FINAL REPORT

STUDY ON MANAGEMENT AND COSTS OF OPERATION AND MAINTENANCE OF IRRIGATION SYSTEMS UNDER THE IRRIGATION DEPARTMENT, SRI LANKA

MAIN REPORT
Volume 1

Submitted to

INTERNATIONAL IRRIGATION MANAGEMENT INSTITUTE
SRI LANKA FIELD OPERATIONS
COLOMBO, SRI LANKA

BY
TEAMS (PVT) LTD

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STUDY ON MANAGEMENT AND COSTS OF OPERATION AND MAINTENANCE OF IRRIGATION SYSTEMS UNDER THE IRRIGATION DEPARTMENT, SRI LANKA

The study reported in this volume was carried out by TEAMS (Pvt) Ltd under a research agreement with IIMI. The study was funded by the United States Agency for International Development (USAID) under a Cooperative Agreement between USAID and IIMI (Agreement Number 383-0080-A-PG-7040-00). Under this Agreement, IIMI is responsible for managing the applied research component of the Irrigation Systems Managment (ISM) Project. Overall guidance and coordination is done through the ISM Research Advisory Committee, chaired by the Director of the Irrigation Management Division, and with the assistance of the ISM Project Director.

This study examines the management of O&M, especially maintenance, on five major schemes. Based on the research, the study attempts to identify alternative levels of maintenance of systems, recommends one particular level, and analyzes the costs involved. The study also analyzes the present system for planning, budgeting, allocating funds, implementing O&M, and monitoring and evaluating the results. Important gaps in the present management system are clearly identified; and a number of useful recommendations are made for improvements.

This Final Report has been prepared taking into consideration the comments and suggestions made by IIMI and by members of the ISM Project Research Advisory Committee at a meeting several months ago. Although there may still be sections that could be further improved, nevertheless the report is a very useful pioneering attempt to address a very difficult and complex problem. The report would provide a basis for further analysis and work, to assist the Department in developing more effective management systems for O&M.

IIMI would like to express its appreciation to the Irrigation Department for having requested this study initially, and having cooperated fully in its implementation. We believe that the results will be useful to the Department as it works to strengthen its capacity to improve the performance of irrigation systems in Sri Lanka. We would also like to thank the Research Advisory Committee members for their support and comments on previous drafts. We are very appreciative of USAID's support, including its close involvement in guiding and evalulating the results. I am also grateful to the Chairman of TEAMS, Professor Wimal Gunawardena, for his patience with and responsiveness to our constantly asking for further analysis, or additional data, sometimes beyond the orginal terms of reference.

The views expressed in this report are those of the authors (TEAMS) alone. They do not necessarily represent the views of IIMI or of the agencies and individuals who have cooperated in this study.

Sincerely,

Doug Merrey

Douglas J Merrey
Head, Sri Lanka Field Operations

Please Note: This report has been produced in two volumes. Volume 1 contains the main report. Volume 2 contains the appendices. We have made fewer copies of the second volume to control costs, but it will be available at the IIMI Headquarters Library.

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Our Ref: DS/04/89 16th May, 1991.

Dr. Douglas Merrey,
Head, Sri Lanka Operations,
International Irrigation Management Institute,
107, Havelock Road,
Colombo.

Dear Dr. Merrey,

O&M Cost Study Under ISMP

Herewith we are submitting 3 copies of the **Final Report** of the above study.

We take this opportunity to pay our gratitude to the members of: IMD, ID, ISMP, USAID and IIMI Sri Lanka Operations including yourself for providing assistance and guidance to complete this study successfully.

Yours truly,

Wimal Gunawardena
Team Leader

E X E C U T I V E S U M M A R Y

This study which was initiated as a part of the ISMP research component, investigates the Operation & Maintenance (O & M) Cost of certain selected irrigation schemes and seeks to establish technically adequate levels of maintenance under given resource constraints, and to identify institutional arrangements to ensure cost effective adequate maintenance. The scope of the study in the above sense embraces five objectives as specified in the Terms of Reference. This report covers the full study and deals with the five objectives. The investigation was done in five selected schemes: **Giritale, Ridi Bendi Ela, Gal Oya Left Bank, Inginimitiya and Mahakanadarawa.** This Final Report is based on **overall observations** and conclusions of the study.

Chapter 1 summarises the methodology of work adopted for this study. A review of the evolution of institutions and procedures relevant to O & M are presented in **Chapter 2.** This historical analysis highlights many factors which may be useful when seeking desirable future changes.

The investigation process was focused on the details of the existing levels of maintenance and the present methods of executing O & M works. These details are presented in **Chapter 3.**

An in-depth analysis of the collected data including comparison of various expenditures is carried out in **Chapter 4** which also elucidates the recent trends in the allocation of O&M funds.

Chapter 5 attempts to define different levels of maintenance and arrive at a practical definition of desirable level of O&M. The adequate level of maintenance, as estimated by the Consultant is satisfying the technical needs of the schemes and also the needs of the farmers and is considered as the desirable level. This chapter also identified the different scenarios and analyses the economics of the alternative O&M regimes, considering mainly assumed rehabilitation cycles on the basis at social tolerance limit and ignoring the effect on production (due to lack of data).

A wide range of observations have been included in **Chapter 6.** Many difficulties in collecting data related to "expenditure and completed O & M work" were faced and a sound judgement had to be exercised in order to classify and interpret data collected from a wide array of records. The study gathered many interesting and reasonable views expressed by the farmers which have to be taken into account in trying to improve O & M related proceedings in the future.

The careful examination of the item-wise O & M **estimates** and **expenditure** revealed that there is no connection between these. In reality, O & M estimates are made for the sake of framing an estimate for granting allocations. It was found that the funds released for O &M works at present are not based on the specific needs of the irrigation scheme but are calculated on a hypothetical basis according to the availability of funds. The cost of repairs to damaged structures and cost of their maintenance were found to be relatively small items in terms of overall O & M costs.

The costs of improving existing physical systems to the technically desirable levels as estimated by the consultants for Giritale, RBE, Gal Oya L.B., Inginimitiya and Mahakanadarawa are Rs.403/-, 432/-, 373/-, 334/- and 329/- per acre respectively.

In Chapter 7, major Conclusions are arrived at, regarding the existing O&M activities in the five selected schemes. It concludes that allocated funds for O&M do not meet the actual requirements. Also, even the available financial resources do not yield optimum benefits due to poor management of O&M in the areas of programming and executing, allocation and supervision of work accounting documentation of information attention given by Management **upto senior** level, farmer participation, etc. The conclusions indicate that even with the presently available financial resources, there is ample scope for improving the O&M performance by better management which is within the capacity of the Organisations handling O&M.

Based on the above conclusions and the knowledge and the experiences of the Consultant, specific recommendation are made in chapter 8 for the improvement of O&M activities in the major irrigation schemes in general. It is recommended that maintenance work should be identified and prioritised annually under each sub item of work and be programmed on the basis of available resources and priority.
The execution of work should be planned well and carried our according to the plan and the physical & financial progress documented and monitors by the Engineer. Wherever there is lapse, corrective action be taken. Active monthly review by Range Deputy Director and Director of Irrigation on progress of work is essential. It is suggested that the performance of an Irrigation scheme related to O&M is measured by the its ability to distribute water equitably and in correct time. Consultant recommends installation of water measuring devices at strategic locations.

Development and active participation of Farmers Associations particularly at Distributory canal level is a strategy to bridge the gap between required and available resources.

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Conversion Factors

1 ft = 0.3048 meter

1 mile = 1.6097 Kms

1 Engineers Chain = 100 ft = 30.48 meters

1 Acre = 0.4048 hectare

1 Acre ft = 0.0012344×10^6 m^3

1 Sq. ft = 0.0929 m^2

1 Square = 100 Sq. ft = 9.2903 m^2

1 Bushel of Paddy//Acre = 51.6 Kgs/ha

1 Cube = 100 Cu ft. = 2.832 m^3

1 Cusec = 1 Cu ft/Sec = 0.02832 m^3/Sec

1. INTRODUCTION & PROJECT PERFORMANCE

1.1 Scope of the Study

The work on the consultancy services for the **O & M Cost Study** commenced in June 1989 with International Irrigation Management Institute (IIMI) as the client. This research study is financed with a grant under the ISMP from USAID made to the Government of Sri Lanka (GOSL). The implementing agency for the ISMP project is the Irrigation Management Division (IMD) of the Ministry of Lands, Irrigation and Mahaweli Development (M/L.I.& M.D). The research component which is handled by the IIMI on behalf of the IMD contracted TEAMS (Pvt) Ltd. for this study.

The main objective of the study is to **define a level of O&M which can be considered as adequate,** technically and socially while being financially viable. The scope of work as specified in the Terms of Reference (TOR) can be summarised as follows:

To carry out applied research on O&M useful to ISM Project, ID, IMD and Other Organisations using the guidelines given below:

1. Specify the actual expenditure on both operation and maintenance and how resources are obtained and used on O&M.

2. Specify technically desirable levels of maintenance intensity and investment when constructed and at present.

3. Design and analyse the present institutional framework and actual procedures.

4. Propose alternative scenarios of maintenance intensity and improvement with different Technical and Organisational implication and identify possible cost effective and practical methods for improving quality of maintenance.

5. Suggest recommendations for appropriate organisational and management processes that would make improved maintenance methods more effective and sustainable.

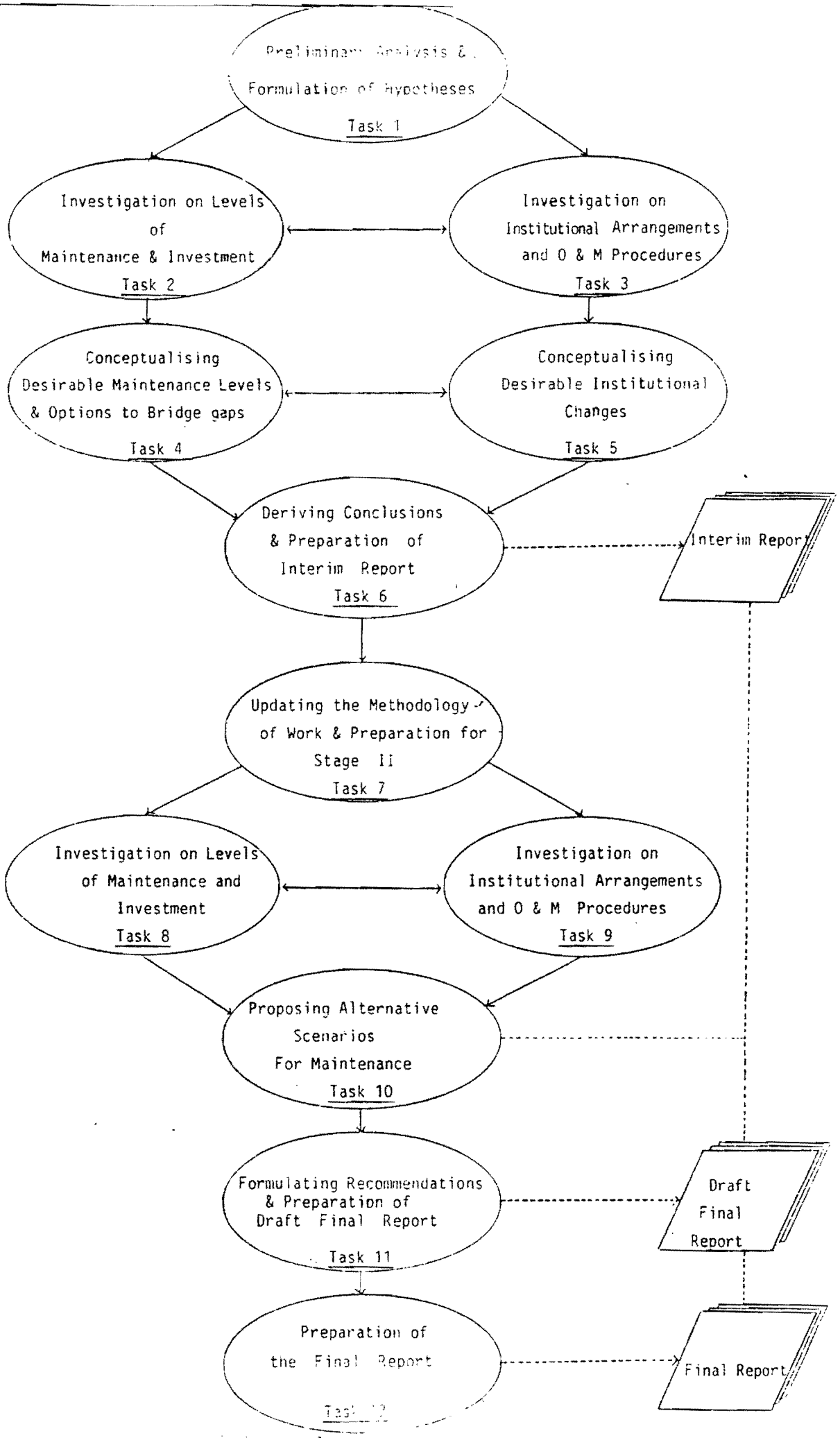
By taking into consideration the detailed tasks specified in the TOR the study recognised that in order to satisfy the envisaged objectives, it would be necessary to go into detailed analysis of present levels of O & M, funds spent, procedures, institutions, etc. It was also recognised that in this process, very interesting findings would emerge to get a broader perspective of the subject which can help to search acceptable solutions.

In the TOR it is envisaged that the present level of O&M could be improved by using efficient management practices, closer monitoring of expenditure and other possible measures. However, even after developing a highly efficient system of O & M, there could be a gap between what is actually required and what is possible with available resources.

1.2 Methodology and Work Done

The TOR lists **5 objectives** for this study of which **Phase I** covered specifically the first three objectives. Under **Phase II** all five objectives were covered. **Diagram 1** shows the overall approach to the study.

The TOR required five irrigation systems to be studied and for this purpose four medium sized schemes and one large scheme were selected jointly with the client. These schemes are: Giritale of Hingurakgoda Irrigation Division in Polonnaruwa District, Ridi Bendi Ela (RBE) of Nikaweratiya Division in Kurunegala District, Galoya L.B. of Ampara Division in Ampara District, Inginimitiya of Inginimitiya Irrigation Division in Puttlam District and Mahakandarawa of Mahakandarawa Irrigation Division in Anuradhapura District. A brief description of these 5 schemes are given in section 1.3.


Preliminary Analysis & Formulation of Hypotheses
Task 1
Investigation on Levels of Maintenance & Investment
Task 2
Investigation on Institutional Arrangements and O & M Procedures
Task 3
Conceptualising Desirable Maintenance Levels & Options to Bridge gaps
Task 4
Conceptualising Desirable Institutional Changes
Task 5
Deriving Conclusions & Preparation of Interim Report
Task 6
Interim Report
Updating the Methodology of Work & Preparation for Stage II
Task 7
Investigation on Levels of Maintenance and Investment
Task 8
Investigation on Institutional Arrangements and O & M Procedures
Task 9
Proposing Alternative Scenarios For Maintenance
Task 10
Formulating Recommendations & Preparation of Draft Final Report
Task 11
Draft Final Report
Preparation of the Final Report
Final Report

At the inception of the study it was recognised that any data in a meaningful form will not be available under O&M beyond a reasonable period of the recent past. Further, most of the ID officials attached to the scheme beyond a certain period and with whose assistance, the required data has to be collected, may not be available now, due to transfers etc. Also recollection of any unrecorded data or even correct interpretation of recorded data of such long past may not be possible. On the other hand, it was felt that data collected for just one or two years will not reveal any significant trend and is inadequate to meet with the aims of this study. Thus the period of five years from 1985 to 1989 is considered for data collection for Phase 1.

After reviewing the results of Phase I of the study, it was felt that the investigations could be restricted to three years namely 1987, 1988 and 1989 to get the required results in a meaningful manner. Period of study for Phase II was so selected in consultation with the client.

The data collected was analysed in order to determine the levels of O & M programmes implemented, annual expenditure and existing institutional arrangements and procedures. The study enabled the consultants to understand the existing situation and some of the constraints faced by the O & M activities. This understanding helped to conceptualise the direction in which future O & M activities together with procedures and institutional developments should move in order to get better results from the available resources.

Detailed field investigations in Giritale, RBE, Galoya L.B. Inginimitiya and Mahakandarawa Schemes were done initially to assess the quantum of maintenance work required in each scheme and to prepare a cost estimate for such works. The divisional officers responsible for the O & M work in these five schemes were visited to collect available data for the purpose of analysis.

In addition, the actual O & M estimates prepared by the Irrigation Engineers (IEE) were also collected. Furthermore, the estimates based on the allocations of ID and IMD when available were collected. In instances where such estimates were not available the consultants prepared hypothetical estimates on the same basis.

The actual O & M work done in each scheme, each year together with the corresponding expenditure was collected and a comparative statement was prepared for various items of work for analysis.

Amounts of expenditures were extracted by reference to the votes ledger, cash book and other connected accounting books. In order to identify the expenditure schemewise and itemwise, further reference had to be made to various other relevant documents mentioned. In case of expenditure common to all schemes, it was divided appropriately. Quantities of physical work done were obtained from measurement books, distribution rolls, contract registers etc. Work done under farmers collection on F.CC other than structures were excluded.

As part of the investigation a "walk-in-the canal" of all five schemes was done which was helpful for the investigators and consultants to get first hand observations on the actual level of maintenance requirement.

1.3 Irrigation Schemes which were Studied

A brief description of these five schemes which were studied under the present project is presented below:

Table 1.1: Acreages under selected Schemes

Giritale	-	2507 ha	specified
Ridi Bendi Ela	-	2064 ha	"
Galoya L.B.	-	12710 ha	"
Inginimitiya	-	2644 ha	"
Mahakandarawa	-	2545 ha	"

(a) Giritale Scheme

The Giritale Scheme is situated in the Polonnaruwa District in the North Central Province. The scheme is controlled by the Irrigation Engineer, Hingurakgoda Division under the supervision of the Deputy Director Polonnaruwa Range. The Giritale system is a reservoir scheme within the Mahaweli catchment. Its catchment area is 24 square km. producing a yield of 241,000 m^3/sq.km during the Maha season and 24,100 m^3/sq.km. during Yala.

The gross storage capacity of the reservoir is 23,206,000 cubic metres with a full supply area of 307.7 ha. The main dam 518 m long has 1 on 3 upstream and downstream slopes. The top width of the dam is 7.62 m designed to be at an elevation of 94.51 metres MSL. The maximum height of the dam is 14.02 m . Originally there were two tower type sluices one on the R.B with the sill elevation at 80.49 metres MSL and the other on the LB. The LB tower sluice is now closed and water to the LB canal system is presently being supplied from the RB canal through a separate off-take. There is a C.O. ogee spillway 38.11 metres long with crest elevation at 92.07 metres MSL.

The total length of the main canal system is 17.60 Kms and the distributory canal length of the entire system is 48.30 Kms.

The specified irrigable area is 2507 ha but the present estimated area cultivated is around 3025 ha. The general layout of the scheme and some other features are shown in Figure (1).

This is an ancient irrigation system restored in 1954.

(b) Ridi Bendi Scheme

This scheme is located in the Kurunegala district in the North Western Province and controlled by the Irrigation Engineer - Nikaweratiya division under the direction of the Deputy Director - Kurunegala Range.

The Ridi Bendi Ela scheme is a combined reservoir - diversion system and falls within the Deduru Oya river basin. Water is diverted from the Deduru Oya by means of a diversion weir and directed through an inlet canal into the Magalle wewa reservoir from where the irrigation distribution system has been developed. The catchment area for this scheme is 53.7 sq.kms. producing a yield of 217,000 cubic metres/km^2 in Maha and 62,700 m^3 /Km^2 during Yala. The gross storage of the reservoir is 9,135,000 m^3 having an area at FSL of 264.4 ha at an elevation of 44.24 metres MSL. The calculated HFL is 44.80 metres MSL while the observed value in 1957 is 49.42 metres MSL. The top level of the dam is 52.62 metres MSL having a width of 2.44 m. The dam upstream and downstream slopes are both 1 on 2 1/2 and 2.38 km long. There are 3 tower type sluices one on the LB, one on the RB and one in the centre which feed the three main canals.

There are two spillways one (30.5m) on the LB and the other 61m with planked bays on the RB.

The total length of the Main and Branch canals is 42.6 Km. There are 22.7 Kms of the distributory canal system.

The specified irrigable area is 2064 ha and the extent cultivated is around 2500 ha. The general features and the layout of the scheme are shown in Figure (2).

This is an ancient irrigation system restored in 1950s.

(c) <u>Gal Oya (L.B)</u>

The area under study is part of the Senanayaka Samudra scheme situated in the Eastern province. The scheme falls within the Gal-Oya river basin. The study area is part of the main L.B. canal area 12710 ha in extent falling under the control of the Irrigation Engineer - Ampara who is supervised by the Deputy Director Ampara Range.

The system is a reservoir scheme within the Gal Oya catchment. The reservoir intercepts a catchment area of 983 sq.kms. producing a yield of 2,686,700 m^3/sq.km. during Maha and 726,900 m^3 / sq.km during Yala. The gross storage of the reservoir is 950,488,000 m^3 having an area at FSL of 7793 ha at an elevation of 79.27 metres MSL. The estimated HFL is 81.10 metres MSL. The top level of the 1097 m long dam is 82.93 m. The upstream and downstream slopes of the earthern dam are 1 on 3 and 1 on 2.5 respectively. The reservoir is provided with one HP electricity operated tower sluice. There is a 234.75 metre long spillway provided with 16 nos 1.75x1.75 m. gates.

In the study area of Gal Oya LB, the length of main and branch canal is 70.5 km and that of distributory canals is 128.7 km.

The total specified irrigable area is 43654 ha. The extent of the irrigable area in the study area is however 12710 ha. This is the area controlled by the Irrigation Engineer - Ampara.

The scheme was constructed during 1949 to 1952 as an entirely new development. The study area has been rehabilitated recently within the last 5 years or so. The general features and layout of the scheme are shown in Figure (3).

(d) <u>Inginimitiya Scheme</u>

This is a reservoir scheme located in the North Western Province in the Puttalam district. The scheme is controlled and operated by the Irrigation Engineer - Inginimitiya under the direction of the Deputy Director - Puttalam Range.

The scheme is fed by the water of the Mee Oya drainage basin receiving a yield of 144,650 m^3/sq.km in Maha and 24,100 m^3/sq.km. in Yala. The catchment area at the reservoir site is 550 sq. km. The gross storage capacity of the reservoir is m^3 having a dead storage of 6,076,950 m^3 . The FSL of the reservoir is 61.89 metres. MSL having a water spread area of 1750 ha. The flood lift

above FSL is 0.31 m. The dam is an earthern enbankment with a top width of 6.09 m having a top level at 64.63 m MSL and 4878 m long. The upstream and downstream side slopes are 1 on 3 and on 2 1/2 respectively. The reservoir is provided with three tower type controlled sluices with the sills at level 55.18m MSL. A radial gated spillway 53.35 m long has been provided to release flood discharges.

The total length of the main canals is 42.3 kms and the distributory canal system length is 29.4 km.

The specified irrigable area is 2644 ha. while the total area cultivated is estimated to be about 2700 ha.

The general features and layout of the scheme are shown in Figure (4).

This scheme was constructed in 1986.

(e) Mahakanadarawa Scheme

This scheme is located in the North Central Province in the Anuradhapura district and is managed by the Irrigation Engineer, Mahakanadarawa division under the supervision of the Deputy Director - Anuradhapura Range.

The Mahakanadarawa scheme is a reservoir project. The catchment area intercepted by the reservoir is 322 sq. km. producing a yield of 163,950 m^3 /sq. km. during Maha and 24,100 m^3 per square Km during Yala.

The gross storage capacity of the reservoir is 44,747,000 m^3 with the FSL at 94.82 metres MSL. The dead storage provided is 4,469,000 m^3. Inspite of the estimated yields, the reservoir rarely fills up during the monsoonal periods and the lands under its command have been rarely cultivated successfully with paddy crops. Most of the crops cultivated are highland crops to a limited extent depending on the availability of water. This scheme has been an unsuccessful one since it was constructed in the 1950 s.

The main dam is 3.74 km long with upstream and downstream slopes of 1 on 3 and 1 on 2 1/2 respectively. The top width of the dam is 5.5 m maintained at an elevation of 97.56 m MSL. There are two tower sluices with sill elevations at 89.02 metres MSL. The reservoir is provided with two radial gated ogee spillways of 91.46m and 97.56m lengths and spill crest at 94.82 metres MSL and one natural spillway of length 192.07 m long with spill crest at 94.82 metres MSL. The computed HFL of the reservoir is 96.19 metres MSL giving a flood lift of 1.37 meters.

The total length of the main canal system is 39.0 km and that of the D-canals is 29.7 km The specified irrigable area is 2545 ha.

This is an ancient irrigation system first restored in the 1958s and rehabilitated in 1977. This is one of the schemes which experiences shortages of water since it was constructed. No proper and successful cultivation has been done during the period 1984 to 1989 due to shortage of water from catchment yields.

The general lay out and other features of the scheme are shown in Figure (5).

A summary of important physical features of the irrigation schemes under study is given in **Table 1.2.**

Table 1.3: Physical Features of Schemes under Study

Description	Unit	Giritale	Ridibendi Ela	GalOya LB	Inginimitiya	Mahakanadara
1. Brief history						
When Constructed	Year	1954	1952	1952	1986	1958
When rehabilitated during last years	Year		1984	1985	Not rehabilitated	1982
2. Reservoir						
Catchment area	Km^2	24	53.7	983	550	322
Net capacity	mcm	23.206	9.135	950.488	66.546	42.278
F.S.D	m	11.58	4.79	33.54	6.71	5.80
F.S.L	m(msl)	92.07	49.24	79.27	61.89	94.82

3. Dam						
Type	-	Earthern	Earthern	Earthern	Earthern	Earthe
Length	Km	0.518	2.38	1.10	4.88	3.737
Top Level	m(msl)	94.51	52.62	82.93	64.63	97.56
4. Sluice LB						
Type			Tower	H.I. Tower	Tower	Tower
Sill level	m(msl)	-	44.89	45.73	55.18	89.02
5. Sluice Rb						
Type		Tower	Tower	-	Tower	Tower
Sill level	m(msl)	80.49	44.43	-	55.18	89.02
6. Sluice Centre						
Type		-	Tower	-	Hume pipe	Tower -
Sill level	m	-	44.89	-	54.52	-
7. Spill Lb						
Type		Co with ogee	natural	Ogee with 16 No	None	-
Length	m	38.11	30.5	234.75		
Crest level	m(msl)	92.07	49.24	79.27		
8. Spill RB						
Type		None		None		
Length	m	33.75				91.46
Crest level	m	-	49.24	None		
9. Centre Spill						
Type						
Length	m					97.56
Crest level	m				61.89	94.84
10. Distributory System						
Main and Branch canal	Km	17.6	42.6	70.5	42.3	39.0
Distributory canals total length	Km	48.3	22.7	128.7	29.4	29.7
11. Structures						
Head works	None	2	5	2	3	5
Main canals		34			140	161
D-Canals & F.C.C		128			206	167
12. Irrigable Areas	ha.	2507	2064	12,710	2,644	2,545
13. Canal Density						

The densities of main and branch and distributory canals are given below:

Scheme	Irrigable Extent (ha)	Canal Length (km) Main + Branch	Distributory	Main + Branch Distrib.	Canal density (km/ha) Main + Branch	Distributory	Main + Branch Distributory
Giritale	2507	17.6	48.3	65.9	0.007	0.019	0.026
Ridibendi Ela	2064	42.6	22.7	65.3	0.021	0.011	0.032
Gal Oya LB	12710	70.5	128.7	199.2	0.006	0.010	0.016
Inginimitiya	2644	42.3	29.4	71.7	0.16	0.011	0.027
Mahakanadarawa	2544	39.0	29.7	68.7	0.015	0.012	0.027

Table showing rate per hectare for adequate and well maintioned estimated levels

	Giritale(1954)		Ridibendi Ela(1952)		Gal Oya LB(1952)		Inginimitiya(1986)		Mahakanadarawa(1958)	
	Adequate R.P. ha	well R.p.ha	Adequate R.P. ha	well R.P. ha	Adequate R.P. ha	well R.P. ha	Adequate R.P. ha	well R.P. ha	Adequate R.P. ha	well R.P. ha
Head works Mainten. Rs.	55.84	63.82	43.60	43.60	6.29	14.94	23.83	46.17	55.01	129.67
Distributory canal system maintenance	683.94	1017.39	715.46	1097.59	734.02	1462.30	357.73	1358.33	403.67	1659.01
Miscellaneous Charges	8.81	14.54	87.76	117.67	3.66	6.06	5.44	8.50	7.30	7.30
Operation Cost	211.41	267.25	242.24	339.14	177.03	196.70	438.00	440.00	346.02	346.02
Total per ha.	960.00	1363.00	1089.00	1598.00	921.00	1680.00	825.00	1853.00	812.00	2142.00
Irrigablee area & hectares	2507.00	2507.00	2064.00	2064.00	12,710.00	12,710.00	2644.00	2644.00	2545.00	2545.00

2. EVOLUTION OF INSTITUTIONS AND PROCEDURES ON OPERATION & MAINTENANCE

2.1 Status of O & M during the Eighties

The new policy thrust on effecting sustainable development of of O & M in irrigation systems during eighties was an important stage in policy management for irrigation development. During the second half of 70s the importance of O & M in irrigation development was not explicitly started in programmes implemented for modernisation and rehabilitation. However, it is to be noted that poor O & M was often identified as a reason for low irrigation performance and deterioration in the physical system. This position is partly explained by the preoccupation of planners and implementors with strategies for physical improvement of the irrigation systems through rehabilitation projects funded by bilateral and multilateral agencies.

In retrospect the first intervention in irrigation policy effected through a review of the irrigation programme by FAO/IBRD mission in mid-sixties was an important milestone in the modern irrigation development which resulted in phasing out the design and construction culture in the Irrigation Department. The new directions envisioned by the FAO/IBRD Mission placed renewed emphasis on increasing the production potential in the irrigation systems already established by mobilising local funds through budgetary sources. Shortage of local funds required to invest in the irrigation development programme and the imperative need to invite foreign funds were decisive factors which necessitated a drastic revision to the irrigation policy. Although rehabilitation and improvement reviewed overwhelming consideration since seventies, emphasis on O & M was destined to emerge as the culmination of programmes designed to improve performance in irrigation systems.

The design of the O & M programme in mid-eighties took place amidst heightened expectations from Gal Oya programme. Therefore, lessons learnt from Gal Oya and other experiments carried out in the field had an inevitable impact on the design of the O & M programme.

The need to develop a system of accountability to farmer organisations through participatory approaches and close consultations in identifying priorities in O & M work and implementation provided a new 'twist' to programmes implemented in the irrigation sector. Therefore the designers of the O & M programme evinced an understandable eagerness to break-away from the past approaches implemented to improve O & M. Officers responsible for implementing the programme were prompted through instructions leaflets to describe the new levy as an O & M 'fee' as different from the much-maligned 'irrigation rate' which extended an authoritarian and top-down approach to the collection of O & M levy as a part of government revenue with no responsibility to the farmer community for effective maintenance. In the final analysis the programme attempted to be partly innovative and partly conforming to the dictates of donor agencies who emphasised the amount of fees collected as the principal criterion to measure the success of the programme.

It did not take very long however for the implementing agencies to understand the intricacies and areas of emphasis in implementing the O&M programme. Towards the second half of eighties it was clearly evident that the organisational and management aspects related to the collection and expenditure of money for O&M should receive priority attention to make the programme sustainable by means of gaining acceptance among farmers.The following features in the O&M programme implemented in eighties reflect the emerging trends in thinking among policy planners and policy managers.

2.1.1 The programme to collect 'O&M fee' as a service fee was based on a calculation of the cost of O&M per acre as implemented by the Irrigation Department. Full cost of O&M was however not expected to be recovered. Instead a more graduated approach was adopted whereby the farmers were asked to pay half the cost of O&M in the first year with a plan to recover the full cost of Rs.200/- per acre in the fifth year after the commencement of the programme.

2.1.2 O&M fees were levied on an area-based mode and expected to be collected in each season. Volumetric water issues were not counted upon due to difficulty in accomplishing accurate measurements of water.

2.1.3 A keen desire to define the fee in a new perspective of an irrigation service fee was projected as against the 'Irrigation rates' which were considered harsh and unacceptable.

2.1.4 Consultation with farmers and promoting decision making in participation with farmers in order to recognise the need to identify the programme with farmer welfare.

2.1.5 Incorporation of reciprocal measures which act as incentives for farmers to participate in the programme willingly and contribute their local knowledge of the system for decision making. The original programme envisaged that the central government grant provided with voted funds for O&M was expected to be allocated to each system on a reciprocal basis as matching contributions to the amount collected by farmers so that the highest allocation would accrue to the scheme with the highest O&M fee collection from farmers. During implementation, this aspect was jettisoned on the grounds that a large majority of irrigation schemes would fail to qualify for the grant contribution and thus run the risk of total collapse over time due to no maintenance.

2.1.6 The areas under Mahaweli programme Scheme under the Irrigation Development adopted two different approaches which were dictated by the level of understanding and facilitation provided by supporting programmes. The more important aspect of the diversity in the two approaches was the recognition of the need for pragmatism to evolve a hands-on approach with a view to improve on programme performance. The decision to suspend the annual increase of 20% in the O&M fee was one such step taken to improve the overall performance.

2.1.7 Towards the end of eighties, it became evident that the thrust on organisational and management development was far more important for the purpose of developing a sustainable O&M programme than getting entangled in the collection of O&M fees per se and mobilise the field staff for enforcement measures. The need to fine-tune the programme for greater acceptance among the farmer community was therefore given highest consideration.

2.1.8 The programme accorded an important position to the mobilisation of local resources in a much broader sense and encouraged new experimentation such as in Kimbulwana Oya to involve farmers meaningfully in O&M work. The programme implementation was therefore not hamstrung and obsessed by a need to apply rigid and uniform standards for implementation.

The system of allocating government funds through budgetary sources for irrigation in 1984 was as follows:

a. Construction of all types of irrigation works	- Totally financed by the - Government.
b. Improvement, Rehabilitation Modernisation and Repair of major and minor irrigation works.	- - do -
c. Flood damage, drainage etc of all types.	- - do -
d. O&M in major irrigation works	- Main system including head works main branch and distributory canals and structures in field canals were totally financed by the Govt. Earth work & weeding in Field canals which cosist of the tertiary system were maintained by farmers.

e. O & M in minor irrigation works	-	Responsibility with farmers. No financial contribution collected from them. The extent of 80 ha was later revised upwards to 200 ha, below which fees were not collected.

2.2 Present Institutional Frame Work

The objective of an Irrigation Scheme is to provide the resources and inputs necessary for the farmers to obtain the maximum agricultural production. In order to provide the required services, there are several governmental and semigovernmental organisations in the project area. The more important institutions can be stated as follows:

Irrigation Department	- Water
Irrigation Management Division	- Management
Agrarian Services Department	- Seeds fertiliser etc.
Agriculture Department	- Extension
P.M.B	- Purchase of agricultural produce
Banks	- Credit Facilities

Although there are several institutions involved in irrigation management the development and management of all major and medium irrigation schemes are under the purview of the Ministry of Lands, Irrigation and Mahaweli Development (MLI & MD). The schemes other than those coming under Mahaweli Development Authority are handled by the Irrigation Department and the Irrigation Management Division.

Under the Provincial Councils the above setting is partly changed from 1990 and the schemes other than inter-provincial and those of overall national interest are brought under Provincial Councils. The organisations for Irrigation activities under Provincial Councils are variable and are in transition stages. Since the operational period covered in this study is up to 1989

which is prior to these changes the chapter deals with the earlier setting, the change being mainly decentralisation.

The remaining sections of the Chapter describes Key institutions, procedures and programmes relevant to the management of O&M.

2.1.1 Irrigation Department

Operation, Maintenance, Improvements and Water Management for major and medium schemes are a set of main functions of the Irrigation Department. Under the Director of Irrigation a Senior Deputy Director at Head Office is in charge of the above set of functions.

The field activities of the ID are managed at senior level by a Deputy Director of a Range (RDD) which may cover a part of or whole District or even two Districts. Some of his functions among various others are:

i. Overall supervision and management of ID activities in the Range in co-ordination with District level interests.

ii. Operation and Maintenance of irrigation works in the Range ensuring proper Water Management.

iii. Preparation of Annual Implementation Programme and Budget for irrigation works in the Range in consultation with District level interests.

iv. Execution of Implementation Programme assisted by chief/senior Irrigation Engineer for Technical Control, Accountant for Financial Control and Administrative Officer for Administrative Control.

The field activities of the ID are managed at middle level by Irrigation Engineers (IE) in charge of Divisions. Some of his functions among various others are:

i. Overall supervision and management of the Division in co-ordination with local interests.

ii. Operation and Maintenance of irrigation works in the division ensuring proper Water Management.

iii. Preparation of Annual Implementation Programme and Budget for Irrigation works in the Division in consultation with local interests.

iv. Direct execution of irrigation works in the Division according to approved physical and financial programmes, with technical, financial and administrative control.

The field activities of the ID are managed at junior level by Technical Assistants (TA) assisted by Work Supervisors. Their functions are to assist Middle Management by direct involvement in the functions of the Middle Management.

2.1.2 Irrigation Management Division
(Source : Information Booklet No:2 of MLLD on INMAS)

Irrigation Management Division (IMD) consists of inter-disciplinary group with experience in Irrigation Management and is headed by a Director. Some of its main functions are:

i. Implementation of Integrated Management of Major Irrigation Schemes (INMAS) programme.
ii. Allocation of funds for O&M, improvements and rehabilitation of major and medium irrigation schemes.
iii. Implementation of programmes for rehabilitation of major schemes.
iv. Establishing farmer institutions in major schemes with main focus on irrigation.
v. Monitoring irrigation and agricultural activities in major schemes.
vi. Integrated development of agricultural land and socio-economic development of the farming community in major schemes.

Except for INMAS programme IMD has no field level organisations but carries out its activities through other line agencies.

Since the functioning of the IMD is concentrated around INMAS programme a brief description of the programme is important.

The programme for Integrated Management of Major Irrigation Schemes (INMAS) seeks to establish a harmonisation of the various inputs and services necessary for increasing agricultural productivity with special focus on the use of irrigation water which has been identified as the most critical and limiting resource in irrigated agriculture. It seeks to co-ordinate the activities of various institutions involved in irrigated agriculture through a system of Project Management and to the setting up of farmer institutions to provide an effective farmer - officer dialogue and to involve farmers to participate in the management of O&M.

Initial emphasis under the programme would be project management with a view to

i. Increasing agricultural production per unit of irrigation water and per unit of land
ii. Adequate equitable and timely distribution of irrigation water and also other agricultural inputs
iii. Organise and develop farmer institutions to facilitate their participation in management
iv. Recovery of O&M costs and allocation of these funds for maintenance
v. Maintenance of irrigation systems at optimum level of performance
vi. Farmer education

The **organisation** of the INMAS Programme for its **implementation** can be summarised as follows:

i. **Administrative Authorities**: IMD will function as the **administering authority** for this programme under the policy guidelines and direction from the Central Co-ordinating committee on Irrigation Management and will operate through Project Managers at project level.

ii. **Central Co-ordinating Committee** for Irrigation Management is responsible at **National level** for direction, co-ordination and implementation of INMAS. The committee of the following:

a. Secretary, Ministry of Lands, Irrigation and Mahaweli Development (chairman)
b. Secretary, Ministry of Agricultural Development and Research
c. Chairman, Agricultural Development Authority
d. Director IMD (Secretary)
e. Director of Irrigation
f. Director of Agriculture
g. Land commissioner
h. Commissioner of Agrarian Services
i. Representatives of State Banks
j. Representative of any other Agency deemed necessary

The committee is expected to meet as required but not less than once every season.

iii. **Sub committee of District Agricultural Committee (DAC sub committee)** is the instrument of implementation and monitoring of the programme at **District level** and is represented by the following:

a. Government agent of the District (Chairman)
b. Range Deputy Director of Irrigation (Secretary)
c. Additional Government Agent, Lands
d. Deputy Provincial Director of Agricultural Development Authority
e. Assistant Director of Agriculture
f. Assistant Commissioner of Agrarian Services
g. Assistant Commissioner of Co-operative Development
h. District/Regional Manager, Paddy marketing Board
i. District Manager, Agricultural Insurance Board
j. District Managers of State Banks
k. Project Managers
l. District Heads of other agencies as and when required.

The committee is expected to meet as often as required but not less than once every quarter. Minutes of the meetings will be circulated among the respective local Heads with copies to IMD.

iv. **Project committee at Project Level** comprises of field staff of all Agencies involved in irrigated agricultural production and the farmer representatives. The main functions of the committee are as follows:

a. Formulation and implementation of cultivation programmes and holding of timely cultivation meetings for each cultivation season
b. Ensure proper distribution of irrigation water
c. Average for timely provision of other agricultural inputs
d. Monitor programmes & take corrective actions
e. Recovery of O&M costs
f. Arrangements for O&M
g. Promote formation & participation of Farmer Organisations in Project activities
h. Identify and arrange training of farmers and officers
i. Report to DAC sub committee and IMD

The Project Committee consists of:

a. Project Manager (Chairman)
b. Representative of ID (TAA and sometimes IE)
c. Representative of Agriculture Department
d. Representative of Agrarian Services Dept
e. Representative of Agricultural Development Authority
f. Representative of Land Commissioners Dept
g. Representatives of state banks
h. Representatives of Farmer Organisations
i. Representatives of any other agencies and NGO as & when necessary

The committee is expected to meet at least once every month. Minutes of the meetings will be sent to DAC sub committee, IMD and the local Heads.

v. **Project Manager**

Project Manager appointed under INMAS programme in the IMD at Project level is basically a co-ordinator who is expected to harmonise the various inputs from the respective line agencies. He is also expected to provide for interaction and dialogue between farmers and officers regarding irrigated agricultural activities and encourage farmer participation in project activities.

The functions of the Project Manager are:

a. Co-ordinate related functions of line agencies at project level
b. Arrange for the holding of cultivation meetings
c. Organise farmer institutions in the Project
d. Co-ordinate the supply of agricultural inputs, services and irrigation water
e. Represent project at DAC sub committee and convene and Chair Project Committee meetings
f. Motivate farmers to optimise on irrigation water use and to pay O&M rates
g. Reporting to DAC sub Committee and IMD

vi. **Farmer Organisations**

Farmer participation in project activities constitutes an essential part of the INMAS programme. Farmer Organisations provide the forum for dialogue and interaction among farmers and between farmers and officers.

A three tier system of farmer organisation is adopted:

a. **Primary Level - Turn out /Field Canal Group**

It is the lowest level but the most important. This level of organisation represents all farmers served by a turn out/field canal.

b. **Secondary Level - Distributory Canal Committee**

The committee members are representatives from primary level organisations selected generally by consensus.

c. **Tertiary Level - Project Committee**

Farmer representatives to this committee are from primary or secondary level organisations as the case may be generally selected by consensus.

d. **Sub-Project Committee**

It consists of farmer representatives from group of distributory canal committees and includes officials as well. Technical Assistants in charge of the group of distributory canals will be the secretary of the committee. Formation of this committee started in 1990.

Some of the main functions of farmer organisations and representatives are as follows:

Farmer Organisations

a. Identify critical areas of Irrigation system
b. Operate and maintain field canals
c. Participate in decision making regarding irrigated agriculture
d. Check irrigation offenses
e. Handle maintenance work on contract under supervision of Irrigation authorities

Farmer Representative

a. Is the spokesman for the group he represents at all levels of the organisational hierarchy
c. Is responsible for operation and maintenance of field canals
d. Will take up with Project Management all issues regarding irrigated agriculture
e. Will ensure that cultivation decisions are carried out.

2.3 Management of Projects Under Study

This section highlights the project management details relevant to the schemes which were investigated under the present study.

The ID personnel managing the five schemes of this study at IE's Division level are given in the following table:

Table 2.1: Management Personnel of ID

Scheme	Irrigable extent ha	No. of Management Personnel			Labourers on operation headworks & Distribution system				
		Irrigation Engineer	Technical Assistant	Permanent regular work sup.	Permanent	Casual	Total	Head works	Distributory system (T.O.A)
1. Giritale	2507	1	4	4	6	5	11	0+	11
2. RidiBendi Ela	2064	1	3	4	7	5	12	1	11
3. Gal Oya LB	12710	1	5	5	15	48	63	-	63
4. Inginimitiya	2644	1	5	5	2	10	12	1	12
5. Mahakanadarawa	2545	1	3	3	-	5	5	3	2

(TOA - Turn out attendants)

Table 2.2: Average area per management personnel

Scheme	Average area (ha) per		
	Technical Assistant	Work Supervisor	TOAA
1. Giritale	627	627	228
2. Ridibendi-Ela	688	516	188
3. Gal Oya LB	2542	2542	202
4. Inginimitiya	529	529	220
5. Mahakanadarawa	848	848	1273

All the five schemes have been brought under INMAS programmes since its inception. The number of farmer organisations are given in the following table.

Table 2.3: Farmer Organisation

Scheme	Project Manager		No.of farmer organisation		Average area per farmer organisation (ha)	
	Field Canal	Dis. Canal	Field Canal	Dis. Canal		
1. Giritale	1		137	7	18	358
2. Ridibendi-Ela	1		156	10	13	206
3. Gal Oya LB	1		435	43	29	296
4. Inginimitiya	1		140	20	19	132
5. Mahakanadarawa	1		73	5	35	509

The common and specific management and institutional aspects are discussed using Giritale as a base for general review and thereafter for other schemes, specific details are presented.

(a) Giritale

The Irrigation Engineer (I.E) Hingurakgoda under D.D. Polonnaruwa maintains the schemes in addition to another with an irrigable extent of 6775 ha. A total of 4 Technical Assistants with the help of 4 Work Supervisors are in charge of the scheme at field level. An average of 6 permanent and 5 regular casual labourers are engaged on operation of the scheme. One of these labourers cover the headworks as well. The ID norms of the scheme according to the average for the operation of distribution system are 3 Work Supervisors and 12 Turn out Attendants. During non-operating period the operations labour is engaged on maintenance. The permanent labourers' output on maintenance is generally poor and often they take a lease through this period.

The I.E holds regular meetings with all Divisional Technical Assistants in the office. At these meetings, O&M of schemes in addition to other matters are reviewed,

any problems and farmers responses and requests discussed and decisions made. I.E. also frequently inspects the scheme with individual Technical Assistants. The scheme is a few miles away from IE's office. The Divisional Assistant (normally the senior most Technical Assistant in a Division) who also handles cash payments, is in charge of a section of the scheme but also assists IE in the overall O&M of the scheme by following up the decisions etc.

The D.D. of Irrigation in Polonnaruwa also holds meetings with the Divisional I.E.'s in his range. He too inspects the scheme with I.E. and Technical Assistants examines O&M activities at site and directs I.E on any corrective measures in keeping with the general policy of ID and in response to representations either by farmers or members of Parliament or Government Agent or any other recognised individual or Institution. Generally IE Hingurakgoda who has a good number of years of service at field level has been capable of managing technical aspects of O&M. What is beyond his control is the allocations. For any extra work or special work he requests for additional allocation which if reasonable and available is released by DD.

The Senior DD (O&M) at ID Head Office in Colombo monitors the O&M activities of major and medium schemes in the Island. He receives returns at regular interval for each scheme sent by IE indicating the details of cultivation, water issues, rainfall, reservoir storages etc. He follows up on any notable shortcomings in the operation of specific schemes. He also monitors O&M allocations and expenditure. His contact with range DD is at the RDD's conference in Colombo, during Range DD's visit to Colombo, occasional inspections of the schemes by the senior DD and through telephone and correspondence.

Giritale reservoir receives its water replenishment from its own catchment and also from Mahaweli Diversion. Senior DD (O&M) interacts with the water management section of the Mahaweli Development Authority regarding decision making and problems by attending arranged meetings and through direct contact with the relevant authority in that section.

Under the INMAS programme Giritale scheme has one Project Manager and 7 distributory canal and 137 field canal farmer organisations. Normally Technical Assistants attend the regular meetings of the project committee and take active part in the discussion and decision making. According to IMD sources, these farmer organisations are quite strong in number as well as participation in O&M and all 28 Distributory Canals have been taken up for O&M by the farmer organisations. They do more work voluntarily than paid for. In fact some farmer representatives who were interviewed by the consultants had definite and active thinking regarding O&M, the critical items of maintenance work and rehabilitation etc. They preferred the maintenance work to be given to them rather than getting them done on force account, so that more work could be done than provided for and also wanted the operation to be entrusted to farmers. They accepted the rotational water issues.

IE expressed the view that the efficiency of O&M could be further improved by more co-operation and active participation of farmers particularly for maintenance. There is good interaction between IE and Project Manger and farmers.

Project Manager sends minutes of the project committee meetings to IE, RDD and IMD in Colombo. IMD closely monitors the performance of the schemes not only on the water issues but also the resulting productivity.

ISMP which included fairly heavy civil engineering work in rehabilitation was started in Giritale in 1987 and the Technical Assistants in charge of O&M also handled ISMP. For the implementation of ISMP, IE and the Technical Assistants had to work hard in investigation, preparation of plans and estimates, contract procedures, setting and supervision, measurement and payment of work, procurement of stores, documentation etc. Hence the attention by them on O&M has naturally become some what secondary.

(b) Ridibendi-Ela

The scheme is under the IE of Nikeweratiya in Kurunegala Range. Two other schemes with an irrigable area of 514 ha are also maintained by this Division. 3 Technical Assistants and 4 Work Supervisors handles the schemes at field level. An average of 7 permanent and 5 regular casual labourers are engaged on operations. One of these labourers is for the headworks. The ID norms are 3 Work Supervisors and 10 Turn Out Attendants. During non-operating period, the output by permanent labourers is comparatively low.

In this scheme during the period of study the Divisional Assistant did not take active part in O&M. The technical Assistant had to contact IE on all O&M matters. IE had only a few years of experience in the ID.

The DD Irrigation of Kurunegala during his inspections found that the O&M labourers were not giving the required output and that there was no control or proper supervision of their work. He reorganised the O&M system in such a way that the O&M labourers were made responsible for the section handled by each one. The documentation of the expenditure was also improved to maintain a better control. DD was closely monitoring O&M procedures and gave decisive instructions to IE.

The scheme has one project manager and 10 distributory and 156 field canal level farmer organisations. Technical Assistants attend the meetings. According to IMD officials, the farmer organisations had not been very effective and the management through the Project Committee was not very efficient. Part of the reasons was the prevailant disturbing conditions in that area particularly below distributory canals. The Project Manager could not carry out his duties properly and even could not stay at station.

During the period of study no substantial improvement or rehabilitation works were carried out in this scheme.

(c) Gal Oya LB

The scheme is in Ampara Division under DD Amparai. The Division also maintains another 4 schemes with irrigable extent of 15,654 ha. Number of Technical Assistants and Work Supervisors in charge of Gal Oya LB is 5 each. Operation labourers are 15 permanent and 48 regular casual. (ID norms are 13 Work Supervisors and 63 TOAA). Power is generated under the scheme and the head-works are operated by the Ceylon Electricity Board. Due to this arrangement there has to be a fair degree of interaction between IE and the Electricity Board personnel at Gal Oya.

One unique feature in the management of operation is the usage of computer facilities which is under the charge of a senior Technical Assistant in the Divisional office. The computer system is found to be a good management tool for efficient operation of the scheme. However the day to day data has to be accurate and complete to make its utilisation useful.

The output of permanent labourers is relatively low. Some substantial maintenance work in this scheme is awarded on contract, particularly the weeding and some structure repairs.

Gal Oya LB is covered by one Project Manager and 43 distributory and 435 field canal level farmer organisations. One unit namely Annamalai unit out of the 5 field units in this scheme is not brought under the Project Manager. The farmer organisations are said to be strong and resourceful. Lot of shramadana works and other diversified activities are carried out. According to IMD officials the O&M fee collection from farmers had been good. 11 nos. distributory canals were taken over by the farmer organisations for O&M in 1989 and 44 more will be taken over in 1990.

Another significant feature is that the office of DD Ampara is close to the scheme and this office and IE's office are in the same location. Thus there is very good interaction between IE and the DD, IE and the farmers and also between DD, farmers, relevant officials etc. For

any O&M problem beyond IE's control and capacity, DD could be contacted quickly and decisions taken even after a joint inspection by DD, IE, farmers etc.

The IE with his Technical Assistants attend monthly Project Committee meetings. He also attends DAC sub committee meetings which are also attended by DD. Most interaction with other departments take place at these meetings. Outside these meetings, direct contact also takes place.

Institutional Organisers (I.O) who were employed in Gal Oya Scheme were disengaged in 1985. However ten new IO's were employed in 1990.

The Gal Oya Rehabilitation Project implemented in Gal Oya LB in 1987, was handled at field level by the Technical Assistants in charge of O&M.

(d) Inginimitiya

This is in Inginimitiya Division under DD Puttalam, and there is only one other comparatively small scheme of irrigable extent of 150 ha maintained by this Division. A staff of 5 Technical Assistants with 5 work supervisors are in charge of the scheme at field level. An average of 2 permanent and 10 regular casual labourers are engaged on O&M. The ID norms for work supervisors and turn out attendants are 3 and 13 respectively. One Work Supervisor is assigned for headworks and the camp is located close to the headworks. Further one regular casual labourer out of 13 is looking after operation of headworks.

There is one Project Manager and 20 distribution and 140 field canal level farmer organisations. Again according to IMD sources, Project Management under INMAS had been not very active and the farmer organisations had been selected haphazardly selecting the local traditional leaders such as velvidanes etc. who were not competent enough to operate under a large irrigation system as farmer representatives. In 1989 the farmer organisations had to be reorganised.

The scheme is comparatively new and the maintenance of office and the camp which serviced the construction had to be continued even after the construction was over. This was a heavy burden on the O&M funds, particularly when there was no other substantial work load under this Division. Some of the staff who were paid on works estimate and who could not be transferred out after the construction was over added to this burden. That is one reason why, the O&M expenditure on general charges in this division is very high.

(e) Mahakanadarawa

The scheme is maintained by Mahakanadarawa Division under Anuradhapura Range. Other schemes under O&M by this division are 8 in number with an irrigable extent of 1689 ha.

There have been 3 Technical Assistants, 3 Work Supervisors and 5 regular casual labourers under this scheme, even though the ID norms being to have 3 Work Supervisors and 13 Turn Out Attendants (TOAs). Of the 5 labourers, 3 are engaged on O&M of headworks. The reason for this samll number of TOAs was the low irrigation activities in the scheme due to poor replenishment in the reservoir.

One Project Manager and 5 distributory and 73 field canal farmer organisations are in the scheme under INMAS. Project Management is not much as the irrigated cultivation has been poor. In 1990, there is a programme to sink wells to irrigate subsidiary food crops.

There had not been many construction activities during the period of study and the major allocation to the division was for O&M of this scheme, other schemes being comparatively small and amounts smaller than in proportion were allocated to these other schemes. Hence the maintenance of office & camp had to be met from this allocation and again, this was the reason why the general charges were fairly high.

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3. EXISTING LEVELS AND EXECUTION METHOD OF OPERATION & MAINTENANCE

3.1 Specification of the Activities of O & M

In terms of the objectives of this research, sufficient time was devoted at the beginning of the study to make a clear distinction between **Operation** and **Maintenance**. The outcome of this work is given below:

The purpose of **Maintenance** of an Irrigation System	- to efficiently distribute and drain water and, - to safeguard the system against deterioration.
The purpose of **Operation** of an Irrigation System	- to deliver the water to the farms according to a delivery schedule, ensuring delivery at the proper time, at the proper place and in sufficient quantity, - to ensure an equitable, reliable and adequate supply of water, - to safeguard the system from floods, other damages and theft.

The analysis revealed that the main activities under operation and maintenance are:

a. Operation

i. Operation of reservoir sluices
ii. Operation of reservoir spill gates, if any
iii. Operation of turn-outs along canals
iv. Operation of regulators & canal spills

v. Observation of hydrometeorological and flow measurements.
vi. Safeguarding of strategic structures & patrolling along canals to prevent damages and unlawful operation.
vii. Any other related work.

b. Maintenance
i. Weeding and jungle clearing
ii. Removal of water plants
iii. Desilting of canal beds
iv. Earth work in filling scours and pot-holes including removal of ant-hills.
v. Minor repairs to structures
Earthwork in filling scours and backfill, Concreting, R.R. Masonry, Plastering, Replacement of stop planks/gates
Removal of weeds, etc. in cracks & joints, painting and greasing.
vi. Gravelling of canal bund roads
vii. Other items such as turfing, removal of obstructions etc.

(Supervision, transport & other administrative costs are common to both).

Operation and Maintenance are parallel but separate activities. Since these occur concurrently and most of the items are supervised by the same staff, there may be some overlap of activities and expenditure during implementation.

Maintenance of field Canals except structures is not included since this activity is the responsibility of the farmers.

Maintenance of drainage canals is not included since drainage canal areas have already been illicitly cultivated in most cases in all these schemes.

3.2 Data Collection on Existing Levels of O & M

The services of Field Investigators (FIs) were hired to undertake field investigations, assessments and data collection from documents maintained in the offices, to hold interviews with officials and farmers and to compile and process all the data so collected in a standard form. They were supervised by a Field Investigation Co-ordinator (FIC) under the overall guidance of a Senior Engineering Consultant. In addition he directly took part in some of the field investigations and assessments.

As required by the TOR, the data collection was done in close collaboration with the ID Staff at Project and Head Office levels. FIs had interviews with the following personnel at Project Level:

i. Range Deputy Directors of Polonnaruwa, Kurunegala, Ampara, Puttalam and Anuradhapura Irrigation Ranges.

ii. Irrigation Engineers of Hingurakgoda, Nikaweratiya, Ampara, Inginimitiya and Mahakandarawa Irrigation Divisions.

iii. Staff in the above five Divisions who are directly engaged on O & M works in the field in the five selected schemes (Technical Assistants and Work Supervisors).

iv. Staff in the above five divisions who maintained accounts and expenditure (Head clerks).

v. Staff in the above five divisions who maintained technical data (Draughtsmen).

vi. Farmers of the five selected schemes.

vii. Other relevant personnel.

The Field Staff of the ID assisted FIs in the collection of data on O & M work done, in terms of actual physical quantities of various items, while the accounting staff assisted in the collection of expenditure on O & M during the five years of study. Technical data was obtained

through the technical staff of the ID. Discussions were also held in Colombo by the Consultants with ID and IMD staff on various aspects of this study. The FIC scrutinised the relevant sections of the following documents maintained in the divisional offices and gathered the required data with the help of FII.

i. Votes Ledgers
ii. Cash Books
iii. Committed Expenditure Statements
iv. Schedule of Accounts
v. Allocation Files
vi. Check roll registers
vii. Check rolls and Distribution rolls
viii. Measurement books
xi. Contract Registers
x. Estimate files
xi. Progress Reports
xii. Maintenance diagrams, scheme plans, issue trees and other related documents

Data so gathered directly and through the staff were reviewed, verified and corrected in the best possible manner with the available information. The data gathering, verification and correction were not simple tasks but quite difficult, as will be seen in the subsequent paragraphs. A very patient and judicious scrutiny of the documents, skillful handling of the personnel, sound knowledge and judgement of the subject in question and co-operation of all concerned were essential to produce meaningful and reliable data.

Finally the data is tabulated in a standard comparative statement form for all the schemes for each year of study. This data collection and processing work was done parallel to a "management audit" carried out simultaneously by the consultants in order to understand the existing management procedures and other qualitative dimensions relevant to the study.

3.3 Management of Financial Resources for O & M Works

The data collected in the above form and processed thereafter coupled with the in-depth investigation in the "management audit" helped the Consultants to comprehend procedures relevant to the management of financial resources for O&M works. Funds available under Consolidated Funds of the state budget, as block provisions for various types of activities in Major Irrigation Schemes, are in the following categories voted to the Irrigation Department (ID) and Irrigation Management Division (IMD) of the Ministry.

(i) **Irrigation Department (ID)**

a. Wages and allowances of permanent Work Supervisors (W.SS) and labour engaged on O & M of Major Irrigation Schemes

b. Flood damage repairs to Major Irrigation Works.

c. Improvements to strengthen and the safety of Headworks.

(ii) **Irrigation management Division(IMD)**

a. O & M of Major Irrigation Schemes
b. Improvements to Major Irrigation Schemes
c. Improvements to existing Irrigation Systems for Water Management.

Some of the existing Major Irrigation Schemes were/are rehabilitated partly or fully under Special Projects with Foreign and Local Funding. The five schemes selected fall within this category :

a. Giritale - Irrigation System Management Project (ISMP)
b. Ridi Bendi Ela - Integrated Rural Development Project (IRDP)
c. Galoya L.B - G.O.W.M.P.
d. Inginimitiya - New Scheme
e. Mahakanadarawa - Modernisation work under World Bank Aid (TIMP).

O & M Fees are collected from farmers of major irrigation schemes and these funds are used for maintenance, minor repairs and improvements of field and distributory canals. The items of work are selected and prioritised by the farmers themselves.

Of the various categories of funds listed earlier, those relating to special repairs, improvements and rehabilitation works are outside the scope of this study. The expenditure and works done under the following funding are considered for this study:

a. IMD - Consolidated Fund

- O & M of Major Irrigation Schemes
  (For field canals, only maintenance of structures are included; operation and balance maintenance of field canals are expected to be done by farmers)

b. ID - Consolidated Fund

- Wages and allowances of permanent Work Supervisors and labour engaged on O & M of major irrigation schemes.

c. Advance Account - Farmers' Collections

- Maintenance and minor repairs/improvements of distributory canals and structures in field canals.

Funding Sources

The request for consolidated fund allocations from the General Treasury consists of two parts.

i. Funds for O & M works in major irrigation schemes to meet expenditure on casual labour wages, transport, materials etc. allocated under the Ministry votes (IMD).

ii. Funds for the payment of salaries to permanent work supervisors and labourers in the Irrigation Department engaged in O & M works in major irrigation schemes allocated under the Irrigation Dept. votes.

In the case of item (i) above, the requirement of funds for the year are obtained from each irrigation division by the range DD. and submitted to the Director of Irrigation. ID had collected and analysed data on O&M procedures and expenditure in 16 selected schemes (one in each Range of ID) in 1981 and issued guidelines indicating typical cost estimate per annum (annexure 1) with norms fixed for various items of O&M work. Based on this typical estimate, IE works out the full requirement of funds for O&M of schemes in his Division. The Director of Irrigation collects such information from all the ranges and submits the information to the IMD. The IMD in consultation with the Irrigation Department submits the requirement of funds for this item for inclusion in the draft estimates of the Ministry. Since it is known that there is a constraint in the availability of funds, the total amount requested is generally limited to about 25% in excess of the preceding year's allocation.

In item (ii) above, the Irrigation Department prepares the budget based on the actual number of permanent Work Supervisors and labourers engaged in O&M works in major irrigation schemes. The amount applied for, takes into consideration any statutory increases in salaries and increments that have to be paid during the year. The funds requested for this item are included in the budget estimates of the Irrigation Department and submitted to the Ministry.

The Ministry forwards the total requirements to the Treasury which in consultation with the Ministry adjusts the figures as deemed necessary due to constraints in the availability of funds. The Treasury, then submits the final adjusted estimates to be presented at the budget proposals in the Parliament. Thus, what is included in the **budget proposals is for a lower level of O&M than** evisaged in the **typical O&M estimate.** How much lower depends on the availability of funds. This is generally insufficient to meet the full demands of O & M.

Once the budget is passed in Parliament, the allocations are released to the respective authorities.

Funds from Farmers' Collection

Funds collected from farmers in each major irrigation scheme are accounted separately and deposited in the bank. Towards the end of a calendar year, the IMD intimates to the Project Manager of the scheme, the estimated collection for the year and he is requested to initiate action in the Project Committee to get the farmers' recommendations regarding the items of work to be executed with these funds. In January of the year when the amount available for the scheme from the Farmers' Collection is known, the Project Committee prepares the list of works to be executed and the ID is requested to prepare estimates. Once the estimates are received and the Project Committee approves them the Project Manager informs the IMD to release funds to the ID to execute the works.

Distribution of Funds

After the Budget is approved, the ID grants block allocations to each R.DD for wages and allowances of work supervisors and labour engaged in O & M on the basis of actual requirements. IMD grants block allocations to each R.DD for O & M with due consideration of the overheads, length of canals, dams, roads and the acreages. Generally about 35% of the total O&M allocation is for operation and 65% for maintenance. The allocation of IMD for maintenance are somewhat on the following basis:

Headworks - per acre of irrigable area
Canals - per chain of length
Main, branch, distributory and
field canals - ratio of 2.5, 1.5 1 and 1 respectively
Road - 20% of main plus branch canals.

The R.DD in turn re-allocate these funds to Divisions according to the total acreage maintained in each division. A certain percentage of the allocation is sometimes retained with the Range Office to be utilised for any urgent work during the course of the year. At the end of the year, some adjustments are made in the allocations and in expenditure to match with each other.

The allocation for O & M is distributed under roads, dams and channels for Operation and Maintenance separately. However a scrutiny of books and discussions with staff revealed that debits of expenditure on certain items had not been strictly according to the allocation for that item. Towards the end of the year adjustments are made among items to keep within the amount allocated. Since the expenditure under each item does not reflect the actual position, only the total allocation is identified for this study. Although this may not represent reality adequately, this was found to be the best approach.

The allocation received by a Divisional Engineer is for all the schemes in his division and not separately for the different schemes. Expenditure is also recorded accordingly. In order to identify the allocation available for a particular scheme in a meaningful manner, the total allocation is divided in proportion to the specified acreages under each scheme.

On the above basis, allocations for O & M and for wages of W.SS and labour set apart for Giritale and RBE schmes during the five year study period from 1985 to 1989 and for Galoya L.B, Inginimitiya and Mahakandadarawa schmes for the period 1987 to 1989 are given below. Allocations for advance account works under farmers' collections for the specific schemes are also given below.

Table 3.1: Summary of Allocations (Rs.)

1. Operation and Maintenance

	1985	1986	1987	1988	1989
Giritale	420,000	443,000	613,900	450,000	542,870
RBE	575,000	537,800	569,200	411,445	589,000
Galoya L.B.			2,393,000	1,751,000	1,976,000
Inginimitiya			1,225,000	942,000	804,000
Mahakanadarawa			511,000	487,000	568,000

2. Wages & allowances of W.SS & Labour on O & M

Giritale	214,700	208,400	216,500	199,400	141,750
RBE	124,100	173,000	192,000	141,300	130,000
Galoya L.B			778,000	792,000	190,000
Inginimitiya			303,000	308,000	283,000
Mahakanadarawa			132,000	165,000	129,000

3. Farmers' Collections

Giritale	356,819	462,007	292,095	32,116	-
RBE	49,500	78,000	-	19,788	-
Galoya L.B.			541,003	368,451	450,550
Inginimitiya			57,275	17,200	34,600
Mahakanadarawa			92,500	-	160,000

Note 1:
Allocations indicated above are on the basis of the initial total allocations at the beginning of the year & additional allocations during the course of the year, granted to the divisions being divided in proportion to the specified irrigable extent in the divisions.

Note 2:
The allocations reflect generally the amounts provided for the services in the Annual Budgets of GOSL; (allocation for work under farmers collection depends on the amount of fees collected) and hence show varying trends year to year. Each of the five schemes are under different R.D.D. Though Head Office of ID has issued guidelines on O & M procedures each R.D.D. may modify the guidelines to suit the local requirement according to his own thinking. Hence, even from system to system, particularly under different ranges, one can expect a varying trend.

Note 3:

Division	Scheme	Specified Irrigable extent (ha)
Hingurakgoda	Giritale	2507
Hingurakgoda	All major schemes	9282
Nikaweraeiya	R.B.E.	2064
Nikaweratiya	All major schemes	2578
Ampara	Galoya L.B	12710
Ampara	All major schemes	28364
Inginimitiya	Inginimitiya	2644
Inginimitiya	All major schemes	2794
Mahakanadarawa	Mahakanadarawa	2545
Mahakanadarawa	All major schemes	4234

3.4 Present Methods of Elaborating Cost Estimates of O&M

The Irrigation Department had compiled a Manual of Practice and Procedure on the Maintenance of Irrigation Works in 1956 and this was revised in 1977. This Manual consists of the following main chapters.

Chapter 1 - Data for Maintenance
Chapter 2 - Maintenance Practice
Chapter 3 - Maintenance Estimates and Expenditure
Chapter 4 - Miscellaneous
Appendices

It is further sub-divided into 37 sectors which cover a wide range of aspects related to O & M. In addition to this manual, from time to time a number of circulars have been issued by the Irrigation Department on O & M practices and procedures, standing orders, estimation, implementation etc. in keeping with the changes in practices and strategies. Also in the recent past, there was an increased concern for the high cost, financing and implementation of new systems and a recognition of problems in the existing systems. It is felt that the massive capital investments have not yielded the full potential of the schemes and were not as productive as originally envisaged and that this was due to a combination of physical, economic and political rationale. This thinking has increased the emphasis on

O & M and water management in the irrigation schemes. Furthermore, the foreign funding agencies for rehabilitation of existing schemes required the assurance of the Sri Lanka Government - as a pre-requisite for funding - that a concentrated effort would be made on O&M and the system would be operated and maintained at high efficiency so as to reach the potential of the scheme and prevent significant deterioration. Since the farmers are the beneficiaries of the irrigation schemes their participation in decision making and contribution towards O & M was thought to be essential for successful implementation of O & M. The Government decided to collect fees from farmers for O & M in addition to their obligations at field canal level. In order to determine the amount of fees to be collected from farmers for O&M, it was necessary to estimate fairly accurately, the cost of annual O & M.

As mentioned earlier the Director of Irrigation issued guidelines in 1983 to prepare O & M estimates on the basis of performance in 16 selected schemes during 1981 at one per Range. The estimate in annexure 1 shows typical O & M costs per acre per annum for various items of O & M work as determined by the above exercise as well as the updated version in 1988. The main classification of these items is as follows:

a. Labour
b. Supervision
c. Drivers and Operators
d. Travelling and combined allowance
e. Fuel and repairs to vehicles and machinery
f. Purchase of Materials and tools
g. Physical contingencies
h. Administration and overheads
i. Depreciation of vehicles and equipment

Guidelines were also issued previously and subsequently for O & M cost estimation on the above lines.

As mentioned earlier, funds for the following categories of O & M works are allocated separately under different votes.

1. Operation and Maintenance of Major Irrigation Schemes - IMD

2. Wages and allowances of Work Supervisors and labour on O &M - ID

3. Maintenance mainly at secondary and tertiary levels - Farmers' collections

Hence cost estimates are also prepared for these three categories separately.

But, it has been observed that the format used in the five schemes under study are different in certain respects. However, the format used in Giritale is in line with the guidelines.

Hence in order to use a standard format for the purpose of this study, it was decided to adopt the format used for Giritale estimates. Items in the R.B.E., Gal Oya L.B., Inginimitiya and Mahakanadarawa estimates were appropriately re-classified while the lump sum provisions were hypothetically quantified to fit-in with the standard format.

The finally adopted standard format consisted of the following main items.

I. **Operation**

a. Salaries, allowances, over-time, travelling and combined allowances of labour and night watchers for structures.

II. **Maintenance (labour)**

Weeding and jungle clearing, removal of water plants, desilting, earth work in filling scours and potholes, repairs to structures, earth excavation in foundations, concrete works, rubble masonry, plastering, laying hume pipes, stop planks, gravelling and other items.

III. **Construction Materials**

Cement, sand, metal, rubble, gravel, paint, gunny bags, cane baskets, stop planks, hume pipes, steel, gates, tools and other items.

IV. **General Charges**

Salaries and allowances for supervision, watchers, casual office employees, travelling and combined allowances of Work Supervisors and Technical Assistants, salaries, allowances, overtime and combined allowances of operators and drivers, fuel and lubricants and repairs to vehicles etc.

Administration and overhead cost provided in the typical O & M estimate under H are not included in the above estimates for O & M since there is a separate vote to meet such cost. Wages of work supervisors also were brought under the separate vote from March 1989. Depreciation cost in the typical O&M estimate under I is also not in the above O&M estimate as this cost is not accounted. Salaries of casual watchers engaged under O&M and a part of the salaries of casual office employees are included in the estimate though not allowed for, in the typical estimate.

For the purpose of comparison, full O & M estimates under IMD funds for all five Schemes were prepared by the Consultant from 1985 to 1989 for Giritale and RBE; and from 1987 to 1989 for Galoya L.B, Inginimitiya and Mahakanadarawa using the norms fixed by the ID guidelines and are included in the comparative statements in annexures 3A to 7C .

For the O&M works under IMD funds allocations do not meet the full needs and therefore the estimates have been prepared generally, to cover the amount of allocations indicated. Sometimes additional O & M estimates are also prepared when the allocations are increased. Thus the estimates are prepared as a matter of procedure which may not have much relevance in controlling the expenditure. The actual estimates are included in the comparative statments in annexures 3A to 7C.

Regarding salaries and allowances of work supervisors and labour staff on O & M (under ID funds), hypothetical full estimates were prepared by the Consultants for purposes of comparison based on ID guidelines according to which the norms for the number of Work Supervisors and Turn Out Attendants (labour staff on operation in distribution system) are one per 1000 ha/one per 200 ha respectively. Actual estimates are for the staff stationed in a scheme which may exceed the fixed norms and hence actual estimates may exceed full estimates.

There is no full estimate as such for maintenance work done with farmers' collections. A priority list is prepared at the Project Committee to meet the requirements of the farmers. Allocations which depend on the amount of fees collected from farmers are communicated to the Irrigation Engineer who prepares the estimates taking into account the amount of the allocations and selecting the items of work in the order of priority. The works thus estimated are mainly maintenance and minor improvements in distributory and field canals. As specified earlier, works on FCC other than structures are extracted and excluded from the approved estimates for the purposes of this study. The balance estimate is broken up into items to fit-in with the standard format.

The total cost of the full and approved estimates is summarised below:

Table 3.2: Summary of Estimates (Rs.)

a. O & M under IMD funds

	1985	1986	1987	1988	1989
Giritale					
- Full	1,020,000	1,020,000	1,050,000	1,080,000	1,200,000
- Appd	420,000	380,000	595,000	460,350	1,200,000
R.B.E.					
- Full	830,000	850,000	1,000,000	1,000,000	1,130,000
- Appd	950,000	561,300	569,200	400,000	870,000

Galoya L.B.					
- Full			5,000,000	5,400,000	5,800,000
- Appd			2,200,000	1,785,000	2,460,000
Inginimitiya					
- Full			1,550,000	1,650,000	1,800,000
- Appd			1,583,600	805,000	1,090,000
Mahakanadarawa					
- Full			1,100,000	1,150,000	1,300,000
- Appd			Est. not prepared	Est. not prepared	1,460,000

b. W.SS. & labour on O & M under ID funds

Giritale					
- full	196,152	213,912	217,632	297,852	307,440
- Actual	199,152	216,672	220,512	288,336	312,480
R.B.E					
- Full	182,704	199,224	202,704	277,212	286,560
- Actual	117,400	127,920	130,160	177,928	184,080
Galoya L.B.					
- Full			1,080,456	1,615,128	1,787,82
- Actual			723,600	671,400	1,095,96
Inginimitiya					
- Full			227,736	329,256	367,548
- Actual			266,784	343,344	375,600
Mahakanadarawa					
- Full			235,944	330,696	363,948
- Actual			Est. not prepared	Est. not prepared	190,488

c. Maintenance with Farmers' Collections

Giritale	295,024	361,478	154,383	-	-
R.B.E	34,650	55,560	-	11,410	-
Galoya L.B.	-	-	340,158	259,561	293,127
Inginimitiya	-	-	45,445	-	27,319
Mahakanadarawa	-	-	-	-	117,342

3.5 Observations on Implementation of O & M and Monitoring

IE is directly responsible for the execution of O&M works in major irrigation schemes in his Division under the direction and supervision of his Range Deputy Director. The I.E. gets the work done through Technical Assistants who are attached to the schemes. Each T.A. is assisted by a work supervisor (WS) who is his subordinate and has to supervise the work in the field throughout the day.

Generally, the works in a division is carried out either on measurement contract or on force account. It is observed that during the period of study, all maintenance works under IMD funds were executed on force account except in Galoya LB where a substantial amount of maintenance work was executed on contract. Materials necessary for O & M work like sand, metal, rubble, gravel, timber, etc. are either collected/ produced on force account or locally purchased. Materials like cement, hume pipes, steel etc. are procured from corporations, M.P.C.SS and manufacturing organisations. Other materials such as gunny bags, cane baskets, paints, tools etc. are locally procured.

The O&M work is generally carried out throughout the year with some special maintenance work that cannot be done during water issues, such as desilting, repairs to structures, etc. which are undertaken during the closed season. Weeding in canal reservations is done, generally, twice a year and priority is given to this item of work particularly within the water flow section. Desilting, especially at critical locations such as drainage crossings etc. is also carried out on a priority basis. During the course of the year, priority maintenance items are identified by the inspecting officials such as Range Deputy Director, Irrigation Engineer, Technical Assistants and Work Supervisors. Furthermore, on representations received from farmers, directly or through Project Committees, special maintenance works are carried out, depending on the availability of funds. In this manner some of the O & M works are done on a routine basis and some special maintenance is done as priority items during the course of the year. Thus it would be seen that some O & M works executed are outside the estimates prepared at the beginning of the year.

In the case of maintenance work with farmers' collections, the items to be executed are identified, prioritised, estimated and thereafter carried out. Expenditure incurred is recorded in the appropriate books against allocations received. Sometimes, expenditure exceeds the allocations and either additional allocations are granted or expenditure is adjusted at the end of the year.

It may be noted that while O&M estimates and allocations under ID and IMD are annual and are closed at the end of the year, estimates and allocations under farmers' collections are for specific items of work and will be in force even in the years following the year of commencement till the specified works are completed.

In several years during the period of study, O & M expenditures were maintained under the following items separately and controlled by allocations against each of these items.

Roads - Operation and Maintenance

Dams - Operation and Maintenance

Canals - Operation and Maintenance

However, as explained earlier, some debits were not strictly against the correct items. Sometimes, expenditure incurred on one item is charged against another item, if allocation for the first item is exhausted but available for the latter, particularly towards the year end. It was left to the consultant staff to scrutinise the documents and books to sort out the correct expenditures against the correct items.

Quantities of work done are recorded in distribution rolls for force account works and in contract registers for contract works. The details are recorded in measurement books.

Monthly statements of accounts, expenditure and physical work done item-wise are forwarded by I.E. of the division to Range Deputy Director. But these statements are in respect of all schemes added together and not scheme-wise. This exercise is mainly for the control and audit of the expenditure against provision under specific votes.

Frequent inspections are carried out by I.E. and R.D.D. and a qualitative assessment of O & M works is made. R.D.D. discusses the physical and financial progress of O&M with the I.E. during his inspections and at office meetings, directs I.E. on problems and shortcomings and generally has an overall control on O&M.

Actual work done and expenditure incurred during each year of study are included in the comparative statements in Annexures 3A to 7C.

The annual expenditures on O&M (IMD), W.SS and labour (ID) and maintenance under farmers' collection during the period of study are given below.

Table 3.3: Summary of O & M expenditure (Rs.)

Fund	1985	1986	1987	1988	1989
1. O & M (IMD)					
Giritale	466,327	612,634	671,756	467,988	537,784
RBE	589,269	586,387	567,562	409,541	412,311
Galoya L.B.			2,469,785	1,948,339	2,145,428
Inginimitiya			1,089,601	926,783	741,797
Mahakanadarawa			634,298	694,141	756,230
2. W.SS and labour on O & M (ID)					
Giritale	199,152	216,672	220,512	288,336	302,680
RBE	112,822	154,938	167,893	185,498	268,309
Galoya			760,891	946,299	1,197,775
Inginimitiya			262,304	273,120	285,500
Mahakanadarawa			79,423	106,500	16,716

3. Farmers' Collections' (Maintenance)

Giritale	173,536	349,641	191,471	-	-
RBE	33,707	47,672	-	4,482	-
Galoya L.B.			112,155	427,629	261,303
Inginimitiya			43,537		23,787
Mahakanadarawa					79,038

The TOR for this O & M cost study specifies that the expenditures at the "main system level" (reservoir main and branch canals) should be differentiated from those at the level of distributory and field canals. However, identification of expenditures scheme-wise and item-wise itself has been a formidable task. Identifying expenditure canal level-wise was almost next to impossible particulary in the cases of Giritale and Ridi Bendi Ela and any attempt to do such an identification would have been futile since any data collected would be highly inaccurate. For these two schemes, expenditures were identified separately for headworks and distribution system. For Gal Oya LB, Inginimitiya and Mahakandarawa it was possible to further sort out the expenditure on distribution system under main plus branch canals and distributory plus field canals separately.

It may be noted that the amount of annual O&M expenditure merely reflects the allocation made available during that year of expenditure.

3.6 Specific O & M Procedures

The O & M allocation and expenditure procedure is described for **Giritale** as a general base and thereafter any procedure specific to each of the other four schemes and differ from Giritale is discussed.

i) **Giritale** Scheme is in Hingurakgoda Division of Polonnaruwa Range. When D.D. Polonnaruwa Range receives O & M allocation from IMD at the beginning of the year, he indicates to IE Hingurakgoda, the allocation available for the Division on the basis of acreage and asks him to submit the O&M estimate. In 1985 IE had submitted the O&M estimate, similar to any other work estimate prepared in the ID. D.D. had

returned this estimate requesting IE to prepare same in the new standard format in keeping with IDs typical O & M estimate. Items not in typical estimate could be based on actual requirements. The estimate should be limited to the allocation. DD also releases an initial allocation to meet the immediate expenditure which is incurred right from the beginning of the year. IE prepares the O&M estimate for each scheme accordingly and submits to DD who scrutinizes same, makes necessary changes in his office or gets it changed by IE, if necessary, and approves it and releases the total allocation for the Division indicating amounts under categories of roads, dams and canals for operation and maintenance separately.

For Giritale, O & M estimates for each year of Study except 1989, was prepared in the typical O & M estimate pattern with adjustments in sub-items of work to limit the estimated amount to the expected allocation. Variations between allocations and approved estimates in some years were due to the actual allocation being different from what was expected and also additional allocations being granted sometimes to carry out specific work such as desilting at critical sections, repairs to important structures etc.

For 1989, IE had prepared the O&M estimate to meet the full requirement envisaged in the form of a typical estimate as an exercise and as a result the approved estimate and the full estimate are the same and equivalent to Rs.1,200,000 for that year. The approved estimates were less than full estimates since the allocations were less than the full requirement due to budgetary constraints, for the other years.

It is thus seen that the approved O&M estimates were not on the basis of actual field requirements item-wise for the this specific scheme and were unrealistic. These were only a procedural requirement and provided no control in executing O&M item wise.

According to the guidelines of the ID, the norms for O&M personnel in Giritale scheme would be 3 Work Supervisors and 12 Turn Out Assistants (TOAs) and using an average wage for each category, full estimates were prepared by the consultant. Actual estimates were prepared by I.E. on the basis of the staff already engaged on O&M The amounts of full and actual estimates for the five years were very close.

Estimates for work to be done under farmers collection were prepared according to the actual field condition in respect of items selected in the order of priority as finalised at the Project Committee and limited to the IMD allocation from farmers' fee collection. Amounts of estimate and expenditure under this item given in the report excludes weeding, desilting, earthwork etc., in field canals (except structures) as these items are farmer's responsibility.

IE gets these estimates prepared and checked through Divisional Assistant (most senior Technical Assistant in the Division), Technical Assistants in charge of the schemes and the Draughtsman attached to the Divisional Office.

Four Technical Assistants are in charge of Giritale scheme and under each of them, there is one Work Supervisor. An average of 6 permanent and 5 regular casual labourers are engaged for the operation of the scheme and their wages are charged under ID votes. One of them partly covers headworks and partly distribution and the balance ten, the distribution system. During non-operating periods these labourers are expected to carry out maintenance work. An average of one labourer's wage is charged against IMD'S allocation for O & M, as operation costs for distribution system.

Most of the maintenance work is done as a routine, particularly weeding which consumes a fairly large portion of the maintenance allocation. Depending on

the availability of funds, desilting, earthwork, repairs to structures, etc., are selected on priority basis at critical sections. This selection is decided at the monthly meetings which IE normally has with TAA, during joint inspection, Project Committee meetings, individual discussions with T.AA and farmers etc. in response to the farmers request and the system's requirement as and when the needs arise.

Maintenance work in Giritale is executed on force account. Technical Assistant applies to the IE for check rolls (C.R.), a few days prior to the commencement of a month indicating the specific items and location of work and the cost of labour to be employed during the month. IE after scrutiny and adjustments, if necessary, with or without consultation with T.AA issues the check roll together with a distribution roll (DR). Labourers are generally employed from the locality and their daily attendance is marked in the C.R. by the Work Supervisor who keeps and maintains CR & DR. Daily distribution of labour to various items of work are marked in the D.R. The work is supervised by the Work Supervisor and frequently inspected by the Technical Assistant who gives instructions to Work Supervisors on how and what works are to be carried out. The I.E. inspects the scheme, checks whether the maintenance works are executed properly and takes corrective measures if needed. Less often inspections are done by Range D.D.

The materials such as metal and sand are locally quarried on force account and sometimes procured locally. Cement, humepipes, reinforcement, timber etc are bought from recognised factories and shops. Other miscellaneous items are procured locally. Since the quantity of materials used for maintenance is not much, materials procured under other construction work in bulk and sometimes used for maintenance though cost of such materials is not debited against maintenance. The Technical Assistant submits monthly material returns indicating the materials used for the works under him.

C.R. & D.R. are checked by inspecting Technical Assistant, I.E. staff officers from Range office and sometimes even Range D.D. for the accuracy of attendance and other documentations.

At the end of the month, C.R. & D.R. are closed and the wages of the labour employed during the month calculated. Quantities of various items of maintenance work done during the month and corresponding labour expenditure against each of these items and documented in the D.R. as well as in a measurement book. Often quantities of some of the works are given in mandays rather than say cubes of earth work. In order to assess the work being done and to have a better control of expenditure, this type of quantifying should be avoided and the TA should make more effort on this matter.

These documents are checked in IE's office, scrutinized by I.E. and certified. Thereafter at predetermined dates the labourers are paid according to the certified C.R. by the Divisional Assistant.

For permanent labourers, separate pay abstracts are prepared in IEs office and payments made to them as monthly salaries. Work done by them is not documented in the C.R. and it is used only to mark their attendance.

The paid vouchers are documented in the Cash Book and the debits against the allocation in ledgers. The Monthly Committed Expenditure Statement indicating the O & M expenditure under different categories for all the schemes added together and the monthly accounts are rendered by I.E. to the Range D.D. D.D. in turn sends the Committee Expenditure statement to Head Office. The following three monthly returns in respect of O & M allocation by IMD are sent to IMD.

1. Monitoring of Operations costs
2. Expenditure statement of maintenance costs - labour and materials
3. Quantities of work done under maintenance

These statements and returns are for an overall control on total O & M expenditure but not very useful in monitoring O & M performance physically and financially in each scheme.

Expenditure on Work Supervisors and labour on O & M was almost same as the estimated amount for each year.

Works under farmers' collection were executed on force account in 1985 and 1986 and only continuation work in 1987. New works in 1987 were done on contracts awarded to local societies and organisations at estimated rates without open tenders, under small scale agreements.

Some expenditures are common to the Division and not just O & M. Examples are transport (fuel, drivers, repairs etc) casual office employees, office and camp watchers, office and camp maintenance (telephone, electricity, sanitation, materials etc) Circuit Bungalow upkeeping etc, for which no or very little specific allocations are available. Part of these expenditures are also charged to O & M by IE by apportioning under various allocations by judgment.

Operation and maintenance (except structures) of field canals are the farmers' responsibility.

ii. **Ridibendi Ela**

The scheme is in Nikaweratiya Division of Kurunegala Range. Some rehabilitation works were done in 1984 under IRDP Range. I.E.'s O & M estimate for 1985 was generally on the basis of the norms provided in the typical estimate, but allowed higher amounts for overheads under operation. That is why, this estimate of Rs. 950,000 exceeded the consultant's full estimate of Rs. 830,000. For 1986 to 1988, i.E.'s estimates were limited to the expected allocation. 1986 estimate generally followed the typical estimate pattern with some simplifications. Quantities for estimates for 1987 & 1988 were measured at site in the order of priority and

computed. In 1989, the new R.D.D. gave instructions to prepare the O & M estimate according to the field requirement irrespective of the allocation and the 1989 estimate was so prepared and approved for Rs.870,000 which was less than the consultants full estimate of Rs. 1,130,000 prepared according to the norms of the typical estimate. While the amount for overheads under operation in the approved estimate was higher, the maintenance provision was lower. The O&M allocation for 1989 was only Rs. 589,000.

In 1987, R.D.D. informed the I.E. that the O & M cost be distributed under roads, dams, canals and vehicle repairs for accounting purposes in the ratio of 7:9:51:1 and the expenditure posted in the ledger under these categories separately. 10% of the operation cost should be reserved for expenses of D.D.'s office. The rationale for this ratio would have been the work load for these categories of work. The exact ratio might have been based on the allocation received from IMD.

Full estimates for wages of work supervisors and labour on O & M provided for 3 work-supervisors and 12 labourers according to the practicing norms of the ID while the actual estimates were somewhat limited to the initial allocation and hence lower than full estimates.

An average of 7 permanent and 5 regular casual labourers were engaged on operation and charged under ID vote.

The permanent labourers were comparatively old and did only a little work during non-operating period. About 6 labourers' wages were charged under IMD allocation as operation costs for distribution system.

The maintenance works were done on force account mainly on main canals and less in distribution system. In addition to weeding, desilting and earthwork, substantial repairs to structures also have been done in this scheme. Only very little gravelling was done.

The works under farmers' collection were executed on force account in 1985 and 1986 and on contract with recognised societies and organisations in 1988.

iii) **Gal Oya LB**

The scheme is in Ampara Division of Ampara Range and was rehabilitated up to 1985 under Water Management Project. I.E.'s estimates for O & M for the three years of study namely 1987, 1988 & 1989 followed the typical estimate pattern but limited to the expected allocations. Lump sum provisions were allowed for general charges under operation and the quantities of maintenance work were computed from field measurement in the order of priority and in units of those quantities. For 1987 & 1989, the approved estimates were almost half the full estimates prepared by the Consultant, while for 1988 it was one third.

The major item of maintenance work carried out was weeding. Most of the weeding and some repairs to structures were given on contract to recognised societies and organisations at estimated rates without open tenders. The estimate for weeding thus, had some control on the quantity of work done and expenditure, the estimate and what was done being close to each other.

The average number of labourers on operation charged under ID votes was 15 permanent and 48 regular casual making a total of 63 which is the norm for this scheme. In this case two permanent labour was allocated maintenance work during non-operating period but their output was not measured and generally not commensurate with the wages they drew. About 6 labourers wages were charged under O & M allocation by IMD as operation costs for distribution system.

The average number of work supervisors was only 5 which was less than the allowable norm of 13 for this scheme. This means that the inputs of Technical

Assistants and the work supervisors and even the I.E. were high demonstrating that the general charges could be cut down by reducing the staff and carrying out the duties more efficiently.

In 1987 a Gal Oya Rehabilitation Project was being implemented and substantial overheads of office and scheme were charged to that project. Hence the O & M expenditure for general charges for 1987 was comparatively low as Rs.528,292. For 1988 and 1989 this expenditure was high as Rs. 929,259 and Rs. 889,871 respectively, Since all the over heads were changed to O & M in the absence of the Project.

The Office of Range D.D. and IE are located in the same place at Ampara though in two separate buildings. This closeness enables better dialogue between DD & IE, quick contact and decision making regarding any problem and DD exercising close monitoring and supervising O & M work. This has contributed for a better management of the scheme.

Galoya irrigation system is operated by computer applications since 1984. The computer centre is established at IE's office and computer models have been developed to dertermine weekly irrigation requirement at each off take of distributing canal from main or branch canal and the required flow in main and branch canals and to create a data file.

In Gal Oya scheme some field canals of total length of 16 km were identified to be maintained by I.E. since these canals are too unwieldy for the farmers to operate and maintain.

iv) <u>Inginimitiya</u>

The scheme is in Inginimitiya Division under Puttalam Range. It is a new scheme, being completed in 1986.

The actual O & M estimates for the three years of study were slightly different from the typical estimate pattern in the units of quantities, materials not being given separately etc. The estimate for 1987 for Rs. 1,583,600 was to meet the full requirement of O & M and hence was almost same as the consultant's full estimate of Rs. 1,550,000 in the total amount, though varied under various sub items. Estimates for 1988 & 1989 were limited to the expected allocation.

The major maintenance item was weeding. Works were executed on force account.

Labourers on operation charged under ID votes were 2 permanent and 10 regular casual. A small amount for operation of distribution system was debitted against IMD allocation.

A significant feature in the O & M expenditure in the Division was a very high expenditure for general charges, an average of Rs. 705,474 out of total expenditure of Rs. 1,193,035. The scheme was under construction till 1986 and the office and camp were maintained to service the construction work. Once the construction work was over, the office and camp served only O & M of this scheme and another scheme with an irrigable area of only 150 ha. Hence most of the expenditure on overheads such as transport, casual and works estimate, employees in office, office and camp watches, electricity and telephone bills, excess works estimate staff etc., were met from O & M allocation resulting in a high proportion of general charges. Since the Division has taken up a few number of construction works from 1990, it is expected that by judicious appropriation of overheads expenditure, this anomaly will be rectified.

v) **Mahakandarawa**

This scheme is in Mahakanadarawa Division under Anuradhapura Range. A comprehensive modernisation of the physical system of the scheme was completed in 1982.

There were no O & M estimates prepared in the Division for 1987 and 1988 but in 1989, the O & M was estimated @ Rs. 1,460,000, providing lump sums for each of the items of overheads and materials and some quantities for operation of head works, weeding and repairs to structures. Other maintenance items were not estimated. Probably the estimate was so prepared and adjusted to the total amount based on a certain pro-rata cost per ac. The total amount was slightly in excess of the consultant's full estimate of Rs. 1,300,000 for that year.

In this scheme too the major maintenance item done was weeding. Significant expenditure was incurred for desilting and earthwork as well.

Though norms of the ID allows 13 operation labourers for this scheme, only an average of 5 were employed, since there was not much of irrigation activates due to a water shortage in the main reservoir.

Here again the general charges were high, an average of Rs. 372,423 against a total O & M expenditure of Rs. 762,436. The Division handles in addition to O&M of this scheme, only O & M of another major scheme and seven medium schemes with an irrigable area of 1689 ha. O & M expenditure in these balance schemes, particularly the medium schemes were low and not in proportion to the acreages even, the schemes being small. Hence most of the office and camp overheads had to be met from the O & M allocation for Mahakandarawa.

3.7 Other Data

Other data on water issues (dates, quantity etc.), cultivation (cultivated acreage, crop, yield, performance etc.), hydrometeorology (rainfall, etc) were also obtained from records maintained in ID & IMD and given in Annexures 18 A to 22 B.

4. ANALYSIS OF DATA ON O & M EXPENDITURE

4.1 General Observations

For this purpose the various items of O&M are regrouped under the following four main items:

I.	Operation	- Labour for operation of the scheme
II.	Maintenance (Labour)	- Labour on various items of maintenance
III.	Construction Materials	- Materials for O&M
IV.	General Charges	- Supervision, watching, administration, transport etc.

The expenditure corresponding to the above items was extracted from the comparative statements of expenditure and tabulated appropriately (see Annexures 8 to 12 titled "Summary and Analysis of Actual Expenditure incurred and comparison with Consultant's Estimate). The distribution of expenditure on the items during each year and that of the average expenditure per year is computed as percentages also. The expenditure considered above is for the combined amount under O&M funds of IMD and ID funds for Work Supervisors (WSs) and permanent labour on O&M.

The Consultant's Estimates for "adequately" and "well" maintained levels are also included in the statements.

4.2 Analysis of Average Expenditure

For comparison, average expenditure under ID & IMD votes from **1985 to 1989** in Giritale and RBE, and from **1987 to 1989** in Galoya LB, Inginimitiya and Mahakanadarawa is given below under the four items as described above. The Consultant's estimate for "adequate" maintenance is also given for reference.

Table 4.1: Average Expenditure and adequate maintenance estimate

Giritale Scheme

	Average expenditure (ID & IMD) 1985 - 1989		Consul.Estimate for Adequate Maintenance		Average Exp. adequate estimate
	Exp. Rs.	%	Est. Rs.	%	
I. Operation	193,127	24	166,600	7	1.16
II.Maintenance (lobour)	283,369	36	1,123,300	45	0.25
III.Construction Materials					
(a) For structures	31,980	4	200,208	8	0.16
(b) For gravel	-	-	506,000	20	0
IV. General charges	288,293	36	503,892	20	0.57
Total	796,769	100	2,500,000 (997/Ha.)	100	0.32

A perusal of the above table 4.1 shows that the available funds have been used mostly for payment of salaries while less emphasis has been given for the procurement of construction materials. Due to this reason, the repairs to structures, which are very important, may have been at a very low level. If an attempt has been made to reduce the staff engaged on O&M in keeping with financial constraints a more balanced level of maintenance could have been achieved with the available funds.

Ratio of average expenditure to the consultants estimate for adequate level of maintenance in respect of the operation item is more than one indicating that the labour engaged on operation is excessive.

Table 4.2: Average Expenditure

Ridi-Bendi-Ela Scheme

		Average expenditure (ID & IMD) 1985 - 1989		Consul.Estimate for Adequate Maintenance		Average Exp. / adequate Est.
		Exp. Rs.	%	Est. Rs.	%	
I.	Operation	189,706	27	121,500	6	1.56
II.	Maintenance (Labour)	264,265	38	955,000	43	0.28
III.	Construction Materials					
	(a) For structures	33,299	5	156,000	7	0.21
	(b) For gravel	4,360	1	480,700	22	0.01
IV.	General charges	199,276	29	486,800	22	0.41
	Total	690,906	100	2,200,000 (1065/Ha.)	100	0.31

From the above table 4.2 it is seen that the average expenditure on operation in this scheme too is much more than what is allowed in the Consultant's estimate for **adequate level of maintenance.** The average expenditure on construction materials for structures is very small, being Rs.33,299 (5%). The expenditure on the other items more or less follows a similar pattern as in Giritale. Here too, the major part of the expenditure has been on salaries paid to O&M staff. Perhaps a judicious reduction of the staff could have resulted in a better level of maintenance with the available funds.

Table 4.3: Average Expenditure
Galoya L.B. Scheme

		Average expenditure (ID & IMD) 1987 - 1989		Consul.Estimate for Adequate Maintenance		Average Exp adequate estimate
		Exp. Rs.	%	Est. Rs.	%	
I.	Operation	1,045,204	33	1,243,000	11	0.84
II.	Maintenance (Labour)	1,136,343	36	6,523,242	55	0.17
III.	Construction materials					
	(a) For structures	192,151	6	2,088,544	17	0.09
	(b) For gravel	-		762,116	7	0
IV.	General charges	782,474	25	1,083,098	10	0.72
	Total	3,156,172	100	11,700,000 (900/Ha.)	100	0.27

Above table 4.3 indicates that the average expenditure on general charges is comparatively low.

Still a judicious reduction of the expensive items within the general charges could have been more profitably used for better maintenance of the project. It may be possible to reduce the expenditure on operation and use the savings in repairs to structures.

Table 4.4: Average Expenditure
Inginimitiya Scheme

		Average Expenditure (ID & IMD) 1987-1989		Consul. Estimate for Adequate Maintenance		Average Ex adequate estimate
		Exp Rs.	%	Est. Rs.	%	
I.	Operation	218,290	18	312,000	14	0.70
II.	Maintenance (Labour)	214,047	18	696,000	32	0.31
III.	Construction materials					
	(a) For Structures	41,620	4	96,000	4	0.44
	(b) For Gravel	13,604	1	217,000	10	0.06
IV.	General charges	705,474	59	863,000	40	0.82
	Total	1,193,035	100	2,184,000 (806/Ha.)	100	0.54

In Inginimitiya scheme operation charges are low as could be seen from the above table 4.3 but the general charges are extremely high. This is due to the fact that the overheads in office and camp maintenance, transport, etc had to be charged against O&M allocation which were the only funds available for this Division. Provision for general charges in adequate estimate is allowed on this basis. The general charges of this scheme should be drastically reduced to use the available resources for better maintenance work, by suitable arrangements either to meet or to avoid high overheads.

Table 4.5: Average Expenditure - Mahakanadarawa Scheme

		Average expenditure (ID & IMD) 1987 - 1989		Consul.Estimate for Adequate Maintenance		Average Exp adequate estimate
		Exp. Rs.	%	Est Rs.	%	
I.	Operation	85,055	11	280,000	13	0.30
II.	Maintenance (Labour)	298,567	39	789,205	38	0.38
III.	Construction Materials					
	a. For structures	6,391	1	182,261	9	0.03
	b. For gravel	-	-	76,800	4	0
IV.	General Charges	372,423	49	741,734	36	0.50
	Total	762,436	100	2,070,000 (813/Ha.)	100	0.37

Above table 4.5 shows substantial O&M expenditure for Mahakandarawa.

During the period of study there has been no significant cultivation in the scheme. However some minimum maintenance had to be carried out. Expenditure on general charges was high again due to high overheads for office and camp maintenance, transport etc. Provision for this item in adequate estimate is allowed on this basis. Provision for operation is allowed in adequate estimate for full operation of the scheme.

Table 4.6: Comparison of Average Expenditure componentwise

Components			Average Expenditure					
			Operation		Maintenance		General charges	
			Amount (Rs)	%	Amount (Rs)	%	Amount (Rs)	%
Giritale								
1. Head Works	Amount	Rs.	623	1	31,498	10	62,677	22
		%	1		33		66	
2. Distribution systtem	Amt	Rs.	192,504	99	283,851	90	225,616	78
		%	28		40		32	
3. Total	Amount	Rs.	193,127	100	315,349	100	288,293	100
		%	24		40		36	
Ridibendi Ela								
1. Head Works	Amount	Rs.	6,446	3	28,009	9	25,525	13
		%	11		47		42	
2. Distribution System	Amt	Rs.	183,260	94	273,915	91	173,751	87
		%	29		43		28	
3. Total	Amount	Rs.	189,706	100	301,924	100	199,276	100
		%	27		44		29	
Gal Oya LB								
1. Head Works	Amount	Rs.	-	0	66,930	5	237,568	30
		%	0		22		78	
2. Main + Branch canals	Amt	Rs	421,550	40	563,808	42	254,749	33
		%	34		45		21	
3. Distributory + Field canals	Amount	Rs.	623,654	60	697,756	53	290,157	37
		%	39		43		18	
Sub total Distribution System	Amount	Rs.	1,045,204	100	1,261,564	95	544,906	70
		%	37		44		19	
Total	Amount	Rs.	1,045,204	100	1,328,494	100	782,474	100
		%	33		42		25	

Inginimitiya

1. Head Works	Amount Rs.	17,880	8	78,257	29	93,001	27
	%	6		27		67	
2. Main + Branch canals	Amt Rs.	118,967	55	134,650	50	320,398	46
	%	2d		24		56	
3. Distributory + Field canals							
	Amount Rs.	81,443	37	56,364	21	192,075	27
	%	25		17		58	
Sub Total Distribution System							
	Amount Rs.	200,410	92	191,014	71	512,473	73
	%	22		21		57	
Total	Amount Rs.	218,290	100	269,271	100	705,474	100 1
	%	18		23		59	

Mahakanadarawa

1. Head Works	Amount Rs.	54,192	64	48,650	16	136,810	37
	%	23		20		57	
2. Main + Branch canals							
	Amounts Rs.	17,017	20	222,065	73	192,837	52
	&	4		51		45	
3. Distributory + Field canals							
	Amount Rs.	13,846	16	34,243	11	42,776	11
	%	15		37		48	
Sub Total Distribution System							
	Amount Rs.	30,863	36	256,308	84	235,613	63
	%	6		49		45	
Total	Amount Rs.	85,055	100	304,958	100	372,423	100
	%	11		40		49	

Note: For Giritale and Ridibendi Ela, expenditure figures for main and branch canals and distributory and field canals were not available separately.

The Giritale and Ridibendi-Ela, the expenditure on distribution system could not be further sorted out under different categories of canals.

As could be expected, the figures show that the operation and maintenance expenditures on distribution system was much higher than for head works. Operation expenditure for Mahakanadarawa distribution system was however low due to much lower level of irrigation.

For Inginimitiya and Mahakanadarawa operation and maintenance expenditures on main and branch canals were more than that of distribution and field canals while for Gal Oya LB, they were lower. Two reasons can be attributed to the e different trends. One is the comparative physical conditions of the categories of canals and the other is the individual Engineer approach to priorities the O&M work.

The debit of general charges against the various components is some what arbitrary and componentwise distribution of the expenditure has no significance.

In Mahakanadarawa scheme though there was not much of irrigation, operation expenditure was 11% of the total O&M expenditure. This was due to the employment of minimum regular labour to look after the system particularly the headworks for which the operation cost was highest 64%. They would have done maintenance work too but their wages were debited against operation costs.

4.3 Comparison of O & M Expenditure (ID & IMD)

The expenditure incurred by the five schemes on (a) operation (b) maintenance, and (c) general charges are compared. Expenditure per hectare, componentwise expenditure rates per hectare and also per km of canals and expenditure subitemwise under maintenance and general charges are also discussed.

a. Operation

Table 4.7 Average per Expenditure/Hectare

	Irrigable Extent ha	Av. Exp. Rs.	% of Tot.Exp.	Exp/ha Rs.
Giritale	2507	193,127	24	77
R.B.E .	2064	189,706	27	91
Gal Oya LB	12710	1,045,204	33	82
Inginimitiya	2644	218,290	18	82
Mahakanadarawa	2545	85,055	11	33

Excluding Mahakandarawa, the above table shows that cost of operation ranges from 18% in Inginimitiya to 33% in Gal Oya. The cost of operation per ha ranges from Rs.77 to Rs. 91.

Even though the percentages vary from 18% to 33% the cost per ha which is more realistic for comparison, is nearly the same except for R.B.E. Therefore the Consultant is of opinion that this is a reasonable amount.

Table 4.8: Average Expenditure Rate Component wise - operation

Scheme	Headworks Rs./Ha.	Distribution System Rs./ha. Main + Branch	Distributory	Total	Whole System Rs./ha	Distribution System Rs./km. Main + Branch	Distributory	Total
Giritale	0.25	-	-	76.78	77.03	-	-	2,921
Ridibendi Ela	3.12	-	-	88.79	91.91	-	-	2,806
Gal Oya LB	-	33.17	49.07	82.24	82.24	5,980	4,846	5,247
Inginimitiya	6.76	45.00	30.80	75.80	82.56	2,813	2,770	2,795
Mahakanadarawa	21.29	6.69	5.44	12.13	33.42	436	466	449

Operation expenditure on headworks is comparatively high for Mahakanadarawa due to the necessity of engaging regular labour for the general up keep of the headworks. In the other schemes, headworks are partly covered by labour engaged on distribution system. But due to very low irrigation under Mahakanadarawa, only a very few labourers were employed in the distribution system and could not cover the headworks. Expenditure per hectare on distribution system was of the same order for the schemes other than Mahakanadarawa ranging from Rs.75.80 to 88.79. However while the expenditure per less on distribution system in Giritale, Ridibendi-Ela and Inginimitiya was of the same order ranging from Rs.2795 to Rs.2921, it is about 1 3/4 times for Gal oya LB. This high expenditure per Km was partly due to the low canal density in Gal Oya LB. Thus the allocation for operation cannot be on the basis of canal lengths.

b. Maintenance

Table 4.9: Average of expenditure/Hectare - Maintenance (Labour)

	Irrigable Extent ha	Av.Exp Rs.	% of Tot.Exp.	Exp./ha Rs.
Giritale	2507	283,369	36	114
R.B.E.	2064	264,265	38	128
Galoya L.B.	12710	1,136,343	36	89
Inginimitiya	2644	214,047	18	82
Mahakanadarawa	2545	298,567	39	116

The cost of maintenance as seen from the above table 4.9 varies from 18% in Inginimitiya to 39% in Mahakanadarawa and rate per ha varies from Rs. 82 in Inginimitiya to Rs.128 in R.B.E. Mahakanadarawa had no cultivation during this period even though expenditure had been high (Rs.116 per ha).

In the case of Inginimitiya the percentage of funds spent on maintenance is low. More economy in the expenditure in general charges could have diverted more funds to this item.

The average total expenditure per year incurred in Inginimitiya is Rs. 452/ha, the next highest Rs. 336 at RBE and lowest is Rs. 249 for Gal oya LB. Inginimitiya seems to have been in a very favourable position with regard to the allocation of O & M funds, this higher allocation being to meet the high overheads of office & camp maintenance. With better management these funds could have been used more efficiently.

In the case of Giritale, RBE and Gal oya LB the percentages are 36,38 & 36 respectively and the maintenance cost per ha Rs. 114, Rs. 128 and Rs. 89 respectively. The low rate per acre in Gal oya LB was because of the scheme being rehabilitated recently and of the low canal density perhaps.

Table 4.10: Average of Expenditure/Hectare Construction Materials for structures

	Irrigable Extent ha	Av.Exp Rs.	% of Tot.Exp.	Exp/ha Rs.
Giritale	2507	31,980	4	12.75
R.B.E.	2064	33,299	5	16.13
Galoya LB	12710	192,151	6	15.12
Inginimitiya	2644	41,620	4	15.73
Mahakanadarawa	2545	6,391	1	2.52

The expenditure on construction materials for structures is an indication of the repairs done on structures. The percentage expenditure varies between 4% and 6% when Mahakanadarawa is not considered. The rate per hectare varies from Rs. 12.75 in Giritale to Rs. 16.13 in R.B.E. Consultant is of opinion that better financial management could have released more funds to this item, since repairs to structures is very important for the proper control and issue of water.

Table 4.11: Average Maintenance Expenditure on Sub Items of Maintenance (Rs.)

	Giritale	RBE	Galoya L.B.	Inginimitiya	Mahakanadarawa	Av . Exp. excluding Gal Oya L.B.
Weeding	141,896 45%	95,451 32%	950,466 71%	147,404 55%	200,215 66%	146,241 49.5%
Disilting	38,684 12%	49,518 16%	23,895 2%	6,177 3%	56,267 19%	37,993 12.5%
Earthwork	82,756 26%	30,836 10%	80,028 6%	14,348 5%	41,285 13%	41,975 13.5%
Repairs to Structure	40,016 13%	71,191 24%	249,240 19%	49,030 18%	7,191 2%	41,857 14.25%
Gravellin	-	8,503 3%	-	14,702 5%	-	-
Other Items	11,997 4%	46,425 15%	24,865 2%	37,610 14%	-	24,008 8.25%
Total	315,349 100%	301,924 100%	1,328,494 100	269,271 100%	304,958 100%	

Note: The average percentage given in the last column is the average of the percentages given under each scheme.

From above table 4.11 it is seen that most of the maintenance money has been spent on weeding and next is repairs to structures with earthwork and desilting next in order. The percentage expenditure on weeding seems to be too high in proportion. It should be possible to reduce the expenditure on this item and increase the expenditure on repairs to structures, desilting and earthwork.

Table 4.12: Average Expenditure on Sub Items of Maintenance Component wise (Rs.)

Sub Items of Maintenance	Average Expenditure (Rs.)				
	Head works	Distribution System			Total
		Main+Branch Canals	Distributory + Field Canals	Total	
GIRITALE					
1. Weeding	18,748			123,148	141,896
2. Disilting	-			38,684	38,684
3. Earth work	5,219			77,537	82,756
4. Repairs to structures	3,656			36,360	40,016
5. Gravelling	-			-	-
6. Other items	3,875			8,123	11,997
Total	31,498			283,851	315,349
RIDIBENDI ELA					
1. Weeding	10,512			84,939	95,451
2. Desilting	-			49,518	49,518
3. Earth work	2,889			27,947	30,836
4. Repairs to structures	-			71,191	71,191
5. Gravelling	-			8,503	8,503
6. Other items	14,608			31,817	46,425
Total	28,009			273,915	301,924
GAL OYA LB					
1. Weeding	41,524	541,631	367,311	908,942	950,466
2. Desilting	-	-	23,895	23,895	23,895
3. Earth work	5,615	11,917	62,496	74,413	80,028
4. Repairs to structures	2,468	5,146	241,626	246,772	249,240
5. Gravelling	-	-	-	-	-
6. Other items	17,323	5,114	2,428	7,542	24,865
Total	66,930	563,808	697,756	1,261,564	1,328,494

INGINIMITIYA

1. Weeding	37,398	95,128	14,878	110,006	147,404
2. Desilting	-	1,245	4,932	6,177	6,177
3. Earth work	12,047	1,059	1,242	2,301	14,348
4. Repairs to Structures	13,917	7,607	27,506	35,113	49,030
5. Gravelling	6,250	7,736	716	8,452	14,702
6. Other items	8,645	21,875	7,090	28,965	37,610
Total	78,257	134,650	56,364	191,014	269,271

MAHAKANADARAWA

1. Weeding	29,167	139,472	31,576	171,048	200,215
2. Desilting	-	53,600	2,667	56,267	56,267
3. Earth work	19,283	22,002	-	22,002	41,285
4. Repairs to Structures	200	6,991	-	6,991	7,191
5. Gravelling	-	-	-	-	-
6. Other items	-	-	-	-	-
Total	48,650	222,065	34,243	256,308	304,958

Note: 1. O & M of field canals except maintenance of Structures are the farmer's responsibility and hence the cost of same is not included except structures.

2. For Giritale and Ridibendi Ela expenditure figures for main and branch canals and Distributory and field canals were not available separately.

Table 4.13: Average Expenditure Rate Component Wise - Maintenance - Weeeding

Scheme	Headworks Rs./Ha.	Distribution System Rs./ha. Main + Branch	Distribution System Rs./ha. Distributory	Distribution System Rs./ha. Total	Whole System Rs./ha	Distribution System Rs./km. Main + Branch	Distribution System Rs./km. Distributory	Distribution System Rs./km. Tota
Giritale	7.48	-	-	49.12	56.60	-	-	1,869
Ridibendi Ela	5.09	-	-	41.15	46.24	-	-	1,301
Gal-Oya LB	3.27	42.61	28.90	71.51	74.78	7,683	2,854	4,563
Inginimitiya	14.14	35.98	5.63	41.61	55.75	2,249	506	1,534
Mahakanadarawa	11.46	54.80	12.40	67.20	78.66	3,577	1,063	2,490

Table 4.13 above shows that the weeding expenditure per ha and also per km on distributory system in Giritale, Ridibendi-Ela and Inginimitiya were of the same order, in Mahakanadarawa higher and in Gal-Oya LB highest. Gal Oya LB being recently rehabilitated had less work in respect of other sub items of maintenance and hence accommodated larger weeding work. Weeding in Gal-Oya LB included trimming of wetted canal slopes and the rate for this trimming is high, being about three times the normal weeding. The figures in the table also shows that more attention was given to main and branch canals than to distributory canals. Most of the weeding and trimming was done on contract in Gal Oya LB.

Table 4.14: Average Expenditure Rate Component wise - Maintenance - Desilting

Scheme	Headworks Rs./Ha.	Distribution System Rs./ha. Main + Branch	Distribution System Rs./ha. Distributory	Distribution System Rs./ha. Total	Whole System Rs./ha	Distribution System Rs./km. Main + Branch	Distribution System Rs./km. Distributory	Distribution System Rs./km. Tota
Giritale	-	-	-	15.43	15.43	-	-	587
Ridibendi Ela	-	-	-	23.99	23.99	-	-	759
Gal-Oya LB	-	-	1.88	1.88	1.88	-	186	120
Inginimitiya	-	[illegible]	1.87	2.34	2.34	29	[illegible]	[illegible]
Mahakanadarawa	-	[illegible]	1.05	22.11	[illegible]	1,374	[illegible]	[illegible]

According to the above table 4.14, desilting in Gal-Oya LB and Inginimitiya was comparatively very low. This is probably due to the former being recently rehabilitated and the latter being newly constructed. Desilting in the other three schemes were fairly high because of the cross drainages bringing silt from cleared highlands.

Table 4.15: Average Expenditure Rate Component Wise - Maintenance - Earth Work

Scheme	Headworks Rs./Ha.	Distribution System Rs./ha. Main + Branch	Distributory	Total	Whole System Rs./ha	Distribution System Rs./km. Main + Branch	Distributory	Tota
Giritale	2.08	-	-	30.93	33.01	-	-	1,176
Ridibendi Ela	1.40	-	-	13.54	14.94	-	-	42
Gal-Oya LB	0.44	0.94	4.92	5.86	6.30	169	485	37
Inginimitiya	4.56	0.40	0.47	0.87	5.43	25	42	3
Mahakanadarawa	7.58	8.65	-	8.65	16.23	564	-	32

Earth work too in Gal-Oya LB and Inginimitiya was low for the same reason as for desilting, that is Gal Oya LB being recently rehabilitated and Inginimitiya being newly constructed especially the latter as observed from the table 4.15 above. More work was done in distributory than in main and branch canals. Earthwork in Mahakanadarawa was also low due to the scheme not being in full operation and hence less attention was given to this item of work which is otherwise expensive.

Table 4.16: Average Expenditure Rate Component Wise - Maintenance - Repairs to Structures

Scheme	Headworks Rs./Ha.	Distribution System Rs./ha. Main + Branch	Distributory	Total	Whole System Rs./ha	Distribution System Rs./km. Main + Branch	Distributory	Total
Giritale	1.46	-	-	14.50	15.96	-	-	552
Ridibendi Ela	-	-	-	34.49	34.49	-	-	1,090
Gal-Oya LB	0.19	0.41	19.01	19.42	19.61	73	1,877	1,239
Inginimitiya	5.26	2.88	10.40	13.28	18.54	180	936	490
Mahakanadarawa	0.08	2.75	-	2.75	2.83	179	-	102

Note: Length of Field Canal not considered

Figures in the above table 4.16 indicate that expenditure per ha on structure repairs in distribution system in Giritale, Gal-Oya LB and Inginimitiya was of the same order ranging from Rs. 13.28 ha to 19.42 ha. Ridibendi Ela had the highest expenditure on this item indicating the priority given in this division. Mahakanadarawa expenditure was very low due to low level of operation.

Most of the repairs to structures were done in distributory and field canals except in Mahakanadarawa.

High expenditure per km in Gal-Oya LB was probably due to the low canal density.

Table 4.17: Average Expenditure Rate Component Wise - Maintenance - Gravelling

Scheme	Headworks Rs./Ha.	Distribution System Rs./ha. Main + Branch	Distributory	Total	Whole System Rs./ha	Distribution System Rs./km. Main + Branch	Distributory	Total
Giritale	-	-	-	-	-	-	-	-
Ridibendi Ela	-	-	-	4.12	4.12	-	-	-
Gal-Oya LB	-	-	-	-	-	-	-	-
Inginimitiya	2.36	2.93	0.27	3.20	5.56	183	24	118
Mahakanadarawa	-	-	-	-	-	-	-	-

Only a little gravelling was done in Ridibendi-Ela and Inginimitiya scheme and no gravelling in the other three.

Table 4.18: Expenditure Rate Componentwise - Maintenance - Other Items

Scheme	Headworks Rs./Ha.	Distribution System Rs./ha. Main + Branch	Distributory	Total	Whole System Rs./ha	Distribution System Rs./km. Main + Branch	Distributory	Total
Giritale	1.54	-	-	3.24	4.78	-	-	123
Ridibendi Ela	7.08	-	-	15.42	42.50	-	-	487
Gal-Oya LB	1.36	0.40	0.19	0.59	1.95	72	19	38
Inginimitiya	3.28	8.26	2.68	10.94	14.22	517	241	404
Mahakanadarawa			-	-	-	-	-	-

There was a fair amount of miscellaneous items of work that could not be and was not categorised, he other specified items of maintenance, according to the above table 4.18 shows expenditure was high in Ridibendi-Ela and Inginimitiya.

Table 4.19: Average Expenditure Rate Componentwise Total Maintenance

Scheme	Headworks Rs./Ha.	Distribution System Rs./ha. Main + Branch	Distributory	Total	Whole System Rs./ha	Distribution System Rs./km. Main + Branch	Distributory	Tota
Giritale	12.56	-	-	113.22	125.78	-	-	4,307
Ridibendi Ela	13.59	-	-	132.71	146.28	-	-	4,195
Gal-Oya LB	5.26	44.36	54.90	99.26	104.52	7,997	5,421	6,333
Inginimitiya	29.60	50.92	21.32	72.24	101.84	3,183	1,917	2,664
Mahakanadarawa	19.12	87.26	13.45	100.71	119.83	5,694	1,153	3,731

That the maintenance work in a rehabilitated (Gal-Oya LB) or a newly constructed scheme is less is demonstrated by the above table 4.19 in which the expenditure in these two schemes was the lowest.

Expenditure per km is the highest for Gal-Oya LB because of the low canal density. This again shows that allocation on the basis of length of canals alone is not justified.

Per km, expenditure of main and branch canals was higher than that of distributory canals.

c. General Charges

Table 4.20: Average of Expenditure/Hectare - on General Charges

	Irrigable Extent ha	Av. Exp. Rs.	% of Tot.Exp.	Exp./ha Rs.
Giritale	2507	288,293	36	115
RBE	2064	199,276	29	96
Gal-Oya LB	12710	782,474	25	62
Inginimitiya	2644	705,474	59	267
Mahakanadarawa	2545	372,423	49	146

The expenditure on general charges varies from 25% in Gal Oya LB to 59% in Inginimitiya and the cost/ha varies from Rs. 62 in Gal-Oya LB to Rs. 267 in Inginimitiya. The expenditure in Gal-Oya LB seems to be reasonable though could be further improved, whereas in all other schemes this is too high. The high expenditure in Inginimitiya and Mahakandarawa has already been discussed. This points out to the fact that proper financial management could substantially reduce this type of expenditure and use such savings in essential items such as maintenance of canals and repairs to structures.

Table 4.21: Average Expenditure Rate Componentwise - Genera Charges

Scheme	Headworks Rs./Ha.	Distribution System Rs./ha. Main + Branch	Distributory	Total	Whole System Rs./ha	Distribution System Rs./km. Main + Branch	Distributory	Tota
Giritale	25.00	-	-	90.00	115.00	-	-	3,424
Ridibendi Ela	12.37	-	-	84.18	96.55	-	-	2.661
Gal -Oya LB	18.69	20.04	22.83	42.87	61.56	3,614	2,255	2.735
Inginimitiya	73.00	121.18	72.64	193.82	266.82	7,574	6,533	7,148
Mahakanadarawa	53.76	75.77	16.81	92.58	146.34	4,945	1,440	3.430

The distribution of expenditure component wise is somewhat arbitary and does not indicate any significant trend.

The items that are categorised under general charges are:

SI 12 Supervision
SI 13 Watching
SI 14 Casual Office Employees
SI 15 Travelling and combined allowance of W.SS & T.AA
SI 16 Transport charges (repairs to vehicles, fuel, operators wages etc.)
SI 17 Other miscellaneous items

Table 4.21: Average Expenditure on Sub Items under General Charges (Rs.)

	Giritale	RBE	Galoya LB	Inginimitiya	Mahakanadarawa	Average fo 5 schemes
Supervsion	72,839 (9)	52,081 (8)	120,592 (4)	128,091 (11)	36,684 (5)	82,057 (7.4)
Watching	76,798 (10)	46,227 (7)	128,637 (4)	22,234 (2)	162,576 (22)	87,295 (9)
Casual Office Employees	25,616 (3)	3,452 (0+)	152,754 (5)	28,126 (2)	22,854 (3)	46,560 (2.6)
Trav. & Comb. allow of W.S.S & T.AA	16,106 (2)	16,891 (2)	68,169 (2)	43,829 (4)	24,000 (3)	33,799 (2.6)
Transport	77,934 (10)	72,975 (11)	263,927 (8)	305,859 (25)	115,976 (15)	167,334 (13.8)
Misc	19,000 (2)	7,650 (1)	48,395 (2)	177,335 (15)	10,333 (1)	52,543 (4.2)
Total Cost	288,293	199,276	782,474	705,474	372,423	469,588
% Exp.	(36)	(29)	(25)	(59)	(49)	(40)
Cost/ha Rs.	116	96	62	267	146	104
Deviation for average						
Total Cost	0.61	0.42	1.67	1.50	0.79	1.0
% Exp.	0.90	0.73	0.63	1.48	1.23	1.0
Cost/ha	1.12	0.93	0.60	2.57	1.40	1.0

* Figures within parenthesis are percentages of the average O&M expenditure.

In going through the detail expenditures in Annexure 3 to 7 as given in above table it is seen that most of the expenditure has been incurred on transport. The variation is from 10% in Giritale to 25% in Inginimitiya. In Gal-Oya LB it is only 8%. Inginimitiya is a newly constructed scheme in the middle of a very rural and "out of way" area where there had been very poor public transport facilities. Further the canal density is high and hence distance of travel for inspection is more. These may be the causes that contributed to the high transport expenditure. Gal-Oya LB expenditure is low in comparison because of the largeness of the scheme and low canal density.

d. Total O&M Expenditure

Table 4.22: Average of Total Expenditure/Hectare

	Irrigable Extent ha	Av. Exp. Rs.	Exp./ha Rs.
Giritale	2507	796,769	318
RBE	2064	690,906	335
Galoya L.B.	12710	3,156,172	248
Inginimitiya	2644	1,193,035	452
Mahakanadarawa	2545	762,436	300

Table 4.23: Average O&M Expenditure Rate Componentwise - Total

Scheme	Headworks Rs./Ha.	Distribution System Rs./ha. Main + Distributory Branch		Total	Whole System Rs./ha	Distribution System Rs./km. Main + Distributory Branch		Total
Giritale	37.81	-	-	280.00	317.81	-	-	10,652
Ridibendi Ela	29.06	-	-	305.68	334.74	-	-	9,662
Gal-Oya LB	23.95	97.57	126.80	224.37	248.32	17,591	12,522	14,319
Inginimitiya	109.36	217.10	124.76	341.86	451.22	13,570	11,220	12,607
Mahakanadarawa	94.17	169.72	35.70	205.42	299.59	11,075	3,059	7,610

O & M expenditure in the distribution system of Gal-Oya LB was the lowest per ha. leaving Mahakanadarawa but highest per km. This was again because of the low canal density. The highest O&M expenditure per ha was for Inginimitiya mainly because of the high general charges. This is demonstrated by the following table 4.24.

Table 4.24: **Average O&M expenditure per ha excluding general charges.**

Scheme	Average O&M expenditure / ha excluding General charges (Rs/ha)
Giritale	203
Ridibendi Ela	238
Gal-Oya LB	187
Inginimitiya	184
Mahakanadarawa	153

Lowerst expenditure / ha excluding general charges was on Mahakanadarawa (to 153/ha) where the operation was at a very low level and maintenance at minimum level. Gal Oya LB and Inginimitiya have the next lowest expenditures, being Rs. 187/ha and to 184/ha respectively. The reason for this low expenditure can be the recent rehabilitation of Gal Oya LB and Inginimitiya being a new construction. The higher expenditures were for Giritale (Rs. 203 / ha) and Ridibendi Ela (Rs. 238 /ha).

Looking at the overall picture Gal-Oya LB seems to have exercised better financial control than the other four schemes and the average total expenditure had been Rs.249/ha.

Even though in Mahakanadarawa there had been no significant cultivation during the period of study, a fair amount of O&M expenditure had to be incurred to keep the scheme at a minimum operational level and to meet the overhead charges.

A close scrutiny of the expenditure on General Charges could help to improve the efficiency of expenditure by reducing the actual expenditure on this item so that more funds will be available for maintenance work.

4.4 Comparison of Expenditure under Maintenance and Operation + General Charges (ID & IMD)

The charging of expenditure under operation and general charges could be rather indistinct. Therefore if the expenditure on these two items is added together the comparison with maintenance could be more realistic.

Table 4.24: Comparison of Expenditure under Maintenance and Operation plus General Charges

	Maintenance		Operation + General charges	
	Rs.	%	Rs.	%
Giritale	315,349	40	481,420	60
R.B.E.	301,924	44	388,982	56
Gal-Oya L.B.	1,328,494	42	1,827,678	58
Inginimitiya	269,271	23	923,764	77
Mahakandarawa	304,958	40	457,478	60

From the above table 4.24 it is seen that 40% - 44% of the total expenditure is on maintenance if we do not consider Inginimitiya. The balance is for operation & general charges. Irrigation Department should take a close look at the expenditure on operation and general charges to ascertain whether this level of expenditure can be reasonably justified. According to the analysis of the consultant the expenditure on general charges could be reduced by administrative and other steps and use the savings to improve the maintenance.

The above analysis is based on average expenditure during the period of study. In order to see the pattern of expenditure annually the following data is presented.

Table 4.25: Comparison of annual expenditures (Rs.)

	1985	1986	1987	1988	1989
Giritale					
Total Exp.	665,479	829,306	892,268	756,324	840,464
Maintenance	289,987 44%	361,560 44%	406,309 45%	257,608 4%	261,278 31%
Operation & General charg.	375,492 56%	467,746 56%	485,959 55%	498,716 6%	579,186 69%
R.B.E.					
Total Exp.	702,091	741,325	735,455	595,039	680,620
Maintenance	380,491 54%	326,396 44%	296,945 40%	220,742 37%	285,044 58%
Operation & General charg.	321,600 46%	414,929 56%	438,510 60%	374,297 63%	395,576 42%

	1987	1988	1989
Gal-Oya L.B.			
Total Expenditure	3,230,676	2,894,638	3,343,203
Maintenance	1,800,839 56%	945,211 33%	1,239,433 37%
Operation & General Charg.	1,429,837 44%	1,949,427 67%	2,103,770 63%
Inginimitiya			
Total Expenditure	1,351,905	1,199,903	1,027,297
Maintenance	323,166 24%	238,022 20%	246,624 24%
Operation & General charg.	1,028,739 76%	961,881 80%	780,673 76%

	1987	1988	1989

Mahakandarawa

Total Expenditure	713,721	800,641	772,946
Maintenance	293,020 41%	311,050 39%	310,804 40%
Operation & General	420,701 59%	489,591 61%	462,142 60%

From the above it is seen that the total expenditure has not changed very much during the period of study. However expenditure on maintenance has generaly declined. The Operation & General Charges have increased in amount as well as percentage except in Inginimitiya where this item is very high from the beginning.

All this analysis points to the fact that expenditure on operation & general charges-mainly the general charges-needs a closer look to improve the efficiency of utilising O & M funds. There is a good possibility of making available a greater portion of O & M funds for maintenance. This will certainly bring added benefits to the performance of the schemes and there by to the farmers.

In the following table a closer view at expenditure on some important items of maintenance is presented.

From the foregoing analysis it is apparent that more attention should be paid to rationalising expenditure on the various items of work in the O & M programme. Funds should be spent to keep the irrigation system in a better state of maintenance by improving the pattern of expenditure with improved programming and management.

4.5 Comparison of Expenditure on ID & IMD Votes

In the folowing tables the expenditure incurred with ID & IMD votes is given separately to identify the activities implemented with each vote in the five schemes.

Table 4.26: Comparison of Expenditure on ID & IMD Votes (Rs)

	ID Rs.	%	IMD Rs.	%	Total Rs.	%
Giritale						
Operation	161,319	70	15,520	3	176,829	23
Maintenance	-	-	328,866	59	328,866	42
General charges	69,850	30	210,290	38	280,140	35
Total	236,169	100	554,676	100	796,769	100
R.B.E.						
Operation	100,615	65	88,893	17	189,508	27
Maintenance	-		366,143	57	366,143	45
General Charges	54,674	35	143,153	26	197,827	28
Total	155,289	100	528,189	100	690,906	100
Gal - Oya LB						
Operation	875,659	91	169,545	8	1,045,204	33
Maintenance	-	-	1,328,494	60	1,328,494	42
General charges	82,197	9	700,277	32	782,474	25
Total	957,856	100	2,198,316	100	3,156,172	100
Inginimitiya						
Operation	157,033	57	61,257	7	218,290	18
Maintenance	-	-	269,271	29	269,271	23
General Charges	116,608	43	588,866	64	705,474	59
Total	273,641	100	919,394	100	1,193,035	100

Mahakanadarawa

Operation	30,863	46	54,192	8	85,055	11
Maintenance	-	-	304,958	44	304,958	40
General Charges	36,683	54	335,740	48	372,423	49
Total	67,546	100	694,890	100	762,436	100

Note : The above averages were for 1985 to 1988 in respect of Giritale and RBE and for 1987 to 1989 for the other three schemes.

From the above it is seen that the ID allocation is used mainly for operation and general charges and IMD allocation for operation, maintenance and general charges.

4.6 Recent Trends in the Allocation of O&M Funds

In order to observe the trends in the allocation of O&M funds during the period of study from 1987 to 1989 the Consultant considered it necessary to determine the real value of the allocation for each year with reference to a base year. In this analysis 1987 was considered as the base year. The allocation in 1988 and 1989 were adjusted using an index to give the 1987 value of the 1988 & 1989 allocation.

In the actual analysis the amount of O&M allocation during each year was not used but instead the actual expenditure incurred by each scheme during each year from 1987 to 1989 was used since the expenditure figures were considered more realistic than allocation figures.

In annexures 8 to 12 the actual expenditure during 1987 to 1989 was given under the following main categories.

i Operation
ii Maintenance (Labour)
iii Cost of Materials
iv General Charges
v Total Expenditure.

In the analysis, items ii and iii above were combined and given under the following.

i Operation
ii Maintenance
iii General Charges
iv Total Expenditure

In order to derive an index the full estimates, prepared from estimates obtained from Divisional Engineers suitably modified by the Consultant was used and is given below.

Table 4.27: Full Estimate - Gal Oya Scheme

S.I. No.	Description	Full Estimate Unit	Qty.	1987 Amount	1988 Amount	1989 Amount
Item 1	Operation					
1.	Salaries and Allowance of Labourers on O of Hdwork	ac	-	-	-	-
1a.	Salaries & allowances of Labour. on O of dis. Sys	ac	-	-	-	-
2.	Sal. & Allow. of Watchers	mm	144	168,480	234,720	259,200
3.	Sal. & Allow. of operators & drivers	ac	31,394	241,734	244,873	251,152
4.	Sal. & Allow. of Casual Office Employees	mm	36	35,100	44,280	46,512
4a.	Sal. & Allow. of W.S.S	ac	-	-	-	-
5.	Travelling & Combined Allow. of W.S.S & T.AA	ac	31,394	72,206	75,345	78,485
6.	O/T, Trav. & Com. Allow. of T.O.AA	ac	31,394	11,930	12,557	15,697
7.	O/T, Com. Allow. of Operators & Drivers	ac	31,394	15,070	15,697	18,836
8.	Cost of Fuel & Lubricant	gal	3,140	120,890	127,170	127,170
9.	Other misc. expenses	item	allow.	84,590	95,358	82,940
10.	Repairs to Vehicle	item	allow.	50,000	50,000	70,000
				800,000	900,000	950,000

ITEM. II MAINTENANCE (LABOUR)

11.	Weeding	sq	627,880	1,255,760	1,255,760	1,255,760
12.	Removal of Water Plants Clearing wetted section	sq	62,790	313,950	313,950	313,950
13.	Desilting	cu	15,700	942,000	942,000	1,117,500
14.	E/W in filling scours etc	m/d	4,710	197,820	268,470	282,600
15.	Repairs Structures	m/d	3,140	273,180	367,380	389,360
	a) E/E in found & backfill					
	b) Ct.Concrete					
	c) R.R Masonry					
	d) Ct. Plastering					
	e) Laying H.PP					
	f) Stop planks/gats					
15a.	Other Items	item	allow	10,000	10,000	10,000
16.	Spreading gravel	sq	6,280	37,680	37,680	50,240
				---	---	---
				3,030,390	3,195,240	3,479,410
				=========	=========	=========

ITEM III MATERIALS

17.	Cement	bags	3,140	392,500	423,900	439,600
18.	Sand	cu	157	18,840	24,335	28,260
19.	Metal	cu	157	94,200	102,050	109,900
20.	Rubble	cu	157	75,360	75,360	78,500
21.	Gravel	cu	1,570	314,000	392,500	471,000
22.	Paint	gal	157	54,165	76,930	70,650
23.	Gunny bags	no	4,710	70,650	70,650	70,650
24.	Cane baskets	no	1,570	31,400	31,400	26,690
25.	Misc. materials	ac	31,394	15,697	31,394	31,394
	a) Stop planks					
	b) H.PP					
	c) Steel					
	d) Other item					
26.	Tools	ac	31,394	15,697	31,394	31,394
				---	---	---
				1,082,509	1,259,913	1,358,038
				=========	=========	=========
27.	Physical Contingencies	item	allow	87,101	44,847	12,552
				---	---	---
	GRAND TOTAL			5,000,000	5,400,000	5,800,000
				=========	==========	==========

Using the above data the following index of O&M costs (1987 base) was obtained.

Table 4.28: Index of O&M costs (1987 base) amounts given in Rs.'000

	1987	1988	1989
1.Operation	800.00	900.00	950.00
Index	1.00	1.13	1.19
2.Maintenance (Labour)	3030.00	3195.00	3479.00
Index	1.00	1.05	1.15
3.Materials	1082.00	1259.00	1358.00
Index	1.00	1.16	1.26
4.Maintenance (2+3)	4112.00	4454.00	4837.00
Index	1.00	1.08	1.18
5.Total	5000.00	5400.00	5800.00
Index	1.00	1.08	1.16

The index is derived by dividing the value of the relevant item for the particular year by the value of the same item for 1987 eg. to obtain the index 1.13 for operation during 1988 the cost of operation in 1988 (900.00) was divided by the cost of operation in 1987 (800.00).

The total index and its components were compared with the following indices of the Central Bank of Sri Lanka

i CCPI - Colombo Consumer Price Index
ii WPI - Wholesale Price Index
iii House Construction - Index of house construction in Colombo

The indices are as follows.

Table 4.29: Indices of the Central Bank of Sri Lanka

CCPI	1.00	1.13	1.27
WPI	1.00	1.17	1.25
House construction	1.00	1.10	1.31

The comparison shows no relationship between the Consultant's index and the other indices given above. This is to be expected since the baskets of goods and services considered are different from one index to another.

The best approach in the case of O&M would be to decide on an appropriate basket of goods and physical quantity weights and then monitor annual/seasonal changes in price. This is not a difficult task for ID since unit costs of relevant items are assembled annually to guide contract award etc.

Although the Consultant used the "full estimate" for the convenience of having data for the past three years, the "adequate" of "well" maintenance baskets may be used.

When time series data are available for a number of years, it may be possible to construct an econometric model for future forecasts.

The Real O&M Costs of O&M in the 1987 - 1989 Period

The following data gives the real values in 1988 and 1989 in terms of 1987 for i Operation, ii Maintenance, iii General Charges and iv Total O&M Cost for the five schemes separately. As an example, the real value of the cost of operation in Giritale during 1988 in terms of 1987 value (208.05) is obtained by dividing the corresponding nominal value (235.10) by the corresponding index 1.13

Table 4.30: Analysis of O&M costs 1987 - 89 in 1987 prices amounts given in Rs.' 000

i **Operation**

	1987	1988	1989
Index	1.00	1.13	1.19
Giritale			
Nominal	159.97	235.10	258.28
Real	159.97	208.05	217.04
RBE			
Nominal	177.78	185.50	190.50
Real	177.78	164.16	160.08
Gal Oya LB			
Nominal	901.54	1020.16	1213.89
Real	901.54	902.80	1020.08
Inginimitiya			
Nominal	233.43	229.03	192.40
Real	233.43	202.68	161.68
Mahakanadarawa			
Nominal	82.18	110.57	62.40
Real	82.18	97.85	52.44

ii **Maintenance**

	1987	1988	1989
Index	1.00	1.05	1.15
Giritale			
Nominal	406.30	259.60	274.27
Real	406.30	247.24	238.50
RBE			
Nominal	296.93	220.73	285.04
Real	296.93	210.22	247.86
Gal Oya LB			
Nominal	1800.83	945.20	1239.45
Real	1800.83	900.19	1077.78

Inginimitiya			
Nominal	323.15	238.02	246.61
Real	323.15	226.69	214.44
Mahakanadarawa			
Nominal	223.26	311.05	310.80
Real	223.26	296.24	270.26

iii **General Charges**

	1987	1988	1989
Index	1.00	1.13	1.19
Giritale			
Nominal	325.98	263.60	320.90
Real	325.98	233.27	269.66
RBE			
Nominal	260.72	188.79	205.07
Real	260.72	167.07	172.33
Gal Oya LB			
Nominal	528.29	929.25	889.87
Real	528.29	822.35	747.79
Inginimitiya			
Nominal	795.30	732.80	588.26
Real	795.30	648.50	494.34
Mahakanadarawa			
Nominal	338.51	379.02	399.73
Real	338.51	335.42	335.91

iv **Total O&M Cost**

	1987	1988	1989
Index	1.00	1.08	1.16
Giritale			
Nominal	892.26	756.32	840.46
Real	892.26	700.30	724.53

RBE			
Nominal	735.54	595.03	680.62
Real	735.54	550.95	586.74
Gal Oya LB			
Nominal	3230.67	2894.63	3343.20
Real	3230.67	2680.21	2882.07
Inginimitiya			
Nominal	1351.90	1199.90	1027.29
Real	1351.90	1112.02	885.59
Mahakanadarawa			
Nominal	713.72	800.64	772.94
Real	713.72	741.33	666.33

A study of the above data shows the following.

i. Expenditure under operation has increased in Giritale and Gal Oya LB from 1987 to 1989 while in the other three schemes it has decreased
ii. Expenditure under maintenance has decreased in all schemes except in Mahakanadarawa.
iii. General charges has decreased in all schemes except in Gal Oya LB.
iv. Total expenditure has decreased in all schemes.

From the above it is seen that expenditure on items has got adapted to the available funds which has decreased from 1987 to 1989.

4.7 Economic Analysis of Alternative Operation and Maintainance Regimes

In this section an attempt is made to compare four feasible O&M scenarios in economic terms based on the technical analyses in the preceding sections.

The four scenarios analysed are:

1. No O&M at all,
2. O&M costs as at the present actual regime,
3. O&M at "adequate" level, and
4. O&M at "well maintained" level.

The data and informational requirements for a conclusive economic analysis are of a very high order. The time period of the life cycle from original construction and/or rehabilitation to another rehabilitation will differ from one regime to another. The annual O&M costs may increase, decrease or stay constant. Along with various physical changes occuring in the system from one rehabilitation to another, the productivity of the system will decline. Again the rate of productivity decline may differ from one regime to another.

The present study covered only five major irrigation schemes and generated data only for five years on the costs of O&M and the impact. The data generated on water duty, crop yield, cropping intensity etc. did not generate sufficient information on the impact of the present O&M regime on crop production. The time period for which data could be gathered was inadequate to concieve what the time period from one rehabilitation to another will be. In fact, this study was not designed to be full fledged research to undertake the necessary modelling and quantitative analysis.

Such studies are time consuming and highly resource intensive. Although many of the relavant parameters are technical parameters they exist within a social system and as such controlled experiments of labortary type are not feasible within irrigation systems. In the first place O&M regimes are not consistent over time. They are subject to changes over time in terms of the activities

physical quantities of intervention and their financial values. As such, the present day state of repair of any system is not the result of one O&M regime but the result of a mix of regimes. Secondly, exogenous shocks to the system such as technological changes, market changes etc. tend to mask the impact of deteriorating physical system on agricultural productivity. Thirdly, the responses of the beneficiaries of the system for changes result in chain reaction type changes. For example, when water is scarce, farmers substitute labour, chemicals and draught power for weed control a major contribution from water in paddy cultivation. Fourthly, location specific environmental differences make generalisations difficult. Fifthly, for the reasons given above all irrigation systems are at different stages of the life cycle. Thus an average system cannot be easily constructed to derive statistically valid conclusions.

The other three regimes under consideration are purely hypothetical since they do not really exist. The following analysis is therefore based on the judgement of the team on likely impact of alternative O&M regimes and serves as an illustration as to how an economic analysis may be conducted.

Life Cycle

It is assumed that the rate of deterioration of a major irrigation system will decline from scenario 1 to 4. With no O&M at all the deterioration will be the fastest. For our analysis it is assumed that a rehabilitation will be required on the eigth year for scenario 1, 16th year for scenario 2, 32nd year for scenario 3 and 40th year for scenario 4.

Costs

The operation and maintenance costs actually incurred at present in the five irrigation schemes under this study were presented earlier. For each scheme current costs for an adequate "maintenance regime and for a "well" maintained regime were estimated and presented. The engineering analysis of the impact of alternative O&M regimes suggest a decline in the annual O&M costs for the

two latter regimes. Obviously the decline in the annual cost will be greater in the case of a "well" maintained regime than in the case of an "adequately" maintained regime. The extension of the same argument will suggest that the annual O&M costs in real terms will increase in the case of the present regime. Accordingly the costs increase at the rate of 5% per annum in regime 2. In regimes 3 and 4, the annual O&M costs decline at the rate of 5% and 6%.

The costs of regimes 2-3 were estimated and presented earlier and requires no repetition here. By definition, regime 1 has no cost, upto the time when a rehabilitation is required.

Benefits

Purely on theoretical grounds the effects of alternative maintainence regimes can be expected to be reflected on adequacy, reliability and equity in the delivery of water to the farmers. If all other factors which influence crop yield remains unchanged, then, differences in adequacy, reliability and equity may be reflected in location specific crop yields and total output from an irrigation scheme. It is assumed here that a rehabilitation will be undertaken when the net benefit from agriculture, i.e., output x price - cost of inputs, has reduced by 30%. According to the life cycle assumptions given above, it will take 8 years, 16 years, 32 years and 40 years repectively under the scenarios 1 to 4 for the productivity to decline to this level.

The first year benefit of Rs. 12,000 per acre is estimated from the costs and returns for 200% cropping intensity and an average yield of 100 BU/Ac per season. The three annual maintainence costs are as per those estimated for Inginimitiya.

The analysis shows that the net present value of the "adequate" maintainence regime recommended in the preceding sections to be superior to others at the discount rates of 20% and 15% but second to a "well" maintained regime at a discount rate of 10%. In all cases the worst was the scenario 1 followed by scenario 2.

This analysis may give different results for different assumptions:

a) Benefits which in turn are determined by cropping pattern, crop yields, prices etc.

b) time from one rehabilitation to another.

c) costs of O&M of alternative regimes,

d) costs of rehabilitation, and

e) rate of discount applied.

Final

Benefit Cost Analysis of Alternative O&M Regimes (Rs. Ac. of Paddy)

	O&M and Rehabilitation Costs				Agric Benefits				Net Economic Benefits			
Year	None	Actual	Adequate	Well	None	Actual	Adequate	Well	None	Actual	Adequate	Well
1	0	157	334	750	12000	12000	12000	12000	12000	11843	11666	11250
2	0	165	317	705	11485	11760	11881	11910	11485	11595	11564	11205
3	0	166	314	663	10970	11520	11762	11820	10970	11354	11448	11157
4	0	168	311	623	10455	11280	11643	11730	10455	11112	11332	11107
5	0	170	308	586	9940	11040	11524	11640	9940	10870	11216	11054
6	0	172	305	550	9425	10800	11405	11550	9425	10628	11100	11000
7	0	173	302	517	8910	10560	11286	11460	8910	10387	10984	10943
8	14000	175	299	486	8400	10320	11167	11370	5600	10145	10868	10884
9	0	177	296	4577	12000	10080	11048	11280	12000	9903	10752	10823
10	0	179	293	430	11485	9840	10929	11190	11485	9661	10636	10760
11	0	180	290	404	10970	9600	10810	11100	10970	9420	10520	10696
12	0	182	287	380	10455	9360	10691	11010	10455	9178	10404	10630
13	0	184	284	357	9940	9120	10572	10920	9940	8936	10288	10563
14	0	186	281	336	9425	8880	10453	10830	9425	8694	10172	10494
15	0	188	278	315	8910	8640	10334	107740	8910	8452	10056	10425
16	14000	14000	276	296	8400	8400	10215	10650	5600	5600	9939	10354
17	0	157	273	279	12000	12000	10096	10560	12000	11843	9823	10281
18	0	159	270	262	11485	11760	9979	10470	11485	11601	9707	10208
19	0	160	267	246	10970	11520	9858	10380	09770	11360	9591	10134
20	0	162	265	231	10455	11280	9739	10290	10455	11118	9474	10059
21	0	163	262	218	9940	11040	9620	10200	9940	10877	9358	9982
22	0	165	260	205	9425	10800	9501	10110	9425	10635	9241	9905
23	0	167	257	192	910	10560	9382	10020	8910	10393	9125	9828
24	14000	168	254	181	8400	10320	9263	9930	5600	10152	9009	9749
25	0	170	252	170	12000	10080	9144	9840	12000	9910	8892	9670
26	0	172	249	160	11485	9840	9025	9750	11485	9668	88776	9590
27	0	173	247	150	10970	9600	8906	660	10970	9427	8659	9510
28	0	175	244	141	10455	9360	8787	9570	10455	99185	8543	9429
29	0	177	242	133	9940	9120	8668	94480	9940	8943	8426	9347
30	0	179	239	125	9425	8880	8549	9390	9425	8701	8310	9265
31	0	180	237	117	8910	8640	8450	9300	8910	8460	8213	9183
32	14000	14000	14000	110	8400	8400	8400	9210	5600	5600	5600	9100
33	0	157	334	104	12000	12000	12000	9120	12000	11843	11666	9016
34	0	159	331	97	11485	11760	11881	90030	11485	11601	11550	8933
35	0	160	327	91	10970	11520	11762	940	10970	11360	11435	8849
36	0	162	324	86	10455	11280	11643	8850	10455	11118	11319	8764
37	0	163	321	81	9940	11040	11524	8760	9940	1087	11203	8679
38	0	165	318	76	9425	10800	11405	8670	9425	10635	11087	8594
39	0	167	314	71	8910	10560	11286	580	8910	10393	10972	8509
40	14000	168	311	14000	8400	10320	11167	8400	5600	10152	10856	5600
41	0	170	308	750	12000	10080	11048	12000	12000	9910	10740	11250
42	0	172	305	705	11485	9840	10929	11910	11485	9668	10624	11205
43	0	173	302	663	10970	9600	108810	11820	10970	9427	10508	11157
44	0	175	299	623	10455	9360	10691	11730	10455	9185	10392	11107
45	0	177	296	586	9940	9120	10572	11640	9940	8943	10276	11054
46	0	1779	293	550	9425	8880	10453	11550	9425	7701	10160	11000
47	0	180	290	517	8910	88640	10334	11460	8910	8460	10044	10943
48	14000	14000	287	486	8400	8400	10215	11370	5600	5600	9928	1084
49	0	157	284	457	12000	12000	10096	11280	12000	11843	9812	10823
50	0	159	282	423	11485	11760	9977	11190	11485	11601	9695	10767
					None	Actual	Adequate	Well				
NPV 50 yrs @20%					49122	53459	55497	54861				
					53600	59550	[illegible]	72390				

5. TOWARDS A METHODOLOGY OF IDENTIFYING DESIRABLE LEVEL OF MAINTENANCE

One of the main objectives of this study is to identify the Desirable Level of Maintenance of Major Irrigation Schemes, for which it is necessary to understand the different levels of maintenance of major irrigation systems in Terms of the real world practices adopted in Sri Lanka. Towards the end of this research study it was also recognised that the client organisations such as the ID and IMD could be benefited better if some views can be expressed towards the development of the methodology, norms and procedures of identifying the level at which a system is being maintained. The work commenced first, by investigating the notion of desirable level of maintenance in the light of other levels of actual maintenance in a conceptual form and then by improving such understanding making use of information gathered from field observations and data collection.

5.1 Definitions of Different Levels of Maintenance

In trying to understand the level at which a system is being maintained, the following definitions are useful:

i. **No Maintenance** : After some years of construction/ rehabilitation, canal discharge will be grossly inadequate to meet the cultivation requirements, resulting in total crop failure. Also the physical system will deteriorate rapidly to a total collapse. **Maintenance cost is nil.**

ii. **Poor Maintenance** : To carry out maintenance only at very critical sections. The Canal will discharge significantly but still not adequately in the sense of sufficiency and timely distribution. Crop failures are likely as a result of this level of maintenance. Also the physical system will deteriorate badly and will be in need of rehabilitation at frequent intervals to avoid collapse of the system. **Maintenance cost is low.**

iii. **Adequate Maintenance** : To enable the canals to function at its existing capacity during the particular year under consideration and prevent deterioration at critical locations. At this level crops will not fail. However significant deterioration of the physical system may take place every year and a full scale rehabilitation will have to be undertaken after, say, about 10-15 years of construction/rehabilitation. **Maintenance cost is medium.**

iv. **Well Maintained** : This implies adequate level plus maintenance activities that will prevent significant deterioration. Rehabilitation may not be undertaken full scale for a long time except some selected improvement works. **Maintenance cost is high.**

v. **Full Maintenance** : To keep the system at or near its original operating and physical conditions. This is almost a minor rehabilitation each year and no rehabilitation on a full scale will be required during the life span of the scheme. **Maintenance cost is very high.**

Technical levels are not the only criteria to decide on a "desirable" level. The O & M level should also be economically and institutionally "desirable". Thus the concept of technically desirable level of O & M irrespective of resource constraints may not be appropriate for analysis under this study.

The term "adequately maintained" is used for the O & M level which will cause the canal to perform at its existing capacity during the particular year under consideration, and prevent deterioration at critical locations. Significant deterioration of the physical system may take place year after year, with this level of O & M and the scheme will have to be rehabilitated after about, say, 10 - 15 years.

The term " well maintained" is for the O & M level which will in addition to the "adequate" level, prevent significant deterioration. Annual expenditure for this level of O&M would be high, but rehabilitation may be necessary after a longer period.

For the above purpose, estimates for each of these two levels namely "adequate" & "well" for the five schemes were prepared by the consultant. This was done by inspection, visible assessment and a few measurements along tank bunds, main channels and representative samples of distributory and field canals. Quantities of various items of O & M work were calculated on the basis of the above after discussions with I.E., field staff and farmers. Applying the current rates, the estimates were prepared in the modified format already discussed.

5.2 Analytical Comments on the Levels of Maintenance

The concepts of adequate maintenance of an irrigation system are basically derived from the capacity of the canal systems to deliver the water needed to feed the lands under its command. The maintenance needed is to ensure that the designed flows are released through the canal systems. The flow parameters that affect performance of canals are the wetted area, depth of flow, canal roughness and longitudinal slope. The longitudinal slopes of the canals are fixed during original construction and cannot be changed conveniently at a subsequent period. The wetted area and depth of flow can, however, be remodelled by clearing of weed growth within the water ways and removing a part of the silt that may have settled in some reaches of the canal and desilting in heavily sedimented regions. The removal of weed growth on the canal boundaries within the water-way will also reduce the roughness to induce higher velocities of flow and increase the discharge to cater to flow demands.

The major items of maintenance needed are therefore, desilting and clearing of weed growth within the canal boundaries. Repairs to structures where necessary, earth

work in filling scours and gravelling of the road ways where absolutely necessary including filling pot-holes are the other maintenance items needed under an adequately maintained system. Greasing and painting of steel control mechanisms and items such as removal of ant hills, clearing rock, toe filters, repairs to rip-rap protection and other items needed to ensure the safety of head works and distribution systems have also to be included in these programmes of maintenance. Quantities of work required to be carried out in the respective schemes - Giritale, Ridibendi-Ela, Gal Oya (LB) study areas, Inginimitiya and Mahakanadarawa have been computed on the basis of the guidelines given above after detailed field inspections and estimates for adequate maintenance prepared with rates prevalent in each of the schemes (1989 prices). The estimated rates for adequate maintenance are Rs.997/= /ha (Rs.431 Ac) for Giritale (Rs.1065/=/ ha (Rs.431/ Ac) for Ridibendi-Ela, Rs.921/= /ha (Rs.373/= Ac) for Galoya (LB) Rs.839/= /ha (Rs.339/= /Ac) for Inginimitiya and Rs.812/= /ha (Rs.329/= /Ac) for Mahakanadarawa.

Estimates for **well maintained** requirements were also prepared along with those for adequately maintained proposals. In the well maintained proposals full weeding within canal reservation was proposed and silt-removal extended upto the original design levels. Allowance was made for full repairs to all structures, removal of all ant-hills, filling scours and graveling of all the canal roads in addition to executing all work connected with the safety of the head works and distribution system. Quantities of work needed for this purpose were computed in respect of the 5 schemes- Giritale, Ridibendi Ela, Galoya (LB), Inginimitiya and Mahakanadarawa on the basis given above and estimates for well maintained levels prepared with rates prevailing in each of the five schemes (1989 prices)

The estimated rates for well maintained levels are:

Rs. 1,363/ha (Rs.552/Ac) for Giritale
Rs. 1,598/ha (Rs.647/Ac) for Ridibendi-Ela

Rs. 1,680/ha (Rs.680/Ac) for Galoya (LB) study area
Rs. 1,853/ha (Rs.750/Ac) for Inginimitiya
Rs. 2,142/ha (Rs.867/Ac) for Mahakanadarawa

Technically the most desirable level of maintenance is the well maintained level. If however financial resources become a constraint to meet this level of maintenance the next level of adequate maintenance may be adopted as a desirable level. In the adequate level concept, water for irrigation can be delivered equitably in time and in sufficient quantities to meet the requirements of the various farms.

5.3 Defining Desirable Level of O&M

Immediate costs associated with well maintained or full maintenance levels may not be balanced by benefits from such maintenance levels, since there is a time-lag between maintenance expenditure and related benefits. The canal system is usually designed and constructed/ rehabilitated to discharge 5% to 15% more than the requirements for the planned acreage. Hence even with a low level of maintenance with the canal sedimented and overgrown with weeds, the canal could discharge the requirement and it takes some years for the canal not to discharge the required quantity. Even with slightly lesser discharge, the crop yields may not decrease significantly.

Even with the last two levels of maintenance some deterioration is inevitable. Further, the Irrigation System is of a dynamic nature with new concepts of water management, agro-technical methods, changing ideas and policies and sophistication of operation procedures, etc.

Given this reality, to keep a system at or near its original operating and physical conditions is not feasible. A lower level of maintenance (causing a certain degree of deterioration) and periodic rehabilitation will be **"desirable"** economically. In addition to the technical aspects and consideration of the dynamic nature of the system, the economics of

different levels of maintenance, that is low cost of low maintenance level together with high cost of full scale rehabilitation versus high cost of higher maintenance level coupled with low rehabilitation cost, should be analysed to determine the best level of maintenance to be adopted.

As mentioned earlier the study commenced with a theoretical notion of "Desirable Level" of maintenance. This understanding was eventually updated based on the observations gained from the investigations carried out in Giritale, Ridi Bendi Ela, Galoya L.B, Inginimitiya and Mahakanadarawa. The views of the consultants are given here. The "Desirable Level" of O&M can be defined as the level of O&M which satisfies the following criteria.

(i) The level of O&M which satisfies the technical needs of the schemes.

(ii) The level of O&M which is economicaly viable.

(iii) The level of O&M which satisfies the needs of the farmers and therefore socially acceptable.

We have given definitions of five levels of maintenance beginning with the case of "No Maintenance" and upto a level of "Full Maintenance". Since these two can be considered as the two extremes the "Desirable Level" of maintenance should be between these two levels.

In selecting a "desirable level" one has to be realistic as far as possible to the existing circumstances and therefore the selection criteria should not be purely theoretical. However, since the aim here is to define the term "Desirable Level" irrespective of visualising the difficulties to achieve that level, one need not be concerned too much of the existing constraints, in particular the finances for the purpose of deriving the definition. Therefore, the selection should be guided by experience and sound judgement of the researchers rather than the difficulties to attain such a level of maintenance.

To understand what are the technical needs that should be satisfied, it is necessary to look at what is the main function of the system. In short it can be said that the basic function of an irrigation scheme is to store and divert the natural flow of a river/stream to farmers' land as required. If the various components of the scheme, namely headworks, main canals, Branch canals, distributory canals and field canals can be made to function as expected above, then the scheme satisfies the basic technical needs.

In going through the various levels of O&M defined earlier we see that the definition of "Adequate Maintenance" just reach this level. We see that "Well Maintained" will give a greater degree of confidence. But considering the realities of financing we should not desire too much. The "Desirable Level" is person specific. We try to convince the persons concerned to accept this as an acceptable definition.

Under "Adequate Maintenance" it is stated: "To enable the canals to function at its existing capacity during the particular year under consideration and prevent deterioration at critical locations". Thus under this level of maintenance the canal should continue to discharge the required volume of water as a continuation of the previous years level of functioning. However certain components of the scheme will deteriorate but such level of deterioration would be confined to safety margins already built into the system. The level in canal bunds would reduce during the year; minor defects in structures, such as cracks, scours may occur. Roads would start settling and pot-holes would begin to appear. However critical items would be repaired and kept in a functional condition. Over a number of years the defects above would accumulate and gradually the scheme will degrade, may be in 10-15 years, upto a state when rehabilitation would become necessary.

The amount of funds required to maintain the scheme at "Adequate Level" would be different from location to location and how well the scheme was originally designed

and constructed. Hence it is not possible to give a definite period for the rehabilitation cycle. Even to arrive at the period of rehabilitation cycle for a particular scheme it would be necessary to monitor the expenditure, physical work done, discharges in canals and other relevent data for about 10 years. It is improbable that reliable data for such an analysis is available for any irrigation scheme in Sri Lanka.

To satisfy the second criteria for the "Desirable Level" of maintenance, it is necessary to establish the economic viability of adopting the "Adequate Level of maintenance.

In economic terms, desirable level of maintenance is the level which maximizes the net present value of the future benefits/costs streams at the current "social rate of discount".

The technically desirable level has been defined as a level of maintenance which will permit adequate performance of the system for a reasonable period before rehabilitation. Economically desirable level on the other hand, is based on the technical relationship between the economic costs and benefits attached to alternative technically acceptable maintenance regimes.

This requires the identification of the inter-temporal (over time) relationship between costs and benefits for technically acceptable alternative maintenance regimes.

The information required is:

a. the effect of each alternative regime on project life from construction to rehabilitation, and

b. the annual project benefits over the time span [which varies according to the maintenance regime (a)] from construction to rehabilitation. This recognises the fact that project performance deteriorates for any conceivable maintenance regime. In other words, the life span of a man made artifact or for that matter any material thing is finite.

c. shadow prices for all quantified costs and benefits as at the date of analyses expressed preferably at the mid-point of project life.

The social-institutional point of view is determined by what the society and the institutions can sustain over time. This can differ from the technically and economically desirable level.

Costs which appear to be economically justified may not be feasible from socio-political and institutional point of view. The growing literature on O&M fee collection bears ample witness for this point.

The economic methodology to determine the desirable level of maintenance of any major irrigation scheme needs a careful analysis of a number of factors affecting an irrigation scheme.

The approach with the highest level of theoretical soundness and analytical vigour is described earlier.

In spite of the great deal of effort applied on information gathering in our study, it became apparent that a "first best" approach of the type discussed is not feasible with given information, time and other resource constraints.

Hence a "second or third best" approach has to be designed/developed.

If time and other resources were available, and O&M problems could await findings of a "first best" approach solution, then the answer is to carefully monitor several selected schemes for a long period. This, clearly is not an available option.

The other acceptable means of constructing the benefit-cost relationship over time is to select a number of irrigation schemes which represent different stages of a typical scheme over the economic life from construction to rehabilitation. The greatest challenge here is to

abstract from problems of location specificity. Thus the accumulated experience of irrigation engineers will have to be relied upon to select schemes which have more or less similar design, command area, natural environment and socio-economic environment.

Then information gathering can commence in a scheme just constructed, another mid-way in the cycle, another just before rehabilitation and finally a scheme which has just been rehabilitated.

Thus it will be possible to determine whether the present O&M regime (average) is economical. However, the selection of an optimum regime would require educated guesses. The difficulty here is in judging what changes are brought about by incremental changes in the O&M regime.

Yet another possibility is to develop a theoretical model which relates O&M costs into known, measurable variables and then statistically estimate the co-efficients of the independent variables of that functional relationship. Apart from the derivation of the functional relationship by theoretical means, this involves the generation of data on the relevant variables from a sufficiently large sample of irrigation schemes.

This is an option discussed at length by the Consultant, but discarded due to measurement problems and the prohibitively high resource requirements of such an exercise to cover the necessary observations number which will give the required degrees of freedom for statistical estimation. Another major problem is location specificity and the large number of environmental variables which affect the performance of irrigation projects.

Considering the facts discussed above it may not be possible to determine accurately the economically desirable level of maintenance.

The third criteria to be discussed is the acceptance of this level of maintenance by the farmers. It can be stated that the farmer is mostly concerned with the availability of water in his allotment to carry out his agricultural activities to his satisfaction. For this purpose the distribution system must deliver water to his farm in adequate quantity at the proper time. If this function could continue year after year he would have confidence in the irrigation system.

This is a basic need for him to give his best efforts and investments to the cultivation and the result would be an optimal level of production. If the level of maintenance defined as "adequate" could satisfy this need during a rehabilitation cycle then we can assume the farmer would be satisfied with the system and therefore it would be socially acceptable.

The above analysis for the purpose of establishing that the **"Adequate Level"** of maintenance can be considered as the **"Desirable Level"** of maintenance, has given positive responses in two of the three criteria stated earlier. The second criteria is accurately indeterminate under the present study. Since, according to this analysis, two of the criteria are satisfied, it is recommended that the **"Adequate Level"** of maintenance be accepted as the **"Desirable Level"** of maintenance.

5.4 Basic Activities under "desirable" level

The work done so far indicates that the basic activities under " desirable" level of maintenance are:

1) **Weeding** & removal of water plants within the water flow area before each irrigation season and in the rest of the canal reservation once a year or even less frequently, depending on the growth rate of weeds.

   It may be mentioned that the value of Manning's Coefficient in the Manning's formula will increase from 0.025 adopted in canal design to as high as 0.04 or even more with overgrown weed and roughness of the water flow area.

2) **Desilting**:- Sedimentation in canals reduce the capacity and increases the water level which can cause overflowing of canal bunds & breaching. Thus siltation of more than 3" should be removed before the cultivation season and at least once a year.

3) **Earthwork in filling scours and potholes**:- This is mainly a patching up exercise to have a uniform surface on bund top and side slopes where necessary. It is not required to bring the canal profile to the original design section.

4) **Repairs of Structures**:- Only minor repairs and improvements should be carried out to prevent rapid deterioration and collapse of the structure; such as removal of plant growth in cracks and joints, arresting leaks, little concrete work, rubble masonry or plastering, replacement or provision of stop-planks/gates, hume pipes to farm outlets, padlocks, etc. Filling up of scours down-stream and undermining of sides and foundation should be attended to immediately.

5) **Gravelling**:- This activity is usually postponed. However, to facilitate transport of agricultural products by farmers and to arrest damage to the canal bunds, gravelling should be done at least once in 2 years to a thickness of about 3".

Apart from routine weeding, other activities of maintenance are identified and executed as and when the need arises on a priority basis according to the availability of O & M funds.

A "desirable" level of maintenance requires certain management tasks. The understanding so far indicates that the following basic tasks require attention:

a) **Performance Measurement**:- As discussed earlier, there is a time lag between maintenance in a particular year and benefits from such maintenance. Hence in a scheme with O & M at some satisfactory level, the crop yield may not reflect the performance level of the system.

Water conveyance efficiency is a reflection of the degree of O & M carried out within the canal water flow area. For this purpose measurement devices will have to be installed at strategic locations.

A combination of the above and other related factors are necessary to measure the performance at different levels of O & M.

b) **Farmer Participation**:- The farmer organisations should be geared to fulfil the farmer's obligation to maintain field canals.

After ensuring the technical, physical and organisational capabilities of farmer organisations, these should be entrusted with O & M work on small scale contracts at estimated rates in preference to force-account work. It should be further ensured that the farmers execute the contract work not for a profit but to improve the system to perform more efficiently. This will improve their own income on the long run with less investment by the State and the farmers.

For the operation of the distributory system, the labourers may be selected from the farmers' organisations. As mentioned earlier many of the operational labour staff come from distant places and are unable to operate the system efficiently.

Farmer representatives should be allowed to participate in decision making at all levels of the system. A constant dialogue between the officials and the farmers should be maintained informally by direct contact and formally through Project Committees.

c. Irrigation Scheduling

Irrigation schedules should be prepared in advance and applied for the operation of the system. Field inspections and when necessary adjustments in the issues could be done as complementary to the irrigation schedule.

d. Accounting Procedure & Monitoring

A monitoring structure for O & M, item wise and component wise, physically and financially will have to be formulated. The accounting procedure should incorporate a system which will identify expenditure on O & M, item & component wise and prevent excesses, unrealistic and unrelated charges of overheads and other items.

5.5 Comparison of TEAMS' Estimate for Adequate Level of Maintenance Emerging from the Study with Irrigation Department's Estimate of 1981

The **Adequate level** of maintenance defined by TEAMS in this study is that level of maintenance which would enable the canals to function at its existing capacity during the particular year under consideration and prevent deterioration at critical locations. Efficiency of the distribution system at such level will be high enough not only to discharge irrigation water according to the planning but also prevent large scale deterioration annually. In this case the area of flow of irrigation water, as well as rest of the canal sections, canal bunds, canal bund roads, (including gravelling) structures, gates etc are kept at adequate level of maintenance. Estimate for each scheme should be prepared separately by "walking the canal exercise" or similar methods.

In describing a methodology for determining the adequate level of maintenance it is useful to compare the emerging definition with the estimates made by ID in 1981 to compute O&M Fee of Rs.200/=. The **ID estimate** is based on typical performance outputs prepared after examining the performance for 1981 in **16 selected schemes** at one per Range. Though this estimate is expected to meet the maintenance requirement, the level of such maintenance is not defined in explicit terms. It could be observed that, the maintenance level corresponding to ID's estimate is somewhat lower than the TEAMS adequate level.

In TEAMS estimate for adequate level all the sub items of work are quantified in terms of the respective quantities (cubes for earthwork, concrete, gravel, etc., squares for weeding, etc.) after the "walking the canal exercise". Where as in ID's estimate earthwork and repairs to structures are quantified in units of man days. For a comparison of O&M estimates by TEAMS and ID sub-item wise, Gal Oya L.B. scheme is considered:

(i) Weeding

TEAMS estimate provides 11% of the total O&M estimate for adequate level for this item. ID estimate for typical O&M provides 25% for this item and in addition there is provision for clearing wetted section. However quantities of weeding in the two estimates are close to each other.

(ii) Desilting

TEAMS estimate provides 8% as against 19% provision in ID estimate. In this case too the quantities in both estimates are similar.

(iii) Earthwork in filling scours

TEAMS has allowed 18% whereas ID allows only 4%, Quantity in TEAMS estimate is much more than in ID estimate.

(iv) Repairs to structures (labour)

TEAMS estimate allows 7% and ID's estimate allows 5%.

(v) Construction materials (excl. gravel)

A provision of 17% in TEAMS estimate is almost same as that in ID's estimate, namely 16%. But quantity-wise, TEAMS estimate provides more materials than ID's estimate.

(vi) Gravelling

In this case too, the percentages are similar namely 7% in TEAMS and 6% in ID's estimates, but quantity-wise TEAMS estimate provides more.

It is thus seen that distribution sub item-wise ID estimate provides more for weeding and desilting. This is because weeding is almost fully done to prevent the system being allowed to overgrow with jungle and desilting is essential to discharge the planned quantity of water. TEAMS's paid adequate attention to scours on canal bunds, gravelling, repairs to structures etc and hence quantity wise these items are more in the TEAM's estimate. Thus while ID typical estimate provides sufficiently for weeding and perhaps desilting, provisions for earthwork in filling scours and repairs to structures are inadequate and this shortfall is made good in TEAMS estimate. This appears to be the general pattern, but may vary from scheme to scheme.

Further details relevant to the proposed **Methodology of Identifying** the **Desirable Level** of Maintenance of Irrigation Systems are given in **Section 7.2.1** of this report.

6. OBSERVATIONS & CONCLUSIONS

6.1 Observations on Data Collection

Some of the main problems faced while collecting data on O & M required for this study can be summarised as follows:

i. This study required data on expenditure and physical work done for each scheme, under operation and maintenance, separately. This data needs to be identified under headworks and canals and further sub-divided into work items. However, there were no detailed records for this identification.

   The available data had to be extracted from various books and documents maintained in the divisional offices with the assistance of the staff. These records had to be carefully studied and interpreted correctly, with clarifications when necessary, from the staff maintaining such records.

ii. Patterns of O & M estimates for the five schemes were different. For comparison and analysis of data, it was necessary to use a standard format for all the schemes.

   The extracted data had to be classified into items to fit in with this format. Since the description of the data included are not in sufficient detail, sound judgement had to be applied for the classification.

iii. In most cases, the expenditure figures furnished by the accounting staff did not commensurate or match with the quantities of physical work done as furnished by the field staff. Hence an in-depth scrutiny of the books and documents had to be carried out to identify missing and inaccurate data. Descrepencies were rectified and a set of reasonably accurate data was compiled.

Tracing connected measurement books was very difficult and many books were not available. Bundles of distribution rolls had to be scrutinised to collect quantitites of work done.

In many instances, output of work done is given in labour-days rather than in physical quantitites. After discussing with officers concerned, the labour-days were converted into quantitites of work done with a fair degree of accuracy.

Other than a general picture, it is not possible to check or measure in the field, the O & M work done during the previous years due to the nature of O&M work.

iv. The staff was co-operative in this data collection. However they too were busy and sometimes, it was difficult to devote their time on this study due to pressure of official work.

Many officers who handled O & M work in these five schemes, both in accounting and field work, in the earlier years of the period of the study were not available due to transfers and other reasons. Hence some specific matters related to O & M work in that period could not be discussed and clarified.

The task of data collection to meet the requirements of the TOR was very tedious and difficult. Perseverance, patience, persuasion and skillful handling of officials, a sound knowledge & judgement was necessary in order to collect, analyse and present the data in a meaningful manner with a reasonable degree of reliability and accuracy, for comparison and analysis to arrive at valid conclusions.

6.2 Observations on Collected Data

This section summarises observations related to (a) O&M Estimates, (b) O&M Allocations, (c) O&M Activities, (d) Water Issue and (e) Monitoring of O&M based on the collected and processed data.

(a) O & M Estimates

i. A scrutiny of the O & M estimates (under IMD allocation) and expenditures item-wise, reveals that there is no direct connection between these two. O & M estimates are being prepared for the sake of having an estimate and granting allocations. But once the estimates are approved and allocatios granted, O & M works are executed irrespective of the estimate. Further the full estimate is far in excess of the allocations granted.

ii. O & M estimates under IMD allocations does not provide for labour for operation of the distribuotry system. This work is expected to be carried out by permanent and or regular casual labour for the salaries of whom there is a separate provision under I.D. votes. However, work done by permanent labour engaged on O & M is rather vague. Since they are paid on a pay-sheet rather than in check-rolls, measurement of work done by them are not taken and recorded in distribution rolls as are done for casual labour. The check-rolls are marked just for attendance only. It is suggested that work performed by the permanent maintenance labourers are also measured, recorded and monitored since the expenditure on them is fairly substantial.

iii. In the estimate format for Giritale which is modified to develop the standard format, as explained earlier, sub-items common to both operation and maintenance such as watchers, work supervisors, operators and drivers of vehicles; repairs and maintenance of vehicles were included under the Item on Operation. In order to identify

and control expenses on operation and maintenance separately the sub-items are regrouped under I operation, II Maintenance (labour), III. Maintenance (Materials), IV. General charges.

Further, the units of acreages and man-days are used even for sub-items which could be directly quantified. For better understanding and identifying the quantities of work to be done, the estimate should be presented with the sub-items with appropriate and relevant quantitites which can be calculated on the basis of acreages, lengths of canals etc.

(b) <u>O & M Allocations</u>

i. Funds allocated for O & M works are not according to the needs of each of the projects but rather on a hypothetical basis which may or may not be realistic. Very often, the funds released for this is much less than the amount required for sufficient O & M.

A revised procedure to meet the actual needs of O&M funding should be urgently implemented.

ii. The practice of charging unrelated overhead costs to O & M allocations increase the operation costs which could otherwise have been used for more urgently needed maintenance items.

iii. O & M allocations are given under roads, dams and canals for operation and maintenance. The roads in the schemes are mainly tank bund roads and canal bund roads. Since these roads are maintained simultaneously with the tank bund and canals, the tank bund roads will have to be combined with the headworks and canal bund roads with canals. Such a combination has been done for this study.

It is observed that, particularly towards the latter part of the year,the debit of expenditure is against items for which balance allocations are available irrespective of whether the expenditure is under that specific item or not.

iv. The yield of agricultural produce per unit of land area is not an indicator of the level of O & M in these schemes. The records available show that the yield has been steady or even increased while the monies allocated for O & M works have steadily declined.

(c) <u>O & M Activities</u>

i. The cost of maintenance of headworks is comparatively small. The major part of the maintenance required on the headworks is the weeding on the earthen dams, removal of ant-hills and backfilling, painting and greasing of control gates etc.

ii. A major part of the O & M funds released is utilized in weeding canal boundaries and desilting canals. Weeding has to be carried out generally twice a year although desilting canal beds can be restricted to once a year.

For improved performance of the canals, it is necessary to provide structures to prevent sediment inflows from the canal catchments. Removal of sediment/silt from canal beds is one of the most expensive items in canal maintenance.

iii. The cost of earthwork in filling scours, washaways and removal of ant-hills on canal bunds varies from scheme to scheme and does not consume much of the maintenance allocation. These scours and washaways occur mainly during the monsoon season.

iv. Cost of repairs to damaged structures is only a small fraction of the maintenance allocation. This is because the items of work to be done under any maintenance programme are restricted to minor repairs such as sealing of cracks, plastering, rubble pitching, earthwork in backfilling etc.

v. Gravelling of main and branch canal roadways is necessary to facilitate transport of agricultural produce. As this is a very costly item under the maintenance allocation, this work is often not done due to shortage of funds resulting in serious damage to canal bund roads while transporting agricultural produce, especially during the wet season.

(d) Water Issues

i. It is observed in the field that water issues are mainly guided by visible evidence of the availability of water in the fields and not by pre-planned Irrigation Scheduling. For the successful and efficient operation of the system, it is essential to schedule the irrigation issues in advance and operate accodingly. The schedule should be flexible to allow for adjustments due to rainfall, change in the cultivation calendar etc. Field inspections are also necessary to observe and rectify any defects in the water issues. Ad-hoc issues should be avoided.

For larger schemes, the use of computers for water scheduling is a good management tool for improved operation.

ii. Analysis of the data on water issues at Giritale, R.B.E., Galoya L.B, Inginimitiya and Mahakanadarawa during the period of study and the costs incurred on O & M indicate that there is no significant relationship between the water duty (O&M fee) measured at source and the level of maintenance. The level of maintenance can probably be related to the conveyance efficiency of the system but data for computing this efficiency is not available.

(e) Monitoring of O & M

i. It would appear that O & M works are not monitored in a meaningful manner. Any monitoring, if at all, is done qualitatively and in an overall sense rather than in item-wise quantities and expenditure. A suitable monitoring methodology should be formulated with better and realistic procedures for planning, estimating and execution of work. Accounting of O & M expenditure should be done with a view for better control and efficiency.

ii. The cost per hectare to improve the existing physical systems to the technically desirable levels as estimated by "the Consultant" is as follows:

Table 6.1: Cost per Hectare of Technically Desirable Level of O&M

Giritale	- 2507 ha	Rs. 997/- per ha
R.B.E.	- 2064 ha	Rs.1066/- per ha
Galoya L.B.	-12710 ha	Rs. 921/- per ha
Inginimitiya	- 2644 ha	Rs. 825/- per ha
Mahakanadarawa	- 2545 ha	Rs. 812/- per ha

6.3 Observations of Farmers

As part of the investigation phase a series of informal discussions were carried out with farmers of the 5 schemes under study. Some of the suggestions made by the farmers are as follows:

i. Main canals should be widened to meet the additional demand for water due to extra land, other than originally planned, being cultivated.

ii. In O & M programmes, priority should be given to distributory canals.

iii. Weeding and desilting are the most important items in maintenance works.

iv. High siltation of canals occur due to drainage streams carrying silt discharging into the canals. This should be cleared each year. Suitable drainage crossings at these locations will prevent such silting up.

v. Sill levels of existing farm outlets should be modified, where necessary.

vi. Repairs to the structures are necessary.

vii. Gravelling of canal bund roads should be done to a thickness of 4" once in two years.

viii. Rotational water issues are acceptable and appreciated.

ix. Maintainence work done on force account is inefficient since there is little control on the output of each labourer. Whether he does less or more work, he gets his full pay.

Better work could be done by farmers if given on contract to farmer organisations. Because of their recognition of the benefits they stand to gain by good maintenance, the farmers will do more work than specified in the contract for the payment of the same contract amount.

x. Many turn-out attendants come from long distances and hence cannot effectively and efficiently operate the system, either to meet with the farmers requirements or as pre-planned. Therefore the farmers should be entrusted with the operation of the system.

6.4 Conclusions

The Consultant after analysing the data collected and processing the observations made via a range of field investigations, arrived at the following major conclusions regarding the existing conditions of O&M in the five major irrigation schemes. viz. Giritale, Ridi Bendi Ela, Gal Oya LB, Inginimitiya and Mahakanadarawa.

i. Funds allocated does not meet the actual requirements for adequate O & M.

The preparation of the annual budget estimates is not based on estimates prepared for actual O & M work required under each scheme. The annual budgeting is purely an exercise in apportioning available funds and has very little connection with the realities in the field. Information on actual requirements of O & M funds collected by the Divisional Engineers for the preparation of annual budget estimates has little bearing with the final allocation appearing in the printed estimates. Out of all items of allocations given in the annual printed estimates O & M allocation seems to be the item which is far away from realities. Due to this reason the engineers are discouraged from making realistic and accurate O & M estimates. This situation has created a sense of laxity in the estimation and expenditure of O&M funds and has resulted in inefficient O & M programmes. To correct this situation a management action oriented approach has to be developed from the initial stages of estimation of expenditure up to the monitoring of actual costs and benefits.

ii. In real terms the amount of funds allocated annually is being gradually decreased.

The increases in total payments to personnel engaged in O & M work and purchase of materials significantly reduces the amount of work that can be executed.

iii. Due to poor management even the available financial resources do not yield optimum benefits.

There is no uniform management procedure devised to enable the monitoring of the expenditure in relation to the actual expenditure incurred. Even if any system is adopted it depends on the motivation and capabilities of each Divisional Engineer. In general terms it can be concluded that methods adopted are ad-hoc and implementation decisions are based on the solution of immediate problems rather than on long term sustainability of O & M activities.

iv. Inadequate attention given to the identification and prioratisation of items of maintenance work; preparation of detailed estimates based on funds actually available is a major weakness in O & M programmes.

Since the O & M estimates prepared by the Divisional Engineer do not get adequate attention at the senior levels of management, little attention is paid to identify and prioratise items during the preparation of estimates. The estimates are based on very general terms such as weeding, earth work, silt clearing, repairs to structures etc. rather than on specific items based on actual quantity of work etc.

v. Sufficient attention is not given to the preparation of an annual programme of O & M activities on a monthly basis, based on O & M estimates, in physical and financial terms.

Preparation of an annual implementation programme based on monthly activities to suit the funds allocated could help the Divisional Engineer to monitor the actual expenditure on O & M items accurately and clearly. This programme would help the Engineer to obtain optimum output for the funds spent.

vi. **Planning of O & M activities and mobilisation of resources, based on the monthly programme of works would help the efficient implementation of O & M.**

The O & M activities programmed for each month should be carefully planned to identify and obtain the required resources such as funds, materials, machinery and labour at the correct time and in sufficient quantity. The method of execution should be given careful thought and planned. This could prevent waste and inefficiency during the actual implementation and achieve optimum productivity and economy.

vii. **Implementing O & M activities on an ad-hoc basis rather than on a planned basis would create inefficient water distribution in the project.**

Decisions regarding the implementation of O & M items of work are made to meet the immediate requirements on a crisis scenario. At such a time there is little attention that could be given to rational use of resources to obtain optimum output based on inputs. For instance a maintenance repair with 1 cube of earth at initial stages could later magnify to require 100 cubes. Due to this kind of situation implementation of O & M work could become an activity dependent on ' crisis management' rather than 'management by objectives'.

viii. **Maintenance of Headworks should pay sufficient attention to prevent the deterioration of safety factors.**

Normally the farmers are more interested in the functioning of the distribution system than in the Headworks. In a large scheme the proportion of farmers in close proximity to the Headworks is quite small. In a major scheme like Gal Oya or PSS the majority of farmers have very little knowledge about the actual state of the Headworks. Therefore the officers receive hardly any complaints about the Headworks. These facts contribute to the reduced degree of attention on the safety of Head works. This can lead to a dangerous situation and hence the Irrigation Officials on their own should pay great

attention to this matter. Prompt attention should be paid to signs of cracks, washaways, failure of rip rap protection, impaired functioning of toe filters etc. to avoid any threat to the safety of the Headworks.

ix. Improved supervision is necessary to obtain adequate work output in relation to the costs incurred.

Supervision of O & M work is generally inadequate. There is little attention paid to recording of accurate details regarding work done and justification with costs incurred. Due to this reason optimum output for the input of resources cannot be achieved. Often comparatively easy work such as weeding on the canal banks and road reservations is done instead of removal of water weeds in the canal, silt clearing, earth work on scours or even repairs to structures. This is clearly seen in the analysis of maintenance expenditure in Giritale & RBE Schemes.

x. Accounting of expenditure should be accurate and related to the actual items of work executed. It should reflect the true picture of expenditure rather than make adjustments to keep in line with detailed items in the allocation.

Examination of accounting documents show this fairly clearly. Particularly toward the latter part of the year expenditure is charged to items depending on where there are savings. But this method of accounting does not reflect the true picture and is of little value for management decisions. This is a result of poor programming at the begining of the year. For instance the actual expenditure on fuel is quite out of proportion but cannot be easily identified in the accounting documents.

xi. Lack of adequate and accurate management information makes it impossible to monitor the output of O & M activities and the performance of O & M programmes.

There is very little, if any at all, in the presentation of management information. Lack of a proper programme of activities and costs make it impossible to prepare a statement showing actual expenditure against estimated expenditure. The MP & CR would have been a useful document to monitor the physical work done against expenditure.

xii. There are no pre-determined norms or standards to evaluate the results of O & M activities.

In an irrigation scheme it is difficult to develop norms as stated above, unless systems are developed to measure the conveyence efficiency of the irrigation system on a continuing basis. This needs recording of continuous measurement of discharges in canals and analysis of such data.

xiii. As an overall observation it can be stated that O&M of irrigation schemes does not receive adequate attention it deserves from the lowest level in the scheme upto the Senior Management level.

The long tradition of design and construction of irrigation works has diverted the attention of irrigation officials away from O & M Programmes. Under the present conditions rehabilitation of O & M work has come to the forefront for obvious reasons. Necessarily it will take some time to develop management systems and pay greater attention to the subject of O & M. The consultants have observed that ID officials are progressing in this direction.

xiv. There is inadequate participation of the beneficiary farmers in the implementation of maintenance.

Even though there is an increase in the participation of farmers in irrigation activities, particularly in the distribution of irrigation water, participation in maintenance has been rather slow. There seems to be some reservation among the farmers and Project Committees to get closely involved in maintenance programmes. Therefore it is felt that the ID officers should convince the farmers about the importance of maintenance for efficient functioning of the system. They should encourage the farmers to join them in the process of identifying, prioratisation and execution of maintenance works. Vigilence and cooperation of the farmers would be invaluable to ensure improved quality and economy in maintenance work. The farmers should be made aware of maintenance programmes and funds available for such work. If the farmers are taken into confidence and given a place in the management of the system, they may voluntarily offer their services for maintenance work when there is a deficiency of funds. Maintenance work such as weeding, removal of water plants and silt clearing could be entrusted to Farmer Organisations on job contract. The Consultants consider that this will yield better results than employing casual labour who has no direct interest in the scheme.

xv. Charging of expenditure on Administration to O & M estimates.

Quite often expenditure incurred for the administration of the office is charged to the O & M estimates. This could be due to specific provision for such expenditure not being available from other sources. Payments to casual office staff, watchers, drivers etc., quite out of proportion to their contribution to the O & M work, is charged. Generally charging such expenditure to project estimates is avoided as far as possible since such estimates have a limited amount of funds to complete a specific quantity of work. The O & M estimates have more flexibility. This is not a good practice but often the Engineer has no option but to make this kind of charge. This matter should be taken up at higher levels and resolved in order to prevent problems to the Engineer

xvi. Expenditure incurred under General Charges is clearly out of proportion. A concerted effort is essential to reduce this expenditure to reasonable levels.

Analysis of average expenditure in the five schemes has clearly shown this fact as shown below:

Table 7.1 Expenditure on General Charges

	Average	Av. Exp. (Rs.)	%	Cost/acre (Rs.)
Giritale	6192	288,293	36	47
RBE	5097	199,276	29	39
Galoya L.B.	31394	782,474	25	25
Inginimitiya	6530	705,474	59	108
Mahakandarawa	6287	372,423	49	59

A perusal of the detailed expenditure on General Charges show that in Inginimitiya Scheme drivers and operators' wages, fuel, repairs to vehicles has an average cost of Rs.305,859 which is 25% of the total expenditure. Therefore it is clearly seen that expenditure on General Charges should be looked into carefully and take all possible action to reduce it. This could bring in additional funds for the actual maintenance work.

xvii. Use of permanent labourers on items of work under operation could improve the operation of the schemes.

The salaries of WSS and permanent labour is paid from ID allocations for this specific purpose. Therefore employing such permanent labour in operation would not tax the O & M funds released through IMD. It is also well known that permanent labour has very little productivity when employed on normal maintenance work. Since the number involved is small strict supervision is difficult. However there are people with long experience in irrigation schemes and hence, their knowledge and experience could be better utilised if they are engaged on operational duties. Further they will prefer to do

this type of work than manual labour in order to maintain their status. The ID should look at the total number of permanent labour in the department and distribute them in the major irrigation schemes according to their needs. In fact it may be possible to describe this labour as operational labour and get them into the P.E. votes.

xviii. Maintaining a separate gang of labour for repairs to structures in the entire scheme could yield better output rather than from separate gangs for repair of structures in each WSS area.

Quite often each WS maintains carpenters and masons for the purpose of attending to various repairs to structures in his own area. The data on expenditure shows the amount spent on repairs to structures is small. Therefore there may not be sufficient work in each WS area to keep a number of skilled labourers such as masons without idling. It is recommended that in each scheme a separate gang is formed with masons and carpenters to attend to repairs of structures in the whole scheme. It has to be noted that adequate transport such as a tipper or a farm tractor should be allocated to this gang for their own transport as well as for transport of materials.

xix. Action is necessary to hand over main roads in the scheme to the RDA for maintenance.

The policy of the government is that all roads used by public transport should be maintained by the RDA. But in many instances the roads in major irrigation schemes, even though they come under this category, have not been taken over by the RDA. The main and branch canal roads in major irrigation schemes are generally linked to public road networks of the area. Therefore for the purpose of improving these roads it is desirable if they are taken over by the RDA. This matter should be taken up at higher levels and resolved. If not the ID will have no option but to continue with expensive maintenance work on these roads using the meagre O & M allocation. If the roads are not properly maintained there could be pressure from the politicians and the public to attend to such work. This will result in reduced maintenance to the irrigation system

xx. During rehabilitation sufficient attention should be given to achieve a reduction in O & M costs after the rehabilitation work is completed.

When designing rehabilitation work this fact should be given very serious thought. There are instances where some rehabilitation works executed need constant and expensive maintenance thereafter. This kind of work saves on initial capital expenditure but increases maintenance costs.

A long-term strategy to reduce recurrent O & M expenditure is to redesign the canal system on stable canal theories and implement the revised designs during the rehabilitation programme. Structures that do not function satisfactorily should also be redesigned and constructed during rehabilitation. Provision of suitable structures to prevent sediment inflow into the canal system will eliminate or reduce desilting which is a major component of expenditure during maintenance.

7. RECOMMENDATIONS

7.1 Introduction

In Section 6.4 the Consultant has listed 20 items as conclusions which need to be taken into consideration. These have been identified by analysing the data collected from the five Irrigation Schemes. Since these schemes are generally representative of all major irrigation schemes under the ID, it can be said that these conclusions are applicable to all major irrigation schemes. The Consultant while presenting the facts that effect O&M under each item has given some recommendations to overcome the problems. In this Chapter the Consultant has gone into further details and made recommendations regarding the most important aspects for the improvement of O & M activities under the following headings.

i. Programming and Planning of O&M activities.
ii. Improving the management procedures.
iii. Recording of physical output of works and expenditure.
iv. Development of a methodology to measure the performance of an irrigation scheme.
v. Strategies to bridge the gap between resources available and resources required.

In any country there is always severe competition between development projects and social welfare programmes to get enhanced allocations from the available financial resources. The Treasury is always pressurized from various quarters to give priority to their particular project when allocating funds. This is very accute particularly in a Third-World country such as Sri Lanka. Hence it is futile to expect allocation of what we consider as adequate funds to meet the requirements of O&M expenditure. Therefore, the Consultant considers the most important contribution that can be made in this study is to give pragmatic and reasonable recommendations to obtain the best returns with the funds actually available.

A perusal of the printed estimates of GOSL for 1990 shows the following allocations of funds.

Table 7.1 Allocation of Funds 1990.

I.M.D. Votes

i	Operation and Maintenance of Major Irrigation Schemes	Rs. 65,550,000
ii	Improvements to Major Irrigation Works	Rs. 7,000,000
iii	Improvements to Water Management	Rs. 8,000,000

I.D. Votes

iv	Payment of salaries to W.SS and permanent labour	Rs. 23,100,000
v	Strengthening of Headworks in Major Irrigation Schemes	Rs. 12,285,000
	Total of ID & IMD votes	Rs.115,935,000

In this report even though the funds allocated each year under items ii, iii, and v above were not considered for the study, in actual fact similar funds were used during the period of study for some form of maintenance activity. From the above details it is possible to see the total amount of funds made available for O&M expenditure is fairly reasonable. The total area under major irrigation schemes being about 650,000 Ac. this works out to Rs. 178/acre. Hence the Consultant is of the opinion that under the present level of financing, it is possible to achieve a higher level of maintenance than at present by optimising the amount of work done for the amount of expenditure. The Consultant's recommendations on the five items described below are based on this basic assumption.

7.2 Programming & Planning of O&M works

By about August-September of any year fairly accurate figures of funds available for allocation during the coming year is known by the ID and IMD. Once these amounts are known, ID & IMD should work out the actual allocations that will be made available to each major scheme. As soon as this information is received by the Engineer in charge of a particular scheme he should identify and prioritise the items of operation and maintenance work that should be carried out during that particular year. Items of work such as weeding within the canal waterway, removal of water weeds in the canal, desilting and repairs to structures need to be considered as priority items. For the purpose of prioritisation he could use the check list for his guidance given below. Further the farmer's response for the prioratisation could also be obtained using the format given under (v) below. Then he should prepare a detailed O & M estimate for the items identified and the finances that will be available.

Based on this estimate he should prepare a detailed programme of work for the year with physical and financial targets of items of work identified for execution during each month. These programmes should be updated if necessary at the end of monthly progress review meetings, and if and when there are changes in the financial allocation. Monthly monitoring of this programme is an essential requirement if these programmes are to serve any useful purpose.

The annual O & M programme should be prominently displayed in diagramatic form in the Engineer's office and continuously updated as required. The diagram should include physical and financial programme and progress on a monthly basis.

7.2.1 Identification and Prioritising of Maintenance Work

During the study the Consultant found that the present procedure of identification and prioritising of items of maintenance could be improved by providing a check list for the guidance of the officers.

Accordingly the Consultant reviewed some of the guidelines already available for some schemes and modified in general terms to cover all major irrigation schemes.

The format given below can be presented to the respective Irrigation Engineers in charge of major irrigation schemes so as to guide the technical staff to utilize the available maintenance funds in the most economical manner. The format presented shows the items of work and activities according to Headworks, Main Canals, Distributory Canals, Field Canals and Drainage Canals.

Format for Identification & Prioritising of Maintenance Work

Item	Description of Work	Frequency of Maintenance
I Headworks		
Embankment	- Weeding/clearing slopes and reservations	Twice a Year
	- Repairs to upstream rip-rap Protection	Once a Year
	- Repairs to slopes/crest	Once a Year
	- Repairs to toe drain/filter and clearing same.	Once a Year
	- Removal of ant-hills	Once a Year
	- Inspection for cracks, settlements, sink-holes, seepage	Once a Month

Sluices	- Inspection of sluice barrel	Twice a year
	- Inspection of sluice gates, emergency gates and trash racks	Twice a year
	- Clean trash racks	Frequently
	- Lubrication of lift mechanism	Four times a year
	- Clean groves/guides-painting	Once a year
	- Painting gauge marks on sluices	Once a year
	- Inspection and repairs to stilling basin	Twice a Year
Spillway	- Inspection and clearing of approach channel	Once a Year
	- Inspection of Ogee and abutments for cracks etc. and repair	Once a Year
	- Inspection of stilling basin for cracks and damages and repair.	Twice a Year
	- Inspection of tail canal for obstructions and clearing	Once a Year
	- Inspection of radial gates, rubber seals and lifting mechanism	Twice a Year
	- Lubrication and painting of lifting mechanism	Twice a Year
	- Painting of radial gates	Once in 5 years
	- Inspection and cleaning of stop-logs	Once a Year

Item	Description of Work	Frequency of Maintenance
II. Distribution System		
Canal Bund	- Inspection and repair of cracks, settlements, seepage and scouring including filling scours	Twice a year
	- Weeding and clearing bund slopes	Once a year
	- Removal of ant-hills on bund	Once a year
	- Gravelling of bund roads	Once in 2 years
Main Canals and D-Canals	- Weeding canal slopes and Removal of water plants	Twice a year
	- Desilting	Once a year
	- Repair of gauges in measuring devices	Once a year
	- Inspection and repair of control gates	Twice a year
	- Greezing,oiling and painting of gate control mechanisms	Twice a year
	- Clearing of debris and silt at structures	Twice a year
	- Inspection and repair of concrete works/rubble, masonry in structures	Once a year
	- Repairs to retaining walls/rubble pitching	Once a year
	- Inspection and repair of canal spills	Twice a year
	- Repair of hand rails on bridges	Twice a year

	- Clearing of silt and debris in drainage under-crossings	Twice a year
	- Inspection and clearing of debris and silt in syphon barrels	Twice a year
	- Inspection and repair of cracks in flumes and aqueducts	Once a year
	- Clearing of reservations	Once a year
Field Canals	- Weeding and clearing of canal, roadway and reservations	Twice a year
	- E/W on canal bunds and cart tracks	Twice a year
	- Desilting of canal beds	Twice a year
	- Inspection and repair of cracks, settlements and scouring of structures	Once a year

III. Drainage Channels

Drainage Channels	- Clearing debris, shrub and silt in drainage canals.	Twice a year

Description of Structures

1. Measuring Structures
2. Control regulators
3. Turn-out Structures
4. Drop Structures
5. Canal lining
6. Rubble pitching
7. Canal Spills
8. Syphons
9. Flumes
10. Canal profiles
11. Retaining Walls
12. Bridges
13. Drainage canal crossings
14. Roadways
15. Cause ways
16. Bi-furcation structures

In order to illustrate how maintenance work could possibly be prioritised, the Giritale scheme is selected. The sub-item in the format at Table 7.2 above are greatly condensed into a few items in order to simplify the illustration. The actual distribution of average expenditure of Rs.315,000 on maintenance, how the consultant would have distributed the fund and the consultant's estimate for adequate maintenance are given in table 7.3 below.

Table 7.3: Distribution of Maintenance funds

(Amounts given are to the nearest Rs. 1000)

Sub items	Actual average Expenditure (Rs.)	Consultants Distribution (Rs.)	Consultants Estimate for adequate maintenance (Rs.)
1. Weeding	142,000	101,000	198,000
2. Desilting	39,000	80,000	428,000
3. Earth Work	83,000	83,000	270,000
4. Repairs to Structures	19,000	19,000	239,000
5. Gravelling	-	-	647,000
6. Misc items.	32,000	32,000	48,000
Total	315,000	315,000	1,830,000

In the above distribution, the Consultant suggests the transfer of some weeding expenditure to desilting, because desilting is a critical problem in the scheme as observed personally by the consultants. This is also the view of some of the farmer representatives interviewed.

The question now arises as to how to prioritize the expenditure if the allocation is included. The distributions of the additional allocations of these ranges namely (a) upto Rs. 100,000, (b) between Rs. 100,000 & Rs. 200,000 and (c) between Rs. 200,000 & Rs. 500,000 are suggested in the table 7.4.

Table 7.4: Distribution of additional allocation (Rs.)

Sub items	< 100,000 %	Total Amount	>100,000 & 200,000 %	Total Amount	>200,000 & %	T
1. Weeding	5	106,000	5 to 12	125,000	12 to 16.8	
2. Desilting	60	140,000	60 to 55	190,000	55 to 50	
3. Earth work	15	98,000	15	113,000	15	
4. Repairs to Structures	10	29,000	10	39,000	10	
5. Gravelling	0	-	0	-	0 t0 5	
6. Misc. items	10	42,000	10 to 8	48,000	8 to 3.2	
Total	100	415,000	100	515,000	100	

Note: 1. % is the percentage of additional allocation.

2. Total amount is the percentage of the upper limit of the additional allocation range added to the Consultants' distribution of expenditure given under table 7.3.

Desilting is given highest priority for additional allocation and gravelling least priority. Though gravelling too is an important item, it is expensive and can be taken up only when the allocation is fairly high except at some critical sections.

Each sub-item should again be prioritized according to the degree and the necessity of various sections of the irrigation system by careful and close examination.

7.2.2 Methodology for O & M Costing

The present poor physical condition of the irrigation systems of Giritale, Ridi Bendi Ela, Galoya L.B., Inginimitiya and Mahakandarawa are the cumulative effects of ineffective maintenance carried out over the past years due to insufficient funds being released for this purpose. The financial requirement to build up these systems to technically desirable levels will, therefore, have to be estimated. Detailed investigations will be needed in the first instance to [illegible] at a reasonable

cost estimate. It will be necessary to take longitudinal and distributory canals and roadway systems and compute the quantities of silt that have to be removed from the canal beds to ensure that the designed longitudinal bed slopes are maintained. The next step is to compute the flow that can be released through the existing water-way. If the computed value is either equal to or greater than the designed value, there will be no need to interfere with the canal profile except to widen any constrictions or other irregularities that may obstruct the flow. In this manner the total quantity of earthwork required to improve the canals can be computed.

The longitudinal and cross-sectional profiles of the roadways and embankments will indicate the areas that need to be strengthened. It is to be expected that the embankments would have settled, but bringing them up to designed levels would be a task that may have to be done under a rehabilitation programme. Reaches that have settled heavily reducing the free board to dangerous levels should only be taken up for purposes of regular maintenance. Quantities of earthwork needed for such work together with the earthwork necessary for filling potholes on roadways should also be assessed under the maintenance programme envisaged "under the technically desirable level of maintenance".

The items of maintenance needed to be carried out on the Headworks are weeding of the embankment, removal of ant-hills, painting and greasing of gates and control mechanisms, etc. The cost of maintenance of the Headworks of Giritale, R.B.E., Inginimitiya and Mahakandarawa schemes were found to be small compared to the total investment in maintaining these schemes at a technically desirable level of maintenance.

However, the maintenance cost of Headworks of Gal Oya scheme has not been taken into account as this work is for the entire Galoya scheme of which the area under study is a part.

Heavy weed growth within the canal waterways and reservations is a common feature in Giritale, Ridi Bendi Ela, Galoya LB, Inginimitiya and Mahakandarawa schemes. Weed growth also takes place on the slopes of the

Headworks embankments. It is necessary to remove weeds within the canal waterways and reservations at least twice a year to prevent resistance to flow. Under "the technical desirable level of maintenance", clearing of weeds in the Headworks and in the full width of the canal and road reservations can be restricted to once a year. Other varieties of aquatic plants are also found in certain sections of the canal network in these schemes and have to be removed before the cultivation season to prevent resistance to flow and reducing the discharge capability of the system. The quantities of work required to be done for this purpose should be worked out on the basis of the actual areas needing maintenance.

The maintenance requirements for the structures of the distribution system can be evaluated after inspection. The items of maintenance generally required cover sealing cracks, plastering, rubble pitching, concreting of damaged sections, rubble packing etc. The quantities of work to be done can be estimated by inspection and site measurements. Estimates for cost of repairing field canal structures and replacing farm pipe outlets can also be made after field inspections.

The roadways need to be satisfactorily maintained to facilitate transport of agricultural produce. Therefore, 3 inches of gravelling along the designed length and width of the roadways have to be provided and similar maintenance work carried out every two years.

It is suggested that the full O & M cost estimates be cast and presented in the form as shown in Annexure-A2.

The rates applicable for each item of work can be the rates prevalent in the area and separated out into labour, material and general charges according to the analysis of rates prepared by the Department of Irrigation. The price fluctuations in the cost of labour and materials could be absorbed by providing a reasonable sum under the contingencies item.

The first estimate of work required to bring the system to the technically desirable levels will probably be high due to the cumulative effects of poor maintenance inputs carried out earlier but the costs will probably stabilise later at an acceptable level.

7.2.3 Statement of Resources Required

For the purpose of improving financial control it is recommended that a statement, which shows under each item of work, the resources required to execute that particular item separated into monthly targets, is prepared by the Engineer at the beginning of the year based on the O&M estimate.

These resources could be classified under -

a. Salaries to labour, casual and permanent,
b. Overtime, combined allowances, travelling and other allowances.
c. Cost of materials such as cement, steel, metal, rubble etc.,
d. Cost of fuel and lubricants,
e. Cost of repairs to vehicles,
f. Cost of tools, hire of machinery etc.
g. Salaries to Work Supervisors,
h. Salaries of casual office employees,
i. Salaries of watchers, drivers, operators etc.
j. Any other important items

The Consultant is of the opinion that the above programme and statement of resources will help the Engineer to monitor the expenditure and physical out-put of each item of work.

7.2.4 Execution of Work

For the purpose of executing the O&M activities for each month, each TA should submit a plan of work, for that particular month, that he proposes to implement and the financial and other resources required, before the end of the previous month. The Engineer should carefully scrutinise the plan of action and the resources required, compare it with the programme and the targets for the same month and approve it, if in order, before issuing materials, check rolls etc. At the end of the month the TA should submit a statement giving the expenditure incurred and quantity of work done in relation to the approved plan for the month. The Engineer should prepare

a summary of all expenditure and physical progress for each month from the progress statements submitted by all the TAA. This summary should be compared with the programme and corrective action taken if and where necessary.

The objective of this recommendation is to enable the Engineer to get a proper control of the expenditure on O&M works and ensure the optimising of physical progress on important items of work. Without a realistic annual programme and monthly targets, both physical and financial, the Engineer will not be able to continuously assess the position. Otherwise he could find himself in a crisis situation by exhausting the full O&M allocation before the end of the year.

7.3 Improving the Management Process

The following improvements to the existing management and institutional arrangement are recommended in order to increase the efficiency of O&M management.

i. O&M work should be considered as a joint management responsibility between the agencies and the farmers' organisations. Therefore, the appropriate approach to management improvement is a two-way process, whereby the capability and productivity of the irrigation agencies need to be enhanced while on the other hand, the minimum necessary capacity of the farmers organisations in O&M activities needs to be established.

ii. In trying to improve the O&M related capability and productivity of the Irrigation Department as the main agency, the responsibility of O&M should be given high priority by creating a post of Additional Director in-charge of O&M at national level. The same way in obtaining funds and allocating them priority should be placed on O&M.

The Treasury should be convinced the need for receiving funds demanded by the adequate level of maintenance described in the report. In order to

gain support from the Treasury to receive such funds, there is a need for the ID to adopt a new budgetary system based on real-world requirements to suit each individual scheme, rather than requesting funds on a "universal pro-rata" basis per acre as at present.

iii. Each irrigation scheme should be considered as a "cost centre" with a "market driven" management task for its sustainable functioning where O&M is the principal functional area.

For achieving this end it is quintessential that the present record keeping methods are improved with an itemised system as indicated in this report.

Similarly, an efficient and effective system for progress monitoring and evaluation of the O&M activities needs to be established by implementing norms and procedures for monitoring the effectiveness and efficiency of the "quality and quantity" of O&M work to be undertaken by each scheme.

iv. In order to improve management information between the top management and the field level it is recommended that a separate engineer, a CIE or a NPQ engineer, with long experience in O&M work should be given the responsibility of monitoring the financial and physical progress of O&M activities of all irrigation schemes in a given Range of a DD.

There should be a monthly progress review meeting in the range office chaired by the Deputy Director to monitor and evaluate the financial and physical progress of each irrigation scheme for the preceding month. This meeting should review the plans and programme for the following months and

where necessary make adjustments for transfer of resources between irrigation schemes in the range. After this meeting the range office should prepare a progress statement for all schemes in the range and submit to the Additional Director (O&M).

The O&M branch of the Headoffice should evaluate the progress reports of each range for each month and submit a report with recommendations to the Additional Director for his information and any instructions.

At the Range Deputy Directors' conference held once in three months in the Head Office, the monthly progress reports submitted by the O&M branch should be discussed and action taken, where necessary, to resolve any problems or make any changes in the annual allocations.

The Consultant considers that the above management plan will ensure the flow of information from the field to the highest level of management to ensure timely and correct senior management decisions and action.

v. Technical Assistants and Work Supervisors in charge of O&M of schemes are also engaged on rehabilitation of the scheme and even other construction works elsewhere. Such construction demands more attention of the field officers for investigations, preparation of plans & estimates, contract procedures, setting and supervision of work, procurement of stores, measurement of work etc. Thus they cannot and do not give the attention O&M requires. Hence O&M personnel at field level should exclusively look after O&M. Any rehabilitation work except some repairs and minor improvements should be enlisted to other field officers and suitable arrangements made to avoid clash of duties in the same sections of the scheme.

O&M needs not only technical skill but also institutional development. While the technical expertise can be independent of personal qualities, institutional effectiveness in dealing with farmers, officials of other institutions etc. depends on such qualities. Thus appropriate field officers should be selected as far as possible to handle O&M & suitable training given.

The field officers namely Technical Assistants and Work Supervisors on O&M should be stationed within the schemes for better interaction with farmers, quicker attention to problems, closer supervision of O&M and more time spent by the officers to understand the scheme more thoroughly and operate and maintain it more efficiently. Their quarters in the scheme can be the unit office. Necessary facilities and incentive should be provided to such field officers as encouragements.

vi. Works in some divisions are only O&M of schemes and sometimes even the irrigable extents of such schemes are too low. Such Divisions face financial problems to meet the overheads even if kept at minimum level . As a result, the overheads consume an unfair portion of O&M allocation. Either these Divisions should be amalgamated with adjoining Divisions or more work should be created in the Divisions so that the overheads can be distributed.

vii. Another problem a construction Division faces is that after the construction is over some overheads still remain and they face similar financial problems. The staff should be reduced to the minimum required level by possible transfer (there may be some administrative, political and humanitarian problems) and part of the buildings be handed over to the other institutions which may move in for O&M and even other settlement and infrastructure development activities.

viii. ID has specified norms for the number of operation personnel. These norms should be treated as only a guidance and upper most limit. The number should be fixed to meet with local requirements and not in view of providing employment.

ix. For the operation of the scheme resourceful intelligent and impartial farmer representatives can be engaged. An interview in the scheme to test their capabilities will be helpful to select such personnel.

x. There is a tendancy to select the traditional village leaders as farmer representatives. They become leaders by virtue of their social standing, wealth etc. Though leadership is an important quality for farmer representatives in leading the farmers to act according to decisions taken, other qualities such as intelligence, understanding of large irrigation systems in large irrigation systems in contrast with village types, impartiality, resourceful broad and selfless interest in the scheme are also essential. Such farmers do exist but remain in the background, probably because of their poor social standing, lack of wealth etc. They should be identified by suitable administration machinery under INMAS or otherwise and selected by consensus.

xi. The farmers can be made capable of handling operation of scheme for distributory canal level downwards with some guidance of ID & IMD and training of selected farmers with appropriate qualities. Due to the complex nature (technical and social) of the operation of headworks and main and branch canals, farmers may not be able to operate and maintain the whole system. However the farmers should be made to actively participate in the decision making on O&M of the whole system not only to make use of their experience and knowledge but also to make them feel that they too are partners in this venture. This is now being done to some extent through project management but should be further activated.

xii. User of the irrigation water is the farmer community and the supplier is GOSL whose local representative is the IE who is directly responsible for the management of the scheme. Project Manager under INMAS is the co-ordinator of various agencies connected with irrigated agriculture and farmers. Project Management has brought much better interaction between ID personnel and farmers, though some what indirectly. It is suggested that these two (user and supplier) should interact closely and directly by better understanding of each others problems. For example, when a structure is broken by a farmer, the damage itself may not be the problem but was caused by some other technical or management problem in the equitable and timely distribution of water. ID personnel should investigate such causes and take remedial measures rather than blaming the farmer & repairing the structure which may be broken up again.

On the other hand farmers also should understand the technical problems of the scheme and the administrative and personnel matters of ID officials. Hence a further step from Project Committee system in the present form is necessary to bring ID personnel and farmers closer and directly with better understanding as far as the irrigation water, which is accepted as the most critical factor in irrigated agriculture, is concerned.

7.4 Recording of Physical Output of Works and Expenditure

Prompt and correct management decisions can be made only if accurate and timely information is made available to the Managers.

The recording of detailed pbysical output of work and expenditure incurred under each item is vital for the management process. Each TA in charge of any particular item of work should have accurate measurements of work done with the location of such work, and the expenditure incurred with details of resources utilised and their cost.

At the monthly review meeting the Engineer should scrutinize the accounting documents to ensure the accuracy of accounts. This type of monthly review of accounts will give the Engineer timely warning of any impending problems and enable him to take proper action to maintain accurate accounting information.

The availability of accurate accounting information will help the realization of optimum, physical output on expenditure incurred. If such information had been maintained accurately this study could have been done more expeditiously and the conclusions could have been more accurate.

It is unfortunate that Monthly Progress and Cost Records (MP&CR) are not being maintained now. The Consultant strongly recommends that this should be initiated. A clerk or a work supervisor or a junior TA could be employed in the office to maintain these cost records.

7.5 Development of a Methodology to Measure the Performance of an Irrigation Scheme

Considerable thought was given by the Consultant to recommend a methodology to measure the performance of an irrigation scheme related to Operation & Maintenance activities.

The final output of an irrigation scheme is the total production of agricultural crops, mainly paddy. Even though in reality there is a co-relation between O&M activities and crop production, it is difficult to identify this relationship due to the large number of factors effecting the total crop production. All factors are inter-linked and it is virtually impossible to separate the effects of each.

The total crop production has a close link with the supply of irrigation water to each farmer at the proper time and in adequate quantities. The adequate quantity depends on the availability at the source and what the irrigation authorities need to ensure is the equitable distribution of the available quantity to all farmers but not less than the minimum requirements. Therefore the

performance of the irrigation system can be measured by assessing its ability to distribute the water (i) equitably (ii) at the correct time.

The irrigation system is designed to meet these demands. Therefore if the irrigation system functions as designed, then it should satisfy these needs. The objective of O&M is to ensure the functioning of the system as designed.

The designs are made on the basis of conveyance capacity required in each canal to satisfy the demands of the farmers under that canal. Therefore if the canals function continuously according to the designed conveyance capacity, then the O&M programmes can be considered as satisfactory. Based on the above reasoning the Consultant recommends that there should be continuous monitoring of conveyance capacity and conveyance efficiency of each canal in order to monitor the results of the O&M activities. To implement this proposal, the Consultant recommends the following-

(a) Main Canal - Construction of a parshall flume at the beginning of the main canal and recording of daily discharge measurements.

Construction of a parshall flume or other suitable measuring structure on the main canal at the end of each tract and recording daily discharges.

(b) Distributory Canal - Construction of a measuring structure on the D/S end of the D-Canal off-take and recording daily discharge measurements.

(c) Field Canal - Construction of a measuring structure on the D/S end of the FC off take and recording daily discharges.

(d) Drainage Canals - Construction of a measuring structure at the end of each tract and recording daily discharges.

(e) Location of Rain Gauges at suitable locations in the project areas, preferably one for each tract if feasible, and recording of daily rain fall.

The availability of data recorded as indicated above will help to determine the conveyance efficiency of the distribution system as well as the determination of irrigation efficiency.

If the analysis of the above data confirms the functioning of the irrigation system as designed then the O&M activities can be generally considered as satisfactory. However, any reduction of conveyance efficiency in any canal would indicate the need for improved maintenance in that canal. The entire process of analysis should be computerised to enable the performance to be monitored daily.

7.6 Strategies to Bridge the Gap Between Resources Required and Resources Available

How to reduce the gap between the existing level of maintenance and the desirable level of maintenance is a subject to which the Consultant gave much attention and thought.

At the present stage when, the economically desirable level of maintenance has not been determined, it is not possible to state definitely whether such a gap exists in the first place.

The engineers in the consultant's team have identified a technically desirable level for 'adequate' as well as 'good maintenance' of the five schemes studied. In resource terms these are much higher than the present actuals.

The above identification was based on estimates derived by "walking the channel". The quantities of maintenance work identified as required in this manner cannot be strictly taken as the annual requirement. If the present O & M regime is technically sub-optimal, then the work identified will have the accumulated effect of differed maintenance over the years. Once the accumulated backlog is removed by doing the amount of work identified by "walking the channel", the real (after allowance is made for inflation) annual O & M cost would be somewhat less.

Therefore, the estimate of the technically desirable O&M level is also not firm.

Eventually when a gap, if it exists, is identified a search can be made to find ways and means of removing that.

However, it is assumed that there is a gap between the resources required for effective O&M and the resources actually available. In order to bridge this gap the Consultant considered three basic approaches.

(a) Improve the efficiency of management in order to optimise the benefits with the available resources.

(b) Get the cooperation of the farmers to constribute extra resources, if and when necessary.

(c) Use farmer's responses to support the request for adequate funds from the government.

In the previous four recommendations 7.2 to 7.5 the objective is to achieve the basic approach stated in (a) above. Hence under this item 7.6 the Consultant will make recommendations regarding (b)&(c) above.

Whether the farmers contribute to the O&M efforts or not, the active participation and full involvement of the farmer is essential to get the best out of an irrigation scheme. Therefore it is necessary to organise the farmers by forming Farmer Associations to obtain their active participation. This is now being done in most major irrigation schemes. Further sustained effort is necessary to develop very strong Farmer Associations.

As the first step, it is necessary to strengthen the Turnout group of farmers at the field canal level to effectively operate and maintain the field canal. They should ensure to keep the field canal functioning efficiently and equitably distribute water among the farmers. In order to improve their knowledge and capabilities in managing the water and other resources at the field canal level training would be very useful.

The next step in this strategy is the development of formal Farmer Associations at the Distributory Canal Level (DCO). Here too these organisations are either already formed or being formed. These organisations should be given the authority and responsibility to operate the irrigation system for the distribution of water among the field canals and to maintain the network of canals in their area. Since the farmers do not have adequate financial resources or the necessary technical skills to handle these responsibilities, the government should allocate a reasonable amount of funds to the DCO on the basis of the length of canals, number of structures, length of roadways and acreage. The Irrigation Department should give all necessary technical advice, training and support.

The DCO, once they accept this responsibility would be able to utilise the funds granted to them more efficiently, since they will be using their own labour for most of the actual work. They would voluntarily contribute their own physical efforts to bridge any gap between the available funds and actual requirements.

Until the DCO develops the confidence and ability to manage their own affairs ID and IMD should advice and guide them. This has to be done with a great deal of tact and diplomacy and hence be entrusted only to carefully selected and trained officers who have a sympathetic attitude towards the farmers. It is stressed that this is a very sensitive task and "one black sheep could easily topple the whole apple cart".

In planning the maintenance work, the DCO should be advised to use the Government funds for the repair of structures as first priority since this type of work require the purchase of materials such as cement etc., employment of skilled labour such as masons etc., and payment for transport. Weed clearing, desilting and earth work is well within the capabilities of the farmers themselves.

Already in a number of schemes such as Nagadeepa Irrigation Scheme farmer organisations have taken over the responsibility of operating and maintaining distributory canal systems.

Before proceeding any further, it is desirable to consolidate the position at this level.

At the Project Committee in the scheme the ID should inform the total funds available for O&M and jointly prepare the O&M programme for execution. During the actual execution of O&M activities the farmers should be encouraged to help the ID to supervise the work in order to ensure satisfactory work. Cordial relationship between the farmers and officials is essential to ensure the efficient management of the irrigation schemes.

At the present time farmers are required to maintain the field canals except the structures while the Irrigation Department is responsible for maintenance of the headworks, main and branch canals and D-canals. However, with the setting up of farmer organisations and other institutional developments, the maintenance of D-canals is being gradually handed over to be managed by farmers. It is unlikely that the maintenance of main and branch canals and headworks could be handed over to the farmers in the near future.

With the gradual strengthening and development of the institutional frame work as is being pursued at present, it is hopeful that a fully farmer managed irrigation system can be developed within a time frame which is difficult to predict at present.

A fully farmer managed irrigation system is undoubtedly the most efficient way of utilising available resources. Such a system will not only benefit the farming community but will also provide an opportunity for the government and other agencies funding O & M to divert these funds for other development works. A farmer managed system will also guarantee equitable water distribution and reduce farmer conflicts.

Until a fully farmer managed system is developed, the farmer organisations should be given the task of maintaining the D-canals while the government should maintain the headworks and the main and branch canal systems. When the main and branch canals are properly maintained and water is released through them the farmers will be encouraged to keep D-Canals in good condition.

7.6.1 Different Scenarios for Institutional Development

The following scenarios for institutional development are considered possible:

i. Responsibilities for O&M rest with the Irrigation Department supported by farmers and their organisations.

ii. Responsibilities for O&M in the main system excluding the distributory canals remain with the Irrigation Department. Farmer organisations are handed over the O & M responsibilities in the field canals and distributory canals but resource allocation and resource mobilisation including the collection of fees from farmers is the responsibility of one or more government agencies. Farmer Organisations participate in decision making.

iii. Responsibilities for decision making on resource allocation, resource mobilisation, prioritisation, programming, implementation and monitoring of O&M works rest with different management committees headed by farmers at each level in the system. State agencies and official cadres act as facilitators to develop the capacity and capability among farmer organisations under a joint system of management.

iv. All responsibilities of O&M rest with farmer organisations including resource mobilisation, resource allocation, decision making, implementation and monitoring. State agencies provide grant-aid and farmer organisations hire services of professionals and skilled persons to implement O&M [illegible]

The above four scenarios broadly outline the possible permutations in the present transition from state managed irrigation systems to joint managed or farmer managed systems. Current thinking moves in the direction of joint managed systems with a division of labour which recognises the need to guarantee sustainable activities and the best combination of factors which optimises the inherent capacity of each organisational group to render different forms of services to the O&M programme. This approach however does not discount the ability of farmers to manage large irrigation systems as experienced in other countries clearly illustrate that some of the best managed irrigation systems in the world are managed by farmers.

An obsession often encountered in the process of developing a management framework and identifying responsibilities for different areas of work is that farmers do not have the professional knowledge and the ability to deal with situations which the state agencies accomplish through their technical cadres. It is not realistic to expect farmers to acquire all that knowledge but farmers have often exhibited the capacity to make judgment regarding the development of hired skills to accomplish their work. This distinction is not difficult to understand in relation to daily chores in an individual's life where many such decisions have to be taken almost on a daily basis.

7.6.2 Use of Farmers' Response to get Adequate Funds

Obtaining the farmers' responses for identifying and prioritising O&M activities in addition to helping the Engineer to prepare O&M programmes could be a strategy to persuade the government to allocate increased funds for O&M. If the farmers are properly organised into strong farmer associations they will be a formidable lobby which no government could ignore.

Their active participation in managing irrigation schemes to optimise production will encourage the government to act generously and with confidence.