5-4-2 Service Rate

As mentioned earlier in 3-4, the service rate for house connections in the urban section of the said district stands at 10%; the rest of the area depends on public wells and public faucets. However, with the emergence of LIE, it is expected that the district residents will experience a drastic change in their environment and life style as caused by the sudden population growth and increased economic strength. Consequently, a shift from public faucets to house connections among users of water supply facilities is also anticipated.

Hence, the service rate together with the improvement of public hygiene is projected as follows:

(a) The present plan adopts the combined use of public faucets and house connections with the latter gradually replacing the former.

(b) By 1985, the service rate in the urban areas (Merida, Matlang all the poblacions in Isabel) is projected to be at 70% for public faucets and 30% for house connections. By 2005, the service rate in these same areas is expected to be 15% for public faucets and 85% for house connections.

(c) On the other hand, by 1985, the rural areas (all areas except those mentioned in para (b)) are expected to have a 100% service rate for public faucets. This situation is expected to change to a 50% service rate for both public faucets and house connections by the year 1995. By 2005, the service rate in the rural areas is expected to equal that of the urban area: 85% for house connections and 15% for pubic faucets.

The service rates for both urban and rural districts are shown in Figures 5-4 and 5-5, and Tables 5-4 and 5-5.

Fig. 5-4 Service Rate (Poblacion)

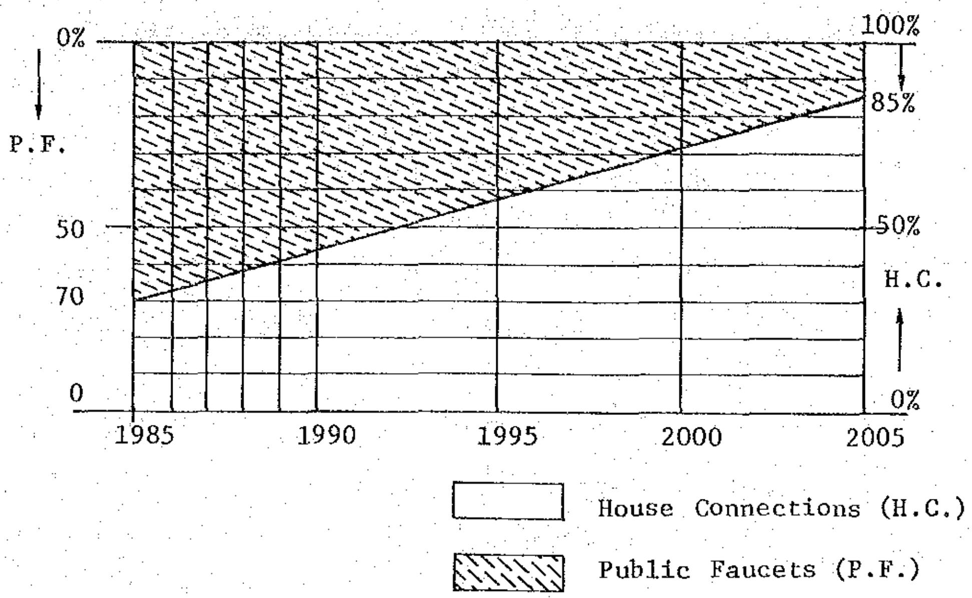


Fig. 5-5 Service Rate (Barangay & Sitios)

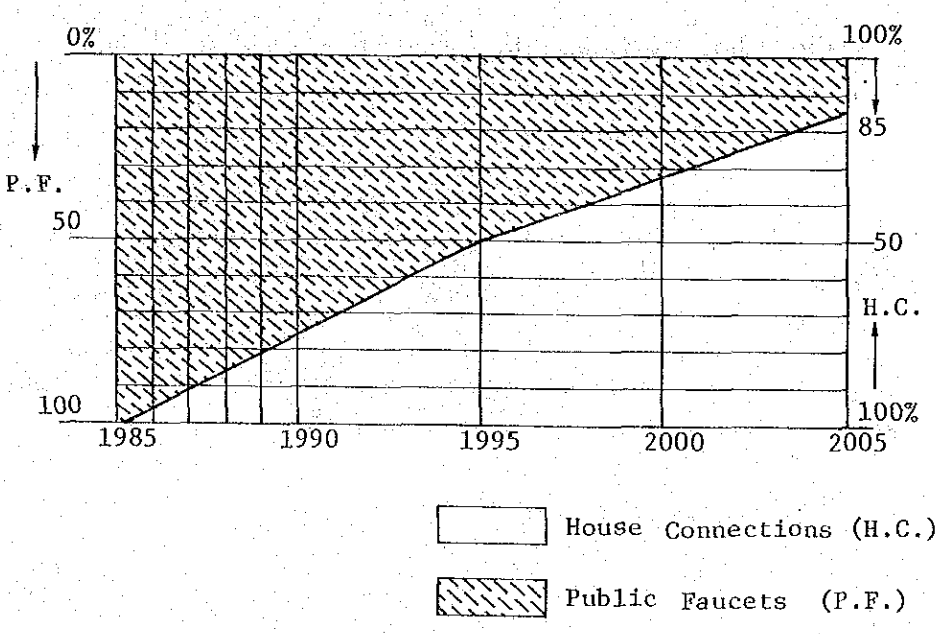


Table 5-4 Service Rate (Poblacion)

Unit (%)

Service Connection \ Year	1985	1986	1987	1988	1989	1990	1995	2000	2005
Public Faucet	30	32.8	35.5	38.3	41.0	43.8	57.5	71.3	85.0
House Connection	70	67.2	64.5	61.7	59.0	56.2	42.5	28.7	15.0

Table 5-5 Service Rate (Barangay & Sitios)

Unit (%)

Service Connection \ Year	1985	1986	1987	1988	1989	1990	1995	2000	2005
Public Faucet	100	95	90	85	80	75	50	32.5	15
House Connection	0	5	10	15	20	25	50	67.5	85

5-4-3 Served Population of Proposed Water District

Table 5-6 shows the distribution of the served population in each water district by year. This was obtained by multiplying the population times the service rate. (Tables 5-4, 5-5)

Table 5-6 Served Population for Each Water District

District	Service Connection	1985	1986	1987	1988	1989	1990	1995	2000	2005
Cabaliwan	House Connection	0	49	100	151	204	258	541	767	1,016
	Public Faucet	980	940	899	858	815	772	541	370	179
Puerto Bello	House Connection	0	183	369	558	752	949	1,996	2,832	3,747
	Public Faucet	3,614	3,467	3,318	3,164	3,009	2,848	1,995	1,364	661
Merida	House Connection	1,398	1,709	1,883	2,073	2,388	2,599	3,771	5,169	6,722
	Public Faucet	3,263	3,502	3,420	3,339	3,436	3,335	2,788	2,080	1,186
Calunangan	House Connection	0	179	363	557	838	1,068	2,383	3,595	4,955
	Public Faucet	2,910	3,393	3,268	3,156	3,352	3,204	2,382	1,731	874
Matlang	House Connection	1,625	2,180	2,399	2,647	3,198	3,483	5,100	7,070	9,225
	Public Faucet	3,790	4,467	4,359	4,263	4,602	4,469	3,770	2,846	1,628
Isabel	House Connection	2,673	3,589	3,949	4,356	5,264	5,733	8,394	11,638	15,187
	Public Faucet	6,238	7,352	7,174	7,018	7,574	7,355	6,205	4,685	2,680
Total	House Connection	5,696	7,889	9,063	10,342	12,644	14,090	22,185	31,071	40,852
	Public Faucet	20,795	23,121	22,438	21,798	22,788	21,983	17,681	13,076	7,208

5-5 Understanding of Industrial Production

Changes in water demand are dictated by each industry's production and expansion program. The yearly production targets for both PASAR and PHILPHOS are tabulated in Tables 5-7 & 5-8.

Table 5-7 PASAR's Projected Industrial Production

(Unit: 1,000 MT)

Year	1984	1985	1986	1987	1988	1989	1990
Volume of Smelted Copper	138	138	276	276	276	414	414

Table 5-8 PHILPHOS' Projected Industrial Production

(Unit: %)

Year	1984	1985	1986	1987	1988	1989	1990	2000
Rate of Productivity *	30	55	65	70	80	85	85	85

* When rate of productivity is 100%, amount of production is as follows;

SULFURIC ACID	495,000 MT/Y
AMMONIUM SULFATE	169,000
PHOSPHORIC ACID	380,000
GRANULATION	
DAP	512,000
MAP	170,000
16-20-0	126,000
15-15-15	72,000
14-14-14	55,000

Source: PASAR/PHILPHOS

5–6 Estimated Water Consumption and Water Supply

The rate of water consumption and water supply for the proposed water districts (previously mentioned in 5-3-1) are further discussed below.

5-6-1 Communities

At present the existing water supply system except for the city of Ormoc, aside from being small in scale is also inefficient. The present system does not provide sufficient water to even satisfy the present demand. However, the resulting industrilization from L.I.E. is projected to strongly influence the living standards of the residents economically and environmentally. This, in turn, is expected to accelerate the consumption of water. Based on the present actual rate of consumption, planning of the future water supply faces many problems.

The calculation of the planned average water consumption per capita per day and the planned average water supply per capita per day for domestic, commercial and institutional water is based on two manuals: namely;

(a) LWUA Technical Standards Manual (LTSM)

(b) LWUA Methodology Manual - Water Supply Feasibility Study of Twelve Provincial Areas (LMM).

This report quotes mostly from the concepts and principles stated in LMM.

Tables 5-9 and 5-10 show the planned average water supply per capita per day for public faucets and house connections. Table 5-11 shows the planned daily average water supply per water district by year.

As stated in LTSM, the planned maximum water supply per capita per day is derived by multiplying the water demand factor of 1.25 (value assigned is the median of residential - 1.20 and urban 1.30 factors) times the planned average water supply per capita per day for service connections (refer to Table 5-12). Moreover, the planned total maximum daily water supply per water district is obtained by multiplying the maximum daily water supply per capita times the values given in Table 5-6. The results are shown in Table 5-13.

Table 5-9 Planned Daily per Capita Water Supply for Public Faucets

Item		Year / Unit	1985	1986	1987	1988	1989	1990	1995	2000	2005
(1) Water Consumption	Domestic Water	GPCD	25	25	25	26	26	26	28	29	30
		LPCD	94	95	96	98	99	100	105	110	115
	Commercial & Institutional Water	GPCD	5	5	5	4	4	4	4	3	3
		LPCD	19	18	18	17	17	16	14	12	10
* (2) Unaccounted-for-Water		GPCD	6	6	6	6	6	6	6	6	7
		LPCD	23	23	23	23	23	23	24	24	25
Water Supply ((1) + (2))		GPCD	36	36	36	36	36	36	38	38	40
		LPCD	136	136	137	138	139	139	143	146	150

Table 5-10 Planned Daily per Capita Water Supply for House Connections

Item		Year / Unit	1985	1986	1987	1988	1989	1990	1995	2000	2005
(1) Water consumption	Domestic Water	GPCD	36	37	38	38	38	39	41	42	44
		LPCD	138	140	142	143	145	147	154	160	166
	Commercial & Institutional Water	GPCD	7	7	7	7	7	6	5	5	4
		LPCD	28	27	26	26	25	24	20	18	16
* (2) Unaccounted-for-Water		GPCD	9	9	9	9	9	9	9	10	10
		LPCD	33	33	33	34	34	34	35	36	37
Water Supply ((1) + (2))		GPCD	52	53	53	54	54	54	55	57	58
		LPCD	199	200	201	203	204	205	209	214	219

* For Tables 5-9 & 5-10, the amount of unaccounted-for-water is considered normal if it is 20% or less, of the sum of consumed water and unaccounted-for-water.

GPCD = Gallon per Capita per Day

LPCD = Liter per Capita per Day

Table 5-11 Planned Average Water Supply Per Day By Districts

Water District	Service Connection		1985	1986	1987	1988	1989	1990	1995	2000	2005年
CABALIWAN	Public Faucet	P	980	940	899	8585	815	772	541	370	179
		W	133	128	123	118	113	107	77	54	27
	House Connection	P	0	49	100	151	204	258	541	767	1,016
		W	0	10	20	31	43	53	113	164	223
	Total	CMPD	133	138	143	149	155	160	190	218	250
		GPM	24	25	26	27	28	29	35	40	46
PUERTO BELLO	Public Faucet	P	3,614	3,467	3,318	3,164	3,009	8,848	1,995	1,364	661
		W	492	472	455	437	418	396	285	199	99
	House Connection	P	0	183	369	558	752	949	1,996	2,832	3,747
		W	0	37	74	113	153	195	417	606	821
	Total	CMPD	492	503	529	550	571	591	702	805	920
		GPM	990	93	97	101	105	108	129	148	169
MERIDA	Public Faucet	P	3,263	3,502	3,420	3,339	3,436	3,335	2,788	2,080	1,186
		W	444	476	469	461	478	464	399	304	178
	House Connection	P	1,398	1,709	1,883	2,073	2,388	2,599	3,771	5,169	6,722
		W	278	342	378	421	487	533	788	1,106	1,472
	Total	CMPD	772	818	847	882	965	997	1,187	1,410	1,650
		GPM	132	150	155	162	177	183	218	259	303
CALUNANGAN	Public Faucet	P	2,910	3,393	3,268	3,156	3,352	3,204	2,382	1,731	874
		W	396	461	448	436	466	445	341	253	131
	House Connection	P	0	179	363	557	838	1,068	2,383	3,595	4,955
		W	0	36	73	113	171	219	493	769	1,085
	Total	CMPD	396	497	521	549	637	664	839	1,022	1,216
		GPM	73	91	96	101	117	122	154	187	223
MATLANG	Public Faucet	P	3,790	4,467	4,359	4,263	4,602	4,469	3,770	2,846	1,628
		W	515	608	597	588	640	621	539	416	244
	House Connection	P	1,625	2,180	2,399	2,647	3,198	3,483	5,100	7,070	9,225
		W	323	436	482	537	652	714	1,066	1,513	2,020
	Total	CMPD	838	1,044	1,079	1,125	1,292	1,335	1,605	1,929	2,264
		GPM	154	191	198	206	237	245	294	354	415
ISABEL	Public Faucet	P	6,238	7,352	7,174	7,018	7,574	7,355	6,205	4,685	2,680
		W	848	1,000	983	968	1,053	1,022	887	684	402
	House Connection	P	2,673	3,589	3,949	4,356	5,264	5,733	8,394	11,638	15,187
		W	532	718	794	884	1,074	1,175	1,754	2,491	3,326
	Total	CMPD	1,380	1,718	1,777	1,852	2,127	2,197	2,641	3,175	3,728
		GPM	253	1,044	326	340	390	403	484	582	683
GRAND TOTAL	Public Faucet	P	20,793	23,121	22,438	21,798	22,788	21,983	17,681	13,076	7,208
		W	2,828	3,145	3,075	3,008	3,168	3,055	2,528	1,910	1,081
	House Connection	P	5,696	7,889	9,063	10,342	12,644	14,000	22,185	31,071	40,852
		W	1,133	1,579	1,821	2,099	2,579	2,889	4,636	6,649	8,947
	Total	CMPD	3,961	4,724	4,896	5,107	5,747	5,944	7,164	8,559	10,028
		GPM	726	866	898	936	1,054	1,090	1,313	1,569	1,838

NOTE: P: Projected Served Population
W: Average Daily Water Supply (CMPD)

Table 5-12 Planned Maximum Water Supply per Day for Service Connections

Service connection \ Year		1985	1986	1987	1988	1989	1990	1995	2000	2005
Public Faucet	GPCD	45	45	45	45	45	45	48	48	50
	LPCD	170	170	171	173	174	174	179	183	188
House Connection	GPCD	65	66	66	68	68	68	69	71	73
	LPCD	249	250	251	254	255	256	261	268	274

Note: GPCD = Gallon per Capita per Day
LPCD = Liter per Capita per Day

Table 5-13 Planned Maximum Water Supply Per Day

Water District			1985	1986	1987	1988	1989	1990	1995	2000	2005
CABALIWAN	Public Faucet	P	980	940	899	858	815	772	541	370	179
		W	170	160	160	150	150	140	100	70	40
	House Connection	P	0	49	100	151	204	258	541	767	1,016
		W	0	20	30	40	60	70	150	210	2 0
	Total	CMPD	170	180	190	190	210	210	250	280	320
		GPM	31	33	35	35	39	39	46	51	59
PUERTO BELLC	Public Faucet	P	3,614	3,467	3,318	3,164	3,009	2,848	1,995	1,364	661
		W	620	590	570	550	530	500	360	250	130
	House Connection	P	0	183	369	558	752	949	1,996	2,832	3,747
		W	0	50	100	150	200	250	520	760	1,030
	Total	CMPD	620	640	670	700	730	750	880	1,010	1,160
		GPM	114	117	123	128	134	138	161	185	213
MERIDA	Public Faucet	P	3,263	3,502	3,420	3,339	3,436	3,335	2,788	2,080	1,186
		W	560	600	590	580	600	580	500	380	230
	House Connection	P	1,398	1,709	1,883	2,073	2,388	2,599	3,771	5,169	6,722
		W	350	430	480	530	610	670	990	1,390	1,850
	Total	CMPD	910	1,030	1,070	1,110	1,210	1,250	1,490	1,770	2,080
		GPM	167	189	196	204	222	229	273	324	382
CALUNANGAN	Public Faucet	P	2,910	3,393	3,268	3,156	3,352	3,204	2,382	1,731	874
		W	500	580	560	550	590	560	430	320	170
	House Connection	P	0	179	363	557	838	1,068	2,383	3,595	4,955
		W	0	50	100	150	220	280	630	970	1,360
	Total	CMPD	500	630	660	700	810	840	1,060	1,290	1,530
		GPM	92	116	121	128	149	154	194	237	281
MATLANG	Public Fancet	P	3,790	4,467	4,359	4,263	4,602	4,469	3,770	2,846	1,628
		W	650	760	750	740	800	780	680	520	310
	House Connection	P	1,625	2,180	2,399	2,647	3,198	3,483	5,100	7,070	9,225
		W	410	550	610	680	820	900	1,340	1,900	2,530
	Total	CMPD	1,060	1,310	1,360	1,420	1,620	1,680	2,020	2,420	2,840
		GPM	194	240	250	261	297	308	371	444	521
ISABEL	Public Faucet	P	6,238	7,352	7,174	7,018	7,574	7,355	6,205	4,685	2,680
		W	1,060	1,250	1,230	1,220	1 320	1,280	1,110	860	510
	House Connection	P	2,673	3,589	3,949	4,356	5,264	5,733	8,394	11,638	15,187
		W	670	900	1,000	1,110	1,350	1,470	2,190	3,120	4,170
	Total	CMPD	1,730	2,150	2,230	2,330	2,670	2,750	3,300	3,980	4,680
		GPM	317	394	409	427	490	505	605	730	859
GRAND TOTAL	Public Faucet	P	20,795	23,121	22,430	21,798	22,788	21,983	17,681	13,076	7,208
		W	3,560	3,940	3,860	3,790	3,990	3,840	3,180	400	1,390
	House Connection	P	5,696	7,889	9,063	10,342	12,644	14,090	22,185	31,071	40,852
		W	1,430	2,000	2,320	2,660	3,260	3,640	5,820	8,350	11,220
	Total	CMPD	4,990	5,940	6,180	6,450	7,250	7,480	9,000	10,750	12,610
		GPM	915	1,089	1,134	1,103	1,331	1,373	1,650	1,972	2,315

The planned maximum hourly water supply per capita is obtained by multiplying the peak hour factor of 1.63 (mean of residential values 1.50 to 1.75) to the planned daily average water supply per capita as shown in Table 5-14. In addition, the planned total maximum hourly water supply is derived by multiplying the values in Table 5-14 times the population (Table 5-6). The distribution according to water districts is shown in Table 5-15.

Table 5-14 Planned Maximum Water Supply per Day for Service Connections

Service Connection \ Year		1985	1986	1987	1988	1989	1990	1995	2000	2005
Public Faucet	GPCD	59	59	59	59	60	60	62	63	65
	LPCD	222	222	223	225	227	227	233	238	245
House Connection	GPCD	86	86	87	87	88	88	90	92	94
	LPCD	324	326	328	331	333	334	341	349	357

Table 5-15 Planned Hourly Maximum Water Supply For Each Water District

Water District	Service Connection		1985	1986	1987	1988	1989	1990	1995	2000	2005
CABALIWAN	Public Faucet	P	980	940	899	858	815	772	541	370	179
		W	218	209	200	193	185	175	126	88	44
	House Connection	P	0	49	100	151	204	258	541	767	1,016
		W	0	16	33	50	68	86	184	268	363
	Total	CMPD	218	226	233	243	253	261	310	356	407
		LPS	2,528	2,604	2,697	2,813	2,928	3,021	3,588	4,120	4,711
PUERTO BELLO	Public Faucet	P	3,614	3,467	3,318	3,164	3,009	2,848	1,995	1,364	661
		W	802	770	740	712	683	646	465	325	162
	House Connection	P	0	183	369	558	752	949	1,996	2,832	3,747
		W	0	60	121	185	250	317	680	988	1,338
	Total	CMPD	802	830	861	897	933	963	1,145	1,313	1,500
		LPS	9,282	9,606	9,965	10,382	10,799	11,146	13,252	15,197	17,361
MERIDA	Public Faucet	P	3,263	3,502	3,420	3,339	3,436	3,335	2,788	2,080	1,181
		W	724	777	763	751	780	757	650	495	291
	House Connection	P	1,398	1,709	1,883	2,073	2,388	2,599	3,771	5,169	6,722
		W	453	557	618	686	795	868	1,286	1,804	2,400
	Total	CMPD	1,177	1,334	1,381	1,437	1,575	1,625	1,936	2,299	2,691
		LPS	12,683	15,440	15,984	16,632	18,229	18,808	22,407	26,609	31,146
CALUNANGAN	Public Fancet	P	2,910	3,393	3,268	3,156	3,352	3,204	2,382	1,731	874
		W	646	753	729	710	761	727	555	412	214
	House Connection	P	0	179	363	557	838	1,068	2,383	3,595	4,955
		W	0	58	119	184	279	357	813	1,255	1,769
	Total	CMPD	646	811	848	894	1,040	1,084	1,368	1,667	1,983
		LPS	7,477	9,387	9,815	10,347	12,037	12,546	15,833	19,294	22,951
MATLANG	Public Faucet	P	3,790	4,467	4,359	4,263	4,602	4,469	3,770	2,846	1,628
		W	841	992	972	959	1,045	1,014	878	677	399
	House Connection	P	1,625	2,180	2,399	2,647	3,198	3,483	5,100	7,070	9,225
		W	527	711	787	876	1,065	1,163	1,739	2,467	3,293
	Total	CMPD	1,368	1,703	1,759	1,835	2,110	2,177	2,617	3,144	3,692
		LPS	15,883	19,711	20,359	21,238	24,421	25,197	30,289	36,389	42,731
ISABEL	Public Faucet	P	6,238	7,352	7,174	7,018	7,574	2,355	6,205	4,685	2,680
		W	1,385	1,632	1,600	1,579	1,719	1,670	1,446	1,115	657
	House Connection	P	2,673	3,589	3,949	4,356	5,264	5,733	8,394	11,638	15,187
		W	866	1,170	1,295	1,442	1,753	1,915	2,862	4,062	5,422
	Total	CMPD	2,251	2,802	2,895	3,021	3,472	3,585	4,300	5,177	6,079
		LPS	26,053	32,431	33,507	34,965	40,185	41,493	49,861	59,919	10,359
GRAND TOTAL	Public Faucet	P	20,795	23,121	22,438	21,798	22,788	21,983	17,681	13,076	7,208
		W	4,616	5,133	5,004	4,904	5,173	4,989	4,120	3,112	1,767
	House Connection	P	5,696	7,889	9,063	10,342	12,644	14,090	22,185	31,071	40,852
		W	1,846	2,572	2,973	3,423	4,210	4,706	7,564	10,844	14,585
	Total	CMPD	6,462	7,705	7,977	8,327	9,383	9,695	11,684	13,956	16,352
		LPS	74,791	89,179	92,327	96,377	108,599	112,211	135,230	161,528	189,259

CMPD = Cubic Meter Per Day. LPS = Liter Pe Second.

P: Projected Served Population
W: Hourly Maximum Water Supply (CMPD)

5-6-2 Other Industries

Other Industries ("Others") in this report refers to the industrial water demand outside of PASAR from PHILPHOS, the Wharf and Light Industries.

The projected water demand of PHILPHOS listed below is based on the data provided by the firm itself.

The amount of water lost during transmission is considered negligible since PHILPHOS has its own regulating reservoir which makes adjustments for hourly and daily changes and emergencies. Hence, it is assumed that water demand is equal to the water supply.

Table 5-16 shows the planned average water supply for other Industries.

Table 5-16 Planned Average Daily Water Supply for "Others"

Industries	Units / Year	1985	1986	1987	1988	1989	1990	1995	2000	2005
PHILPHOS	GPM	1,400	1,500	1,600	2,000	2,000	2,000	2,000	2,000	2,000
	CMPD	7,630	8,180	8,720	10,900	10,900	10,900	10,900	10,900	10,700
WHARF	GPM	100	100	100	100	100	100	100	100	100
	CMPD	550	550	550	550	500	550	550	550	550
LIGHT INDUSTRIES	GPM	300	340	380	420	460	500	500	500	500
	CMPD	1,640	1,860	2,080	2,290	2,510	2,730	2,730	2,730	2,730
TOTAL	GPM	1,800	1,940	2,080	2,520	2,560	2,600	2,600	2,600	2,600
	CMPD	9,820	10,590	11,350	13,740	13,960	14,180	14,180	14,180	14,180

Notes: (1) PHILPHOS provided the above data on May 12, 1982.
(2) Data for Wharf and Light Industries provided by Leyte Industrial Estate Master Plan.
(3) Water demand include both domestic water and water for public use.
(4) GPM = gallons per minute
CMPD = cubic meters per day

5-6-3 PASAR's Water Requirements

Table 5-17 shows PASAR's water demand which is also regarded as its water supply. These calculations were based on production data provided by PASAR.

Table 5-17 Planned Average Daily Water Supply for PASAR

Unit \ Year	1985	1986	1987	1988	1989	1990	1995	2000	2005
GPM	1,200	1,600	1,600	1,700	2,100	2,100	2,100	2,100	2,100
CMPD	6,540	8,720	8,720	9,270	11,450	11,450	11,450	11,450	11,450

Note: GPM = Gallon per Minute
CMPD = Cubic Meter per Day

5-7 Planned Intake Amount

The present plan does not require the use of water treatment facilities in supplying clean water except for disinfection facilities. The water does not have to go through sand filtration or undergo the process of purification; hence, the planned amount of water transmitted is considered to be equal to planned intake amount. This amount is based on planned maximum daily water supply.

Table 5-18 shows the projected total intake amount and the percentage held by the served areas. Table 5-19 shows the planned intake amount for the Community and "Others."

Table 5-18 Planned Total Amount of Water Intake & Its Distribution to the Service Areas

Unit \ Year		1985	1986	1987	1988	1989	1990	1995	2000	2005
Community & "Others"	GPM	2,715	3,029	3,214	3,703	3,891	3,973	4,250	4,572	4,915
	CMPD	(69.4%) 14,810	(65.5%) 16,530	(66.8%) 17,530	(68.5%) 20,190	(64.9%) 21,210	(65.4%) 21,660	(66.9%) 23,180	(68.5%) 24,930	(70.6%) 26,790
PASAR	GPM	1,200	1,600	1,600	1,700	2,100	2,100	2,100	2,100	2,100
	CMPD	(30.6%) 6,540	(34.5%) 8,720	(33.2%) 8,720	(31.5%) 9,270	(35.1%) 11,450	(34.6%) 11,450	(33.1%) 11,450	(31.5%) 11,450	(29.9%) 11,450
TOTAL	GPM	3,915	4,629	4,814	5,403	5,991	6,073	6,350	6,672	7,015
	CMPD	(100%) 21,350	(100%) 25,250	(100%) 26,250	(100%) 29,460	(100%) 32,660	(100%) 33,110	(100%) 34,630	(100%) 36,380	(100%) 38,240

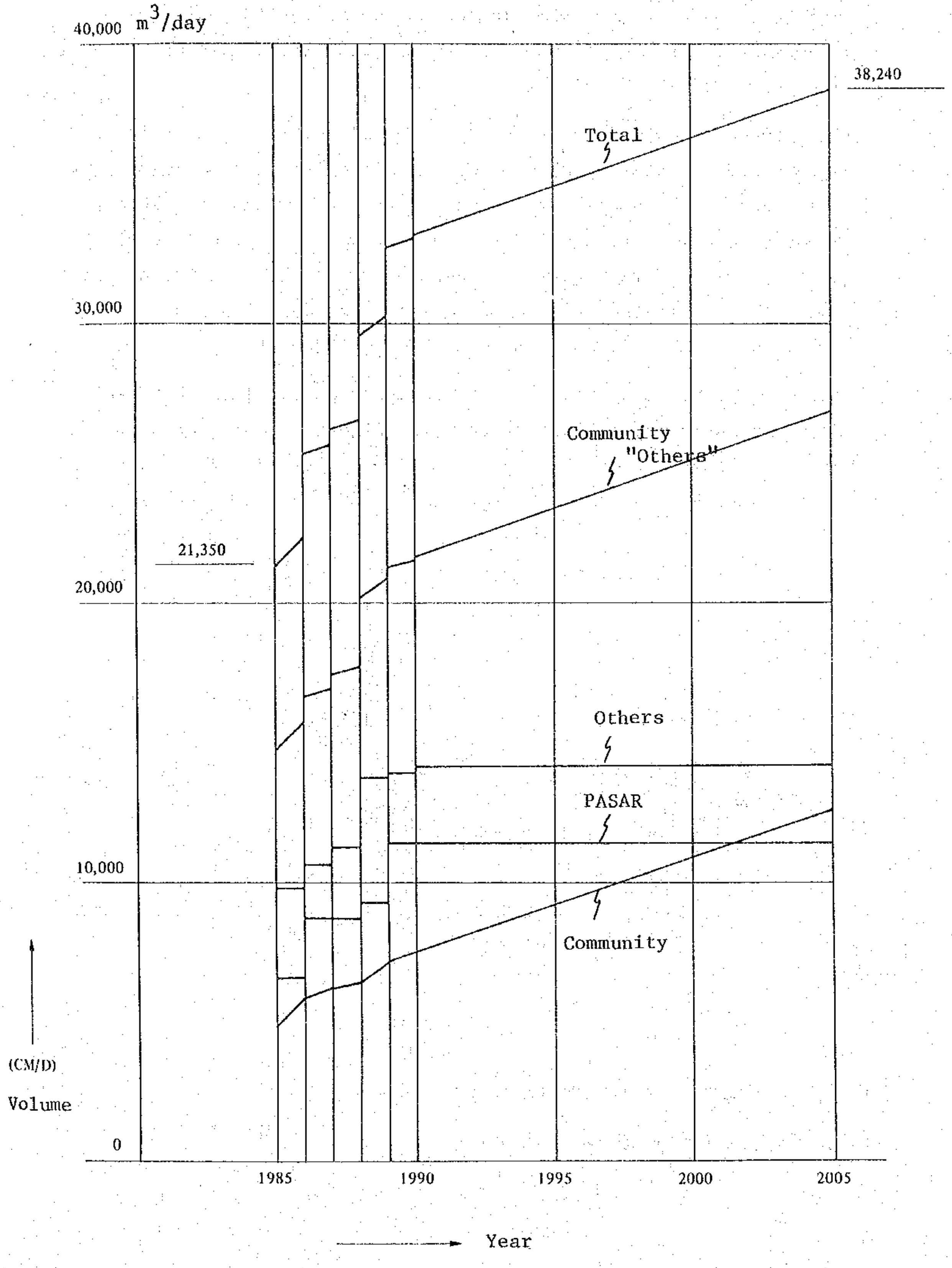
Note: GPM = Gallon per Minute
CMPD = Cubic Meter per Day

Table 5-19 Planned Total Amount of Water Intake for Community & "Others"

Unit \ Year		1985	1986	1987	1988	1989	1990	1995	2000	2005
Community	GPM	915	1,089	1,134	1,183	1,331	1,373	1,650	1,972	2,315
	CMPD	(34%) 4,990	(36%) 5,940	(35%) 6,180	(32%) 6,450	(34%) 7,250	(35%) 7,480	(39%) 9,000	(43%) 10,750	(47%) 12,610
"Others"	GPM	1,800	1,940	2,080	2,520	2,560	2,600	2,600	2,600	2,600
	CMPD	(66%) 9,820	(64%) 10,590	(65%) 11,350	(68%) 13,740	(66%) 13,960	(65%) 14,180	(61%) 14,180	(57%) 14,180	(53%) 14,180
Total	GPM	2,715	3,029	3,214	3,703	3,891	3,973	4,250	4,572	4,915
	CMPD	(100%) 14,810	(100%) 16,530	(100%) 17,530	(100%) 20,190	(100%) 21,210	(100%) 21,660	(100%) 23,180	(100%) 24,930	(100%) 26,790

Note: Percentage of yearly total.

Fig. 5-6 Planned Total Amount of Water Intake by Year



5-8 Planned Amount of Water Supply for the Community

This section deals with the planned amount of water supply which determines the scale of the distribution facilities (discussed later in Chapter 8).

The planned amount of water supply is based on either the planned maximum hourly water supply or the sum of the planned maximum daily water supply and the fire fighting requirements whichever provide the more conservative margin of safety. However in the case of the rural district, fire-fighting requirements were not considered for economic reasons; thus, the planned amount of water supply is based solely on the planned daily maximum hourly water supply.

Double outlet fire hydrants with a capacity of 22 liters per second are to be installed as part of the fire-fighting devices considered for the urban districts during the entire design period. Table 5-20 shows the planned amount of water supply for the six water districts.

Table 5-20 Planned Amount of Water Supply

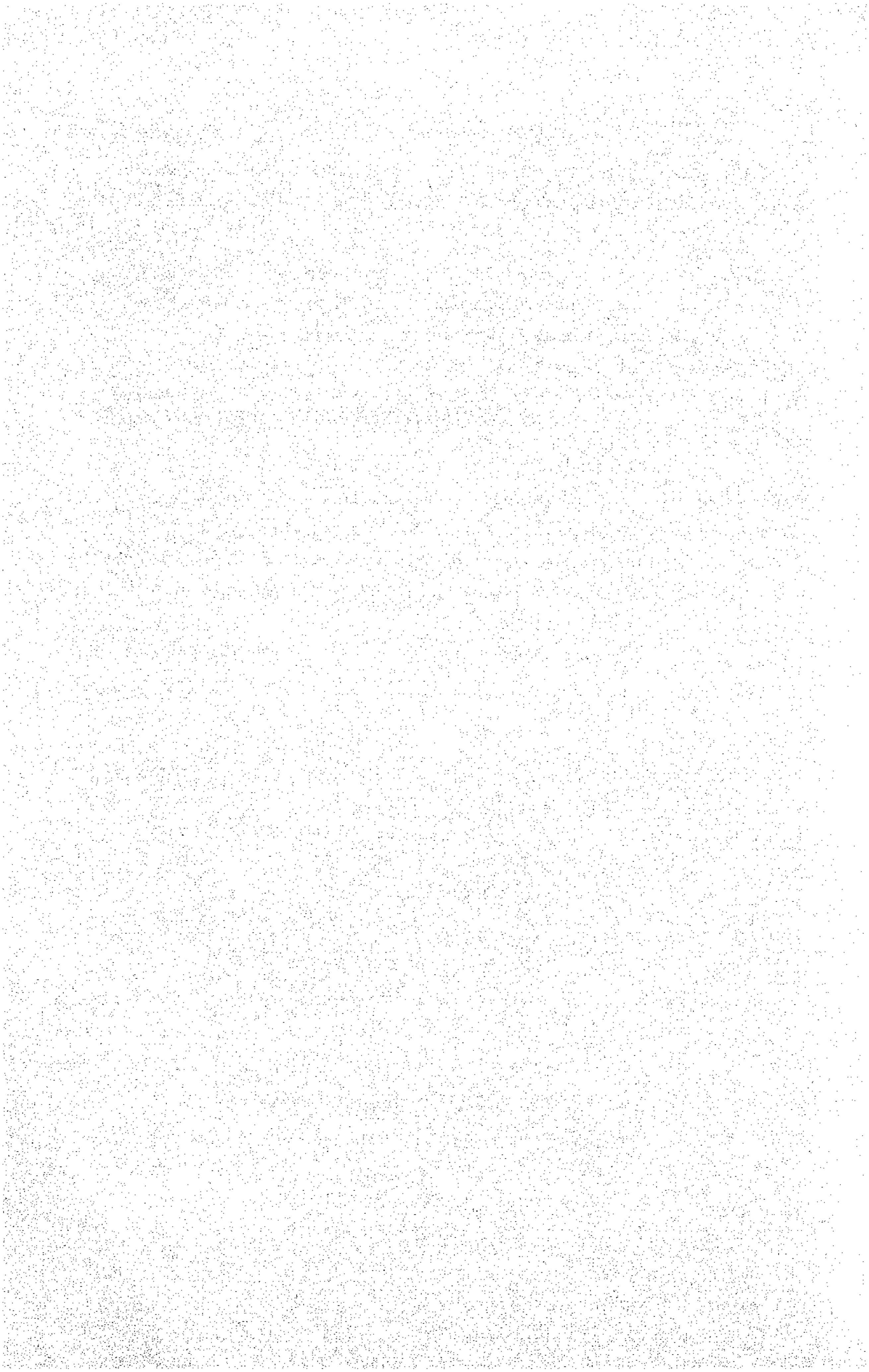
Water District	UNIT:	1985	1986	1987	1988	1989	1990	1995	2000	2005
CABALIWAN	CMPD	218	225	233	243	253	261	310	356	407
	LPS	2,523	2,604	2,697	2,813	2,928	3,021	3,588	4,120	4,711
PUERTO BELLO	CMPD	802	830	861	897	933	963	1,145	1,313	1,500
	LPS	9,282	9,606	9,965	10,382	10,799	11,146	13,252	15,197	17,361
MERIDA	CMPD	2,810	2,930	2,970	3,010	3,110	3,150	3,390	3,670	3,980
	LPS	32,532	33,921	34,384	34,847	36,005	36,468	39,245	42,486	46,074
CALUNANGAN	CMPD	646	811	848	894	1,040	1,084	1,368	1,667	1,983
	LPS	7,477	9,387	9,815	10,347	12,037	12,546	15,833	19,294	22,951
MATLANG	CMPD	2,960	3,210	3,260	3,320	3,520	3,580	3,920	4,320	4,740
	LPS	34,269	37,162	37,741	38,435	40,750	41,444	45,380	50,009	54,870
ISABEL	CMPD	3,630	4,050	4,130	4,230	4,570	4,650	5,200	5,880	6,580
	LPS	42,023	46,884	47,810	48,968	52,903	53,829	60,194	68,065	76,167
TOTAL	CMPD	11,066	12,056	12,302	12,594	13,426	13,688	15,333	17,206	19,190
	LPS	128,106	139,564	142,412	145,792	155,422	158,454	177,492	199,171	222,134

Legend:

☐ Fire-fighting Water Requirement Included

☐ Based on Hourly Maximum Water Supply

CHAPTER 6 WATER RESOURCES DEVELOPMENT



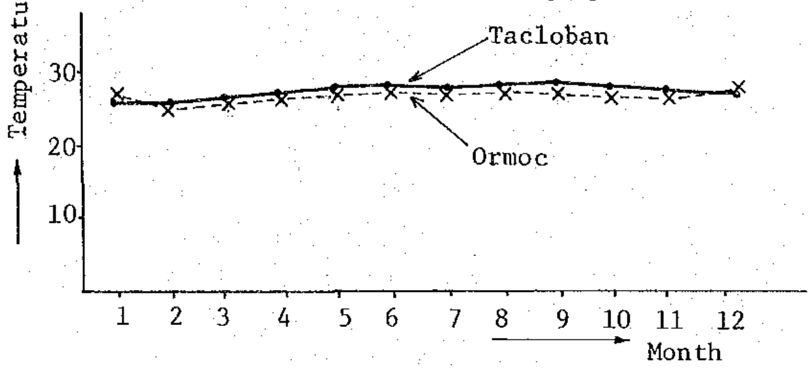
Chapter 6 WATER RESOURCES DEVELOPMENT

6–1 Groundwater Development

6-1-1 Climate

Leyte Island, the location of the study site, lies almost in the center of the Philippine Islands. Its climate follows the tropical standard of the Philippines. The mean monthly temperature is as shown on the following graph and mean annual rainfall is shown Fig. 6-1.

(Mean monthly temperature graph)



The Ormoc plain rainfall at the study site is about 2,200 mm/year, however, more than 4,000 mm/year may occur in the east mountain area according to Bao River discharge data.

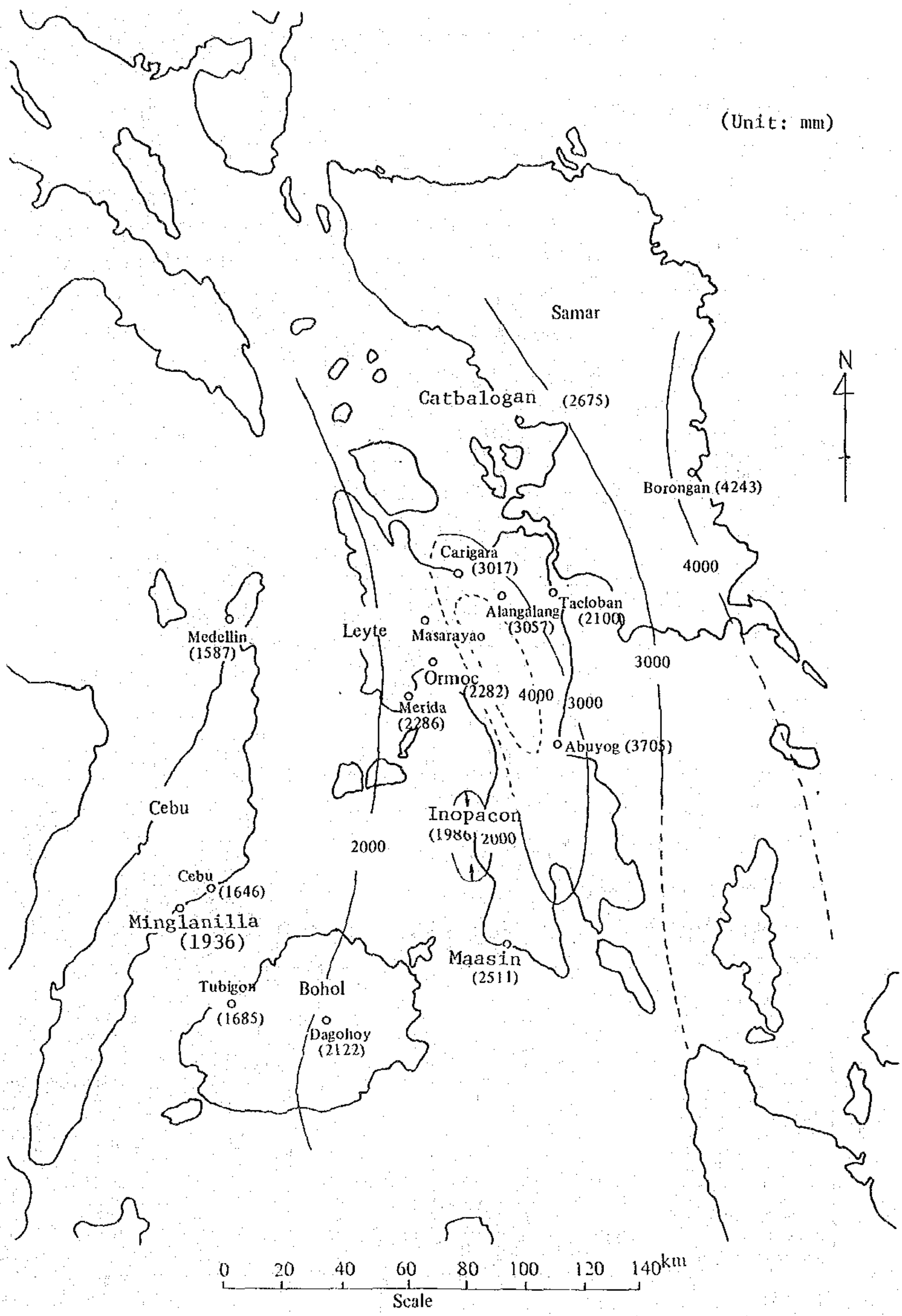
The possible evapo-transpiration value that was calculated using Thornthwaite formula and adjusted for humidity is as follows.
(Possible evapo-transpiration table calculated for Ormoc stations)

Item \ Month	1	2	3	4	5	6	7	8	9	10	11	12	Year
Temperature °C	26.3	25.8	26.4	27.1	27.5	27.4	27.4	27.5	27.1	27.0	26.9	26.6	Mean 26.9
Relative humidity %	80	80	79	77	80	80	79	79	82	82	82	81	Mean 80
Evapo-transpiration calculated in mm *	130	128	131	140	144	143	143	144	140	140	139	136	Total 1,658
Possible evapo-transpiration (above x0.89) mm	113	111	114	122	125	124	124	125	122	122	121	118	Total 1,441

Humidity source : LWUA

* Thorthuaite formula used.

Fig. 6-1 Mean Annual Rainfall Distribution Map



6-1-2 Geology

(a) Topography and geology

The study area is a basin which faces Ormoc Bay and is formed of four topographic reliefs: (western highland, north hills, eastern highland, low ground).

The western highland consists of mountains and hills generally ranging in height from 200 m to 500 m.

The north highland consists of hills generally ranging in height from 100 m to 200 m with a gradual gradient. The eastern highland which is located in the Philippine fault zone consists of shaped mountains and valleys. The eastern highland is located in the Leyte mountains. This area consists of two different topographic types. In the mountains, there are many peaks. The highest among them being 1100 m. Land hills which are less than 400 m in height form a wide fan. Many rivers that exist, radiate straight on the fan but flowing streams do not appear except for two or three major rivers during the dry season.

The center of the study area is a wide low ground. In the low ground, Pagsangahan River flows to Ormoc Bay. The gradient of the river is very gradual and a point which is over 100 m in elevation only exists 20 km from the mouth of the river. This area consists of lower ground along the river and some low terraces.

The geology of the study area is shown on the geological map (Fig. 6-2) and geological succession (Table 6-1).

(b) Geological structure

The heading is assumed to be as follows based on the foregoing geological condition, existing water well logs, Tongonan geothermal data, Matlang deep well data, and geo-electrical survey data.

The underground geological structure is shown diagrammatically in Fig. 6-3. In the geological map, the boundary of contact

Fig. 6-2 Geological Map

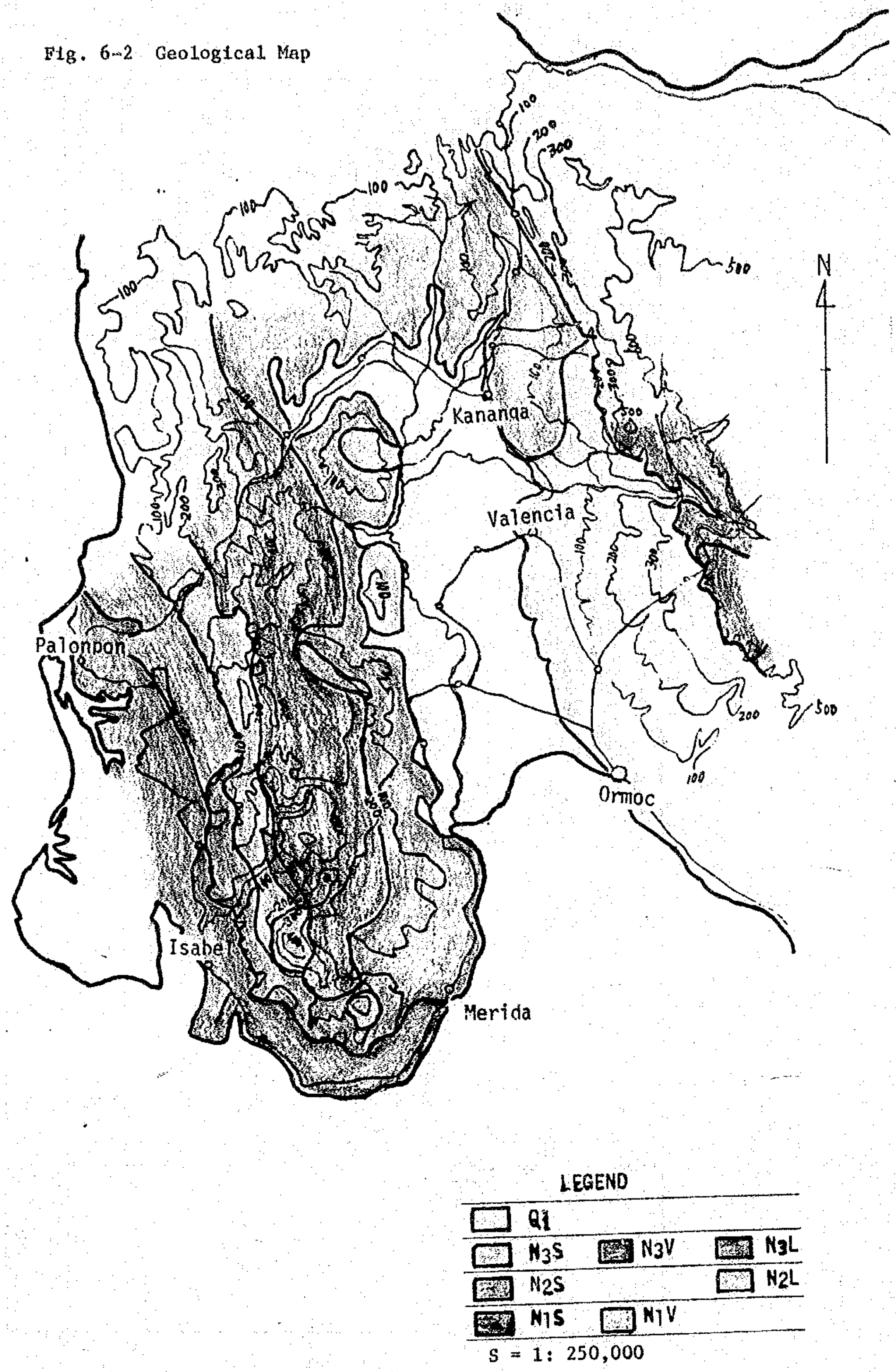


Table 6-1 Geological Succession

Geological time	Type of rock	Sedimentary rocks	Volcanic rocks	Limestones
Quarternary	Alluvium	Non fixed deposits (sand, clay, gravel), talus	No data	
	Pleistocene ~ Pliocene	N_3S formation agglomerate (large boulder) conglomerate, sandstone, shale almost flat to 15° dips. thickness 50 to 400 m	N_3V formation andesite lava flow, agglomerate, welded ash flow and volcanic boulder	N_3L formation coralline limestone underlain by sandstone, shale and conglomerate
Tertiary	Pliocene ~ Late Miocene	N_2S formation agglomerate, tuff, tuffaceous sandstone and shale. 3° to 5° dips. thickness 800 m NE and Western Leyte	No data	N_2L formation coralline limestone partly crystallized limestone. Dips 5° to 40°. underlain by shale, sandstone and local conglomerate.
	Middle Miocene ~ Early Miocene	N_1S formation sandstone, shale. strongly folded (40° to 85° dips) thickness as much as 1,300 m in Northwest Leyte.	N_1S formation andesite, basalt, dacite lava flow. agglomerate, volcanic boulder.	No data

between N_2S formation and the new deposit formed is very straight. We assume that the alluvial deposit is in fault contact with N_2S formation. Based on the results of geo-electrical survey, it has been determined that the boundary exists, because a difference in resistivity is indicated. It is located about 3 kilometers east of the contact line and tends toward N-S. The resistivity of the eastern field is higher than that of the western field. In the eastern field, the thickness of the surficial soil is very thin and the N_3S formation exists under the surface soil. We assume that in the western field, the fault valley is eroded along the river and eventually the area is covered by the new deposit. The maximum thickness of the new deposit is more than 100 m.

It is concluded that the boundary based on the geo-electrical survey divides the high resistivity area of N_3S formation from the low resistivity area of the new deposit.

(c) Hydrogeology

N_1S, N_2S, and N_1V formations, are distributed over the west highland and a portion of the east mountain area. They may be hard rock with low permeability due to consolidation resulted from the older sediment age.

Conversely, new N_3S and Q_1 formation developed over the Ormoc plain may be quite permeable because it is an unconsolidated sediment and consequently there is a possibility of an aquifer existing in this underground formation.

Based on the topographic and geologic conditions, it was expected to be formed of a groundwater basin in the Ormoc plain. Our recent study target was to evaluate this basin capacity. (Surface water drainage system).

Pagsangahan River flows through the Ormoc plain. In the upper stream, it branches out to Bao, Tebangho, and Tubong river respectively. From that, these rivers all originate from the east mountain area, it is assumed that this same area will have extensive rainfall.

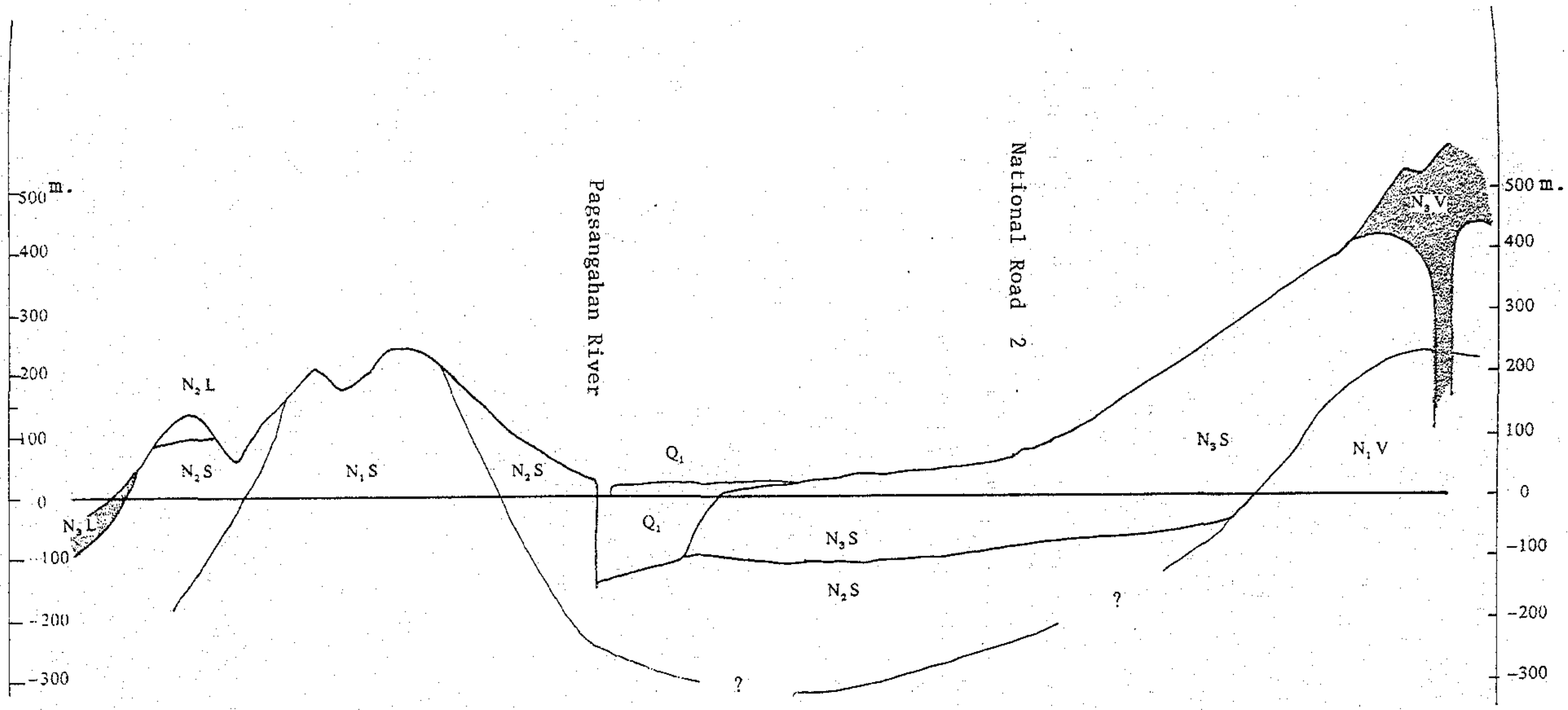


Fig. 6-3 Assumed Underground Structure Map
(Profile line as shown in Fig.-2)

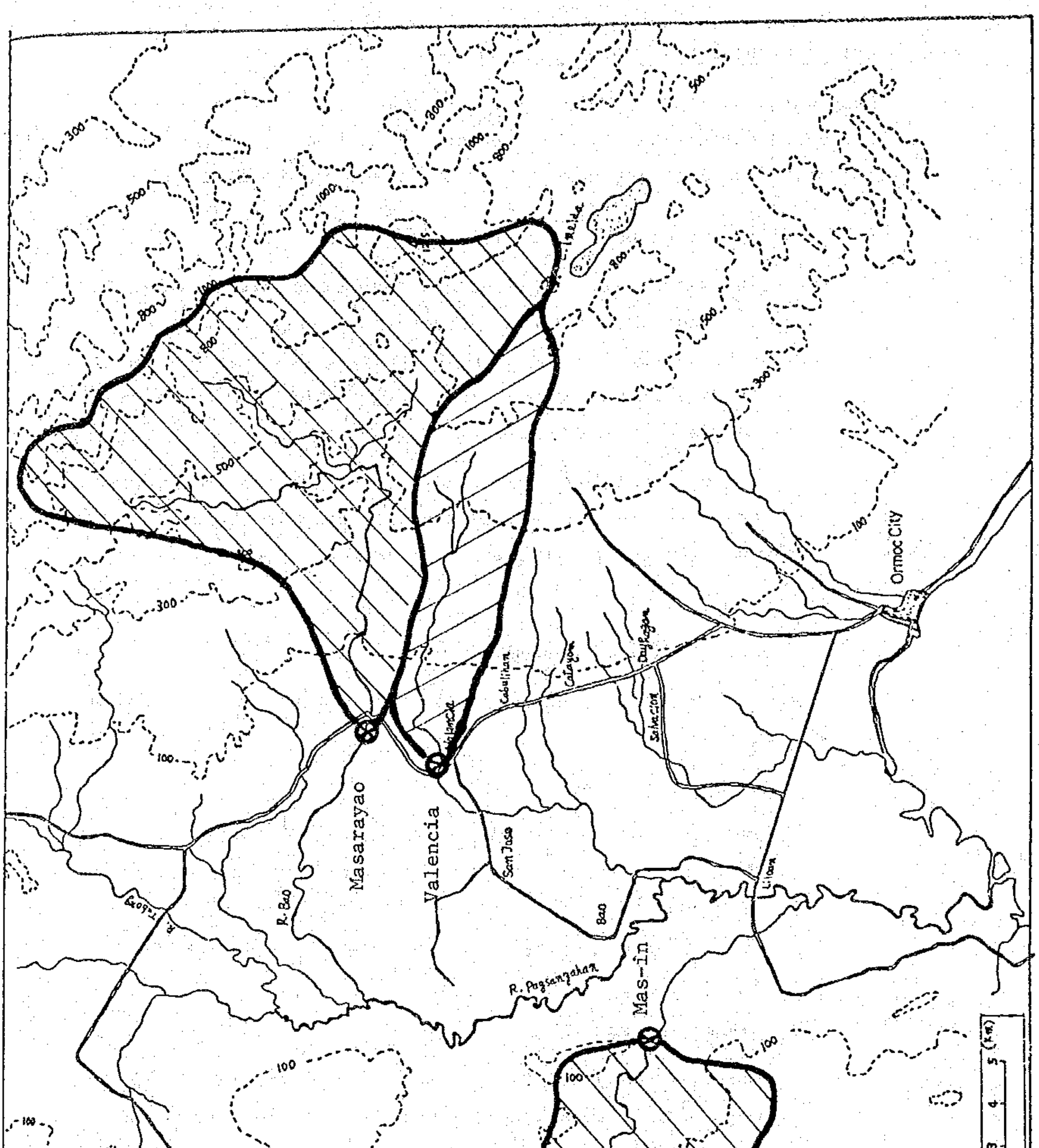
Many streams on the terrace of east piedmont, between Sinangan and Valencia provide no discharge and are considered to be rivers. It is thought, therefore, taht adequate permeability of the terrace soils must be considered.

Surface water discharge data has been observed as follows. (River flow regime table)

Name of River	Base station		Mean annual discharge quantity	Remarks
	Location	Drainage area		
Baleon	Valencia	19 Km^2	1.05 m^3/sec	Period 1956-1970
Bao	Masarayao	65	6.68	" 1951-1970
Mas-in	Mas-in	22	1.16	" 1956-1970

Source : Philippine Water Resources

These data have been used as basis for the water balance calculations.



Masarayao
Valencia
Mas-in
Ormoc City
R. Pagsangahan
R. Bao
San Jose
Scale
0 1 2 3 4 5 (km)
100
300
500
800
1000
N

6-1-3 Existing Water Well Investigation

Many water wells already exist in the Ormoc plain and data was collected concerning these wells including, simple water quality tests and sampling for some laboratory tests in the field.

(a) Existing water well conditions

Existing water well locations and conditions are indicate in Fig. 6-5 and Table 6-2 respectively. The number of flowing wells are numerous (30 flowing among 69 wells); well depth is comparatively shallow (only 4 wells of more than 100 m), and well diameter is generally small.

From 8 geological logs collected, it is observed that numerous boulders exist in the east terrace and clay in the west. Consequently, the possibility of good aquifer exists in the east.

(b) Conductivity and water temperature

Each well heading value measured by a portable meter is given in Table 6-3.

(1) Conductivity

The measured results are shown on the following map. Then there is a tendency for less than 200 μs/cm and good quality in the east. This indicates that the groundwater originating in the east piedmont is moving to the southwest.

(2) Water temperature

The measured value indicates 27 - 30°C which is close to the average atmosphere temperature with a tendency for low temperatures in the east and high in the southwest. This also suggests that an underflow exists in the southwest direction of percolated water from the cool mountain area.

Fig. 6-5 Existing Water Well Location Map

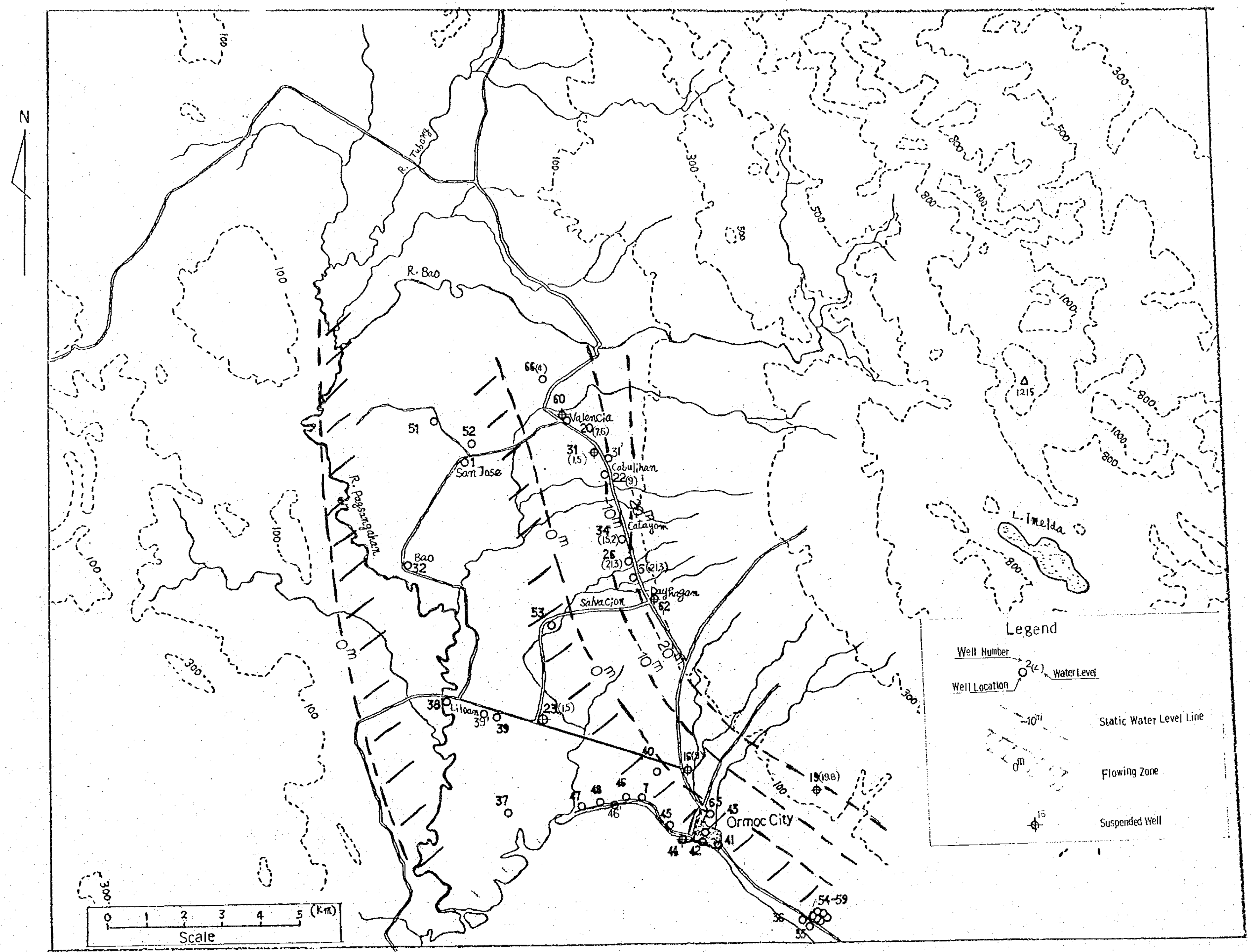


Table 6-2 Existing Water Well Data Summary

LWUA Well No.	MPW No.	Location (Bario)	Well Depth (m)	Casing Depth (m)	ϕ (in)	SWL (m)	ℓ/min/ Draw down (m)	Comple- tion Date	Discharge m^3/d	Remarks
1	5379	San Jose	71	67	4	2.1	26/–	2/17/52	13	3/16/77 flowing
2		St. Agustine St.	66			flowing	76/–	8/20/52	109	
3	6320	Macabog	57	57	6	flowing	19/–	6/19/54	27	
4	296071	Matica-a	26	26	4	2.4	57/1.2	9/30/60	unknown	
5	296045	Dayhagan	42	42	4	21.3	26/2.7	11/28/60	42	
6	10180	Linao	70	60	6	3.0	76/	8/2/56	unknown	
7	5667	Linao	70	67	4	flowing	576/–	1/16/53	816	
8	14384	Bantique	27	25	4 1/2	+1.2	19/–	6/27/57	27	
9	6319	Ipil	100	73	6	flowing	76/3.0	6/1/54	109	
10	–	Burgos St.	65	65	4 1/2	flowing	189/0.6	9/25/52	272	
11	2442	Alegria	57	–	–	–	76	2/14/58	unknown	
12	18795	Mas-in	49	35	4 1/2	6.1	–	2/21/58	unknown	
13	11476	Malunod	8	8	4 1/2	–	–	2/28/57	unknown	
14	20574	Borok	47	45	4	36.6	–	9/19/58	unknown	
15	2502	Cantubo	6	5	4 1/2	2.7	57/1.2	7/20/52	unknown	
16	20573	Cogon Combado	42	42	4	8∼9	–	4/30/58	0	no use
17	18784	Nasugon	13	12	4	5.8	–	8/26/57	unknown	
18	2460	Punta	59	–	–	flowing	76/–	12/11/50	109	
19	14333	Sumanga	48	48	4	19.8	–	5/25/57	0	abandoned
20	2479	Valencia	28	–	–	7.6	–	6/8/51	120	
21	–	Mabini St.	43	–	–	–	–	9/8/52	unknown	
22	11474	Cabulihan	15	15	4 1/2	9.0	–	2/24/57	18	
23	5414	Libertad	65	65	4	1.5	76/2.1	4/14/52	0	no use
24	–	Naungan	77	27	4 1/2	+1.5	113/0.9	10/13/52	unknown	
25	5441	Liloan	71	71	6	flowing	8/–	5/14/52	12	
26	296046	Sitio Esperanza Catayum	51	32	4	21.3	26/24	1/31/61	19	
27	296231	Naungan	82	72	4	0.9	113/–	1/13/62	unknown	
28	–	San Vicente St.	41	–	6	1.5	95/–	8/20/52	unknown	
29	11477	San Antonio	10	–	4 1/2	–	–	–	unknown	
30	11475	Logon Lumbado	16	–	4 1/2	–	–	–	unknown	
31	39762	Lagbuhangin	12	–	4 1/2	1.5	19/0	4/2/76	0	no use
31'		Lagbuhangin	Shallow	–	3				42	
32	5730	Sabang Bao	30	–	4	4.3	113/–	12/20/51	107	3/22/77 flowing
33	13285	San Juan	7	7	4 1/2	1.2	57/–	8/18/56	unknown	
34	5355	Catayom	23	23	4	15.2	19/–	11/20/57	18	

LWUA Well No.	MPW No.	Location (Bario)	Well Depth (m)	Casing Depth (m)	ϕ (in)	SWL (m)	ℓ/min/ Draw down (m)	Comple- tion Date	Discharge m^3/d	Remarks
35	1	Ipil	106	106	6	flowing	834/–		1,200	
36	2	Ipil	106	106	6	flowing	500∼ 800/–		936	
37	2489	Lao	61	–	6			6/15/28	unknown	formerly flowing
38		Liloan	33	–	2	flowing	18/–	1959	55	
39		Liloan	48	–	2	flowing	30/–	1979	43	
39'		Liloan	60	–	4	flowing	96/–	1972	138	
40		Ormoc City	67	–	6	flowing		1977	216	not pumping flowing
41		Caneding	51	–	6	flowing	333/–	1928	480	
42		Burgas St.	60	–	6	flowing	60/–	1928	86	
43		Ormoc City	51	–	8	flowing	60/–	1928	86	
44	9442	Alegria	60	–	6			1928	0	flowing stop (3 years ago) abandoned
45		Punta	60	–	6	flowing	167/–	1928	240	
46	10186	Linao	54	–	6	flowing	9/–	8/2/56	13	
46'		Linao	Shallow	–	2	flowing	10/–		14	
47		Naungan	27	–	6	flowing	15/–	1928	22	
48		Naungan	138	–	4	flowing	500∼ 800/–	1968	936	
49		Punta	60	–	3	flowing	83/–	1975	120	
50									unknown	
51		San Jose	6	–	4	flowing		1961	5	1961 SWL 1.5 m
52		San Jose	13	–	1 1/2	flowing	30/–	1980	43	
53		Nasunugan	39	–	2	flowing	30/–	1980	43	
54	1	Ipil	41	–	12	6.0	470/12	1977	677	
55	2	Ipil	38	–	12	7.8	483/10.2	1977	695	
56	3	Ipil	16	–	12	8.3	1100/6.7	1977	1584	
57	4	Ipil	50	–	12	16.5	700/10.5	1977	1008	
58	5	Ipil	33	–	12	flowing	1166/2.2	1977	1679	not pumping flowing
59	6	Ipil	72	–	12	flowing	1000/1.2	1977	1440	not pumping flowing
60	296031	Valencia	36	–	4	6.1		1960	0	no use
61									unknown	
62	2465	Dayhagan	54	–	4	18.0		1928	0	abandoned
63									unknown	
64									unknown	
65		Ormoc City	111	–	6	flowing	4000/–	10/4/69	5760	
66	8011281	Valencia	9	–	5	4.0	17/0.6	12/29/81	24	

Totals 19,381 ≒ 20,000 m^3/d

Table 6-3 Existing Water Well Quality Summary

Simple Field Test Results

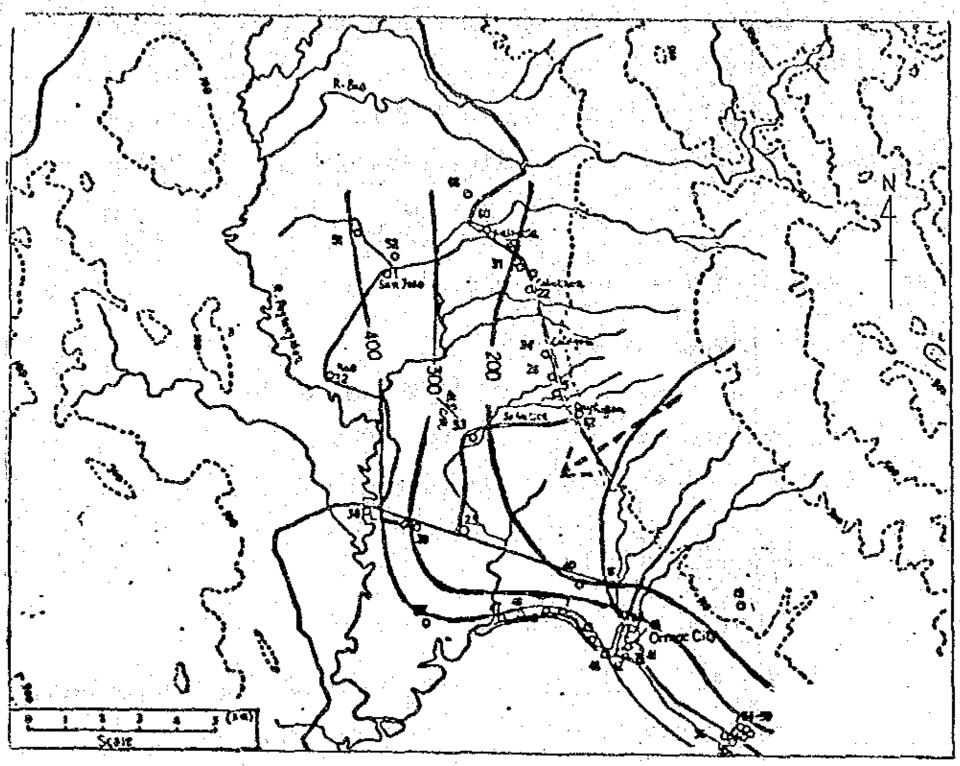
	Well no.	Location	Withdrawal	Depth m	Discharge ℓ/m	Temperature ℃	Conductivity μS/cm	PH	NH_4 ppm	Fe ppm	Cℓ ppm	Remarks
○	1	San Jose	Flowing	71	9	29.4	436	7.1	0.2	0.7	18	
○	5	Dayhagan	Pump	42		27.0	192	6.3	0.1	0.3	18	
○	7	Linao	Flowing	70	570	31.3	452	7.5	0.8	0.5	21	
	22	Cabulihan	Turbine	15			178					Tank Water 27.7c
	23	Libertad	Pump	65		27.7	677	>7.6	0.7	0.5	36	Suspended Well
	31'	Lagbuhangin	〃			27.4	137					
	32	Sabang Bao	Flowing	30	74	28.2	470	6.9	4.0	7.5	32	
	34	Catayom	Pump	23		27.6	153					
	35	Itil	Flowing	117	834	39.4	1,860					Sugar Company
	38	Liloan	〃	34	18	28.3	431	7.3	3.0	4.0	25	
○	39	Liloan	〃	49	30	27.6	306					
	39'	Liloan	〃		96	28.1	286	7.1	0.8	0.8	18	
	40	Ormoc City	Turbine	66			187					Tank Water 25.4c
	41	Caneding	Flowing	51	333	27.3	206					
	42	Burgas St.	〃	60	60	27.4	259					
	45	Punta	〃	60	167	29.4	429					
	46	Linao	〃	54	9	30.9	763					
	46'	Linao	〃		5	29.7	4,160				818	
	47	Naungan	〃	28	15	30.6	1,412	7.3		0.6	206	
	51	San Jose	〃	6	1	29.3	355	6.7		3.0		
	52	San Jose	〃	14	30	28.8	349					
○	53	Nasunugan	〃	39	30	27.1	236	6.9	0.1	0.1	18	
	59	Itil	Turbine	72		28.7	306					Biomass Factory
○	60	Valencia	Pump	37		27.2	270	5.8	0.2	>5	57	
	65	Ormoc City	Flowing	111	4,000	28.0	325					Suspended Well

Laboratory Test Results

Well No.	Location	PH	Turbidity	Total N	NH_4-N ppm	NO_3-N ppm	NO_2-N ppm	Fe ppm	Mn ppm	Ca ppm	Mg ppm	Na ppm	K ppm	SO_4^{2-} ppm	HCO_3^- ppm	Cl^- ppm	CO_3^{2-} ppm	CO_2 ppm	Remarks
1	San Jose	7.2	0	0.389	0.06	0.01	0.069	0.138	0.254	42	11	28.0	6.02	0.16	11	4.3	0	22	
5	Dayhagan	6.6	0	1.152	0.06	0.82	0.002	0.052	0.008	16	7.3	11.6	3.44	N.D	4.3	2.7	0	20	
7	Linao	7.5	0.5	0.842	0.50	0.04	0.002	0.052	0.017	34	14	31.6	7.70	0.63	10	3.3	0	17	
39'	Liloan	7.3	0	0.711	0.09	0.42	0.001	0.380	0.194	12	11	28.0	5.74	0.94	6.7	5.1	0	11	
53	Nasunugan	7.3	0	0.352	0.13	0.03	0.002	0.052	0.008	20	9.7	14.6	3.04	1.57	5.6	3.1	0	17	
60	Valencia	6.1	5	0.424	0.07	0.02	0.014	7.418	0.245	14	10	13.4	2.67	2.67	2.5	39	0	11	Suspended Well

Note: 0 - Laboratory Test was Performed on These Wells.

Fig. 6-6 Well Location & Analysis



(c) Water quality

(1) Simple field test

The values of p.H, NH_4^+, Fe^{2+}, $C\ell^-$ were measured roughly using a simple tester in the field. These results are shown in Table 6-3.

(2) Laboratory test

The typical six well sample collected was analyzed in a laboratory. These well locations and analysis results are located on the map above (Fig. 6-6) and Table 6-3 respectively.

From these studies using the Key-Diagram method, each of wells Numbers 1, 5, 7, and 53 can be expressed as a shallow aquifer type and only No. 39' well as a deep type. They are all considered to be part of the common groundwater category.

6-1-4 Existing Geo-electrical Survey Data Analysis

A geo-electrical survey of the Ormoc plain was recently performed by LWUA (surveyor is Water Resources Center of San Carlos University, Cebu). From this report we were able to study and evaluate the sediment conditions and aquifer capacity of the Ormoc groundwater basin.

(a) Geo-electrical Survey Outline

Total number of point : 151
Survey depth : AB/2 (100 - 250 m)
Survey interval : 500 - 800 m
Point locations are shown in Fig. 6-7.

(b) Results of Analysis

(1) Aquifer distribution

The following table was obtained from the existing well conductivity near the survey area.

(Expected aquifer resistivity table)

Location	Well No. (Conductivity)	Water Re-sistivity	Good Aquifer	Aquifer
	μS/cm	Ω-m	Ω-m	Ω-m
Dayhagan	No. 5 (192)	52	156 - 312	52 - 156
Nasunugan	No. 53 (236)	42	126 - 252	42 - 126
San Jose	No. 1 (436)	23	69 - 138	23 - 69
Liloan	No. 39 (306)	33	99 - 198	33 - 99

The above table is not conclusive because of lack of simple sediment condition. It is thought to be indicative of the site's aquifer resistivity. The survey classification results are also shown on Fig. 6-8.

Fig. 6-7 Geo-electrical Survey Location Map

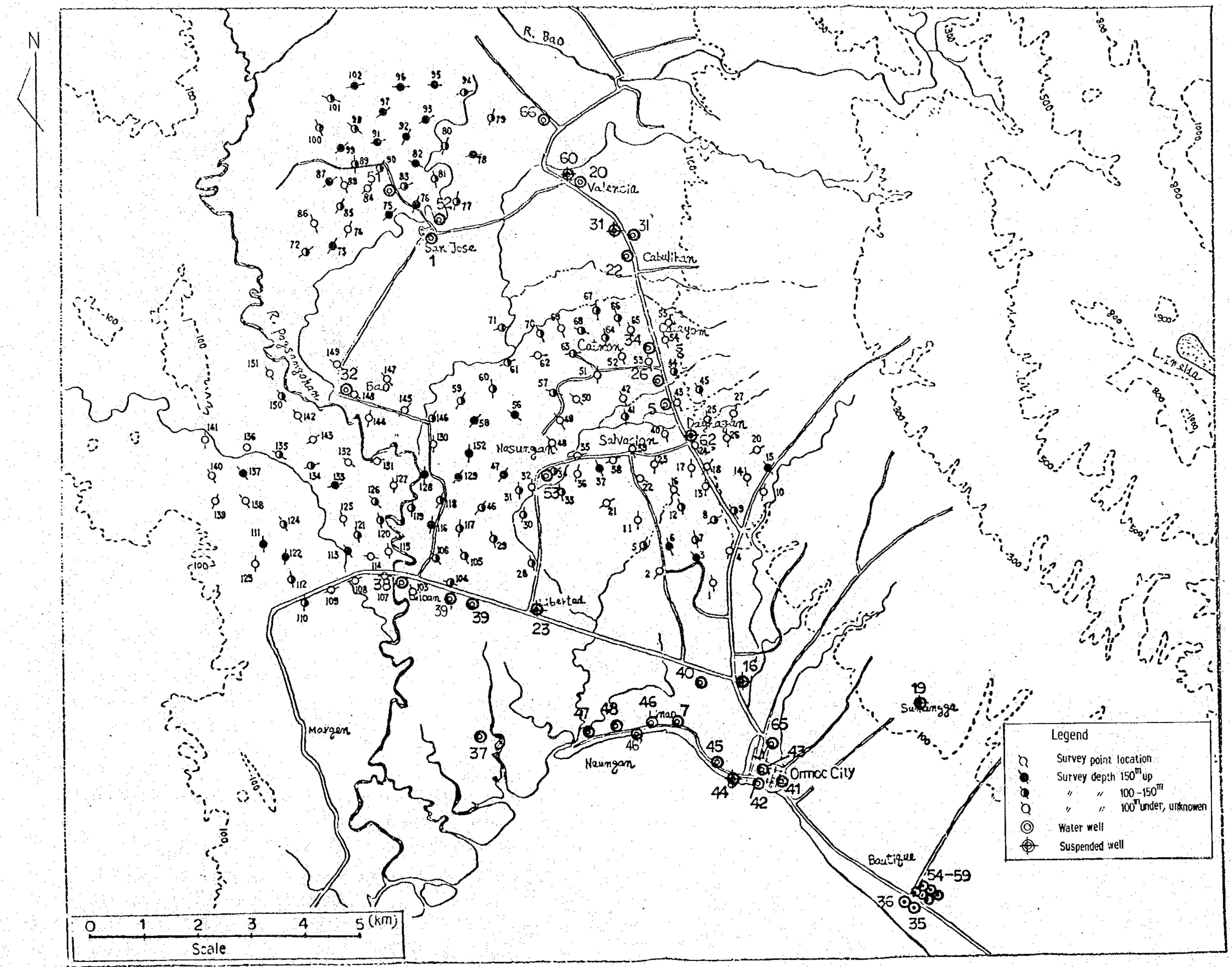
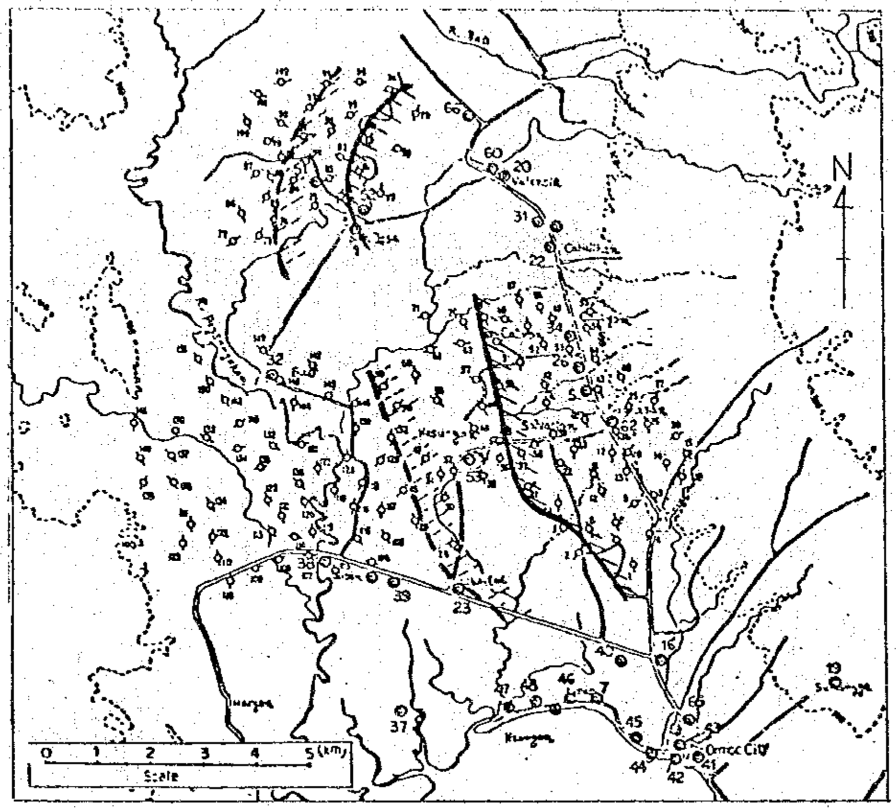


Fig. 6-8 Surving Classification Map



Legend:

Assumed good aquifer zone

Assumed possible aquifer zone

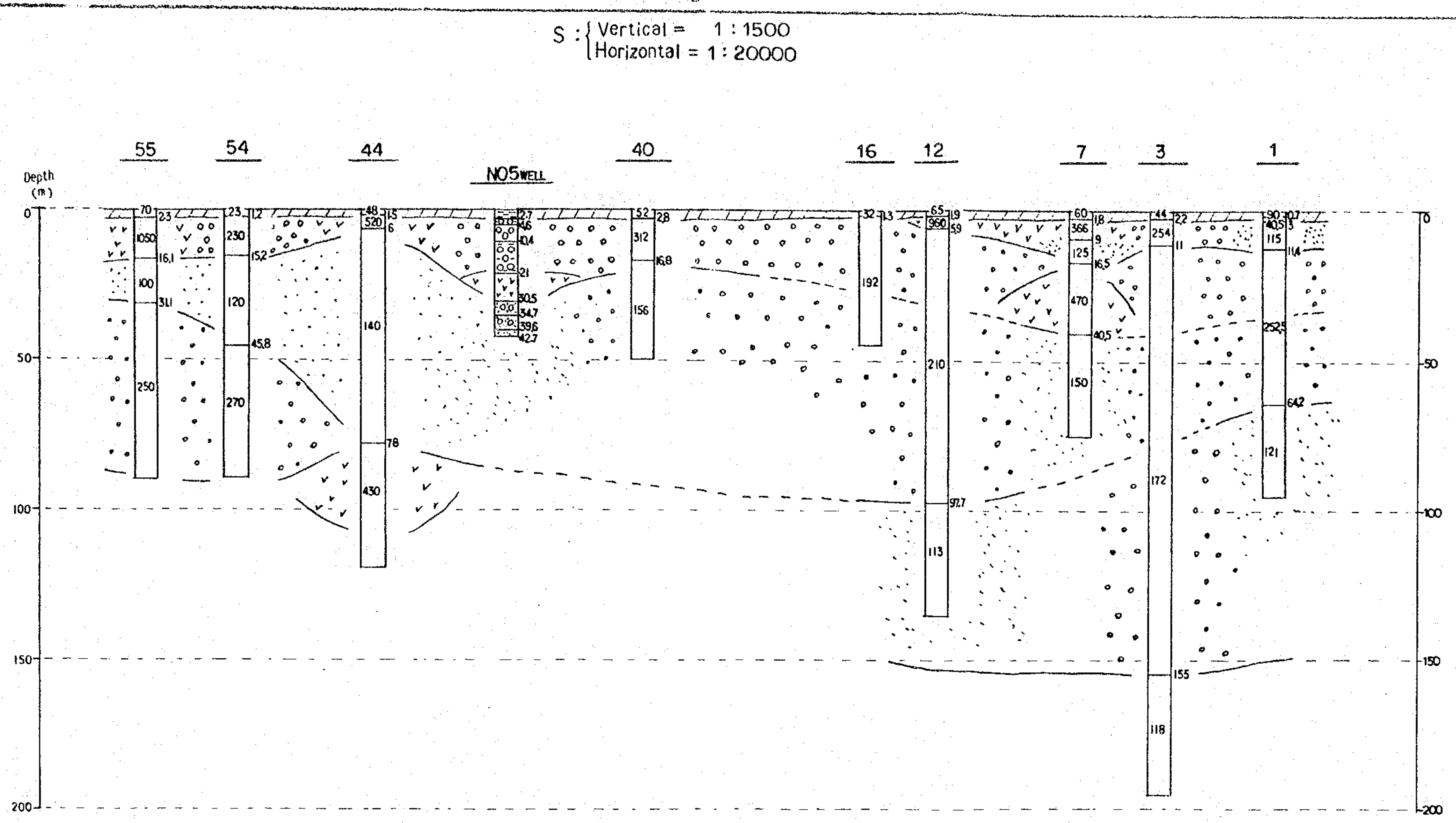
Good aquifer distribution is found widely in Dayhagan - Catayom area and partly in San Jose. The next possible aquifer is located in a belt along the same west side, however these have been replaced by clay rediment and cannot possibly be an aquifer.

(2) Aquifer thickness

The assumed resistivity cross section for a good resistivity area is shown in Fig. 6-9 and 6-10. Existing well logs nearby were evaluated for these correlations.

The Dayhagan area generally is dominated by conglomerate and its thickness amounts to 50 - 100 m. On the other hand, the San Jose area is worse because it is dominated by sand.

Fig. 6-9 Assumed Resistivity Sectional Diagram



Legend

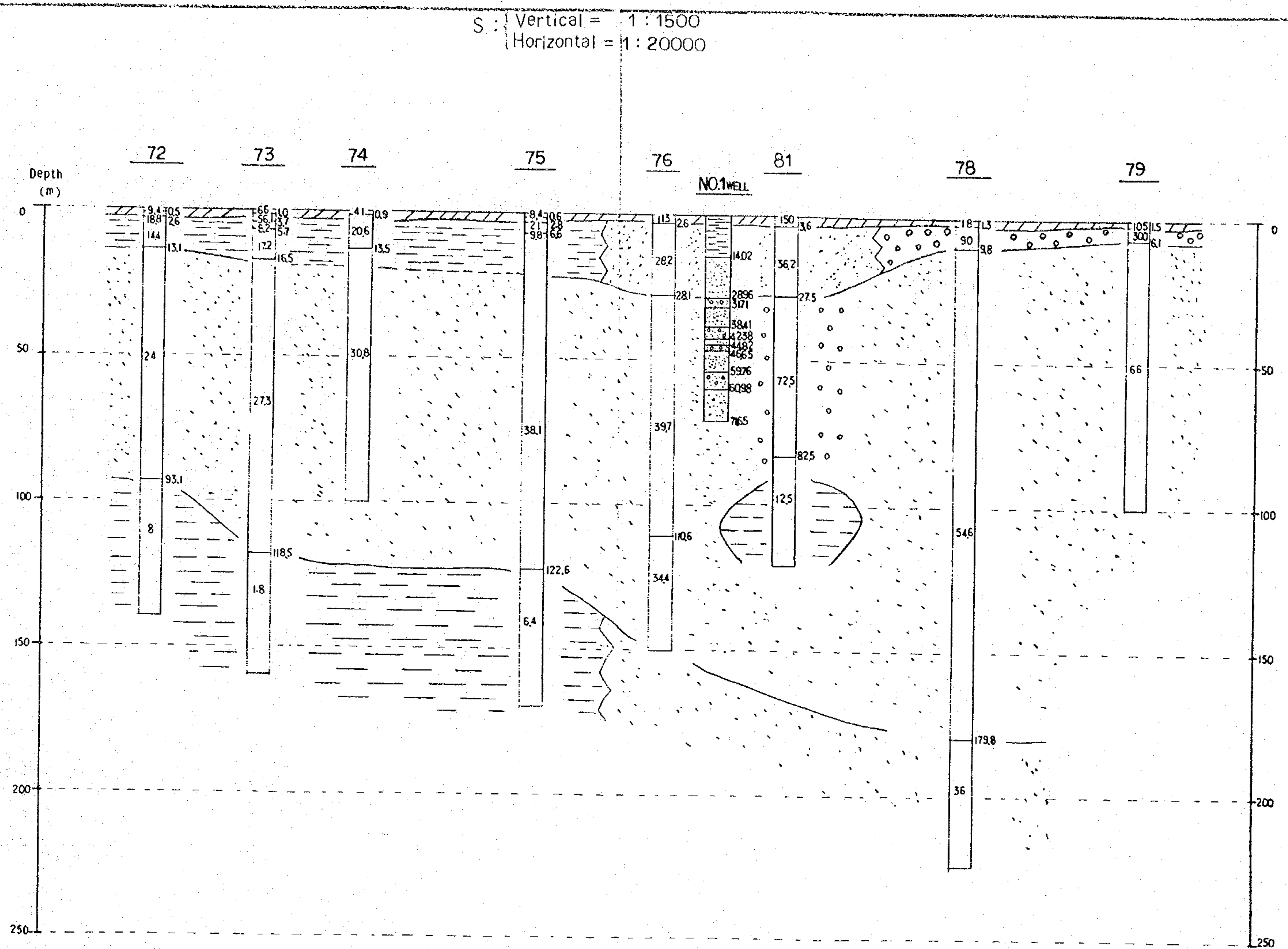
Surface soil

Conglomerate sediment (good aquifer)

Sandy sediment (aquifer)

Clayey sediment

Fig. 6-10 Assumed Resistivity Sectional Diagram



Legend

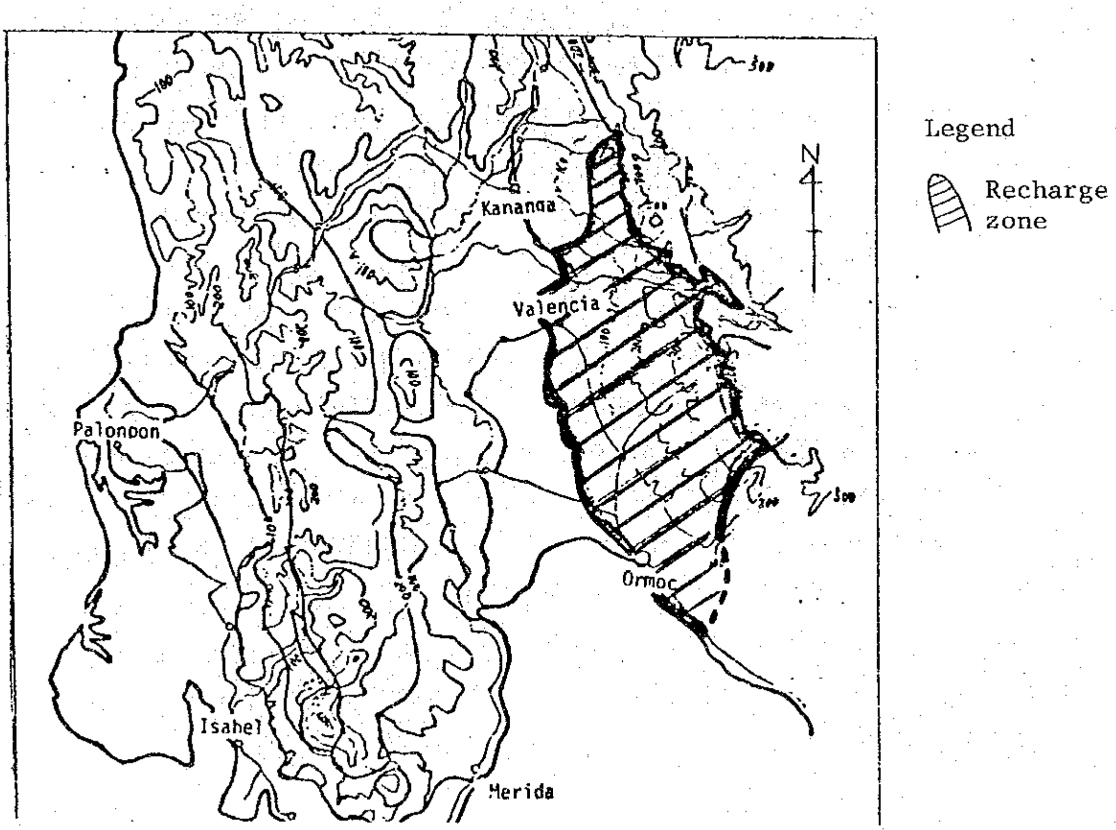
- Surface soil
- Conglomerate sediment (good aquifer)
- Sandy sediment (aquifer)
- Clayey sediment

6-1-5 Water Balance

(a) Recharge zone

The Ormoc groundwater basin is formed by new Q, and N_3S sediments developed in the east terrace from the alluvial plain. Q, however, will be excluded from the recent study objective because of its clayey sediment and small scale groundwater. Therefore the main aquifer included as a target is the under sediment N_3S. Its recharge zone is thought to be limited in the N_3S distributed area as shown on the following map amounting only to about 110 km^2.

Fig. 6-1 Recharge Zone



(b) Recharge volume

The results of the study of Baleon river drainage area was introduced to the heading calculation resulting in the following:

Baleon river drainage annual recharge volume

= assumed rainfall 3,339 mm/year - assumed evapotranspiration 1,153 mm/year - river discharge 1,743 mm/year

= 443

foregoing zone's recharge volume

$$= \frac{110 \text{ km}^2 \times 443 \text{ mm}}{365 \text{ days}} \times 0.8 = 107{,}000 \text{ m}^3/\text{day}$$

(c) Water balance

the recharge volume, abnormal water level drop--salt water invasion and ground subsidence--will not be generated.

The Ormoc basin's water balance can be summarized as follows:-

recharge volume : 107,000

discharge : 20,000 " (cf. Table 6-2)

therefore

water balance = recharge volume-discharge

= ⊕ 87,000 m3/day

The Ormoc study site's water balance indicated a surplus of 87,000 m^3/day, however, this result must be regarded only as a rough standard based on the calculations. This result is considered possible to meet the 38,300 m3/day water supply required from the PASAR project.

6-1-6 Conclusion

The Ormoc plain groundwater investigations were mainly performed for the purpose of collecting data. A great deal of assistance was received from LWUA, for the field survey, and the analytical study. The conclusions are as follows:

- The largest alluvial plain on the westside of Leyte Island has developed in around Ormoc City, and its drainage area is about 55 km long and 45 km wide. The rainfall at the study site is estimated to be 2,200 mm/year.

  The local geology, consists of older Tertiary Miocene formation which is the basement rock around the study site, and is distributed over the west highland and part of the east mountain area. As the formation descends to the plain area, these formations are altered to a younger age sediment from Tertiary, Pliocene to Quaternary, and tend to be more permeable and are considered good aquifers in the unconsolided sediment. Consequently the Ormoc plain was considered to possibly form a groundwater basin.

- There are a total of 69 existing water wells in the Ormoc plain. Shallow wells of about 50 m depth (only 4 wells of more than 100 m) and small holes less than 6" are generally numerous due to their domestic use. Many wells situated on the lower ground are almost flowing and 5 wells among them yield more than 500 ℓ/min. Extensive conglomerate is found in some of the geological logs, providing a possibility for an aquifer in the Ormoc plain.

- The water quality results from simple field tests and laboratory analysis indicated that the conductivity is 200 - 400 μs/cm, temperature 27 - 29°C, PH about 7, NH_4^+ 0.1 - 4.0 ppm, Fe^{2+} 0.1 - 7.5 ppm, and $C\ell^-$ about 10 ppm which conforms to PNSDW (Philippine National Standard Drinking Water) except for Fe^{2+} in westside plain and $C\ell^-$ of one shallow well along the coast line. Generally, the east terrace area has good quality water and the southwest plain bad.

- According to an analysis of the extensive geo-electrical survey report of the Ormoc plain recently performanced by LWUA, conglomerate superior sediment (good aquifer) is assumed to develop in the east terrace area, but may be altered to clayey sediment (aquiclude) as it descends to the west plain area. Since this survey is thought to be only approximate because of the long point interval, a detailed survey will be necessary doing the future development stage.

- Since ground water originates only from the recharge of rainfall, the public pollution (ground subsidence and salt water intrusion etc.) will be not generated if discharge is kept within the recharge volume.

  The water balance calculation results for the Ormoc groundwater basin indicated a surplus of 87,000 m^3/day, consequently, it is assumed that it will be possible to meet the water supply demand of 38,300 m^3/day required by the PASAR project.

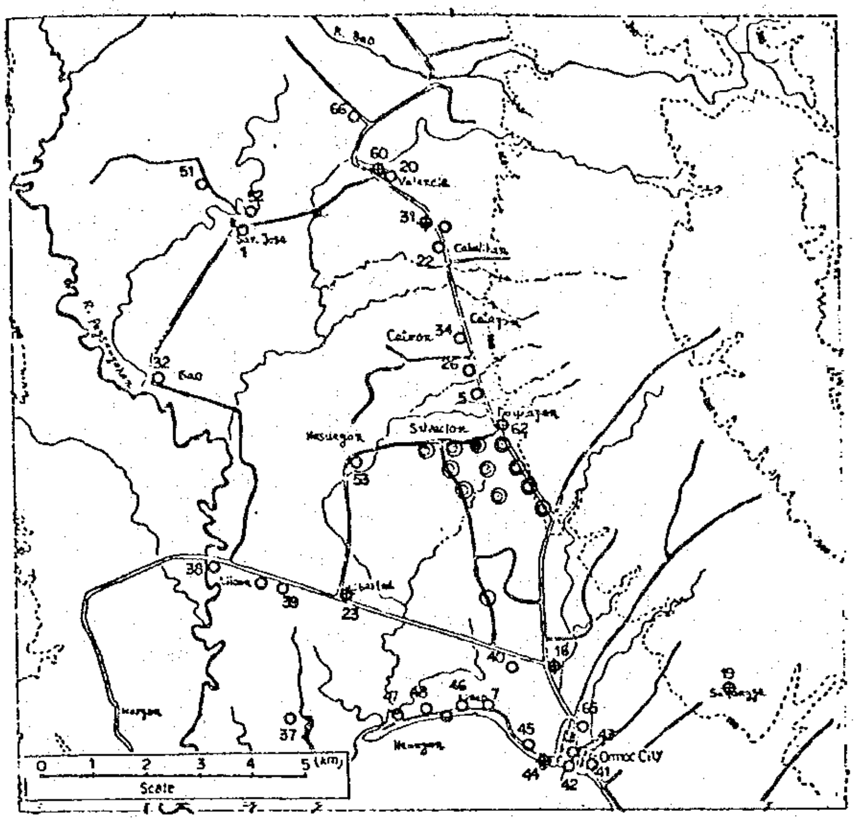
- The Ormoc plain is considered to have good groundwater potential based on the recent investigation, however, eventually one exploration well (200 m depth) must be drilled in the Dayhagan area, and the aquifer tested for well discharge capacity and water quality. This test well can be subsequently shifted to become a production well.

- The present deep well development plan for the water supply is expected to require drilling of a total of 11 production wells (included one spare well) and one observation well. At that time, well spacing and a distance from existing water wells must be carefully considered and evaluated and observation wells must also be drilled and monitored considering the relationship with the climate.

- The Ormoc ground water development is planned as follows : An exploration well will be drilled near the proposed well site's center, with well spacing more than 500 m. while distance between the existing well should be more than 1,000 m. An observation well will be located a minimum 2,000 m. from the proposed well. These well locations are shown on Fig. 6-12.

For the deep well drilling, percussion method is thought to be suitable because of numerous boulders in the sedimentary deposit. More strainers will also have to be considered.

Fig. 6-12 Deep Well Location



Legend

⊙ Exploration well

◎ Proposed deep well

○ Observation well

NOTE:

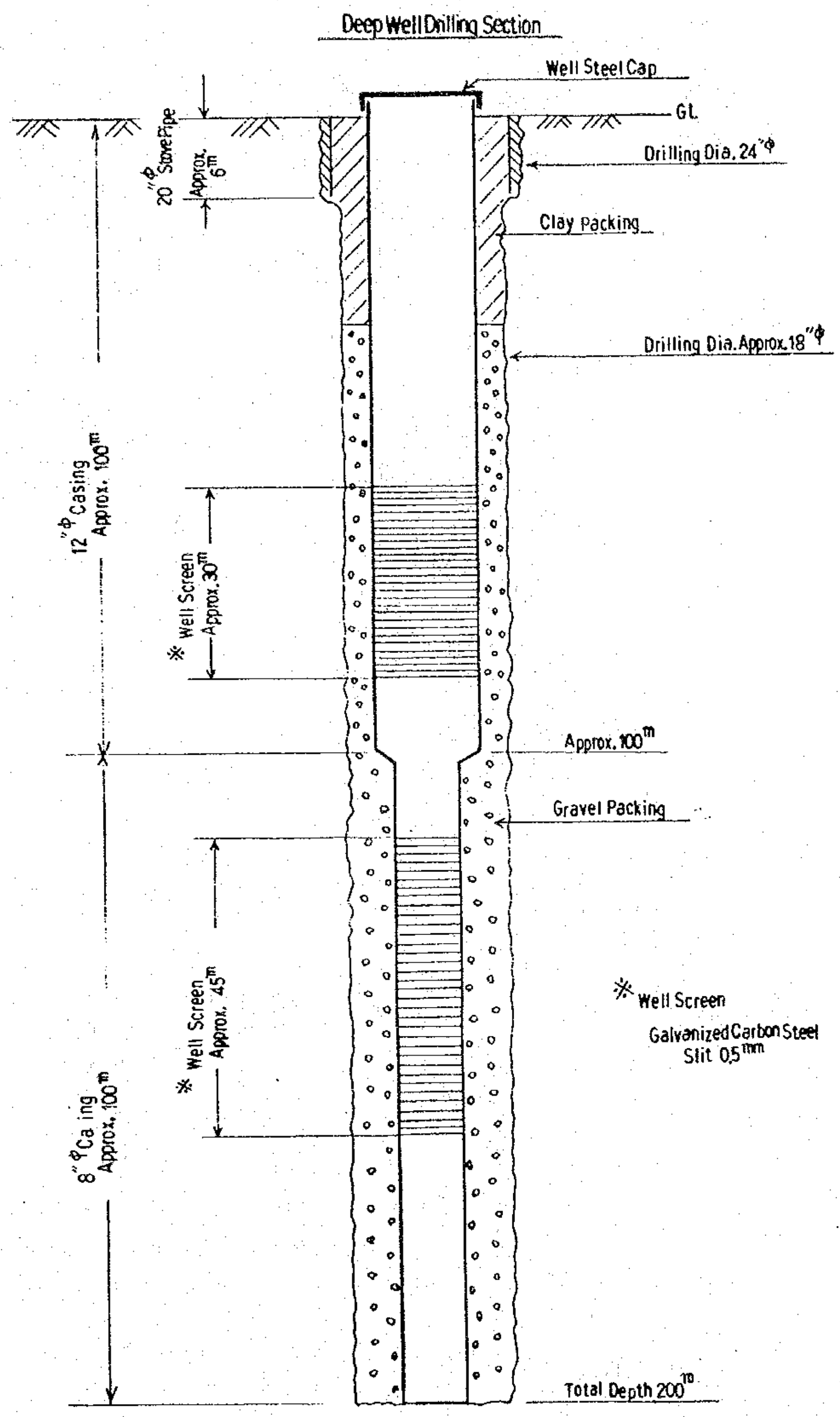
1) Deep well drilling scheme (cf. Fig. 6-13)

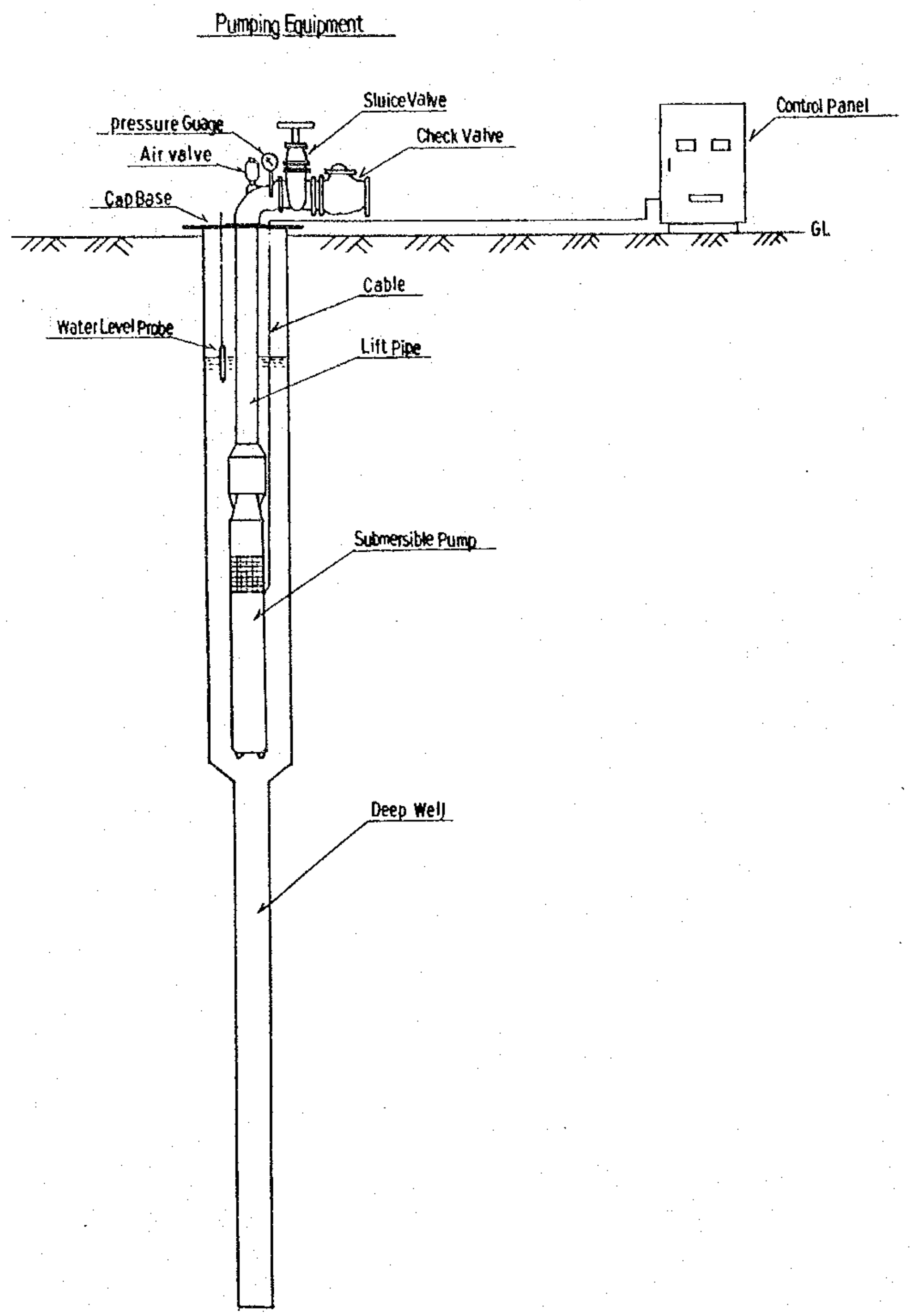
Depth	200^{m}
Drilling size	about 18"
Casing size	12"
Strainer length	about 75^{m} (galvanized carbon steel)
Completion method	gravel packing
Pumping method	submersible pump

2) Observation well plan

Depth	200^{m}
Casing size	8"

Fig. 6-13 Deep Well Scheme Diagram





6–2 Surface Water Development

6-2-1 Selection of Surface Water Source

Supply of domestic water and industrial water for the Leyte Industrial Estate could be provided by the following rivers in the area:

(1) Manay and Quiot Rivers located in wester Leyte

(2) Dupon River which flows near Isabel

(3) Pagsangahan River and Bao Rivers which both flow into Ormoc Bay.

In general, the factors affecting the choice of water sources in relation to the water districts are as follows: Location of water sources, and more importantly, quality and volume of water. Chapter 5 discussed the amount of water supply required by the year 2005 (38,240 cum/day). Needless to say, the chosen water source should have this capacity. As a result of the investigations made, Manay, Quiot and Dupon Rivers were found to be insufficient while Bao and Pagsangahan Rivers have the potential capacity to supply the required amount of water (refer to 6-2-2 below). Hence water quality tests were conducted for Pagsangahan and Bao Rivers. (Refer to 6-2-3)

6-2-2 Water Volume of Pagsangahan River

The formula used for the volume of water and the results are shown below:

$$Q = A \times V = \underset{\text{(survey)}}{32.6\ m^2} \times \underset{\text{(survey)}}{0.075\ m/sec.}$$

$$= 2.4^3 m\ /sec.$$

$$= 207,360\ m^3/day$$

The above volume can readily supply the required amount of approximately 38,500 cu.m/day (planned amount of supply = 38,240 cu.m/day) without affecting the downstream flow of the river. Even after the required supply is subtracted, 169,000 cu.m/day of water still remains.

6-2-3 Water Quality

(a) Water Quality

Figure 6-14 shows the spots where water sampling was conducted, the results of which are shown in Table 6-4.

(b) Location of Water Sources

Water quality tests detected the presence of arsenic in location (4). This could be attributed to the waste water released by the geothermal power plant located in the upstream area of the Bao River.

The Ministry of Health standards allow up to 0.05 p.p.m., but the tests showed an arsenic concentration of 0.085, an amount above the permissible amount thereby making the water unfit for drinking. Arsenic was not found in locations (1), (2) and (3) but since location (1) and (2) are of the same characteristics as location (4), there is a strong possibility that these waters will also be contaminated with arsenic since the capacity of the geothermal power plant is planned to increase ten-fold. Naturally, the amount of waste water will also increase. In view of this, location (3) remains the only alternative water source. An evaluation of location (3)'s, water quality and the appropriate type of water treatment required to convert the water into potable drinking water is discussed in the following section.

(c) Evaluation of Water Quality and Water Treatment System

The tests indicate that the color, turbidity and lead content of the water exceeded MOH Standards. The presence of ammonium nigrogen and nitrous acid were also detected. This was attributed to waste excreted by livestock raised by the farmers around the upstream area of Pagsangahan River. However, the amount is minimal and could be treated by chlorination, thereby removing the necessity of installing water treatment facilities. Nevertheless, in order to eliminate the color, turbidity and lead content found (color 12 degrees; turbidity 9 degrees; lead content 0.1 p.p.m.), slow sand filtration would be most effective. However, it should be noted that

Fig. 6-14 Location of Water Sampling Surface Water

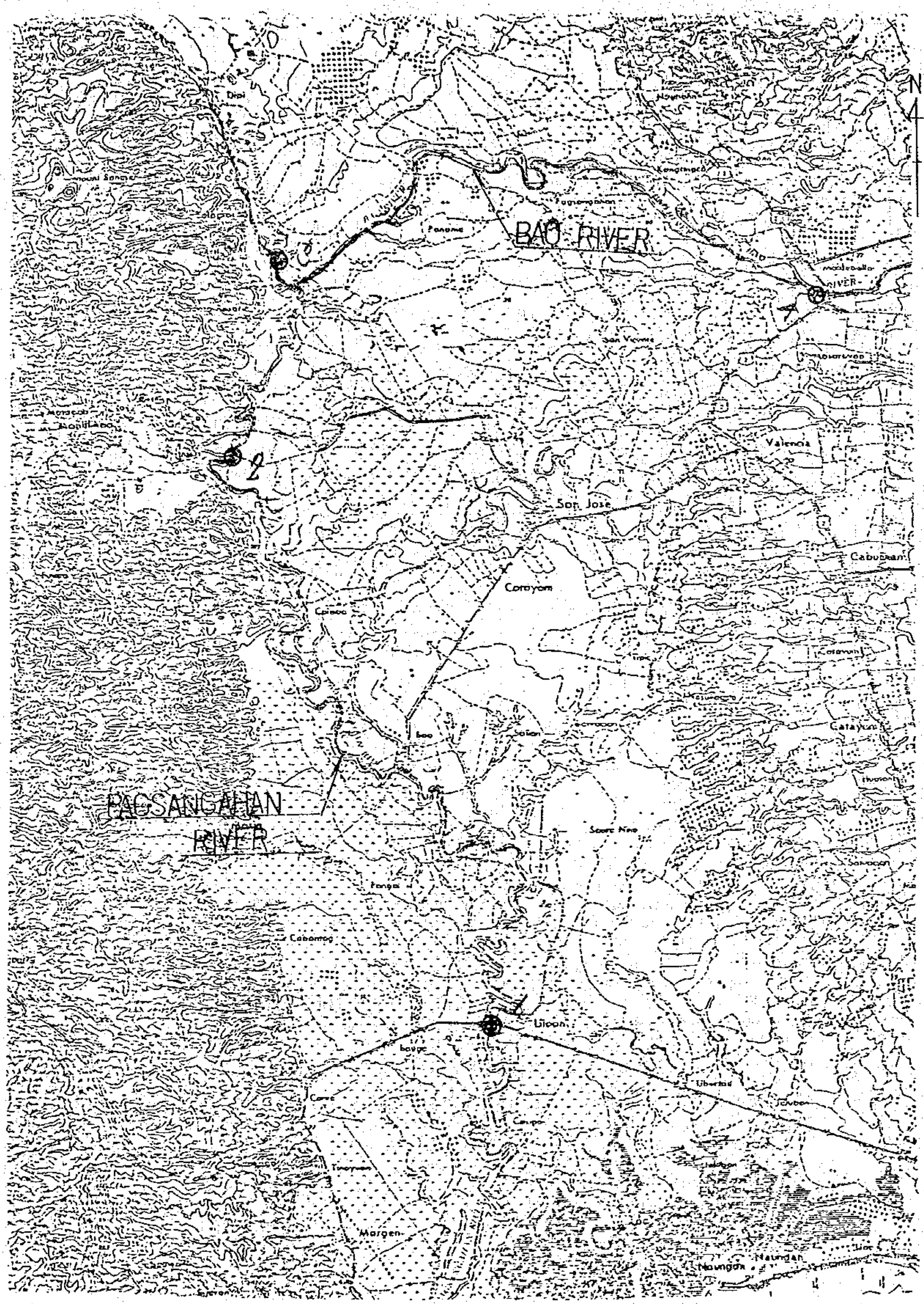


Table 6-4 Analysis of Water Quality Tests

Elements Tested		Test Location No.				MOH	WHO
No.	Item	①	②	③	④		
0	Color	2	2	12	27	5	–
1	Odor	non	non	non	non	non	–
2	Turbidity, FTU	2	1.5	9	11	5	–
3	pH	7.2	7.2	7.6	7.2	6.5∿8.5	6.5∿8.5
4	Alkalinits as $CaCO_3$	46	36	111	24	–	–
5	Free Carbon Dioxide, mg/ℓ CO_2	7	7	10	11	–	–
6	Total Solid, mg/ℓ	208	165	256	511	500	500
7	Total Hardness, mg/ℓ $CaCO_3$	81	57	102	108	–	–
7^1	Total N	0.467	0.364	0.687	0.365	–	–
8	NH–N, mg/ℓ	0.08	0.05	0.05	0.04	–	–
9	NO_3–N, mg/ℓ	0.04	0.01	0.26	0.00	–	–
10	NO_2–N, mg/ℓ	0.037	0.024	0.017	0.005	–	–
11	O–Phosphate, mg/ℓ P	0.022	0.023	0.030	0.037	–	–
12	Coliform Bacteria, No/mℓ	43	93	4	4	10/100 mℓ	10,000/100 mℓ
13	Fe, mg/ℓ	1.10	1.12	0.29	0.64	1.0	0.3
14	Mn, mg/ℓ	0.05	0.14	0.02	0.07	0.5	0.1
15	Cl^-, mg/ℓ	71	45	14	174	–	–
16	As, mg/ℓ	N.D.	N.D.	N.D.	0.085	0.05	0.2
17	Pb, mg/ℓ	N.D.	N.D.	0.10	N.D.	0.05	0.1
18	$KMnO_4$ mg/ℓ (Potassium Permanganate Expenditures)	5.6	5.3	7.8	7.3	–	–
19	Zn, mg/ℓ	0.012	N.D.	N.D.	0.012	5.0	–
20	Cu, mg/ℓ	0.002	0.002	0.005	0.004	1.0	–

Note: Tests and analysis performed by Kitazato University, Environmental Science Research Institute and PCI Laboratory the quality of surface water changes throughout the year, especially during floods which cause turbidity and an increase of bacteria in the water. Since the tests were conducted during a short period, it may be necessary to conduct additional tests. It is doubtful that slow sand filtration is the most appropriate purification method that could be adopted for the whole year.

(d) Conveyance System:

Topographically, the area between the intake spot and Liloan is flat. Hence, the treated water is to be transmitted by transmission pumps through pipes running underneath the existing rural roads along the Pagsangahan River. (ϕ700mm diameter pipes shall be used).

6-3 Choice of Water Sources

The quality and volume of water are important factors in the choice of water sources, whether it be surface water or ground water. According to LWUA's investigation, groundwater is plentiful in the plain of Ormoc and the tests proved the water to be of good quality. On the other hand, surface water, although plentiful even in times of drought, has poor quality.

The recent study recommended the use of the show sand filtration method for treatment, but considering the year round changes in water quality, rapid sand filtration may be necessary to produce an adequate amount of good quality water. The operation of this system requires high technology and the use of chemicals (sulfuric acid, PAC) which automatically increase operating costs.

To assess this situation, the following criteria were considered:

(a) Low cost of construction

(b) Simpler management

(c) Adequate supply of water

Based on these criteria, this study recommends the utilization of groundwater as the water source.

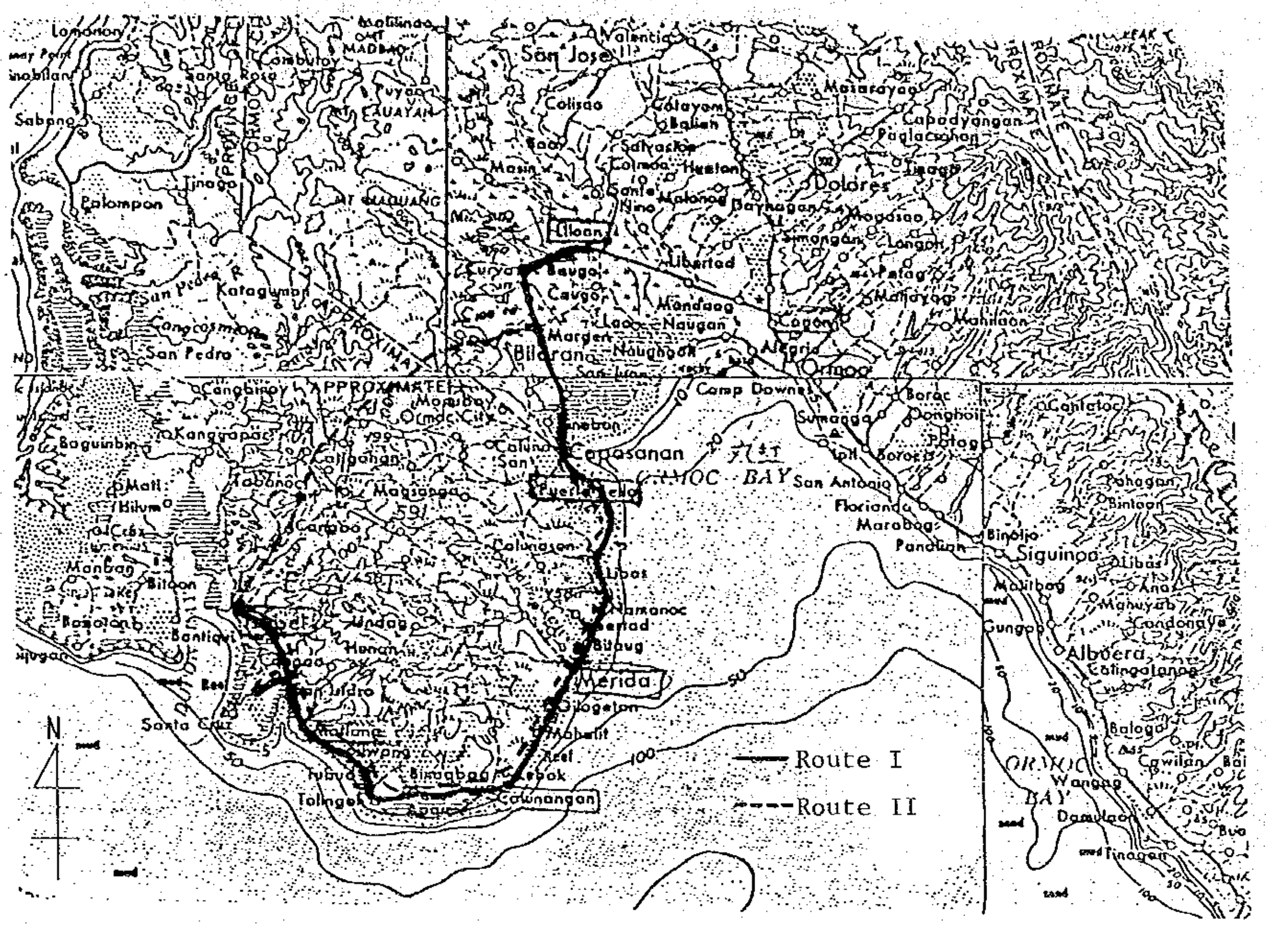
CHAPTER 7 EXAMINATION OF TRANSMISSION ROUTES

Chapter 7 EXAMINATION OF TRANSMISSION ROUTES

7–1 Comparison of Two Alternative Routes

The two selected alternative routes are shown in the map below.

Figure 7-1



Route I starts from Liloan, passes through the barangays of Cabaliwan, Merida and Matlang and ends up in PASAR. This route goes underneath the national road along the coastline where the majority of the population is concentrated, allowing water to be distributed to the residents on the way to PASAR.

Route II passes through the mountains, goes through PASAR and then distributes water to the local residents. Since PASAR accounts for 70% of the total water demand, this route has the advantage of supplying water directly the PASAR over the shortest distance possible. Afterwards, water shall then be distributed to the Barangays of Matlang, Merida and Cabaliwan through smaller pipes.

The specifications for both Route I and Route II are shown in the next pages.

Route I Facilities

Main Facilities For Route I

1. Transmission Pump (60 Hz)
   $Q = 26.56\ m^3/min$ $H = 67\ m$
   Double Suction Volute Pump 4 (one standby) 160 kw

2. Booster Pump (60 Hz)
   $Q = 24.08\ m^3/min$
   Double Suction Volute Pump 4 (one standby) 160 kw

Transmission Main

Liloan → Cabaliwan
ϕ 700 L = 5000 m

Cabaliwan → Puerto Bello
ϕ 700 L = 5000 m

Puerto Bello → Merida
ϕ 700 L = 9000 m

Merida → Calunangan
ϕ 700 L = 6400 m

Calunangan → Matlang
ϕ 700 L = 7500 m

Matlang → Libertad
ϕ 700 L = 2200 m

Libertad → PASAR's Reservoir
ϕ 600 L = 800 m

Libertad → Isabel
ϕ 300 L = 2900 m

Main Facilities For Route II

1. Transmission Pump
   $Q = 26.56\ m^3/min$ $H = 90\ m$
   Double suction volute pump 4 (one standby) 220 kw

2. No.1 Booster Pump (60 Hz)

$Q = 26.56\ m^3/min$ H = 80 m

Double Suction Volute Pump 4 (1 standby) 190 kw

3. No.2 Booster Pump (60 Hz)

$Q = 26.56\ m^3/min$ H = 80 m

Double Suction Volute Pump 4 (1 standy) 190 kw

4. No.3 Booster Pump (60 Hz)

$Q = 2.47\ m^3/min$ H = 30 m

Single Suction Volute Pump 3 (1 standby) 22 kw

5. No.4 Booster Pump (60 Hz)

$Q = 0.22\ m^3/min$ H = 40 m

Single Suction Volute Pump 2 (1 standby) 3.7 kw

Liloan ⟶ No.1 Booster Pump

ϕ 700 L = 6200 m

No.1 Booster Pump ⟶ No.2 Booster Pump

ϕ 700 L = 900 m

No.2 Booster Pump ⟶ Junction Well (1)

ϕ 700 L = 900 m

Junction Well (1) ⟶ Junction Well (2)

ϕ 600 L = 6,300 m

Junction Well (2) ⟶ Junction Well (4)

ϕ 500 L = 5,400 m

Junction Well (4) ⟶ Isabel

ϕ 600 L = 5,300 m

Isabel ⟶ PASAR

ϕ 500 L = 3,700 m

Libertad ⟶ Matlang

ϕ 350 L = 2,200 m

Matlang ⟶ No.4 Booster Pump (Calunangan)

ϕ 350 L = 12,900 m

No.3 Booster Pump ⟶ Merida

ϕ 300 L = 6200 m

Merida ⟶ No.4 Booster Pump (Puerto Bello)

ϕ 200 L = 9,000 m

No.4 Booster Pump ⟶ Cabaliwan

ϕ 100 L ≒ 5,080 m

Fig -7·2 Longitudinal Section for Transmission Main (Alternative Scheme "Route I")

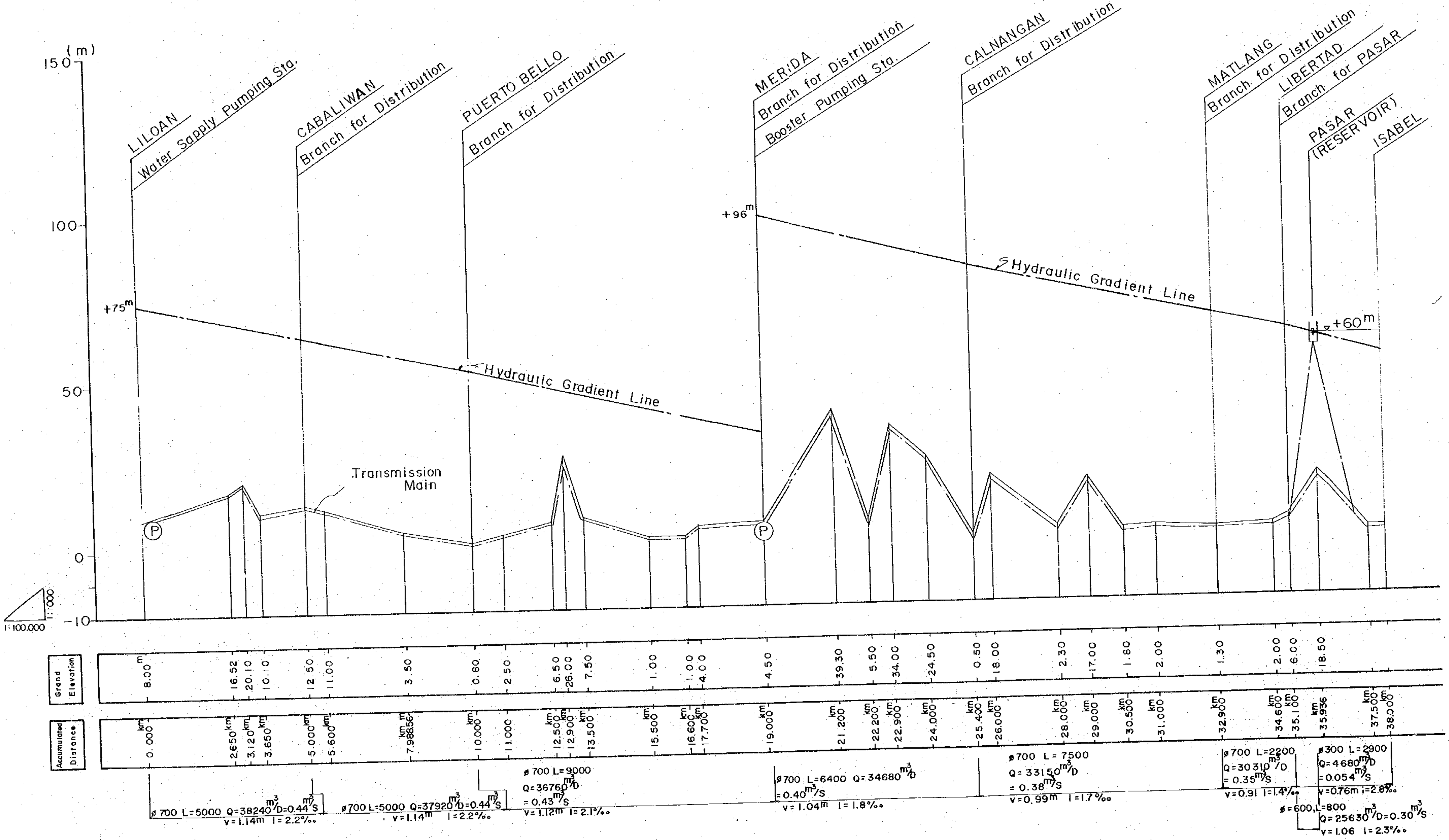


Fig-7·3 Longitudinal Secton for Transmision Main (Alternative Scheme 'Route II')

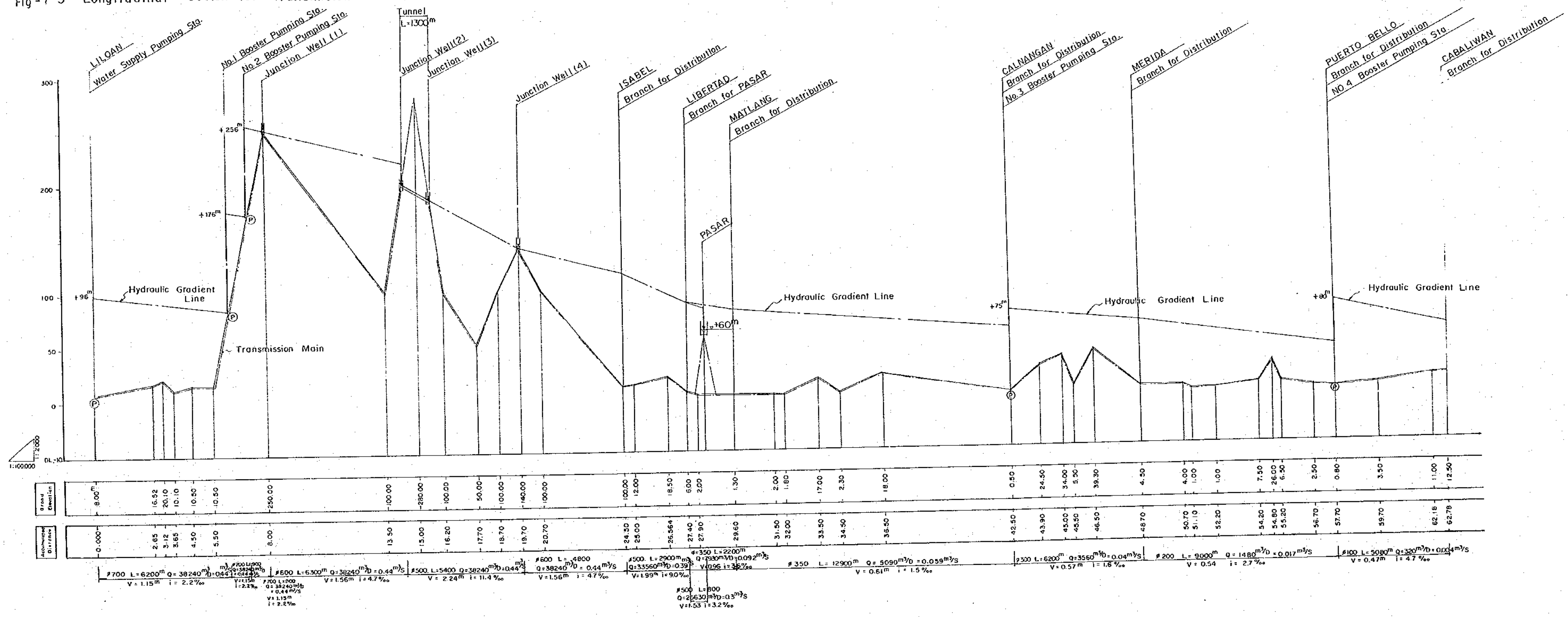


Table 7-1 Construction Costs

(Unit: thousand pesos)

	Item / Route	Route I	Route II
Cost of Main Transmission Facilities	Transmission Pump	10,100	10,100
	No.1 Booster Pump	9,000	9,000
	No.2 Booster Pump	———	9,000
	No.3 Booster Pump	———	500
	No.4 Booster Pump	———	300
	Junction Well	———	200
Cost of Mains and Transmission Pipes	ϕ 700	L = 35100 m 66,690	L = 8000 m 15,200
	ϕ 600	L = 800 m 1,280	L = 11,100 m 17,760
	ϕ 500	———	L = 9,100 m 10,920
	ϕ 350	———	L = 15,100 m 12,700
	ϕ 300	L = 2900 m 2,030	L = 6,200 m 4,340
	ϕ 200	———	L = 9,000 m 3,180
	ϕ 100	———	L = 5,080 m 665
	Additional Costs (Tunnels, etc.)	———	L = 1,300 m 20,000
	Sub-Total	89,100	113,865
Others	Cost of New Roads	———	L = 20,000 25,000
	Cost of Cable Lines	———	5,000
Total		89,100	143,865
Cost of Land Acquisition		100	1,020
Grand Total		89,200	144,885

7–2 Selection of the Transmission Route

Judging from the different criteria involved in the selection of an appropriate transmission route, Route I is considered to be best suited for this project. First of all, the construction costs of the main facilities show that Route I is more economical. Secondly, more people would be served along this route since the majority of the population is concentrated along the coast, and furthermore, this area is expected to increase upon the completion of the LIE oroject. Thirdly, the construction of service and access roads and the purchase of land for pipe-laying purposes on Route II could create a lot of problems. Whereas in the case of Route I, pipe-laying underneath the national roads could be easily accomplished.

CHAPTER 8 PROPOSED FACILITIES AND CONSTRUCTION SCHEDULE

Chapter 8 PROPOSED FACILITIES AND CONSTRUCTION SCHEDULE

8–1 Proposed Facilities

Normally, the planning of water supply facilities is designed to suit the water demand and water supply for each year of the design period. In addition, these facilities are constructed in several stages based on the growth process in the area. However, a different approach is recommended for this project. As previously discussed (Chapter 5 Water Demand), nearly 60% of the total water demand is to be supplied during the first year of operation. Three years later (1987), this would have to increase to 70% and five years later (1989) it is expected to reach 85% of total water demand. Thus, it can be deduced that it would be necessary to complete the construction of all facilities within a short period. Since the planning of this project is based on supplying the increasing needs of the communities and PASAR and other industries (PHILPHOS, Wharf and Light Industries), two alternative schemes are described below.

Scheme 1 All the facilities are to be completed by the first year of operation.

Scheme 2 Construct the facilities in two stages based on the expansion program of PASAR and other industries.
(The first stage construction would be designed to supply 32,680 cu.m./day which is the sum of the required water supply by 1987 (26,250 cu.m./day) and the additional water supply required by the communities from 1988 to 2005 (6,430 cu.m./day). The facilities suited to supply the remaining water requireements (5,560 cu.m./day) would be constructed in the second stage).

Table 8-1 Comparison of Scheme 1 & Scheme 2 and Problems

Item / Scheme	Size of Facilities	Problems
Scheme 1	Intake Facilities - Deep Wells - 11 (ϕ - 300 mm.) (Depth - 200 m.) Junction Wells - 2 Conveyance Facilities - Aqueducts ϕ 600 mm. ϕ 350 mm. Transmission Facilities - Transmission Main ϕ 700 mm. ϕ 300 mm. Transmission Pumping Station Booster Pumping Station	Compared with Scheme 2, construction costs are cheaper, but if PASAR and the other Industries do not expand as projected, it will turn out to be uneconomical since facilities of this scale will not be required.
Scheme 2	Intake Facilities - Same as above Conveyance Facilities - Same as above Transmission Facilities - Transmission main to be constructed separately ϕ 600 mm. main during the first stage and ϕ 350 mm. main during the second stage. - Transmission Pumping Station - Booster Pumping Station both similar to Scheme 1	Although the total cost of construction for first and second stage is higher compared to Scheme 1, one is assured that all facilities constructed will be used to maximum capacity

The planned facilities for both alternatives are further described in detail in the next sections.

8-1-1 Deep Wells

According to the results of ground water investigation, the exact number of wells needed to satisfy the water supply requirements during the entire design period (by 2005, 38,240 cu.m./day) shall be drilled in Salvacion and Malunad. At present, each well is capable of pumping up 4,000 cum. of water per day. Thus, eleven wells need to be drilled (including one stand-by well).

The specifications are listed below (see also Table 8-2) and illustrated in Figure 8-1 (a and b).

Depth	200 m.
Casing	300 mm.
Strainer	75 m. screen
Finishing	Gravel packing
Pumping - Up System	Submersible pump

Fig. 8-1 (a) Plan of Pump House

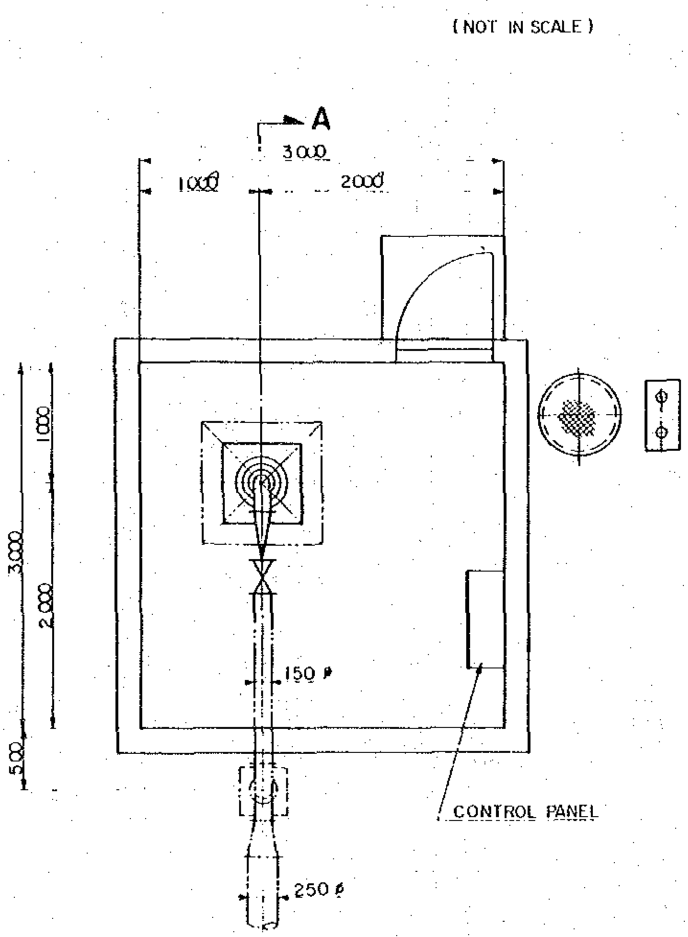


Fig. 8-1 (b) Cross Section of A - A

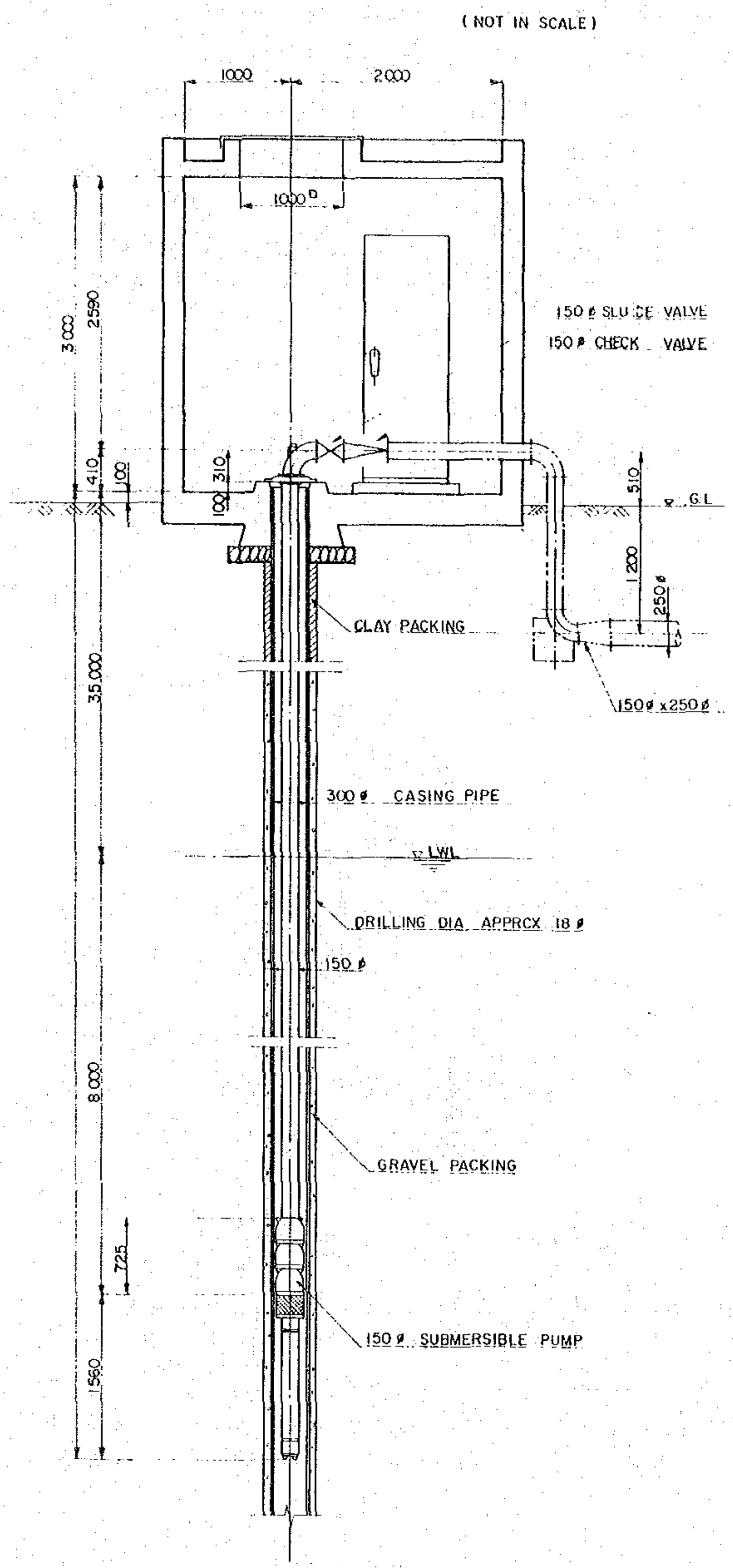


Table 8-2 Intake Pump Specifications

Item	Specifications		
	Scheme 1	Phase I	Phase II
Type of Pump		Same as Scheme I	Same as Scheme II
No. of Units	10	8	2
No. of Standby Pumps	1	1	0
Diameter (mm.)	150	Same as Scheme I	Same as Scheme I
Total Head (m.)	48 m	"	"
Minimum Head (m^3/min)	2.70	"	"
Revolution per Minute (r.p.m.)	3,600	"	"
Motor Output (KW)	45	"	"
(V) Voltage Frequency x (P) No. of Poles	380x60x2	"	"
Length of Lift Tube (m)	45	"	"
Length of Submersible cable (m)	55	"	"
Diameter of Wells (mm)	300	"	"

8-1-2 <u>Conveyance Method for Ground Water</u>

Water from the wells is pumped into Liloan where the transmission pumping station is planned to be located. Raw water is centrally collected by a junction well channelled through an aqueduct. Topographically, this area is about 40 m. higher than Liloan; therefore the water could be transmitted by gravity flow using ϕ 600 mm. pipes.

Two junction wells are to be built because the wells are situated far apart from one another.

8-1-3 Operation and Control of Submersible Pumps

Each unit of the submersible pump is automatically controlled by the rise and fall of the level of junction well water. An abnormal drop in the water level of the deep wells automatically brings the submersible pump to a stop. The submersible pumps are centrally controlled from the substation and control room located near the junction wells.

8-1-4 Substation and Control Room

Two substations and control rooms are to be established on the well site for sending and receiving electricity to each well. These stations consist of a transformer room, a control room, a generator room, a fuel oil tank room, etc.

The substation shall have the following facilities:

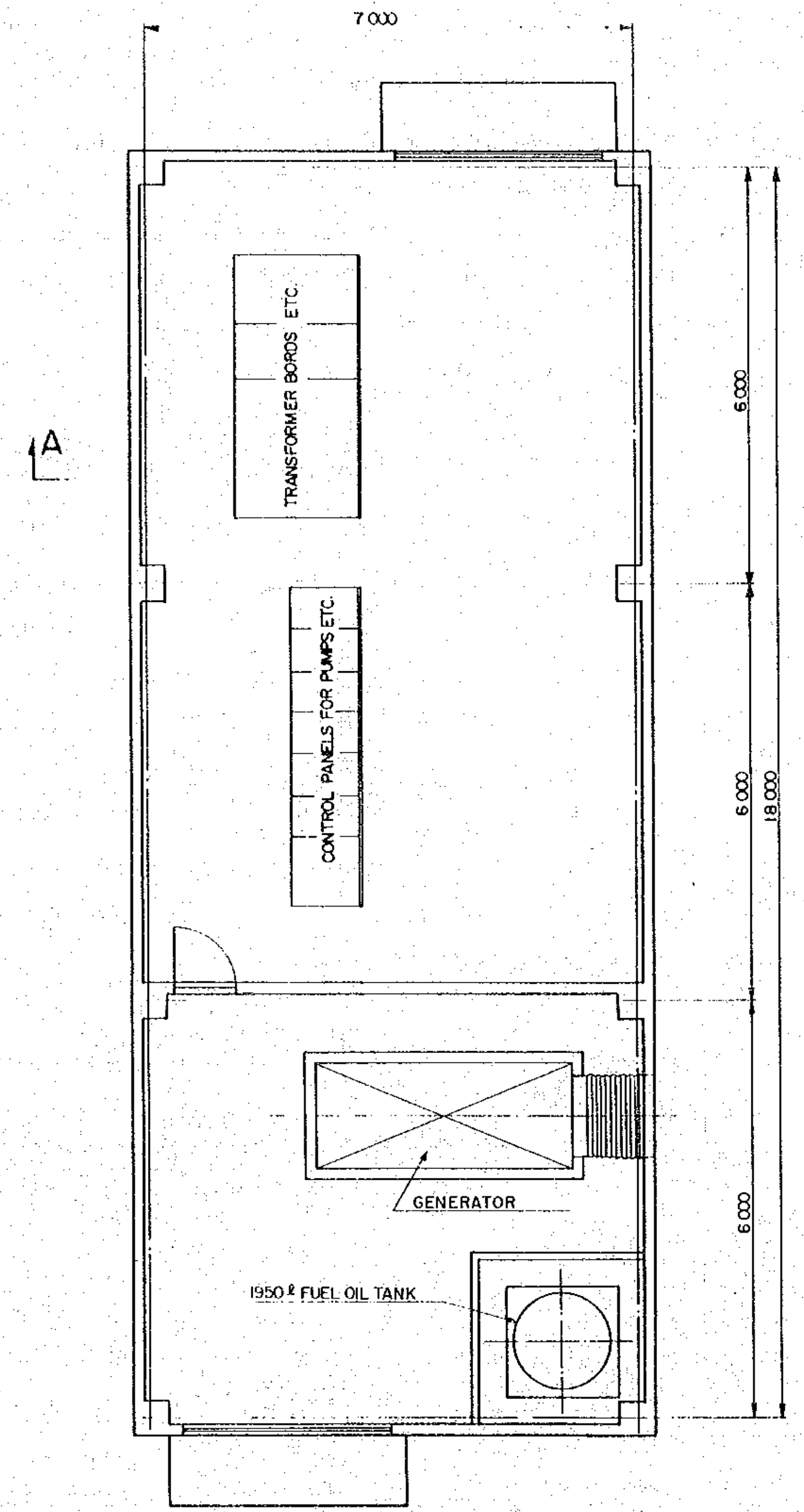
(1) transformer with capacity for 5 pump unit

(2) a control panel for six pump units which shall send electricity to their submersible pumps. The control of the 6 pumps shall be carried out through a central control system in the substation. A generator with the same capacity as the transformer should also be installed in the transformer room for emergency purposes so that it can automatically take over the operation of pumps in case of electric power failure.

Figure 8-2 shows the plan.

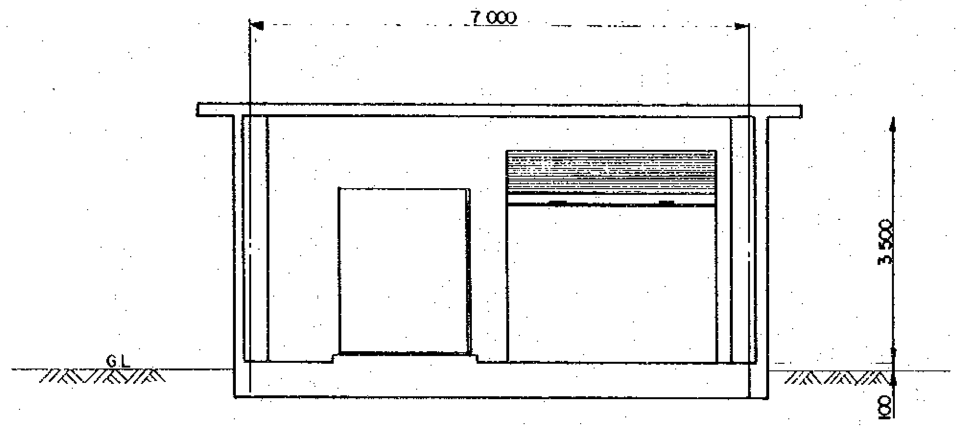
Fig-8·2, SUBSTATION AND CONTROL ROOM

(NOT IN SCALE)



CROSS SECTION A - A

(NOT IN SCALE)



8-1-5 Transmission Pumping and Booster Pumping Stations

A transmission pumping station is to be built in Liloan and a booster pumping station in Merida, 19 kms. away from Liloan.

The scale of these two pumping stations is to be based on the number of pumps, control system and its economic merits.

In the first scheme, the transmission pumping station and the booster pumping station shall each have three regular pumps (ϕ 250) and one stand-by pump (ϕ 250). On the other hand, the second scheme is divided into two stages: three regular pumps (ϕ 250) and one stand-by pump (ϕ 250) are installed in the first stage and another regular pump (ϕ 200) is to be added during the second stage.

8-1-6 Selection of Pumps

The type of pumps to be used is based on the criteria listed below:

(i) planned amount of transmitted water and amount of water fluctuation
(ii) durability and maintenance
(iii) suction performance
(iv) location of pump units
(v) reliability

A double-suction volute pump is recommended for this project because it can stand frequent water volume changes and can easily be checked and repaired.

Table 8-3 Pump Specifications

Item	Scheme I	Scheme II	
		Phase I	Phase II
Type of Pump	Doule-Saction volarcpomp	Same as Scheme I	Same as Scheme I
No. of Units	3	3	1
No. of Standby Pumps	1	1 1	1
Diameter (Suction) (mm)	250	250	200
Diameter (Discharge) (mm)	150	150	150
Total Head (m)	67	88	63
Amount of Pumped Up Water (m^3/min.)	8.9	7.6	3.9
Revolutions per Miute (RPm)	1,750	Same as Scheme I	Same as Scheme I
Motor Output (KW)	160	180	750
Voltage (V)	4,160	Same as Scheme I	Same as Scheme I
Frequency (Hz)	60	Same as Scheme I	Same as Scheme I
No. of Poles (P)	4	Same as Scheme I	Same as Scheme I

8-1-7 Operation and Control of Pumps

(i) Transmission Pumping Station

(a) The rate of discharge from the three pumps is measured by the flow meter which automatically checks and controls each unit.

(b) When the water in the receiving basin drops to a low level, the transmission pump automatically stops.

(c) In order to prevent the occurence of water hammer, which could result in negative pressure, the installation of flywheels and one-way surge tanks are to be implemented.

(d) Control and surveillance of the three pump units shall be directly done by the central control system in the control room.

(ii) Booster Pumping Station

(a) The rate of discharge from the three pumps measured by the flow meter automatically checks and controls each pumping unit.

(b) When the water pressure going into the pump is abnormally low, the booster pump automatically stops functioning.

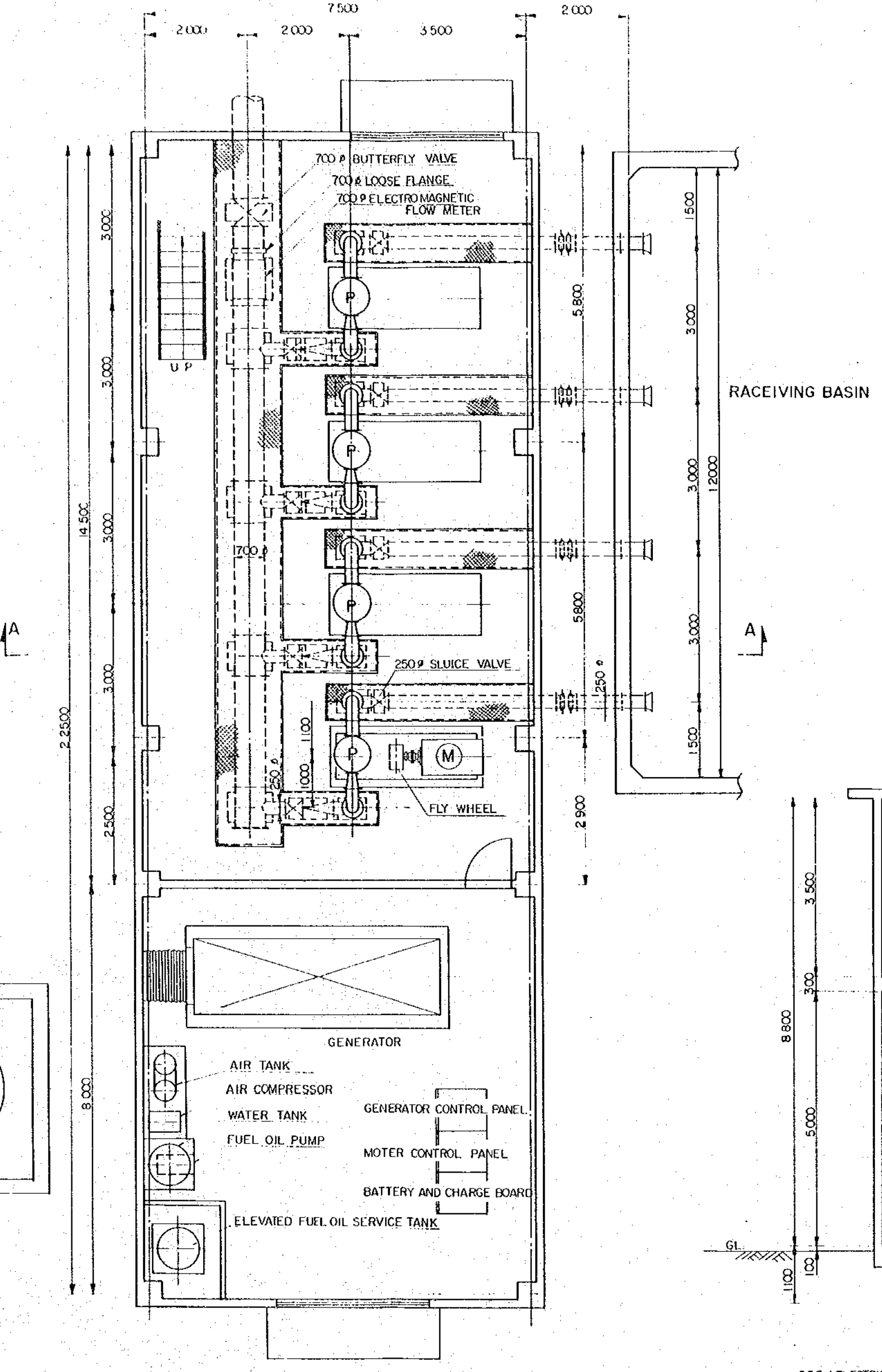
8-1-8 Electric Power System

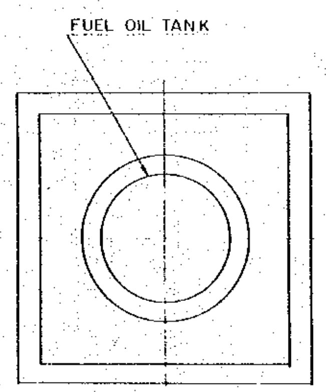
Each pumping station (transmission and booster) is equipped with a substation and control room. The primary power source has a frequency of 60 hz. and a voltage of 4,160 volts and the secondary power source has a frequency of 60 hz. and 418 volts. The control panel of the four pumps is located at the substation and control room. Furthermore, in cases of emergency, a generator with a power capacity for three pumps is also installed which could automatically take over in case of electric power failure.

Figures 8-3 and 8-4 illustrate the facilities for the transmission pumping station and the booster pumping station.

Fig－8.3 TRANSMISSION PUMPING STATION

PLAN OF PUMPING STATION NOT IN SCALE



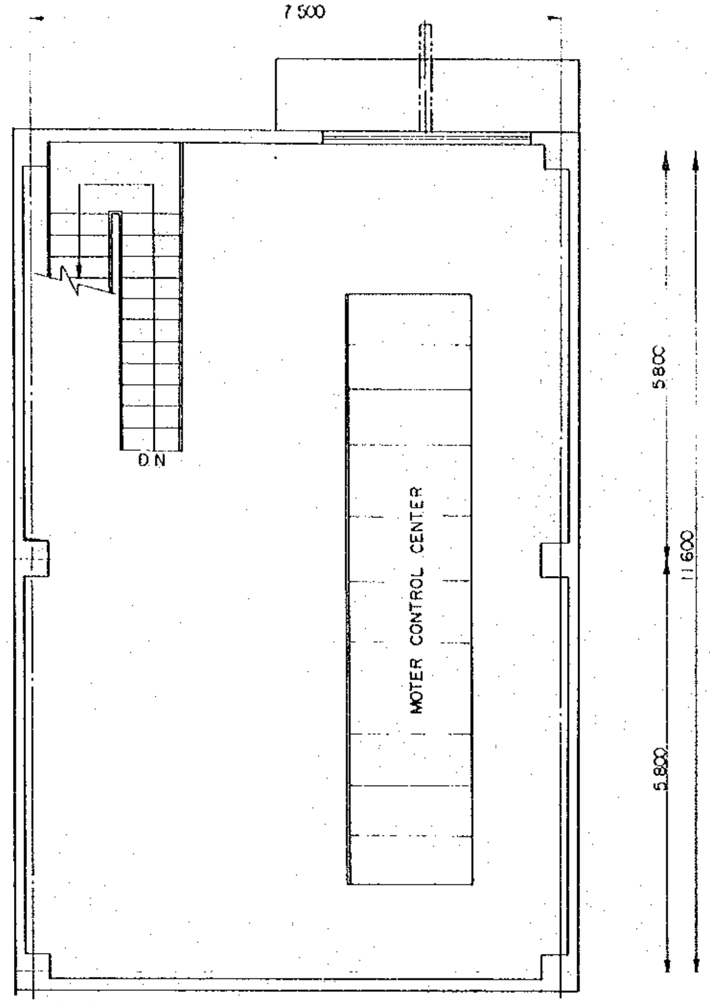


LEGEND

Ⓟ PUMP

Ⓜ MOTOR

PLAN OF OPERATION ROOM (2F) NOT IN SCALE



CROSS SECTION A－A NOT IN SCALE

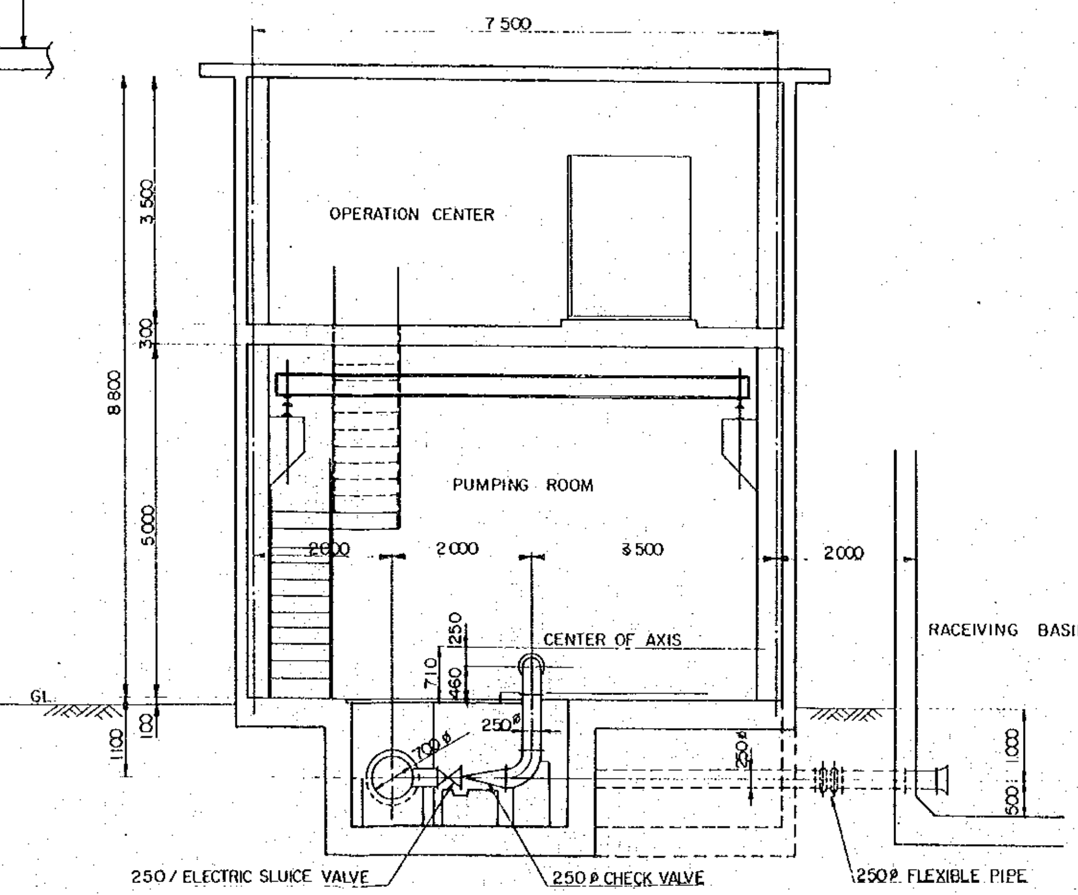


Fig-9.4 BOOSTER PUMPING STATION