Since the treatment plant locates in the central part of the service area, it is able to make a equitable distribution of water over the service area.

The proposed layout plan of the water supply facilities is shown in Fig. 3.2

3.3.3 Location and Condition of Project Site

The project area locates on the alluvial plain brought by the Red River and the ground surface is quite flat of which altitude is in a range between +4 m and +10 m above sea level.

Electricity supplied by the national electric company is available all over the project area and the high tension power line is available at the treatment plant.

The national highway passes through the service area in parallel with the national railways. The junction of the national highway No.1 with the No.5 locates in the central part of the project area. The national railways also extends to Hai Phonh in parallel with the Highway No.5. In this respect there would be no problem in transportation of materials and equipment for construction of the project.

The treatment plant locates on the eastern side of the national highway No.5 in the central part of the project area. The land preparation of the treatment plant is scheduled to include the area for future extension of the treatment plant to meet the water demand in 2010. Therefore, the land for the future extension will be utilized for storage yard for the project.

3.3.4 Outline of Facilities and Equipment

All facilities and equipment proposed are necessary for provision of potable water for the project area by the year 2000 as summarized below:

1) Water source

Water wells	12 nos.
Well houses	12 nos.
Auxiliary facilities	12 sets

2) Raw water transmission

Pipeline	7.75 km
Chlorination facility	32,100 m^3/day x one series
Sludge treatment facility	1,381 kg/day

3) Treatment plant

Aeration facility	16,050 m^3/day x 2 series
Iron and manganese removal facility	16,050 m^3/day x 2 series

4) Distribution facilities

Ductile iron pipe	Ø75 - 700 mm, 52.2 km
Vinyl chloride pipe	Ø75 - 100 mm, 41.3 km

5) House connections

Water meter	7,070 Nos.
Connection pipes	Ø20 - 40 mm, 20 m - 50 m, 7,140 nos

3.3.5 Operation and Maintenance Plan

3.3.5.1 Supply and Demand Relationship

Since the required volume of construction of works of the project is so large that it is proposed to take a phased implementation, three phases.

Construction of water wells and distribution pipelines will start at the first phase. The well construction will be completed the second phase and the construction of the distribution pipelines will continue until the third phase.

In the second phase, the treatment plant of 16,050 m^3/day and related structure will be constructed and the remaining 16,050 m^3/day capacity treatment plant will be completed in the last phase.

The raw water transmission line is proposed to be constructed in the second phase. (Fig. 4.5)

The maximum supply capacity is 13,636 m^3/day by the facility with the design capacity of 16,050 m^3/day in 1996 while the water demand in 1996 is estimated at 14,280 m^3/day. Therefore, 96 % of total demand will be supplied in 1996.

In the third phase in 1997, the additional facility with the design capacity of 16,050 m^3/day will be completed. The total design capacity of the facility will be 32,100 m^3/day at the daily maximum rate which enable to meet the demand until 2000 at the daily maximum rate. (Fig. 3.3 and Table 3.3)

It is, recommended to prepare the extension plan during the period between 2000 and 2005 incorporating the existing condition of urbanization at that time to meet the increasing future water demand.

3.3.5.2 Production Cost

(1) Cost Components

Cost components of water production of the project are listed as shown below:

1) Salaries
2) Chemicals
3) Electricity
4) Repair

(2) Salaries

The annual cost of the proposed Gia Lam Water Supply Company is shown in Appendix 7 and the annual cost of the company is summarized as shown below:

Item	Annual Cost (million dong/year)
1) Administration and finance	88.8
2) Workshop	98.4
3) Production	132.0
4) Distribution	64.0
Total	384.0

Table 3.3 Supply and Demand Relationship

Item	1995	1996	1997	1998	1999	2000	2001	2002
	m3/day	m3/day	m3/day	m3/day	m3/day	m3/day	m3/day	m3/day
Design capacity	**5,500.00**	**16,050.00**	**32,100.00**	**32,100.00**	**32,100.00**	**32,100.00**	**32,100.00**	**32,100.00**
Demand								
Item								
Residential	6,647.00	7,314.00	7,981.00	8,649.00	9,317.00	9,986.00	11,038.00	12,090.00
Sub Urban	2,868.00	2,953.00	3,038.00	3,123.00	3,208.00	3,293.00	3,342.00	3,391.00
Industry	1,980.00	2,244.00	2,508.00	2,772.00	3,036.00	3,304.00	3,628.00	3,952.00
Public	884.00	920.00	956.00	992.00	1,028.00	1,065.00	1,132.00	1,199.00
Cleaning	555.00	577.00	599.00	621.00	643.00	666.00	686.00	706.00
Irrigation	228.00	272.00	316.00	360.00	405.00	447.00	491.00	535.00
Demand	**13,162.00**	**14,280.00**	**15,398.00**	**16,517.00**	**17,637.00**	**18,761.00**	**20,317.00**	**21,873.00**
Loss(10%+0.25%*n)		1,428.00	1,578.30	1,734.29	1,895.98	2,063.71	2,285.66	2,515.40
Plant consumption(7%)		1,099.56	1,188.34	1,277.59	1,367.31	1,457.73	1,582.19	1,707.19
Total loss		2,527.56	2,766.64	3,011.87	3,263.29	3,521.44	3,867.85	4,222.58
Total production	**4,000.00**	**16,807.56**	**18,164.64**	**19,528.87**	**20,900.29**	**22,282.44**	**24,184.85**	**26,095.58**
Actual Production								
Residential		6,991.00	7,981.00	8,649.00	9,317.00	9,986.00	11,038.00	12,090.00
Suburban		2,809.00	3,010.00	3,082.00	3,154.00	3,293.00	3,342.00	3,391.00
Industry		2,145.00	2,508.00	2,772.00	3,036.00	3,304.00	3,628.00	3,952.00
Public		879.00	956.00	992.00	1,028.00	1,065.00	1,132.00	1,199.00
Cleaning		552.00	599.00	621.00	643.00	666.00	686.00	706.00
Irrigation		260.00	316.00	360.00	405.00	447.00	491.00	535.00
Total Water Sold	**4,000.00**	**13,636.00**	**15,370.00**	**16,476.00**	**17,583.00**	**18,761.00**	**20,317.00**	**21,873.00**
Loss(10%+0.25%xn)		1,364.00	1,575.43	1,729.98	1,890.17	2,063.71	2,285.66	2,515.40
Plant consumption(7%)		1,050.00	1,186.18	1,274.42	1,363.12	1,457.73	1,582.19	1,707.19
Total Loss	2,000.00	2,414.00	2,761.60	3,004.40	3,253.29	3,521.44	3,867.85	4,222.58
Actual production		**16,050.00**	**18,131.60**	**19,480.40**	**20,836.29**	**22,282.44**	**24,184.85**	**26,095.58**

Table 3.3 Supply and Demand Relationship

Item	2003	2004	2005	2006	2007	2008	2009	2010
	m3/day	m3/day	m3/day	m3/day	m3/day	m3/day	m3/day	m3/day
Design capacity	**32,100.00**	**32,100.00**	**32,100.00**	**32,100.00**	**32,100.00**	**32,100.00**	**32,100.00**	**32,100.00**
Demand								
Item								
Residential	13,142.00	14,194.00	15,246.00	16,298.00	17,350.00	18,403.00	19,456.00	20,509.00
Sub Urban	3,440.00	3,489.00	3,538.00	3,567.00	3,636.00	3,685.00	3,734.00	3,784.00
Industry	4,276.00	4,600.00	4,924.00	5,248.00	5,572.00	5,896.00	6,221.00	6,545.00
Public	1,266.00	1,333.00	1,400.00	1,467.00	1,534.00	1,602.00	1,670.00	1,738.00
Cleaning	726.00	746.00	766.00	786.00	806.00	827.00	848.00	869.00
Irrigation	579.00	623.00	668.00	713.00	758.00	803.00	848.00	893.00
Total demand	**23,429.00**	**24,985.00**	**26,542.00**	**28,079.00**	**29,656.00**	**31,216.00**	**32,777.00**	**34,338.00**
Loss(11%+0.25%*n)	2,752.91	2,998.20	3,251.40	3,326.00	3,385.00	3,444.00	3,502.00	3,560.00
Plant consumption(7%)	1,832.73	1,958.82	2,085.54	2,095.00	2,095.00	2,095.00	2,095.00	2,095.00
Total loss	4,585.64	4,957.02	5,336.93	5,421.00	5,480.00	5,539.00	5,598.00	5,656.00
Total production	**28,014.64**	**29,942.02**	**31,878.93**	**32,100.00**	**32,100.00**	**32,100.00**	**32,100.00**	**32,100.00**
Actual Production								
Residential	13,142.00	14,194.00	15,246.00	15,083.00	15,050.00	15,016.00	14,983.00	14,950.00
Suburban	3,440.00	3,489.00	3,538.00	3,232.00	3,225.00	3,217.00	3,210.00	3,203.00
Industry	4,276.00	4,600.00	4,924.00	5,040.00	5,029.00	5,018.00	5,006.00	4,995.00
Public	1,266.00	1,333.00	1,400.00	1,714.00	1,710.00	1,706.00	1,703.00	1,700.00
Cleaning	726.00	746.00	766.00	908.00	906.00	904.00	902.00	900.00
Irrigation	579.00	623.00	668.00	690.00	688.00	688.00	686.00	684.00
Total Water Sold	**23,429.00**	**24,985.00**	**26,542.00**	**26,667.00**	**26,608.00**	**26,549.00**	**26,490.00**	**26,432.00**
Loss(11%+0.25%xn)	2,752.91	2,998.20	3,251.40	3,333.00	3,392.00	3,450.00	3,510.00	3,568.00
Plant consumption(7%)	1,832.73	1,958.82	2,085.54	2,100.00	2,100.00	2,100.00	2,100.00	2,100.00
Total Loss	4,585.64	4,957.02	5,336.93	5,433.00	5,492.00	5,550.00	5,610.00	5,668.00
Total production	**28,014.64**	**29,942.02**	**31,878.93**	**32,100.00**	**32,100.00**	**32,099.00**	**32,100.00**	**32,100.00**

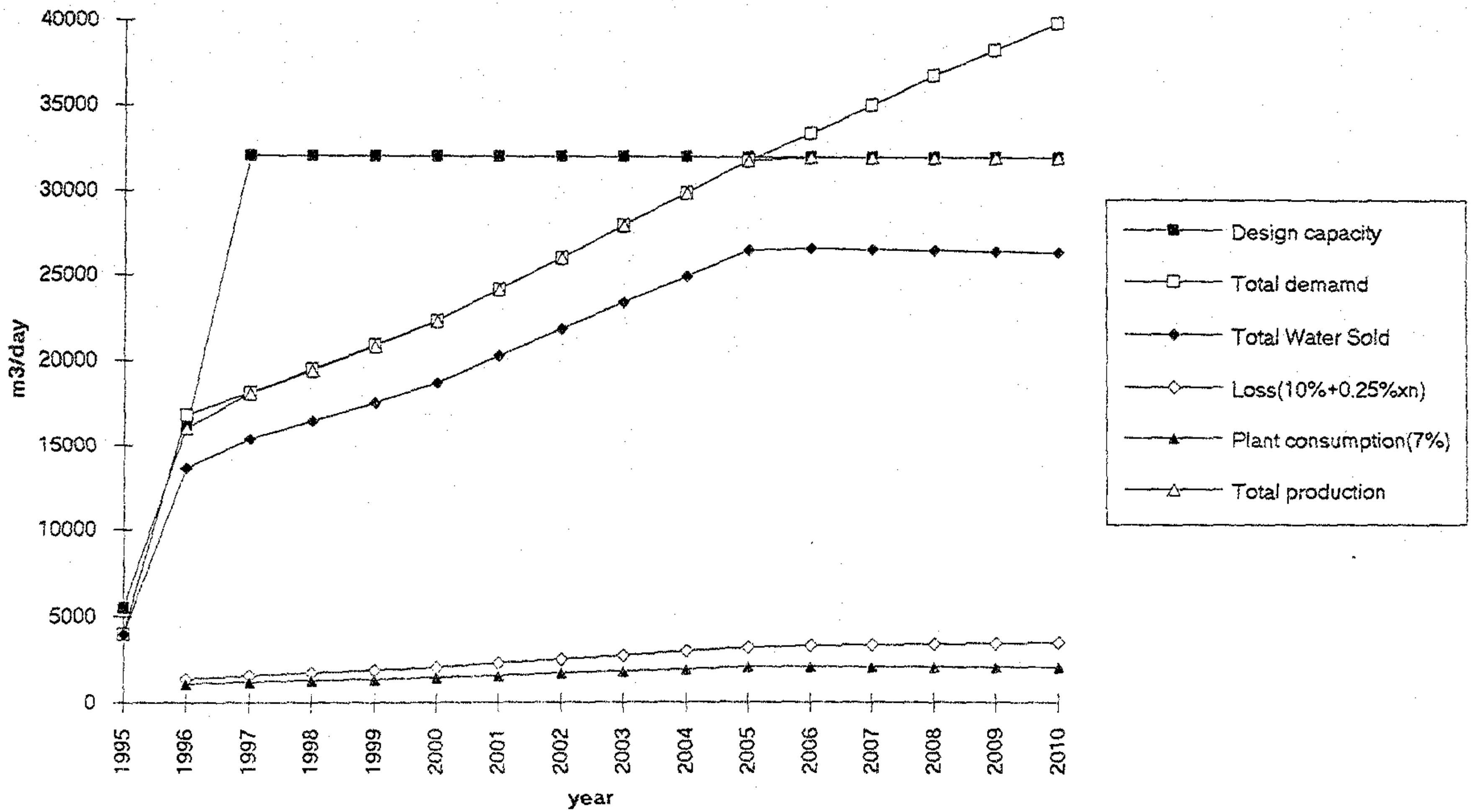


Fig. 3.3 Supply and Demand Relationship

The annual over all an average salary is estimated at 200,000 dong in 1996 considering annual increase of 5 % of the average salary in 1993.

The unit cost of salaries is estimated as shown below

384,000,000 dong/year/365 days/23,000 m^3/day = 45.7 dong/m^3

(3) Chemical cost

The necessary cost items of chemicals of the project are liquid chlorine for sterilization and aluminum sulfate for sludge thickening. The consumption rate of these chemicals are:

1) Chlorine
2,9 mg/l x 23,000 m^3/day /1,000 = 67 kg/day

2) Aluminum sulfate
2,570 x 50 x 15 /10/1,000 = 193 kg/day

Therefore, the chemical costs are:

1) Chlorine
3,000 dong/kg x 67 kg/day = 201,000 dong/day

2) Aluminum sulfate
2,000 dong/kg x 193 kg/day = 386,000 dong/day

Total chemical cost is estimated at 586,000 dong/day and the unit cost is estimated as shown below:

586,000 dong/day /23,000 m^3/day = 25.5 dong/m^3

(4) Electricity

The power capacity required for the project is summarized as shown below:

Item		Load (kW/unit)	Number of Units	Operation Hour (hr/day)	Total Capacity (kW/day)
1)	Intake pump 1	37	8	20	5,920
2)	Intake pump 2	22	1	20	400
3)	Back wash pump 1	20	1	6x0.3x4	144
4)	Back wash pump 2	4	1	6x0.3x2	15
5)	Distribution pump	95	4	24	9,120
6)	Blower	27	1	6x0.3x2	240
7)	Lighting and others	10	1	24	240
8)	Sludge treatment	20	1	12	240
	Total				16,177

The raw water quality requires ammonia removal in addition to iron and manganese removal. The raw water transmission also requires power so that the highest production cost component is electricity. Assuming the unit electricity charge is 600 dong/kW, total cost of electricity is estimated at 9,706,200 dong/day:

600 dong/kW x 16,177 kW/day = 9,706,200 dong/day

Therefore, the unit cost of electricity is estimated as shown below:

9,706,200 dong/day /32,100 m^3/day = 324.0 dong/m^3

(5) Repair

The water supply facilities of Ha Noi City is 120,000 m^3/day at present. Although new treatment plants were constructed and related distribution mains have been rehabilitated, there are still many aged distribution branch lines. For this reason a large amount of repair cost is reported in 1993.

The repair cost is approximately 10 % of the total production cost as a rule of thumb. Considering that all facilities of Gia Lam water supply are newly constructed, the cost for repair is estimated as shown below in comparison with the same cost of Ha Noi Water Supply:

Item	Ha Noi W/S (x1,000dong)	Gia Lam W/S (x1,000dong)
1) Equipment and plant	800,000	31,000
2) Workshop	2,880,000	144,000
3) Distribution		
Meter and pipes	1,037,000	20,740
Network	300,000	15,000
Common repair	500,000	10,000
Total	5,517,000	220,740

Therefore, the unit cost is estimated as shown below:

220,740,000 dong/day /23,000 m^3/day = 26.3 dong/m^3

(6) Production Cost

The production cost components of Gia Lam water supply is summarized as shown below in comparison with those of Ha Noi water supplyin 1993:

Production Cost Components

	Item Ha Noi W/S		Gia Lam W/S	
	(dong/m^3)	%	(dong/m^3)	%
1) Chemicals	12.9	4.2	25.5	6.1
2) Electricity	196.8	63.6	324.0	76.9
3) Salaries	40.9	13.2	45.7	10.8
4) Repair	59.0	19.0	26.3	6.2
Total	309.6	100.0	421.5	100.0

In both cases, the largest cost component is the electricity and Gia Lam water supply requires pumps for transmission and other electricity costs for treatment of iron and manganese removal.

The production cost of water depends on the volume of the water production and the volume of water production is determined by the water demand. The production cost of water is estimated in accordance with the water demand as shown in Table 3.4.

(7) Water Price

In order to maintain financial sustenance of the water supply, the price of water must cover most of the cost of the project and it must be also in an affordable level of the household economy in the service area.

Since the decision of the central government to maintain financial sustainability of the water supply, Ha Noi City water supply has revised the tariff structure as shown below:

Ha Noi City Water Supply Tariff (dong/m^3)

Item	Oct.1990	Dec.1990	1992	1993
Foreigner	US$ 0.45	US$ 0.45	US$ 0.45	US$ 0.45
Car wash	-	-	5,000	5,000
Industry	1,000	1,500	3,000	3,000
Public use	420	500	1,200	1,200
Domestic	300	300	600	800

Ha Noi Water Supply company obtained 2.01 billion dong on water sale in 1992 and recorded the profit of 0.167 billion dong corresponding to 8.3 % of total water sale.

The people's committee of Gia Lam estimates that an average monthly per capita income in the whole area of 175.6 km^2 is in a range between 30,000 and 40,000 dong. Majority of habitants are farmers in the area.

On the other hand the household economy of the project area is assumed to be similar to the households of Ha Noi City of which monthly income level is in a range between 200,000 dong/family and 300,000 dong/family, however, unreported income of side business is assumed to be in the same magnitude of the reported income.

Table 3.4 Unit Production Cost

Item	1995	1996	1997	1998	1999	2000	2001	2002
	m3/day	m3/day	m3/day	m3/day	m3/day	m3/day	m3/day	m3/day
Design capacity	5,500.00	16,050.00	32,100.00	32,100.00	32,100.00	32,100.00	32,100.00	32,100.00
Actual Production								
Residential		6,991.00	7,981.00	8,649.00	9,317.00	9,986.00	11,038.00	12,090.00
Suburban		2,809.00	3,010.00	3,082.00	3,154.00	3,293.00	3,342.00	3,391.00
Industry		2,145.00	2,508.00	2,772.00	3,036.00	3,304.00	3,628.00	3,952.00
Public		879.00	956.00	992.00	1,028.00	1,065.00	1,132.00	1,199.00
Cleaning		552.00	599.00	621.00	643.00	666.00	686.00	706.00
Irrigation		260.00	316.00	360.00	405.00	447.00	491.00	535.00
Total Water Sold	4,000.00	13,636.00	15,370.00	16,476.00	17,583.00	18,761.00	20,317.00	21,873.00
Loss(10%+0.25%xn)		1,364.00	1,575.43	1,729.98	1,890.17	2,063.71	2,285.66	2,515.40
Plant consumption(7%)		1,050.00	1,186.18	1,274.42	1,363.12	1,457.73	1,582.19	1,707.19
Total Loss	2,000.00	2,414.00	2,761.60	3,004.40	3,253.29	3,521.44	3,867.85	4,222.58
Total production		16,050.00	18,131.60	19,480.40	20,836.29	22,282.44	24,184.85	26,095.58
Production cost								
Salaries(384mil/Q)		65.55	58.02	54.01	50.49	47.21	43.50	40.32
Chemical(25.5)		25.50	25.50	25.50	25.50	25.50	25.50	25.50
Electricity(324/m3)		324.00	324.00	324.00	324.00	324.00	324.00	324.00
Repare(23.8d/m3)		23.80	23.80	23.80	23.80	23.80	23.80	23.80
Total(dong/m3)		438.85	431.32	427.31	423.79	420.51	416.80	413.62

Table 3.4

Item	2003	2004	2005	2006	2007	2008	2009	2010
	m3/day	m3/day	m3/day	m3/day	m3/day	m3/day	m3/day	m3/day
Design capacity	32,100.00	32,100.00	32,100.00	32,100.00	32,100.00	32,100.00	32,100.00	32,100.00
Actual Production								
Residential	13,142.00	14,194.00	15,246.00	15,083.00	15,050.00	15,016.00	14,983.00	14,950.00
Suburban	3,440.00	3,489.00	3,538.00	3,232.00	3,225.00	3,217.00	3,210.00	3,203.00
Industry	4,276.00	4,600.00	4,924.00	5,040.00	5,029.00	5,018.00	5,006.00	4,995.00
Public	1,266.00	1,333.00	1,400.00	1,714.00	1,710.00	1,706.00	1,703.00	1,700.00
Cleaning	726.00	746.00	766.00	908.00	906.00	904.00	902.00	900.00
Irrigation	579.00	623.00	668.00	690.00	688.00	688.00	686.00	684.00
Total Water Sold	23,429.00	24,985.00	26,542.00	26,667.00	26,608.00	26,549.00	26,490.00	26,432.00
Loss(10%+0.25%xn)	2,752.91	2,998.20	3,251.40	3,333.00	3,392.00	3,450.00	3,510.00	3,568.00
Plant consumption(7%)	1,832.73	1,958.82	2,085.54	2,100.00	2,100.00	2,100.00	2,100.00	2,100.00
Total Loss	4,585.64	4,957.02	5,336.93	5,433.00	5,492.00	5,550.00	5,610.00	5,668.00
Total production	28,014.64	29,942.02	31,878.93	32,100.00	32,100.00	32,099.00	32,100.00	32,100.00
Production cost								
Salaries(384mil/Q)	37.55	35.14	33.00	32.77	32.77	32.78	32.77	32.77
Chemical(25.5)	25.50	25.50	25.50	25.50	25.50	25.50	25.50	25.50
Electricity(324/m3)	324.00	324.00	324.00	324.00	324.00	324.00	324.00	324.00
Repare(23.8d/m3)	23.80	23.80	23.80	23.80	23.80	23.80	23.80	23.80
Total(dong/m3)	410.85	408.44	406.30	406.07	406.07	406.08	406.07	406.07

Table 3.5 Revenue and Production Cost

Item	1995	1996	1997	1998	1999	2000	2001	2002
Design capacity(m3/day)		16,050	32,100	32,100	32,100	32,100	32,100	32,100
Demand(m3/day)	13,162	14,266	15,370	16,476	17,583	18,693	20,201	21,711
Total loss(m3/day)		2,252	2,762	3,004	3,253	3,509	3,846	4,191
Total demand(m3/day)		16,518	18,132	19,480	20,836	22,202	24,047	25,902
Actual production(m3/day)								
Residential		6,991	7,981	8,649	9,317	9,986	11,038	12,090
Sub Urban		2,809	3,010	3,082	3,154	3,293	3,342	3,391
Industry		2,145	2,508	2,772	3,036	3,304	3,628	3,952
Public		879	956	992	1,028	1,065	1,132	1,199
Cleaning		552	599	621	643	666	686	706
Irrigation		260	316	360	405	447	491	535
Total demand(m3/day)	**13,162**	**13,636**	**15,370**	**16,476**	**17,583**	**18,761**	**20,317**	**21,873**
Loss(10%+0.25%*n)		1,364	1,575	1,730	1,890	2,064	2,286	2,515
Plant consumption(7%)		1,050	1,186	1,274	1,363	1,458	1,582	1,707
Total loss(m3/day)		2,414	2,762	3,004	3,253	3,521	3,868	4,223
Total production(m3/day)	13,162	16,050	18,132	19,480	20,836	22,282	24,185	26,096
Water sold(m3/day)	13,162	13,636	15,370	16,476	17,583	18,761	20,317	21,873
Production cost(d/m3)	439	431	427	424	421	417	414	411
Revene								
Domestic (800d/m3)		2,862	3,209	3,425	3,642	3,877	4,199	4,520
Industry (3,000 d/m3)		2,349	2,746	3,035	3,324	3,618	3,973	4,327
Public (1,200 d/m3)		385	419	434	450	466	496	525
Total(d mil/year)		**5,595**	**6,374**	**6,895**	**7,416**	**7,962**	**8,667**	**9,373**
Production cost (d mil/year)		**2,527**	**2,828**	**3,013**	**3,199**	**3,392**	**3,654**	**3,917**
Depreciation constructed by viet nam		**882**	**882**	**882**	**882**	**882**	**882**	**882**
Civil works 6000 milx0.9x0.018		97	97	97	97	97	97	97
Equipment 800 mildx0.9x0.062		67	67	67	67	67	67	67
Building&pipeline 29,530mildx0.9x0.27		718	718	718	718	718	718	718
Profit (d mil/year)		**2,187**	**2,665**	**3,000**	**3,335**	**3,688**	**4,132**	**4,575**
Depreciation of other facilities(d mil/year)		**15,448**	**15,448**	**15,448**	**15,448**	**15,448**	**15,448**	**15,448**
Civil Works 64,225 mildongx0.9x0.018		1,040	1,040	1,040	1,040	1,040	1,040	1,040
Pipeline 82,618 mildongx0.9x0.027		2,008	2,008	2,008	2,008	2,008	2,008	2,008
Equipment 222,149 mildongx0.9x0.062		12,400	12,400	12,400	12,400	12,400	12,400	12,400
Financial status(d mil/year)		-10,213	-9,735	-9,400	-9,065	-8,712	-8,268	-7,825

Item	2003	2004	2005	2006	2007	2008	2009	2010
Deisgn capacity(m3/day)	32,100	32,100	32,100	32,100	32,100	32,100	32,100	32,100
Demand(m3/day)	23,221	24,733	26,245	27,758	29,271	30,784	32,297	33,810
Toltaloss(m3/day)	4,545	4,907	5,277	5,730	6,121	6,519	6,926	7,341
Tolta demand(m3/day)	27,766	29,640	31,522	33,488	35,392	37,303	39,223	41,151
Acdual production(m3/day)								
Redsilential	13,142	14,194	15,246	15,083	15,050	15,016	14,983	14,950
SulbUrban	3,440	3,489	3,538	3,232	3,225	3,217	3,210	3,203
Indsutry	4,276	4,600	4,924	5,040	5,029	5,018	5,006	4,995
Puiblc	1,266	1,333	1,400	1,714	1,710	1,706	1,703	1,700
Clreaing	726	746	766	908	906	904	902	900
Irrigaion	579	623	668	690	688	688	686	684
Tolta demand(m3/day)	23,429	24,985	26,542	26,667	26,608	26,549	26,490	26,432
Loiss(10%+0.25%*n)	2,753	2,998	3,251	3,333	3,393	3,450	3,510	3,568
Plan consumption(7%)	1,833	1,959	2,086	2,100	2,100	2,100	2,100	2,100
Tolta loss(m3/day)	4,586	4,957	5,337	5,433	5,492	5,550	5,610	5,668
Tolta production(m3/day)	28,015	29,942	31,879	32,100	32,100	32,100	32,100	32,100
Weatr sold(m3/day)	23,429	24,985	26,542	26,608	26,549	26,490	26,432	26,374
Prdouction cost(d/m3)	408.79	406.68	406.07	406.07	406.07	406.07	406.07	406.07
Reevne								
Doemstic (800d/m3)	4841.944	5,163.44	5,484.93	5,347.98	5,336.30	5,324.04	5,312.36	5,300.68
Indsutry (3,000 d/m3)	4682.22	5,037.00	5,391.78	5,518.80	5,506.76	5,494.71	5,481.57	5,469.53
Puiblc (1,200 d/m3)	554.508	583.85	613.20	750.73	748.98	747.23	745.91	744.60
Total(d mil/year)	10,079	10,784.29	11,489.91	11,617.51	11,592.04	11,565.97	11,539.84	11,514.80
Production cost (d mil/year)	4,180	4,444.54	4,724.95	4,757.72	4,757.72	4,757.72	4,757.72	4,757.72
Depreciation constructed by viet na	882	882	882	882	882	882	882	882
Civil works 6,000milx0.9x0.018	97	97	97	97	97	97	97	97
Equipment 1,200mildx0.9x0.062	67	67	67	67	67	67	67	67
Building&pipeline 29,530mildx0.9x0.27	718	718	718	718	718	718	718	718
Profit (d mil/year)	5,017	5,458.00	5,883.21	5,978.04	5,952.57	5,926.51	5,900.37	5,875.33
Depreciation(mil d/year)	15,448	15,448	15,448	15,448	15,448	15,448	15,448	15,448
Civil Works 74,620mildongx0.9x0.018	1,040	1,040	1,040	1,040	1,040	1,040	1,040	1,040
Pipeline 140,650mildongx0.9x0.027	2,008	2,008	2,008	2,008	2,008	2,008	2,008	2,008
Equipment 212,691mildongx0.9x0.062	12,400	12,400	12,400	12,400	12,400	12,400	12,400	12,400
Financial status(d mil/year)	-7,383	-6,942.00	-6,516.79	-6,421.96	-6,447.43	-6,473.49	-6,499.63	-6,524.67

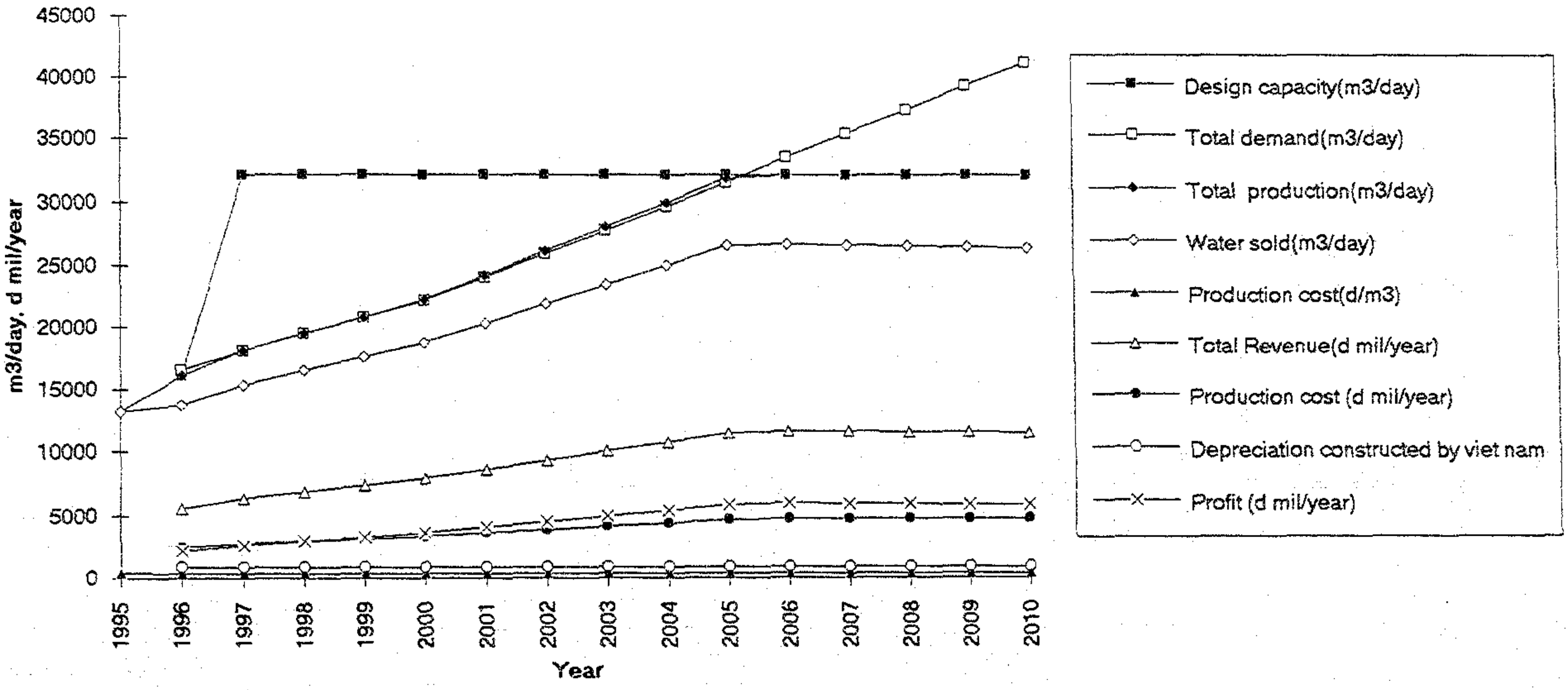


Fig. 3.4 Revenue and Production Cost

The price of the domestic water is 800 dong/m³ in 1993. Assuming the number of an average family is five, the monthly water charge of an average family is estimated as shown below:

800 dong/m³ x 0.15 m³/day x 5 persons x 30 days =
18,000 dong/month

This is corresponding to 7.2 % of the monthly income which is rather high proportion to an average monthly income, however, it would be acceptable considering the income of side business.

(8) Production Cost and Income of Water Charge

Taking the present water tariff of Ha Noi City, the income of on water sale Gia Lam water supply company is estimated as shown in Table 3.5.

The income on water sale of the company is 2,527 million dong in 1996 and it increases in accordance with increase in water demand until 2006. Then after 2006, the income start to decrease slightly since the supply amount stays in a same level but leakage increases while the production cost remains the same.

The project can produce profit to a certain extent, however, it is far insufficient to cover the depreciation costs of the facilities.

Water Income on Water Sale and Production Cost

Item	1996 (mil d/y)	1997 (mil d/y)	2000 (mil d/y)	2005 (mil d/y)	2006 (mil d/y)	2010 (mil d/y)
Design capacity (m³/day)	16,050	32,100	32,100	32,100	32,199	32,100
Water production (m³/day)	16,050	18,132	22,202	31,522	32,180	32,100
Leakage (m³/day)	1,364	1,575	2,056	3,215	3,333	3,568
Plant consumption (m³/day)	1,050	1,186	1,452	2,062	2,100	2,100
Water sold (m³/day)	13,636	15,370	22,282	26,542	26,608	26,374
Production cost	2,527	2,828	3,392	4,725	4,758	4,758
Water charge income	5,595	6,374	7,962	11,490	11,618	11,515
Depreciation	882	882	882	882	882	882
Profit	2,187	2,665	3,688	5,883	5,978	5,876

In the above estimate, the depreciation of the facilities to be constructed by Ha Noi City is included, however, depreciation of total capital investment cost can not completed through the project life. Details are shown in Table 3.5 and Fig. 3.4.

(9) Forecast of Financial Situation

As the national economy grows, the income of household in the project area may increase as well as the water production costs.

The current national five year economic development plan sets the target growth rate of national product at 5.5 % - 6.5 % and Ha Noi City estimates that actual growth rate of that in the past few years is 3.5 %.

When the production cost increases at the same rate as the national product growth rate, 3.5 %, the production cost will increase as shown below:

Item	1996	2000	2005	2010
Water production (m^3/day)	16,050	22,282	31,522	32,100
Unit production cost (dong/m^3)	438.9	482.8	554.3	655.5
Production cost (mil dong/year)	2,571	3,912	6,377	7,680

On the other hand, the water tariff will be revised in each 5 years at an annual rate of 5 %, the water charge income will be estimated as shown below:

Item	1996	2000	2005	2010
Domestic(dong/m^3)	800	882	1,182	1,368
Industrial(dong/m^3)	3,000	3,302	4,431	5,130
Public use(dong/m^3)	1,200	1,323	1,772	2,052
Income of water charge (mil dong/year)	5,595	8,778	16,971	19,690

Further details are shown in Table 3.6 and Fig. 3.4.

The water supply is a public service and it is preferable to maintain financial self sustainance. Since it requires a large amount of initial capital investment, it is commonly observed to receive either central or local government subsidize in many countries. However, even receiving the government subsidize, it must produce necessary capital reserve for replacement of machinery and equipment of which life time is short, admitting that other depreciation cost is covered by the government subsidies.

In case of Gia Lam water supply, a cumulative profits totaling 102 billion dong, during 15 years from commencement of the project until 2010 is assumed to be sufficient to meet replacement of machinery and equipment when the increase in the water charge is revised in accordance with increase in the production costs.

3.4 Necessity of Technical Cooperation

Ha Noi Water Supply Company has sufficient capability in water supply activity through its long time experience. Much of cooperation will be provided for the Gia Lam water Supply Company by the Ha Noi Water Supply Company. In this respect there would be no problem in operation and maintenance of the project implementation. However, since the raw water quality of the project requires removal of heavily contained iron and a type of sophisticated system is introduced for the treatment plant. It would be preferable to have a short term technical cooperation in 1 to 2 years for the treatment plant.

In order to maintain financial self sustainance of the project it is a must to provide satisfactory services for complete collection of water charges. However, the government decision to maintain financial self sustenance of water supply is still a new concept in Viet Nam so that technical cooperation is recommended for management of the new company including water charge collection practice and even necessary advise of financial aspects to Ha Noi City authority for 2 to 4 years.

The proposed technical cooperation shall be provided by experts who have sufficient capability through practical experience. In this respect, the international cooperation under JICA's program would be applicable.

Table 3.6 Financial Forecast

	Item	1996	1997	1998	1999	2000	2001	2001	2002
1	Design capacity(m3/day)	16,050	32,100	32,100	32,100	32,100	32,100	32,100	32,100
2	Water production(m3/day)	16,050	18,132	19,480	20,836	22,202	24,047	24,185	25,902
3	Water sold(m3/day)	13,636	15,730	16,476	17,583	18,761	20,201	20,313	21,711
4	Residential	6,991	7,981	8,649	9,315	9,986	11,038	11,038	12,090
5	Suburban	2,809	3,010	3,082	3,154	3,293	3,342	3,342	3,391
6	Industry	2,145	2,508	2,772	3,036	3,304	3,628	3,628	3,952
7	Public	879	956	992	1,028	1,065	1,132	1,132	1,199
8	Cleaning	552	599	621	643	666	686	686	706
9	Irrigation	260	316	360	405	447	491	491	535
10	Water charge 5%/y,3yrs								
11	Domestic d/m3	800	800	800	882	882	882	882	1,021
12	Industry d/m3	3,000	3,000	3,000	3,308	3,308	3,308	3,308	3,828
13	Public d/m3	1,200	1,200	1,200	1,323	1,323	1,323	1,323	1,531
14	Revenew (d mil/year)								
15	Domestic(4*11)	2,862	3,209	3,425	4,014	4,275	4,629	4,629	5,768
16	Industry(5*12)	2,349	2,746	3,035	3,665	3,989	4,380	4,381	5,522
17	Public(6*13)	385	419	434	496	514	547	547	670
18	Total revenew(15+16+17)	5,595	6,374	6,895	8,176	8,778	9,556	9,557	11,960
19	Production cost	439	431	427	424	421	417	417	414
20	Salariies(d/m3)	66	58	54	50	47	44	44	41
21	Chemicals(d/m3)	26	26	26	26	26	26	26	26
22	Electricity(d/m3)	324	324	324	324	324	324	324	324
23	Repare(d/m3)	24	24	24	24	24	24	24	24
24	Inflated production cost(3.5%/yr)								
25	Salaries(d/m3)	66	60	58	56	54	50	50	50
26	Chemicals(d/m3)	26	26	27	28	29	30	31	31
27	Electricity(d/m3)	324	335	347	359	372	385	398	398
28	Repare(d/m3)	24	25	25	26	27	28	29	29
29	**Production cost(d mil/year)**								
30	Salaries(25*3)	384	397	411	426	441	441	441	472
31	Chemicals(26*3)	149	175	194	215	237	266	277	296
32	Electricity(27*3)	1,898	2,219	2,468	2,732	3,013	3,378	3,516	3,765
33	Repare(28*3)	139	163	181	201	221	248	258	277
34	Total Production cost(d mil/year)	2,571	2,954	3,255	3,573	3,912	4,332	4,491	4,810
35	Depreciation of VN investment(d mil/year)	882	882	882	882	882	882	882	882
36	Civil Works (6,000 mil dongx0.9x0.018)	97	97	97	97	97	97	97	97
37	Equipment(1,200mil dongx0.9x0.062)	67	67	67	67	67	67	67	67
38	Building&Pipeline (29,530mil dongx0.9x0.027)	718	718	718	718	718	718	718	718
39	Profit(18-34,d mil/year)	2,142	2,538	2,759	3,720	3,984	4,342	4,183	6,268
40	Cumulative profit(d mil)	2,142	4,680	7,439	11,159	15,143	19,485	23,668	25,753
41	Depreciation of other facilities(d mil/year)	15,448	15,448	15,448	15,448	15,448	15,448	15,448	15,448
42	Civil Works(64,225 mil dongx0.9x0.018)	1,040	1,040	1,040	1,040	1,040	1,040	1,040	1,040
43	Pipelines(82,618 mil dongx0.9x0.027)	2,008	2,008	2,008	2,008	2,008	2,008	2,008	2,008
44	Equipment (222,149 mil dongx0.9x0.062)	12,400	12,400	12,400	12,400	12,400	12,400	12,400	12,400
46	Financial status(39-41,d mil/year)	-13,306	-12,910	-12,689	-11,728	-11,464	-11,106	-11,265	-9,180

Table 3.6 Financial Forecast

	Item	2003	2004	2005	2006	2007	2008	2009	2010
1	Design capacity(m3/day)	32,100	32,100	32,100	32,100	32,100	32,100	32,100	32,100
2	Water production(m3/day)	27,766	29,640	31,522	32,100	32,100	32,100	32,100	32,100
3	Water sold(m3/day)	23,221	24,733	26,245	26,667	26,608	26,550	26,490	26,432
4	Residential	13,142	14,194	15,246	15,083	15,050	15,016	14,983	14,950
5	Suburban	3,440	3,489	3,538	3,232	3,225	3,217	3,210	3,203
6	Industry	4,276	4,600	4,924	5,040	5,029	5,018	5,006	4,995
7	Public	1,266	1,333	1,400	1,714	1,710	1,706	1,703	1,700
8	Cleaning	726	746	766	908	906	904	902	900
9	Irrigation	579	623	668	690	688	688	686	684
10	Water charge 5%/y,3yrs								
11	Domestic d/m3	1,021	1,021	1,182	1,182	1,182	1,368	1,368	1,368
12	Industry d/m3	3,828	3,828	4,431	4,431	4,431	5,130	5,130	5,130
13	Public d/m3	1,531	1,531	1,772	1,772	1,772	2,052	2,052	2,052
14	Revenew (d mil/year)								
15	Domestic(4*11)	6,178	6,589	8,101	7,899	7,882	9,104	9,007	9,064
16	Industry(5*12)	5,975	6,427	7,964	8,151	8,133	9,396	9,373	9,353
17	Public(6*13)	708	745	906	1,109	1,106	1,278	1,276	1,273
18	Total revenew(15+16+17)	12,860	13,761	16,971	17,159	17,121	19,778	19,656	19,690
19	Production cost	411	409	407	406	406	406	406	406
20	Salariies(d/m3)	38	35	33	33	33	33	33	33
21	Chemicals(d/m3)	26	26	26	26	26	26	26	26
22	Electricity(d/m3)	324	324	324	324	324	324	324	324
23	Repare(d/m3)	24	24	24	24	24	24	24	24
24	Inflated production cost(3.5%/yr)								
25	Salaries(d/m3)	48	47	45	45	46	48	50	51
26	Chemicals(d/m3)	32	34	35	36	37	39	40	41
27	Electricity(d/m3)	412	427	442	457	473	490	507	524
28	Repare(d/m3)	30	31	32	34	35	36	37	39
29	**Production cost(d mil/year)**								
30	Salaries(25*3)		506	523	523	542	561	580	601
31	Chemicals(26*3)	329	363	400	421	436	451	467	484
32	Electricity(27*3)	4,178	4,616	5,081	5,355	5,542	5,736	5,937	6,145
33	Repare(28*3)	307	339	373	393	407	421	436	451
34	Total Production cost(d mil/year)	5,302	5,824	6,377	6,693	6,927	7,170	7,421	7,680
35	Depreciation of VN investment(d mil/year)	882	882	882	882	882	882	882	882
36	Civil Works (6,000 mil dongx0.9x0.018)	97	97	97	97	97	97	97	97
37	Equipment(1,200mil dongx0.9x0.062)	67	67	67	67	67	67	67	67
38	Building&Pipeline (29,530mil dongx0.9x0.027)	718	718	718	718	718	718	718	718
39	Profit(18-34,d mil/year)	6,676	7,055	9,712	9,584	9,312	11,726	11,353	11,128
40	Cumulative profit(d mil)	32,429	39,484	49,196	58,780	68,092	79,818	91,171	######
41	Depreciation of other facilities(d mil/year)	15,448	15,448	15,448	15,448	15,448	15,448	15,448	15,448
42	Civil Works(64,225 mil dongx0.9x0.018)	1,040	1,040	1,040	1,040	1,040	1,040	1,040	1,040
43	Pipelines(82,618 mil dongx0.9x0.027)	2,008	2,008	2,008	2,008	2,008	2,008	2,008	2,008
44	Equipment (222,149 mil dongx0.9x0.062)	12,400	12,400	12,400	12,400	12,400	12,400	12,400	12,400
46	Financial status(39-41,d mil/year)	-8,772	-8,393	-5,736	-5,864	-6,136	-3,722	-4,095	-4,320

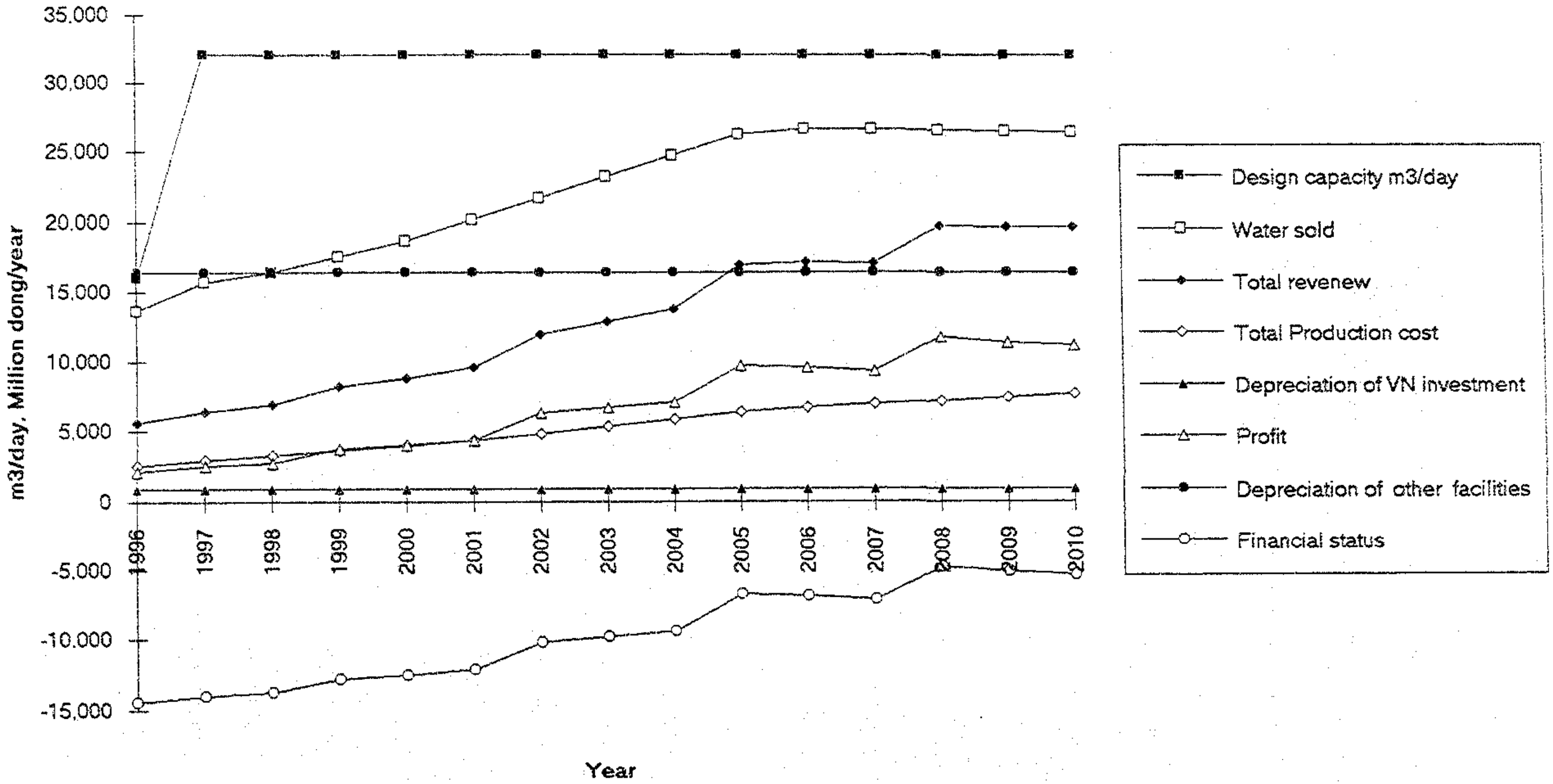


Fig. 3.5 Financial Forecast

4. Basic Design

4. Basic Design

4.1 Design Concept

4.1.1 Scope of design

This is the basic design of all facilities to provide potable water to meet the demand of the service area in 2000. Major items of facilities are sammarized as shown below:

1. Water source 12 water wells,
2. Raw water transmission line,
3. Treatment plants,
4. Sludge treatment plant,
5. Distribution Reservoir & Pump facilities,
6. Distribution mains and branch lines and
7. House connections.

4.1.2 Distribution piplines

Distribution pipeline route is determined based on the existing road network. No distribution pipe is designed for the area where there is no access along permanent roads. In this case, the design capacity of the distribution pipe at the terminal point to such areas is designed to be sufficient to provide the water for such areas when the distribution lines will be extended in future.

4.1.3 Facility installation conditions

4.1.3.1 Intake facility

Stations for eight intake well pumps to be constructed in the well field along the river are designed by taking the water level during flood of the river into account. The elevation of the site planned for the pump station is 10.43 m above the sea level. An average water level during flood of the river is 12.50 m above the sea level and the height of the levee of the river is at 13.50 m. Accordingly, the floor level of the pump station is determined at 13.50 m above the sea level.

4.1.3.2 Treatment plant

The site planned for the treatment plant is paddy fields at present. The present elevation is about 4 m above the sea, and the water level during the flood in the rainy season is assumed to rise further. Since the road height of National Highway No.5 running near the proposed site of the plant is 6.00 m above the sea level, the site will be banked by 2 m above the existing elevation to meet the finish elevation of 6.00 m above the sea level.

4.1.4 Drainage facility

Drainage from the treatment facility contains high concentration of iron. As the site inspection result on the topography of the proposed site indicated no river to receive the drainage, a sludge treatment plant is proposed to be constructed. The sludge treated by this treatment plant is transported by truck to be used for land reclamation, etc. Supernatant separated in the sludge treatment plant is returned to the water treatment line for reuse.

4.1.5 Treatment process

Since the chemicals available locally for the treatment process are poor in the purity and expensive, the treatment process is designed to minimize the chemical application. In this view, the iron removal treatment is designed as a two step filtration type, instead of a coagulating sedimentation method using coagulant. On the other hand, ammonia contained in the water requires large amount of chlorine consumption. Such large amount of consumption of chlorine can be reduced by removing iron by a biological filtration system which can remove ammonia at the same time.

4.1.6 Distribution and service facilities

The design is based in principle on continuous services for 24-hour water supply a day. (However, in case of failure of public electric power supply, the emergency power generator will operate one distribution pump.) The distribution reservoir tank is constructed in the treatment plant to cope with fluctuation of water demands. The distribution system is a direct pumping type. The National Water Supply Facility Standard of Vietnam sets the required pressure at the water pipe end to be 20 ~ 25 m, which enables direct water supply to three-storied buildings.

4.1.7 Construction schedule

The water pipe laying work by Vietnam will take about two years. When about seven months for manufacture and transport of these materials and equipment are included, the overall piping work period will require two years and seven months. The piping work is more critical through the overall construction schedule. Accordingly, the overall period is divided into three phases and construction of each facility will be scheduled with due consideration on the piping work.

4.2 Review of Design Conditions

4.2.1 Proposed service area

The proposed service area was set according to the Gialam District Development Plan (2010) of Ha Noi City. The content of the plan is described in Chapter 3, and the size of the service area is 989.8 ha, with the projected population of 121,000 in the year 2000.

4.2.2 Water demand

According to the estimated water demand in Chapter 3, the water demand in 2000 will be 18,761 m^3/day in an average.

4.2.3 Design capacity

The design capacity is determined according to calculation described below:

(1) The daily average water demand is 18,761 m^3/day as determined by the water demand projection.

(2) Maximum daily water demand (Q1) = Daily average demand x maximum daily factor (1.4)

Q1 : 18,761 m^3/day x 1.4 = 26,265 m^3/day

(3) Unaccounted-for water (Q2) is assumed to be 11.25 % for the maximum daily water demand in the target year of 2000.

Q2 : 26,265 m^3/day x 0.1125 = 2,955 m^3/day

(4) Maximum daily water demand (Q) = Q1 + Q2 = 29,220 m^3/day so that the maximum daily water demand (Q) is determined to be 30,000 m3/day.

(5) The required water to be consumed in the treatment plant, is assumed to be 7 % (2,100 m^3/day) of the design maximum daily water demand.

(6) The design capacity for intake, transmission of raw water, and treatment plant is 32,100 m^3/day.

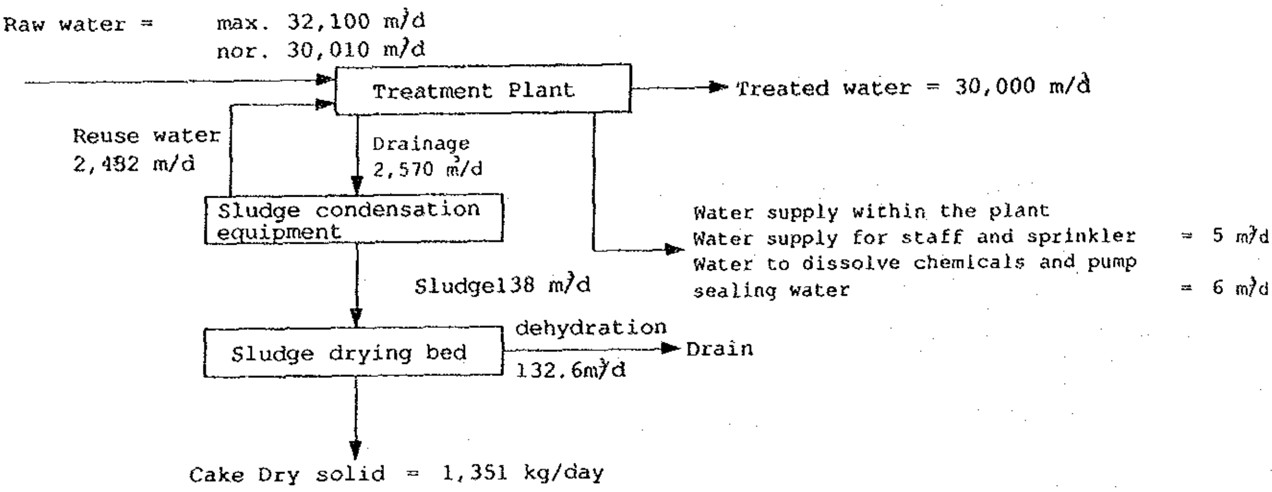
(7) The distribution reservoirs will be constructed in the treatment plant. The capacity of the distribution reservoir is calculated to be 20 % of the maximum daily demand (30,000 m^3/day) or 6,000 m^3. This capacity includes the water rate used inside the treatment plant and that for fire fighting.

(8) For the water demand of the distribution piping, the maximum hourly demand is used. The maximum hourly factor is 1.35. Maximum hourly demand :

30,000 x 1.35/24 = 1,687.5 m^3/hour (468.75 lit/sec)

The demand calculated above is shown in Fig. 4-1, Mass Balance of Design Water Rate. The drainage shown in the figure is the actual calculated drainage.

Fig. 4-1 Water mass balance



4.2.4 Review of water source

4.2.4.1 Pumping rate of ground water

The design capacity of the facility is maximum 32,100 m^3/d (371,53 lit/sec). The safe yield per well is 45.81 lit/sec in an average according to the latest well records (Maidich purification plant). The screen diameter is 350 mm and its length 17 - 18 m. In this plan, the design with the screen diameter of 350 mm and length of 36 m is proposed to enable water intake at a pumping rate of 50 lit/sec. Therefore, the design capacity of the pumping rate per well is determined to be 50 lit/sec. On the basis that the intake pumps are operated for 20 hours a day, the number of required wells is determined to be nine. Three more spare wells, as required by the Hanoi Standard, are added making a total of 12 wells to be drilled.

4.2.4.2 Water balance of ground water

The ground water of the aquifer in originated from the underflow water of Red river and rain water. The recharge rate per unit period of the aquifer is estimated at 1.18 x 10.7 m^3/year. This corresponds to about 0.01 % of the annual discharge rate of 1.46 x

10.11 m^3/y of the river. Judging from this value, the recharge rate is sufficient as the water source of the project. The water balance of the ground water in the area is discussed in Annex 5.

4.2.4.3 Circle of influence

The distance between wells to avoid influence of draw down is estimated to be 250 m. Factors and conditions used for calculation are shown below. Detailed calculation is described in the Annex 5, Review of Underground in the Planned District.

Transmissibility coefficient	:	1.90×10^{-2} m^3/sec
Storage coefficient of aquifer	:	1.0×10^{-3}
Pumping rate	:	50 lit/sec
Continuous pumping time	:	20 hours
Diameter of well	:	350 mm

4.2.5 Facility layout plan

The overall facility layout plan is shown in the basic design drawing (DWG No.1). Installation conditions for each facility are described below.

4.2.5.1 Intake facility

Principal conditions to select the well field are as follows:

1) The main aquifer (qp1) must exist in sufficient thickness.

2) The well field must be as near as possible to the treatment plant.

3) The well field must be free from various environmental influences arising along with urbanization in the future. The number of planned wells is 12. Eight wells are located at the well field along the river and additional 4 wells at the treatment plant.

4.2.5.2 Raw water transmission pipeline

The raw water transmission pipeline route is shown in the facility layout plan, running in the shortest distance along the public roads from the intake facility to the treatment plant detouring the airport. The pipeline (600 mm cast iron pipe) from the well field along the river runs across a levee at one point. Since cutting of the levee body is prohibited by the regulation, the pipe is proposed to cross over the existing levee (road). In connection with such cross-over of the pipe, a part of the levee will be heightened and the approach grade of the road before and after this cross-over point is modified.

4.2.5.3 Treatment plant

The treatment plant location was selected on the basis of the following requirements:

(1) Near to the intake point

(2) Location approximately in the center of the service area

(3) Easiness to acquire the land

(4) Availability of power supply in the vicinity

(5) Access road

(6) Not an important location for development in the future.

The result of selection is shown below.

Table 4-1 Evaluation table for selection of the location of the purification plant

Evaluation item	Result of selection	Evaluation
1 Distance from the intake point	- About 7 km	- Slightly distanced
2 Distance from the service area	- Approximately in the center	- Good
3 Land purchase	- Land provided by Vietnam	- Good
4 Distance from power supply	- 100 m or less to the site	- Good
5 Access	- None (about 500 m from the national road)	- Approach planned by Vietnam
6 Development district	- Out of the area of land use plan	- Height limited to 10 m around the airport

From the table above;

(1) The intake place has been determined to be the optimum position in the development plan and the geological survey of water source of this plan. The appropriate land for the treatment plant (about 7 ha) could not be found in an area around the intake place.

(2) It is possible to design the facility within the height limit as set forth around the airport.

(3) Distribution pipeline route

As a rule, the pipeline is buried along the existing public roads. Note that the water pipe will not be buried under the existing levee road because of the regulation. For large roads (national highway, etc.), the distribution branch pipe must be laid on both sides of the road because of technical aspects of the service pipe branching work.

4.2.6 Quality standards for raw water and treated water

For raw water quality, the maximum value of each chemical component of the water quality of existing wells is taken as the design water quality. The design water quality is shown in Table 4-2. The treated water quality is in compliance with Chapters 4 and 5, Provisional Environmental Criterias, Ministry for Science, Technology and Environment. The treated water quality standards is shown in Tables 4-3 and 4-4.

Among raw water quality items, iron and manganese exceed the drinking water quality standard. Ammonia, though within the standard range, may cause increase in the chlorine consumption for disinfection, resulting in increase in the running cost. The treatment process must be designed to remove not only iron and manganese, but also ammonia.

4.2.7 Water treatment process

4.2.7.1 Treatment Process

The water treatment process to remove iron, manganese, and ammonia contained in the raw water is illustrated as shown in Fig. 4-2.

Each component of the above system is summarized as shown below.

Fig. 4-2 Equipment flow

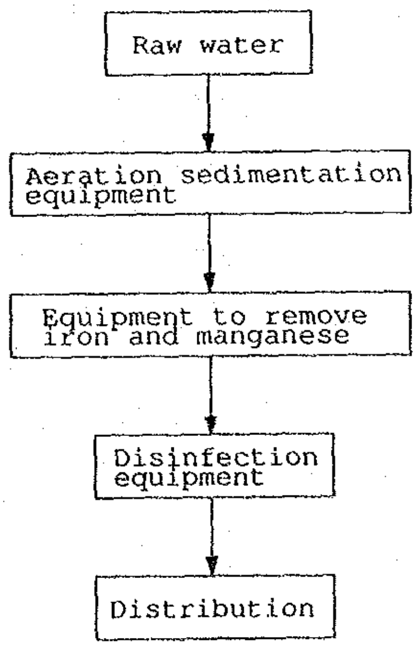


Table 4-2 Design Raw Water Quality

Characteristic	Maximum Concentration	Minimum Concentration
Turbidity	0	0
Colour	0	0
Water Temperature	27 °C	24 °C
pH	6.8	6.5
Total Iron	22 mg/l	10 mg/l
Total Manganese	2.0 mg/l	0.4 mg/l
Ammonia	1.0 mg/l	0.7 mg/l
Ca as $CaCO_3$	55 mg/l	-
HCO_3 as $CaCO_3$	200 mg/l	-
Alkalinity as $CaCO_3$	250 mg/l	-
Total Hardness as $CaCO_3$	180 mg/l	-
Chloride Ion	31 mg/l	-
NO_2	nil	-
NO_3	nil	-
PO_4	3.0 mg/l	-
SO_4	4.0 mg/l	-

Table 4-3 Standard for Drinking and Domestic Water Quality
(Provisional Environmental Criteria)

Characteristic	Unit	Standard
Colour	-	less than 10
Taste (after boiled 40-50 °C)	-	0
TDS	mg/l	less than 1,000
pH	-	6.5 - 8.5
Total Hardness	odH	12
NaCl (Sea Area)	mg/l	less than 400
NaCl (Normal Area)	mg/l	less than 100
Nitrite (NO_3)	mg/l	less than 6
Nitrate (NO_2)	mg/l	0
Hydrogen Sulfide (H_2S)	mg/l	0
Ammonia (Surface Water)	mg/l	0
Ammonia (Ground Water)	mg/l	less than 3
Lead	mg/l	less than 0.1
Copper	mg/l	less than 3
Zinc	mg/l	less than 5
Total Iron	mg/l	less than 0.3
Allowable Total Iron	mg/l	less than 0.5
Total Manganese	mg/l	less than 0.2
Fluoride	mg/l	0.7 - 1.5
Iodin	mg/l	0.005 - 0.007
Calcium	mg/l	75 - 100
Chromium	mg/l	0
Cyanide	mg/l	0
Phenol	mg/l	0
Total Residual Chlorine	mg/l	0.5
Residual Free Chlorine	mg/l	0.05
COD	mg/l	0.5 - 2.0

Table 4-4 Standard for Drinking and Domestic Water Quality
(Provisional Environmental Criteria)

Treated Water Entering the Distribution System

Characteristic	Unit	Standard
Facal Coliforms	Number/100 ml	0
Coliform organisms	Number/100 ml	0

Remarks : - Turbidity < 1 NTU, for disinfection with Chlorine,
- pH preferably < 8,
- free Chlorine residual 0.2 - 0.5 mg/l, following 30 min (minimum) contact.

Water in the Distribution System

Characteristic	Unit	Standard
Facal Coliforms	Number/100 ml	0
Coliform organisms	Number/100 ml	0
		less than 3.0

Remarks : - Coliform organisms = 0, examined throughout the year in the case of large supplies when sufficient samples are examined.
- Coliform organisms < 3, in an occasional sample but not in consecutive sample.

4.2.7.2 Aeration Facility

Dissolved iron in the raw water is oxidized by aeration and precipitates as ferric hydra-oxide ($Fe(OH)_3$) in the water.

A sedimentation basin is provided immediately after aeration to trap precipitated iron for reduction of filtration load of the filter. According to the results of the field experiment of sedimentation of ferric hydra-oxide, approximately 35 % of iron is removed by the sedimentation after the aeration. (Appendix 11)

4.2.7.3 Removal of Iron and Manganese

For this purpose, three alternative processes are compared:

1. Up ward flow two step filtration
2. Down ward flow two step filtration
3. Combination coagulation and sedimentation

Detailed comparison of these three processes are shown in Table 5.5.

Considering efficiency of treatment, type of structure required and cost aspects, the down ward flow two step filtration process is proposed. Since no coagulant is applied this process also meet Ha Noi City's intention to minimize application of chemicals for water treatment.

4.2.7.4 Chlorination

Chlorine is proposed for disinfection. For prevention of chlorine consumption by oxidation of ammonia, sufficient aeration for oxidizing ammonia is made before the iron removal process.

Table 4.5 Comparison of treatment process

Type of process	Type 1 Up ward flow two step filtration	Type 2 Down ward flow two step filtration	Type 3 Coagulation and filtration
1.System	Iron and ammonia are removed by the first step up ward flow filtration. Manganese is removed by the second step down ward filtration.	Both of two step filtration are down ward flow. Function of filtration facilities are same as Type 1.	Combined system of slurry blanket sedimentation and filtration. Iron is removed in sedimentation and manganese is removed in filtration.
2.Specifications	1st step filtration Filtration velocity:400m/day Thickness:5,200mm Duration of filtration:24hrs 2nd step filtration Filtration velocity:180m/day Thickness:900mm Duration of filtration:48 hrs	1st step filtration Filtration velocity:150m/day Thickness:2,000mm Duration of filtration:24hrs 2nd step filtration Filtration velocity:180m/day Thickness:900mm Duration of filtration:48hrs	Sedimentation Surfac load:60mm/min Detension time:50min Filtration Filtration velocity:125m/day Thickness:600mm Duration of filtration:24hrs
3.Efficiency Iron Ammonia Manganese	● ○ ● Chlorine consumOption is high	● ● ● Chlorine is required	● Coagulant is required X ● Chroline consumption is extremely high
4. Structure	a.Filtration basin shall be lifted to secure necessary hydraulic head. b.Additional device is requires to prevent washout of filter meia.	a.Chlorine consumption of manganese is saved since ammonia is removed in the 1st step aeration. b.Structure of down ward flow filtration is simple compared with the strucure of up ward flow filtration.	a.Simple structure is applicable, however, coagulant is required. b.Chlorine consumption in filtration is high since ammonia is not remeved in sedimentation.
5.Maintenance	Cleaning of lower part of up ward flow filter is very difficult.	No problem in maintenance in particular.	Structure and maintenance of sedimentation is simpler compared with these of filtration, however, attention will be necessary to sulurry blanket.
7.Comparison of construction costs	100	90	85

Table 4.5 Comparison of treatment process

Type of process	Type 1 Up ward flow two step filtration	Type 2 Down ward flow two step filtration	Type 3 Coagulation and filtration
8.Comparison of opration costs			
Chlorination			
Injection rate	Max. 6.6 mg/l	Max.2.6 mg/l	Max. 10.6 mg/l
Injection amount	Max.6.6 mg/l x 32,100m^3/day ≈211.9kg/day	Max 2.6mg/l x 32,100m^3/day ≈85.3 kg/day	Max 10.6 mg/lx 32,100m^3/day ≈340 kg/day
Cost	3,000d/kg x 211.9 kg/day ≈635,700 d/day	3,000 d/kg x 85.5 kg/day ≈250,500 d/day	3,000 d/kg x 340 kg/day ≈1,020,000 d/day
Electricity			
Blower	9kw x 2 units 24 hrs operation	9 kw x 2 units 24 hrs operation	
Air scouring	22kw x one unit 1 hr/day operation	22 kw x one unit 3 hrs/day operation	20 kw x one unit one hr operation
Back wash pump	15 kw x 2 units 3 hrs operation	15 kw x 2 units 3 hrs operation	35 kw x one unit one hr operation
	15 kw x one unit 2 hrs operation	15 kw x one unit 2 hrs operation	
Power consumption	600 d/kw x574 kw/day ≈344,400 d/day	600 d/kw x574kw/day ≈370,800 d/day	600 d/kw x 55 kw/day ≈33,000 d/day
Total cost	980,100 d/day	621,000 d/day	1,695,000 d/day

4.2.8 Pipe Material

The quality of raw water is corrosive for steel material. Therefore, anti corrosive pipe materials shall be selected.

pH of raw water:	7.744
Langelier Index:	6.8 - 7.44 = -0.944

Considering the alkalinity and pH of the raw water, the amount of free carbonic acid is assumed to be in an order of 80 mg/l. Through aeration, 90 % of free carbonic acid could be oxidized. So that after aeration the Langeier Index will be changed to non corrosive level. Considering nature of the raw water quality, pipe materials are selected as summarized below:

Raw water transmission line

Considering corrosiveness of the raw water, the pipeline route along the highways and its size, the pipe materials require strength and anti corrosive nature. Therefore, ductile iron pipe with mortal lining pipes are proposed for the raw water transmission lines.

Piping in the treatment plant

Aeration is provided at the entrance of the treatment plant so that corrosiveness at the aeration would be high, however, after the aeration, no corrosiveness of the water is observed. For this reason, stainless steel is proposed for aeration facility and steel pipes with tar-epoxy lining is proposed for the rest of pipe materials in the treatment plant considering the material cost.

Distribution lines

Ductile iron pipe with mortal lining is proposed for pipe material for the pipe more than 150 mm diameter while the hard type poly vinyl chloride pipe is proposed for pipes with diameter less than 150 mm. Joint with rubber ring is proposed to prevent leakage through joints.

Polyethylene pipe is proposed for pipes of house connections.

4.2.9 Water hammer analysis

(1) Raw water transmission line

Negative pressure in a magnitude of -6 m of water column may takes place over 6.00 m along the transmission line. To prevent this, air-lerease valves will be installed at 940 m, 2,970 m from the well No. 8 and the outlet of the No. 8 well.

(2) Distribution lines

At some parts of the terminal point of tertiary distribution lines, negative pressure may take place to the magnitude of -16 m of water column. To prevent this, air-lerease valve will be installed at outlet of distribution pumps.

4.3 Facility Plan

4.3.1 Standards

Standards applied for the project are standards of Viet Nam, however whenever it is required reference is made to JIS or ISO.

4.3.2 Civil Works

Design conditions are refered to Japanese standards as shown in Appendix 12.

4.3.3 Buildings

The basic design conditions are based on the domestic standard of Japan as shown in Appendix 13.

4.3.4 Intake facility

4.3.4.1 Drilling of wells

The diameter of well drilling is 500 mm and the depth is 82 m. The diameter of a casing and screen is 350 mm.

4.3.4.2 Intake pump

The design capacity per well is 50 lit/sec. The intake pump will be operated for 20 hours a day. A pressure gauge and flow meter of a local indication type will be installed on the discharge end of each pump. The power supply is as follows:

For river side area	10 kV/380 V
For treatment plant	3.5 kV/380 V

The local control panel issues the batch alarm and the signal to the central control panel in the treatment plant to enable remote control for each pump.

There are a total of 12 wells, of which eight will be installed in the Red river side while four in the treatment plant.

Intake pumps of deep wells in the river side are:

Pump type	:	Submergible motor pump
Pumping rate	:	50 liter/sec = 3.00 m^3/min

Actual pump head = (Water level in aeration reservoir

of the treatment plant) - (Dynamic level of well)
= (+16.0) - (-4.0) = 20.0 m

Pipeline loss head = 23.03 m
(Refer to Appendix 15, Pipe and Hydraulic Calculation)

Loss around pump = 1.50 m
Total head = 20.0 + 23.03 + 1.50 = 44.53 m --> 45.0 m

Diameter of the pump discharge port
= 146 x (3.00/2.5) ** (0.5) = 159.9 --> 150 mm

Pump motor output =)0.168 x 3.00 x 45.0/0.7) x
(1 + 0.15) = 86.2 kW -- 37 kW

No. of pumps: 8 units (8 wells)

Specifications of the intake pump of deep wells in the treatment plant are:

Pump type, pumping rate, actual head and pump discharge port aperture are the same as above.

Pipeline loss head = 5.00 m

Loss around pump = 1.50 m
Total head = 20.0 + 5.00 + 1.50 = 26.5 m --> 27.0 m
Pump motor output = (0.168 x 8.00 x 27.0/0.7) x
(1 + 0.15) = 21.7 kW -- 22 kW

No. of pumps: 4 units (4 wells)

4.3.5 Raw water transmission facility

4.3.5.1 Basic design conditions

(1) Pipe type

For the pipe material, the ductile cast iron pipes with mortar lining for water service will be used.

(2) Pipe size

The pipe is designed with the water velocity of about 1.0 m/sec and the hydraulic gradient of 2/1,000 to 4/1,000 to ensure the economic pipe size for pump operation. The pipeline near the most distant well must have a relatively large diameter to prevent excessively large loss head and thus to ensure homogenization of the water rate from each well.

(3) Embeded pipe

As a rule, all pipes will be buried in the ground. The standard soil cover is 1.2 m. The transmission pipeline (600 m) from eight wells installed in the river side must cross the levee on the left bank, and the pipe must be installed over the levee because cutting of the levee is not permitted. The pipe protection and correction of the gradient of the levee road must be provided. An air valve (double ported) will be also installed at an elevated point of the cross-over section above the levee to discharge air in the pipeline.

(4) Protection of pipe bends

Bends of pipes will be protected with concrete blocks.

4.3.5.2 Specifications of facilities

(1) Transmission pipeline from the river land to the treatment plant.
The transmission pipeline route is shown in the design Drawing No. 5.

The length of pipeline from the end well (No.8 well) to the plant is about 7,280 m. The graphical view of hydraulic calculation and the hydraulic calculation sheet for the pipeline are attached as Appendix 15. For the pipe material, the ductile cast iron pipe (with mortar lining) will be used because of its large size (mainly 600 mm), burying in the general motor ways, and sufficient strength required. Soil cover of pipe soil cover is 1.20 m for ground surface.

Table 4-6
Total length of transmission pipeline
(From river side to treatment plant)

Pipe size/type	Length
600 mm ductile cast iron pipe	L = 6,100 m
450 mm	L = 1,180 m
250 mm	L = 470 m
Total length	7,750 m

(2) Transmission pipeline in the treatment plant

The graphical view of hydraulic calculation and the hydraulic calculation sheet for the pipeline inside the plant are attached as Appendix 15. For the pipe material, the ductile cast iron pipe with mortar lining will be used.

Table 4-7
Total length of transmission pipeline
(inside the plant)

Pipe size/type	Length
450 mm ductile cast iron pipe	L = 60 m
350 mm	L = 240 m
250 mm	L = 520 m
Total length	820 m

4.3.6 Treatment plant

4.3.6.1 Design conditions

(1) Treatment series

Two series, each with a capacity of 16,050 m^3/d, are designed to achieve a total of 32,100 m^3/d.

(2) Aeration and contact basin

The purpose of the contact basin is oxidation of iron contained in the raw water into the readily removable form by the subsequent filtering. Oxidation proceeds takes place as follows:

$$2Fe\,(HCO_3)_2 + 1/2O_2 + H_2O \rightarrow 2Fe(OH)_3 4CO_2$$

In this plan, aeration is made by water spray from nozzle. Since the iron is not immediately oxidized by aeration, the raw water must be retained for a certain period after aeration. Accordingly, the contact basin is provided to allow the oxidized iron to settle down. The retaining period in the sedimentation reservoir tank is 60 minutes or more.

(3) Iron removal facility

The structure proposed is reinforced concrete type. The system is of a two-stage down flow filter type. According to the experimental data in Japan, the iron quantity collected per 1 m^3 of the filter sand is estimated to be 2 kg with the filter sand size in a range from 2 mm to 1.8 mm. The required amount of filter sand is as follows when the backwashing frequency is assumed to be once in a day:

Sludge drain capacity per day is determined:

$$32{,}100\ m^3/d \times 22\ mg/1 \times 108.8/55.8 = 1.851\ kg/d$$

Amount of sludge draw of from the sedimentation tank is determined:

$1{,}351\ kg/d \times 0.65 = 878\ kg/d$

Amount of trapped sludge amount in the filter sand is:

$2\ kg/m^2$

Required filter sand volume is:

$489\ m^3$

On the other hand, ammonia in the water is decomposed by the nitrobacterium generated in the filter bed. As ammonia nitrated per 1 m^3 of the filtration material is assumed to be 0.1 kg/d, the required filter sand volume is determined as follows:

Ammonia inflow rate per day :

82,100 m^3/d x 1 mg/l = 82.1 kg/d

Nitration capacity of filter sand:

0.1 $kg/m^3/d$

Required filter sand volume:

82.1 kg/c 0.1 $kg/m^3/d$ = 321 m^3

The filling amount of the filter sand is the larger value of the above two, that is, 489 m^3. The aeration of the previous stage is for oxidation of the iron, and further aeration is necessary for nitration of ammonia. The oxygen necessary for such further aeration is supplied directly into the filter unit by a blower. The oxygen necessary for oxidation of ammonia is determined as follows:

$$2NH_4 + 3O_2 \rightarrow 2NO_2 + 2H_2O + 4H$$
$$2NO_2 + O_2 \rightarrow 2NO_3$$

In the course of the above reaction, 1g of ammonia nitrogen consumes 4.6 g of oxygen. Accordingly, the required oxygen amount necessary for nitrification of 1 mg/l of ammonia in the raw water is determined as follows:

Inflow rate of ammonia per day :

32,100 m^3/d x 1 mg/l = 32.1 kg/d

Oxygen amount required per day :

32.1 kg/d x 4.6 = 147.66 kg/d

Required air amount :

147.66 kg/d x 5 = 738.3 kg/d

Required air volume :

738.30 g/d ÷ 1.2 = 615 m^3/d

If the dissolution efficiency is assumed to be 4 %,

Air supply rate :

615 x 1/0.04 = 15.875 m^3/d = 11 m^3/min

Blower specification :

6.5 m^3/min x 5.00 mmAq x 9 kW (shaft output) x 2 sets

(4) Manganese removal equipment

Manganese is removed by a rapied sand filter. Chlorine is necessary to remove manganese, and it is desirable to fill the manganese sand if efficient treatment is achieved from the beginning. But, even when the normal sand filtering material is used, passing the water containing both manganese and chlorine will turn the sand gradually into the manganese sand. In this case, complete removal of manganese is possible for the initial period after operation start. Since ammonia has been removed in the previous stage, addition of the chlorine only in an amount enough for removal of manganese is necessary. The consumption of chlorine is about 1.3 times when the manganese amount is assumed to be 1.0. When the concentration of manganese in the raw water is 1 mg/l, the chlorine consumption becomes as follows:

Dosing ratio : 2.6 mg (max.) for manganese

Dosing rate : 32,100 m^3/d x 2.6 mg = 83.5 kg/d

Filtration rate and duration are as shown in Table 4-8.

Table 4-8 Filtration rate and duration

	Filtration rate	Filter sand thickness	Duration
Filtration at first stage	150 m/d or less	2,000 mm	24 hours or more
Filtration at second stage	180 m/d or less	900 mm	48 hours or less

The filter media is cleaned by air and water. For the operation filtering facility, a one-man control and timer control are available.

(5) Chlorination facility

Chlorinator is designed by gas chlorinator solusion feed. The dosing ratio was determined as shown in Table 4-9.

Table 4-9 Chlorine injection ratio

Purpose	Mean injection ratio	Max. dosing ratio
Removal of manganese	1.3 mg/lit	2.6 mg/lit
Disinfection	1.0 mg/lit	2.0 mg/lit
Total	2.3 mg/lit	4.6 mg/lit

The chlorine storage capacity is designed for 10 days. The gas mask and leakage detector are essential safety equipment.

(6) Sludge treatment facility

The overall discharge rate of sludge from the filter is 2,570 m^3/d. The volume of drainage is calculated as follows:

Drainage from aeration sedimentation reservoir tank

Total sludge amount : 1,851 kg/day

Sedimentation drain concentration : 0.5 % (5 kg/m^3)

Deposited sludge amount : 85 %

1,851 kg/d x 0.85 = 478 kg/d

Drainage rate : 473 kg/d/5kg/d = 95 m^3/d

Table 4-10 Filter drainage amount

	Filtration, 1st stage	Filtration, 2nd stage
Filtration area per one filter bed	18.6 m^2	14.9 m^2
Detention water in filter	18.6 m^2 x 1.0 m = 18.6 m^3	22.4 m^3
Washing water for air scour	18.6 m^2 x 0.4 m/min x 5 min = 37.2 m^2	7.5 m^3
Water washing	18.6 m^2 x 0.8 m/min x 7 min = 104.2 m^3	62.6 m^3
Duration	24 hours	48 hours
Total	160 m^3	92.5 m^3

Total capacity for sludge treatment in esstimated as below,

$$95 + 160 \times 12 + 92.5 \times 6 = 2,570 \ m^3/day$$

Two storage reservoirs are provided, and drain water is received once by the storage reservoirs and sent in the predetermined quantity to the sludge thickener. The capacity of each storage reservoir tank is designed to accept effluent from two times of back washing. The maximum design dosing rate (50 mg/lit) of alum is added as a coagulant before the effluent flows into the sludge condensation reservoir tank. The separation rise speed of the thickener tank is designed to be 9 mm/min. The standard concentration of sludge before entry into the drying bed is 1 %. The capacity per bed is for storage of maximum sludge amount for 10 days. The floor area load is 30 kg/m^2. Sludge in the sludge thickener is drained every day and loaded onto the drying bed.

(7) Electric facility and instrumentation

The power supply used in the treatment plant is as follows:

High-voltage power supply	:	AC 8.5 kV
Low-voltage power supply	:	AC 380 V, 3-phase, 4-wire
		AC 220 V, single-phase

The local power generator is provided to be used as emergency power supply. The capacity is calculated to cover one distribution pump and indoor lighting only. The operation monitoring panel is designed to be a graphic panel in the operation room, enabling monitoring of equipment.

Standard operation is proposed as follows:

Aeration, sedimentation reservoir tank :
Local manual

Filtration reservoir tank :
Remote control from the filter operation room/local manual

Distribution pump :
Remote control from the electric room/local manual

Chlorination	:	Local manual
Sludge treatment	:	Local manual
Indoor lighting	:	Local manual

The outdoor electric wiring work is either direct burying of the cable or wiring in the cable pit. The indoor electric wiring work is either wiring in the cable conduit or wiring on rack.

4.3.6.2 Specifications of equipment

The specifications of the equipment in the treatment plant are outlined in Table 4-11. For detailed specifications, refer to the Appendix 14,

Table 4-11 Specifications of equipment in the treatment plant

Name of equipment	Quantity	specifications
Aeration	2 units	Water spray type made of concrete
Sedimentation tank	2 tanks	Concrete made Conventional sedimentation reservoir tank 740 m^3/reservoir tank
Iron removing equipment	12 filter beds	Concrete made. Air washing type 3 m (width) x 6.2 m (length)/ filter bed Filte sand grain size 1.6 - 2 mm Filte sand thickness 2,000 mm
Manganese removing equipment	8 reservoirs	Concrete made 8,000 m^3 2.4 m (width) x 6.2 m (length)/ filter bed Filte sand grain size 1.6 - 2 mm Filte sand thickness 900 mm
Distribution reservoir tank	2 reservoirs	Concrete made. 8,000 m^3/reservoir tank
Chlorinator unit	4 units	2,000 g/hour, 1 ton container x 4
Distribution pump	6 units	7.03 m^3/min x 50 m
Emergency power supply	1 unit	500 kVA, 4-cycle 520 ps
Waste water storage reservoir tank	2 tanks	Concrete made. 10 m (width) x 18 m (length) x 8.4 m/tank
Sludge condensation reservoir tank	2 tanks	Concrete made circular thickener Separation area 100 m^2/tank
Sludge drying bed	5 tanks	Concrete made, 1.381 kg/h10 m (width) x 18 m (length) x 8.4 m/tank
Chemical dosing facility	1 set	Dissolution reservoir tank, dosing pump x 3
Electric instrumentation	1 set	Three central monitoring panels

4.3.7 Distribution and House Connection

4.3.7.1 Design Conditions

1) Capacity of Reservoir:

Capacity of reservoir shall be 20 % equivalent to the daily maximum water demand (4.80 hours' capacity), which is the same criterion as Hanoi's Water Master Plan.

For the maximum day demand of 30,000 m^3/day, the capacity of the reservoir (V) will be:

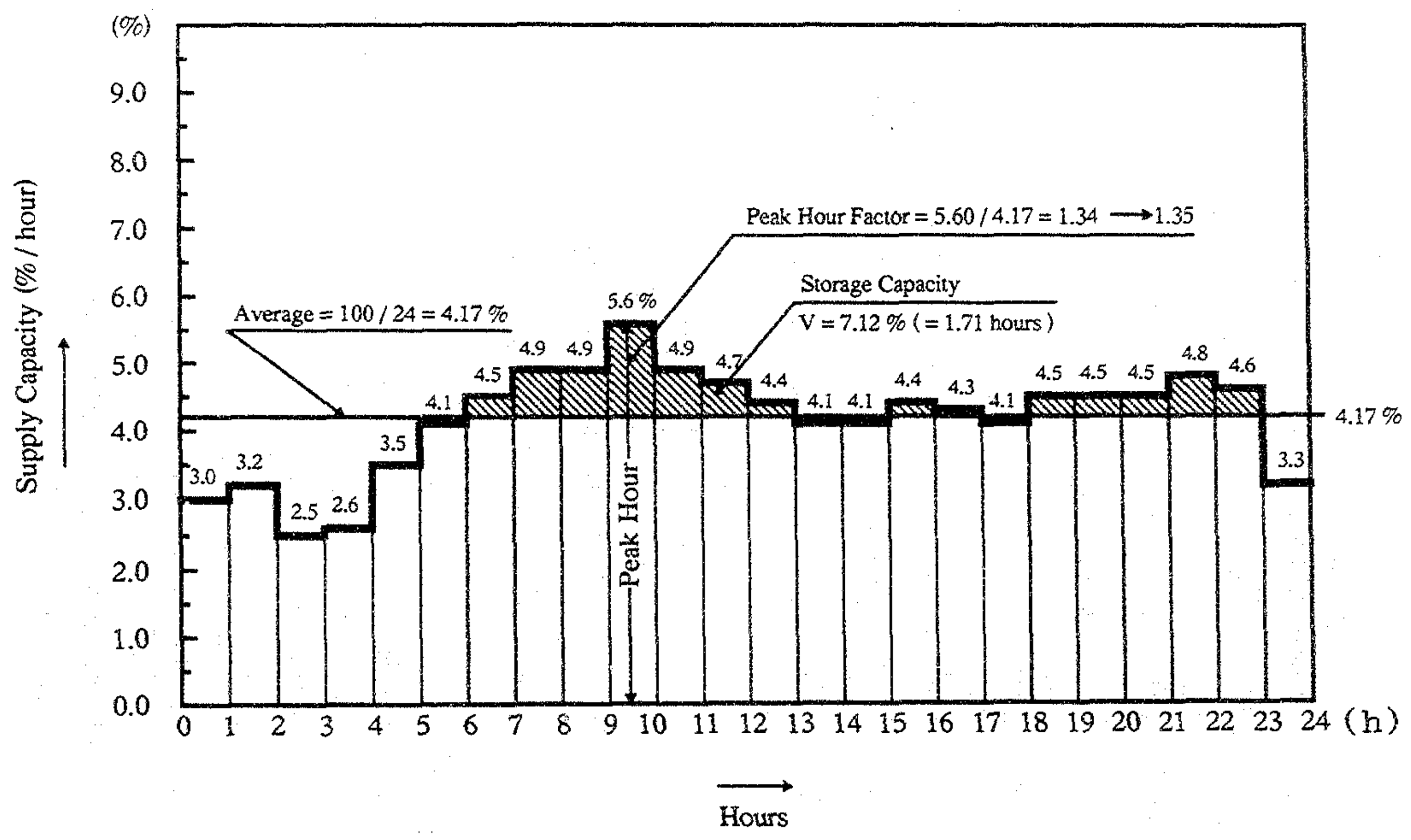
$$V = 30{,}000 \text{ m}^3 \times 20\ \% = 6{,}000 \text{ m}^3$$

(Note):
The capacity of the reservoir is to be determined based on balancing capacity of hourly variation between demand and production. As hourly supply data for Gia Lam area have not been available, data for Hanoi City (Fig. 4.3) were analysed. This data was obtained from actual supply records from existing treatment plants and interview survey to consumers during the course of the Study.

According to the data analysis, required capacity of the reservoir is calculated at 7.2 % (equivalent to 1.7 hours' capacity) of the daily demand. This value is considered smaller than general value of 6-10 hour's capacity which is popular in other countries. The reason is supposed that consumers have a traditional custom to keep water in their tanks in their houses whenever water is available, since water supply is available for a limited duration in a day. When 24 hours supply is guaranteed in the future, however, water storage in houses will be reduced and peoples will depend on reservoirs in the treatment plants. Therefore, the above criteria of 20 % (4.8 hours' capacity) is considered to be reasonable.

In addition to the balancing water, the reservoir shall keep water for fire-fighting work and back-wash for filters in the plant. Their quantity, however, is comparatively small such as 100 m^3 or so, which is much smaller than the balancing capacity of 6,000 m^3, and capacity for such purposes will not be added in the project.

Fig. 4.3 Hourly Supply Pattern



2) Distribution Pipelines:

Diameters of distribution pipelines will be determined based on the peak hour flow. The peak hour factor is 1.35 based on the data analysis of the hourly variation curve, Fig. 4.3.

Hydraulic calculation of distribution pipelines will be done by Hazen-William Formula which is widely used among the world. Velocity coefficient (C) in the formula is proposed 110 (C=110).

- Capacity of Distribution Pumps and Unit Number:

  Total capacity for the pump shall meet the peak hour demand (30,000 m^3/day x 1.35 = 1,688 m^3/hour)

  Number of pump units will be four (4) in operation and two (2) standby, totaling six (6), taking unit capacity and hourly variation into consideration.

  Power for pumps will be from public electricity. In the case of the electric failure, a generator in the plant will be operated for one distribution pump (25 % capacity of peak hour demand) operation.

- Pressure in Distribution Pipelines:

  Static pressure in distribution pipes will be 55.0 m in the maximum from a economical viewpoint such as pump power, leakage in pipelines, pipe materials, pipe maintenance, etc..

  Minimum dynamic pressure is planned to be 20 - 25 m in main distribution pipelines, considering direct supply to three-storied buildings.

- Pipe Materials:

  Ductile cast iron pipes with mortar lining (push-on type joint) will be used for diameters of 150 mm or larger. Polyvinyl chloride pipes (PVC pipes or VP) with rubber ring joint type will be used in principle for 100 mm pipes or less. However, in the case of heavy traffic roads, ductile cast iron pipes will be used even in smaller diameters.

3) Stop Valves:

For the convenience of pipeline maintenance, stop valves will be installed at strategical points, mainly at branching points. At the branching points, stop valves will be installed in principle at downstream sides of pipelines.

4) Fittings Protection:

Fittings such as Tees and Bends will be protected by concrete block work.

5) Fire Hydrants:

For the purpose of fire-fighting work, fire hydrants will be installed to pipes of 150 mm in diameter or larger in principle and at 300 m intervals. Type of the fire hydrants will be underground one with nominal diameter of 65 mm. The fire hydrants will be used also for drain work of the pipelines.

6) House Connections:

House connections will be made from pipes of diameter 200 mm or smaller in principle through branch saddles. In the case of Highways or busy roads which have wide width and heavy traffic volume, branched distribution pipelines (100 - 75 mm) will be installed on the both sides of the roads in order to facilitate installation of house connection service pipes.

Pipe material of service pipes will be in principle polyethylene pipes (PE). diameters of service pipes will be 20 mm for ordinary houses and 40 mm for apartment-type buildings or the like.

All service pipes shall be equipped with water meters for billing purpose.

4.3.7.2 Distribution Facilities

The distribution facility consists of supply reservoirs to be constructed in the plant, distribution pumps in the plant and distribution pipelines from the plant to consumers in the service area.

1) Supply reservoir

- Location for construction : In the treatment plant
- Capacity of the reservoir

= (20 % of the daily maximum demand)

= 30,000 m^3 x 20 % = 6,000 m^3

- Structure : Reinforced concrete (RC)
- Water depth = 3.00 m
- Water level : HWL = +6.20 m, LWL = +3.20 m

2) Distribution Pumps

- Type of pump : Horizontal volute pump
- Total pumping capacity

  = 30,000m^3/day x 135 %

  = 0.469 m^3/sec = 28.1 m^3/min = 1,688 m^3/hour
- Number of pump :

  (4 units in operation) + (2 units in standby)

  = 6 units in total
- Unit pumping capacity

  = 0.469/4 = 0.117 m^3/sec

  = 7.03 m^3/min = 422 m^3/hour
- Total pumping head = 50.0 m
- Pump diameter = 146 x (7.03/2.5)**(0.5) = 244.8 mm --> 250 mm
- Power required = (0.163 x 7.03 x 50.0/0.75) x (1+0.15) = 87.8 --> 90 kw

Specification of pumps: 250 mm x 7.03 m^3/min x 50.0 m x 90 kw x 6 units

3) Service Area and Pipeline Routes

Pipeline routes for distribution are proposed based on the field reconnaissance on housing condition, road condition and future development potential in the area. Priority for pipeline installation was placed on existing roads. For areas where permanent roads have not been constructed but future development is expected, valves or branch pipes for the areas will be installed in this project. Based on the topographical status in the project area, National Highways No. 1 and No. 5, and the old highway in Gia Lam were selected for routes of trunk distribution pipelines.

Each development block defined in the section of Demand Forecast is to be supplied through distribution mains. Their diameters were decided based on the hydraulic calculation for peak hour demand (135 % of the daily maximum demand). Residual water pressure in distribution mains was planned at a level of 20 - 25 m at in the minimum of water head. Hydraulic calculation is shown in Figs. 3.4 and in Appendix 15 and Tables 3 and 4 in Appendix 15.

- Pipelines Planning

Routes and diameters of pipelines are proposed and shown in Drawing 8-17, and fittings details in Drwings 18-29. Distribution pipelines (diameters and distance) to be installed in the project are summarized in the following table.

	Pipe Material and Diameter	Service Area			
		Duc Giang	Sai Dong	Gia Lam	Total
Trunk Mains	DIP 700 mm	660	-	-	660
	DIP 600 mm	1,280	-	-	1,280
	DIP 450 mm	760	1,500	630	2,890
	DIP 400 mm	420	710	-	1,130
	DIP 350 mm	-	550	-	550
	DIP 300 mm	-	-	2,310	2,310
	DIP 250 mm	2,910	1,860	750	5,520
Distri-bution pipes	DIP 200 mm	1,320	1,220	420	2,960
	DIP 150 mm	4,040	4,780	3,540	12,360
	DIP 100 mm	260	1,200	1,740	3,200
	DIP 75 mm	6,440	2,770	10,090	19,300
	Sub Total (DIP)	18,090 m	14,590 m	19,480 m	52,160 m
Distri-bution pipes	VI 100 mm	1,290 m	550 m	850 m	2690 m
	VI 70 mm	3,750	3,990	2,810	10,550
	VI 50 mm	9,680	8,010	10,380	28,070
	Sub Total (VP)	14,720 m	12,550 m	14,040 m	41,310 m
	Total (DIP+VP)	32,810 m	27,140 m	33,520 m	93,470 m

(Notes)

DIP : Ductile Cast Iron Pipe (with mortar lining)
VP : Polyvinyl Chloride Pipe

4) Service Connections

Service house connections to be taken from distribution pipelines are illustrated in Drawing No. 44 and 45 as standards both for private houses (Type-A) and flat building houses (Type-B). Diameters for connections will be 20 mm for private houses and 40 mm for flat houses. Service pipes for factories and large consumers such as governmental offices, enterprises, schools, hospital will be in principle 40 mm in diameter. Material of the service pipes will be polyethylene (PE). All service connections are proposed to be equipped with water meters for billing purpose. Branching work for service connections is to be done from distribution pipelines with diameters of 200 mm or less, by way of branch saddles or tee branches.

Number of service connections for the project is calculated as below:

Population in the year 2000 in Gia Lam will be 66,570 in urban areas and 54,880 in sub-urban areas; 121,450 in total. Supposing that saturation rate will be 85 % tentatively, population will be:

- Population in urban areas:	66,570 x 85 % = 56,590
- Population in sub-urban areas:	54,880 x 85 % = 46,650
	Total = 103,240

Suppose that 80 % of peoples in urban areas will live in private houses, and 20 % in flat buildings, and 100 % of sub-urban areas in private houses.

Then,

- Population of private houses in urban areas
  = 56,590 x 80 % = 45,270

- Population of flat buildings in urban areas
  = 56,590 x 20 % = 11,320

- Population of private houses in sub-urban areas
  = 46,650 x 100 % = 46,650

Rate of public water supply coverage will be 90 % for private houses in urban areas, 100 % for flat buildings in urban areas and 80 % for private houses in sub-urban areas. Therefore, population to be served will be:

- For private houses in urban areas
  = 45,270 x 90 % = 40,750 persons

- For flat buildings in urban areas =
  = 11,320 x 100 % = 11,320 persons

- For private houses in sub-urban areas =

= 46,650 x 80 % = 37,320 persons

Total = 89,390 persons

Method of supply will be private connections in urban areas, for both private houses and flat buildings; and for 80 % of sub-urban areas. Remaining 20 % of sub-urban areas will be supplied by way of public taps (20 mm in diameter). That is:

- Population served through private connections in private houses
  - = (population served in private houses in urban areas) + (population served in sub-urban areas) x 80 %
  - = (40,750) + (37,320 x 80 %) = 40,750 + 29,850 = 7,600 persons
- Population served in flat buildings = 11,320 persons
- Population served through public taps
  - = (Population in sub-urban areas) x 20 %
  - = 37,320 x 20 % = 7,470 persons

Suppose that one household (one connection of 20 mm pipes with water meters) will supply to twelve (12) persons, and one flat buildings contain fifteen (15) households; and one public tap supply to 150 persons. Then, number of service connections is calculated below:

- Number of private house connections
  - = Number of private houses
  - = 70,600/12 = 5,890 Nos. (20 mm pipe with water meter)

- Number of house connections in flat buildings
  - = Number of households in flat buildings
  - = 11,320/12 = 950 Nos. (20 mm pipe with water meter)

- Number of header pipes to flat buildings
  - = (Number of households in flat buildings)/15 households
  - = 950/15 = 64 --> 70 Nos. (40 mm pipe without water meter)

- Number of public taps
  - = 7,470/150 = 50 Nos. (20 mm pipe with water meter)

As for factories, one (1) factory will exist in one (1) ha, in 50 % of development rate. Each factory will be supplied with 40 mm

- Number of connections for factories = 120 ha x 1 No. x 50 %
  = 60 Nos. (40 mm pipe with water meters)

The above is summarized below:

Table 4-12 Number of Service Connections

Category	Diameter and Distance	Nos. of Connections	Water Meter	
			Diameter	Nos.
a) Private connections for private houses	20 mm x 20 m	5,890	20 mm equivalent	5,890
b) Private connections for flat buildings	20 mm x 10 m	950	20 mm equivalent	950
c) Header connections for flat buildings	40 mm x 20 m	70	-	-
d) Public taps	20 mm x 20 m	50	20 mm equivalent	50
e) Factories	40 mm x 50 m	60	40 mm	60
f) Others	40 mm x 50 m	120	40 mm	120
Total		7,140		7,070

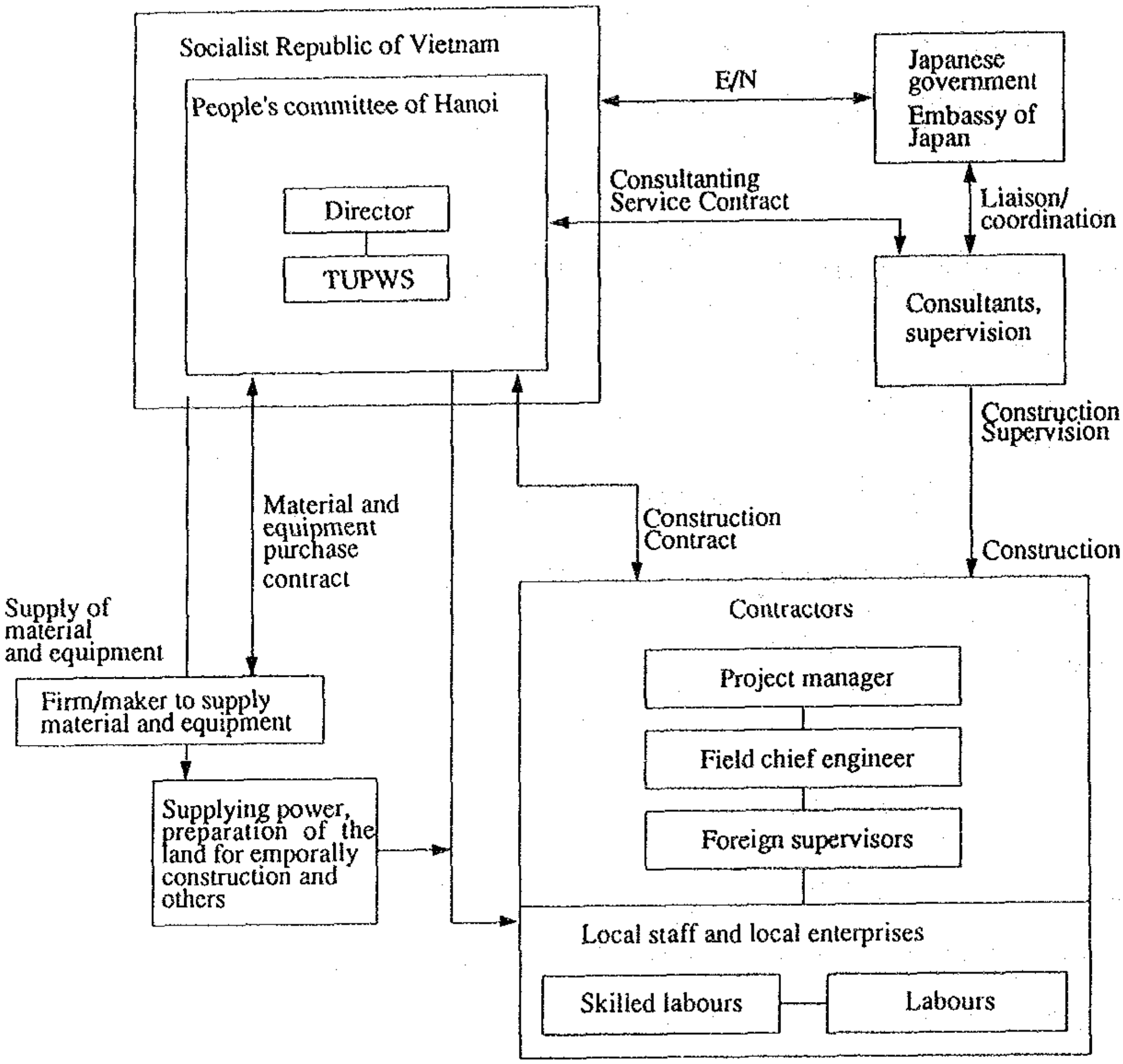
4.4 Construction of works

4.4.1 Construction policy

4.4.1.1 Executing organization

The Viet Nam organization in charge of execution of the project is the Transportation and Urban Public Works Service (TUPWS) of Ha Noi City. The organization of the project execution is shown in Fig. 4.4.

Fig. 4.4 Organization for execution of the plan



4.4.1.2 General consideration

For execution of the project, detailed design, assistance to TUPWS concerning the bidding, supervision of the construction of works will be made by the Japanese consultant.

The distribution lines and raw water transmission piping work will be made by Vietnam. On the other hand, this plan assumes the unaccounted for water rate will be 11.25% for the year 2000. Most of this value is caused by water leakage from the distribution pipes and house connections. In this plan, the Japanese engineer will provide guidance in the field on the piping joint method with which the local engineers are not familiar, thereby minimizing the leakage of water.

With regard to drilling of wells, which is included in the scope of work by Vietnam, the Vietnamese engineers have sufficient experience and are capable of executing the work. Therefore, guidance by Japanese engineers is not necessary. Consequently, only the guidance on the machines supplied from Japan will be necessary.

For the scope of the work of Japan, TUPWS will complete all of the works to be executed by TUPWS, such as the access roads to all work sites, land preparation, and well drilling, one month before start of the works by Japanese contractor. Because of the nature of the project, the construction will be of a lump sum contract type, with the contract well experienced in the construction of waterworks selected through competitive bidding. The selection criteria of the contractor will be determined during preparation of the tender documents by consultation of TUPWS.

The share of construction of works is shown in Table 4.13. All equipment and materials not available in Viet Nam are to be provided by the Government of Japan including these structures to be constructed by Viet Nam.

Table 4.13 Scope of work for Japan and Viet Nam

(1) Intake and raw water transmission facilities

Item	Japan	Vietnam
Purchase and land preparation for the pump station and electric facility construction site		0
Construction of the access roads to the pump station		0
Well drilling and construction of the well field		0
Supply of well construction equipment	0	
Incoming construction for high tension power supply and transformer		0
Low voltage power supply and control panel	0	
Intake pump remote control panel (materials and construction)	0	
Construction of intake pump house	0	
Construction of intake pump equipment	0	
Raw Water transmission pipe (Materials)	0	
Raw Water transmission pipe (Construction)		0

(2) Water treatment plant

Item	Japan	Vietnam
Construction of the access to the plant		0
Purchase and land preparation (including in land filling)		0
Drainage system in the plant	0	
Fence		0
Maintenance road in the plant	0	
Outdoor lighting in the plant	0	
Raw water transmission pipes (materials)	0	
Aeration equipment (civil, mechanical and electrical works including materials)	0	
Iron and Manganese removal equipment (ditto)	0	
Pipe and valves for the equipment (materials and construction	0	
Chlorination (materials and construction)	0	
Distribution pump station (materials and construction including house construction)	0	
Distribution piping and valves in the treatment plant (work and materials)	0	
Sludge and waste water storage reservoirs (civil work, and electric and mechanical work and materials)	0	
Sludge thicknner (civil work, and electric and mechanical work and materials)	0	
Sludge drying bed (civil work, and electric and mechanical work and materials)		0
Chemical dosing equipment of the sludge facility (chemical injection room construction, and electric and mechanical work and materials)	0	
Chemical dosing equipment of the sludge facility (chemical injection room construction, and electric and mechanical work and materials)	0	
Low-voltage incoming equipment and cable laying	0	
Power incoming		0
Equipment control panel and wiring work	0	
Instrumentation equipment and wiring work	0	
Water supply and drainage equipment in the site	0	
Administration building, guard house		0

(3) Water distribution and service equipment

Item	Japan	Vietnam
Distribution reservoir		0
Distribution pipes and fittings	0	
Distribution pipes and fittings installation work		0
Service pipe and system materials (up to the water meter)	0	
Service pipe and system installation work		0

4.4.2 Necessary stock yards and storing

The project includes large number of equipment and materials, such as pipes, fittings, valves, and water meters, so that ware houses to store equipment and materials are required as follow:

Materials and equipment	Type of store	Space
Cast iron pipes	Outdoor stacking possible	2,400 m^2 x 3.0 m(H)
PVC pipes	Roof necessary to protectthem from direct sun-shine	150 m^2 x 8 m (H)
Valves	Outdoor stacking possible	200 m^2 x 2.5 m (H)
Water meter	Closed warehouse	400 m^2 x 8 m (H)

4.4.3 Construction supervision

4.4.3.1 Detailed Design

The detailed design for the project is to be prepared based on the Basic Design. The detailed design prepared by the consultant shall be approved by TUPWS.

4.4.3.2 Tendering

Tender documents for the Project prepared by the consultant must be approved by TUPWS. The consultant will assist TUPWS by making the tender announcement, receiving tender application from contractors, issuing tender documents to the tender participants, receiving tender documents from the participants, and evaluation of the tenders. After selecting a successful Japanese contractor, TUPWS will make a contract agreement with the contractor.

4.4.3.3 Construction Supervision

The consultant will evaluate and approve the tender documents submitted by the prequalified contractors and will assist TUPWS in the procurement of materials and equipment in order to start the construction of works as early as possible.

The consultant will hold a series of meetings with TUPWS officials and the contractor prior to commencement of the construction of works, witness and provide the contractor with instruction related to the construction of works, equipment installation, test operations, and post-installations inspections.

Additionally, the consultant will control the Project's construction schedule, be responsible for quality control, and exert an effort to complete the project's construction on schedule.

4.4.4 Construction Schedule

4.4.4.1 Construction of Works

1) Time Requirement

major components of the works of the project consist of drilling water wells, raw water transmission, treatment plants and distribution facilities including reservoir, pumping facility and distribution pipelines. Construction of works will be undertaken by Japanese and Viet Namese constructors in accordance with the working share as shown in Table 4.13.

The largest work volume is required for construction of pipelines of raw water transmission and distribution lines. These pipe laying work consists of two types; construction of cast iron pipes and PVC pipes.

Total length of the cast iron pipelines is 52,200 m and that of the PVC pipelines is 41,300 m. The largest work volume is required for the construction of the cast iron pipelines.

Assuming that a daily competion rate of cast iron pipelines by one lot is 20 m on an average and six lots are applied, it may take approximately 23 months to complete construction of cast iron pipelines of the project includint 10 % of tome allowance.

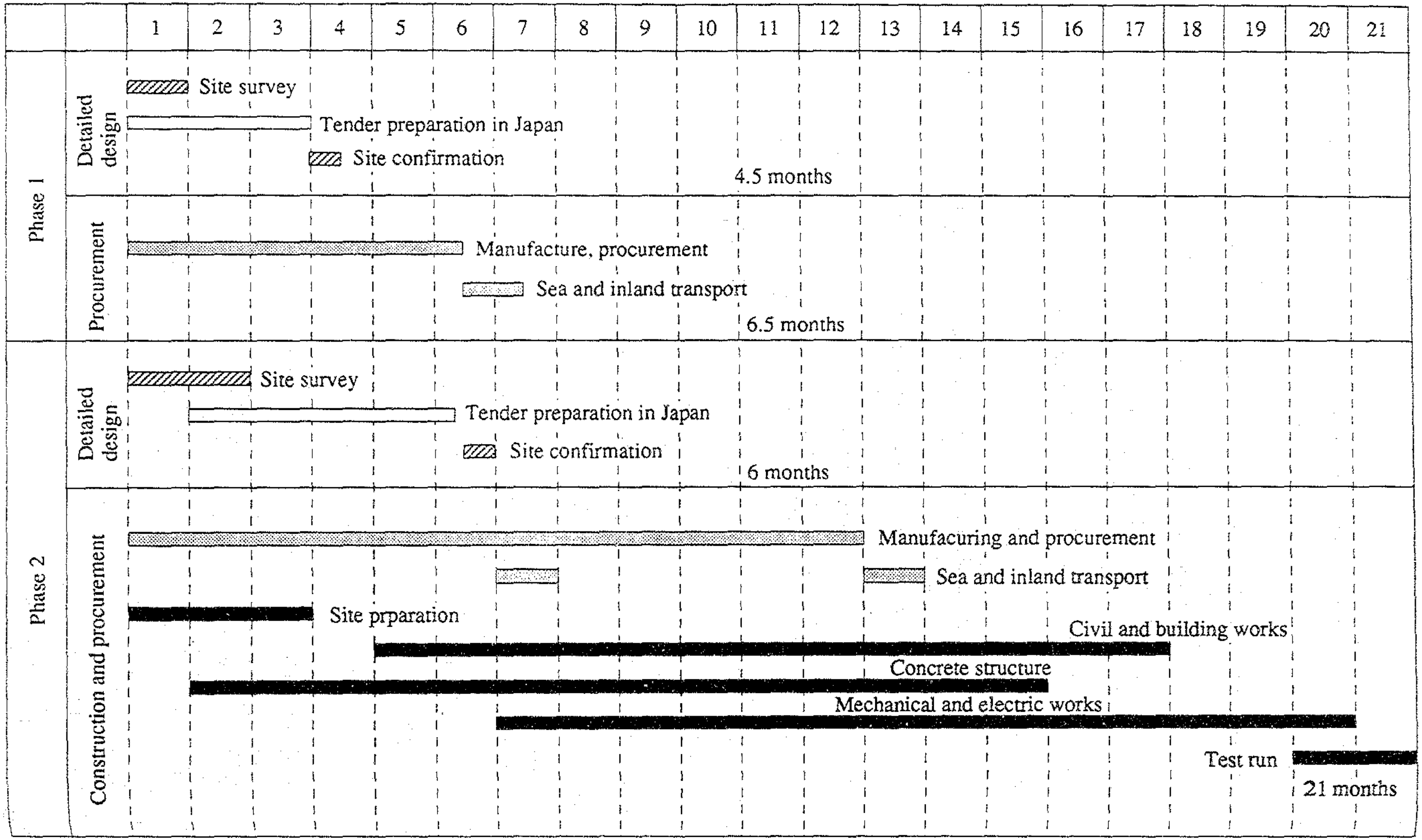
A large volume of materials and equipment not available in Viet Nam, will be purchased from either Japan or the third countries. It is assumed that procurement of these items may require for 7 months.

Therefore, it is estimated that the duration of time from procurement of materials and equipment and completion of works takes 30 months. It is proposed to take two phased implementation schedule as shown in Table 4.14 and further detailed proposed schedule is illustrated in Fig. 4.5.

Table 4.14 Work by phase

1st phase	2nd phase
Supply of equipment and materials	Construction work
Well drilling rigs	Intake pump x 12
Raw water transmission waterials	Treatment plant
Distribution piping materials	Electrical and mechanical works
Water service equipment and materials	Civil works
	Building works
	Supply of pipe material
	Distribution branch pipe

Fig. 4.5 Project execution schedule



5. Project Evaluation and Conclusion

5. Project Evaluation and Conclusion

5.1 Project Evaluation

The project area locates in the north eastern part of Ha Noi City beyond the Red River. The national highways No.1 and No.5 pass through the project area in parallel with the national railways communicating with the further inland as well as Hai Phong, one of the major international seaport of the Republic. In this respect, the project area is a terminal point of land transportation in the northern Viet Nam.

Since 1950's, a locomotive factory and some other factories have been producing necessary items for national economy in the project area. In this sense, the project area has been being incorporated in the economic circle of Ha Noi metropolis.

Due to recent introduction of market economy led by the central government, various kinds of private industries are invited to the industrial areas in the project area.

These historical background envisages the economic potential of the project area. However, there is only small and aged water supply facilities in the area, although land transportation, electricity and telephone have been available since long time.

Under the circumstance, Ha Noi City formulated the Gia Lam Water Master Plan aiming at the year 2010 corresponding to the target year of Ha Noi City Water Master Plan which is under implementation as Ha Noi Water Supply Program to be completed in 1996.

According to the master plan, the water demand of the project area is prudently estimated to be 22,000 m^3/day and 34,000 m^3/day in 2000 and 2010 respectively. However, some part of the land use plan of the project area is still to be completed and whole picture of the urban development in 2010 is not a clear foresight.

For this reason, this basic design is formulated for the water demand in 2000 of the project area on condition that the extension plan will be formulated in 2000 incorporating the urban development conditions at that time.

Implementing the project, water supply in the project area will be much improved as summarized below:

	1995	1996	1997	2000	2010
Population	103,400	105,600	109,200	121,500	177,000
Water demand (m^3/day)	13,000	14,280	15,398	18,761	34,338
Design capacity of facilities (m^3/day)	5,500	16,050	32,100	32,100	32,100
Supply capacity (m^3/day)	2,000	16,050	18,132	24,047	32,100
Population served	15 %	100 %	100 %	100 %	93 %

Existing water supply facility is able to provide only 15 % of the population in the project area, however, implementing the project, 96 % of the population will be served by the piped water supply in 1996. Constructing additional facilities of 16,050 m^3/day, all people in the project area will have easy access to the piped water from 1997 to 2005. However, as the demand increases the design capacity of the water supply facilities remain the same and there would be 22 % of deficit of water supply in 2010. New extension plan ought to be formulated during the time from 2000 and 2005.

Already land transportation, supply of electricity and telephone communication are available in the project area. Implementing the project, the last item of the basic social infrastructure, the water supply will be provided for the project area which may increase the value of the lands for further economic development of the project area. Simultaneously, contribution of the project is not negligible to achieve the national target of the urban water supply to provide for 85 % of the urban population in the three largest cities with the piped water supply in 2000.

Due to the central government's decision to introduce market economy, the water supply companies have been requested to maintain financial self sustainance. For this purpose water tariff structure has been revised several times especially in large cities. It is assumed that the present tariff is affordable for beneficiary of the urban water supply.

The water charge income of the project will cover the production costs and even depreciation of facilities to be constructed by Ha Noi City, however, the profit of the project is for insufficient to meet the depreciation cost of all facilities to be provided by the grant aid cooperation.

Generally speaking, the urban water supply requires a large amount of initial capital investment, especially in case of the project which requires all facilities to be newly constructed since no existing facility is available. The subsidize of either central or local government to the urban water supply is observed in many cities in other countries. For this reason it would be quite reasonable to considered that the capital investment of the grant aid portion is a sort of government subsidize.

However, even in this case, it would be necessary for the project to be able to provide necessary cost for replacement of equipment and machinery with short life time compared with civil engineering structures. For this purpose, it would be necessary to increase water tariff to meet the above conditions. According to a preliminary analysis, it would be possible to provide costs for rehabilitation or replacement of equipment and machinery in 10 to 15 years when the water charge is increased every three years at average annual rate of 5 %.

As the major portion of the facilities are constructed by the low cost capital and the decision made by the central government to maintain financial self sustenance, it would be possible to maintain financially sound conditions.

Year	1996 mil. dong	2000 mil day	2005 mil.day	2010 mil. dong
Depreciation of facilities constructed by Viet Nam	882	882	882	882
Profit before Direction	2,142	3,984	9,712	11,128
Depreciation of all facilities	16,330	16,330	16,330	16,330
Profit after depreciation	-14,188	-12,316	-6,618	-5,202

For management and operation and maintenance of the project, Ha Noi City has an intention to establish a water supply company. Key staffs will be transferred from Ha Noi Water Supply Company. Ha Noi Water Supply Company has been operating 120,000 m^3/day capacity water supply facilities which will be extended to 330,000 m^3/day at completion of Ha Noi Water Supply Program in 1996. Therefore, the company has sufficient experience in management and operation of urban water supply. In this respect, it is assured that experienced key staff are available for the water supply company of the project.

The major concerns of the new company would be to maintain satisfactory service level to assure beneficiaries willingness to pay for water charge and financial self sustainance to be able to meet the operation cost and rehabilitation or replacement costs of equipment and machinery. The major income of the company shall be the revenue from the water charge collection. For this purpose, processing and collection of water charge must be completed to secure operation costs and future replacement cost of equipment and machinery. For this purpose, it would be necessary to revise water tariff structure incorporating the increase in price of the production cost components within an affordable level of household economy in the project area. In addition, it is a must to complete house connections in an early stage of the project to maintain satisfactory service level.

5.2 Recommendations

With understanding of these recommendations, the project can be regarded as a model of the medium scale urban water supply schemes in Viet Nam:

(1) Although it is definitely required to increase the water tariff in near future in accordance with increase in production costs of water and income level of beneficiaries, the water tariff is set to maintain financial self sustenance of the water company.

(2) For this purpose, it is strongly recommended to establish a new financially and institutionally independent water supply company under supervision of TUPWS.

(3) In order secure water charge collection, house connections shall be completed in an early stage of the project implementation.

For this purpose, construction of the distribution pipeline shall be completed within the construction period of the project.

(4) As special attention shall be paid at construction of distribution pipelines to prevent leakage through joints, a special inspection team shall be organized.

(5) In 2006 an extension of the project facilities will be required to meet the future water demand. Prior to the extension of facilities, a new water supply plan shall be formulated incorporating the urban conditions at that time.

(6) In order to prevent environmental deterioration caused by the water pollution, it is strongly recommended to take necessary measures for drainage and sewerage system in the project area.

5.3 Conclusion

The necessity and effects of the project is clearly confirmed and the production costs will be able to be covered by the income of water charge collection with the current water tariff of Ha Noi City water supply. Increasing the water price within an affordable level of household economy in the project area, necessary reserve will be available for future rehabilitation or replacement of machinery and equipment.

However, the profit produced by the project is far insufficient to meet the depreciation of whole facility since the water price is forced to be able to maintain its financial self sustainance, the project can be implemented only with the low cost capital investment which can be regarded as a sort of government subsidize.

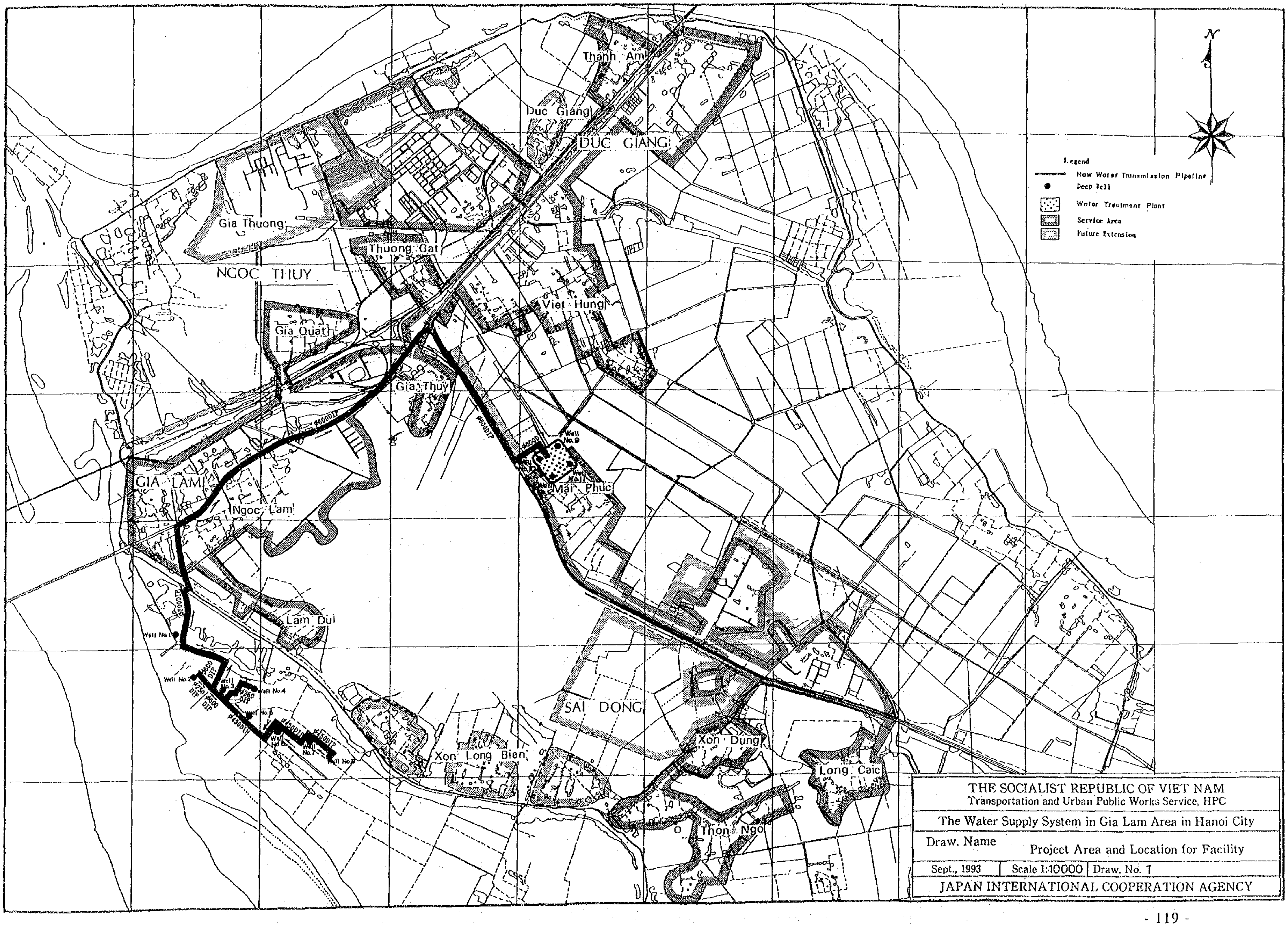
For this reason, it is concluded that the project is suitable to implement under the grant aid cooperation program, considering the necessity and effects of the project.

Drawings

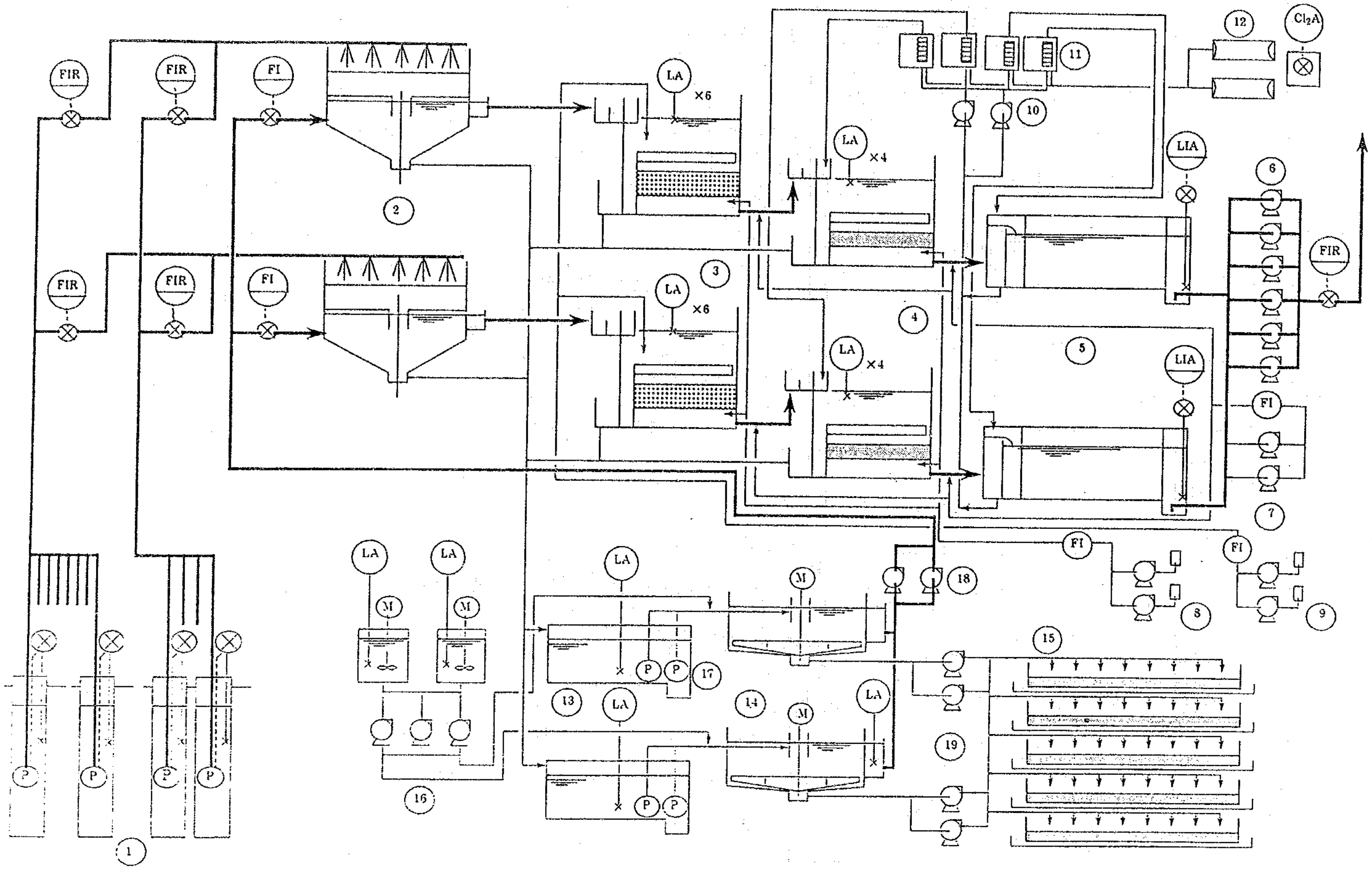
DRAWING LIST

Drawing Name	Drawing No.	Scale
I. Outline		
1. Project Area and Site of Facility	1	1/10,000
2. Flow Sheet of Water Supply System	2	Non
II. Intake Facility and Raw Water Transmission Pipe		
3. Intake Well Facility	3	Non
4. Intake Well House	4	1/100
5. Raw Water Transmission Pipeline Route	5	1/10,000
6. Trench Work Standard of Raw Water Transmission Pipeline	6	Non
7. Valve Box for Raw Water Transmission Pipeline	7	1/50
8. Raw Water Transmission Pipeline Concrete Works for Bends & Tees (1)	8	Non
9. Raw Water Transmission Pipeline Concrete Works for Bends & Tees (2)	9	Non
III. Water Treatment Plant		
III-1 Outline for Water Treatment Plant		
10. Layout Plan of Water Treatment Plant	10	1/1,500
11. Hydraulic Profile of Water Treatment Plant	11	Non
III-2 Mechanical Equipment for Water Treatment Plant		
12. Aeration and Sedimentation Equipment	12	1/200
13. Iron and Manganese Removal Equipment (1)	13	1/200
14. Iron and Manganese Removal Equipment (2)	14	1/100
15. Iron and Manganese Removal Equipment (3)	15	1/100
16. Reservoir Tank	16	1/200
17. Chlorination Equipment	17	1/100
18. Sludge Treatment Equipment	18	1/200
19. Sludge Drying Bed	19	1/200
III-3 Electrical Equipment for Water Treatment Plant		
20. Layout Plan for Electrical Equipment	20	1/1,000
21. Electric Single Diagram of Water Treatment Plant	21	Non

Draw Name	Drawing No.	Scale
22. Electric Single Diagram of Water Treatment Plant (1)	22	Non
23. Electric Single Diagram of Water Treatment Plant (2)	23	Non
24. Electric Single Diagram of Water Treatment Plant (3)	24	Non
25. Electric Cable Laying Plan	25	1/1,000
26. Distribution Pump	26	1/100
III-4 Civil Works for Water Treatment Plant		
27. Layout Plan for Civil Works	27	1/1,500
28. Aeration and Sedimentation Basin (1)	28	1/200
29. Aeration and Sedimentation Basin (2)	29	1/200
30. Iron and Manganese Removal Basin (1)	30	1/200
31. Iron and Manganese Removal Basin (2)	31	1/200
32. Reservoir Tank	32	1/200
33. Sludge Treatment Basin (1)	33	1/200
34. Sludge Treatment Basin (2)	34	1/200
35. Sludge Drying Bed (1)	35	1/200
36. Sludge Drying Bed (2)	36	1/200
III-5 Architectural Works for Water Treatment Plant		
37. Filter Control House Architectural Drawings	37	1/200
38. Distribution Pump House Architectural Drawings	38	1/200
39. Chlorination House Architectural Drawings	39	1/100
40. Sludge Treatment House Architectural Drawings	40	1/200
IV. Distribution Equipment		
41. Key Map for Distribution Pipeline	41	1/10,000
42. Distribution (1) - (10)	42-51	1/5,000
43. Fitting Detail (1) - (12)	52-63	Non
44. House Connection Type (A)	64	Non
45. House Connection Type (B)	65	Non



N
Legend
Raw Water Transmission Pipeline
Deep Well
Water Treatment Plant
Service Area
Future Extension
Thanh Am
Duc Giang
DUC GIANG
Gia Thuong
Thuong Cat
NGOC THUY
Viet Hung
Gia Quat
Gia Thuy
Well No.9
Mai Phuc
GIA LAM
Ngoc Lam
Lam Du
Well No.1
Well No.2
Well No.3
Well No.4
Well No.7
Well No.8
SAI DONG
Xon Dung
Xon Long Bien
Long Caic
Thon Ngo
THE SOCIALIST REPUBLIC OF VIET NAM
Transportation and Urban Public Works Service, HPC
The Water Supply System in Gia Lam Area in Hanoi City
Draw. Name
Project Area and Location for Facility
Sept., 1993
Scale 1:10000
Draw. No. 1
JAPAN INTERNATIONAL COOPERATION AGENCY



LEGEND

1	Intake Pump
2	Aeration Equipment
3	Iron Removal Equipment
4	Manganese Removal Equipment
5	Treated Water Reservoir
6	Distribution Pump
7	Backwash Pump
8	Air Scouring Blower
9	Aeration Blower
10	Pressurized Water Pump
11	Chlorinator
12	Chlorine Container
13	Sludge Reservoir Basin
14	Sludge Thickning Basin
15	Sludge Drying Bed
16	Coagulant Dosing Equipment
17	Sludge Transfer Pump
18	Clear Water Return Pump
19	Concentrated Sludge Discharge Pump
FIR	Flow Indicator and Recorder
LIA	Level Indicator with Alarmer
Cl_2 A	Chlorine Leak Detector
LA	Level Alarmer
FI	Flow Indicator

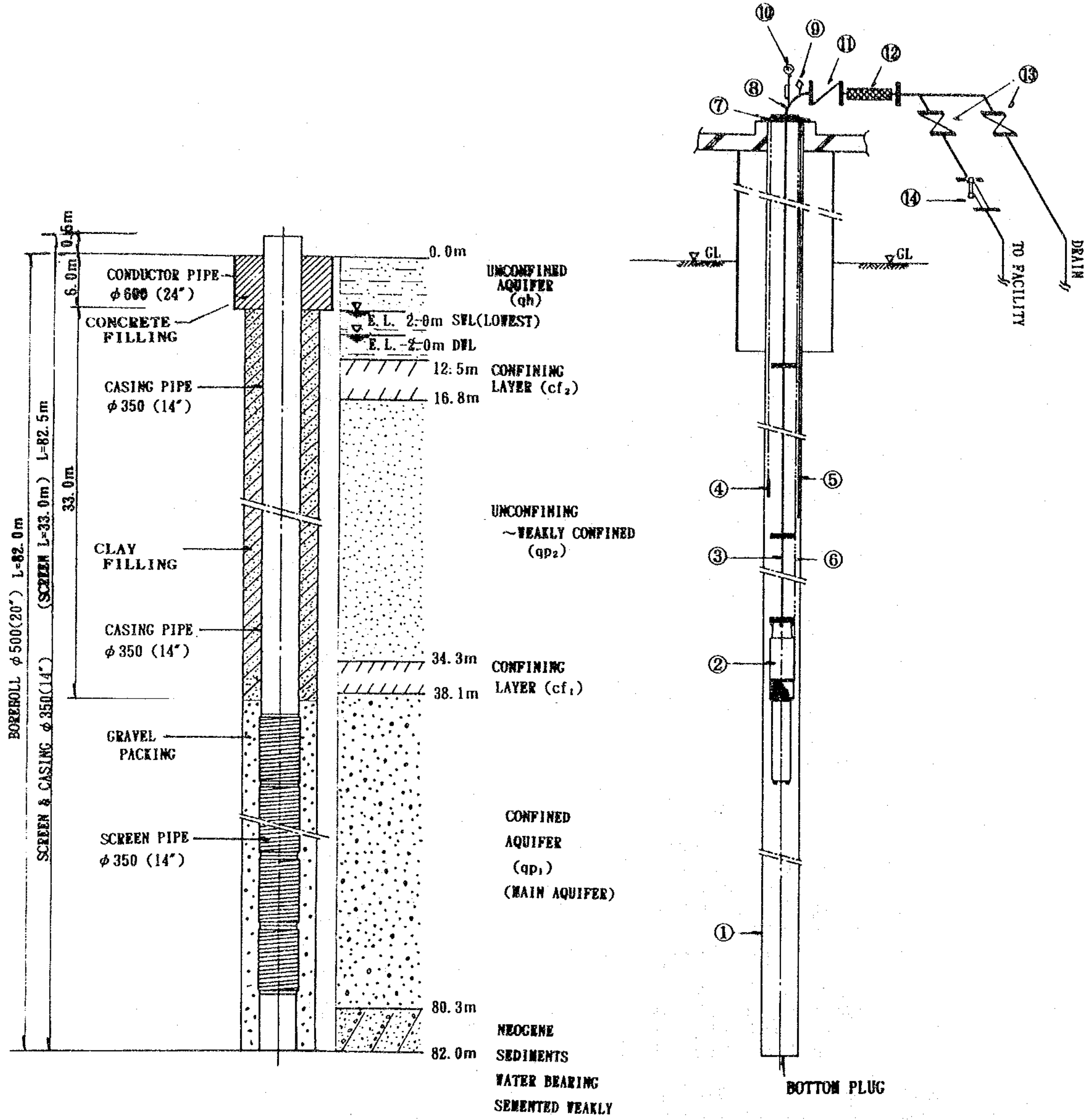
THE SOCIALIST REPUBLIC OF VIET NAM
Transportation and Urban Public Works Service, HPC

The Water Supply System in Gia Lam Area in Hanoi City

Draw. Name: Flow Sheet of Water Supply System

Sept. 1993 | Scale | Draw No. 2

JAPAN INTERNATIONAL COOPERATION AGENCY



No.	DESCRIPTION
14	φ150 FLOW METER (INDICATOR TYPE)
13	φ150 GATE VALVE
12	φ150 FLEXIBLE TUBE
11	φ150 CHECK VALVE
10	PRESSUREGAUGE
9	AIR BLEEDER VALVE
8	DICHARGE ELBOW
7	WELL COVER
6	CABLE
5	WATER LEVEL TESTING PIPE
4	LOW WATER LEVEL ELECTRODE
3	φ150 RISER PIPE
2	SUBMERSIBLE MOTOR PUMP
1	φ350 CASING PIPE

SUBMERSIBLE MOTOR PUMP

TYPE	DIAMETER (mm)	DISCHARGE RATE(m^3/min)	TOTAL HEAD (m)	OUTPUT (Kw)	Q'TY
IN-YARD	150	3.0	27	22	4
OUT-YARD	150	3.0	45	37	8

RISER PIPE (EACH WELL)

TYPE	DIAMETER (mm)	LENGTH (m)	QUANTITY (pcs)	T. LENGTH (m)
IN & OUT	150	2.75	8	
YARD	150	0.30	1	22.30

THE SOCIALIST REPUBLIC OF VIET NAM Transportation and Urban Public Works Service, HPC		
The Water Supply System in Gia Lam Area in Hanoi City		
Draw. Name Intake Well Facility		
Sept. 1993	Scale	Draw No. 3
JAPAN INTERNATIONAL COOPERATION AGENCY		