Table 3.3.-2 Proposed Wastewater Discharge, Pollution Load and Wastewater Quality in 2020 for the Whole Sewerage Systems in the RMR (3/3)

No.	Sewerage System	Area (ha)	Population (persons)	Wastewater Discharge (m^3/ day)			Pollution Load (kg/ day)		Wastewater Quality (mg/l)	
				Daily average	Daily maximum	Hourly maximum	BOD	SS	BOD	SS
59	Aldeia/Araçá	126	6,625	1,220	1,353	1,757	358	397	293	326
60	Aldeia/Besouro	608	26,742	5,702	6,284	8,112	1,444	1,605	253	281
61	Aldeia/Mina	261	10,685	2,301	2,515	3,209	577	641	251	279
62	Aldeia/Pacas	135	5,527	1,190	1,301	1,660	298	332	251	279
63	Araçoiaba	118	14,986	2,158	2,458	3,432	809	899	375	417
64	Brennand	161	6,052	1,581	1,751	2,278	327	363	207	230
65	Charneca	34	10,393	1,447	1,707	2,487	561	624	388	431
66	Cidade Universitária	157	6,348	1,761	1,965	2,559	370	412	210	234
67	Currupio	217	24,054	3,943	4,544	6,348	1,299	1,443	329	366
68	Garapú	171	30,179	4,509	5,263	7,527	1,630	1,811	361	402
69	Igarassu 1	620	35,312	7,090	7,973	10,621	1,907	2,119	269	299
70	Itamaracá 1	868	16,827	5,851	6,272	7,534	909	1,010	155	173
71	Itamaracá 2	388	7,768	2,649	2,843	3,426	419	466	158	176
72	Itapissuma 3	47	4,946	747	846	1,168	267	297	357	397
73	Macacos	68	2,788	650	716	927	151	167	231	257
74	Nossa Senhora do Ó	190	24,774	3,919	4,538	6,396	1,338	1,486	341	379
75	Parque Industrial (Cabo)	212	1,061	1,049	1,075	1,155	57	64	55	61
76	Pau Ferro	72	2,952	636	695	887	159	177	251	279
77	Pirapama	179	20,741	3,364	3,882	5,438	1,120	1,244	333	370
78	Ponte do Serrambi	138	414	648	658	689	22	25	35	38
79	Praia de Gaibu/Suape	260	5,393	1,796	1,931	2,336	291	324	162	180
80	Praia de Itapoama	132	807	672	693	753	44	48	65	72
81	Praia de Maracaípe	56	947	345	364	425	51	57	148	165
82	Praia do Cupe	129	3,362	979	1,063	1,315	182	202	185	206
83	Praia do Gamboa	101	507	501	514	552	27	30	55	61
84	Praia Toco Grande e Pau Alto	87	521	440	453	492	28	31	64	71
85	Suape	245	489	1,118	1,131	1,167	26	29	24	26
86	TIP	13	297	93	100	122	16	18	173	192
	Total	**36,425**	**3,634,298**	**601,191**	**690,509**	**957,243**	**197,126**	**219,029**		

Table 3.3.-3 Proposed Sewerage Systems for the Mastar Plan (1/2)

No	Sewerage System	Zone				Served Area and Population				
		Coastal Area	Low-Income Area	Area with Existing Sewers	Area with Existing Treatment	Served Area (ha)	Served Population	Density (person/ha)	Cumulative Population (from No1)	Percentage of Total Served Population
1	Caetés			O	O	884.5	60,779	69	60,779	2%
2	Peixinhos	O	O	O	O	2,548.2	398,839	157	459,618	13%
3	Caixa D'água		O			454.7	35,305	78	494,923	14%
4	Nova Descoberta		O			386.9	65,506	169	560,429	15%
5	Aguazinha		O	O		372.6	59,005	158	619,434	17%
6	Dois Unidos		O	O		422.9	63,495	150	682,929	19%
7	Ponte dos Carvalhos					131.7	24,365	185	707,293	19%
8	Charnequinha					66.5	15,096	227	722,389	20%
9	Camaragibe/Recife 1		O	O		954.4	61,043	64	783,431	22%
10	Camaragibe/Recife 2					268.7	16,477	61	799,908	22%
11	Camaragibe 1			O		446.3	24,870	56	824,778	23%
12	Camaragibe 2		O			246.3	26,107	106	850,885	23%
13	Cabanga	O	O	O		2,260.4	304,394	135	1,155,279	32%
14	Cordeiro		O	O		675.3	100,048	148	1,255,327	35%
15	Caxangá		O	O		508.9	37,326	73	1,292,653	36%
16	Igarassu 2					816.7	50,251	62	1,342,904	37%
17	Ipojuca - Sede					105.4	17,856	169	1,360,760	37%
18	Itapissuma 1			O	O	101.7	10,679	105	1,371,439	38%
19	Itapissuma 2					99.2	10,416	105	1,381,855	38%
20	Comportas		O			487.1	49,970	103	1,431,825	39%
21	Curcurana	O	O	O		909.9	123,636	136	1,555,460	43%
22	Prazeres	O	O	O		1,547.7	233,403	151	1,788,863	49%
23	Jaboatão 1		O	O		396.2	45,472	115	1,834,335	50%
24	Jaboatão 2					803.3	56,231	70	1,890,566	52%
25	Ibura de Cima		O	O		321.9	51,984	161	1,942,550	53%
26	Jaboatão 3					528.2	36,974	70	1,979,524	54%
27	Bonança					114.2	5,025	44	1,984,548	55%
28	Moreno 1					208.8	18,792	90	2,003,340	55%
29	Moreno 2			O	O	71.5	6,435	90	2,009,775	55%
30	Moreno 3					38.5	3,465	90	2,013,240	55%

Table 3.3.-3 Proposed Sewerage Systems for the Mastar Plan (2/2)

No	Sewerage Sub-System	Zone				Served Area and Population				
		Coastal Area	Low-Income Area	Area with Existing Sewers	Area with Existing Treatment	Served Area (ha)	Served Population	Density (person/ha)	Cumulative Population (from No1)	Percentage of Total Surved Population
31	Camaragibe 3			○		621.8	30,238	49	2,043,479	56%
32	São Lourenço 1			○		921.7	45,783	50	2,089,261	57%
33	São Lourenço 2					652.7	33,288	51	2,122,549	58%
34	Boa Viagem	○	○	○		1,281.3	159,314	124	2,281,863	63%
35	Imbiribeira		○	○		550.4	56,497	103	2,338,360	64%
36	Jardim São Paulo			○		497.1	56,101	113	2,394,461	66%
37	Ibura de Baixo		○	○		1,399.9	179,179	128	2,573,641	71%
38	Ignês Andreazza			○		47.4	6,579	139	2,580,219	71%
39	Mangueira		○	○	○	285.8	42,642	149	2,622,862	72%
40	Roda de Fogo		○	○		170.8	27,810	163	2,650,672	73%
41	Janga	○		○	○	2,878.7	316,075	110	2,966,747	82%
42	Paulista			○		783.3	68,930	88	3,035,677	84%
43	Conceição	○		○		709.6	62,445	88	3,098,122	85%
44	Apipucos					129.7	10,339	80	3,108,461	86%
45	Curado		○	○		102.5	18,626	182	3,127,087	86%
46	Praia Porto de Galinhas	○				49.4	3,705	75	3,155,644	87%
47	Jardim Paulista			○	○	282.4	24,851	88	3,151,939	87%
48	Mirueira			○		401.5	34,009	85	3,189,653	88%
49	Mutirão			○		72.5	6,380	88	3,196,033	88%
50	Nova Cruz					92.0	5,244	57	3,201,277	88%
51	Parque Capibaribe			○	○	460.3	23,475	51	3,224,752	89%
52	Parque Pirapama		○	○	○	172.6	32,794	190	3,257,546	90%
53	Vila Burity			○	○	68.1	11,397	167	3,268,943	90%
54	Vila dos Milagres			○		99.4	14,289	144	3,283,232	90%
55	27 de Novembro			○		48.6	9,369	193	3,292,601	91%

Table 3.3-4 Basic Scheme of Sewerage Development

No.	Sewerage Systems	Sewage Collection Facilities			Sewage Treatment Facilities				Remarks
		Development of Facilities		Rehabilitation of Existing Facilities	Development of Facilities			Rehabilitation of Existing Facilities	
		New Installation	Additional Installation		New Installation	Additional Installation	Installation of Disinfection System		
1	Caetes		●	●		●	●	●	
2	Peixinhos		●	●		●	●	●	
3	Caixa D'agua	●			●		●		
4	Nova Descoberta	●			●		●		
5	Aguazinha		●	●	●		●		
6	Dois Unidos		●	●	●		●		
7	Ponte dos Carvalhos	●			●		●		
8	Charnequinha	●			●		●		
9	Camaragibe/Recife 1		●	●	●		●		
10	Camaragibe/Recife 2	●			●		●		
11	Camaragibe 1		●	●	●		●		
12	Camaragibe 2	●			●		●		
13	Cabanga		●	●		●	●	●	
14	Cordeiro		●	●	●	●	●	●	The existing ETEC-08 will be used as another system after modification, separately from the main Subsystem.
15	Caxanga		●	●	●		●		
16	Igarassu 2	●			●		●		
17	Ipojuca - Sede	●			●		●		
18	Itapissuma 1		●	●	●		●		
19	Itapissuma 2	●			●		●		
20	Comportas	●			●		●		
21	Curcurana		●	●	●	●	●	●	The existing ETEC-03 and ETEC-09 will be used as another systems after rehabilitation, separately from the main Subsystem.
22	Prazeres		●	●	●	●	●	●	The existing ETEC-02 will be used as another system after modification, separately from the main Subsystem.
23	Jaboatao 1		●	●	●		●		
24	Jaboatao 2	●			●		●		
25	Ibura de Cima		●	●	●		●		
26	Jaboatao 3	●			●		●		

Table 3.3-4 Basic Scheme of Sewerage Development

No.	Sewerage Systems	Sewage Collection Facilities			Sewage Treatment Facilities				Remarks
		Development of Facilities		Rehabilitation of Existing Facilities	Development of Facilities			Rehabilitation of Existing Facilities	
		New Installation	Additional Installation		New Installation	Additional Installation	Installation of Disinfection System		
27	Bonanca	●			●		●		
28	Moreno 1	●			●		●		
29	Moreno 2		●	●		●	●	●	
30	Moreno 3	●			●		●		
31	Camaragibe 3		●	●	●		●		
32	Sao Lourenco 1		●	●	●		●		
33	Sao Lourenco 2	●			●		●		
34	Boa Viagem		●	●	●		●		
35	Imbiribeira		●	●	●		●		
36	Jardim Sao Paulo		●	●	●		●		
37	Ibura de Baixo		●	●	●		●		
38	Ignes Andreazza		●	●			●	●	Only the rehabilitation and the installation of disinfection system will take place for the STF.
39	Mangueira		●	●		●	●	●	
40	Roda de Fogo		●	●	●		●	●	
41	Janga		●	●		●	●	●	
42	Paulista		●	●		●	●	●	
43	Conceicao		●	●	●		●		
44	Apipucos	●			●		●		
45	Curado		●	●		●	●	●	
46	P.P. de Galinhas	●			●		●		
47	Jardim Paulista		●	●		●	●	●	
48	Mirueira		●	●	●		●		
49	Mutirao		●	●		●	●	●	
50	Nova Cruz	●			●		●		
51	Parque Capibaribe		●	●		●	●	●	
52	Parque Pirapama		●	●		●	●	●	
53	Vila Burity		●	●		●	●	●	
54	Vila dos Milagres		●	●		●	●	●	
55	27 de Novembro		●	●		●	●	●	

Source: JICA Study Team

Note: The columns marked by " ● " means that the corresponding work items are implemented for respective systems.

Table 3.3-5 Development Works of Sewage Collection Facilities (1/2)

No.	Sewerage Systems	Basic Planning Conditions			Sewers							Pump Stations	
								Trunk and Pressure Sewers					
		Sewerage Area in 2020 (ha)	Existing Sewerage Area (ha)	Hourly Maximum Sewage Flow in 2020 (m^3/day)	Condom. Collectors (km)	Coneven-tional Collectors (km)	Branch Sewers (km)	Maximum Diameter of Pipes (mm)	Length of Trunk Sewers (km)	Length of Pressure Sewers (km)	Total Length (km)	Quantities of Pumps (set)	Motor Power (CV)
1	Caetes	884.5	705.1	16,682	-	32.3	16.6	350	2.2	0.4	51.5	3	4.9
2	Peixinhos	2,548.2	963.2	95,111	89.3	151.4	157.4	700	2.5	1.2	401.7	12	164.6
3	Caixa D'agua	454.7	-	7,820	23.7	46.4	43.1	500	2.5	1.1	116.7	12	141.1
4	Nova Descoberta	386.9	-	11,849	37.5	13.5	38.0	700	2.1	1.8	92.9	18	200.8
5	Aguazinha	372.6	2.7	10,858	41.7	4.0	34.8	500	2.2	1.5	84.3	24	228.6
6	Dois Unidos	422.9	23.6	13,600	26.1	32.7	39.9	500	0.8	2.4	101.9	15	145.1
7	Ponte dos Carvalhos	131.5	-	6,051	-	23.7	12.2	400	1.0	0.7	37.5	6	51.1
8	Charnequinha	66.5	-	3,684	-	12.0	6.7	300	-	0.4	19.0	3	29.7
9	Camaragibe/Recife 1	955.0	80.4	17,022	14.6	135.6	86.0	900	1.5	2.7	240.3	15	478.4
10	Camaragibe/Recife 2	268.7	-	4,882	4.5	41.7	26.6	500	0.3	0.1	73.1	3	24.5
11	Camaragibe 1	446.3	89.3	6,464	3.7	58.7	35.7	500	-	0.1	98.2	3	59.0
12	Camaragibe 2	246.3	-	5,327	9.1	30.7	24.6	400	-	0.0	64.4	3	46.1
13	Cabanga	2,260.4	1,799.4	91,362	19.9	53.1	46.1	300	-	0.1	119.2	3	35.4
14	Cordeiro	675.3	129.2	27,034	19.7	68.7	51.0	700	5.4	1.4	146.3	15	330.4
15	Caxanga	508.9	31.3	10,337	11.2	69.2	44.6	500	3.2	0.5	128.7	9	106.4
16	Igarassu 2	816.7	-	14,595	-	147.0	76.9	700	11.5	1.4	236.7	6	124.3
17	Ipojuca - Sede	105.4	-	4,473	-	19.0	9.9	700	1.0	0.3	30.1	6	50.4
18	Itapissuma 1	101.7	20.8	2,522	-	14.6	7.3	300	0.5	0.5	22.9	12	43.4
19	Itapissuma 2	99.2	-	2,460	-	17.9	9.3	300	0.6	0.5	28.3	9	40.9
20	Comportas	487.1	-	13,265	11.5	70.4	47.3	800	6.5	0.8	136.4	6	142.4
21	Curcurana	909.9	46.2	35,051	13.0	136.0	84.3	900	3.2	3.8	240.2	9	401.4
22	Prazeres	1,547.7	71.5	53,840	69.3	161.8	143.6	1,000	9.1	2.7	386.5	18	1,239.8
23	Jaboatao 1	396.2	151.2	9,442	5.0	36.6	23.3	900	6.8	0.9	72.6	6	211.8
24	Jaboatao 2	803.3	-	14,435	-	144.6	76.9	900	4.9	1.6	227.9	18	629.0
25	Ibura de Cima	321.9	153.3	10,010	8.8	17.1	15.8	500	2.3	1.1	45.1	12	154.5
26	Jaboatao 3	528.2	-	9,492	-	95.1	50.9	700	2.1	1.7	149.8	6	172.7
27	Bonanca	114.2	-	1,473	-	20.6	10.3	200	2.5	0.3	33.6	6	14.7
28	Moreno 1	208.8	-	4,566	-	37.6	18.4	500	2.8	1.5	60.3	12	105.5
29	Moreno 2	71.5	32.6	1,564	-	7.0	3.7	250	1.7	1.0	13.5	6	10.5

Table 3.3-5 Development Works of Sewage Collection Facilities (2/2)

No.	Sewerage Systems	Basic Planning Conditions			Sewers							Pump Stations	
								Trunk and Pressure Sewers					
		Sewerage Area in 2020 (ha)	Existing Sewerage Area (ha)	Hourly Maximum Sewage Flow in 2020 (m^3/day)	Condom. Collectors (km)	Coneven-tional Collectors (km)	Branch Sewers (km)	Maximum Diameter of Pipes (mm)	Length of Trunk Sewers (km)	Length of Pressure Sewers (km)	Total Length (km)	Quantities of Pumps (set)	Motor Power (CV)
30	Moreno 3	38.5	-	842	-	6.9	3.9	200	1.2	0.4	12.3	3	12.1
31	Camaragibe 3	621.8	150.9	8,555	2.6	80.8	46.0	600	2.2	1.7	133.4	12	177.5
32	Sao Lourenco 1	921.7	298.9	14,115	0.1	112.0	59.0	900	6.2	4.1	181.3	9	114.2
33	Sao Lourenco 2	652.7	-	10,309	-	117.5	61.3	500	4.5	1.1	184.4	6	34.5
34	Boa Viagem	1,281.3	152.1	45,402	17.6	176.9	103.8	1,000	13.1	3.7	315.1	33	612.7
35	Imbiribeira	550.4	168.2	16,251	8.2	56.5	31.5	700	8.1	3.5	107.8	27	307.8
36	Jardim Sao Paulo	497.6	104.6	13,511	13.7	50.2	37.9	1,000	7.1	5.2	114.1	36	2,016.4
37	Ibura de Baixo	1,400.4	93.9	38,075	55.1	152.6	121.5	800	2.4	1.4	332.9	9	115.2
38	Ignes Andreazza	47.4	37.9	1,620	-	1.7	0.9	-	-	-	2.7	-	-
39	Mangueira	285.8	112.8	10,641	9.0	17.7	17.3	-	-	-	44.0	-	-
40	Roda de Fogo	170.8	144.6	6,477	0.9	3.4	2.6	-	-	-	6.9	-	-
41	Janga	2,878.7	1,105.7	97,013	-	319.1	174.7	900	4.7	5.1	503.6	6	341.5
42	Paulista	783.3	345.2	16,997	-	78.9	42.0	800	1.8	2.5	125.2	15	324.2
43	Conceicao	709.6	50.0	19,888	-	118.7	63.3	800	2.7	4.0	188.7	9	304.7
44	Apipucos	129.7	-	3,281	1.6	21.0	13.0	-	-	-	35.5	-	-
45	Curado	102.5	102.5	3,399	3.2	-	-	-	-	-	3.2	-	-
46	Praia Porto de Galinhas	49.4	-	936	-	15.6	8.7	-	-	-	24.3	-	-
47	Jardim Paulista	282.4	282.4	6,066	-	-	-	-	-	-	-	-	-
48	Mirueira	401.5	401.5	8,386	-	-	-	-	-	-	-	-	-
49	Mutirio	72.5	65.3	2,132	-	1.3	0.7	-	-	-	2.0	-	-
50	Nova Cruz	92.0	-	1,577	-	16.6	9.2	-	-	-	25.8	-	-
51	Parque Capibaribe	460.3	425.2	7,270	-	6.3	3.5	-	-	-	9.8	-	-
52	Parque Pirapama	172.6	51.8	8,124	-	21.7	12.1	-	-	-	33.8	-	-
53	Vila Burity	68.0	20.5	2,220	4.1	2.4	4.8	-	-	-	11.3	-	-
54	Vila dos Milagres	99.4	99.4	2,994	-	-	-	-	-	-	-	-	-
55	27 de Novembro	48.6	3.2	1,620	5.7	-	4.5	-	-	-	10.3	-	-
Total of 55 Systems		**29,959**	**8,516**	**852,970**	**530.2**	**3,076.5**	**2,063.0**	**24,600**	**133.0**	**65.0**	**5,867.7**	**441**	**9,748**

Table 3.3-6 Development Works of STFs (1/2)

No.	Sewerage Systems	Basic Planning Conditions			Applied Unit Process of Sewage Treatment												Remarks
		Daily Ave. Sewage Flow in 2020 (m^3/day)	Existing Capacity (Daily Ave. Flow) (m^3/day)	Capacity to be Expanded (Daily Ave. Flow) (m^3/day)	Influent Pump	Grit Chamber	Primary Sedimentation Tank	RAFA Reactor	Lagoon	Bio-Filter and Final Sedimentation Tank	Aeration Tank and Final Sedimentation Tank	Chlorination Unit	Sludge Thickener	Sludge Digester	Dehydrator	Sludge Drying Bed	
1	Caetes	11,014	8,900	2,114		●		●	□			●				●	
2	Peixinhos	57,279	36,000	21,279		●		●		●		●	●	□	●		
3	Caixa D'agua	5,134	-	5,134	●	●		●		●		●				●	
4	Nova Descoberta	7,138	-	7,138	●	●		●		●		●				●	
5	Aguazinha	6,569	-	6,569	●	●		●		●		●				●	
6	Dois Unidos	8,243	-	8,243	●	●		●		●		●				●	
7	Ponte dos Carvalhos	3,615	-	3,615		●		●	●			●				●	
8	Charnequinha	2,174	-	2,174	●	●		●		●		●				●	
9	Camaragibe/Recife 1	11,254	-	11,254		●		●	●			●				●	
10	Camaragibe/Recife 2	3,220	-	3,220		●		●	●			●				●	
11	Camaragibe 1	4,450	-	4,450		●		●	●			●				●	
12	Camaragibe 2	3,380	-	3,380	●	●		●		●		●				●	
13	Cabanga	55,239	80,000	55,239	□		□	●		◎		●	●	□	●		
14	Cordeiro	16,319	4,416	11,903	●	●		●		●		●				●	The existing ETEC-08 will be used as an another station.
15	Caxanga	6,690	-	6,690	●	●		●		●		●				●	
16	Igarassu 2	9,690	-	9,690		●		●	●			●				●	
17	Ipojuca - Sede	2,687	-	2,687		●		●	●			●				●	
18	Itapissuma 1	1,614	-	1,614	●	●		●		●		●				●	
19	Itapissuma 2	1,574	-	1,574		●		●	●			●				●	
20	Comportas	8,275	-	8,275		●		●	●			●				●	
21	Curcurana	21,280	404	20,876	●	●		●		●		●				●	The existing ETEC-11will be used an another station.
22	Prazeres	32,581	1,625	30,956	●	●		●		●		●				●	The existing ETEC-02 will be used an another station.
23	Jaboatao 1	5,956	-	5,956		●		●	●			●				●	
24	Jaboatao 2	9,656	-	9,656	●	●		●		●		●				●	
25	Ibura de Cima	6,097	-	6,097	●	●		●		●		●				●	
26	Jaboatao 3	6,349	-	6,349		●		●	●			●				●	
27	Bonanca	1,046	-	1,046	●	●		●		●		●				●	
28	Moreno 1	2,969	-	2,969	●	●		●		●		●				●	
29	Moreno 2	1,017	854	163	●	●		●	□			●				□	

Table 3.3-6 Development Works of STFs (2/2)

No.	Sewerage Systems	Basic Planning Conditions			Applied Unit Process of Sewage Treatment												Remarks
		Daily Ave. Sewage Flow in 2020 (m^3/day)	Existing Capacity (Daily Ave. Flow) (m^3/day)	Capacity to be Expanded (Daily Ave. Flow) (m^3/day)	Influent Pump	Grit Chamber	Primary Sedimentation Tank	RAFA Reactor	Lagoon	Bio-Filter and Final Sedimentation Tank	Aeration Tank and Final Sedimentation Tank	Chlorination Unit	Sludge Thickener	Sludge Digester	Dehydrator	Sludge Drying Bed	
30	Moreno 3	547	-	547	●	●		●		●		●				●	
31	Camaragibe 3	5,967	-	5,967		●		●	●			●				●	
32	Sao Lourenco 1	9,619	-	9,619	●	●		●		●		●				●	
33	Sao Lourenco 2	6,981	-	6,981	●	●		●		●		●				●	
34	Boa Viagem	27,794	-	27,794	●	●		●		●		●				●	
35	Imbiribeira	10,103	-	10,103		●		●	●			●				●	
36	Jardim Sao Paulo	8,384	-	8,384		●		●	●			●				●	
37	Ibura de Baixo	23,557	-	23,557	●	●		●		●		●				●	
38	Ignes Andreazza	988	2,217	-	□	□					□	●				□	
39	Mangueira	6,430	3,732	2,698		●		●	●			●				●	
40	Roda de Fogo	3,892	4,752	3,892	●	●		●	●			●				●	
41	Janga	59,891	34,214	25,677		●		●	●			●				●	
42	Paulista	11,052	6,750	4,302		●		●	□			●				●	
43	Conceicao	12,515	-	12,515		●		●	●			●				●	
44	Apipucos	2,076	-	2,076	●	●		●	□	●		●				●	
45	Curado	2,031	7,021	2,031	□	□		●	●			●				●	
46	Praia Porto de Galinha	621	-	621		●		●	●			●				●	
47	Jardim Paulista	3,954	3,085	3,954		●		●	□			●				●	
48	Mirueira	5,478	-	5,478	●	●		●		●		●				●	
49	Mutirao	1,334	1,700	1,334	□	□		●	□			●				●	
50	Nova Cruz	1,053	-	1,053		●		●	●			●				●	
51	Parque Capibaribe	4,923	2,735	2,188	●	●		●	□			●				●	
52	Parque Pirapama	4,845	3,060	1,785	●	●		●	□			●				●	
53	Vila Burity	1,350	1,250	1,350	●	●		●	●			●				●	
54	Vila dos Milagres	1,853	1,853	1,853	□	□		□	□			□				□	
55	27 de Novembro	963	963	963	□	□		●	□			●				●	
Total		**530,710**	**204,146**	**428,658**													

Note: 1) The unit processes marked by "●" are newly installed and the ones marked by "□" represents existing components.

2) The existing primary sedimentation tank marked by "◎" are used as the final sedimentation ones.

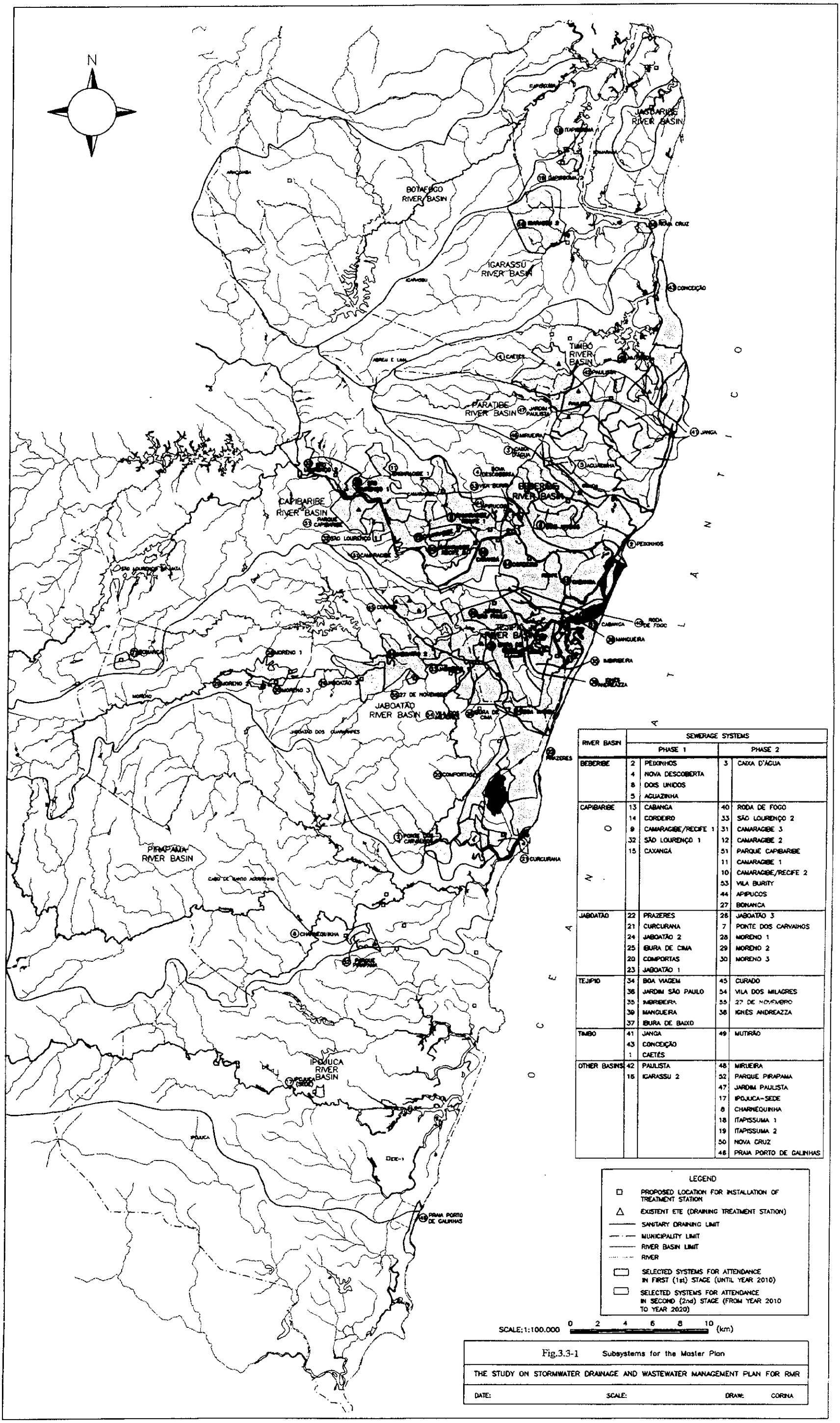
Table 3.3-7 Rehabilitation Works of Existing Sewerage Systems (1/2)

No.	Sewerage System	Pump Stations to be Rehabilitated	Sewage Treatment Facilities
1	Caetes	EEJ-4(Caetes-3), EEJ-22(Caetes-I)	ETEJ-03(Caetes): Repair and replacement of mechanical parts of screen, flow meter, aerators, etc., and dredging of lagoons.
2	Peixinhos	EEJ-14(Varadouro), EEX-1(Arruda), EEX-2(Encruzilhada), EEX-3(Rui Barbosa), EEX-11(Convention Center), EEX-12(Joao Paulo-II), EEX-13(Varadouro-II), EEX-14(COHAB),	ETEX-01(Peixinhos): Repair and replacement of mechanical parts of screen, grit chambers, primary sedimentation tanks, bio-filter, final sedimentation tanks, pumps and digesters, repair of civil and architectural structures, and replacement of filter-media.
3	Aguazinha	EEX-20(Passarinho), EEX-21(Varadouro-I), EEX-22(Canaa)	None
4	Cabanga	EEX-4(Aurora), EEX-5(J. Brasil), EEX-7(Ponte Velha), EEX-10)Henrique Dias), EEC-1(Afogados), EEC-2(Internacional), EEC-8(D-3), EEC-9(Jiquia), EEC-15(Abdias de Carvalho), EEC-17(Prive da	ETEC-01(Cabanga): Repair and replacement of mechanical parts for influent pumps, screens, grit chambers, primary sedimentation tanks, digesters, etc. and repair of civil and architectural structures.
5	Cordeiro	None	ETEC-8(Vila Iputinga) to be used as another system, separately from the main Subsystem: Repair and replacement of machinery parts for influent pumps, etc. and civil and architectural structures.
6	Curcurana	EEC-10(Barra de Jangada), EEC-21(Costa do Sol)	ETEC-03(Barra de Jangada) and ETEC-09(Praia Grande) to be used as another facility, separately from the main Subsystem: Repair and replacement of machinery parts of influent pumps, etc., civil and architectural structures.
7	Prazeres	EEC-16(Jardim Piedade), EEC-29(Praia Grande)	ETEC-02(Jardam Piedade) to be used as another facility, separately from the main Subsystem: Repair and replacement of machinery parts of influent pumps, aerators, etc., civil and architectural structures and dredging of a lagoon.
8	Moreno 2	None	ETES-13(Vila Liberdade): Repair of mechanical parts, internal pipings and desludging of a septic tank.
9	Boa Viagem	EEC-6(D-18), EEC-13(D-20), EEC-19(Boa Viagem)	None
10	Imbiribeira	EEC-20(Imbiribeira)	None
11	Ignes Andreaza	None	ETES-01(Ignes Andreaza): Repair and replacement of mechanical parts of influent pumps, screens, grit chambers, a sedimentation tank, aeration tanks, aerators, etc. and repair of civil and architectural structures.
12	Mangueira	None	ETEC-10(Mangeira): Repair and replacement of mechanical parts for influent pumps, screens, grit chambers, etc., repair of civil structures and dredging of a lagoon.
13	Roda de Fogo	EEC-24(Roda de Fogo-01), EEC-25(Roda de Fogo-02), EEC-26(Roda de Fogo-03), EEC-27(Roda de Fogo-04)	ETES-07(Vila Roda de Fogo): Repair of mechanical parts, internal piping and desludging of a septic tank.

Table 3.3-7 Rehabilitation Works of Existing Sewerage Systems (2/2)

No.	Sewerage System	Pump Stations to be Rehabilitated	Sewage Treatment Facilities
14	Janga	EEJ-2(Maranguape-II), EEJ-3(pedras Altas), EEJ-5(Managuape-II), EEJ-8(Bairro Nova), EEJ-X(Dona Duda), EEJ-18(Inoccop Janga)	ETEJ-01(Janga): Repair and replacement of mechanical parts of screens, grit chambers, a sedimentation tank, aeration tanks, aerators, etc. and repair of civil and architectural structures.
15	Paulista	EEJ-19(Arthur Lundgren)	ETEJ-02(Arthur Lungren): Repair and replacement of mechanical parts of screen, flow meter, aerators, etc., and dredging of lagoons.
16	Conceicao	EEJ-17	None
17	Curado	EES-1(Curado-IV), EES-4(Curado-II),	ETES-2(Curado-IV): Repair and replacement of mechanical parts of screen, flow meter, aerators, etc., and dredging of lagoons.
18	Jardim Paulista	EEJ-7(Paulista)	ETEJ-04(Jardim Paulista): Repair and replacement of mechanical parts for screen, flow meter, aerators, etc., and dredging of lagoons.
19	Mutirao	EEJ-11(Engenho Maranguape), EEJ-21(EE-2)	ETEJ-06(Mutirao): Repair of mechanical parts, internal pipings and desludging of a septic tank.
20	Parque Capibaribe	EES-13(Parque Capi-II), EES-14(Parque Capi-III)	ETES-04(Capibaribe Park): Repair and replacement of mechanical parts of screen, flow meter, aerators, etc., and dredging of lagoons.
21	Parque Pirapama	None	ETES-03(Pirapama Housing): Repair and replacement of mechanical parts for screen, flow meter, aerators, etc., and dredging of lagoons.
22	Vila Burity	EEX-16(vila Burity-I), EEX-17(vila Burity-X), EEX-18(vila Burity-III)	ETEX-02 to 05(Burity Village): Repair of mechanical parts, internal pipings and desludging of a septic tank.
23	Vila dos Milagres	EEX-16(Cabo-III), EES-21(vila dos Milagres), EES-22(vila dos Milagres)	ETEC-10(Mangeira): Repair and replacement of mechanical parts of influent pumps, screens, grit chambers, , etc. and repair of civil and dredging of a lagoon.
24	27 de Novembro	None	ETES-05(UR-II-Ibura): Repair of mechanical parts, internal pipings and desludging of a pond.

Source: Compiled by JICA Study Team based on the results of site investigation, reviewing the data prepared by



RIVER BASIN	SEWERAGE SYSTEMS			
	PHASE 1		PHASE 2	
BEBERIBE	2	PEIXINHOS	3	CAIXA D'ÁGUA
	4	NOVA DESCOBERTA		
	8	DOIS UNIDOS		
	5	AGUAZINHA		
CAPIBARIBE	13	CABANGA	40	RODA DE FOGO
	14	CORDEIRO	33	SÃO LOURENÇO 2
	9	CAMARAGIBE/RECIFE 1	31	CAMARAGIBE 3
	32	SÃO LOURENÇO 1	12	CAMARAGIBE 2
	15	CAXANGÁ	51	PARQUE CAPIBARIBE
			11	CAMARAGIBE 1
			10	CAMARAGIBE/RECIFE 2
			53	VILA BURITY
			44	APIPUCOS
			27	BOAVISTA
JABOATÃO	22	PRAZERES	26	JABOATÃO 3
	21	CURCURANA	7	PONTE DOS CARVALHOS
	24	JABOATÃO 2	28	MORENO 1
	25	IBURA DE CIMA	29	MORENO 2
	20	COMPORTAS	30	MORENO 3
	23	JABOATÃO 1		
TEJIPIO	34	BOA VIAGEM	45	CURADO
	36	JARDIM SÃO PAULO	54	VILA DOS MILAGRES
	35	IMBIRIBEIRA	55	27 DE NOVEMBRO
	39	MANGUEIRA	38	INÊS ANDREAZZA
	37	IBURA DE BAIXO		
TIMBO	41	JANGA	49	MUTIRÃO
	43	CONCEIÇÃO		
	1	CAETÉS		
OTHER BASINS	42	PAULISTA	48	MIRUEIRA
	15	IGARASSU 2	52	PARQUE PIRAPAMA
			47	JARDIM PAULISTA
			17	IPOJUCA-SEDE
			8	CHARNECUINHA
			18	ITAPISSUMA 1
			19	ITAPISSUMA 2
			50	NOVA CRUZ
			46	PRAIA PORTO DE GALINHAS

Fig.3.3-1 Subsystems for the Master Plan

THE STUDY ON STORMWATER DRAINAGE AND WASTEWATER MANAGEMENT PLAN FOR RMR

DATE: SCALE: DRAW: CORINA

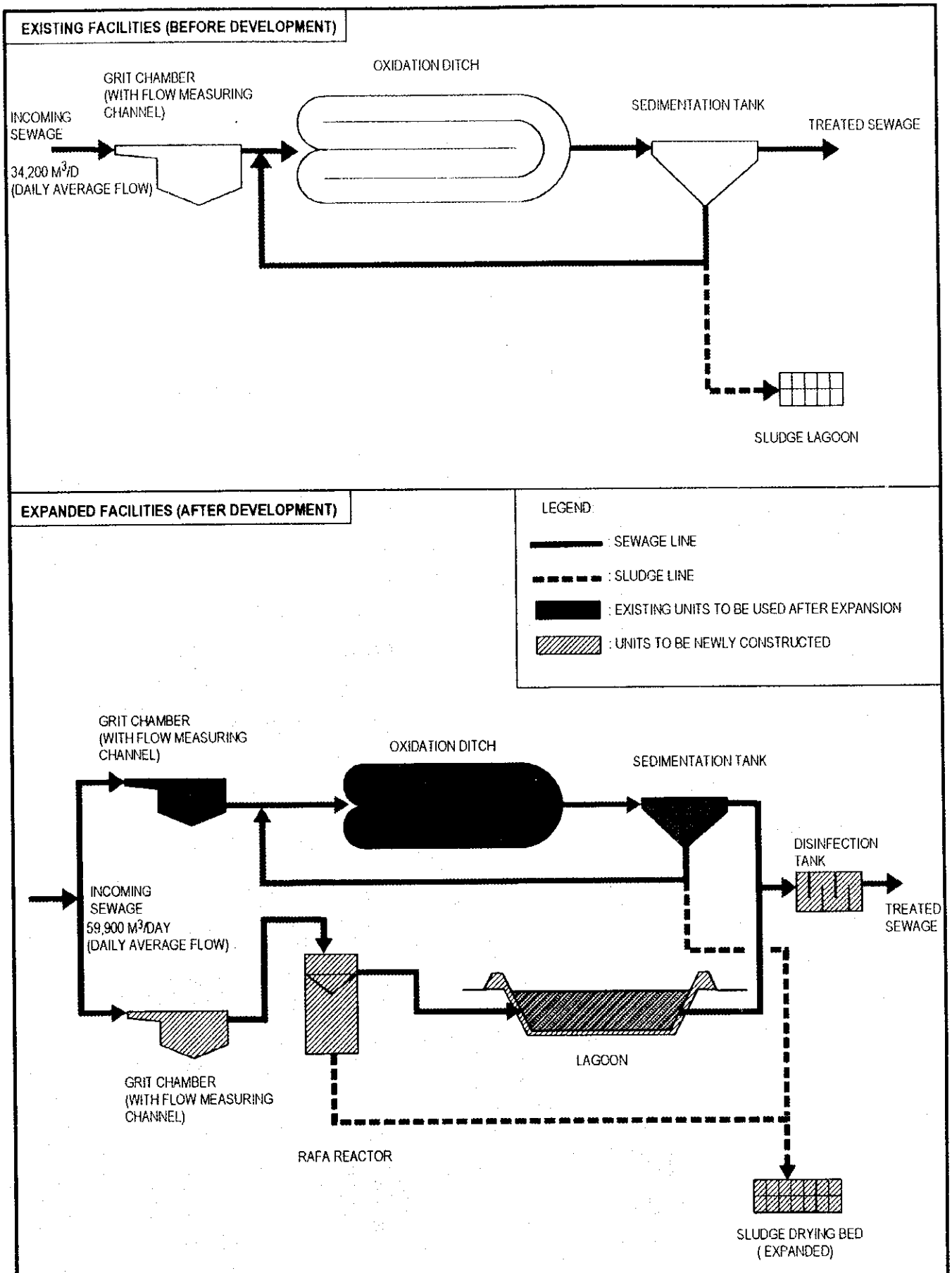


Fig. 3.3-2 **Flow Diagram of Janga STF**

THE STUDY ON STORMWATER DRAINAGE AND SEWERAGE MANAGEMENT PLAN FOR RMR

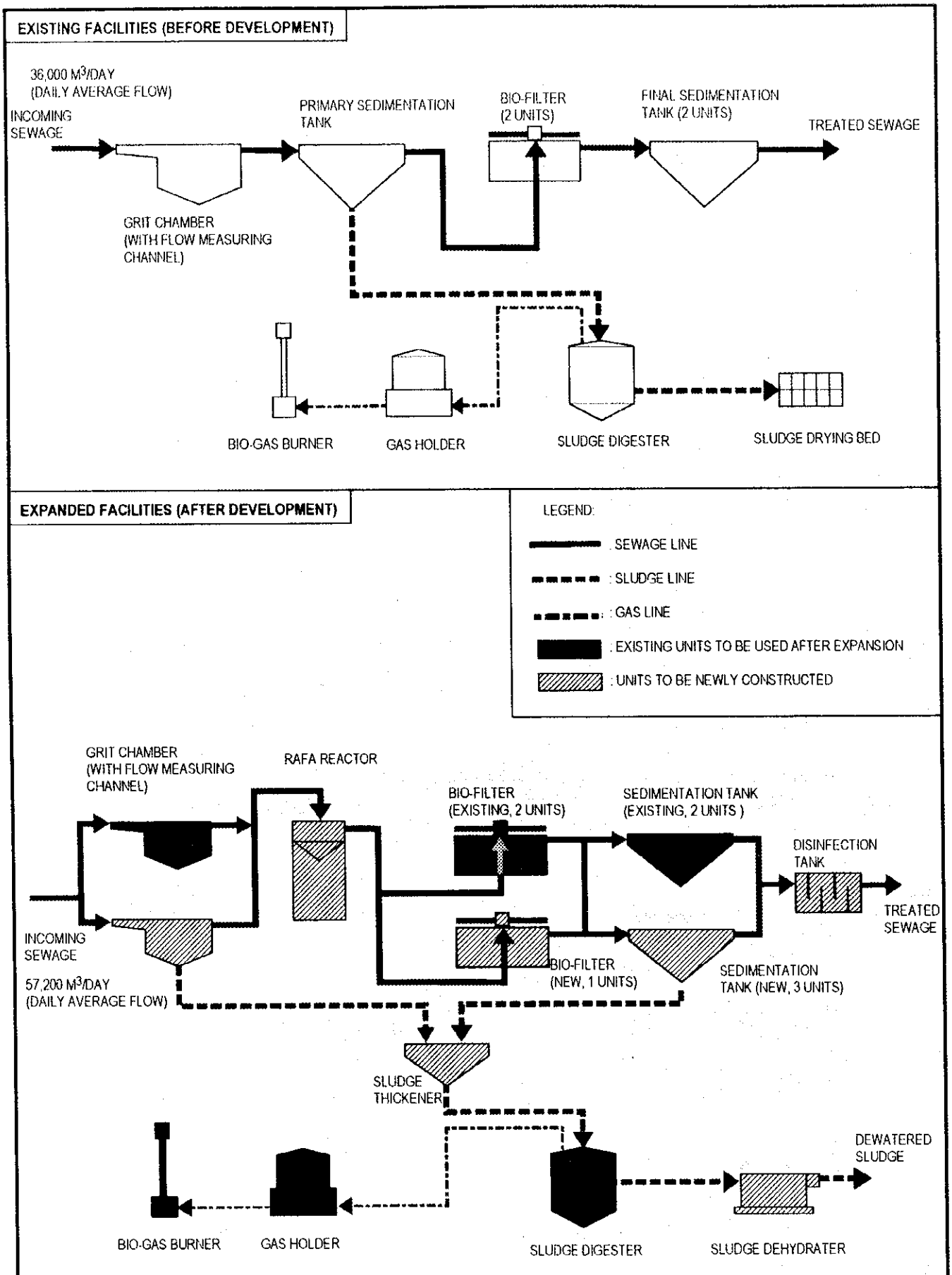


Fig. 3.3-3 **Flow Diagram of Peixinhos STF**

THE STUDY ON STORMWATER DRAINAGE AND SEWERAGE MANAGEMENT PLAN FOR RMR

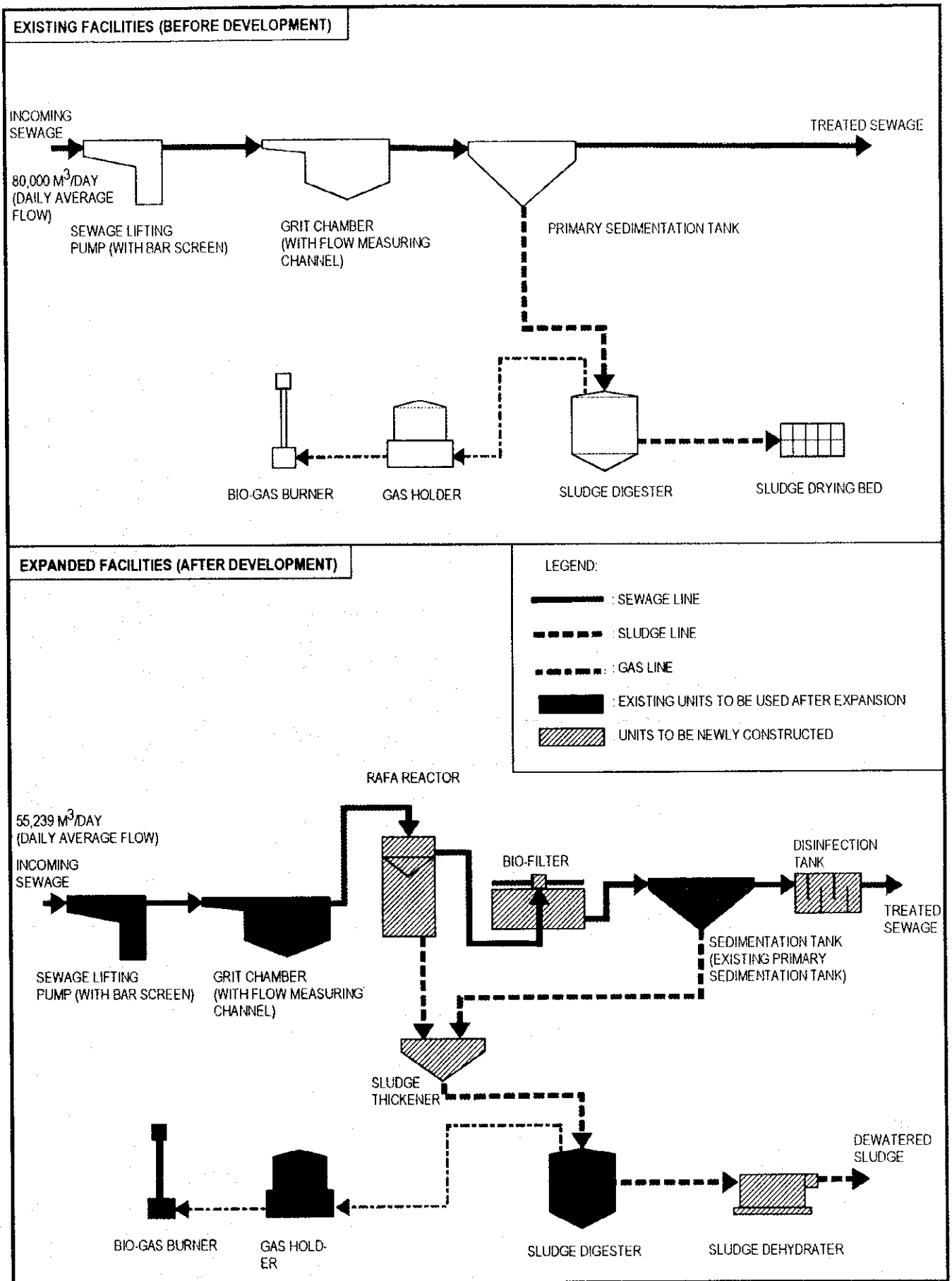


Fig. 3.3-4 **Flow Diagram of Cabanga STF**

THE STUDY ON STORMWATER DRAINAGE AND SEWERAGE MANAGEMENT PLAN FOR RMR

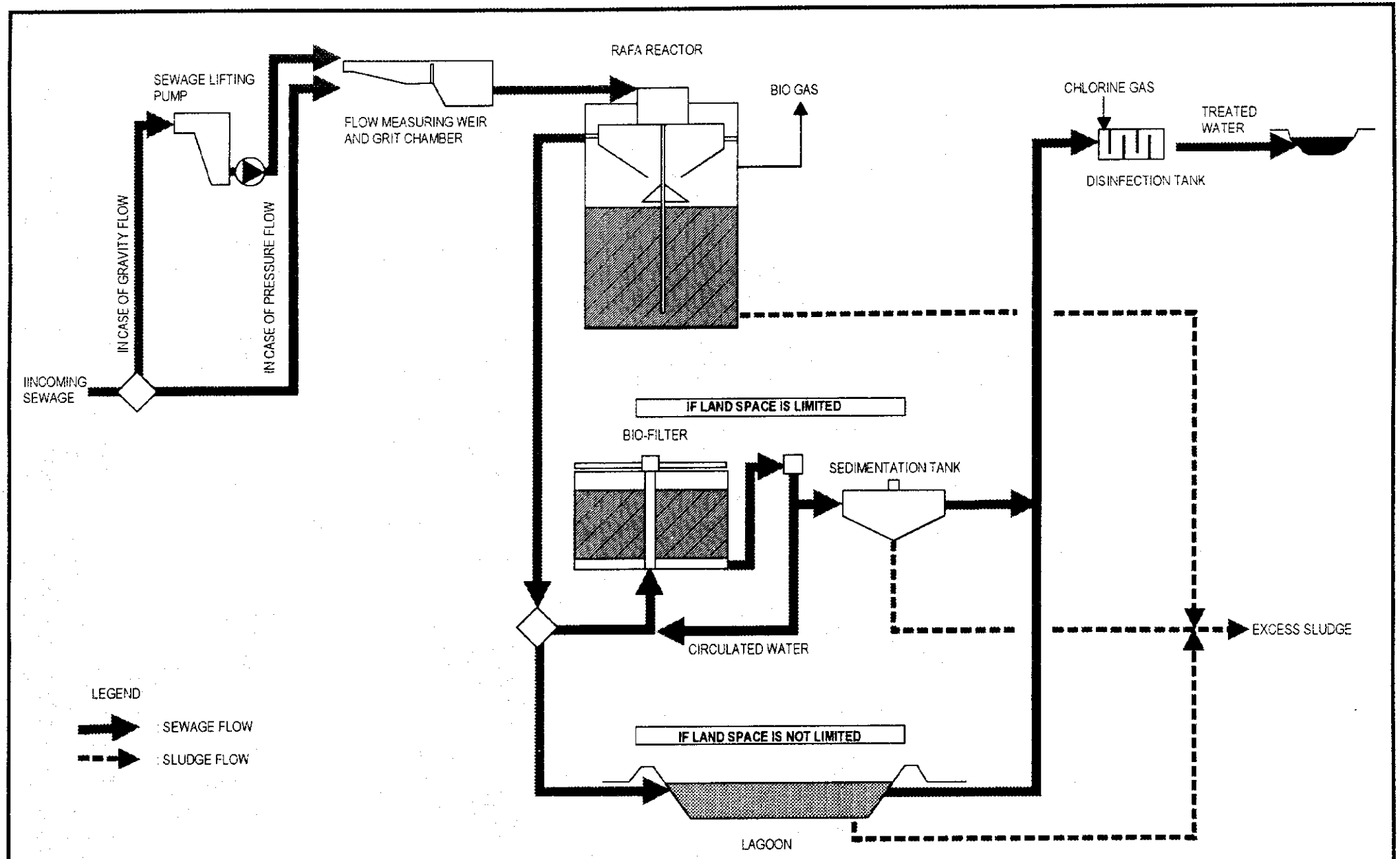
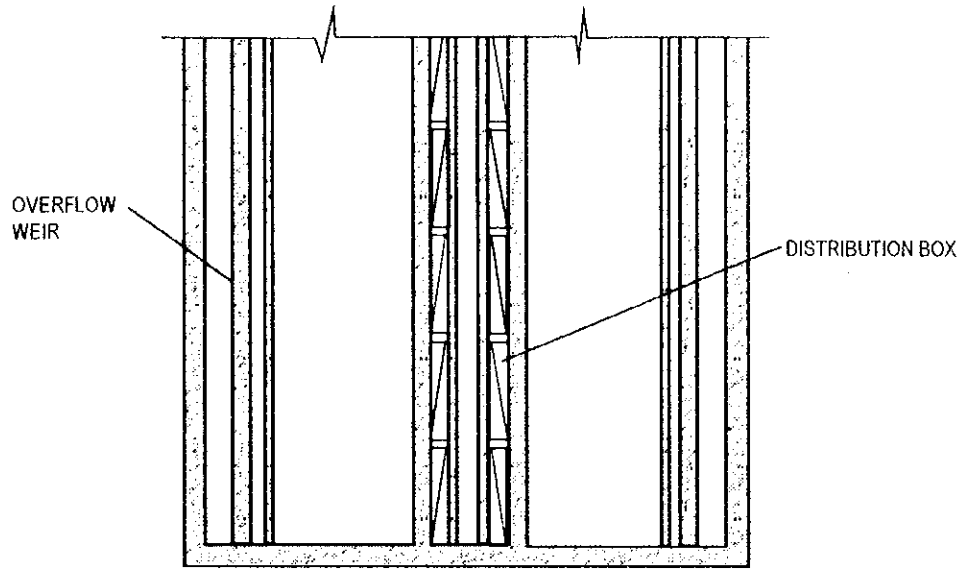
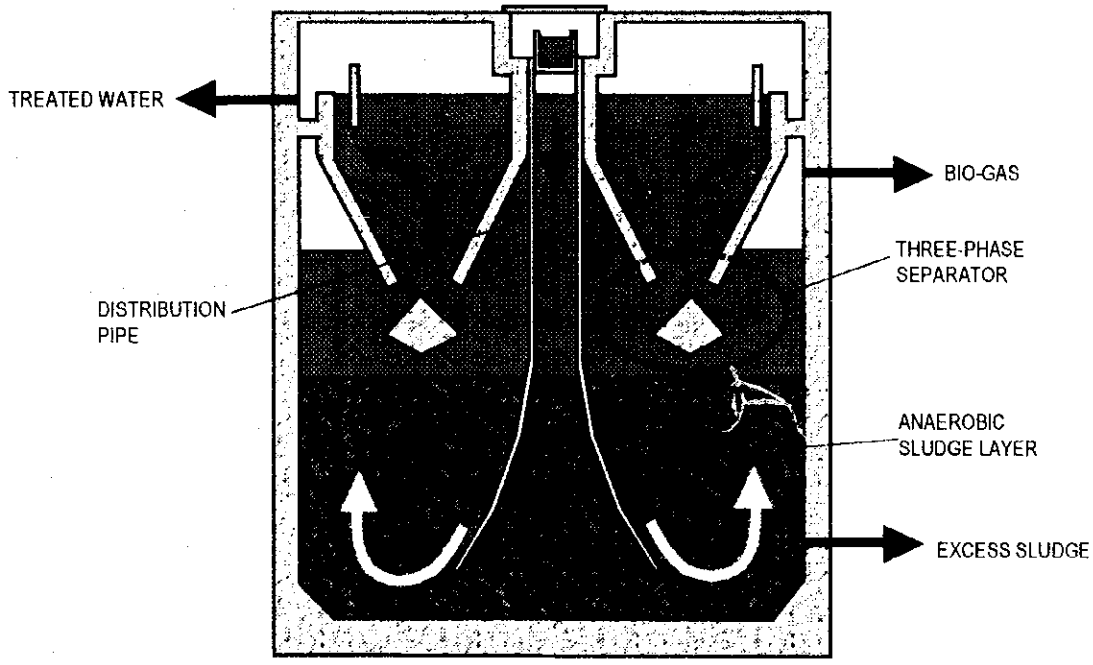


Fig. 3.3-5 **Flow Diagram of Combined RAFA Process**

THE STUDY ON STORMWATER DRAINAGE AND SEWERAGE MANAGEMENT PLAN FOR RMR



PLAN VIEW



SIDE VIEW

NOTE: RAFA IS THE ABBREVIATION OF REATOR ANAEROBICO DE FLUX ASCENDENTE (UPFLOW ANAEROBIC SLUDGE BLANKET) IN PORTUGUESE.

Fig. 3.3-6	Typical Configuration of RAFA Reactor

THE STUDY ON STORMWATER DRAINAGE AND SEWERAGE MANAGEMENT PLAN FOR RMR

Fig. 3.3.-7 Implementation Plan for 55 sewerage Systems

River Basin	Sewerage Subsystem	2020 Population	Construction cost(1000R$)	Phase 1										Phase 2									
				2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Beberibe	Peixinhos	398,839	48,558																				
	Nova Descoberta	65,506	11,529																				
	Dois Unidos	63,495	11,790																				
	Aguazinha	59,005	10,882																				
	Caixa D'água	35,305	11,340																				
Capibaribe	Cabanga	304,394	30,376																				
	Cordeiro	100,048	17,128																				
	Camaragibe/Recife 1	61,043	20,424																				
	São Lourenço 1	45,783	18,301																				
	Caxangá	37,326	12,733																				
	Roda de Fogo	27,810	2,149																				
	São Lourenço 2	33,288	16,064																				
	Camaragibe 3	30,238	13,395																				
	Camaragibe 2	26,107	6,556																				
	Parque Capibaribe	23,475	2,061																				
	Camaragibe 1	24,870	7,830																				
	Camaragibe/Recife 2	16,477	5,939																				
	Vila Burity	11,397	1,654																				
	Apipucos	10,339	3,970																				
	Bonanca	5,025	3,420																				
Jaboatão	Prazeres	233,403	44,768																				
	Curcurana	123,636	26,570																				
	Jaboatão 2	56,231	22,163																				
	Ibura de Cima	51,984	7,119																				
	Comportas	49,970	12,794																				
	Jaboatão 1	45,472	9,543																				
	Jaboatão 3	36,974	13,027																				
	Ponte dos Carvalhos	24,365	3,955																				
	Moreno 1	18,792	6,532																				
	Moreno 2	6,435	1,342																				
	Moreno 3	3,465	1,929																				
Tejipio	Boa Viagem	159,314	37,145																				
	Jardim Sao Poulo	56,101	16,932																				
	Imbiribeira	56,497	11,160																				
	Mangueira	42,642	4,050																				
	Ibura de Baixo	179,179	32,217																				
	Curado	18,626	1,049																				
	Vila dos Milagres	14,289	122																				
	27 de Novembro	9,369	1,158																				
	Ignês Andreazza	6,579	1,038																				
Timbo	Janga	316,075	47,192																				
	Conceição	62,445	17,688																				
	Caetés	60,779	4,647																				
	Mutirão	6,380	683																				
Other Basins	Paulista	68,930	11,191																				
	Igarassu 2	50,251	17,772																				
	Mirueira	34,009	3,296																				
	Parque Pirapama	32,794	3,288																				
	Jardim Paulista	24,851	1,298																				
	Ipojuca - Sede	17,856	3,239																				
	Charnequinha	15,096	3,101																				
	Itapissuma 1	10,679	3,339																				
	Itapissuma 2	10,416	2,818																				
	Nova Cruz	5,244	2,231																				
	Praia Porto de Galinhas	3,705	2,027																				

RIVER BASIN	NO	PRIORITY PROJECTS		
		SYSTEM	SERVED AREA(HA)	POPULATION IN 2020
CAPIBARIBE	13	■	2,260	304,394
	14	■	675	100,048
		SUB-TOTAL	2,935	404,442
JABOATÃO	22	■	1,548	233,403
	21	■	910	123,636
		SUB-TOTAL	2,458	357,039
TEJIPIO	34	■	1,281	159,314
		SUB-TOTAL	1,281	159,314
TIMBO	41	■	2,879	316,075
	43	■	710	62,445
		SUB-TOTAL	3,589	378,520
OTHER BASINS				
		SUB-TOTAL	0	0
PRIORITY PROJECTS TOTAL			12,811	1,698,154

LEGEND

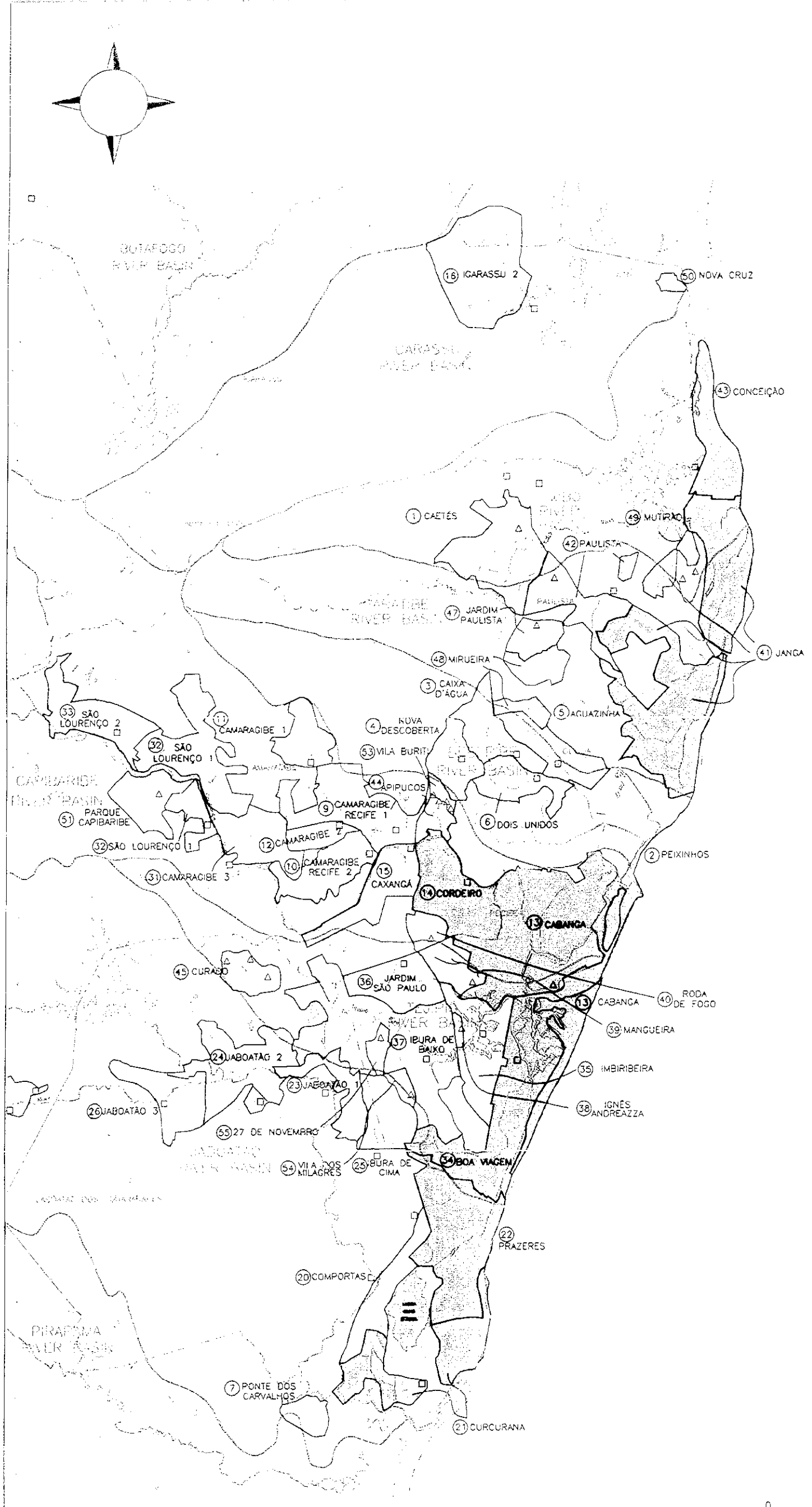
- □ PROPOSED LOCATION FOR INSTALLATION OF TREATMENT STATION
- △ EXISTENT ETE (DRAINING TREATMENT STATION)
- SANITARY DRAINING LIMIT
- MUNICIPALITY LIMIT
- RIVER BASIN LIMIT
- RIVER
- ■ Priority Projects

SCALE;1:100.000 0 2 4 6 8 10 (km)

Fig.3.3-8 Subsystems for the Master Plan

THE STUDY ON STORMWATER DRAINAGE AND WASTEWATER MANAGEMENT PLAN FOR RMR

DATE: SCALE: DRAW: CORINA



RIVER BASIN	NO	PRIORITY PROJECTS SYSTEM	SERVED AREA(HA)	POPULATION IN 2020
CAPIBARIBE	13	CABANGA	2,260	304,394
	14	CORDEIRO	675	100,048
		SUB-TOTAL	2,935	404,442
JABOATÃO	22	PRAZERES	1,548	233,403
	21	CURCURANA	910	123,636
		SUB-TOTAL	2,458	357,039
TEJIPIO	34	BOA VIAGEM	1,281	159,314
		SUB-TOTAL	1,281	159,314
TIMBO	41	JANGA	2,879	316,075
	43	CONCEIÇÃO	710	62,445
		SUB-TOTAL	3,589	378,520
OTHER BASINS		SUB-TOTAL	0	0
PRIORITY PROJECTS TOTAL			12,811	1,698,154

LEGEND

- PROPOSED LOCATION FOR INSTALLATION OF TREATMENT STATION
- EXISTENT ETE (DRAINING TREATMENT STATION)
- SANITARY DRAINING LIMIT
- MUNICIPALITY LIMIT
- RIVER BASIN LIMIT
- RIVER
- Priority Projects

SCALE;1:100,000 0 2 4 6 8 10 (km)

Fig.3.3.8 Subsystems for the Master Plan

THE STUDY ON STORMWATER DRAINAGE AND WASTEWATER MANAGEMENT PLAN FOR RMR

DATE: SCALE: DRAW. CHKD.

3.4 Stormwater Drainage

3.4.1 General

A major task in this stormwater drainage study was reviewing the PQA reports, PE, RD-1 and RD-2. Most of the flood problems in the RMR occur in the three cities of Olinda, Recife and Jaboatao dos Guararapes. Therefore, this drainage study focuses on these three city areas as studied in the PQA. Discussions with the related authorities of these cities were held and these confirmed the contents of the PQA proposals / plans and ongoing projects.

Flood problems in the RMR are summarized as follows:

1) Flooding in the swampy areas along the coast and around the lake where low-income people are living. High tides and river flooding affect these areas.
2) Flooding along the rivers/channels, where informal settlements are located, due to the accumulation of solid wastes, aquatic plants and sediments.
3) Increase in flood and sediment runoffs due to unplanned developments in the hilly and sloped areas.
4) Fooding of roads due to inadequate drainage.
5) Local flooding due to inadequate drainage.

Except in items 4) and 5), a single sector of stormwater drainage alone will not give a complete or sustainable solution of these flood problems, because of their social nature and other factors. Under such conditions, a multi-sector project including drainage improvement works is underway.

3.4.2 Basic Conditions and Criteria

(1) Study Area

The area to be studied is the flood prone area in the urban areas of the RMR, namely the same areas as those in the PQA-RD. Most of the potential flood areas are located in the above mentioned three cities.

(2) Land Use in 2020

Land use in 2020 is the same as that for the sewerage plan. The drainage channels to be improved are located in urban areas. The basins in 2020 are assumed to be in urban areas for design discharge calculations. The projected population in 2020 in the PQA could be used for project evaluation since almost all of the flood areas are residential.

(3) Design Rainfall

The design rainfall for a 20-year return period was adopted in the PQA for the design discharge calculation. This design scale seems to be large compared with the big cities in other countries such as Jakarta, Manila, Kuala Lumpur, Tokyo, etc; however, the difficulty in land acquisition/compensation is high in these cities. The small rivers and drainage channels in the RMR could be expanded if informal houses did not exist along the channels. Therefore, the design rainfall for a 10 to 20-year return period can be adopted for the small rivers/main channels (macro drainage).

The design rainfall adopted in the PQA is as follows:

1) The design rainfall in the 1980 Plan was used.
2) Design return period of storms is 20 years.
3) Two equations relating rainfall intensity-duration-return period were compared and whichever gave a higher value was adopted. The following are the equations compared.

Equation (I): $\mathbf{I_1 = (T - 1.5)^{0117} \times 456.768\ (1 - t^8 \times 4.54 \times 10^{-21}) / (t + 6)^{0.5811}}$

Equation (II): $\mathbf{I_2 = 72.153\ (T - 1.75)^{0.173} / (t/60 + 1)^{0.74826}}$

where

I = Rainfall intensity for duration of storm "t (minutes)" in mm/hr

T = Return period of storm in years

4) The two equations were developed in 1980 using the automatic rain gauge data recorded at Recife Airport for about 70 years. The values for the rainfall intensity in the two equations show a large difference, for instance, 56.3 and 71.0 mm/hour for a 20-year return period for 60 minutes duration (refer to Table 3.4-1).

There are 30 rainfall stations in the RMR measuring only daily rainfall. The daily rainfall data from 1961 to 1998 is available at Recife Station. The daily rainfall was measured at the fixed time of 7:00 am. For more accurate calculations of the design discharges, yearly maximum rainfall of short duration (10min, 30min, 60min, 24 hours, etc) for many years are required. Since enough data is not available now, the design rainfall will be reviewed in the future.

Measurement of rainfall of short duration at about three stations would be required to review the design rainfall. At first, the relationship between daily rainfall and short duration rainfall should be established by using the data of several years to review the design rainfall. The design rainfall (rainfall intensity – duration curves for several return periods) could be

established after a long-term measurement.

In this Study, the design rainfall in the PQA is applied.

(4) Design Tide Level and River Flood Level

The maximum high spring tide during the rainy season (March to August) is recommended as the lower boundary condition. The maximum spring tide is 2.50 - 1.14 = 1.36 m (say 1.35m) above mean sea level. (The tide-gauge datum at Resife Port is 1.14m below mean sea level.) The observed maximum tide level is 2.82 – 1.14 = 1.68 m above mean sea level.

The river flood level is an outlet condition of a drainage channel. River improvement plans for the Beberibe, Capibaribe and Jaboatao river systems are required, which include longitudinal profile, typical cross sections and alignments of the rivers. It is assumed that 0.5 m below bank level is the river flood level for the drainage planning in this stage.

3.4.3 Design Discharge

(1) Design Discharge

In the reports, PQA-RD, detailed design discharges for the related rivers/channels were calculated after comparison of three methods. At this stage, the design discharges calculated in the PQA are used (refer to Table 3.4-2). For other rivers or channels, the curves showing the relationship between drainage area and discharge (20-year return period) or some specific discharges could be used as required. Design discharge is calculated by using the following Rational Formula.

Q = (1/3.6) C R A

where Q = Design peak discharge in m^3/sec

C = Runoff coefficient (the same as PQA-RD)

R = Rainfall intensity for storm duration "t(minutes)" (the same as PQA-RD)

A = Drainage area in km^2

For micro drainage (drainage of road surface and small areas), some standard discharge or standard design described in the PQA could be applied.

(2) Channel Design

Manning's Formula described below and the coefficients proposed in the PQA are adopted.

$Q = (1/n)\ R^{2/3}\ I^{1/2}\ A$

where Q = Discharge (m^3/s), n = Roughness coefficient
R= Hydraulic radius (m), I = Slope(V-H ratio),
A:= Flow area (m^2)

3.4.4 Drainage Improvement Plan

(1) Drainage Method

1) Drainage by gravity flow to the rivers is applied, in principle, as proposed in the PQA.
2) The areas lower than around 2.0 m are difficult to drain by gravity and considered to be a marsh. Such areas should not be developed unless the area is reclaimed.
3) Drainage by pumping is not recommended for financial reasons.

(2) Project Components

The drainage improvement plan in the PQA is reviewed and basically adopted. The PQA plan for drainage improvements in the cities of Recife, Jaboatao and Olinda are shown in Table 3.4-3 and summarized below:

1) Recife

Drainage improvements of the 15 critical flood areas including,

- Revetments of two open channels: Cross section = 2m x 2m, Side slope = 1:1.5, Length = 800 + 150 = 950m
- Cleaning of channel: 550m
- Culverts and pipes: New = 450m, Cleaning, Rehabilitation
- Road surface drains, pavements and manholes

2) Jaboatao dos Guararapes

Drainage improvements of the 4 critical flood areas including,

- Revetment of three open channels: Cross section = 2m x 2m, Side slope = V1.0:H1.5, Length = 900 + 1,200 + 1,200 = 3,300m
- Cleaning of channel: 2,800m
- Culverts and pipes: New = 550m, Cleaning 700m, Rehabilitation 80m
- Road surface drains, pavements and manholes

3) Olinda

Drainage improvements of the 3 critical flood areas including,

- Revetment of two open channels: Cross section = 2m x 2m, Side slope = V1.0:H1.5, Length = 1,800m
- Cleaning of channel: 400m
- Culverts and pipes: Cleaning 1,500m, Rehabilitation 150m
- Road surface drains, pavements and manholes

Drainage improvement plans in the PQA for the municipalities are shown in Fig. 3.4-1.

The ongoing projects managed by the municipalities should be continued. Major projects are the following.

1) Road surface drainage by the municipality of Recife. A detailed survey of existing facilities has been scheduled.
2) Improvements of the remaining drainage channels in Recife
3) Improvements of the drainage channels in Olinda
4) Redevelopment of the swamp area in Olinda
5) Improvements of the drainage channels in Jaboatao dos Guararapes

3.4.5 Operation and Maintenance

Operation and maintenance of the stormwater drainage is proposed as follows:

1) The municipalities are responsible for design, construction and maintenance of the drainage facilities.
2) A river flood control plan, as a basis for the drainage, is to be prepared by the State Government. This should be reinforced.
3) The municipalities are carrying out the education of residents regarding solid waste disposal into the rivers/channels, occupation of the water front areas, etc. This should be promoted for smooth O/M of the drainage facilities.

3.4.6 Phased Program

The basic concept of the phased program is as follows:

(1) First 5 Years

- Measure rainfall for short duration and river flood levels
- Review hydraulic design conditions such as rainfall, river flood levels, land use

topographic conditions, etc

- Design and construct the drainage projects in the PQA after topographic survey,
- Conduct a survey of existing drainage facilities and design, and execute the road surface drainage works

Other related projects and measures related to stormwater drainage should be executed.

1) Pro-Metropole Project for the informal areas in the Beberibe River basin
2) Land use regulation of the areas along the rivers and swamps
3) Prepare development plans of the informal settlement areas in low lands and along the rivers and execute the projects as required
4) Improvement of the Canal Olho d'Agua from the Lagoon outlet to the Jaboatao River confluence (planning/design and construction)

(2) Second 5 Years

1) Prepare the river improvement plans of required reaches of the major rivers
2) Review the flood areas and drainage projects; both planned and implemented

(3) 2010 to 2020

1) Establish the design conditions
2) Review the flood control and drainage conditions and revise the contents of the projects if any changes are required.

Table 3.4-1 Rainfall Intensity-Duration Relationship (1/3)

Time	TR = 10 YEARS				
	EQUATION 1		EQUATION 2		USED VALUE
min	mm/h	mm	mm/h	mm	mm
10.0	117.14	20	92.62	15	20
15.0	100.02	25	87.96	22	25
20.0	88.35	29	83.81	28	29
22.5	83.76	31	81.91	31	31
25.0	79.76	33	80.10	33	33
30.0	73.12	37	76.74	38	38
40.0	63.42	42	70.93	47	47
50.0	56.57	47	66.04	55	55
60.0	51.41	51	61.88	62	62
70.0	47.37	55	58.28	68	68
80.0	44.08	59	55.14	74	74
90.0	41.35	62	52.36	79	79
100.0	39.04	65	49.90	83	83
110.0	37.04	68	47.68	87	87
120.0	35.30	71	45.69	91	91
130.0	33.76	73	43.88	95	95
140.0	32.39	76	42.22	99	99
150.0	31.15	78	40.71	102	102
160.0	30.02	80	39.32	105	105
170.0	28.98	82	38.03	108	108
180.0	28.02	84	36.84	111	111
190.0	27.10	86	35.73	113	112
200.0	26.23	87	34.70	116	116
210.0	25.37	89	33.73	118	118
220.0	24.52	90	32.83	120	120
230.0	23.65	91	31.97	123	123
240.0	22.74	91	31.97	125	125

Table 3.4-1 Rainfall Intensity-Duration Relationship (2/3)

Time	TR = 20 YEARS				
	EQUATION 1		EQUATION 2		USED VALUE
min	mm/h	mm	mm/h	mm	mm
10.0	128.30	21	106.26	18	21
15.0	109.55	27	100.91	25	27
20.0	96.76	32	96.15	32	32
22.5	91.73	34	93.97	35	35
25.0	87.36	36	91.89	38	38
30.0	80.09	40	88.04	44	44
40.0	69.46	46	81.37	54	54
50.0	61.95	52	75.77	63	63
60.0	56.31	56	70.99	71	71
70.0	51.88	61	66.86	78	78
80.0	48.28	64	63.26	84	84
90.0	45.29	68	60.07	90	90
100.0	42.76	71	57.24	95	95
110.0	40.57	74	54.70	100	100
120.0	38.67	77	52.41	105	105
130.0	36.98	80	50.34	109	109
140.0	35.48	83	48.44	113	113
150.0	34.12	85	46.70	117	117
160.0	32.88	88	45.11	120	120
170.0	31.75	90	43.63	124	124
180.0	30.69	92	42.26	127	127
190.0	29.69	94	40.99	130	130
200.0	28.73	96	39.81	133	133
210.0	27.79	97	38.70	135	135
220.0	26.85	98	37.66	138	138
230.0	25.90	99	36.68	141	141
240.0	24.91	100	35.76	143	143

Table 3.4-1 Rainfall Intensity-Duration Relationship (3/3)

Time	TR = 50 YEARS				
	EQUATION 1		EQUATION 2		USED VALUE
min	mm/h	mm	mm/h	mm	mm
10.0	143.62	24	125.72	21	24
15.0	122.62	31	119.39	30	31
20.0	108.31	36	113.77	38	38
22.5	102.68	39	111.18	42	42
25.0	97.79	41	108.72	45	45
30.0	89.65	45	104.17	52	52
40.0	77.75	52	96.27	64	64
50.0	69.35	58	89.65	75	75
60.0	63.03	63	83.99	84	84
70.0	58.07	68	79.11	92	92
80.0	54.05	72	74.84	100	100
90.0	50.70	76	71.08	107	107
100.0	47.86	80	67.73	113	113
110.0	45.42	83	64.72	119	119
120.0	43.28	87	62.01	124	124
130.0	41.39	90	59.56	129	129
140.0	39.71	93	57.31	134	134
150.0	38.19	95	55.26	138	138
160.0	36.81	98	53.37	142	142
170.0	35.54	101	51.62	146	146
180.0	34.35	103	50.00	150	150
190.0	33.23	105	48.50	154	154
200.0	32.15	107	47.10	157	157
210.0	31.11	109	45.79	160	160
220.0	30.06	110	44.56	163	163
230.0	28.99	111	43.40	166	166
240.0	27.88	112	42.31	169	169

Table 3.4-2 Design Discharges by PQA (1/3)

CAPIBARIBE BASIN

NAME OF CHANNEL	CROSS SECTION	DRAINAGE AREA (km^2)	DESIGN DISEHARGE (m^3/S)		APPLIED METHOD
			10-Y-FLOOD	20-Y-FLOOD	
CAIARA	Natural	1.41	12.83	16.87	TUCCI
COHAB	Rectangular				
SPORT	Trapezoidal				
VALENCA	Natural	0.58	5.09	6.13	SCS
ZUMBI	Trapezoidal	1.25	9.37	12.10	TUCCI
LINS PETIT	Natural	0.66	5.57	7.06	SCS
IPA	Natural				
ABC SUPERIOR	Natural	2.38	14.34	18.69	TUCCI
ABC INFERIOR	Natural				
PARNAMIRIM	Natural	2.20	14.57	18.90	TUCCI
SERPRO	Trapezoidal	0.18	3.51	3.84	RATIONAL
CAVOUCO	Natural	4.46	26.23	33.66	TUCCI
SANTA ROSA	Natural	1.43	10.18	12.91	TUCCI
DERBY-TACARUNA	Trapezoidal	6.46	31.48	40.76	TUCCI
GOLF CLUB	Natural	1.50	12.48	16.15	TUCCI
PRADO	Rectangular	2.46	17.59	22.71	TUCCI
SAO MATEUS	Natural	0.61	7.12	8.44	SCS
COOUE	Trapezoidal				

Source: PQA RD-2, Table 3.2

Table 3.4-2 Design Discharges by PQA (2/3)

BEBERIBE BASIN

NAME OF CHANNEL	CROSS SECTION	DRAINAGE AREA (km^2)	DESIGN DISEHARGE (m^3/S)		APPLIED METHOD
			10-Y-FLOOD	20-Y-FLOOD	
VASCO DA GAMA	Trapezoidal	13.040	69.61	88.87	TUCCI
CORREGO DO EUCLIDES	Trapezoidal	0.462	6.49	7.45	RATIONAL
CORREGO SAO GABRIEL	Rectangular	0.225	5.15	5.64	RATIONAL
SAO SEBASTIAO	Trapezoidal	1.220	14.19	17.01	SCS
TAMARINEIRA	Trapezoidal	1.020	10.52	12.57	SCS
REGENERACAO	Natural	1.040	9.01	10.85	SCS
PEDRO DE MELO PEDROSA	Natural	0.180	3.04	3.33	RATIONAL
PONTO DE PARADA	Trapezoidal	1.380	9.84	13.15	TUCCI
CORREGO DA AREIA	Rectangular	1.045	11.35	13.97	SCS
FREDERICO OSANAN	Natural	0.130	3.55	3.89	RATIONAL
MALACO	Rectangular	0.175	3.54	3.88	RATIONAL
NOVA DESCOBERTA (B.RIO MORNO)	Natural	1.840	15.13	19.10	TUCCI
NOVA DESCOBERTA (B.VASCO DA GAMA)	Natural	0.310	6.51	7.13	RATIONAL
CORREGO DA IMBAUBA	Natural	0.057	2.11	2.31	RATIONAL
CORREGO DO ARCANJO	Natural	0.048	1.77	1.94	RATIONAL
CORREGO DO EUCALIPTO	Natural	0.310	7.08	7.75	RATIONAL
BOMBA DO HEMETERIO	Cover	3.100	24.46	30.82	TUCCI
DOMINGOS SAVIO	Rectangular	0.126	3.50	3.83	RATIONAL
JOSE GRANDE	Rectangular	0.195	4.81	5.27	RATIONAL
CORREGO DO TIRO	Natural	0.208	4.40	4.82	RATIONAL
COTO	Natural	0.260	5.00	5.47	RATIONAL

Source: PQA RD-1, Table 5.12

Table 3.4-2 Design Discharges by PQA (3/3)

CAPIBARIBE BASIN

NAME OF CHANNEL	CROSS SECTION	DRAINAGE AREA (km^2)	DESIGN DISEHARGE (m^3/S)		APPLIED METHOD
			10-Y-FLOOD	20-Y-FLOOD	
MARINHA	Natural	0.34	5.27	6.04	RATIONAL
30 DE OUTUBRO	Natural	0.21	4.06	4.45	RATIONAL
CURADO	Natural	10.73	53.81	69.16	TUCCI
AREIAS	Natural	1.05	10.61	13.33	SCS
GUARULHOS	Natural	7.51	37.91	48.66	TUCCI
SAO PEDRO	Natural	0.34	5.65	6.19	RATIONAL
BARRETO(VACA)	Natural	0.42	6.15	7.09	RATIONAL
JD.SAO PAULO	Natural	4.38	33.63	42.23	TUCCI
RIO JIQUIA	Natural	20.38	92.40	118.21	TUCCI
ESTANCIA	Natural	2.54	18.86	23.38	TUCCI

Table 3.4-3 (1/2) Proposed Drainage Improvement in PQA: RECIFE

Critical Point No	Name of Neighborhood	Influence Channel	Channel Cleaning (m)	Revestment of Channel			Paved Roads (m) (2)	Drainage Inlet			Paving	
				Length (m)	Cross Section Type	Cross Section Dim. (m)		Cleaning (places)	Rehabili. (places.)	New	Length (m)	No. of Roads
1	Ponta de Parada	Ponto de Parada	350.00	150.00	Trapezoidal	2.00*2.00	450.00	20	2	4	50.00	1
2	Cajueiro	Rio Beberibe								14	200.00	1
3	Fundao	Canal da Regeneracao		800.00	Trapezoidal	2.00*2.00				34	500.00	5
4	Santo Amaro	Derbi-Tacaruna					150.00	8	1			1
5	Santo Amaro	Derbi-Tacaruna					450.00	20	2			1
6	Parque Amorim	Derbi-Tacaruna										
7	Derbi	Derbi-Tacaruna										
8	Paissandu	Derbi-Tacaruna										
9	Aflitos	Derbi-Tacaruna					100.00	6	1			1
10	Remedios	ABC					100.00	6	1	8	100.00	1
11	Cordeiro	Santa Rosa					700.00	30	3			
12	Cordeiro	Santa Rosa										
13	Caxanga	Golf Club	100.00				150.00	8	1	14	200.00	4
14	Iputinga	Caiara	100.00				250.00	12	1			
15	Ilha do Recife						700.00	30	3			

Note : (1) * Height, With side slopeof 1,00V : 1,5 H

(2) - Aproximate length (Visual quantification in the field) paving roads areas under imediate influence of inundation

Critical Point No	Name of Neighborhood	Gutter (m)	Major Gutter (m)	Lateral Drain (m)	Drainage Culvert/Pipe				Manhole				Observation
					Official Length (m)	Cleaning (m)	Rehabili (m)	New (m)	Official (places)	Cleaning (places)	Rehabili (places)	New (places)	
1	Ponta de Parada	100.00	7.00		225.00	225.00	20.00	50.00	5	5		2	Diverse roads stream
2	Cajueiro	400.00	28.00					50.00				2	Rua Barao de Tamandare
3	Fundao	800.00	70.00	200.00				150.00				4	Diverse roads stream
4	Santo Amaro				75.00	75.00	10.00		2	2			Rua Conde D Eu
5	Santo Amaro			300.00	225.00	225.00	20.00		5	5			Rua do Norte
6	Parque Amorim												Diverse roads stream
7	Derbi												Diverse roads stream
8	Paissandu												Av. Agamenon Magalhaes
9	Aflitos			50.00	50.00	50.00	10.00		2	2			Rua Amelia
10	Remedios	100.00	14.00	100.00	50.00	50.00	10.00		2	2			Diverse roads stream
11	Cordeiro				350.00	350.00	40.00		8	8			Rua do Forte
12	Cordeiro												Rua Clotilde de Oliveira
13	Caxanga	400.00	28.00		75.00	75.00	10.00	200.00	2	2		5	Diverse roads stream
14	Iputinga			250.00	125.00	125.00	10.00		3	3			Av. Caxanga
15	Ilha do Recife			250.00	350.00	350.00	40.00		8	8			Rua do Brum

Source; PQA-RD-2

Table 3.4-3 (2/2) Proposed Drainage Improvement in PQA - JABOATAO DOS GUARARAPES and OLINDA

<Jaboatao dos Guararapes>

Critical Point N°	Name of Neighborhood	Influence Channel	Channel Cleaning (m)	Revestment of Channel Length (m)	Revestment of Channel Cross Section Type	Revestment of Channel Cross Section Dim. (m)	Paved Roads (m) (2)	Dranege Inlet Cleaning (places)	Dranege Inlet Rehabili. (places)	Dranege Inlet New (places)	Pavement Length (m)	Pavement Quant. Of Roads
1	Jd. Copacabana	Setubal	1,100.00				500.00	22	2	102	1,500.00	10
2	Candeias	Carolinas	1,200.00	900.00	Trapezoidal	2.00*2.00	500.00	22	2	102	1,500.	10
3	Candeias	Aniceto Carmo	500.00	1,200.00	Trapezoidal	2.00*2.00	200.00	10	1			
4	Cajueiro Seco	Cor. Do Carmo		1,200.00	Trapezoidal	2.00*2.00	200.00	10	1			

Note : (1) * Side slope = V1.0 : H1.5 1

(2) - Approximate length(Visual quantification in the field) of paved roads in the areas of imediate influence of inundation

<Jaboatao dos Guararapes>

Critical Point No	Name of Neighborhood	Gutter (m)	Major Gutter (m)	Lateral Drain (m)	Drainage Culvert/Pipe Official Length (m)	Drainage Culvert/Pipe Cleaning (m)	Drainage Culvert/Pipe Rehabili. (m)	Drainage Culvert/Pipe New (m)	Manhole Official (No.)	Manhole Cleaning (No.)	Manhole Rehabili. (No.)	Manhole New (No.)	Observation
1	Jd. Copacabana	2,600.00	210.00	400.00	250.00	250.00	30.00	300.00	6	6		7	Diverse roads stream
2	Candeias	2,500.00	210.00	500.00	250.00	250.00	30.00	250.00	6	6		6	
3	Candeias			500.00	100.00	100.00	10.00		3	3			
4	Cajueiro			200.00	100.00	100.00	10.00		3	3			Diverse roads stream

<Olinda>

Critical Point N°	Name of Neighborhood	Influence Channel (m)	Channel Cleaning (m)	Revestment of Channel Length (m)	Revestment of Channel Cross Section Type	Revestment of Channel Cross Section Dim. (m)	Paved Roads (m) (2)	Dranege Inlet Cleaning (places)	Dranege Inlet (places)	Dranege Inlet New (places)	Pavement Length (m)	Pavement No. of Street
1	Aguas Compridas	Cor Do Abacaxi		1800.00	Trapezoidal	2.00*2.00	2000.00	82	8			
2	Azeitona		200				1400.00	58	6			
3	Jardim Brasil	Canal Da Malaria	200									

Note : (1) Base * Side slope = V1.0 : H1.5 1

(2) - Approximate length(Visual quantification in the field) of paved roads in the areas of imediate influence of inundation

<Olinda>

Critical Point No	Name of Neighborhood	Gutter (m)	Major Gutter (m)	Dranage Pipe (m)	Drainage Culvert/Pipe Official Length (m)	Drainage Culvert/Pipe Cleaning (m)	Drainage Culvert/Pipe Rehabili. (m)	Drainage Culvert/Pipe New (m)	Manhole Official (places)	Manhole Cleaning (places)	Manhole Rehabili (places)	Manhole New (places)	Observation
1	Aguas Compridas			150.00	500.00	500.00	50.00		11	11			Diverse roads stream
2	Azeitona			500.00	1000.00	1000.00	100.00		21	21			Av. Pres. Kennedy
3	Jardim Brasil												Diverse roads stream

Source: PQA-RD-2

3.5 Construction Plan and Cost Estimate

3.5.1 Construction Plan

(1) Sewerage Project

The proposed projects are divided into six groups based on the river basins, i.e. the Beberibe, Capibaribe, Jaboatao, Tejipio, Timbo and other river basins. The projects are planned to be implemented in two Phases from 2000 to 2010 and from 2011 to 2020. Implementation of the projects in each group consists of preparatory, detailed design and construction works.

The construction schedule of the projects is prepared on the basis of the conceptual designs of the projects in the Master Plan, after referring the program proposed in the PQA,

Construction Schedule of the Projects

NO	Construction Works Group(Basin)	Work Item	Phase 1 2000-2010	Phase 2 2011-2020
			1 2 3 4 5 6 7 8 9 10	11 12 13 14 15 16 17 18 19 20
1	(Basin) Group 1 Beberibe	Preparatory Work Detailed Design Construction		
2	Group 2 Capibaribe	Preparatory Work Detailed Design Construction		
3	Group 3 Jaboatao	Preparatory Work Detailed Design Construction		
4	Group 4 Tejipio	Preparatory Work Detailed Design Construction		
5	Group 5 Timbo	Preparatory Work Detailed Design Construction		
6	Group 6 Others	Preparatory Work Detailed Design Construction		

(2) Drainage Project

The stormwater drainage projects are scheduled to be completed within five years considering the volume of the works and their urgency.

3.5.2 Project Cost Estimate

(1) Sewerage Projects

1) Basis of Cost Estimate

- The project cost is expressed in R$(Real).
- The price level is based the economic conditions that prevailed in November 1999. The prevailing exchange rates of currency are R$1.90 = US$1.00 = ¥105.00.
- Basic construction unit prices data are derived from:
  (i) Service price table by COMPESA, June 1999
  (ii) Construction services costs by PINI, November 1999

2) Project Cost

The project cost, which includes direct and indirect costs, is estimated at R$ 853 million. The direct cost is composed of construction cost and land acquisition/compensation cost, while an indirect cost includes administration costs, engineering service costs and physical contingencies.

(i) Construction Cost

- The construction cost was estimated principally with the cost function of each work quantity for the sewerage facilities proposed in the Master Plan. The cost functions used for the cost estimate are shown in Table 3.5-1. The construction cost comprises the expansion and rehabilitation works of sewerage subsystems as shown in Table 3.5-2. The construction costs of these sewerage subsystems are aggregated in the two construction stages (Phase 1 and Phase 2) and the works groups as shown in Table 3.5-3. A further breakdown of construction cost is tabulated in Table 3.5-2.

(ii) Engineering Services cost

- The cost of engineering services for the feasibility study, detailed design and construction supervision is assumed to be 10% of the construction cost.

(iii) Government Administration Cost

- The Government administration cost in sewerage systems is assumed to be 10% of the construction cost to cover the cost of supervision and management of the project.

(iv) Physical Contingencies

- The physical contingency allowance is assumed to be 10% of the construction cost. The price contingency is not included in this project cost because of the unforeseeable

escalation price increase during the long time span of the implementation period.

The breakdown of the project cost is as follows:

	(Unit: million R$)
1. Construction Cost	634.5
1) Phase 1	504.7
A) Expansion	
a) Collector and Branch Sewers	280.8
b) Trunk and Pressure Pipes	55.6
c) Pumping Facilities	17.5
d) Sewerage Treatment Facilities	133.5
Total	487.4
B) Rehabilitation Works	
a) Sewer Networks	4.0
b) Pumping Facilities	2.0
c) Sewage Treatment Facilities	11.2
Total	17.3
2) Phase 2	129.8
A) Expansion Works	
a) Collectors and Branch Sewers	74.9
b) Trunk and Pressure Pipes	6.4
c) Pumping Facilities	4.5
d) Sewerage Treatment Facilities	41.3
Total	127.1
B) Rehabilitation Works	
a) Sewer Networks	1.2
b) Pumping Facilities	0.3
c) Sewerage Treatment Facilities	1.2
Total	2.7
2. Land Acquisition Cost	
1) Phase 1	23.6
2) Phase 2	4.1
Total	27.7
3. Government Administration Cost	63.5
4. Engineering Service Cost	63.5

5. Physical Contingency	63.5
Grand Total	852.7

The construction cost of each group is shown in Table 3.5-3.

Land acquisition cost is shown in Table 3.5-4, 3.5-5 and 3.5-6.

(2) Stormwater Drainage Project

1) Basic Condition

- The project cost is expressed in R$(Real).
- The price level is based on the economic conditions that prevailed in November 1999. The prevailing exchange rates of currency are R$1.90 = US$1.00 = ¥105.00.
- Basic construction unit prices are derived from.
  (i) Service Price Table by COMPESA, June 1999
  (ii) Construction Services Cost by PINI, November 1999

2) Project Cost

The project cost for the stormwater drainage system is estimated at R$ 5.0 million at November 1999 prices. The project cost consists of the engineering services cost, the construction cost, the government administration cost and physical contingencies.

(i) Construction Cost

- The construction cost is estimated by updating the cost proposed in the PQA (10 % added for price escalation from 1998 to 1999).

(ii) Engineering Services Cost

- The cost of engineering services for detailed design and construction supervision is assumed to be 10% of the construction cost.

(iii) Government Administration Cost

- The Government administration cost for the sewerage system is assumed to be 3% of the construction cost to cover the cost of supervision and management of the project.

(iv) Physical Contingency

- The physical contingency allowance is assumed to be 10% of the construction cost.

The breakdown of the project cost is as follows.

R$ (million)

1. Construction Cost	4.18
i) Recife	0.81
ii) Olinda	1.03
iii) Jaboatao	2.34
2. Engineering Services Cost	0.42
3. Government Administration	0.13
4. Contingency	0.42
5. Project Cost	5.15

A further breakdown of the improvement costs is shown in Table 3.5-7.

3.5.3 Operation and Maintenance Cost

The annual cost for Operation and Maintenance (O/M) is estimated by assuming a percentage of the construction cost referring to the O/M costs in similar projects and cost estimates of routine O/M activities.

(1) Sewerage Project

A major portion of the O/M cost of the proposed sewerage facilities is the electric power charge for equipment and the cost of personnel. The O/M costs are estimated at R$ 44 million, 7% of the construction cost as follows:

Phase	(R$. million)	
1) Phase 1.	35.3	Construction Cost x 7%
2) Phase 2.	9.1	Construction Cost x 7%
Total	44.4	

(2) Stormwater Drainage Project

A major portion of O/M cost of the drainage system is the cost of personnel for cleaning the drainage channels. The O/M cost is estimated at R$ 84 thousand, 2% of the construction cost.

Table 3.5-1 Cost Function of Construction Cost for Sewerage Facilities

No.	Work Items	Cost Functions	Symbols
1	Piping works of polyvinylchloride pipe	$C_{vp} = 0.0121D^{1.52}$	C_{vp} : Unit cost of PVC piping works (R$/m) D : Nominal diameter (mm)
2	Piping works of ductile iron pipe	$C_{dip} = 0.0389D^{1.43}$	C_{dip} : Unit cost of DIP piping works (R$/m) D : Nominal diameter (mm)
3	Pumping Station	$C_p = 73.3CV^{0.271}$	C_p : Construction Cost (R$1000) CV : Motor shaft power (CV)
4	Sewage lifting facilities	$C_{lf} = 4.67Q^{0.355}$	C_{lf} : Construction Cost (R$1000) Q : Average daily sewage flow (m^3/day)
5	Grit chamber	$C_{gc} = 0.370Q^{0.649}$	C_{gc} : Construction Cost (R$1000) Q : Average daily sewage flow (m^3/day)
6	RAFA reactor	$C_{raf} = 0.0972Q + 262$	C_{raf} : Construction Cost (R$1000) Q : Average daily sewage flow (m^3/day)
7	Lagoon	$C_{rag} = 0.0655Q + 117$	C_{rag} : Construction Cost (R$1000) Q : Average daily sewage flow (m^3/day)
8	Bio-filter	$C_{bf} = 0.2075Q + 580$	C_{bf} : Construction Cost (R$1000) Q : Average daily sewage flow (m^3/day) (This includes the cost of secondary sedimentation tank)
9	Disinfection facilities	$C_{dis} = 0.0186Q + 126$	C_{dis} : Construction Cost (R$1000) Q : Average daily sewage flow (m^3/day)
10	Sludge drying bed	$C_{sdb} = 1.23Q^{0.605}$	C_{sdb} : Construction Cost (R$1000) Q : Average daily sewage flow (m^3/day)
11	Sludge Thickener	$C_{st} = 0.364Q^{0.60}$	C_{st} : Construction Cost (R$1000) Q : Average daily sewage flow (m^3/day)
12	Belt-press dehydrator	$C_{bp} = 345Q^{0.1504}$	C_{bp} : Construction Cost (R$1000) Q : Average daily sewage flow (m^3/day)

Source: Formulated by JICA Study Team

Note: The costs are those of November of 1999.

Table 3.5-2 Construction Cost of Expansion and Rehabilitation Works for Sewerage Facilities (1/2)

Line No.	Name of Sewerage Subsystem	Expansion Works (R$1000)					Rehabilitation Works (R$1000)				Grand Total {=(1)+(2)} (R$1000)
		Sewage Collection and Transport Facilities			Sewage Treatment Facilities	Sub-Total (1)	Sewer Networks	Pumping Facilities	Sewage Treatment Facilities	Sub-Total (2)	
		Collectors and Branch Sewers	Trunk and Pressure Sewers	Pumping Facilities							
1	Caetes	2,963	301	84	801	4,148	433	16	50	499	4,647
2	Peixinhos	26,113	1,173	582	14,539	42,407	592	479	5,081	6,151	48,558
3	Caixa D'agua	7,269	613	538	2,920	11,340	-	-	-	-	11,340
4	Nova Descoberta	6,090	1,020	748	3,671	11,529	-	-	-	-	11,529
5	Aguazinha	5,551	825	1,030	3,459	10,864	2	16	-	18	10,882
6	Dois Unidos	6,547	495	652	4,082	11,776	15	-	-	15	11,790
7	Ponte dos Carvalhos	2,171	280	259	1,246	3,955	-	-	-	-	3,955
8	Charnequinha	1,157	32	136	1,776	3,101	-	-	-	-	3,101
9	Camaragibe/Recife 1	14,826	1,705	909	2,934	20,374	49	-	-	49	20,424
10	Camaragibe/Recife 2	4,577	77	129	1,155	5,939	-	-	-	-	5,939
11	Camaragibe 1	6,157	17	164	1,437	7,775	55	-	-	55	7,830
12	Camaragibe 2	4,150	4	154	2,249	6,556	-	-	-	-	6,556
13	Cabanga	7,722	6	143	17,975	25,846	1,105	460	2,965	4,530	30,376
14	Cordeiro	8,774	1,768	791	5,511	16,843	79	-	205	284	17,128
15	Caxanga	7,759	1,054	379	3,504	12,696	19	18	-	37	12,733
16	Igarassu 2	13,632	1,219	324	2,596	17,772	-	-	-	-	17,772
17	Ipojuca - Sede	1,757	195	256	1,030	3,239	-	-	-	-	3,239
18	Itapissuma 1	1,319	61	395	1,551	3,326	13	-	-	13	3,339
19	Itapissuma 2	1,648	81	327	762	2,818	-	-	-	-	2,818
20	Comportas	8,128	2,044	334	2,288	12,794	-	-	-	-	12,794
21	Curcurana	14,581	3,580	610	7,617	26,387	28	54	100	182	26,570
22	Prazeres	24,162	6,314	1,330	12,452	44,258	44	36	430	510	44,768
23	Jaboatao 1	4,039	3,252	383	1,776	9,450	93	-	-	93	9,543
24	Jaboatao 2	13,566	2,925	1,069	4,603	22,163	-	-	-	-	22,163
25	Ibura de Cima	2,676	539	528	3,282	7,025	94	-	-	94	7,119
26	Jaboatao 3	8,959	1,842	362	1,864	13,027	-	-	-	-	13,027
27	Bonanca	1,848	89	168	1,315	3,420	-	-	-	-	3,420
28	Moreno 1	3,338	591	514	2,089	6,532	-	-	-	-	6,532
29	Moreno 2	654	93	171	355	1,272	20	-	50	70	1,342

Table 3.5-2 Construction Cost of Expansion and Rehabilitation Works for Sewerage Facilities (2/2)

Line No.	Name of Sewerage Subsystem	Expansion Works (R$1000)					Rehabilitation Works (R$1000)				Grand Total {=(1)+(2)} (R$1000)
		Sewage Collection and Transport Facilities			Sewage Treatment Facilities	Sub-Total (1)	Sewer Networks	Pumping Facilities	Sewage Treatment Facilities	Sub-Total (2)	
		Collectors and Branch Sewers	Trunk and Pressure Sewers	Pumping Facilities							
30	Moreno 3	670	54	107	1,098	1,929	-	-	-	-	1,929
31	Camaragibe 3	8,019	1,045	588	3,651	13,302	93	-	-	93	13,395
32	Sao Lourenco 1	10,439	2,675	415	4,590	18,117	184	-	-	184	18,301
33	Sao Lourenco 2	10,882	1,338	231	3,613	16,064	-	-	-	-	16,064
34	Boa Viagem	18,290	5,901	1,563	11,135	36,889	93	162	-	255	37,145
35	Imbiribeira	5,718	1,414	1,160	2,686	10,978	103	78	-	181	11,160
36	Jardim Sao Paulo	6,460	5,847	2,250	2,312	16,868	64	-	-	64	16,932
37	Ibura de Baixo	20,808	1,302	423	9,626	32,159	58	-	-	58	32,217
38	Ignes Andreazza	165	-	-	149	314	23	-	701	725	1,038
39	Mangueira	2,877	-	-	1,104	3,981	69	-	-	69	4,050
40	Roda de Fogo	443	-	-	1,471	1,914	89	96	50	235	2,149
41	Janga	30,537	5,951	426	6,628	43,542	679	688	2,283	3,649	47,192
42	Paulista	7,407	1,588	786	1,122	10,903	212	6	70	288	11,191
43	Conceicao	11,158	2,725	558	3,205	17,646	31	12	-	43	17,688
44	Apipucos	2,233	-	-	1,737	3,970	-	-	-	-	3,970
45	Curado	97	-	-	820	917	63	20	50	133	1,049
46	Praia Porto de Galinhas	1,510	-	-	517	2,027	-	-	-	-	2,027
47	Jardim Paulista	-	-	-	937	937	173	138	50	361	1,298
48	Mirueira	-	-	-	3,050	3,050	247	-	-	247	3,296
49	Mutirao	126	-	-	451	577	40	16	50	106	683
50	Nova Cruz	1,601	-	-	631	2,231	-	-	-	-	2,231
51	Parque Capibaribe	610	-	-	1,127	1,737	261	12	50	323	2,061
52	Parque Pirapama	2,102	-	-	1,104	3,206	32	-	50	82	3,288
53	Vila Burity	765	-	-	768	1,534	13	48	60	121	1,654
54	Vila dos Milagres	-	-	-	-	-	61	11	50	122	122
55	27 de Novembro	717	-	-	389	1,106	2	-	50	52	1,158
Total		**355,765**	**62,036**	**21,974**	**174,757**	**614,531**	**5,231**	**2,364**	**12,394**	**19,989**	**634,520**

Note:

(1) The rehabilitation works are defined as the ones to recover the original functions and capacities of existing facilities, including the cleaning of sewage pipelines.

(2) The expansion works are defined as the ones to meet the requirements set in the Master Plan for 2020, including the additional installation of disinfection systems.

Table 3.5-3 Construction Cost of Each Work Group

Phase	Work Group	River Basin	Expansion Works (R$1000)					Rehabilitation Works (R$1000)				Total {=(1)+(2)} (R$1000)
			Sewage Collection and Transport Facilities			Sewage Treatment Facilities	Sub-Total (1)	Sewer Networks	Pumping Facilities	Sewage Treatment Facilities	Sub-Total (2)	
			Collectors and Branch Sewers	Trunk and Pressure Sewers	Pumping Facilities							
Phase 1	1	Beberibe	44,301	3,513	3,011	25,751	76,576	608	495	5,081	6,183	82,759
	2	Capibaribe	49,520	7,207	2,636	34,514	93,877	1,437	478	3,170	5,084	98,961
	3	Jaboatao	67,152	18,654	4,254	32,018	122,078	259	90	530	879	122,957
	4	Tejipio	54,153	14,464	5,395	26,863	100,876	388	240	0	628	101,504
	5	Timbo	44,657	8,977	1,067	10,634	65,336	1,143	715	2,333	4,191	69,527
	6	Other Basins	21,039	2,807	1,110	3,718	28,675	212	6	70	288	28,963
		Total	280,822	55,623	17,474	133,498	487,417	4,047	2,024	11,183	17,254	504,671
Phase 2	1	Beberibe	7,269	613	538	2,920	11,340	0	0	0	0	11,340
	2	Capibaribe	39,684	2,570	1,434	18,523	62,211	510	156	160	826	63,037
	3	Jaboatao	15,791	2,860	1,412	6,652	26,715	20	0	50	70	26,785
	4	Tejipio	978	0	0	1,358	2,336	149	31	851	1,031	3,367
	5	Timbo	126	0	0	451	577	40	16	50	106	683
	6	Other Basins	11,094	370	1,115	11,355	23,934	465	138	100	703	24,637
		Total	74,943	6,413	4,499	41,259	127,114	1,184	340	1,211	2,736	129,850
Grand Total			355,765	62,036	21,974	174,757	614,531	5,231	2,364	12,394	19,989	634,520

Table 3.5-4 Land Acquisition Cost in the Sewerage Service Areas in the RMR (1/2)

N0.	Sewerage system	Area	City	Location	Land cost (R$/m²)
1	Caetés	Existing system extension	Abreu e Lima	Situa-se na UE AL 1 próxima a etc Caetés	16.92
2	Peixinhos	Existing system Priority area	Olinda		111.00 116.00
3	Caixa D'Agua	Priority area	Olinda	Situa-se a margem direita da estrada de Caixa Dàgua (cont. da estrada de Passarinho) , junto a invasão Vila do Teto	10.00
4	Nova Descoberta	Priority area		Situa-se a margem esquerda da Estrada do Brejo , em frente a Associação dos Auditores do Estado de Pe.	Data unavailable
5	Aguazinha	Priority area	Olinda	Situa-se na UE OL 03 , no final das ruas Maria josé Riqueira e 2° Travessa T. Valência , bairro de Aguazinha	Data unavailable
6	Dois Unidos	Priority area	Olinda	Situa-se próximo ao encontro do rio Morno c/ o Beberibe ,no campo de futebol	15.00
7	Ponte dos Carvalhos	Existing project	Cabo de Santo Agostinho	Situa-se próximo a final da rua Joaquim da Silva UE CS 02	6.00
8	Praia de Gaibu /Suape	Existing project			Data unavailable
9	Praia de Itapoama	Existing project			1.00
10	Charnequinha	Existing project	Cabo de Santo Agostinho	Situa-se entre a BR 101 e a RFFSA , Próxima a UE CS 06 e o Hospital São Lucas	2.62
11	Camaragibe/Recife 1	Priority area	Recife	Situa-se entre o rio Camaragibe e o rio Capibaribe na UE REC 30, rua Ribeiro Pessoa , cont. Da rua Dom Manuel de Medeiros	3.15
12	Camaragibe/Recife 2	Priority area	Recife	Situa-se na UE REC 31,no lado esquerdo da rua Joaquim Ribeiro	3.15
13	Cabanga	Existing system extension	Recife		1,000.00
14	Cordeiro	Priority area	Recife	Situa-se na UE REC 41,entre o final das ruas Antero Mota e a rua N. S. da Saúde, no bairro do Cordeiro, vizinho a Exposição de Animais	35.00
15	Caxangá	Priority area	Recife	Situa-se na UE REC 37, bairro Caxangá , próxima a rua João Alberto	83.33 35.00
16	Igarassu 2	Existing project	Igarassu	Situa-se na UE IG 08 , próxima ao Loteamento Jardim Paraíso	12.00
17	Itamaracá 1	Existing project	Itamaracá	Situa-se a margem direita da pista que dá acesso ao norte da ilha (próxima a penitenciária B. Campelo	4.48
18	Itapissuma 1	Existing system	Itapissuma		17.77

Source: Secretariat of Planning and Social Development

Table 3.5-4 Land Cost in the Sewerage Service Areas in the RMR (2/2)

N0.	Sewerage system	Area	City	Location	Land cost (R$/m²)
19	Curcurana	Existing project	Jaboatão dos Guararapes	Situa-se a esquerda da estrada de Curcurana , aprox. 450m da travessia do channel Olho Dàgua , próxima a rua Capanema ae ao loteamento Orla Barra de jangada	5.00
20	Prazeres	Existing project	Jaboatão dos Guararapes	Situa-se na UE JB 25 , do lado esquerdo da RFFSA por trás das fábricas da Coca-cola e Iquine	121.79
21	Jaboatão 3	Existing project	Jaboatão dos Guararapes	Situa-se por trás da sub-estação e dentro da Usina Bulhões na UE JB 02	121.79
22	Moreno 1	Existing project	Moreno	Situa-se na margem direita da PE –07 , próxima a fábrica de colchões	2.57
23	Moreno 2	Existing system extention	Moreno	Situa-se na UE 03 , denominada pela COMPESA ETES 013	2.57
24	São Lourenço 2	Existing project	São Lourenço da Mata	Situa-se na UE SL 05 , próxima a fábrica de rações Purina	1,125.00
25	Boa Viagem	Existing project	Recife	Situa-se na UE REC 80 , bairro da Imbiribeira , entre a linha férrea a Av. General Mac Arthur e o rio Jordão	265.95 333.33
26	Imbiribeira	Existing project	Recife	Situa-se na UE REC 76 , bairro da Imbiribeira , próxima a comunidade de Sítio Grande , no lado esquerdo da Lagoa do Araça	111.00
27	Ignes Andreazza	Existing system			
28	Mangueira	Existing system			17.00
29	Roda de Fogo	Existing system			12.00
30	Janga	Existing system	Paulista		39.13
31	Apipucos		Recife	Situa-se a direita da BR-101 , sentido Recife-Dois Irmãos , após o cruzamento da BR com o Rio Capibaribe	545.45
32	Curado	Existing system			3.50 2.00
33	Praia do Cupe	Existing project	Ipojuca	Situa-se na praia do Cupe	
34	Praia de Porto de Galinhas	Existing project	Ipojuca	Situa-se na praia de Porto de Galinhas	35.00 7.50
35	Praia de Maracaipe	Existing project			
36	Jardim Paulista	Existing system			44.00
37	Mutirão	Existing system			10.00
38	Parque Capibaribe	Existing system			16.21
39	Parque Pirapama	Existing system			13.10
40	Vila Burity	Existing system			11.00
41	Vila dos Milagres	Existing system			15.00

Source: Secretariat of Planning and Social Development.

Table 3.5-5 Land Acquisition Cost for Sewage Treatment Facilities

Phase	River Basin	Required area (ha)	Land cost (R$1,000)	Remarks
Phase 1	Beberibe	1.72	204	
	Capibaribe	5.37	8,948	
	Jaboatao	9.89	6,254	
	Tejipio	8.89	5,458	
	Timbo	5.31	1,743	
	Other Basins	6.62	961	
	Total	37.80	23,568	
phase 2	Beberibe	0.41	41	
	Capibaribe	7.76	1,296	
	Jaboatao	3.36	1,143	
	Tejipio	2.32	263	
	Timbo	0.54	211	
	Other Basins	5.86	1,119	
	Total	20.25	4,073	
Grand Total		58.05	27.671	

Table 3.5-6 Land Acquisition Cost of Sewage Treatment Facilities for Sewerege Subsystems

Line No.	Name of Sewerage Subsystem	Required area (ha)	Unit cost (R$/m^2)	Land cost (R$1,000)	Remarks
1	Caetes	1.50	16.9	254	
2	Peixinhos			0	Existing
3	Caixa d'Agua	0.41	10.0	41	
4	Nova Descoberta	0.56	10.0	56	
5	Aguazinha	0.53	10.0	53	
6	Dois Unidos	0.63	15.0	95	
7	Ponte dos Carvalhos	1.60	6.0	96	
8	Charnequinha	0.12	2.6	3	
9	Camaragibe/Recife 1	2.80	3.2	90	
10	Camaragibe/Recife 2	0.84	3.2	27	
11	Camaragibe 1	1.55	3.2	50	
12	Camaragibe 2	0.22	3.2	7	
13	Cabanga			0	Existing
14	Cordeiro	1.19	35.0	417	
15	Caxanga	0.68	83.3	566	
16	Igarassu 2	3.22	12.0	386	
17	Ipojuca - Sede	0.80	3.2	26	
18	Itapissuma 1	0.61	17.8	109	
19	Itapissuma 2	0.60	17.8	107	
20	Comportas	2.72	3.2	87	
21	Curcurana	1.52	5.0	76	
22	Prazeres	2.08	121.8	2,533	
23	Jaboatao 1	1.83	121.8	2,229	
24	Jaboatao 2	0.74	15.0	111	
25	Ibura de Cima	1.00	121.8	1,218	
26	Jaboatao 3	0.84	121.8	1,023	
27	Bonanca	0.36	3.2	12	
28	Moreno 1	0.56	2.6	15	
29	Moreno 2	0.16	2.6	4	
30	Moreno 3	0.20	2.6	5	
31	Camaragibe 3	2.11	3.2	68	
32	Sao Lourenco 1	0.70	1125.0	7,875	
33	Sao Lourenco 2	0.51	3.2	16	
34	Boa Viagem	0.21	333.3	700	
35	Imbiribeira	3.60	111.0	3,996	
36	Jardim Sao Paulo	2.77	15.0	416	
37	Ibura de Baixo	2.31	15.0	347	
38	Ignes Andreazza	0.45	15.0	68	
39	Mangueira		17.0	0	
40	Roda de Fogo		12.0	0	
41	Janga		39.1	0	
42	Paulista	3.40	16.9	575	
43	Conceicao	3.81	39.1	1,490	
44	Apipucos	0.15	545.5	818	
45	Curado	0.74	3.5	26	
46	Praia Porto de Galinhas	0.16	35.0	56	
47	Jardim Paulista	1.22	44.0	537	
48	Mirueira	0.38	10.0	38	
49	Mutirao	0.54	39.1	211	
50	Nova Cruz	0.46	10.0	46	
51	Parque Capibaribe	1.47	16.2	238	
52	Parque Pirapama	1.51	13.1	198	
53	Vila Burity	0.55	11.0	61	
54	Vila dos Milagres	0.68	15.0	102	
55	27 de Novembro	0.45	15.0	68	
Total		58.05		27,640	

Table 3.5-7 Improvement Cost of Existing Channels (Recife) (1/2)

(Unit: R$1000)

No	Place	Name of channel	Cln. channel	Rev.	Entrance box			Pav.	L ditch	Inflow at curve stone	Drainage pipe				Manhole				Construction Cost	
					Cln.	Ref.	Con.				Sur.	Cln.	Ref.	Con.	Sur.	Cln.	Ref.	Con.	After review of PQA at 1998 price	At November 1999 price
1	PONTO DE PARADA	PONTO DE PARADA	21.00	67.50	0.18	0.24	1.68	1.75	0.90		0.46	1.58	0.4	2.25	0.01	0.06		1.5	99.51	109.461
2	CAJUEIRO	RIO BEBERIBE					5.88	7.00	3.60					2.25				1.50	20.23	22.253
3	FUNDÃO	CANAL DA REGENERAÇÃO		360.00			14.28	17.50	7.20	24.00				6.75				3.00	432.73	476.003
4	SANTO AMARO	DERBI-TACARUNA			0.07	0.12					0.15	0.53	0.20		0.00	0.02			1.09	1.199
5	SANTO AMARO	DERBI-TACARUNA			0.18	0.24				36.00	0.46	1.58	0.40		0.01	0.06			38.93	42.823
6	PARQUE AMORIM	DERBI-TACARUNA																	0.00	0
7	DERBI	DERBI-TACARUNA																	0.00	0
8	PAISSANDU	DERBI-TACARUNA																	0.00	0
9	AFLITOS	DERBI-TACARUNA			0.05	0.12				6.00	0.10	0.35	0.20		0	0.02			6.84	7.524
10	REMÉDIOS	ABC			0.05	0.12	3.36	3.50	0.90	12.00	0.10	0.35	0.20		0.00	0.02			20.60	22.66
11	CORDEIRO	SANTA ROSA			0.27	0.36					0.72	2.45	0.80		0.02	0.10			4.72	5.192
12	CORDEIRO	SANTA ROSA																	0.00	0
13	CAXANGÁ	GOLF CLUB	6.00		0.07	0.12	5.88	7	3.6		0.15	0.53	0.2	9	0	0.02		3.75	36.32	39.952
14	IPUTINGA	CAIARA	6.00		0.11	0.12				30	0.26	0.88	0.2		0.01	0.04			37.62	41.382
15	ILHA DO RECIFE				0.27	0.36				30	0.72	2.45	0.8		0.02	0.1			34.72	38.192 0
			33.00	427.50	1.25	1.80	31.08	36.75	16.20	138.00	3.12	10.70	3.40	20.25	0.07	0.44	0.00	9.75	733.31	806.641

Note : Cln.- Cleaning Rev.- Revetment Ref.- Reform Con.- Construction Pav.- Pavement Sur.- Survey

Table 3.5-7 Improvement Cost of Existing Channels (Olinda and Jaboatao) (2/2)

< Olinda >

(Unit: R$1000)

NO	Place	Name of channel	Cln. channel	Rev.	Entrance box			Pav.	L ditch	Inflow at curve stone	Drainage pipe				Manhole				Construction cost	
					Cln.	Ref.	Con.				Sur.	Cln.	Ref.	Con.	Sur.	Cln.	Ref.	Con.	After review of PQA at 1998 price	At November 1999 price
1	ÁGUAS COMPRIDA	CÓR. DO ABACAXI		810.00	0.74	0.96				18	1.03	3.5	1		0.02	0.13			835.38	918.92
2	AZEITONA		12.00		0.52	0.72				60.00	2.05	7.00	2.00		0.04	0.25			84.58	93.04
3	JARDIM BRASIL	CANAL DA MALÁR	12.00																12.00	13.20
	Total		24.00	810.00	1.26	1.68	0.00	0.00	0.00	78.00	3.08	10.50	3.00	0.00	0.06	0.38	0.00	0.00	931.96	1025.16

<Jaboatao>

(Unit: R$1000)

NO	Place	Name of channel	Cln. channel	Rev.	Entrance box			Pav.	L ditch	Inflow at curve stone	Drainage pipe				Manhole				Construction cost	
					Cln.	Ref.	Con.				Sur.	Cln.	Ref.	Con.	Sur.	Cln.	Ref.	Con.	After review of PQA at 1998 price	At November 1999 price
1	JD. COPACABANA	SETÚBAL	66.00		0.2	0.24	42.84	52.5	23.40	48	0.51	1.75	0.6	13.5	0.01	0.07		5.25	254.87	280.36
2	CANDEIAS	CAROLINAS	72.00	405.00	0.20	0.24	42.84	52.50	22.50	60.00	0.51	1.75	0.60	11.25	0.01	0.07		4.50	673.97	741.37
3	CANDEIAS	ANICETO VAREJÃO	30.00	540.00	0.09	0.12				60.00	0.21	0.70	0.20		0.01	0.04			631.37	694.51
4	CAJUEIRO SECO	CÓR DO CARMO		540.00	0.09	0.12				24.00	0.21	0.70	0.20		0.01	0.04			565.37	621.91
			168.00	1485.00	0.58	0.72	85.68	105.00	45.90	192.00	1.44	4.90	1.60	24.75	0.04	0.22	0.00	9.75	2,125.58	2338.14

Note : Cln.- Cleaning Rev.- Revetment Ref.- Reform Con.- Construction Pav.- Pavement Sur.- Survey

3.6 Initial Environmental Examination (IEE)

3.6.1 IEE for Master Plan and Priority Projects

(1) Scope of Work and Objectives

1) Scope of work

According to the Manual of Guidelines for Evaluation of Environmental Impacts by the CPRH (1998) and the Environmental Guidelines by JICA (1994), the Initial Environmental Examination (IEE) of the project is to cover the following:

i) Physical Resources
- Soil and geological impacts

ii) Ecological Impacts
- Impact on air quality
- Impact on acoustic environment
- Impact on water quality
- Impact in terms of odor
- Impact on flora and fauna

iii) Socio-economic Impacts
- Impact on local community
- Resettlement and rehabilitation caused by the project

This IEE study was carried out based on the secondary data. On examination of the IEE scrutiny, a more detailed Environmental Impact Assessment (EIA) is to be carried out in the F/S stage.

2) Objective of the study

The objective of this study is to prepare an IEE report that includes information on the existing environmental conditions and an evaluation of the environmental impacts to be caused by the implementation of the project. This study is to include an investigation of the environmental conditions and related federal and state laws.

3) Procedures for Acquiring Environmental Licenses

In the state of Pernambuco the CPRH is responsible for the licensing of potential polluting undertakings. The Sewerage Management Project is categorized under "Item 4: Wastewater Projects" in the Handbook of Environmental Licensing of the CPRH (1998) as requiring a "Preliminary License", "Installation License" and "Operation License". This project requires Environmental Licenses from the CPRH before implementation. General

procedures for obtaining Environmental Licenses are as follows:

- There are three environmental licenses, namely the Preliminary License, Installation License and Operation License,
- The Preliminary, Installation, and Operation Licenses may be issued separately or successively in accordance with the nature and stages of the project,
- The projects, activities or works with significant potential of degradation of the environment are subject to the presentation of the Study and the Evaluation of Environmental Impact (EIA), which is demanded by the CPRH during the analysis of the application for the Preliminary License,
- Verified the beginning of the installation and/or operation of projects, activities or works before the expedition of the respective licenses or authorisation, the CPRH will communicate the fact to the financing entities,
- For Projects/Activities that are unable to be licensed or authorised, the denial of environmental licensing/authorisation is to be issued, containing all the related information and reasons of the CPRH for disapproval of the licence,
- The Approved Technical documents should be stamped by the CPRH.

Fig. 3.6-1 shows the procedures for analysis of the EIA/RIMA by the CPRH.

(3) Existing Environment

The RMR is located in the eastern part of the state of Pernambuco. It has 14 municipalities, of which general environmental conditions are shown in the following table:

General Conditions of 14 Municipalities in 1996

Municipality	Population	Area (km^2)	Urbanized Area (%)	Sewage Treatment Service Rate (%)
Itamaraca	11,826	67	9.2	0
Itapissuma	16,504	75	2.3	16.1
Aracoiaba	10,289	90	0.9	0
Igarassu	54,874	300	3.8	1.8
Abreu e Lima	73,113	138	7.9	13.8
Paulista	234,144	99	30.4	46.5
Olinda	350,999	41	61.5	33.2
Camaragibe	113,622	51	44.5	0
Sao Lourenco Da Mata	80,358	263	6.4	13.4
Recife	1,355,817	218	49.8	25.7
Moreno	32,162	193	2.2	0
Jaboatao dos Guararapes	465,708	259	16.3	8.6
Cabo de Santo Agostinho	128,360	445	2.7	0.7
Ipojuca	31,605	527	1.7	0
RMR	2,959,381	2,766	10.9	21.6

The existing environmental conditions of the major basins in the RMR, namely the Beberibe, Capibaribe, Ipojuca, Jaboatao, and Timbo Basins where most wastewater treatment facilities exist, are described in the following tables.

1) Existing Conditions of Major Basins

Beberibe Basin:

ITEM	DESCRIPTION
Meteorological Data	Average annual precipitation : 2,121mm Average Temperature : 25.9 °C Humidity : 78.3 % Predominant wind direction : Southeast Average wind speed : 3m/s Data is recorded from 1989-1998 at Curado, Recife.
Physical Environment	The Beberibe river basin is small and partially covers the municipalities of Recife, Olinda, Paulista, and Sao Lourenco da Mata. Basin area : 82 km^2 Average width : less than 5 km Longest distance in the east-west direction: 19 km Longest distance in the north-south direction: 11 km
Atmospheric Environment	No atmospheric monitoring station is installed in the Beberibe basin. However, since there is no violation of air quality standard at nearby air monitoring stations (Encruzilhada, Boa Vista, and Santo Antonio), there may not be serious air pollution.
Ecological Environment	The Beberibe basin is made up of cultivated land and forest to the west up to the national highway route 101. Olinda, to the east, is highly urbanized area. A vegetation map is shown in Fig. 3.6-2.
Water Environment	The water quality of the Beberibe river is described in Chapter 2.6.

Capibaribe Basin:

ITEM	DESCRIPTION
Meteorological Data	Average annual precipitation : 2,121mm Average temperature : 25.9 °C Humidity : 78.3 % Predominant wind direction : Southeast Average wind speed : 3m/s Data is recorded from 1989-1998 at Curado, Recife.
Physical Environment	The Capibaribe river basin is long and wide and is the biggest hydrographic basin in the rural region of Penambuco. Basin area : 7,445 km^2 Average width : less than 40 km Longest distance in the east-west direction: 203 km Longest distance in the north-south direction: 64 km
Atmospheric Environment	There are monitoring stations at Encruzilhada, Boa Vista, Santo Antonio, Bongi, Curado, and Ipsep. In 1998 no violations of the ambient air standards for SO_2, NO_2, Suspended Particulate Matter, and Fumes were observed.
Ecological Environment	In the west of the Capibaribe basin, sugarcane fields cover most of the area. The central area is half-cultivated and half-urbanized. In the East is Recife, which is highly urbanized.
Water Environment	The water quality of the Capibaribe river is described in Chapter 2.6.

Ipojuca Basin:

ITEM	DESCRIPTION
Meteorological Data	Average annual precipitation : 2,121mm Average Temperature : 25.9 °C Humidity : 78.3 % Predominant wind direction : Southeast Average Wind speed : 3m/s Data is recorded from 1989-1998 at Curado, Recife.
Physical Environment	The Ipojuca river basin is long and narrow and extends from the northeastern plateau. Basin area : 3,479 km^2 Average width : less than 20 km Longest distance in the east-west direction: 230 km Longest distance in the north-south direction: 59 km
Atmospheric Environment	No atmospheric monitoring station is installed in the Ipojuca basin. However, since there is no industrial area and most of the populations are concentrated in the coastal area, there may not be serious air pollution.
Ecological Environment	Sugarcane fields occupy most of the Ipojuca basin, but there is a large-scale mangrove forest develops in the river mouth area.
Water Environment	The water quality of the Ipojuca river is described in Chapter 2.6.

Jaboatao Basin:

ITEM	DESCRIPTION
Meteorological Data	Average annual precipitation : 2,121mm Average Temperature : 25.9 °C Humidity : 78.3 % Predominant wind direction : Southeast Average Wind speed : 3m/s Data is recorded from 1989-1998 at Curado, Recife.
Physical Environment	The Jaboatao river basin is comparatively small and it partially includes the municipalities of Vitoria de Santo Antao, Jaboatao, Moreno, Sao Lourenco da Mata, Cabo, and Recife. Basin area : 442 km^2 Average width : less than 10 km Longest distance in the east-west direction: 42 km Longest distance in the north-south direction: 25 km
Atmospheric Environment	There is a monitoring station at Jaboatao. In 1998 no violations of the ambient air standards for SO_2, NO_2, and Fumes were observed. However, Suspended Particulate Matter exceeded the ambient standard by 2%.
Ecological Environment	More than 50 % of the Jaboatao basin is sugarcane field and patches of cultivated land are widely distributed. The edge of the Olho D'Agua lake is urbanized near the eastern beach. There is a large mangrove forest at the mouth of the Jaboatao river. Coconut trees grow along the beach.
Water Environment	The water quality of the Jaboatao river is described in Chapter 2.6.

Timbo Basin:

ITEM	DESCRIPTION
Meteorological Data	Average annual precipitation : 2,121mm Average Temperature : 25.9 °C Humidity : 78.3 % Predominant wind direction : Southeast Average wind speed : 3m/s Data is recorded from 1989-1998 at Curado, Recife.
Physical Environment	The Timbo river basin is comparatively small and partially includes the municipalities of Abreu e Lima, Igarassu, and Paulista. Basin area : 90 km^2 Average width : less than 10 km Longest distance in the east-west direction: 22 km Longest distance in the north-south direction: 10 km
Atmospheric Environment	There is a monitoring station in Paulista. In 1998 no violation of the ambient air standards for SO_2, NO_2, Suspended Particulate Matter, and Fumes were observed.
Ecological Environment	Forest and cultivated land extend from the western edge of the Timbo basin to the central part. The central part includes the urbanized area of Paulista. The eastern part is extensively cultivated. There are mangroves and coconut trees in the estuary of the Timbo river.
Water Environment	The water quality of the Timbo river is described in Chapter 2.6.

2) Priority project sites

The existing conditions of selected priority project sites are summarized as follows:

PROJECT SITE	CURRENT CONDITIONS
Boa Viagem	Location: shown in Fig. 3.6-3. A vacant site of around 4 hectares facing a canal connected to the estuary of the Tejipio river. The surrounding area is a densely populated low-income residential area. On the river side of the canal is a mangrove forest. In the vacant land there are around 50-100 mango, cashew, olive, and palm trees. The central part is level and ready to be used as an athletic field. The residents seem to use this vacant land as a playground, possibly for soccer. See following Photo-1.
Cabanga	Location: shown in Fig. 3.6-3. Cabanga sewage treatment facility is separated from residential area by a road on the northern side. The station was operating with an activated sludge treatment system, but now it is not in operation and discharges untreated wastewater into the river. At the entrance of the station there is a strong odor. See following Photo-2.
Conceicao	Location: shown in Fig. 3.6-3. There is a cement factory (the operation is currently suspended). This cement factory is going to be removed and the construction of a theme park is planned for the area. The planned location of the wastewater treatment station is on a little top of a damp area where is the vacant land that a weed grows on currently. See following Photo-3.
Cordeiro	Location: shown in Fig. 3.6-3. The planned location is next to the agricultural show ground of the State of Pernambuco Agriculture Department and is around 50 m away from the Capibaribe River. Currently it is vacant land with thick vegetation. There is a residential area next to it. See following Photo-4.
Curcurana	Location: shown in Fig. 3.6-3. It was not possible to examine the planned wastewater treatment construction site, but the neighboring sites have shrubs and grassland. See following Photo-5.
Janga	Location: shown in Fig. 3.6-3. There are no houses on the site itself, but there are some to the side of the access road. The distance from the station to the houses is around 200 m. According to the plan the station is going to be extended to the east of the site. The planned expansion area is vacant land (grassland) where goats graze. See following Photo-6.
Prazeres	Location: shown in Fig. 3.6-3. The area is an industrial zone and there are no dwellings nearby. The planned wastewater treatment site is vacant land at present with shrubs and grasses. See following Photo-7.

(4) Environmental Impact Evaluation

1) Air Quality and Offensive odor

For almost all-atmospheric pollutants, environmental standards are satisfied in the whole RMR area. Since no large-scale facilities are planned on a single site in this project, the generation of air pollutants from the operation of construction machinery and haulage vehicles is not anticipated to be significant. Therefore, the project will not cause significant impact on the atmospheric environment. However, sewage treatment facilities and vehicles transporting sludge may emit foul smelling gases. Therefore, the influence of foul smelling gases in the environment is to be examined on the basis of the concrete construction plan in the feasibility study.

2) Hydrological situation

There is no direct change in the shape of a river caused by the implementation of the project, but effluent from sewage treatment plants is to be discharged into adjacent rivers; therefore, a change in river flow is expected. The influence of effluent discharge on the river environment is to be examined on the basis of the concrete facility plans and on the existing conditions of the rivers in the feasibility study.

3) Noise and Vibration

Since no large-scale facilities are planned in this project, the noise and vibration problems during the construction period and in the operational phase will probably not be significant.

4) Ecological Resources

Rehabilitation and expansion of the existing facilities and new constructions are planned in this project. These facilities will be planned in the area of the existing facilities and/or on vacant land where there is biologically no important flora and fauna. Therefore, no significant influence on the ecosystem in the area is anticipated.

However, there is a project site rich in vegetation like Boa Viagem. There is a project site where mangrove develops in a river of discharging point. Therefore, influence of the implementation of the project on ecology is to be examined based on the concrete facility plan in the feasibility study.

5) Landscape

No large-scale facilities will be built, but it is important to harmonize the facilities with the surrounding environment. Therefore, the influence of the implementation of the project on

the landscape is to be investigated on the basis of the concrete construction plan in the feasibility study.

6) Water Quality

In the first place, the implementation of the wastewater treatment facility itself aims at improving the water environment of a basin. Therefore, influence on the water environment by the accomplishment of this sewerage plan is expected to be positive. However, local deterioration of water quality at the discharge points of sewage treatment facilities can be expected. However, influence of the discharged water on the quality of local water should be investigated on the basis of the concrete project and the condition of the discharge points in the future feasibility study.

The screening for each environmental item based on the guidelines of JICA was conducted and the result is shown in the following table.

Screening check list

No	Environmental Items	Content	Evaluations	Grounds
Socio-economic Environment				
1	Resettlement	Resettlement by occupancy of proposed land (removal of rights or residence and land ownership)	No	No human settlement is to be removed by implementation of this project.
2	Economic activities	Loss of a productive opportunity such as land, and change of economic structure	No	Construction or/and rehabilitation of the sewerage treatment facility and drainage network will not cause any economic activities.
3	Traffic and public facilities	Influence of existing traffic such as congestion, accidents on schools etc.	No	No public facility exists the the sites.
4	Split of communities	Split of communities by obstruction of traffic	No	Split of community by implementation of the project is not anticipated.
5	Cultural property	Loss of cultural property and falling of value	No	No cultural property exists in the project area.
6	Water rights and rights of common	Obstruction of fishing rights, water rights, common rights of forest	No	No disputes with regard to fishing rights and water rights are likely to occur.
7	Health and sanitation	Deterioration of hygienic environment by production of refuse by noxious insects	Unkonwn	It is going to be checked in EIA.
8	Waste	Occurrences of waste dumps and solid waste	Yes	Sludge will be generated.
9	Hazards	Increase of possibility of danger of landslide and accident	No	No possibility of occurrence of hazards.
Natural Environment				
10	Topography and Geology	Change of valuable topography and geology by digging or fill	No	No permanent change in valuable topography and geology is expected.
11	Soil Erosion	Flow of surface soil by rain water after land development and forest felling	No	No forest felling is envisaged and there is no planting area involved.
12	Ground Water	Pollution by drainage or leach water by digging construction	No	Ground water will not be polluted.
13	Hydrological Situation	Change of flow pattern and the change in river water quality by inflow of drainage	Yes	Change in flow pattern and quality of the water by drainage from the treatment station can be expected.
14	Coast and Sea area	Change of beach erosion and vegetation by a change of declamation or sea condition	No	No facilities are planned to be constructed on the coastline.
15	Flora and Fauna	Breeding obstruction and extinction of species by a change of an inhabitable condition	No	Habitat of valuable flora and fauna does not exist.
16	Climate	Change of temperature and wind conditions by the large land development and architecture	No	Large scale felling and construction of high building are not planned.
17	Landscape	Change of topography by land development and harmonious obstruction by structural objects	Unknown	It is going to be checked in EIA.
Environmental Pollution				
18	Air Pollution	Pollution by emission gas and dust from vehicles or/and facilities	Yes	Impact by emission gas from the facilities or sludge transportation is anticipated.
19	Water Pollution	Pollution by inflow of earth and sand and industrial waste water	Yes	There may be change in water quality because of discharge of treated wastewater.
20	Soil Contamination	Pollution by drainage or leach water	Unknown	It is going to be checked in EIA.
21	Noise and Vibration	Occurrence of noise and vibration by facilities	No	Impact on noise and vibration by facilities could be very small.
22	Ground Subsidence	Subsidence by change of ground and fall of ground water level	No	No ground subsidence is expected.
23	Offensive odor	Occurrence of exhaust gas and offensive odor	Yes	Wastewater treatment facilities may give off offensive odor.
Comprehensive assessment: Is it necessary to implement EIA for the Project?			Yes	Many items are possibly affected.