Appendix 5

Memorandum

MEMORANDUM OF DISCUSSIONS
ON
BASIC DESIGN STUDY ON THE PROJECT
FOR
THE WATER SUPPLY SYSTEM IN GIA LAM AREA
IN
HANOI CITY IN THE SOCIALIST REPUBLIC OF VIET NAM

Based on the minutes of discussions exchanged on 18 May, 1993, officials concerned of the Government of the Socialist Republic of Viet Nam and JICA Study Team further continued the study and exchanged views on the Basic Design on the Project.

According to the results of the above study, the both parties agreed the proposed concept of the Basic Design of the project as shown in the attachments.

1 June, 1993

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Basic Design Study Team
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ATTCHMENT

During the field survey, various discussions were made with officers concerned in all aspects of the project in addition to the field inspection. The following part of this attachment summarizes provisional conclusion of the field survey and proposal for the project. Further details will be studied and analyzed at head office in Tokyo to finalize the Basic Design Study.

1. The Project Area

The project area of this Basic Design Study coincide with the project area of the Water Master Plan for Gia Lam Precinct.

2. Service Area

The service areas of the project are determined based on the land use plan proposed by the Planning Institute of Hanoi on 25 May, 1993.

These proposed service areas coincide with the service areas for urban areas proposed in the above master plan, however there are a small difference between the two due to the revision of the land use plan.

In addition to the proposed service areas in the urban area, the sub-urban areas are included in the proposed service areas. These sub-urban areas are the areas where densely populated rural communities are observed adjacent to the urban area.

Land Use Plan(ha)

Urban Area	Total	Residential	Offices	Pub. Util	Industry	Storing	Parks	
Ngoc Thuy	51.0	19.0	14.0	2.0	13.0	3.0	0	
Gia Lam	137.0	76.4	11.0	12.0	21.0	2.0	14.0	
Duc Giang	238.0	75.0	17.0	11.0	69.0	43.0	23.0	
Sai Dong	250.8	80.0	18.0	12.0	117.0	3.0	20.0	1.0
Total	676.8	250.4	60.0	37.0	220.0	51.0	57.0	1.0

* Excluding the area of roads.

Sub-urban areas of 313 ha are included as shown in the water demand calculation sheets (Table 1). An average population density in the sub-urban area is estimated at 160/ha in 2000.

3. Design Period

The Water Master Plan for Gia Lam Princinct intends to plan the water supply facilities until the year 2010. However, the project area has just commenced its rapid growth of urbanization and there are a lot of uncertainties in the future projection of urban development in the area so that the design period of this study is proposed to be the year of 2000 to minimize contradictions between the actual urban development and the utility plan in future.

The water demand of the proposed service areas is estimated to be 28,845 m3/day of which daily maximum demand is almost 30,000 m3/day corresponding to the requested design capacity of Hanoi authority.

4. Water Demand

Since there is much of uncertainty in the future urban development in the project area, the over all avreage unit water consumption rate each categories is taken after the Hanoi Water Master Plan. However, since the water supply facilities in Hanoi City are partly very old and recorded a large amount of the water unaccounted for, the losses and other water use corresponding to 35% of the total demand is proposed to be defined in the study as all facilities of the project are to be constructed and no heavy losses are expected.

Accordingly, the proposed unit water consumption rate for the project is determined as shown below:

	W/M.Plan	Gia Lam Water Supply
Domestic water	150 l/c/day	150 l/c/day
Sub-urban area	60 l/c/day	60 l/c/day
Small scale industry	12 l/c/day	-
Public service	16 l/c/day	16 l/c/day
Washing	10 l/c/day	10 l/c/day
Industry	50% of 30m3/ha/day	50% of 30m3/ha/day
Losses and other use	35% of Design Capacity	
Consumption at plant		7% of Day Max
Irrigation		40% of 20m3/ha/day
Losses		11.25% of Day Max.

The water demand of the project is estimated at 28,845 m3/day as the daily maximum demand (20,603 m3/day daily average) according to the above assumption:

5. Design Criteria and Conditions

1) Design Capacity

The design capacity of the project is determined to be 30,000m3/day at the daily maximum demand corresponding to the design capacity requested by the Hanoi authority.

Taking the standard peak factor of the design criteria of Viet Nam (1.4) the average daily demand (ADD) is calculated as 21,430 m3/day.

As the required amount of water in the treatment process is estimated at 7% of the max. daily demand (MDD), the design capacity of the water treatment facilities is 32,100 m3/day.

The peak hour factor for distribution networks design is 1.35.

2) Water Quality

Based on the result of interpretation of the existing water quality of the ground water, the design raw water quality is determined as shown in Table 2,while the standards for drinking water quality is shown in Table3.

Necessary treatment facilities shall be provided to purify the design raw water quality to the water quality to satisfy the standards of the drinking water.

3) Water Source

Based on the result of interpretation of hydrogeological conditions in the well fields, the safe yield of one well is determined at 50 l/sec (180 m3/hr)

Assuming 20hrs operation of pump, 3,600 m3/hr of water is available from a single well. The required number of wells to meet the design capacity of the project is 9 (32,100/3,600=8.9). Considering 30% of the number of standby pumps (3 units) out of number of operating pumps, total number of pumps required for the project is 12.

Type of the pump is proposed to be submersible pump.

Based on hydrogeological analysis, the minimum distance to avoid influence of draw down of wells is estimated to be 250 m in the well field of the project. Taking this condition into consideration, the size of the proposed well field along the Red River is a little insufficient to accommodate 12 wells. For this reason, it is proposed to provided 8 wells at the well field along the Red River and another 4 wells at the treatment plant site.(Fig. 1)

The proposed well design is shown in Fig.2.

4) Raw Water Transmission Pipeline

The rout of the raw water transmission line is proposed to be along the highway No.1 and the No.5 for about 7 km.(Fig 1)

Proposed pipe material is ductile cast iron pipe (DIP) wit mortar lining. The diameter of the raw water transmission pipeline is in a range between 250 mm and 600 mm and majority of the pipes is 600 mm in diameter.

5) Water Treatment Plant

Major concern of the water treatment is removal of iron, manganese and ammonia.

i). Treatment Process

In order for determination of the treatment process, three alternatives will be compared including non-chemical system as shown in Fig.3.

Major considerations of the above comparison are:

-Economical aspects
-Technical aspects
-Easiness of operation and maintenance

Provisionally the alternative 2 is proposed for the project.

ii).Layout Plan

Proposed site of the treatment plant was the area adjucent to the junction of the highway No.1 with the highway No.5. Howver, this area is subject to accident under the approach area of airplanes to the Gia Lam air port. Inaddition the proposed area would be utilized more efficiently for commercial area.Therefore, the plant site isproposed to transfer further south for about one kilometer along the highway No. 5.(Fig. 1)

A preliminary layout plan is shown in Fig.4. The required land size is estimated at about 7 ha (260 m x 260 m). All buildings shown in the Fig.4 will be provided by JICA except item No. 13, 14 and 15 which will be supposed to be constructed by Viet Nam authority.

iii). Operation and Instrumentation System

The pumps of wells shall be operated at the central control panel in the water treatment plant.(Fig 5)

Filter washing system will be designed to be either the one man control or timer control.

The treatment plan will be equipped with analytical appartus necessary for chemical water quality analysis of temperature,pH, iron,manganese and residual chlorine.

iv). Supply Reservoir

The storage capacity of the supply reservoir is 20% of the maximum daily demand (4.80 hrs);The design capacity of the supply reservoir is 6,000 m3 (30,000 X 0.2 = 6,000 m3).

6).Distribution System

Although the land use plan is determined by the Planning Institue of Hanoi, implementation schedule of the utility plan especially road consrruction plan is stil to be determined. For this reason a part of distribution of the water demand estimated in each part of service areas can not be completed until the consrtuction of road will be completed.

Therefore, distribution is planned to supply water through pipelines installed along the existing roads which may sufficiently be able to meet the water demand even in near future.(Fig.6)

i).Distribution system and Power Supply.

A direct pumping system is proposed for the project. In order to distribute 30,000 m3/day(daily maximum demand) six (6) pump units will be installed including two (2) units for standby. Operation hours is 24 hours in normal conditions.

For emergency case of failure in public electric supply, generator sets will be provided in capacity of 25% of total power requirement. The generator sets will be provided in the treatment plant site.

ii). Minimum Pressure in Pipe Line Networks

The minimum pressure of the distribution networks will be maintained at 20 m water pressure at the peak hour time.

iii). Fire Hydrant

The fire hydrants will be installed at 300m intervals along the main roads where fire-fighting car can go through. The fire hydrants will be connected with the distribution lines with a diameter 150 mm or more. Type of the fire hydrant is under ground type in diameter of 65 mm.

iv). Pipe Materials

Ductile iron pipes (DIP)with mortar lining will be installed in the pipelines with diameter of 200mm and more.

PVC or PE pipes will be utilized for the pipelines with diameter of 150 mm and less.

DIP will be installed in the pipeline even less than 150 mm or less where vehicle traffic is expected.

7). Electrical Works

i). Design,Condtions

Rated voltage 380 V, 50 HZ shall be used for the power supply and single phase 220 V shall be used for control circuit.

Although the single phase 220 V shall be used in general, the sigle phase 100 V may be used the control circuit of equipment for measurement. However, such usage of the 100 v must be minimized.

Final sub-circuit for the lighting and receptacle shall be single phase 220 V.

Cable and Wire

Following cables and wires shal be utilised for the each circuit:

-H.T. cable

35 KV XLPE

-Low voltage cable for motor

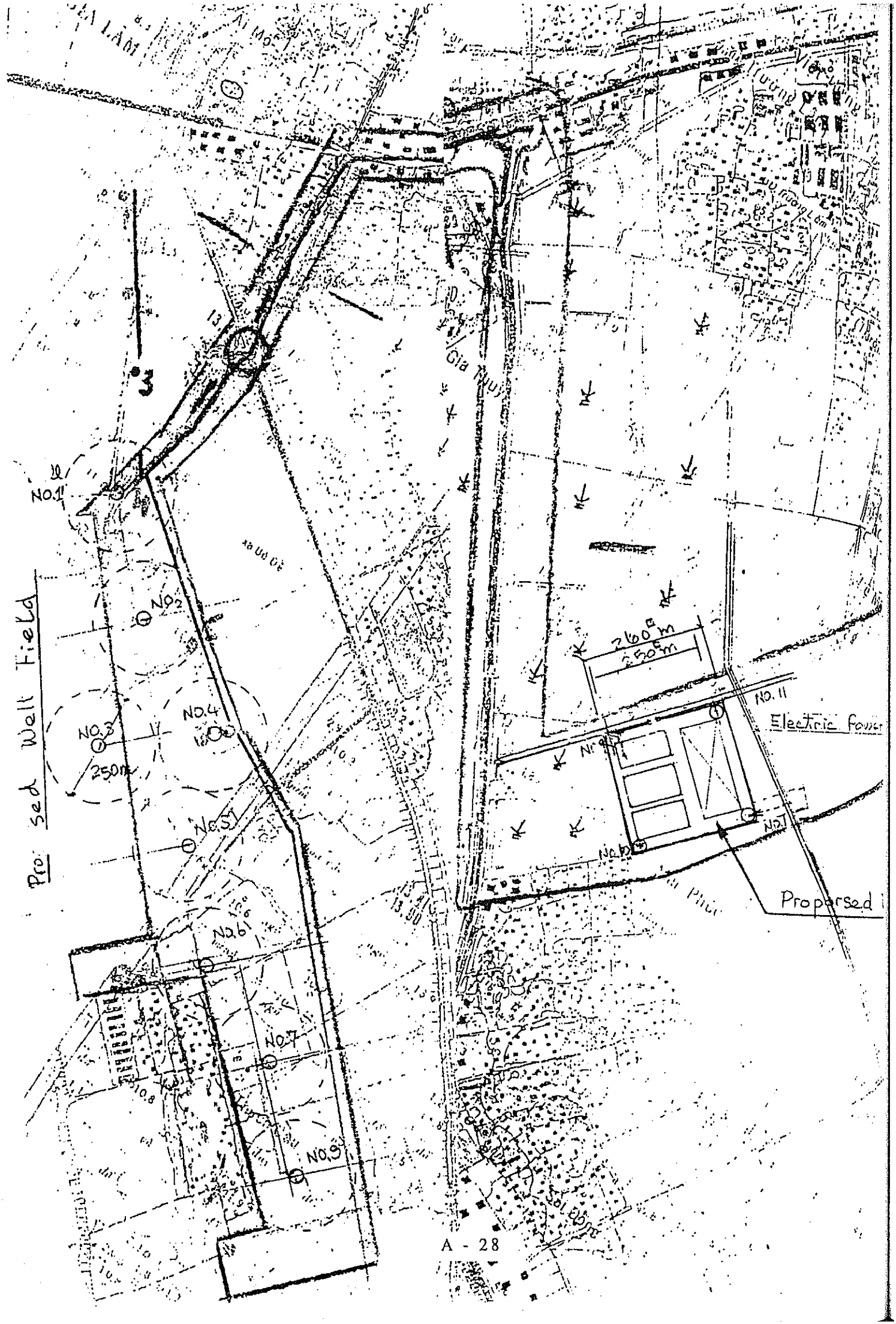
600 V PVC or XLPE cable

Standby Power Supply System

Diesel generator to be installed in the water treatment plant shall be provided for emergency standby power supply for lighting and a distribution pump.

ii). Electric Power Supply System

There are three power supply systems as shown in Fig. 7.


Proposed Well Field
NO.1
NO.2
NO.3
NO.4
NO.5
NO.6
NO.7
NO.8
NO.9
250m
NO.11
Electric Power
Proposed

TYPICAL WELL STRUCTURE

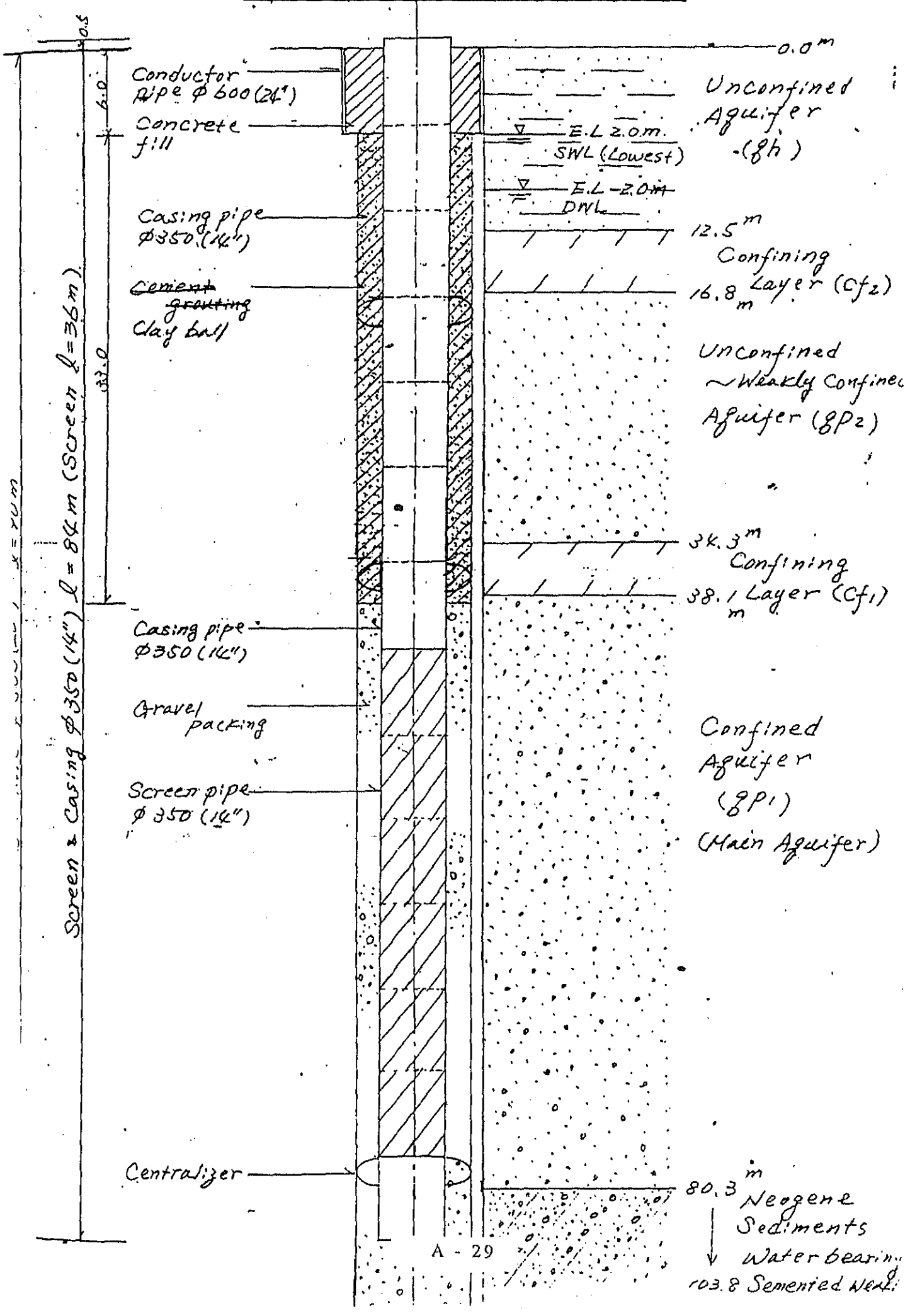
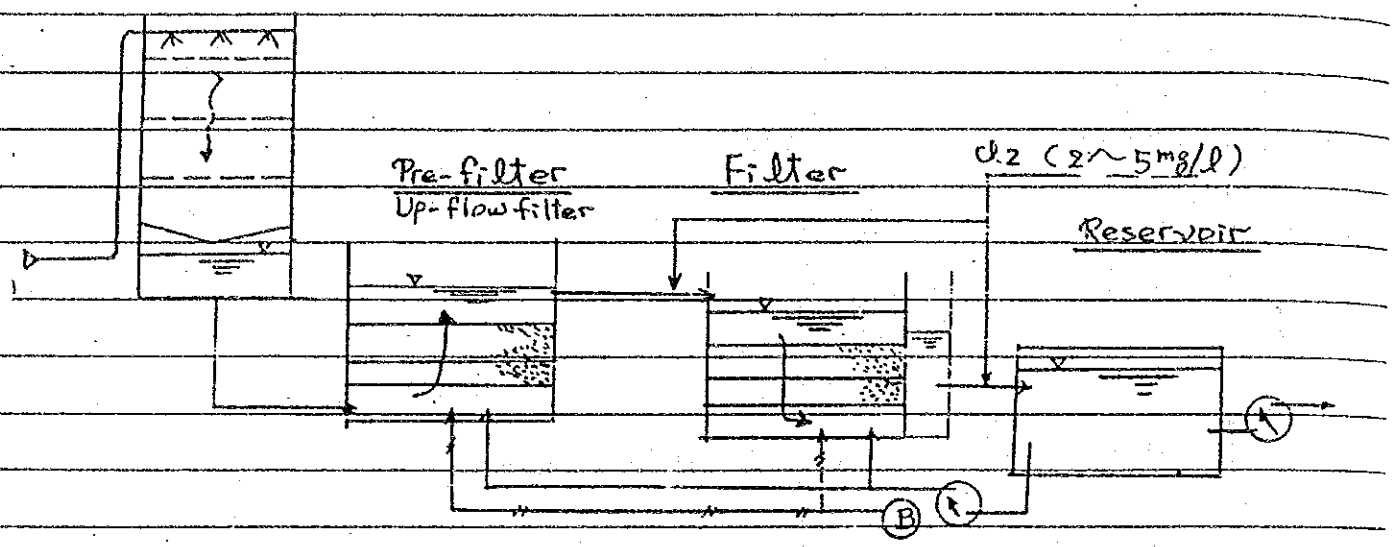


Fig 3-a

1. Process Flow

Alternative 1 2 stepes filtralation system



Alternative 2 2 stepes filtration system

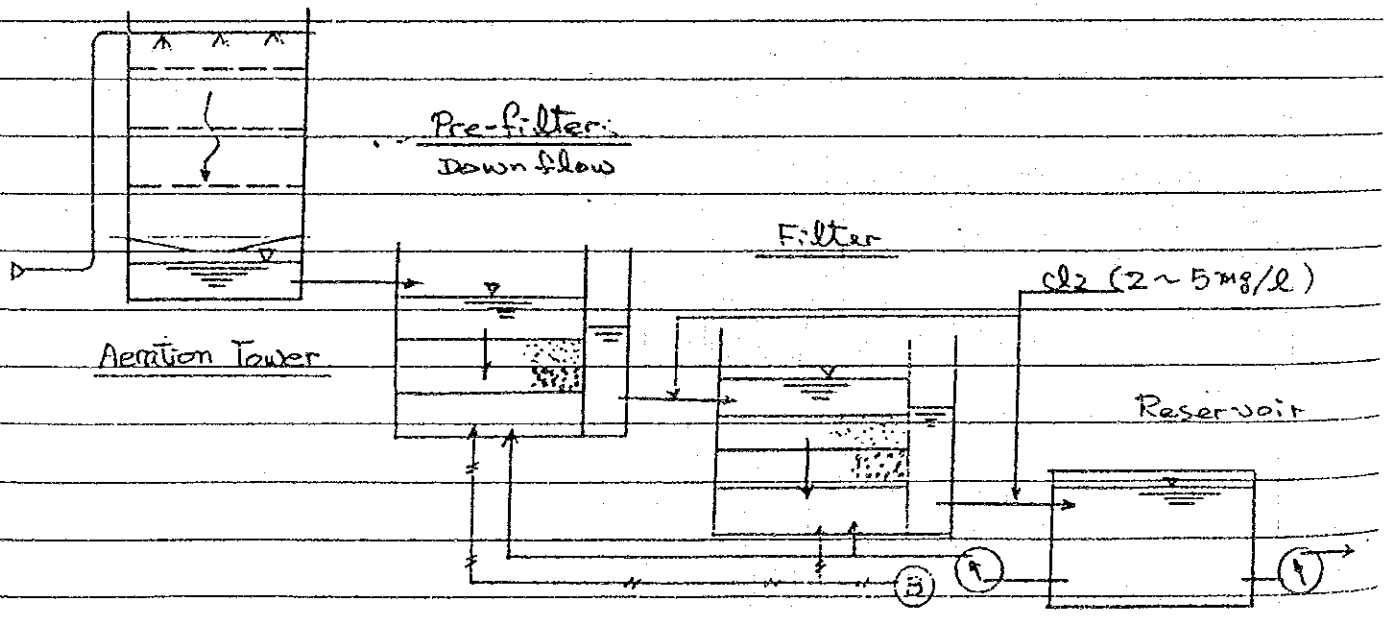
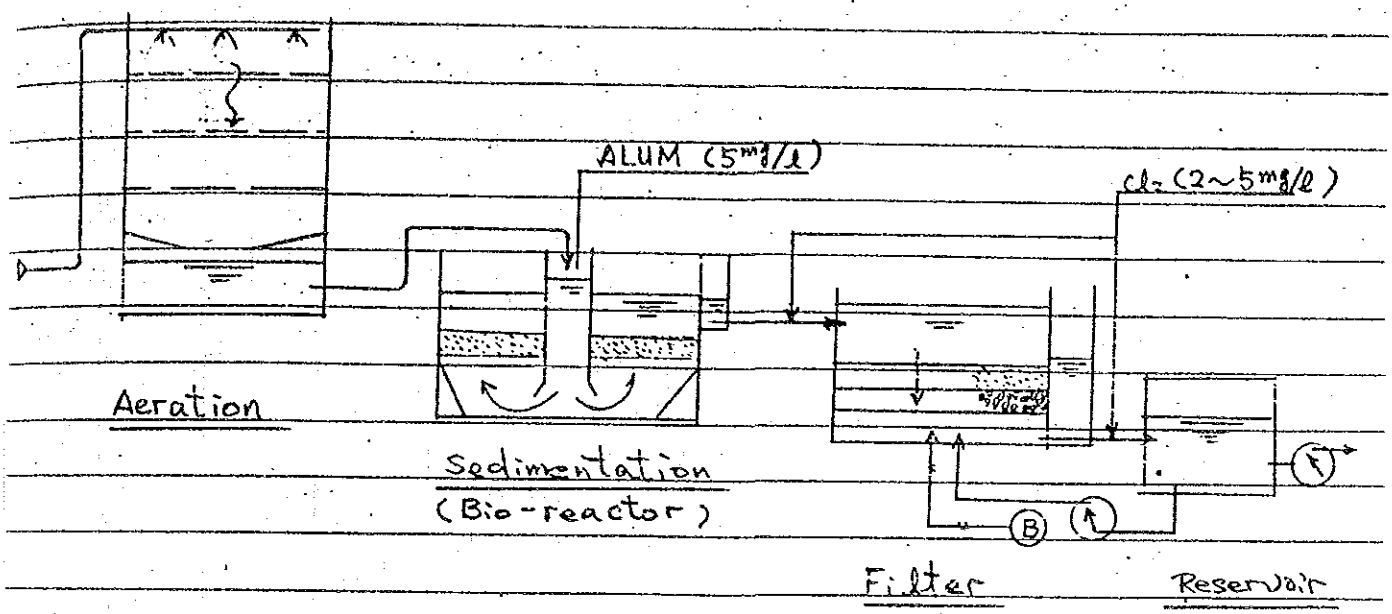
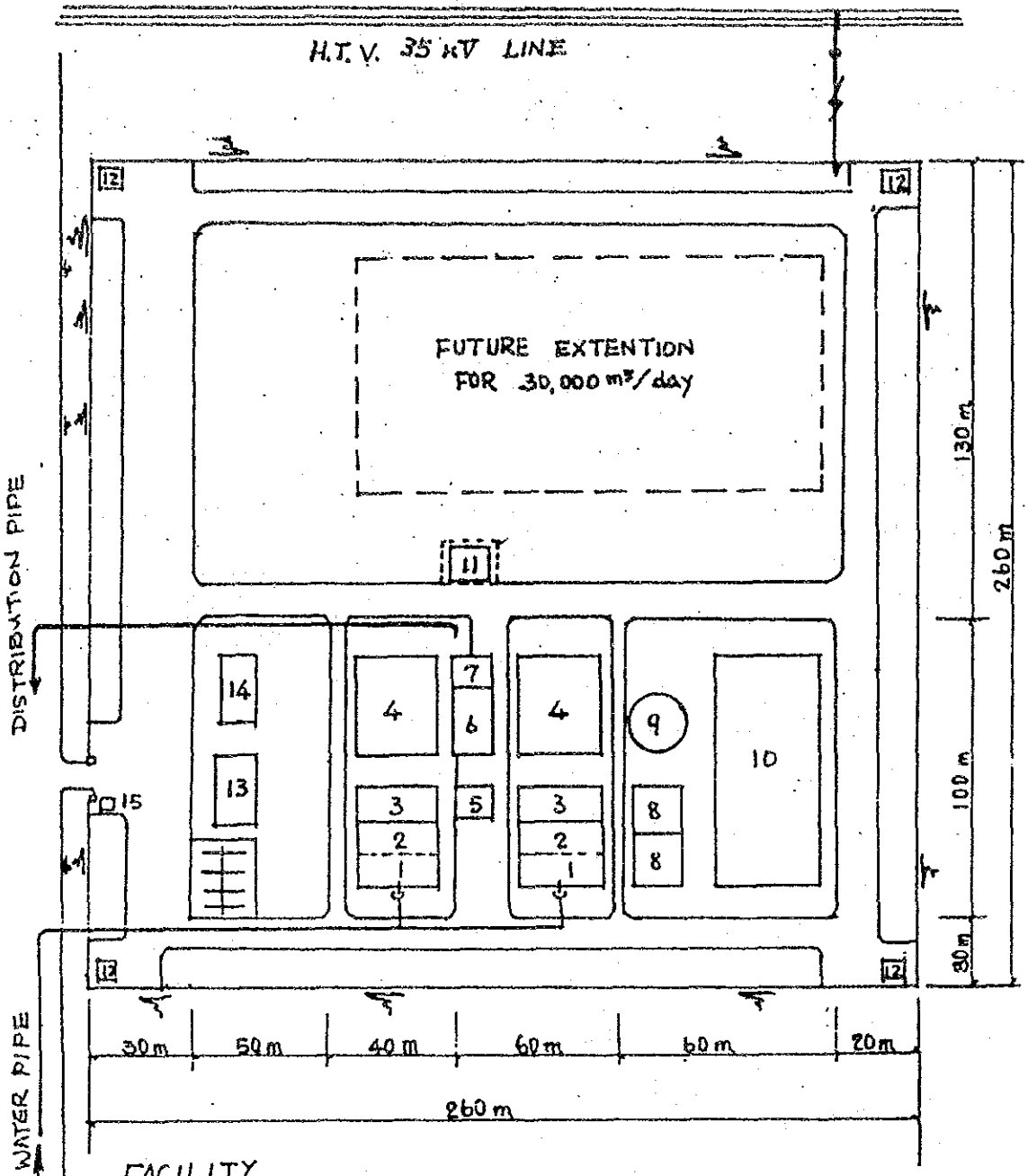


Fig 3 b

Alternative 3 sedimentation and filter.





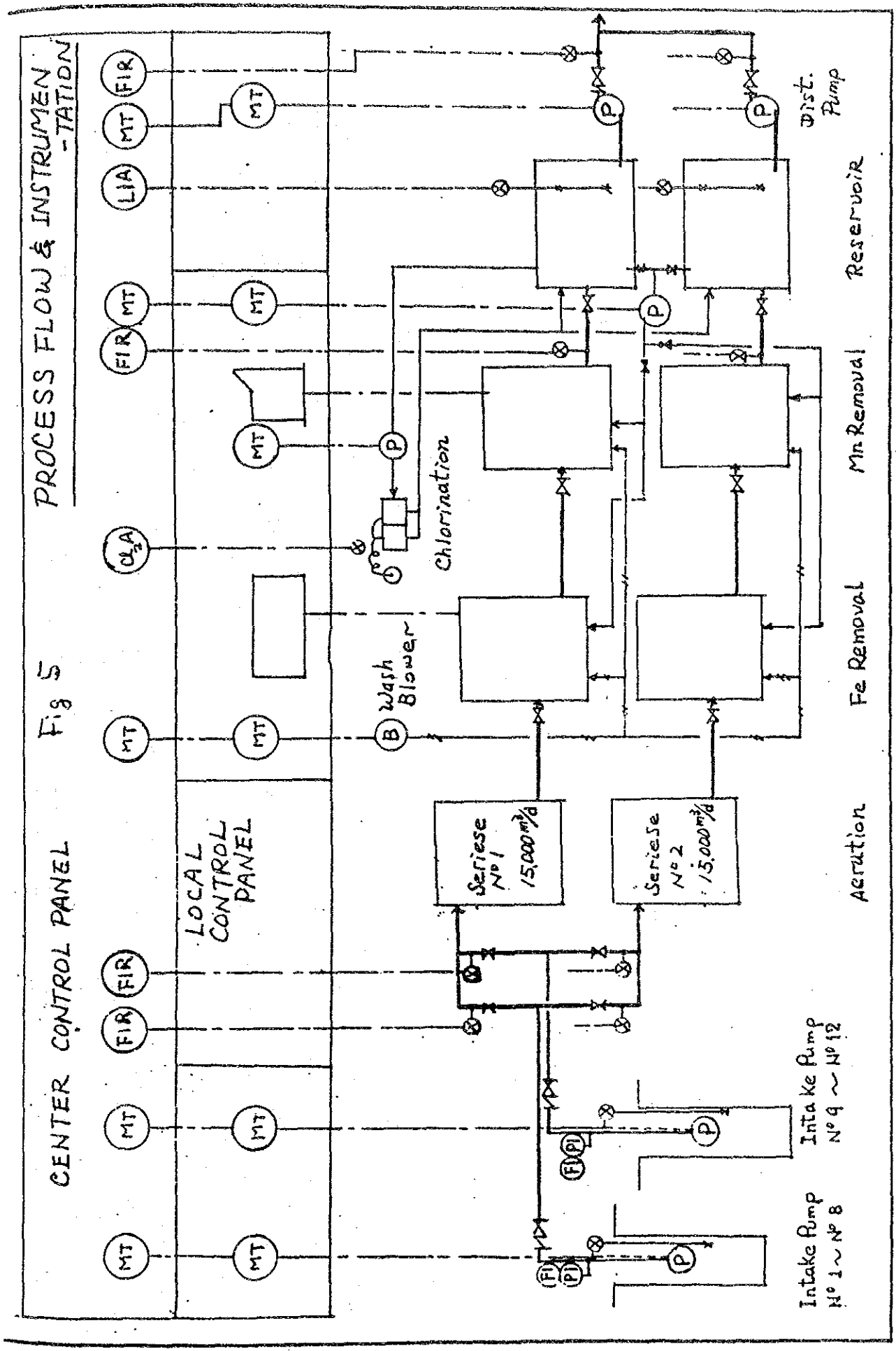
FACILITY

1. AERATION TOWER
2. IRON REMOVE
3. MANGANESE REMOVE
4. RESERVOIR TANK
5. CHLORINATION HOUSE
6. PUMP HOUSE
7. ELECTRIC CONTROL HOUSE
8. SLUDGE RESERVOIR
9. THIKNER
10. DRAYING BED
11. ELECTRICAL SUB STATION
12. INTAKE WELL
13. ADMINISTRATION BLD.
14. WORK-SHOP & STORE
15. GUARD HOUSE

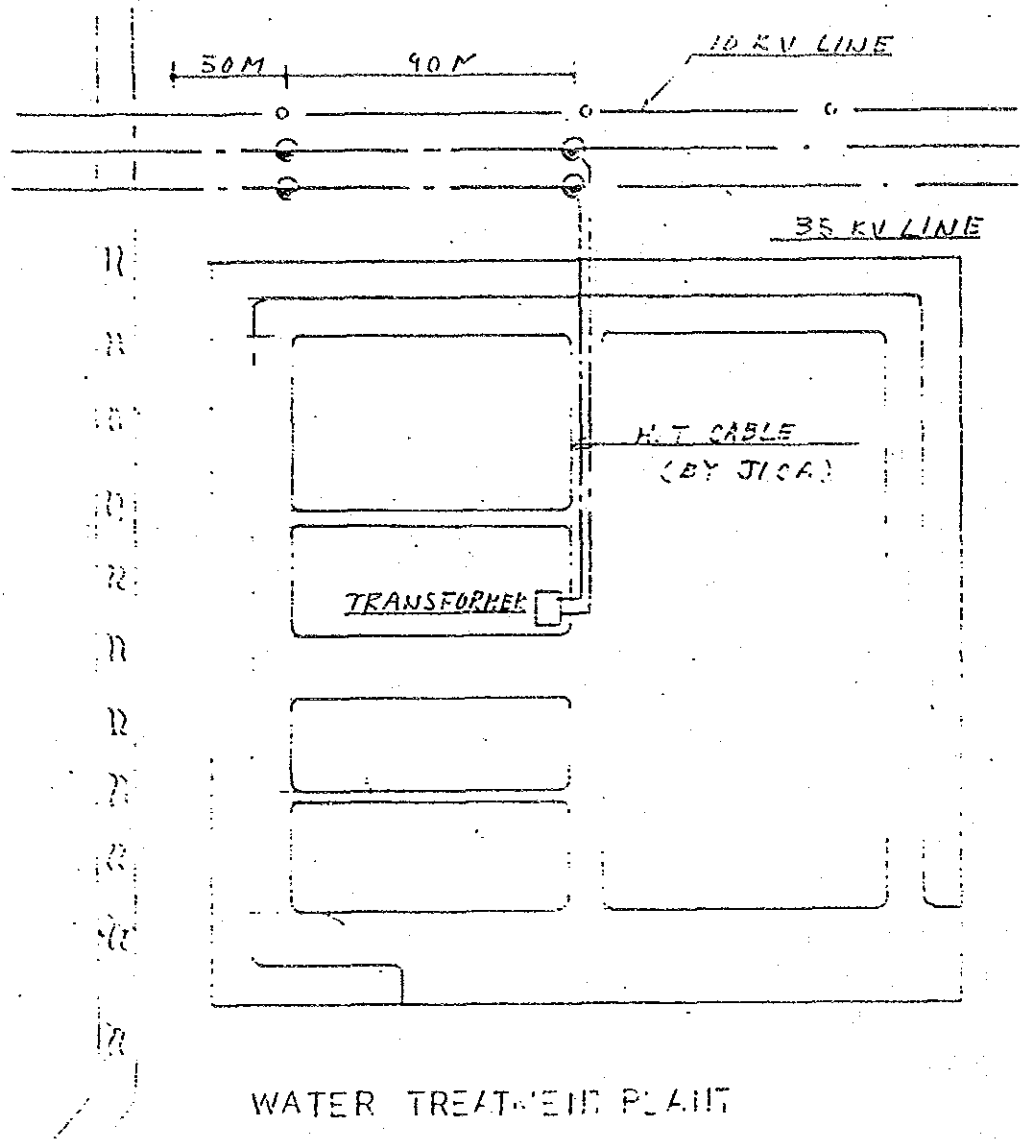
LAYOUT PLAN
FOR
WATER TREATMENT
PLANT

PRELIMINARY

ROUTE N° 5
⟹ HẢI PHÒNG

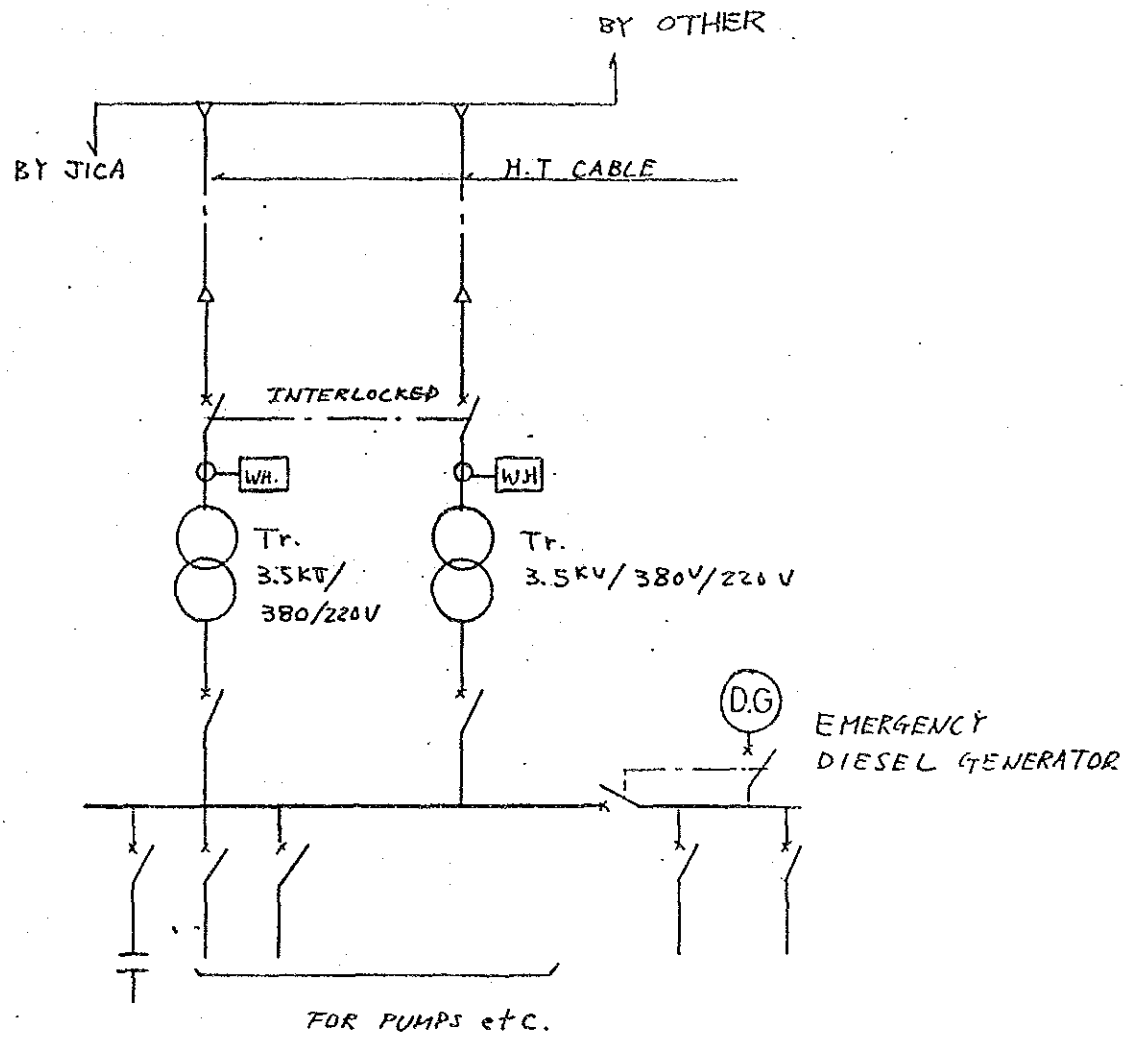

PROCESS FLOW & INSTRUMEN -TATION
Fig 5
CENTER CONTROL PANEL
LOCAL CONTROL PANEL
FIR
MT
LIA
Cl_2A
B
Wash Blower
Chlorination
Seriese No 1 15,000m³/d
Seriese No 2 15,000m³/d
Aeration
Fe Removal
Mn Removal
Reservoir
Dist. Pump
Intake Pump No 1 ~ No 8
Intake Pump No 9 ~ No 12
FI
P

POWER CONNECTION FOR WATER PLANT



SINGLE LINE DIAGRAM

(In case of two (2) Transformer will be installed)



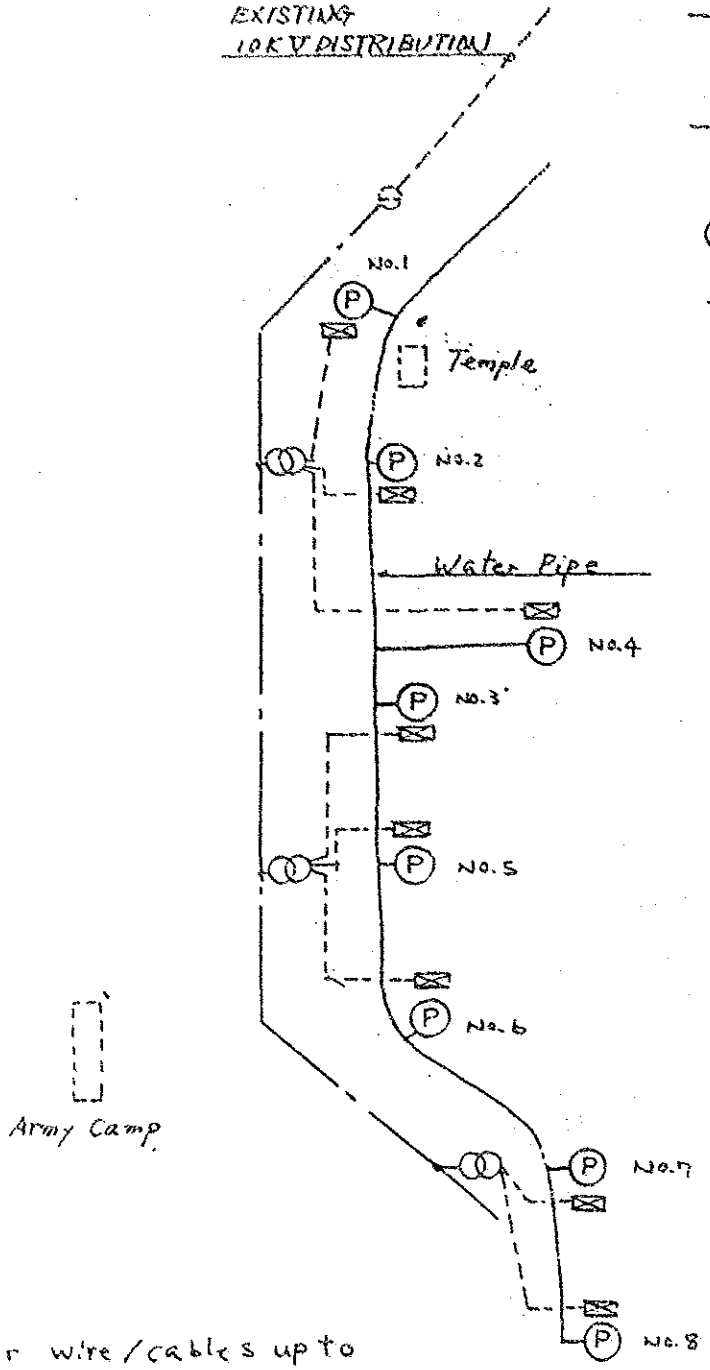
Note

All standard meters such as Amp. Meter Volt. Meter var Meter, Power Factor etc. shall be provided.

W.H.M shall be provided at both H.T and L.V side.

H.T side W.H.M. shall be used for calculating the Tariff.

WELL FIELD POWER DISTRIBUTION



LEGEND

- NEW 10KV DISTRIBUTION LINE
- NEW 380V DISTRIBUTION LINE
- TRANSFORMER
- MOTOR CONT. BOARD (BY JICA)
- WELL PUMP 37 KW (BY JICA)

NOTE

All power wire/cables up to Motor Control Board shall be supplied and installed by other.

LAND USE PLAN OF GIA LAM WATER SUPPLY SERVICE AREA Table 1-a

KHU NGOC THUY

Block No	1992	2000	2010	Domestic		Public Use	Cleaning	Irrigation	Total	Loss	Daily Ave.	Daily Max.	Plant Ope.	Intake Capa.	
				Residential	Industrial									D Ave	D Max
				150 l/c/d	30*50%	18 l/c/d	10 l/c/d	20 m3/ha	m3/d	1.25% of 1	10+11	12*1.4	12 * 7%	12+14	13+14
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
A1	125	156	195	23	185	2	2	0	222	26	248	347	17	265	364
A2	155	1,028	2,120	154	0	18	10	0	181	20	201	282	14	215	296
A3	370	932	1,635	140	0	15	9	0	164	18	183	256	13	195	269
Total	650	2,117	3,950	318	185	34	21	0	568	64	631	884	44	676	928

LNDUSE2.XLS

Table 1-b

Block No	1992	2000	2010	Domestic		Public Use	Cleaning	GIA LAM Irrigation	Total	Loss	Daily Ave.	Daily Max.	Plant Ope.	Intake Capa.	
				Residential	Industrial									D Ave	D Max
				150 l/c/d	30*50%	16 l/c/d	10 l/c/d	20 m3/ha *40%	m3/d	1.25% of 1	10+11	12*1.4	12 * 7%	12+14	13+14
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
B1	1,360	1,360	1,360	204	0	22	14	0	238	27	288	373	19	285	381
B2	1,500	1,627	1,786	244	0	26	16	9	285	33	328	460	23	351	483
B3	3,000	2,731	2,384	410	0	44	27	16	497	56	552	773	38	591	812
B4	600	804	608	91	300	10	6	0	406	46	452	633	32	484	664
B5	1,500	1,935	2,478	280	0	31	18	0	341	38	379	530	27	405	557
B6	1,630	1,746	1,891	262	0	28	17	0	307	35	342	479	24	366	503
B7	2,280	2,229	2,166	334	11	36	22	0	403	45	448	628	31	480	660
B8	2,200	1,966	1,448	280	0	30	18	0	328	37	365	511	26	391	537
B9	1,500	1,440	1,368	216	0	23	14	0	254	29	282	395	20	302	415
B10	2,100	1,888	1,127	250	0	27	17	0	293	33	327	457	23	349	480
B11	1,200	1,118	1,016	168	0	18	11	0	197	22	219	307	15	234	322
B12	1,100	780	380	117	0	12	8	28	165	18	184	257	13	197	270
B13	0	171	384	26	0	3	2	10	40	4	44	62	3	47	65
B14	40	71	110	11	5	1	1	29	47	5	52	73	4	56	76
B15	500	616	760	82	0	10	6	0	108	12	121	169	8	129	177
B16	350	502	691	75	0	8	5	0	88	10	98	137	7	105	144
B17	380	422	475	63	0	7	4	0	74	8	83	116	6	88	122
B18	150	383	630	55	0	6	4	0	64	7	71	100	5	76	105
B19	0	299	672	45	0	5	3	0	53	6	58	82	4	63	86
B20	1,800	1,825	1,407	244	0	26	16	0	286	32	318	446	22	341	468
B21	2,000	1,788	1,478	265	0	28	18	0	311	35	348	485	24	370	509
B22	0	227	510	34	0	4	2	8	48	6	55	78	4	59	80
B23	400	853	1,419	128	0	14	9	6	157	18	174	244	12	186	256
B24	200	127	35	19	0	2	1	2	25	3	27	38	2	29	40
Prk &Grn				0	0	0	0	2	2	0	3	4	0	3	4
Total	25,790	26,146	26,591	3,922	316	418	261	112	5,030	566	5,596	7,834	392	5,987	8,225

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Table 1-c

DUC GIANG

Block No	1992	2000	2010	Domestic		Public Use	Cleaning	Irrigation	Total	Loss	Daily Ave	Daily Max	Plant Ope.	Intake Capa.	
				Residential	Industrial									D Ave	D Max
				150 l/c/d	30*50%	16 l/c/d	10 l/c/d	20 m3/ha *40%	m3/d	11.25% of 1	10+11	12*1.4	12 * 7%	12+14	13+14
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
C1	0	0	0	0	114	0	0	0	114	13	127	178	9	136	186
C2	220	744	1,400	112	148	12	7	10	289	33	322	450	23	344	473
C3	1,875	2,321	2,878	348	0	37	23	36	445	50	495	892	35	529	727
C4	0	0	0	0	68	0	0	0	68	8	75	105	5	80	110
C5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C6	2,225	2,417	2,656	382	50	38	24	4	478	54	533	746	37	570	783
C7	320	178	0	27	240	3	2	0	271	31	302	423	21	323	444
C8	0		0	0	0	0	0	0	0	0	0	0	0	0	0
C9	480	1,013	1,680	152	0	16	10	0	178	20	198	278	14	212	292
C10	600	511	400	77	0	8	5	3	93	10	104	145	7	111	152
C11	600	760	960	114	0	12	8	8	142	16	158	221	11	168	232
C12	200	287	418	45	0	5	3	3	55	6	62	86	4	66	91
C13	900	1,040	1,216	156	0	17	10	10	193	22	215	301	15	230	316
C14	900	1,007	1,140	151	0	16	10	14	192	22	213	298	15	228	313
C15	50	72	100	11	0	1	1	0	13	1	14	20	1	15	21
C16	50	418	878	63	21	7	4	0	95	11	105	147	7	113	155
C17	2,272	2,272	2,272	341	0	36	23	2	402	45	448	627	31	479	658
C18	800	722	624	108	0	12	7	0	127	14	141	198	10	151	208
C19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C20	0	320	720	48	0	5	3	0	56	6	63	88	4	67	92
C21	0	785	1,768	119	0	13	8	10	150	17	167	233	12	178	245
C22	0	0	0	0	0	0	0	25	25	3	28	40	2	30	42
C23	2,084	1,892	1,852	284	35	30	19	0	368	41	408	573	29	438	602
C24	2,516	2,828	3,217	424	21	45	28	57	575	65	640	898	45	685	941
C25	858	477	0	72	339	8	5	0	423	48	471	658	33	504	692
Total	16,850	20,083	24,000	3,013	1,035	321	201	184	4,754	535	5,288	7,404	370	5,658	7,774

LNDUSE2.XLS

Table 1-d

				SAI DONG											
Block No	1992	2000	2010	Domestic		Public Use	Cleaning	Irrigation	Total	Loss	Daily Ave.	Daily Max.	Plant Ope.	Intake Capa.	
				Residential	Industrial									D Ave	D Max
				150 l/c/d	30*50%	16 l/c/d	10 l/c/d	20 m3/ha *40%	m3/d	1.25% of 1	10+11	12*1.4	12 * 7%	12+14	13+14
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
D1	120	644	1,300	97	0	10	6	0	113	13	126	177	9	135	185
D2	100	500	1,000	75	0	8	5	0	88	10	98	137	7	105	144
D3	70	650	1,375	98	0	10	7	0	114	13	127	178	9	136	187
D4	0	422	950	63	0	7	4	0	75	8	83	116	6	89	122
D5	200	273	364	41	0	4	3	0	48	5	53	75	4	57	79
D6	1,280	1,778	2,400	267	0	26	18	0	313	35	348	487	24	372	512
D7	180	722	1,400	108	0	12	7	0	127	14	141	198	10	151	208
D8	100	56	0	8	345	1	1	0	354	40	394	552	28	422	580
D9	616	342	0	51	65	5	3	16	141	16	157	219	11	168	230
D10	760	422	0	63	107	7	4	0	181	20	201	282	14	215	296
D11	1,960	2,042	2,144	306	0	33	20	0	359	40	400	560	28	428	588
D12	1,515	1,714	1,962	257	0	27	17	0	302	34	336	470	23	359	493
D13	0	0	0	0	51	0	0	16	67	8	75	105	5	80	110
D14	2,177	2,134	2,080	320	15	34	21	11	402	45	447	626	31	478	657
D15	900	789	650	116	184	13	8	0	323	36	359	503	25	385	528
D16	842	857	875	129	0	14	9	10	160	18	178	250	12	191	262
D17	300	167	0	25	224	3	2	22	275	31	306	429	21	328	450
D18	0	0	0	0	190	0	0	16	206	23	229	320	16	245	336
D19	0	0	0	0	216	0	0	15	231	26	257	360	18	275	378
D20	0	0	0	0	360	0	0	0	360	41	401	561	28	429	589
D21	0	902	2,030	135	0	14	9	0	159	18	177	247	12	189	260
D22	500	1,878	3,600	282	0	30	19	2	333	37	370	518	26	396	544
D23	380	1,931	3,870	290	0	31	19	0	340	38	378	529	26	405	556
Frk&Grn				0	0	0	0	45	45	5	50	70	3	53	73
Total	12,000	18,223	28,000	2,733	1,755	292	182	154	5,116	575	5,692	7,968	398	6,090	8,367

Table 1-a

SUMMARY

Block No	1992	2000	2010	Domestic		Public Use	Cleaning	Irrigation	Total	Loss	Daily Ave.	Daily Max.	Plant Ope.	Intake Caps.	
				Residential	Industrial									D Ave	D Max
				150 l/c/d	30*50%	16 l/c/d	10 l/c/d	20 m3/ha *40%	m3/d	11.25% of 1	10+11	12*1.4	12 * 7%	12+14	13+14
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Ngoc Thu	650	2,117	3,850	318	185	34	21	0	568	64	631	884	44	676	928
Gia Lam	25,780	26,146	28,581	3,822	316	419	261	112	5,030	566	5,596	7,834	392	5,987	8,225
Duc Giang	16,950	20,083	24,000	3,019	1,035	321	201	184	4,754	535	5,288	7,404	370	5,659	7,774
Sai Dong	12,000	18,223	26,000	2,733	1,755	292	182	154	5,118	576	5,692	7,968	398	6,090	8,367
0	55,380	66,569	80,541	8,985	3,301	1,065	668	450	15,487	1,740	17,207	24,090	1,204	18,412	25,294

Sub Urban

Block No	Name	Area	Demand											
		ha	m3/day											
A1	Gia Thuong	5.5	52.8					53	6	59	82	6	64	88
B1	Gia Quat	12.5	120											
B2	Gia Thuy	17	158											
B3	Ngoc Lam	26	250											
B4	Lam Du	30	288											
sub total		85	818					818	92	908	1,271	64	971	1,334
C1	Viet Hung	64	614											
C2	Thuong Cat	25	235											
C3	Duc Giang	12	115											
C4	Thanh Am	14	134											
sub total		115	1,099					1,099	124	1,223	1,712	86	1,308	1,797
D1	Gia Thuy	25	240											
D2	Xon Dang	8	72											
D3	Thon Ngo	35	336											
D4	Xon Long Bien	46	437											
sub total		113	1,085					1,085	122	1,207	1,690	84	1,292	1,774
Total		313	3,053					3,053	343	3,386	4,755	238	3,634	4,992
Grand Total			13,038	3,301	1,065	668	450	18,520	2,083	20,603	28,845	1,442	22,046	30,287

Table 2

Design Raw Water Quality

	Max.	Min
Turbidity	0	0
Colour	0	0
Temp.	27°C	24°C
pH	6.8	6.5
Σ Fe ($Fe^{2}+Fe^{3}$) · mg/l	22	10
Σ Mn "	1.0	0.5
NH_4-N "	1.0	0.7
Ca (as $CaCO_3$) "	55	
HCO_3 (as $CaCO_3$) "	200	
Alkalinity (as $CaCO_3$) "	250	
Total Hardness (as $CaCO_3$) "	180	
Cl^-	31	
NO_2^-	0	
NO_3^-	0	
PO_4^{-2}	3.0	
SO_4^{-2}	4.0	

Standard for Drinking and Domestic Water Quality
(Water Supply Design Standard, 20 TCN-33-85)
Standard for ~~the~~ Urban Area

Contents	standard	Remarks
Colour	< 10	
Taste (after boiled 40°~50°C)	0	
Unsolubud Suspended Solid	≤ 3	mg/l
Dry Sisspended Solid	< 1000	"
pH	6.5 ~ 8.5	
Hardiness	< 12	°dH
Nacl (Sea area)	< 400	mg/l
" (Normal area)	70 ~ 100	"
NO_3^-	< 6	"
~~H_2S~~ NO_2^-	0	"
H_2S	0	"
NH_4^+ (Surface water)	0	"
" (Under-ground water)	< 3	"
Pb^+	< 0.1	
As^+	< 0.05	"
Cu^{++}	< 3	"
Zn^{++}	< 5	"
Fe	< 0.3 *1	"
Mn	< 0.2	"
F^-	0.7 ~ 1.5	"
I^-	0.005 ~ 0.007	"
COD	0.5 ~ 2	"
Ca^{++}	75 ~ 100	"
PO_4	1.2 ~ 2.5	
Cr	ND	
CN	ND	
Phenol	0	mg/l

Table 3

Residual chlorine (total) at	< 0.5	mg/l
" (free at end of network)	< 0.05	"
*1. Allowable iron content	is ~~up to~~ not exceed 0.5	mg/l

Appendix 6

Annual Report of Ha Noi Water Supply Company

HANOI WATER SUPPLU COMPANY FINANCIAL REPORT '93

Water production:		115,200,000 m^3/year
Water billed:		63,360,000 m^3/year
Water sold:		53,856,000 m^3/year
Non accounted water:		45% of loss + Public tap 15%
Water tariff:	Domestic	800 d/m^3
	Industry	1,600 d/m^3
	Foreigner	0.45 US$/$m^3$
	Public	1,200 d/m^3
Number of employees		
	Graduates	117
	Highschool	99
	Others	1,448
Total		1,689

I. Chemical cost

1) Chlorine

4,200 d/kg 1kg/1,000 m^3

(115,200,000x85%x4,200x1.05)/1,000= 431,827,000

2) Hypochlorine(15%)

50 l/1,000 m^3 1,000 d/kg

(115,200,000x15%x50x1,000x1.05)/1,000= 907,200,000

3) Chlorine cylinge maintenance 150,000,000

Total 1,489,027,200

II Electricity

0.41kw/m^3, 480d/km

480x0.41x115,200,000= 22,671,360,00

480x0.41=196.8 d/m^3III Salaries

Average salary: 184,000 d/month

184,000x950x12= 2,097,600,000

IV.Operation cost of euipment

Fixed asset 31,12,1992	62,000,000,000	
Increase in 1992	33,000,000,000	
Total		95,000,000,000
Depreciation:5%	4,750,000	
3%	2,850,000	
Salaries: 184,000x94x12=	211,968,000	
Repare	8,,,000,000	
Total		8,611,968,000

74.8 d/m^3

V.Workshop cost

Salaries: 184,000x51x12=	112,608,000	
Safety cloth: 12,000x174=	209,640,000	
Fuel for transportation:	210,000,000	
Diesel :	33,000,000	
Skocial insurance:184,000x747x12=	655,753,920	
Other expense:	50,000,000	
Electricity:	20,000,000	
Material for maintenance:	2,880,000,000	
Total		4,351,001,920

37.8 d/m^3

VI. Distribujtion

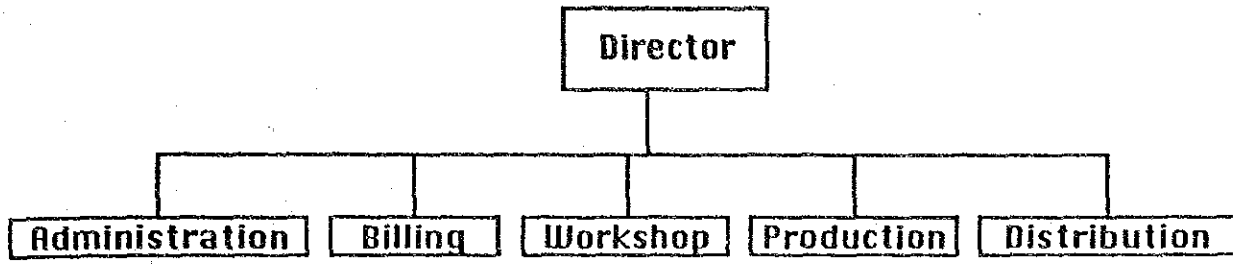
Saralies: 184,000x450x12=	993,600,000	
Meter repare:	917,000,000 }	
Pipe repare:	120,000,000 }	
Flushing and air scouring:	79,000,000	
Pipe repare of net works	300,000,000 -	
Public taps:	60,000,000	
Advertizemrent:	200,000,000	
Electricity for booster pump:	400,000,000	
Regular repare:	500,000,000 -	
Others:	50,000,000 -	
Total		3,619,900,000
	399.8 d/m^3	

Appendix 7

Proposed Water Supply Company for Gia Lam

PROPOSED ORGANIZATION
OF
GIA LAM WATER SUPLY CORPORATION

The organization of the water supply corpaoration of Gia Lam Water Supply is proposed as shown below.



Number of necessary staff is estimated considering the production capacity of Mai Dih and Gia Lam treatment plants.

1. Administration 16 17

2. Billing 20

3. Workshop

Manager	1
Deputy Manager	1
Sanitary Engineer	2
Electrical Engineer	2
Mechanical Engineer	2
Piping Engineer	3
Workers	30
Total	41

4. Production

Manager	1
Operator	2 (Water Quality Specialist 1
Worker	20
Attendant	
Foreman	1
Water Source	2
Electric/Mechanical	2
Guardman at wells	2
Guardman at Plant	2
Sub total 8 x 4 shift	=32
Total	55

5. Distribution

Manager	1
Assistant	2
Piping Engineer	2
Surveyor	2
Worker	20
Grand Total	158

ESTIMATION OF WATER PRODUCTION COST

	Dong / year
1. Salaries	
Administration and Billing 200,000x37x12=	88,800,000
2. .Administration	
1) Transportation 15,000x160x50%x12=	14,400,000
2) Sacurity	7,000,000
3)Fire Preventive	3,600,000
4) Drinking water 1,500x160x12=	2,880,000
5) Medical care 2,000x160x12=	4,000,000
6) Medical iusurance	15,000,000
7) Electricity	30,000,000
8) Reception cost for adviser	10,000,000
9) Training	6,000,000
10) Transportation	16,000,000
11) Communication	6,000,000
12) Printing	12,000,000
13) Stationary	

		7,000,000
14) Reception and holiday		4,000,000
15) Social insurance		38,400,000
16) Others		80,000,000
Total		256,280,000
3 Workshop		
1) Salaries 200,000x41x12=		98,400,000
2) Safety cloth 120,000x41=		4,920,000
3) Fuel for transportation		20,000,000
4) Diesel		3,000,000
5) Other expense		5,000,000
6) Electricity		2,000,000
7) Meintenance materials		144,000,000
Total		272,404,000
4 Production		
1) Salaries 200,000x55x12=		132,000,000
2) Chemicals Chlorine and Al.sulfate	25.5 d/m3xQ	
3) Electricity	141 d/m3xQ	
5. Distribution		
1) Salaries 200,000x27x12=		64,800,000
2) Electricity	183 d/m3xQ	

3) Repare	24,740,000

6.Depreciation

Construction cost	
1) Intake	285,200,000
Drilling	31,200,000
Equipment	
Well house	
2) Raw water transmission	360,000,000
600mm DIP 6.1km	
450mm DIP 1.2km	
250mm DIP 0.5km	
3) Treatment plant	2,200,000,000
30,000m^3/day	
4) Distribution pipelines	784,400,000
600mm DIP 1.9km	
450mm DIP 4.6km	
250mm DIP 10.7km	
100mm VP 2.2km	
75mm VP 5.4km	
50mm VP 28.0km	
Water supply device 10,000 pcs	
5) Land acquisition	
40,000x100x6.8x5x10	136,000,000
6) Access road	
13,000x8x550	57,200,000
7) Extension of power line	11,570,000
8) Cousulting fee	300,000,000
Total	4,103,170,000

Appendix 8

Hydrogeology in Project Area

Study of Groundwater Resources
in
the Project Area

CONTENTS

Tables

Figures

I. Topography and Geology

The Red River delta is vast, about 150km long and about 80km wide spreading in a NW-SE direction, and reaching the Gulf of Tongking. The Red River, which originates in China and flows into the Gulf of Tongking, is the second largest river in Vietnam, with a catchment area of 143,600km2 and a length of 1,183km of which 510km flows in Vietnamese territory. Hanoi City, the capital of Vietnam, is situated on the upper part of the Red River delta and is about 100km from the sea. The project area, the Gia Lam area of Hanoi, is situated on the left bank of the Red River with the central part of Hanoi across of the river. All of the project area, except the southeastenr part, is surrounded by the Red River and its tributary, the Duong River. The Red and Duong rivers are raised-bed rivers, because their riversides have an elevation of about 10m, while the central part of the project area (protected lowland) is about 4 to 6m.

The Red River delta is composed of deposits mainly transported by the Red River in the period from the Pleistocene to the Holocene ages. These deposits average 80m in thickness in the project area and form good aquifers in their coarse-grained layers such as those composed of sand and gravel. The hills and mountains around the delta are mainly composed of Mesozoic rocks; the basement of the delta, however, is composed of Tertiary sediments.

II. Hydrogeology

Pleistocene and Holocene deposits in the Red River delta average 80m in thickness and form good aquifers in their coarse-grained layers such as those composed of sand and gravel. Groundwater in the delta has been developed aggressively since the French colonial era and hydrogeology of the delta has been investigated to some extent by the collection and analysis of the existing well data by the Vietnamese Department of Geology and other organizations concerned.

II-1.Existing Wells

Fig.1 is the location map of the existing wells in the project area. The details of those wells are shown in Table 1 through Table 3. Existing wells in the project area were classified into three categories and defined as follows:

1)Monitoring Wells

The main objective of these wells is to observe groundwater levels. Well construction and level observation has been done since 1989 with FINNIDA assistance. Observation of the groundwater level is done by the staff of the Department of Geology every other week. Thirteen wells which target four different aquifers have been constructed in seven groups, named M-1 to M-7, and more wells are planned for the future. The screen diameter of these wells ranges from 60 to 110mm.

2)Pilot Wells

The objective of these wells, usually constructed prior to the exploiting wells described below, is to geologically survey and/or conduct pumping tests. There are 12 wells, named P-1 to P-12. The screen diameter ranges from 108 to 168mm.

3)Exploiting Wells

The objective of these wells is to tap groundwater for domestic water supply and/or industrial use. There are 30 wells in 23 groups, named E-1 to E-23. The total pumped water quantity available has been calculated at 19,000m3/d; it is, however, estimated to be 30,000m3/d, actually. The screen diameter ranges from 168 to 370mm.

II-2. Hydrogeology

Fig.3 shows the hydrogeological outline in and around the project area.

II-2-1. Neogene Tertiary Basement Rocks(m4)

This formation forms the basement of the Red River delta. The upper part, 16 to 31m thick, is composed of weakly cemented conglomerates and sandstone, and holds water. The beds of shale, siltstone, sandstone, and conglomerates below are solid, poorly fractured, and hold little water.

Several pumping tests have been carried out in this formations in and around the project area. According to the test results, the specific capacity and transmissivity range from 1.10 to 3.75l/sec/m(2.53l/sec/m on the average) and from 46 to 1,064m2/d(604 m2/d on the average),respectively(screen diameter was 108 to 168mm).

II-2-2. Quaternary

a. Pleistocene

a-1. Confined Aquifer(qp1)

This is the main aquifer which almost all of the exploiting wells in the project area are targeting. The upper and middle parts of this aquifer are composed of sand and gravel, and the lower part is mainly sand, silty sand, and fine cobbles. This aquifer tends to thicken from the northwest to the southeast, and is mostly between 30 to 50m in thickness, with a maximum thickness of 84.6m and a minimum of 28.6m.

According to the pumping tests of this aquifer in and around the project area, the specific capacity and transmissivity range from 1.54 to 7.99l/sec/m(5.37l/sec/m on the average) and 957 to 2,900m2/d(1,628m2/d=1.90 x 10*(-2)m2/sec),respectively(screen diameter was 108 to 168mm).

From the Vietnamese well records for 1992(excepting M-2, for which 1990 records were used and M-1, which has abnormal values), the piezometric heads of this aquifer observed in the monitoring wells show the lowest values at an elevation of 2.33 to 3.28m (2.75m on the average)in April or May and the highest values at an elevation of 6.05 to 7.97m(7.16m on the average) in July or August. The piezometric heads of the monitoring wells in the project area show almost the same values, a flat elevation,

within a season; those differences between the lowest and the highest, however, reach 4.41m.

a-2. Confining Layer I(cf1)

This layer which exists between the aquifer(qp1) and the aquifer(qp2)described below, is an aquiclude or an impermeable layer, which is composed of clay mixed with sand and varies from 0.9 to 6.9m in thickness(3.9m on the average). This layer does not exist in a part of the riverside along the Red River.

a-3. Unconfined or Weakly Confined Aquifer(qp2)

There is no exploiting well targeting this aquifer in the project area. This aquifer ranges from 2.5 to 22.5m in thickness(usually 15 to 20m)and is mainly composed of medium to coarse-grained sand mixed with some gravel near the bottom.

According to the observation records of the wells targeting this aquifer near the project area, the confining pressure of this aquifer is generally weak, and the water level(piezometric head)is about 4m down from the surface.

b. Holocene

b-1. Confinig Layer II(cf2)

This layer exists between the aquifer(qp2) and the unconfined aquifer(qh) described below, and is an aquiclude or an impermeable layer which is composed of clayey soil ranging from 1.7 to 6.9m in thickness(4.3m on the average). This layer does not exist in a part of the riverside along the Red River.

According to the pumping tests in Hanoi area, the average permeability of this aquifer is 0.023m/d.

b-2. Unconfined Aquifer(qh)

Dug wells usually target this aquifer.

BThis aquifer ranges from 7.5 to 19.5m in thickness(12.53m on the average), and is mainly composed of sand and silty sand increasingly mixed with gravel in a downward direction. The water level of this aquifer is usually two to four meters deep.

According to tests conducted near the project area, the specific capacity and permeability of this aquifer are 1.98l/sec/m and 27.9m/d, respectively.

II-3. Groundwater Quality

Table 4 shows the groundwater quality sampled from the main aquifer(qp1) in the project area. Due to a difference in objectives, different items were analyzed in the monitoring and exploiting wells. Total iron(Fe) and manganese(Mn) should be noted, because both values greatly exceed both the WHO and Vietnamese drinking water standards.

III. Study of Groundwater Potential

III-1. Groundwater Balance

The planned water demand is 32,100m3/d, which is about 1,170 x 10*4m3/year, including a loss of 7%.

The confined groundwater balance equation is as follows;

Qr=AS(dh/dt)+Qd.....(1)

where

Qr =Groundwater inflow(recharge)to the study area over time

Qd =Groundwater outflow(approximately well discharge)from the study area over time

A =Study area(project area)in square meters

S =Average storativity of the study area

dh/dt=Average piezometric head variation(drawdown) of the study area

The study area is 36 x 10*(6)m2, surrounded by the Red River, the Duong River, and Tailoring Enterprise No.10. The time period was a year.

In the case of confined groundwater, the groundwater is recharged to the aquifer due to well drawdown. In the project area, the groundwater is recharged by surface water, such as the Red River and the Duong River, and precipitation. Therefore, the rechargeable groundwater is a fraction of the total annual flow of the two rivers and the annual precipitation minus evapotranspiration. Here, only the annual river flow was studied.

Red River annual average flow :3,740m3/sec

Duong River annual average flow: 886m3/sec

Two rivers' total annual flow:

(3,740+886) x 86,400 x 365=1.46 x 10*(11)m3/year

This total flow is regarded as the flow that exists after that the drawdown due to the existing well discharge and the groundwater recharge have balanced.

In this project, the proposed annual discharge is 32,100 x 365=1,170 x 10*(4)m3/year, the average storativity(S) is 1.0 x 10*(-3)(assumed), and the piezometric head variation(dh/dt) is 4.0m; the right side of equation(1) is as follows;

(36 x 10*(6)) x (1.0 x 10*(-3)) x 4.0 + (1,170 x 10*(4))=1.18 x 10*(7)m3/year

As this value, 1.18 x 10*(7), corresponds to only about 0.01% of the two

rivers' annual flow of 1.46 x 10*(11), the groundwater recharge from the river water should be sufficient.

III-2. Study of Groundwater Resources

The water resources were calculated assuming groundwater resources are used and there is a discharge of 50l/sec per well, varying the well structure, radius of influence, and well field location. Here, the former two items are described.

- Well Structure

A 350mm(14") diameter for the casing and screen pipe were decided upon after referring to the results of the FINNIDA project in Hanoi City. The diameter of the borehole was set at 500mm(20") considering the thickness of the packing gravel. The total screen length of each well is designed so that the main target aquifer(qp1) is screened more than 70% of its total thickness. The depth and length of the screen section are determined considering the unit length of the casing and screen pipe. Then, the depth of the borehole is determined.

- Radius of Influence

1)Transmissivity(T)

The average transmissivity of the target aquifer(qp1) is 1.90 x 10*(-2)m2/sec.

2)Storativity(S)

The storativity is presumed to be 1.0 x 10 *(-3),which is used as a general value of the storativity due to the lack of available data and is one power lower than the order of transmissivity in m2/sec.

3)Pumping Discharge(Q)

The proposed pumping discharge is 50l/sec(50 x 10*(-3)m3/sec)

4)Pumping Time(t)

The designed continuous pumping time is 20 hours(20 x 3,600=7.2 x 10*(4)sec)

5)Well Diameter(2r)

The proposed well diameter is 350mm, therefore, well radius(r)=350/2mm=35/2 x 10*(-2)m

Theis'formula is as follows;

$s=QW(u)/4\ T$.....(1)

where
s =drawdown
W(u)=well function

with Q, T, and equation(1)
s=2.09 x 10*(-1)W(u).....(2)

while
u=r*(2)S/4Tt
with r, S, T, and t
u=5.59 x 10*(-9)
from the Theis type curve, W(u)=18 against u=5.59 x 10*(-9)
therefore, with equation(2)
s=2.09 x 10*(-1) x 18=3.76, that is, drawdown(s) is 3.76m

The radius of influence(R) to the point where a 1.0m drawdown of groundwater level is observed is calculated with equation(3)
(s-1)=Qln(R/r)/2 t.....(3)

with calculated s, Q, r, t, and equation(3)
logR=2.10, R=126, that is,the distance between wells should be 126 x 2=252, or about 250m.

Table 1. Monitoring Well List in Gia Lam Area

No.	Well Name	Location X , Y	Owner	Constructed Date	Elevation (m)	Depth (m)	Screen d(mm),l(m)	Water Level L/H (El.m)	Remarks
M-1	P13a	30.000, 92.675	-	Sep/1989	5.19	50.00	60, 3.0	4.74(0.45)/+0.10(5.29)	SW:P13b for aquifer(qh)
M-2	P15a	27 , 93	-	Sep/1989	6.91	50.00	60, 3.0	4.12(2.79)/+0.11(7.02)	SW:P15b for qh
M-3	Q120b	26 , 94	-	Sep/1989	5	46.51	-,10.1	1.72(3.28)/+1.05(6.05)	SW:Q120 for qh,Q120a for qp2
M-4	P33a	26.716, 89.452	-	Aug/1991	9.66	62.00	90, 9.0	7.33(2.33)/ 2.08(7.58)	SW:P33b for qh
M-5	P49a	24.735, 91.913	-	Sep/1991	10.86	62.00	110,11.0	8.28(2.58)/ 2.89(7.97)	SW:P49b for qh
M-6	Q32	31 , 90	-	Dec/1992	10.00	16.00	90, 9.0	- / -	For qh
M-7	Q121	31 , 91	-	Dec/1992	10	16.00	90, 9.0	- / -	For qh

* Water Level of "M-2" is in 1990, the others are in 1992.
* "L/H" in "Water Level" means the lowest and the highest in a year respectively.
* "SW" in "Remarks" means "set well" and its aiming aquifer.

Table 2. Pilot Well List in Gia Lam Area

No.	Well Name	Location X , Y	Owner	Constructed Date	Elevation (m)	Depth B/W(m)	Screen d(mm),l(m)	Water Level	Remarks
P- 1	M38	30 , 92	-	-	-	22.8/ 7.5	108, 4.5	-	For aquifer(qh)
P- 2	820	25 , 96	-	-	-	87.0/ 82.0	108,23.0	-	For qp1 & m4,T=957m2/d
P- 3	M03	27 , 97	-	-	-	13.0/ 13.0	108, 3.0		For pq2
P- 4	900	32 , 92	-	-	-	111.7/ -	-	-	-
P- 5	4HN	28 , 94	-	-	-	130.0/ 63.0	108,12.0	-	For qp1,T=1,026m2/d
P- 6	7HN	31 , 93	-	-	-	110.0/ 64.0	127,20.0		For qp1
P- 7	49	27 , 90	-	-	-	130.0/125.3	127,49.5	-	For qp1,T=2,900m2/d
P- 8	VTHHSD	27 , 96	-	-	-	60.0/ 57.9	108, 9.0	-	For qp1
P- 9	CHACQ	25 , 97	-	-	-	70.8/ 70.8	168,16.5	-	For qp1
P-10	TCHQ	27 , 90	-	-	-	70.0/ 68.0	168,17.5	-	For qp1
P-11	6HN	28 , 90	-	-	-	118.0/ 59.0	127, 9.0	-	For qp1
P-12	GYV	32 , 94	-	-	-	40.0/ 36.5	127, 7.0	-	For qp1

* "B/W" in "Depth" means borehole and well depth respectively.
* "T" in "Remarks" is transmissivity (m2/day).

Table 3. Exploiting Well List in Gia Lam Area

No.	Well Name	Location X , Y	Owner	Constructed Date	Elevation (m)	Depth (m)	Screen d(mm),l(m)	Water Level	Discharge (m3/d)	Pumping Hour/day	Remarks
E- 1	HMG	31 ,94	Ply-Timber Factory	1973	-	70.0	219,12.0	-	1,680	10	3 wells
E- 2	HMD	31 ,94	Match Factopy	1989	-	68.0	168,10.0	-	720	6	2 wells
E- 3	HCDG	31.250,92.030	DuGiang Chem. Fac.	1975	-	70.0	325,12.0	-	3,240	18	
E- 4	BVDKOC	30.175,93.150	O Cach Hospital	-	-	65.0	168,10.0	-	150	5	
E- 5	QKTD	27 ,90	Military Base	-	-	-	- , -	-	40	-	
E- 6	GL	28 ,91	Gia Lam Water Plant	1958	-	65.0	370,20.0	-	3,500	24	2 wells
E- 7	SD	27 ,93	SaiDon Water Plant	1974	-	68.0	370,32.0	-	1,000	15	2 wells
E- 8	NMKKTL	27.375,94.800	ThangLong Met. Fac.	-	-	-	- , -	-	80	4	
E- 9	CNC14	27.200,94.950	Bridge Enter. No.14	-	-	60.0	219,15.0	-	120	4	
E-10	CNVLMB	27.100,94.000	Airoplane Enter.	-	-	70.0	168,12.0	-	60	3	
E-11	M10	27 ,95	Garment Enterprise	1976	-	70.0	325,12.0	-	1,600	12	2 wells
E-12	CNC12	26 ,98	Bridge Enter. No.12	-	-	-	- , -	-	240	-	
E-13	CKXDGL	26 ,97	GL Mech.Construc.Co	-	-	-	- , -	-	60	-	
E-14	TDHNN	24 ,97	Agricultural Univ.	-	-	67.0	219,12.0	-	1,920	16	2 wells
E-15	TTXNDB23027	,98	Residents of E-12	-	-	-	- , -	-	150	-	
E-16	DTTTW	29 ,90	Mulberry Farm	-	-	60.0	146, 6.0	-	200	10	
E-17	XN26	30 ,90	Enterprise No.26	-	-	70.0	168,12.0	-	420	10	
E-18	J112	30 ,90	J112 Enterprise	-	-	-	- , -	-	150	5	
E-19	HVHC	30 ,91	Military Insti.	-	-	70.0	219,14.0	-	300	10	
E-20	DKYV	31 ,94	YenVien Oxgen Fac.	-	-	70.0	219,14.0	-	600	12	
E-21	-	29 ,91	Locomotive Factory	1970	-	81.0	400, -	-	1,500	20	
E-22	-	28 ,90	Gen. Dep. Customs	1980	-	60.0	325, -	-	400	20	
E-23	-	30 ,92	Gen. Petrol. Stores	1981	-	61.0	273, -	-	200	8	

Table 4. Groudwater Quality in Gia Lam Area:Aquifer(qp1)

No.	Well No.	pH	Na+	K+	Ca++	Mg++	Fe+++	Fe++	NH4+	Al+++	Mn++	Cl-	SO4--	HCO3--	CO3--	NO2--	NO3--	PO4--	Analyzed Date
1	M- 1	7.10	37.50	0.63	14.63	4.50	*	16.80			-	9.04	2.40	128.14			1.30	-	Sep/'90
2	M- 2	8.40	16.00	1.00	39.08	7.90	0.70	8.38			-	10.32	6.00	152.55	12.00		7.60	-	Feb/'91
3	M- 3	7.30	32.30	0.38	12.02	6.08	16.76	4.19			-	8.30	14.41	134.24				-	Mar/'93
4	M- 4	7.00	13.64	0.75	44.09	21.89	2.09	2.79			-	7.66		256.28		10.50	0.30	-	Jul/'91
5	E- 3	6.50	-	-	-	-	*	16.50	-	-	0.40	42.00	-	-	-	-	-	-	Apr/'72
6	E- 6	7.00	-	-	-	-	*	10.50	-	-	1.92	30.70	-	-	-		1.60	0.06	Jun/'85
7	E- 6	7.00	-	-	-	-	*	9.00	-	-	2.20	17.90	-	-	-		-	2.56	May/'85
8	E- 6	7.00	-	-	-	-	*	19.50	-	-	1.92	31.20	-	-	-		-	1.60	May/'85
9	E- 6	7.00	-	-	-	-	*	10.00	-	-	0.80	10.65	-	-	-	0.92		2.40	Sep/'86
10	E- 6	7.00	-	-	-	-	*	10.00	-	-	1.40	17.70		-	-	0.02		3.00	Sep/'86
11	E-16	7.50	-	-	-	-	*	17.50	-	-	0.26	11.40	8.23	-	-			3.00	Apr/'77
12	E-21	6.50	-	-	-	-	*	14.20	-	-	0.33	50.00	-	-	-	-	-	-	Apr/'72
13	E-22	6.80	-	-	-	-	*	14.50	-	-	0.95	12.05	18.20	-	-	0.05		2.90	May/'89
	VIET. STAN.	6.5 8.5			75 to 100		Total	<0.3	<3		<0.2					0	<6		
	WHO STAN.				75	50	Total	0.3	0.5		0.1	200	200				40		

* Unit of "mg/l" except "pH"
* In case of "*" in "Fe3+", "Fe" is analized as total "Fe".
* "-" means "not analized" and "no mark" means "0 value".
* "VIET.STAN."and "WHO STAN."mean Vietnamese and WHO standard respectively.

Table 5. Hydrologic Data of the Red River and the Duong River

- Red River(Hanoi Station)

Value \ Year	1983	1984	1985	1986	1987	1988	1989	1990
Water level max	12,07	10,48	11,96	12,35	10,18	10,15	10,23	11,94
min	2,34	2,46	2,76	2,17	2,19	2,07	2,12	2,6
Amplitute	9,74	8,02	9,20	10,18	7,99	8,08	8,11	9,34
Q max m3/s	12400	10000	13700	14600	8360	8360	9100	12500
Q min	533	594	909	602	530	486	448	650
max Time	23,26	16,84	15,07	24,25	15,77	17,2	20,31	19,23
min								
V max m3/s	1,6	1,54	1,62	2,88	1,96	1,85	1,46	1,39
min m3/s	0,61	0,6	0,59				1,42	0,39
Turbidity max g/m3	3820	2030	2440	12500	3500	1620	3330	3430
min g/m3	41,5	5,9	9,7	32,4	16,6	9,4	9,5	7,4

- Duong River(Thuong Cat Station)

Value \ Year	1986	1987	1988	1989	1990			
Water level max	11,98	10,05	9,97	10,0	11,58			
min	2,62	2,68	2,7	2,68	3,21			
Amplitutue	9,36	7,37	7,27	7,32	8,37			
Q max m3/s	6200	3990	3440	3280	5830			
Q min	120	100	90,5	96,6	196			
max time	51,67	39,9	38,01	33,95	29,74			
min								
V max m3/s	2,78	2,09	2,34	1,94	1,95			
min m3/s				0,4	0,39			
Turbidity max g/m3	15100	5220	2040	2170	3570			
min g/m3	17,5	25,2	6,7	10,9	19,7			

Table 6. Water Quality of the Red River and the Duong River

- Red River(Son Tay & Hanoi Station:1980-1991)

Parameters	St. Son Tay			St. Hanoi		
	Min	Max	Ave.	Min	Max	Ave.
Temperature (°C)	15.6	31.6	24.4	14.8	81.2	24.1
pH	5.5	8.3	7.4	6.0	8.3	7.2
Fe total (mg/l)	0.04	1.3	0.3	0.04	1.4	0.2
SiO_2 (mg/l)	2.0	60.0	14.2	2.0	28.0	13.3
Ca^{++} (mgdl/l)	0.78	1.8	1.3	0.78	1.9	1.3
Mg^{++} (mgdl/l)	0.16	1.3	0.5	0.08	1.2	0.5
Na+K (mgdl/l)	0.02	0.9	0.4	0.05	0.8	0.4
HCO^{-} (mgdl/l)	1.2	3.1	2.0	1.4	2.5	2.1
SO_4^{--} (mgdl/l)	0.02	0.5	0.2	0.02	1.1	0.2
Cl (mgdl/l)	0:02	0.5	0.1	0.01	0.2	0.1
Total ion (mgdl/l)	3.17	6.3	4.4	3.13	5.8	4.5
Alkality (mgdl/l)	1.2	3.1	2.0	1.4	2.5	2.1
Hardness (mgdl/l)	1.16	2.9	1.8	1.24	2.5	1.8

- Duong River(Thuong Cat Station:1980-1991)

Parameters		Min.	Max.	Aver.
Temperature	C	15	31.2	24.3
pH		6.4	8.5	7.4
Fe total	mg/l	0.04	3.2	0.3
SiO_2	mg/l	2.0	48.0	16.8
Ca	mgdl/l	0.42	2.0	1.3
Mg	mgdl/l	0.12	1.29	0.56
Na+K	mgdl/l	0.04	1.27	0.42
HCO_3	mgdl/l	1.6	3.3	2.08
SO_4	mgdl/l	0.02	0.62	0.15
Cl	mgdl/l	0.01	1.72	0.12
Total ion	mgdl/l	3.36	6.86	4.51
Alkality	mgdl/l	1.6	3.3	2.08
Total hardnees	mgdl/l	0.87	2.84	1.82

Table 7. Well List in the FINIDA Project

No.	Water Plant	Well No.	Depth (m)	Screen d(mm),l(m)	Discharge (m3/h)	Remarks
1		K27	71.0	350,18.0	200	
2	Ngosi	K28	70.5	350,18.0	172	
3	lien	K29	76.0	350,18.0	68	
4		K30	76.0	350,18.0	58	
5		K31	76.0	350,18.0	132	
6		K 1	65.0	350,18.0	154	
7		K 2	65.0	350,18.0	130	
8		K 3	64.5	350,17.3	130	
9	Phap	K 4	64.5	350,17.3	140	
10	van	K 5	64.5	350,17.3	170	
11		K 6	61.5	350,17.3	140	
12		K 7	62.5	350,17.3	210	
13		K 8	64.6	350,17.3	195	
14		K 9	62.3	350,17.3	180	
15	Tuong	K19	76.0	350,18.0	62	
16	mai	K20	73.0	350,18.0	-	
17		K10	69.0	350,18.0	172	
18	Ngoc	K11	63.0	350,18.0	200	
19	ha	K12	63.0	350,17.4	170	
20		K13	63.5	350,17.4	170	
21		K14	62.5	350,17.4	270	
22		K10	62.0	350,24.0	80	
23	Yen	K19	68.0	350,18.0	55	
24	phu	K29	70.0	350,18.0	83	
25		K30	69.0	350,18.0	135	
26		K 1	59.5	350,18.0	-	
27		K 2	58.0	350,18.0	155	
28		K 3	58.5	350,18.0	200	
29		K 4	62.5	350,18.0	196	
30		K 5	54.0	350,18.0	216	
31		K 6	55.0	350,18.0	-	
32	Mai	K 7	56.5	350,18.0	120	
33	dich	K 8	58.5	350,24.0	155	
34		K 9	57.5	350,24.0	120	
35		K10	57.2	350,17.4	170	
36		K11	56.0	350,18.0	175	
37		K12	64.0	350,17.4	167	
38		K13	60.0	350,17.4	150	
39		K14	58.0	350,17.4	168	
40		K15	58.0	350,17.4	180	
41		K16	60.0	350,17.4	140	

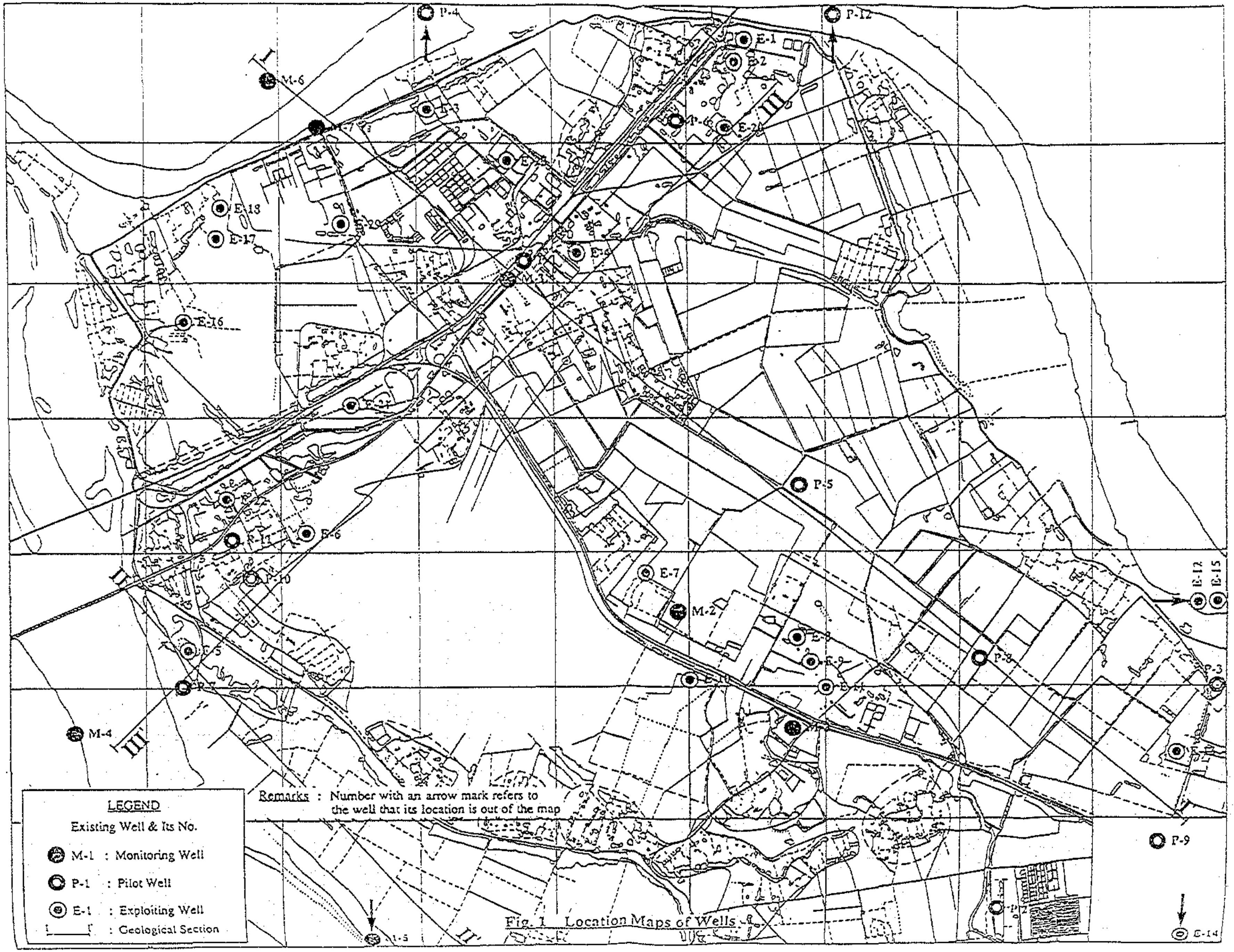
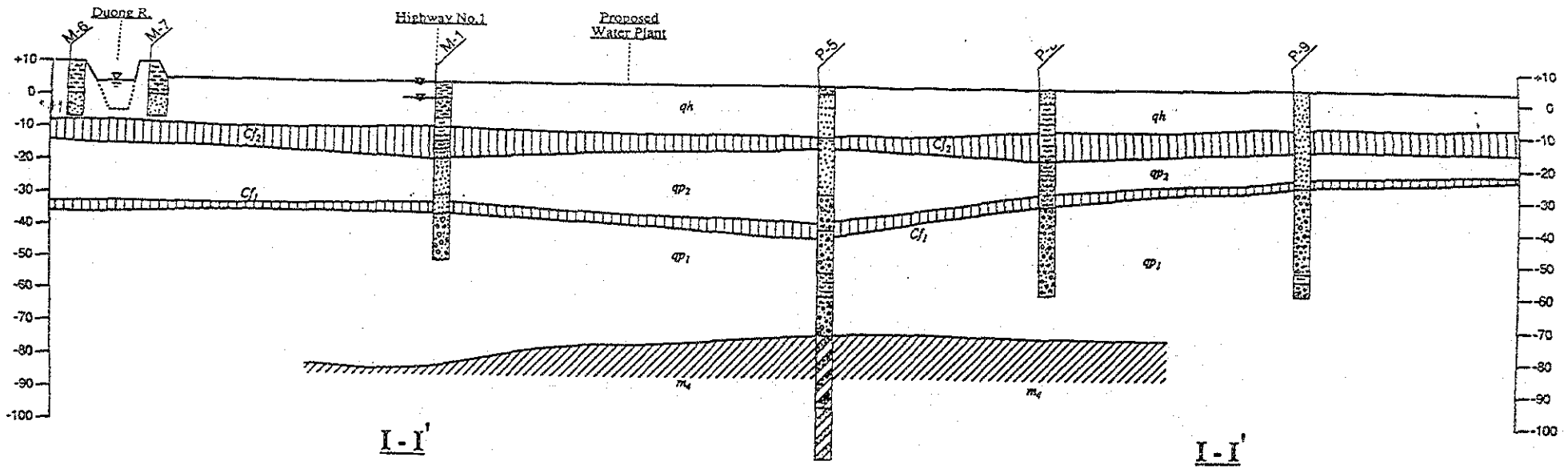
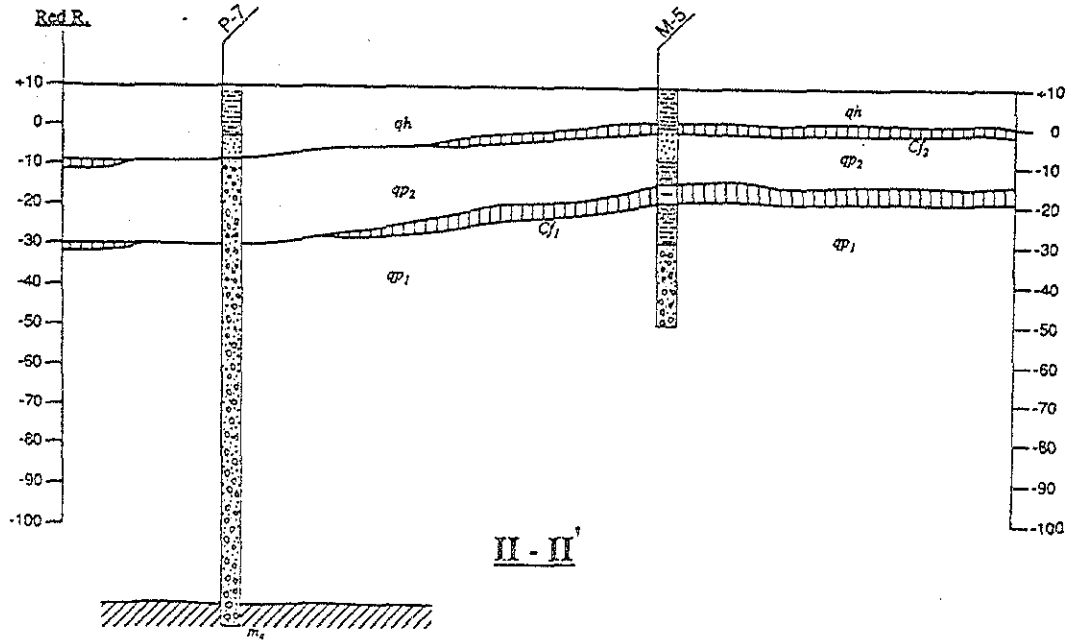


Fig. 1 Location Maps of Wells





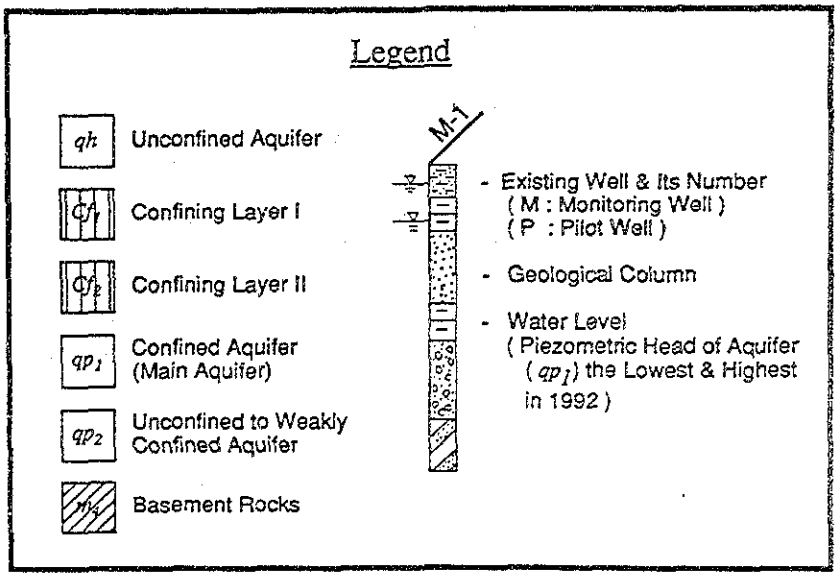


Fig. 2 Hydrological Profiles

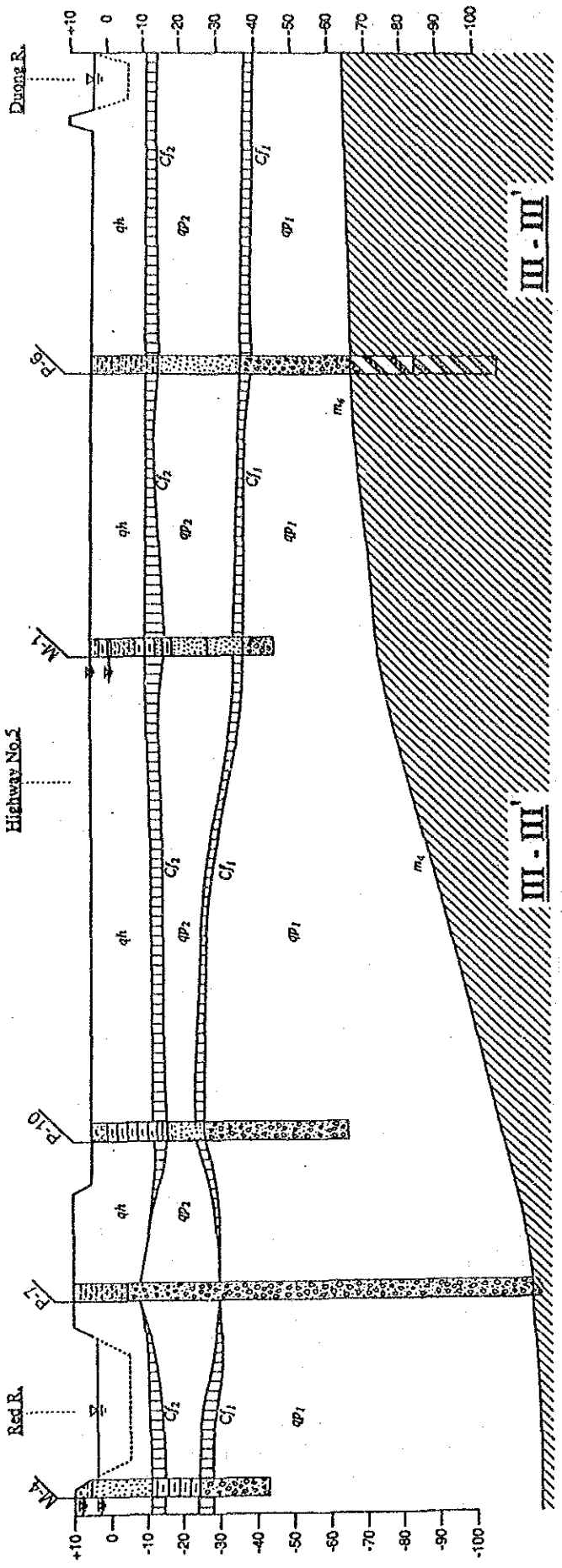
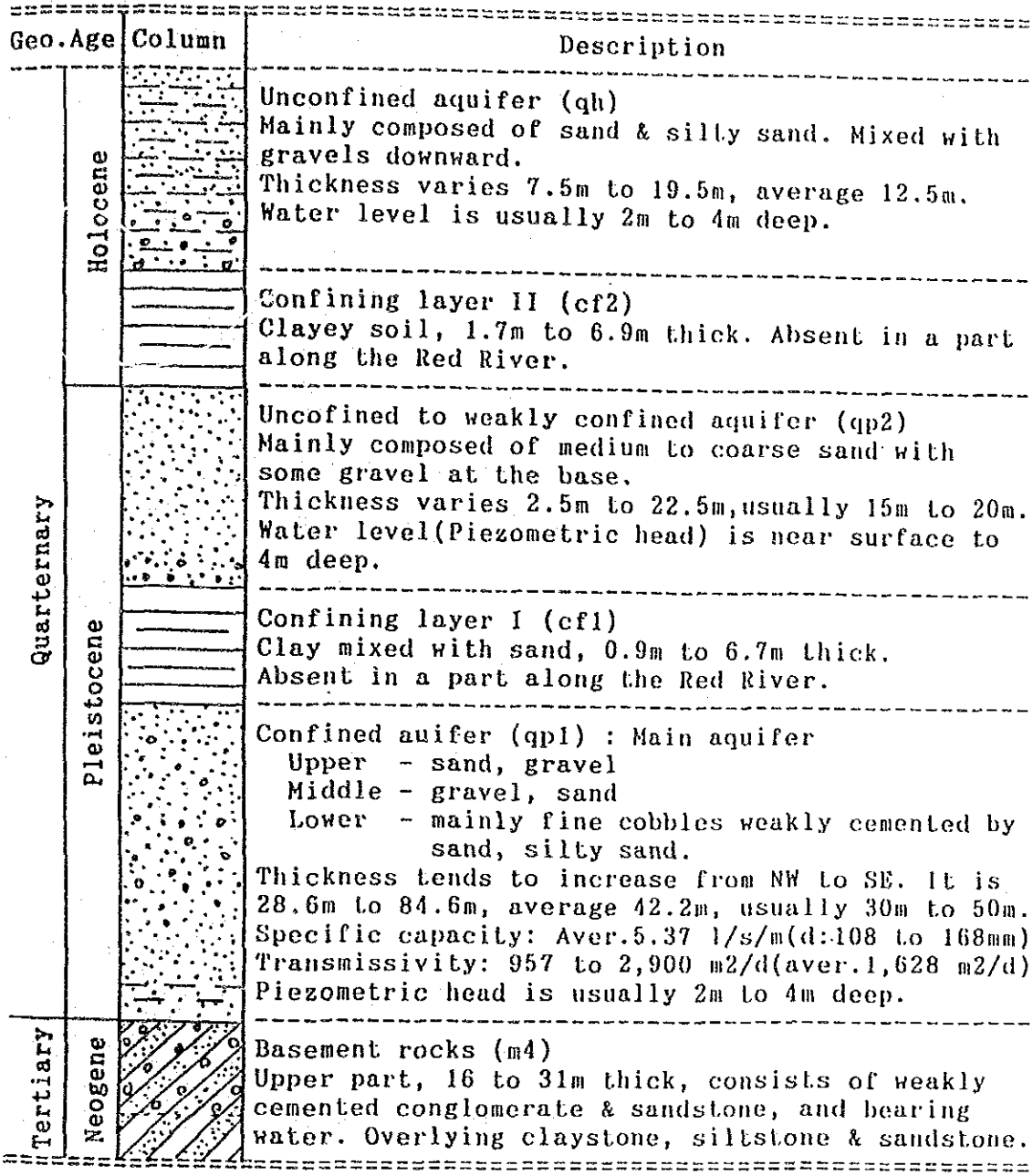

Duong R.
Highway No.5
Red R.
III - III'
III - III'
P-9
P-10
P-7
M-1
M-4
+10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100

Fig. 3. Hydrogeological Outline in Gia Lam Area



Appendix 9

Technical Description of Intake Pump and Water Hammer Analysis of Raw Water Transmission Line

Calculation sheet, Shaft power of submersible motor pump.

Calculation below shows required shaft power for pump driving.

$$P = \frac{Pw}{\eta p} = \frac{0.163 \gamma Q H}{\eta p}$$

Here

P	: Shaft power.		(Kw)
Pw	: Theoretic power.		(Kw)
γ	: Specific gravity of the liquid.	1.0	
Q	: Discharge rate.	3.0	(m^3/min)
H	: Total head.		
	No. 1 to No. 8 Wells. :	45.0	(m)
	No. 9 to No. 12 Wells. :	27.0	(m)
ηp	: Pump efficiency.	65.0	(%)

1. No. 1 to No. 8 Wells.

$$P = \frac{0.163 \times 1.0 \times 3.0 \times 45.0}{0.65} = 33.85$$

Therefore, Required shaft power for above shall be 37(Kw) in standardized articles.

2. No. 9 to No. 12 Wells.

$$P = \frac{0.163 \times 1.0 \times 3.0 \times 27.0}{0.65} = 20.31$$

Therefore, Required shaft power for above shall be 22(Kw) in standardized articles.

VIETNAM Raw Water Transmission Pipe

(Original Condition)

LEVEL -2.000 M

DT .00871 SEC

--- PIPELINE DATA ---

NO	LENGTH M	CLASS	D MM	T MM	E	ORIGINAL PIPELINE		PUMP-NO	S-NO	V-NO	END	PLOT	Q M3/M	PIPE LOSS M	VALVE LOSS M	2L/A SEC	ROW	POINT	DIVISION	
A	50.0	FCD3	250	6.0	1.600			1	0	0	0	0	3.000	3.430	.000	.0871	19.9081	4	10	.0
B	140.0	FCD3	450	7.5	1.600	A		0	0	0	0	0	3.000	.670	.000	.2619	5.7195	4	30	.0
C	10.0	FCD3	250	6.0	1.600			2	0	0	0	0	3.000	3.500	.000	.0174	19.9081	1	2	.0
D	320.0	FCD3	450	7.5	1.600	B	C	0	0	0	0	0	6.000	.390	.000	.5986	5.7195	3	68	.0
E	10.0	FCD3	250	6.0	1.600			3	0	0	0	0	3.000	3.500	.000	.0174	19.9081	1	2	.0
F	330.0	FCD3	450	7.5	1.600	D	E	0	0	0	0	0	9.000	.860	.000	.6173	5.7195	4	70	.0
G	10.0	FCD3	250	6.0	1.600			4	0	0	0	0	3.000	3.500	.000	.0174	19.9081	1	2	.0
H	250.0	FCD3	450	7.5	1.600	F	G	0	0	0	0	0	12.000	1.110	.000	.4676	5.7195	5	54	.0
I	270.0	FCD3	250	6.0	1.600			5	0	0	0	0	3.000	5.050	.000	.4701	19.9081	5	54	.0
J	10.0	FCD3	250	6.0	1.600			6	0	0	0	0	3.000	3.500	.000	.0174	19.9081	1	2	.0
K	10.0	FCD3	400	7.0	1.600	I	J	0	0	0	0	0	6.000	.060	.000	.0185	7.3153	1	2	.0
L	120.0	FCD3	600	9.0	1.600	H	K	0	0	0	0	0	18.000	.280	.000	.2299	3.1419	12	26	.0
M	150.0	FCD3	250	6.0	1.600			7	0	0	0	0	3.000	4.340	.000	.2612	19.9081	4	30	.0
N	650.0	FCD3	600	9.0	1.600	L	M	0	0	0	0	0	21.000	2.000	.000	1.2450	3.1419	3	144	.0
O	10.0	FCD3	250	6.0	1.600			8	0	0	0	0	1.320	3.500	.000	.0174	19.9081	1	2	.0
P	1010.0	FCD3	600	9.0	1.600	N	O	0	0	0	0	0	22.320	3.490	.000	1.9346	3.1419	3	224	.0
Q	4290.0	FCD3	600	9.0	1.600	P		0	0	0	0	1	22.320	14.800	.000	8.2171	3.1419	3	944	.0

--- PUMP DATA ---

NO	SET	TYPE	VALVE	V-NO	PLOT A	PLOT B	HEAD M	Q M3/M	KW	P	GD2 KG-M2	GD2 (WHEEL) KG-M2	RPM	%	START CONDITION HEAD K	START CONDITION HEAD M	START CONDITION Q M3/M	START CONDITION Q N	START CONDITION Q M
1	1	1	1	0	0	0	45.000	3.000	37.0	0	5.000	.000	2950	65	.2844	45.000	3.000	1.000	1.000
2	1	1	1	0	0	0	44.900	3.000	37.0	0	5.000	.000	2950	65	.2838	44.900	3.000	1.000	1.000
3	1	1	1	0	0	0	44.510	3.000	37.0	0	5.000	.000	2950	65	.2813	44.510	3.000	1.000	1.000
4	1	1	1	0	0	0	43.650	3.000	37.0	0	5.000	.000	2950	65	.2759	43.650	3.000	1.000	1.000
5	1	1	1	0	0	0	42.150	3.000	37.0	0	5.000	.000	2950	65	.2664	42.150	3.000	1.000	1.000
6	1	1	1	0	0	0	40.600	3.000	37.0	0	5.000	.000	2950	65	.2566	40.600	3.000	1.000	1.000
7	1	1	1	0	0	0	41.100	3.000	37.0	0	5.000	.000	2950	65	.2598	41.100	3.000	1.000	1.000
8	1	1	1	0	0	0	38.260	1.320	37.0	0	5.000	.000	2950	65	.1064	38.260	1.320	1.000	1.000

--- PIPELINE OUTPUT ---

A B D F H L N P Q

--- PIPELINE PROFILE ---

NO	LENGTH M	HEIGHT M	LENGTH M	HEIGHT M	LENGTH M	HEIGHT M	LENGTH M	HEIGHT M
A	.0	14.00	50.0	8.70				
B	50.0	8.70	290.0	8.70				
D	290.0	8.70	610.0	8.70				
F	610.0	8.70	940.0	8.70				
H	940.0	8.70	1190.0	8.70				
L	1190.0	8.70	1310.0	8.70				
N	1310.0	8.70	1960.0	8.70				
P	1960.0	8.70	2960.0	8.70	2970.0	14.00		
Q	2970.0	14.00	3020.0	14.00	3030.0	3.50	7260.0	3.50

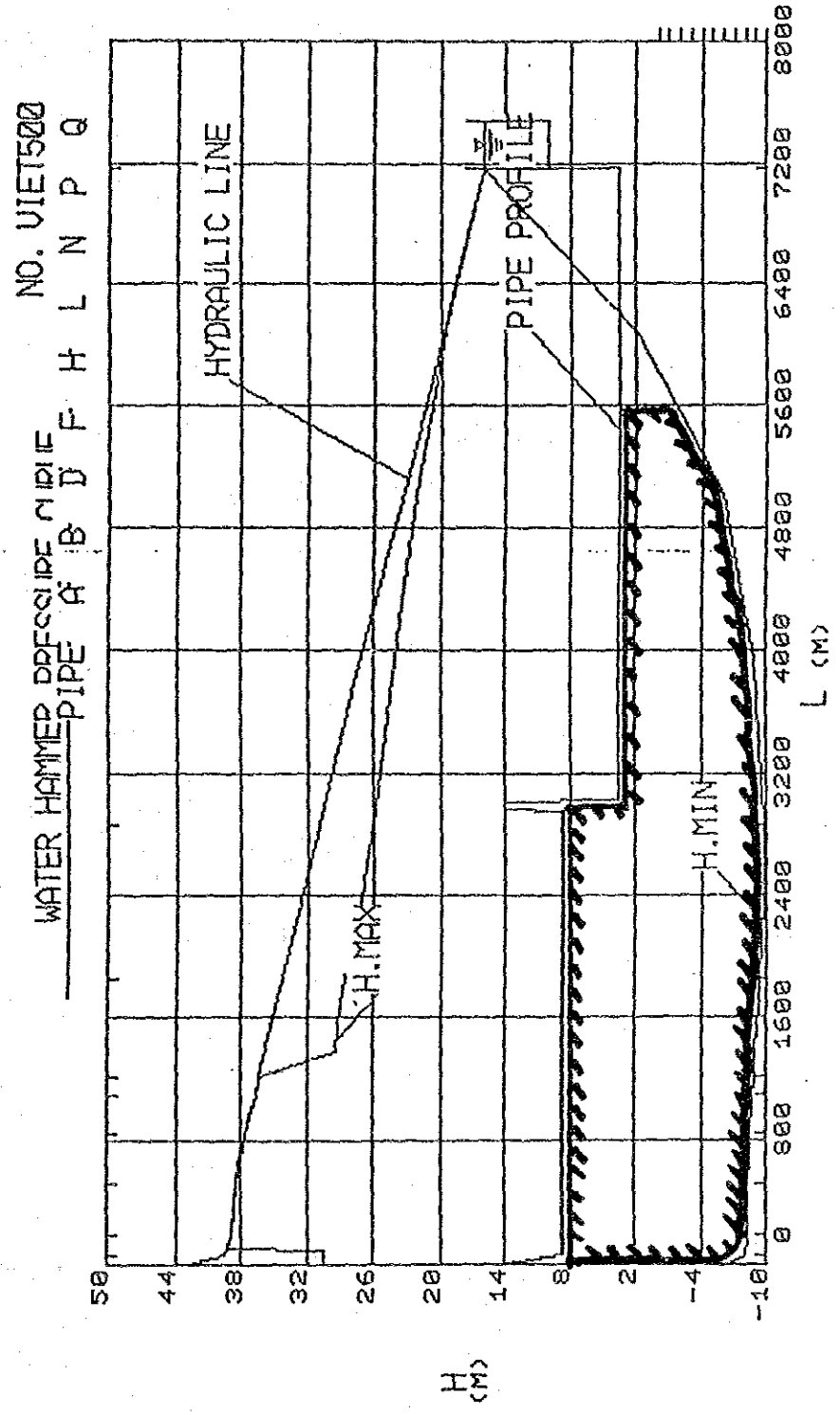
1. ANALYSIS INTERVAL 923

3. PIPELINE PRESSURE

NO		LENGTH M	MAX TIME SEC	MAX Q M3/M	MAX HEAD M	MAX LEVEL M	MIN TIME SEC	MIN Q M3/M	MIN HEAD M	MIN LEVEL M
A	0/ 5	.0	50.013	.000	32.500	30.500	11.997	1.911	-4.737	-6.737
A	1/ 5	10.0	50.021	.000	32.497	30.497	12.023	1.911	-5.011	-7.011
A	2/ 5	20.0	50.030	.000	32.493	30.493	12.014	1.911	-5.302	-7.302
A	3/ 5	30.0	50.030	.000	32.477	30.477	11.753	1.914	-5.541	-7.541
A	4/ 5	40.0	50.039	.001	32.450	30.450	11.858	1.914	-5.809	-7.809
B	0/ 5	.0	49.752	.000	32.449	30.449	11.884	1.914	-6.079	-8.079
B	1/ 5	28.0	49.743	-.001	32.440	30.440	11.884	1.913	-6.126	-8.126
B	2/ 5	56.0	.087	3.000	41.303	39.303	11.840	1.914	-6.183	-8.183
B	3/ 5	84.0	.061	3.000	41.169	39.169	11.849	1.913	-6.229	-8.229
B	4/ 5	112.0	.035	3.000	41.035	39.035	11.884	1.914	-6.272	-8.272
C	0/ 2	.0	49.873	.000	32.437	30.437	11.892	1.879	-4.981	-6.981
C	1/ 2	5.0	49.869	.000	32.434	30.434	11.792	1.882	-5.648	-7.648
D	0/ 4	.0	.009	6.000	40.901	38.901	11.753	3.802	-6.315	-8.315
D	1/ 4	80.0	.083	6.000	40.804	38.804	11.688	3.802	-6.339	-8.339
D	2/ 4	160.0	.157	6.000	40.706	38.706	11.605	3.806	-6.348	-8.348
D	3/ 4	240.0	.083	6.000	40.608	38.608	11.531	3.808	-6.358	-8.358
E	0/ 2	.0	50.639	.000	32.147	30.147	11.579	1.893	-4.992	-6.992
E	1/ 2	5.0	50.635	.000	32.137	30.137	11.496	1.897	-5.671	-7.671
F	0/ 5	.0	.009	9.000	40.510	38.510	11.457	5.709	-6.361	-8.361
F	1/ 5	66.0	.070	9.000	40.338	38.338	11.405	5.712	-6.395	-8.395
F	2/ 5	132.0	.131	9.000	40.166	38.166	11.344	5.714	-6.441	-8.441
F	3/ 5	198.0	.131	9.000	39.994	37.994	11.274	5.718	-6.468	-8.468
F	4/ 5	264.0	.070	9.000	39.822	37.822	11.179	5.722	-6.501	-8.501
G	0/ 2	.0	50.448	.000	32.185	30.185	11.152	1.935	-5.100	-7.100
G	1/ 2	5.0	50.444	.000	32.180	30.180	11.157	1.935	-5.834	-7.834
H	0/ 6	.0	.009	12.000	39.650	37.650	11.152	7.659	-5.540	-8.540
H	1/ 6	41.7	.048	12.000	39.465	37.465	11.122	7.660	-6.591	-8.591
H	2/ 6	83.3	.087	12.000	39.280	37.280	11.074	7.665	-6.627	-8.627
H	3/ 6	125.0	.126	12.000	39.095	37.095	11.000	7.669	-6.673	-8.673
H	4/ 6	166.7	.096	12.000	38.910	36.910	10.961	7.671	-6.722	-8.722
H	5/ 6	208.3	.057	12.000	38.725	36.725	10.957	7.672	-6.774	-8.774
I	0/ 6	.0	49.908	.000	32.135	30.135	11.144	2.125	-4.264	-6.264
I	1/ 6	45.0	49.921	.000	32.108	30.108	11.157	2.125	-4.686	-6.686
I	2/ 6	90.0	49.873	-.003	32.000	30.000	11.065	2.125	-5.099	-7.099
I	3/ 6	135.0	49.860	-.004	31.911	29.911	11.035	2.126	-5.527	-7.527
I	4/ 6	180.0	.087	3.000	40.284	38.284	10.996	2.126	-5.954	-7.954
I	5/ 6	225.0	.048	3.000	39.442	37.442	10.948	2.125	-6.361	-8.361
J	0/ 2	.0	50.143	.000	31.769	29.769	10.874	2.254	-4.816	-6.816
J	1/ 2	5.0	50.139	.000	31.760	29.760	10.878	2.254	-5.797	-7.797

3. PIPELINE PRESSURE

NO		LENGTH M	MAX TIME SEC	MAX Q M3/M	MAX HEAD M	MAX LEVEL M	MIN TIME SEC	MIN Q M3/M	MIN HEAD M	MIN LEVEL M
K	0/ 2	.0	.009	6.000	38.600	36.600	10.917	4.380	-6.781	-8.781
K	1/ 2	5.0	.013	6.000	38.570	36.570	10.922	4.380	-6.790	-8.790
L	0/13	.0	.017	18.000	38.540	36.540	10.909	12.056	-6.800	-8.800
L	1/13	9.2	.026	18.000	38.519	36.519	10.909	12.056	-6.810	-8.810
L	2/13	18.5	.035	18.000	38.497	36.497	10.900	12.056	-6.819	-8.819
L	3/13	27.7	.044	18.000	38.475	36.475	10.865	12.055	-6.827	-8.827
L	4/13	36.9	.052	18.000	38.454	36.454	10.874	12.056	-6.839	-8.839
L	5/13	46.2	.061	18.000	38.432	36.432	10.883	12.054	-6.841	-8.841
L	6/13	55.4	.070	18.000	38.411	36.411	10.891	12.054	-6.845	-8.845
L	7/13	64.6	.078	18.000	38.390	36.390	10.874	12.057	-6.846	-8.846
L	8/13	73.8	.087	18.000	38.368	36.368	10.848	12.060	-6.853	-8.853
L	9/13	83.1	.096	18.000	38.346	36.346	10.813	12.060	-6.855	-8.855
L	10/13	92.3	.104	18.000	38.325	36.325	10.822	12.061	-6.866	-8.866
L	11/13	101.5	.113	18.000	38.303	36.303	10.822	12.062	-6.873	-8.873
L	12/13	110.8	.122	18.000	38.282	36.282	10.830	12.060	-6.874	-8.874
M	0/ 5	.0	50.274	.000	31.919	29.919	10.891	2.198	-4.555	-6.555
M	1/ 5	30.0	50.256	-.001	31.856	29.856	10.917	2.198	-5.027	-7.027
M	2/ 5	60.0	50.230	-.003	31.791	29.791	10.917	2.199	-5.490	-7.490
M	3/ 5	90.0	.078	3.000	39.996	37.996	10.822	2.199	-5.950	-7.950
M	4/ 5	120.0	.104	3.000	39.128	37.128	10.848	2.199	-6.433	-8.433
N	0/ 4	.0	.131	21.000	38.260	36.260	10.839	14.258	-6.874	-8.874
N	1/ 4	162.5	49.987	-.050	31.419	29.419	10.647	14.277	-7.020	-9.020
N	2/ 4	325.0	49.752	-.096	31.231	29.231	10.508	14.290	-7.157	-9.157
N	3/ 4	487.5	49.673	-.116	31.004	29.004	10.369	14.304	-7.281	-9.281
O	0/ 2	.0	49.490	.000	30.638	28.638	10.221	1.318	-3.944	-5.944
O	1/ 2	5.0	.622	.978	36.044	34.044	10.216	1.318	-5.679	-7.679
P	0/ 4	.0	49.508	-.179	30.626	28.626	10.212	15.638	-7.404	-9.404
P	1/ 4	252.5	49.282	-.301	29.817	27.817	9.951	15.684	-7.579	-9.579
P	2/ 4	505.0	49.038	-.419	29.076	27.076	9.707	15.734	-7.703	-9.703
P	3/ 4	757.5	48.785	-.508	28.545	26.545	9.463	15.795	-7.763	-9.763
Q	0/ 4	.0	48.542	-.588	28.046	26.046	9.254	15.857	-7.760	-9.760
Q	1/ 4	1072.5	47.506	-.691	26.158	24.158	8.924	16.016	-7.024	-9.024
Q	2/ 4	2145.0	46.487	-1.192	24.271	22.271	7.896	16.880	-3.922	-5.922
Q	3/ 4	3217.5	72.768	-.862	21.519	19.519	7.095	18.232	3.977	1.977


WATER HAMMER PRESSURE CURVE
PIPE A B D F H L N P Q
NO. VIET500
HYDRAULIC LINE
PIPE PROFILE
H.MAX
H.MIN
H (M)
L (M)
50
44
38
32
26
20
14
8
2
-4
-10
0
800
1600
2400
3200
4000
4800
5600
6400
7200
8000

VIETNAM

LEVEL -2.000 M
DT .00871 SEC

--- PIPELINE DATA ---

NO	LENGTH M	CLASS	D MM	T MM	E	ORIGINAL PIPELINE		PUMP-NO			S-NO	V-NO	END	PLOT	Q M3/M	PIPE LOSS M	VALVE LOSS M	2L/A SEC	ROW	POINT	DIVISION	
A	100.0	FCD3	250	6.0	1.600			1	0	0	1	0	0	0	3.000	4.040	.000	.1741	19.9081	3	20	.0
B	190.0	FCD3	450	7.5	1.600	A		0	0	0	0	0	0	0	3.000	.060	.000	.3554	5.7195	3	40	.0
C	10.0	FCD3	250	6.0	1.600			2	0	0	0	0	0	0	3.000	3.500	.000	.0174	19.9081	1	2	.0
D	320.0	FCD3	450	7.5	1.600	B	C	0	0	0	0	0	0	0	6.000	.390	.000	.5986	5.7195	3	68	.0
E	10.0	FCD3	250	6.0	1.600			3	0	0	0	0	0	0	3.000	3.500	.000	.0174	19.9081	1	2	.0
F	330.0	FCD3	450	7.5	1.600	D	E	0	0	0	2	0	0	0	9.000	.860	.000	.6173	5.7195	4	70	.0
G	10.0	FCD3	250	6.0	1.600			4	0	0	0	0	0	0	3.000	3.500	.000	.0174	19.9081	1	2	.0
H	250.0	FCD3	450	7.5	1.600	F	G	0	0	0	0	0	0	0	12.000	1.110	.000	.4676	5.7195	5	54	.0
I	270.0	FCD3	250	6.0	1.600			5	0	0	0	0	0	0	3.000	5.050	.000	.4701	19.9081	5	54	.0
J	10.0	FCD3	250	6.0	1.600			6	0	0	0	0	0	0	3.000	3.500	.000	.0174	19.9081	1	2	.0
K	10.0	FCD3	400	7.0	1.600	I	J	0	0	0	0	0	0	0	6.000	.060	.000	.0185	7.3153	1	2	.0
L	120.0	FCD3	600	9.0	1.600	H	K	0	0	0	0	0	0	0	18.000	.280	.000	.2299	3.1419	12	26	.0
M	150.0	FCD3	250	6.0	1.600			7	0	0	0	0	0	0	3.000	4.340	.000	.2612	19.9081	4	30	.0
N	650.0	FCD3	600	9.0	1.600	L	M	0	0	0	0	0	0	0	21.000	2.000	.000	1.2450	3.1419	3	144	.0
O	10.0	FCD3	250	6.0	1.600			8	0	0	0	0	0	0	1.320	3.500	.000	.0174	19.9081	1	2	.0
P	1010.0	FCD3	600	9.0	1.600	N	O	0	0	0	0	0	0	0	22.320	3.490	.000	1.9346	3.1419	3	224	.0
Q	4290.0	FCD3	600	9.0	1.600	P		0	0	0	3	0	1	0	22.320	14.800	.000	8.2171	3.1419	3	944	.0

--- PUMP DATA ---

NO	SET	TYPE	VAL VE	V-NO	PLOT A	PLOT B	HEAD M	Q M3/M	KW	P	GD2 KG-M2	GD2 (WHEEL) KG-M2	RPM	%	START CONDITION HEAD K	START CONDITION HEAD M	START CONDITION Q M3/M	START CONDITION N	START CONDITION M
1	1	1	1	0	0	0	45.000	3.000	37.0	0	5.000	.000	2950	65	.2844	45.000	3.000	1.000	1.000
2	1	1	1	0	0	0	44.900	3.000	37.0	0	5.000	.000	2950	65	.2838	44.900	3.000	1.000	1.000
3	1	1	1	0	0	0	44.510	3.000	37.0	0	5.000	.000	2950	65	.2813	44.510	3.000	1.000	1.000
4	1	1	1	0	0	0	43.650	3.000	37.0	0	5.000	.000	2950	65	.2759	43.650	3.000	1.000	1.000
5	1	1	1	0	0	0	42.150	3.000	37.0	0	5.000	.000	2950	65	.2664	42.150	3.000	1.000	1.000
6	1	1	1	0	0	0	40.600	3.000	37.0	0	5.000	.000	2950	65	.2566	40.600	3.000	1.000	1.000
7	1	1	1	0	0	0	41.100	3.000	37.0	0	5.000	.000	2950	65	.2598	41.100	3.000	1.000	1.000
8	1	1	1	0	0	0	38.260	1.320	37.0	0	5.000	.000	2950	65	.1064	38.260	1.320	1.000	1.000

--- SURGE TANK DATA ---

NO	TYPE	V-NO	PLOT	HEAD M	AREA M2	LOSS M	LENGTH M	CLASS	D MM	T MM	E	2L/A SEC	ROW	DIVISION	AIR-Q M3	LOSS M
1	1	0	0	16.000	999.000	7.347	.0	0	0	.0	.000	.0000	.000	0	.0	.000
2	1	0	0	10.700	999.000	7.347	.0	0	0	.0	.000	.0000	.000	0	.0	.000
3	1	0	1	16.000	999.000	7.347	.0	0	0	.0	.000	.0000	.000	0	.0	.000

--- PIPELINE OUTPUT ---

A B D F H L N P Q

--- PIPELINE PROFILE ---

NO	LENGTH M	HEIGHT M	LENGTH M	HEIGHT M	LENGTH M	HEIGHT M
A	.0	14.00	10.0	8.70	100.0	8.70
B	100.0	8.70	290.0	8.70		
D	290.0	8.70	610.0	8.70		

--- PIPELINE PROFILE ---

NO	LENGTH M	HEIGHT M	LENGTH M	HEIGHT M	LENGTH M	HEIGHT M	LENGTH M	HEIGHT M
F	610.0	8.70	940.0	8.70				
H	940.0	8.70	1190.0	8.70				
L	1190.0	8.70	1310.0	8.70				
N	1310.0	8.70	1960.0	8.70				
P	1960.0	8.70	2960.0	8.70	2970.0	14.00		
Q	2970.0	14.00	3020.0	14.00	3030.0	3.50	7260.0	3.50

1. ANALYSIS INTERVAL 700

2. WATER LEVEL IN THE TANKS

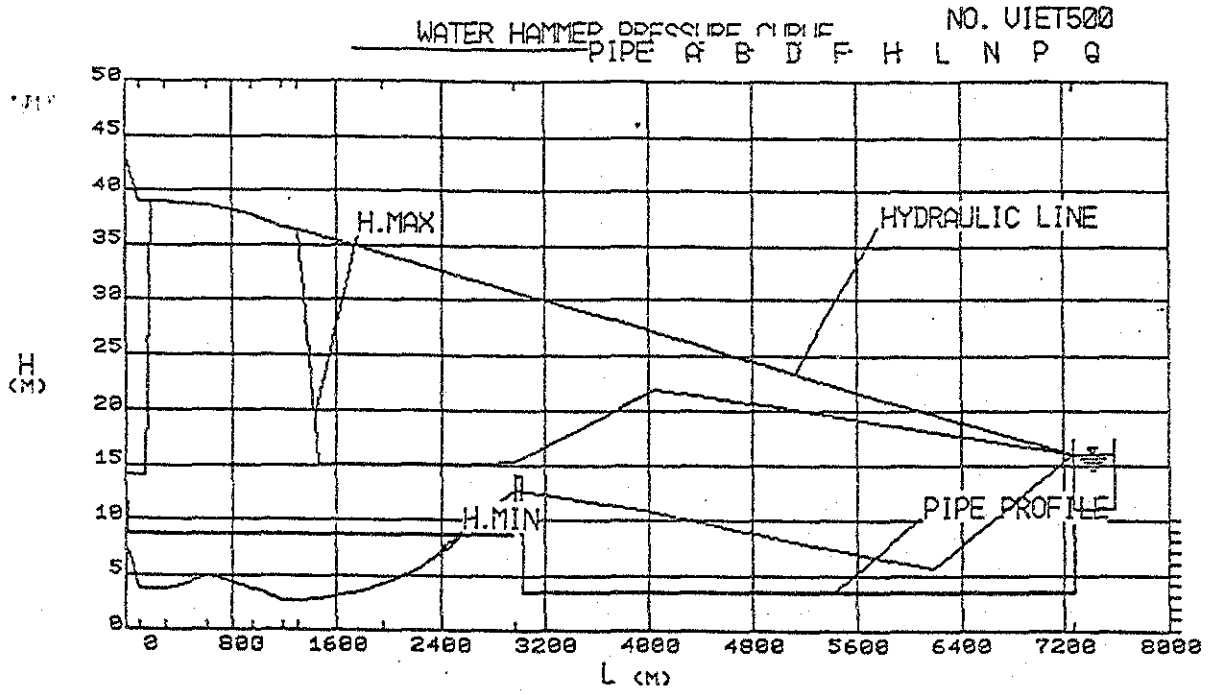
NO	- - M A X - - HEAD M	- - M A X - - LEVEL M	- - M I N - - HEAD M	- - M I N - - LEVEL M	WATER LEVEL IN THE TANKS M	AREA M2	Q M3
1	16.000	14.000	16.000	14.000	.000	999.0000	.000
2	10.700	8.700	10.698	8.698	.002	999.0000	1.649
3	16.000	14.000	15.992	13.992	.008	999.0000	7.823

3. PIPELINE PRESSURE

NO		LENGTH M	- - - - - M A X - - - - - TIME SEC	Q M3/M	HEAD M	LEVEL M	- - - - - M I N - - - - - TIME SEC	Q M3/M	HEAD M	LEVEL M
A	0/ 4	.0	119.898	.272	15.940	13.940	7.348	2.816	9.527	7.527
A	1/ 4	25.0	119.536	.278	15.967	13.967	7.317	2.814	8.589	6.589
A	2/ 4	50.0	119.549	.277	15.989	13.989	7.226	2.807	7.636	5.636
A	3/ 4	75.0	119.580	.276	16.015	14.015	7.274	2.811	6.683	4.683
B	0/ 4	.0	119.575	.276	16.035	14.035	7.252	2.809	5.732	3.732
B	1/ 4	47.5	113.142	.306	16.043	14.043	7.209	2.808	5.703	3.703
B	2/ 4	95.0	.096	3.000	40.930	38.930	7.174	2.810	5.716	3.716
B	3/ 4	142.5	.052	3.000	40.915	38.915	7.121	2.812	5.719	3.719
C	0/ 2	.0	120.298	.000	16.096	14.096	7.069	.003	5.528	3.528
C	1/ 2	5.0	120.302	.000	16.100	14.100	7.074	.001	5.604	3.604
D	0/ 4	.0	.009	6.000	40.900	38.900	7.034	2.823	5.679	3.679
D	1/ 4	80.0	.083	6.000	40.803	38.803	7.013	2.830	5.935	3.935
D	2/ 4	160.0	.157	6.000	40.705	38.705	7.078	2.803	6.260	4.260
D	3/ 4	240.0	.083	6.000	40.608	38.608	7.161	2.765	6.632	4.632
E	0/ 2	.0	120.594	.000	16.820	14.820	7.391	.000	6.927	4.927
E	1/ 2	5.0	120.598	.000	16.824	14.824	7.361	.000	6.932	4.932
F	0/ 5	.0	.009	9.000	40.510	38.510	7.243	9.172	6.939	4.939
F	1/ 5	66.0	.070	9.000	40.338	38.338	7.182	9.167	6.703	4.703
F	2/ 5	132.0	.131	9.000	40.166	38.166	7.121	9.164	6.487	4.487
F	3/ 5	198.0	.131	9.000	39.994	37.994	7.061	9.160	6.262	4.262
F	4/ 5	264.0	.070	9.000	39.822	37.822	6.895	9.137	6.028	4.028
G	0/ 2	.0	120.368	.000	16.976	14.976	6.930	.001	5.538	3.538
G	1/ 2	5.0	120.372	.000	16.973	14.973	6.934	-.001	5.634	3.634
H	0/ 6	.0	.009	12.000	39.650	37.650	6.939	9.139	5.730	3.730
H	1/ 6	41.7	.048	12.000	39.465	37.465	5.115	10.037	5.664	3.664
H	2/ 6	83.3	.087	12.000	39.280	37.280	5.076	10.030	5.453	3.453
H	3/ 6	125.0	.126	12.000	39.095	37.095	5.036	10.023	5.245	3.245
H	4/ 6	166.7	.096	12.000	38.910	36.910	4.997	10.017	5.042	3.042
H	5/ 6	208.3	.057	12.000	38.725	36.725	4.958	10.010	4.837	2.837
I	0/ 6	.0	119.950	.000	17.393	15.393	12.389	.043	4.065	2.065
I	1/ 6	45.0	119.919	-.001	17.364	15.364	11.801	.262	4.452	2.452
I	2/ 6	90.0	119.958	.001	17.308	15.308	11.831	.255	4.788	2.788

3. PIPELINE PRESSURE

NO		LENGTH M	MAX TIME SEC	MAX Q M3/M	MAX HEAD M	MAX LEVEL M	MIN TIME SEC	MIN Q M3/M	MIN HEAD M	MIN LEVEL M
I	3/ 6	135.0	119.989	.003	17.190	15.190	5.045	1.903	4.805	2.805
I	4/ 6	180.0	.087	3.000	40.284	38.284	5.006	1.910	4.742	2.742
I	5/ 6	225.0	.048	3.000	39.442	37.442	4.967	1.918	4.677	2.677
J	0/ 2	.0	120.350	.000	16.991	14.991	9.342	.076	5.500	3.500
J	1/ 2	5.0	120.346	.000	16.980	14.980	4.932	1.912	5.292	3.292
K	0/ 2	.0	.009	6.000	38.600	36.600	4.928	3.839	4.614	2.614
K	1/ 2	5.0	.013	6.000	38.570	36.570	4.923	3.840	4.629	2.629
L	0/13	.0	.017	18.000	38.540	36.540	4.919	13.845	4.635	2.635
L	1/13	9.2	.026	18.000	38.519	36.519	4.910	13.848	4.639	2.639
L	2/13	18.5	.035	18.000	38.497	36.497	4.901	13.850	4.641	2.641
L	3/13	27.7	.044	18.000	38.475	36.475	4.893	13.851	4.635	2.635
L	4/13	36.9	.052	18.000	38.454	36.454	4.884	13.854	4.640	2.640
L	5/13	46.2	.061	18.000	38.432	36.432	4.875	13.856	4.637	2.637
L	6/13	55.4	.070	18.000	38.411	36.411	4.867	13.858	4.642	2.642
L	7/13	64.6	.078	18.000	38.389	36.389	4.858	13.861	4.644	2.644
L	8/13	73.8	.087	18.000	38.368	36.368	4.849	13.863	4.644	2.644
L	9/13	83.1	.096	18.000	38.346	36.346	4.840	13.864	4.640	2.640
L	10/13	92.3	.104	18.000	38.325	36.325	4.832	13.867	4.642	2.642
L	11/13	101.5	.113	18.000	38.303	36.303	4.823	13.869	4.645	2.645
L	12/13	110.8	.122	18.000	38.282	36.282	4.814	13.871	4.647	2.647
M	0/ 5	.0	120.507	.000	17.246	15.246	10.935	.003	4.723	2.723
M	1/ 5	30.0	120.507	.000	17.223	15.223	10.909	.013	5.120	3.120
M	2/ 5	60.0	120.550	.001	17.189	15.189	4.884	1.940	5.197	3.197
M	3/ 5	90.0	.078	3.000	39.996	37.996	4.858	1.945	5.014	3.014
M	4/ 5	120.0	.104	3.000	39.128	37.128	4.832	1.949	4.832	2.832
N	0/ 4	.0	.131	21.000	38.260	36.260	4.806	15.828	4.650	2.650
N	1/ 4	162.5	121.412	.175	17.051	15.051	4.649	15.904	4.837	2.837
N	2/ 4	325.0	120.890	.187	17.024	15.024	4.492	15.998	5.135	3.135
N	3/ 4	487.5	121.047	.179	17.072	15.072	4.336	16.107	5.517	3.517
O	0/ 2	.0	121.847	.000	17.112	15.112	11.701	.298	9.688	7.688
O	1/ 2	5.0	.622	.978	36.044	34.044	4.183	1.395	8.065	6.065
P	0/ 4	.0	121.882	.166	17.110	15.110	4.179	17.650	6.130	4.130
P	1/ 4	252.5	122.126	.163	17.127	15.127	3.935	17.952	7.463	5.463
P	2/ 4	505.0	121.691	.167	17.146	15.146	3.700	18.359	9.518	7.518
P	3/ 4	757.5	121.578	.167	17.147	15.147	3.456	18.958	12.572	10.572
Q	0/ 4	.0	122.857	.142	17.258	15.258	18.169	15.357	14.588	12.588
Q	1/ 4	1072.5	10.404	17.653	23.965	21.965	8.175	19.580	12.703	10.703
Q	2/ 4	2145.0	9.376	17.755	22.240	20.240	7.148	19.619	10.078	8.078
Q	3/ 4	3217.5	8.349	17.798	20.135	18.135	6.294	19.624	7.591	5.591


WATER HAMMER PRESSURE CURVE
NO. VIET500
PIPE A B D F H L N P Q
H.MAX
HYDRAULIC LINE
H.MIN
PIPE PROFILE
H (M)
L (M)
0
5
10
15
20
25
30
35
40
45
50
0
800
1600
2400
3200
4000
4800
5600
6400
7200
8000

W A T E R H A M M E R A N A L Y S I S NO. viet100 PAGE 1

VIETNAM PLANT Raw Water Transmission Pipe in Treatment Plant

(Original Condition)

LEVEL -2.000 M

DT .00871 SEC

--- PIPELINE DATA ---

NO	LENGTH M	CLASS	D MM	T MM	E	ORIGINAL PIPELINE		PUMP-NO	S-NO	V-NO	END	PLOT	Q M3/M	PIPE LOSS M	VALVE LOSS M	2L/A SEC	ROW	PO IN T	DIVISION	
A	250.0	FCD3	250	6.0	1.600			1	0	0	0	0	2.580	4.570	.000	.4353	19.9081	4	50	.0
B	10.0	FCD3	250	6.0	1.600			2	0	0	0	0	2.580	3.500	.000	.0174	19.9081	1	2	.0
C	250.0	FCD3	250	6.0	1.600			3	0	0	0	0	3.000	4.930	.000	.4353	19.9081	4	50	.0
D	10.0	FCD3	250	6.0	1.600			4	0	0	0	0	3.000	3.500	.000	.0174	19.9081	1	2	.0
E	80.0	FCD3	350	6.5	1.600	A	B	0	0	0	0	0	5.160	.250	.000	.1463	9.6740	3	16	.0
F	160.0	FCD3	350	6.5	1.600	C	D	0	0	0	0	0	6.000	.670	.000	.2925	9.6740	15	34	.0
G	30.0	FCD3	450	7.5	1.600	E	F	0	0	0	0	1	11.160	.120	.000	.0561	5.7195	5	6	.0

-- PUMP DATA ---

NO	SET	TYPE	VAL VE	V-NO	PLOT A	PLOT B	HEAD M	Q M3/M	KW	P	GD2 KG-M2	GD2 (WHEEL) KG-M2	RPM	%	- - - START CONDITION - - - K	HEAD M	Q M3/M	N	M
1	1	1	1	0	0	0	26.220	2.580	22.0	0	5.000	.000	2950	65	.1425	26.220	2.580	1.000	1.000
2	1	1	1	0	0	0	25.150	2.580	22.0	0	5.000	.000	2950	65	.1367	25.150	2.580	1.000	1.000
3	1	1	1	0	0	0	27.000	3.000	22.0	0	5.000	.000	2950	65	.1706	27.000	3.000	1.000	1.000
4	1	1	1	0	0	0	25.570	3.000	22.0	0	5.000	.000	2950	65	.1615	25.570	3.000	1.000	1.000

-- PIPELINE OUTPUT ---

C F G

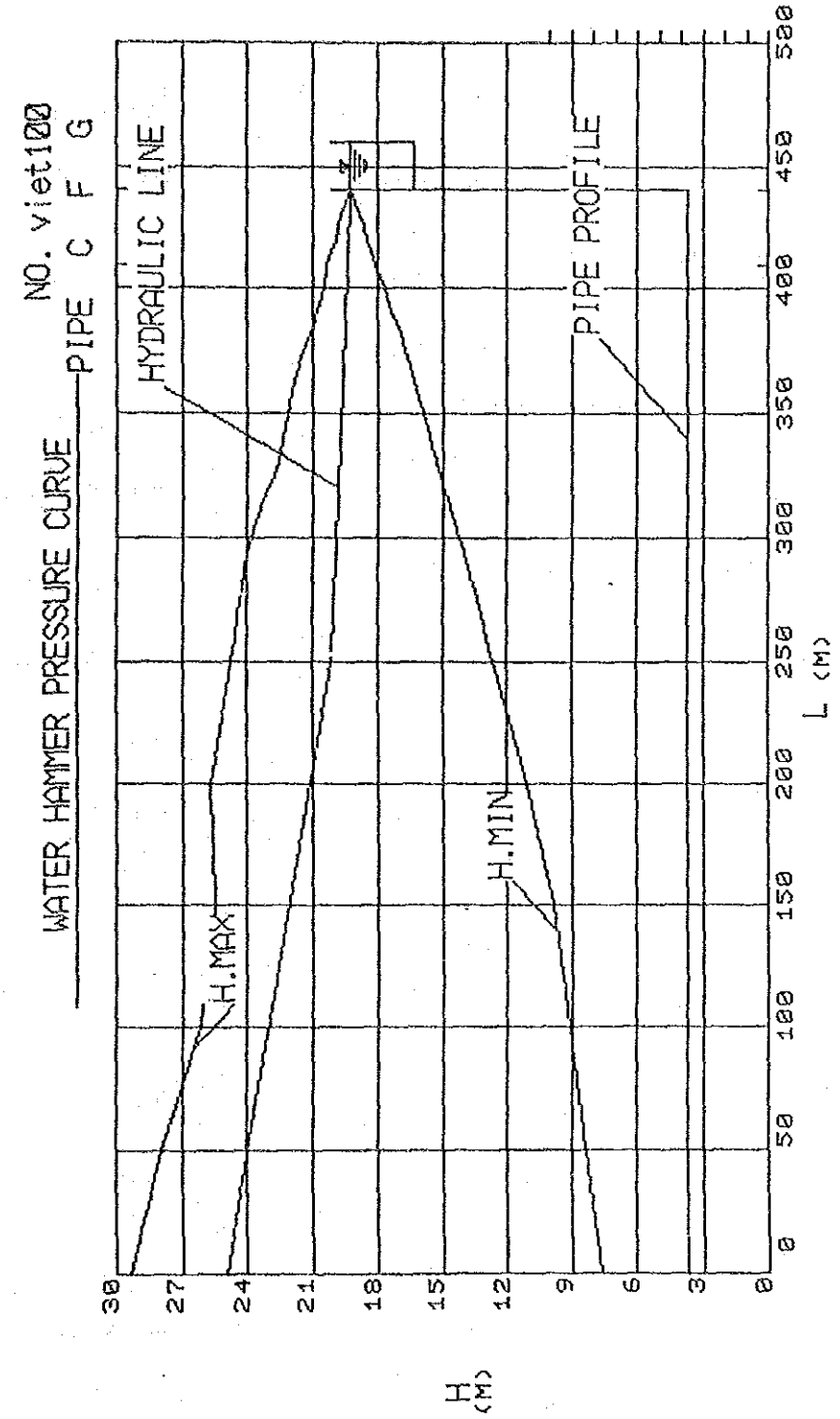
-- PIPELINE PROFILE ---

NO	LENGTH M	HEIGHT M	LENGTH M	HEIGHT M	LENGTH M	HEIGHT M	LENGTH M	HEIGHT M
C	.0	3.70	250.0	3.70				
F	250.0	3.70	410.0	3.70				
G	410.0	3.70	440.0	3.70				

1. ANALYSIS INTERVAL 16

3. PIPELINE PRESSURE

NO		LENGTH M	MAX TIME SEC	MAX Q M3/M	MAX HEAD M	MAX LEVEL M	MIN TIME SEC	MIN Q M3/M	MIN HEAD M	MIN LEVEL M
A	0/ 5	.0	5.102	.000	30.389	28.389	4.440	.063	11.868	9.868
A	1/ 5	50.0	5.093	.001	29.280	27.280	4.214	.260	12.774	10.774
A	2/ 5	100.0	5.015	-.066	27.768	25.768	3.639	.741	13.669	11.669
A	3/ 5	150.0	6.068	-.018	26.989	24.989	6.625	-.028	14.917	12.917
A	4/ 5	200.0	6.042	-.036	25.649	23.649	6.634	-.046	16.400	14.400
B	0/ 2	.0	6.094	.000	24.174	22.174	2.516	.009	16.910	14.910
B	1/ 2	5.0	6.099	.001	24.144	22.144	2.520	.003	17.153	15.153
C	0/ 5	.0	5.711	.000	31.333	29.333	4.893	.075	9.556	7.556
C	1/ 5	50.0	5.702	-.006	29.891	27.891	4.405	.482	10.290	8.290
C	2/ 5	100.0	5.633	-.080	28.138	26.138	4.449	.463	11.012	9.012
C	3/ 5	150.0	5.580	-.098	27.433	25.433	4.492	.443	11.828	9.828
C	4/ 5	200.0	5.546	-.091	27.689	25.689	4.518	.423	13.064	11.064
D	0/ 2	.0	5.520	.000	26.751	24.751	3.038	.000	14.185	12.185
D	1/ 2	5.0	5.515	-.001	26.713	24.713	3.043	-.005	14.393	12.393
E	0/ 4	.0	6.103	.012	24.131	22.131	2.525	1.657	17.405	15.405
E	1/ 4	20.0	6.085	-.004	23.825	21.825	2.533	1.638	18.086	16.086
E	2/ 4	40.0	6.085	-.008	23.343	21.343	2.533	1.638	18.776	16.776
E	3/ 4	60.0	6.059	-.052	22.731	20.731	2.560	1.585	19.462	17.462
F	0/17	.0	5.511	-.110	26.713	24.713	3.004	1.895	14.597	12.597
F	1/17	9.4	5.502	-.117	26.571	24.571	3.004	1.895	14.901	12.901
F	2/17	18.8	5.493	-.125	26.422	24.422	3.021	1.863	15.202	13.202
F	3/17	28.2	5.485	-.134	26.245	24.245	3.021	1.864	15.500	13.500
F	4/17	37.6	5.476	-.141	26.116	24.116	4.544	.402	15.795	13.795
F	5/17	47.1	5.467	-.152	25.905	23.905	3.004	1.895	16.106	14.106
F	6/17	56.5	5.467	-.151	25.616	23.616	2.995	1.912	16.422	14.422
F	7/17	65.9	5.459	-.171	25.226	23.226	4.518	.449	16.705	14.705
F	8/17	75.3	5.459	-.173	24.778	22.778	2.986	1.928	17.046	15.046
F	9/17	84.7	5.441	-.211	24.462	22.462	2.977	1.945	17.381	15.381
F	10/17	94.1	5.424	-.239	24.227	22.227	3.744	1.210	17.690	15.690
F	11/17	103.5	5.415	-.248	24.044	22.044	3.735	1.227	18.014	16.014
F	12/17	112.9	5.406	-.263	23.761	21.761	3.726	1.242	18.311	16.311
F	13/17	122.4	5.406	-.261	23.481	21.481	3.744	1.210	18.640	16.640
F	14/17	131.8	5.398	-.281	23.092	21.092	3.744	1.209	18.946	16.946
F	15/17	141.2	5.389	-.300	22.736	20.736	3.752	1.189	19.344	17.344
F	16/17	150.6	6.051	.211	22.452	20.452	3.761	1.170	19.712	17.712
G	0/ 6	.0	6.051	.147	22.269	20.269	3.770	1.777	20.118	18.118
G	1/ 6	5.0	6.046	.132	22.097	20.097	3.765	1.794	20.316	18.316
G	2/ 6	10.0	6.068	.202	21.935	19.935	2.577	4.290	20.509	18.509
G	3/ 6	15.0	6.072	.214	21.796	19.796	3.783	1.728	20.684	18.684
G	4/ 6	20.0	6.068	.201	21.650	19.650	3.787	1.712	20.859	18.859
G	5/ 6	25.0	5.358	-.157	21.481	19.481	3.783	1.730	21.056	19.056


NO. viet100
WATER HAMMER PRESSURE CURVE ——PIPE C F G
HYDRAULIC LINE
PIPE PROFILE
H.MAX
H.MIN
H (M)
L (M)
0
3
6
9
12
15
18
21
24
27
30
0
50
100
150
200
250
300
350
400
450
500

DUC GIANG AREA

Distribution Pipe

(Original Condition)

LEVEL 2.200 M

DT .05812 SEC

--- PIPELINE DATA ---

NO	LENGTH M	CLASS	D MM	T MM	E	ORIGINAL PIPELINE	PUMP-NO	S-NO	V-NO	END	PLOT	Q M3/M	PIPE LOSS M	VALVE LOSS M	2L/A SEC	ROW	POINT	DIVISION	
1	600.0	FCD3	700	10.0	1.600		1	0	0	0	0	28.130	1.500	.000	1.1625	2.2820	3	20	.0
2	.0	FCD3	450	7.5	1.600	1	0	0	0	1	0	9.520	19.290	.000	.0581	5.7195	0	1	.0
3	1400.0	FCD3	600	9.0	1.600	1	0	0	0	0	0	18.610	3.440	.000	2.6816	3.1419	3	48	.0
4	.0	FCD3	450	7.5	1.600	3	0	0	2	0	0	9.290	15.850	.000	.0581	5.7195	0	1	.0
5	400.0	FCD3	450	7.5	1.600	3	0	0	0	0	0	9.320	1.110	.000	.7482	5.7195	3	12	.0
6	.0	FCD3	100	6.0	1.600	5	0	0	3	0	0	.160	14.740	.000	.0581	140.0032	0	1	.0
7	400.0	FCD3	450	7.5	1.600	5	0	0	0	0	0	9.160	1.080	.000	.7482	5.7195	3	12	.0
8	.0	FCD3	100	6.0	1.600	7	0	0	4	0	0	1.350	13.660	.000	.0581	140.0032	0	1	.0
9	400.0	FCD3	400	7.0	1.600	7	0	0	0	0	0	7.800	1.420	.000	.7404	7.3153	3	12	.0
22	.0	FCD3	100	6.0	1.600	9	0	0	11	0	0	4.190	12.240	.000	.0581	140.0032	0	1	.0
10	300.0	FCD3	250	6.0	1.600	9	0	0	0	0	0	3.610	2.530	.000	.5224	19.9081	3	8	.0
11	.0	FCD3	100	6.0	1.600	10	0	0	5	0	0	.260	9.710	.000	.0581	140.0032	0	1	.0
12	600.0	FCD3	250	6.0	1.600	10	0	0	0	0	0	3.350	4.400	.000	1.0447	19.9081	5	18	.0
13	.0	FCD3	100	6.0	1.600	12	0	0	6	0	0	.400	5.310	.000	.0581	140.0032	0	1	.0
14	200.0	FCD3	250	6.0	1.600	12	0	0	0	0	0	2.950	1.160	.000	.3482	19.9081	5	6	.0
15	.0	FCD3	100	6.0	1.600	14	0	0	7	0	0	.520	4.150	.000	.0581	140.0032	0	1	.0
16	500.0	FCD3	250	6.0	1.600	14	0	0	0	0	0	2.430	2.020	.000	.8706	19.9081	6	14	.0
17	.0	FCD3	100	6.0	1.600	16	0	0	8	0	0	1.510	2.130	.000	.0581	140.0032	0	1	.0
18	800.0	FCD3	200	6.0	1.600	16	0	0	0	0	0	.920	1.590	.000	1.3433	32.2567	3	24	.0
19	.0	FCD3	100	6.0	1.600	18	0	0	9	0	0	.570	.540	.000	.0581	140.0032	0	1	.0
20	400.0	FCD3	150	6.0	1.600	18	0	0	0	0	0	.350	.540	.000	.6458	59.6353	3	12	.0
21	.0	FCD3	100	6.0	1.600	20	0	0	10	0	0	.350	.000	.000	.0581	140.0032	0	1	.0

--- PUMP DATA ---

NO	SET	TYPE	VAL VE	V-NO	PLOT A	PLOT B	HEAD M	Q M3/M	KW	P	GD2 KG-M2	GD2 (WHEEL) KG-M2	RPM	%	START CONDITION HEAD K	START CONDITION HEAD M	START CONDITION Q M3/M	N	M
1	1	1	1	0	0	0	50.000	7.030	90.0	0	8.100	.000	1475	84	1.4148	50.000	7.030	1.000	1.000

--- SURGE TANK DATA ---

NO	TYPE	V-NO	PLOT	HEAD M	AREA M2	LOSS M	LENGTH M	CLASS	D MM	T MM	E	2L/A SEC	ROW	DIVISION	AIR-Q M3	LOSS M
1	2	0	0	48.500	9.377	7.347	.0	0	0	.0	.000	.0000	.000	0	.0	.000
2	2	0	0	45.060	6.203	7.347	.0	0	0	.0	.000	.0000	.000	0	.0	.000
3	2	0	0	43.950	3.107	7.347	.0	0	0	.0	.000	.0000	.000	0	.0	.000
4	2	0	0	42.870	3.053	7.347	.0	0	0	.0	.000	.0000	.000	0	.0	.000
5	2	0	0	38.920	1.203	7.347	.0	0	0	.0	.000	.0000	.000	0	.0	.000
6	2	0	0	34.520	1.117	7.347	.0	0	0	.0	.000	.0000	.000	0	.0	.000
7	2	0	0	33.360	.983	7.347	.0	0	0	.0	.000	.0000	.000	0	.0	.000
8	2	0	0	31.340	.810	7.347	.0	0	0	.0	.000	.0000	.000	0	.0	.000
9	2	0	0	29.750	.307	7.347	.0	0	0	.0	.000	.0000	.000	0	.0	.000
10	2	0	0	29.210	.117	7.347	.0	0	0	.0	.000	.0000	.000	0	.0	.000
11	2	0	0	41.450	2.600	7.347	.0	0	0	.0	.000	.0000	.000	0	.0	.000

--- PIPELINE OUTPUT ---

1 3 5 7 9 10 12 14 16 18 20 21

--- PIPELINE PROFILE ---

NO	LENGTH M	HEIGHT M	LENGTH M	HEIGHT M	LENGTH M	HEIGHT M	LENGTH M	HEIGHT M
1	.0	4.50	600.0	4.50				
3	600.0	4.50	2000.0	4.50				
5	2000.0	4.50	2400.0	4.50				
7	2400.0	4.50	2800.0	4.50				
9	2800.0	4.50	3200.0	4.50				
10	3200.0	4.50	3500.0	4.50				
12	3500.0	4.50	4100.0	4.50				
14	4100.0	4.50	4300.0	4.50				
16	4300.0	4.50	4800.0	4.50				
18	4800.0	4.50	5600.0	4.50				
20	5600.0	4.50	6000.0	4.50				
21	6000.0	4.50	6000.0	4.50				

1. ANALYSIS INTERVAL 500

2. WATER LEVEL IN THE TANKS

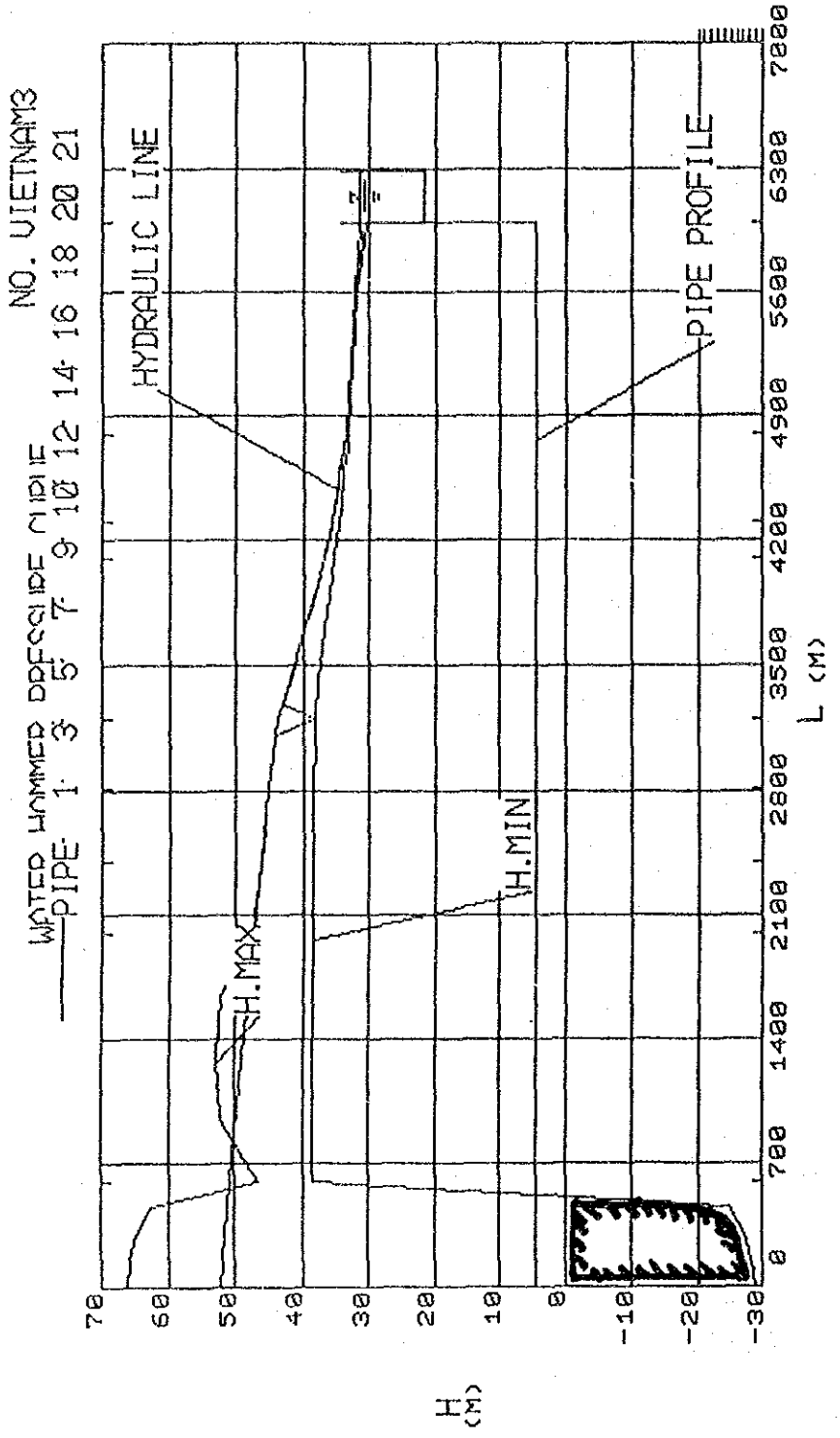
NO	- - M A X - - HEAD M	LEVEL M	- - M I N - - HEAD M	LEVEL M	WATER LEVEL IN THE TANKS M	AREA M2	Q M3
1	48.500	50.700	36.611	38.811	11.889	9.3767	111.482
2	45.060	47.260	36.594	38.794	8.466	6.2033	52.518
3	43.950	46.150	36.599	38.799	7.351	3.1067	22.836
4	42.870	45.070	36.542	38.742	6.328	3.0533	19.323
5	38.920	41.120	35.457	37.657	3.463	1.2033	4.168
6	34.520	36.720	33.133	35.333	1.387	1.1167	1.549
7	33.360	35.560	32.385	34.585	.975	.9833	.959
8	31.340	33.540	30.850	33.050	.490	.8100	.397
9	29.750	31.950	29.415	31.615	.335	.3067	.103
10	29.210	31.410	28.166	30.366	1.044	.1167	.122
11	41.450	43.650	36.262	38.462	5.188	2.6000	13.488

3. PIPELINE PRESSURE

NO		LENGTH M	- - - - - M A X - - - - - TIME SEC	Q M3/M	HEAD M	LEVEL M	- - - - - M I N - - - - - TIME SEC	Q M3/M	HEAD M	LEVEL M
1	0/ 4	.0	2.267	.000	63.965	66.165	1.104	10.387	-30.982	-28.782
1	1/ 4	150.0	2.180	-.074	63.627	65.827	1.017	10.478	-30.616	-28.416
1	2/ 4	300.0	2.034	-.275	62.710	64.910	.872	10.723	-29.554	-27.354
1	3/ 4	450.0	1.889	-.770	60.450	62.650	.727	11.315	-26.929	-24.729
2	0/ 1	.0	12.206	8.439	44.376	46.576	581.841	5.713	36.156	38.356
3	0/ 4	.0	12.206	12.748	44.376	46.576	581.841	1.288	36.156	38.356
3	1/ 4	350.0	3.255	16.844	49.826	52.026	582.190	1.288	36.153	38.353
3	2/ 4	700.0	5.929	15.325	50.752	52.952	581.842	1.290	36.158	38.358
3	3/ 4	1050.0	5.812	15.228	49.949	52.149	581.493	1.291	36.164	38.364
4	0/ 1	.0	4.127	9.276	45.013	47.213	583.236	6.146	36.145	38.345
5	0/ 4	.0	4.127	9.273	45.013	47.213	583.236	-.253	36.145	38.345
5	1/ 4	100.0	3.458	9.286	44.824	47.024	583.323	-.253	36.145	38.345
5	2/ 4	200.0	6.336	9.175	44.594	46.794	583.236	-.253	36.147	38.347
5	3/ 4	300.0	6.365	9.174	44.342	46.542	583.149	-.253	36.150	38.350
6	0/ 1	.0	3.604	.160	43.950	46.150	583.585	.110	36.146	38.346
7	0/ 4	.0	3.604	9.160	43.950	46.150	583.585	1.952	36.146	38.346
7	1/ 4	100.0	3.052	9.160	43.680	45.880	583.672	1.952	36.136	38.336
7	2/ 4	200.0	2.964	9.160	43.410	45.610	583.585	1.952	36.128	38.328
7	3/ 4	300.0	15.083	9.101	43.144	45.344	583.497	1.953	36.120	38.320
8	0/ 1	.0	8.893	1.360	42.870	45.070	583.933	.967	36.106	38.306
9	0/ 4	.0	8.893	7.800	42.870	45.070	583.933	3.216	36.106	38.306
9	1/ 4	100.0	9.561	7.800	42.515	44.715	584.020	3.216	36.049	38.249
9	2/ 4	200.0	9.649	7.800	42.160	44.360	583.933	3.216	35.995	38.195
9	3/ 4	300.0	9.736	7.800	41.805	44.005	583.846	3.217	35.941	38.141

3. PIPELINE PRESSURE

NO		LENGTH M	MAX TIME SEC	MAX Q M3/M	MAX HEAD M	MAX LEVEL M	MIN TIME SEC	MIN Q M3/M	MIN HEAD M	MIN LEVEL M
22	0/ 1	.0	.535	.535	35.881	38.081	584.282	3.098	35.881	38.081
10	0/ 4	.0	.535	.535	35.881	38.081	584.282	1.895	35.881	38.081
10	1/ 4	75.0	22.436	3.610	40.817	43.017	584.340	1.895	35.711	37.911
10	2/ 4	150.0	22.494	3.610	40.185	42.385	584.282	1.895	35.543	37.743
10	3/ 4	225.0	22.436	3.610	39.553	41.753	584.224	1.895	35.375	37.575
11	0/ 1	.0	37.781	.260	38.920	41.120	584.514	.204	35.204	37.404
12	0/ 6	.0	37.781	3.350	38.920	41.120	584.514	2.361	35.204	37.404
12	1/ 6	100.0	37.868	3.350	38.187	40.387	584.602	2.361	34.846	37.046
12	2/ 6	200.0	37.955	3.350	37.453	39.653	584.514	2.361	34.491	36.691
12	3/ 6	300.0	38.042	3.350	36.720	38.920	584.427	2.361	34.135	36.335
12	4/ 6	400.0	40.396	3.350	35.987	38.187	584.340	2.361	33.780	35.980
12	5/ 6	500.0	40.484	3.350	35.253	37.453	584.253	2.361	33.424	35.624
13	0/ 1	.0	53.532	.400	34.520	36.720	585.037	.341	33.064	35.264
14	0/ 6	.0	53.532	2.951	34.520	36.720	585.037	2.344	33.064	35.264
14	1/ 6	33.3	31.300	2.950	34.327	36.527	585.008	2.344	32.944	35.144
14	2/ 6	66.7	31.329	2.950	34.133	36.333	585.037	2.344	32.824	35.024
14	3/ 6	100.0	31.242	2.950	33.940	36.140	584.950	2.344	32.704	34.904
14	4/ 6	133.3	31.271	2.950	33.747	35.947	584.979	2.344	32.585	34.785
14	5/ 6	166.7	31.242	2.950	33.553	35.753	584.892	2.344	32.465	34.665
15	0/ 1	.0	27.900	.520	33.360	35.560	585.211	.452	32.344	34.544
16	0/ 7	.0	27.900	2.431	33.360	35.560	585.211	2.111	32.344	34.544
16	1/ 7	71.4	9.474	2.430	33.071	35.271	585.270	2.111	32.129	34.329
16	2/ 7	142.9	9.532	2.430	32.783	34.983	585.212	2.111	31.914	34.114
16	3/ 7	214.3	9.358	2.430	32.494	34.694	585.153	2.111	31.700	33.900
16	4/ 7	285.7	9.416	2.430	32.206	34.406	585.095	2.111	31.485	33.685
16	5/ 7	357.1	9.416	2.430	31.917	34.117	585.037	2.111	31.271	33.471
16	6/ 7	428.6	9.474	2.430	31.629	33.829	584.979	2.112	31.056	33.256
17	0/ 1	.0	9.184	1.510	31.340	33.540	585.618	1.324	30.840	33.040
18	0/ 4	.0	9.184	.921	31.340	33.540	585.618	.877	30.840	33.040
18	1/ 4	200.0	6.161	.920	30.943	33.143	585.793	.877	30.483	32.683
18	2/ 4	400.0	6.219	.920	30.545	32.745	585.618	.877	30.127	32.327
18	3/ 4	600.0	5.812	.920	30.148	32.348	585.444	.877	29.771	31.971
19	0/ 1	.0	148.793	.423	29.507	31.707	586.315	.353	29.414	31.614
20	0/ 4	.0	148.793	.549	29.507	31.707	586.315	.531	29.414	31.614
20	1/ 4	100.0	7.178	.366	29.421	31.621	586.403	.531	29.104	31.304
20	2/ 4	200.0	7.847	.379	29.050	31.250	586.315	.531	28.795	30.995
20	3/ 4	300.0	8.515	.391	28.678	30.878	586.228	.531	28.485	30.685
21	0/ 1	.0	5.464	.350	29.210	31.410	56.846	.633	28.164	30.364


WATER HAMMER PROFILE
PIPE- 1 3 5 7 9 10 12 14 16 18 20 21
NO. VIETNAM3
HYDRAULIC LINE
PIPE PROFILE
H.MAX
H.MIN
H (M)
L (M)
70
60
50
40
30
20
10
0
-10
-20
-30
0
700
1400
2100
2800
3500
4200
4900
5600
6300
7000

DUC GIANG AREA

Distribution Pipe

(With Protection System)

LEVEL 2.200 M

DT .05812 SEC

--- PIPELINE DATA ---

NO	LENGTH M	CLASS	D MM	T MM	E	ORIGINAL PIPELINE	PUMP-NO	S-NO	V-NO	END	PLOT	Q M3/M	PIPE LOSS M	VALVE LOSS M	2L/A SEC	ROW	POINT	DIVISION	
1	600.0	FCD3	700	10.0	1.600		1 0 0	1	0	0	0	28.130	1.500	.000	1.1625	2.2820	3	20	.0
2	.0	FCD3	450	7.5	1.600	1	0 0 0	2	0	1	0	9.520	19.290	.000	.0581	5.7195	0	1	.0
3	1400.0	FCD3	500	9.0	1.600	1	0 0 0	0	0	0	0	18.610	3.440	.000	2.6816	3.1419	3	48	.0
4	.0	FCD3	450	7.5	1.600	3	0 0 0	3	0	1	0	9.290	15.850	.000	.0581	5.7195	0	1	.0
5	400.0	FCD3	450	7.5	1.600	3	0 0 0	0	0	0	0	9.320	1.110	.000	.7482	5.7195	3	12	.0
6	.0	FCD3	100	6.0	1.600	5	0 0 0	4	0	1	0	.160	14.740	.000	.0581	140.0032	0	1	.0
7	400.0	FCD3	450	7.5	1.600	5	0 0 0	0	0	0	0	9.160	1.080	.000	.7482	5.7195	3	12	.0
8	.0	FCD3	100	6.0	1.600	7	0 0 0	5	0	1	0	1.360	13.660	.000	.0581	140.0032	0	1	.0
9	400.0	FCD3	400	7.0	1.600	7	0 0 0	0	0	0	0	7.800	1.420	.000	.7404	7.3153	3	12	.0
22	.0	FCD3	100	6.0	1.600	9	0 0 0	12	0	1	0	4.190	12.240	.000	.0581	140.0032	0	1	.0
10	300.0	FCD3	250	6.0	1.600	9	0 0 0	0	0	0	0	3.610	2.530	.000	.5224	19.9081	3	8	.0
11	.0	FCD3	100	6.0	1.600	10	0 0 0	6	0	1	0	.260	9.710	.000	.0581	140.0032	0	1	.0
12	600.0	FCD3	250	6.0	1.600	10	0 0 0	0	0	0	0	3.350	4.400	.000	1.0447	19.9081	5	18	.0
13	.0	FCD3	100	6.0	1.600	12	0 0 0	7	0	1	0	.400	5.310	.000	.0581	140.0032	0	1	.0
14	200.0	FCD3	250	6.0	1.600	12	0 0 0	0	0	0	0	2.950	1.160	.000	.3482	19.9081	5	6	.0
15	.0	FCD3	100	6.0	1.600	14	0 0 0	8	0	1	0	.520	4.150	.000	.0581	140.0032	0	1	.0
16	500.0	FCD3	250	6.0	1.600	14	0 0 0	0	0	0	0	2.430	2.020	.000	.8706	19.9081	6	14	.0
17	.0	FCD3	100	6.0	1.600	16	0 0 0	9	0	1	0	1.510	2.130	.000	.0581	140.0032	0	1	.0
18	800.0	FCD3	200	6.0	1.600	16	0 0 0	0	0	0	0	.920	1.590	.000	1.3433	32.2567	3	24	.0
19	.0	FCD3	100	6.0	1.600	18	0 0 0	10	0	1	0	.570	.540	.000	.0581	140.0032	0	1	.0
20	400.0	FCD3	150	6.0	1.600	18	0 0 0	0	0	0	0	.350	.540	.000	.6458	59.6353	3	12	.0
21	.0	FCD3	100	6.0	1.600	20	0 0 0	11	0	1	0	.350	.000	.000	.0581	140.0032	0	1	.0

--- PUMP DATA ---

NO	SET	TYPE	VAL VE	V-NO	PLOT A	PLOT B	HEAD M	Q M3/M	KW	P	GD2 KG-M2	GD2 (WHEEL) KG-M2	RPM	%	K	START CONDITION HEAD M	START CONDITION Q M3/M	N	M
1	1	1	1	0	0	0	50.000	7.030	90.0	0	8.100	.000	1475	84	1.4148	50.000	7.030	1.000	1.000

--- SURGE TANK DATA ---

NO	TYPE	V-NO	PLOT	HEAD M	AREA M2	LOSS M	LENGTH M	CLASS	D MM	T MM	E	2L/A SEC	ROW	DIVISION	AIR-Q M3	LOSS M
1	1	0	1	23.000	999.000	7.347	.0	0	0	.0	.000	.0000	.000	0	.0	.000
2	2	0	0	48.500	9.377	7.347	.0	0	0	.0	.000	.0000	.000	0	.0	.000
3	2	0	0	45.060	6.203	7.347	.0	0	0	.0	.000	.0000	.000	0	.0	.000
4	2	0	0	43.950	3.107	7.347	.0	0	0	.0	.000	.0000	.000	0	.0	.000
5	2	0	0	42.870	3.053	7.347	.0	0	0	.0	.000	.0000	.000	0	.0	.000
6	2	0	0	38.920	1.203	7.347	.0	0	0	.0	.000	.0000	.000	0	.0	.000
7	2	0	0	34.520	1.117	7.347	.0	0	0	.0	.000	.0000	.000	0	.0	.000
8	2	0	0	33.360	.983	7.347	.0	0	0	.0	.000	.0000	.000	0	.0	.000
9	2	0	0	31.340	.810	7.347	.0	0	0	.0	.000	.0000	.000	0	.0	.000
10	2	0	0	29.750	.307	7.347	.0	0	0	.0	.000	.0000	.000	0	.0	.000
11	2	0	0	29.210	.117	7.347	.0	0	0	.0	.000	.0000	.000	0	.0	.000
12	2	0	0	41.450	2.600	7.347	.0	0	0	.0	.000	.0000	.000	0	.0	.000

--- PIPELINE OUTPUT ---

1 3 5 7 9 10 12 14 16 18 20 21

--- PIPELINE PROFILE ---

NO	LENGTH M	HEIGHT M	LENGTH M	HEIGHT M	LENGTH M	HEIGHT M	LENGTH M	HEIGHT M
1	.0	4.50	600.0	4.50				
3	600.0	4.50	2000.0	4.50				
5	2000.0	4.50	2400.0	4.50				
7	2400.0	4.50	2800.0	4.50				
9	2800.0	4.50	3200.0	4.50				
10	3200.0	4.50	3500.0	4.50				
12	3500.0	4.50	4100.0	4.50				
14	4100.0	4.50	4300.0	4.50				
16	4300.0	4.50	4800.0	4.50				
18	4800.0	4.50	5600.0	4.50				
20	5600.0	4.50	6000.0	4.50				
21	6000.0	4.50	6000.0	4.50				

1. ANALYSIS INTERVAL 500

2. WATER LEVEL IN THE TANKS

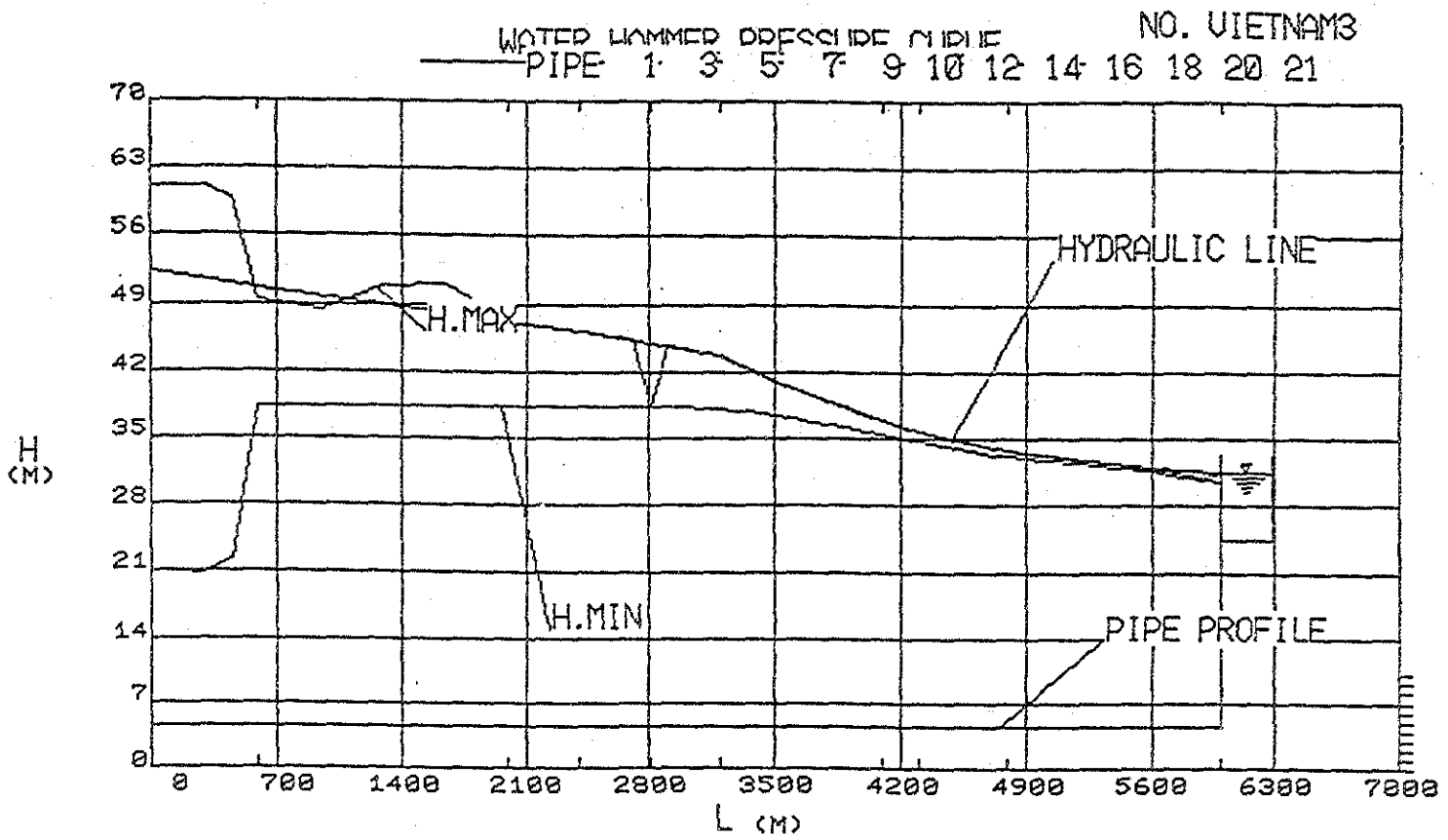
NO	- - M A X - - HEAD M	- - M A X - - LEVEL M	- - M I N - - HEAD M	- - M I N - - LEVEL M	WATER LEVEL IN THE TANKS M	AREA M2	Q M3
1	23.000	25.200	22.999	25.199	.001	999.0000	.566
2	48.500	50.700	36.621	38.821	11.879	9.3767	111.386
3	45.060	47.260	36.604	38.804	8.456	6.2033	52.454
4	43.950	46.150	36.609	38.809	7.341	3.1067	22.805
5	42.870	45.070	36.552	38.752	6.318	3.0533	19.292
6	38.920	41.120	35.464	37.664	3.456	1.2033	4.158
7	34.520	36.720	33.137	35.337	1.383	1.1167	1.544
8	33.360	35.560	32.388	34.588	.972	.9833	.956
9	31.340	33.540	30.851	33.051	.489	.8100	.396
10	29.750	31.950	29.415	31.615	.335	.3067	.103
11	29.210	31.410	28.166	30.366	1.044	.1167	.122
12	41.450	43.650	36.272	38.472	5.178	2.6000	13.463

3. PIPELINE PRESSURE

NO		LENGTH M	- - - - - M A X - - - - - TIME SEC	Q M3/M	HEAD M	LEVEL M	- - - - - M I N - - - - - TIME SEC	Q M3/M	HEAD M	LEVEL M
1	0/ 4	.0	4.011	.000	58.720	60.920	1.046	21.292	18.790	20.990
1	1/ 4	150.0	4.272	.000	58.712	60.912	1.017	21.292	18.575	20.776
1	2/ 4	300.0	4.301	.003	58.706	60.906	.872	21.292	18.361	20.561
1	3/ 4	450.0	4.214	-.270	57.448	59.648	.727	21.708	20.021	22.221
2	0/ 1	.0	.697	9.305	47.243	49.443	581.841	5.717	36.166	38.366
3	0/ 4	.0	.697	18.410	47.243	49.443	581.841	1.290	36.166	38.366
3	1/ 4	350.0	5.406	16.202	46.099	48.299	582.190	1.290	36.163	38.363
3	2/ 4	700.0	8.021	15.166	48.674	50.874	581.842	1.291	36.168	38.368
3	3/ 4	1050.0	7.963	15.029	48.886	51.086	581.493	1.293	36.173	38.373
4	0/ 1	.0	3.313	9.282	45.026	47.226	583.236	6.150	36.154	38.354
5	0/ 4	.0	3.313	9.316	45.026	47.226	583.236	-.253	36.154	38.354
5	1/ 4	100.0	2.761	9.319	44.781	46.981	583.323	-.253	36.155	38.355
5	2/ 4	200.0	8.602	9.124	44.527	46.727	583.236	-.252	36.157	38.357
5	3/ 4	300.0	8.573	9.125	44.276	46.476	583.149	-.252	36.160	38.360
6	0/ 1	.0	5.871	.160	43.949	46.149	583.585	.110	36.156	38.356
7	0/ 4	.0	5.871	9.160	43.949	46.149	583.585	1.954	36.156	38.356
7	1/ 4	100.0	4.214	9.160	43.680	45.880	583.672	1.954	36.146	38.346
7	2/ 4	200.0	4.185	9.160	43.410	45.610	583.585	1.954	36.138	38.338
7	3/ 4	300.0	4.098	9.160	43.140	45.340	583.497	1.955	36.130	38.330
8	0/ 1	.0	.536	.535	36.115	38.315	583.933	.967	36.115	38.315
9	0/ 4	.0	.535	.535	36.115	38.315	583.933	3.219	36.115	38.315
9	1/ 4	100.0	10.898	7.800	42.515	44.715	584.020	3.219	36.059	38.259
9	2/ 4	200.0	10.985	7.800	42.160	44.360	583.933	3.220	36.004	38.204

3. PIPELINE PRESSURE

NO		LENGTH M	MAX TIME SEC	MAX Q M3/M	MAX HEAD M	MAX LEVEL M	MIN TIME SEC	MIN Q M3/M	MIN HEAD M	MIN LEVEL M
9	3/ 4	300.0	11.073	7.800	41.805	44.005	583.846	3.220	35.950	38.150
22	0/ 1	.0	21.796	4.190	41.450	43.650	584.282	3.100	35.890	38.090
10	0/ 4	.0	21.796	3.610	41.450	43.650	584.282	1.897	35.890	38.090
10	1/ 4	75.0	23.715	3.610	40.817	43.017	584.340	1.897	35.720	37.920
10	2/ 4	150.0	23.773	3.610	40.185	42.385	584.282	1.897	35.552	37.752
10	3/ 4	225.0	23.715	3.610	39.553	41.753	584.224	1.897	35.383	37.583
11	0/ 1	.0	39.059	.260	38.920	41.120	584.514	.204	35.211	37.411
12	0/ 6	.0	39.059	3.350	38.920	41.120	584.514	2.363	35.211	37.411
12	1/ 6	100.0	39.147	3.350	38.187	40.387	584.602	2.362	34.854	37.054
12	2/ 6	200.0	39.234	3.350	37.453	39.653	584.514	2.363	34.498	36.698
12	3/ 6	300.0	39.321	3.350	36.720	38.920	584.427	2.363	34.142	36.342
12	4/ 6	400.0	41.733	3.350	35.987	38.187	584.340	2.363	33.786	35.986
12	5/ 6	500.0	41.820	3.350	35.253	37.453	584.253	2.363	33.429	35.629
13	0/ 1	.0	53.823	.400	34.520	36.720	585.037	.341	33.068	35.268
14	0/ 6	.0	53.823	2.951	34.520	36.720	585.037	2.345	33.068	35.268
14	1/ 6	33.3	31.300	2.950	34.327	36.527	585.008	2.346	32.947	35.147
14	2/ 6	66.7	31.329	2.950	34.133	36.333	585.037	2.345	32.828	35.028
14	3/ 6	100.0	31.242	2.950	33.940	36.140	584.950	2.346	32.707	34.907
14	4/ 6	133.3	31.271	2.950	33.747	35.947	584.979	2.346	32.588	34.788
14	5/ 6	166.7	31.242	2.950	33.553	35.753	584.892	2.346	32.467	34.667
15	0/ 1	.0	27.900	.520	33.360	35.560	585.211	.452	32.347	34.547
16	0/ 7	.0	27.900	2.431	33.360	35.560	585.211	2.112	32.347	34.547
16	1/ 7	71.4	9.474	2.430	33.071	35.271	585.270	2.112	32.132	34.332
16	2/ 7	142.9	9.532	2.430	32.783	34.983	585.212	2.112	31.917	34.117
16	3/ 7	214.3	9.358	2.430	32.494	34.694	585.153	2.112	31.702	33.902
16	4/ 7	285.7	9.416	2.430	32.206	34.406	585.095	2.113	31.487	33.688
16	5/ 7	357.1	9.416	2.430	31.917	34.117	585.037	2.113	31.273	33.473
16	6/ 7	428.6	9.474	2.430	31.629	33.829	584.979	2.113	31.058	33.258
17	0/ 1	.0	9.184	1.510	31.340	33.540	585.618	1.324	30.841	33.041
18	0/ 4	.0	9.184	.921	31.340	33.540	585.618	.877	30.841	33.041
18	1/ 4	200.0	6.161	.920	30.943	33.143	585.793	.877	30.484	32.684
18	2/ 4	400.0	6.219	.920	30.545	32.745	585.618	.877	30.128	32.328
18	3/ 4	600.0	5.812	.920	30.148	32.348	585.444	.877	29.772	31.972
19	0/ 1	.0	149.026	.423	29.507	31.707	586.315	.354	29.415	31.615
20	0/ 4	.0	149.026	.549	29.507	31.707	586.315	.531	29.415	31.615
20	1/ 4	100.0	7.178	.366	29.421	31.621	586.403	.531	29.105	31.305
20	2/ 4	200.0	7.847	.379	29.050	31.250	586.199	.531	28.795	30.995
20	3/ 4	300.0	8.515	.391	28.678	30.878	586.228	.531	28.485	30.685
21	0/ 1	.0	5.464	.350	29.210	31.410	56.846	.633	28.164	30.364


WATER HAMMER PRESSURE PROFILE
NO. VIETNAM3
PIPE 1 3 5 7 9 10 12 14 16 18 20 21
70
63
56
49
42
35
28
21
14
7
0
H (M)
H.MAX
H.MIN
HYDRAULIC LINE
PIPE PROFILE
0
700
1400
2100
2800
3500
4200
4900
5600
6300
7000
L (M)

Appendix 10
Soil Conditions at Treatment Plant Site

(Annex)

Bearing Capacity of Pile

1. Ground Condition

The location plan and the study results of the two borings made near the proposed site for the water purification plant shall be as shown below.

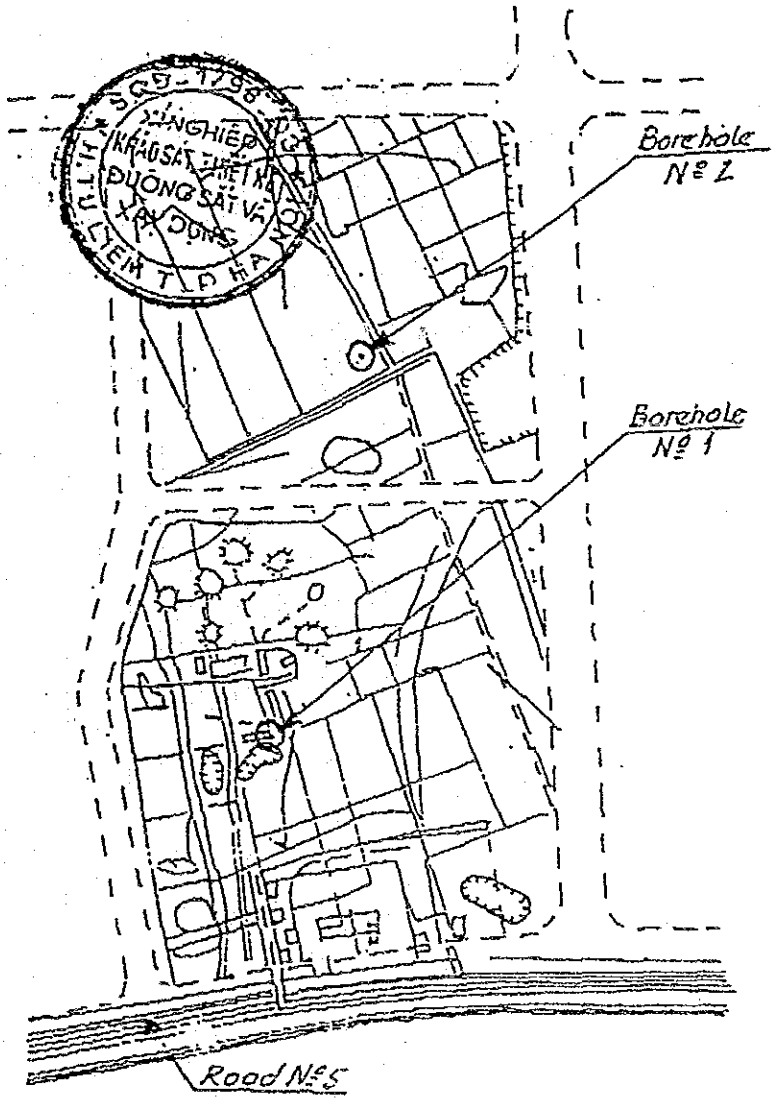


Fig. 1 Location Plan of Borings

LOCATION AND SOIL PROFILE OF BOREHOLE Nº 1

STANDARD PENETRATION TEST

WORK
BOREHOLE Nº 1

PROJECT: GIA LAM WATER SUPPLY
DRILLING METHOD
SAMPLING METHOD

Ground Level +4.35
Under Ground water Level 2.65

DATE 08.11.93 DRILLER

Depth (m)	Profile	Soil Type Relative Density G.W.L	Log Sample No.	Number of Blows per 15cm (1st)	15cm (2nd)	15cm (3rd)	N	Number of Blows. N (10 20 30 40 50 60 70 80 90)	Depth (m)
1.5		Fill: sandy clay, brown, from 0 to 1.5m mixed with broken brick							1.5
2.1		clay, brow. hard plastic	2	4	4	8			3.4
5.0		clay, dark grey, soft and running plastic	3	1	1	2			4.4
				2	2	4			5.5
		clay, yellow, hard plastic	4	7	5	12			6.5
				10	7	17			8.5
				5	5	10			9.5
8.3		clay, bluish yellow, soft and running plastic	5	1	1	2			8.5
				3	3	6			9.5
10.0		clay, brownish yellow, hard plastic		6	5	11			10.5
			6	12	10	22			11.5
			7	7	5	12			12.5
				15	11	26			13.5
				14	11	25			14.5
				15	13	28			15.5
				15	13	28			16.5
17.3		Sand, medium - grained yellowish grey, bluish grey water saturated		9	6	15			17.5
				10	6	16			18.5
20.0				12	10	22			19.5
				12	9	21			20.5
				12	8	20			21.5
				13	9	22			22.5
				14	9	23			23.5
25.0				16	13	29			24.5
			9	18	16	34			25.5
				18	16	34			26.5
				18	16	34			27.5
				18	16	34			28.5
				18	16	34			29.5
30.0				19	16	35			30.5
				20	17	37			31.5
				18	16	34			32.5
33.3		clayey sand, light grey		11	8	19			33.5
			10	12	9	21			34.5
35.3		Sand, medium - grained, bluish grey		13	16	29			35.5
				20	16	36			36.5
				25	16	41			37.5
				20	16	36			38.5
39.5		clay, brown, soft plastic	11	7	7	14			39.5
41.5							50		41.5
		sand mixed gravel, sand content decrease and gravel content increases in increase of depth					100		43.5
							100		45.5
							100		47.5
							100		49.5

① N = 3
② N = 13
③ N = 4
④ N = 21
⑤ N = 21
⑥ N = 34
⑦ N = 40

Note: From depth of 43.5m down words, cone rammer is used to drive drill rods.
: weight of rammer : 63.5 Kg
: height of free falling 76 cm

LOCATION AND SOIL PROFILE BOREHOLE Nº 2

PENETRATION TEST

WORK :

BOREHOLE Nº 2

GROUND LEVEL 4.0 m

PROJECT: GIA LÂM WATER SUPPLY — UNDER GROUND WOTER LEVEL 1.85

DRILLING METHOD:

SAMPLING METHOD: DATE 06.09.93 DRILLER

Depth (m)	Profile	Soil Type Relative Density GWL	Lab Sample Nº	Number of Blows per 15cm (min)	15cm (min)	N	(Number of Blows - N) 10 20 30 40 50 60 70 80 90	Depth (m)	
		clay, brown, soft plastic				3		1.5	① N = 3
2.2		Clay, dark grey, running plastic				3 1 1		3.5	4.6 m
4.6		Clay, brownish yellow, hard plastic				14 16		5.5	② N = 13
6.9		Clay, yellowish grey, running plastic				2 4 4 5		8.5	③ N = 4
11.8		Clay, brownish yellow, hard plastic				13 14 19 20		12.5	④ N = 21
15.2		clay, brownish yellow, soft plastic				6 7		16.2	6.4
18.2		Sand, medium-grained, bluish, yellowish grey, Water-saturated				13 14 37 48 38 36 35			⑤ N = 21 7.7
28.0						37 35 36			⑥ N = 34 15.5 m

Note: For location of borehole Nº 2 is in low-land rice-field, so that light dinamic peretration testing to be used. With technical specifications as follows:

- Weight of rammer : 30 kg
- height of free falling 40 cm
- Peretration rate : 20 cm/blow
- Diametre of driving-shoe : 3.568 cm (area : 10 cm²)
- Peak angle of driving shoe 60°

From the results, the ground condition is set as shown below.

Table-1 Ground Condition

Strata No.	Elevation (EL m)	Thickness (m)	Depth (m)	Classification	N-value	Skin Friction f (t/m²)	Specs., Piles (Aeration Equip.)
①	+6.0 ~ +4.0	2.0	2.0	Fill			EL +5.3 m RC Pile (Push-in Pile) □ - 400*400 L = 28.0 m • Coal tar shall be applied to the portion 12 m from the pilehead to deal with the negative friction. • Spacing of piles 3.0 m x 3.0 m EL -22.7 m
	+4.0 ~ -1.0	5.0	7.0	Clay	3	(3.0)	
②	-1.0 ~ -4.3	3.3	10.3	Clay	13	(13.0)	
③	-4.3 ~ -6.0	1.7	12.0	Clay	4	(4.0)	
④	-6.0 ~ -13.3	7.3	19.3	Clay	21	15.0	
⑤	-13.3 ~ -21.0	7.7	27.0	Sand	21	4.2	
⑥	-21.0 ~ -36.5	15.5	42.5	Sand	34	6.8	
⑦	-36.5 ~			Sand w/gravel	40 or more	8.0	

Note 1) The top elevation of the drilled hole is EL +4.0 m.

2) The groundwater level is set at EL +2.15 m.

3) The skin friction is not considered for the layers ① - ③.

4) This specification of a pile is an example of the one to be used for the aeration equipment. The specifications of the piles for each structure are shown on the next page.

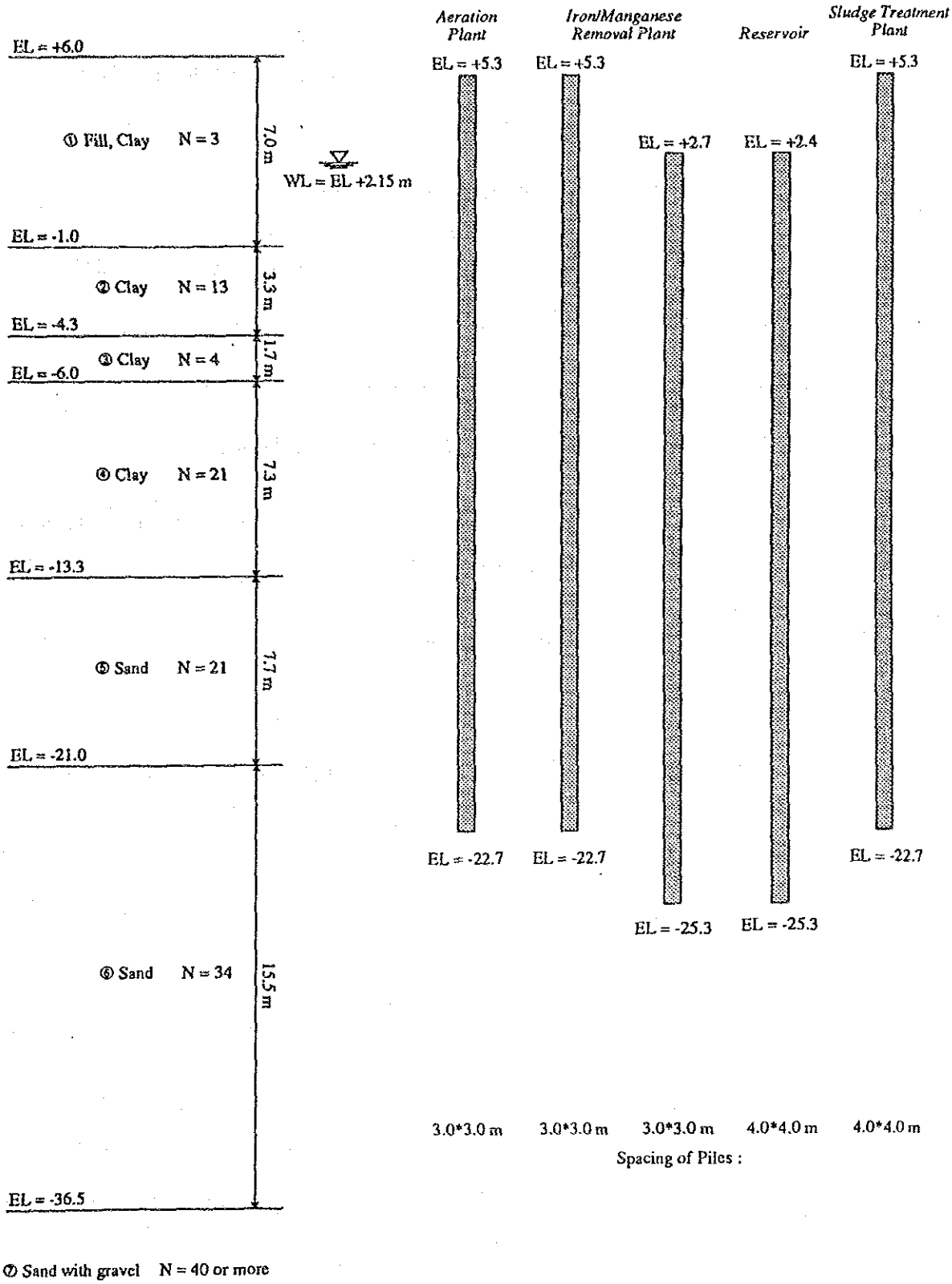


Fig. 2 Specifications of Piles

2. Calculation of Allowable Bearing Power

The piles for the aeration equipment shall be checked as stated below.

(1) Skin Friction Force

Skin friction force $\Sigma f1 = 0.4 \times 4 \times (15 \times 7.3 + 4.2 \times 7.7 + 6.8 \times 1.7)$
$= 245.4$ t/pile

Where, U : Circumference of pile (m)
f : Unit skin friction force (t/m^2)
l : Thickness of the layer subjected to the skin friction force (m)

(2) Point Bearing Capacity

Point Bearing Capacity $qd \cdot A = 30N \cdot A = 30 \times 34 \times 0.4 \times 0.4 = 163.2$ t/pile

Where, qd : Ultimate bearing power per unit area to be borne at the point of the pile (t/m^2)
A : Area of pile point (m^2)
N : Design N-value at pile point

(3) Ultimate Bearing Capacity

Ultimate bearing capacity $Ru = U\Sigma f1 + qd \cdot A = 245.4 + 163.2 = 408.6$ t/pile

(4) Allowable Bearing Capacity

Allowable bearing capacity $Ra = Ru/Fs = 408.6/3 = 136.2$ t/pile

Where, FS : Safety factor of friction pile

3. Reaction of Pile

(1) Assumption of Unit Load

The vertical load per unit area of civil work structures shall be assumed to be approx. 11.5 t/m^2 for the aeration equipment.

(2) Reaction of Pile

When the pile-interval is 3.0 m x 3.0 m,

Reaction of Pile R = 11.5 t/m^3 x 3.0 m x 3.0 m

= 103.5 t/pile < Ra = 136.2 t/pile ... OK

Appendix 11

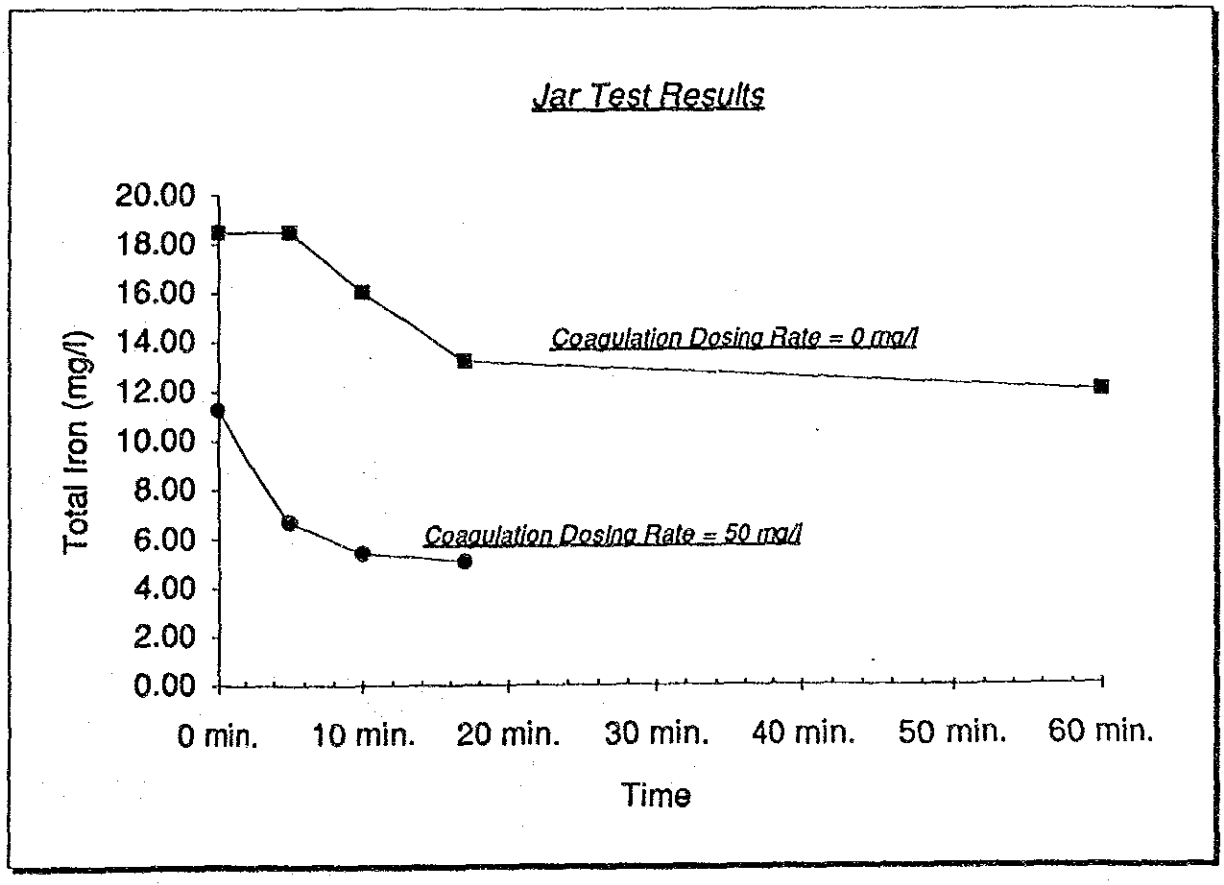
Field Experiment of Treatment Process

Table Jar Test Results

Coagulation Dosing Rate	Total Iron after Testing Time (mg/l)				
	0 min.	5 min.	10 min.	17 min.	60 min.
0 mg/l	18.50	18.50	16.00	13.20	12.00
50 mg/l	11.25	6.70	5.40	5.07	-

Note : Raw Water Conditions are as follows :

Item	Coagulation Dosing Rate	
	0 mg/l	50 mg/l
Total Iron (mg/l)	18.50	11.25
Water Temperature (°C)	27.0	27.0
pH	6.95	6.95
Test Solution	1.0% $Al_2(SO_4)_3 \cdot 14H_2O$	



Appendix 12

Design Conditions of Civil Works

Contents

1 Loads

1.1 Dead Loads

Table-1 Weight of Materials, Unit Volume (kgf/m^3)

Material	Unit Weight	Material	Unit Weight
Steel, Cast Steel, Malleable Steel	7,850	Concrete	2,350
Cast-Iron	7,250	Cement Mortar	2,150
Aluminum	2,800	Timber	800
Reinforced Concrete	2,500	Bitumen (Waterproofing)	1,100
Pre-stressed Concrete	2,500	Asphalt Pavement	2,300

Table-2 Weight of Soils, Unit Volume (tf/m^3)

Ground / Classification		Loose	Dense
Natural Ground			
	Sand/Sand and Gravel	1.8	2.0
	Sandy Soil	1.7	1.9
	Cohesive Soil	1.4	1.8
Embankment			
	Sand/Sand and Gravel	2.0	
	Sandy Soil	1.9	
	Cohesive Soil	1.8	

Note (1) The unit weight of the soil located below the ground water level shall be obtained by subtracting 0.9 from each of the above figures.

(2) The weight of crushed stones shall be the same as that of gravels. For mucks and rock masses, the weight shall be determined in consideration of the kind, shape and void, etc. thereof.

(3) The weight of sandy soil with gravel or cohesive soil with gravel shall be determined appropriately according to the mix-proportion and the condition thereof.

(4) The water level shall be considered the mean value which comes after construction.

1.2 Earth Pressure

(1) Active and Passive Earth Pressures

In principle, the Coulomb's Formula shall be applied for the earth pressure acting against movable walls. However, the earth pressures acting against easy-to-warp structures, e.g. steel sheet-piles, shall be treated in a separate manner.

(2) Earth Pressure at Rest

The coefficient of earth pressure acting against fixed walls shall be: Ko = 0.5.

1.3 Loads on Ground Surface

(1) Where the load cannot be specified:

$$Q = 1.0\ t/m^2$$

(2) Road-crossing Portion

$$Q = 1.0\ t/m^2 \text{ or T-10}$$

1.4 Service Load

300 kg/m^2 shall be used for the administration room, stairs and corridors. However, where large loads are to be brought in, the matter shall be treated in a separate way.

1.5 Loads of Piping and Equipment

To be considered.

1.6 Water Pressure

Hydrostatic pressure due to water-level of the pond or groundwater level shall be considered.

1.7 Buoyancy

Buoyancy acting to the floor slab shall be considered.

1.8 Wind Load

Wind load shall only be considered for the aeration equipment.

1.9 Seismic Road

Not to be considered.

1.10 Combination of Loads

In the structural calculation, the most disadvantageous combination of loads shall be considered long-period-wise as well as short-period-wise.

2. Design in General

2.1 Physical Constants of Materials to be Used

Table-3 Physical Constants

Kind	Young's Modulus
Concrete (Design Standard Strength 210 kg/cm^2)	2.35 x 10^5 kg/cm^2
Steel bars (SD295A, Equivalent)	2.1 x 10^6 kg/cm^2

Note: The Young's Modulus Ratio to be used n the calculation of the unit stress of the reinforced concrete members shall be: n = 15.

2.2 Allowable Unit Stress

(1) Structural Concrete

- Design Standard Strength σ_{ck} =210 kg/cm^2
- Compressive Unit Stress
  - Bending Compressive Unit Stress σ_{ca} = 70 kg/cm^2
  - Axial Compressive Unit Stress σ_{ca} = 55 kg/cm^2
- Shearing Unit Stress
  - Where the shearing force is to be borne by only concrete τ_{a1} = 3.6 kg/cm^2
  - Where the same is to be borne by combination with oblique tension-bars τ_{a2} = 16.0 kg/cm^2
  - Punching Shearing Unit Stress τ_{a3} = 8.5 kg/cm^2
- Bonding Unit Stress
  - Round Bars 7 kg/cm^2
  - Deformed Bars 14 kg/cm^2
- Bearing Unit Stress

$$\sigma_{ba} = \left(0.25 + 0.05 \frac{Ac}{Ab}\right) \sigma_{ck}$$

However, $\sigma_{ba} \leq 0.5\ \sigma_{ck}$

Where, σ_{ba} : Allowable bearing unit stress of concrete (kgf/cm^2)

Ac : Total area of the concrete surface where local loading is applied (cm^2)

Ab : Total area of the concrete surface to bear the local load (cm^2)

σ_{ck} : Design standard strength of concrete (kgf/cm^2)

(2) Concrete for Paving

- Design standard bending strength $\sigma_{bk} = 45$ kg/cm^2

(3) Reinforcement Bars

- Standard JIS/SD 295A or Equivalent
- Tensile Unit Stress

  General Members $\sigma_{sa} = 1{,}800$ kg/cm^2

  For calculation of lap-joint length and anchorage length $\sigma_{sa} = 1{,}800$ kg/cm^2
- Compressive Unit Stress $\sigma_{sa} = 1{,}800$ kg/cm^2

(4) Extra Allowable Unit Stress

- Long period (general) Factor for increase 1.0
- Short period (typhoon) Factor for increase 1.5

2.3 General Condition

The ground condition shall be set from the results of borings and laboratory tests.

2.4 Safety Factor

The following safety factors shall apply in the calculation of the structural stability.

Table-4 Safety Factors

Item			Safety Factors	
			Long Period	Short Period
Direct Foundation	Bearing		3.0	2.0
	Sliding		1.5	1.2
	Over turning		$e \leq B/6$	$e \leq B/3$
Pile Foundation	Pushing-in	Bearing Pile	3.0	2.0
		Friction Pile	4.0	3.0
	Pulling-Out		6.0	3.0
Floating			1.05	—

3. Rainwater Drainage

In-premises rainwater drainage work shall be calculated as follows.

3.1 Design Criteria

(1) Standard Rainfall Intensity

The rainfall intensity of I = 100 mm/h shall be applied for the surface drainage planning.

(2) Coefficient of Discharge

Basic coefficient of surface discharge are as shown on the table below.

Table-5 Basic Coefficients of Surface Discharge

Ground Surface		Coefficient
Road Surface	Paved	0.70 - 0.95
	Gravel Road	0.30 - 0.70
Road Shoulder, Slope Surfaces, etc.	Fine Soil	0.40 - 0.65
	Rough soil	0.10 - 0.30
	Hard Rock	0.70 - 0.85
	Soft Rock	0.50 - 0.75
Turfed Area of Sandy Soil	Slope 0 - 2 %	0.05 - 0.10
	Slope 2 - 7 %	0.10 - 0.15
	Slope >7%	0.15 - 0.20
Turfed Area of Cohesive Soil	Slope 0 - 2 %	0.13 - 0.17
	Slope 2 - 7 %	0.18 - 0.22
	Slope >7%	0.25 - 0.35
Roof		0.75 - 0.95
Vacant Lot		0.20 - 0.40
Parks with Lawns and Trees		0.10 - 0.25
Mountains w/gentle slopes		0.20 - 0.40
Mountains w/steep slopes		0.40 - 0.60
Rice-paddies, Water-surface		0.70 - 0.80
Cultivated Land		0.10 - 0.30

Using the above table as a reference, the coefficients of discharge to be adopted for this project shall be set as shown below.

Table-6 Coefficients of Discharge

Ground Surface		Coefficients C
Road Surface	Paved	0.85
	Gravel Road	0.50
Roof		0.85
Vacant Lot		0.30

(3) Calculation

The discharge quantity of rainwater shall be obtained by the following formula.

$$Q = \frac{CIa}{3.6 \times 10^6} \quad (m^3/sec)$$

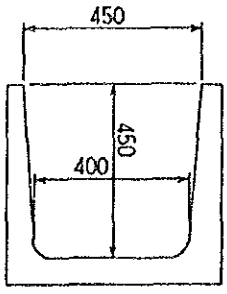
Where, Q : Discharge quantity of rainwater (m^3/sec)
C : Coefficient of Discharge
I : Rainfall intensity (I = 100 mm/h)
a : Catchment area (m^2)

3.2 Calculation of Discharge

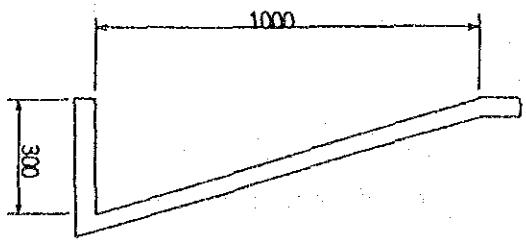
(1) Discharge Quantity

From the classified catchment area, coefficient of discharge and rainfall intensity of the premises, the max. discharge Q = 0.12 m^3/sec.

The cross-sectional shapes of the drainage units to be used are as shown below. The U-type units shall be used for the road-crossing portions and L-type units shall be used for the general portions.



U-450 x 450
(of concrete)



L-1,000 x 300
(of cast-in-place concrete)

(2) U-type Drainage Work

- Shape of cross section U - 450*450 (of concrete)

  If the depth of the water is 80%, the area of flow A = 0.144 m^2, the length of wet-sides P = 1.170 m and hydraulic mean radius R = A/P = 0.123 m.

- Longitudinal slope I = 4/1,000 (assumed)

- Coefficient of roughness n = 0.014

Quantity of flow shall be calculated as follows. The velocity of flow is obtained by Manning's Formula.

$$V = \frac{R^{2/3} I^{1/2}}{n} = 1.117 \text{ (m/sec)}$$

Where, V : Velocity of flow (m/sec)

Therefore, the quantity of flow Qa shall be:

Qa = A • V = 0.144 x 1.117 = 0.16 (m^3/sec) > Q = 0.12 (m^3/sec) ... OK

(3) L-type Drainage Work

- Shape of cross section U - 1,000*300 (cast-in-place concrete)

  If the depth of the water is 100%, the area of the flow A = 0.150 m^2, the length of wet-sides P = 1.344m and hydraulic mean radius R = A/P = 0.112m.

- Longitudinal slope I = 4/1,000 (assumed)

- Coefficient of roughness n = 0.015

Quantity of flow shall be calculated as follows. The velocity of flow is obtained by Manning's Formula.

$$V = \frac{R^{2/3} I^{1/2}}{n} = 0.980 \text{ (m/sec)}$$

Where, V : Velocity of flow (m/sec)

Therefore, the quantity of flow Qa shall be:

$Qa = A \cdot V = 0.150 \times 0.980 = 0.147\ (m^3/sec) > Q = 0.12\ (m^3/sec)$ ... OK