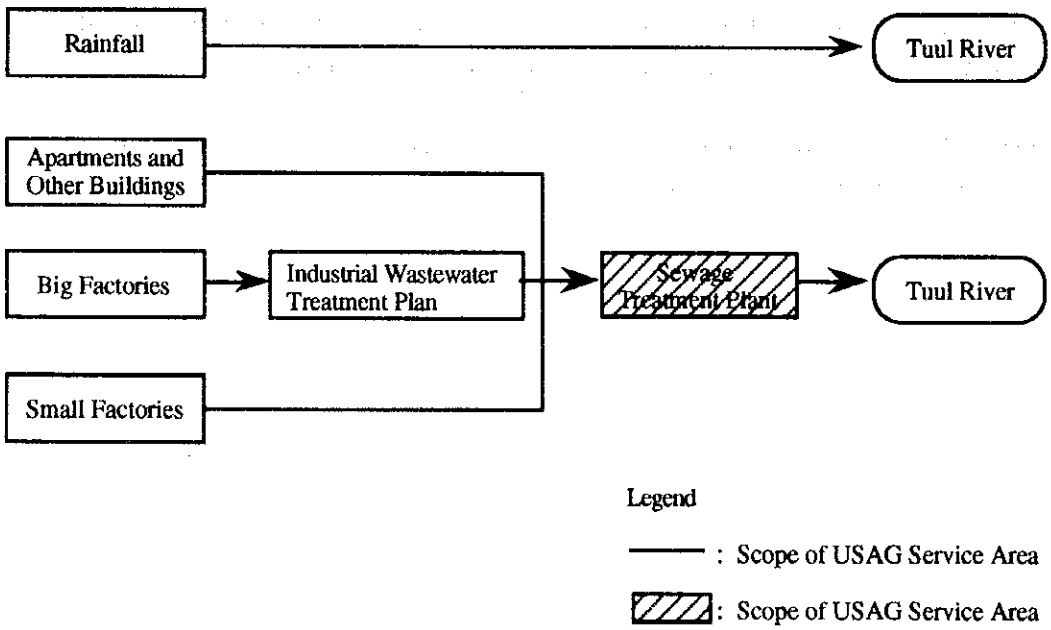
1.3. PRESENT CONDITIONS OF SEWERAGE SYSTEM

1.3.1 Sewage Collection System

The sewage collection system of Ulaanbaatar City is separate sewer system, since the average annual rainfall is only about 300 mm in the city.

Sewage is conveyed by gravity flow through sewer pipeline from service area including industrial area, to sewage treatment plant. Therefore the pumping stations for sewage are not necessary in this system. Sewerage system diagram is given in below



[Sewerage System Diagram]

1.3.2 Sewage Treatment Plant

(1) Present Situation of Equipment

1) Location

The sewage treatment plant is located about 12 Km west from center of Ulaanbaatar City. The location is shown in Fig III.1.10.

2) Sewage Quantity

The inflow waste water quantity of sewage treatment plant is as follows.

Design Flow Rate : 230,000 m^3/day
Actual Flow Rate : 190,000 m^3/day (in Sep. ,1993)

3) Construction Year

The construction year of sewage treatment plant is as follows.

1963 : Mechanical Equipment
(Screen, Primary Sedimentation Tank, etc.)
These facilities are not being used at present because they are deteriorated.

1968 : Mechanical Equipment
(New Primary Sedimentation Tank, etc.)
These facilities have an ability enough at present and are working.

1979 : Biological Equipment
(Aeration Tank, final sedimentation Tank, drying Beds, etc.)
These facilities have enough capacities at present and are working.

4) Sewage Treatment System

A Conventional Activated Sludge Process is adopted for the sewage treatment, which is shown in Fig III.1.11.

5) Condition of Sewage Treatment

The treatment function in the treatment plant is sufficient and condition of treatment is very well. Suspended solid of treated waste water looks like about less than 20 mg/l and transparency by cylinder test was more than two (2) meters.

The results of measurement of sludge volume (SV30) of mixed liquor in an aeration tank conducted by Study Team on November, 1993 are as follows. From this result, the treatment condition is very good.

Time (Minute)	0	5	10	15	20	25	30
Sludge Volume (%)	100	—	53	45	40	36	34

Present conditions of main equipment are as follows.

(i) Screen and Grit Chamber

The auto mechanical screen is already broken. However, it can be used by manual operation at present.

Grit chamber is working in good condition. The meader type is adopted for sludge collectors.

(ii) Primary Sedimentation Tank

The four (4) primary sedimentation tanks are working in good condition. The supernatant of them are clean also.

Main specification are described follows.

Type : Circular Type

Diameter * Nos : 24 m * 4
Sludge Collector : Circumference Drive Type

(iii) Aeration Tank

Mixing intensity and color of mixed liquor were satisfactory. Also condition of the sludge coagulation in the aeration tanks was very good.

Main specifications are as follows.

Type : Rectangular Type
Capacity : 230,000 m^3
Retention Time : 24 hour

(iv) Final Sedimentation Tank

Five (5) final sedimentation tanks are working in good condition also. The supernatant of them are clean.

Main specification of them are as follows.

Type : Circular Type
Diameter * Nos : 24 m * 5
Sludge Collector : Circumference Drive Type

(v) Sludge Treatment Equipment

Sludge digestion method was adopted in the beginning. However, sludge drying bed system are used at present.

Type : Sludge Drying Bed
Total Area : 13 ha
Unit Area * Nos : 0.325 ha * 40

6) Treated Wastewater

Treated waste water is being discharged to Tuul River.

7) Wastewater Quality Analysis of Sewage Treatment Plant

The results of water quality analysis for the past 5-years in term of Suspended Solid and Biochemical Oxygen Demand conducted by USAG are shown in following table.

Results of actual monthly water quality analysis of recent 5-years for raw waste water and treated waste water are given in Appendix III.1.11.

Results of Water Quality Analysis of Past 5-Years (Average)

Item	Raw Wastewater (mg/l)	Treated Wastewater (mg/l)	Removal Ratio (%)
Suspended Solid [SS]	237.78	15.38	93.12
Biochemical Oxygen Demand [BOD]	54.32	22.49	90.80

8) Industrial Wastewater Treatment

The effluent standard for discharging to sewerage system was enacted by the joint decision of Ministry of Communal Service , Ministry of Water Industry and Ministry of Health on 26 August, 1980 (Ref. No. 244/197/219). It is shown in following table. In case that water quality of treated water from industrial waste water treatment plant, which flows into sewer pipe, does not clear the above standard, the factory has to pay some penalties. Penalties are as follows.

(a) To stop the operation.

(b) To pay three (3) times of normal sewer charge.

(c) Others

The Effluent Standards to Public Sewerage System

No	Items	Allowable Limit Value (mg/l)	For Reference Standard in TOKYO
1	pH	-	5.7 to 8.7
2	Biochemical Oxygen Demand [BOD]	400.00	300.00
3	Chemical Oxygen Demand [COD]	500.00	-
4	Suspended Solid [SS]	500.00	300.00
5	Oil (Mineral)	25.00	5.00
6	Oil (Animals & Vegetables)	-	30.00
7	Copper [Cu]	0.50	3.00
8	Tin [Sn]	0.10	-
9	Selenium [Se]	0.10	-
10	Chromium (Valence of three) [Cr3]	2.50	-
11	Chromium (Total) [T-Cr]	-	2.00
12	Arsenic [As]	0.10	0.50
13	Mercury (Total) [T-Hg]	0.01	0.01
14	Zinc [Zn]	1.00	1.00
15	Sulfide [S]	1.00	-
16	Phenol	5.00	5.00
17	Nickel [Ni]	0.50	-
18	Cadmium [Cd]	0.10	0.10
19	Cobalt [Co]	0.10	-
20	Cyanide [CN]	1.50	1.00
21	Nitrogen (Total) [T-N]	30.00	-

Outline of the industrial waste water from leather factories is as follows.

(i) Kind of Factories : Manufacture of Leather,

(ii) Wastewater Quantity : 13,000 m^3/day (Actual Flow) (on September 1993)

: 21,000 m^3/day (Design Flow)

(iii)	Wastewater Treatment Process	:	Neutralization, Coagulation and Sedimentation Process
(iv)	Sludge Treatment Process	:	Drying Bed System.
(v)	Results of Water Quality Analysis	:	Refer to Table III.1.6 and Table III.1.7

Many data exceed the standard, which shows that the treatment plant, being operated and maintained by the factory, is not work due to deterioration of the facilities.

9) Sewer Pipe List

The diameter, materials and length of existing sewer pipeline is shown in the following table.

List of Sewer Pipeline

Pipe Diameter (mm)	Concrete Pipe		Cast Iron Pipe		Vitrified-Clay Pipe		Total Length
	Length (m)	Construction Year	Length (m)	Construction Year	Length (m)	Construction Year	
1400	10,180	1983~1988	0		0		10,180
1200	8,860	1966~1968	0		0		8,860
1100	0		0		0		0
1000	6,290	1983~1984	0		0		6,290
900	0		2,060	1988~1989	0		2,060
800	2,795	1960~1989	0		0		2,795
700	0		0		0		0
600	13,370	1960~1978	0		900	1959~1960	14,270
500	2,150	1970~1984	0		0		2,150
400	11,320	1970~1984	0		2,640	1957~1960	13,960
300	7,820	1972~1984	0		1,560	1957~1960	9,380
250	1,600	1970~1976	0		1,170	1957~1960	2,770
200	4,920	1970~1976	0		1,530	1957~1960	6,450
150	0		0		1,270	1957~1960	1,270
100	0		0		0		0
Total	**69,305**		**2,060**		**9,070**		**80,435**

(2) Operation and Maintenance

1) Operation Method for Sewage Treatment Plant

Operation method of the plant is a manual operation at machine side. However, an automatic operation is adopted for pumps depending on the water level.

2) Countermeasure for Power Failure

The countermeasures for power failure such as generator, two (2) lines power supply system and so on are not provided. However, there has not been a major trouble in the past.

3) Present Situation of Operation and Maintenance

(i) Mechanical Equipment

The damaged mechanical equipment is only auto system of the coarse and fine screens. Other mechanical equipment such as rake of sedimentation tanks, pumps, aeration blowers and so on are in good condition. The equipment is better than pumping stations and intake water wells of the water supply system.

(ii) Electrical and Instrumentation Equipment

The equipment look deteriorated. Flow meters and pressure gages are removed. Electrical equipment looks unsafe.

4) Water Analysis Center

In the laboratory, analysis for items required for operation management is conducted sufficiently.

5) Organization

The organization is as follows. Their works are operation, maintenance, checking and small repairing.

Engineer	(5 persons)	:	Working Time 8 Hours/Day
Laboratory	(6 persons)	:	Working Time 8 Hours/Day
Sift Workers	(100 persons)	:	Working Time 12 Hours/Day
Service Workers	(21 persons)	:	4 Group * 2 Shift/Day
Total	132 persons		

6) Sewer Charge

A sewer charge system consists of two(2) kinds of tariff system. One is for households, and the other is for factories, hospitals, community buildings, etc.

General Family : 6.7 Tg/m^3

Others : 39.0 Tg/m^3

Table III.1.1 List of Distribution Pumps (No.1)

Name of Pumping Station : Central Water Source Distribution Pumping Station (Old: 4 units; Nos.1-4) (New: 3 units; Nos.5-7)
Number of Pump Installed : 4+3= 7 units
Type of Pump : Double-suction volute pump

No. of Pump	Pump Specifications						Year of Installation	Present Condition as of Oct. 1993			Pump to be Replaced
	Diameter (mm)	Flow rate (m3/h)	Head (m)	Volt (V)	Motor Power (kw)	rpm		Workable	Minor Damage	Heavy Damage	
No.1	300 x250	630	90	380 50Hz	250	1,470	1959 ->1990			√	√
No.2	300 x250	540	94	380 50Hz	200	1,475	1959 ->1969	√			√
No.3	300 x250	630	90	380 50Hz	200	1,475	1959 ->1987	√			√
No.4	300 x250	540	94	380 50Hz	200	1,475	1959 ->1962			√	√
No.5	500 x300	2,000	100	6000 50Hz	800	1,000	1972 ->1985		√		-
No.6	500 x300	1,750	88	6000 50Hz	630	1,000	1972	√			√
No.7	500 x300	2,000	100	6000 50Hz	800	1,000	1972 ->1985		√		-

Table III.1.2 List of Distribution Pumps (No.2)

Name of Pumping Station : Tasgan Pumping Station
Number of Pump Installed : 4 units
Type of Pump : Double-suction volute pump

No. of Pump	Pump Specifications						Year of Installation	Present Condition as of Oct. 1993			Pump to be Replaced
	Diameter (mm)	Flow rate (m^3/h)	Head (m)	Volt (V)	Motor Power (kw)	rpm		Workable	Minor Damage	Heavy Damage	
No.1	300 x250	630	90	380 /660	160	1,475	1984			√	√
No.2	300 x250	630	90	380 /660	160	1,475	1984	√			-
No.3	300 x250	630	90	380 /660	160	1,475	1984		√		-
No.4	300 x250	630	90	380 /660	160	1,475	1984	√			-

Table III.1.3 List of Distribution Pumps (No.3)

Name of Pumping Station : Industrial Pumping Station
Number of Pump Installed : 4 units
Type of Pump : Double-suction volute pump

No. of Pump	Pump Specifications						Year of Installation	Present Condition as of Oct. 1993			Pump to be Replaced
	Diameter (mm)	Flow rate (m^3/h)	Head (m)	Volt (V)	Motor Power (kw)	rpm		Workable	Minor Damage	Heavy Damage	
No.1	400 x300	900	60	380 /660	200	1,470	1973	√			-
No.2	300 x250	630	90	380 /660	250	1,475	1987		√		√
No.3	300 x250	630	60	380 /660	200	1,470	1987		√		-
No.4	400 x300	900	60	380 /660	200	1,475	1962	√			√

Table III.1.4 List of Distribution Pumps (No.4)

Name of Pumping Station : Meat Complex Pumping Station
Number of Pump Installed : 4 units
Type of Pump : Double-suction volute pump

No. of Pump	Pump Specifications						Year of Installation	Present Condition as of Oct. 1993			Pump to be Replaced
	Diameter (mm)	Flow rate (m^3/h)	Head (m)	Volt (V)	Motor Power (kw)	rpm		Workable	Minor Damage	Heavy Damage	
No.1	300 x250	630	90	380 /660	250	1,475	1988 ->1992	√			-
No.2	300 x250	630	90	380 /660	250	1,470	1990 ->1992	√			-
No.3	300 x250	500	65	380 /660	160	1,475	1988 ->1992	√			-
No.4	300 x250	500	65	380 /660	160	1,475	1985 ->1992	√			-

Table III.1.5 List of Distribution Pumps (No.5)

Name of Pumping Station : Upper Source Pumping Station
Number of Pump Installed : 6 units
Type of Pump : Double-suction volute pump

No. of Pump	Pump Specifications						Year of Installation	Present Condition as of Oct. 1993			Pump to be Replaced
	Diameter (mm)	Flow rate (m^3/h)	Head (m)	Volt (V)	Motor Power (kw)	rpm		Workable	Minor Damage	Heavy Damage	
No.1	400 x300	1,000	180	6000 50Hz	630	1,500	P1989 M1988	√			-
No.2	400 x300	1,000	180	6000 50Hz	500	1,500	P1987 M1987			√	√
No.3	400 x300	1,000	180	6000 50Hz	500	1,500	P1987 M1987			√	√
No.4	400 x300	1,000	180	6000 50Hz	500	1,500	P1987 M1987		√		-
No.5	400 x300	1,000	180	6000 50Hz	500	1,500	P1982 M1987		√		-
No.6	400 x300	1,000	180	6000 50Hz	630	1,500	P1989 M1988	√			-

Table III.1.6 Result of the Actual Water Quality Analysis of Industrial Wastewater (1) (Treatment Plant for Leather Factory)

No	Item	Unit	Kind of Factory	January 29, 1992		April 02, 1993		April 04, 1993	
				Inflow	Effluent	Inflow	Effluent	Inflow	Effluent
1	Suspended Solid (SS)	mg/l	Cr Factories	1,693.00		1,699.20		1,146.00	
			Chemical Factories	1,560.00	1,300.00	1,447.00	771.40	375.00	120.00
2	Chemical Oxygen Demand (COD)	mg/l	Cr Factories	1,125.50		1,295.10			
			Chemical Factories	388.10	659.80	3,607.00	1,017.60		
3	Biochemical Oxygen Demand (BOD)	mg/l	Cr Factories			245.90			
			Chemical Factories			475.90	82.00		
4	Oxidability	mg/l	Cr Factories			248.00			
			Chemical Factories			336.00	240.00		
5	Alkalinity	mg/l	Cr Factories			9.00			
			Chemical Factories			19.00	21.00		
6	Ammonia (NH3)	mg/l	Cr Factories	12.50		87.10		20.90	
			Chemical Factories	8.30	10.70	70.20	50.50	16.00	19.00
7	Chromium (Cr3)	mg/l	Cr Factories	18.00		20.00		39.20	
			Chemical Factories	24.00	12.80	16.00	20.00	34.40	36.00
8	Transparency by Cylinder Test	cm	Cr Factories	0.60		0.60			
			Chemical Factories	0.80	1.00	0.70	1.00		
9	Water Temperature	Degree	Cr Factories	15.00		19.00			
			Chemical Factories	15.00	15.00	19.00	19.00		
10	Nitrite (NO2)	mg/l	Cr Factories			12.50			
			Chemical Factories			20.40	9.50		
11	Nitrate (NO3)	mg/l	Cr Factories			0.18			
			Chemical Factories			1.10	1.01		
12	Chloride Ion (Cl)	mg/l	Cr Factories	1,034.10		1,093.10		1,924.00	
			Chemical Factories	551.50	1,275.40	1,468.90	1,639.70	754.20	857.00
13	Oil	mg/l	Cr Factories	156.00		40.00			
			Chemical Factories	20.00	25.00	20.00	20.00		
14	pH	-	Cr Factories	9.00		8.40		7.80	
			Chemical Factories	8.00	9.50	10.90	10.30	10.20	9.90
15	Sulfur (S)	mg/l	Cr Factories	13.90		326.30		12.50	
			Chemical Factories	12.40	6.96	319.00	275.50	31.50	14.00

Table III.1.7 Result of the Actual Water Quality Analysis of Industrial Wastewater (2)
(Treatment Plant for Leather Factory)

1988	Jan.		Feb.		Mar.		Apr.		May		Jun		Jul.		Aug.		Sep.		Oct.		Nov.		Dec.			
Item	INF	EFF	INF	EFF	INF	EFF	INF	EFF	INF	EFF	INF	EFF	INF	EFF	INF	EFF	INF	EFF	INF	EFF	INF	EFF	INF	EFF	Permissible	Unit
SS																	130.9	159.5	98.5	51						mg/l
BOD							110.2	21.4		17									500	800					400	mg/l
NH4							0.05	0.09		1.86															0.39	mg/l
Cr.Toual											3.034	2.548													2.5	mg/l
NO2										0.2	0.506	2.372							0.27	0.376					0.02	mg/l
NO3							3.15	2.51		1.25							1.26	0.79		7.76					10	mg/l
Cl							987.3	1301		965.6	1141.5	625.8						937.9	1261	1392.7					350	mg/l
pH							9.2	8		11.4	11.6	9.3					12	11.8	7.4	11					6.5-8.5	
SO4							234	544		493							284.8	185.2							400	mg/l
DO							630	548		171	26.3	28.1					21.7	21	20.3	20.3					10	mg/l
P							0.383	0.193		0.13							0.094	0.133	0.252	0.099					0.1	mg/l
Fe							2.39	2.39		2.4	1.251	10.5					0.97	0.71	6.1	4.64					0.5	mg/l
Si										40.4															10	mg/l
Oil																									20	mg/l

1989	Jan.		Feb.		Mar.		Apr.		May		Jun		Jul.		Aug.		Sep.		Oct.		Nov.		Dec.			
Item	INF	EFF	INF	EFF	INF	EFF	INF	EFF	INF	EFF	INF	EFF	INF	EFF	INF	EFF	INF	EFF	INF	EFF	INF	EFF	INF	EFF	Permissible	Unit
SS	706	74	1899	911	1103	972	2596	1352	2191.5	720.2	1265.7	917	916	487.2	82	41	1305	717	1246.5	942.2	1410	1153.4	2879.5	1666		mg/l
BOD	390	150	370	350	375	335	310	275	360	260	740	410	310	160	275	100	300	210	13.5	7.87	680	345	680	330	400	mg/l
NH4	17.19	10.71							51	29.4					63.8	24.3									0.39	mg/l
Cr.Total					4.85	4.65			4.58	4.46	22.07	12.06	10.56	8.42					1.166	0.7	1.712	1.232	4.212	2.775	2.5	mg/l
NO2	0.11	0.037							0.4	0.31					0.073	0.021					0.205	0.031			0.02	mg/l
NO3	7.217	5							2.26	0.984					2.118	0.459									10	mg/l
Cl																									350	mg/l
pH	7.7	7.6	11.7	8.7	12.2	12	9.3	9.2	6.82	6.55	11.3	11	12.49	6.45	8.69	6.71	7.9	7.9	12.17	11.37	12.44	11.67	12.19	10.86	6.5-8.5	
SO4																									400	mg/l
DO	92	92	20.8	69.6	75.2	8	312	320	784	308	148.8	249.6	24.2	19.3	7.2	18.4	312	432	139.2	368	476	404	24	23.2	10	mg/l
P			1.02	0.36					0.823	0.272					1.43	0.975									0.1	mg/l
Fe			1.344	1.101									0.274	0.162							0.6	0.14			0.5	mg/l
Si																									10	mg/l
Oil				1.194					1.46						0.329	0.236						0.469			20	mg/l

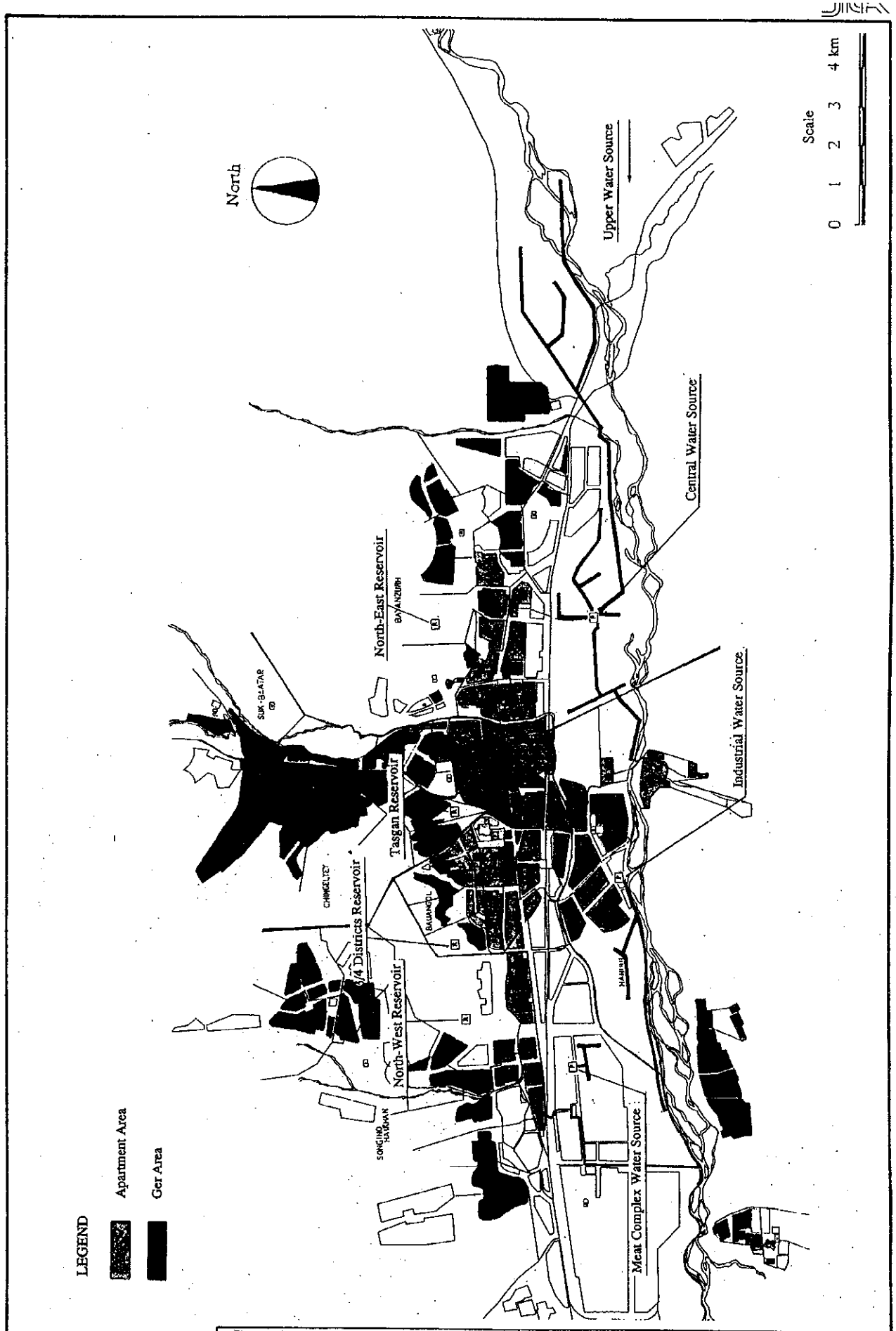


Fig. III.1.1 Service Area by the USAG Water Supply System at Present

JICA	The Study on Water Supply System in Ulaanbaatar and Surroundings

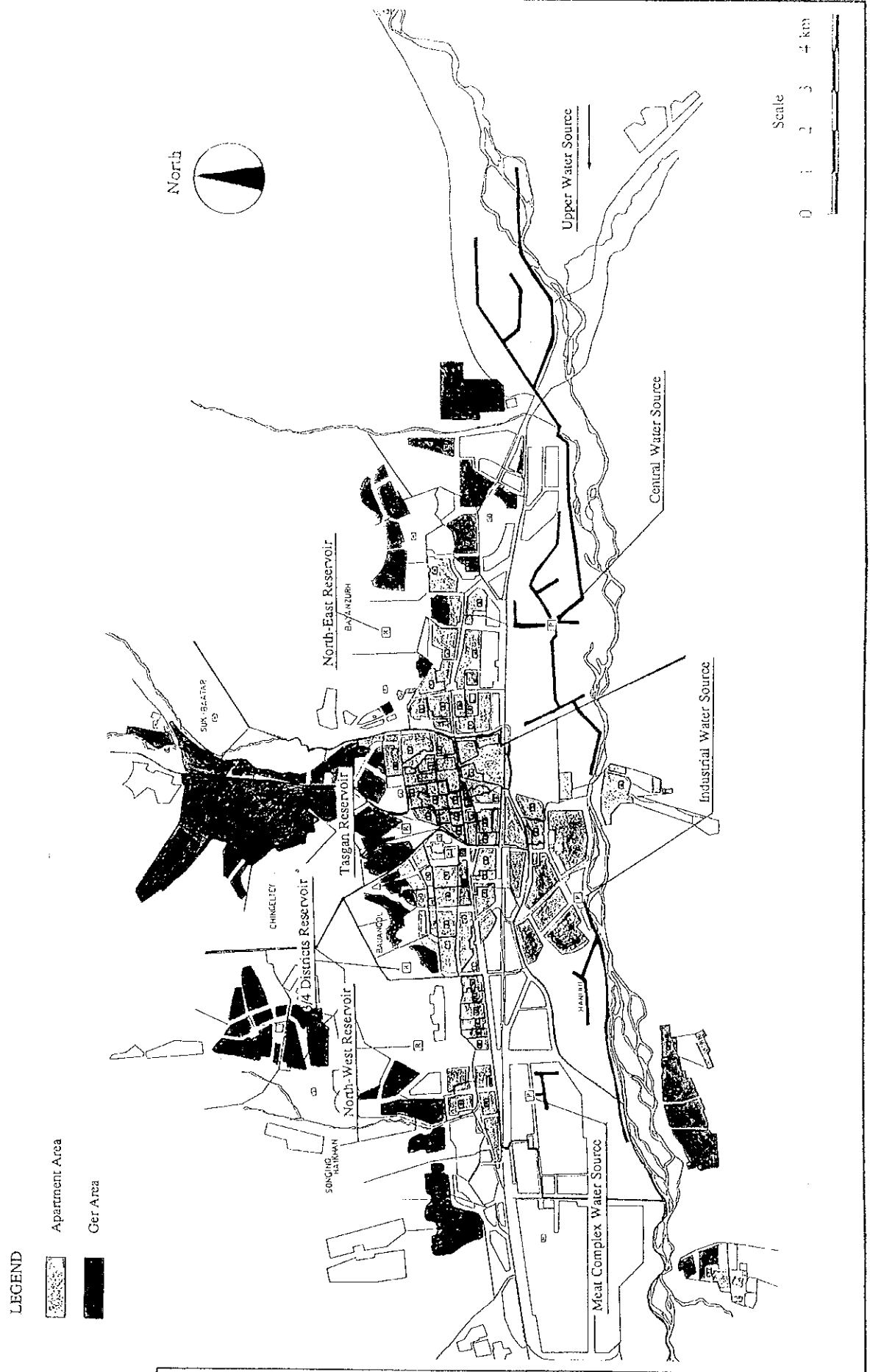


Fig. III.1.1 Service Area by the USAG Water Supply System at Present

JICA | The Study on Water Supply System in Ulaanbaatar and Surroundings

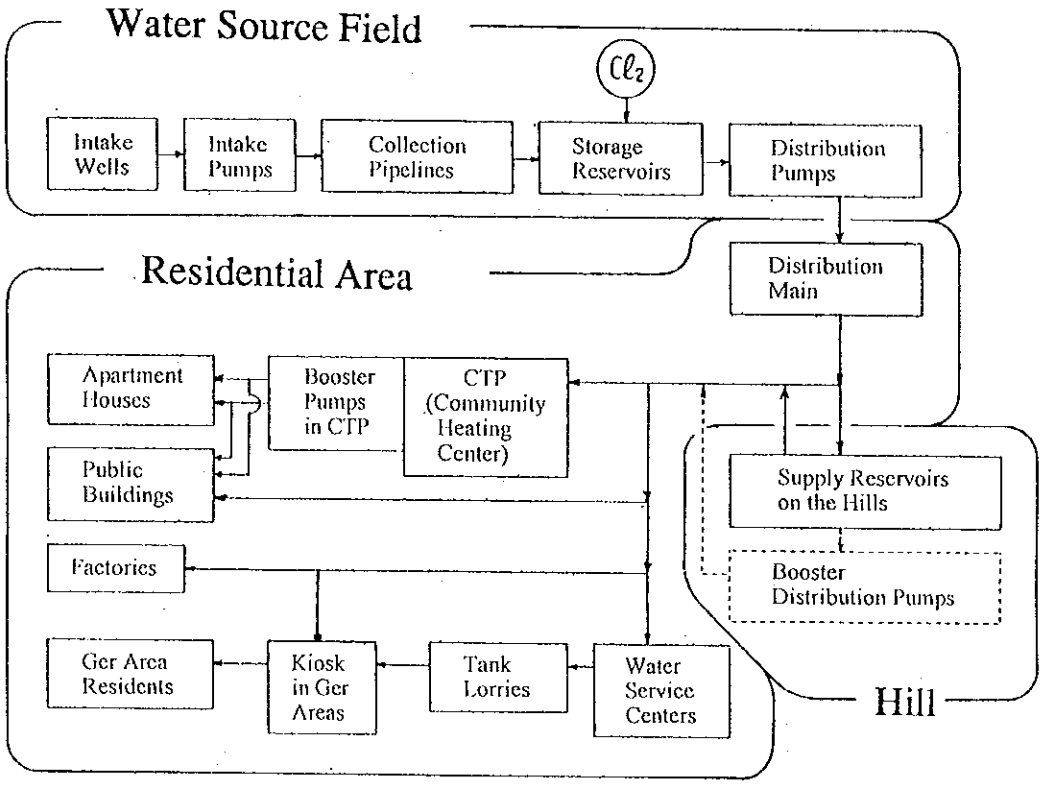


Fig. III.1.2 Flow Chart of Water Supply System in Ulaanbaatar City

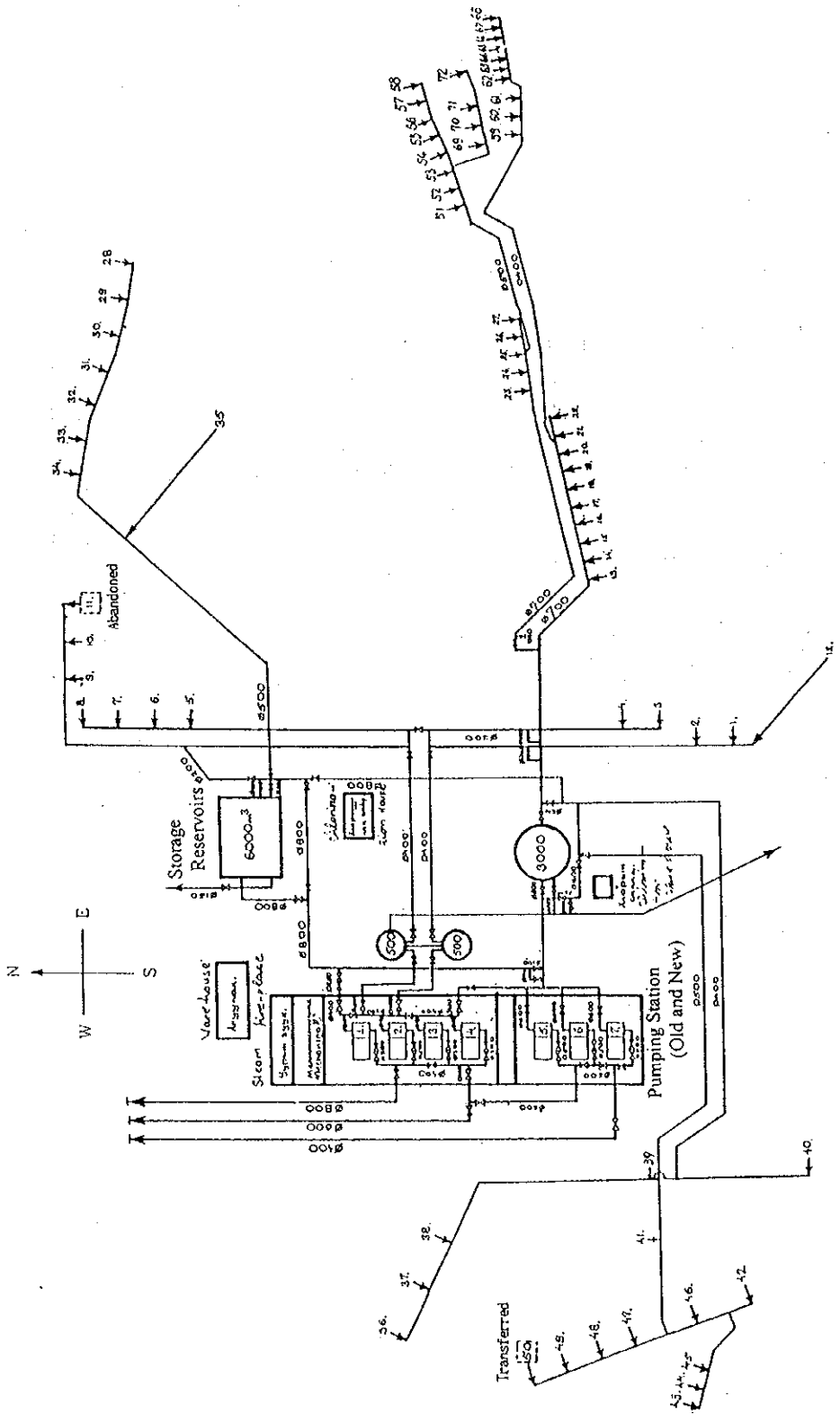


Fig. III.1.3 Central Water Source Schematic Layout

JICA	The Study on Water Supply System in Ulaanbaatar and Surroundings

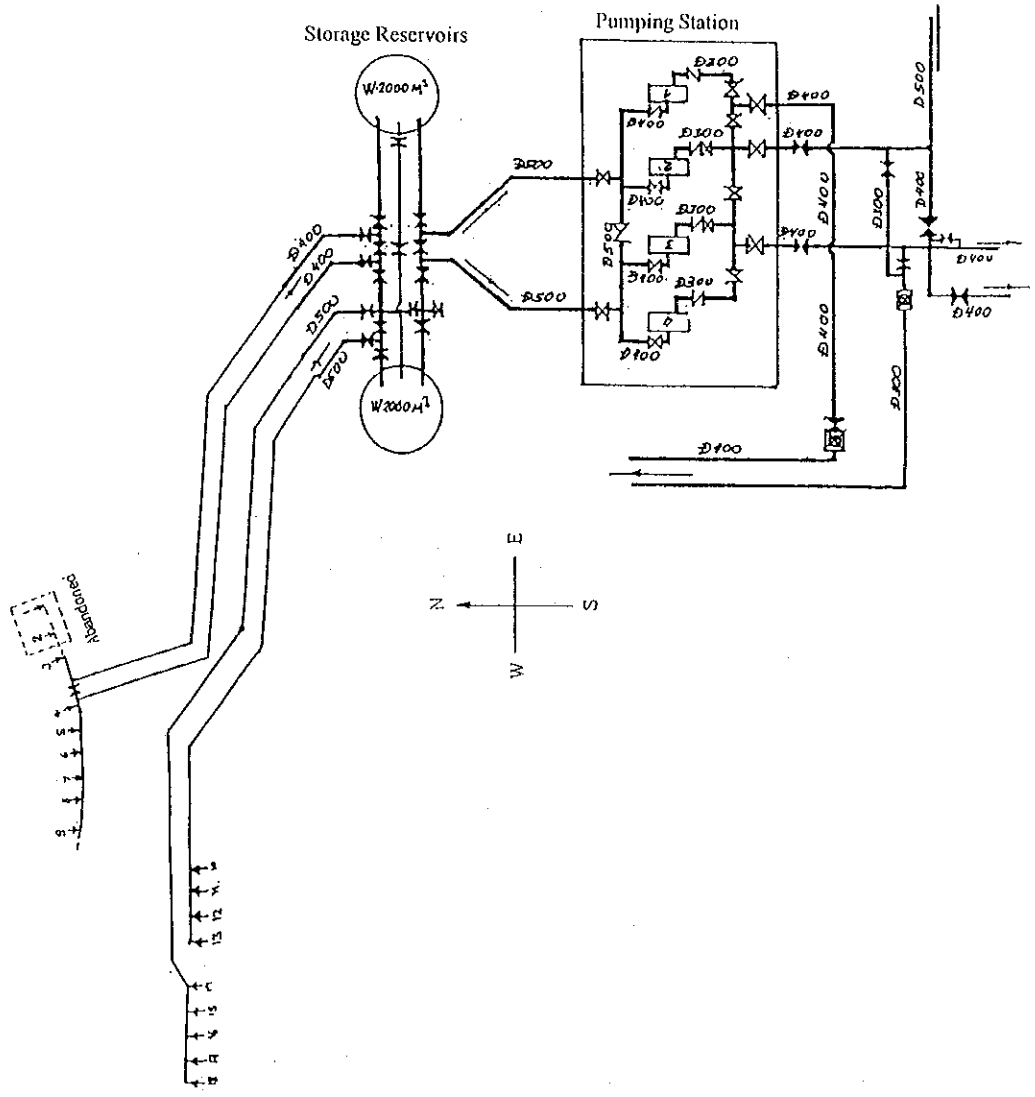


Fig. III.1.4 Industrial Water Source Schematic Layout

JICA	The Study on Water Supply System in Ulaanbaatar and Surroundings

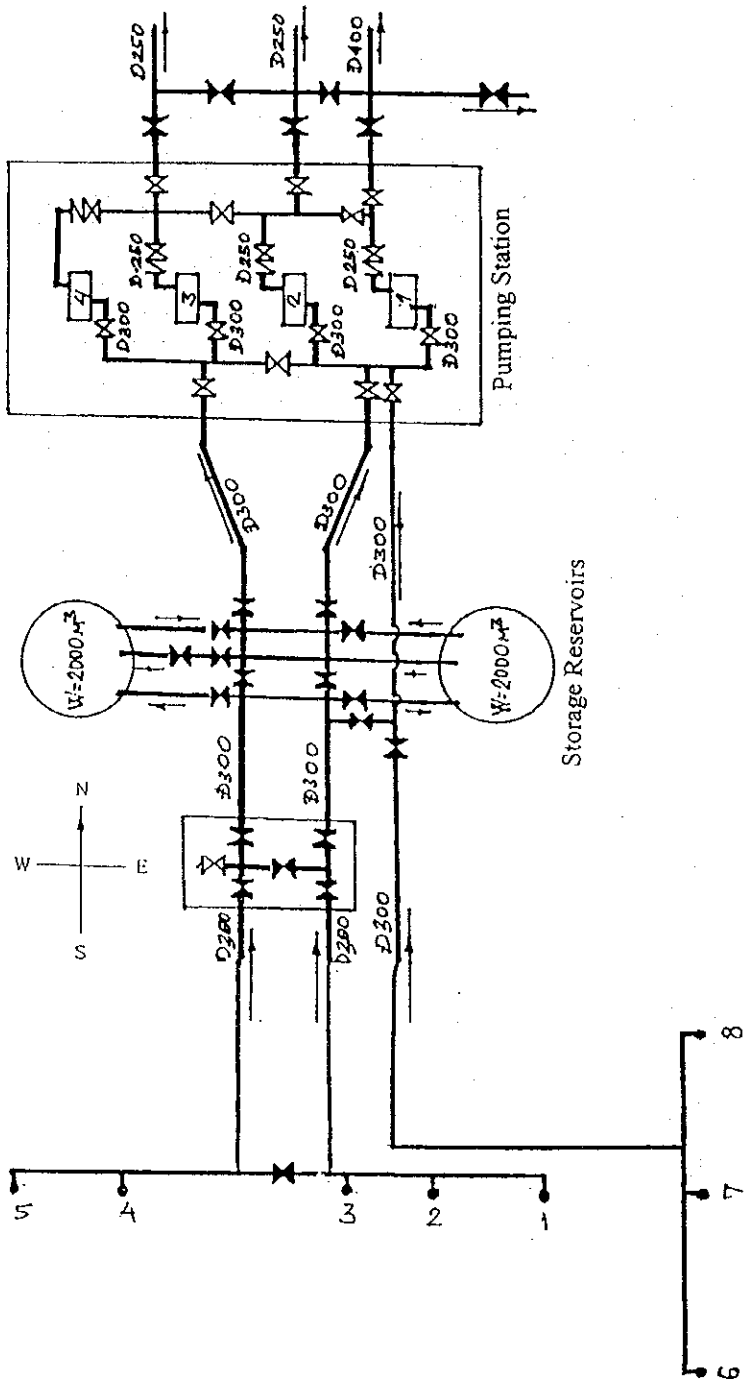


Fig. III.1.5 Meat Complex Water Source Schematic Layout

JICA | The Study on Water Supply System in Ulaanbaatar and Surroundings

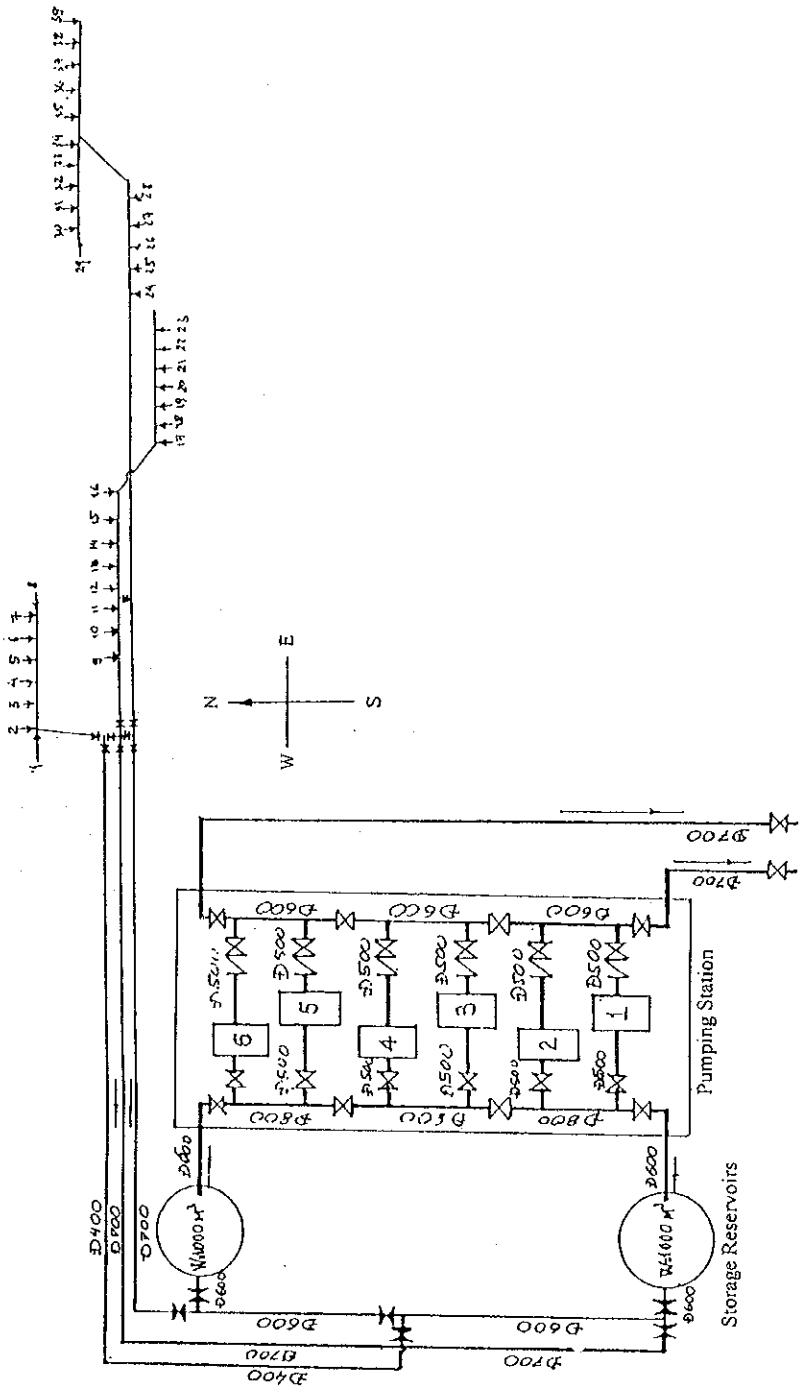
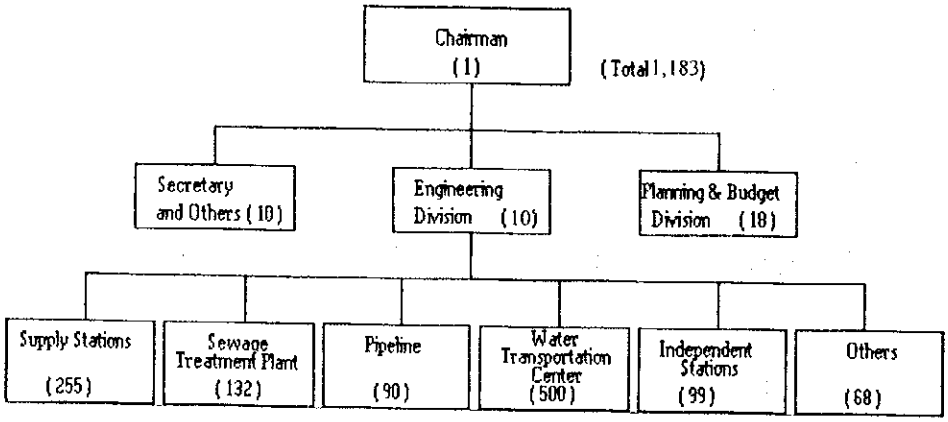


Fig. III.1.6 Upper Water Source Schematic Layout

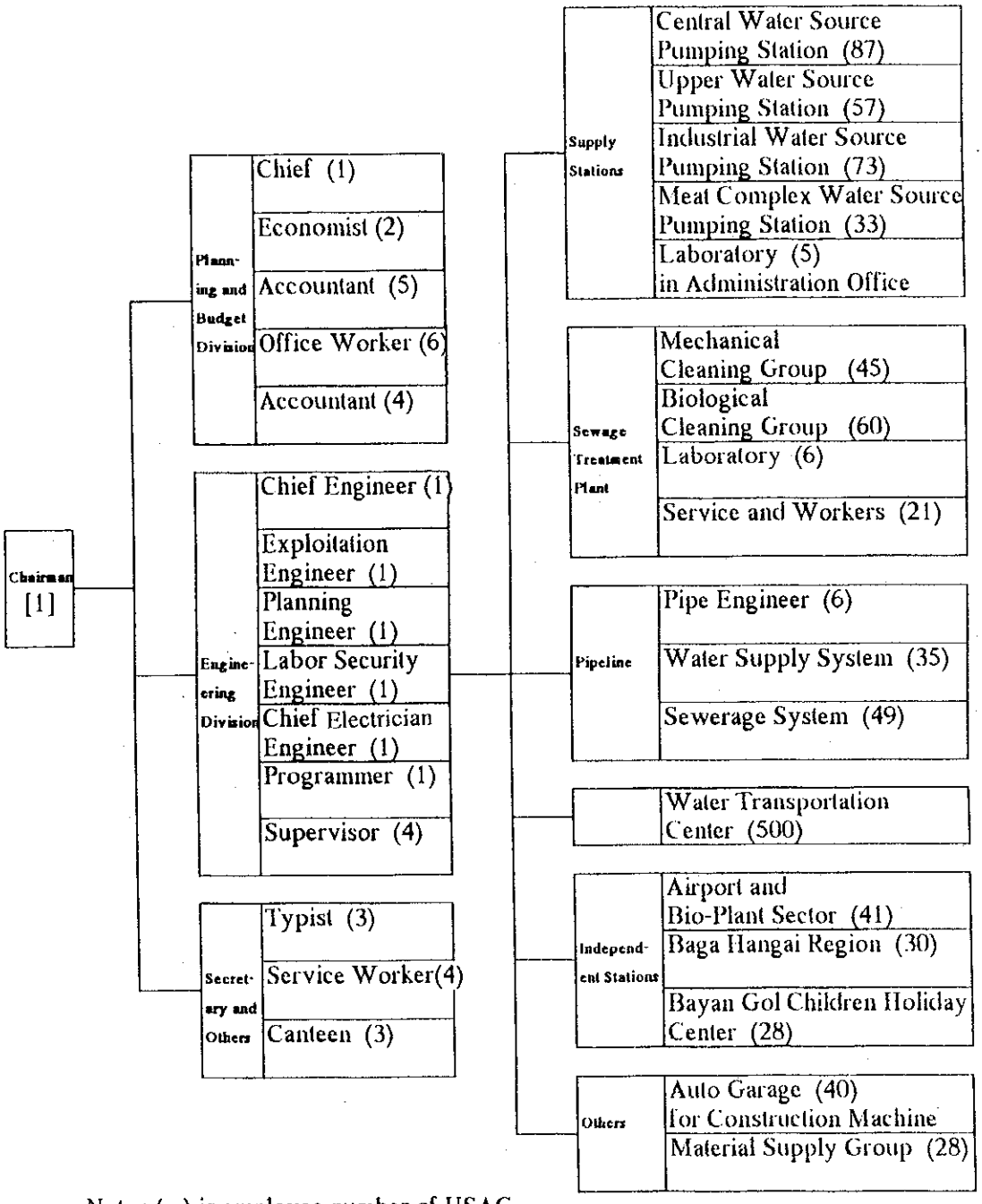
JICA	The Study on Water Supply System in Ulaanbaatar and Surroundings



Note
( ) : Number of Employee

Fig. III.1.7 Number of USAG Employee

JICA	The Study on Water Supply System in Ulaanbaatar and Surroundings



Note : ( ) is employee number of USAG.

Fig. III.1.8 Organization of USAG

JICA	The Study on Water Supply System in Ulaanbaatar and Surroundings

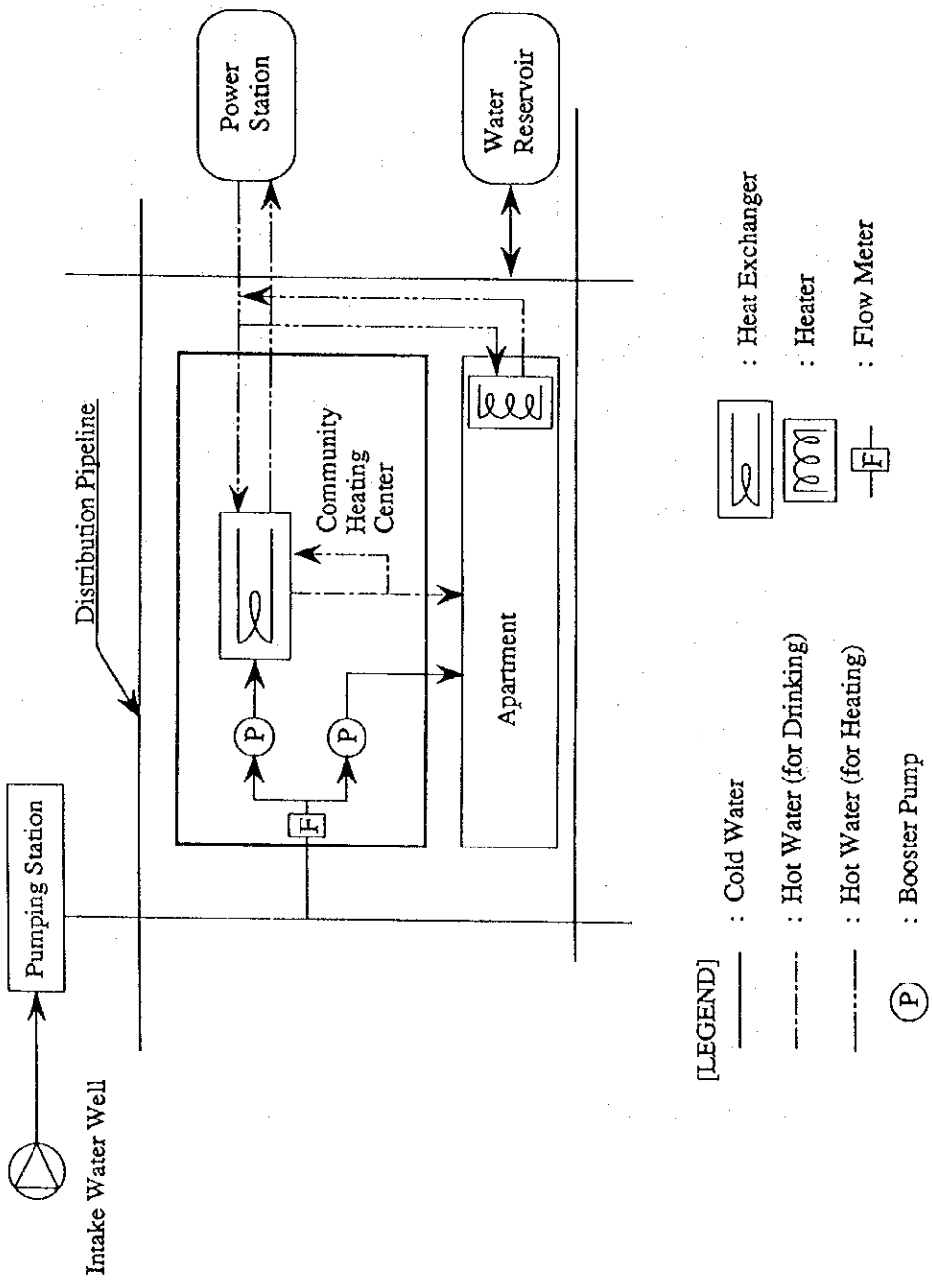


Fig. III.1.9 Typical Water Supply System of CTP

JICA	The Study on Water Supply System in Ulaanbaatar and Surroundings

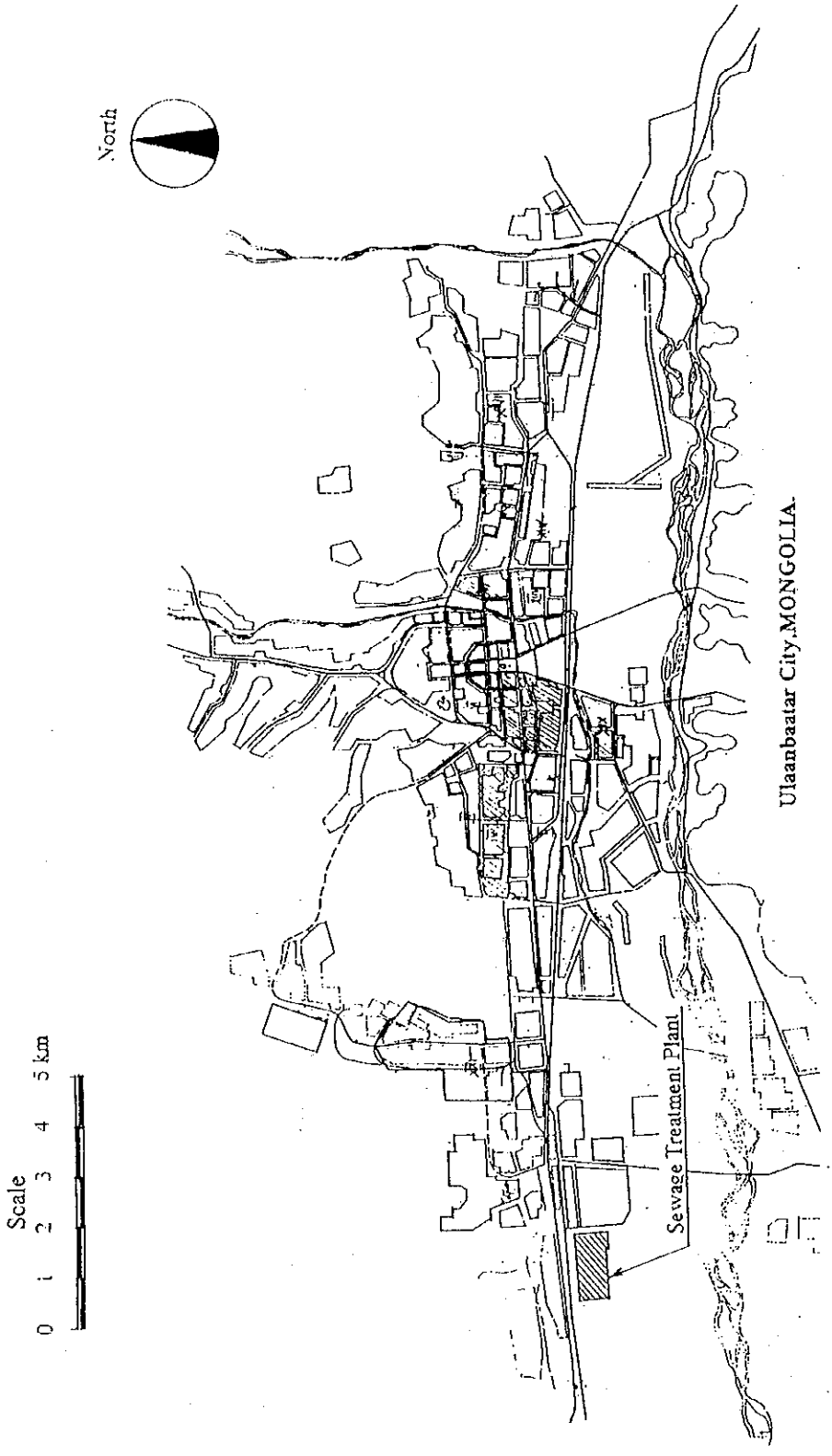
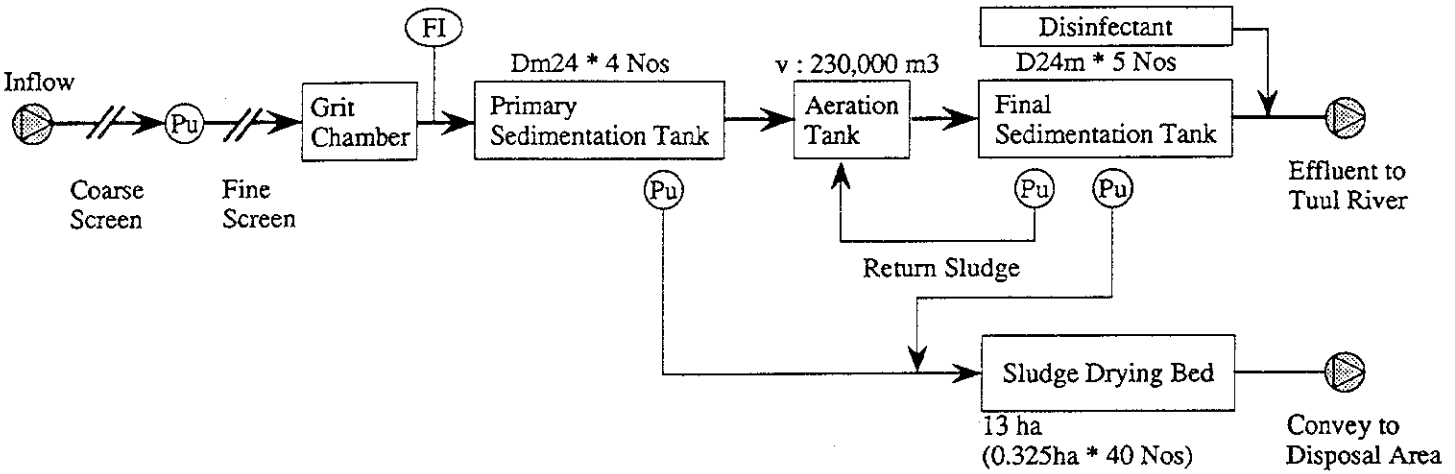


Fig. III.1.10 Location of Sewage Treatment Plant

JICA	The Study on Water Supply System in Ulaanbaatar and Surroundings



Legend

(Pu) : PUMP

(FI) : FLOW METER

Fig. III.1.11 Diagram of Sewage Treatment Plant

CHAPTER 2 MASTER PLAN STUDY FOR WATER SUPPLY FACILITIES

CHAPTER 2. MASTER PLAN STUDY FOR WATER SUPPLY FACILITIES

2.1 POPULATION SERVED AND SERVICE AREA IN FUTURE

2.1.1 Population Forecast

Population forecast until the target year 2010 in total Ulaanbaatar City divided into Central (Apartment) area and Ger area is as follows. More details of them are shown in Chapter 3 on the Main Report.

(Unit : Person)

Year	Central Area	Ger Area	Total
1995	358,000	292,000	650,000
2000	406,000	332,000	738,000
2005	458,000	375,000	833,000
2010	512,000	420,000	932,000

2.1.2 Population Served and Service Area in 2010

Population served and service area from the central water supply system by USAG in 2010 were studied based on the population forecast shown in the preceding clause.

Future service area is proposed after discussion with the Town Planning Department as shown in Fig III.2.1

In the year 2010, the water supply system by USAG will supply the water also to the area which have not been supplied by USAG at present (a part of District No.1 and 2, and Nalaih and Gachuul).

From the results of above discussion, the population served and the service area in 2010 which is to be supplied by central water supply system of USAG, is as follows.

(Unit : Person)

No	Districts	Apartments	Ger	Total
1	Central City Area	450,774	330,335	781,109
2	Nalaih	9,005	26,777	35,782
3	Gachuut	0	5,275	5,275
	Total	459,779	362,387	822,166

Note: (1) Central City Area consists of six districts as follows;
Han-Uul, Bayanzurh, Suhbaatar, Chingeltei, Bayangol, Songinohairhan
(2) Central water supply system does not supply the water to Nalaih at present.
However, the pipeline from the Upper Water Source to Nalaih district was already installed.
In 2010, the water will be supplied to Nalaih district by the existing pipeline.
(3) In Gachuurt district, there is no water supply from the Central water supply system at present.
In 2010, the water from the Lower Part of Nalaih newly developed can be easily supplied to Gachuurt, because the Distribution Reservoirs of the Lower Part of Nalaih will be installed next to the Gachuurt Ger area.

2.2 WATER DEMAND FORECAST

2.2.1 Water Demand Forecast

(1) Unit Water Consumption (l/person/day)

1) Apartment Dwellers

In the apartment buildings, actual usage capacity will be increased, in accordance with change or improvement of life style. However, the present leakage water capacity is considered to be too much and it should be decreased as much as possible. To decrease the leakage water capacity, the present water tariff system (8 Tg x 150 l/person/day) should be changed to the actual water consumption system by providing the water flow meters.

In the Main Report of the Final Report, installation of water flow meters at CTP was proposed in the emergency rehabilitation program. However, the installation of water flow meters at each apartment will be required finally.

2) Ger Dwellers

Unit water consumption in Ger areas will also be increased. However, the increasing ratio will not be considered so high, considering the general life style in the area.
On the other hand, water supply system by pipeline system, that is, public hydrant system to the Ger area should be considered as much as possible, taking the easiness of getting the water for the people into consideration.

(2) Other Water Demand

Water demands for industrial factories and other consumers in 2010 were studied. Water demand for industrial factories was forecasted after consulting with the Ministry of Infrastructure Development. Water demand for other consumers was calculated by the same increasing ratio as the total population.

2.2.2 The Study on Water Demand in 2010

(1) Unit Consumption Rate in the Apartment Building and Ger Area

1) Apartment Dwellers

In the apartment buildings, actual usage capacity will be increased, because of change or improvement of life style. However, the present water leakage is considered to be too much from results of our site investigation and it should be decreased as much as possible.The unit water consumption at present is adopted to

The unit water consumption at present is adopted to be 420 litter per person per day (l/p/d) on the basis of because survey results of Ministry of Communities in 1988 and JICA Study Team in 1994.

From the results of discussions, the unit water consumption rate of 430 l/person /day is adopted for the basis of water demand forecast from the year 2000 up to 2010.

2) Ger Dwellers

Unit water consumption in Ger areas will also be increased. However, the increasing ratio is not considered to be so high, keeping in view the general life style of the area. It is estimated to be 10 l /person/day from the year 2000 up to 2010.

(2) Water Usage in Industrial Factories and Other Consumers

The results of the forecast of water usage in industrial factories and other consumers are shown in following table.

(Unit : m^3/day)

Year	Factories	Others
1994	11,452	8,100
2000	20,500	10,500
2005	32,000	11,850
2010	42,500	13,300

Note : 1) The future water demand of factories is estimated from the results of discussion with USAG after consulting with Ministry of Infrastructure Department.
2) The future water demand of other consumers is estimated assuming it same as growth rate of population.

(3) Water Demand in 2010

As the results of above water demand forecasts, total water demand in 2010 supplied from USAG was calculated as shown in the following table. And future water demand curve is shown in Fig. III.2.2

(Unit : m^3/day)

No	Consumers	Water Demand
1	Apartment Dwellers	197,700
2	Ger People	3,600
3	Industrial Factories	42,500
4	Other Consumers	13,300
5	Loss	28,600
	Total	285,700

(4) Other Water Demand

Power stations in Ulaanbaatar City has installed own wells in the precincts of them . The intake water capacity for them are forecasted until 2010 as follows.

		Intake Water Capacity (m^3/day)				
No	Power Station	1994	1995	2000	2005	2010
1	Power Station No1	0	0	0	0	0
2	Power Station No2	4,815	7,000	0	0	0
3	Power Station No3	29,280	35,000	35,000	35,000	35,000
4	Power Station No4	16,190	25,000	48,000	48,000	48,000
	Total	50,285	67,000	83,000	83,000	83,000
	Remarks	Actual	Plan	Plan	Plan	Plan

Note 1) Intake water capacity in 1994 is an actual water use.
2) No2 Power Station will be closed in 1997 or 1998.
3) Data Source : From Town Planning Department in July 1994.

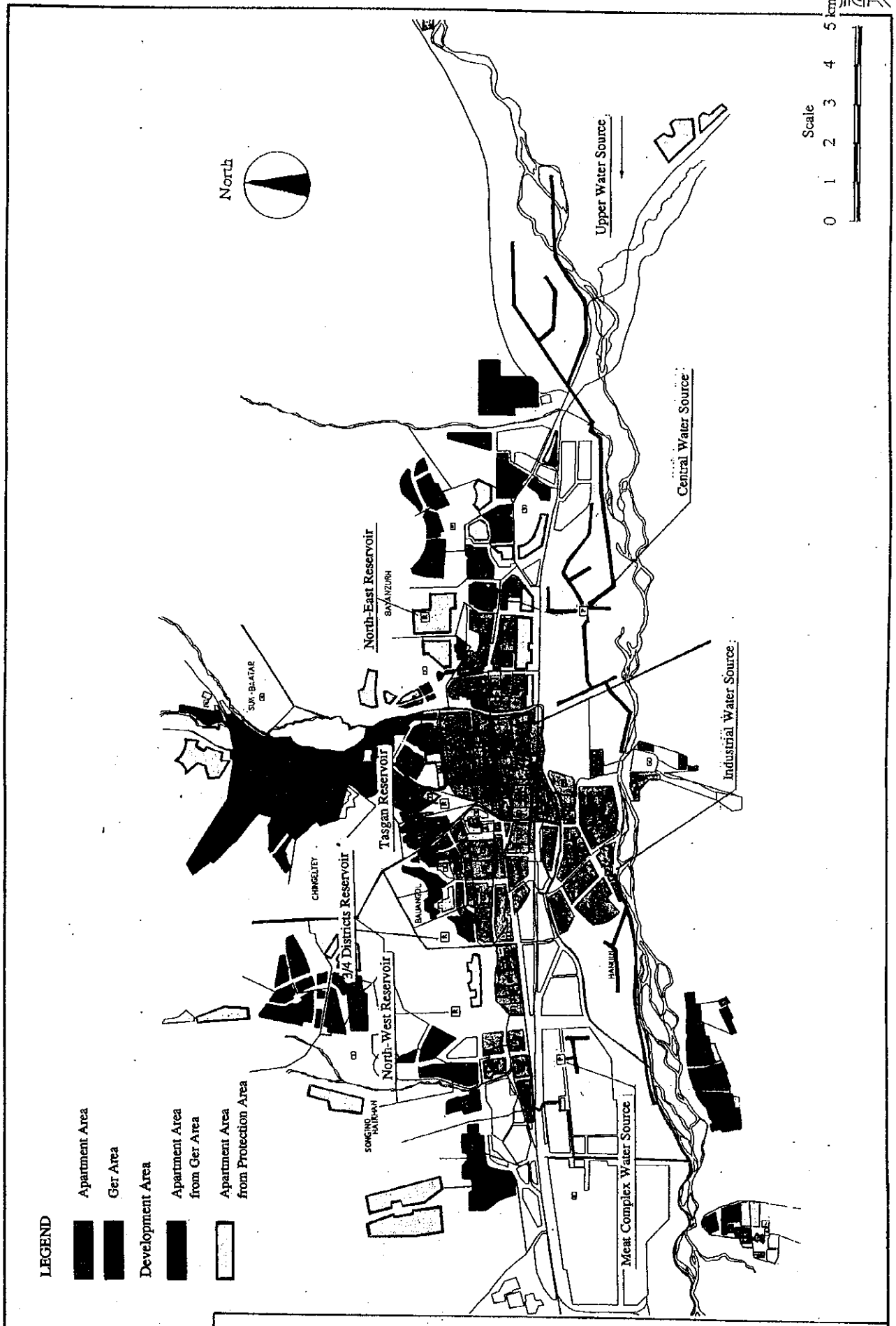


Fig. III.2.1 Service Area by USAG in 2010

JICA	The Study on Water Supply System in Ulaanbaatar and Surroundings

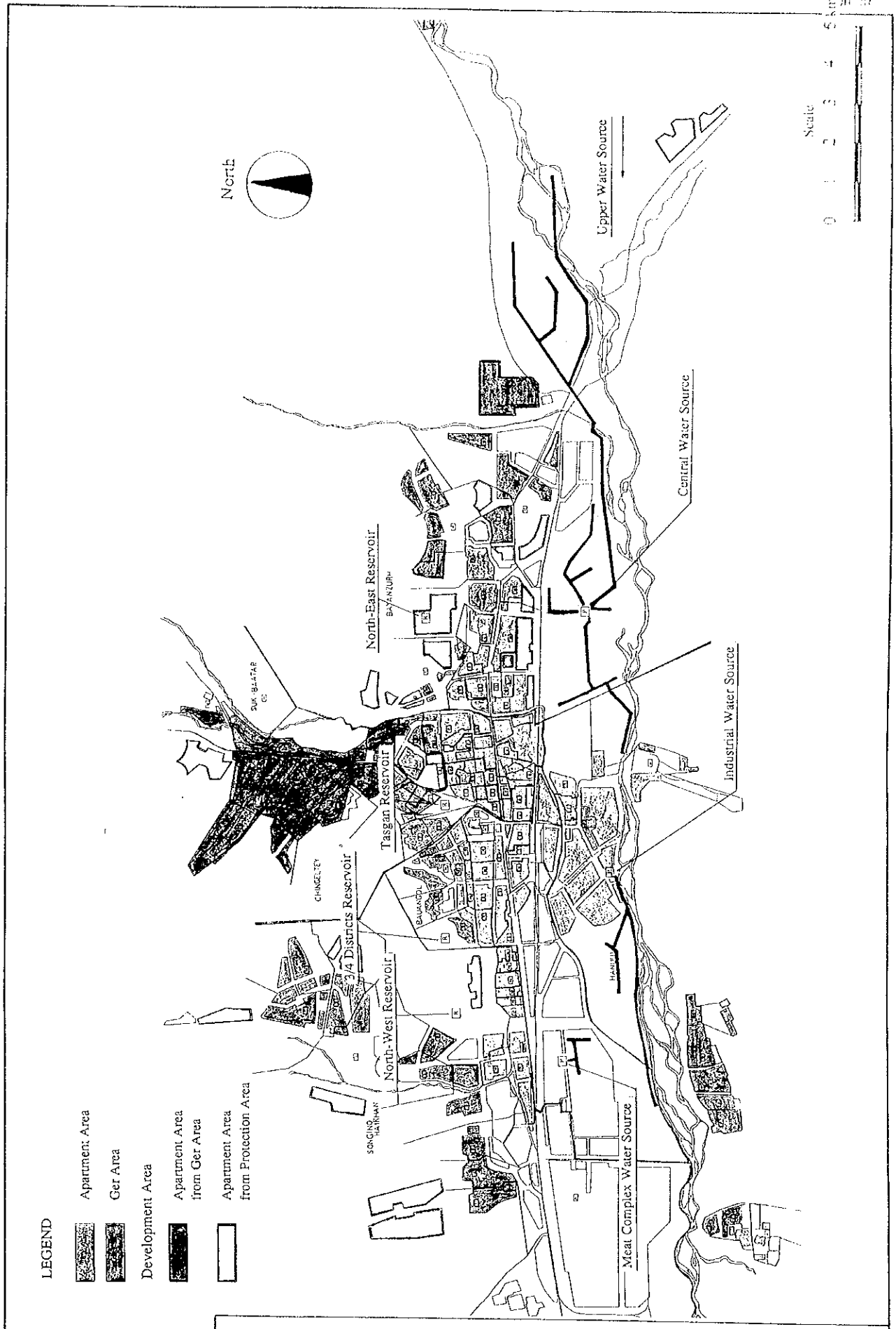
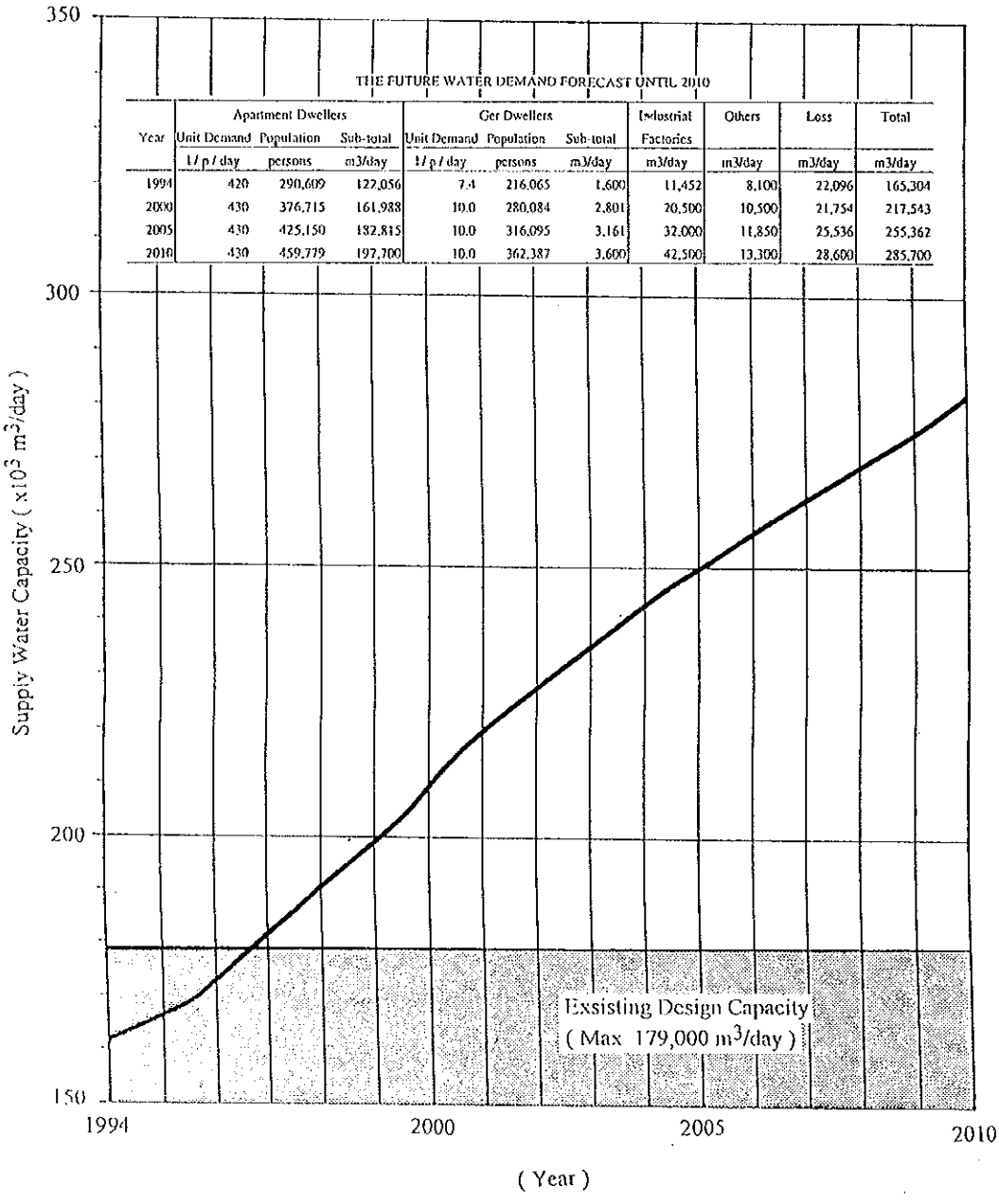


Fig. III.2.1 Service Area by USAG in 2010

JICA | The Study on Water Supply System in Ulaanbaatar and Surroundings



THE FUTURE WATER DEMAND FORECAST UNTIL 2010

Year	Apartment Dwellers			Ger Dwellers			Industrial	Others	Loss	Total
	Unit Demand	Population	Sub-total	Unit Demand	Population	Sub-total	Factories			
	l / p / day	persons	m3/day	l / p / day	persons	m3/day	m3/day	m3/day	m3/day	m3/day
1994	420	290,609	122,056	7.4	216,065	1,600	11,452	8,100	22,096	165,304
2000	430	376,715	161,988	10.0	280,084	2,801	20,500	10,500	21,754	217,543
2005	430	425,150	182,815	10.0	316,095	3,161	32,000	11,850	25,536	255,362
2010	430	459,779	197,700	10.0	362,387	3,600	42,500	13,300	28,600	285,700

Fig.III.2.2 Future Water Demand Curve

JICA | The Study on Water Supply System in Ulaanbaatar and Surroundings

CHAPTER 3 FEASIBILITY STUDY FOR WATER SUPPLY FACILITIES

CHAPTER 3. FEASIBILITY STUDY FOR WATER SUPPLY FACILITIES

3.1 DEVELOPMENT PLAN FOR WATER SOURCES

3.1.1 Water Supply Capacity

(1) Population Served and Service Area in Year 2010

Population served in the target year 2010 is 822,166 in total, 459,779 correspond to Apartment area and 362,387 correspond to Ger area, as described in Chapter 2. And the service area consists of six (6) districts inside the Central Area of the City and two (2) districts (Nalaih and Gachuut) in the Suburbs Area of the City.

(2) Water Supply Capacity to be Developed

Water balance between water supply capacity required in the year 2010 and the existing production capacity in 1994 is shown below.

	Item	Water Capacity
(A)	Water supply demand (Daily average)	285,700 m^3 /day
(B)	Existing production capacity	179,000
	(as of 1994)	
	1) Central Water Source	97,000
	2) Industrial Water Source	43,000
	3) Meat Complex	15,000
	4) Upper Water Source	24,000
(C)	Water supply capacity to be developed [C = (A) - (B)]	106,700

Therefore, additional water supply capacity shall be developed by 106,700 m^3/day before the year 2010.

3.1.2 Study on Water Source to be Developed

Study on water source to be developed to meet the supply water demand in the year 2010 was conducted.

In order to meet this requirement, two (2) kinds of development of water supply capacity can be considered; one is an expansion of the existing water sources, and the other is an exploitation of a new water source.

(1) Expansion of the Existing Water Sources

Possibility of expansion and possible capacity to be expanded for the existing water sources were studied.

The results are as follows.

1) Upper Water Source

Supply capacity from the Upper Water Source to the Ulaanbaatar City is found to be 24,140 m^3/day in average from October 1993 to September 1994. As a result of our study, the supply capacity can be increased up to maximum 90,000 m^3/day by additional improvement works shown below.

Facilities required to increase the capacity of Upper water Source

No.	Facilities	Total Water Supply Capacity (after Improvement)	
		Case A : 72,000 m3/day	Case B : 90,000 m3/day
1	Additional Facilities		
	1) Intake Wells 120 m3/hr x 60 m	Not necessary	18 Nos
	2) Distribution Pumps 1000 m3/hr x 180 m	Not necessary	2 Nos
2	Improvement of the Existing Facilities		
	1) Water level indicator system	4 Sets	4 Sets
	2) Chlorination equipment	1 Set	1 Set
	3) Telecommunication System	Three Locations (1 Set)	Three Locations (1 Set)
	4) Others (Valves, pipe, pumps)	1 Set	1 Set

(Note) 1. According to the USAG, the planned capacity at the construction stage was 90,000 m^3/day.
2. Considering the facilities required to increase the capacity, the capacity will be easily increased up to 72,000 m^3/day (Case A).

2) Central Water Source

Central Water Source is a main water source for the City because of the following reasons.

(i) It is located near the central area of the City.
(ii) There is no source of contamination around the wells and the water quality is good for the drinking water.
(iii) The capacity of groundwater is abundant.

As a result of our groundwater simulation, the capacity of the Central Water Source can be increased up to 114,300 m^3/day from the existing capacity, 97,000 m^3/day, by the following additional installation works of Intake Facilities.

No.	Item	Nos.
1	Wells	14
2	Well Pump and others	14
3	Remote Control System	1 Set
4	Pump Houses	14
5	Collection Main Pipeline	1 Set
6	Power Distribution Line	1 Set

3) Industrial Water Source

Supply capacity from the Industrial Water Source is found to be 40,714 m^3/day in average from October 1993 to September 1994. And the water quality of the groundwater almost satisfies the standard limits for drinking water. However, considering that this water source is located near the industrial area and there might be a possibility to get contaminated in future, an expansion of this water source is not recommendable.

4) Meat Complex Water Source

This water source, having the capacity of 15,000 m^3/day, supplied 12,962 m^3/day of potable water in average from October 1993 to September 1994. And the results of the water quality analysis for the groundwater of this water source show the quality almost keeps the limits of the standard. However, the future expansion is not recommendable from the same reasons as in the Industrial Water Source.

5) New Water Source (Lower Part of Nalaih)

Lower Part of Nalaih is comparatively good water resource from the economical, hydrogeological, and water quality points of view. The construction and running cost of Lower Part of Nalaih is expected to be cheaper comparing with the others.

3.1.3 Development Plan

Based on the above studies on water sources to be developed, case studies to select the most suitable development plan to meet the water demand in the year 2010 were conducted.

(1) Case Study

To develop the water source having the capacity of 106,700 m^3/day before the year 2010, the following alternatives can be considered.

Case I : To expand the capacity of the existing Upper Water Source up to 72,000 m^3/day and to develop Lower Part of Nalaih having the capacity of 58,700 m^3/day.

Case II : To expand the capacity of the existing Upper Water Source up to 90,000 m^3/day and to develop Lower Part of Nalaih having the capacity of 40,700 m^3/day.

Case III : To expand the capacity of the existing Upper Water Source up to 72,000 m^3/day and the existing Central Water Source up to 114,300 m^3/day and to develop Lower Part of Nalaih having the capacity of 41,400 m^3/day.

Case IV : To expand the capacity of the existing Upper Water Source up to 90,000 m^3/day and the existing Central Water Source up to 114,300 m^3/day and to develop Lower Part of Nalaih having the capacity of 23,400 m^3/day.

The results of comparison of the above four (4) cases are shown in the following table.

Comparison Table for Future Water Sources
(Except the existing facilities)

No	Item	Unit	Existing	Case I	Case II	Case III	Case IV
1	Supply Water Capacity						
1)	Lower Part of Nalaih	m3/day	0	58,700	40,700	41,400	23,400
2)	Central	m3/day	97,000	97,000	97,000	114,300	114,300
3)	Industrial	m3/day	43,000	43,000	43,000	43,000	43,000
4)	Meat Complex	m3/day	15,000	15,000	15,000	15,000	15,000
5)	Upper Water Source	m3/day	24,000	72,000	90,000	72,000	90,000
	Total	m3/day	179,000	285,700	285,700	285,700	285,700
2	Technical Matter and Others						
1)	Water Development Potential		----	Enough	Enough	Enough	Enough
2)	Water Quality		Good	Good	Good	Good	Good
3)	Water Treatment		Unnece-ssary	Unnece-ssary	Unnece-ssary	Unnece-ssary	Unnece-ssary
4)	Water Rights		Good	Good	Good	Good	Good
5)	Land Acquisition		Ease	Ease	Ease	Ease	Ease
3	Cost (Except the existing facilities)						
1)	Construction Cost	T-US$		69,400	69,500	67,300	68,700
2)	Unit Construction Cost	US$/m3/d		650	651	631	644
3)	Electricity Cost	T-US$/Y		611	728	663	771
4)	Present Value of Total Cost (between Year 1995 and 2020)	T-US$		54,700	53,300	51,500	52,800
	EVALUATION			NO GOOD	NO GOOD	EXCE-LLENT	GOOD

Note
1) Shaded cells are the existing water supply capacity as of November 1994.
2) Exchange Rate : US$ 1.00 = Yen 100.0 , US$ 1.00 = Tg 400.0
3) Cost : as of December 1994
5) M-US$: Million US Dollar
6) Unit Power Rates : 4.4 Yen/kwh (17.6 Tg/kwh)
7) Escalation Rate for present value to be calculated : 7 %/Year
8) Present value of total cost estimated by "Method of Net Present Value "

From the above comparison study, Case III was selected for the best development plan.

(2) Implementation Plan

Implementation Plan for the water source development before the year 2010 divided into three (3) stages, taking the water demand shown in the 2.2 in this Report and investment efficiency for the construction works into consideration, is proposed as follows.

First Stage : Expansion of the Upper Water Source up to 72,000 m^3/day
Second Stage : Expansion of the Central Water Source up to 114,300 m^3/day
Third Stage : Development of the Lower Part of Nalaih having the capacity of 41,400 m^3/day

The relation between water demand and water supply capacity until the year 2010 is shown in Fig. III.3.1.

3.2 STUDY ON WATER SUPPLY FACILITIES

Together with the development plan of Water Sources, the study on the water supply facilities required for the development was conducted.

Results of the Study for each water source are described below.

3.2.1 Upper Water Source

Upper Water Source will be expanded up to 72,000 m^3/day from the existing capacity 24,000 m^3/day at the first stage. Study results of the facilities required for the expansion are as follows.

(1) Intake Facilities

The existing wells, well pumps and collection pipeline have enough capacity to cope with the expansion and the expansion of these facilities not required.

And the Storage Reservoir is not required to be expanded also, because it will have about 40 minutes of retention time after expansion.

(2) Transmission Facilities

It is not necessary to increase the number of Transmission Pumps, because the required capacity of supply water can be obtained by three (3) pumps among the existing six (6) pumps having the unit capacity of 1,000 m^3/hr.

However, the Surge Protection Facilities as a countermeasure against Water Hammer will be required.

And installation/replacement of instruments such as Flow meter, Level meter and Temperature meter will also be required for the operation.

The flow diagram for these facilities is shown in Fig. III.3.2.

Transmission Main from the Pumping Station to the Zavsariin Reservoir, which is located at about 15 km east from the central area of the City and not utilized at present, is confirmed to have a transportation capacity of 90,000 m^3/day by JICA Study Team.

However, the supply capacity of distribution pipeline from the Zavsariin Reservoir to the City area, not included in this Study, should be studied before implementation. An additional pipeline work in the distribution line might be required if necessary after the study.

Therefore an increase of the capacity of this Transmission Main from Pumping Station up to Zavsariin Reservoir will not be required.

The details of the study on the capacity are shown in Table III.3.3.1 and Fig. III.3.3. The water hammer analysis for transmission pumps are given in Table III.3.2.

(3) Others

1) Water Level Indication System of the Existing Reservoirs
Total four (4) numbers of Water Level Meters will be installed at Zavsariin Reservoir and North-East Reservoir and water level indication system will be created by monitoring.

2) Chlorination equipment
A Chlorination Equipment is not installed in the water supply system for the Upper Water Source at present.
Therefore the Chlorination Equipment will be installed at the Zavsariin Reservoir.
Chlorination will be conducted to supply 72,000 m^3/day of water with a dosage ratio of 1.0 mg/ℓ all the year round.
Dosage equipment will be installed in the existing building at the Zavsariin Reservoir.

3) Telecommunication System
Telecommunication System will be installed in Upper Water Pumping Station, Zavsariin Reservoir and North-East Reservoir for mutual voice communication of condition of water levels at reservoir, operation of pumps and so on.
A radio communication equipment will be provided at these three locations with an antenna and un-interrupted power supply for continuous communication in case of power failure.

4) Accessories of Zavsariin Reservoir
Accessories of Zavsariin Reservoir such as valves, pipes and small pumps will be installed.

3.2.2 Central Water Source

Central Water Source will be expanded up to 114,300 m^3/day from the existing capacity 97,000 m^3/day at the second stage. Study results of the facilities are as follows.

(1) Intake Facilities

14 wells including two (2) stand-by wells will be newly installed to cater the capacity of 17,300 m^3/day to be expanded. Collection Pipeline to the existing Storage Reservoirs will also be installed.

Well facilities consist of submersible pump, valves (including motor driven delivery valve), pipes, flow meter, control panel, room heater, room light, step down transformer and pump house (including hoist) besides the well itself. Operation and monitoring of well facilities will be conducted at the control room in the existing Pumping Station by remote control system. Refer to Fig. III.3.4~15 and Table III.3.3.

The expansion of the existing storage reservoir will not be required, because the retention time will be enough (about 120 minutes) even after expansion of the water supply capacity.

The specification of the facilities required is shown below.

No.	Item	Nos.	Specifications
1	Wells	14	30 m Deep, 1500 m3/day/well
2	Well Pump and others	14	Submersible Pumps
3	Remote Control System	1 Set	For Pumps and Motor Valves
4	Pump Houses	14	made by Brick (5m x 5m x H 8m)
5	Collection Main Pipeline	10,500 m	DCIP ø150 ~ 500 mm
6	Power Distribution Line	1 Set	

(2) Distribution Facilities

An increase of Distribution Pumps will not be required, because the total capacity of the existing Pumps is 199,680 m^3/day (as of 1994).

3.2.3 Lower Part of Nalaih

Lower Part of Nalaih having the capacity of 41,400 m^3/day will be installed at the third stage. Study results of the facilities are as follows.

(1) Intake Facilities

41 wells including seven (7) stand-by wells along the Tuul River, collection pipeline and distribution reservoirs will be newly installed.

Operation and monitoring of well facilities will be conducted at the control room in the distribution reservoirs newly installed by remote control system. Refer to Fig. III.3.16~24 and Table III.3.4.

The specifications of the facilities are shown below.

No.	Item	Nos.	Specifications
1	Wells	41	1,220 m3/day/well 20 m (38Nos) & 30 m(3Nos) Deep
2	Well Pump and others	41	Submersible Pumps
3	Remote Control System	1 Set	For Pumps and Motor Valves
4	Pump Houses	41	made by Brick (5m x 5m x H 8m)
5	Collection Main Pipeline	10,750 m	DCIP ø150 ~ 800 mm
6	Power Transmission Line	1 Set	
7	Power Distribution Line	1 Set	

(2) Distribution Facilities

Distribution Reservoirs will be installed at the eastern part of Gachuult Town, from where the water to the City area can be supplied by gravity flow. The retention time in the reservoirs will be eight (8) hours.

Chlorination equipment will also be installed at the distribution reservoirs. Planned dozing ratio is 1.0 mg/ℓ.

Distribution main from the reservoirs to the City area will be installed along the existing road. Pipe diameter is 800 mm and the length is about 21 km. Refer to Fig. III.3.25~32 and Table III.3.5.

The specifications of the facilities are shown below.

No.	Item	Nos.	Specifications
1	Distribution Reservoirs	2	6,900 m^3 x 2 (Retention Time = 8 hr)
2	Chlorination Equipment	1 Set	41,400 m3/day x 1.0 mg/l
3	Distribution Main	21,000 m	DCIP ø800 mm
4	Electrical Equipment	1 Set	
5	Buildings	1 Set	

(3) Topographical Survey

The topographical survey for the study on the Lower Part of Nalaih was conducted. Outline of the survey are as follows. See Fig. III.3.33.

(i) New distribution facilities are (Gachuult): 20,000 m^2 (plane-table survey)

(ii) Pipeline Rout: (longitudinal and cross sectional survey)

- Collection Pipeline : 5.4 km
- Distribution Main : 12.5 km

More details data and drawings of survey are shown in III. WATER SUPPLY of "DATA BOOK".

3.2.4 Land Acquisition

The required land area (hectare: ha) for the construction of the facilities are as follows.

Development Area	Facilities	Required Area (ha)
Upper Water Source	Intake	0
	Transmission	0
	Distribution	0
Central Water Source	Intake	4.0
	Distribution	0
Lower Part of Nalaih	Intake	6.0
	Distribution	9.0
	[Total]	19.0

The intake, transmission and distribution facilities will be constructed in the all government reserved lands. The collection pipeline of each water source and distribution main of Lower Part of Nalaih will be installed parallel with existing roads.

Hence, the construction of the above facilities will not require any land acquisition, although some procedure to get approval may be required.

3.3 COST ESTIMATES

The results of cost estimates for the construction of the facilities are shown below.

Total Investment Cost (As of December 1994 Price)

(Unit : US Dollar)

No.	Work Item	1 st Stage	2 nd Stage	3 rd Stage	Amount
1	Direct Construction Cost				56,347,590
-1	Upper Water Source (Expansion of Existing Facilities)	1,148,270	0	0	1,148,270
1)	Transmission Facilities	394,290	0	0	394,290
2)	Others (for Zavsariin Reservoir, etc.)	564,640	0	0	564,640
3)	Telecommunication System	189,340	0	0	189,340
-2	Central Water Source (Expansion of Existing Facilities)	0	8,371,390	0	8,371,390
1)	Intake Facilities	0	8,371,390	0	8,371,390
-3	Lower Part of Nalaih	0	0	46,827,930	46,827,930
1)	Intake Facilities	0	0	19,762,150	19,762,150
2)	Distribution Facilities	0	0	27,065,780	27,065,780
2	Land Acquisition Cost	0	0	0	0
3	Engineering Cost	492,900	807,800	2,361,900	3,662,600
4	Administration Cost [3% of 1]	34,448	251,142	1,404,840	1,690,430
5	Physical Contingency [10% of 1]	114,827	837,139	4,682,794	5,634,760
	Total	1,790,445	10,267,471	55,277,464	67,335,380

Note
1) Exchange Rate : US$ 1.00 = Yen 100.0 , US$ 1.00 = Tg 400.0

The direct construction costs are further broken down as shown in Table III.3.6.

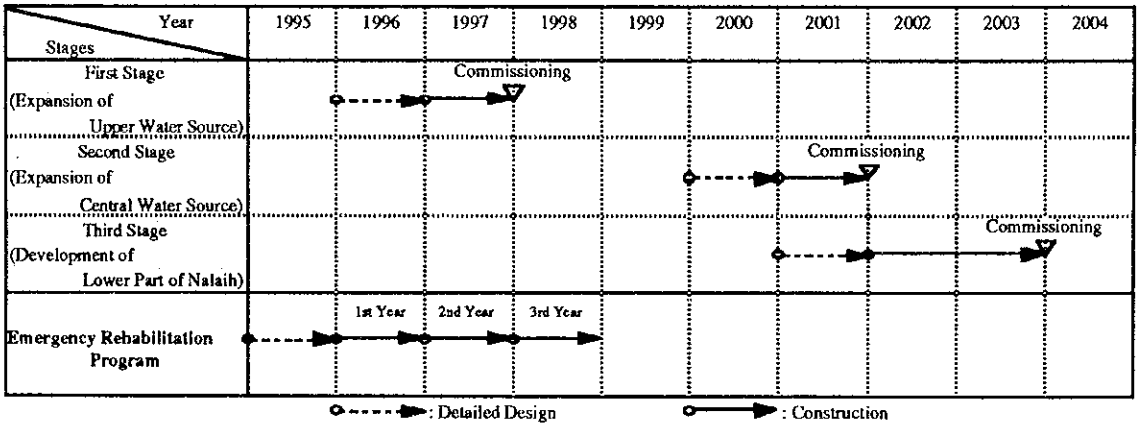
3.4 IMPLEMENTATION PROGRAM

3.4.1 Implementation Schedule

This development plan of water supply facilities is scheduled in parallel with the Emergency Rehabilitation Program shown in Appendix in the Main Report. Construction period of this development plan is estimated to be seven (8) years from 1996 to 2004 as shown below.

This implementation schedule of "Emergency Rehabilitation Program" is studied assuming that rehabilitations is to be done by three years from 1996.

Implementatiion Schedule



3.4.2 Disbursement Schedule

The proposed disbursement schedule of the project cost is shown in Table III.3.7.

3.5 OPERATION AND MAINTENANCE

3.5.1 General

Operation and maintenance of the water supply facilities are conducted by USAG, including the facilities developed. Water supply facilities newly developed in Upper Water Source (1st Stage) and Central Water Source (2nd Stage) can be operated and maintained by the existing organization of USAG. However, the facilities in Lower Part of Nalaih (3rd Stage) will be operated and maintained by the staff at the control station in the distribution facilities located at the eastern part of Gachuult Town. Therefore the staff of the Lower Part of Nalaih will be newly appointed by USAG.