CHAPTER 3
ENVIRONMENTAL CONDITIONS, LAWS, REGULATIONS AND STANDARDS

3.1 GENERAL

The Santiago City and its surrounding areas are undergoing a remarkable rate of population growth. Between 1981 and 2000 the City's urban population has almost doubled, now reaching a level of 650,000. Such a rapid urbanization has brought much environmental problems to the Area. Urban utility systems have failed to develop to serve the expanding urban districts and the increasing urban population.

The Santiago City is located at the upper stream tributary of the Yaque del Norte River basin. The River is the largest one in the country and an important water source for domestic, industrial and irrigation purposes. The ever-increasing amount of wastewater discharge into the River due to an uncontrolled urban expansion and a lack of urban infrastructure development causes a serious deterioration of water quality in the Study Area.

3.2 WATER ENVIRONMENT

3.2.1 CURRENT STATUS OF WATER ENVIRONMENT

(1) The Yaque del Norte River

Since July 1999, CORAASAN has been undertaking a water quality monitoring program in the Yaque del Norte River on the typical water quality parameters such as BOD, COD, SS, pH, electric conductivity, sulfate, ammonia-nitrogen, nitrite, nitrate, etc. at the five selected monitoring points in the River within the Santiago City, and at four points in small streams tributary to the River.

At the point St. 1 (Toma de Pastor) of the River, which was not affected by the Santiago City urban wastewater discharge, the BOD concentrations range from 0.4 to 11mg/L with the average concentration of 2 mg/L, as shown in the table below. At point St.5 (A.N. Rafey: the downstream of the Rafey WWTP) the river water was more polluted due to the urban wastewater discharge, with BOD concentrations ranging at 18 ~ 40 mg/L. Similar trends were observed in concentrations of COD, NH_4-N, etc.

INDRHI has also been undertaking a water quality-monitoring program, by setting up 17 monitoring points for the whole catchments area of the Yaque del Norte River since 1993, under the cooperation of German GTZ. on BOD, COD, etc. and some river water quality data are available.

As already discussed in Chapter 2, the water quantities released from the Lopez Angustura Reservoir to the Yaque del Norte River fluctuated largely between 20 and 120 m^3/s. The flow rates (the agriculture water intake + down flowing amount), at the observation point 4 km upstream from the agriculture water intake canal, ranged from 15 to 52 m^3/s with an average flow rate of about 30 m^3/s.

The agriculture water intake were in the order of 7 ~ 27 m^3/s. As such, the river flow rates through the City could be in the range of 3 ~ 35m^3/s, but the actual river flow rates during the dry season would have been much lower than the estimated water balance.

The water qualities observed at the five monitoring points are shown in the following table:

Water Quality of Yaque del Norte River

Monitoring Point		Pollution Indicator	Month, 2000			
			July	August	October	November
St.1	Antes Toma de Pastor	BOD_5 (mg/l)	1.3	0.4	-	11
		COD_{Cr} (mg/l)	4	6	23	29
		NH_4-N (mg/l)	0.08	0.03	0.15	0.13
		DO (mg/l)	7.4	6.3	4.72	5.5
		Electric Conductivity (μ S/cm)	172	160	120	125
St.2	Antes Obra Toma de Canal	BOD_5 (mg/l)	4.8	1.3	-	18
		COD_{Cr} (mg/l)	8	21	19	40
		NH_4-N (mg/l)	0.18	0.23	0.28	0.28
		DO (mg/l)	7	6	4.47	5.4
		Electric Conductivity (μ S/cm)	184	208	160	163
St.3	Despues Descarga Teneria Bermudez	BOD_5 (mg/l)	17	29	-	23
		COD_{Cr} (mg/l)	143	160	25	12
		NH_4-N (mg/l)	1.41	1.81	2.18	0.61
		DO (mg/l)	N.D.	N.D.	2	4.6
		Electric Conductivity (μ S/cm)	557	613	480	157
St.4	Frente Planta Rafey	BOD_5 (mg/l)	19	30	-	17
		COD_{Cr} (mg/l)	159	154	112	68
		NH_4-N (mg/l)	0.2	1.08	0.8	0.4
		DO (mg/l)	N.D.	N.D.	0.87	4.8
		Electric Conductivity (μ S/cm)	607	650	492	188
St.5	Despues Descarga A. N. Rafey	BOD_5 (mg/l)	18	40	-	19
		COD_{Cr} (mg/l)	113	148	175	53
		NH_4-N (mg/l)	0.74	2.78	2.48	0.5
		DO (mg/l)	N.D.	N.D.	2.2	5.1
		Electric Conductivity (μ S/cm)	661	796	528	226

Source: CORAASAN

In the dry season when the flow rate is low, the dilution and assimilation capacity of the River is significantly reduced, and the water quality is much degraded. Since there is a close relation between the water quality and the flow rate in the River, it is essential that the exact quantity of water taken for the agriculture use is confirmed, and the real river water balance be ascertained.

The major factors affecting the water quality deterioration of the Yaque del Norte River may be summarized as follows:

- Even if all the Santiago City wastewater were collected to the WWTPs, much portion of the wastewater would be discharged to the River without treatment, due to the defective WWTPs;

- The raw wastewater coming from outside the area where no sewerage system is provided would also be discharged to the River;

- According to CORAASAN, there exist approximately 250 factories and other establishments in the Santiago City as of February 2001. Almost all of the wastewater from these sources is currently being discharged to the River and its tributaries either without pre-treatments or with insufficient pre-treatments;

- The wastewater from inhabitants along the river sides discharge the wastewater that is highly contaminated due to dumped solid waste into the River;

- As considerable quantity of water is taken for irrigation use at the immediate downstream of the sampling point St. 2 of the River, the River water quality tends to be deteriorated particularly after such water is taken; and

- Chemicals used in the farmlands of the River upstream are also considered as a source of the river water contamination.

(2) Tributaries to the Yaque del Norte River

The Yaque del Norte River has many branches across the Santiago City area. Hydrologically, Santiago City area may be divided into four separate zones, which correspond to various small river basins. Each of the zones has river branches and drainage channels that carry a significant amount of contaminants into the River, contributing partly to the current severe water contamination in the River.

The situations have been much worse in the high population density urban zones, where the uncontrolled garbage and solid wastes disposals into the rivers and streams are practiced. At many locations along the rivers and streams small houses encroach even into the riverside and discharge wastewater to rivers.

CORAASAN also conducts monthly water quality monitoring of the four small rivers: 1) Arroyo Hondo, 2) Arroyo Nibaje, 3) Arroyo Gurabo, and 4) Jacagua Rivers, flowing into Yaque del Norte River in the City. The following table shows the water quality data of four small rivers monitored by CORAASAN:

WATER QUALITY OF TRIBUTARY RIVERS OF YAQUE DEL NORTE RIVER

Monitoring Point		Pollution Indicator	Month, 2000			
			August	September	October	November
St.6	Arroyo Hondo	COD_{Cr} (mg/l)	35	20	129	63
		NH_4-N (mg/l)	1.7	1.0	1.0	2.4
		DO (mg/l)	3.2	4.9	5.8	5.6
		Electric Conductivity (μ S/cm)	421	245	200	313
St.7	Arroyo Nibaje	COD_{Cr} (mg/l)	92	56	69	43
		NH_4-N (mg/l)	4.4	5.2	5.2	7.4
		DO (mg/l)	2.7	5.0	0.7	5.5
		Electric Conductivity (μ S/cm)	871	920	894	816
St.8	Arroyo Gurabo	COD_{Cr} (mg/l)	128	54	139	64
		NH_4-N (mg/l)	3.0	2.6	1.3	3.3
		DO (mg/l)	1.8	2.6	3.8	3.2
		Electric Conductivity (μ S/cm)	1,203	751	740	1,118
St.9	Jacagua River	COD_{Cr} (mg/l)	164	124	105	186
		NH_4-N (mg/l)	8.3	5.7	1.3	9.0
		DO (mg/l)	0.8	2.3	2.5	1.7
		Electric Conductivity (μ S/cm)	1,499	1,273	1,044	1,272

Source: CORAASAN

The above data show that the four rivers have already been polluted. The values of electric conductivity, which have rare measurement errors, also indicated that the Jacagua River was most polluted, followed by Arroyo Gurabo, Arroyo Nibaje, and Arroyo Hondo. Other parameters

also show same tendency.

3.2.2 WATER QUALITY SURVEY

A water quality survey was conducted by the Study Team. The main objectives of the survey are as follows:

- Grasping the current conditions of water quality in Santiago region, especially Yaque del Norte River and its tributaries;
- Grasping the operating conditions of wastewater treatment plants and industrial factories in and around Santiago city.
- Obtaining basic data for projecting future water quality in Santiago city when the sewerage improvement project is implemented.

(1) Collection of Samples

A total of sixty-six (66) samples were collected in two events. In each event, thirty-tree (33) samples were taken on March 1 and March 6, 2001 respectively. Sapling locations are as shown in the table below and in Figure 3.1:

- Five (5) wastewater treatment plants: [TP1 – TP5]
- Ten (10) points of rivers and channels: [RC1 – RC10]
- Fifteen (15) factories discharging industrial effluents: [F1 – F15]

Sampling Locations for Water Quality Survey

WWTPs			River/Channel		Factory	
TP1	Rafey	Influent	RC1	Antes Toma de Pastor	F1	Embotelladora Dominicana
		Effluent	RC2	Antes Obra Toma de Canal	F2	Hilos A & E
TP2	Cienfuegos	Influent	RC3	Despues Descarga Teneria Bermudez	F3	Wash & Finish
TP3	Embrujo	Influent	RC4	Frente Planta Rafey	F4	Sadosa
		Effluent	RC5	Despues Descarga A.N. Rafey	F5	Hoyo De Lima
TP4	Los Salados	Influent	RC6	Arroyo Hondo	F6	Baltimore Dominicana
TP5	Tamboril	Influent	RC7	Arroyo Nibaje	F7	Teneria Bermudez
		Effluent	RC8	Arroyo Gurabo	F8	Destileria Bermudez
			RC9	Arroyo Jacagua	F9	Procesadora De Carnes Checo
			RC10	Diversion channel for irrigation	F10	Acero Del Cibao
					F11	Bojos Leatrher
					F12	E. Leon Jimenez
					F13	Corporacion Industrial Del Norte
					F14	Pasteurizadora Cibao
					F15	Isidro Bordas

(2) Analyzed Parameters

The following thirty-three (33) parameters were analyzed considering the characteristics of samples.

1) Water temperature 2) pH 3) Electric conductivity 4) Dissolved oxygen(DO) 5) Biochemical oxygen demand(BOD_5) 6) Chemical oxygen demand(COD_{Cr}) 7) Suspended Solis(SS) 8) Chlorides(Cl^-) 9) Sulfate($SO4^{2-}$) 10) Ammonia nitrogen(NH^{4-}-N) 11) Nitrate nitrogen(NO_3^-—N) 12) Nitrite nitrogen(NO_2^-—N) 13) Total nitrogen(T-N) 14) Phosphate phosphorus(PO_4^{3-}) 15) Total phosphorus(T-P) 16) Oil and Grease 17) Total Coliforms 18) Total fecal Coliforms 19) Phenols 20) Cadmium(Cd) 21) Lead(Pb) 22) Zinc(Zn) 23)Hexavalant chromium(Cr(VI)) 24) Total chromium(T-Cr) 25) Arsenic(As) 26) Total mercury(T-Hg) 27) Copper(Cu) 28) Iron(Fe) 29) Cyanide(CN^-) 30) Magnesium(Mg) 31) Linear alkylate sulfonate(LAS) 32) Organochloric compounds 33) Pesticides

(3) Survey Results

The survey results are summarized in Appendix-2 of the Supporting Report. As for the toxic substances, heavy metals, organochlorine compounds and pesticides, no significant concentrations were detected in the river waters. The results indicate that the water contamination of Yaque del Norte River is caused mainly by organic matters.

3.2.3 SUMMARY OF WATER QUALITIES IN THE STUDY AREA

The survey results and the CORAASAN's monitored data are combined together to calculate the average values of the major water parameters at the monitoring stations of the river water in the Study Area.

The following table summarizes the calculated values for respective monitoring stations from RC1 to RC10.

Average Values of Water Pollution Indicators at River Water in Santiago City (Average value of Year of 2000 and 2001)

Monitoring Point		RC1	RC2	RC3	RC4	RC5	RC6	RC7	RC8	RC9	RC10
BOD_5	**[mg/L]**	2.8	5.7	31	32	26	43	22	39	79	6
COD_{Cr}	**[mg/L]**	21	22	90	105	108	73	65	72	202	23
SS	**[mg/L]**	113	159	125	386	385	165	142	218	210	214
Electric Conductivity	**[μS/cm]**	141	186	486	532	564	457	844	1,018	1,362	225
NH_4-N	**[mg/L]**	0.08	0.25	1.90	1.50	1.97	2.0	5.5	3.7	8.5	0.3
NO_3-N	**[mg/L]**	1.1	1.3	0.9	1.0	1.9	1.9	2.3	1.3	2.0	2.5
NO_2-N	**[mg/L]**	0.006	0.013	0.025	0.035	0.072	0.058	0.057	0.038	0.019	0.020
T-N	**[mg/L]**	0.56	4.4	7.6	24	7.6	5.3	51.9	10.5	14.9	13.0
T-P	**[mg/L]**	0.82	0.57	1.32	1.90	0.18	2.66	0.60	1.82	1.55	0.89
DO	**[mg/L]**	6.6	6.7	2.3	2.0	2.1	5.2	3.6	1.6	1.2	7.9

Source: CORAASAN, JICA Study Team

The water quality at RC1, located at the uppermost stream of the Yaque del Norte River in the Study Area, is relatively good (BOD_5: 2.8 mg/L, DO: 6.6mg/L). This water quality would be suitable for the irrigation use and also for the potable water source with treatment.

The water quality survey results clearly show that the river water quality has been gradually degraded from upstream to downstream (from RC1 to RC5) i.e. the concentrations of BOD_5 and electric conductivity increased but DO decreased toward the downstream. It is also confirmed that the water quality from the monitoring station RC3 to RC5 became worse after receiving polluted water from the tributaries and other waterways (from RC6 to RC9).

3.3 PUBLIC HEALTH CONDITIONS

The recent uncontrolled urban development and the shortage of sanitary facilities are the major courses of the deteriorated sanitary conditions in the area. About 90 percent of the wastewaters produced in the built-up urban districts in the City are collected through the existing sewer networks. However, only 15 percent or 54,432 m^3/d of the total wastewater production is treated with WWTPs according to the CORAASAN's estimate. The rest of the raw wastewaters find their ways toward the nearby watercourses. These conditions are probably the major courses for spreading such diseases as diarrhea, typhoid fever, hepatitis and dengue in wide areas.

The numbers of the patients by disease related to the water contamination in Santiago City area, and the mortality rates due to ten major diseases in the Santiago Province are listed in the following tables. The data on water-borne diseases in the region clearly indicate that these diseases and mortality rates tend to be increasing.

Water-Borne Diseases Registered in Santiago City

Diseases	1990	1994
1. Acute renal infection	10,696	13,572
2. Acute diarrhea	6,800	9,642
3. Typhoid	162	1,047
4. Hepatitis A	68	133

Source: CORAASAN

Numbers of Cases and Mortality Rates Due to Ten Major Diseases in Santiago Province

Diseases	Number of Cases	Numbers/1,000 population
1. Acute renal infection	31,088	38.8
2. Acute diarrhea	14,565	18.2
3. Arterial hypertension	13,825	17.3
4. Gynecologic disease	7,117	8.9
5. Urinary disease	7,607	8.3
6. Dermatological disease	5,924	7.4
7. Headache	5,918	7.3
8. Diabetes	5,215	6.5
9. Anemia	3,655	4.6
10.Bronchial asthma	3,366	4.2
Total	97,280	

Source: Informe Annual de la Dirección Provincial de Santiago, 1997.

The following table shows the percentage of the registered disease cases in Santiago, Tamboril and Licey Cities. During last 12 months, the different diseases in these areas affected only 18 percent householders in Santiago, 24% in Licey, and 20% in Tamboril, respectively.

The common types of diseases in Santiago, Tamboril and Licey were parasite, infective hepatitis and enter virus infection. However, in Santiago and Tamboril typhoid and dengue were important diseases that affected many households' members too. In all of these cases the percentage varies between 2 and 8 percent. Other diseases like dysentery and amoebas are not registered.

Disease Record in the Study Area

MUNICIPALITY	DISEASES RECORD (%)								
DISEASES	Typhoid	Dysentery	Parasite	Infective hepatitis	Amoebas	Gastroen-teritis	Dengue	Enter virus infection	No disease
SANTIAGO	3	0.75	4	2	0	0.25	4	3	82
TAMBORIL	4	0	4	4	0	0	6	2	80
LICEY	0	0	4	8	0	4	0	6	76
TOTAL	3	1	4	2	0	1	4	3	82

Source: People's awareness survey, February 2001.

3.4 STORMWATER DRAINAGE

Oficina de Obras Públicas Municipales del Ayuntamiento de Santiago (Public Works Office of Santiago City Council) is responsible for planning and implementation of the stormwater drainage system in Santiago City. The Office plans, constructs, operates, and maintains the drainage conduits, pipes, canals and other auxiliary facilities. For the routine drainage operation and maintenance works, three working groups are involved, each group comprises six crews and one van truck.

Runoffs on the streets generally flow down through street gutters (generally L-shaped) and inflow to side gutter inlets installed at 30 to 50 m intervals, then discharged to the rivers either directly or through nearby drainage channels.

During the wet seasons in April to May, drainage channels at some low-lying streets are occasionally inundated because of insufficient hydraulic capacities of the street gutters and inlets or depressed ground. During September through December, rainfalls are rather moderate with an average of 10.4-day rainfalls a month thus with less inundations.

Other serious problems relative to the drainage system are those practiced in high population density areas. Uncontrolled disposal of garbage and other solid wastes into open drainage channels and canals are accustomed practice in such areas. The accumulated solid wastes in the drain channels have caused water stagnations at many points, resulting in severe water contamination and odor emanation. Inundations have most frequently occurred at Av. Salvador Estella Sadhala and el Mirador del Yaque.

Notwithstanding such incidents, the stormwater drainage has fewer problems than the wastewater discharge due to the favorable topographic conditions in the area. Particularly at the areas with 220 m or higher above seawater elevation, there have been no such serious inundations.

3.5 SOLID WASTES MANAGEMENT

The Santiago municipality privatized part of the solid waste management, entrusting the solid collection and disposal works to "Servicio de Limpieza de Santiago (SLS)" to cover 18 Sectors and serving about 30 percent of the total urban population. In 1997, the City Council allowed SLS for managing the solid wastes in 20 Sectors or 53 percent of the total urban district area, and serving the population of 340,330 or 64 percent of the then City population.

In 1998 a total of 460 t/d solids were collected, of which about 68.9 % came from residences,

the rest are from commercial, industrial institutions, streets and other sources. At many locations throughout the urban districts, however, a significant amount of garbage and trash has been still littered on the streets, drains and rivers.

The collected solid wastes by sources in the City are shown in the following:

Solid Waste Collected in Santiago City by Source

Sectors	Solids Waste Collected (t/d)	Percentage of Collection
1. Residential	317	68.9
2. Free Zones and Industries	56	12.2
3. Markets	25	5.4
4. Parks and Streets	25	5.4
5. Commercials	19	4.1
6. Institutions	18	3.9
Total	460	100.00

Source: CEUR/PUCMM, 1998.

At present, the collected solid wastes are transported by garbage trucks or other means and disposed of to 47 garbage disposal sites located throughout the City. Many of these small garbage depots have been left uncovered or unclean, consequently creating unsanitary conditions to the nearby areas. The major land disposal site is located about 2 km west of the Rafey WWTP with a total of 3.13 hectares. This site will be fully filled up in near future, and the Santiago Municipality now plans to select another appropriate disposal site.

3.6 LAWS, REGULATIONS AND STANDARDS ON WATER POLLUTION CONTROL

3.6.1 GENERAL LAW

The "General Law on the Environment and Natural Resources (Law No. 6418-2000) " is a basic law for environmental management and protection. This law includes 204 articles of 6 titles and was promulgated on August 18, 2000. In the General Law, Article 86 to Article 89 of Section II of Title III, stipulates the framework of the conservation and protection of water quality in the Dominican Republic.

3.6.2 REGULATIONS

The "Secretaria de Estado de Medio Ambiente y Recursos Naturales (SEMARENA)" has recently elaborated a series of "Normas Ambientales":

- Norms on water quality and control of discharge (AG-CC-01);
- Norms on Air Quality and Emission Control to Atmosphere (AR-CA-01);
- Norms on Control of Noise Pollution (RU-CA-01); and
- Norms on Solid Wastes and Radioactive Wastes (RE-DH-01).

The Norms have adapted the previous standards and define the permissible limits for parameters of noise, air, water and other various environmental parameters. Since the Norms were enforced all the previously applied standards are superceded.

The Norms as to the water quality control are those defined under "Norma de calidad del agua y control de descargas, AG-CC-01, June 2001" which comprise the permissible water quality and controls of municipal and industrial wastewater discharge to the region's public waters and public owned sewer systems.

(1) Water Quality Standards

The Norms on water quality and control of discharge (AG-CC-01), define the surface water quality standards. In the Norm, surface water is classified into four (4) categories by water use. Water quality parameters more than 70 are set for each category. The water quality standards are shown in Tables in Appendix-11 of the Supporting Report. Major standard values and water use for each category are summarized in the followings:

Category	Water Use	Major Water Quality Parameters				
		pH	BOD_5 (mg/L)	SS (mg/L)	DO (%Sat.)	Coliform (MPN/ 100mL)
A	Water supply with simple treatment, recreational activities with direct contact etc.,	6.5 - 8.5	2	-	> 80	1,000 **(400)
B	Water supply with proper treatment, irrigation, natural conservation, water sports, etc.,	6.5 - 9.0	5	-	> 70	1,000 (1,000)
C	Navigation	5.0 - 10.0	100	-	> 50	10,000 (4,000)
D-1*	Surface water to be preserved in natural conditions	-	-	-	-	-

*Note) * D-1 applied to Surface Water. ** figures in ( ) are the numbers of Fecal Coliform*

The following are described in the Norm for the respective Category of surface water:

Category A – Waters be used for public or industrial water supply without previous treatment necessary, except for filtration and simple disinfections. Waters could also be used for conservation of natural environment, such as species propagation purposes, and for agricultural purposes including irrigation of vegetable in raw (or direct) consumption, and for recreation uses with direct contact, i.e. swimming.

Category B – Waters be used for public water supply with conventional water treatment including sedimentation and filtration processes. Water could also be used for preservation of the flora and fauna, for irrigation, water sports without direct contact, some industrial and farming processes.

Category C – Waters be used for navigation but with a limited interaction with the environment.

Category D (1) – Surface waters to be preserved in natural conditions, for it exceptional quality or great ecological value. The uses of these areas include demonstrations and scientific investigations, aesthetic activities and landscaping, like the activities related with management and conservation that do not alter the environment. All of these ecosystems must be conserved in natural conditions, referring to those ruling conditions before external agents existed that modified its natural balance. For this, the discharges carried out must not affect the conditions of this ecosystem.

(2) Effluent Standards

Norms on water quality and control of discharge (AG-CC-01) also stipulate the control of wastewater discharge, and establish effluent standards: 1) Permissible wastewater discharge qualities to surface waters and ground, 2) Permissible wastewater discharge qualities to coastal waters, 3) Permissible wastewater discharge qualities from chemical industries to surface waters and ground, 4) Wastewater discharge quality limits from industrial wastewaters to public sewers, and 5) Maximum limits of industrial discharge.

For the permissible wastewater discharge qualities are defined for both surface and coastal wa-

ters under the Section 4 of the Norms, Table 4.1, which cover the maximum values of physical, chemical and biological parameters by the type of receiving water uses.

The permissible wastewater discharge qualities to the public water bodies and sewerage systems are shown in the following tables:

Permissible Wastewater Discharge Qualities to Surface Waters

Population equivalent	Measuring Units (mg/L)								Total Coliform Numbers(MPN/ 100mL)
	pH	BOD_5	COD	SS	$N\text{-}NH_4$	$N\text{-}(NH_4+NO_3)$	$P\text{-}PO_4$	Res. Cl.	
<1,000	6 –8.5	50	160	50	-	-	-	0.05	1,000
1,001 – 5,000	6 –8.5	50	160	50	-	-	-	0.05	1,000
5,001 – 10,000	6 –8.5	45	150	45	-	-	-	0.05	1,000
10,001 – 100,000	6 –8.5	35	130	40	10	18	3	0.05	1,000
>100,000	6 –8.5	35	130	35	10	18	2	0.05	1,000

Note: Per capita daily BOD_5 production is approximately 60g/day.
Source: Tabla 5.1. Descargas de agua residual municipal en aguas superficiales y el subsuelo, pp. 21.

Permissible Wastewater Discharge Qualities to Coastal Waters

Population equivalent	Measuring Units (mg/L)								Total Coliform Numbers(MPN/ 100mL)
	pH	BOD_5	COD	SS	$N\text{-}NH_4$	$N\text{-}(NH_4+NO_3)$	$P\text{-}PO_4$	Res. Cl.	
<1,000	6 –8.5	100	400	90	-	-	-	0.05	1,000
1,001 – 5,000	6 –8.5	100	400	90	-	-	-	0.05	1,000
5,001 – 10,000	6 –8.5	100	400	90	-	-	-	0.05	1,000
10,001 – 100,000	6 –8.5	70	300	75	30	50	8	0.05	1,000
>100,000	6 –8.5	70	300	75	30	50	8	0.05	1,000

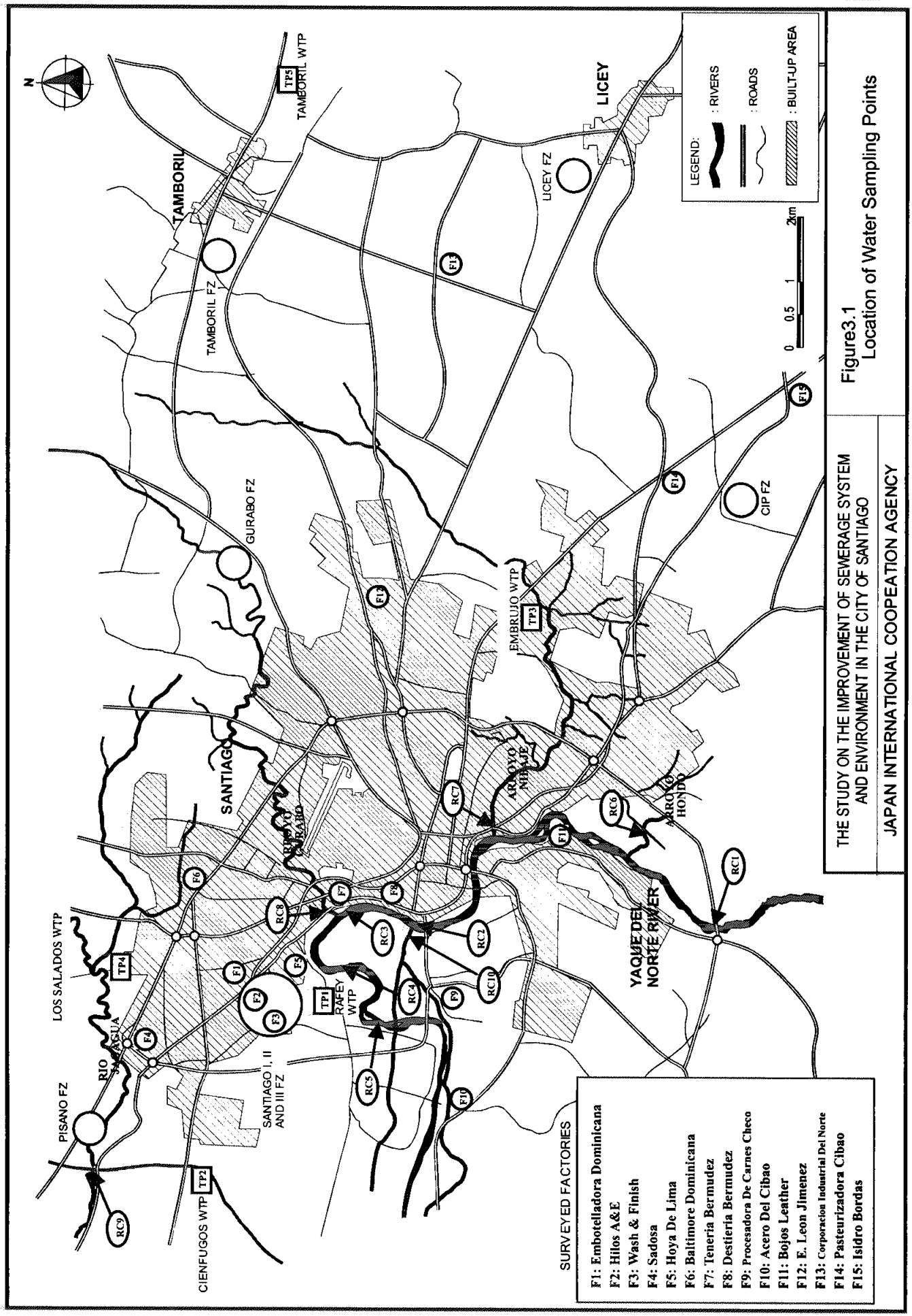
Note: Per capita daily BOD_5 production is approximately 60g/day.
Source: Tabla 5.2. Descargas de agua residual municipal en aguas costeras, pp. 22.

Wastewater Discharge Quality Limits to Public Sewers

Parameter	Permissible Quality (mg/L)
BOD_5	350
COD	900
T-P	10
T-N	40
PH	6 - 9
SS	400

Source: Tabla 5.4. Descargas de agua residul municipal en aguas superficiales y el subsuelo, pp. 26.

Industrial wastewater discharges to the public water bodies are also defined under Section 2.5, Tables 5.3, 5.4, and the limits of maximum values of industrial wastewater discharge qualities in Table 5.5. According to the type of receiving water body, industrial wastewater discharges are subdivided into categories, including, i) chemical industries, ii) discharge into coastal waters, iii) discharge into sewerage system, v) discharge to surface waters and on the ground. Further details on industrial wastewater discharge quality standards are described in Chapter 5, Current Industrial Wastewater Treatment and Management.


N
TAMBORIL
TAMBORIL WTP
TP5
TAMBORIL FZ
LICEY
LICEY FZ
LEGEND:
: RIVERS
: ROADS
: BUILT-UP AREA
0 0.5 1 2km
GURABO FZ
SANTIAGO
EMBRUJO WTP
TP3
CIP FZ
F13
F14
F15
RIO YABACOA
ARROYO NIAGUE
ARROYO HONDO
RC6
RC7
RC1
YAQUE DEL NORTE RIVER
LOS SALADOS WTP
TP4
PISANO FZ
RIO JAMAGUA
SANTIAGO I, II AND III FZ
TP1
RAFEY WTP
RC2
RC3
RC4
RC5
RC8
RC9
RC10
TP2
CIENFUGOS WTP
F1
F2
F3
F4
F5
F6
F7
F8
F9
F10
F11
F12
SURVEYED FACTORIES
F1: Embotelladora Dominicana
F2: Hilos A&E
F3: Wash & Finish
F4: Sadosa
F5: Hoya De Lima
F6: Baltimore Dominicana
F7: Teneria Bermudez
F8: Destieria Bermudez
F9: Procesadora De Carnes Checo
F10: Acero Del Cibao
F11: Bojos Leather
F12: E. Leon Jimenez
F13: Corporacion Industrial Del Norte
F14: Pasteurizadora Cibao
F15: Isidro Bordas
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JAPAN INTERNATIONAL COOPEATION AGENCY
Figure3.1
Location of Water Sampling Points