Table 6-3-2 Comparative Table of Construction Cost

(Unit: x1,000฿)

No.	NSD	Design Capacity (cum/hr)		Water Source		Intake Works		Transmission Work		Treatment Works						Distribution Works		Total cost	O/M Cost	Unit cost ฿/m³/h	Priority
				Capacity	Working Cost	Pump station	Pump cost	Pipe length (m)	Pipe cost	Treatment Type	Working cost	Storage Reservoir	Elevated tank	Distribution pump	Sub-Total	Pipe line Total length	Cost				
13	Kusuman	1	40	Reservoir	-	100	300	ø150 ℓ = 4,250	1,060	RA	720	350	780	740	2,590	9,560m	780	4,830	324	128	3
		2	40	Deep Well W x 3	540	30	180	ø100 ℓ = 1,690	190	A,F,C	300	350	770	740	2,160	9,210m	710	3,780	303	102	1
		3	40	"	540	30	180	-	-	A,F,C	300	350	1,325	740	2,715	9,210m	650	4,115	303	110	2
17	Pon-charoen	1	60	Reservoir	500	120	300	ø200 ℓ = 12,500	5,000	RA	1,200	600	770	820	3,390	12,260m	1,310	10,620	794	190	2
		2	40	Reservoir W x 4	500	100	300	ø150 ℓ = 12,500	3,125	RA	750	370	770	800	3,540	12,100m	1,270	10,100	831	182	1
			20			40	800	ø100 ℓ = 3,820	420	A,F,C	600	250									
		3	40	Reservoir W x 4	500	100	300	ø150 ℓ = 12,500	3,125	RA	750	370	2,340	800	5,110	12,100m	1,030	11,000	831	197	3
			20			40	800			A,F,C	600	250									
18	Nong Song Hong	1	50	Reservoir	4,050	120	200	ø150 ℓ = 200	50	RA	800	480	740	860	2,880	8,850m	910	8,210	294	170	1
		2	30	Reservoir W x 3	3,650	100	200	ø150 ℓ = 200	50	RA	750	320	740	800	3,310	8,850m	910	9,100	309	188	3
			20		-	30	600	ø100 ℓ = 2,700	300	A,F,C	500	200									
		3	30	Reservoir W x 3	3,650	100	200	ø150 ℓ = 200	50	RA	750	320	1,870	800	4,440	9,590m	840	9,900	309	204	4
			20		-	30	600	-	-	A,F,C	500	200									
		4	30	Reservoir W x 3	3,650	100	200	ø150 ℓ = 200	50	RA	750	320	1,000	800	3,570	10,590m	730	8,930	309	184	2
			20		-	30	600	-	-	A,F,C	500	200									

Note; RA ; Rapid Sand Filtration F ; Filtration
A ; Aeration C ; Chlorination

CHAPTER VII. PROPOSED PROJECT

CHAPTER VII. PROPOSED PROJECT

7.1. Project Formulation

7.1.1. Objectives of the Project

The main purpose of the project is to provide an improved living standard for the local people through a stabilized water supply in the Sanitary District areas. In addition to the above, the related objectives are to support growth of local industries, commercial enterprises, institutions such as schools and hospitals, and agricultural activities surrounding the Sanitary District.

With the development of the Project, it is expected that the urban activities in the Sanitary Districts, which would have the characteristics in-between of "Urban" and "Rural", will be encouraged to grow vigorously in future, and that the related water supply services will be properly upgraded to further promote the urban activities.

The effects of the sanitary district water supply project are summarized as follows:

- Health improvements by minimizing/preventing risks of water-borne diseases and infection, particularly acute diarrhea, dysentery, hepatitis and so on.
- Alleviation of the burden on young children and women in carrying water, so that the time and energy that had been reserved for it can be saved and may be used for other income generating works,
- Improvement of operation/maintenance technology of water supply facilities,
- Institutional improvement in terms of organization management.

In order to achieve the above mentioned targets and objectives, the implementation of the subject project is anticipated to lead acceleration of the rural area development.

7.1.2. Scope of the Project

The scope of the project covers mainly (1) the construction of new waterworks facilities from intakes to distribution systems, (2) the establishment of an operation and maintenance organization for the waterworks and (3) the promotion of the improvement of sanitary environment in the respective Sanitary District areas.

In addition to the construction of the main facilities incorporated in this project, service pipes and water tap systems for the respective consumers, will have to be implemented in parallel with the implementation of the main system as associated project in order to realize quick benefit generation and an upgrading of the living standard.

The respective Sanitary Districts will execute the project works under the supervision of the Department of Public Works in Ministry of Interior.

7.2. Preliminary Design

7.2.1. General Description

The preliminary design of the respective waterworks was carried out based on the detailed field survey and investigation, design criteria, alternative study, review of existing data, informations and reports available and a series of discussion meetings with Thai authorities concerned.

The planning index and the design discharge for the respective Sanitary Districts are summarized in Table 7-2-1 and 7-2-2. The results of the preliminary design for respective Sanitary Districts are shown in Table 7-2-3.

Table 7-2-1. Planning Index of Sanitary District

NSD Code No.	NSD Name	No. of Muban	Population in 2000 Total (A)	Population in 2000 Served (A)x0.07	No.of Household Served	Daily* Maximum Capacity
5	Kham Sake Sang	3	8,559	6,000	790	900
6	Nong Bua Lai	4	6,366	4,500	610	675
7	Huai Thalaeng	3	19,028	13,300	1,520	1,995
8	Nong Ki	12	24,089	16,900	2,470	2,535
10	Huai Rat	4	7,037	4,900	590	735
12	Khun Han	7	7,190	5,000	650	750
13	Kusuman	2	8,788	6,200	920	930
17	Phon Charoen	8	15,084	10,600	1,580	1,590
18	Nong Song Hong	5	12,310	8,600	1,035	1,290
20	Huai Kha Yung	4	7,011	4,900	730	735

Note: * ... 150 liter per capita x served population

7.2.2. Intake Facilities and Water Transmission

(1) Water Sources

The water sources for the respective Sanitary Districts are the river from which the water is diverted for Huai Kha Yung (NSD No.20), the groundwater for Kusuman (NSD No.13), and the existing reservoirs for the remaining NSDs.

(2) Storage Reservoirs and Related Structures

Some of the existing reservoirs must be improved to increase their storage capacity in order to meet the water demand of the subject project.

Kham Sakae Sang Project is required to construct a new diversion weir on the Huai Yung and two kilometers long feeder canal from the weir to the existing Bun Chiwuk reservoir.

For the Huai Thalaeng Project and the Nong Song Hong Project, their embankments will have to be heightened 1.50 m and 1.30 m, respectively. Furthermore, five project areas, including two

projects mentioned previously, require construction of feeder canals between the existing reservoirs and the water treatment plants.

(3) Intake Pump Station

One submerged pump will be used for intake for each well of the Kusuman Project, and the operation time must be limited to 20 hours per day in the dry season in taking into account for availability of the groundwater.

The Huai Kya Yung Project where the water source depends on the river is adopted an inclined mixed flow type of pumps from technical and economical point of views.

A single suction pump is recommended for the remaining project. Two units including one stand-by pump will be installed for each of the pumping station.

(4) Transmission Pipeline

The routes of transmission pipelines are planned along the existing public roads in taking into consideration convenience of pipe installation, operation/maintenance and land acquisition, etc.

The pipeline system proposed for the respective NSD, is to be based on a pressure conveyance method from the intake pump station to the water treatment plant. Asbestos cement pipes with a diameter of 150 mm to 250 mm, will be installed in all NSD Project areas, except the Nong Bua Lai Project and the Kusuman Project.

Appurtenant facilities as required for the system, such as sluice valves, air valves and blow-off valves, are provided at appropriate points in the course of the system.

(5) Water Treatment Plants

The capacity of a water treatment plant ranges from 30 to 100 cu.m per hour. A plant with a capacity of more than 50 cu.m per hour was designed with two sedimentation basins for better water management and emergency control. The proposed water treatment process are classified into the following three types.

(a) Rapid Sand Filtration System

Description	RA1 Type	RA2 Type
- Coagulant & Coagulant Aid	Alum	Alum, Soda ash
- Mixing, Measuring	Weir	Weir
- Flocculation	Vertical Baffled Channel	Vertical Baffled Channel
- Sedimentation	Horizontal Flow	Horizontal Flow
- Sand Filtration	Rapid Sand Filter	Rapid Sand Filter
- Washing	Back & Surface Washing	Back & Surface Washing

(b) Aeration and Rapid Sand Filtration

Description	AR Type
- Aeration	Multi-Tray
- Sand Filtration	Rapid Sand Filter
- Washing	Back & Surface Washing

The proposed water treatment plants are as follows:

Type of Plant	Number of Sedimentation	
	One Row	Two Rows
RA1 Type	Kham Sakae Sang Nong Bua Lai Huai Rat	Huai Thalaeng Nong Ki
RA2 Type	Khum Han Huai Kha Yung	Phon Charoen Nong Song Hong
AR Type	Kusuman	

The dimension of the typical design of the water treatment plant are shown in Table 7-2-4 and Figure 7-2-1.
Hydraulic analysis of the plants is discussed in Appendix D.

(6) Distribution Systems

The distribution systems consist of a distribution reservoir, distribution pumps, an elevated tank and distribution pipelines. The distribution pipelines are sub-divided into the main, sub-main, branch and service pipes.

(a) Reservoir and Elevated Tank

A distribution reservoir is rectangular in shape. An elevated tank is circular in shape. Both of them are made of reinforced concrete. The capacity and dimensions of them are shown as follows:

NSD Code No.	Name of NSD	Distribution Reservoir Volume (cu.m)	Elevated Tank Volume (cu.m)	Elevated Tank L.W.L (m)
5	Kham Sakae Sang	250	80	18
6	Nong Bua Lai	200	60	18
7	Huai Thalaeng	500	160	18
8	Nong Ki	600	200	18
10	Huai Rat	200	60	14
12	Khun Han	200	60	14
13	Kusuman	250	80	18
17	Phon Charoen	400	120	14
18	Nong Song Hong	300	100	14
20	Huai Kha Yung	200	60	18

Note; * Low water Level above the ground.

(b) Distribution Pumps

A single suction volute pump with horizontal axis is recommended, and there should be three pumps including one stand-by unit. The same size and specifications of

the pumps are recommended, in view of changeability of spare parts and convenience of O & M. The prime mover of the pumps is an electric motor for two units and a diesel engine for the remainder. The specifications of the pumps are summarized as follows:

NSD Code No.	Design Capacity Total (cu.m/hr)	Design Capacity Per Unit (cu.m/min)	Total Lift (m)	Bore (mm)	Power (KW)
5	56.3	0.469	25	80	5.5
6	42.2	0.352	25	65	3.7
7	124.7	1.039	25	100	11.0
8	158.4	1.320	25	125	11.0
10	45.9	0.383	20	65	3.7
12	46.9	0.391	20	65	3.7
13	58.1	0.484	25	80	5.5
17	99.4	0.828	20	100	7.5
18	80.6	0.672	20	80	5.5
20	45.9	0.383	25	65	5.5

(c) Distribution Pipelines

The diameter of the pipes is determined by networks analysis. The summary of the information for this distribution and service pipes are as follows, and detailed information is tabulated in Appendix D.

NSD Code No.	Service Area (sq.km)	Distribution Pipe Total (m)	Distribution Pipe Per sq./km (m/sq.km)
5	2.00	10,450	5,220
6	3.03	6,900	2,270
7	2.63	12,250	4,650
8	5.40	25,580	4,730
10	1.73	8,970	5,180
12	2.20	6,700	3,040
13	4.00	9,210	2,300
17	10.00	12,100	1,210
18	4.53	13,230	2,920
20	2.80	13,460	4,800

Table 7-2-2 Design Discharge of Respective Facility

NSD Code No.	Intake Transmission			Treatment plant			Distribution Pipeline	Water Resources Available	
	Daily (cu.m/d)		Annum	Daily (cu.m/d)		Hourly		Reservoir or River	
	Average	Maximum	(cu.m/y)	Average	Maximum	(cu.m/h)	cu.m/d	cu.m/y or cu.m/d	(cu.m/h)xn
	(A)	(B)	(C)	(D)	(E)	(F)	(G)		
5	800	990	300,000	720	900	38	1,350	Bun Chiwuk Re 340,000	
6	590	740	200,000	540	675	28	1,013	Nong Samp Re 300,000	
7	1,760	2,200	640,000	1,600	1,995	83	2,993	Nong Takai Re 160,000	
8	2,230	2,790	810,000	2,030	2,535	105	3,802	Tung Kraten Re 1,600,000	
10	650	810	240,000	590	735	31	1,103	Huai Talet Re 18,500,000	18 x 3
12	660	830	220,000	600	750	31	1,125	Nong Si 3,800,000	
13	(810)	(1,020)	300,000	740	930	39	1,395		
17	1,400	1,750	510,000	1,270	1,580	66	2,370	Nong Loeng Re 2,000,000	
18	1,140	1,420	420,000	1,030	1,290	53	1,935	Nong Song Hong Re 400,000	
20	650	810	240,000	590	735	31	1,103	Huai Kha Yung Ri Qmins = 870,000	

Note: A = D x 110%
B = E x 110%
C = A x 365
F = E/24
G = E x 1.5

Table 7-2-3 Dimensions of the Facilities

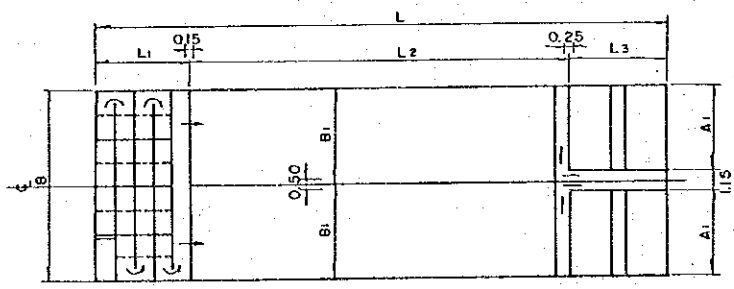
Description	Unit	NSD-5	NSD-6	NSD-7	NSD-8	NSD-10	NSD-12	NSD-13	NSD-17	NSD-18	NSD-20
1. Water Demand											
Annual water demand	m^3/y	300,000	200,000	640,000	810,000	240,000	220,000	300,000	510,000	420,000	240,000
Daily max.	m^3/d	900	675	1,995	2,535	735	750	930	1,590	1,290	735
Hourly max.	m^3/hr	56.3	42.4	124.7	158.4	45.9	46.9	58.1	99.4	80.6	45.9
2. Water source	-	Reservoir	Reservoir	Reservoir	Reservoir	Irrigation canal	Reservoir	Ground Water	Reservoir	Reservoir	River
3. Intake facilities											
(1) Feeder canal	m	2,000	-	100	100	100	-	-	500	200	-
(2) Improvement of reservoir	m	-	-	ΔH = 1.5	-	-	-	-	-	ΔH = 1.3	-
(3) Pump	-	$\phi 80^{mm} \times 11^{kW}$ x 2 sets	ø80x2.2x2	ø125x30x2	ø150x22x2	ø80x3.7x2	ø80x2.2x2	Deep Well ø65x3.7x3	ø125x30x2	ø100x3.7x2	ø80x4.5x2
(4) Others	-	Intake weir	-	-	-	Turn-out from canal	-	-	-	-	-
4. Transmission											
Pipe diameter	mm	ACP ø150	-	ACP ø200	ACP ø250	ACP ø150	ACP ø150	PVC ø100	ACP ø200	ACP ø150	ACP ø150
Length	m	5,800	-	6,000	3,050	100	470	1,690	12,500	200	1,000
5. Treatment plant											
Capacity	m^3/hr	38	28	83	105	31	31	39	66	53	31
Type of filtration	-	Rapid sand	Rapid sand	Rapid sand	Rapid sand	Rapid sand	Aeration sand Rapid sand	-	Rapid sand	Rapid sand	Rapid sand
Chemical feeding	-	Alum	Alum	Alum	Alum	Alum	Alum, soda	-	Alum, soda	Alum, soda	Alum, soda
6. Distribution tank											
Reservoir tank	m^3	250 x 1	200 x 1	500 x 1	600 x 1	200 x 1	200 x 1	250 x 1	400 x 1	300 x 1	200 x 1
Elevated tank	m^3	80 x 1	60 x 1	160 x 1	200 x 1	60 x 1	60 x 1	80 x 1	120 x 1	100 x 1	60 x 1
7. Distribution pump	-	$\phi 80^{mm} \times 5.5^{kW}$ x 3 sets	ø65x3.7x3	ø100x11x3	ø125x11x3	ø65x3.7x3	ø65x3.7x2	ø80x5.5x3	ø100x7.5x3	ø80x5.5x3	ø65x5.5x3
8. Distribution pipe line	m	10,450	6,900	12,250	25,580	8,970	6,700	9,210	12,100	13,230	13,460
Main ø100 - ø200	m	4,130	2,540	6,100	6,970	3,150	2,410	3,790	4,700	2,970	3,500
Sub main ø75	m	1,120	890	-	5,810	1,320	910	780	1,240	1,410	3,200
Branch ø50	m	5,200	3,470	6,150	12,800	4,500	5,380	4,640	6,160	8,850	6,760

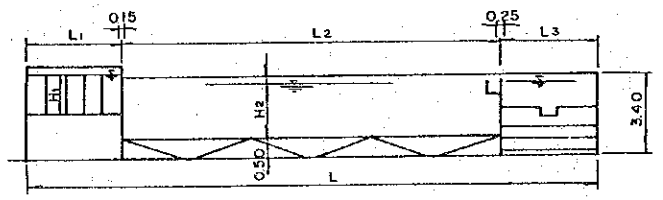
Table 7-2-4 Standard Diemnsions of Water Treatment Plant

Description	Unit	Type A (Two Raws)				Type B (One Raw)	
1. Capacity	m^3/hr	50	60	80	100	30	40
2. Receiving Well & Flocculation Basin							
- L1	m	2.40	2.40	2.60	2.60	2.90	2.90
- B	m	5.25	6.25	7.85	9.45	3.00	3.80
- H1	m	1.30	1.30	1.30	1.30	1.30	1.30
- Volume L1·B·H1	m^3	16.38	19.50	26.53	31.94	11.31	14.32
- Detention Time	min.	19.7	19.9	19.9	19.2	22.6	21.5
3. Sedimentation Basin							
- L2	m	11.50	11.50	11.70	12.00	11.50	11.70
- ΣB1	m	2x2.50	2x3.00	2x3.80	2x4.60	3.00	3.80
- H2	m	2.70	2.70	2.70	2.70	2.70	2.70
- Volume L2·B1·H2	m^3	155.3	186.3	240.1	298.1	93.2	120.0
- Detention Time	min.	3.1	3.1	3.0	3.0	3.1	3.0
4. Rapid Sand Filter							
- L3	m	2.40	2.40	2.40	2.40	2.40	2.40
- ΣA1	m^2	2x2.05	2x2.55	2x3.35	2x4.15	2x1.25	2x1.65
- Area	m^2	9.84	12.24	16.08	19.92	6.00	7.92
- Flow Rate	m/d	122	118	119	120	120	121
5. Length (L)	m	16.70	16.70	17.10	17.40	17.20	17.40

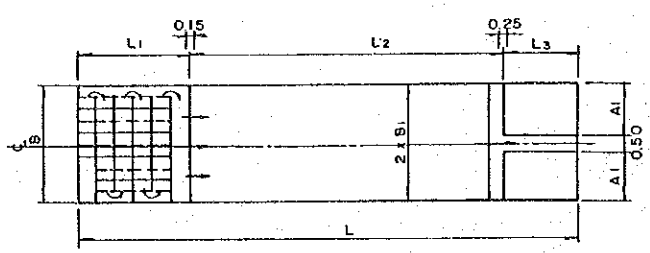
Figure 7-2-1 Typical Design of Water Treatment Plant

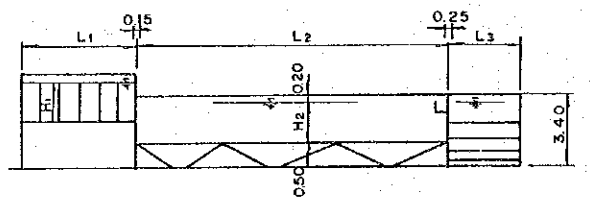
Type A





Type B





7.3. Project Implementation and Cost Estimate

7.3.1. Executing Agency and Administrative Supervision for the Project Implementation

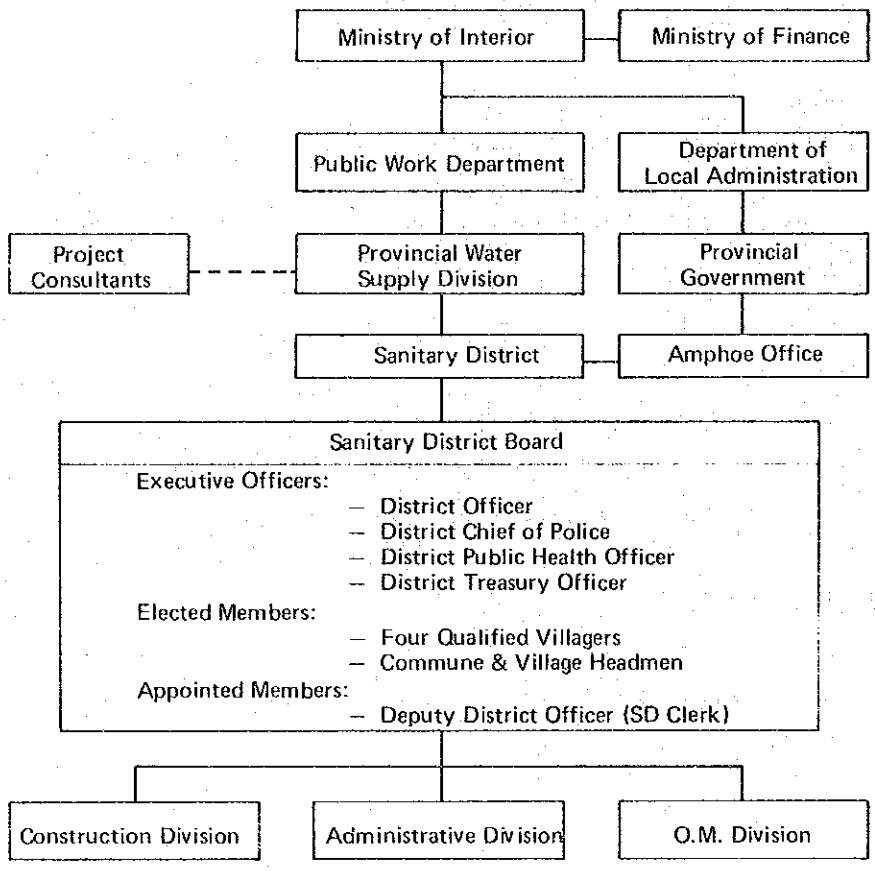
The Sanitary District has a function as a local governmental organization and its own budget system as described previously in Section 2.2.

The agency that will implement the project will be the Sanitary District Board of the respective service areas. Guidances and arrangements on the administrative and budgetary aspects will be provided by the Department of Local Administration (DOLA) of the Ministry of Interior, Provincial Government and Amphoes Office concerned. Technical advices, design, and supervision of the project will be provided in the responsibility of the Public Works Department (PWD).

The proposed organization of the project implementation is presented in Figure 7-3-1.

The Sanitary Districts will gain the revenues in their juridical area as taxes, levees and duties. The amount collected and/or contributions given to the authorities concerned will be smaller than the required capital cost of the subject project. In this connection, the DOLA has a vitally important function to subsidize the capital cost and to make a loaning arrangement for the project implementation. The SD Board will prepare project implementation programmes along with a basic plan of the waterworks and have a consensus from the beneficiary consumers prior to commencement of the project. Furthermore, the SD Board shall arrange the necessary financing and follow the loaning procedures based on the financial proposal made in this feasibility report. The implementation agency may consider to employing consultants in order to prepare the detailed design/tender documents and to carry out the project management, if necessity requires.

Figure 7–3–1 Proposed Organization of the Project Implementation



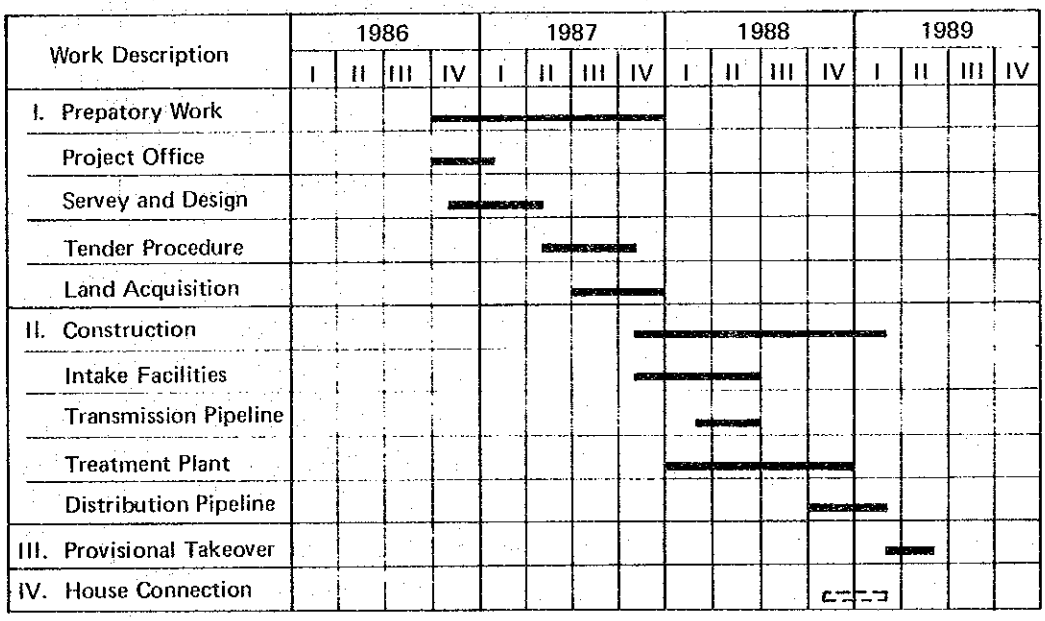
7.3.2. Project Implementation Schedule

The project implementation schedules are prepared on the basis of working procedures/volumes, and staffing capacity and ability. The typical implementation schedule of the SD waterworks is illustrated in Figure 7-3-2. The majority of the preparatory work, except land acquisition, will be carried out by the PWD or the employed consultants, with close cooperation of the respective Sanitary District offices.

The construction period, after the contract is concluded between the agency and the contractors, will be about 16 months, starting from the beginning of a dry season to the end of the next dry season.

The installation of house connection (service pipes) should be carried out in parallel with the construction of the main facilities so as to accrue quick and equitable benefit for the entire service area proposed. Provisional take-over of the completed facilities will be realized at the termination of the project by the both PWD and SD Boards concerned, and/or related operation and maintenance offices.

Figure 7–3–2 Implementation Schedule



7.3.3. Cost Estimate

(1) Components of Project Cost

Estimation of the Project cost is made on the basis of foreign exchange and local currency to meet the international financing guideline. The major components of the cost are described as follows:

(a) Construction Cost

This item includes the costs of intake facilities, water transmission pipelines, water treatment plants and distribution systems excluding service pipes. These costs are estimated based on respective unit costs including, the construction materials, fuel and oil, labor, the depreciation cost of the construction equipment, and its cost of repair. The construction costs are estimated on a Contract basis. The construction works are composed of the following items.

(i) Intake work: to include intake pump stations, intake weirs, feeder canals, improvement of existing reservoirs, well drilling and related structures.

(ii) Water transmission: to include main transmission pipelines up to treatment plants and appurtenant structures.

(iii) Water treatment plant: to include receiving wells, flocculation basin, sedimentation basins, sand filters and required appurtenant facilities and devices.

(iv) Distribution work: to include distribution reservoirs, distribution pump stations, elevated tanks and distribution pipelines such as mains, sub-mains and branches and appurtenant structures.

(b) Land Acquisition

The cost includes procurement of the land to be occupied by the proposed waterworks facilities.

(c) Engineering services

The cost covers the engineering services for survey investigations, detailed design and construction supervision. The cost accounts for about 10 percent of the total construction cost.

(d) Administration Cost

The cost covers the salaries, wages, transportation charges, office construction, office facilities and miscellaneous items. The cost accounts for about 10 percent of the total construction cost.

(e) Physical and Price Contingencies

Ten percent of the total cost consisting of those for construction, land acquisition, engineering and administration is taken as physical contingencies which cover minor differences between the actual results estimated quantities and, cost increase by unexpected difficulties in construction works and so forth.

Price escalation of 5.0 to 8.0 percent per annum for the foreign currency components and that of 7.0 percent per annum for the local currency portion are allowed respectively.

(2) Total Project Cost

The total project cost shall include the cost for price escalation but exclude the interest during the construction period. The said cost is estimated at 174.5 million baht for ten NSDs of which about 91.3 million baht will be covered by foreign currency component and about 83.2 million baht by the local currency component, respectively. Table 7-3-1 shows the breakdown of the project cost and details can be referred to in Appendix E.

Table 7-3-1 Total Cost of the Project

(Unit: 1,000 ฿)

Description	NSD-5			NSD-6			NSD-7			NSD-8		
	F/C	L/C	Total	F/C	L/C	Total	F/C	L/C	Total	F/C	L/C	Total
1. Construction cost												
1) Intake work	680	440	1,120	280	190	470	4,250	3,390	7,640	620	230	850
2) Transmission	970	810	1,780	0	0	0	1,630	1,280	2,910	1,150	850	2,000
3) Treatment plant	1,750	1,720	3,470	1,500	1,400	2,900	2,200	2,150	4,350	2,400	2,160	4,560
4) Distribution work	1,620	1,480	3,100	1,040	960	2,000	2,010	1,970	3,980	3,710	3,870	7,580
Sub-Total	5,020	4,450	9,470	2,820	2,550	5,370	10,090	8,790	18,880	7,880	7,110	14,990
2. Land acquisition	0	200	200	0	50	50	0	50	50	0	0	0
3. Engineering service	752	188	940	420	110	530	1,510	380	1,890	1,200	300	1,500
4. Administration	188	752	940	110	420	530	380	1,510	1,890	300	1,200	1,500
Sub-Total (1 - 4)	5,960	5,590	11,550	3,350	3,130	6,480	11,980	10,730	22,710	9,380	8,610	17,990
5. Physical contingency	596	559	1,155	335	313	648	1,198	1,073	2,271	938	861	1,799
Sub-Total (1 - 5)	6,556	6,149	12,705	3,685	3,443	7,128	13,178	11,803	24,981	10,318	9,471	19,789
6. Price contingency	1,801	1,658	3,459	1,020	941	1,961	3,521	3,144	6,664	2,903	2,661	5,564
Grand Total	8,357	7,807	16,164	4,705	4,384	9,089	16,699	14,947	31,645	13,221	12,132	25,353

Description	NSD-10			NSD-12			NSD-13			NSD-17		
	F/C	L/C	Total	F/C	L/C	Total	F/C	L/C	Total	F/C	L/C	Total
1. Construction cost												
1) Intake work	340	220	560	300	210	510	690	180	870	690	270	960
2) Transmission	20	20	40	80	70	150	410	440	850	3,390	2,680	6,070
3) Treatment plant	1,500	1,430	2,930	1,500	1,430	2,930	1,530	1,310	2,840	2,000	1,860	3,860
4) Distribution work	1,360	1,310	2,670	990	920	1,910	1,440	1,350	2,790	1,880	2,110	3,990
Sub-Total	3,200	2,980	6,200	2,870	2,630	5,500	4,070	3,280	7,350	7,960	6,920	14,880
2. Land acquisition	0	0	0	0	0	0	0	50	50	0	0	0
3. Engineering service	496	124	620	440	110	550	584	146	730	1,180	300	1,480
4 Administration	124	496	620	110	440	550	146	584	730	300	1,180	1,480
Sub-Total (1 - 4)	3,840	3,600	7,440	3,420	3,180	6,600	4,800	4,060	8,860	9,440	8,400	17,840
5. Physical contingency	384	360	744	342	318	660	480	406	886	944	840	1,784
Sub-Total (1 - 5)	4,224	3,960	8,184	3,762	3,498	7,260	5,280	4,466	9,746	10,384	9,240	19,624
6. Price contingency	1,178	1,097	2,275	1,037	957	1,994	1,458	1,226	2,683	2,818	2,514	5,332
Grand Total	5,402	5,057	10,459	4,799	4,455	9,254	6,738	5,692	12,429	13,202	11,754	24,956

Description	NSD-18			NSD-20			Total			Remarks
	F/C	L/C	Total	F/C	L/C	Total	F/C	L/C	Total	
1. Construction cost										
1) Intake work	3,070	2,830	5,900	580	310	890	11,500	8,270	19,770	
2) Transmission	40	30	70	170	140	310	7,860	6,320	14,180	
3) Treatment plant	1,900	1,800	3,700	1,490	1,440	2,930	17,770	16,700	34,470	
4) Distribution work	1,790	1,610	3,400	1,890	1,780	3,670	17,730	17,360	35,090	
Sub-Total	6,800	6,270	13,070	4,130	3,670	7,800	54,860	48,650	103,510	
2. Land acquisition	0	50	50	0	50	50	0	450	450	
3. Engineering service	1,040	260	1,300	624	156	780	8,248	2,072	10,320	
4. Administration	260	1,040	1,300	156	624	780	2,072	8,248	10,320	
Sub-Total (1 - 4)	8,100	7,620	15,720	4,910	4,500	9,410	65,180	59,420	124,600	
5. Physical contingency	810	762	1,572	491	450	941	6,518	5,942	12,460	
Sub-Total (1 - 5)	8,910	8,382	17,292	5,401	4,950	10,351	71,698	65,362	137,060	*1: 52.3% of the total
6. Price contingency	2,401	2,239	4,641	1,514	1,373	2,887	19,650	17,810	37,460	
							*1	*2		*2: 47.7% of the total
Grand Total	11,211	10,621	21,933	6,915	6,323	13,238	91,348	83,172	174,520	

7.4. Operation and Maintenance

7.4.1. Organization and Staffing

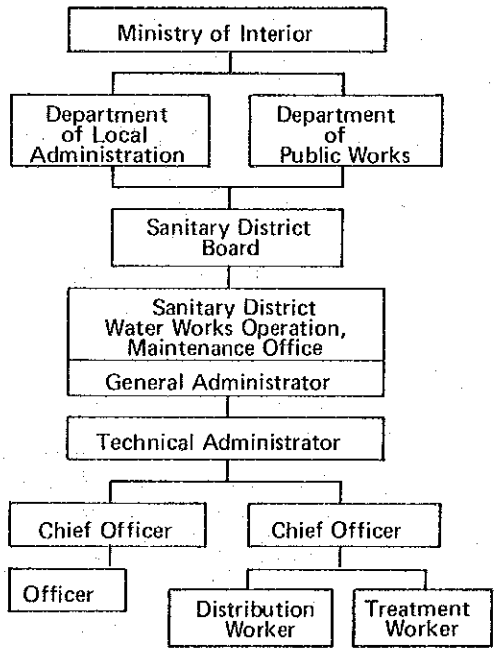
The proposed organization of the operation and maintenance office in the respective Sanitary Districts are presented in Figure 7-4-1. Major tasks of the O & M office are operation/maintenance of the waterworks, collection of data/information of water production and consumption, collection of water charges, preparation of budget allocation and disbursement schedule, and amortization of the loan. Besides, the office shall take care of the training of workers under the instruction/supervision of DOLA, PWD and Sanitary District Board.

Giving due consideration to the responsibilities and work requirements, operators and officers under the general administrator, who is the deputy district officer, will be assigned.

As discussed in the previous sections, the Sanitary District Board shall function not only as an executing body but also as the top supervising organization of the operation/maintenance (with the assistance of PWD) for the water-works, until the activities of the O & M office can be stabilized and strengthened.

The number of staffs for operation/maintenance works is proposed according to the scale of service area and water supply capacity. The standard staffing is a technical administrator, a chief officer, a chief operator and one or two worker and/or officers for the scale of water supply capacity less than 100 cu.m per hour.

Figure 7-4-1 Organization of Operation and Maintenance Office



7.4.2. Function and Responsibility

The main objective of the O & M program is to ensure continuous delivery of adequate and safe water supply in the Sanitary District areas through maintaining the water facilities in good working condition, and immediately repairing them in the case that they are broken. The major functions and management of O & M for the water works are the controls of water quantity and water quality, keeping a sanitary environment, handling emergencies, and keeping a well-balanced system of operation/maintenance.

Management of water quantity is, 1) to measure and record water quantity at intakes, treatment and distribution system, 2) to efficiently control the water supply to beneficiaries, and 3) to minimize water leakage/wastage in transmission and distribution pipeline.

Management of water quality is, 1) to supply potable water to beneficiaries, 2) to analyze water quality at service pipes as to turbidity, colour, taste, odor, residual chlorine and pH.

Management of a sanitary environment is to keep a sanitary environment around the waterworks in order to prevent pollution of the surrounding area, prevent possible contamination of the potable water, and hence and to keep operators healthy.

Management of emergencies is to stop the water supply immediately after accidents or malfunctions happen and to repair them as soon as possible or to establish an emergency set-up.

The major work responsibility by the respective staffs are summarized as follows;

- The Technical administrator, who has a technical license on water supply works authorized by the Ministry shall;
  - manage overall operation/maintenance works of the facilities.

- ° prepare financial proposals, reports on O & M activities, evaluations, plans for immediate expansion or the rehabilitation of the facilities.
- ° take countermeasures in emergency cases.
- ° supervise administrative activities including water charge collection.

- The chief operator shall;
  - ° record on the daily released water at treatment plants and distribution mains, and repairing, water quality.
  - ° prepare reports on the daily O & M works.
  - ° patrol the waterworks facilities and service pipes of house connection, etc.

- The chief officer shall;
  - ° prepare a budget plan, financial proposal, repayment schedule of the loan and bills for water charges.
  - ° collect water charges from consumers.
  - ° perform administrative and accounting services.

7.4.3. Water Quality Monitoring and Control

Monitoring of water quality involves sampling and analysis of raw water, and sanitary inspection of the upgraded systems as well as the new water supply facilities to be built. The main objective is to ensure continuous delivery of safe drinking and domestic water, and additional objectives of the activities are summarized as follows:

- To ensure a safe product by checking the quality of drinking and domestic water over periods of time;
- To provide information to public health authorities for general public health protection purposes;
- To identify any sources of contamination and provide disinfections;
- To assess the performance of the water treatment plants, and to suggest improvement, if necessary;

- To evaluate water supply systems for future improvement.

The proposed monitoring program will be carried out in two parts in order to achieve the above-mentioned objectives.

Part 1: Surveillance program; this is undertaken in order to identify the potential partially polluted water sources by means of indicative tests.

Part 2: Assessment program; This is undertaken so as to assess the water quality for national planning.

CHAPTER VIII. PROJECT JUSTIFICATION

CHAPTER VIII. PROJECT JUSTIFICATION

8.1. General

A public water supply to sanitary districts is essential as a basic human need. The Project can expect direct and indirect benefits after the water supply project is completed. For the successful implementation of the project, it is necessary to satisfy the human need, and financial and economic viability.

In this chapter, from the stand point of the public enterprise management and the national economy, financial and socio-economic analyses were carried out for the selected ten NSD's waterworks projects. A financial analysis was made to determine a reasonable water charge by using the parameters, such as a government subsidy in the project cost, loan conditions, break-even point and financial internal rate of return. On the other side, from the socio-economic analysis, the effects of the project implementation for the regional and national socio-economy were clarified. And, after the comparison of the benefits in monetary terms and the project cost, the economic significance of the Project will be come to light.

8.2. Financial Analysis

8.2.1. Establishment and Evaluation of Fundamental Indicators

Fundamental indicators for the financial analysis are the average water rate charge, the governmental subsidy in the project cost, and loan conditions. These indicators were evaluated through the careful studies to clarify the financial status of the water works' O & M organization.

(1) Average Water Charge

To determine the average water charge per cubic meter, in first of all, a careful attention was paid to the possibility that the water charge would be sufficient to cover the project cost, with a reasonable financial internal rate of return. The average water charge depends, to a great extent, upon the lending terms, based on which major part of investment capital is loaned. If the terms are too hard to this particular project, it will inevitably push up the water charge to make both ends meet in the project finance, resulting in an over-rate to consumers' paying ability.

To evaluate beneficiaries willingness and ability to pay, a socio-economic survey was conducted by the study Team and the PWD authorities concerned. As the results of the survey and assessment, an average level of willingness to pay, which was evaluated by tabulating the already invested cost for equipment to haul the raw water, the cost of the large storage jar etc. and the estimated labor cost for hauling domestic water supply, was about 4.7 Baht per cu.m. The figure indicates that it is quite similar in value to that of the existing water tariff system for waterworks being applied by the Provincial Waterwork Authority.

On the other hand, for a household in the developing countries, it is well known that the upper limit of "the ability to pay a water charge" is four to five percent of their income. As the result of the sample survey in ESD, it is confirmed that the average water charges and expenses for the facilities are shared at 3.5% of the agricultural households income and at 4.8% of the non-agricultural household income, respectively (See Table F-1-4, Appendix F).

According to the socio-economic statistical data of Northeastern Sanitary Districts of Thailand in 1979 (Source: NSO), the average income per month per household (1985 price level) was about 2,900 Baht (See Table F-3-1, Appendix F). Eight Baht per cu.m of water would correspond to four percent of the monthly income.

Water Charge per Cubic Meter (฿/m^3)	Monthly Water Charge/ Monthly Income (%)
4	2.0
5	2.5
6	3.0
7	3.5
8	4.0

Note:
i) Average family size in the Sanitary Districts of the Northeast Thailand is at 5.3 (Source: NSO, 1979).
ii) Daily average supply of water is at 0.09 cubic meter/capita.

(2) Subsidy in Project Cost

According to the cost estimate of the project in Chapter VII, the foreign and the local currency components to the total project cost occupy approximately 50 percent each. The sanitary districts, which has a plan of the project on the waterworks construction, usually deposit the fund of about ten percent of the prospected project cost. On the other hand, in order to meet the Government's policy that the state enterprises and related organizations of the water supply works must become self-financing, the subsidizing of water rate by the Government was assumed at about 25 percent of the total capital cost as minimum requirements after the case study had been carried out.

After all-round simulations were conducted, it has been assumed recommended that the loaning terms are four to eight percent of annual interest rate with a 20 to 30 years repayment period, and having five to ten year grace period for the foreign currency portion, four to 14 percent of the annual interest rate and a ten years period of repayment with one year grace period for the local currency portion.

(3) Implementation Schedule of the Project

The Project implementation will take about three years covering the preparatory works, construction works and provisional take-over of the completed facilities.

8.2.2. Financial Indicators

(1) Cumulated Deficit Years

The cumulated deficit years can be calculated based on the statement of income and expenditure, so that the year after the cancellation of the cumulated deficit, is the break-even point. The carried deficit financing of the waterworks project will exert pressure upon the general account of sanitary districts, and the money transfer from the SD budget for a long period of years is undesirable in consideration of sound finance. The project should save the cumulated deficit at a one-third of the project life of about 40 years. So it is desirable that the break-even point is 10 to 15 years after start of the system operation.

(2) Financial Internal Rate of Return (FIRR)

The FIRR is a rate that makes the net present worth of the project's return stream equal to zero. FIRR can be compared with the real interest rate of the country. The real interest rate can be estimated from open market rate of interest minus annual inflation rate. The real interest rate in Thailand may be estimated from six to seven percent. Therefore, from the stand point of the capital investment, the FIRR of the project need to cover from six to seven percent.

8.2.3. Result of the Analysis

(1) Proto-type

The result of the analysis is summarized in the following table and is detailed in Table 8-2-1. Without any government subsidy to the project, and some projects (No.5-Kham Sakae Sang and No.20-Huai Kha Yung) would not be able to continue the sound financing. Finally, it is found that at least 25 percent government subsidy for the total project cost will be needed.

The loaning conditions and the government financial support are fixed in the same amount to all the projects but, each project has different water charges. But, the water charge for every project is within the acceptable range at below eight Baht per cubic meter.

NSD Code No.	NSD Name	Water Charge (฿/m^3)	Cumulated Deficit Year	Financial Rate of Return
5	Kham Sakae Sang	8	14	7.3
6	Nong Bua Lai	7	14	7.7
7	Huai Thalaeng	7	14	7.3
8	Nong Ki	5	12	8.6
10	Huai Rat	7	14	7.6
12	Khun Han	6	15	7.3
13	Kusuman	6	14	7.4
17	Phon Charoen	7	14	7.3
18	Nong Song Hong	6	15	6.5
20	Huai Kha Yung	8	15	7.0

(2) Sensitivity analysis

Sensitivity analysis has been made with the parameters of an increase in construction cost, reduction in water service and charge collection, and combinations of these parameters.

Referring to existing project areas, the case of the combination of reduction in water service and charge collection is considered to be prone to occur. (See sensitivity test No.6, Table F-3-6, APPENDIX F). In addition to the above, if operation and maintenance would be insufficient, cumulated deficit years would increase about 13 years and FIRR would fall by 3.5 percent, respectively.

Table 8-2-1 Financial Indicator of the Project (1)

No.	Water Charge (฿/m³)	1. NSD-5 Kham Sakae Sang Cumulated Deficit Years	FIRR	2. NSD-6 Nong Bua Lai Cumulated Deficit Years	FIRR	3. NSD-7 Huai Thalaeng Cumulated Deficit Years	FIRR	4. NSD-8 Nong Ki Cumulated Deficit Years	FIRR	5. NSD-10 Huai Rat Cumulated Deficit Years	FIRR
Case 1											
1-1	4	-	-	-	-	-	-	21	3.1	-	-
1-2	5	-	-	-	-	-	-	9	6.2	-	-
1-3	6	36	0.9	19	3.1	19	2.9	5	8.7	22	3.0
1-4	7	18	3.2	12	5.5	12	5.0	4	10.9	14	5.3
1-5	8	12	5.0	8	7.4	8	6.7	4	12.9	10	7.2
Case 2											
2-1	4	-	-	-	-	-	-	30	3.1	-	-
2-2	5	-	-	-	-	-	-	16	6.2	-	-
2-3	6	-	0.9	27	3.1	29	2.9	11	8.7	30	3.0
2-4	7	27	3.2	17	5.5	19	5.0	8	10.9	19	5.3
2-5	8	19	5.0	13	7.4	14	6.7	6	12.9	14	7.2
Case 3											
3-1	4	-	-	-	-	-	-	15	5.1	-	-
3-2	5	-	-	35	1.5	33	1.7	6	8.6	39	1.5
3-3	6	27	2.7	15	5.1	15	4.9	4	11.5	17	5.0
3-4	7	14	5.2	9	7.7	9	7.3	3	14.1	11	7.6
3-5	8	8	7.3	5	9.9	5	9.2	3	16.6	8	9.8
Case 4	( ) Proto-Type)										
4-1	4	-	-	-	-	-	-	22	5.1	-	-
4-2	5	-	-	-	1.5	-	1.7	12	8.6	-	1.5
4-3	6	36	2.7	20	5.1	21	4.9	8	11.5	21	5.0
4-4	7	20	5.2	14	7.7	14	7.3	5	14.1	14	7.6
4-5	8	14	7.3	10	9.9	11	9.2	4	16.6	10	9.8
Case 5											
5-1	4	-	-	-	-	-	-	26	5.1	-	-
5-2	5	-	-	-	1.5	-	1.7	15	8.6	-	1.5
5-3	6	39	2.7	24	5.1	25	4.9	10	11.5	26	5.0
5-4	7	24	5.2	17	7.7	18	7.3	7	14.1	18	7.6
5-5	8	17	7.3	13	9.9	14	9.2	5	16.6	14	9.8
Case 6 (included the cost of house connection)											
6-1	4	-	-	-	-	-	-	31	2.9	-	-
6-2	5	-	-	-	0.1	-	0.6	16	6.0	-	-
6-3	6	-	1.4	26	3.7	27	3.7	11	8.6	29	2.9
6-4	7	25	3.8	17	6.1	18	5.9	7	10.8	18	5.3
6-5	8	17	5.7	13	8.2	14	7.8	5	12.9	13	7.2

Table 8-2-1 Financial Indicator of the Project (2)

No.	Water Charge (฿/m³)	6. NSD-12 Khun Han Cumulated Deficit Years	6. NSD-12 Khun Han FIRR	7. NSD-13 Kusuman Cumulated Deficit Years	7. NSD-13 Kusuman FIRR	8. NSD-17 Phon Charoen Cumulated Deficit Years	8. NSD-17 Phon Charoen FIRR	9. NSD-18 Hong Song Hong Cumulated Deficit Years	9. NSD-18 Hong Song Hong FIRR	10. NSD-20 Huai Kha Yung Cumulated Deficit Years	10. NSD-20 Huai Kha Yung FIRR
Case 1											
1-1	4	-	-	-	-	-	-	-	-	-	-
1-2	5	22	2.5	23	2.5	-	0.2	23	1.8	-	-
1-3	6	13	5.1	12	5.1	22	3.0	13	4.2	-	0.5
1-4	7	9	7.2	7	7.2	12	5.1	7	6.1	20	2.9
1-5	8	6	9.0	5	9.0	7	6.9	5	7.8	13	4.8
Case 2											
2-1	4	-	-	-	-	-	-	-	-	-	-
2-2	5	31	2.5	33	2.5	-	0.2	35	1.8	-	-
2-3	6	19	5.1	19	5.1	32	3.0	21	4.2	-	0.5
2-4	7	14	7.2	13	7.2	19	5.1	15	6.1	30	2.9
2-5	8	12	9.0	10	9.0	14	6.9	12	7.8	20	4.8
Case 3											
3-1	4	-	-	-	0.3	-	-	-	-	-	-
3-2	5	18	4.4	17	4.5	-	1.9	16	3.9	-	-
3-3	6	11	7.3	8	7.4	15	4.9	8	6.9	32	2.2
3-4	7	7	9.7	5	9.8	7	7.3	5	8.7	15	4.9
3-5	8	5	11.8	4	11.9	4	9.4	4	10.6	10	7.0
Case 4	(→ Proto-type)										
4-1	4	-	-	-	0.3	-	-	-	-	-	-
4-2	5	23	4.4	24	4.5	-	1.9	25	3.9	-	-
4-3	6	15	7.3	14	7.4	23	4.9	15	6.5	-	2.2
4-4	7	11	9.7	10	9.8	14	7.3	11	8.7	22	4.9
4-5	8	9	11.8	7	11.9	10	9.4	8	10.6	15	7.0
Case 5											
5-1	4	-	-	-	0.3	-	-	-	-	-	-
5-2	5	27	4.4	28	4.5	-	1.9	29	3.9	-	-
5-3	6	18	7.3	18	7.4	27	4.9	19	6.5	-	2.2
5-4	7	14	9.7	13	9.8	18	7.3	14	8.7	26	4.9
5-5	8	11	11.8	10	11.9	13	9.4	11	10.6	19	7.0
Case 6 (included the cost of house connection)											
6-1	4	-	-	-	-	-	-	-	-	-	-
6-2	5	31	2.7	33	2.5	-	0.6	30	2.8	-	-
6-3	6	19	5.4	18	5.1	29	3.5	17	5.4	-	0.9
6-4	7	14	7.5	13	7.2	17	5.7	12	7.4	27	3.5
6-5	8	12	9.4	9	9.1	12	7.6	9	9.2	18	5.5

Calculation Condition:

	Local Burden in Local Currency(%)	Government subsidy(%) F.C.	Government subsidy(%) L.C.	Loan Condition: Foreign Currency Interest (%)	Foreign Currency Grace Period (years)	Foreign Currency Repayment Period (years)	Local Currency Interest (%)	Local Currency Grace Period (years)	Local Currency Repayment Period (years)
Case 1	20	0	0	4	10	30	4	1	10
Case 2	20	0	0	4	10	30	14	1	10
Case 3	20	25	25	4	10	30	4	1	10
Case 4	20	25	25	4	10	30	14	1	10
Case 5	20	25	25	8	5	20	14	1	10
Case 6	20	25	25	4	10	30	14	1	10

Table 8-2-2 Statement of Income and Expenditure
Project: Kham Sakae Sang (5)

(Unit: 000 Baht)

	Year	Income from Water Supply (1)	Expenditure: Business Expenses: Operation and Maintenance (2)	Expenditure: Business Expenses: Depreciation Reserve (3)	Expenditure: Repayment Interest: Loan (4)	Expenditure: Repayment Interest: Floating Debt (5)	Expenditure: Total (6)	Profit and Loss (7)	The Sum of Profit and Loss (8)
1	1985	0.	0.	0.	0.	0.	0.	0.	0.
2	1986	0.	0.	0.	7.	0.	7.	-7.	-7.
3	1987	0.	0.	0.	46.	0.	46.	-46.	-53.
4	1988	0.	0.	0.	317.	0.	317.	-317.	-371.
5	1989	528.	353.	0.	599.	0.	952.	-424.	-794.
6	1990	1,090.	496.	303.	611.	0.	1,411.	-321.	-1,115.
7	1991	1,133.	507.	303.	564.	0.	1,374.	-241.	-1,356.
8	1992	1,176.	518.	303.	516.	0.	1,338.	-162.	-1,517.
9	1993	1,219.	529.	303.	469.	0.	1,302.	-82.	-1,600.
10	1994	1,263.	540.	303.	422.	0.	1,265.	-3.	-1,602.
11	1995	1,306.	551.	303.	374.	0.	1,229.	77.	-1,526.
12	1996	1,359.	565.	303.	325.	0.	1,194.	166.	-1,360.
13	1997	1,413.	579.	303.	272.	0.	1,154.	259.	-1,101.
14	1998	1,467.	592.	303.	220.	0.	1,116.	351.	-750.
15	1999	1,521.	606.	303.	181.	0.	1,090.	430.	-320.
16	2000	1,575.	620.	303.	169.	0.	1,092.	483.	163.
17	2001	1,575.	620.	303.	162.	0.	1,085.	489.	652.
18	2002	1,575.	620.	303.	156.	0.	1,079.	496.	1,148.
19	2003	1,575.	620.	303.	149.	0.	1,072.	502.	1,650.
20	2004	1,575.	620.	303.	143.	0.	1,066.	509.	2,159.
21	2005	1,575.	620.	303.	136.	0.	1,059.	515.	2,674.
22	2006	1,575.	620.	303.	129.	0.	1,053.	522.	3,196.
23	2007	1,575.	620.	303.	123.	0.	1,046.	528.	3,724.
24	2008	1,575.	620.	303.	116.	0.	1,040.	535.	4,259.
25	2009	1,575.	620.	303.	110.	0.	1,033.	542.	4,801.
26	2010	1,575.	620.	303.	103.	0.	1,026.	548.	5,349.
27	2011	1,575.	620.	303.	97.	0.	1,020.	555.	5,904.
28	2012	1,575.	620.	303.	90.	0.	1,013.	561.	6,465.
29	2013	1,575.	620.	303.	84.	0.	1,007.	568.	7,033.
30	2014	1,575.	620.	303.	77.	0.	1,000.	574.	7,607.
31	2015	1,575.	620.	303.	70.	0.	994.	581.	8,188.
32	2016	1,575.	620.	303.	64.	0.	987.	587.	8,775.
33	2017	1,575.	620.	303.	57.	0.	981.	594.	9,369.
34	2018	1,575.	620.	303.	51.	0.	974.	601.	9,970.
35	2019	1,575.	620.	303.	44.	0.	967.	607.	10,577.
36	2020	1,575.	620.	303.	38.	0.	961.	614.	11,190.
37	2021	1,575.	620.	303.	31.	0.	954.	620.	11,810.
38	2022	1,575.	620.	303.	25.	0.	948.	627.	12,437.
39	2023	1,575.	620.	303.	18.	0.	941.	633.	13,070.
40	2024	1,575.	620.	303.	11.	0.	935.	640.	13,710.
41	2025	1,575.	620.	303.	5.	0.	928.	646.	14,357.
42	2026	1,575.	620.	303.	0.	0.	923.	651.	15,008.
	Total	55,988.	22,572.	11,226.	7,182.	0.	40,980.	15,008.	

A. Calculation Condition:

1. Local burden of the construction cost (local currency) 20%
2. Government subsidy of the construction cost 25%
3. Loan condition

	(Interest)	(Grace Period)	(Repayment Period)
- Foreign currency	4%	10 years	30 years
- Local currency	14%	1 year	10 years

B. Financial Indicators:

1. Cumulated deficit years ..... 14 years
2. Break-even point ..... 1999 - 2000
3. Financial Internal Rate of Return (FIRR) 7.3%
4. Water charge ..... 8.0 ฿/m^3

Table 8-2-3 Statement of Income and Expenditure
Project: Nong Bua Lai (6)

(Unit: 000 Baht)

Year		Income from Water Supply (1)	Expenditure: Business Expenses: Operation and Maintenance (2)	Expenditure: Business Expenses: Depreciation Reserve (3)	Expenditure: Repayment Interest: Loan (4)	Expenditure: Repayment Interest: Floating Debt (5)	Expenditure: Total (6)	Profit and Loss (7)	The Sum of Profit and Loss (8)
1	1985	0.	0.	0.	0.	0.	0.	0.	0.
2	1986	0.	0.	0.	4.	0.	4.	-4.	-4.
3	1987	0.	0.	0.	23.	0.	23.	-23.	-27.
4	1988	0.	0.	0.	171.	0.	171.	-171.	-198.
5	1989	326.	274.	0.	332.	0.	607.	-281.	-478.
6	1990	676.	352.	175.	343.	0.	871.	-195.	-674.
7	1991	706.	359.	175.	317.	0.	851.	-145.	-819.
8	1992	737.	366.	175.	291.	0.	832.	-95.	-914.
9	1993	768.	373.	175.	264.	0.	812.	-45.	-958.
10	1994	798.	380.	175.	238.	0.	793.	6.	-953.
11	1995	829.	387.	175.	211.	0.	773.	56.	-897.
12	1996	868.	396.	175.	184.	0.	754.	114.	-783.
13	1997	907.	404.	175.	154.	0.	733.	174.	-609.
14	1998	946.	413.	175.	125.	0.	713.	234.	-375.
15	1999	986.	422.	175.	102.	0.	699.	287.	-88.
16	2000	1,025.	430.	175.	95.	0.	700.	324.	236.
17	2001	1,025.	430.	175.	91.	0.	697.	328.	564.
18	2002	1,025.	430.	175.	87.	0.	693.	332.	895.
19	2003	1,025.	430.	175.	84.	0.	689.	335.	1,231.
20	2004	1,025.	430.	175.	80.	0.	686.	339.	1,570.
21	2005	1,025.	430.	175.	76.	0.	682.	343.	1,912.
22	2006	1,025.	430.	175.	73.	0.	678.	346.	2,259.
23	2007	1,025.	430.	175.	69.	0.	675.	350.	2,609.
24	2008	1,025.	430.	175.	65.	0.	671.	354.	2,962.
25	2009	1,025.	430.	175.	62.	0.	667.	357.	3,320.
26	2010	1,025.	430.	175.	58.	0.	664.	361.	3,681.
27	2011	1,025.	430.	175.	54.	0.	660.	365.	4,045.
28	2012	1,025.	430.	175.	51.	0.	656.	368.	4,414.
29	2013	1,025.	430.	175.	47.	0.	653.	372.	4,786.
30	2014	1,025.	430.	175.	43.	0.	649.	376.	5,162.
31	2015	1,025.	430.	175.	40.	0.	645.	379.	5,541.
32	2016	1,025.	430.	175.	36.	0.	642.	383.	5,924.
33	2017	1,025.	430.	175.	32.	0.	638.	387.	6,311.
34	2018	1,025.	430.	175.	29.	0.	634.	391.	6,702.
35	2019	1,025.	430.	175.	25.	0.	631.	394.	7,096.
36	2020	1,025.	430.	175.	21.	0.	627.	398.	7,494.
37	2021	1,025.	430.	175.	17.	0.	623.	402.	7,895.
38	2022	1,025.	430.	175.	14.	0.	619.	405.	8,301.
39	2023	1,025.	430.	175.	10.	0.	616.	409.	8,710.
40	2024	1,025.	430.	175.	6.	0.	612.	413.	9,122.
41	2025	1,025.	430.	175.	3.	0.	608.	416.	9,538.
42	2026	1,025.	430.	175.	0.	0.	606.	419.	9,958.
	Total	36,215.	15,749.	6,481.	4,027.	0.	26,257.	9,958.	

A. Calculation Condition:

1. Local burden of the construction cost (local currency) 20%
2. Government subsidy of the construction cost 25%
3. Loan condition

	(Interest)	(Grace Period)	(Repayment Period)
- Foreign currency	4%	10 years	30 years
- Local currency	14%	1 year	10 years

B. Financial Indicators:

1. Cumulated deficit years ..... 14 years
2. Break-even point ..... 1999 - 2000
3. Financial Internal Rate of Return (FIRR) 7.7%
4. Water charge ..... 7.0 ฿/m^3

Table 8-2-4 Statement of Income and Expenditure
Project: Huai Thalaeng (7)

(Unit: 000 Baht)

Year		Income from Water Supply (1)	Expenditure: Business Expenses: Operation and Maintenance (2)	Expenditure: Business Expenses: Depreciation Reserve (3)	Expenditure: Repayment Interest: Loan (4)	Expenditure: Repayment Interest: Floating Debt (5)	Expenditure: Total (6)	Profit and Loss (7)	The Sum of Profit and Loss (8)
1	1985	0.	0.	0.	0.	0.	0.	0.	0.
2	1986	0.	0.	0.	15.	0.	15.	-15.	-15.
3	1987	0.	0.	0.	93.	0.	93.	-93.	-108.
4	1988	0.	0.	0.	649.	0.	649.	-649.	-757.
5	1989	954.	549.	0.	1,193.	0.	1,743.	-789.	-1,546.
6	1990	1,981.	834.	618.	1,188.	0.	2,640.	-659.	-2,205.
7	1991	2,075.	860.	618.	1,097.	0.	2,575.	-500.	-2,704.
8	1992	2,170.	887.	618.	1,006.	0.	2,510.	-340.	-3,044.
9	1993	2,265.	913.	618.	915.	0.	2,446.	-181.	-3,225.
10	1994	2,360.	939.	618.	824.	0.	2,381.	-21.	-3,246.
11	1995	2,455.	965.	618.	733.	0.	2,317.	138.	-3,108.
12	1996	2,576.	999.	618.	639.	0.	2,256.	320.	-2,788.
13	1997	2,698.	1,033.	618.	536.	0.	2,187.	512.	-2,276.
14	1998	2,820.	1,067.	618.	436.	0.	2,121.	699.	-1,577.
15	1999	2,941.	1,100.	618.	361.	0.	2,079.	862.	-715.
16	2000	3,063.	1,134.	618.	339.	0.	2,091.	972.	257.
17	2001	3,063.	1,134.	618.	326.	0.	2,078.	985.	1,242.
18	2002	3,063.	1,134.	618.	313.	0.	2,065.	998.	2,240.
19	2003	3,063.	1,134.	618.	300.	0.	2,052.	1,011.	3,251.
20	2004	3,063.	1,134.	618.	287.	0.	2,038.	1,024.	4,275.
21	2005	3,063.	1,134.	618.	273.	0.	2,025.	1,038.	5,313.
22	2006	3,063.	1,134.	618.	260.	0.	2,012.	1,051.	6,363.
23	2007	3,063.	1,134.	618.	247.	0.	1,999.	1,064.	7,427.
24	2008	3,063.	1,134.	618.	234.	0.	1,986.	1,077.	8,504.
25	2009	3,063.	1,134.	618.	221.	0.	1,973.	1,090.	9,595.
26	2010	3,063.	1,134.	618.	208.	0.	1,959.	1,103.	10,698.
27	2011	3,063.	1,134.	618.	194.	0.	1,946.	1,117.	11,815.
28	2012	3,063.	1,134.	618.	181.	0.	1,933.	1,130.	12,944.
29	2013	3,063.	1,134.	618.	168.	0.	1,920.	1,143.	14,087.
30	2014	3,063.	1,134.	618.	155.	0.	1,907.	1,156.	15,243.
31	2015	3,063.	1,134.	618.	142.	0.	1,894.	1,169.	16,413.
32	2016	3,063.	1,134.	618.	128.	0.	1,880.	1,182.	17,595.
33	2017	3,063.	1,134.	618.	115.	0.	1,867.	1,196.	18,791.
34	2018	3,063.	1,134.	618.	102.	0.	1,854.	1,209.	20,000.
35	2019	3,063.	1,134.	618.	89.	0.	1,841.	1,222.	21,222.
36	2020	3,063.	1,134.	618.	76.	0.	1,828.	1,235.	22,457.
37	2021	3,063.	1,134.	618.	63.	0.	1,815.	1,248.	23,705.
38	2022	3,063.	1,134.	618.	49.	0.	1,801.	1,262.	24,966.
39	2023	3,063.	1,134.	618.	36.	0.	1,788.	1,275.	26,241.
40	2024	3,063.	1,134.	618.	23.	0.	1,775.	1,288.	27,529.
41	2025	3,063.	1,134.	618.	10.	0.	1,762.	1,301.	28,830.
42	2026	3,063.	1,134.	618.	0.	0.	1,752.	1,311.	30,141.
	Total	107,992.	40,766.	22,862.	14,223.	0.	77,851.	30,141.	

A. Calculation Condition:

1. Local burden of the construction cost (local currency) 20%
2. Government subsidy of the construction cost 25%
3. Loan condition

	(Interest)	(Grace Period)	(Repayment Period)
- Foreign currency	4%	10 years	30 years
- Local currency	14%	1 year	10 years

B. Financial Indicators:

1. Cumulated deficit years ..... 14 years
2. Break-even point ..... 1999 - 2000
3. Financial Internal Rate of Return (FIRR) 7.3%
4. Water charge ..... 7.0 ฿/m^3

Table 8-2-5 Statement of Income and Expenditure
Project: Nong Ki (8)

(Unit: 000 Baht)

Year		Income from Water Supply (1)	Expenditure: Business Expenses: Operation and Maintenance (2)	Expenditure: Business Expenses: Depreciation Reserve (3)	Expenditure: Repayment Interest: Loan (4)	Expenditure: Repayment Interest: Floating Debt (5)	Expenditure: Total (6)	Profit and Loss (7)	The Sum of Profit and Loss (8)
1	1985	0.	0.	0.	0.	0.	0.	0.	0.
2	1986	0.	0.	0.	12.	0.	12.	-12.	-12.
3	1987	0.	0.	0.	57.	0.	57.	-57.	-69.
4	1988	0.	0.	0.	435.	0.	435.	-435.	-503.
5	1989	908.	542.	0.	889.	0.	1,431.	-524.	-1,027.
6	1990	1,877.	834.	473.	957.	0.	2,264.	-387.	-1,414.
7	1991	1,956.	857.	473.	885.	0.	2,215.	-259.	-1,673.
8	1992	2,035.	881.	473.	812.	0.	2,166.	-131.	-1,804.
9	1993	2,114.	905.	473.	739.	0.	2,116.	-3.	-1,806.
10	1994	2,193.	929.	473.	666.	0.	2,067.	126.	-1,681.
11	1995	2,272	952.	473.	593.	0.	2,018.	254.	-1,427.
12	1996	2,372.	982.	473.	517.	0.	1,973.	399.	-1,028.
13	1997	2,471.	1,012.	473.	435.	0.	1,920.	551.	-476.
14	1998	2,571.	1,042.	473.	354.	0.	1,869.	701.	225.
15	1999	2,670.	1,072.	473.	290.	0.	1,835.	835.	1,060.
16	2000	2,770.	1,102.	473.	266.	0.	1,840.	929.	1,989.
17	2001	2,770.	1,102.	473.	255.	0.	1,830.	940.	2,929.
18	2002	2,770.	1,102.	473.	245.	0.	1,820.	950.	3,879.
19	2003	2,770.	1,102.	473.	235.	0.	1,809.	960.	4,839.
20	2004	2,770.	1,102.	473.	224.	0.	1,799.	970.	5,809.
21	2005	2,770.	1,102.	473.	214.	0.	1,789.	981.	6,790.
22	2006	2,770.	1,102.	473.	204.	0.	1,779.	991.	7,781.
23	2007	2,770.	1,102.	473.	193.	0.	1,768.	1,001.	8,782.
24	2008	2,770	1,102.	473.	183.	0.	1,758.	1,012.	9,794.
25	2009	2,770.	1,102.	473.	173.	0.	1,748.	1,022.	10,816.
26	2010	2,770.	1,102.	473.	162.	0.	1,737.	1,032.	11,849.
27	2011	2,770.	1,102.	473.	152.	0.	1,727.	1,043.	12,891.
28	2012	2,770.	1,102.	473.	142.	0.	1,717.	1,053.	13,944.
29	2012	2,770.	1,102.	473.	132.	0.	1,706.	1,063.	15,008.
30	2014	2,770.	1,102.	473.	121.	0.	1,696.	1,074.	16,081.
31	2015	2,770.	1,102.	473.	111.	0.	1,686.	1,084.	17,165.
32	2016	2,770.	1,102.	473.	101.	0.	1,675.	1,094.	18,259.
33	2017	2,770.	1,102.	473.	90.	0.	1,665.	1,105.	19,364.
34	2018	2,770.	1,102.	473.	80.	0.	1,655.	1,115.	20,479.
35	2019	2,770.	1,102.	473.	70.	0.	1,644.	1,125.	21,604.
36	2020	2,770.	1,102.	473.	59.	0.	1,634.	1,136.	22,739.
37	2021	2,770.	1,102.	473.	49.	0.	1,624.	1,146.	23,885.
38	2022	2,770.	1,102.	473,	39.	0.	1,613.	1,156.	25,041.
39	2023	2,770.	1,102.	473.	28.	0.	1,603.	1,166.	26,208.
40	2024	2,770.	1,102.	473.	18.	0.	1,593.	1,177.	27,385.
41	2025	2,770.	1,102.	473.	8.	0.	1,583.	1,187.	28,572.
42	2026	2,770.	1,102.	473.	0.	0.	1,575.	1,195.	29,767.
43	2027	2,770.	1,102.	473.	0.	0.	1,575.	1,195.	30,961.
	Total	100,987.	40,860.	17,972.	11,194.	0.	70,026.	30,961.	

A. Calculation Condition:

1. Local burden of the construction cost (local currency) 20%
2. Government subsidy of the construction cost 25%
3. Loan condition

	(Interest)	(Grace Period)	(Repayment Period)
- Foreign currency	4%	10 years	30 years
- Local currency	14%	1 year	10 years

B. Financial Indicators:

1. Cumulated deficit years ..... 12 years
2. Break-even point ..... 1997 - 1998
3. Financial Internal Rate of Return (FIRR) 8.6%
4. Water charge ..... 5.0 ฿/m^3

Table 8-2-6 Statement of Income and Expenditure
Project: Huai Rat (10)

(Unit: 000 Baht)

Year		Income from Water Supply (1)	Expenditure: Business Expenses: Operation and Maintenance (2)	Expenditure: Business Expenses: Depreciation Reserve (3)	Expenditure: Repayment Interest: Loan (4)	Expenditure: Repayment Interest: Floating Debt (5)	Expenditure: Total (6)	Profit and Loss (7)	The Sum of Profit and Loss (8)
1	1985	0.	0.	0.	0.	0.	0.	0.	0.
2	1986	0.	0.	0.	5.	0.	5.	-5.	-5.
3	1987	0.	0.	0.	25.	0.	25.	-25.	-30.
4	1988	0.	0.	0.	190.	0.	190.	-190.	-220.
5	1989	368.	292.	0.	377.	0.	669.	-300.	-520.
6	1990	762.	386.	201.	396.	0.	983.	-221.	-741.
7	1991	795.	394.	201.	365.	0.	960.	-166.	-906.
8	1992	828.	402.	201.	335.	0.	938.	-110.	-1,016.
9	1993	860.	410.	201.	305.	0.	915.	-55.	-1,071.
10	1994	893.	417.	201.	274.	0.	892.	1.	-1,070.
11	1995	926.	425.	201.	244.	0.	870.	56.	-1,014.
12	1996	967.	435.	201.	212.	0.	848.	119.	-895.
13	1997	1,009.	445.	201.	178.	0.	824.	185.	-710.
14	1998	1,050.	455.	201.	144.	0.	800.	250.	-460.
15	1999	1,091.	465.	201.	118.	0.	783.	308.	-152.
16	2000	1,133.	474.	201.	109.	0.	784.	349.	197.
17	2001	1,133.	474.	201.	105.	0.	780.	353.	550.
18	2002	1,133.	474.	201.	100.	0.	776.	357.	907.
19	2003	1,133.	474.	201.	96.	0.	771.	361.	1,268.
20	2004	1,133.	474.	201.	92.	0.	767.	365.	1,633.
21	2005	1,133.	474.	201.	88.	0.	763.	370.	2,003.
22	2006	1,133.	474.	201.	83.	0.	759.	374.	2,377.
23	2007	1,133.	474.	201.	79.	0.	755.	378.	2,755.
24	2008	1,133.	474.	201.	75.	0.	750.	382.	3,137.
25	2009	1,133.	474.	201.	71.	0.	746.	387.	3,524.
26	2010	1,133.	474.	201.	67.	0.	742.	391.	3,915.
27	2011	1,133.	474.	201.	62.	0.	738.	395.	4,310.
28	2012	1,133.	474.	201.	58.	0.	733.	399.	4,709.
29	2013	1,133.	474.	201.	54.	0.	729.	403.	5,113.
30	2014	1,133.	474.	201.	50.	0.	725.	408.	5,520.
31	2015	1,133.	474.	201.	45.	0.	721.	412.	5,932.
32	2016	1,133.	474.	201.	41.	0.	717.	416.	6,348.
33	2017	1,133.	474.	201.	37.	0.	712.	420.	6,769.
34	2018	1,133.	474.	201.	33.	0.	708.	425.	7,193.
35	2019	1,133.	474.	201.	29.	0.	704.	429.	7,622.
36	2020	1,133.	474.	201.	24.	0.	700.	433.	8,055.
37	2021	1,133.	474.	201.	20.	0.	695.	437.	8,492.
38	2022	1,133.	474.	201.	16.	0.	691.	441.	8,934.
39	2023	1,133.	474.	201.	12.	0.	687.	446.	9,379.
40	2024	1,133.	474.	201.	7.	0.	683.	450.	9,829.
41	2025	1,133.	474.	201.	3.	0.	679.	454.	10,283.
42	2026	1,133.	474.	201.	0.	0.	675.	457.	10,741.
	Total	40,133.	17,336.	7,435.	4,621.	0.	29,392.	10,741.	

A. Calculation Condition:

1. Local burden of the construction cost (local currency) 20%
2. Government subsidy of the construction cost 25%
3. Loan condition

	(Interest)	(Grace Period)	(Repayment Period)
- Foreign currency	4%	10 years	30 years
- Local currency	14%	1 year	10 years

B. Financial Indicators:

1. Cumulated deficit years ..... 14 years
2. Break-even point ..... 1999 - 2000
3. Financial Internal Rate of Return (FIRR) 7.6%
4. Water charge ..... 7.0 ฿/m^3

Table 8-2-7 Statement of Income and Expenditure
Project: Khum Han (12)

(Unit: 000 Baht)

Year		Income from Water Supply (1)	Expenditure: Business Expenses: Operation and Maintenance (2)	Expenditure: Business Expenses: Depreciation Reserve (3)	Expenditure: Repayment Interest: Loan (4)	Expenditure: Repayment Interest: Floating Debt (5)	Expenditure: Total (6)	Profit and Loss (7)	The Sum of Profit and Loss (8)
1	1985	0.	0.	0.	0.	0.	0.	0.	0.
2	1986	0.	0.	0.	4.	0.	4.	-4.	-4.
3	1987	0.	0.	0.	21.	0.	21.	-21.	-26.
4	1988	0.	0.	0.	174.	0.	174.	-174.	-200.
5	1989	281.	255.	0.	340.	0.	595.	-314.	-514.
6	1990	589.	313.	180.	350.	0.	843.	-254.	-768.
7	1991	623.	320.	180.	323.	0.	822.	-199.	-967.
8	1992	658.	326.	180.	296.	0.	802.	-144.	-1,110.
9	1993	693.	333.	180.	269.	0.	782.	-89.	-1,199.
10	1994	728.	340.	180.	242.	0.	761.	-33.	-1,232.
11	1995	763.	346.	180.	215.	0.	741.	22.	-1,211.
12	1996	809.	355.	180.	187.	0.	722.	87.	-1,124.
13	1997	854.	364.	180.	157.	0.	700.	154.	-969.
14	1998	900.	372.	180.	127.	0.	679.	221.	-748.
15	1999	946.	381.	180.	104.	0.	665.	282.	-467.
16	2000	992.	390.	180.	97.	0.	666.	326.	-141.
17	2001	992.	390.	180.	93.	0.	662.	330.	189.
18	2002	992.	390.	180.	89.	0.	659.	333.	522.
19	2003	992.	390.	180.	86.	0.	655.	337.	859.
20	2004	992.	390.	180.	82.	0.	651.	341.	1,200.
21	2005	992.	390.	180.	78.	0.	647.	345.	1,545.
22	2006	992.	390.	180.	74.	0.	644.	348.	1,893.
23	2007	992.	390.	180.	70.	0.	640.	352.	2,246.
24	2008	992.	390.	180.	67.	0.	636.	356.	2,602.
25	2009	992.	390.	180.	63.	0.	632.	360.	2,961.
26	2010	992.	390.	180.	59.	0.	629.	363.	3,325.
27	2011	992.	390.	180.	55.	0.	625.	367.	3,692.
28	2012	992.	390.	180.	52.	0.	621.	371.	4,063.
29	2013	992.	390.	180.	48.	0.	617.	375.	4,438.
30	2014	992.	390.	180.	44.	0.	613.	379.	4,816.
31	2015	992.	390.	180.	40.	0.	610.	382.	5,199.
32	2016	992.	390.	180.	37.	0.	606.	386.	5,585.
33	2017	992.	390.	180.	33.	0.	602.	390.	5,974.
34	2018	992.	390.	180.	29.	0.	598.	394.	6,368.
35	2019	992.	390.	180.	25.	0.	595.	397.	6,765.
36	2020	992.	390.	180.	22.	0.	591.	401.	7,166.
37	2021	992.	390.	180.	18.	0.	587.	405.	7,571.
38	2022	992.	390.	180.	14.	0.	583.	409.	7,980.
39	2023	992.	390.	180.	10.	0.	580.	412.	8,392.
40	2024	992.	390.	180.	7.	0.	576.	416.	8,808.
41	2025	992.	390.	180.	3.	0.	572.	420.	9,228.
42	2026	992.	390.	180.	0.	0.	569.	423.	9,651.
	Total	34,629.	14,223.	6,651.	4,105.	0.	24,979.	9,651.	

A. Calculation Condition:

1. Local burden of the construction cost (local currency) 20%
2. Government subsidy of the construction cost 25%
3. Loan condition

	(Interest)	(Grace Period)	(Repayment Period)
- Foreign currency	4%	10 years	30 years
- Local currency	14%	1 year	10 years

B. Financial Indicators:

1. Cumulated deficit years ..... 15 years
2. Break-even point ..... 2000 - 2001
3. Financial Internal Rate of Return (FIRR) 7.3%
4. Water charge ..... 6.0 ฿/m^3

Table 8-2-8 Statement of Income and Expenditure
Project: Kusuman (13)

(Unit: 000 Baht)

Year		Income from Water Supply (1)	Expenditure: Business Expenses: Operation and Maintenance (2)	Expenditure: Business Expenses: Depreciation Reserve (3)	Expenditure: Repayment Interest: Loan (4)	Expenditure: Repayment Interest: Floating Debt (5)	Expenditure: Total (6)	Profit and Loss (7)	The Sum of Profit and Loss (8)
1	1985	0.	0.	0.	0.	0.	0.	0.	0.
2	1986	0.	0.	0.	6.	0.	6.	-6.	-6.
3	1987	0.	0.	0.	31.	0.	31.	-31.	-36.
4	1988	0.	0.	0.	227.	0.	227.	-227.	-263.
5	1989	424.	303.	0.	443.	0.	746.	-322.	-586.
6	1990	872.	403.	236.	461.	0.	1,100.	-228.	-813.
7	1991	903.	410.	236.	427.	0.	1,073.	-170.	-983.
8	1992	934.	416.	236.	393.	0.	1,045.	-111.	-1,094.
9	1993	964.	423.	236.	358.	0.	1,017.	-53.	-1,147.
10	1994	995.	430.	236.	324.	0.	990.	5.	-1,142.
11	1995	1,026.	437.	236.	289.	0.	962.	63.	-1,079.
12	1996	1,063.	445.	236.	254.	0.	935.	128.	-951.
13	1997	1,100.	453.	236.	214.	0.	904.	197.	-754.
14	1998	1,138.	462.	236.	176.	0.	874.	264.	-490.
15	1999	1,175.	470.	236.	146.	0.	852.	323.	-167.
16	2000	1,212.	478.	236.	136.	0.	850.	362.	195.
17	2001	1,212.	478.	236.	131.	0.	845.	368.	563.
18	2002	1,212.	478.	236.	125.	0.	840.	373.	935.
19	2003	1,212.	478.	236.	120.	0.	834.	378.	1,314.
20	2004	1,212.	478.	236.	115.	0.	829.	383.	1,697.
21	2005	1,212.	478.	236.	110.	0.	824.	389.	2,086.
22	2006	1,212.	478.	236.	104.	0.	818.	394.	2,480.
23	2007	1,212.	478.	236.	99.	0.	813.	399.	2,879.
24	2008	1,212.	478.	236.	94.	0.	808.	405.	3,284.
25	2009	1,212.	478.	236.	88.	0.	803.	410.	3,693.
26	2010	1,212.	478.	236.	83.	0.	797.	415.	4,108.
27	2011	1,212.	478.	236.	78.	0	792.	420.	4,529.
28	2012	1,212.	478.	236.	73.	0.	787.	426.	4,954.
29	2013	1,212.	478.	236.	67.	0.	782.	431.	5,385.
30	2014	1,212.	478.	236.	62.	0.	776.	436.	5,822.
31	2015	1,212.	478.	236.	57.	0.	771.	441.	6,263.
32	2016	1,212.	478.	236.	51.	0.	766.	447.	6,710.
33	2017	1,212.	478.	236.	46.	0.	760.	452.	7,162.
34	2018	1,212.	478.	236.	41.	0.	755.	457.	7,619.
35	2019	1,212.	478.	236.	36.	0.	750.	463.	8,082.
36	2020	1,212.	478.	236.	30.	0.	745.	468.	8,550.
37	2021	1,212.	478.	236.	25.	0.	739.	473.	9,023.
38	2022	1,212.	478.	236.	20.	0.	734.	478.	9,501.
39	2023	1,212.	478.	236.	15.	0.	729.	484.	9,985.
40	2024	1,212.	478.	236.	9.	0.	724.	489.	10,474.
41	2025	1,212.	478.	236.	4.	0.	718.	494.	10,968.
42	2026	1,212.	478.	236.	0.	0.	714.	498.	11,466.
	Total	43,330.	17,561.	8,736.	5,567.	0.	31,864.	11,466.	

A. Calculation Condition:

1. Local burden of the construction cost (local currency) 20%
2. Government subsidy of the construction cost 25%
3. Loan condition

	(Interest)	(Grace Period)	(Repayment Period)
- Foreign currency	4%	10 years	30 years
- Local currency	14%	1 year	10 years

B. Financial Indicators:

1. Cumulated deficit years ..... 14 years
2. Break-even point ..... 1999 - 2000
3. Financial Internal Rate of Return (FIRR) 7.4%
4. Water charge ..... 6.0 ฿/m^3

Table 8-2-9 Statement of Income and Expenditure
Project: Phon Charoen (17)

(Unit: 000 Baht)

Year		Income from Water Supply (1)	Expenditure: Business Expenses: Operation and Maintenance (2)	Expenditure: Business Expenses: Depreciation Reserve (3)	Expenditure: Repayment Interest: Loan (4)	Expenditure: Repayment Interest: Floating Debt (5)	Expenditure: Total (6)	Profit and Loss (7)	The Sum of Profit and Loss (8)
1	1985	0.	0.	0.	0.	0.	0.	0.	0.
2	1986	0.	0.	0.	11.	0.	11.	-11.	-11.
3	1987	0.	0.	0.	57.	0.	57.	-57.	-68.
4	1988	0.	0.	0.	479.	0.	479.	-479.	-547.
5	1989	898.	553.	0.	925.	0.	1,477.	-580.	-1,127.
6	1990	1,842.	852.	467.	936.	0.	2,255.	-413.	-1,540.
7	1991	1,897.	869.	467.	865.	0.	2,201.	-304.	-1,844.
8	1992	1,951.	886.	467.	794.	0.	2,147.	-196.	-2,040.
9	1993	2,006.	904.	467.	723.	0.	2,093.	-88.	-2,127.
10	1994	2,060.	921.	467.	652.	0.	2,039.	21.	-2,106.
11	1995	2,115.	938.	467.	581.	0.	1,986.	129.	-1,977.
12	1996	2,178.	958.	467.	507.	0.	1,932.	246.	-1,731.
13	1997	2,240.	978.	467.	426.	0.	1,870.	370.	-1,362.
14	1998	2,303.	998.	467.	347.	0.	1,812.	491.	-870.
15	1999	2,365.	1,017.	467.	286.	0.	1,770.	595.	-275.
16	2000	2,428.	1,037.	467.	267.	0.	1,771.	657.	382
17	2001	2,428.	1,037.	467.	257.	0.	1,761.	667.	1,049.
18	2002	2,428.	1,037.	467.	247.	0.	1,750.	678.	1,727.
19	2003	2,428.	1,037.	467.	236.	0.	1,740.	688.	2,415.
20	2004	2,428.	1,037.	467.	226.	0.	1,730.	698.	3,113.
21	2005	2,428.	1,037.	467.	215.	0.	1,719.	709.	3,822.
22	2006	2,428.	1,037.	467.	205.	0.	1,709.	719.	4,541.
23	2007	2,428.	1,037.	467.	195.	0.	1,698.	730.	5,271.
24	2008	2,428.	1,037.	467.	184.	0.	1,688.	740.	6,011.
25	2009	2,428.	1,037.	467.	174.	0.	1,678.	750.	6,761.
26	2010	2,428.	1,037.	467.	164.	0.	1,667.	761.	7,522.
27	2011	2,428.	1,037.	467.	153.	0.	1,657.	771.	8,293.
28	2012	2,428.	1,037.	467.	143.	0.	1,647.	781.	9,074.
29	2013	2,428.	1,037.	467.	132.	0.	1,636.	792.	9,866.
30	2014	2,428.	1,037.	467.	122.	0.	1,626.	802.	10,668.
31	2015	2,428.	1,037.	467.	112.	0.	1,615.	813.	11,481.
32	2016	2,428.	1,037.	467.	101.	0.	1,605.	823.	12,304.
33	2017	2,428.	1,037.	467.	91.	0.	1,595.	833.	13,137.
34	2018	2,428.	1,037.	467.	80.	0.	1,584.	844.	13,981.
35	2019	2,428.	1,037.	467.	70.	0.	1,574.	854.	14,835.
36	2020	2,428.	1,037.	467.	60.	0.	1,563.	864.	15,699.
37	2021	2,428.	1,037.	467.	49.	0.	1,553.	875.	16,574.
38	2022	2,428.	1,037.	467.	39.	0.	1,543.	885.	17,459.
39	2023	2,428.	1,037.	467.	29.	0.	1,532.	896.	18,355.
40	2024	2,428.	1,037.	467.	18.	0.	1,522.	906.	19,261.
41	2025	2,428.	1,037.	467.	8.	0.	1,512.	916.	20,178.
42	2026	2,428.	1,037.	467.	0.	0.	1,504.	924.	21,102.
43	2027	2,428.	1,037.	467.	0.	0.	1,504.	924.	22,026.
Total		89,838.	38,914.	17,732.	11,166.	0.	67,812.	22,026.	

A. Calculation Condition:

1. Local burden of the construction cost (local currency) 20%
2. Government subsidy of the construction cost 25%
3. Loan condition

	(Interest)	(Grace Period)	(Repayment Period)
- Foreign currency	4%	10 years	30 years
- Local currency	14%	1 year	10 years

B. Financial Indicators:

1. Cumulated deficit years ..... 14 years
2. Break-even point ..... 1999 - 2000
3. Financial Internal Rate of Return (FIRR) 7.3%
4. Water charge ..... 7.0 ฿/m^3

Table 8-2-10 Statement of Income and Expenditure
Project: Nong Song Hong (18)

(Unit: 000 Baht)

Year		Income from Water Supply (1)	Expenditure: Business Expenses: Operation and Maintenance (2)	Expenditure: Business Expenses: Depreciation Reserve (3)	Expenditure: Repayment Interest: Loan (4)	Expenditure: Repayment Interest: Floating Debt (5)	Expenditure: Total (6)	Profit and Loss (7)	The Sum of Profit and Loss (8)
1	1985	0.	0.	0.	0.	0.	0.	0.	0.
2	1986	0.	0.	0.	10.	0.	10.	-10.	-10.
3	1987	0.	0.	0.	67.	0.	67.	-67.	-77.
4	1988	0.	0.	0.	448.	0.	448.	-448.	-525.
5	1989	628.	335.	0	827.	0	1,161.	-534.	-1,059.
6	1990	1,289.	443.	433.	830.	0.	1,706.	-417.	-1,476.
7	1991	1,327.	449.	433.	766.	0.	1,648.	-321.	-1,797.
8	1992	1,365.	455.	433.	701.	0.	1,590.	-225.	-2,022.
9	1993	1,403.	462.	433.	637.	0.	1,531.	-128.	-2,150.
10	1994	1,441.	468.	433.	572.	0.	1,473.	-32.	-2,182.
11	1995	1,479.	474.	433.	508.	0.	1,415.	65.	-2,117.
12	1996	1,523.	481.	433.	441.	0.	1,355.	168.	-1,949.
13	1997	1,567.	488.	433.	368.	0.	1,289.	278.	-1,671.
14	1998	1,611.	496.	433.	298.	0.	1,226.	385.	-1,286.
15	1999	1,655.	503.	433.	245.	0.	1,180.	474.	-812.
16	2000	1,698.	510.	433.	229.	0.	1,172.	526.	-286.
17	2001	1,698.	510.	433.	220.	0.	1,163.	535.	250.
18	2002	1,698.	510.	433.	212.	0.	1,154.	544.	794.
19	2003	1,698.	510.	433.	203.	0.	1,145.	553.	1,347.
20	2004	1,698.	510.	433.	194.	0.	1,136.	562.	1,909.
21	2005	1,698.	510.	433.	185.	0.	1,128.	571.	2,480.
22	2006	1,698.	510.	433.	176.	0.	1,119.	580.	3,059.
23	2007	1,698.	510.	433.	167.	0.	1,110.	589.	3,648.
24	2008	1,698.	510.	433.	158.	0.	1,101.	598.	4,246.
25	2009	1,698.	510.	433.	149.	0.	1,092.	606.	4,852.
26	2010	1,698.	510.	433.	140.	0.	1,083.	615.	5,467.
27	2011	1,698.	510.	433.	131.	0.	1,074.	624.	6,092.
28	2012	1,698.	510.	433.	122.	0.	1,065.	633.	6,725.
29	2013	1,698.	510.	433.	114.	0.	1,056.	642.	7,367.
30	2014	1,698.	510.	433.	105.	0.	1,047.	651.	8,018.
31	2015	1,698.	510.	433.	96.	0.	1,038.	660.	8,678.
32	2016	1,698.	510.	433.	87.	0.	1,030.	669.	9,347.
33	2017	1,698.	510.	433.	78.	0.	1,021.	678.	10,025.
34	2018	1,698.	510.	433.	69.	0.	1,012.	687.	10,711.
35	2019	1,698.	510.	433.	60.	0.	1,003.	696.	11,407.
36	2020	1,698.	510.	433.	51.	0.	994.	704.	12,111.
37	2021	1,698.	510.	433.	42.	0.	985.	713.	12,825.
38	2022	1,698.	510.	433.	33.	0.	976.	722.	13,547.
39	2023	1,698.	510.	433.	24.	0.	967.	731.	14,278.
40	2024	1,698.	510.	433.	16.	0.	958.	740.	15,018.
41	2025	1,698.	510.	433.	7.	0.	949.	749.	15,767.
42	2026	1,698.	510.	0.	0.	0.	510.	1,189.	16,956.
	Total	61,145.	18,819.	15,583.	9,787.	0.	44,189.	16,956.	

A. Calculation Condition:

1. Local burden of the construction cost (local currency) 20%
2. Government subsidy of the construction cost 25%
3. Loan condition

	(Interest)	(Grace Period)	(Repayment Period)
- Foreign currency	4%	10 years	30 years
- Local currency	14%	1 year	10 years

B. Financial Indicators:

1. Cumulated deficit years ..... 15 years
2. Break-even point ..... 2000 - 2001
3. Financial Internal Rate of Return (FIRR) 6.5%
4. Water charge ..... 6.0 ฿/m^3

Table 8-2-11 Statement of Income and Expenditure
Project: Huai Kha Yung (20)

(Unit: 000 Baht)

Year	Income from Water Supply (1)	Expenditure: Business Expenses: Operation and Maintenance (2)	Expenditure: Business Expenses: Depreciation Reserve (3)	Expenditure: Repayment Interest: Loan (4)	Expenditure: Repayment Interest: Floating Debt (5)	Expenditure: Total (6)	Profit and Loss (7)	The Sum of Profit and Loss (8)
1 1985	0	0.	0.	0.	0.	0.	0.	0.
2 1986	0.	0.	0.	6.	0.	6.	-6.	-6.
3 1987	0.	0.	0.	33.	0.	33.	-33.	-39.
4 1988	0.	0.	0.	236.	0.	236.	-236.	-275.
5 1989	423.	315.	0.	470.	0.	785.	-362.	-637.
6 1990	874.	426.	250.	499.	0.	1,176.	-302.	-938.
7 1991	911.	435.	250.	461.	0.	1,146.	-236.	-1,174.
8 1992	948.	444.	250.	423.	0.	1,117.	-170	-1,344.
9 1993	984.	454.	250.	385.	0.	1,088.	-104.	-1,448.
10 1994	1,021.	463.	250.	346.	0.	1,059.	-38.	-1,486.
11 1995	1,058.	472.	250.	308.	0.	1,030.	28.	-1,459.
12 1996	1,104.	483.	250.	269.	0.	1,002.	102.	-1,357.
13 1997	1,151.	494.	250.	226.	0.	971.	180.	-1,177.
14 1998	1,197.	506.	250.	184.	0.	940.	257.	-920.
15 1999	1,243.	517.	250.	151.	0.	919.	325.	-595.
16 2000	1,290.	529.	250.	139.	0.	918.	372.	-224.
17 2001	1,290.	529.	250.	134.	0.	913.	377.	153.
18 2002	1,290.	529.	250.	128.	0.	907.	382.	536.
19 2003	1,290.	529.	250.	123.	0.	902.	388.	924.
20 2004	1,290.	529.	250.	117.	0.	897.	393.	1,317.
21 2005	1,290.	529.	250.	112.	0.	891.	399.	1,716.
22 2006	1,290.	529.	250.	107.	0.	886.	404.	2,120.
23 2007	1,290.	529.	250.	101.	0.	880.	409.	2,529.
24 2008	1,290.	529.	250.	96.	0.	875.	415.	2,944.
25 2009	1,290.	529.	250.	90.	0.	870.	420.	3,364.
26 2010	1,290.	529.	250.	85.	0.	864.	426.	3,790.
27 2011	1,290.	529.	250.	80.	0.	859.	431.	4,221.
28 2012	1,290.	529.	250.	74.	0.	853.	436.	4,657.
29 2013	1,290.	529.	250.	69.	0.	848.	442.	5,099.
30 2014	1,290.	529.	250.	63.	0.	843.	447.	5,546.
31 2015	1,290.	529.	250.	58.	0.	837.	453.	5,999.
32 2016	1,290.	529.	250.	53.	0.	832.	458.	6,457.
33 2017	1,290.	529.	250.	47.	0.	826.	463.	6,920
34 2018	1,290	529.	250.	42.	0.	821.	469.	7,389.
35 2019	1,290.	529.	250.	36.	0.	816.	474.	7,863.
36 2020	1,290.	529.	250.	31.	0.	810.	480.	8,343.
37 2021	1,290.	529.	250.	26.	0.	805.	485.	8,828.
38 2022	1,290.	529.	250.	20.	0.	799.	490.	9,318.
39 2023	1,290.	529.	250.	15.	0.	794.	496.	9,814.
40 2024	1,290.	529.	250.	9.	0.	789.	501.	10,315.
41 2025	1,290.	529.	250.	4.	0.	783.	507.	10,821.
42 2026	1,290.	529.	250.	0.	0.	779.	511.	11,332.
Total	45,737.	19,286.	9,264.	5,855.	0.	34,405.	11,332.	

A. Calculation Condition:

1. Local burden of the construction cost (local currency) 20%
2. Government subsidy of the construction cost 25%
3. Loan condition

	(Interest)	(Grace Period)	(Repayment Period)
- Foreign currency	4%	10 years	30 years
- Local currency	14%	1 year	10 years

B. Financial Indicators:

1. Cumulated deficit years ..... 15 years
2. Break-even point ..... 2000 - 2001
3. Financial Internal Rate of Return (FIRR) 7.0%
4. Water charge ..... 8.0 ฿/m^3

8.3. Socio-Economic Analysis

8.3.1. Project Economic Benefit and Cost

(1) Economic Benefits

From the national socio-economic point of view, various kinds of directly and or indirectly associated benefits would be created from the project. These benefits could be considered an additional value, to be generated through implementation of the project works. Among these benefits, the direct benefit in monetary terms of the water supply can be estimated on the basis of the cash expenditures for such equipment as jars, bicycle-drawn cart, and etc., and the saving of labor hours spent on bringing water for the beneficiaries between without and with project. Result of the cost estimate of without and with the project, these figures per cubic meter are 13.47 and ฿0.28 respectively. (Refer to the Table F-4-1 in Appendix F.)

(2) Economic Costs

The capital cost consist of foreign and local components, and the latter component is re-evaluated into the economic cost to warrant comparison with the economic benefit of the project. For the estimation of the project economic cost, the domestic cost of construction materials to be purchased in Thailand and the cost of common labor, are evaluated with the conversion factors. Similar evaluation has also been made with respect to the O & M cost. The conversion factors employed are those determined by the World Bank.

(3) Economic Internal Rate of Return

Based on comparison between the project economic cost and benefits, Economic Rate of Return totals from 6.8 to 12.9 percent by the NSDs. For the project is one of the social project that aims to enhance the living standard of beneficiaries, the above figures are considered reasonable in spite of low level.

NSD Code No.	NSD Name	Economic Rate of Return (%)
5	Kham Sakae Sang	6.9
6	Nong Bua Lai	9.4
7	Huai Thalaeng	8.7
8	Nong Ki	13.4
10	Huai Rat	8.4
12	Khun Han	10.3
13	Kusuman	9.9
17	Phon Charoen	8.6
18	Nong Song Hong	9.7
20	Huai Kha Yung	6.8

8.3.2. Socio-Economic Impacts

Besides the direct benefits in monetary terms mentioned above, the project will realize both the indirect and associated benefits and will exert various influences on the backward sanitary district societies. From the socio-economic stand point, the following benefits will be considered:

(1) Benefit at the Project Area Level

- The project will liberate the beneficiaries especially women and children from the cruel daily chore of bringing water through the establishment of a stable water supply.
- Through supplying safe water, the project will enable the beneficiaries to prevent the spread of water borne diseases. Moreover, this will improve the public health in the Sanitary Districts.
- With the project, the provided hydrant will be more conveniently utilized for fire fighting. Provision of hydrants will certainly save many lives and house belongings.

(2) Benefit at the National Level

- The project will improve the people's living standard by providing a safe and reliable water supply. Namely, the project is not only for promoting rural public welfare but also alleviating the disparity in the living standards between the regions.

CHAPTER IX. CONCLUSION AND RECOMMENDATIONS

CHAPTER IX. CONCLUSION AND RECOMMENDATIONS

9.1. Conclusion

The proposed waterworks plans of the respective Sanitary districts, in which the facilities consist of intake works, water transmission pipeline, water treatment plants and distribution works, are technically sound. The operation and maintenance of the facilities will also be technically facile and economically feasible.

The proposed water charge of 5.0 to 8.0 Baht per cu.m is theoretically acceptable and within the paying ability of the consumers concerned, if the proposed loan rates on the investment capital are four percent for foreign exchange components and 14 percent for local currency components, and if about 25 percent of the total investment cost could be subsidized by the Government.

When the above mentioned conditions and/or requirements could be realized amicably, the 6.0 to 8.0 percent FIRR (financial internal rate of return) is a standard level for the project in the water supply sector, and as such the project is primarily judged feasible. Moreover, critically important is the magnitude and dimension of the intangible benefit to be expected from the project, such as release from the sorrow of diseases and death as well as from the drudgery of daily water fetching.

NSD Code No.	NSD Name	Water Charge Proposed (1985 price) (฿/m^3)
5	Kham Sakae Sang	8
6	Nong Bua Lai	7
7	Huai Thalaeng	7
8	Nong Ki	5
10	Huai Rat	7
12	Khun Han	6
13	Kusuman	6
17	Phon Charoen	7
18	Nong Song Hong	6
20	Huai Kha Yung	8

9.2. Recommendations

(1) Technical Aspects

(a) Topographic surveys and geological investigations shall be undertaken prior to and/or during the detailed design stage.

(b) The allocation of stored water in respect to water consumption and the construction method to be used in heightening the dam top shall be discussed between project agencies and managing authorities concerned.

(c) Raw water sampling and testing for the proposed water sources shall be carried out continuously by the executing agency, until commencement of the project.

(d) The whole distribution networks as well as service pipes shall be planned in the entire subject area in due period so that beneficiaries can enjoy a sufficient supply of the treated water and the service rate could be promoted up to the target level.

(e) This feasibility report was prepared as a model study to be applicable to the establishment of a development plan for any sanitary district waterwork project. Therefore, effective utilization of the reports shall be made for preparation of feasibility reports for similar project.

(2) Financial and Institutional Aspects

(a) Project implementation agencies and leading agencies of the central government shall consider and establish the policies of the financial supports by government subsidies and loaning arrangements.

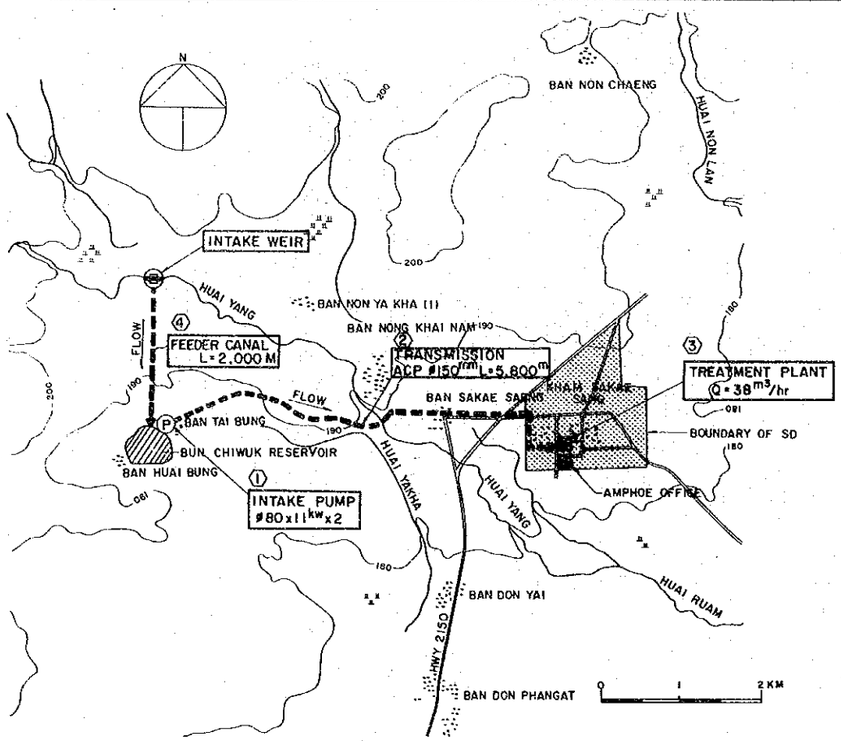
(b) The agencies of project executions shall discuss and confirm consumers' requirements, and have their consensus on the water supply, operation/maintenance, capital cost arrangement, water tariff, construction of service pipes, and so forth.

(c) Leading agencies of the central government shall prepare training programmes for O & M staffs to be assigned to do operation and maintenance works, including field repairing practices of the waterwork systems.

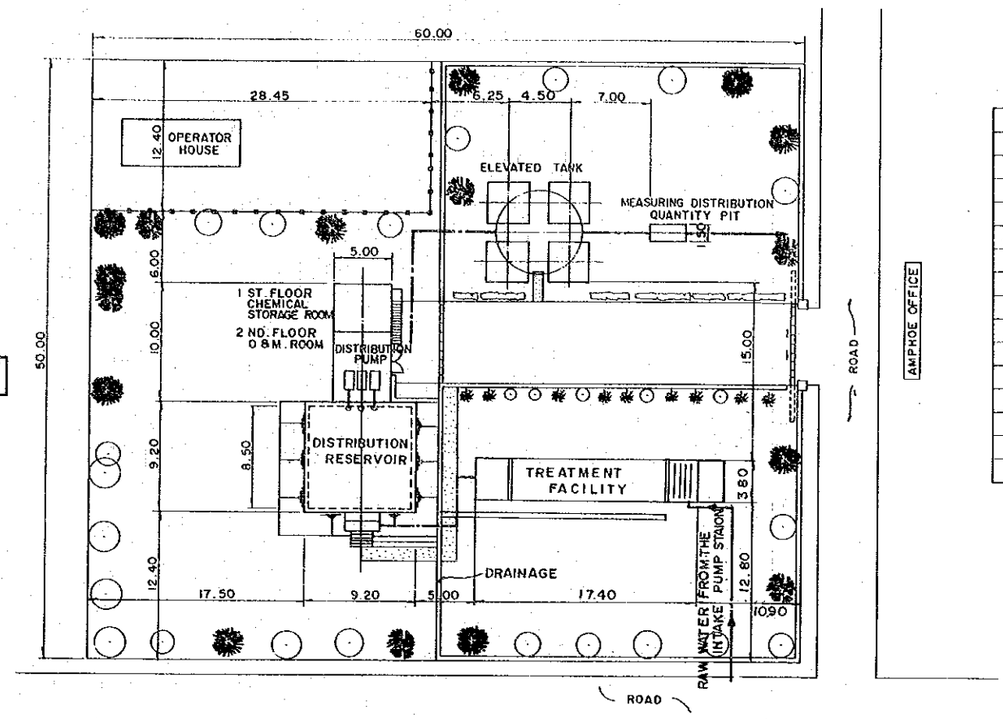
DRAWINGS

LIST OF DRAWING

No.	Name of Drawing		
1	Water Transmission and Treatment Plant	Kham Sakae Sang	(NSD-5)
2	- " -	Nong Bua Lai	(NSD-6)
3	- " -	Huai Thalaeng	(NSD-7)
4	- " -	Nong Ki	(NSD-8)
5	- " -	Huai Rat	(NSD-10)
6	- " -	Khun Han	(NSD-12)
7	- " -	Kasuman	(NSD-13)
8	- " -	Phon Charoen	(NSD-17)
9	- " -	Nong Song Hong	(NSD-18)
10	- " -	Huai Kha Yung	(NSD-20)
11	Installation Plan of Distribution Pipe	Kham Sakae Sang	(NSD-5)
12	- " -	Nong Bua Lai	(NSD-6)
13	- " -	Huai Thalaeng	(NSD-7)
14	- " -	Nong Ki	(NSD-8)
15	- " -	Huai Rat	(NSD-10)
16	- " -	Khun Han	(NSD-12)
17	- " -	Kusuman	(NSD-13)
18	- " -	Phon Charoen	(NSD-17)
19	- " -	Nong Song Hong	(NSD-18)
20	- " -	Huai Kha Yung	(NSD-20)
21	Typical Structure	Flow Diagram and Hydraulic Profile of Sand Filtration System	
22	- " -	Water Treatment Plant	
23	- " -	Distribution Reservoir and Elevated Tank	
24	- " -	Intake Pumping Station	
25	- " -	Typical Cross Section and Appurtenant Structures of Pipeline	



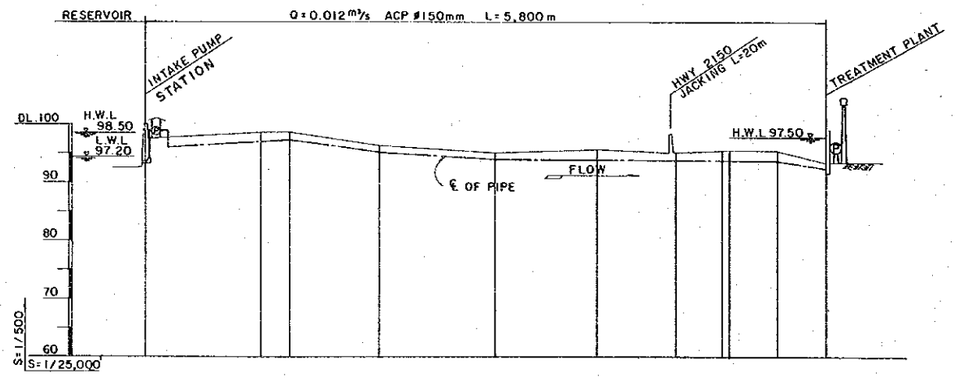
GENERAL PLAN



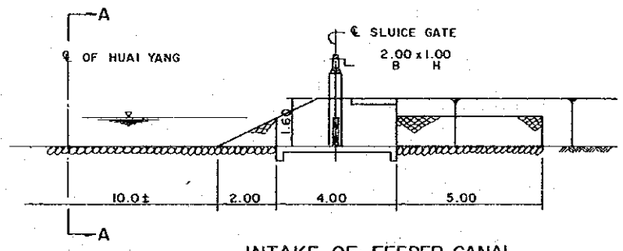
PLAN OF WATER TREATMENT PLANT

DIMENSION OF MAIN FACILITIES

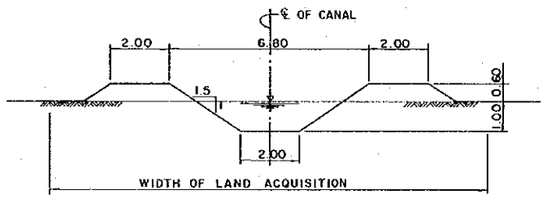
DESCRIPTION	DIMENSION
1. INTAKE	
DESIGN CAPACITY	0.012 cu.m/s
INTAKE PUMP TYPE	VOLUTE PUMP
(1 FOR STAND-BY)	ϕ80 x 11.0kw x 2
2. TRANSMISSION	ACP ϕ150 x 5,800m
3. TREATMENT PLANT	
DESIGN CAPACITY	38 cu.m/h
DISTRIBUTION RESERVOIR	250 cu.m
ELEVATED TANK	80 cu.m
DISTRIBUTION PUMP(1 STAND BY)	ϕ80 x 5.5kw x 3
4. OTHERS	
FEEDER CANAL	2,000 m
INTAKE WEIR	1 LS



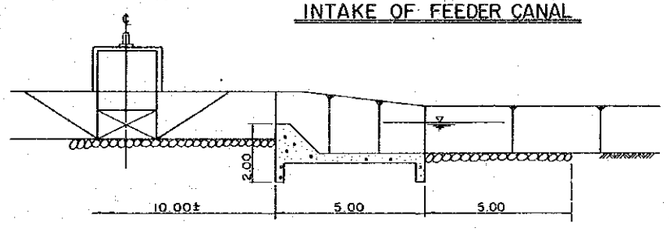
PROFILE OF WATER TRANSMISSION



INTAKE OF FEEDER CANAL



SECTION OF FEEDER CANAL



SECTION A-A

INTAKE WEIR AND FEERER CANAL

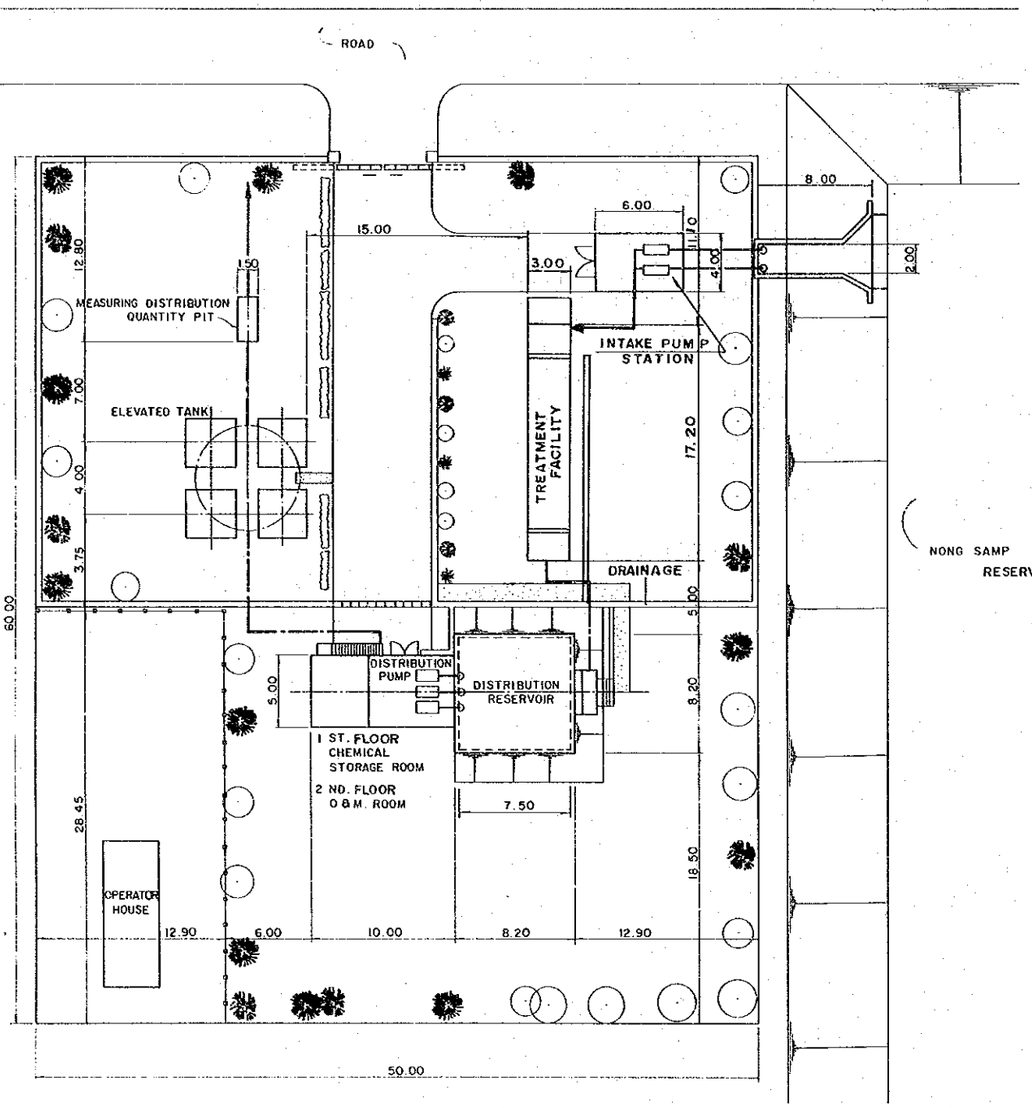
KINGDOM OF THAILAND MINISTRY OF INTERIOR
PUBLIC WORKS DEPARTMENT

THE SANITARY DISTRICT WATER WORKS PROJECT
IN THE NORTH EASTERN REGION OF THAILAND

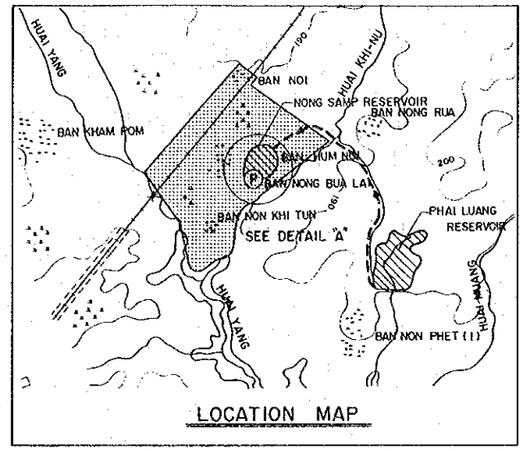
WATER TRANSMISSION AND WATER TREATMENT PLANT KHAM SAKAE SANG (NSD-5)

DATE | DWG 1

JAPAN INTERNATIONAL COOPERATION AGENCY



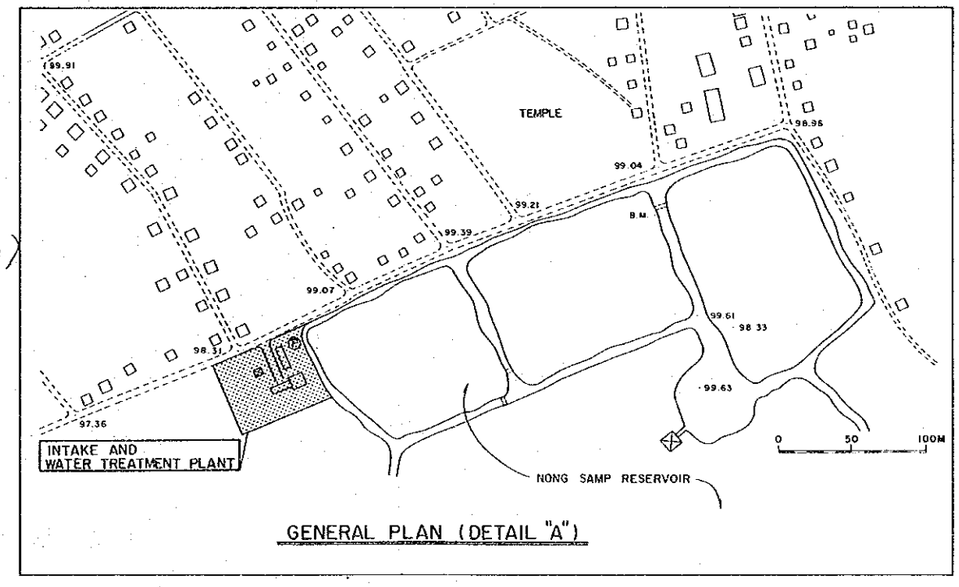
PLAN OF TREATMENT PLANT



LOCATION MAP

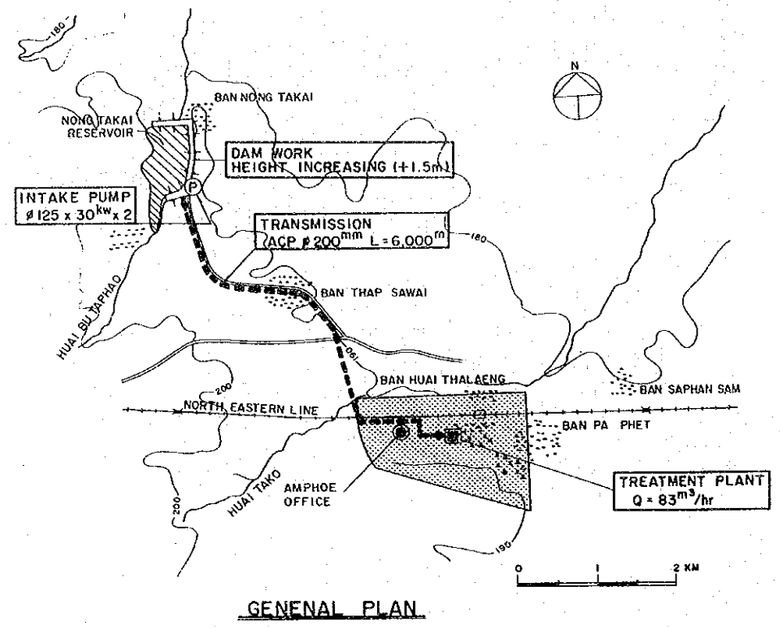
DIMENSION OF MAIN FACILITIES

DESCRIPITION	DIMENSION
1. INTAKE	
DESIGN CAPACITY	0.009 m^3/s
INTAKE PUMP	VOLUTE PUMP
(1 FOR STAND - BY)	ϕ80 x 2.2kw x 2
2. TRANSMISSION	—
3. TREATMENT PLANT	
DESIGN CAPACITY	28 cu.m/h
DISTRIBUTION RESERVOIR	200 cu.m
ELEVATED TANK	60 cu.m
DISTRIBUTION PUMP	ϕ65 x 3.7kw x 3
(1 FOR STAND - BY)	

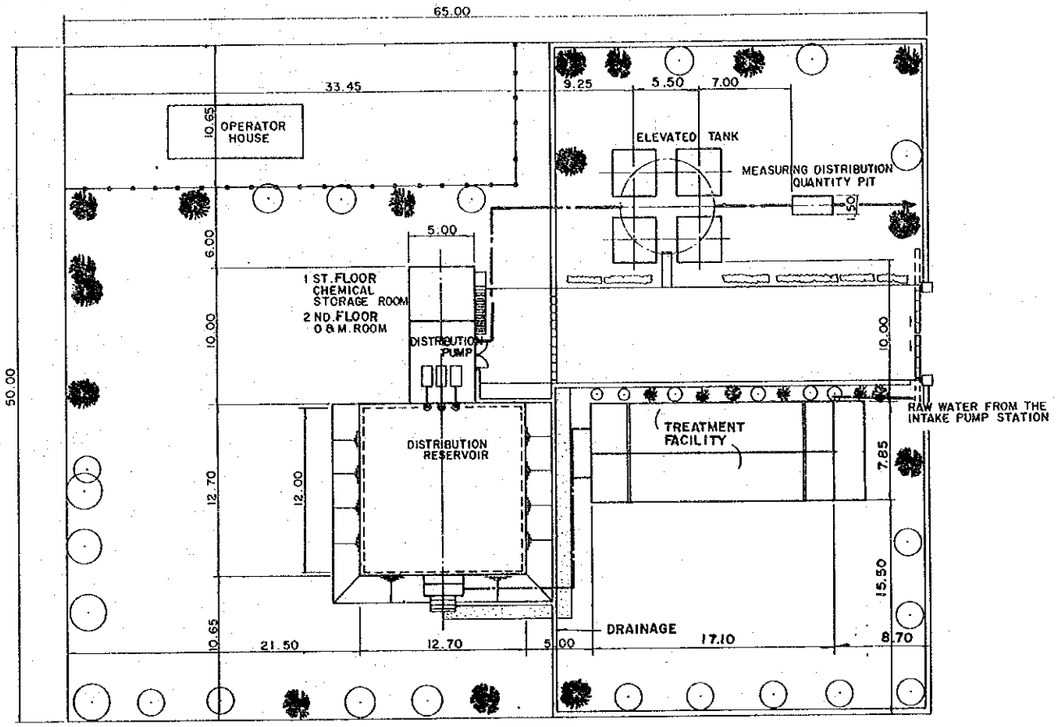


GENERAL PLAN (DETAIL "A")

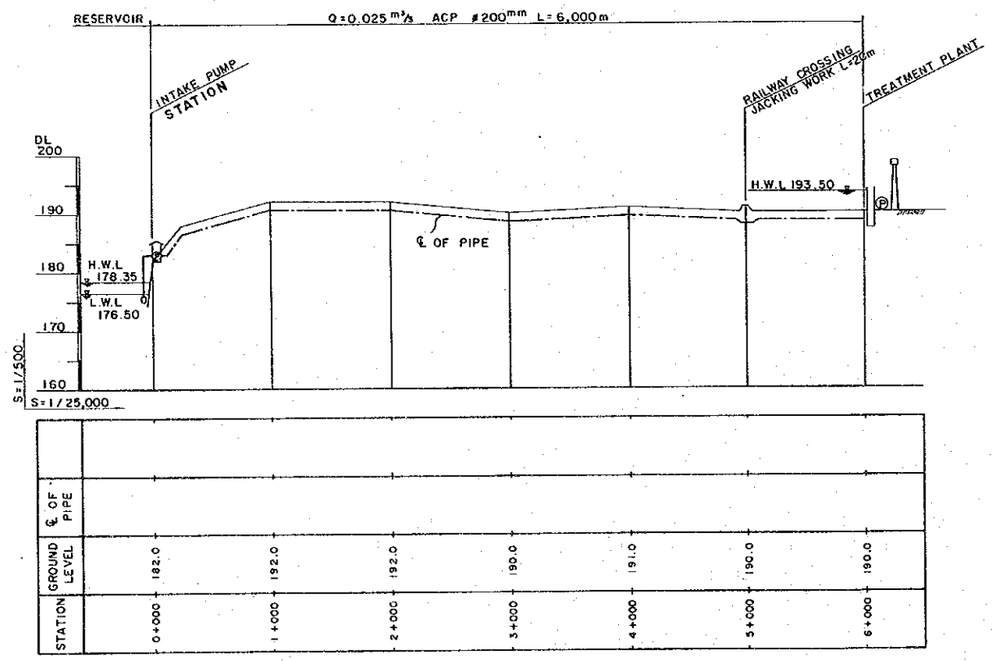
KINGDOM OF THAILAND MINISTRY OF INTERIOR PUBLIC WORKS DEPARTMENT			
THE SANITARY DISTRICT WATER WORKS PROJECT IN THE NORTH EASTERN REGION OF THAILAND			
WATER TRANSMISSION AND WATER TREATMENT PLANT NONG BUA LAI (NSD-6)			
DATE		DWG	2
JAPAN INTERNATIONAL COOPERATION AGENCY			



GENENAL PLAN



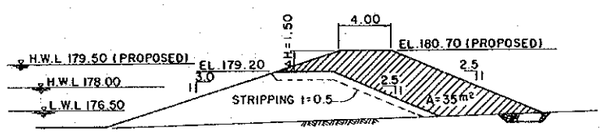
PLAN OF WATER TREATMENT PLANT



PROFILE OF TRANSMISSION

DIMENSION OF MAIN FACILITIES

DESCRIPTION	DIMENSION
1. INTAKE	
DESIGN CAPACITY	0.025 m³/s
INTAKE PUMP	VOLUTE PUMP
(1 FOR STAND-BY)	ø125 x 30kw x 2
2. TRANSMISSION	ACP ø200 x 6,000m
3. TREATMENT PLANT	
DESIGN CAPACITY	83 cu.m/h
DISTRIBUTION RESERVOIR	500 cu.m
ELEVATED TANK	160 cu.m
DISTRIBUTION PUMP (1 STAND BY)	ø100 x 11kw x 3
4. OTHERS	
IMPROVEMENT OF RESERVOIR	ΔH = + 1.5 m
(HEIGHT INCREASING)	



TYPICAL CROSS SECTION OF DAM HEIGHT INCREASEMENT

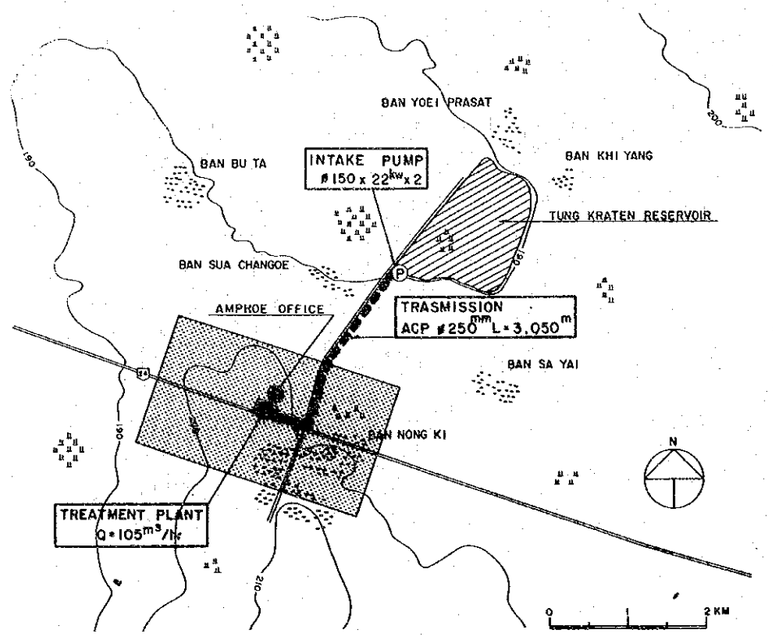
KINGDOM OF THAILAND MINISTRY OF INTERIOR
PUBLIC WORKS DEPARTMENT

THE SANITARY DISTRICT WATER WORKS PROJECT
IN THE NORTH EASTERN REGION OF THAILAND

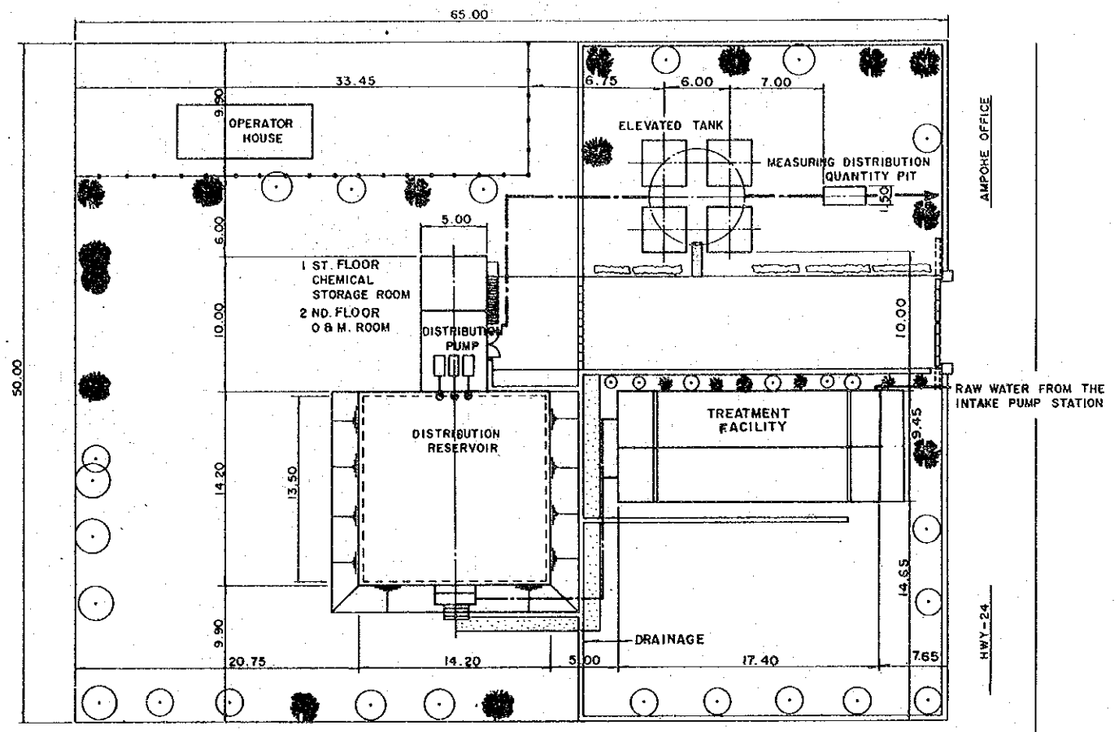
WATER TRANSMISSION AND
WATER TREATMENT PLANT
HUAI THALAENG (NSD-7)

DATE		DWG	3

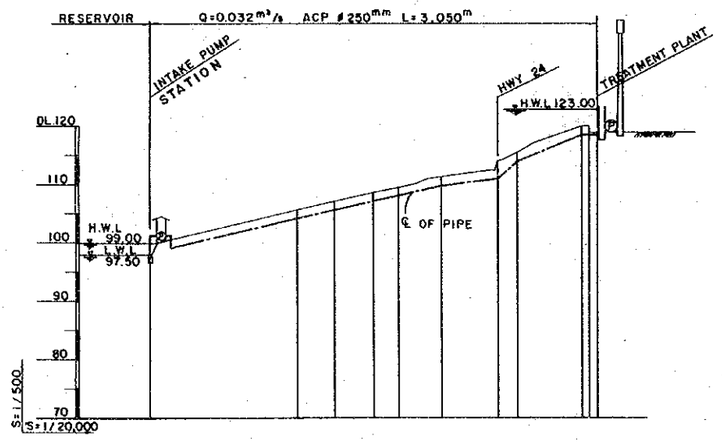
JAPAN INTERNATIONAL COOPERATION AGENCY

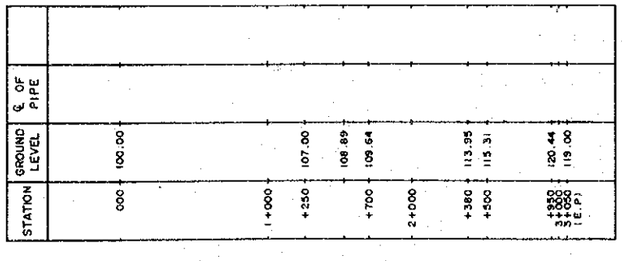


GENERAL PLAN



PLAN OF WATER TREATMENT PLANT





PROFILE OF TRANSMISSION

DIMENSION OF MAIN FACILITIES

DESCRIPTION	DIMENSION
1. INTAKE	
DESIGN CAPACITY	0.032 cu.m/s
INTAKE PUMP TYPE	VOLUTE PUMP
(1 FOR STAND-BY)	ϕ150 x 22kw x 2
2. TRANSMISSION	ACP ϕ250 x 3,050m
3. TREATMENT PLANT	
DESIGN CAPACITY	105 cu.m/h
DISTRIBUTION RESERVOIR	600 cu.m
ELEVATED TANK	200 cu.m
DISTRIBUTION PUMP TYPE	VOLUTE PUMP
(1 FOR STAND-BY)	125 x 11kw x 3

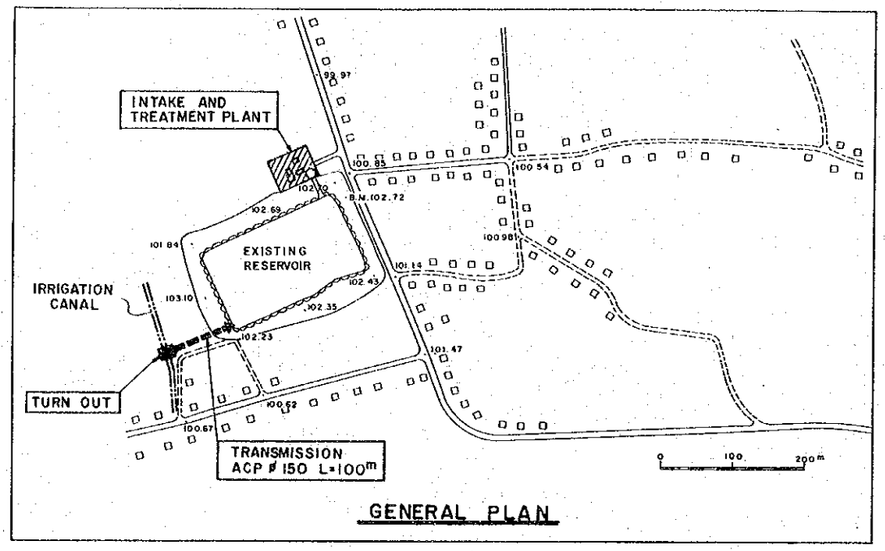
KINGDOM OF THAILAND MINISTRY OF INTERIOR
PUBLIC WORKS DEPARTMENT

THE SANITARY DISTRICT WATER WORKS PROJECT IN THE NORTH EASTERN REGION OF THAILAND

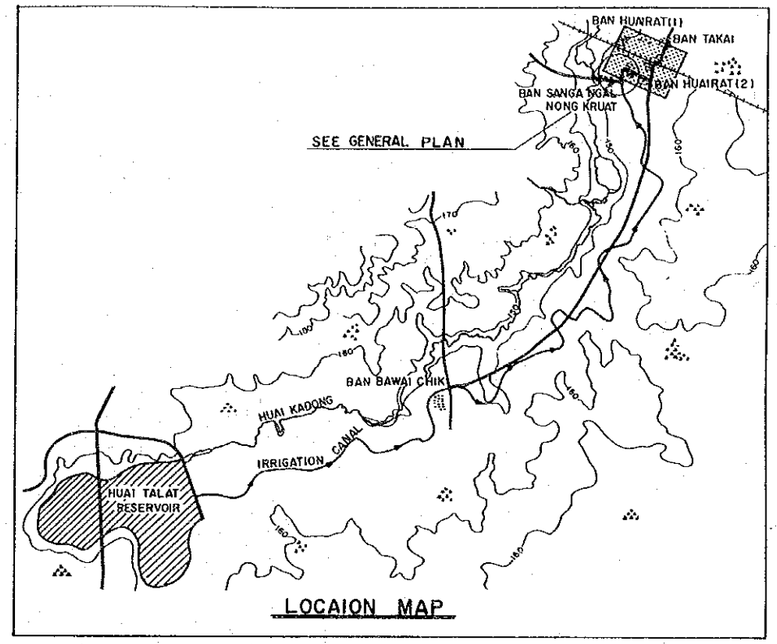
WATER TRANSMISSION AND WATER TREATMENT PLANT NONG KI (NSD-8)

DATE		DWG.	4

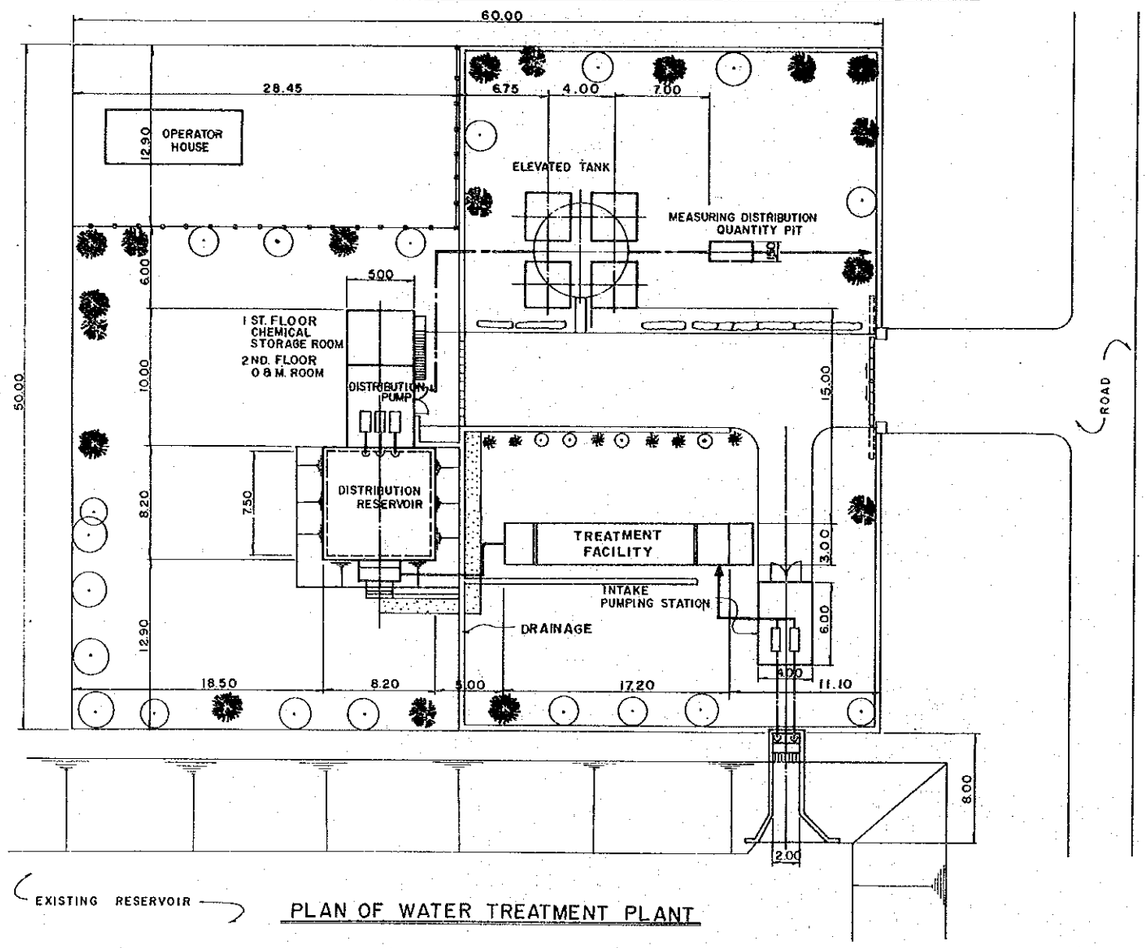
JAPAN INTERNATIONAL COOPERATION AGENCY



GENERAL PLAN



LOCAION MAP



PLAN OF WATER TREATMENT PLANT

DIMENSION OF MAIN FACILITIES

DESCRIPTION	DIMENSION
1. INTAKE	
DESIGN CAPACITY	0.009 $^{cum}/_{h}$
INTAKE PUMP TYPE	VOLUTE PUMP
(1 FOR STAND-BY)	ϕ80 x 3.7^{kw} x 2
2 TRANSMISSION	ϕ150x100^{M}
3. TREATMENT PLANT	
DESIGN CAPACITY	31 $^{cu.m}/_{h}$
DISTRIBUTION RESERVOIR	200 $^{cu.m}$
ELEVATED TANK	60 $^{cu.m}$
DISTRIBUTION PUMP TYPE	VOLUTE PUMP
(1FOR STAND-BY)	ϕ 65x3.7^{kw}x3
4. OTHERS	TURN-OUT

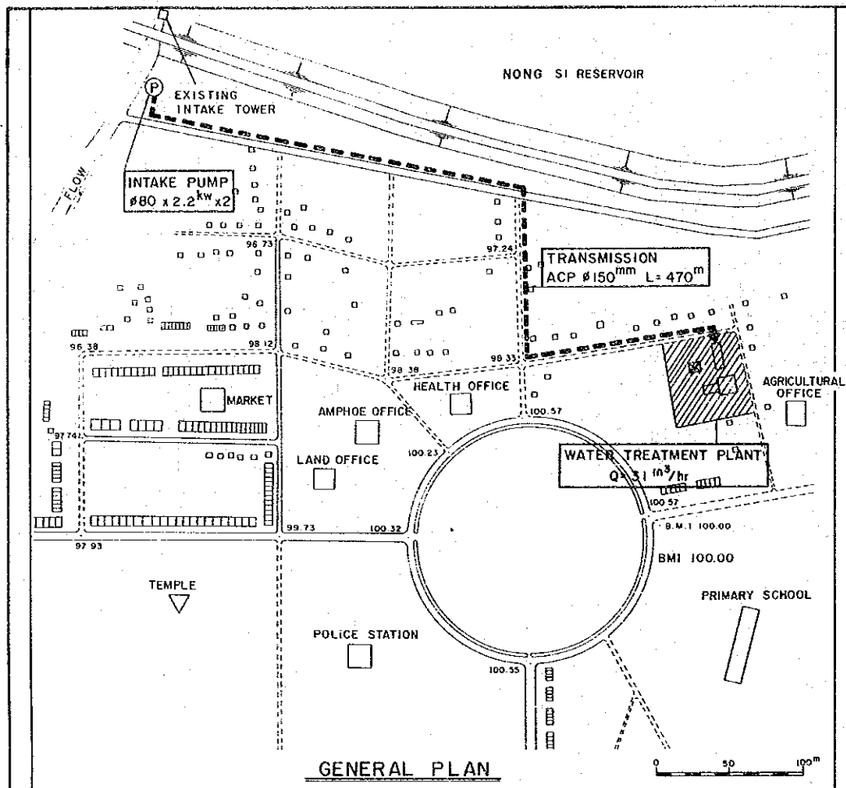
KINGDOM OF THAILAND MINISTRY OF INTERIOR
PUBLIC WORKS DEPARTMENT

THE SANITARY DISTRICT WATER WORKS PROJECT
IN THE NORTH EASTERN REGION OF THAILAND

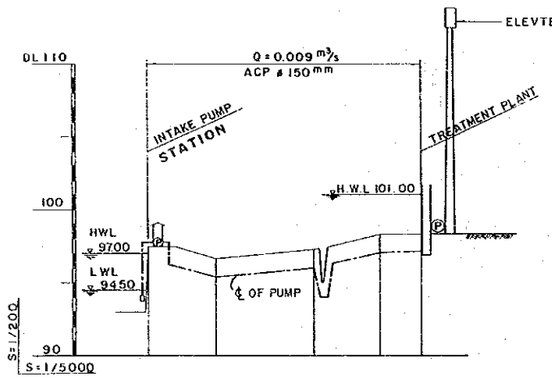
WATER TRANSMISSION AND
WATER TREATMENT PLANT
HUAI RAT (NSD-10)

DATE		DWG	5

JAPAN INTERNATIONAL COOPERATION AGENCY

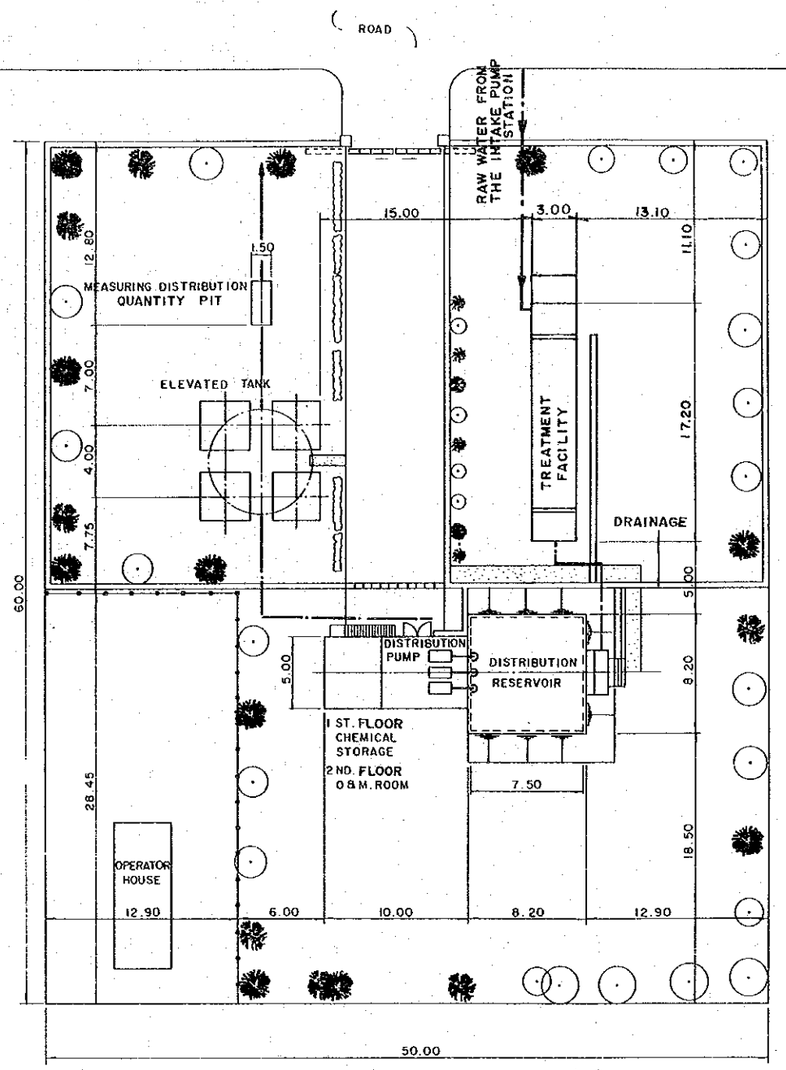


GENERAL PLAN



STATION	0+000	+115	+285	+400	+470
GROUND LEVEL	96.50	96.70	97.30	98.30	98.30
℄ OF PIPE					

PROFILE OF TRANSMISSION

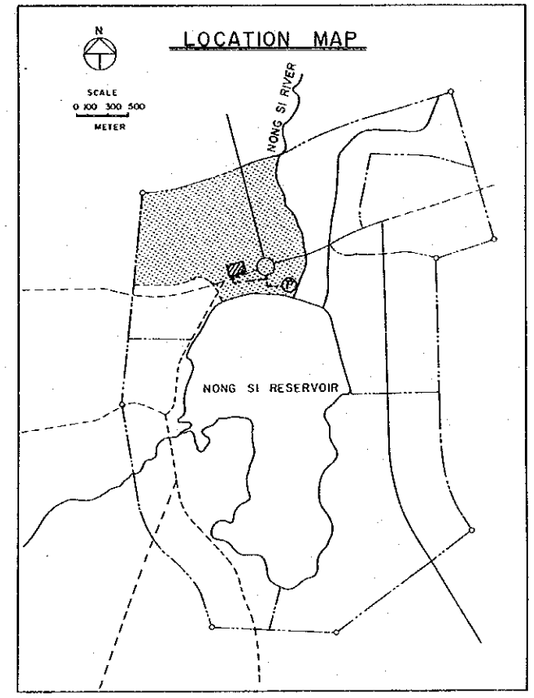


PLAN OF WATER TREATMENT PLANT

DIMENSION OF MAIN FACILITIES

DESCRIPTION	DIMENSION
1. INTAKE	
DESIGN CAPACITY	0.009 cum/s
INTAKE PUMP TYPE	VOLUTE PUMP
(1 FOR STAND-BY)	ø80 x 2.2kw x 2
2. TRANSMISSION	ACP ø150 x 470m
3. TREATMENT PLANT	
DESIGN CAPACITY	31 cum/h
DISTRIBUTION RESERVOIR	200 cu.m
ELEVATED TANK	60 cu.m
DISTRIBUTION PUMP TYPE	VOLUTE PUMP
(1 FOR STAND-BY)	ø65 x 3.7kw x 3

LOCATION MAP



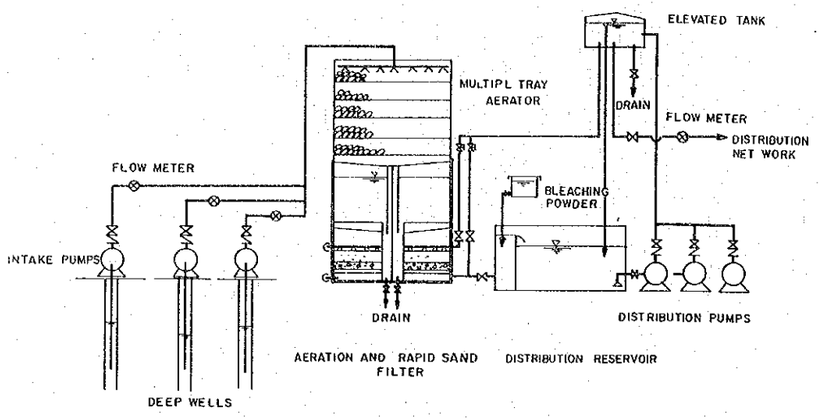
KINGDOM OF THAILAND MINISTRY OF INTERIOR
PUBLIC WORKS DEPARTMENT

THE SANITARY DISTRICT WATER WORKS PROJECT
IN THE NORTH EASTERN REGION OF THAILAND

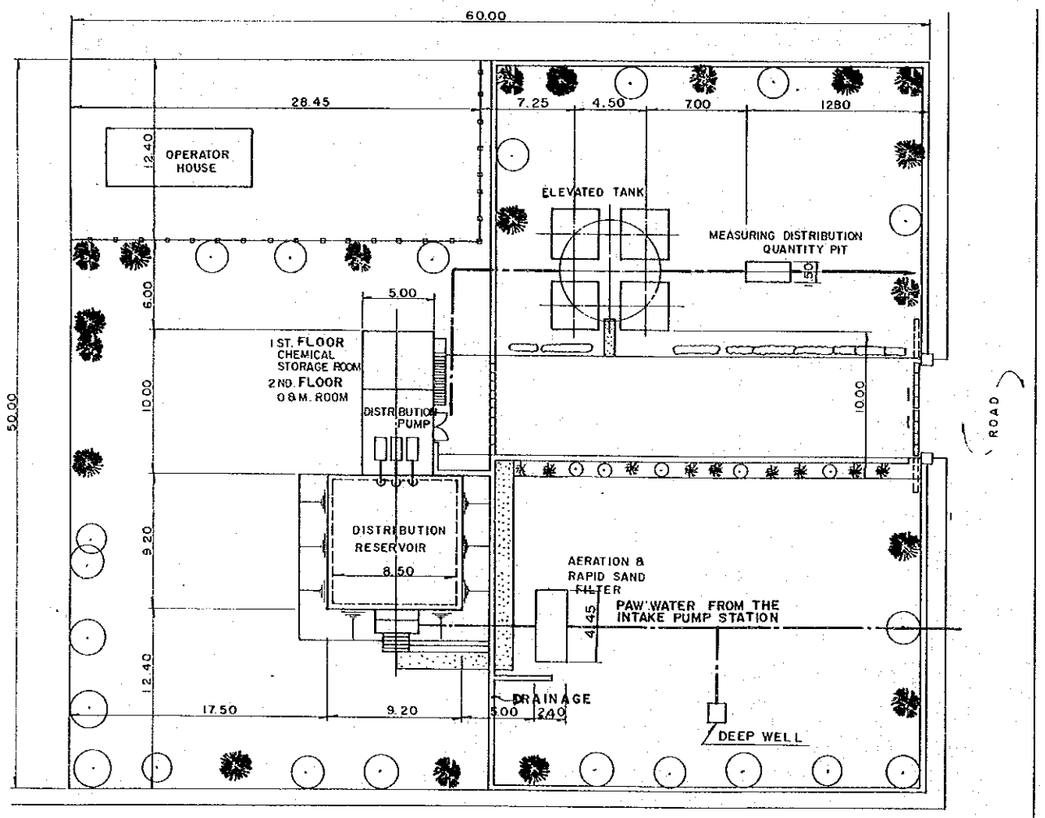
WATER TRANSMISSION AND WATER TREATMENT PLANT KHUN HAN (NSD-12)

DATE		DWG	6

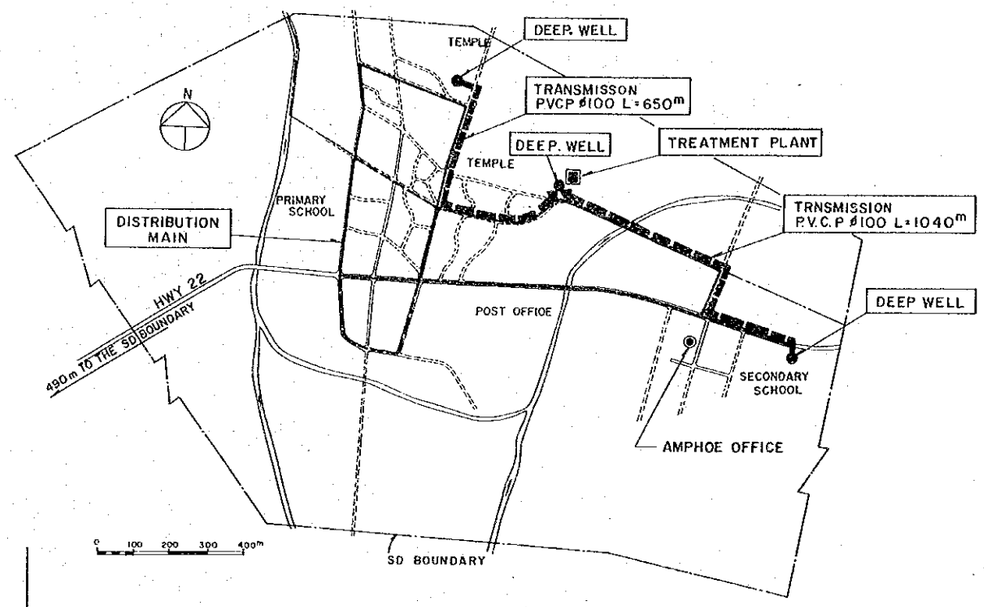
JAPAN INTERNATIONAL COOPERATION AGENCY



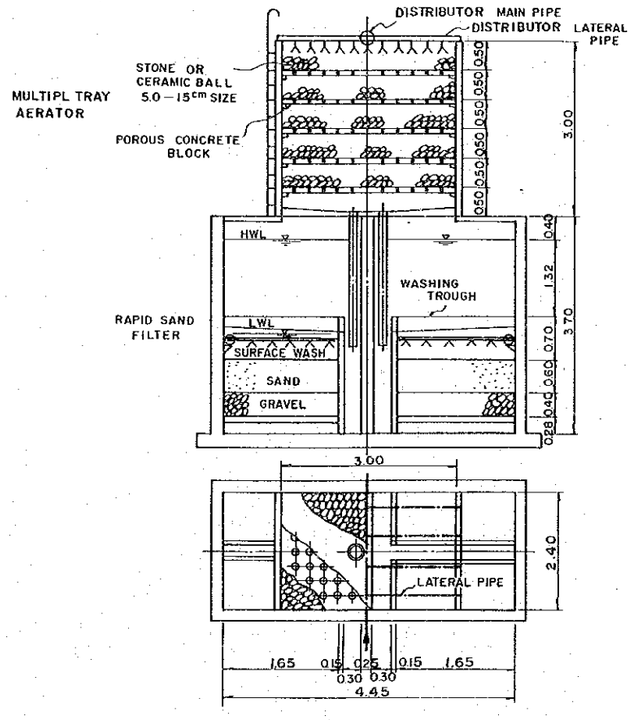
AERATION AND RAPID SAND FILTER PROCESS FLOW DIAGRAM



PLAN OF WATER TREATMENT PLANT



GENERAL PLAN



AERATION AND RAPID SAND FILTER

DIMENSION OF MAIN FACILITIES

DESCRIPTION	DIMENSION
1. INTAKE	
DESIGN CAPCITY	$3 \times 0.0039^{cum/s}$
INTAKE PUMP TYPE	SUBMERGED PUMP
	$\phi 65 \times 3.7^{kw} \times 3$
2. TRANSMISSION	P.V.C.P $\phi 100 \times 1690^{m}$
3. TREATMENT PLANT	
DESIGN CAPACITY	$39^{cum/h}$
DISTRIBUTION RESERVOIR	250^{cum}
ELEVATED TANK	80^{cum}
DISTRIBUTION PUMP TYPE	VOLUTE PUMP
(1 FOR STAND - BY)	$\phi 80 \times 5.5^{kw} \times 3$

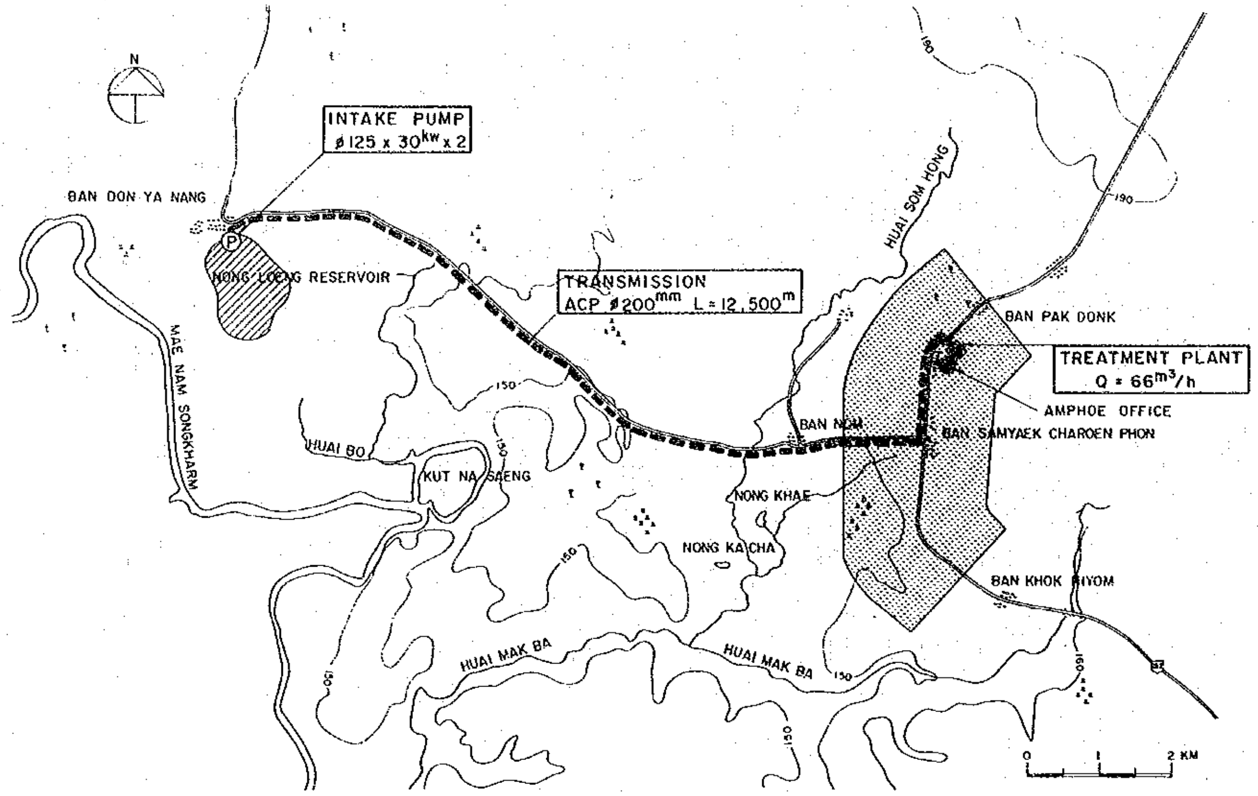
KINGDOM OF THAILAND MINISTRY OF INTERIOR
PUBLIC WORKS DEPARTMENT

THE SANITARY DISTRICT WATER WORKS PROJECT
IN THE NORTH EASTERN REGION OF THAILAND

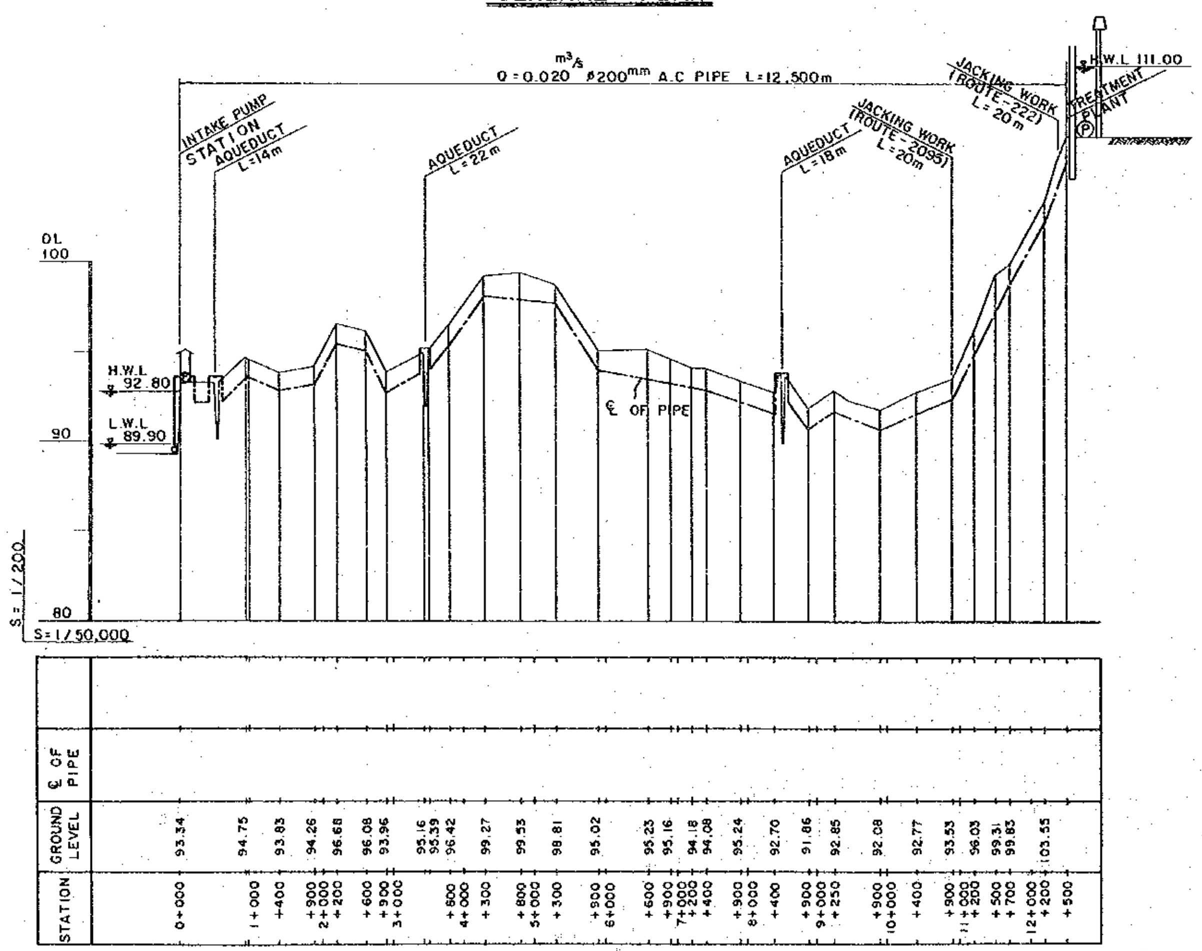
WATER TRANSMISSION AND WATER TREATMENT PLANT KUSUMAN (NSD-13)

DATE		DWG	7

JAPAN INTERNATIONAL COOPERATION AGENCY



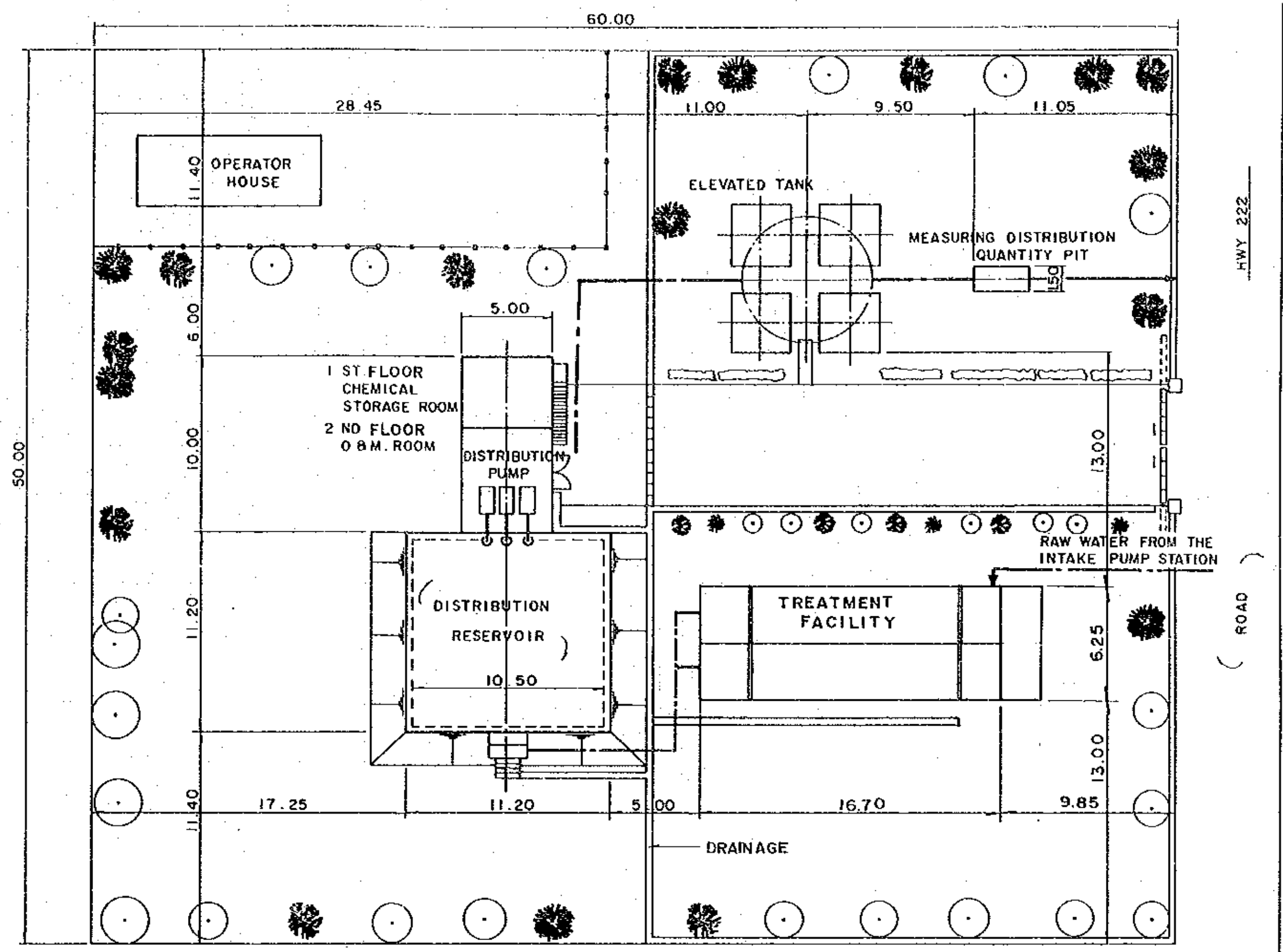
GENERAL PLAN



PROFILE OF TRANSMISSION

DIMENSION OF MAIN FACILITIES

DESCRIPTION	DIMENSION
1. INTAKE	
DESIGN CAPACITY	0.020 cu.m/s
INTAKE PUMP	VOLUTE PUMP
(1 FOR STAND-BY)	ø125 x 30kw x 2
2. TRANSMISSION	ACP ø200mm x 12,500m
3. TREATMENT PLANT	
DESIGN CAPACITY	66 cu.m/h
DISTRIBUTION RESERVOIR	400 cu.m
ELEVATED TANK	120 cu.m
DISTRIBUTION PUMP TYPE	VOLUTE PUMP
(1 FOR STAND-BY)	ø100 x 7.5kw x 3



PLAN OF WATER TREATMENT PLANT

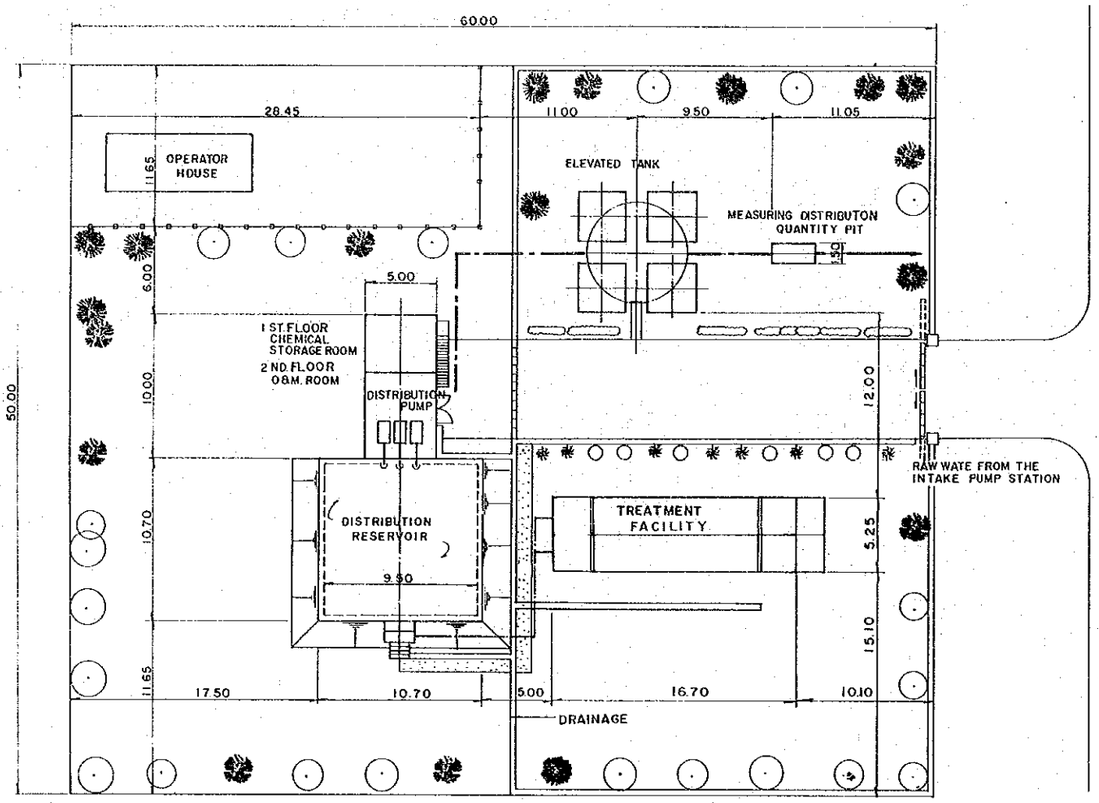
KINGDOM OF THAILAND MINISTRY OF INTERIOR
PUBLIC WORKS DEPARTMENT

THE SANITARY DISTRICT WATER WORKS PROJECT
IN THE NORTH EASTERN REGION OF THAILAND

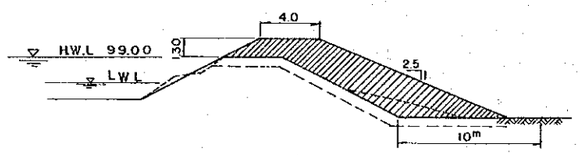
WATER TRANSMISSION AND
WATER TREATMENT PLANT
PHON CHAROEN (NSD-17)

DATE		DWG	8

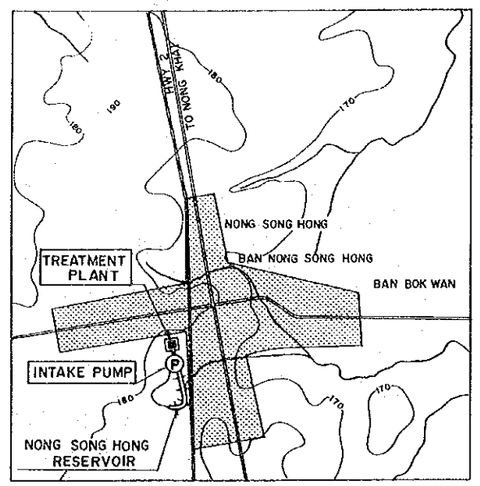
JAPAN INTERNATIONAL COOPERATION AGENCY



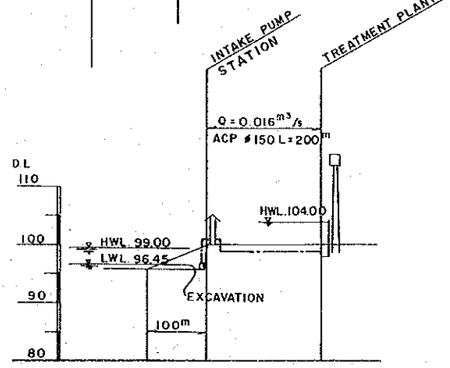
PLAN OF WATER TRETMENT PLANT



TYPICAL CROSS SECTION OF DAM HEIGHT INCREASEMENT



LOCATION MAP



PROFILE OF TRANSMISSION

DIMENSION OF MAIN FACILITIES

DESCRIPTION	DIMENSION
1. INTAKE	
DESIGN CAPACITY	0.016 $^{cu.m}/_{s}$
INTAKE PUMP TYPE	VOLUTE PUMP
(1 FOR STAND-BY)	ϕ100 x 3.7^{kw} x 2
2. TRANSMISSION	ACPϕ150 x 200^{m}
3 TREATMENT PLANT	
DESIGN CAPACITY	53 $^{cu.m}/_{h}$
DISTRIBUTION RESERVOIR	300 $^{cu.m}$
ELEVATED TANK	100 $^{cu.m}$
DISTRIBUTION PUMP	ϕ80 x 7.5^{kw} x 3
4. OTHERS	
IMPROVEMENT OF RESERVOIR (HEIGHT INCREASING)	H = + 1.30^{m}

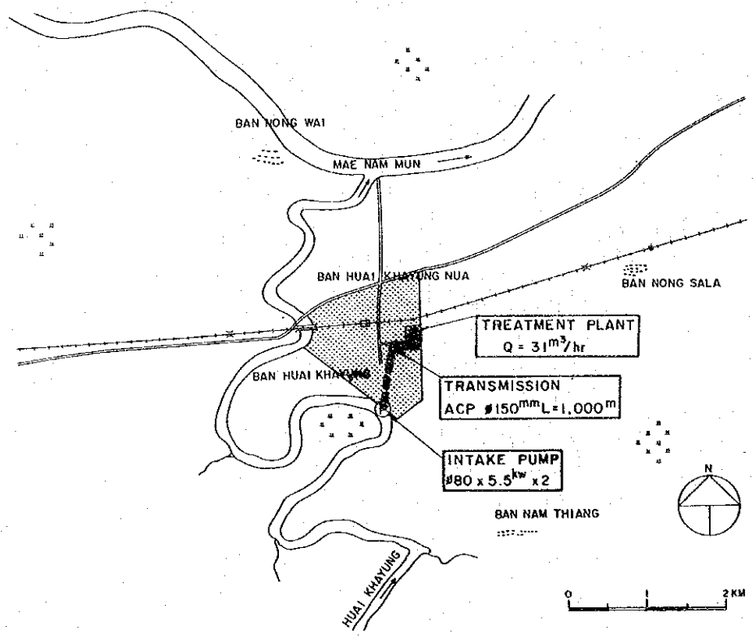
KINGDOM OF THAILAND MINISTRY OF INTERIOR
PUBLIC WORKS DEPARTMENT

THE SANITARY DISTRICT WATER WORKS PROJECT IN THE NORTH EASTERN REGION OF THAILAND

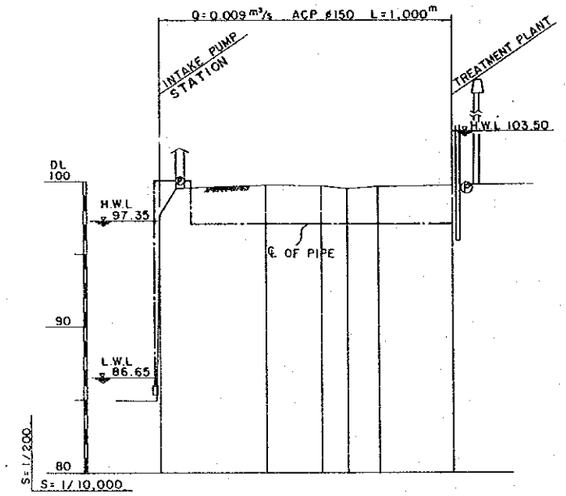
WATER TRANSMISSION AND WATER TREATMENT PLANT
NONG SONG HONG NSD-18

DATE		DWG	9

JAPAN INTERNATIONAL COOPERATION AGENCY

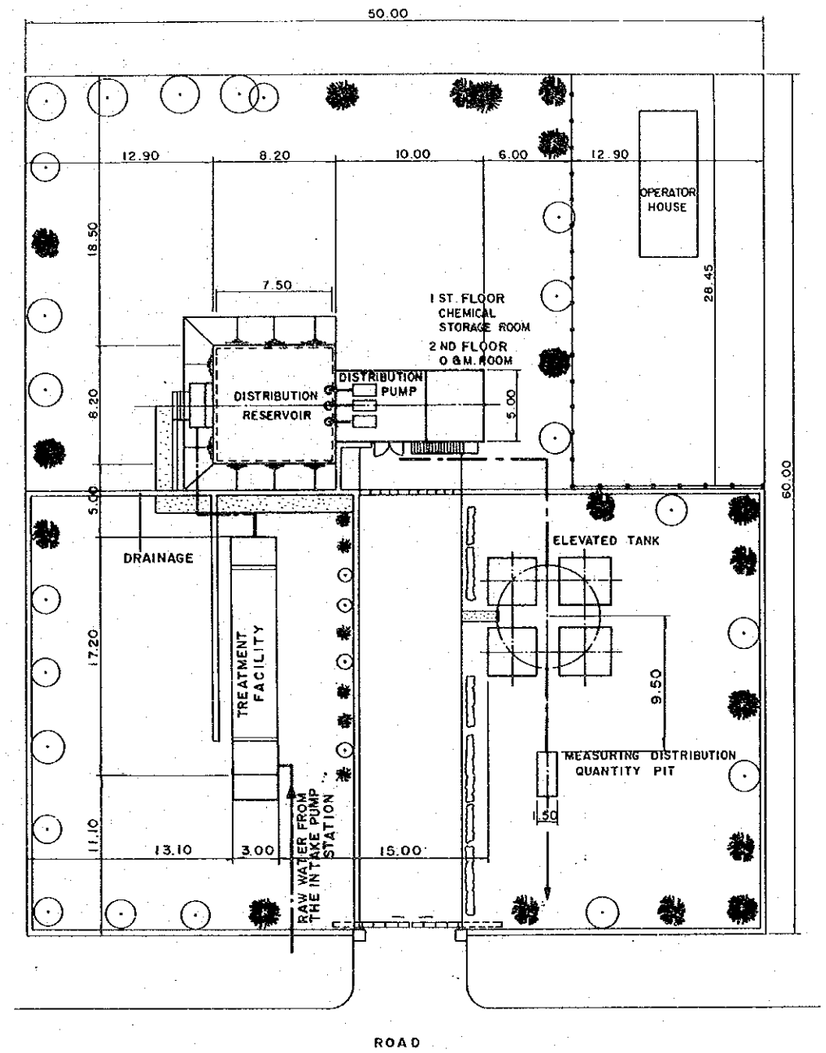


GENERAL PLAN



STATION	GROUND LEVEL	℄ OF PIPE
0+000	97.60	
+370	99.70	
+560	99.70	
+650	99.53	
+750	99.63	
1+000 (E.P.)	99.63	

PROFILE OF TRANSMISSION



PLAN OF WATER TREATMENT PLANT

DIMENSION OF MAIN FACILITIES

DESCRIPTION	DIMENSION
1. INTAKE & TRANSMISSION	
DESIGN CAPACITY	0.009 cu.m/s
INTAKE PUMP	MIXED FLOW PUMP
(1 FOR STAND-BY)	ϕ80 x 5.5kw x 2
2. TRANSMISSION	ACP ϕ150 x 1,000m
3. TREATMENT PLANT	
DESIGN CAPACITY	31 cu.m/h
DISTRIBUTION RESERVOIR	200 cu.m
ELEVATED TANK	60 cu.m
DISTRIBUTION PUMP	VOLUTE PUMP
	ϕ65 x 5.5kw x 3

KINGDOM OF THAILAND MINISTRY OF INTERIOR
PUBLIC WORKS DEPARTMENT

THE SANITARY DISTRICT WATER WORKS PROJECT
IN THE NORTH EASTERN REGION OF THAILAND

WATER TRANSMISSION AND
WATER TREATMENT PLANT
HUAI KHA YUNG (NSD-20)

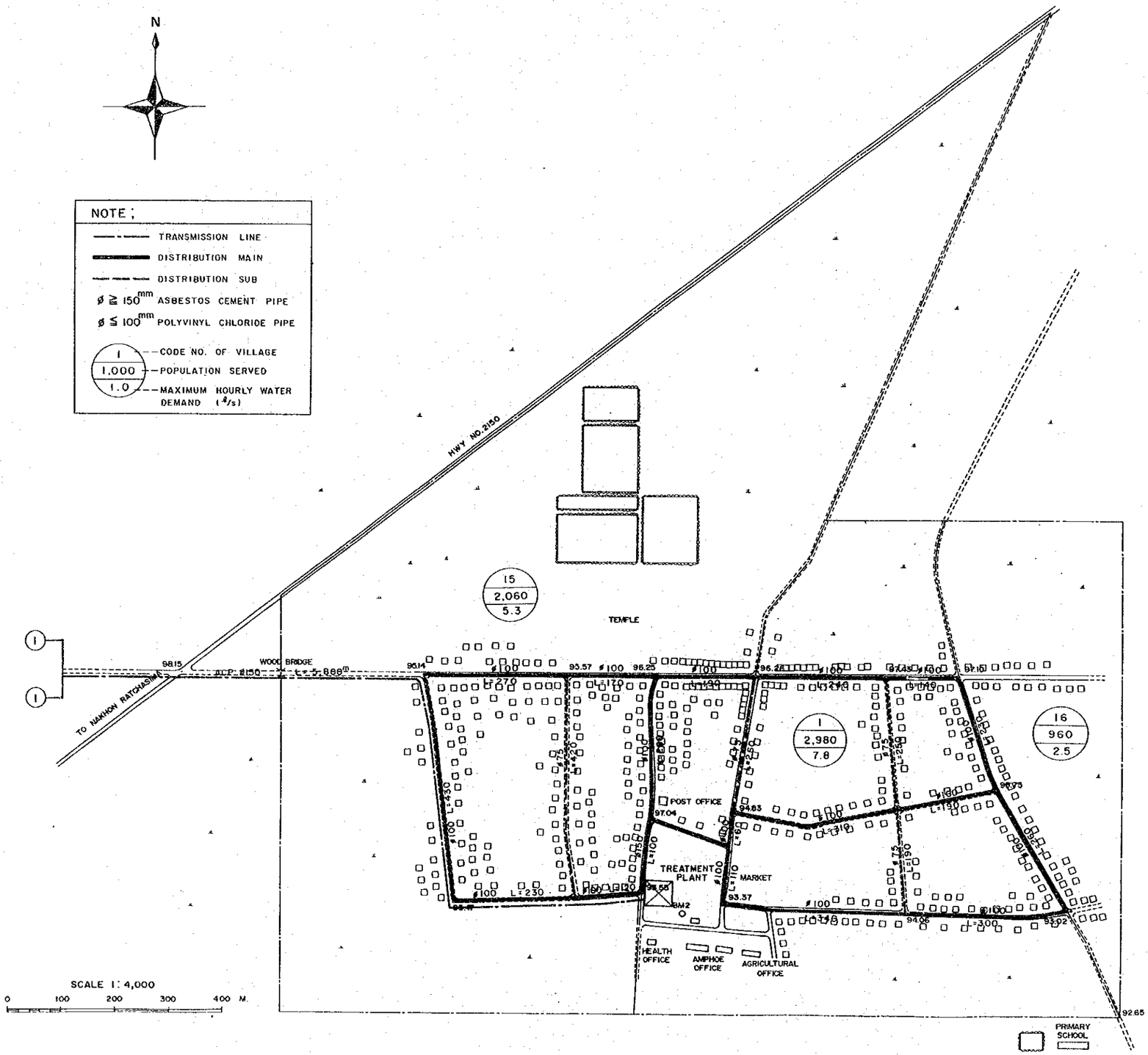
DATE		DWG	10

JAPAN INTERNATIONAL COOPERATION AGENCY

N

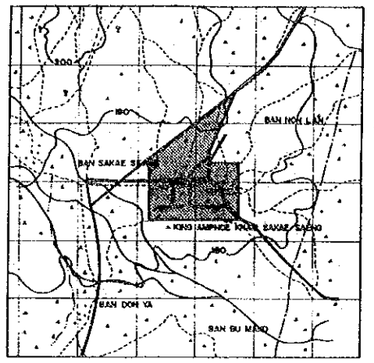
NOTE ;

- TRANSMISSION LINE
- DISTRIBUTION MAIN
- DISTRIBUTION SUB
- ø ≧ 150 mm ASBESTOS CEMENT PIPE
- ø ≦ 100 mm POLYVINYL CHLORIDE PIPE
- 1 / 1,000 / 1.0 — CODE NO. OF VILLAGE / POPULATION SERVED / MAXIMUM HOURLY WATER DEMAND (m^3/s)



LOCATION MAP

SCALE 1 : 50,000



SD DIMENSIONS

NSD NO. 5		
SANITARY DISTRICT		KHAM SAKAE SANG
AMPHOE		KHAM SAKAE SANG
CHANGWAT		NAKHON RATCHASIMA
AREA		2.0 Km^2
PROSPECT POPULATION (2,000 YEAR)		8,559
PROSPECT SERVED POPULATION (2,000 YEAR)		6,000
WATER DEMAND (DAILY MAXIMUM)		900 m^3/DAY
WATER SOURCE		BUN CHIWUK RESERVOIR
TRANSMISSION MAIN	LENGTH	5.80 Km
	DIAMETER	ø = 150 mm.
TREATMENT CAPACITY		38 m^3/h
DISTRIBUTION MAIN		ø = 100~150 mm.

LEGEND

- SD BOUNDARY
- VILLAGE BOUNDARY
- PAVED ROAD
- UNPAVED ROAD
- RAILWAY
- HOUSE
- POND
- RIVER

KINGDOM OF THAILAND MINISTRY OF INTERIOR
PUBLIC WORKS DEPARTMENT

THE SANITARY DISTRICT WATER WORKS PROJECT
IN THE NORTH EASTERN REGION OF THAILAND

KHAM SAKAE SANG (NSD-5)
INSTALLATION PLAN OF DISTRIBUTION PIPE

DATE		DWG	11

JAPAN INTERNATIONAL COOPERATION AGENCY

200 M. TO THE SD BOUNDARY

TO NAKHON RATCHASIMA

RAILWAY STATION

TO KHON KAEN

N

NOTE ;

- TRANSMISSION LINE
- DISTRIBUTION MAIN
- DISTRIBUTION SUB
- ø ≧ 150 mm ASBESTOS CEMENT PIPE
- ø ≦ 100 mm POLYVINYL CHLORIDE PIPE
- 1 / 1,000 / 1.0 — CODE NO. OF VILLAGE / POPULATION SERVED / MAXIMUM HOURLY WATER DEMAND (ℓ/s)

9 / 610 / 1.6

10 / 390

1 / 3,000 / 7.8

11 / 500 / 1.3

MARKET

HEALTH OFFICE

RICE MILL

PRIMALY SCHOOL

TEMPLE

B.M.

PRIMALY AND SECONDALY SCHOOL

TREATMENT PLANT

NONG SAMP RESERVOIR

95.78 98.92 98.61 97.12 97.37 99.87 103.28 102.78 99.91 99.08 98.96 99.04 99.21 99.38 99.07 96.86 97.36 96.56 99.61 98.33 99.63

ø100 L=210 ø100 L=210 ø100 L=150 ø75 L=150 ø100 L=100 ø75 L=100 ø100 L=430 ø75 L=350 ø100 L=250 ø100 L=90 ø100 L=150 ø150 L=160 ø100 L=240 ø75 L=240 ø100 L=100

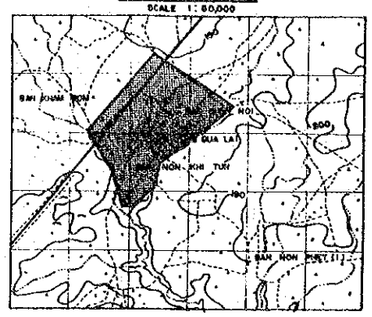
400 M. TO THE SD BOUNDARY

150 M. TO THE SD BOUNDARY

300 M. TO THE SD BOUNDARY

LOCATION MAP

SCALE 1 : 50,000



SD DIMENSIONS

NSD NO. 6		
SANITARY DISTRICT		NONG BUA LAI
AMPHOE		BUA YAI
CHANGWAT		NAKHON RATCHASIMA
AREA		3.028 Km^2
PROSPECT POPULATION (2,000 YEAR)		6,366
PROSPECT SERVED POPULATION (2,000YEAR)		4,500
WATER DEMAND (DAILY MAXIMUM)		675 m^3/DAY
WATER SOURCE		NONG SAMP RESERVOIR
TRANSMISSION MAIN	LENGTH	Km
	DIAMETER	mm
TREATMENT CAPACITY		28 m^3/h
DISTRIBUTION MAIN		ø = 100~150 mm.

LEGEND

- SD BOUNDARY
- VILLAGE BOUNDARY
- PAVED ROAD
- UNPAVED ROAD
- RAILWAY
- HOUSE
- POND
- RIVER

SCALE 1 : 2,000

0 100 200 M.

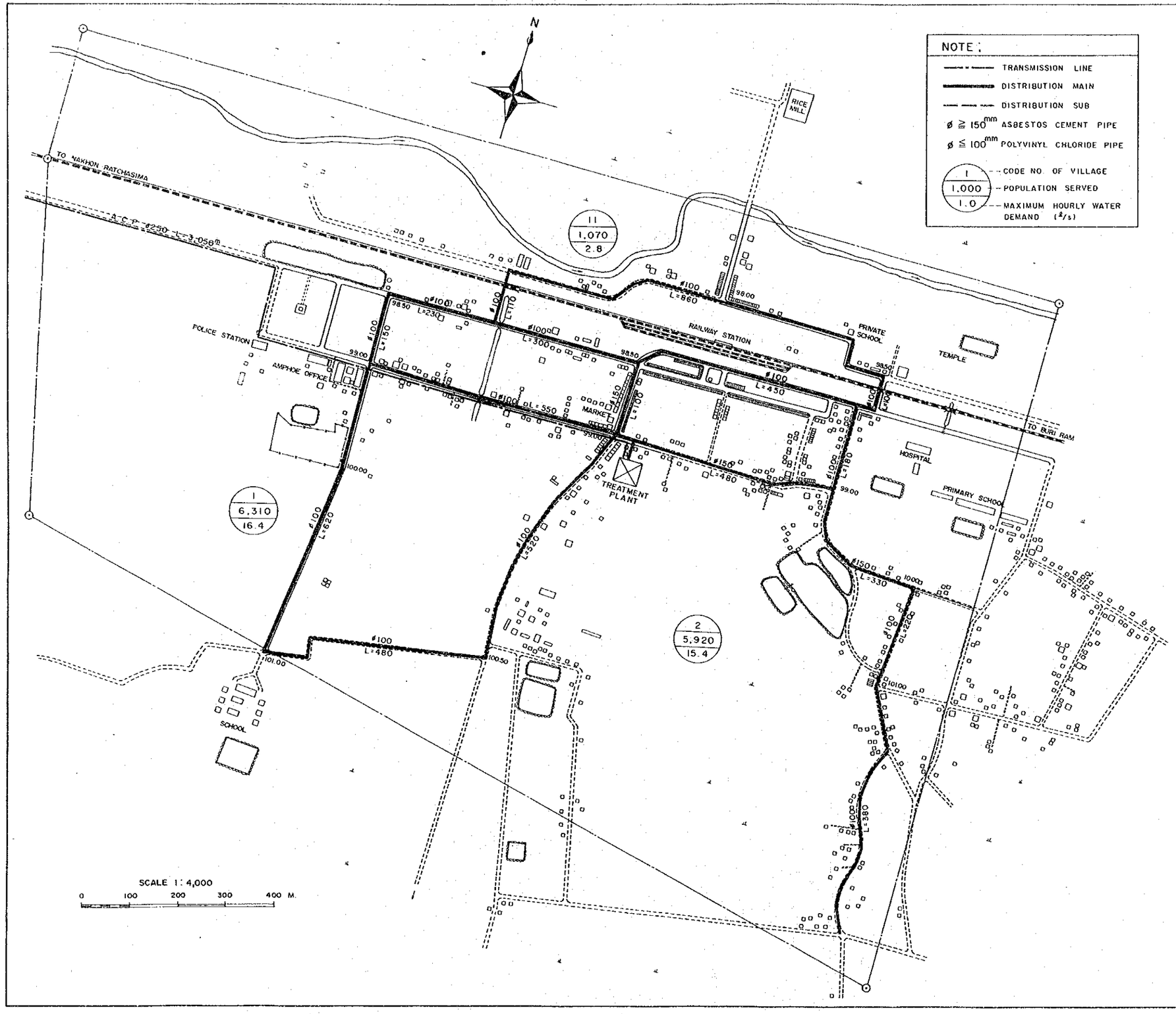
KINGDOM OF THAILAND MINISTRY OF INTERIOR
PUBLIC WORKS DEPARTMENT

THE SANITARY DISTRICT WATER WORKS PROJECT
IN THE NORTH EASTERN REGION OF THAILAND

NONG BUA LAI (NSD-6)
INSTALLATION PLAN OF DISTRIBUTION PIPE

DATE		DWG	12

JAPAN INTERNATIONAL COOPERATION AGENCY

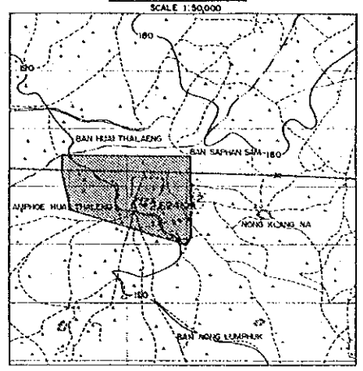


NOTE ;

- TRANSMISSION LINE
- DISTRIBUTION MAIN
- DISTRIBUTION SUB
- ø ≧ 150 mm ASBESTOS CEMENT PIPE
- ø ≦ 100 mm POLYVINYL CHLORIDE PIPE
- 1 — CODE NO. OF VILLAGE
- 1,000 — POPULATION SERVED
- 1.0 — MAXIMUM HOURLY WATER DEMAND (ℓ/s)

LOCATION MAP

SCALE 1:50,000



SD DIMENSIONS

NSD NO. 7		
SANITARY DISTRICT		HUAI THALAENG
AMPHOE		HUAI THALAENG
CHANGWAT		NAKHON RATCHASIMA
AREA		2.624 Km^2
PROSPECT POPULATION (2,000 YEAR)		19,028
PROSPECT SERVED POPULATION (2000 YEAR)		13,300
WATER DEMAND (DAILY MAXIMUM)		1,995 m^3/DAY
WATER SOURCE		NONG TAKAI RESERVOIR
TRANSMISSION MAIN	LENGTH	6.0 Km
	DIAMETER	ø = 200 mm
TREATMENT CAPACITY		83 m^3/h
DISTRIBUTION MAIN		ø = 100 ~ 150 mm

LEGEND

- SD BOUNDARY
- VILLAGE BOUNDARY
- PAVED ROAD
- UNPAVED ROAD
- RAILWAY
- HOUSE
- POND
- RIVER

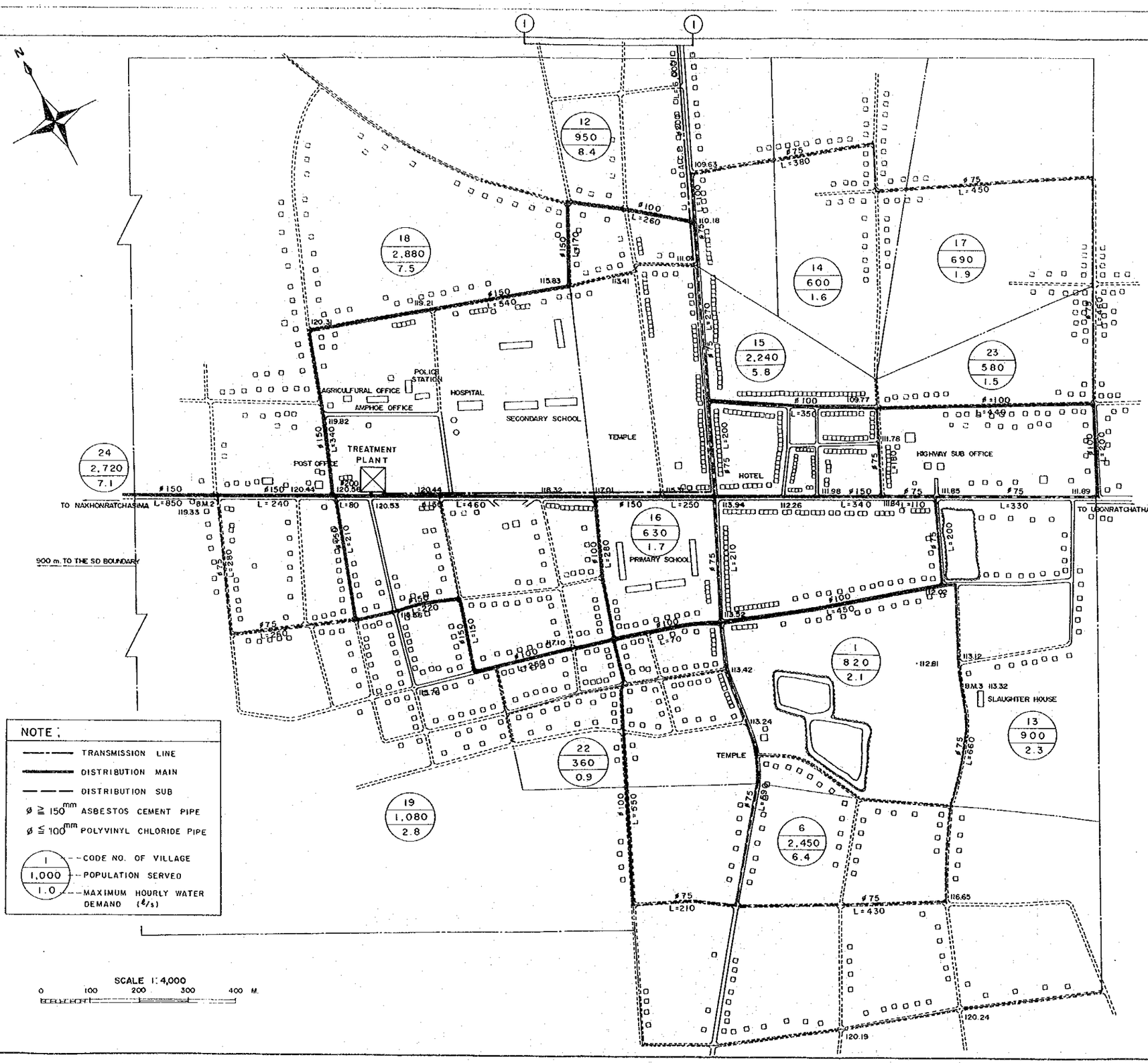
KINGDOM OF THAILAND MINISTRY OF INTERIOR
PUBLIC WORKS DEPARTMENT

THE SANITARY DISTRICT WATER WORKS PROJECT
IN THE NORTH EASTERN REGION OF THAILAND

HUAI THALAENG (NSD-7)
INSTALLATION PLAN OF DISTRIBUTION PIPE

DATE		DWG	13

JAPAN INTERNATIONAL COOPERATION AGENCY



NOTE :

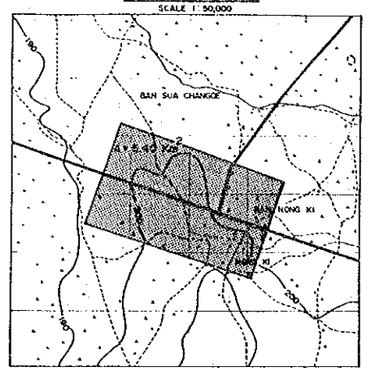
- TRANSMISSION LINE
- DISTRIBUTION MAIN
- DISTRIBUTION SUB
- ø ≧ 150 mm ASBESTOS CEMENT PIPE
- ø ≦ 100 mm POLYVINYL CHLORIDE PIPE
- 1 — CODE NO. OF VILLAGE
- 1,000 — POPULATION SERVED
- 1.0 — MAXIMUM HOURLY WATER DEMAND (ℓ/s)

SCALE 1:4,000

0 100 200 300 400 M.

LOCATION MAP

SCALE 1:50,000



SD DIMENSIONS

NSD NO.8		
SANITARY DISTRICT		NONG KI
AMPHOE		NONG KI
CHANGWAT		BURIRUM
AREA		5.4 Km^2
PROSPECT POPULATION (2,000 YEAR)		24,089
PROSPECT SERVED POPULATION(2,000 YEAR)		16,900
WATER DEMAND (DAILY MAXIMUM)		2,535 m^3/DAY
WATER SOURCE		TUNG KRATEN RESERVOIR
TRANSMISSION MAIN	LENGTH	3,050 Km
	DIAMETER	ø = 250 mm
TREATMENT CAPACITY		105 m^3/h
DISTRIBUTION MAIN		ø = 100~200 mm

LEGEND

- SD BOUNDARY
- VILLAGE BOUNDARY
- PAVED ROAD
- UNPAVED ROAD
- RAILWAY
- HOUSE
- POND
- RIVER

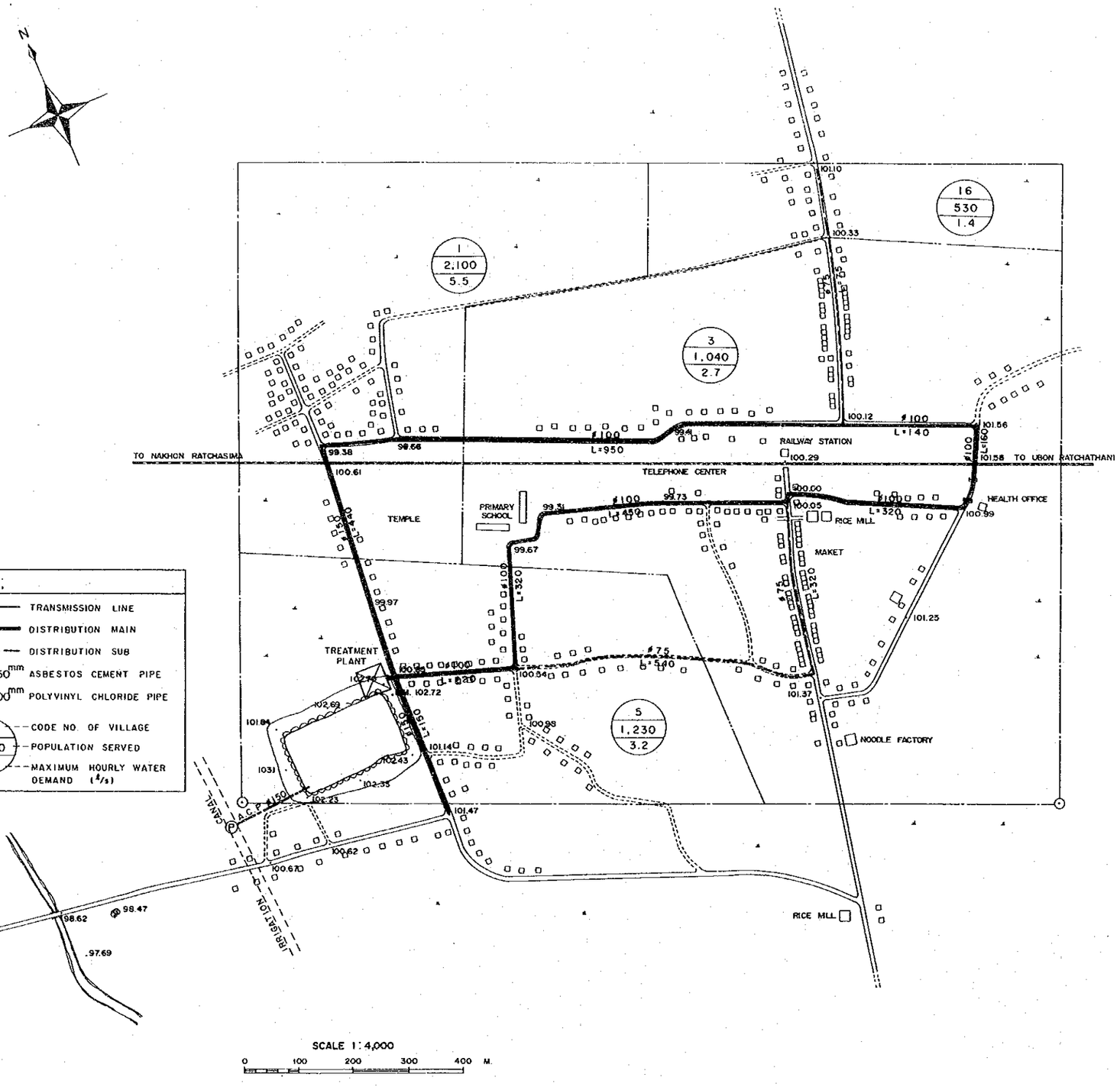
KINGDOM OF THAILAND MINISTRY OF INTERIOR
PUBLIC WORKS DEPARTMENT

THE SANITARY DISTRICT WATER WORKS PROJECT
IN THE NORTH EASTERN REGION OF THAILAND

NONG KI (NSD - 8)
INSTALLATION PLAN OF DISTRIBUTION PIPE

DATE		DWG	14

JAPAN INTERNATIONAL COOPERATION AGENCY

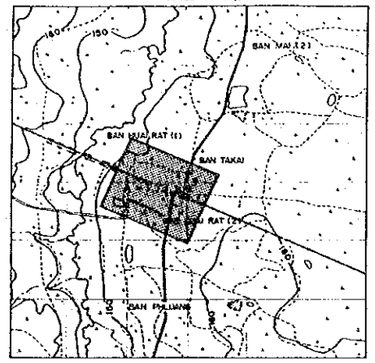


NOTE ;

- TRANSMISSION LINE
- DISTRIBUTION MAIN
- DISTRIBUTION SUB
- ø ≧ 150 mm ASBESTOS CEMENT PIPE
- ø ≦ 100 mm POLYVINYL CHLORIDE PIPE
- 1 / 1,000 / 1.0 — CODE NO. OF VILLAGE / POPULATION SERVED / MAXIMUM HOURLY WATER DEMAND (l/s)

LOCATION MAP

SCALE 1:50,000



SD DIMENSIONS

NSD NO. 10		
SANITARY DISTRICT		HUAI RAT
AMPHOE		MUANG
CHANGWAT		BURIRUM
AREA		1.725 km^2
PROSPECT POPULATION (2,000 YEAR)		7,037
PROSPECT SERVED POPULATION (2,000 YEAR)		4,900
WATER DEMAND (DAILY MAXIMUM)		735 m^3/DAY
WATER SOURCE		HUAI TALET RESERVOIR
TRANSMISSION MAIN	LENGTH	0.10 Km
	DIAMETER	ø = 150 mm
TREATMENT CAPACITY		31 m^3/h
DISTRIBUTION MAIN		ø = 100~150 mm

LEGEND

- SD BOUNDARY
- VILLAGE BOUNDARY
- PAVED ROAD
- UNPAVED ROAD
- RAILWAY
- HOUSE
- POND
- RIVER

KINGDOM OF THAILAND MINISTRY OF INTERIOR
PUBLIC WORKS DEPARTMENT

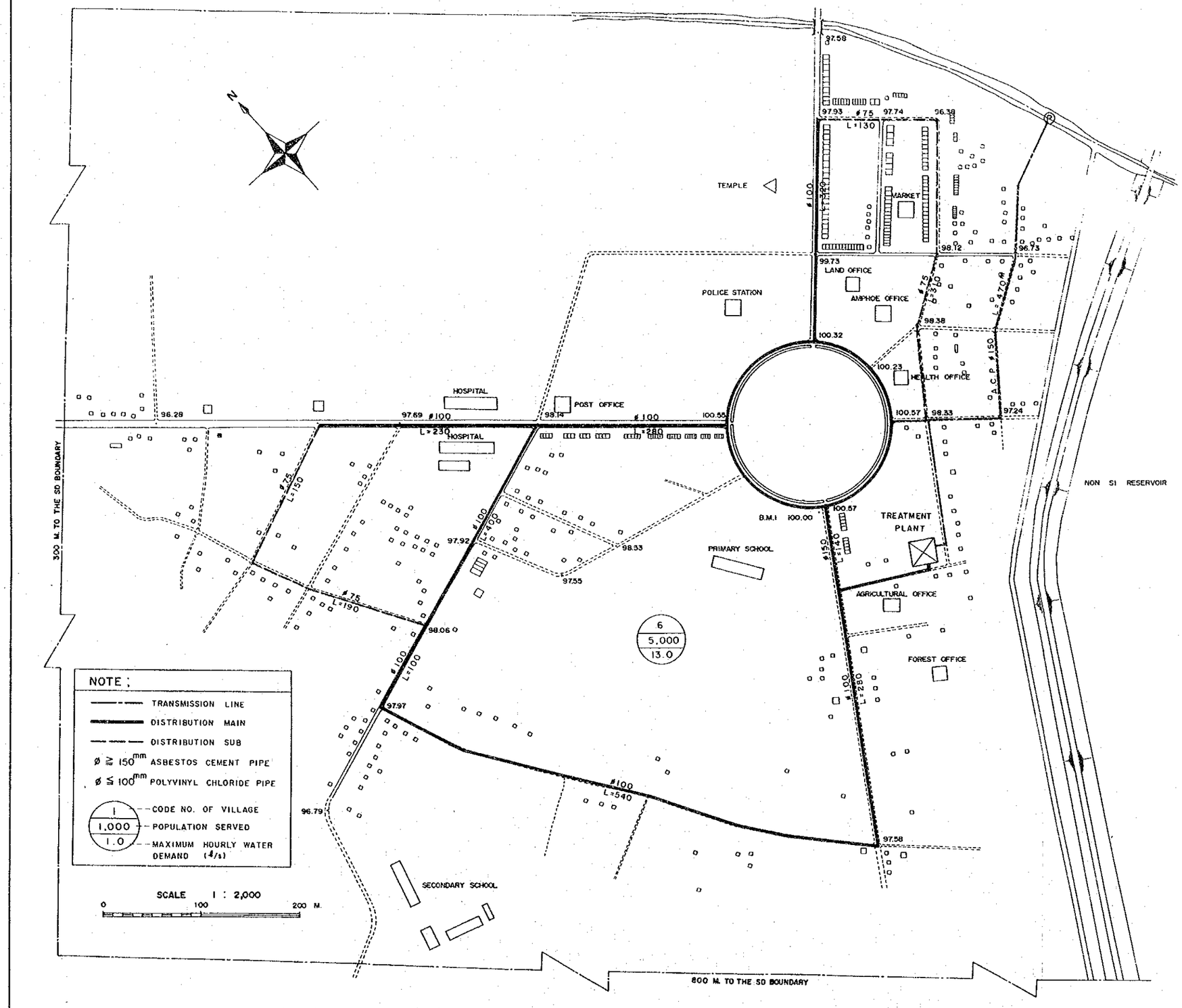
THE SANITARY DISTRICT WATER WORKS PROJECT
IN THE NORTH EASTERN REGION OF THAILAND

HUAI RAT (NSD-10)

INSTALLATION PLAN OF DISTRIBUTION PIPE

DATE		DWG	15

JAPAN INTERNATIONAL COOPERATION AGENCY



NOTE ;

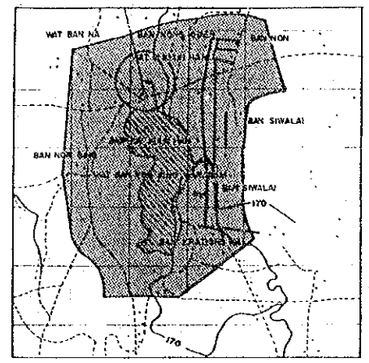
- TRANSMISSION LINE
- DISTRIBUTION MAIN
- DISTRIBUTION SUB
- ø ≧ 150 mm ASBESTOS CEMENT PIPE
- ø ≦ 100 mm POLYVINYL CHLORIDE PIPE
- 1 — CODE NO. OF VILLAGE
- 1,000 — POPULATION SERVED
- 1.0 — MAXIMUM HOURLY WATER DEMAND (l/s)

SCALE 1 : 2,000

0 100 200 M.

LOCATION MAP

SCALE 1: 50,000



SD DIMENSIONS

NSD NO. 12		
SANITARY DISTRICT		KHUN HAN
AMPHOE		KHUN HAN
CHANGWAT		SISAKET
AREA		12.0 Km^2
PROSPECT POPULATION (2,000 YEAR)		7,190
PROSPECT SERVED POPULATION (2,000 YEAR)		5,000
WATER DEMAND (DAILY MAXIMUM)		750 m^3/DAY
WATER SOURCE		NONG SI RESERVOIR
TRANSMISSION MAIN	LENGTH	0.47 Km
	DIAMETER	ø = 150 mm
TREATMENT CAPACITY		31 m^3/h
DISTRIBUTION MAIN		ø = 100 ~ 150 mm

LEGEND

- SD BOUNDARY
- VILLAGE BOUNDARY
- PAVED ROAD
- UNPAVED ROAD
- RAILWAY
- HOUSE
- POND
- RIVER

KINGDOM OF THAILAND MINISTRY OF INTERIOR
PUBLIC WORKS DEPARTMENT

THE SANITARY DISTRICT WATER WORKS PROJECT
IN THE NORTH EASTERN REGION OF THAILAND

KHUN HAN (NSD-12)

INSTALLATION PLAN OF DISTRIBUTION PIPE

DATE		DWG	16

JAPAN INTERNATIONAL COOPERATION AGENCY

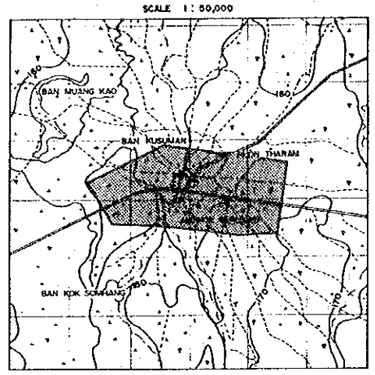
N

NOTE ;

- TRANSMISSION LINE
- DISTRIBUTION MAIN
- DISTRIBUTION SUB
- ø ≧ 150 mm ASBESTOS CEMENT PIPE
- ø ≦ 100 mm POLYVINYL CHLORIDE PIPE
- WELL
- 1 — CODE NO. OF VILLAGE
- 1,000 — POPULATION SERVED
- 1.0 — MAXIMUM HOURLY WATER DEMAND (ℓ/s)

LOCATION MAP

SCALE 1 : 50,000



SD DIMENSIONS

NSD NO. 13		
SANITARY DISTRICT		KUSUMAN
AMPHOE		KUSUMAN
CHANGWAT		SAKON NAKHON
AREA		4.0 Km^2
PROSPECT POPULATION (2,000 YEAR)		8,788
PROSPECT SERVED POPULATION (2,000 YEAR)		6,200
WATER DEMAND (DAILY MAXIMUM)		930 m^3/DAY
WATER SOURCE		DEEP WELL
TRANSMISSION MAIN	LENGTH	1.69 Km
	DIAMETER	ø = 100 mm
TREATMENT CAPACITY		39 m^3/h
DISTRIBUTION MAIN		ø = 100~150 mm

LEGEND

- SD BOUNDARY
- VILLAGE BOUNDARY
- PAVED ROAD
- UNPAVED ROAD
- RAILWAY
- HOUSE
- POND
- RIVER

6 / 2,050 / 5.3

1 / 4,150 / 10.8

TEMPLE
TREATMENT PLANT
PRIMARY SCHOOL
MARKET
POST OFFICE
AMPHOE OFFICE
SECONDARY SCHOOL
ROUTE 22
490 m TO THE SD BOUNDARY
700 m TO THE SD BOUNDARY
B.M.1 103.46
ACP ø100 L=650m
ø150 L=350
ø100 L=1,040m
ø100 L=500
ø100 L=800
ø100 L=100
ø100 L=400
ø100 L=2800
ø100 L=300
ø100 L=230
99.95
100.41
101.11
100.82
100.67
102.32
105.72
98.36
98.76
98.79
98.20
100.24
101.54
102.55
103.20
104.16
101.88
100.21

SCALE 1 : 4,000

0 100 200 300 400

KINGDOM OF THAILAND MINISTRY OF INTERIR
PUBLIC WORKS DEPARTMENT

THE SANITARY DISTRICT WATER WORKS PROJECT
IN THE NORTH EASTERN REGION OF THAILAND

KUSUMAN (NSD-13)

INSTALLATION PLAN OF DISTRIBUTION PIPE

DATE		DWG	17

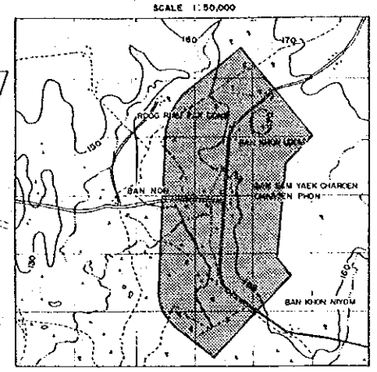
JAPAN INTERNATIONAL COOPERATION AGENCY

NOTE :

- TRANSMISSION LINE
- DISTRIBUTION MAIN
- DISTRIBUTION SUB
- ø ≧ 150 mm ASBESTOS CEMENT PIPE
- ø ≦ 100 mm POLYVINYL CHLORIDE PIPE
- 1 / 1,000 / 1.0 — CODE NO. OF VILLAGE / POPULATION SERVED / MAXIMUM HOURLY WATER DEMAND (ℓ/s)

LOCATION MAP

SCALE 1:50,000



SD DIMENSIONS

NSD NO. 17		
SANITARY DISTRICT	PHON CHAROEN	
AMPHOE	PHON CHAROEN	
CHANGWAT	NONG KHAI	
AREA	10.0	Km^2
PROSPECT POPULATION (2,000 YEAR)	15,084	
PROSPECT SERVED POPULATION(2,000 YEAR)	10,600	
WATER DEMAND (DAILY MAXIMUM)	1,590	m^3/DAY
WATER SOURCE	NONG LOENG RESERVOIR	
TRANSMISSION MAIN — LENGTH	12.50	Km
TRANSMISSION MAIN — DIAMETER	ø × 200	mm
TREATMENT CAPACITY	66	m^3/h
DISTRIBUTION MAIN	ø × 100~150	mm

LEGEND

- SD BOUNDARY
- VILLAGE BOUNDARY
- PAVED ROAD
- UNPAVED ROAD
- RAILWAY
- HOUSE
- POND
- RIVER

SCALE 1:4,000

0 100 200 300 400 M

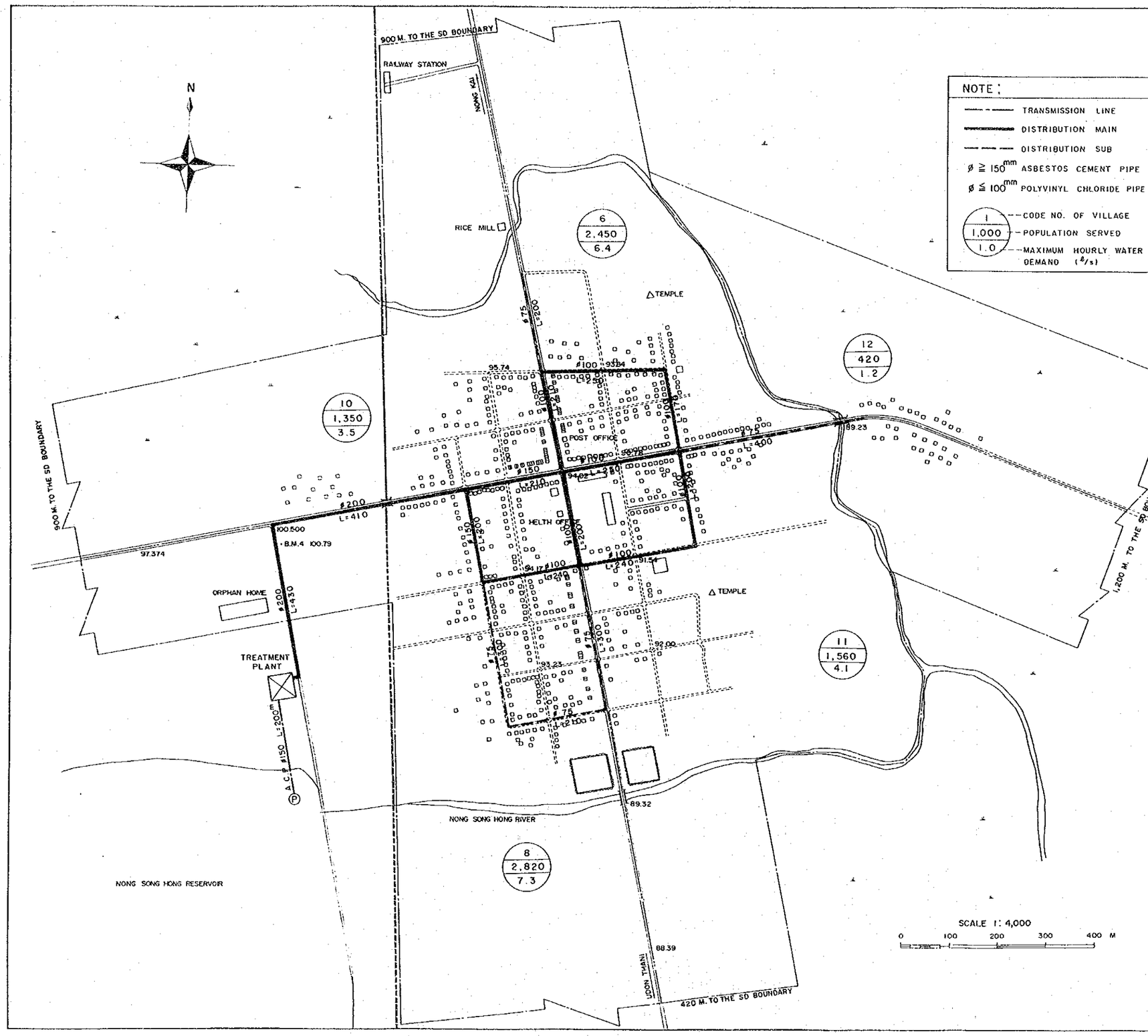
KINGDOM OF THAILAND MINISTRY OF INTERIOR
PUBLIC WORKS DEPARTMENT

THE SANITARY DISTRICT WATER WORKS PROJECT
IN THE NORTH EASTERN REGION OF THAILAND

PHON CHAROEN (NSD-17)
INSTALLATION PLAN OF DISTRIBUTION PIPE

DATE		DWG	18

JAPAN INTERNATIONAL COOPERATION AGENCY

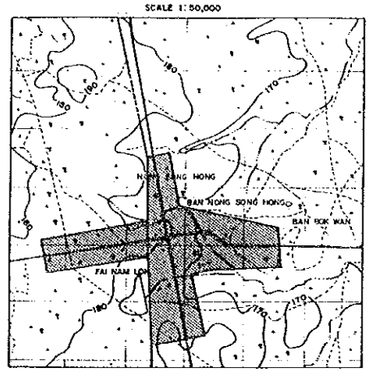


NOTE :

- TRANSMISSION LINE
- DISTRIBUTION MAIN
- DISTRIBUTION SUB
- $\phi \geqq 150^{mm}$ ASBESTOS CEMENT PIPE
- $\phi \leqq 100^{mm}$ POLYVINYL CHLORIDE PIPE
- 1 — CODE NO. OF VILLAGE
- 1,000 — POPULATION SERVED
- 1.0 — MAXIMUM HOURLY WATER DEMAND (ℓ/s)

LOCATION MAP

SCALE 1: 50,000



SD DIMENSIONS

NSD NO. 18		
SANITARY DISTRICT		NONG SONG HONG
AMPHOE		MUANG NONG KHAI
CHANGWAT		NONG KHAI
AREA		4.53 Km^2
PROSPECT POPULATION (2,000 YEAR)		12,310
PROSPECT SERVED POPULATION (2,000 YEAR)		8,600
WATER DEMAND (DAILY MAXIMUM)		1,290 m^3/DAY
WATER SOURCE		NONG SONG HONG RESERVOIR
TRANSMISSION MAIN	LENGTH	0 20 Km
	DIAMETER	ø = 150 mm
TREATMENT CAPACITY		53 m^3/h
DISTRIBUTION MAIN		ø = 100~200 mm

LEGEND

- SD BOUNDARY
- VILLAGE BOUNDARY
- PAVED ROAD
- UNPAVED ROAD
- RAILWAY
- HOUSE
- POND
- RIVER

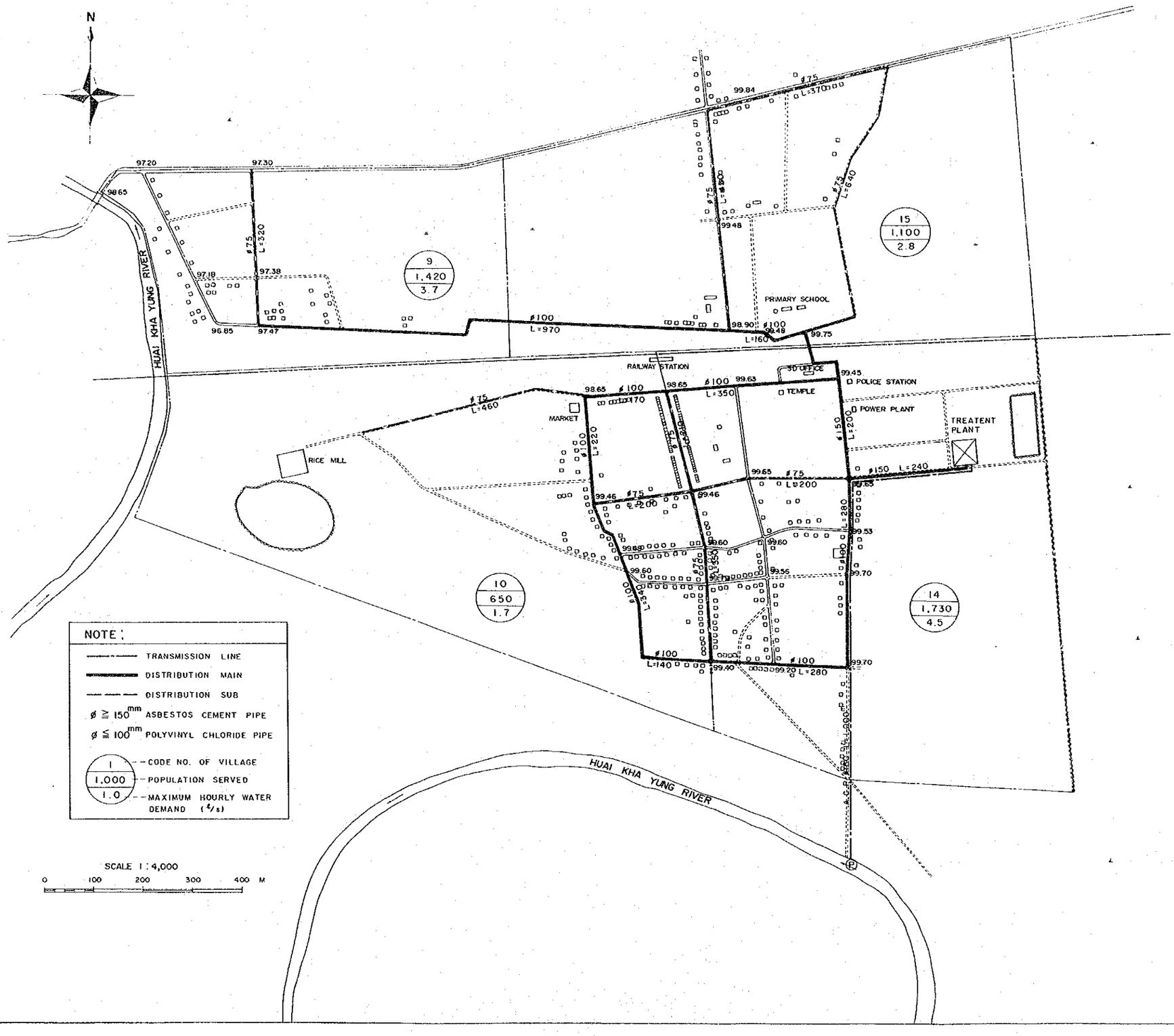
KINGDOM OF THAILAND MINISTRY OF INTERIOR
PUBLIC WORKS DEPARTMENT

THE SANITARY DISTRICT WATER WORKS PROJECT
IN THE NORTH EASTERN REGION OF THAILAND

NONG SONG HONG (NSD-18)
INSTALLATION PLAN OF DISTRIBUTION PIPE

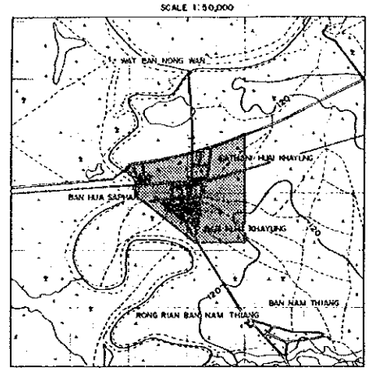
DATE		DWG	19

JAPAN INTERNATIONAL COOPERATION AGENCY



LOCATION MAP

SCALE 1:50,000



SD DIMENSIONS

NSD NO. 20		
SANITARY DISTRICT		HUAI KHA YUNG
AMPHOE		WARIN CHAMRAP
CHANGWAT		UBON RATCHATHANI
AREA		2.80 Km^2
PROSPECT POPULATION (2,000 YEAR)		7,011
PROSPECT SERVED POPULATION(2,000 YEAR)		4,900
WATER DEMAND (DAILY MAXIMUM)		735 m^3/DAY
WATER SOURCE		HUAI KHA YUNG RIVER
TRANSMISSION MAIN	LENGTH	1.0 Km
	DIAMETER	ø = 150 mm
TREATMENT CAPACITY		31 m^3/h
DISTRIBUTION MAIN		ø = 100~150 mm

LEGEND

- SD BOUNDARY
- VILLAGE BOUNDARY
- PAVED ROAD
- UNPAVED ROAD
- RAILWAY
- HOUSE
- POND
- RIVER

KINGDOM OF THAILAND MINISTRY OF INTERIOR
PUBLIC WORKS DEPARTMENT

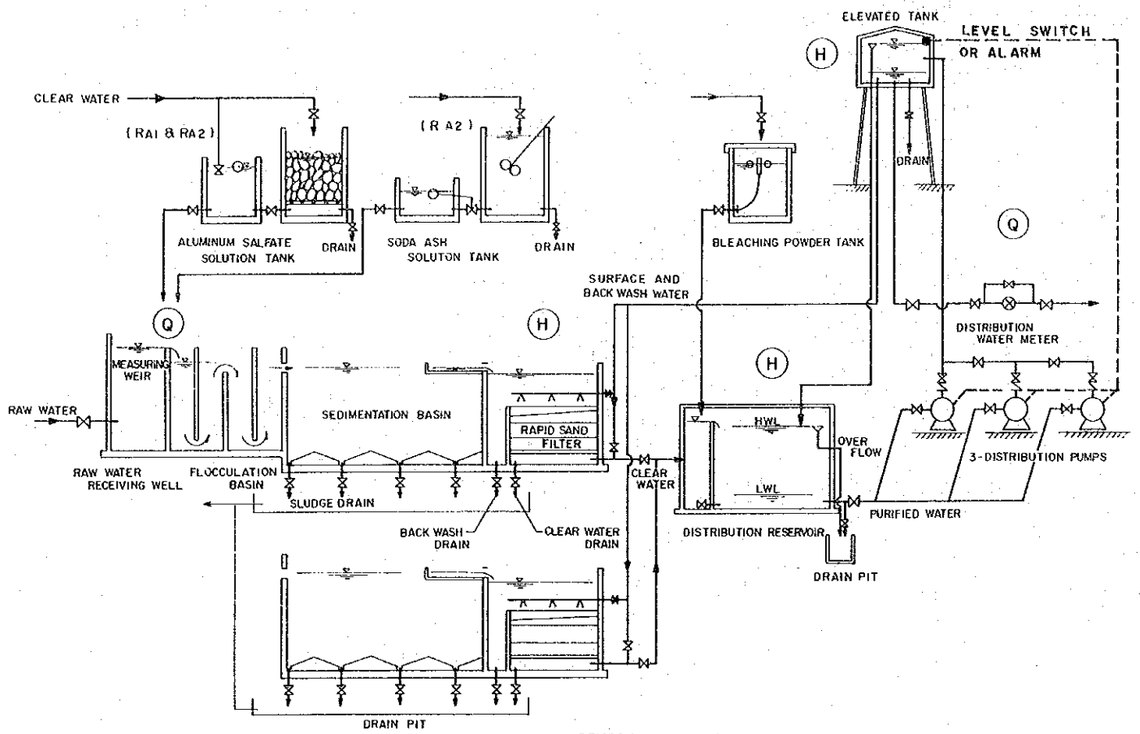
THE SANITARY DISTRICT WATER WORKS PROJECT
IN THE NORTH EASTERN REGION OF THAILAND

HUAI KHA YUNG (NSD-20)

INSTALLATION PLAN OF DISTRIBUTION PIPE

DATE		DWG	20

JAPAN INTERNATIONAL COOPERATION AGENCY

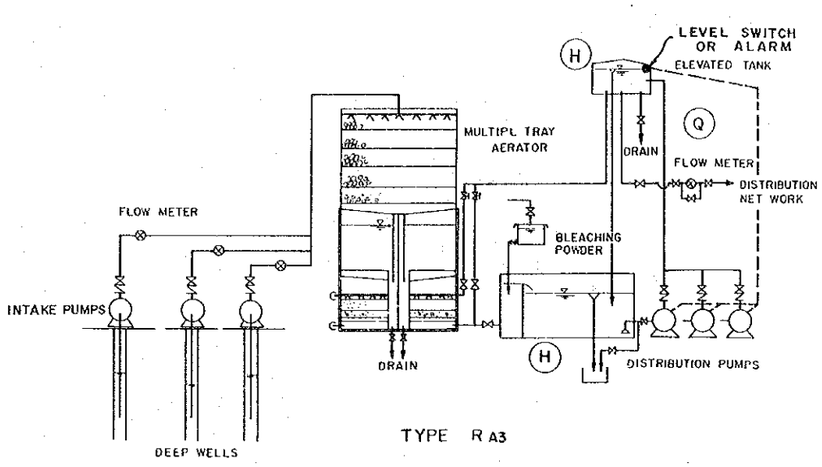


REMARK

Ⓠ MEASURING OF WATER QUANTITY

Ⓗ MEASURING OF WATER LEVEL

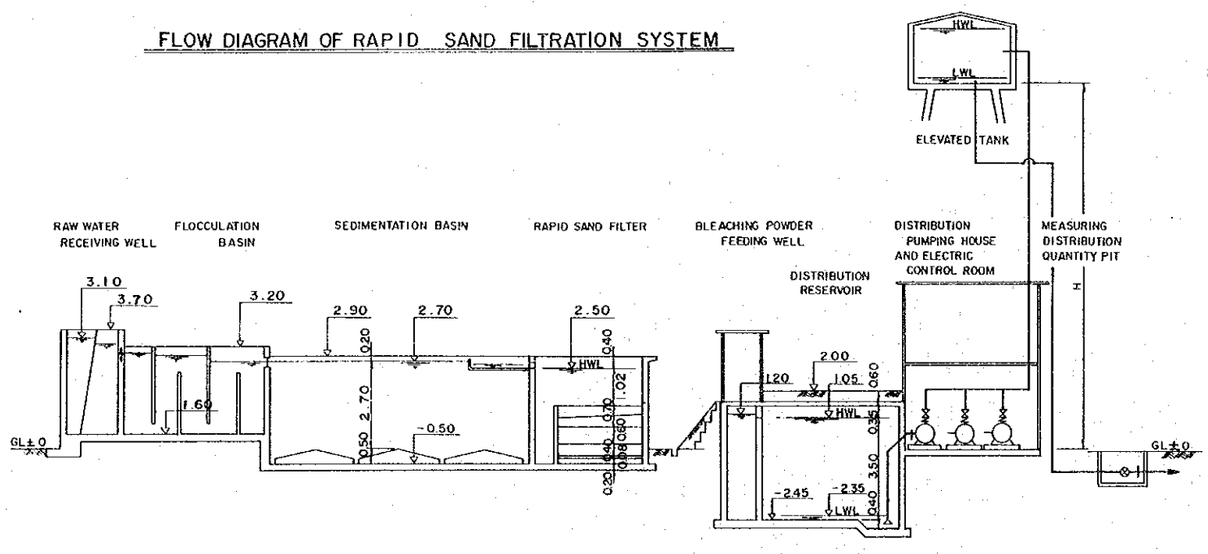
TYPE RA1, RA2



TYPE RA3

FLOW DIAGRAM OF AERATION AND RAPID SAND FILTRATION

FLOW DIAGRAM OF RAPID SAND FILTRATION SYSTEM



HYDRAULIC PROFILE OF A RAPID SAND FILTRATION SYSTEM

DIMENSIONS

NSD NO	TYPE	CAPACITY				CHEMICAL FEEDING		
		TREAT	O.RESERVOIR	E. TANK	PUMP	ALUM	SODA	B.POWDER
		m^3/h	m^3	m^3 x m	kw			
5	RA1	38	250	80 x 18	ø 80x55x3	○	—	○
6	-do-	28	200	60 x 18	ø 65x37x3	○	—	○
7	-do-	83	500	160 x 18	ø100x11x3	○	—	○
8	-do-	105	600	200 x 18	ø125x11x3	○	—	○
10	-do-	31	200	60 x 14	ø 65x37x3	○	—	○
12	RA2	31	200	60 x 14	ø 65x37x3	○	○	○
13	RA3	39	250	80 x 18	ø 80x55x3	○	—	○
17	RA2	66	400	120 x 14	ø100x75x3	○	○	○
18	RA2	53	300	100 x 14	ø 80x55x3	○	○	○
20	RA2	31	200	60 x 18	ø 65x55x3	○	○	○

NOTE

THE ELEVATIONS ARE TYPICALLY INDICATED FROM GROUND LEVEL.

KINGDOM OF THAILAND MINISTRY OF INTERIOR
PUBLIC WORKS DEPARTMENT

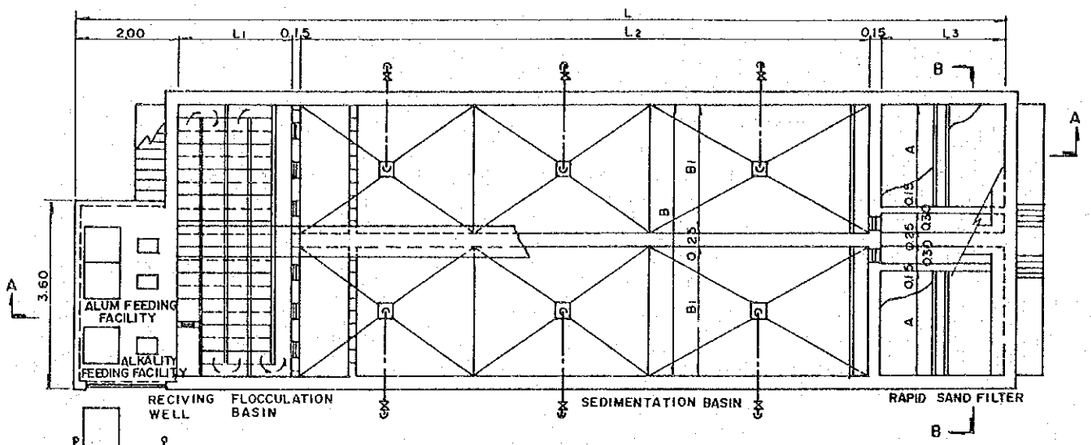
THE SANITARY DISTRICT WATER WORKS PROJECT IN THE NORTH EASTERN REGION OF THAILAND

TYPICAL DRAWING
FLOW DIAGAM AND HYDRAULIC PROFILE FILTRATIDN SYSTEM

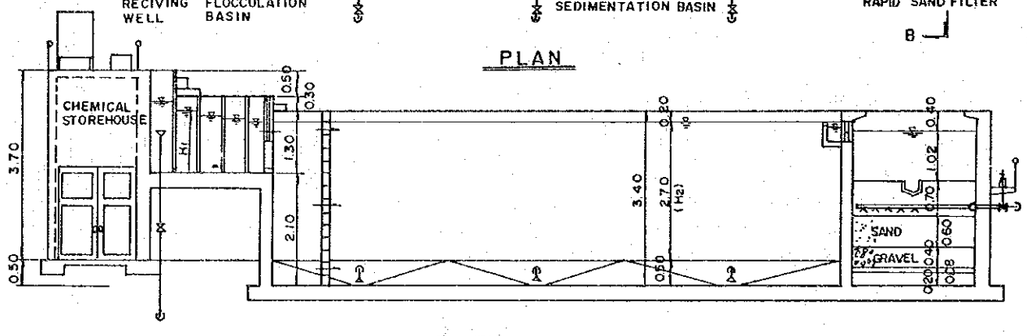
DATE		DWG	21

JAPAN INTERNATIONAL COOPERATION AGENCY

TYPE "A" TREATMENT PLANT

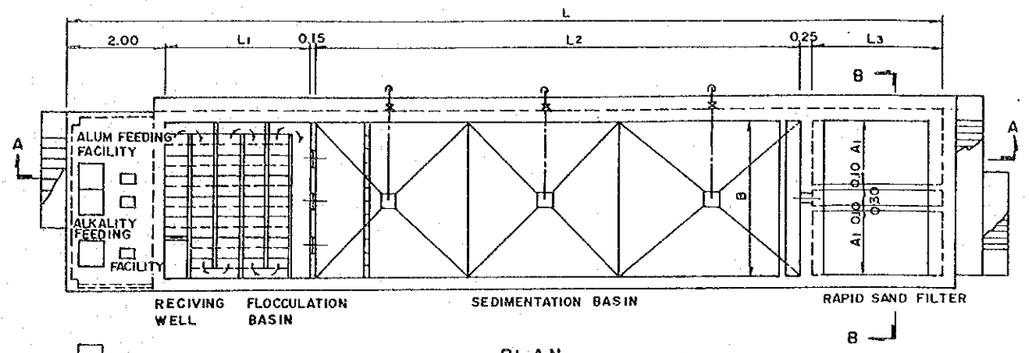


PLAN

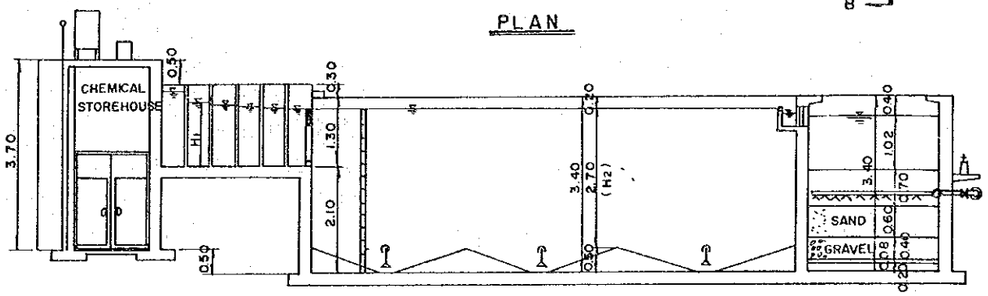


SECTION A-A

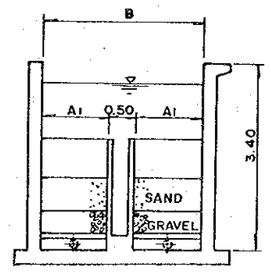
TYPE "B" TREATMENT PLANT



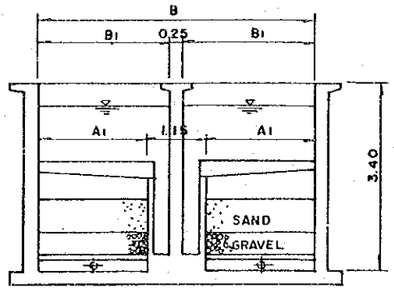
PLAN



SECTION A-A



SECTION B-B



SECTION B-B

DESIGN STANDARD ON THE RAPID SAND FILTRATION

UNIT: METER

TYPE	CAPACITY (Cum/H)	N S D	L	RECIVING WELL & FLOCCULATION BASIN			SEDIMENTATION BASIN			RAPID SAND FILTER		REMARKS
				L1	B	H1	L2	2 x B1	H2	L3	2 A1	(FEEDING)
A	50 ±	NSD-18 NONG SONG HONG	18.70	2.40	5.25	1.30	11.50	2 x 2.50	2.70	2.40	2x2.05	ALUM ALKALITY
	60 ±	NSD-17 PHON CHAROEN	18.70	2.40	6.25	1.30	11.50	2 x 3.00	2.70	2.40	2x 2.55	ALUM ALKALITY
	80 ±	NSD-7 HUAI THALAENG	19.10	2.60	7.85	1.30	11.70	2 x 3.80	2.70	2.40	2x 3.35	ALUM
	100 ±	NSD-8 NONG KI	19.40	2.60	9.45	1.30	12.00	2x 4.60	2.70	2.40	2x 4.15	ALUM
B	30 ±	NSD-6 NONG BUA LAI	19.20	2.90	3.00	1.30	11.50	3.00	2.70	2.40	2x 1.25	ALUM
		NSD-10 HUAI RAT										ALUM
		NSD-12 KHUN HAN										ALUM ALKALITY
		NSD-20 HUAI KYA YUNG										ALUM ALKALITY
	40 ±	NSD-5 KHAM SAKAE SANG	19.40	2.90	3.80	1.30	11.70	3.80	2.70	2.40	2x1.65	ALUM
		NSD-13 KUSUMAN	—	—	—	—	—	—	—	2.40	2x1.65	—

KINGDOM OF THAILAND MINISTRY OF INTERIOR
PUBLIC WORKS DEPARTMENT

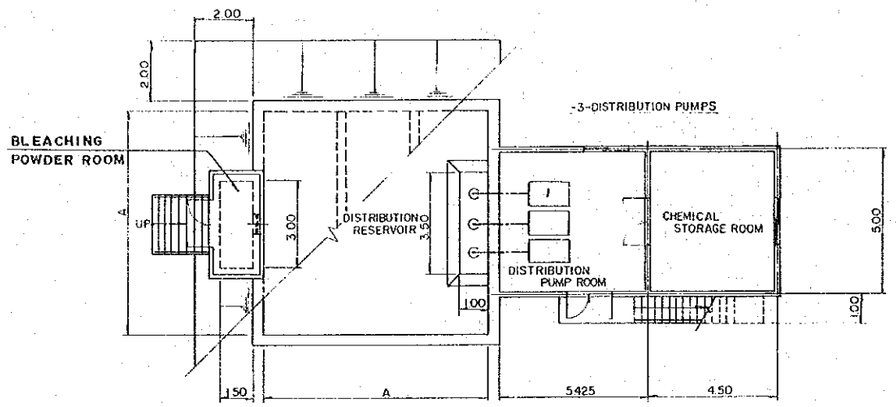
THE SANITARY DISTRICT WATER WORKS PROJECT
IN THE NORTH EASTERN REGION OF THAIL AND

TYPICAL DRAWING
WATER TREATMENT PLANT

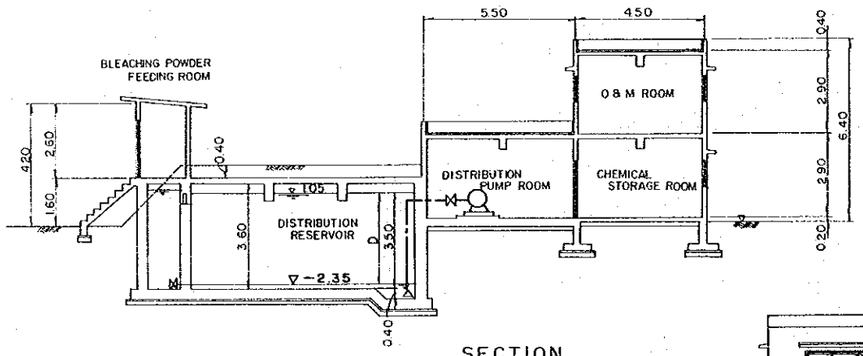
DATE		DWG	22

JAPAN INTERNATIONAL COOPERATION AGENCY

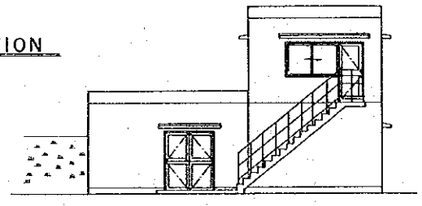
DISTRIBUTION RESERVOIR



PLAN



SECTION

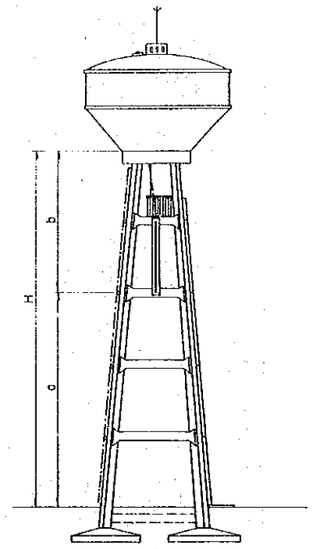


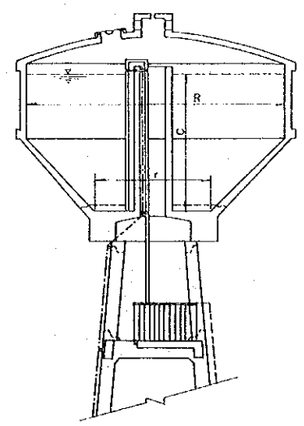
ELEVATION

DIMENSINS

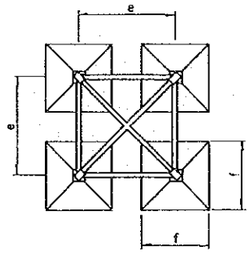
CAPACITY	N. S. D		A m	D m	
200 cum	6	NONG BUA LAI	7.50	3.40	
	10	HUAI RAT	〃	〃	
	12	KHUN HAN	〃	〃	
	20	HUAI KYA YUNG	〃	〃	
250	5	KHAM SAKAE SANG	8.50	〃	
	13	KUSUMAN	〃	〃	
300	18	NONG SONG HONG	9.50	〃	
400	17	PHON CHAROEN	10.50	3.40	
500	7	HUAI THALAENG	12.00	3.40	
600	8	NONG KI	13.50	3.40	

ELEVATED TANK





ELEVATION



DIMENSIONS

CAPACITY	TYPE	NSD. NO	H (m)	a m	b m	c m	e m	f m	R m	r m
60 cum	A	6 , 20	18.00	3.60x5	—	3.10	4.00	3.00	6.00	2.70
	B	10 , 12	14.00	3.60x3	3.20	〃	〃	〃	〃	〃
80	—	5 , 13	18.00	3.60x5	—	3.30	4.50	3.50	6.50	3.00
100	—	18	14.00	3.60x3	3.20	3.55	5.00	3.50	7.00	3.20
120	—	17	14.00	3.60x3	3.20	3.80	5.00	4.00	7.50	3.50
160	—	7	18.00	3.60x5	—	4.05	5.50	4.00	8.00	4.00
200	—	8	18.00	3.60x5	—	4.55	6.00	4.00	8.50	4.00

KINGDOM OF THAILAND MINISTRY OF INTERIOR
PUBLIC WORKS DEPARTMENT

THE SANITARY DISTRICT WATER WORKS PROJECT
IN THE NORTH EASTERN REGION OF THAILAND

TYPICAL DRAWING
DISTRIBUTION RESERVOIR & ELEVATED TANK

DATE | DWG 23

JAPAN INTERNATIONAL COOPERATION AGENCY