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REPUBLIC OF PERU

SERVICIO DE AGUA POTABLE Y ALCANTARILLADO DE LIMA

(SEDAPAL)

THE FEASIBILITY STUDY ON THE IMPROVEMENT OF SEWERAGE SYSTEM IN SOUTHERN PART OF LIMA

FINAL REPORT

VOLUME III
APPENDICES

MARCH, 1990

JAPAN INTERNATIONAL COOPERATION AGENCY

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APPENDIX 2

BIBLIOGRAPHIES

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APPENDIX 3

PRESENT CONDITION OF INDUSTRIAL WASTEWATER

APPENDIX 3 Present Condition of Industrial Wastewater

	Lima	Surco	Quantity (m^3/day)
1A = Envasadoras de Pescados y Mariscos	14	1	1,380
1B = Envasadoras de Carne y Canales	28	6	16,787
1C = Refinerías de Aceites Comestibles	7	-	-
1D = Mercados y Centros de Abasto	44	12	16,254
1E = Textiles con Lavado de Lana Cruda	5	-	-
1F = Curtiembres	35	6	49,992
1G = Grandes Chifas y Restaurantes	10	5	4,382
1H = Servicentros con Lavado y Engrase	36	7	5,463
3A = Envasadoras de Leche y Derivados	6	6	6,014
3B = Envasadoras de Frutas y Legumbres	7	3	8,738
3C = Fcas de Detergentes y Artículos de Tocador	12	3	2,380
3D = Fcas de Losetas, Mosaicos y Derivados	39	7	8,489
3E = Galvenoplastías y Ensambladoras	97	20	40,079
3F = Fcas de Papel y Cartón	22	9	28,839
3G = Lavanderías	27	13	9,126
3H = Baños Públicos, Hoteles y Clubes	67	14	78,162
3I = Hospitales y Clínicas	8	9	9,546
6A = Fcas de Cerveza y Bebidas Alcohólicas	10	3	56,714
6B = Fcas de Bebidas Gaseosas	4	-	-
6C = Textiles con Tejido y Acabado	116	62	329,963
6D = Fcas de Pinturas y Derivados	16	1	671
6E = Fcas de Vidrios y Espejos	9	5	4,056
6F = Industrias Químicas y Petroquímicas	98	24	88,767
6G = Laboratorios Farmacéuticos	47	23	42,380
6H = Fcas de Alimentos Deshidratados	54	10	28,490
Total	818	249	836,593.=

Present Industrial Wastewater: 0.323 m^3/sec

APPENDIX 4

EXISTING TREATMENT PLANTS IN PERU

APPENDIX 4 EXISTING TREATMENT PLANTS IN PERU

A4.1 General

Relevant data on public sewage treatment plants in Peru are given in TABLE A4-1. Among these plants, only San Juan STP and Carapongo STP (aerated lagoon) which started operation only in 1988, are located in Metropolitan Lima. The plants are classified according to treatment method and scale in TABLE A4-2.

TABLE A4-2 CLASSIFICATION OF INFLOW AND TREATMENT METHOD OF EXISTING SEWAGE TREATMENT PLANTS IN PERU

	INFLOW (m^3/day)				
TREATMENT METHOD	below 5,000	5,000 10,000	10,000 50,000	Unknown	Total
Imhoff tank	-	1(1) *1	1(1)	4	6(2)
Waste stabilization pond	8	2(1)	3(1)	13	26(2)
Aerated lagoon	1	1	2(1)	-	4(1)
Trickling filter	-	-	1	1	2(1)
Total	9	4(2)	7(4)	18	38(6)

*1 Combination with two treatment methods in one plant.

According to the classifications given in TABLE A4-2 the treatment method most commonly used in Peru is the waste stabilization ponds method (especially facultative pond method), which constitutes 68% of the total. This is followed by methods using Imhoff tank, aerated lagoon and trickling filter. Scales of treatment of many plants are not known, but most are assumed to be small.

In most cases waste stabilization ponds and aerated lagoons are selected because of their low costs of construction and maintenance, and they do not require high-level treatment techniques. Also they are easily adaptable to natural conditions of warm climate and little rainfall.

San Juan and Carapongo treatment plants are described in Section 4.4 while the outline and operational conditions of Tacna and Arequipa treatment plants are given in the ensuing paragraphs.

TABLE A4-1 EXISTING SEWAGE TREATMENT PLANT IN PERU

Location	Planned Flow(lps)	Classification of Sewage	Treatment Method	Outline
1.San Juan, Lima	160	Domestic Sewage 50,000 persons	Primary and Secondary Facultative Ponds	21 Ponds, 2 Series Total 20 ha.
2.Ventanilla, Lima	-	Domestic Sewage	Primary and Secondary Facultative Ponds	8 Ponds, 2 Series Total 6.5 ha.
3.Los Recaudadores Lima	-	Domestic Sewage	Facultative Ponds	2,900 m2 x 1.23 mD x 1 Pond
4.Puente Piedra Lima	105	Domestic Sewage 40,000 persons	Aerated Lagoon	4,500 m2 x 2.1 mD x 2 Lagoons
5.Huaral,Lima	110	Domestic Sewage 50,000 persons	Facultative Ponds	16,000 m2 x 1.5 mD x 2 Ponds, 5 days
6.Carhuamayo,Junin	-	Domestic Sewage	Facultative Ponds	10,000 m2 x 0.9 mD x 2 Ponds
7.Pto.Chicama, La Libertad	-	Domestic Sewage 6,000 persons	Facultative Ponds	4 Ponds, 2 Series 1.2 m & 0.9 mD
8.Chocope, La Libertad	55	Domestic Sewage 10,000 persons	Aerated Lagoon	1,236 m2 x 3.0 mD x 2 Lagoons,1.55 day
9.Moche, La Libertad	12	Domestic Sewage 5,000 persons	Facultative Pond	12,000 m2 x 1.1 mD x 1 Pond, 12.7 days
10.Viru, La Libertad	5	Domestic Sewage 4,000 persons	Facultative Ponds	4 Ponds, 2 Series
11.Illimo,Lambayeque	11	Domestic Sewage 5,500 persons	Facultative Ponds	6,000 m2 x 1.1 mD 2 Ponds, 13.7 days
12.Jayanca, Lambayeque	27	Domestic Sewage 6,000 persons	Facultative Ponds	12,000 m2 x 1.1 mD x 1 Pond, 5.5 days
13.Monsefu, Lambayeque	45	Domestic Sewage 18,000 persons	Facultative Ponds	11,000m2x1.5mx1Pond 25,000m2x0.87mx1Pond
14.Pacora,Lambayeque	-	Domestic Sewage	Facultative Pond	1 Pond
15.Sana,Lambayeque	12	Domestic Sewage 5,000 persons	Facultative Pond	9,000 m2 x 1.1 mD x 1 Pond, 9.5 days
16.Piura,Piura	-	Domestic Sewage	Facultative Ponds	4 Ponds, 2 Series Total 27,000 ha.
17.Tacna, Tacna	180	Domestic Sewage 76,000 persons	Aerated Lagoon + Facultative Ponds	Aer.Lagoon x 2 Fac.Pond x 2
18.Ayacucho	60	-	Imhoff tanks + F.P.	-
19.Ica	270	-	Facultative Ponds	-
20.Nazca	20	-	Facultative Ponds	-
21.Moquegua	30	-	Facultative Ponds	-
22.Lurin	-	-	Imhoff Tank	-
23.Olmos	-	-	Imhoff Tank	-
24.San Pedro de Lajas	-	-	Imhoff Tank	-
25.Chiquian	-	-	Imhoff Tank	-
26.Buenos Aires	-	-	Facultative Ponds	-
27.Arequipa	330	Domestic and Industrial	Imhoff Tank + Percolating Filter	I.T. x 4 Basin P.F. x 2 Basin
28.Sullana	-	-	Facultative Ponds	
29.Paita	-	-	Facultative Ponds	
30.Cajamarca	-	-	Facultative Ponds	-
31.Chicha	-	-	Facultative Ponds	-
32.Chepen	-	-	Facultative Ponds	-
33.Huanta	-	-	Percolating Filters	-
34.Juliaca	-	-	Facultative Ponds	-
35.Carapongo Chosica,Chaclacayo	139	Domestic Sewage 69,000 Persons	Aerated Lagoon	94m x 94m x 2.5mD x 4 Basin

Source : 1.Reuse of Waste Water at the San Juan Stabilization Ponds, CEPIS, 1984.
2.Lagunas de Estabilizacion en America Latina, CEPIS.

A4.2 Tacna Sewage Treatment Plant

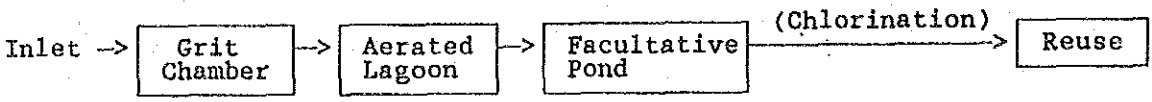
(1) Outline

Tacna STP is located in the Tacna on the southern end of Peru. The treatment plant began operation in 1975 as a facility for experiments on sewage reuse. All treated water is recycled as irrigation water for farm lands and other areas of vegetation. "Servicio de Agua Potable y Alcantarillado de TACNA(SEDATACNA)" is in charge of operation and maintenance work for this plant.

(2) Facilities

The design flow is 15,600 m^3/day and the treatment method is aerated lagoon and facultative pond.

Flow diagram

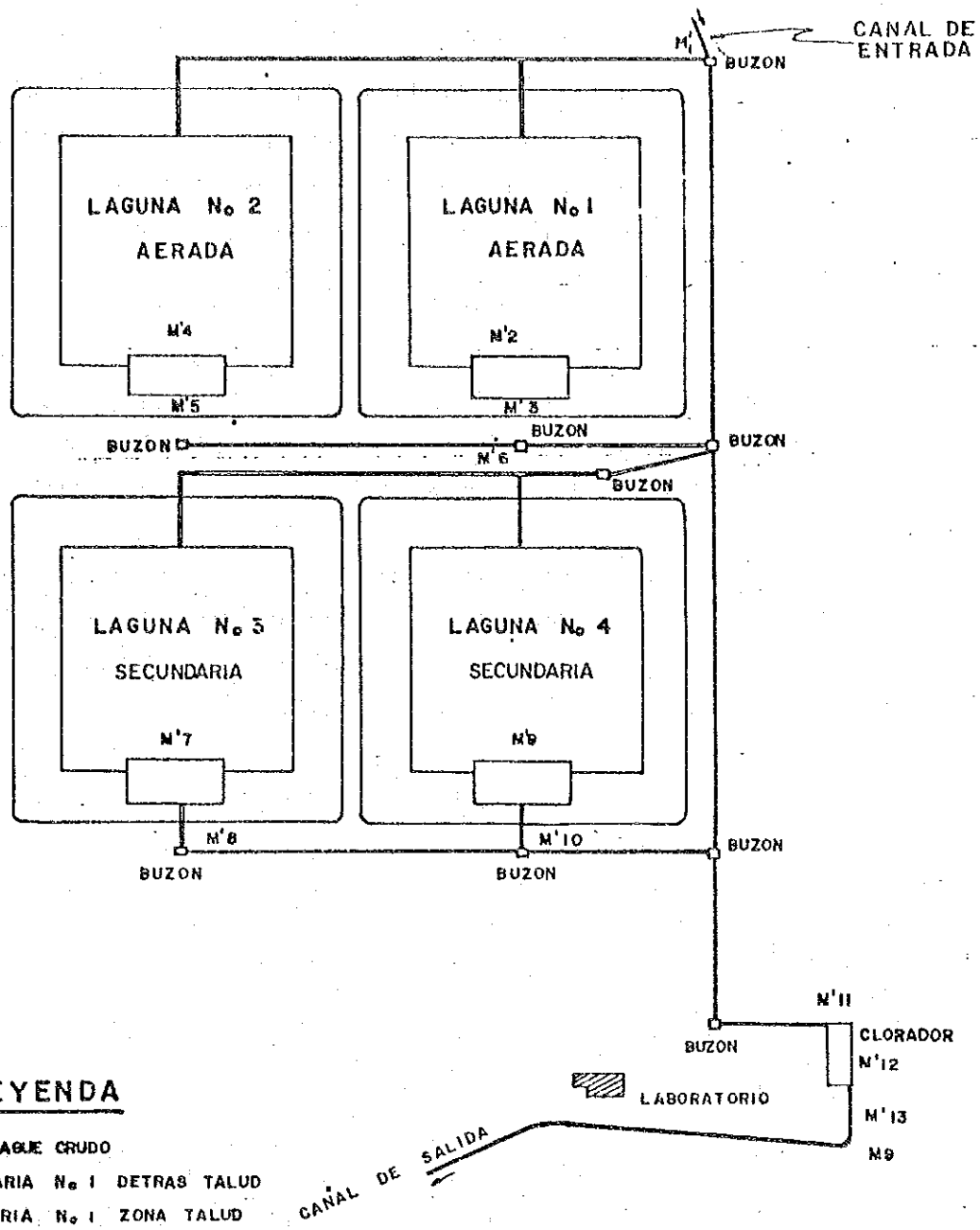


Detailed flow diagram is shown in FIGURE A4-1.

Facility

Aerated Lagoon: Embanked Rectangular Type
98m x 98m x Depth 4.5m x 2 basin
Detention Time 5.5 days
BOD Areal Loading 2,000 kg-BOD/ha.day
Aerator 8 units

Facultative Pond: Embanked Rectangular Type
(no aerator) 98m x 98m x Depth 4.5m x 2 basin
Detention Time: 5.5 days



LEYENDA

M'1	EFLUENTE DESAGUE CRUDO
M'2	LAGUNA PRIMARIA No 1 DETRAS TALUD
M'3	LAGUNA PRIMARIA No 1 ZONA TALUD
M'4	LAGUNA PRIMARIA No 2 DETRAS TALUD
M'5	LAGUNA PRIMARIA No 2 ZONA TALUD
M'6	CANAL MEZCLA EFLUENTES PRIMARIOS
M'7	LAGUNA SECUNDARIA No 3 DETRAS TALUD
M'8	LAGUNA SECUNDARIA No 3 ZONA TALUD
M'9	LAGUNA SECUNDARIA No 4 DETRAS TALUD
M'10	LAGUNA SECUNDARIA No 4 ZONA TALUD
M'11	ENTRADA CAMARA CONTACTO
M'12	CAMARA DE CONTACTO
M'13	SALIDA CAMARA CONTACTO

FIGURE A4-1 FLOWDIAGRAM OF TACNA SEWAGE TREATMENT PLANT

SOURCE: Estudio de Factibilidad del Proyecto de Agua Potable y Alcantarillado de la ciudad de Tacna, Volúmen 2 SENAPA.

(3) Operation

The operational data of the Tacna STP for 1977 are given in TABLE A4-3. The flow was approximately 12,000 m^3/day. At the inflow side, concentration of BOD was 278 mg/l and coliform bacteria 2.3×10^7 - 3.8×10^7 MPN/100ml at the discharge side, these values were 38mg/l and 3.1×10^4 - 5.4×10^4 MPN/100ml, respectively.

In April 1989, the average inflow was 17,300 m^3/day, concentration of BOD in the inflow 260 mg/l and that in the outflow 45mg/l, indicating a removal rate of about 85%. Judging from the areal BOD load, operation at present is being carried out under conditions of slight overload.

The removal rate of coliform bacteria is high but that of pathogenic bacteria is low. For this reason, construction of maturation ponds has been planned, taking into consideration the reuse of the treated water on agricultural lands and other areas of vegetation.

(4) Field Investigation on the Tacna Sewage Treatment Plant

Field investigation for operation and maintenance condition of sewage treatment plant and sewage reuse project was conducted in October 1989. The result of survey is summarized below:

A. Outline of Tacna City

Population	: Approx. 170,000 persons
Percent of population served by public water supply system	: Approx. 70 % (out of this percentage, 30 % is indirectly supplied by tanker truck)
Percent of population served by sewerage system	: Approx. 50 %

B. Operation and maintenance condition for Sewage Treatment Plant

1) Inflow ;

Planned sewage inflow	:	180 l/s
Actual total sewage flow	:	approx.280 l/s (Oct.1989)
Actual inflow into Plant	:	approx.200 l/s (Oct.1989)

TABLE A4-3 CHARACTERISTICS OF RAW SEWAGE AND TREATED WATER INTACNA STP, 1977

Parameter	Range (mg/l)	
	Raw Sewage	Treated Sewage
Color	gray	green
pH	6.0 - 7.55	7.0 - 7.83
Electric Conductivity*	940 - 2400	936 - 1970
Alkalinity	92 - 234	104 - 196
Sulfates	325 - 530	315 - 678
Chloride	99 - 138	88 - 130
Sodium Chloride	163 - 219	145 - 215
BOD5	278	38
Total Nitrogen	48	18
Anmonium Nitrogen	No Investigation	12
Ortophosfate	No Investigation	13
Total Residue	1120 - 1390	910 - 1275
Disorved Residue	840 - 1140	850 - 1175
Suspended Residue	210 - 285	60 - 100
Sedimentable Residue**	2.8 - 9.5	0.23 - 0.46
Total Coliform***	2.3×10^7 - 3.8×10^7	3.1×10^4 - 5.4×10^4
Fecal Coliform***	4.3×10^6 - 1.7×10^7	2.7×10^3 - 1.4×10^3
Salmonella sp.***	47 - 666	6 - 58
Shigella sp.	---	---

* : µmho/cm at 25°C
** : ml/l
*** : MNP/100 ml.
--- : Not Detected
Source: Estudio de Factibilidad del Proyecto de Agua Potable Y Alcantarillado de la Ciudad de Tacna, Volúmen 2, SENAPA.

Differential flow of 80 l/s of raw sewage is diverted before it reaches the Plant and is used for irrigation without treatment.

2) Water Quality ;

		Raw Sewage	Treated Water
BOD (mg/l)	:	197	--
SS (mg/l)	:	248	80
Total Residue (mg/l)	:	1,255	1,093
Total Coliforms (MPN/100 ml)	:	$1.0x10^7$-$2.6x10^7$	$2.4x10^5$-$5x10^5$
Fecal Coliforms (MPN/100 ml)	:	$3.6x10^6$-$2.1x10^7$	$4.1x10^5$

Source : Direction Regional de Agriculture

3) Operational Condition ;

- Aerators are of the vertical floating type. Each of the two lagoons are equipped with 4 sets (10HP) of aerators. Aerators have been running 24 hrs continuously and have been maintained in good condition with no trouble since start of operation.

- As for treatment condition, Aerated Lagoon is overloaded and is in anaerobic condition, which situation is observed to have been brought about by the following causes;

  i. The sludge was never removed since start of operation, thus has presently accumulated to about half of the depth. Actual detention time, therefore, has been reduced to 2.5 days which is not sufficient for treatment. As a rule, periodic removal of accumulated sludge in the Lagoon should be carried out.

  ii. Considering the inlet load, aerators lack about 40 % of necessary capacity.

  iii. Water depth (4.5 m) is so great that mixing in the Lagoon is not sufficient.

- SEDATACNA has prepared the plans for a new plant to be constructed at another site in order to treat the actual total sewage flow quantity.

4) Operation and Maintenance Cost and Organization in Charge

- Power consumption per one month was about 20,000 kWH and power charge was estimated at US$ 6,000 per annum.

- O/M cost was defrayed by the tariff collections from water supply and sewage charges of SEDATACNA.

C. Present Condition for Agriculture Area of Sewage Reuse

1) Total Irrigation Area by Treated Water Reuse:
Approx. 252 ha, at present

2) Category of Farm Products in the Irrigation Area:
Farm products are as follows:
Starchy corn
Yellow corn
Chili
Squash
Alfalfa
Sweet potato
Potato

3) Irrigation Method:
Flooding by ridge method.
Local water rate is about 0.8 l/s/ha.

4) Organization and Administration of the Area:
Agricultural Cooperation "Tupac Maru", consists of 52 families.

5) Water Tarif from Farmer:
In principle water tarif should be collected from farmer, however, it is not collected at present.

6) Marketing Area:
Mainly, the City of Tacna.

A4-3 Chilpina Sewage Treatment Plant, Arequipa

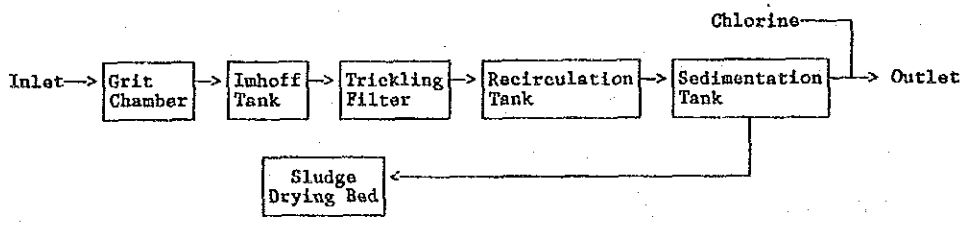
(1) Outline

Chilpina STP is located in Arequipa, a city south of Peru which is the second largest city in the country next to Lima. The treatment plant began operation in 1978. The inflow into the plant contains a high proportion of industrial waste water mainly from food industries. As in the Tacna STP treated water treated is returned to agricultural lands. Operation and maintenance of this plant is undertaken by SEDAPAR (Arequipa).

(2) Facilities

The treatment facilities consist of Imhoff tanks and trickling filters.

Flow diagram



Detailed flow diagram is shown in FIGURE A4-2.

Facility

Imhoff Tank	:	4 basins
Trickling Filter	:	600 m^2 x 1.8 mH x 2 basins
Sedimentation Tank	:	Circular Tank with clarifier
		630 m^3 x 1 basin, 300 m^3 x 2 basins

(3) Operation

According to the records of April 1989, the average daily inflow was 28,330 m^3/day. BOD concentration at the inflow side was 439.1 mg/l and that of coliform bacteria was 4 x 10^6 MPN/100 ml. BOD concentration of the treated water was 221.6 mg/l and coliform bacteria was 8 x 10^5 MPN/100ml. The removal rates of BOD and SS were approximately 50% and 87%, respectively. These data were obtained at average operational conditions. An aver-

age of 0.5 ppm of chlorine is injected for disinfection.

There has been no machinery breakdowns since it operation but the concentration of the inflow is high because of the influence of industrial wastewater and the plant as a whole is thought to be operating under overload condition.

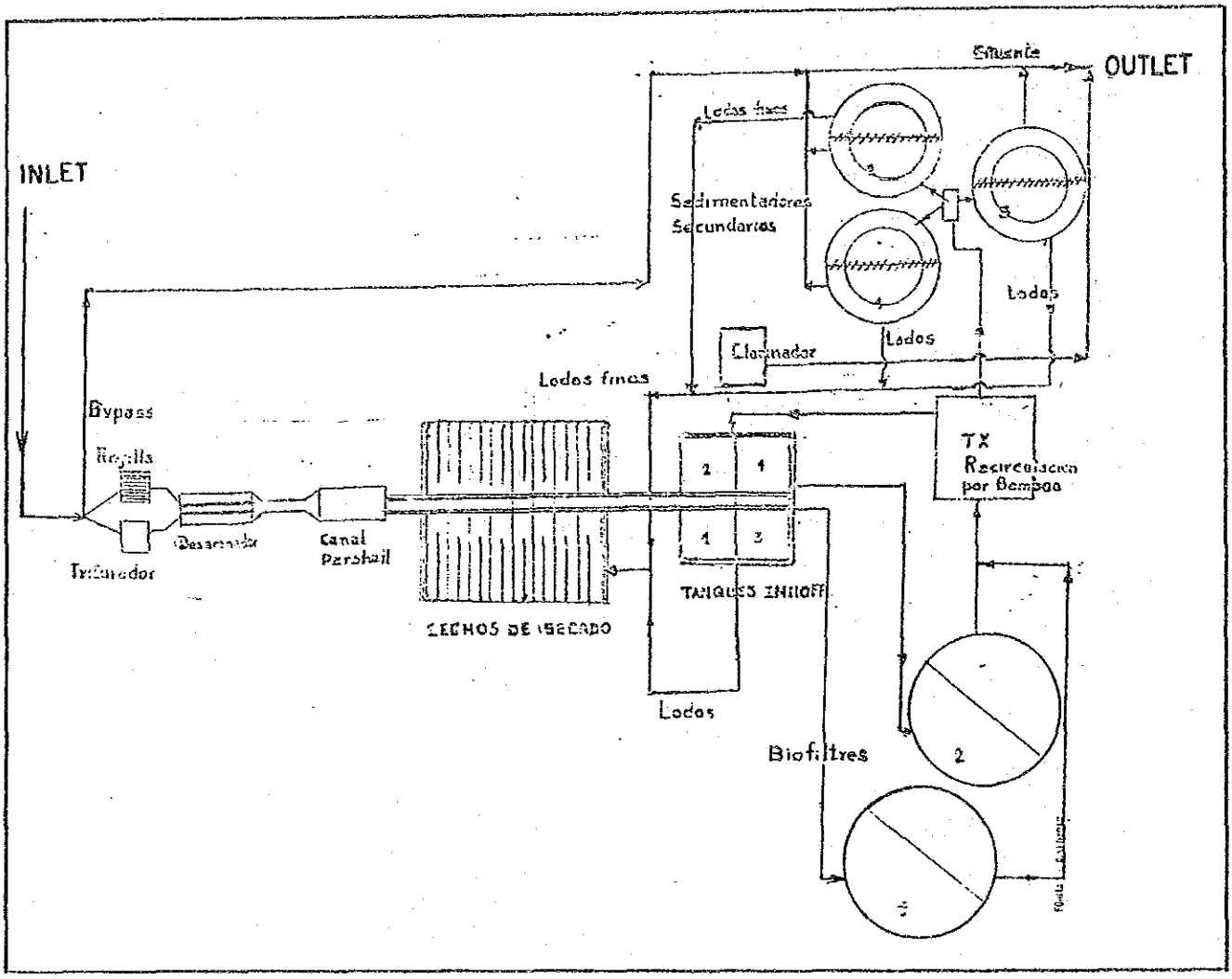


FIGURE A4-2 **FLOWDIAGRAM OF CHILPINA SEWAGE TREATMENT PLANT**

SOURCE: SEDAPAR.

APPENDIX 5

RESULTS OF SEWAGE QUALITY ANALYSIS

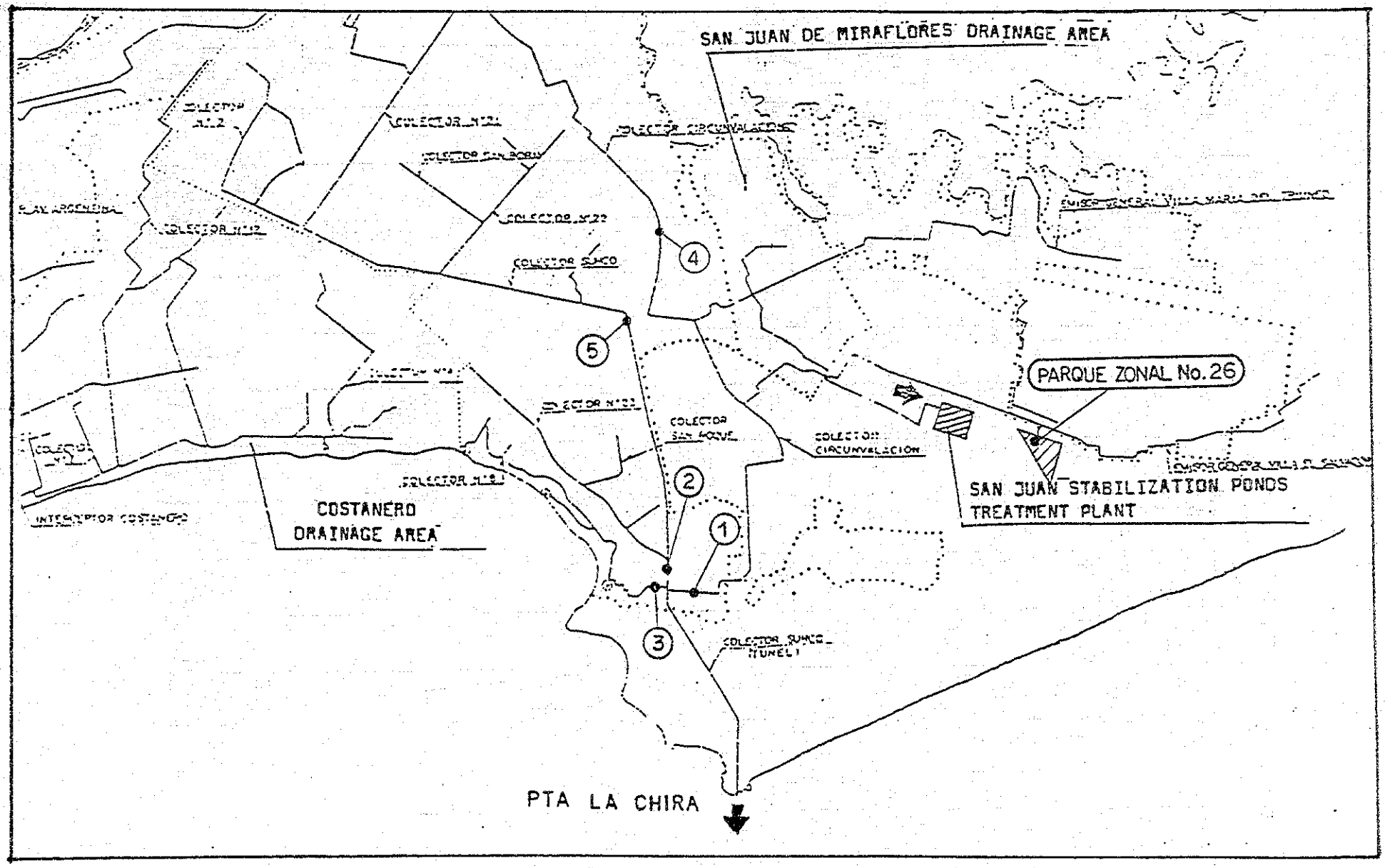


FIGURE A5-1 SAMPLING POINTS ON COLLECTORS, 1989

TABLE A5-1 QUALITY OF SEWAGE IN COLLECTORS

(June 19 to 20, 1989)

(½)

SAMPLE		Cir. 11	Surco. 12	B-Sur. 13	21	22	23
PARAMETER \ DATE		19-6	19-6	19-6	19-6	19-6	19-6
TIME		10:00	10:00	10:00	16:00	16:00	16:00
Conductivity	Umhos/cm.	1,260	1,130	990	1,390	1.060	900
Total Residue	mg/l.	736		950	1,182		868
Alcalinity	($CaCO_3$) mg/l.	292	320	254	240	234	200
Total Hardness	($CaCO_3$) mg/l.	400	345	315	380	390	300
Chloride	(Cl.) mg/l.	116	78	65	164	84	58
Sulfates	(SO_4) mg/l.	350	150	150	200	188	175
Nitrites + Nitrates	(N.) mg/l.	0.2	0.16	0.18	0.24	0.24	0.06
COD (Mn)	mg/l.	54.4	47.6	23.1	25.8	28.5	21.7
BOD	mg/l.	340	282	262	222	505	335
Total Coliform	MPN/100 ml	$4.6x10^7$	$1.1x10^8$	$1.1x10^8$	$4.6x10^7$	$2.4x10^7$	$2.4x10^7$

(2/2)

SAMPLE			31	32	33	41	42	43
PARAMETER \ DATE			19-6	19-6	19-6	20-6	20-6	20-6
TIME			22:00	22:00	22:00	4:00	4:00	4:00
Conductivity		Umhos/cm.	1,350	1,050	910	1,540	800	710
Total Residue		mg/l.	1,072	840	818	1,096	634	576
Alcalinity	($CaCO_3$)	mg/l.	250	214	418	184	159	154
Total Hardness	($CaCO_3$)	mg/l.	380	350	330	440	330	310
Chloride	(Cl.)	mg/l.	131	93	58	259	64	37
Sulfates	(SO_4)	mg/l.	150	200	163	138	350	175
Nitrites + Nitrates	(N.)	mg/l.	0.12	0.09	0.04	1.4	0.5	0.5
COD (Mn)		mg/l.	8.9	8.1	6.5	4.9	2.4	1.6
BOD		mg/l.	110	175	145	23	50	30
Total Coliform		MPN/100ml	4.6×10^7	2.4×10^7	4.6×10^7	9.3×10^6	4.3×10^6	4.6×10

TABLE A5-2 PHISICAL CHEMISTRY ANALYSIS RESULTS ON COLLECTOR SURCO AND OTHERS

(Oct. 19 to 20, 1989)

SURCO SEWER AND OTHER Cir. Surco B-Sur (½) 1989

SAMPLE			21	22	23	31	32	33	41	42	43	51	52	53
PARAMETER \ DATE			19-10	19-10	19-10	19-10	19-10	19-10	19-10	19-10	19-10	20-10	20-10	20-10
TIME			10:00	10:00	10:00	14:00	16:00	16:00	22:00	22:00	22:00	04:00	04:00	04:00
pH.			7.2	6.95	7.05	6.95	6.45	6.45	6.75	6.60	6.65	6.75	6.60	6.75
CONDUCTIVITY		Umhos/cm.	1,200	1,100	925									
TOTAL RESIDUE		mg/l.	1,372	1,220	918	1,196	1,256	942	1,312	1,014	1,006	894	782	652
SUSPENDED SOLIDS		mg/l.	376	352	248	226	360	254	192	220	366	140	224	92
CHLORIDE	Cl.	mg/l.	162	96	58	164	127	55	165	100	55	136	53	36
NITRITE + NITRATES	N.	mg/l.	0.01	0.0	0.01	0.05	0.01	0.03	0.1	0.1	0.2	0.2	0.3	0.25
AMMONIA	as N.	mg/l.	28.6	27.1	25.7	16.0	16.2	15.6	15.1	16.2	18.5	10.0	7.5	9.9
ORGANIC NITROGEN	as N.	mg/l.	18.0	22.0	15.0									
TOTAL PHOSPHORUS	as P	mg/l.	10.4	8.9	7.4	7.2	7.4	5.6	4.3	2.0	1.7	2.3	1.9	1.8
ORTHOPHOSPHATE		mg/l.	4.5	4.4	4.4	4.1	4.2	4.6	5.0	3.9	4.2	1.9	1.9	1.6
BOD		mg/l.	306	277	273	230	304	226	233	180	176	135	105	94
COD (Mn)		mg/l.	160	176	106	84	112	76	80	88	72	32	48	20

OFICINA DE CONTROL DE CALIDAD DE AGUA Y DESAGUE

PHISICAL CHEMISTRY ANALYSIS RESULTS (3/2)

SURCO SEWER AND OTHER 1989

SAMPLE			11	12	13
PARAMETER \ DATE			18-10	18-10	18-10
TIME			10:00	10:00	10:00
pH.			7.05	6.95	6.95
CONDUCTIVITY		Umhos/cm.	-	-	-
TOTAL RESIDUE		mg/l.	-	-	-
SUSPENDED SOLIDS		mg/l.	-	-	-
CHLORIDE	Cl.	mg/l.	-	-	-
NITRITE + NITRATES	N.	mg/l.	0.4	0.02	0.08
AMMONIA		mg/l.	26.0	28.0	23.5
ORGANIC NITROGEN	as P	mg/l.	-	-	-
TOTAL PHOSPHORUS	as P	mg/l.	9.0	10.2	9.2
ORTHOPHOSPHATE		mg/l.	4.6	4.8	4.5
BOD		mg/l.	378	334	254
COD (Mn)		mg/l.	120	163	114

TABLE A5-3 BACTERIOLOGICAL ANALYSIS RESULTS ON COLLECTOR SURCO AND OTHERS

(Oct. 19 to 20, 1989)

SURCO SEWER AND OTHERS Cir. Surco. B-Sur. 1989

SAMPLE	11	12	13	21	22	23	31	32	33	41
DATE / PARAMETER	18-10	18-10	18-10	19-10	19-10	19-10	19-10	19-10	19-10	19-10
TIME	10:00	10:05	10:10	10:00	10:05	10:10	16:00	16:05	16:10	22:00
TOTAL COLIFORM. MPN/100 ml.	2.4×10^{8}	9.3×10^{7}	4.3×10^{7}	4.6×10^{8}	2.3×10^{7}	4.3×10^{7}	7.5×10^{7}	9.3×10^{7}	4.3×10^{7}	7.5×10^{7}
FECAL COLIFORM. MPN/100 ml.	9.3×10^{7}	4.3×10^{7}	2.3×10^{7}	2.4×10^{3}	2.3×10^{7}	4.3×10^{7}	4.3×10^{7}	2.3×10^{7}	2.3×10^{7}	4.3×10^{7}

SAMPLE	42	43	51	52	53					
DATE / PARAMETER	19-10	19-10	20-10	20-10	20-10					
TIME	22:05	22:10	04:00	04:05	04:10					
TOTAL COLIFORM. MPN/100 ml.	4.6×10^{8}	4.3×10^{7}	9×10^{6}	9×10^{6}	4×10^{6}					
FECAL COLIFORM. MPN/100 ml.	2.4×10^{8}	4.3×10^{7}	4×10^{6}	9×10^{6}	4×10^{6}					

REMARK ----------

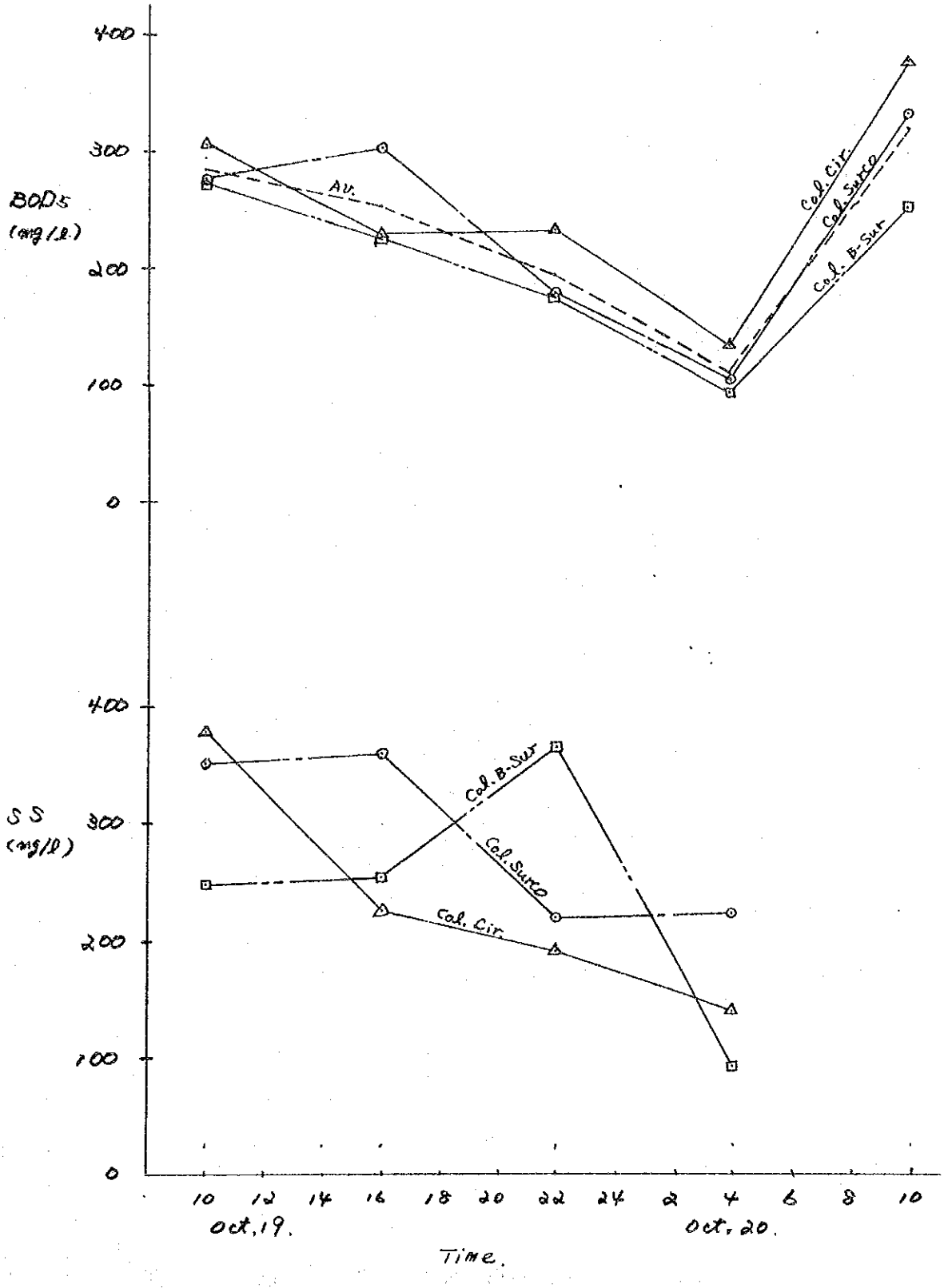


FIGURE A5-2 VARIATION OF RAW SEWAGE QUALITY ON COLLECTOR SURCO AND OTHERS
(BOD, SS Oct.19 to 20, 1989)

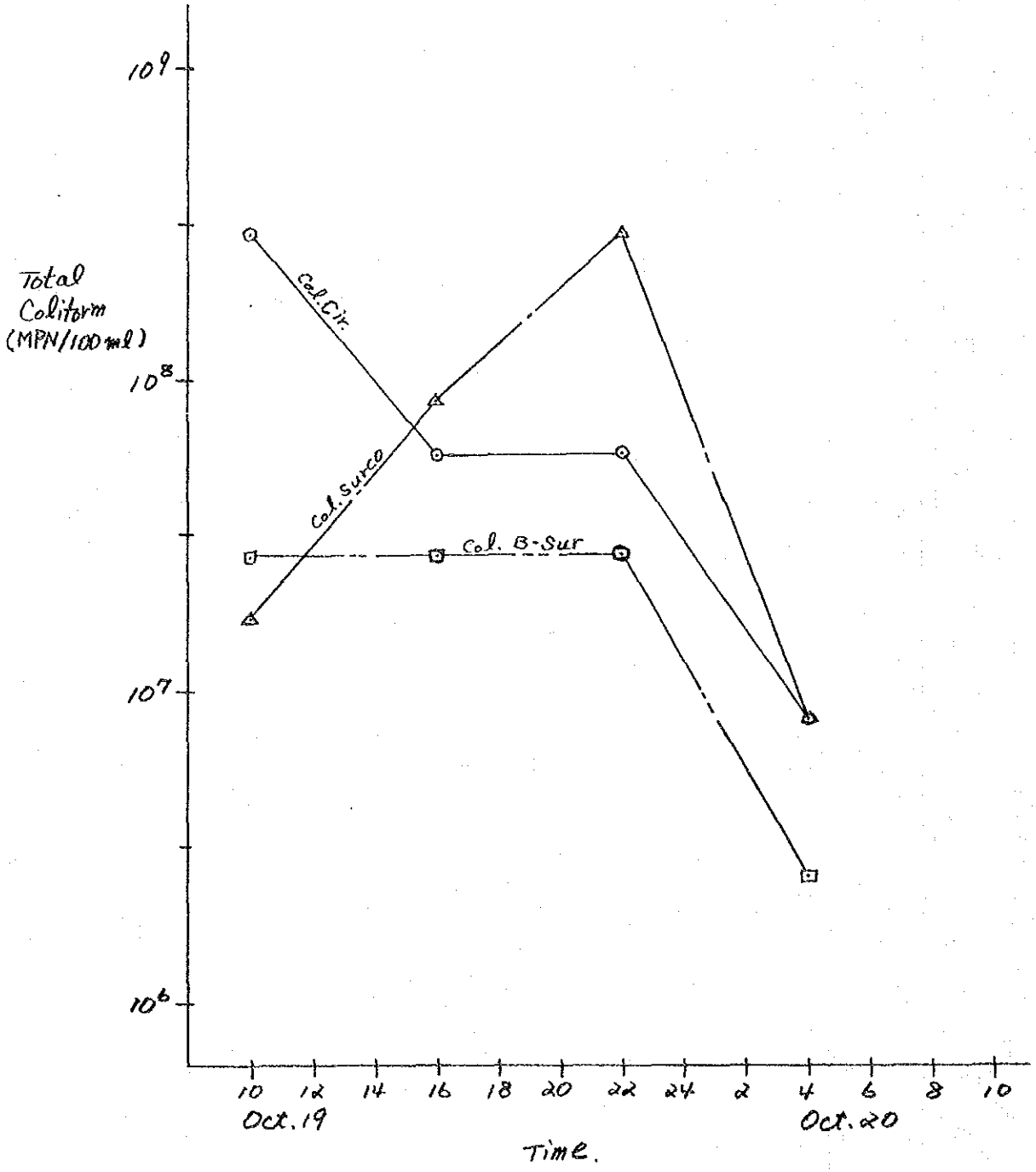


FIGURE A5-3 VARIATION OF RAW SEWAGE QUALITY ON COLLECTOR SURCO AND OTHERS
(Total Coliforms, Oct. 19 to 20, 1989)

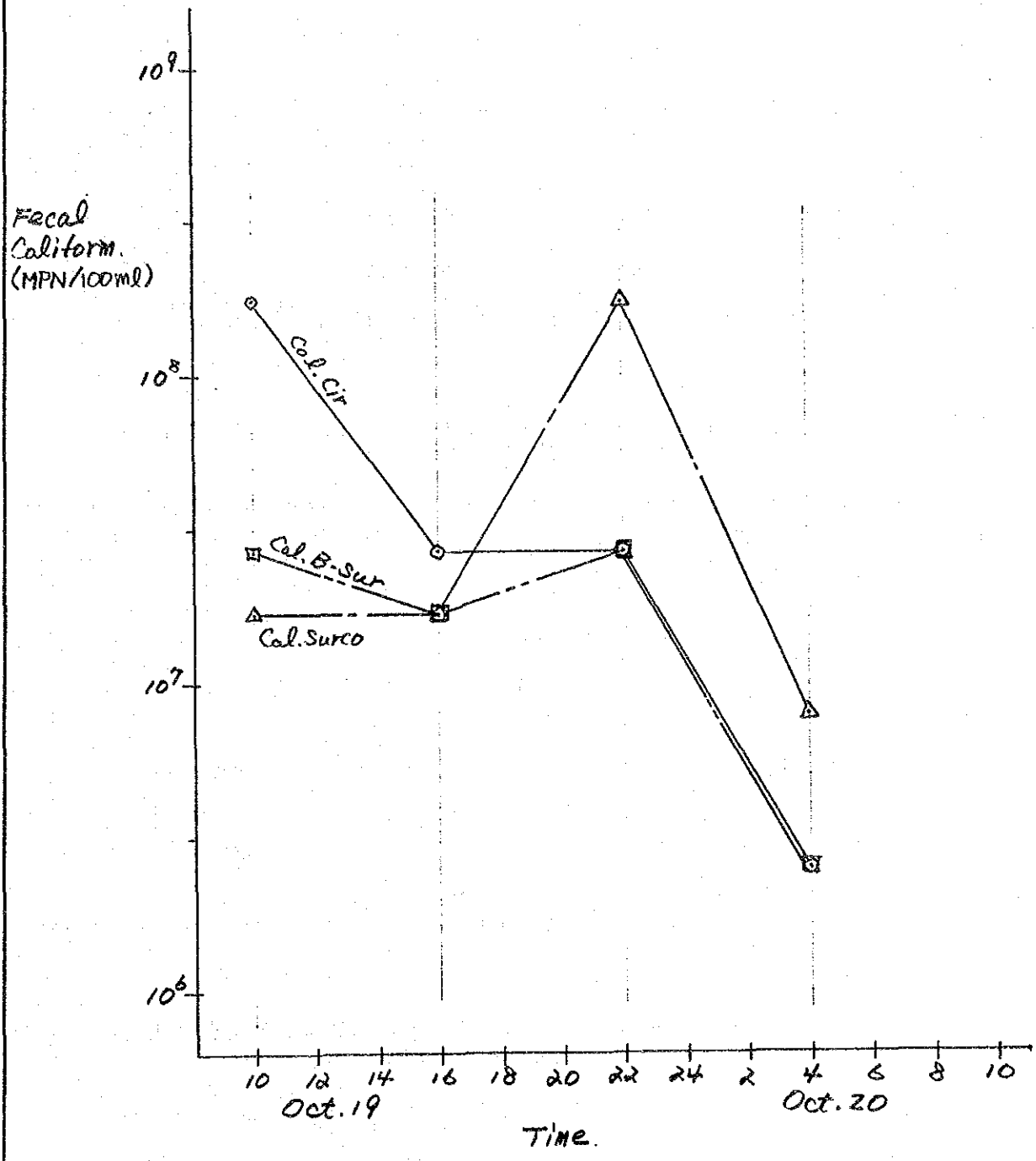


FIGURE A5-4 VARIATION OF RAW SEWAGE QUALITY ON COLLECTOR SURCO AND OTHERS
(Fecal Coliforms, Oct.19 to 20, 1989)

TABLE A5-4 QUALITY OF SEWAGE IN THE CANAL IN PARQUE ZONAL No.26 (1989)

Item	Time	May 31 14:15	June 1 10:25	June 1 13:15
NO3+NO2-N (mg/l)		1.5	0.3	0.15
NH4-N (")		59.0	53.2	59.0
Organic-N (")		--	36.4	--
Total - P (")		14.0	8.7	11.8
BOD (")		542	405	213
COD (Mn) (")		68	74	72
Total Coliform (MPN/100 ml)		1.1x10E9	4.6x10E8	4.6x10E8
Fecal Coliform (MPn/100ml)		2.4x10E8	2.4x10E8	2.4x10E8

TABLE A5-5 QUALITY OF SEWAGE AT CARAPONGO STP (May 24, 1989)

Sample No.		1	2	3	4	1	2	3	4
Sampling Date		24-5	24-5	24-5	24-5	24-5	24-5	24-5	24-5
Sampling Time		9:05	9:22	9:40	9:45	14:20	14:25	14:40	14:45
pH		6.9	6.95	7.3	7.45	6.95	7.0	7.2	7.25
Nitrites+Nitrates	as N mg/l.	1.5	1.1	1.4	1.6	0.08	0.07	0.8	1.1
Ammonia	as N mg/l.	14.1	13.5	11.3	10.4	14.2	12.7	10.7	10.0
Organic Nitrogen	as N mg/l.	6.0	3.0	2.8	3.6	NA	NA	NA	NA
Total Phosphorus	as P mg/l.	2.7	3.1	3.1	2.9	4	2.8	3.0	2.9
Suspended Solids	mg/l.	-	-	-	-	84	70	52	16
Total Residue	mg/l.	-	-	-	-	846	646	666	668
BOD	mg/l.	280	15	35	17	230	20	20	5
COD (Mn)	mg/l.	37	36	10	7	34	32	9	6

TABLE A5-6 NUMBER OF TOTAL COLIFORM OF SEWAGE AT CARAPONGO STP (May 24, 1989)

Sample	1	2	3	4	1	2	3	4
Date (day-month)	24-5	24-5	24-5	24-5	24-5	24-5	24-5	24-5
Time	9:05	9:22	9:40	9:45	14:20	14:25	14:40	14:45
Total Coliform (CFU/ 1 ml)	1.5x10E5	1x10E3	1x10E3	1x10E2	5x10E5	9x10E3	3x10E2	1x10E2

TABLE A5-7 MLSS VALUES IN CARAPONGO STP (June 2, 1989)

Pond No.1

Sample Number	Depth (m)	MLSS (mg/l)	Sample Number	Depth (m)	MLSS (mg/l)	Sample Number	Depth (m)	MLSS (mg/l)
101	0.5	22	111	0.5	60	122	0.5	76
102	1.2	56	112	1.2	130	121	1.2	1,576
103	2.3	108	113	2.3	2,056	123	2.3	6,856

Pond No.2

Sample Number	Depth (m)	MLSS (mg/l)
201	0.5	4
202	1.2	24
203	2.3	664

Sedimentation Tank No.4

Sample Number	Depth (m)	MLSS (mg/l)
301	0.5	80
302	1.2	108
303	2.3	120

TABLE A5-8 WATER QUALITY AT CARAPONGO STP (June 8, 1989)

Item	Point No.* 1	2	3	4
NO3 + NO2-N (mg/l)	1.6	0.4	1.1	1.2
NH4-N (")	19.3	12.6	10.9	10.6
Organic-N (")	12.7	11.2	8.4	6.4
Total - P (")	3.8	3.2	1.2	1.0
Suspended Solid (")	251	55	26	10
Total Residue (")	935	692	650	608

* Sampling Point : 1. Raw Sewage
2. After Pond No. 3
3. Before Sedimentation
4. Treated Sewage

TABLE A5-9 WATER QUALITY OF SAN JUAN STABILIZATION POND
(Upper Battery, April 12, 1989)

Item \ Sampling Point	Entrance	Exit
Temp (C)	24	26
E.C (uS/cm)	790	680
pH	6.8	7.4
Cl- (mg/l)	56	42
SO4 (")	150	150
NO3-N (")	0.1	0.8
NH4-N (")	22	16
Total-P (")	6.4	4.6
SS (")	306	114
TR (")	830	494
BOD (")	263	100 *(34)
TOC (")	135	48
IOC (")	86	38
Total Coliform (MPN/100ml)	1.1x10E8	4.6x10E5
Fecal Coliform (MPN/100ml)	2.4x10E7	2.4x10E5

* Dissolved BOD

TABLE A5-10 WATER QUALITY OF SAN JUAN STABILIZATION POND
AT EACH POND (June 7, 1989)

ITEM	Sampling Point					
	1	2	3	1	2	3
NO3+NO2-N (mg/l)	0.14	0.41	0.50	0.08	0.36	0.32
NH4-N (")	17.4	22.6	17.9	13.4	20.7	19.0
Organic-N (")	12.8	10.7	10.1	-	-	-
Total - P (")	6.7	5.2	5.0	4.6	4.2	5.1
SS (")	206	31	23	88	29	22
TR (")	926	748	731	802	744	727
BOD (")	300	90	120	230	120	120
COD (Mn) (")	55.0	14.6	11.7	70.4	17.6	13.2
Total Coliform (MPN/100ml)	2.4×10^{8}	1.1×10^{7}	2.4×10^{6}	4.3×10^{7}	4.3×10^{6}	2.4×10^{5}
Fecal Coliform (MPN/100ml)	2.4×10^{7}	2.4×10^{6}	2.4×10^{5}	2.4×10^{7}	$2.\times10^{5}$	2.4×10^{4}

TABLE A5-11 RESULTS OF PREVIOUS WATER QUALITY ANALYSIS AT SAN JUAN STABILIZATION POND

(mg/l)

Sampling Point	Date	As	Cd	Cu	Fe	Pb	Zn	Na	K
Effluent of Lower Battery	4.20.87	4.0	<0.005	14.0	124.0	<10	66.0	52,000.0	15,220.0
	8. 3.87	0.0	<0.005	17.0	105.0	<10	52.0	35,840.0	9,460.0
	8.10.87	10.0	<0.005	17.0	140.0	<10	110.0	40,285.0	2,030.0

(mg/l)

Sampling Point	Date	pH	Temp(C)	Pb	Cd	Cu	Fe	Zn
Lower Battery	11.11.86	6.8	22.0	10	<0.005	6	300	32
Upper Battery	11.17.86	7.1	22.5	<10	<0.005	12	300	63

Sampling Point	Date	Water Temp	Amb. Temp	pH	DO mg/l	Total Coli MPN/100ml	Fe.Coli MPN/100ml	Salmonella MPN/100ml	NH4+ mg/l	COD mg/l	BOD mg/l
Eff.of Lower Batt.	11.11.86	22.0	20.0	6.8	4.7	5.0x10E5	5.0x10E5	7.5x10	21.5	170.7	36.0
-do-	3.30.87	26.0	24.0	6.2	4.2	9.0x10E5	3.0x10E5	4.3x10	14.0	196.0	38.0
-do-	8.10.87	19.0	17.5	7.6	8.4	1.3x10E5	5.0x10E4	2.3x10	22.0	141.0	49.0
Eff.of Upper Batt.	11.17.86	22.5	23.0	7.1	2.9	5.0x10E6	3.0x10E6	9.3x10	29.0	170.7	49.0
-do-	4.20.87	25.0	23.0	7.2	2.2	9.0x10E6	5.0x10E6	1.1x10E3	28.5	151.0	98.0
-do-	8. 3.87	19.5	17.0	7.5	4.1	3.0x10E5	1.7x10E5	2.3x10	25.5	110.0	51.0

TABLE A5-12 ANALYSIS RESULTS FOR HEAVY METALS ON COLLECTOR SURCO AND OTHERS
(Oct.9 AND 18, 1989)

SURCO SEWER AND OTHERS 1989

SAMPLE		SURCO ⑤ SEWER	CIRCUNVALACION ④ SEWER	CIR. ① 11	SURCO ② 12
PARAMETER	DATE	9-10	9-10	18-10	18-10
TIME IN HOUR		10:30	13:30	10:00'	10:00
pH.		6.95	8.00	7.05	6.95
NITRITES + NITRATES	as N mg/l.	0.04	1.15	0.4	0.02
AMMONIA	as N mg/l.	20.7	30.2	26.0	28.0
ORGANIC NITROGEN	as N mg/l.	16.8	26.3	ND	ND
TOTAL PHOSPHORUS	as P mg/l.	7.8	9.1	9.0	10.2
ORTHOPHOSPHATE	as P mg/l.	3.6	0.9	4.6	4.8
SUSPENDED SOLIDS	mg/l.	268	278	ND	ND
TOTAL RESIDUE	mg/l.	1072	1480	ND	ND
BOD	mg/l.	233	169	378	334
COD (Mn)	mg/l.	50	28	120	163
MERCURY	Hg ug/l.	1.3	0.3	0.9	1.3
CADMIUM	Cd. mg/l.	0.010	0.020	0.005	0.008
LEAD	Pb. mg/l.	0.02	0.27	0.08	0.12
CHROMIUM	Cr. mg/l.	0.00	0.00	0.00	0.00
IRON	Fe. mg/l.	1.27	1.20	1.26	1.04
MANGANESE	Mn mg/l.	0.06	0.08	0.06	0.06
COPPER	Cu : mg/l.	0.10	0.06	0.22	0.08
ZINC	Zn mg/l.	0.53	0.40	0.32	0.41
TOTAL COLIFORM	MPN/100 ml	4.3×10^7	4.3×10^7	2.4×10^8	9.3×10^7
FECAL COLIFORM	MPN/100 ml	2.3×10^7	2.3×10^7	9.3×10^7	4.3×10^7

SURCO SEWER IS NEAR TOMAS MARZANO AVENUE...
CIRCUNVALACION SEWER IS TAKED AT PANAMERICAN HIGH WAY
ST 11 (SURCO) IS AT MEXICO STREET
ST 12 (CIRCUNVALACION) IS NEAR MEXICO STRET
ND : NOT DETERMINED

TABLE A5-13 COMPARISON OF HEAVY METALS IN COLLECTORS RAW SEWAGE AND STANDARD

Parameter		Past Data	Analysis Result in Field Work	Water Quality Standard *
		Collector Surco	Collector Surco and Cir.	CLASS - III
Date		Nov. 1984	Oct. & Nov. 1989	-
Mercury	Hg μg/l	-	0.3 - 1.3	10
Cadmium	Cd mg/l	0.01 - 0.03	0.005 - 0.02	0.05
Lead	Pb mg/l	0.15 - 0.35	0.02 - 0.27	0.1
Chromium	Cr mg/l	-	0.00	1.0
Iron	Fe mg/l	3.2 - 6.25	1.2 - 1.44	1.0
Manganese	Mn mg/l	0.05 - 0.12	0.06 - 0.08	0.5
Copper	Cu mg/l	0.1 - 0.55	0.06 - 0.22	0.5
Zinc	Zn mg/l	0.16 - 0.34	0.32 - 0.53	25
Arsenic	As mg/l	0.02 - 0.04	-	0.2

Remark ; * : Ley General de Aguas, Decreto Ley No.17752, Nov. 1983
Government of Peru.
Based upon the Standards of EPA, United States.

APPENDIX 6

POPULATION PROJECTION BY THREE METHODS

APPENDIX 6 POPULATION PROJECTION BY THREE METHODS

Based on the estimated population by district in each census year shown in TABLE 4-5 in the Section 4.1 of Main Report, population in the future can be projected by the following three methods:

(1) Logistic Curve Method

This curve shows the population change with respect to time which is assumed to start from zero in the distant past, initially increases slowly, rises abruptly at about midpoint, gradually decreases in growth rate as it passes the point of inflection, and reaches saturation point in the distant future.

Its formula is expressed as:

$$Px = \frac{K}{1 + e(a-bx)} \qquad (1)$$

where: Px: population in year x
x: time in years from the base year
e: natural logarithm base
k: saturation population
a,b:constants

The population of 1961, 1971* and 1981 were used as a base to calculate the saturated population (theoretical) through the logistical curve formula. Population in 1971* is calculated by interpolating the figures from the 1961 and 1981 census.

TABLE A6-2 shows the saturation populations calculated mathematically. Of these values, saturation populations of some districts which do not have theoretical solution were calculated using estimated saturation population densities based on the past population densities or those compared with other districts (TABLE A6-1), and areas measured from the map.

Using the saturation population and census figures, the future population was calculated through the logistic curve method.

TABLEs A6-3 and A6-4 show the calculated values and the parameters for calculation, respectively.

As a result of estimates made by this method, the following population projections were obtained:

YEAR	POPULATION
1989	5,896,600
1990	6,035,200
1995	6,673,600
2000	7,239,000

TABLE A6-1 POPULATION DENSITY (as of July 30,1961,1972,1981)

(unit: pop./ha)

DISTRICT	AREA (ha)	1961	1972	1981
LIMA	2,121	123.72	172.80	184.12
ANCON	28,883	0.14	0.20	0.31
ATE	9,822	8.24	6.44	14.13
BARRANCO	273	160.07	185.88	179.15
BRENA	320	321.25	362.60	369.60
CARABAYLLO	35,557	1.22	0.82	1.56
CHACLACAYO	4,405	2.18	5.04	7.55
CHORRILLOS	3,681	9.05	25.56	40.56
CIENEGUILLA	24,470	0.05	0.11	0.20
COMAS	4,621	21.08	38.91	64.46
EL AGUSTINO	1,836	41.99	66.15	96.15
INDEPENDENCIA	1,336	63.70	85.20	108.47
JESUS MARIA	425	203.76	204.68	205.94
LA MOLINA	4,169	0.50	1.49	7.14
LA VICTORIA	909	222.00	302.24	313.45
LINCE	282	300.71	304.53	300.21
LURIGANCHO-CHOSICA	24,667	1.36	2.16	2.78
LURIN	33,251	0.19	0.40	0.54
MAGDALENA DEL MAR	318	180.50	184.96	183.76
PUEBLO LIBRE	470	150.21	172.05	188.03
MIRAFLORES	912	99.89	113.20	119.36
PACHACAMAC	15,364	0.79	0.31	0.46
PUCUSANA	3,027	0.59	0.97	1.43
PUENTE PIEDRA	6,267	1.37	3.13	5.70
PUNTA HERMOSA	293	1.02	3.21	3.63
PUNTA NEGRA	278	1.44	2.76	2.09
RIMAC	1,215	122.30	146.94	159.77
SAN BARTOLO	15,134	0.07	0.10	0.20
SAN BORJA	1,046	51.24	65.83	56.66
SAN ISIDRO	1,007	38.73	65.06	72.20
S.J. DE LURIGANCHO	14,034	1.66	6.44	19.45
S.J. DE MIRAFLORES	2,351	27.22	47.14	74.19
SAN LUIS	356	24.16	70.43	149.74
SAN MARTIN DE PORRES	5,791	17.25	41.44	73.56
SAN MIGUEL	1,018	23.48	64.40	102.56
SANTA MARIA DEL MAR	755	0.13	0.06	0.13
SANTA ROSA	1,982	0.05	0.11	0.26
SANTIAGO DE SURCO	3,493	13.34	19.99	42.11
SURQUILLO	413	56.90	72.14	237.94
VILLA EL SALVADOR	3,368	-	-	42.33
V.M. DEL TRIUNFO	7,149	13.26	26.31	26.28
TOTAL (PROV. LIMA)	267,069	7.96	11.58	16.41
CALLAO	4,565	27.29	45.05	59.25
BELLAVISTA	456	97.15	90.44	151.64
CARMEN DE LA LEGUA	212	86.32	127.25	186.31
LA PERLA	275	80.00	125.92	175.86
LA PUNTA	75	81.33	92.21	85.55
VENTANILLA	7,352	2.34	2.36	2.74
TOTAL (PROV. CALLAO)	14,698	15.82	22.64	30.90
TOTAL (METRO. LIMA)	281,767	8.37	12.15	17.16

NOTE: 1/ Total area of Provincia de Constitucional de Callao include the area of island (1,763 ha).

TABLE A6-2 ESTIMATED SATURATION POPULATION

DISTRICT	TOTAL AREA (ha)	POPULATION 1981	POPULATION SATURAT'N		AREA TO BE INHABITED ha	AREA TO BE INHABITED %	POPULATION DENSITY (pop./ha.) TOTAL AREA 1981	TOTAL AREA SATURAT'D	INHABITED SATURAT'D
LIMA	2,121	390,513	396,800	*	2,121	100	184.12	187.08	187.08
ANCON	28,883	8,865	288,800		2,888	10	0.31	10.00	100.00
ATE	9,822	138,746	392,800		1,964	20	14.13	39.99	200.00
BARRANCO	273	48,907	68,300		273	100	179.15	250.00	250.00
BRENA	320	118,271	118,800	*	320	100	369.60	371.25	371.25
CARABAYLLO	35,557	55,558	355,600		3,556	10	1.56	10.00	100.00
CHACLACAYO	4,405	33,243	45,300	*	441	10	7.55	10.28	102.72
CHORRILLOS	3,681	149,294	194,600	*	1,841	50	40.56	52.87	105.70
CIENEGUILLA	24,470	4,783	122,400		1,224	5	0.20	5.00	100.00
COMAS	4,621	297,870	462,200		2,311	50	64.46	100.02	200.00
EL AGUSTINO	1,836	176,537	257,000		1,285	70	96.15	139.98	200.00
INDEPENDENCIA	1,336	144,918	187,000		935	70	108.47	139.97	200.00
JESUS MARIA	425	87,525	106,300		425	100	205.94	250.00	250.00
LA MOLINA	4,169	29,786	417,000		2,085	50	7.14	100.02	200.00
LA VICTORIA	909	284,922	286,400	*	909	100	313.45	315.07	315.07
LINCE	282	84,660	86,000		282	100	300.21	305.00	305.00
LURIGANCHO-CHOSICA	24,667	68,542	246,700		2,467	10	2.78	10.00	100.00
LURIN	33,251	18,104	332,500		3,325	10	0.54	10.00	100.00
MAGDALENA DEL MAR	318	58,437	79,500		318	100	183.76	250.00	250.00
PUEBLO LIBRE	470	88,374	118,100	*	470	100	188.03	251.28	251.28
MIRAFLORES	912	108,859	114,700	*	912	100	119.36	125.77	125.77
PACHACAMAC	15,364	7,134	153,600		1,536	10	0.46	10.00	100.00
PUCUSANA	3,027	4,319	15,100		151	5	1.43	4.99	100.00
PUENTE PIEDRA	6,267	35,694	286,500	*	1,253	20	5.70	45.72	228.65
PUNTA HERMOSA	293	1,063	2,900		29	10	3.63	9.90	100.00
PUNTA NEGRA	278	582	1,400		14	5	2.09	5.04	100.00
RIMAC	1,215	194,123	212,600	*	1,215	100	159.77	174.98	174.98
SAN BARTOLO	15,134	3,067	151,300		1,513	10	0.20	10.00	100.00
SAN BORJA	1,046	59,270	209,200		1,046	100	56.66	200.00	200.00
SAN ISIDRO	1,007	72,706	74,500	*	1,007	100	72.20	73.98	73.98
S.J. DE LURIGANCHO	14,034	272,943	561,400		2,807	20	19.45	40.00	200.00
S.J. DE MIRAFLORES	2,351	174,426	329,200		1,646	70	74.19	140.03	200.00
SAN LUIS	356	53,306	71,200		356	100	149.74	200.00	200.00
SAN MARTIN DE PORRES	5,791	426,010	1,197,200	*	4,054	70	73.56	206.73	295.31
SAN MIGUEL	1,018	104,405	139,900	*	1,018	100	102.56	137.43	137.43
STA.MARIA DEL MAR	755	101	7,600		76	10	0.13	10.07	100.00
SANTA ROSA	1,982	518	9,900		99	5	0.26	4.99	100.00
SANTIAGO DE SURCO	3,493	147,105	698,600		3,493	100	42.11	200.00	200.00
SURQUILLO	413	98,269	103,300		413	100	237.94	250.00	250.00
VILLA EL SALVADOR	3,368	267,039	421,000		1,684	50	79.29	125.00	250.00
V.M. DEL TRIUNFO	7,149	322,977	715,000		2,860	40	45.18	100.01	250.00
TOTAL (PROV. LIMA)	267,069	4,641,771	10,038,200		56,622	21.2	17.38	37.59	177.28
CALLAO	4,565	270,499	384,700	*	2,283	50	59.25	84.27	168.51
BELLAVISTA	456	69,148	114,000		456	100	151.64	250.00	250.00
CARMEN DE LA LEGUA	212	39,498	53,000		212	100	186.31	250.00	250.00
LA PERLA	275	48,362	68,800		275	100	175.86	250.00	250.00
LA PUNTA	75	6,416	7,500		75	100	85.55	100.00	100.00
VENTANILLA	7,352	20,177	367,600		3,676	50	2.74	50.00	100.00
TOTAL (PROV. CALLAO)	14,698	454,100	995,600		6,977	47.5	30.90	67.74	142.70
TOTAL (METRO. LIMA)	281,767	5,095,871	11,033,800		63,599	22.6	18.09	39.16	173.49

Note: 1. Total area of Prov. Callao includes the area of islands (1,763 ha).
2. Saturation population with an asterisk is calculated as a theoretical solution.

TABLE A6-3 PROJECTED POPULATION (METROPOLITAN LIMA, LOGISTIC CURVE)

DISTRICT	1961	1972	1981	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
LIMA	262,400	366,501	390,513	395,200	395,400	395,600	395,800	396,000	396,100	396,200	396,300	396,400	396,500	396,500	396,600
ANCON	4,000	5,792	8,865	11,800	12,300	12,800	13,300	13,800	14,300	14,900	15,500	16,100	16,700	17,300	18,000
ATE	80,900	63,235	138,746	140,500	143,600	146,800	150,000	153,300	156,600	159,900	163,200	166,500	169,900	173,200	176,600
BARRANCO	43,700	50,746	48,907	52,300	52,500	52,700	52,900	53,100	53,400	53,600	53,800	54,000	54,200	54,400	54,600
BRENA	102,800	116,031	118,271	118,700	118,700	118,700	118,700	118,700	118,700	118,800	118,800	118,800	118,800	118,800	118,800
CARABAYLLO	43,500	28,981	55,558	50,000	50,500	51,000	51,600	52,100	52,600	53,200	53,700	54,300	54,900	55,400	56,000
CHACLACAYO	9,600	22,195	33,243	39,600	40,200	40,700	41,100	41,600	41,900	42,300	42,600	42,900	43,100	43,400	43,600
CHORRILLOS	33,300	94,088	149,294	176,800	178,900	180,800	182,500	184,000	185,300	186,400	187,400	188,300	189,100	189,800	190,400
CIENEGUILLA	1,300	2,628	4,783	7,900	8,400	8,900	9,500	10,100	10,700	11,400	12,100	12,800	13,600	14,400	15,300
COMAS	97,400	179,819	297,870	362,300	369,600	376,400	382,900	388,900	394,600	399,900	404,900	409,500	413,800	417,700	421,400
EL AGUSTINO	77,100	121,445	176,537	205,200	208,400	211,600	214,500	217,300	220,000	222,500	224,800	227,000	229,100	231,100	232,900
INDEPENDENCIA	85,100	113,827	144,918	159,100	160,700	162,300	163,800	165,200	166,500	167,700	168,900	170,000	171,100	172,100	173,000
JESUS MARIA	86,600	86,991	87,525	87,800	87,900	87,900	88,000	88,000	88,100	88,100	88,100	88,200	88,200	88,300	88,300
LA MOLINA	2,100	6,218	29,786	68,100	76,100	84,900	94,400	104,500	115,400	127,000	139,200	152,000	165,200	178,800	192,700
LA VICTORIA	201,800	274,735	284,922	286,100	286,200	286,200	286,300	286,300	286,300	286,300	286,300	286,400	286,400	286,400	286,400
LINCE	84,800	85,878	84,660	85,400	85,400	85,400	85,400	85,400	85,400	85,400	85,400	85,400	85,500	85,500	85,500
LURIGANCHO-CHOSICA	33,500	53,220	68,542	89,100	91,700	94,300	96,900	99,600	102,200	104,900	107,700	110,400	113,200	115,900	118,700
LURIN	6,400	13,259	18,104	28,600	30,100	31,600	33,200	34,900	36,600	38,400	40,300	42,200	44,300	46,400	48,600
MAGDALENA DEL MAR	57,400	58,816	58,437	59,200	59,200	59,300	59,300	59,400	59,400	59,500	59,500	59,600	59,600	59,700	59,700
PUEBLO LIBRE	70,600	80,864	88,374	94,100	94,800	95,400	96,000	96,600	97,200	97,800	98,400	99,000	99,500	100,100	100,600
MIRAFLORES	91,100	103,235	108,859	111,500	111,700	111,900	112,100	112,300	112,500	112,700	112,800	113,000	113,100	113,200	113,300
PACHACAMAC	12,100	4,705	7,134	7,700	7,900	8,000	8,200	8,300	8,500	8,700	8,800	9,000	9,200	9,400	9,600
PUCUSANA	1,800	2,941	4,319	5,700	5,900	6,100	6,300	6,500	6,700	6,900	7,100	7,300	7,600	7,800	8,000
PUENTE PIEDRA	8,600	19,616	35,694	60,000	63,700	67,500	71,500	75,700	80,100	84,500	89,200	93,900	98,800	103,800	108,900
PUNTA HERMOSA	300	940	1,063	1,700	1,700	1,800	1,800	1,900	2,000	2,000	2,100	2,100	2,100	2,200	2,200
PUNTA NEGRA	400	768	582	800	800	800	800	800	800	800	800	900	900	900	900
RIMAC	148,600	178,538	194,123	202,000	202,800	203,400	204,100	204,700	205,200	205,700	206,200	206,700	207,100	207,500	207,900
SAN BARTOLO	1,000	1,518	3,067	4,400	4,700	4,900	5,200	5,500	5,800	6,100	6,500	6,800	7,200	7,600	8,000
SAN BORJA	53,600	68,862	59,270	66,500	66,800	67,200	67,500	67,900	68,300	68,600	69,000	69,300	69,700	70,100	70,400
SAN ISIDRO	39,000	65,513	72,706	74,100	74,100	74,200	74,200	74,300	74,300	74,300	74,400	74,400	74,400	74,400	74,400
S.J. DE LURIGANCHO	23,300	90,393	272,943	420,900	436,400	450,700	463,700	475,500	486,100	495,500	504,000	511,400	518,000	523,700	528,800
S.J. DE MIRAFLORES	64,000	110,833	174,426	219,600	225,100	230,500	235,700	240,800	245,700	250,400	254,900	259,200	263,300	267,300	271,000
SAN LUIS	8,600	25,072	53,306	64,100	65,000	65,800	66,500	67,200	67,700	68,200	68,600	68,900	69,300	69,500	69,800
S.MARTIN DE PORRES	99,900	239,973	426,010	639,300	666,000	692,500	718,700	744,300	769,500	793,900	817,700	840,700	862,800	884,100	904,600
SAN MIGUEL	23,900	65,559	104,405	125,200	126,800	128,300	129,700	130,800	131,900	132,900	133,700	134,400	135,100	135,700	136,200
STA.MARIA DEL MAR	100	46	101	100	100	100	100	100	100	100	100	100	100	100	100
SANTA ROSA	100	226	518	900	1,000	1,100	1,200	1,300	1,400	1,500	1,600	1,700	1,800	1,900	2,100
SANTIAGO DE SURCO	46,600	69,817	147,105	201,100	210,500	220,200	230,100	240,200	250,500	261,000	271,700	282,600	293,600	304,700	315,900
SURQUILLO	23,500	29,792	98,269	101,200	101,600	101,900	102,100	102,400	102,500	102,700	102,800	102,900	103,000	103,000	103,100
VILLA EL SALVADOR *	-	-	142,567	251,000	267,000	278,700	291,100	302,800	313,900	324,300	333,900	342,800	351,000	358,500	365,300
V.M. DEL TRIUNFO *	94,800	188,115	187,878	306,300	323,000	339,300	356,000	372,600	389,100	405,500	421,800	437,700	453,300	468,500	483,300
TOTAL (PROV. LIMA)	2,125,600	3,091,731	4,382,200	5,381,900	5,513,200	5,638,200	5,762,700	5,884,700	6,003,900	6,120,500	6,234,600	6,345,600	6,454,100	6,559,100	6,661,500
CALLAO	124,600	205,631	270,499	314,500	319,000	323,200	327,200	331,000	334,600	338,000	341,200	344,200	347,000	349,600	352,100
BELLAVISTA	44,300	41,239	69,148	72,300	73,400	74,500	75,600	76,700	77,700	78,800	79,800	80,800	81,800	82,800	83,700
CARMEN DE LA LEGUA	18,300	26,977	39,498	44,500	45,100	45,600	46,200	46,600	47,100	47,500	47,900	48,300	48,700	49,000	49,300
LA PERLA	22,000	34,627	48,362	55,800	56,700	57,400	58,200	58,900	59,600	60,200	60,800	61,300	61,800	62,300	62,800
LA PUNTA	6,100	6,916	6,416	6,800	6,800	6,800	6,800	6,800	6,800	6,800	6,800	6,900	6,900	6,900	6,900
VENTANILLA	17,200	17,341	20,177	20,800	21,000	21,200	21,300	21,500	21,700	21,800	22,000	22,200	22,300	22,500	22,700
TOTAL (PROV.CALLAO)	232,500	332,731	454,100	514,700	522,000	528,700	535,300	541,500	547,500	553,100	558,500	563,700	568,500	573,100	577,500
TOTAL (METRO. LIMA)	2,358,100	3,424,462	4,836,300	5,896,600	6,035,200	6,166,900	6,298,000	6,426,200	6,551,400	6,673,600	6,793,100	6,909,300	7,022,600	7,132,200	7,239,000

Note: * Population data in 1989 and 1990 are quoted from INE projection.

TABLE A6-4 PARAMETERS OF LOGISTIC CURVES

DISTRICT	K		a	b
LIMA	396,800	*	(2.545460)	0.172734
ANCON	288,800		3.842034	0.040417
ATE	392,800		1.178518	0.034866
BARRANCO	68,300		(0.866052)	0.018498
BRENA	118,800	*	(3.786585)	0.177221
CARABAYLLO	355,600		2.016281	0.012184
CHACLACAYO	45,300	*	0.035553	0.116356
CHORRILLOS	194,600	*	0.058113	0.138470
CIENEGUILLA	122,400		3.807638	0.066536
COMAS	462,200		0.328914	0.095153
EL AGUSTINO	257,000		0.003082	0.081117
INDEPENDENCIA	187,000		(0.546288)	0.070313
JESUS MARIA	106,300		(1.510378)	0.002910
LA MOLINA	417,000		3.924067	0.134725
LA VICTORIA	286,400	*	(3.242821)	0.219191
LINCE	86,000		(4.988364)	0.002241
LURIGANCHO-CHOSICA	246,700		1.335552	0.044997
LURIN	332,500		3.286003	0.054343
MAGDALENA DEL MAR	79,500		(1.008970)	0.003479
PUEBLO LIBRE	118,100	*	(0.776887)	0.034656
MIRAFLORES	114,700	*	(2.210296)	0.078659
PACHACAMAC	153,600		3.296488	0.020844
PUCUSANA	15,100		1.408548	0.054207
PUENTE PIEDRA	286,500	*	2.627637	0.076376
PUNTA HERMOSA	2,900		1.092175	0.082409
PUNTA NEGRA	1,400		0.332971	0.031434
RIMAC	212,600	*	(1.667271)	0.075426
SAN BARTOLO	151,300		4.456800	0.056052
SAN BORJA	209,200		0.896713	0.007808
SAN ISIDRO	74,500	*	(2.047553)	0.180092
S.J. DE LURIGANCHO	561,400		1.512843	0.153526
S.J. DE MIRAFLORES	329,200		0.608933	0.076711
SAN LUIS	71,200		0.399178	0.152777
S.MARTIN DE PORRES	1,197,200	*	1.397662	0.090219
SAN MIGUEL	139,900	*	0.120244	0.132903
STA.MARIA DEL MAR	7,600		4.576773	(0.002118)
SANTA ROSA	9,900		3.690010	0.084086
SANTIAGO DE SURCO	698,600		2.009343	0.064905
SURQUILLO	103,300		(0.417556)	0.203127
VILLA EL SALVADOR **	421,000		(0.403829)	0.134345
V.M. DEL TRIUNFO **	715,000		0.287653	0.093012
TOTAL (PROV. LIMA)	10,217,000			
CALLAO	384,700	*	(0.141486)	0.079897
BELLAVISTA	114,000		0.167840	0.042305
CARMEN DE LA LEGUA	53,000		(0.213044)	0.084777
LA PERLA	68,800		(0.093496)	0.080406
LA PUNTA	7,500		(1.919267)	0.018078
VENTANILLA	367,600		2.949835	0.008129
TOTAL (PROV.CALLAO)	995,600			
TOTAL (METRO. LIMA)	11,212,600			

Note: 1. Saturated population with an asterisk is calculated as a theoretical solution.

2. Formula used for projection is as follows:

$$Pi = K / (1 + (e ^ (a - b * x)))$$

where ;

- Pi ; population in the year i.
- x ; number of years after the basic year. basic year ; 1972 (**;1989)
- e ; base of natural logarithm
- K ; constant (saturation population)
- a,b ; constants

(2) Exponential Curve Method

This method can be applied to calculate future population under various increase or decrease conditions.

It is expressed by the formula:

$$Px = Po + A * x^a \quad (2)$$

where: Px: population in x years from the base year
Po: population in the base year
x: time in years from the base year
A,a:constants

Using the population data shown in TABLE 4-5 as a base, calculate the parameters through the exponential curve formula. The results are shown in TABLE A6-5 while the parameters are in TABLE A6-6.

As a result of estimates made by this method, the following population projections were obtained:

YEAR	POPULATION
1989	6,592,800
1990	6,858,600
1995	8,360,200
2000	10,206,400

TABLE A6-5 POPULATION PROJECTION..(METROPOLITAN LIMA, EXPONENTIAL CURVE)

DISTRICT	1961	1972	1981	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
LIMA	262,400	366,501	390,513	406,400	408,200	409,900	411,600	413,200	414,800	416,400	418,000	419,500	421,000	422,500	423,900
ANCON	4,000	5,792	8,865	12,500	13,100	13,800	14,100	14,700	15,200	15,800	16,400	17,000	17,600	18,200	18,800
ATE 1/	80,900	63,235	138,746	161,900	164,800	167,700	170,600	173,500	176,300	179,200	182,100	185,000	187,900	190,809	193,700
BARRANCO	43,700	50,746	48,907	48,100	48,000	47,900	47,900	47,800	47,700	47,700	47,600	47,600	47,500	47,500	47,400
BREÑA	102,800	116,031	118,271	119,700	119,900	120,000	120,200	120,300	120,400	120,600	120,700	120,800	121,000	121,100	121,200
CARABAYLLO 1/	43,500	28,981	55,558	60,400	61,000	61,600	62,200	62,800	63,400	64,000	64,600	65,200	65,800	66,400	67,000
CHACLACAYO	9,600	22,195	33,243	43,300	44,600	45,800	47,100	48,400	49,700	50,900	52,200	53,500	54,800	56,100	57,400
CHORRILLOS	33,300	94,088	149,294	200,200	206,600	213,100	219,600	226,100	232,600	239,100	245,700	252,200	258,800	265,400	272,000
CIENEGUILLA	1,300	2,628	4,783	7,300	7,600	8,000	8,400	8,700	9,100	9,500	9,900	10,300	10,700	11,100	11,500
COMAS	97,400	179,819	297,870	428,000	445,700	463,700	482,000	500,600	519,500	538,600	558,100	577,800	597,700	618,000	638,500
EL AGUSTINO	77,100	121,445	176,537	233,700	241,400	249,000	256,800	264,700	272,700	280,700	288,900	297,100	305,400	313,700	322,200
INDEPENDENCIA	85,100	113,827	144,918	175,500	179,500	183,500	187,500	191,600	195,700	199,800	204,000	208,100	212,300	216,600	220,800
JESUS MARIA	86,600	86,991	87,525	88,100	88,200	88,300	88,300	88,400	88,500	88,600	88,700	88,800	88,800	88,900	89,000
LA MOLINA	2,100	6,218	29,786	83,000	92,600	102,900	114,000	125,900	138,700	152,300	166,900	182,400	198,800	216,300	234,800
LA VICTORIA	201,800	274,735	284,922	291,300	292,000	292,600	293,300	293,900	294,500	295,100	295,700	296,300	296,900	297,400	298,000
LINCE 2/	84,800	85,878	84,660	83,600	83,500	83,400	83,300	83,200	83,100	83,000	82,900	82,800	82,700	82,600	82,500
LURIGANCHO-CHOSICA	33,500	53,220	68,542	81,900	83,600	85,300	86,900	88,600	90,200	91,900	93,500	95,200	96,800	98,500	100,100
LURIN	6,400	13,259	18,104	22,200	22,700	23,200	23,700	24,200	24,700	25,200	25,700	26,200	26,700	27,200	27,700
MAGDALENA DEL MAR	57,400	58,816	58,437	58,300	58,300	58,200	58,200	58,200	58,200	58,200	58,200	58,200	58,200	58,100	58,100
PUEBLO LIBRE	70,600	80,864	88,374	94,800	95,600	96,400	97,200	98,000	98,800	99,500	100,300	101,100	101,900	102,600	103,400
MIRAFLORES	91,100	103,235	108,859	113,100	113,600	114,100	114,600	115,100	115,500	116,000	116,500	116,900	117,400	117,800	118,300
PACHACAMAC 2/	12,100	4,705	7,134	10,300	10,800	11,300	11,800	12,400	13,000	13,600	14,200	14,900	15,600	16,300	17,100
PUCUSANA	1,800	2,941	4,319	5,700	5,900	6,100	6,300	6,500	6,700	6,900	7,100	7,300	7,500	7,700	7,900
PUENTE PIEDRA	8,600	19,616	35,694	53,600	56,000	58,500	61,000	63,600	66,200	68,800	71,500	74,200	77,000	79,800	82,600
PUNTA HERMOSA	300	940	1,063	1,100	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200
PUNTA NEGRA	400	768	582	500	500	500	500	500	500	500	500	500	500	500	500
RIMAC	148,600	178,538	194,123	206,200	207,700	209,100	210,500	211,900	213,300	214,600	216,000	217,300	218,700	220,000	221,300
SAN BARTOLO	1,000	1,518	3,067	5,500	5,900	6,300	6,700	7,100	7,600	8,100	8,500	9,100	9,600	10,100	10,700
SAN BORJA	53,600	68,862	59,270	56,800	56,700	56,500	56,300	56,200	56,100	56,000	55,800	55,700	55,600	55,600	55,500
SAN ISIDRO	39,000	65,513	72,706	77,600	78,100	78,700	79,200	79,700	80,200	80,700	81,200	81,700	82,100	82,600	83,100
S.J. DE LURIGANCHO	23,300	90,393	272,943	546,300	588,200	631,900	677,400	724,700	773,700	824,600	877,300	931,900	988,300	1,046,500	1,106,700
S.J. DE MIRAFLORES	64,000	110,833	174,426	242,900	252,200	261,600	271,100	280,700	290,500	300,400	310,500	320,600	330,900	341,300	351,900
SAN LUIS	8,600	25,072	53,306	87,000	91,800	96,600	101,500	106,600	111,800	117,100	122,600	127,900	133,500	139,200	145,000
SAN MARTIN DE PORRES	99,900	239,973	426,010	624,600	651,300	678,400	705,800	733,600	761,800	790,300	819,200	848,400	878,000	907,900	938,100
SAN MIGUEL	23,900	65,559	104,405	140,500	145,100	149,800	154,600	159,000	163,700	168,400	173,100	177,800	182,500	187,200	191,900
SANTA MARIA DEL MAR 1/	100	46	101	100	100	100	100	100	100	100	100	100	100	100	100
SANTA ROSA	100	226	518	900	1,000	1,000	1,100	1,200	1,200	1,300	1,400	1,500	1,500	1,600	1,700
SANTIAGO DE SURCO	46,600	69,817	147,105	275,900	296,500	318,100	340,800	364,600	389,600	415,600	442,800	471,100	500,600	531,200	563,100
SURQUILLO	23,500	29,792	98,269	324,600	371,700	424,100	482,400	546,900	618,000	696,200	782,000	875,800	978,200	1,089,600	1,210,600
VILLA EL SALVADOR 3/	-	-	142,567	251,000	267,000	283,400	300,000	316,900	334,000	351,300	368,900	386,700	404,600	422,700	441,000
V.M. DEL TRIUNFO 3/	94,800	188,115	187,878	306,300	323,000	339,900	357,100	374,400	392,000	409,600	427,500	445,500	463,600	481,900	500,300
TOTAL (PROV. LIMA)	2,125,600	3,091,731	4,382,200	6,030,700	6,281,200	6,541,300	6,812,700	7,095,700	7,390,500	7,697,400	8,017,800	8,351,200	8,698,300	9,059,800	9,436,600
CALLAO	124,600	205,631	270,499	327,700	334,900	342,000	349,100	356,300	363,400	370,500	377,600	384,700	391,800	398,900	406,000
BELLAVISTA 1/	44,300	41,239	69,148	79,100	80,300	81,600	82,800	84,100	85,300	86,500	87,800	89,000	90,300	91,500	92,800
CARMEN DE LA LEGUA	18,300	26,977	39,498	53,300	55,200	57,200	59,100	61,100	63,100	65,100	67,200	69,300	71,400	73,600	75,800
LA PERLA	22,000	34,627	48,362	61,900	63,700	65,600	67,200	69,000	70,800	72,700	74,500	76,400	78,200	80,100	82,000
LA PUNTA	6,100	6,916	6,416	6,300	6,300	6,300	6,300	6,200	6,200	6,200	6,200	6,200	6,200	6,200	6,200
VENTANILLA	17,200	17,341	20,177	33,800	37,000	40,800	45,000	49,900	55,500	61,800	68,900	76,900	85,900	95,900	107,000
TOTAL (PROV. CALLAO)	232,500	332,731	454,100	562,100	577,400	593,300	609,500	626,600	644,300	662,800	682,200	702,500	723,800	746,200	769,800
TOTAL (METRO. LIMA)	2,358,100	3,424,462	4,836,300	6,592,800	6,858,600	7,134,600	7,422,200	7,722,300	8,034,800	8,360,200	8,700,000	9,053,700	9,422,100	9,806,000	10,206,400

Note: Exponential formula are adopted except districts w/numbers 2 & 3.
1/ Population in 1972 is modified using average growth rate from 1961 to 1981 due to mathematical reason.
2/ Average growth rate from 1972 to 1981 is adopted for projection due to mathematical reason.
3/ Population in 1989 and 1990 are quoted from the population estimate by INE.

TABLE A6-6 PARAMETERS OF EXPONENTIAL CURVE

DISTRICT	1961	A	a
LIMA	262,400	45280.847	0.347170
ANCON	4,000	32.629352	1.670580
ATE	80,900	2892.1633	1.000016
BARRANCO	43,700	23702.897	(0.505918)
BRENA	102,800	7065.5489	0.261618
CARABAYLLO	43,500	602.94555	0.999975
CHACLACAYO	9,600	1007.3612	1.053410
CHORRILLOS	33,300	4552.7516	1.080806
CIENEGUILLA	1,300	27.770930	1.612848
COMAS	97,400	2331.9089	1.486774
EL AGUSTINO	77,100	1738.5631	1.350743
INDEPENDENCIA	85,100	1515.7768	1.226871
JESUS MARIA	86,600	12.365775	1.440336
LA MOLINA	2,100	1.9739111	3.187423
LA VICTORIA	201,800	43171.204	0.218690
LINCE 1/	84,800	0.9984140	
LURIGANCHO-CHOSICA	33,500	1965.3712	0.961657
LURIN	6,400	804.31318	0.893837
MAGDALENA DEL MAR	57,400	4939.4980	(0.521052)
PUEBLO LIBRE	70,600	1134.5689	0.918468
MIRAFLORES	91,100	2634.5940	0.636961
PACHACAMAC 1/	12,100	1.0473357	
PUCUSANA	1,800	47.615552	1.324704
PUENTE PIEDRA	8,600	298.08951	1.505366
PUNTA HERMOSA	300	316.20273	0.294043
PUNTA NEGRA	400	6198.7237	(1.177706)
RIMAC	148,600	5574.3873	0.701009
SAN BARTOLO	1,000	2.0123562	2.314809
SAN BORJA	53,600	809905.79	(1.656266)
SAN ISIDRO	39,000	10123.339	0.401515
S.J. DE LURIGANCHO	23,300	345.03173	2.197844
S.J. DE MIRAFLORES	64,000	1501.0489	1.434768
SAN LUIS	8,600	300.27528	1.670097
SAN MARTIN DE PORRES	99,900	4723.8526	1.413548
SAN MIGUEL	23,900	2965.6464	1.101976
SANTA MARIA DEL MAR 1/	100	1	0.000000
SANTA ROSA	100	1.0267009	2.005897
SANTIAGO DE SURCO	46,600	65.059458	2.451041
SURQUILLO	23,500	0.3071037	4.140132
VILLA EL SALVADOR 2/	142,567	9508.8619	1.170502
V.M. DEL TRIUNFO 2/	187,878	11487.242	1.121766
CALLAO	124,600	7660.3688	0.983684
BELLAVISTA	44,300	1242.2177	1.000049
CARMEN DE LA LEGUA	18,300	241.22373	1.494105
LA PERLA	22,000	659.30518	1.231249
LA PUNTA	6,100	36661.865	(1.586841)
VENTANILLA	17,200	0.0006862	5.101577

Note: Formula used for projection is as follows:

$$Pi = P1961 + A * (x \hat{} a)$$

(1/ $Pi = P1961 * A \hat{} x$)

where ;

Pi ; population in the year i.

P1961; population in 1961 (2/ 1981).

x ; number of years after the basic year.
x = (calender year) - 1961

A,a ; constants

(3) Geometrical Method

This method calculates the future population assuming that the rate of increase or decrease as obtained from past data remains constant.

It is expressed by the formula:

$$Px = Po * (1 + r)^x \quad (3)$$

where: Px: the population x years from the base year
Po: the population in the base year
r: average annual rate of increase

The rate is calculated from the population data for 1972 and 1981 shown in TABLE 4-5.

Formula (3) is used to calculate the future population using the calculated increase in rate. TABLE A6-7 shows the calculated values.

As a result of estimates made by this method, the following population projections were obtained:

YEAR	POPULATION
1989	6,858,600
1990	7,200,400
1995	9,371,100
2000	12,655,700

TABLE A6-7 PROJECTED POPULATION (METROPOLITAN LIMA, GEOMETRICAL METHOD)

DISTRICT	1961	1972	1981	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
LIMA	262,400	366,501	390,513	413,200	416,100	419,000	422,000	425,000	428,000	431,000	434,100	437,200	440,200	443,400	446,500
ANCON	4,000	5,792	8,865	12,900	13,600	14,200	14,900	15,600	16,400	17,200	18,000	18,900	19,800	20,800	21,800
ATE 1/	80,900	63,235	138,746	172,200	176,900	181,700	186,700	191,800	197,000	202,400	207,900	213,600	219,500	225,500	231,600
BARRANCO	43,700	50,746	48,907	47,300	47,100	46,900	46,700	46,600	46,400	46,200	46,000	45,800	45,600	45,400	45,200
BRENA	102,800	116,031	118,271	120,300	120,600	120,800	121,100	121,300	121,600	121,800	122,100	122,400	122,600	122,900	123,100
CARABAYLLO 1/	43,500	28,981	55,558	61,300	62,000	62,800	63,600	64,300	65,100	65,900	66,700	67,600	68,400	69,200	70,100
CHACLACAYO	9,600	22,195	33,243	47,600	49,800	52,100	54,500	57,000	59,600	62,300	65,200	68,200	71,300	74,600	78,000
CHORRILLOS	33,300	94,088	149,294	225,000	236,900	249,400	262,500	276,300	290,800	306,200	322,300	339,200	357,100	375,900	395,700
CIENEGUILLA	1,300	2,628	4,783	8,100	8,700	9,300	9,900	10,600	11,400	12,100	13,000	13,900	14,800	15,800	16,900
COMAS	97,400	179,819	297,870	466,500	493,400	521,900	552,000	583,800	617,500	653,100	690,800	730,600	772,800	817,400	864,500
EL AGUSTINO	77,100	121,445	176,537	246,200	256,600	267,500	278,900	290,700	303,000	315,900	329,300	343,300	357,800	373,000	388,900
INDEPENDENCIA	85,100	113,827	144,918	179,600	184,500	189,500	194,700	200,000	205,400	211,000	216,700	222,600	228,700	234,900	241,300
JESUS MARIA	86,600	86,991	87,525	88,000	88,100	88,100	88,200	88,200	88,300	88,400	88,400	88,500	88,500	88,600	88,700
LA MOLINA 1/	2,100	6,218	29,786	86,000	98,200	112,200	128,100	146,200	167,000	190,700	217,700	248,600	283,800	324,100	370,000
LA VICTORIA	201,800	274,735	284,922	294,300	295,500	296,700	297,900	299,100	300,300	301,500	302,700	304,000	305,200	306,400	307,700
LINCE	84,800	85,878	84,660	83,600	83,500	83,300	83,200	83,100	82,900	82,800	82,700	82,500	82,400	82,300	82,100
LURIGANCHO-CHOSICA	33,500	53,229	68,542	85,800	88,300	90,800	93,400	96,000	98,800	101,600	104,500	107,500	110,500	113,700	116,900
LURIN	6,400	13,259	18,104	23,900	24,700	25,600	26,500	27,400	28,400	29,400	30,400	31,500	32,600	33,800	34,900
MAGDALENA DEL MAR	57,400	58,816	58,437	58,100	58,100	58,000	58,000	57,900	57,900	57,900	57,800	57,800	57,700	57,700	57,600
PUEBLO LIBRE	70,600	80,864	88,374	95,600	96,600	97,500	98,500	99,500	100,500	101,500	102,500	103,500	104,500	105,600	106,600
MIRAFLORES	91,100	103,235	108,859	114,100	114,800	115,500	116,200	116,800	117,500	118,200	118,900	119,600	120,300	121,000	121,800
PACHACAMAC	12,100	4,705	7,134	10,300	10,800	11,300	11,900	12,400	13,000	13,600	14,300	15,000	15,700	16,400	17,200
PUCUSANA	1,800	2,941	4,319	6,100	6,300	6,600	6,900	7,200	7,500	7,900	8,200	8,600	8,900	9,300	9,700
PUENTE PIEDRA	8,600	19,616	35,694	60,800	65,000	69,400	74,200	79,300	84,700	90,600	96,800	103,500	110,600	118,200	126,300
PUNTA HERMOSA	300	940	1,063	1,200	1,200	1,200	1,200	1,300	1,300	1,300	1,300	1,300	1,300	1,400	1,400
PUNTA NEGRA	400	768	582	500	400	400	400	400	400	400	400	400	300	300	300
RIMAC	148,600	178,538	194,123	209,100	211,100	213,000	215,000	217,000	219,100	221,100	223,200	225,300	227,400	229,500	231,600
SAN BARTOLO 1/	1,000	1,518	3,067	4,800	5,100	5,400	5,700	6,000	6,400	6,700	7,100	7,500	8,000	8,400	8,900
SAN BORJA	53,600	68,862	59,270	51,900	51,000	50,200	49,300	48,500	47,700	46,900	46,200	45,400	44,600	43,900	43,200
SAN ISIDRO	39,000	65,513	72,706	79,800	80,700	81,600	82,600	83,500	84,500	85,500	86,500	87,500	88,500	89,500	90,600
S.J. DE LURIGANCHO	23,300	90,393	272,943	728,900	824,200	931,800	1,053,600	1,191,200	1,346,800	1,522,800	1,721,700	1,946,700	2,201,000	2,488,500	2,813,700
S.J. DE MIRAFLORES	64,000	110,833	174,426	261,000	274,500	288,700	303,600	319,300	335,800	353,200	371,400	390,600	410,800	432,000	454,300
SAN LUIS	8,600	25,072	53,306	104,200	113,300	123,200	134,000	145,700	158,500	172,300	187,400	203,800	221,600	241,000	262,000
SAN MARTIN DE PORRES	99,900	239,973	426,010	709,500	756,300	806,100	859,100	915,700	976,000	1,040,300	1,108,800	1,181,800	1,259,600	1,342,600	1,431,000
SAN MIGUEL	23,900	65,559	104,405	157,900	166,300	175,100	184,400	194,200	204,500	215,300	226,700	238,800	251,400	264,800	278,800
SANTA MARIA DEL MAR 1/	100	46	101	100	100	100	100	100	100	100	100	100	100	100	100
SANTA ROSA 1/	100	226	518	1,000	1,100	1,200	1,300	1,400	1,500	1,600	1,800	1,900	2,100	2,300	2,500
SANTIAGO DE SURCO 1/	46,600	69,817	147,105	233,000	246,800	261,400	276,800	293,200	310,600	328,900	348,400	369,000	390,800	413,900	438,400
SURQUILLO 1/	23,500	29,792	98,269	174,200	187,100	201,000	215,900	231,900	249,100	267,500	287,400	308,700	331,600	356,100	382,600
VILLA EL SALVADOR 2/	-	-	142,567	251,000	267,000	284,100	302,200	321,500	342,100	363,900	387,200	411,900	438,200	466,200	495,900
V.M. DEL TRIUNFO 2/	94,800	188,115	187,878	306,300	323,000	340,600	359,200	378,800	399,500	421,300	444,300	468,600	494,200	521,100	549,600
TOTAL (PROV. LIMA)	2,125,600	3,091,731	4,382,200	6,281,200	6,605,300	6,955,200	7,334,900	7,745,800	8,192,900	8,678,300	9,206,900	9,783,200	10,410,800	11,097,500	11,848,000
CALLAO	124,600	205,631	270,499	345,200	355,800	366,800	378,200	389,900	401,900	414,400	427,200	440,400	454,000	468,100	482,600
BELLAVISTA 1/	44,300	41,239	69,148	82,600	84,500	86,400	88,300	90,300	92,400	94,400	96,600	98,700	101,000	103,200	105,600
CARMEN DE LA LEGUA	18,300	26,977	39,498	55,400	57,800	60,300	62,900	65,700	68,500	71,500	74,600	77,800	81,200	84,700	88,300
LA PERLA	22,000	34,627	48,362	65,100	67,500	70,100	72,800	75,500	78,400	81,300	84,400	87,600	90,900	94,300	97,900
LA PUNTA	6,100	6,916	6,416	6,000	6,000	5,900	5,900	5,800	5,800	5,700	5,700	5,600	5,600	5,500	5,500
VENTANILLA	17,200	17,341	20,177	23,100	23,500	23,900	24,300	24,700	25,100	25,500	26,000	26,400	26,900	27,300	27,800
TOTAL (PROV. CALLAO)	232,500	332,731	454,100	577,400	595,100	613,400	632,400	651,900	672,100	692,800	714,500	736,500	759,600	783,100	807,700
TOTAL (METRO. LIMA)	2,358,100	3,424,462	4,836,300	6,858,600	7,200,400	7,568,600	7,967,300	8,397,700	8,865,000	9,371,100	9,921,400	10,519,700	11,170,400	11,880,600	12,655,700

Note: 1/ Population data in 1961 and 1981 are used to calculate growth rate to avoid too high growth rate.
2/ Population data in 1989 and 1990 are quoted from the estimated population by INE. Growth rate is calculated from those data.

APPENDIX 7

REULTS OF SEWAGE FLOW MEASUREMENT

TABLE A7-1 RESULTS OF SEWAGE FLOW MEASUREMENT (SURCO OUTFALL)

unit : cu.m/sec.

MEASURING TIME	May 31 - June 1 , 1989					October 19-20, 1989				
hh : mm	SURCO	CIRCUN.	B.SUR	TOTAL Q	RATE	SURCO	CIRCUN.	B.SUR	TOTAL Q	RATE
10 : 00	4.744	1.358	0.284	6.386	1.189	4.395	1.562	0.289	6.246	1.258
10 : 15	4.791	1.358	0.280	6.428	1.197	4.413	1.578	0.289	6.281	1.265
10 : 30	4.726	1.454	0.276	6.456	1.202	4.413	1.443	0.286	6.141	1.237
10 : 45	4.929	1.345	0.295	6.569	1.223	4.432	1.462	0.286	6.180	1.245
11 : 00	4.855	1.382	0.305	6.542	1.218	4.413	1.457	0.289	6.159	1.240
11 : 15	4.827	1.321	0.304	6.452	1.201	4.422	1.440	0.296	6.159	1.240
11 : 30	4.754	1.269	0.289	6.312	1.175	4.477	1.380	0.288	6.145	1.238
11 : 45	4.901	1.269	0.280	6.450	1.201	4.349	1.372	0.281	6.002	1.209
12 : 00	4.837	1.338	0.273	6.447	1.200	4.331	1.380	0.283	5.993	1.207
12 : 15	4.763	1.294	0.276	6.332	1.179	4.358	1.365	0.278	6.001	1.209
12 : 30	4.837	1.276	0.275	6.387	1.189	4.331	1.360	0.282	5.973	1.203
12 : 45	4.869	1.276	0.271	6.357	1.193	4.340	1.343	0.280	5.963	1.201
13 : 00	4.809	1.251	0.280	6.340	1.180	4.303	1.331	0.278	5.912	1.191
13 : 15	4.818	1.251	0.275	6.344	1.181	4.349	1.321	0.280	5.949	1.198
13 : 30	4.763	1.246	0.271	6.281	1.169	4.340	1.303	0.282	5.925	1.193
13 : 45	4.781	1.271	0.269	6.322	1.177	4.303	1.289	0.277	5.869	1.182
14 : 00	4.661	1.219	0.268	6.149	1.145	4.322	1.276	0.276	5.874	1.183
14 : 15	4.625	1.219	0.265	6.108	1.137	4.303	1.299	0.272	5.874	1.183
14 : 30	4.763	1.222	0.260	6.245	1.162	4.258	1.331	0.263	5.851	1.178
14 : 45	4.680	1.227	0.256	6.163	1.147	4.267	1.274	0.262	5.803	1.169
15 : 00	4.717	1.227	0.253	6.197	1.154	4.312	1.256	0.262	5.831	1.174
15 : 15	4.698	1.246	0.248	6.193	1.153	4.276	1.254	0.262	5.791	1.166
15 : 30	4.689	1.246	0.241	6.177	1.150	4.276	1.234	0.260	5.770	1.162
15 : 45	4.689	1.271	0.251	6.212	1.156	4.267	1.202	0.260	5.729	1.154
16 : 00	4.708	1.271	0.260	6.238	1.161	4.230	1.189	0.254	5.673	1.143
16 : 15	4.579	1.214	0.248	6.041	1.124	4.249	1.177	0.251	5.677	1.143
16 : 30	4.597	1.214	0.242	6.053	1.127	4.212	1.169	0.249	5.631	1.134
16 : 45	4.597	1.209	0.234	6.040	1.124	4.212	1.179	0.242	5.634	1.135
17 : 00	4.597	1.209	0.228	6.034	1.123	4.139	1.172	0.249	5.560	1.120
17 : 15	4.615	1.174	0.225	6.014	1.120	4.185	1.187	0.240	5.611	1.130
17 : 30	4.615	1.179	0.221	6.016	1.120	4.157	1.199	0.233	5.590	1.126
17 : 45	4.579	1.202	0.207	5.938	1.115	4.076	1.189	0.233	5.498	1.107
18 : 00	4.533	1.202	0.209	5.943	1.106	4.166	1.187	0.218	5.571	1.122
18 : 15	4.487	1.259	0.205	5.951	1.108	4.176	1.182	0.210	5.568	1.121
18 : 30	4.432	1.259	0.200	5.891	1.097	4.203	1.119	0.209	5.531	1.114
18 : 45	4.413	1.174	0.195	5.782	1.076	4.103	1.132	0.209	5.443	1.096
19 : 00	4.349	1.174	0.186	5.709	1.063	4.076	1.149	0.210	5.434	1.094
19 : 15	4.358	1.129	0.176	5.664	1.054	4.076	1.147	0.211	5.433	1.094
19 : 30	4.377	1.129	0.178	5.684	1.058	4.030	1.137	0.199	5.366	1.081
19 : 45	4.377	1.134	0.173	5.683	1.058	4.012	1.092	0.186	5.290	1.065
20 : 00	4.386	1.147	0.167	5.699	1.061	3.958	1.104	0.176	5.238	1.055
20 : 15	4.230	1.149	0.162	5.541	1.031	3.877	1.099	0.174	5.150	1.037
20 : 30	4.267	1.149	0.160	5.576	1.038	3.716	1.109	0.157	4.982	1.003
20 : 45	4.258	1.134	0.155	5.546	1.032	3.609	1.104	0.153	4.867	0.980
21 : 00	4.249	1.134	0.151	5.534	1.030	3.689	1.082	0.157	4.928	0.992
21 : 15	4.285	1.139	0.142	5.566	1.036	3.645	1.089	0.144	4.878	0.982
21 : 30	4.285	1.142	0.140	5.567	1.036	3.600	1.092	0.142	4.834	0.973
21 : 45	4.139	1.137	0.138	5.414	1.008	3.662	1.077	0.144	4.883	0.983

TABLE A7-1 (Cont'd)

22 : 00	4.194	1.137	0.133	5.464	1.017	3.689	1.072	0.138	4.899	0.986
22 : 15	4.112	1.112	0.130	5.354	0.997	3.609	1.062	0.136	4.807	0.968
22 : 30	4.103	1.114	0.128	5.345	0.995	3.494	1.054	0.122	4.671	0.941
22 : 45	4.003	1.087	0.125	5.215	0.971	3.512	1.015	0.114	4.641	0.935
23 : 00	3.967	1.089	0.120	5.176	0.963	3.530	1.027	0.113	4.670	0.940
23 : 15	3.943	0.923	0.116	4.979	0.927	3.468	1.012	0.133	4.613	0.929
23 : 30	3.958	0.911	0.107	4.976	0.926	3.433	0.965	0.124	4.522	0.911
23 : 45	3.850	1.034	0.108	4.992	0.929	3.416	0.938	0.116	4.470	0.900
0 : 00	3.850	1.034	0.107	4.991	0.929	3.225	0.946	0.109	4.279	0.862
0 : 15	3.671	1.027	0.113	4.811	0.896	3.199	0.919	0.103	4.221	0.850
0 : 30	3.707	1.030	0.109	4.845	0.902	3.096	0.921	0.093	4.110	0.828
0 : 45	3.680	0.865	0.107	4.652	0.866	2.994	0.916	0.093	4.003	0.806
1 : 00	3.320	0.868	0.105	4.292	0.799	2.894	0.950	0.086	3.930	0.791
1 : 15	3.096	0.906	0.101	4.103	0.764	2.827	0.938	0.085	3.850	0.775
1 : 30	3.045	0.909	0.098	4.052	0.754	2.671	0.955	0.086	3.712	0.747
1 : 45	3.011	0.911	0.095	4.018	0.748	2.638	0.978	0.080	3.696	0.744
2 : 00	3.020	0.911	0.091	4.022	0.749	2.566	0.985	0.080	3.631	0.731
2 : 15	2.894	0.909	0.088	3.890	0.724	2.518	0.987	0.079	3.584	0.722
2 : 30	2.827	0.909	0.087	3.823	0.711	2.518	1.000	0.076	3.594	0.724
2 : 45	2.794	0.911	0.086	3.792	0.706	2.486	0.997	0.078	3.561	0.717
3 : 00	2.769	0.911	0.084	3.765	0.701	2.446	0.955	0.077	3.478	0.700
3 : 15	2.835	0.916	0.082	3.833	0.713	2.534	0.894	0.078	3.506	0.706
3 : 30	2.844	0.921	0.083	3.848	0.716	2.438	0.841	0.078	3.357	0.676
3 : 45	2.827	0.916	0.086	3.830	0.713	2.391	0.846	0.087	3.324	0.669
4 : 00	2.794	0.914	0.088	3.795	0.706	2.367	0.846	0.085	3.298	0.664
4 : 15	2.827	0.839	0.091	3.756	0.699	2.391	0.841	0.082	3.314	0.667
4 : 30	2.852	0.839	0.088	3.778	0.703	2.313	0.848	0.079	3.240	0.652
4 : 45	2.860	0.884	0.089	3.834	0.713	2.383	0.843	0.076	3.302	0.665
5 : 00	2.978	0.887	0.091	3.955	0.736	2.367	0.875	0.079	3.321	0.669
5 : 15	2.877	0.887	0.088	3.852	0.717	2.415	0.877	0.078	3.370	0.678
5 : 30	2.860	0.889	0.091	3.841	0.715	2.462	0.872	0.077	3.411	0.687
5 : 45	2.894	0.923	0.094	3.911	0.728	2.478	0.904	0.083	3.465	0.698
6 : 00	2.919	0.923	0.097	3.939	0.733	2.526	0.911	0.082	3.519	0.708
6 : 15	2.994	0.941	0.094	4.029	0.750	2.510	0.990	0.086	3.586	0.722
6 : 30	3.020	0.941	0.094	4.054	0.755	2.502	1.005	0.083	3.590	0.723
6 : 45	3.164	1.005	0.095	4.264	0.794	2.728	1.097	0.087	3.912	0.788
7 : 00	3.302	1.097	0.099	4.498	0.837	2.844	1.132	0.088	4.063	0.818
7 : 15	3.451	1.092	0.107	4.649	0.865	3.096	1.194	0.109	4.399	0.886
7 : 30	3.716	1.236	0.120	5.072	0.944	3.294	1.259	0.129	4.682	0.943
7 : 45	4.048	1.239	0.133	5.421	1.009	3.662	1.316	0.163	5.141	1.035
8 : 00	4.285	1.271	0.158	5.714	1.064	3.877	1.353	0.185	5.415	1.090
8 : 15	4.413	1.345	0.176	5.935	1.105	4.121	1.411	0.228	5.761	1.160
8 : 30	4.523	1.353	0.192	6.068	1.130	4.249	1.474	0.244	5.966	1.201
8 : 45	4.579	1.387	0.222	6.187	1.152	4.249	1.562	0.275	6.085	1.226
9 : 00	4.837	1.454	0.248	6.539	1.217	4.258	1.581	0.280	6.118	1.232
9 : 15	4.883	1.387	0.287	6.557	1.221	4.276	1.583	0.288	6.147	1.238
9 : 30	4.652	1.384	0.293	6.330	1.178	4.331	1.608	0.289	6.227	1.254
9 : 45	4.744	1.392	0.290	6.426	1.196	4.422	1.612	0.290	6.324	1.274
10 : 00	4.744	1.358	0.284	6.386	1.189	4.395	1.562	0.289	6.246	1.258
MAXIMUM Qmax	4.929	1.454	0.305	6.569	1.223	4.477	1.612	0.296	6.324	1.274
AVERAGE Qave	4.058	1.134	0.178	5.370	1	3.625	1.157	0.181	4.963	1
MINIMUM Qmin	2.769	0.839	0.082	3.756	0.699	2.313	0.841	0.076	3.240	0.652

Location of Measuring Point, and Measuring Date and Time

1. Surco : Colector Surco, Diameter 1.54 meters

TABLE A7-1 (Cont'd)

Av. JR Mexico 270, Surquillo
1st : from 10:00, May 31 to 10:00, June 1, 1989
2nd : from 8:45, October 19 to 8:30, October 20, 1989

2. Circun. : Colector Circunvalacion, Diameter 1.31 meters
Av. Julio Calero 140, Surquillo
1st : from 10:30, May 31 to 10:30, June 1, 1989
2nd : from 8:45, October 19 to 8:30, October 20, 1989

3. B. Sur : Colector Balnearios del Sur, Diameter 0.75 meters
Av. Daniel Portocarrero 264, Surquillo
1st : from 10:30, May 31 to 10:30, June 1, 1989
2nd : from 8:45, October 19 to 8:30, October 20, 1989

TABLE A7-2 RESULTS OF SEWAGE FLOW MEASUREMENT

unit : cu.m/sec.

MEASURING TIME	Intake Point No.1 Circunvalacion				Intake Point No.2 Villa Maria				Intake Point No.3 Surco			
	6/06-07		10/24-25		6/06-07		10/24-25		6/06-07		10/24-25	
hh : mm	FLOW	RATE	FLOW	RATE	FLOW	RATE	FLOW	RATE	FLOW	RATE	FLOW	RATE
10 : 00	0.4865	1.33	0.5373	1.26	0.1367	1.13	0.0684	1.40	3.1817	1.15	3.1026	1.20
10 : 15	0.4668	1.28	0.5478	1.29	0.1379	1.14	0.0670	1.37	3.2643	1.18	3.0919	1.20
10 : 30	0.4194	1.15	0.5270	1.24	0.1356	1.12	0.0725	1.49	3.3469	1.21	3.0919	1.20
10 : 45	0.4965	1.36	0.5373	1.26	0.1312	1.08	0.0670	1.37	3.3163	1.20	3.1026	1.20
11 : 00	0.4476	1.23	0.5116	1.20	0.1323	1.09	0.0725	1.49	3.0973	1.12	3.1026	1.20
11 : 15	0.5690	1.56	0.5270	1.24	0.1142	0.94	0.0591	1.21	3.0973	1.12	2.9848	1.15
11 : 30	0.2443	0.67	0.5116	1.20	0.0983	0.81	0.0617	1.26	3.2027	1.15	2.9361	1.14
11 : 45	0.3488	0.96	0.5531	1.30	0.1152	0.95	0.0591	1.21	3.2027	1.15	3.0439	1.18
12 : 00	0.4287	1.18	0.5270	1.24	0.1163	0.96	0.0554	1.13	3.2079	1.16	3.1185	1.21
12 : 15	0.4381	1.20	0.5116	1.20	0.1183	0.97	0.0630	1.29	3.2443	1.17	3.0919	1.20
12 : 30	0.4865	1.33	0.5531	1.30	0.1081	0.89	0.0542	1.11	3.1765	1.15	3.0439	1.18
12 : 45	0.4766	1.31	0.5637	1.32	0.1091	0.90	0.0604	1.24	3.2702	1.18	3.0385	1.17
13 : 00	0.4523	1.24	0.5270	1.24	0.1215	1.00	0.0554	1.13	3.1660	1.14	2.9686	1.15
13 : 15	0.4381	1.20	0.5531	1.30	0.0983	0.81	0.0518	1.06	3.2753	1.18	2.9902	1.16
13 : 30	0.4865	1.33	0.5531	1.30	0.1031	0.85	0.0460	0.94	3.1660	1.14	3.0385	1.17
13 : 45	0.5167	1.42	0.5270	1.24	0.1022	0.84	0.0405	0.83	3.2443	1.17	3.0706	1.19
14 : 00	0.4381	1.20	0.5690	1.34	0.1071	0.88	0.0427	0.87	3.1660	1.14	3.0813	1.19
14 : 15	0.4103	1.12	0.5690	1.34	0.0983	0.81	0.0416	0.85	3.1555	1.14	3.0063	1.16
14 : 30	0.3745	1.03	0.5637	1.32	0.1002	0.82	0.0405	0.83	3.1396	1.13	3.0063	1.16
14 : 45	0.3404	0.93	0.5321	1.25	0.1012	0.83	0.0482	0.99	3.1449	1.13	3.0171	1.17
15 : 00	0.4381	1.20	0.5321	1.25	0.1031	0.85	0.0344	0.70	3.2027	1.15	2.9848	1.15
15 : 15	0.5167	1.42	0.5373	1.26	0.1041	0.86	0.0374	0.77	3.1555	1.14	3.0063	1.16
15 : 30	0.4766	1.31	0.5116	1.20	0.0983	0.81	0.0335	0.68	3.1291	1.13	3.0919	1.20
15 : 45	0.4766	1.31	0.4815	1.13	0.1012	0.83	0.0354	0.72	2.9794	1.07	3.0332	1.17
16 : 00	0.4572	1.25	0.4815	1.13	0.1002	0.82	0.0364	0.74	3.0439	1.10	2.9577	1.14
16 : 15	0.4381	1.20	0.5270	1.24	0.1091	0.90	0.0316	0.64	3.0706	1.11	2.9469	1.14
16 : 30	0.4766	1.31	0.5270	1.24	0.1142	0.94	0.0364	0.74	2.8817	1.04	2.9577	1.14
16 : 45	0.4915	1.35	0.5065	1.19	0.1101	0.91	0.0364	0.74	2.7721	1.00	2.9523	1.14
17 : 00	0.4287	1.18	0.5116	1.20	0.1091	0.90	0.0354	0.72	2.9361	1.06	2.9577	1.14
17 : 15	0.3922	1.07	0.5270	1.24	0.1061	0.87	0.0271	0.55	3.0706	1.11	2.8980	1.12
17 : 30	0.4381	1.20	0.5270	1.24	0.1051	0.86	0.0316	0.64	3.1079	1.12	2.7446	1.06
17 : 45	0.4668	1.28	0.5116	1.20	0.1031	0.85	0.0471	0.96	3.0760	1.11	2.7391	1.06
18 : 00	0.4381	1.20	0.5116	1.20	0.1081	0.89	0.0604	1.24	3.0385	1.10	2.7335	1.06
18 : 15	0.4287	1.18	0.4523	1.06	0.1132	0.93	0.0591	1.21	3.0332	1.09	2.7115	1.05
18 : 30	0.4012	1.10	0.4572	1.07	0.1041	0.86	0.0542	1.11	2.9955	1.08	2.6949	1.04
18 : 45	0.3404	0.93	0.4766	1.12	0.1121	0.92	0.0506	1.04	3.0063	1.08	2.7391	1.06
19 : 00	0.3702	1.01	0.4815	1.13	0.1204	0.99	0.0542	1.11	2.7721	1.00	2.8489	1.10
19 : 15	0.3745	1.03	0.4334	1.02	0.1081	0.89	0.0579	1.19	2.7721	1.00	2.8215	1.09
19 : 30	0.3789	1.04	0.4381	1.03	0.1121	0.92	0.0566	1.16	2.8434	1.02	2.7391	1.06
19 : 45	0.3833	1.05	0.4334	1.02	0.1121	0.92	0.0542	1.11	2.8434	1.02	2.6894	1.04
20 : 00	0.3922	1.07	0.4334	1.02	0.1132	0.93	0.0617	1.26	2.8380	1.02	2.7004	1.04
20 : 15	0.3615	0.99	0.4381	1.03	0.1163	0.96	0.0657	1.35	2.8980	1.04	2.6673	1.03
20 : 30	0.3404	0.93	0.4523	1.06	0.1204	0.99	0.0630	1.29	2.8980	1.04	2.4841	0.96
20 : 45	0.3001	0.82	0.4334	1.02	0.1236	1.02	0.0697	1.43	2.8106	1.01	2.5008	0.97
21 : 00	0.2696	0.74	0.4668	1.10	0.1226	1.01	0.0670	1.37	2.7996	1.01	2.5119	0.97
21 : 15	0.2270	0.62	0.4194	0.98	0.1183	0.97	0.0670	1.37	2.7721	1.00	2.4953	0.96

TABLE A7-2 (Cont'd)

21 : 30	0.2103	0.57	0.4057	0.95	0.1091	0.90	0.0697	1.43	2.7721 1.00	2.5342 0.98
21 : 45	0.2622	0.72	0.3877	0.91	0.1132	0.93	0.0670	1.37	2.7115 0.98	2.5119 0.97
22 : 00	0.2808	0.77	0.4194	0.98	0.1121	0.92	0.0617	1.26	2.7060 0.98	2.4841 0.96
22 : 15	0.2622	0.72	0.3922	0.92	0.1121	0.92	0.0566	1.16	2.7666 1.00	2.5175 0.97
22 : 30	0.2808	0.77	0.3922	0.92	0.1132	0.93	0.0579	1.19	2.7611 1.00	2.3285 0.90
22 : 45	0.2006	0.55	0.3745	0.88	0.1121	0.92	0.0518	1.06	2.7060 0.98	2.2120 0.85
23 : 00	0.1501	0.41	0.3789	0.89	0.1101	0.91	0.0449	0.92	2.7170 0.98	2.2287 0.86
23 : 15	0.1529	0.42	0.3573	0.84	0.1111	0.91	0.0374	0.77	2.7721 1.00	2.2952 0.89
23 : 30	0.1789	0.49	0.3615	0.85	0.1121	0.92	0.0344	0.70	2.7115 0.98	2.2730 0.88
23 : 45	0.2006	0.55	0.3199	0.75	0.1091	0.90	0.0325	0.66	2.6063 0.94	2.4063 0.93
0 : 00	0.2771	0.76	0.3199	0.75	0.1111	0.91	0.0307	0.63	2.6063 0.94	2.4230 0.94
0 : 15	0.2550	0.70	0.2733	0.64	0.1091	0.90	0.0344	0.70	2.5952 0.93	2.2896 0.88
0 : 30	0.2443	0.67	0.2923	0.68	0.1081	0.89	0.0325	0.66	2.5397 0.91	2.1512 0.83
0 : 45	0.2478	0.68	0.2923	0.68	0.1111	0.91	0.0307	0.63	2.4563 0.88	2.1347 0.82
1 : 00	0.2550	0.70	0.3404	0.80	0.1132	0.93	0.0289	0.59	2.4063 0.87	2.1954 0.85
1 : 15	0.1943	0.53	0.3488	0.82	0.1142	0.94	0.0254	0.52	2.3285 0.84	2.2176 0.86
1 : 30	0.2006	0.55	0.3446	0.81	0.0983	0.81	0.0280	0.57	2.3285 0.84	2.1789 0.84
1 : 45	0.1881	0.51	0.2622	0.61	0.1002	0.82	0.0230	0.47	2.3452 0.84	2.2120 0.85
2 : 00	0.1789	0.49	0.2622	0.61	0.1022	0.84	0.0246	0.50	2.2065 0.79	2.2231 0.86
2 : 15	0.2550	0.70	0.2659	0.62	0.1002	0.82	0.0230	0.47	2.2176 0.80	2.2508 0.87
2 : 30	0.3363	0.92	0.2478	0.58	0.1031	0.85	0.0246	0.50	2.1678 0.78	2.2674 0.88
2 : 45	0.2443	0.67	0.2478	0.58	0.1002	0.82	0.0222	0.45	2.1512 0.77	2.2342 0.86
3 : 00	0.1912	0.52	0.2338	0.55	0.1002	0.82	0.0222	0.45	2.1678 0.78	2.1016 0.81
3 : 15	0.2846	0.78	0.2338	0.55	0.1031	0.85	0.0222	0.45	2.0961 0.75	1.7972 0.69
3 : 30	0.2622	0.72	0.2478	0.58	0.1081	0.89	0.0271	0.55	2.1071 0.76	1.7120 0.66
3 : 45	0.2696	0.74	0.2338	0.55	0.1142	0.94	0.0246	0.50	2.1071 0.76	1.5138 0.58
4 : 00	0.3615	0.99	0.2270	0.53	0.0983	0.81	0.0271	0.55	1.5292 0.55	1.5292 0.59
4 : 15	0.2771	0.76	0.2304	0.54	0.1061	0.87	0.0238	0.48	1.5189 0.55	1.5757 0.61
4 : 30	0.2202	0.60	0.2338	0.55	0.0993	0.82	0.0230	0.47	1.6330 0.59	1.6017 0.62
4 : 45	0.2103	0.57	0.2478	0.58	0.0936	0.77	0.0271	0.55	2.1512 0.77	1.6697 0.64
5 : 00	0.2270	0.62	0.2478	0.58	0.0964	0.79	0.0254	0.52	2.0851 0.75	1.7067 0.66
5 : 15	0.2478	0.68	0.2270	0.53	0.0945	0.78	0.0280	0.57	2.1071 0.76	1.7651 0.68
5 : 30	0.2622	0.72	0.2006	0.47	0.0964	0.79	0.0298	0.61	2.1512 0.77	1.7332 0.67
5 : 45	0.2923	0.80	0.2103	0.49	0.1081	0.89	0.0335	0.68	2.1399 0.79	1.8671 0.72
6 : 00	0.3001	0.82	0.2550	0.60	0.1101	0.91	0.0374	0.77	2.1899 0.79	1.9593 0.76
6 : 15	0.3079	0.84	0.2733	0.64	0.1194	0.98	0.0591	1.21	2.2065 0.79	1.9811 0.76
6 : 30	0.3159	0.86	0.2696	0.63	0.1290	1.06	0.0657	1.35	2.2508 0.81	2.1182 0.82
6 : 45	0.3001	0.82	0.3001	0.70	0.1952	1.61	0.0643	1.32	2.2896 0.82	2.1182 0.82
7 : 00	0.3001	0.82	0.3530	0.83	0.1952	1.61	0.0684	1.40	2.3618 0.85	2.2342 0.86
7 : 15	0.3922	1.07	0.3833	0.90	0.2018	1.66	0.0711	1.46	2.5730 0.93	2.4508 0.95
7 : 30	0.4766	1.31	0.4766	1.12	0.2085	1.72	0.0754	1.55	2.6617 0.96	2.6396 1.02
7 : 45	0.5015	1.38	0.4865	1.14	0.2153	1.78	0.0812	1.67	2.8817 1.04	2.7225 1.05
8 : 00	0.5270	1.45	0.5270	1.24	0.2181	1.80	0.0827	1.70	2.9577 1.07	2.8215 1.09
8 : 15	0.5531	1.52	0.5531	1.30	0.2222	1.83	0.0827	1.70	3.0760 1.11	2.9686 1.15
8 : 30	0.5961	1.64	0.5961	1.40	0.2045	1.69	0.0827	1.70	3.2339 1.17	2.9848 1.15
8 : 45	0.5798	1.59	0.5373	1.26	0.2085	1.72	0.0711	1.46	3.2339 1.17	3.0278 1.17
9 : 00	0.5744	1.58	0.6693	1.57	0.1822	1.50	0.0711	1.46	3.2391 1.17	3.1344 1.21
9 : 15	0.5906	1.62	0.5798	1.36	0.1599	1.32	0.0697	1.43	3.2443 1.17	3.1132 1.20
9 : 30	0.6071	1.67	0.5426	1.27	0.1345	1.11	0.0697	1.43	3.2235 1.16	3.1291 1.21
9 : 45	0.5167	1.42	0.5584	1.31	0.1447	1.19	0.0670	1.37	3.2026 1.15	3.1239 1.21
10 : 00	0.4865	1.33	0.5373	1.26	0.1367	1.13	0.0684	1.40	3.1817 1.15	3.1026 1.20
MAXIMUM Qmax	0.6071	1.67	0.6693	1.57	0.2222	1.83	0.0827	1.70	3.3469 1.21	3.1344 1.21
AVERAGE Qave	0.3632	1	0.4243	1	0.1209	1	0.0486	1	2.7611 1	2.5751 1
MINIMUM Qmin	0.1501	0.41	0.2006	0.47	0.0936	0.77	0.0222	0.45	1.5189 0.55	1.5138 0.58

TABLE A7-2 (Cont'd)

Location of Measuring Point, and Measuring Date and Time

1. Diversion Pt. No.1 : Colector Circunvalacion, Diameter 1.3 meters
   Parque Fundadores, Av. J. de Aliaga, Santiago de Surco
   1st : from 10:45, June 6 to 10:30, June 7, 1989
   2nd : from 9:45, October 24 to 9:30, October 25, 1989
2. Diversion Pt. No.2 : Colector Emisor Villa Maria del Triunfo
   1st : Av. Pachacutec 828, Diamater 1.2 meters
   from 11:15, June 6 to 11:00, June 7, 1989
   2nd : Av. Pachacutec/Jose Carlos Mariategui, Dia. 0.632 meters
   from 9:30, October 24 to 9:15, October 25, 1989
3. Diversion Pt. No.3 : Colector Surco, Diameter 1.25 meters
   Av. Nueva Tomas Marsano/Jorge Chavez CDA 38
   1st : from 11:00, June 6 to 10:45, June 7, 1989
   (Data at 9:30, 9:45 and 10:15 are interpolated.)
   2nd : from 9:15, October 24 to 9:00, October 25, 1989

TABLE A7-3 **RESULTS OF FLOW MEASUREMENT (1988)**

CUADRO RESUMEN AFORO DE COLECTORES

EMISOR LA CHIRA

FEBRERO/MARZO 1988

COLECTORES: CIRCUNVALACION-BALNEARIOS DEL SUR-SURCO

	CIRCUNVALACION			BALNEARIOS DEL SUR			SURCO			TOTAL
DIA	Q prom. m3/s.	Q max. m3/s.	Q min. m3/s.	Q prom. m3/s.	Q max. m3/s.	Q min. m3/s.	Q prom. m3/s.	Q max. m3/s.	Q min. m3/s.	Q prom. m3/s.
Thr 25	1.097	1.471	0.711	0.161	0.226	0.090	3.406	4.103	2.307	4.664
Fri 26	1.086	1.328	0.771	0.149	0.203	0.102	3.261	4.012	2.391	4.496
Sat 27	1.156	1.461	0.949	0.156	0.227	0.095	3.420	4.606	2.379	4.732
Sun 28	1.029	1.194	0.834	0.150	0.182	0.104	3.346	4.094	2.311	4.525
Mon 29	1.109	1.497	0.839	0.218	0.369	0.121	3.591	4.551	2.328	4.914
Tue 1	1.104	1.502	0.844	0.209	0.345	0.101	3.597	4.358	2.606	4.910
Wed 2	1.125	1.464	0.844	0.234	0.357	0.105	3.809	4.772	2.728	5.168

GASTO PROMEDIO :

CIRCUNVALACION	1.100 m3/s.
BALNEARIOS DEL SUR	0.192 m3/s.
SURCO	3.490 m3/s.
GASTO PROMEDIO EMISOR LA CHIRA	4.772 m3/s.

ANALISIS DE GASTOS MAXIMOS Y MINIMOS CON GASTOS RECIPROCOS EN HORAS COINCIDENTES :

	CIRCUNVALACION		BALNEARIOS DEL SUR		SURCO	
	DIA/HORA	Q m3/s	DIA/HORA	Q m3/s	DIA/HORA	Q m3/s
MAXIMO	1/0.521	1.273	1/0.521	0.355	1/0.521	4.772
MINIMO	28/0.167	0.843	1	0.126	28/0.167	2.344

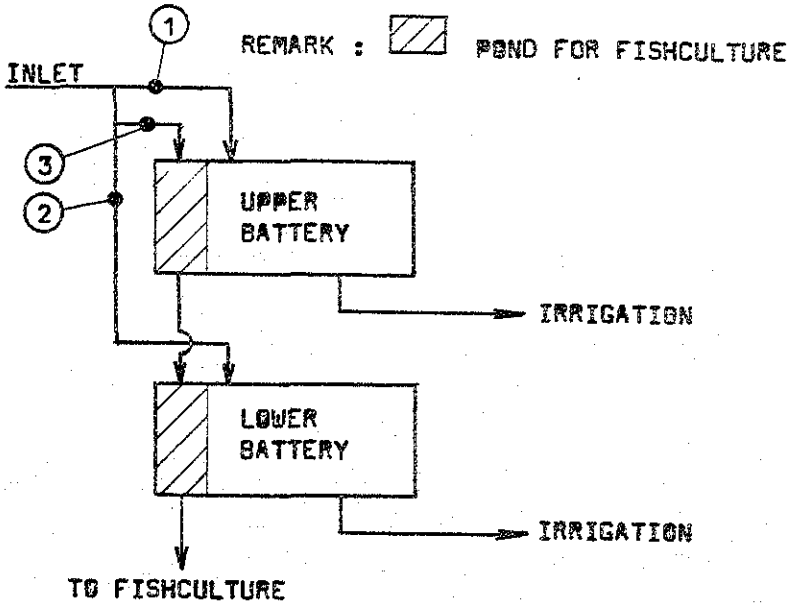
GASTO MAXIMO DIARIO ASUMIDO 6.400 m3/s

GASTO MINIMO DIARIO ASUMIDO 3.313 m3/s

GASTO PROMEDIO DIARIO 4.772 m3/s

TABLE A7-4 VARIATION OF INFLOW AMOUNT AT SAN JUAN STABILIZATION POND, JUNE. 1989.

HOUR	QUANTITY (cu.m/h)		
	① UPPER	② LOWER	TOTAL
6/20 11:00	590.4	579.6	1,170.0
12:00	572.4	558.0	1,130.4
13:00	576.0	507.6	1,083.6
14:00	568.8	514.8	1,083.6
15:00	561.6	529.2	1,090.8
16:00	604.8	604.8	1,209.6
17:00	684.0	583.2	1,267.2
18:00	669.6	482.4	1,152.0
19:00	662.4	478.8	1,141.2
20:00	655.2	496.8	1,152.0
21:00	637.2	489.6	1,126.8
22:00	633.6	424.8	1,058.4
23:00	615.6	435.6	1,051.2
24:00	601.2	432.0	1,033.2
6/21 1:00	550.8	367.2	918.0
2:00	525.6	352.8	878.4
3:00	536.4	356.4	892.8
4:00	522.0	345.6	867.6
5:00	615.6	349.2	964.8
6:00	716.4	363.6	1,080.0
7:00	828.0	381.6	1,209.6
8:00	871.2	381.6	1,252.8
9:00	763.2	378.0	1,141.2
10:00	640.8	374.4	1,015.2
MEAN VALUE	633.5	448.7	1,082.2



TOTAL INFLOW ;

① UPPER	15,204 cu.m/day
② LOWER	10,769 cu.m/day
SUB TOTAL	25,973 cu.m/day
③ FOR FISHCULTURE (AV.0.025 cu.m/s)	2,160 cu.m/day
TOTAL	28,133 cu.m/day

FIGURE A7-1 VARIATION OF SEWAGE INFLOW AT SAN JUAN STABILIZATION POND
JUNE, 1989

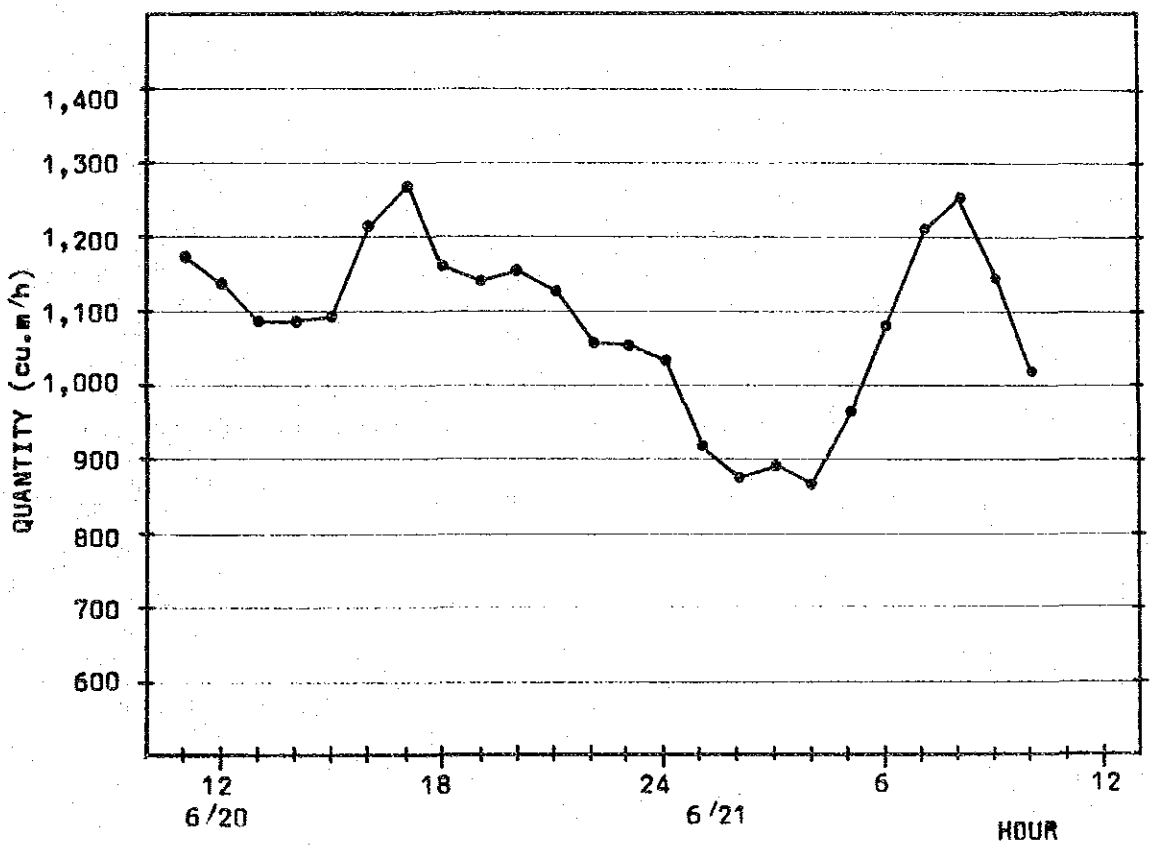
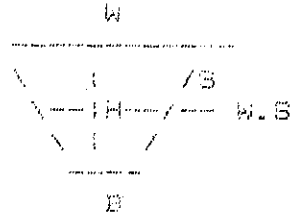


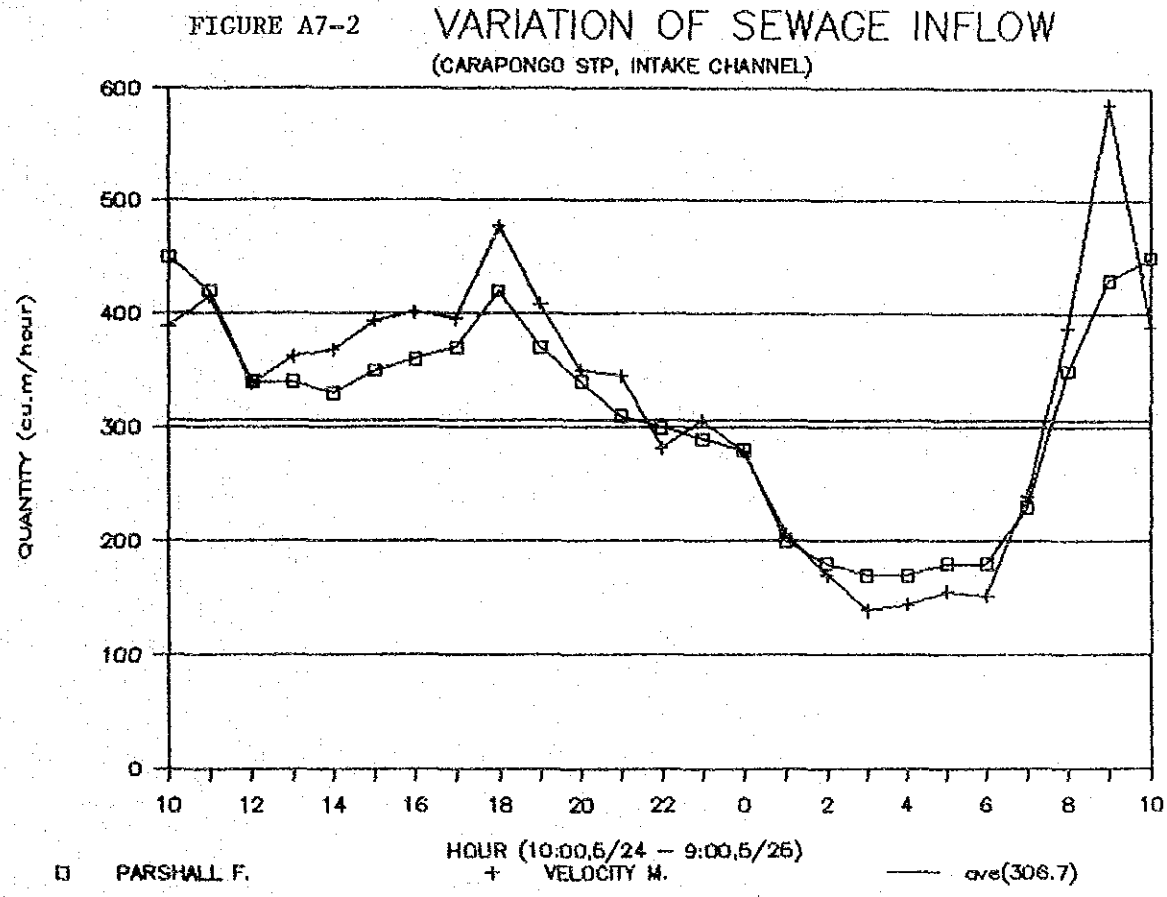
TABLE A7-5 . VARIATION OF INFLOW AMOUNT AT DARAPONGO STP

Upper width of channel (W) = 1,310 mm
Bottom width of channel (B) = 500 mm
Height of channel (H) = 820 mm



HOUR	PARSHALL FLUME		VELOCITY METER		
	INDICATION (x 10 cu.m/hour)	QUANTITY (cu.m/hour)	SLOPE LENGTH TO W.S.	VELOCITY (m/sec.)	QUANTITY (cu.m/h)
5/24 10:00	45	450	585	0.566	388.9
11:00	42	420	600	0.640	415.4
12:00	34	340	640	0.615	338.8
13:00	34	340	630	0.630	362.2
14:00	33	330	640	0.668	368.0
15:00	35	350	630	0.685	393.9
16:00	36	360	620	0.670	401.6
17:00	37	370	620	0.660	395.6
18:00	42	420	590	0.708	477.5
19:00	37	370	620	0.682	408.8
20:00	34	340	640	0.638	349.8
21:00	31	310	650	0.655	345.2
22:00	30	300	665	0.573	281.8
23:00	29	290	655	0.594	306.0
5/25 0:00	28	280	662	0.559	278.8
1:00	20	200	700	0.500	206.0
2:00	18	180	730	0.490	169.8
3:00	17	170	735	0.414	139.1
4:00	17	170	717	0.385	144.2
5:00	18	180	715	0.411	155.8
6:00	18	180	712	0.395	152.3
7:00	23	230	678	0.519	234.7
8:00	35	350	615	0.634	387.8
9:00	43	430	556	0.769	586.3
MEAN VALUE.	30.7	306.7	650	0.586	320.6
TOTAL (cu.m/day)		7,360.0			7,693.4

FIGURE A7-2 VARIATION OF SEWAGE INFLOW



APPENDIX 8

STUDY ON PER CAPITA SEWAGE QUANTITY

APPENDIX 8 STUDY ON PER CAPITA SEWAGE QUANTITY

The average per capita sewage discharge is estimated based on the area classification by use, and the projected population for the target year. The following data were considered for this calculation:

(1) Per capita sewage discharge based on design standard.
(2) Per capita sewage discharge based on supplied volume of drinking water.
(3) Per capita sewage discharge based on flow measurement results.

(1) Per capita sewage discharge based on Design Standard

The sewage discharge is set at 90% of the average consumption of supplied drinking water administered by SEDAPAL according to the design standard of SEDAPAL which is shown in TABLE A8-1.

TABLE A8-1 Per Capita Sewage Discharge Based on Design Standard

CATEGORY OF WATER CONSUMPTION TYPE	SUPPLIED WATER VOLUME/ CAPITA/DAY (lpcd)	PERCENTAGE OF WATER DISCHARGE	BASIC SEWAGE DISCHARGE/ CAPITA/DAY (lpcd)
D/S.H.	300	90 %	270
D/S.L.	250	90 %	225
I.D.	150	90 %	135

Note: The volume of supplied water and the rate of sewage discharge is based on the Design Standard of SEDAPAL.

(2) Per capita sewage discharge based on Volume of Supplied Water

Per capita sewage discharge can be determined from the actual volume of supplied drinking water. According to statistics of the Project Department of SEDAPAL, the actual volume of supplied water during the period from January to December of 1988 is as shown in TABLE A8-2.

TABLE A8-2 Volume of Actual Supplied Water

(m^3/year)	(m^3/year)	
645,440,000	346,777,000	53.73%

Source: Project Dept, SEDAPAL, 1988.

Given the amount of supplied water, the percentage of sold drinking water, and the percentage of discharge to the sewer system (90% of consumed drinking water), the per capita sewage discharge is determmined as shown in TABLE A8-3.

TABLE A8-3 Per Capita Sewage Discharge Based on Supplied Volume

CATEGORY OF WATER CONSUMPTION	SUPPLIED WATER/ CAPITA/DAY (lpcd)	SOLD PERCENTAGE	PERCENTAGE OF SEWAGE DISCHARGE	SEWAGE DISCHARGE/ CAPITA/DAY (lpcd)
D/S.H.	300	53.73 %	90 %	145
D/S.L.	250	53.73	90	120
I.D.	150	53.73	90	72

(3) Per Capita Sewage Discharge Based on Flow Measurement Results

Per capita sewage discharge based on flow measurement results will be calculated taking into account the following points in determining the actual discharge volume of domestic sewage.

a) Analysis of measured flow
b) Management of water of unknown origin

a) Analysis of measured flow

To calculate per capita sewage discharge from the analysis of measured flow, all factors in the production of sewage in the project area are con-

sidered. Measurement results are shown in TABLE A8-4.

TABLE A8-4 Flow Measurement

DATE OF MEASUREMENT	MEASURED FLOW (m^3/sec.)	REMARKS
May 31 - Jun. 1, 1989	5.370	JICA
Oct.19 - Oct.20, 1989	4.963	JICA
Feb.25 - Mar. 2, 1988	4.773	SEDAPAL
average	around 5.0	

(refer to APPENDIX 7)

The sewage quantity estimated from water supply amount is shown in TABLE A8-5.

TABLE A8-5 Volume of Sewage Discharge into Colector Surco

PRODUCTION VOLUME m^3/sec	% ADMIN. SOUTHERN DISTRICT	% ADMIN. SURCO DRAINAGE ZONE	% SOLD	% DIS-CHARGED	DRAINAGE m^3/sec
1)	2)	3)	4)	5)	6)
20.467	53.13	55.68	53.73	90	2.928

1) Annual Volume of Water Produced
645,440,000 m^3/year = 20.467 m^3/sec

2) Percentage supplied to Southern District

$$\frac{\text{Southern Dist.}}{\text{Total Admin.}} = \frac{9.17\ m^3/sec.}{17.26\ m^3/sec.} = 53.13\ \%$$

3) Percentage supplied to Surco drainage area

$$\frac{\text{Surco Drainage Area}}{\text{Vol. supplied to Surco Area}} = \frac{5.106\ m^3/sec.}{9.17\ m^3/sec.} = 55.68\ \%$$

4) Percentage sold (see TABLE A8-2)

5) Discharge: (referred to the Regulation and Design Standard of SEDAPAL)

The sewage in Colector Surco includes domestic sewage and industrial wastewater and that from unknown origin.

* Volume of domestic sewage: 2.928 - 0.323 m^3/sec = 2.605 m^3/sec.
* Industrial wastewater: 0.323 m^3/sec (see APPENDIX 3)
* Unknown water volume: 5.0 m^3/sec - 2.928 m^3/sec = 2.072 m^3/sec

From the aforementioned results, 2.072 m^3/sec or 41% of the total volume of sewage in Colector Surco is of unknown origin.

b) Management of Water of Unknown Origin

Investigation on the source of unknown water is possible up to a certain extent by analyzing the water quality, but because of lack of information and the peculiarity of land in large areas, it is very difficult to determine exactly the source of the wastewater. However, from the little information available, the following conclusions related to unknown water can be drawn:

1) Inaccuracy of the amount supplied because of defective water meter.
2) Direct flow into sewers from breaks in drinking water supply pipes.
3) Exact data on domestic consumption of well water are not available.
4) Intrusion of water from irrigation canal at many points.

For the above reasons and because of the fact that the percentage of water sold increased from 42.7 % in 1986 to 53.73 % in 1988, it is deemed appropriate to consider that a large part of the unknown water originates from domestic sewage.

In the future, water intrusion from irrigation canals would be eliminated and is therefore excluded from the subject of treatment. The volume categorized "Others" is considered as "volume produced by industrial activities of unknown sources", and given the same treatment as that for industrial wastewater.

Per capita domestic sewage discharge can be obtained by multiplying per capita domestic water supply by the percentages in sold water and discharged sewage. Therefore, it is necessary to use an adjusted value of the percentage of water sold based on the latest figure of 53.73%. According to Information from the Planning and Budget Administration 1988, of SEDAPAL, the percentage of sold water for the month of April, 1986 was 42.7%, in-

creasing to 53.73% in 1988. This means an improvement of 25% in a span of two years, which is expected to further increase to 30% in the future. Accordingly, the percentage in sold of 53.73% is readjusted in the following manner:

Readjusted Percentage of Water Sold = 53.73% x 1.30 = 69.8 = 70%

TABLE A8-6 shows the per capita sewage discharge obtained by applying the readjusted percentage in water sold.

TABLE A8-6 Per Capita Sewage Discharge Based on Sewage Flow Measurement

CATEGORY OF WATER CONSUMPTION	BASIC UNIT OF VOLUME ADMIN. l/capita/day	REVISED % OF WATER SOLD	PER CAPITA SEWAGE DISCG. l/capita/day
D/S.H.	300	70	210
D/S.H.	250	70	175
I.D.	150	70	105

To determine the basic unit of volume of sewage, three points, namely, (1) Design Standard, (2) Volume of Supplied Water, and (3) Measurement of Sewage Flow are considered.

From the foregoing analysis, it can be concluded that the value obtained by measuring the sewage flow proved to be closest to the actual value, and is therefore adopted with specific adjustments as shown in TABLE A8-7.

TABLE A8-7 Per Capita Domestic Sewage Unit

l/capita/day

WATER CONSUM.	DESIGN STANDARD	VOLUME ADMIN.	SEWAGE MEASUREMENT	BASIC UNIT DETERMINED
D/S.H.	270	145	210	210
D/S.L.	225	120	175	180*
I.D.	135	72	105	110*

* With application of specific readjustments

(4) Planned Sewage Quantity

Since the planned sewage quantity is a basic value in determining the cost and volume, it will be calculated by considering the SEDAPAL Project

Regulations and Standards, and the "Guidelines for Design of Sewerage Facilities" edited by the Japan Sewage Works Association.

1) Daily Maximum Quantity

Because the project area is large, the daily maximum quantity is taken as 120% of the average daily quantity.

D/S.H. = 210 x 1.2 = 252 = 250 l/capita/day
D/S.L. = 180 x 1.2 = 216 = 210 l/capita/day
I.D. = 110 x 1.2 = 132 = 132 l/capita/day

2) Daily Average Quantity

D/S.H. = 210 l/capita/day
D/S.L. = 180 l/capita/day
I.D. = 110 l/capita/day

3) Hourly Maximum Quantity

Considering the future increase in water supply, the average value given in the above reference was used, thus:

$$(2.6 + 1.2 \times 1.8) \times 1/2 = 2.38 = 2.4 \text{ times}$$

Therefore, 2.4 times of the daily average quantity is adopted as hourly maximum quantity.

D/S.H. = 210 x 2.4 = 504 = 500 l/capita/day
D/S.L. = 180 x 2.4 = 432 = 430 l/capita/day
I.D. = 110 x 2.4 = 264 = 260 l/capita/day

The following TABLE A8-8 is a summary of the above calculations;

TABLE A8-8 Programmed Per Capita Sewage Discharge

ITEM	D/S.H. l/capita/day	D/S.L. l/capita/day	I.D. l/capita/day
Daily Maximum. of sewage	250	210	130
Daily Average of sewage	210	180	110
Hourly Maximum of sewage	500	430	260

"SEDAPAL: Project Regulations and Standards" and the "Guidelines for Design of Sewerage Facilities" give the following values:

REFERENCE	(1) DAILY MAXIMUM	(2) DAILY AVERAGE	(3) HOURLY MAXIMUM
SEDAPAL	1.3 times of (2)	90% of admin. drinking water	2.6 times of (2)
JSWA	Total drinking water admin. plus other water	70 - 80% of (1)	1.3 to 1.8 times of (1)