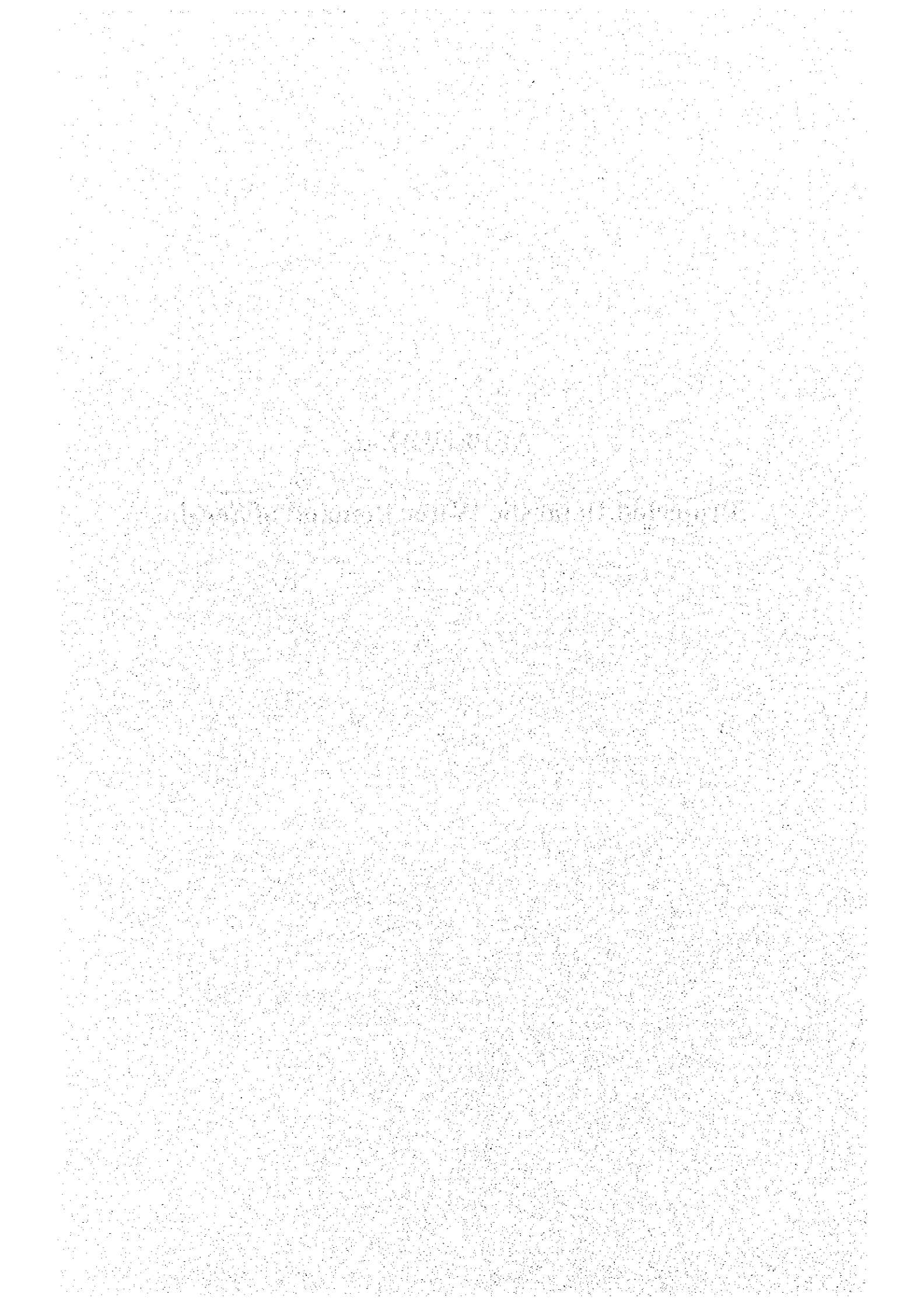


APPENDIX-2

Projected Domestic Water Demand of Sergipe



Appendix-2 (1) Projected Domestic Water Demand of Sergipe in Urban Area

(m³/day)

Code	Name of Municipality and Region	Trend Scenario						Strategic Scenario					
		1997	1998	2000	2005	2010	2015	2020	2000	2005	2010	2015	2020
01-0120	Caninde de Sao Francisco	1,305	1,352	1,417	1,720	2,015	2,431	2,890	1,447	2,861	4,290	5,830	7,568
01-0220	Feira Nova	460	490	551	836	1,133	1,458	1,830	551	836	1,133	1,458	1,830
01-0240	Gararu	401	404	411	413	427	452	487	411	413	427	452	487
01-0260	Gracho Cardoso	338	345	360	393	435	489	554	360	393	435	489	554
01-0310	Itabi	421	426	437	451	476	514	564	437	451	476	514	564
01-0420	Monte Alegre de Sergipe	932	955	1,002	1,114	1,253	1,424	1,632	1,002	1,114	1,253	1,424	1,632
01-0450	Nossa Senhora da Gloria	2,533	2,597	2,725	3,078	3,477	3,928	4,437	2,725	3,592	4,521	5,565	6,777
01-0540	Poco Redondo	977	1,023	1,115	1,452	1,815	2,224	2,699	1,115	1,452	1,815	2,224	2,699
01-0560	Perto da Folha	1,283	1,310	1,365	1,481	1,634	1,828	2,069	1,365	1,481	1,634	1,828	2,069
02-0140	Carra	1,419	1,464	1,552	1,796	2,081	2,417	2,820	1,552	1,796	2,081	2,417	2,820
02-0230	Frei Paulo	976	1,014	1,092	1,341	1,617	1,934	2,306	1,092	1,341	1,617	1,934	2,306
02-0445	Nossa Senhora Aparecida	315	331	365	495	634	789	968	365	495	634	789	968
02-0500	Pedra Mole	152	156	163	177	196	219	249	163	177	196	219	249
02-0520	Pinhao	453	467	494	566	651	752	874	494	566	651	752	874
02-0600	Ribeiropolis	1,468	1,507	1,585	1,776	2,010	2,294	2,640	1,585	1,776	2,010	2,294	2,640
03-0020	Aquidaba	1,422	1,459	1,533	1,714	1,935	2,205	2,534	1,533	1,714	1,935	2,205	2,534
03-0190	Cumbe	330	337	351	380	419	469	530	351	380	419	469	530
03-0380	Malhada dos Bois	221	233	257	354	457	571	702	257	354	457	571	702
03-0430	Muribeca	436	446	467	515	575	650	742	467	515	575	650	742
03-0460	Nossa Senhora das Dores	2,015	2,062	2,158	2,373	2,647	2,987	3,405	2,158	2,373	2,647	2,987	3,405
03-0700	Sao Afuguel do Aleixo	206	208	212	216	227	242	264	212	216	227	242	264
04-0050	Areia Branca	1,087	1,207	1,446	3,358	5,276	7,333	9,643	1,446	3,358	5,276	7,333	9,643
04-0100	Campo do Brito	1,136	1,213	1,366	2,107	2,873	3,713	4,671	1,366	2,107	2,873	3,713	4,671
04-0290	Itabaiana	7,964	8,233	8,771	10,301	12,097	14,206	16,684	8,771	12,014	15,452	19,282	23,701
04-0370	Macambira	288	302	331	442	559	691	844	331	442	559	691	844
04-0390	Malhador	754	765	787	819	873	948	1,047	787	819	873	948	1,047
04-0410	Moita Bonita	499	518	557	683	822	982	1,170	557	683	822	982	1,170
04-0680	Sao Domingos	624	652	706	895	1,101	1,335	1,608	706	895	1,101	1,335	1,608
05-0550	Poco Verde	1,454	1,491	1,565	1,741	1,959	2,226	2,553	1,565	1,741	1,959	2,226	2,553
05-0710	Simao Dias	2,497	2,572	2,722	3,122	3,594	4,156	4,831	2,722	3,122	3,594	4,156	4,831
05-0740	Tobias Barreto	4,141	4,261	4,503	5,137	5,891	6,791	7,876	4,503	5,137	5,891	6,791	7,876
06-0350	Lagarto	5,803	5,911	6,126	6,706	7,340	8,035	8,795	6,126	6,706	7,340	8,035	8,795
06-0580	Riachao do Dantas	634	653	691	793	914	1,058	1,231	691	793	914	1,058	1,231
07-0010	Amparo de Sao Francisco	184	187	192	201	216	235	261	192	201	216	235	261
07-0070	Brejo Grande	610	621	643	683	740	816	913	643	683	740	816	913
07-0110	Canhoba	235	239	245	254	271	293	323	245	254	271	293	323
07-0160	Cedro de Sao Joao	646	646	647	623	619	630	655	647	623	619	630	655
07-0270	Ilha das Flores	571	583	605	650	712	791	890	605	650	712	791	890
07-0440	Neopolis	1,601	1,730	1,986	2,843	4,071	5,828	8,343	1,986	3,857	5,750	7,792	10,098
07-0470	Nossa Senhora de Lourdes	404	421	457	580	714	867	1,045	457	580	714	867	1,045
07-0570	Propria	3,683	3,712	3,772	3,925	4,084	4,250	4,423	3,772	4,202	4,734	5,384	6,177
07-0730	Telha	149	151	157	166	180	198	222	157	166	180	198	222
07-9999	Santana de Sao Francisco	644	696	799	1,382	1,976	2,622	3,355	799	1,382	1,976	2,622	3,355
08-0130	Capela	2,505	2,531	2,583	2,719	2,862	3,012	3,171	2,583	3,045	3,573	4,190	4,925
08-0200	Divina Pastora	274	279	288	303	327	359	399	288	303	327	359	399
08-0650	Santa Rosa de Lima	314	320	333	357	391	435	489	333	357	391	435	489
08-0720	Siriri	435	447	471	531	603	690	796	471	531	603	690	796
09-0330	Japaratuba	1,098	1,117	1,156	1,260	1,373	1,497	1,631	1,156	1,436	1,744	2,096	2,508
09-0340	Japoata	567	573	586	596	624	666	725	586	596	624	666	725
09-0490	Pacatuba	354	360	371	402	434	470	508	371	402	434	470	508
09-0530	Pirambu	580	614	681	970	1,273	1,609	1,995	681	970	1,273	1,609	1,995
09-0690	Sao Francisco	319	326	341	375	419	473	539	341	375	419	473	539
10-0150	Carnopolis	1,071	1,113	1,197	1,465	1,764	2,106	2,509	1,197	1,465	1,764	2,106	2,509
10-0250	General Maynard	245	250	261	286	318	357	406	261	286	318	357	406
10-0360	Laranjeiras	3,194	3,318	3,566	4,354	5,231	6,239	7,426	3,566	4,354	5,231	6,239	7,426
10-0400	Maruim	1,733	1,726	1,712	1,612	1,565	1,555	1,576	1,712	1,612	1,565	1,555	1,576
10-0590	Riachuelo	981	1,002	1,045	1,135	1,254	1,404	1,591	1,045	1,135	1,254	1,404	1,591
10-0610	Rosario do Catete	899	936	1,010	1,254	1,523	1,831	2,192	1,010	1,254	1,523	1,831	2,192
10-0660	Santo Amaro das Brotas	1,242	1,243	1,245	1,201	1,195	1,217	1,266	1,245	1,201	1,195	1,217	1,266
11-0030	Aracaju	83,500	85,758	90,273	102,805	117,076	131,880	151,837	90,273	92,532	97,384	104,628	114,380
11-0060	Barra dos Coqueiros	1,329	1,354	1,404	1,497	1,631	1,804	2,023	1,404	1,497	1,631	1,804	2,023
11-0480	Nossa Senhora do Socorro	17,418	18,071	19,379	22,185	26,225	33,036	39,464	19,379	22,594	26,314	30,692	35,920
11-0670	Sao Cristovao	9,128	9,311	9,677	10,403	11,398	12,676	14,277	9,677	10,403	11,398	12,676	14,277
12-0040	Araua	646	659	686	740	813	906	1,022	686	740	813	906	1,022
12-0067	Boquim	2,379	2,429	2,529	2,737	3,015	3,367	3,806	2,529	2,737	3,015	3,367	3,806
12-0170	Cristinapolis	872	888	918	972	1,052	1,158	1,292	918	972	1,052	1,158	1,292
12-0300	Itabaianinha	2,225	2,277	2,382	2,619	2,921	3,295	3,755	2,382	2,619	2,921	3,295	3,755
12-0510	Pedrinhas	904	927	973	1,081	1,217	1,382	1,584	973	1,081	1,217	1,382	1,584
12-0620	Salgado	761	798	872	1,146	1,439	1,770	2,153	872	1,146	1,439	1,770	2,153
12-0750	Tomar do Geru	609	633	683	844	1,021	1,225	1,464	683	844	1,021	1,225	1,464
12-0760	Umbauba	1,514	1,555	1,636	1,839	2,085	2,383	2,745	1,636	1,839	2,085	2,383	2,745
13-0210	Estancia	7,368	7,415	7,508	7,746	7,992	8,245	8,507	7,508	8,578	9,847	11,362	13,185
13-0280	Indiaroba	673	681	697	714	751	806	881	697	714	751	806	881
13-0320	Itaporanga d'Ajuda	1,327	1,364	1,437	1,640	1,872	2,137	2,439	1,437	2,183	2,957	3,807	4,778
13-0630	Santa Luzia do Itanhhy	375	390	420	518	626	750	895	420	518	626	750	895
01- Sergipana do Sertao do Sao Francisco		8,648	8,903	9,414	10,939	12,696	14,747	17,162	9,414	12,593	15,985	19,784	24,179
02- Carra		4,784	4,939	5,250	6,151	7,188	8,406	9,857	5,250	6,151	7,188	8,406	9,857
03- Nossa Senhora das Dores		4,629	4,746	4,978	5,552	6,260	7,124	8,177	4,978	5,552	6,260	7,124	8,177
04- Agreste de Itabaiana		12,353	12,890	13,965	18,604	23,601	29,208	35,667	13,965	20,318	26,956	34,283	42,684
05- Tobias Barreto		8,092	8,324	8,789	10,000	11,444	13,173	15,260	8,789	10,000	11,444	13,173	15,260
06- Agreste de Lagarto		6,436	6,563	6,817	7,499	8,255	9,093	10,026	6,817	9,007	11,354	13,989	17,043
07- Propria		8,727	8,986	9,503	11,308	13,584	16,532	20,429	9,503	12,599	15,913	19,630	23,938
08- Cotinguiba		3,528	3,577	3,675	3,910	4,183	4,496	4,855	3,675	4,236	4,894	5,674	6,609
09- Japaratuba		2,918	2,991	3,136	3,603	4,123	4,714	5,397	3,136	3,978	4,895	5,936	7,151
10- Baixo Cotinguiba		9,365	9,589	10,036	11,308	12,849	14,710	16,967	10,036	11,308	12,849	14,710	16,967
11- Aracaju		111,375	114,494	120,732	136,890	156,330	179,395	207,602	120,732	127,027	136,726	149,799	166,600
12- Boquim		9,910	10,167	10,679	11,977	13,563	15,485	17,823	10,679	11,977	13,563	15,485	17,823
13- Estancia		9,744	9,850	10,062	10,618	11,241	11,938						

Appendix-2 (2) Projected Domestic Water Demand of Sergipe in Rural Area

Code	Name of Municipality and Region	Trend Scenario and Strategic Scenario							Unit: m ³ /day
		1997	1998	2000	2005	2010	2015	2020	
01-0120	Caninde de Sao Francisco	707	718	740	799	862	930	1,003	
01-0220	Feira Nova	200	192	177	146	119	98	80	
01-0240	Gararu	804	797	783	748	715	684	653	
01-0260	Gracho Cardoso	328	325	318	303	288	273	260	
01-0310	Itabi	232	229	223	209	195	182	171	
01-0420	Monte Alegre de Sergipe	459	456	450	435	420	406	393	
01-0450	Nossa Senhora da Gloria	925	908	876	801	733	670	613	
01-0540	Poco Redondo	1,307	1,262	1,173	978	816	681	568	
01-0560	Porto da Folha	1,591	1,570	1,529	1,432	1,341	1,255	1,175	
02-0140	Carira	843	844	845	847	850	852	855	
02-0230	Frei Paulo	574	575	577	583	588	594	599	
02-0445	Nossa Senhora Aparecida	618	599	561	479	409	349	297	
02-0500	Pedra Mole	148	150	153	163	174	185	197	
02-0520	Pinhao	206	205	202	195	189	182	176	
02-0600	Ribeiropolis	566	554	529	474	424	379	339	
03-0020	Aquidaba	903	902	901	898	895	892	889	
03-0190	Cumbe	155	154	153	151	149	147	144	
03-0380	Malhada dos Bois	163	163	164	166	168	170	172	
03-0430	Muribeca	435	432	426	412	398	384	371	
03-0460	Nossa Senhora das Dores	834	822	800	747	697	651	607	
03-0700	Sao Miguel do Aleixo	187	185	180	169	158	148	139	
04-0050	Areia Branca	852	881	938	1,101	1,292	1,517	1,780	
04-0100	Campo do Brito	859	853	842	815	789	764	739	
04-0290	Itabaiana	2,525	2,529	2,538	2,561	2,584	2,606	2,630	
04-0370	Macambira	363	384	385	389	393	397	401	
04-0390	Malhador	651	662	682	737	796	860	929	
04-0410	Moita Bonita	744	751	764	797	831	867	905	
04-0680	Sao Domingos	480	477	473	461	450	439	429	
05-0550	Poco Verde	897	877	837	745	663	591	526	
05-0710	Simao Dias	1,936	1,926	1,905	1,853	1,803	1,754	1,707	
05-0740	Tobias Barreto	1,633	1,630	1,625	1,613	1,601	1,588	1,576	
06-0350	Lagarto	4,170	4,172	4,176	4,186	4,196	4,206	4,216	
06-0580	Riachao do Dantas	1,474	1,480	1,494	1,528	1,563	1,598	1,635	
07-0010	Amparo de Sao Francisco	91	91	92	94	97	99	101	
07-0070	Brejo Grande	318	314	306	287	269	253	237	
07-0110	Canhoba	255	253	250	243	237	230	224	
07-0160	Cedro de Sao Joao	119	120	121	125	128	132	135	
07-0270	Ilha das Flores	432	435	441	456	472	488	506	
07-0440	Neopolis	738	702	628	481	368	281	215	
07-0470	Nossa Senhora de Lourdes	308	313	322	345	370	397	426	
07-0570	Propria	331	331	331	332	332	332	333	
07-0730	Telha	164	168	176	197	220	247	276	
07-9999	Santana de Sao Francisco	197	188	168	129	98	75	58	
08-0130	Capela	1,073	1,071	1,065	1,051	1,037	1,024	1,011	
08-0200	Divina Pastora	122	123	125	132	138	146	153	
08-0650	Santa Rosa de Lima	145	141	134	117	103	90	79	
08-0720	Siriri	440	444	452	472	494	516	540	
09-0330	Japaratuba	728	731	735	746	757	769	781	
09-0340	Japota	725	720	709	683	658	634	610	
09-0490	Pacatuba	932	922	901	853	807	764	723	
09-0530	Pirambu	270	278	292	331	376	427	485	
09-0690	Sao Francisco	57	58	61	67	74	82	90	
10-0150	Carmopolis	140	138	135	128	121	114	108	
10-0250	General Maynard	91	92	94	100	106	112	119	
10-0360	Laranjeiras	202	190	164	116	82	58	41	
10-0400	Marum	381	382	384	388	393	398	403	
10-0590	Riachuelo	178	172	159	131	108	89	73	
10-0610	Rosario do Catete	122	121	120	118	116	114	112	
10-0660	Santo Amaro das Brotas	243	234	217	180	149	123	102	
11-0030	Aracaju	0	0	0	0	0	0	0	
11-0060	Barra dos Coqueiros	913	999	1,171	1,772	2,683	4,062	6,149	
11-0480	Nossa Senhora do Socorro	73	75	81	97	115	138	165	
11-0670	Sao Cristovao	174	181	195	235	284	343	414	
12-0040	Araua	693	688	678	654	631	609	587	
12-0067	Boquim	955	943	918	858	802	750	701	
12-0170	Cristinapolis	812	848	921	1,136	1,401	1,728	2,131	
12-0300	Itabaianinha	1,993	1,997	2,005	2,026	2,046	2,067	2,088	
12-0510	Pedrinhas	253	252	252	250	249	247	246	
12-0620	Salgado	1,371	1,370	1,369	1,366	1,363	1,360	1,357	
12-0750	Tomar do Geru	936	948	973	1,038	1,107	1,181	1,260	
12-0760	Umbauba	780	799	835	935	1,047	1,173	1,313	
13-0210	Estancia	1,187	1,223	1,294	1,494	1,726	1,993	2,301	
13-0280	Indiaroba	815	816	818	825	831	838	845	
13-0320	Itaporanga d'Ajuda	1,247	1,225	1,181	1,078	985	899	821	
13-0630	Santa Luzia do Itanhay	923	938	967	1,046	1,130	1,222	1,321	
01- Sergipana do Sertao do Sao Francisco		6,554	6,459	6,270	5,850	5,489	5,180	4,916	
02- Carira		2,954	2,925	2,868	2,741	2,633	2,541	2,464	
03- Nossa Senhora das Dores		2,676	2,658	2,624	2,542	2,464	2,391	2,322	
04- Agreste de Itabaiana		6,495	6,537	6,623	6,861	7,135	7,450	7,812	
05- Tobias Barreto		4,466	4,433	4,367	4,211	4,067	3,933	3,809	
06- Agreste de Lagarto		5,644	5,653	5,670	5,714	5,758	5,804	5,850	
07- Propria		2,954	2,914	2,836	2,689	2,592	2,535	2,511	
08- Cotinguiba		1,780	1,778	1,776	1,772	1,773	1,776	1,782	
09- Japaratuba		2,713	2,708	2,698	2,680	2,672	2,674	2,688	
10- Baixo Cotinguiba		1,357	1,329	1,273	1,160	1,074	1,008	957	
11- Aracaju		1,160	1,255	1,447	2,104	3,083	4,543	6,728	
12- Boquim		7,794	7,846	7,951	8,263	8,646	9,114	9,682	
13- Estancia		4,172	4,201	4,261	4,443	4,672	4,954	5,288	
Sertao Sergipano (01-02)		9,508	9,385	9,138	8,591	8,122	7,721	7,380	
Agreste Sergipano (03-06)		19,280	19,281	19,283	19,328	19,425	19,578	19,793	
Leste Sergipano (07-13)		21,929	22,033	22,241	23,112	24,511	26,601	29,636	
Sergipe		50,717	50,699	50,662	51,031	52,057	53,900	56,809	

Appendix-2 (3) Projected Domestic Water Demand of Sergipe in Urban and Rural Area

Unit: m³/day

Code	Name of Municipality and Region	Trend Scenario						Strategic Scenario					
		1997	1998	2000	2005	2010	2015	2020	2000	2005	2010	2015	2020
01-0120	Caninde de Sao Francisco	2,012	2,071	2,188	2,519	2,907	3,361	3,893	2,188	3,660	5,152	6,760	8,571
01-0220	Feira Nova	660	682	728	982	1,252	1,556	1,910	728	982	1,252	1,556	1,910
01-0240	Gararu	1,205	1,201	1,194	1,161	1,142	1,135	1,140	1,194	1,161	1,142	1,135	1,140
01-0260	Gracho Cardoso	666	670	679	695	723	762	814	679	695	723	762	814
01-0310	Itabi	653	656	660	659	672	697	735	660	659	672	697	735
01-0420	Monte Alegre de Sergipe	1,391	1,411	1,452	1,549	1,674	1,830	2,025	1,452	1,549	1,674	1,830	2,025
01-0450	Nossa Senhora da Gloria	3,457	3,505	3,601	3,879	4,210	4,598	5,050	3,601	4,393	5,254	6,235	7,389
01-0540	Poco Redondo	2,284	2,285	2,288	2,430	2,631	2,905	3,267	2,288	2,430	2,631	2,905	3,267
01-0560	Porto da Folha	2,874	2,881	2,895	2,913	2,975	3,083	3,244	2,895	2,913	2,975	3,083	3,244
02-0140	Carira	2,263	2,307	2,397	2,644	2,931	3,270	3,675	2,397	2,644	2,931	3,270	3,675
02-0230	Frei Paulo	1,550	1,589	1,669	1,923	2,205	2,528	2,906	1,669	1,923	2,205	2,528	2,906
02-0445	Nossa Senhora Aparecida	932	930	926	974	1,043	1,138	1,265	926	974	1,043	1,138	1,265
02-0500	Podra Mole	300	305	316	340	369	401	445	316	340	369	401	445
02-0520	Pinhao	659	671	696	761	839	934	1,050	696	761	839	934	1,050
02-0600	Ribeiropolis	2,034	2,061	2,114	2,250	2,434	2,674	2,979	2,114	2,250	2,434	2,674	2,979
03-0020	Aquidaba	2,325	2,361	2,434	2,611	2,830	3,097	3,423	2,434	2,611	2,830	3,097	3,423
03-0190	Cumbe	485	491	504	531	568	615	675	504	531	568	615	675
03-0380	Malhada dos Bois	384	396	421	520	624	740	874	421	520	624	740	874
03-0430	Muribeca	870	878	893	926	973	1,035	1,114	893	926	973	1,035	1,114
03-0460	Nossa Senhora das Dores	2,849	2,885	2,958	3,120	3,344	3,638	4,012	2,958	3,120	3,344	3,638	4,012
03-0700	Sao Miguel do Aleixo	393	393	393	385	385	391	403	393	385	385	391	403
04-0050	Areia Branca	1,939	2,087	2,383	4,459	6,569	8,849	11,423	2,383	4,459	6,569	8,849	11,423
04-0100	Campo do Brito	1,995	2,066	2,209	2,922	3,662	4,476	5,410	2,209	2,922	3,662	4,476	5,410
04-0290	Itabaiana	10,489	10,763	11,309	12,861	14,680	16,813	19,314	11,309	14,575	18,036	21,889	26,331
04-0370	Macambira	671	686	717	831	952	1,088	1,245	717	831	952	1,088	1,245
04-0390	Malhador	1,406	1,427	1,470	1,556	1,669	1,809	1,976	1,470	1,556	1,669	1,809	1,976
04-0410	Moita Bonita	1,243	1,269	1,321	1,479	1,653	1,849	2,074	1,321	1,479	1,653	1,849	2,074
04-0680	Sao Domingos	1,104	1,129	1,179	1,357	1,551	1,774	2,036	1,179	1,357	1,551	1,774	2,036
05-0550	Poco Verde	2,351	2,368	2,402	2,486	2,623	2,817	3,079	2,402	2,486	2,623	2,817	3,079
05-0710	Simao Dias	4,433	4,498	4,626	4,975	5,397	5,910	6,538	4,626	4,975	5,397	5,910	6,538
05-0740	Tobias Barreto	5,773	5,892	6,128	6,750	7,491	8,379	9,453	6,128	6,750	7,491	8,379	9,453
06-0350	Lagarto	9,973	10,083	10,302	10,892	11,536	12,241	13,011	10,302	12,399	14,636	17,136	20,028
06-0580	Riachao do Dantas	2,107	2,133	2,185	2,321	2,477	2,656	2,865	2,185	2,321	2,477	2,656	2,865
07-0010	Amparo de Sao Francisco	275	278	285	296	312	334	362	285	296	312	334	362
07-0070	Brejo Grande	928	935	949	970	1,009	1,069	1,150	949	970	1,009	1,069	1,150
07-0110	Canhoba	490	492	496	498	507	523	547	496	498	507	523	547
07-0160	Cedro de Sao Joao	765	765	768	748	747	762	790	768	748	747	762	790
07-0270	Ilha das Flores	1,003	1,017	1,046	1,106	1,184	1,279	1,396	1,046	1,106	1,184	1,279	1,396
07-0440	Neopolis	2,340	2,431	2,615	3,324	4,439	6,109	8,559	2,615	4,338	6,118	8,074	10,313
07-0470	Nossa Senhora de Lourdes	712	734	779	925	1,085	1,264	1,471	779	925	1,085	1,264	1,471
07-0570	Propria	4,014	4,043	4,103	4,257	4,416	4,583	4,756	4,103	4,534	5,066	5,716	6,510
07-0730	Telha	313	320	333	363	400	445	498	333	363	400	445	498
07-9999	Santana de Sao Francisco	841	883	967	1,510	2,075	2,698	3,412	967	1,510	2,075	2,698	3,412
08-0130	Capela	3,578	3,601	3,648	3,770	3,899	4,036	4,181	3,648	4,096	4,610	5,214	5,936
08-0200	Divina Pastora	396	402	413	435	465	504	552	413	435	465	504	552
08-0650	Santa Rosa de Lima	459	461	467	475	494	525	568	467	475	494	525	568
08-0720	Sitiri	875	891	923	1,003	1,097	1,206	1,336	923	1,003	1,097	1,206	1,336
09-0330	Japarutuba	1,827	1,848	1,891	2,006	2,131	2,266	2,412	1,891	2,182	2,501	2,865	3,289
09-0340	Japota	1,292	1,293	1,295	1,279	1,281	1,300	1,335	1,295	1,279	1,281	1,300	1,335
09-0490	Pacatuba	1,286	1,282	1,273	1,255	1,241	1,233	1,230	1,273	1,255	1,241	1,233	1,230
09-0530	Pirambu	850	891	973	1,301	1,649	2,036	2,479	973	1,301	1,650	2,036	2,479
09-0690	Sao Francisco	376	385	402	442	493	554	629	402	442	493	554	629
10-0150	Carmopolis	1,211	1,251	1,332	1,593	1,884	2,220	2,617	1,332	1,593	1,884	2,220	2,617
10-0250	General Maynard	336	342	356	386	423	469	525	356	386	423	469	525
10-0360	Laranjeiras	3,397	3,508	3,730	4,470	5,313	6,297	7,467	3,730	4,470	5,313	6,297	7,467
10-0400	Maruim	2,114	2,108	2,096	2,001	1,958	1,953	1,979	2,096	2,001	1,958	1,953	1,979
10-0590	Riachuelo	1,160	1,174	1,204	1,266	1,362	1,493	1,664	1,204	1,266	1,362	1,493	1,664
10-0610	Rosario do Catete	1,021	1,057	1,130	1,373	1,640	1,945	2,304	1,130	1,373	1,640	1,945	2,304
10-0660	Santo Amaro das Brotas	1,485	1,477	1,462	1,381	1,343	1,340	1,368	1,462	1,381	1,343	1,340	1,368
11-0030	Aracaju	83,500	85,758	90,273	102,805	117,076	131,850	151,837	90,273	92,532	97,388	104,628	114,380
11-0060	Barra dos Coqueiros	2,241	2,352	2,574	3,270	4,313	5,865	8,172	2,574	3,270	4,313	5,865	8,172
11-0480	Nossa Senhora do Socorro	17,490	18,147	19,459	22,281	26,341	33,174	39,629	19,459	22,691	26,430	30,830	36,085
11-0670	Sao Cristovao	9,303	9,492	9,872	10,639	11,683	13,018	14,691	9,872	10,639	11,683	13,018	14,691
12-0040	Araua	1,339	1,348	1,364	1,394	1,444	1,515	1,609	1,364	1,394	1,444	1,515	1,609
12-0067	Boquim	3,334	3,372	3,447	3,595	3,817	4,117	4,508	3,447	3,595	3,817	4,117	4,508
12-0170	Cristinapolis	1,684	1,736	1,839	2,108	2,453	2,885	3,423	1,839	2,108	2,453	2,885	3,423
12-0300	Itabaianinha	4,218	4,275	4,387	4,644	4,967	5,361	5,843	4,387	4,644	4,967	5,361	5,843
12-0510	Pedrinhas	1,157	1,179	1,224	1,332	1,465	1,629	1,830	1,224	1,332	1,465	1,629	1,830
12-0620	Salgado	2,132	2,168	2,241	2,511	2,802	3,129	3,510	2,241	2,511	2,802	3,129	3,510
12-0750	Tomar do Geru	1,545	1,582	1,656	1,881	2,129	2,406	2,724	1,656	1,881	2,129	2,406	2,724
12-0760	Umbauba	2,295	2,354	2,472	2,774	3,132	3,556	4,058	2,472	2,774	3,132	3,556	4,058
13-0210	Estancia	8,555	8,637	8,802	9,240	9,717	10,238	10,808	8,802	10,072	11,573	13,351	15,486
13-0280	Indiaroba	1,488	1,497	1,516	1,539	1,582	1,644	1,726	1,516	1,539	1,582	1,644	1,726
13-0320	Itaporanga d'Ajuda	2,574	2,589	2,618	2,718	2,857	3,036	3,260	2,618	3,262	3,942	4,706	5,599
13-0630	Santa Luzia do Itanhuy	1,298	1,328	1,387	1,563	1,756	1,972	2,216	1,387	1,563	1,756	1,972	2,216
01 - Sergipana do Sertao do Sao Francisco		15,201	15,362	15,684	16,789	18,185	19,927	22,078	15,684	18,443	21,475	24,963	29,095
02 - Carira		7,738	7,865	8,118	8,892	9,821	10,947	12,321	8,118	8,892	9,821	10,947	12,321
03 - Nossa Senhora das Dores		7,305	7,404	7,602	8,094	8,724	9,515	10,500	7,602	8,094	8,725	9,515	10,500
04 - Agreste de Itabaiana		18,848	19,428	20,587	25,465	30,736	36,658	43,479	20,587	27,179	34,093	41,734	50,496
05 - Tobias Barreto		12,558	12,757	13,156	14,211	15,511	17,106	19,069	13,156	14,211	15,511	17,106	19,069
06 - Agreste de Lagarto		12,080	12,216	12,487	13,213	14,013	14,897	15,876	12,487	14,721	17,113	19,793	22,894
07 - Propria		11,681	11,900	12,339	13,997	16,175	19,066	22,940	12,339	15,287	18,505	22,165	26,448
08 - Cotinguiba		5,308	5,355	5,450	5,683	5,955	6,271	6,637	5,450	6,008	6,666	7,449	8,392
09 - Japarutuba		5,631	5,699	5,834	6,284	6,796	7,389	8,085	5,834	6,658	7,568	8,611	9,839
10 - Baixo Cotinguiba		10,722	10,918	11,309	12,469	13,923	15,718	17,924	11,309	12,469	13,924	15,71	

APPENDIX-3

Distribution of Workers by Type of Industry and by Municipality: 1991/92

Appendix-3 (1) Distribution of Workers by Type of Industry and by Municipality: 1991/92

Code	Name of Municipality	Traditional Industry										
		Mining	Wood	Furniture	Leather	Textile	Apparel	Food	Beverage	Tobacco	Printing	Others
01-0120	Caninde do Sao Francisco		1	2			3	24				
01-0220	Feira Nova							3				
01-0240	Gararu							6				
01-0260	Gracho Cardoso							2				
01-0310	Itabi							6				
01-0420	Monte Alegre de Sergipe							17				
01-0450	Nossa Senhora da Gloria			1				100				
01-0540	Poco Redondo							13				
01-0560	Porto da Folha			8				18				
02-0140	Carira							37				
02-0230	Frei Paulo					95		49	1			
02-0445	Nossa Senhora Aparecida			2				8				
02-0500	Pedra Mole											
02-0520	Pinhao											
02-0600	Ribetropolis			1		11		16				
03-0020	Aquidaba			5				19				
03-0190	Cumbe							3				
03-0380	Malhada dos Bois							3				
03-0430	Muribeca							8				
03-0460	Nossa Senhora das Dores							43				
03-0700	Sao Miguel do Aleixo							11				
04-0050	Areia Branca		2					12				
04-0100	Campo do Brito		6	13			3	39				
04-0290	Itabaiana	1	57	5		60	26	152				17
04-0370	Macambira							2				
04-0390	Malhador		8					5				
04-0410	Moita Bonita		9					9				
04-0680	Sao Domingos							8				
05-0550	Poco Verde		2		1			16				
05-0710	Simao Dias					1		51				
05-0740	Tobias Barreto		4		8	5	27	50				7
06-0350	Lagarto		4	32	3	2	39	315		117	21	
06-0580	Riachao do Dantas							12	1			
07-0010	Amparo de Sao Francisco											
07-0070	Brejo Grande							5				
07-0110	Canhoba											
07-0160	Cedro de Sao Joao							14				
07-0270	Ilha das Flores		3	5				17				
07-0440	Neopolis		3	4		701	1	39				
07-0470	Nossa Senhora de Lourdes							7				
07-0570	Propria	8	6	1			7	113	6			10
07-0730	Telha											
08-0130	Capela		2					355	22			
08-0200	Divina Pastora											
08-0650	Santa Rosa de Lima							2				
08-0720	Siriri							6				
09-0330	Japarutuba		7	8				16				
09-0340	Japoata							11				
09-0490	Pacatuba							8				
09-0530	Pirambu	2						16				
09-0690	Sao Francisco							4				
10-0150	Carmopolis							11				
10-0250	General Maynard							6				
10-0360	Laranjeiras							756				
10-0400	Maruim		3			316	1	7	5			
10-0590	Riachuelo					522						
10-0610	Rosario do Catete							1				
10-0660	Santo Amaro das Brotas							4				
11-0030	Aracaju	3,113	79	444	21	2,221	4,223	2,335	455		719	344
11-0060	Barra dos Coqueiros						1	20				
11-0480	Nossa Senhora do Socorro		9	5		371	44	233			1	3
11-0670	Sao Cristovao		2	2			15	98	24			
12-0040	Arara						7	89	3			
12-0067	Boquim			14			1	82				
12-0170	Cristinapolis							13				
12-0300	Itabaianinha		1					22	2			
12-0510	Pedrinhas		4					14				
12-0620	Salgado							22	4			
12-0750	Tomar do Geru							12				
12-0760	Umbauba		29	12				19				
13-0210	Estancia		25	32		1,202	7	832			23	7
13-0280	Indiaroba							9				
13-0320	Itaporanga d'Ajuda		2	5			385	13				
13-0630	Santa Luzia do Itanhy		5					4				
01- Sergipana do Sertao do Sao Francisco			1	11			3	189				
02- Carira				3		106		110	1			
03- Nossa Senhora das Dores				5				87				
04- Agreste de Itabaiana		1	82	18		60	29	227				17
05- Tobias Barreto			6		9	6	27	117				7
06- Agreste de Lagarto			4	32	3	2	39	327	1	117	21	
07- Propri		8	12	10		701	8	195	6			10
08- Cotinguiba			2					363	22			
09- Japarutuba		2	7	8				55				
10- Baixo Cotinguiba			3			838	1	785	5			
11- Aracaju		3,113	88	451	21	2,592	4,283	2,686	479	0	720	347
12- Boquim			34	26			8	273	9			
13- Estancia			32	37		1,202	392	858			23	7
Sertao Sergipano (01-02)			1	14		106	3	299	1			
Agreste Sergipano (03-06)		1	92	55	12	68	95	758	1	117	45	
Leste Sergipano (07-13)		3,123	178	532	21	5,333	4,692	5,215	521	0	753	354
Sergipe		3,124	271	601	33	5,507	4,790	6,272	523	117	798	354

Source: Cadastro Industrial Sergipe 1991/2, SEICT, CODISE and SEBRAE

Appendix-3 (2) Distribution of Workers by Type of Industry and by Municipality: 1991/92

Code	Name of Municipality	Modern Industry											Supporting Services Industry	Total	
		Non-Metallic	Metal	Machinery	Electric Materials	Transport Materials	Paper Products	Rubber Products	Chemical Products	Medicinal Products	Perfume, Soap, etc.	Plastic Products			Construction
01-0120	Caninde do Sao Francisco	4	4										6,358		6,396
01-0220	Feira Nova														3
01-0240	Gararu														6
01-0260	Gracho Cardoso														2
01-0310	Itabi														6
01-0420	Monte Alegre de Sergipe												4		21
01-0450	Nossa Senhora da Gloria	4											3		108
01-0540	Poco Redondo												2		15
01-0560	Povo da Folha	2											2		30
02-0140	Carira	2											1		40
02-0230	Frei Paulo														145
02-0445	Nossa Senhora Aparecida												1		11
02-0500	Pedra Mole														0
02-0520	Pinhao														0
02-0600	Ribeiropolis														28
03-0020	Aquidaba	1													25
03-0190	Cumbe														3
03-0380	Malhada dos Bois														3
03-0430	Muribeca														8
03-0460	Nossa Senhora das Dores												1		44
03-0700	Sao Miguel do Aleixo														11
04-0050	Areia Branca												1	64	79
04-0100	Campo do Brito	3				1						3			68
04-0290	Itabaiana	331	24		13	143		27			6	2	1		865
04-0370	Macambira														2
04-0390	Malhador												1		14
04-0410	Moita Bonita														18
04-0680	Sao Domingos												3		11
05-0550	Poco Verde												12		31
05-0710	Simao Dias	158											9		219
05-0740	Tobias Barreto	6	6												113
06-0350	Lagarto	36	21	6		7			9		4	152	3	24	795
06-0580	Riachao do Dantas														13
07-0010	Amparo de Sao Francisco														0
07-0070	Brejo Grande														5
07-0110	Canhoba														0
07-0160	Cedro de Sao Joao														14
07-0270	Iha das Flores														25
07-0440	Neopolis	41							94						883
07-0470	Nossa Senhora de Lourdes														7
07-0570	Propria	8	3										175		337
07-0730	Telha														0
08-0130	Capela	17	2										1	25	424
08-0200	Divina Pastora	21													21
08-0650	Santa Rosa de Lima														2
08-0720	Siriri	80													86
09-0330	Japaratuba												1		32
09-0340	Japoata		3												14
09-0490	Pacatuba	78													86
09-0530	Pirambu												4		22
09-0690	Sao Francisco												1		5
10-0150	Carmopolis													6	17
10-0250	General Maynard														6
10-0360	Laranjeiras	378							446				2		1,582
10-0400	Maruim	41							55				89		517
10-0590	Riachuelo														522
10-0610	Rosario do Catete								572				1	44	618
10-0660	Santo Amaro das Brotas												107		111
11-0030	Aracaju	805	291	151	83	73	59	44	96	13	48	45	7,360	4,227	27,249
11-0060	Barra dos Coqueiros					132									153
11-0480	Nossa Senhora do Socorro	140	25	10		2	6	60	13		2		119	155	1,198
11-0670	Sao Cristovao	45	1								7		2	24	218
12-0040	Araua														99
12-0067	Boquim		3												100
12-0170	Cristinapolis												5		18
12-0300	Itabaianinha	228	3												256
12-0510	Pedrinhas														18
12-0620	Salgado	3													29
12-0750	Tomar do Geru	5											3		20
12-0760	Umbauba	37	13										69		179
13-0210	Estancia	51	51		49			23	7					296	2,605
13-0280	Indiaroba														9
13-0320	Itaporanga d'Ajuda														405
13-0630	Santa Luzia do Itanhy														9
01- Sergipana do Sertao do Sao Francisco		10	4										6,369		6,587
02- Carira		2											2		224
03- Nossa Senhora das Dores		1											1		94
04- Agreste de Itabaiana		334	24		13	144		27			6		10	65	1,057
05- Tobias Barreto		164	6										21		363
06- Agreste de Lagarto		36	21	6		7			9		4	152	3	24	808
07- Propri		49	3						94				175		1,271
08- Cotinguiba		118	2										1	25	533
09- Japaratuba		78	3										6		159
10- Baixo Cotinguiba		419							1,073				199	50	3,373
11- Aracaju		990	317	161	83	207	65	104	109	13	57	45	7,481	4,406	28,818
12- Boquim		273	19										77		719
13- Estancia		51	51		49			23	7					296	3,028
Sertao Sergipano (01-02)		12	4										6371		6,811
Agreste Sergipano (03-06)		535	51	6	13	151		27	9		10	152	35	89	2,322
Leste Sergipano (07-13)		1,978	395	161	132	207	65	127	1,283	13	57	45	7,939	4,777	37,901
Sergipe		2,525	450	167	145	358	65	154	1,292	13	67	197	14,345	4,866	47,034

APPENDIX-4

Average Unit Rates of Industrial Production by Type of Industry

Appendix-4 Average Unit Rates of Industrial Production by Type of Industry

No. Type of Industry	Sample Number of Establishments	Employees (Persons)	Per Establishment				Consumption (m ³ /day)	Water Use Replenishment (m ³ /day)	Value Added (Yen Million)	Production (Yen Mil /Person)	Per Employee		Water Recirculation Rate %	Building to Land Area Ratio %	Effluent to Replenishment Water Ratio %
			Production (Yen Million)	Factory Site Area (m ²)	Factory Built Area (m ²)	Total Floor Area (m ²)					Production (Yen Mil /Person)	Factory Site Area (m ² /Person)			
Traditional Industry															
Wood	1,143	68	1,756	21,406	5,545	6,175	63	53	580	26	315	0.8	15.9	25.9	54.4
Furniture	1,222	79	1,968	12,886	4,695	6,133	46	41	792	25	163	0.5	10.9	36.4	48.8
Leather	411	72	1,395	5,604	1,778	2,448	60	57	515	19	78	0.8	5.0	31.7	70.8
Textile	3,249	89	1,584	16,668	6,374	7,714	978	776	581	18	187	8.7	20.7	38.2	38.8
Apparel	4,181	70	584	3,607	1,173	1,574	16	16	272	8	52	0.2	0.0	32.5	39.2
Food	7,034	99	2,464	12,014	3,285	4,545	597	369	861	25	121	5.7	38.2	27.3	36.7
Beverage	564	105	10,156	40,235	12,619	17,157	1,860	1,351	3,236	97	385	12.9	27.4	51.4	48.2
Tobacco	35	268	67,568	85,383	33,460	54,760	752	709	7,491	252	319	2.6	5.7	39.2	31.5
Printing	2,976	102	3,137	3,494	1,490	3,075	70	33	1,538	31	34	0.3	52.9	42.6	13.2
Others	1,297	89	2,582	9,890	3,083	4,275	141	64	1,030	29	111	0.7	54.6	31.2	26.2
Modern Industry															
Non-Metallic	2,865	89	2,362	37,424	7,676	9,397	1,227	348	1,166	27	420	3.9	71.6	20.5	21.1
Metal	4,639	87	2,472	15,592	5,328	6,419	229	125	993	28	179	1.4	45.4	34.2	33.1
Machinery	6,130	131	4,389	20,411	6,315	7,844	288	96	1,667	34	156	0.7	66.7	30.9	12.5
Electric Materials	9,771	166	5,258	13,100	3,710	5,702	555	156	1,888	32	79	0.9	71.9	28.3	13.9
Transport Materials	3,345	243	13,477	41,307	13,101	15,812	3,665	276	3,474	55	170	1.1	92.5	31.7	36.9
Paper Products	1,841	99	3,954	29,851	8,583	11,289	8,565	4,853	1,323	40	502	49.0	43.3	28.8	83.3
Rubber Products	831	147	3,686	19,829	7,114	9,007	1,312	310	1,630	25	135	2.1	76.4	35.9	4.6
Chemical Products	721	185	13,704	127,315	17,180	23,220	51,742	7,277	5,526	74	688	39.3	85.9	13.5	5.0
Medicinal Products	557	163	9,006	44,934	7,354	12,879	3,254	1,321	6,003	55	276	8.1	59.4	16.4	11.7
Perfume, Soap, etc.	852	129	7,102	38,253	6,607	10,060	3,428	958	3,384	55	296	7.4	72.1	17.3	11.1
Plastic Products	2,769	92	2,767	16,025	5,024	6,481	843	327	980	30	174	3.6	61.2	31.4	6.1

Source: Research Report of Unit Rate for Industrial Location in Japan, March 1993, Japan Industrial Location Center (Establishments Having More Than 30 Employees in 1992 in Japan)

APPENDIX-5

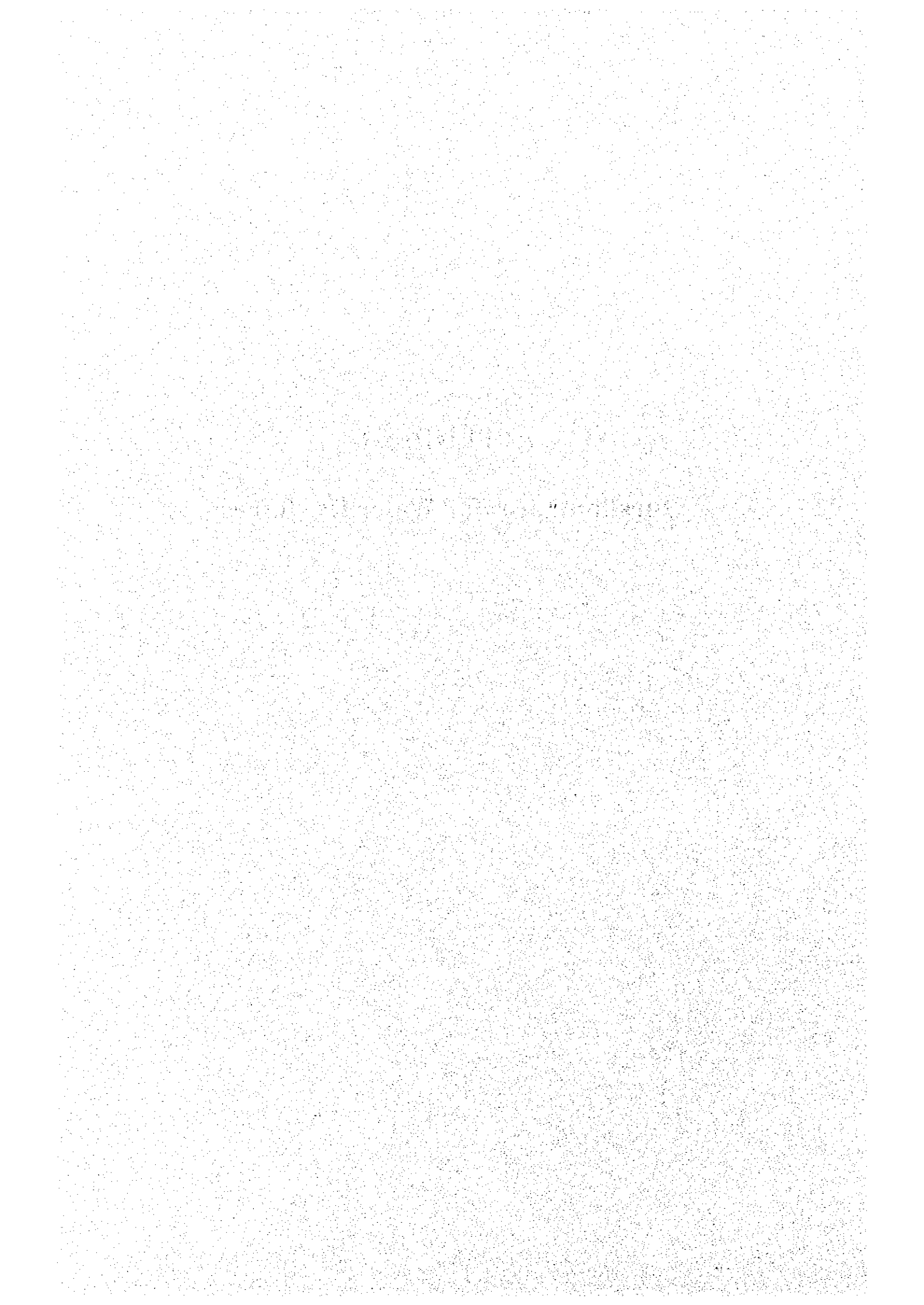
Projected Industrial Water Demand by Trend Scenario and Strategic Scenario

Appendix-5 Projected Industrial Water Demand by Trend Scenario and Strategic Scenario

Code	Name of Municipality and Region	Trend Scenario						Strategic Scenario					Unit: m ³ /day	
		1997	1998	2000	2005	2010	2015	2020	2000	2005	2010	2015		2020
		01-0120	Caninde de Sao Francisco	55	58	64	84	109	140	181	64	1,236		2,977
01-0220	Feira Nova	2	2	2	3	4	5	6	2	3	4	5	7	
01-0240	Gararu	14	15	17	22	29	37	48	17	22	28	36	47	
01-0260	Gracho Cardoso	0	0	0	0	0	0	0	0	0	0	0	0	
01-0310	Itabi	71	75	83	2	2	3	3	83	108	140	181	234	
01-0420	Monte Alegre de Sergipe	458	485	539	702	910	1,177	1,519	539	702	910	1,176	1,517	
01-0450	Nossa Senhora da Gloria	753	797	885	1,154	1,496	1,934	2,495	885	1,729	2,929	4,607	6,917	
01-0540	Poco Redondo	18	19	21	26	34	44	57	21	28	36	47	60	
01-0560	Porto da Folha	44	47	52	69	89	115	149	52	68	88	114	147	
02-0140	Carira	44	47	52	67	88	113	146	52	68	88	114	147	
02-0230	Frei Paulo	192	203	226	293	380	491	634	226	294	381	492	635	
02-0445	Nossa Senhora Aparecida	0	0	0	1	2	2	3	0	0	0	0	0	
02-0500	Pedra Mole	0	0	0	0	0	0	0	0	0	0	0	0	
02-0520	Pinhao	0	0	0	0	0	0	0	0	0	0	0	0	
02-0600	Ribeiropolis	4	4	5	6	8	10	13	5	6	8	10	13	
03-0020	Aquidaba	248	263	292	381	494	639	824	292	380	493	637	822	
03-0190	Cumbe	55	58	64	83	108	140	180	64	83	108	140	180	
03-0380	Malhada dos Bois	0	0	0	0	0	0	0	0	0	0	0	0	
03-0430	Muribeca	0	0	0	0	0	0	0	0	0	0	0	0	
03-0460	Nossa Senhora das Dores	50	53	59	77	100	130	167	59	77	100	130	167	
03-0700	Sao Miguel do Aleixo	0	0	0	0	0	1	1	0	0	0	0	0	
04-0050	Areia Branca	32	34	38	48	63	81	104	38	49	64	83	107	
04-0100	Campo do Brito	178	188	209	271	351	454	586	209	272	353	456	588	
04-0290	Itabaiana	2,384	2,524	2,803	3,651	4,734	6,122	7,898	2,803	5,378	9,035	14,142	21,166	
04-0370	Macambira	10	11	12	15	20	25	33	12	15	20	26	33	
04-0390	Malhador	77	81	90	117	152	196	253	90	117	152	197	254	
04-0410	Moita Bonita	16	17	19	24	30	39	51	19	25	32	41	53	
04-0680	Sao Domingos	121	128	142	185	240	311	401	142	185	240	311	401	
05-0550	Poco Verde	4	4	5	5	6	8	10	5	6	8	10	13	
05-0710	Simao Dias	1,227	1,299	1,443	1,879	2,436	3,150	4,064	1,443	1,879	2,436	3,151	4,064	
05-0740	Tobias Barreto	107	113	126	163	211	273	352	126	164	212	275	354	
06-0350	Lagarto	12,128	12,839	14,261	18,578	24,088	31,150	40,182	14,261	20,297	28,379	39,157	53,433	
06-0580	Riachao do Dantas	2	2	2	4	6	7	10	2	3	4	5	7	
07-0010	Amparo de Sao Francisco	0	0	0	0	0	0	0	0	0	0	0	0	
07-0070	Brejo Grande	12	13	14	19	25	32	41	14	19	24	31	40	
07-0110	Canhoba	0	0	0	0	0	0	0	0	0	0	0	0	
07-0160	Cedro de Sao Jeao	2	2	2	2	3	3	4	2	3	4	5	7	
07-0270	Iha das Flores	10	11	12	15	19	25	32	12	15	20	26	33	
07-0440	Neopolis	3,623	3,836	4,261	5,551	7,197	9,309	11,992	4,261	5,980	8,269	11,308	15,317	
07-0470	Nossa Senhora de Lourdes	8	9	9	13	17	22	28	9	12	16	21	27	
07-0570	Propria	325	344	382	499	647	842	1,079	382	493	647	842	1,079	
07-0730	Telha	6	6	7	8	11	14	18	7	9	12	16	20	
07-9999	Santana de Sao Francisco	20	21	24	30	38	50	64	24	31	40	52	67	
08-0130	Capela	1,316	1,425	1,583	2,061	2,672	3,456	4,458	1,583	2,049	2,749	3,612	4,777	
08-0200	Divina Pastora	115	122	135	176	228	295	380	135	176	228	295	381	
08-0650	Santa Rosa de Lima	8	9	9	13	17	23	29	9	12	16	21	27	
08-0720	Siriri	36	38	43	55	71	92	118	43	56	72	93	120	
09-0330	Japarutuba	2	2	2	4	6	7	9	2	2	2	4	6	
09-0340	Japoata	4	4	5	7	10	13	16	5	6	8	10	13	
09-0490	Pacatuba	1,692	1,791	1,989	2,590	3,360	4,342	5,601	1,989	2,806	3,896	5,345	7,261	
09-0530	Pirambu	2	2	2	2	3	3	4	2	3	4	5	7	
09-0690	Sao Francisco	0	0	0	0	0	0	0	0	0	0	0	0	
10-0150	Carmopolis	388	410	456	590	765	990	1,277	456	593	769	995	1,283	
10-0250	General Maynard	0	0	0	1	2	2	3	0	0	0	0	0	
10-0360	Laranjeiras	56,528	59,843	66,472	85,587	112,267	145,180	187,277	66,472	86,550	112,219	145,118	187,193	
10-0400	Marum	2,297	2,432	2,701	3,520	4,564	5,902	7,613	2,701	3,517	4,560	5,897	7,603	
10-0590	Riachuelo	5,852	6,195	6,882	8,965	11,624	15,031	19,390	6,882	8,960	11,617	15,023	19,373	
10-0610	Rosario do Catele	13,939	14,756	16,391	21,349	27,681	35,796	46,176	16,391	21,341	27,671	35,783	46,151	
10-0660	Santo Amaro das Brotas	79	83	93	119	155	200	258	93	121	156	202	260	
11-0030	Aracaju	57,459	60,828	67,566	88,010	114,112	147,566	190,355	67,566	81,085	96,900	115,944	137,311	
11-0060	Barra dos Coqueiros	182	192	214	278	360	466	601	214	278	361	466	601	
11-0480	Nossa Senhora do Socorro	14,496	15,346	17,046	22,204	28,789	37,229	48,024	17,046	20,456	24,446	29,137	34,641	
11-0670	Sao Cristovao	921	974	1,082	1,410	1,828	2,364	3,049	1,082	1,409	1,827	2,363	3,041	
12-0040	Araua	218	231	256	333	432	559	720	256	332	432	565	717	
12-0067	Boquim	6	6	7	9	12	16	20	7	9	12	16	20	
12-0170	Cristinapolis	22	24	26	33	42	55	71	26	34	44	57	73	
12-0300	Itabaiantina	1,027	1,088	1,208	1,574	2,041	2,639	3,405	1,208	1,573	2,040	2,638	3,401	
12-0510	Pedrinhas	0	0	0	1	1	2	2	0	0	0	0	0	
12-0620	Salgado	18	19	21	27	35	45	59	21	28	36	47	61	
12-0750	Tomar do Geru	50	53	59	78	101	131	168	59	77	100	130	167	
12-0760	Umbauba	28	30	33	44	58	74	96	33	43	56	73	94	
13-0210	Estancia	6,708	7,101	7,888	10,275	13,322	17,227	22,223	7,888	11,423	16,185	22,569	31,061	
13-0280	Indiaroba	2	2	2	3	4	5	6	2	3	4	5	7	
13-0320	Itaporanga d'Ajuda	16,141	17,088	18,981	24,725	32,058	41,456	53,477	18,981	25,289	33,477	44,111	57,871	
13-0630	Santa Luzia do Itanhuy	0	0	0	0	0	0	0	0	0	0	0	0	
01- Sergipana do Sertao do Sao Francisco		1,415	1,498	1,664	2,062	2,673	3,457	4,459	1,664	3,895	7,112	11,655	17,951	
02- Carira		240	254	282	368	477	617	795	282	368	477	617	795	
03- Nossa Senhora das Dores		353	374	415	542	703	909	1,173	415	541	701	907	1,171	
04- Agreste de Itabaiana		2,818	2,983	3,314	4,311	5,590	7,229	9,325	3,314	6,043	9,897	15,257	22,601	
05- Tobias Barreto		1,338	1,417	1,574	2,046	2,653	3,431	4,425	1,574	2,049	2,657	3,436	4,431	
06- Agreste de Lagarto		12,130	12,841	14,264	18,582	24,094	31,157	40,191	14,264	20,300	28,383	39,162	53,441	
07- Propria		4,007	4,242	4,712	6,136	7,956	10,294	13,258	4,712	6,999	10,106	14,298	19,901	
08- Cotinguiba		1,506	1,594	1,771	2,305	2,988	3,865	4,985	1,771	2,738	4,065	5,871	8,301	
09- Japarutuba		1,700	1,799	1,999	2,604	3,378	4,366	5,632	1,999	3,034	4,450	6,369	8,941	
10- Baixo Cotinguiba		79,083	83,720	92,994	121,130	157,057	203,102	261,994	92,994	121,082	156,994	203,019	261,881	
11- Aracaju		73,057	77,341	85,908	111,901	145,089	187,625	242,029	85,908	103,229	123,534	147,461	175,601	
12- Boquim		1,371	1,451	1,612	2,100	2,723	3,521	4,542	1,612	2,097	2,721	3,524	4,531	
13- Estancia		22,851	24,191	26,871	35,003	45,384								

APPENDIX-6

Questionnaires for Water Use Survey



Appendix-6 (1) Questionnaires for Water Use Survey

Questionnaire to Mayor

Mesorregiao (01: Sertao Sergipano, 02: Agreste Sergipano, 03: Leste Sergipano)
 Microrregiao (01, 02, 03, 04, 05, 06, 07, 08, 09, 10, 11, 12, 13)
 Municipality name() code(), NO.(),
 Date of survey; Aug. , 1998 Interviewer; ()
 Interviewee; Name (); Position ()

- 1 Has your municipality already been supplied with water by water projects ?; (01; yes, whole area, 02; yes, part of area, 03; no)
- 1.1 If yes, what kind of water supply system is used for domestic use?;
- | | | share by household | share by inhabitants |
|----|-------------|--------------------|----------------------|
| 01 | private tap | | |
| 02 | public tap | | |
| 03 | others () | | |
- 1.2 Are the inhabitants satisfied with water supply hours?; (01; yes, 02 no)
- 1.2.1 If no, what do they expect?; (01; time extension, 02; time change, 03; others)
- 1.3 Are they satisfied with water quality?; (01;yes, 02; no)
- 1.3.1 If no, what is their requirement?; (01; better sanitary treatment, 02; less impurities, 03; others)
- 1.4 In case of public tap, who will manage the water supply?; (01; all inhabitants of the community, 02; designated person to be changed periodically, 03; others;)
- 1.4.1 Does the person who manages the water supply get any payment?; (01; yes, 02; no)
- 1.4.1.1 If yes, how much?; () Reais/day
- 1.5 Why is water supplied to only part of area?; because of (01; no water project in the area, 02; no requirements from inhabitants, 03; others;)
- 2 As to all inhabitants not supplied with water by water project;
- 2.1 What kind of water do they use for their daily domestic use?; (01; rainwater, 02; river water, 03; own well , 04; neighborhood well, 05; tanker supply, 06; others)
- 2.1.1 In case of wells, are they deep or shallow?; (01; deep, 02; shallow)
- 2.2 Future water project implementation;
- 2.2.1 Is there any plan to establish a new water project here?; (01; yes, 02; no)
- 2.2.2 Are the inhabitants in favor of water supply project to be established here?; (01; yes. 02; no)
- 2.2.2.1 If no, why?; (01; increase of household expenses, 02; satisfied with current situation, 03; others)
- 2.2.2.2 If yes, why?; (01; quality improvement, 02; stable supply, 03; labor hours cut, 04; others)
- 2.2.3 which is desirable for them?; (01; private tap, 02; public tap)
- 2.2.4 How much is desirable for monthly water charges in case of piped water in dwellings? () Reais/ house
- 2.2.5 Can they afford to contribute to the construction and maintenance of the water projects? (01; yes, 02; no)
- 2.2.5.1 If yes; how much is desirable for contribution?;
- 2.2.5.1.1 charges; () Reais/house or head
- 2.2.5.1.2 and/ or labor offering; days (01; less than 1 week, 02; more than 1 week),
- 2.2.5.1.3 preferable months for labor; (01; 02; 03;)
- 3 Are there any particular agreements among users of river water and well water ?; (01; yes, 02; no)
- 3.1 If yes, are there water users associations?; (01; yes, 02; no)
- 3.2 How many associations are there in your municipality?; ()
- 3.3 How is the chairman selected?; (01; election by members, 02; election by users, 03; designation, 04; others)
- 3.4 Number of members
- | | name of association | number of members | (number of women included) |
|---|---------------------|-------------------|----------------------------|
| 1 | | | |
| 2 | | | |
| 3 | | | |
- 3.5 Implementation bodies of water supply in your municipality; ()

Appendix-6 (2) Questionnaires for Water Use Survey

Questionnaire to Urban Inhabitants

Mesorregiao (01: Sertao Sergipano, 02: Agreste Sergipano, 03: Leste Sergipano)

Microrregiao (01, 02, 03, 04, 05, 06, 07, 08, 09, 10, 11, 12, 13)

Municipal name () code(), Residence(01: rural, 02: urban)

NO.(), Date of survey; Aug. , 1998 Interviewer; ()

Interviewee; Name (01: head of household, 02: spouse, 03: parent or others) sex(01:M, 02:F) age()

- 1 Have you already been supplied with water by water project?; (01; yes, 02; no)
- 1.1 If yes, what kind of water supply system do you use for your domestic use ?; (01; private tap, 02; public tap, 03; well in house, 05; others)
- 2 How much water do you use in a day for daily domestic use?; () liter/house/day
- 3 How many hours in a day is the water supplied here?; (01; 24, 02: less than 24) hours/day
- 4 Are you satisfied with water supply hours?; (01; yes, 02 no)
- 4.1 If no, what do you expect?; (01; time extension, 02; time change, 05; others)
- 5 Are you satisfied with water quality?; (01; yes, 02; no)
- 5.1 If no, what is your requirement?; select one (01; better sanitary treatment, 02; less impurities, 03; others)
- 6 How much is your monthly payment for water use?; () Reais/house
- 7 What is your opinion on current water charges?; (01; moderate, 02; too expensive, 03; too cheap)
- 8 What do you expect from water supply entity in future?; (01; quality improvement, 02; stable supply, 03; others)
- 9 Family structure; total; () persons

		sex	age	occupations, school	educational background
1	head of household				
2	spouse				
3	child				
4	child				
5					
6					
7					
8					

- 10 How are you making your living? (01; employed private comp., 02; employed local government 03; retail sale, 04; self employed, 05; others)
- 11 How much is your monthly income?; () minimum salary/month
- 12 How much does your house spend in a month ?;
- 12.1 Total expenditure; Reais
- 12.2 Expenditure especially for food; Reais
- 12.3 Expenditure especially for water; Reais
- 12.4 How much is your current savings?; () Reais
- 12.5 How much is your current debt?; () Reais

Appendix-6 (3) Questionnaires for Water Use Survey

Questionnaire to Rural Inhabitants

Mesorregiao (01: Sertao Sergipano, 02: Agreste Sergipano, 03: Leste Sergipano)
 Microrregiao (01, 02, 03, 04, 05, 06, 07, 08, 09, 10, 11, 12, 13)
 Municipality name() code(), Residence(01: rural, 02: urban) Village name ()
 NO.(), Date of survey; Aug. , 1998 Interviewer; ()
 Interviewee; Name (01: head of household, 02: spouse, 03: parent or others) sex(01:M, 02:F) age()

- A. Have you already been supplied with water by water projects ?; (01; yes, 02; no)
- 1 If no;
- 1.1 What is your daily water for domestic use?
 (01; rainwater, 02; river water, 03; own well , 04; neighborhood well, 05; tanker supply, 06; others)
- 1.2 How to get it;
- 1.2.1 Who will carry and supply water to house regularly?;
 (01; head of household, 02; spouse, 03; children, 04; others)
- 1.2.2 How many hours do you need to carry to satisfy your everyday water use ?;
- 1.2.2.1 in rainy season; () hours/day
- 1.2.2.2 in dry season ; () hours/day
- 1.2.3 How far is the distance from your house to the water location?;
- 1.2.3.1 in rainy season; () m
- 1.2.3.2 in dry season ; () m
- 1.2.4 What kind of container do you use to carry water?;
 (01; small container, 02; drum, 03; others;)
- 1.3 Own well in dwelling;
- 1.3.1 How much did you pay to construct it?;() times monthly earnings
- 1.3.2 Is your well ?; (01; shallow, 02; deep)
- 1.4 Future implementation of water project ;
- 1.4.1 Are you in favor of water supply project to be established here?; (01; yes, 02; no)
- 1.4.1.1 If no, why?; (01; increase of household expenses, 02; satisfied with current situation, 03; others)
- 1.4.1.2 If yes, which is desirable for you?; (01; private tap, 02; public tap)
- 1.4.2 What do you expect most from the project?;
 (01; quality improvement, 02; stable supply, 03; labor hours cut, 04; others)
- 1.4.3 Are you willing to pay water charges if the project comes true?; (01; yes, 02; no)
- 1.4.3.1 If yes; how much can you afford?
- 1.4.3.1.1 private tap; () Reais/ month/house
- 1.4.3.1.2 or () % out of income
- 1.4.3.1.3 public tap ; () Reais/ month/house
- 1.4.3.1.4 or () % out of income
- 1.4.4 Can you afford to contribute to the construction and maintenance of the water project?
 (01; yes, 02; no)
- 1.4.4.1 If yes; how much can you afford?;
- 1.4.4.1.1 charges; () Reais/house or head
- 1.4.4.1.2 And/ or labor offering; (01; 1, 02; more than 1) persons/day/house
- 1.4.4.1.3 And who does it?; (01; head of household, 02; spouse, 03; children, 04; others)
- 2 If yes;
- 2.1 Since when?; () years before
- 2.2 What kind of water supply system do you use for your domestic use ?;
 (01; private tap, 02; public tap, 03; others)
- 2.3 Contribution to water supply project;
- 2.3.1 Did you pay any contributions when project was implemented?; (01; yes, 02; no)
- 2.3.1.1 If yes,
- 2.3.1.1.1 How much did you pay ?; () Reais
- 2.3.1.1.2 The payment was?; (01; per house, 02; per family size)
- 2.3.1.1.3 And /or did you offer any labor force?;
 (01; a few days, 02; one week, 03; more than one week)/house
- 2.3.1.1.4 And who did it?; (01; head of household, 02; spouse, 03; children, 04; others)

- 2.4 Do you pay any contribution when water project is repaired? (01; yes, 02; no)
 2.4.1 If yes,
 2.4.1.1 How much do you pay ?; () Reais (payment per house or per head)
 2.4.1.2 And /or do you offer any labor force?;
 (01; a few days, 02; one week, 03; more than one week)/house
 2.4.1.3 And who will do it?; (01; head of household, 02; spouse, 03; children, 04; others)
 2.5 How many hours in a day is the water supplied here?;() hours/day
 2.5.1 Are you satisfied with water supply hours?; (01; yes, 02 no)
 2.5.1.1 If no, what do you expect?; (01; time extension, 02; time change, 05; others)
 2.6 How much is your monthly payment for water use?; () Reais/house
 2.6.1 Is a water use meter set up?; (01; yes, 02; no)
 2.6.2 What is your opinion on current water charges?; (01; moderate, 02; too expensive, 03; too cheap)
 2.7 Water supply from public tap;
 2.7.1 Who will regularly carry and supply water to house ?;
 (01; head of household, 02; spouse, 03; children, 04; others)
 2.7.2 How many hours do you need to carry to satisfy your everyday water use?; () hours/day
 2.7.3 How far is the distance from your house to the water location?; () m
 2.7.4 What kind of container do you use to carry water?;
 (01; small container, 02; drum, 03; others;)
 2.8 What do you expect from water supply entities in future?;
 (01; quality improvement, 02; stable supply, 03; labor hours cut, 04; others)
 2.9 Do you use water other than currently supplied water?; (01; yes, 02; no)
 2.9.1 If yes; what do you use?;
 (01; rainwater, 02; well, 03; river water, 04; bottled water, 05; others)

B. To all water users

- 1 How much water do you use in a day?;
 1.1 for daily domestic use?; () liter/house/day
 1.2 for livestock use?; () liter/house/day
 2 Are you satisfied with water quality ?; (01; yes, 02; no)
 2.1 If no, what is your requirement?;
 (01; better sanitary treatment, 02; less impurities 03; others)
 3 Is Any permission required when you use well water?; (01; yes, 02; no)
 3.1 If yes; the name of the managing body of the water use right?; ()
 4 Is there a water users' association in your resident area?; (01; yes, 02; no)
 4.1 If yes, what is the name of association?; ()
 5 Are there any particular agreements among users of well water in your region?; (01; yes, 02; no)
 5.1 If yes; contents of the agreement in brief?;
 1.
 2.
 3.

6 Family structure; total; () persons

		sex	age	occupation, school	educational background
1	head of household				
2	spouse				
3	child				
4	child				
5	child				
6					
7					
8					

7 Work time of family;

	4	6	8	10	12	14	16	18	20	22	24
1											
2											
3											
4											
5											

- 8 Household financial situation
- 8.1 What are you making your living?
(01; agriculture, 02; cattle breeding, 03; fishing, 04; retail sale, 05; employed, 06; others)
- 8.2 In case of farmer, are you ? (01; landowner, 02; tenant farmer, 03 landed farmer)
- 8.2.1 What is your main product ? select one;
(01; orange, 02; corn, 03; beans, 04; sugar cane, 05; vegetables, 06; cattle, 07; poultry, 08 others)
- 8.2.2 Area of your land; () ha
- 8.2.3 When do you irrigate?; months;
(01; Jan., 02; Feb., 03; Mar., 04; Apr., 05; May, 06; June, 07; Jul 08; Aug., 09; Sept., 10; Oct., 11; Nov., 12; Dec.)
- 8.2.4 Average irrigation water volume?; () m³/day
- 8.2.5 Irrigation area?; () ha
- 8.2.6 Is Any permission required when you irrigate?; (01; yes, 02; no)
- 8.2.6.1 If yes; the name of the managing body of the water use right?; ()
- 8.2.7 Is there a water users' association in your resident area?; (01; yes, 02; no)
- 8.2.7.1 If yes, the name of association?; ()
- 8.3 In the case of fisherman, is fishing right required to operate in the river?; (01; yes, 02; no)
- 8.3.1 If yes, the name of managing body of the right?; ()
- 8.4 How much is your monthly income?; () minimum salary/month
- 8.5 How much does your house spend in a month ?;
- 8.5.1 Total expenditure; Reais
- 8.5.2 Expenditure especially for food; Reais
- 8.5.3 Expenditure especially for water; Reais
- 8.6 How much is your current savings?; () Reais
- 8.7 How much is your current debt?; () Reais

Appendix-6 (4) Questionnaires for Water Use Survey

Questionnaire to Manufacturers

Company name: ()
 Company Address: ()
 Interviewee: () Position: ()

I – Company profile

- 1.1 – Number of associates (including directors); ()
- 1.2 – Number of employees (approximate monthly average); ()
- 1.3 – Approximate gross turnover (monthly average); (R\$)
- 1.4 – Monthly production ; ()

Name of the products	Product Unit
01 -	
02 -	
03 -	
04 -	

II – Water use

- 1 – Source**
 - 01 – Public entity
 - 02 – Own private installations

- 2 –Type of source**
 - 01 – Public Net
 - 02 – Deep Well
 - 03 – Shallow well
 - 04 – River, lake or small stream
 - 05 – Others ()

- 3 – Water consumption (average)**
 - 3.1 – Water supplied by public entity; () m³/month
 - 3.2 – Water supplied by private installations; () m³/month

- 4 – Price or Cost of the Water**
 - 4.1 – Water supplied by public entity; () R\$/month
 - 4.2 – Water supplied by private installations; () R\$/month

- 5 – Problems concerning the water if any**
 - 5.1 – Supplied by Public entity
 - (1) Low quality
 - (2) Insufficient quantity
 - (3) Instability of supply
 - (4) High price
 - (5) Others; ()

 - 5.2 – Supplied by private installations
 - (1) Low quality
 - (2) Insufficient quantity
 - (3) Instability of supply
 - (4) Expensive maintenance cost
 - (5) Others; ()

JAPAN INTERNATIONAL COOPERATION AGENCY

**STATE SECRETARIAT OF PLANNING, SCIENCE AND TECHNOLOGY
THE STATE OF SERGIPE, THE FEDERATIVE REPUBLIC OF BRAZIL**

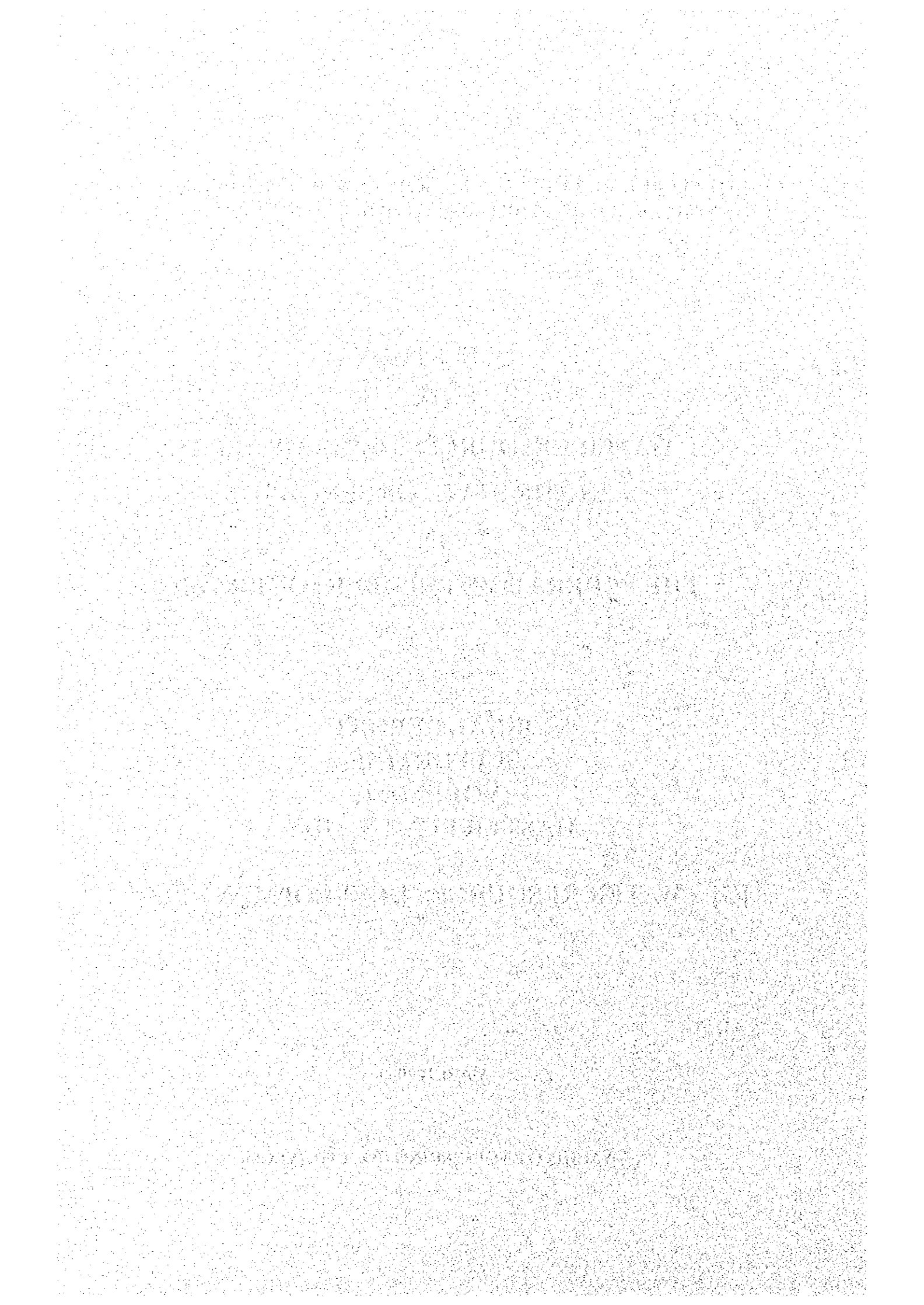
**THE STUDY
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IN
THE FEDERATIVE REPUBLIC OF BRAZIL**

**FINAL REPORT
SUPPORTING
(VOLUME I)
MASTER PLAN STUDY**

[G] WATER RESOURCES DEVELOPMENT PLAN

MARCH 2000

YACHIYO ENGINEERING CO., LTD. (YEC)



**THE STUDY ON WATER RESOURCES DEVELOPMENT
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**SUPPORTING REPORT (G)
WATER RESOURCES DEVELOPMENT PLAN**

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CHAPTER 1 CURRENT CONDITION OF DOMESTIC AND INDUSTRIAL WATER SUPPLY

1.1 Water Supply Institutions and Services

In Sergipe State, main institutions that implement water resources development and supply projects, are the five of DESO, COHIDRO, PRO-SERTAO, CODEVASF and FNS. Table-1.1 clarifies the service areas, service sectors, water sources and water supply facilities. The roles of these five institutions are described as follows:

- **DESO:** Water resources development and domestic and industrial water supply to 70 urban cities and about 200 large rural villages. Most of the systems are private-tap systems, which supply water to each house or building. DESO charges for supplying water on the consumption basis.
- **COHIDRO:** Water resources development and agricultural water supply as well as residential water supply to about 700 small rural villages. Agricultural water (Irrigation, livestock and fishpond etc.) in Sergipe State is mainly developed by COHIDRO. A residential water supply system, which is called as "single well system", consists of a deep well, a pump, a water pipe, a tank and a tap. All the systems are public tap systems, which are used together by villagers. COHIDRO does not charge for supplying water. Construction of watering ponds mainly for livestock and rainfall collecting systems for residential use are also the duties of COHIDRO.
- **PRO-SERTAO:** Residential water supply to rural areas especially in 17 semi-arid municipalities by means of wells and rainfall collecting systems. There are many cooperation works with COHIDRO.
- **CODEVASF:** Agricultural development with water sources created in Sao Francisco River and its tributaries. Domestic water supply is scarcely implemented by CODEVASF.
- **FNS:** Domestic and industrial water supply to specific five municipalities, namely Capela, Siriri, Carmopolis, Estancia and Sao Cristovao, including some rural villages. The water supply system and management are equivalent to the DESO's.

DESO is the largest and responsible institution for domestic and industrial water supply in Sergipe State. As for urban water supply, DESO covers 70 municipalities, 93% of supply amount and 92% of urban population. FNS covers other 5 municipalities, 7% of supply amount and 8% of urban population. As for rural water supply, DESO and FNS cover 225 villages, 8% of supply amount and 21% of rural population. COHIDRO covers 700 villages, 23% of supply amount and 14% of rural population. Residential water in the other rural villages depends on rainfall collecting systems and watering ponds, which mainly constructed by COHIDRO and PRO-SERTAO.

Another institutions concerning with the water sector are CEHOP and DNOCS. CEHOP, which is a state agency, designs and constructs various projects including the water sector and hands over facilities to DESO or COHIDRO etc. after their completion. DNOCS, which is a federal agency, was used to construct many dams for irrigation and domestic water supply a several decades ago. Some of these facilities are still under the management by DNOCS. However it plans to transfer the control to COHIDRO and currently has little activities for the water sector.

On an emergency basis of severe drought, DC (Defesa Civil) delivers potable water by trucks with water tank, according to a request from a municipality. After inspection of drought condition, DC dispatches hiring trucks in order to calm down drought.

Table-1.1 Institutions and Services

Items	Sergipe State Institutions			Federal Institution	
	DESO	COHIDRO	PRO-SERTAO	CODEVASF	FNS
Water Service Area					
- Urban	yes	-	-	-	yes
- Large Rural	yes	yes	-	-	-
- Small Rural	-	yes	yes	-	yes
Service Sector					
- Domestic Water	yes	yes	yes	-	yes
- Industrial Water	yes	-	-	-	yes
- Irrigation Water	-	yes	-	yes	-
Water Source					
- Sao Francisco River	yes	yes	-	yes	-
- River / Weir	yes	yes	-	-	yes
- River / Dam Reservoir	yes	yes	-	yes	-
- Groundwater	yes	yes	yes	-	yes
- Rain Water	-	yes	yes	-	-
Water Supply Facilities					
- Storage Dam	yes	yes	-	yes	-
- Intake with Weir	yes	yes	-	-	yes
- Well & Spring	yes	yes	yes	-	yes
- Elevation Pump	yes	yes	yes	yes	yes
- Pipeline	yes	yes	-	yes	yes
- Water Treatment	yes	yes	-	-	yes
- Desalinizer	-	yes	yes	-	-

1.2 Water Supply Systems and Facilities

1.2.1 Types of Water Sources and Water Supply System

(1) Type of Water Sources

Water sources utilized in Sergipe State are itemized as follows:

- 1) Surface Water: Direct Intake from Sao Francisco River
- 2) Surface Water: Direct Intake from Other Rivers (including weirs)
- 3) Surface Water: Dam reservoir
- 4) Groundwater: Well/Spring
- 5) Rain Water: Rainfall Collecting Cistern

(2) Type of Water Supply System

Water supply systems currently operated in Sergipe State are categorized as a private-tap system and a public-tap system based on utilized form. The former is defined as the system to supply water to each house or building through pipelines, and the latter as the system to supply water in public mainly for villagers. The types of the both systems in Sergipe State are listed as follows:

< Private-tap System: Urban and Large Rural Water Supply >

- 1) Integrated Pipeline System by Sao Francisco River Intake
- 2) Integrated Pipeline System by Dams, Weirs and Wells/Springs
- 3) Independent Pipeline System by Weirs and Wells/Springs in Small Scale

< Public-tap System: Small Rural Water Supply >

- 4) Single Well System
- 5) Rainfall Collecting System

1.2.2 Private-tap System (Urban and Large Rural Water Supply)

(1) Integrated and Independent Water Supply Systems

Private-tap systems in Sergipe State could be divided into Integrated and Independent water supply systems, which are defined as follows:

- **Integrated Water Supply System:** the system supplying water to some municipalities including urban and rural areas
- **Independent Water Supply System:** the system supplying water, in general, to only one municipality including urban and rural areas

There are 86 water supply systems currently operated in Sergipe State. These systems are being operated by DESO and FNS. Of these, seven systems are integrated water supply system and 79 systems are independent pipeline systems.

Of seven integrated water supply systems, the four systems are located in Sertao Sergipano and their water sources depend on Sao Francisco River. The other three systems are located in Agreste Sergipano and their water sources depend on surface and ground water from the southern basins of Vaza Barris and Piaui Rivers. The main specification and their locations are shown in Table-1.2 and Figure-1.1.

Table-1.2 Main Specification of Integrated Water Supply Systems

Systems	Water Sources	Intake Pump Capacity (m ³ /day)	Purification Plant Capacity (m ³ /day)	Water Way Length (km)
Aracaju	Direct Intake: Sao Francisco R.	120,100	162,900	144.0
	Weir: Sergipe R.	66,100		
	Deep Well/Spring: Sergipe R.	29,500		
Itabaianinha	Weir: Piaui R.	500	12,200	24.8
	Spring: Piaui R.	8,200		
Piauitinga	Weir: Piaui R.	12,400	12,500	97.3
	Deep Well: Piaui R.	6,800		
Itabaiana	Cajaiba Dam: Vaza Barris R.	10,000	17,400	48.1
	Weir: Vaza Barris R.	8,900		
	Deep Well: Vaza Barris R.	100		
Propria	Direct Intake: Sao Francisco R.	11,200	11,200	8.9
Sertaneja	Direct Intake: Sao Francisco R.	21,400	30,200	90.7
Alto Sertao	Direct Intake: Sao Francisco R.	24,200	30,200	41.6

79 systems of Independent water supply are mostly located in Sertao Sergipano that is characterized by much rainfall of 1,000-1,600 mm per annum. There are four exceptions of municipalities, such as Poco Verde and Tobias Barreto where are supplied water from Bahia State, further Caninde do Sao Francisco and Gararu where are supplied water by Sao Francisco River. It is noted that rural part of Gararu municipality is supplied water by Sertaneja Integrated Water Supply System.

(2) Water Supply Facilities and Water Sources

A private-tap system consists of intake pump (station), booster pump (station), purification plant, reservoir and pipeline. The number and capacity of these facilities operated in Sergipe State are summarized in Table-1.3. Whole intake pump capacity in Sergipe State, namely present amount of water resources development, is compiled by water sources and river basins, showing in Table-1.4.

Based on this information, water supply facilities and water sources of private-tap system in Sergipe State are characterized as follows:

- Intake capacity of water is 437,580 m³/day (5.1 m³/s) in Sergipe State. The 82% (360,776 m³/day) of this water is purified and supplied. Total reservoir volume (136,475 m³) covers 31% of daily intake amount of water.
- Integrated water supply systems cover 73% of water resources, and independent systems cover 23%. It is noted that rural water supplied by private-tap systems account only for 0.5%.
- As for independent water supply systems, water sources depend mainly on weirs and deep wells accounting for 84%, not on direct intakes of Sao Francisco River with 9%. However, water sources of integrated water supply systems depend on direct intakes of Sao Francisco River and weirs (intake from the other rivers) accounting for 55% and 28% respectively.
- In Sergipe State as a whole, Sao Francisco River occupies important water sources with 43% share. The second is weirs (intake from the other rivers) with 33%. Adding 1% of water sources from a large dam, surface water covers 77% of water sources in Sergipe State. The rest of water sources is groundwater accounting for 23%.

Table-1.3 Water Supply Facilities of Private-tap System in Sergipe State

Water Supply Facilities		Integrated System		Independent System		Total	
		Number	Capacity (m ³ /day)	Number	Capacity (m ³ /day)	Number	Capacity (m ³ /day)
Intake Pump Station	Sao Francisco River (Main River)	4 (15%)	176,880 (55%)	11 (9%)	10,810 (9%)	15 (10%)	187,690 (43%)
	Large Dam	1 (4%)	9,983 (3%)	-	-	1 (1%)	9,983 (2%)
	Weir	6 (23%)	87,851 (28%)	24 (20%)	57,455 (49%)	30 (20%)	145,306 (33%)
	Deep Well	13 (50%)	19,192 (6%)	77 (63%)	41,400 (35%)	90 (61%)	60,592 (14%)
	Spring	2 (8%)	25,392 (8%)	10 (8%)	8,617 (7%)	12 (8%)	34,009 (8%)
	Total	26 (100%)	319,298 (100%)	122 (100%)	118,282 (100%)	148 (100%)	437,580 (100%)
Booster Pump Station		54	427,082	58	96,452	112	523,534
Purification Plant		12	270,175	46	90,601	58	360,776
Reservoir		122	108,608m ³	131	27,867m ³	253	136,475m ³
Main Pipe Line (50-900 mm)		Length: 455.3 km		Length: 313.0 km		Length: 768.3 km	

Table-1.4 Present Amount of Water Resources Development

Water Sources River Basin	Sao Francisco River Intake		Surface Water		Groundwater		Total	
	Number	Intake Capacity (m ³ /day)	Number	Intake Capacity (m ³ /day)	Number	Intake Capacity (m ³ /day)	Number	Intake Capacity (m ³ /day)
Sergipe State	15	187,690 (100%)	31	155,289 (100%)	102	94,602 (100%)	148	437,580 (100%)
Sao Francisco River	15	187,690 (100%)	2	1,634 (1%)	17	8,060 (9%)	34	197,384 (45%)
Japaratuba River	-	-	6	10,583 (7%)	28	18,322 (19%)	34	28,905 (6%)
Sergipe River	-	-	4	69,946 (45%)	32	47,676 (50%)	36	117,622 (27%)
Vaza Barris River	-	-	6	24,091 (15%)	4	564 (1%)	10	24,655 (6%)
Piaui River	-	-	10	38,464 (25%)	16	9,565 (10%)	26	48,029 (11%)
Real River	-	-	3	10,570 (7%)	5	10,415 (11%)	8	20,985 (5%)

Note. Water in the following towns are supplied from Real River basin in Bahia State; including in the above table.

- Poco Verde: 74 m³/day (Groundwater: 2 deep wells)
- Tobias Barreto: 300 m³/day (Surface water: Weir)
- Samanbahia: 20 m³/day (Groundwater: 2 Deep Wells)

1.2.3 Public-tap System (Small Rural Water Supply)

"Single Well System" constructed mainly by COHIDRO, consists of following facilities:

- 1) Deep well (60 m in depth and 6 inches in diameter)
- 2) Pump house
- 3) Pipe line (50-110 mm in diameter)
- 4) Reservoir (5 – 10 m³)
- 5) Public watering place (Public-tap)
- 6) Fence

Single well system supplies residential water only to small rural areas by means of public-tap system. In this report, the single well system is called as public-tap system against private-tap system in urban and large rural areas. Number of localities supplied by this system reach 700 localities, account for 23% of total rural localities (2,979 localities as of 1996) in Sergipe State.

1.2.4 Other Systems

The population that is not covered by private-tap and public-tap systems depends mainly on rainfall collecting systems (Cisternas) for residential water. As rainwater is not a reliable water source, delivery truck water complements this system in severe drought conditions on emergency basis, especially in Semi-arid region. Watering pond (Aguadas) sometimes supplies water for human use but mainly for livestock.

1.3 Present Condition of Water Supply

1.3.1 Data Sources

As of private-tap system, DESO and FNS provide consumed water amount, supply water amount and supply population. The data is compiled by localities on the monthly basis as of 1997.

As of public-tap system, COHIDRO has only the number of the systems as of 1996. There are no available data of wells' operation. According to COHIDRO, some systems were constructed in 1997 but no credible data. Thus, this data is to be used on the assumption of the data as of 1997.

1.3.2 Water Supply Population and Rate

Based on the data of DESO, FNS and COHIDRO, number of localities supplied as well as population and rate of water supply by private-tap and public-tap are tabulated in Table-1.5 to Table-1.7.

Since water supply population by DESO could not be necessarily compiled according to the municipality division, it is found that supply population is more than total population in some municipalities.

Water supply rate is calculated to be 80-130% by urban municipalities and the most of municipalities have around 100% of water supply rate. Thus, it could be assumed that the supply rate in urban areas be 100%.

Water supply rate in rural area by private-tap systems varies from 0% to over 100%. It is also caused by the different water supply division from municipality boundary. As it might not be over 100%, water supply rates were set at 0, 20, 40, 60% by municipalities based on the calculated water supply rate by the data of DESO.

Table-1.6 shows the rate set in such way, and the supplied population calculated with the rate and total population.

Rural population supplied by COHIDRO public tap system was estimated, assuming that one deep well could supply water to 100 peoples.

Summarizing the above considerations, the average water supply rates in 1997 in Sergipe State are described as follows:

- Urban: 100% (Private tap system)
- Rural: 35% (21% by private tap system, 14% by public tap system)

Note that other systems such as rainfall collecting system and watering pond also supply water to 65% of rural population. However, water supply by the other systems is not counted due to its uncertainty.

Table-1.5 Number of Localities Supplied as of 1997

River Basin	Number of Total Localities			Number of Localities Supplied				
				Private Tap System			Public Tap System	Other Systems
	Urban	Rural	Total	Urban	Rural	Total	Rural	Rural
Sergipe State	75	2,979	3,054	75	223	298	700	2,056
	100%	100%	100%	100%	7%	10%	23%	70%
Sao Francisco River	22.0	796	818	22	117	139	111	567
	100%	100%	100%	100%	15%	17%	14%	71%
Japaratuba River	10.5	212	223	10.5	28	38.5	53	131
	100%	100%	100%	100%	13%	17%	25%	62%
Sergipe River	17.5	470	488	17.5	30	47.5	134	306
	100%	100%	100%	100%	6%	10%	29%	65%
Vaza Barris River	9.0	345	354	9	19	28	125	200
	100%	100%	100%	100%	6%	8%	36%	58%
Piaui River	10.5	722	732.5	10.5	18	28.5	188	515
	100%	100%	100%	100%	2%	4%	26%	72%
Real River	5.5	435	440.5	5.5	10	15.5	89	336
	100%	100%	100%	100%	2%	3%	20%	78%

Table-1.6 Population and Rate of Water Supply by Private-tap System as of 1997

River Basin	Total Population			Population and Rate of Water Supply		
	Urban	Rural	Total	Urban	Rural	Total
Sergipe State	1,170,784	483,022	1,653,806	1,170,784	102,273	1,273,057
	100%	100%	100%	100%	21%	77%
Sao Francisco River	114,768	111,050	225,817	114,768	42,118	156,886
	100%	100%	100%	100%	38%	69%
Japaratuba River	56,279	35,922	92,201	56,279	12,619	68,897
	100%	100%	100%	100%	35%	75%
Sergipe River	697,487	81,062	778,549	697,487	6,456	703,943
	100%	100%	100%	100%	8%	90%
Vaza Barris River	96,907	63,124	160,030	96,907	7,505	104,411
	100%	100%	100%	100%	12%	65%
Piaui River	149,958	134,232	284,189	149,958	27,678	177,636
	100%	100%	100%	100%	21%	63%
Real River	55,387	57,632	113,019	55,387	5,897	61,284
	100%	100%	100%	100%	10%	54%

Table-1.7 Population and Rate of Water Supply by Public-tap and Other Systems as of 1997

River Basin	Total Rural Population	Public Tap System		Other System	
		Rural Population Supplied	Supply Rate (%)	Rural Population Supplied	Supply Rate (%)
Sergipe State	483,022	70,000	14	310,749	65
Sao Francisco River	111,050	11,081	10	57,851	52
Japarutuba River	35,922	5,310	15	17,993	50
Sergipe River	81,062	13,428	17	61,178	75
Vaza Barris River	63,124	12,498	20	43,121	68
Piaui River	134,232	18,785	14	87,769	65
Real River	57,632	8,897	15	42,837	74

1.3.3 Water Loss Rate

(1) Private-tap System

The water loss means the uncountable balance of water volume between supply/production and consumption due to pipe water leakage and the lack of measurement or other unknown reasons. Water loss is expressed as the following equations:

$$Q_L = Q_P - Q_C$$

$$R_L = Q_L / Q_P$$

Where Q_L : Water loss volume
 R_L : Water loss rate
 Q_P : Water production volume measured as out-going flow volume from the storage tanks to the distribution nets
 Q_C : Consumed water volume measured by means of the water meters installed inside of each consumer's property line

Water loss rate as of 1997 varied from 35% to 60% by water supply systems and municipalities. The water loss rate on the average of the whole state accounts for 48%, based on the water supply and consumption data from DESO and FNS. On the other hand, according to the material by DESO and Caixa Economica Federal, Water loss rate in the past and the future program is shown in Table-1.9.

Table-1.9 Water Loss Rate of Actual Condition and Future Program

Actual/Program	Actual						Program				
	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Water Loss Rate	44%	45%	45%	48%	48%	42%	38.25%	37.60%	36.64%	36.64%	36.64%

Note: This actual water loss rate includes measurement error.

This water loss includes 1) physical loss, 2) water consumption by unauthorized users, 3) consumption and operational loss, and 4) inaccuracy of measurement of water production.

According to Table-1.9, water loss rate was improved to 42 % in 1998 from 48% in 1997 after the improvement project of measurement equipment in Aracaju. It means that measured water production is too large. As a result, actual water loss rate except measurement error is estimated to be less than 48% presently. Therefore, water loss rate in 1997 could be set at 42% in this Master Plan.

(2) Public-tap System

There is no information about water loss rate of public-tap system. In general, the figure of 10% is employed as water loss rate, which includes pipe loss, consumption loss and operation loss.

1.3.4 Seasonal Fluctuation of Water Consumption on Private-tap System

Coefficient of seasonal fluctuation of water consumption is defined to be the ratio between the maximum and the average of daily water consumption. It was calculated based on the fluctuation of monthly water consumption in 1997. Seasonal fluctuation is shown in Table-1.10.

As Aracaju has large population, seasonal fluctuation of water consumption is not so big, the coefficient accounting for only 1.04. Contrarily, the other cities with less than 110,000 of population have 1.22 of the coefficient of seasonal fluctuation on average.

Table-1.10 Coefficient of Seasonal Fluctuation of Water Consumption in 1997

Urban Population	0 ~2,000	2,000 ~5,000	5,000 ~10,000	10,000 ~20,000	20,000 ~110,000	Average	439,472 (Aracaju)
Coefficient of Seasonal Fluctuation	1.21	1.21	1.24	1.28	1.18	1.22	1.04

1.3.5 Present Water Supply Capacity

(1) Private-tap System

Based on the present water consumption and assumed water loss rate (42% in the whole state), present water supply capacity by municipalities is estimated as following equation:
 $[Present\ Water\ Supply\ Capacity] = [Water\ Consumption] \times (1 - [Water\ Loss\ Rate])$

(2) Public-tap System

According to COHIDRO, present water supply capacity of public tap system is assumed to be 30 liter/capita/day. Assuming that 100 persons utilize a well, present water supply capacity per well was estimated as following equation:

$$Water\ supply\ capacity\ per\ well = 30\ liter/capita/day\ 100\ person = 3\ m^3/day\ per\ well$$

(3) Present Water Supply Capacity

Present water supply capacities of private-tap and public-tap systems are summarized as the following table.

Table-1.12 Present Water Supply Capacity

River Basin	Private Tap System			Public Tap System		
	Water Consumption (m ³ /day)	Water Loss Rate (%)	Water Supply Capacity (m ³ /day)	Water Consumption (m ³ /day)	Water Loss Rate (%)	Water Supply Capacity (m ³ /day)
Sergipe State	163,234	42	281,438	2,100	10	2,333
Sao Francisco River	16,514	42	28,472	332	10	369
Japaratuba River	8,301	42	14,312	159	10	177
Sergipe River	104,556	42	180,270	403	10	448
Vaza Barris River	13,772	42	23,744	375	10	417
Piaui River	14,356	42	24,752	564	10	625
Real River	5,735	42	9,888	267	10	297

1.3.6 Drought and Water Supply Restriction

In dry season, rural areas in Semi-arid region suffer from water shortage. The years of 1983 and 1984 were in the severest drought and about 6,700 trucks in 6 drought months were dispatched to the municipalities, of which water supply mainly depends on rainfall collecting systems.

Even in municipality capitals, water supply is not stable and water supply is often restricted in dry season. In 1998, Aracaju has been suffering from severe water shortage, as well as livestock and rain fed agriculture in Sergipe State were damaged by this drought.

1.4 Future Programs of Water Resources Development and Supply

1.4.1 PROAGUA Projects Proposed by Sergipe State

The following three projects were submitted as PROAGUA Project. The summary of these projects is shown in Table-1.13.

- Expansion Project of Agreste Integrated System
- Expansion Project of Piauítinga Pipeline System
- Small Rural Water Supply Project in Semi-arid and Agreste Region

Table-1.13 PROAGUA Projects Proposed by Sergipe State

Project	Item	Description
Expansion Project of Itabaiana Pipeline System	Outline	The aim of this project is to expand the water supply capacity of Agreste Integrated Water Supply System (Itabaiana Pipeline System) to meet the increased water demand in its coverage area until the year 2016. The Integrated System covers the communities of Areia Branca, Itabaiana, Campo do Brito, Macambira, Ribeira, Cajaiba and Mangueiras. New water sources from Jacarecica II Dam is added to the existing water source to meet the increased water demand.
	Project Description (Alternative I)	<ul style="list-style-type: none"> - the reform and expansion of the intake and the pump station at Ribeira - the intake and the pump station at Cajaiba - the water treatment station in Ribeira and Cajaiba - the treated water pump station at Cajaiba - the pipeline system to Campo do Brito
	Project Description (Alternative II)	<ul style="list-style-type: none"> - the reform and expansion of the intake and the pump station at Ribeira - the intake and the pump station at Cajaiba - the water treatment stations in Ribeira and Carrilho - the duplication of pipeline from Ribeira to Cajaiba - the water treatment station and treated water pump station at Cajaiba/Mangueiras - the water treatment station and treated water pump station at Itabaiana - the duplication of the pipeline system to Campo do Brito - the pump station at Campo do Brito for Tapera da Serra - the treated water pipeline for Garangal/Tapera da Serra
	Project Cost	R\$ 5,028,357
Expansion Project of Piauitinga Pipeline System	Outline	The aim of this Project is to expand the water supply capacity of Piauitinga Integrated Water Supply System (Piauitinga Pipeline System) to meet the increased water demand in its coverage area until the year 2016. The Integrated System covers the communities of Lagarto, Simao Dias, Riachao do Dantas and Colonia XIII, Tanque Novo and the villages on the way from Simao Dias to Sao Jose. New water source from Gov. Dionizio Machado Dam is added to the existing water source to meet the increased water demand.
	Project Description	<p>The expansion works are implemented in the three stages, namely, the immediate stage, 1st stage and 2nd stage and include the following major works:</p> <ul style="list-style-type: none"> - the reform of existing treated water pump station in Salgado and Lagarto - the raw water intake from the existing compensation reservoir of COHIDRO - the water treatment station in Lagarto - the booster pump stations to Simao Dias and Riachao do Dantas - the pipeline - the elevated tanks for the distribution of water to the villages
	Water Sources	The water from Gov. Dionizio Machado Dam and the water from other water sources shall be mixed because of the salinity of water from the dam in the proportion of 20% to 30% of water from the dam and 80% to 70% of water from other sources.
	Implementation Schedule	<ul style="list-style-type: none"> - The immediate stage shall be finished until the year 2001. - The 1st stage shall be implemented at the year 2000. - The 2nd stage shall be implemented at the year 2005.
	Project Cost	R\$ 9,962,382
Project	Item	Description
Small Rural Water Supply Project in Semi-arid and Agreste Region	Outline	The objective of this Project is to support low-income families in 24 municipalities located in the Semi-arid and Agreste region, through supplying good quality water to those communities for human and animal consumption. Direct beneficiaries reach 84,840 persons through the project.
	Project Description	<ul style="list-style-type: none"> - Installation of 300 deep wells - Construction of 120 watering ponds - Construction of 3,480 rainfall collecting systems - Recovering of 204 single public-tap water supply system (deep well)
	Implementation Schedule	- Implementation Period: 4 years
	Project Cost	R\$ 16,197,000

1.4.2 Expansion Project of Sao Francisco Pipeline System

Summary of the expansion project of Sao Francisco Pipeline System is shown in Table-1.14.

Table-1.14 Expansion Project of Sao Francisco Pipeline System

Item	Description
Outline	The 1st stage of the project of Sao Francisco Pipeline System was implemented in 1980, to be realized within 10 years. The aim of this project was based on the necessity to meet the increase of water demand in Aracaju city and the implementation of big industrial projects. The 1st stage of the system consists of 1) the intake located 2 km from the Propria City with a pumping capacity of 5,000m ³ /h (1.39m ³ /s or 120,000m ³ /day), 2) 90 km of pipeline in gravity and pressure flow sections, 3) passage tanks, 4) pressure release tank and 5) treatment station with 0.74 m ³ /s capacity.
Objectives	The implementation of 2nd stage of Sao Francisco Pipeline System is aimed to meet the necessity of water supply to Aracaju city and to the industrial sectors located along the pipeline until the year 2010.
Project Description 1st Phase of 2nd Stage (on going)	<p><u>Pipeline</u></p> <ul style="list-style-type: none"> - The duplication of gravity-flow pipeline with 14,480m long, with diameter of 1200 mm, of ductile cast-iron pipes, series K-7 - Passage tank from the pressure line to gravity line, with capacity of 30,000m³. Alteration of control system for energy dissipation in pressure relief tank constructed in 1st phase. - Recovering and restoring of the existing pipeline, principally anti-corrosion works <p><u>Treatment Station</u></p> <p>Treatment station of complete conventional type with a capacity of 0.90 m³/s.</p> <p><u>Contracted Value</u></p> <p>R\$ 36,857,046.00</p>
Project Description 2nd Phase of 2nd Stage	<p><u>Pumping Station</u></p> <ul style="list-style-type: none"> - Pump House: 5 more pumping units to be installed in the existing Pump House, with individual flow volume and potency of 3.51m³/s and 1810 cv, respectively. - Control Building: The various equipment for protection, command and control to be installed in the existing control building. - Substation: One more power transformer of 7.5 MVA shall be installed in the existing substation for step-down of voltage from 69 kV to 4.16 kV. <p><u>Pipeline</u></p> <ul style="list-style-type: none"> - Pressure Flow Section: Pipeline with 24,495m long, with diameter of 1,000 mm, in welded steel plate tubes, standard API 5L X-42, with 5/16" of thickness. - Section in gravity flow I: Pipeline with 16,007m long of 1,200 diameter and 9,765m long of 1,100 mm diameter, in welded steel plate pipe, standard API-5L Gr B. - Section in gravity flow II: Pipeline with 24,096 long and 1,200 diameter in ductile cast iron, series K-7; and 2,536 m long and 1,200 mm diameter in welded steel plate tubes, standard API-5L Gr B, thickness from 9/32" to 5/16".
Implementation Schedule	The execution period is estimate to be 18 months
Project Cost	2nd Phase of 2nd Stage: R\$112,561,759.91

1.4.3 Semi-arid Project Concerning with Sergipe State

Semi-arid Project is the proposal of water resources development and supply in northeastern semi-arid region in Brazil, utilizing water sources of Sao Francisco River. The proposal includes the plans of the whole river basin. Water distribution systems concerning with Sergipe State are Sertao Sergipe Project (T3-B) and Xingo Project (T-4) as follows:

- Water intake T3-B in the Itaparica reservoir, to supply the Alto Sergipe Project which allows to irrigate around 55,000 ha in the region of Paulo Afonso and Brigida, in Bahia and transporting the basin up to next of the city Pinhao-PE.
- Water intake T-4 in the Xingo reservoir, to supply the Xingo Project which has the objective to irrigate around 15,000 ha in the neighborhood of Poco Redondo city in Sergipe, beside to benefit the local population with other uses of water.

Table-1.15 Water Supply Project concerning with Sergipe State

Project		Sertao Sergipe Project	Xingo Project
Water Catchment		T3-B (Itaparica Dam Reservoir)	T-4 (Xingo Dam Reservoir)
Irrigation Area		55,000 ha	15,000 ha
Reservoirs	Number	25	8
	Total Volume	1,940 million m ³	390 million m ³
Channel Extension		335 km	50 km
Tunnel	Number	-	-
	Extension	-	-
Siphons	Number	1	1
	Extension	0.2 km	2.0 km
Aqueducts	Number	-	-
	Extension	-	-
Gates		5	-
Water Pumping Station	Number	-	2
	Manometric Height	-	40 m and 50 m
	Flow	-	10 m ³ /s
	Annual Power Consumption	-	100 Gwh
Hydro-electric Generation Plant	Number	1	-
	Power	30 Mw	-
	Annual Generation Capacity	38.0 Gwh	-
Total Cost of Implementation		R\$ 315 million	R\$ 70 million

CHAPTER 2 OBJECTIVES, POLICY AND PLANNING CRITERIA

2.1 Objectives of the Plan

Toward the target year of 2020, a plan of water resources development and management, which is a state vision from the water sector, is proposed through sustainable water resources development for the purpose of securing stable life of the state people. The objectives of the plan is set as follows:

- 1) to supply clean and enough water for state people through public water supply.
- 2) to supply industrial water through public water supply for the growth of manufacturing industries.
- 3) to supply irrigation water to agriculturally potential land for the achievement of high productivity.
- 4) to maintain environmental quality through sustainable water resources development.

The state economic development will be accelerated achieving the above objectives. The GRDP in 2020 becomes R\$ 4,400 per capita in the state of Sergipe. This GRDP corresponds to over 1.8 times of present GRDP and to 57 % of national GDP per capita (currently 53 %).

2.2 Planning Policy

(1) Future Water Demand

Concerning domestic water demand, the demand required for improving the level of existing water supply services (service level improvement demand) shall be gauged, together with the demand that takes future population increase into account (population increase demand). The service level improvement demand refers to the demand made necessary by increase of per capita consumption and supply rate, resulting in improved living standards. The population increase demand is necessary to gauge demand for the possible cases where population movement from rural areas to the cities continues and urban population concentration reaches a peak.

Industrial water demand and agricultural water demand are strategic water demands concerned with economic vitalization. Since this is demand for water needed to achieve the correction of regional disparities in the state and the mitigation of poverty (important issues in water resources development projects), it is necessary to strike a balance with the long-term development plans and industrial development plans. Furthermore, if the processing of agricultural products (agro-industry) is developed in districts where irrigated farming has been introduced, this will lead to the creation of a further demand for water.

In this Mater Plan Study, the "strategic scenario", in which population and industry was redistributed in consideration with decentralization, is adopted, since the Aracaju cosmopolitan area has already been saturated with population and industry, and decentralization is also advisable in the view point of water supply and development in Sergipe State.

(2) Water Resources Development

The water resources to be targeted are surface water and groundwater within Sergipe State. Surface water to be targeted for development refers to the waters of the six rivers that flow through Sergipe State, i.e. Sao Francisco River, Japaratuba River, Sergipe River, Vaza Barris River, Piaui River and Real River. Sao Francisco River, which is a major river flowing through seven states, is the most stable water resource of the said rivers. Vaza Barris River and Real River originate in Bahia State, and the river flow that originates from this state is also considered to possess potential for development. Water quality, especially saline contamination, shall be taken into account for water resources development.

Although groundwater can not be expected to provide as much water potential as surface water, it is cheaper and more convenient water source. Groundwater sources could be made use as the domestic water for small and medium towns, and moreover it could complement surface water sources of urban and large rural cities.

In the western and northern semi-arid districts in the state, rainwater is commonly used as water resources by directly collecting and storing rainwater. However, as its reliability is relatively low and water truck must assist to supply water in a dry year, rainwater source is not applied in this plan.

(3) Water Supply

Concerning surface water development facilities, examination shall first be carried out on the plan for water conveyance from Sao Francisco River, which possesses the most stable and abundant potential. Xingo Dam, located in the northern tip of the state, is a promising intake point that allows water to be supplied over the widest possible area. Regarding the other rivers, intakes weirs, dams, reservoirs and other development facilities shall be examined.

In districts which cannot be covered by the above water conveyance plan or intake weir, dam and reservoir plans, the appropriateness of groundwater use shall be ascertained. Concerning groundwater that possesses high salt concentration, the feasibility of using desalination to improve water quality shall be examined.

(4) Implementation of Project

The construction of facilities contained in the Master Plan should be implemented step by step in line with increasing water demand. Facilities for municipal water supply shall be constructed in line with population increase. In the case of industrial water and agricultural water, since plans also exist for the construction of basic infrastructure not related to water supply, facilities shall be constructed in accordance with plans laid down by the state for long-term industrial development.

The project for water conveyance from Sao Francisco River should be a multi-purpose project intended to supply municipal and irrigation water to the semi-arid belt and other districts. Since the supply of domestic water to semi-arid districts might be implemented under PROAGUA, it is necessary to clarify the cost allocation concerning this.

(5) Institutional Plan and Operation & Maintenance Plan

An important factor in water resources development and management is the achievement of an appropriate distribution of limited water resources to each consumer sector and the proper operation of the distribution system. In view of this, the following measures are required:

- Setting up of a system for coordinating the interests of each consumer sector (public water supply, power generation, industry, tourism, environment, etc.)
- Cost recovery and demand control through pricing
- Participation of users and residents, and decentralization in the area of water resources management and development
- Institutional development for the implementation of multi-purpose projects

The institutional plan contained in the Study will not only compile a plan for the strengthening of water resources-related organizations in Sergipe State (encompassing the above components), but will also contribute to the realization of the PROAGUA project objectives.

2.3 Goal of Water Resources Development and Supply

The goals of water resources development and supply as well as river basin management are set as follows:

(1) Target Year

Target year for the Master Plan was set at the year of 2020.

(2) Domestic Water Supply

(a) Water Supply Rate

As of 1997, the water supply rate for urban population has reached almost 100%. The water supply rate for the rural population in Sergipe State is estimated to be 21% by private-tap system and 14% by public-tap system, totally 35%. Water supply for the other 65% of the rural residents depends on rainfall collecting systems. The targets after 1997 have not yet been officially addressed in Sergipe State.

The goal of municipal water supply rate is set to provide clean water to urban and rural population in the following manners:

- **For urban areas:** to continue and achieve complete coverage (100%) in 75 municipality capitals.
- **For rural areas:** to provide water for 60% of the rural population with the private-tap system and for 25 % with the public-tap system by 2020. Total 85% of rural population will be supplied with clean water.
- **Replacing public-tap to private-tap:** Half of the present public-tap systems in the small rural areas are to be replaced with the private-tap system by 2020.

Present water supply rates in the municipalities are so different each other that future water supply rates are to be set by municipalities according to current conditions. Water supply rate improvement in Sergipe State toward the target year of 2020 is set up as shown in Table-2.1.

Table-2.1 Domestic Water Supply Rate

Year		1997	1998	2000	2005	2010	2015	2020
Urban Water Supply Rate		100%	100%	100%	100%	100%	100%	100%
Rural Water Supply Rate	Large Rural Area	21%	22.7%	26.1%	34.6%	43.0%	51.5%	60%
	Small Rural Area	14%	14.5%	15.4%	17.8%	20.2%	22.6%	25%
	Total	35%	37.2%	41.5%	52.4%	63.2%	74.4%	85%

Note: Rural water supply rate was set by municipalities based on the present supply rate. But the rate in 2020 is same in whole the Sergipe State.

(b) Unit Consumption Rate of Domestic Water

Unit consumption rate of municipal water are set as shown in Table-2.2.

Table-2.2 Unit Consumption Rate of Domestic Water

District		Unit Consumption Rate
Urban Area	Aracaju City	190 lit./capita/day
	Other Urban Area	160 lit./capita/day
Rural Area	Large Rural Area	120 lit./capita/day
	Small Rural Area	70 lit./capita/day

(c) Water Supply Loss Rate

The total supply amount of water required is obtained by adding the margin for losses and leakage to total water demand to be consumed. The margin should cover losses and leakage, which occur at intake, conveyance, treatment, distribution etc. For private-tap system, present water loss rate is set at 42% and the goal of the future improvement program is set at 25% in 2020. For public-tap system, 10% is employed as water loss rate. Thus the design water supply loss rates are set as follows.

Table-2.3 Water Supply Loss Rate

Year		1997	1998	2000	2005	2010	2015	2020
Water Loss Rate	Private-tap System	42%	41.33%	40.00%	36.25%	32.50%	28.75%	25%
	Public-tap System	10%	10%	10%	10%	10%	10%	10%

(3) Industrial Water Supply

Industrial water supply rate is defined to be a ratio of total industrial water demand to public industrial water supply (by private-tap system). The industrial water supply rates were set by micro-regions as shown in Table-2.4, in accordance with the current rate of DESO's water supply to industries, as well as industrial development strategy and water resources potential.

The rest of industrial water to be not supplied by public water supply system, namely private industrial water, shall be obtained individually by means of deep wells development at the near site of factories.

(4) Agricultural Water Supply

Irrigation projects are planned so as to contribute 1 % in the 5 % of projected GRDP growth. Thus water resources development for irrigation is planned to satisfy the water demand of those irrigation projects.

Table-2.4 Industrial Water Supply Rate through Public Water Supply

Year	1997	1998	2000	2005	2010	2015	2020
Sergipe State	5%	5%	5%	10%	15%	20%	28%
01- Sergipana do Sertao do Sao Francisco	9%	9%	9%	25%	42%	58%	75%
02- Carira	7%	7%	7%	3%	53%	77%	100%
03- Nossa Senhora das Dores	3%	3%	3%	15%	26%	38%	50%
04- Agreste de Itabaiana	10%	10%	1%	14%	26%	38%	50%
05- Tobias Barreto	30%	30%	3%	21%	39%	57%	75%
06- Agreste de Lagarto	0%	0%	0%	13%	25%	38%	50%
07- Propria	2%	2%	2%	8%	14%	19%	25%
08- Cotinguiba	0%	0%	0%	6%	13%	19%	25%
09- Japarutuba	2%	2%	2%	8%	13%	19%	25%
10- Baixo Cotinguiba	0%	0%	0%	6%	13%	19%	25%
11- Aracaju	14%	14%	14%	17%	19%	22%	25%
12- Boquim	3%	3%	3%	15%	26%	38%	50%
13- Estancia	0%	0%	0%	6%	13%	19%	25%

(5) Water Resources Management

Institutional and juridical proposal and plan is made in order to maintain sustainable water resources development and conservation, and to properly implement proposed projects for water resources development and supply.

(6) Regional Development Scenario

Two regional development scenarios, namely “trend scenario” and “strategic scenario”, were proposed for future development in Sergipe State. Water demand of both scenarios in 2020 were estimated and are compared in Table-2.5.

The 40% of the water shortage of Aracaju in the trend scenario are to be distributed mainly to the micro-regions of Estancia, Agreste de Lagarto, Agreste de Itabaiana and Sergipana do Sertao do Sao Francisco in the strategic scenario. In this study, “strategic scenario” is adopted for the Water Resources Development Master Plan in Sergipe State.

Table-2.5 Water Shortage by Scenarios in 2020

Unit: 1000m³/day

Micro-Region	Strategic Scenario				Trend Scenario				Difference			
	Indus-try	Urban	Rural	Total	Indus-try	Urban	Rural	Total	Indus-try	Urban	Rural	Total
SERGIPE STATE	247.5	252.4	47.2	547.1	229.7	260.3	47.2	537.2	17.8	-7.9	0.0	10.0
01- Sergipana do Sertao do Sao Francisco	17.7	21.8	2.1	41.6	4.2	12.4	2.1	18.7	13.5	9.4	0.0	22.9
02- Carira	1.0	7.9	1.4	10.3	1.0	7.9	1.4	10.3	0.0	0.0	0.0	0.0
03- Nossa Senhora das Dores	0.8	5.7	1.2	7.7	0.8	5.7	1.2	7.7	0.0	0.0	0.0	0.0
04- Agreste de Itabaiana	15.0	43.3	7.7	66.0	6.2	33.9	7.7	47.8	8.9	9.4	0.0	18.2
05- Tobias Barreto	4.4	11.4	3.8	19.6	4.4	11.4	3.8	19.6	0.0	0.0	0.0	0.0
06- Agreste de Lagarto	35.6	16.7	4.9	57.2	26.8	7.3	4.9	39.0	8.8	9.4	0.0	18.2
07- Propria	6.5	21.6	1.1	29.2	4.3	16.9	1.1	22.3	2.2	4.7	0.0	6.9
08- Cotinguiba	2.8	4.3	1.3	8.4	1.7	2.0	1.3	4.9	1.1	2.3	0.0	3.4
09- Japarutuba	2.9	5.7	1.9	10.5	1.8	3.3	1.9	7.1	1.1	2.3	0.0	3.4
10- Baixo Cotinguiba	87.3	12.8	0.9	101.0	87.3	12.8	0.9	101.0	0.0	0.0	0.0	0.0
11- Aracaju	40.9	68.2	7.4	116.5	63.0	122.9	7.4	193.3	-22.1	-54.7	0.0	-76.8
12- Boquim	3.0	14.4	9.5	26.8	3.0	14.4	9.5	26.8	0.0	0.0	0.0	0.0
13- Estancia	29.6	18.7	4.0	52.3	25.2	9.3	4.0	38.6	4.4	9.4	0.0	13.8

2.4 Planning Criteria

2.4.1 Domestic and Industrial Water Resources Development and Supply

(a) Water Supply System

Domestic water supply systems are divided into following two categories according to present condition of water supply system in Sergipe State.

- Urban and large rural area: Private-tap water supply system
- Small rural area: Public-tap water supply system

Another water supply means, such as rainfall collecting system and watering pond are not discussed in this study because of their unreliability. Water-truck delivery system is not situated as a water supply system but as an emergency activity.

(b) Urban and Large Rural Area

In urban and large rural area, domestic and industrial water is supplied by private-tap system, which is divided into integrated system and independent system.

The areas supplied with water presently by the integrated systems are planned to be supplied by the integrated system in general, because of no good potential of surface water and groundwater in these areas.

In general, the nearer water resources are the economical development. The areas supplied with water presently by the independent systems are planned as following rules:

- Except areas with water supply potential of Sao Francisco River, the first alternative is groundwater development if there is good potential groundwater aquifer.
- In the case of no good groundwater potential and much developed water requested, following alternatives are studied, such as 1) surface water development by weirs and intake pumps, and 2) connecting integrated systems.

(c) Small Rural Area

In small rural area, residential water is supplied by public-tap system, which is named "Single Well System", by means of groundwater development. Desalinizer is also planned if necessary.

(d) Industrial Water Supply

Industrial water is assumed to be consumed in urban and large rural area but not in small rural area. Then industrial water is supplied by private-tap system with the supply rate mentioned in Table-2.4. The rest of industrial water not supplied by private-tap system is assumed to be developed by means of groundwater near the site by individual industries.

2.4.2 Policy on Agricultural Water Resources Development

The policies for water resources development in agricultural sector are set as follows:

- Agriculture water supply projects are classified as: 1) Irrigation Project, 2) Livestock Project and 3) Aquaculture Project. Water sources of livestock breeding depend mainly on watering ponds (Aguadas) or wells near farms because the livestock water demand is regionally scattered and the volume of individual demand is small. The project scale of aquaculture in Sergipe State is very small and its necessary water amount is considered to be negligible. Thus, irrigation water development plan is mainly discussed in this study.
- Water sources for irrigation are to be mainly surface water of Sao Francisco River and large dam reservoirs. Groundwater and direct intake from a river are applied only for small scale irrigation projects.

2.4.3 Surface Water Development

(1) Level of Compensation Discharge

In Brazil, the 10-year return period 7-day flow (Q7,10) has recently come to be used in low water management. The (Q7,10) refers to the mean annual minimum 7-day flow with 10-year return period, and this is secure as compensation discharge to the downstream when developing new water resources of river flow. How many percents of (Q7,10) should be secured varies according to the states, namely 100% in Sao Paulo State, 50% in Parana State and 30% in Minas Gerais State. Unfortunately the rate has not been stipulated yet in Sergipe State.

The "compensation discharge" could be defined as the discharge necessary to maintain the normal function of a river, and consists of maintenance discharge and water-use discharge. Maintenance discharge has been stipulated to be maintained even at times of low flow, with overall consideration to the follows: 1) boat transportation, 2) fishing, 3) scenery, 4) groundwater level maintenance, 5) preservation of plants and animals, 6) preservation of cleanliness of river flow. Water-use discharge is the flow necessary for the consumptive use of the river water at all points downstream.

In detailed planning, the maintenance discharge should be studied, taking into account of the items mentioned above, and water-use discharge should be investigated from a survey of the river water rights. However in framework planning, detailed investigation is not afforded because of limited information and time. In this Study, the 20% and 100% of (Q7,10) is applied as compensation discharge for direct intake plan and for dam plan respectively.

(2) Security Level of Water Supply

Low flow security in plans of weirs and direct intakes has been set to ensure the abstraction of new development discharge even in the worst drought in ten years for domestic and industrial water supply, and in five years for irrigation water supply. In the case of dam development, both cases of single and multi-purpose, low flow security is set against the worst drought in ten years as determined for water supply projects for domestic and industrial use.

(3) Compensation Discharge and Available Discharge

The detail setup of compensation discharge (Q_{CM}) and available discharge (Q_{AV}) is as follows:

< Perennial River >

Weir Intake or Direct Intake

Q_{CM} = 20% of (Q7,10) (Security Level: 10 years return period)

Q_{AV} = 80% of (Q7,10) (Security Level: 10 years return period for human use)

Q_{AV} = 100% of (Q7,5) – Q_{CM} (Security Level: 5 years return period for irrigation use)

Dam and Reservoir

Q_{CM} = 100% of (Q7,10) (Security Level: 10 years return period)

Q_{AV} = Newly developed discharge (Security Level: 10 years return period)

< Non-perennial River >

Weir Intake or Direct Intake (Monthly Basis)

Q_{CM} = 10% of (Q_{MAV} , 10) (Security Level: 10 years return period)

Q_{AV} = 90% of (Q_{MAV} , 10) (Security Level: 10 years return period for human use)

Q_{AV} = 100% of (Q_{MAV} , 5) – Q_{CM} (Security Level: 5 years return period for irrigation use)

Dam and Reservoir

Q_{CM} = 10% of Q_{REG} (Security Level: 10 years return period)

Q_{AV} = 90% of Q_{REG} (Security Level: 10 years return period for human and irrigation use)

Where, Q_{MAV} : Monthly Average Discharge
 Q_{REG} : Development Discharge

2.4.4 Groundwater - Deep Well Development

(1) Planning Criteria

The required number of deep wells to meet the regional demands is estimated for the formulation of the groundwater development plan. Deep wells provide a more stable source of water with better quantity and quality than shallow wells, which are affected by droughts and are not a reliable source for sustainable development. The following criteria are applied for the development plans:

- **Urban and Large Rural Water Supply:** Water supply in urban areas requires large volume of water. Pumped water from one borehole is determined based on the assessment of safe yield according to the hydrogeological characteristics of the area. Standard size of boreholes is 15 cm in diameter and 100m in depth. Desalinizer is not installed and pure water wells should be developed. A well, if saline water is found, should be abandoned and a new pure water well should be developed because of much development water volume required in urban and large rural areas.
- **Rural Water Supply:** Standard size of boreholes is 15 cm in diameter and 60m in depth. A deep well is assumed to cover an area with 100 people. A desalinizer should be installed if saline water is appeared.

(2) Safe Yield

Groundwater development is carried out through drilling boreholes. Yields of boreholes are limited and over pumping causes adverse effects, not only to groundwater environment around the borehole, but also to the borehole itself. Therefore, the safe yield should be determined for each borehole for sustainable groundwater use. Success rates in quantity and in quality are also taken into account for deep well development. The safe yield, success rates in quantity and quality depend on main aquifer and the best aquifers in Sergipe are Alluvium, Barreiras/Sergipe and Sergipe formation. Refer to Table-2.6. These yields and-rates are compiled by municipalities and vary as follows:

- Expected Yield : 40-600 m³/day
- Success rate in quantity : 45-90 %
- Success rate in quality : 10-100 %

Table-2.6 Well Capacity and Water Quality by Aquifer

Aquifer	Expected yield (m ³ /day)	Specific capacity (m ³ /day/m)	Success rate in quantity (%)	Success rate in quality (%)
Alluvium	600	140	95	100
Barreiras/Sergipe	140	17	80	85
Barreiras/Craton	70	4	85	90
Tucano	100	4	60	60
Sergipe	140	13	70	60
Dominio Caninde	40	2	45	10
Dominio Poco Redondo	40	2	45	10
Dominio Maranco	40	2	45	10
Dominio Macurure	40	2	60	15
Dominio Vaza-Barris	80	7	75	40
Dominio Estancia	50	3	70	50
Craton do Sao Francisco	40	2	75	30
Domos de Itabaiana	70	4	75	35

Note: 'Fresh water' means chlorine (Cl) is less than 250 mg/l.