...STUDY

...A, CORTES

...COLONIA SAN PEDRO SULA, CORTES

FINAL REPORT

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

MINISTRY OF COMMUNICATIONS
PUBLIC WORKS AND TRANSPORTATION
THE REPUBLIC OF HONDURAS

THE MASTER PLAN STUDY
ON
THE EROSION AND SEDIMENT CONTROL
IN
THE PILOT RIVER BASIN, CHOLOMA, SAN PEDRO SULA, CORTES
IN
THE REPUBLIC OF HONDURAS

FINAL REPORT

PRELIMINARY ENVIRONMENTAL ASSESSMENT REPORT

JANUARY 1994

PACIFIC CONSULTANTS INTERNATIONAL, TOKYO
IN ASSOCIATION WITH
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(As of June, 1993)

ENVIRONMENT

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS

BID	Inter American Development Bank (Banco Interamericano de Desarrollo)
BOD	Biochemical Oxygen Demand
CITES	Convention on International Trade of Endangered Species
COD	Chemical Oxygen Demand
DIMA	Municipal Division for Waters, San Pedro Sula (División Municipal de Aguas)
DO	Dissolved Oxygen
SECOPT	Ministry of Communications, Public Works and Transportation (Secretaría de Comunicaciones, Obras Públicas y Transporte)
UNDP	United Nations Development Programme
WB	World Bank
WHO	World Health Organization

1. INTRODUCTION

The Study Area of this Erosion and Sediment Control Master Plan covers a portion of Western Sula Valley and Merendon mountain ranges with an area of about 717 sq. km (ref. *Fig.* 1.1). The area encompasses the Munipalities of San Pedro Sula and Choloma.

The Study Area comprises several tributaries and their respective drainage basins and alluvial fans of the Rio Chamelecon. Such tributaries include Rio Choloma, Rio Blanco, Rio El Sauce and Rio Chotepe.

The land elevation in the Western Merendon mountain ranges of the Study Area rises up to 1700m, while it is almost at mean sea level in the lagoons and the associated wetlands of the Sula Valley, resulting in a steep overall gradient. The Valley is extensively developed for a variety of agriculture.

The Valley area comprises many lagoons. Among the lagoons larger ones include Jucutuma, Ticamaya, El Carman and Lama.

The climate in most part of the study area is tropical, other than in the high Merendon mountain range along the western boundary of the study area, where it is sub-tropical.

Due to its steep gradient the study area is vulnerable to soil erosion, land slide and the resultant debris flow and sedimentation in rivers. This is in addition to the flooding problems which at times intensified by the above debris flow.

Man made factors such as deforestation and unsustainable agriculture in mountain ranges exacerbate these erosion and debris flow problems.

The baseline environmental conditions in the Study Area is identified on a preliminary basis based on both field reconnaissances and available secondary data.

The overall environmental condition in the whole Study Area is referred to as "Total Environment" while that of the major urban area, San Pedro Sula city, as "Urban Environment". The total (overall) environment of the Study Area essentially differs from that of San Pedro Sula city in consideration to the progressing urban and industrial developments and the associated environmental concerns of the city.

These baseline environmental conditions along with the relevant environmental laws, regulations and standards and environmental impacts are dealth with in the subsequent chapters.

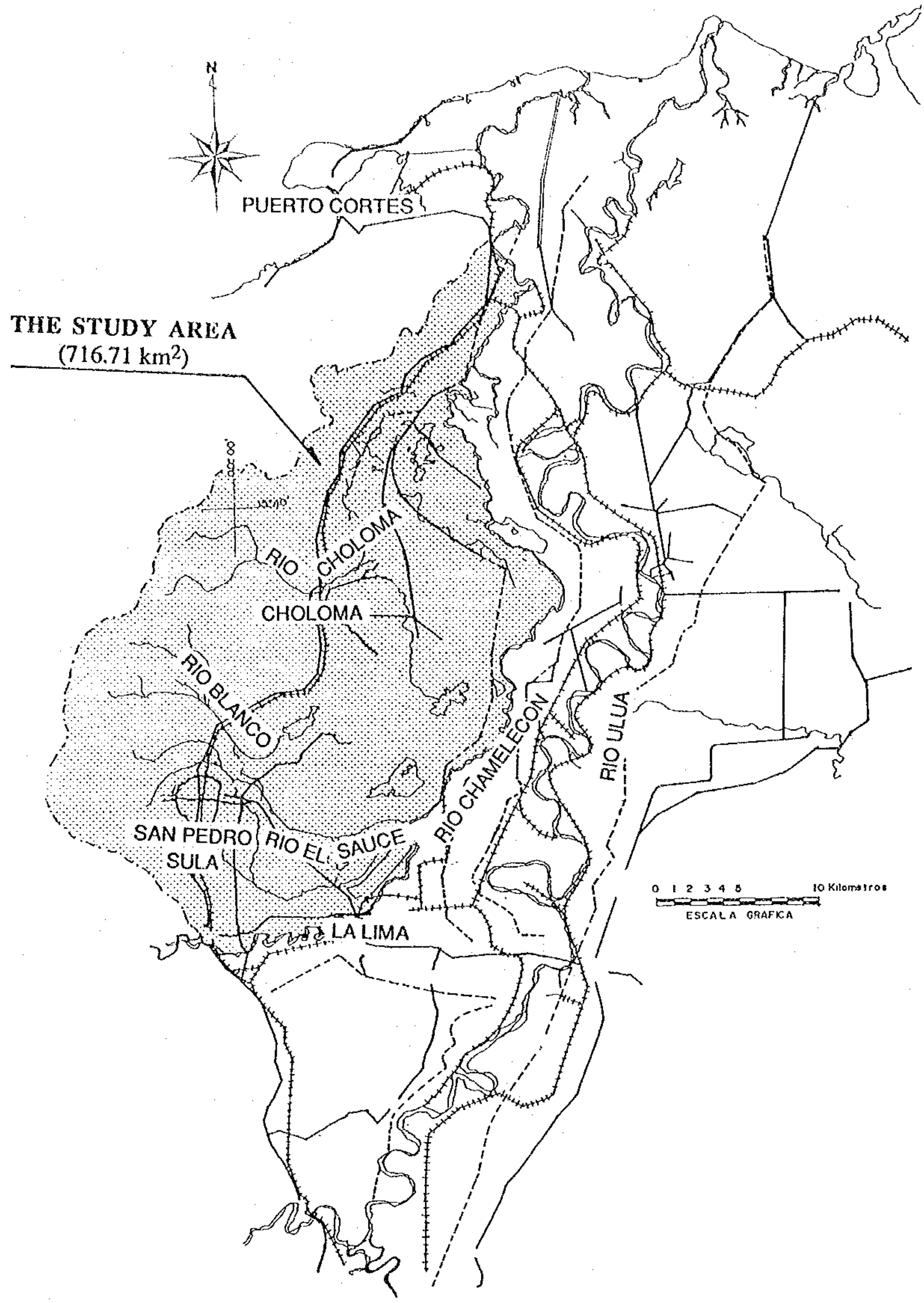

FIG. 1.1 STUDY AREA OF MASTER PLAN

2. TOTAL ENVIRONMENT

The overall environment in the Study Area, referred to as total environment, comprises two (2) broad distinct environmental components of high lands, the Merendon range and associated elevated lands and the low lands, the Sula Valley and the associated aquatic environment of lagoons and wet lands.

The line of demarcation between these two broad environments could be approximated as the highway across the study area that links the San Pedro Sula city with Choloma and Puerto Cortes to the north and Chamelecon to the south.

The Study Area of 717 km^2 could be divided between high land area of 304 km^2 and low land area of 413 km^2.

The baseline ecological condition of this total environment along with the relevant species of flora, fauna, agriculture and livestock and aquaculture/fishery is established based on a comprehensive ecological survey, conducted principally based on available secondary information in combination with judicious field verification.

This survey was conducted during the two (2) month period of June and July 1993 conforming the Terms of Reference (TOR) formulated during the initial stage of the study. The relevant TOR could be referred to in the Initial Environmental Examination Report, dated March 1993.

The baseline ecological condition and the related inventory data on flora, fauna, agriculture and aquaculture as identified by this preliminary survey is illustrated in the subsequent sections.

2.1 Ecology

Honduras, a country in the middle of Central America, covering 112,000 km^2, stretches from east to west 650 km and the greatest distance north to south is 325 km. It has a coastline of about 600 km along the Caribbean sea to the north and is in contact with the Pacific Ocean by way of the Gulf of Fonseca on the south. Mainland Honduras lies between latitudes 13° and 16°N well within the tropics. Honduras may be separated into three physiographic regions: The Pacific Lowland region, the Caribbean Lowland region and the Serrania Region (Willson and Mayer 1985).

The region of interest, that comprises the Study Area, the Caribbean Lowland region may be divided into smaller unit as:

a) Motagua Plain
b) Ulua-Chamelecon Plain
c) Nombre de Dios Piedmont
d) Aguan-Tinto Negro Plain
e) Mosquito Coast

The lower valley of the Rio Ulua-Rio Chamelecon represents an alluvial plain formed by the confluence of the Rio Chamelecon, which drains extreme western Honduras, and the Rio Ulua, which drains most of the western one-fifth of the country. This plain extends inland from the sea for a distance of about 90 kilometers and varies in width from 20 to 35 kilometers. The Study Area is entirely included in the sub-basin of Rio Chamelecon.

2.1.1 Climate

The most significant feature of the climate, due to the country's latitudinal position, is the relative stability of temperatures throughout the year.

Although latitudinal position insures the country against pronounced seasonality of temperatures, there is considerable variability along an altitudinal gradient. The altitudinal decrease of air temperature in Honduras, roughly approximates the normal lapse rate, of vertical temperature gradient, of 0.65°C per 100 meters.

Another important climatic factor, particularly in producing localized patterns, is the topography of the country. Mountains block the flow of large air masses, causing the precipitation of abundant moisture of the windward side and relative dryness on the leeward side.

2.1.2 Ecological Association

Honduras was characterized by Carr (1959) into various habitats, with regard to vegetation. Holdridge (1962) based on those habitats and precipitation and temperature, outlined the overall ecosystems in Honduras, by categorizing them into nine (9) forest formations as given below.

1) Tropical moist forest
2) Tropical dry forest

3) Tropical arid forest
4) Subtropical wet forest
5) Subtropical moist forest
6) Subtropical dry forest
7) Lower montane wet forest
8) Lower montane moist forest
9) Montane rainforest

Agudelo et al (1980) with due consideration to edaphic factors, that were identified to exert significant influence on the ecological associations of Honduras, proposed the following 13 associations that included transitional ones.

1) Wet low montane subtropical forest
2) Wet subtropical forest
3) Moist subtropical forest
4) Moist tropical forest transition to subtropical forest
5) Dry tropical forest transition to subtropical forest

6) Dry subtropical forest
7) Dry low montane subtropical forest
8) Moist low montane subtropical forest
9) Moist subtropical forest transition to tropical forest
10) Moist subtropical forest transition to submoist forest
11) Dry subtropical forest transition to moist forest
12) Dry subtropical forest transition to semiarid forest
13) Arid tropical forest transition to subtropical forest

The Study Area of this master plan, other than the lagoons and the associated wetlands, could be represented by the first five (5) of the above ecological associations.

The high land Merendon mountain ranges essentially belong to the three (3) ecological associations of wets low montane subtropical forest, wet subtropical forest and moist subtropical forest.

While most low land Sula Valley area belongs to dry tropical forest transition to subtropical forest. The low hilly areas and the base of the Merendon mountain range, including the urban areas of San Pedro Sula, belongs to the highly localized ecological association of moist tropical forest transition to subtropical forest.

Both the above transitional associations have been highly modified with virtually no primary forestation remaining. Most of urban, industrial, agricultural and animal husbandry developments in the Study Area occupy the areas of these two (2) transitional associations of dry tropical forest transition to subtropical forest and moist tropical forest transition to subtropical forest.

Other than these ecological associations, the distinct ecosystem that occupies the low land Sula Valley area is the lagoons and the associated wetlands of Jucutuma, Ticamaya, El Carmen, Lama and others.

2.1.3 Flora

The flora species in the Study Area are broadly classified in between the low land Sula Valley and high land Merendon mountain range.

The plant diversity in the Merendon mountain range is still high in comparison to the low land Sula Valley, which is under intense cultivation. Inspite of high plant diversity in the Merendon range, no detailed inventory study, to identify and classify the flora species, has ever been done.

The high plant diversity of Merendon range is attributed to the existence of virgin forests in the Rio Santa Ana and Rio Piedras basins, the two (2) major potable water sources of San Pedro Sula water supply scheme, that remain protected.

The dominant species of this high land Merendon mountain range belong to the category of tall trees due to the availability of abundant moisture.

In the low land Sula Valley area, the primary forestation has been extensively modified by residential, agricultural, plantation, animal husbandry and other related economic development activities. The remaining terrestrial flora are scattered representatives of dry tropical forest.

Nevertheless, the lagoons and the associated wetlands of this Sula Valley area remain undisturbed at least physically, may be due to their lack of potential neither for agriculture nor animal husbandry development.

The common aquatic plant species of the lagoons and associated wetlands in this valley area are Eichornia crassipes (Jacinto acuatico/Water hyacinth), Pistia stratiotes (Lechuga) and Typha sp. (Tifa).

All these three (3) species are aquatic weeds and their proliferation in the major lagoons of Jucutuma, Ticamaya and El Carmen indicate the availability of excess nutrients of nitrogen (N) and phosporus (P), and the resultant water quality deterioration.

It is noted that almost all point and non point pollution run-off of domestic, industrial, animal husbandry and agriculture origin could contribute to these nutrients of nitrogen and phosporus. They tend to accumulate in stationary water bodies like lagoons.

These lagoons, with their proliferation of aquatic weeds, are defacto wastewater treatment lagoons. Regular removal of these weeds, to induce their growth, would also lead to net removal of nutrients in the form of plant tissue and hence enhancement of lagoon water quality. Still, as a permanent water quality enhancement measure, in addition to regular weed removal, regulation of pollution load run-off into lagoons would be required.

Based on water quality sampling and analysis conducted by the Study Team, the lagoons are evaluated as moderately polluted (*ref. Section 3.1.3 of Chapter 3*).

As the result of this preliminary flora species study, conducted both based on available secondary information in combination with field inspection and transit analysis in the high land Merendon mountain range, a total of 137 common flora species of natural origin are identified in the Study Area. Their breakdown between the low land (Sula Valley) and high land (Merendon Mountains) are as follows:

Low land	Aquatic flora	8
	Terrestrial flora	9
High land	Terrestrial flora	107
Low land and High land	Terrestrial flora common to both areas	13
Study Area (717 sq·km) Total:		137

The list of these identified species are given in Annex-1. Based on this data, potential species of reforestation in the Merendon mountain area are selected, considering the species versatility, tolerance and growth capability. These selected species of reforestation are shown in *Table* 2.1.

Reforestation of eroded and deforested Merendon mountain areas in an important ongoing environmental improvement programme undertaken by DIMA, which operates a plant nursery at El Gallito to culture seedlings of potential species for reforestation.

2.1.4 Fauna

The wild fauna species in the Study Area were identified principally based on the available secondary data. The species as classified into amphibians, reptiles, birds and mammals, are a total of 421. Their breakdown is as follows:

Amphibians	27
Reptiles	54
Birds	266
Mammals	74
Total:	421

The list of these identified wild fauna species along with their habitant and status is given in Annex-1.

These identified species include 25 endangered ones as per the CITES convention. They are shown in *Table* 2.2.

Though habitat destruction for agriculture and plantation development and hunting are supposed to be causes of these species to become endangered, the degree of such habitat destruction that could be attributed to the Study Area is not known.

The necessary protection measures for these endangered species along with their habitat requirement is recommended to be planned at national level.

In this regard, based on further studies, the major lagoons and the associated wetlands like Jucutuma and Ticamaya could be awarded legal protection in the form of a wildlife sanctuary or national park. These lagoons posses the potential to serve as sanctuary to those species of wetland and lagoon habitat including the endangered fauna.

2.1.5 Agriculture

The Sula Valley low land of the Study Area is extensively developed for a variety of basic and commercial agriculture and pasture for livestock (animal husbandry), of which cattle ranch is dominant.

In the high land Merendon mountain range of the Choloma area, the natural forestation is vastly replaced with agriculture, pasture and other planted trees of direct economic benefits. However, the agricultural practice is largely on a subsistence basis other than for cattle ranch pastures.

Soil erosion is a serious problem in this Choloma portion of the Merendon mountain range due to this agricultural practice with virtually no soil erosion control means like terracing.

The major agricultural crops, fruits, and pastures of the Study Area and the livestock animals are shown in *Table* 2.3.

2.1.6 Aquaculture

There exists no intensive natural fishery or artificial culturing (aquaculture) of fish in the Study Area.

The fishing activities are essentially confined to Rio Chamelecon and the major lagoons of Jucutuma, Ticamaya and Lama.

Major portion of the fishing activity is on a subsistence basis, though some small scale commercial activity is also noted. Such commercial fishery is reported to be dominant in Laguna Lama.

Based on field investigation the species of fish commonly caught by fishermen for consumption and sale in the lagoons are identified as Tilapia sp. (Tilapiya), Cichlasoma spilurum (Congo or Chancha), Cichlasoma managuense (Guapote tigre) and Cichlasoma motaguense (Guapote).

Moreover Tilapia sp. is reported to be widely caught in the lagoons. This species is very tolerant to low DO (dissolved oxygen) and hence to polluted waters. In fact it can even grow in wastewater treatment ponds.

Proliferation of this pollution tolerant species could be attributed to the poor water quality in the lagoons, which is also justified by the proliferation of aquatic weeds (*ref. Section 2.1.3*) and the evaluation of lagoons water quality (*ref. Section 3.1.3 of Chapter 3*).

Based on both the available secondary information (Martin 1972) and field investigation a total of 29 fish species are identified in the rivers (Rio Chamelecon) and lagoons of the Study Area. The list of identified fish species is given in Annex-1.

2.2 Land Use

The existing land use in the Study Area was determined based on available land use maps, interpretation of aerial photographs and field reconnaissance.

The identified land use in the Study Area of about 717 km^2 is shown in *Fig.* 2.1. The composition of land use distinguished between the high land Merendon range and low land Sula Valley, where agricultural use is dominant, is given below.

1) High Land (Merendon Range)

Type of use	Area (km^2)	Percent (%)
Forestation	99.36	13.9
Brushwood	36.96	5.1
Agriculture/pasture	142.74	19.9
Built-up area	21.40	3.0
Water body	3.32	0.5
Sub-total (High land)	303.78	42.4

2) Low Land (Sula Valley)

Type of use	Area (km^2)	Percent (%)
Natural pasture	132.67	19.4
Cultivated pasture	106.30	14.8
Banana	14.67	2.1
Rice/corn	8.24	1.2
Vegetables/citrics/sugar	23.81	3.3
Other crops/vegetation	38.07	5.3
Brushwood	4.43	0.6
Forestation	1.00	0.1
Built-up area	54.74	7.6
Water body	23.00	3.2
Sub-total (Low land)	412.93	57.6

3) Study Area

Sub-total (High land)	:	303.78 km^2	:	42.4%
Sub-total (Low land)	:	412.93 km^2	:	57.6%
Total		716.71 km^2		100%

The extensive change in land use in the north-western Merendon mountain ranges of Choloma area from forestation to agriculture and other planted vegetation could be visualized from the existing land use in this area as shown in *Fig*. 2.1.

Moreover the extensive production oriented change in land use the Sula Valley area (low land) has undergone is evident from the fact that agriculture, pasture and related uses and built-up area almost account for 90% of the total area of about 413 sq·km.

Table 2.1 Potential Flora Species of Reforestation

COMMON NAME	SCIENTIFIC NAME
1. María	Calophyllum brasilensis
2. Cedro real	Cedrela odorata
3. Sombra de ternero	Cordia bicolor
4. Laurel	Cordia diversifolia
5. Laurel negro	Cordia gerascanthus
6. Pito	Erythirina berteroana
7. Gualiqueme/Pito	Erythrina glauca
8. Madreado	Gliricidia sepium
9. Caulote/Guácimo	Guazuma ulmifolia
10. Guama	Inga sp.
11. Liquidambar	Liquidambar styraciflua
12. Mango	Manguifera indica
13. Pino	Pinus maximinoi
14. Pino	Pinus oocarpa
15. Pino	Pinus patula subsp. tecuumanii
16. Roble de montaña	Quercus skinnerii
17. Cortés	Roseodendron donnell-smithii
18. Caoba	Swietenia macrophylla
19. Macuelizo	Tabebuia guayacan
20. San Juan Rojo	Vochysia guianensis

Table 2.2 Endangered Fauna Species in Study Area

A-REPTILES

COMMON NAME	SCIENTIFIC NAME	HABITAT
1. Caiman	Caiman crocodilus chiapasius	W
2. Lagarto	Crocodylus acutus	W
3. Garrobo Gris	Ctenosaura similis	V
4. Iguana Verde	Iguana iguana	V W
5. Boa	Boa constrictor	V

B-BIRDS

COMMON NAME	SCIENTIFIC NAME	HABITAT
1. Pato Real	Cairina moschata	W
2. Pajuil	Crax rubra	M
3. Pava	Penelope purpurascens	M
4. Patito negro	Fulica americana	W
5. Pava negra	Penelopina nigra	M
6. Lora nuca amarilla	Amazona ochrocephala	V M

C-MAMMALS

COMMON NAME	SCIENTIFIC NAME	HABITAT
1. Mono Congo	Allouata palliata	V M W
2. Mono Araña	Atelles geoffroyi	M
3. Mono Cara Blanca	Cebus capucinus	V M W
4. Perezoso 2 Dedos	Choloepus hoffmanni	V M
5. Perezoso 3 Dedos	Bradypus variegatus	V M
6. Oso Caballo	Myrmecophaga tridactyla	V
7. Nutria	Lutra longicaudis	V W
8. Tigrillo	Felis pardalis	V M
9. Tigrillo	F. wiedii	V M
10. León de Montaña	F. concolor	V M
11. Tigre	Panthera onca	V M W
12. Danto, Tapir	Tapirus bairdii	M W
13. Jagüilla	Tayassu tajacu	V M
14. Quequeo	T. pecari	V M

Note: V - Valley; the low land Sula Valley area
M - Mountain; the high land Merendon mountain area
W - Wetland; lagoons, riparian habitat or floodplains in low land Sula Valley

Table 2.3 Farmed Plants and Animals in Study Area

a) Fruits and crops in Sula Valley

COMMON NAME	SCIENTIFIC NAME
1. Rice	Oryzy sativa
2. Corn	Zea mays
3. Beans	Phaseolus vulgaris
4. Soy beans	Glycina maxima
5. Citrus	Citrus sp.
6. Avocado	Persea americana
7. Mango	Mangifera indica
8. Papaya	Carica papaya
9. Coconut tree	Coccus nucifera
10. Banana	Musa sp
11. Plantain	Musa paradisiaca
12. Sugar cane	Saccharum officianalis
13. Bixa	Bixa orellana

b) Grasses and pastures in Sula Valley

COMMON NAME	SCIENTIFIC NAME
1. Jaraguá grass	Myparrhenia rufa
2. Para grass	Panicum purpurscens
3. Calinglero	Milinis minitiflora
4. Elephant	Pennisetum purpurescens
5. Guinea	Panicum maximum
6. Pangola	Digitaria decumbens
7. Estrella	Cynodon Plectostachyina
8. Leucaena	Leucaena Leucocephala

c) Upland cultivated plants-Merendon Ranges

COMMON NAME	SCIENTIFIC NAME
1. Pear	Pirus communis
2. Apple	Pirus malus
3. Prunes	Prunus sp
4. Apricots	Prunus persica
5. Strawberry	Fregaria sp

d) Domestic animals in Study Area

1. Cows
2. Horses
3. Pigs
4. Chickens

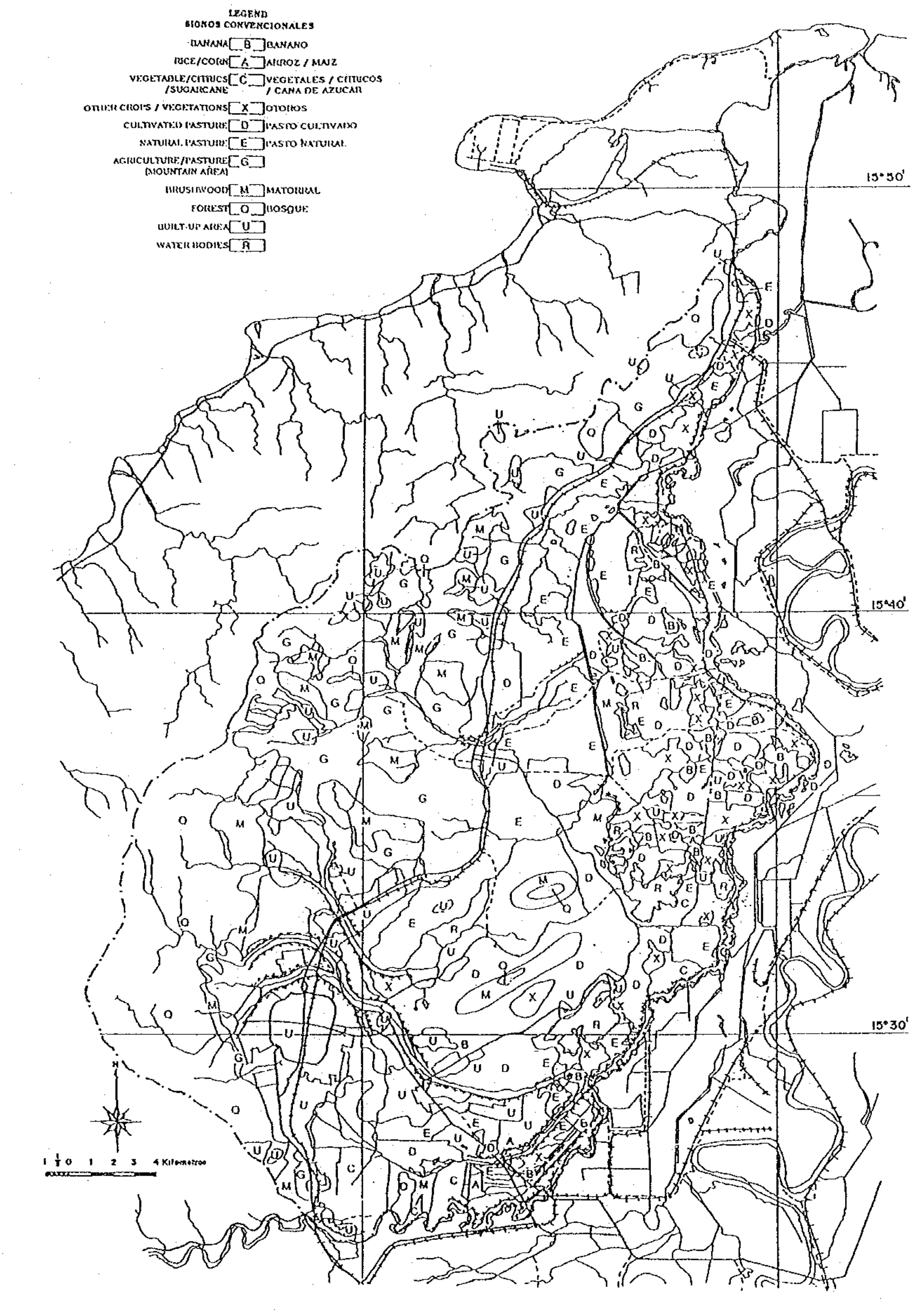

FIG. 2.1 EXISTING LAND USE

3. URBAN ENVIRONMENT

San Pedro Sula city and its surroundings, including the built-up areas of Choloma, is the most developed, and still growing, urban and industrial area in the Study Area. The city is the second largest in Honduras next only to the capital city of the nation, Tegucigalpa. However, the city and its surroundings of the Study Area boasts the largest and still expanding industrial zones in the country.

San Pedro Sula city has become a major source of water pollution to its surroundings due to the absence of any water pollution control measures to limit the pollution load run-off of both domestic and industrial origin. As a result, the receiving surface water bodies at downstream of the city are severely polluted. In fact the effect of untreated wastewater discharge on surrounding water bodies is strikingly visual in Rio El Sauce and Rio Chotepe.

Surface water being the prime indicator of environmental quality followed with solid waste, for an urban environment, they are specifically evaluated in the subsequent sections.

3.1 Surface Water

The Study Area comprises many surface water bodies of rivers, lagoons and wetlands. All rivers crisscrossing are tributaries of Rio Chamelecon. The major tributaries of Rio Chamelecon include Rio Choloma, Rio Blanco and Rio El Sauce.

3.1.1 Water Use

Depending on the quality of water, at least aesthetically, the rivers and lagoons are used for a variety purpose such as potable water source, irrigation and agriculture, washing, bathing and wastewater and refuse disposal.

The water quality of the rivers at high land mountain ranges, at upstream of population centres, are good. In fact the Rio Piedras and Rio Santa Ana are dammed and utilized as the major potable surface water sources of San Pedro Sula water supply scheme.

The polluted waters at down stream of the city, the Rio El Sauce and Rio Chotepe are also used for such purposes as washing and irrigation of sugar cane fields.

The lagoons including the major ones of Jucutuma and Ticamaya are essentially used for washing, bathing and subsistence fishery purposes.

The major rivers of Rio Blanco, Rio Choloma and Rio Chamelecon are used for a variety of beneficial uses such as washing, bathing large scale irrigation of agricultural crops. These rivers are aesthetically good as they do not receive direct pollution loads from either San Pedro Sula or Choloma city. In fact these rivers are remote from the urban environment of San Pedro Sula.

3.1.2 Sources of Water Pollution

The major sources of water pollution affecting the surroundings of the urban areas of San Pedro Sula and Choloma are both of domestic and industrial origin.

The San Pedro Sula city itself has a sewage collection system that contributes very much to a good environmental and sanitary condition within the city. However, the collected sewage is discharged with no treatment toward the surrounding lowland Sula valley area at south-east resulting in a deteriorated environment in this surrounding low income communities.

All these untreated wastewater discharges including that of industrial origin end up in Rio El Sauce and Rio Chotepe making them black in colour with offensive odour. These waterways are open sewers with no beneficial use.

DIMA with a loan from BID is about to formulate a rehabilitation plan to intercept the sewage with conveyance sewers to a treatment plant, for treatment before final disposal. With the implementation of this plan, the environmental conditions of this surrounding area of San Pedro Sula city is expected to be improved.

Nevertheless, the necessary means of control industrial discharges, at least to ensure their bio-treatability, also to be instituted. In fact, DIMA is in the process of formulating an effluent discharge criteria for industries.

It is noted that virtually all pollution load run-off of urban, industrial and agricultural and animal husbandry origin from the respective areas of Choloma end up in Canal San Reque. Consequently, this canal also blakish in colour and emanates offensive odour, and hence visibly polluted.

3.1.3 Water Quality

1) Surface Water

(1) Available Data

There is no surface water quality monitoring programme in any of the rivers or lagoons in the Study Area.

However, the two (2) prime potable surface river water sources of San Pedro Sula city water supply scheme, the Rio Piedras and Rio Santa Ana, are regularly monitored by DIMA at their respective water intake dam locations, in order to ensure their potable use.

Both water intake locations are upstream of the city in the western highland mountain ranges, and account for about 50% of the city water supply of about 150,000 m^3/d.

Water quality parameters monitored include pH, turbidity, total alkalinity, total hardness, total dissolved solids (TDS), chloride, inorganic nitrogens (NH_4-N, NO_2N, NO_3N), BOD, DO and also undesirable and heavy metal ions of Fe, Mn, Cr, Pb, Ag and Cu.

Based on results of these water quality parameters, the water quality of these two rivers are evaluated as pristine with very low tubidity of less than 5NTU most of the times.

All undesirable and heavy metal concentrations are also well below the recommended limitations for potable use.

This pristine water quality of these rivers is justified as their respective watersheds are the only ones still remaining as natural forestation with minimum human interference. These two (2) watersheds were bought by the Municipality long ago in 1917. Since then they are being maintained as forest reserve zones, thereby ensuring the pristine water quality of these rivers.

Other than these no other significant monitoring is done for any other rivers or lagoons to facilitate a comprehensive water quality evaluation.

(2) Sampling by JICA

The Study Team conducted a water quality sampling and analysis programme encompassing the rivers and lagoons of the Study Area of Master Plan at fifteen (15) locations in order to determine the baseline stream (environmental) water quality condition.

The water quality sampling locations are shown in *Fig.* 3.1. These locations, with eleven (11) in rivers and four (4) in lagoons, are selected so as to assess potential effects of urban and industrial discharges in the Study Area on their surrounding water bodies, to the extent possible.

The sampling were conducted two (2) times, both during rainy season, in June and August of 1993.

The locations of sampling are given below.

A. RIVERS

1. Rio Majaine
2. Rio La Jutosa
3. Rio Choloma
4. Canal San Roque
5. Rio Chamelecon in Copen at downstream of its confluence with Rio El Sauce/Chotepe
6. Rio Chamelecon in Chamelecon
7. Rio Piedras at DIMA potable water intake
8. Rio Santa Ana at DIMA potable water intake
9. Rio Blanco
10. Rio El Sauce
11. Rio Chotepe

B. LAGOONS

12. Laguna Jucutuma
13. Laguna Ticamaya
14. Laguna Lama
15. Laguna El Carmen

The parameters of water quality analysis comprised metal parameters including heavy metals in addition to the general physical, chemical, biochemical and biological parameters. The heavy metal parameters are representative to industrial discharges. The parameters analyzed are given below.

1. General Parameters

Temperature	COD
Colour	Suspended Solids (SS)
Odour	NH_4-N
Turbidity	Org-N
pH	T-P
Electric Conductivity (EC)	Chloride (Cl^-)
DO	Fecal Coliform (FC)
BOD_5	Total Coliform (TC)

2. Metal Parameters

Fe, Mn, Cr (hexavalent), Pb, Cu, Cd and Zn

The results of water quality analysis separated between the major general parameters and the metal parameters are shown in *Table* 3.1 and *Table* 3.2 respectively for the initial (June) and repeat (August) sampling.

(3) Water Quality Evaluation

Both based on the analysis results as well field inspection and the resultant aesthetics at the sampling locations, the water quality of sampled water bodies are classified into one (1) of the following five (5) categories, based on their relative pollution level.

They are, in the order of increasing pollution level;

(i) Pristine (excellent) water
(ii) Very good water
(iii) Good water
(iv) Moderately polluted water
(v) Polluted water

Metal parameter results did not indicate any specific metal pollution even in the polluted water bodies.

(i) Pristine (excellent) water

The following four (4) rivers, all located at upstream of major urban and industrial centres in the high land Merendon mountain range, namely, Rio Majaine, Rio La Jutosa, Rio Piedras and Rio Santa Ana are categorized as pristine.

This is in consideration to very low pollution level with respect to all measured parameters including sediment load (measured as turbidity and suspended solids) and bacterial pollution (measured as fecal and total coliforms).

All these rivers recorded very low turbidity of less than 5 NTU and suspended solids (SS) less than 10 mg/l, on average. Moreover fecal coliform concentrations (FC) were very low of less than 100 cells/100 ml. It is noted that a turbidity less than 5 NTU is in fact the standard for potable water adopted internationally, including WHO.

Quality-wise all these rivers are excellent potable water sources. In fact the two (2) rivers, Rio Piedras and Rio Santa Ana are the major sources of San Pedro Sula water supply, meeting 50% of the potable water requirement.

(ii) Very good water

The two (2) rivers of Rio Blanco and Rio Choloma are classified into this category. These are also suited for any beneficial use including as potable water source with conventional treatment.

In comparison to the preceding category of pristine water, these rivers recorded higher sediment loads with turbidity in the range of 5 ~ 20 NTU and suspended solids (SS) of 15 ~ 90 mg/l. This is in fact the major difference in quality between these very good waters and pristine waters.

Despite the proximity of Rio Blanco to the built-up areas of San Pedro Sula and Rio Choloma to that of Choloma, these rivers do not receive significant pollution load run-off from their respective built-up areas, thereby justifying their very good water quality.

(iii) Good water

The Rio Chamelecon at Chamelecon is classified into this category. This is also suited for all potential beneficial uses, though it carries relatively high sediment load with suspended solids (SS) around 1000 mg/l and to some extent polluted bacteriologically in comparison to the preceding category of very good water.

(iv) Moderately polluted water

All the four (4) lagoons of Jucutuma, Ticamaya, Lama and El Carmen are categorized as moderately polluted.

These water bodies recorded rather low DO level around 4 mg/l and high COD level around 150 mg/l. Consequently they are being categorized as moderately polluted. In fact these four (4) lagoon are bacteriologically polluted, marginally, as their fecal coliform (FC) level exceeds 1000 cells/100 ml. This bacteriological standard of 1000 cells/100 ml is recognized internationally, including the Japanese standards, as the limit for beneficial use of bathing/swimming.

Still, these four lagoons support critically fishery (aquaculture) and suited for restricted irrigation and water contact activities, other than bathing/swimming, in consideration to their high bacterial pollution.

(v) Polluted water

The three (3) rivers that carry bulk of the urban, industrial, agricultural and animal husbandry pollution load discharge of San Pedro Sula and its surroundings including that of Choloma, namely Rio El Sauce, Rio Chotepe and Canal San Roque are classified into this category.

It is noted that the former two (2) rivers receive most of their pollution load from the built-up areas of San Pedro Sula while the last one, the Canal San Roque, from that of Choloma.

Moreover, the Rio Chamelecon reach at its confluence with two (2) of the above polluted rivers of Rio El Sauce and Chotepe in Copen also falls under this category. This demonstrates the extent of urban and related pollution load discharges from San Pedro Sula area even to Rio Chamelecon at this sampled river reach. Nevertheless, the river is expected to be self-purified at its reaches at further downstream.

All these rivers recorded high pollution level with respect to most pollution indicators, including those of BOD, COD and bacterial pollution (fecal and total coliforms). Still, Canal San Roque would be the least polluted among these four (4) river locations, in consideration to its relatively low BOD, COD and other pollution indicator values. However, all these rivers are severely polluted bacteriologically with fecal coliform (FC) level around 100,000 cells/100 ml.

All these four (4) river locations, especially the three (3) rivers of Rio El Sauce, Rio Chotepe and Canal San Roque are blakish in colour and emanate offensive odour. These three (3) rivers have become open sewers with no beneficial use. They also point out the lack of urban and industrial pollution control measures in the form wastewater treatment prior to final disposal at both the built-up areas of San Pedro Sula and Choloma.

2) Effluent Quality

(1) Sewage Effluent

Recently in May ~ June 1992, DIMA conducted an effluent quality monitoring at 28 sewage outlets from the city sewage system. All these outlet are towards the eastern lowland of the city and the discharged wastewater finally end up in the two rivers of El Sauce and Chotepe. These locations, approximated as 7 major outlets, are shown in *Fig*. 3.2.

Though this monitoring study was aimed only at domestic effluent wastewater quality, hence excluded exclusive industrial discharge locations, most effluents in fact are a composition of domestic and industrial discharges.

The water quality parameters measured included pH, total solids (TS), total volatile solids (TVS), COD, BOD, NH_4N and the undesirable and heavy metal ions of Fe, Cu, Cr and Pb.

This monitoring study was aimed at analyzing the wastewater quality for its treatability, biologically.

As expected, typical to a raw wastewater, high BOD, COD and NH_4N values were measured. Even rather high concentration of undesirable and heavy metals of Fe and Cr were noted. This is attributed to industrial wastewater discharges. There is no evidence of any industry even pretreat its wastewater before discharge.

(2) Industrial Effluent

DIMA conducted an industrial waste effluent monitoring targeting five (5) industries located at north of city centre in Bermejo, a well known industrial complex adjacent to the city (ref. *Fig.* 3.2). This monitoring was conducted in 1990 and the targeted industries and their industrial activity are as follows:

1. Kativo de Honduras - Paint
2. Empresa de curtidos de centro america - Tannery
3. Productos lacteos sula - Dairy
4. Textiles San Pedro - Textiles
5. Cerveceria Hondurena S.A - Brewery

The parameters measured were selected based on the raw material used for each industrial activity, and consisted of physical, biochemical and heavy metal ion parameters.

All industrial effluents contained high COD levels, as anticipated, in the range of 1000 ~ 3000 mg/l. The tannery effluent contained very high Cr (Chromium - heavy metal) level up to 50 mg/l.

The above monitoring was conducted to determine the industrial effluent characteristics under local conditions.

3.2 Solid Wastes

The solid waste collection and disposal service by Municipality is satisfactory within the central city area. However in the surrounding areas, especially in the polluted river reaches of Rio El Sauce and Rio Chotepe and other canal reaches of the south-east lowland of the city, widespread garbage dumping is observed along the river and canal banks as well inside the water body.

It seems that the solid waste collection does not extend to these surrounding communities, the major cause for further deterioration of already polluted water ways, by refuse dumping.

The collected solid waste is disposed in a landfill area located at about 8 km east of the city centre in Hacienda Santa Marta. This is a relatively high land area in the defined low land Sula Valley.

This final landfill disposal means as practiced could be classified as "semi-sanitary." Eventhough, compaction of solid wastes is practiced, there is no means to manage the leachate generated.

A solid waste management master plan study is in progress with financial assistance from BID, which is expected to deal with these issues and propose necessary improvement measures as appropriate.

3.3 Environmental Improvement

Various urban and living environmental improvement project studies targeting San Pedro Sula city and its surroundings are either planned or on-going.

Such major projects include the following:

1. A potable water supply improvement master plan formulated for San Pedro Sula city until the year 2010, is implemented by DIMA with financial assistance from WB (World Bank). In this regard, a project to rehabilitate the existing water treatment plants is ongoing with grant aid from the Government of Japan.

2. A wastewater disposal improvement plan to collect and treat the sewage discharged untreated, into the waterways of Rio El Sauce and Rio Chotepe at present, is to be studied by DIMA with financial assistance from BID.

3. A solid waste management master plan study is ongoing by the Municipality of San Pedro Sula with financial assistance from BID.

4. An environmental sanitation improvement plan targeting the small towns surrounding the San Pedro Sula city is being formulated with UNDP assistance.

The above studies are adequate to enhance the living environmental and sanitation conditions of the city and its vicinity.

It is also noted that DIMA is in the process of formulating the criteria to regulate industrial discharges, and hence to control industrial pollution. Its early implementation by the concerned agency of DIMA or others with necessary judicial authority is recommended.

Finally it is concluded that urban environmental issues are addressed by the above mentioned projects. Hence they are not considered to be of priority for being addressed by this master plan. Moreover, they are remote to this erosion and sediment control study, and amenable for independent improvement plans, as in the case with the above mentioned projects.

Table 3.1 (a) Water Quality Sampling Results in Study Area (June 1993)
- General Parameters -

Location		pH	EC	DO	BOD	COD	SS	NH_4-N	Org-N	T-P	Cl^-	FC	TC
No.	Description		(Umho/cm)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(No./100ml)	(No./100ml)
1	Rio Majaine	7.6	160	7.5	0.7	13	6.0	0.01	< 0.15	0.03	4.1	3.0×10^1	3.0×10^2
2	Rio La Jutosa	7.3	194	7.2	1.0	14	5.6	0.01	< 0.15	0.02	1.2	1.0×10^1	3.1×10^2
3	Rio Choloma	7.5	225	6.0	1.1	16	17.2	0.01	< 0.15	0.05	6.6	1.5×10^2	7.1×10^2
4	Canal San Roque	6.9	1900	0.1	8.8	23	5.2	0.25	0.58	0.21	11.5	3.0×10^5	$> 1.0 \times 10^6$
5	Rio Chamelecon at Copen	7.0	375	4.6	3.7	112	282.0	1.71	0.38	0.40	8.6	1.0×10^5	$> 1.0 \times 10^6$
6	Rio Chamelecon at Chamelecon	7.3	450	6.8	1.4	84	987.5	0.10	0.12	0.04	3.6	3.0×10^2	9.0×10^2
7	Rio Piedras	7.6	176	8.0	0.5	10	5.2	0.08	< 0.10	0.01	3.7	1.0×10^1	1.9×10^2
8	Rio Santa Ana	7.7	89	7.3	0.4	18	7.2	0.06	< 0.10	0.01	2.8	7.0×10^1	3.6×10^2
9	Rio Blanco	7.5	100	7.3	0.6	12	88.1	0.06	< 0.10	0.02	3.5	6.0×10^1	4.5×10^2
10	Rio El Sauce	6.8	3800	0.3	77.8	214	990.0	8.71	0.75	0.75	7.6	1.6×10^5	$> 1.0 \times 10^6$
11	Rio Chotepe	6.5	5600	0.1	121.4	268	109.0	1.60	0.83	1.06	7.2	1.3×10^5	$> 1.0 \times 10^6$
12	Laguna Jucutuma	6.9	640	7.9	5.7	126	70.0	0.09	0.84	0.42	37.8	2.8×10^3	$> 3.0 \times 10^4$
13	Laguna Ticamaya	6.7	920	3.4	8.8	185	8.0	0.15	0.48	0.04	58.3	2.5×10^3	$> 3.0 \times 10^4$
14	Laguna Lama	7.1	514	3.3	3.8	144	22.8	0.07	0.59	0.10	8.2	1.5×10^3	$> 1.5 \times 10^4$
15	Laguna El Carmen	7.1	112	1.0	3.4	158	26.0	0.08	0.15	0.03	6.4	1.5×10^3	5.0×10^3

Table 3.1 (b) Water Quality Sampling Results in Study Area (June 1993)
- Metal Parameters -

Location		Fe	Mn	Cr-hex	Pb	Cu	Cd	Zn
No.	Description	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)
1	Rio Majaine	0.04	N.D.	0.005	0.013	0.007	N.D.	0.004
2	Rio La Jutosa	0.01	N.D.	0.008	0.017	0.007	N.D.	0.010
3	Rio Choloma	0.01	0.02	0.006	0.012	0.008	N.D.	0.006
4	Canal San Roque	0.28	N.D.	0.040	0.012	0.005	N.D.	0.059
5	Rio Chamelecon at Copen	0.41	N.D.	0.005	0.018	0.010	N.D.	0.013
6	Rio Chamelecon at Chamelecon	0.80	0.02	N.D.	0.024	0.015	N.D.	0.380
7	Rio Piedras	N.D.	N.D.	0.008	0.014	0.009	N.D.	0.017
8	Rio Santa Ana	N.D.	0.02	0.020	0.013	0.011	N.D.	0.013
9	Rio Blanco	0.10	N.D.	0.020	0.009	0.010	N.D.	0.006
10	Rio El Sauce	1.80	0.02	0.020	0.016	0.006	N.D.	0.015
11	Rio Chotepe	0.80	N.D.	N.D.	0.016	0.005	N.D.	0.008
12	Laguna Jucutuma	0.15	N.D.	0.003	0.018	0.006	N.D.	0.007
13	Laguna Ticamaya	0.28	N.D.	0.004	0.018	0.005	N.D.	0.015
14	Laguna Lama	0.28	N.D.	0.020	0.019	0.005	N.D.	0.010
15	Laguna El Carmen	0.35	N.D.	0.007	0.016	0.007	N.D.	0.002

Note: N.D. - Not detected

Table 3.2 (a) Water Quality Sampling Results in Study Area (August 1993)
- General Parameters -

Location		pH	EC	DO	BOD	COD	SS	NH_4-N	Org-N	T-P	Cl^-	FC	TC
No.	Description		(Umho/cm)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(No./100ml)	(No./100ml)
1	Rio Majaine	7.4	166	7.8	0.8	13	1.6	0.02	< 0.16	0.11	4.2	2.0×10^1	3.5×10^2
2	Rio La Jutosa	7.1	185	7.0	1.1	13	10.3	0.01	< 0.16	0.10	1.9	1.0×10^1	4.1×10^2
3	Rio Choloma	7.4	240	6.8	1.0	14	16.5	0.03	< 0.16	0.16	7.0	1.2×10^2	8.5×10^2
4	Canal San Roque	6.8	890	1.9	4.9	18	36.0	0.31	0.52	0.50	8.8	1.0×10^5	$> 6.0 \times 10^5$
5	Rio Chamelecon at Copen	6.8	325	4.6	2.1	128	167.4	1.11	0.34	0.29	6.2	6.8×10^4	$> 6.0 \times 10^5$
6	Rio Chamelecon at Chamelecon	7.3	525	7.6	1.5	60	55.3	0.06	0.14	0.21	3.3	2.5×10^2	6.5×10^2
7	Rio Piedras	7.4	168	7.7	0.6	10	12.5	0.01	< 0.10	0.02	3.2	Nil	8.0×10^1
8	Rio Santa Ana	7.4	94	6.9	0.5	12	12.0	0.01	< 0.10	0.06	1.4	1.0×10^1	2.5×10^2
9	Rio Blanco	7.4	105	8.3	0.6	13	46.0	0.04	< 0.10	0.09	3.0	3.0×10^1	1.8×10^2
10	Rio El Sauce	6.7	4100	3.7	52.4	198	1361.0	1.13	0.67	0.26	6.8	1.5×10^5	$> 1.0 \times 10^6$
11	Rio Chotepe	6.7	6000	2.6	89.2	217	447.5	1.22	0.76	0.49	6.6	1.5×10^5	$> 6.0 \times 10^5$
12	Laguna Jucutuma	6.8	529	4.6	3.6	130	15.7	0.05	0.30	0.37	36.4	3.0×10^3	$> 1.5 \times 10^5$
13	Laguna Ticamaya	6.6	925	3.0	3.1	160	9.4	0.07	0.34	0.03	60.1	2.0×10^3	$> 1.5 \times 10^5$
14	Laguna Lama	7.2	410	2.5	2.8	140	30.5	0.05	0.55	0.34	8.5	1.0×10^3	$> 5.0 \times 10^4$
15	Laguna El Carmen	7.2	170	3.0	3.7	144	26.0	0.07	0.16	0.19	7.2	1.8×10^3	4.5×10^3

Table 3.2 (b) Water Quality Sampling Results in Study Area (August 1993)
- Metal Parameters -

Location		Fe	Mn	Cr-hex	Pb	Cu	Cd	Zn
No.	Description	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)
1	Rio Majaine	0.03	N.D.	0.010	0.027	0.005	N.D.	0.021
2	Rio La Jutosa	N.D.	N.D.	0.019	0.024	0.011	N.D.	0.029
3	Rio Choloma	N.D.	N.D.	0.017	0.031	0.004	N.D.	0.021
4	Canal San Roque	0.50	N.D.	0.075	0.013	0.010	N.D.	0.025
5	Rio Chamelecon at Copen	0.58	N.D.	0.008	0.034	0.021	N.D.	0.033
6	Rio Chamelecon at Chamelecon	0.04	N.D.	0.012	0.025	0.016	N.D.	0.025
7	Rio Piedras	N.D.	N.D.	0.017	0.022	0.010	N.D.	0.019
8	Rio Santa Ana	N.D.	N.D.	0.022	0.020	0.004	N.D.	0.018
9	Rio Blanco	0.30	N.D.	0.020	0.022	0.002	N.D.	0.016
10	Rio El Sauce	0.22	N.D.	0.015	0.028	0.020	N.D.	0.028
11	Rio Chotepe	0.71	N.D.	0.020	0.038	0.018	N.D.	0.032
12	Laguna Jucutuma	0.16	N.D.	0.067	0.031	0.013	N.D.	0.025
13	Laguna Ticamaya	0.05	N.D.	0.025	0.021	0.007	N.D.	0.031
14	Laguna Lama	N.D.	N.D.	0.098	0.034	0.012	N.D.	0.027
15	Laguna El Carmen	0.18	N.D.	0.072	0.020	0.006	N.D.	0.014

Note: N.D. - Not detected

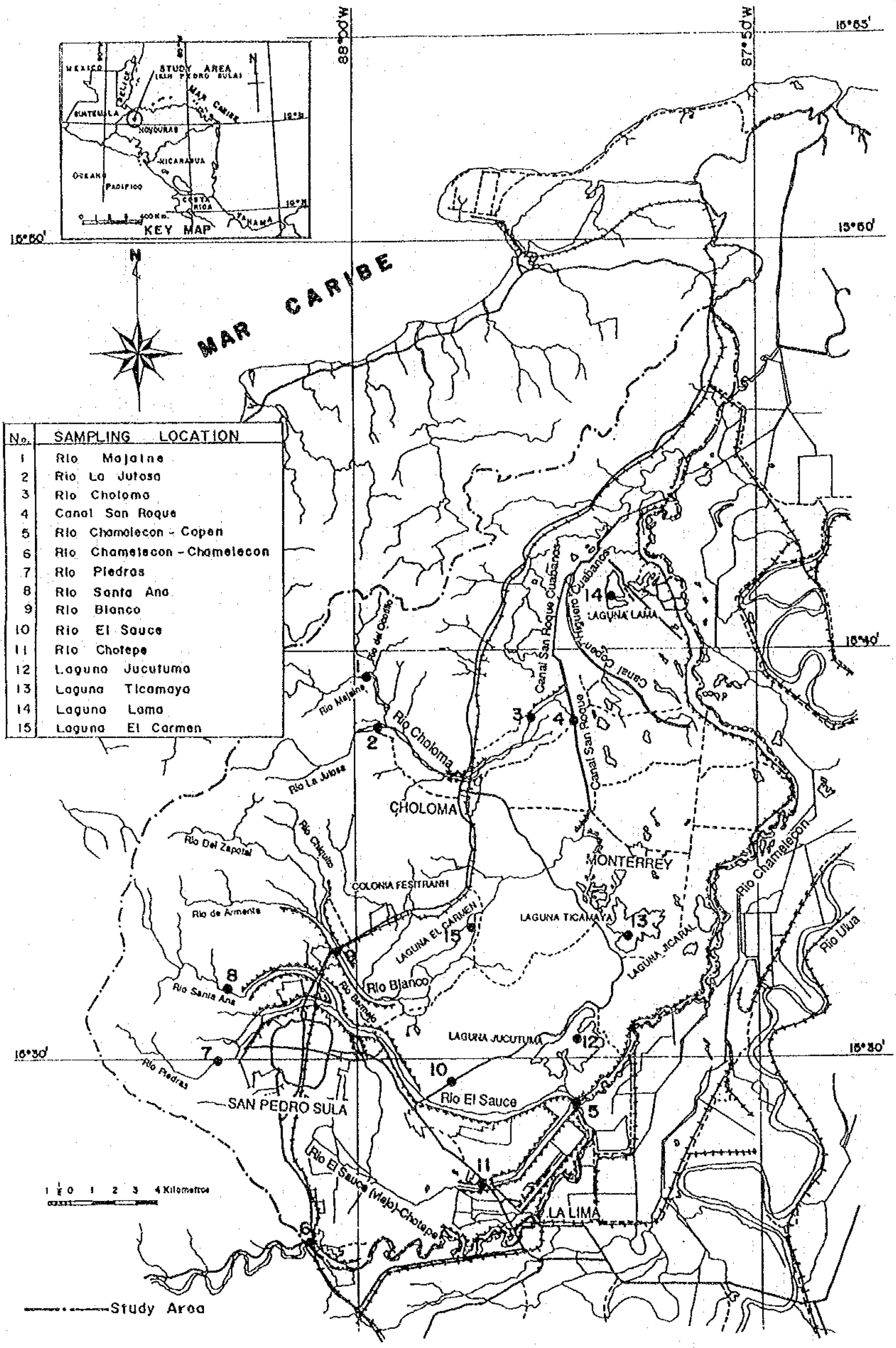

FIG. 3.1 WATER QUALITY SAMPLING LOCATION - JICA

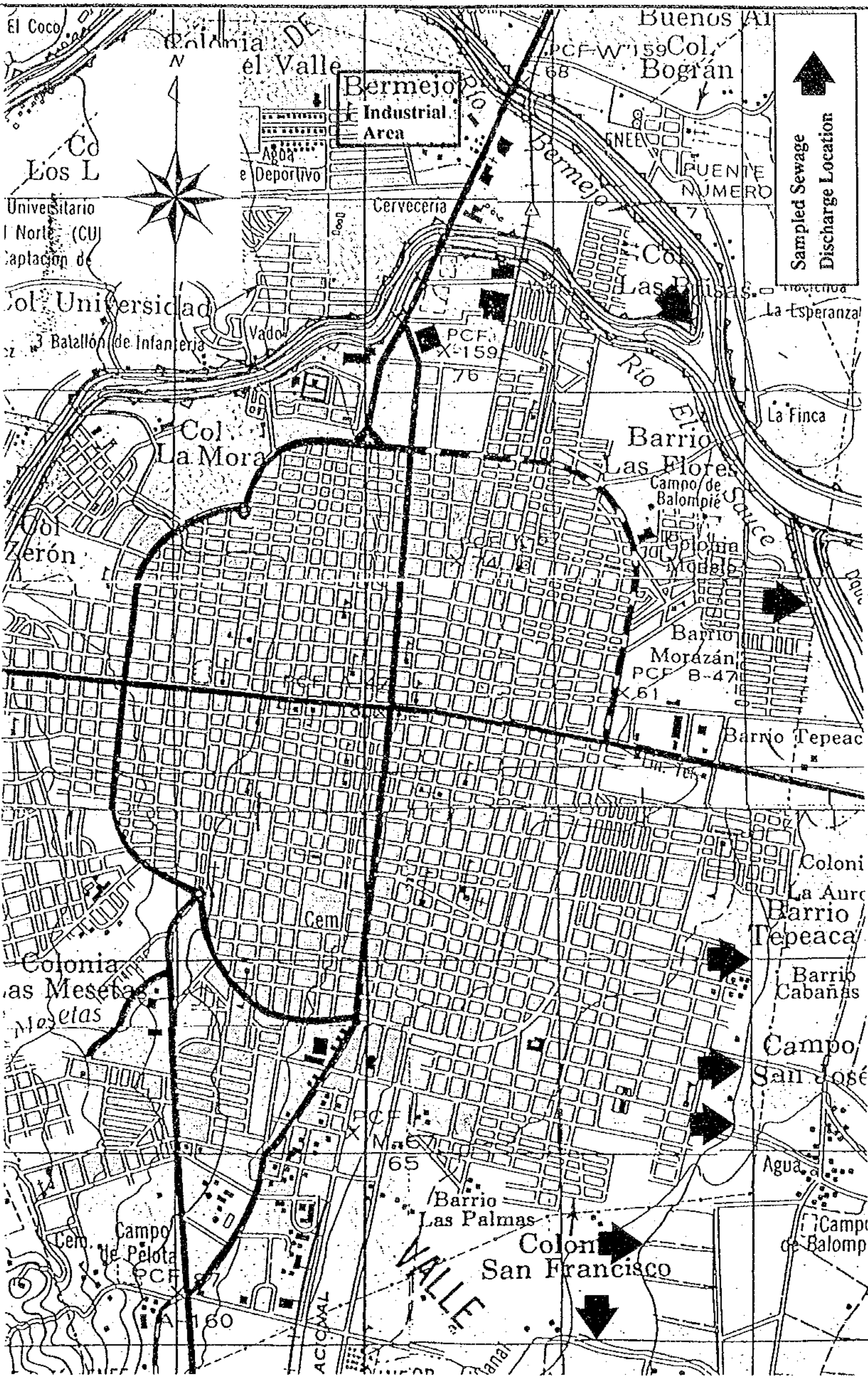

FIG. 3.2 DOMESTIC AND INDUSTRIAL WASTE SAMPLING LOCATION - DIMA

4. ENVIRONMENTAL LAWS, REGULATIONS AND STANDARDS

4.1 National Laws

The basic framework concerned to environmental protection, "The General Environmental Law", was promulgated at national level very recently by the National Congress of the Government of Honduras.

The Decree Number 104-93, dated 30, June 1993 in the national gazette presents the entire national environmental law that is comprised of one hundred and eleven (111) articles.

This law stipulates all basic requirement of environmental protection including environmental impact assessment (EIA).

4.2 Environmental Regulations and Standards

There exist no environmental regulations or standards concerned to even the basic aspects of stream water quality or ambient air quality.

Formulation of environmental regulations and standards at national level, is the logical follow-up activity of the recently promulgated national environmental law.

5. ENVIRONMENTAL ISSUES

The important environmental issues requiring priority consideration in the Study Area are delineated in this chapter based on the baseline environmental conditions described in the foregone Chapters.

The major environmental issues identified are deforestation, agriculture practice, water pollution and lack of an environmental management system to address such problems, that have no direct relation to this proposed master plan.

5.1 Deforestation

Destruction of forestation for agriculture practice and other plantations of direct economic benefits has been widespread in the Merendon mountain ranges of the Study Area.

In fact the natural forestation is virtually modified entirely in the Choloma mountain ranges, as evident from the land use map shown in *Fig.* 2.1.

Most deforestation due to slash and burn, and shifting agriculture in the San Pedro Sula portion of the Merendon mountains occurred long ago during the period of 1917 ~ 1954. Since then deforestation in this area is more or less controlled. However, deforestation for agriculture has been progressing for a long time, even at present, in the Choloma portion of the Merendon mountain ranges.

DIMA is entrusted to maintain about 400 km^2 of forest area in the Merendon mountain range at west of San Pedro Sula, as reserved forestation, as per a recent Decree (Decree No. 46-90, July 12, 1990). About 15% of this reserved forestation lies within this Study Area, and covers the watersheds of Rio Piedras, Rio Santa Ana and Rio del Zapotal.

The Hydrographic Section of DIMA estimated that about 45% of this reserved area is affected by deforestation, hence requires reforestation.

DIMA has already established a plant nursery to culture seedlings for reforestation in El Gallito, located along the western most boundary of the Study Area in the upper most watershed of Rio Piedras.

The seedlings grown include pine species (Pinus oocarpa and Pinus maximinoi), liquidambar (Liquidambar styraciflua) and other forestry plants. In addition economically beneficial species like pear (Pirus communis) apple (Pirus malus) are also cultured for replantation in homesteads.

Replantation works for reforestation in the affected areas of this reserved zone is in progress, though much remain to be done.

Moreover, in the Rio Choloma basin, that remains much affected both by deforestation and improper agricultural practice, an agroforestation programme is ongoing with the assistance of Spanish International Cooperation Agency.

It is recommended that DIMA be engaged in more cooperative reforestation programme with the Municipality of Choloma as well. Still, the progress made by DIMA on reforestation is commendable. However, lack of funds and qualified manpower is reported to be the major constraints limiting the progress of reforestation activities.

As reforestation is a long term process, efforts similar to that of DIMA is recommended to be followed by other Municipalities like Choloma as well. Its contribution to control soil erosion at source needs no further exemplification.

Forests in slope terrains is not only an important means of soil conservation but also has much broader environmental benefits of climatic stabilization, mitigation of desertification, flora and fauna conservation and others.

The potential native species of reforestation, selected from the inventory data on terrestrial species in the high land environment (Merendon mountain), are shown in *Table* 2.1. These species are selected in consideration to their versatility, tolerance and growth capability.

5.2 Agricultural Practice

Deforestation for agriculture and pasture for animal husbandry in itself does not necessarily be a cause of soil erosion, even though it may cause other undesirable environmental consequences. It is the subsequent unsustainable agricultural practice, typically in sloping terrains, that lead to soil erosion and the resultant shifting of cultivated land.

Agricultural practice with due consideration to soil conservation on sloping terrains, though possible with terracing, has some limitations with respect to the type of agricultural practice.

For example, cattle ranches on sloping terrains are very difficult to amenable for soil conservation. However, growing of fodder as feed for livestock may be amenable, at least technically if not economically, for soil conservation even on sloping terrains.

Erosion control agriculture practice like terracing is virtually absent in the Study Area, even though much of the Choloma mountain terrain land use has been modified from natural forestation to agricultural and crop lands. There are even cattle ranches on these sloping terrains.

It has been reported that various national and international organizations tried to deal with this issue of erosion control agriculture with terracing. However, mostly they all failed to achieve the objective. Lack of long term commitment and inadequate consideration to economic viability of crop selection for farming could be the major causes for such failures.

The means of soil conservation agricultural practice in sloping terrains by terracing had been illustrated long ago in 1979 by Harza-Cinsa master plan study. It is strongly recommended that the concerned Municipalities of San Pedro Sula and Choloma to institute an Agricultural Development Division to enforce sustainable agricultural practice. This has much relevance to this study as well, because sustainable agriculture with erosion control on sloping terrains is very significant for controlling erosion and flooding at source.

Another important environmental concern of extensive agricultural and animal husbandry practice, specially in the low land Sula Valley area, is the potential soil and water pollution due to their run-off.

The agrochemicals and pesticides used in the cultivation may lead to profound effect on surrounding environment that has a variety of water bodies of rivers and lagoons and the associated wetlands, and their flora and fauna.

The non point source characteristics of agricultural run-off pollution, makes it practically amenable to only regulation concerning the usage of agrochemicals and pesticides. However, their use remain unregulated. Hence it is recommended to carry out an investigation on the use and the corresponding pollution effects of agrochemicals and pesticides in order to regulate their usage, by the Agricultural Development Division, proposed above.

5.3 Water Pollution

The water quality evaluation, based on the sampling and analysis results of Study Team, presented in Chapter 3 (*Section 3.1.3*) clearly demonstrates the extent of water quality deterioration of rivers and lagoons in the low land Sula Valley area.

The major cause of water pollution in these water bodies is the discharge of untreated domestic and industrial wastewater from the built-up areas of San Pedro Sula, Choloma and their surroundings. Pollution load run-off due to agriculture and animal husbandry activities like cattle ranches should also be a significant factor.

The major discharge locations of untreated domestic and industrial wastewater around San Pedro Sula city are shown in *Fig.* 3.2.

An early implementation of the wastewater master plan of DIMA to intercept and treat the domestic wastewater from San Pedro Sula city prior to its final disposal into Rio El Sauce and Rio Chotepe is recommended.

Moreover, an early implementation of the industrial pollution control criteria that is being formulated by DIMA, is recommended to regulate industrial discharges.

A similar urban and industrial pollution control programme targeting the built-up and still developing areas of the Choloma municipality is recommended to be initiated.

5.4 Environmental Management

As pointed out in Chapter 4, the national environmental law, as the basic framework of environmental protection, has recently been promulgated by the National Congress.

Accordingly, DIMA is recommended to institute a regular environmental monitoring plan at local level, as the follow-up activity of this law.

As illustrated in Chapter 3, DIMA has undertaken various project based water quality monitoring works covering domestic (sewage) and industrial wastewaters.

Moreover, DIMA has a potable raw water monitoring programme covering Rio Piedras and Rio Santa Ana at their respective water intake locations.

Environmental monitoring is the basic step in realizing a sound environmental management. Accordingly, DIMA is recommended to undertake a continuos time series monitoring programme of stream river and lagoon water quality as the initial step. The monitoring programme, could be further expanded to cover groundwater and ambient air quality as well in future.

6. ENVIRONMENTAL IMPACTS BY PROJECT

The anticipated environmental impacts by the proposed plan are both direct and indirect. However, the adverse effects directly by the plan is anticipated to be insignificant in comparison to the beneficial effects. The proposed plan in itself is an environmental improvement plan aimed at disaster mitigation.

The proposed facilities of master plan are shown in *Fig.* 6.1.

The anticipated beneficial and adverse effects both directly and indirectly by this master plan of erosion and sediment control are delineated below.

6.1 Beneficial Effects

The effects by the project will be mostly beneficial as the project is aimed at disaster mitigation of erosion and sediment control.

No adverse effects by the project on the high land Merendon mountain range is anticipated, other than the beneficial effects of disaster mitigation due to run-off of eroded slopes and soils. However, in order to enhance the beneficial effects of erosion control, slope stabilization and erosion control measures at source like reforestation, agroforestation and soil conservation agricultural practice with terracing are necessary.

Table 2.1 presents potential natural species of reforestation, identified based on the inventory study of flora species in the Merendon mountain range.

The major beneficial effect by the project due to control of sediment flow and flooding of the rivers will be to the low land Sula Valley area.

The mitigation of flooding will enhance the land use potential of this fertile terrain to a variety of economically beneficial uses like urban, industrial and agricultural development. Moreover, enhanced protection to such existing land utilization will be obtained. It is noted that under existing conditions, about 90% land use of this low land Sula Valley area occupies potential economic beneficial use (*ref. Section 2.2 of Chapter* 2).

6.2 Adverse Effects

No significant adverse effects by the project to the high land Merendon mountain range is anticipated. The project facilities on these areas are confined to check dams to control debris flow and consolidation works to stabilize river beds. Other than these, no other river works are involved. Hence, no adverse effects by project on this high land area is anticipated.

In the low land Sula Valley area, the lagoons and the associated wetlands of Jucutuma, Ticamaya, El Carmen, Lama and others are a delicate ecosystem. Most of them are formed due to their distinct topography of a low land area surrounded with a relatively high land or hilly area as its catchment area.

None of the proposed river improvement or embankments (ref. *Fig.* 6.1), either along Rio Choloma, Rio Blanco or Rio El Sauce are expected to interfere with any of these lagoon and wetlands.

Nevertheless, the proposed diversion of Rio Blanco to Rio El Sauce, to follow its original course, would have some effects on Laguna El Carmen. Under the existing conditions, though originally not so, Rio Blanco discharges into this lagoon.

The diversion of Rio Blanco would in fact be beneficial to El Carmen as sediment load in the river, a potential source for siltation of the lagoon will be eliminated. Still, the lagoon will be preserved due to its distinct low land topography and being fed with its catchment area.

Accordingly, it is concluded that potential direct adverse effects by this proposed master plan on the lagoons and the associated wetlands, and hence the entire low land Sula Valley area, is also insignificant likewise the high land Merendon mountain area.

An important adverse social impact by the proposed plan will be the requirement of resettlement and compensation of those people affected by land acquisition for river improvement, embankment and river diversion works adjacent to respective reaches of Rio Choloma, Rio Blanco and Rio El Sauce. Under the existing conditions, such population resettlement requirement is not very significant.

As indirect adverse effect due to enhanced land use potential of the low land Sula Valley area, increased pollution load discharge by progressing urban, industrial and agricultural development to the surrounding water bodies is anticipated. This is a concern even under the existing conditions as pointed out in sections 5.2 and 5.3 of foregone Chapter 5. However, the solution lies in the control of pollution load run-off by means of pollution control regulation, wastewater treatment prior to final disposal and water quality monitoring, in the form of an integrated environmental management programme.

Area/River	Flood Control Facilities/Works	Main Feature	Area/River	Sediment Control Facilities/Works	Main Feature
1.Rio Choloma	1) Embankment	15.6 km	1 Rio Choloma *Rio Mejia & Rio La Jutosa	1) Sabo (Check) Dam	10 pls
	2).Revetment	4.6 km		2) Consolidation Dam	17 pls
	3). Channel Improvement	7.8 km		3) Training Levee	1,325 m
	4).Bridge Improvement	3pls			
	5).Land Acquisition	51.0 ha			
2.Rio Blanco-Canal San Roque With Rio El Sauce 2.1. Rio Blanco	1).Embankment *Left Bank Only	1.3 km	2.1 Rio Blanco *Rio Chiquito Rio Del Zapotal & Rio De Armenia	1) Sabo (Check) Dam	9 pls
	2).Land Acquisition	4.2 ha		2) Consolidation Dam	7 pls
				3) Channel Works	1pls
				4) Training Levee	4,060 m (9pls)
2.2 Diversion Canal (2.6 km) *Rio Blanco-El Sauce	1).Embankment	5.2 km			
	2). Channel Improvement	2.6km			
	3).Diversion Weir	1 Pls			
	4) Land Acquisition	66.7 ha			
2.3 El Sauce 1) Left Bank	1).Embankment	5.5 km	2.3 El Sauce * Rio Santa Ana & Rio Piedras	1) Sabo (Check) Dam	14 pls
2).Right Bank	1). Embankment *Heightening	7.5 km		2) Consolidation Dam	0
	2). Channel Improvement	7.5km		3) Channel Works Ground Sill Riverbed Girdle	2 pls (12 pls) (4pls)
	3).Revetment	2.0 km			
	4) Bridge	1			
	5).Land Acquisition	117.8 ha			

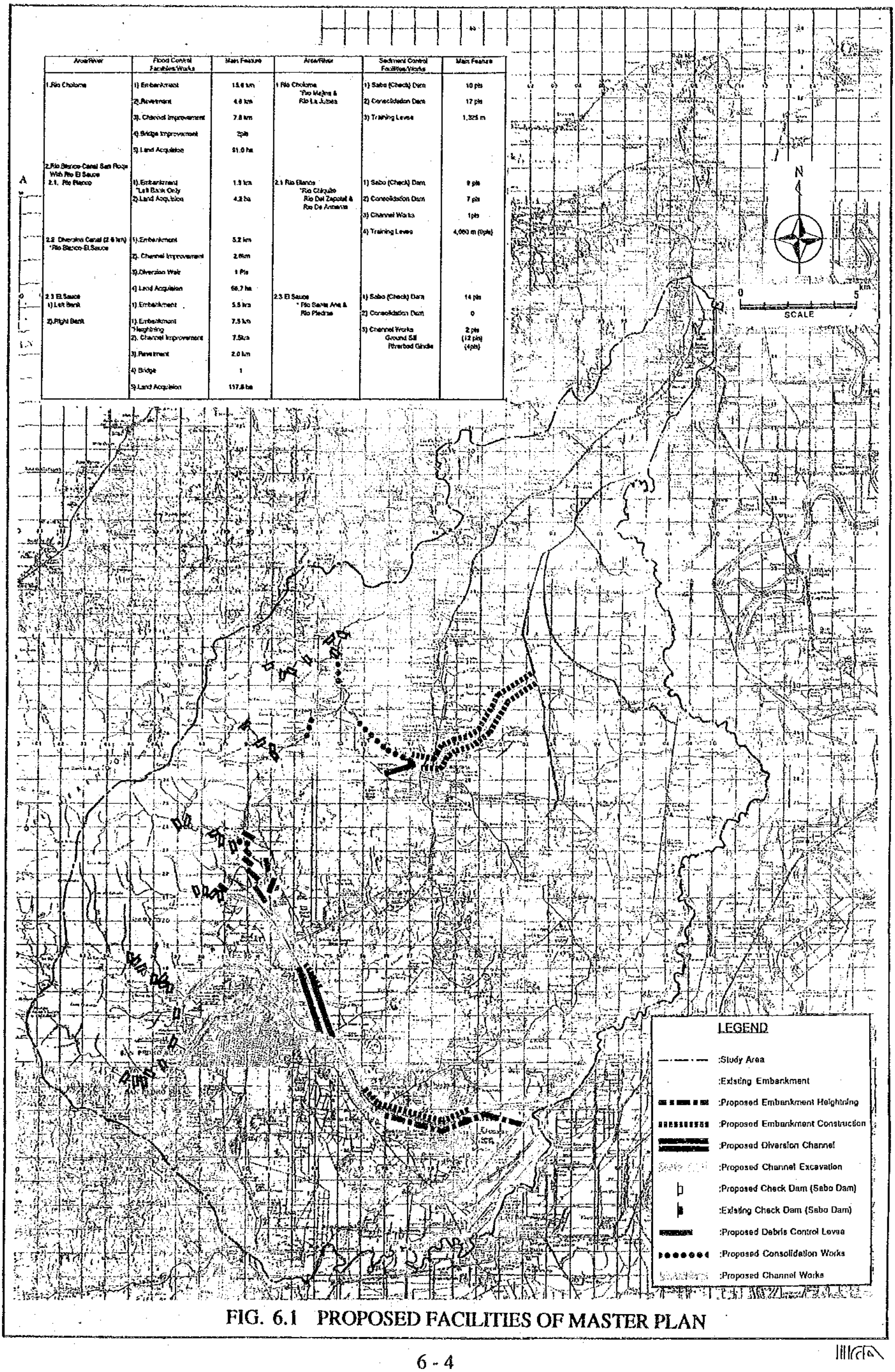

FIG. 6.1 PROPOSED FACILITIES OF MASTER PLAN

7. CONCLUSION AND RECOMMENDATION

The major environmental issues in the Study Area have no direct relevance to this proposed master plan of erosion and sediment control as illustrated in foregone Chapter 5. While, the insignificance of direct environmental concerns by this master plan is illustrated in Chapter 6.

It is concluded that the proposed master plan is an environmental improvement plan. This plan is aimed at disaster mitigation of erosion debris run-off exacerbated, if not caused, by deforestation and unsustainable agricultural practice in sloping terrains of Merendon mountain area and flood mitigation by drainage improvement in the low land Sula Valley area.

In addition the following recommendations are made based on the findings of this preliminary environmental study.

1. Conservation of Lagoon Ecology

   The lagoons in the low land Sula Valley area possess the potential for conservation and development of aquatic and wetland flora, fauna and fish (aquaculture) resources. This is referred to as conservation of lagoon ecology.

   The lagoons require water quality enhancement for realizing this ecological conservation. This would require a lagoon water quality enhancement programme to identify and regulate the major pollution run-off sources into a lagoon, regular removal of aquatic weeds like Eichornia crassipes (Jacinto acuatico/Water hyacinth) and Pistia stratiotes (Lechuga) as the means of excess nutrient removal from lagoon, and a lagoon water quality monitoring.

   The improvement of lagoon water quality will enhance the species diversity of aquatic flora and fauna and fish, and hence their conservation and development. This will also lead to other secondary beneficial effects of enhanced recreation potential of lagoon such as swimming, fishing and other water contact activities.

   In this regard, legal protection of some major lagoons like Jucutuma and Ticamaya as wildlife sanctuaries or national parks may be considered, as the means of ensuring habitats for even the endangered species.

2. Soil Conservation in Sloping Terrains

Soil conservation in sloping terrains, particularly in the Merendon mountain ranges, is the most effective means of erosion and flood control at source, and hence disaster mitigation.

In this regard, the ongoing reforestation programme by DIMA in the deforested areas of Merendon mountains is recommended to be intensified. Potential species of reforestation are shown in *Table* 2.1. The Choloma portion of the Merendon mountain range, where agricultural and related land use is dominant, urgently requires an appropriate soil conservation programme with reforestation, agroferestaion and agricultural practice with erosion control like terracing.

Moreover a detailed inventory survey of identification and classification of flora species in this mountain area is recommended.

3. Environmental Monitoring

Environmental monitoring is the basic step in realizing a sound environmental management. As the initial step in this direction, a stream and lagoon water quality monitoring programme is recommended to be established. In addition measures to regulate domestic, industrial and other pollutant run-off with appropriate wastewater treatment programmes prior to final disposal shall be established.

4. Land Acquisition and Compensation

The required land acquisition, house compensation and resettlement of population for the required facilities of this master plan are recommended to be expedited by the concerned agencies like SECOPT and the respective municipalities of San Pedro Sula and Choloma.

Prompt action to acquire and reserve the required land area, for both the right of way and the entire planned facilities of river improvement works, embankments and diversion channel to link Rio Blanco with Rio El Sauce, is the most effective means to mitigate and minimize both the inevitable social impacts of population resettlement and the cost of compensation. This would ensure the implementation of the plan on schedule.

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ANNEX - 1

ECOLOGY

TABLE 1 COMMON FLORA SPECIES IN STUDY AREA

I. LOWLAND AREA

a) COMMNON AQUATIC SPECIES IN THE LAGOONS AND WETLANDS

COMMON NAME	SCIENTIFIC NAME
1. Jacinto o lirio	Eichornia crassipes + af
2. Lechuga	Pistia stratiotes
3. Tifa	Typha sp.
4. Camalote	Paspalum sp.
5. Ninfa	Nymphaea sp.
6. Junco	Thalia sp. + fb
7. zacate	Cyperus sp.
8. Lemna	Lemna minor

b) COMMON TERRESTRIAL SPECIES

COMMON NAME	SCIENTIFIC NAME
1. Ceiba	Ceiba pentandra + t
2. Guanacaste	Enterolobium cyclocarpum + t
3. Coyol	Acrocomia mexicana + f
4. Carao	Cassia grandis + f
5. Guarumo	Cecropia sp.
6. Higuero \ Higo	Ficus sp.
7. Madreado	Gliricidia sepium + lf
8. Negrito	Simaruba glauca + f
9. Macuelizo	Tabebuia rosea + t

COMMON NAME	SCIENTIFIC NAME	
10. Tamarindo	Tamarindus indica	+ f
11. Corozo	Orbignya cohume	+ i ; f
12. San Juan	Vochysia hondurensis	+ t
13. Tuna	Opuntia deamii	
14. Guácimo \ Caulote	Guazuma ulmifolia	+ lf
15. Chaparro	Curatela americana	
16. Paterna	Inga paterna	
17. Guayaba	Psidium guajaba	+ f
18. Bijao	Heliconia bihai	
19. Manaca	Attalea coyune	+ c
20. Guapinolillo	Cynometra retusa	
21. Pito \ Gualiqueme	Erythrina glauca	+ lf
22. Pito	Erythrina berteroana	+ lf

af= animal feed   f= fruits   c= construction
fb= fiber   lf= live fence
t= timber   i= industrial oil production

II. MOUNTAIN AREA .- MERENDON MOUNTAIN

COMMON TERRESTRIAL SPECIES FROM 60-500 meters.

COMMON NAME	SCIENTIFIC NAME
1. Guanacaste blanco	Albizzia caribaea + t
2. Frijolillo	Astronium graveolens
3. Jobo	Spondias mombin
4. Cortes	Roseodendron donell-smithii +* t
5. Macuelizo	Tabebuia guayacan +* t
6. Balsa/Mozote	Ochroma pyramidala
7. Laurel negro	Cordia gerascanthus +* t
8. Carao	Cassia grandis
9. Paleto/tamarindo	Dialium guianansis
10. Guapinol	Hymanaea courbaril
11. Tambor	Schizollobium parahybum
12. Guapinolillo	Cynometra retusa
13. Cachimbo	Crataeva tapia
14. Hance de montaña	Clethra macrophylla
15. Guaco	Hernandia sonora
16. Guaco	Ocotea caniculata
17. Madreado	Gliricidia sepium +* lf
18. Manzano	Bellucia axinanthera
19. Carbón	Guarea brevianthera + fw
20. Carbón colorado	Guarea glabra + fw
21. Caoba	Switenia macrophylla +* t
22. Gualiqueme\ Pito	Erythrina glauca +* lf
23. Pino	Pinus caribaea + t
24. Roble	Quercus sp. + fw

COMMON NAME	SCIENIIFIC NAME
25. Hule	Castilla elástica
26. Guanacaste	Enterolobium cyclocarpum + t
27. Almendro de rio	Andira inermis
28. Candelillo	Albizzia adinocephala
29. Espino	Zanthoxylum belizence
30. Tela	Zanthoxylum microcarpum
31. Caulote \ Guacimo	Guazuma ulmifolia +* lf
32. Castaño	Sterculia apetala
33. Caulote blanco/contamal	Luehea seemannii
34. Cortes de la Costa	Tabebuia chrysantha + t
35. Zapote	Calocarpum mamosum + f
36. Corozo	Orbignya cohume + f; i
37. Guayaba	Psidium guajaba + f
38. Indio desnudo	Bursera simaruba
39. Negrito	Simaruba glauca + f
40. Guarumo	Cecropia sp.
41. Cedro real	Cedrela odorata +* t
42. Cojón de burro	Stemmadenia donell-smithii
43. Cojón de mico	Tabernaemontana chrysocarpa
44. Cincho	Lonchocarpus sp.
45. Guayabillo	Terminalia chiriquensis
46. Higo \ Higuero	Ficus sp.
47. Ceibo	Ceiba pentandra + t
48. San Juan	Vochysia guianensis +* t
49. Barba de jolote	Pithecolobium sp.
50. Mango	Manguifera indica +* f
51. Guama	Inga sp.
52. Capulin	Trema sp.
53. Nance	Byrsonima crassifolia. + f

t= timber   i = industrial oil production
f= fruits
fw = firewood
lf = live fence

COMMON TERRESTRIAL SPECIES 500-1000 METERS

COMMON NAME	SCIENTIFIC NAME	
1. Encino	Quercus sp.	+ c ; fw
2. San Juan Colorado	Vochysia ferruginea"	+ t
3. San Juan Rojo	Vochysia guianensis	+ t
4. Ciruelillo	Mosquitoxylon jamaicense	
5. Magaleto	Xylopia frutescens	
6. Cajón de Burro	Stemmadenia donell-smithii	
7. Arenillo	Ilex skutchii	
8. Ceibo	Ceiba pentandra	+ t
9. Laurel	Cordia diversifolia	+* c ; t
10. Guapinolillo	Cynometra retusa	
11. Kerosen	Tetragastris panamensis	+ fw ; t
12. Manchado	Billia hippocastanum	
13. Indio desnudo	Bursera simaruba	
14. Jagua	Magnolia hondurensis	+ t
15. Cucharo	Mangolia yoroconte	+ t
16. Llama del Bosque	Trichilia anisopleura	
17. Cola de Marrano	Pithecellobium longifolium	
18. Guarumo	Cecropia sp.	
19. Pito	Erythrina berteroana	+* lf
20. Chaperno negro	Lonchocarpus lasiotropis	+ If
21. Granadillo	Dalbergia tucurensis	+ t
22. Carreto	Albizzia longepedata	+ t
23. Barba de Jolote	Pithecellobium arboreum	
24. Maria	Callophyllum brasiliense	+ t
25. Nance	Byrsonima crassifolia	+ f
26. Guama	Inga sp.	
27. Corozo	Orbingnya cohume	+ f ; i
28. Guyabon	Terminalia amazonia	
29. Caoba	Swietenia macrophylla	+* t
30. Cedro	Cedrela odorata	+* t
31. Laurel	Cordia sp.	+* t

COMMON TERRESTIAL SPECIES FROM 1000-1500 METERS

COMMON NAME	SCIENTIFIC NAMNE
1. Pino	Pinus oocarpa +* t
2. Zorra	Jacaranda copaia
3. Sombra de ternero	Cordia bicolor +* t
4. Tontol	Protium sessiliflorum
5. Madreado de montaña	Swartzia panamensis
6. Quesillo	Alchornea latifolia
7. Pilón	Hicronyma alchorneoides
8. Palo Prieto	Pera barbellata
9. Lechero	Sapium aucuparium
10. Cacao de montaña	Carpotroche platyptera
11. Maria	Calophyllum brasilensis +* t
12. Jocote de mico	Rheedia intermedia
13. Aguacatillo negro	Nectandra gentlei
14. Pepenance	Byrsonima spicata
15. Cirin	Miconia argentea
16. Manzana Rosa	Eugenia jambos + f
17. Hormigo	Platysmiscius dimorphandrum
18. Pasa	Hirtella americana
19. Caimito	Chrysophyllum cainito + f
20. Tempisque	Mastichodendron capiri
21. Coloradito	Laplacea grandis
22. Liquidambar	Liquidambar styraciflua *
23. Guama	Inga sp. *
24. Peine de mico	Apeiba sp + t
25. Higo \ Higuero	Ficus sp.
26. Aguacatillo	Phoebe sp.
27. Achotillo	Sloanea sp.
28. Encino	Quercus sp. + fw
29. Aceituno	Mosquitoxylum jamaicense

COMMON TERRESTRIAL SPECIES ABOVE 1500 METERS

COMMON NAME	SCIENTIFIC NAME
1. Roble de Montaña	Quercus skinnerii +* fw
2. Liquidambar	Liquidambar styraciflua *
3. Cedro Negro	Junglans olanchana + t
4. Pino	Pinus maximinoi +* t
5. Ciprés	Cupressus sp. + t
6. Pino	Pinus patula subsp. tecuumanii +* t
7. Cojon de mico	Tabernaemontona chrysocarpa
8. Cojon de Burro	Stemmadenia donell-smithii
9. Frijolillo	Astronium graveolens
10. Mangle	Clusia Sp.
11. Peine de mico	Apeiba sp + t
12. Guarumo	Cecropia sp.
13. Manchador	Luehea sp.
14. Aguacatillo	Phoebe sp.
15. Aguacatillo	Ocotea Sp.
16. Labio de mujer	Cephaellis cerosa
17. Capuca	Chamaedorea Sp. + f
18. Pacaya	Chamaedorea Sp. + f
19. Cirin	Miconia Sp.
20. Uva de montaña	Tococa Sp.
21. Guama negra	Inga Sp.
22. Ciriaco	Cyathea Sp. + f
23. Gallinazos	Tillandsia Sp.
24. Zorzaparrilla	Smilax Sp.
25. Rompe piedra	Gunera Sp.

+ = Economically important species
* = recommended species for reforestation.

TABLE 2 COMMON FAUNA SPECIES IN STUDY AREA

1 . AMPHIBIANS

SCIENTIFIC NAME	COMMON NAME	HABITAT	STATUS
1.- Family Caecilidae			
1.1-Dermophis mexicanus	Tepelcuda	V	R
2.- Family Plethodontidae			
2.1-Bolitoglossa conanti	Cantil	M	R
2.2-Bolitoglossa dunni	Cantil	M	R
2.3-Bolitoglossa mexicana	Salamandra	V M	R
2.4-Nototriton nasalis	Cantil	M	R
3.-Family Bufonidae			
3.1-Bufo marinus	Sapo Comun	V M W	C
3.2-Bufo valliceps	Sapo	V M	C
4.- Family Centrolenidae			
4.1-Centrolenella fleischmani	Rana de Vidrio	V M	R
5.- Family Hylidae			
5.1-Agalychnis callidryas	Rana Ojos Rojos	V M	R
5.2-Hyla bromeliacea	Rana Arboricola	M	R
5.3-Hyla loquax	Rana Hyla	V M	R
5.4- Hyla microcephala	Rana Hyla	V M	R
5.5- Duellmanohyla soralia	Rana Ojos Rojos	M	R
5.6- Phrynohyas venulosa	Rana Ligosa	V M	C
5.7- Plectrohyla dasypus	Rana	M	R
5.8- Plectrohyla guatemalensis	Rana	M	C
5.9- Plectrohyla teuchestes	Rana	M	R
5.10-Ptychohyla hypomykter	Rana Arboricola	M	C
5.11-Smilisca baudinii	Rana Manchada	V M	C
6.- Family Leptodactylidae			
6.1- Eleutherodactylus gollmeri	Rana	V M	R
6.2- Eleutherodactylus milesi	Rana	M	R
6.3- Eleutherodactylus rugulosus	Rana	M	R
6.4- Eleutherodactylus rostralis	Sapito de Mascara	M	R
6.5- Leptodactylus labialis	Rana	V M	R
6.6- Hypopachus varioloseus	Sapito	V	R
7.- Family Ranidae			
7.1- Rana maculata	Rana	M	C
8.- Family Rhinophrynidae			
8.1- Rhinophrynus dorsalis	Sapo Buche	V	R

2. REPTILES

SCIENTIFIC NAME	COMMON NAME	HABITAT	STATUS
1.- Family Chelidridae			
1.1-Chelydra serpentina	Sambunango	W	R
2.- Family Emydidae			
2.1-Trachemys scripta	Jicotea	W	C
3.- Family Kinosternidae			
3.1-Kinosternon leucostomun	Culuca	W	C
4.- Family Staurotypidae			
4.1-Staurotypus triporcatus	Tortuga Tresquillas	W	R
5.- Family Alligatoridae			
5.1-Caiman crocodilus chiapasius	Caiman	W	E
6.- Family Crocodylidae			
6.1-Crocodylus acutus	Lagarto	W	E
7.- Family Anguidae			
7.1-Celestus montanus	Lisa	V M	R
7.2-Mesaspis moreleti	Lisa	V M	R
8.-Family Gekkonidae			
8.1-Coleonyx mitratus	Talconete	V	R
8.2-Sphaerodactylus dunni	Talconete	V	R
8.3-Thecadactylus rapicauda	Talconete	V	R
9.- Family Iguanidae			
9.1- Basiliscus vittatus	Charancaco	V M W	C
9.2-Corytophanes cristatus	Camaleon	V M	R
9.3- Ctenosaura similis	Garrobo gris	V	E
9.4- Laemanctus longipes	Soldado	M	R
9.5- Norops amplisquamosus	Pichete	M	R
9.6- Norops capito	Pichete	M	R
9.7- Norops lemurinus	Pichete	V	R
9. 8- Norops sericeus	Bebe leche	V M	C
9.9-Norops tropidonotus	Pichete	V M	C
9.10-Norops johnmeyeri	Pichete	M	R
9.11-Iguana iguana	Iguana Verde	V W	E
9.12-Sceloporus malachiticus	Pichete Escorpion	V M	C
9.13-Sceloporus variabilis	Pichete Escorpion	V M	C
10.-Family Sciucidae			
10.1-Mabuya mabouya	Lisa	V M	R
10.2-Sphenomorphus cherriei	Lisa	V M	C
11.-Family Teidae			
11.1-Ameiva festiva	Rimbo	V M	C
11.2-Ameiva undulata	Quijina	V M	C
11.3-Cnemidophorus deppei	Quijina Rayada	V	C
12. Family Xantusiidae			
12.1-Lepydophyma flavimaculatum	Talconete	V M	R
13.- Family Boidae			
13.1-Boa constrictor	Boa	V	E

14.- Family Colubridae					
14.1-Conophis lineatus	Guarda Caminos	V	M		C
14.2-Dryadophis dorsalis	Sonda		M		C
14.3-Drymarchon corais	Sumbadora	V	M		C
14.4-Drymobius chloroticus	Tamagas Verde	V	M		C
14.5-Drymobius margaritiferus	Tamagas verde	V	M		C
14.6-Elaphe flavirufa	Culebra	V			R
14.7-Enulius flavitorques	Culebra	V			R
14.8-Imantodes cenchoa	Bejuquilla	V	M		C
14.9- Lampropeltis triangulum	Falso coral		M		R
14.10-Masticophis mentovarius	Sumbadora	V			C
14.11-Ninia atrata	Culebra		M		R
14.12-Oxybelis aeneus	Bejuquilla cafe	V			C
14.13-Oxybelis fulgidus	Bejuquilla verde	V			C
14.14- Scaphiodontophis annulatus	Tamagas coral	V	M		R
14.15-Spilotes pullatus	Mica	V	M		C
14.16-Stenorrhina degenhardtii	Alacranera		M		R
14.17-Tretanorhinus nigroluteus	Culebra de agua	V		W	C
14.18-Tantilla schistosa	Culebra		M		R
15.- Family Elapidae					
15.1- Micrurus nigrocintus	Coral	V	M		R
16.- Family Viperidae					
16.1-Bothrops asper	Barba Amarilla	V	M		C
16.2-Bothriechis marchi	Tamagas verde		M		R
16.3- Crotalus durissus	Cascabel	V			R
16.4- Cerrophidiam godmani	Tamagas chingo	V	M		C

V= valley M= mountain W= wetland

C= common R = rare E= endangered

3 . BIRDS

SCIENTIFIC NAME	COMMON NAME	HABITAT	STATUS
1.- Family Anhingidae			
1.1.- Anhinga anhinga	Pato aguja	W	C
2.- Family Ardeidae			
2.1- Egretta thula	Garza pequeña	W	R
2.2.- Bubulcus ibis	Garza garrapatera	V,W	C
2.3.- Hydranassa tricolor	Garza oscura	W	R
2.4.- Heteroenus mexicanus	Ajoquin	W	R
2.5.- Ardea herodes	Garza blanca	W	R
2.6.- Casmerodius albus	Garzon	W	R
2.7.- Butorides striatus	Garcita verde	W	R
2.8.- Tigrisoma lineatum	Garza tigre	W	R
3.- Family Cochleariidae			
3.1.- Cochleurius cochleurius	Bujaja	W	R
4.- Family Ciconidae			
4.1.- Mycteria americana	Cigueña	W	R
5.- Family Anatidae			
5.1.- Dendrocygma autumnalis	Pichiche	W	C
5.2.- Cairina Moschata	Pato real	W	E
6.- Family Cathartidae			
6.1.- Coragyps atratus	Zopilote	V,M	C
6.2.- Cathartes aura	Zopilote	V,M	C
7.- Family Accipitridae			
7.1.- Elanus leucurus	Gavilan gris	V,M	R
7.2.- Leptodon caymanensis	Gavilan blanco y negro	V,M	R
7.3.- Accipiter bicolor	Aguilucho	M	R
7.4.- Buteo magnirostris	Gavilan cafe	V,M	C
7.5.- Buteo nitidus	Gavilan empedrado	V,M	C
7.6.- Buteogallus anthracinu	Gavilan cangrejero	W	C
7.7.- Morphanus guayanensis	Gavilan	M	R
7.8.- Spizaster melanoleucus	Aguilucho	V	R
7.9.- Spizaestus ornatus	Aguilucho	V,M	R
7.10.-Spizastus tyranus	Aguilucho	V,M	R
7.11.-Geranospiza caerulescens	Aguilucho	V,M,W	R
8.- Family Falconidae			
8.1.- Herpetotheres Cachinnans	Gavilan guaco	V,W	R
8.2.- Micrastur semitarquatus	Gavilan de collar	V,M	R
8.3.- Micraster ruficollis	Gavilan gris	V	R
8.4.- Daptrius americanus	Querque	V	R
8.5.- Poliborus plancus	Cara cara	V,M	C
8.6.- Falco rufigularis	Gavilan murcielaguero	V,M	R
8.7.- Falco sparverius	Lis lis	V,M	R
9.-Family Cracidae			
9.1.- Crax rubra	Pajuil	M	E
9.2.- Penelope purpurscens	Pava	M	E
9.3.- Ortalis vetula	Chachalaca	V,M	R
9.4.- Penelopina nigra	Pava negra	M	E
10.-Family Phasianidae			
10.1.-Odontophorus guttatus	Codornis/ Quail	V,M	R
11.-Family Rallidae			
11.1.-Gallinula chloropus	Gallinita negra	W	R
11.2.-Fulica americana	Patito negro	W	E
11.3.-Porphirula martinica	Gallinita de agua	W	R
12.-Family Heliornithidae			
12.1.-Heliornis fulica	Ave sol	W	R

13.-Family Jacanidae			
13.1.-Jacana spinosa	Gallito de agua	W	R
14.-Family Charadiidrae			
14.1.-Charadrius collaris			R
14.2.-Charadrius vociferus			R
15.-Family Scolopocidae			
15.1.-Actitis macularia	Alza colita	V,W	U
15.2.-Catoptrophorus semipalmatus	Arenero/sandpiper	V,W	U
15.3.-Gallinago gallinago	Common sandpiper	V,W	U
15.4.-Erolia minutilla	Least sandpiper	V,W	U
16.-Family Columbidae			
16.1.-Columba cayennensis	Paloma panza blanca	V,W	U
16.2.-Zenaida asiatica	Paloma ala blanca	V,M	C
16.3.-Scardafella inca	Turca cola larga	V,M	C
16.4.-Columbigallina talpacoti	Turquita empedrada	V	R
16.5.-Claravis pretiosa	Turquita celeste	V,W	R
16.6.-Leptotilla Verreauxi	Paloma cafe	V	R
16.7.-Leptotila plumbeiceps	Paloma cabeza gris	V	R
16.8.-Leptotila cassinii	Paloma	V	R
16.9.-Geotrygon albifacies	Paloma cara blanca	M	R
16.10.Columbina passerina	Tortolita	V,M	C
17.-Family Psittacidae			
17.1.-Aratinga astec	Perico verde	V	C
17.2.-Pionopsitta haematotis	Lora cabeza cafe	V	U
17.3.-Pionus senilis	Cotorra corona blanca	M	U
17.4.-Amazona albifrons	Maicero	V	C
17.5.-Amazona autumnalis	Naranjera	V,M	R
17.6.-Amazona ochrocephala	Lora nuca amarilla	V,M	E
18.-Family Cuculidae			
18.1.-Piaya Cayana	Pajaro leon	V,M,W	R
18.2.-Crotophaga Sulcirostris	Tijul	V,M	C
18.3.-Tapera naevia	Pajaro leon vareteado	V,M,W	R
18.4.-Dromococcyx phasianellus	Pajaro leon cafe	V,M	R
18.5.-Geococcyx velox	Correcaminos	V	R
19.-Family Tytonidae			
19.1.-Tyto alba	Lechuza	V,M	R
20.-Family Stringidae			
20.1.-Otus guatemalensis	Buho	V,M	R
20.2.-Pulsatrix perspicillata	Buho de anteojos	V,M	R
20.3.-Glaucidium brasilianum	Buho pigmeo	V,M	R
21.-Family Nyctibiidae			
21.1.-Nyctibis griseus	Pucuyo	V,M	C
22.-Family Caprimulgidae			
22.1.-Nyctidromus albicollis	Chotocabra	V,M	C
23.-Family Apodidae			
23.1.-Streptoprocne zanaris	Avioncito	V,M,W	U
24.-Family Trochilidae			
24.1.-Phaethornis longuemereus	Colibri	V	C
24.2.-Phaeocroa curieril	Colibri	V	U
24.3.-Campylopterus hemileucurus	Colibri	V,M	U
24.4.-Florigna mellivora	Colibri	V	U
24.5.-Colibri delphinae	Colibri	M	U
24.6.-Antracothorax provostii	Colibri	V,M	C
24.7.-Abeillia abeilei	Colibri	M	U
24.8.-Paphosia helene	Colibri	V	U
24.9.-Chlorostilbon canivetii	Colibri	V,M	U
24.10.Thalurania furenta	Colibri	V,M	U
24.11.Amazilia candida	Colibri	V,M	U
24.12.Amazilia cyanocephala	Colibri	M	C
24.13.Amazilia rutila	Colibri	V	C
24.14.Amazilia tzacatl	Colibri	V,M	U
24.15.Eupherusa eximia	Colibri	V,M	U
24.16.Lampornis viridipallens	Colibri	M	R
24.17.Heliothryx barroti	Colibri	V	U
24.18.Archilachus colubris	Colibri	V	U

25.-Family Trogonidae

25.1.-Trogon massona	Coa coa	V	U
25.2.-Trogon melanocephalus	Coa coa cabeza negra	V	U
25.3.-Trogon collarais	Coa coa de collar	V	U
25.4.-Trogon violaceus	Coa coa pecho amarillo	V	U

26.-Family Alcedinidae

26.1.-Chloroceryl amazona	Martin pescador	V,W	C
26.2.-Chloroceryl aenea	Martin pescador	V,W	C
26.3.-Megaceryle torquata	Martin pescador grande	V,W	C
26.4.-Megaceryle alcyon	Martin pescador	V,W	C

27.-Family Momotidae

27.1.-Hylomanes momotula	Torobos pigmeo	V	U
27.2.-Eumomota superaliosa	Taragon	V	U
27.3.-Momotus momota	Taragon	V	U

28.-Family Galbulidae

28.1.-Galbulus raficaudus	Jacamar	V,W	U

29.-Family Bucconidae

29.1.-Malacoptila panamensis	?	V,W	U

30.-Family Ramphastidae

30.1.-Aulacorhynchus prasinus	Tucan verde	M	U
30.2.-Pteroglossus torquatus	Tilis	V,M	U
30.3.-Ramphastus sulfuratus	Pico de navaja	V,M	U

31.-Family Picida

31.1.-Picumnus olivaceus	?	V	R
31.2.-Piculus rubiginosus	Carpintero verde	V,M	U
31.3.-Celeus castaneus	Checo de copete	V,M	R
31.4.-Dryocopus lineatus	Carpintero	V,M	R
31.5.-Melanopes formicivorous	Checo negro	V,M	R
31.6.-Melanerpes aurifrons	Checo comun	V,M	C
31.7.-Venichornis fumigatus	Checo cafe	V,M	R
31.8.-Phloeoceastes guatemalensis	Checo grande	M	R

32.- Family Dendrocolaptidae

32.1.-Dendrocinela homochroma	Trepatroncos cafe	M	U
32.2 .Sittasomus grisercapillus	Trepatroncos gris	M,W	U
32.3 .Glyphorynchus spirurus	Trepatroncos pequeño	V,M	U
32.4 .Dendrocoluptes carthia	Trepatroncos rayado	V	U
32.5 .Xiphorhynchus guttatus	Trepatroncos	V,M	U
32.6 .Xiphorhynchus flavigaster	Trepatroncos pico blanco	V,M	R
32.7 .Xiphorhynchus erythropygius	Trepatroncos empedrado	V,M	R
32.8 .Lepidocoluptes Souleyetii	Trepatroncos cabeza rayada	V,M	R

33.-Family Furnariidae

33.1.-Synallaxis erythrotorax	Hornero	V,M	U
33.2.-Anahaerthia variegaticeps	Hornero	V,M	U
33.3.-Xenops minutus	Hornero chiquito	V	U
33.4.-Sclerurus guatemalensis	Hornero garganta empedrada	V,M	U

34.-Family Formicariidae

34.1.-Taraba major	Hormiguero grande	V,M	U
34.2.-Thamnophilus dolintus	Hormiguero rayado	V,M	U
34.3.-Thamnophilus punctatus	Hormiguero gris	V	U
34.4.-Myrmotharula schisticolor	Hormiguero chico	V,M	U
34.5.-Microrhopius guaxensis	Hormiguero negro de alas pisquiadas	V	U
34.6.-Cereomacra tyrannina	Hormiguero gris	V	U
34.7.-Formicarius analis	Hormiguero cara negra	V	U
34.8.-Gymnopithys bicolor	Hormiguero	V,M	U
34.9.-Grallaria guatemalensis	Hormiguero empedrado	M	U

35.-Family Pipridae

35.1.-Pipra mentalis	Manakin cabeza roja	M	U
35.2.-Manacus candei	Manakin de collar	V	U
35.3.-Schiffornis turdinus	Manakin cafe	V,M	U

36.-Family Cotingidae

36.1.-Cotinga amabilis	Cotinga azul	V,M	U
36.2.-Attila spadiceus	Atila amarilla	V	U
36.3.-Rhytipterna holerythra	Mañanero cafe	V,M	U
36.4.-Platypsaris aglaiae	Garganta rosada	V,M	U
36.5.-Tityra semifasciata	Titita enmascarada	V, M	U
36.6.-Tityra inquisitor	Titira corona negra	V,M	U

37.-Family Tyrannidae			
37.1.-Muscivora forficata	Tijereta	V,M	U
37.2.-Muscivora tyrannus	Tijereta	V,M	U
37.3.-Tyrannus melancholicus	Chilero amarillo	V,M	C
37.4.-Megarhyncus pitangua	Chilero pico de zapato	V,M	C
37.5.-Myiozetetes similis	Chilero social	V	C
37.6.-Pitangus sulphuratus	Chilero Cristo fue	V	C
37.7.-Myiarhus crinitus	Chilero de copete	V	C
37.8.-Myiarhus tyrannulus	Chilero de copete	V	C
37.9.-Empidonax flaviventris	Chilero de copete	V	C
37.10.Empidonax minimus	Chilero chiquito	V,M	U
37.11.Empidonax flavescens	Chilero amarillento	M	U
37.12.Terenotriccus erythrurus	Chilero cola cafe	V	U
37.13.Myiobius barbatus	Chilero	V	U
37.14.Onychorhynchus mexicanus	Chilero real	V	U
37.15.Platyrhyncus mystaceus	Chilero pico ancho	V,W	U
37.16.Tolmomyas sulphurescens	Chilero	V	U
37.17.Rhynchocyclus brevirostris	Chilero	V,M	U
37.18.Todirostrum cinereum	Chilero	V	U
37.19.Todirostrum sylvia	Chilero	V	U
37.20.Oncostena cinereigulare	Chilero pico curvo	V	U
37.21.Elaenia flavogaster	Chilero	V	U
37.22.Elaenia frantzii	Chilero	M	U
37.23.Myiopagis viridicata	Chilero	V	U
37.24.Camptostoma imberbe	Chilero	V	U
37.25.Leptopogon amaurocephalus	Chilero corona cafe	V	U
37.26.Pipromorpha oleaginea	Chilero cintura ocre	V	U
38. Family Hirundinidae			
38.1.-Progne chalybea	Golondrina pecho gris	V,M	C
39 - Family Corvidae			
39.1.-Psilorhinus morio	Urraca cafe/ pia pia	V,M	C
39.2.-Cyanocorax Yncas	Urraca verde	V,M	U
39.3.-Cyanolyca cucullata	Urraca azul	M	U
40.-Family Troglodytidae			
40.1.-Campylorhynchus yufinucha	Sacacolchon cafe	V	C
40.2.-Thryothorus modestus	Sacacolchon	V,M	U
40.3.-Thryothorus maculipectus	Sacacolchon con lunares en el pecho	V	U
40.4.-Troglodytes aedon	Sacacolchon comun	V,M	C
40.5.-Henicorhina leucosticta	Sacacolchon pecho blanco	V,M	U
40.6.-Henicorhina leucophrys	Sacacolchon pecho gris	M	U
40.7.-Microcerculus marginatus	Sacacolchon pigmeo cafe	V,M	U
41.- Family Mimidae			
41.1.-Dumetella carolinensis	?	V	U
42.-Family Turdidae			
42.1.-Turdus assimilis	Zorzal garganta blanca	V,M	R
42.2.-Turdus grayi	Zorzal cafe	V,M	C
42.3.-Myadestes unicolor	Zorzal gris	V,M	U
42.4.-Hylocichla mustelina	Zorzal	V	U
42.5.-Catharus ustulatus	Zorzal	V,M	U
42.6.-Catharus mexicanus	Zorzal	M	U
43.- Family Vireonidae			
43.1.-Hylophylus ochraceiceps	Chipe	V, M	U
43.2.-Hylophylus decurtatus	Chipe	V,M	U

44.-Family Coerebidae			
44.1.-Cyanerpes cyaneus	Chipe azul	V	U
44.2.-Coereba flaveola	Bananaquit	V	U
45.- Family Parulidae			
45.1.-Mniotilta varia	Black and White warbler	V,M	U
45.2.-Helmintheros vermivorus	Come gusanos	V,M	U
45.3.-Vermivora peregrina	Warbler de Tennessee	V	U
45.4.-Dendroica magnolia	Chipe amarillo	V,M,W	U
45.5.-Dendroica coronata	Chipe garganta blanca	V,M	U
45.6.-Dendroica virens	Chipe garganta negra	V,M	U
45.7.-Dendroica cerulea	Chipe pecho blanco	V,M	U
45.8.-Dendroica petechia	Chipe amarillo	V,M	C
45.9.-Dendroica pensylvanica	Chipe	V,M	U
45.10.Seiurus aurocapillus	Chipe corona dorada	V,M	U
45.11.Seiurus noveboracensis	Chipe norteño	V	U
45.12.Geothlypis trichas	Chipe garganta amarilla	V	U
45.13.Geothlypis poliocephala	Chipe corona gris	V	U
45.14.Icteria virens	Chipe pecho amarillo	V	U
45.15.Wilsonia citrina	Chipe cabeza y cuello negro	V	U
45.16.setophaga nutieilla	Chipe negro y cafe	V	U
45.17.Myioborus miniatus	Chipe	V	U
45.18.Basileuterus eulicivorus	Chipe corona dorada	V	U
46.-Family Icteridae			
46.1.-Zarhynchus wagleri	Oropendola pequeña	V,M	U
46.2.-Gymnostinops monctezumae	Oropendola grande	V,M W	U
46.3.-Amblycereus holosericeus	Cacique	V,M	U
46.4.-Scaphidura oryzivora	Cacique grande	V	U
46.5.-Tangavius aeneus	Cacique ojo rojo	V	U
46.6.-Quiscalus mexicanus	Zanate / Clarinero	V,M,W	C
46.7.-Dives dives	semillero negro	V	C
46.8.-Icterus spurius	Chorcha cafe	V,M	U
46.9.-Icterus prosthemelas	Chorcha amarillo y negro	V,M	U
46.10.Icterus mesomelas	Chorcha cola amarilla	V,M,W	U
46.11.Icterus chrysater	Chorcha espalda amarilla	M	U
46.12.Icterus gularis	Chorcha garganta negra	V	U
46.13.Icterus galbula	Chorcha dorada	V	U
46.14.Agelaius phoeniceus	Sargento	V,W	C
47.- Family Thraupidae			
47.1.-Chlorophonia occipitalis	Rualdo	M	U
47.2.-Tanagra affinis	Pintado	M	U
47.3.-Tanagra lauta	Pintado	M	U
47.4.-Tanagra gouldi	Pintado	M	U
47.5.-Tanagra larvata	Siete colores	V,M	U
47.6.-Thraupis virens	Azulejo	V,M	U
47.7.-Thraupis abbas	Azulejo ala amarilla	V,M	U
47.8.-Ramphocelus passerinii	Espalda roja	V,M	U
47.9.-Phlogothraupis sanguinolenta	Cuello rojo	V,M	U
47.10.Piranga rubra	Tanagra rojo	V,M	U
47.11.Piranga leucoptera	Tanagra barrasa blancas	M	U
47.12.Piranga bidentata	Tanagra alas blancas	M	U
47.13.Habia rubica	Tanagra corona roja	V,M	U
47.14.Habia fuscicauda	Tanagra garganta roja	V,M	U
47.15.Lanio aurantius	Tanagra garganta negra	V,M	U
47.16.Eucometis penicillata	Tanagra cabeza gris	V	U
47.17.Chlorospingus ophthalmicus	Tanagra comun	M	U

48.- Family Fringillidae			
48.1.-Saltator atriceps	Saltador cabeza negra	V,M	U
48.2.-Saltator maximus	Saltador garganta amarilla	V,M	U
48.3.-Saltator coerulescens	Saltador gris	V,M	U
48.4.-Caryothraustes poliogaster	Semillero amarillo	V,M	U
48.5.-Pheuebleus ludovicianus	Semillero pecho rosado	V,M	U
48.6.-Cyanocompsa cyanoides	Semillero azul oscuro	V,M	U
48.7.-Cyanocompsa parellina	Semillero negro	V,M	U
48.8.-Passerina cyanea	Semillero azul	V,M	U
48.9.-Passerina ciris	Semillero Verde violeta y rojo	V,M	U
48.10.Spiza americana	Dickeissel	V,M	U
48.11.Sporophila torqueola	Semillero blanco y negro	V,M,W	C
48.12.Sporophila aurita	Semillero negro	V	U
48.13.Volatinia jacarina	Semillero negro	V,M	C
48.14.Atlapetes brunneinucha	Saltador cabeza cafe	M	U
48.15.Arremonops chloronotus	SaltadorEspalda grande	V,M	U
48.16.Passerculus sandwichensis	Saltador de savanas	V,W	U
48.17.Chondestes grammacus	Saltador cabeza de codornis	V	U
48.18.Spinus notatus	Semillerocabeza negra	V,M	U
49.- Family Phalacrocoracidae			
49.1.-Phalacrocorax olivaceus	Cormoran	W	C
50.- Family Threskgornithidae			
50.1- Ajaia ajaja	Espatula rosada	W	R

V= valley M= mountain W= wetland

C= common R= rare E= endangered U= unknown

4. MAMMALS

SCIENTIFIC NAME	COMMON NAME	HABITAT	STATUS
1.-Family Didelphidae			
1.1- *Didelphis marsupialis*	Tacuazín	V M W	C
1.2- *D. virginiana*	Tacuazín	V M	U
1.3- *Marmosa alstoni*	Marmosa	V M	U
1.4- *M. mexicana*	Marmosa	V M	U
1.5- *Metachirops opossum*	Perrito de Agua	V W	U
1.6- *Chironectes minimus*	Cuatro Ojos	V W	U
1.7- *Caluromys dervianus*	Perrito de Agua	V W	U
2.-Family Emballonuridae			
2.1- *Rhynchonycteris naso*	Murciélago	V M	U
2.2- *Saccopteryx biliniata*	Murciélago	V M	U
2.3- *Diclidurus virgo*	Murciélago	V M	U
3.-Family Noctilionidae			
3.1- *Noctilio leporinus*	Murciélago	V W	C
3.2- *N. alviventris*	Murciélago	V	U
4.-Family Mormoopidae			
4.1- *Pteronotus parnellii*	Murciélago	V	U
5.-Family Phyllostomidae			
5.1- *Micronycteis magalotis*	Murciélago	V	U
5.2- *Tonatia minuta*	Murciélago	V	U
5.3- *Glossophaga soricina*	Murciélago	V M	U
5.4- *Carollia perspicillata*	Murciélago	V M	U
5.5- *Vampiressa pusilla*	Murciélago	V	U
5.6- *Ectophilla alba*	Murciélago Blanco	V	U
5.7- *Artibeus cinereus*	Murciélago	V M	U
5.8- *A. toltecus*	Murciélago	V	U
5.9 *A. aztecus*	Murciélago	V	U
5.10 *A. jamaicensis*	Murciélago	V M W	U
5.11 *A. literatus*	Murciélago	V M W	U
6.- Family Desmodontidae			
6.1- *Desmodus rotundus*	Murciél. Vampiro	V	U
7.-Family Thyropteridae			
7.1- *Thyroptera discifera*	Murc. de Ventosas	V	U
8.-Family Vespertilionidae			
8.1- *Myotis nigricans*	Murciélago	V	U
8.2- *M. riparius*	Murciélago	V W	U
9.- Family Molossidae			
9.1- *Tadarina brasiliensis*	Murciélago	V	U
9.2- *Molossus pretiosus*	Murciélago	V	U
10.- Family Cebidae			
10.1- *Allouata palliata*	Mono Congo	V M W	E
10.2- *Atelles geofroyi*	Mono Araña	M	E
10.3- *Cebus capucinus*	Mono Cara Blanca	V M W	E
11.- Family Bradypodidae			
11.1- *Choloepus hoffmanni*	Perezoso 2 Dedos	V M	E
11.2- *Bradypus variegatus*	Perezoso 3 Dedos	V M	E
12.- Family Mymercophagidae			
12.1- *Myrmecophaga tridactyla*	Oso Caballo	V	E
12.2- *Cyclopes didactylus*	Pereza, Angel	V M	U
12.3- *Tamandua mexicana*	Oso Hormiguero	V W	U
13.-Family Dasypodidae			
13.1- *Cabassous centralis*	Tumbo Armado	V M	C
13.2- *Dasypus novemcinctus*	Cusuco	V M	C
14.-Family Leporidae			
14.1- *Sylvilagus brasiliensis*	Conejo	V M	C
14.2- *S. floridanus*	Conejo	V M	C
15.- Family Sciuridae			
15.1- *Sciurus deppei*	Ardilla Mora	V M	C
15.2- *S. variegatoides*	Ardilla Jaspeada	V M	C

16.- Family Geomyidae			
16.1- *Orthogeomys grandis*	Taltuza, Topo	V	U
16.2- *O. matagalpae*	Taltuza, Topo	V	U
17.-Family Muridae			
17.1- *Sigmodon hispidus*	Rata Espinoza	V M	U
18.-Family Erethizontidae			
18.1- *Coendu mexicanus*	Puerco Espin	V M	U
19.-Family Agoutidae			
19.1- *Agouti paca*	Tepescuinte	V M	U
19.2- *Dasyprocta punctata*	Guatuza	V M	U
20.-Family Cannidae			
20.1- *Urocyon cinereoargenteus*	Zorra	V M	C
20.2- *Canis latrans*	Coyote	V M	R
21.- Family Procyonidae			
21.1- *Procyon lotor*	Mapache	V M W	C
21.2- *Nasua narica*	Pizote	V M W	C
21.3- *Potos flavus*	Mico de Noche	V M W	C
21.4- *Bassaricyon gabii*	Rintel	M	R
22.- Family Mustelidae			
22.1- *Mustela frenata*	Comadreja	V M	R
22.2- *Eira barbara*	Lepasil, Cadejo	V M	R
22.3- *Galictis vittata*	Grisón	V	R
22.4- *Spilogale putorius*	Zorrillo	V M	U
22.5- *Mephitis macroura*	Zorrillo	V M	U
22.6- *Conepatus mesoleucus*	Zorrillo	V M	U
22.7- *C. semistriatus*	Zorrillo	V M	U
22.8- *Lutra longicaudis*	Nutria	V W	E
23.-Family Felidae			
23.1- *Felis pardalis*	Tigrillo	V M	E
23.2- *F. wiedii*	Tigrillo	V M	E
23.3- *F. yagouaroundi*	Gato de Monte	V M W	R
23.4- *F. concolor*	León de Montaña	V M	E
23.5- *Panthera onca*	Tigre	V M W	E
24.- Family tapiridae			
24.1- *Tapirus bairdii*	Danto, Tapir	M W	E
25.-Family Tayassuidae			
25.1- *Tayassu tajacu*	Jagüilla	V M	E
25.2- *T. pecari*	Quequeo	V M	E
26.- Family Cervidae			
26.1- *Odocoileus virginianus*	Venado	V M	R
26.2- *Mazama americana*	Güisisil	V M	R

V = Valley
M = Mountain
W = Wetland: Lagoons, riparian habitat or floodplains
R = Rare: Population low but available habitat
C = Common
E = Endangered: Low population due to habitat destruction and ecological stresses
U = Population status unknown.

TABLE 3 COMMON FISH SPECIES IN THE SULA VALLEY

FAMILY	SCIENTIFIC NAME	COMMON NAME	HABITAT
CHARACIDAE	Astynax fasciatus	sardina	R,L
	Brycon guatemalensis	machaca	R
	Hypohessobrycon milleri	sardina	R,L
GYMNOTIDAE	Gymnotus cylindricus	anguila	R
PIMELODIDAE	Rhamdia guatemalensis	bagre	R,L
	Rhamdia cabrerae	juilin	R,L
	Rhamdia motaguensis	juilin	R
CYPRINODONTIDAE	Profundulus guatemalensis	olomina	R,L
	Rivulus tenuis	olomina	R,L
	Rivulus godmani	olomina	R,L
POECILIIDAE	Alfaro huberi	olomina	R,L
	Poecilia mexicana	olomina	R,L
	Poecilia sphenops	olomina	R,L
	Xiphophorus helleri	olomina	R,L
	Gambusia nicaraguensis	olomina	R,L
	Belonesox belizianus	pepesca	R
	Heterandria bimaculata	olomina	R,L
	Poeciliopsis gracilis	olomina	R,L
	Phallichthys amates	olomina	R,L
SYMBRANCHIDAE	Symbranchus marmoratus	anguila	R
CICHLIDAE	Cichlasoma maculicauda	bocachele o chocolatera	R
	Cichlasoma spilurum	congo o chan-cha.	R,L
	Cichlasoma octofasciatum	congo	R,L
	Cichlasoma urophthalmus	galaxia	R,L
	Cichlasoma friedrichthalii	guapote	R,L
	Cichlasoma motaguense	guapote	R,L
	Cichlasoma managuense	guapote tigre	R,L
	Cichlasoma robertsoni	congo	R,L
	Tilapia sp.	Tilapia	R,L

N.B. Olominas are also known as bubuchas

Habitats : R = rivers
L = lagoons

ANNEX - 2

WATER QUALITY

TABLE 1A WATER QUALITY SAMPLING RESULTS IN STUDY AREA (JUNE 1993)

No	LOCATION	DATE /TIME	T °C	Col, PtCo	Odor	Tur, NTU	pH	E.C. υMHOS	D.O. mg/l	BOD mg/l
1	RIO MUJAINE	21-6 11:47	28	47	N.O.	2.2	7.6	160	7.5	0.7
2	RIO LA JUTOSA	21-6 12:14	29.8	16	N.O.	1.4	7.3	194	7.2	1.0
3	RIO CHOLOMA	21-6 13:02	31.5	64	N.O.	6.0	7.5	225	6.02	1.1
4	CANAL SAN ROQUE	21-6 14:03	29	177	F	4.2	6.9	1900	0.05	8.8
5	RIO CHAMEL/COPEN	22-6 17:16	29.4	424	F	240	7.0	375	4.55	3.7
6	RIO CHAMEL/BRIDGE	21-6 6:05	29.5	518	N.O.	360	7.25	450	6.8	1.4
7	RIO PIEDRAS	21-6 7:51	23.3	36	N.O.	1.2	7.55	176	8.02	0.5
8	RIO SANTA ANA	21-6 9:17	23.5	46	N.O.	2.1	7.7	89	7.25	0.4
9	RIO BLANCO	21-6 10:05	30.5	261	N.O.	32	7.45	100	7.25	0.6
10	RIO EL SAUCE	22-6 18:21	31	387	F	36	6.8	3800	0.25	77.8
11	RIO CHOTEPE	22-6 19:19	30	394	F	54	6.5	5600	0.05	121.4
12	LAGUNA JUCUTUMA	22-6 18:02	32	405	U	29	6.9	640	7.85	5.7
13	LAGUNA TICAMAYA	22-6 16:30	31	79	U	7.6	6.7	920	3.35	8.8
14	LAGUNA LAMA	22-6 15:30	32	161	U	10	7.1	514	3.28	3.8
15	LAGUNA EL CARMEN	21-6 10:45	27.5	292	U	24	7.1	112	0.95	3.4

N.O. = No Odor
U = Unpleasent
F = Foul

TABLE 1B WATER QUALITY SAMPLING RESULTS IN STUDY AREA (JUNE 1993)

No	LOCATION	COD mg/l	S.S. mg/l	N-NH4 MG/L	N-org mg/l	T-P mg/l	Cl mg/l	F.c/100	T.c./100
1	RIO MUJAINE	13	6.0	0.014	< 0.150	0.028	4.14	30	300
2	RIO LA JUTOSA	14	5.6	0.010	< 0.150	0.016	1.24	10	310
3	RIO CHOLOMA	16	17.2	0.005	< 0.150	0.049	6.55	150	710
4	CANAL SAN ROQUE	23	5.2	0.245	0.584	0.206	11.52	300 000	>1000000
5	RIO CHAMEL/COPEN	112	282	1.705	0.375	0.396	8.6	100 000	>1000000
6	RIO CHAMEL/BRIDGE	84	987.5	0.098	0.120	0.035	3.58	300	900
7	RIO PIEDRAS	10	5.2	0.081	< 0.1	0.011	3.67	10	190
8	RIO SANTA ANA	18	7.2	0.061	< 0.1	0.012	2.84	70	360
9	RIO BLANCO	12	88.1	0.056	< 0.1	0.017	3.54	60	450
10	RIO EL SAUCE	214	990	8.709	0.750	0.747	7.61	160 000	>1000000
11	RIO CHOTEPE	268	109	1.601	0.630	1.064	7.17	125 000	>1000000
12	LAGUNA JUCUTUMA	126	70	0.089	0.840	0.418	37.75	2 800	>30 000
13	LAGUNA TICAMAYA	185	8.0	0.152	0.480	0.042	58.31	2 500	>30 000
14	LAGUNA LAMA	144	22.8	0.074	0.590	0.104	8.15	1 500	>15 000
15	LAGUNA EL CARMEN	158	26	0.081	0.150	0.033	6.38	1 500	5 000

F.c./100 = fecal coliform /100 ml   T.c./100 = Total coliform/100 ml

TABLE 1C WATER QUALITY SAMPLING RESULTS IN STUDY AREA (JUNE 1993)

No	LOCATION	Fe mg/l	Mn mg/l	Cr-hex mg/l	Pb mg/l	Cu mg/l	Cd mg/l	Zn mg/l
1	RIO MUJAINE	0.04	N.D.	0.005	0.0125	0.0071	N.D.	0.0042
2	RIO LA JUTOSA	0.01	N.D.	0.008	0.0168	0.0070	N.D.	0.010
3	RIO CHOLOMA	0.01	0.02	0.006	0.0119	0.0075	N.D.	0.006
4	CANAL SAN ROQUE	0.28	N.D.	0.04	0.0115	0.0054	N.D.	0.059
5	RIO CHAMEL/COPEN	0.41	N.D.	0.005	0.0179	0.0104	N.D.	0.013
6	RIO CHAMEL/BRIDGE	0.80	0.02	N.D.	0.0242	0.0147	N.D.	0.38
7	RIO PIEDRAS	N.D.	N.D.	0.008	0.0144	0.0094	N.D.	0.017
8	RIO SANTA ANA	N.D.	0.02	0.020	0.0132	0.0111	N.D.	0.013
9	RIO BLANCO	0.1	N.D.	0.020	0.0086	0.0095	N.D.	0.006
10	RIO EL SAUCE	1.80	0.02	0.020	0.0163	0.0056	N.D.	0.015
11	RIO CHOTEPE	0.80	N.D.	N.D.	0.0161	0.0048	N.D.	0.008
12	LAGUNA JUCUTUMA	0.15	N.D.	0.003	0.0177	0.0060	N.D.	0.007
13	LAGUNA TICAMAYA	0.28	N.D.	0.004	0.0175	0.0053	N.D.	0.015
14	LAGUNA LAMA	0.28	N.D.	0.02	0.0186	0.0048	N.D.	0.010
15	LAGUNA EL CARMEN	0.35	N.D.	0.007	0.0156	0.0074	N.D.	0.002

TABLE 2A WATER QUALITY SAMPLING RESULTS IN STUDY AREA (AUGUST 1993)

No	LOCATION	DATE	TIME	T 'C	Col. PtCo	Odor	Tur. NTU	pH	E.C. uMHOS	D.O. mg/l	BOD mg/l
1	RIO MUJAINE	VIII-2	15:50	27.5	21	N.O.	2.5	7.4	166	7.8	0.8
2	RIO LA JUTOSA	VIII-2	16:30	29	36	N.O.	3.2	7.1	185	6.95	1.1
3	RIO CHOLOMA	VIII-2	17:35	31	43	N.O.	5.2	7.4	240	6.77	1.0
4	CANAL SAN ROQUE	VIII-3	12:50	28.5	136	F	8.0	6.8	890	1.87	4.9
5	RIO CHAMEL/COPEN	VIII-3	11:20	28.5	1413	F	124	6.8	325	4.6	2.1
6	RIO CHAMEL/BRIDGE	VIII-2	11:10	29	42	N.O.	42	7.3	525	7.62	1.5
7	RIO PIEDRAS	VIII-2	11:45	23	10	N.O.	0.6	7.4	168	7.65	0.6
8	RIO SANTA ANA	VIII-2	12:25	25	19	N.O.	0.7	7.4	94	6.85	0.5
9	RIO BLANCO	VIII-2	14:00	31	71	N.O.	6.2	7.35	105	8.3	0.6
10	RIO EL SAUCE	VIII-3	09:12	29.5	1024	F	116	6.7	4100	3.65	52.4
11	RIO CHOTEPE	VIII-3	10:30	27.5	172	F	172	6.7	6000	2.6	89.2
12	LAGUNA JUCUTUMA	VIII-3	16:15	29.2	224	U	10	6.8	529	4.55	3.6
13	LAGUNA TICAMAYA	VIII-3	15:32	31	73	U	4.2	6.6	925	2.95	3.1
14	LAGUNA LAMA	VIII-3	14:28	29.8	152	U	4.6	7.2	410	2.52	2.8
15	LAGUNA EL CARMEN	VIII-2	14:50	29.7	173	U	10	7.2	170	2.95	3.7

N.O. = No Odor
U = Unpleasant
F = Foul

TABLE 2B WATER QUALITY SAMPLING RESULTS IN STUDY AREA (AUGUST 1993)

No	LOCATION	COD mg/l	S.S. mg/l	N-NH4 MG/L	N-org mg/l	T-P mg/l	Cl mg/l	Fec Col	Tot col
1	RIO MUJAINE	13	1.6	0.018	< 0.160	0.105	4.20	20	350
2	RIO LA JUTOSA	13	10.25	0.010	< 0.160	0.095	1.86	10	410
3	RIO CHOLOMA	14	16.5	0.030	< 0.160	0.160	7.01	120	850
4	CANAL SAN ROQUE	18	36	0.308	0.522	0.504	8.75	100000	>600000
5	RIO CHAMEL/COPEN	128	167.4	1.113	0.344	0.288	6.19	68000	>600000
6	RIO CHAMEL/BRIDGE	60	55.3	0.061	0.140	0.208	3.26	250	650
7	RIO PIEDRAS	10	12.5	0.012	< 0.1	0.020	3.16	0	80
8	RIO SANTA ANA	12	12.0	0.014	< 0.1	0.060	1.44	10	250
9	RIO BLANCO	13	46	0.044	< 0.1	0.088	2.98	30	180
10	RIO EL SAUCE	198	1361	1.128	0.672	0.264	6.83	145000	>1000000
11	RIO CHOTEPE	217	447.5	1.217	0.764	0.485	6.55	150000	>600000
12	LAGUNA JUCUTUMA	130	15.7	0.054	0.298	0.373	36.4	3000	>150000
13	LAGUNA TICAMAYA	160	9.4	0.069	0.336	0.027	60.1	2000	>150000
14	LAGUNA LAMA	140	30.5	0.054	0.548	0.338	8.45	1000	> 50000
15	LAGUNA EL CARMEN	144	26	0.066	0.160	0.190	7.21	1800	4500

TABLE 2C WATER QUALITY SAMPLING RESULTS IN STUDY AREA (AUGUST 1993)

No	LOCATION	Fe mg/l	Mn mg/l	Cr-hex mg/l	Pb mg/l	Cu mg/l	Cd mg/l	Zn mg/l
1	RIO MUJAINE	0.03	N.D.	0.010	0.027	0.005	N.D.	0.021
2	RIO LA JUTOSA	N.D.	N.D.	0.019	0.024	0.011	N.D.	0.029
3	RIO CHOLOMA	N.D.	N.D.	0.017	0.031	0.004	N.D.	0.021
4	CANAL SAN ROQUE	0.5	N.D.	0.075	0.013	0.010	N.D.	0.025
5	RIO CHAMEL/COPEN	0.58	N.D.	0.008	0.034	0.021	N.D.	0.033
6	RIO CHAMEL/BRIDGE	0.04	N.D.	0.012	0.025	0.016	N.D.	0.025
7	RIO PIEDRAS	N.D.	N.D.	0.017	0.022	0.010	N.D.	0.019
8	RIO SANTA ANA	N.D.	N.D.	0.022	0.020	0.004	N.D.	0.018
9	RIO BLANCO	0.3	N.D.	0.020	0.022	0.002	N.D.	0.016
10	RIO EL SAUCE	0.22	N.D.	0.015	0.028	0.020	N.D.	0.028
11	RIO CHOTEPE	0.71	N.D.	0.020	0.038	0.018	N.D.	0.032
12	LAGUNA JUCUTUMA	0.16	N.D.	0.067	0.031	0.013	N.D.	0.025
13	LAGUNA TICAMAYA	0.05	N.D.	0.025	0.021	0.007	N.D.	0.031
14	LAGUNA LAMA	N.D.	N.D.	0.098	0.034	0.012	N.D.	0.027
15	LAGUNA EL CARMEN	0.18	N.D.	0.072	0.020	0.006	N.D.	0.014

N.D.= NOT DETECTED