CHAPTER 5 : Polambakkam Tank Area

CHAPTER 5 POLAMBAKKAM TANK AREA

5.1 General

5.1.1 Location

Polambakkam Tank of which the registered command area is 94.6 ha is located about 11 km south to Madurantakam town along the Madurantakam - Chanampet road as shown in Fig. 5.1.1. The tank is located about two (2) km west of the road. Administratively it belongs to Polambakkam Village in Madurantakam Taluk of Kanchipuram District.

The village area is surrounded by Nethapakkam Village on its north side, Paiyambadi and Saravanambakkam villages on its east side, Chitamur, Mukundagiri and Perumbakkam villages on its south side, and Gurumbirai and Maluvankaranai villages on its west side.

5.1.2 Topography

Polambakkam Tank is located about two (2) km west from Madurantakam - Chanampet road along the unpaved village road, and its waterspread area is measured to be 0.63 km^2. The ayacut areas of 94.6 ha expand to the east of the tank toward the Madurantakam - Chanampet road. The catchment area of the tank expands in the areas to the south and west of the tank.

The bund of about 1.3 km runs from north to south along the eastern edge of the tank. At the northern end of the bund, a surplus arrangement is provided. A small additional tank is attached at the southern end, and this small tank is connected with a sluice gate to enable it to receive the surplus water during the flood time.

The residential areas of the village are located at the center of the village territory, and the public facilities of village are located there.

The ayacut areas are generally flat with mild slope toward east, and the earthen irrigation channels run generally eastward branching into many off-take channels. There are 57 wells in the ayacut areas to take domestic and irrigation water.

There are two (2) village roads to have access with the main roads running near the village. One is the unpaved road running from east to west connecting the village to the Madurantakam - Chanampet road, and the other is that running from north to south connecting the Cheyyur - Vandavasi road.

5.1.3 Geology

The thin alluvial formation is underlined by granites. The underlined granites are highly weathered up to a depth of 7 to 9m. The rocks are fractured between 12 to 18m. Micaschist are present in certain regions of this area. Joints are clearly noticed in some of the well sections.

5.1.4 Soils

The types of soils are mainly red sandy silt in the catchment and black clayey loam in the ayacut area. No saline soils are found in the area.

5.1.5 Vegetation

A major part of the catchment area is covered by eucalyptus and acacia species forest. Other trees found in the catchment are *Borassus Flabellifer (Palmyrah)*, *Azadirachta Indica (Neem)* and *Prosopis Juliflora*. In the waterspread area, tank bed plantation under the social forestry is found but it is not well operated.

5.1.6 Objectives

The Polambakkam tank is categorized as a NR-2, which belongs to the Northern Study Area or annual rainfall more than 1,000 mm, and having the average cultivation area more than 75% of registered ayacut area, at a scale between 60 to 100 ha. This means that water resources are rather rich in surface and groundwater, and even at present all the ayacut area might be possible to be irrigated after irrigation efficiency is increased by channel lining. The tank was transferred from Zamindar tank to PWD tank recently.

According to the Baseline Survey, the Polambakkam Tank shows that almost every year it has surplus water, and cultivation ratio is more 79 %.

Therefore, objectives of the Polambakkam Tank rehabilitation are: 1) to maximize the tank water instead of groundwater; and 2) to distribute tank water in equity through the physical tank facility rehabilitation and channel lining.

5.2 Meteo-hydrology

5.2.1 Climate

The climate prevailing over the tank area is sub-tropical. The basic and consolidated climatological data of temperature, relative humidity, sunshine, wind speed and evaporation data are available for Tirutani meteorological station located in the Nandhi River basin maintained by the Groundwater Wing of the PWD. Since, Polampakkam Tank, belongs to the same North eastern agro-climatic zone, the climatological data of Tirutani Meteorological Station is representative of Polampakkam Tank also. The

coordinates and the monthly average climatological parameters are presented in Section 3.2.1.

5.2.2 Rainfall

The rainfall in the catchment area of the tank varies with season and it receives considerable rainfall both in Southwest and Northeast monsoon. For all rainfall computations, data recorded at the nearest Madurantagam Rainfall Station, maintained by the Revenue Department is used. The mean monthly rainfall data of the last 25 years are as shown below:

Mean Monthly Rainfall of Polampakkam Tank Catchment Area

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean	12.6	16.7	2.5	5.1	20.8	46.7	90.6	156.9	132.6	197.9	304.4	124.7	1,111.5
Maximum	124.0	272.0	39.0	29.0	74.0	276.8	395.0	427.0	311.0	616.0	885.0	525.0	2,114.4
Minimum	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	15.0	20.0	31.0	0.0	395.0

The entire calendar year can be divided into four seasons with the following rainfall distribution.

- Southwest Monsoon (June-September):	426.8 mm	(38.4 %)
- Northeast Monsoon (October-December):	627.0 mm	(56.4 %)
- Winter (January - February):	29.3 mm	(2.6 %)
- Summer (March - May):	28.4 mm	(2.6 %)
- Total:	1,111.5 mm	(100 %)

The tank catchment receives its maximum rainfall in the North-east monsoon season while the lowest rainfall occurs during the winter months of January and February. The mean monthly maximum rainfall is 304.4 mm in November, and the minimum rainfall is 2.5 mm in March. The annual maximum rainfall of 2,114.4 mm occurred during 1977 while the minimum of 395.0 occurred in the year 1988.

5.2.3 Catchment Area

Polampakkam Tank is a non-system tank located in the Kiliyar Minor basin. In preparation for the field visits a 1:50,000 map of the tank was obtained which permitted an assessment of catchment and command area. As shown in Table 3.2.1, Polampakkam Tank receives its runoff water from its free catchment of 2.276 km^2 and an intercepted catchment of 3.693 km^2 and hence the combined catchment (free + intercepted) area is 5.969 km^2 and the equivalent catchment (free + 1/5th of intercepted) area is 3.015 km^2. As per the PWD norms, the catchment is classified as "average" having gentle slope and moderate vegetation. The registered ayacut of this tank is 94.590 ha, and hence the ratio between free catchment and registered ayacut is 2.41.

5.2.4 Hydrological Analysis

The hydrological analysis procedures are similar to that of Echur Tank. Rainfall - runoff computations have been carried out for monsoon period (September - December) and annual (January - December) period for a continuous period of 16 years based on Strange Tables. There is no hydrological gauging station in the tank catchment and command area.

Yield and Runoff from the Catchment Area of Polampakkam Tank

Year	September - December			January - December		
	Rainfall (cm)	Yield (cm)	Runoff (Mm^3)	Rainfall (cm)	Yield (cm)	Runoff (Mm^3)
1980	40.1	3.2	0.097	80.9	17.6	0.532
1981	67.4	11.5	0.345	98.9	27.2	0.820
1982	36.4	2.4	0.071	55.5	7.5	0.226
1983	69.0	12.4	0.374	111.9	35.8	1.080
1984	77.6	15.9	0.480	143.3	60.9	1.836
1985	128.5	47.8	1.441	190.2	123.6	3.728
1986	15.7	0.8	0.024	39.6	3.0	0.089
1987	47.1	5.0	0.152	53.3	6.7	0.201
1988	23.0	0.6	0.018	39.5	3.2	0.095
1989	62.5	9.7	0.292	68.6	12.0	0.362
1990	54.6	7.1	0.214	81.2	17.4	0.526
1991	80.3	17.3	0.521	116.6	39.1	1.178
1992	85.7	20.1	0.607	122.6	43.9	1.323
1993	78.8	16.5	0.499	103.7	30.6	0.923
1994	62.8	9.9	0.299	91.0	22.6	0.681
1995	84.3	19.4	0.584	110.7	35.4	1.068
Mean	63.4	12.5	0.376	94.2	30.4	0.917
Maximum	128.5	47.8	1.441	190.2	123.6	3.728
Minimum	15.7	0.6	0.018	39.5	3.0	0.089

During 1980 - 1995, the average annual yield was 30.4 cm with a maximum of 123.6 cm in 1985 and a minimum of 3 cm in 1986. The corresponding values of estimated annual runoff are 0.917 Mm^3, 3.728 Mm^3 and 0.089 Mm^3. The monsoon period (September - December) yield and runoff values also have been estimated and are presented in the table. The 16 year average monsoon period yield was 12.5 cm and that of runoff was 0.376 Mm^3. In an average the monsoon period yield accounts for nearly 41.1 % of total annual yield.

The estimated runoff values based on the daily rainfall data for the years 1986 - 1995 are presented in Table 3.5.4 and 3.5.5. The annual runoff values vary from 0.527 Mm^3 to 5.286 Mm^3 with an 10 year average value of 2.066 Mm^3, the average runoff ratio being 53 %. Similarly, the monsoon (September - December) runoff varies from 0.294 Mm^3 to 4.676 Mm^3. For this 10 year period, average monsoon runoff was calculated to be 1.717 Mm^3, with a runoff ratio of 60 %.

5.3 Social Conditions

5.3.1 Present Social Conditions and Facilities

(1) Available Social Facilities in the Village

The drinking water supply system is provided for all the villagers. About 66 % of villagers use the piped supply system, and the remaining 34 % take the water from shallow and deep wells. The water quality of these sources is considered to be good. However, the electricity supply system is provided for only 64 % of villagers.

There is a community hall which the villagers use for various functions such as marriage ceremony, etc., and a Primary Health Center (PHC) is also available in the village. There are primary (Grade 1 -5) and higher secondary (Grade 6 - 12) schools. There are two (2) village roads connecting to the main roads, and frequent bus services for Madurantakam are available at the junction.

(2) Social Settings of the Ayacut Area

1) Land Holding and Relating Villages or Hamlets

There exist 139 farmers in the ayacut areas of Polambakkam Tank, and their average land holding size is calculated to be about 0.66 ha. About 88 % of the farmers are accounted for marginal and small farmers. All the farmers in the ayacut areas live in Polambakkam Village. There is no farmer of the other villages and hamlets in the ayacut areas.

Since Polambakkam Tank is a former Zamindar tank, the descendants of those Zamindars and their family members still occupy large extent of farm lands in the ayacut areas even after the land reform. The rest of the farm lands is shared by many marginal and small farmers.

2) Caste Composition

The approximate caste composition of the farmers in the ayacut areas are as follows:

Caste Composition in the Polambakkam Tank Ayacut Area

(Unit: %)

Others	BC	MBC	SC	ST	Total
9	35	5	50	1	100

The most predominant caste category is SC composed of the group of Adidravida, and it shares about 50% of all the farmers in the ayacut. The second predominant caste category is BC composed of Sengunthar sharing about 35%. In this ayacut area, the share of the other caste groups are composed of Reddiar

nine (9) % and this value is considered rather large comparing with other villages. The share of MBC (Vanniar) and ST (Vettaikkaran) categories are not so much as five (5) % and one (1) %, respectively.

3) Water Distribution and Decision Making Procedure

There is no registered organization for distributing water in the ayacut area. There is no meeting or discussion held among the farmers in the ayacut areas. However, two (2) *Neerkatis* are nominated once in every three (3) years as a traditional system. The operations of sluices are made in consultation with influential farmers such as the descendants of Zamindar. The small farmers expect the leadership of the village president who was elected recently.

4) Maintenance of Irrigation Facilities

No regular maintenance activity of the irrigation facilities is conducted in the ayacut area except for the emergency repair works of tank bund and the desilting works done at the initial stage of the every irrigation period. The removal of weeds and the desilting works of the sluice are carried out by the assigned *Neerkatis*.

5) Conflicts and Problems

According to the farmers in the ayacut areas, there is no conflict among either the caste groups or the farmers having advantage or disadvantage in receiving irrigation water. However, marginal farmers' lands are apt to be left abandoned during the drought periods, and they have to work as agricultural laborers for a few large farmers. Their grievances are considered serious, and this situation may lead a conflicts between castes though there is no visible conflict at present.

6) Other Employment Opportunity

The nearest town are Madruntakam and Acharapakkam located about 9 km away from the village. However, the villagers do not go to these towns to get jobs, because any attractive opportunity is not expected. They usually work as agricultural laborers for the large farmers.

5.3.2 Sociological Evaluation

Based on the criteria described in Section 2.5, the sociological conditions of Polambakkam Tank ayacut are evaluated as stated below.

Results of Social Scoring of Polambakkam Tank

Factors	Hamlets	Farm Size	Conflicts	WUA	Leader-ship	Resource Mobilization	Main-tenance	Overall Score
Scores	5	1	10	4	10	10	5	45

This results show that, at present, the ayacut is not good on sociological grounds and the timing of community organizer for formulating WUA shall be six months prior to estimation preparation.

5.4 Agriculture

5.4.1 Present Agriculture

(1) Land Use

The registered command area is 94.6 ha of which the irrigable area is 79.7 ha (84.2 % of the command area). In this area, paddy is cultivated in staggered cropping because irrigation water is limited. In 1995-96, paddy was cultivated during July to December and October to February in the area of 13.1 ha (12.3 %) and 81.3 ha (79.7 %), respectively. The total cropped area in the year was 94.4 ha and the crop intensity was 99.5 %. In a normal year, paddy is grown in the area of 12.3 ha (13.0 %) from July to December and in the area of 79.7 ha (84.2 %) from October to February. Groundnut is grown in a small area of 2.0 ha (2.1 %) after the harvest of the 1st paddy crop. Consequently the crop intensity in normal year comes to 99.4 %.

(2) Soil and Land Capability

The type of soil is mainly black clayey loam in the ayacut area which is suitable for wet and dry cultivation. No saline soils are found in the ayacut area. The present cultivation of those soils show that the soils are suitable for irrigation.

(3) Agricultural Production

1) Crop Production

The main crops cultivated in the area are paddy and groundnut. The total production of paddy in the area was 354.0 tons sharing 49.1 tons in the 1st crop and 304.9 tons in the 2nd crop in 1995-96. The amount of paddy in normal year is almost the same as the year of 1995 - 1996.The average yield was 3,750 kg/ha in 1995 - '96 and 3,800 kg/ha in normal year. The main varieties of paddy cultivated is white ponni and ADT39 for the 1st crop and IR36 and IR50 for the 2nd crop. In normal year, groundnut is grown in an area of 2.0 ha during the period from January to April after harvest of paddy. The average yield is 1,250

kg/ha.

2) Irrigation Water

Tank water is available from October to January with irrigable area of 79.7 ha in normal year. There are 45 wells with irrigable area of 18.6 ha.

3) Fertilizer Application

According to the data of farmers' interview survey, 68 kg/ha of N and 40 kg/ha of P_2O_5 and 21 kg/ha of K_2O was applied in split applications of 2 to 3 times for the paddy in 1995-96. The amount of N applied is around half of that of government recommendation. Therefore, yield increase with improved fertilizer application will be expected.

4) Labor Input

According to the farmers' interview survey, the average labor input for paddy cultivation in the 10 study areas was about 200 man-day/ha of which 28 % was allotted to harvesting, 24 % to weeding and 21 % to transplanting. While the family agricultural labor in the area is 1.1 men/house and the potential agricultural labor is 3.3 men/house. According to these data, the necessary staggering period in the command area to accomplish the farm works of paddy cultivation by family labor require 11 days. The labor requirements for vegetable, sugarcane and groundnut cultivation are around 4.3 times, 2.3 times and 0.6 times of the paddy, respectively.

5) Livestock Breeding

In the area, breeding of livestock is lively, especially breeding of pig is conspicuous. 650 heads of cattle, 840 heads of goat, 1,200 heads of sheep, 250 heads of pig and 650 heads of chickens have been raised in the area. The average number of heads raised per farm household is 4.2 on cattle, 5.2 on goat, 50 on sheep, 62.5 on pig and 3.5 on chicken.

(4) Farm Size and Land Tenure

The number of farm holders in the area is 139 of which 12 % are holders of more than 2 ha, 58 % are holders of 1 to 2 ha and 3 0 % are holders below 1 ha (marginal). The average farm size is 0.68 ha which is same as the average of the Study Area.

5.4.2 Agricultural Development Plan

(1) Land Use

As shown in Table 3.4.1, the crop intensity is planned to be increased from 99.4 % at present to 108.5 % in the plan by introduction of high return crops such as ladies finger (4.3 ha, Feb.-May), eggplant (4.3 ha, Feb.-Jul.), turmeric (5.0 ha, Jun.- Mar.) and banana (5.0 ha May - May) in the dry season. These crops are grown by well water.

(2) Cropping Plan

The cropping plan was made as shown in Fig. 5.4.1. In the plan, 79.7 ha were allotted to paddy grown in September to January with tank water. Besides, as a high return crops, ladies' finger, eggplant, turmeric and banana were introduced in an area of 18.6 ha in total in the dry season using well water. Black gram was also introduced in an area of 4.3 ha grown under rainfed conditions.

(3) Crop Budget and Production Plan

The planned production amounts, the production costs and the net incomes of crops are shown in Table 3.4.2. In the plan, the total crop net income amounted to Rs.2,742,000 of which paddy, ladies' finger, black gram, egg plant, turmeric and banana shared 60.5 %, 6.9 %, 2.0 %, 6.3 %, 13.7 % and 10.7 %, respectively. The total amount of net income in the area corresponded to 3 times of the present.

(4) Employment and Working Opportunity

The introduction of the high return crops for 18.6 ha in the dry season will bear a certain increase in employment and working opportunity throughout a year. The labor requirement is estimated at the amount corresponding to the labor requirement of about 74 ha in paddy cultivation.

(5) Farm Management and Farm Budget

1) Farm Management Plan

For Polambakkam Tank area, the balance between on-farm works and off-farm works is observed in a good way but the integrated agriculture has been found not being intensively applied. The application of integrated agriculture at each farm is recommended to be established with related documents for making local farmers obtaining this knowledge.

From these basic concepts, after confirming the related feasibilities for realization, the proper plan for farm management for each individual farm

should be further elaborated for each corresponding farm based on the following elements:

- Existing natural conditions for farming
- Local traditions in agriculture
- Periods of possible water supply from tank, groundwater etc.
- Available capital for investing in agricultural production
- Evaluation of possible crop budgets
- Preparations of farmland ,inputs and related techniques
- Selection of crops for planting through the year
- Harvesting and marketing capabilities and proceedings
- Estimates on net farm revenues after all production costs
- Estimates on the balance after all family living expenses

2) Farm Budget Plan

Due to the rather intensive application of off-farm works in this tank area. the farm budget is recommended to be elaborated on this basis for maintaining a higher farm budget for small and marginal farms.

Besides, as the integrated agriculture is observed being neglected in this tank area, the application of integrated agriculture should also be considered for increasing farm revenues, particularly on the aspects of raising stock at farm basis and aquaculture in the tank with cooperative scheme.

(6) Marketing Plan

The road from the tank area to the trunk road is recommended to be made in good conditions for possible transports to the villages in the rainy season. At the villages near the trunk road, basic post-harvest treatment facilities such as drying yard, godown etc. for their agricultural produces are recommended to be established.

Besides, some transport vans are expected to be equipped for quick transportation of agricultural produces to village godowns and district markets.

5.4.3 Agricultural Supporting Services and Institutional Plan

(Same as notified in this part for Echur Tank Area)

5.5 Rehabilitation of Tank Irrigation System

5.5.1 Present Conditions

(1) Irrigation and Drainage System

Polambakkam tank is jointed with small tanks and is connected with a water gate at the southeastern corner of the tank bund. At present no gate control is practiced for the inflow to the small tank. The small tank has one sluice, commanding about 15 ha.

There are 2 sluices, during the reporting period: No. 2 sluice is under rehabilitation by PWD; No.1 sluice is the main sluice, and its channel commanding more than 75 % of ayacut area and the channel water is extended beyond the district road. No.2 sluice channel located in the northern part of tank bund, and conduct water along the tank bund then turns to east. According to the village map surveyed in 1979, most of wells located in the tail reaches of No. 2 sluice channel. Recently many wells are installed in the ayacut area. According to the Tank Inventory, there are 57 wells installed and the density of well is estimated 0.6 wells/aycut area in ha.

Village road runs from the north to south crossing main channels and dividing the ayacut area into head reaches and middle/tail reaches.

A surplus weir and a sand wash is installed at the northern end of the tank bund. The surplus channel of these surplus arrangements, flows into Sadaedu Tank, which command area is located in the northern edge of Polambakkam Tank command area.

During the high water stage, the paddy field at the toe of the tank bund is swampy wet with seepage water through the tank bund.

According to the data collected from Polambakkam Village VAO (village administrative officer), the average plot size of cultivation field is 0.26 ha and holding conditions are as shown in the table below:

Average Plot Size in Polambakkam Tank Area

Farm Category	Number of Holders		Holding Size	
Small (less than 1 ha)	158	83 %	57.28 ha	42 %
Medium(1 to 2 ha)	21	11 %	32.49 ha	24 %
Large (more than 2 ha)	12	6 %	46.35 ha	34 %
Total	191	100%	134.01 ha	100%

Source: VAO Polambakkam, July 1997

(2) Tank Bund

The existing dimensions of the tank bund are measured and soil mechanics properties are analyzed. The results are shown in Table 3.5.1 and Table 3.5.2. The

following observation were made during the site visit:

- Longitudinal cracks on the top surface of the bund.
- Soil erosion around the intake facility

(3) Spillway (Surplus Arrangement)

1) Location

There is a spillway of B.C. weir type for this tank. This weir is recently repaired by PWD. Location of these weir is shown in the table and Fig. 5.5.1.

2) Existing condition

All components of the weir including crest, apron and side wall, are under deteriorated condition.

(4) Intake Facilities (Sluices)

1) Location of the Sluice

There are two (2) sluices of Tower-Head type provided in this tank. At present, sluice No. 1 is replaced by PWD for non-functioning as same as the weir. The location is shown in Fig. 5.5.1.

2) Existing condition

In the process of repair of the sluice No. 1, excavation for replacing had been completed, material for replacing such as brick are brought to provide. The sluice No. 2 functions are well kept, any cracking and damage are not confirmed.

3) Water supply control device

Plug and plug rod type are installed in sluice No. 2 in the same way as in the other tanks.

(5) Groundwater Usage

Groundwater is utilized for agricultural purposes from large diameter dug wells and dug cum bore wells. Some of the dug wells has horizontal drill hole at the bottom. These wells yield water of good quantity for irrigation purposes.

(6) Operation and Maintenance

No formal water users' association exist in the ayacut area. Traditional irrigation is practiced. No conflicts appears for the irrigation water distribution. Most of irrigation channels are cleaned at the beginning of the tank operation by farmers. Private channels from well are properly maintained by owners themselves.

At present, there is no drainage facility in the ayacut area, the irrigation channel and paddy field has dual purposes. Poor drainage near the toe of tank bund shows poor yield of paddy caused by seepage water though tank bund during high water storage.

5.5.2 Water Resources Development Plan

(1) Liability of Water

The Indian Meteorological Department's classification of drought based on the monsoon rainfall is given in Section 3.5.2. Following the same classification, the probability of the availability of water for Polampakkam Tank is presented in the following table.

Liability of Water Based on Rainfall

Classification	No. of years	Total No. of years	Probability (%)
Excess	6	25	24.00
Normal	7	25	28.00
Deficit	6	25	24.00
Scanty	6	25	24.00

Among the 25 years 28 % of the years are classified as normal followed by 24 % of excess, deficit and scanty years. The excess rainfall occurred only in 6 years accounting for 24 % of total years.

Apart from this, as mentioned for Echur Tank, another important aspect is the occurrence of drought or flood based on the rain storm. For a five year return period (20% of provability), the drought monsoon rainfall is estimated as 1,058 mm, which is nearly 95 % of average annual rainfall. The above figures shows that, tank rehabilitation measures will yield fruitful results, by collecting all the available rainfall water resources.

(2) Water Quality

Based on the field measurement of the Study Team, the water quality on its pH and electrical conductivity in the area indicate no salinity hazard will be expected for the crop cultivation on the surface and groundwater. Tank water shows pH 8.6/8.9, which is rather alkalinity, and EC between 0.2 to 0.3 dS/m. While EC of groundwater (shallow well) indicates between 0.6 to 0.7 dS/m.

(3) Irrigation Water Requirement

Paddy rice is the dominant crop in the 94.59 ha ayacut of Polampakkam Tank. The Gross Irrigation Water Requirements during the main rice-growing season of (September - December) is presented in Table 3.5.3. With present irrigation efficiency of 40 %, a total water requirement of 1.134 Mm^3 is calculated. By lining the field irrigation canals, the expected increase in the irrigation efficiency is 75 % which reduces the gross irrigation requirement to 0.671 Mm^3. By this way 0.463 Mm^3 of water can be saved which could have been utilized to irrigate more area or used to grow second rice crop in Polampakkam command area.

(4) Water Balance

The capacity of Polampakkam Tank is determined as 1.507 Mm^3, through topographic survey. Based on the daily rainfall for the years 1986 - 1995, runoff values were estimated using the dry-damp-wet method. After subtracting the irrigation demand and the evaporation losses, changes in tank storage were calculated and summarized in Table 3.5.4 and 3.5.5. As per the annual data, among the nine years, surplus occurred only in 10 years accounting for 22.2 % of total years, with the present irrigation efficiency of 40 %. Estimated irrigation area fluctuated between 25 % to 100 % with an average value of 56 % of the registered ayacut of 94.59 ha. This situation could be improved by increasing the irrigation efficiency to 75 % by canal lining and reducing the irrigation water requirements. By this change, the tank could able to irrigate in an average 78 % of the registered ayacut. With canal lining, runoff - ratio could be increased to 305 % from the present value of 180 %. Data based on the monsoon rainfall also showed the same trend. Entire registered ayacut could be commanded by the tank water in five out of ten years, implying the immediate need for field canal lining in the command area.

(5) Drainage Water Requirements

The drainage water requirement of Polampakkam Tank is calculated according to the procedure described for Echur Tank and details are given in Table 3.5.6. Using the Ryve's formula, the estimated maximum flood discharge is 11.76 m^3/s while that using the rational formula is 31.40 m^3/s. Hence a safe design discharge of 31.40 m^3/s may be adopted for designing surplus arrangements, after considering the type of surplus weir and the cost estimates.

(6) Basin Water Management

The Polampakkam tank is located in a chain comprising more than six tanks with an intercepted catchment area of 3.693 ha. As presented in Table 3.2.1. various chain basin ratios were calculated and are presented here for easy reference.

- Free catchment / command area = 2.54
- Intercepted catchment / command area = 3.90
- Capacity /command area = 0.016 Mm^3/ha
- Waterspread Area / Capacity = 0.589 km^2/Mm^3

The surface water resources of Polampakkam Tank basin consists of direct runoff from rainfall and flow in streams from upper tanks. However, irrigation largely depends on available tank water and groundwater. The total ground water recharge of Madurantagam block to which, Polampakkam Tank belongs to was estimated to be 18,640 ha m; utilizable recharge is 15,844 ha m; net groundwater draft is 10,902 ha m and the balance available is 4,942 ha m. This remaining balance of 31.19 %, could be exploitable by digging out more wells in the command area of chain tanks.

The total surface water resources can not be utilized due to certain limitations, as summarized for Echur Tank, which leads to develop basin management strategies as outlined in Section 3.5.2, with the formation of multi-tier farmers association, viz Polampakkam Tank WUA, Polampakkam chain basin farmers council and Kanchipuram District Tank Farmers Federation and formulating specific roles for farmers in tank rehabilitation and post-rehabilitation tank maintenance.

(7) Groundwater Development

The unutilised groundwater potential in this region can be extracted by going for large diameter open wells. In order to locate highly fractured zones a detailed geophysical survey can be carried out.

5.5.3 Tank Irrigation Facilities Rehabilitation Works

General layout of irrigation facilities is shown in Fig. 5.5.1, and required item for rehabilitation works are described in the table shown in the next page.

Countermeasures for Rehabilitation of Polambakkam Tank

Component	Rehabilitation works	Section for Rehabilitation Works	
Tank Bund Improvement (Total bund length 1310m)	Strengthening of the bund for reshaping to standard size.	1275m	
Intake works (Sluice)	Modification of intake system using gearing shutter Protection of back-fill for side slope.	Tower head type	2 units
Surplus arrangement	Widening as 8.0m of width of B.C type weir. Provision of rough stone for revetment	B.C. type weir	1 units
Selective Lining for Field Channel including On-farm development	Installation of lining canal up to 10ha Provision of diversion boxes with paddle shutter for equal distribution. Reshaping of existing canal. Provision of incidental device such as cart, cattle, and canal/crossing.	1610m as main 890m as branch	2 units 2 units
Building for Farmers' Association	Provision of community hall for WUA, local farmers and inhabitation.	50m^2	1 Nos.

5.6 Farmers' Organization

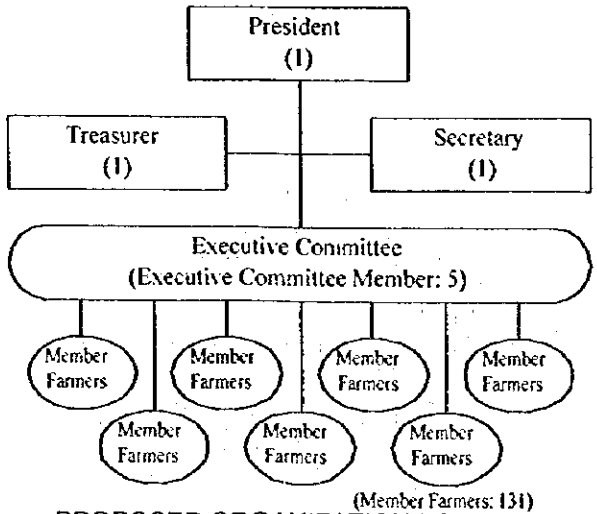
5.6.1 Present Situations of Farmers' Organization

There is no such registered organization as water users' association in the ayacut area as described in Sub-chapter 5.3.1. They have their informal society for water distribution appointing *Neerkatis* for monitoring water distributions.

5.6.2 Proposed Farmers' Organization

(1) Water Users' Association

Since there are 139 farmers in the ayacut areas, the number of the Executive Committee Member is five (5) and the number of member farmers, 131 deducting the number of bearers from the total farmers. The functions of the proposed WUA for the Echur tank are described in Sub-section 4.3.4 of Volume II Report.



PROPOSED ORGANIZATION FOR WATER USERS' ASSOCIATION OF POLAMBAKKAM TANK

(2) Farmers' Organization for Agricultural Production

As explained in Sub-section 4.3.4 of Volume II Report, the sections which have the following functions are proposed to be attached to the WUA in Polambakkam Tank area to realize sustainable agricultural development.

- Operation and maintenance technology for water-saving irrigation
- Agricultural technology extension services crop diversification and value-added agriculture, etc.
- Various agricultural supporting services such as supply of agricultural input materials, marketing, including agricultural credit services

5.7 Project Evaluation

5.7.1 Project Costs and Benefits

(1) Project costs

Unit cost for rehabilitation works are estimated based on *the Standard schedule of Rates for Anna & M.G.R District* issued by P.W.D. At the 1997 price level, direct construction cost is estimated at about Rs. 2,493,000, as shown in the table.

Direct Construction Cost for Polambakkam Tank

Description	Total Cost (Rs.)	Percentage	Unit Rates (Ayacut 94.59ha) (Rs./ha)
Tank Bund Improvements	232,000	9.31%	2,453
Sluices Improvement	220,000	8.82%	2,326
Surplus Improvement	36,000	1.44%	381
Tank Supply Channel Improvement	-	0.00%	-
Selective lining for Field Channel & OFD	1,875,000	75.21%	1,982
Building for Farmers' Association	130,000	5.21%	1,374
Community Well	-	0.00%	
Direct Construction Cost	2,493,000	100.00%	

The Project cost consisting of direct cost, supervision charges, contingencies, preparation work cost and overhead charges is Rs. 3,659,000.

Project Cost for Rehabilitation Works in Polambakkam Tank

Description	Cost (Rs.)
Direct Construction Cost)	2,493,000
Petty Supervision Charges & Contingencies	399,000
Preparation Cost (Govt. Share)	35,000
Overhead Charges	767,000
Total	3,659,000

Economic price for the economic analysis is estimated using the conversion factor (SCF, 0.8) for the direct construction cost.

(2) Project Benefits

The Project mainly aims at stabilizing the agricultural production through the year in the medium command area of about 94.6 ha by introducing proper agricultural production techniques for better farming system for higher farm revenues as well as improving living conditions of small and marginal farms after the rehabilitation works.

At present, though the whole command area is cropped with paddy for double crops in a year, the cultivated area for the first paddy crop has been taken place only in a small part of the whole command area at the start of wet season. Besides, due to main factor of unstable water supply, the average unit yield of paddy is observed relatively low at about 3.8 ton per ha.

With the Project implementation, major benefits of the Project, therefore, will be come from two sources from the economic point of view: 1) increases of crop benefits, and 2) value-added benefits from post-harvest treatments.

For the increases of crop benefits, the cropping pattern, detailed elaboration on water requirements, plan for land use, applied farming system including the cropping schedule, varieties as well as estimates on inputs and yields for projected crops etc. were carefully evaluated in order to obtain higher farm revenues. This resulted in an increase of net agricultural production value from the presents Rs.1.03 million to about Rs.2.29 million, or more than two times (Table 5.7.1).

Besides, with the establishment of various facilities for organizing farm management and improving treatments on storing, marketing etc., an estimated amount of value-added of about Rs.0.11 million as 5 % of the net agricultural production value "with Project" would be annually obtained accordingly. This is estimated on the basis of results from the Study Team's site surveys that with the application of some basic post-harvest treatments such as storage and selling at markets only will make a profit margin of average 10 % higher than selling at farm sites during harvesting periods.

5.7.2 Economic Evaluation

The economic evaluation is carried out to judge the project viability in terms of direct contribution to the national economy. The Project covers a command area of 58.6 ha with a total number of 166 farms for a total number of approximately 750 beneficiaries.

For the economic analysis, the related EIRRs for Polambakkam Tank area are basically calculated as follows:

i) EIRR under basic conditions : 29.6 %
ii) EIRR at 10% cost-increase: 27.0 %

iii) EIRR at 10% benefit-decrease: 24.6 %
iv) EIRR at 3-year benefit delay: 17.6 %

From these figures, the EIRR under basic conditions of 29.6 % shows the Project viability. Even the risk case of a 3-year delay of benefits showed a EIRR of 17.6 %.

5.7.3 Financial Evaluation

In this Project, the financial evaluation is for mainly dealing with the analysis of farm budget for the representative farms in both cases of "without project" and "with project". The related results are as follows

- "Without Project" CropNet Income per Farm: Rs.6,553
- "With Project" Crop Net Income per Farm: Rs.19,727
- "With Project" Value add: Rs.986
- Incremental Net Farm Income: Rs.14,160

With the project implementation, the annual increase in net farm income for an average farm will be approximately Rs.14,160.

However, in order to achieve these figures, proper supports on technical aspects as well as more investments in farm inputs should be made with an annual increase of average Rs.5,000 for a small farm and average Rs.2,500 for a marginal farm. This should be made in a new scheme of financial support for these farm categories in the newly established farmers' organization.

5.7.4 Labour Force Requirement

Monthly labor force requirement for the planned cropping schedule are shown in Table 3.7.3. The peak of labor requirement in the area is reached in September with the labor requirement of 6,098 man-day/month. This labor requirement amount can be satisfied by the staggering period of 14 days when the potential family labor is used. The potential family labor in this area is 459 man per day.

5.7.5 Farm Household Economy

With the Project implementation, the farm household economy of small and marginal farms will be largely improved. From the financial analysis on farm budgets of these farm categories, the project implementation would offer an annual increase in net agriculture production of about Rs. 13,200 and an value added of about Rs.1,000 per average farm for a total amount of Rs. 14,200.

Besides, better conditions on water supply and supporting institutions for agricultural production in the project framework will offer small and marginal farms basic privileges to improve their basic living standards.

Even for landless farmers, apart from the proposed work scheme for landless people in the farmers' organization as mentioned in the above, they would obtain more labour works from big and medium farms to support their living expenses. A legislative measure to make big and medium farms in the tank areas hiring on annual basis a quota of landless farmers i.e. 2 males or 1 male and 2 females per ha, if permissible, would be promoted for basically supporting their living conditions.

5.8 Environmental Issues

5.8.1 Present Environmental Conditions

(1) Health and Sanitary Conditions

Major diseases in this area are allergic bronchitis, mumps, diarrhea/ADD and filariasis. Diarrhea is a seasonal disease occurring in the wet season. In relation to the irrigation and drainage, small number of filariasis cases are found.

(2) Natural Environment

The Tank Area is generally a flat land. Catchment area is covered by forest mainly, houses and cultivated land. No aquatic weeds are seen in the tank. Tank bed plantation of acacia species under the social forestry program has been executed unsuccessfully. Wildlife seen by the villagers are only natural birds.

(3) Surface Water and Groundwater

Quality of tank water, as measured by the Study Team, is found suitable for irrigation. Groundwater is also utilized widely for irrigation in the dry season. There are 57 private open dug wells in the ayacut. From the result of the water quality measurement, it can be stated that the groundwater will have no salinity problems and sufficiently good for irrigation use.

5.8.2 Environmental Impact of The Project

As summarized in Table 5.8.1 and Table 5.8.2, the environmental impact study for the Polambakkam Tank area was conducted through the field survey and in consideration of the Project components.

(1) Social Environmental Impact

1) Social Institutions and Customs

In regard to the introduction of a WUA under the Project, almost the same impact as stated in Section 3.8 for Echur Tank area will be considered.

2) Health and Sanitary Issues

As to agrochemical aspect, the same situation as stated in Section 3.8 for Echur Tank area can be expected. That is, the use of agro-chemicals will be increased in the future.

For rural health and diseases, since the area is affected by filariasis the same as Cherukkanur Big Tank area stated in Section 4.8, proper water management and adequate drainage shall be required in the Project.

(2) Natural Environmental Impact

Groundwater with EC value of about 0.65 dS/m is suitable for irrigation but groundwater development potential will be less. Likely problems of groundwater induced by the groundwater development will be the changes of groundwater table. Large scale groundwater extraction will be a cause of lowering water tables.

5.8.3 Recommendations

As a result of the environmental impact study described above, it can be concluded that the Project will not induce any serious direct negative environmental impact. But, the development activities may induce some indirect impacts. Details are presented in Volume IV of the Report.

i) For the establishment of WUAs, it is recommended that an effective procedure involving NGOs with close cooperation among government agencies shall be provided.

ii) For the expansion of the irrigated agriculture, it is recommended that AD shall extend the guidance to the farmers on agrochemical use.

iii) For the expansion of the irrigation practice, it is recommended that proper water management and adequate drainage shall be provided and spread of filariasis be monitored.

iv) For the groundwater development for irrigation, it is recommended that the scale of groundwater development shall be carefully planned.

Table 5.7.1 Calculation of Crop Economic Benefits for Polambakkam Tank

"Without Project":

Crop	Area (ha)	Production				Production Cost		Net Production Value (1000Rs)	Remarks
		Yield (T/ha)	Production (T)	Unit Price (Rs/T)	Value (1000Rs)	Unit Cost (Rs/ha)	Total Cost (1000Rs)		
1. Paddy (1st Crop)	12.3	3.80	46.7	4,736.0	221.4	5,008.0	61.6	159.8	
2. Paddy (2nd Crop)	79.7	3.80	302.9	4,736.0	1,434.3	7,200.0	573.8	860.5	
3. Groundnut	2.0	1.25	2.5	7,168.0	17.9	3,900.0	7.8	10.1	
Total	94.0		352.1		1,674.3		643.2	1,030.4	

"With Project":

Crop	Area (ha)	Production				Production Cost		Net Production Value (1000Rs)	Remarks
		Yield (T/ha)	Production (T)	Unit Price (Rs/T)	Value (1000Rs)	Unit Cost (Rs/ha)	Total Cost (1000Rs)		
1. Paddy (1st Crop)	79.7	5.00	398.5	4,736.0	1,887.3	5,760.0	459.1	1,428.2	
2. Ladies Finger	4.3	15.00	64.5	3,600.0	232.2	18,800.0	80.8	151.4	
3. Egg Plant (2nd Crop)	4.3	20.00	86.0	2,400.0	206.4	17,600.0	75.7	130.7	
4. Black Gram (3rd Crop)	4.3	1.20	5.2	11,200.0	57.8	3,300.0	14.2	43.6	
5. Turmeric (3rd Crop)	5.0	25.00	125.0	3,200.0	400.0	20,100.0	100.5	299.5	
6. Banana (1 year)	5.0	27.97	139.8	2,400.0	335.6	20,000.0	100.0	235.6	
Total	102.6		819.0		3,119.3		830.3	2,289.0	

Incremental Crop Benefits:

"With Project" NPV:	2,289.0
"Without Project" NPV:	1,030.4
Incremental Crop Benefits:	1,258.6
Value Added (5%) :	114.4
Incremental Total	1,373.0

Table 5.8.1 Possible Environmental Impacts for Polambakkam Tank Area

A : Significant environmental impact is unquestionably induced by the Project
B : Significant environmental impact is likely to be induced by the Project
C : There is no environmental impact likely to be induced by the Project
D : Not known or there likely to be no impact

	Categories of Environmental Impact	Evaluation A	B	C	D	Evaluation Base
1.	Planned residential settlement			x		No plan
2.	Involuntary resettlement			x		No plan
3.	Substantial changes in the way of life			x		Not expected
4.	Conflict among communities and people		x			Conflict in water distribution may increase
5.	Negative impact on native people			x		Positive impact by improvement of socio-economic conditions
6.	Population increase			x		Not expected
7.	Drastic change in population composition			x		Not expected
8.	Changes in bases of economic activities			x		Not expected
9.	Occupational change and loss of job opportunities			x		Positive impact by increase of seasonal employment in agriculture
10.	Increase in income disparities			x		Not expected
11.	Adjustment & regulation of water or fishing (repairing) rights		x			Establishment of WUAs needs new water sharing adjustment
12.	Changes in social and institutional structures		x			Establishment of WUAs impacts on traditional community
13.	Changes in existing institutions and customs		x			Traditional water sharing needs to be modernized
14.	Increased use of agrochemicals				x	Agrochamicals application may increase under expansion of irrigated agriculture
15.	Outbreak of endemic diseases			x		Not expected
16.	Spreading of epidemic diseases				x	Expansion of irrigation favours spread of filariasis
17.	Residual toxicity of agrochemicals			x		Not expected
18.	Increase in domestic and other human wastes			x		Not expected
19.	Impairment of historic remains and cultural assets			x		Not found in the area
20.	Damage to aesthetic sites			x		Not expected
21.	Impairment of buried assets			x		Not found in the area
22.	Changes in vegetation			x		Not expected
23.	Negative impact on important or indigenous fauna and flora			x		Not expected
24.	Degradation of ecosystems with biological diversity			x		Not expected
25.	Proliferation of exotic and/or hazardous species			x		Not expected
26.	Destruction of wetlands and peatlands			x		No wetlands and peatlands in the area
27.	Decrease of tropical rain forests and wildlands			x		No tropical rain forests in the area
28.	Destruction or degradation of mangrove			x		No mangrove forests in the area
29.	Degradation of coral reefs			x		No coral reefs in the area
30.	Soil erosion			x		Not expected
31.	Soil salinization			x		Not expected
32.	Deterioration of soil fertility			x		Not expected
33.	Soil contamination by agrochemicals and others				x	Intensive/improper application of agrochemicals may lead to soil contamination
34.	Devastation or desertification of land			x		Not expected
35.	Devastation of hinterland			x		Not expected
36.	Ground subsidence			x		Not expected
37.	Change in surface water hydrology			x		Not expected
38.	Change in ground water hydrology		x			Large scale development may lower the water table
39.	Inundation and flooding			x		Not expected
40.	Sedimentation			x		Not expected
41.	Riverbed degradation			x		Not expected
42.	Impediment of inland navigation			x		Not expected
43.	Water contamination and deterioration of water quality				x	Excess use of agrochemicals may lead to water contamination
44.	Water eutrophication			x		Not expected
45.	Sea water intrusion			x		Not expected
46.	Change in temperature of water			x		Not expected
47.	Air pollution			x		Not expected

Table 5.8.2 Environmental Impacts (Irrigation) for Polambakkam Tank Area

	Check Items	Major	Small	None	Not Clear	Problems	Action and Countermeasures Planned	Remarks
Pollution	1. Air Pollution caused by spraying of agricultural chemicals			x		Not expected		
	2. Effect on aquatic organisms, fisheries, and other water utilization of change in the water system resulting from project construction			x		Not expected		
	3. Water pollution caused by effluent from irrigated fields		x		x	1. Excess and improper use of agrochemicals may lead to soil and water contamination. 2. Large scale groundwater development will lower water table.	1. Farmers training on proper use of agrochemicals is extended. 2. Appropriate development scale is planned with careful hydrological study.	
Natural Environment	1. Effect of construction and operation of the facilities on the ecology			x		Not expected		
	2. Effect on landscape			x		Not expected		
Human Environment	1. Effect of the project on historical and cultural heritage			x		Not found in the project area		
	2. Effect on existing infrastructure			x		Not expected		
	3. Relocation and effect on land-use			x		Not expected		
	4. Effect on other water use				x x	1. Introduction of WUA may cause increase of friction and conflict on water sharing in the community. 2. Expansion of irrigation water use may cause increase of filariasis.	1. Appropriate procedure is taken in preparation stage through farmers participation. 2. Proper water management and drainage system are provided.	
Others	1. Effect on the environment during construction period			x		Not expected		
	2. Environmental Monitoring		x			1 Present monitoring activities are not sufficient.	1. Monitoring shall be conducted by relevant agencies.	

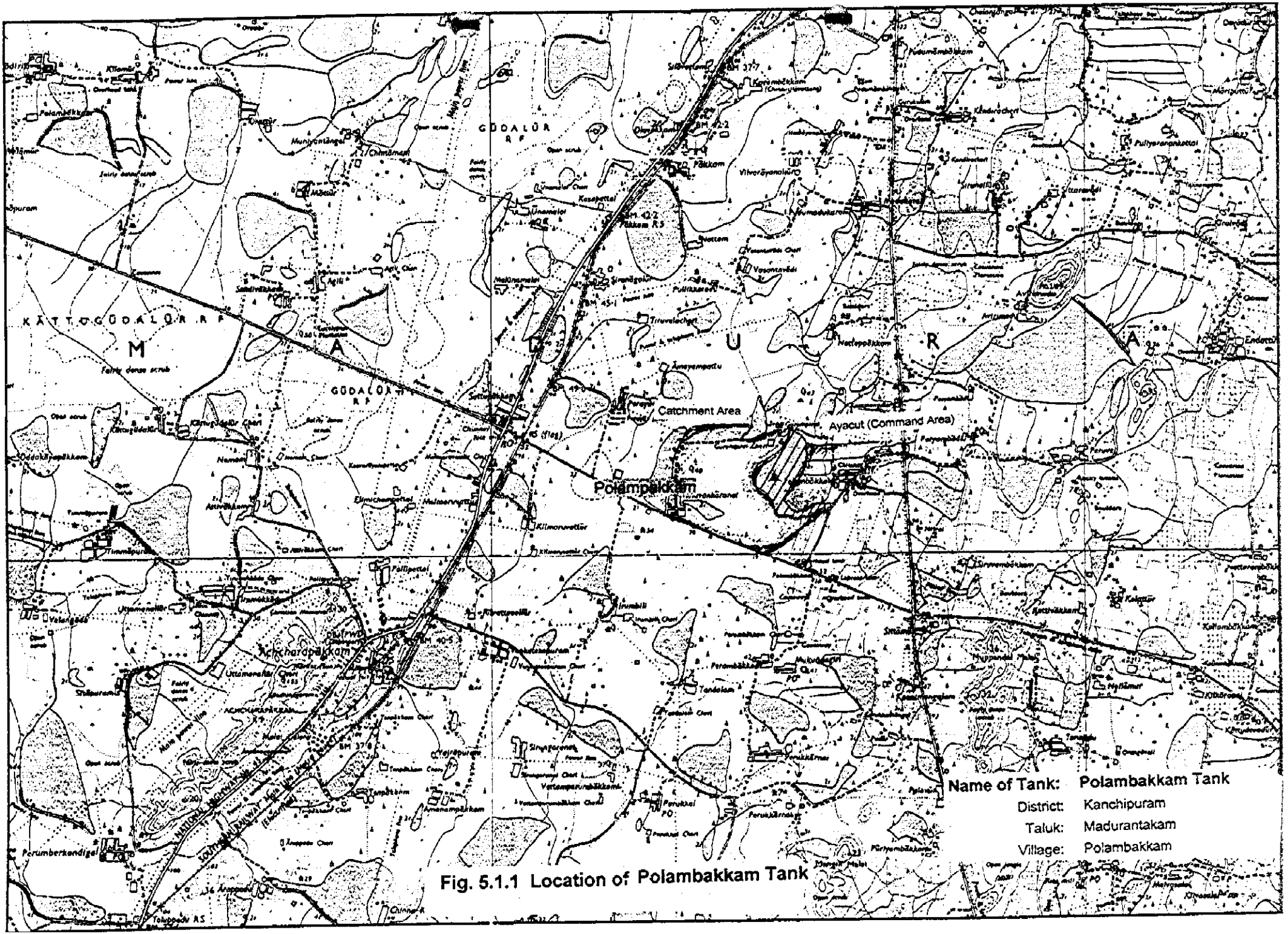


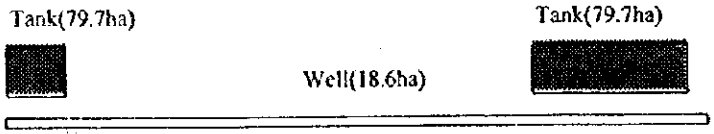
Fig. 5.1.1 Location of Polambakkam Tank

1 Name of Tank	Polambakkam Tank
2 Ayacut Area	94.6 ha
3 Main Soil	Black soil: 60%, Red soil: 40%
4 Water pH,EC	pH: Tank water 8.6, Groundwater 7.6 to 8.1, EC: Tank water 0.33 dS/m, Groundwater 0.576 to 0.701 dS/m
5 No. of Farm Households	139 farm households
6 Self-Support Amount of Rice	278tons (139 x 2,000 kg/Household)
7 Geographical Irrigable Area	79.7ha
8 Total Irrigable Area and Month by Tank	Normal year: 79.7ha (Oct-Jan)
9 No. of Wells and Irrigable Area	Normal year: 45 Wells, 18.6 ha
10 Average Rainfall(mm)	

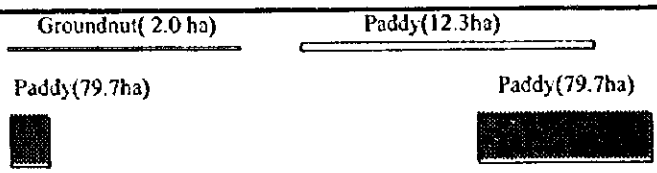
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
12.6	16.7	2.5	5.1	20.8	46.7	90.6	156.9	132.6	197.9	304.4	95.8	####

11 Cropping

1) Irrigable Area and Period



2)Present Cropping Pattern

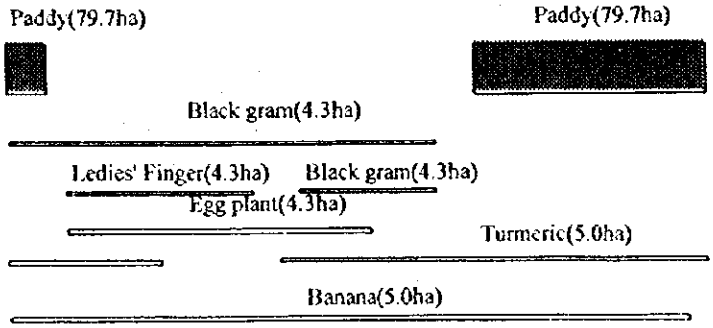


3) Cropping Plan

a) Paddy Area for Self-Support

55.6 ha(278t/5t/ha)

b) Cropping Plan



c) Evaluation

	Crop Intensity(%)	Net Income(1000Rs)
Plan	108.5	2,742
Present	99.4	911
Plan/Presen	1.09	3.01

Fig. 5.4.1 Cropping Plan in Polambakkan Tank Area

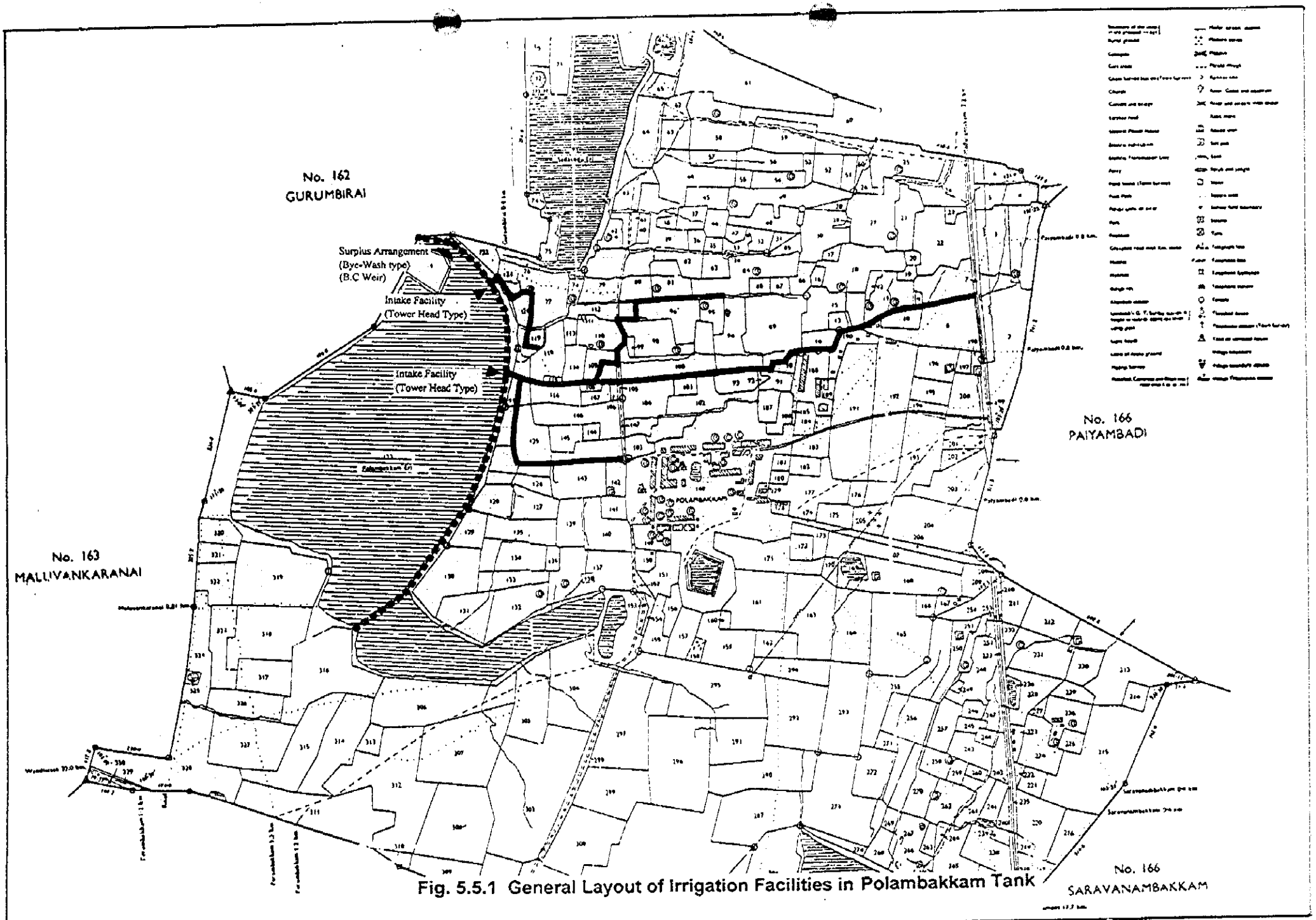


Fig. 5.5.1 General Layout of Irrigation Facilities in Polambakkam Tank

CHAPTER 6 : Enadur Big Tank Area

CHAPTER 6 ENADUR BIG TANK AREA

6.1 General

6.1.1 Location

Enadur Big Tank which has a registered command area of 574.7 ha is located about three (3) km north to Kancheepuram town along the feeder road from the National Highway No. 4 running from east to west as shown in Fig. 6.1.1. The tank is located just north of the highway. Administratively it belongs to Enadur Village in Kanchipuram Taluk of Kanchipuram District.

The village area is surrounded by Karai, Semanthanoal, Vedel and Sittambakkam villages on its north side, Karur village on its east side, Murukanthangal, Ulaiyur, Vaiyavour, Nallur, Konericuppam and Thirumalpadthangal villages in south side, and Inlambakkam village on its west side.

6.1.2 Topography

Enadur Big Tank is located about three (3) km north from the Kancheepuram town along the feeder road of the National Highway No. 4, and its waterspread area is measured to be 0.73 km^2. The ayacut area of 574.7 ha expand southeastward with a narrow and long strip of farm lands crossing the National Highway. The catchment area of the tank expands in the areas north and west of the tank.

The urbanization of the village areas are being progressed recently in the southern parts of the area along the village road to Kancheepuram and the areas along the National Highway. About 15 ha of lands have been changed for the use of residential plots along the National Highway near the Chettierpet hamlet. Further, in this area, a construction of engineering college is also planned and about nine (9) ha of lands are planned to be used for its yards. As for the southern part of the village, various educational institutions such as college, liblary, etc. and factories have been constructed so far.

The bund of about 2.1 km runs from north to south along the eastern edge of the tank. There are three (3) surplus arrangements on the northern part of bund, and the surplus water flows eastward along the northern edge of the ayacut area. A supply channel is provided on the west of the tank, and surplus water of the upstream flows into the tank.

There are three (3) residential areas in the village. One is the main residential area of the village, about one (1) km south from the National Highway, another is the residential area called Chettierpet located beside the National Highway, and the other is the hamlet called Kattavakkam located in between the two. Most of SC people lives in the above main village site.

The ayacut areas are generally flat mildly sloping toward east and north, and the earthen main channels run generally eastward, and their off-take channels flow northward. There are 55 wells in the ayacut areas to take domestic and irrigation water.

There are two (2) unpaved village roads from Kanchipuram to the National Highway running from south to north and from southwest to northeast, main roads running near the village. One is the unpaved road running from east to west connecting the village to Madurantakam - Chanampet road, and the other is that running from north to south connecting Cheyyur - Vandavasi road.

6.1.3 Geology

This region is covered by thick alluvial formations. The alluvial formations are characterized by the mixture of clay and sand in various proportions. The thickness of this formation varies from 25 to 35 m. Crystalline rocks of Archean age underlies this alluvium. The thickness of weathered layer is expected to be about 5 - 6 m. There is no major fractured zone in the basement crystalline rocks.

6.1.4 Soils

The type of soil is mainly black sandy silt in the catchment and black clay to silty clay and partly sandy silt in the ayacut area.

6.1.5 Vegetation

A major part of the catchment area is eucalyptus and acasia species forest. Other trees found in the catchment are Borassus Flabellifer (Palymrah), Prosopis Juliflora and natural shrubs. No tank bed plantation is seen in the waterspread area.

6.1.6 Objectives

Enadur Big Tank is categorized as a NR-3, which belongs to the Northern Study Area or annual rainfall more than 1,000 mm, and having an average cultivation area more than 75 % of registered ayacut area, at a large scale of more than 100 ha. This means surface water and groundwater resources are rather rich, and even at present all the ayacut area might be possible to be irrigated after irrigation efficiency is increased by channel lining. The tank is located along the National Highway No.4, and near to Kanchipuram, capital town of Kanchipuram district, therefore urbanization in the ayacut area is proceeding.

According to the Baseline Survey, tanks in Kanchipuram Development Block more than 80 % of years have surplus water, and cultivation ratio is more than 100 % with 30 % of total tank area cultivated more than twice a year.

Therefore, objectives of Enadur Big Tank rehabilitation are 1) maximize the tank water instead of groundwater, 2) distribute tank water in equity through the physical tank

facility rehabilitation and channel lining, 3) rehabilitation of tank irrigation system against recent rapid urbanization.

6.2 Meteo-hydrology

6.2.1 Climate

The climate prevailing over Enadur Big Tank area is sub-tropical. The basic and consolidated climatological data of temperature, relative humidity, sunshine, wind speed and evaporation data are available for Tirutani Meteorological Station located in the Nandi River basin maintained by the Groundwater Wing of the PWD. Since, Enadur Big Tank, belongs to the same North-eastern agro-climatic zone, the climatological data of Tirutani Meteorological station is the representative of Enadur Big Tank also. The coordinates and the monthly average climatological parameters are presented in Section 3.2.1.

6.2.2 Rainfall

The rainfall in the catchment area of the tank varies with season and it receives considerable rainfall both in South-west and North east monsoon. For all rainfall computations, data recorded at the nearest Kanchipuram Rainfall Station, maintained by the Revenue Department, is used. The mean monthly rainfall of the last 60 years are estimated as shown below:

Mean Monthly rainfall (mm) of Enadur Big Tank Catchment Area

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean	16.2	7.0	9.7	19.9	52.4	81.0	110.7	172.4	151.3	209.4	230.1	95.8	1,155.8
Maximum	147.0	157.0	140.2	183.6	258.0	237.0	354.0	385.0	339.3	935.3	635.0	566.4	1,841.9
Minimum	0.0	0.0	0.0	0.0	0.0	3.0	7.1	10.0	0.0	15.7	0.0	0.0	542.4

The entire calendar year can be divided into four seasons with the following rainfall distribution.

- South-West Monsoon (June-September): 515.3 mm (44.6 %)
- North-East Monsoon (October-December): 535.2 mm (46.3 %)
- Winter (January - February): 23.2 mm (2.0 %)
- Summer (March - May): 82.1 mm (7.1 %)
- Total: 1,155.8 mm (100 %)

The tank catchment receives its maximum rainfall in North-east monsoon while the lowest rainfall occurs during the winter months of January and February. The average monthly maximum rainfall is 230.1 mm in November, and the minimum rainfall of 7.0 mm occur in February. The annual maximum rainfall of 1841.9 mm occurred during 1947 while the minimum 555.3 mm was occurred in the year 1981.

6.2.3 Catchment Area

Enadur Big Tank is a non-system tank located in the Kanchipuram Minor Basin. In preparation for the field visits the 1:50,000 map of the tank was obtained which permitted an assessment of catchment and command area. Enadur Big Tank receives its runoff water from its free basin of 14.6 km^2 and an intercepted catchment area of 13.080 km^2 and hence the total catchment (free + intercepted) is 27.68 km^2 and the equivalent catchment (free + 1/5th of intercepted) area of 17.216 km^2. As per the PWD norms, the catchment is classified as "average" having gentle slope and moderate vegetation. The registered ayacut of this tank is 574.67 ha, and hence the ratio between free catchment and registered ayacut is 2.54.

6.2.4 Hydrological Analysis

The hydrological analysis procedures are similar to that employed for Echur Tank. Rainfall - runoff computations carried out according to the Strange Tables for monsoon (September - December) and annual (January - December) for a continuous period of 16 years is presented in the following table. There is no hydrological station exist in the tank catchment or command area.

Yield and Runoff into Enadur Big Tank

Year	September - December			January - December		
	Rainfall (cm)	Yield (cm)	Runoff (Mm^3)	Rainfall (cm)	Yield (cm)	Runoff (Mm^3)
1980	81.6	17.6	3.043	103.6	30.5	5.272
1981	20.1	0.4	0.062	54.2	6.8	1.170
1982	56.3	7.7	1.321	105.6	31.7	5.468
1983	50.9	5.9	1.018	83.1	18.7	3.227
1984	87.8	21.1	3.637	148.1	65.8	11.351
1985	62.7	9.7	1.677	112.8	36.3	6.269
1986	104.0	31.0	5.351	179.4	95.8	16.539
1987	40.6	3.2	0.560	64.0	10.4	1.788
1988	70.6	12.7	2.194	112.4	36.0	6.209
1989	59.0	8.6	1.477	110.5	35.1	6.065
1990	83.7	18.8	3.250	161.3	80.7	13.920
1991	75.6	15.1	2.610	139.2	58.2	10.043
1992	82.0	18.1	3.128	105.2	31.0	5.356
1993	93.0	24.0	4.139	126.9	47.4	8.188
1994	60.8	9.1	1.574	119.6	41.9	7.225
1995	50.3	5.6	0.972	158.5	74.5	12.858
Mean	67.4	13.0	2.251	117.8	43.8	7.559
Maximum	104.0	31.0	5.351	179.4	95.8	16.539
Minimum	20.1	0.4	0.062	54.2	6.8	1.170

During 1980 - 1995, the average annual yield was 43.8 cm with a maximum of 95.8 cm in 1986 and a minimum of 6.8 cm in 1981. The corresponding values of estimated annual runoff from equivalent catchment area are 7.559 Mm^3, 16.539 Mm^3 and 1.170 Mm^3. The monsoonal (September - December) yield and runoff values also have been estimated and are presented in the table. The 16 year average monsoonal yield was 13.0

cm and that of runoff from the equivalent catchment area was 2.251 Mm^3. In an average the monsoonal yield accounts for nearly 30 % of total annual yield as per the strange table calculations.

The runoff estimation based on the daily rainfall data for the years 1986 - 1995 using the dry-damp-wet method are presented in Table 3.5.4 and 3.5.5. The annual runoff values vary from 4.879 Mm^3 to 13.543 Mm^3. The average annual runoff for this 10 years period is 9.900 Mm^3, with runoff ratio being 46 %. On the other hand, the monsoon (September-December) runoff varies from 2.851 Mm^3 to 10.045 Mm^3. The average monsoon runoff is estimated to be 6.404 Mm^3, with a runoff ratio of 51 %.

6.3 Social Conditions

6.3.1 Present Social Conditions and Facilities

(1) Available Social Facilities in the Village

The piped drinking water supply system is provided for all the villagers, and the shallow and deep wells are also constructed to supplement it. The water quality of these sources is considered to be good. Tthe electricity supply system is provided for 90 % of villagers.

There are no public facilities such as community halls in the villager areas. However, the village is located in the suburbs of Kancheepuram, and the villagers are able to use various facilities in Kancheepuram. A Health Sub-center (HSC) is available in the village. There are primary (Grade 1 -5) and higher (Grade 6 - 10) schools. There are two (2) village roads connecting to the National Highway and Kancheepuram, and bus services for Chennai and Kancheepuram are available.

(2) Social Settings of the Ayacut Area

1) Land Holding and Relating Villages or Hamlets

There are 427 farmers in the ayacut areas of Enadur Big Tank, and their average land holding size is calculated to be about 1.28 ha. About 95 % of the farmers are marginal and small farmers. All the farmers in the ayacut areas live in the above-mentioned residential areas in Enadur Village.

Since Enadur Big Tank is a former Zamindar tank handed over to PWD in 1982, the descendants of those Zamindars and their family members still occupy large extent of farm lands in the ayacut areas. The rest of the farm lands are shared by many marginal and small farmers. The holding size is larger near the tank, according to the villagers. Generally, the farm lands of SC villagers are located in the eastern side of the ayacut, tail end portion in the irrigation system.

2) Caste Composition

The approximate caste composition of the farmers in the ayacut areas are as follows:

Caste Composition in Enadur Big Tank Ayacut Area

(Unit: %)

Others	BC	MBC	SC	ST	Total
2	25	25	47	1	100

The most predominant caste category is SC composed of the group of Adidravida, and it shars about 47 % of all the farmers in the ayacut. The second predominant caste categories are BC composed of Vanniar and MBC composed of Agamudiar sharing about 35 %. In this ayacut area, the share of the Other caste group composed of Brahmana is two (2) %. The share of ST (Irullars) categories are as small as one (1) %.

3) Water Distribution and Decision Making Procedure

There is no registered organization for distributing water in the ayacut area. There are some meetings or discussions held among the farmers in the ayacut areas, and four (4) *Neerkatis* are nominated every year as a traditional system; two (2) for Enadur and the other two (2) for Chettierpet and Kattavakkam villages. The operations of sluices are made in consultation with the farmers who mainly hold their lands in the head reaches.

4) Maintenance of Irrigation Facilities

No regular maintenance activity of the irrigation facilities is conducted in the ayacut area except for the emergency repair works of tank bund and the desilting works done at the initial stage of the every irrigation period. The removal of weeds and the desilting works of the sluice are carried out by the assigned *Neerkatis*.

5) Conflicts and Problems

According to the farmers in the ayacut areas, there is no conflict among either the caste groups or the farmers having advantage or disadvantage in receiving irrigation water. However, the marginal farmers' lands located at the tail end portions are apt to be left abandoned during the drought periods, and they have to seek for off-farm jobs in Kanchipuram instead of farming. Their complaints are considered serious, and this situation may cause conflicts between castes or farmers of tail end and upstream.

6) Other Employment Opportunity

The nearest town is Kanchipuram located about seven (7) km away from the village. They work usually as construction laborers and helpers in weaving factories, etc.

6.3.2 Sociological Evaluation

Based on the criteria described in Section 3.3.2, the sociological conditions of Enadur Big Tank ayacut are evaluated as stated below.

Results of Social Scoring of Enadur Big Tank

Factors	Hamlets	Farm Size	Conflicts	WUA	Leader-ship	Resource Mobilization	Main-tenance	Overall Score
Scores	3	5	10	8	30	20	5	81

This results show that the ayacut is good on social screening and timing of the community organizer for formulating WUA should be at the commencement of the estimation preparation.

6.4 Agriculture

6.4.1 Present Agriculture

(1) Land Use

The registered command area is 574.7 ha of which irrigable area is 322.0 ha (56.0 % of the command area). In 1995 - 1996, paddy and groundnut were cultivated in the area of 357.6 ha (62.2 % of the command area) and 10.0 ha (1.7 %), respectively. The total cultivated area was 367.6 ha with the crop intensity of 63.9 %. In normal year, crop cultivated is paddy only. The area is 322.0 ha and the crop intensity is 56.0 %.

(2) Soil and Land Capability

The type of soil in the ayacut area is in the wide range black clay to silty clay and partly sandy silt. No saline soils are found in the ayacut area.

(3) Agricultural Production

1) Crop Production

In 1995-96, 1,273.1 tons of paddy and 8.0 tons groundnuts were produced. Their average yield were 3,560 kg/ha and 800 kg/ha, respectively. In a normal year, 12,880 tons of paddy is produced with an average yield of 4,000 kg/ha.

2) Irrigation Water

Tank water is available from September to January with an irrigable area of 255.3 ha in a normal year. On the other hand, there are 38 available wells with an irrigable area of 125.0 ha in a normal year.

3) Fertilizer Application

According to the data of farmers' interview survey, 68 kg/ha of N and 10 kg/ha of P_2O_5 and 26 kg/ha of K_2O was applied in split application of 2 to 3 times for the paddy in 1995 - '96. These amounts applied are half or less than half of the government recommendated amounts (N: 120 - 150 kg/ha, P_2O_5: 38 - 50 kg/ha, and K_2O: 38-50 kg/ha). Yield increase with improvement of fertilizer application would be expected.

4) Labor Input

According to the farmers' interview survey, the average labor input for paddy cultivation in the Study Areas was about 200 man-day/ha in which 28 % was allotted to harvesting, 24 % to weeding and 21 % to transplanting. The average available family agricultural labor in the area is 2.9 men/house and the potential agricultural labor is 4.1 men/house. According to these data, the necessary staggering period in the command area to accomplish the farm works for the paddy cultivation by family labor required is 11 days at least when all the potential labor is used. The labor requirements for vegetable, sugarcane and groundnut cultivation are around 4.3 times, 2.3 times and 0.6 times of the paddy, respectively.

(4) Farm Size and Land Tenure

The number of farm holders in the area is 448 of which 5 % is farm holders of more than 2 ha, 15 % is farm holders of 1to 2 ha and 80 % is farm holders of below 1 ha (marginal). The average farm size is 1.23ha which is larger than that of the state (0.93 ha). However, the marginal holders occupy 80% of the total farm holders in the area.

6.4.2 Agricultural Development Plan

(1) Land Use

As shown in Table 3.4.1, the crop intensity is planned to be increased from 56.0 % at present to 68.2 % in the plan by reason of introduction of cash crops such as groundnut (10.0 ha, Jan. - Apr.), ladies' finger (5.0 ha, Jan. - Apr.), chili (50.0 ha, Jan. - Aug.) and banana (5.0 ha, May - May) in the dry season. These crops are

grown by well water.

(2) Cropping Plan

The cropping plan was made as shown in Fig.6.4.1. In the plan, paddy is cultivated in the rainy season by tank water and well water in an area of 322 ha keeping the present area. While groundnut, ladies' finger, chili and banana are introduced in an areas of 10.0 ha, 5.0 ha, 50.0 ha and 5.0 ha respectively, with use of well water. The irrigable area by wells is 125 ha in normal year.

(3) Crop Budget and Production Plan

The planned production amounts, the production costs and the net incomes of crops are shown in Table 3.4.2. In the plan, the total net income in the command area amounted to Rs.8,790,200 of which paddy, groundnut, ladies' finger, chili and banana shared 57.6 %, 1.6 %, 2.1 %, 36.0 % and 2.7 %, respectively. The total amount of net income in the area corresponded to 1.9 times of the present.

(4) Employment and Working Opportunity

The introduction of the cash crops for 120 ha in the dry season will bear a certain increase in employment and working opportunity throughout a year. The labor requirement is estimated at the amount corresponding to the labor requirement of about 480 ha in paddy cultivation.

(5) Farm Management and Farm Budget

1) Farm Management Plan

Due to the special characteristic of a partly system tank, this tank area has in general a good water supply through the year to carry out the double cropping of mainly paddy. The cropping of other cashcrops such as sugarcane etc. is presently restricted due to improper drainage network results inwater logging. The water management for other cashcrops is recommended to be elaborated for further crop diversification, In this framework, the integrated agriculture is recommended to be applied at a farm level for improving the farm income.

Another special characteristic for this tank area is the very high share of farms in tenancy system, approximately one half of small and marginal farms. They have due responsibilities to honour their cropping contracts. The substantial changes in cropping schedules, therefore, will be mutually agreed by both sides.

2) Farm Budget Plan

Elaboration on crop diversification is recommended to be applied for cropping

cashcrops apart from paddy. From the abundant water supply, the integrated agriculture with inland fisheries and raising livestock such as raising duck is recommended to be promoted in the farm budgeting procedure.

As the integrated agriculture is observed being neglected in this tank area, the application of integrated agriculture should also be considered for increasing farm revenues, particularly on the aspects of raising livestock at a farm level and aquaculture in the tank with the formation of a cooperative scheme.

(6) Marketing Plan

The marketing plan for this tank are is envisaged as follows:

i) The establishment of some shops for supporting the integrated agriculture and its safe of produces are recommended to be made at village level.

ii) The installation of some post-harvest and basic agro processing facilities such as godowns, processed rice products, etc., in the village should be considered.

iii) Besides, some transport vans are subjected to be equipped for quick transportation of agricultural produces to village godowns and district markets.

6.4.3 Agricultural Supporting Services and Institutional Plan

(Same as notified in this part for Echur Tank)

6.5 Rehabilitation of Tank Irrigation System

6.5.1 Present Conditions

(1) Irrigation and Drainage System

Enadur Big Tank is located at the border of the Kambakkal Canal System Tanks and rainfed tank area. The upper tank of this is Kuram Tank, a system tank.

The ayacut area of Enadur Big Tank extends about 5.7 km long with an average width of about 1 km from the tank in a southeastern direction. There are about 14 panchayat tanks (among them 3 tanks have sluices) and a PWD rainfed tank, the Kattayakkam Tank, are scattered in or at the border of the ayacut area. They receive water from their own catchment area and Enadur Big Tank, excess water after irrigating the aycut area.

There are two sluices in the tank. No. 1 sluice commands about 51 ha on the south

western part of the ayacut area and its channel runs along the southern border of the ayacut area and flows into the Kattavakkam Tank and join the No. 2 sluice channel at the tail. Most of the command area of No. 1 sluice channel after crossing NH-4, is developed as residential area by urbanization.

No.2 sluice is a main sluice commanding more than 520ha. NH-4 and district road, connecting Kanchipuram, Enadur village and NH-4, divide the command area head, middle and tail reaches. The head reach of the channel is encroached by an engineering college recently. At the tail reaches, the channel water enter into small tanks through paddy field and again the water is distributed some 5 ha through two sluices of small tank.

The surplus channel runs along the northern border of ayacut, and the channel functions as main drainage channel of the ayacut area.

There are 55 wells in the ayacut area, they are mostly concentrated in the head reaches upto NH-4. The well water is used as supplemental water during wet season cultivation and main water source for the second cropping for about 42 ha area. Well density of the registered ayacut area is 0.1 wells/ha.

(2) Tank Bund

Existing dimension and soil mechanics properties of tank bund are shown in Table 3.5.1 and 3.5.2. Soil erosion and longitudinal cracks occur around the intake facility, and sand bag for reinforcement was piled up as temporary works.

(3) Spillway (Surplus Arrangement)

1) Location

There are three (3) weirs of B.C. type, in this tank. Location of these weirs are shown in Fig. 6.5.1.

2) Existing Condition

Although some parts of the weirs such as crest, apron and side wall, are confirmed to suffer from material deterioration; as a consequence, all the weir keep flowing excessive water.

(4) Intake Facilities (Sluices)

1) Location of the Sluice

There are two (2) sluices served by this tank. Both sluices are head tower type controlling effective water depth in the tank. Location of their facilities are

shown in Fig. 6.5.1.

2) Existing Condition

Some cracks and damages are confirmed on the operation board in these sluices. Both sluices maintain normal condition on the function of intake works.

3) Water supply control device

Both sluices have two (2) vents for plug and rod for plug are not installed in these sluices. Height of the tower is about 4.0 m and effective water control is not possible in the rainy season.

(5) Groundwater Usage

The dug wells and the deep wells located in this area are mainly used for irrigation. Because of the presence more amounts of clay along with the sand in the upper part of the sequence, dug wells yield reasonable amount of water. But the shallow bore wells are unable to extract more amount of water, probably because of less hydraulic conductivity. In order to increase the yield horizontal drilling has been carried out by a few farmers to increase the effective diameter of the wells. Some of the wells in this area are over exploited to met the demand for irrigation.

(6) Operation and Maintenance

No formal water users' association exists in the ayacut area. Traditional irrigation is practiced. No conflicts appears for the irrigation water distribution. Most of irrigation channels are maintained at the beginning of the tank operation by farmers. Private channels from well are maintained properly by owners themselves.

6.5.2 Water Resources Development Plan

(1) Liability of Water

A classification of availability of rainfall is developed by the Indian Meteorological Department is given in Section 3.5.2. Following the same outline, the probability of availability of rain water for Enadur Big Tank is presented in the following table.

Liability of Water Based on Rainfall

Classification	No. of Years	Total No. of Years	Probability (%)
Excess	7	60	11.67
Normal	14	60	23.33
Deficit	27	60	45.00
Scanty	12	60	20.00

Among the 60 years 45 % of the years are classified as deficit followed by normal years 23.33 %, scanty years 20 %. The excess rainfall occurred only in 7 years accounting for 11.67 %.

Apart from this, as mentioned for Echur Tank, another important aspect is the occurrence of drought or flood based on the rain storm. For a five year return period (20% of provability), the drought monsoon rainfall is estimated as 878 mm, which is nearly 83.8 % of average monsoon rainfall. The above facts and figures forces to rehabilitate the existing tank facilities to harvest all the available rainfall water.

(2) Water Quality

Based on the field measurement of the Study Team, the water quality on its pH and EC (electric conductivity) in the Areas indicate moderate salinity hazard will be expected for the crop cultivation. Tank remained water shows pH 9.2, which indicates a rather high alkalinity, and EC has a level between 0.84 and 1.07 dS/m. The water smells like sea water, and fish and shells remain in the water too, therefore it is possible that these water quality figures will be improved during the rrainy season. On the other hand, groundwater (shallow well) indicates pH less than 8.0 and EC between 11.07 to 1.75 dS/m. The EC in lower reaches shows higher figures than head reaches.

(3) Irrigation Water Requirement

In an registered ayacut of 574.67 ha, rice is the major crop irrigated by Enadur Big Tank. The gross irrigation water requirement for the paddy rice is presented in Table 3.5.3, for every fortnight of the crop growing season. The total estimated gross irrigation requirement is 6.983 Mm^3 with the present irrigation efficiency of 40 %. By lining the field canals only, the efficiency could be increased to 75 % reducing the gross irrigation water requirement to 4.128 Mm^3, thus saving a water amount of 2.855 Mm^3. This saved amount of water can be used to irrigate more area or to irrigate the next paddy crop.

(4) Water Balance

The capacity of Enadur Big Tank is determined as 3.205 Mm^3, by the topographic survey. Based on daily rainfall for the years 1986 - 1995, runoff values were estimated by dry-damp-wet method and presented in Table 3.5.4 and 3.5.5. As per the annual and monsoon (September - December) rainfall data, surplus occurred in six out of 10 years. All the runoff water stored in the tank is used to irrigate a registered ayacut of 574.67 ha. With its richness in water resources, Enadur Big Tank could satisfy an average of 80 % of the irrigation demands. With present conditions (Ef = 40 %), the estimated irrigated area varies between a minimum of 43 % to a maximum of 100 % of the registered ayacut. The runoff/irrigation ratio remains as 140 %. This situation could be further improved by canal lining, with an

increased Ef = 75 %, resulting in decreased irrigation water requirements. By this change, tank water could irrigate an average of 97 % of the registered ayacut. Beside this, the runoff - irrigation ratio is increased to 238 % and more surplus water (average 2.190 Mm^3) is available to the down stream tanks. Monsoon data also showed the same trend, but with a slight increase in runoff ratio. The above facts point out that partial canal lining is desirable as rehabilitation measure to increase the command area of Enadur Big Tank.

(5) Drainage Water Requirements

The drainage water requirement of Enadur Big Tanks is calculated according to the procedures outlined in the previous section 3.5.2 and details are given in Table 3.5.6. Using the Ryve's formula, the estimated maximum flood discharge is 60.42 m^3/s while that using the rational formula is 143.47 m^3/s. Hence a safe design discharge need to be adopted in between these, for designing surplus arrangements, considering the type of weir and the cost estimate. But, in making such an estimate, it is not necessary to have a more liberal estimate where the possibilities for serious disaster are very remote and where breach would merely cause a measure of local loss or inconvenience.

(6) Basin Water Management

Enadur Big Tank receives its runoff water from the free catchment and surplus water from the two upstram tanks of Ariyaperumpakkam and Kuram. Its surplus water gets into down stream Krishnapuram Tank. As presented in Table 3.2.1, various chain basin ratios were calculated.

- Free catchment / command area = 2.54
- Intercepted catchment / command area = 3.90
- Waterspread area / command area = 0.34
- Capacity / command area = 0.006 Mm^3/ha
- Waterspread area / capacity = 0.611 km^2/Mm^3

The surface water resources of Enadur Big Tank basin consists of direct runoff from rainfall and flow in streams. However, irrigation is largely depend on available tank water and ground water. The total ground water recharge of Kanchipuram block to which, Enadur Big Tanks belongs, was estimated to be 10,249 ha m. Utiliziable recharge is 8,712 ha m, Net Ground water draft is 4,569 ha m and the balance available is 4,143 ha m. Therefore, exploitable ground water resources of 47.5 %, can be drawn up with digging more wells in the chain tank command areas.

Similarly, the total surface water resources can not be utilized due to certain limitations as summarized under Echur Tank and so it is necessary to develop basin management strategies as detailed in Section 3.5.2, with the formation of multi-tier farmers' association at tank level, chain basin level and district level and assigning

responsible role for farmers in tank management after its rehabilitation.

(7) Groundwater Development

Groundwater development is possible in this area after proper assessment of the subsurface geology. There is not much information about the nature of the basement rocks. The basement rocks may have major fracture systems. Hence, after through investigation more deep wells or dug cum bore wells can be planned in this area.

6.5.3 Tank Irrigation Facilities Rehabilitation Works

General layout of irrigation facilities is shown in Fig. 6.5.1, and the required item for rehabilitation works are described in the table shown below.

Countermeasures for Rehabilitation of Enadur Big Tank

Component	Rehabilitation works	Section for Rehabilitation works	
Tank Bund Improvment (Total bund length 2,665m)	• Strengthening of the bund for reshaping to standard size.	2,512m	
Intake works (Sluice)	• Modification of intake system using gearing shutter • Protection of back-fill for side slope.	Tower head type	2 units
Surplus arrangement	-	-	-
Selective Lining for Field Channel including On-farm development	• Installation of lining canal • Provision of diversion boxes with paddle shutter for equal distribution. • Reshaping of existing canal. • Provision of incidental device such as cart, cattle, and canal/crossing.	Concrete lining 4,920m as main Earthen lining 1,100m as main 7,370m as branch	1 unit 1 unit 9 units
Building for Farmers' Association	• Provision of community hall for WUA, local farmers and inhabitation.	50m²	1 Nos.

6.6 Farmers' Organization

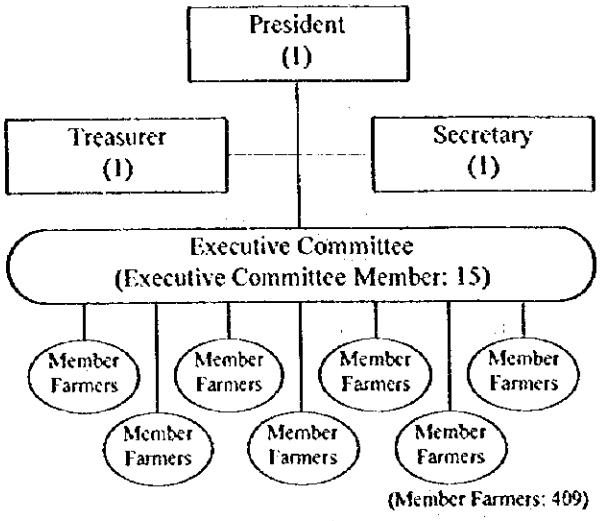
6.6.1 Present Situations of Farmers' Organization

There is no such registered organization as water users' association in the ayacut area as described in Sub-chapter 6.3.1. They have their informal society for water distribution appointing *Neerkatis* for watching water distributions.

6.6.2 Proposed Farmers' Organization

(1) Water Users' Association

Since there are 448 farmers in the ayacut areas, the number of the Executive Committee Member becomes 15 and the number of member farmers is 420 deducting the number of office bearers from the total farmers. The functions of the proposed WUA for the Echur Tank are described in Sub-section 4.3.4 of Volume II Report. Since this WUA is comprised of the farmers in three (3) hamlets, it is necessary to form the organization which facilitate the smooth coordination of water distribution among those hamlets



PROPOSED ORGANIZATION FOR WATER USERS' ASSOCIATION OF ENADUR BIG TANK

(2) Farmers' Organization for Agricultural Production

As explained in Sub-section 4.3.4 of Volume II Report, the sections which have the following functions are proposed to be attached to the WUA in Cherukkanur Big Tank area to realize sustainable agricultural development.

- Operation and maintenance technology for water-saving irrigation
- Agricultural technology extension services crop diversification and value-added agriculture, etc.
- Various agricultural supporting services such as supply of agricultural input materials, marketing, including agricultural credit services

6.7 Project Evaluation

6.7.1 Project Costs and Benefits

(1) Project Costs

Unit cost for rehabilitation works are estimated based on *the Standard schedule of Rates for Anna & M.G.R District* issued by P.W.D. At the 1997 price level, direct construction cost is estimated at about Rs.11,499,000, as shown in the table.

Direct Construction Cost for Enadur Big Tank

Description	Total Cost (Rs.)	Percentage	Unit Rates (Ayacut 574.67ha) (Rs./ha)
Tank Bund Improvements	620,000	5.42%	1,079
Sluices Improvement	374,000	3.27%	651
Surplus Improvement	-	0.00%	-
Tank Supply Channel Improvement	-	0.00%	-
Selective lining for Field Channel & OFD	10,325,000	90.19%	17,966
Building for Farmers' Association	130,000	1.14%	226
Community Well	-	0.00%	-
Direct Construction Cost	11,449,000	100.00%	

The Project cost consisting of direct cost, supervision charges, contingencies, preparation work cost and overhead charges is Rs.16,806,000, as shown in the table.

Project Cost for Rehabilitation Works in Echur Tank

Description	Cost (Rs.)
Direct Construction Cost	11,449,000
Petty Supervision Charges & Contingencies	1,488,000
Preparation Cost (Govt. Share)	165,000
Overhead Charges	3,361,000
Total	16,806,000

Economic price for the economic analysis is estimated using the conversion factor (SCF, 0.8) for the direct construction cost.

(2) Project Benefits

The Project mainly aims at stabilizing the agricultural production through the year in the large command area of about 574.7 ha by providing a better water supply from the tank and the introduction of proper agricultural production techniques for better farming system for higher farm revenues as well as improving living conditions of small and marginal farms after the rehabilitation works.

At present, the whole command area is dominantly cropped with paddy for as the first crop only due to lack of water supply from tank. In the dry season, the whole command area is let in fallow condition. Besides, due to the main factor of unstable water supply in the first crop, the average unit yield of the first paddy crop is observed at about 4 ton per ha.

With the Project implementation, major benefits of the Project, therefore, will come from two sources; 1) increases of crop benefits, and 2) value-added benefits from post-harvest treatments.

For increasing of crop benefits, the cropping pattern, detailed elaboration on water

requirements, plan for land use, applied farming system including the cropping schedule, varieties as well as estimates on inputs and yields for projected crops etc. were carefully evaluated in order to obtain higher farm revenues. This results in an increase in the net annual production value of agriculture from the present Rs.5.0 million to approximately Rs.7.4 million (Table 6.7.1).

Besides, with the establishment of various facilities for organizing farm management and improving treatments on storing, marketing etc., an estimated amount of value-added of about Rs.0.37 million as 5 % of the net agricultural production value "with Project" would be annually obtained. This is estimated on the basis of results from the site surveys that with the application of some basic post harvest treatments such as storage and selling at markets only will make a profit margin of average 10 % higher than selling at farm sites during harvesting periods.

6.7.2 Economic Evaluation

The economic evaluation is made to judge the project viability in terms of direct contribution to the national economy. The Project covers a command area of 574.7 ha with a total number of 448 farms as beneficiaries.

For the economic analysis, the related EIRRs for Enadur Big Tank area are basically calculated as follows:

i)	EIRR under basic conditions:	11.7 %
ii)	EIRR at 10% cost-increase:	9.9 %
iii)	EIRR at 10% benefit-decrease:	9.0 %
iv)	EIRR at 3-year benefit delay:	7.1 %

From these figures, the EIRR under basic conditions of 11.7 % shows the Project viability. The risk case of 3-year delay of benefits showed the lowest EIRR of 7.1 %.

6.7.3 Financial Evaluation

In this Project, the financial evaluation is done mainly for dealing with the analysis of farm budget for the representative farms in both cases of "without project" and "with project". The related results are as follows:

-	"Without Project" Net Income per Farm:	Rs.10,278
-	"With Project" Net Income per Farm:	Rs.19,621
-	"With Project" Value add:	Rs.981
-	Incremental Net Farm Income:	Rs.10,324

With the project implementation, the annual increase in net farm income for an average farm will be about Rs.10,400.

However, in order to achieve these figures, proper supports on technical aspects as well as more investments in farm inputs should be made with an annual increase of average Rs.5,000 for a small farm and average Rs.2,500 for a marginal farm. This should be made in a new scheme of financial support for these farm categories in the newly established farmers' organization.

6.7.4 Labour Force Requirement

Monthly labor force requirement for the planned cropping schedule are shown in Table 3.7.3. The peak of labor requirement in the area comes August with the requirement of 38,788 man-day/ month. To meet this labor amount, 21 days in staggering period is needed when the potential family labor is used. The potential family labor in the area is 1,837 man per day.

6.7.5 Farm Household Economy

With the Project implementation, the farm household economy of small and marginal farms will be largely improved accordingly. From the financial analysis on farm budgets of these farm categories, an increase in the net agricultural production value of Rs.9,343 and a value added of about Rs.981 would be obtained for a total amount of Rs.10,324 per farm per year.

Besides, better conditions on water supply and supporting institutions for agricultural production in the project framework will support small and marginal farms to improve largely their basic living standards.

Even for landless farmers, apart from the proposed work scheme for landless people in the farmers' organization as mentioned in the above, they would obtain more labour works from big and medium farms to support their living expenses. A legislative measure to make big and medium farms in the tank areas hiring on annual basis a quota of landless farmers i.e. 2 males or 1 male and 2 females per ha, if permissible, would be promoted for basically supporting their living.

6.8 Environmental Issues

6.8.1 Present Environmental Conditions

(1) Health and Sanitary Conditions

Major diseases in this area are bronchitis, diarrhea, dysentery, common fever and eye disease. In relation to irrigation and drainage, neither waterborne nor mosquito-related diseases occur.

(2) Natural Environment

The tank area is generally flat land. Catchment area is covered by forest as a main part, houses and cultivated land. No aquatic weeds are seen in the tank. Wildlife seen by the villagers are only monkeys, fox and natural birds.

(3) Surface Water and Groundwater

Quality of tank water, as measured by the Study Team, is found to be high alkaline and little saline which may be due to the dry season measurement. Groundwater is also utilized widely for irrigation in the dry season. There are 55 private open dug wells in the Ayacut.

From the result of the water quality measurement, it can be stated that the groundwater will have little salinity problems for irrigation use.

6.8.2 Environmental Impact of the Project

As presented in Table 6.8.1 and Table 6.8.2, the environmental impact study for Enadur Big Tank area was conducted through the field survey and in consideration of the Project components.

(1) Social Environmental Impact

1) Social Institutions and Customs

In regard to the introduction of a WUA under the Project, almost the same impact as stated in Section 3.8 for Echur Tank area will be considered. However, since the Ayacut is comprised of three villages under two Panchayats, rather serious conflict may arise between villages or Panchayats.

2) Health and Sanitary Issues

As to agrochemical aspect, the same situation as stated in Section 3.8 for Echur Tank area can be expected. That is, the use of agro-chemicals will be increased in the future. For rural health and diseases the Project will not be a cause of any waterborne or mosquito-related diseases.

(2) Natural Environmental Impact

1) Soil and Land Resources

Since the groundwater is little saline the groundwater development for irrigation may induce soil salinization and damage the crops.

2) Hydrology and Quality of Water

Groundwater with EC value of about 1.4 dS/m is little saline for irrigation and groundwater in this area will still have development potential. Likely problems of groundwater induced by the groundwater development will be salinization of soil but it will not be a serious one. Large scale groundwater extraction will be a cause of lowering water tables.

6.8.3 Recommendations

As a result of the environmental impact study described above, it can be concluded that the Project will not induce any serious direct negative environmental impact. But, the development activities may induce some indirect impacts. Details are presented in Volume IV Report.

i) For the establishment of WUAs, it is recommended that an effective procedure involving NGOs with close cooperation among government agencies shall be provided.

ii) For the expansion of the irrigated agriculture, it is recommended that AD shall extend the guidance to the farmers on agrochemical use.

iii) For the groundwater development for irrigation, it is recommended that the scale of groundwater development and the selection of crops considering water salinity shall be carefully planned.

Table 6.7.1 Calculation of Crop Economic Benefits for Enadur Big Tank

"Without Project":

Crop	Area (ha)	Production				Production Cost		Net Production Value (1000Rs)	Remarks
		Yield (T/ha)	Production (T)	Unit Price (Rs/T)	Value (1000Rs)	Unit Cost (Rs/ha)	Total Cost (1000Rs)		
1. Paddy (1st Crop)	322.0	4.00	1,288.0	4,736.0	6,100.0	5,008.0	1,092.0	5,008.0	
Total	322.0		1,288.0		6,100.0		1,092.0	5,008.0	

"With Project":

Crop	Area (ha)	Production				Production Cost		Net Production Value (1000Rs)	Remarks
		Yield (T/ha)	Production (T)	Unit Price (Rs/T)	Value (1000Rs)	Unit Cost (Rs/ha)	Total Cost (1000Rs)		
1 Paddy (1st Crop)	102.0	4.75	484.5	4,736.0	2,294.6	5,760.0	587.5	1,707.1	July - November
2 Paddy (1st Crop)	220.0	4.75	1,045.0	4,736.0	4,949.1	5,760.0	1,267.2	3,681.9	August - Decmber
3 Ground nut (2nd Crop)	10.0	1.90	19.0	7,168.0	136.2	4,440.0	44.4	91.8	
4 Ladies Finger (2nd Crop	5.0	15.00	75.0	3,600.0	270.0	18,800.0	94.0	176.0	
5 Dry Chilli (2nd Crop)	50.0	2.50	125.0	20,000.0	2,500.0	20,000.0	1,000.0	1,500.0	
6 Banana (1 year)	5.0	28.00	140.0	2,400.0	336.0	20,000.0	100.0	236.0	
Total	392.0		1,888.5		10,485.9		3,093.1	7,392.8	

Incremental Crop Benefits:

"With Project" NPV:	7,392.8
"Without Project" NPV:	5,008.0
Incremental Crop Benefits:	2,384.8
Value Added (5%) :	369.6
Incremental Total	2,754.4

Table 6.8.1 Possible Environmental Impacts for Enadur Big Tank Area

A : Significant environmental impact is unquestionably induced by the Project
B : Significant environmental impact is likely to be induced by the Project
C : There is no environmental impact likely to be induced by the Project
D : Not known or there likely to be no impact

Categories of Environmental Impact	Evaluation A	B	C	D	Evaluation Base
1. Planned residential settlement			x		No plan
2. Involuntary resettlement			x		No plan
3. Substantial changes in the way of life			x		Not expected
4. Conflict among communities and people		x			Conflict in water distribution may increase
5. Negative impact on native people			x		Positive impact by improvement of socio-economic conditions
6. Population increase			x		Not expected
7. Drastic change in population composition			x		Not expected
8. Changes in bases of economic activities			x		Not expected
9. Occupational change and loss of job opportunities			x		Positive impact by increase of seasonal employment in agriculture
10. Increase in income disparities			x		Not expected
11. Adjustment & regulation of water or fishing (repairing) rights		x			Establishment of WUAs need new water sharing adjustment
12. Changes in social and institutional structures		x			Establishment of WUAs impacts on traditional community
13. Changes in existing institutions and customs		x			Traditional water sharing need to be modernized
14. Increased use of agrochemicals				x	Agrochamicals application may increase under expansion of irrigated agriculture
15. Outbreak of endemic diseases			x		Not expected
16. Spreading of epidemic diseases					Not expected
17. Residual toxicity of agrochemicals			x		Not expected
18. Increase in domestic and other human wastes			x		Not expected
19. Impairment of historic remains and cultural assets			x		Not found in the area
20. Damage to aesthetic sites			x		Not expected
21. Impairment of buried assets			x		Not found in the area
22. Changes in vegetation			x		Not expected
23. Negative impact on important or indigenous fauna and flora			x		Not expected
24. Degradation of ecosystems with biological diversity			x		Not expected
25. Proliferation of exotic and/or hazardous species			x		Not expected
26. Destruction of wetlands and peatlands			x		No wetlands and peatlands in the area
27. Decrease of tropical rain forests and			x		No tropical rain forests in the area
28. Destruction or degradation of mangrove			x		No mangrove forests in the area
29. Degradation of coral reefs			x		No coral reefs in the area
30. Soil erosion			x		Not expected
31. Soil salinization				x	Increase of saline groundwater use may enhance soil salinization
32. Deterioration of soil fertility			x		Not expected
33. Soil contamination by agrochemicals and others				x	Intensive/improper application of agrochemicals may lead to soil contamination
34. Devastation or desertification of land			x		Not expected
35. Devastation of hinterland			x		Not expected
36. Ground subsidence			x		Not expected
37. Change in surface water hydrology			x		Not expected
38. Change in ground water hydrology		x			Large scale development may lower the water table
39. Inundation and flooding			x		Not expected
40. Sedimentation			x		Not expected
41. Riverbed degradation			x		Not expected
42. Impediment of inland navigation			x		Not expected
43. Water contamination and deterioration of water quality				x	Excess use of agrochemicals may lead to water contamination
44. Water eutrophication			x		Not expected
45. Sea water intrusion			x		Not expected
46. Change in temperature of water			x		Not expected
47. Air pollution			x		Not expected

Table 6.8.2 Environmental Impacts (Irrigation) for Enadur Big Tank Area

	Check Items	Major	Small	None	Not Clear	Problems	Action and Countermeasures Planned	Remarks
Pollution	1. Air Pollution caused by spraying of agricultural chemicals			x		Not expected		
	2. Effect on aquatic organisms, fisheries, and other water utilization of change in the water system resulting from project construction			x		Not expected		
	3. Water pollution caused by effluent from irrigated fields		x		x	1. Excess and improper use of agrochemicals may lead to soil and water contamination.	1. Farmers training on proper use of agrochemicals is extended.	
						2. Large scale groundwater development will lower water table.	2. Appropriate development scale is planned with careful hydrological study.	
					x	3. Saline groundwater irrigation will cause soil salinization but not serious.	3. Cropping pattern is carefully planned.	
Natural Environment	1. Effect of construction and operation of the facilities on the ecology			x		Not expected		
	2. Effect on landscape			x		Not expected		
Human Environment	1. Effect of the project on historical and cultural heritage			x		Not found in the project area		
	2. Effect on existing infrastructure			x		Not expected		
	3. Relocation and effect on land-use			x		Not expected		
	4. Effect on other water use				x	1. Introduction of WUA may cause increase of friction and conflict on water sharing in the community.	1. Appropriate procedure is taken in preparation stage through farmers participation.	
Others	1. Effect on the environment during construction period			x		Not expected		
	2. Environmental Monitoring		x			1 Present monitoring activities are not sufficient.	1. Monitoring shall be conducted by relevant agencies.	

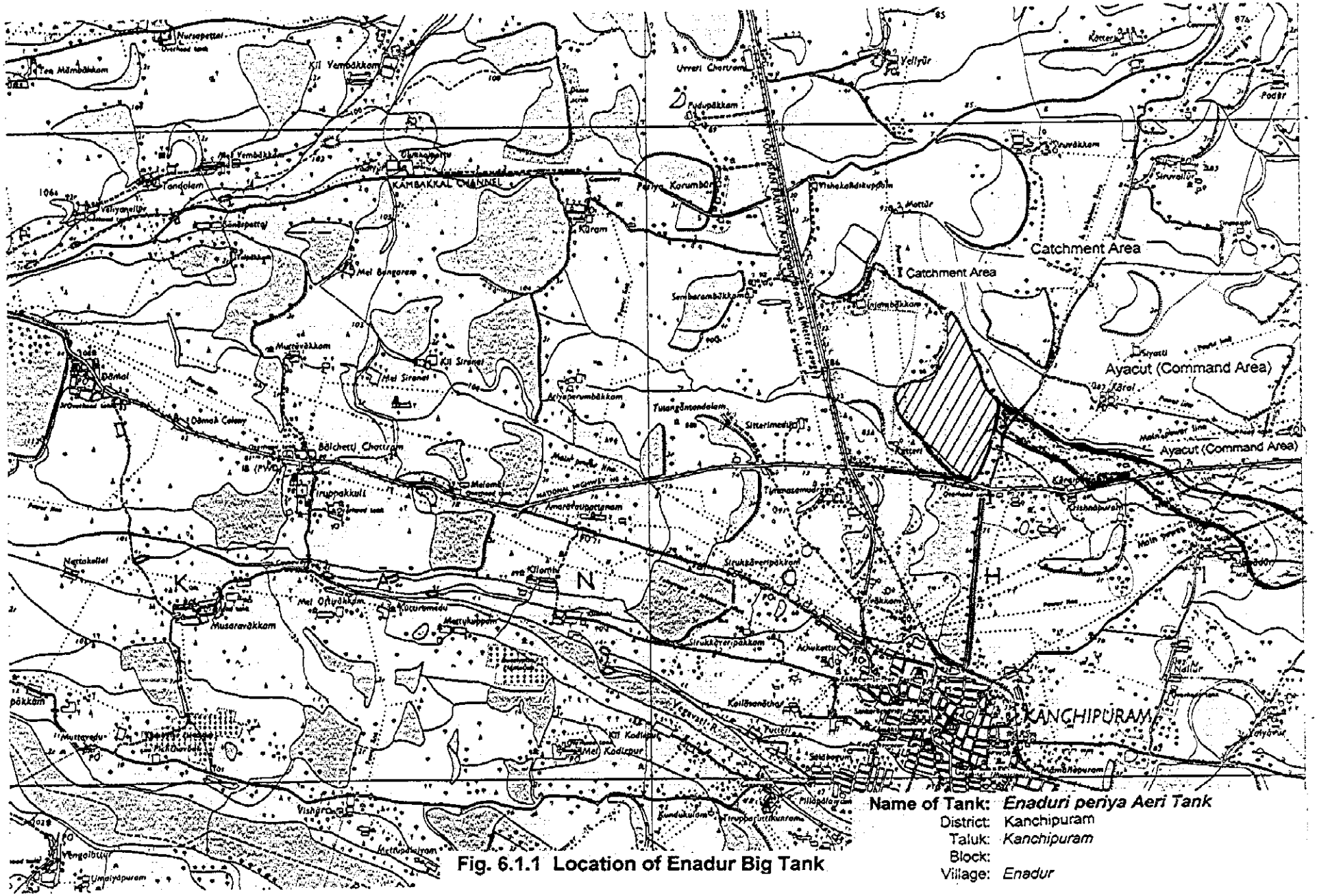


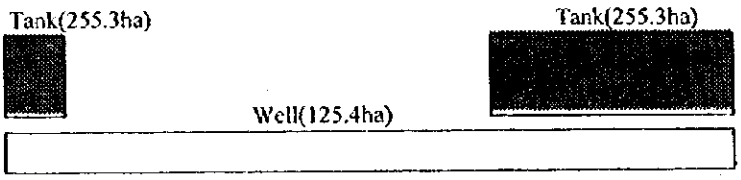
Fig. 6.1.1 Location of Enadur Big Tank

1 Name of Tank	Enadur Big Tank
2 Ayacut Area	574.7ha
3 Main Soil	Black soil: 90(Clay)%, Red soil/Red Sandy/Lateric soil: 10%
4 Water pH,EC	pH: Tank 9.2, Groungwater 7.6 to 7.8, EC: Tank 0.84 dS/m, Groundwater 1.184 to 1.74 dS/m
5 No. of Farm Households	448 farm households
6 Self-Support Amount of Rice	896tons (448 x 2,000 kg/Household)
7 Geographical Irrigable Area	Normal year: 322.0 ha
8 Total Irrigable Area and Month by Tank	Normal year: 255.3 ha(Sep-Jan)
9 No. of Wells and Irrigable Area	Normal year: 38 wells, 125.4 ha
10 Average Rainfall(mm)	

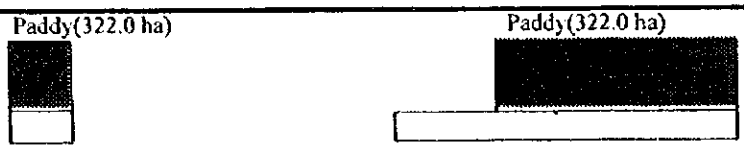
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
16.2	7.0	9.7	19.9	52.4	81.0	110.7	172.4	151.3	209.4	230.1	95.8	#####

11 Cropping

1) Irrigable Area and Period



2) Present Cropping Pattern

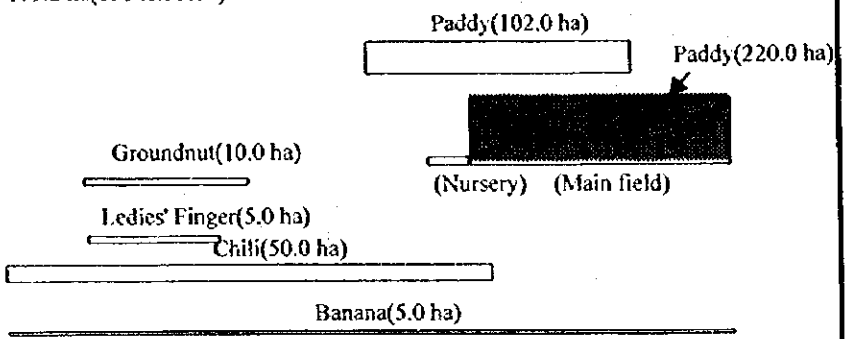


3) Cropping Plan

a) Paddy Area for Self-Support

179.2 ha(896 ton/5ton)

b) Cropping Plan



c) Evaluation

	Crop Intensity(%)	Net Income(1000Rs)
Plan	68.2	8,790
Present	56.0	4,605
Plan/Presen	1.22	1.91

Fig. 6.4.1 Cropping Plan in Enadur Big Tank Area

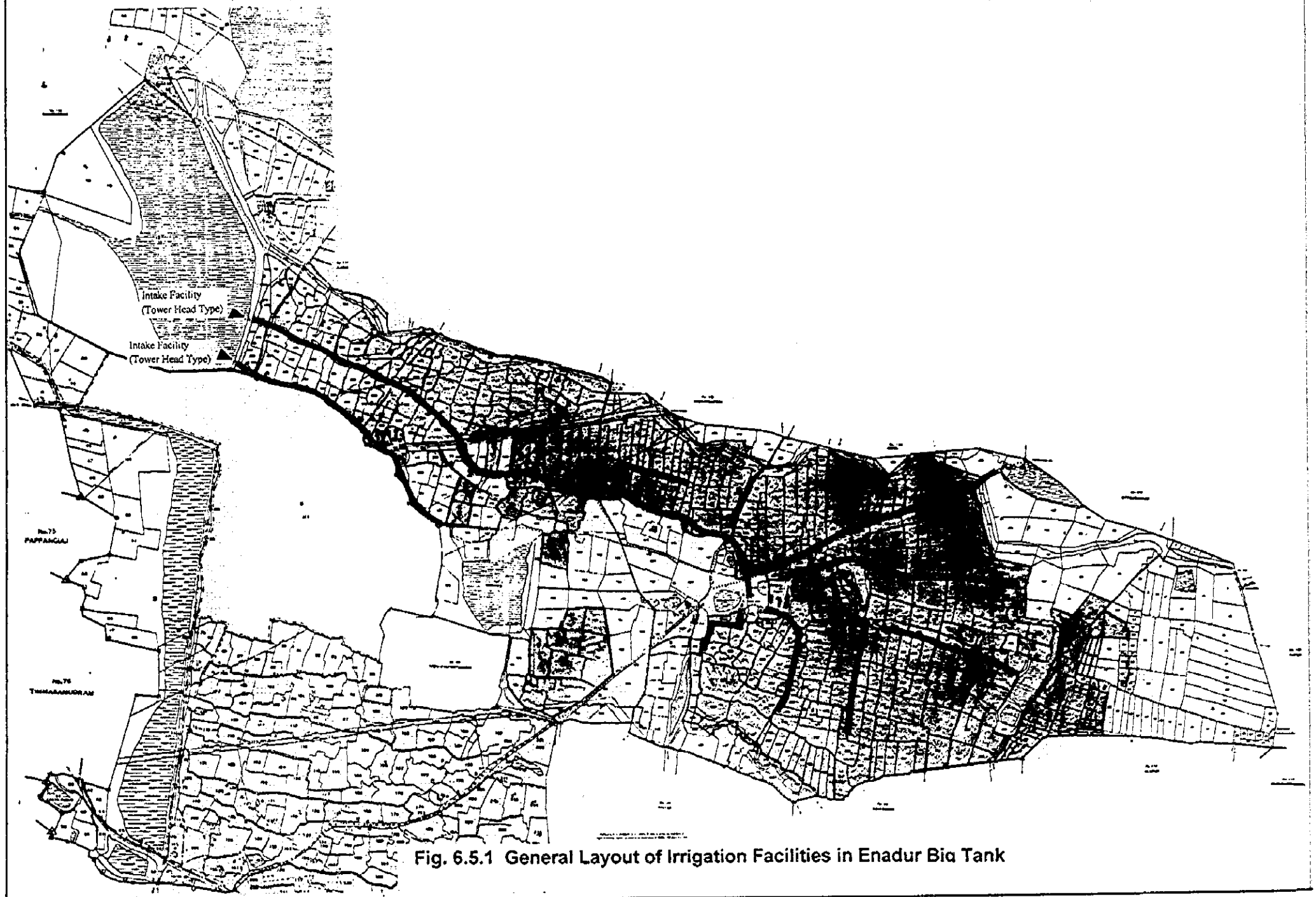


Fig. 6.5.1 General Layout of Irrigation Facilities in Enadur Big Tank