JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

CORPORACIÓN DEL ACUEDUCTO Y ALCANTARILLADO DE SANTIAGO (CORAASAN) THE DOMINICAN REPUBLIC

THE STUDY ON THE IMPROVEMENT OF SEWERAGE SYSTEM AND ENVIRONMENT IN THE CITY OF SANTIAGO IN THE DOMINICAN REPUBLIC

FINAL REPORT

VOLUME I
EXECUTIVE SUMMARY

FEBRUARY 2002

NIHON SUIDO CONSULTANTS CO., LTD.
NIPPON KOEI CO., LTD.

EXCHANGE RATE

The Currency exchange rates used in this Study are:

US Dollar (US$) 1.00 = Japanese Yen (¥) 125

= Dominican Peso (RD$) 17.00

As of October 2001

PREFACE

In response to a request from the Government of the Dominican Republic, the Government of Japan decided to conduct a study on the Improvement of Sewerage System and Environment in the City of Santiago in the Dominican Republic and entrusted the study to the Japan International Cooperation Agency (JICA).

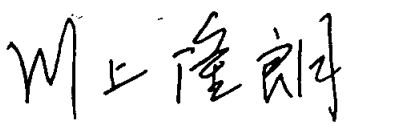
JICA sent to the Dominican Republic a study team headed by Mr. Harutoshi Uchida, Nihon Suido Consultants Co., Ltd., and Nippon Koei Co., Ltd., two times between January 2001 and December 2001.

The team held discussions with the officials concerned of the Government of the Dominican Republic, and conducted field surveys at the study area. After the team returned to Japan, further studies were made and the present report was prepared.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the Dominican Republic for their close cooperation extended to the team.

February, 2002



Takao Kawakami
President
Japan International Cooperation Agency

February, 2002

Mr. Kunihiko Saito
President
Japan International Cooperation Agency
Tokyo, Japan

Letter of Transmittal

Dear Sir,

We are pleased to submit this Final Report on the Study on the Improvement of Sewerage System and Environment in the City of Santiago in the Dominican Republic. This report incorporates the views and suggestions of the authorities concerned of the Government of Japan, including your Agency. It also includes the comments made by the Water Supply and Sewerage Corporation of Santiago (CORAASAN), Santiago City and other government agencies concerned in the Dominican Republic during the meetings organised by the Coordination Committee in Santiago where the Draft Final Report was discussed.

The Final Report comprises a total of four volumes as listed below.

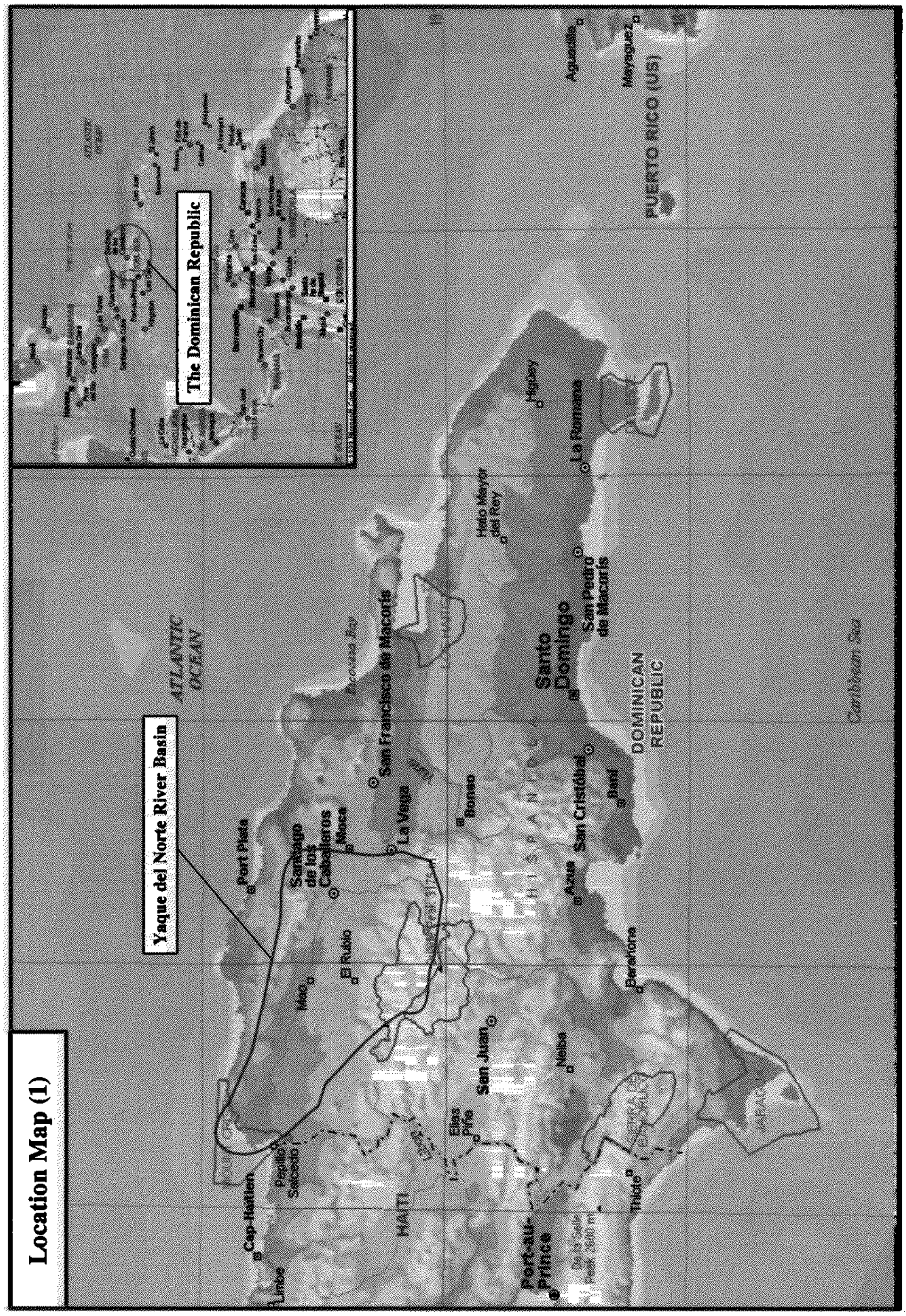
Volume I	: Executive Summary
Volume II	: Main Report
Volume III	: Supporting Report
Volume IV	: Drawings

This report contains the Study Team's findings, conclusions and recommendations derived from the Phase 1 and Phase 2 Studies. The main objectives of the Phase 1 Study was to investigate current situations, to formulate a long term master plan and to identify priority projects, whilst that of the Phase 2 Study was to examine the feasibility of the priority project which had previously been identified in Master Plan during the course of the Phase 1 Study.

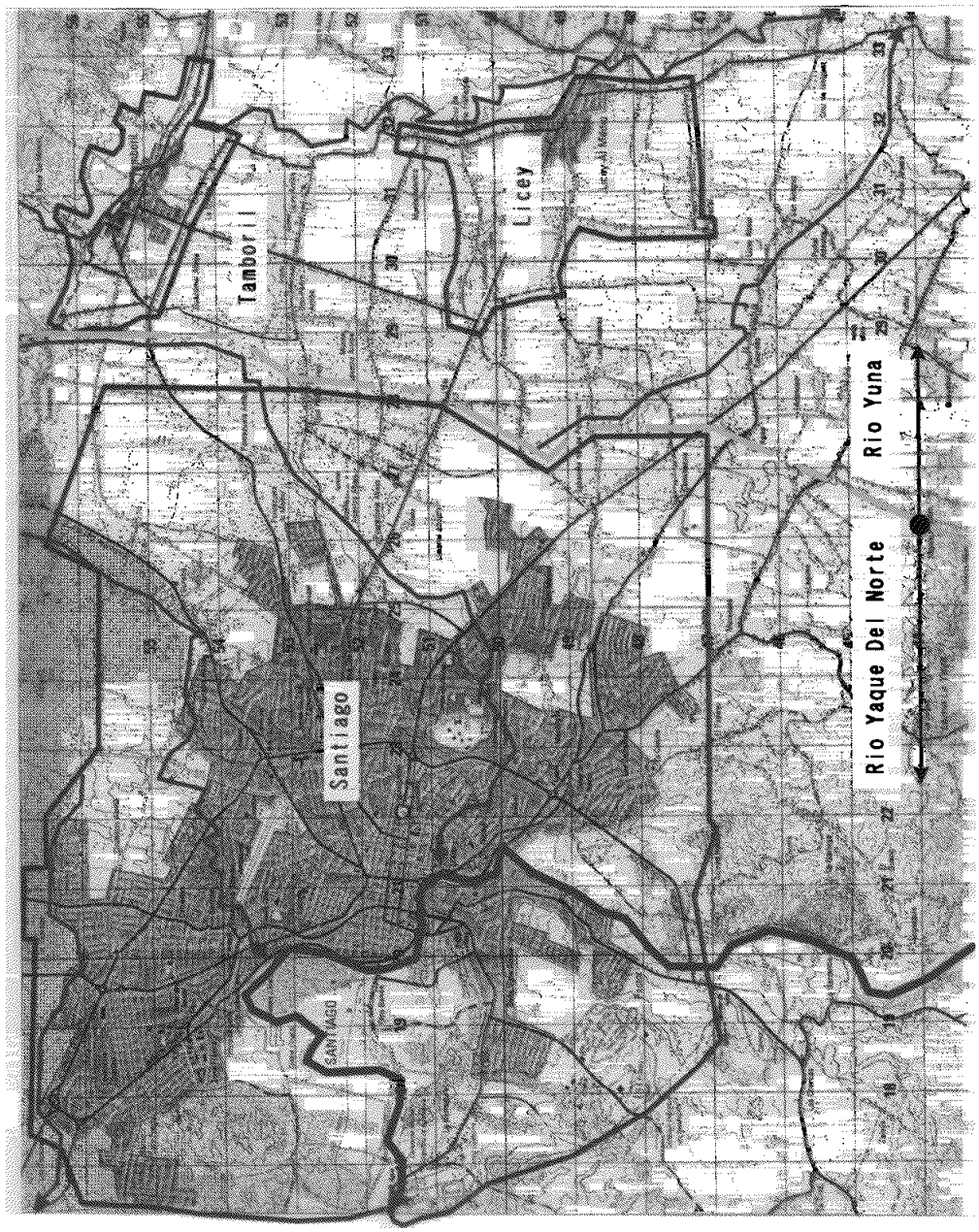
We wish to take this opportunity to express our sincere gratitude to your Agency, the Ministry of Foreign Affairs and the Ministry of Land, Infrastructure and Transport of the Government of Japan for their valuable advice and suggestions. We would also like to express our deep appreciation to the relevant offices for the Ministry of Environment and Natural Resources (SEMARENA), CORAASAN and other agencies of the Dominican Republic for their cooperation and assistance extended to us throughout our Study.

Very truly yours,

Harutoshi Uchida
Team Leader, Study on the Improvement of
Sewerage System and Environment
in the City of Santiago



THE STUDY ON THE IMPROVEMENT OF SEWERAGE SYSTEM AND ENVIRONMENT IN THE CITY OF SANTIAGO	Study Area Location Map (1)
JAPAN INTERNATIONAL COOPERATION AGENCY	



Boundary of River Basin

Boundary of Study Area

River

THE STUDY ON THE IMPROVEMENT OF SEWERAGE SYSTEM AND ENVIRONMENT IN THE CITY OF SANTIAGO

JAPAN INTERNATIONAL COOPERATION AGENCY

Study Area

Location Map (2)

STUDY ABSTRACT

1. PRESENT SITUATION

Among the nation's most important strategy "Environmental Protection," the public attention has been focused on the provision of sewerage systems as the most urgently required infrastructure, because of the recent population influx to urban areas of large cities.

Of the present 580,000 administrative populations in Santiago City, 520,000 reside in the urban districts, generating an average daily wastewater of 120,000m^3. Although more than 90 percent of the residents in the central urban districts have access to the public sewers, rapidly expanding peripheral areas of the City are without proper wastewater collector/interceptor sewers. Consequently, most of the raw wastewaters coming down from these districts are being directly inflowing to the nearby drains and streams without receiving any proper treatment. Such uncontrolled wastewater discharge has caused serious unsanitary living conditions and environmental disruptions throughout the area.

The existing wastewater treatment plants with the total capacity of 60,000 m^3/day or, about 50 percent of the wastewater generated in the area, has not been fully functioned due mainly to the defective wastewater treatment facilities. At present, the plants are treating only 27,800m^3 wastewater that accounts for only 23 percent of the total wastewater generated. In view of these conditions, CORAASAN is now enthusiastically conducting the sewerage improvement program to improve the ever-deteriorating water quality in the Yaque del Norte River.

2. SEWERAGE MASTER PLAN

For the sewerage system master planning, the study area of 11,450 hectares, covering Santiago, Tamboril and Licey municipalities, is divided into eight sewerage districts. In each district, such planning bases as administrative and sewer service populations, and sanitary wastewater quantity and quality are determined, based on which the necessary sewerage system facilities plan is developed. The sewerage system is planned to receive the industrial wastewater in the area to the maximum extent practicable. Thus, about 58 percent of the total industrial wastewater will be accepted to the public sewers.

Since a huge amount of investment is required for implementing the whole sewerage system, a construction priority of component facilities is determined for the staged construction. Under the master plan for 2015, the first implementation priority is given to the construction of wastewater collector/ interceptor mains. The wastewater treatment plant improvement program is to be implemented as required basis, taking into account the future condition of Yaque del Norte River water quality.

The master plan proposes that the sewerage improvement program be implemented under the following three consecutive stages:

- The First Stage (2003~2006); rehabilitation works of the existing Rafey, Cienfuegos and Los Salados wastewater treatment plants; construction of Zona Sur wastewater treatment plant; and construction of main sewers.

- The Second Stage (2007~2010); rehabilitation and construction of collector/ interceptor mains; expansion of Rafey wastewater treatment plant; and rehabilitation of Tamboril wastewater treatment plant, and

- The Third Stage (2011~2015); construction/rehabilitation of sewers, rehabilitation of Embrujo wastewater treatment plant, and expansion of Zona Sur wastewater treatment plant.

The cost estimates, economic and financial analyses for the proposed sewerage system are made, and the improvement of the CORAASAN's organization is proposed.

The possible water quality improvement in the Yaque del Norte River is forecast for the conditions after the sewerage system is completed and the industrial wastewater is treated as planned in the master plan. The river water quality targets from the point of entrance to the City urban areas down to a point of the Gurabo River confluence are also established, so that the river water environment is conserved. The river water improvement plan also proposes the necessary water quality monitoring items as a reference for establishing a comprehensive river water quality monitoring/controlling program by INDRHI.

The high priority sewerage system selected as the first stage component facilities are studied under the Feasibility Study. The First Stage Project can immediately contribute to significantly improve deteriorated sanitary/environmental conditions in the area by i) providing collector/interceptor mains along the drains and rivers to collect and treat the wastewater in appropriate manner; and ii) rehabilitating existing WWTPs and constructing Zona Sur WWTP to alleviate the pollutant loads to the Yaque del Norte River.

3. FEASIBILITY STUDY ON THE FIRST STAGE PROJECT (PRIORITY PROJECT)

Under the Feasibility Study, the preliminary engineering design of the sewerage facilities selected in the master plan are carried out, taking into account the results of field inspections and surveys. The First Stage Project, from 2003 through 2006, comprises the rehabilitation of Rafey, Cienfuegos and Los Salados WWTPs, the construction of Zona Sur WWTP, and the construction of main sewers of 14.6 km long.

To effectively and smoothly implement the Project, the strengthening of CORAASAN's organization (improvement of the organization, training for operation and maintenance staff) is proposed. The proposal includes the procurement of sewer cleaning equipment, and a new organization to control industrial wastewater discharge to the public sewers, together with the cost estimates for such works.

The First Stage Project costs US$59million, which is composed of US$ 35 million direct cost, US$12 million indirect cost, and US$12 million for cost escalations. The additional operation and maintenance cost for the First Stage facilities in 2006 is estimated to be US$1.6 million.

Since the capital investment to the project of this magnitude far exceeds CORAASAN's own financial capability, bilateral assistance loan of US$37million, subsidy (grant) or capital fund of US$12million by the Central Government, and CORAASAN's own US$10million capital reserve are assumed to be available for the financial plan. Under such conditions, the total annual cost for the loan refund and the facility O/M could be in the order of US$3.6 million, which repayment/benefit ratio appears to remain within a financially safe line.

In this financial plan it is a prerequisite that the present user charge collection ratio of 82 percent be increased to 95 percent, and the present unit revenue attributable to the project of US$0.38/$m^3$ be increased by about 60 percent to US$0.61/$m^3$.

The FIRR of the priority project is estimated to be 10.9 percent, which is higher than the present assumed opportunity cost of 9.5 percent in the capital market of Dominica. The net present value of US$4.3 million estimated at 2002 price level is also higher than the diverging point of profit and loss balance.

The EIRR indicate that 12.2 percent for the willingness to pay model, whereas for the marginal cost pricing model it is 14.1 percent. These values far exceed the values of 8~10 percent that are generally expected economic opportunity costs in the urban environmental and infrastructure projects including sewerage sectors. These economic analyses clearly indicate that this project can feasibly implemented from the viewpoint of the national economy.

THE STUDY ON THE IMPROVEMENT OF SEWERAGE SYSTEM AND ENVIRONMENT IN THE CITY OF SANTIAGO

VOLUME I EXECUTIVE SUMMARY

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ORGANIZATIONS AND PROGRAMS

AFM	Administration and Finance Management
CAASD	Corporación del Aqueducto y Alcantarillado de Santo Domingo

	(Water Supply and Sewerage Corporation of Santo Domingo)
CIPRCYN	Consejo Inter Institucional para el Rescate de la Cuenca del Rio Yaque del Norte(Inter-Institutional Council for the Recovery of the Yaque del Norte River Basin)
CM	Commercial Management
CODESA	Consejo de Salud Zona Sur (South Zone Health Council)
CONAS	Consejo Nacional de Agua y Saneamiento (National Council of Water and Sanitation)
CORAAMOCA	Corporación del Aqueducto y Alcantarillado de Moca (Water Supply and Sewerage Corporation of Moca)
CORAAPLATA	Corporación del Aqueducto y Alcantarillado de Puerto Plata (Water Supply and Sewerage Corporation of Puerto Plata)
CORAAROM	Corporación del Aqueducto y Alcantarillado de La Romana (Water Supply and Sewerage Corporation of La Romana)
CORAASAN	Corporación del Aqueducto y Alcantarillado de Santiago (Water Supply and Sewerage Corporation of Santiago)
CORSAS	Consejo Nacional de Regulación de Servicios de Agua y Saneamiento (National Council of Water and Sanitation Service Regulation)
DG	Director General (General Manager)
DIGENOR	Dirección General de Normas y Sistemas (General Bureau of Norms and Systems)
EM	Engineering Management
EMD	Electromechanical Maintenance Department
ES	Environmental Sanitation
ESM	Environmental Sanitation Management
GSD	General Services Department
IAD	Instituto Agrario Dominicano (Dominican Agrarian Institute)
IDB	Inter-American Development Bank
INAPA	Instituto Nacional de Agua Potable y Alcantarillado (National Institute of Potable Water and Sewerage)
INDRHI	Instituto Nacional de Recursos Hidráulicos (National Institute of River Management and Hydraulics)
INPRA	Instituto Nacional de Protección Ambiental (National Institute of Environmental Protection)
ISA	Instituto Superior de Agricultura (Agriculture Institute)
IWQCS	Industrial Wastewater Quality Control Section
JICA	Japan International Cooperation Agency
LCD	Loss Control Department
NGO	Non Governmental Organization
NMD	Network Maintenance Department
ONAPLAN	Oficina Nacional de Planificación (National Office of Planning)
ONAPPAS	Oficina Nacional de Politica y Planificación del Sector Agua Potable y Saneamiento National Office of Policy and Planning for Water and Sanitation Sector)
O&M	Operation and Maintenance
O&MM	Operation and Maintenance Management
ORR del SAPYS	Oficina Rectora de la Reforma y Modernización del Sector Agua Potable y Saneamiento (Directing Office of Reform and Modernization of Water and Sanitation Sector)
PNDS	Plan Nacional de Desarrollo Social (National Plan of Social Development)
PROMASIR	Programa de Administración de Sistemas de Riego para Usuarios (Management Program of Irrigation System for Users)

PUCMM	Pontifica Universidad Católica Madre y Maestra (University of Pontifical Catholic Mother and Master)
SEA	Secretaría de Estado de Agricultura (Ministry of Agriculture)
SEMARENA	Secretaría de Estado de Medio Ambiente y Recursos Naturales (Ministry of Environment and Natural Resources)
SEOP	Secretaría de Estado de Obras Públicas y Comunicaciones (Ministry of Public Works and Communications)
SESPAS	Secretaría de Estado de Salud Pública y Asistencia Social (Ministry of Public Health and Social Assistance)
SGA	Sub-Secretaria de Gestión Ambiental (Vice Secretary of Environmental Management)
STP	Secretaria Técnico de la Presidencia (Technical Secretary of Presidency)
UGAM	Unidad Gestion Ambiental Municipal (Municipal Unit of Environmental Management)
WUA	Water Users' Association

I. MASTER PLAN (UP TO 2015)

1.1 THE SEWERAGE IMPROVEMENT STUDY, BACKGROUND AND OUTLINE

1.1.1 BACKGROUND OF THE STUDY

As the second largest city in the Dominican Republic, the City of Santiago is the Provincial Headquarters for the Santiago Province and has considerable strategic importance for the national economy of supplying industrial and agricultural products, services and employment for the region. The Cibao valley plain has important agricultural production and values.

The Yaque del Norte River is the largest river in the country in its tributary area, and an important water source for the domestic, industrial and irrigational purposes. The Santiago city is located in the upper area of Yaque del Norte River basin with an area of 7,053 km^2. The city is the urban center in the river basin, having the present population of 583,000 corresponded about 48 percent of the total population of 1,200,000 in the river basin. Because of the rapid population growth and industrial developments in the urban areas, the amount of wastewater discharged into the river is increasing and then the water quality is deteriorating.

A sewerage maser plan to the year 2000 was formulated in the early 1970s under the assistance of the Italian Government. In the plan, all the wastewater generated in the urban center of the City was planned to be collected through sanitary sewers and conveyed to a centralized wastewater treatment plant (WWTP) in the Rafey District. Under the first stage project, major sewers and the Rafey WWTP with a quarter of the ultimate treatment capacity were constructed.

In the early 1980s, two small-scale WWTPs were built at El Embrujo and La Loteria, and four more WWTPs one each at the Cienfuegos, Los Salados, Embrujo and Tamboril Districts were constructed from 1994 to 1997. However, these WWTPs have not been fully functional due mainly to electrical and mechanical equipment problems.

As against the present wastewater generation of about 120,000m^3/day, the total existing WWTPs' treatment capacity is about 60,000m^3/day, or 50 percent of the total wastewater generated, but the actually treated wastewater volume accounts for only 23 percent of the total wastewater generated. Under these conditions, much of the raw wastewaters find their ways directly to the nearby water bodies. Consequently, in such urban built-up areas, particularly close to such contaminated water courses, sanitary conditions have deteriorated and become deplorable levels.

Under the circumstances, the Government of Dominican Republic made an official request to the Government of Japan concerning the needs of Santiago and neighboring towns. In response to the request, the Japanese Preparatory Study Team sent by the Japan International Cooperation Agency (hereinafter referred to as "JICA") visited the Dominican Republic in August, 2000.

Through a series of discussions with the Dominican authorities concerned, the Scope of Work (S/W) for the Study on the Improvement of Sewerage System and Environment in the City of Santiago was finally agreed and signed between CORAASAN and JICA on September, 2000.

1.1.2 OUTLINE OF THE STUDY

The Study on Santiago sewerage system improvement plan has been undertaken following the Scope of Works (S/W) to achieve the following three major purposes:

(1) Establish a sewerage master plan for the target year of 2015 to improve the Santiago City environmental/sanitary conditions and the river water pollution caused by the uncontrolled waste-

water discharge from the built-up urban districts;

(2) Conduct the feasibility study on the selected high priority project, taking into account the acute demand for the construction of new WWTP(s), rehabilitation of existing WWTPs, and provision of sewer networks; and

(3) Transfer technology to the counterpart staff of CORAASAN through the study.

In pursuance of the ultimate objective of improving environmental conditions throughout the Study Area, investigations and studies have been made into the adequacy of the existing sewerage, industries and sanitation facilities, and methods whereby deficiencies can be eliminated. The study result was compiled in the Progress Report and submitted to CORAASAN in March 2001.

On the basis of the results of the investigations and studies, planning bases for the sewerage system improvement master plan have been developed in relation to population estimates, wastewater productions, wastewater characteristics, planning/design bases, facility planning, and project implementation programs. The master plan was compiled in the Interim Report and submitted to CORAASAN in August 2001. In the following, outline of the Master Plan and results of the Feasibility Study (F/S) on the selected high priority program are presented.

1.2 STUDY AREA

1.2.1 SEWERAGE MASTER PLAN AREA

The sewerage Master Plan Area covers a total of 11,450 hectares urban districts in Santiago, Tamboril and Licey municipalities. The Master Plan Area was selected to encompass all the feasible collection areas consistent with topography, existing and probable future population concentrations and distributions, and urban developments.

1.2.2 SEWERAGE DISTRICTS

The entire sewer service area (Master Plan Area) is divided into eight Sewerage Districts; six in Santiago, and one each in Tamboril and Licey. The division has been elaborated taking into account the present sewerage system, topographic conditions, needs of future sewer extensions, and the trend of urban development programs. Figure 1 shows the sewerage districts in the City of Santiago. The Rafey Sewerage District is planned to integrate portion of the Embrujo Sewerage District, while part of the present Rafey District is to be diverted to the Zona Sur Sewerage District.

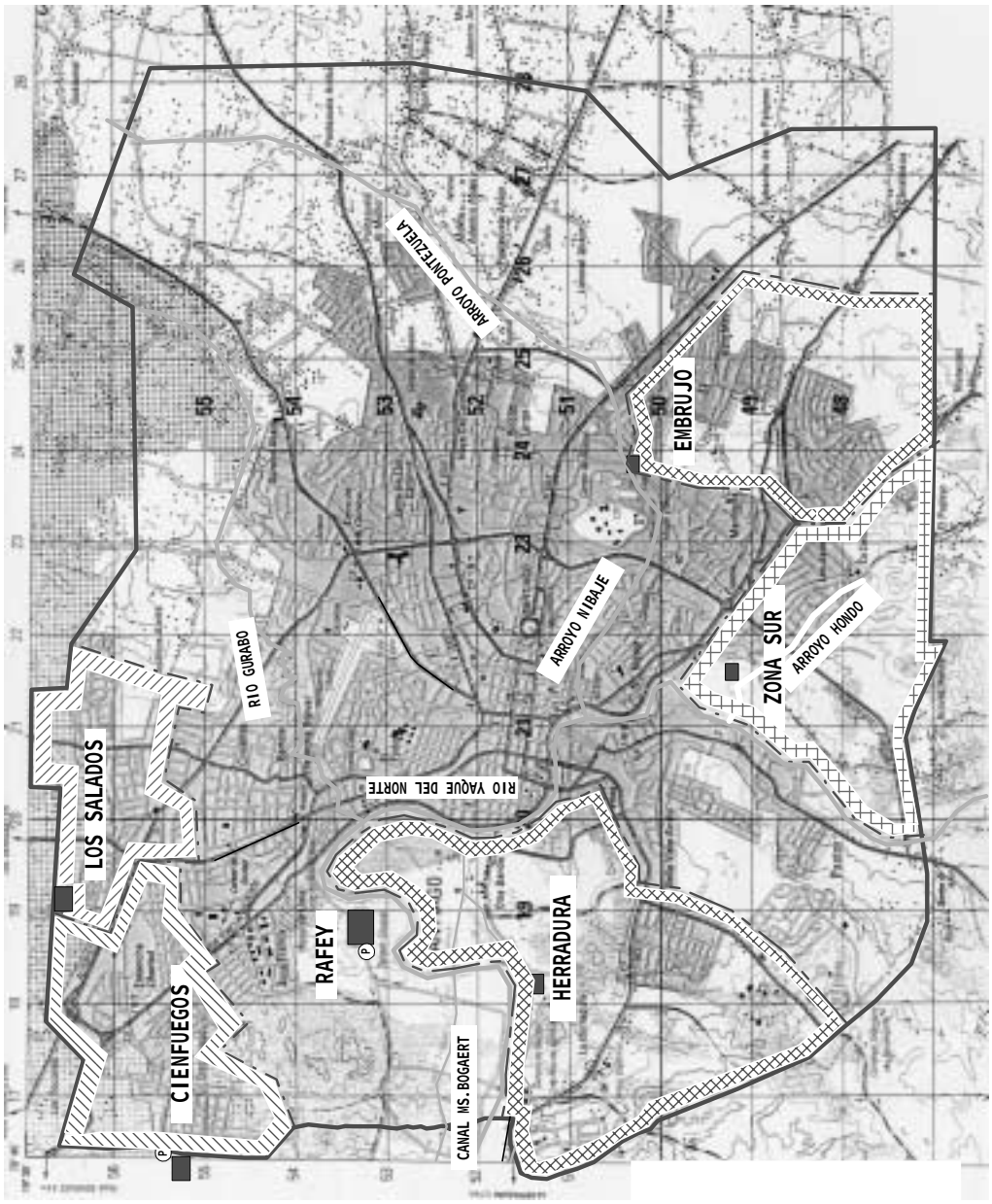
Sewerage Districts and Areas (ha.)

Santiago							Tamboril	Licey
Rafey	Cienfuegos	Los Salados	Embrujo	Zona Sur	Herradura	Sub-total		
6,700	540	380	590	600	1,150	9,960	600	890

1.3 POPULATION

1.3.1 POPULATIONS OF MUNICIPALITIES

The total population within the municipalities in the Study Area was 649,700 in 2000. The population is expected to further increase at annual growth rates of 2.4 to 2.8 percent, reaching at 929,000 by 2015. The estimated populations in the three municipalities by stage are shown in the following:



THE STUDY ON THE IMPROVEMENT OF SEWERAGE SYSTEM AND ENVIRONMENT IN THE CITY OF SANTIAGO

JAPAN INTERNATIONAL COOPERATION AGENCY

Figure 1

Santiago Sewerage Districts

Estimated Total Populations in Municipalities

Municipalities	2000	2005	2010	2015
Santiago	582,600	655,900	738,400	831,400
Tamboril	46,000	51,800	58,400	65,700
Licey	21,100	24,300	27,900	32,000
Total	649,700	732,000	824,700	929,100

1.3.2 SEWERED POPULATIONS IN SEWERAGE DISTRICTS

The following is the estimated population distribution in the Sewerage Districts by stage:

Population Distributions by Sewerage District (2000 to 2015)

Sewerage District	Area (ha)	District Population (persons)			
		2000	2005	2010	2015
1. Santiago					
Rafey	6,700	358,400	413,300	465,500	518,800
Cienfuegos	540	35,900	42,000	48,100	54,000
Los Salados	380	22,800	26,600	30,400	34,000
Embrujo	590	28,800	33,100	37,300	41,500
Zona Sur	600	32,500	37,700	42,800	47,700
Herradura.	1,150	39,200	44,000	47,800	52,300
Sub-total	9,960	517,600	596,700	671,900	748,300
2. Tamboril	600	25,300	30,700	35,100	39,400
3. Licey	890	8,500	11,800	15,600	19,200
Total	11,450	551,400	639,200	722,600	806,900

It is assumed that the sewered areas would not be fully inhabited even by 2015. The percentage of the sewered population to the whole inhabitant in each sewerage district has been estimated, assuming that the sewer service population ratios would increase annually at 2 to 5 percent.

Sewer Service Ratios and Populations by Districts and Year

Sewerage District	Sewer Service Ratio and Population							
	2000		2005		2010		2015	
I. Santiago	ratio	population	ratio	population	ratio	population	ratio	population
Rafey	70 %	251,800	76 %	313,700	85 %	394,800	95 %	493,000
Cienfuegos	67 %	23,900	74 %	30,900	80 %	38,300	87 %	46,800
Los Salados	70 %	16,000	77 %	20,500	83 %	25,200	90 %	30,600
Embrujo	72 %	20,600	78 %	25,700	84 %	31,200	89 %	36,800
Zona Sur	74 %	24,000	83 %	31,200	90 %	38,700	99 %	47,100
Herradura	9 %	3,600	29 %	12,900	50 %	24,000	71 %	37,000
Sub-total	66 %	339,900	73 %	434,900	82 %	552,200	92 %	691,300
II. Tamboril	42 %	10,500	54 %	16,500	67%	23,500	82 %	32,500
III.Licey	0 %	0	0 %	0	30 %	4,700	50 %	9,600
Total	64%	350,400	71 %	451,400	80 %	580,400	91 %	733,400

1.4 WASTEWATER QUANTITIES AND CHARACTERISTICS

1.4.1 DOMESTIC WASTEWATER

(1) Domestic Wastewater Quantity

1) Unit Design Flow of Domestic Wastewater

For the sewerage system hydraulic analysis, flow variations during a day and year have been estimated. The per capita domestic wastewater design flows under varied conditions are:

(1) Average daily per capita wastewater generation:	0.75 x Water consumption (lpcd)
(2) Average daily per capita wastewater flow	(1) + 25 (lpcd)
(3) Maximum daily per capita wastewater flow:	(1) x 1.2 + 25 (lpcd)
(4) Maximum hourly per capita wastewater flow:	(1) x 1.2 x 1.5 + 25 (lpcd)

The per capita domestic wastewater flows are expected to increase from the present 195 L/day/capita to 225L/day/capita in 2015 as shown below:

Per Capita Domestic Wastewater Flows by Year (lpcd)

Category	2000	2005	2010	2015
1. Per Capita Water Consumption	260	273	287	300
2. Per Capita Wastewater Generation	195	205	215	225
3. Infiltration/Inflow	25	25	25	25
4. Per Capita Average Daily flow	220	230	240	250
5. Per Capita Maximum Daily Flow	260	270	285	300
6. Per Capita Maximum Hourly Flow	380	400	415	430

2) Domestic Wastewater Quantities

The domestic wastewater productions are estimated by multiplying the populations (administrative and sewered population) by the per capita wastewater productions. The domestic wastewater quantities are those collected through the existing sewers plus those to be expanded under the Master Plan program.

At present, about 64 percent of the total domestic wastewater is collected through the sewerage system. The collection rate will be increased up to 90 percent by 2015 by improving the sewerage system.

Domestic Wastewater Productions (m^3/day)

Year	Santiago	Tamboril	Licey	Total		Collection Ratio by Sewerage
1) Domestic Wastewater Productions in the Study Area						
2000	100,930	4,930	1,660	107,520	①	
2005	122,330	6,290	2,420	131,040	②	
2010	144,460	7,550	3,360	155,360	③	
2015	168,370	8,870	4,320	181,560	④	
2) Domestic Wastewater Quantities to be Collected (Domestic wastewater to be collected through the sewerage system)						
2000	66,280	2,050	0	68,330	⑤	⑤/① 64%
2005	89,160	3,380	0	92,540	⑥	⑥/② 71%
2010	118,720	5,050	0	123,770	⑦	⑦/③ 80%
2015	155,540	7,290	0	162,830	⑧	⑧/④ 90%
3) Domestic Wastewater Productions Outside the Sewerage Planning Area						
2000	34,650	2,890	1,660	39,200		
2005	33,170	2,910	2,420	38,500		
2010	25,740	2,490	3,360	31,590		
2015	12,830	1,580	4,320	18,730		

(2) Domestic Wastewater Pollutant Loads

1) Unit Domestic Wastewater Pollutant Loads

The present unit pollutants loads are set based on the survey results on the influent wastewater qualities to the existing WWTPs. The current per capita pollutant loads are calculated assuming the unit domestic wastewater flow of 200 lpcd: The future unit pollutants loads are set as shown in the table below, considering the current unit pollutants loads will be increased due to the living standards will be upgraded.

Per Capita Pollutant Loads of Domestic Wastewater by Year

Pollutant Parameters	2000	2005	2010	2015
BOD_5 (kg/capita/day)	30	33	37	40
SS (kg/capita/day)	35	40	45	50
T-N (kg/capita/day)	7	8	8	9
T-P (kg/capita/day)	0.4	0.5	0.5	0.6

2) Domestic Wastewater Pollutant Loads

BOD_5 is used as a representative indicator of the domestic wastewater pollutant loads. As shown in the following table, about 64 percent of the total generated domestic wastewater BOD_5 is collected through the sewerage system. The collection ratio is planned to increase to 90 percent by 2015.

BOD_5 Due to Domestic Wastewater (kg/day)

Year	Santiago	Tamboril	Licey	Total
1) BOD_5 generations				
2000	15,528	759	255	16,542
2005	19,691	1,013	389	21,093
2010	24,862	1,299	577	26,738
2015	29,932	1,576	768	32,276
2) BOD_5 to be collected through the sewerage system				
2000	10,197	315	0	10,512
2005	14,353	545	0	14,898
2010	20,431	870	0	21,301
2015	27,652	1,296	0	28,948
3) BOD_5 generations outside the sewered area				
2000	5,344	444	255	6,033
2005	5,339	469	389	6,197
2010	4,431	429	577	5,437
2015	2,280	280	768	3,328

1.4.2 INDUSTRIAL WASTEWATERS

(1) Industrial Wastewater Productions

There are at present a total of 148 major factories within the Study Area, producing 20,400m^3/day industrial wastewater. The industrial wastewater production is expected to increase annually at the rates from 3 to 8 percent, reaching at 44,400 m^3/day by 2015.

Estimated Industrial Wastewater Productions by Year

2000 (Present)	2005	2010	2015
20,430 m^3/day	29,010 m^3/day	38,310 m^3/day	44,410 m^3/day

(2) Industrial Wastewater Qualities

The discharged industrial wastewater pollutant loads at present and in the future are calculated on the conditions that part of the generated pollutant loads would be treated by the existing Industrial wastewater treatment facilities.

Present Industrial Wastewater Pollutant Loads Production (as of 2000)

Items	Pollutant loads (kg/day)	Average quality (mg/L)	Remarks
BOD_5	8,539	418	*)Population equivalent of 284,600 persons
SS	10,984	538	
N	673	33	
P	110	5.4	

Note: *) 30g/capita/day BOD_5 is assumed.

Present Wastewater Pollutant Loads After Treatment

Items	Pollutant loads (kg/day)	Average quality (mg/L)	Remarks
BOD_5	6,282	308	Population equivalent, 209,400 persons
SS	5,704	279	
N	641	31	
P	105	5.1	

Note: *) 30g/capita/day BOD_5 is assumed.

The future industrial wastewater pollutant loads are estimated assuming that the present capacities of the wastewater treatment facilities will remain the same as they are now. The estimated Industrial wastewater and waste load generations are as follows:

Present and Future Industrial Wastewater Loads

Year	Generated Pollutant Loads		Discharged Pollutant Loads	
	BOD (kg/day)	SS (kg/day)	BOD (kg/day)	SS (kg/day)
2000	8,539	10,984	6,282	5,704
2005	12,547	16,139	10,290	10,859
2010	16,013	20,598	13,754	15,317
2015	18,564	23,879	16,305	18,598

1.4.3 WASTEWATER QUANTITIES AND CHARACTERISTICS

(1) Wastewater Generations

As shown in the following table, the total wastewater production in the Study Area is expected to further increase. The percentage of the wastewater collection through the sewer system to the whole wastewater production is planned to increase from the present 62 percent to 83 percent by 2015.

Wastewater Generated and Collected in the Study Area (m^3/day)

Year	Total of domestic wastewater	Total of industrial wastewater	Total of wastewater		Collection Ratio by Sewerage	
1) Wastewater generated in the Study Area						
2000	107,520	20,430	127,950	①		
2005	131,040	29,020	160,060	②		
2010	155,360	38,310	193,670	③		
2015	181,560	44,410	225,970	④		
2) Collected wastewater through sewerage system (Wastewater generations in sewered areas)						
2000	68,330	11,620	79,950	⑤	⑤/①	62 %
2005	92,540	17,080	109,620	⑥	⑥/②	68 %
2010	123,770	22,040	145,810	⑦	⑦/③	75 %
2015	162,830	25,560	188,390	⑧	⑧/④	83 %
3) Wastewater generated outside the sewer service areas						
2000	39,200	8,810	48,010			
2005	38,500	11,940	50,440			
2010	31,590	16,270	47,860			
2015	18,730	18,850	37,580			

(2) Wastewater Pollutant Loads

As a representative indicator of the wastewater pollutant loads, BOD_5 generations are calculated by the wastewater type and year, as shown in the table below. It is assumed that the present 58 percent of the BOD_5 inflow to the sewerage system will be increased up to 72 percent by 2015.

BOD_5 Productions in the Study Area (kg/day)

Year	Domestic wastewater	Industrial wastewater	Total		Collection Ratio by Sewerage	
1) Total BOD_5 generation						
2000	16,542	6,282	22,824	①		
2005	21,093	10,290	31,383	②		
2010	26,738	13,754	40,492	③		
2015	32,276	16,305	48,581	④		
2) BOD_5 loads to be collected through the sewerage system						
2000	10,512	2,653	13,165	⑤	⑤/①	58 %
2005	14,898	3,911	18,809	⑥	⑥/②	60 %
2010	21,301	5,053	26,354	⑦	⑦/③	65 %
2015	28,948	5,862	34,810	⑧	⑧/④	72 %
3) BOD_5 loads generated outside the sewer service areas						
2000	6,033	3,629	9,662			
2005	6,197	6,379	12,576			
2010	5,437	8,701	14,138			
2015	3,328	10,443	13,771			

1.4.4 PLANNED WASTEWATER QUANTITIES AND CHARACTERISTICS INFLOWS TO SEWERAGE SYSTEM

The industrial wastewater quantities and qualities expected to be inflowing to the sewerage system are estimated for each Sewerage District, as shown in the following table. The domestic wastewaters are estimated by the served populations multiplied by the per capita wastewater productions for the average daily, maximum daily and maximum hourly flow rates.

The industrial wastewater quantities are estimated by the Sewerage District based on the amount of the industrial wastewaters discharged to the sewers, whereas the qualities are estimated waste loads inflowing to each Sewerage District. These are then divided by the average daily wastewater flow rates to estimate average wastewater qualities, based on which the characteristics of influent wastewater to WWTPs are estimated. The overall wastewater quantities and pollutant loads inflowing to each of the WWTPs are estimated as shown in the following tables:

Overall Wastewater Inflows to Sewerage System (m^3/day)

Flow Type/ District	2000	2005	2010	2015
1. Average daily wastewater flow				
Rafey	65,640	87,210	113,970	145,520
Cienfuegos	5,740	7,820	10,110	12,750
Los Salados	3,910	5,290	6,770	8,490
Embrujo	4,540	5,920	7,490	9,200
Zona Sur	5,310	7,220	9,340	11,840
Herradura	1,110	3,430	6,340	9,930
Subtotal	86,250	116,890	154,020	197,730
Tamboril	2,480	4,050	5,960	8,470
Total of average daily flows	**88,730**	**120,940**	**159,980**	**206,200**
2. Maximum daily wastewater flow				
Rafey	75,710	99,750	131,730	170,170
Cienfuegos	6,700	9,060	11,830	15,090
Los Salados	4,550	6,110	7,910	10,020
Embrujo	5,360	6,940	8,900	11,040
Zona Sur	6,270	8,470	11,080	14,190
Herradura	1,250	3,950	7,420	11,780
Subtotal	99,840	134,280	178,870	232,290
Tamboril	2,900	4,710	7,020	10,090
Total of maximum daily flows	**102,740**	**138,990**	**185,890**	**242,380**
3.Maximum hourly flows				
Rafey	116,180	155,580	202,260	256,520
Cienfuegos	10,050	13,780	17,710	22,230
Los Salados	6,850	9,330	11,900	14,830
Embrujo	7,830	10,280	12,950	15,830
Zona Sur	9,180	12,560	16,170	20,380
Herradura	1,990	6,080	11,130	17,260
Subtotal	152,080	207,610	272,120	347,050
Tamboril	4,330	7,100	10,400	14,680
Total of maximum hourly flows	**156,400**	**214,710**	**282,520**	**361,730**

Overall Wastewater Load Inflows to Sewerage System (m^3/day)

District	Av. Inflow	BOD5		SS		T-N		T-P	
	(m^3/d)	(mg/L)	(kg/d)	(mg/L)	(kg/d)	(mg/L)	(kg/d)	(mg/L)	(kg/d)
I. Year 2000									
1. Rafey	65,640	151	9,891	169	11,114	32	2,076	2.6	170
2. Cienfuegos	5,740	142	815	172	987	32	182	2.3	13
3. Los Salados	3,910	145	568	167	652	32	127	2.3	9
4. Embrujo	4,540	136	618	159	721	32	144	1.8	8
5. Zona Sur	5,310	137	725	159	845	32	169	1.9	10
6. Herradura	1,110	155	172	155	172	32	36	2.7	3
7. Tamboril	2,480	151	375	176	436	32	80	2.4	6
Total	**88,730**	**148**	**13,164**		**14,927**	**32**	**2,814**	**2.5**	**219**
II. Year 2005									
1. Rafey	87,210	158	13,791	184	16,016	34	2,970	3.0	259
2. Cienfuegos	7,820	149	1,165	186	1,456	35	270	2.7	21
3. Los Salados	5,290	152	806	181	955	35	187	2.8	15
4. Embrujo	5,920	143	848	174	1,028	35	206	1.8	13
5. Zona Sur	7,220	144	1,038	174	1,255	35	252	1.9	16
6. Herradura	3,430	154	528	180	618	35	120	2.7	10
7. Tamboril	4,050	156	633	182	760	35	141	2.4	11
Total		**156**	**18,809**	**188**	**22,088**	**34**	**4,146**	**2.9**	**345**
III. Year 2010									
1. Rafey	113,970	167	19,001	195	22,227	33	3,746	2.9	329
2. Cienfuegos	10,110	158	1,602	198	2,005	33	335	2.5	25
3. Los Salados	6,770	162	1,097	193	1,306	34	231	2.8	19
4. Embrujo	7,490	154	1,154	187	1,404	33	250	2.1	16
5. Zona Sur	9,340	154	1,442	187	1,751	33	312	2.0	19
6. Herradura	6,340	161	1,023	192	1,217	34	214	2.5	16
7. Tamboril	5,960	165	982	199	1,186	33	199	2.5	15
Total	**159,980**	**164**	**26,301**	**194**	**31,096**	**33**	**5,287**	**2.7**	**439**
IV. Year 2015									
1. Rafey	145,520	171	24,814	205	29,823	35	5,119	3.1	448
2. Cienfuegos	12,750	164	2,086	209	2,666	36	454	2.7	35
3. Los Salados	8,490	167	1,415	204	1,729	36	308	2.9	25
4. Embrujo	9,200	160	1,472	200	1,840	36	331	2.4	22
5. Zona Sur	11,840	160	1,896	200	2,365	36	426	2.4	28
6. Herradura	9,930	165	1,639	203	2,013	36	359	2.7	27
7. Tamboril	8,470	169	1,426	209	1,768	36	305	2.7	23
8. Licey	2,690	166	446	204	550	36	96	3.0	8
Total	**206,200**	**168**	**34,748**	**205**	**42,204**	**35**	**7,302**	**2.9**	**608**

1.5 SEWERAGE SYSTEM

1.5.1 EXISTING SEWERAGE SYSTEM

(1) Wastewater Collection System

In Santiago City, the separate sewer networks, in principle by gravity flow, have been gradually expanded since the 1970's. The present sewerage system comprises i) sewer reticulations of 781 km

long, consisting mainly of 200 mm diameter concrete pipes to collect wastewater from households, and ii) submain and main sewers of 58.3 km long consisting of 12" to 70" (305 mm to 1,750 mm) in diameter made of concrete, polyethylene and reinforced concrete. Tamboril City has gravity sewer networks mainly of 200 mm diameter concrete pipes, whereas Licey City has no sewerage system yet.

There are at present four pumping stations in Santiago sewerage system (EB-No.1, EB-No.2, Otra Band and Zerro Alto). EB-No.1 and EB-No.2 have almost no operational pump and auxiliary facility and have long been out of operation. Other two stations also have not been functioned properly due to frequent power failures and defective equipment. Consequently, most of the raw wastewater inflows to the stations are often discharged directly to the nearby drains.

(2) Wastewater Treatment Facilities

There are at present eight WWTPs within the Study Area, seven plants in Santiago and one in Tamboril. Out of the seven WWTPs, five are of the activated sludge process. The first WWTP was constructed in Rafey in 1976, Embrujo in 1980, and three WWTPs (Cienfuegos, Los Salados and Tamboril) of the same size and configuration from 1994 to 1997. In the expansion program in for Embrujo WWTP in 1996, part of the additional civil structure was constructed, but some facilities and equipment were not installed and the whole system have been left unused.

The function and treatment capacity of each WWTP have been reviewed based on the collected data and information together with the results of field inspections. As indicated in the following, the major reasons for the evaluated low performance of the WWTPs are mainly due to obsolete and defective equipment and power failures. Cienfuegos and Los Salados WWTPs are evaluated practically out of order for the low operation efficiencies due to the power failure and defective equipment.

Treatment Capacities and Treated Wastewater Quantities of Existing Activated Sludge Treatment Plants

WWTP	Year of construction	Treatment capacity (m^3/day)		Actually treated wastewater (m^3/day)
		CORAASAN	Study Team *	
1. Rafey	1976	77,800	35,800	25,000
2. Cienfuegos	1994	15,100	10,000	0
3. Los Salados	1995	15,100	10,000	0
4. Embrujo	1980s	7,000	-	3,300
5. Tamboril	1997	15,100	10,000	6,900

* More details on the evaluation of treatment capacity are described in the Main Report（4.4 Evaluation of Existing WWTP）.

The remaining three existing WWTPs comprise two Imhoff tank and one stabilization pond systems with small treatment capacities ranging from 1,700 to 3,500m^3/day. The Imhoff tank is of a primary treatment process, and hence is planned to be abandoned when the sewer service area is integrated to the Rafey Sewerage District in the future. The stabilization pond system in the University campus will be used continuously for treatment only of the University wastewater.

1.5.2 SEWERAGE SYSTEM IMPROVEMENT PLAN

The sewerage improvement program contemplates that all the existing sewer s be connected to the main/collector sewers so that all the wastewaters could be collected by the sewer networks and

safely treated in the WWTPs. Such magnitude of the program as requiring a huge amount of capital investment is hardly completed by 2015. Therefore, the sewerage component facilities to be provided by 2015 are selected among the ultimately required component facilities based on the following priority criteria:

(1) Improvement of living/sanitary conditions;

(2) Improvement of water environmental conditions directly related to the residents or the nearby water bodies; and

(3) Reduction of waste loads inflowing to the Yaque del Norte River.

Form the viewpoint of the above criteria, planning concepts are determined, including i) full utilization of the existing sewers by providing collector/interceptor sewers so as to expand the sewer service, and ii) rehabilitation and expansion of major portion of WWTPs. Subsequently, the sewerage facilities to be provided by 2015 are selected as the component facilities under the Master Plan Project. These are discussed in the following paragraphs. The location of the sewerage facilities are shown in Figure 2 and Figure 3.

(1) Sewers

The sewerage implementation plan is summarized in the table below:

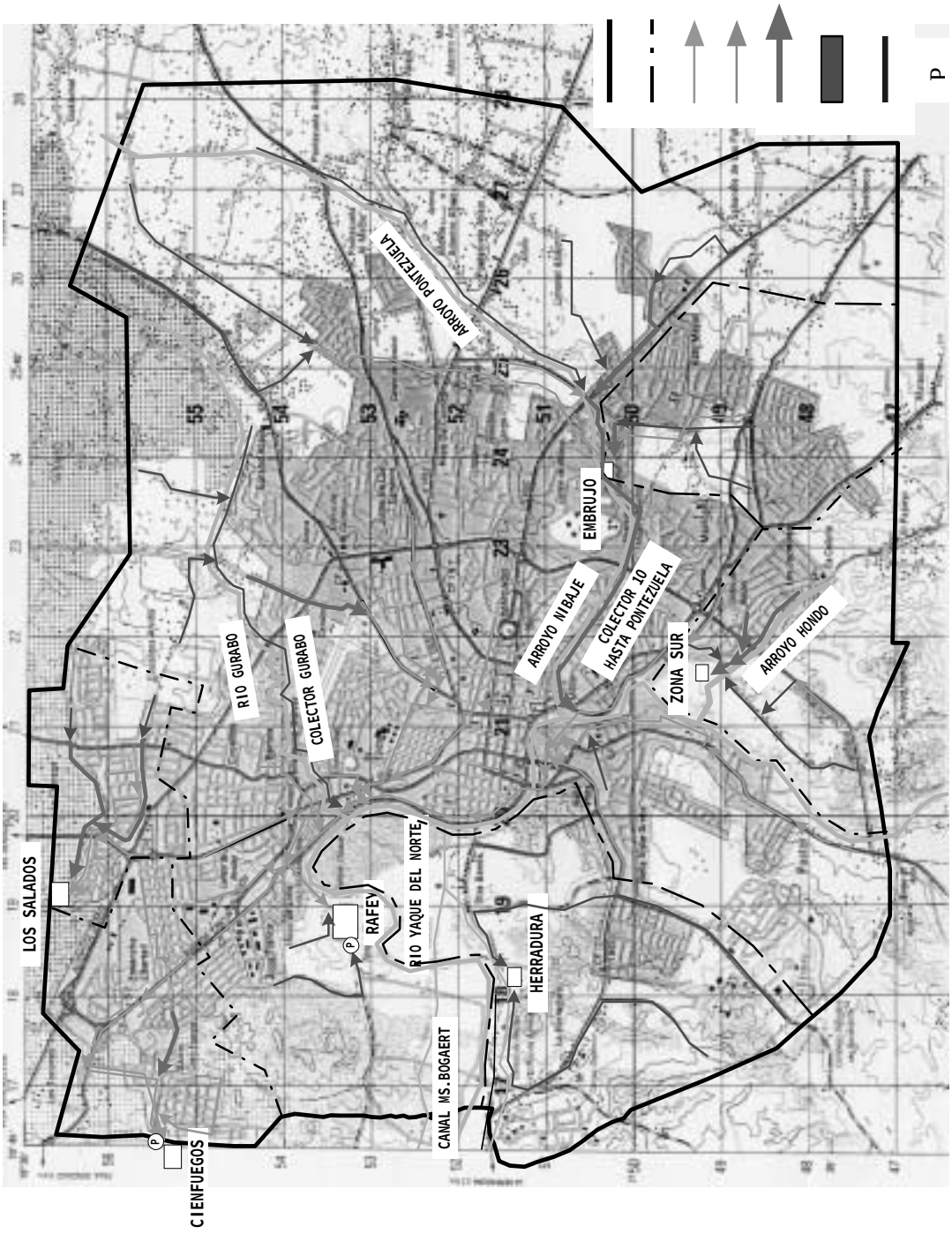
Proposed Sewer System Improvement Program up to 2015

Sewers by District	Sewer Length (km)		
	Branch/lateral Sewers	Main/sub-main Sewers	Total
1. Rafey	46.8	38.0	84.8
2. Embrujo	2.5	3.8	6.3
3. Cienfuegos	2.6	0.6	3.2
4. Los Salados	1.6	4.2	5.8
5. Zona Sur	2.3	3.6	5.9
6. Herradura	5.1	7.9	13.0
7. Tamboril	5.1	1.4	6.5
Total	66.0	59.5	125.5

It should be noted that the housing developers have to construct the necessary branch/lateral sewer networks to collect the household wastewater and lead to disposal places (mainly to nearby rivers), and then CORAASAN provides necessary main/submain sewers to collect such wastewater. In principle, CORAASAN bears no such construction costs; however, there may be the cases that CORAASAN needs to install such sewer networks to properly collect the housing wastewater. For this reason, CORAASAN may need to construct 10 percent of the network sewers, and thus the costs are included in the proposed implementation program under the Master Plan.

(2) Pumping Stations

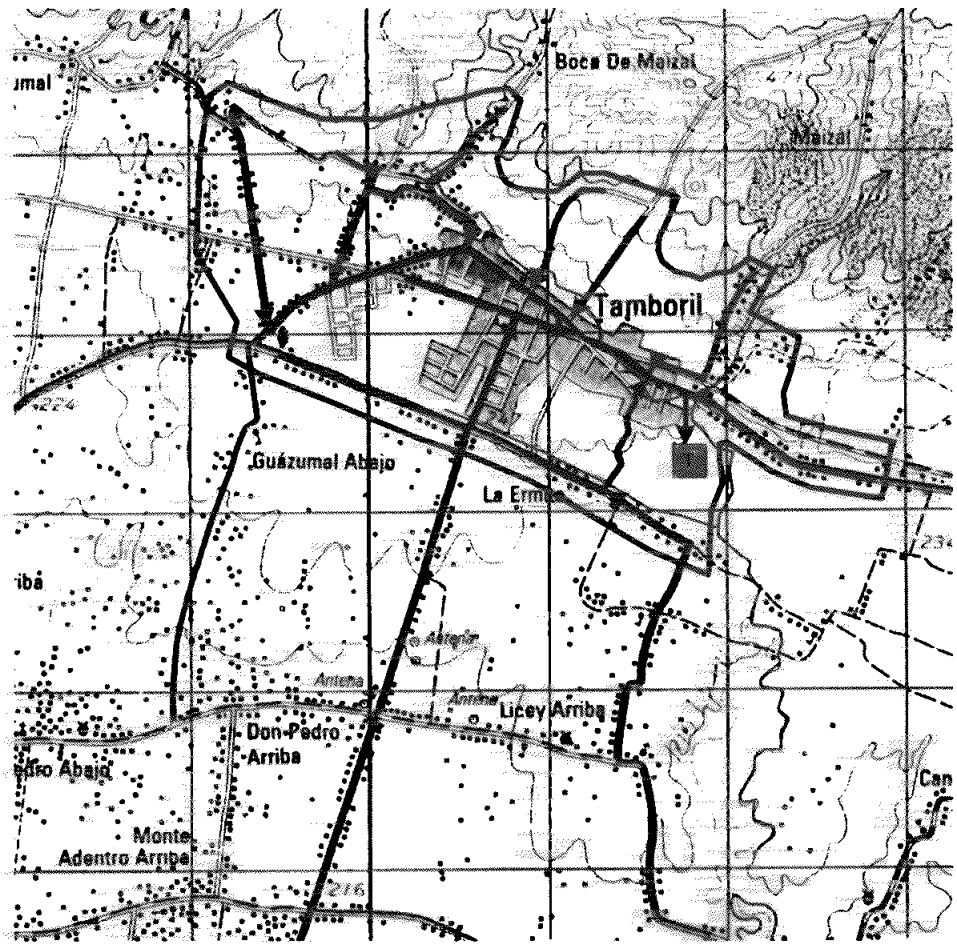
Although sewers are planned in principle to flow by gravity, the following pumping stations are planned for further use by providing rehabilitation, expansion, power generator installation, etc. The two pumping stations (without pumping equipment) in the Zona Sur Sewerage District will be abandoned in the future because a part of the present Rafey District will be integrated to the Zona Sur Dirtsict, and the sewers presently discharging the wastewater to these pumping stations will be able to flow by gravity to the new WWTP in the Zona Sur District.



THE STUDY ON THE IMPROVEMENT OF SEWERAGE SYSTEM AND ENVIRONMENT IN THE CITY OF SANTIAGO

JAPAN INTERNATIONAL COOPERATION AGENCY

Figure 2 General Plan of Sewerage System in The City of Santiago



LEGEND

- Boundary of Planned Area
- Existing Sewer
- Planned Sewer
- WWTP
- River

THE STUDY ON THE IMPROVEMENT OF SEWERAGE SYSTEM AND ENVIRONMENT IN THE CITY OF SANTIAGO	Figure 3 General Plan of Tamboril Sewerage System
JAPAN INTERNATIONAL COOPERATION AGENCY	

Proposed Pumping Stations Improvement Program up to theYear 2015

Pumping Stations by District	Capacity	Remarks
1. Rafey Sewerage District		
Rehabilitation of existing two stations	0.43 m^3/min.	Otra Banda and Cerro Alto
Construction of a new station	9.20 m^3/min..	
2. Cienfuegos Sewerage District		
Construction of one station	7.60 m^3/min.	
3. Zona Sur Sewerage District		
Demolition of existing two stations	0.43, 0.66 m3/min.	EB No.1 and No.2

(3) Wastewater Treatment Plants (WWTPs)

The WWTPs improvement plans and treatment capacities are shown in following:

WWTPs Improvement Program up to Year 2015

WWTP	Treatment Capacity (m^3/day)	Remarks
1. Rafey WWTP	Total: 71,600	Necessary capacity: 170,100 m^3/day
Rehabilitation of existing facility	35,800	
Construction of one train of facility	35,800	
2. Embrujo WWTP	Total: 11,000	
Rehabilitation of existing facility	11,000	
3. Cienfuegos WWTP	Total: 10,000	Necessary capacity: 15,100 m^3/day
Rehabilitation of existing facility	10,000	
4. Los Salados WWTP	Total: 10,000	
Rehabilitation of existing facility	10,000	
5. Tamboril	Total: 10,000	
Rehabilitation of existing facility	10,000	
6. Zona Sur WWTP	Total: 10,000	Necessary capacity: 15,000 m^3/day
Construction of new plant	10,000	
7. Herradura WWTP	No implementation	Necessary capacity: 12,000 m^3/day
8. Licey WWTP	No implementation	Necessary capacity: 3,200 m^3/day

Note: " Necessary capacity" means that required to treat all the wastewater coming from the whole planned service area (maximum daily flow rate), but for the financial reasons, part of the wastewater is planned to be treated under the Master Plan.

1.6 STAGED SEWERAGE IMPLEMENTATION PROGRAM

1.6.1 IMPLEMENTATION POLICY FOR STAGED SEWERAGE IMPROVEMENT

In order to utilize the limited amount of the funds in an efficient way, each of the Sewerage Districts is evaluated in its effectiveness of environmental improvement by the sewerage system implementation. In the course of preparation of the implementation program, the system components in each Sewerage Districts are prioritized considering the following selection criteria:

(1) Contribution to the improvement of living/sanitary conditions in the sewer service area;

(2) Contribution to the improvement of water environmental directly related to nearby residents;

(3) Pollutant loads reduction level to be achieved by each Sewerage District to the Yaque del Norte River with the provision of the sewerage system improvement.

(4) Expected early environmental improvement; and

(5) Possibility of effective use of the existing sewerage facilities.

Evaluation of Improvement and Implementation Priority in Each Sewerage District Due to Sewerage System Provision (1/2)

Sewerage District	Planning Bases	Living/Environmental Improvement	Water Environmental Improvement in Nearby Water Bodies	Reduction of Pollutant Load to the Yaque del Norte River	Early Effects in Environmental Improvement and Effective Use of the Existing Sewerage Facilities	Fundamentals for Staged Implementation Plan
1.1 **Rafey**	Planned sewer service population will increase by about 241,200 from the present 251,800 (2000) to 493,000 by 2015. The ratios of sewered population to the district population in the six sewerage districts in Santiago City is 74% at present and will be 71% in 2015. The collected wastewater through sewers (design average daily flow) will increase by 79,880m^3/day and reach at 145,520 m^3/day by 2015. The wastewater collection ratios in the six sewerage districts within the Yaque del Norte River tributary account for 76% at present and 74% in 2015, respectively The total BOD loads collected through the sewers will increase by14,923 kg/day and reach at 24,814 kg/day by 2015. The six districts in Santiago City collect totally 77% of the pollutant loads at present which will be of 74% by 2015.	This sewerage district is the largest one among the Santiago City districts in terms of service population, and collected wastewater quantity and waste loads. Consequently, the district can significantly contribute to the improvement of the residents' living conditions and environment ◎	The district is planned to collect the wastewater from the areas along the Nibaje river and its upstream of the Pontezuela river (located from east to south of the City). Hence, the direct wastewater discharge to these rivers can be cut off, and thus contribute significantly to improve the water qualities in these rivers. ◎	The possible reduction of pollutant loads of the district is the largest among the Santiago sewerage districts. Hence, the pollutant loads reduction can be achieved in an efficient manner by adding the wastewater treatment facilities, in proportion to the wastewater flow increase. The expansion of the WWTP system is restricted under the Master Plan due to the financial constraint, much pollution reduction cannot be expected with Rafey WWTP. However, the WWTP discharges the wastewater to the downstream of the Yaque del Norte River within the City area, thus could avoid the impacts on the residents' living environment. ○	By providing new sewers upstream of the existing sewers, early improvement of living and water environmental conditions becomes possible. Further, when the existing Rafey WWTP is rehabilitated, treatment efficiency will be increased and stable operation expected even during the power failures, thereby, early and stable pollutants reduction can be expected. For the effective use of the existing sewerage facilities, it is possible to rehabilitate the existing facilities and ensure the improvement of operational efficiency and stable operation, thus connecting the existing sewer networks to the public sewers and expanding the sewer service areas. ◎	Main sewers will be installed from the downstream close to the WWTP. In particular, the priority is placed on "Collector 10" which serves the eastern part of the District. Then, submain and branch sewers will be connected to the mains gradually following the expansion of sewer service areas. Upgrading and extension of the WWTP will be planned in light of available funds and timing for investment.
1.2 **Cienfuegos**	The planned service population will be increased by 22,900 from the present 23,900 to 46,800 by 2015. In the sewerage districts other than Rafey, including this district, the increase of service population is not significant, and the pattern of served population increase may be more or less the same. The wastewater quantity collected through sewers will increase by 7,010m^3/day and reach at 12,750 m^3/day by 2015. BOD loads collected through sewers will also increase 1,271 kg/day reaching at the level of 2,086 kg/day.	Contribution of this district to the environmental/sanitation improvement will be of more or less the same level as other districts except Rafey District. ○	Main sewers have already been laid in this district. The sewer construction plan now underway is that by increasing the presently lacking flow capacity of sewers the sewer service areas can be expanded and service level will be improved. Should the sewer provision delays, the nearby areas' water environment may further be deteriorated. ○	By rehabilitating and repairing the WWTP facility and improved operational practice, pollutant loads currently being discharged to the river will be cut off. The Jacagua river, recipient of the WWTP effluent, inflows to the downstream of the Yaque del Norte River outside the urban districts, and with the treatment capacity of a medium size, the contribution to the River water quality improvement would be rather limited. △	By appropriately rehabilitating the WWTP presently out of operation, early pollutants reduction is expected. Further, by adding new main sewers to the existing collection system, sewer service areas can be easily expanded, and living and water environment in the nearby areas will be improved. Also, by the rehabilitation works for the WWTP, and the associated improved wastewater treatment efficiency and stable operation, the plan fully utilizing existing facilities can be implemented. ◎	To increase the existing sewerage system capacity immediately, first provide sewer system then the additional pumping stations, to meet the increased requirements for the expanded service areas. The WWTP is to be rehabilitated soon so as to ensure the practicable and stable operation.
1.3 **Los Salados**	The planned service population will increase by 14,600 from the present 16,000 to 30,600 by 2015. In the sewerage districts other than Rafey, including this district, the increase of service population is not significant, and the pattern of served population increase may be more or less the same. The wastewater quantity collected through sewers will increase 4,580m^3/day and reach at 8,490 m^3/day by 2015. The BOD loads collected through sewers will also increase 847kg/day reaching at the level of 1,415 kg/day.	Contribution of this district to the environmental/sanitation improvement will be of more or less the same level as other districts except Rafey District. ○	It is expected that the heavily contaminated Jacagua river water will be significantly improved, as the wastewater presently being discharged to the river will be intercepted and sent to the WWTP through the new main sewers. The river water contamination problem should be solved collectively with the prevention of the uncontrolled garbage disposal to rivers currently practiced. ◎	By rehabilitating and repairing of the existing WWTP facility and improved operational practice, pollutant loads being discharged to the river will be reduced. The Jacagua river, receiving the WWTP effluent, inflows to a point downstream of the Yaque del Norte River outside the urban districts, and the WWTP with a medium capacity, the contribution to the River water quality improvement would be rather low. △	By appropriate rehabilitation of the WWTP, which operation has been suspended, an early and stable pollutant loads reduction is expected. It is further planned that by adding main sewers to the existing sewer system, the expansion of sewer service areas and increase of sewer flow capacities are expected, thus the effective use of the existing sewer system can be encouraged. ◎	Main sewers are to be laid to the earliest possible time to prevent the present raw wastewater discharge to the Jacagua river. The WWTP is to be rehabilitated without delay so as to ensure a stable WWTP operation.

Note: The rating for the extent of effectiveness; ◎Excellent, ○Good, △Fair but low effects, ×Almost no effects, －No outcome

Evaluation of Improvement and Implementation Priority in Each Sewerage District Due to Sewerage System Provision (2/2)

Sewerage District	Planning Bases	Living/Environmental Improvement	Water Environmental Improvement in Nearby Water Bodies	Reduction of Pollutant Load to the Yaque del Norte River	Early Effects in Environmental Improvement and Effective Use of the Existing Sewerage Facilities	Fundamentals for Staged Implementation Plan
1.4 **Embrujo**	The present service population of 20,600 is predicted to increase 16,200 and reach at 36,800 by 2015. The wastewater quantity to be collected through sewers will increase to 4,660m^3/day and reach at 9,200 m^3/day by 2015. The BOD loads collected through sewers will also increase by 854kg/day reaching at the level of 1,472 kg/day.	Contribution of this district to the environmental/sanitation improvement will be of more or less the same level as other districts except Rafey District. ○	It is expected that the contaminated Nibaje river water will be significantly improved, as the wastewater presently being discharged to the river will be intercepted and by the new main sewers and sent to the WWTP for treatment. ◎	By rehabilitating the facility and installing plant equipment together with appropriate operation, the pollutant loads can be alleviated. Since the Nibaje river, which is the recipient of the WWTP effluent, is located at the upstream of the Yaque del Norte River, and the WWTP's treatment capacity is a medium size, this district's contribution to the river water quality improvement seems to be not so significant. ○	At present, only the old WWTP, constructed in 1980, has been in operation (3,3000m^3/day). The new WWTP, abandoned after only part of civil structures was constructed. To complete the WWTP and start its operation, large-scale rehabilitation and repair works are mandatory, which will take a considerable time to complete. Therefore, early effects to the water quality improvement cannot be expected. ×	Sewers will be installed immediately so as to effectively utilize the existing WWTP facility. Other sewerage facilities will be provided by stage following the expansion of sewer service areas.
1.5 **Zona Sur**	The present service population of 24,000 is expected to increase by 23,100 and reach at 47,100 by 2015. The wastewater quantity to be collected through sewers will increase 6,530m^3/day and arrive at 11,840m^3/day by 2015, whereas the present BOD loads collected through sewers will also increase by 1,171kg/day reaching at 1,896 kg/day.	Contribution of this district to the environmental/sanitation improvement will be of more or less the same level as other districts except Rafey District. ○	It is anticipated that the heavily contaminated Hondo river water will be significantly improved, when the wastewater presently being discharged to the river will be intercepted and sent to the WWTP through the new main sewers. ◎	By constructing the new WWTP and appropriately operating it, pollutant loads alleviation is expected. The Hondo river, which receives the WWTP effluent, joins the Yaque del Norte River at the upper most point of the river, and that the contribution of this district to the water quality improvement is considered to be effectual, although the WWTP treatment capacity is not so large, ○	The early improvement of the Hondo river water environment is possible by providing the new main sewers and connecting existing sewer networks to the main sewers, thus preventing discharge of raw wastewater to the river.. ○	Early provision of main sewers and new WWTP is to be realized so that sanitary conditions and the nearby water environment are improved. By doing so, the water pollution in the upstream of the Yaque del Norte River is to be controlled. Thereafter, the sewerage facilities will be implemented in accordance with the sewer service areas extended.
1.6 **Herradura**	The sewer service population is estimated to increase 33,400 by 2015 from the present 3,600 to 37,000. The wastewater quantities to be collected through the sewers will increase by 8,820 m^3/day in 2015 totaling 9,930 m^3/day The BOD to be collected through the sewers will also increase by 1,467 kg/day from the present level and reach at 1,639 kg/day.	Contribution of this district to the environmental/sanitation improvement will be of more or less the same level as other districts except Rafey District. However, this district is likely to develop as an urban area in the future, the environmental improvement due to sewer provision is expected in the future too. ○	As the district is expected to develop as an urban district in the future, the improvement of water environment in nearby areas is expected too in the future. ○	Since the WWTP effluent is to be discharged into the Yaque del Norte River at downstream of Rafey WWTP, it is unlikely that the WWTP will contribute to the Yaque del Norte River water quality improvement. ×	Since WWTP construction is not considered in the implementation plan, early environmental improvement is hardly possible. The effective use of the existing facilities cannot also be expected, because presently not so many sewers exist. ×	Necessary sewerage facilities are to be provided following the future urbanization
2. **Tamboril**	The sewer service population is estimated to increase by 22,000 from the present 10,500 to 32,500 by 2015. The wastewater quantities to be collected through the sewers will become to 8,470m^3/day in 2015 increasing by 5,990m^3/day The BOD inflow to the sewers will also increase by 1,051kg/day from the present level and reach at 1,426 kg/day.	Contribution of this district to the environmental/sanitation improvement will be of more or less the same level as other districts except Rafey District. ○	Sewers are laid within the urban central portion, and the wastewater is transported to the WWTP, the future water environment improvement may be limited to the nearby sewered areas. △	The district located in the tributary of the Yuna river, outside the Yaqued del Norte River tributary, and that there will be no contribution to reduce the pollutant loads to the Yaque del Norte River. –	Although being operated, the existing WWTP needs rehabilitation and repair works to ensure the efficient and stable operation. By constructing new main sewers and integrating the existing sewer networks, combined with the improved WWTP, the effective use of existing sewerage system can be achieved. ○	The necessary WWTP rehabilitation works are to be implemented so as to ensure stable plant operation. Thereafter, the main sewers are to be laid and sewer service areas expanded so that the WWTP can be effectively used.
3. **Licey**	The sewer service population is estimated to increase to 9,600 by 2015. The wastewater quantities to be collected through the sewers will become 2,690m^3/day by 2015. BOD inflows to the sewers will also increase and reach at 446 kg/day by 2015.	Should the sewer system is installed, its impact will be significant, and the qualitative improvement of the nearby water environment is expected. ○	When the sewer system is provided, the improvement of the nearby water environment is expected. ○	The district located in the tributary of the Yuna river, outside the Yaqued del Norte River tributary, and that there will be no contribution to reduce the pollutant loads to the Yaque del Norte River. –	This district is to be newly provided, and as such, neither early effects of sewer provision nor effective use of the existing system can be expected. –	Under the present financial constraint, and its location outside the Yaque del Norte River tributary, the investment to the sewerage implementation in this district is hardly justifiable. For these reasons, sewerage implementation is to be deferred after 2015.

Note: The rating for the extent of effectiveness; ◎Excellent, ○Good, △Fair but low effects, ×Almost no effects, –No outcome

1.6.2 STAGED IMPLEMENTATION PROGRAM

(1) Staging

In view of the priority of implementation and various other factors inherent in the Area, the entire 13-year sewerage implementation program is divided into three consecutive construction stages, starting from 2003 and lasting until 2015.

The First Stage Program is of an emergency plan, which concentrates to the rehabilitation of the existing WWTPs, together with the construction of main/intercepting sewers, over a four-year period until the end of 2006. During the subsequent Second and Third Stages from 2007 to 2015, the project works comprise the construction and extension of WWTPs. Figure 4 illustrates the treatment capacity development program for each WWTP.

(2) First Stage Program (2003 to 2006)

The First Stage Program over a four-year period will undertake the rehabilitation of Rafey, Cienfuegos, and Los Salados WWTPs; and the construction of the Zona Sur WWTP, along with the sewer laying of about 33.6km. The First Stage Program will comprise the following component facilities:

Component Facilities in the First Stage Program

District	Collection System	WWTPs
1. Rafey	Construction of km sewers Rehabilitation of Existing Pumping Station	Rehabilitation of 35,800 m^3/day WWTP
2. Cienfuegos	Construction of 3.2 km sewers	Rehabilitation of 10,000 m^3/day WWTP
3. Los Salados	Construction of 4.6 km sewers	Rehabilitation of 10,000 m^3/day WWTP
4. Embrujo	Construction of 1.0 km sewers	-
5. Zona Sur	Construction of 2.0 km sewers	Construction of 5,000 m^3/day WWTP

(3) Second Stage Program (2007 to 2010)

The Program during this stage will include the construction/rehabilitation of sewers, pumping station, Rafey WWTP facility, and Tamboril WWTP, as summarized in the following:

Component Facilities in the Second Stage Program

District	Collection System	WWTPs
1. Rafey	Construction of 31.0 km sewers Construction of a pumping station	Construction of 35,800 m^3/day WWTP
2. Cienfuegos	Construction of a pumping station Rehabilitation of existing sewers	-
3. Los Salados	Construction of 1.2 km sewers	-
4. Embrujo	Construction of 2.6 km sewers Rehabilitation of existing sewers	-
5. Zona Sur	Construction of 3.9 km sewers	-
6. Herradura	-	-
7. Tamboril	-	Rehabilitation of 10,000 m^3/day WWTP
8. Licey	-	-

(4) Third Stage Program (2011 to 2015)

The components under the Third Stage Program will include the construction and rehabilitation of main sewers, the rehabilitation of the Embrujo WWTP, and the extension of one train of treatment facilities at the Zona Sur WWTP.

Component Facilities in the Third Stage Program

District	Collection System	WWTPs
1. Rafey	Construction of 31.0 km sewers Rehabilitation of existing sewers	-
2. Cienfuegos	-	-
3. Los Salados	Rehabilitation of existing sewers	-
4. Embrujo	Construction of 2.6 km sewers Rehabilitation of existing sewers	Rehabilitation of 10,000m^3/day WWTP
5. Zona Sur	Rehabilitation of existing sewers	Expansion of 5,000m^3/day WWTP
6. Herradura	Construction of 13 km sewers Rehabilitation of existing sewers	-
7. Tamboril	Construction of 6.5 km sewers Rehabilitation of existing sewers	-
8. Licey	-	-

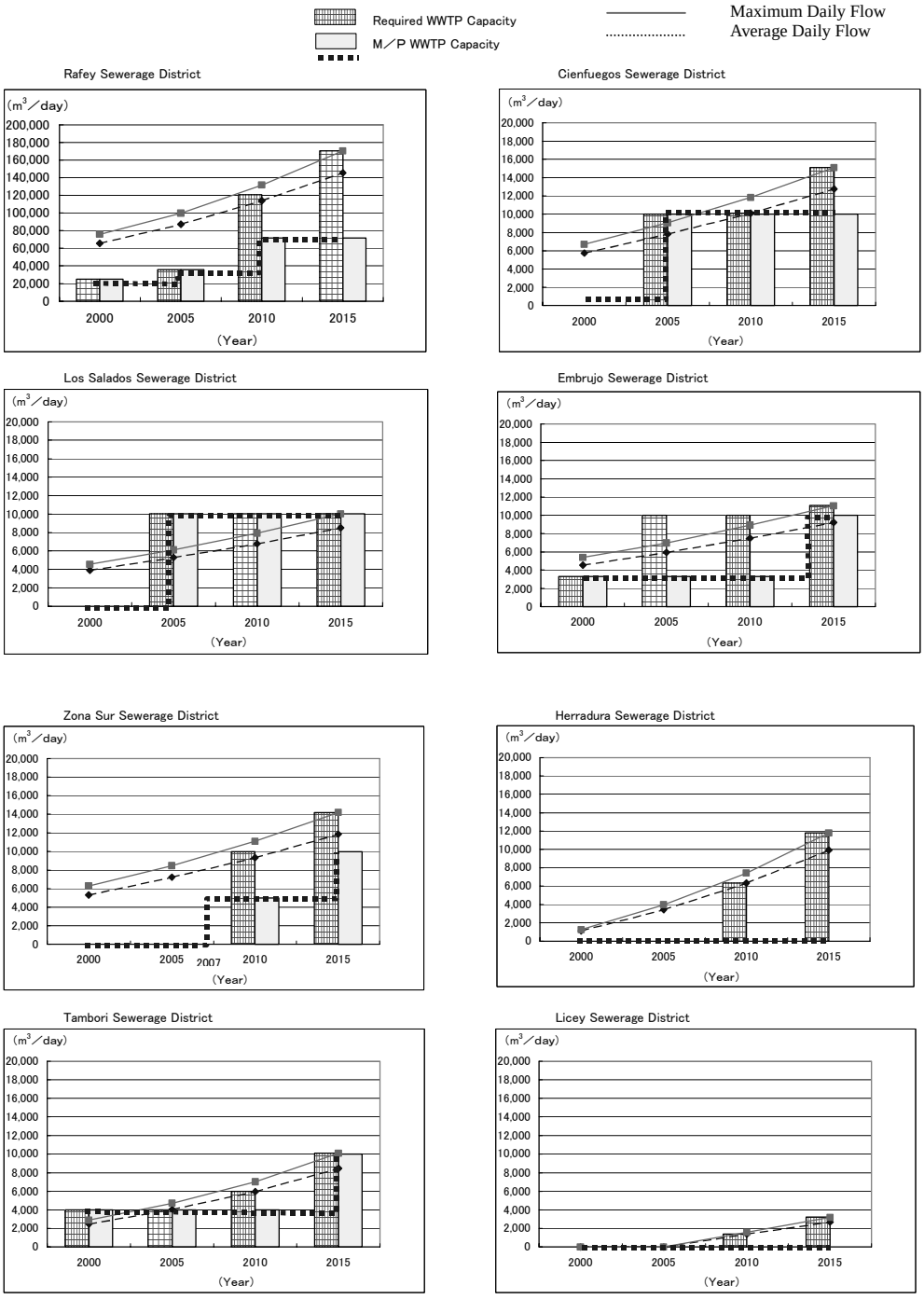


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Figure 4

WWTP Capacity Increment Plan

1.7 COSTS OF THE RECOMMENDED PROGRAM

The recommended plan for implementing sewerage system calls for construction, operation and maintenance in the three construction stages. The following table shows the construction costs, including both local and foreign currency portions. Operation and maintenance costs by stage are also summarized. All the construction costs include contingency and engineering. All costs are estimated based on mid-2001 price levels and escalations are considered.

1.7.1 CAPITAL COSTS

Total capital cost, including indirect cost, is estimated 209.8 million the selected priority project components, as shown in the table below:

Summary of Capital Cost (Unit: US$1,000)

Cost Item		Project for Selected Components		
		FC	LC	Total
Direct Construction Cost				
1	Rafey District	49,163	51,233	**100,396**
2	Embrujo District	4,152	2,826	**6,978**
3	Cienfuegos District	4,067	2,348	**6,415**
4	Los Salados District	3,270	2,378	**5,648**
5	Zona Sur District	9,603	8,041	**17,644**
6	Licey District	0	0	**0**
7	Herradura District	1,749	3,988	**5,737**
8	Tamboril District	2,540	677	**3,217**
Total of Direct Construction Cost		**74,544**	**71,491**	**146,035**
Indirect Cost				
1	Land Acquisition and Compensation	0	350	**350**
2	Administrative Expense	0	4,385	**4,385**
3	Engineering Services	17,522	4,385	**21,907**
4	Physical Contingency	7,455	7,152	**14,607**
5	ITBIS (Value Added Tax)	0	22,480	**22,480**
Total of Indirect Cost		**24,977**	**38,752**	**63,729**
Total Capital Cost at 2001 Price		**99,521**	**110,243**	**209,764**

1.7.2 OPERATION AND MAINTENANCE COSTS

The annual expense of CORAASAN in 1999 was RD$ 185.2 million or US$ 10.9 million. The expenses of water supply and sewerage sections are assumed to be US$ 8.0 million and US$ 2.9 million respectively. CORAASAN was exempted from electric power cost in 1999, but this will be charged from 2001. Consequently, electric power cost is included in the future operation and maintenance cost estimates.

In accordance with operation and maintenance costs as of 1999 and planned future treatment volume, annual operation and maintenance cost of sewerage section of CORAASAN will be increased US$ 6.0 million, 8.7 million and 9.8 million at year 2005, 2010 and 2015 respectively.

Operation and Maintenance Cost

Year	2002	2005	2010	2015
Annual OM costs (US$ million)	3.5	6.0	8.7	9.8

1.8 FINANCIAL ANALYSIS

The financial indicators are computed for each sewerage district and the proposed sewerage system implementation programs up to 2015, based on various assumptions. The conditions for the evaluation are as follows:

(1) For the financial analysis a term is set to start after the completion of the Second Stage Project and lasting until 2040 for over 30 years;

(2) For the facilities which are depreciated during the period, the capital costs for the renewed facilities are included in the investment costs. Those not depreciated at by the end of the period no residual value is considered;

(3) The user charges will be raised stage wise by 55 percent (same as the increased rate in 2001) each in 2004, 2007, 2010 and 2013;

(4) The user charge recovery (collection efficiency) rate of 82 percent in 2001 will be raised to 98 percent by 2009; and

(5) A discount rate of 3 percent per annum is applied in view of the project characters and interest rates of the available foreign currency loans.

The results of the financial analyses are as summarized in the following. The total project FIRR of 3.3 percent is higher than the interest rates of the possible foreign soft loans, which range about one to two percent. The NPV of the total project is positive and the B/C slightly exceeds 1.0. These results indicate that the Master Plan project will be self-sustainable.

Summary of Financial Viability Indicators

	NPV * (US$ Million)	B/C *	FIRR	Financial Priority
Rafey	47.3	1.3	5.5%	3rd
Herradura	17.3	4.0	n.a.	1st
Cienfuegos	-17.2	0.5	n.a.	5th
Los Salados	-18.5	0.4	n.a.	6th
Embrujo	-3.6	0.7	n.a.	4th
Zona Sur	-27.8	0.3	n.a.	7th
Tamboril	1.7	1.1	5.8%	2nd
Total	6.7	1.0	3.3%	

* Discounted at 3% p.a.

1.9 ECONOMIC ANALYSIS

The sewerage system implementation program up to 2015 has been evaluated based on various assumptions, as summarized below:.

(1) For the economic evaluation the term of analysis is set for over 30 years until 2040, the same as the financial analysis, starting after the Second Stage Project completed;

(2) Based on the amounts of users' willingness to pay to the sewerage provision, as obtained by the social surveys of the present Study, the total amount of the willingness to pay of the residents, commercials, institutions, and industries within the Study Area are assumed, the results of which are used as the basis for the estimation of the project economic benefits.

(3) A conversion factor of 0.9 is applied to convert the local costs (shadow prices) to international market prices.

(4) The discount rate is set to be 10 percent in view of the general opportunity costs for the capitals.

The results of the analysis are summarized in the following table. The EIRR of 7.7 percent is higher than the FIRR of 3.3 percent. Although the EIRR is lower than a general economic opportunity cost of 10 percent, the gap is not so wide. This result provides a sufficient room for the positive consideration of the Master Plan.

Economic Viability Indicators of M/P Project

NPV *	B/C *	EIRR
US$ -17.8 million	0.8	7.7%

* Discounted at 10% p.a.

1.10 WATER ENVIRONMENT

1.10.1 PRESENT CONDITIONS OF WATER ENVIRONMENT

Within the Study Area there are the Yaque del Norte River crossing Santiago City area and its four small branches (natural streams). For the river water quality analysis, hydraulic data collected by CORAASAN at five points of the Yaque del Norte River, at four points of the urban streams (From February 1997 through December 1997), and the water flow data by INDRHI were collected. The locations of the monitoring points are illustrated in Figure 5. Further water quality survey was conducted under the Study twice in March 2001. Form these data the present water environment in the area may be characterized as follows.

The water quality data obtained at the point RC1 (Toma de Pastor, located close to the water intake, at the uppermost of the Yaque del Norte River), with the average BOD_5 and DO of 2.8 mg/L and 6.6 mg/L respectively, indicates that the water has not been contaminated yet. In light of the Japanese river water quality standards, the conditions are comparable either to Class A (BOD_5 of 2 mg/L or lower and DO of 7.5 mg/L or higher) or Class B (BOD_5 of 3mg/L or lower and DO of 5mg/L or higher). The water taken as the drinking water source needs such water treatments as sedimentation and filtration processes. However, if the water is further contaminated, much higher level of treatment preceded by pretreatment may become necessary.

At the monitoring point RC2 (Obra Toma de Canal) located in the mid point of the Yaque del Norte River within the Study Area, the contaminated water inflow through the Hondo and Nibaje rivers. Hence, the River water has been polluted and the average BOD and DO became 2.8 mg/L and 6.6 mg/L respectively. At about 200 m downstream from this point is the irrigation water intake (water intake of 7~27 m^3/s). Because of this, the River flows in the downstream are drastically reduced to 3～35 m^3/s compared with the upstream flows of 15～52 m^3/s.

Between the monitoring points RC3 (Descarga Teneria Bermudez) and RC5 (Descarga A.N.Rafey) the contaminated Gurabo river water inflows to the Yaque del Norte River. This condition degrades the River water quality, since the River water flows are low, high rate of the water dilution cannot be expected. The bypassed raw wastewater from Rafey WWTP inflows to the River at the point RC5, the inflowing waste loads exceed the River's assimilation capacity. Consequently, the River water quality has been degraded to the level of 26 mg/L BOD and 2 mg/L DO.

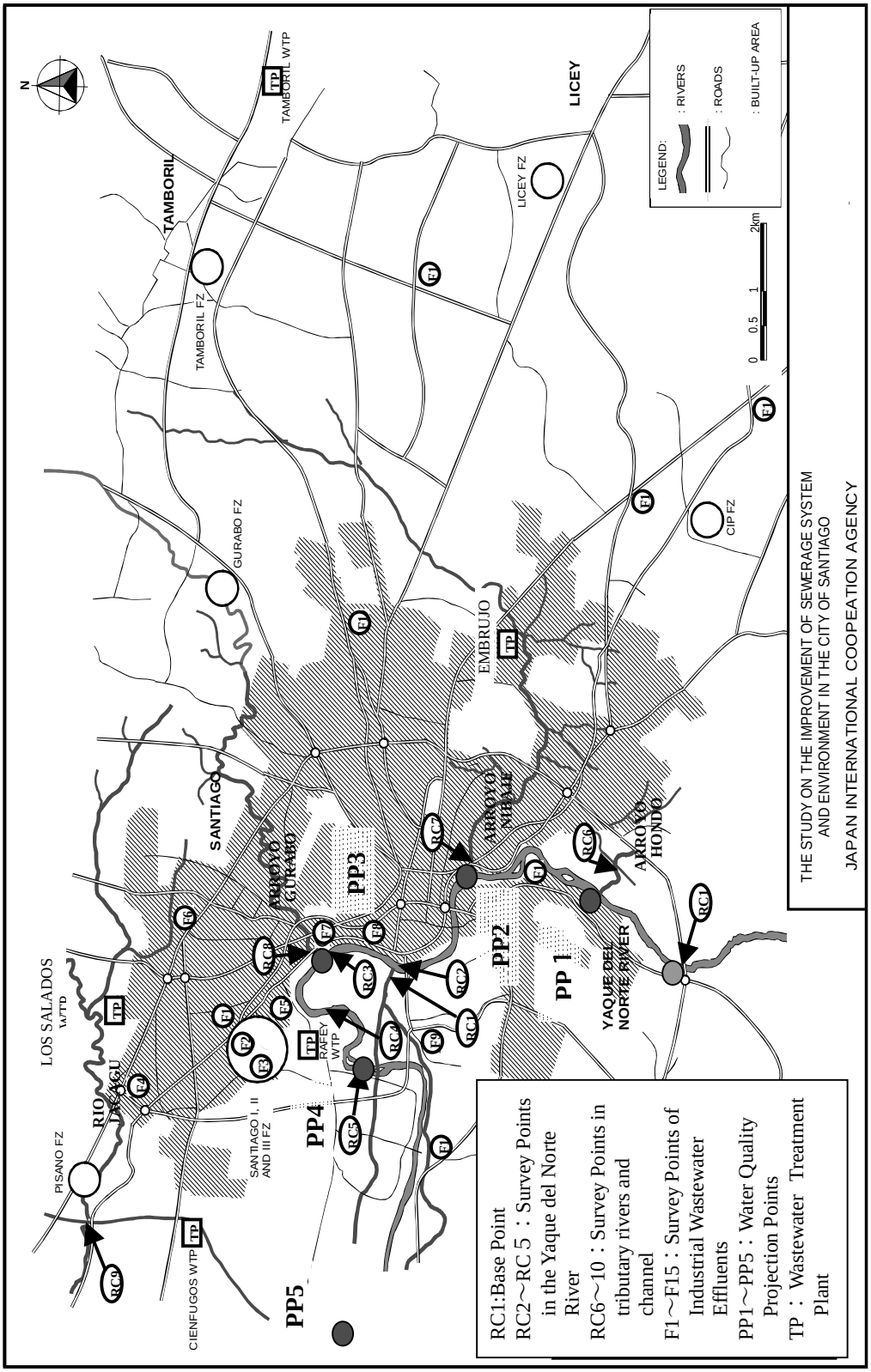

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Figure 5
Water Quality Survey Points and Water Quality Projection Points

The urban streams inflowing to the Yaque del Norte River are contaminated by the uncontrolled disposals of the raw wastewater and garbage into the River, thus average BOD, COD_{cr} and NH_4-N reach as high as 22~79 mg/L, 73~202 mg/L and 2.5 ~8.5 mg/L, respectively.

The water from sewerage system, industries, and rivers are sampled and analyzed, as to toxic substances, heavy metals, organic chlorine compounds, pesticide. The survey results indicate that no significantly high concentrations of these substances are observed.

1.10.2 PREDICTION OF FUTURE RIVER WATER QUALITIES

Based on the available river water quality and hydrographic data, the waste loads discharge to the Yaque del Norte River are estimated for three alternative cases; i) without implementing any additional sewerage system, ii) with the implementation of sewerage system and industrial wastewater treatment programmed under the Master Plan, and iii) with the whole required sewerage system. For each alternative plan, the River water qualities are predicted at every five years until 2015, then each alternative plan is evaluated in its effectiveness of the River water quality improvement.

At the five monitoring points, four at the branch river confluences to the Yaque del Norte River and the other at present monitoring point RC5 (at the downstream of Rafey WWTP outfall), the future water qualities are estimated in terms of BOD5, SS, T-N and T-P. The water quality monitoring points are shown in Figure 5 and described as follows:

Water Quality Monitoring Points

Points	Locations	Distance from point (RC1)	Remarks
PP1	Downstream of the Hondo river confluent point	2.1 km	
PP2	Downstream of the Nibaje river confluence point	4.1 km	Irrigation water intake is located at 4.3km upstream of point RC1.
PP3	Downstream of the Gurabo river confluent point	7.6 km	
PP4	Downstream of Rafey WWTP outlet	10.4 km	= RC5
PP5	Downstream of the Jacagua river confluent point.	13.0 km	

*At the confluence with a branch river, the location is set within 200 m from the confluent point.

The possible River water qualities are examined in terms of BOD_5 inflowing to the River under two cases, i.e. without sewerage system, and with the sewerage system as planned in the Master Plan and industrial wastewater treatment facilities.

The discharged BOD5 to the River, and the expected BOD load reductions in each case by year are summarized in the following table and presented in Figure 6.

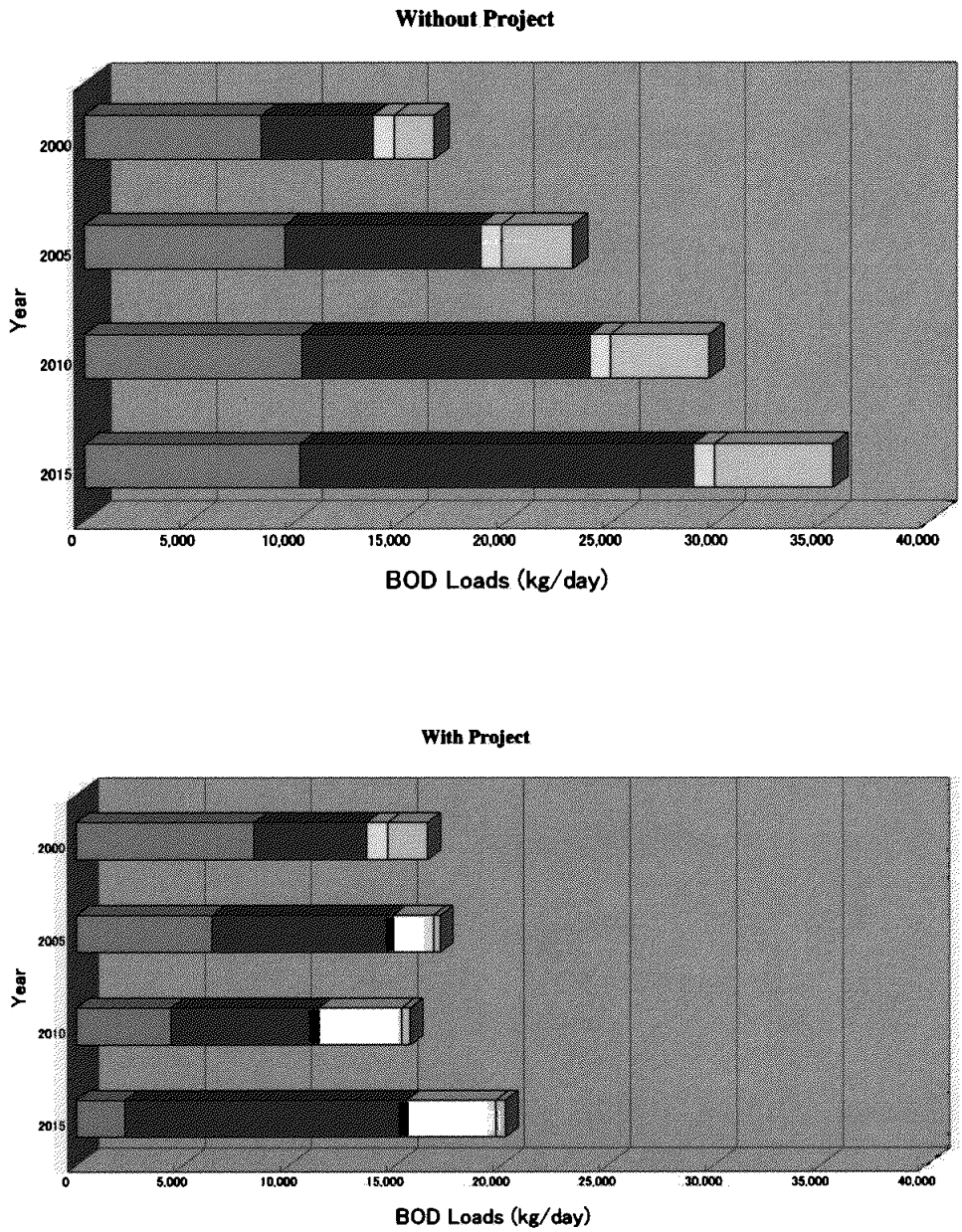
BOD Discharges to the Yaque del Norte River（kg/day）

Conditions	Sources of BOD Loads	2000 (Present)	2005	2010	2015
Without Project	Domestic wastewater loads from unsewered areas	8,352	9,479	10,274	10,168
	Raw wastewater loads by-passed ahead of WWTPs	5,300	9,258	13,612	18,619
	Waste loads by WWTP effluents	991	991	991	991
	Sub-total	14,643	19,728	24,877	29,778
	Industrial WWTP effluents	1,880	3,369	4,657	5,605
	Total	16,523	23,097	29,534	35,383
With Project	Domestic wastewater loads from unsewered areas	8,352	6,374	4,431	2,280
	Raw wastewater loads by-passed ahead of WWTPs	5,300	8,500	6,949	13,249
	Waste loads by WWTP effluents	(991)	1,919	3,908	4,177
	Sub-total	14,643	16,793	15,288	19,706
	Industrial WWTP effluents	1,880	305	394	460
	Total	16,523	17,098	15,682	20,166
	Reduction of waste load discharge		5,999	13,852	15,217

The following table shows BOD discharges down to each monitoring point and presented in Figure 7.

BOD Discharges at Monitoring Points (kg/day)

Year	Conditions	BOD Discharge at Monitoring Points				
		PP1	PP2	PP3	PP4	PP5
2000	Present	1,229	4,384	3,280	5,022	2,608
2005	**With Project**	**1,570**	**1,968**	**3,565**	**8,415**	**1,581**
	Without Project	1,596	5,667	3,618	8,401	3,815
2010	**With Project**	**700**	**1,713**	**2,090**	**9,781**	**1,397**
	Without Project	1,885	7,027	3,649	11,933	5,040
2015	**With Project**	**843**	**1,031**	**1,113**	**15,276**	**1,903**
	Without Project	2,109	8,195	3,215	15,573	6,292



THE STUDY ON THE IMPROVEMENT OF SEWERAGE SYSTEM AND ENVIRONMENT IN THE CITY OF SANTIAGO	Figure 6 BOD Loads discharged to the Yaque del Norte River
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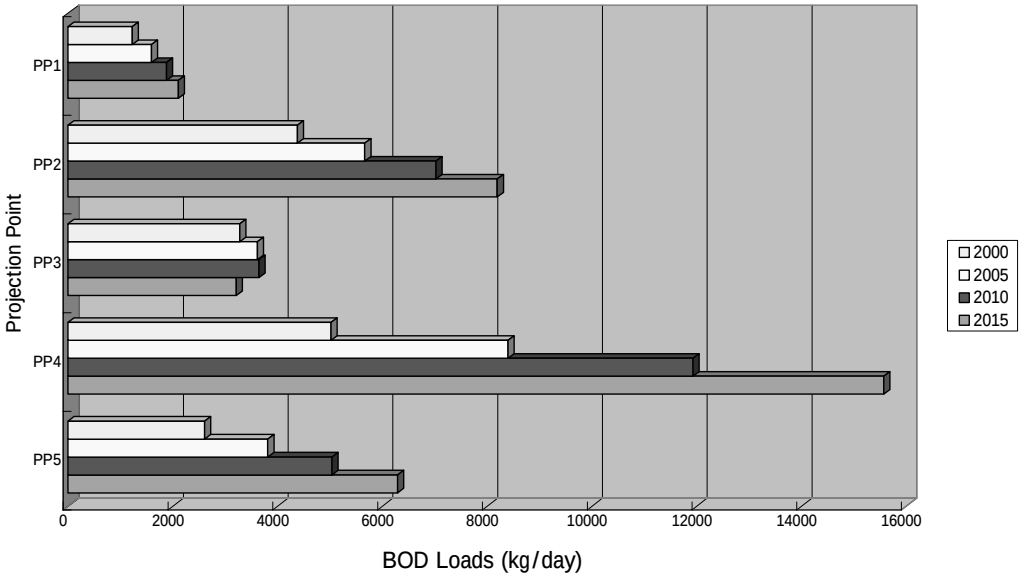
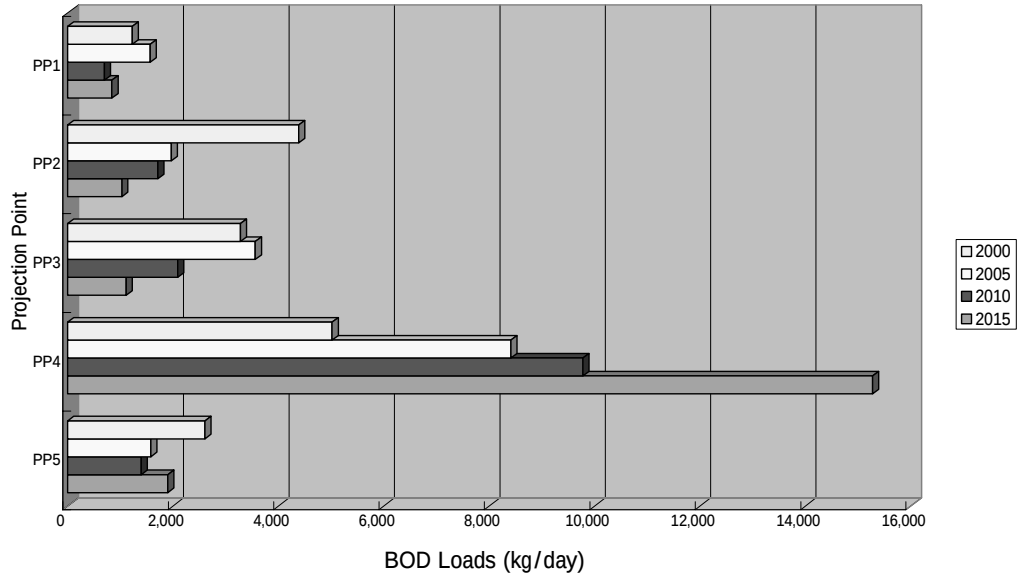
Without Project



With Project



THE STUDY ON THE IMPROVEMENT OF SEWERAGE SYSTEM AND ENVIRONMENT IN THE CITY OF SANTIAGO	Figure 7 BOD Loads discharged to the Yaque del Norte River at each Projection Point
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BOD concentrations at the water quality monitoring points are estimated by using the following average river flow rates:

Average Flow Rates of Analyzed Rivers (m^3/s)

Yaque del Norte River		Branch Rivers*			
Before Irrigation Water Intake	**After Intake**	**Hondo**	**Nibaje**	**Gurabo**	**Jacagua**
29.9	14.1	0.30	0.68	0.45	0.90

Note: Data in Branch rivers are those sampled by CORAASAN.

Average BOD Concentrations under Varied Flows at Monitoring Points (mg/L)

Year	Conditions	Predicted BOD concentrations at monitoring points				
		PP1	**PP2**	**PP3**	**PP4(RC5)**	**PP5**
2000	Present	3.3	5.2	8.0	12.2	13.2
2005	With Project	**3.5**	**4.3**	**7.4**	**14.2**	**14.4**
	Without Project	3.5	5.9	9.0	16.0	17.5
2010	With Project	**3.0**	**3.7**	**5.3**	**12.6**	**12.6**
	Without Project	3.5	6.2	9.1	18.1	20.2
2015	With Project	**3.1**	**3.4**	**4.3**	**15.6**	**15.7**
	Without Project	3.6	6.8	9.2	20.8	23.4

Note: BOD_5=2.8mg/L at RC1

Because the River water quality will be much influenced by the River flow rate, the expected water qualities are calculated based upon the collected flow data, then, the variation of the River water quality are estimated. The following table presents the river water flow rates used for the analysis:

The Yaque del Norte River Flow Rates Assumed

Flows	From RC1 to PP2	From PP3 to PP5
Lowest flows	15.3 m^3/s	3.1 m^3/s
Highest flows	51.8 m^3/s	35.1 $m^3/$

From the water quality predictions as presented in the following table, it is evident that if sufficient river water flow is secured, the River water quality would be significantly improved from the present condition. Under the low flows, River water quality improvements could be achieved as far as the Gurabo river confluence (PP3), but at the points further downstream might not be significantly improved even after the proposed master plan sewerage system has been provided.

Accordingly, such necessary measures are to be taken as to secure the sufficient quantity of the river flow and increase the treatment capacity of Rafey WWTP capacity, to improve the River water qualities.

Predicted BOD Concentrations Based on the River Flow Rates (mg/L)

Year	Flow Conditions	BOD Concentrations (at point RC1, BOD_5=2.8mg/L)				
		PP1	PP2	PP3	PP4(RC5)	PP5
2000	Lowest flows	3.8	7.2	17.8	31.2	30.6
	Average flows	3.3	5.2	8.0	12.2	13.2
	Highest flows	3.1	4.2	5.4	7.2	7.8
2005	Lowest flows	4.1	5.5	17.2	37.4	33.3
	Average flows	3.5	4.3	7.4	14.2	14.4
	Highest flows	3.2	3.7	5.0	8.0	8.2
2010	Lowest flows	3.3	4.4	10.9	32.2	28.6
	Average flows	3.0	3.7	5.3	12.6	12.6
	Highest flows	2.9	3.3	4.0	7.2	7.4
2015	Lowest flows	3.4	4.0	7.3	40.2	35.8
	Average flows	3.1	3.4	4.3	15.6	15.7
	Highest flows	3.0	3.2	3.5	8.5	8.8

Because the existing data applied for the future water quality prediction are limited in the number of data and their sampling period, it is necessary that an accurate River water quality model that precisely reflects the present situation be developed in the future to establish the appropriate water quality monitoring system.

1.10.3 PROPOSED WATER QUALITY TARGET AND GOAL IN THE YAQUE DEL NORTE RIVER IN THE STUDY AREA

Through a series of water quality studies under the sewerage implementation program up to 2015, the following target qualities and goals for the water environment of the Yaque del Norte River in the Study Area are proposed.

Proposed Target Waster Quality and Water Use

Proposed	Water Quality	Water Use	Remarks
Level 1	BOD < 5 mg/L, Coliform <1,000MPN/100mL, DO > 80% Saturation 6.5< pH L<9.0	Water supply with conventional treatment, irrigation, natural conservation	Category B in the new Norm (AG-CC-01)
Level 2	BOD < 10 mg/L, Coliform <5,000MPN/100mL, Fecal Coli. < 2,000 MPN/100mL DO > 60% Saturation 6.5< pH L<9.0	Water supply with advance water treatment such as biological, activated carbon, ultra filtration process. , recreational activities without direct contacts	

Proposed Water Quality Goals in the River and Necessary Actions

Target Period	Target Level	Proposed Sewerage Implementation	Other Actions required
Short Term (2002 to 2005)	Level 1 (PP1) Level 2 (PP1, PP2)	- Preparation and implementation of the First Stage Project - Establishment of organizations.	- Facilitate the implementation industrial wastewater treatment and management. - Establishment of monitoring system
Mid Term (2006 to 2010)	Level 1 (PP1, PP2) Level 2 (up to PP3)	- Commissioning the first stage project, and implementation of the second stage project	- Operation of the proposed organization and monitoring system (SEMARENA and CORAASAN) - Proper industrial wastewater management
Long Term (up to 2015)	Level 1 (PP1, PP2) Level 2 (up to PP3)	- Commissioning the 2nd stage project, and implementation of the 3rd stage project	- Coordinate to use irrigation water as dilution source for the river natural preservation purposes. - Appropriate Solid wastes management

Note: PP1 to PP3 is a proposed observation locations where the following rivers join the Yaque del Norte river: PP1 (the Hondo river), PP2 (the Nibaje river) and PP3(the Gurabo river).

1.10.4 SUGGESTED WATER MONITORING PARAMETERS

Water monitoring program for the Yaque del Norte in the Study Area is indispensable to manage the water quality and to secure compliance with the effluents standards. INDRHI is conducting a water quality survey for the whole Yaque del Norte river basin in order to establish a comprehensive river monitoring program. The followings are a suggested parameters to measure.

Suggested Water Monitoring Parameters in the river

Items	Suggested Parameters	Remarks
Flow Measurement at monitoring locations	Flow rate (water depth, flow velocity)	monthly, surveys of river section at locations are necessary
Basic Quality Parameters	BOD, DO, Transparancy	monthly or weekly
Monitoring Parameter A	TOC, T-N, T-P, SS, Water ambient temperature, pH, and Fecal Coliform	monthly or weekly
Monitoring Parameter B	Heavy Metals, Pesticides, Chlorinated compounds,	periodically and/or request base
Monitoring Parameter C	Bioassay	all year
Monitoring Parameter D	Flora and Fauna	yearly, seasonally

1.11 PRIORITY PROJECT FOR FEASIBILITY STUDY

As to the Priority Project for the Feasibility Study, the system components under the First Stage Program is proposed and confirmed by CORAASAN. The table below shows sewerage component facilities included in the Priority Project.

The Priority Project (the First Stage Program proposed) can be characterized as an emergency program which will concentrate to the rehabilitation of existing WWTPs to provide the earliest benefits to reduce the pollutant loads to Yaque del Norte River or rivers in the vicinity of residential areas, and to provide better living and sanitary environment through rehabilitation/construction of

sewer networks and collector/interceptor sewers and pumping station. And it is also characterized as the first step program to contribute to reduce the pollutant loads to Yaque del Norte River and to improve the river water quality by the provision of construction of new wastewater treatment plant in Zona Sur District, which is located in the uppermost stream in the Study Area.

Sewerage Component Facilities in the First Stage Project

District	Collection System	WWTPs
1. Rafey	Construction of 7.2 km main sewers Construction of 15.6 km lateral sewers Rehabilitation of Existing Pumping Station	Rehabilitation of 35,800 m^3/day WWTP
2. Cienfuegos	Construction of 0.6 km main sewers Construction of 2.6 km lateral sewers	Rehabilitation of 10,000m^3/day WWTP
3. Los Salados	Construction of 3.5 km main sewers Construction of 1.1 km lateral sewers	Rehabilitation of 10,000m^3/day WWTP
4. Embrujo	Construction of 0.4 km main sewers Construction of 0.6 km lateral sewers	-
5. Zona Sur	Construction of 1.1 km main sewers Construction of 0.9 lateral sewers	Construction of 5,000 m^3/day WWTP

1.12 INSTITUTIONAL IMPROVEMENTS IN CORAASAN

The main institutional improvements suggested by the Study are set out below:

(1) To create a 5-year planning and monitoring system to be based in Engineering Management (EM) and linked to financial plans in Administration and Finance Management (AFM);

(2) To create a small community relations section (like CAASD) to address the serious problems of a) abuse of the sewerage system, b) non-payment of bills, and c) water wastage;

(3) To increase staff productivity and reduce operating costs by launching a serious cost reduction program in CORAASAN to be run by senior management and the HR Office;

(4) To consider and implement one of several options for reorganizing ESM maintenance, to allow ESM more control over its own maintenance;

(5) A staff and training needs analysis to be conducted as part of the sewerage O&M review. As initiated by Commercial Manager, to examine all 23,000 unpaid accounts by setting up a special temporary task force of about 20 persons and decide action on each account;

(6) To establish and publish commercial policies and targets and monitor the achievement of these, thereby contributing to improved commercial performance.

(7) To establish a unit within ESM to be responsible for controlling the quality of industrial wastewater entering the sewerage system1. This is to ensure compliance with Environmental Law No. 6418-2000 and the New Norms. This unit could also be used by SEMARENA under temporary contract to monitor industrial discharges to the environment;

(8) To group WWT laboratories with the new IWQCS in a new Process Control Division

(9) To systematically investigate the scope for additional private sector participation in the provision of general support services to CORASAAN. In this, it will be necessary to a) evaluate potential, b) do some benchmark testing of external versus internal cost and output, and c) establish main procedures.

[1] The unit could be named “Industrial Wastewater Quality Control Section (IWQCS)”.

(10) During the Feasibility Study a HRD plan will be prepared to help ensure an efficient and effective workforce to operate and maintain the sewerage system proposed in the Master Plan. The HRD plan will outline staff numbers and types in ESM and EM and the main training required: a) currently, b) at the mid- to end- 2005, and c) at the end of 2006. The dates b) and c) are the expected completion dates for additional sewerage facilities under Stage 1 of the Master Plan, when more O&M staff may be needed.

1.13 NATIONAL LEGISLATION AND ORGANIZATION IN THE WATER SECTOR

1.13.1 LEGISLATION AND ORGANIZATION

There is an urgent need to enact the proposed governing legislation for the water and wastewater sector, having ensured that it is internally consistent. The proposed Water Supply Law that has been before Congress for at least a year, the newly prepared General Water Law (intended to be the umbrella legislation for the water sector and will specify an enlarged role for INDHRI), should both be enacted[2] as soon as possible, *as long as they are consistent with each other and with Environment Law No. 6418-2000.*

The enactment of this legislation will permit the policy making, supervisory and regulatory body(ies) for the water sector to be established and made operational, and will also allow progress to be made in the commercialization of water and wastewater service providers.

1.13.2 SEMARENA

It is recommended that SEMARENA should speed up the documentation and dissemination of its organization, responsibilities and activities. It is important that its scope, remit, objectives and plans, authority and achievements are fully understood by industry, all agencies in the water sector and the public. As a minimum, there should be a published "corporate" plan, a published customer charter, and small informative brochures. Also, a scale of charges and penalties is needed, to be levied when discharges to the environment exceed the permitted levels.

[2] On the major assumption that this is the most effective way of updating water sector legislation