5.2.4 Cultivation Plan

The cultivation plan is planned based on the land use plan (5.1) and basic concept on agricultural production (5.2.1).

(1) Area of land use plan

Area of land use plan is set based on the following conditions as shown in Table 5.2.4.

1) Conversion of traditional coffee planted area to upland and fruit tree cultivation areas

The majority of traditional coffee planted areas in Groups 1 and 4 areas is located in the areas which are not suitable for production of coffee. Therefore, high profits cannot be expected even conversion is made to improved varieties. Such area is converted into fruit tree cultivation area or upland field of high profitability in this project. Furthermore, since local variety areas which are suitable for production of coffee are located in the fruit juice materials production promotion areas of the Coffee Committee, conversion is to be made to fruit trees area of higher profitability than that of coffee of improved varieties.

2) Conversion of grassland to upland and fruit cultivation areas

The area of grassland required for breeding the current number of cattle is maintained by the improvement of pasture and its carrying capacity, and the remaining portion of the grassland is converted. The planned carrying capacity in each group is set as shown below.

TABLE 5.2.8 EXISTING AND PROPOSED CARRYING CAPACITY(Unit:head/ha)

Group	1	2	3	4
Existing	0.86	2.00	1.83	0.60-0.67
Plan	2.00	2.00	2.00	1.00

Group 1 (Circasia Area)

It can be said that this area has the potentiality to achieve the pasture productivity equal to that of the livestock advanced area in Quindio if extension of rearing technology and grassland managing technology are accomplished, when the rainfall, temperature, topographic conditions and presence of broad unused grassland are taken into account. Therefore, the proposed carrying capacity is determined as 2.0 heads/ha.

Group 2 (Quindio River Right Margin Area, Quindio River Left Margin Area(2))

Existing carrying capacity is kept held because high technology such as irrigation to grassland and introduction of improved grassland is already expanded.

Group 3 (Quindio River Left Margin Area(1))

It can be said that this area has the potentiality to achieve the pasture productivity equal to that of the livestock advanced area in Quindio when grassland is improved, as natural grassland occupies approximately 90% of this area and this area is blessed with topographical conditions. Therefore, the proposed carrying capacity is determined as 2.0 heads/ha.

Group 4 (Salento Area, Pijao Area, Genova Area)

This area is mostly composed of natural grassland at present and it can be expected that its grazing capabilities will increase to a major extent when the grassland is improved.

However, the proposed carrying capacity is determined as 1.0 head/ha, which is equivalent to 50% of that of advanced areas, in consideration of the topography and rainfall conditions in this area.

3) Maintaining existing upland crop area

The fields in Quindio River Right Margin Area have already mechanized by investment of the farmhouses. Therefore, the current fields is kept as they are.

(2) Plan of farming practice

Proposed cropping patterns are established based on the following cultivation plans. The principal cropping patterns are shown in Fig. 5.2.2.

1) Vegetables

- To cultivate vegetables in areas of Zones 1 and 2 only.

- To plant vegetables of high profitability in the Circasia Area so that harvesting can be made in the dry season when the prices of vegetables are high, by catalyzing advantageous climatic characteristics of high rainfall in the area. That is, to plant sub-vegetables with low cultivation density in the early rainy season and to plant main vegetables of high profitability at the middle of the rainy season by mixing with sub-vegetables.

- To rotate crops between vegetables and pasture, in order to avoid injury by continuous cultivation and also to save fertilizer.

- To introduce cultivation of vegetables to flat and gentle sloped areas in order to prevent soil erosion during the coffee collar pruning period and also to increase the land productivity. To increase the soil fertility, cultivation of leguminous crops before cultivation of vegetables is to be introduced.

2) Upland crop

- To cultivate upland crops in the areas of Zones 1, 2 and 4.

- To promote the cropping pattern to combine crops of different types in order to prevent injury by continuous cultivation.

- Cassava is a special product of Quindio and is of high productivity. However, it is of high nutrition absorbing capacity and it is said to cause soil erosion. Continuous cultivation shall be avoided in the cultivation of cassava. Furthermore, since the length of time when the soil surface is exposed is long during the early period of growth, it is necessary to perform cultivation as mixed with plants of leguminous crops for covering the soil surface and for increasing the soil fertility.

- To cover the soil surface by performing cultivation as mixed with leguminous crops and leguminous pasture during the collar pruning period at the coffee cultivation area located on slopes (Zones 4 and 6). To also perform mixed cultivation of cassava at flat land and gentle slopes (Zones 1 and 2).

3) Fruit

- To cultivate fruit mainly on slopes (Zones 4 and 6) in the Circasia , Salento , Pijao and Genova Areas. Furthermore, to establish erosion protection belt along contour lines in order to prevent soil erosion.

- To introduce agro-forestry to the area with steep slope, (Zone 6) and also to consider cultivation of fruit such as lulo under trees.

- Since the length of time before citrus fruits are ripened is long, passion fruits, etc. shall be cultivated as intercrops in order to secure farmers' income in the mean time.

- To cultivate pitahaya as mixed with plants of leguminous crop such as kidney beans, in order to prevent erosion and to increase the soil fertility, because the much soil surface is exposed at pitahaya cultivation land.

4) Livestock

- To perform grazing in flat and gentle sloped areas (Zones 1, 2, 3, 4 and 5). To use forage trees as fence trees for graze land in order to prevent soil erosion and also to supply firewood to farmers.

- To increase the carrying capacity by renewing the pasture. To seed leguminous pasture and graminous pasture as mixed in order to prevent soil erosion and also to increase soil fertility .

- To cultivate pasture for cutting in band shape as a countermeasure for preventing erosion in the peripheries of fruit tree cultivation area and vegetable cultivation area on slopes (Zones 4 and 6), and also in order to use it as feed.

- To avoid continuous grazing.

- To promote rearing in drylot through expansion of pasture for cutting.

5.2.5 Production Plan

In the cultivation of crops, the cultivation technology and growing environment will be improved through improvement of research and extension organizations and improvement of crop cultivation limiting factors such as poor drainage as a result of implementation of the Project, and the production will increase to the proposed yield from the current level. Furthermore, producers' cooperatives will be organized, and volition of farmhouses for production is uplifted through establishment of collecting and shipping facilities, improvement of farm roads, etc.

The proposed cultivation area is calculated based on the land use plan, and the target yield of diversification planned by the Coffee Committee is used as the reference in the estimation of the proposed target yield. The target yield, proposed cultivation area and production of principal crops to be introduced are shown in Tables 5.2.5, 5.2.6 and 5.2.7. (See Annex D for details of fertilization rate, agricultural chemicals spraying rate, labor force to be required, etc.) The proposed cultivation area and production volume are calculated for representative crops.

TABLE 5.2.2 PROFITABILITY AND SUITABILITY OF CROP BY AREA

Crop	Profit**	Suitability			
		1	2	3	4*
Coffee	1.00	▲	◎	×	▲
Improved V.**					
Vegetable					
Onion	0.33	◎	◎	◎	◎
Tomato	2.70	◎	◎	◎	○
Green Pea	0.53	◎	×	×	◎
Welish onion	0.40	◎	×	×	◎
Pimenton	0.46	◎	×	×	△
Upland Crop					
Kidney bean	0.40	◎	◎	◎	△
Maize	0.14	◎	◎	◎	◎
Soybean**	0.27	×	◎	◎	×
Sorghum**	0.13	×	◎	◎	×
Fruit					
Citrus	1.22	×	◎	◎	×
Pitahaya	4.92	×	◎	◎	×
Passion fruit	1.51	×	◎	◎	×
Pineapple	1.23	×	◎	◎	×
Black berry	0.75	▲	×	×	○
Lulo	0.92	○	×	×	◎
Cruba	0.24	○	×	×	◎
Tree Tomato	0.65	○	×	×	◎
Others					
Cassava	1.53	×	◎	◎	▲
Plantain	0.84	◎	◎	◎	○

Suitability:◎: >80% ○:80%-50% △:50-20%
▲: <20% ×:0%
*: No. of group **: Source Caja Agraria
***: Profit of coffee improved variety is 1.00
Source:FEDECAFE

TABLE 5.2.3 MAIN PROMISING CROP FOR INTRODUCTION

Group / Area / Crop	1 Circasia	2 Right M., Left M. (2)	3 Left M. (1)	4 Salent, Pijao, Genova
Vegetable	Tomato, Onion, Welish onion, Cabbage, Carrot, Green pea, Lettuce	Tomato	-	Tomato, Onion, Welish onion, Cabbage, Coriander
Upland Crop	Kidney bean	Soy bean, Sorghum, Maize, Cassava, Kidney bean	Soy bean, Sorghum, Maize, Kidney bean	Kidney bean
Fruits	Lulo, Tree tomato, Black Berry	Citrus, Maracuya, Pitaya, Papaya, Plantain	-	Black berry, Tree Tomato, Lulo
Pasture -Grazing -Cutting	 Kikuyu, Rye grass, Micay, Clover King grass, Imperial 60	 Estrella de la India, Para, Puntero, Brachiaria humidicola India, Imperial 60, King grass	 Estrella de la India, Puntero, Papa, Puntero, Brachiaria humidicola India, Imperial60, King grass	 Rye grass, Kikuyu, Micay, Yaragua, Clover King grass, Imperial 60
Forage Tree Material & Fire Wood Others	Quiebrabarrigo, Chachafruto Eucalyptus grandis, Nogal, Guamo, Vainillo, Lemon grass, Vetiver, Mulbery, Bamboo	Maramaton, Leucaena Eucalyptus grandis, Nogal, Guadua, Lemon grass, Mulbery, Bamboo	Matarraton, Leucaena Eucalyptus grandis, Nogal, Guadua, Baboo	Quiebrabarrigo, Chachafruto, Leucaena Eucalyptus grandis, Pine, Cypress, Cedar, Guamo, Lemon grass, Mulbery, Bamboo, Vainillo

TABLE 5.2.4 CHANGE OF LAND USE

(Unit:ha)

Area / Land Use	Circasia		Salento		Right Margin		Left Margin(1)		Left Margin(2)		Pijao		Genova	
	Ex.	Plan	Ex.	Plan	Ex.	Plan	Ex.	Plan	Ex.	Plan	Ex.	Plan	Ex.	Plan
Upland crop	5	195	2	13	213	213	276	310	0	0	3	10	1	0
Coffee	667	246	125	46	834	763	0	0	64	58	298	36	280	43
Fruit-1*	0	606	0	0	336	371	0	0	1	1	2	0	0	0
Fruit-2**	-	596	-	212	-	42	-	0	-	7	-	414	0	364
Grazing	1,660	714	425	285	330	330	267	244	82	82	361	224	210	126
Forest	370	370	89	89	321	321	56	56	27	27	97	97	63	63
Idle land	25	0	4	0	6	0	11	0	1	0	20	0	41	0
Others	8	8	0	0	0	0	0	0	0	0	19	19	0	0
Total	2,735	2,735	645	645	2,040	2,040	610	610	175	175	800	800	595	595

*:Fruit planted area in Zone1-3 **:Fruit planted area in Zone 4 and 6.

TABLE 5.2.5 TARGET YIELD

(Unit:t/ha)

Crop	Ex. Yield*	Target Yield**
Vegetable		
Onion	-	15.0
Tomato	23.8	43.0
Green Pea	-	7.0
Welish Onion	-	38.0
Pimenton	-	12.0
Upland Crop		
Kidney bean	0.8	1.2
Maize	1.9	3.0
Soy Bean	2.1	2.5
Sorghum	3.8	4.5
Perennial Crop		
Citrus	18.0	24.0
Pitahaya	-	8.0
Passionfruit	-	25.0
Pineapple	-	80.0
Black Berry	8.8	16.7
Lulo	8.0	10.0
Curuba	6.0	10.7
Tree Tomato	22.1	25.0
Others		
Cassava	18.0	20.0
Plantain	12.3	15.0

Source: *: URPA(Average of Quindio in 1988)
**: FEDECAFE

TABLE 5.2.6 PROPOSED CALTIVATION AREA

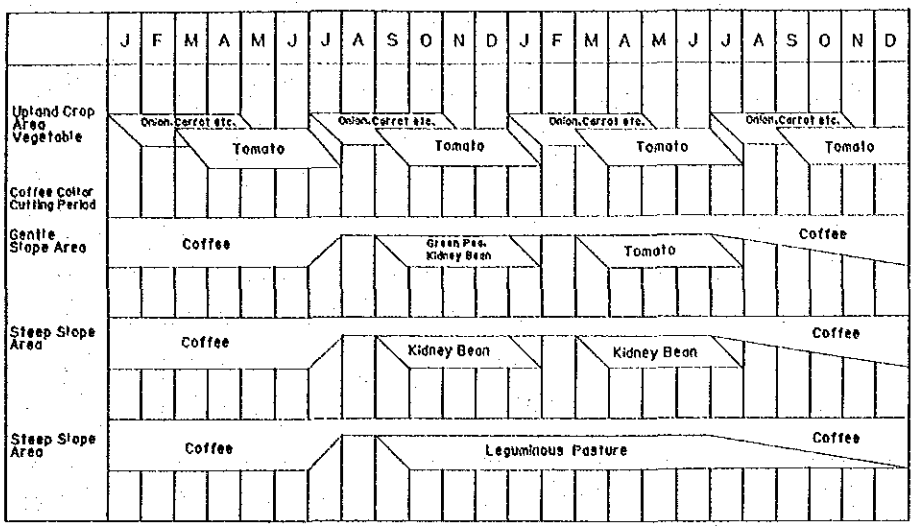
(Unit:ha)

Crop / Area	Tomato	Onion	Green Pea	Kidney Bean	Soy-bean	Sorghum	Maize	Cassava	Cofee Imp.	Cofee V.	Plantain Mixed	Plantain Single	Citrus	Pitahaya	Passion fruit	Black berry	Lulo	Tree Tomato	Total
Circasia	254	79	14	14	0	0	0	0	197	14	0	0	0	0	265	265	265		1.367
Salento	8	8	0	5	0	0	0	0	37	17	0	0	0	0	46	46	46		213
Quindio River Right Margin	17	0	0	112	160	40	40	67	610	325	120	150	60	12	0	0	0		1.713
Quindio River Left Margin(1)	0	0	0	0	331	165	0	0	0	0	0	0	0	0	0	0	0		496
Quindio River Left Margin(2)	2	0	0	8	0	0	0	2	46	9	0	6	0	-	0	0	0		73
Pijao	6	6	0	4	0	0	0	0	29	23	0	0	0	0	83	83	83		317
Genova	0	0	0	4	0	0	0	0	34	18	0	0	0	0	73	73	73		275
Total	287	93	14	147	491	205	40	69	953	406	120	156	60	12	467	467	467		4.454

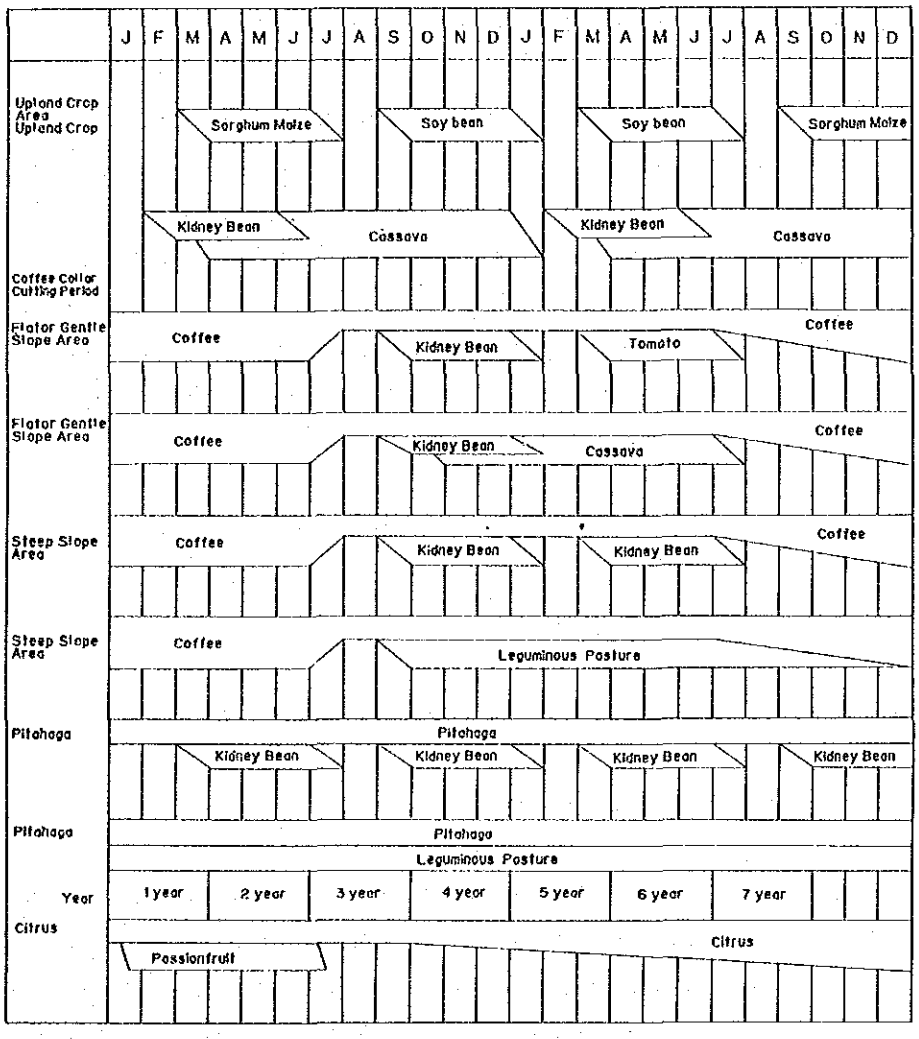
TABLE 5.2.7 PROPOSED CROP PRODUCTION

(Unit:ton)

Area \ Crop	Tomato	Onion	Green Pea	Kidney Bean	Soy-bean	Sorghum	Maize	Cassava	Cofee Imp. V.	Plantain Mixed	Plantain Single	Citrus	Pitahaya	Passion fruit	Black berry	Lulo	Tree Tomato
Circasia	10,922	1,185	98	14	0	0	0	0	394	0	0	0	0	0	4,426	2,650	6,625
Salento	344	120	0	6	0	0	0	0	69	68	0	0	0	0	701	420	1,050
Quindio River Right Margin	731	0	0	134	400	180	120	1,340	1,318	2,275	1,800	3,600	480	300	0	0	0
Quindio River Left Margin(1)	0	0	0	0	828	743	0	0	0	0	0	0	0	0	0	0	0
Quindio River Left Margin(2)	86	0	0	10	0	0	0	40	97	63	0	144	0	12	0	0	0
Pijao	258	90	0	5	0	0	0	0	46	92	0	0	0	0	1,386	830	2,075
Genova	0	0	0	5	0	0	0	0	49	72	0	0	0	0	1,219	730	1,825
Total	12,341	1,395	98	174	1,228	923	120	1,380	1,973	2,633	1,800	3,744	480	312	7,732	4,630	11,575



CIRCASIA AREA



QUINDIO RIVER RIGHT AND LEFT MARGIN AREAS

FIG.5.2.2 PROPOSED CROPPING PATTERN

5.3 Marketing and Agroindustry Development Plan

5.3.1 Principles for Formulation of the Plan

Except for coffee, no agro-products produced in the Department of Quindio are traded through secured marketing channel. This fact has constituted one of constraints on realization of diversified farming activities. Although there are some products such as cassava, plantain, orange and tomato which are marketed outside the Department and highly appreciated by consumers there, their marketing channel from producers to wholesale markets is far from being appropriate. These unfavorable marketing circumstances have been against producers' interest.

On the other hand, an agroindustry in Quindio has been underdeveloped up to date despite of raw materials for the industry being sufficiently produced within the region, which is correlated with dull performance of the regional economic activities.

The above cited situation is well understood by leaders of the Department, thus various plans and programs have been proposed. Examples of these plans and programs are listed below:

(a) Establishment of Agroindustry Promotion Committee

(b) Diversification Plan of Coffee Committee

(c) Armenia Wholesale Market Construction Plan

(d) Cooperative Re-construction Plan

Of the said plans and programs, (a) and (b) are in progress now, while regarding. (c) and (d),their feasibility study has been finished and financing arrangement for their implementation is tried. Because these plans and programs are directly concerned with the Project,due consideration shall be made on them in formulating proposed marketing and agroindustry development plan.

5.3.2 Marketing Plan

(1) Marketing system

Except for locally consumed plantain, cassava and kidney bean, the great majority of agro-products is planned to traded outside the Project Area represented by Armenia and other big markets such as Bogota, Medellin and Cali. Passion fruits shall be destined for international markets after being transformed at factories, and other fruits composed of tree tomato, blackberry and lulo shall be assessed for their possibility for export.

As discussed above, most of commodities to be produced in the Project Area shall be traded at markets outside the Project Area, and no marketing facilities but for collecting and storage yards to be located between farmers and wholesale markets are taken into account in the Project.

Marketing forecast for crops and livestock products is described hereinunder. As for coffee, marketing channel from growers to loading port for export in firmly established. Thus,it is considered that further development of marketing channel for coffee is unnecessary within the Project. Up to date, coffee growers have been supported by the Government of Colombia in relation to production and marketing of their products, because coffee has been contributed greatly to foreign exchange earning of the country. Nevertheless, due to continuously depressed international prices, it is of doubt that coffee growers will be treated in the future as favorably as they are at present.

With the implementation of the Project, cultivated area of coffee will be reduced due to shifting of its area covered by traditional varieties to other crops. The drop in production associated with reduced cultivated area will account for as few

as 0.7% of the departmental production (1989), thus this shrinkage will be negligible within the context of the economic performance of the Department of Quindio.

Plantain and cassava are staple foodstuff for the Colombian diet and their demand is consistent. With high reputation in the country's major markets such as Bogota, Medellin and Cali, it will be no need for apprehension in terms of marketing them, although an improvement of the market channel between farmers and wholesale markets is expected, because excessive intervention of intermediaries has been disadvantageous for farmers. Cooperative marketing by means of farmer's organization is proposed for its improvement.

An expansion of cultivated area for citrus is envisaged within the diversification plan promoted by the Coffee Committee, and as a part of the said plan, an incorporation of a processing plant is included. Under the circumstances, citrus to be produced in the Project Area is to be brought to this processing plant. Passion fruits are getting into the spotlight as non-traditional export-oriented commodities with better marketing conditions. As a destination of the fruits, existing concentrated juice production plants in the Departments of Caldas and Valle as well as a plant to be constructed in Cicolsa are proposed.

Pitaya, the origin of which is Colombia, has become appreciated highly in both national and international markets owing to its mild and refreshing taste; especially in the latter market, this fruit is prosperous without competitive countries. It is regretful that sanitary problem has taken place, resulting in being shutout recently in the external markets. Immediate measures to remove this constraint is required. Soybean including its oil is one of major imports in Colombia, so an increase of its production is encouraged by the Ministry of Agriculture. According to " Selective Supply Plan " formulated

at the time of the Barco Administration, it was targeted to attain the self-sufficiency of the grain by 1995 and for this target its cultivated area needed to be triplicated. Soybean is to be traded to oil manufacturing plants in Valle as it is done actually. Sorghum is an important crop to feed animals with high and consistent demand. The same marketing channel as for soybean is considered.

Tomato may be the only vegetable which has a market in addition to the local market in Quindio. The crop is sold to wholesale markets in Bogota, Medellin etc. In comparison to other crops, higher net returns are expected, but seasonable imbalance between supply and demand affects the profitability of its product. In this context, it is recommended to form organization of its growers as that efficient marketing is to be made and up-to-date and wide ranged marketing information will be collected.

Within Quindio, onions and green peas are not cultivated commercially and their consumption by local population is satisfied with supply from the Corabasto in Bogota and Cajamarca in Tolima. Therefore, these vegetables to be produced in the Project Area are to be traded within Quindio, mainly in America. As in the case of tomato, organization of farmers is important for better marketing.

Some portion of the production for kidney bean and maize are to be left for consumption of farmers and farm workers, and the rest shall be sold to local markets or to markets in Armenia.

Presently, blackberries, lulos and tree tomatoes are sold within the Department, because their output is very few, although their processed products (frozen pulps) have a market in Bogota. The Project envisages a drastic expansion of these fruits, and as for their marketing, the following are proposed:

1) By producing high quality products and with an Individual Quick Freezing method, to export them to European countries and other markets.

2) To freeze their pulps within the Department and to market processed products to Bogota, Medellin, Cali and other country's major markets.

3) To trade fresh fruits.

It is advisable that for the time being the latter two proposals should be practiced, then the former proposals should be studied on its feasibility for implementation. In any proposals, the production of there fruits is to be undertaken by medium and small farmers. Therefore, the success in marketing shall only be attained with organizing these farmers.

(2) Marketing infrastructure

As discussed in the previous sub-section (1), an organization of farmers is proposed in respect of marketing of plantain, tomato, onion, green pea, blackberry, lulo and tree tomato in view that:

1) Most of growers for these crops will be medium and small farmers.

2) At present, marketing of these crops is constrained from an absence of established channels.

A proposed marketing channel for the said crops is as illustrated in Fig.5.3.1

As this diagram shows, collection and storage yards administrated and operated by cooperatives shall be established in respective municipality of Circasia, Salento, Pijao and Genova, and products are to be traded to wholesale markets or

supermarkets located in Armenia, Bogota, etc. through this channel. Outline of these collection and storage yards is given in 5.4.2

5.3.3 Agro-industry Development Plan

(1) Development principle

Bearing in mind that the quantity of agro-products other than coffee in the area is limited, it is not feasible to develop large scaled agro-industries within the Projects Area. Even if the supply of raw materials from outside the Project Area is expected, geographical condition, accessibility, availability of qualified labor force, etc. will constitute bottle neck for development of agroindustry in the Project Area. It is, therefore, recommended to develop small and medium installations to process agriculture related raw materials.

Advantageous aspects to develop these small and medium enterprises are:

- To require relatively low amount of investment;
- By and large more job opportunity is expected in comparison with the capacity of facilities;
- Sometimes it is possible to install a plant within farms or in isolated rural areas;
- Technology is not complicated and administration is simple; and
- Full operation of plants can be accomplished in shorter time.

(2) Plants installation plan

Five(5) units of plants for freezing pulps extracted from fruits of blackberry, tree tomato and lulo are to be installed in Circasia (two units), Salento, Pijao and Genova.
General specifications of proposed plant are as follows:

Boiling tank: 190 1
Pulp extraction capacity: 100-150 kg/hr.
Packing: 420 bags/hr.
Refrigerating unit: 7 m3
Freezing unit: 5 m3

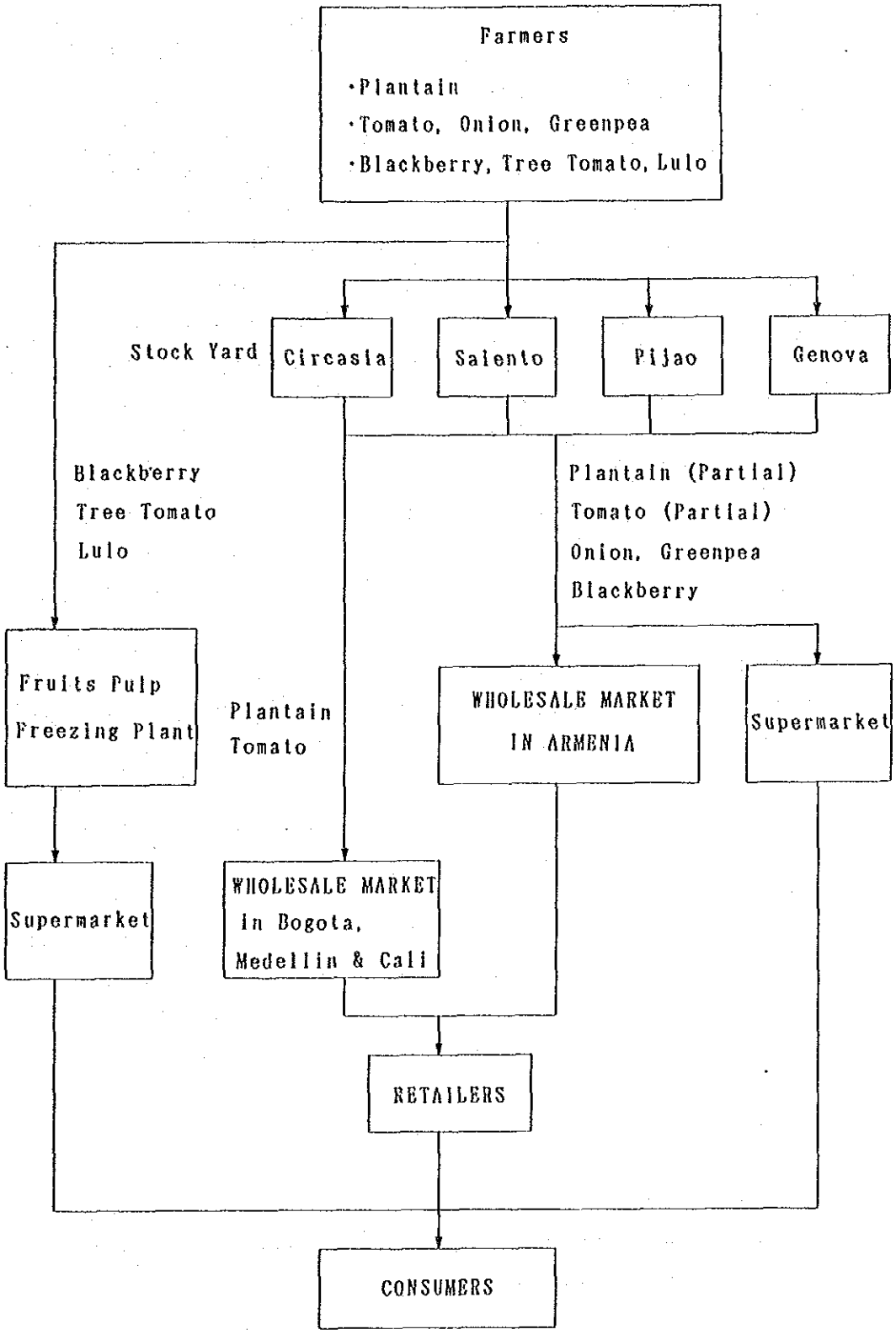


FIG 5.3.1 FLOW CHART FOR MARKETING OF VEGETABLES AND FRUITS

5.4 Agriculture Support Organization Promotion Program

(1) Research and extension organization

The majority of the crops to be introduced in the Project are currently cultivated in the area in small space or for own consumption. However, strengthening of suitable activities for research and extension of cultivation technology are required for cultivating these cops on the commercial basis. It is recommended that the organization that implements research and extension of crops proposed in the Project is C.R.Q. The proposed organization is shown in Fig. 5.4.1.

The headquarters of the organization shall be established at the land of Bremen (Circasia Area) possessed by C.R.Q. The organizations that implement research and extension shall be located in the same premise in order to promote exchange of information between them. Furthermore, an Agricultural Technology Promotion Committee shall be established and period exchange of opinions between researchers and extension staff shall be made in order to smoothen transfer of results of research to the extension staff and feedback of problems from farmhouses to the research division.

The researchers shall be dispatched from the organizations that belong to the Agriculture Promotion Committee of the Department. The extension services shall make use of the extension staff of the Agriculture Bureau of the Department.

1) Research division

The research division is to be composed of four research sections. The contents of operations of each research section are as follows:

- Farming system section
  Studies on the cultivation methods which take into account

prevention of soil erosion against crops to be introduced and studies on the farm management structure that combines crop cultivation, stockbreeding and forestry suitable for each area.

- Crop introduction section
  Selects the crops and varieties suitable for the respective areas from the seeds of crops and varieties to be introduced from ICA and other research organizations.

- Post-harvest section
  Studies on methods for shipping and processing of vegetables and fruits and methods for use of coffee treatment waste.

- Water quality section
  Studies on methods for treatment of coffee waste water and monitoring of the water quality of each river.

- Branches
  The branches shall be located in areas of different natural conditions for implementation of testing of introduced crops and of farming system. These branches shall also function as display fields. The area of each branch shall be around 1 to 2 ha, and it shall be rented from farmhouses.

2) Extension division

The extension division shall be organized by strengthening the Agriculture Bureau of Quindio. The extension division shall be composed of extension section and farmers organization section. Extension of technology shall be made through the unions, not individually to farmhouses, because the number of farmhouses is large. Therefore, importance shall be attached to promotion of organization of farmhouses. A training center for conducting practice and training of farmhouses shall be provided in the extension section.

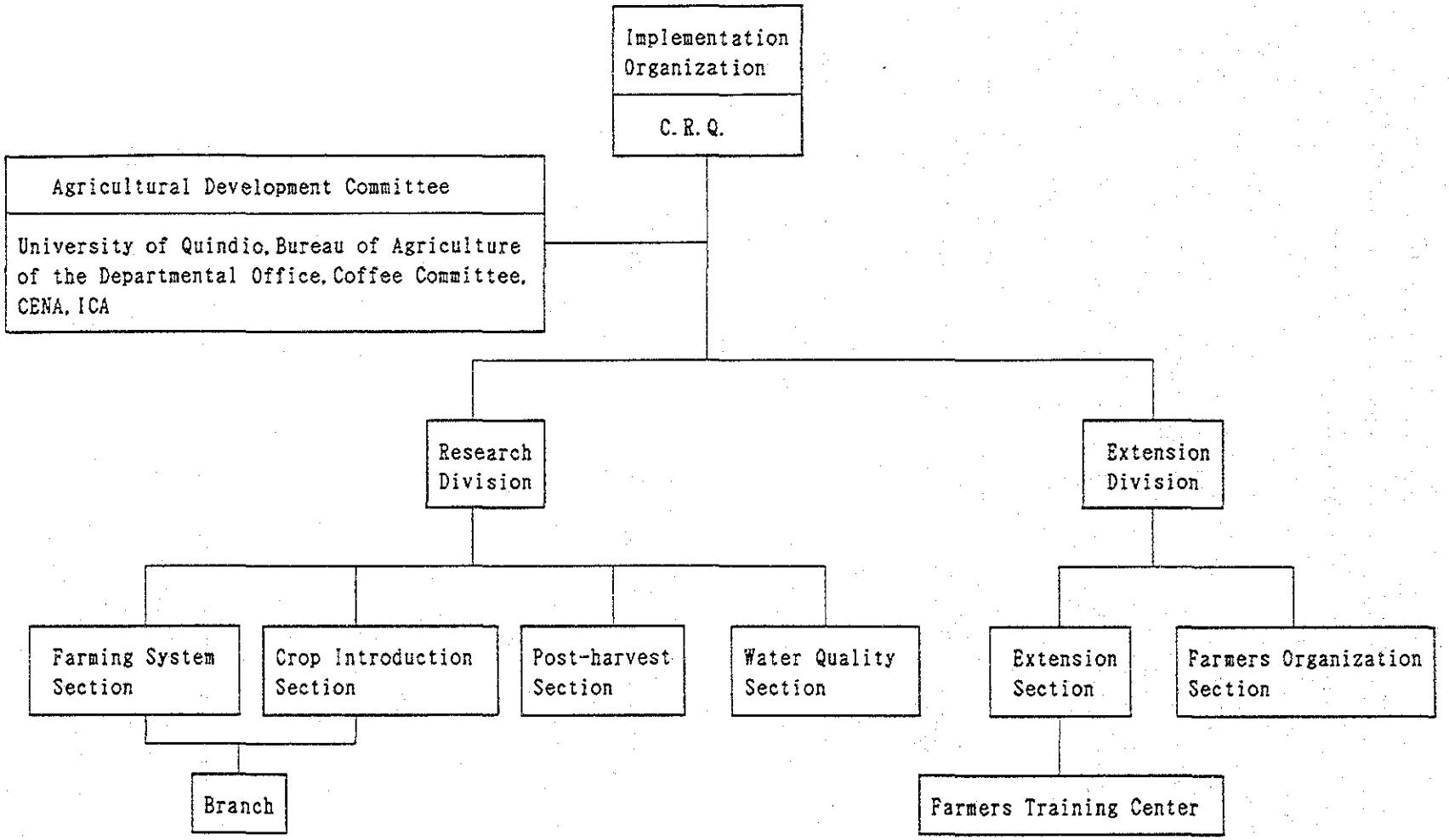


FIG. 5.4.1 PROPOSED AGRICULTURAL RESEARCH AND EXTENSION ORGANIZATION

5.5 Farmer' Organization Plan

5.5.1 Planning Principle

In the Project Area, farmers engaging in the cultivation of vegetables and fruits(except for citrus, passion fruit and pitaya) are in their greater portion medium and small farmers, and marketing of their products is conducted mainly through intermediaries. In this transaction, farmers are disadvantageous in setting prices of their products, because they negotiate with intermediaries solely. In order to strengthen farmers' capacity of negotiation in the stage of transportation of their products, it is prerequisite that farmers be formed in organization, and in this connection it is advisable to incorporate a cooperative formed by farmers.

In the Department of Quindio, in line with the said consideration, a cooperative of vegetables and fruits growers called "COHOFRUQUIN" has been established since 1987, but its operation is virtually suspended. It is informed that this inactiveness in operation is rooted in unconsolidated organization for both financial and managerial aspects as well as lack of experience in marketing of products. For successful operation of the cooperative, the following supporting services by relevant institutions are anticipated:

- Credit service for installation of office, collection and storage warehouse, procurement of vehicles and other equipment required.

- Education and campaign to farmers with regard to participation in farmer's organization.

- Technical assistance in marketing of products and in management (accounting, organization) of a cooperative.

5.5.2 Incorporation and Operation Plan

Farmers' cooperative shall be incorporated in Circasia, Salento, Pijao and Genova with objectives of purchasing plantain, tomato, onion, green pea, blackberry, tree tomato and lulo from their associate members and marketing them to wholesale markets or supermarkets. In case that associate members desire to market products other than those cited above, it shall be studied within board of directors of cooperatives.

Prices of fruits and vegetables to be transacted by cooperatives fluctuate considerable depending upon wholesale prices established at Corabastos, Bogota. It is thus essential that information collection system on supply and demand of products is incorporated so that coordination and arrangement for production and marketing might be attained.

Activities of cooperatives proposed in the Project shall be limited to marketing of crops. but if organization of cooperative becomes consolidated, they may be expanded to such fields as procurement of inputs, credit service, saving, etc. In particular, it is desirable that considerable capital formation is accomplished in such manner as to subsidize associate members in time of slump for prices of products.

Installations affiliated to cooperatives are office and collection and storage yard of products. In such cooperatives, one director, one secretary (cum accountant), one marketing researcher and a couple of persons responsible for collecting and transacting products.

5.6 Agricultural Infrastrycture Plan

5.6.1 Basic Concept

In the Project Area, agricultural infrastructures such as farm roads, farmland reclamation, irrigation facilities and drainage facilities are not sufficient. Farm roads which are most important facilities for agricultural development are to be improved. Furthermore, for improving the productivity of farm lands, irrigation and drainage facilities shall be provided, in case of practicable. Improvement of domestic water supply facilities is not made in consideration of the present condition of domestic water availability.

5.6.2 Farm Road Improvement Plan

The access to the project areas from the main rural roads and connection between the project areas are practicably sufficient at present. Therefore, in the Project, the main and branch farm roads within the project areas only are to be improved. In this connection, not only the construction of new farm roads but also rehabilitation of existing areas are planned.

The criteria of the proposed plan are as follows:

- Main farm road

  Connection between main rural road and branch farm road

- Branch farm road

  Connection between main farm road and farmland (approx. 4ha), in general.

- Road layout

Road layout is planned in consideration of the proposed land use plan, farm management plan and topography. In principle, distance between branch farm roads are 400-800m and mainfarm roads are 1,600m.

- Road width

Main : total 4.6m(effective 4.0m)
Branch: total 3.6m(effective 3.0m)

- Pavement

Gravel surfacing(100mm)

- Related structure

Road cross drain:locations are determined
in consideration of road
profile,catchment area,
etc.
Bridge:submergible type

The proposed farm road network is compiled in Volume III and typical section of farm roads in shown in Fig 5.6.1. The total length and density of the proposed farm road system for respective project areas are shown in Table 5.6.1.

5.6.3 Irrigation Plan

Annual rainfall of 1,600 - 2,800 mm is in each project area and the absolute necessity of irrigation is minor. But irrigation is planned for vegetables as the target because highirrigation effect can be expected for annual crops, by the irrigation in the dry season. However, since water sources are despendent on small streams in each area, the possible intake discharge is limitted and it is impossible to irrigate the entire area. Accordingly, an irrigation plan is established within the range of possible intake discharge.

(1) Areas to be irrigated

Each area to be irrigated is selected out of the fields where vegetables are to be planted under such conditions that a stream from which a certain intake discharge can be expected is located nearby, it is possible to construct water intake and delivery facilities economically and farmland of certain scale (5 ha and more) is located together. The result is as shown in Table 5.6.2. Three areas (38 ha in total) are selected in the Circasia Area and seven areas (74 ha in total) are selected in the Quindio River Right Margin Area.(Annex H.1.3)

(2) Water sources

A stream in the area is used as the water source for irrigation in each area. The possible intake discharge is calculated based on the specific flow during the dry season.(Annex B, Table B.4.12).The dimensions for 5 year return period which is adopted in general in Colombia is adopted for the design.

(3) Irrigation Method

Since each area to be irrigated is located on a slope and the water source available for irrigation is not sufficient, furrow irrigation is not suitable. Therefore, sprinkler irrigation (portable type) is adopted.

(4) Irrigation Water requirements

1) Potential evapotranspiration (ETP)

Since the weather data for adopting the Penman method is insufficient in the study area, calculation is made by the Garcia Lopez method which is adopted for the areas of altitude 1,000 -2,000 m in Colombia.

$$ETP = 1.21 \times 10^{n} \times (1 - 0.01 \times HR) + 0.21 \times T - 2.30$$

where; ETP:Potential evapotranspiration
HR :Relative Humidity (%)
T :Temperature(^{o}C) n= 7.45 x T/(234.7 + T)

The result of calculation is 110 mm per month at maximum, 54 mm per month at minimum. (Annex H, Table H.1.1)

2) Crop water requirements (ETC)

The crop water requirement are calculated by month and by area by using the crop coefficient (Kc) in accordance with the guideline of FAO. The results are shown in Annex. H, Table H.1.2.

3) Irrigation requirements

The irrigation requirement are calculated (Annex H, 1.4) based on the particulars stated above, and the results are shown in Table 5.6.3.

(5) Method for intake

Pumping up the water is required because each area to be irrigated is of an altitude higher than that of the stream be used as the water source. It is proposed to use a non-powered pump (RUM) because of low operation and maintenance expenses for pumping up water. The pump specification for each area to be irrigated is as shown in Table 5.6.3. A standard structure is shown in Fig. 5.6.2.

(6) Farm pond

The design irrigation water is to be secured by providing a farm pond in each area to be irrigated, because the stream water to be used as the water source is less than the desigh irrigation requirements during the dry season (August).

The planned farm pond capacity is shown in Table 5.6.3. The structure is of concrete walls and rubber sheet at bottom in consideration of the proposed site for farm pond being a slope area.

(7) Water delivery facilities

A fixed pipeline is to be installed from the farm pond to the field. Delivery of water is made with an engine-powered pump installed at the farm pond. (Annex H, H.1.8.2)

(8) Dimensions of irrigation

The Dimension of irrigation are as shown below:

Water requirement (net): 3 mm/day
Water requirement (gross): 4 mm/day
Irrigation interval: 6 days
Irrigation water at a time: 24 mm
Irrigation intensity: 7.8 mm
Irrigation period for one time: 3 hours
Number of irrigation times per day: 3 times
Sprinkler arrangement: 18 x 12 m
Sprinkler: Medium pressure type(2.5kg/cm2)
Nozzle bore 4.4 x 3.2 mm
Irrigation water 28.5 l/min

5.6.4 Drainage Plan

Some portions of the Quindio River Left Margin (1) and (2) Areas are of flat topography, and in addition, the soil is of clay type. Accordingly, growth of crops is inferior due to poor drainage, and some of these portions are shelved as grazing land. Even if some drainage canals have been constructed in these areas, they are insufficient in both quality and quantity. Therefore, it is planned to construct drainage canales along the farm roads in order to increase productivity of land. The gravitable drainage system is adopted, and the structure of the drainage canals are of non-lining type.

TABLE 5.6.4 Drainage Canal

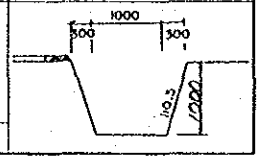
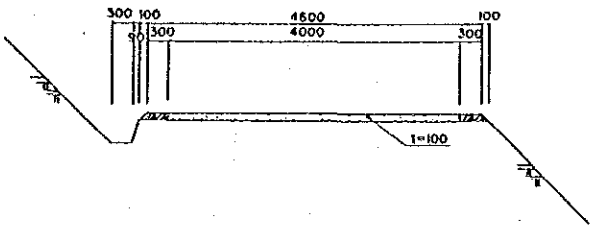
Area	Total Length(km)	Section
Quindio River Left Margin(1)	10.8	
〃 (2)	0.8	
Total	11.6	

Table 5.6.1 LENGTH AND DENSITY OF FARM ROAD

Study area	New Road (km)			Existing Road (km)				Grand Total (km)	Area (ha)	Road Density (m/ha)
	Main (km)	Branch (km)	Sub-Total (km)	Main (km)	Branch (km)	National Provincial (km)	Sub-Total (km)			
Cristales	4.2	36.9	41.1	7.1 [7.1]	23.9 [23.9]	17.0	48.0	89.1	2,735	32.6 (17.6)
Salento	1.8	15.9	17.7	6.3 [6.3]	1.5 [1.5]	7.8	15.6	33.3	645	51.6 (24.2)
Quindio Right	2.6	18.1	20.7	22.9 [3.9]	26.2 [10.5]	-	49.1	69.8	2,040	34.2 (24.1)
Quindio Left(1)	-	9.9	9.9	5.7 [2.0]	1.8 [-]	-	7.5	17.4	610	28.5 (12.3)
Quindio Left(2)	-	1.5	1.5	- [-]	2.3 [1.5]	-	2.3	3.8	175	21.7 (13.1)
Pijao	3.9	19.9	23.8	2.7 [2.2]	2.5 [2.5]	7.9	13.1	36.9	800	46.1 (16.4)
Genova	1.8	17.3	19.1	4.7 [2.3]	5.8 [5.8]	6.3	16.8	35.9	595	60.3 (28.2)
Total	14.3	119.5	133.8	49.4 [23.8]	64.0 [45.7]	39.0	152.4	286.2	7,600	37.7 (20.1)

Note: [ ] shows the improvement
( ) shows the existing

Main Farm Road



Branch Farm Road

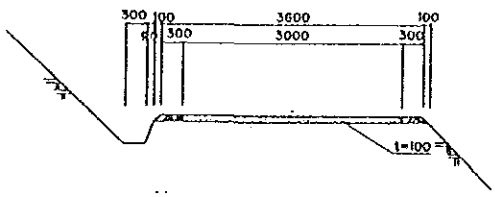


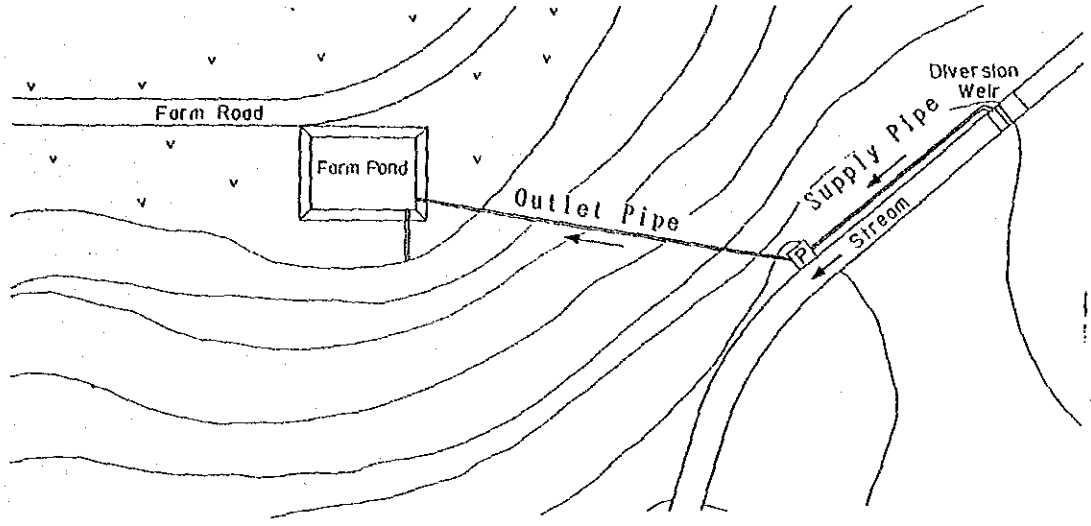
FIG 5.6.1 TYPICAL SECTION OF FARM ROAD

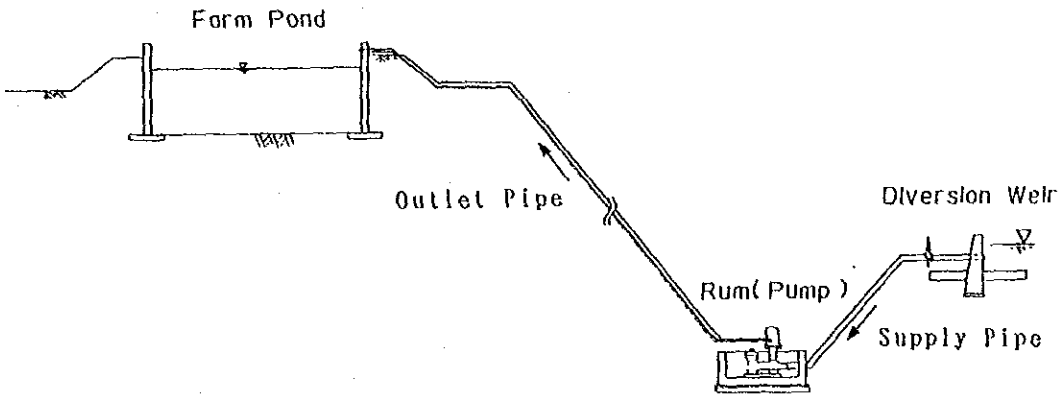
TABLE 5.6.2 PROPOSED IRRIGATION AREA

Area	Proposed Area(ha)	Altitude (m)	Name of River	Altitude of Intake(m)
Circasia Area				
C-A Area	10.0	1,690- 1,710	SAN LUIS	1,665
C-B 〃	19.0	1,660- 1,690	SAN JOSE	1,655
C-C 〃	9.0	1,725- 1,745	LAS YEGUAS	1,695
Sub-total	38.0			
Quindio River Right Margin Area				
Q-A Area	10.0	1,150- 1,155	JARAMILLA	1,125
Q-B 〃	9.0	1,155- 1,165	JARAMILLA	1,145
Q-C 〃	14.0	1,175- 1,181	CANTARO	1,145
Q-D 〃	7.0	1,166- 1,179	JARAMILLA	1,145
Q-E 〃	18.0	1,145- 1,163	ARGENTINA	1,135
Q-F 〃	6.0	1,145- 1,168	CINCO	1,120
Q-G 〃	10.0	1,135- 1,141	CRISTALES	1,080
Sub-total	74.0			
Total	112.0			

TABLE 5.6.3 INTAKE FACILITIES

Irrigation Area	Area (ha)	Pumping Capacity(l/min)	Pump Head(m)	Diameter (mm)	Farm Pond Capacity(m^3)
Circasia Area					
C-A Area	10.0	42.93	35.0	150	420
C-B 〃	19.0	228.45	20.0	200	715
C-C 〃	9.0	46.13	40.0	150	370
Quindio River Right Margin Area					
Q-A Area	10.0	66.19	27.5	150	405
Q-B 〃	9.0	78.24	15.0	150	355
Q-C 〃	14.0	219.40	33.0	300	500
Q-D 〃	7.0	55.76	27.5	150	280
Q-E 〃	18.0	235.66	19.0	200	670
Q-F 〃	6.0	58.93	36.5	150	235
Q-G 〃	10.0	180.00	58.0	300	345





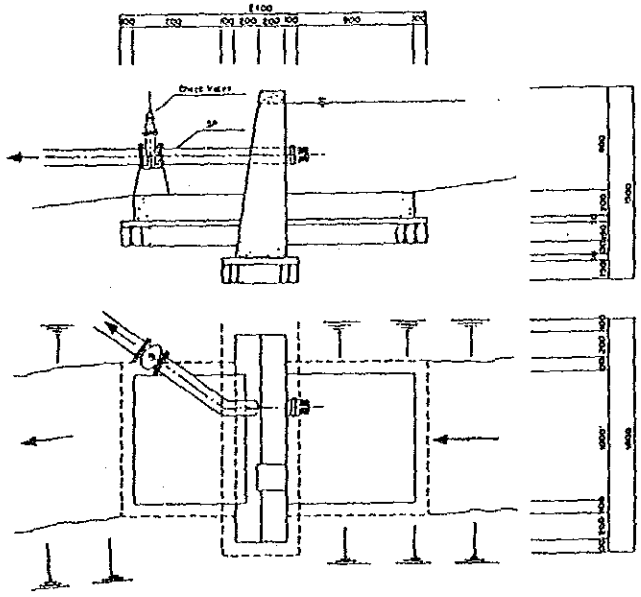


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FIG 5.6.2 INTAKE FACILITY

CHAPTER 6 : COFFEE WASTE WATER TREATMENT PLAN

CHAPTER 6 COFFEE WASTE WATER TREATMENT PLAN

6.1 Basic Concept

A coffee waste water treatments plan for the Cristales river basin, the study area, is to be established, considering present situation of coffee waste water, properties of the waste water and of river's water pollution. In order to establish the plan, pilot areas are to be selected and with the performance of detailed studies for identification of applicable treatment methods, model plants for examinations of water quality improvement are constructed.

The following point will be considered for establishment of the waste water treatment plan.

a) Target value of parameters for water quality improvement shall be realizable value
b) The waste water treatment method is studied with considerations of low facility cost, easiness of maintenance and not requiring highly technical skill in its operation
c) Treatment method will be proposed considering application of not only the Quindio Department but also other departments in Colombia.

6.2 Target Value of Parameters for Water Quality Improvement

6.2.1 Basic Consideration

The target value of parameters of coffee waste water quality improvement are established with the following considerations for various water use at lower part of rivers.

1) For environment
   Not to provide unpleasant influence for daily life and to be able to use rivers for the place of recreation
2) For domestic water supply

To provide water with quality enough for making a good potable water using simple filtration or disinfection

3) For agriculture
Not to obstruct to growth of crops neither not to make any problem for cultivation the vegetables when river water is used for irrigation.

4) For pisciculture
Not to obstruct to growth of fishes neither not to make any problem for breeding eatable fish

5) For industry
No interference to factory's operation and to produce high quality pure water by water treatment technology

6.2.2 Target Value of Parameters of River Water Quality Improvement

The target value of parameters of river water quality improvement were determined as shown in Table 6.2.1 taking into consideration of regulations provided by Ministry of Health Colombia, the criteria for quality of water for agricultural use (Article 40), the regulation for waste water emission control (Article 72), the regulation for waste water emission to public servers(Article 73), the regulation for the concentration of matters restricted in water from hygienic point of view (Article 74) and the criteria of water quality for agricultural use in Japan, 1970 (see Annex J) and based on the consultation with C.R.Q.

Table 6.2.1 TARGET QUALITY OF RIVER WATER

Item	Standard Value (Daily Average)	Allowable maximum Value
Appearance, odor and taste	To be normal	To be normal
pH	5.8 - 8.6	5.8 - 8.6
BOD5(mg/l)	< 2	< 3
CODcr(mg/l)	< 20	< 30
DO(mg/l)	> 7.5	> 5
Suspended Solid(mg/l)	< 25	< 40
Nitrate nitrogen(mg/l)	< 10	< 45
Number of coliform group (MPN/100ml)	5,000	10,000
Cyanides, Mercury. Organic Mercury&Phosphorus	Not detectable	Not detectable
Cd(mg/l)	< 0.01	< 0.01
Pb(mg/l)	< 0.10	< 0.10
Zn(mg/l)	< 0.50	< 0.50
As(mg/l)	< 0.05	< 0.05
Cr Vl(mg/l)	< 0.005	< 0.05
Cu (mg/l)	< 0.02	< 0.02

Note : The value for SS shall not be applied when it rains
: Water discharge of the Cristales river (catchment area is 94km2) is estimated to be 1.795 m3/s in November when the amount of harvested coffee is the highest in a year using specific discharge of 19.12 l/s/km2 for 5 year return period.

6.2.3 Target of Quality of Coffee Waste Water

Considering the target quality of river water and the water discharge volume of the Cristales river, the target of quality of coffee waste water is set up as shown in Table. 6.2.2.

Table 6.2.2 TARGET OF QUALITY OF COFFEE WASTE WATER

Item	Standard Value (Daily Average)	Allowable maximum Value
Appearance odor and taste	To be normal	To be normal
Temperature(oC)	<40	<40
PH	5.8 - 8.6	5.8 - 8.6
BOD5(mg/l)	<40	<60
CODcr(mg/l)	<300	<450
DO(mg/l)	> 5	> 3
Suspended Solid(mg/l)	<30	<45
Nitrate nitrogen (mg/l)	<10	<45
Number of coliform group (MPN/100ml)	5,000	10,000
Organic phosphate(mg/l)	<0.05	<0.05
Cu(mg/l)	<0.20	<0.20

: Maximum allowable value shall not exceed for 24 hr continuously

6.3 Selection of Waste Water Treatment System

6.3.1 Waste Water Treatment System

There are many treatment methods for waste water from processing of agricultural products including coffee waste water, and those are summarized as shown in Table 6.3.1.

6.3.2 Determination of the Basic Processing System

According to the comparison shown in Table 6.3.1, it can be considered the anaerobic biological treatment system, which is the most economical in initial cost and in running cost, is the best. However, coffee processing waste water is highly concentrated organic waste water and can not be treated completely with a individual treatment. That is, even if 90% of organic matters in

Table 6.3.1 COMPARISON OF WASTE WATER TREATMENT METHODS

Treatment Method	Aerobic Treatment	Anaerobic Treatment	Chemical Treatment
General Characteristics	Water purifying method for sewage and waste water utilizing aerobic bacteria, fungi, Protozoa, algae, plankton and other aerobic organism to decompose organic matters, represented by active sludge process, aerobic lagoon, etc.	Water purifying method for sewage and waste water by utilizing activities of anaerobic bacteria e.g. anaerobic digester and septic tank. Many studies on high rate anaerobic digester are performed recently.	Water purifying method by dosing with inorganic and organic additives represented by coagulation and sedimentation.
Merit	•To be able to reduce organic matters with low content in water to an order of some 10 mg/l effectively.	•Few items for daily maintenance. •Low running cost. •Few excess sludge generation.	•Rapid treatment can be realized. •Flexible to the loading fluctuation. •Good appearance of treated water.
Demerit	•Requiring oxygen supply. •Consuming considerable electricity for oxygen supply. •Some methods generate large amount of excess sludges, therefore, disposing method of excess sludges and its running cost should be considered.	•Slow reaction. •Taking time for starting. •Strict operational control for temperature, hazardous matters, pH, etc. •Large scale facilities will be required for treatment of organic matters to low level.	•Incapability of stable treatment for organic matters. •Generating large amount of sludges. •High price of chemical used.

the coffee waste water are removed by the anaerobic biological treatment, 1,000mg/l-CODcr still remain in the treated water.

Characteristics of the water treated by the anaerobic biological treatment system are as follows:

1) Dissolved oxygen in the treatment water is nearly zero.

2) There is an offensive smell which is specific in the anaerobic biological treatment.

3) The water with 1,000mg/l-CODcr is still highly concentrated in the waste water.

Generally, The efficiency of the anaerobic biological treatment falls down when the concentration of organic matters in the waste water is decreased. On the other hand, the aerobic biological treatment system is an already well developed method and the organic matters in water can be reduced by this system to an order of some tens mg/l. However, it is necessary to keep the aerobic condition and a power source is required for air supply.

The chemical treatment system is not appropriate for this area because of its high cost and difficulty of maintenance. Therefore, the combination of the anaerobic and aerobic system shall be considered as the treatment method for this area. The anaerobic system is applied to the initial treatment and the aerobic system to the secondary treatment.

From the results of the laboratory test, the quality of the water treated by the initial and secondary treatments can not satisfy the target quality for rivers. Therefore, a stabilization pond with aquatic plants is considered to reduce COD and BOD as the tertiary treatment. Further more, a neutralization process of the waste water before the anaerobic treatment is adopted because adjusting the pH of waste water is required before the anaerobic treatment.

The system flow of coffee processing waste water treatment mentioned above is summarized in Fig. 6.3.1.

6.3.3 Study of Treatment System for Respective Unit

The treatment methods were studied and decided for respective treatment unit in the basic system mentioned before. Those are summarized below: (See Annex J.)

(1) Neutralization

As coffee waste water is acidity(pH3.5 - 4.7), the coffee waste water can not be treated directly by anaerobic biological treatment method and it is necessary to be neutralized the water before the treatment. For the neutralization, considering the value of pH, common alkalinizer such as sodium hydroxide, calcium oxide(quick lime), sodium carbonate, sodium bicarbonate and limestone can be applicable.

From the result of study of alkalinizer (its merits, demerits and economic efficiency), limestone which is easily obtained at around the study area was selected as the alkalinizer considering its economic efficiency, its safety in handling, even though its rate of reaction is not quick. The neutralization tank has a buffer function between coffee treatment facility and anaerobic tank and constant volume of discharge will flow into anaerobic tank.

(2) Anaerobic bio mass treatment

A lot of anaerobic treatment methods are devised, and the respective characteristic on such as treatment capacity, easiness in operation, economic efficiency, easiness in construction, running cost, etc. are deferent from each other. These treatment methods are listed in Table 6.3.2.

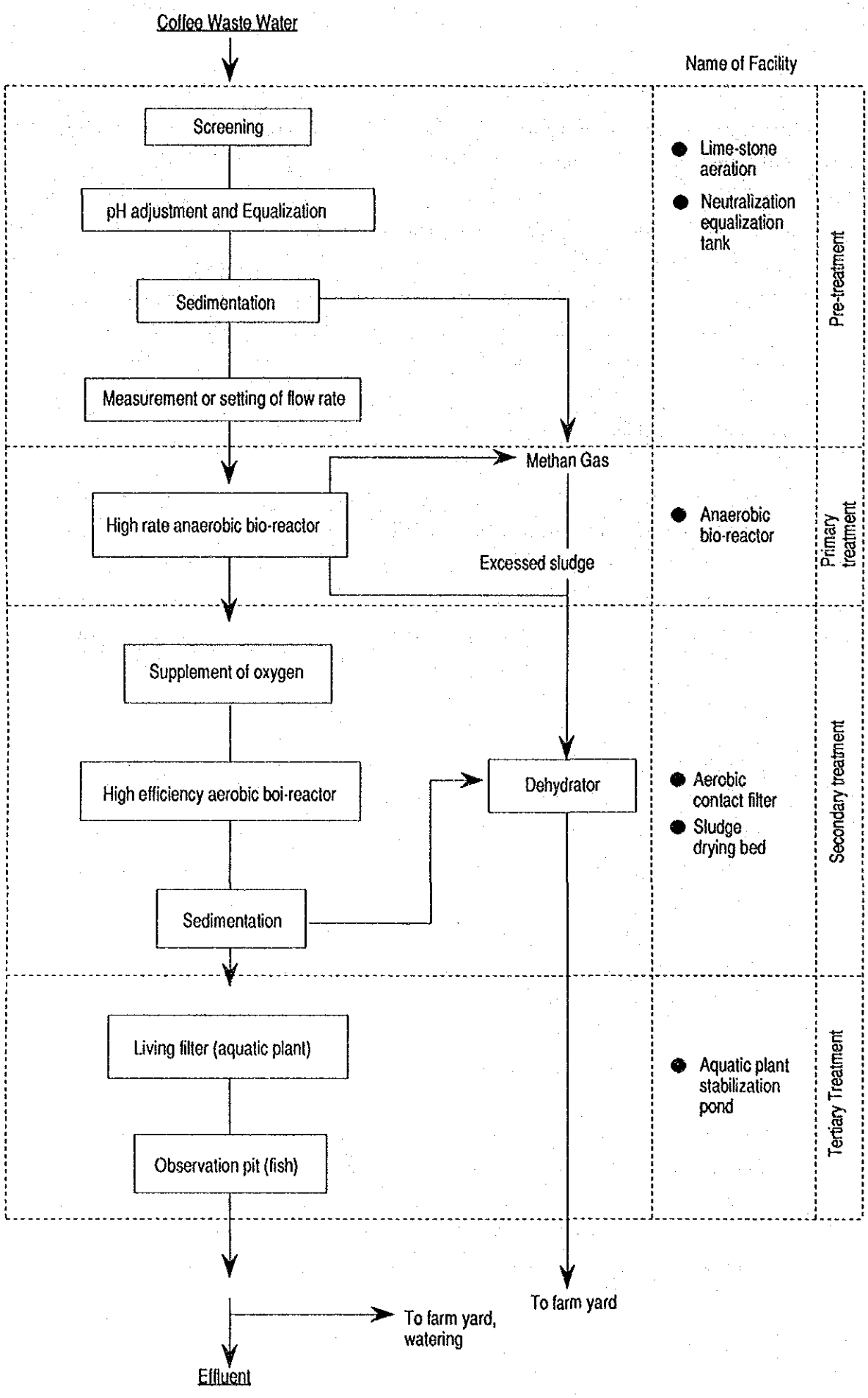

FIG. 6.3.1 FLOW OF COFFEE WASTE WATER TREATMENT

TABLE 6.3.2 ANAEROBIC BIO MASS REACTORS

	Name	Reactor
PFD	Plug flow digester	Sludge bed
CMD	Completely mixed digester	Suspended
ACD	Anaerobic contact digester	Suspended
DAFD	Down flow anaerobic film digester	Bio-film
UAFD	Up flow anaerobic film digester	Bio-film
FBR	Fluidized bed reactor	Bio-film
USBR	Up flow sludge bed reactor	Sludge bed
UASB	Up flow anaerobic sludge blanket	Suspended
ARC	Anaerobic rotating contactor	Bio-film
AL	Anaerobic lagoon	Lagoon
MCB	Micro carrier bed	Sludge bed
AACF	Agglomerated anaerobic sludge and Bio film	Suspended + Bio film

Characteristics of the above methods are summarized as follows:

1) PFD, CMD and ACD are included in grope of HRT and those initial costs are high.

2) DAFD, UAFD, ARC & FBR are a group of anaerobic bio film type and they are not suitable for the water with high organic substance content and suspended solid.

3) ARC has a weak point on rotating parts and it's module.

4) AL is an excellent in land space for the system.

5) USBR is strong against loading shock but its operation is rather difficult.

6) MCB & UASB require a long time self-immobilization period. In addition, it is difficult to obtain the self-immobilized anaerobic sludge in Colombia.

7) AACF has agglomerated anaerobic sludge zone and anaerobic bio film, not requiring seed sludge, and is excellent in handling. And, the amount of washed out sludge by gas generation is small.

AACF shall be adopted as an suitable type of anaerobic biomass reactor for Cristales coffee farms for the treatment of equalized and neutralized coffee waste water.

Characteristics of AACF method are mentioned as below;

a) High speed waste water treatment by anaerobic bacteria

What enables high speed treatment such as UASB, etc. which can be said as prototypes of the high speed anaerobic treatment method, is established by formation of bacteria with high concentration per unit volume and by formation of granulated and agglomerated sludge which is not easily washed out. The main problems of this method are as follows.

i) Strict operation control is required for sludge granulation.

ii) It takes a long time(3-6months) for acclimatization of being granulated.

iii) It is difficult to obtain large amount of ready made granulated sludges at present.

Such being the condition, an agglomeration by organic polymers is applied to anaerobic lagoon sludges of urban sewage, which provides the following merits.

i) Agglomerated anaerobic bacteria group can be made in a short time.

ii) Anaerobic bacteria group with high sedimentation velocity can be obtained.

b) General characteristic of digested sewerage sludge

The digested sludge has generally low organic substances in comparing with fresh sewage sludge. The characteristics of sewage digested sludge are shown below:

pH	7.0 - 8.5
Electric conductivity	100 - 120 ms/cm
Suspended solid	1.5 - 4.5%
VSS/SS	35 - 75%
Cellulose	7% or less

c) Agglomeration of digested sludge

Anaerobic bacteria, the main component of digested sludge, is chairing (-) ordinary, therefore, cationic organic polymers are adopted for agglomeration.
Cationic polymers

i) neutralize (-) charge of sludge particles, and

ii) agglomerate with the digested sludge by absorption and by bridging simultaneously then form fine primary agglomerates with low non-reacted rate.

For such sludges, low-medium cationic property is suitable and copolymer of vinyl polymeric polyalkyl (meta acrylate and polyacrylamide with a molecular weigh of around $600x10^3$ is used.

(3) Aerobic biomass treatment

Aerobic biomass reactor is divided roughly into 2(two) types. One is the aerobic bio film type and the other is suspending activated sludge type. The characteristics of each type are as follows:

a) In aerobic bio film type, fixation is done after organisms generating on carriers.

b) In activated sludge type, organisms are suspended in reactors to be contacted with polluted water.

The both types requires aerobic condition. After a comparative studies of these two types, aerobic bio film type was found to be superior to suspending activated sludge type (see Annex J).

The advantages and the disadvantages of the aerobic bio film type are as follows.

Advantages

a) Unnecessary of returning sludge
b) Unnecessary of MLSS control
c) Few excess sludge generation
d) To have durability to loading shock
e) Low running cost
f) Easy restarting after operation stop

Disadvantages

a) High initial cost than suspending type
b) Necessary of back washing for immobilized organisms

As mentioned above, the easiness in operation is considered a great merit for coffee farmers although it is accompanied with

some demerits. Representative varieties of reactors adopting biomass film are as follows.

1. Trickling filter(prototype of biomass film):

   Standard trickling filter, high rate trickling filter, etc.

2. Dipping biomass contact filter:

   Upper-flow outer aeration, Down-flow outer aeration,
   Up-flow inner aeration, Down-flow inner aeration

3. Fluidized bed:

   Up-flow outer aeration

4. Aerobic disc rotating device

The result of comparison among the above reactor are as follows,

A) Trickling filter is not suitable for farmers because trickling mechanism becomes driving part, trickling can't be stopped and because it breeds files, etc.

B) In dipping biomass contact filter method, carrier is packed in the pit (or tank) and aerated, and this reactor is comparatively compact. The item to be controlled is daily DO control in the reactor only.

C) Fluidized bed is under exploitation at present, and its equipment cost is higher than that of two reactors mentioned above.

D) In aerobic disc rotating system, treatment is carried out by moderate rotation of a drum packed with many disc-shaped or

modules with high efficiency without special air supply, however, troubles such as breakage of rotating axis and falling off of modules are heavy maintenance burden for farmers.

As a whole, dipping biomass contact filter method is considered the most appropriate method.

(4) Aquatic plant stabilization pond

As aquatic plant water hyacinth is applied to stabilization pond. It is well known that water hyacinth consumes dissolved phosphate and nitrogen as resource of nourishment and can reduce organic matters expressed COD and BOD too.

To accomplish of our water quality target, the stabilization pond which has normally 14 days retention time is introduced as tertiary treatment.

The merit of application of water hyacinth are as follows.

a) The water temperature being kept 15 C or higher throughout a year at an altitude of 1500m or below, the water hyacinth will not die because of low temperature.

b) The water hyacinth (Buchon de agua) is indigenous in the studied area, which is said to be its native habitat.

c) COD and BOD value were apparently reduced in the batch test for coffee waste water.

d) Decrease of BOD, N and P can be measured and good effect by aquatic symbiotic small animals for waste water treatment is also expected at the same time.

e) Protection of growth of Chlorophyta and decrease of water evaporation by their leaves cutting sun light are also expected.

f) Water hyacinth in excess can be utilized as feed and as fertilizer.

(5) Auxiliary facilities

A sludge drying bed for excess sludge, a rain water storage tank as water resource and an air blower aerobic treatment are required.

(6) Laboratory scale examination

In order to decide waste water treatment system described above, labo-scale examination was carried out in CRQ laboratory for 8 months.

The summary of the examination results are mentioned below:

a) Neutralization

The pH value of the coffee waste water flowing down through the limestone layer with air bubbling from lower part increased more than pH6. Limestone bed was considered to be cleaned and washed by water.

b) Anaerobic bio mass reactor

The maximum CODcr removal ratio of 92% was achieved when anaerobic sludge was agglomerated beforehand and the up flow treatment by a pump with fixed rate was carried out for the waste water neutralized by limestone bed, and the CODcr removal ratios became high when the CODcr values of waste water were high, Plenty of anaerobic gas (methane gas) was

generated in the reactor and the reactor is durable enough against varying load. It is considered that a successful of anaerobic treatment will be expected if appropriate engineering is performed.

c) Aerobic bio film reactor

The maximum CODcr removal ratio of 72% was achieved after the aerobic treatment by the dipping biomass contact filter column with down flow. This method is considered effective when an appropriate scale is taken into consideration for an application to a practical device.

d) Result of treatment by the total system

The quality of water at the effluent of the stabilization pond was as follows.

- The maximum removal ratio of CODcr was 99%.
- The pH of treated water during treatment could cover well the influence of pH against the anaerobic treatment always indicating pH values higher than pH 7.0.
- The result of the laboratory test gave the design criteria for the actual plant eventually.
- Well designed plant seemed to be able to achieve removal ratio of CODcr higher than 90% in an average.

6.4 Selection of the Pilot Area for Coffee Waste Water Treatment

The pilot area for coffee waste water treatment project was selected from 9,400ha of Cristales basin, considering the following conditions.

1. To exist in the same catchment area of a stream
2. To be abundant in coffee farms
3. To include various size of coffee farms
4. To acquire the land for facility easily
5. To be convenience for construction, operation and maintenance
6. To be expected a effect of exhibition

820 ha of Cristales Alto, upstream basin of the Cristales river, and 1,020 ha of Chispero river basin were considered to have high possibility for the pilot areas(Annex J), and after further Comparative detailed study on the basins, the Chispero river basin was selected for the pilot area (see Fig.6.4.1). The process of the selection is described in Annex J, and the outlines of the said two areas are summarized in Table 6.4.1.

TABLE 6.4.1 COMPARISON OF THE PROPOSED PILOT AREAS

	Cristales Alto	Chispero
General Condition		
Distance from Armenia:	1 ~ 12 km	8 ~ 16 km
Required time from Arme.:	5 ~ 15 min	15 ~ 20 min
Altitude:	1,200 ~ 1,400 m	1,200 ~ 1,280 m
Topography:	Sharply undulated gorge	Gently undulated gorge
Farming scale	number:	number:
> 100 ha	-	1
50 ~ 100 ha	1	3
30 ~ 50 ha	3	5
20 ~ 30 ha	2	8
10 ~ 20 ha	5	8
5 ~ 10 ha	9	8
1 ~ 5 ha	13	15
< 1 ha	-	4
Total	33	52
Area of basin	820 ha(8.7 % of Cristales total)	1,020 ha(10.9 % Cristales total)
Coffee cultivation	574 ha(8.1 % of Cristales coffee)	918 ha(12.9 % Cristales coffee)
Ratio of coffee area	70.0 %	90.0 %
Infrastructural conditions		
Roads:	Connected to the national road. Inner roads are narrow and steep, only small jeep is possible to drive.	Connected to the national road. Inner roads are not paved. Truck is possible to drive.
Location of farms:	Located along the mountain streams.	Mainly located along the roads.
Power and water supply:	At good conditions.	At good conditions.
Mountain stream	Water flow is constantly rich, upstream width is about 1 m.	Water flow is constantly rich, width is narrower than 1 m.
Other contaminating factors except coffee waste water	Castella, which is part of Armenia city and has a population of 4,400, exists at the upperest area of the basin. Waste water from there flows into the streams. Two big scale leisure facilities, which are crowded with people on holidays, exist at point of 12 km from Armenia to La Tebaida.	There are no big scale villages and facilities. Numbers of farms are fluctuating seasonally.

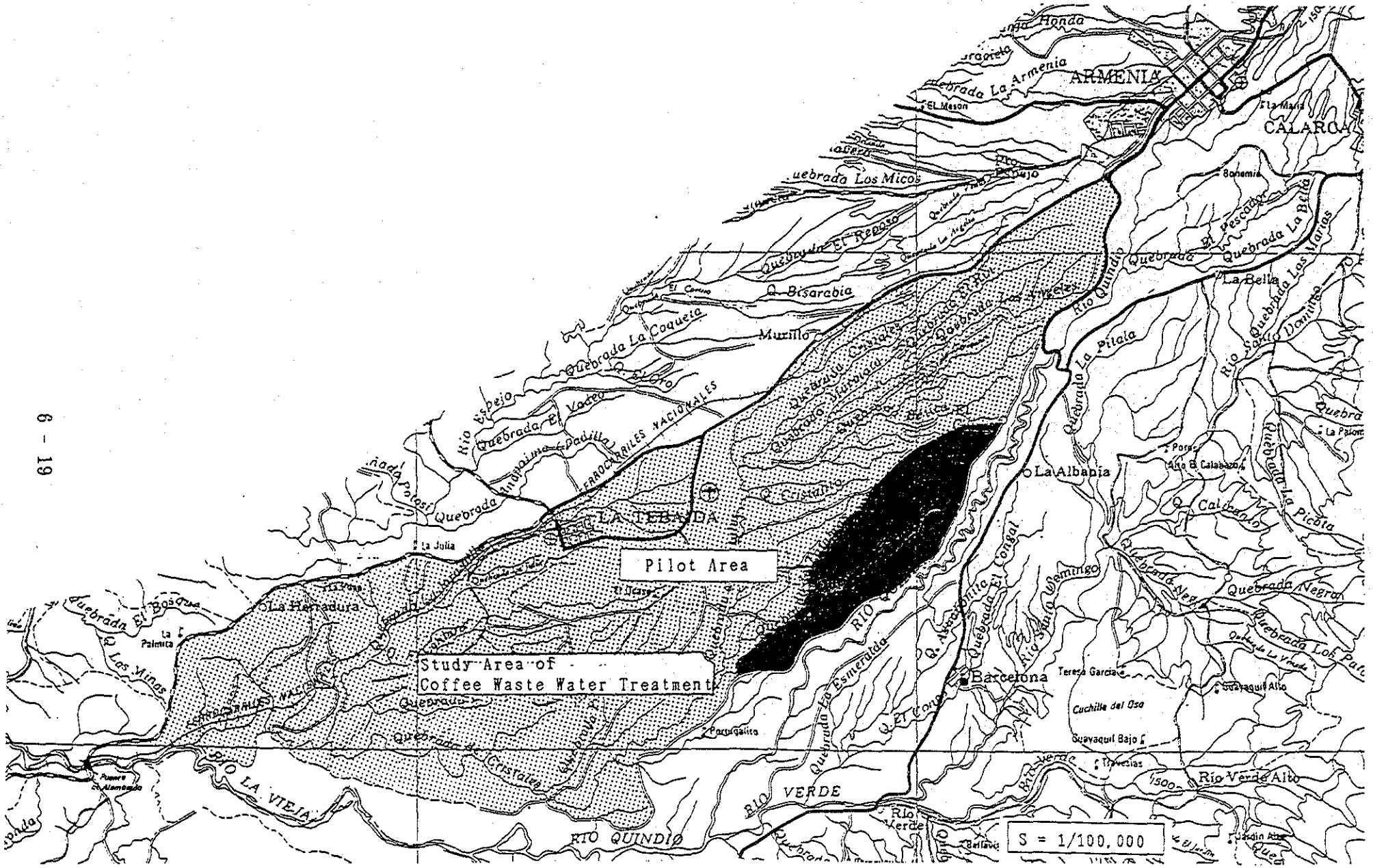

FIG 6.4.1 LOCATION MAP OF PILOT AREA

6.5 Waste Water Treatment Plan in Pilot Area

6.5.1 Basic Strategy

A plan of the coffee waste water treatment for the whole pilot area (the Chispero area) of 1,020ha shall be established. For a method, a combination of the anaerobic treatment, the aerobic treatment and the stabilization pond determined in Section 6.3 is applied. The determination of the facility whether an individual treatment or a centralized treatment is done after comparative studies.

6.5.2 Conditions for Design

Project area	: 1,020ha (including coffee cultivation area of 918ha)
Number of farms	: 52
Discharged river	: Chispero
Treatment method for waste water	: A combination of the anaerobic, the aerobic treatments and the stabilization pond.
Designed discharge of coffee waste water	: 22.5 l/kg (dried coffee beans)
Quality of waste water before treatment	: Shown in Table 6.5.1
Quality of waste water after treatment	: Shown in Table 6.5.2

6.5.3 Selection of Waste Water Treatment System

The following type of coffee waste water treatment systems can be considered.

(1) Individual treatment - the facilities are installed at respective farm

(2) Centralized treatment - waste water is collected and treated at treatment center

The following type of centralized treatment can be considered.

a) Coffee cherry is processed and waste water is treated at centralized treatment facility

b) Coffee waste water is collected by pipeline net work and is treated at centralized treatment facility

c) Coffee waste water is collected by vacuum car and is treated at centralized treatment facility

d) Combination of a), b), d) methods

The comparison of the above methods are shown in Table 6.5.4.

Consequently, the following conclusions is obtained, considering the conditions mentioned above.

a) In the case of individual treatment, it is necessary to observe and control the operation by official institution because there is possibility of irregular effluent water quality from respective coffee farm. However, self-consciousness for the environmental conservation of farmer can be expected through the operation and farmers will be interested in the other waste for environment.

b) It is an ideal to treat the all process such as coffee cherry processing, coffee waste water treatment and etc. by centralized treatment system. However, it is difficult to apply this system because the consensus of coffee farmers' opinion against centralized treatment can not be obtain in present condition.

c) In case of the centralized treatment system using pipeline for collection of the waste water, it is difficult to construct, operate and maintain the pipeline system and further more the construction cost is very high.

d) The centralized treatment system using vacuum car for collection of the waste water is not realistic to apply because the operation of water collecting work is very hard and the construction, operation and maintenance costs are so high.

From the reason mentioned above, the individual treatment system is applied for the pilot area, considering economic condition and earlier project implementation.

For the project implementation, it is necessary to establish the organization for institution of design, construction and operation and for financing the construction fund.

6.5.4 Facility Plan

(1) Size and Disposition of the Plant

Composition of farms in the pilot area is classified by the coffee cultivation scale as below.

Area	Number of farm
100 ha or more	1
50 - 100ha	3
30 - 50ha	5
20 - 30ha	8
10 - 20ha	8
5 - 10ha	8
1 - 5ha	15
1 ha or less	4
Total	52

Coffee waste water treatment plants shall be installed at each farms. The plants are classified into 4 types based on the area of coffee cultivation as shown below.

Type	A -------	5 ha or less
	B -------	5 ha - 10 ha
	C -------	10 ha - 20 ha
	D -------	20 ha or more

The disposition of the coffee waste water treatment facilities in the pilot area is shown in Fig 6.5.1.

(2) Specifications

The basic specifications of each treatment unit of each treatment plant are as follows.

1) Standard of water volume

Design of waste water volume

Max.	30.0 l/kg(dry beans)
Average	22.5 l/kg(dry beans)

Amount of production of coffee beans

Max.	18.3 kg/day/ha of dried beans (in main harvesting season)
Average	15.0 kg/day/ha of dried beans

Amount of discharged waste water

Max.	0.550 m3/ha/day
Average	0.338 m3/ha/day

2) Rain water storage tank

This is a storage tank of rain water to be used for washing precipitations in the neutralization tank, The water of overflow is used for supplying oxygen to the aquatic plant stabilization pond. This is not necessary to be built newly if there is the same facility already made. Operating frequency shall be once a week.

3) Limestone aeration neutralization/equalization tank

Coffee processing waste water is intensively discharged ordinary within 2 or 3 hours of one day process of coffee beans production. The concentration and the flow rate are varying according to time. Usually the temporary primary equalization tank with a capacity for one day is necessary, and after then treatment is carried out by a fixed flow rate, however, considering minimization of the construction cost and simplification of the facility, the facility serves as a equalization and a neutralization tank at the same time.

A screen is installed at the inlet of the neutralization tank. The screen shall be a box type with 10 meshes per square inch. Remnants shall be removed by hand periodically.

Volume of air diffused

Air volume	-----	0.01 Nm3/min(per 1 m3 of tank)
Air pressure	-----	More than 1,000 mm Aq

Neutralized water sedimentation tank

Type	-----	Thickener
Linear velocity	-----	Less than 12 m/day
Retention time	-----	More than 2 hours
Angle of repose of sludge zone	-----	More than 60 degree
Feed well	-----	Cylindrical outlet with baffle plate, 1 set

4) Anaerobic Bio Reactor (SNYMIF)

SNYMIF anaerobic reactor is different from the conventional 30 days thermospheric digestion method in its high speed treatment of 0.3 to 3 days.

As to the present method, pre-agglomerated sludge is charged into the reactor for the preparation of heavy sludge zone. Then anaerobic contact filter with crushed mineral carbon is installed above the sludge zone. These make polishing for waste water and stopping sludge carry over by gas generation possible. By these procedures treated water with expected quality is obtained in an early stage after starting running the facility and appropriate treatment of waste water influenced during harvesting period can be controlled.

Type	Up flow agglomerated anaerobic sludge zone, SGS, function anaerobic contact filter reinforced concrete made, rectangular type AACF named "SNYMIF"
CODcr load of reactor	5 kg-CODcr/m3 or less
Agglomerated sludge	
Standard density of sludge	40,000 mg/l
Hydraulic retention time	60 hours or more
SGS mechanism	
Packing media	Coke(Product in Colombia)
Size	10 mm dia.(50%) and 40 mm dia.(50%)
Height of packing	750 mm

5) Forced draft oxygen supplement tower

Type	Forced draft aeration tower type
Number of tower	1

Linear velocity	5 m/hour or less
Packing media	Coke (product in Colombia)
Size	30mm dia
Height of packing	600mm
Air blower	
Air volume	80 Nm3/min(per 1 m3 of tank)
Air pressure	100 mmAq or more

6) Aerobic contact filter

Coke obtained in the region is used as filter media. In the porous part, aerobic organic matter decomposing bacteria are maintained. As to this filter returning sludge is not required, therefore, returning pump facility is not necessary. Since activated sludge is maintained onto the filter, high loading becomes available compared with suspending activated sludge method, and the same tie volume of excessive activated sludge becomes small.

Possibility of bulking is small also. Main operation is air controlling, thus, operation is comparatively easy. The facility is high efficiency and can be used as anaerobic filter during off season and when the load is low.

Type	Aerobic contact filter media packing air diffusing method, concrete made type
CODcr load of the reactor	2.5 kg CODcr/Reactor m3 or less
Detention time	24 hours or more
Aeration	
Air volume	0.07 Nm3/min(per 1 m3 of tank)
Air pressure	1,000 mm or more
Packing media	Coke (Product in Colombia)
Size	10 x 10 mm

7) Aerobic treated water sedimentation pit

Type	Thickener
Linear velocity	Less than 30 m/day
Detention time	More than 1 hour
Angle of repose of sludge zone	More than 60 degree
Excessive sludge storage pit	1 set

8) Sludge drying bed

As to drying sludge, solar drying method is applied, therefore, no power and no chemicals are required. Coffee harvest season is comparatively rainy season, so, drying bed with roof is applied.

Type	Brick made, mortar finishing, rectangular type, with roof, winds drying
Capacity	
Water content of sludge	99%
Water content of dry cake	85% or less for 1 tank, 1 week drying

Packing media

Name of packing media	Size	Packing Height
Gravel	10-20 mm dia.	250 mm
Coarse sand	3-5 mm dia.	250 mm
Sand	0.8-1 mm dia.	250 mm

9) Aquatic plant stabilization pond

Retention time	: 15 days
Depth	: Less than 1,000 mm

TABLE 6.5.1 QUALITY OF COFFEE WASTE WATER

Item	Maximum	Average
Temperature	Normal	Normal (18～28 ° C)
Appearance	Turbid Yellowish brown	Turbid yellowish brown
pH	3.5	4.0
Suspended Solid(SS)	3,000mg/l	2,000mg/l
CODcr	15,000mg/l	10,000mg/l
BOD5	10,000mg/l	6,700mg/l

TABLE 6.5.2 QUALITY OF TREATED WATER

Item	Standard of Colombia	Target Value
Appearance		Turbid light yellow
pH	5 ～ 9	5.8 ～ 8.6
SS	400 mg/l (80% removal)	30 mg/l (98.5% removal)
CODcr	2,000 mg/l (80% removal)	300 mg/l (97% removal)
BOD	1,340 mg/l (80% removal)	

TABLE 6.5.3 DESIGN REMOVAL RATIO AND TARGET CODcr AND SS

Treatment / Item	Crude waste water	Pre-treatment	Inicial treatment	Secondary treatment	Tertiary treatment	Removal ratio (%)
pH		5 - 6	5.8 - 8.6	5.8 - 8.6	5.8 - 8.6	
CODcr(mg/l)	10,000	-	2,500	625	312.5	
CODcr removal ratio			75%	75%	50%	96.9%
SS(mg/l)	2,000	-	-	100	30	
SS removal ratio				90%	85%	98.5%
Name of facility and remarks	Average value	Lime stone neutriza-tion, eration, qualizatio	SNYMIF anaerobic reactor	Aerobic reactor	Living filter stabilization pond	Colombia standard BOD, SS 80%

TABLE 6.5.4 COMPARISON OF COFFEE WASTE WATER TREATMENT METHOD

(Unit: Col$ 1,000)

Treatment Method		Individual Treatment	Centrolized Treatment		
			Collection of coffee cherry	Collection of waste water	Collection of waste water
Chracteristics		- The lowest cost	- The most rational	- Stability of waste water quality	- Stability of waste water quality
Problems		- Increase of coffee production cost - Necessity of area for treatment facility by farm - Ununiformity of waste water quality - Necessity of financing for construction	- Increase of coffee production cost - Useless of existing facility - Impossible of realization by farmer's demand	- Increase of coffee production cost - Necessary to solve many technical dificulties clogging of piping system due to the high SS in the waste water - Necessary to custall priming pump system in each farm	- Increase of coffee production cost - Necessary to waste water storage tank for one day - Necessary to widning of access road - Necessary to new facilities
Cost for collection	Construction	-	-	536,200 (US$ 1,016,100)	903,000 (US$ 1,711,100)
	Operation & maintenance	-	-	13,800 (US$ 26,200)	261,000 (US$ 494,600)
Cost for treatment	Construction	661,010 (US$ 1,252,000)	779,600 (US$ 1,477,300)	779,600 (US$ 1,477,300)	779,600 (US$ 1,477,300)
	Operation & maintenance	6,600 (US$ 12,500)	100,200 (US$ 189,900)	100,200 (US$ 189,900)	100,200 (US$ 189,900)
Total	Construction	661,010 (US$ 1,252,000)	779,600 (US$ 1,477,300)	1,315,800 (US$ 2,493,400)	1,682,600 (US$ 3,188,400)
	Operation & maintenance	6,600 (US$ 12,500)	100,200 (US$ 189,900)	114,000 (US$ 216,100)	361,200 (US$ 684,500)

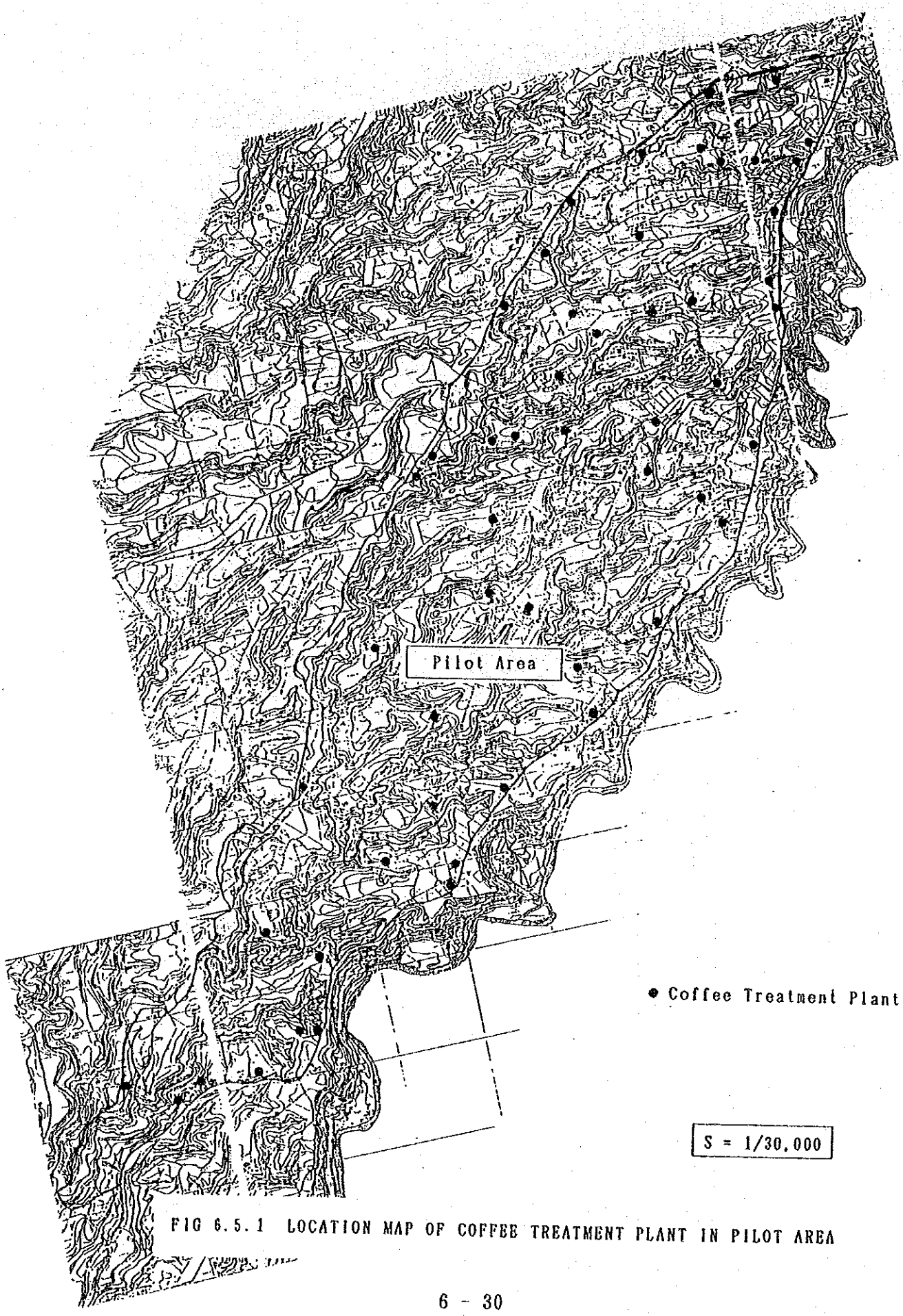

FIG 6.5.1 LOCATION MAP OF COFFEE TREATMENT PLANT IN PILOT AREA

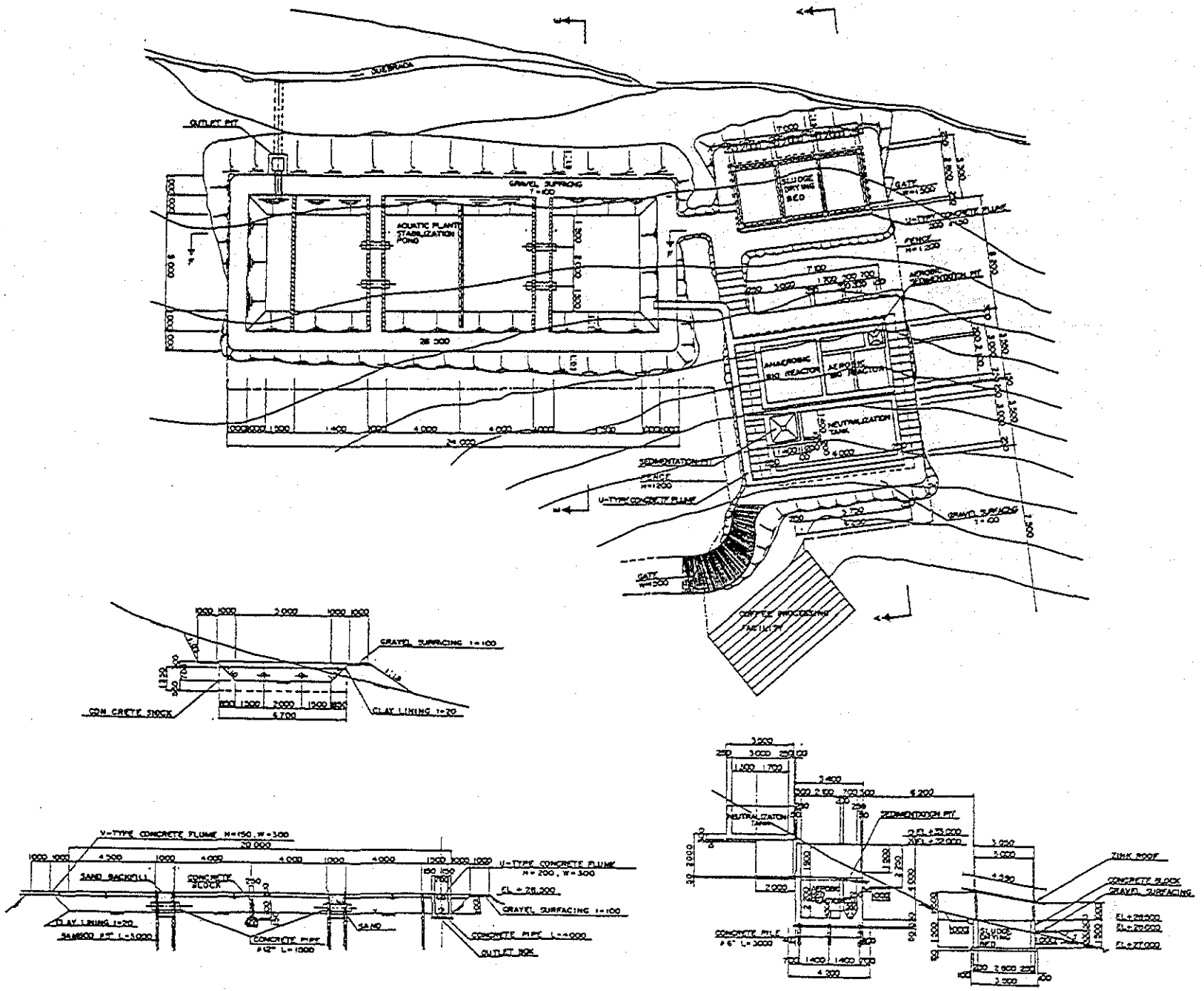

FIG 6.5.2 PLAN OF COFFEE WASTE WATER TREATMENT

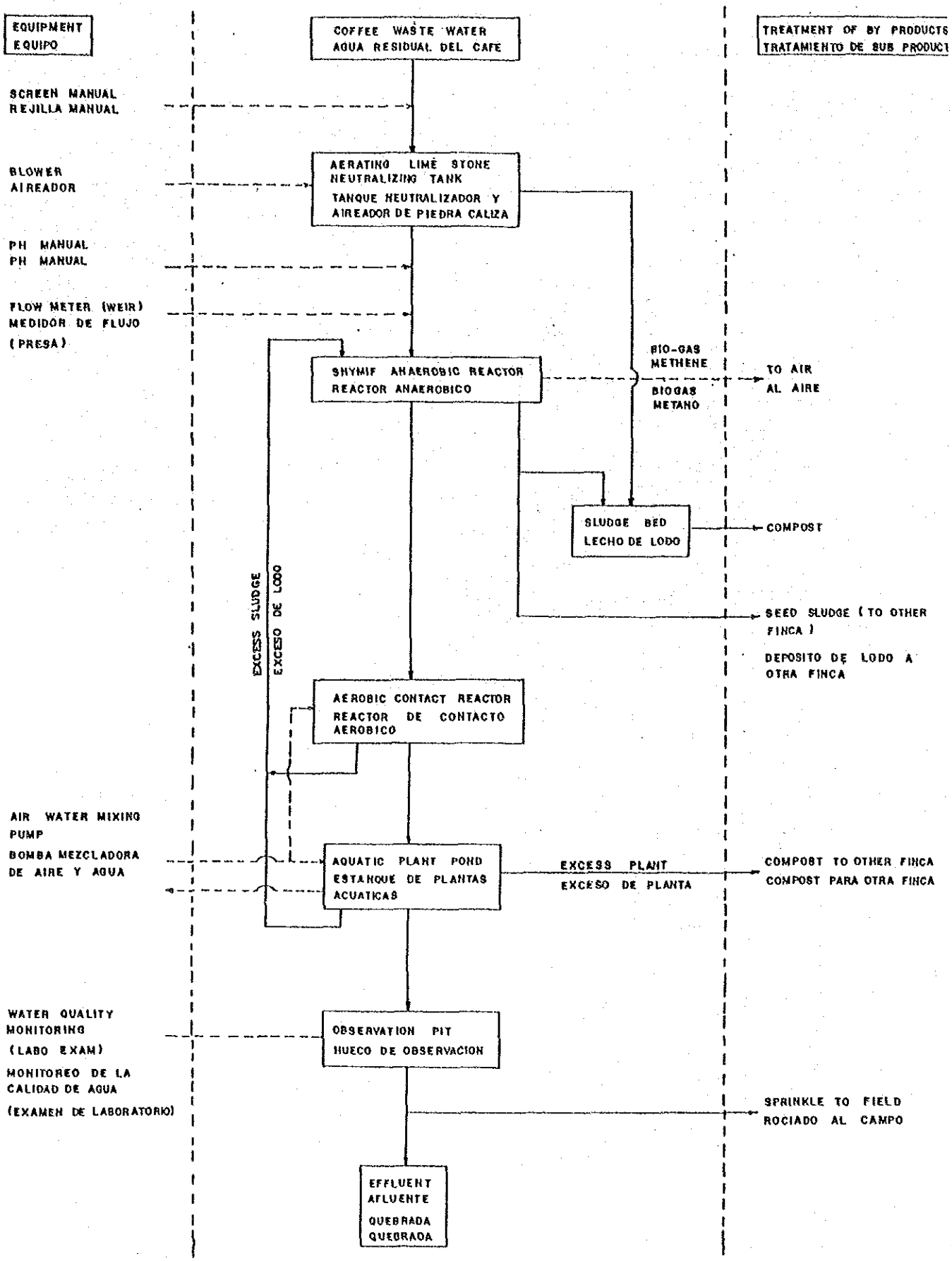

FIG 6.5.3 SCHEMATIC FLOW OF COFFEE WASTE WATER TREATMENT(1)

(5-10ha)

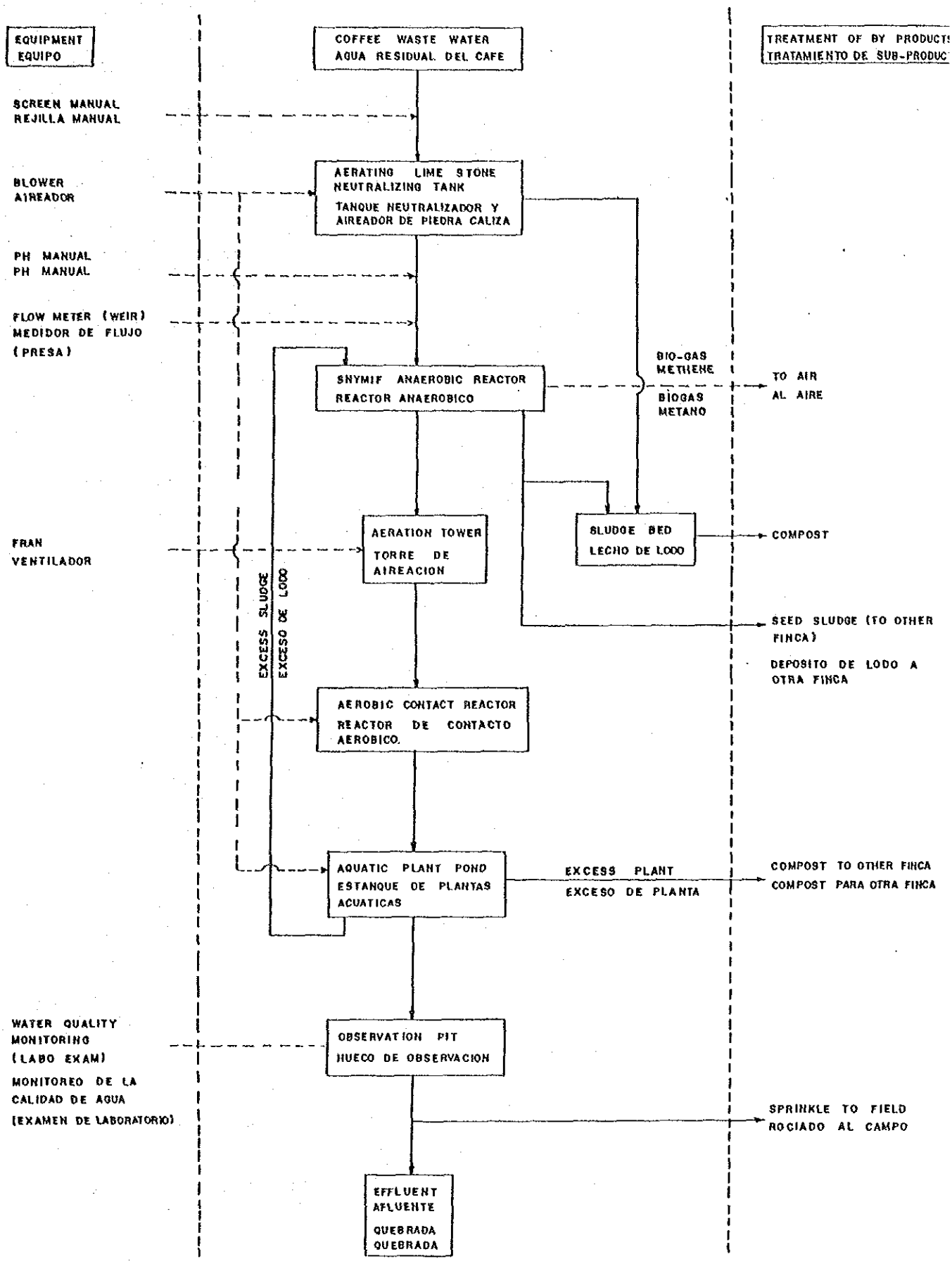

FIG 6.5.3 SCHEMATIC FLOW OF COFFEE WASTE WATER TREATMENT(2)
(20-30ha)

6.6 Construction of Model Plant

6.6.1 General

The effect of the proposed coffee waste water treatment system was confirmed in the laboratory test, however, it is necessary to make further confirmation using experimental model plant before to implement the pilot project. Therefore, two model plants, one for middle scale and another for small scale, were constructed for further experimentation.

The construction of model plants were started in November 1990 and completed February 1991. In the model plants, confirmation of the effect of waste water treatment, confirmation of the point of improvement, instruction of operation and maintenance and instruction of management for a person in charge were carried out.

6.6.2 Selection of Site for Model Plants

It was necessary to request the farmers to offer the land for Model plant and the farmers were expected to understand the significant of coffee waste water treatment (environmental conservation). Therefore, farmers were selected by the collaboration with the CRQ based on the following viewpoints.

(1) Farmers to be selected should offer land for the model plant and well understand meaning of waste water treatment.

(2) Their farms should be located in a same stream basin and be adjacent to each other wherever practicable.

(3) The farms should be located in the pilot project area.

(4) The size of coffee cultivation area should be appropriate for the model plant.

(5) The farmers should be able to operate and maintain the plants.

(6) The farms should be located easy to access for the purpose of exhibit effect.

(7) The farms should be located in the place where waste from other farm give little influence.

Two farms, El Rocio (with 8ha of coffee cultivated area) and Sebastopol (with 25ha), were selected for the construction of model plant and the locations are shown in Fig.6.6.1.

6.6.3 Design of Model Plants

(1) Design Policy

The model plants were designed using the following materials to be obtained in Colombia as far as possible.

1) Lime stone produced in the suburbs of Cali City which is using for soil improvement

2) For the contact filter media porous mineral carbon produced in/around the Quindio which is using for for solid fuel

3) Bamboo growing naturally in Quindio for applying to fence

4) Rainfall water for miscellaneous purpose

5) Water hyacinth (Buchong de Aqua) growing naturally considered an original plant of South America

Lime stone, coke and bamboo can be obtained easy in Colombia and are very cheap, then, it is expected to reduce the initial cost of plant. Furthermore, by the construction of model plant, economically and technically appropriate treatment method will be studied,new technological developments will be promoted and engineers concerned will be educated.

(2) Design Criteria

The effluent discharge, the target value and other factors which were mentioned in section 6.2 was applied for design.

(3) Facility Plan

The plan of the model plants are shown in Fig.6.6.2. Using the existing steep slope, the model plants were designed with a consideration of reduction of construction cost as much as possible.

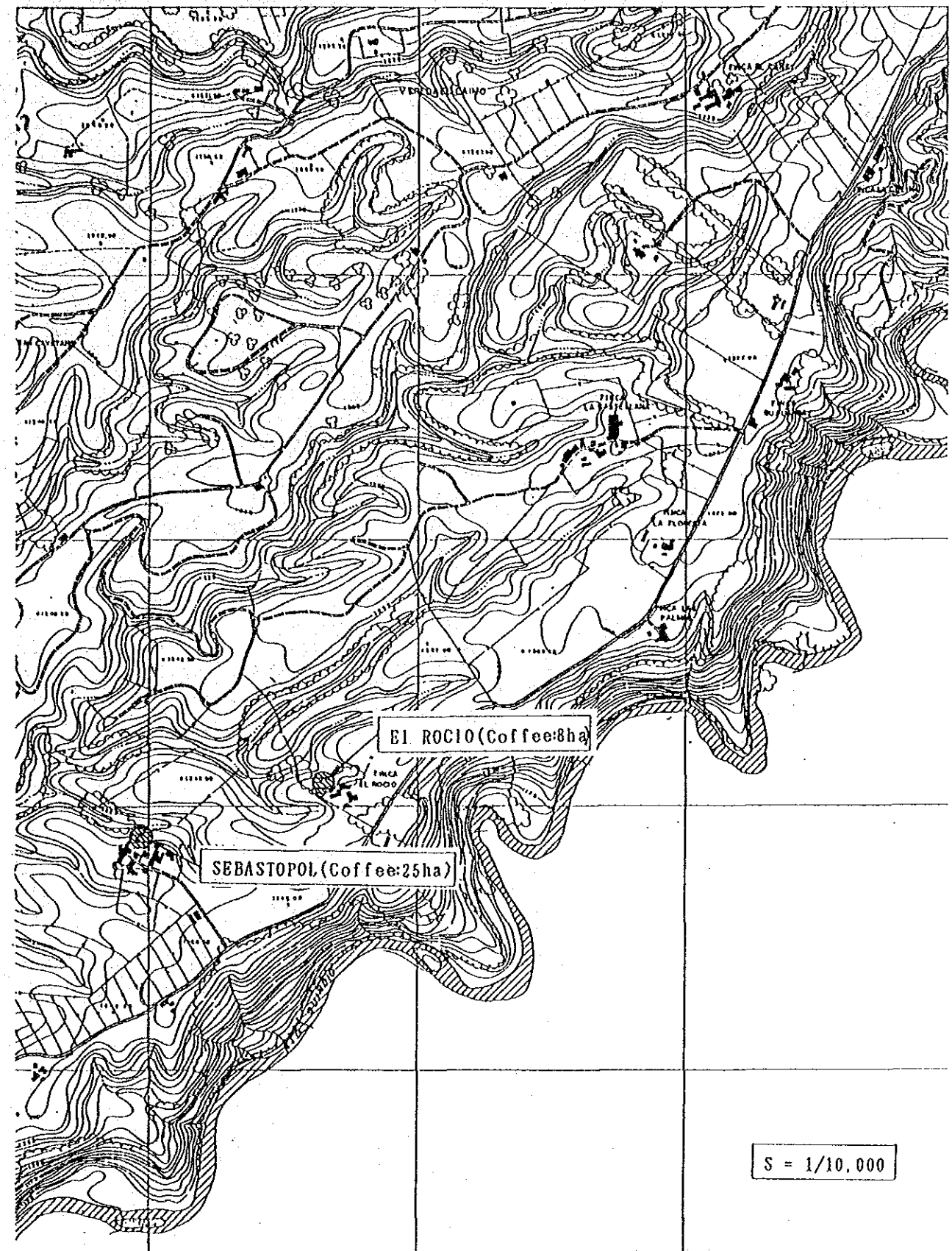

FIG 6.6.1 LOCATION MAP OF MODEL PLANT

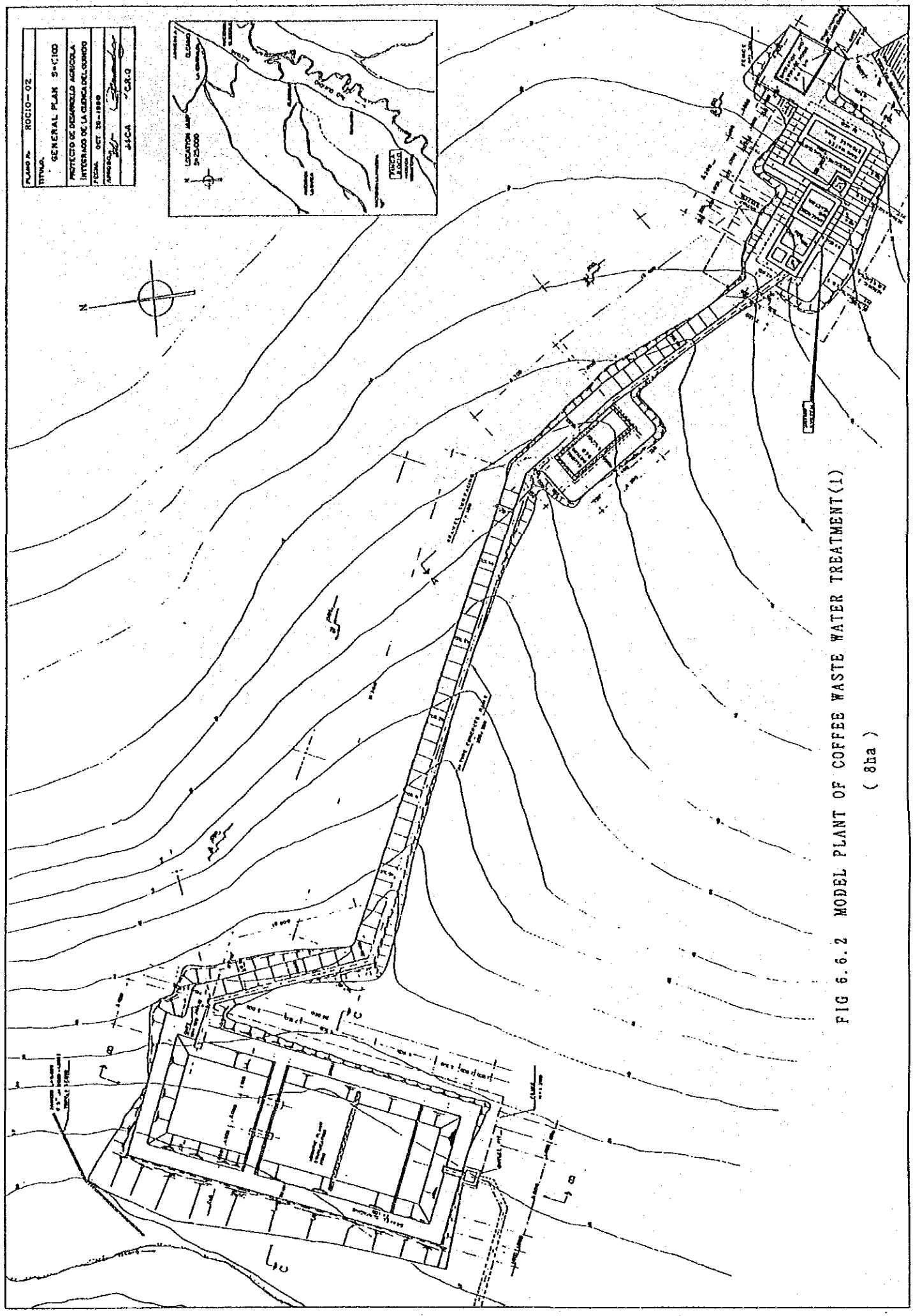

FIG 6.6.2 MODEL PLANT OF COFFEE WASTE WATER TREATMENT(1)
(8ha)

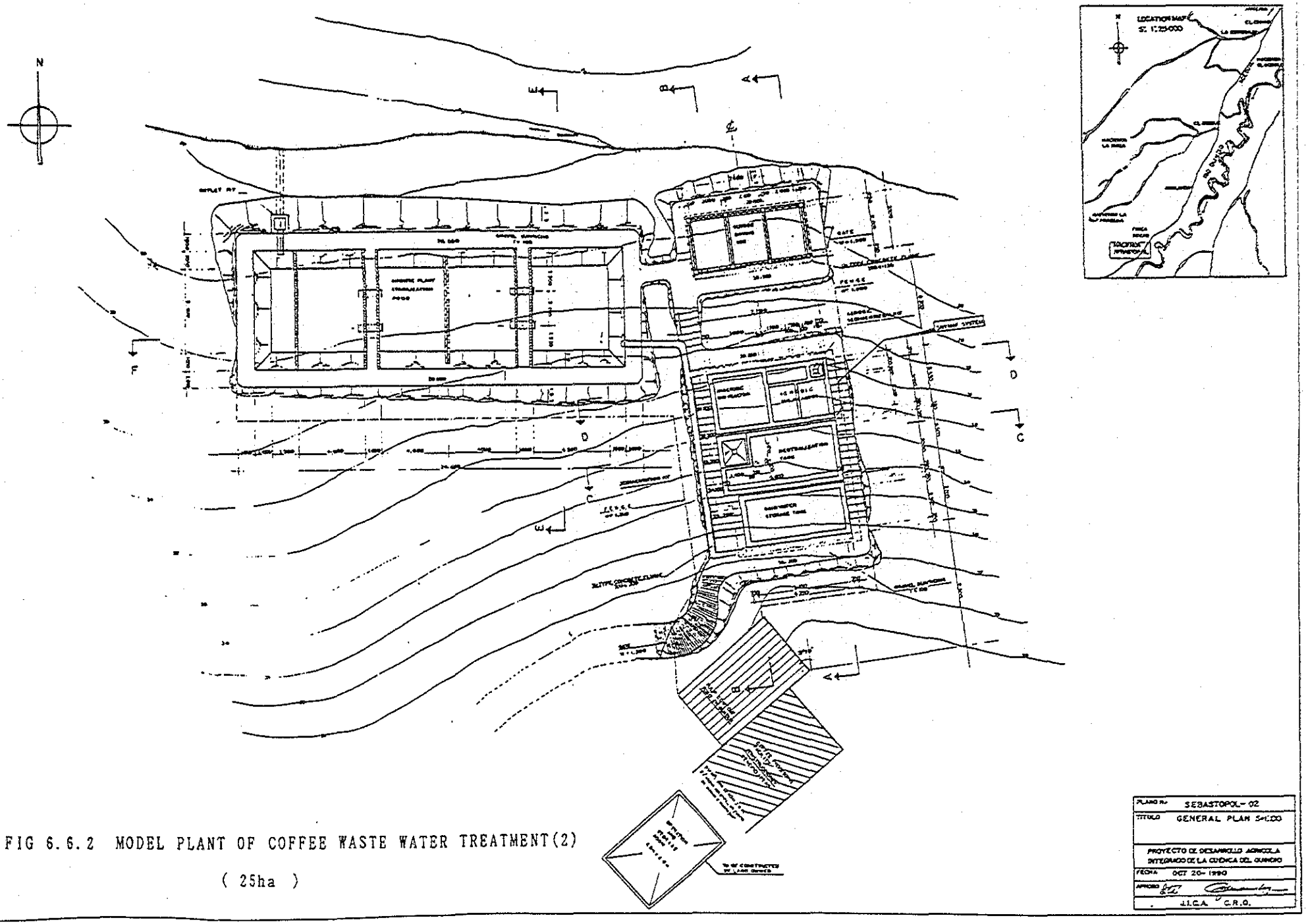

FIG 6.6.2 MODEL PLANT OF COFFEE WASTE WATER TREATMENT(2)

(25ha)

6.7 Recommendation

1. The awareness and enlightenment of importance of water quality conservation.

   The enlightenment activity should be promoted for peoples' well understanding the following matter.

   a) Quindio has the responsibility of water quality conservation such as one of the departments of water resources in Colombia.

   b) Nobody has a right to use the river as the place of abandonment and as the conveyer to remove for agro-industry waste.

   c) The conservation of the river contributes for the healthy human life and the national profits in Colombia.

   d) To destroy of original ecological system of the river and the formation of unsuitable water environment for human life, domestic water supply and agricultural water use means the grovel destruction of natural resources.

2. Establishment of leading organization

   a) A leading organization which is consist of the non-governmental and governmental people who understand the meaning of water quality conservation exactly should be established.

   b) The activity should be operated effectively not only in Quindio with grovel view and it is necessary to request the officers concerned about budget of operation.

   c) The following corporations should be carried out.

b) To promote the construction of centralized coffee processing factory with coffee waste water treatment facility.

c) To give the obligation for installation of coffee waste water treatment facilities the farms which do not want to entrust their cherry preparation.

In case of the Cristales basin,

1) By execution of coffee waste water treatment against to total 55 of large size farms (4,100ha of total coffee cultivated area), about 60% of the contaminant load will be reduced.

2) By execution of coffee waste water treatment against to total 385 of large and medium size farms (6,100ha of total coffee cultivated area), about 90% of the contaminant load will be reduced.

3) Therefore, the obligation of installation of coffee waste water treatment should be given to the large and middle scale farms as soon as possible.

d) To give the obligation for the installation of coffee waste water treatment facilities to the existing centralized coffee factories with a top priority.

e) To prohibit of weather pulp at coffee farms situating near the river.

f) Except an indispensable water for fermented beans washing, an investigation on reduction of water consumption should be done immediately.

g) Low contaminated water used for quality classification should not reuse and discharge to out of factory.

1) To carry out the activity of enlightenment against coffee industries and coffee farmers from the instructive view.

2) To take part the role of pipeline between farms and government.

3) To establish the automatic water quality observation system, to analyze the condition of water contamination through the year and to make a comment on the result.

4) To research and develop of water quality improvement.

5) To collect the waste pulp and To promote the research and development of effective use of waste pulp.

6) To make a plan, design and technical instruction waste water treatment.

7) To educate the practical engineer

8) To make amity with other relative organizations in other department and foreign countries.

3. Establishment and enforcement of the appropriate water quality control regulations.

The water quality regulations suitable for the Quindio basin and effluent water regulation appropriate to Quindio should be established and enforced as soon as possible.

4. Improvement of specific contaminants source

a) To cut the specific contaminants source like of coffee waste water.

5. The scheme of the water quality conservation

a) A scheme of the water quality conservation and the improvement for source of contaminants such as coffee waste water, and sewerage should be drought and executed immediately.

b) The following items will be included in the scheme.

1) Establishment of the vision of whole Quindio on water quality conservation

2) Understanding the actual situation of farms

3) Planing of annual scheme for waste water treatment on specific contaminant source

4) Establishment of water quality automatic observation systems

5) To ensure of manpower

6) Establishment of money funds

7) Execution of an activity enlightenment

CHAPTER 7 : PROJECT IMPLEMENTATION PLAN

CHAPTER 7 PROJECT IMPLEMENTATION PLAN

7.1 Project Implementation Plan

7.1.1 Project Implementation Organization

It is proposed that Regional Autonomous Corporation of Quindio (CRQ) shall be the organization for implementation of the Project, and detailed design of the facilities and management of execution of construction works shall be performed by a consultant firm to be employed by CRQ. Construction works shall be of contract basis and the contractor shall be selected through competitive bidding. Management shall be made by a project office to be established in CRQ.

The organization related to implementation of the Project is as shown in Fig. 7.1.1.

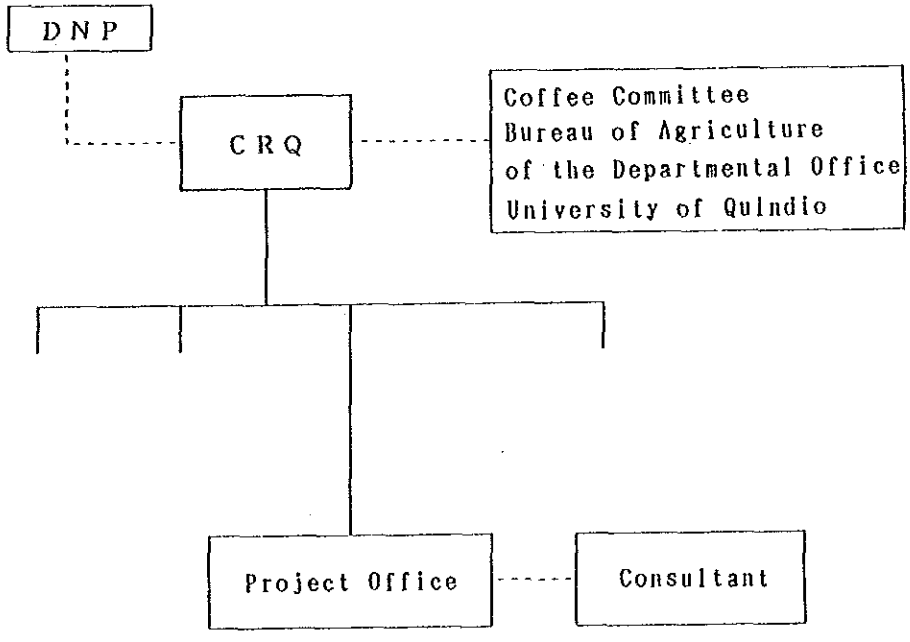

FIG 7.1.1 PROJECT IMPLEMENTATION ORGANIZATION

7.1.2 Project Implementation Method

(1) Project funds

The project costs are classified into local currency and foreign currency. Financial planning is made based on the assumption that the local currency portion is prepared by the Goverment of Colombia and the foreign currency portion is funded as loans by foreign funding organizations.

(2) Contractor

The required construction works shall be made with contract basis, and the contractor shall be determined through competitive bidding.

(3) Project management office

The project management office shall be organized in CRQ in order to to manage and supervise the construction works in coordination with the consultant during the construction period.

7.1.3 Project Implementation Schedule

The project implementation schedule is planned by giving the priority to the items with which early occurrence of project benefits can be anticipated and items which are socially required of their early completion. The overall schedule is established considering the project cost, budget on the Colombia side and work execution capabilities of the implementation organization.

7.2 Project Cost

The project cost is composed of construction cost, land acquisition cost, procurement of O/M equipment, general administration cost, engineering service cost and physical contingency.

7.2.1 Estimation Method

The project cost is estimated based on the following conditions:

(1) Construction method

The heavy equipment required for the construction works is to be prepared by the contractor, and the its expenses in the estimation of construction cost are summed up as expenses for rent of equipment.

(2) Basic cost

The fundamental costs such as labor cost, materials cost, and machinery cost are determined with the market prices in the Republic of Colombia being taken into account.

(3) Unit prices

The unit prices are constituted by work item, and indirect cost of 30% is added to the direct cost for each work item.

(4) Foreign currency exchange rate

The monthly average exchange rate in September, 1990, that is, US$1.00 = Col$527.73, is used.

(5) Physical contingency

The physical contingency is summed up, as physical reverse

cost, by 15% for construction works and land acquisition cost, and by 5% for procurement cost of O/M equipment, general administration cost, etc.

7.2.2 Project Cost

(1) Construction cost

The construction works are classified into works related to agricultural development (farm road , irrigation facilities, agroindustry) and works related to coffee waste water treatment. The construction cost is estimated as Col$3,011 million (foreign currency portion: Col$1,890 million, local currency portion: Col$1,121 million) for the former, and Col$661 million (foreign currency portion: Col$409 million, local currency portion: Col$252 million) for the latter.

TABLE 7.2.1 SUMMARY OF CONSTRUCTION COST

(Unit:Col$1,000,000)

Item	Cost
Agricultural Development	
Farm Road Improvement(incl.Drainage Canal)	1,712
Irrigation Facilities	1,190
Agro-industry	47
Research Center	62
Sub Total	3,011
Coffee Waste Water Treatment	661
Total	3,672

(2) Land acquisition cost

The land acquisition cost requited for construction of agroindustry facilities is estimated as Col$5 million, and it is entirely born by the local currency.

(3) Procurement cost of O/M equipment

The procurement cost of O/M equipment required for operation and maintenance of farm roads including drainage canals irrigation facilities and coffee waste water treatment facilities is estimated as Col$377 million, and it is entirely born by the foreign currency. The o/m equipment is to be procured by the project management office in the last year of the construction works.

(4) Administration cost

The administration cost required for maintaining the project management office includes office equipment cost, salary for administration staff and miscellaneous cost. The total administration cost is estimated as Col$48 million, and it is entirely born by the local currency.

(5) Engineering service cost

The cost required for hiring a consultant is estimated as Col$1,950 throughout the detailed design period (including topographic surveying) and construction works period.

(6) Physical contingency

The physical contingency cost is estimated as Col$670 million, of which the foreign currency portion is Col$456 million (68%) and the local currency portion is Col$214 million (32%).

(7) Project cost

Table 7.2.2 indicates the summary of the project cost. The total amount is estimated as Col$6,722 million, of which the foreign currency portion is Col$4,967 million (74%) and the local currency portion is Col$1,755 million (26%).

7.2.3 Disbursement Schedule

Expenditure of the project cost shall be made in five year program. The amount of expenditure in each year is as shown in Table 7.2.3. Total project cost considering inflation rate and exchange rate forecasted by DNP is estimated at Col.$ 16,110,530,000(US$ 16,203,000) and the annual disbursement schedule is shown in Table 7.2.4. The foreign currency portion of the project cost shall be financed by loans from an international institution and the local currency portion by Colombian Government.

The disbursement schedule plan of foreign currency funded by international finance organizations is as shown in Table 8.4.1 when calculation is made based on the conditions that annual interest rate is 5%, term is 25 years (grace period: 7 years, repayment:twice a year),and capital repayment is equally divided. The largest annual repayment amount is US$970,000 in the 8th year

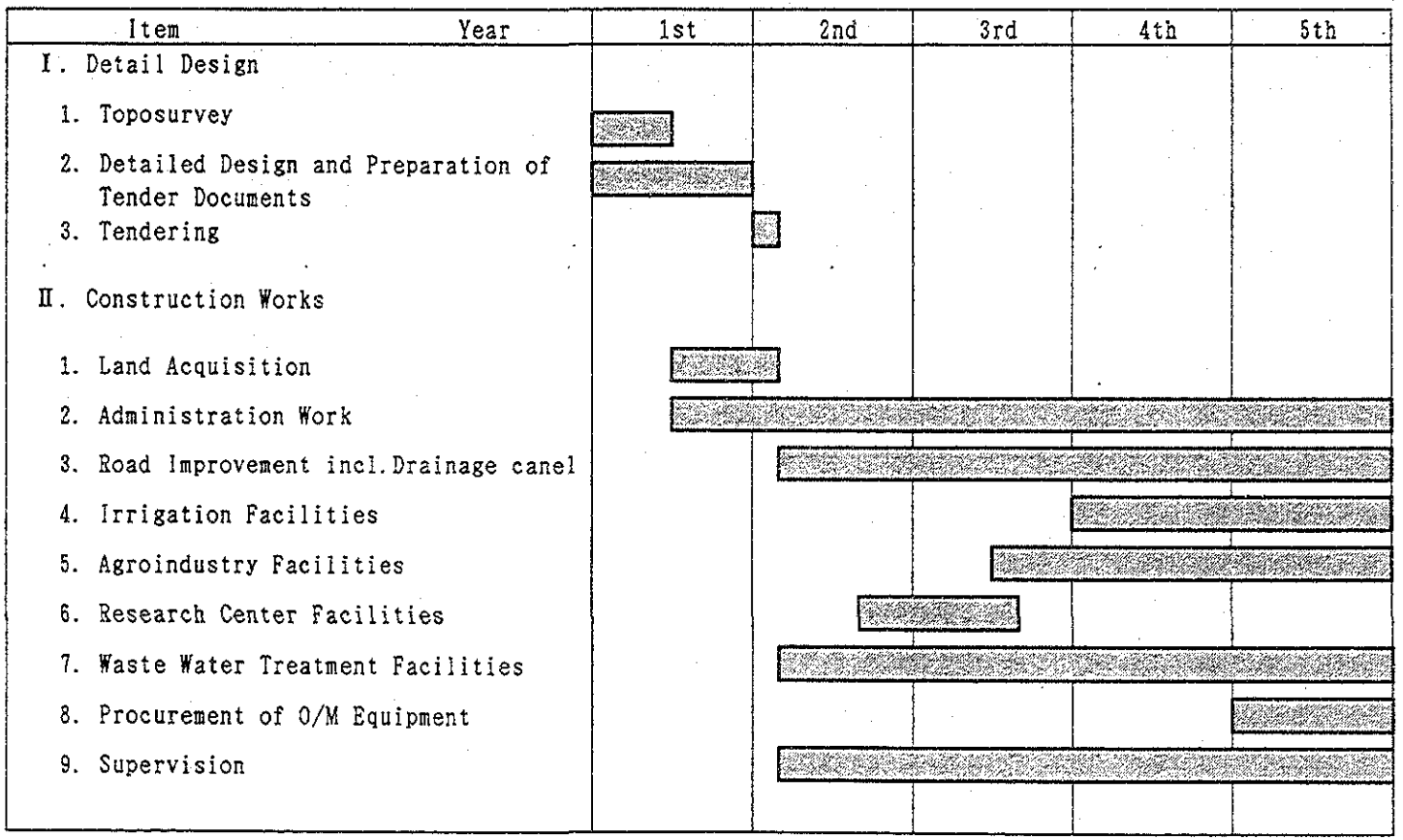

FIG. 7.1.2 PROJECT IMPLEMENTATION SCHEDULE

TABLE 7.2.2 PROJECT COST

[Unit:Col$1,000]

Item	Project Cost		
	Foreign Currency	Local Currency	Total
1. Construction Cost of Agriculture Development			
1) Construction Cost			
- Farm Road(Incl. Drinage Canal)	1,074,010	637,710	1,711,720
- Irrigation Facilities	738,360	452,160	1,190,520
- Agroindustry Facilities	31,440	15,630	47,070
- Research Center	46,500	15,500	62,000
Sub Total	1,890,310	1,121,000	3,011,310
	(3,581)	(2,125)	(5,706)
2. Construction Cost of Coffee Waste Water Treatment Facilities	408,880	252,130	661,010
	(775)	(478)	(1,253)
3. Land Acquisition Cost	0	5,000	5,000
		(9)	(9)
4. General Cost			
1) Procurement Cost of O/M Equipment	377,180	0	377,180
2) Administration Cost	0	47,600	47,600
3) Engineering Services Cost	1,835,420	114,390	1,949,810
Sub Total	2,212,600	161,990	2,374,590
	(4,193)	(307)	(4,500)
5. Physical Contingency	455,490	214,310	669,800
	(863)	(406)	(1,269)
Total	4,967,280	1,754,430	6,721,710
	(9,412)	(3,325)	(12,737)

( ) : US$1,000

TABLE 7.2.3 DISBURSEMENT SCHEDULE OF PROJECT COST

(Col. $1,000)

Despriction	year	1th	2nd	3rd	4th	5th	Total
Detailed Design	F/C	539,120	102,780				641,900
	L/C	33,600	6,400				40,000
	Total	572,720	109,180				681,900
Land Acquisition	F/C						0
	L/C		5,000				5,000
	Total		5,000				5,000
Adainistration Cost	F/C						0
	L/C	7,620	9,520	10,155	10,155	10,150	47,600
	Total	7,620	9,520	10,155	10,155	10,150	47,600
Farm Road (Incl. Drainage Canal)	F/C		214,800	286,400	286,400	286,410	1,074,010
	L/C		127,540	170,060	170,060	170,050	637,710
	Total		342,340	456,460	456,460	456,460	1,711,720
Irrigation Facilities	F/C				443,000	295,360	738,360
	L/C				271,200	180,960	452,160
	Total				714,200	476,320	1,190,520
Agro-Industry	F/C			18,020	13,420		31,440
	L/C			9,270	6,360		15,630
	Total			27,290	19,780		47,070
Research Center	F/C			46,500			46,500
	L/C			15,500			15,500
	Total			62,000			62,000
Coffee Waste Water Treatment Plant	F/C		81,780	109,040	109,030	109,030	408,880
	L/C		50,420	67,240	67,240	67,230	252,130
	Total		132,200	176,280	176,270	176,260	661,010
O/M Equipment	F/C					377,180	377,180
	L/C					0	0
	Total					377,180	377,180
Supervision	F/C		238,710	318,270	318,270	318,270	1,193,520
	L/C		14,880	19,840	19,840	19,830	74,390
	Total		253,590	338,110	338,110	338,100	1,267,910
Sub-Total	F/C	539,120	638,070	778,230	1,170,120	1,386,250	4,511,790
	L/C	41,220	213,760	292,065	544,855	448,220	1,540,120
	Total	580,340	851,830	1,070,295	1,714,975	1,834,470	6,051,910
Physical contingency	F/C	53,420	64,920	78,570	118,630	139,950	455,490
	L/C	5,740	29,750	40,640	75,820	62,360	214,310
	Total	59,160	94,670	119,210	194,450	202,310	669,800
Total	F/C	592,540	702,990	856,800	1,288,750	1,526,200	4,967,280
	L/C	46,960	243,510	332,705	620,675	510,580	1,754,430
	Total	639,500	946,500	1,189,505	1,909,425	2,036,780	6,721,710

TABLE 7.2.4 DISBURSEMENT SCHEDULE INCLUDING PRICE CONTENGENCY

(Unit:Col$1,000)

Item	Year		1 st	2 nd	3 rd	4 th	5 th	Total
Total Cost	F/C		592,540 [1,123]	702,990 [1,332]	856,800 [1,624]	1,288,750 [2,442]	1,526,200 [2,892]	4,967,280 [9,413]
	L/C		46,960 [89]	243,510 [461]	332,705 [630]	620,675 [1,176]	510,580 [968]	1,754,430 [3,324]
	Total		639,500 [1,212]	946,500 [1,794]	1,189,505 [2,254]	1,909,425 [3,618]	2,036,780 [3,860]	6,721,710 [12,737]
Price Escaration ratio (%)*	F/C	4.00	4.00	4.00	4.00	4.00	4.00	
Accumrated ratio		1.04	1.08	1.12	1.17	1.22	1.27	
Price Escaration ratio (%)*	L/C	24.34	24.34	24.34	24.34	24.34	24.34	
Accumrated ratio		1.24	1.54	1.92	2.38	2.96	3.69	
Exchange Rate Value(Col$/US$)		527.73	644.30	766.70	912.40	1,038.00	1,177.60	
Exchange Rate Ratio		1.00	1.22	1.45	1.73	1.97	2.23	
Grand total	F/C		781,887 [1,214]	1,148,849 [1,498]	1,732,951 [1,899]	3,084,047 [2,971]	4,309,207 [3,659]	11,056,941 [11,243]
	L/C		72,404 [112]	466,832 [609]	793,074 [869]	1,839,625 [1,772]	1,881,654 [1,598]	5,053,589 [4,961]
	Total		854,291 [1,327]	1,615,680 [2,106]	2,526,025 [2,769]	4,923,672 [4,743]	6,190,861 [5,257]	16,110,530 [16,203]

Note : [US$1,000], *Based on the data of DNP

TABLE 7.2.5 AMORTIZATION SCHEDULE OF FOREIGN LOAN

Unit: US$ x 1000

Year	Foreign Loan	Outstanding Amount	Interest Payment	Capital Repayment	Total Payment
1	1,214	1,214	36		36
2	1,498	2,712	81		81
3	1,899	4,611	138		138
4	2,971	7,582	227		227
5	3,659	11,241	337		337
6		11,241	337		337
7		11,241	337		337
8		11,241	337	633	970
9		10,608	318	624	942
10		9,984	300	624	924
11		9,360	281	624	905
12		8,736	262	624	886
13		8,112	243	624	867
14		7,484	225	624	849
15		6,864	206	624	830
16		6,240	187	624	811
17		5,616	168	624	792
18		4,992	150	624	774
19		4,368	131	624	755
20		3,744	112	624	736
21		3,120	94	624	718
22		2,496	75	624	699
23		1,872	56	624	680
24		1,248	37	624	661
25		624	19	624	643
Total	11,241	156,551	4,697	11,241	15,938

7.3 Operation and Maintenance Plan

The general operation and maintenance of the facilities shall be made by CRQ, and actual operation and maintenance of individual facilities shall be transferred to the agencies below:

Main farm roads : The current road administrators
Branch farm roads : The farmers' cooperative to be organized by local farmers
Agroindustry facilities: The farmers' cooperative to be organized by local farmers
Irrigation facilities : CRQ
Waste water treatment facilities: Each farmer under the guidance of CRQ.

7.3.1 Operation and Maintenance Organization

It is planned that operation and maintenance of the completed facilities are to be made by CRQ and also by farmers' organizations to be organized in respective areas. Management of the equipment for operation and maintenance is to be made by CRQ. Since farmers are not experienced in the operation and maintenance of coffee waste water treatment facilities, it is necessary that CRQ provides guidance to the farmers by making full use of the knowledge accumulated though the operation of the model plant. Furthermore, it is also necessary that advice from research organization and Coffee Committee can be obtained as required.

The organization for operation and maintenance stated above is proposed as shown in Fig.7.3.1.

7.3.2 Equipment for Operation and Maintenance

The equipment required for operation and maintenance after completion of the works are selected as follows:

TABLE 7.3.1 REQUIRED EQUIPMENT FOR OPERATION AND MAINTENANCE

Equipment	Capacity	Quantity	Purpose
Motorgrader	Blade Width 2.2m	1	Road repair
Backhoe	0.6m3	1	Road repair
Dump truck	10 ton	1	Road repair
Trailer truck	20 ton	1	Transportation of equip
Vehicles(4WD)	2,300 cc	2	

7.3.3 Operation and Maintenance Cost

Operation and maintenance cost is estimated to be Col$88 million per year. The machinery and vehicles shall be replaced when their service life are passed. It is planned that annual operation and maintenance cost is born by beneficial farmers.

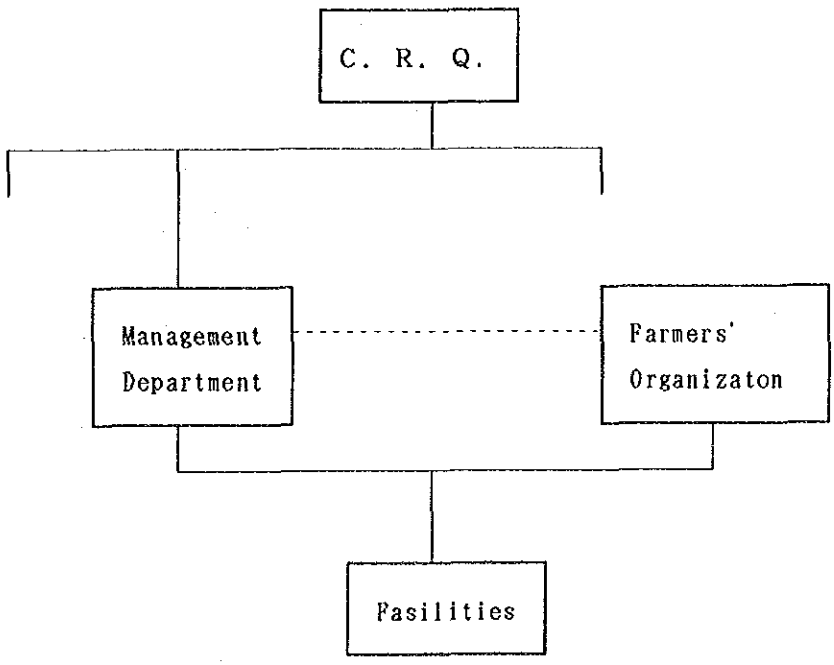

FIG 7.3.1 OPERATION AND MAINTENANCE ORGANIZATION

CHAPTER 8 : PROJECT EVALUATION

CHAPTER 8 PROJECT EVALUATION

8.1 Criteria for Evaluation

The Quindio Basin Integrated Agricultural Development Project is composed of two projects, i.e., Agricultural Development Project and Coffee Waste Water Treatment Project. The feasibility of the former project is evaluated by means of economic analysis on the benefit and cost of the project. Regarding the latter, on the other hand, since the benefit (improvement of quality of river water) obtained as a result of implementation of the project is hardly to measure, on the economic basis, analysis on benefit and cost can not be made, the effect to natural conditions and social impact are used as the criteria for its evaluation.

The economic analysis of the Agricultural Development Project is made by making use of internal rate of return (IRR), net present value (NPV) and benefit/cost ratio (B/C), with the difference between the benefit and cost that will arise "with" project and they would be "without" project. Furthermore, in consideration of the change of situations in the stage of implementation of the project, based on some assumed situations, sensitivity analysis is made in order to forecast how the values of IRR vary according to the changes of the situations. Besides, the effect of propagation to the neighboring areas by implementation of the Project, social influence such as employment creation effect and the impact exerted over the environment are also mentioned.

The economic analysis is made based on the standard procedures Colombia adopted by organizations such as HIMAT, DNP, etc. In the calculation of shadow prices in particular, "Estimacion de precios de cuenta para Colombia, Feb. 1990", which was prepared by DNP as a result of joint work with IDB, is used as a reference. The assumptions used for this analysis are as follows:

(1) The period of evaluation is fifty (50) years from the start of the works. It is assumed that the facilities and equipment, the service life of which matures within this period, are replaced and their replacement cost is summed up in the project cost.

(2) US$1 = Col$527.73, which is the mean value during September, 1990, is adopted as the exchange rate between Colombia peso (Col$) and US$. Furthermore, the value of official rate x 1.18 is adopted as the shadow price of foreign currency.

(3) The prices of farm products are calculated based on the farm gate prices in Quindio in the latter half of 1990, but the parity prices are adopted for the following export products:

Export crop: coffee, passion fruits, beef cattle
Import crop: soybean, sorghum

(4) The construction cost of the project facilities is calculated based on the market prices in September, 1990. On the other hand, the farm production cost is calculated based on "Base Technologicas Costos e Ingresos de Actividates Agropecurias de Diversification 1990, Caja Agaria" prepared by the Coffee Committee, with information collected through interview to the farmers conducted by the study team as a reference.

Of these costs, the labor cost of non-skilled laborers is calculated by multiplying 0.7, which is the conversion factor adopted in Colombia in general, to the market price. Furthermore, of the crop and livestock production costs, shadow prices are applied to agricultural chemicals and fertilizers and also to farm machinery, assuming that foreign currency portion occupies 40% of agricultural chemicals and fertilizers and 80% of farm machinerry.

8.2 Economic Evaluation

8.2.1 Project Benefit

A research center for promotion of cultivation of vegetables and fruits is to be established and irrigation facilities are also to be introduced. The latter in particular will permit cultivation of vegetables in the dry season when supply is insufficient, productivity of agricultural products (which will contributes to rise of farm gate prices) will rise and increase of agricultural production is anticipated. The gross amount of net benefit of agricultural production will reach the level of Col$117,105 million with the implementation of the Project, which is equivalent to 1.89 times the level without project (Col$61,823 million). On the other hand, construction and improvement of farm roads will promote the distribution of agricultural products, and will make contribution to the reduction of the carriage cost of agricultural products(Col$2,387 million). Therefore, the total of increased benefit obtained as a result of implementation of the Project will become Col$57,669 million.

8.2.2 Project Costs

The project cost which is used for economic evalition of the Project is composed of construction and O/M costs of the agricultural development works, general administrative expenses, consulting service fees and physical contingency. Marketing prices of these components are calculated at first and they are adjusted to economic prices taking account of conversion factors, The total project cost converted to economic prices are Col$ 11,450 million.

8.2.3 Profitability of the Project

(1) Profitability in the whole project area

The following figures are obtained when IRR, NPV and B/C for the whole project area are calculated based on the benefit and cost stated above.

IRR: 14.5%
NPV: Col$1,121,074 (Discount rate of 12%)
B/C: 1.24

The figure of IRR exceeds 12%, which is the value of the opportunity cost of capital in Colombia, and the values of NPV and B/C also indicate soundness of the Project. It can, therefore, be said that implementation of the Project is economically feasible.

(2) Profitability of respective areas

The result of calculation of IRR by area is as shown below.

TABLE 8.2.1 PROFITABILITY BY AREA

Group	Area	IRR(%)
1	Circasia	28.4
2	Quindio River Right Margin	10.7
	Quindio River Left Margin(2)	20.4
3	Quindio River Left Margin(1)	10.5
4	Salento	23.3
	Pijao	21.2
	Genova	17.9

The above result shows that the economic effect to be obtained by implementation of the Project will be extremely high in the areas in Groups 1 and 4, where agricultural development has not yet made good progress by this time. On the other hand, in the areas in Groups 2 and 3, where agricultural development has already made relatively good progress by this time, the growth of the economic effect to be obtained by implementation of the Project will be less than the average figure except for Quindio River Left Margin (2) area. From these facts, it is considered desirable to firstly implement of the projects for the areas in Groups 1 and 4 where high economic effect can be expected.

8.2.4 Sensitivity Analysis

Sensitivity analysis is made with IRR for the following cases in order to check fluctuation of costs such as construction cost, time of occurrence of benefit and prices of agricultural products. The result is as shown below:

TABLE 8.2.2 RESULT OF SENSITIVITY ANALYSIS

Case	IRR(%)
1) Original Case	14.5
2) 15% increase of construction cost	13.0
3) 15% decrease of construction cost	16.4
4) 15% increase in price of agricultural products and/or yield	17.4
5) 15% reduction in price of agricultural products and/or yield	11.8
6) Two years delay of appearance of project benefit	11.9
7) Three years delay of appearance of project benefit	11.0

It was found as a result of sensitivity analysis that profitability of the Project makes response more sensitively to increase/decrease of the benefit than to that of cost and that delay of occurrence of benefit extremely spoils profitability of the Project. Therefore, it is important that the agricultural research and extension centers will produce excellent results together with efforts of farmers themselves in order to achieve the yield of agricultural products targeted with the Project.

8.3 Evaluation of Coffee Waste Water Treatment Project

Implementation of coffee waste water treatment should be given first priority in the Project considering following results of the study.

1) Removal ratio is expected to achieve 95 % by treatment of the plant. The treated water can be used for domestic water with simplified treatment as well as for irrigation and fish culture.

2) Construction cost of the waste water treatment plant of the whole pilot area, which consists of 52 farmhouses and 918 ha of coffee planted area, is estimated at Col.$ 661 million accounting for Col.$ 720,400/ha. Construction cost by farm size is that, for example, 5 ha of coffee planting farmer is estimated at Col.$ 3,600 thousand and 20 ha at Col.$ 14,400 thousand.

3) The amount to be born by farm size is that 5 and 20 ha farmers reach Col.$ 145,440 and 581,760,(1% O/M cost included) respectively on the assumption that durable period of the treatment facility is 25 years.

4) The expense to be born by a farmer accounts for from 2 to 3 percent of production cost of coffee. Therefore, a farmer can disburse the expense. And the disbursement of farmers will be alleviated by subsidy of Coffee Committee.

5) Environmental conservation is essential element for sustainable development of regions in recent years. Therefore, expansion of the coffee waste water treatment plant as well as purification of domestic and industrial sewerages should be urged.

6) To implement coffee waste water treatment prior to other sewerage treatments such as domestic and industrial sewerages is significant step for river water quality improvement.

7) The high effects of demonstration for enlightenment of environmental conservation will be expected by the construction of coffee waste water treatment plants for all coffee planted farmers in Chispero river basin, where is selected as the pilot area and consists of 52 coffee planted farmers.

8) Implementation in the order of their farm size will give a remarkable effect even in the case that all farmers would not be able to attach the plant from the beginning of the Project. The removal ratio of the river water pollution is estimated at 85 %, if the plants of 17 farmers cultivating coffee more than 10 ha are implemented.

9) The above estimation can be also applied to the whole Christales river basin. Alleviation effect of the contamination expected by the construction of the plants by farm size is estimated as follows:

Case	Removal ratio(%)
Large - scale farmers	60 %
Large - scale and medium - scale farmers	90 %

Therefore,the construction of coffee waste water treatment plant in the whole Cristales river basin is proposed to enhance the exhibition effect and to expand the alleviation effect.

8.4 Farmhouse Economy

The variation of farmhouse economy which occurs as a result of implementation of the Project is estimated for each group. The estimation is made for model farmhouses of large-scale (30 ha), medium-scale (15 ha) and small-scale (5 ha) suitably established. The result of the estimation is as shown in Table 8.4.1.

TABLE 8.4.1 FARMHOUSE ECONOMY OF MODEL FARMHOUSES BY GROUP

(Unit: Col$ 1,000)

Group	Area	Farm Size		Gross Production	Production Cost	Income	Ratio (P/Ex)
1	Circasia	Large Scale (30 ha)	Ex.	6,027	3,910	2,117	
			Plan	25,256	12,358	12,898	6.1
		Medium Scale (15 ha)	Ex.	3,174	2,083	1,091	
			Plan	14,897	7,112	7,785	7.1
		Small Scale (5 ha)	Ex.	1,284	752	532	
			Plan	6,225	2,629	3,596	6.8
2	Quindio River Right Margin, Left Margin (2)	Large Scale (30 ha)	Ex.	18,077	8,662	9,415	
			Plan	18,635	8,710	9,925	1.1
		Medium Scale (15 ha)	Ex.	9,026	4,325	4,701	
			Plan	9,458	4,350	5,108	1.1
		Small Scale (5 ha)	Ex.	2,028	1,200	828	
			Plan	1,994	892	1,102	1.3
3	Quindio River Left Margin(1)	Large Scale (30 ha)	Ex.	10,389	5,874	4,515	
			Plan	17,137	8,681	8,456	1.9
4	Salento, Pijao, Genova	Large Scale (30 ha)	Ex.	12,305	8,453	3,892	
			Plan	21,016	11,552	9,464	2.5
		Medium Scale (15 ha)	Ex.	3,065	2,191	874	
			Plan	10,616	5,126	5,490	6.3
		Small Scale (5 ha)	Ex.	1,025	732	293	
			Plan	3,514	1,709	1,832	6.3

As it is apparent from the above table, improvement of income can be expected at farmhouses of all the areas as a result of implementation of the Project. There are large differences in the income at present situations between areas of Group 2 and 3 where agricultural development has made progress with coffee production or large-scale mechanized farming and other areas where agricultural development has been delayed. But it is anticipated that these differences by area will be almost gone or that the income level in said other areas will become even better.

Furthermore, when the figures are observed by the farmhouse scale, it can be estimated that the growth of income of medium and small scale farmhouses will be far larger than that of large scale farmhouses.

8.5 Social Evaluation

Appearance of the following secondary effects and indirect effects such as increase of farm productivity, reduction of transportation cost, increase of opportunities of employment for construction works and farm production and effect of propagation to the regional society can be expected as a result of implementation of the Project.

- Increase of opportunities of employment accompanying construction works

- Increase of processing and distribution operations caused by increase of agricultural products and inputs

- Increase of opportunities of employment accompanying conversion of farming system from extensive agriculture to intensive one

- Improvement of living standard caused by stabilization of farmhouse economy and increase of volume of distribution of farming materials and equipment will make contribution to the activation of the economy in and around the areas.

- The development technique adopted in this area will give impact to the agricultural development in the similar areas of Colombia, and in its turn will make contribution to the development of the agriculture in Colombia.

- The proposed coffee waste water treatment method will become a model of coffee waste water treatment in Colombia, and will be able to make major contribution to the improvement of environment of the coffee producing areas.

8.6 Environmental Evaluation

8.6.1 Problem Identification

The principal problems against the environment in the Project Area are identified as follows:

- Increase of soil erosion and soil loss caused by poor management of grazing land and cultivated land

- Reduction of water retention effect, reduction of rainwater outflow buffering effect and increase of flooding caused by reduction of forest area

- Worsening of river water quality caused by discharge of untreated coffee waste water to rivers

8.6.2 Environmental Impact

Farm production will increase and economic activation of the area will be promoted by the implementation of the Project. On the other hand, however, there may be a fear that the peripheral environment is adversely affected by the implementation of the Project. The volume of civil engineering works is not large, and the extent is only such that construction of farm roads is planned. Furthermore it is planned that the existing roads are used to the

most possible extent. Considering the above, there is no case where forests or farm land is heavily destroyed by the implementation of the Project.

8.6.3 Measures for Environmental Conservation

The following measures are taken into the Project against the problems in the current situations stated earlier and against the influence over the environment by the implementation of the Project:

- Farming system considering prevention of soil erosion is introduced for the farming on slopes.

- The present forest area is excluded from the project of development. Therefore, deterioration of the natural environment caused by rupture of forests can be prevented.

- Rehabilitation of rural roads is the subject of civil engineering works. Therefore, the civil engineering works will not exert adverse effect such as serious contamination to water quality, atmosphere, soil, etc.

- Soil erosion will be prevented at both grassland and farm land by this agricultural development , and in addition, water retention capacity and recharging capacity of water resources will also be improved in the whole area.

- If the proposed coffee waste water treatment is implemented, purification of river water will be achieved.

8.6.4 Effect of Environmental Improvement

The environment improving effects which can be expected as a result of implementation of the Project are as described below:

- Reduction of soil erosion in farm land and grazing land and increase of water retention capacity of soil by introducing the new farming system

- Reduction of cutting of forest trees and wind erosion by introduction of erosion protection belt

- Improvement of recharging capacity of water resource and reduction of flooding by these effects

- Improvement of river water quality by coffee waste water treatment

8.7 Comprehensive Evaluation

The disparity between advanced areas and developing areas will be reduced, the income of medium- and small-scale farmers will increase, and improvement of living standard of the residents in and around the Project Area can be expected from increase of farm production, creation of opportunities for employment, increase of income, etc. as a result of implementation of the Project. Furthermore, this agricultural development project that is mainly applicable to sloped area has a meaning of a model development for similar areas in Colombia, and it will make major contribution to the growth of agriculture in Colombia.

The coffee waste water treatment project improves the water quality of the objective river. At the same time, the treatment method adopted in this project will become a new model of coffee waste water treatment in Colombia, and it can be expected to make major contribution to other coffee producing areas in Colombia where coffee waste water treatment is a social problem.

From what is mentioned above, it is judged that implementation of the Project is feasible from the economic effect calculated from the tangible benefit. It can also be judged that socio-economic effect and environment improving effect can also be fully expected as evaluated from the intangible benefit.

TABLE 8.2.3 ECONOMIC INTERNAL RATE OF RETURN

UNIT: COL$ X 1000

YEAR	Construction Cost	O/M Cost	Project Cost	Incremental Benefits	Project Return
1	571,765		571,765	-973,540	-1,545,305
2	840,496		840,496	-251,440	-1,091,936
3	1,035,000		1,035,000	518,672	-516,328
4	1,831,959		1,831,959	1,261,379	-570,580
5	2,002,581	50,160	2,052,741	661,279	-1,391,462
6		88,580	88,580	692,738	604,158
7		88,580	88,580	870,656	782,076
8		88,580	88,580	1,702,267	1,613,687
9		88,580	88,580	962,923	874,343
10		88,580	88,580	826,722	738,142
11		88,580	88,580	642,848	554,268
12		88,580	88,580	1,626,864	1,538,284
13		88,580	88,580	1,065,579	976,999
14		88,580	88,580	1,034,464	945,884
15		88,580	88,580	1,299,503	1,210,923
16		88,580	88,580	1,997,779	1,909,199
17		88,580	88,580	1,290,748	1,202,168
18		88,580	88,580	1,166,811	1,078,231
19		88,580	88,580	1,265,662	1,177,082
20		465,760	465,760	1,996,038	1,530,278
21		88,580	88,580	853,564	764,984
22		88,580	88,580	899,536	810,956
23		88,580	88,580	1,042,341	953,761
24		88,580	88,580	1,791,486	1,702,906
25		88,580	88,580	1,105,946	1,017,366
26		88,580	88,580	1,022,342	933,762
27		88,580	88,580	1,168,900	1,080,320
28		88,580	88,580	1,827,010	1,738,430
29		88,580	88,580	1,161,097	1,072,517
30		88,580	88,580	1,039,679	951,099
31		88,580	88,580	771,851	683,271
32		88,580	88,580	1,702,693	1,614,113
33		88,580	88,580	1,067,234	978,654
34		88,580	88,580	988,464	899,884
35		465,760	465,760	1,204,156	738,396
36		88,580	88,580	1,998,646	1,910,066
37		88,580	88,580	1,257,232	1,168,652
38		88,580	88,580	1,172,389	1,083,809
39		88,580	88,580	1,334,676	1,246,096
40		88,580	88,580	1,999,890	1,911,310
41		88,580	88,580	873,985	785,405
42		88,580	88,580	915,432	826,852
43		88,580	88,580	1,092,212	1,003,632
44		88,580	88,580	1,855,826	1,767,246
45		88,580	88,580	1,215,456	1,126,876
46		88,580	88,580	1,130,162	1,041,582
47		88,580	88,580	1,258,919	1,170,339
48		88,580	88,580	1,955,034	1,866,454
49		88,580	88,580	1,209,601	1,121,021
50		465,760	465,760	1,095,039	629,279
Total	6,281,801	5,167,800	11,449,601	57,668,751	46,219,150
				IRR =	0.1453123346

TABLE 8.2.4 NVP AND B/C

UNIT: COL$ X 1000

YEAR	Project Costo	Incremental Benefit	NPV with discount rate of 12%	
			Cost	Benefit
1	571,765	-973,540	510,504	-869,232
2	840,496	-251,440	670,038	-200,447
3	1,035,000	518,672	736,693	369,180
4	1,831,959	1,261,379	1,164,243	801,629
5	2,052,741	661,279	1,164,780	375,228
6	88,580	692,738	44,877	350,963
7	88,580	870,656	40,069	393,841
8	88,580	1,702,267	35,776	687,517
9	88,580	962,923	31,943	347,240
10	88,580	826,722	28,520	266,182
11	88,580	642,848	25,465	184,803
12	88,580	1,626,864	22,736	417,576
13	88,580	1,065,579	20,300	244,203
14	88,580	1,034,464	18,125	211,672
15	88,580	1,299,503	16,183	237,414
16	88,580	1,997,779	14,449	325,881
17	88,580	1,290,748	12,901	187,990
18	88,580	1,166,811	11,519	151,732
19	88,580	1,265,662	10,285	146,952
20	465,760	1,996,038	48,284	206,923
21	88,580	853,564	8,199	79,006
22	88,580	899,536	7,320	74,340
23	88,580	1,042,341	6,536	76,912
24	88,580	1,791,486	5,836	118,027
25	88,580	1,105,946	5,211	65,055
26	88,580	1,022,342	4,652	53,694
27	88,580	1,168,900	4,154	54,814
28	88,580	1,827,010	3,709	76,496
29	88,580	1,161,097	3,311	43,406
30	88,580	1,039,679	2,957	34,702
31	88,580	771,851	2,640	23,002
32	88,580	1,702,693	2,357	45,306
33	88,580	1,067,234	2,104	25,355
34	88,580	988,464	1,879	20,968
35	465,760	1,204,156	8,821	22,806
36	88,580	1,998,646	1,498	33,798
37	88,580	1,257,232	1,337	18,982
38	88,580	1,172,389	1,194	15,805
39	88,580	1,334,676	1,066	16,065
40	88,580	1,999,890	952	21,492
41	88,580	873,985	850	8,386
42	88,580	915,432	759	7,843
43	88,580	1,092,212	678	8,355
44	88,580	1,855,826	605	12,675
45	88,580	1,215,456	540	7,412
46	88,580	1,130,162	482	6,153
47	88,580	1,258,919	431	6,120
48	88,580	1,955,034	384	8,486
49	88,580	1,209,601	343	4,688
50	465,760	1,095,039	1,612	3,789
Total	11,449,601	57,668,751	4,710,110	5,831,184

NPV = 1,121,074

B/C = 1.24

CHAPTER 9 : RECOMENDATION

CHAPTER 9 RECOMMENDATION

1. Implementation of the Project is judged to be feasible both technically and economically as mentioned in Chapter 8. Although it is most desirable to implement the Project in all of seven areas in a batch, in the case where borrowing of the foreign currency portion is difficult, it is recommended that partial implementation of the Project is promoted. Because earlier implementation of the Project from the area which have higher priority is more desirable for the activation of Quindio economy.

2. Fundamental studies for cultivation of vegetables and fruit trees, introduction of which is planned in the Project are not yet sufficient. The research and extension of this field are particularly important for the success of the Project.

3. It is widely known that the good quality of Colombian coffee is assured by its wet processing. However, this processing is producing the waste water which contaminates the river water and surrounding environment. The realization of treatment of coffee waste water will give high reputation to the Republic of Colombia. Therefore, early implementation of the coffee waste water treatment project is strongly recommended.

4. Coffee waste water treating Project, which exerts particularly large influence over contamination of rivers, is planned in the Project. It is important to take measures against domestic and industrial sewerages simultaneously in parallel with coffee waste water treatment project as total measures against contamination of river water. It is strongly requested to implement these sewerage treatment together with enlightenment of residents and factory operators.

5. In the case where each farmhouse has a duty to construct a coffee waste water treatment plant in the future, it is necessary to increase the working efficiency through standardization of the plants.

6. The treatment is successfully performed with the delicate know-how which is attained through careful research and operation of the plant in addition to the provision of a treatment plant. Therefore, it is very important to consult the specialist during test operation of the plant as required.

7. Treatment of coffee pulp is also an important, matter together with waste water treatment, and it is desired that research and development are made on the treatment methods including reuse of the coffee pulp.