2.5 SURVEY RESULTS

Main results of the survey are as follows;

Tables 2-4 (a) and (b) : Results of spring survey for day and wet season

Tables 2-5 (a) and (b) : Results of river survey for day and wet season

Table 2-6 : Result of spring survey questionnaire

Table 2-7 : Description of sampling points for springs

Table 2-8 : Description of sampling points for rivers

Table 2-1 DETAILS OF EXISTING STREAM GAGING STATIONS

NWRB NUMBER	RIVER	LOCATION	LATITUDE	LONGITUDE	DRAINAGE AREA km^2	PERIOD OF RECORDS	ANNUAL MEAN DISCHARGE cms	SPECIFIC DISCHARGE cms/km^2
422	Ilang-Ilang	Alapan, Imus, Cavite	14-24-30	120-54-20	60	1952 - 1979	0.83	0.01
423	Panaysayan	Palubluban, Gen. Trias	14-22-22	120-52-55	29	1957 - 1979	1	0.03
424	Balsahan	Palangue, Naic, Cavite	14-16-59	120-48-30	22	1954 - 1979	1.35	0.06
425	Maragondon	Mabacao, Maragondon	14-16-20	120-44-20	260	1945 - 1979	21.73	0.08

MEAN MONTHLY DISCHARGE, in cms

NWRB NUMBER	RIVER	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
422	Ilang-Ilang	0.15	0.08	0.06	0.05	0.53	0.86	1.74	3.54	4.38	1.68	2.27	0.88
423	Panaysayan	0.30	0.21	0.27	0.21	0.72	1.59	2.45	2.97	2.29	1.39	0.92	0.51
424	Balsahan	0.52	0.35	0.33	0.30	0.96	2.40	3.64	3.57	4.01	2.14	1.67	0.84
425	Maragondon	2.63	2.88	2.48	2.24	9.52	16.26	43.98	67.37	56.42	19.40	16.61	10.15

Table 2-2 NIA IRRIGATION DIVERSIONS

River/Creek	River Basin	Diversion Capacity (lps)	Ave. Area Irrigated (has)		Water Requirement (m^3/y)				
			Wet Season	Dry Season	Jan-Mar	Jun-Oct	Nov-Dec	Annual	Basin WR
* Balayungan R.	1	1,004	669	150	1,745,744	7,633,613	530,189	9,909,545	
* Maragondon R.	1	1,100	733	164	1,912,667	8,363,520	580,884	10,857,071	20,766,617
Culong-Culong R.	2	583	389	87	1,013,714	4,432,666	307,869	5,754,248	
* Balsahan R.	2	1,241	827	185	2,157,836	9,435,571	655,343	12,248,751	
Kay Alemang R.	2	950	633	142	1,651,849	7,223,040	501,673	9,376,562	
Sahing R.	2	576	384	86	1,001,542	4,379,443	304,172	5,685,157	33,064,718
Timalan R.		600	400	89	1,043,273	4,561,920	316,846	5,922,039	
Puting Tubig R.		890	593	133	1,547,522	6,766,848	469,988	8,784,358	
Mabaknog C.		78	52	12	135,626	593,050	41,190	769,865	
Mabiling C.		75	50	11	130,409	570,240	39,606	740,255	
Balagbag R.		710	473	106	1,234,540	5,398,272	374,934	7,007,746	
Quintana R.	3	2,010	1,340	300	3,494,965	15,282,432	1,061,434	19,838,831	
Polonan R.	3	1,080	720	161	1,877,892	8,211,456	570,323	10,659,670	
Patda C.	3	483	322	72	839,835	3,672,346	255,061	4,767,241	
* Matang Ulang R.	3	550	367	82	956,334	4,181,760	290,442	5,428,536	
* Panaysayan R.	3	830	553	124	1,443,194	6,310,656	438,303	8,192,154	48,886,432
Rio Grande R.	4	1,000	667	149	1,738,788	7,603,200	528,076	9,870,065	
* Ylang-Ylang R.	4	1,041	694	155	1,810,079	7,914,931	549,728	10,274,738	
* Biluso C.	4	850	567	127	1,477,970	6,462,720	448,865	8,389,555	
* Malinta R.	4	905	603	135	1,573,604	6,880,896	477,909	8,932,409	37,466,767
Imus R.	5	800	533	119	1,391,031	6,082,560	422,461	7,896,052	
Baluctot R.	5	750	500	112	1,304,091	5,702,400	396,057	7,402,549	15,298,601
Malaking Ilog R.		605	403	90	1,051,967	4,599,936	319,486	5,971,389	
TOTAL		18,711	12,474	2,789	32,534,471	142,263,475	9,880,839	184,678,786	155,483,133

*Diversions Above Streamflow Gaging Stations

Table 2-3 TENTATIVE SURFACE RUNOFF ESTIMATES BY RIVER BASIN

River Basin	MARAGONDON		LABAC		CANAS		SAN JUAN	
River	Maragondon		Balsahan		Panaysayan		Ilang-Ilang	
Drainage Area	260km^2		22km^2		29km^2		60km^2	
	(cms)	(m^3/mo)	(cms)	(m^3/mo)	(cms)	(m^3/mo)	(cms)	(m^3/mo)
JAN	2.63	7,044,192	0.26	696,384	0.19	508,896	0.09	241,056
FEB	2.88	6,967,296	0.12	290,304	0.15	362,880	0.07	169,344
MAR	2.48	6,642,432	0.09	241,056	0.20	535,680	0.05	133,920
APR	2.24	5,806,080	0.07	181,440	0.20	518,400	0.04	103,680
MAY	9.52	25,498,368	0.55	1,473,120	0.27	723,168	0.11	294,624
JUN	14.97	38,802,240	1.74	4,510,080	1.56	4,043,520	0.95	2,462,400
JUL	23.04	61,710,336	3.60	9,642,240	2.33	6,240,672	1.80	4,821,120
AUG	46.03	123,286,752	2.49	6,669,216	2.54	6,803,136	1.43	3,830,112
SEP	28.44	73,716,480	3.85	9,979,200	2.70	6,998,400	1.95	5,054,400
OCT	17.55	47,005,920	1.43	3,830,112	1.15	3,080,160	1.54	4,124,736
NOV	14.15	36,676,800	1.53	3,965,760	0.42	1,088,640	1.18	3,058,560
DEC	8.53	22,846,752	0.52	1,392,768	0.26	696,384	0.71	1,901,664
ANNUAL, mcm		456,003,648		42,871,680		31,599,936		26,195,616
MEAN, cms	14.37		1.35		1.00		0.83	
Irrigation								
Diversion								
mcm		20,766,617		5,754,248		13,620,690		27,596,702
cms	2.10		0.58		1.38		2.80	
TOTAL RUNOFF								
mcm		473,111,855		46,468,088		42,821,106		48,930,668
mm		1,820		2,112		1,477		816
BASEFLOW, mm	2.24	324	0.07	491	0.20	545	0.04	345
SURFACE RUNOFF, mm		1,495		1,621		931		471

Table 2-4(a) RESULTS OF SPRING SURVEY FOR DRY SEASON

SPR. NO.	NAME OF SPRING	LATITUDE (Deg-Min-Sec)	LONGITUDE (Deg-Min-Sec)	ELEVATION MSL	DISTANCE FROM POBLACION	BARANGAY MUNICIPALITY	DISCHARGE (lps)	pH	EC mS/cm	TEMP C	DATE OF SURVEY
1	IKLOY SPRING	14-11-05	120-52-20	327.00	1.50 km	Kaytambog, Indang, Cavite	181.22	7.09	0.292	25.40	05-07-94
2	NIYOG SPRING	14-10-53	120-53-14	360.00	2.00 km	Buna Cerca, Indang, Cavite	6.58	7.48	0.289	26.40	05-16-94
3	IPIE I SPRING	14-10-56	120-52-23	330.00	1.70 km	Kaytambog, Indang, Cavite	* 57.80	7.13	0.288	24.80	05-13-94
4	IPIE II SPRING	14-10-49	120-52-25	324.00	1.75 km	Kaytambog, Indang, Cavite	17.48	7.25	0.288	24.80	05-13-94
5	ULO SPRING	14-10-27	120-52-50	370.00	2.50 km	Kayquit, Indang, Cavite	5.31	7.02	0.287	24.85	05-16-94
6	BUHO SPRING	14-10-52	120-52-10	300.00	2.00 km	Kaytambog, Indang, Cavite	9.78	6.91	0.274	25.10	05-16-94
7	PULO SPRING	14-09-48	120-52-37	380.00	3.00 km	Pulo, Indang, Cavite	3.03	6.82	0.270	25.25	05-13-94
8	SILOY SPRING	14-08-33	120-52-25	440.00	6.50 km	Carasuchi, Indang, Cavite	38.68	6.92	0.301	24.60	05-13-94
9	SILID-SILIRAN	14-10-27	120-52-50	370.00	2.50 km	Kayquit, Indang, Cavite	6.04	7.41	0.288	24.80	05-16-94
10	LUCSUHIN SPRING	14-12-31	120-57-23	340.00	2.00 km	Lucsuhin, Silang, Cavite	* 11.71	7.03	0.285	25.80	05-25-94
11	ILOG NG BAYAN	14-13-31	120-58-26	310.00	0.20 km	Ilog Bayan, Silang, Cavite	1.60/(2.37)	8.53	0.386	30.40	05-12-94
12	SULSUGIN SPRING	14-10-26	120-57-50	425.00	5.50 km	Balete II, Silang, Cavite	0.827	7.86	0.256	24.95	05-12-94
13	PULONG USIW SPRING	14-08-08	121-00-27	550.00	10.00 km	Iruhin, Tagaytay City	0.586	6.89	0.275	24.30	05-16-94
14	MATANG TUBIG SPRING	14-08-09	120-59-10	530.00	8.00 km	Francisco, Tagaytay City	8.16	7.13	0.284	25.20	05-16-94
15	KAYBUBUTUNG SPRING	14-05-43	120-55-13	324.00	2.00 km	Sambong, Tagaytay City	168.4	8.67	0.279	25.20	05-10-94
16	SABANG I	14-21-11	120-55-18	50.00	3.50 km	Sabang, Dasmariñas, Cavite	0.985	7.45	0.357	27.25	05-12-94
17	SABANG III	14-21-02	120-55-35	48.00	3.00 km	Sabang, Dasmariñas, Cavite	0.227	7.39	0.391	27.40	05-12-94
18	BUCAL SPRING	14-16-58	120-57-26	130.00	5.80 km	Bucal, Dasmariñas, Cavite	3.47	8.00	0.429	28.30	05-07-94
19	BUCAL SPRING	14-11-05	120-56-22	390.00	2.50 km	Bucal, Amadeo, Cavite	0.212	8.01	0.282	25.70	05-12-94
20	BALETE SPRING	14-12-17	120-55-27	320.00	7.00 km	Halang, Amadeo Cavite	42.5	7.83	0.291	25.70	05-12-94
21	ALIBANDOG SPRING	14-07-24	120-51-53	475.00	2.50 km	Mangas I, Alfonso, Cavite	1.53/(1.64)	7.03	0.279	25.20	05-07-94
22	STA. THERESA I	14-07-45	120-49-07	370.00	4.50 km	Sta. Theresa, Alfonso, Cavit	11.36	6.78	0.244	25.60	05-14-94
23	STA. THERESA II	14-07-30	120-49-32	380.00	4.00 km	Sta. Theresa, Alfonso, Cavit	0.176	7.09	0.221	25.15	05-14-94
24	SALVACION	14-09-37	120-50-45	335.00	2.50 km	Taywanak Ilaya, Alfonso, C	1.098	7.40	0.222	25.05	05-14-94
25	TAYWANAK II	14-09-27	120-51-00	350.00	2.00 km	Taywanak Ilaya, Alfonso, C	0.43	7.34	0.241	25.30	05-14-94
26	TAYWANAK I	14-08-55	120-51-18	380.00	1.00 km	Taywanak Ilaya, Alfonso, C	0.72	7.06	0.290	25.05	05-14-94

* VALUES TAKEN FROM PREVIOUS STUDIES
0 MINOR SPRINGS

Table 2-4(b) RESULTS OF SPRING SURVEY FOR RAINY SEASON

SPR. NO.	NAME OF SPRING	LATITUDE (Deg-Min-Sec)	LONGITUDE (Deg-Min-Sec)	ELEVATION MSL	DISTANCE FROM POBLACION	BARANGAY MUNICIPALITY	DISCHARGE (lps)	pH	EC mS/cm	TEMP C	DATE OF SURVEY
1	IKLOY SPRING	14-11-10	120-52-14	327.00	1.50 km	Kaytambog, Indang, Cavite	209.00	6.20	0.291	25.20	09-17-94
2	NIYOG SPRING	14-10-53	120-53-14	360.00	2.00 km	Buna Cerca, Indang, Cavite	11.72	6.60	0.304	25.40	09-15-94
3	IPIE I SPRING	14-11-03	120-52-23	330.00	1.70 km	Kaytambog, Indang, Cavite	70.00	7.00	0.291	25.50	09-17-94
4	IPIE II SPRING	14-10-59	120-52-27	324.00	1.75 km	Kaytambog, Indang, Cavite	159.00	7.00	0.260	25.00	09-17-94
5	ULO SPRING	14-10-29	120-52-50	370.00	2.50 km	Kayquit, Indang, Cavite	21.50	6.50	0.289	25.50	09-15-94
6	BUHO SPRING	14-10-57	120-52-12	300.00	2.00 km	Kaytambog, Indang, Cavite	16.00	6.30	0.276	25.80	09-17-94
7	PULO SPRING	14-10-39	120-51-59	380.00	3.00 km	Pulo, Indang, Cavite	44.79	6.10	0.280	25.80	09-15-94
8	SILOY SPRING	14-08-52	120-52-26	440.00	6.50 km	Carasuchi, Indang, Cavite	68.50	6.40	0.303	25.10	09-15-94
9	SILID-SILIRAN	14-10-27	120-52-50	370.00	2.50 km	Kayquit, Indang, Cavite	16.26	6.50	0.293	25.40	09-15-94
10	LUCSUHIN SPRING	14-12-31	120-57-23	340.00	2.00 km	Lucsuhin, Silang, Cavite	* 11.71	7.00	0.281	25.80	09-15-94
11	ILOG NG BAYAN	14-13-25	120-58-28	310.00	0.20 km	Ilog Bayan, Silang, Cavite	4.35/(2.50)	6.40	0.395	25.80	09-14-94
12	SULSUGIN SPRING	14-11-38	120-58-03	425.00	5.50 km	Balete II, Silang, Cavite	0.89	6.70	0.270	25.50	09-14-94
13	PULONG USIW SPRING	14-10-08	121-00-56	550.00	10.00 km	Iruhin, Tagaytay City	0.56	6.20	0.293	24.80	09-14-94
14	MATANG TUBIG SPRING	14-08-23	120-59-15	530.00	8.00 km	Francisco, Tagaytay City	26.30	6.30	0.224	24.80	09-14-94
15	KAYBUBUTONG SPRING	14-05-38	120-55-28	324.00	2.00 km	Sambong, Tagaytay City	177.00	8.40	0.265	25.00	09-16-94
16	SABANG I	14-21-06	120-55-15	50.00	3.50 km	Sabang, Dasmariñas, Cavite	1.03	6.50	0.394	27.50	09-14-94
17	SABANG III	14-21-02	120-55-35	48.00	3.00 km	Sabang, Dasmariñas, Cavite	0.75	6.50	0.402	28.10	09-17-94
18	BUCAL SPRING	14-16-58	120-57-26	130.00	5.80 km	Bucal, Dasmariñas, Cavite	5.00	7.40	0.403	26.50	09-06-94
19	BUCAL SPRING	14-10-29	120-56-04	390.00	2.50 km	Bucal, Amadeo, Cavite	0.57	6.60	0.275	24.60	09-14-94
20	BALETE SPRING	14-12-06	120-54-50	320.00	7.00 km	Halang, Amadeo Cavite	44.80	7.70	0.294	25.60	09-14-94
21	ALIBANDOG SPRING	14-07-24	120-51-53	475.00	2.50 km	Mangas I, Alfonso, Cavite	.73/(3.26)	6.80	0.276	25.00	09-13-94
22	STA. THERESA I	14-07-45	120-49-07	370.00	4.50 km	Sta. Theresa, Alfonso, Cavite	18.70	6.50	0.222	25.20	09-13-94
23	STA. THERESA II	14-07-38	120-49-29	380.00	4.00 km	Sta. Theresa, Alfonso, Cavite	1.56	6.40	0.238	25.20	09-13-94
24	SALVACION	14-09-48	120-50-18	335.00	2.50 km	Taywanak Ilaya, Alfonso, Cavite	5.15	6.60	0.286	25.20	09-13-94
25	TAYWANAK II	14-09-49	120-51-51	350.00	2.00 km	Taywanak Ilaya, Alfonso, Cavite	4.33	6.40	0.272	25.30	09-13-94
26	TAYWANAK I	14-08-55	120-51-18	380.00	1.00 km	Taywanak Ilaya, Alfonso, Cavite	2.49	6.60	0.282	25.10	09-13-94

* VALUES TAKEN FROM PREVIOUS STUDIES
0 MINOR SPRINGS

Table 2-5(a) RESULTS OF RIVER SURVEY FOR DRY SEASON

STN. NO.	NAME OF RIVER / CREEK	Latitude (Deg-Min-Sec)	Longitude (Deg-Min-Sec)	BARANGAY	MUNICIPALITY	DISCHARGE (lps)	pH	EC mS/cm	Temp C	DATE OF SURVEY	REMARKS
1	DASMARIÑAS RIVER	14-17-10	121-02-17	Bucal	Dasmariñas	123.73	8.00	0.328	28.37	05-07-94	
2	ILANG-ILANG RIVER	14-19-25	120-55-32	San Francisco	General Trias	88.00	7.96	0.332	28.40	05-07-94	Diversion Channel
3	ILANG-ILANG RIVER	14-20-35	120-55-22	San Jose	Dasmariñas	10.02	8.70	0.370	33.60	05-07-94	
4	ILANG-ILANG RIVER	14-23-31	120-54-17	Alapan	Imus	35.60	8.64	0.390	30.75	05-08-94	Gaging Station
5	DASMARIÑAS RIVER	14-19-53	120-55-42	Fiesta Subd., San Jose	Dasmariñas	182.00	8.03	0.470	28.35	05-07-94	Diversion Channel
6	PASONG CAMACHILE RIVER	14-22-32	120-53-32	Pasong Camachile	General Trias	49.52	8.14	0.381	28.60	05-08-94	Diversion Dam
7	RIO GRANDE RIVER	14-22-48	120-52-43	Prinza	General Trias	157.38	8.24	0.342	30.20	05-08-94	Diversion Channel
8	RIO GRANDE RIVER	14-18-52	120-54-43	Buenavista	General Trias	544.30	8.36	0.285	25.75	05-09-94	
9	PANAYSAYAN RIVER	14-20-20	120-52-43	Pasong Cawayan II	General Trias	78.24	8.77	0.291	30.70	05-08-94	Gaging Station
10	CAÑAS RIVER	14-20-22	120-52-19	Pasong Cawayan II	General Trias	233.73	8.18	0.344	28.70	05-08-94	
11	CAÑAS RIVER	14-20-22	120-52-26	Pasong Cawayan II	General Trias	30.46	8.05	0.415	28.15	05-08-94	
12	PALUBLUBAN RIVER	14-23-11	120-52-15	San Juan	General Trias	346.10	8.29	1.850	30.30	05-08-94	
13	BALSAHAN RIVER	14-17-00	120-53-15	Palangui	Naic	115.60	8.36	0.277	27.50	05-09-94	Gaging Station
14	BALSAHAN RIVER	14-14-12	120-50-30	Calumpang Lejos	Indang	638.60	9.29	0.291	29.10	05-09-94	Upstream of Diversion Dam
15	ALEMANG RIVER	14-18-50	120-47-28	Sabang	Naic	381.50	8.73	0.373	31.75	05-09-94	Diversion Channel
16	MARAGONDON RIVER	14-16-22	120-46-36	Mabacao	Maragondon	1,037.90	8.96	0.256	29.45	05-09-94	
17	MARAGONDON RIVER	14-15-47	120-47-35	Balayungan	Maragondon	1,496.40	8.77	0.258	29.22	05-09-94	Upstream of Diversion Dam
18	MARAGONDON RIVER	14-16-19	120-44-52	Bucal	Maragondon	1,380.85	8.72	0.262	29.05	05-10-94	Upstream of Gaging Station
19	BIÑAN RIVER	14-17-03	121-02-43	Timbao	Carmona	12.80	8.10	0.301	28.25	05-10-94	
20	BIÑAN RIVER	14-17-28	121-02-30	Lantic	Carmona	13.00	9.00	0.396	31.30	05-10-94	
21	BIÑAN RIVER	14-18-07	121-02-19	Lantic	Carmona	11.36	9.04	0.351	27.60	05-10-94	
22	BIÑAN RIVER	14-18-57	121-02-45	Mabuhay	Carmona	8.58	8.84	0.400	31.00	05-13-94	
23	IMUS RIVER	14-21-00	120-56-39	Salatran III	Dasmariñas	67.05	8.67	0.610	32.90	05-14-94	Diversion Channel
24	BALUCTOT RIVER	14-21-05	120-58-12	Salawag	Dasmariñas	16.00	8.03	0.334	31.15	05-14-94	
25	IMUS RIVER	14-22-33	120-56-27	Anabu Segunda	Imus	50.70	8.80	0.768	31.60	05-14-94	
26	UNNAMED RIVER	14-05-23	120-58-48	Caloocan	Talisay	38.30	8.30	0.263	31.90	05-31-94	
27	BUBUTONG RIVER	14-04-13	120-56-13	Leviste	Laurel	76.00	9.00	0.294	28.00	05-31-94	Upstream of Diversion Dam
28	PATA CREEK	14-03-42	120-56-04	Pata	Laurel	16.60	8.06	0.523	30.30	05-31-94	
29	BENIRAYAN CREEK	14-05-12	120-57-53	Benirayan	Talisay	11.70	8.96	0.571	29.30	05-31-94	
30	CALOOCAN RIVER	14-05-20	120-58-17	Sampaloc	Talisay	11.90	8.98	0.407	28.10	05-31-94	

Table 2-5(b) RESULTS OF RIVER SURVEY FOR RAINY SEASON

STN. NO.	NAME OF RIVER / CREEK	Latitude (Deg-Min-Sec)	Longitude (Deg-Min-Sec)	BARANGAY	MUNICIPALITY	DISCHARGE (lps)	pH	EC mS/cm	Temp C	DATE OF SURVEY	REMARKS
1	DASMARIÑAS RIVER	14-17-07	120-57-22	Bucal	Dasmariñas	269.90	8.10	0.333	29.60	09-06-94	
2	ILANG-ILANG RIVER	14-19-25	120-55-32	San Francisco	General Trias	38.30	8.10	1.394	33.10	09-06-94	Diversion Channel
3	ILANG-ILANG RIVER	14-20-35	120-55-22	San Jose	Dasmariñas	171.90	8.00	0.275	28.00	09-06-94	
4	ILANG-ILANG RIVER	14-23-14	120-54-13	Alapan	Imus	69.70	8.00	0.286	31.30	09-07-94	
5	DASMARIÑAS RIVER	14-19-50	120-55-38	Fiesta Subd., San Jose	Dasmariñas	421.50	7.60	0.305	27.20	09-06-94	Kasundu Dam
6	PASONG CAMACHILE RIVER	14-22-32	120-53-32	Pasong Camachile	General Trias	388.90	7.70	0.360	28.70	09-07-94	Pasong Camachile Dam
7	RIO GRANDE RIVER	14-22-48	120-52-43	Prinza	General Trias	557.90	7.70	0.296	30.50	09-07-94	Bayan Dam
8	RIO GRANDE RIVER	14-18-52	120-54-43	Buenavista	General Trias	969.60	7.90	0.315	29.20	09-07-94	
9	PANAYSAYAN RIVER	14-20-20	120-52-43	Pasong Cawayan II	General Trias	212.10	8.40	0.342	31.30	09-07-94	BRS Gaging Station
10	CAÑAS RIVER	14-20-22	120-52-13	Pasong Cawayan II	General Trias	56.90	8.00	0.283	30.30	09-07-94	
11	CAÑAS RIVER	14-20-22	120-52-19	Pasong Cawayan II	General Trias	75.20	7.60	0.327	28.50	09-07-94	
12	PALUBLUBAN RIVER	14-21-35	120-52-12	Pinagtipunan	General Trias	362.00	7.70	0.348	27.70	09-07-94	
13	BALSAHAN RIVER	14-17-00	120-48-15	Palangui	Naic	94.50	8.30	0.285	27.30	09-09-94	
14	BALSAHAN RIVER	14-14-12	120-50-30	Calumpang Lejos	Indang	808.60	8.30	0.283	25.80	09-09-94	Culong-Culong Dam
15	ALEMANG RIVER	14-18-50	120-47-25	Sabang	Naic	712.30	7.60	0.337	28.50	09-09-94	Sabing Dam
16	MARAGONDON RIVER	14-16-27	120-46-35	Mabacao	Maragondon	4,091.20	8.30	0.230	27.50	09-09-94	
17	MARAGONDON RIVER	14-15-07	120-47-54	Pantijan	Maragondon	2,393.70	8.20	0.281	28.00	09-09-94	
18	MARAGONDON RIVER	14-16-25	120-45-30	Bucal	Maragondon	4,853.40	8.10	0.242	27.30	09-09-94	BRS Gaging Station
19	BIÑAN RIVER	14-17-03	121-02-43	Timbao	Carmona	137.5	7.80	0.340	28.20	09-10-94	
20	BIÑAN RIVER	14-17-28	121-02-30	Lantic	Carmona	31.20	7.20	0.382	27.80	09-10-94	
21	BIÑAN RIVER	14-18-07	121-02-09	Lantic	Carmona	49.30	7.90	0.229	27.50	09-10-94	
22	BIÑAN RIVER	14-18-56	121-02-20	Mabuhay	Carmona	131.40	8.10	0.311	28.40	09-10-94	
23	IMUS RIVER	14-21-06	120-56-30	Salitran III	Dasmariñas	407.60	7.40	0.331	27.10	09-06-94	Salitran Dam
24	BALUCTOT RIVER	14-21-05	120-58-12	Salawag	Dasmariñas	402.80	7.70	0.265	27.30	09-10-94	
25	IMUS RIVER	14-22-33	120-56-27	Anabu Segunda	Imus	810.40	8.50	0.669	31.60	09-10-94	
26	UNNAMED RIVER	14-05-21	120-58-45	Caloocan	Talisay	73.20	8.40	0.311	31.20	09-10-94	
27	BUBUTONG RIVER	14-04-13	120-56-13	Leviste	Laurel	78.60	8.50	0.313	28.40	09-10-94	Upstream of Diversion Dam
28	PATA CREEK	14-03-42	120-56-04	Pata	Laurel	26.20	7.60	0.554	31.50	09-10-94	
29	BENIRAYAN CREEK	14-05-14	120-57-51	Benirayan	Talisay	14.40	8.60	0.605	29.50	09-10-94	
30	CALOOCAN RIVER	14-05-20	120-58-17	Sampaloc	Talisay	25.30	8.60	0.422	27.30	09-10-94	
31	HASAAN CREEK	14-19-19	120-55-45	San Francisco	General Trias	504.50	8.30	0.285	28.50	09-06-94	Hasaan Dam
32	ILANG-ILANG RIVER	14-19-39	120-55-42	San Francisco	General Trias	212.70	8.20	0.281	27.80	09-06-94	
33	IMUS RIVER	14-20-15	120-56-55	San Manuel	Dasmariñas	465.30	7.50	0.337	27.90	09-10-94	Justo Dam

Table 2-6 RESULTS OF SPRING SURVEY QUESTIONAIRE

SPRING NUMBER	NAME OF SPRING	LOCATION	ELEVATION ABOVE POBLACION, m	TYPE OF SPRING	USER	POPULATION SERVED	FACILITIES
S-1	IKLOY**	Kaytambog, Indang	27	Depression	Indang Water District	6,490 (1990)	Spring Box with 18" dia. pipe to Pumping Station, 2" dia. and 4" dia. transmission pipes
S-2	NIYOG**	Buna Cerca, Indang	60	Depression	Privately Owned Factory		Spring Box with 3/4" dia. intake pipe (2) 2" dia. and 6" dia. overflow pipes
S-3	IPIE I	Kaytambog, Indang	30	Depression	Indang Water District	590 (1990)	Spring Box with 4" dia. intake pipe
S-4	IPIE II	Kaytambog, Indang	24	Depression	Indang Water District	5,900 (1990)	Spring Box with 4" dia. supply pipe to Ikloy and 4" dia. overflow pipe
S-5	ULO	Kayquit, Indang	70	Contact	Brgy. Kayquit	3,670 (1990)	None
S-6	BUHO	Kaytambog, Indang	30	Depression	Brgy. Kaytambog	590 (1990)	Spring Box with 4" dia. overflow pipe
S-7	PULO	Pulo, Indang	80	Depression	Brgy. Pulo	470 (1990)	3" dia. and 4" dia. intake pipes
S-8	SILOY	Carasuchi, Indang	140	Depression	Brgy. Banaba	890 (1990)	Spring Box with 6" dia. supply pipe and (2) 6" dia. overflow pipes
S-9	SILID-SILIRAN	Kayquit, Indang	70	Depression	Brgy. Kayquit	3,670 (1990)	None
S-10	LUCSUHIN**	Lucsuhin, Silang	23	Depression	Silang Water District	23,746 (1994)	Pumping Station
S-11	ILOG NG BAYAN**	Ilog Bayan, Silang	-7	Depression	Brgy. Ilog Bayan	1,922 (1994)	Spring Box with (3) 3" dia. overflow pipes
S-12	SULSUGIN	Balete II, Silang	105	Depression	Brgy. Balete II		None
S-13	PULONG USIW	Iruhin, Tagaytay City	-122	Depression	Tagaytay City Water District		Pumping Station
S-14	MATANG TUBIG**	Francisco, Tagaytay Cit	-142	Depression	Tagaytay City Water District		Pumping Station
S-15	KAYBUBUTUNG**	Sambong, Tagaytay City	-348	Impervious Rock	Tagaytay City Water District		Reservoir and Pumping Station
S-16	SABANG I	Sabang, Dasmariñas	-30	Artesian	Brgy. Sabang	2,174 (1994)	2" and 1" dia. overflow pipes
S-17	SABANG III	Sabang, Dasmariñas	-32	Artesian	Brgy. Sabang	2,174 (1994)	None
S-18	BUCAL**	Bucal, Dasmariñas	50	Depression	Dasmariñas Water District	705 (1994)	Spring Box with 6" dia. transmission pipe, (3) 4" dia. overflow pipes and (2) 4" dia. drain pipes
S-19	BUCAL	Bucal, Amadeo	-40	Depression	Brgy. Bucal		None
S-20	BALETE**	Halang, Amadeo	-90	Depression	Brgy. Halang		None
S-21	ALIBANDOG**	Mangas I, Alfonso	75	Depression	Poblacion		Spring Box with 6" dia. supply pipe and 3" dia. overflow pipe
S-22	STA. THERESA I**	Sta. Theresa, Alfonso	-30	Depression	Brgy. Sta. Theresa		Spring Box with 4" dia. supply pipe and 3" dia. overflow pipe
S-23	STA. THERESA II	Sta. Theresa, Alfonso	-20	Depression	Brgy. Sta. Theresa		None
S-24	SALVACION	Taywanak Ilaya, Alfonso	-65	Depression	Brgy. Taywanak		Spring box with 4" dia. intake pipe
S-25	TAYWANAK II	Taywanak Ilaya, Alfonso	-50	Depression	Brgy. Taywanak		None
S-26	TAYWANAK I	Taywanak Ilaya, Alfonso	-80	Depression	Brgy. Taywanak		Spring box with 3" dia. intake pipe
S-27	KAYBUBUTONG II						
S-28	KAYBAGAL						

* VALUES TAKEN FROM PREVIOUS STUDIES
** SAMPLING POINTS FOR WATER QUALITY ANALYSIS
( ) MINOR SPRINGS
LATITUDE, LONGITUDE, ELEVATIONS AND DISTANCE WERE BASED FROM THE TOPOGRAPHIC MAP

Table 2-7 DESCRIPTION OF SAMPLING POINTS FOR SPRINGS

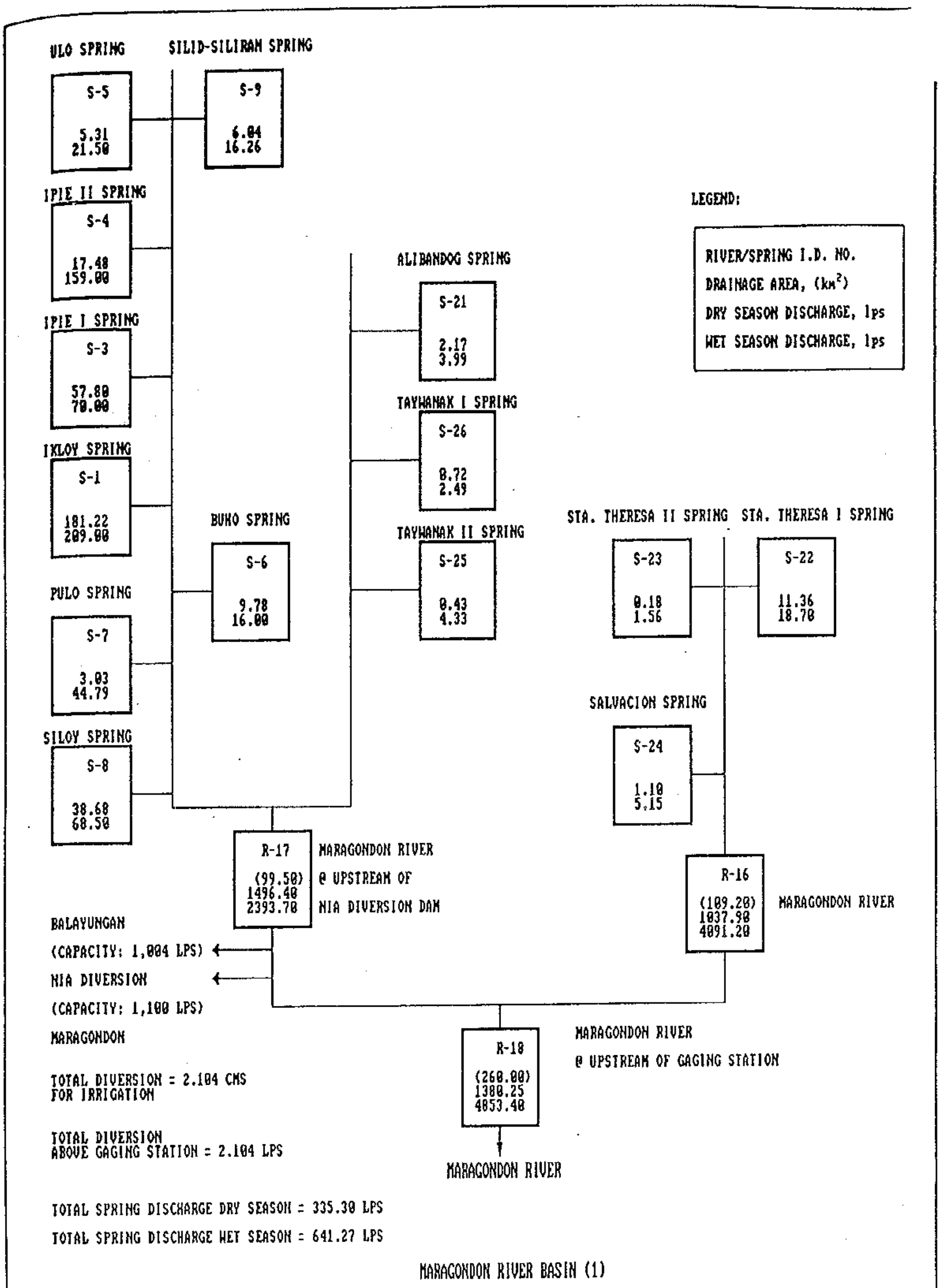
SPR NO.	NAME OF SPRING	LATITUDE (Deg-Min-Sec)	LONGITUDE (Deg-Min-Sec)	BARANGAY MUNICIPALITY	DISTANCE FROM POBLACION	ELEVATION MSL	DATA OF SURVEY DRY SEASON	RAINY SEASON
1	STA. THERESA I	14-07-45	120-49-07	Sta. Theresa, Alfonso, Cavite	4.50 km	370.00	05-14-94	09-13-94
2	ALIBANDOG SPRING	14-07-24	120-51-53	Mangas I, Alfonso, Cavite	2.50 km	475.00	05-07-94	09-13-94
3	IKLOY SPRING	14-11-10	120-52-14	Kaytambog, Indang, Cavite	1.50 km	327.00	05-07-94	09-17-94
4	KAYBUBUTONG SPRING	14-05-38	120-55-28	Sambong, Tagaytay City	2.00 km	324.00	05-10-94	09-16-94
5	BALETE SPRING	14-12-06	120-54-50	Halang, Amadeo Cavite	7.00 km	320.00	05-12-94	09-14-94
6	MATANG TUBIG SPRING	14-08-23	120-59-15	Francisco, Tagaytay City	8.00 km	530.00	05-16-94	09-14-94
7	NIYOG SPRING	14-10-53	120-53-14	Buna Cerca, Indang, Cavite	2.00 km	360.00	05-16-94	09-15-94
8	LUCSUHIN SPRING	14-12-31	120-57-23	Lucsuhin, Silang, Cavite	2.00 km	340.00	05-25-94	09-15-94
9	ILOG NG BAYAN	14-13-25	120-58-28	Ilog Bayan, Silang, Cavite	0.20 km	310.00	05-12-94	09-14-94
10	BUCAL SPRING	14-16-58	120-57-26	Bucal, Dasmariñas, Cavite	5.80 km	130.00	05-07-94	09-06-94

* VALUES TAKEN FROM PREVIOUS STUDIES
0 MINOR SPRINGS

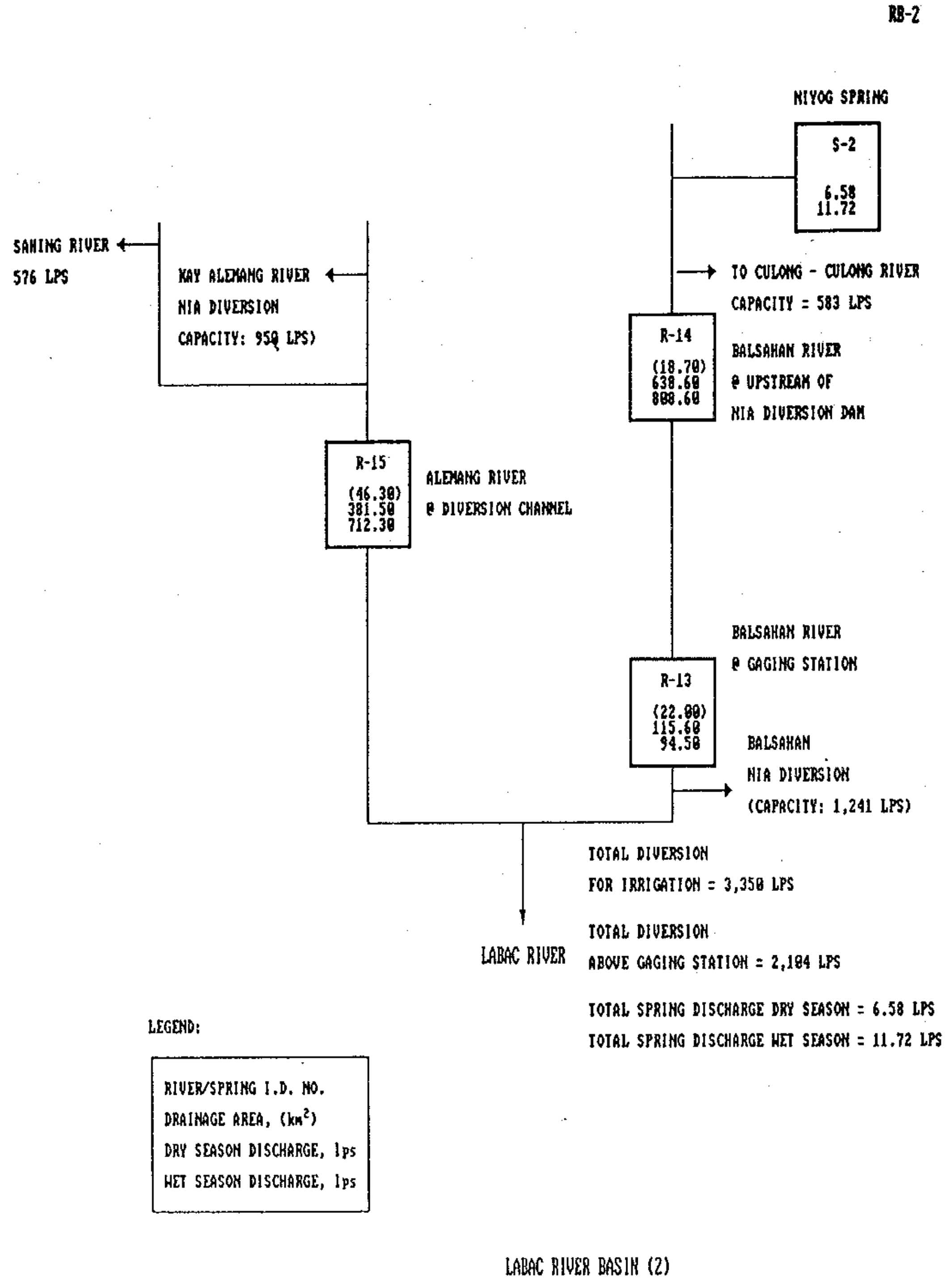
Table 2-8 DESCRIPTION OF SAMPLING POINTS FOR RIVERS

STN. NO.	NAME OF RIVER	Latitude (Deg-Min-Sec)	Longitude (Deg-Min-Sec)	BARANGAY	MUNICIPALITY	DATA OF SURVEY DRY SEASON	RAINY SEASON
1	MARAGONDON RIVER	14-16-25	120-45-30	Bucal	Maragondon	05-10-94	09-09-94
2	MARAGONDON RIVER	14-16-27	120-46-35	Mabacao	Maragondon	05-09-94	09-09-94
3	BALSAHAN RIVER	14-14-12	120-50-30	Calumpang Lejos	Indang	05-09-94	09-09-94
4	CAÑAS RIVER	14-15-00	120-52-45	Bitaingan	Trece Martires	05-20-94	10-11-94
5	RIO GRANDE RIVER	14-18-52	120-54-43	Buenavista	General Trias	05-09-94	09-07-94
6	ILANG-ILANG RIVER	14-20-35	120-55-22	San Jose	Dasmariñas	05-07-94	09-06-94
7	PANAYSAYAN RIVER	14-20-20	120-52-43	Pasong Cawayan II	General Trias	05-08-94	09-07-94
8	IMUS RIVER	14-21-06	120-56-30	Salitran III	Dasmariñas	05-14-94	09-06-94
9	BIÑAN RIVER	14-17-28	121-02-30	Lantic	Carmona	05-10-94	09-10-94
10	BIÑAN RIVER	14-19-50	121-04-35	Maduya	Carmona	05-23-94	10-18-94

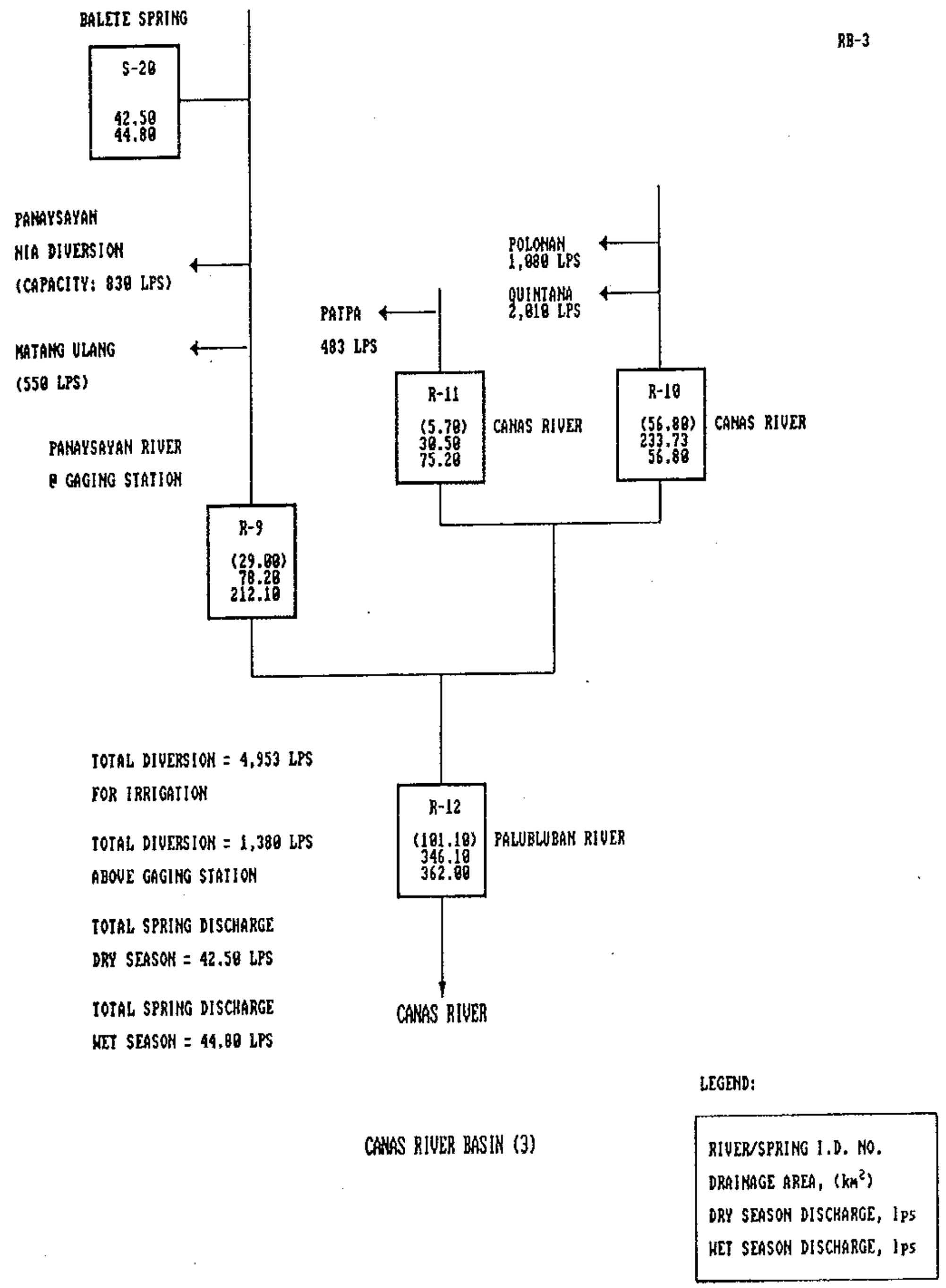
- DISCHARGE WAS NOT MEASURED



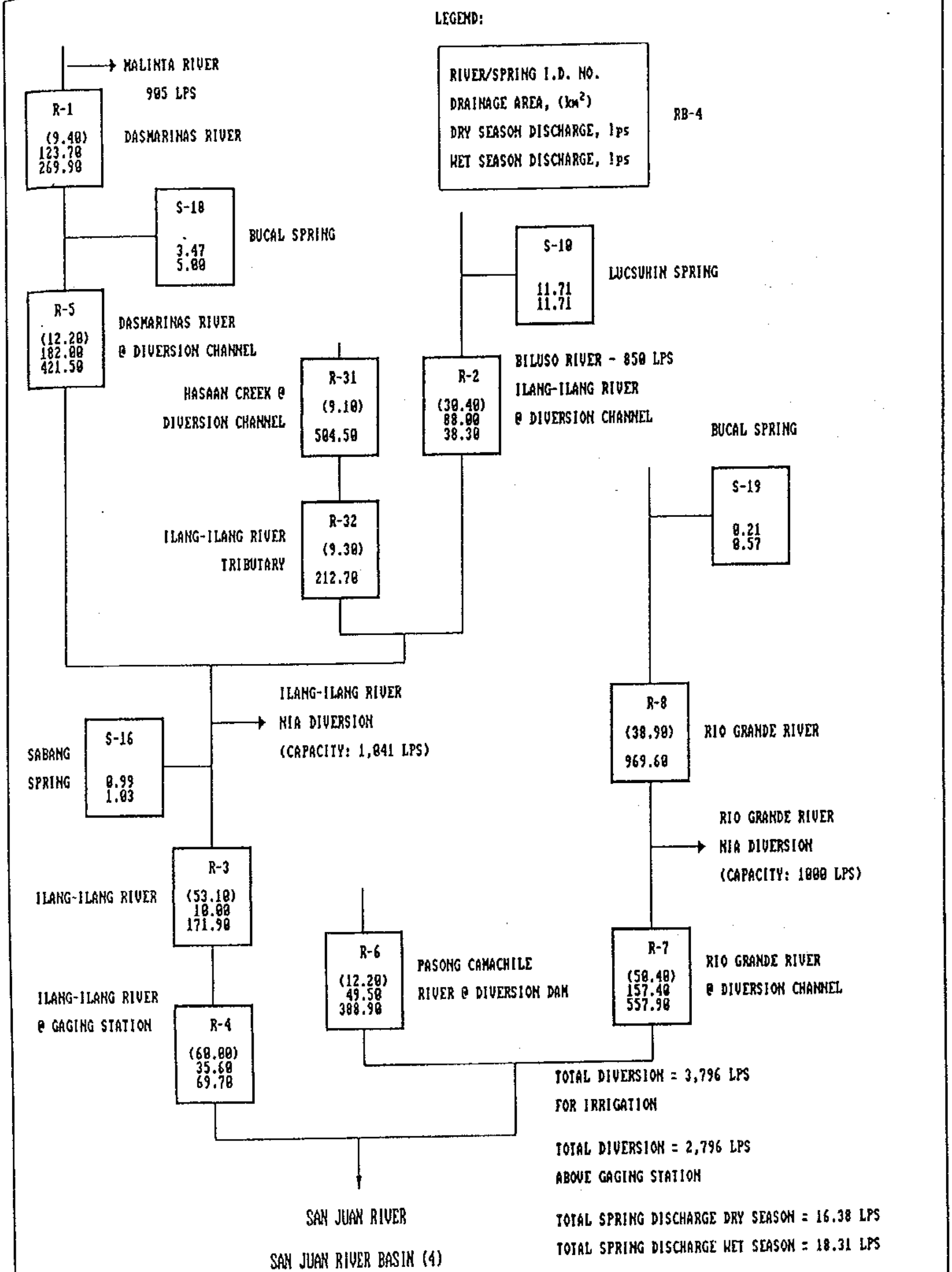
CAVITE WATER SUPPLY DEVELOPMENT STUDY	**Fig. 2-1**
JAPAN INTERNATIONAL COOPERATION AGENCY	FLOW SCHEME OF MARAGONDON RIVER BASIN SYSTEM



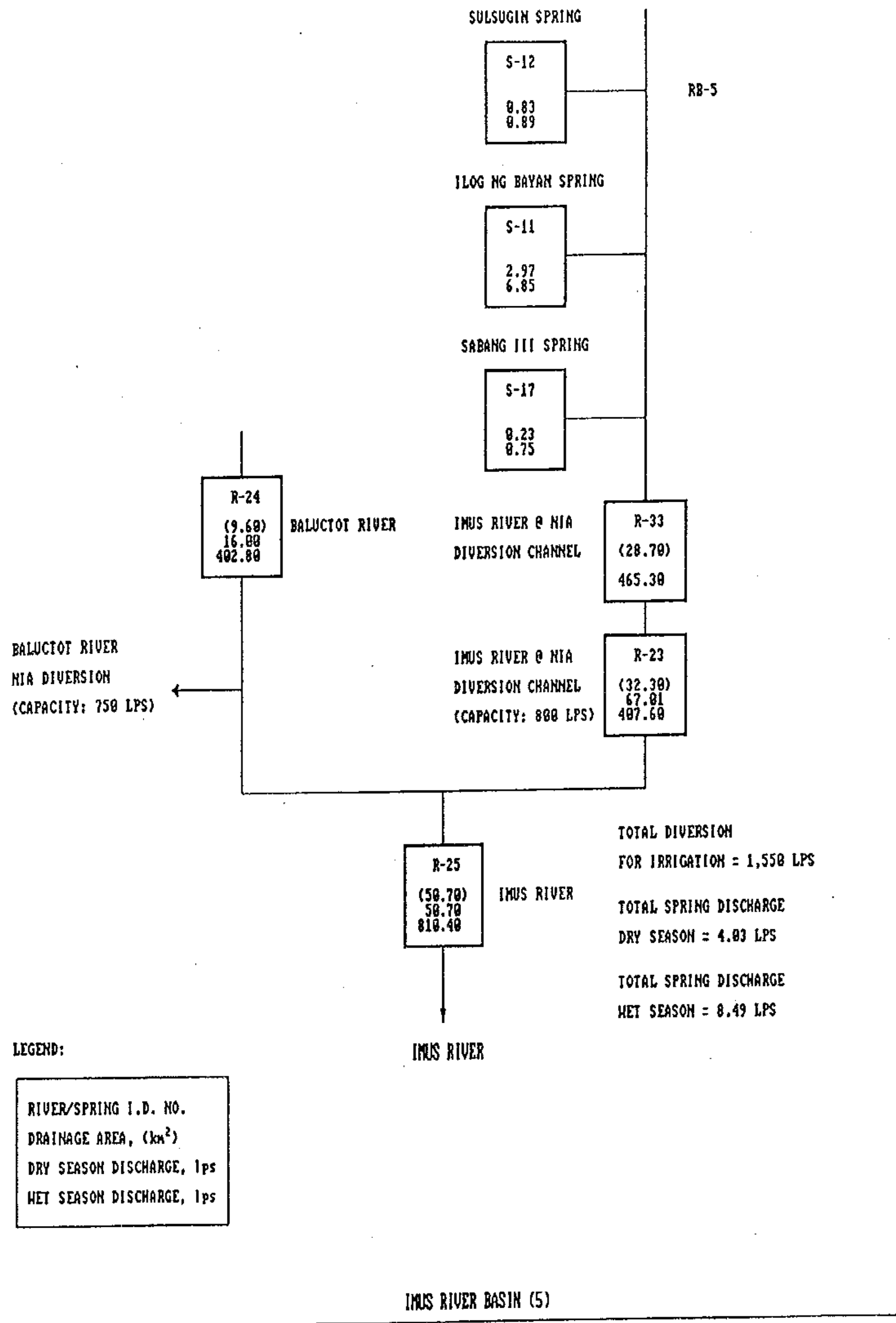
CAVITE WATER SUPPLY DEVELOPMENT STUDY	Fig. 2-2
JAPAN INTERNATIONAL COOPERATION AGENCY	FLOW SCHEME OF LABAC RIVER BASIN SYSTEM



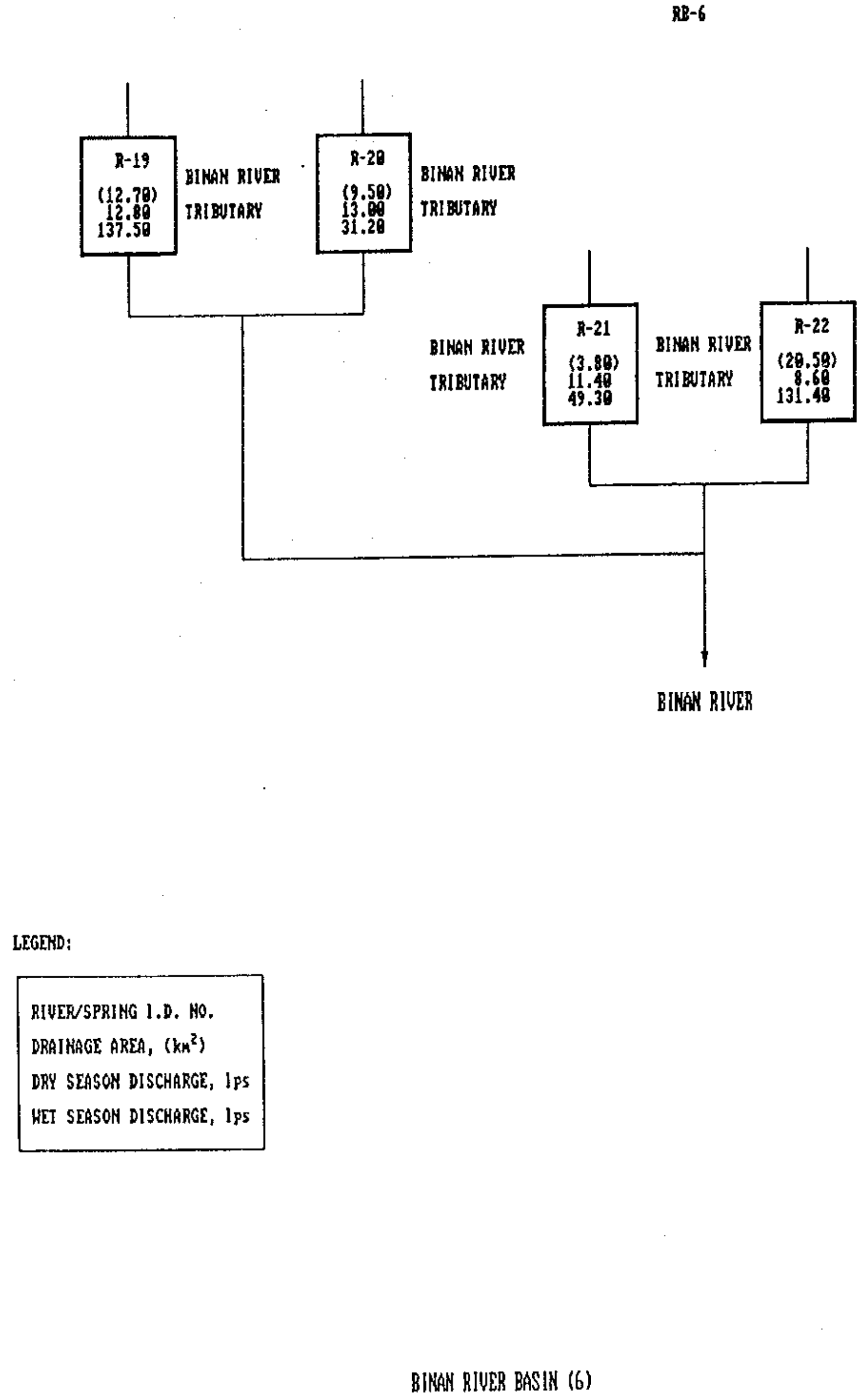
CAVITE WATER SUPPLY DEVELOPMENT STUDY	**Fig. 2-3**
JAPAN INTERNATIONAL COOPERATION AGENCY	FLOW SCHEME OF CAÑAS RIVER BASIN SYSTEM



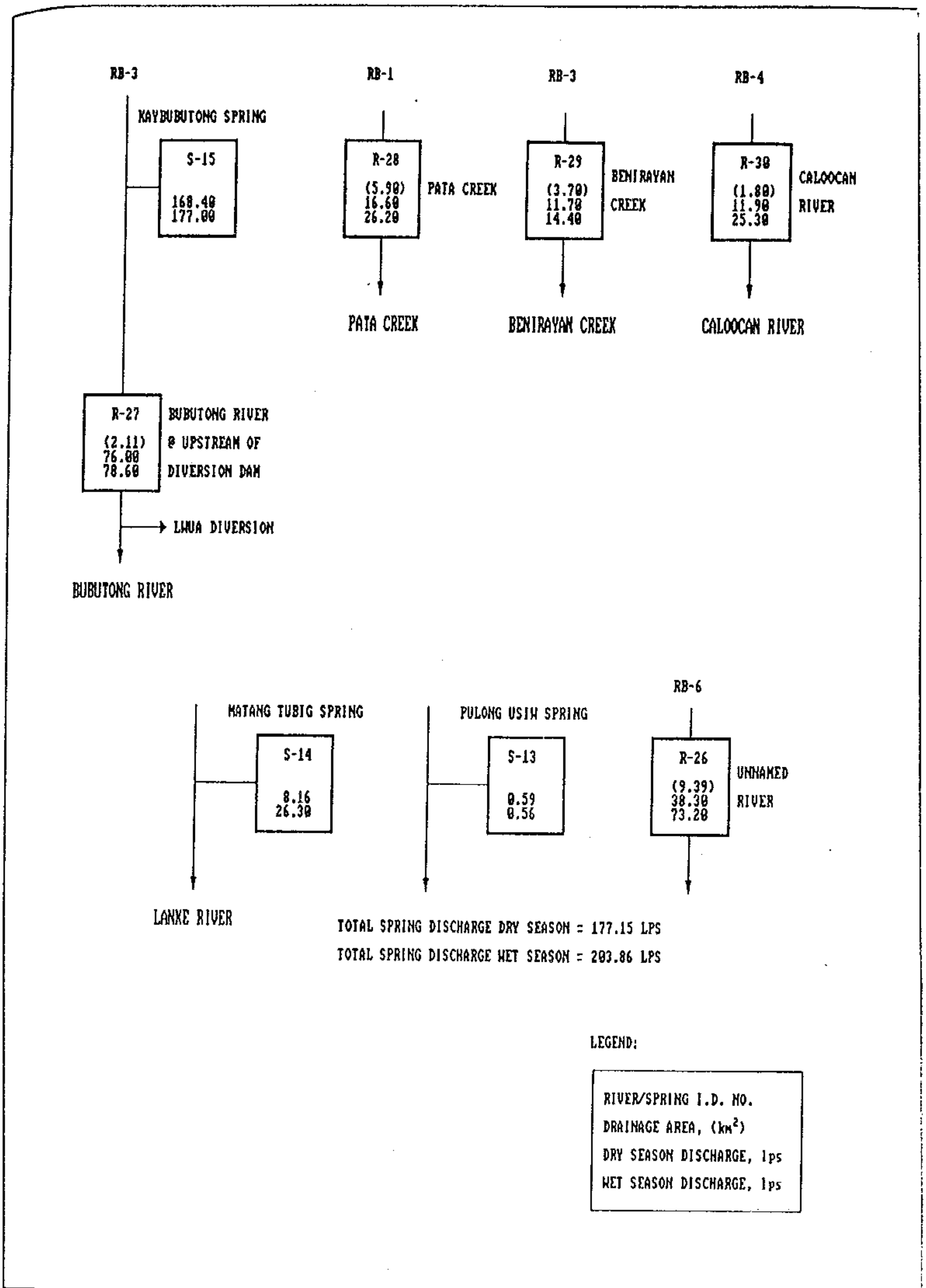
CAVITE WATER SUPPLY DEVELOPMENT STUDY	**Fig. 2-4** FLOW SCHEME OF SAN JUAN RIVER BASIN SYSTEM
JAPAN INTERNATIONAL COOPERATION AGENCY	



CAVITE WATER SUPPLY DEVELOPMENT STUDY	**Fig. 2-5** FLOW SCHEME OF IMUS RIVER BASIN SYSTEM
JAPAN INTERNATIONAL COOPERATION AGENCY	



CAVITE WATER SUPPLY DEVELOPMENT STUDY	**Fig. 2-6**
JAPAN INTERNATIONAL COOPERATION AGENCY	FLOW SCHEME OF BIÑAN RIVER BASIN SYSTEM



CAVITE WATER SUPPLY DEVELOPMENT STUDY	**Fig.2-7**
JAPAN INTERNATIONAL COOPERATION AGENCY	FLOW SCHEME OF RIVER SYSTEMS BELOW TAGAYTAY RIDGE ON BATANGAS SIDE

3. PUMPING DISCHARGE SURVEY

3. PUMPING DISCHARGE SURVEY

3.1 METHODOLOGY AND SURVEY AREA

A Pumping Discharge Survey of the Study Area were conducted to estimate the amount of groundwater use in the objective area for groundwater simulation.

The survey area covers the San Juan River Basin, the objective area for groundwater simulation and its vicinity. The San Juan River Basin is bounded by Tagaytay Ridge to the south, Aguinaldo Highway to the east, Manila Bay to the north, and Tagaytay-Gen. Trias Road to the west. It comprises portions of Tagaytay City, Amadeo, Silang, Dasmarinas, Gen. Trias, Imus, Noveleta, and Kawit.

The survey was carried out using the questionnaire method. A total of 117 deep wells in the simulation area and its vicinity were visited, and survey questionnaire forms were handed to the well owners for them to accomplish. Accomplished survey questionnaire forms were collected on the date arranged with the well owners.

These wells were located from different private well owners, Water Districts, Barangay Water Supply, Rural Waterworks and Sanitation Association and MWSS. Out of 117 wells, only 22 wells were included and registered in the Philippine Groundwater Data Bank (PGDB). The remaining 95 wells were located and surveyed in the field considering better distribution in the groundwater simulation area. The distribution of 117 well owners among the municipalities and city in the simulation area was surveyed regardless of whether the well is for industrial, commercial, institutional or public supply use. The distribution of this 117 wells by Municipality are as follows:

MUNICIPALITY	NO. OF SURVEYED WELLS
Amadeo	7
Dasmarinas	41
Gen. Trias	20
Imus	7
Kawit	5
Noveleta	6
Rosario	9
Silang	17
Tagaytay City	5
Total	117

Of which, one hundred ten (110) wells were operational, three (3) wells inactive, and four (4) wells standby. Two-thirds of the 117 wells are located in Dasmarinas (41), Trias (20) and Silang (17). **Fig. 3.1** plots the location of the 117 surveyed wells.

Table 3.1 shows the profile of data gathered during the survey. Note that well discharge was estimated in all the 117 wells.

Table 3.2 presents the distribution of surveyed wells in the survey area by municipality and type of user. Seventy four (74) wells are for domestic, thirty three (33) for industrial and ten (10) for commercial and institutional. Forty six (46) wells are located in Dasmarinas and Silang. Most industrial wells are located in Gen. Trias.

3.2 SURVEY RESULTS

Table 3.3 shows the average well discharge in the survey area by municipality and type of user. Industrial wells in Dasmarinas (24.86 lps). For domestic use, the highest well discharge is 15.46 lps in Dasmarinas, followed by Noveleta (11.53 lps). For institutional and commercial, the highest is 3.99 lps in Tagaytay and 21.00 lps in Dasmarinas, respectively.

Table 3.4, 3.5 and **3.6** presents respectively the average number of hours of operation per day in the survey area, the average number of days of operation per week, and the average number of weeks of operation per year.

Table 3.7 shows the total daily groundwater pumpage in the survey area by municipality and type of user. The highest amount of groundwater and its withdrawal is 59,618 cubic meters per day (CMD) (79.46%) for domestic use, second highest is 14,962 CMD (20%) for industrial use, third is 253 CMD (0.30%) for institutional use, and fourth is 184 CMD (0.24%) for commercial use. For domestic and commercial uses, Dasmarinas has the highest daily groundwater production at 36,254 CMD and 113 CMD respectively. Rosario at 7,140 CMD registers the highest production for industries. Only Tagaytay produces water for institutional use in the survey area. The top three municipalities in the groundwater production in the survey area are Dasmarinas with 38,504 CMD, Rosario with 8,892 CMD, and Silang with 8,166 CMD.

Table 3.8 shows the average static water level (SWL) in the survey area by municipality. The SWL is deeper in the upland such sa Tagaytay, Amadeo, and Silang, and shallower in the lowland like Rosario, Imus, and Noveleta.

Table 3.9 shows the average specific capacity in the survey area. The highest average can be found in Noveleta at 3.26 lps/m, followed by Imus at 3.12 lps/m. Third highest average is 1.94 lps/m in Dasmarinas, followed by 1.66 lps/m in Kawit.

Table 3.10 shows the present groundwater pumpage (MCM/year) by type of use and by river basin.

Table 3.1 SURVEYED DATA PROFILE

DATA	NO. OF WELLS WITH DATA	DATABASE FIELD NAME
WELL CODE	117	W_CODE
CITY/MUNICIPALITY	117	MUN
MUNICIPAL CODE	117	MUN_CODE
ADDRESS OF WELL SITE	117	ADDRESS
LATITUDE DEGREES	117	LAT_DEG
LATITUDE MINUTES	117	LAT_MIN
LATITUDE SECONDS	117	LAT_SEC
LONGITUDE DEGREES	117	LONG_DEG
LONGITUDE MINUTES	117	LONG_MIN
LONGITUDE SECONDS	117	LONG_SEC
X-COORDINATE	117	X
Y-COORDINATE	117	Y
OWNER	117	OWNER
PRESENT STATUS OF WELL	117	STATUS
DRILLER	39	DRILLER
YEAR CONSTRUCTED	77	COMP_YY
SURVEYED PUMPING DISCHARGE	117	SURDISC
AVE. PUMPING DISCHARGE IN DRY SEASON	64	DISC_DRY
AVE. PUMPING DISCHARGE IN RAINY SEASON	61	DISC_WET
AVE. NO. OF HOURS OF OPERATION PER DAY IN DRY SEASON	108	HOPD_DRY
AVE. NO. OF HOURS OF OPERATION PER DAY IN RAINY SEASON	107	HOPD_WET
AVE. NO. OF DAYS OF OPERATION PER WEEK IN DRY SEASON	105	DOPW_DRY
AVE. NO. OF DAYS OF OPERATION PER WEEK IN RAINY SEASON	105	DOPW_WET
AVE. NO. OF WEEKS OF OPERATION PER YEAR	92	WOPY
YIELD	67	YLD
PUMPING WATER LEVEL	72	PWL
STATIC WATER LEVEL	79	SWL
SPECIFIC CAPACITY	61	SP_CAP
OBSERVED POWER CONSUMPTION	47	POWER_OBS
AVERAGE POWER CONSUMPTION	43	POWER_AVE
OTHER WATER SOURCE	0	OTHER_SRCE
PUMP HP RATING	112	PUMP_HP
RATED PUMP CAPACITY	86	PUMP_CAP
TOTAL DYNAMIC HEAD (TDH)	54	TDH
PUMP SETTING	91	PUMP_SET
GROUNDWATER USE	117	GWUSE

Table 3.2 DISTRIBUTION OF SURVEYED WELLS

TYPE OF USER	MUNICIPALITY									TOTAL
	AMADEO	DASMARIÑAS	GEN. TRIAS	IMUS	KAWIT	NOVELETA	ROSARIO	SILANG	TAGAYTAY	
DOMESTIC	7	33	4	2	5	6	3	13	1	74
INSTITUTIONAL	0	0	1	0	0	0	0	2	3	6
COMMERCIAL	0	1	1	0	0	0	1	0	1	4
IND. (FOOD & BEVERAGES)	0	2	6	3	0	0	0	0	0	11
IND. (CHEM. DISTIL., DRUGS)	0	0	1	0	0	0	0	0	0	1
IND. (LEATHER & FOOTWEAR)	0	0	0	0	0	0	0	0	0	0
IND. (TEXTILE, PAPER, PULP)	0	1	3	0	0	0	0	1	0	5
IND. (OTHERS)	0	4	4	2	0	0	5	1	0	16
TOTAL	7	41	20	7	5	6	9	17	5	117

Table 3.3 AVERAGE WELL DISCHARGE IN THE SURVEY AREA

UNIT : lps

TYPE OF USER	MUNICIPALITY								
	AMADEO	DASMARIÑAS	GEN. TRIAS	IMUS	KAWIT	NOVELETA	ROSARIO	SILANG	TAGAYTAY
DOMESTIC	1.18	15.46	7.20	9.71	10.53	11.53	6.83	11.25	1.51
INSTITUTIONAL	0.00	0.00	0.32	0.00	0.00	0.00	0.00	3.28	3.99
COMMERCIAL	0.00	21.00	2.05	0.00	0.00	0.00	2.52	0.00	1.50
IND. (FOOD & BEVERAGES)	0.00	8.54	8.70	8.00	0.00	0.00	0.00	0.00	0.00
IND. (CHEM. DISTIL., DRUGS)	0.00	0.00	7.56	0.00	0.00	0.00	0.00	0.00	0.00
IND. (LEATHER & FOOTWEAR)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
IND. (TEXTILE, PAPER, PULP)	0.00	8.54	0.25	0.00	0.00	0.00	0.00	2.52	0.00
IND. (OTHERS)	0.00	24.86	15.14	21.00	0.00	0.00	21.22	2.63	0.00

Table 3.4 AVERAGE NUMBER OF HOURS OF OPERATION PER DAY IN THE SURVEY AREA

TYPE OF USER	MUNICIPALITY								
	AMADEO	DASMARIÑAS	GEN. TRIAS	IMUS	KAWIT	NOVELETA	ROSARIO	SILANG	TAGAYTAY
DOMESTIC	8.70	19.20	16.40	20.60	24.00	24.00	21.00	16.10	6.00
INSTITUTIONAL	0.00	0.00	2.00	0.00	0.00	0.00	0.00	5.80	4.20
COMMERCIAL	0.00	1.50	1.10	0.00	0.00	0.00	5.30	0.00	2.60
IND. (FOOD & BEVERAGES)	0.00	12.00	12.20	15.30	0.00	0.00	0.00	0.00	0.00
IND. (CHEM. DISTIL., DRUGS)	0.00	0.00	7.00	0.00	0.00	0.00	0.00	0.00	0.00
IND. (LEATHER & FOOTWEAR)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
IND. (TEXTILE, PAPER, PULP)	0.00	8.00	19.00	0.00	0.00	0.00	0.00	17.50	0.00
IND. (OTHERS)	0.00	12.00	8.00	9.50	0.00	0.00	17.90	4.00	0.00

Table 3.5 AVERAGE NUMBER OF DAYS OF OPERATION PER WEEK IN THE SURVEY AREA

TYPE OF USER	MUNICIPALITY								
	AMADEO	DASMARIÑAS	GEN. TRIAS	IMUS	KAWIT	NOVELETA	ROSARIO	SILANG	TAGAYTAY
DOMESTIC	6.60	6.90	5.80	7.00	7.00	7.00	7.00	7.00	5.50
INSTITUTIONAL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.00	7.00
COMMERCIAL	0.00	7.00	0.00	0.00	0.00	0.00	7.00	0.00	0.00
IND. (FOOD & BEVERAGES)	0.00	6.80	7.00	5.00	0.00	0.00	0.00	0.00	0.00
IND. (CHEM. DISTIL., DRUGS)	0.00	0.00	4.50	0.00	0.00	0.00	0.00	0.00	0.00
IND. (LEATHER & FOOTWEAR)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
IND. (TEXTILE, PAPER, PULP)	0.00	7.00	6.00	0.00	0.00	0.00	0.00	7.00	0.00
IND. (OTHERS)	0.00	6.50	5.50	4.50	0.00	0.00	6.60	7.00	0.00

Table 3.6 AVERAGE NUMBER OF WEEKS OF OPERATION PER YEAR IN THE SURVEY AREA

TYPE OF USER	MUNICIPALITY								
	AMADEO	DASMARIÑAS	GEN. TRIAS	IMUS	KAWIT	NOVELETA	ROSARIO	SILANG	TAGAYTAY
DOMESTIC	50.80	52.00	50.70	52.00	52.00	52.00	52.00	50.20	52.00
INSTITUTIONAL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	52.00	50.00
COMMERCIAL	0.00	52.00	0.00	0.00	0.00	0.00	52.00	0.00	0.00
IND. (FOOD & BEVERAGES)	0.00	48.00	52.00	0.00	0.00	0.00	0.00	0.00	0.00
IND. (CHEM. DISTIL., DRUGS)	0.00	0.00	31.00	0.00	0.00	0.00	0.00	0.00	0.00
IND. (LEATHER & FOOTWEAR)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
IND. (TEXTILE, PAPER, PULP)	0.00	52.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
IND. (OTHERS)	0.00	51.00	51.50	50.00	0.00	0.00	52.00	47.00	0.00

Table 3.7 TOTAL DAILY GROUNDWATER PUMPAGE IN THE SURVEY AREA

UNIT : m^3

TYPE OF USER	MUNICIPALITY									T O T A L
	AMADEO	DASMARIÑAS	GEN. TRIAS	IMUS	KAWIT	NOVELETA	ROSARIO	SILANG	TAGAYTAY	
DOMESTIC	272.31	36,254.60	2,034.05	889.92	4,548.96	5,978.87	1,703.16	7,903.44	32.62	59,617.93
INSTITUTIONAL	0.00	0.00	2.30	0.00	0.00	0.00	0.00	66.15	184.84	253.29
COMMERCIAL	0.00	113.40	8.12	0.00	0.00	0.00	48.08	0.00	14.04	183.64
IND. (FOOD & BEVERAGES)	0.00	887.83	2,142.36	745.20	0.00	0.00	0.00	0.00	0.00	3,775.39
IND. (CHEM. DISTIL., DRUGS)	0.00	0.00	190.51	0.00	0.00	0.00	0.00	0.00	0.00	190.51
IND. (LEATHER & FOOTWEAR)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
IND. (TEXTILE, PAPER, PULP)	0.00	245.95	51.30	0.00	0.00	0.00	0.00	158.76	0.00	456.01
IND. (OTHERS)	0.00	1,002.24	922.32	1,436.40	0.00	0.00	7,140.64	37.87	0.00	10,539.47
T O T A L	272.31	38,504.02	5,350.96	3,071.52	4,548.96	5,978.87	8,891.88	8,166.22	231.50	75,016.24

Table 3.8 AVERAGE STATIC WATER LEVEL IN THE SURVEY AREA

UNIT : mbgs

TYPE OF USER	MUNICIPALITY								
	AMADEO	DASMARIÑAS	GEN. TRIAS	IMUS	KAWIT	NOVELETA	ROSARIO	SILANG	TAGAYTAY
DOMESTIC	68.00	28.16	15.00	16.15	25.89	13.50	7.40	54.81	31.80
INSTITUTIONAL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	85.00	108.00
COMMERCIAL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
IND. (FOOD & BEVERAGES)	0.00	16.72	33.75	9.00	0.00	0.00	0.00	0.00	0.00
IND. (CHEM. DISTIL., DRUGS)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
IND. (LEATHER & FOOTWEAR)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
IND. (TEXTILE, PAPER, PULP)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
IND. (OTHERS)	0.00	29.84	24.00	4.65	0.00	0.00	7.55	0.00	0.00
MUNICIPALITY	68.00	27.60	26.62	9.93	25.89	13.50	7.46	56.96	69.90

Table 3.9 AVERAGE SPECIFIC CAPACITY IN THE SURVEY AREA

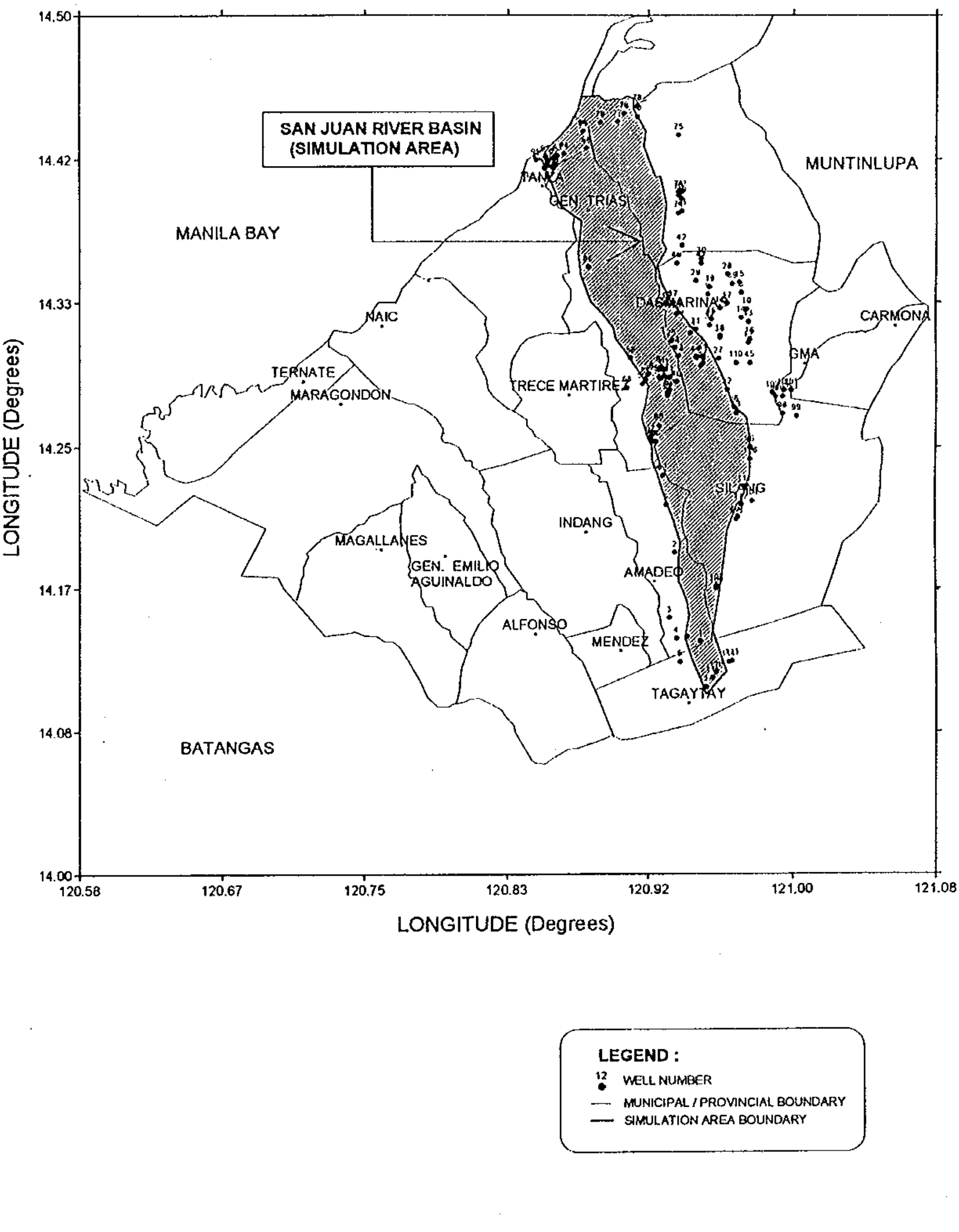
UNIT : lps/m

TYPE OF USER	MUNICIPALITY								
	AMADEO	DASMARIÑAS	GEN. TRIAS	IMUS	KAWIT	NOVELETA	ROSARIO	SILANG	TAGAYTAY
DOMESTIC	0.00	2.09	0.00	2.10	1.66	3.26	2.16	0.83	0.05
INSTITUTIONAL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
COMMERCIAL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
IND. (FOOD & BEVERAGES)	0.00	0.69	0.00	0.27	0.00	0.00	0.00	0.00	0.00
IND. (CHEM. DISTIL., DRUGS)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
IND. (LEATHER & FOOTWEAR)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
IND. (TEXTILE, PAPER, PULP)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
IND. (OTHERS)	0.00	0.83	1.25	7.00	0.00	0.00	0.36	0.00	0.00
MUNICIPALITY	0.00	1.94	1.25	3.12	1.66	3.26	1.26	0.83	0.05

Table 3.10 PRESENT GROUNDWATER PUMPAGE (MCM/YR) BY TYPE OF USE AND BY RIVER BASIN

GROUNDWATER USE	WITHIN STUDY AREA	OUTSIDE STUDY AREA
Domestic	18.09	12.002
Institutional	0.436	0.000
Commercial	2.909	0.436
Agricultural	4.144	0.751
Industrial	6.993	1.424

	WITHIN STUDY AREA	NO. OF WELLS	WITHIN WATER BALANCE AREA	NO. OF WELLS
Study Area	32.573	814	3.724	1053
RB-1 Maragòndon	1.55	194	1.155	194
RB-2 Labac	0.32	90	0.32	90
RB-3 Cañas	0.782	78	4.573	95
RB-4 San Juan	12.221	142	20.153	233
RB-5 Imus	11.657	126	20.383	256
RB-6 Biñan	5.879	123	5.879	123



CAVITE WATER SUPPLY DEVELOPMENT STUDY	Figure 3.1
JAPAN INTERNATIONAL COOPERATION AGENCY	LOCATION MAP OF 117 SURVEYED WELLS

4. WATER QUALITY ANALYSIS

4. WATER QUALITY ANALYSIS

4.1 ANALYTICAL ITEMS

Water quality analysis were conducted to determine the chemical characteristics from the viewpoint of beneficial use, to grasp the groundwater flow system and to evaluate deterioration of water resources.

Of all the water quality parameters, 15 (color, odor, pH, E.C., dissolved solid, alkalinity, Na, K, Ca, Mg, HCO_3, SO_4, Fe and Mn) are ordinary analytical items. Especially, Na, K, Ca, Mg, HCO_3, Cl and SO_4 are analyzed to determine the chemical characteristics of water from an hydrogeological point of view. In general, the concentration of these items in groundwater varies with the characteristics of bearing formations, flowing speed, salt water intrusion, and fossil water. Two minerals, Fe and Mn, are often naturally abundant in groundwater. If a large amount of these two minerals are contained in groundwater, it is unsuitable for drinking purposes.

On the other hand, 11 parameters (Phenols, NH_4-N, NO_2-N, NO_3-N, As, Cu, Pb, Se, Zn, Bacteriological test, and Pesticide) are indicators of pollution. Four of them (NH_4-N, NO_2-N, NO_3-N, Bacteriological test) are indicators of pollution caused by night soil or decomposed organic matters. Likewise, Phenols, As, Cu, Pb, Se, and Zn indicate pollution caused by solutions derived from industries or mining area while pesticide is a pollutant brought by agricultural activities.

Furthermore, groundwater samples were analyzed to detect, if any, the presence of the two most popularly used pesticides, Thiodan 35 EC (generic name: Endosulfan) and Azodrin 202R (generic name: Monocrotophos). A survey on the pesticide outlets in the Study Area has revealed that Thiodan 35 EC and Azodrin 202R have been popularly used for quite a long time. Both pesticides are recently banned in the Philippines by the Fertilizer and Pesticide Authority (FPA) because of their adverse effects on human health and environment. Endosulfan has been identified by the National Poison Control Center as the leading cause of poisoning in this country (Editorial, Philippine Daily Inquirer, June 1, 1994).

Details of the sampling points for deep well is summarized and presented in **Table 4–1**.

Details of the sampling points for spring and river are summarized and presented in **Tables 2–7** and **2–8**.

4.2 ANALYTICAL RESULTS

Water quality analysis results of both the dry season and the wet season are presented in **Tables 4–2 to 4–7**.

Results on parameter lead (Pb) of springs and rivers in dry season were very high, even exceeded the NSDW. These can not be explained reasonably because no any pollution source can be identified in the Study Area. The problem was considered to be attributed to the analysis method and the re–analysis by other method with higher accuracy was inquired to the local laboratory. The re–analysis result of samples collected from deep wells shows no Pb can be detected, and in fact the results of deep wells also exceeded NSDW in the first analysis. Therefore, the concentration of Pb in springs and rivers in dry season should the same as deep well, being below the analysis limit which below the NSDW.

Comparison of these data shows some analysis results on SO4 of springs and deep wells in rainy season are abnormal high than others. They springs of No. 3, 5, 6, 7 and 8 and deep wells of No. 11, 12 and 13.

To check if these data are real value of the water samples, method of ion balance were applied. As it is well known that epm (equivalents per million) of total anions is general equal to epm of total cations in condition of the pH of water sample is not far from 7 as the water samples of springs and deep wells in the Study Area being. Moreover, it has been made clear that defining indicator A = (total anions – total cations) / total anions, the value of A is ordinarily less than 5% in low concentration (total anions < 0.5 epm) samples, and less than 3% in samples with total anions greater than 1 epm.

Based on the above principle, the following process are adopted to check and amend the SO4 analysis results.

Calculation of total anions and total cations in epm.

Establishment of the criteria to judge if the water quality analysis result is really abnormal. Electric Conductivity is usually used in this kind of judgement because there is a well known relationship that the total ion volume in unite of epm is approximately equal to 0.01 EC in unite of μmho/cm. However, the calibration show that this relationship can hardly be used in the Study Area, and no other clear relationship can be found. Therefore, the total ion content were checked by the comparison of the problem sample to other samples and to sample taken in the same point in the dry season. And the abnormal were identified when the total ions content seems a little more than other samples, and the total anions is more than 110 percent of total cations. This criteria is a little rough because it is not an absolute one to be treated by a clear calculation equation. Knowledge or experience and understand of the hydrogeological condition of the Study Area are needed here. However, the criteria can be considered safe because the abnormal high content of SO4 is quite obvious. Moreover, more than 10 percent difference between the total contents of anions and cations is exceed 3 times of its experiential value.

Calculation of indicator A. If the value of A is greater than 0.1, the content of SO4 was considered as too high to be amended.

Calculation of appropriate content of SO4. Difference of total anions and 1.1 of total cations were considered as the estral content of SO4. Therefore, the appropriate content of SO4 were calculated by cutting out the estral content of SO4 from the given result of water quality analysis.

Using the above process, SO4 content of springs No. 3, 5, 6, 7 and 8, and deep wells of No. 11, 12 and 13 were obtained as 52.57, 64.12, 67.33, 57.78, 66.97, 68.56, 78,81 and 57.58.

Rhombus pattern of water quality, which are presented in **Fig.s 4-1 to 4-3**, are drawn by above amended values. It is obvious that the amending made the patterns appear in a reasonable balance.

4.3 POLLUTION MECHANISM

(1) Surface Water

Domestic wastewater may be the most significant pollution source for rivers, especially in the vicinity of urban centers because there is no sewerage system in the Study Area.

Besides domestic wastewater, all the pollution sources presented of industrial effluent, poor managed dumpsites and illegal dumps affect directly the river water quality.

Industrial factories with no WTP undoubtedly cause river water contamination. Even if industrial establishments have WTP, some of these facilities do not treat industrial waste efficiently. Thus the risk of polluting rivers can not be excluded at once. In fact, Cease and Desist Order (CDO) were issued by the Pollution Adjudication Board (PAB) to several piggeries in the Study Area, for serious standards violations in BOD and Suspension Solids (SS) effluent.

The effect of illegal dumpsites along the banks of creeks/rivers are beyond doubt. Municipal dumpsites, as they being now, constitutes high pollution threat for river water and groundwater, because no measures have been adopted to prevent runoff and leachate by rainfall or scattering by wind. **Photo 4-1** shows a municipal dumpsite located at the head of a valley. If no improvement measures are taken, it will be impossible to protect water quality of the river downstream of the dumpsite.

In the rainy season, more pollutants come into rivers by runoff and leachate, however, the analysis results show a better water quality than in the dry season. This is obviously because the river discharge is greater than the pollutant amount released in the river. Therefore, it seems that the control of pollution sources is much more required in the dry season than in the rainy season.

(2) Groundwater

Groundwater is, as mentioned above, a safe source for drinking water supply in the Study Area, however, groundwater pollution has been detected in several wells.

Groundwater pollution should be identified by comparing the present concentration with its base value, but not with the standards established for certain purposes such as NSDW. To confirm the base value in the Study Area, results of water quality analysis of springs were used because springs are distributed in the upland area which are less industrialized or less cultivated for rice fields. Therefore, spring waters can be considered to be less contaminated by pollution before it springs to the surface. A relatively small standard deviation of STD, shown in **Table 4-8**, can be an evidence of this detection.

The pollution index of deep wells were calculated and presented in **Table 4–9** and **Fig.4–4.** About half of the Ii values exceed 1, meaning that deep well waters in the Study Area have been widely contaminated, though the degree is relatively low from the viewpoint of drinking water supply.

(3) Pollution Route of Groundwater

Generally, under the condition of uniform stratum like in the Study Area, pollutants have to reach deep groundwater by either of the two following ways. One route is Pollution source → Soil → Shallow groundwater → Deep groundwater. Infiltration is the main movement aspect of pollutant in this way. The other way is the construction of wells, through which pollutant can leak or even flow into deep groundwater. In the former way, a relatively long time is needed for the movement of pollutant, and pollutant's concentration decreases with depth.

Fig. 4–5 presents Well depth and groundwater pollution index. The figure shows that there is no relationship between the two factors. That means the mechanism of groundwater pollution is not infiltration from the strata but the leachate or flow along wells.

(4) Pollution Source

As nitrogen compounds can transfer from one kind to another in some special condition, they are discussed in the Study to clarify pollution sources. It can be found in **Table 4–9** that the increase of I_{TDS} seems accompanied by the increase of nitrogen compounds especially NH_3–N, meaning that pollution from domestic or agricultural sources influences almost all the deteriorated wells.

In spite of the base value of C_o-_{NH3-N} being higher than C_o-_{NO3-N}, the I_{NH3-N} values over 1 outnumber the I_{NO3-N} values over 1. Hence, it can be confirmed that it did not take a long time or a long distance for nitrogen pollutant to enter wells. This result is consistent with the discussion of pollution route and can be supported by the results of IEE and EIA. In the Study Area, septic tanks sometimes are constructed less than 25 meters away from water supply sources and are generally inefficient.

In contrast to I_{NO3-N}, which seems rarely vary with seasons, the I_{NH3-N} obviously increased in rainy season. These differences might only be considered as the effect of stronger leachate by concentrated rainfall to various pollution sources in the vicinity of deep wells.

The other parameter that should be heeded is phenols, for it has lessened groundwater of some wells from class AA to class B even C. As phenols pollution is usually attributed to industries, a thorough investigation was carried out in the EIA survey. Only one industry (a fabric/yarn knitting factory) was found near one of the wells (No.10), but the test results showed phenols in its wastewater is below the NSDW standard (0.001mg/l).

Along with erasion of industries from the polluters' list, the identification of pollution source becomes harder. Nonetheless, the control of phenols pollution can be attained by proper management of facilities because the phenols affect ground surface rather than aquifer as stated above.

Given that the coliform or bacterium can scarcely move over several meters in soil or porous aquifer, the abnormal high content of coliform in wells No.19 in Phase I and No.4, 14, 15 in Phase II, resulted obviously from wastewater of either domestic or agricultural source which directly flows into the wells.

Table 4-1 DETAILS OF SAMPLING POINTS FOR DEEPWELLS

SAMPLE NUMBER	LAB. ID NO.	WELL NUMBER	WELL OWNER	LOCATION	WELL DEPTH (m)	DATE / TIME OF MEAS.	pH	TEMP. Deg. C	EC mS/cm	REMARKS
1	1	SIL-130	SILANG WATER DISTRICT (Pumping Station #4)	Poblacion, Silang	188.00	5-21-94/01:15	7.70	30.0	0.316	Pesticide sample
2	2		DASMARIÑAS WATER DISTRICT (Pumping Station #16)	Bgy. San Luis, Dasmariñas		5-19-94/11:40	7.30	32.0	0.436	
3	3	GEN-162	GMA WATER DISTRICT	Teacher's Village, GMA	213.41	5-27-94/10:55	8.00	30.5	0.308	Pesticide sample
4	4	MEN-142	MENDEZ WATER DISTRICT	Alfonso Rd., Payapa, Mendez	243.90	5-30-94/14:25	7.30	30.0	0.276	
5	5	TRE-140	LA PAZ HOMES	Trece Martirez	242.00	6-04-94/14:15	8.90	30.4	0.428	
6	6	TAN-94	TANZA WATER DISTRICT	Poblacion, Tanza	115.00	6-03-94/13:18	8.30	34.0	0.618	Pesticide sample
7	7		MARAGONDON WATER DISTRICT	Poblacion, Maragondon	33.84	6-05-94/15:05	7.40	34.1	0.594	Pesticide sample
8	8		BGY. 8 WATERWORKS ASSOCIATION	Poblacion, Amadeo	73.17	6-08-94/14:20	7.70	28.4	0.338	
9	D-1		PUERTO AZUL LAND, INC.	Bgy. Camandag, Ternate	92.00	6-08-94/14:35	7.92	32.7	0.505	
10	D-5	TAN-139	CHUNG FU TEXTILE	Bgy. Tanauan, Tanza	122.00	6-09-94/15:15	8.21	30.8	0.527	
11	D-6		BGY. AGOS-OS WATERWORKS ASSOC.	Bgy. Agos-Os, Indang		6-13-94/14:45	7.73	28.5	0.347	
12	D-15		BGY. GUYAM NA MUNTI WATERWORKS ASSOCIATION	Bgy. Guyam na Munti, Indang	61.00	6-13-94/15:45	7.18	24.1	0.344	
13	D-20		BGY. ALULOD WATERWORKS ASSOC.	Bgy. Alulod, Indang	28.90	6-13-94/14:00	7.39	28.1	0.278	
14	D-22	ALF-167	ROBEO HILLS	Esperanza, Alfonso	240.00	6-13-94/17:10	7.21	23.3	0.217	
15	D-14	TAG-143	RFM BREEDER FARM (Well #3)	Tagaytay City	213.41	6-15-94/13:45	8.01	27.0	0.288	
16	D-13		BGY. ULAT WATERWORKS ASSOC.	Bgy. Ulat, Silang	157.00	6-15-94/15:15	7.39	30.5	0.317	
17	D-8		BUREAU OF EQUIPMENT (DPWH)	De Ocampo, Trece Martires		6-15-94/17:00	8.02	29.4	0.451	Pesticide sample
18	D-24	CAR-160	FIL-ESTATE GOLF AND DEVT. CORP.	Mla. Southwoods, Carmona	250.00	6-16-94/11:45	7.87	31.0	0.456	
19	D-9	TRI-10	GATEWAY BUSINESS PARK (Well #1)	Bgy. Javalera, Gen. Trias	200.00	6-16-94/18:10	7.91	27.7	0.421	
20	D-23		MAGALLANES RWSA	Poblacion, Magallanes	51.83	6-16-94/15:45	7.31	30.0	0.378	

Table 4-2 RESULT OF RIVER WATER QUALITY ANALYSIS IN DRY SEASON

No.	1	2	3	4	5	6	7	8	9	10
Temp.	24	24	24	24	24	24	25	25	25	25
COLOR	150	>500	7.5	>500	250	>500	150	50	12.5	150
Odor	Unob.	Unob.	Unob.	Unob.	Unob.	Unob.	Unob.	Unob.	Unob.	Unob.
pH	8.72	8.96	9.29	9.29	8.36	8.7	8.77	8.67	9	8.6
EC	5820	185	284	271	278	256	309	494	336	828
TDS	3725	118	182	173	178	164	198	316	215	530
Alka.	68	64	106	98	91	87	106	163	132	231
Ca	128	12	32	25	26	21	24	36	37	69
Mg	66	10	10	11	9	10	12	15	9	8
HCO3	83	78	129	120	111	106	129	198	161	281
Cl	1597	15	9	11	11	13	13	29	13	60
Cu	0.1	0.06	0.04	0.05	0.05	0.13	0.09	0.04	0.04	0.05
Fe	1.99	5	0.15	2.96	4.89	8.5	2.22	0.23	0.17	0.92
Mn	0.26	0.16	0.25	0.28	0.38	0.39	0.65	0.25	1.07	0.22
Pb	0.059	0.039	0.039	0.059	0.059	0.039	0.039	0.059	0.039	0.059
Zn	0.008	0.036	0.02	0.016	0.016	0.084	0.023	0.008	0.012	0.008
Na	144.675	14.1	18.378	17.532	20.515	20.087	25.644	47.868	24.361	73.725
K	43.643	5.133	5.989	7.701	6.844	5.133	7.701	11.978	5.989	21.389
SO4	273.24	38.68	29.22	26.75	27.98	37.45	27.16	40.33	39.92	55.96

Table 4-3 RESULT OF RIVER WATER QUALITY ANALYSIS IN WET SEASON

No.	1	2	3	4	5	6	7	8	9	10
Temp.	23	23	24	24	24	24	24	23	25	23
Color	20	20	nil	nil	15	>5	75	50	10	20
Odor	Unob.	Unob.	Unob.	Unob.	Unob.	Unob.	Unob.	Unob.	Unob.	Unob.
EC	234	220	242	271	284	230	264	307	304	655
TDS	150	141	155	173	182	147	169	196	195	419
Alka.	76	76	101	94	90	65	76	76	72	158
Hard.	94	76	110	168	100	85	119	113	106	195
Ca	23	20	23	25	24	21	25	26	33	47
Mg	--	10	12	10	10	8	14	11	6	18
Na	15.12	14.81	19.23	19.73	19.05	13.74	17.61	19.49	19.74	64.76
K	2.94	2.94	4.29	6.01	8.43	4.6	4.6	4.414	7.727	9.445
Fe	0.43	0.41	0.45	0.31	0.31	2.73	3.24	3.4	0.2	0.2
Mn	0.29	0.35	0.03	nil	0.25	0.28	0.33	0.26	nil	0.11
Zn	ND	ND	0.132	0.013	0.014	0.008	0.186	0.235	0.077	0.009
Pb	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
HCO3	92	92	106	88	110	79	92	92	88	193
SO4	40.33	39.51	65	60.3	56.79	79.01	68.93	37.45	54.53	76.95
Cl	11	7	8	8	21	9	25	15	13	45

Table 4-4 RESULT OF SPRING WATER QUALITY ANALYSIS IN DRY SEASON

No.	1	2	3	4	5	6	7	8	9	10
Temp.	25	25	24	25	25	25	25	25	25	25
COLOR	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil
pH	6.78	7.63	7.69	8.67	7.83	7.13	7.48	7.03	8.53	8.66
EC	219	276	289	270	280	278	288	275	348	371
TDS	140	177	185	173	179	178	184	176	223	237
Alka.	76	98	102	102	87	68	68	76	87	151
Na	13.7	16.7	20.9	19.7	18.0	18.4	19.2	17.1	28.2	32.1
K	5.13	5.13	4.28	5.99	4.28	5.99	5.99	5.13	6.84	6.84
Ca	27	26	35	31	27	26	32	31	30	42
Mg	5	11	5	6	11	8	8	7	11	--
Cu	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Fe	0.05	0.04	0.05	0.17	0.15	0.15	0.14	0.14	0.18	0.16
Mn	0.1	0.07	0.07	0.11	0.20	0.19	0.18	0.16	0.15	0.13
Pb	0.039	0.039	0.059	0.059	0.039	0.039	0.039	0.039	0.020	0.020
Zn	0.008	0.008	0.012	0.013	0.012	0.008	0.008	0.016	0.008	0.004
HCO3	92	120	125	125	106	83	83	92	106	185
SO4	40.7	56.8	23.0	41.2	24.3	55.6	27.2	44.9	48.6	54.3
Cl	11	13	15	11	11	15	16	13	18	15

Table 4-5 RESULT OF SPRING WATER QUALITY ANALYSIS IN WET SEASON

No.	1	2	3	4	5	6	7	8	9	10
Temp.	23	23	23	25	25	25	23	25	24	24
Color	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil
Odor	Unob.	Unob.	Unob.	Unob.	Unob.	Unob.	Unob.	Unob.	Unob.	Unob.
EC	212	244	282	275	285	276	292	276	387	389
TDS	136	156	180	176	182	177	187	177	248	249
Alka.	76	83	94	79	76	65	83	68	90	151
Hard.	88	94	102	97	103	94	102	94	126	138
Ca	17	16	24	24	24	22	23	23	33	33
Mg	11	13	10	9	10	9	11	9	11	14
Na	14.67	17.71	20.24	20.24	17.71	18.21	19.23	18.72	26.93	28.58
K	5.15	4.29	6.01	5.15	5.15	6.01	6.868	5.15	6.89	6.12
Fe	0.2	0.2	0.31	0.2	0.1	0.1	0.29	0.1	0.18	0.17
Zn	0.018	0.113	0.018	0.009	0.014	0.121	0.013	0.067	ND	ND
Mn	0.09	0.1	nil	nil	nil	nil	nil	0.05	0.22	0.22
Pb	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
HCO3	92	101	114	97	92	79	101	83	110	185
SO4	20.16	39.09	74.9	50.61	128.8	107.2	68.1	70.57	36.83	46.09
Cl	9	14	9	9	8	8	13	8	20	9

Table 4-6 (1/2) RESULT OF DEEP WELL WATER QUALITY ANALYSIS IN DRY SEASON

NO.	Temp.	Color	Odor	pH	Alkali.	EC	PHENOLS	NH3-N	NO2-N	NO3-N	As	T. COL.	F. COL	H. E. C.	TDS
1	25	Nil	N. Obj.	7.7	106	295	0.003	3.3	0.005	1.74	<0.001	1	1	82	189
2	25	Nil	N. Obj.	7.3	151	395	0.002	2.98	0.005	0.56	<0.001	4	4	102	253
3	25	Nil	N. Obj.	8.0	155	381	<0.001	6.99	0.005	0.64	<0.001	50	2	156	244
4	25	Nil	N. Obj.	7.3	98	261	0.001	1.41	0.005	1.87	<0.001	1	1	80	167
5	25	Nil	N. Obj.	8.9	181	468	<0.001	1.35	0.005	0.47	<0.001	12	5	135	300
6	25	Nil	N. Obj.	8.3	208	528	0.004	5.78	0.065	0.06	<0.001	5	2	98	338
7	25	Nil	N. Obj.	7.4	170	499	<0.001	2.39	0.019	0.58	<0.001	11	4	112	319
8	25	Nil	N. Obj.	7.7	110	361	<0.001	2.84	0.019	2.99	<0.001	10	1	118	231
9	25	Nil	N. Obj.	7.9	136	421	0.002	0.05	0.005	0.02	<0.001	2	2	97	269
10	25	Nil	N. Obj.	8.2	189	468	0.001	2.91	0.005	0.02	<0.001	17	4	112	300
11	25	Nil	N. Obj.	7.7	117	315	<0.001	3.04	0.096	0.56	0.002	8	8	109	202
12	25	Nil	N. Obj.	7.2	102	337	<0.001	3.3	0.02	2.92	<0.001	1	1	74	216
13	25	Nil	N. Obj.	7.4	97	259	<0.001	2.26	0.177	0.05	<0.001	11	2	116	166
14	25	5	N. Obj.	7.2	87	233	<0.001	2.39	0.026	2.66	<0.001	14	2	150	149
15	24	Nil	N. Obj.	8.0	76	294	0.001	3.69	0.013	2.56	<0.001	11	1	113	188
16	24	Nil	N. Obj.	7.4	121	364	<0.001	2	0.023	2.52	0.004	1	1	90	233
17	24	Nil	N. Obj.	8.0	147	402	<0.001	3.69	0.033	0.32	<0.001	14	1	135	257
18	24	Nil	N. Obj.	7.9	155	408	<0.001	5.67	0.015	0.49	<0.001	19	9	182	261
19	24	Nil	N. Obj.	7.9	151	407	<0.001	6.55	0.013	0.37	<0.001	1600	1600	312	260
20	24	Nil	N. Obj.	7.3	125	339	<0.001	5.82	0.017	0.13	<0.001	130	2	180	217

T.COL. : Total Coliform Test MPN/100ml
F.COL : Fecal Coliform Test MPN/ml
H.E.C. : Heterotrophic Plate Count CFU/ml.

Table 4-6(2/2) RESULT OF DEEP WELL WATER QUALITY ANALYSIS IN DRY SEASON

NO.	Ca	Mg	HCO3+CO3	Cl	Cu	Fe	Mn	Pb	Se	SO4	Zn	Na	K
1	25	12	129	15	0.02	0.36	0	ND	0.09	27.57	.007	21.8	5.13
2	47	8	185	16	0.02	0.29	0.06	ND	0.09	48.97	.025	30.35	7.7
3	34	17	189	9	0.02	0.36	0	ND	0.09	46.91	.018	30.77	7.7
4	24	9	120	15	0.02	0.31	0.03	ND	0.09	46.09	.004	18.81	5.99
5	44	18	221	11	0.02	0.19	0.02	ND	0.09	51.44	.050	33.34	6.84
6	29	14	254	13	0.02	0.31	0.05	ND	0.09	39.09	.011	72.65	17.11
7	39	22	208	29	0.02	0.19	0.02	ND	0.09	30.86	.036	38.47	8.56
8	26	17	134	15	0.02	0.22	0.01	ND	0.09	46.5	.007	22.22	8.56
9	36	18	166	29	0.02	0.22	0.02	ND	0.09	46.91	.043	28.21	5.13
10	42	15	231	15	0.02	0.16	0.16	ND	0.09	36.21	.097	44.08	6.84
11	25	15	143	16	0.02	0.23	0.02	ND	0.09	30.45	.011	22.65	8.56
12	28	16	125	13	0.02	0.14	0.01	ND	0.09	31.69	.137	20.52	5.99
13	19	14	111	9	0.01	0.47	0.02	ND	0.09	42.38	.083	17.52	6.84
14	25	11	106	9	0.02	0.33	0	ND	0.09	41.56	.007	14.1	5.99
15	22	0	92	13	0.02	0.31	0.01	ND	0.09	51.03	.187	17.95	8.56
16	0	0	148	12	0.03	0.22	0.01	ND	0.09	56.79	.008	20.52	5.99
17	30	17	180	13	0.05	0.32	0	ND	0.09	43.62	.388	33.34	9.41
18	31	16	189	13	0.04	0.26	0	ND	0.09	25.51	.266	34.19	8.56
19	31	0	185	11	0.03	0.35	0.01	ND	0.09	42.8	.007	35.47	10.27
20	29	13	152	16	0.03	0.76	0.5	ND	0.09	38.68	.043	25.64	7.7

T.COL. : Total Coliform Test MPN/100ml
F.COL : Fecal Coliform Test MPN/ml
H.E.C. : Heterotrophic Plate Count CFU/ml.

Table 4-7 (1/2) RESULT OF DEEP WELL WATER QUALITY ANALYSIS IN RAINY SEASON

NO.	T.	Color	Odor	Alkali.	EC	PHENOLS	NH3-N	NO2-N	NO3-N	As	T. COL.	F. COL	H. E. C.	TDS
1	23	nil	N. Obj.	97	297	ND	5.06	0.032	1.84	0.019	<2	<2	87	190
2	24	nil	N. Obj.	140	394	ND	5.34	0.027	0.19	0.002	<2	<2	94	252
3	24	nil	N. Obj.	144	382	ND	5.22	0.048	1.01	0.004	<2	<2	92	244
4	23	nil	N. Obj.	90	256	ND	5.06	0.01	2.04	0.005	240	240	178	164
5	24	nil	N. Obj.	144	386	ND	4.59	0.048	0.18	ND	2	<2	161	247
6	24	nil	N. Obj.	191	534	0.01	5.05	0.021	ND	0.006	<2	<2	91	342
7	23	nil	N. Obj.	155	487	ND	4.93	0.023	0.553	ND	32	32	204	312
8	24	nil	N. Obj.	94	340	0.01	4.54	0.027	2.961	ND	500	26	202	218
9	23	nil	N. Obj.	130	411	ND	4.86	0.015	0.507	ND	<2	<2	92	263
10	24	77.5	N. Obj.	166	485	0.006	4.7	0.032	0.189	ND	2	2	70	310
11	23	nil	N. Obj.	108	316	0.006	4.99	0.01	1.22	0.003	59	53	299	202
12	23	nil	N. Obj.	94	334	0.005	5.11	0.021	2.96	0.006	13	<2	140	214
13	23	nil	N. Obj.	97	270	0.003	5.06	0.021	1.88	0.005	2	2	107	173
14	23	nil	N. Obj.	61	214	ND	5	ND	0.491	ND	439	118	343	137
15	23	nil	N. Obj.	68	274	0.003	5.05	0.03	2.886	ND	139	139	306	175
16	24	nil	N. Obj.	296	296	0.005	4.75	0.016	3.027	ND	<2	<2	68	189
17	24	nil	N. Obj.	154	409	ND	4.99	0.043	0.29	0.002	<2	<2	83	262
18	23	nil	N. Obj.	144	394	ND	4.7	ND	0.353	ND	<2	<2	77	252
19	24	nil	N. Obj.	155	392	ND	5.17	0.017	ND	ND	<2	<2	36	251
20	23	nil	N. Obj.	97	322	ND	4.99	ND	1.627	ND	<2	<2	66	206

T.COL. : Total Coliform Test MPN/100ml

F.COL. : Fecal Coliform Test MPN/ml

H.E.C. : Heterotrophic Plate Count CFU/ml.

Table 4-7(2/2) RESULT OF DEEP WELL WATER QUALITY ANALYSIS IN RAINY SEASON

Ca	Mg	HCO3	Cl	K	Fe	Mn	Pb	Se	SO4	Zn	Na
26	13	119	11	6.12	0.07	0.21	ND	ND	43.62	0.113	21.75
38	16	171	13	5.36	0.25	0.22	ND	ND	54.53	0.053	25.48
33	17	176	5	6.12	0.2	0.4	ND	ND	48.97	0.014	23.82
29	10	110	8	5.36	0.07	0.22	ND	ND	66.25	0.008	19.47
34	17	176	7.5	6.87	0.2	0.23	ND	ND	39.09	0.608	30.36
34	13	233	16	16.08	0.24	0.42	ND	ND	52.67	0.008	73.23
41	20	189	23	6.01	0.2	0.21	ND	ND	72.84	0.71	35.42
23	21	114	9	5.15	0.1	0.2	ND	ND	57.2	0.064	21.25
36	17	158	25	5.15	0.2	0.07	ND	ND	63.78	0.034	27.32
40	21	184	9	8.59	0.53	0.5	ND	ND	46.5	0.205	45.53
30	14	132	11	6.89	0.06	0.21	ND	ND	76.75	0.186	20.3
33	13	114	13	6.12	0.07	0.21	ND	ND	146.9	0.106	18.65
23	14	119	8	4.6	0.06	0.2	ND	ND	92.79	0.102	18.23
16	7	75	8	5.15	0.1	0.07	ND	ND	47.32	0.004	12.65
24	8	83	11	6.01	0.1	0.08	ND	ND	67.07	0.633	17.71
25	14	110	8	5.15	0.1	0.19	ND	ND	43.2	0.043	20.24
33	17	189	11	6.12	0.23	0.18	ND	ND	42.8	0.307	31.28
29	19	176	9	8.59	0.1	0.05	ND	ND	33.74	0.034	31.88
36	17	189	6	7.73	0.02	0.18	ND	ND	49.75	0.035	33.9
28	11	119	15	6.01	0.1	0.05	ND	ND	63.37	0.052	22.26

Table 4-8 STANDARD SPRING WATER QUALITY

SPRING	TDS		Ca		Mg		Na+K		Zn		Fe		Mn		Pb		HCO3+CO3		SO4		CL	
NO.	DRY	RAINY	DRY	RAINY	DRY	RAINY	DRY	RAINY	DRY	RAINY	DRY	RAINY	DRY	RAINY	DRY	RAINY	DRY	RAINY	DRY	RAINY	DRY	RAINY
1	140	136	27	17	5	11	18.81	19.82	0.008	0.018	0.05	0.2	0.1	0.09	ND	ND	92	92	40.7	20.16	11	9
2	177	156	26	16	11	13	21.8	22	0.008	0.113	0.04	0.2	0.07	0.1	ND	ND	120	101	56.8	39.09	13	14
3	185	180	35	24	5	10	25.22	26.25	0.012	0.018	0.05	0.31	0.07	nil	ND	ND	125	114	23.0	52.57	15	9
4	173	176	31	24	6	9	25.65	25.39	0.013	0.009	0.17	0.2	0.11	nil	ND	ND	125	97	41.2	50.61	11	9
5	179	182	27	24	11	10	22.23	22.86	0.012	0.014	0.15	0.1	0.2	nil	ND	ND	106	92	24.3	64.12	11	8
6	178	177	26	22	8	9	24.37	24.21	0.008	0.121	0.15	0.1	0.19	nil	ND	ND	83	79	55.6	67.33	15	8
7	184	187	32	23	8	11	25.22	26.1	0.008	0.013	0.14	0.29	0.18	nil	ND	ND	83	101	27.2	57.78	16	13
8	176	177	31	23	7	9	22.23	23.87	0.016	0.067	0.14	0.1	0.16	0.05	ND	ND	92	83	44.9	66.97	13	8
9	223	248	30	33	11	11	35.04	33.82	0.008	ND	0.18	0.18	0.15	0.22	ND	ND	106	110	48.6	36.83	18	20
10	237	249	42	33	—	14	39.04	34.7	0.004	ND	0.16	0.17	0.13	0.22	ND	ND	185	185	54.3	46.09	15	9
NSDW	500		—		—		200		5		1		0.5		0.01		—		250		250	
AVG.	185.2	186.8	30.7	23.9	8.0	10.7	26.0	25.9	0.010	0.047	0.12	0.19	0.14	0.07	0.00	0.00	111.7	105.4	41.6	50.2	13.8	10.7
STD.	25.6	33.9	4.7	5.3	2.4	1.6	5.9	4.6	0.003	0.044	0.05	0.07	0.05	0.08	0.00	0.00	28.8	28.5	12.2	14.3	2.3	3.7
Co(BV)	236.4	254.7	40.1	34.5	12.7	13.9	37.9	35.0	0.016	0.135	0.23	0.33	0.23	0.24	0.0	0.0	169.3	162.3	66.1	78.8	18.3	18.1
AVGBV	245.5		37.29		13.32		36.45		0.067		0.276		0.232		ND		165.8		72.48		18.21	

Source : JICA Study Team

TDS : Total Dissolved Solids
DRY : Dry Season
RAINY : Rainy Season
NSDW : Philippine National Standards for Drinking Water
AVG : Average
STD : Standard Deviation
Co(BV) : Base Value = AVG + 2*STD
AVGBV : Yearly Average Base value.

Table 4-9 POLLUTION INDEX OF DEEP WELL WATER

WELL	TDS		Ca		Mg		Na+K		Zn		Cu		Fe		Mn		Pb		HCO3+CO3		SO4		CL		PHENOLS		NH3-N		NO3-N	
NO.	DRY	RAIN	DRY	RAIN	DRY	RAIN	DRY	RAIN	DRY	RAIN	DRY	RAIN	DRY	RAIN	DRY	RAIN	DRY	RAIN	DRY	RAIN	DRY	RAIN	DRY	RAIN	DRY	RAIN	DRY	RAIN	DRY	RAIN
1	0.80	0.75	0.6	0.8	0.9	0.9	0.7	0.8	0.4	1.1	0.78	--	1.6	0.2	0.0	0.9	ND	ND	0.8	0.7	0.4	0.3	0.8	0.6	3.0	0.0	1.7	2.5	1.7	1.8
2	1.07	0.99	1.2	1.1	0.6	1.2	1.0	0.9	1.6	0.5	1.03	--	1.3	0.8	0.3	0.9	ND	ND	1.1	1.1	0.7	0.4	0.9	0.7	2.0	0.0	1.5	2.7	0.6	0.2
3	1.03	0.96	0.8	1.0	1.3	1.2	1.0	0.9	1.1	0.1	0.99	--	1.6	0.6	0.0	1.7	ND	ND	1.1	1.1	0.7	0.4	0.5	0.3	0.9	0.0	3.5	2.6	0.6	1.0
4	0.71	0.64	0.6	0.8	0.7	0.7	0.7	0.7	0.3	0.1	0.68	--	1.4	0.2	0.1	0.9	ND	ND	0.7	0.7	0.7	0.5	0.8	0.4	0.9	0.0	0.7	2.5	1.9	2.0
5	1.27	0.97	1.1	1.0	1.4	1.2	1.1	1.1	3.1	6.1	1.12	--	0.9	0.6	0.1	1.0	ND	ND	1.3	1.1	0.8	0.3	0.6	0.4	0.9	0.0	0.7	2.3	0.5	0.2
6	1.43	1.34	0.7	1.0	1.1	0.9	2.4	2.6	0.7	0.1	1.39	--	1.4	0.7	0.2	1.8	ND	ND	1.5	1.4	0.6	0.4	0.7	0.9	4.0	10.0	2.9	2.5	0.1	0.0
7	1.35	1.22	1.0	1.2	1.7	1.4	1.2	1.2	2.3	7.1	1.29	--	0.9	0.6	0.1	0.9	ND	ND	1.2	1.2	0.5	0.6	1.6	1.3	0.9	0.0	1.2	2.5	0.6	0.6
8	0.98	0.85	0.6	0.7	1.3	1.5	0.8	0.8	0.4	0.6	0.92	--	1.0	0.3	0.0	0.8	ND	ND	0.8	0.7	0.7	0.4	0.8	0.5	0.9	10.0	1.4	2.3	3.0	3.0
9	1.14	1.03	0.9	1.0	1.4	1.2	0.9	0.9	2.7	0.3	1.09	--	1.0	0.6	0.1	0.3	ND	ND	1.0	1.0	0.7	0.5	1.6	1.4	2.0	0.0	0.0	2.4	0.0	0.5
10	1.27	1.22	1.0	1.2	1.2	1.5	1.3	1.5	6.1	2.0	1.25	--	0.7	1.6	0.7	2.1	ND	ND	1.4	1.1	0.5	0.4	0.8	0.5	1.0	6.0	1.5	2.4	0.0	0.2
11	0.85	0.79	0.6	0.9	1.2	1.0	0.8	0.8	0.7	1.9	0.82	--	1.0	0.2	0.1	0.9	ND	ND	0.8	0.8	0.5	0.5	0.9	0.6	0.9	6.0	1.5	2.5	0.6	1.2
12	0.91	0.84	0.7	1.0	1.3	0.9	0.7	0.7	8.6	1.1	0.88	--	0.6	0.2	0.0	0.9	ND	ND	0.7	0.7	0.5	0.6	0.7	0.7	0.9	5.0	1.7	2.6	2.9	3.0
13	0.70	0.68	0.5	0.7	1.1	1.0	0.6	0.7	5.2	1.0	0.69	--	2.1	0.2	0.1	0.8	ND	ND	0.7	0.7	0.6	0.5	0.5	0.4	0.9	3.0	1.1	2.5	0.1	1.9
14	0.63	0.54	0.6	0.5	0.9	0.5	0.5	0.5	0.4	0.0	0.59	--	1.5	0.3	0.0	0.3	ND	ND	0.6	0.5	0.6	0.4	0.5	0.4	0.9	0.0	1.2	2.5	2.7	0.5
15	0.80	0.69	0.5	0.7	0.0	0.6	0.7	0.7	11.7	6.3	0.75	--	1.4	0.3	0.0	0.3	ND	ND	0.5	0.5	0.8	0.5	0.7	0.6	0.9	3.0	1.8	2.5	2.6	2.9
16	0.99	0.74	0.0	0.7	0.0	1.0	0.7	0.7	0.5	0.4	0.87	--	1.0	0.3	0.0	0.8	ND	ND	0.9	0.7	0.9	0.3	0.7	0.4	0.9	5.0	0.0	2.4	2.5	3.0
17	1.09	1.03	0.7	1.0	1.3	1.2	1.1	1.1	24.2	3.1	1.06	--	1.5	0.7	0.0	0.8	ND	ND	1.1	1.2	0.7	0.3	0.7	0.6	0.9	0.0	1.8	2.5	0.3	0.3
18	1.10	0.99	0.8	0.8	1.3	1.4	1.1	1.2	16.6	0.3	1.05	--	1.2	0.3	0.0	0.2	ND	ND	1.1	1.1	0.4	0.3	0.7	0.5	0.9	0.0	2.8	2.4	0.5	0.4
19	1.10	0.98	0.8	1.0	0.0	1.2	1.2	1.2	0.4	0.4	1.04	--	1.6	0.1	0.0	0.8	ND	ND	1.1	1.2	0.6	0.4	0.6	0.3	0.9	0.0	3.3	2.6	0.4	0.0
20	0.92	0.81	0.7	0.8	1.0	0.8	0.9	0.8	2.7	0.5	0.87	--	3.5	0.3	2.3	0.2	ND	ND	0.9	0.7	0.6	0.5	0.9	0.8	0.9	0.0	2.9	2.5	0.1	1.6
Co(BV)	236	255	40.1	34.5	12.7	13.9	37.9	35.0	.016	0.1	0.04	--	0.22	0.3	0.22	0.2	ND	ND	170	163	66.1	128	18.3	18.1	0.001		2		1	

Source : JICA Study Team

TDS : Total Dissolved Solids

DRY : Dry Season

RAINY : Rainy Season

Co(BV) : Base Value calculated with the results of spring water quality analysis and the formulation Co=AVG+2*STD

Fig. 4-1 Rhombus Pattern of River Water Quality

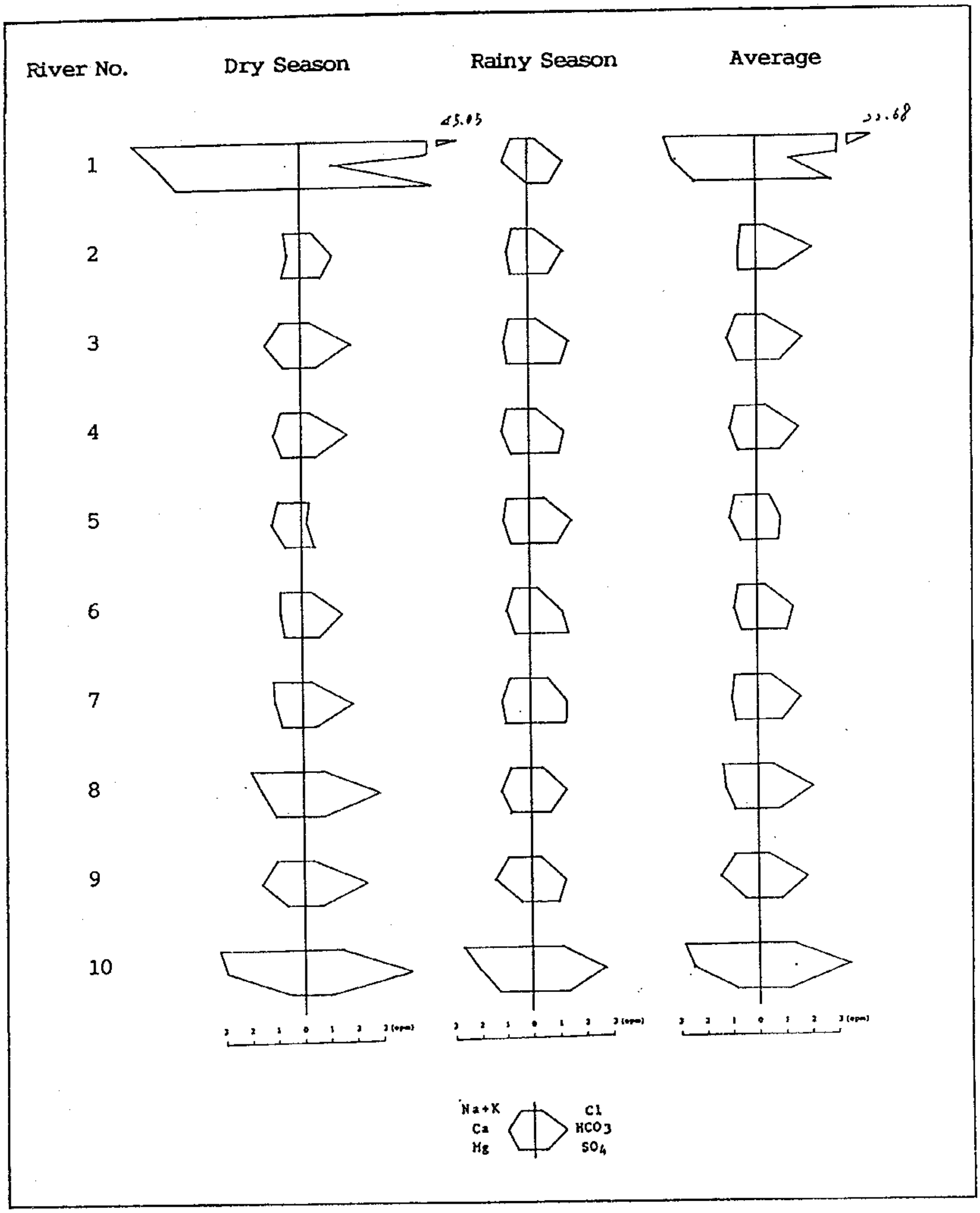


Fig.4-2 Rhombus Pattern of Spring Water Quality

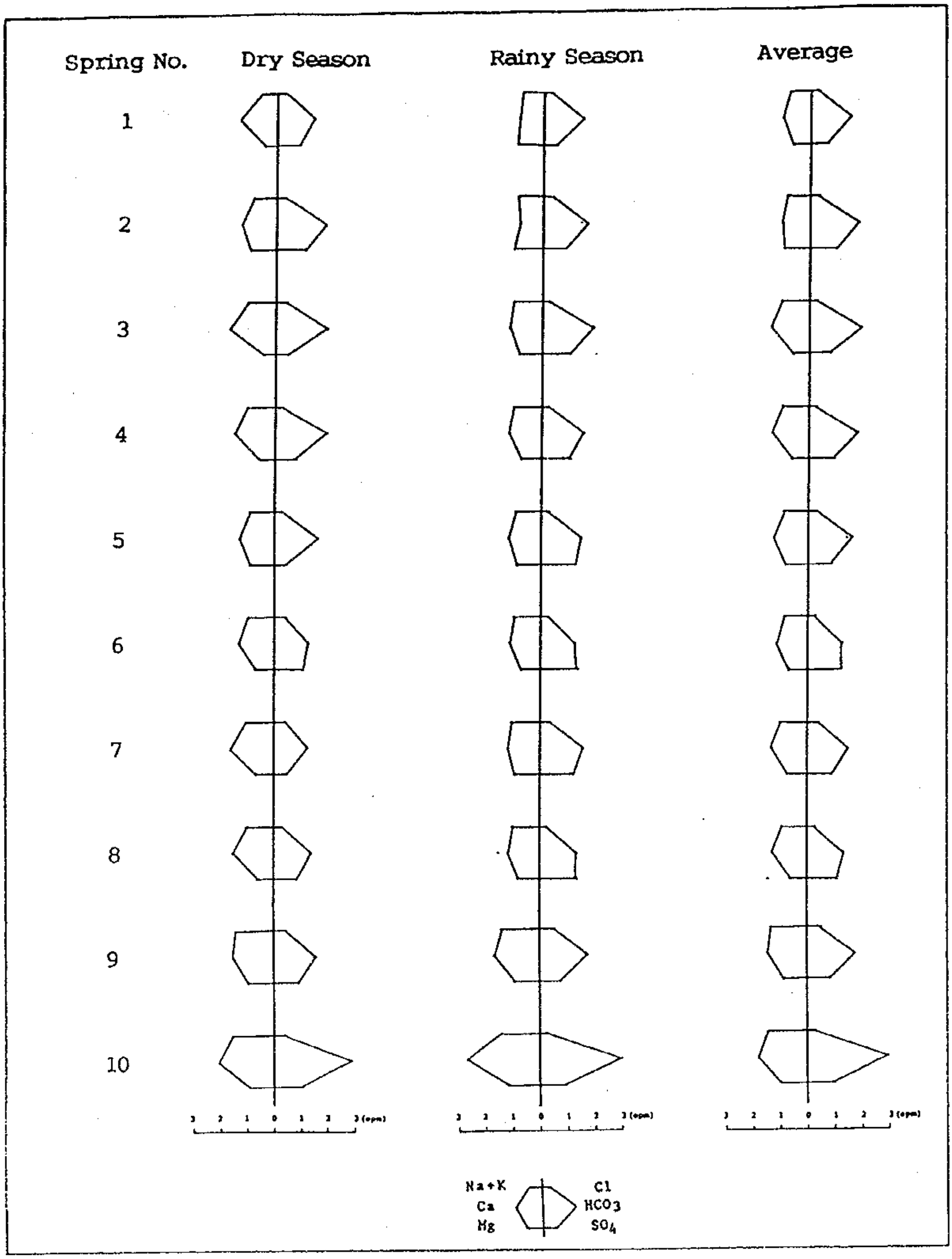


Fig. 4-3 Rhombus Pattern of Deep Well Water Quality (1)

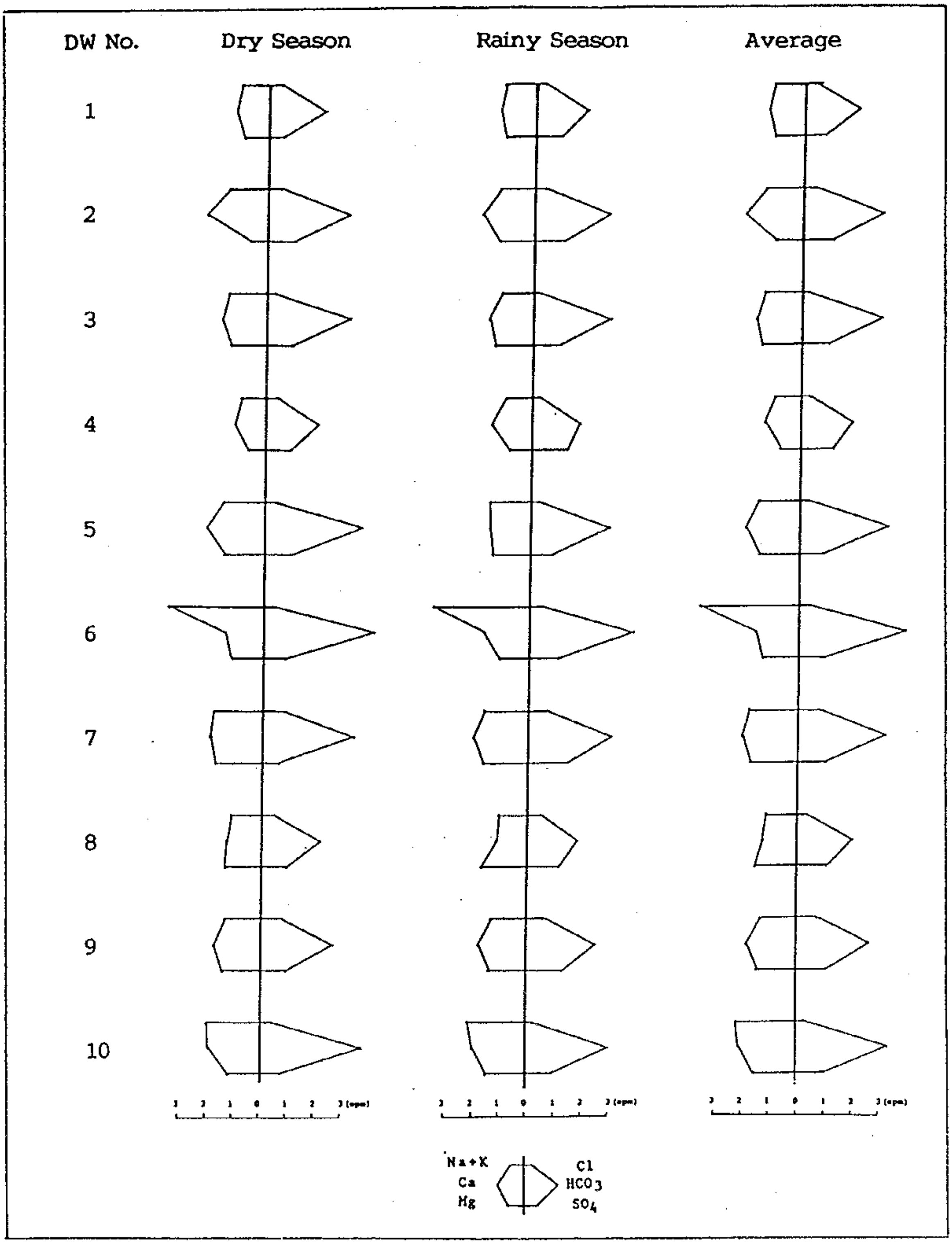


Fig. 4-3 Rhombus Pattern of Deep well Water Quality (2)

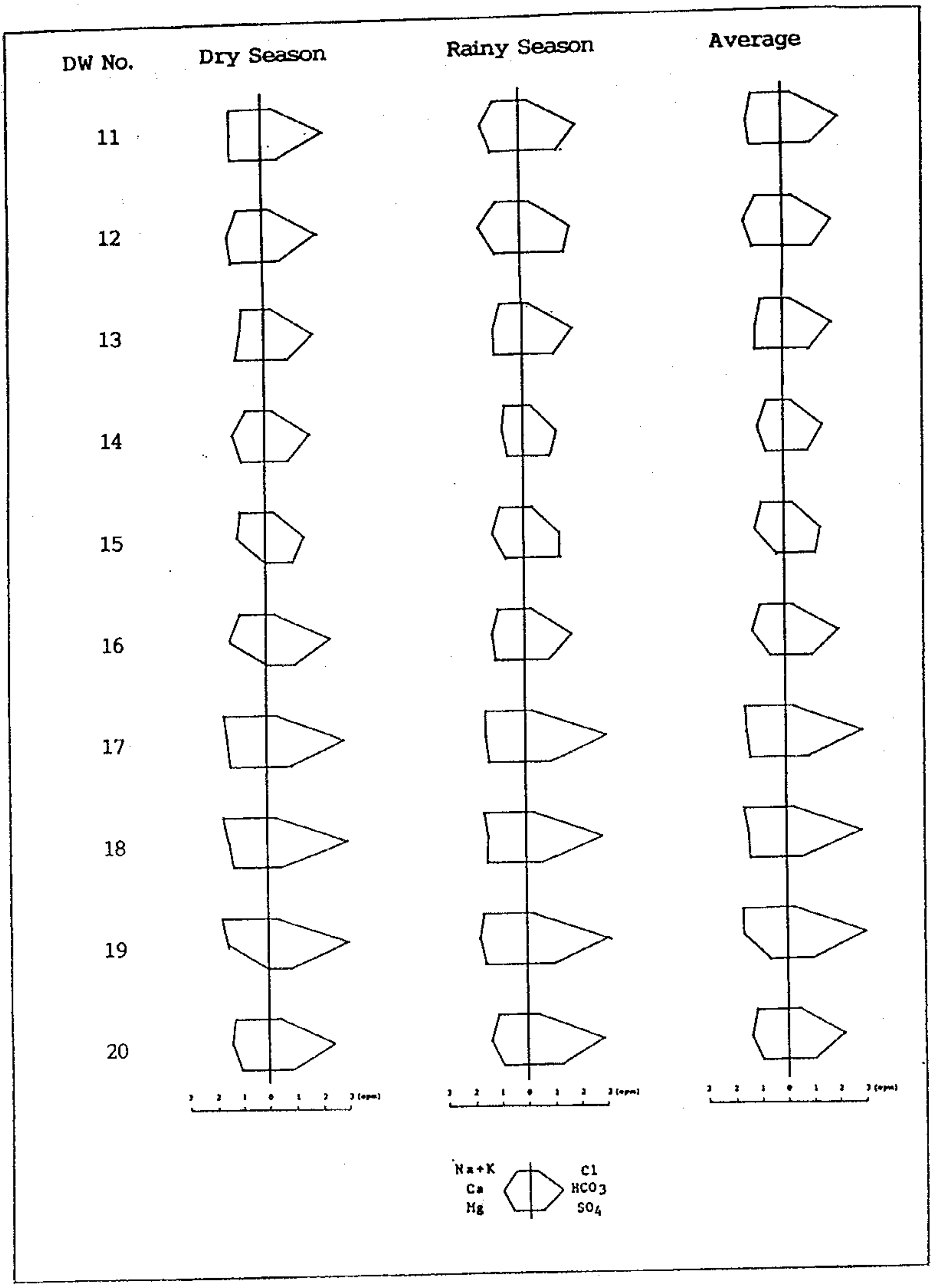
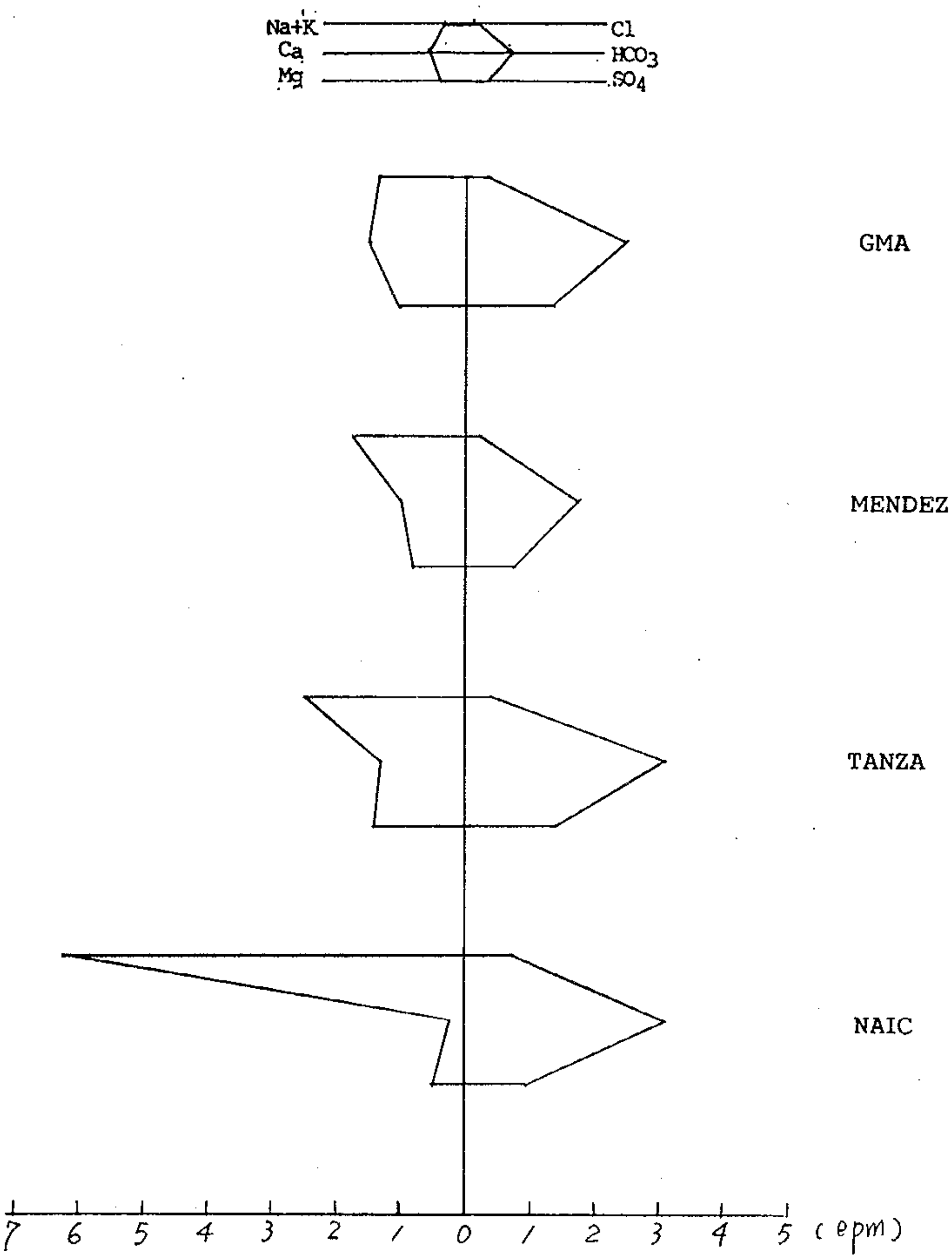
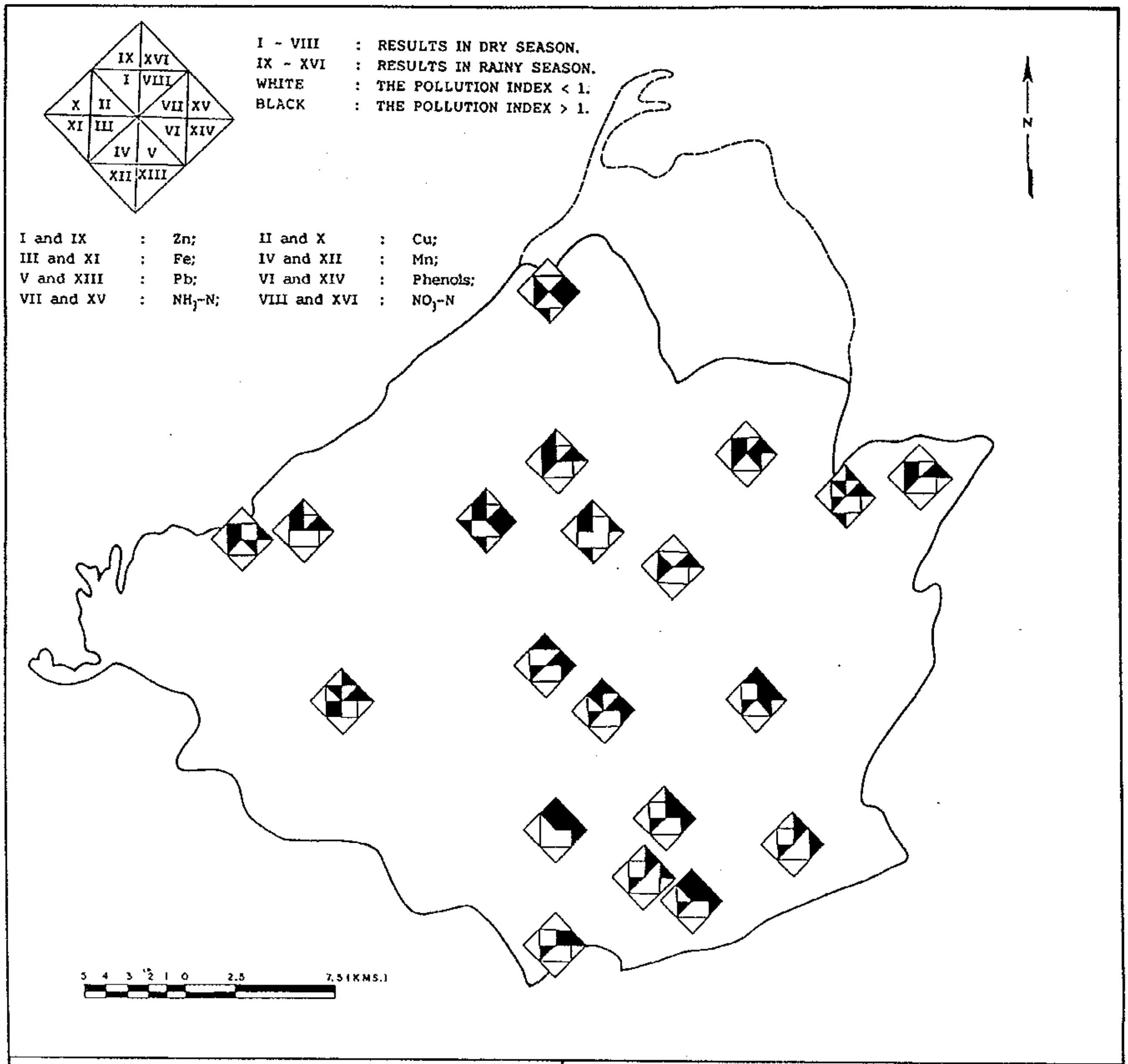


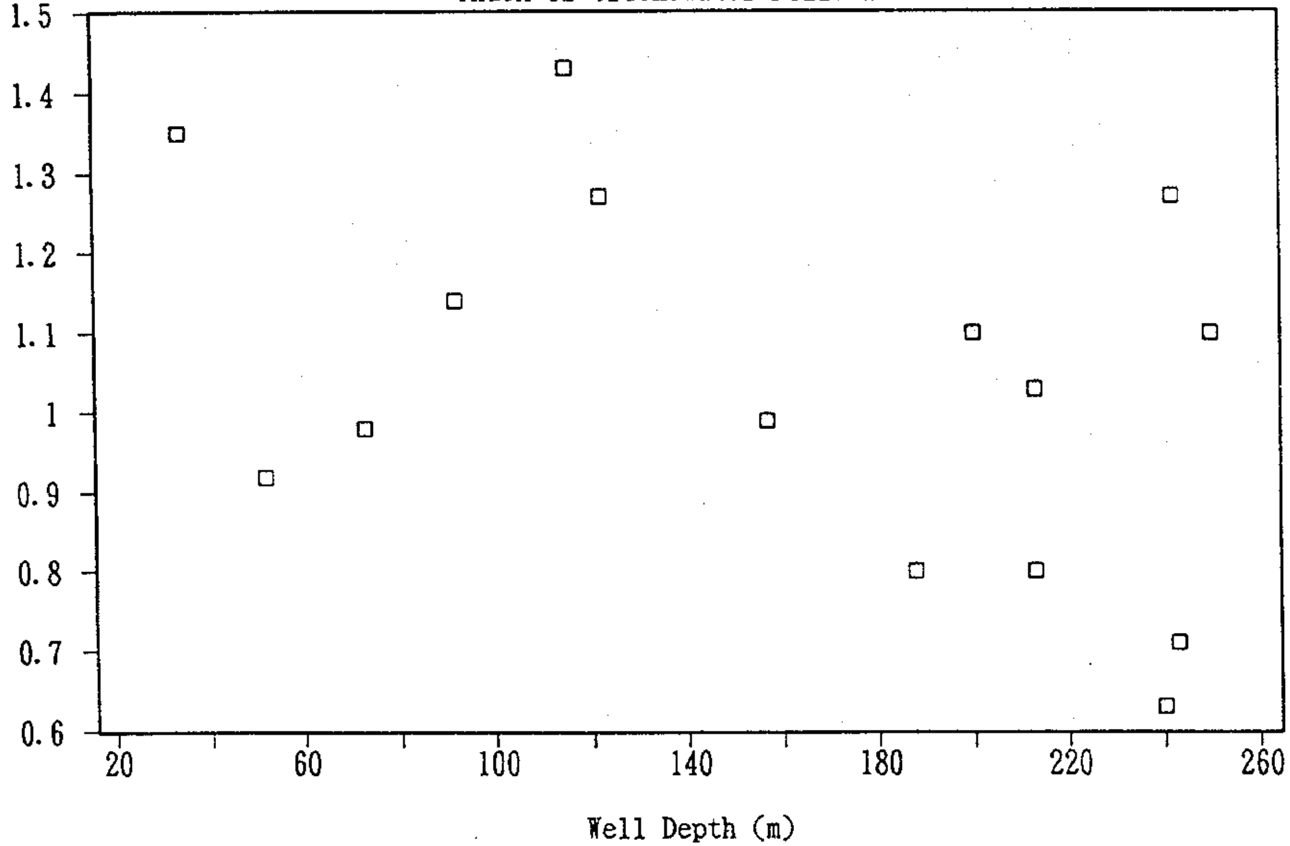
Fig. 4-3' Rhombus Pattern of JICA Test Well Water Quality

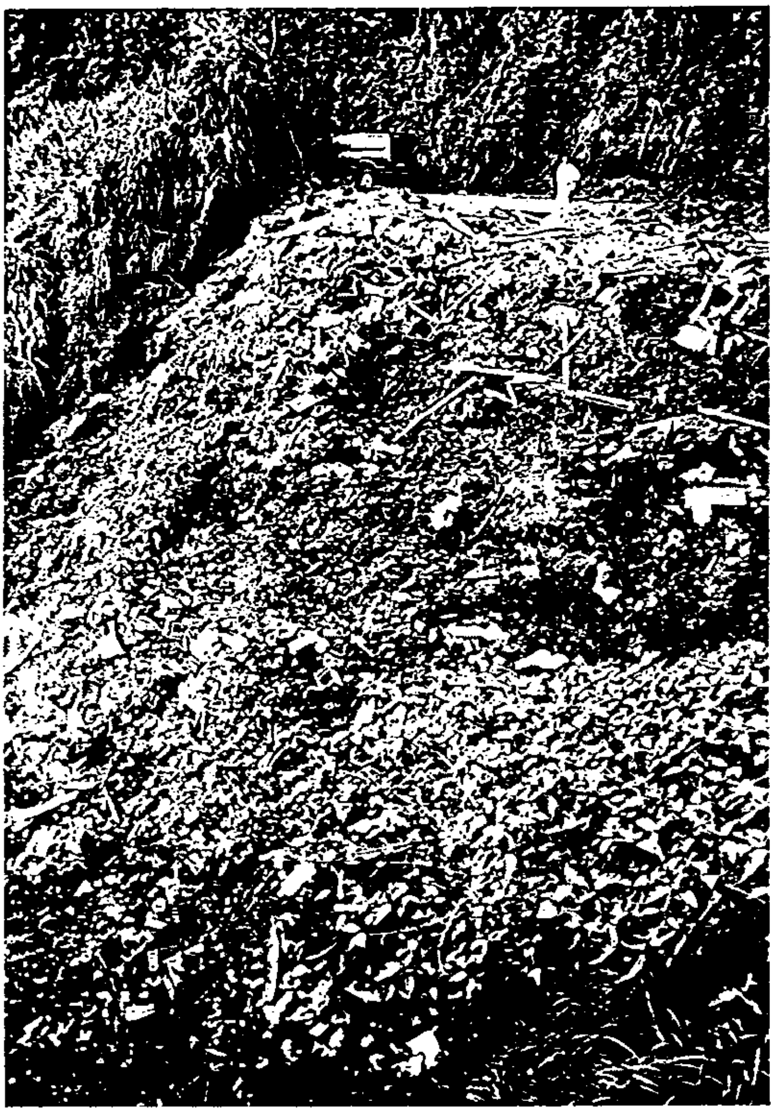




CAVITE WATER SUPPLY DEVELOPMENT STUDY	**Fig. 4-4** POLLUTION INDEX DISTRIBUTION
JAPAN INTERNATIONAL COOPERATION AGENCY	

Fig. 4-5 Relation Between well Depth and Index of Groundwater Pollution





CAVITE WATER SUPPLY DEVELOPMENT STUDY	Photo 4-1
JAPAN INTERNATIONAL COOPERATION AGENCY	TAGAYTAY CITY DUMPSITE

5. WELL INVENTORY SURVEY

5. WELL INVENTORY SURVEY

A well inventory Survey of the Study Area were conducted to provide basic well data needed in carrying out the different investigations and surveys of this Study.

Through a UNDP grant, LWUA, together with other government agencies, has established a groundwater data bank system for the whole country known as the Philippines Groundwater Data Bank(PGDB). In this Study, supplementary well data were collected and added to this system to form a new Well Inventory Database for Cavite. Hence, this survey aims to collect and arrange / transcribe data and information on existing deep wells and to update LWUA's Well Inventory Database.

There are about 1500 deepwells in the Study Area, and about 10% of which have data recorded in detail. The survey therefore involves the well inventory of 150 deep wells with enough hydrogeological information.

The new well inventory database formed on the basis of the results of this survey, were used in well selection, elucidation of hydrogeological structure, calculation of aquifer parameters and prediction of groundwater discharge.

The survey was carried out through the following steps:

1) Review of previous feasibility study reports and the existing well data registered in the Philippine Groundwater Data Bank (PGDB).

2) Collection of supplementary well data (non-PGDB-registered wells) from different private drillers, private well owners, Water Districts, Barangay Water Supply, Rural Waterworks and Sanitation Associations (RWSA), and Provincial Engineer's Office.

3) Field survey to determine the unknown locations of non-PGDB-registered wells.

4) Selection of at least 150 wells with sufficient hydrogeological information from PGDB-registered wells and non-PGDB-registered wells to make an even distribution over the Study Area.

5) Preparation of a well location map (1:75,000) of the selected wells registered in the well inventory.

6) Arrangement of non-PGDB-registered well data into the PGDB Well Inventory Form.

7) Encoding of the non-PGDB-registered well data into the PGDB data bank system.

8) Generation of PGDB printouts of the wells registered in the updated PGDB Well Inventory Database for Cavite.

After reviewing and making an inventory of the well data for Cavite Province, 639 wells located in the Study Area are presently registered in this PGDB. Of these 639 wells, 472 wells are found to have known well locations. Out of these 472 wells, 307 wells have sufficient hydrogeological data, 40 wells have well construction data, 155 wells have pumping test data, and 55 wells have water quality analysis data. These data were provided to the Study Team and used in the analyses of the Study.

Well data collection from different private drillers, private well owners, Water District, Barangay Water Supply, Provincial Engineer's Office, and Rural Waterworks and Sanitation Associations (RWSA) was carried out to supplement the existing PGDB-registered well data and to form a new well inventory database for Cavite Province. Through this activity 81 new deep well data (non-PGDB-registered wells) were collected but most of them had unknown well locations. To determine the well location of these unlocated wells, visits of the well sites were made but only 62 wells were able to be located in the field. From these 62 new wells, 48 wells have sufficient hydrogeological data, 53 wells have well construction data, 33 wells have pumping test data, 13 wells have water quality analysis data, and 42 wells have resistivity loges data. These new well data were also used to supplement the well data from PGDB. The classification of existing wells is shown in **Table 5-1**.

Since the results of the survey aim to provide the basic data to carry out the different investigations and surveys of this Study, e.g., selection of sites for test wells, measurement and monitoring of groundwater levels and quality, and conduct of geological and geophysical surveys, the well data of the 62 non-PGDB-registered wells would not be sufficient. To meet that requirement, well selection from 307 PGDB-registered wells was made. Considering not only the sufficiency of hydrogeological data but also the distribution over the Study Area, 105 wells from PGDB-registered wells were selected for a total of 167 deep wells.

Table 5-2 presents the availability of hydrogeological and well construction data of the 167 inventoried wells.

Table 5-3 presents tch stratigrajphic horizon of the aquifers utilized by the existing wells.

Summaries of well data of 105 wells selected from PGDB and of 62 non-PGDB-registered wells are shown in **Table 5-4** and **5-5** respectively.

Table 5-1 CLASSIFICATION OF EXISTING WELLS

MUNICIPALITY	NUMBER OF WELLS		1 LOCATION		1+ WELL CONST. DATA		1+ STRATA LOG DATA		1+ PUMPING TEST DATA		1+WATER QLTY. ANAL DATA		1+ ELEC. LOGS	
	*1 P.G. D.B.	*2 NEW DATA	*1 P.G. D.B.	*2 NEW DATA	*1 P.G. D.B.	*2 NEW DATA	*1 P.G. D.B.	*2 NEW DATA	*1 P.G. D.B.	*2 NEW DATA	*1 P.G. D.B.	*2 NEW DATA	*1 P.G. D.B.	*2 NEW DATA
ALFONSO	51	–	44	–	3	–	41	–	19	–	5	–		–
AMADEO	19	–	12	–	2	–	8	–	5	–	1	–		–
CARMONA	78	12	77	6	1	4	44	6	12	2	5	–		4
DASMARINAS	67	36	49	27	6	24	22	16	22	12	9	7		23
GEN. E. AGUINALDO	5	–	2	–	0	–	0	–	0	–	0	–		–
GMA	2	3	2	3	1	3	1	3	0	2	0	–		2
GEN. TRIAS	46	1	33	1	4	1	19	1	8	1	3	1		1
INDANG	65	–	43	–	9	–	32	–	23	–	5	–		–
MAGALLANES	14	–	4	–	0	–	3	–	2	–	0	–		–
MARAGONDON	39	1	30	1	0	1	14	1	6	1	6	1		1
MENDOZ	24	1	22	1	2	1	20	1	17	1	3	–		–
NAIC	54	–	41	–	2	–	30	–	6	–	5	–		–
SILANG	70	13	44	13	4	10	32	13	17	12	1	1		5
TAGAYTAY	13	5	12	4	0	3	3	2	1	–	1	–		1
TANZA	52	1	40	1	5	1	26	1	10	–	8	–	1	1
TERNATE	23	2	11	2	0	2	8	2	3	1	0	2		1
TRECE MARTIRES	17	5	6	2	1	2	4	1	4	1	3	1		2
TOTAL	639	80	472	61	40	52	307	47	155	33	55	13	1	41
	719		533		92		354		188		68		42	

(Note)

*1 : P.G.D.B: PHILIPPINE GROUNDWATER DATA BASE
*2 : New Data : Well Data Collected by This Study

Table 5-2 AVAILABILITY OF HYDROGEOLOGICAL AND WELL CONSTRUCTION DATA OF THE 167 INVENTORIED WELLS

MUNICIPALITY	WITH LITH. LOG & SCREEN DATA		WITH LITH. LOG NO SCREEN DATA		WITH SCREEN DATA NO LITH. LOG		NO LITH. LOG & SCREEN DATA WITH ELECTRIC LOGS		TOTAL	
	PGDB	NON-PGDB	PGDB	NON-PGDB	PGDB	NON-PGDB	PGDB	NON-PGDB	PGDB	NON-PGDB
ALFONSO	3	1	5	-	-	-	-	-	8	1
AMADEO	1	-	4	-	-	-	-	-	5	-
CARMONA	-	4	3	2	-	-	-	-	3	6
DASMARINAS	6	15	3	2	-	9	-	1	9	27
GEN. E. AGUINALDO	-	-	1	-	-	-	-	-	1	-
GEN. M. ALVAREZ	1	3	-	-	-	-	-	-	1	3
GEN. TRIAS	4	1	1	-	-	-	-	-	5	1
INDANG	10	-	5	-	-	-	-	-	15	-
MAGALLANES	-	-	5	-	-	-	-	-	5	-
MARAGONDON	-	1	6	-	-	-	-	-	6	1
MENDEZ	2	1	2	-	-	-	-	-	4	1
NAIC	2	-	9	-	-	-	-	-	11	-
SILANG	4	9	6	3	-	1	-	-	10	13
TAGAYTAY	-	2	1	-	-	1	-	1	1	4
TANZA	5	1	5	-	-	-	-	-	10	1
TERNATE	-	2	5	-	-	-	-	-	5	2
TRECE MARTIREZ	2	1	4	-	-	1	-	-	6	2
T O T A L	*40*	*41*	*65*	*7*	-	*12*	-	*2*	*105*	*62*
	81		*72*		*12*		*2*		*167*	

Table 5-3 **STRATIGRAPHIC HORIZON OF THE AQUIFERS UTILIZED BY THE EXISTING WELLS**

Elevation Zone	Stratigraphic Horizon of the Screens	Representative Area
High Elevation Zone (EL: 200~600 m)	o Layers of pumice, scoria, sand or gravel intercalated in the middle horizon of Kaybubutong Formation	Southern part of Silang, Mendez Alfonso, Springs of Kaybubutong and Iholy
Middle Elevation Zone (EL: 50~200 m)	o Layer of scoria intercalated in the middle horizon of Kaybubutong Formation. o Layer of sand and gravel intercalated middle horizon of Kaybubutong Formation. o Layers of sand and gravel intercalated in Talisay Formation	Southern part of Silang, Dasmarinas, Western part of G.M.A., Trece Martirez Springs in Dasmarinas
Low Elevation Zone (EL: lower than 50 m)	o Layers of sand and gravels intercalated in the lower horizon of Kaybubutong Formation. o Sandstone or conglomerate layers intercalated in Talisay Formation.	Northern part of Tanza Northern part of Naic Dasmarinas Northern part of Maragondon

Table 5-4 SUMMARY OF WELL DATA OF 105 WELLS SELECTED FROM PGDB

MUNICIPALITY	WELL OWNER	PGDB NO.	PLOTTED WELL NO.	LATITUDE	LONGITUDE	DEPTH (m)	CAS. DIA. (mm)	SWL (mbmp)	DATE MEASURED	DISCHARGE (lps)	SPEC. CAP. (lps/m)	LITH. LOG	WELL DESIGN	PUMPING TEST	WATER QUAL. ANALYSIS
AMADEO	BPW	31621-0007	1	14 10 13	120 55 32	152.40	100	56.71	01-01-48	1.26	0.40	Y	Y	Y	-
AMADEO	BPW	31621-0003	2	14 12 0	120 55 55	58.80	-	32.01	05-09-55	0.32	0.20	Y	-	Y	-
DASMARINAS	DASMARINAS WD	31621-0023	3	14 19 36	120 56 18	176.00	356/203	-	-	-	-	Y	Y	-	-
DASMARINAS	VINE VILLAGE	31621-0018	4	14 19 5	120 56 40	122.00	200/150	36.60	-	9.45	2.00	Y	Y	Y	-
DASMARINAS	VIA VERDE VILLAGE	31621-0185	5	14 19 14	120 57 8	183.00	203	25.90	03-30-87	6.94	0.80	Y	Y	Y	-
DASMARINAS	MANILA MEM. PARK	31621-0196	6	14 17 41	120 58 16	183.00	304	49.60	02-27-90	-	-	Y	Y	-	-
DASMARINAS	FCIE	31621-0183	7	14 17 15	120 56 0	200.00	334	33.75	08-06-91	-	-	Y	Y	-	-
DASMARINAS	BPW	31621-0029	8	14 17 45	120 59 32	227.10	-	41.16	-	0.95	0.60	Y	-	Y	-
GEN. TRIAS	BPW	31621-0038	9	14 15 10	120 55 26	91.40	150	45.42	-	2.08	0.40	Y	Y	Y	-
GEN. TRIAS	GATEWAY	31621-0182	10	14 15 45	120 55 21	200.00	250/200	24.78	12-22-89	21.90	1.00	Y	Y	Y	-
INDANG	BPW	31621-0043	11	14 13 23	120 51 11	32.00	100	7.62	09-04-67	0.50	0.10	Y	Y	Y	-
INDANG	BPW	31621-0048	12	14 11 20	120 53 15	76.20	150	25.90	05-21-56	0.63	0.40	Y	Y	Y	-
INDANG	BPW	31621-0056	13	14 12 34	120 51 15	91.40	150	27.43	-	-	-	Y	Y	-	-
INDANG		31621-0067	14	14 10 36	120 53 0	48.80	140	19.80	-	-	-	Y	Y	-	-
INDANG	BPW	31621-0040	15	14 12 52	120 53 20	29.00	100	12.20	04-17-60	0.32	0.10	Y	Y	Y	-
INDANG	BPW	31621-0072	16	14 10 29	120 52 57	88.40	112	39.63	03-09-56	0.50	0.40	Y	Y	Y	-
INDANG	BPW	31621-0063	17	14 11 40	120 50 37	40.80	100	27.44	03-02-60	0.32	0.10	Y	Y	Y	-
INDANG	BPW	31621-0065	18	14 11 37	120 50 50	44.80	150	34.40	05-18-60	0.32	0.07	Y	Y	Y	-
INDANG	BPW	31621-0046	19	14 13 0	120 52 20	35.70	100	11.60	06-29-62	0.32	0.20	Y	-	Y	-
INDANG	BPW	31621-0051	20	14 10 28	120 53 56	55.20	150	42.70	04-29-56	0.63	0.40	Y	-	Y	-
INDANG	BPW	31621-0061	21	14 14 17	120 50 57	90.80	150	30.60	04-13-56	0.63	0.40	Y	-	Y	-
INDANG	INDANG ELEM. SCH.	31621-0066	22	14 11 34	120 52 26	61.00	50	44.20	-	-	-	Y	-	-	-
MAGALLANES	BPW	31621-0089	23	14 10 35	120 46 49	36.60	-	21.34	01-19-61	0.32	0.20	Y	-	Y	-
MAGALLANES	BPW	31621-0517	24	14 11 20	120 46 14	56.40	102	44.21	09-20-57	0.63	0.40	Y	-	Y	-
MARAGONDON	BPW	31621-0091	25	14 16 0	120 45 20	158.50	-	-	-	1.26	0.40	Y	-	Y	-
MARAGONDON	DPWH	31621-0167	26	14 14 48	120 47 40	67.10	50	-	-	-	-	Y	-	-	-
MARAGONDON	DPWH	31621-0168	27	14 13 49	120 48 14	67.00	50	-	-	-	-	Y	-	-	-
MARAGONDON	BPW	31621-0522	28	14 10 43	120 49 50	79.20	102	25.91	-	-	-	Y	-	-	-
NAIC	NIA	31621-0102	29	14 17 40	120 47 52	100.00	200	12.50	11-23-75	3.60	0.43	Y	Y	Y	Y
NAIC	NIA	31621-0109	30	14 19 9	120 47 12	200.00	310/200	11.09	09-22-75	10.22	0.91	Y	Y	Y	Y
NAIC	BPW	31621-0108	31	14 17 34	120 45 16	131.10	-	9.14	05-02-57	-	-	Y	-	-	-
NAIC	BPW	31621-0110	32	14 19 18	120 45 24	167.80	-	3.04	11-17-52	-	-	Y	-	-	-
NAIC	BPW	31621-0113	33	14 18 32	120 46 24	90.80	-	-	-	0.94	0.61	Y	-	Y	Y
NAIC	DPWH	31621-0171	34	14 17 0	120 48 20	67.00	50	-	-	-	-	Y	-	-	-
NAIC	DPWH	31621-0172	35	14 16 52	120 46 50	61.00	50	11.58	-	-	-	Y	-	-	-
NAIC	DPWH	31621-0173	36	14 16 18	120 47 27	54.90	50	9.14	-	-	-	Y	-	-	-
NAIC	DPWH	31621-0176	37	14 19 23	120 46 8	48.80	50	2.44	-	-	-	Y	-	-	-
SILANG	BPW	31621-0127	38	14 13 0	120 59 40	91.40	150	-	-	-	-	Y	Y	-	-
SILANG		31621-0134	39	14 11 41	120 59 4	91.40	150/100	30.48	-	1.26	0.34	Y	Y	Y	-
SILANG		31621-0123	40	14 10 41	120 57 0	90.00	-	60.98	-	0.31	0.08	Y	-	Y	-
SILANG	DPWH	31621-0179	41	14 10 12	120 58 45	76.20	100	21.32	-	-	-	Y	-	-	-
TANZA		31621-0137	42	14 19 47	120 51 30	187.00	244/152	13.14	06-17-82	-	-	Y	Y	-	-
TANZA	DPWH	31621-0181	43	14 19 31	120 53 35	33.50	50	0.91	-	-	-	Y	-	-	-
TRECE MARTIREZ	BPW	31621-0142	44	14 18 31	120 54 20	182.90	150/112	23.00	08-15-55	1.58	0.43	Y	Y	Y	Y
TRECE MARTIREZ	BPW	31621-0141	45	14 16 53	120 54 56	33.50	63	12.00	08-22-62	0.32	0.13	Y	Y	Y	Y
TRECE MARTIREZ		31621-0139	46	14 16 40	120 51 20	55.50	-	13.41	04-24-59	0.50	0.12	Y	-	Y	-
TRECE MARTIREZ	BPW	31621-0143	47	14 17 50	120 52 30	33.50	100	13.00	06-30-62	0.32	0.04	Y	-	Y	-
ALFONSO	BPW	31622-0020	48	14 7 47	120 51 40	53.60	65	38.00	08-09-59	-	-	Y	Y	-	-
ALFONSO	BPW	31622-0029	49	14 7 36	120 49 36	50.00	63	32.00	09-06-59	0.32	0.20	Y	Y	Y	-
ALFONSO	BPW	31622-0032	50	14 7 0	120 50 0	46.60	100	36.57	01-12-60	0.32	0.30	Y	Y	Y	-

Table 5-4 (CONT...)

MUNICIPALITY	WELL OWNER	PGDB NO.	PLOTTED WELL NO.	LATITUDE	LONGITUDE	DEPTH (m)	CAS. DIA. (mm)	SWL (mbmp)	DATE MEASURED	DISCHARGE (lps)	SPEC. CAP. (lps/m)	LITH. LOG	WELL DESIGN	PUMPING TEST	WATER QUAL. ANALYSIS
ALFONSO	BPW	31622-0004	51	14 7 5	120 52 30	65.50	102	40.85	03-08-58	0.63	0.50	Y	-	Y	-
ALFONSO	BPW	31622-0012	52	14 5 58	120 53 12	149.40	-	-	-	-	-	Y	-	-	Y
ALFONSO	BPW	31622-0013	53	14 6 20	120 49 16	94.50	150/100	26.52	-	-	-	Y	-	-	-
ALFONSO	BPW	31622-0035	54	14 9 36	120 50 37	46.60	-	18.29	03-08-62	0.32	0.07	Y	-	Y	-
ALFONSO	MWSS	31622-0098	55	14 8 34	120 50 46	123.50	204/152	17.37	11-28-58	-	-	Y	-	-	Y
AMADEO		31622-0087	56	14 9 26	120 56 30	91.40	140	64.01	-	-	-	Y	-	-	-
AMADEO		31622-0089	57	14 8 17	120 56 20	94.50	140	60.96	-	-	-	Y	-	-	-
AMADEO	BPW	31622-0102	58	14 8 58	120 55 46	76.20	-	-	-	0.63	0.10	Y	-	Y	-
GEN. E. AGUINALDO	BPW	31632-0502	59	14 9 50	120 48 45	48.80	140	13.72	-	-	-	Y	-	-	-
INDANG	BPW	31622-0066	60	14 9 2	120 52 42	91.90	100	59.76	08-18-58	0.32	0.50	Y	Y	Y	-
INDANG	BPW	31622-0067	61	14 8 46	120 52 38	50.60	100	37.72	10-03-58	0.25	0.20	Y	Y	Y	-
INDANG	NWSA	31622-0104	62	14 9 16	120 51 50	61.00	-	45.73	06-07-57	0.63	1.00	Y	-	Y	-
MAGALLANES	BPW	31621-0514	63	14 8 17	120 47 41	28.00	200	12.20	10-20-59	0.32	0.10	Y	-	Y	Y
MENDEZ	BPW	31622-0050	64	14 7 55	120 52 30	121.90	150	56.69	04-27-85	1.83	2.10	Y	Y	Y	-
MENDEZ	BPW	31622-0055	65	14 8 0	120 53 40	125.30	100	97.00	05-30-58	0.63	1.03	Y	Y	Y	-
MENDEZ	BPW	31622-0040	66	14 7 50	120 53 26	140.20	-	81.40	06-19-58	0.63	0.29	Y	-	Y	-
MENDEZ	BPW	31622-0056	67	14 7 24	120 53 37	106.40	-	56.40	07-02-58	0.63	0.69	Y	-	Y	-
SILANG		31622-0074	68	14 8 12	120 57 12	70.10	140	42.70	-	-	-	Y	Y	-	-
SILANG	BPW	31622-0077	69	14 9 11	120 57 21	91.40	150	42.67	-	2.65	0.54	Y	Y	Y	-
SILANG	BPW	31622-0082	70	14 9 44	120 59 36	157.00	-	111.00	11-17-57	0.50	0.28	Y	-	Y	-
SILANG	BPW	31622-0080	71	14 8 44	120 57 50	91.40	-	54.86	-	-	-	Y	-	-	-
TAGAYTAY	BPW	31622-0063	72	14 6 44	120 54 30	186.00	-	-	-	-	-	Y	-	-	-
TRECE MARTIREZ	BPW	31632-0510	73	14 15 38	120 51 40	61.00	50	28.96	-	-	-	Y	-	-	-
TRECE MARTIREZ	BPW	31632-0511	74	14 16 5	120 52 45	61.00	50	22.86	-	-	-	Y	-	-	-
MAGALLANES	DPWH	31623-0004	75	14 9 14	120 44 52	54.90	-	-	-	-	-	Y	-	-	-
MAGALLANES	BPW	31624-0002	76	14 11 48	120 44 58	38.10	-	13.72	04-03-61	0.32	0.20	Y	-	Y	-
MARAGONDON	BPW	31624-0008	77	14 16 10	120 43 50	48.20	-	15.85	09-21-57	-	-	Y	-	-	-
MARAGONDON	BPW	31624-0048	78	14 17 0	120 43 55	81.10	-	19.82	09-20-57	0.95	1.50	Y	-	Y	-
NAIC		31624-0013	79	14 18 40	120 44 15	124.10	-	-	-	-	-	Y	-	-	-
TERNATE	BPW	31624-0016	80	14 17 40	120 43 10	106.70	-	2.44	01-15-73	1.19	2.70	Y	-	-	-
TERNATE	BPW	31624-0018	81	14 17 15	120 42 55	104.60	-	4.26	04-09-57	-	-	Y	-	-	-
TERNATE	BPW	31624-0023	82	14 17 0	120 41 55	40.90	-	3.04	05-02-57	-	-	Y	-	-	-
TERNATE	BPW	31624-0030	83	14 18 10	120 43 55	47.90	-	-	-	-	-	Y	-	-	-
TERNATE	MARBELLA CLUB, INC.	31624-0045	84	14 16 1	120 38 37	107.30	-	15.24	01-09-81	-	-	Y	-	-	-
DASMARINAS	HOMETOWN DEV'T.	31632-0262	85	14 20 46	120 56 38	183.00	200	18.00	07-26-82	8.33	0.60	Y	Y	Y	-
DASMARINAS	DPWH	31632-0318	86	14 21 39	120 58 51	67.10	50	32.00	11-28-88	-	-	Y	-	-	-
DASMARINAS	BPW	31632-0258	87	14 20 46	120 55 30	64.00	-	9.15	11-30-55	0.95	1.00	Y	-	Y	-
GEN. TRIAS	NIA	31632-0222	88	14 22 6	120 52 32	98.00	200	7.18	03-29-76	16.72	3.10	Y	Y	Y	Y
GEN. TRIAS	NIA	31632-0224	89	14 21 4	120 54 8	200.00	310/200	4.23	05-03-76	19.05	4.40	Y	Y	Y	Y
GEN. TRIAS	DPWH	31632-0321	90	14 24 25	120 52 57	48.80	50	3.05	08-30-88	-	-	Y	-	-	-
NAIC	BPW	31632-0003	91	14 20 13	120 47 0	93.20	-	-	-	-	-	Y	-	-	-
TANZA	NIA	31632-0234	92	14 21 48	120 48 28	100.00	200	4.60	01-08-76	9.50	1.05	Y	Y	Y	Y
TANZA	NIA	31632-0244	93	14 21 22	120 52 12	200.00	305/200	9.40	07-02-76	15.60	3.60	Y	Y	Y	Y
TANZA	TANZA WD	31632-0384	94	14 23 39	120 51 13	115.00	250/200	4.33	10-27-90	28.63	2.02	Y	Y	Y	Y
TANZA	NIA	31632-0251	95	14 20 12	120 49 28	250.00	305/204	12.52	-	-	-	Y	Y	-	-
TANZA	BPW	31632-0227	96	14 23 8	120 49 56	131.70	-	-	-	-	-	Y	-	-	-
TANZA	BPW	31632-0238	97	14 24 18	120 50 40	70.10	-	1.52	08-17-57	-	-	Y	-	-	-
TANZA	BPW	31632-0245	98	14 22 20	120 50 10	129.60	-	10.67	08-19-57	0.94	1.54	Y	-	Y	-
TANZA	DPWH	31632-0336	99	14 22 26	120 51 16	36.60	50	2.44	-	-	-	Y	-	-	-
CARMONA	BPW	32624-0028	100	14 18 55	121 1 45	118.00	-	64.02	-	0.63	0.40	Y	-	Y	-

Table 5-4 (CONT...)

MUNICIPALITY	WELL OWNER	PGDB NO.	PLOTTED WELL NO.	LATITUDE	LONGITUDE	DEPTH (m)	CAS. DIA. (mm)	SWL (mbmp)	DATE MEASURED	DISCHARGE (lps)	SPEC. CAP. (lps/m)	LITH. LOG	WELL DESIGN	PUMPING TEST	WATER QUAL. ANALYSIS
CARMONA	BPW	32624-0069	101	14 18 35	121 1 21	194.50	-	-	-	-	-	Y	-	-	-
CARMONA		32624-0082	102	14 15 46	121 1 25	40.00	100	8.20	-	-	-	Y	-	-	-
GEN. M. ALVAREZ	SUNSHINE HOMES	32624-0048	103	14 19 20	121 2 22	152.40	152	82.32	-	-	-	Y	Y	-	-
SILANG	BPW	32624-0013	104	14 12 55	121 1 45	100.00	-	57.01	06-19-57	0.38	0.25	Y	-	Y	-
SILANG	BPW	32624-0008	105	14 11 10	121 0 45	106.70	100	67.06	10-30-84	1.50	0.08	Y	-	Y	-

"Y" MEANS DATA AVAILABLE
"-" MEANS NO DATA AVAILABLE

Table 5-5 SUMMARY OF WELL DATA OF 62 SUPPLEMENTARY WELLS

MUNICIPALITY	WELL OWNER	PLOTTED WELL NO.	PGDB NO.	LATITUDE	LONGITUDE	DEPTH (m)	CAS. DIA. (mm)	SWL (mbgs)	DATE MEASURED	DISCHARGE (lps)	SPEC. CAP. (lps/m)	LITH. LOG	WELL DESIGN	PUMPING TEST	WATER QUAL. ANALYSIS	ELEC. LOGS	REMARKS
DASMARINAS	DASMARINAS WATER DISTRICT	106	31621-0601	14 16 23	120 57 57	188.00	250/200	51.40	12-17-86	18.18	2.45	Y	Y	Y*	Y	Y	MALINTA PUMPING STATION
DASMARINAS	CITY HOMES RESORT VILLE (LANGKAAN)	107	31621-0615	14 18 31	120 55 49	182.00	200	16.46	11-27-93	13.25	0.99	-	Y	Y*	-	Y	WELL #2
DASMARINAS	SOLAR HOMES	108	31621-0608	14 18 27	120 55 56	213.00	-	-	-	[illegible]	-	-	-	-	-	Y	
DASMARINAS	IGLESIA NI CRISTO	109	31621-0604	14 16 56	120 57 44	183.00	150	31.55	03-07-92	16.11	0.82	Y	Y	Y*	Y	Y	WELL #2
DASMARINAS	DASMARINAS WATER DISTRICT	110	31621-0605	14 19 49	120 57 30	182.93	200/150	31.10	02-07-81	22.40	3.87	Y	Y	Y*	Y	Y	NHA WELL #5
DASMARINAS	MANILA MEMORIAL PARK	111	31621-0622	14 17 40	120 58 30	244.00	250	35.06	-	20.82	0.96	Y	Y	Y	-	Y	WELL #2
DASMARINAS	MANILA MEMORIAL PARK	112	31621-0607	14 17 45	120 58 37	244.00	250	29.52	-	23.16	0.56	Y	Y	Y	-	Y	WELL #3
DASMARINAS	MANILA MEMORIAL PARK	113	31621-0603	14 17 35	120 58 35	240.00	250	43.24	-	20.82	1.13	Y	Y	Y	-	Y	WELL #4
DASMARINAS	CITY HOMES (BAGUMBAYAN)	114	31621-0609	14 18 25	120 57 35	182.00	200	-	-	-	-	-	Y	-	-	Y	WELL #1
DASMARINAS	CITY HOMES (BAGUMBAYAN)	115	31621-0610	14 18 30	120 57 42	182.00	-	-	-	-	-	-	Y	-	-	Y	WELL #2
DASMARINAS	CITY HOMES RESORT VILLE (LANGKAAN)	116	31621-0611	14 18 40	120 55 48	182.00	-	-	-	-	-	-	Y	-	-	Y	WELL #1
DASMARINAS	FIESTA HOMES	117	31621-0612	14 19 58	120 55 37	136.00	200	-	-	-	-	-	Y	-	-	Y	
DASMARINAS	SOUTHCREST VILLAGE	118	31621-0613	14 19 12	120 56 52	182.00	200	-	-	-	-	Y	Y	-	-	Y	
DASMARINAS	ST. CHARBEL VILLAGE	119	31621-0614	14 8 6	120 57 48	152.00	200	-	-	-	-	-	Y	-	-	Y	
DASMARINAS	REYNOLDS PHILS. CORP.	120	31621-0602	14 18 8	120 56 53	152.44	300	-	-	-	-	Y	Y	-	-	Y	
DASMARINAS	REYNOLDS PHILS. CORP.	121	31621-0616	14 18 15	120 56 50	152.44	300	19.21	09-04-77	41.65	4.14	Y	Y	Y	-	-	
DASMARINAS	DASMARINAS WATER DISTRICT	122	31621-0617	14 19 26	120 57 12	170.00	-	-	-	-	-	Y	-	-	Y	-	SUMMERWIND IV PUMPING STATION
DASMARINAS	DASMARINAS WATER DISTRICT	123	31621-0618	14 19 58	120 57 42	182.93	200/150	-	-	-	-	-	Y	-	-	-	NHA AREA-H
DASMARINAS	MOLDEX REALTY, INC.	124	31621-0619	14 18 8	120 56 49	200.00	250	35.06	03-02-92	25.24	3.37	Y	Y	Y*	-	Y	METROGATE DASMARINAS WELL #1
DASMARINAS	MOLDEX REALTY, INC.	125	31621-0620	14 18 7	120 56 40	200.00	250	24.39	03-23-93	28.26	3.03	Y	Y	Y*	-	Y	METROGATE DASMARINAS WELL #2
GMA	GMA WATER DISTRICT	126	31621-0621	14 17 7	120 59 58	182.93	200/150	-	-	-	-	Y	Y	-	-	-	AREA K
GMA	GMA WATER DISTRICT	127	31621-0606	14 16 58	120 59 57	213.41	200/150	49.21	-	7.71	0.77	Y	Y	Y	-	Y	
GEN. TRIAS	GATEWAY PROPERTY HOLDINGS, INC.	128	31621-0623	14 16 7	120 54 57	194.00	250/200	14.72	04-25-92	10.30	1.25	Y	Y	Y*	Y	Y	PUMPING WELL #4
MARAGONDON	BUCAL RWSA	129	31621-0624	14 16 30	120 45 33	70.00	200	22.09	03-15-90	16.00	1.27	Y	Y	Y*	Y	Y	
SILANG	SILANG WATER DISTRICT	130	31621-0625	14 13 37	120 58 19	198.00	250/200	59.87	12-09-86	9.33	0.21	Y	Y	Y*	Y	Y	PUMPING STATION #4
SILANG	SILANG WATER DISTRICT	131	31621-0626	14 12 58	120 58 13	204.00	250/200	70.80	11-17-92	16.39	0.56	Y	Y	Y	-	Y	GABRIELA PUMPING STATION
SILANG	MOLDEX REALTY, INC.	132	31621-0627	14 14 26	120 58 17	210.00	200	34.50	08-06-92	14.80	0.30	Y	Y	Y*	-	Y	METROGATE SILANG WELL #1
SILANG	SILANG WATER DISTRICT	133	31621-0628	14 15 0	120 58 30	225.00	250/200	64.84	01-06-94	16.07	1.70	-	Y	Y*	-	Y	BGY. BIGA I
SILANG	SILANG WD (BULIHAN PROD. WELL #1)	134	31621-0629	14 16 45	120 59 25	155.50	200/150	30.57	11-30-82	8.17	0.29	Y	Y	Y*	-	-	SWL = 40.06m (06-04-90)
SILANG	SILANG WD (BULIHAN PROD. WELL #2)	135	31621-0630	14 16 10	120 59 37	170.73	200/150	36.33	12-01-82	11.15	0.34	Y	Y	Y*	-	-	SWL = 50.00m (12-28-89)
SILANG	SILANG WD (BULIHAN PROD. WELL #4)	136	31621-0631	14 16 57	120 59 42	182.87	200	37.78	05-12-83	6.30	0.37	Y	Y	Y*	-	-	
SILANG	SILANG WD (LWUA PROD. WELL #3)	137	31621-0632	14 13 6	120 58 35	170.73	250	64.23	12-23-89	7.18	1.17	Y	Y	Y*	-	-	SWL = 65.74m (06-10-90)
SILANG	SILANG WD (LWUA PROD. WELL #2)	138	31621-0633	14 17 55	120 58 1	246.00	250	69.55	12-21-89	15.92	0.39	Y	Y	Y*	-	-	SWL = 67.14m (05-10-90)
TANZA	CHUNG FU TEXTILE CO.	139	31621-0634	14 17 23	120 49 55	122.00	200	-	-	-	-	Y	Y	-	-	Y	
TRECE MARTIREZ	LA PAZ HOMES CAVITE DEV. CORP.	140	31621-0635	14 16 12	120 53 13	242.00	250/200	13.75	01-15-93	12.50	0.74	Y	Y	Y*	Y	Y	WELL #1
TRECE MARTIREZ	DON BOSCO EXECUTIVE VILLAGE	141	31621-0636	14 17 27	120 51 25	182.00	200	-	-	-	-	-	Y	-	-	Y	
MENDEZ	MENDEZ WATER DISTRICT	142	31622-0601	14 7 32	120 54 8	243.90	200/150	87.20	12-12-92	5.68	0.78	Y	Y	Y*	-	-	
TAGAYTAY CITY	RFM BREEDER FARM	143	31622-0602	14 6 34	120 56 1	213.41	250/200/150	-	-	-	-	Y	Y	-	-	-	
TAGAYTAY CITY	SMC TRAINING CENTER	144	31622-0603	14 4 28	120 51 35	158.00	-	-	-	-	-	-	-	-	-	Y	WELL #1
TAGAYTAY CITY	TAGAYTAY ROYALE	145	31622-0604	14 5 5	120 52 17	210.36	250/200	-	-	-	-	-	Y	-	-	-	
TERNATE	TERNATE DEV. CORP.	146	31624-0601	14 16 42	120 40 27	183.00	200	-	-	-	-	Y	Y	-	Y	-	
TERNATE	PUERTO AZUL LAND, INC.	147	31624-0602	14 16 0	120 40 36	100.00	200	5.80	08-07-93	4.85	0.13	Y	Y	Y*	Y	Y	PALICPICAN WELL #3
DASMARINAS	DASMARINAS WATER DISTRICT	148	31632-0602	14 20 33	120 57 8	182.93	200/150	14.63	08-14-80	18.30	0.95	Y	Y	Y*	Y	Y	NHA WELL #1
DASMARINAS	DASMARINAS WATER DISTRICT	149	31632-0603	14 20 18	120 57 3	182.93	200/150	32.01	10-08-80	20.70	3.75	Y	Y	Y*	Y	Y	NHA WELL #3
DASMARINAS	ORCHARD	150	31632-0604	14 21 25	120 56 55	183.00	-	-	-	-	-	Y	Y	-	-	Y	WELL #2
DASMARINAS	ORCHARD	151	31632-0605	14 21 30	120 57 35	183.00	-	-	-	-	-	-	Y	-	-	Y	WELL #3
DASMARINAS	ORCHARD	152	31632-0606	14 21 35	120 58 36	182.00	-	-	-	-	-	-	Y	-	-	Y	WELL #10
DASMARINAS	SAN MIGUEL YAMAMURA ASIA CORP.	153	31632-0607	14 21 50	120 56 5	200.00	300/250	-	-	-	-	-	Y	-	-	Y	
DASMARINAS	DASMALINAS WATER DISTRICT	154	31632-0608	14 20 1	120 55 50	152.44	-	13.29	02-08-92	-	-	Y	-	-	Y	-	WOOD STATE PUMPING STATION
TAGAYTAY CITY	FOCOLARE COMPOUND	155	32623-0601	14 7 40	121 0 40	164.63	200	-	-	-	-	Y	Y	-	-	-	

Table 5-5 (CONT...)

MUNICIPALITY	WELL OWNER	PLOTTED WELL NO.	PGDB NO.	LATITUDE	LONGITUDE	DEPTH (m)	CAS. DIA. (mm)	SWL (mbgs)	DATE MEASURED	DISCHARGE (lps)	SPEC. CAP. (lps/m)	LITH. LOG	WELL DESIGN	PUMPING TEST	WATER QUAL. ANALYSIS	ELEC. LOGS	REMARKS
CARMONA	MOTOROLA PHILS., INC.	156	32624-0601	14 19 29	121 3 50	194.00	200	-	-	-	-	Y	Y	-	-	Y	WELL #1
CARMONA	PHILIPPINE SYNTHETIC	157	32624-0602	14 19 20	121 3 15	122.00	250	-	-	-	-	Y	Y	-	-	Y	
CARMONA	PHIL. CARRAGEENAN MFG. CORP.	158	32624-0603	14 19 18	121 3 18	152.44	-	-	-	-	-	Y	-	-	-	-	
CARMONA	RICO PHILIPPINES MFG. CORP.	159	32624-0604	14 19 22	121 3 20	152.44	-	-	-	-	-	Y	-	-	-	-	
CARMONA	THE MANILA SOUTHWOODS (FIL-ESTATE)	160	32624-0607	14 18 53	121 2 31	250.00	350/200	13.00	12-14-92	22.72	15.33	Y	Y	Y	-	Y	WELL #7
CARMONA	THE MANILA SOUTHWOODS (FIL-ESTATE)	161	32624-0611	14 18 50	121 2 35	237.80	350/200	4.20	02-25-93	26.00	1.50	Y	Y	Y	-	Y	WELL #8
GMA	GMA WATER DISTRICT	162	32624-0605	14 17 30	121 0 16	213.41	200/150	55.00	-	6.81	0.14	Y	Y	Y	-	Y	TEACHER'S VILLAGE
SILANG	SILANG WD (BULIHAN PROD. WELL #3)	163	32624-0608	14 16 4	121 0 6	182.87	200/150	47.98	04-22-83	6.77	0.21	Y	Y	Y*	-	-	
SILANG		164	32624-0609	14 14 47	121 0 12	32.01	100	12.20	11-19-59	-	0.10	Y	-	-	-	-	
SILANG		165	32624-0610	14 13 25	121 0 30	51.83	100	25.91	09-14-60	-	0.21	Y	-	-	-	-	
SILANG	BPW	166	32624-0606	14 10 15	121 0 43	123.40	-	-	-	-	-	Y	-	-	-	Y	
ALFONSO	RODEO HILLS	167	31622-0605	14 4 48	120 51 25	240.00	200	-	-	-	-	Y	Y	-	-	Y	

"Y" MEANS DATA AVAILABLE
"-" MEANS NO DATA AVAILABLE
"Y*" MEANS WITH PUMPING TEST REPORT

6. INITIAL ENVIRONMENTAL EXAMINATION

6. INITIAL ENVIRONMENTAL EXAMINATION

The survey was carried out through literature review of previous studies, interviews with the concerned staff of the government agencies and other data collection activities such as personal interview with dealers.

All pertinent reports, records and literature issued by institutes, universities, government agencies both national and local and other concerned organizations were listed, obtained and abstracted for those very relevant ones.

The most common impacts of water systems development have been briefly discussed. The lack of data and studies in the Philippines limits its presentation. Nevertheless, the impacts are summarized in **Table 6-1**.

Concerned agencies of the government, both local and national, were visited and interviews with key staff were made. Where necessary, data obtained from national agencies were counterchecked and resorted at the provincial offices e.g. FPA and DOH.

Where data could not be easily obtained, visits were made in the field and interviews conducted with concerned persons. Some of the data on the brand name of pesticides locally used were obtained from actual interviews with dealers and storekeepers in at least three (3) municipalities in Cavite.

6.1 GENERAL ENVIRONMENTAL CONDITIONS IN THE PHILIPPINES

6.1-1 Health and Sanitation

Recent health indicators (1991) point that life expectancy in the Philippines is 64.3 years and infant mortality is 5 percent. Diarrhea is among the leading causes of morbidity. The rate was 502 per 100,000 population in 1982, and rose to 1,301 in 1991. Only 69 percent of the 1991 population had access to sanitary toilets. The population served by sewerage is still below 2 percent.

The scarce investments in water and sanitation sector were poured in Metro Manila and urban areas. Urban sources of water are becoming polluted or are threatened by pollution which can be correlated to almost non-existent sewerage. Impediments to the sanitation / sewerage improvements include low government priority given to sewerage, low political visibility and the utmost lack of appreciation of benefits by householders.

6.1-2 Air, Water and Soil Pollution

Air Pollution and Noise

Air pollution happens mostly in highly urbanized cities as the main contributor of air pollution are the transport vehicles which account for about 70 percent. The remaining 30 percent is due to industrial sources. The specific pollutants are the total suspended articulates (TSP), sulfur dioxide (SO_2), oxides of nitrogen (NO_x) and carbon monoxide (CO). As the country is moving towards industrialization it is expected that the contribution from the industrial sources will increase.

In terms of TSP, the reported yearly average in 1989 in Metro Manila was over 2 times the ambient air quality standards, or an increase of three times in barely ten (10) years. SO_2 in major cities is still within the standards. However, CO level continues to rise from 4.2 ppm in 1980 to 8.6 ppm in 1983.

Noise levels in Metro Manila's residential and commercial areas are generally higher than standards.

Water Pollution

Rivers in highly-urbanized areas are mostly grossly polluted. For example in Metro Manila, all its three (3) river systems are considered biologically dead meaning "devoid of oxygen needed to sustain aquatic life".

In terms of Biochemical Oxygen Demand (BOD), the largest freshwater lake is in the hyper-eutrophic stage due to high nutrient contents. The coasts of Manila Bay have bacterial counts over 100 times higher than the standards (for waters used for recreation).

Overall, about half of the country's 421 rivers are still not polluted. Regarding heavy metals and toxic substances, the levels in these rivers are still within standards.

The sources of water pollution are domestic wastewater (50 to 60%), industrial (30 to 40%), agricultural fertilizers and pesticides, squatters and garbage.

Soil Pollution

Agricultural production has relied mainly on the use of chemical fertilizers. Also on pesticides use, it was estimated that there was a three-fold increase in the importation of pesticides from 1980 to 1987.

The increased use of chemical fertilizers and pesticides is causing an environmental threat to the soil as well as to the groundwater. In the Philippines, soil pollution would only mean that the soil has lost (or impaired) its productivity. Soil pollution could also come form the indiscriminate and accidental spillage of mine tailings. Groundwater contamination could come from municipal garbage dumps, polluted surface waters, leaking underground storage tanks, illegal industrial disposal, etc.

At the moment there is still no data about groundwater pollution available in the country.

Regarding soil / land pollution caused by garbage, a study has come up with a range of characteristics of leachate from dumpsites.

6.1-3 Disposal of Solid Waste

The practice in the rural areas and urbanized centers is that all garbage are collected and place in open dumpsites. Only a very few cities have managed to construct a sanitary landfill for this purpose e.g. San Mateo in Rizal, Carmona in Cavite which are serving Metro Manila.

According to estimates about 4,000 tons of garbage is generated in Metro Manila alone. Of this, about 30 percent are uncollected which are left out in the streets and eventually clog up the drains and pollute the waterways, rivers and coastal areas.

From **Table 3.2**, it can be seen that yard / field waste accounts for about one-third (1/3) of the domestic waste. Another third could be recovered and recycled e.g. wood, plastics, textiles, metals, etc.

6.1-4 Disposal of Domestic and Industrial Wastewater

<u>Domestic Wastewater</u>

Only a very small percentage say 2% of the total population of 63 million is served by a sewerage system and these sewerage areas are in urban centers. For example, metro manila has a sewerage system designed for 500,000 people only. For practical purposes, all of the domestic wastewater in the households end up in the rivers or sea.

<u>Industrial Wastewater</u>

Industrial wastewater are mostly treated before discharge into water bodies. This provision is implemented by DENR under the industrial pollution control program. Industrial effluents are the main sources of heavy metal and toxic pollution and organic pollution in water bodies.

Industrial wastewater is subject to effluent standards meaning nobody will be allowed to discharge into any water body without first complying with the effluent standards. If after due notice, the factory still pollute, this factory is subject to the "Cease and Desist order" from the Pollution Adjudication Board (PAB). This order temporarily stops the operations and activities of the factory causing pollution until the same has been remedied or abated.

Besides the above environmental problems, some other issues such as urban population, depletion of natural resources, deforestation, soil erosion and so on are also reviewed in the survey.

6.2 ENVIRONMENTAL IMPACTS OF GROUNDWATER DEVELOPMENT

(1) Groundwater Depletion

The effect of uncontrolled withdrawal of groundwater in metro Manila, for example, resulted in the groundwater levels in different residential and industrial centers. It was reported that piezometric surface was at 50 m below sea level for most of the city in 1980. The rate of decline then was 1 m per year. It was also observed that during the period 1981 - 90, more that 75 percent of metro Manila experienced a negative change in the piezometric levels in varying degrees. Depletion rate during the same period was highest in Valenzuela / Caloocan (-60 m lowering), Tondo (-50 m lowering) and Las Piñas (-50 m lowering). In 1991, it was noted that except in Caloocan and Quezon City, areas in Metro Manila have groundwater levels lower than the sea level. The biggest and lowest depression occurred in Malabon / Caloocan / Valenzuela (-210 m).

It was noted that groundwater table has lowered during the dry season in Norzagaray, Bulacan due to heavy pumping of groundwater for irrigation use coupled with the occurrence of low rainfall and high evapotranspiration. The number of people affected was not specified but it did dry up the shallow wells in the area so that farmers were complaining about.

In Cebu City, the zero groundwater level or that level the same as the sea level was 2 km. inland as of mid-1980s.

In Cavite in 1991, the coastal towns of Rosario, Kawit, Noveleta, Bacoor and Cavite City have piezometric levels lower than the sea level. Other parts have positive piezometric levels. It was also observed that these areas experienced a negative change in piezometric levels during the period 1981 - 90.

(2) Saline Water Intrusion

In coastal aquifers, the attendant risk of seawater intrusion into the fresh water aquifer has become even greater with an increasing dependence on groundwater sources. Uncontrolled withdrawal of groundwater has also resulted in increase in salinity in some of the major cities (like Manila and Cebu) located in the coastal area in the Philippines.

In 1991, high chloride content (more than 600 mg/L) groundwater was observed at Las Piñas spreading towards Parañaque and Pasay City and at Malabon (Tinajeros) spreading towards Caloocan City. The first is pretty close to the observed trough in piezometric surface at Parañaque while the second occurrence coincided with the trough at Malabon / Caloocan / Valenzuela area.

In the mid-80s salinity intrusion was already advancing to 4 km from the coast (lesser contamination), the first 1.5 km form the shoreline of which has high chloride content. it was estimated that the affected area in the Malabon area was 16 sq.km., Pasay (1 sq.km.) and Las Piñas (2.5 sq.km.). These areas have a chloride content more than 400 mg/L.

The total areas affected by salinity intrusion in Metro Manila was estimated to be 12,400 hectares or about 186,000 people. Translated into monetary terms, the damage or loss was about P14 million (1983 prices). This meant P1.20 per family per day was spent to get alternative source of water. These areas are mostly blighted where low-income group thrives. Water is needed in these blighted areas mostly for drinking and cooking. As a consequence, these people were forced to pay more in order to get safer and more acceptable water.

In Cebu City in 1985, it was first estimated that on the average, salinity intrusion was about 1 km. form the shoreline. However, the impact is less felt as the area affected was commercial rather than residential. Nevertheless, the estimate of the people affected was about 57,400 people.

The industry sector is affected by excessively high saline water as it would result in the reduction of product quality and increased cost for water treatment. For example, a bijon (noodles) factory in Cebu City was forced to close shop due to the effect of salt water on its product.

In agriculture, excessive salt in irrigation water could damage plant growth resulting to the reduction of the crop yield. It was estimated in 1987 that 50 percent reduction of yield in the coastal areas was caused by saltwater intrusion. In Pampanga, it was estimated that 5 to 20 percent of the cropland was affected resulting t P10 million loss. Excessive salt intake reduces livestock productivity, however, no local incident of this type was reported yet.

Farmers responded to this phenomena by delaying the transplanting of rice until the rainy season and growing of salt-tolerant variety or crop (e.g. cotton). The former resulted in economic losses to the farmers.

In the Study Area, seawater intrusion is found also. Of all the 639 wells located in the Study Area and registered in the Philippines Groundwater Data Bank, 67 wells have water quality analysis records. Most of them are recorded in 1970s, that is, rather than the situation of water quality distribution, the data may be more appropriate to use for background analysis, however, 11 wells had already failed in water drinking standard because of their high content of chloride or TSD. As shown in **Fig. 6-1**, these wells can be divided into two groups. The one concentrated in southern Dasmarinas, the other are those scattered along sea shore in Naic and Tanza.

(3) Land Subsidence

Although there is no sufficient evidence to show that the land subsidence exists in Metro Manila, a number of sings have already been visible such as the daily occurrence of tidal flooding in the Navotas-Malabon area and the apparent rise f the mean sea level as shown by the tidal records of NAMRIA.

(4) Other Impacts Concerning Water-Supply and Wastewater

Water supply system if not properly maintained may also cause some environmentally unacceptable conditions. Leakages from supply pipes and improperly designed / constructed drainage systems may bring out waterlogging or drainage problems. It is common knowledge that non-revenue water of MWSS is very high (about 30%) but there is still a need to document the impacts of such water system losses.

Having the most direct effect on the environment, improper wastewater and sanitation facilities or the lack of it has created undesirable environmental impacts for Metro Manila and for the Laguna Lake Basin.

6.3 SITUATION OF POTENTIAL POLLUTION SOURCES

(1) Status and Control of Industrial Pollution

Table 6-2 shows the statistical summary of industrial establishments located in Cavite.

As of 1993 there were 54 industrial establishments which are potential to came water pollution in Cavite, 37 of which are under the jurisdiction of DENR. Of there 37 factories, six (6) were given a Cease and Desist Order (CDO) by PAB as shown in **Table 6-3**.

The list of rivers and discharge points in **Table 6-4** from which estimates of the percentage of the number of firms discharging into different water bodies were derived. In the same table, only two (2) rivers in Cavite are classified by DENR i.e. Ilang-Ilang River (Class B) and the Banabang-Molino-Imus River (Class C).

Tables 6-5 and **6-6** show the statistics summary of cases filled with the PAB.

The summary of industrial pollution indicators for the period 1989 - 93 is given in **Table 6-7**. There has been a generally increasing trend in the number of firms surveyed. The number of plants / firms inspected has been more or less the same and this reflects the capability of the DENR Regional Office. The number of complaints investigated had gone down during the period.

There has been a very low full compliance rating for the past five (5) years except in 1990. Potentially-water-pollution firms are said to be in full compliance with the regulatory requirements if they are given permanent permit to operate (PO) by DENR or LLDA. They are said to have slight pollution problems if they are only given a temporary permit to operate. In extreme cases, they are given a CDO for not grossly complying or just a Notice of Violation (NOV) if the violation is a minor one.

The number of firms not complying has gone down by about one-third since 1992. However, the data used here are not the same as in 1992 and 1993 instead the number of technical conferences held served as the indicator for non-compliance.

(2) Sewerage Condition

The province of Cavite does not have a sewerage system. In fact, only metro Manila and Baguio City have sewerage systems in the Philippines. The "Development Plan on Water Supply, Sewerage, and Sanitation - Cavite province" indicated that there is little chance of any sewerage system being implemented in the near future. Hence, disposal of domestic wastewater is therefore done on-side.

(3) Solid Waste

In Cavite province, there are no province-wide study on solid waste management. The only available secondary data is the monitoring data of the provincial health Office regarding the number of households with satisfactory and unsatisfactory solid waste management system as indicated in **Table 6-8**. There are no reliable data on waste volume generation. Solid waste are usually disposed at the backyard.

In metro Manila, solid waste management data were generated by the previous studies. **Table 6-9** shows the composition of domestic waste in metro manila, and **Table 6-10** shows the leachate characteristics in Pasing and Payatas Dumpsites.

(4) Pesticides and Fertilizers

Data on pesticide and fertilizer consumptions for the province of Cavite are not available. Monitoring activities of the Fertilizer and Pesticide Authority (FPA) and the Department of Agriculture do-not include the amount consumed by the whole province. The FPA only monitors the total quantities imported by the country.

Table 6-11 shows the pesticide list which registered in FPA.

A brief survey on the previous and present type of pesticides available in the market was conducted in the towns of Tanza, Dasmariñas, and Trece Martires City. Interviews conducted indicated that pesticide usage in the lowland is much higher than in the upland due to rice cultivation in the lowland. High usage of endosulfan was noted in the lowland due to its use as a poison to a snail locally know as "kuhol". Another popular pesticide is methyl parathion.

6.4 CHECKLIST OF POTENTIAL IMPACTS

Referring to examples of initial environmental examination document for a water source development project in the Philippines, and the Guideline of JICA for Environment Consideration in

Development Survey, all items concerning with the proposed project are checked and presented in **Table 6-12**.

Items contained in the list can be divided into three groups, they are, items on

social environment (1 to 9),
natural environment (10 to 17),
public hazard (18 to 23).

6.4-1 Social Environment

(1) Resettlement

Because the project will be formulated on the basis of the local development strategy, the project should be in compliance with the land use plan of local government, or even more can be expected, play a role in accelerating the accomplishment of the plan. The other advantage may be the increase of the land price because of the improvement of water supplies will make the land more available for either dwelling or economic activities.

Negative impact may take place when the occupants of identified site for wter supply facilities do not cooperate. This problem was already encountered during the Test Drilling survey, the drilling site in Naic and Tanza were relocated in order to avoid trouble. This experience proved that the problem could be solved if there was a negotation with concerned occupants and the alternative plans such as land exchange were taken into consideration.

(2) Economic Activities

Because the purpose of the project is solving the existing or predicted problems concerning water supplies to meet the needs of economic development and the increase of population in the Study Area, the project is expected to be such a significant one that will accelerate or ensure a smooth economic development in the Study Area.

On the other hand, the project will directly bring additional business opportunities for those engaged in the supply of construction materials.

(3) Traffic and Public Facilities

Though almost no materials are needed to be transported in the operation of water supply systems, the impact might occur in the construction of facilities. If the construction of pipeline do not involve digging of roads, the impact can be neglected, but if the digging of road is needed, serious consultation with all the concerned respects is necessary before the pipeline is going to be constructed.

The same as Item 2, because the project is planned for the improvement of living standard of dwellers in the Study Area, along with the implementation of the project, sufficient water with good quality can be supplied to institutional facilities such as schools and hospitals to make these facilities more efficient and more comfortable.

The project itself is factually the most important part of the public facilities. Therefore, the project can be expected to significantly contribute to the improvement of public facilities.

(4) Split of Communities

The project will not cause the change of roads except in construction and when the digging of roads is necessary. Even in that case, however, the split of communities will not be a serious issue because it is restricted in a relatively short time, and measures such as temporary road can be adopted to mitigate this negative influence.

(5) Cultural Property

Up to the present, no relics nor cultural asset is reported in the Study Area, so consideration on this item can be neglected.

(6) Water Right and Right of Common

Interviews were made regarding the possible disputes over water rights, such as, abandonment of shallow wells due to heavily pumping of deeper wells. Based on the survey, there has been no such incidents. Perhaps, incidents like these seldom occur in the Study Area.

A check with NWRB revealed that there are only very few cases of water disputes in the country involving ground water level decline. However, the office is not keeping record of these cases, if any, besides, disputes of this nature were easily settled.

Although the implementation of the project will improve the level of groundwater development and mitigate the impact concerning abandonment of shallow wells as a result of over pumping, ground water level decline is inevitable to occur as in any other project of groundwater tapping. Therefore, awareness on the impact of misused ground water resources should be imparted to well owners, users, and other concerned people.

(7) Public Health Condition

This item can be divided into three subitems, they are:

1) supply of good quality drinking water to ensure human health;
2) supply of sufficient water for domestic use such as washing and bath;
3) avoidance of increase of non- or poor disposal waste water increased with the new water supplies.

One main, if not the most important, reason or purpose of the project is to provide sufficient drinking water with good water quality. This will be particularly significant to those areas with poor water facilities, where waterborne disease such as acute diarrhea have a relatively high incidence during rainy season.

The improvement of sanitary situation, the convenience of inhabitants to take bath or wash clothes, can also be expected by the new water supplies as a desired result of the project.

Most of the increased human water use will re–emerge as waste water, household sullage or sewage, and it is unlikely that the facilities for wastewater collection and treatment such as sewerage system will be implemented in the near future. Hence the increased volumes of waste water could become new permanent water bodies offering a breeding ground for certain insects like mosquitos or a generation source of offensive odor and pollution.

(8) Waste

The water supply system will be operated without significant waste generation, but in the construction of facilities especially during drilling, attention is necessary to prevent polluting water bodies and soil around the construction site by mud and oil used for drilling. In the test drilling survey, not any trouble caused at all by the waste.

(9) Hazards (Risk)

Drawdown of water level in the extraction of shallower groundwater may reduce the threat of landslide or mud–rock flow, which may occur in hilly areas with relatively steep slope.

Compare with the impact of the change of situation of groundwater, the scale of facilities contained in the project is too small to be considered for protection against calamities.

6.4–2 Natural Environment Items

(10) Topography and Soil Condition

The project will not contain any public works with large scale digging or filling that will make change topography and soil condition.

(11) Soil Erosion

Soil erosion is generally resulted from the change of vegetation or topography. Neither of them will be changed by the project, thus, soil erosion is not a major concern.

(12) Groundwater

Tapping new groundwater sources will normally lower the aquifer in the vicinity of the well or borehole. If continued and severe, the depletion will start to affect water extraction from the same aquifer elsewhere. Therefore, the result of assessment will depend on whether groundwater can be extracted in a stable designed amount while the water drawdown will not exceed the safe limit.

The environmentally acceptable project must be formulated on the basis of integrated analysis of hydrogeological features in the Study Area, to ensure that the designed pumpage amount balances, the development potential and the water demand now and in the future.

Moreover, a monitoring program is necessary after the operation of the system to check the designed pumpage amount and to adjust the pumpage when social and natural conditions change such as the rapid increase and over concentration of private wells in an industrial zone or the unusual occurrence of continuous drought years.

(13) Hydrological Situation

When water table is withdrawn in extracting groundwater, the infiltration of rainfall will be increased while the discharge from aquifer to surface water will be decreased. Therefore, in the Study Area, springs and rivers would be adversely impacted to reduce their discharge, when the well are designed in their recharge area.

On the other hand, as stated in (7), wastewater increases along with the project, which will become a new pollution source for surface water if no appropriate measure will be done.

(14) Coastal Zone

The project will not involve any public works which have such a large scale that it can affect the coastal conditions.

(15) Fauna and Flora

A part of the Study Area points to the national park for the protection of forest and animals living in it. Therefore, it should be adopted that no trees will be cut as much as possible during the construction.

(16) Meteorology

The scale of works involved in the project is quite small that its impact on meteorology can be neglected.

(17) Landscape

The impact of facilities on landscape can be caused by the storage tank, which must be elevated above houses to keep the water pressure high enough for providing water to these houses, and to have some large volume to regulate the amount of water. At present, water tanks scattered somewhere in the Study Area are quite conspicuous and have actually become a feature of the local landscape. People's feeling about this landscape may differ from one another. The construction of a water tank will not alter the characteristic of this landscape.

As stated in item (2), comparing with the case without the project, the wells or tanks will be relatively lesser in number. And, if the highly erected tanks are necessary to be dismantled in the future, it can be replaced by automatic pressure system provided by stable electric supply and enough equipment investment.

6.4-3 Public Hazard items

(18) Air Pollution

No part of the project can be related to the generation of waste gas.

(19) Water Pollution

The project will be extracting groundwater from deep aquifer for its stable supply and good quality, and the extraction will inevitably cause a change in the groundwater flow system. As a result of this change, the possibility of groundwater flow from shallow aquifer, through underlain aquiclude, to deep aquifer will occur. The more probable way for shallow groundwater to enter the extraction aquifer is in the case of poorly developed wells or when the well sealing is damaged. Therefore, it is necessary to determine whether some route may exist between shallow and deep aquifers, and not only insurance the development of the well completely according the design, but also maintenance of well after operation must be done seriously.

The projecte will reduce the number of private wells thus mitigate the threat of groundwater pollution.

The other important aspect concerning water quality deterioration is salinity intrusion in coastal regions.

(20) Soil Contamination

Possibility of mud and oil during drilling causing soil contamination has been stated in item 8, and the influence of waste water was discussed in (7).

(21) Noise and Vibration

Noise and vibration will be generated during drilling work, so measures such as to avoid working at night must be taken into account to mitigate impact to dwellers around. After operation, noise will only originate from pumps. Though this is relatively small, the pump station should be located from houses as far as possible, not only because of the noise to dwellers, but also because of the required protection of water source.

(22) Ground Subsidence

Because of the distribution of clay layer in the Study Area, the possibility of ground subsidence exists when water level declines permanently. Particular attention must be paid to the coastal region which is being considered as a candidate site for water source of the project, because the coastal area is geologically alluvial.

(23) Offensive Odor

Indirectly, offensive odor may be generated from waste water as stated in (7).

6.4-4 Overall Evaluation

It has been clarified in the above discussion that from the viewpoint of environment the project will bring about large advantages in various of aspects like improvement of sanitary situation, progress of daily life convenience, acceleration of economic activities and so on.

However, for items such as water right and landscape, the impact may be negative, and therefore must be taken into account when the design and operation of the project. Furthermore, those negative impacts such as generation of wastewater, groundwater depletion, and water pollution will, though may not at all, inevitably accompany the project.

Some of these negative impacts can be avoided and mitigated by paying enough attention to them and adopting some measures. These items are considered in items (3), (4), (8), (20), and (21).

Some items have to remain without a clear conclusion such as items (6) and (17). However, based on the situation of groundwater development in the Philippines and in Cavite, the impacts of these aspects would not, at least, lead to incurable natural environment damages and annoying social problems.

The rest of the items confirmed as having possible negative impacts must be considered as factors that will influence the project. These include items (7), (12), (13), (19), and (22).

Table 6-1 REPRESENTATIVE REPORTS ON THE ENVIRONMENT PROBLEMS CONCERNING GROUNDWATER DEVELOPMENT IN THE PHILIPPINES

Author's Name	Kind of Environment Issue	Affected Area	Affected Population
Luis (1980)	Groundwater Depletion	Norzagaray,Bu Bulacan	not specified no. of farmers
Roca (1993)	Groundwater Depletion	Metro Manila	More than 20% of MWSS wells
Apelo and Angeles (1991)	Groundwater Pollution	Metro Manila	Water bodies around dumpsites
David etc. (1991)	Groundwater Pollution	Quezon City	19 barangays (districts)
Genandraline (1993)	Groundwater Pollution	Metro Manila	about half of production wells
NEPC (1986)	Salinity Intrusion	Metro Manila	about 20 sq. km
NEPC (1986)	Salinity Intrusion	Bulacan & Pampanga	not specified no. of farmers
NEPC(1986) & Soriano(1985)	Salinity Intrusion	Cebu City	58,000 mostly along the coast
MWSS/ ELECTROWATT (1983)	Land Subsidence	Metro Manila	not Determined

Table 6-2 **No. of Firms in Cavite (DENR and LLDA Jurisdiction)**

Type of Industry	No. of Firms		Kind of Pollution Potential
	DENR	LLDA	
Rice Mill	92	1	Air Pollution
Lumber and Hardware	25	2	Air & Noise Pollution
Piggery	11	1	Water Pollution
Garments	8	4	Water Pollution
Food Processing	4	3	Water Pollution
Feed Mill	4	1	Odor Pollution
Plastics	3	1	Water Pollution
Steel Fabrication/ Galvanizing	2	2	Water Pollution
Marble	3	0	Water Pollution
Laundry	2	0	Water Pollution
Electronics	1	3	Toxic Waste/Water Pollution
Paper Mill	1	0	Water Pollution
Textile	2	2	Water Pollution
Leather	0	1	Water Pollution
Others*	28	27	Air and other Pollution
TOTAL	186	38	Grand Total = 224

Source: DENR IV-A, EMPAS, 1993 & LLDA, 1993

Note: * Types of industry include cordage, LPG refiller, electrical supply, tire recapping, gas, adhesive, sawmill, glass making, etc.

- A total of 37 potentially-water pollutive industrial firms are under the jurisdiction of DENR
- There are 17 potentially-water pollutive firms within LLDA jurisdiction

Table 6-3 LIST OF FIRMS ISSUED CDO IN CAVITE PROVINCE (WATER POLLUTION)

Name of Firms	Location	Industry Type	Violation Items	Date Issued
Neat Sanitary Laundry	Noveleta	Laundry	BOD,SS, Color	---
Sanitary Steam Laundry	Dasmarinas	Laundry	BOD,SS, Color	---
CESA Piggery Farm	Tanza	Piggery	BOD,SS	91. 03
Don Juan Integrated Farm	Trece Martirez	Piggery	BOD,SS	92. 10
Fil-Transit Bus Terminal	Imus	Bus Terminal	Noise and Oil spillage	91. 09
Cathay Farms Dev. Corp	Tanza	Piggery	BOD,SS	91. 12
Monti Textile Mfg.Corp.	Imus	Textile	BOD,Color	94

Source: DENR-IV EMPAS, 1993 & PAB, 1994

Table 6-4 List of Rivers and Discharge Points in Cavite

Name of River/ Discharge Point	Water Classification	Coverage[1]
1. Ilang-Ilang R.	B	Noveleta, Dasmariñas
2. Panaysayan (Cañas) R.	NC	Gen. Trias, Tanza, Trece Martires, Tagaytay
3. Labac-Balsahan R.	NC	Naic, Indang, Mendez-Nuñez, Amadeo
4. Maragondon R.	NC	Maragondon, Magallanes, Alfonso, Gen. Aguinaldo
5. Banabang-Molino-Imus	C	Imus, Bacoor, Kawit
6. Manila Bay	SB/SC	Ternate, Bacoor, Kawit
7. Laguna de Bay	C	Carmona, Silang

Note: NC - not classified

[1]The whole municipality is assumed draining into the nearest river as there is no definite watershed boundaries (ricefields) and rivers are running almost parallel to each other. Except for Carmona and Silang, all rivers are assumed draining towards Manila Bay.

[2]Filantopia, Ibod and Kaliwa Rivers which are listed in the NWRB principal rivers are nowhere to be found in the reference maps.

Sources: NWRB, EMB

Table 6-5 **Number of Pollution Cases (1988 to 1993)**

Region	Air Pollution	Water Pollution	Air/Water Pollution	Others	Total
I	3	3	1	0	7
II	1	1	0	1	3
III	9	53	12	1	75
IV	6	38	2	0	46
V	0	10	1	0	11
VI	10	31	2	1	44
VII	4	23	0	11	38
VIII	0	9	1	2	12
IX	3	6	0	2	11
X	8	23	5	1	37
XI	2	11	1	0	14
XII	5	5	1	0	11
NCR	21	124	6	15	162
CAR	1	2	0	0	3
Total	73	339	32	30	474

Source: PAB (1994)

Table 6-6 **Number of PAB Cases Issued CDO**

Region	1988	1989	1990	1991	1992	Total
I	1	0	0	0	2	3
II	0	0	0	1	0	1
III	6	3	6	29	14	58
IV	2	0	4	29	9	44
V	0	0	3	3	3	10
VI	0	7	17	3	13	40
VII	0	2	4	15	16	37
VIII	0	0	2	4	2	8
IX	0	0	2	6	2	10
X	0	2	6	12	6	26
XI	2	1	1	5	1	10
XII	3	2	0	3	3	11
NCR	6	58	53	32	22	171
CAR	0	2	2	0	1	6
Total CDO	20	79	100	142	94	435
Total No. of Cases	78	71	90	132	34	405

Source: PAB (1994)

Table 6-7 Summary of Industrial Pollution Control Indicators (Region 4)

Indicator/Year	1989	1990	1991	1992	1993
Plants Surveyed	-	50	105	143	132
No. of Firms Inspected	206	360	359	354	340
No. of Complaints Investigated	69	80	42	25	26
No. of Firms Fully Complied (regular permit)	17	333	40	-	60
No. of Firms Partially Complied (temporary permit)	164	40	342	-	433
No. of Firms Not Complied (Notice of Violation Given)	152	144	253 (55)	52 **	40 **

Note: both air and water data
** technical conference

Table 6-8 1993 Diarrhea and Sanitation Data
Cavite Province

Rural Health Unit	Unsatisfactory Solid Waste Disposal (%)	Unsanitary Toilets (%)	Without Toilets (%)	Seen Diarrheal Cases (%)
1. Alfonso	75.5	15	5	2.3
2. Amadeo	95.2	14	5	2.5
3. Bacoor I	100.0	1	11	1.8
4. Bacoor II	100.0	1	18	3.0
5. Carmona	23.4	6	5	3.6
6. Damariñas	73.7	7	8	2.4
7. DBB	43.8	2	9	2.6
8. Gen. Aguinaldo	33.7	3	26	3.5
9. Gen Trias	46.1	0	52	1.0
10. GMA I	34.3	9	4	2.3
11. GMA II	100.0	17	13	3.4
12. Imus	44.8	3	11	2.6
13. Indang	32.7	4	6	1.2
14. Kawit	19.1	4	15	2.3
15. Magallanes	40.0	7	29	3.6
16. Maragondon	100.0	1	33	2.6
17. Mendez	24.9	3	5	1.4
18. Noveleta	100.0	5	14	3.2
19. Rosario	97.6	2	28	5.0
20. Silang	61.2	19	7	2.0
21. Tanza	40.6	1	43	2.0
22. Ternate	100.0	2	53	6.5
23. Naic	20.7	1	49	3.0
24. Bulihan	100.0	5	1	5.2
Entire Province	67.1	5	18	3.4

Notes:

a. Columns on solid wastes and toilets refer to the percentage of households within the coverage of a rural health unit.

b. The seen diarrheal cases refer to the percentage of the expected cases among children of 4 years old and below.

Source: Provincial Health Unit

Table 6-9 COMPOSITION OF DOMESTIC WASTE IN METRO MANILA

Components	Percent Weight
Yard/field waste	33.5
Fines/inerts	12.9
Wood	11.5
Foodwaste	11.0
Paper/cardboard	10.2
Plastics/Petroleum	9.8
products	4.1
Textiles	3.3
Metals	1.9
Glass	1.8
Leather/rubber	

Source : LWUA PGD, Dec., 1993

Table 6-10 Leachate Characteristics in Pasig and Payatas Dumpsites

Water quality Parameter	Pasig Dumpsite	Payatas Dumpsite
COD (Mn)	230 mg/L	270 mg/L
BOD_7	57 mg/L	110 mg/L
NO3-N	<0.02 mg/L	<0.02 mg/L
Lead	0.3 mg/L	0.11 mg/L
Cadmium	<0.01 mg/L	<0.01 mg/L
Chromium	0.04 mg/L	0.08 mg/L

Source : Leachate Pollution from Open Dumpsites, 1992c (EMB)

Table 6-11 REGISTERED PESTICISE PRODUCTS IN THE PHILIPPINES

Data source : FPA

COMMON NAME	USE
2,4-D AMINE	H
2,4-D IBE	H
3-CPA	O
ACEPHATE	I
ALCHOL +ORG SUCCINATES	O
ALGNINUM PHOSPHIDE	I
ALKYLARYLPOLYGLYCOLETRER	O
ALKYLPHENOOL ETHOXYLATE	O
ALUMINUM PHISPHIDE	I
AMETRYNE	H
AMETRYAN + ARAZINE	H
AROMATIC OIL	F
ATRAZINE	H
AVERMECTIN	I
AZAMETHIPHOS	I
AZINPHOS ETHYL	I
AZYPETAC ZINC + PERMETHRIN	
A-NAPHTHALENE ACETIC ACID	O
BACILLUS THURINGIENSIS	I
BEADIOCARB	I
BENOMYL	F
BENSULFURON	H
BITERTANOL	F
BNAA + ADCPA	I
BPMC	I
BRODIFACOUM	
BROMACIL	H
BROMACIL + DIURON	H
BUPROFEZIN	I
BUTACHLOR	H
BUTACHLOR + PROPANIL	H
BUTACHLOR + 2,4-D	H
CADUSAFOS	I
CALCIUM CYANAMIDE	F
CAPTAN	F
CARBARYL	I
CARBOFURAN	I
CARTAP	I
CARTAP HCL	I
CARVOSULFAN	I

I : Insecticide
H : Herbicide
F : Fungicide
N : Nematicide
R : Rodenticide
A : Acaricide
M : Molluscicide
0 : Others (avicide, bactericide, etc.)

Table 6-11 PESTICIDES LIST (con't)

CHINOMETHINOAT	I/F
CHLORDANE	I
CHLORMENVINPHOS	I
CHLORNDANE + TBP - M	I
CHLORFLUAZURON	I
CHLORFLURENOL	
CHLOROTHALONIL	F
CHLORPYRIFOS	I
CHLORPYRIFOS + BPMC	I
CHLORPYRIFOS + CYPERMETHRIN	I
COPPER, CHROHE, ARSENIC	O
COPPER HYDROXIDE	F
COPPER OXYCHLORIDE	F
COUMATETRALYL	R
CUPRIC HYDROXIDE	F
CURRIC HYDROXIDE	F
CYANAZINE	N
CYFLUTHRIN	I
CYPERMETHRIN	I
CYROMAZINE	O
DALAPON	H
DAZOMET	O
DELTAMETHRIN	I
DIAZINON	I
DICHLOROPROPENE	I
DICHLORVOS	I
DICLORAN	F
DIMETHOATE	I
DIMRTHOATE	I
DISODIUM METHANEARSONATE	H
DIURON	H
EDIFINPHOS	F
ELEMENTAL SULFUR	F
ENCAP METHYL PARATHION	I
ENDOSULFAN	I
ETHEPHON	O
ETHEPON	O
ETHEPON+POTASSIUM NITRATE	O
ETHOFENPROX	I
ETHOPROP	I
ETOFENPROX	I
FATTY ACIDS AMIDE	O
FENITROTHION	I
FENTHION	I
FENVALERATE	I
FLUAZIFOP-BUTYL	H
FLUAZIFOP-P-BUTYL	H
FORMETANTE HCL	I
FOSETHYL-AL	F
GIBBERRELIC ACID	O
GLUFOSINATE AMMONIUM	H
GLYPHOSATE	H
IMIDACKOPRID	I
IPRODIONE	F
ISAZOFOS	I
ISOPROCARB (MIPC)	I
ISOPROPYLAMINE SALT OF GLYJPHOSATE	H

Table 6-11 PESTICIDES LIST (con't)

LADACYHALOTHRIN	I
LAMDACYHALOTHRIN	I
LINDANE	I
LINURON	H
MAFLATHION	I
MALATHION	I
MAGNESIUM PHOSPHIDE	I
MALATHION	I
MALATHION + FENITROTHION	I
MANCOZEB	F
MANCOZEB-ZN	F
MANEB	F
METHYL BROMIDE	I
MFANCOZEB + CYMOZANIL	F
MALATHION	I
MAMEB	F
MAMEB W/ZINC	F
MAMEB-ZINC	F
MANCOZEB	F
MCPA	H
MCPA + TRA	H
METALAXYL	F
METALAXYL + MANCOZEB	F
METALDEHYDE	M
METHAMIDOPHOS	I
METHIDATHION	I
METHIOCARB	I
METHOMYL	I
METHYL BROMIDE	I
METHYL PARATHION	I
METHRIBUZIN	H
MEVINPHOS	I
MIMERAL OIL	F
MIPC	I
Mn-Zn ETHYLENE BISDITHIOCARBAMATE	F
MONOCROTOPHOS	I
MONOCROTOPHOS + CYPERMETHRI	I
MONOCROTOPHOS + FENVALERATE	I
MONOCROTOPHOS + MEVINPHOS	I
MONOSODIYM METHANEARSONATE (MSMA)	H
NICLOSAMID	M
NICLOSAMID	M
OXAMYL	I
OXYFLOUREN	H
OMETHOATE	I
OXADIAZON	H
OXYDEHETON-METHYL	I
P. OCTYL PHENNOL ETHER	O
PAECILOMYCES LILACINUS	H
PACLOVUTRAZOL	O
PARAQUAT DICHLORODE	H
PARAQUAT + DIURON	H
PENDIMETHALIN	H
PERMETHRIN	I
PHENTHOATE	I
PHENTHOATE + BPMC	I
PHENTHOATE + MTMC	I

Table 6-11 PESTICIDES LIST (con't)

PHENAMIPHOS	H
PHOSALONE	I
PHORATE	I
PHOSPHAMIDON	I
PHTHALANILIC ACID	O
PHTHALIC GLY ALKYD RESIN	O
PICLORAM + 2,4-D	H
PIPEROPHOS + 2,4-D IBE	H
PIRIMIPHOS METHYL	I
PRETILACHLOR	H
PROFENOFOS	I
PROFENOFOS + CYPERHETHRIH	I
PROMETRYNE	H
PROPAMOCARB HCL	F
PROPICANAZOLE	F
PROPINEB	F
PROPANIL	H
PROPOXUR	I
PYRAZOPHOS	I
SODIUM SALT OF 2,4-D	H
SURFACTANT	O
TANNINS, GLYCOSODES, STEROLS, & FLAVONOIDS	H
TCMTB + MTC	F
TEFLUCENZURON	I
TETRACHLORVINPHLS	I
THIOPHANATE METHYL	F
TOXANON + OIL	O
TRIAZOPHOS	I
TRIDEMORPH	F
TRIFORINE	F
TANNIHS GLYCOSIDES STEROLS & FLAVONOIDS	M
TEFLUVINZURON	I
TEMEPHOS	I
THIABENDAZOLE	F
THIABENDAZOLE + O-PHENOL	F
THIOBENCARB	H
THIOBENCARB + 2,4-D	H
THIODICARB	I
THIOPHAFTE METHYL	F
TRIADEMENOL	F
TRIADIMEFON	F
TRICHLORFON	I
TRICLOPYR	H
WARFARIN	R
ZINC PHOSPHIDE	R

Table 6-11 PESTICIDES LIST (con't)

BANNED PESTICIDES

1. Parathion-ethyl
2. Copper Aceto-arsenite (Paris Green)
3. DDT containing mosquito coils
4. DBCF
5. Nitrofen
6. Leptophos
7. EPN
8. Endrin
9. Mercaric fungicides
10. Toxaphene
11. Flemental phosphorous (White & Yellow)
12. Thalium sulfate
13. 1-Napthylthiourea (ANTU)
14. Gophacide
15. Sodium Flouroacetate
16. Sodium Flouroacetamide (1081)
17. Strychnine
18. 2, 4, 5-T
19. Aldrin
20. Dieldrin
21. Heptachlor
22. Chlordimeform
23. EDB
24. HCH/BHC
25. Organotin compunds
26. Azinphos ethyl
27. Methyl parathion

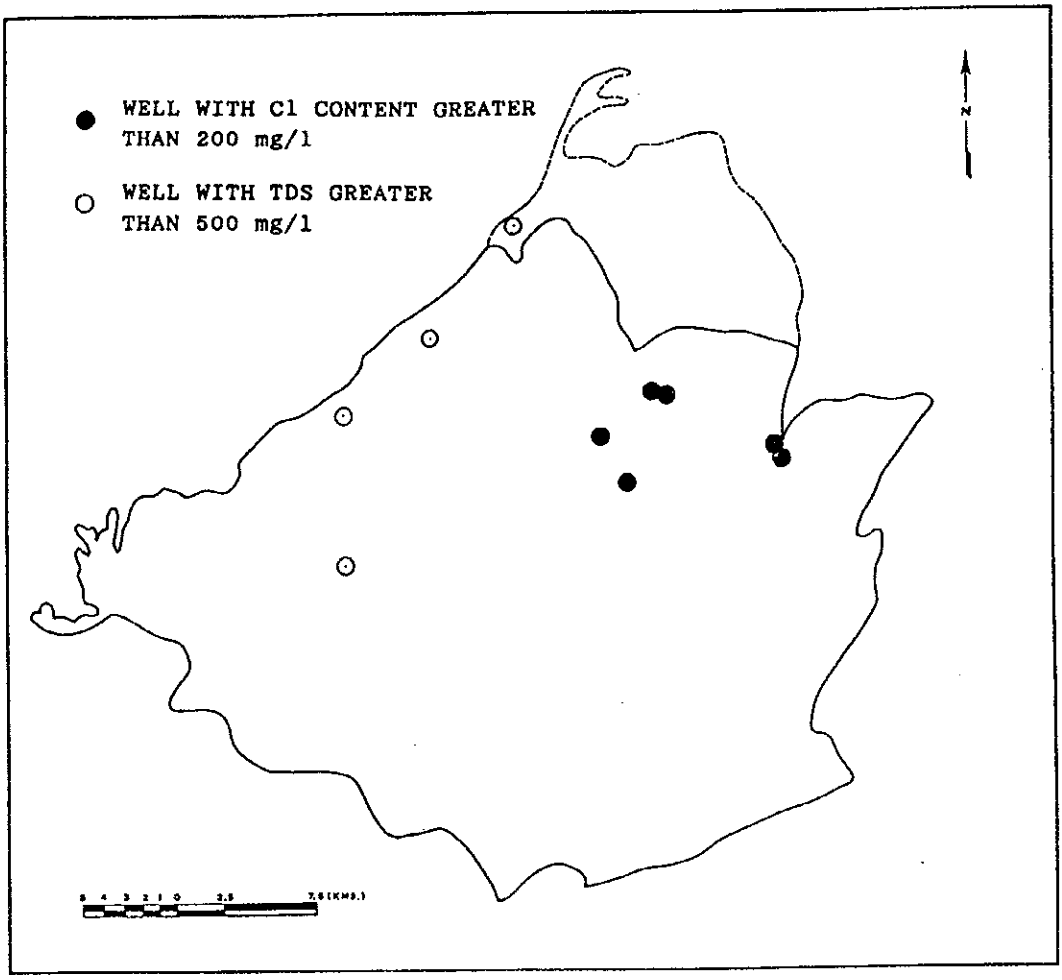
RESTRICTED PESTICIDES

1. Aldicarb
2. Chlordane
3. DDT '
4. Chlordane ''
5. Endosulfan ''
6. Paraquat
7. Phenamiphos
8. Etroprop
9. Methidathion
10. Inorganic Arsenicals (Arsenic Trioxide)
11. Lindane (Gamma/BHC)
12. Pentachlorophenol
13. Methyl bromide
14. Carbon Disulfide
15. Phosphine generating compounds
16. HCN-generating materials
17. Carbon tetrachloride
18. Chloroform
19. Ethylformate
20. Monocrotophos

': All use canceled except for malaria control purposes by the Department of Health.
'': Not for use near Aquatic Ecosystem

Table 6-12 ENVIRONMENTAL IMPACTS OF GROUNDWATER DEVELOPMENT

No.	ENVIRONMENTAL ITEM	POSITIVE	NEGATIVE
1	RESETTLEMENT	---	---
2	ECONOMIC ACTIVITIES	OOO	---
3	TRAFFIC AND PUBLIC FACILITIES	OOO	O
4	SPLIT OF COMMUNITIES	---	O
5	CULTURAL PROPERTY	---	---
6	WATER RIGHT/RIGHT OF COMMON	---	O
7	PUBLIC HEALTH CONDITION	OOO	O
8	WASTE	---	O
9	HAZARDS (RISK)	---	---
10	TOPOGRAPHY AND SOIL CONDITION	---	---
11	SOIL EROSION	---	---
12	GROUNDWATER	---	OOO
13	HYDROLOGICAL SITUATION	---	OO
14	COASTAL ZONE	---	---
15	FAUNA AND FLORA	---	---
16	METEOROLOGY	---	---
17	LANDSCAPE	---	O
18	AIR POLLUTION	---	---
19	WATER POLLUTION	---	OOO
20	SOIL POLLUTION	---	O
21	NOISE AND VIBRATION	---	O
22	GROUND SUBSIDENCE	---	OO
23	OFFENSIVE ODOR	---	---



Data source : Philippines Groundwater Data Bank

Fig. 6-1 LOCATION OF WELLS WITH HIGH CONCENTRATION

OF TDS AND CHLORIDE IN 1970S.

7. ENVIRONMENTAL IMPACT ASSESSMENT

7. ENVIRONMENTAL IMPACT ASSESSMENT

This EIA consists of the following:

1) Determination of the awareness among residents on the need and acceptability of water supply development projects in the Feasibility Study (F/S) Areas.

2) Determination of the occurrence, if any, of environmental impacts of groundwater development in the Study Area which include: reduction in water level or groundwater depletion; saline water intrusion; land subsidence and disputes on water right.

3) Assessment of potential pollution sources and their impacts to groundwater such as contamination due to domestic and industrial wastewater; agricultural activities (fertilizer and pesticides); and from solid waste dumpsites.

4) Identification of possible measures to mitigate or minimize potential impacts of groundwater development.

To carry out the objectives set forth for this EIA, the following tools/ instruments were adopted:

Data Collection. This method was used in all aspects of the Study. Sources of data included, the local water districts, municipal offices, rural waterworks, provincial planning and development office, Department of Environment and Natural Resources (DENR), Laguna Lake Development Authority (LLDA), the industrial estates/parks, and the industrial establishments concerned.

Interview and Questionnaire Survey. This tool was used at the start of the Study particularly in determining the perceptions and awareness of the residents in the five F/S areas. Interviews guided by prepared questionnaire forms were conducted in order to obtain an estimation of needed data and information where documents and studies were not available. These were very useful especially in domestic solid and liquid waste management, the industrial effluent characteristics, and the use of pesticides and fertilizers.

Field Survey. Field visits were done in every aspect of the study, where possible, in order to determine and evaluate the actual site conditions. Actual measurements were taken on the present groundwater levels in wells and on the electrical conductivity of water samples from coastal wells. Locations of dumpsites and areas where garbage were illegally tossed were visited. This activity was photo documented. Water sample was also taken at one of the deepwells near an industrial plant for any possible contamination from industrial effluent.

7.1 IMPACTS OF GROUNDWATER DEVELOPMENT

7.1-1 Water Level Decrease and Groundwater Depletion

The survey on water level decrease was conducted in at least five (5) wells per municipality/city in the Study Area. The total number of wells surveyed is 123. The plot of the surveyed wells in showed in **Fig.7-1**. Data gathered on groundwater levels were evaluated together with the data from actual measurements. Water level decrease was then calculated over a certain period starting from the date the well was completed/operational.

The domestic water demand estimates are presented in **Table 7-1.** Dasmarinas, Silang and GMA, in that order, topped as the heavy water consumers in the Study Area.

The water rights permits granted by NWRB for sources extracted through deepwells as irrigation water is presented in **Table 7-2.**

From the data gathered in the field surveys for industrial water consumption, the tabulation of withdrawal rates for industrial use is given in **Table 7-3.**

The decrease in groundwater level was determined by subtracting the present water level from any reference water level. As there has been no groundwater level monitoring, this reference water level was taken as the water level at the date of completion and/or operation of the particular well.

To remedy the situation, actual groundwater level measurements were taken. About fifty (50) wells were measured. The summary of well data can be found in **Table 7-4,** where the important parameters such as PGDB Nos., time elapsed when measurement was taken and discharge (pumping) rate are presented.

The computed water level decrease vary from well to another as these wells were not constructed at the same time. In this case, the decrease was translated into average annual rates. The plot of these decrease rates is shown in **Fig. 7-2.** It can be noticed that the coastal towns of Tanza, Naic, and Ternate have decrease rates lower than 0.50 m/yr.

Generally, decrease rates are higher at the eastern towns e.g. Silang, Dasmariñas, GMA, and Carmona. The deepest trough is located at Dasmariñas (about 2.5 m/yr.) at the boundary with Silang and Mendez extending to the towns of Carmona and GMA. The ranges of groundwater level decrease rates and the estimated total decrease for the past 14 years are given in **Table 7-6.**

A check on the discharge (pumping) rates using the data from the individual wells yielded an almost apparent relationship between the decrease rates and pumping rates. (Please see **Fig. 7-3**).

7.1-2 Saline Water Intrusion

Areas along the coast such as Naic, Maragondon, Tanza, and Ternate were surveyed for any indication of salinity intrusion in the groundwater. Thirty nine (39) wells about 50 percent of which are shallow dug wells and wells with handpumps were surveyed at the same time electro-conductivity was measured. The results of these surveys can be found at **Table 7-4**.

On the average, the conductivity levels at the coastal area is about 500 uS/cm. However, peaks were noted at Ternate, Puerto Azul (1946 uS/cm), and at Tanza (900 uS/cm).

7.1-3 Land Subsidence

Surveys were made to inquire about and look for possible signs of land subsidence at the suspected heavy water level decrease rates at Dasmariñas, GMA, Tanza, and at the F/S Areas of Tagaytay, Mendez, and Naic. Signs like protruding well casings, cracked building foundations or roads, depressed bridge approaches, leaning buildings, undrained low-lying areas were not found, nor detected nor known by the respondents.

7.1-4 Water Rights Disputes

Interviews were made regarding the possible incidents of disputes over water rights, such as, abandonment of shallow wells due to the entry of deeper and heavily-extracting wells. According to the survey, there has been no such incidents.

If there were incidents like this, affected parties may not be aware at all that the drying up or salinization of his well is due to the heavy pumping of the nearby well.

7.2 GROUNDWATER POLLUTION SOURCES

7.2-1 Domestic Wastewater

Urban centers in Cavite Province, particularly the poblacions, are not provided with sewerage systems.

Results of the survey showed in **Table 7-7**. Domestic wastewaters in the poblacions of Cavite province are channeled through or treated by septic tanks. Except for Tanza, there is no marked difference between the upland and lowland areas with regard to the prevalence of septic tank use. This is inferred to be the same in most of the poblacions of the country. These septic tanks are not provided with a soil infiltration system. Normally, septic tanks are not regularly inspected much less checking the effluent water quality. The checking activities require trained manpower and proper logistics. Nationwide, local governments are not equipped for these activities.

Almost all septic tanks are made of concrete. The usual materials are concrete hollow blocks with thin cement for wall finishing. Wastewater leakage is expected since this concrete tanks are not water tight. In some instances, concrete septic tanks are not provided with bottom slabs to allow for a wastewater infiltration into the ground. Fortunately, only few septic tanks in the survey area do not have bottom slabs. Most of the tanks are still not being cleaned of sludge despite their long years in service. Treatment efficiencies of these tanks are therefore expected to be very low. Availability of a dislodging service is not a problem in the Cavite area since it is quite near to Metro Manila where a number of sludge excavators are operating (e.g. Malabanan Sewage Services).

Effluents from the septic tanks are mostly discharged to the street canals and eventually flow into creeks or rivers. A very small percentage are discharged directly to land. So is the case with the discharges of the kitchen, bathing, and laundry wastewater. However, a very small percentage of households is directing wastewater to septic tank prior to its discharge. Direct discharge in rivers shares a very small percentage as well.

7.2-2 Industrial Wastewater

A field survey of the industrial facilities in the Study Area was conducted and the list of them are presented in **Table 7-5.**

Pertinent information such as water use, source of water, nature of operations and products, number of employees, and discharge points were taken during on-site interviews with industry representatives. Most industries declined to reveal data on production, wastewater treatment or effluent status. Data for the rest of the industries were abstracted from their respective industrial estates administrators or offices, the municipalities, and the provincial development planning office. These data included location, nature of products, water use, and number of employees.

Fig. 7-4 presents the water use, wastewater generation, and treated effluent of industrial establishments in the Study Area. **Table 7-8** presents locations and industrial types of these factories.

Water use is very heavy in Carmona, Dasmarinas, GMA, General Trias, and Silang where water intensive industries such as textile mills, meat/dairy processing, livestock raising, food and beverage, metal and electronics chips, plastics, and adhesives manufacturers are located.

Thirty-five (35) of industries in the Study Area are considered potential polluters. These are concentrated mostly in industrial estates and selected sites of Carmona, Dasmarinas, Gen. Trias and Tanza. **Table 7-9** presents the status of these industries. The majority (66 percent) of potential polluters are equipped with WTP (Water Treatment Plant). Unfortunately, the DENR compliance monitoring records show that many of these systems are inefficient. Wastewater sources, wastewater characteristics and pollution impacts of those industries with no WTP are presented in **Table 7-10.**

LWUA's Deep well No. 10 is located in Tanauan, Tanza and is within the vicinity of Chung Fu Industries (a fabric / yarn knitting factory). Wastewater discharges from Chung Fu operations are estimated at only about 0.020 MCM/yr and are mainly spent cooling and auxiliary wastewater. A representative sample of this wastewater was taken for analysis. Test results showed phenol at < 0.001 mg/L. Hence, the threat to groundwater pollution arising out of Chung Fu's operations is nil.

In general about 80 percent of the total water use of the industries are generated as wastewater. Sixty-nine percent (55 percent from polluters and 14 percent from non-polluters) of the wastewater generated from the industries in the Study Area are untreated. About 20 percent of all discharges drain to open spaces which end up infiltrating the groundwater while about 80 percent drain to canals which find their way to creeks or rivers and eventually to Manila Bay or Laguna de Bay. Furthermore, some seven (or 30 percent) of the potential polluter industries have inadequate or inefficient WTP. With Cavite's improved investor confidence and tourism potentials, influx of industries, tourists, and migrants (workers) would continue in the short and medium terms. Long term effects of these increasing industrial activities if left uncontrolled could have devastating effects to the limited supply and quality of water resources in Cavite.

The DENR field and regional offices are not equipped (manpower and resources) to carry out regular surveillance and monitoring of industrial effluents to all industries. After all the necessary permits have been issued and as more industries become operational, monitoring becomes less and less frequent. In most cases, monitoring becomes a tool to be carried out to verify public complaints.

In 1992–1993, the DENR Office of Region IV collected forty-five (45) effluent samples from twenty-one (21) industries in Cavite Province for the analysis of 5–7 parameters, that is Color, pH, Total Solids, Suspended Solids, DO and BOD. Obviously, these investigations can hardly be considered as sufficient, however, the general situation of effluent discharge may be obtained from the analysis of these data.

Fig. 7–5 shows the effluent classification based on this analysis. About fifty (50) percent of the samples are either Grade 1 or Grade 2. It means that more than 50 percent of the potential polluters are making genuine efforts to treat their effluent, and some having success.

The other half of the industries discharge effluent in violation of the effluent standards. Particularly effluents of Grade 4 mean that the samples have a BOD value equal or greater than 3000 ml/L. DENR AO No.35 considers Grade 4 effluent as being 20 times over the acceptable level. These samples represent a seriously deteriorated effluent that, in fact, has not been treated.

7.2–3 Solid Wastes

Solid wastes come from two major sources – (a) domestic or municipal and (b) industrial. Industrial solid wastes generated from the Study Area per field surveys were minimal and include (1) trash, (2) metallic / glass and plastic scraps, (3) food and meat processing wastes / sludge, (4) textile trimmings, and (4) metallic sludge. Trash and other combustibles were burned while the non-combustibles and putrescibles like food/meat processing wastes were disposed on-site (backyard). Textile / garments trimmings were reused where possible but exact figures were not available as there was no monitoring done. Metallic / glass scraps were likewise not monitored but were sold and recycled. Plastic scraps estimated at 7,200 MT/yr, rubber wastes at about 144 MT/yr, and zinc dross (wastes) at about 18 MT/yr are landfilled to Carmona sanitary landfill. Metallic sludge estimated at 1,320 MT/yr were sold to interested parties for metal recovery. Carmona and Dasmarinas are hosts to a large number of industrial wastes. Though not monitored, accumulated industrial solid wastes generated from these areas may be significant if not properly managed and disposed of.

Domestic or municipal solid wastes are generated from the households. A survey of the dumpsites was conducted in the Study Area. Twelve(12) out of seventeen poblacions have their own dumpsites. These poblacions are Carmona, Gen. Aguinaldo, Gen. Trias, Indang, Maragondon, Mendez, Naic, Silang, Tagaytay, Tanza, Ternate and Trece Martires. These dump sites are all open dumps with no provisions for leachate control and monitoring. Main results on generation amount, collection budget, disposal method and other data are presented in **Table 7-11**.

Alfonso and Amadeo have no dumpsites and individual households practice composing and using the compost materials as organic fertilizer. Wastes from public places like central markets were collected and sent to Carmona for landfilling.

Dasmarinas and GMA have no dumpsites of their own. Because of their proximity to Carmona, household solid wastes are collected by dumptrucks and taken to Carmona Landfill. Indiscriminate dumping of household wastes in river banks was also common in Dasmarinas and GMA.

Open burning and composing were practiced in the barangays unserved by garbage collectors of Maragondon, Naic, Silang, and Ternate.

Despite having a dumpsite, campaigns on waste segregation and composing ("zero waste project") at the barangay levels, and the massive information drive municipal-wide (Mendez Says No To Trash) illegal dumps on creeks are widespread in Mendez. The dumpsite is situated relatively closer to built-up areas. The municipal government decentralizes the solid waste management function to the barangays.

In Tanza municipality, waste disposal is very common to rivers, creeks, roadside, and open spaces even if a local dumpsite and collector trucks are available.

As in most municipalities, creeks and rivers are the common places for illegal dumps. At least about 18 creeks and 6 rivers are used as illegal dumps in the Study Area. A total of about 220 MT of illegally disposed wastes were noted during the survey. These creeks and rivers with corresponding estimated volume of solid wastes are presented in **Table 7-12**.

In general, solid waste disposal in the Study Area can equally be threatening as the industrial wastewater if the present system is not improved. The field survey noted that most illegal dumps are done by individual residents. Apparently, a few illegal dumps are dumped in bulk and may probably resulted from single larger loads or truckloads of solid wastes (from waste collectors). The local government units concerned must police the ranks and monitor the continued illegal dumping of domestic wastes (from both collection trucks and households) in their respective areas.

The F/S areas of Naic and Tanza, being in the lowlands, are located in rice paddies and in close proximity to a few creeks. Since industries in the areas are mainly agri-based, solid wastes disposed of in these open dumps are mainly domestic/garbage. The dumps pose no significant threat to groundwater quality. Tagaytay and Mendez open dumps are only partially used since these two areas have relatively smaller populations. Again, industrial activity is very low in these areas and in general solid wastes disposed of in these dumps are bound not to affect groundwater quality.

7.2-4 Pesticides and Fertilizers

There is no government agency in charge of monitoring the quantity of pesticides produced or consumed in the Philippines. The FPA only monitors the total quantity imported by the country. A twelve-year historical data on pesticides importation nationwide is presented in **Fig. 7-6.**

The farm survey revealed that pesticide use is prevalent in the lowland compared to the upland areas. Shops in Tagaytay City, are not selling pesticides. The non-availability of pesticides in Tagaytay City and its small presence in Mendez may suggest a very low usage of pesticides in the upland areas.

Pesticides use in the lowland is associated mainly with irrigated rice fields. Spraying is the only application mode. Prices of the various pesticides used in rice fields ranges from P140 to P550 per bottle. **Fig. 7-7** presents the main pesticides used formerly and presently.

Thiodan (Endosulfan) and Cymbush (Cypermethrin) are the most popular brands. Cymbush is used during the rainy months, while Thiodan is used during the dry months. The decrease in users of Thiodan is possibly due to the restriction on its use issued last year by the FPA. Most farmers had used unusually high concentrations of Thiodan for the eradication of a rice field snail locally known as "kuhol". This snail could substantially destroy rice seedlings.

Fig. 7-8 shows the historical irrigation and pesticide usage. This figure shows the relative percentage of farmers whose use of pesticides have exceeded a particular number of years. The data indicate that previous pesticide usage was not extensive despite the use of irrigation systems. Pesticide use has only started to increase in the early '70s.

Fertilizers have been used extensively in both upland and lowland areas of Cavite. This finding is also reflected in the results of the shops surveyed in the previously mentioned areas. The 13 shops have a combined fertilizer sales volume of more than 800 tons per year. Fertilizers are sold at a range of P200 to P330 per 50-kg bag.

Fig. 7-9 presents the historical use of fertilizers and irrigation systems. Although the irrigation systems were used since the 1940s, fertilizer usage has started to increase only in the late 1960s.

7.3 PROJECT RECEPTION AND PUBLIC AWARENESS SURVEY

A survey was conducted to determine the project reception and public awareness of the people in the F/S Areas. The sample size for this survey was 50 person-respondents in every poblacion with various groupings such as age, sex, occupation, level of education, etc. Total number of respondents was 250.

An awareness profile was made to cover the above listed points. The respondent's, socio-economic profile and the overall summary of the awareness survey are given in **Table 7-13**.

7.3-1 Public Awareness of the Proposed Project

Respondents were asked if they were aware of the proposed province-wide water supply development project. Only 10 percent are aware of the proposed project. However, 95 percent believe that water supply service will improve with the implementation of the proposed water supply development project. The proposal is very much welcomed by the 98 percent of the respondents and who are willing to cooperate with the study requirements of the project.

7.3-2 Environmental Effects of Groundwater Development

Several people in the area are already aware of the environmental effects of groundwater development. In fact, 62 percent are aware that improper groundwater development could lead to long-term bad effects. In their respective areas, only 39 percent consider as appropriate the continued withdrawal of groundwater, while 52 percent consider it inappropriate. Almost all (97 percent) believe on the necessity of an adequate plan and proper management in the development of groundwater for water supply use.

7.3-3 Perception on Health and Water Supply Relation

There is a low perception on the relationship between water supply and health. Seventy-six (76) percent do not believe that some diseases are related or due to lack of potable water. Only 24 percent think that there is a relationship between some diseases and the lack of potable water. Diarrhea and stomach ache account for 80 percent of all diseases mentioned by the respondents. Majority, equivalent to 89 percent, believe that the present service level of their water supply source is adequate for the health and proper hygiene requirements of their families.

7.3-4 Water Supply Service Perception

Baseline information of people's perception of present water supply service is important in the selection of a scheme for a water supply system. Respondents were therefore asked as to their perception concerning the adequacy of the present water supply service. Ninety-four (94) percent are expecting some improvements to the present water supply service. Everybody considers the availability of potable water to be very important. However, 73 percent are satisfied with the present water supply service and consider it adequate. Seventeen (17) percent consider the service to be not so adequate, while the remaining 10 percent believe it is still inadequate.