(iii) Various water losses caused by the seepage of canals, inadequate system operation, and inefficient on farm management could be collected at tanks and reused at downstream fields. Thus, the overall efficiency of irrigation system will be greatly improved.

(iv) Upland crop irrigation is normally practiced in daytime only, and it is very difficult to adjust the main irrigation system by day and night. The tank cascade system will serve to solve this problem. Under constant supply from the main system, water can be used at uplands and paddy fields during daytime and solely at paddy fields during night time, when water for uplands will be stored in tanks and used in the following day.

In the Walawe left bank area there are many small tanks as commonly found in the dry zone of Sri Lanka. Presently, most of them are abandoned due to breach and/or non storage. Many breaches had been caused by piping action.

The project will properly lay out the irrigation area, canal system and tanks so that water can be reused most effectively through the tank cascade system. Tanks will be either rehabilitated and repaired or newly constructed. Certain tanks will be used for drinking water supply with wells dug close to the bund.

(4) Rural infrastructures

Minimum level of rural infrastructure will be planned as project work.

Lack of drinking water is the most serious problem in the project area. Most wells dry up in the Yala season and water quality is not adequate for drinking purposes. Provision of rural water supply for human beings and cattle is a must.

Transportation is another serious problem in the Extension area. Bus or coach is the main means of transportation. But due to the poor road conditions, there is little traffic. The main rural road system should be established to serve for transport of agricultural inputs and outputs, and subsistence goods. It will activate human movement and promote regional development. The existing road from Suriyawewa to Mirijjawila on the A2 main road is in poor condition. This road should be the main rural road of the Extension area in future and needs pavement to turn it to an all weather road. Another paved main rural road would be needed to connect Suriyawewa with Padalangala across the Walawe river. By this road the 1,040 ha of new development area lying in the west of Suriyawewa will have communication means.

A development center would be proposed in Suriyawewa which is located in the center of the left bank area. The development center will provide faculties such as a meeting room, job training facilities for young men and women, library, audio visual equipment, broadcasting facilities, dormitory, warehouse, and water treatment facilities. Based on the development center, various project activities will be performed in the future. In particular, crop diversification and water management are the most important aspects of the project. Project type technical cooperation programme in these two fields would be needed.

(5) Environmental impact study

The environmental impact study has been conducted focussing on the socio-economic aspects of settlers and how the project will affect the fauna and flora. Measures to mitigate the impacts and improve the environment to ensure sustainable development would be recommended.

4.3 Agricultural Development Plan

4.3.1 Proposed land use plan

(1) Basic development concept

Demarcation of the Project area is one of the most important works for the project formulation. It should be made from broad and comprehensive viewpoints taking into account all the related factors such as agricultural conditions, land use, soils and land suitability, available irrigation water sources, as well as socio-economic conditions, etc. Of these, the most crucial factors for the present project-formulation works are considered to consist of the following;

(i) Land suitability especially with respect to soils and topography
(ii) Available water resource for irrigation development
(iii) Irrigability by mean of gravity irrigation
(iv) Relation to the existing irrigation development schemes in the area

As a result of demarcation, the area of 12,030 ha in net is delineated as the total possible irrigation development area comprising the irrigation command of Uda Walawe reservoir of 11,450 ha and Mahagama tank of 580 ha. The possible irrigation extension area on the left bank under the project excluding Sevanagala sugar area is estimated at about 6,400 ha as shown below:

(Unit: ha in net)

Area	Existing Irrigation Area Area	Extension Irrigation Area Area	Total
1. Sevanagala sugar area	1,480	1,270	2,750
2. Kiriibanwewa area*	1,480	0	1,480
3. Suriyawewa in Old area	1,420	1,040	2,460
4. Extension area	0	5,340	5,340
Total	4,380	7,650	12,030
(Total of items 2, 3 and 4)	(2,900)	(6,380)	(9,280)

Note: The area is including the command area of Mahagama tank.

(2) Land use and soil condition within the possible development area

Soil distribution within the possible development area of 11,780 ha in gross (9,280 ha in net) is summarized as below.

(Unit: ha in gross)

Area	LHG (poor)	RBE (Mod)	RBE (Well)	Total
(A. Existing irrigation area)				
Old Area				
- Kiriibanwewa area	1,510	620	120	2,250
- Suriyawewa in Old area	810	720	490	2,020
Sub-total (A)	2,320	1,340	610	4,270
(B. Possible irrigation Extension area)				
Old Area				
- End of BBC	520	270	440	1,230
Extension Area				
- Nortrh area	1,000	710	1,670	3,390
- South area	740	650	1,500	2,890
Sub-total (B)	2,270	1,630	3,610	7,510
Total (A+B)	4,590	2,970	4,220	11,780

As seen in the above table, the RBE soil of 1,950 ha is the objective area for the crop diversification. It is planned that 820 ha in net of paddy field on RBE in the existing irrigated paddy field is changed into the upland field. In the Extension area, since all of the area is the new irrigation development area, the land of 2,270 ha on LHG soils is allotted to the paddy field and the remaining land of 5,240 ha is allotted for the upland field crops.

(3) Overall land use plan

Based on the basic concept of the land use plan within the possible irrigation extension area, the overall land use plan of the objective area is prepared as below and its details are tabulated in Table 7.

(Unit: ha)

Land use	Old area*	Extension Area	Total
Irrigated paddy*	2,220	2,320	4,540
Irrigated upland field*	1,720	3,020	4,740
Upland (Rainfed)/Chena	1,030	1,120	2,150
Homestead	2,490	1,200	3,690
Shrub/Pasture land	605	4,310	4,915
Open/Firewood forest	260	690	950
Madunagala Forest reserve	0	960	960
Livestock farm	25	410	435
Plantation	0	20	20
Barren/rock	700	490	1,190
Others	1,990	1,160	3,150
Total	11,040	15,700	26,740

*: Net irrigation area

4.3.2 Proposed cropping pattern

In the process of crop selection and formulation of cropping patterns for recommendation as the basis for large scale human settlement, the physical conditions of the Study area, the general crop selection criteria and the current development policies were carefully considered under the following concepts and conditions:

(i) Adaptability of the crop to soil and agro-climatic conditions of the area and its ability to perform optimally under irrigation.

(ii) Expected level of technology and the availability of credit and inputs to the farmers.

(iii) Practicality in terms of the available labour force in the project area.

(iv) Market potential and price prospects for the agricultural products.

(v) Optimization of the use of the supplied water resource.

(vi) Government objectives of crop diversification and creating employment through promotion of agro-industry.

(vii) Generation of maximum benefits to the farmers, to the region and to the country as a whole.

The three alternative cropping patterns developed using linear programming (LINDO) were subjected to detailed discussion and further refinements made in relation to current agricultural development policies, proposed agro-processing facilities, crop diversification plans in the Walawe right bank, and other technical considerations. The basis for the decision to include sugarcane in the proposed cropping pattern is the strong assurance given by MASL on the commitment for timely expansion of the Sevanagala sugar factory to accept the entire cane production under the project conditions. The proposed cropping pattern, developed after due consideration of matters discussed, is summarized below and is presented in Figure 8.

(Unit: ha)

Crop	Maha	Yala	Total
Paddy	4,540	4,540	9,080
Big Onion	630	630	1,260
Vegetables	500	500	1,000
Banana	610	610	610
Sugarcane	3,000	3,000	3,000
Total	9,280	9,280	14,950

4.3.3 Proposed farming practices

Specific crop recommendations and comprehensive production guidelines prepared based on agricultural research are available for extension staff as well as the farmers. Farmers in the area have comparatively performed well on production of paddy and sugarcane as evident from the published yield data. Some general considerations for improvement are: (i) maximum use of irrigated plot for crop production; (ii) adherence to the agreed cropping calender; (iii) introduction of Integrated Pest Management Programme of DOA; (iv) use of quality seeds and planting materials; and (v) use of straight fertilizers.

Some specific recommendations are outlined below.

(i) Paddy: Immediate field puddling after second ploughing, recycling of unutilized straw (most straw are utilized as material of paper and fodder of livestock, but some are unutilized), seed paddy replacement cycle of every four seasons and transplanting practices are proposed.

(ii) Sugarcane: Use of heat treated seed cane of less than eight months, thorough earthing up, improved ratoon management and coordinated maturing of cane are proposed.

(iii) Big onion: Use of dry sets specially in the Maha cultivation, establishment of commercial nurserymen and proper drying of the bulbs for storage are proposed.

(iv) Banana: Selection for product uniformity and use of cut pieces of combs as propagation material are proposed

(v) Vegetable: Use of quality seeds and planting materials and broadbasing the range and varieties are proposed.

4.3.4 Expected yields and production

In estimating the yields of the crops proposed for the project, the available yield data from the following sources were taken into consideration.

(i) Existing irrigated areas in RB and LB Old area of the Walawe project
(ii) Outside areas where conditions are similar to the project area
(iii) Potential crop yields from experimental data

The expected yields and the production are shown in the table below.

Crop	Extent (ha)	Anticipated Yield (t/ha)	Anticipated Annual Prodn.(t)
Paddy*1	4,540	5.5	49,940
Big Onion*1	630	12.0	15,120
Vegetable*1	500	25.0	25,000
Banana*2	610	17.0*3	10,370
Sugarcane*2	3,000	114.0 *4	342,000

*1: double cropping *3: average of 5 years
*2: perennial crop *4: average of 4 years

The Ministry of Agriculture Development and Research and the Department of Agriculture recognized that an average yield level of 5.0 ton/ha had already been achieved Walawe region as well as Mahaweli systems H and G areas. The target yields in the 1991 - 92 season set by the Ministry were 5.3, 5.5 and 5.5 ton/ha for Walawe, Mahaweli system H and G, respectively.

The average paddy yield of 5.5 ton/ha can be expected as long as the following conditions are satisfied.

(i) Stable irrigation water supply
(ii) Adoption of proposed farming practices
(iii) Utilize of recommendable varieties (BG34/6, BG94/1 and BG 350, etc.) and application of proper quantity of fertilizers and agro-chemicals
(iv) Reinforcement of suitable agricultural supports

4.3.5 Marketing, processing, and price prospects

(1) Marketing development

Agricultural marketing is the performance of all activities involved in the flow of agricultural products from the point of initial production to the consumers. The main proposals for marketing development in the Project area are as follows:

(i) An agreement in the form of Memorandum of Understanding between MASL and the Ministry of Plantation Industries on the development plans and an undertaking to purchase the cane produced by the farmers in the Project area.

(ii) Broadbasing the range of vegetables and introduction of new varieties of different age classes to minimize the seasonal market gluts and quality improvement of products to enhance price prospects.

(iii) Establishment of strong farmer organizations for marketing activities in the Project area and formation of peoples companies on a pilot project scale as an alternative to marketing development through water management organizations and cooperatives.

(iv) Establishment of a well linked marketing information office at the proposed Development Center.

(v) Provision of infrastructure facilities to open up two Polas in the proposed new Block areas of the Extension area.

(vi) Strengthening of the project Marketing Division with competent staff and well organized training.

(vii) Demonstration or implementation of technical know-how to farmers to store OFCs in farm yard as a means to stabilizing harvest-time farm gate prices.

(2) Processing of agricultural products

(i) Sevanagala sugar factory: The present mill capacity of the factory is 1,430 ton-cane/day (tcd) and it is required to be expanded to 3000 tcd for it to process the additional cane produced in the project area. The mill capacity expansion programme proposed by the Sugarcane Research Institute is phased over three development stages, each taking 2-3 years. The mill capacity will be increased to 2,400, 4,000, and 5,000 tcd, respectively. The development programme is expedited to be undertaken by a corporate investor.

(ii) Cold chain system: Aitken Spence Agricultural Developments Ltd., (ASAD) has initiated an agricultural production and processing venture in the Walawe right bank area to test and develop high value export crops with financial assistance from United States Agency for International Development (USAID) special project grant, administered by the Mahaweli Enterprise Development Project (MED). It is envisaged to construct a cold chain system with hydro-cooling, cold storage, and transportation facilities. The 10 ton per day capacity plant is scheduled for implementation in 1992.

(3) Price prospects

The price prospects for the agricultural products are assessed based on the current market prices and the future demand and supply projections.

(i) The present price level of sugarcane is ensured by the Government decision to maintain a minimum efficiency price of US$500 per ton of locally manufactured sugar. With the expected improvement in the production efficients, it is envisaged that the cane price will stabilize at Rs. 900 per ton.

(ii) The prices of paddy, big onion, vegetables, and bananas are expected to be unaffected and remain at the present level.

The anticipated farm gate prices are shown in the following table.

Crop	Unit	Present Price	Anticipated Price
Paddy	Rs./kg	8.00	8.00
Big Onion	Rs./kg	12.00	12.00
Vegetables	Rs./kg	4.00	4.00
Banana	Rs./kg	10.00	10.00
Sugarcane	Rs./ton	800.00	900.00

4.3.6 Crop budgets and production value

Crop budgets for the proposed crops, prepared based on estimated production costs and gross incomes are summarized as follows:

(Unit: Rs./ha)

Crop	Gross Income	Production Cost	Net Income
Paddy	44,000	20,600	23,400
Big onion	180,000	60,000	120,000
Vegetables	100,000	43,900	56,100
Banana			
Yr 1	50,000	24,200	25,800
Yr 2-5	200,000	16,800	183,200
Sugarcane			
Yr 1	126,000	44,700	81,300
Yr 2-4	94,500	23,900	70,600

The production value under 'with project condition' is calculated and summarized below.

Crop	Production (ton)	Production Value (Rs. 1,000)
Paddy	49,940	212,472
Sugarcane*1	342,000	219,825
Banana*2	10,370	92,549
B. Onion	15,120	151,200
Vegetable	25,000	56,100
Total	732,146	

*1: average of 4 years *2: average of 5 years

4.3.7 Farm economy

In the assessment of future farm income, the following conditions were assumed.

- Farm size is 1 ha without exception.
- Each farmer will have both paddy and upland fields.
- Farmers in the Extension area will earn a similar net farm income.

The typical crop combinations and estimated farm incomes of farmers in the Extension area are summarized below.

Item	Extension North		Extension South	
	Pattern 1	Pattern 2	Pattern 1	Pattern 2
Farm size (ha)				
Paddy	0.39	0.40	0.45	0.61
Sugarcane	0.45	0.47	0.43	0.00
Banana	0.10	0.00	0.04	0.04
B. Onion	0.06	0.09	0.09	0.00
Vegetable	0.00	0.04	0.00	0.35
Farm income (Rs.)				
Paddy	18,300	18,700	21,100	28,500
Sugarcane	33,000	34,400	31,200	0
Banana	15,200	0	6,100	6,600
B. Onion	14,400	20,800	20,400	0
Vegetable	0	5,000	0	39,000
Total	80,900	78,900	78,800	74,100

As is shown in the above table, the farm income for average farmers under 'with project condition' will be far higher than that under 'without project condition.

4.3.8 Settlements plan

(1) Present situation in the Study area

General

According to the data and information of (i) Uda Walawe Left Bank Extension Project Census of 1991/92 conducted by the PMU of MASL, and (ii) the records at MEA project office, a large number of second generation families in the existing irrigated areas of RB and LB are landless and they are awaiting for the development of the left bank area.

Old area

The present irrigation extent of 2,900 ha in the Old area will increase to 3,940 ha under with project condition. The new developed irrigated area of 1,040 ha will be given to settlers who have been tentatively allotted the land plot by MASL. They have been cultivated upland crops under rainfed condition. Some modification of land boundary, however, will be required due to construction of project facilities. This will benefit the total recorded 4,157 farm families including 406 farmer in Bedigantota already in the area.

Extension area

In the Extension area, 5,340 ha of new irrigated lands will be developed under the project. According to the census survey, 6,018 families live in and around the Extension area. The number includes 1,650 farm families regularized by MASL, 840 farm families who have annual permits or long term leases issued Crown Lands Ordinance, and 3,529 families of encroachers. Regularized families by MASL are settled in the northern part of the area. On the other hand, about 260 farm families who have annual permits or long term leases issued Crown Lands Ordinance lives under minor irrigation tanks. Furthermore, other regularized 579 farm families are scattered in the Extension area. The balance of 3,529 families are encroachers. It is considered that re-allotment of land will be required based on the consideration that the regularized farm families will have a priority to get right of settlement.

(2) Selection criteria and instructions

The policy on land alienation followed by MASL entitles a farm family to be allocated a total of 1.20 ha consisting of one ha of irrigated plot (farm) and 0.20 ha of upland homestead plot. In line with the policy, the size of the farm holding will be one ha without exception. According to MEA-Land Branch, the selection criteria and instructions for the selection of settlers for the Mahaweli Development Project are as following:

(i) Land Kachcheries for the selection of settlers should be held under the provisions of the Land Development Ordinance and its regulations and orders.

(ii) Selections should compulsorily be done at Land Kachcheries.

(iii) Every selectee is entitled to 1 ha of irrigated lands and 0.2 ha of upland homestead plot.

(iv) Every applicant should satisfy the following qualifications:

i. Should be a citizen of Sri Lanka
ii. Should be over 18 years of age
iii. Should be a permanent resident of the Assistant Government Agents/Grama Seva Officer's area.
iv. Should be a peasant
v. Should not own 0.8 ha or more of private or leased land
vi. Family income should not exceed Rs. 9,000 per annum
vii. Should not be Government, Corporation or Private sector employees

It is presumed that the existing procedures with regard to land alienation will be followed in the land allocations. In the process of selection of farm families, it appears appropriate that consideration is given to eligible families already residing in and around the area.

(3) Settlement assistance

If the selected farm families hail from areas outside the project area, proper orientation of the families to the project conditions will be of particular importance. Orientation programmes should commence prior to physical shifting of the families and should be aimed at minimizing the re-location and acclimatization problems that are usually associated with transmigration programmes. Settlements during the rainy season should be avoided and the time period between the arrival in the project and showing of the homestead allotments, where the settlers are kept in camps, should be minimized. To avoid social and cultural conflicts, settlers hailing from the same area should be settled in one hamlet/village.

The Mahaweli settlers are provided with a package of settlement assistance. These include housing, sanitation, land development, seeds and planting materials and subsistence assistance. Provision has been made to provide the new settlers with similar assistance with project conditions. The settlements should commence after the rural infrastructure is in place to avoid hardships to the families. The facilities proposed will include drinking water supply, health and medical care, roads, educational services, postal services, etc.

4.3.9 Agricultural credit and supporting services

(1) Agricultural credit

In the existing irrigated areas, an action plan is required to improve the institutional credit worthiness of the farmers. The lost time due to repeated visits to the banks presently required in availing agricultural credit facilities should be minimized by streamlining the procedures.

Establishment of branch offices of commercial banks in each of the two Blocks in the Extension area before the commencement of agricultural operations will be necessary to take charge of agricultural credit disbursement. The present area of paddy needs to be expanded to include all the crops in the project area. Where such credit coverage is not available, MEA should pursue through DOA, to ensure that the Central Bank and the commercial banks get these crops included in their credit programmes.

(2) Agricultural research

Research that should be given priority are identified below.

(i) Diversifying the varietal spectrum of sugarcane: (a) to avoid the risks of depending on a single variety; (b) to improve yield and milling quality; and (c) to attain maturity at different times of the season. Development of a cost effective package of cultural practices for the small farmer to replace the present estate scale field practices needs to be pursued.

(ii) Development of suitable paddy varieties for the area that combine the red grain character with three month crop duration.

(iii) Testing of new types and varieties of vegetables under the project conditions and demonstrating to farmers the advantages and returns associated with the new materials.

(iv) In view of the high cost of fertilizers and agro-chemicals, as well as possible environmental hazard arising from their indiscriminate application in crop production, it is proposed that use of organic matters and natural pesticides is encouraged in the project area. For this purpose, documentation and testing of natural pesticides to develop practical field applications measures are proposed. Further, development of practical methods to utilize of crop residues, particularly sugarcane and sugar factory wastes for extensive use in the upland crops need to be pursed. It is envisaged that these studies will be undertaken at the proposed Development Center.

(3) Agricultural extension

The project envisages a high degree of crop diversification and a large number of new farm families. The intensity of farmer coverage offered under the MEA proposed new extension system is not considered adequate enough to serve the anticipated development pace of the

project. It is proposed that the reference group should comprise of farmers from two adjacent field canals and the total number of farmers should not exceed 25. The field level agricultural extension agent (Agricultural Assistant) should visit each farmer group every fortnight. At the project level, elements of the Training and Visit system are proposed to be retained while maintaining research linkages through the proposed Provincial RTWG. Training of agricultural staff on the crops proposed for the project should be undertaken prior to commencement of agricultural operations.

The broadcast for agricultural extension with the radio broadcasting equipment set at the Development Center in Suriyawewa should cover an area of the Project area. The broadcast programs should consist water management, agricultural extension, marketing and living information, etc., the useful information for beneficiary farmers should be broadcasted in real time. In preparation for the second phase of agricultural extension where increased cost effectiveness of the extension trust, it is proposed that elements of multimedia approach are introduced early into the system. The project will provide for the basic equipment and training required for this purpose.

(4) Agricultural inputs

Establishment of private supply sources of agricultural inputs, particularly, in the Extension area will take time. In the interim period, arrangements for the supply of all required inputs should be made by the project management organization. Early establishment of private sector dealer networks for supply of farm inputs needs to be encouraged.

4.4 Irrigation and Drainage Development Plan

4.4.1 Basic planning concepts and considerations

(1) Basic planning concept and development objective

The basic planning concepts applied for the irrigation and drainage development plan are: (i) full use of available water resources for the irrigation development, (ii) no adverse effect to the existing environmental situation by the proposed development, (iii) introduction of gravity irrigation and drainage system, and (iv) full utilization of the existing irrigation and drainage facilities.

Improvement and upgrading works of the existing facilities in the Old area aims not only to improve and upgrade the existing facilities but also to extend the irrigation area in the Extension area through saving water in the area. The development objective of rehabilitation and improvement plan for the Old area is set as follows through the assessment of the existing irrigation and drainage facilities.

- Objective facilities of the work are the existing irrigation canals and related structures under the management of MASL. These facilities have been damaged and have collapsed considerably due to deterioration and poor design.

- An improvement plan for the existing drainage facilities is not planned since no serious drainage problems have occurred in the area due to the existence of the Uda Walawe reservoir, steep ground slope, and rather high level of the irrigation area.

- No work is planned for irrigation and drainage facility in the Sevanagala sugar area since the facilities were constructed recently (existing facilities were completed in 1986) by the sugar cooperation and these facilities are well maintained by them.

Aiming at full utilization of the available land and water resources in the area, the construction of irrigation and drainage facilities for irrigation extension areas is planned. The irrigation extension areas extend over the southwest end of the Old area, about 1,000 ha, and the Extension area, about 5,300 ha.

(2) Irrigation management plan and method

For proper and full utilization of available water in the Uda Walawe reservoir, the irrigation water is planned to be supplied based on the scheduled demand basis. Aiming to distribute irrigation water to each benefited farmer equitably, continuous irrigation supply is planned for major canals comprising main, branch and distributary canals. Rotational irrigation is planned within field-canal in principal during the land preparation period. Irrigation water is planned to be supplied for 24 hours a day in paddy field and 12-14 hours in upland fields.

Irrigation of paddy fields is planned to be practiced by mean of a basin method, under which the fields are to be continuously submerged with water till the drying-up period for harvesting. As for the upland crops, furrow irrigation method is proposed based on the results of the field irrigation test.

(3) Irrigation and drainage systems

Equable distribution of irrigation water is to be realized through (i) upgrading of the major canal system including provision of proportional diversion structures on the turnouts and discharge measuring devices, and (ii) enhancement of management staff and water users (farmers) through a series of training courses. Lining of canals especially for distributary and field canals is also planned in order to save the water losses in small scale canals, and maintenance work and cost. Enhancement of the water users association through training farmers is one of the effective methods for proper water management from the view point of institutional organization for water management.

The irrigation extension area in the Extension area extends over valleys. Bottoms of the valleys are planned for paddy fields and higher parts for upland crops. Irrigation areas by crops are 2,760 ha of paddy and 3,620 ha of upland crops including 2,620 ha of sugar cane.

The basic concept of the irrigation system in the irrigation extension area is to introduce a tank cascade system. The system aims at high irrigation efficiency with rather low level water management in the end users. The system will realize reuse of return flows. Existing tanks scattered in the area are fully utilized and incorporated in the proposed irrigation system. Farm ponds for upland crop irrigation are also planned at the beginning of distributary canals to regulate canal flow in the night (called high tanks, tanks in the valley bottom are called low tanks). Double canal systems, namely, canals mainly for paddy field from low tank and upland field from high tank, are planned taking into account the location of the tanks and commanding area of paddy field and upland fields.

Existing natural streams are fully utilized as the main drainage canal. Due to the existence of the tanks in the valleys, drainage of water outside the project area could be minimized except in flood time. This means that the effect of drainage development to the outside area such as the commanding area of Liyangastota irrigation scheme and Karagan lagoon is minimized by the tanks.

(4) Canal alignment in the irrigation extension area

Alignment of irrigation canals is made based on the available topographic maps taking into consideration the tank system. Contour canals are basically applied to avoid deep cuts and high embankments taking into account the results of the geological survey, and to minimize construction cost. According to the results of the survey, hard rocks extend along ridge lines with rather shallow overburden.

Left Bank Main Canal (LBMC) will be extended from the existing end point at Suriyawewa for about 25 km, along the water shed line between the Walawe river and Malala river (refer to Volume-IV, Drawings).

4.4.2 Rehabilitation and improvement plan for the existing irrigation and drainage facilities

(1) Rehabilitation and improvement plan for canals

Most of the small scale canals such as distributary (D) and field (F) canals have deteriorated due to lack of maintenance of the canal sections and erosion by water especially on the bends of the canals. This has occurred from excess flow of irrigation water and high water velocity in the canals, and poor design of irrigation facilities. To sustain the proper water distribution, and to save the conveyance losses in the canals and financial burdens for maintenance cost, a concrete lined canal is planned for D and F canals.

Regarding the main and branch canals, improvement work for canals is planned by heightening canal banks for 14 km, in total, and side slope protection at the eroded portion, especially on the outer bend of the curve portion and up and downstream of structures. Assessment of flow capacity for the existing LBMC and BBC (Beddewewa Branch Canal) indicates that some stretches of both canals require heightening of canal banks for the extension of the irrigation area. Required length of the bank heightening work is estimated at 8 km in total for LBMC and 6 km in total for BBC. Regarding BBC, the end stretch of about 2 km requires reconstruction to convey irrigation water with appropriate water level to the irrigation extension area which is located at the end of the canal. Extension of canal length is also planned in order to irrigate whole farm plots from field canals through farm turnouts. Improvement plan of the canals are summarized below.

Item	Length (km)
Extension of canal length	30.3
Protection work of eroded portion	10.2
Canal lining	132.2
Heightening of canal bank	14.0
Total	186.7

(4) Rehabilitation and improvement plan for related structures

According to the inventory list and report on conditions of the existing related structures on the existing irrigation canals prepared by MEA, two-thirds (2/3) of the related structures in the area require repair or replace, as follows:

Canal	No Repair Needed	Repair Needed	Replace Needed	Total
LBMC	16	26	24	66
Branch canals	25	60	2	87
D-canals	118	205	110	433
F-canals	581	450	626	1,657
Total	740	741	762	2,243

According to the above conditions and the water management plan, improvement work is planned as follow:

(i) Reconstruction of the aqueduct superstructure on LBMC for crossing the Mau river to expand the flow capacity of the canal;

(ii) Construction of discharge measuring devices at or near turnouts on major canals, where water head is available;

(iii) Modification of the intakes of the turnouts to sustain the proportional intake according to the canal discharge in parent canals;

(iv) Replacement of all gates on the existing gated structures with steel gates;

(v) Construction of additional farm turnouts;

(vi) Repair or replacement and additional construction of drops and culverts;

(vii) Construction of additional footpath bridges and bathing steps on major canals;

(viii) Construction of additional check structures on distributary canals, to control canal flow in emergencies such as canal break and very severe drought;

(ix) Construction of spillways at the end of the canals to evacuate any excess water.

4.4.3 Extension plan for the irrigation and drainage area

The irrigation extension areas covering 6,380 ha in total comprise 1,040 ha in the Old area and 5,340 ha in the Extension area. The irrigation extension area in the Old area is located at the western end of the existing Beddewewa branch canal (BBC). The valley bottoms are planned to be used for paddy fields and higher parts are for upland crops.

For successful agricultural development through irrigation development, construction of the following irrigation facilities is planned:

- Construction of irrigation canals of 362 km in total:
- Construction of drainage canals of 254 km in total
- Construction of related structures
- Rehabilitation of 15 existing village tanks, construction of 4 new low tanks, 28 high tanks and one small scale intake weir on drainage for (i) providing buffer ponds of upland fields to regulate the continuous 24 hour basis supply to day-time operation, (ii) collecting return flows from upstream areas, and (iii) providing a water source for the farmers and livestock

- Construction of roads along irrigation and drainage canals
- On-farm development including construction of field canals and related structures
- Reclamation of farm lands of 5,240 ha in total

4.4.4 Drainage plan in the irrigation extension area

(1) Basic plan

The drainage plan is formulated based on the available topographic maps and rainfall data in the area. The unit drainage requirement is estimated at 4.1 l/s/ha for paddy fields and 6.9 l/s/ha for other fields, based on the one-day rainfall of 119 mm/day with return period of five years.

Drainage block in the irrigation extension area is broadly divided into three drainage areas, namely the irrigation extension area in the Suriyawewa block, northern and southern part of the Extension areas. Excess water from the irrigation extension area in the Suriyawewa block will be drained to the Walawe river directly through several natural streams. The excess water from the northern part of the Extension area will be drained into the main canal of the Ridiyagama tank. Because of no cancellation of the existing tanks in the Extension area, it is considered that the inflow discharge to the canal will not be changed. The excess water from southern part of the Extension area will flow into the Karagan lagoon through existing natural streams.

(2) Drainage system

The proposed drainage canal layout is made in accordance with the above drainage plan and proposed irrigation canal layout. The existing natural drains are fully utilized and incorporated into the system.

4.4.5 Water management and maintenance plan for the facilities

(1) Organization

Two deputy resident project managers (DRPM), who will be responsible for the management of the left bank area as well as for right bank area, are required for proper and successful management of the Walawe area under the management of MASL, taking into account the commanding area of 12,000 ha in total on the left bank. In addition, establishment of two irrigation blocks for the Extension area is required for water management and maintenance, and settlement services including agricultural extension as shown in Figure 9. An irrigation engineer who is responsible to manage water distribution of the left bank area is to be appointed. The engineer shall have experience in upland irrigation management and practices since about 50% of the irrigation commanding area is occupied by upland crops. Integration of the Sevanagala sugar area into MEA's management area is also to be considered according to the privatarization of the area.

A coordination committee (or Water users committee of the Walawe river) is to be established for basin wide water resource management. The anticipated members of the committee are, (i) MEA's project office, (ii) Irrigation office for the Liyangastota scheme, (iii) representatives from CEB who is responsible for operation of the Samanalawewa reservoir, (iv) representatives of water management secretariat of MASL, (v) representatives of MASL and MEA head office, and (vi) local governments concerned.

The water will be managed by the O&M office of MEA in collaboration with water users (farmers). The water users association organized by the farmers should strengthen the water management and maintenance work on minor canals through the training of farmers, at least on field canals and preferably on distributary canals.

(2) Water management

The basic goal of water management is to have equitable, proper, and timely distribution of the irrigation water and full utilization of the available water resources in the area.

Water management is to be practiced on a scheduled demand basis according to the detailed irrigation schedule prepared by MEA before irrigation season. The schedule will be based on irrigation area, crops, water requirements and irrigation conditions obtained last season, results of monitoring return flows, and study results of forecasting rainfall and river discharge in the Walawe basin. Monitoring of water distribution for each canal and irrigation area during an appropriate period (about 10 days) is to be practiced and reviewed. Daily inspection of canals and turnouts is to be practiced by not only gate keepers but also irrigation engineers to monitor the actual irrigation distribution condition.

(3) Maintenance

Maintenance work is to be executed by both the project O&M office and water users, in principle. The office is to be responsible for execution of the work for major canals which have a large commanding area such as main and branch canals and farmers for minor or small scale canals. The maintenance work of minor canals shall be made by the water users themselves to save the burdens of the government.

(4) O&M equipment

It is planned to provide O&M equipment for the left bank area to sustain proper O&M works as follow:

Operation equipment

1. Operation vehicles (3 nos)
2. Motor cycles (22 nos)
3. Micro-computer for data processing (2 sets)
4. Wireless communication (1 set)
5. Meteo-hydrological equipment (2 sets)
6. Spare parts for operation equipment (LS)

Maintenance equipment

1. Hydraulic backhoe (2 nos.)
2. Bull dozer (2 nos.)
3 Grader (2 nos.)
4. Concrete mixer (3 nos.)
5. Ordinary track (2 nos.)
6. Dump truck (1 no.)
7. Spare part for maintenance equipment (LS)

4.4.6 Timbolketiya river irrigation water augmentation plan

(1) Background

There are three major tributaries downstream of the Uda Walawe reservoir, namely the Hulanda and the Timbolketiya rivers on the right bank, and the Mau river on the left bank. The Hulanda and the Mau rivers have already been developed and incorporated into the irrigation systems of the Walawe development scheme. Only the Timbolketiya river has not been used directly. Is was considered formerly that the river flow was needed to satisfy the downstream water users such as the Liyangastota anicut scheme. However, as a result of extensive reclamation of paddy fields on both banks of the Walawe river, return flow from the paddy fields appears in the Walawe river and its volume is adequate.

Results of the water balance study indicated that;

(i) In the case of "with Samanalawewa reservoir and without development of the Timbolketiya river", water shortages will occur at the Uda Walawe reservoir in 4 out of 20 years for the proposed cropping pattern. This satisfies the 80% dependability of water supply.

(ii) In the case of "with Samanalawewa reservoir and with development of the Timbolketiya river", shortages occur in 2 out of 20 years. This result shows that the Timbolketiya diversion plan is rather effective for stabilizing the water supply to the Walawe area.

In order to augment the water resources for the Walawe development scheme, a plan is studied to link the Timbolketiya with the Right Bank Main Canal (RBMC) and use part of the Timbolketiya flow for the right bank area. It is expected that the commensurate amount of water could be stored in the Uda Walawe reservoir and more reliable water could be supplied from the reservoir.

(2) Basic conditions and considerations

The Timbolketiya river is a right tributary of the Walawe river. Average annual runoff of the river at the station is estimated at 124 MCM. According to the "Engineering Survey Map", the gradient of the river bed is estimated at 1/600. The river has two major tributaries, the Rakwana river (CA=200 km^2) and Andolu river (CA=69 km^2). They join just upstream of the Timbolketiya bridge on route A-18.

The probable peak flood discharges of the Timbolketiya, Rakwana, and Andolu rivers with return period of 50 years, design flood of the diversion weir, are estimated at 300 m^3/sec, 225 m^3/sec and 75 m^3/sec, respectively. According to the geological investigations results along the rivers, there is a good possibility to place the weir body directly on the fresh or weathered bedrocks. These bedrocks are rather shallow , not deeper than 4 m from the original ground surface.

Most of the riverine land along main stream and both tributaries are glass land except for small patches of irrigated paddy area. No permanent houses are also found in the riverine area except near the bridge.

It is planned to divert river flow with 80% reliability. Annual amount of diversion water is estimated at 77 MCM (about 60 % of annual runoff). The diversion discharges to RBMC range between 1 and 4 m^3/s, and its average is 2.5 m^3/s.

Supply point of the water from the Timbolketiya is planned just downstream of the Timbolketiya siphon (4 km point of RBMC) taking into account the locations of the river and canal, and to avoid excess inflow of sediment and diverted water into the siphon. The design water level at the outlet of the siphon is El. 72.06 m

The Rakwana river has about three times the base flow discharge than that of the Andolu river. This means that the diversion plan should include the flow of the Rakwana river. There are no suitable sites for a diversion weir for a gravity system on the Timbolketiya main stream so that a reasonable distance can be maintained between the bridge on A-18 and the siphon on RBMC.

(2) Alternative diversion plans

Considering the conditions and limitations of the river and RBMC, three alternative diversion plans have been prepared. Two plans (Alternative 1 and 2) are gravity intake by construction of a diversion weir(s) and the other is a lifting plan (Alternative 3) by installing pumps and a low weir as follows:

- Alternative 1 : Construction of two diversion weirs on both the Rakwana and Andolu rivers. Diverted water of the Rakwana river is conveyed to the other weir site on the Andolu river through a supply canal of about 1.1 km, then both river flows are diverted by the weir on the Andolu river. The length of link channel from the weir to RBMC is estimated at 3.2 km. Heights from river bed to weir crest are 8 m for the Rakwana river site and 9 m for the Andolu river site.
- Alternative 2 : Construction of one diversion weir at the confluence of Rakwana and Andolu rivers. Length of link canals to RBMC of 2.3 km which is shorter than that of Alternative 1. Height from river bed to weir crest is about 9 m.
- Alternative 3 : Construction of pump station and low diversion weir on the river just upstream of the siphon for RBMC on the Timbolketiya river. A lifting plan by installing a pump is planned to avoid artificial inundation to the upper stretch of the river and to save the construction cost of a link canal to the RBMC. Lifting height of pumps will be about 14 m. The weir height from river bed to weir crest is about 4 m. Canal length to RBMC is 0.4 km.

(3) Preliminary design of alternative plans

A movable type diversion weir is selected based on the considerations of; (i) water depth at the weir site between present river bed level and required intake water level (or crest of weir) is about 8 - 9 m, (ii) design water levels of weirs are just below the river bank level, and (ii) backwater effect to the upstream stretch of the weirs to be avoided as much as possible to conserve riverine conditions. Selection of the movable weir type is made through a comparative study on (i) girder type roller gate and (ii) rubber tube weir. As a result of the comparative study, rubber tube weir is selected for the scheme.

The pump plan consists of two major diversion facilities; pump station and low diversion weir. Diversion weir is planned to sustain the stable intake condition for the suction of pump equipment. Fixed type weir is planned taking into account the low height of weir and wide width of valley. Height of the weir is planned to be 2.4 m taking into account the suitable suction condition of pumps. Three pumps with capacity of 78 m^3/min/unit and 14 m lifting height are planned to be installed at the pump station taking into account the intake discharge of 3.9 m^3/s and its seasonal variation, and maintenance of pump units. Volute mixed flow type with diameter of 800 mm is selected based on the design discharge and required lifting height.

The estimated direct construction cost of the three alternative plans are summarized below.

(Unit : Rs. million)

Item	Alt-1 (2 weirs plan)	Alt-2 (one weir plan)	Alt-3 (pump plan)
1. Diversion weir	247.8	183.1	38.7
2. Pump station	0.0	0.0	165.3
3. Canalization	23.0	14.3	2.3
Total	270.8 (137)	197.4 (100)	206.3 (105)

(4) Conclusion and recommendation

As a result of the study, Alternative 2, construction of one diversion weir at the confluence of Rakwana and Andolu rivers, is the most economical and suitable plan among the three alternative plans from the viewpoints of construction and operation costs, and maintenance. This plan could divert river water to RBMC by gravity.

However, it is considered that the implementation of the plan is to be suspended till project management of the left bank area is fully developed or additional water demand will occur in outside the basin.

It is recommended that a comprehensive study on development of the Timbolketiya river is to be executed including the hydrological observation of the river flow, environmental impact assessment of riverine area influenced by flood and back water effects of the weir, the monitoring of return flows available at the Liyangastota anicut at the full development stage of the left bank area, and water management of the irrigation area upstream of the anicut.

4.5 Water Balance Study

4.5.1 General

Objectives of the water balance study are:

(i) to determine the potential development area on the left bank,

(ii) to examine the impacts of the left bank development on the existing water users downstream of the Uda Walawe reservoir,

(iii) to assess the effects of the Samanalawewa operation on the overall water management of the Walawe basin ,

(iv) to investigate the possibility of the Timbolketiya diversion plan.

Four check points have been established for the water balance study: they are the Samanalawewa dam, the Uda Walawe dam, the Liyangastota anicut, and the Ambalantota bridge.

Monthly inflow data of the Samanalawewa dam and Uda Walawe dam have been prepared for 31 years from 1960 to 1990. But data regarding the operation of the Samanalawewa reservoir prepared by CEB are available only for 20 years from 1970 to 1989. Therefore, water balance calculation has been undertaken for 31 years on a monthly basis except for the Samanalawewa dam which the calculation has been done for 20 years.

Water balance study is a process of trial and error. First, a hypothetical development area and its water requirements are assumed and the water balance between supply and demand at a certain check point is examined. If the result does not satisfy the predetermined condition, the process is repeated changing the hypothetical figures until the result satisfies the condition.

In this study, 80% dependability has been adopted as the criteria to judge the success or failure of the study result. This criteria is commonly used in most irrigation projects under international financing. Therefore, occurrence of water shortage in four years out of 20 years will be accepted.

The schematic diagram of the Walawe basin is presented in Figure 10.

4.5.2 Available water resources

(1) Uda Walawe reservoir

Monthly inflow data of the Uda Walawe reservoir for 31 years from 1960 to 1990 have been estimated as shown in Annex II. Annual average inflow is 900 MCM. The active storage capacity of the reservoir is 240 MCM. Evaporation loss from the surface water has been included in the water balance calculation.

(2) Samanalawewa reservoir

Monthly inflow data of the Samanalawewa reservoir have been estimated by CEB for 30 years from 1960 to 1989. Annual average inflow is 527 MCM. The active storage capacity of the reservoir is 218 MCM. Monthly turbine flow (outflow) data of the Samanalawewa power station are available for 20 years from 1970 to 1989 which have been prepared by CEB in their simulation study.

(3) Liyangastota anicut and Ambalantota

Discharge at the Liyangastota anicut is composed of the discharge from the intermediate basin between the Uda Walawe dam and the anicut plus the release from the Uda Walawe reservoir plus the return flow from part of the paddy irrigation areas on both banks.

Monthly discharge data at Embilipitiya have been estimated for 31 years from 1960 to 1990. Discharge from the intermediate basin between the Uda Walawe dam and Embilipitiya has been estimated by reducing the Uda Walawe discharge from the Embilipitiya discharge. The discharge from the intermediate basin is about 250 MCM per annum.

Monthly discharge data of the Mau river river have been estimated for 31 years from 1960 to 1990. Annual average discharge is only 9 MCM. Run-off of the Hulanda river river is regulated by the Chandrikawewa for irrigation of the Walawe right bank area. Water resources of both rivers are disregarded in the estimation of discharge at the Liyangastota anicut for safety.

Discharge at Ambalantota comprises the excess water released from the Liyangastota anicut and the return flow from part of the irrigation areas under the Liyangastota irrigation system.

(4) Timbolketiya river

Monthly discharge data of the Timbolketiya river have been estimated for 31 years from 1960 to 1990. Annual average discharge is 124 MCM.

The Timbolketiya diversion plan has been conceived to augment water resources in the Walawe basin by creating a more intensified water reuse system. It is intended to divert part of the Timbolketiya flow to the Walawe right bank main canal by means of anicut(s) or pumping. The diverted flow is expected to return to the Walawe river and be used at the Liyangastota anicut. The amount of water to be diverted is about 76 MCM per annum.

(5) Return Flow

Irrigation water requirements for paddy field reclaimed on RBE soils in the Study area have been estimated as high as 4.3 to 6.9 m per annum due to the high percolation/seepage loss and

canal loss. However, most of these losses are expected to re-appear in the downstream drains or rivers. This is called the return flow and there is a possibility it can be reuse downstream. According to the research undertaken by the Tropical Agriculture Research Center of Japan in the dry zone of Sri Lanka during the 1970s, the percentage of return flow were 90 to 100% of the percolation/seepage loss. In this study, 90% of the percolation/seepage loss and 80% of canal loss are assumed for the estimation of return flow.

4.5.3 Water demands

(1) Walawe Right Bank Area

The Walawe Irrigation Improvement Project is presently under way with ADB's finance aiming at rehabilitation and improvement of irrigation facilities for 12,300 ha of the Walawe right bank area. In the project appraisal report of 1984, the annual water requirements for the right bank were estimated at 435 MCM comprising 405 MCM for irrigation demand and 30 MCM for industrial demand.

However, ADB expressed their view in the meeting held at MASL on June 10th, 1992 that these figures should not be considered in determining the water requirements for the right bank because substantial insight has been gained regarding the validity of the appraisal assumptions according to studies made in recent years by IIMI and other consultants who were of opinion that more water would be required than the appraisal figures in view of the actual water use in the past .

MASL supports the original figure of 405 MCM considering the favorable prospect of crop diversification in future.

In response to ADB and MASL's request, MMP (a British consultant attached to WIIP) made another estimate of 346 MCM taking into account the crop diversification, improved water management including effective use of upper catchment run-off and return flows, improved physical infrastructure, and better cooperation between farmers.

It was agreed between MASL and the JICA Study Team that the water balance study would principally be based on 435 MCM for irrigation and industrial requirements (referred to as Scenario 1) with a sensitivity analysis based on 376 MCM of irrigation and industrial requirements (referred to as Scenario 2).

(2) Liyangastota anicut

The anicut presently commands 6,210 ha of paddy field on both banks. The irrigation water requirements have been estimated at 273 MCM per annum based on the water requirements for LHG soil used for the Walawe left bank. In addition, domestic and other demands of 18,000 m^3/day, which was estimated by the Irrigation Office, has been included.

The Ridiyagama tank lying on the left bank and receiving supply from the anicut has an active storage capacity of 23.2 MCM. However, the regulating function of the Ridiyagama tank has been disregarded in this study.

(3) Hambantota-Ambalantota water supply scheme

The scheme supplies pipe borne water to Ambalantota and Hambantota cities. Water is taken from the Walawe river and pumped after treatment to towers at Hambantota and Ambalantota.

The treatment consists of aeration, coagulation, sedimentation, rapid sand filtration, and disinfection. The scheme presently supplies about 3,400 m^3/day of treated water.

Estimating the population in 2010 to be 23,000 in Ambalantota and Hambantota and the demand to be 240 l/day/head, the net water requirement has been estimated at 0.2 MCM per month (5,600 m^3/day x 30 days). Considering allowances, a requirement of 1 MCM per month has been assumed in the water balance study.

(4) Kaltota irrigation scheme

The scheme covers 870 ha of paddy field lying just downstream of the Samanalawewa dam. The irrigation water requirements have been estimated based on the same unit water requirements for LHG soil as the Walawe left bank and the effective rainfall at M 060 station. The estimated water requirements are 52 MCM per annum, of which 41 MCM returns to the Walawe river.

(5) Old and Extension areas on the Left Bank

Irrigation water requirements for the Old and Extension areas on the left bank covering a net irrigation area of 12,030 ha have been estimated at 340 MCM per annum.

Regarding the Sevanagala sugar area, the water demand of 61 MCM/year for the development of 2,750 ha which has been estimated by the Sugar Industry, is taken as the entire water demand of the scheme. The demand comprises irrigation water requirement of 56 MCM and other demand of 5 MCM such as sugar factory demand and settlers demand.

Irrigation water requirements for MEA control area covering 9,280 ha in net have been estimated at 282 MCM based on the proposed cropping pattern. This area includes 2,900 ha of existing irrigation area and 6,380 ha of new irrigation area.

Water demands other than irrigation in the left bank except Sevanagala sugar scheme have been estimated at 3 MCM per annum comprising (a) drinking water supply for the settlers and (b) water demand of agro-industries.

4.5.4 Water balance calculation

(1) Priority of water use

The existing water users are deemed to have priority. The Kaltota irrigation scheme is supplied with water through the irrigation water outlet of the Samanalawewa dam. The Liyangastota anicut and the Ambalantota domestic water supply scheme have been dealt with as priority water users in the Walawe basin, too. In the water balance calculation, deficit has been offset with the release from the Uda Walawe reservoir.

However, the right bank area has been dealt with as part of the overall Walawe irrigation scheme composed of the right and left banks, because it would be very difficult to give priority to the right bank area in actual water management practice.

(2) Alternative cases

The water balance has been examined for 25 cases based on 17 calculations. Check points are the Samanalawewa dam (one case), the Uda Walawe dam (8 cases for with and without

Samanalawewa, with and without Timbolketiya, and Scenario 1 and 2), the Liyangastota anicut (for the same 8 cases), and Ambalantota (for the same 8 cases).

4.5.5 Results of water balance study

(1) Potential development area of the Left Bank

Assuming 6,380 ha of new irrigation development area on the left bank, the probability of occurrence of deficits at the Uda Walawe reservoir have been calculated for 4 cases; with Samanalawewa, with and without Timbolketiya diversion and under Scenario 1 and 2.

Since all the four cases satisfy the targeted probability of 1/5, it can be said that the proposed new irrigation development of 6,380 ha on the left bank has been justified.

(2) Water Balance at the Samanalawewa dam

Results of the water balance calculation indicate that the Samanalawewa reservoir empties almost every year, which renders not only power generation but also the irrigation supply to the Kaltota scheme unstable. However, as the Samanalawewa reservoir is located upstream of the Uda Walawe dam, it does not affect the development potential of the left bank.

(3) Water balance at the Liyangastota anicut and Ambalantota

Results of the water balance calculation indicate a small amount of deficit occurs once in 20 years for some cases. But the deficit can be ignored because the volume is very small and can be negated by the regulating function of the Ridiyagama tank. No deficit will occur at Ambalantota.

(4) Effect of the Samanalawewa reservoir operation

Results of the water balance calculation indicate operation of the Samanalawewa reservoir will decrease the frequency of occurrence of deficit at the Uda Walawe reservoir. Therefore, it is considered the operation of the Samanalawewa reservoir will bring forth favorable effects to the overall water management of the Walawe basin.

(5) Effect of the Timbolketiya diversion plan

Results of the water balance calculation indicate the Timbolketiya diversion plan will augment the water resources of the Uda Walawe reservoir and reduce the amount of deficit in drought years.

The Timbolketiya diversion plan will give no adverse effect on the water balance at the Liyangastota anicut from drawing off the Uda Walawe dam.

(6) Difference between Scenario 1 and Scenario 2

Results of the water balance calculation indicate that there will be no difference between Scenario 1 and 2 in the potential development area on the left bank under the condition of with Samanalawewa and without Timbolketiya, because both Scenarios give the same probability of occurrence of deficit. However, the deficit is smaller in Scenario 2 than Scenario 1 for the same case.

Under the condition of with Samanalawewa and with Timbolketiya, Scenario 2 gives a smaller probability of occurrence of deficit than Scenario 1, which indicate the possibly, that a larger area than 6,380 ha could be developed (8,140 ha based on a simple calculation using unit requirements for the south area).

(7) Water management of Uda Walawe reservoir

Deficit at the Uda Walawe dam normally occurs in the latter part of the Yala season which gives certain prospects on the water management method of the Uda Walawe reservoir in drought years. As practiced by MASL in 1992, the cropping area should be limited to a certain extent according to the storage capacity of the Uda Walawe and Samanalawewa reservoirs at the beginning of the Yala season.

4.6 Rural Infrastructure Development Plan

4.6.1 Basic considerations

(1) Objective area

Based on the study results on the situation of the existing facilities, it is judged that the existing infrastructure in the Old area has been developed and satisfies the minimum required provision level.

It is planned that development of rural infrastructure for the Extension area is to be devoted under the Project since there is no substantial infrastructure in the area and the infrastructure is indispensable for the settlers and successful achievement of the Project. It is estimated that about 50,000 persons or about 9,000 families are expected to live permanently in the Extension area at full development stage of irrigation development of about 5,400 ha under the Project.

(2) Provision level of rural infrastructure

Provision level of rural infrastructure is determined based on the study of the present situation of the rural infrastructure in the Study area and by referring to "Settlement Criteria" applied by MASL. According to the criteria, the minimum required facilities and services for the settlement scheme consists of: (i) education facilities, (ii) health and medical care facilities, (iii) postal service facilities, (iv) drinking water supply facilities, (v) road network, (vi) electricity supply, and (vii) administration facilities for project management.

Among them, in view of the serious drinking water problem in the Extension area, provision of rural water supply for settlers would be a important item. It is considered that the provision of main rural road is an indispensable facility for the irrigation Extension area to serve for the transport of agricultural inputs and production, and subsistence goods. It will activate human movement and promote regional development including post harvest facilities and processing facilities for agricultural products.

(3) Village alignment

The settlement areas will be established in groups of inhabitants by their farming level and social activities so that the social and technical services can be rendered more effectively and efficiently. Under the condition, the project will provide Hamlets as alimentary settlements, and the Village Center will be set as cores of the primary activity sphere. Moreover, the Area Center will be established in the center of the secondary sphere.

The settlement areas are planned to be located in the areas unsuitable for irrigation farming so far as the aerial conditions can allow. About 9,000 settled families in the project area will be accommodated in 22 settlement areas. The settlement areas are arranged in a hierarchy consisting of three types of settlement; (i) hamlets, each having about 250 farm households with appropriate social and community facilities, (ii) village centers, and (iii) area center. Facilities of a village center services for three to four hamlets, and area center provide the highest service facilities for the settlers in the area being the core of the settlement services. Required space of the settlement areas is estimated based on the number of families, unit plot size of homesteads of 0.2 ha/family and firewood forest area of 0.1 ha/family. Starter facilities and services for settlers including materials for houses, seeds, and foods will also be required to be provided by the Project. Principal features of settlement areas are summarized below.

Item	Hamlet	Village/C.	Area/C.	Total
1. Land				
Cultivation area (ha)	3,750	540	1,050	5,340
Village area (ha)	820	130	250	1,200
Fire wood forest (ha)	475	60	135	670
2. Village				
Villages (no)	18	2	2	22
3. Population				
Farm families	3,750	540	1,050	5,340
Non-Farm families	2,710	390	760	3,860
Population total	34,900	5,000	9,800	49,700

4.6.2 Development plan

Based on the above considerations, the following facilities for the development of rural infrastructure are planned:

(Unit : nos.)

Item	Hamlet	Village/C.	Area/C.	Total
1. Settlement area	18	2	2	22
2. Education facilities	18	4	6	28
3. Health & medical care	8	2	2	12
4. Postal service facilities	0	2	2	4
5. Drinking water supply	18	2	2	22
6. Road (km)				
Village roads	93	14	12	119
Main farm road				31
7. Electricity supply	0	2	2	4
8. Telecommunication facility	0	2	2	4
9. Administration office	18	2	2	22
10. Agro extension facilities	0	2	4	6

4.7 Basic Approach to Organizational Development

4.7.1 Summary of problems of organization

The MEA has been involved in human settlements and post-settlement activities, as the executing agency, of several major projects under the Accelerated Mahaweli Development Programme (AMDF). The experience it has gained over the years could contribute towards successful implementation of the proposed project.

The existing Organizational structure of the MEA, in general, is adequate to undertake the settlement and post-settlement management of the project. Some areas that need strengthening and/or re-organizing for further improvement are highlighted below:

(i) The functioning of the delicately arranged of management matrix, with line and functional relations inter-woven in the Management Organization, would require good inter-personal relations in addition to the line authority. Some operational problems are apparent at the unit level, where Field Assistant (Agricultural Assistant), who is functionally responsible to the Block Agricultural Officer, is placed under the line management of the Unit Manager.

(ii) The high degree of crop diversification anticipated under with project conditions necessitate the establishment of strong marketing systems. It is therefore, vital that the marketing organization of MEA be strengthened and its scope enlarged to serve the project needs effectively.

(iii) The MEA is proposing to expand the area served by a Unit Manager to several villages (hamlets) from the original single village concept. Such an approach may be applicable to old settlement areas where a certain level of consolidation has been achieved. In the new settlement area under with project conditions it is considered best that every village (of about 200 farm families) is served by one Unit Manager.

(iv) Provision of full staff complement is vital for effective management of the system.

4.7.2 Basic approach for development

The Basic approach to organizational development is centered on the following concepts:

(i) In the Extension area, a Unit Manager to serve one village of 200-250 farm families.

(ii) Emphasize and restrict the functional areas at the block level to Water Management, Agriculture and Community Development.

(iii) Strengthen the project level functional areas, particularly those of marketing and credit land administration and farmer institution development, in order to co-ordinate their respective activities directly with farmers through Block Managers and Unit Managers.

(iv) Establish an official co-ordinating body at the Project level consisting of representative from Sevanagala Sugar Company Ltd., local Government authorities and other relevant organizations.

(v) As far as possible, the existing organization structure of MEA should be maintained.

4.7.3 Proposed improvement

It is proposed that the RB and LB areas of the Walawe project area are brought under a Resident Project Manager, assisted by two Deputy Resident Project Managers for each area. The functionally specialized divisions of the project will serve both areas.

At the Block level, it is proposed to reduce the present functional areas to water management, agriculture and community development.

In keeping with the current policy of MEA, the Field Assistants as the extension agent will be replaced by Agricultural Assistants. Each Agricultural Assistant will serve about 400-500 farm families in 2 villages and will report directly to the Block Agricultural Officer and not to the Unit Manager.

The proposed organizational structure is shown in Figure 9.

4.7.4 Training programme (Agricultural Training)

The project proposes large scale cultivation of Sugarcane, a crop that is new to Mahaweli projects. The required expertise on Sugarcane is, therefore lacking within the organization. It is proposed that specific training programmes be arranged at the SRI for intensive training of officers before the commencement of settlements. Such specific training is also proposed in the field of high quality vegetable production and storage of agricultural products.

Training of officers and farmers under agricultural extension forms an integral part of the extension system. These programmes include:

(i) Pre-seasonal training of officers conducted prior to commencement of each production season by DOA, to constantly update the knowledge.

(ii) Bi-weekly training of extension staff conducted by the project subject matter officers at the Block level to develop extension massages.

(iii) Bi-weekly farmer group training conducted by the Agricultural Assistants to decimate the extension messages.

CHAPTER 5 PROJECT WORKS

5.1 Irrigation and Drainage Work

5.1.1 General

The main project works proposed consist of two major items; (i) rehabilitation and improvement work for the existing irrigation facilities in the Old area of 2,900 ha, and (ii) irrigation extension work of 6,380 ha.

The main work items for the rehabilitation and improvement work are: (i) rehabilitation and upgrading work of the canals of about 190 km long in total, (ii) repair and replacement of about 1,500 related structures, and (iii) construction of 2,800 new structures. The major works for irrigation extension work are: (i) construction of irrigation canals 360 km in total comprising main, branch and distributary canals, (ii) construction of 250 km of drainage canals, (iii) construction of about 1,600 related structures, (iv) construction of 406 km of roads along irrigation and drainage canals, (v) rehabilitation and construction of 47 tanks, (vi) on-farm development of 6,380 ha, (vii) land reclamation of 5,240 ha, and (viii) procurement of O&M equipment.

The basic design of the irrigation and drainage facilities is made based on the available topographic map on a scale of 1:3,170 and national map on a scale of 1:50,000. Supplemental topographic survey data of the existing major canals are also employed for the design. The geotechnical data and information investigated were considered in the design.

Principal features of the proposed project works are summarized in Table 8.

5.1.2 Rehabilitation and improvement work

(1) Canals

Improvement work for the main and branch canals consists of heightening of canal banks for 14 km, and side slope protection of 11.1 km in total at the eroded portion, especially at the outer bend of curved portions and up and downstream of structures. Required length of the bank heightening work is estimated at 8 km for LBMC and 6 km for BBC. Maximum and average required heightening of LBMC are estimated at 1.7 m and 0.4 m. Regarding BBC, the tail end stretch of about 2 km requires reconstruction to convey irrigation water with appropriate water level to the irrigation extension area which is located at the end of the canal.

Most of the small scale canals such as distributary and field canals have deteriorated due to lack of maintenance of the canal sections and erosion by water especially on the bends of the canals. To sustain the proper water distribution, and to save the conveyance losses in the canals and financial burdens for maintenance cost, a concrete lined canal is planned for the distributary and field canals of 132 km in total. Extension of distributary and field canals of 30 km in total is also planned to distribute irrigation water properly for whole farm plot from field canals through farm turnouts.

(2) Related structures

The proposed works for the related structures are summarized below.

(i) Repair and upgrading of the existing 742 structures. Major items are 426 drops, 124 farm turnouts, 126 field turnouts and 1 aqueduct on LBMC for crossing the Mau river.

(ii) Replacement of the 738 existing structures. Major items are 373 farm turnouts, 307 drops, and 46 field turnouts.

(iii) Construction of 2,848 new structures. Major items are 2,219 farm turnouts, 407 culverts, 75 bathing steps, and 44 discharge measuring devices.

5.1.3 Irrigation extension work

(1) General

The irrigation canal system comprises main, branch, distributary, and field canals and related structures including tanks. Alignment of irrigation canals are made taking into consideration the proposed tank cascade system. Left Bank Main Canal (LBMC) is extended from the existing end point at Suriyawewa for 25.0 km along the water shed line. Canal route is selected to avoid deep cuts and high embankments. A contour canal is basically applied for distributary canals to avoid deep cuts and high embankments taking into account the results of the geological survey. For saving water losses and maintenance costs, thin concrete lining, 7.5 cm thickness, is proposed for full stretch of branch, distributary and field irrigation canals.

The tank cascade system is introduced for the irrigation system in the irrigation extension area aiming at high irrigation efficiency with rather low level water management in the end users. The tanks will realize reuse of return flows (low tank) and function as buffer pond for upland irrigation (high tank). Existing tanks scattered in the area are fully utilized as low tanks and incorporated in the proposed irrigation system. Farm ponds for upland crop irrigation (high tank) are planned at the beginning of distributary canals to regulate canal flow. One small scale anicuts (pick-up structure) for collecting drainage water is planned on the Aliolu river in the Suriyawewa block.

(2) Proposed work

To realize successful agricultural development through construction of irrigation and drainage facilities, the following irrigation facilities and rural infrastructures are proposed to be constructed:

(i) Construction of about 360 km of irrigation canals, comprising extension of LBMC of 25.0 km, 8 branch canals of 35.1 km in total, and 71 distributary canals of 302 km in total.

(ii) Construction of about 254 km of drainage canals. About 50 km of these drains could utilize the existing natural drains with reshaping and expanding their flow section.

(iii) Construction of about 1,600 related structures on main, branch, and distributary canals. Major items are 580 farm turnouts, 172 distributary turnouts, 545 drops, 44 culverts and 15 regulators.

(iv) Rehabilitation of the 15 existing village tanks, construction of 4 new low tanks, 28 high tanks, and 1 small anicut.

(v) Construction of 406 km of roads along the irrigation and drainage canals. Effective width of roads are 4.5 m for roads along the 60 km of main and branch irrigation canals and 2.1 m for distributary canals. Pavement is required for roads along the main and branch irrigation canals.

(vi) On-farm development of 6,380 ha in total including construction of about 380 km of field canals and about 6,400 related structures.

(vii) Reclamation of farm lands of 5,240 ha in total comprising 2,410 ha of paddy fields and 2,830 ha of upland fields. The work includes clearing of bush, land levelling and grading, and initial ploughing. It is assumed that construction of levees for paddy fields, furrows for upland fields, and required additional land preparation work for cultivation is to be done by settled farmers.

(viii) Procurement of O&M equipment.

5.2 Rural Infrastructure Work

(1) General

Project works proposed are ; (i) construction of buildings for 28 schools, (ii) construction of buildings for 12 medical and health care centers, (iii) construction of buildings for 4 post service facilities, (iv) construction of 23 drinking water supply systems, (v) construction of 141 km of rural roads, (vi) construction of buildings for 22 project administration offices, (vii) construction of buildings for 6 agro-extension facilities, (viii) construction of buildings for 1 development center and provision of equipment, (ix) land preparation work for a settlement area of 1,200 ha, and (x) provision of networks for electric supply and telecommunication.

The scale and grade of facilities are decided by referring to the facility design applied to a similar project in the country based on the consideration that the project will provide the minimum required facilities and services for the settlement scheme.

(2) Education facilities

28 school buildings are planned to be constructed under the project. Buildings consist of (i) 22 primary schools are for each hamlet, (ii) 4 junior schools in village centers and area centers, and (iii) 2 senior schools in area centers. Average number of pupils for one primary school is estimated at 150 and junior and senior school 600 and 800, respectively. Each school has class rooms, practice rooms and a teacher's room.

(3) Health and medical care facilities

10 unit (Gramodaya) health care centers, as a primary medical treatment unit, and 2 sub-divisional health centers in the area centers are planned. In each of the former centers, one public health nurse is stationed. One doctor and two or three nurses are stationed in each of the latter centers. Spaces of building of each unit and sub-divisional center are 50 and 250 m^2.

(4) Water supply

Drinking water will be supplied all settlers through communal taps in the settlement area. Total number of taps planned are 270. Water in the canals or tanks are diverted by intake structure

and treated by sand filter and clarification facilities. It is considered that bathing,washing, etc. will be made in the canal and tanks at the bathing steps.

(5) Administration buildings

Construction of 20 "unit service centers" and 2 "block offices" is planned for management of the project. Unit service centers are located at each hamlet and village center and block offices are in the area centers. Office space for unit service center and block office are 180 m^2 and 640 m^2, respectively. Block office consists of rooms for block office manager, engineers, agricultural officers, administration, meeting, store, kitchen, and toilet.

(6) Road network

The road network conforms to the irrigation and drainage layout, because village roads will function as operation and maintenance roads as well. The road network consist of three categories of roads, namely main, market, and hamlet roads.

The existing road from Suriyawewa to Mirijjawila is in poor condition. This road will be the main rural road of the extension area in the future and needs pavement to turn it to an all weather road. Another paved main rural road would be needed to connect Suriyawewa with Padalangala across the Walawe river. By this road, the new irrigation development area of 1,040 ha lying in the west of Suriyawewa will have communication means.

The main road of 30.5 km shall an effective width of 6 m to allow two units of heavy farm machines or heavy trucks to pass. This main road is to be paved with asphalt. One bridge about 90 m long is proposed on the main road for crossing the Walawe river to connect both left and right banks of the area.

Market roads of 87 km in total will connect village centers and area centers. The effective width is 4.5 m so that farm machines such as tractors and trucks will be able to pass. The road surface is paved with asphalt. Hamlet roads of 24 km in total connect hamlets and cultivation areas. The road has effective width of 4.5 m and the surface is paved with gravel.

(7) Collection and shipping facilities, and pola

Four collection and shipping centers and two polas (public market) are planned for marketing of agricultural products from the project. Collection and shipping centers have building space of about 450 m^2 consisting of warehouses and administration buildings. Facilities needed for a pola are a concrete yard with shelter of 350 m^2 and administration building. Land area required for each collection and shipping center and pola are 1,000 m^2 and 10,000 m^2.

(8) Development center

One development center is located at Suriyawewa with area of 20,000 m^2. Building space is estimated at 1,200 m^2. The center has a rooms for agricultural extension work, community development work, and common use section. Since the center provides various training activities and events, some equipment such as audio-visual equipment, laboratory equipment, and food processing facilities are provided. The center would lay priority to the need for participation of women in farmers organization and training in cottage industry.

(9) Other facilities

The electricity supply system will be expanded to village centers and area centers, especially for the activities of the public service agencies. Actual work for extension of the power supply line will be done by CEB.

The telecommunication system will also be expanded to village centers and area centers by extension of the available telephone line. Public phones will be available at the sub-post office.

Two post boxes at the village centers and two sub-post offices at area centers will be constructed for the convenience of settlers.

5.3 Implementation Programme

5.3.1 General

The actual construction work of the Project is scheduled to be implemented from the middle of 1995 after detailed design and pre-construction arrangements for the construction works. Following the progress of irrigation development, the cultivation area of sugar cane will be increased gradually. It is planned that the extension of the processing capacity of the Sevanagala sugar factory, to receive the additional sugar cane, produced in the project area, will be implemented by the Sevanagala sugar company and completed at the end of 1998. Close coordination between the execution agency of the project and the Ministries concerned for the implementation of the two projects is strongly required.

Implementation time schedule of the project works as well as development area is presented in Figure 11.

5.3.2 Implementation time schedule

(1) Time schedule for pre-construction arrangement

Budgetary arrangement for both detailed design and construction work is required urgently to realize the project. The arrangement is to be started in the beginning of 1993 and the detailed design works for 1.5 years will be started in late 1993. The detailed design will include a review of the feasibility study, preparation of a topographic map, and preparation of the tender documents for both improvement and extension works of the project including rural infrastructure.

The pre-construction program broadly consists of selection of contractor-(s) and land acquisition. Tendering of the work will commenced from the beginning of 1995. In parallel with the tendering work, land acquisition for the construction work will commence.

(2) Construction time schedule

The actual construction work of the project will commence in the middle of 1995 and complete in the middle of 1998. Total construction period of the work is scheduled to be 3 years from the time of contract signing between the execution agency and construction contractor. Rehabilitation and improvement work in the Old area is scheduled for 2 years. Construction of rural infrastructure except block office and some unit offices in the Extension area will be implemented according to the progress of the irrigation and drainage extension works. Construction of block and some unit offices is scheduled to be made in the early stage of construction for construction management and settlement administration.

5.3.3 Organization and management

(1) Construction stage

MASL will be the executing agency for implementation of the project works, coordinating all the activities of the all governmental agencies, especially with Ministry of Plantation and Industry for the extension work of the Sevanagala sugar factory, and regional administrative organization in connection with the project implementation. MASL has sufficient capability and plenty of experience in carrying out the implementation of the project including detailed design and construction management.

For smooth and proper execution of the construction management, it is proposed to establish the project office in Suriyawewa in detailed design stage and early construction stage. Proposed organization of the project implementation for construction stage is presented in Figure 12.

(2) Operation and maintenance stage

It is proposed that the operation and maintenance works of the project facilities will be made by MEA's site office in Embilipitiya under the jurisdiction of MASL. A deputy resident project manager is required, who will be responsible for water management and agricultural activities as well as settlers. In addition, establishment of two block offices are required for management of the irrigation extension area.

It is also proposed to establish a coordination committee for basin wide water resources management. The anticipated members of the committee are MEA's site officer as a secretary of the committee, officer of water management secretariate (WMS) of MASL, representatives of MASL & MEA head office, irrigation officer for Liyangastota anicut scheme, CEB officer who manages Samanalawewa reservoir, an agent from the Sevanagala sugar company, and local government agents concerned.

The proposed organization of operation and maintenance stage is presented in Figure 9.

5.4 Cost Estimate

5.4.1 Conditions of cost estimate

Constitution of the construction cost is as follows:

(i) Direct construction cost of the project facilities consisting of irrigation and drainage work and rural infrastructure work including physical contingency;

(ii) Associated cost consisting of administrative expenses and engineering services cost;

(iii) Price contingencies.

Construction cost for the project is estimated on the price level at August 1992. The exchange rate used was US$1 equals Rs. 44. The construction cost is estimated using foreign currency (F.C) and local currency (L.C) components in accordance with the origin of the material. The currency for the cost estimate is expressed in Sri Lanka Rupees for both local and foreign currency components.

Physical contingency is assumed to be 15% taking into account the degree of design and investigations for the project. The annual price escalation rate is taken at 3.8% for the foreign currency component and 11.6% for the local currency component.

5.4.2 Initial investment cost

(1) Direct construction cost for irrigation and drainage works

Constitution of the work cost is as follows:

(i) Civil work for rehabilitation and upgrading works of the existing irrigation facilities for 2,900 ha;

(ii) Civil work for construction of irrigation and drainage canals with related structures in the irrigation extension area of 6,280 ha including land reclamation and on-farm development;

(iv) Procurement of O&M equipment;

(v) Physical contingency for the civil works.

The direct construction cost for works is estimated on a unit price basis multiplying the unit price of works by the corresponding work quantity. The total direct construction cost of civil work is estimated at Rs. 2,100 million, of which foreign currency component is Rs. 1,327 million (equiv. to US$48 million) and local currency component is Rs. 773 million, respectively.

(2) Direct construction cost of rural infrastructure

The cost for the rural infrastructure consist of: (i) land preparation for the settlement area, (ii) building work comprising schools, health and medical care center, management office, post office, development center, (iii) farm and village road network, (iv) water supply, (v) electric power supply, (vi) telecommunication system, (vii) farm operation facilities consisting of collection and shipping centers and polas, and (viii) starter facilities of settlers including supply of housing materials, subsidy of foods for the initial year and seeds.

The cost is estimated based on the current unit prices applied to similar projects under MASL. The total direct cost of rural infrastructure work is estimated at Rs. 1,318 million, of which foreign currency component is Rs. 813 million (equiv. to US$18 million) and the local currency component is Rs. 505 million, respectively.

(3) Cost of environmental mitigative action and monitoring

The cost consists of: (i) construction of power fence for elephants, (ii) tree planting for soil conservation, and (iii) studies and monitorings of aquatic vegetation, surface water quality, and soil salinity. The cost is estimated based on the current cost applied for similar projects. Estimated cost is Rs. 10 million in local currency.

(4) Administration expenses

The administration expenses consists of MASL's direct administration cost at the construction site and the compensation cost for the crops and houses to be affected by the execution of the construction works. The cost is estimated at Rs. 220 million in local currency.

No allowance has been made for land acquisition as all the land in the project area belongs to the Government. Required land space for the project facilities is estimated at about 400 ha.

(5) Engineering service cost

The engineering services cost consists of detailed design, additional surveys and investigations and construction supervision, and training. The cost is estimated based on the required man-month (M/M) of the consultant engineers require 730 M/M in total comprising foreign consultants of 244 M/M and local consultant of 486 M/M , and cost for additional surveys and investigations including mapping (s=1/2,000). The estimated cost is Rs. 345 million in foreign currency.

(6) Disbursement schedule and price contingency

A price contingency of Rs. 1,492 million, consisting of Rs. 470 million of foreign currency and Rs. 1,022 million of local currency, is estimated based on the disbursement schedule and escalation rates. Annual disbursement schedule is shown in Table 10.

(7) Summary of initial investment cost

The total project costs are summarized below and details are shown in Tables 9.

(Unit: Rs. million)

Description	L/C	F/C	Total
A. Direct construction cost	**1,090**	**1,816**	**2,906**
(1) Rehabilitation and upgrading works	(108)	(157)	(265)
(2) Extension work of irrigation area	(545)	(969)	(1,514)
(3) Rural infrastructure work	(427)	(690)	(1,117)
(4) Environmental mitigation measures	(10)	(0)	(10)
B. Associated cost	**220**	**345**	**565**
(1) Administration expenses	(220)	(0)	(220)
(2) Engineering service cost	(0)	(345)	(345)
C. Physical contingency	197	323	520
Sub- total (A + B + C)	**1,507**	**2,484**	**3,991**
D. Price contingency	**1,022**	**470**	**1,492**
Total	**2,529**	**2,954**	**5,483**

5.4.3 Operation, maintenance, and replacement cost

(1) Operation and maintenance cost

The annual operation and maintenance costs for irrigation and drainage facilities include salary cost of project administration, water management and maintenance, and agricultural and settlement services staffs, labour cost for repair and maintenance cost of the facilities, and cost for operational and maintenance of the O&M equipment. Annual O&M cost is estimated at Rs. 21.0 million (1% of the direct construction cost of civil works) consisting of a salary cost for 200 staff of Rs. 12 million, facility cost including equipment running and maintenance cost and office running cost of Rs. 4 million, work cost for maintenance work of Rs. 2 million, agriculture and settlement services cost of Rs. 1 million, and monitorings of waters, soils and health care, etc. of Rs. 2 million.

(2) Replacement cost

Assuming that the economic durable year of gates and O&M equipment is 20 years and other facilities are 50 years, the replacement cost is estimated at Rs. 71.0 million in total comprising foreign currency of Rs. 57.3 million and local currency of Rs. 13.7 million.

CHAPTER 6 JUSTIFICATION OF PROJECT

6.1 General

For the economic evaluation, three measures of project worth, namely, economic internal rate of return (EIRR), benefit-cost ratio (B/C) and benefit minus cost (B-C) were examined. In addition, a sensitivity analysis in terms of EIRR was made to evaluate the economic viability of the Project against possible changes in project costs and benefits.

For the financial evaluation, the effect of the Project on farm budget of average farmers are analyzed in the farm budget assessment.

The indirect benefits and socio-economic effects, which would impact on the regional and national economy, were also studied briefly.

6.2 Economic Evaluation

6.2.1 Basic assumptions

The project evaluation from the view point of the national economy is made on the following basic assumptions:

(i) The economic useful life of the Project is fifty (50) years.

(ii) All prices are expressed in 1992 constant prices.

(iii) The exchange rate of US$1.00 = Rs. 44.0.

(iv) The period of construction work including preparatory works is six (6) years.

(v) A standard conversion rate (SCR) of 0.75 is applied to economic prices of non-trade goods and services.

(vi) The price contingency and transfer payments are excluded from the economic project costs.

(vii) Cost of unskilled labour is evaluated taking account of the shadow wage rate (SWR) of 0.72

6.2.2 Economic project costs

The project costs for economic evaluation consist of capital cost, annual operation and maintenance (O&M) cost and replacement cost. The economic cost was estimated based on the financial project cost by applying SCR of 0.75 to local currency component. The economic construction cost is summarized below.

(Unit: Rs. million)

Case	Foreign Currency	Local Currency	Total
1. Rehabilitation	217	112	329
2. Extension area	1,320	573	1,893
3. Rural Infrastructure	947	446	1,392
Total	2,484	1,130	3,614

The economic annual operation and maintenance cost (O&M cost) for project facilities are estimated at Rs. 16 million and would be initially disbursed in 1999 when full operation would start.

Gates and O&M equipments, etc. will be replaced at a certain period within the project life. These facilities were assumed to imported and then the economic replacement cost of them was estimated on the basic of same projection with project construction cost. The cost are estimated at Rs. 67 million.

6.2.3 Economic irrigation benefits

The economic farm gate price of rice was estimated at the average value of import parity prices on the basis of the international market price forecasted for the year of 2000 by the world bank. As for sugarcane, economic farm gate price was estimated at the import substitution on the basic of same projection with rice. Since the project was formulated on the assumption that the mill capacity of Sevanagala Sugar Factory would be expanded by the factory, the economic farm gate price of sugarcane was estimated using processing cost including a deprecation cost of new processing equipments. Domestic consumption crops were valued at financial prices estimated on the basis of current market or farm gate prices prevailing in the Project area in 1992.

The direct project benefits consist of irrigation benefits and will accrue primarily from increased crop production owing to stable irrigation water supply. Irrigation benefit to be expected is defined as the difference between primary profit from crops in future with and without project conditions. By multiplying the economic net return per hectare for each crop to those harvested area, the total economic net return by crop production is calculated on both under with and without project conditions as shown in Table 11. The estimated irrigation economic benefit is summarized as below. The annual economic irrigation benefit at full development stage is estimated at Rs. 684 million, as shown below. The benefits would start to accrue from 1996, and would gradually increase up to the full benefit in 2002.

(Unit: Rs. 1,000)

Item	Value
Without Project Condition	
- Paddy	88,320
- OFC	11,408
- Banana	5,494
Total	105,222
With Project Condition	
- Paddy	216,104
- Sugarcane	303,600
- B. Onion	142,632
- Vegetable	48,500
- Banana	78,080
Total	788,916
Economic Benefit	683,694

6.2.4 Economic evaluation

(1) EIRR, B/C and B-C

In order to compute EIRR, B/C and B-C, the annual economic costs and benefits flows were firstly prepared as shown in Table 12. In estimating B/C and B-C, an assumed discount rate 10% was employed. EIRR is estimated at 17.3% and B/C and B-C are 1.72 and Rs. 1,766 million. These results indicate that the Project is economically viable.

(2) Sensitivity analysis

Project sensitivity in terms of EIRR was analyzed in respect of changes in project costs and benefits. The possible adverse changes in the future are as follows.

(i) Cost overrun by 10 or 15%
(ii) Reduction of irrigation benefit by 10%
(iii) Combined effect of above cases

The results of analysis are summarized below.

(EIRR: %)

Cost Overrun	Benefit Reduction	
	0%	10%
0%	17.3	15.6
10%	15.8	14.2
15%	15.1	13.6

The sensitivity analysis shows that if project costs increase by 10% and project benefits decrease by 10% and the feasibility of the Project is economically marginal.

6.3 Financial Evaluation

6.3.1 Farm budget analysis

In order to evaluate the project from a farmers' financial point of view, the farmers' economic analysis were made under both with and without project conditions.

After implementation of the project , the project will provide bases for introduction of improved irrigation farming through the year and improve the quality and quantity of farm inputs and farming practices. As a result, an increase of unit yield of crops and cropping intensity will be much expected under the with project condition. A drastic increase of farm income under the with project condition should be expected especially in the Extension area. On the other hand, substantial increase on farm income will not be expected under the without project condition.

Farm budget of the beneficiary farmers is summarized as follows:

(Unit: Rs./year)

Item	Old Area	Extension Area
Gross Income		
Agricultural Income	123,300	122,000
(Net Agricultural Income)	(79,100)	(78,800)
Gross Outgo		
Production Cost	44,200	43,200
Living Expenses	40,000	40,000
Net Reserve	39,100	38,800

Farm income of the beneficiary farmer in the Extension area is expected to increase to about 7.8 times the present ones. Thus, living standards of the tenants in the extension area would be enhanced remarkably by implementation of the project. In the Old area, farm income is expected to increase to about two times of the present ones by implementation of the crop diversification program. The project is thus justified from the view point of farmers' economy.

6.3.2 Repayment capability of project

The repayment capability of the Project was studied by preparing cash flow statements on the basis of an annual disbursement schedule of the financial project initial cost as summarized below. The price contingency was estimated on the basis of the world manufacturing unit value index forecast by the World Bank and recent tends of consumer price index in Sri Lanka.

(Unit: Rs. million)

Item	F.C.	L.C.	Total
Direct construction cost	2,139	1,278	3,417
Associated cost	345	230	575
Price contingency	470	1,022	1,492
Total	2,954	2,529	5,483

It is assumed that the capital cost required for the implementation of the project will be arranged under the following conditions:

(i) Foreign currency portion of the capital cost is financed by a loan for an international organization.

(ii) Interest rate of the loan is 2.6% per annum and repayment period is 30 years including a 10 year grace period.

(iii) Local currency portion of the capital cost is financed by the Government budget without repayment.

According to the above assumptions, the total fund requirements for construction of the Project was estimated with its yearly breakdown as shown below.

(Unit: Rs. million)

Year	International Fund	Government Budget	Total
'93	15	10	25
'94	95	40	135
'95	316	228	544
'96	858	663	1,521
'97	968	876	1,844
'98	702	713	1,415
Total	2,954	2,529	5,483

The financial inflow and outflow of the project executing agency is shown in Table 13. The statement indicates that repayment of the fund will have to be made from a subsidy from the Government which is estimated at Rs. 161 million on average during the repayment period.

6.4 Increase of Employment Opportunity

After implementation of the project, the employment opportunities for jobless peoples in and around project area will greatly expand. Farm work will provide employment to the majority of the population in the project area. The number of the new beneficiary farmers under with project condition will amount to 6,380. As a result, increase of full-time farm labours is estimated at 12,760. For the non-farm families in and around the project area, they will be basically involved in the service sector as part-time farm-labour or labour for other jobs. The demand for labour for farm work is estimated at 3,850 based on the labour balance study. Furthermore, expanding capacity of the Sevanagala Sugar Factory will employ more workers.

In a commercial center in the extension area such as village center and area center, commercial and business activities will promote the employment opportunities drastically. Implementation of public corporations and offices, banks, schools, hospitals etc. will offer employment opportunities for educated jobless people. Thus, a drastic increase in employment opportunity will be produced in the project area. Expected employment opportunity under with project conditions are shown in Table 13 and summarized as shown below.

(Unit: person)

Item	Employment	Family	Population
Farm Labour	16,610	8,400	45,360
Sugar Factory	460	300	1,620
Village Center	2,010	1,100	5,940
Offices	1,270	1,200	6,480
Total	20,350	11,000	59,400

Thus, employment opportunity for the jobless people in and around project area will be enhanced remarkably and the number of new workers required will reach 20,350. The estimate is based on the assumption that the project is in the early stage. After the year have mellowed the project, employment opportunity will increase gradually. Thus, the project will generate considerable employment opportunity and have a great impact on the economic activity in Sri Lanka.

6.5 Indirect Benefits and Socio-economic Impacts

In addition to the direct benefits counted in the economic evaluation, various secondary and intangible benefits and/or favorable socio-economic impacts are expected from the implementation of the project. Principal socio-economic impacts are described hereunder.

(1) Securing a stable food supply and acquisition of foreign money

The Project will contribute to the sacrament of self-sufficiency in rice, which has been one of the main objects of the national development plan. Sufficient supply of food will also make an important contribution to attain economic independence of Sri Lanka. As a result, the surplus would decrease the annual amount of imports and thereby save the foreign exchange.

(2) Expansion of the willingness to work

In contrast with low productivity of the current agricultural husbandry, the farmers would find the satisfaction due to the improvement of the living standard through the increase of crop production in the future. As a result, they will desire more agricultural products and improve the living standard through the expansion from their willingness to work.

(3) Enlargement of the employment opportunity

Employment opportunity to the local people will be increased by the implementation of the Project, and favorable impacts to the regional economy will be expected through the increased monetary movement. The employee will gain more experience, technical know-how, skills in various working fields. These accumulations of working techniques would be applied to the future development in Sri Lanka.

(4) Enhancement of economic and social activities

The local transportation will be improved much by the construction and rehabilitation of the roads and bridges. The expanded road system will not only enhance the economic activity in and around the project area but also contribute to inter-regional accessibility and communication.

(5) Enhancement of the social supporting services

Social supporting services will be enhanced according to the rural development center. Furthermore, in accordance with the creation of the close connection between the farmers and the agencies concerning the supporting services, current agricultural activities would be innovated under the future conditions.

(6) Development of the regional economy

After implementation of the Project, income of farmers estimated at 78,000 Rs./year is expected to increase considerably as a direct result of the increase in crop production and crop diversification. Such increase in income would contribute to improving farmers' living standards. Moreover, it is expected that farmers' purchasing power would increase along with improvement of their living standards, and this increased purchasing power would benefit the development of the regional economy.

Future marketing in the area is likely to expand as compared with the present condition. With anticipated higher agricultural production, more farm products could be marketed by the farmers and the proportion of sales would also increase relative to consumption. The merchants would have a larger turnover which could increase their incomes.

(7) Improvement of the sanitary condition

According to the establishment of the drinking water supply system, the quality of drinking water will be improved and the occurrence of water-borne disease will be depressed.

(8) Women's in Development (WID)

In Sri Lanka, the entry of women into the social community as public servant and employee of private sectors has been realized. At the public offices, schools and other private offices in Walawe area, many women play an active role as agricultural extension workers, engineers, teachers and officers. In the Walawe right bank area, CEDA initiated a loan scheme to enhance the socio-economic status of women. Under this scheme 20 women formed Mahaweli farm women's association and started banana cultivation in each 0.5 acres of land. The loan amounting Rs. 3,000 has been used for the land preparation, nursery planting and fertilizer.

Employment opportunity of the women will be increased by the implementation of the Project and that will contribute to the women's entry to social. Through construction and upgrading of the drinking water supply system, road, firewood forest and the Development Center, women's heavy work load will be reduced and the living standard of rural people shall be enhanced.

The rural banks for women have been established under the Janasaviya programme in the Extension area and providing low interest loans up to Rs. 2,000 for rainfed cultivation. The programme should be further promoted to expand the women's access to the rural credits. Furthermore, it is recommended that settlers to the project area should be selected without any distinction against women's headed households. That will contribute to the relief to the poor women's headed households and promote women's participation in the Project.

CHAPTER 7 ASSESSMENT OF ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

7.1 Basic Concept of Environmental Conservation

Historically, Sri Lanka has had a proud record of environmental conservation. There is ample evidence that both ruler and subject gave recognition to the wise use of natural resources. Different actions in this regard were complemented by religious and ethical beliefs, and contributed to a lasting culture of respect for living beings and sustainable use of all resources.

Since the late 1970s, with the introduction of a new accelerated economic development policy in Sri Lanka, a large number of development projects have been launched both by the public and private sectors. Many of these projects have paid little or no attention to associated environmental consequences. Project approval remained the prerogative of individual institutions responsible for the project concerned. Serious adverse environmental impacts, such as soil erosion, landslides, flooding, loss of valuable flora and fauna, and loss of historical and cultural resources have occurred over the years.

Consequently, the need for integrating environmental, economic and social considerations with the planning and decision-making process was realized and the government of Sri Lanka decided to introduce Environmental Impact Assessment (EIA) of development projects as an aid to development planning, through which possible adverse environmental impacts of proposed development projects can be minimized or prevented. Accordingly, as of January 1984, by Cabinet decision, EIA was made mandatory for all development projects.

In 1980, the National Environmental Act (No.47) was passed by the Parliament and the Central Environmental Authority (CEA) was instituted as an apex policy making and the coordinating agency for a wide range of environmental subjects. EIA was made mandatory for all development projects in 1984 by a cabinet decision. In 1988, the National Environmental (Amendment) Act No.56 made project approval a legal requirement and CEA was given the regulatory powers. The Environmental Assessment Procedure (EAP) developed by CEA in collaboration with USAID, was implemented through a number of Project Approving Agencies (PAAA) identified by the cabinet. The Ministry of Mahaweli Development is one of PAAA.

The basic concept of EAP is to ensure that development can be planned to make optimum or sustainable use of resources, to avoid environmental degradation and even to improve the quality of the environment. EAP forms part of the planning of such environmentally sound development. The guidelines of EAP consist of five distinct phases as follows:

a. Initial Environmental Examination (IEE)
b. Scoping
c. Environmental Assessment (EA)
d. Environmental Action Plan (EAP)
e. Supplemental Environmental Report (SER)

This report deals with the Environmental Assessment (EA). EA is a detailed study of probable significant effects both beneficial and adverse which a proposed project will have on the environment and is intended for use in the feasibility phase of project planning. EA will be reviewed by interested agencies and parties within a specified time period. Comments will be incorporated as appropriate into an EA report before it is included in feasibility phase of project implementation.

7.2 Natural Environment

7.2.1 Vegetation

(1) General

The original natural vegetation of the project area belonged to the Dry Mixed Evergreen Forest type, which can be described as a secondary climax forest that evolved following the decline of the ancient civilization. What remains now is a much degraded dry zone forest.

The Old area is devoid of any appreciable extent of natural vegetation as it has been developed. Due to human influence the forests in this area have been degraded. In the Extension area, shifting cultivation has been the main occupation of the people, supported by cattle husbandry cattle and buffalo. What exists as forest vegetation can be categorized as follows:

(i) Primary dry mixed evergreen forest

The only primary forest is the Madunagala, Karambagala forest which also provides shelter to the hermitage. It lies in Mahapelessa North, east of the Ridyagama tank and south of Mahaweligada river. The undisturbed forest is only about 140 ha in extent. The canopy is 20 to 25 m high and there is a 3 to 5 m shrub layer. In most places it is an open canopy. The trees are stunted where the land rises and is rocky. Species exhibit xeromorphic features. The canopy species include *halmilla, kaluwara, milla,* and *wira, palu Manilkara hexandra buratha* and *kolon* are some of the emergents.

(ii) Degraded secondary forest

To the east of the Suriyawewa-Mirijjawila road, are degraded secondary forests. The other boundaries roughly are the Andarawewa Maha Ara area in the north, the project boundary on the east and a few kilometers to the north of Arabokka on the southern side. Degradation has to various extent depended on the shifting cultivation, timber, and fuel wood requirements and materials for homesteads. This forest zone can be sub-divided into a very arid region lying north of Bellagaswewa and Kattanawewa (SFZ-A) and a less dry verdurous region (SFZ-V) lying south and southeast of Bellagaswewa and Kattanawewa. In both regions, the matrix is shrub jungle of 3 to 4 m, with scattered trees, shrubs are represented by *katupila (luegga leucopyrus) kapukinissal (Hibiscus sp)* and maila (Bahunia racemosa). The rain tree species are *divul (Feronia limonia), ehela (Cassia fistula), wira, palu burutha* and *kohomba (Azadirachta indica).* In the SFZ-V region, the forest is greener and has more trees per unit area than the SFZ-A region.

(iii) Scrub jungle or thorn scrub land

Except for the vegetation types described above, scrub jungle or thorn scrub land is the general matrix of terrestrial vegetation throughout the Extension area. Extensive shifting cultivation taken its toll on the natural forest vegetation and scrub is the result. Species exhibit xeromorphic characteristics and are 2 to 5 m in height. An undergrowth of grass is sometimes seen. Common species are *katupila,*the endemic *eraminiya, Zizyphus napeca, andara (Dichrostachys cinerea) karamba (Carissa spinarum), habara (Diospyros sp.)* and *katuandara(Acacia levcophloea).*

Towards the southern coastal belt, the common tree species are *divul, ehela, ingini (Strychnos potatorum)* and *kohomba.* Succulents such as *daluk (Euphorbia antiquorum), komarika (Aloe vera)* and *heeressa (Cissus quadrangularis)* are also abundant.

(iv) Aquatic vegetation

The low lying land on the edges of the tanks support a variety of marshy vegetation. A large amount of marsh area is found on the southern and western borders of Udaberagamawewa, extending over about 20 ha. Species include *Eichhornia, Salvinia, Pistia, Marselia* and *Ludwigia.*

Aquatic weeds are found in many tanks, canals, and even paddy fields. *Eichhornia* is present to a large extent in Kadawarawewa, Mahagamawewa, and Udaberagamawewa. The canal draining water out of Udaberagamawewa is completely choked with weeds, mostly *Eichhornia* and *Salvinia.* Phytoplankton is found in the waters of tanks and canals and in paddy fields. The samples examined did not show the presence of species such as *Microcystis* and *Spirulina,* which are usually associated with polluted waters.

(v) Riverine vegetation

Riverine vegetation usually has characteristics of its own due to the favorable moisture regime all through the year. The trees are taller than these on more well drained sites and species not normally associated with this agro-ecological zone can be found along rivers and streams. The height of trees decreases moving away from the bank. Ecologically, riverine vegetation serves the very useful purpose of preventing bank erosion and permitting a smoother river flow. Such areas are also a habitat for burrowing animals, reptiles, amphibians, small mammals, and birds. This type of vegetation is found only in small patches.

(2) Productivity

The existing forest vegetation can be divided into the following timber yield classes:

(i) Low-yield vegetation

Most of the primary forest is of this class. The trees are about 15 m high. The crowns are small and it is an open forest. Common species include *wira, kaluwara, palu, milla,* and relatively small numbers of other species such as *helamba,(Mitragyna* and *parvifolia) halmilla.*

(ii) Non-productive vegetation

The main canopy is less than 6 m in height. Crowns are small. Canopy density varies from low, open shrub, to a closed, smooth surface. This class does not bear species of economic value. However, it provides fuel wood. Predominant tree species are *wira, weliwenna,* and *panakka (Pleurostylis opposita).* Other species described above occur as widely scattered isolated trees. Approaching the coastal belt tree species such as *kohomba, maila, wira, palu,* and *ranawara (Cassia auriculata)* are more abundant.

(3) Introduced tree species

(i) In the southeast corner of the project is a Forest Department plantation of *Eucalyptus camaldulensis,* extending over 1,493 ha, varying in age from 11 to 16 years. The plantation extends outside the project boundary eastwards.

(ii) At Mirijjawila is the 5 to 10 ha cashew plantation - all that has been achieved of the 1975 proposal to have a 1,550 ha plantation.

7.2.2 Animals

(1) General

The Old area does not contain natural habitats for wildlife. This and some parts of the Extension area are inhabited by farmer families practising either settled types of agriculture or shifting cultivation. This area is referred to as the Human Inhabited Zone (HIZ).

The Extension area is for the most part covered with secondary forest and grassland, consequent to shifting cultivation and is referred to as the Human Uninhabited or sparsely inhabited Zone (HUZ). Despite the degraded condition this area serves as reasonably good wildlife habitat, sustaining a diversity of animals ranging from invertebrates to fish, amphibians, reptiles, birds, and mammals.

The Madunagala forest of limited primary vegetation and its associated secondary jungle, is a reasonably good wildlife habitat and merits proper management to benefit its flora and fauna. The wildlife habitats of the Extension area can be zoned using the Suriyawewa-Mirijjawila road (100 foot road) as a landmark boundary of convenience.

The area west of the "100 foot road" has been subjected to shifting cultivation in the recently and the vegetation is in a successional stage, comprising ill-developed and sparse secondary forests and grasslands that cannot be considered as of good wildlife habitat. The same is true for a strip of land oriented parallel to and immediately eastward of the "100 foot road".

Between this strip and the eastern boundary of the Extension area is a zone of secondary forest that supports a diversity of wildlife. A sub-division of this zone will demarcate a very arid area (SFZ-A) lying north of Nellegaswewa/Kattanawewa, and a more verdurous secondary forest area (SFZ-V), south and northeast of it. There are settled families around Bellegaswewa and Kattanawewa. The zone described above adjacent to the eastern project boundary is a better endowed wildlife habitat.

The aquatic habitats can be broadly categorized into two: (i) the flowing waters of the Walawe and its tributaries and canals, and (ii) the still waters of tanks and waterholes. The aquatic environment also contains other localized habitats such as swamps and lagoons which contain fresh or saline waters. The habitats experience fluctuating water levels depending on water input and output, which in turn is linked to seasonal weather patterns and water issues from the Uda Walawe and other reservoirs. During the rainy season, most of the habitats are inter-connected while during the dry season, some of the habitats such as tanks and waterholes completely dry out.

The flowing waters can be further stratified into habitats such as deep pools (habitat for large fish and crocodiles), waters with sandy or slightly muddy bottoms (habitat for aquatic insect larvae and bivalve mollusca), waters with pebbles and boulders on the bed (habitat for loach-like fish and gastropod mollusca), shallow edges (habitat for fish larvae and aquatic invertebrates) and waters containing detritus mixed vegetation (habitat for shrimp and insect larval forms).

Until recent times, the area supported a rich diversity of wild animals, including a large elephant (*Elephas maximus*) population. Water buffalo (*Bubalus bubalus*), sambur (*Cervus unicolor*), spotted deer (*Axis axis ceylonensis*), red deer (*Munticus muntjak mousedeer (Tragulus meminna)*, wild boar (*Sus srofa*), leopard (*Panthera pardus*), bear (*Melursus ursinus inornatus*), grey langur (*Piesbytis entellus*), toque macaque (*Macaca sinica*), flying squirrel

(*Petinomys fuscocapillus layardi*), rock squirrel (*Ratufa macroura dandolena*), civet cat (*Viverricula indica mayori*), and black-naped hare (*Lepus nigricollis*) were common. In the past 15 to 20 years, these species have been almost completely wiped out of the area, mostly at the hands of poachers. The elephant however, has managed to hold out amidst great odds. It has not been possible to ascertain

(2) Elephants

Traditionally, elephants in large numbers have inhabited the lower Walawe basin from ancient times. Ptolemy (circa 150 - 175 AD) in his account of Ceylon, had identified "the feeding grounds of elephants" south of the central mountain massif. It is therefore considered useful to trace the recent development efforts vis-a-vis elephant conservation.

The elephants lived in this area in large numbers until their habitat was opened up under the Walawe scheme in the 1960s. As the habitat became fragmented by various developments on the left and right banks, the elephant population became dispersed. Herds were pushed north into the Hambegamuwa forests, south and southeast to the Ridiyagama-Gonnoruwa - Wirawila forests and southwest to the Ranna-Bata-ata jungle pocket. Those that moved north found accommodation in the Uda Walawe National Park, which was established in 1973, while those trapped in the right bank command area were either captured and domesticated or were driven to the safety of the Ridiyagama- Gonnoruwa forests. However these forests too have come under development over the years, increasing the conflicts of man and elephant, and threating the future of some 150 or more animals.

The development of the right bank command area south to Ranna and the left bank command area southeast to Suriyawewa, effectively prevented the elephants isolated in Ridiyagam-Gonnoruwa-Mattala, moving north to Uda Walawe or west across the river. However, they had a wide range that linked with Yala National Park - through the Mattala - Lunugamvehera gap on the Hambantota - Wellawaya road in the northeast. These elephants, numbering over 150, moved in small family groups from one village tank to another, feeding in the scrub, as well as in the *hennas* and home gardens.

The Ridiyagama livestock farm was regularly visited by large herds to forage on the lush pasture and herds took refuge in the 600 to 800 ha. Block of forest reserved for possible extensions to the livestock farm. Later, with humans taking over the forest reserve for cultivation, the herds sought refuge during day time in the Madunagala and Karambagala forest pockets.

In the 1980s, the Hambantota Integrated Rural Development Project completed the rehabilitation of some 20 village tanks in Gonnoruwa, Weliwewa, and Mattala, and this further restricted elephant movement.

Furthermore, with the development of the right bank command area of the Kirindi Oya Irrigation Settlement Project (KOISP), the plight of the elephants pocketed between Ridiyagama and Wirawila/Mattala, became worse. KOISP swallowed a large chunk of elephant habitat, including the Wirawila Sanctuary of 4164 ha. It also blocked their only escape route northeast past Kirindi Oya to the Yala National Park.

As their range dwindled and access to feeding grounds and watering points became more and more difficult, human-elephant confrontations increased to serious proportions in and around Mattala, Badagiriya, Gonnoruwa, Hambantota, and Ridiyagama.

The commissioning of the KOISP right bank canal brought about a curious situation where elephants had ample water from the main canal and food (paddy) across it. When chased by the farmers and departmental staff, they move towards the village tanks in Mattala, Gonnoruwa

and Ridiyagama. Since the area between Gonnoruwa and Ridiyagama tank is sparsely populated, herds are not exposed to such severe disturbance as in the Gonnoruwa-Badagiriya-Mattala area. The Ridiyagama livestock farm inspite of its degraded nature is still an attractive resource point.

In 1991, the Department of Wildlife Conservation(DWC) made an unsuccessful attempt to drive and evacuate the trapped elephants across Kirindi Oya, northeast past Lunugamvehera and Menik Ganga into the Yala National Park. It is reported that only some 50 animals were driven to the Lunugamvehera forests, and within a week these animals back-tracked to their old haunts. In the past two years the Department has also captured and removed some elephants and taken them to the Yala National Park.

Presently there are around 50 to 75 elephants in herds, and 5 to 6 loners, concentrating in and around the Extension area. During the wet months, they move in family groups of 10 to 20 animals, while in dry weather, these groups coalesce into herds of about 30 to 50 animals, around Ridiyagama tank and the livestock farm. Madunagala and Karambagala forest pockets are also favorite refuges during periods of drought.

Conflicts between man and elephant have accentuated around the Ridiyagama livestock farm, Mahapelessa, Andarawewa, Gonnoruwa, Arabokka, Keligama and in the KOISP right bank area between Badagiriya and Mattala - Weligatte. Here the loners are particularly problematical. The incidence of crop damage is high and a number of elephant and human deaths have been reported within the project area. A 1988/89 study by the Elephant Conservation Unit of the DWC, revealed the presence of 150 to 160 elephants in the area between Ridiyagama and Mattala.

(3) Migratory species

The project area serves as the wintering grounds for a variety of birds coming, in large numbers, from as far away as northern Siberia. Over 150 species are known to be annual winter visitors. All of them continue to stay in Sri Lanka during the winter months. There are no "passage-migrants". They arrive by mid-August through late-November and leave between March and May. Species include dwellers of the forest, grassland, sea shore, and aquatic habitats. Thousands are seen in the lewayas and open grasslands and scrub jungle during these months, where they find the warm climate with plentiful food very attractive. Some species do not leave when the time comes, for various reasons, one of which do be lack of energy. The Blue-tailed Bee-Eater (*Merops philippinus philippinus*) is a species known to have changed its status from being a regular migrant to a breeding resident.

(4) Rare/threatened/endangered/endemic species

The wild elephant population is highly endangered all over Sri Lanka due primarily to habitat depletion and settlement schemes that have been established in its territory. In the Extension area, there are an estimated 150 to 160 elephants roaming over a vast area east of Ridiyagama.

7.3 Socio-economic Environment

(1) General

In the Old area which is developed, three distinct cultivated areas are evident. These are: Sevanagala sugar cane area of about 5,400 ha; Kiriibanwewa block of about 6,000 ha; and Suriyawewa block of about 5,100 ha.

The Sevanagala sugar cane area is technically managed by Sevanagala Sugar Industries Ltd. on the basis of individual farm allotments, supplying cane to the factory. Yield has been consistently better under irrigated conditions. The crop is grown on a 4-year cycle of one plant crop and three ratoon crops.

The Kiriibanwewa and the Suriyawewa blocks are managed by the Mahaweli Authority. Paddy is the main crop under irrigation. Other crops are small amounts of cereals, vegetables, grain legumes, chill, and onion. Banana is also widely cultivated.

It is difficult to determine the present land use in the Extension area, except for the three new unit areas of the Suriyawewa block that are managed by MEA. Extensive shifting cultivation has almost destroyed the entire natural forest in the area. Areas that are not in shifting cultivation are usually under secondary scrub jungle or grass (presently abandoned lands). Cropping pattern in the area shows that the cultivation in minor irrigation tanks is nearly similar to highland and chena cultivation. Cultivation is only during the Maha season and is totally dependent on the rainfall, the difference being that areas under tanks are cropped with paddy while field crops are cultivated on the highlands.

About 90 percent of the farmers in the Extension area depend on the rainfed cultivation. The usual crops are cereals, grain legumes, and vegetables. From a discussion with the farmers it transpired that they are aware of the adverse impacts of shifting cultivation, but it is the main source of income for them. If the rains fail for two or three years, even this cultivation is not possible. Farmers are at the mercy of droughts, failed monsoons, weeds, insect pests, wild animals, and even domesticated animals. Their returns are, therefore, never assured. What little is harvested is with much toil. If irrigation water is available and if they are provided with land, they are willing to abandon chena cultivation.

Most of the farmers permanently reside in these areas, having very poor facilities; even drinking water is brought long distances by bicycle. There are also many farmers who are not totally dependent on chena, but who also cultivate irrigated paddy on a small plot. Accurate data on shifting cultivation is not available because almost all land is illegally encroached Crown land.

Although, there is not much pasture land in the Uda Walawe project, a considerable amount of livestock farming has developed. In spite of the many efforts, it has been unimpressive. A coordinated attempt to develop livestock production was initiated in 1990 with the formal takeover of all livestock activities in the project area by the Draught Animal and Dairy Development Project of the Mahaweli Authority. Neat cattle, buffalo, goats, poultry, and pigs are the common livestock types.

(2) Settlement

In the Extension area, patterns of settlement are diverse. Encroachers have settled in a haphazard manner. However, the settlers/settlements can be categorized as follows: (i) regularized settlers under minor tanks and rainfed irrigation projects; (ii) regularized second generation settlers from the Ridiyagama systems along the western boundary; (iii) settlers who have encroached; (iv) settlements under the Janasaviya programme; (v) settlements under MEA; (vi) long standing permanent settlement under minor irrigation tanks awaiting regularization; (vii) new settlements along the western boundary of the Extension area; (viii) recent encroachments; (ix) lands allocated to organizations; and (x) seasonal migrants.

The non-regularized farmers (encroacher) constitute approximately 59 percent of the total families in and around the Extension area. Settlement in the Extension area is largely concentrated around small tanks and along the western boundary of the project area as a result of natural expansion of the villages established under the Ridiyagama scheme. In fact, many

settlers under the more recently established tank systems were second and third generation members of original settler families in the Ridiyagama scheme. Some of the farm families leave the project area during the dry season for their home towns and return for the Maha cultivation. This has been practised for several years.

(3) Income

The seasonal tanks in the Extension area generally do not get enough water for successful cultivation. Only when heavy rains are experienced during a Maha season, cultivation is possible. Hence paddy cultivation under these tank irrigation schemes is not a stable income source for most of the farmers.

Other income sources of farmers living in the Extension area are by the collection and sale of items such as firewood, wood apple, margosa seed, tamarind fruit, and game and skins.

Farm income supplemented by working in neighboring areas, eg, Suriyawewa and Ridiyagama. Furthermore, one of the most important income sources is the Janasaviya Programme, which is a grant aid program for poor people. Janasaviya beneficiaries receive Rs. 1,458 every month for two years. They can spend Rs. 1,000 per month on food and deposit Rs. 458 per month in the Bank. The deposits can be used to buy agro-equipment after two years. The Food Stamp Scheme provided by the Department of Social Services is also an important income source for low income people. Foodstuffs and kerosene are supplied to beneficiaries through co-operatives.

However, 44 percent of the total annual income of Janasaviya beneficiaries is derived from the assistance they receive under the programme. On conclusion of the programme after two years, a general sustainable upliftment in the socio-economic conditions of the farmers through the efforts of the beneficiary is expected. The Janasaviya beneficiaries are not entitled to receive foodstamps in the future.

It was difficult to measure the economic status of farmers in the project area. Often farmers had access to highland plots, partial ownership of land or encroached land elsewhere, but the terms and conditions of ownership were loosely defined. In the Extension area farmers don't have any part-time jobs which supplement their income. The lack of off-farm employment is another difficulty. However, most of the farmers are disappointed by the lack of water, lack of potential employment around the project area, lack of facilities, and poor health conditions.

(4) Rural infrastructure

Some parts of the project area, such as Sevanagala sugar area, Kiriibanwewa and Suriyawewa blocks, in the Old area are already settled and therefore basic rural infrastructure such as settlement plots, roads, schools, postal and medical facilities have been improved by MEA. However, the scenario is very different in the Extension area. A few organizations have moved into this area to provide very limited facilities. Hambantota Integrated Rural Development Project (IRDP) and Unesco are such organizations. Apart from that under the Government Agent's allocation only certain limited facilities in the Extension area have been improved.

The most difficult problems settlers face are lack of domestic water supply and transport services. Several farmers indicated that domestic water supply was a major problem they faced. Domestic water is supplied by tankers once in two days. Public transport facilities are not available. Farmers have to use tractors or bicycles. Other problems faced by farmers include lack of medical facilities, schools, and housing. Owning rice land and not just irrigated land was their primary motive in staying in the project.

(5) Housing

Clusters of houses are aggregated into hamlets, usually on highland areas. A hamlet is the smallest unit. In the Extension area, there is some attempt at organized settlement under minor irrigation schemes and along its western boundary. Encroachers have built semi-permanent houses to stake legal claim to the land. Most of the housing units are of a temporary or semi-permanent nature.

(6) Roads

The Old area is well served by a range of roads. There is one "A" class road, numbered A 18, running on the right bank, while there are 40 "C" class roads and 27 "D" class roads, in addition to farm roads. Road A 18 links the A 2 southern highway with the A 4 from Colombo to Hambantota and further down. The Extension area on the other hand is poorly linked. One main gravel road -"100 foot road" - connects Suriyawewa and Mirijjawila in the south. There are no "C" and "D" class roads.

(7) Transportation

The bus or coach is the main means of transportation in the Old area. Privately-owned cars are few. Many farmers use 2-wheel tractors and trailers, while others use motor cycles and bicycles, to move from place to place. People living in the Extension area cannot stake claim to such modes of transportation let alone ownership of cars and motor cycles.

(8) Communications

A central post office is located at Embilipitiya and divisional post offices are at Suriyawewa and Kiriibanwewa. Telephone facilities are available at Embilipitiya only but there is no direct dialling to other parts of the country. The nearest such facility is at Hambantota. The Extension area lacks such facilities.

(9) Electricity

Power from the Uda Walawe reservoir is supplied to the towns of Suriyawewa and Kiriibanwewa, and to the sugar factory village. Power is also distributed to Hambantota and Tangalle. The Extension area has no access to electricity. Some effort has been made to introduce biogas but without continued success.

(10) Sanitation

While the facilities in the Old area are somewhat acceptable, those in the Extension area are rather primitive.

(11) Water supply

In the study area, tube wells, open wells and streams are the predominant sources of water. Due to high salinity levels most of the tube wells are not suitable for drinking purposes. Most farmers have open wells which are about 10 m deep with a water depth 0.3 to 3.0 m. Many of them dry out in the dry season. The sugar factory village and Suriyawewa town have water supply schemes and beneficiaries number 364 and 250 respectively.

At present, domestic piped water supply is available in the urban areas of Ambalantota and Hambantota. Two intakes at the Walawe River are used to obtain water for Ambalantota and Hambantota. In Ambalantota 125,000 persons benefit from piped water while in Hambantota, 150,000 persons receive potable water. The average consumption is 30 liters/person/day.

Abandoned ancient village tanks are a common feature in the project area. Most of them dry up fully or partially during the dry season. These tanks are normally found in topographic depressions. Therefore an accumulation of salts take place which is subsequently fed into the groundwater system with the next rains. Pollution by man is insignificant in this area. Apart from high EC levels, the ground water in the coastal belt shows a high content of fluoride. This problem mainly exists in deep aquifers in the eastern part of Hambantota AGA division. High fluoride consumption has long term effects such as decaying of teeth and bone structure of humans.

High concentration of iron in the ground water is another problem. Though this is not a health hazard, it gives an undesirable taste and also stains clothes and vessels. It is a serious problem in the western part of the Hambantota district and has contributed to deterioration of the interior parts of tube well hand pumps. Aeration and water filtering in iron removal plants can reduce the high iron content, but the filter media should be cleaned frequently.

(12) Health care

Investigations have revealed that malaria, dysentery, amoebiasis and skin diseases are most common in the project area. Three vector-borne diseases have been reported. The most common is malaria while Japanese Encephalitis and dengue also occur. The incidence of filariasis has also been reported. The Anti-Malaria Campaign is operative in the project area.

Although amoebiasis and dysentery are the most common water-borne diseases, many of the settlers build up resistance or at least tolerance, and rarely seek medical treatment. It is clear, that there is a high incidence of the above stemming from two human behavioral characteristics. One is that very few proper latrines are in use. The other is that very few people in the project area boil water before drinking it. Farmers frequently drink from irrigation channels when they are working in the field.

There is no centralized supply of domestic water. The supply of domestic water is limited and it is not adequate. Several settlers complained about the water supply by tankers and the quality of water. A very limited water supply has been supplied to the townships of Suriyawewa and Kiriibanwewa.

The reduction of water-borne diseases through improvement in sanitation and drinking water supply in the rural areas in some parts of the Extension area has been an objective of many initiatives by the Department of Health, Hambantota IRDP (HIRDP) and Unesco for many years. HIRDP has funded several programmes in community and environmental health. A major project has provided improved latrines on a self-help basis, whereby household labor is used to dig pits and build walls and a roof and HIRDP provides a concrete squatting slab, a siphon, and the materials for the roof and walls. Between 1983 and 1990, HIRDP has provided assistance for 25,000 latrines. These programmes are implemented under "AGA/GA Development Projects" and "Local-level planning" by line agencies and by private voluntary organizations such as Sarvodaya.

Malnutrition is very common among the settlers due to poverty. Every Saturday (the day of the fair) at Suriyawewa, the Government Dispensary provides treatment to approximately 150 people. Surveys in 1975/76, 1980/82 and 1987/88 showed malnutrition among young children, and anaemia among the whole population, to be quite widespread in the Extension

area. Acute malnutrition was found in 6.3 percent and chronic malnutrition in 29.7 percent of pre-school children and pregnant women. Vitamin A deficiency is also fairly prevalent.

Other existing environmental health hazards are poisoning and snake bite. Two types of poisoning have been reported: (i) misuse of chemicals and (ii) suicide. At least three cases of attempted suicide are being reported per week in the project, area. Snake bite is another major environmental health hazard among the Sri Lankan farmers, especially those clearing jungle land. The main threat is from the viper. More than 250 patients per year are brought to hospital in the Hambantota district.

7.4 Environmental Beneficial Impacts of the Project

The project is designed to bring about the upgrading and extension of irrigation facilities as well as provision of necessary rural infrastructures in an under-developed left bank area of approximately 30,000 ha. It will benefit some 6,400 farmer families who will settle in the Extension area and 4,600 non-farm families by providing about 20,000 job opportunities and higher incomes than at present. In addition, about 3,000 farm families presently operating in the MEA area will increase their farm incomes through improved irrigation water supply and crop diversification.

Given that much of the area is degraded and will continue in this manner if measures are not taken, the project is expected to outweigh undesirable impacts.

The overall economic benefits of implementing the project proposal accrue from:

- the upgrading of the irrigation infrastructure in the Old area and bringing about rational land use;
- more efficient use of available irrigation water through better distribution and management;
- provision of irrigation water to hitherto unproductive areas by extending the left bank canal into the Extension area;
- increase the land under cultivation and create a diversified, market-oriented basket of crops;
- increasing the national production of paddy, sugar, grain legumes, vegetables, fruits, and livestock products;
- reducing the foreign exchange expenditure on food imports and paving the way to the export of selected food items;
- rehabilitating 17 small tanks in the Extension area and using them in a cascade system to recapture returns flows and make optimum use of the water;
- transfer of technology to the impoverished Extension area and improving the living conditions of the poor;
- providing settled patterns of agriculture as an alternative to land-degrading shifting cultivation;
- making available opportunities for a range of agro-based industries;

- creating a variety of employment opportunities through services that support agriculture in the main, and industry to a lesser degree;

- creating an environmentally-sound, sustainable, agro-ecosystem, ensuring compatibility of the integral components through integrated management;

- creating opportunities of providing a more suitable homeland for some 150 elephants, now more or less trapped in the Extension area, thereby eliminating losses on both sides, such as agricultural products, property and life on the development side, and a national asset (the elephant) on the conservation side;

- With an altered water regime in the Extension area, assuring soil moisture supply in the usual dry period, the project will create certain beneficial impacts on humans, on plants and on animals. The micro-climate along the canals and water bodies will also change and those animals such as burrowing reptiles and amphibians requiring moist soils will find favorable conditions throughout the year;

- The existing vegetation along the water bodies will change. Apart from the usual species growing luxuriantly, even characteristic wet zone species may thrive. The increased number of water bodies will benefit aquatic invertebrates, birds, fish, amphibians, and reptiles;

- Taking advantage of this favorable moisture condition, it would be desirable to enrich the riverine vegetation that is now in a degraded condition, so as to profit from the ecological benefits associated with such vegetation types. Benefits include controlling bank erosion and providing stability to the banks, providing habitats to birds and the smaller animals, and altering favorably certain conditions for crop growth, eg, acting as windbreaks;

- In the Old area, project benefits will mainly consist of an improved irrigation infrastructure. The water will be carried further because of an improved canal network and the availability of water during the dry months over a large part of the project area will bring about desirable micro-climatic benefits and enhance the biotic environment to some degree;

- Likewise, in the Extension area, the network of canals will enhance most aspects of human life and certain aspects of the biotic environment.

7.5 Proposed Mitigation Measures for Adverse Impacts

The mitigating measures listed relate to the biotic, physico-chemical, and socio-economic environments in the proposed project area.

(1) Flora

As a compensatory measure for the loss of plant cover, tree planting should take place along river banks, canal banks, and in the tank watersheds. It should also be done along roads. School compounds should be used to provide refuge to some of the plant species that are disappearing fast. These mini arboreta can serve educational needs as well. Settlers should be provided with saplings of their choice to be planted in home gardens. The marshy habitat at Udaberagama may be conserved for educational purposes. The saplings can be provided from FD or MASL nurseries. The estimated cost is Rs. 350,000.

(2) Fauna - Elephant

With the possibility of a long drawn out struggle between man and elephant, the ideal appears to be a separation of the two, by having the elephants moved to safe locations where conflict is minimized, if not prevented. To reap maximum benefits of the stated project objectives, this is a vital necessity. Moreover, in view of the historical and cultural importance, the plight of the elephant merits close attention.

It appears from emerging trends in natural resource use, that man and elephant can co-exist without serious conflict, only in low densities. The elephant issue in the Hambantota district can be resolved by creating conditions and the means for their judicious dispersal to more suitable areas, thereby eliminating/reducing the almost year-round pressure on cultivations and settlements.

The mitigating strategies are based on three major proposals: (i) to set up jungle corridors to facilitate movement to the national parks from the Extension area and the Bundala sanctuary, (ii) to set up electric fencing along the eastern border of the Extension area, and (iii) evacuation of elephants.

(i) Two jungle corridors are proposed. The first extends from Badagiriya tank to the right bank of Malala river and then, northwards to meet the southern boundary of the proposed Uda Walawe-Lunugamvehera corridor.

The second corridor begins at the 152nd km post on the Hambantota-Wellawaya road (which is also the northern boundary of the Bundala sanctuary), and extends through Mettigatwewa and Buruthakanda to meet the Badagiriya - Uda Walawe corridor. The corridors can be 1 to 2 km in width.

(ii) A main power/solar power fence along the eastern border of the Extension area from Suriyawewa in the north to Sippikulama near Karagan Lewaya is the second major proposal.

(iii) The Department of Wildlife Conservation (DWC) should evacuate all elephant herds from in and around the project area to the Badagiriya - Uda Mattala forest pocket, east of the Hambantota-Gonnoruwa-Meegahajandura road and Malala river. Timing of erection of the fence and driving the herds east are important so as to prevent back-tracking.

(iv) DWC should capture by immobilization and remove all loners found remaining after the herds have been driven eastward. Only five or six loners will remain. The captured loners should not be released near the project area.

(v) DWC staff should be posted to the project area on a permanent basis to undertake the following tasks.

- monitor movement of evacuated elephants to prevent them backtracking;
- monitor efficiency of the electric fence;
- induce elephant movement north along the corridor to the Uda Walawe National Park;
- induce elephant movement northeast through Devranvehera (Ranawaranawewa) to the proposed Lunugamvehera National Park.

(3) Aquatic environment

(i) Aquatic weeds

Aquatic weeds have a widespread coverage in the Old area and the potential for spreading in the Extension area is high when irrigation commences. Practical solutions have to be found to keep the canals and water bodies free of weeds. While some herbicides such as 2.4-D and Diquat have minimum harmful effects on other organisms, there is the need to physically remove the dead growth. In practise it is cheaper to remove the growth without recourse to spraying.

Biological control of Salvinia has reportedly been successful under field conditions elsewhere in Sri Lanka and may also be tried in the project area. The use of water weeds in biogas digestors, as manures and mulches, in composing, and as animal feed are some of the other possibilities. Studies on possible applications of water weeds should continue. Minimum fertilizer use is recommended to arrest eutrophication due to nutrient-loaded runoff and return flows.

Responsibilities lie with MASL, Departments of Agriculture and Agrarian Services, District Secretariats and Farmer's Organizations. The estimated cost is Rs. 400,000.

(ii) Aquatic fauna

The undesirable impacts on aquatic fauna will arise from the excessive use of fertilizers and agrochemicals. The discharge of industrial effluents into the main river, is a seasonal problem. As no baseline data is available on the amounts present in the aquatic environment, it is proposed that water samples from selected points in the basin be analyzed to ascertain the current status. The promotion of techniques of integrated pest management, along with education of farmers on the environmental implications of excessive fertilizer and agrochemical use, are short-term measures. In the long-term, breeding varieties resistant to some of the major pests and diseases and the use of more organic manures will be a step in the right direction in minimizing use of these inputs.

(4) Physico-chemical environment

(i) Erosion control and soil conservation

Erosion control and soil conservation should be a primary consideration from the outset, ie. from land clearing and construction stages. These activities should be carried out during the dry season as impacts will be less than during the wet season. The use of heavy machinery should be minimized and the following measures are recommended:

- forming windrows of brush along the contours;
- moving layers of top soil be avoided;
- minimizing ripping;
- using disk harrows for clearing light growth;
- conducting all operations in upland areas on the contour.

Other possible techniques are alley cropping, agroforestry, mulching terracing, crop rotations, mixed croppings and inter-cropping. After land preparation, with the first showers of rain in Maha, the land should be sown to a quick-growing legume eg. *Pueraria, Crotalaria* or pasture, grain legume or a cereal such as *kurakkan*, in

order to minimize surface runoff during the rainy season. This intermediate crop is essentially a cover crop and can be ploughed in at the beginning of the next Yala, to improve the organic matter status of the soil.

If the farmers are not settled by the first Maha rains after land preparation, the project management should undertake this activity. Reservations of rivers, canals, and tanks should be used to grow food, fuel wood, fodder, or medicinal trees to serve the needs of the people as well as to act as windbreaks. Windbreaks will benefit agricultural crops. These activities can be carried out by Farmer's Organizations.

Institutional responsibility will be with MASL, Departments of Agriculture and Agrarian Services, Divisional Secretariats, HIRDP and private voluntary organizations. The responsibility that lies with MASL, may sometimes be executed through a contractor who will need to be adequately briefed. The estimated cost for tree planting is Rs. 250,000.

(ii) Monitoring of water quality

Analysis of surface waters should be carried out at least twice a year, during the wet and dry seasons to determine the nature and levels of contamination by organic, inorganic and bacterial pollutants. The main parameters should include pH, dissolved oxygen, temperature, suspended solids, major anions and cations, conductivity, nutrient salts, heavy metals, pesticides and coliform bacteria. (The possibility of agricultural pollution is discussed in Annex X.)

Based on the nature of pollution, remedial measures should be taken. Further information is required and solutions have to be sought. In one particular area industrial effluents are discharged into the river. As a number of public and private institutions have responsibilities and interests in the region, each institution should develop its own mechanisms for carrying out the analytical and remedial measures and these should be coordinated by MASL. The institutions are Department of Agriculture, Department of Health, Divisional Secretariats, National Water Supply and Drainage Board, HIRDP, National Paper Corporation, Sevanagala Sugar Industries and interested private voluntary organizations. The estimated cost is Rs. 500,000.

(iii) Monitoring of salinity

As a routine measure, it will be desirable to monitor salinity in the agricultural areas, especially those near the coast, in irrigation waters, at the mouth of the Walawe, and in ground water. Studies are recommended on salinity problems in irrigated farming and impacts of agricultural run-off into Karagan Lewaya. Responsibility lies with MASL, Department of Agriculture, and NWSDB. The estimated cost is Rs. 400,000.

(5) Socio-economic Environment

(i) Fuel wood

With the elimination of a large part of the vegetation in the Extension area, fuel wood will be a basic settler need. Fuel wood coops should be established very early - after village sites have been determined. Fast-growing fuel wood species such as eucalyptus and ipil-ipil, and casuarina nearer the coastal belt, can also be grown on homestead boundaries, canal banks and road reservations and other

vacant non-irrigable areas. As the urban centers outside the project area grow, there will be an increasing demand for fuel wood from these as well.

Another key area is the introduction of improved stoves among the settlers so as to economize on fuel wood consumption. Responsibility lies with the MASL, Forest Department, farmer organizations and District Secretariats.

(ii) Drinking water

The poor quality of ground water as indicated by analysis of well water samples is due to natural causes. In view of this, and the fact that using irrigation water for drinking can be problematical the provision of potable water is considered imperative. Responsibility lies with MASL, NWSDB, and private voluntary organizations.

(iii) Farmers organization

Given the constraints of government responsibility down to the field-level, it is recommended that farmer's organizations be established and responsibility delegated, after initial training, which later should be carried out at regular intervals. Responsibility lies with MASL.

(iv) Health care

Past records document the increasing difficulties faced by settlers in their early months. Hence there should be the minimum health care facilities available when the settlers arrive. Diarrhoea, dysentery, snake bite, malaria, poisoning and agricultural accidents are commonly encountered. A survey of illicit gem mining is recommended. An acceptable level of sanitation is very important. It is recommended to flush irrigation canals every seven days as a vector-control measure. Responsibility lies with MASL, Department of Health and private voluntary organizations.

(v) Archaeological sites

Archaeological sites and artefacts found during the construction phase or subsequently, will have to be reported immediately to the Department of Archaeology. Such sites will have to be isolated from the rest of project activities. Artefacts unearthed are the legal property of the Department.

CHAPTER 8 CONCLUSION AND RECOMMENDATIONS

1. The Walawe left bank irrigation project aims to increase the production of rice, sugar and other field crops, generate about 20,000 job opportunities, promote agro-industry, and enhance incomes and living standards of rural people by means of upgrading and extension of irrigation facilities and rural infrastructures for 9,280 net ha on the left bank of the Walawe river.

2. The Project essentially forms part of the 30 year old Uda Walawe scheme and is intended to complete the scheme as per originally conceived. The Project is inexpensive, because it takes advantage of full utilization of the past investments such as the Uda Walawe reservoir, and the already constructed left bank main canal and irrigation system.

   The current feasibility study concludes that the Project is technically feasible and economically sound, and that adverse environmental impacts could be minimized by mitigation measures and the Project would outweigh undesirable environmental impacts.

3. It is recommended that the Government immediately implement the Project starting from the arrangement of an investment schedule with an international funding agency followed by the detailed designing of the Project.

4. It is recommended that the Government take the following measures to ensure the realization of planned crop diversification by farmers:

   - to intensify research and extension activities concerning farming practices of OFCs;
   - to train farmers through demonstration of pilot farms and arrangement of visiting tours to model farms;
   - to provide marketing facilities at proposed village centers;
   - to disperse market information through radio broadcasting;
   - to build a development center in Suriyawewa providing a meeting room, job training facilities for young men and women, library, audio visual equipment, broadcasting facilities, demonstration farms, training facilities for food processing, dormitory, warehouse, and water treatment facilities;
   - to develop and disperse farming methods utilizing organic manure and natural pesticide.

5. It is recommended that the Government would adopt the tank cascade system to realize the most efficient irrigation water management of the Project and train management staff and farmers to accustom themselves to the irrigation management under the tank cascade system.

   Operation of the irrigation system and related facilities must be easy and simple. From this point of view the system should be designed with the minimum number of operation points and preferably the maximum degree of automation.

6. It is recommended that the Government make careful arrangements to synchronize the production of sugarcane by farmers and the processing of it by the Sevanagala sugar factory.

7. It is recommended that the Government take the proposed mitigation measures for adverse environmental impacts of the Project and make a bench mark survey and periodical monitorings on the environment of the Project area.

TABLES

Table 1 PER CAPITA PRODUCTION INDICES

Item	1985	1986	1987	1988	1989	1990
Food	102.33	99.30	86.41	88.48	85.49	88.96
Agriculture	100.11	96.85	86.17	88.36	84.07	88.05
Crops	99.96	98.12	85.07	88.87	84.03	88.57
Livestock	106.64	86.04	104.78	94.57	99.41	97.00
Cereals	117.78	112.97	91.65	105.17	86.46	91.32

(1979-81=100)
Source: FAO Production Yearbook 1990

Table 2 DOMESTIC PRODUCTION AND IMPORT

(unit:1000 ton)

Item		1985	1986	1987	1988	1989	1990
Rice	Production	2,661	2,588	2,128	2,477	2,063	2,200
	Import	-	211	80	194	313	132
Wheat	Production	-	-	-	-	-	-
	Import	720	699	440	732	817	818
Sugar	Production	21	21	24	25	27	31
	Import	384	340	351	327	339	309

Source: FAO Production and Trade Yearbooks

Table 3 METEOROLOGICAL CONDITION

Item	Unit	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1. Temperature	(°C)													
Mean		25.7	26.2	27.6	28.6	28.9	28.2	28.3	28.0	28.1	28.0	27.2	26.6	27.6
2. Relative Humidi	(%)													
Mean		81.9	79.4	79.6	80.6	78.7	79.0	77.6	77.3	78.8	79.0	82.0	82.1	79.6
3. Evaporation	(mm)													
Mean		144.8	146.3	170.2	156.2	160.0	162.5	167.2	164.0	160.3	143.7	129.6	139.4	1,799.3
4. Sunshine Hour	hour)													
Mean		217.8	241.2	242.0	221.2	232.2	212.5	221.8	228.5	213.2	219.8	231.2	188.6	2,563.7
6. Wind Velocity	(km/h)													
Mean		4.0	4.2	4.1	3.1	4.9	6.2	5.7	6.1	5.4	4.0	3.4	4.9	4.7
5. Rainfall	(mm)													
Mean		83.3	35.5	79.0	101.5	57.2	86.7	25.7	57.2	92.5	127.8	139.8	70.8	921.8

Station: Agriculture Research Station
Station Index: ARS
Latitude: 6°10' N.
Longitude: 80°53' E.

Item	Unit	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1. Temperature	(°C)													
Mean		26.6	27.3	27.9	28.4	29.3	28.7	28.8	29.0	28.9	28.2	27.3	26.6	28.2
Mean Max.		31.5	32.9	33.1	32.9	33.0	32.8	33.1	33.3	33.5	32.9	31.7	31.0	32.6
Mean Min.		21.6	21.7	22.8	23.8	25.4	24.6	24.5	24.8	24.4	23.6	22.9	22.2	23.6
2. Relative Humidi	(%)													
Mean		76.6	74.1	75.9	79.0	78.1	72.9	70.0	69.2	70.7	77.6	82.8	80.2	75.6
3. Evaporation	(mm)													
Mean		147.1	160.5	165.3	140.2	143.8	157.2	185.6	195.8	179.7	153.1	116.4	127.1	1,871.9
4. Sunshine Hour	hour)													
Mean		195.9	226.8	231.6	200.2	212.0	190.0	218.8	203.9	195.7	195.0	175.6	180.0	2,447.4
6. Wind Velocity	(km/h)													
Mean		3.7	3.3	3.0	2.4	3.7	6.6	8.1	8.6	6.8	3.7	2.8	3.3	4.9
5. Rainfall	(mm)													
Mean		62.1	76.5	179.9	146.9	107.6	39.7	28.7	37.7	58.5	255.6	276.3	141.8	1,411.3

Station: Sugar Research Institute
Station Index: SRI
Latitude: 8°126' N.
Longitude: 80°553' E.
Elevation of the Station above MSL: 60.1 meters

Table 4 PRESENT HOUSEHOLD ECONOMIC SITUATION

Block	Value (Rs./year)
Sevanagala (Sugar area)	
Gross Income	
1 Agricultural Income	42,400
2 Others (labour wage etc.)*1	11,800
Total	54,200
Gross Outgo	
1 Production Costs	21,000
2 Living Expences	26,600
Total	47,600
Net Reserve	6,600
Kiriibanwewa Block	
Gross Income	
1 Agricultural Income	34,700
2 Others (labour wage etc.)*1	10,300
Total	45,000
Gross Outgo	
1 Production Costs	23,500
2 Living Expences	20,700
Total	44,200
Net Reserve	800
Suriyawewa Block	
Gross Income	
1 Agricultural Income	34,800
2 Others (labour wage etc.)*1	13,900
Total	48,700
Gross Outgo	
1 Production Costs	20,400
2 Living Expences	27,000
Total	47,400
Net Reserve	1,300
Southern Part in the Extension Area	
Gross Income	
1 Agricultural Income	25,900
2 Others (labour wage etc.)*1	12,500
Total	38,400
Gross Outgo	
1 Production Costs	2,900
2 Living Expences	31,800
Total	34,700
Net Reserve	3,700

Block	Value (Rs./year)
Middle in the Extension Area	
Gross Income	
1 Agricultural Income	8,300
2 Others (labour wage etc.)*	9,100
Total	17,400
Gross Outgo	
1 Production Costs	2,300
2 Living Expences	14,700
Total	17,000
Net Reserve	400
Suriyawewa Block in the Extension Area	
Gross Income	
1 Agricultural Income	7,700
2 Others (labour wage etc.)*	17,300
Total	25,000
Gross Outgo	
1 Production Costs	7,900
2 Living Expences	16,300
Total	24,200
Net Reserve	800
Western Part in the Suriyawewa Block	
Gross Income	
1 Agricultural Income	15,000
2 Others (labour wage etc.)*	12,000
Total	27,000
Gross Outgo	
1 Production Costs	3,900
2 Living Expences	23,000
Total	26,900
Net Reserve	100
Western Part in the Extension Area	
Gross Income	
1 Agricultural Income	4,300
2 Others (labour wage etc.)*	10,400
Total	14,700
Gross Outgo	
1 Production Costs	1,900
2 Living Expences	15,100
Total	17,000
Net Reserve	-2,300

Source: Socio-economic Survey
*1: including Subcidy and Loan

Table 5 PRINCIPAL FEATURES OF EXISTING IRRIGATION AREA IN THE STUDY AREA

No.	Item	Management Block			Total of Left Bank Area (Old area only)
		Kiriibanwewa Block	Suriyawewa Block	Sevanagala Sugar Area	
1	Management agency/firm	MEA of MASL	= do as left =	Sevanagala sugar industries Ltd.	
2	Irrigation area in 1990/91 (in ha)				
	a. Total gorss area of scheme	5,700	5,000 *	3,300	14,000
	b. Total net irrigable area	1,480	1,420	1,470	4,370
	c. Net irri. area in Maha-90/91	1,480	1,420	1,470	4,370
	d. Net irri. area in Yala-90	1,410	1,420	1,470	4,300
3	Condition of beneficiaries				
	a. Numbers of beneficiaries (1991)	2,849	5,187	1,894	9,930
	b. Ave. land holding size in ha	1.2	0.8	1.0	
4	Irrigation water source	LBMC and Mau Area (575 ha)	LBMC	LBMC	
5	Irrigation canals and related structures				
	a. Length of canals (km)	85	38	257	410 *
	b. Related structures	1,509	668	3,685	5,928 *
	c. Year construction completed	in 1967	in 1968	in 1987	
6	Drainage canals and related structures				
	a. Length of canals (km)	35	49	80	164
	b. Related structures (nos.)	-	16	32	48
7	Farm roads				
	a. Main farm roads (km)	10	82	18	110
	b. Secondary raods (km)	135	172	34	341
	c. Tertiary roads (km)	-	146	260	406
	Total	160	400	312	872
8	On-farm development (in 1991)				
	a. Area already developed (ha)	1,060	1,420	1,470	3,950
	b. Area under development (ha)	420	100	580	1,100
	c. Area under design/planning (ha)	0	0	700	700
	Total	1,480	1,520	2,750	5,750

Note:
Area in old area only
*; Total includes figure of main canal (LBMC) of 30 km and 66 nos.

Source: Questionnaire survey conducted by the Team in October 1991

Table 6 WATER ISSUE AND IRRIGATION AREA OF THE UDA WAWALE RESERVOIR

Year (Oct-Sep)	Annual Water Issue (MCM)*			Irrigation Area (ha)**		
	Right bank canal	Left Bank canal	Total	Right bank canal	Left Bank*** canal	Total
1968-69	438.5	245.1	683.6	-	-	-
1969-70	488.3	45.5	533.8	-	-	-
1970-71	342.0	67.5	409.5	-	-	-
1971-72	410.5	61.7	472.2	-	-	-
1972-73	449.6	114.0	563.6	-	-	-
1973-74	512.5	97.3	609.8	-	-	-
1974-75	549.5	116.6	666.1	4,538	950	5,488
1975-76	508.9	210.2	719.1	5,578	1,089	6,667
1976-77	470.5	142.8	613.3	3,661	898	4,559
1977-78	522.9	186.0	708.9	5,371	1,195	6,566
1978-79	523.1	211.1	734.2	5,354	753	6,107
1979-80	537.5	217.6	755.1	5,888	1,101	6,989
1980-81	491.2	158.2	649.4	6,234	1,428	7,662
1981-82	422.4	225.2	647.6	6,987	2,038	9,025
1982-83	418.1	175.9	594.0	7,920	2,568	10,488
1983-84	-	-	-	-	-	-
1984-85	448.5	185.7	634.2	-	-	-
1985-86	420.0	166.5	586.5	8,675	2,736	11,411
1986-87	465.7	166.1	631.8	8,620	2,804	11,424
1987-88	496.7	140.7	637.4	8,135	3,138	11,273
1988-89	524.3	175.1	699.4	8,403	3,248	11,651
Average	472.0	155.4	627.5			

Note: Data of water issue during 1968/69 to 1982/83 and of irrigation area during 1975 to 1983 : Final Reoirt on Walawe Irrigation Rehabilitation and Improvement Project, Vol-II;Annex, MASL, 1984

*; The amount includes industrial and domestic supply amount during off season of irrigation season of irrigation.

**; Average irrigation area of Maha and Yala seasons reported by Agricultural devision of MEA Uda Walawe Special Project Area offcie, but the area of Sevenagala area is not included.

***; Commanding area of Mahagama tank of 575 ha is excluded.

****; According to the irrigation division of the Uda Walawe office of MEA, the actual extent of irrigation area on Right bank is as follow (infromation was given in March 1992):

Year	Average irrigation extent in Maha and Yala (ha)	Water supply for irrigation purpose (MCM/year)	Water supply for indust. & domestic (MCM/year)	Total water issue for Right bank (MCM/year)
1982/83	9,392	315.9	42.2	358.1
1983/84	9,702	294.7		
1984/85	9,961	374.4	74.1	448.5
1985/86	10,134	398.4	21.6	420.0
1986/87	9,389	385.0	80.7	465.7
1987/88	8,971	451.3	45.4	496.7
1988/89	8,951	477.3	47.0	524.3
1989/90	9,123	503.0		
Average	9,453	400.0	51.8	452.2

Table 7 PROPOSED LAND USE PLAN

Present Land Use	without Project	With project (Planed Land Use)														
		Homesteads	Irragated Area*					Total Irrigated Area	Upland (Rainfed)/ Chena	Other	Plantation	Livestock farm	Shrub/ Pasture Land	Open/ Firewood Forest	Forest reserve	Barrenland Rock
			Paddy	Sugar	B. Onion	Banana	Vegetable									
A Existing Irrigation Area																
1. Sevanagala Sugar Area																
(1) Homesteads	1,800	1,800														
(2) Sugarcane (Irrigated)*	1,120			1,120				1,120								
(3) Paddy (Irrigated)*	370		370					370								
(4) Upland (Rainfed)	985		360	525				885		100						
(5) Open Forest	620			375				375		60				185		
(6) Barrenland/Rocky Lands	60															60
(7) Others	485									485						
Sub-total	5,440	1,800	730	2,020	0	0	0	2,750	0	645	0	0	0	185	0	60
2. Old Area																
(1) Homesteads	2,490	2,490														
(2) Paddy (Irrigated)*	2,540		1,780		240	260	260	2,540								
(3) Upland crops (Irrigated)*	360			220		140		360								
(4) Paddy (Rainfed)	70		60					60		10						
(5) Upland (Rainfed)	2,180		380	600				980	1,030	170						
(6) Open Forest	260													260		
(7) Shrub	605												605			
(8) Livestock farm	25											25				
(9) Barrenland/Rocky Lands	700															700
(10) Others	1,810									1,810						
Sub-total	11,040	2,490	2,220	820	240	400	260	3,940	1,030	1,990	0	25	605	260	0	700
B Extension Area																
(1) Homesteads	200	50	70		50			120		30						
(2) Paddy (Rainfed)	260		220					220		40						
(3) Chena/upland crops	2,520		800		340		50	1,190	1,120	210						
(4) Open Forest	740	50												690		
(5) Plantation	20										20					
(6) Forest Reserve	960														960	
(7) Shrub	10,310	1,100	1,230	2,180		210	190	3,810		680		410	4,310			
(8) Barrenland/Rocky Lands	490															490
(9) Others	200									200						
Sub-total	15,700	1,200	2,320	2,180	390	210	240	5,340	1,120	1,160	20	410	4,310	690	960	490
Total	32,180	5,490	5,270	5,020	630	610	500	12,030	2,150	3,795	20	435	4,915	1,135	960	1,250
(MEA Managed area)	26,740	3,690	4,540	3,000	630	610	500	9,280	2,150	3,150	20	435	4,915	950	960	1,190

*: Net irrigation area only

Table 8 PRINCIPAL FEATURES OF THE PROPOSED PROJECT WORKS

Item	Description
1 Location	150 km south-east from Colombo, Hambantota district of Southern province and Monaragala district of Uva province, Left bank of the Walawe river
2 Water Resources	Walawe river/ Uda Walawe reservoir and Mau river/ Mahagama tank
3 Project Command Area	Net irrigation area of 9,280 ha
4 Agricultural Development Plan	
(1) Land use plan	Paddy of 4,540 ha (49 %), sugar cane of 3,000 ha (32 %), and other field crops of 1,740 ha (19 %)
(2) Cropping intensity	200%
(3) Annual incremental production	
(i) Paddy	28,000 ton/year
(ii) Sugarcane	342,000 ton/year
(iii) Other crops (banana, vegetables, onion)	44,000 ton/year in total (10,000, 19,000, 15,000)
5 Proposed Project Works	
(1) Rehabilitation and improvement of the existing irrigation facilities for Old Area of 2,900 ha	231 canals of 186 km in total (rehabilitation/improvement of 156 km and new canals of 30 km)
(2) Construction of irrigation and drainage facilities for irrigation extension areas of 6,380 ha	Extension of LBMC of 25 km, 201 irrigaiton canals of 338 km in total, drainage canals of 254 km in total, road along canals of 322 km
(3) Land reclamation and construction of on-farm facities	Land reclamation of 5,240 ha and on-farm developement of 6,380 ha
(4) Construction of rural infrastructure	Land preparation for settlement area of 1,200ha, construction of 28 schools, 2 health facilities, farm road of 140 km including main farm road of 31 km and bridge on the Walawe river, 23 drinking water supply system, agricultural development center at Suriyawewa, etc.
(5) Procurement of O&M equipment	Operation vehicles, maintenance equipment, etc.
6 Project Cost	
(1) Direct construction cost	Rs.3,417 million
- Rehabilitation and upgrading works	(Rs. 313 million)
- Irrigation extension works	(Rs. 1,787 million)
- Rural infrastructure	(Rs. 1,318 million)
(2) Administration and E/S	Rs. 575 million
(3) Price contingency	Rs. 1,492 million
Total	Rs. 5,483 million
7 Project Fund Requirement	
(1) Foreign currency portion	Rs. 2,954 million (US$ 67 million)
(2) Local currency portion	Rs. 2,529 million (US$ 57 million)
(3) Total cost	Rs. 5483 million (US$ 124 million)
8 Implementation Program	
(1) Implementation period	
(i) Detailed design and pre-construction management	2.5 yeas (detailed design for 1.5 year)
(ii) Construction works	3 years in total
(iii) Total period	5.5 years
(2) Executing agency	Mahaweli Authority of Sri Lanka (MASL, M/LIMD)
9 Econimic Evaluation	
(1) Economic capital cost (Rs. million)	Rs. 3,614 million
(2) Annual economic benefits (Rs. million)	Rs. 684 million
(3) E-IRR	17.3%
(4) Benefit-Cost (B/C) ratio (at 10% discount ratio)	Rs. 1,766 million
Benefit minus Cost (B-C) ratio (at 10% discount ratio	1.72

Note:
(1) Conversion rate: US$ 1.0 = Rs. 44.0 = JY 126.5
(2) Price escalation ration per year : Foreign currency ; 3.8% , Local currency; 11.6 %