CHAPTER 3

URBAN PLANNING AND LAND USE

CHAPTER 3 URBAN PLANNING AND LAND USE

Target Year of the Study

The year 2003 is the medium term of the City Planning Master Scheme and was chosen as the target year for this study by the preliminary study of JICA in accordance with the Ministry of Housing and City Planning (Ministère du Logement et de l'Urbanisme).

- Road (BW1) that will be the route of the interceptor will be completed by the year 2001
- The private harbor in Locodjoro will be completed by the year 2002

3.1 Population Projection

According to a study on urbanization for the actualization of the Master Scheme of Abidjan (Schéma de structure, Note de présentation, Novembre 1997; Etudes d'Urbanisme pour l'actualisation du Schéma Directeur d'Abidjan, Etude No. 5 (phase 1); BNETD), the analysis on population evolution gives the following characteristics:

- Over the past 15 years, the ratio decreased from 10% to 4%;
- A net decrease in immigration;
- The young and female population ratio is increasing;
- A decrease in the death rate;
- A decrease in the birth rate.

The result of the general census of 1998 is not yet available therefore, the population forecast is derived from the 1988 general census. The forecast was prepared by BNETD, as in the case of PDA, on the basis of the rhythm of the population density that comes about with an increase of:

- The number of persons in a room;
- The number of rooms in a parcel;

- The number of parcels or houses which are inhabited;
- The number of parcels per ha.

This is therefore a complex phenomenon that is based on several parameters such as: available land for construction, increase in the landlords/tenants ratios, access by public transportation, population increase, and the income situation of the households.

Each district has been divided into sectors and each sector has been divided into quarters.

Fig. 3.1 shows an administrative division in the Study Area.

Fig. 3.2 and Fig. 3.3 shows the division of the district of Attécoubé and Yopougon by sector and quarter, respectively.

The projected population of Abidjan, Attécoubé and Yopougon Districts are shown in Fig. 3.4. The projected population of Abidjan, Attécoubé and Yopougon Districts are shown in Tables 3.1, 3.2 and 3.3, respectively.

3.2 Present and Future Land Use

According to the above-mentioned study, the evolution of land use from 1965 to 1993 was as follows:

(i) An irregular land use in Abidjan where the area increased five (5) times in less than 30 years. The land use increased from 3,700 hectares in 1965 to 17,000 hectares in 1993; that gave an annual increase of 800 hectares in the period 1965-1975 then an annual increase of 450 hectares between 1975 and 1990. Between 1990 and 1993, it was estimated that the extension was less than 400 hectares annually; this regression is due to the decrease in the population rate from 10% to 4% and the land reserved for large scale public equipment and industrial activities

(ii) Extensions were located in the northern part of Abidjan (Abobo and Yopougon) and more and more to Cocody

(iii) A progressive congestion of the housing area increases from 190 inhabitants/ha to 210 inhabitants/ha

(iv) A soft extension in the neighboring cities, Grand-Bassam City in particular, and a stagnation of urban land in Songon City.

The Banco plateau is located in the western part of Abidjan and is made of the Communes of Yopougon and West-Attécoubé with a surface area of 7,653 hectares (5,500 ha of urban land). The population in this area was estimated to be 448,000 inhabitants (1988).

The configuration of Abidjan is that the Banco Plateau isolated by the lagoon is only connected to Abidjan by the North Highway (Autoroute du Nord) which is an east-west large road (2 x 3-lane road) located in the extreme north of this area. The existence of this unique road did not favor the urbanization of the vast area to the south of the Banco Plateau because the employment areas were far from home. The available urban area is more than 2,500 hectares with a potential capacity of 700,000 inhabitants. The extension of Abidjan is of great actuality and it seems justified to develop an area that is centrally located.

Land Use (MOS) in 1989

1) Attécoubé

The district of Attécoubé has a particular configuration with a "hat (chapeau)" which consists of the Banco forest and two (2) "legs (pieds)" each rive of the Banco bay where the inhabited areas are located.

The surface area of the district of Attécoubé is 4,029 ha which is 11.2% of Abidjan's total area.

2) Yopougon

The district of Yopougon has a surface area of 6,667 hectares which is 18.5% of Abidjan's total area. Yopougon has a recently urbanized area having a population which increased from 94,000 inhabitants in 1975 to 374,500 inhabitants in 1988.

LAND USE IN ATTECOUBE AND YOPOUGON

	1989	
	Attécoubé	Yopougon
Natural spaces	3522 (87.4%)	3803 (57.0%)
Urban land	91 (2.3%)	842 (12.6%)
Housing	337 (8.4%)	1207 (18.1%)

Activities	29 (0.7%)	390 (5.9%)
Equipment	50 (1.2%)	425 (6.4%)
Total	4029 (100%)	6667 (100%)

The actualization of the Urban Master Plan that started in 1993 has not yet been achieved. Besides the MOS of 1989, the last available land use map is given in Fig 3.5.

According to the classification given in the MOS, the different posts correspond to the following definitions:

i) The natural spaces correspond to land not exploited (bush, woods and forests), residual area (banks, beaches, embankments, interstitial areas), protected areas (Banco forest) and to land that will be exploited for agricultural purpose (intensive and extensive farming, plantations).

ii) The urban land is considered as the built-in town future extensive zone for the establishment of formal and legal habitat segments, and some economical activities. In 1989, this post represented 3,396 ha, that is to say 9.4% of the built-in town area.

iii) The habitat is split into 11 posts that permit a fine comprehension of the various forms of habitat encountered in Abidjan City and its suburbs. Precarious habitat is described according to 3 posts (habitats in plantations, aligned in parallel and non aligned) and habitat in courtyards that constitutes the traditional habitats according to 2 posts (aligned in parallel and non aligned). The modern habitat, individual houses and accommodations in buildings are classified into 6 posts: individual houses (dense i.e. with renting and none dense), group of houses (dense i.e. renting and none dense) and blocks of flats (group operation or outside group operation).

iv) With 1778 ha, the activities occupied 4.9% of the built-in town area in 1989. Among these activities, modern activities with industrial dominant features represent more than 67% with large industrial zones in Treichville, Port-Bouët, Yopougon and Koumassi (97% of the total). The precarious zone of craftsman's and commercial activities represent 13.5% of the area reserved to activities; that shows the importance of the informal sector.

v) The equipment is diversified, they deal with State and local Government (decentralized administration) as regards to the administration and security (police stations, barracks), leisure and tourism, culture and religion, transport (harbor, airport, railways, etc.), networks (telecommunication, electricity, clean water), and cemeteries.

3.3 Living Standard in Quarters

From the "Perspectives Décennales" (Decade Projection) in 1980, the distribution of the population in Abidjan is made according to the living standards based on different types of habitat.

Although there is a sub-division for many levels, a distribution in five (5) levels was taken as appropriate for the present study. The availability of some socio-economic data indicates that some levels have to be put together. The levels are given as follows:

(i) Level A: Residential habitat of high and middle class as realized by real estate companies;

(ii) Level B: Residential habitat of economic or very economic types as realized by real estate companies;

(iii) Level C: Old progressive housing development, such as in Treichville and Adjamé, which are characterized by the old infrastructure;

(iv) Level D: Actual progressive housing development, that are not well equipped with infrastructures. Also, housing development from compensation as realized by SETU;

(v) Level E: Spontaneous brick-constructed habitat, according to the shape of the plots, without a legal authorization or habitat constructed by using salvage equipment (wooden house);

(vi) Level V: Villages of traditional habitat.

Table 3.4 and Table 3.5 shows the classification of habitat and level of living standards in Yopougon and Attécoubé.

In 1990, a study on housing was made by DAUC (Département Aménagement Urbain et Construction) of BNETD based on the general census of 1988 prepared by INS (Institut

National de la Statistique). The census was made based on area defined as "ilots" or blocks of houses and the DAUC made a classification according to sectors and quarters in each district. The classification according to the type of habitat and the average income is given in Table 3.6 as follows:

(i) Precarious
(ii) Individual economic
(iii) Individual middle class
(iv) Individual high class
(v) Economic apartment buildings
(vi) Middle class apartment buildings
(vii) High class apartment buildings

According to the documents "Aperçu de la Commune d'Attécoubé, BNETD, Novembre 1996" and "Aperçu de la Commune de Yopougon, BNETD, Novembre 1996", the housing is classified as follows:

(i) Precarious habitat
(ii) Collective habitat
(iii) Courtyard Habitat
(iv) Individual habitat

TABLE 3.1 PROJECTED POPULATION OF 10 DISTRICTS OF ABIDJAN FROM 1993 TO 2015

Year	COMMUNE										
	ABOBO	ADJAME	ATTECOUBE	COCODY	KOUMASSI	MARCORY	PLATEAU	PORT BOUET	TREICHVILLE	YOPOUGON	TOTAL
1993	460,992	215,173	199,862	156,719	244,505	163,291	12,128	201,644	122,507	463,180	2,240,000
1994	476,791	219,038	210,126	163,402	248,446	167,463	12,184	210,889	125,982	486,680	2,321,000
1995	493,964	223,279	221,245	170,652	252,780	172,014	12,249	220,912	129,768	512,138	2,409,000
1996	512,094	227,678	233,060	178,336	257,256	176,786	12,309	231,546	133,748	539,187	2,502,000
1997	530,768	232,031	245,402	186,316	261,642	181,630	12,353	242,616	137,811	567,431	2,598,000
1998	549,573	236,147	258,091	194,453	265,721	186,399	12,370	253,942	141,848	596,455	2,694,990
1999	568,510	240,023	271,131	202,747	269,487	191,092	12,360	265,527	145,856	626,268	2,793,000
2000	587,779	243,736	284,624	211,273	273,027	195,774	12,325	277,469	149,888	657,105	2,893,000
2001	607,378	247,277	298,578	220,034	276,330	200,440	12,266	289,772	153,941	688,983	2,995,000
2002	627,508	250,716	313,102	229,105	279,473	205,153	12,185	302,540	158,062	722,154	3,099,990
2003	648,166	254,039	328,208	238,492	282,437	209,905	12,081	315,779	162,249	756,644	3,208,000
2004	669,347	257,230	343,907	248,198	285,202	214,690	11,952	329,499	166,497	792,477	3,318,990
2005	691,251	260,349	360,316	258,301	287,834	219,565	11,800	343,805	170,854	829,924	3,433,990
2006	713,470	263,229	377,239	268,657	290,144	224,395	11,617	358,507	175,214	868,528	3,551,000
2007	736,002	265,859	394,683	279,267	292,119	229,175	11,402	373,610	179,575	908,308	3,670,000
2008	758,645	268,158	412,548	290,058	293,669	233,839	11,150	389,016	183,888	949,030	3,790,000
2009	781,597	270,190	430,947	301,108	294,863	238,446	10,864	404,830	188,197	990,958	3,912,000
2010	804,658	271,878	449,776	312,343	295,615	242,930	10,540	420,954	192,455	1,033,851	4,035,000
2011	827,825	273,217	469,040	323,763	295,919	247,291	10,179	437,391	196,658	1,077,718	4,159,000
2012	851,296	274,266	488,857	335,448	295,837	251,584	9,781	454,248	200,853	1,122,831	4,285,000
2013	875,069	275,014	509,235	347,401	295,357	255,804	9,346	471,530	205,037	1,169,207	4,413,000
2014	898,944	275,390	530,064	359,545	294,402	259,891	8,870	489,136	209,162	1,216,595	4,541,990
2015	923,118	275,450	551,467	371,962	293,027	263,898	8,356	507,176	213,272	1,265,276	4,673,000

TABLE 3.2 FUTURE POPULATION IN YOPOUGON

(unit: habitant)

			1988	1998	2003	2005	2015
01 YOPOUGON ATTIE							
	01	ANDOKOI 1	22,502	36,061	45,745	50,176	76,497
	02	ANDOKOI 2	3,427	16,178	20,523	22,511	34,320
	03	LA GARE	7,396	11,853	15,036	16,492	25,143
	04	YOPOUGON ATTIE 1	22,802	29,129	36,952	40,531	61,792
	05	YOPOUGON ATTIE 4	19,489	24,565	31,163	34,181	52,111
	06	YOPOUGON ATTIE 5	5,805	11,208	14,218	15,595	23,775
	07	YOPOUGON ATTIE 8	3,516	5,635	7,148	7,840	11,953
	08	CENTRE URBAIN	895	1,434	1,819	1,996	3,043
	09	SOGEFIHA SIPOREX 1	6,006	9,625	12,210	13,392	20,418
	10	SOGEFIHA SOLIC 2	5,864	9,397	11,921	13,076	19,935
	11	SOGEFIHA SOLIC 1	10,153	16,271	20,641	22,640	34,516
	12	SELMER	13,506	19,739	25,041	27,466	41,874
	13	SICOGIANCIEN QUARTIER	41,473	52,981	67,210	73,719	112,390
		SUB TOTAL	162,834	244,076	309,627	339,615	517,767
02 BANCO NORD							
	01	BANCO NORD 1 ERE TRANCHE	595	3,811	4,834	5,302	8,083
	02	BANCO NORD 2 ERE TRANCHE	214	2,051	2,601	2,853	4,350
	03	BANCO NORD 3 ERE TRANCHE	2,543	6,932	8,794	9,646	14,706
	04	GFCI BEL AIR	3,853	6,175	7,833	8,592	13,098
	05	SOPM	626	1,003	1,273	1,396	2,128
	06	SICOGI NOUVEAU QUARTIER	17,002	27,247	34,564	37,912	57,799
		SUB TOTAL	24,833	47,219	59,899	65,701	100,164
03 BANCO SUD							
	01	BANCO SUD 9 EME TRANCHE CITE UNIVERSITAIRE	7,921	12,694	16,103	17,663	26,928
	02	CITE SGBCI TIEMOKO COULIBALY	2,017	3,232	4,100	4,498	6,857
	03	SODECI	4,368	7,000	8,880	9,740	14,849
	04	YOPOUGON SANTE (DEGUERPIS DU PORT)	162	260	329	361	551
	05	SOGEFIHA (USINE AWA)	6,835	10,953	13,895	15,241	23,236
		SUB TOTAL	21,303	34,139	43,307	47,503	72,421
04 EXTENSION DU PORT							
	01	EXTENSION DU PORT	3,291	5,274	6,690	7,338	11,188
	02	BEAGO	1,032	1,654	2,098	2,301	3,508
	03	CHAPOUU	414	663	842	923	1,407
	04	YOPOUGON SANTE	1,530	2,452	3,110	3,412	5,201
		SUB TPTAL	6,267	10,043	12,740	13,974	21,304
05 YOPOUGON KOUTE							
	01	KOUTE VILLAGE ET EXTENSION	9,009	14,437	18,315	20,089	30,626
	02	YOPOUGON KOUTE EXTENSION EST (CAMP MILITAIRE)	11,811	18,928	24,011	26,337	40,152
	03	YOPOUGON KOUTE EXTENSION OUEST (SIDECI)	21,555	34,543	43,820	48,064	73,277
	04	CNPS	15,446	24,753	31,401	34,442	52,509
		SUB TOTAL	57,821	92,661	117,547	128,932	196,564
06 ZONE INDUSTRIELLE							
	01	ZONE INDUSTRIELLE SETU	1,717	2,752	3,491	3,829	5,837
	02	ZONE INDUSTRIELLE DE YOPOUGON (DU)	3,816	6,115	7,758	8,509	12,973
	03	PRISON CIVILE(MACA)	3,650	5,849	7,420	8,139	12,408
		SAB TOTAL	9,183	14,716	18,669	20,477	31,218
07 HOPITAL							
	01	QUARTIER HOPITAL (MAMIE ADJOUA)	2,498	4,003	5,078	5,570	8,492
	02	QUARTIER GESCO	4,878	7,817	9,917	10,877	16,583
		SUB TOTAL	7,376	11,820	14,995	16,447	25,075
08 NIANNGON NORD							
	01	PORT BOUET II 1ERE ET 2 EME TRANCHE	23,227	28,651	36,345	39,866	60,778
	02	NIANGON NORD 1 EME TRANCHE (EECI,NOVALIM)	2,591	4,152	5,267	5,778	8,808
	03	NIANGON NORD 2 EME TRANCHE	0	8,572	10,874	11,927	18,183
	04	NIANGON ADJAME (EXTENSION)	142	228	289	317	483
	05	ANANERAIE	0	13,482	17,103	18,759	28,600
		SUB TOTAL	25,960	55,085	69,879	76,647	116,852
09 NIANGON SUD							
	01	NIANGON SUD A DROITE (SOGEFIHA)	5,067	8,120	10,301	11,299	17,225
	02	NIANGON SUD A GAUCHE (SICOGI SOGEFIHA)	22,042	31,295	39,700	43,544	66,386
	03	NIANGON NORD SICCGI	8,599	13,780	17,481	19,174	29,233
	04	GFCI (CITE VERTE)	705	1,130	1,433	1,572	2,397
	05	ZONE INDUSTRIELLE	231	370	470	515	785
	06	AZITO	751	1,204	1,527	1,675	2,553
	07	NIANGON LOKOA	4,252	5,962	7,563	8,296	12,647
	08	NIANGON ADJAME VILLAGE	1,219	1,954	2,478	2,718	4,144
	09	ACADEMIE DE LA MER	360	1,429	1,812	1,988	3,031
	10	NIANGON SUD CANAL	3,865	6,194	7,857	8,618	13,139
		SUB TOTAL	47,091	71,438	90,622	99,399	151,540
10 OPSTOM (ADIOPODOUME)							
	01	NIANGON ATTIE	1,788	2,865	3,635	3,987	6,078
	02	ADIOPODOUME (KM17)	5,674	9,093	11,535	12,652	19,289
	03	ORSTOM	216	346	439	482	734
	04	INSTITUT PASTEUR	84	135	171	187	286
	05	CIMETIERE	1,760	2,820	3,578	3,925	5,983
		SUB TOTAL	9,522	15,259	19,358	21,233	32,370
		GRAND TOTAL	372,190	596,455	756,641	829,924	1,265,276

TABLE 3.3 FUTURE POPULATION IN ATTECOUBE

(unit: habitant)

			1988	1998	2003	2005	2015
01 ABIDJAN TE							
	01	ABIDJAN TE	8,284	12,977	16,503	18,117	27,729
		SUB TOTAL	8,284	12,977	16,503	18,117	27,729
02 ADJAME SANTE							
	01	ABIDJAN SANTE VILLAGE (SEBROKO)	3,807	5,964	7,584	8,326	12,743
	02	BOLIBANA	10,892	17,063	21,699	23,821	36,459
	03	ATTECOUBE LAGUNE	2,902	4,546	5,781	6,347	9,714
		SUB TOTAL	17,601	27,573	35,064	38,494	58,916
03 QUARTIER DE LA PAIX							
	01	QUARTIER DE LA PAIX	11,872	18,598	23,651	25,965	39,739
		SUB TOTAL	11,872	18,598	23,651	25,965	39,739
04 SAINT JOSEPH							
	01	SAINTE JOSEPH	7,615	11,929	15,170	16,654	25,490
	02	MOSQUEE	6,537	10,241	13,023	14,297	21,881
	03	QUARTIER DES ECOLES	3,362	5,267	6,698	7,353	11,254
		SUB TOTAL	17,514	27,437	34,891	38,304	58,625
05 GBEBOUTO							
	01	GBEBOUT	22,484	35,223	44,792	49,174	75,261
		SUB TOTAL	22,484	35,223	44,792	49,174	75,261
06 AGBAN							
	01	AGBAN VILLAGE	7,403	11,597	14,748	16,191	24,780
	02	CITE FAIRMONT	5,426	8,500	10,809	11,867	18,162
		SUB TPTAL	12,829	20,097	25,557	28,058	42,942
07 SANTE II							
	01	SANTE II VILLAGE	2,489	3,899	4,958	5,444	8,331
	02	SANTE II EXTENSION	1,796	2,814	3,578	3,928	6,012
		SUB TOTAL	4,285	6,713	8,536	9,372	14,343
08 SANTE III							
	01	SANTE III VILLAGE	6,558	10,274	13,065	14,343	21,952
	02	SANTE III EXTENSION	3,630	5,687	7,232	7,939	12,151
	03	LOUKOUKRO EKARE	2,176	3,409	4,335	4,759	7,284
	04	MOSSIKRO	3,911	6,127	7,791	8,554	13,091
		SAB TOTAL	16,275	25,497	32,423	35,595	54,478
09 LOCODJORO							
	01	LOCODJORO VILLAGE	9,149	14,332	18,226	20,009	30,624
	02	JERUSALEM I	8,602	13,476	17,137	18,813	28,793
	03	LACK MAN	995	1,559	1,982	2,176	3,331
		SUB TOTAL	18,746	29,367	37,345	40,998	62,748
10 ABOBO DOUME							
	01	ABOBO DOUME VILLAGE	7,349	11,513	14,640	16,073	24,599
	02	ABOBO DOUME EXTENSION	5,959	9,335	11,871	13,033	19,947
	03	JERUSALEM II	7,082	11,094	14,108	15,489	23,706
	04	MARINE NATIONALE	582	912	1,159	1,273	1,948
		SUB TOTAL	20,972	32,854	41,778	45,868	70,200
11 ATTECOUBE III							
	01	AGBAN ATTIE (PETIT BANCO)	2,442	3,826	4,865	5,341	8,174
	02	NEMATOULAYE	5,994	9,390	11,941	13,109	20,064
	03	DIENE	4,707	7,374	9,377	10,294	15,756
	04	ATTECOUBE III	456	714	908	997	1,526
		SUB TOTAL	13,599	21,304	27,091	29,741	45,520
12 FORET DU BANCO							
	01	PARC NATIONAL DU BANCO	289	453	576	632	967
		SUB TOTAL	289	453	576	632	967
		GRAND TOTAL	164,750	258,091	328,208	360,319	551,467

TABLE 3.4 TYPE OF HOUSING AND LIVING STANDARD IN YOPOUGON DISTRICT

Sectors	Quarters	1988 (BNETD)			1980 (PDA)
		Courtyard	Block	Individual	Level
1	ANDOKOI 1	3498	198	545	V
	ANDOKOI 2	623	0	47	V
	YOPOUGON GARE	1213	46	263	C
	YOPOUGON ATTIE 1ERE, 2EME ET 3EME TRANCHES	2802	361	737	C
	YOPOUGON ATTIE 4EME TRANCHE BANCO II	2285	201	1092	V
	YOPOUGON ATTIE 5EME TRANCHE	203	97	795	C
	YOPOUGON ATTIE 8EME TRANCHE	400	1	459	C
	CENTRE URBAIN	2	76	73	C
	SOGEFIHA SIPOREX 1	6	91	647	B
	SOGEFIHA SOLIC 2	9	2	1276	B
	SOGEFIHA SOLIC 1	3	93	654	B
	SELMER	21	151	1728	B
	SICOGI ANCIEN QUARTIER	222	302	4927	B
2	BANCO NORD 1ERE TRANCHE	1	3	110	A
	BANCO NORD 2EME TRANCHE	0	2	32	A
	BANCO NORD 3EME TRANCHE	446	0	407	A
	GFCI BEL AIR	3	0	505	B
	SOPIM	10	4	107	B
	SICOGI NOUVEAU QUARTIER	39	2	2090	B
3	BANCO SUD 9EME TRANCHE CITE UNIVERSITAIRE	115	199	894	B
	CITE SGBCI TIEMOKO COULIBALY	21	0	206	B
	SODECI	14	18	549	B
	YOPOUGON SANTE (DEGUERPIS DU PORT)	34	0	1	D
	SOGEFIHA (USINE AWA)	108	67	844	B
4	EXTENSION DU PORT	330	14	251	E
	BEAGO	42	0	202	V
	CHAPOULI	55	0	8	E
	YOPOUGON SANTE	265	2	31	V
5	KOUTE VILLAGE ET EXTENSION	1176	25	357	V
	YOPOUGON KOUTE EXTENSION EST (CAMP MILITAIRE)	46	14	1622	B
	YOPOUGON KOUTE EXTENSION OUEST (SIDECI)	196	60	2681	B
	CNPS	343	130	1667	B
6	ZONE INDUSTRIELLE SETU	143	40	238	C
	ZONE INDUSTRIELLE DE YOPOUGON (DU)	546	0	192	C
	PRISON CIVILE (MACA)	0	151	20	B
7	QUARTIER HOPITAL (MAMIE ADJOUA)	232	0	450	B
	QUARTIER GESCO	511	12	320	B
8	PORT BOUET II 1ERE ET 2EME TRANCHES	4263	0	782	C
	NIANGON NORD 1ERE ET 2EME TRANCHES	99	12	288	B
	NIANGON NORD 2EME TRANCHE	0	0	0	A
	NIANGON ADJAME (EXTENSION)	1	0	30	D
	ANANERAIE	0	0	0	A
9	NIANGON SUD A DROITE (SOGEFIHA)	25	0	711	B
	NIANGON SUD A GAUCHE (SICOGI SOGEFIHA)	391	10	2900	B
	NIANGON NORD SICOGI	26	2	1123	B
	GFCI (CITE VERTE)	17	0	89	B
	ZONE INDUSTRIELLE	10	0	39	C
	AZITO	13	1	128	A
	NIANGON LOKOA	593	9	362	V
	NIANGON ADJAME VILLAGE	161	8	56	V
	ACADEMIE DE LA MER	14	0	21	B
	NIANGON SUD CANAL	107	2	395	B
10	NIANGON ATTIE	180	2	172	V
	ADIOPODOUME (KM 17)	770	0	315	A
	ORSTOM	0	1	53	A
	INSTITUT PASTEUR	0	0	11	A
	CIMETIERE	140	1	143	D
	TOTAL YOPOUGON	22773	2410	34645	

TABLE 3.5 TYPE OF HOUSING AND LIVING STANDARD
IN ATTECOUBE DISTRICT

Sectors	Quarters	1988 (BNETD)			1980 (PDA)
		Courtyard	Block	Individual	Level
1	ABIDJAN TE	1,559	44	21	V
2	ABIDJAN SANTE VILLAGE (SEBROKO)	900	11	8	V
	BOLIBANA	2,758	0	2	E
	ATTECOUBE LAGUNE	677	1	9	V
3	QUARTIER DE LA PAIX	2,048	167	37	C
4	SAINT JOSEPH	1,122	216	38	C
	MOSQUEE	1,072	97	27	C
	QUARTIER DES ECOLES	416	58	190	C
5	GBEBOUTO	4,281	68	115	C
6	AGBAN VILLAGE	1,192	178	34	V
	CITE FAIRMONT	427	9	486	B
7	SANTE II VILLAGE	325	10	48	V
	SANTE II EXTENSION	106	5	218	V
8	SANTE III VILLAGE	1,335	0	72	V
	SANTE III EXTENSION	795	2	36	C
	LOUKOUKRO EKARE	370	0	136	V
	MOSSIKRO	666	2	254	E
9	LOCODJORO VILLAGE	1,274	48	124	V
	JERUSALEM I	1,886	1	43	E
	LACK MAN	167	0	13	E
10	ABOBO DOUME VILLAGE	1,277	20	176	V
	ABOBO DOUME EXTENSION	945	21	103	V
	JERUSALEM II	1,349	1	74	E
	MARINE NATIONALE	102	0	2	A
11	AGBAN ATTIE (PETIT BANCO)	456	0	28	V
	NEMATOULAYE	1,245	3	35	V
	DIENE	808	1	141	V
	ATTECOUBE III	80	0	1	C
12	PARC NATIONAL DU BANCO	24	0	15	B
TOTAL ATTECOUBE		**29,662**	**963**	**2,486**	

TABLE 3.6 AVERAGE INCOME IN EACH DISTTRICT IN 1993

CLASSIFIED BY TYPE OF HOUSING

	Illegal	Courtyard	Individual*1	Individual*2	Individual*3	Block*1	Block*2	Block*3
Abobo	50,940	87,426	184,625	322,143	531,944	190,000	235,833	471,957
Adjame	43,530	90,710	161,800	281,667	531,944	161,000	245,000	471,957
Attecoube	35,691	80,360	232,500	193,333	531,944	197,083	425,000	471,957
Cocody	43,705	94,392	252,759	292,653	531,944	197,813	322,366	471,957
Koumassi	39,600	93,844	208,261	475,000	531,944	231,304	259,231	471,957
Marcory	48,262	69,500	166,145	309,355	531,944	207,105	346,957	471,957
Plateau	0	0	179,118	223,750	531,944	116,786	177,917	471,957
Port-Bouet	56,897	86,728	167,214	260,349	531,944	309,333	433,500	471,957
Treichville	42,742	84,306	211,071	30,000	531,944	160,588	191,897	471,957
Yopougon	42,688	91,588	161,641	237,857	531,944	167,500	241,111	471,957
Total	44,806	87,463	182,008	277,476	531,944	187,133	282,000	471,957

*1: economic

*2: midium standing

*3: good standing

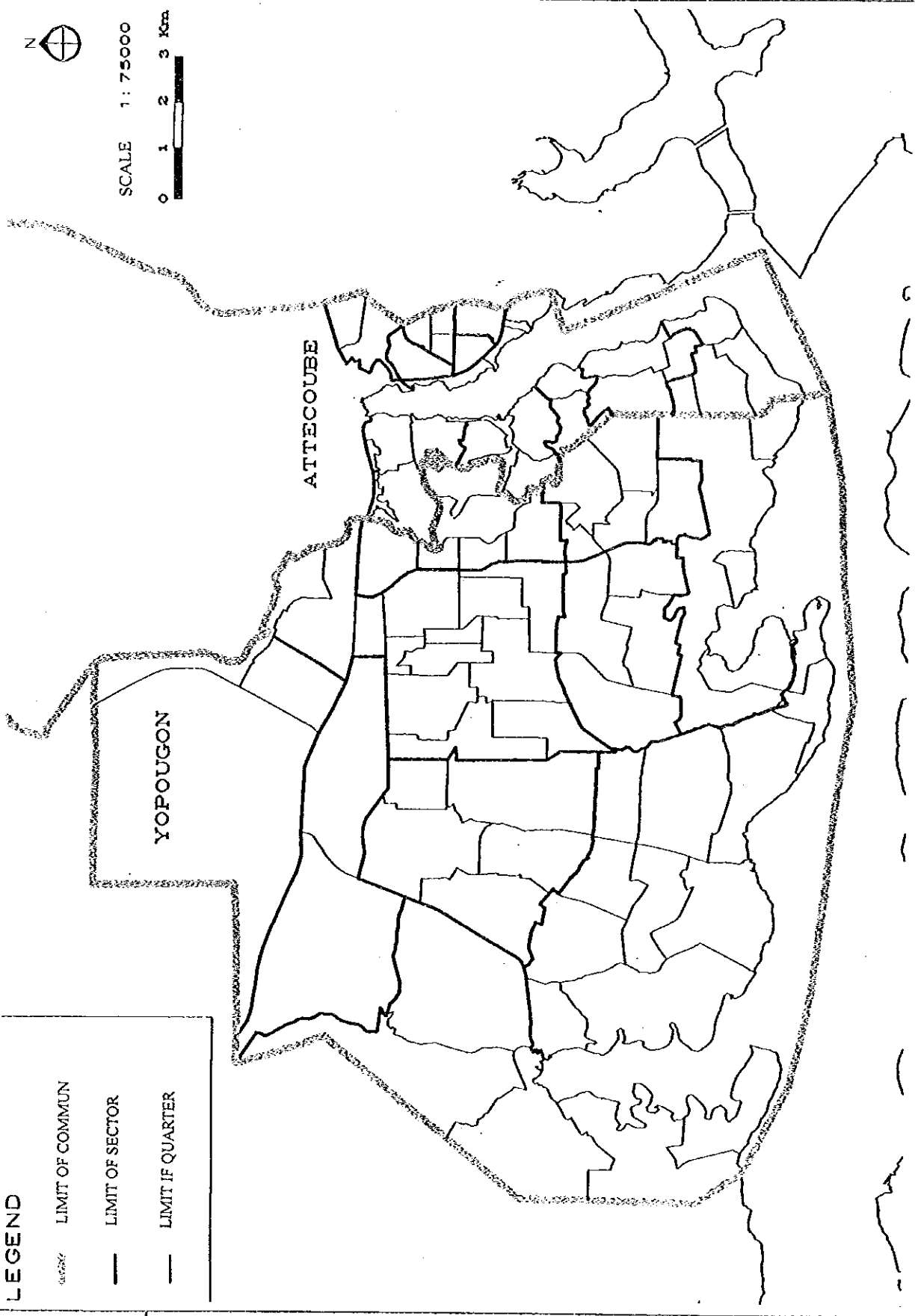


FIG. 3.1 ADMINISTRATIVE DIVISION MAP IN STUDY AREA

THE FEASIBILITY STUDY ON SEWERAGE FACILITIES IN WESTERN DISTRICT OF ABIDJAN CITY IN THE REPUBLIC OF COTE D'IVOIRE

JICA

COMMUNE D'ATTÉCOUBÉ

DÉCOUPAGE PAR SECTEUR ET QUARTIERS

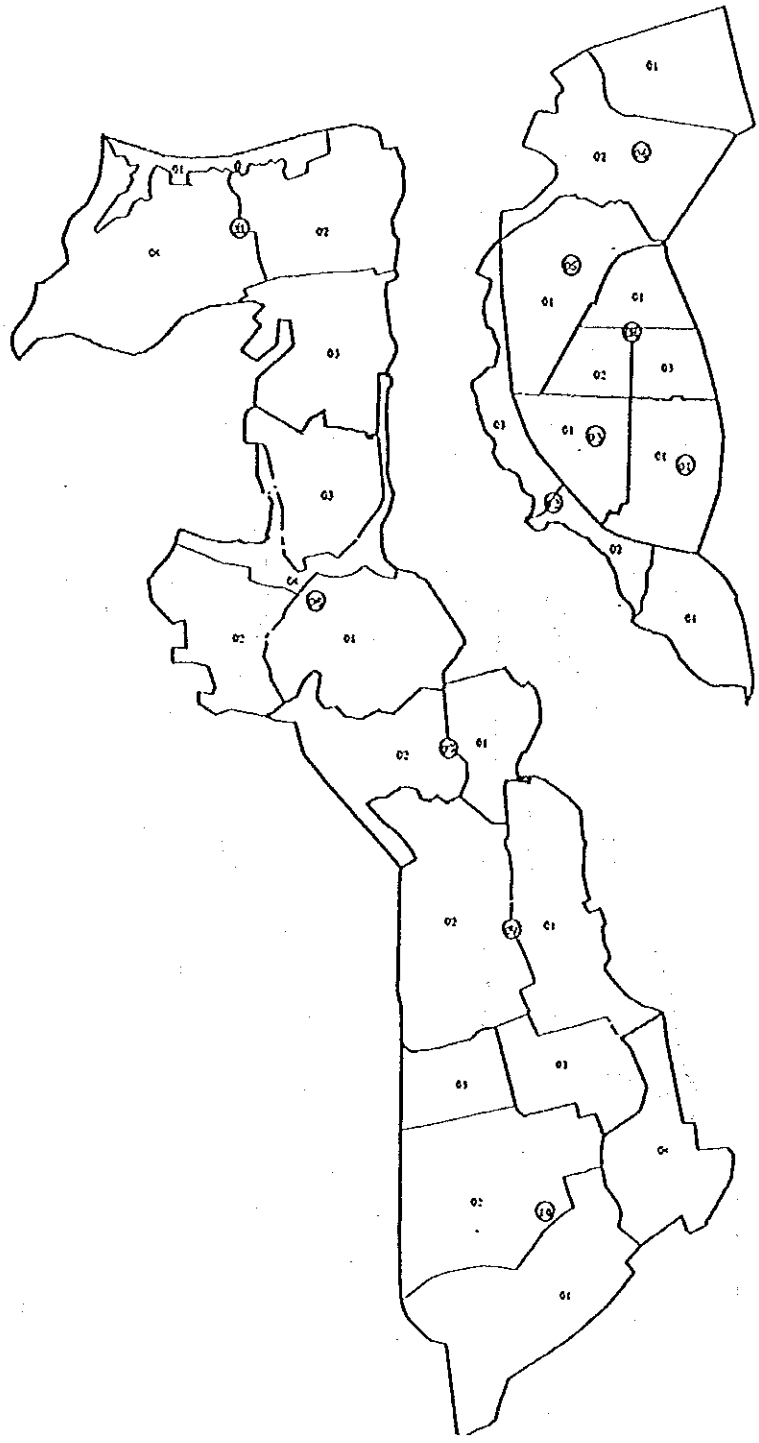


FIG. 3.2 DIVISION OF ATTECOUBE DISTRICT BY SECTORS AND QUARTERS

COMMUNE DE YOPOUGON

DECOUPAGE PAR SECTEUR ET QUARTIER

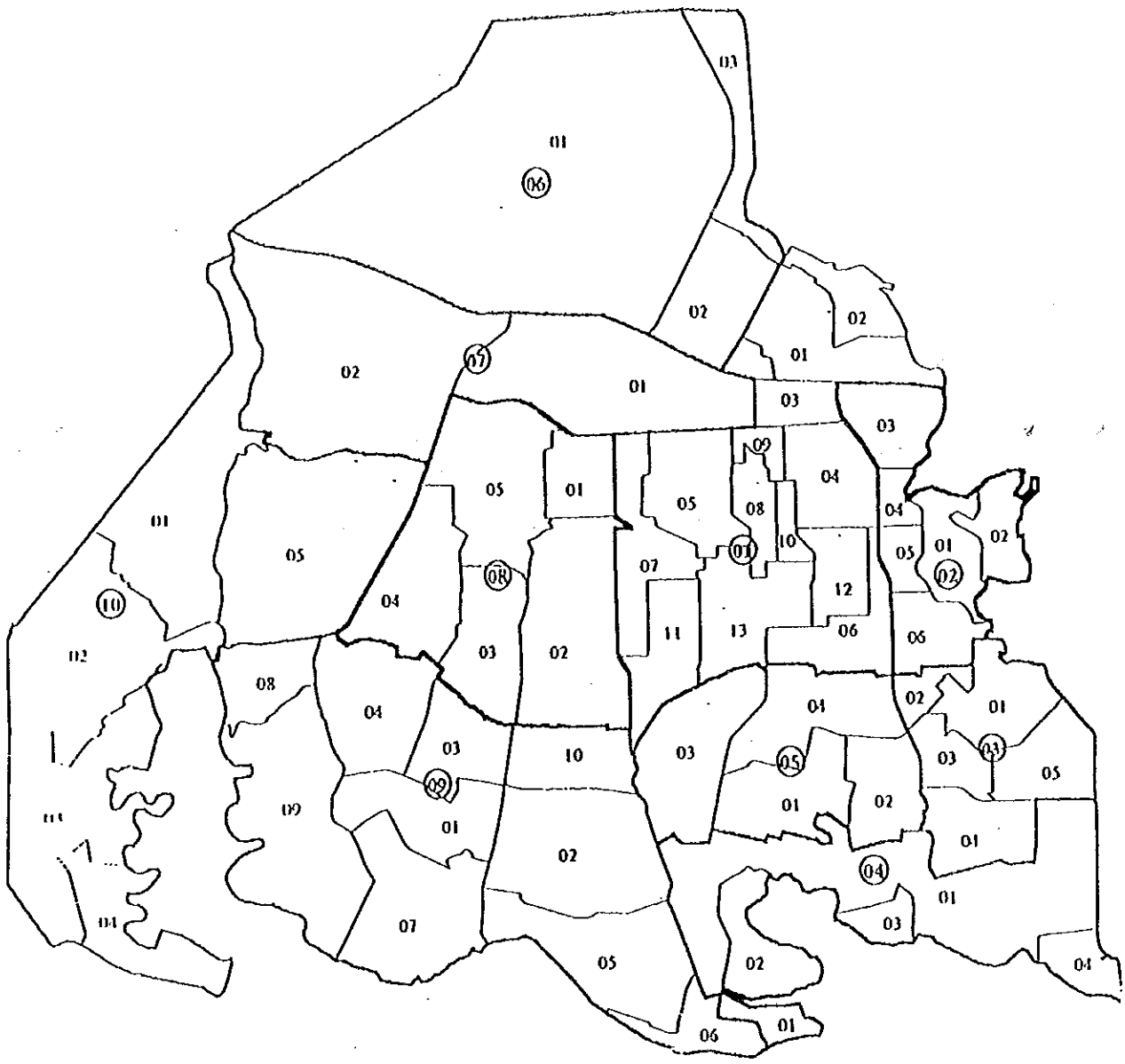


FIG. 3.3	DIVISION OF YOPOUGON DISTRICT BY SECTORS AND QUARTERS

THE FEASIBILITY STUDY ON SEWERAGE FACILITIES IN WESTERN DISTRICT OF ABIDJAN CITY IN THE REPUBLIC OF COTE D'IVOIRE

JICA

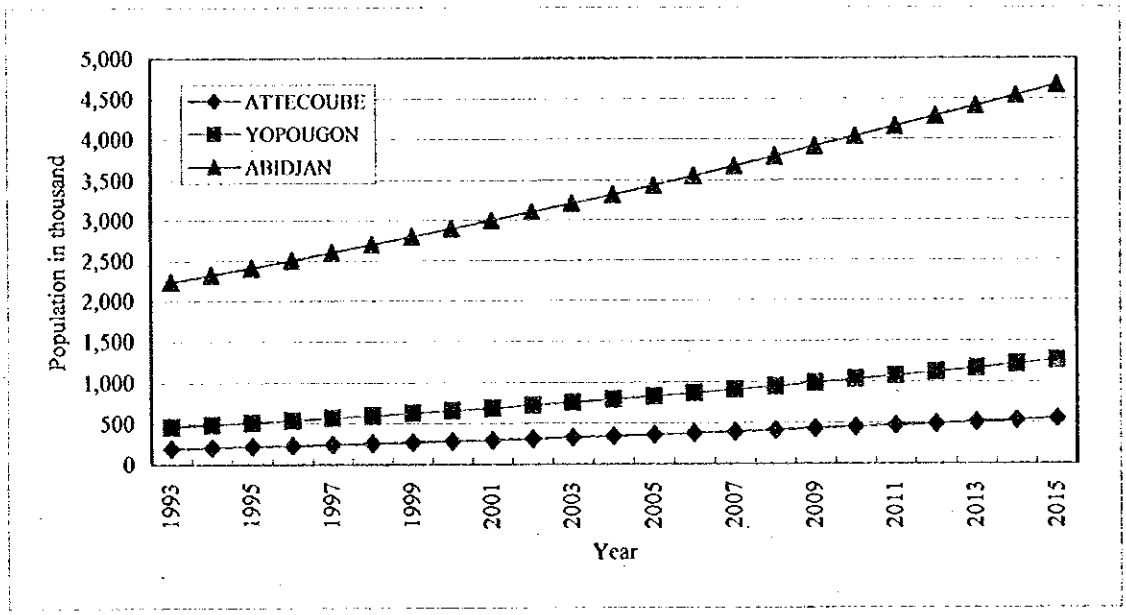


FIG. 3.4 PROJECTED POPULATION OF ABIDJAN CITY AND DISTRICTS OF ATTECOUBE AND YOPOUGON

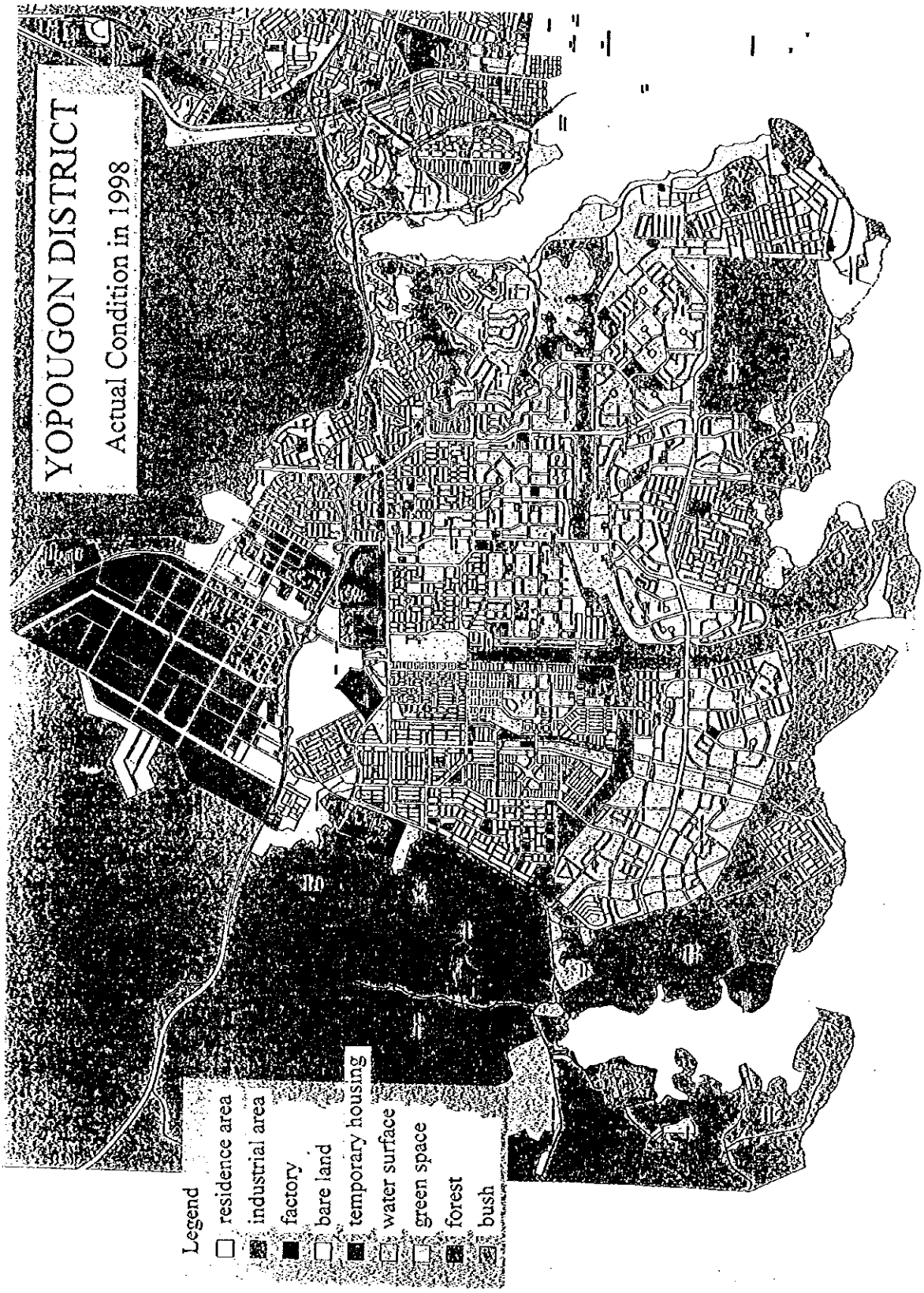


FIG. 3.5 LAND USE IN STUDY AREA IN 1998

CHAPTER 4

ECONOMIC AND FINANCIAL FRAMEWORK UP TO 2003

CHAPTER 4 SOCIO-ECONOMIC AND FINANCIAL FRAMEWORK UP TO 2003

4.1 Socio-economic Framework

1) Structure of Government Finance

Until the devaluation of CFA franc in January, 1994 and the start of structural reform, the financial deficit was extremely large in this country.

(1) The structure of the finance revenue (Table 4.1)

In almost any country, the basis of governmental finance depends on tax with various types. But in case of this country, the taxes applied on the income including individual income tax and corporate income tax consists of less than twenty percent of the government revenue.

And it seems to be different that this ratio will increase rapidly. The majority of government tax revenues are relying on the import duties (customs) and the export duties. As the paucity of such an income tax revenue corresponds with the remarkably low employment ratio in a formal sector. The World Bank is strongly proposing that imposes fixed property tax by preparing the cadastre as an integral part of structure adjustment. A land possession person seems to be generally considered to have income proportionally.

(2) The structure of finance disbursement (Table 4.2)

The government disbursement is divided into general disbursement and investment disbursement. Until the structure adjustment, the government tax revenues was not able to cover even general disbursement. As the guidance of the World Bank was so extensive, it is able to control the total amount of public officer salary. As a result, general disbursement is controlled substantially and recently is within the range of tax revenues. However, in order to pay the foreign interest and the investment expenditure, the foreign financial assistance is still necessary.

2) Foreign Debt Repayment Issue (Table 4.3)

The ratio of the capital repayment and interest payment of the foreign debt to the export revenue is called as debt service ratio (DSR).

The healthy upper limit of this ratio is 15%. The present DSR is 36% (It means the severe indebtedness with 6 times of government annual revenue and 1.4 times of GDP). The advanced countries and the international financial organizations have discussed the reduction plan of DSR because the economy of this country is not able to become independent as it is in current level. DSR will be reduced to 15% by 2016, according to the plan that was settled recently.

If the structure adjustment goes on right track, the foreign debt gradually should decrease. But the construction of infrastructure with new foreign debt will be difficult for a moment. Even if the investment is to be planned, the new financial framework that does not give any additional financial burden to the government such as BOT scheme must be developed, naturally. BOT assumes the privatization. The function of the government will shift from fund supplier to facilitator in the private business environment.

3) Structure Adjustment Issue (Table 4.4)

Although the structure adjustment of this country is extensive, in relation to the Feasibility Study, the primary issues are the governance of the government and anti-poverty measure. Until recently, it has been conceived that if economy grows the poverty problems will be solved eventually. However, the poverty layer is surely increasing, although economic growth is getting on the track in fact. Thereupon, the growth policy must interweave the policy for poverty layer. The supply of the safety drinking water to the poverty layer is an important subject, because there are many cases that the poverty layer is not supplied safe drinking water.

When the Study Team thinks the frame from such a viewpoint to 2003, the present structure adjustment will proceed smoothly and in 2003 GDP per capita will be about USD 800 at 1997 price.

4.2 Financial Framework

Both the World Bank and the Ivorian government has the firm policy of the reduction and

privatization of the government activities. Especially the sewerage service is being entrusted to SODECI with the water supply service and it is not conceivable that this framework of the privatization will set back by 2003.

In the case of the sewerage service, the construction cost is very expensive. Even in the advanced countries, it is very difficult to recover the whole construction cost with the tariff on the consumers. The huge subsidy from the government general account are required. But as we mentioned before, this country does not have the domestic financial resources for infrastructure construction such as sewerage service. In order to keep the financial deficit as small as possible, the financial expenditure of this country is now severely limited. In addition, as the matter of priority, the urgency of safety water supply exceeds the sewerage service.

This country is now requesting financial rescue plan that cancels a portion of the accumulated debt. Therefore, it is naturally unthinkable to add additional loan to sewerage construction project. The only available source of investment fund will be the grant from foreign countries.

While the priority of sewerage investment is not urgent as mentioned before, if we consider the environmental deterioration, the conclusion will be different. The water pollution in the Ebrie Lagoon in Abidjan is very serious. Therefore, as the countermeasure to environmental deterioration, this project deserves the highest priority.

The financial feasibility will be examined in detail in the next report. But at least the direct operation and maintenance cost after completion should be recovered in order to be sustainable in the operation.

Therefore, the study of the sewerage tariff systems will focus the direct cost recovery of the operation and maintenance cost and the affordability of the various customers.

Until June 1999, SODECI was not collecting the sewerage water service charges. The maintenance of the sewerage system was done within the government expenditure which consists less than 4 percent of total revenue of SODECI. There is no accounting separation

between water supply and sewerage service. The total maintenance of the sewerage is unclear. The one way to guess the rough maintenance cost will be the way using the number of labor forces engaging in sewerage service.

Although the contents of new contract between the ministries and SODECI are not disclosed, the government allows to SODECI to collect the sewerage tariff based upon the water consumption from July 1, 1999. In addition to the introduction of tariff collection, the right and responsibility to improve the connection rate for the sewerage service will be given to SODECI. Although many legal and administrative frameworks are required to facilitate the activity of SODECI, it will be the critical step toward the promotion of the sewerage service.

4.3 Implication for Feasibility Study

Thinking of current level of the per capita income and the employment structure in this country, it seems to be unrealistic that the cost of the operation and maintenance of the sewerage service will be allocated to the public general. Rather, the business customers in mainly central business district could afford the most portion of the running cost of the sewerage service.

According to the annual report of SODECI, there are five tariff categories in water supply service (Table 4.5). The cheapest tariff category is "social connection". In terms of billed water volume, this category consumes 31 % of the total billed water but the tariff revenue from this group is only 9.9 % of total revenue. Computing from Table 4.5, the effective water tariff for the "social connection" is only one tenth of the highest (normal) tariff rate.

The new tariff system for sewerage service is based on the volume of the water consumption and the water tariff structure. Therefore, the customers with social connections will not bear the cost proportionally to the volume of their wastewater discharge. The Study Area of this Feasibility Study - Western district of Abidjan has huge low-income residents. The service revenue that covers the operation costs may not be recovered within the district if we compute separately. Rather, we should try to meet costs with revenue within a whole Abidjan city as single computation unit. The detailed financial

examination of the operational cost recovery will be discussed later in next report.

On the contrary to the water supply, in case of the sewerage service, the construction cost of domestic facility has to be paid by individual customers in addition to the monthly fee. As this initial cost is substantial to low income customers, the increase of the connection rate to the sewerage will not be realized automatically.

Usually, the compulsory connection is enforced with the specified time limit. This enforcement will be accompanied with the subsidy and/or low interest loan program for low-income customers. Without these supporting measures the sewerage connection rate will not improved. The many experiences in the advanced countries suggest the necessity of such measures.

Also, the existing sewerage network in the Western district is learned to be severely damaged at the various points by our field survey. The rehabilitation of these damaged sewerage networks will be discussed separately in the Chapter 9. While the cost for the rehabilitation is not included in the Feasibility Study, the arrangement of the rehabilitation is prerequisite for the Feasibility Study. Otherwise, the facility that is planed to be constructed in this study does not have the wastewater, which is collected by the existing network. Without the wastewater to be carried, the financial examination of the project is impossible.

In summary, the financial examination of this project assumes the rehabilitation works for the existing sewerage network, the legal systems that enforces the connection to the sewerage service, the systems that supply the subsidy and/or low interest loan to domestic works in low income residences and the tariff systems that requires the large portion of the operational costs will be allocated to the business users, especially to large volume consumers such as international hotels who are able to bear the costs. These frameworks will make up the financial scheme of this project.

It is the common customs that the sewerage tariff will be based on the water consumption and the tariff for the sewerage service is usually from 40 % to 60 % of water tariff and total monthly amount of water and sewerage tariff should be within 2 -5 % percent of disposable

income.

The new sewerage tariff is far less than these common standard. But starting to collect sewerage tariff is remarkable progress in this country.

In order to collect the sewerage tariff smoothly, the tariff collection system for water supply must be established in advance. Examining SODECI case, it takes more than 300 days to collect water tariff on average and there are huge arrears in heavy users such as public organizations and schools. Usually, these arrears are partly canceled after receiving lump sum payment. SODECI has to graduate such tariff collection practice as soon as possible.

TABLE 4.1 COMPOSITION OF GOVERNMENT REVENUE

(in billions FCFA)

Item	Year						
	1990	1991	1992	1993	1994	1995	1996
Financial Revenue							
Direct Taxes	143.5	120.7	120.7	100.6	126.4	202.1	229.4
Goods & Service	123	130.3	131.6	116.6	131.1	167.1	195.7
Import Taxes	249.9	240.9	242	212.3	280.7	341.7	404.1
Export Taxes	8	8	5.6	5.7	140.5	177.3	193
Others	114.7	104.6	109.6	97.7	198.1	205.1	146.7
Dons-projets	0	0	0	0	0	44.1	40
Total	639.1	604.5	609.5	532.9	876.8	1137.4	1208.9

(%)

Item	Year						
	1990	1991	1992	1993	1994	1995	1996
Direct Taxes	22.5	20.0	19.8	18.9	14.4	17.8	19.0
Goods & Service	19.2	21.6	21.6	21.9	15.0	14.7	16.2
Import Taxes	39.1	39.9	39.7	39.8	32.0	30.0	33.4
Export Taxes	1.3	1.3	0.9	1.1	16.0	15.6	16.0
Others	17.9	17.3	18.0	18.3	22.6	18.0	12.1
Dons-projets	0.0	0.0	0.0	0.0	0.0	3.9	3.3
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

TABLE 4.2 TREND OF PUBLIC FINANCE

Item	Unit	Year						
		1990	1991	1992	1993	1994	1995	1996
Public Finance								
Revenue	% of GDP	21.7	20.4	20.6	18.1	21.2	22.8	22.0
Expenditure	% of GDP	40.4	40.2	36.0	36.1	32.7	30.3	29.5
Financial Deficit	% of GDP	-18.7	-19.8	-15.4	-18.0	-11.5	-7.5	-7.5
External Aid	Billions FCFA	253.0	211.7	193.5	206.7	685.0	488.7	281.0
	% of GDP	8.6	7.2	6.5	7.0	16.6	9.7	5.1
Financial Balance	% of GDP	-10.1	-12.6	-8.9	-11.0	5.1	2.2	-2.4
Total Revenue	Billions FCFA	639.1	604.5	609.5	532.9	876.8	1146.4	1211.9
Total Expenditure	Billions FCFA	1188.9	1188.5	1065.2	1062.4	1352.5	1523.8	1622.3
Primary Expenditure	Billions FCFA	760.2	709.8	693.4	670.4	812.6	931.7	994.6
Interest	Billions FCFA	288.4	323.1	224.4	258.8	348.3	341.3	336.4
Investment (BSIE)	Billions FCFA	140.3	155.6	147.4	133.2	191.6	250.8	291.3
Total Expenditure	% of GDP	40.4	40.2	36.0	36.1	32.7	30.3	29.5
Primary Expenditure	% of GDP	25.9	24.0	23.5	22.8	19.6	18.5	18.1
Interest	% of GDP	9.8	10.9	7.6	8.8	8.4	6.8	6.1
Investment (BSIE)	% of GDP	4.8	5.3	5.0	4.5	4.6	5.0	5.3
Revenue - Pri. Exp.	% of GDP	-4.2	-3.6	-2.9	-4.7	1.6	4.3	3.9
GDP	Billions FCFA	2939.3	2960.0	2956.0	2946.5	4136.1	5031.3	5496.5
Foreign exchange rate	FCFA/USD	256.6	278.6	275.0	260.0	557.6	500.0	500.0

TABLE 4.3 TREND AND PROSPECT OF DEBT SERVICE RATIO (= DEBT SERVICE / EXPORT)

Item	Unit	Year						
		1996	1997	1998	1999	2000	2006	2016
Debt service/Export								
Public	%	25.0	20.8	20.2	14.1	12.7	9.0	5.5
Private	%	10.3	11.1	11.6	11.4	11.1	10.7	9.5
Total	%	35.3	31.9	31.8	25.5	23.8	19.7	15.0
NPV public debt/GDP	%	144.7	130.4	72.4	65.5	61.0	36.6	14.3
NPV public debt/government revenue	%	643.0	587.5	326.8	310.1	292.9	174.4	67.9
Public debt service/government revenue	%	52.1	43.6	41.0	29.7	27.3	18.7	11.4
Memorandum items:								
Exports	Billions FCFA	2,564.9	2,788.4	2,940.3	3,171.8	3,436.4	5,208.3	10,785.6
Government revenue	Billions FCFA	1,231.9	1,328.0	1,446.6	1,499.3	1,602.4	2,512.2	5,186.6
GDP	Billions FCFA	5,473.6	5,983.4	6,529.8	7,100.2	7,690.7	11,977.2	24,698.3
NPV of public debt	Billions FCFA	7,921.1	7,802.5	4,727.8	4,648.7	4,693.4	4,386.8	3,524.3
NPV of private debt	Billions FCFA	1,755.9	1,973.1	2,095.7	2,219.4	2,348.6	3,454.3	6,310.2
NPV of total debt	Billions FCFA	9,677.0	9,775.6	6,823.5	6,868.1	7,042.0	7,841.1	9,834.5
Reference exchange rate	FCFA per USD	598.8	598.8	598.8	598.8	598.8	598.8	598.8

TABLE 4.4 TREND AND FORECASTING OF GDP AND GDP PER CAPITA

Item	Unit	Year																								
		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Nominal GDP	Billions FCFA	2939.3	2960	2956	2960	4256	4997.7	5473.6	5903.6	6529.8	7100.2	7690.7	8306.1	8962.5	9647.8	10374.3	11148.2	11977.2	12858.8	13801.8	14823.9	15925.6	17119.9	18408.1	19800.7	21309.6	22955.9	24693.3
Growth of nominal GDP	%		0.7%	-0.1%	41.3%	44.5%	17.2%	9.7%	9.3%	9.1%	8.7%	8.3%	8.0%	7.9%	7.6%	7.5%	7.5%	7.4%	7.3%	7.4%	7.4%	7.4%	7.5%	7.5%	7.6%	7.6%	7.6%	7.7%
GDP deflator (1997=100)		60.6	61.0	60.8	60.9	83.9	95.4	97.7	100.0	102.4	104.9	107.6	110.0	112.6	115.3	116.9	118.5	120.2	121.9	123.6	125.3	127.1	128.9	130.7	132.5	134.3	136.2	138.1
Growth of GDP deflator	%		0.7%	-0.4%	0.2%	37.7%	13.7%	2.4%	2.4%	2.4%	2.4%	2.4%	2.4%	2.4%	2.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%
Population	Thousands	11,650.0	12,040.0	12,550.0	13,030.0	13,520.0	14,030.0	14,563.1	15,116.5	15,691.0	16,287.2	16,906.1	17,379.5	17,866.1	18,366.4	18,825.5	19,296.2	19,778.6	20,273.1	20,779.9	21,299.4	21,831.9	22,377.7	22,937.1	23,510.5	24,098.3	24,700.8	25,318.3
Growth of Population	%	3.8%	3.8%	3.8%	3.8%	3.8%	3.8%	3.8%	3.8%	3.8%	3.8%	2.8%	2.8%	2.8%	2.8%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%
Nominal GDP per capita	FCFA	252,300	246,830	235,538	226,044	314,793	355,502	375,853	395,818	416,150	435,937	454,900	477,925	501,647	525,297	551,086	577,741	605,564	634,083	664,140	695,978	729,557	765,064	802,547	842,206	884,154	929,535	975,315
Real GDP per capita	FCFA (1997)	416,066	401,075	387,561	371,199	375,003	372,769	384,873	395,818	406,397	415,242	423,068	434,670	445,552	455,622	471,392	487,369	503,786	520,229	537,407	555,352	574,109	593,722	614,227	635,680	658,128	681,621	706,077
Growth of real GDP per capita (FCFA)	%		-3.6%	-3.4%	-4.2%	1.1%	-0.7%	3.2%	2.8%	2.7%	2.1%	1.9%	2.6%	2.5%	2.3%	3.5%	3.4%	3.4%	3.3%	3.3%	3.3%	3.4%	3.4%	3.5%	3.5%	3.5%	3.6%	3.6%
Nominal exchange rate	FCFA/USD	272.3	282.1	275.0	283.2	555.2	499.1	511.6	582.4	594.5	591.6	598.3	585.0	574.0	570.0	570.0	570.0	570.0	570.0	570.0	570.0	570.0	570.0	570.0	570.0	570.0	570.0	570.0
Nominal GDP per capita	USD	926.6	867.9	856.5	798.4	567.0	712.3	734.7	679.6	700.9	746.9	773.3	817.0	874.0	921.6	966.8	1,013.6	1,062.4	1,112.4	1,165.2	1,221.0	1,279.9	1,342.2	1,408.0	1,477.6	1,551.1	1,629.0	1,711.1
Real GDP per capita	USD (1997)	1,528.0	1,421.7	1,409.3	1,310.7	676.1	746.9	752.3	679.6	683.6	702.7	720.3	743.0	776.2	799.3	827.0	855.0	883.8	912.7	942.8	974.1	1,007.2	1,041.6	1,077.6	1,115.2	1,154.6	1,195.8	1,238.7
Growth of real GDP per capita (USD)	%		-7.0%	-0.9%	-7.0%	-48.4%	10.5%	0.7%	-9.7%	0.6%	2.8%	2.5%	3.2%	4.5%	3.0%	3.5%	3.4%	3.4%	3.3%	3.3%	3.3%	3.4%	3.4%	3.5%	3.5%	3.5%	3.6%	3.6%

TABLE 4.5 REVENUE COMPOSITION AND VOLUME COMPOSITION OF WATER SUPPLY BY TARIFF CATEGORIES

Tariff Categories	Revenue (%)	Consumption (%)	Remarks
Normal	25.1	8.6	Including repair works
Industrielle	28.7	12.0	
Administrative	21.1	19.6	
Domestique	15.2	28.8	
Sociale	9.9	31.0	

CHAPTER 5

INSTITUTIONAL AND ORGANIZATIONAL FRAMEWORK UP TO 2003

CHAPTER 5 INSTITUTIONAL AND ORGANIZATIONAL FRAMEWORK UP TO 2003

5.1 Institutional Framework and Structural Reform

As for the framework until 2003, the present institutional framework as described in 2.3.1 should be continued with some fortification of the financial basis of SODECI by the new contract effective on July 1, 1999. Although it is the outside of this study, the water tariff collection should be improved. If the revenue inflow will be more predictable, the investment by SODECI will become more positive. World Bank report told that the investment for the water supply by the SODECI has been improved remarkably from the era of the operation by the government.

The collection of the tariff is epoch-making progress. Of course it takes long time until the sewerage fee collection becomes satisfactory and the substantial portion of the operational cost will be recovered from the sewerage tariff. But, anyway, the tariff collection has started. The experience on the tariff collection will be accumulated. The assignment of the promotion of the sewerage connection to SODECI will be welcome. While many additional measures by the government are required in order to increase the number of connection such as the legal enforcement and the supply of subsidy and/or low interest loan to low income customers, the fundamental freedom and obligation to expand the business must be given to SODECI. It conforms the philosophy of the privatization and the disengagement of the government from the business activity that is currently promoted by the government

Until now, SODECI only takes the charge of small-scale repair regarding sewerage service. The large scale investment for sewerage service is not only authorized but also financially too risky to SODECI. But, in addition to the above-mentioned legal and financial framework, the further development of financial scheme that attracts international fund to SODECI is required. Major responsibility of the government is to develop the scheme to reduce business and financial risk of the investment without hindering the freedom of private business that will destroy the attractiveness of investment.

Sewerage service requires huge investment, which is usually unprofitable to private business. Therefore, the introduction of private capital will not realize easily. The development of financial scheme to water supply will come at first. But eventually the financing scheme to sewerage service and environmental protection project should be materialized.

5.2 Organizational and Regulatory Framework

In the advanced countries including Japan, the construction and operation of social infrastructure projects is usually assigned to the public sector. The sewerage service is too.

These traditional systems of constructing and maintaining the social infrastructure are introduced to the newly independent states in the developing world. In addition, because the private sector is less developed, the government has to take larger responsibility than advanced countries in the construction and operation of these social infrastructures.

This country has been very famous for market friendly economic management from the date of the independence. But the government still had to involve too many business activities partly due to the less development stage of the private business activities.

But, around the world, the most government-owned and operated businesses have failed to perform successfully, the privatization of the government owned and operated businesses is currently world trend. It is actually the redefinition of the activity of the government from the producer to the good regulator. The wave of the privatization that has been started by Prime Minister of the United Kingdom, Ms. Satcher is now arriving to here with the strong support of IMF and the World Bank.

But, the new economic scheme does not mean free economic system simply. In order to facilitate the activities of the private businesses in the area formerly perceived as the domain of public service, the sophisticated financial arrangement and favorable supporting environment are necessary. The most schemes have to be formulated from now on. The World Bank will have the workshop centering the effective regulatory framework in the context of infrastructure development in Sub-Sahara Africa in the coming September.

CHAPTER 6

WASTEWATER

CHAPTER 6 WASTEWATER

6.1 Wastewater Flow

6.1.1 Domestic Wastewater

Unit wastewater flow is estimated by considering the inhabitant water consumption trend, measuring actual flow during the Study, interview and previous studies on water supplies and sewerage systems.

1) Water Consumption Per Capita

With the assistance of the World Bank, the Sewerage and Drainage Master Plan of Abidjan was prepared in 1971. In 1981-1982, the Government reviewed the Master Plan of 1971. This Feasibility Study is conducted based on the revised Master Plan.

The Master Plan of 1971 proposed water supply consumption per capita for Abidjan according to the living standards based on different types of housing (Ref. to Chapter 3: Urban Planning and Land Use). Based on the classification of housing types, water consumption per capita is as follows:

Level A	402 L/person/day (Lpcd)
Level B	81 Lpcd
Level C	78 Lpcd
Level D	65 Lpcd
Level E+V	26 Lpcd
None service area	15 Lpcd

In March 1981, IBRD evaluated the Master Plan of Great Abidjan. IBRD suggested that the above estimated water consumption is higher compared to the actual one. Especially in Level A habitant, the consumption has not reached 402 Lpcd. The water consumption per capita was revised as shown in Table 6.1.

The connection ratio of water supply system according to the living standards based on the different types of housing is as shown in Table 6.2.

The wastewater flowrate largely depends on water use. A significant portion of the supplied water does not reach the sewers. For example, in the case of residential habitant of high and middle class (A Level habitant), a part of water is used for garden sprinkling, car washing, etc. The illegal housings, traditional villages and scattered inhabitants are not served by the sewerage system but have access to water supply. Many of households dispose of sullage (kitchen and bathroom wastewater) directly to the ground, drains, ditches or public roads.

The discharge rate, which means the percentage of discharged wastewater into the sewers out of the total water consumption, is smaller in the A Level (higher water consumption) and is higher in the B, C+D, and E+V Levels (lower water consumption) (Table 6.3).

2) Sewage Flow Per Capita

The sewage flow per capita for the Feasibility Study was determined based on 1995 data. Using the value indicated in Table 6.1 to 6.3, the flow is estimated (Table 6.4).

3) Commercial Wastewater

The Master Plan adopted commercial wastewater generation as 16.1% of the domestic sewage in 1990 and 16.6 % in 1995. This Feasibility Study adopted the commercial wastewater generation as 16.0% of the domestic sewage.

4) Total Sewage Flow Per Capita

Considering the commercial wastewater generation, total sewage flow per capita is estimated:

		Total Per-Capita Sewage Flow
A Level	155 x 1.16 =	180 Lpcd
B Level	75 x 1.16 =	90 Lpcd
C+D Level	45 x 1.16 =	52 Lpcd
E+V Level	5 x 1.16 =	6 Lpcd

6.1.2 Industrial Wastewater

The opening of the Virdi Canal in 1950, followed by the construction of Abidjan harbor, gave a real boost to the economy in Côte d'Ivoire. The construction of the harbor also brought industrial development: more than 70% of the industries in the country are located in Abidjan (food products, breweries, soft drinks, slaughtering, textiles, oil refinery, pulp & paper, iron & steel, wood processing, chemicals etc). According to SIIC, there are about 3,000 industries in Côte d'Ivoire in which about 2,230 industries are in Abidjan alone. Among all industries in Côte d'Ivoire, 360 industries are believed to be causing significant pollution to air and water. Production of solid wastes is of great concern, too. The region wise distribution of 360 industries in Côte d'Ivoire is given in Table 6.5.

The number of industries in Yopougon district is 223. Among them, 95% are located in the Zone-Industrielle of Yopougon. The industry types are given as follows:

Food products: 6 companies, Textiles: 9 companies, Chemicals: 40 companies, Machinery: 70 companies, Wood processing: 25 companies and Others: 73 companies.

Table 6.6 shows the top 15 industries in the Zone-Industrielle of Yopougon in terms of effluent volume. The characteristics of the 15 industries are as follows:

- 2693 employees
- Industrial wastewater: 7500 m^3/day
- Domestic wastewater: 27 m^3/day
- Water consumption per capita: 100 L/day

The effluent quantity from small industries in the Zone-Industrielle of Yopougon is estimated by the Master Plan as follows:

- Heavy industrial zone: 40 m^3/day/ha
- Medium industrial zone: 20 m^3/day/ha
- Light industrial zone: 5 m^3/day/ha

In addition, industrial wastewater from the planned Sea Port should be considered. The Sea Port Plan is to extend the existing harbor to Locodjoro of 200 ha, a part of the Study Area, under phase II of the Plan. Phase I will be completed in the year 2002 in an area of 100 ha. Factories and related facilities will be constructed under the Plan. Based on the Master Plan, the Study Team adopts the industrial effluent from the Sea Port Plan area as an amount of 20 m^3/day/ha.

6.2 Wastewater Characteristics and Pollution Loads

Among several parameters BOD_5 and SS are two important parameters for the design and operation of a wastewater treatment plant, and for management of water quality. BOD_5 in particular, is a key parameter for establishing the type of process and performance of the plant.

The Study Team investigated the sewage quantity and quality by conducting two 24 hour monitoring and samplings in the existing trunk sewers, pumping stations (S1 and 7J1 pumping stations), and sewage pre-treatment plant (APPENDIX C).

6.2.1 Domestic Wastewater Characteristics and its Pollution Load

The Master Plan proposes the pollution load per capita to the sewerage system according to living standards based on different types of housing. The load is as follows:

A Level	35 g BOD_5/person/day (gpcd)
B Level	30 gpcd
C+D Level	25 gpcd
E+V Level	20 gpcd
None service area	Not considered

BOD_5 load per capita in developed and developing countries is shown in Table 6.7. The load varies widely from country to country. The load is high in the developed countries.

6.2.2 Industrial Wastewater Characteristics and its Pollution Load

The characteristics of industrial effluents in the Study Area are shown Table 6.8. Among them, industries of agriculture, food manufacturing and textiles production constitutes about 85% of the wastewater volume and 95% of the pollution load.
Toxic compounds are not measured by any organization although pesticide industries and the glue and wood preservative industries may produce the compounds. An average BOD_5 of industrial wastewater is 1100 mg/L from Table 6.6 and 6.8.

Table 6.9 shows the industrial effluent standards in West African countries such as Côte d'Ivoire, Nigeria, Benin and Ghana. Nigeria and Ghana have norms and standards defined for only concentration. There is no specification of allowable fluxes.
Concentration regulated is almost the same in all 4 countries.

To reduce the industrial activity impact on the environment, the Ministry of Environment and Forest has implemented many actions.

These are:

- The establishment of an important legislative framework: environment code, decree of the classified industries, decree on the EIA, decree for individual exploitation;
- The creation of National Agency for Environment (ANDE).

In spite of the regulatory and structural arrangements, the industrial pollution is still increasing. According to SIIC, there are about fifty industries in Abidjan causing serious water pollution. Among them, about only 20 industries have treatment plants. However, many of these plants are non-functional or poorly managed.

The Code of Environment (Le Code de l'Environment Law No. 96-766 of October 3, 1996) forecasts in its article 35.5, the Principle of Polluter-Pay to force the manufacturers to contribute to the protection of the environment. This pollution tax system will lead the polluter to be more involved in the fight against industrial pollution through the establishment of facilities to prevent pollution. SIIC has proposed to the Government for this tax as 5 FCFA per ton of pollution produced per day, whatever the type is. According to SIIC, at first the choice for 5 FCFA/ton/day is more symbolic because 5 FCFA is the

minimum monetary unit in force in Côte d'Ivoire. Secondary, its application will cause some costs, which seem to be bearable by the industries in Côte d'Ivoire.

TABLE 6.1 WATER CONSUMPTION ESTIMATED BY IBRD IN ABIDJAN

(Unit: Lpcd)

Level	1980	1985	1990	1995
A	330	335	340	345
B	80	85	90	93
C+D	70	72	75	77
E+V	26	27	28	29
None service area	15	15	15	15

TABLE 6.2 SEWER CONNECTION RATIO

(%)

Level	1980	1985	1990	1995
A	100	100	100	100
B	90	95	100	100
C+D	50	50	60	70
E+V	15	15	15	15

Source: World Bank

TABLE 6.3 DISCHARGE RATIO

(%)

A Level	B Level	C+D Level	E+V Level	None service area
45	80	80	80	0

Source: World Bank

TABLE 6.4 SEWAGE FLOW PER CAPITA

(Unit: Lpcd)

	Water Consumption	Connection Ratio (%)	Discharge Ratio (%)	Sewage Flow Per Capita
A Level	345	100	45	155
B Level	93	100	80	75
C+D Level	77	70	80	45
E+V Level	29	15	80	5
None service area	15	0	0	0

Source: World Bank

TABLE 6.5 INDUSTRIES AS HIGH RANKED POLLUTERS IN REGION

Region	Number of Industries	Percentage of total
Abidjan - Economic capital	274	76
South-west (San-Pedro)	25	7
Center (Bouake)	24	6.7
West (Man)	7	2
Center-west (Daloa)	12	3.3
East (Abengourou)	7	2
North (Korhogo)	11	3
TOTAL	360	100

Source: SIIC

TABLE 6.6 INDUSTRIES DISCHARGING HIGH AMOUNTS OF EFFLUENT

Industry	Location	Treatment Method	Effluent Quantity (m^3/day)
UNIWAX	Laguné côté Azito	PHYSICAL (DECANTATION)	4800
IMPRIMERIE INDUST. IVOIR	Laguné côté Azito	NO TREATMENT	150
CIREPCI		NO TREATMENT	
CEMOI C.I.		PHYSICAL (DECANTATION)	150
COPACI	Laguné côté Azito	NO TREATMENT	22
EUROLAIT		NO TREATMENT	150
FIB-CI			50
IVOIRE TEINTURE		PHYSICAL (DECANTATION)	250
NESTLE - YOP		BIOLOGICAL	240
PARF. GANDOUR		NO TREATMENT	75
SAEC[1]	Laguné côté Yopniangon	PHYSICO-CHEMICAL	60
SAPLED		PHYSICAL (DECANTATION)	200
SIVOP	Laguné côté Azito	NO TREATMENT	22
SOLIBRA		PHYSICAL (DECANTATION)	750
SONACO		PHYSICO-CHEMICAL	138
TEXTPLAST		NO TREATMENT	
WRANGLER - SAB	Laguné côté Azito	NO TREATMENT	400

Source: SIIC

TABLE 6.7 BOD_5 LOAD PER CAPITA

(Unit: g BOD_5/person/day)

Country	Parameters	Black (toilet) Wastewater	Sullage (kitchen & bathroom wastewater)	Total
Japan (in 1990)	BOD_5	18	39	57
	COD_{Mn}	10	18	28
	SS	20	23	43
	T-N	9	3	12
	T-P	0.9	0.3	1.2
United States	BOD_5	18	39	57
Tropical countries	BOD_5	22	18	40
South East Asia *	BOD_5	-	-	43
India *	BOD_5	-	-	30 to 45

*Source: Urban Drainage and Sewage Treatment in Developing Countries: Ministry of Construction, Japan.

TABLE 6.8 INDUSTRIAL EFFLUENT CHARACTERISTICS

INDUSTRY	TREATMENT METHOD	BOD_5 (mg/l)	SS (mg/l)	COD (mg/l)	Flux COD (kg/day)
UNIWAX	PHYSICAL (DECANTATION)	160	103	500	2400
IMPRIMERIE INDUST. IVOIR	NO TREATMENT				
CIREPCI	NO TREATMENT				
CEMOI C.I.	PHYSICAL (DECANTATION)				
COPACI	NO TREATMENT	1746	20	4365	94
EUROLAIT	NO TREATMENT	281	850	2400	
FIB-CI					
IVOIRE TEINTURE	PHYSICAL (DECANTATION)	320	69	800	2000
NESTLE - YOP	BIOLOGICAL	65	13	73	18
PARF. GANDOUR	NO TREATMENT	66	15	200	15
SAEC[1]	PHYSICO-CHEMICAL	50	38	170	10
SAPLED	PHYSICAL (DECANTATION)	293	960	2351	470
SIVOP	NO TREATMENT	640	250	1100	24
SOLIBRA	PHYSICAL (DECANTATION)	800	330	1400	1050
SONACO	PHYSICO-CHEMICAL	2458	433	6144	849
TEXTPLAST	NO TREATMENT				
WRANGLER - SAB	NO TREATMENT	921	545	2302	921

[1] pH 6.5; T°(C) 25.0; Cu<0.02 mg/l; Chrome<0.05 mg/l; Pb<0.2 mg/l; Total hydrocarbon<5 mgHC/l.

Source: SIIC

TABLE 6.9 INDUSTRIAL EFFLUENT STANDARDS OF WEST AFRICAN COUNTRIES

Parameters	Nigeria	Cote d'Ivoire	Benin	Ghana
Temperature	40℃	40℃	<5 ℃ above ambient	40 ℃
Color [Lovibond Units]	7	-	-	200 TCU
pH	6 ~9	5.5~8.5 5.5~9.5 if chemically treated	6 ~9	6~9
Turbidity	-	-	-	75 NTU
Conductivity	-	-	-	1,500 mg/cm
BOD_5 at 20 ℃	50 mg/l	150 mg/l if flux < 50 kg/d 100 mg/l if flux > 50 kg/d	100 mg/l if flux < 30 kg/d 30 mg/l if flux > 30 kg/d	50 mg/cm
COD	100 mg/l	500 mg/l if flux < 150 kg/d 300 mg/l if flux > 150 kg/d	300 if flux < 100 kg/d 125 if flux > 100 kg/d	250 mg/l
Total Suspended Solids	30 mg/l	150 mg/l if flux < 15 kg/d 50 mg/l if flux > 15 kg/d	100 if flux < 15 kg/d 35 if flux > 15 kg/d	50 mg/l
Total Dissolved Solids	2,000 mg/l	-	-	1,000 mg/l
Aluminum (Al)	20 mg/l	-	-	-
Arsenic (AS)	0.1 mg/l	-	0.5 if flux > 1 g/d	1.0 mg/l
Barium (Ba)	5 mg/l	-	-	-
Boron (B)	5 mg/l	-	-	-
Cadmium (Cd)	1 mg/l	-	1 mg/l if flux > 5 g/d	0.1 mg/l
Calcium (Ca)	200 mg/l	-	-	-
Chloride (Cl^-)	600 mg/l	-	-	250 mg/l
Chlorine (Cl)	1.0 mg/l	-	1 mg/l if flux > 5 g/d	-
Chromium hexavalent (Cr)	1 mg/l	0.1 mg/l if flux > 1 g/d	0.1 mg/l if flux > 1 g/d	0.1 mg/l
Total Chromium	-	-	2.5 if flux > 5 g/d	-
Copper (Cu)	1 mg/l	-	2.5 mg/l if flux > 5 g/d	5 mg/l
Cyanide (CN)	0.1 mg/l	-	1 mg/l if flux > 1 g/d	1 mg/l
Iron (Fe)	20 mg/l	-	-	-
Lead (Pb)	1 mg/l	-	1 mg/l if flux > 5 g/d	0.1 mg/l
Magnesium (Mg)	200 mg/l	-	-	-
Manganese (Mn)	5 mg/l	-	-	-
Mercury (Hg)	0.05 mg/l	-	0.03 mg/l if flux > 0.01 g/d	0.005 mg/l
Nickel (Ni)	1 mg/l	0.5 mg/l if flux > 5 g/d	2.5 mg/l if flux > 5 g/d	0.5 mg/l
Nitrate (NO_3^-)	20 mg/l	-	-	50 mg/l
Total Nitrogen	-	-	200 if flux < 50 kg/d 30 if flux > 50 kg/d	-
Global Nitrogen (N organic + N ammoniac + N oxide)	-	50 mg/l if flux > 100 kg/d	10 if flux > 50 kg/d	-
Phosphate (PO_4^{2-})	5 mg/l	-	-	-
Total Phosphorus (TP)	-	15 mg/l if flux > 30 kg/d	100 if flux > 50 kg/d	-
Selenium	1 mg/l	-	-	1.0 mg/l
Silver (Ag)	0.1 mg/l	-	-	5 mg/l
Sulfate (SO_4^{2-})	500 mg/l	-	-	200 mg/l
Sulfide (S^{2-})	0.2 mg/l	-	4 mg/l if flux > 50 g/d	1.5 mg/l
Tin (Sn)	10 mg/l	-	-	-
Zinc (Zn)		0.2 mg/l if flux > 20 g/d	5 mg/l if flux > 20 g/d	10 mg/l
Detergents	15 mg/l	-	-	-
Oil and Grease			100 mg/l if flux < 1 kg/d 30 mg/l if flux < 1 kg/d	5 mg/l

Total pesticide	0.01 mg/l	-	-	0.5 mg/l
PCBs	0.003 mg/l	-	-	-
Phenolic (Ph)	0.2 mg/l	0.3 mg/l if flux > 3 g/d	1 mg/l if flux > 3 g/d	2.0 mg/l
Total Metals	3 mg/l	-	-	-
Total Coliforms	400 MPN/100 ml	-	-	400 MPN/100 ml
E. Coli	-	-	-	0 MPN/100 ml

Source: UNIDO

CHAPTER 7

BASIC CONSIDERATIONS FOR SEWERAGE PLANNING

CHAPTER 7 BASIC CONSIDERATIONS FOR SEWERAGE PLANNING

7.1 Sewerage System Planning

7.1.1 Division for Sewerage Basin

In the Study Area the sewerage basin is divided into 7 sewerage basins considering the topographical feature and the existing sewerage systems. The sewerage basins are shown in Fig. 7.1. There are six trunk sewers in the Study Area. Four trunk sewers discharge sewage into the Lagoon and two trunk sewers discharge sewage into the western part of Banco Bay. In general, the area developed for housing by the land developers has a reticulation system connected to the existing sewers. The squatters, which are scattered in the Study Area, have neither a reticulation system nor connection to the sewerage system. The feature of each basin is explained as follows:

1) Western Edge Basin

This basin encompasses the ZONE-INDUSTRIELLE in the northern part, HOPITAL in the Central part and ORSTOM & NIANGON SUD in the southern part. This basin is almost forest and has an area of 2,190 ha. Adiapo-Doumé is the biggest village in the basin. Additionally, several dwellings are scattered in the basin. There are many ridges about 100 m long, which run from south to north.

2) 1-2-3 AB Basin

This basin, which has an area of 1,320 ha, encompasses a part of ZONE-INDUSTRIELLE and HOPITAL in the northern part, the most of NIANGON NORD & NIANGON SUD in the central & southern part. In this basin, the development of housing progresses as per the increase of population. The housing development has been concentrating especially in the south part of NIANGON SUD. The topographical feature of the basin is comparatively flat and the overall inclination is from north to south.

3) UNIWAX Basin

This basin, which has an area of 2,520 ha, has about 40% of the entire population and 45% of the total sewage flow of the Study Area. This is the biggest basin in the Study Area

and encompasses a part of ZONE-INDUSTRIELLE and HOPITAL in the northern part and the most of YOPOUGON ATTIE & YOPOUGON KOUTE in the southern part. The industrial zone of the northern part and the residential area of the southern part were already developed and saturated.

4) 21-22 Basin

The middle part of this basin of an area of 390 ha was already developed and saturated. The natural space occupies most of the upstream and downstream area. The downstream area along the Lagoon is expected to be developed under Phase II of the Sea Port Plan. The area and population of the basin is relatively small.

5) 25-26-27 Basin

This basin with an area of 790 ha is divided into two sub-basins. Each sub-basin is inclined in different directions. The south sub-basin is inclined towards Ebrié Lagoon whereas the east sub-basin towards Banco Bay, because the ridges are parallel to Banco Bay.

The upstream side of the south sub-basin is already developed and saturated. The downstream side along the Lagoon is expected to be developed under Phase I of the Sea Port Plan, which is scheduled to be completed in 2002 in an area of 100 ha. The factory and its related facilities are also scheduled to be constructed under the Plan. On the other hand, there are many ridges which are inclined in the direction of the Lagoon.

6) 33-34 Basin

This basin of an area of 240 ha encompasses a residential area in the upstream part. In the downstream part, there are several ridges. The dwellings are concentrated in the narrow area enclosed by the ridges. The whole area of this basin inclines towards Banco Bay.

7) 35-36 Basin

This basin of an area of 360 ha has an overall inclination towards Banco Bay. There was a plan to develop housing at the foot of the ridges and the sewer was installed to ensure the development of houses in the area. The plan was later abandoned because of a large

amount of stormwater runoff through the area. Over the years in the absence of any maintenance, the manholes and sewer have become completely choked with garbage, litter, solids, etc. and it seems to be difficult to clean up and use again. The area is presently occupied by scattered houses.

The upstream boundary of the basin starts from the north of the highway and adjacent to the Forest of Banco. The plateau part of the basin is densely developed with housing. The inclination of the downstream basin near the Bay area is very steep towards the Bay.

8) Attécoubé Basin

This basin with an area of 250 ha located east of Banco Bay, which is outside of the Study Area, was also studied considering the actual condition of the basin and future connection to the New Interceptor. This area is crowded with old houses and enclosed by the highway. The land inclines towards Banco Bay.

7.1.2 Sewage Flow and Pollution Load

In Côte d'Ivoire, the census for COMMUNE, SECTEUR and QUARTIER was carried out in 1998. The census is carried out once every ten years. However, official results of census have not yet been announced. Therefore, the Study Team adopted the interim census results announced, which was obtained from BNETD.

The Study Area was divided into eight basins considering the topographical feature and the existing sewerage systems. The largest basin UNIWAX has served a population of approximately 440,000, which is 40% of the total population in the Study Area. The population and housing is also increasing in other basins. There is a great deal of natural space in the western edge basin, which is located at the west side of the Study Area. The population density of this basin is comparatively low compared to the other basins. The area, served population, sewage flow and pollution load of each basin are given in Table 7.1.

7.2 Design Criteria

7.2.1 Sewer Pipes

The sewer pipes of the interceptor, in principle, will be installed underground along the proposed urban road or existing road. In case of crossing the Bay, sewer pipes will be installed at the bottom of the Bay or in the deep solid foundation layer.

The flow system will be gravity or pressurized type. Under these conditions, the design criteria are as follows:

1) Design wastewater flow

A peak factor of 1.5 is applied to the daily average flow for the design of the interceptor sewer pipes.

2) Minimum velocity

The minimum velocity will be 0.60 m/s considering the self-cleaning function.

3) Hydraulic calculation

Manning's Formula is applied in case of the gravity flow type and the Hazen Williams' Formula is applied in case of the pressurized flow type.

4) Pipe material

The material of the pipe will be selected by taking into account a flow system, the construction method, and the protection against corrosion.

5) Construction method

The open-cut method will be used for the shallow underground installation of the sewer pipe. The jacking method will be used for the deep underground installation of the sewer pipe.

In case of crossing the Bay, the Supported Seabed Pipe-Laying Method (SSPL) will be applied for the installation at the bottom of the Bay, and the Pipe-Line Arch Drilling Method (PLAD) will be applied for the installation at the deep solid foundation layer of the Bay.

7.2.2 Pumping Station

The sanitary sewage pumping station should be designed on the basis of the peak flow rates. All pipe fittings and conduits should be designed to carry the expected peak flow rates. The following should be taken into account for design of the sewage pumping station:

1) Type and Structure of the Pumping Station

The type of pumping station is decided upon according to the degree of importance of the pumping station, pump type and maintenance requirement. The pit of the standard pumping station is the dry-well type whereas that of the simplified and manhole is the wet–well type. The pumping station is designed as the standard type when the capacity of the submersible pump is insufficient against water hammer and for high pump head. This type of pumping station has a large sewage inflow. In addition, a large quantity of floating materials and grit comes along with the sewage to the pumping station during the rainy season.

The simplified type pumping station is similar to the structure of the manhole type. Inflow to this type of the pumping station is small; therefore, a submersible pump with a flywheel is sufficient against water hammer. To remove large floating material and grit, which is contained in the inflow of the Study Area, the simplified type is provided with a simple pit.

The manhole type pumping station is without a grit chamber which is the same as the existing manhole type pumping station in the Study Area because of the small inflow.

2) Screening

For dry well type pumping stations, bar screens should be considered for protection of pumps and other equipment. All facilities should be readily accessible for maintenance.

3) Grit Removal Facilities

Grit removal facilities should be provided in principle for sewage pumping stations.

Where it may be necessary to pump the sewage prior to grit removal, special attention should be paid to the design of wet wells and the discharge piping should be designed to prevent grit settling in the pump discharge lines of pumps not operating. The grit removal facility should have at least 2 units.

4) Pumps

At least 4 pumps for the standard type, 3 pumps for the simplified type and 3 pumps for the manhole type pumping station should be provided. Pumps of each pumping station also include one standby pump. Pumps will be designed for handling the flow in excess of the estimated maximum inflow. When one pump is out of order, the remaining pumps must have the capacity to handle the maximum sewage flow. The submersible pumps should be made to always function in the submerged condition.

5) Emergency Power Supply

Provision of an emergency power supply for pumping stations principally should be considered based on the condition of the electrical power supply system. If the condition of the electrical power supply system is well maintained well, provision of an emergency power supply will not be required.

7.2.3 Interceptor Crossing Banco Bay

The sewer pipes and the supporting structures will be designed by giving overall consideration to geological conditions, water depth, construction method, environmental issues during construction, maintenance problems, corrosion due to sea water as described below:

(1) The maximum depth of water in the Banco Bay is about 10 meters and the installation and connection of the sewer pipes will be executed under water.

(2) In case of the sewer pipes are installed at the bottom of the Bay, the supporting piles should be needed for 30 to 40 m depth because of the existence of the soft layer.

(3) Construction of the foundation should minimize an effect of mud diffusion at the bottom of the Bay.

(4) Materials for underwater structures should be corrosion resistant.

TABLE 7.1 FEATURES OF SEWERAGE BASINS

Basin	Area (ha)	Served Population (habitant)	Sewage Flow (m^3/s)		Pollution Load (kg/day)
			(m^3/day)	(m^3/S)	
Western Edge	2,190	35,685	4,800		863
1-2-3 AB	1,320	94,010	15,297	0.233	2,858
UNI Wax	2,520	436,961	46,350	0.537	11,722
21-22	390	77,445	10,176	0.118	2,241
25-26-27	790	143,251	9,012	0.104	3,384
33-34	240	39,822	2,328		921
35-36	360	76,642	4,362	0.078	1,737
Attécoubé	250	180,460	10,114	0.117	4,233
Total	8,060	1,084,276	102,439	1.187	27,959

TABLE 7.2 DAILY AVERAGE SEWAGE FLOW IN YOPOUGON

(m3/day)

			Type	1998	2003	2005	2015
01 YOPOUGON ATTIE							
	01	ANDOKOI 1	V	216	274	301	459
	02	ANDOKOI 2	V	97	123	135	206
	03	LA GARE	C	616	782	858	1,307
	04	YOPOUGON ATTIE 1	C	1,515	1,922	2,108	3,213
	05	YOPOUGON ATTIE 4	V	147	187	205	313
	06	YOPOUGON ATTIE 5	C	583	739	811	1,236
	07	YOPOUGON ATTIE 8	C	293	372	408	622
	08	CENTRE URBAIN	C	75	95	104	158
	09	SOGEFIHA SIPOREX 1	B	866	1,099	1,205	1,838
	10	SOGEFIHA SOLIC 2	B	846	1,073	1,177	1,794
	11	SOGEFIHA SOLIC 1	B	1,464	1,858	2,038	3,106
	12	SELMER	B	1,777	2,254	2,472	3,769
	13	SICOGIANCIEN QUARTIER	B	4,768	6,049	6,635	10,115
		SUB TOTAL		13,263	16,826	18,455	28,136
02 BANCO NORD							
	01	BANCO NORD 1 ERE TRANCHE	A	686	870	954	1,455
	02	BANCO NORD 2 ERE TRANCHE	A	369	468	514	783
	03	BANCO NORD 3 ERE TRANCHE	A	1,248	1,583	1,736	2,647
	04	GFCI BEL AIR	B	556	705	773	1,179
	05	SOPM	B	99	115	126	192
	06	SICOGI NOUVEAU QUARTIER	B	2,452	3,111	3,412	5,202
		SUB TOTAL		5,401	6,852	7,515	11,457
03 BANCO SUD							
	01	BANCO SUD 9 EME TRANCHE CITE UNIVERSITAIRE	B	1,142	1,449	1,590	2,424
	02	CITE SGBCI TIEMOKO COULIBALY	B	291	369	405	617
	03	SODECI	B	630	799	877	1,336
	04	YOPOUGON SANTE (DEGUERPIS DU PORT)	V	2	2	2	3
	05	SOGEFIHA (USINE AWA)	B	986	1,251	1,372	2,091
		SUB TOTAL		3,051	3,870	4,245	6,472
04 EXTENSION DU PORT							
	01	EXTENSION DU PORT	E	32	40	44	67
	02	BEAGO	V	10	13	14	21
	03	CHAPOUU	E	4	5	6	8
	04	YOPOUGON SANTE	V	15	19	20	31
		SUB TPTAL		60	76	84	128
05 YOPOUGON KOUTE							
	01	KOUTE VILLAGE ET EXTENSION	V	87	110	121	184
	02	YOPOUGON KOUTE EXTENSION EST (CAMP MILITAIRE)	B	1,704	2,161	2,374	3,614
	03	YOPOUGON KOUTE EXTENSION OUEST (SIDECI)	B	3,109	3,944	4,326	6,595
	04	CNPS	B	2,228	2,826	3,100	4,726
		SUB TOTAL		7,127	9,041	9,920	15,118
06 ZONE INDUSTRIELLE							
	01	ZONE INDUSTRIELLE SETU	C	143	182	199	304
	02	ZONE INDUSTRIELLE DE YOPOUGON (DU)	C	318	403	442	675
	03	PRISON CIVILE(MACA)	B	526	668	733	1,116
		SAB TOTAL		987	1,253	1,374	2,095
07 HOPITAL							
	01	QUARTIER HOPITAL (MAMIE ADJOUA)	B	360	457	501	764
	02	QUARTIER GESCO	B	704	893	979	1,492
		SUB TOTAL		1,064	1,350	1,480	2,257
08 NIANNGON NORD							
	01	PORT BOUET II 1ERE ET 2 EME TRANCHE	C	1,490	1,890	2,073	3,160
	02	NIANGON NORD 1 EME TRANCHE (EECI,NOVALIM)	B	374	474	520	793
	03	NIANGON NORD 2 EME TRANCHE	A	1,543	1,957	2,147	3,273
	04	NIANGON ADJAME (EXTENSION)	D	12	15	16	25
	05	ANANERAIE	A	2,427	3,079	3,377	5,148
		SUB TOTAL		5,845	7,415	8,133	12,399
09 NIANGON SUD							
	01	NIANGON SUD A DROITE (SOGEFIHA)	B	731	927	1,017	1,550
	02	NIANGON SUD A GAUCHE (SICOGI SOGEFIHA)	B	2,817	3,573	3,919	5,975
	03	NIANGON NORD SICCGI	B	1,240	1,573	1,726	2,631
	04	GFCI (CITE VERTE)	B	102	129	141	216
	05	ZONE INDUSTRIELLE	C	19	24	27	41
	06	AZITO	V	7	9	10	15
	07	NIANGON LOKOA	V	36	45	50	76
	08	NIANGON ADJAME VILLAGE	V	12	15	16	25
	09	ACADEMIE DE LA MER	D	74	94	103	158
	10	NIANGON SUD CANAL	B	557	707	776	1,183
		SUB TOTAL		5,595	7,098	7,785	11,869
10 ORSTOM (ADIOPODOUME)							
	01	NIANGON ATTIE	V	17	22	24	36
	02	ADIOPODOUME (KM17)	V	55	69	76	116
	03	ORSTOM	A	62	79	87	132
	04	INSTITUT PASTEUR	A	24	31	34	51
	05	CIMETIERE	D	147	186	204	311
		SUB TOTAL		305	387	424	647
		GRAND TOTAL		42,699	54,166	59,416	90,578

TABLE 7.3 HOURLY MAXIMUM SEWAGE FLOW IN YOPOUGON

(m3/day)

			Type	1998	2003	2005	2015
01 YOPOUGON ATTIE							
	01	ANDOKOI 1	V	1,205	1,292	1,332	1,568
	02	ANDOKOI 2	V	146	185	203	309
	03	LA GARE	C	925	1,173	1,286	1,961
	04	YOPOUGON ATTIE 1	C	2,272	2,882	3,161	4,820
	05	YOPOUGON ATTIE 4	V	221	280	308	469
	06	YOPOUGON ATTIE 5	C	874	1,109	1,216	1,854
	07	YOPOUGON ATTIE 8	C	440	558	612	932
	08	CENTRE URBAIN	C	112	142	156	237
	09	SOGEFIHA SIPOREX 1	B	1,299	1,648	1,808	2,756
	10	SOGEFIHA SOLIC 2	B	1,269	1,609	1,765	2,691
	11	SOGEFIHA SOLIC 1	B	2,197	2,787	3,056	4,660
	12	SELMER	B	2,665	3,381	3,708	5,653
	13	SICOGIANCIEN QUARTIER	B	7,152	9,073	9,952	15,173
		SUB TOTAL		20,775	26,118	28,563	43,084
02 BANCO NORD							
	01	BANCO NORD 1 ERE TRANCHE	A	1,029	1,305	1,432	2,182
	02	BANCO NORD 2 ERE TRANCHE	A	554	702	770	1,175
	03	BANCO NORD 3 ERE TRANCHE	A	1,872	2,374	2,604	3,971
	04	GFCI BEL AIR	B	834	1,057	1,160	1,768
	05	SOPM	B	135	172	188	287
	06	SICOGI NOUVEAU QUARTIER	B	3,678	4,666	5,118	7,803
		SUB TOTAL		8,102	10,277	11,273	17,186
03 BANCO SUD							
	01	BANCO SUD 9 EME TRANCHE CITE UNIVERSITAIRE	B	1,714	2,174	2,385	3,635
	02	CITE SGBCI TIEMOKO COULIBALY	B	436	554	607	926
	03	SODECI	B	945	1,199	1,315	2,005
	04	YOPOUGON SANTE (DEGUERPIS DU PORT)	V	2	3	3	5
	05	SOGEFIHA (USINE AWA)	B	1,479	1,876	2,058	3,137
		SUB TOTAL		4,576	5,805	6,367	9,707
04 EXTENSION DU PORT							
	01	EXTENSION DU PORT	E	47	1,068	1,074	1,108
	02	BEAGO	V	15	19	21	32
	03	CHAPOUU	E	6	224	224	229
	04	YOPOUGON SANTE	V	22	804	807	823
		SUB TOTAL		90	2,115	2,126	2,192
05 YOPOUGON KOUTE							
	01	KOUTE VILLAGE ET EXTENSION	V	130	165	181	276
	02	YOPOUGON KOUTE EXTENSION EST (CAMP MILITAIRE)	B	2,555	3,241	3,561	5,421
	03	YOPOUGON KOUTE EXTENSION OUEST (SIDECI)	B	4,653	5,916	6,489	9,892
	04	CNPS	B	3,787	4,684	5,095	7,534
		SUB TOTAL		11,135	14,006	15,325	23,122
06 ZONE INDUSTRIELLE							
	01	ZONE INDUSTRIELLE SETU	C	5,015	5,072	5,099	5,255
	02	ZONE INDUSTRIELLE DE YOPOUGON (DU)	C	477	605	664	1,012
	03	PRISON CIVILE(MACA)	B	790	1,002	1,099	1,675
		SAB TOTAL		6,281	6,679	6,861	7,942
07 HOPITAL							
	01	QUARTIER HOPITAL (MAMIE ADJOUA)	B	973	1,119	1,185	1,579
	02	QUARTIER GESCO	B	1,055	1,339	1,468	2,239
		SUB TOTAL		2,029	2,457	2,653	3,818
08 NIANNGON NORD							
	01	PORT BOUET II 1ERE ET 2 EME TRANCHE	C	2,235	2,835	3,110	4,741
	02	NIANGON NORD 1 EME TRANCHE (EECI,NOVALIM)	B	888	1,038	1,107	1,516
	03	NIANGON NORD 2 EME TRANCHE	A	2,314	2,936	3,220	4,909
	04	NIANGON ADJAME (EXTENSION)	D	18	23	25	38
	05	ANANERAIE	A	3,640	4,618	5,065	7,722
		SUB TOTAL		9,095	11,449	12,527	18,926
09 NIANGON SUD							
	01	NIANGON SUD A DROITE (SOGEFIHA)	B	1,096	1,391	1,525	2,325
	02	NIANGON SUD A GAUCHE (SICOGI SOGEFIHA)	B	4,225	5,360	5,878	8,962
	03	NIANGON NORD SICCGI	B	1,850	2,360	2,588	3,946
	04	GFCI (CITE VERTE)	B	153	193	212	324
	05	ZONE INDUSTRIELLE	C	29	37	40	61
	06	AZITO	V	11	14	15	23
	07	NIANGON LOKOA	V	54	68	75	114
	08	NIANGON ADJAME VILLAGE	V	18	22	24	37
	09	ACADEMIE DE LA MER	D	111	141	155	236
	10	NIANGON SUD CANAL	B	836	1,061	1,163	1,774
		SUB TOTAL		8,392	10,646	11,677	17,803
10 ORSTOM (ADIOPODOUME)							
	01	NIANGON ATTIE	V	26	33	36	55
	02	ADIOPODOUME (KM17)	V	82	104	114	174
	03	ORSTOM	A	93	119	130	198
	04	INSTITUT PASTEUR	A	36	46	50	77
	05	CIMETIERE	D	220	279	306	467
		SUB TOTAL		457	580	637	970
		GRAND TOTAL		70,933	90,134	98,009	144,751

TABLE 7.4 POLLUTION LOAD IN YOPOUGON

(kg/day)

			Type	1998	2003	2005	2015
01 YOPOUGON ATTIE							
	01	ANDOKOI 1	V	1,161	1,355	1,444	1,970
	02	ANDOKOI 2	V	324	410	450	686
	03	LA GARE	C	296	376	412	629
	04	YOPOUGON ATTIE 1	C	728	924	1,013	1,545
	05	YOPOUGON ATTIE 4	V	491	623	684	1,042
	06	YOPOUGON ATTIE 5	C	280	355	390	594
	07	YOPOUGON ATTIE 8	C	141	179	196	299
	08	CENTRE URBAIN	C	36	45	50	76
	09	SOGEFIHA SIPOREX 1	B	289	366	402	613
	10	SOGEFIHA SOLIC 2	B	282	358	392	598
	11	SOGEFIHA SOLIC 1	B	488	619	679	1,035
	12	SELMER	B	592	751	824	1,256
	13	SICOGIANCIEN QUARTIER	B	1,589	2,016	2,212	3,372
		SUB TOTAL		6,698	8,379	9,148	13,715
02 BANCO NORD							
	01	BANCO NORD 1 ERE TRANCHE	A	133	169	186	283
	02	BANCO NORD 2 ERE TRANCHE	A	72	91	100	152
	03	BANCO NORD 3 ERE TRANCHE	A	243	308	338	515
	04	GFCI BEL AIR	B	185	235	258	393
	05	SOPM	B	30	38	42	64
	06	SICOGI NOUVEAU QUARTIER	B	817	1,037	1,137	1,734
		SUB TOTAL		1,481	1,878	2,060	3,141
03 BANCO SUD							
	01	BANCO SUD 9 EME TRANCHE CITE UNIVERSITAIRE	B	381	483	530	808
	02	CITE SGBCI TIEMOKO COULIBALY	B	97	123	135	206
	03	SODECI	B	210	266	292	445
	04	YOPOUGON SANTE (DEGUERPIS DU PORT)	V	5	7	7	11
	05	SOGEFIHA (USINE AWA)	B	329	417	457	697
		SUB TOTAL		1,022	1,296	1,421	2,167
04 EXTENSION DU PORT							
	01	EXTENSION DU PORT	E	105	134	147	224
	02	BEAGO	V	33	42	46	70
	03	CHAPOUU	E	13	17	18	28
	04	YOPOUGON SANTE	V	49	62	68	104
		SUB TPTAL		201	255	279	426
05 YOPOUGON KOUTE							
	01	KOUTE VILLAGE ET EXTENSION	V	289	366	402	613
	02	YOPOUGON KOUTE EXTENSION EST (CAMP MILITAIRE)	B	568	720	791	1,205
	03	YOPOUGON KOUTE EXTENSION OUEST (SIDECI)	B	1,036	1,315	1,442	2,198
	04	CNPS	B	965	1,164	1,255	1,797
		SUB TOTAL		2,857	3,565	3,890	5,813
06 ZONE INDUSTRIELLE							
	01	ZONE INDUSTRIELLE SETU	C	837	855	864	914
	02	ZONE INDUSTRIELLE DE YOPOUGON (DU)	C	153	194	213	324
	03	PRISON CIVILE(MACA)	B	175	223	244	372
		SAB TOTAL		1,165	1,272	1,321	1,610
07 HOPITAL							
	01	QUARTIER HOPITAL (MAMIE ADJOUA)	B	336	368	383	471
	02	QUARTIER GESCO	B	235	298	326	497
		SUB TOTAL		571	666	709	968
08 NIANNGON NORD							
	01	PORT BOUET II 1ERE ET 2 EME TRANCHE	C	716	909	997	1,519
	02	NIANGON NORD 1 EME TRANCHE (EECI,NOVALIM)	B	289	322	337	428
	03	NIANGON NORD 2 EME TRANCHE	A	300	381	417	636
	04	NIANGON ADJAME (EXTENSION)	D	6	7	8	12
	05	ANANERAIE	A	472	599	657	1,001
		SUB TOTAL		1,782	2,217	2,416	3,597
09 NIANGON SUD							
	01	NIANGON SUD A DROITE (SOGEFIHA)	B	244	309	339	517
	02	NIANGON SUD A GAUCHE (SICOGI SOGEFIHA)	B	939	1,191	1,306	1,992
	03	NIANGON NORD SICOGI	B	413	524	575	877
	04	GFCI (CITE VERTE)	B	34	43	47	72
	05	ZONE INDUSTRIELLE	C	9	12	13	20
	06	AZITO	V	24	31	34	51
	07	NIANGON LOKOA	V	119	151	166	253
	08	NIANGON ADJAME VILLAGE	V	39	50	54	83
	09	ACADEMIE DE LA MER	D	36	45	50	76
	10	NIANGON SUD CANAL	B	186	236	259	394
		SUB TOTAL		2,043	2,592	2,843	4,334
10 ORSTOM (ADIOPODOUME)							
	01	NIANGON ATTIE	V	57	73	80	122
	02	ADIOPODOUME (KM17)	V	182	231	253	386
	03	ORSTOM	A	12	15	17	26
	04	INSTITUT PASTEUR	A	5	6	7	10
	05	CIMETIERE	D	71	89	98	150
		SUB TOTAL		326	414	454	693
		GRAND TOTAL		18,146	22,533	24,542	36,464

TABLE 7.5 DAILY AVERAGE SEWAGE FLOW IN ATTECOUBE

(m3/day)

			Type	1998	2003	2005	2015
01 ABIDJAN TE							
	01	ABIDJAN TE	V	78	99	109	166
		SUB TOTAL		78	99	109	166
02 ADJAME SANTE							
	01	ABIDJAN SANTE VILLAGE (SEBROKO)	V	36	46	50	76
	02	BOLIBANA	E	102	130	143	219
	03	ATTECOUBE LAGUNE	V	27	35	38	58
		SUB TOTAL		165	210	231	353
03 QUARTIER DE LA PAIX							
	01	QUARTIER DE LA PAIX	C	967	1,230	1,350	2,066
		SUB TOTAL		967	1,230	1,350	2,066
04 SAINT JOSEPH							
	01	SAINTE JOSEPH	C	620	789	866	1,325
	02	MOSQUEE	C	533	677	743	1,138
	03	QUARTIER DES ECOLES	C	274	348	382	585
		SUB TOTAL		1,427	1,814	1,992	3,049
05 GBEBOUTO							
	01	GBEBOUT	C	1,832	2,329	2,557	3,914
		SUB TOTAL		1,832	2,329	2,557	3,914
06 AGBAN							
	01	AGBAN VILLAGE	V	70	88	97	149
	02	CITE FAIRMONT	B	765	973	1,068	1,635
		SUB TPTAL		835	1,061	1,165	1,783
07 SANTE II							
	01	SANTE II VILLAGE	V	23	30	33	50
	02	SANTE II EXTENSION	V	17	21	24	36
		SUB TOTAL		40	51	56	86
08 SANTE III							
	01	SANTE III VILLAGE	V	62	78	86	132
	02	SANTE III EXTENSION	C	296	376	413	632
	03	LOUKOUKRO EKARE	V	20	26	29	44
	04	MOSSIKRO	E	37	47	51	79
		SAB TOTAL		415	527	579	886
09 LOCODJORO							
	01	LOCODJORO VILLAGE	V	86	109	120	184
	02	JERUSALEM I	E	81	103	113	173
	03	LACK MAN	E	9	12	13	20
		SUB TOTAL		176	224	246	376
10 ABOBO DOUME							
	01	ABOBO DOUME VILLAGE	V	69	88	96	148
	02	ABOBO DOUME EXTENSION	V	56	71	78	120
	03	JERUSALEM II	E	67	85	93	142
	04	MARINE NATIONALE	A	164	209	229	351
		SUB TOTAL		356	452	497	760
11 ATTECOUBE III							
	01	AGBAN ATTIE (PETIT BANCO)	V	23	29	32	49
	02	NEMATOULAYE	V	56	72	79	120
	03	DIENE	V	44	56	62	95
	04	ATTECOUBE III	C	37	47	52	79
		SUB TOTAL		161	204	224	343
12 FORET DU BANCO							
	01	PARC NATIONAL DU BANCO	B	41	52	57	87
		SUB TOTAL		41	52	57	87
		GRAND TOTAL		6,492	8,255	9,063	13,870

TABLE 7.6 HOURLY MAXIMUM SEWAGE FLOW IN ATTECOUBE

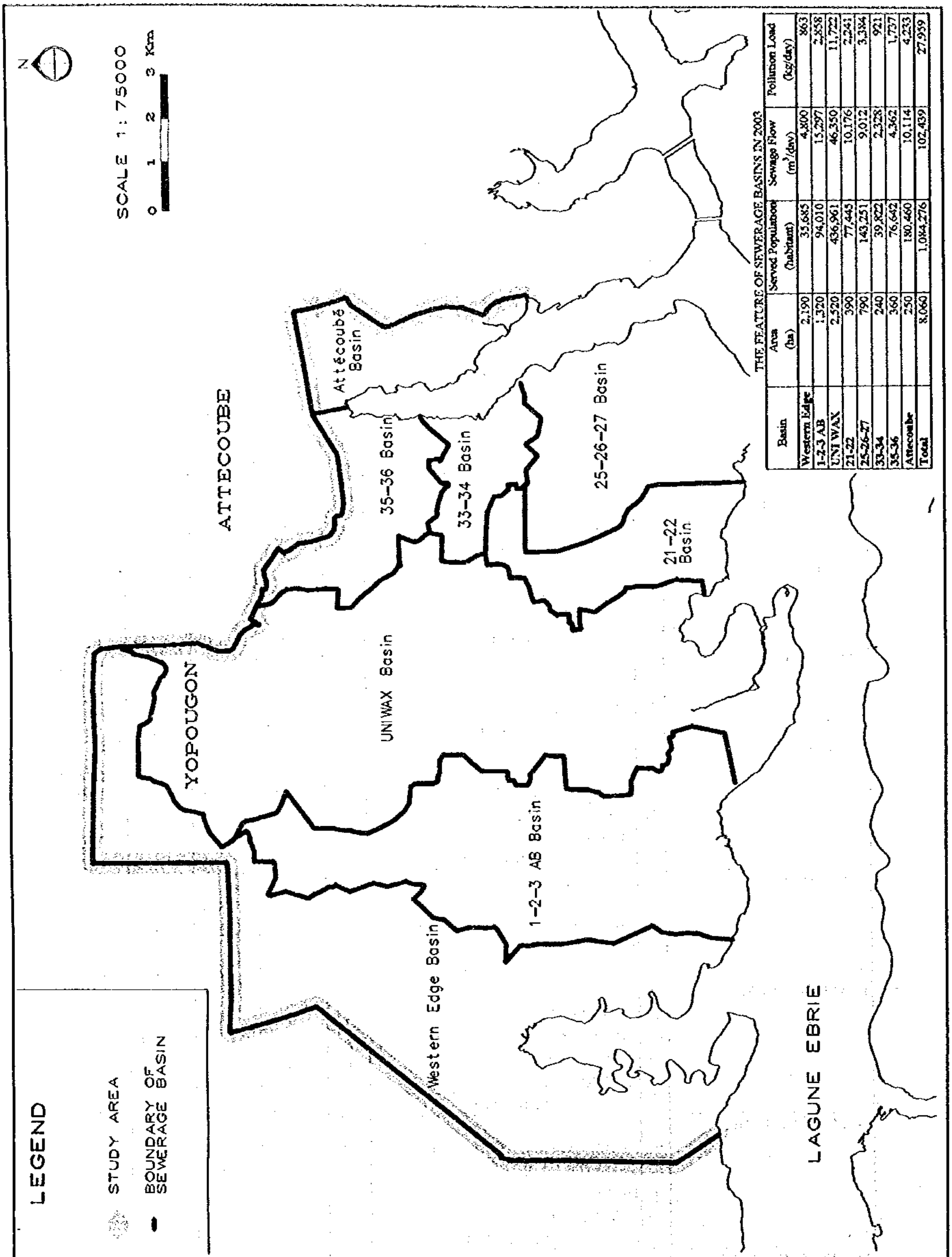
(m3/day)

			Type	1998	2003	2005	2015
01 ABIDJAN TE							
	01	ABIDJAN TE	V	117	149	163	250
		SUB TOTAL		117	149	163	250
02 ADJAME SANTE							
	01	ABIDJAN SANTE VILLAGE (SEBROKO)	V	54	68	75	115
	02	BOLIBANA	E	154	195	214	328
	03	ATTECOUBE LAGUNE	V	41	52	57	87
		SUB TOTAL		248	316	346	530
03 QUARTIER DE LA PAIX							
	01	QUARTIER DE LA PAIX	C	1,451	1,845	2,025	3,100
		SUB TOTAL		1,451	1,845	2,025	3,100
04 SAINT JOSEPH							
	01	SAINTE JOSEPH	C	930	1,183	1,299	1,988
	02	MOSQUEE	C	799	1,016	1,115	1,707
	03	QUARTIER DES ECOLES	C	411	522	574	878
		SUB TOTAL		2,140	2,721	2,988	4,573
05 GBEBOUTO							
	01	GBEBOUT	C	2,747	3,494	3,836	5,870
		SUB TOTAL		2,747	3,494	3,836	5,870
06 AGBAN							
	01	AGBAN VILLAGE	V	104	133	146	223
	02	CITE FAIRMONT	B	1,148	1,459	1,602	2,452
		SUB TPTAL		1,252	1,592	1,748	2,675
07 SANTE II							
	01	SANTE II VILLAGE	V	35	45	49	75
	02	SANTE II EXTENSION	V	25	32	35	54
		SUB TOTAL		60	77	84	129
08 SANTE III							
	01	SANTE III VILLAGE	V	92	118	129	198
	02	SANTE III EXTENSION	C	444	564	619	948
	03	LOUKOUKRO EKARE	V	31	39	43	66
	04	MOSSIKRO	E	55	70	77	118
		SAB TOTAL		622	791	868	1,329
09 LOCODJORO							
	01	LOCODJORO VILLAGE	V	129	164	180	276
	02	JERUSALEM I	E	121	154	169	259
	03	LACK MAN	E	14	18	20	30
		SUB TOTAL		264	336	369	565
10 ABOBO DOUME							
	01	ABOBO DOUME VILLAGE	V	104	132	145	221
	02	ABOBO DOUME EXTENSION	V	84	107	117	180
	03	JERUSALEM II	E	100	127	139	213
	04	MARINE NATIONALE	A	246	313	344	526
		SUB TOTAL		534	679	745	1,140
11 ATTECOUBE III							
	01	AGBAN ATTIE (PETIT BANCO)	V	34	44	48	74
	02	NEMATOULAYE	V	85	107	118	181
	03	DIENE	V	66	84	93	142
	04	ATTECOUBE III	C	56	71	78	119
		SUB TOTAL		241	306	336	515
12 FORET DU BANCO							
	01	PARC NATIONAL DU BANCO	B	61	78	85	131
		SUB TOTAL		61	78	85	131
		GRAND TOTAL		9,737	12,383	13,594	20,806

TABLE 7.7 POLLUTION LOAD IN ATTECOUBE

(kg/day)

			Type	1998	2003	2005	2015
01 ABIDJAN TE							
	01	ABIDJAN TE	V	260	330	362	555
		SUB TOTAL		260	330	362	555
02 ADJAME SANTE							
	01	ABIDJAN SANTE VILLAGE (SEBROKO)	V	119	152	167	255
	02	BOLIBANA	E	341	434	476	729
	03	ATTECOUBE LAGUNE	V	91	116	127	194
		SUB TOTAL		551	701	770	1,178
03 QUARTIER DE LA PAIX							
	01	QUARTIER DE LA PAIX	C	465	591	649	993
		SUB TOTAL		465	591	649	993
04 SAINT JOSEPH							
	01	SAINTE JOSEPH	C	298	379	416	637
	02	MOSQUEE	C	256	326	357	547
	03	QUARTIER DES ECOLES	C	132	167	184	281
		SUB TOTAL		686	872	958	1,466
05 GBEBOUTO							
	01	GBEBOUT	C	881	1,120	1,229	1,882
		SUB TOTAL		881	1,120	1,229	1,882
06 AGBAN							
	01	AGBAN VILLAGE	V	232	295	324	496
	02	CITE FAIRMONT	B	255	324	356	545
		SUB TPTAL		487	619	680	1,040
07 SANTE II							
	01	SANTE II VILLAGE	V	78	99	109	167
	02	SANTE II EXTENSION	V	56	72	79	120
		SUB TOTAL		134	171	187	287
08 SANTE III							
	01	SANTE III VILLAGE	V	205	261	287	439
	02	SANTE III EXTENSION	C	142	181	198	304
	03	LOUKOUKRO EKARE	V	68	87	95	146
	04	MOSSIKRO	E	123	156	171	262
		SAB TOTAL		538	685	752	1,150
09 LOCODJORO							
	01	LOCODJORO VILLAGE	V	287	365	400	612
	02	JERUSALEM I	E	270	343	376	576
	03	LACK MAN	E	31	40	44	67
		SUB TOTAL		587	747	820	1,255
10 ABOBO DOUME							
	01	ABOBO DOUME VILLAGE	V	230	293	321	492
	02	ABOBO DOUME EXTENSION	V	187	237	261	399
	03	JERUSALEM II	E	222	282	310	474
	04	MARINE NATIONALE	A	32	41	45	68
		SUB TOTAL		671	853	936	1,433
11 ATTECOUBE III							
	01	AGBAN ATTIE (PETIT BANCO)	V	77	97	107	163
	02	NEMATOULAYE	V	188	239	262	401
	03	DIENE	V	147	188	206	315
	04	ATTECOUBE III	C	18	23	25	38
		SUB TOTAL		430	546	600	918
12 FORET DU BANCO							
	01	PARC NATIONAL DU BANCO	B	14	17	19	29
		SUB TOTAL		14	17	19	29
		GRAND TOTAL		5,703	7,253	7,962	12,186



THE FEATURE OF SEWERAGE BASINS IN 2003

Basin	Area (ha)	Served Population (habitant)	Sewage Flow (m^3/day)	Pollution Load (kg/day)
Western Edge	2,190	35,685	4,800	863
1-2-3 AB	1,320	94,010	15,297	2,858
UNI WAX	2,520	436,961	46,350	11,722
21-22	390	77,445	10,176	2,241
25-26-27	790	143,251	9,012	3,384
33-34	240	39,822	2,328	921
35-36	360	76,642	4,362	1,737
Attecoube	250	180,460	10,114	4,233
Total	8,060	1,084,276	102,439	27,959

FIG. 7.1 DIVISION OF SEWERAGE BASIN

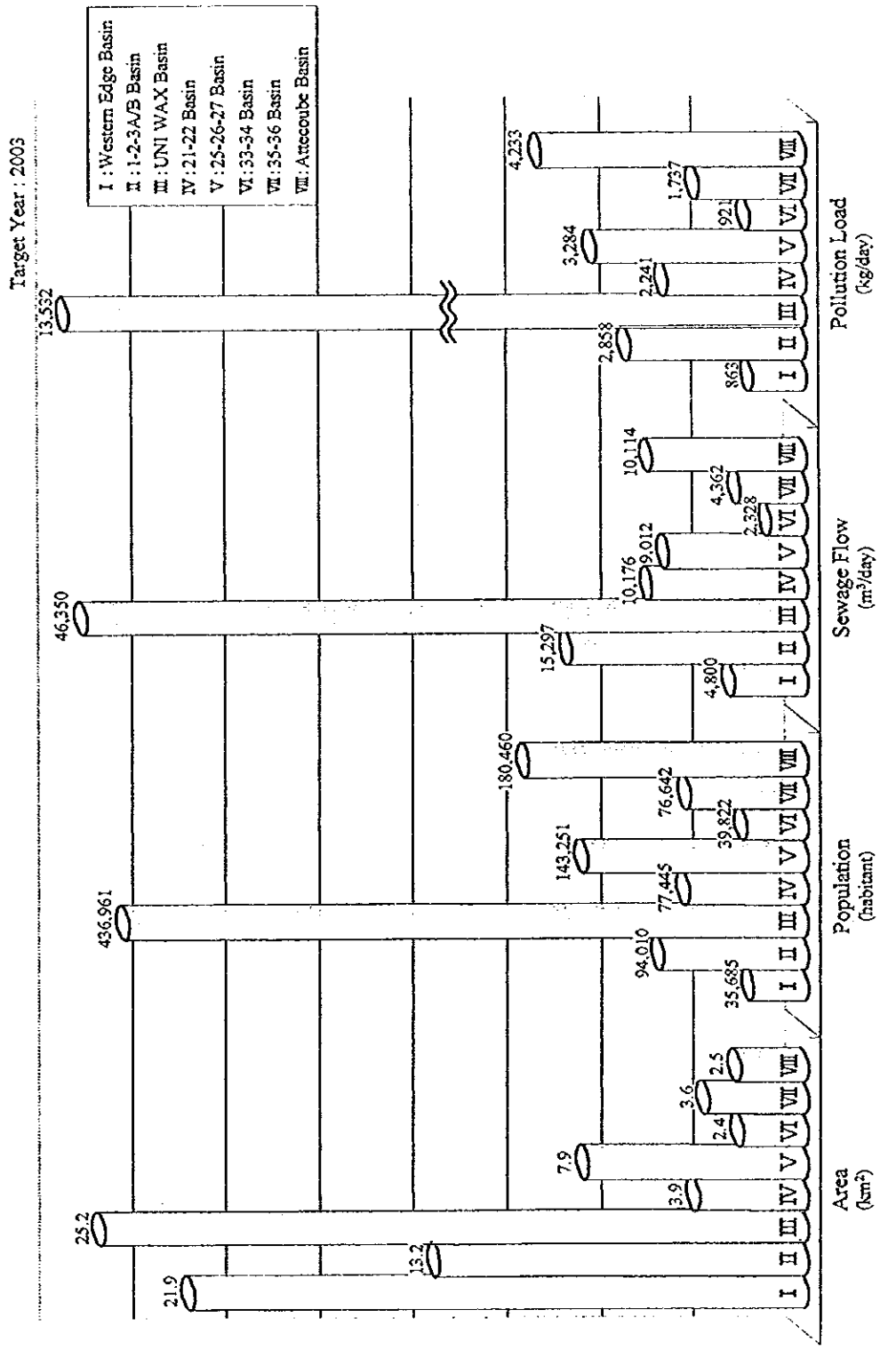


FIG. 7.2 COMPARISON OF POPULATION, SEWERAGE FLOW AND POLLUTION LOAD IN SEWERAGE BASINS

CHAPTER 8

ALTERNATIVE INTERCEPTOR PLANNING

CHAPTER 8 ALTERNATIVE INTERCEPTOR PLANNING

8.1 Existing Conditions of Proposed Routes of Interceptor

The proposed routes of the interceptor were selected as shown in Fig. 8.1. The route was selected by taking into account the location of the existing trunk sewers, proposed urban road and existing roads. The Study proposes to implement the interceptor south of Yopougon and west of Banco Bay. Hereinafter the interceptor in the south and west of Banco Bay is called South Interceptor and West Interceptor, respectively. The south Interceptor is planned to be installed along the Urban Road EW1. Four (4) trunk sewers, which discharge into Ebrie Lagoon, are connected to this Interceptor.

The west Interceptor is planned to be installed along the existing road WB. Two (2) trunk sewers, which discharge into Banco Bay, are collected by the Interceptor.

If Banco Bay is detoured, another interceptor will be needed along the existing road EB in Plateau side. The interceptor is called East Interceptor.

1) Route along Urban Road EW1

This urban road is planned in the long-term plan of the Abidjan Master Scheme. However, 1.2 km of the eastern part is ranked as the mid-term plan. The interceptor is planned to be installed for about 7.0 km along Urban Road EW1. The right-of-way of this road has already been reserved at width of about 50 m. However, there is no marker or indication for the boundary in site. Existing land use in this route is mainly agriculture and moors. But about a 0.5 km section of the route is occupied by a residential area where relocation of houses should be indispensable. Topographically, this route is located between the high plateau and low plateau near the Lagoon, and the undulating landform with several deep valleys was formulated by the natural river. The ground level, except for valleys, is in the range of 20 m to 28 m above sea level.

2) Route along Existing Road WB

This route is located the west side of Banco Bay. The length is 4.4 km between the South Interceptor and 35-36 Trunk Sewer. The highest and lowest elevations of the road in this

section are 16 m and 2.5 m, respectively. The road runs through the villages for about 30 % of its length.

The road is paved with bitumen at a width of 5 to 6 m. In the village area, there are sidewalks of about 1.5 m wide on both sides of road and drainage pipes exist partially along the center line of the road. Along the sidewalks, there are many resident houses and shops. The utility poles which will be obstacles for the construction also exist in the sidewalks.

3) Route along Existing Road EB

On the Plateau side, the interceptor will be installed along Boulevard de la Paix and Boulevard de Général de Gaulle. These are main roads, running at low-lying area along Banco Bay except for the section of hill about 20 m high. The distance from the 35-36 Trunk Sewer to the S1 Pumping Station is about 8.0 km. The roads are 20 m wide including the median and have 3 m sidewalks on both sides. There is sewage pipeline of 1,000 mm in diameter and 2.4 km in length before the F. H. Boigny Bridge in this route. However, the pipe is not used at present.

4) Route crossing Banco Bay

Two routes crossing Banco Bay were studied. One is at the mouth of the Bay and the other is at the inner side. The width of the Bay is about 500 m at its mouth and about 700 m at its inner side. Maximum water depth is estimated to be about 10 meter at both sites. According to the existing geological survey data (Survey conducted in 1978 at the inner side of the Bay for bridge construction), about 30 m to 40 m depth plastic mud exists at the bottom of the Bay. Under this deposit, sand and clayey sand are found. The geological section of Banco Bay is shown in Fig.8.2.

8.2 Design Wastewater Flow and Layout of Alternative Interceptor Routes

The design maximum hourly flowrate of wastewater in 2003 was estimated for each trunk sewer based on recent population statistics (1998). Fig. 8.3 shows schematically the location of each trunk sewer and their design flowrates. In this figure, wastewater from Attécoubé in the Plateau side, which is not included in the Study Area, is also given as a

reference.

The total flowrate of wastewater is estimated to be 1.094 m^3/s most coming from the South Interceptor (93 %). Among trunk sewers connecting to the South Interceptor, UNIWAX trunk sewer occupies about 53 % of the total amount of the area.

In this Study, the following three alternative routes were selected to compare:

i) Alternative Route I: The South Interceptor collecting four (4) trunk sewers in the south area and the West Interceptor collecting two (2) trunk sewers in the west area of Banco Bay. These two interceptors join each other and cross the Banco Bay at its mouth.

ii) Alternative Route II: The South Interceptor is the same as Alternative I. It will be extended along Banco Bay up to the inner side crossing point. The West Interceptor joins the South Interceptor at this point and crosses the Bay. On the Plateau side, the East Interceptor along the existing road will be connected to the S1 Pumping Station partially using existing sewer pipe lines.

iii) Alternative Route III: The South Interceptor is the same as other alternatives and detours the Banco Bay after collecting two trunk sewers of Attécoubé area. In Plateau side, it is able to use the existing sewer pipeline of about 2.4 km long. These alternative routes are shown in Fig.8.4.

8.3 Selection of Flow System

Generally, the gravity flow system is adopted as a sewage flow system. In the Study Area, however, a combination of the gravity and pressure flow systems was selected. The reason is mentioned as follows:

a) If only gravity flow is adopted for the entire stretch, pipes must be installed deeply. This is because the elevation at the uppermost end of the South Interceptor and S1 Pumping Station does not differ much different. It is not feasible.

b) If the pressure flow system is selected, pipes can easily be installed in the shallow ground. However, the running cost is higher than for a combined system. About 90 % of the collecting area is located in high land while the S1 Pumping Station is located in low land. The head between two points can not be used effectively. Therefore, this system has its disadvantage in cost performance.

c) The Interceptor has no inflow pipe for a long distance and about 70 % of the total amount of wastewater comes from the upstream area.

d) Under these topographic conditions, the combined system would be able to minimize construction costs and running costs by utilizing advantages of its system.

Considering the topographic condition, the amount of inflow from each Trunk Sewer and its location, the following four (4) cases of a combination of flow systems were studied.

1) Case-1

The pressure flow system is adopted for the stretch from 1-2-3A/B to UNIWAX because the starting point of the South Interceptor is located in relatively low land. The gravity flow system is adopted for the section from UNIWAX to the S1 Pumping Station which will be constructed by open cut or jacking method. Wastewater from the 33-34 and 35-36 Trunk Sewers located at low land is carried by pressurized flow into the South Interceptor of gravity flow.

2) Case-2

For the section from 1-2-3A/B Trunk Sewer to Banco Bay, gravity flow system is adopted. The sewer pipes are installed using the open cut or jacking method. For the section from the end of the South Interceptor to the S1 Pumping Station, the pressurized flow system is adopted. One pumping station will be constructed on the land near the bay on the Yopougon side. Wastewater from the 33-34 and 35-36 Trunk Sewers flows into the South Interceptor by the same system as in Case 1.

3) Case-3

At the starting point of the South Interceptor, wastewater is pumped up to a height which

enables wastewater to be carried out to the highest point near Banco Bay. Then, Trunk Sewers of UNIWAX, 21-22 and 25-26 will be connected using pumps to the pressurized South Interceptor. This system is called the multiple pressurized flow system.

After a regulation tank is installed at the highest point near Banco Bay, the gravity flow system is adopted up to the S1 Pumping Station. Wastewater from the 33-34 and 35-36 Trunk Sewers is connected to the South Interceptor through the West Interceptor in the same manner as in Case-1.

4) Case-4

At each connecting point of the Trunk Sewer, wastewater of the South Interceptor will be pumped up to the next highest point and flows by gravity flow. For the section from the South Interceptor to the S1 Pumping Station, gravity flow is adopted using enough head between the two points. Wastewater from the 33-34 and 35-36 Trunk Sewers will be connected to the South Interceptor in the same manner as in Case-1.

The flow systems of these four cases are compared in Fig. 8.5. Fig. 8.6 to 8.9 show schematically the proposed pipe line height, water head and existing ground level of each case.

Finally, the optimum flow system would be selected by taking into account the combination with alternative routes and comparing construction methods and costs. The results of comparisons of the four (4) cases are as follows:

	Earth covering in case of gravity flow(m)	Accumulated discharge by pressurized flow (m^3/s)	Evaluation
Case-1	1.2 - 15.0	0.233	adoptable
Case-2	1.2 - 20.0	1.060	unsuitable
Case-3	1.2 - 5.0	1.060	adoptable
Case-4	1.2 - 5.0	3.932	unsuitable

As a construction method, the jacking method should be recommendable for pipe installation in high land in case of gravity flow. The open cut method should be adopted in low land.

Case-2 has a very deep earth covering and has a 4 times larger accumulated discharge compared to Case-1. Case-1 also entails very expensive construction and operation/maintenance costs. Case-3 and Case-4 also have large accumulated discharges and would require high O/M costs. But these have very shallow earth covering.

In conclusion, Case-1 and Case-3 were selected for further comparison with alternative routes.

8.4 Comparison of Alternative Interceptor Routes

Three (3) alternative interceptor routes were compared by taking into account the difficulty of construction, environmental issues, construction cost, operation and maintenance problems, etc. The layouts of the proposed sewerage facilities of each alternative are shown in Fig.8.4. And the profiles of each alternative route are shown in Figures 8.10, 8.11, 8.12 and 8.13.

The planning conditions and characteristics of each alternative interceptor route are as follows:

(1) Alternative Interceptor Route I

This is the shortest route among the three alternatives. The South Interceptor in the high land will be the pressurized type. Banco Bay crossing sewer and the interceptor on the Plateau side will be the gravity flow type. The West Interceptor from the Attécoubé area will be a pressurized sewer. The crossing structure of Banco Bay should be installed in a deep layer at the bottom to avoid damage by dredging. At the Bay mouth, the construction method will be very limited due to the heavy traffic of ships and periodical dredging. The shield tunneling method or Pipe Line Arch-drilling (PLAD) method will be adoptable.

(2) Alternative Interceptor Route II

The total length is about 14.2 km and ranks between Alternatives-I and -III. The South Interceptor between the 1-2-3A/B and 25-26 trunk sewers will be pressurized sewers the same as for Alternative I. The combined system for the South Interceptor (pressurized sewer up to UNIWAX; the remaining section by gravity flow) was also studied but neglected because of its disadvantage in cost. In the proposed crossing site at the inner side

of the Bay, there is no restriction for construction due to navigation and no risk of damage by dredging is expected. The sewer pipes will be supported on piles at the bottom of the Bay. Construction of this kind of crossing structure has been carried out in the Ebrié Lagoon.

The construction cost of Alternative II is lower than the others.

(3) Alternative Interceptor Route III

This route detouring Banco Bay is the longest one among the three alternatives. The total length is about 19.6 km. The South Interceptor between the 1-2-3A/B and 25-26 trunk sewers will be pressurized sewers the same as for Alternative I. There is no pumping station at the West and East Interceptors. In this section, however, the sewer pipes will be pressurized and will have maintenance problems.

Construction cost is estimated to be about nineteen billion FCFA and is the highest among the three alternatives. The jacking method and open cut method will be adopted for the pipe installation. In the West Interceptor, sewer pipes will be installed under the roadway. On the Plateau side, construction work of the East Interceptor is expected to have difficulty due to heavy road traffic.

The results of comparison of the three alternatives are summarized in Table 8.1.

Finally, Alternative II is recommended as an optimum route based on the comprehensive evaluation.

Fig. 8.14 shows a schematic diagram of the multiple pressurized flow system of Alternative II.

TABLE 8.1 COMPARISON OF ALTERNATIVE INTERCEPTOR ROUTES

Alternative Route	Route and Flow System	Construction Method	Difficulty of Construction	Land Acquisition	Environmental Issues	Operation /Maintenance	Construction Cost (10⁶FCFA)	Comprehensive Evaluation
Alternative Route I-1	Crossing Banco Bay at mouth Length : 10km Multiple pressurized and gravity flow system	Open cut: 9.0km Jacking: 0.5km PLAD: 0.5km	Bay crossing will be 50m below sea level in hard layer. Special digging method like boring (Pipe-line arch drilling Method) is needed.	Marine Nationale and Railway	No major negative impact	Difficult in seabed section. Not difficult in remaining sections	15,000	Advantage in cost but partially maintenance problem. **Not Recommendable.**
Alternative Route I-2	—do— Pressurized and gravity flow sysytem	Open cut: 3.9km Jacking: 5.6km PLAD: 0.5km				Difficult in seabed section. Easy in longest section of gravity flow	21,000	Disadvantage in cost comparing with AL.I-1and AL.II. **Not recommendable**
Alternative Route II	Crossing Banco Bay at inner side Length: 14.2km Multiple pressurized and gravity flow system	Open cut: 10.6km Seabed pipeline supported by piles: 0.7km Reinforcement of pipe joint: 2.4km Jacking: 0.5km	No major problem except fixation of pipe with pile foundation in water	Necessary at Plateau side	No major negative impact	Same as I-1. Shallow installation of pipeline in Bay crossing section. Easy	14,500	**Recommendable.** Advantage in cost and easy maintenance.
Alternative Route III	Detouring around Banco Bay, Length: 19.6km Multiple pressurized and gravity flow system	Open cut: 18.1km Reinforcement of pipe joint: 2.4km Jacking: 1.0km	No major problem	Non	No major negative impact	Very difficult for 6 km section of South Interceptor under siphon flow condition	19,000	**Not recommendable** bacause of high cost and maintenance problem.

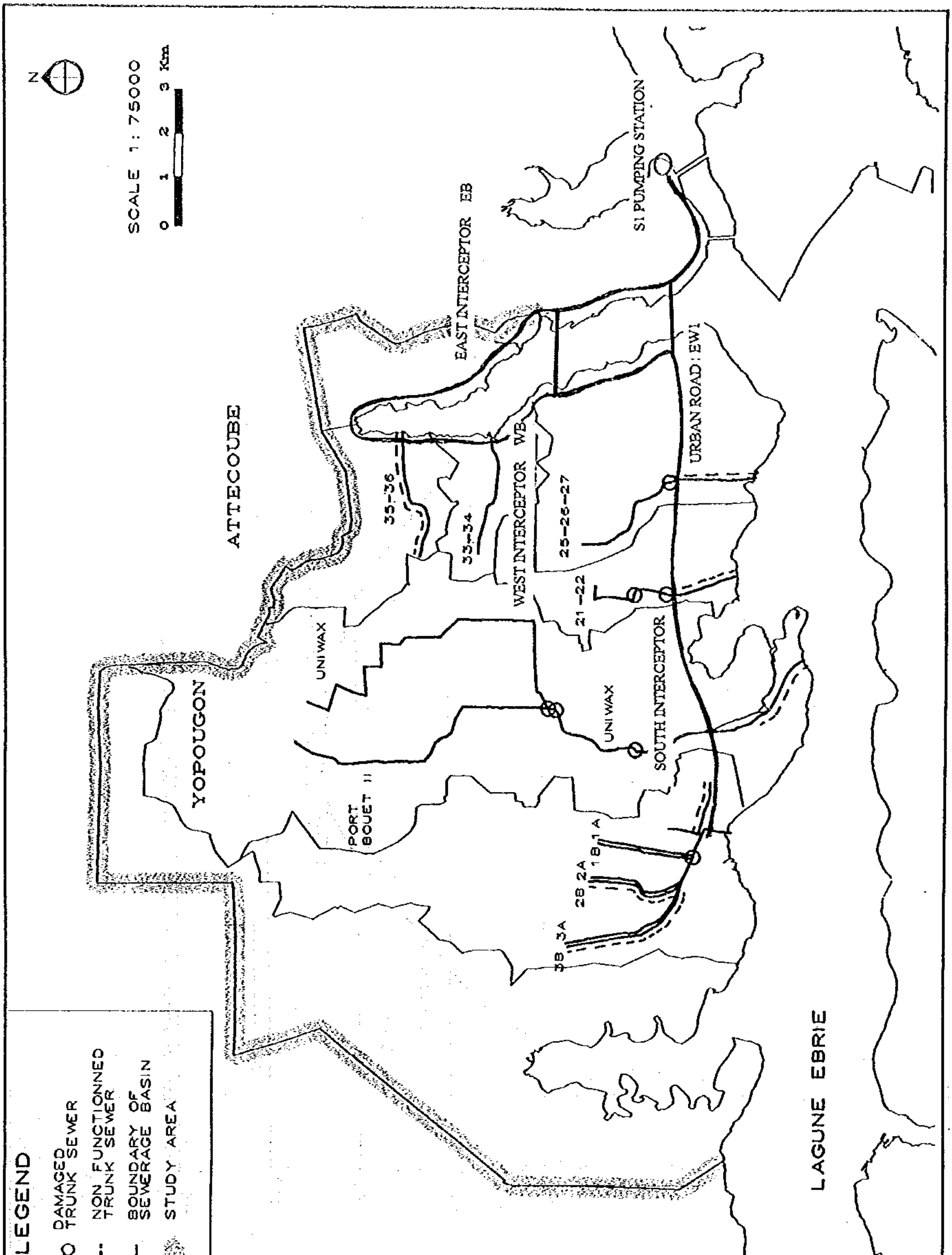


FIG. 8.1	PROPOSED ROUTE OF INTERCEPTOR

THE FEASIBILITY STUDY ON SEWERAGE FACILITIES IN WESTERN DISTRICT OF ABIDJAN CITY IN THE REPUBLIC OF COTE D'IVOIRE

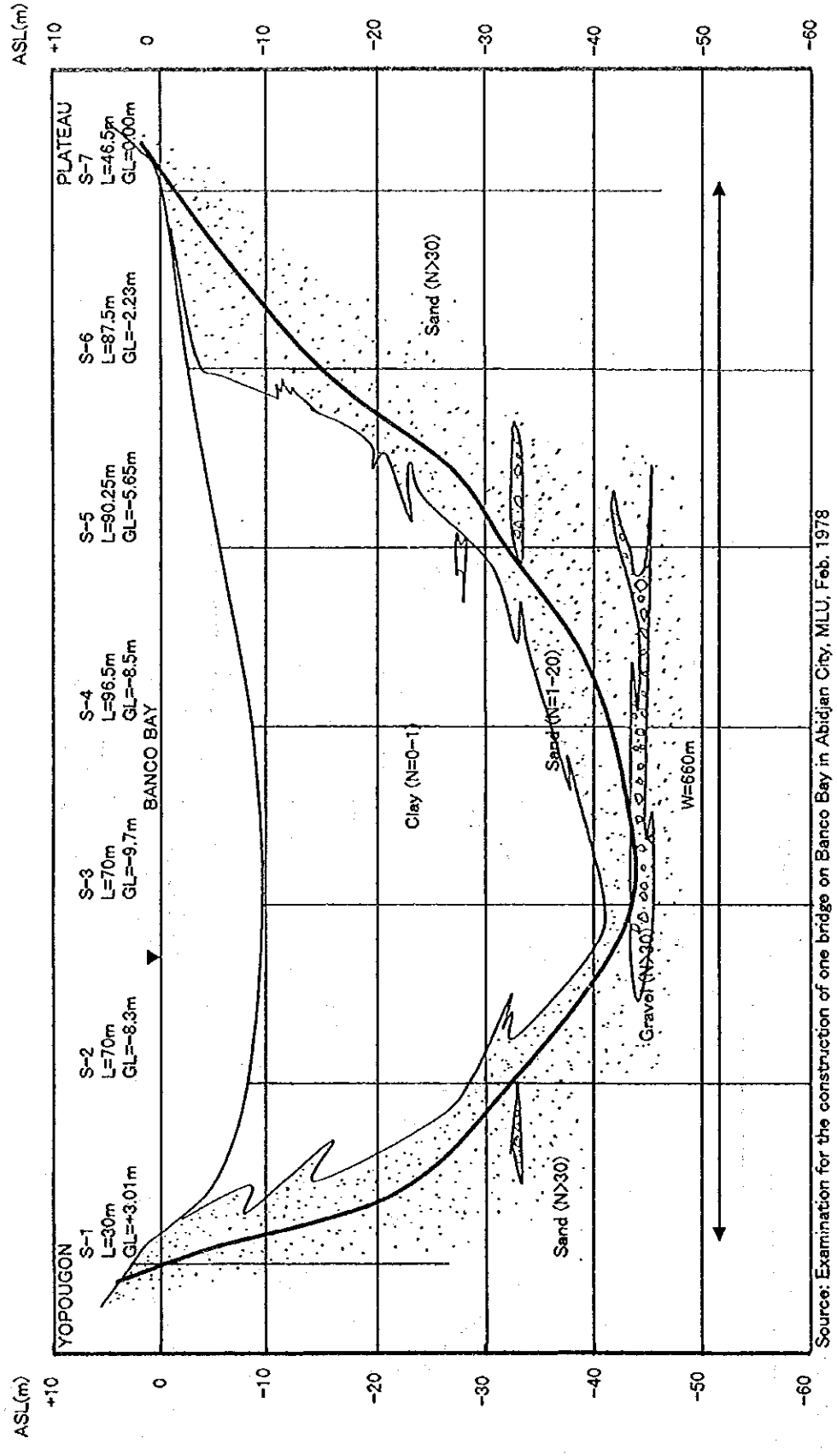


FIG. 8.2 GEOLOGICAL SECTION OF BANCO BAY

THE FEASIBILITY STUDY ON SEWERAGE FACILITIES IN WESTERN DISTRICT OF ABIDJAN CITY IN THE REPUBLIC OF COTE D'IVOIRE

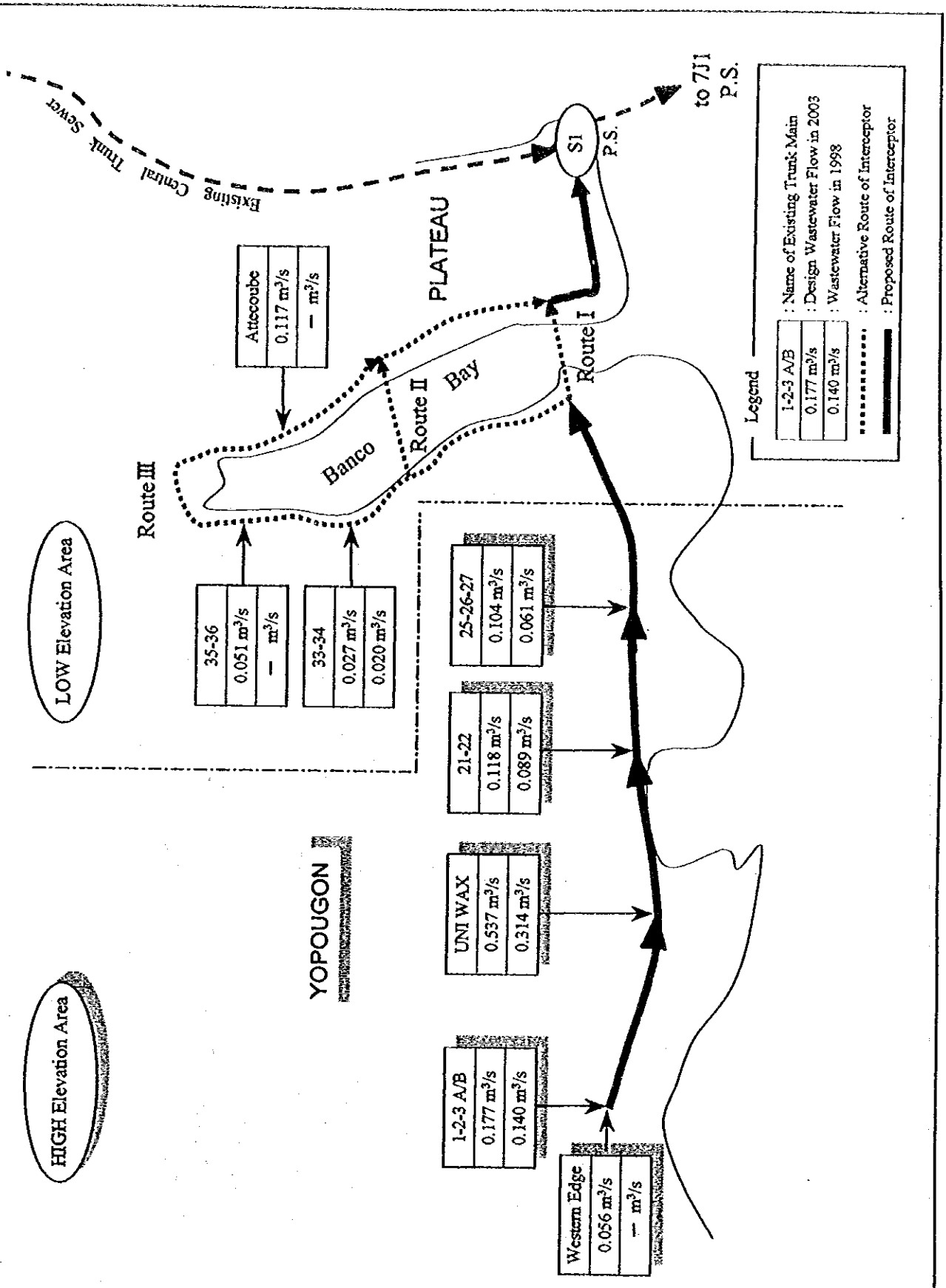


FIG. 8.3 ALTERNATIVE INTERCEPTOR ROUTE AND DESIGN MAXIMUM HOURLY WASTEWATER

THE FEASIBILITY STUDY ON SEWERAGE FACILITIES IN WESTERN DISTRICT OF ABIDJAN CITY IN THE REPUBLIC OF COTE D'IVOIRE

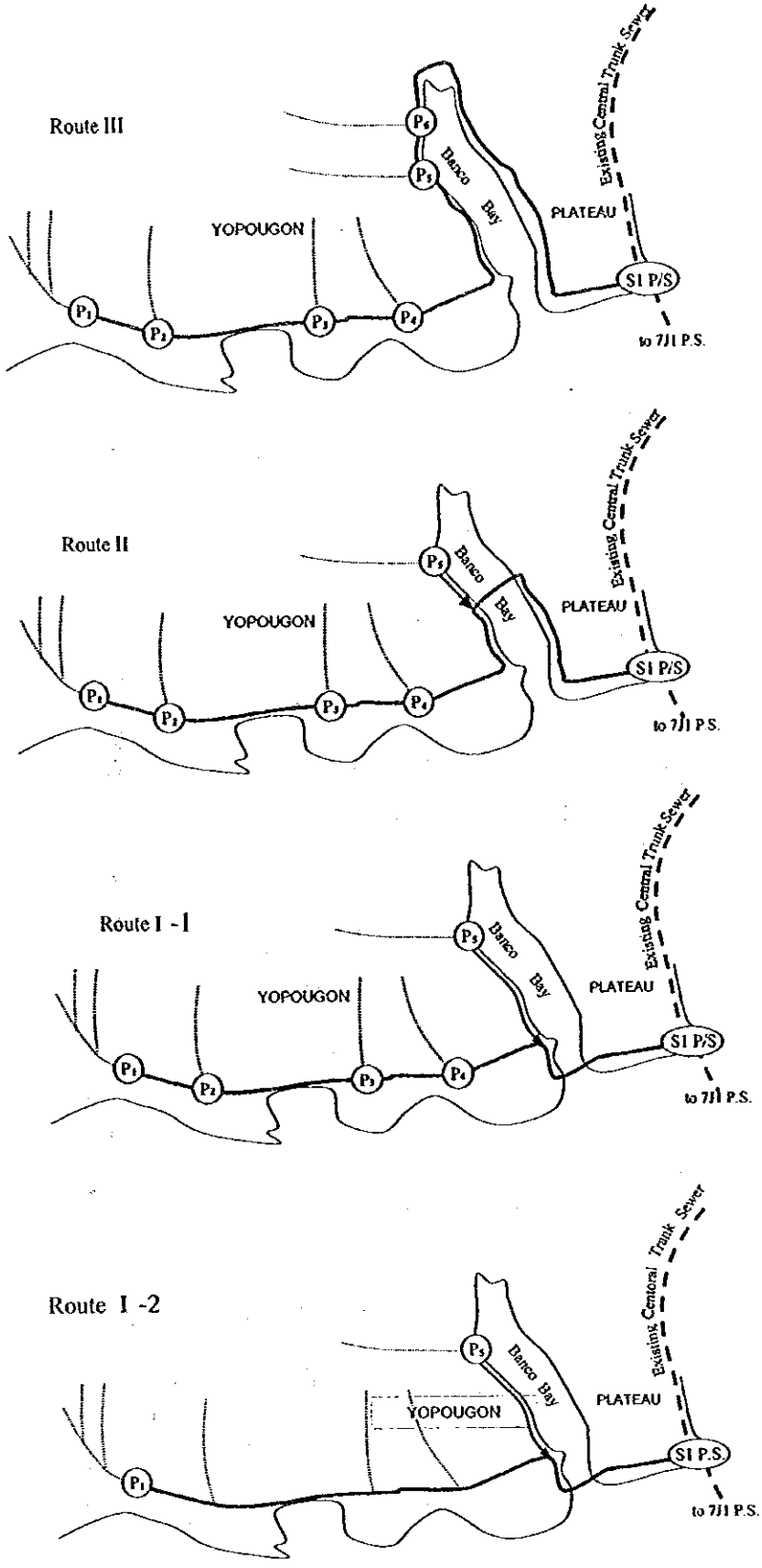
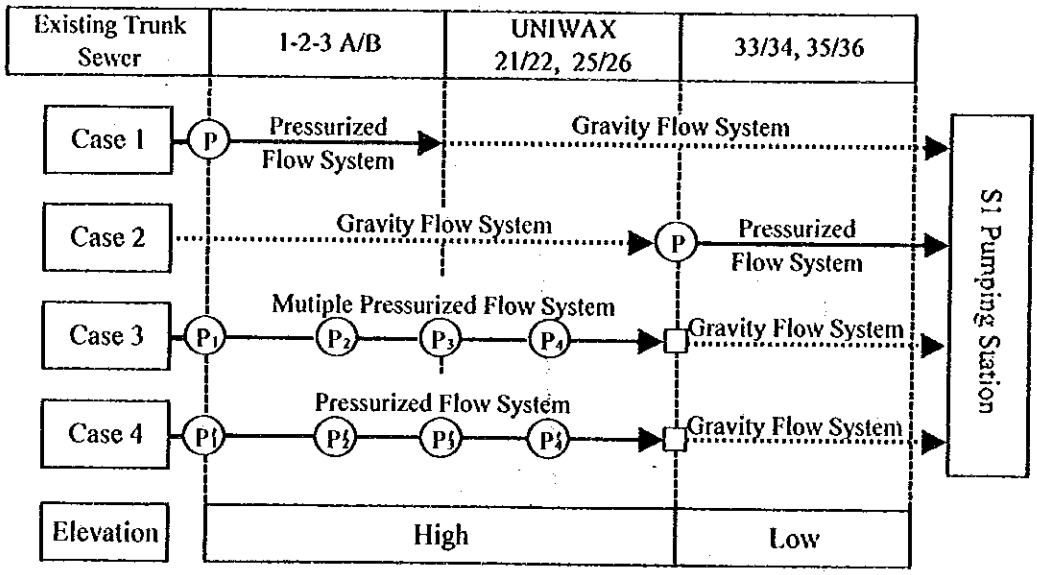


FIG. 8.4	ALTERNATIVES OF INTERCEPTOR ROUTE (I,II AND III)

THE FEASIBILITY STUDY ON SEWERAGE FACILITIES IN WESTERN DISTRICT OF ABIDJAN CITY IN THE REPUBLIC OF COTE D'IVOIRE

JICA



Note: (P) Pumping Station
□ Regulation Tank

FIG. 8.5	COMPARISON OF FLOW SYSTEM

THE FEASIBILITY STUDY ON SEWERAGE FACILITIES IN WESTERN DISTRICT OF ABIDJAN CITY IN THE REPUBLIC OF COTE D'IVOIRE

JICA

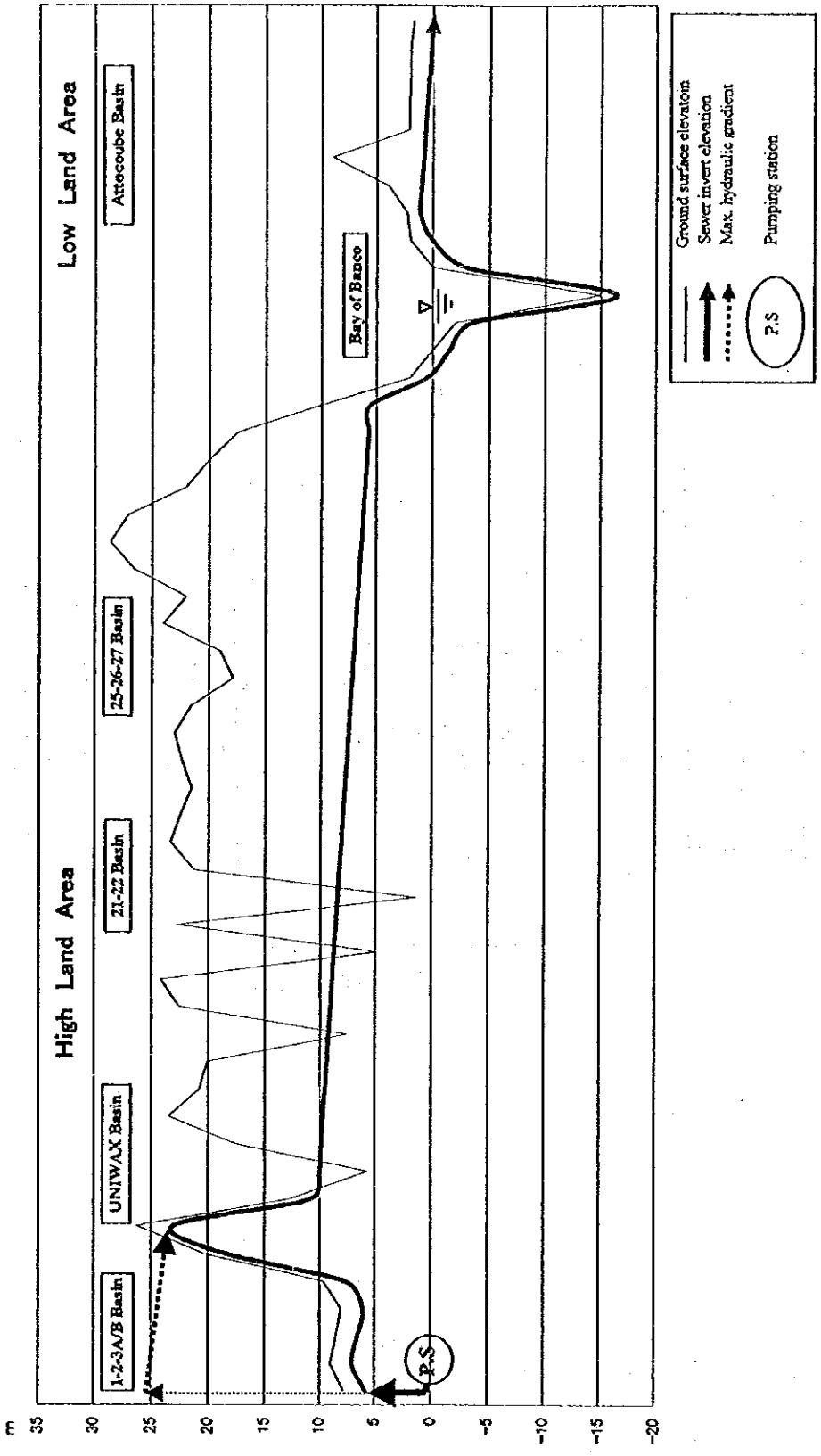


FIG. 8.6 SCHEMATIC PROFILE OF FLOW SYSTEM-CASE-1

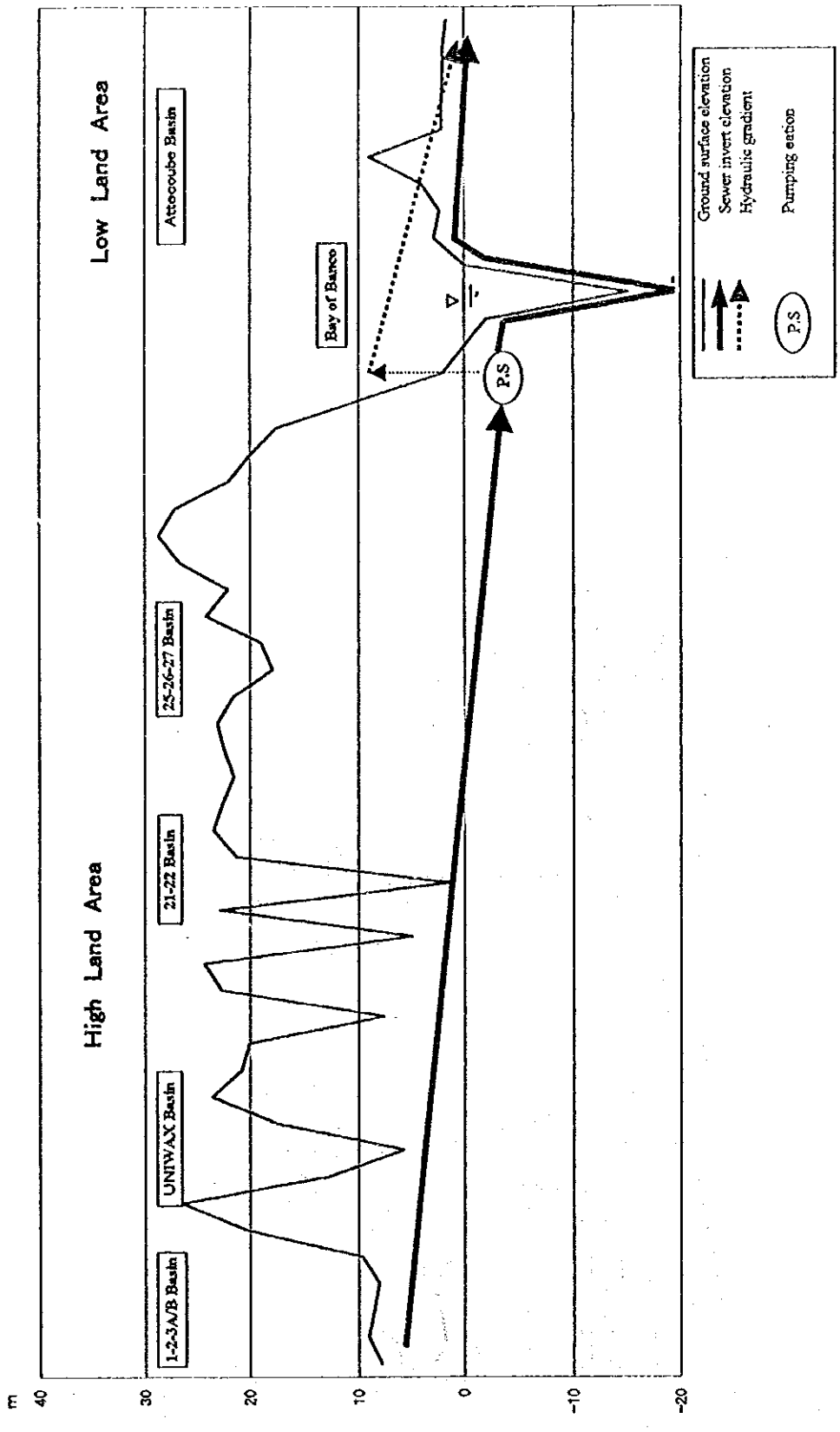


FIG. 8.7 SCHEMATIC PROFILE OF FLOW SYSTEM-CASE-2

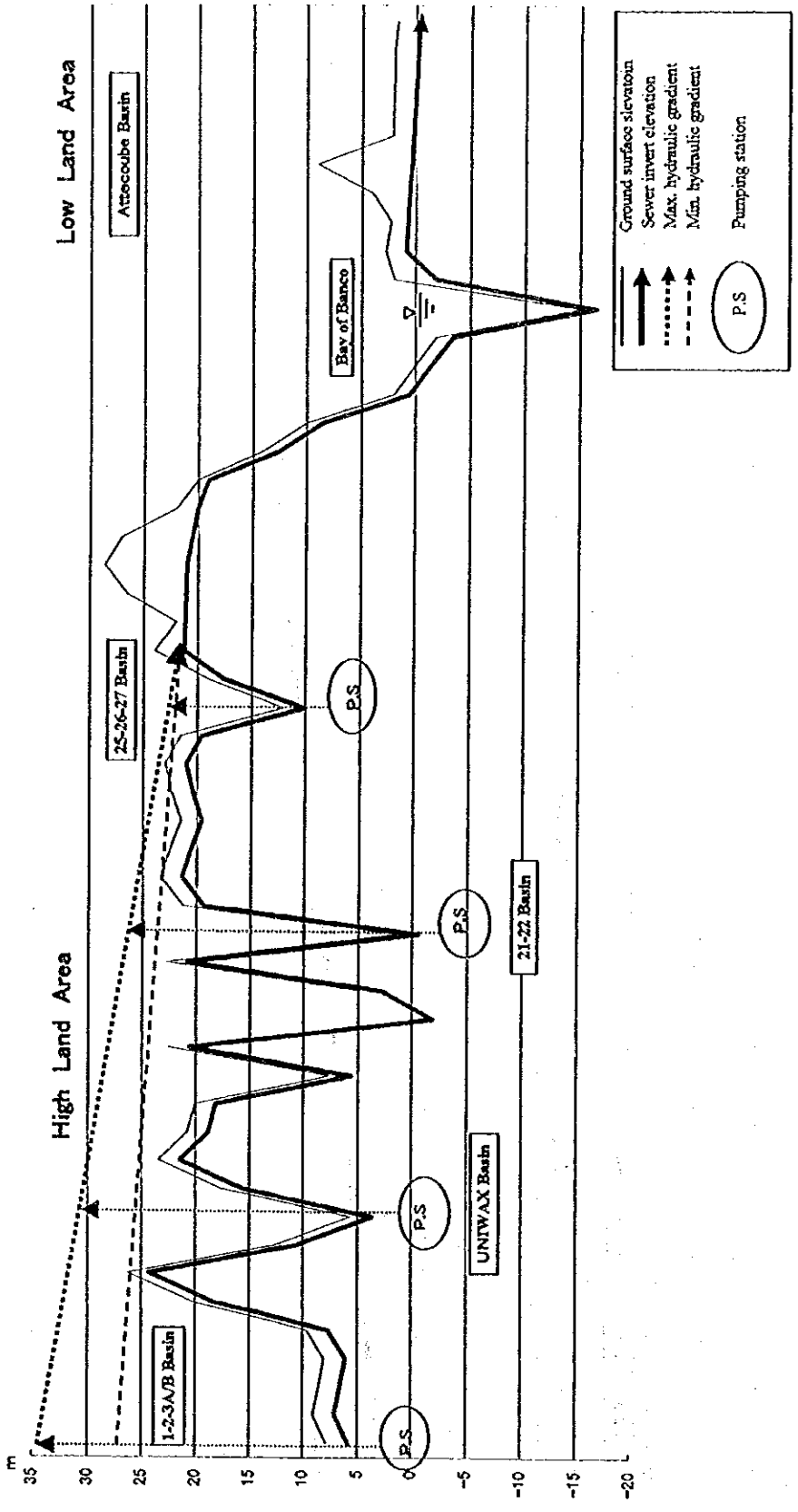


FIG. 8.8 SCHEMATIC PROFILE OF FLOW SYSTEM-CASE-3

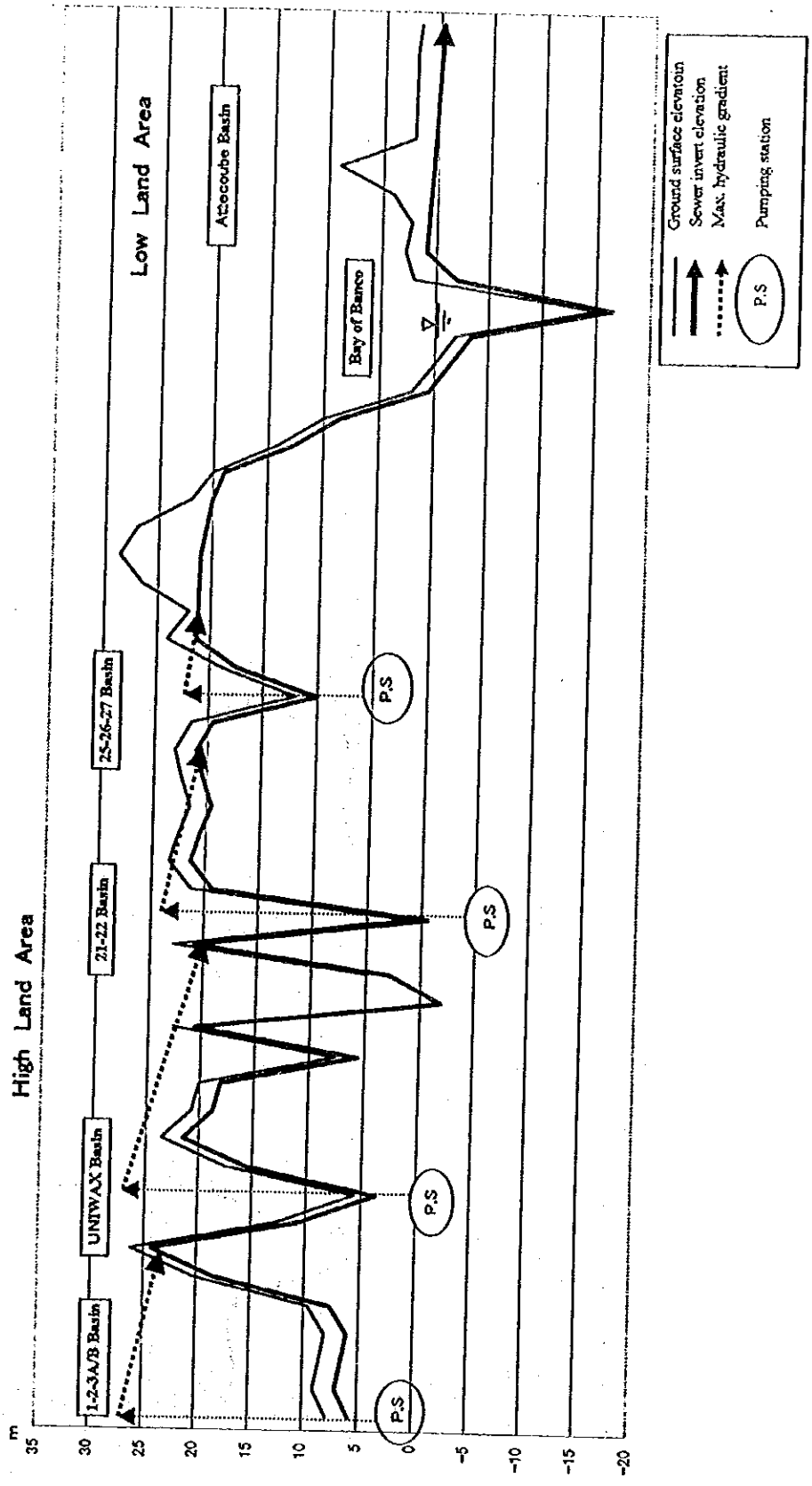


FIG. 8.9 SCHEMATIC PROFILE OF FLOW SYSTEM-CASE-4

THE FEASIBILITY STUDY ON SEWERAGE FACILITIES IN WESTERN DISTRICT OF ABIDJAN CITY IN THE REPUBLIC OF COTE D'IVOIRE

JICA

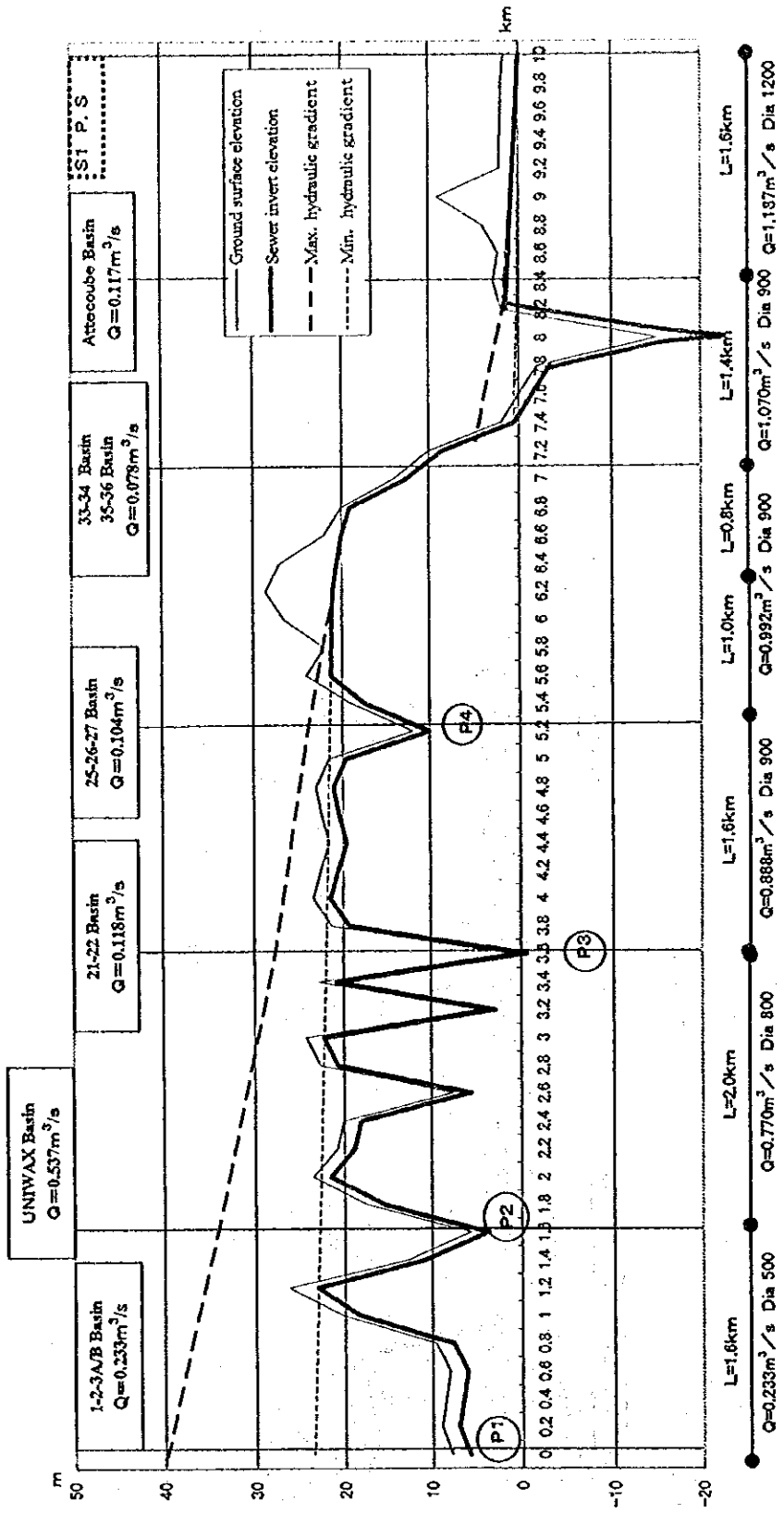


FIG. 8.10 HYDRAULIC GRADIENT OF ALTERNATIVE INTERCEPTOR ROUTE-I-1

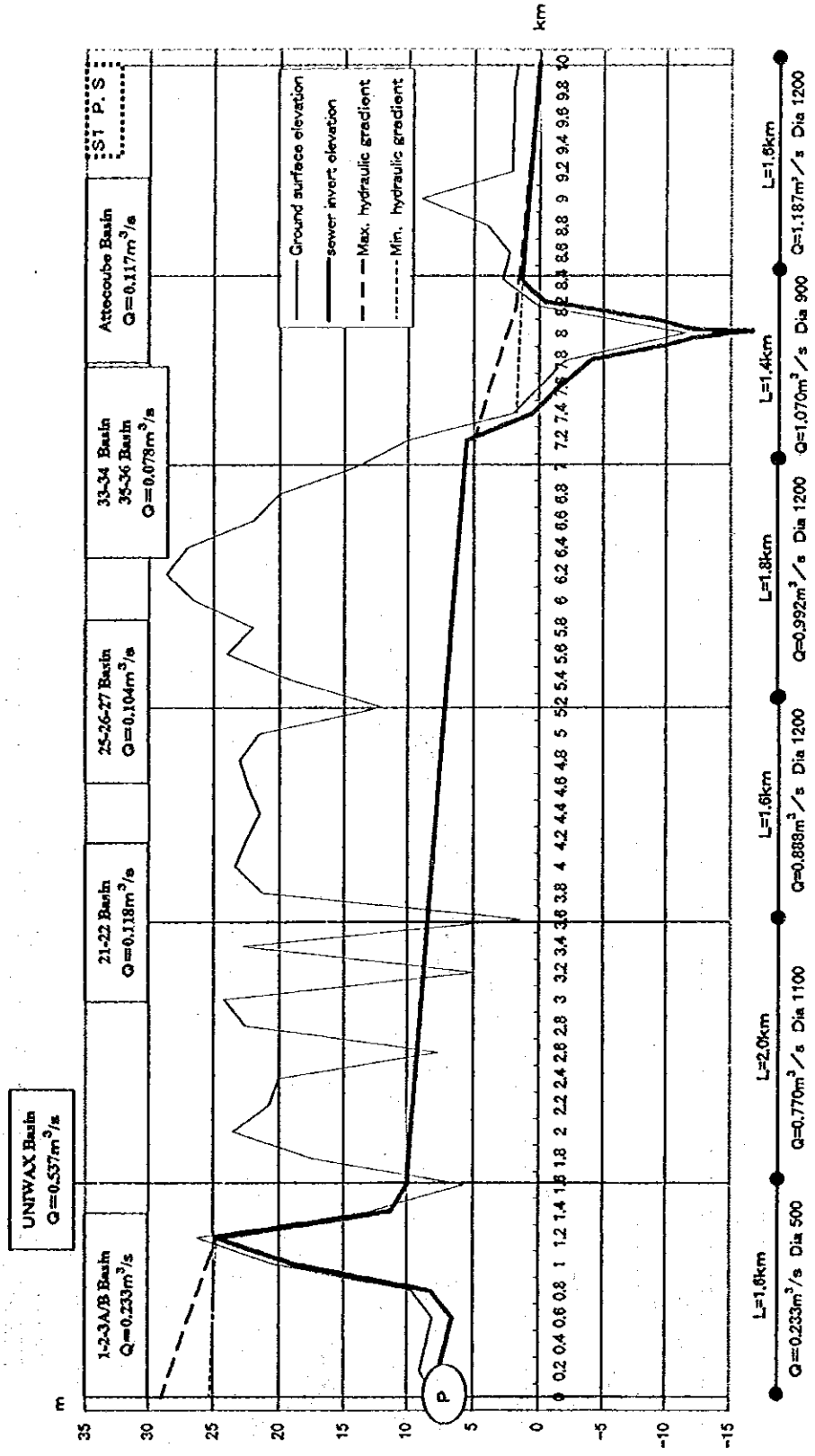


FIG. 8.11 HYDRAULIC GRADIENT OF ALTERNATIVE INTERCEPTOR ROUTE-I-2

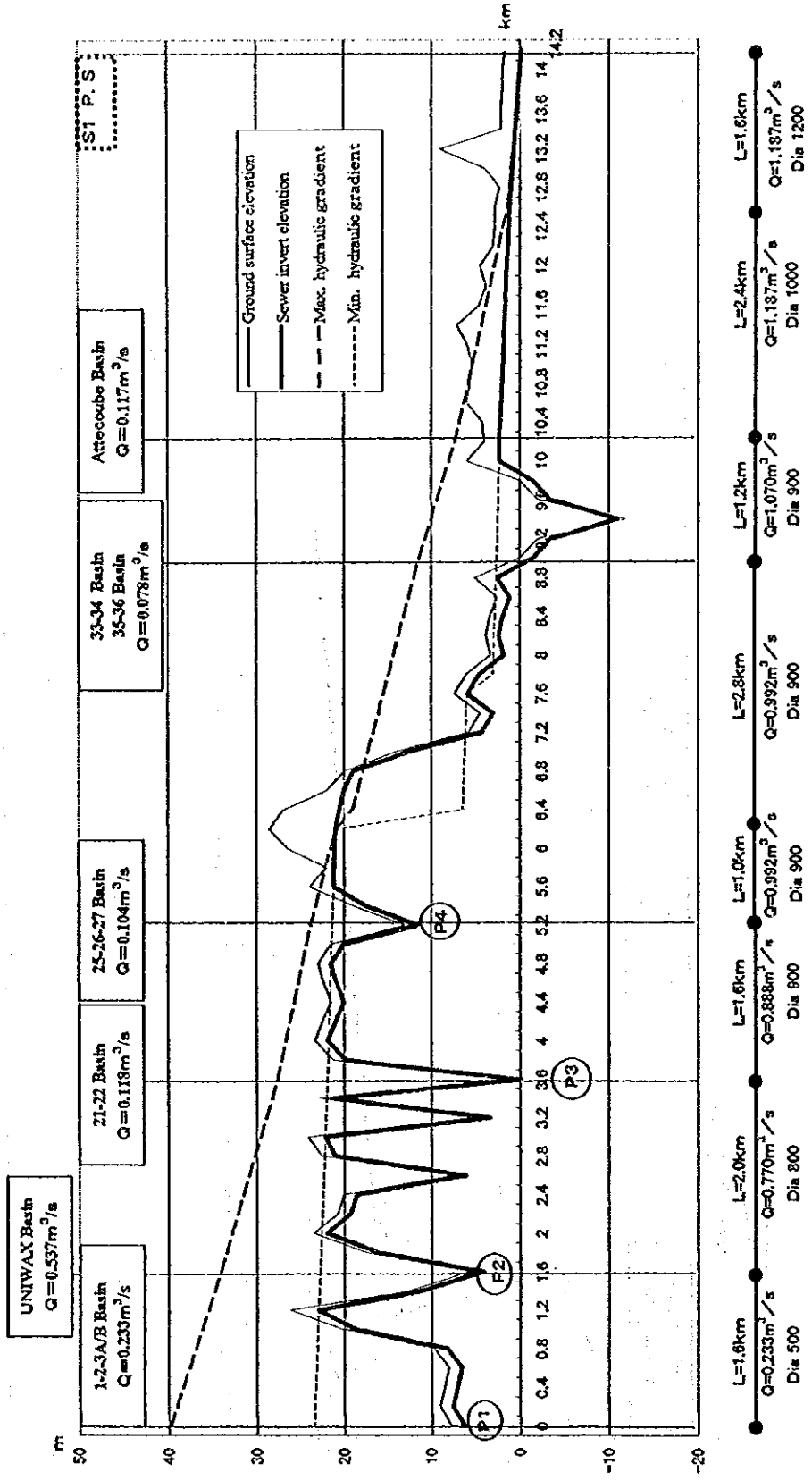


FIG. 8.12 HYDRAULIC GRADIENT OF ALTERNATIVE INTERCEPTOR ROUTE-II

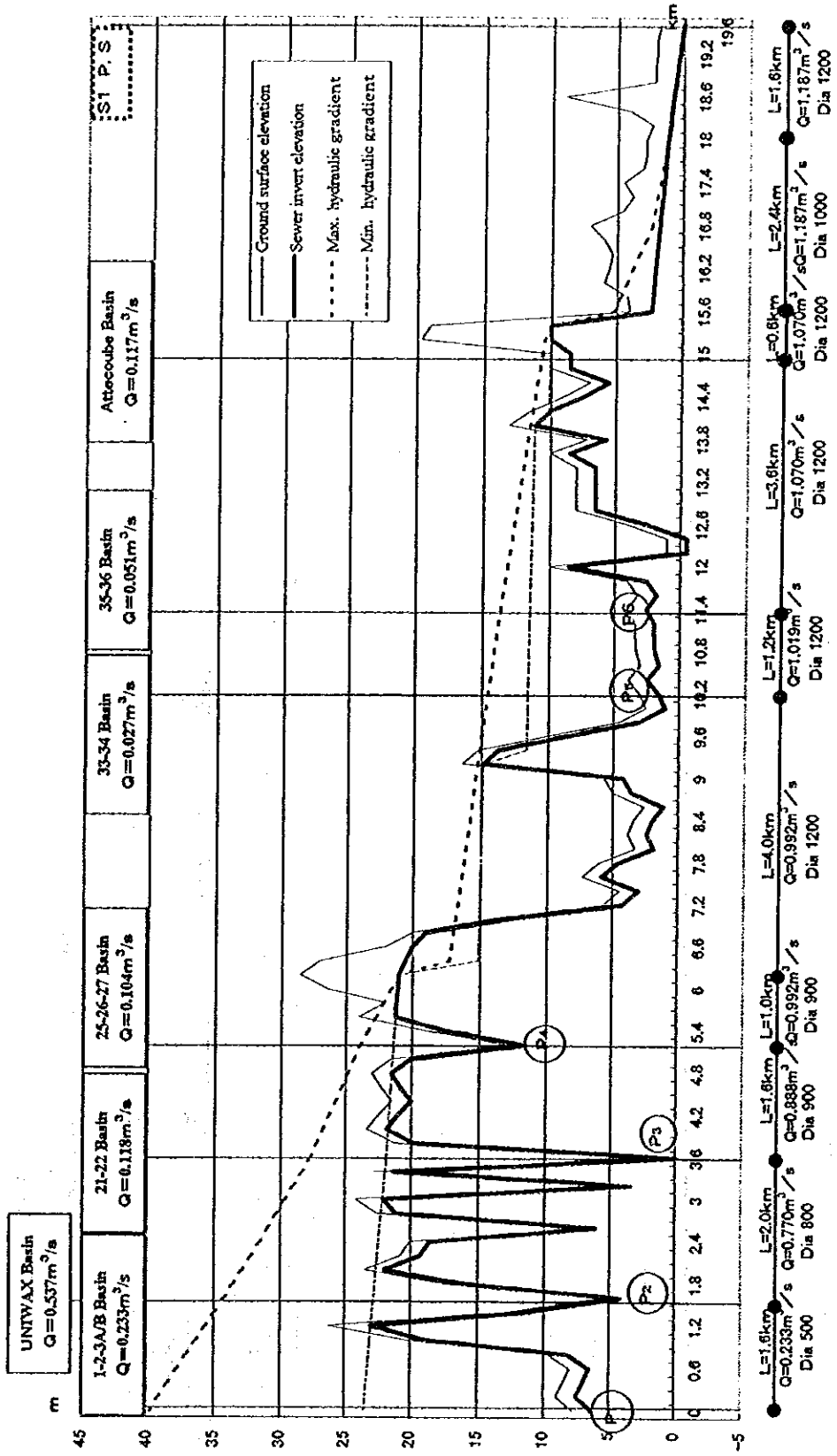


FIG. 8.13 HYDRAULIC GRADIENT OF ALTERNATIVE INTERCEPTOR ROUTE-III

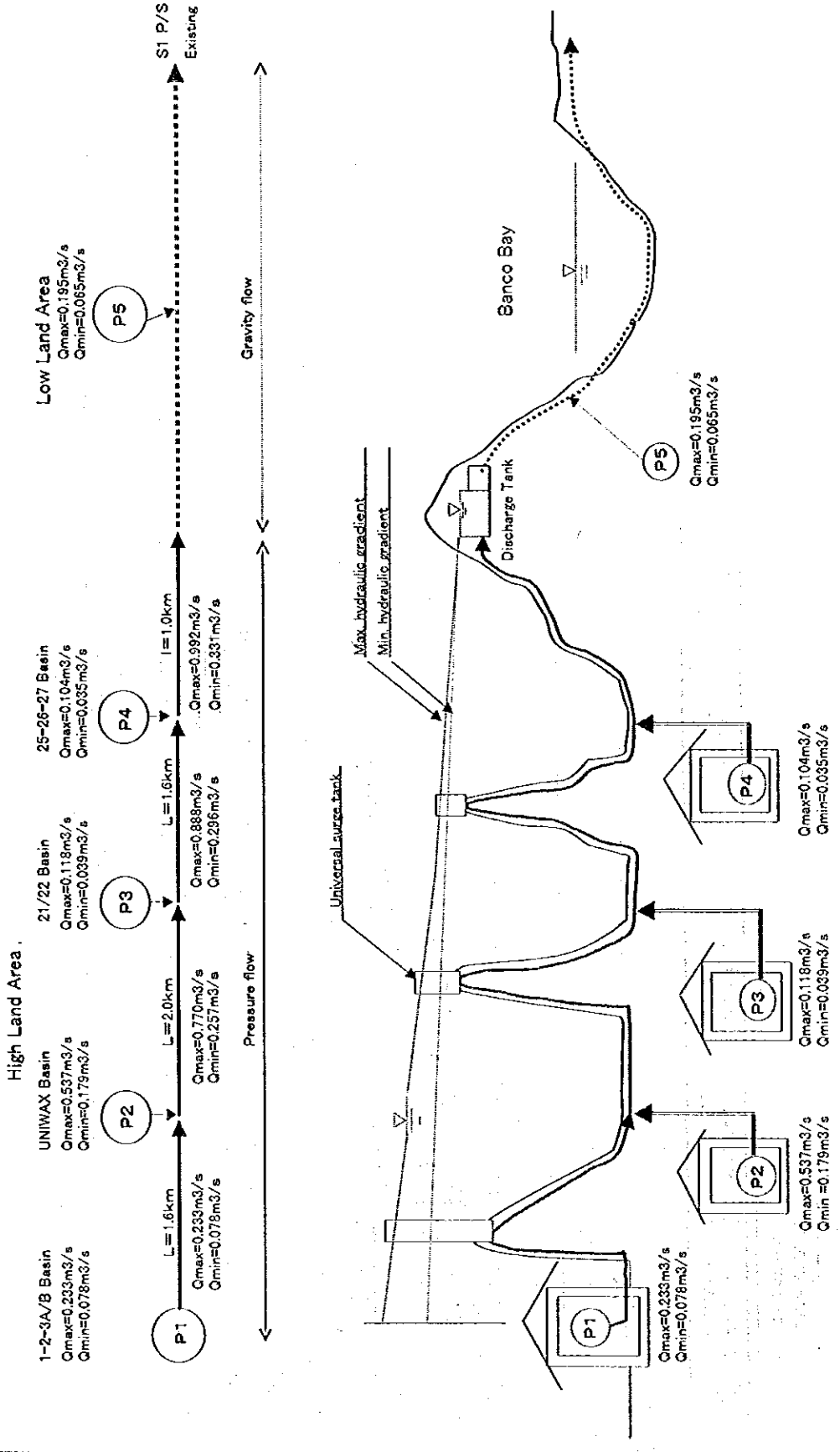


FIG. 8.14 SCHEMATIC DIAGRAM OF MULTIPLE PRESSURIZED FLOW SYSTEM

THE FEASIBILITY STUDY ON SEWERAGE FACILITIES IN WESTERN DISTRICT OF ABIDJAN CITY IN THE REPUBLIC OF COTE D'IVOIRE

JICA

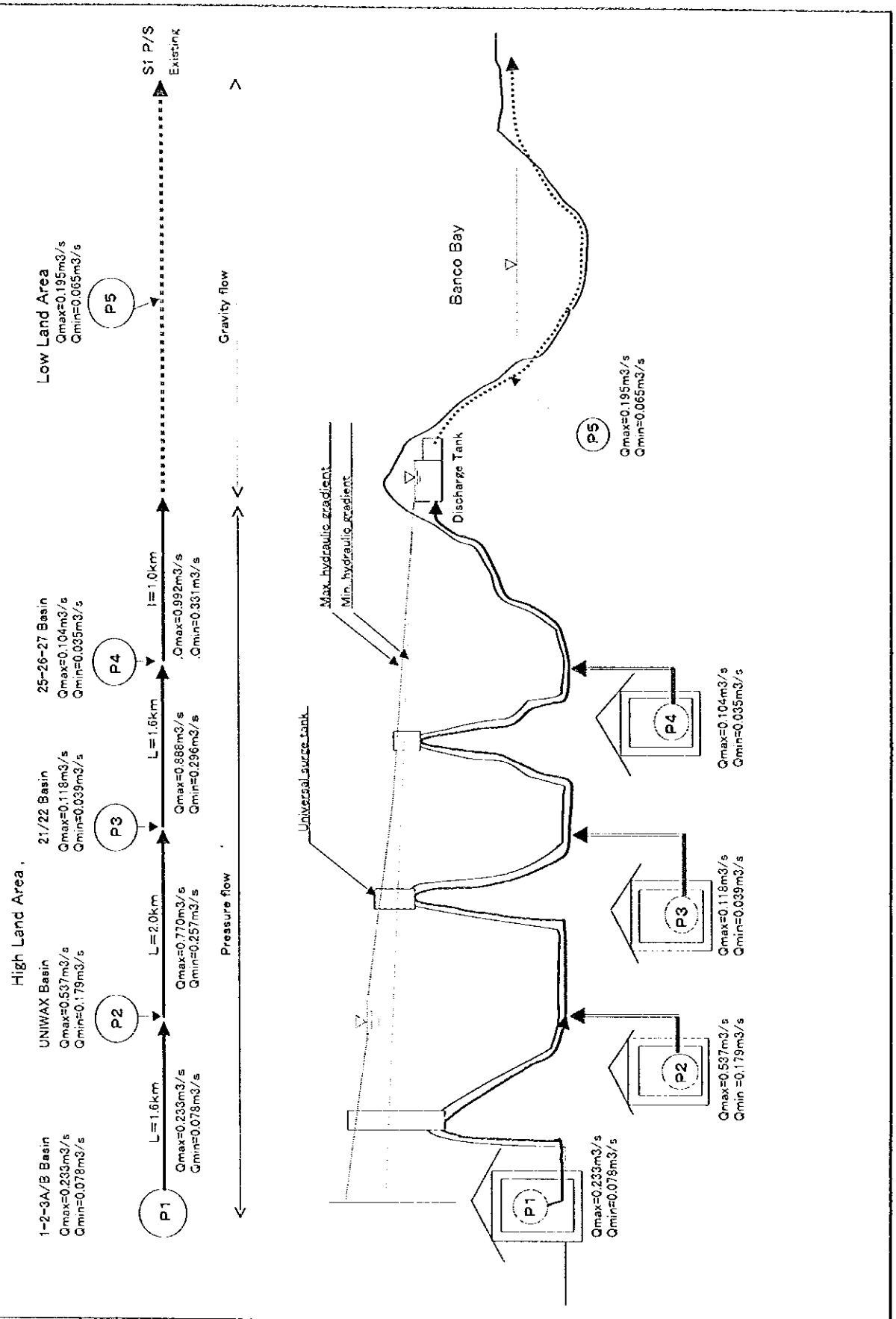


FIG. 8.14 SCHEMATIC DIAGRAM OF MULTIPLE PRESSURIZED FLOW SYSTEM