/sec.

Cost and Benefits

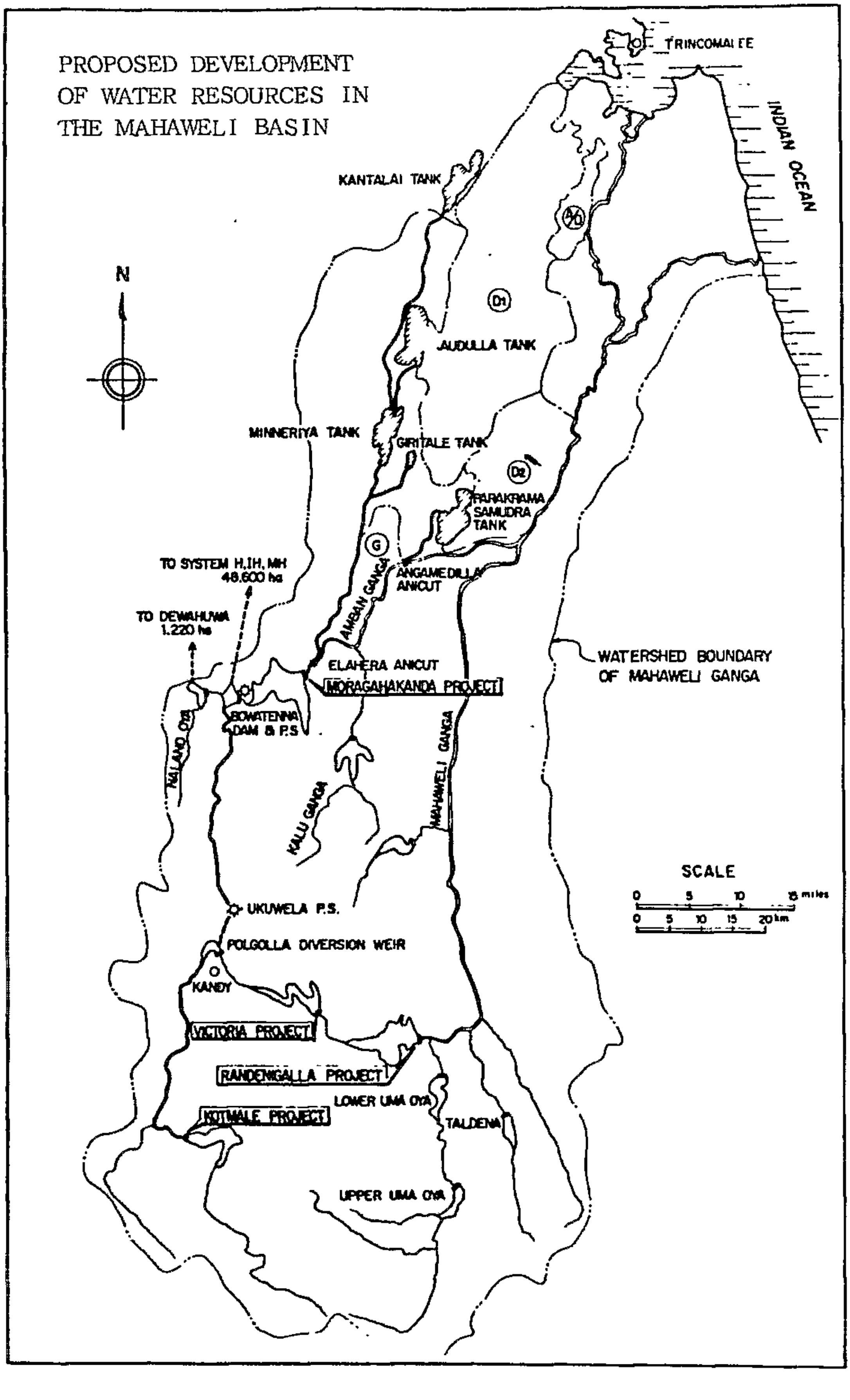
10. Costs as assessed at December 1978 prices would be 1715 million rupees (114 million US$ equivalent) for the Headwork (dams, reservoir, first 26 MW unit, pwoerhouse and transmission-line), of which 1365 million rupees (91 million US$) is in foreign currency and 350 million rupees (23 million US$), in local currency. Costs for improvement and new provision of irrigation/drainage facilities and development of the new land and settlement area in the downstream would total 900 million rupees (60 million US$), of which 453 million rupees (30 million US$) is in foreign currency and 447 million rupees (30 million US$), in local currency. Cost of agricultural and social infranstructure required for integrated rural development in the downstream would amount to 197 million rupees (13 million US$), of which 39 million rupees (2.60 million US$) is in foreign currency and 158 million rupees (10.5 million US$), in local currency. The total project còst would be 2812 million rupees (187 million US$), of which 1857 million rupees (123 million US$-66%) is in foreign currency and 955 million rupees (64 million US$-34%) in local currency.

11. Benefit expected from the downstream development is estimated at 658 million rupees (44 million US$) in term of net additional agricultural production per year at full development, and the annual energy output of the power station would be 145 GWh in the first stage installation.

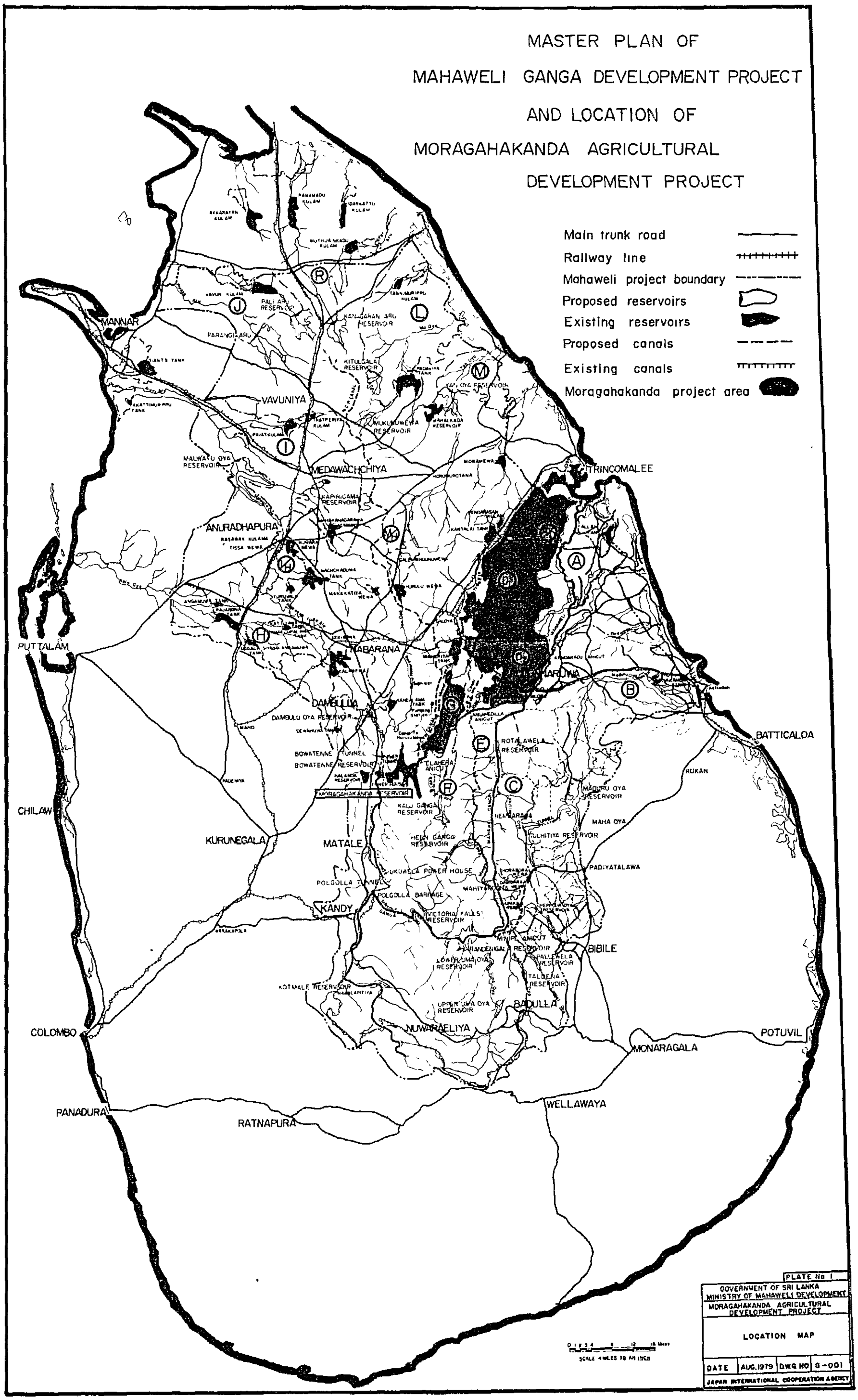
Economic Evaluation

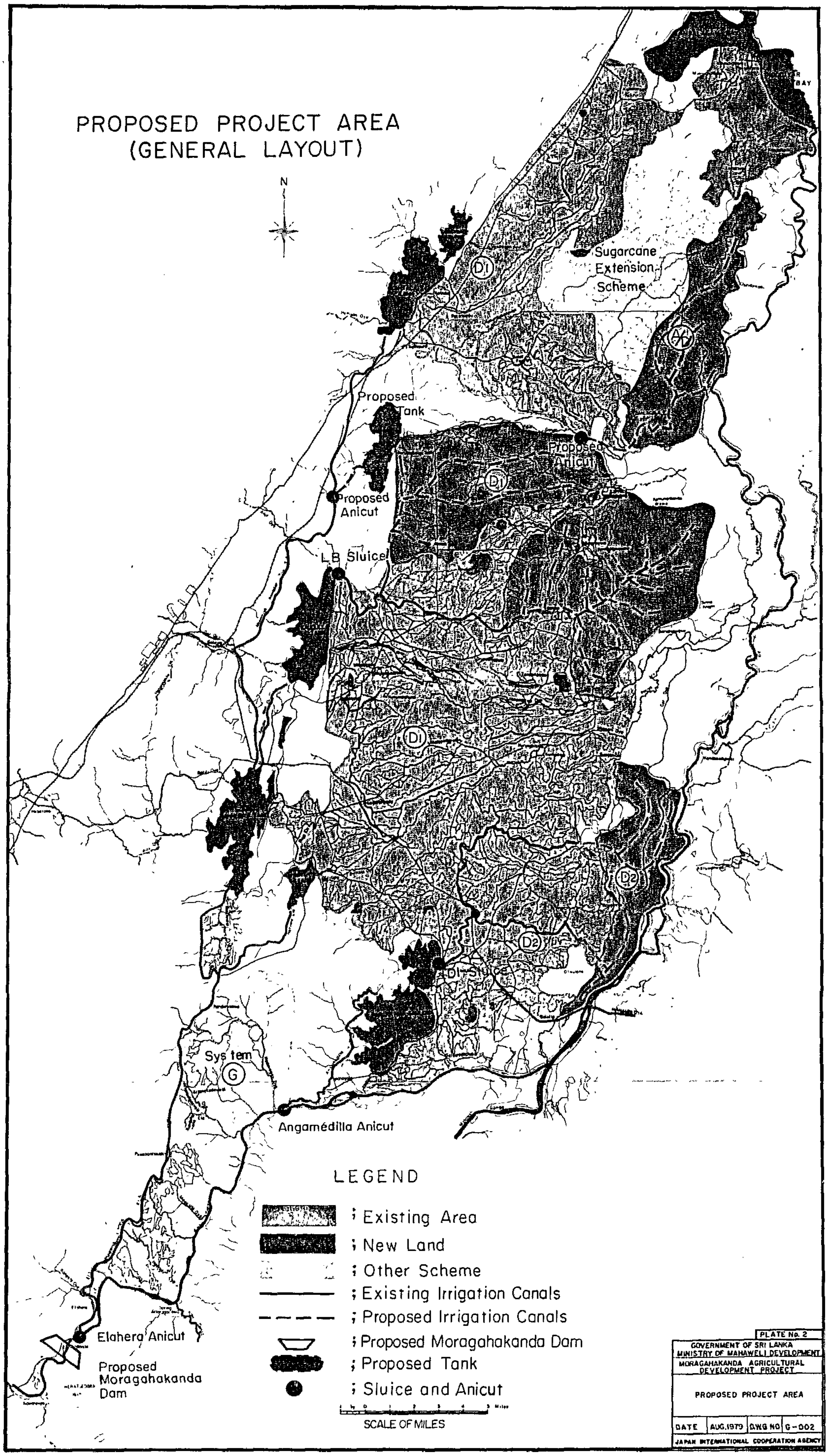
12. Economic returns from the project implementation will amount 576 million rupees (38 million US$) in terms of net present value. Internal rate of return (IRR) is 12.1 per cent, while the Benefit-Cost ratio at the discount rate of 10% is 1.23. The results of the sensitivity analysis which was undertaken to determine its economic viability under possible turns of event show the IRR between 10.8 and 13.0, and B/C ratio between 1.00 and 1.39. Thus implementation of the Moragahakanda Agricultural Development Project can be economically justified from Sri Lankan national economic point-of-view.

13. Recognizing the importance of this Project in the entire Mahaweli Development Program and taking note of that its validity is critically dependant upon timely implementation, side by side with other projects in the Hahaweli basin, this feasibility study should immediately be followed by the detailed design work. Upon completion of the topographic maps covering its downstream development area, the irrigation/drainage improvement plans outlined in this Report will have to be carefully reviewed prior to their implementation. It is to be noted that improvement &/or additional provision of infrastructure alone does not suffice for successful agricultural development. Guidance in cultivation technology and water control/management, provision of well coordinated farmer services through the strengthened farmer organizations and rural institutions is essential to see that the Project will be adequately implemented in both the existing and the new lands. For this purpose, agricultural manpower training must be given the first priority in materialization of this Project.



PROPOSED DEVELOPMENT
OF WATER RESOURCES IN
THE MAHAWELI BASIN
TRINCOMALEE
INDIAN OCEAN
KANTALAI TANK
N
D1
AUDULLA TANK
MINNERIYA TANK
GIRITALE TANK
D2
PARAKRAMA SAMUDRA TANK
G
TO SYSTEM H, IH, MH 46,600 ha
TO DEWAHUWA 1,220 ha
ANGAMEDILLA ANICUT
AMBAN GANGA
ELAHERA ANICUT
MORAGAHAKANDA PROJECT
WATERSHED BOUNDARY OF MAHAWELI GANGA
BOWATENNA DAM & P.S
NALANDA OYA
KALU GANGA
MAHAWELI GANGA
SCALE
0 5 10 15 miles
0 5 10 15 20 km
UKUWELA P.S.
POLGOLLA DIVERSION WEIR
KANDY
VICTORIA PROJECT
RANDENIGALLA PROJECT
LOWER UMA OYA
KOTMALE PROJECT
TALDENA
UPPER UMA OYA


MASTER PLAN OF
MAHAWELI GANGA DEVELOPMENT PROJECT
AND LOCATION OF
MORAGAHAKANDA AGRICULTURAL
DEVELOPMENT PROJECT
Main trunk road
Railway line
Mahaweli project boundary
Proposed reservoirs
Existing reservoirs
Proposed canals
Existing canals
Moragahakanda project area
MANNAR
VAVUNIYA
MEDAWACHCHIYA
TRINCOMALEE
ANURADHAPURA
PUTTALAM
HABARANA
DAMBULLA
MORAGAHAKANDA RESERVOIR
BATTICALOA
CHILAW
KURUNEGALA
MATALE
KANDY
BIBILE
BADULLA
NUWARAELIYA
COLOMBO
POTUVIL
MONARAGALA
PANADURA
RATNAPURA
WELLAWAYA
KALU GANGA RESERVOIR
HEEN GANGA RESERVOIR
ROTALAWELA RESERVOIR
MADURU OYA RESERVOIR
ULHITIYA RESERVOIR
VICTORIA FALLS RESERVOIR
LOWER UMA OYA RESERVOIR
UPPER UMA OYA RESERVOIR
KOTMALE RESERVOIR
POLGOLLA TUNNEL
POLGOLLA BARRAGE
UKUWELA POWER HOUSE
BOWATENNE TUNNEL
BOWATENNE RESERVOIR
DAMBULU OYA RESERVOIR
ELAHERA ANICUT
MINIPE ANICUT
RANDENIGALA RESERVOIR
PALLEWELA RESERVOIR
TALDENA RESERVOIR
KAPIRIGAMA RESERVOIR
MALWATU OYA RESERVOIR
KITULGALA RESERVOIR
MUKUNUWEWA RESERVOIR
PALI ARU RESERVOIR
KANAGARAN ARU RESERVOIR
YAN OYA RESERVOIR
PARANGI ARU
GIANTS TANK
PLATE No 1
GOVERNMENT OF SRI LANKA
MINISTRY OF MAHAWELI DEVELOPMENT
MORAGAHAKANDA AGRICULTURAL DEVELOPMENT PROJECT
LOCATION MAP
DATE AUG.1979 DWG NO G-001
JAPAN INTERNATIONAL COOPERATION AGENCY


PROPOSED PROJECT AREA
(GENERAL LAYOUT)
N
BAY
Sugarcane
Extension
Scheme
D1
D2
Proposed
Tank
Proposed
Anicut
L.B. Sluice
D1 Sluice
System
G
Angamédilla Anicut
Elahera Anicut
Proposed
Moragahakanda
Dam
LEGEND
; Existing Area
; New Land
; Other Scheme
; Existing Irrigation Canals
; Proposed Irrigation Canals
; Proposed Moragahakanda Dam
; Proposed Tank
; Sluice and Anicut
SCALE OF MILES
PLATE No. 2
GOVERNMENT OF SRI LANKA
MINISTRY OF MAHAWELI DEVELOPMENT
MORAGAHAKANDA AGRICULTURAL DEVELOPMENT PROJECT
PROPOSED PROJECT AREA
DATE AUG.1979 DWG NO G-002
JAPAN INTERNATIONAL COOPERATION AGENCY

Principal Features of the Project

DAM AND RESERVOIR

Catchment Area	782 km^2
Reservoir Area	40.5 km^2
Effective Storage Capacity	686 x $10^6 m^3$
High Water Level	EL. + 195 m
Low Water Level	EL. + 170 m

Parameter of Dams

	Main Dam	1st Saddle-dam	2nd Saddle-dam
Type	Rockfill	Concrete Gravity	Rockfill
Crest Elevation	EL. +199.0 m	EL. +197.5 m	EL. +199.0 m
Max. Height	72.0 m	62.5 m	42.0 m
Crest Length	490 m	396 m	490 m
Dam Concrete Volume	-	376,000 m^3	-
Embankment Volume	2,430,000 m^3	-	430,000 m^3

Spillway

Type	Overflow Weir and Stilling Basin
Gates	4 Nos. 17.5 x 8.5
Design Flood Inflow	4,650 m^3/sec. (1.2 times/200 year flood)
" " Outflow	3,400 m^3/sec.

Penstock

Diameter	3,900 mm - 3,200 mm
Length	87 m

Power Station (First Stage only)

Installed Capacity	26 MW
Turbine	1 unit of Vertical Shaft, Francis
Generator	1 unit of 30.5 MVA
Rated head	54.8 m
Design Head	43.5 m
Max. Discharge	56.6 m^3/sec.
Dependable Peak Power	16.1 MW
Annual Energy Output	145.1 GWh

Transmission Line

Voltage	132 kV, Single Circuit
Distance	16 km

Construction Cost

Rs 1,715.1 million (US$114.34 million) on 1978 price basis.

Construction Period

4.5 years (July, 1981 - December, 198[illegible]

DOWNSTREAM DEVELOPMENT

Proposed Project Area

Existing Area	40,000 ha (98,900 ac)
Other Scheme Newland	8,300 ha (20,500 ac) 4,200 ha by Sugar Corporation 4,100 ha by E.E.C.
Moragahakanda Newland	13,900 ha (34,400 ac)
Total	62,200 ha (153,800 ac)

Water Requirements

Mean Annual Diversion Requirements	$1,788 \times 10^6$ m^3
Unit Irrigation Requirements	1.43 l/sec/ha
Unit Diversion Requirements	1.91 l/sec/ha

Improvement of Existing Facilities

Elahera Anicut	No improvement is required
Angamedilla Anicut	To be improved
Improvement of Yoda Ela	21.7 km of Elahera-Minneriya Yoda Ela
Improvement of Main and Branch Canal	16.4 km of Kaudulla H.L.B. 33.5 km of Parakrama Samudra D1. Total 49.9 km
Facility Improvement of Existing Area	38,000 ha (excluding System G 2,000 ha)

Proposed Construction Works for Newland

Irrigation Canal	System D1	58.2 km
	" D2	52.8 km
	" A/D	34.2 km
	Total	145.2 km
Drainage Canal	System D1	44.1 km
	" D2	32.5 km
	" A/D	14.8 km
	Total	91.4 km
Headworks for System A/D	Kalu Ganga Tank Yoda Ela Anicut Kalu Ganga Anicut	

Land Reclamation (unit: ha)

System	Field	Homestead	Total
D1	9,100	1,810	10,910
D2	2,200	440	2,640
A/D	2,600	540	3,140
Total	13,900	2,790	16,690

Related Structures (unit: No.)

	System			
Structure	D1	D2	A/D	Total
Aqueduct	0	3	6	9
Cross Drain	6	0	6	12
Drainage Inlet	9	0	5	14
Bridge	56	45	40	141
Turnout	39	11	22	72
Diversion	4	4	4	12
Check Gate	21	7	13	41
Water Management Divice	6	5	3	14
Drop	24	2	6	32
Spillway and Wasteway	4	2	2	8
Washing and Bathing Place	18	16	11	45

Construction Cost US$60.0 million (1978 price basis)

Weights and Measures

1 acre (ac.)	= 0.405 hectares (ha.)
1 mile (ml.)	= 1.609 kilometers (km.)
1 square mile (sq. ml.)	= 2.589 square kilometers (km^2)
1 foot (ft.)	= 0.3048 meter (m)
1 acre foot (ac.ft.)	= 1,233.5 cubic meters (m^3)
1 cube	= 100 cubic feet = 2.832 m^3
1 inch (in.)	= 25.4 millimeters (mm)
1 cusec	= 0.0283 cubic meters per second (m^3/sec)
1 pound (lb.)	= 0.4536 kilograms (kg)
1 bushel (bu.) of paddy	= 46 lb. = 20.87 kilograms (kg)

Currency Equivalents

1 US$ = 15.0 Rs = 195 Yen (Dec. 1978, Exchange rate)

1 Rs = 0.067 US$ = 13.0 Yen

Democratic Socialist Republic of Sri Lanka

FEASIBILITY REPORT ON THE MORAGAHAKANDA

AGRICULTURAL DEVELOPMENT PROJECT

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CHAPTER I : SCOPE AND OBJECTIVES OF THE STUDY

1.1 Introduction

The Mahaweli Ganga, the longest and the biggest river in Sri Lanka with a total length of 330 km (207 miles), embraces within its 10,500 km^2 basin, the largest water resources which would be made available for irrigation and hydropower generation; since ancient days, their development for irrigation purposes has been made by high-levelled indigenous engineering skills by constructing transbasin canals and tanks. In post-Independent period, the basin's irrigation and hydropower development strategy was established by the UNDP/FAO Master Plan (1965-1968) which envisaged development of 364,000 ha (900,000 ac) of irrigation and 500 MW of hydropower over a period of 30 years. The results obtained so far since the plan implementation in 1970 are the Polgolla-Bowatenne diversions which help Irrigating Systems G, D, and H, and hydropower generation at Ukuwela (40MW) and Bowatenne (40 MW - nearing completion).

The present Government decided to speed up the Mahaweli Ganga program and, under the name of the Accelerated Program, plans to build, in the next 6 years, five major storage and hydropower dams which would altogether provide irrigation water to about 340,000 ac (137,000 ha) lands (both the existing and the newly reclaimable land), as well as installation of hydropower generating capacity upto nearly 400 MW. The Moragahakanda dam which would be built across the Amban Ganga, a major tributary of the Mahaweli Ganga, is given high priority under the Accelerated Program becsuse of its irrigation potential and its associated hydropower project, and the Government of Japan was requested by the Government of Sri Lanka to provide assistance in the planning and implementation of these projects.

1.2 Scope of the Study

Subsequent to discussions between the two Governments, the Scope of Work for the feasibility study on the Moragahakanda Agricultural Development Project was agreed upon in October 1978. In pursuance to this agreement, the Japan International Cooperation Agency (JICA), the official agency responsible for the implementation of technical cooperation programs sponsored by the Government of Japan, sent a team of experts to carry out the survey and studies therein specified.

1.3 Objectives and Execution of the Study

The main objectives of the study by this team are to verify feasibility of the Moragahakanda Agricultural Development Project in: (i) its downstream development covering about 60,000 ha (150,000 ac) of irrigable area, including some newly reclaimable lands in Systems G, D and A/D, and (ii) power generation, with dam construction. Through its field survey and home-works, the Team are expected to prepare and submit the following stage-wise Reports:

1) Field Report - already submitted at the end of the field survey;

2) Interim Report - already submitted in the month of May 1979

3) Draft Final Report - submitted in the early part of September 1979 and commented upon it by the Government at the end of the same month;

4) Final Report - within one month after receipt of the comments on the Draft Final Report.

This Report stands for the Final Report mentioned in the above.

CHAPTER II : BACKGROUND

2.1 The UNDP/FAO Master Plan

'Summary Report on Projects' published by the Mahaweli Development Board (MDB) in November 1977 provides us with the outlines of the UNDP/FAO Master Plan. It consists of 13 dams, 11 of which would have hydropower generating facilities, and 7 regulating reservoirs in the north, outside the basin. By constructing these dams and reservoirs, some 364,000 ha (900,0000 ac) of land would be irrigated (70% of which is newly reclaimable land) in six schemes (System A and Systems C to G) in the basin, System B, mainly in the Maduru Oya basin, and eight schemes in the North (Systems H to M, I(H) and M(H)). A total of 385 MW of hydropower generating capacity, with a firm power output of about 150 MW, would be established at the four major dams. This is an ambitious plan and the size of its geographical expanse can be gauged from the length of the NCP canal alone which runs 164 km (103 miles); the Polgolla-Bowatenne Tunnel was already constructed as an initial part of it.

It is presumed that the Master Plan took into its basic strategical consideration factors such as the scale of Sri Lankan national economy, the size of its treasury, the long-range forecast of its foreign exchange reserves, the prospects for external assistance, and the extent of mobilization of local engineers and skilled labourers for project implementation. It could not ignore, thereby, the need to raise techical levels and increase the number of local engineers and skilled labourers, on one hand, and to divert financial stresses which might be difficult to avoid if predominant part of the investment costs should be met by foreign aids, on the other. As a logical consequence of the combined study of these issues, the order of the Plan implementation was decided to start with the less costly and unsophisticated projects in which the local engineers and labourers could be given chance to learn through experience and for which the foriegn assistance required would not be overwhelminghly big, and gradually move on towards the more expensive and technically more complicated ones, by utilizing the technical resources now made increasingly available locally and the benefits realizable by completion of the earlier projects for project investment in the later projects, which less dependence on foreign aids. It is, therefore, understandable that the total period of time required for completion of the entire Plan was made 30 years.

2.2 The Accelerated Mahaweli Development Program

In the meanwhile, the country's attention had been preoccupied with miscellaneous issues other than implementation effort of the UNDP/FAO Master Plan, in terms of techno-economic feasibility studies and other spade works called for the specific projects involved and, at the turn of the Government, the grim situation ruling in the country was brought home for full review to formulate some drastic action-oriented policies. It was painfully but honestly recognized that: (i) the root cause of the slow tempo and unworthy momentum of her economic development had been due to the stagnant agricultural production which, by obliging the nation to depend on imports for a considerable portion of its food requirements, helped dissipate the hard-won foreign exchanges which could have otherwise been spent for purchasing the development necessities such as machinery, material and technology, to give proper impetus to economic development and provide enough employment opportunities to the people who badly need such, and (ii) the immediate action to be taken by the new Government was to create potentials for fuller agricultural development, primarily for self-sufficiency in foods and increased supply of industrial materials, and for industrial development, essentially to substitute the imported commodities, thereby providing gainful job opportunities to the accumulated unemployed and under-employed, as well as guaranteeing income-through - honest-work with the new comers into labour market. The drastic policy drawn up by the Government during 1977 took the shape, among other things, of the Accelerated Mahaweli Development Program which aims at achieving the potential agricultural and power benefits, which had been envisaged to realize themselves within the 30 years, within 6 to 7 years by speeding up the rate of implementation of the Mahaweli Plan.

Since the Accelerated Program was motivated by a keen desire of the present Government to realize the maximum benefits within the minimum span of time, a number of components of the original UNDP/FAO Master Plan had to be pruned to avoid dissipation of the massive effort required to implement the overall target. Development of Systems I to M was postponed until later because their capital costs would be higher than for the areas within the basin due to very heavy capital investment in the proposed NCP Canal. Rotalawela dam was also sacrificed, together with most of the smaller reservoirs including Taldena, Pallewela, Kalu Ganga, Heen Ganga and the Upper and Lower Uma Oya, on the ground that their contribution to overall water availability and hydropower generation would not be great. Thus the Accelerated Program comprises the following:

(a) Completion of the on-going development of Systems H, I(H), M(H), G and D, and Bowatenne power station;

(b) Construction of three reservoirs on the Mahaweli Ganga, each at Kotmale, Victoria and Randenigala, a Moragahakanda reservoir across the Amban Ganga, and a Maduru Oya reservoir on the Maduru Oya (all these reservoirs will be equipped with hydropower generating facilities);

(c) Irrigation development of Systems C and B, by means of the additional water supplies that will be made available by the reservoirs to be constructed on the Mahaweli and the Maduru Oya, as well as the RB Canal and Ulhitiya reservoir, and development of new lands in Systems D, G, and A/D by the Moragahakanda reservoir, and

(d) Irrigation development of System A from Kandakadu Anicut.

It was, however, felt necessary to review the Master Plan in the light of the proposed Acceleration of its implementation and the new data and information now became available since preparation of the original plan and, in December 1977, the Government of Sri Lanka and the World Bank agreed that an Implementation Strategy Study should be carried out by the NEDECO whose services the Netherlands Government would extend as a part of its technical assistance toward Sri Lanka.

NEDECO began their study in May 1978, in association with MDB, and submitted the Inception Report in two months' time. After preparing seven Technical Annexes (A, B, D, E, F, J and H), NEDECO presented, in November 1978, their Mid-Term Report. Some of the proposals and concepts tentatively made therein attracted the attention of the JICA Feasibility Study Team on the Moragahakanda Project, particularly those referring to the Polgolla diversions in connection with new alignment of an alternative NCP Canal, as diminution of the Mahaweli water so far diverted at Polgolla should give direct influences on the capacity of the Moragahakanda reservoir and, accordingly, the hydropower generation capacity and the irrigable area in its downstream. Our feasibility study was made, however, on the basis of the established diversion rules by the Government of Sri Lanka, as was assured by the Secretary of the Ministry of Mahaweli Development, on February 2, 1979.

2.3 Institutional Setup and External Aids

The institutional framework meant for policy decision, coordination, and implementation of the Mahaweli Development Program has been rather flexible. There has been established the Cabinet Sub-Committee, presided over by the President, and comprising of the Ministers concerned (Finance and Planning, Lands and Land Development, Mahaweli Development and Youth Affairs and Employment), with the Secretaries of these Ministries and the Secretary to the Cabinet as Members. This sub-Committee meets regularly to make decisions on all major policy matters. The Government of Sri Lanka has recently established a Mahaweli Development Authority. It has a Board consisting of three Members nominated by the Minister of Mahaweli Development with the concurrence of the President. The Secretary to the Ministry of Finance and Planning and the Secretary to the Ministry of Mahaweli Development will function as Ex-Officio Members of the Board. The Authority is vested with a broad power with regard to implementation of the Accelerated Mahaweli Program as will be known from the fact that all finances for the development program will be funded with this Authority before they are allocated by the Authority to the executing agencies, and that it has the powers of direction and control of all institutions involved in the Mahaweli Development Program.

At the administrative level, a major reorganization of the Ministries concerned took place in August 1978. The Ministry of Irrigation, Power and Highways (MIPH) which had been previously responsible for overall coordination and implementation of the Program was dissolved with its function being divided among three new Ministries. A Ministry of Mahaweli Development (MMD) was created, while Power and Highways became the responsibility of an independent Ministry of Power and Highways. The Irrigation Department and some other former MIPH Departments were amalgamated with the Land Commissioner and Land Settlement Departments and three departments from the former Ministry of Agriculture and Lands (now the Ministry of Agricultural Development and Research) to form the Ministry of Lands and Land Development. These Ministries and others, such as Finance and Planning, Plan Implementation, Health, Rural Industrial Development and Fisheries, will be involved in the Mahaweli Program. Yet, the prime responsibility for its execution will rest with the Ministry of Mahaweli Development.

The Mahaweli Development Board (MDB), the Central Engineering Consultancy Bureau (CECB) and the River Valleys Development Board (RVDB) are three main subsidiary bodies of the MMD. MDB was established in 1969 and is held responsible for the overall implementation of the Program on behalf of the Goverment and is also charged with coordinating the day-to-day activities of the principal implementing agencies, i.e. CECB, RVDB and the Irrigation Department of the Ministry of Lands and Land Development (ID). The JICA Feasibility Study Team on Moragahakanda Project are very much indebted to the assistance and cooperation of the MDB, CECB and ID and take this opportunity to express their sincere thanks for such.

The Mahaweli Program is attracting the world-wide attention and strong support is being given or promised by the international organizations, as well as through bilateral aid from the friendly countries. As regards international aid, the World Bank is functioning as a coordinating body besides providing finance for the Polgolla and System H scheme, while the UNDP is financing the work of SOGREAH which is acting as technical adviser to CECB. The Asian Development Bank (ADB) has been furnishing finance to the Bowatenne power project and is now considering finance for materialization of the road network plan in Systems A, B and C. As for bilateral aid, the Governments of the Netherlands (assistance by financing the NEDECO's work in connection with the Master Plan study), Britain (Victoria and System C study), Japan (feasibility study of Moragahakanda dam and hydropower and development study of Systems D1, D2 and A/D), Canada (Maduru Oya reservoir and hydropower and System B development), USA (Maduru Oya downstream development in System B and assessment of environmental aspects of the Program), and West Germany (feasibility study of Randenigala dam and System A & B development). Most of these countries are also involved in System H construction.

The Swedish Government is providing financial assistance for the construction of Kotmale Reservoir on grant basis.

CHAPTER III : PLANNING APPROACH

3.1 General

The characteristic of the Moragahakanda Agricultural Development Project is that it cannot be an independent project as it has to be planned by taking into consideration the related projects covered by the Mahaweli Ganga Development Plan, particularly its Accelerated Program. Its reservoir inflow, for example, does consist not only of the own discharge of the Amban Ganga but the Mahaweli water diverted at Polgolla which, again, has been and will continue to be diverted to System H at Bowatenne. Also, according to the UNDP/FAO Master Plan, the storage water of the Moragahakanda dam was eventually envisaged for irrigating the North Central Province area. Under such circumstances, the amount of the Mahaweli water to be diverted at Polgolla and Bowatenne depends on an overall water balance study of the entire Mahaweli Development Program which, however, is not involved in the scope of work of the JICA Feasibility Study Team and, therefore, we have based our inflow computation on the established diversion policies of the Government of Sri Lanka and the amount of water diverted at Bowatenne to meet irrigation requirements in System H. As regard irrigation, we have confined its immediate irrigable area to the existing fields and newly reclaimable lands in System G, D1, D2 and A/D, on the left bank of the Mahaweli Ganga, as prescribed by the Accelerated Program. One caution required in this respect is that irrigation benefits of the Moragahakanda project need to be computed apart from those already attributed to the Polgolla-Bowatenne Diversions.

3.2 Development Objectives and Implementation Problems

3.2.1 Development Objectives

The objectives of the Moragahakanda Agricultural Development Project are twofold and both are to be attained by constructing a dam across the Amban Ganga, the major tributary of the Mahaweli Ganga; the one is the agricultural development in its downstream area to raise agricultural and agro-based production, especially rice, to help attain self-sufficiency and to increase employment, and the other is generation of hydro-electric power to help meet the increasing demand for electricity in the country.

Downstream development planning has been based on the in-depth fact finding survey, and involves: (i) the improvement of the irrigation-drainage facilities in the existing fields (both the area under specification and that under unauthorized cultivation) and the development of new lands, (ii) the introduction of workable water management methodology by the optimal use of the improved irrigation/drainage facilities and their O&M practices to be adhered to by the joint-effort of the officials concerned and the farmers organized for such purposes, (iii) the integration of rural credit, input supply, extension and marketing, and their coordinated provision through the strengthened farmer organizations, and (iv) the implementation of the Integrated Agricultural Development Program(s) in some of the strategic points.

As for hydro-electric power generation, the optimal scale of installation has been determined by taking into account the discharge requirements for irrigation and the regulating capacity of the dam.

3.2.2 Implementation Problems

There seem to be a certain problematic aspects, either existing or feared to crop up under specific conditions and circumstances in the future, which may greatly influence the success and the rate of execution of the projects. Some of them are attributable to the physical, manpower and organizational factors and the rest to the economic and financial ones which might take place, judging from the scale and structure of Sri Lankan economy, at the point of time when the Program would be at the peak of its implementation, unless proper countermeasures should be taken in due course of time or at least seriously taken into account at the project planning stages. They are: (i) mis-management of irrigation water, (ii) poor prospects in mobilizing skilled manpower, (iii) landing, handling and transport bottlenecks from the ports of disembarkation to the project sites, and (iv) inflationary trends or local price escalation when all the five major irrigation-hydropower projects will be constructed almost at the same time. Except (i) mis-management of irrigation water, the rest can be tackled only at the national level.

3.2.3 Policy Issues

Among the policy issues to be considered in preparation and implementation of the Moragahakanda project (and other projects coming under the umbrella of the Accelerated Program) are: (i) those related to the type and method of construction - whether labour-intensive or capital-intensive - to be employed particularly for irrigation/drainage and land reclamation works, (ii) the quality and quantity of productive as well as living facilities and conveniences to be provided for downstream development, (iii) the size of the farm to be allocated to the settlers between different patterns of cropping and, thereby, different net incomes, (iv) policies and administrative actions to minimize non-productive use of irrigation water and hydro-electric power which will be made available by the projects (while irrigation water wastage can be coped with optimal water management institution, the electric power would need to be consumed primarily for productive purposes by strengthening producer goods industries in both the urban and rural sectors).

CHAPTER IV: PRESENT CONDITION OF THE PROJECT AREA

4.1 NATURAL CONDITION

4.1.1 Location

The project area is belt-shaped, running down almost from the south to the north, belonging to both Polonnaruwa and Trincomalee districts in the northeastern part of Sri Lanka and being encircled by Mahaweli and Amban rivers and the national road A-6. This project area corresponds to Systems D1, D2, G and A/D in the Master Plan prepared by UNDP/FAO. The total area covered by the project is 289,700 ac (115,880 ha), whereas the proposed irrigable area, 153,800 ac (62,200 ha), making up of the existing cultivated land of 98,900 ac (40,000 ha), the existing proposed land of 20,500 ac (8,300 ha) and the newly developed land of 34,400 ac (13,900 ha). These areas can be divided into 6 regions, i.e. 5 regions irrigated by the existing 5 tanks and one region irrigated directly by Yoda Ela; district-wise proposed areas are shown in Table 4.1.1.

Moragahakanda dam proposed as a principal water source for the project is Planned to be constructed across Amban river approximately 1.6 km up the existing Elahera headwork. This dam site is located at the border of Polonnaruwa and Matale districts.

4.1.2 Topography

Topography of Sri Lanka is characterized by three steps of peneplains which are composed of highest, middle and lowest plains, having 1,500 - 1,800 m, 90 - 750 m and less than 90 m in altitude respectively. The highest peneplain corresponds to the so-called Central Highland surrounding NUWARA ELIYA town. The middle and lowest peneplains are surrounding the central highland and decreasing the height gradually toward the coastal area.

The Mahaweli Ganga is the biggest river in Sri Lanka and the river rises in the highest peneplain and flows down to the Indian Ocean through the middle and lowest peneplains. The project area is divided into Moragahankanda dam and reservoir area and the agricultural area. The former area is located on the Amban Ganga, one of the tributaries of the

Mahaweli Ganga, flowing on the middle peneplain. The latter area is extending on the lowest peneplain on the left banks of the lower Mahaweli Ganga and the lower Amban Ganga.

General topography of Moragahakanda damsite and the reservoir area shows gentle slope mountain or hilly plain in the midstream of the Amban Ganga, having 150- 600 m in altitude. The Amban Ganga has tributaries of the Sudu Ganga, The Nalanda Oya etc., in its upstream reaches. These tributaries take their rises in the mountain area which surrounds MATALE and NAULA town. The river flow, direction and the continuation of hills and mountain ridges have the clear trend of north-south, reflecting the geological structure.

Moragahakanda damsite is located at a narrow gorge of the Amban Ganga, cutting the north-south mountain ridge. Just from the damsite the upper area is formed of the basin topography. From the topographic conditions, the proposed damsite seems to be the most favourable. The altitude of the river bed at the damsite is about 135 m. Two serial kern cols are located on the north mountain ridge across the proposed damsite. They seem to be the old river beds. The altitudes of these cols are about 150 m and 180 m, respectively.

The damsite and the reservoir area are composed of gentle slope mountain and covered by jungle, so there are not found such unstable slopes that landslide or rockfall woud occur. Along the river bed of the Amban Ganga and its tributaries, there are cultivated only narrow paddy field and vegetable garden.

The agricultural area of the project lies on the left banks of the Mahaweli Ganga and the lower Amban Ganga. These areas have gentle undulation which is typical feature in the lowest peneplain. The alutitude of project area D_1 is 60 - 10 m, covered by jungle. D_2 and A/D areas are Swamp zone ranging from 30 m to 6 m in altitude, and some places thereof are inundated in Maha season. The Project area is an eminent granary in Sri Lanka since old times, using the irrigation system composed of Yoda Ela canal and five main tanks. Mahaweli Ganga and its tributaries meander on the lowest peneplain, and their flow trends are rather complicated. Besides the above five main tanks, many small old irrigation tanks are lying scattered. And erosion remnants, such like Sigiriya Rock, are found at many places.

4.1.3. Meteorology

The project area, which belongs to a tropical zone, is under the influence of monsoons. Seasonal variations in temperature are not so significant, averaging 25° - 28°C. Rainfall significantly varies in accordance with seasons and years. For as seasonal rainfall variations, the rainfall occupies about 60% of the annual rainfall during the period of October to January, about 25% of that during the period of April to May and the rest during June to September. For as annual rainfall variations, according to the past 28-year rainfall data obtained at Hingnrakgoda station in which is located nearly at the centre of the project area, the maximum rainfall accounts for 111.32 inches (2,827 mm), the minimum rainfall for 38.17 inches (970 mm), the average one for 64.87 inches (1,647 mm) and the gap between the maximum and the minimum rainfalls is considerablly large. In addition, the project area belongs to the dry zone (below 75 inches in the average rainfall); there are two seasons, i.e. the Maha season (from October to March) and the Yala season (from April to September).

Annual evaporation is large, accounting for over 2,000 mm, the amount of which is higher than that of rainfall. Evaporation during the Maha season is larger than that during the Yala season.

Winds blow on the wings of monsoons; from northeastern direction during the Maha season and from southwestern direction during the Yala season.

Monthly meteorological data obtained at Maha-Illuppallama, where is near to the project area, are shown in Table 4.1.2.

4.1.4 Geology

Geology of the project area is composed of very old, highly crystalline metamorphic rocks, called Highland series (Pre-cambrian) and Vijayan series (Cambrian). Moragahakanda damsite area is located on the region of the Highland series, and agricultural area is on the both series.

The Highland series is classified into three groups by its rock types; these are Khondalite group, Charnockites and Kadugannawa gneisses.

The Khondalite group is composed of garnet-sillimanite schist and gneiss, quartzite, quartz schist, quartz-feldspar grarulite, quartz-feldspar garnetiferous gneiss, crystalline limstone, calc granulite, calc gneiss and graphitiferous schist. The Charnockites contains various kinds of coloured mineral. Charnockite is generally greenish-grey or bluish-gray coloured and well-consolidated. Rocks of the above two groups are found alternately on the same area. The Kadugannawa gneisses is composed mainly of Amphibolites (hornblendle-plagioclase schist), distributed typically around Kadugannawa town.

The Vijayan series is composed of gneiss, gneissic-granite, granitie gneiss, granite, augen gneiss and migmatite. The Vijayan series are Cambrian polymetamorphic rocks, formed by metamorphism of the Highland series rocks (Pre-cambrian). The above two series are classified by metamorphic grade, and therefore there is transition zone of complicatedly mixed with the two series.

The transition zone develops along the both banks of Mahawedi Ganga from south to north 16 to 19 km in the width. East side of the transition zone are Highland series region and west side are Vijayan series region.

Quarternary deposits covers over the above base rocks. One of those deposits is river bed deposit, along the Mahaweli Ganga and its branches, and the other is reddish brown or light brown coloured sand, silt and loam, covering most part of the project area. The river bed deposits are generally loose unconsolidated sediments, composed of sandy silt and clay, sometimes containing gravels. On the Moragahakanda damsite, the thickness of the above deposits are 6 m to 8 m, and it is seemed to be similar on the agricultural project area. The sand, soil and loam deposits covering other than the river bed are also unconsolidated sediments, which are assumed to be mostly residual deposits. On the damsite area, its thickness is 1 m to 2 m, and also supposed to be similar or a little bigger on the agricultural project area.

Geological structure of the Highland series region is formed by series of parallel folds, NNE-SSW in direction. The Vijayan series region and transition zone are also formed by many folds, but on those regions, the folding direction is less uniform and less continuous than those Highland series region. Dipping of the rock beds of these two series is generally gentle, horizontal to 40°C.

4.2 WATER RESOURCES

4.2.1 General

The water resources of the proposed Moragahakanda Reservoir are some part of the Mahaweli Ganga flow diverted at Polgolla diversion and of natural runoff from its own basin of the Amban Ganga. Polgolla Diversion was completed by 1975 and the diversion has been commenced in January, 1976. After diverted at Polgolla, the water is utilized for power generation at the Ukuwela station of 40 MW and then released to the Sudu Ganga, a tributary of the Amban Ganga.

The Ambang Ganga flow augmented by Polgolla diversion is impounded at the Bowatenna reservoir. A part of the water stored in the reservoir is diverted for irrigation purpose to Kalawewa region (so-called H-area of 48,600 ha), locating in the north of Bowatenna. The remaining water is released to the Amban Ganga through Bowatenna power station of 40 MW.

About 10 kilometers upstream of Bowatenna, Nalanda reservoir exists on the Nalanda Oya, a tributary of the Amban Ganga. A part of the water stored in the said reservoir is also diverted to Dewahuwa area for the irrigation.

Downstream of Bowatenna, there are two existing intake weirs at Elahera and Angamedilla. The water taken at Elahera is sent to the existing fields in system G, and D_1 through the existing tanks, Minneriya, Giritale, Kaudulla and Kantalai.

Total effective capacity of these tanks amounts to 400 million cubic meters (mcm), and the natural runoff from their own catchment basins is also an important water resources to the area. Water diverted at Angamedilla is supplied to the existing fields in system D_2 through Parakrama Samdura tank. Between Elahera and Angamedilla intake weirs, the Kalu Ganga joints to the Amban Ganga and provides an important water resources to the system D_2.

The water flow diagram of the above is as shown is Fig. 4.2.1.

4.2.2 Available Water Resources

As cleared in the above, various hydrologic circumstances are entangled in estimating available water for the Moragahakanda Reservoir. In order to assess the available water for the Reservoir, following hydrologic components have to be taken into considerations.

i) Polgolla diversion flow
ii) Natural runoff of the Amban Ganga
iii) Diversion flow to other basins

(1) Polgolla Diversion

The drainage area of the Mahaweli Ganga is 1,292 km^2 at Polgolla. The nearest gauging station is Gurudeniya situated about 16 km downstream of Polgolla. Flow at Polgolla can be estimated by multiplying the recorde runoff at the Gurudeniya with a factor 0.961, which is a ratio of the catc ment areas at Polgolla and Gurudeniya. The annual runoff at Polgolla is 2,439 mcm or 77.3 m^3/sec on an average from 1950 to 1977. The annual variation in yield is so large that the minimum runoff of 1,322 mcm was recorded in 1976 and the maximum of 3,208 mcm in 1975.

The average monthly runoff is shown in the following table.

Average Monthly Runoff
Mahaweli Ganga at Polgolla
(1950 - 1977)

Unit: mcm

APR.	107	OCT.	321
MAY	199	NOV.	284
JUNE	299	DEC.	218
JULY	273	JAN.	116
AUG.	249	FEB.	70
SPT.	239	MAR.	64
Total	1,366		1,073

The above indicates that about 56 percent of annual runoff occurs during six months from April to September, which are the dry season in the Amban Ganga basin.

According to the diversion policy established by UNDP/FAO and enforced at present, the Mahaweli runoff is diverted to such extent as the maximum of 56.6 m^3/sec (2,000 cusec) so far available after release by 4.25 m^3 sec (150 cusec) for the requirements in the downstream reaches. The monthly diversion discharge through the Polgolla tunnel is estimated by analysing the daily discharge data, according to the diversion policy aforesaid. The results of the estimation are summarized in Table 4.2.1. The average diversion for 28 years amounts to 1,283 mcm per annum, corresponding to 1.7 times the natural flow of the Amban Ganga. Accordingly, the Polgolla diversion flow is the most important water resources for the development in the downstream areas of the Amban Ganga.

Upstream of Polgolla, the construction of Kotmale dam is planned. The Polgolla diversion is also analyzed and expected to be increased to 1,550 mcm per annum in an average after the completion of Kotmale dam which is about 1.2 times the presently diverted discharge. The results of the analysis for 28 years are summarized as shown in Table 4.2.2.

(2) The Amban Ganga

The Amban Ganga is the biggest tributary on the left bank of the Mahaweli Ganga. It originates in Hunasgiriya's Peak (El. 1,513 m), runs down about 38 km to north and then reaches Bowatenna reservoir. Near the reservoir, the river turns its direction to northeast and after flowing down about 13 km reaches to the Moragahakanda dam site. The total length of the river is measured at 123 km from its origin to the confluence with the Mahaweli Ganga. The drainage area above the dam site on the Amban Ganga is 782 km^2. Only one gauging station in the Amban Ganga basin is the Elahera station, located about 2 km upstream of the dam site. Daily average runoff data are available since October 1941. The drainage area at the station is 779 km^2.

The difference in drainage areas at the station and the dam site is so small that it is possible to apply the Elahera data to the dam site without any correction. The recorded runoff at the gage station are summarized for 28 years from 1950 to 1977 in Table 4.2.3. The average annual runoff is 776 mcm, corresponding to about one mcm per square kilometer or about 1,000 mm in depth. As the average annual rainfall in the basin is 2,363 mm, about 42 percent of the rainfall flows out as surface runoff. The seasonal variation of runoff is remarkable and it is directly influenced to annual distribution of rainfall. In general, after showing the maximum runoff in December, the runoff decreases gradually and reaches the minimum in September, which is the end of the dry season, as seen in Fig. 4.2.2. It is noteworthy that much supplement of the water is obtained from the Mahaweli in Yala (dry) season in the Amban Ganga basin. The supplement amounts to about four times the natural runoff of the Amban Ganga.

One of the important tributaries to the Amban Ganga is the Kalu Ganga which enters at a point between Elahera and Angamedilla intake weirs. Amban Ganga water diverted at Angamedilla feeds the Parakrama Samudra tank and is used to irrigate the commanded area of 12,300 ha.

As no reliable data are available at Angamedilla, the estimated flow by NEDECO is adopted in the water balance study. The estimated monthly flow of the Amban Ganga at Angamedilla is shown in Table 4.2.4.

(3) Diversion Flow to Other Basins

In the Amban Ganga basin, there are two existing reservoirs, Nalanda and Bowatenna, from which the Amban Ganga runoff is diverted to Dewahuwa and Kalawewa region, respectively. The Nalanda water is now planned to be supplied to the existing fields of 1,220 ha in Dewahuwa region. The annual diversion flow to Dewahuwa region is 26.6 mcm in an average and the monthly average diversion flows are summarized in the following table.

Unit: mcm

Diversion Requirements to Dewahuwa Region			
APR.	0.8	OCT.	2.5
MAY	3.3	NOV.	1.3
JUNE	3.4	DEC.	1.4
JULY	3.7	JAN.	3.3
AUG.	3.1	FEB.	1.3
SEP.	1.8	MAR.	0.7

A part of the Bowatenna water is diverted to system H, I(H) and M(H) in Kalawewa region through the irrigation tunnel with maximum capacity of 28.3 m^3/s (1,000 cusec). The remaining water is released to the Amban Ganga through the Bowatenna power station (installed capacity of the power station: 40 MW), which is now under construction. The total benefited area of system H, I(H) and M(H) is 48,600 ha, out of which paddy field occupies 60%, and the remainder is upland field. In the paddy field, cultivation is done fully in Maha season but is restricted to 85% in Yala season. In the upland field, cotton and other upland crops are planned to be raised in Yala and Maha seasons, respectively.

Diversion requirements at Bowatenna are estimated by NEDECO taking the tank operation in the region into account. The monthly diversion requirements estimated by NEDECO are shown in Table 4.2.13.

Diversion policy at Bowatenna reservoir is very important for the planning of the Moragahakanda Reservoir. In the diversion policy established in the past, the maximum diversion was limited to 28.3 m^3/s (1,000 cusec) and the priority was given to systems D and G, as they are located in the Amban Ganga basin. However, the benefited area in system H is increased by about 40% of the acreage taken in the water balance study by UNDP/FAO so that shortage of water is expected to occur in system H, unless the diversion policy is modified. Consequently, the following diversion criteria are newly established for planning the Moragahakanda reservoir, referring to the records of diversion and estimated irrigation requirements for the said area:

a. First priority shall be given to the diversion of the minimum flow required for operation of Bowatenna power station. According to the daily load curve of power in Sri Lanka, three hours peak is remarkable. Therefore, the minimum required flow is decided to be 1.03 mcm a day for three hours daily.

b. The remaining water shall be diverted to system H, I(H) and M(H) so much as to meet the irrigation requirements. However, the maximum diversion shall be limited to 31.1 m^3/s (1,100 cusec).

According to the above criteria, the monthly available water at the Moragahakanda dam site before and after the completion of Kotmale dam is calculated shown in Table 4.2.5 and Table 4.2.6 respectively.

4.2.3 Inflow to Tank

In general, irrigation water is supplied to benefited area through the existing tanks. Especially in the Yala (dry) season, the irrigation entirely depends on the water stored in the tanks during the previous rainy season. In the project area, there exist five tanks; KAUDULLA, MINNERIYA, KANTALAI, GIRITALE and PARAKRAMA SAMUDRA. The basic features of these tanks are shown in Table 4.2.7.

Each existing tank has its own catchment basin, the runoff from which is important water resources for the development of the area. However, there are no reliable runoff records on these existing tanks. NEDECO has estimated natural runoff to each existing tank taking into account rainfall, catchment area, topography and vegetation. As the NEDECO data are considered the most reliable at present, assessment of natural runoff to the tanks are based on them. In NEDECO data, however, the catchment areas of the Gal Oya 215 km^2 and Aluth Oya 73 km^2 are disregarded in the estimation of the Kantalai tank inflow as well as the area along the Elahera Minneriya Yoda Ela 145 km^2 in the estimation of the Minneriya tank inflow. For the estimation of natural inflow to these tanks, therefore, the runoff from these catchment areas are also counted, using ratios of catchment areas. The average monthly inflows to the tanks are as shown in Table 4.2.8, 9, 10, 11 and 12.

4.2.4 Quality of Water

Concerning the quality of water in the Mahaweli basin, the detailed water quality test was carried out for the water of Mahaweli Ganga, Amban Ganga and the existing tanks located in North Central Province by United States Operation Mission (USOM) in 1960 to 1961. The electrical conductivity of the water shows less than 475 micro-mhos/cm at any time and places. The water can be classified in C_1 or C_2 by the criteria of U.S. Salinity Laboratory. Sodium Adsoption Ratio (SAR) is less than 10 and the water is classified into S_1 by the same criteria. From the above classification, it can be concluded that the water is the best available for the purpose of irrigation under normal circumstances. The use of this water may not develop any problems of salinity and alkalinity in any soil.

4.2.5 Sedimentation

UNDP FAO Master plan Report has recommended to take total sediment yield for reservoir designs at 334 m^3 km^2 (0.70 ac.ft/sq.mi). The Report has also indicated a sedimentation diagram of Mahaweli basin on the following assumptions:

- Annual total sediment yield would be 0.70 ac.ft/sq.mile and annual yields for both suspended load and bed load would be the same.

- In the case water is to be diverted to another basin, only suspended load would be diverted with water in proportion to the amount of water diverted, and no bed load would be diverted.

- The trap efficiency would be calculated for each reservoir according to the empirical curve obtained by C.M. Brune.

The sedimentation diagram on the Moragahakanda Reservoir is elaborated as shown in Fig. 4.2.3 based on the above assumptions.

At the Bowatenna reservoir, about 50% of suspended load would deposit, and two-thirds of the balance would be flushed out to the Amban Ganga. Then, the volume of sediment deposit of the Moragahakanda Reservoir is estimated at 15 mcm (11,600 ac.ft) for a 100 years' period.

Actual sediment measurements have been carried out at Elahera and Gurudeniya gauging stations for both suspended load and bed load transport. According to the records a total annual sediment yield is estimated at 95 m^3/km^2 (0.2 ac.ft/sq.mile) and 224 m^3/s (0.47 ac.ft/sq.mile) at Elahera and Gurudeniya, respectively. The values are much less than the value recommended by UNDP/FAO.

For the conservative design, the design sediment deposition of the Moragahakanda Reservoir is decided at 15 mcm based on the value recommended by UNDP/FAO.

4.2.6 Evaporation

Near the project area, evaporation has been measured with the standard A-pan at four stations as listed in Table 4.2.14. Annual average evaporation of these stations is within a range from 1,450 mm to 1,930 mm.

Evaporation value from water surface of tank or reservoir can be estimated by applying pan coefficient, which is the ratio of evaporation from A-pan and evaporation from tank or reservoir. Though pan coefficient varies seasonally or with the depth of water, average value is around 0.75. As variation of pan coefficient would little influence to the water balance study of the Moragaharakanda Reservoir, the evaporation from the Reservoir and tanks is assumed at 75% of A-pan value at Kalawewa station, which is the closest to the project area.

4.2.7 Flood Runoff

The flood analysis for the Moragahakanda dam site was carried out by UNDP/FAO. The result of analysis is as shown in Fig. 4.2.4.

The river gauging records of the Amban Ganga at Elahera have been restricted in during low stage flows less than 200 to 300 m^3/sec, and most of the high stage flows have not been recorded because flood water overtops banks of the river. The rainfall data by self-recorders are available but not enough to compute the intensities of rainfall for short durations. It is therefore not possible to derive the unit hydrograph for the dam site or to carry out depth-duration analysis basing on the hydrological data collected in the basin.

While, the results of flood analysis for Bowatenna dam are available for the estimation of flood runoff at the Moragahakanda dam site. On purpose to compare with UNDP/FAO results, the probable flood runoffs at the dam site are calculated by applying the results of flood analysis for Bowatenna dam. The peak discharges of both results are as summarized below.

Return Period years	Estimated Flood Runoff m^3/sec	UNDP/FAO m^3/sec
20	2,008	2,505
50	2,865	3,000
100	3,262	3,481
500	3,990	4,415
1,000	4,624	4,981

For the safe design, the estimated flood runoff by UNDP/FAO is adopted for the feasibility design of the Moragahakanda dam.

4.3 SOILS AND LAND CLASSIFICATION

Soils in the existing cultivated land and even in newly reclaimed land proposed under the project are favourably qualified as a whole and suitable for agricultural development. The general value of acidity is PH 6 - 7; there is hardly a problem about acidity soil and salinity accumulation is found a little in a part of System D_1. (occupying less than 2% of whole area). Alluvial soils are distributing over a zone along Mahaweli Ganga within System D_1, D_2 and A/D. 20% of the whole area is composed of this soils in whole System D_1 while three quater of which is imperfectly/poorly drained soils. In addition, no poor sands and non-clasic brown siols, which are concentratedly distributed on the right bank of Mahaweli Ganga in System B, are found at all within the project area covered by the Moragahakanda Development Plan. The major soils are composed of R.B.E. (reddish brown earths) and L.H.G. (low humic gley), occupying about 50% and 25% of the entire area, respectively. It is deemed that 60% of R.B.E. is well drained and the rest 40%, imperfectly/poorly drained.

From the viewpoint of farm management, the soils seems to cause some problems in its physical rather than its chemical aspect. R.B.E., which occupies nearly a half of the project area, comes under the muddy condition when containing moisture; conversely, under the solid condition like a stone when dry and it becomes adhesive when saturated. Drainage should be paid due attention, or else imperfectly drained soils of R.B.E. are unsuitable for increasing rice production because of the reduction of soil stemmed from excess soil moisture and lack of air. Such properties of R.B.E. are also found in L.H.G. Imperfectly/poorly drained soils of R.B.E. will be most suitable for planting rice if drainage is improved.

As the project area belongs to the dry zone in Sri Lanka, organic matters contained in the soils are quickly resoluted and lost, reaching ten times as much as the maximum loss of organic matters in the temperate zones, accounting yearly for 10 tons per hectare; therefore, it is necessary to supply a great amount of compost, barnyard and green manures.

In view of manuring for crop plantation in the said soils, it is deemed desirable that fertilizer demand for chilly is high, that for pulses, low and that for rice plants, in between. In particular, V_1(N 2.7%, P_2O_5 27% and K_2O 13%) is being applied as a principal manure to rice production and urea as an additional one -- twice manuring for 3 - 3 1/2 month varieties and three times for 4 - 4 1/2 month varieties; however, it should be discussed from farm-management aspects that rice plants will become more sound and protective for damages by blight and noxious insects, thereby leading to an increase in farm incomes, if further additionally manuring potash of 1/4 to 1/2 cwt or TDM 2(N 30.6% and K_2O 80%) of 1 cwt during the early period of full ear when the final additional manure is applied.

With respect to soils and land classification, see Table 4.3.1 Gross Project Area for Different Soil Types and Systems, Table 4.3.2 Irrigable Area of Newland for Different Soil Types and Systems and Table 4.3.3 Soils and Land Classification.

4.4 Present Irrigation and Drainage Systems

4.4.1 Irrigable Area

The area to be benefitted by the Moragahakanda Dam comprises the existing fields which are irrigated by the water being supplied from Elahera and Angamedilla headworks on the Amban Ganga, and the new lands which are to be developed by an increased water supply through construction of the Dam. The irrigation water from these two headworks is sent by Yoda Ela to five major tanks for regulated supply toward the farmlands spreading at the foot of these tanks. The beneficiary area corresponds, as a whole, to Systems D_1, D_2, G and A/D on the map prepared for the Mahaweli Ganga Development Program, and its total area is approximately 1,200 km^2 (460 $miles^2$).

As a result of the survey, the existing irrigated area has been identified as shown below, showing an increase of some 10,400 ha (25,700 ac) upon that appearing in the report previously prepared by MDB (in 1977). This gap is mainly due to the fact that the previous survey did not take into account the 'acreage under unauthorized cultivation' nor the area which was put under cultivation at the foot of anicuts built across the drainage canals and riverlets in the existing colonization schemes' downstream.

Existing Irrigated Area

System	MDB Report (1977)	JICA F/S Team
G	4,800 ac	4,800 ac
D_1	49,400 "	69,100 "
D_2	19,000 "	25,000 "
A/D	-	-
Total	73,200 ac (29,600 ha)	98,900 ac (40,000 ha)

4.4.2 Irrigation Conditions

After the completion of Polgolla-Bowatenne Complex in May 1976, the irrigation conditons in this region have been generally very much improved, particularly in the area fed by Kaudulla Tank and Kantalai Tank. Diversion of the Mahaweli water at Polgolla is designed to meet the irrigation water requirements not only in our Project Area but in System H (including I (H) and M(H)) also. However, as the water requirements in System H are now less than originally designed and currently being diverted at Polgolla because it is not yet fully developed, the subsequent diversion at Bowatenne towards System H is restricted and the surplus water is being flown into the Amban Ganga. Nevertheless, this abundance of water toward our Project Area is not fully utilized as reclamation of new lands which should have followed the Polgolla-Bowatenne Diverson Work has been largely left undone.

Inspite of affluent supply of water over and above the design value, a considerable extent of farmland in this region is still suffering from shortage of water during Yala season. Such a phenomenon is attributable to a lack of facilities for seasonal regulation of the Amban Ganga water, the deterioration of irrigation/drainage structures in the downstream, and an excessive intake of water in the upper streams under undisciplinary water management practices.

Higher cropping intensity in Parakrama Samudra is backed up by better irrigability than others, because it has another important source of water, that is the Kalu Ganga, and all this can be rationally controlled by a single Tank.

4.4.3 Drainage Condition

At present, drainage takes place entirely through such natural rivers as the Aru,Oya, Ganga, etc., and the drainage water finally merges into the Mahaweli Ganga. Without any worthy embankment all along its course in this region, the Mahaweli Ganga would spread in each rainy season over miles on both sides, innundating among elsewhere, System D2 newland which is rather a flat, low land being encircled by rivers and is always isolated if not completely overflooded, during Maha season.

A newly reclaimable land in System A/D which is bordering to the Mahaweli Ganga is protected by an embankment but as it is located nearer to the River's mouth to the ocean, the lower parts are poorly drained and assuming marshy conditions. The Aru, Oya, Ganga, etc., which are being utilized for drainage purposes in the Project Area at present have never been artificially provided for, meandering with low flow capacity as they wish, and often widely flooding over paddyfields along their courses during Maha season.

4.5 AGRICULTURE

4.5.1 Area under Cultivation, Principal Crops and Yields

The land under cultivation in the Moragahakanda Project Area (Systems G, D1, D2 and A/D) may be stipulated as follows:

System	Acreage under Specification (ac)	Acreage under Unauthorized Cultivation (ac)	Total (ac)
G	4,800	-	4,800
D1	55,800	13,300	69,100
D2	19,600	5,400	25,000
A/D	-	-	-
Total	80,200 (32.400 ha)	18,700 (7.600 ha)	98,900 (40.000 ha)

Except System G. Which is getting irrigation water direct from the Elahera-Minneriya Yoda Ela, the absolute majority of the land under cultivation in Systems D1 and D2 consist of the colony lands which have been developed under the major tanks, such as Giritale, Minneriya, Kaudulla and Kantalai in System D1, and Parakrama Samudra in System D2. Although there are many 'purana' Villages fed by indigenous tanks which provide irrigation water supplementarily to monsoon rain during Maha but seldomly during Yala because of the smallness of their capacity, the aggregate size of the land belonging to 'purana' villages is almost negligible in comparison to the colony lands. Thanks to the existence of irrigation networks made up of the major tanks and link canals which are connecting them (such as Elahera-Minneriya and Minneriya-Kantalai), the existing fields in this area are enjoying, inspite of the fact that they are located in the Dry Zone, higher percentage of Yala cultivation and much higher paddy yeilds than the national averages as follows:

	MAHA Season (1977/78)	
	Whole Country	Project Area/1
Harvest Area (ac)	1250982	100007 (8%)
Paddy Yield (bu/ac)	51.52	75.0 (146%)

	YALA Season (1978)	
	Whole Country	Project Area/1
Harvested Area (ac)	683581	80700 (12%)
Paddy Yield (bu/ac)	43.55	60.0 (138%)

/1: System-wise Harvested Areas during this Agricultural Year will be seen in Table 4-5-1: The Existing Farming Area.

The existing fields in the Project area are put under cultivation of paddy and subsidiary food crops,[/1] with their cropping intensity of 174% in the case of paddy and 4% in the case of subsidiary food crops (SFC), totalling 178%, during the 1978 Agricultural Year. Accordingly, it would not be an exaggeration to call this area the 'Rice Bowl of Sri Lanka', and SFC occupy literally subsidiary position only. Their cultivation is limited on the upland during Maha and marginal parts of the paddyfields during Yala, excepting on the homestead gardens here and there.

4.5.2 Relationships between Water Supply and Land-Use

Irrigability of the farmland under major tanks (including that of the 'purana' villages fed by the major tank as in the case of Kantalai Tank which irrigates about 5,600 ac of three 'purana' villages in its downstream) was very much improved since 1975/1976 after completion of Polgolla Diversion as will be known from Table 4-5-1: Irrigability and Irrigated Farming Before & After Polgolla Diversions. Water supply had remained a problem even during Maha when NE monsoons failed to come in time or brought insufficient rains, hence little or no water was made available during Yala in Kantalai Colony, before the Polgolla Diversions. Today, it is 100% irrigable all through the year. In case of Minneriya and Giritale Tanks, particularly the latter which is smaller in capacity, 50% of the area under specification and 20% of the area under unauthorized cultivation was used to be adequately irrigated during Yala through the rotational irrigation of 2 days of a week. After the Polgolla Diversions, the rotational irrigation has been relaxed to 4 days a week and 100% of the former and 50% of the latter has become irrigable. Under Minneriya Tank, the pre-Polgolla irrigability during Yala under the similar rotational irrigation remained 75% in the area under specification and 25% in the area under unauthorized cultivation, but it has been improved to 100% and 50% respectively, in post-Polgolla years. Parakrama Samudra, the biggest tank in Polonnaruwa District with a large catchment area in its hinterland, has also been replenished with the Mahaweli water through Polgolla and its extensive colony is enjoying, even in the middle- and down-streams, 100% irrigability all through the year as far as the area under specification is concerned, and 100% during Maha and 45% during Yala even in the area under unauthorized cultivation. Kantalai and Kaudulla became 100% irrigable all through the year, irrespective of the difference between the manner of land-use.

/1: Subsidiary food crops include green grams, cow peas, soya beans, groundnuts, chillies, onions, maize, etc.

This much improvement in irrigability in each Colony spreading under all these Tanks, where irrigation/drainage facilities are generally in deterioration and water theft and illicit farming even on the drainage canals are taking place, seems to suggest that the water supply made available after Polgolla diversion is in fact beyond the saturation point as far as the reasonable water requirements in the existing fields are concerned. In other words, provided that a more rational water control and management (which would not be very difficult after physical improvement of the existing irrigation/drainage facilities) should have been effected side by side with the Polgolla Diversions works, it might have been possible to develop some new lands beyond the marginal limits of the existing Colonies to alleviate excessive pressure of population on land there, on one hand, and to encourage healthy cultivation practices which should help increase overall agricultural productivity in both the existing fields and the new lands, on the other.

While these positive measures have been neither seriously considered nor practically put into execution, the original colonists who have been settled in these areas for the last quarter of a century have had second and even third generations to be taken care of through fragmentation of their allotments for subsistence farming by the same kith and kin, as they can seldomly find full employment outside the colonies. After exhausting the allotments, they started encroaching on the reserved lands and even on the drainage canals simply to eke out a livelihood. Such practices are named 'unauthorized cultivation' and the land under such cultivation, the 'acreage under unauthorized cultivation.' Most of the unauthorized cultivation has been done by the colonists and their dependants rather than by the squatters from outside the colonies. However, it is really lamentable that a large part of this kind of unauthorized cultivation has been undertaken by the colonists of considerable means solely to augment their income as it is quite ironical that the additional supply of water made available by the Polgolla diversions has been mostly utilized to expand the acreage under unauthorized cultivation to an extremity instead of for developing new lands.

4.5.3 Water Control and Farm Management

In most colonies, irrigation/drainage facilities are obsolete and, suffering from intentional destruction, damage and deformation by the farmers, particularly by the outside labourers who are employed for time work, rational water control is made extremely difficult. In Giritale, for instance, it would take more than two days for the tank water to reach the paddyfields located at the end of the 10-mile-long main canal, and water thus supplied is less than one-third of that in the upper-stream. In addition to inadequacy of water control, the provision of credit and arrangement for the means and services for land preparation is usually left in such a mess of order that many cultivators find it very difficult to obtain buffaloes, tractors and labourers to carry out ploughing, puddling and levelling of their liyadda according to the schedule set forth in the water meeting.[/1] Although colonists are expected to complete land preparation and transplanting within 1 to 1-1/2 months after the water-issue,[/2] only about one-fifth of them can afford to do so, and one-half of them can finish this work within two months. For the rest of them, it would take more than three months.[/3] As the tank water is kept running down along the main canal and every field inlet fully open to receive water, irrespective of whether land preparation is being done or not, a huge amount of tank water simply flows down into the drainage canal without being fully utilized for land preparation purposes. Water level of the tank would drop below half of its effective storage capacity before land preparation and transplanting is over. Polgolla diversion helps to check such a sudden drop of the tank water level, but nothing substantial has been done to stop the wastage of irrigation water in the initial stage of paddy cultivation in the colonies at the foot of major tanks.

/1: Water Meeting = The colonists' general meeting held prior to each cultivation season to discuss and decide the time schedule of working programs over the season. Water Meeting is generally presided over by the Additional Government Agent who is held responsible for food production in the District.

/2: Water Issue = Commencement of water supply from the tank.

/3: See Section 4.6: Socio-Economic Conditions, and compare the performance of land preparation and transplanting with the class structure of the colonists and their ratio of land holdings to find out conformity between the two. The 'rich' farmers who comprise 15% of the population and manage nearly 50% of the land can afford to complete land preparation and transplanting within 1 to 1-1/2 months after water-issue; the 'average' colonists consisting of about 35% of the population and managing some 38% of the land can finish the same job within two months, but the 'poor' colonists including many landless peasants who represent 50% of the population but controlling less than 20% of the land take more than three months to see land preparation and transplanting (or sowing) done in their liyadda.

After land preparation and transplanting is over, rotational irrigation may be adopted if the tank happens to be of smaller capacity or it can not expect timely replenishment from other sources of water. But, in view of assuring the supply of the minimum necessary amount of water for cultivation in the following season, the water gate of the tank is usually closed as scheduled, and the paddyfields prepared and transplanted (or sown) at later stage are left without water supply even before the standing paddy ripens. This is one of the reasons why early ripening but low yielding varieties (3 months) are still in use by some portion of the cultivators even during Maha season.

The area farmers are generally far advanced than their counterparts in other regions in paddy cultivation method. 90% of the seed paddy used is reported to be HYV (BG series) and transplanting is done by 90% during Maha and 50% during Yala; 70% of cultivators are said to be using fertilizers but in fact much less than the Government-recommended dosage. Land preparation and threshing is done by buffaloes and tractors. The weak point is the lack of weeding and those cultivators who weed their paddyfield one month after transplanting are rated as diligent farmers. Only one weeding all through the entire growing period of paddy is done in about 65% of the area paddyfield. Weedicide is a costly material and seldomly used excepting a part of Kantalai colony. Plant protection is not very effectively done mainly because of the difficulties in obtaining chemicals as and when required. Judging from the occurance of pests and diseases in the last couple of years, it appears that 60% of the affected fields could have been adequately counteracted. Reaping is done by hand; threshing was used to be done through stamping by buffaloes till four to five years ago but, due to a rapid decline of buffaloe population during the last three to four years, almost 80% of threshing work is now dependant on four-wheel tractors.

In almost all the phases of paddy cultivation, probably excepting irrigation, nursing of seedlings and fertilizing, the area farmers generally depend very heavily on the hired labour in such as land preparation, transplanting, weeding, harvesting, threshing, winnowing, transportation and storage. Traditional 'attam' (neighbourly exchange of family labour) disappeared due to the expansion of monetized economy into the rural area all over the country and synchronization of farming in the irrigation schemes in the Dry Zone, since decades ago. The seasonal migrant labourers from the Wet and Intermediate Zones plus local landless peasants are the suppliers of farm labour and they are paid in cash and kind (meals, tea, tobacco, soap, etc). The Government-sponsored development projects of various kinds are increasingly absorbing the available labourers and their wages have been rising two to three times higher than five years ago. Consequently, paddy cultivation cost has been continuously swelling in the last several years, although cost increase is not solely due to the inflated labour cost.

Severe shortage of cattle fodder resulting from an exhaustive replacement of grassland and pastureland for production of cereals and root crops, probably excepting in some parts of Kaudulla, Kantalai and Elahera, helped diminishing the number of draft animals to about one-third of that five to six years ago. While the farmers'dependence on tractor increased to replace the animal power, ploughing back of barn manures to farmland decreased. This implied production cost increase side by side with soil fertility decrease. To squeeze additional production out of the lean soil to recover the cost-increase, more chemical fertilizers had to be applied which meant further increase of production cost. In one word, paddy cultivation became a costly job since draft animal population started declining. Although this seems to be a sort of rat race, it has had a specific implication in Sri Lanka where both the tractors (and their fuel) and the chemical fertilizers have to be imported either on cash from the meagre foreign exchange reserves or on international grant/loan basis which is difficult to be made resilient to the domestic demands. As long as they remain as the 'scarce' materials, they are apt to be put at the disposal of the privileged few, as in the case of other commodities in scarcity, inspite and irrespective of any amount of subsidies and rationing. Productive input is influenced not only by these socio-economic (and often political) factors but also physical factors. Paddy cultivating farmers know very well that it brings back no worthy return to put productive materials and labour into the field whose soils are excessively permeable or poorly drained.

Cultivation of subsidiary food crops on uplands and slopes during Maha season and in the marginal portions of paddyfield during Yala often require more labour, fertilizers and agro-chemicals than for paddy. And yet their GPS is inadequate and their marketing facilities are far from desirable, basically due to unorganized demand. In one word, the lack of incentives for the producers is keeping their production very low.

As for sugar cane, its cultivation on plantation basis is going on at the foot of Kantalai Tank, but its extension scheme which had been worked out in expectation of additional supply of irrigation water by Polgolla diversion is not yet implemented.

4.6 SOCIO-ECONOMIC CONDITIONS

4.6.1 Social Stratification among the Colonists

As mentioned earlier, the land under cultivation in the Project area is largely made up of the colony lands which have been developed under the major irrigation schemes such as Elahera (System G); Minneriya, Giritale and Kaudulla (System D1) and Parakrama Samudra (System D2). Land development under these major tanks took place under the Government's "specifications" and the settlers were allocated with 5 ac. of lowland for paddy cultivation and 3 ac. of upland as their homestead, per family. The land brought under additional irrigation through improvement of the tanks and canals was distributed among the offshoots of the original colonists and new settlers at the rate of 3 ac.lowland and 1-2 ac.upland. Recently, the land allocation per family has been reduced to 2-1/2 ac.lowland and 1/2 ac.upland which is also the rule under the Accelerated Mahaweli Development Program.

When the farmers first settled into the colonies, there was little to choose among them in social status. But today, they are very much different from what they were twenty years ago. Colonies themselves survived countless changes. They are larger both in the size of population and the size of land under cultivation. Side by side with an increase of population in terms of the original colonists' second generation and even the third, who could seldom leave their native place to enjoy gainful employment outside the colonies, the expansion of cultivated land took place in the shape of "encroachment" on the Crown land and also "chena." The acreage under unauthorized cultivation today stands for about 20% of the acreage under specification. These changes, however, are more or less quantitative in nature. Social stratification of the colonists (including their offshoots) into three categories and operational or managerial reallocation of the colony-land (including the encroachment) is the qualitative change.

Data and information obtained in the major irrigation schemes in the Project area (except Elahera) which was visited during the Team's field survey period for three months (from early November 1978 to early February 1979) seem to suggest that social stratification generally assumes the following pattern of household structure and farm management distribution:

Category or Group	Household Structure	Farm Management Distribution
Rich	15%	44%
Average	35%	38%
Poor	50%	18%
	100%	100%

Nearly half of the colony land (including encroachment) is managed by the rich who consist of a minority group representing less than one-sixth of the entire colony households, and the average who are equal to a little over one-third of the total households control or operate nearly 40% of the colony-land, and the remainder of the colony land which is less than 20% of the total is left over for operation among the constituents of the poor group which comprise half as many as the total households in the colony.

Let us use a model to explain such a change in more detail. Suppose a colony was developed with 100 settlers who were allocated with 5 ac.lowland per household. This colony, therefore, started with 100 settlers and 500 ac. of paddyland. In the meanwhile, the colonists expanded their land by 20% through encroachment on the Crown land to bring the total colonyland to 600 ac. The number of families increased but if we assume that they belong to each household, the total number of households remain almost the same. What can be the actual situation of this colony today? It will be tabulated on the following page.

	Number of Households in Colony		Average Land Holdings per Household (ac)			Land Holdings by Sub-Groups (ac)			Operational Distribution (%)	
Groups and Sub-Groups	By Household	By Category	Acreage under Specifications	Acreage under Unauthorized Cultivation	Total	Acreage under Specifications	Acreage under Unauthorized Cultivation	Total	By Sub-Group	By Category
Rich	5		22	1.5	23.5	110	7.5	117.5	20	
	5		15	2.0	17.0	75	10.0	85.0	14	
	5		9	3.0	12.0	45	15.0	60.0	10	
		15				230	32.5	262.5		44
Average	35	35	5	1.5	6.5	175	52.5	227.5	38	38
Poor	15		3.5	1.0	4.5	52.5	15.0	67.6	11	
	25		1.7	-	1.7	42.5	-	42.5	7	
	10		-	-	-	-	-	-	-	
		50				95.0	15.0	110		18
	100	100				500.0	100.0	600.0		100

4.6.2 Causes and Reasons for Stratification

The abve Table illustrates the 'ideal typus' of the pattern of social stratification and redistribution of land holdings more or less common among the major irrigation schemes in the Project area. Although the original settlers moved into the colonies almost in an equal status, they had quite different careers, professions and living places. Needless to say, the temperament, constitution and habitude of the heads of the household and the members of their families were all different. Again, some could hope for financial and other assistance from their friends and relatives, while others were so-to-speak 'outcastes' from their previous communities. After settlement, injury or disease set upon the handicapped colonist himself or one or two of his family members would have robbed him of labour to attend at cultivation of the land and, with little money in his pocket, no labourers could have been employed for the purpose either. Under these circumstances, he had no alternative than to borrow money from others or offer his land, either in part on as a whole, to his fellow-colonist under such contracts as Ande, Bin-ande, and Kallaru-Badda, and sometimes even Ugas or Vikneema./1 This means, on the other hand, that there emerged amongst the colonists the persons who could afford to cultivate other colonist's land on tenancy basis, on and above cultivation of their own land. They could also provide usurious finances to their fellow-colonists and cultivate the loanee's land without paying rent so long as the latter failed to pay back the loan in full amount and, eventually, took over semipermanent cultivation-rights of the other colonists' land.

In the colonies, fragmentation of the alloted land through transfer or lease was prohibited and personal operation and maintenance of the alloted land was the obligation, and nomination to a single successor (since 1969, number of legal successor to the allottee was made two but not more) was the rule. Yet, the traditional tenancy systems to which the colonists had been well accustomed invaded into the colonies. The Colonization Officers (C.OO) could little stop prevalence of these 'illicit' land tenure systems as they could not check the 'unauthorized cultivation' or 'encroachment' on the reserved lands. Distribution of the gift of the Nature thanks to sunshine, water and land plus human ingenuity thus became increasingly unequal among the colonists. Today, while one-tenth of them completely lost the cultivation-rights on the state land originally allocated to them and turned agricultural labourers, a minority group (15% of the total colonists) are now operating the land five times as large as their legal allotment, by employing their ex-fellow-colonists as labourers.

/1: Tenancy systems known as Ande, Bin-Ande, Ugas, Kallaru Badda and Vikneema are explained on the following page.

Ande

A kind of share-cropping system. Contract is made before cultivation season and the harvest is shared in paddy between the landowner and the tenant on the threshing-yard (Kamatha). Landower bears taxes, public charges and seed-paddy in total, plus half the amount of fertilizer and chemicals used for cultivation and one-half of tractor-hirage. "Ande" means one-half in Sinhalese language.

Bin-ande

This type of contract is usually made between ill-equipped landowner and well-to-do tenants. Excepting taxes and public charges which go to the landowner, all operational cost will be borne by the tenant who instead takes over 75% of the total yield.

Ugas

Under this system, loanee allows his loaner to cultivate the mortgaged land so long as loanee fails to pay off his debt. In this case, no interest will be exacted upon the borrowed money. If loanee happens to have enough labour and equipment, he may negotiate with his loaner to return the mortaged land on the basis of Ande system. Rs 500 is the amount usually financed against a mortgage on one acre of paddyfield.

Kallaru Badda

Cultivator pays in cash Rs 250 to Rs 300 per acre to his landlord before season. Whole operational cost will be borne by the tenant. When crop totally fails that season, the Kallaru-Badda tenant will be allowed to cultivate the same land again in the following season without any additional payment.

Vikneema

When the lease system called 'Kallaru Badda' will be extended for three to twenty years at a stretch, with its rent payable in advance, such contract will turn to be almost an outright sales of the land in question. Colonists resort to this type of semi-permanent tenancy contract when they intend to 'sell-off' their land though in fact they have been allocated only cultivation-rights of the land but not land itself. (Vikneema literally means "sale" in Sinhalese language.)

Natural course of development in these colonies might have been that of polarization of the colonists into the rich and the poor and their productive combination as the capital and labour, if not distorted by intervention of the outside merchants and money-lenders nor guided by the 'owner-farmer creation' policy of the Government, which is also to be pursued under the Accelerated Mahaweli Development Program. The social stratification briefed in the above as a model or 'ideal typus' is a salient feature observed in the old colonies under the major tanks built or restored in the earlier half of this century. In Elahera in System G and Kaudulla and Kantalai, particularly the latter, in System D1 which have been rapidly improved with their irrigability after the Polgolla diversions, the tendencies of exploitation of the weaker segments of their colinists by the outside merchants and money-lenders are more prominent than by the privileged farmers in the same colonies. Under the prevailing circumstances when the number of defaulters is enormously increasing due to erroneous rural credit policy and practices, such tendencies seem to be very much more intensified.

4.7 INFRASTRUCTURE AND FARMER SERVICES

In this Section, observations will be made mainly on infrastructure directly related to the farmer services and the farmer organizations through which farmer services are being provided.

4.7.1 Agricultural Extension Services

Since the great majority of the land under cultivation in the Project area is spreading in the major colonization schemes, the Agricultural Extension Services conducted by the Agricultural Department of the Ministry of Agricultural Development and Research are being provided in a comparatively more concentrated manner than in the 'purana' villages. Even so, the extension officers are numerically in short and the KVS/1 who are working on the front line in direct contact with the cultivators are mostly of insufficient qualifications, lacking in experiences. Even though their number may be increased and given more mobility through additional supply of transport conveniences such as jeep, motor cycle and bicycle to both expand the coverage of each extension worker and increase the frequency of their visit at the farms, the substantial contribution on behalf of the cultivating farmers would not be possible unless and until a qualitative change, or rather a functional change, takes place. It is very necessary that by conducting intensive refresher course trainings to make them the adequate pipes through which the technical improvements achieved in the laboratories and experimental units may be broadcast among the cultivators, in exchange of the cultivators' problems which would be sent up and again fed back to the cultivators through the extension workers.

Yet, there still seem to exist 'functional limitations' on the Government extension workers' activities. It is put outside of their concern to dig deeper into the farmer's problems and give intensive guidance on his behalf by taking into consideration, for instance, his financial standing, credit worthiness, labour mobilization and technical level, and with specific knowledge of the irrigation conditions of his land, its soil characteristics and marketability of the products, advise him, if necessary, to adopt the more productive cropping patterns and the ways and means to solve his farm-management bottlenecks.

/1: KVS = Kurushikarma Viyapathi Savaka, or village-level extension workers.

Colonists below the average as analyzed in the preceding Section do really want this kind of extension services which can be hardly expected through the Government extension service network as it is today. To make the agricultural development in the Project area a real success, it would be advisable to attach Farm Guidance Specialists to MPCS who, in collaboration with the Government extension workers, provide a coherent guidance to its member-farmers, beginning from procurement of credit and input supplies and ending in processing and marketing of their products. Co-op. Farm Guidance, however, will not be working if it should be too much atomized. It would therefore be necessary to organize the farmers into sizeable groups for joint guidance.

One of the prerequisites for implementation of Co-op. Farm Guidance Program would be the liquidation of rural indebtedness aimed at rehabilitation of the impoverished colonists to the self-standing order. Under the current socio-economic circumstances, the level of consciousness, understanding, knowledge and technique of the colonists below average (who are numerically more than sixty or seventy percent of the whole colonists) do not seem to warrant a wholesome and progressive development of agriculture based on inventiveness and personal initiative of each individual. Therefore, group farming under group guidance seems to be the only way to achieve general agricultural development through provision of a coherent extension and other services combinedly as referred in the above. The genuine aim of rehabilitating the impoverished colonists is to make them qualified to join such group activities.

4.7.2 Farmer Organizations

All the existing farmer organizations in the Project area would unfortunately be evaluated far below the mark, if they should be assessed from the established view-point that the farmer organization ought to be a body of farmers who are resolved to make all possible amenities available for their own socio-economic development through mutual help and joint efforts.
Apart from the agricultural extension services briefly discussed in the preceding paragraph, farmer services such as credit, input supply and marketing are today provided in such an inadequate and unorganized manner that majority of the farmers are not yet allowed to 'take off' from subsistence farming.

Apparently, it is nothing else but income-increase through augmentation of marketable surplus that will permit the cultivators to obtain increasing amounts of fertilizers, agro-chemicals and farm machinery, the products of industrial origin, for full bursting of engine for their plane to fly up into the air. It is quite regretable that there has been no serious effort on the colony level, in a planned and persistent manner, to organically combine the circulation aspect of rural credit, input supply and marketing with the technical aspect of improving the cultivation methods to achieve higher productivity through the farmer organizations.

Agricultural Productivity Committee (APC) whose establishment was rather forced upon the farmers than with their concurrence by the previous Government with the proclaimed aim of combining all the farmer services resulted at a failure and, after suspension of its function by the present Government, only the disturbances to the established system for providing farmer services remained. The idea of APC had been worked out in complete ignorance of, or even with animity towards, the Multi-Purpose Cooperative Society (MPCS) which, however, is also to be blamed for its inefficiency and mismanagement that motivated the establishment of APC.

Long and brilliant though the history of Co-operative Movement and its activities in Sri Lanka has been, it has had a basic handicap to properly serve the agriculturists. Possibly this is because of its genealogy which can be traced back to the consumer co-operative movement which was initiated by Rochdale Pioneers and developed hand in hand with the trade union movement in the Great Britain, and not the Raiffeisen type which started as the rural credit co-operative in Germany. At any rate, Sri Lanka co-op. movement still remains half-way to the required reformation, at least for its rural members, as will be known from its preoccupation with handling of consumer goods at the sacrifice of timely and adequate supply of agricultural inputs, processing and marketing of farm products, and linkage of rural credit with marketing through the proper medium of farm guidance.

Table 4.1.1 District-wise Proposed Areas

District	Tank, Yoda Ela	Existing Land	Existing Proposed L.	New Land
Polonnaruwa	Parakrama Samudra	25,000 ac	-	5,400 ac
	Minneriya	23,000 "	-	-
	Giritale	7,500 "	-	-
	Kaudulla	13,000 "	-	22,400 "
	Yoda Ela	4,800 "	10,000 ac	
Trincomalee	Kantalai	25,600 "	10,500 "	6,600 "
Total		98,900 ac	20,500 ac	34,400 ac

Table 4.1.2 Monthly Meteorological Data at Maha-Illuppallama

Item \ Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
Mean Temperature °C	25	26	28	28	28	28	28	28	28	27	26	26	27
Rainfall mm	113.8	51.3	89.7	182.9	99.3	19.3	30.2	56.9	66.5	226.1	253.5	238.0	1,427.5
Pan-Evaporation mm	127	157	205	174	205	213	229	220	222	164	123	118	2,157
Relative Humidity %	79	74	70	76	76	73	71	70	68	76	82	83	75

Table 4.2.1

* DIVERTED FLOW THROUGH POLGOLLA TUNNEL *(BEFORE KOTMALE)*
IN MILLION CUBIC METERS

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL	MEAN
1950	55	47	49	37	54	107	120	151	136	144	103	53	1056	88
1951	110	78	60	89	51	147	140	13	100	156	147	104	1195	100
1952	117	71	42	111	129	147	125	143	91	144	119	74	1313	109
1953	50	33	36	78	72	63	127	124	107	132	118	100	1040	87
1954	91	54	72	118	127	137	141	152	144	142	135	150	1463	122
1955	141	103	88	104	138	147	152	139	117	135	142	108	1514	126
1956	63	48	62	53	88	129	143	143	144	151	147	144	1315	110
1957	99	78	54	69	70	147	152	131	121	116	147	152	1336	111
1958	136	67	105	93	143	126	152	152	108	135	147	116	1480	123
1959	80	62	57	84	118	142	152	140	136	150	146	109	1376	115
1960	98	113	71	104	131	146	152	144	137	152	147	118	1513	126
1961	68	53	43	53	119	117	126	151	144	126	145	129	1274	106
1962	97	43	34	59	122	120	143	101	140	144	143	120	1266	106
1963	106	61	52	91	106	110	149	146	141	148	145	151	1406	117
1964	109	63	59	45	67	77	143	141	134	125	143	102	1208	101
1965	42	38	24	103	151	146	101	141	121	146	145	142	1300	108
1966	76	30	44	90	49	56	95	98	143	152	150	108	1091	91
1967	79	58	58	45	44	98	143	135	79	116	120	136	1111	93
1968	73	52	47	79	75	122	152	150	140	152	140	130	1312	109
1969	85	44	32	101	119	147	142	112	131	143	131	121	1308	109
1970	121	94	51	111	129	143	134	152	128	144	146	152	1505	125
1971	131	65	58	105	125	130	152	147	140	151	131	136	1471	123
1972	65	31	17	68	139	92	134	126	112	152	147	147	1230	103
1973	88	36	22	43	24	76	111	152	94	96	143	127	1012	84
1974	87	43	54	114	130	147	144	151	147	150	107	80	1354	113
1975	85	36	39	84	101	140	139	150	146	152	147	144	1363	114
1976	100	37	19	86	31	23	83	91	86	139	145	123	963	80
1977	36	21	25	64	147	144	140	100	79	145	134	108	1143	95
TOTAL	2488	1559	1374	2281	2799	3326	3787	3676	3446	3938	3860	3384	35918	2994
MEAN	89	56	49	81	100	119	135	131	123	141	138	121	1283	107

Table 4.2.2

* DIVERTED FLOW THROUGH POLGOLLA TUNNEL (AFTER KOTMALE)
IN MILLION CUBIC METERS

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL	MEAN
1950	80	84	99	75	139	91	108	151	147	151	101	34	1260	105
1951	151	108	92	133	97	147	151	89	147	151	147	151	1564	130
1952	151	101	80	137	151	147	151	151	145	151	132	85	1582	132
1953	84	71	69	83	82	103	151	151	147	151	147	137	1376	115
1954	67	60	107	147	151	147	151	151	147	151	124	151	1554	130
1955	151	131	126	147	151	147	151	151	147	151	147	97	1697	141
1956	101	92	110	101	135	147	151	144	147	151	147	151	1577	131
1957	132	118	99	108	129	147	151	151	129	57	147	151	1519	127
1958	151	106	151	145	157	147	151	151	111	151	147	151	1719	143
1959	108	100	107	130	142	147	151	151	147	151	147	143	1624	135
1960	128	142	96	147	151	147	151	151	147	151	147	135	1693	141
1961	94	76	84	92	151	147	151	151	147	151	147	151	1542	129
1962	113	72	77	100	151	147	151	151	147	151	147	135	1542	129
1963	128	82	93	123	125	147	151	151	147	151	147	151	1596	133
1964	142	105	102	92	129	130	151	151	147	151	147	132	1579	132
1965	91	84	79	144	151	147	129	151	109	151	147	178	1561	130
1966	96	70	85	122	93	87	109	122	147	151	147	127	1356	113
1967	114	99	105	93	93	147	151	151	103	151	147	151	1505	125
1968	104	75	98	115	151	147	151	151	147	151	147	151	1588	132
1969	125	91	81	147	151	147	151	131	147	151	147	151	1620	135
1970	132	124	82	143	151	147	151	151	147	151	147	151	1677	140
1971	161	98	100	147	151	147	151	151	147	151	147	151	1702	142
1972	86	63	64	98	151	147	151	151	139	151	147	151	1499	125
1973	106	65	65	80	68	118	139	151	101	113	147	151	1304	109
1974	108	74	98	147	151	147	151	151	147	151	137	135	1597	133
1975	99	61	72	114	151	147	151	151	147	151	147	151	1542	129
1976	128	68	40	112	72	66	140	118	78	151	147	151	1271	106
1977	73	60	69	103	151	147	112	150	120	151	147	143	1426	119
TOTAL	3204	2480	2530	3325	3726	3829	4059	4076	3828	4096	4022	3897	43072	3591
MEAN	114	89	90	119	133	137	145	146	137	146	144	139	1538	128

Table 4.2.3

* AMBAN GANGA AT ELAHERA
* NATURAL RUNOFF IN MILLION CUBIC METERS
* CATCHMENT AREA ; 779 SQ.KM.

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL	MEAN
1950	144	40	87	26	28	24	25	22	40	36	38	52	562	47
1951	330	101	40	53	28	46	30	13	38	59	125	162	1025	85
1952	265	106	46	53	63	35	16	14	11	79	81	83	852	71
1953	61	36	32	57	9	3	14	9	5	62	60	103	446	37
1954	173	97	61	56	20	12	12	9	5	54	46	260	805	67
1955	214	119	48	62	60	37	17	11	30	26	30	40	694	58
1956	32	54	51	49	30	15	5	3	2	10	99	102	452	38
1957	79	90	36	9	22	32	17	7	4	66	119	398	879	73
1958	114	49	104	88	92	24	18	32	8	51	77	107	764	64
1959	89	28	9	27	37	26	43	31	19	57	92	155	613	51
1960	144	302	73	58	34	23	45	17	17	46	143	99	1001	83
1961	112	65	51	30	43	25	24	26	12	18	99	155	660	55
1962	163	92	32	52	65	23	21	23	26	91	90	147	825	69
1963	257	151	61	69	44	22	19	20	14	33	95	223	1008	84
1964	254	143	80	38	32	18	29	19	20	25	64	130	852	71
1965	79	112	38	71	79	31	17	32	15	52	105	185	816	68
1966	134	74	66	46	22	14	11	9	25	60	147	103	711	59
1967	120	118	56	40	31	24	20	18	10	58	189	246	930	78
1968	128	43	70	34	17	15	31	17	12	52	125	176	720	60
1969	134	94	36	60	31	22	13	29	24	93	63	179	778	65
1970	216	246	63	73	46	22	19	16	20	44	72	161	998	83
1971	210	65	50	68	69	42	26	50	68	60	61	311	1080	90
1972	97	49	18	27	80	19	24	14	12	88	108	227	763	64
1973	61	47	19	19	16	11	10	9	8	9	45	177	431	36
1974	61	19	20	33	21	18	26	33	44	27	21	94	417	35
1975	78	38	45	22	25	25	23	30	29	23	145	116	599	50
1976	165	54	42	30	21	1	15	17	22	64	170	192	793	66
1977	63	22	28	39	142	117	94	47	27	160	232	291	1262	105
TOTAL	3977	2454	1362	1284	1207	726	664	577	567	1503	2741	4674	21736	1812
MEAN	142	88	49	46	43	26	24	21	20	54	98	167	776	65

Table 4.2.4

* AMBAN GANGA AT ANGAMADILLA
* NATURAL RUNOFF IN MILLION CUBIC METERS
* CATCHMENT AREA ; 1458 SQ.KM.

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL	MEAN
1950	271	75	165	49	53	48	48	41	74	50	53	74	999	83
1951	468	180	76	98	45	70	43	24	173	85	200	331	1793	149
1952	371	208	83	110	106	53	24	20	16	113	119	160	1383	115
1953	161	60	68	80	15	4	24	19	9	116	113	196	865	72
1954	326	181	116	108	38	24	24	18	9	81	74	473	1472	123
1955	414	218	101	114	95	56	25	16	41	49	59	74	1262	105
1956	89	86	80	71	45	26	9	4	5	20	191	196	822	69
1957	146	169	68	18	40	60	30	10	6	121	226	748	1642	137
1958	218	91	196	168	170	44	31	60	18	95	143	200	1434	120
1959	168	51	168	51	69	49	80	59	33	108	170	291	1297	108
1960	304	421	111	93	59	36	66	28	29	66	210	176	1599	133
1961	241	134	95	68	75	39	34	36	18	29	196	325	1290	108
1962	345	203	65	101	109	39	33	33	38	130	158	291	1545	129
1963	520	289	115	124	76	34	26	28	21	49	164	424	1870	156
1964	511	278	141	69	55	26	43	29	26	35	89	220	1522	127
1965	150	265	66	119	128	46	24	45	21	79	171	339	1453	121
1966	266	151	140	88	40	21	16	14	36	94	250	183	1299	108
1967	260	241	108	68	50	34	280	25	15	89	351	460	1981	165
1968	308	79	124	69	30	23	48	24	19	75	193	355	1347	112
1969	274	184	65	101	55	34	18	44	34	135	96	359	1399	117
1970	401	453	111	124	76	34	26	26	31	71	123	334	1810	151
1971	390	120	96	114	114	64	40	66	103	89	115	715	2026	169
1972	208	91	64	201	129	26	41	24	28	181	200	464	1657	138
1973	108	64	33	38	30	21	20	20	11	20	86	333	784	65
1974	113	33	38	63	39	31	49	63	80	51	39	176	775	65
1975	148	73	86	41	48	49	44	58	58	44	271	219	1139	95
1976	309	100	78	58	39	1	28	31	41	120	318	359	1482	124
1977	118	41	53	73	265	219	176	89	51	300	434	544	2363	197
TOTAL	7606	4537	2710	2479	2093	1211	1350	954	1044	2495	4812	9019	40310	3361
MEAN	272	162	97	89	75	43	48	34	37	89	172	322	1440	120

Table 4.2.5

* MORAGAHAKANDA RESERVOIR
* INFLOW IN MILLION CUBIC METERS (BEFORE KOTMALE)
* CATCHMENT AREA ; 782 SQ.KM.

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL	MEAN
1950	194	44	72	41	43	44	57	95	97	117	63	53	920	77
1951	436	174	51	109	43	106	94	22	52	159	270	263	1779	148
1952	375	161	49	111	107	95	66	78	35	192	118	79	1466	122
1953	55	43	44	51	36	32	53	54	34	191	157	195	945	79
1954	260	121	116	170	70	62	121	108	69	185	102	408	1792	149
1955	351	220	128	151	179	111	97	110	95	141	97	70	1750	146
1956	44	49	51	49	44	57	60	65	66	89	220	201	995	83
1957	95	141	46	35	41	92	94	78	48	179	264	548	1661	138
1958	246	69	194	120	205	79	82	150	37	170	169	154	1675	140
1959	134	40	36	41	76	142	110	100	77	203	234	262	1455	121
1960	238	413	138	152	102	93	192	145	80	192	288	209	2242	187
1961	167	114	66	42	85	96	82	97	76	140	233	282	1480	123
1962	256	133	52	105	181	119	76	54	88	232	226	265	1787	149
1963	359	210	111	152	90	45	130	94	79	151	236	372	2029	169
1964	359	201	127	45	44	38	84	82	75	145	163	191	1554	130
1965	62	85	66	97	218	92	39	156	57	195	248	325	1620	135
1966	206	80	94	129	41	37	36	61	121	209	295	209	1518	127
1967	192	149	104	46	44	40	75	84	35	146	303	380	1618	135
1968	196	64	89	56	39	50	95	102	74	201	253	304	1523	127
1969	171	79	46	80	66	82	67	91	77	233	188	298	1478	123
1970	353	339	112	161	120	78	77	101	70	181	213	311	2095	175
1971	337	126	104	166	119	85	90	171	152	208	157	445	2160	180
1972	154	47	33	41	132	38	70	62	46	237	245	372	1477	123
1973	112	47	39	38	36	35	36	86	34	36	106	302	907	76
1974	131	36	40	62	64	78	82	102	114	91	43	98	941	78
1975	78	43	49	40	42	78	74	100	96	114	278	211	1203	100
1976	184	49	48	42	40	20	38	58	60	194	307	307	1347	112
1977	65	37	43	46	202	226	222	109	41	286	363	396	2036	170
TOTAL	5790	3333	2128	2378	2509	2150	2399	2615	1985	4817	5839	7510	43453	3622
MEAN	207	119	76	85	90	77	86	93	71	172	209	268	1552	129

Table 4.2.6

* MORAGAHAKANDA RESERVOIR
* INFLOW IN MILLION CUBIC METERS (AFTER KOTMALE)
* CATCHMENT AREA ; 782 SQ.KM.

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL	MEAN
1950	219	61	142	41	80	40	45	95	108	124	61	52	1068	89
1951	459	204	83	153	82	106	112	37	109	205	270	310	2130	178
1952	409	191	71	153	129	95	92	86	78	211	131	90	1736	145
1953	66	43	44	58	36	32	77	81	74	210	186	232	1139	95
1954	236	127	151	199	94	72	131	107	72	194	91	409	1883	157
1955	361	248	166	194	192	111	96	122	125	157	102	59	1933	161
1956	49	62	81	65	78	75	68	66	69	89	220	208	1130	94
1957	128	181	55	41	141	116	95	98	56	120	264	547	1842	154
1958	261	108	240	172	219	100	81	149	40	186	169	189	1914	160
1959	162	43	37	102	169	147	109	111	88	204	235	296	1703	142
1960	268	442	163	195	122	94	191	152	90	191	288	226	2422	202
1961	193	137	107	67	132	126	107	97	79	165	235	304	1749	146
1962	272	162	95	146	210	146	84	104	95	239	230	280	2063	172
1963	381	231	152	184	109	82	132	99	85	154	238	372	2219	185
1964	392	243	170	56	77	61	135	92	88	171	167	221	1873	156
1965	88	154	51	188	218	93	58	166	45	200	250	361	1872	156
1966	226	120	135	161	41	37	36	85	125	208	292	228	1694	141
1967	227	210	151	59	58	104	93	100	35	205	330	395	1967	164
1968	227	87	140	92	84	80	94	103	81	200	260	325	1773	148
1969	211	126	46	175	98	82	76	110	93	241	204	328	1790	149
1970	344	368	143	193	142	82	94	100	89	188	214	310	2267	189
1971	367	159	146	208	145	102	89	175	159	208	173	460	2391	199
1972	175	47	39	41	175	103	87	87	73	236	245	376	1684	140
1973	130	47	39	38	38	42	61	85	34	59	111	326	1010	84
1974	152	36	40	155	92	78	89	102	114	92	73	153	1176	98
1975	92	43	49	51	89	85	86	101	97	113	278	218	1302	109
1976	212	49	48	57	40	32	67	85	52	206	309	335	1492	124
1977	102	37	43	67	283	253	194	159	68	307	376	431	2320	193
TOTAL	6409	3966	2827	3311	3373	2576	2679	2954	2321	5083	6002	8041	49542	4130
MEAN	229	142	101	118	120	92	96	106	83	182	214	287	1769	148

Table 4.2.7 Basic Features of Existing Tanks

			KAUDULLA	MINNERIYA	KANTALAI /1	GIRITALE	P. SAMUDRA
Catchment Area		square km	83	385 /2	588 /3	24	73
Capacity		million cu-m	128.3	136.9	160.6	25.3	135.1
Dead Storage		million cu-m	4.9	0	0	0	18.5
Active Storage		million cu-m	123.4	136.9	160.6	25.3	116.6
Area at F.S.L.		square km	25.9	25.5	28.7	3.2	25.7
H.W.L.		m	73.2	93.7	59.3	92.2	59.1
L.W.L.		m	64.0	82.1(89.9) /4	42.8	79.0	51.8
Existing Irrigable Area		ha	4,330	5,420	8,420	2,500	7,940
Dam	Length	km	9.2	2.8	3.7	0.5	14.7
	Top elevation	m	76.8	97.1	63.4	97.2	61.0
	Top width	m	-	7.6	13.7	9.1	3.7

/1: Including Vendarasam Kulam Tank
/2: Including catchment area along Elabera Minneriya Yoda Ela, 145 km^2
/3: Including catachment area of Gal Oya 215 km^2 and Aluth Oya 73 km^2
/4: Sill elevation of gates to Kantalai and Kaudulla Tank

Table 4.2.8

* KANTALAI TANK
* NATURAL INFLOW IN MILLION CUBIC METERS
* CATCHMENT AREA : 487 SQ.KM.

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL	MEAN
1950	12	10	15	2	12	0	0	10	5	10	22	17	115	10
1951	56	10	5	15	15	0	0	2	10	10	51	20	194	16
1952	42	5	2	12	10	0	2	0	15	15	17	20	140	12
1953	25	5	2	27	0	0	25	7	7	32	20	49	199	17
1954	27	5	17	20	0	0	10	2	0	20	17	44	162	14
1955	27	12	5	20	5	0	0	10	10	7	17	17	130	11
1956	17	5	2	7	0	7	0	2	0	25	29	27	121	10
1957	12	27	0	5	12	0	7	5	5	20	61	137	291	24
1958	25	12	12	7	7	0	0	17	5	12	22	22	141	12
1959	17	0	0	12	12	5	0	2	5	29	37	27	146	12
1960	27	44	7	22	22	0	17	2	15	20	49	10	235	20
1961	47	22	17	12	7	0	0	0	2	27	32	51	217	18
1962	7	7	10	10	5	0	0	10	12	15	22	22	120	10
1963	47	20	20	12	2	0	10	2	15	12	61	51	252	21
1964	15	15	12	2	12	0	10	2	5	17	12	15	117	10
1965	10	20	2	22	22	0	0	12	0	42	42	56	228	19
1966	17	2	17	15	0	0	0	5	17	54	42	22	191	16
1967	2	10	10	7	5	0	0	0	7	34	49	59	183	15
1968	15	0	15	7	2	0	0	10	15	20	25	22	131	11
1969	10	7	0	17	2	0	10	7	17	34	29	88	221	18
1970	12	22	5	20	10	5	0	12	5	7	29	34	161	13
1971	22	10	5	22	12	2	5	5	2	10	15	66	176	15
1972	7	0	2	12	15	0	0	0	37	32	39	32	176	15
1973	0	5	5	5	5	7	22	2	10	15	10	49	135	11
1974	0	5	0	10	17	0	0	0	10	0	12	44	98	8
1975	15	5	7	17	15	0	22	7	12	5	25	20	150	13
1976	2	2	0	17	2	0	5	5	2	10	32	51	128	11
1977	10	5	5	2	2	0	5	5	22	37	39	39	171	14
TOTAL	525	292	199	358	230	26	150	143	267	571	857	1111	4729	396
MEAN	19	10	7	13	8	1	5	5	10	20	31	40	169	14

Table 4.2.9

* KAUDULLA TANK
* NATURAL INFLOW IN MILLION CUBIC METERS
* CATCHMENT AREA ; 83 SQ.KM.

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL	MEAN
1950	2	1	2	0	2	0	0	1	1	1	3	2	15	1
1951	2	1	0	2	2	0	0	0	1	1	6	2	22	2
1952	5	1	0	1	1	0	0	0	2	2	2	2	16	1
1953	3	1	0	3	0	0	3	1	1	4	3	6	25	2
1954	4	0	2	2	0	0	1	0	0	2	2	5	18	2
1955	3	2	1	2	1	0	0	1	1	1	2	2	16	1
1956	2	1	0	1	0	1	0	0	0	3	4	3	15	1
1957	1	3	0	1	1	0	1	0	1	3	8	17	36	3
1958	3	1	1	1	1	0	0	2	1	2	3	3	18	2
1959	2	0	0	1	1	1	0	0	1	4	5	3	18	2
1960	3	5	1	3	3	0	2	0	2	2	6	1	28	2
1961	6	3	2	2	1	0	0	0	0	3	4	7	28	2
1962	1	1	1	1	1	0	0	1	2	2	3	3	16	1
1963	6	3	2	2	0	0	1	0	2	2	8	7	33	3
1964	2	2	2	0	1	0	1	0	1	2	2	2	15	1
1965	1	2	0	3	3	0	0	2	0	5	5	7	28	2
1966	2	0	2	2	0	0	0	1	2	7	5	3	24	2
1967	0	1	1	1	1	0	0	0	1	4	6	8	23	2
1968	2	0	2	1	0	0	0	1	2	2	3	3	16	1
1969	1	1	0	2	0	0	1	1	2	4	4	11	27	2
1970	2	3	1	2	1	1	0	2	1	1	4	4	22	2
1971	3	1	1	3	2	0	0	1	0	1	2	8	22	2
1972	1	0	0	2	2	0	0	0	5	4	5	4	23	2
1973	0	1	1	1	1	1	3	0	1	2	1	6	18	2
1974	0	1	0	1	2	0	0	0	1	0	2	6	13	1
1975	2	1	1	2	2	0	3	1	2	1	3	2	20	2
1976	0	0	0	2	0	0	0	1	0	1	4	6	14	1
1977	1	0	1	0	0	0	1	1	3	5	5	5	22	2
TOTAL	65	36	24	44	29	4	17	17	36	71	110	138	591	49
MEAN	2	1	1	2	1	0	1	1	1	3	4	5	21	2

Table 4.2.10

* MINNERIYA TANK
* NATURAL INFLOW IN MILLION CUBIC METERS
* CATCHMENT AREA ; 386 SQ.KM.

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL	MEAN
1950	8	6	10	2	8	0	0	6	3	6	13	10	72	6
1951	34	6	2	8	10	0	0	2	5	5	29	11	112	9
1952	24	3	2	6	5	0	2	0	8	8	10	11	79	7
1953	14	3	2	16	0	0	14	5	5	18	11	27	115	10
1954	16	2	10	11	0	0	5	2	0	11	10	24	91	8
1955	16	8	3	11	3	0	0	5	6	5	10	11	78	7
1956	10	3	2	5	0	5	0	2	0	14	18	16	75	6
1957	6	16	0	3	6	0	5	2	3	11	35	80	167	14
1958	14	6	6	5	5	0	0	10	3	8	13	13	81	7
1959	10	0	0	6	6	3	0	0	3	18	21	16	83	7
1960	16	26	3	13	13	0	10	2	8	11	29	6	137	11
1961	27	13	10	8	3	0	0	0	2	14	18	30	125	10
1962	5	5	5	6	3	0	0	5	8	8	13	13	71	6
1963	27	11	11	8	2	0	5	2	8	8	35	30	147	12
1964	8	8	8	2	6	0	6	2	3	11	6	8	68	6
1965	5	11	2	13	13	0	0	8	0	24	24	32	132	11
1966	10	2	10	8	0	0	0	3	10	32	24	13	112	9
1967	2	5	5	5	3	0	0	0	5	21	29	34	109	9
1968	8	0	8	3	0	0	0	5	8	11	13	13	69	6
1969	5	3	0	10	2	0	6	3	10	19	16	51	125	10
1970	8	13	3	11	5	3	0	6	3	3	18	19	92	8
1971	13	5	3	13	6	0	2	3	2	5	8	38	98	8
1972	5	0	2	8	8	0	0	0	22	19	22	18	104	9
1973	0	3	3	3	3	5	13	0	5	8	5	29	77	6
1974	0	3	0	6	10	0	0	0	5	0	6	26	56	5
1975	8	3	3	10	8	0	13	5	8	3	14	11	86	7
1976	2	2	0	10	2	0	2	3	2	5	19	29	76	6
1977	5	2	3	0	2	0	3	3	13	21	22	22	96	8
TOTAL	306	168	116	208	132	16	86	84	158	327	491	641	2733	228
MEAN	11	6	4	7	5	1	3	3	6	12	18	23	98	8

Table 4.2.11

* GIRITALE TANK
* NATURAL INFLOW IN MILLION CUBIC METERS
* CATCHMENT AREA : 24 SQ.KM.

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL	MEAN
1950	1	0	1	0	1	0	0	0	0	0	1	1	5	0
1951	2	0	0	1	1	0	0	0	0	0	2	1	7	1
1952	2	0	0	0	0	0	0	0	1	1	1	1	6	1
1953	1	0	0	1	0	0	1	0	0	1	1	2	7	1
1954	1	0	1	1	0	0	0	0	0	1	1	2	7	1
1955	1	1	0	1	0	0	0	0	0	0	1	1	5	0
1956	1	0	0	0	0	0	0	0	0	1	1	1	4	0
1957	0	1	0	0	0	0	0	0	0	1	2	5	9	1
1958	1	0	0	0	0	0	0	1	0	1	1	1	5	0
1959	1	0	0	0	0	0	0	0	0	1	1	1	4	0
1960	1	2	0	1	1	0	1	0	1	1	2	0	10	1
1961	2	1	1	1	0	0	0	0	0	1	1	2	9	1
1962	0	0	0	0	0	0	0	0	1	1	1	1	4	0
1963	2	1	1	1	0	0	0	0	1	1	2	2	11	1
1964	1	1	1	0	0	0	0	0	0	1	0	1	5	0
1965	0	1	0	1	1	0	0	1	0	2	2	2	10	1
1966	1	0	1	1	0	0	0	0	1	2	2	1	9	1
1967	0	0	0	0	0	0	0	0	0	1	2	2	5	0
1968	1	0	1	0	0	0	0	0	1	1	1	1	6	1
1969	0	0	0	1	0	0	0	0	1	1	1	3	7	1
1970	1	1	0	1	0	0	0	0	0	0	1	1	5	0
1971	1	0	0	1	0	0	0	0	0	0	1	2	5	0
1972	0	0	0	1	1	0	0	0	1	1	1	1	6	1
1973	0	0	0	0	0	0	1	0	0	1	0	2	4	0
1974	0	0	0	0	1	0	0	0	0	0	0	2	3	0
1975	1	0	0	1	1	0	1	0	1	0	1	1	7	1
1976	0	0	0	1	0	0	0	0	0	0	1	2	4	0
1977	0	0	0	0	0	0	0	0	1	1	1	1	4	0
TOTAL	22	9	7	15	7	0	4	2	10	22	32	43	173	14
MEAN	1	0	0	1.	0	0	0	0	0	1	1	2	6	1

Table 4.2.12

* PARAKRAMA SAMUDRA TANK
* NATURAL RUNOFF IN MILLION CÚBIC METERS
* CATCHMENT AREA : 73 SQ.KM.

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL	MEAN
1950	2	1	2	0	1	0	0	1	0	2	2	2	13	1
1951	7	2	1	2	0	0	1	1	2	1	5	4	26	2
1952	7	2	1	2	1	0	1	0	1	3	3	3	24	2
1953	3	1	1	3	0	1	2	1	2	4	3	6	27	2
1954	4	1	3	2	0	0	1	1	0	3	3	8	26	2
1955	4	1	0	2	1	0	0	2	2	2	1	2	17	1
1956	2	1	1	1	0	2	0	1	0	3	4	4	19	2
1957	2	4	0	1	2	0	1	0	0	2	9	17	38	3
1958	3	1	1	1	1	0	0	2	0	3	3	6	21	2
1959	4	0	0	1	0	0	0	0	0	5	5	4	19	2
1960	4	6	1	4	2	0	2	0	1	1	4	2	27	2
1961	6	4	1	2	2	0	0	0	0	2	5	7	29	2
1962	3	1	1	1	1	0	0	0	2	2	3	3	17	1
1963	7	4	1	3	1	0	1	0	2	3	7	6	35	3
1964	2	3	4	1	0	0	1	1	1	1	2	2	18	2
1965	1	6	0	3	2	0	0	2	0	3	8	8	33	3
1966	3	0	2	3	0	0	0	2	1	6	1	4	22	2
1967	1	5	2	1	0	0	0	0	0	4	7	7	27	2
1968	2	0	2	1	0	0	0	0	0	3	4	3	15	1
1969	2	1	4	4	0	0	1	1	1	4	2	10	30	3
1970	3	4	0	3	2	1	0	1	1	3	7	5	30	3
1971	2	1	2	2	0	0	2	4	0	3	3	11	30	3
1972	6	0	0	2	2	0	0	0	6	9	8	1	34	3
1973	0	2	1	1	1	1	5	1	5	3	5	18	43	4
1974	0	1	0	2	1	0	0	0	2	0	3	3	12	1
1975	2	2	3	3	2	0	1	1	0	3	4	5	26	2
1976	3	0	0	1	0	1	0	1	1	2	8	10	27	2
1977	2	1	2	3	2	0	2	1	2	4	9	8	36	3
TOTAL	87	55	36	55	24	6	21	24	32	84	128	169	721	61
MEAN	3	2	1	2	1	0	1	1	1	3	5	6	26	2

Table 4.2.13

* SYSTEM - H , IH AND HH
* DIVERSION REQUIREMENTS IN MILLION CUBIC METERS
* IRRIGATION AREA : 48600 HA.

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL	MEAN
1950	1	61	42	83	83	83	82	74	76	60	76	50	771	64
1951	0	3	47	31	39	83	64	73	61	2	0	1	404	34
1952	3	14	53	35	81	83	70	75	75	16	80	76	661	55
1953	75	82	76	34	83	83	82	75	75	0	19	6	690	58
1954	0	28	15	2	73	83	27	49	77	8	77	0	439	37
1955	0	0	6	13	15	69	67	36	49	17	73	76	421	35
1956	80	82	78	83	83	83	83	77	77	69	24	43	862	72
1957	79	25	78	74	6	59	68	56	74	0	0	0	519	43
1958	0	45	13	59	26	67	83	30	76	13	53	67	532	44
1959	31	83	77	53	6	22	80	67	75	1	2	0	497	41
1960	0	0	4	8	59	72	0	12	71	3	0	6	235	20
1961	9	2	26	53	58	42	63	76	77	1	9	0	416	35
1962	0	0	12	4	2	20	83	66	75	0	5	0	267	22
1963	0	0	0	6	56	83	33	68	73	27	2	0	348	29
1964	0	3	10	72	80	83	40	74	76	2	42	39	521	43
1965	78	40	64	25	8	81	83	13	76	0	0	0	468	39
1966	0	22	14	5	83	82	69	42	44	0	0	0	361	30
1967	3	5	8	72	62	63	73	65	76	0	4	0	431	36
1968	1	29	26	55	80	78	83	61	75	0	10	0	498	42
1969	44	57	71	29	80	83	83	46	75	0	4	0	572	48
1970	0	0	0	21	51	83	71	63	75	4	3	0	371	31
1971	0	2	2	5	71	83	83	22	53	0	33	0	354	30
1972	4	83	78	70	6	59	83	74	75	0	8	0	540	45
1973	33	83	76	83	83	83	63	71	75	56	79	0	785	65
1974	13	73	69	12	76	83	83	78	74	83	83	74	801	67
1975	81	83	75	83	75	83	62	76	76	58	12	47	811	68
1976	77	83	75	34	82	83	79	46	45	6	6	6	622	52
1977	30	50	58	60	6	7	7	34	76	1	1	1	331	28
TOTAL	642	1038	1153	1164	1515	1966	1847	1599	1982	427	705	492	14528	1213
MEAN	23	37	41	42	54	70	66	57	71	15	25	18	519	43

Table 4.2.14 Evaporation

unit:mm

Station	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	ANNUAL
KALAWEWA	122	131	164	153	171	181	190	194	198	151	126	120	1,901
KANTALAI	105	106	136	128	162	190	193	183	173	146	102	92	1,716
BATALAGODA	116	129	146	125	118	115	117	130	133	119	98	109	1,455
TOPPAWEWA	108	116	138	143	189	212	235	209	202	152	122	105	1,931
Estimated Value From Tank Surface	92	98	123	115	128	136	143	146	149	113	95	90	1,428

Table 4.3.1 Gross Project Area for Different Soil Types and System

[unit: ac]

	Soil Type	A/D	D_1 (North)	D_1 (South)	D_2	G	Total	Cropping Potential: Maha	Cropping Potential: Yala
1	R.B.E: Well drained	5,510	12,640	13,645	130	7,370	39,295	All upland Crops	All upland Crops
2	R.B.E: drained imperfect/poor	5,215	6,030	9,980	0	5,470	26,695	Lowland Rice Sugarcane/ Pasture	Upland Rice Sugarcane/ Pasture
3	L.H.G	1,260	6,060	25,150	0	2,050	34,490	Lowland Rice	Lowland Rice
4	Alluvial: drained well /moderately	0	970	0	3,650	570	5,190	Cash Crops (Tabacco, Veg.)	Cash Crops (Tobacco, Veg.)
5	Alluvial: drained imperfect/poor	3,760	970	3,465	10,550	0	18,745	Lowland Rice	Lowland Rice
	Sub-Total	15,745	26,640	52,240	14,330	15,460	124,415		
6	Solonetz	0	0	2,825	0	0	2,825	not suitable for Crops except soil improvement	
7	Shallow, Rocky	2,165	1,600	4,205	370	7,720	16,060	not for Cropping Area (Homesteads, Building, etc.)	
	Sub-Total	2,165	1,600	7,030	370	7,720	18,885		
	Total	17,910	28,240	59,270	14,700	23,180	143,300		

Notes:
(1) R.B.E (W.D) : Chillies, Onion, Groundnut, Soybean, Cowpea, Grams, Cotton, Sugar Cane, Turdhal, Maize, Sorghum, Upland Rice, Fruit (attention to deficiency of organic matter.)
(2) L.H.G. : Drainage would be beneficial.
(3) Alluvial (W.D) : D_2 Area (mainly)
(4) Alluvial (imp/poor): Flood problem
(5) Maha : {Chillies (intermediate soils is necessary)
Cotton (raining problems)

Table 4.3.2 Irrigable Area of Newland for Different Soil Types and System

[unit: ac]

	Soil \ System	D_1	D_2	A/D	Total	Remarks
1.	R.B.E (imp/poor)	1,400	-	4,000	5,400	Maha - Yala Paddy - Upland Crops
2.	L.H.G	20,000	-	1,400	21,400	Paddy - Paddy
3.	Alluvial (moderately)	-	1,400	-	1,400	Paddy - Upland Crops
4.	Alluvial (imp/poor)	1,000	4,000	1,200	6,200	Paddy - Paddy
	Total	22,400	5,400	6,600	34,400	

1 + 3 = 6,800 ac (20%)

2 + 4 + 27,600 ac (80%)

Table 4.3.3 Soils and Land Classification

(Gross Area)

(a) Current Farming Area

System	Upland Soils /1	Lowland Soils /2	Unsuitable & Other Land	Total
D_1	20%	70%	10%	100%
D_2	10%	80%	10%	100%
G	30%	60%	10%	100%
A/D	----------------	(Not Developed Yet)	----------------	

(b) Proposed New Land Area

System	Upland Soils	Lowland Soils	Unsuitable & Other Land	Total
D_1	30%	60%	10%	100%
D_2	10%	60%	30%	100%
G	35%	35%	30%	100%
A/D	30%	60%	10%	100%

/1 Upland Soils = Reddish Brown Earth (well-drained) and Alluvial Soils (well-drained);

/2 Lowland Soils = Reddish Brown Earth (imperfect/poor drained), L.H.G and Alluvial Soil (imperfect/poor drained).

Table 4.4.1 Existing Irrigation Area

(unit: acs)

System	Scheme	Acreage under specification	Acreage under unauthorized cultivation	Total
G	Elahera	4,800	-	4,800
D_1	Minneriya	13,500	4,500	18,000
	Giritale	6,200	1,300	7,500
	Kaudulla	10,500	2,500	13,000
	Kantalai Vendarasan-kulam Paravipanchan-kulam	20,800	3,100	23,900
	Galamuna (Minneri oya)	3,300	1,700	5,000
	Kahambiliya	500	100	600
	Wan Ela	1,000	100	1,100
	(Sub total)	(55,800)	(13,300)	(69,100)
D_2	Parakrama samudra	19,600	5,400	25,000
A/D	-	-	-	-
	Total	80,200 (32,400 ha)	18,700 (7,600 ha)	98,900 (40,000 ha)

Table 4 - 5 - 1 Irrigability & Irrigated Farming Before & After Polgolla Diversions

Season	Land Classification	Total Extent of cultivated land (in acres)		Irrigable Area (%)		Cultivable Area (%)		Harvested Area (%)		Yield(bushel per acre)	
				Pre-polgolla	Post-polgolla	Pre-polgolla	Post-polgolla	Pre-polgolla	Post-polgolla	Pre-polgolla	Post-polgolla
MAHA	Acreage under Specification	Giritale	6,200	100	100	100	100	90	100		
		Minneriya	13,500	100	100	100	100	90	95		
		Kaudulla	10,500	50	100	50	100	50	100	70	85
		Parakrama Samudura	19,600	100	100	100	100	100	100		
		Kantalai 1/	20,800	0 80	100	0 80	100	0 80	100		
	Acreage under Unauthorized Cultivation	Giritale	1,300	25	50	25	50	20	40		
		Minneriya	4,500	30	50	30	50	25	40		
		Kaudulla	2,500	10	100	10	100	10	100	50	75
		Parakrama Samudura	5,400	100	100	100	100	90	100		
		Kantalai 1/	3,100	0 50	100	0 50	100	0 50	80		
YALA	Acreage under Specification	Giritale	6,200	50	100	50	100	45	95		
		Minneriya	13,500	75	100	75	100	65	95		
		Kaudulla	10,500	Nil	100	Nil	100	Nil	100	50	80
		Parakrama Samudra	19,600	100	100	100	100	90	100		
		Kantalai 1/	20,800	Nil	100	Nil	100	Nil	100		
	Acreage under Unauthorized Cultivation	Giritale	1,300	20	50	15	25	10	20		
		Minneriya	4,500	25	50	20	25	15	20		
		Kaudulla	2,500	Nil	100	Nil	100	Nil	100	30	65
		Parakrama Samudra	5,400	40	45	30	40	25	35		
		Kantalai 1/	3,100	Nil	100	Nil	100	Nil	50		

Sources: Information supplied by I.E.E., A.I and C.00 at the colonies as well as DAEOO of Polonnaruwa and Trincomalee.

1/ Kantalai Tank area includes the lands irrigated by Vendarasankulam and Paravipancham Tanks.

Table 4 - 5 - 2 Existing Farming Area

(Unit: AC)

Tank or Canal	MAHA 1977/78					YALA 1978				
	Paddy			Sub-sidiary crops	Total	Paddy			Sub-sidiary crops	Total
	Regd.	Not Regd.	Sub Total			Regd.	Sub Regd.	Sub Total		
Elahera	7,322	2,551	9,873	500	10,373	5,000	3,516	8,516	1,000	9,516
Parakrama Samudra	19,600	5,400	25,000	500	25,500	14,700	4,050	18,750	500	19,250
Giritale	6,296	1,300	7,596	200	7,796	4,685	975	5,660	400	6,060
Minneriya	19,642	6,200	25,842	500	26,342	17,678	4,650	22,328	700	23,028
Kaudulla	12,290	3,000	15,290	800	16,090	10,383	2,620	13,003	1,000	14,003
Sub Total	65,150	18,451	83,601	2,500	86,101	52,446	15,811	68,257	3,600	71,857
Kantalai	13,406	3,000	16,406	1,000	17,406	9,442	3,000	12,442	1,000	13,442
Total	78,556	21,451	100,007	3,500	103,507	61,888	18,811	80,699	4,600	85,299

Source: Information obtainable from the Agricultural Instructors.

Sugarcane: There is about 7,400 ac. sugarcane plantation area in the downstream of the Kantalai Tank, apart from the figures given in the above.

Table 4 - 5 - 3 Current Irrigable Area, Cropped Area and Harvested Area in the Existing Field (ha)

		Acreage under Specification			Acreage under Unauthorized Cultivation			Whole Existing Lands		
		Irrigable Area	Cropped Area	Harvested Area	Irrigable Area	Cropped Area	Harvested Area	Irrigable Area	Cropped Area	Harvested Area
MAHA	Paddy	27,514	27,427	27,339	6,317	6,279	5,755	33,831	33,706	33,094
YALA	Paddy	27,239	27,153	26,694	5,243	4,539	3,402	32,482	31,692	30,096
	S.F.C.	275	274	270	135	115	87	410	389	357 /1
Sub-Total		55,028	54,854	54,303	11,695	10,933	9,244	66,723	65,787	63,547
Year-Round	Sugar cane /2	3,000	2,700	2,550	-	-	-	3,000	2,700	2,550
Total		58,028	57,554	56,853	11,695	10,933	9,244	69,723	68,487	66,097

1 : The harvested area of the S.F.C. (Subsidiary Food Crops) consists of Chillie (110 ha); Pulses (110 ha); Red Onion (70 ha); Soya bean (30 ha); Groundnut (20 ha) and Vegetables (17 ha).

2 : Sugarcane is being frown through Estate cultivation.

Fig. 4.2.1. WATER FLOW DIAGRAM

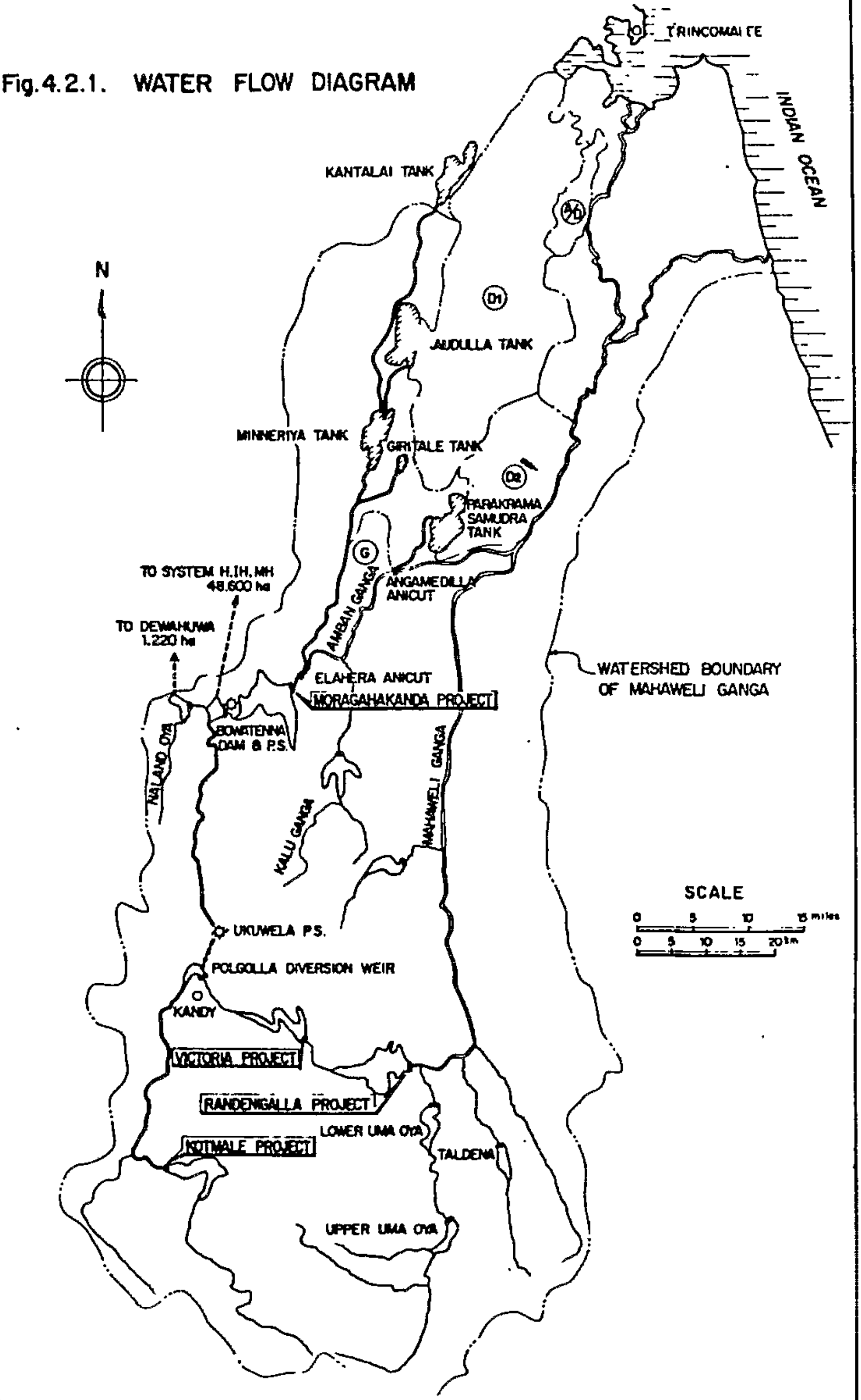


Fig.4.2.2 COMPARISON OF POLGOLLA DIVERSION AND AMBAN GANGA RUNOFF

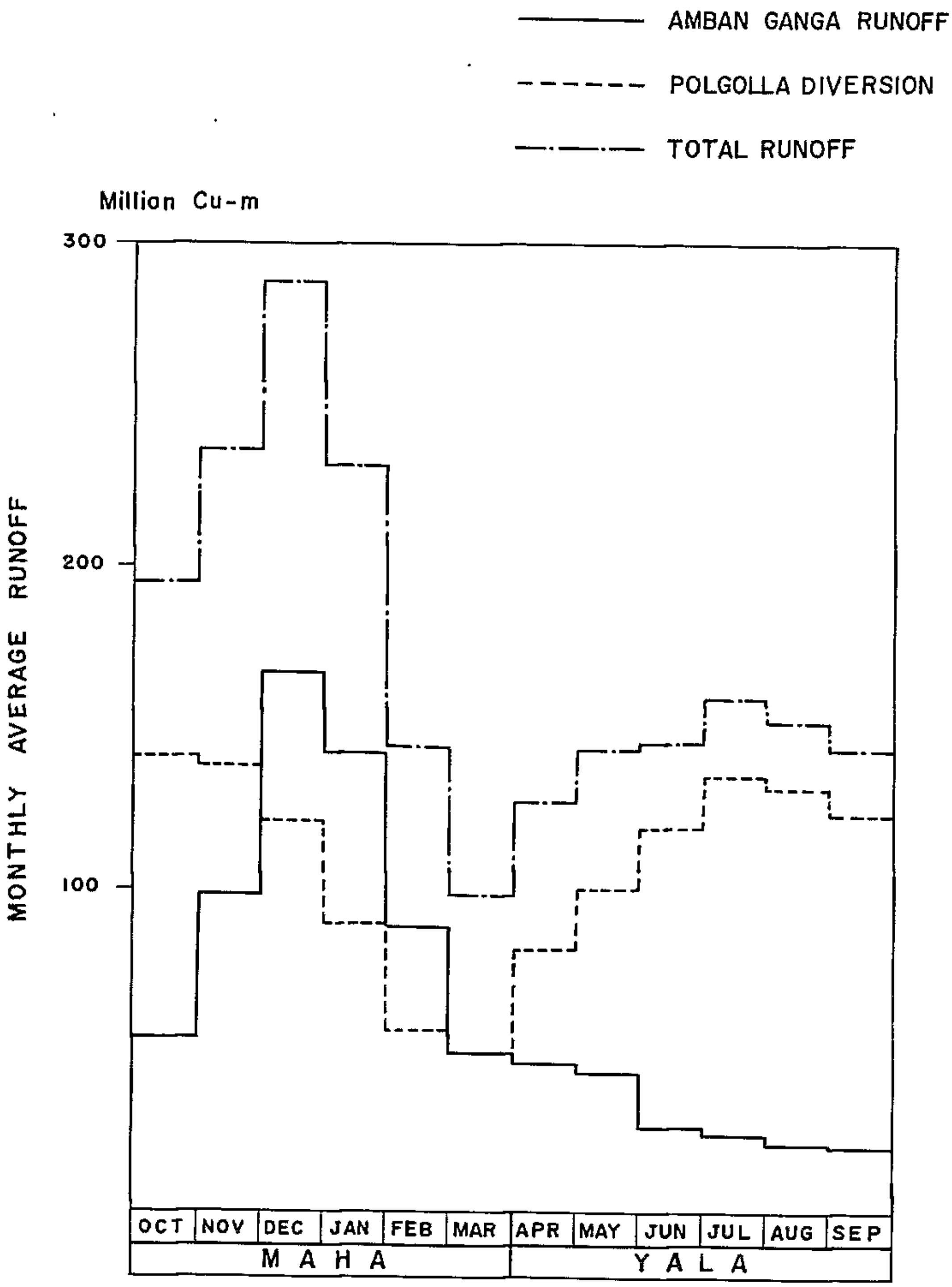
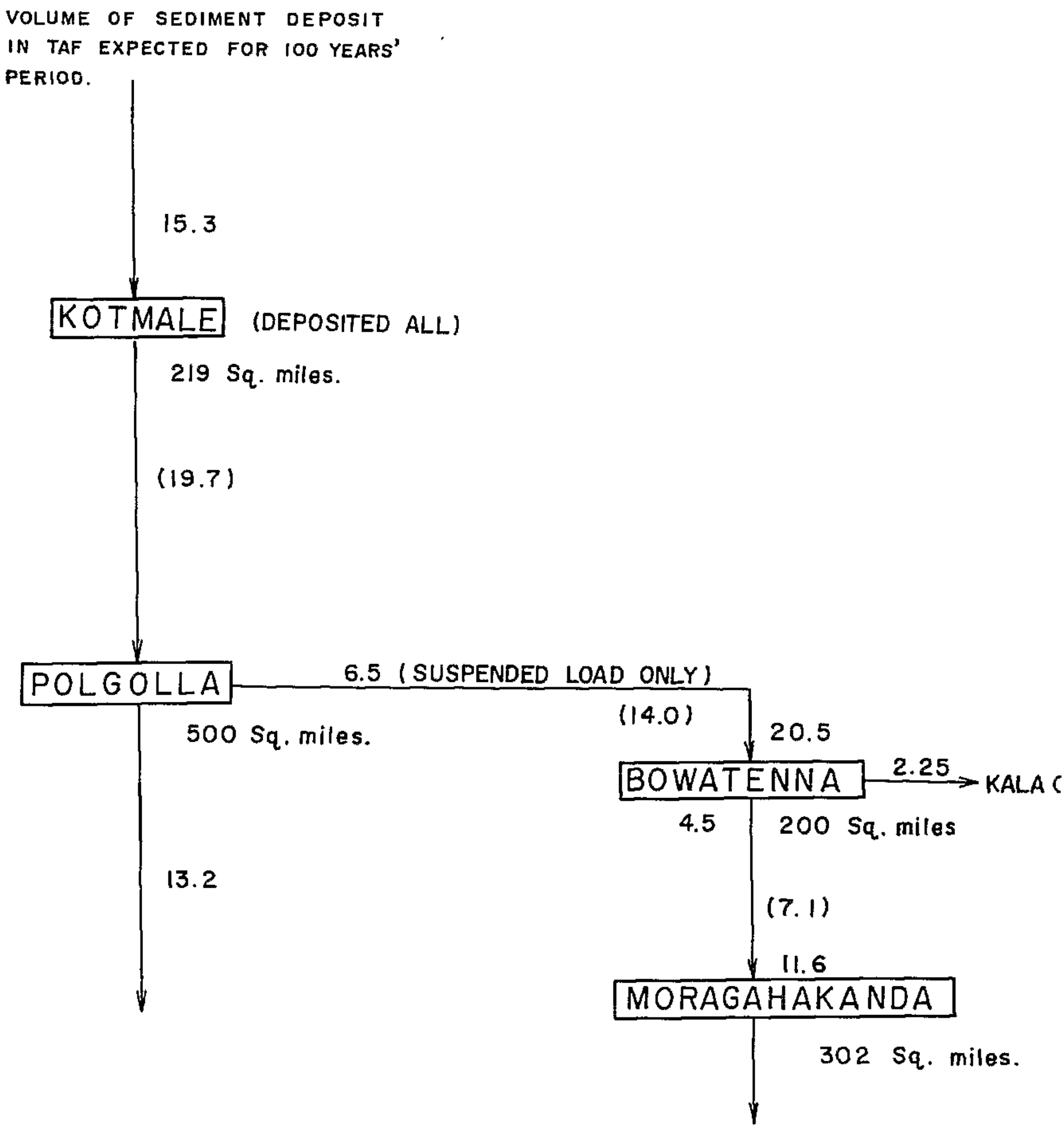
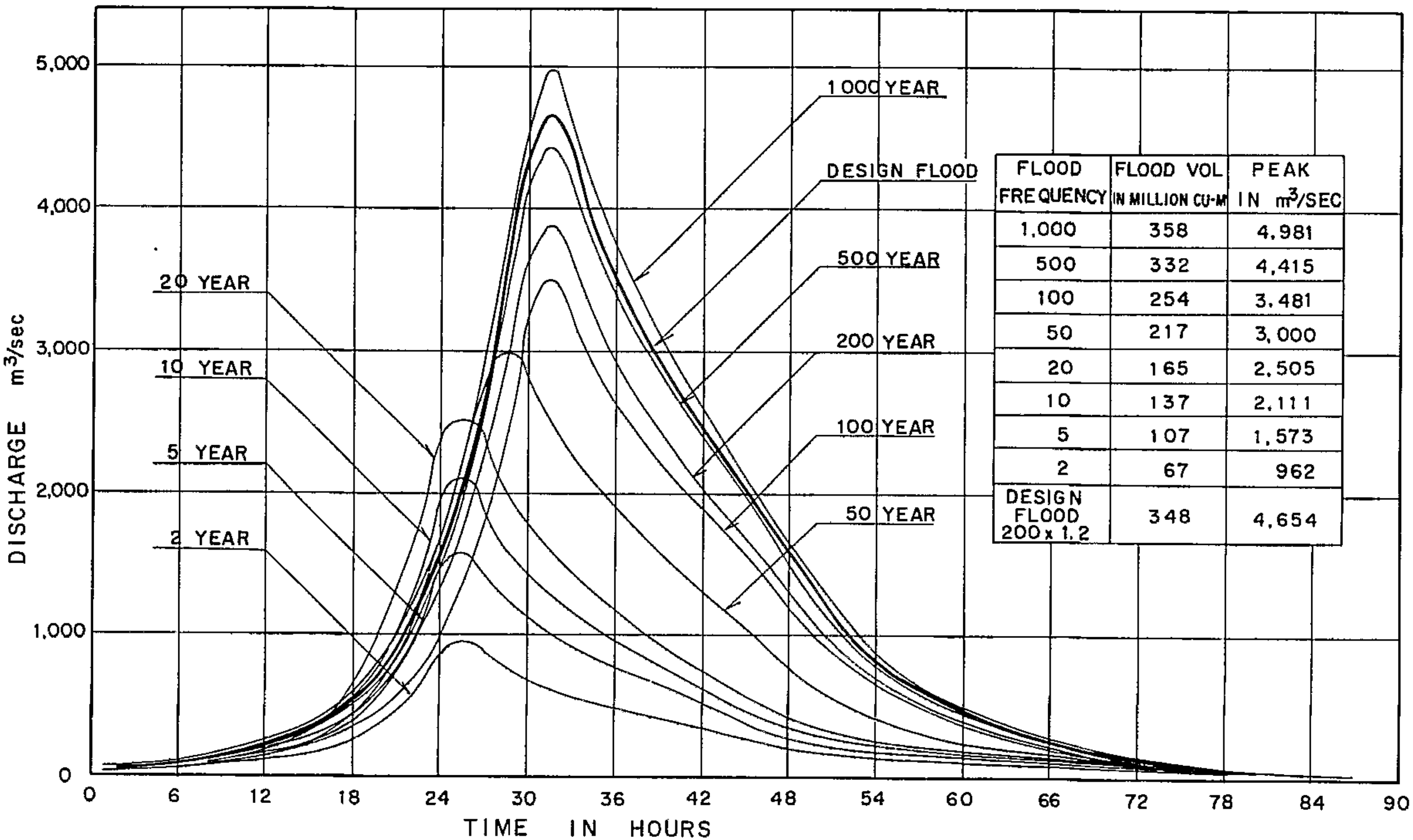


Fig.4.2.3 SEDIMENTATION DIAGRAM



THE FIGURES IN PARENTHESES SHOW THE VOLUME OF THE LATERAL INFLOW OF SEDIMENT BETWEEN TWO ADJACENT RESERVOIRS IN 1,000 AC. ft FOR 100 YEARS' PERIOD.

Fig. 4.2.4 FLOOD HYDROGRAPHS



FLOOD FREQUENCY	FLOOD VOL IN MILLION CU-M	PEAK IN m^3/SEC
1,000	358	4,981
500	332	4,415
100	254	3,481
50	217	3,000
20	165	2,505
10	137	2,111
5	107	1,573
2	67	962
DESIGN FLOOD 200 x 1.2	348	4,654

Fig. 4.4.1 Existing Irrigation & Drainage System

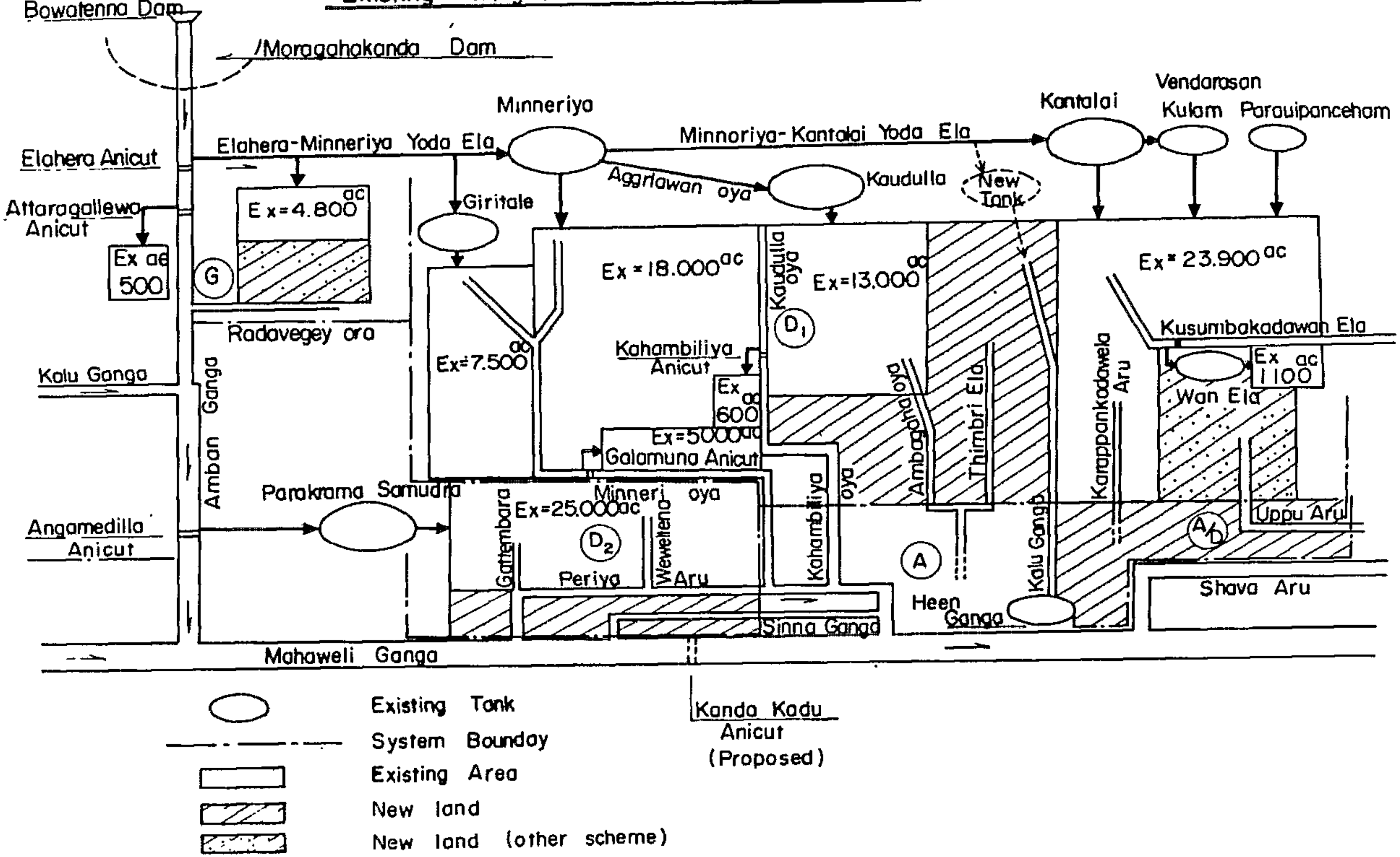
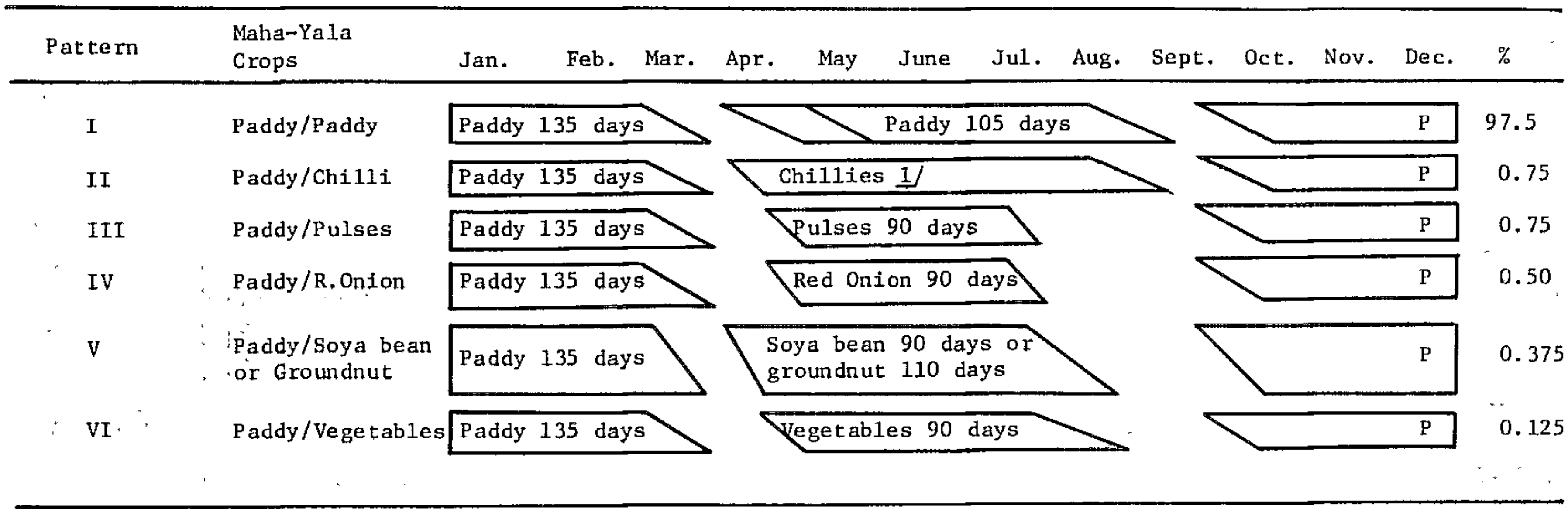
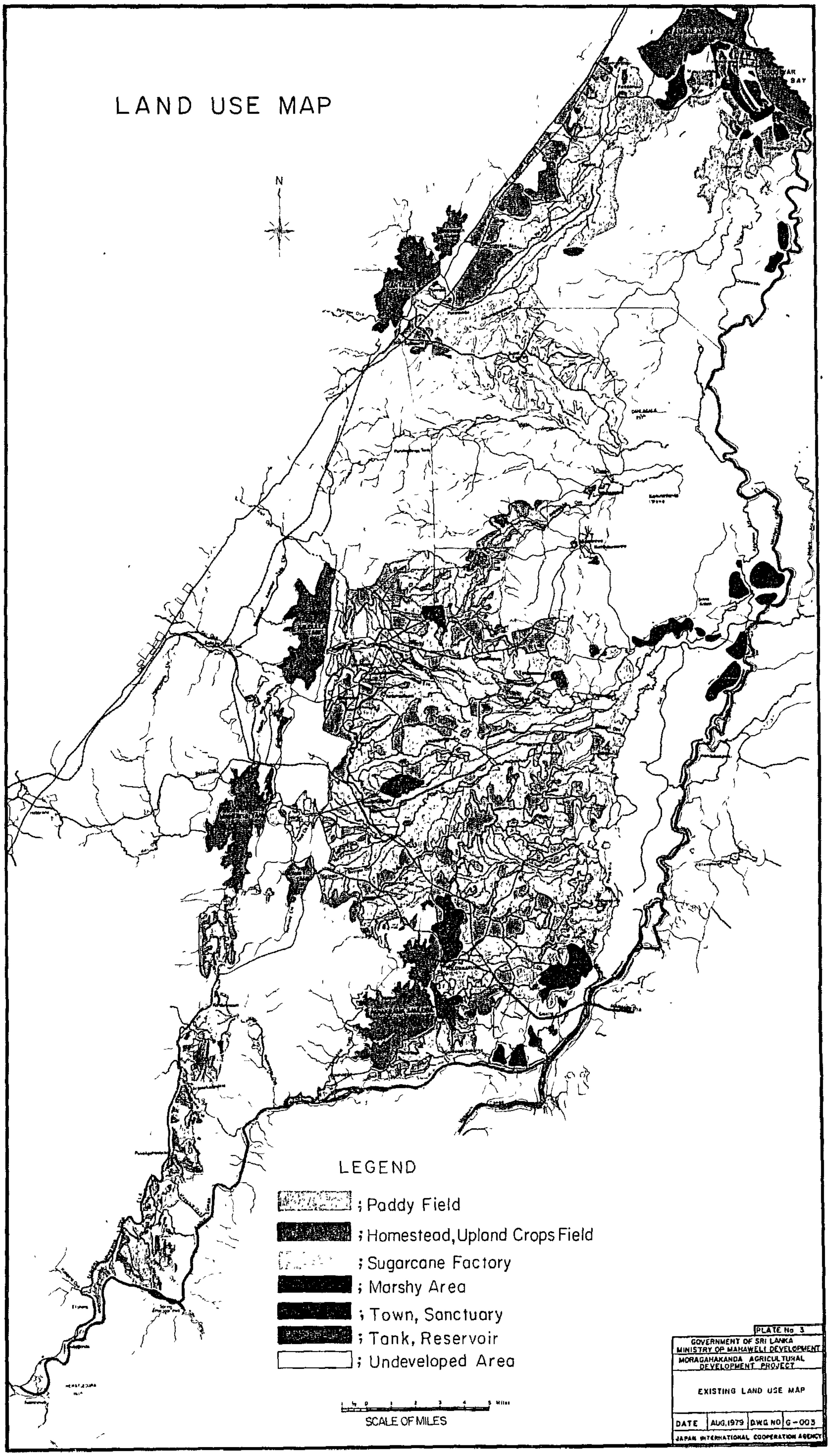


Fig. 4 - 5 - 1 CURRENT CROPPING PATTERNS (Irrigated Area)



1/ Ordinary varieties like MI-1 and MI-2 would attain the highest yields by standing in the field for 6 months. Hence, they would not be combined with 4-4 1/2 months' variety paddy cultivation. Instead, "SANTAKA" chillies whose maturing period run only for 105 days might be preferred.


LAND USE MAP
N
KODDIYAR BAY
LEGEND
; Paddy Field
; Homestead, Upland Crops Field
; Sugarcane Factory
; Marshy Area
; Town, Sanctuary
; Tank, Reservoir
; Undeveloped Area
SCALE OF MILES
PLATE No. 3
GOVERNMENT OF SRI LANKA
MINISTRY OF MAHAWELI DEVELOPMENT
MORAGAHAKANDA AGRICULTURAL DEVELOPMENT PROJECT
EXISTING LAND USE MAP
DATE AUG.1979 DWG NO G-003
JAPAN INTERNATIONAL COOPERATION AGENCY

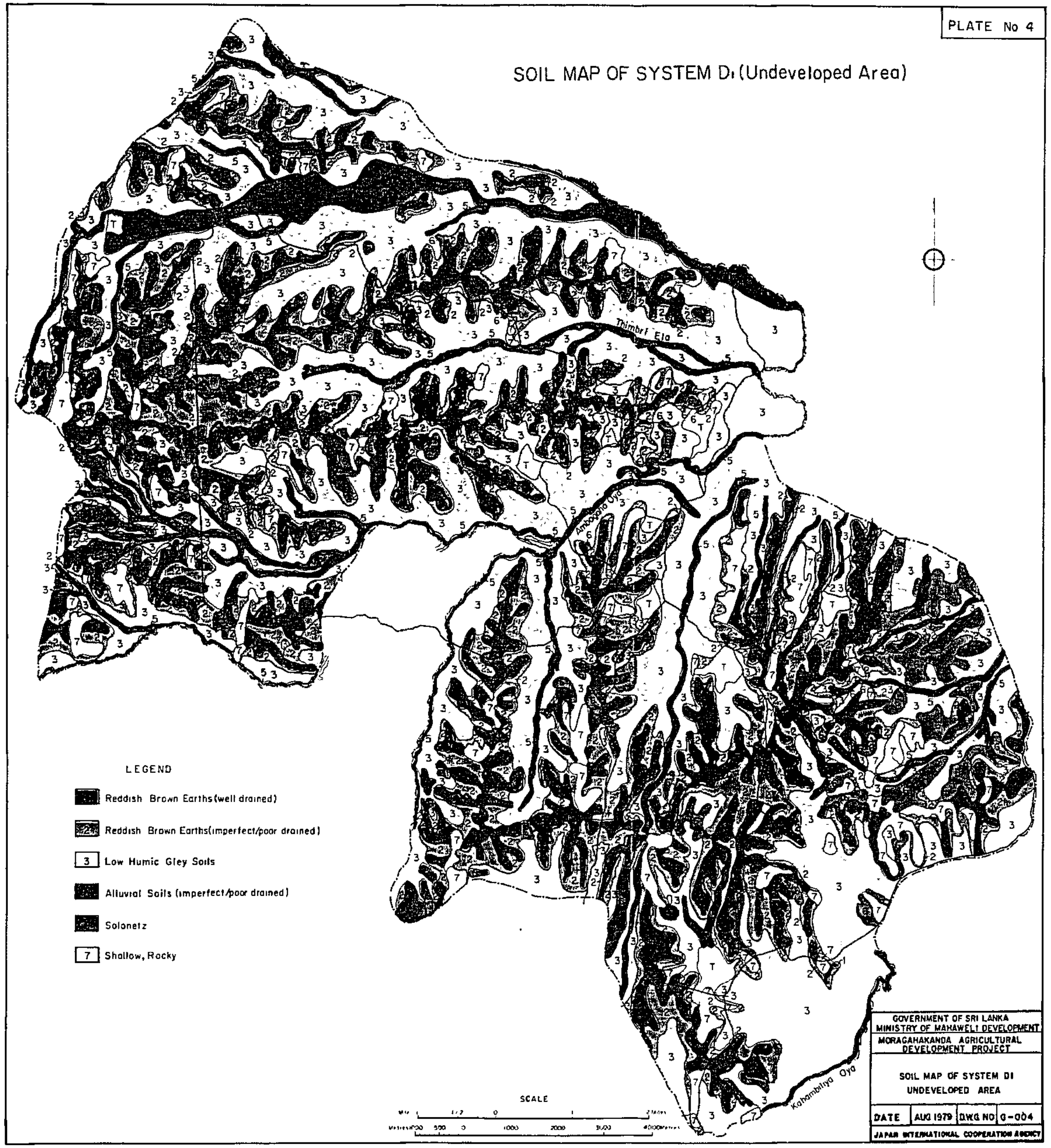


PLATE No 4
SOIL MAP OF SYSTEM D1 (Undeveloped Area)
Thimbiri Ela
Kalambiliya Oya
LEGEND
Reddish Brown Earths (well drained)
2 Reddish Brown Earths (imperfect/poor drained)
3 Low Humic Gley Soils
Alluvial Soils (imperfect/poor drained)
Solonetz
7 Shallow, Rocky
SCALE
GOVERNMENT OF SRI LANKA
MINISTRY OF MAHAWELI DEVELOPMENT
MORAGAHAKANDA AGRICULTURAL DEVELOPMENT PROJECT
SOIL MAP OF SYSTEM DI UNDEVELOPED AREA
DATE AUG 1979 DWG NO G-004
JAPAN INTERNATIONAL COOPERATION AGENCY

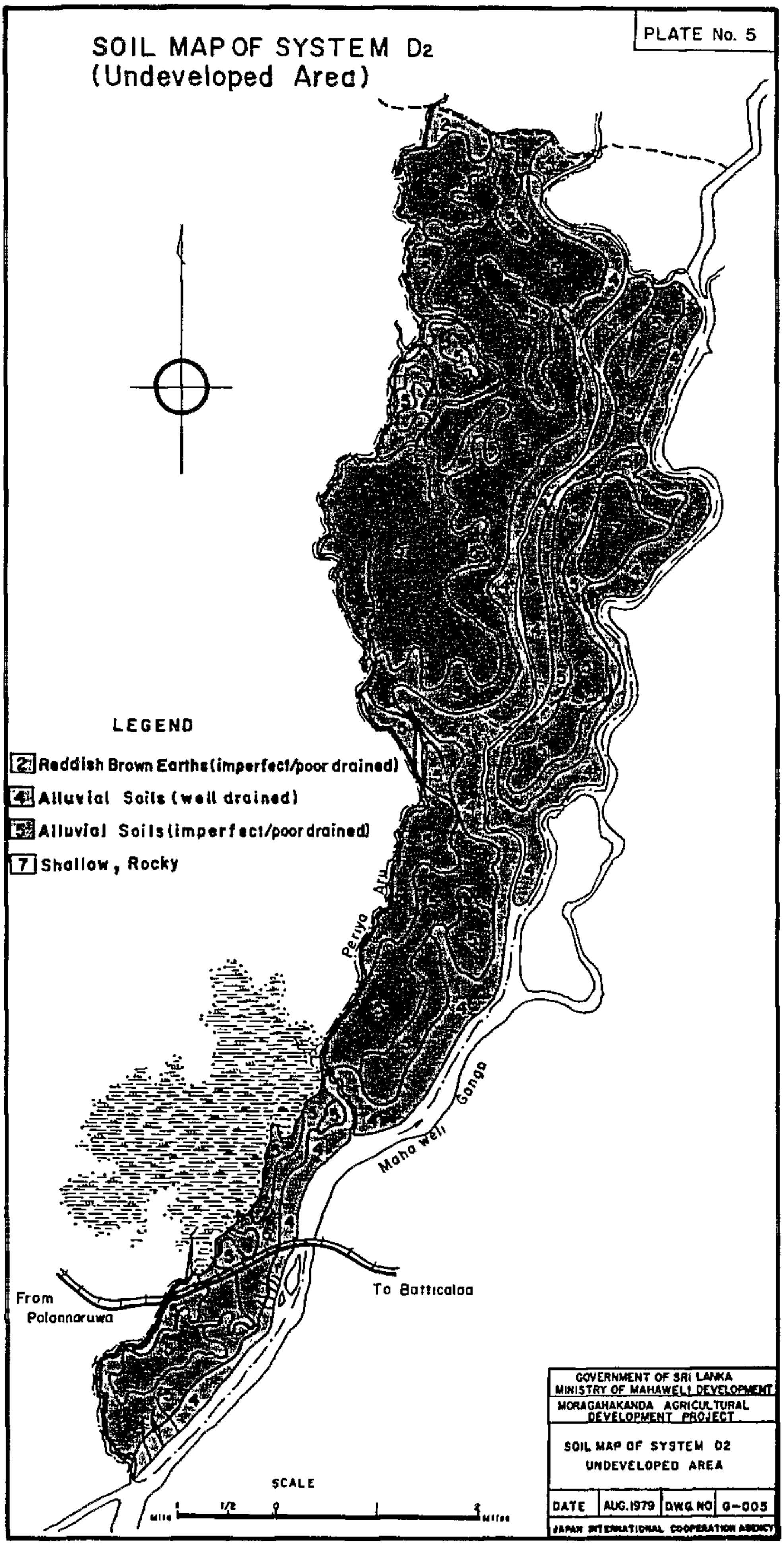
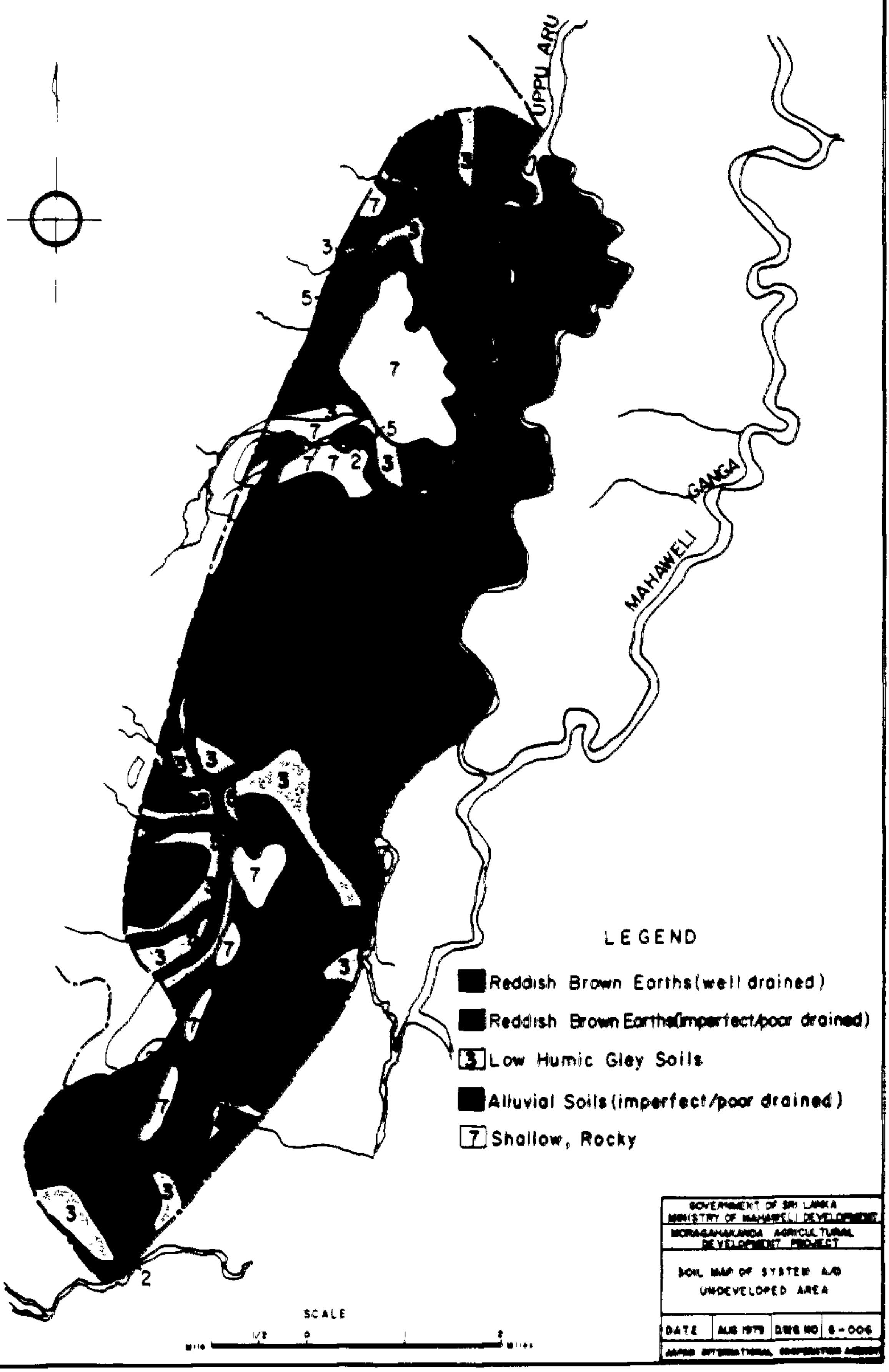


PLATE No. 5
SOIL MAP OF SYSTEM D2
(Undeveloped Area)
LEGEND
2 Reddish Brown Earths (imperfect/poor drained)
4 Alluvial Soils (well drained)
5 Alluvial Soils (imperfect/poor drained)
7 Shallow, Rocky
Periya Aru
Mahaweli Ganga
From Polonnaruwa
To Batticaloa
SCALE
1/2
0
1
2
GOVERNMENT OF SRI LANKA
MINISTRY OF MAHAWELI DEVELOPMENT
MORAGAHAKANDA AGRICULTURAL DEVELOPMENT PROJECT
SOIL MAP OF SYSTEM D2
UNDEVELOPED AREA
DATE
AUG. 1979
DWG. NO
G-005
JAPAN INTERNATIONAL COOPERATION AGENCY

PLATE No. 6

SOIL MAP OF SYSTEM A/D (Undeveloped Area)



SOIL MAP OF SYSTEM G (Undeveloped Area)

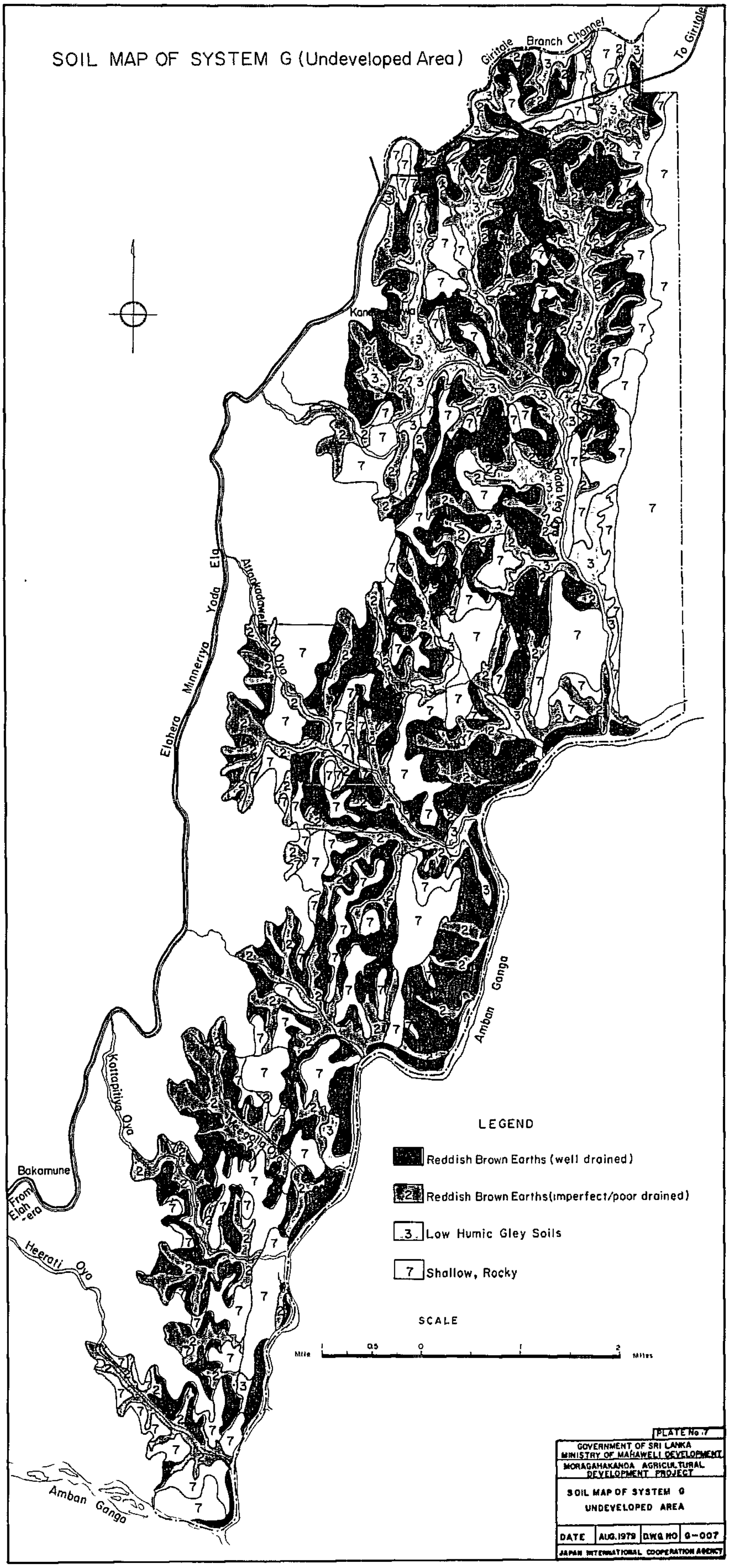
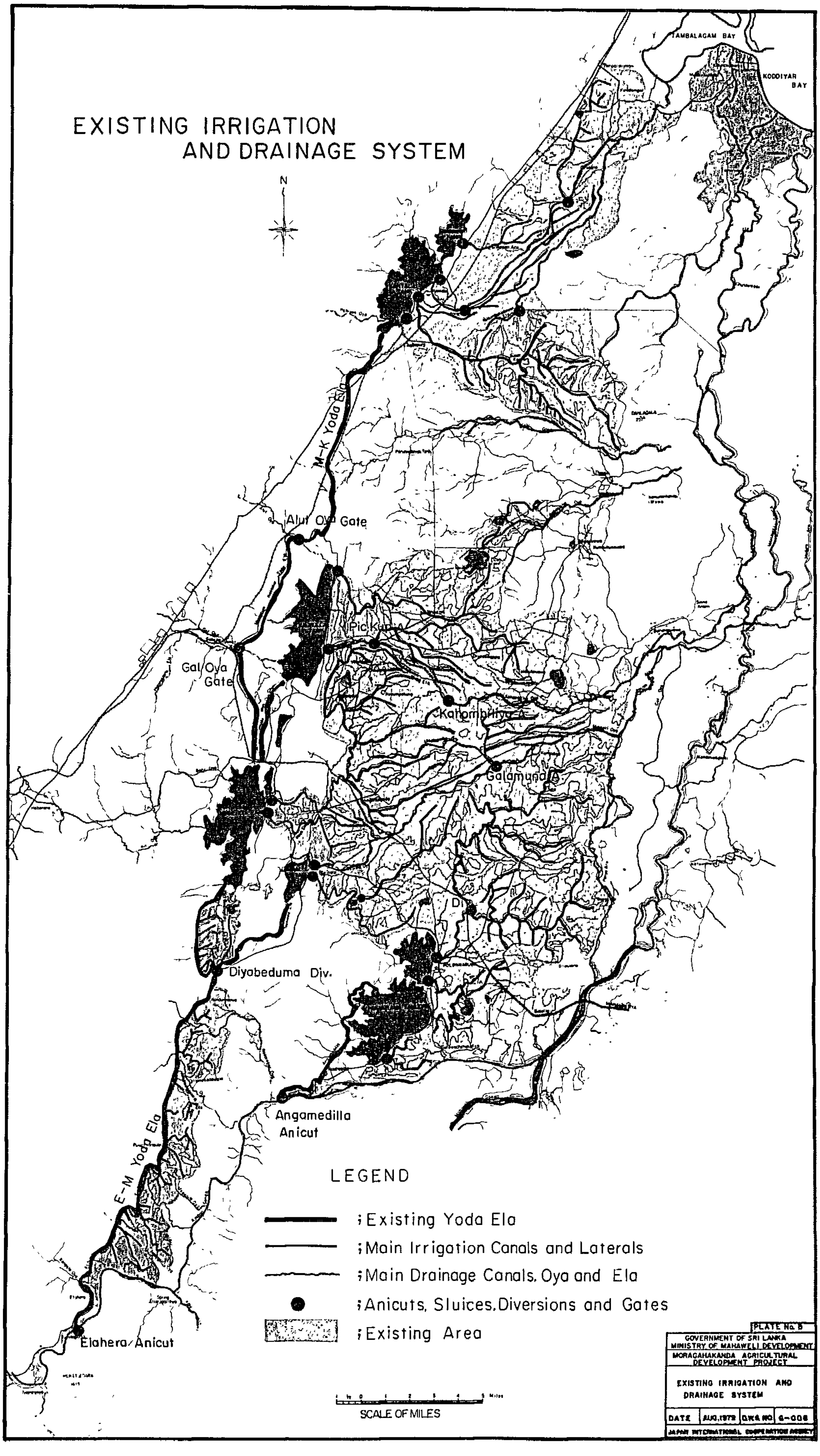


PLATE No.7			
GOVERNMENT OF SRI LANKA MINISTRY OF MAHAWELI DEVELOPMENT			
MORAGAHAKANDA AGRICULTURAL DEVELOPMENT PROJECT			
SOIL MAP OF SYSTEM G UNDEVELOPED AREA			
DATE	AUG.1979	DWG NO	G-007
JAPAN INTERNATIONAL COOPERATION AGENCY			


EXISTING IRRIGATION
AND DRAINAGE SYSTEM
N
TAMBALAGAM BAY
KODDIYAR BAY
M-K Yoda Ela
Alut Oya Gate
Gal Oya Gate
Kalambitiya
Galamuna
Diyabeduma Div.
Angamedilla Anicut
E-M Yoda Ela
Elahera Anicut
LEGEND
; Existing Yoda Ela
; Main Irrigation Canals and Laterals
; Main Drainage Canals, Oya and Ela
; Anicuts, Sluices, Diversions and Gates
; Existing Area
SCALE OF MILES
PLATE No. 5
GOVERNMENT OF SRI LANKA
MINISTRY OF MAHAWELI DEVELOPMENT
MORAGAHAKANDA AGRICULTURAL DEVELOPMENT PROJECT
EXISTING IRRIGATION AND DRAINAGE SYSTEM
DATE AUG.1979 DWG NO. 6-008
JAPAN INTERNATIONAL COOPERATION AGENCY