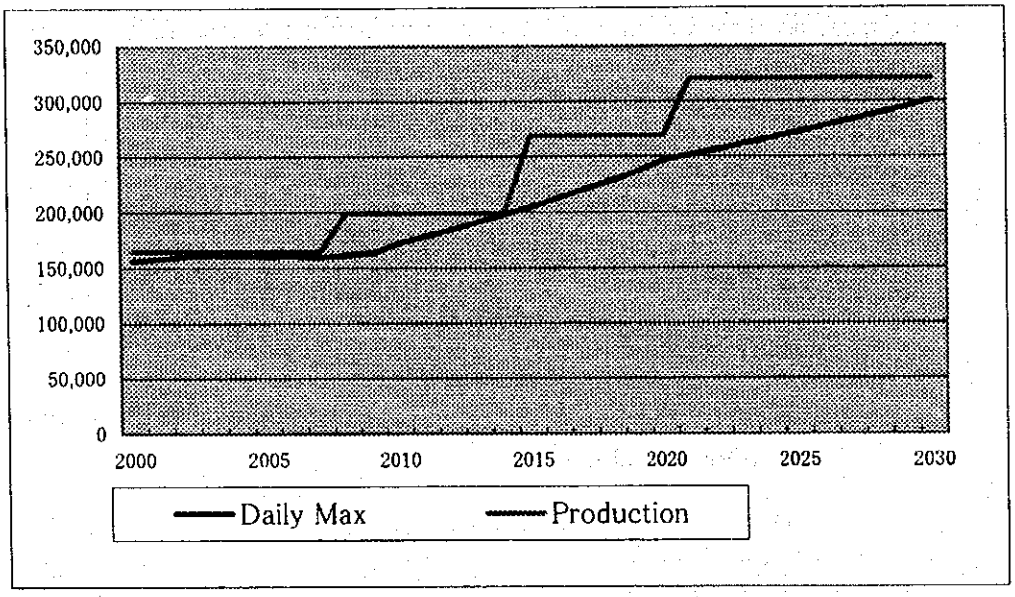
F.3 Water Supply Development Plan

F.3.1 Outline of Water Supply Development Plan

Water supply development plan will be established to cope with the projected future demand, considering the current and future conditions of the existing water supply facility.

Tendency of the future water demand and the required future water production capacity is shown in the following graph.



Water Demand and Proposed Production Capacity

Annual increase of water demand is shown in Figure F.3.1.

Also, district-wise daily maximum water demand is shown in Table F.3.1.

Three major developments are planned by 2030.

Phase 1	2003 - 2007
Phase 2	2011 - 2013
Phase 3	2017 - 2019

Present conditions and development plan for major facilities are summarized in the following table.

Water Supply Development Plan (Unit : m^3/day)

Facility	2010	2020	2030
1. Outline of System			
Population	490,000	690,000	800,000
Water Demand(Daily Max)			
- Drinking	172,800	247,400	301,700
- Technical	44,500	50,500	58,300
2. Water Sources			
Water Source (Vyacheslavsky Res.) (Ishim River)	Vyacheslavsky Res. Ishim River (Irtysh – Karaganda Canal – Ishim)	Vyacheslavsky Res. Ishim River (Irtysh – Karaganda Canal – Ishim)	Vyacheslavsky Res. Ishim River (Irtysh – Karaganda Canal – Ishim)
3. Intake Pump Station			
Vyacheslavsky Res.	200,000 Construction of new pump station	275,000 Installation of additional pumps	350,000 Installation of additional pumps
Ishim River	100,000 Rehabilitation of electrical facilities	100,000 Construction of new pump station	100,000
4. Raw Water Transmission Pipe			
Vyacheslavsky Res. (1000 mm x 2 pipes) (1400 mm x 1 pipe)	200,000	350,000 Construction of new 1400 mm x 1 pipe	350,000
Ishim River (1000 mm x 1 pipe)	100,000	100,000 Construction of new pipe to new plant	100,000
5. Water Treatment Plant			
Right Bank (200,000) (actual : 165,000)	100,000 Construction of new treatment plant		100,000 Construction of additional plant
Left Bank		120,000 Construction of new treatment plant	
6. Distribution Pump Station			
Water Demand - Drinking	241,900 Construction of new station	346,400 Construction of new station Construction of transmission pipe 1000 mm x 1 pipe	422,400 Installation of additional pumps
- Technical	49,000	55,600	64,100
7. Distribution Main			
New Service Area	Resident District 9, 10, 13, 17 and 14(part) Industrial District I, IV, VI and VII	Resident District 4B, 14 (part), 15, 16, 18 and 19 Industrial District III and IV	Resident District 11, 14(part), and 16(part), Industrial District II

Detailed development plan for each facility and each phase is described in the following subsections.

Figure 4.3.3 shows outline of water supply development plan.

F.3.2 Water Source

Detailed development plan for water source will be described in Chapter E. In this chapter, water sources are explained only for water supply of drinking and technical water.

Proposed intake water volume in 2010, 2020 and 2030 is as follows

Raw Water Projection for Drinking and Technical Water Supply

(Million m^3/year)

Raw Water Volume	2010	2020	2030
Annual Water Demand	63.9	89.0	107.8

Vyacheslavsky Reservoir and Ishim River will also be two major water sources in future, Irtish-Karaganda-Ishim Canal, however will supply water to the Vyacheslavsky Reservoir. Groundwater will be only a spare water source for emergency due to limited production.

Intake from Nura-Ishim Canal is not considered, since the possibility of water intake from the canal is still uncertain due to mercury contamination. Therefore, main surface water source will be Vyacheslavsky Reservoir including Irtish-Karaganda Canal, and Ishim River.

F.3.3 Water Intake Facility

(1) Outline of Development Plan

A new intake pump station at Vyacheslavsky Reservoir is proposed at 100 m upstream of the existing pump in Phase 1 Project, due to the deterioration and the difficulty of up grading of the existing facility. In Phase 2, an additional pump station will be proposed to meet the water production for 2030. However, pumps will be installed only for the production capacity of 2020, and the remaining pumps will be installed in Phase 3 Project.

(2) Outline of Facility

Phase 1

- A new pump station with an intake capacity of 200,000 m^3/day, including civil structure, building mechanical and electrical facilities

Phase 2

- An additional pump station with an intake capacity of 150,000 m^3/day, including civil structure, building of 150,000 m^3/day and mechanical and electrical facilities for 75,000 m^3/day

Phase 3

- Additional mechanical and electrical facilities for 75,000 m^3/day for the additional pump station

F.3.4 Raw Water Transmission Pipeline

(1) Outline of Development Plan

The Kazakhstan Government has been installing a new raw water transmission pipeline "Third Transmission Line" with a diameter of 1,400 mm and a length of 51 km, connecting the Vyacheslavsky Reservoir intake pump station and the WTP. The pipeline will be able to cope with the water demand by 2014, subsequently an additional pipeline shall be constructed to meet the water production capacity for 2030. The pipeline shall have transmission capacity, providing some allowance for leakage of this pipeline and losses at the water treatment plants.

(2) Outline of Facility

Phase 2

- An additional raw water transmission pipeline (150,000 m^3/day) from Vyacheslavsky Reservoir pump station to new water treatment plant
- A new raw water transmission pipeline from Ishim River pump station to new water treatment plant

F.3.5 Water Treatment Plant

(1) Outline of Development Plan

Since ASA plans to implement some improvement works to the existing treatment plant, which is evaluated to have a current production capacity of 165,000 m^3/day, and the plant can treat the current capacity for several years. The plant however will lose the treatment performance again soon, in terms of both quantity and quality. A new treatment plant (NO. 1) is proposed to be constructed with a capacity of 100,000 m^3/day to strengthen production

capacity in Phase1 Project. A 120,000 m^3/day water treatment plant (NO. 2) is proposed at the left bank of Ishim River in Phase 2 Project. To meet the rapid increase water demand in 2030, a 100,000 m^3/day water treatment plant (NO. 3) is planned to be constructed in Phase 3 Project.

(2) Location of Water Treatment Plant

There are two adequate options for location of new water treatment plants. The options and their advantages/disadvantages are as follows.

Option 1 – Existing Water Treatment Plant (Advantage) 1. Raw water transmission pipeline and distribution pipeline has already connected. 2. It is easier to operate and maintain the treatment plant located at same site than two plants located different sites. 3. The existing plant is located at almost center of the service area, and it will minimize cost. (Disadvantage) 1. Space in the existing plant is limited.
Option 2 – Near Existing Ishim Pump Station (Left Bank of Ishim River) (Advantage) 1. Raw water can be taken from Ishim River with less cost. 2. Future service area is close-by. 3. Wider space is available. (Disadvantage) 1. Raw water transmission pipeline has to be extended. 2. It is easier to operate and maintain the treatment plant located at same site than two plants located at different sites.

Examining the above features and distance-water supply volume, new water treatment plants will be constructed at both locations by the following stages.

(3) Outline of Facility

Phase 1

- A new water treatment plant (NO.1 - 100,000 m^3/day) at the existing water treatment plant

Phase 2

- A new water treatment plant (NO.2 - 120,000 m^3/day) near the existing Ishim River Pump Station

Phase 3

- A new water treatment plant (NO.3 - 100,000 m^3/day) at the existing water treatment plant

This development of treatment plant is summarized as follows

Production Capacity and Water Demand (Unit: m^3/day)

		2001	2010	2020	2030
Production Capacity (m^3/d)	Existing WTP	165,000	100,000	50,000	---
	New WTP (No.1)	---	100,000	100,000	100,000
	New WTP (No.2)	---	---	120,000	120,000
	New WTP (No.3)	---	---	---	100,000
	Total	165,000	200,000	270,000	320,000
Daily Maximum Water Demand		159,000	173,000	247,000	302,000

Layouts of new water treatment plants are shown in Figure 3.2 and 3.3.

F.3.6 Water Distribution Pump Station

(1) Outline of Development Plan

The existing pumps and their electrical facilities are well maintained, however it is recommended to introduce some automatic operation system for accurate operation. New distribution pump stations will be constructed to meet hourly maximum capacity, 1.4 times of plant capacity.

(2) Outline of Facility

Phase 1

- A new distribution pump station with a capacity of 140,000 m^3/day, including civil structure, building and mechanical/electrical facilities next to the existing distribution pump station

Phase 2

- A new distribution pump station with a capacity of 168,000 m^3/day, including civil structure, building and mechanical/electrical facilities in NO. 2 water treatment plant, and treated water transmission pipe (1,000 mm dia.) between NO. 1 and 2 water treatment plants

Phase 3

- A new distribution pump station with a capacity of 140,000 m^3/day, including civil structure, building and mechanical/electrical facilities in NO. 3 water treatment plant

F.3.7 Water Distribution Pipelines

(1) Outline of Development Plan

Basically water distribution pipeline network will be divided into two networks, one for the existing service area, which is located in northern and western part of the city and another for new service area, which is located in southern and eastern part of the city.

Distribution Network	District
Distribution Network A (Existing Service Area)	Residential District: 1, 2, 3, 4A, 4B, 5, 6, 7, 8 Planning District: IV Industrial District: Central, Northern, Western Power Station: TETs 1&2
Distribution Network B (New Service Area)	Residential District: 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19 Planning District: I, II, III, V, VI, VII, VIII, IX Industrial District: Station 40

Distribution network analysis has been carried out for the existing and future water supply system. In the analysis, velocity of flow and head loss in all pipes was examined to use adequate pipe diameter. Most of the existing pipelines are over-sized but they will have sufficient capacity against future water demand. However, deteriorated pipes should be replaced as soon as possible to eliminate the water leakage, one of the main targets of ASA. Therefore, replacement of the existing pipeline is proposed in Phase 1 Project.

In Phase 2 and 3 Projects, new pipelines for the developed area will be installed, as well as some pipes for reinforcing the existing pipeline.

In general, distribution network analysis and design has been conducted on the following criteria.

a) Hourly maximum flow (1.68 times larger than daily average water demand) for 2030 is applied.
b) Residual water head at end of the network shall be more than 21 m.
c) Network development is planned in three stages following the urban area development plan.

(2) Outline of Facility

<u>Phase 1</u>

- Due to aging, some existing distribution pipes shall be replaced to the following criteria to minimize leakage.
  a) Steel pipe installed before 1970
  b) Cast iron pipe installed before 1960

c) All Asbestos cement pipe, considering unstable joint and hygienic issues

d) Polyethylene pipe installed before 1960

Replacement of Existing Pipe (Unit: m)

Materials	<100mm	125-200mm	225-400mm	>500mm	Total	Rate (%)
Steel Pipe	8,746	9,355	17,751	15,987	51,839	53.1
Cast Iron Pipe	1,195	38,093	2,342	0	41,630	42.7
ACP	0	3,835	237	0	4,072	4.2
PP	0	0	0	0	0	0.0
Total	9,941	51,283	20,330	15,987	97,541	100.0
Rate (%)	10.2	52.6	20.8	16.4	100.0	

Remarks: ACP-Asbestos Cement Pipe, PP-Polyethylene Pipes

- To relieve the low pressure and high flow velocity, two existing pipes should be replaced with new pipes of larger diameters.

District	Existing	New	Material	Length (m)
District 5	600 mm	900 mm	Steel Pipe	150
District 4B	200 mm	250 mm	Ductile Cast Iron Pipe	1,250

- New distribution pipes will be installed at new and expanded service areas. The following list summarizes the service districts and the major distribution pipes to be installed in Phase 1 Project.

Distribution Network (New/Expanded Service Area)	Residential District: 9, 10, 13, 14, 17 Planning District: I, IV, VI, VII Industrial District: Western	
Material	Diameter (mm)	Length (m)
Ductile Cast Iron Pipe	150	3,900
Ductile Cast Iron Pipe	200	15,600
Ductile Cast Iron Pipe	250	6,900
Ductile Cast Iron Pipe	300	19,200
Ductile Cast Iron Pipe	400	12,500
Ductile Cast Iron Pipe	500	9,590
Ductile Cast Iron Pipe	600	1,140
Ductile Cast Iron Pipe	800	2,000
Steel Pipe	900	1,850

Phase 2

- To relieve the low pressure and high flow velocity by increase of water demand, five existing pipes in District 2 should be replaced new pipes with larger diameters.

District	Existing	New	Material	Length (m)
District 2	300 mm	450 mm	Ductile Cast Iron Pipe	180
District 2	300 mm	450 mm	Ductile Cast Iron Pipe	380
District 2	150 mm	250 mm	Ductile Cast Iron Pipe	240
District 2	500 mm	700 mm	Ductile Cast Iron Pipe	650
District 2	500 mm	700 mm	Ductile Cast Iron Pipe	110

- New distribution pipe will be installed at new and expanded service areas. New main distribution pipes will serve water from new NO. 2 treatment plant to the distribution network. The following list summarizes the service districts and the major distribution pipes to be installed in Phase 2 Project.

Distribution Network (New/Expanded Service Area)	Residential District: 4B, 14, 15, 16, 18, 19 Planning District: III, IV	
Material	Diameter (mm)	Length (m)
Ductile Cast Iron Pipe	150	19,100
Ductile Cast Iron Pipe	200	8,600
Ductile Cast Iron Pipe	250	5,800
Ductile Cast Iron Pipe	300	2,200
Ductile Cast Iron Pipe	350	2,100
Ductile Cast Iron Pipe	400	1,900
Ductile Cast Iron Pipe	450	560
Ductile Cast Iron Pipe	500	2,600
Ductile Cast Iron Pipe	600	1,200
Ductile Cast Iron Pipe	700	3,900
Ductile Cast Iron Pipe	800	6,400
Steel Pipe	900	2,200
Steel Pipe	1,100	1,000
Steel Pipe	1,200	2,900

Phase 3

- New distribution pipes will be installed at new and expanded service areas. The following list summarizes the service districts and the major distribution pipes to be installed in Phase 1 Project.

Distribution Network (New/Expanded Service Area)	Residential District: 11, 14, 17 Planning District: II	
Material	Diameter (mm)	Length (m)
Ductile Cast Iron Pipe	150	9,000
Ductile Cast Iron Pipe	200	5,400
Ductile Cast Iron Pipe	300	6,200
Ductile Cast Iron Pipe	350	2,200
Ductile Cast Iron Pipe	450	1,100
Ductile Cast Iron Pipe	600	6,400
Ductile Cast Iron Pipe	800	950
Steel Pipe	1100	1,600

F.4 Pre-Design Proposal for New City Center Area

New City Center consists of Government Area, Diplomatic Area and Business Area, and it is located at Resident District 13 and a part of Resident District 14 in Southern Planning Region. The center will have a population of 8,800 and working population of 94,300 in 2030. Hourly maximum water consumption of

21,630 m^3/day is projected for domestic and public/commercial use in this center in 2030.

Outline of New City Center and Water Demand

Year	2010	2020	2030
Population	8,800	8,800	8,800
Employment	87,600	102,700	110,000
Domestic (m^3/day)	1,150	1,320	1,500
Public/Commercial (m^3/day)	7,880	8,730	8,800
Total Water Consumption (m^3/day)	9,030	10,050	10,300
Hourly Maximum (m^3/day)	18,960	21,110	21,630

By 2014, water will be supplied from the existing water treatment plant, while water will supplied from new treatment plant at left bank of Ishim River after 2014. Therefore, this center will be linked with both treatment plants after 2014, and it will be well secured for a water supply system.

Main water distribution pipelines (300 to 700 mm) will surround the center. The main pipelines (500 mm) are connected to two main pipelines from north and the other two pipelines (300 and 350 mm) from east, and an additional two pipelines (700 and 600 mm) from south after 2014.

Water distribution network will be designed using hourly maximum water demand (21,630 m^3/day) in 2030, which is 1.68 larger than the above water consumption with 20 % of leakage from the network.

Water supply pipelines on Street No. 1 and 2, which are planned to install using *Akimat*'s budget, can be considered as the branches to supply water to each facility in this center. At this stage, the urban plan for this center has been established, but detailed plans for each building are not determined. Therefore, detailed design for water supply pipelines from these distribution mains to each building shall be carried out at the next stage.

Detailed major water distribution pipes in this center are shown in Figure 4.3.4.

TABLE

Table F. 1. 1 Water Quality (Maximum of 1999)

	Item	WHO		Kazakstan		Reservoir	Ishim	Treated
1	Odour	-	-	-	2.0	1/2	2/1	1/1
2	Taste	-	-	-	2.0	-	-	1
3	pH	-	< 8.0	-	6.0 - 9.0	8.65	8.25	7.9
4	Colour	TCU	15.0	-	20.0	25.0	30.0	10.0
5	Turbidity	NTU	5.0	mg/l	1.5	18	22	1.4
6	Hardness	-	-	mg-equ/l	7.0	4.2	5.9	4.3
7	General Radio Activity				NIS	-	-	-
8	General B-Radio Activity				NIS	-	-	-
9	Beryllium (Be)	mg/l		mg/l	0.0002	-	-	0.0000
10	Barium (Ba)	mg/l		mg/l	NIS	-	-	-
11	Boron (B)	mg/l		mg/l	NIS	-	-	-
12	Bromine (Br)	mg/l		mg/l	NIS	-	-	-
13	Cadomium (Cd)	mg/l		mg/l	NIS	-	-	-
14	Sodium (Na)	mg/l		mg/l	NIS	-	-	-
15	Molybdenum (Mo)	mg/l	0.07	mg/l	0.25	-	-	0.000
16	Arsenic (As)	mg/l	0.01	mg/l	0.05	< 0.01	< 0.01	< 0.01
17	Nitrate (NO3-)	mg/l	50.0	mg/l	45.0	1.8	3.4	2.3
18	Res. Acrylamide Polymer	mg/l	-	mg/l	NA	0.0015	0.0015	-
19	Lead (Pb)	mg/l	0.01	mg/l	0.03	-	-	0.005
20	Selenium (Se)	mg/l	0.01	mg/l	0.001	-	0.009	0.000
21	Silver (Ag)	mg/l		mg/l	NA	-	-	-
22	Silicate	mg/l		mg/l	NA	-	-	-
23	Fluoride (F)	mg/l	1.5	mg/l	1.2	0.48	0.38	0.42
24	Chromium (Cr)				NIS	-	-	-
25	Cyanide				NIS	-	-	-
26	Iron (Fe)	mg/l	0.3	mg/l	0.3	0.29	0.17	0.27
27	Manganese (Mn)	mg/l	0.5	mg/l	0.1	0.24	< 0.05	0.084
28	Copper (Cu)	mg/l	1.0	mg/l	1.0	-	0.06	-
29	Sulfate (SO4)	mg/l	250.0	mg/l	500.0	126	20	94
30	Solid Redisue	mg/l	1000.0	mg/l	1000.0	598	440	462
31	Chloride (Cl)	mg/l	250.0	mg/l	350.0	124	105.3	114
32	Zinc (Zn)	mg/l	3.0	mg/l	5.0	-	0.000	-
33	Oil Products				NIS	-	-	-
34	Volutile Phenols				NIS	-	-	-
35	Microorganisms	pc/100ml	0	pc/mm^3	100	175	10	820
36	Bacterias	pc/101ml	0	pc/l	3	270	< 3	450

Table F. 1. 2 (1) Vyacheslavsky Reservoir Intake Pumping Station

Facility	Power Receiving Building	Pump Room	Operation & Electric Room	Pump Loading Room	Administration Room	Stair Room
Type	Prefabricated Concrete	Concrete Structure	Concrete Structure	Brick Structure	Brick Structure	Brick Structure
Number	1	1	1	1	1	1
Dimension	W6m x L30m x H5m	W12m x L34 m x H9.4m	W12m x L34 m x H7.3m	W8m x L18m x H9m	W12m xL9.3m x H4m	W3.3m x L12.2m x H3m
Location	Ground Structure*	2nd Basement	1st Basement	1st Floor	1st and 2nd Basement : Included in Electric Room and Pump Room	

Note : * Power Receiving Building does not belong to P/S, but a independent structure.

Table F. 1. 2 (2) Ishim Intake Pumping Station

Facility	Power Receiving Building	Pump Room	Ground Building	Screen Loading Room	Electric Room
Type	Brick structure	Concrete Structure	Brick structure	Brick structure	Brick structure
Number	1	1	1	1	1
Dimension	W6m x L19m x H4.5m	W10.5m x L19.5m x H7.7m	W12.5m x L27.8m x H8m	W8.8m x L14m x H6m	W4m x14.5m x H5m
Others	Independent Structure				

Table F. 1. 2 (3) Vyacheslavsky Reservoir Intake Pumping Station

Item	Intake Pumps		Drainage Pump	Sand Drain Pump	Ventilation Fan
Type	Centrifugal	Centrifugal	Centrifugal	Centrifugal	Turbo
Number	2	(1)	1+(1)	2	2
Dimension	Q: 4,095 m^3/hr H: 95 m Dia. 800 mm kW: 1,250	Q: 6,300 m^3/hr H: 95 m Dia. 800 mm kW: 2,000	Q: - H: 20 m Dia. 150 mm kW: -	Q: - H: 20 m Dia. 150 mm kW: -	Q: - H: - Dia. 1.0x1.0 m KW:
Item	Electrical Facility			Intake Screen	Pipe & Valves
Type	Power Receiving Facilities (U.H. Voltage)	Power Receiving Facilities (U.H. Voltage)	Control Panel Central + Side	Vertical Bar screen	Steel Pipe
Number	1	1	1+3	2 units /2 line	1
Dimension	50 KV	10KV	Central: 1unit Side: 3 unit	W2.5m x h5.5m	Dia.600-1000mm. Auto Valve 6 unit
Item	Ceiling Crane	Ceiling Crane	Transmission Pipe No.1	Transmission Pipe No.2	Flow meter
Type	Mobile (longitudinal, horizontal and vertical direction)	Mobile (longitudinal, horizontal and vertical direction)	Steel pipe, Installed in 1968	Steel pipe and Ductile iron pipe, Installed in 1988	Ultra-sonic Meter, Installed on March 2000
Number	1	1	1	1	2
Dimension	W8m, 2 Loading equipment 20t+3.2t	Basement W12m x 20t	Diameter 800-1,000mm x 51km	1,000mm x 51km	Transmission pipe

Note : U.H. Voltage = Ultra High Voltage, ( ) Stand-by

Table F. 1. 2 (4) Ishim Intake Pumping Station

Item	Intake Pumps			Drainage Pump	Intake Screen
Type	Centrifugal	Centrifugal	Centrifugal	Centrifugal	Vertical Bar screen
Number	(2) (Stand-By)	(1)	1	2	2 units /3 line ,
Dimension	Q: 2,400 m^3/hr H:55 m Dia.600x800mm kW: 500	Q:2.200 m^3/hr H: 55 m Dia.600x800mm kW: 500	Q:1,600 m^3/hr H: 55 m Dia.400 x 400 mm kW: 350	Q: - H: - Dia.100x100mm kW: -	Coarse and fine screens W3.5m
Item	Electrical Facility			Pipe & Valves	
Type	Electric Receive Facilities (U.H. Voltage)	Steel Pipe	Steel Pipe	Steel Pipe	
Number	1	1	1	1	
Dimension	50 KV	Dia.600-1000mm Auto Valve 6 unit	Dia.400-800mm Auto Valve 6 unit	Dia.400-800mm. Auto Valve 6 unit	
Item	Pump Ceiling Crane	Screen Ceiling Crane	Flow meter	Flow meter	
Type	Mobile (length, side and vertical direction)	Mobile (length, side and vertical direction)	Ultra-sonic	Ultra-sonic	
Number	1	1	2	2	
Dimension	W11m x 20t	W8m x 3.2t	Installed in Transmission pipe	Installed in Transmission pipe	

Table F. 1. 3 (1) Sedimentation and Coagulation Facilities

Item	Rapid Mixing Tank	Coagulant Dissolution Tank	Dissolved Coagulant Storage Tank	Coagulant Injection Tank	Powder Activated Carbon Injection Facilities	Polymer Injection Facilities
Type	Vertical Flow Mixing, Reinforced Concrete	Reinforced Concrete	Reinforced Concrete	Gravity Injection, Reinforced Concrete	Dissolved Tank and Injection Pump	Dissolved Tank and Injection Pump
Number	2	8	3	6	1	1
Dimension	V=368 m^3	W 5.8 x 5.8 x H 2.5, V=84 m^3 x 7 = 588 m^3 Mixer: Air Bubbling, Blower 6 units	W 11.7m x L 5.7m x H 3m, V=200 m^3 x3 = 600 m^3 Transportation Pump: Chemical Pump	3 m^3 x 6 + Injection Pipes and Valves	Dissolve tank: 3 m^3 with agitator, Injection Pump: Centrifugal type	Dissolve tank: 3m^3 with agitator, Injection Pump: Centrifugal type
Status			Used occasionally	Used occasionally	Used occasionally	Used occasionally
Item	Inlet Valve	Rapid Mixing Tank Outlet Valve	Flocculation Basin Inlet Valve	Flocculation Basin	Sedimentation Basin	
Type	Motor Valve	Motor Valve	Motor Valve	Up-flow Reinforced Concrete	Horizontal Reinforced Concrete	
Number	4	3	3	20	20	
Dimension	D-1000	D-1000	D-600	V:2,290 m^3 T:16.5min	V:23,200 m^3 DT:2.8hr Average Horizontal Speed: 0.3m/min	
Status	By-Pass Valve is installed			Drain Pipe is installed	Drain Pipe is installed	

Table F. 1. 3 (2) Filtration Facilities

Item	Filter	Filter Layer and Trough	Filter Washing Pump	Pipes and Valves	Electric Facilities
Type	Rapid	Quartz Sand Gravel	Centrifugal	Steel Pipe and Motor valve	Control Panel
Number	10	10	1(1)	10	10
Dimension	(1)w5.1xL10.5mx2 Area:107.1m^2 Filtration rate: 186.7m/d (no stand-by) Back-Wash: 0.6m/min, Washing Time:10min, Water consumption of washing: 6,000 m^3/d	A : 107.1 m^2 Filter Bed : t= 0.26m Installed steel perforated Pipe Gravel Bed : t=0.6m (4th Layer), Quartz-sand (0.5-1.2mm): t=1.0m Trough : W0.8m x L5.4 x 6 unit x2 line	Q:5,000 m^3/hr (83.3/min) D: 800mm H: 30m kW: 500	Inlet:d-600mm Out-let:d-600mm Drain: d-1.000mm Back-wash: d-800mm	Manual operation for valve & washing facilities
Status			Motor Valve is installed		

Table F. 1. 4 (1) Facilities of Drinking Water Distribution System

Item	Distribution Pumps				Electric Facilities	Power Supply Facilities	Hoist Crane
Type	Centrifugal	Centrifugal	Centrifugal	Centrifugal	Standing Panel	Standing Panel	Hoist type
No. of Unit	(1)	2(1)	1	2(1)	6	1	1
Specification	Q:6,300 m^3/hr H:50m D:1000,800mm kW:1000	Q:3,600 m^3/hr H:55m D:800,600mm kW:630	Q:2,500m^3/hr H:60m D:600,500mm kW:500	Q:1,500.m^3/hr H:65m D:600,400mm kW:315	Renewed in 2,000	Renewed in 2,000	W : 12m Loading Weight: 20t
Status	Motor Valve included	Motor Valve Included	Motor Valve included	Motor Valve included			

Note : ( ) shows stand-by

Table F. 1. 4 (2) Facility List of Technical Water Distribution System

Item	Distribution Pumps			Electric Facilities	Power Supply Facilities
Type	Centrifugal	Centrifugal	Centrifugal	Standing Panel	Standing Panel
No. of Unit	(1)	(1)	3(1)	1	1
Specification	Q:3,600 m^3/hr H:55m D:800,600mm kW:630	Q:3,200 m^3/hr H:55m D:800,600mm kW:630	Q:500 m^3/hr H:70m D:400,300mm kW:320	----	Renewed 2,000
Status	Motor Valve included	Motor Valve included	Motor Valve included		

Note : ( ) shows stand-by

Table F.2.1 SNiP and Water Demand Projection

SNiP		Max.	Min.
High	Houses with Bathtubs and District Hot Water Supply System	230	350
Middle-1	Houses with Bathtubs and Individual Water Heaters	160	230
Middle-2	Houses with no Bathtubs	125	160
Low	Public Faucets	30	50

2010	Population	SNiP		JICA
		Max	Min	M/P
High	322,500	74,175	112,875	51,278
Middle-1	42,100	6,736	9,683	5,768
Middle-2	47,800	5,975	7,648	4,923
Low	77,600	2,328	3,880	1,940
Domestic	490,000	89,214	134,086	63,909
Commercial		-	-	14,610
Public		-	-	5,520
UFW		8,921	13,409	28,800
Total		98,135	147,495	112,839

2020	Population	SNiP		JICA
		Max	Min	M/P
High	575,700	132,411	201,495	94,990
Middle-1	49,700	7,082	9,692	6,460
Middle-2				
Low	64,600	1,938	3,230	2,050
Domestic	690,000	141,431	214,417	103,500
Commercial		-	-	21,063
Public		-	-	8,016
UFW		14,143	21,442	41,240
Total		155,574	235,858	173,819

2030	Population	SNiP		JICA
		Max	Min	M/P
High	691,700	159,091	242,095	124,510
Middle-1	49,700	7,082	9,692	7,960
Middle-2				
Low	58,600	1,758	2,930	3,530
Domestic	800,000	167,931	254,717	136,000
Commercial		-	-	23,000
Public		-	-	8,688
UFW		16,793	25,472	50,280
Total		184,724	280,188	217,968

Table F. 2. 2 Per Capita Water Consumption

Country	Lpcd
Astana, Kazakhstan (2010)	184 (230 x 0.8)
Austria	162
Czech	121
Denmark	145
France	156
Germany	132
Hungary	113
Italy	249
Norway	260
Sweden	191
Swiss	237
Sapporo, Japan	260

Source: Journal of Japan Water Works Association
Data: Per capita water consumption in 1995, excluding industrial use and leakage

Table F.2.3 Water Demand Projection

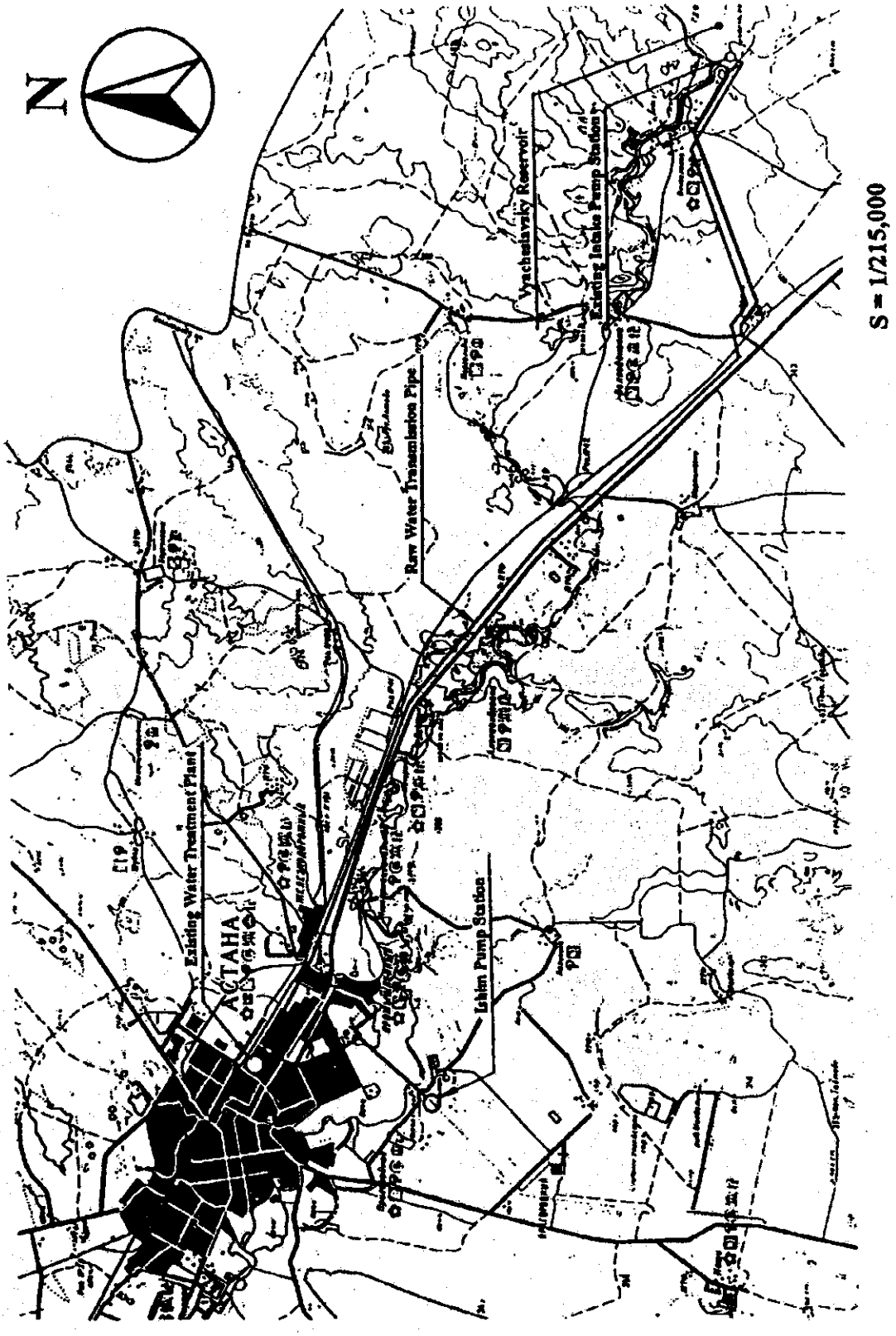
		1998	1999	2010	2020	2030
I. Drinking Water	Unit		(Modified)			
Population	(Person)	276,900	300,800	490,000	690,000	800,000
Public		33,232	36,100	61,900	94,300	108,600
Industry		14,637	15,900	28,000	37,000	44,000
Commercial		87,728	95,300	164,900	247,800	287,500
Demand per Population				130	150	170
Demand per Employee						
Public	(l/empl./day)		133	90	85	80
Industry	(l/empl./day)		133	90	85	80
Commercial	(l/empl./day)			90	85	80
Average	(l/empl./day)		133	89	85	80
Water Volume: Domestic	(m^3/day)	37,452	54,920	63,908	103,500	136,000
Public		6,222	4,814	5,520	8,016	8,688
Industry		26,578	14,790	2,550	3,145	3,520
Commercial				14,610	21,063	23,000
Thermal Plant			22,260	28,590	29,250	29,880
Sub-Total		70,251	96,783	115,180	164,970	201,090
Drinking Water Demand per Capita	(l/c/d)	254	322	235	239	251
Leakage	(m^3/day)	50,862	34,279	28,800	41,240	50,280
Ratio (%)		42%	26%	20%	20%	20%
Total Water Demand		121,100	131,100	144,000	206,200	251,400
Total Distribution Water per Capita	(l/c/d)	437	436	294	299	314
Loss (WTP)	(m^3/day)	13,460	7,000	7,690	10,900	13,200
		10%		5%	5%	5%
Sub-Total		134,600	138,100	151,700	217,100	264,600
II. Technical Water						
Demand for Industry						
Thermal Plant		14,600	15,564	21,444	24,314	28,004
Others			436	756	999	1,188
	(l/empl./day)	-	27	27	27	27
(No. of Employment)		14,637	15,900	28,000	37,000	44,000
Sub total		14,600	16,000	22,200	25,310	29,190
Loss & Leakage		15%	10%	5%	5%	5%
Total		17,200	17,800	23,400	26,600	30,700
Grand Total		151,800	160,320	175,100	243,700	295,300

I. Drinking Water						
Daily Maximum	1.2			172,800	247,400	301,700
Hourly Maximum	1.4			241,900	346,400	422,400
II. Technical Water						
Daily Maximum	1.9			44,500	50,500	58,300
Hourly Maximum	1.1			49,000	55,600	64,100

Table F. 3. 1 Projected District-wise Daily Maximum Water Demand

Planning Region	Sub-Zoning	Domestic Water Demand				Public/Industry/Commercial Water Demand				Total Water Demand			
		(2000)	(2010)	(2020)	(2030)	(2000)	(2010)	(2020)	(2030)	(2000)	(2010)	(2020)	(2030)
A. Ishim River - Right Bank													
1. Central Planning Region	Residential District 3	12,492	9,057	11,811	14,941	5,378	3,209	4,723	5,107	17,870	12,267	16,535	20,048
	Residential District 4A	15,325	12,363	15,719	17,837	5,580	4,470	6,131	6,474	20,905	16,834	21,850	24,310
	Residential District 5	9,254	7,629	9,914	11,250	2,794	715	838	828	12,048	8,344	10,752	12,079
	Residential District 6	10,280	8,275	10,524	11,942	3,894	689	792	786	14,174	8,964	11,316	12,729
2. Northern Planning Region	Northern Industrial District	3,480	1,100	1,270	1,441	3,160	2,841	4,039	4,081	6,640	3,941	5,309	5,522
	TETs-1	0	0	0	0	4,938	4,938	5,928	5,928	4,938	4,938	5,928	5,928
	Central Industrial District	920	667	770	874	4,597	4,274	5,837	5,866	5,517	4,941	6,607	6,740
	TETs-2	0	0	0	0	35,661	37,947	37,947	38,895	35,661	37,947	37,947	38,895
	Planning District I	0	0	0	0	0	0	0	0	0	0	0	0
	Planning District II	0	0	0	0	0	0	0	0	0	0	0	0
	Planning District III	0	0	0	0	0	0	0	0	0	0	0	0
	Planning District IV	0	0	0	0	0	80	155	218	0	80	155	218
3. Southeastern Planning Region	Residential District 7	13,922	15,433	18,494	20,987	1,267	1,285	1,391	1,382	15,189	16,717	19,885	22,368
	Residential District 8	8,148	6,025	6,956	7,893	810	574	598	591	8,958	6,599	7,554	8,484
5. Northwest Planning Region	Residential District 1	1,214	880	2,033	3,460	130	84	175	259	1,344	964	2,207	3,719
	Residential District 2	6,071	4,402	7,046	10,225	2,217	420	606	765	8,288	4,821	7,652	10,991
	West Industrial District	19	14	16	18	0	495	578	596	19	509	594	614
	Residential District 4B	977	708	10,373	11,770	0	67	892	881	977	776	11,264	12,651
Sub-Total		82,101	66,554	94,926	112,638	70,426	62,088	70,630	72,657	152,527	128,642	165,556	185,295
B. Ishim River - Left Bank													
3. Southeastern Planning Region	Residential District 19	0	0	4,047	4,592	0	0	348	344	0	0	4,394	4,936
	Residential District 17	0	11,567	15,644	17,753	0	1,103	1,345	1,329	0	12,670	16,989	19,081
	Residential District 9	728	5,707	6,589	7,477	0	544	566	560	728	6,251	7,155	8,036
	Residential District 10	359	1,135	2,484	2,819	0	108	214	211	359	1,243	2,698	3,030
	Industrial District - Station 40	678	1,968	2,272	2,579	52	485	569	544	730	2,453	2,842	3,123
	Residential District 18	0	0	6,412	7,276	0	0	551	545	0	0	6,963	7,820
	Planning District V	1,051	762	880	998	0	63	65	62	1,051	825	944	1,060
4. Southern Planning Region	Residential District 11	432	771	1,599	13,879	504	73	137	1,039	935	844	1,736	14,918
	Residential District 12	3,427	3,192	3,685	4,181	1,155	304	317	313	4,581	3,496	4,001	4,494
	Residential District 13	0	1,726	1,993	2,262	0	7,268	8,969	9,291	0	8,994	10,962	11,553
	Residential District 14	0	1,908	6,043	11,743	0	4,461	7,192	8,833	0	6,369	13,235	20,575
	Residential District 15	0	0	3,494	4,614	0	0	300	345	0	0	3,794	4,960
	Residential District 16	115	83	4,618	10,550	0	8	397	790	115	91	5,015	11,339
	Planning District VII	347	489	565	641	0	65	287	471	347	554	852	1,112
	Planning District VIII	0	0	0	0	0	0	0	0	0	0	0	0
5. Northwest Planning Region	Planning District IX	0	0	0	0	172	0	0	0	172	0	0	0
Sub-Total		7,136	29,308	60,324	91,362	1,882	14,817	21,581	24,978	9,018	44,125	81,905	116,340
Grand Total		89,237	95,862	155,250	204,000	72,308	76,905	92,211	97,635	161,545	172,767	247,461	301,635

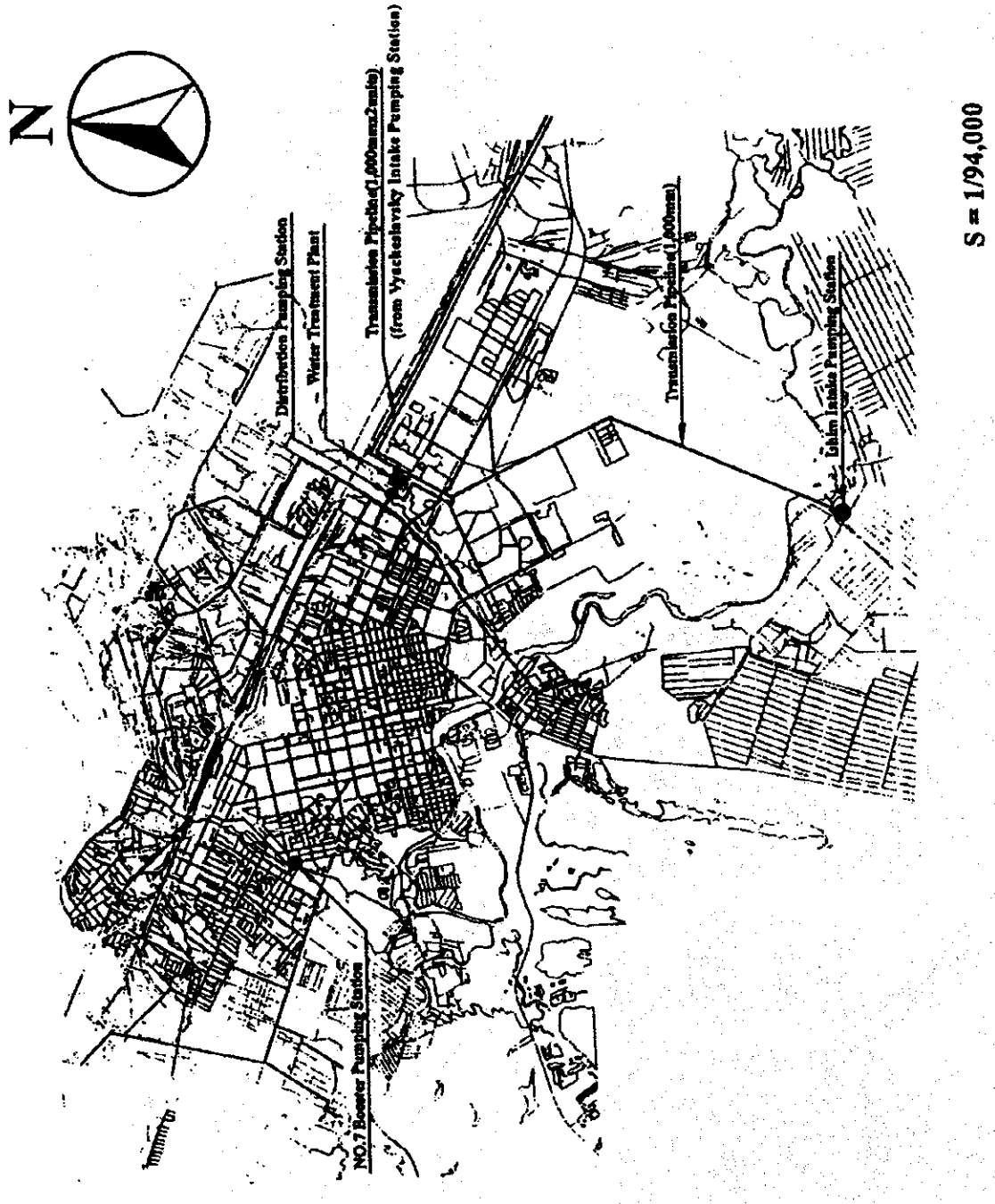
FIGURE



Feasibility Study for Water Supply and Sewerage in the City of Astana

JAPAN INTERNATIONAL COOPERATION AGENCY

Figure F.1.1
Location Map of the Existing Water Supply System in Astana City



Feasibility Study for Water Supply and Sewerage in the City of Astana

JAPAN INTERNATIONAL COOPERATION AGENCY

Figure F.1.2
General Plan of the Existing Water Supply System in the City of Astana

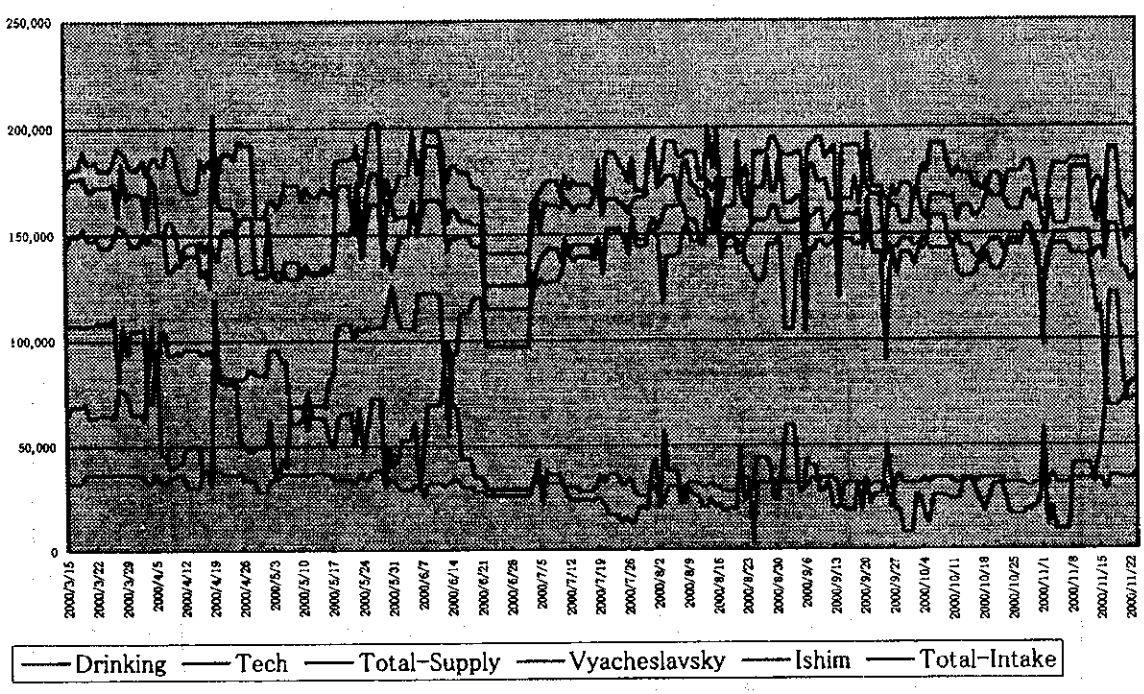
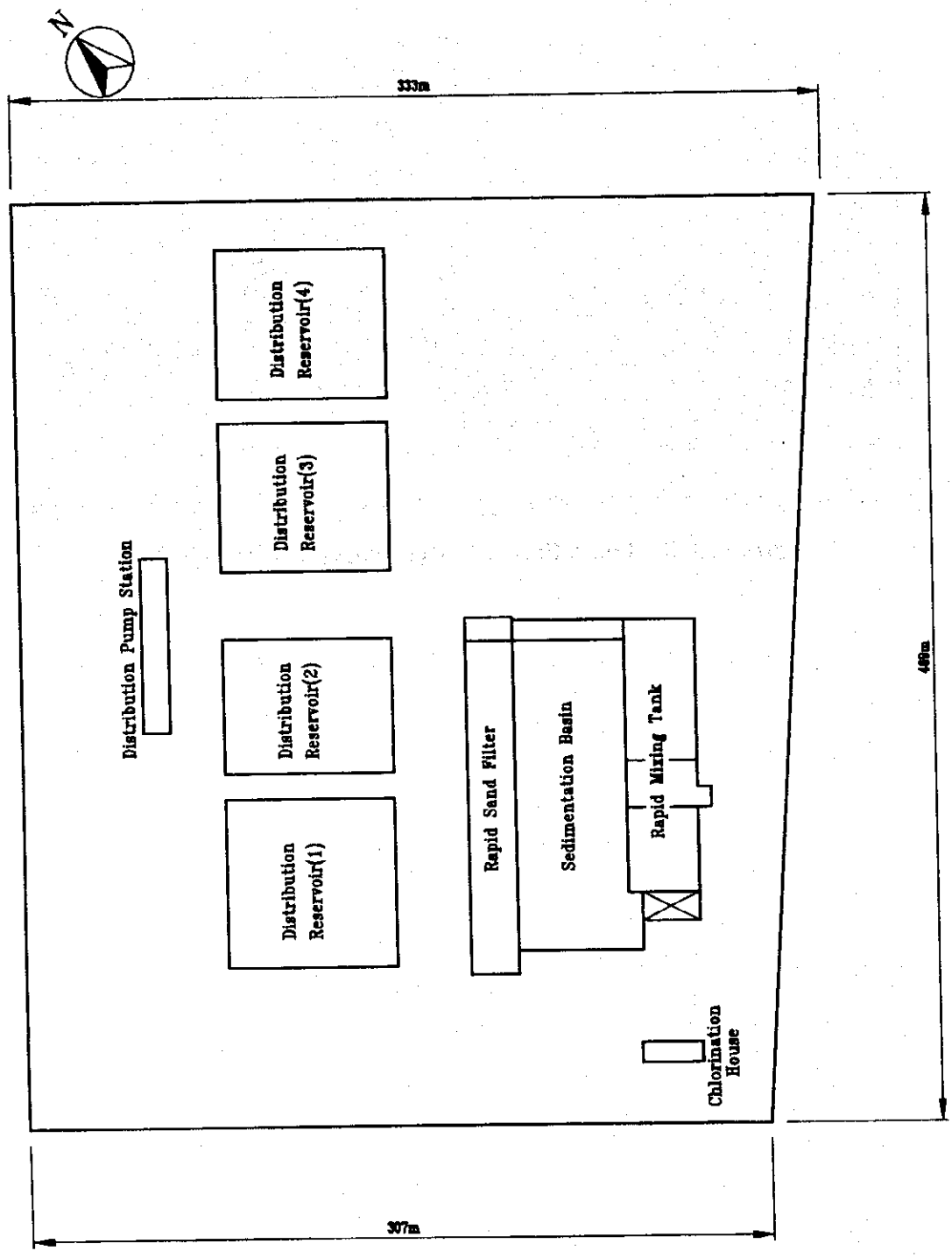


Figure F. 1. 3 Operation of Water Supply Facilities in 2000



Master Plan for the Development of the City of Astana	Figure F.1.4
JAPAN INTERNATIONAL COOPERATION AGENCY	Layout of the Existing Water Treatment Plant

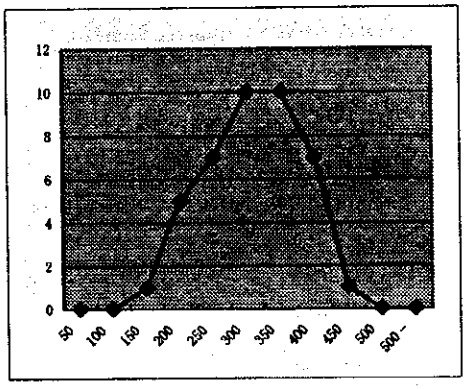
Fifure F. 1. 5 Comparison of Water Consumption

1. Apartment with Bulk Watermeter

a. Per Capita Water Consumption

All	Total
Max	428.2
Min	116.7
Ave	283.1
Median	293.9

Lpcd	NO.
50	0
100	0
150	1
200	5
250	7
300	10
350	10
400	7
450	1
500	0
500 -	0
	41



2. Flat with Individual Watermeter

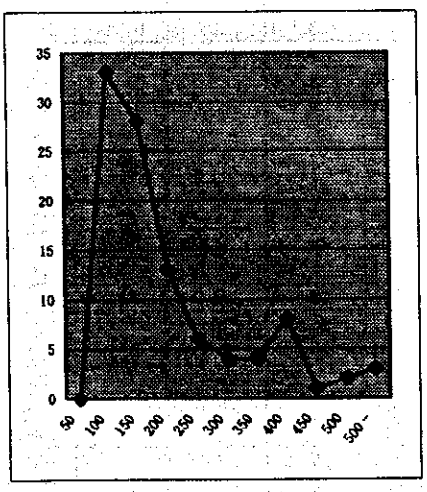
a. Per Capita Water Consumption

All	NO.	Days	M-D	Hot	Cold	Total
Max	5	772	3,335	562.5	354.0	750.0
Min	1	7	7	10.7	17.2	51.7
Ave	2.42	271	667	65.5	67.0	132.5
Median	2	281	562	66.0	68.3	130.6

b. Water Consumption - No. of Family Member

Lpcd	Max	Min	Ave	Median	NO.
1	750	52	262	321	26
2	384	69	143	133	28
3	358	58	111	107	32
4	361	54	106	86	11
5 -	248	72	121	145	5

Lpcd	NO.
50	0
100	33
150	28
200	13
250	6
300	4
350	4
400	8
450	1
500	2
500 -	3
	102



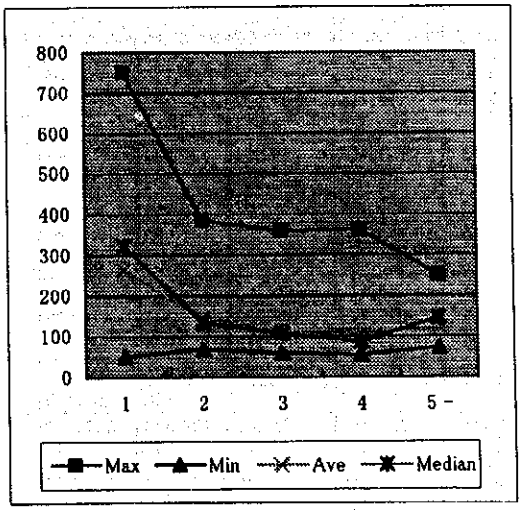
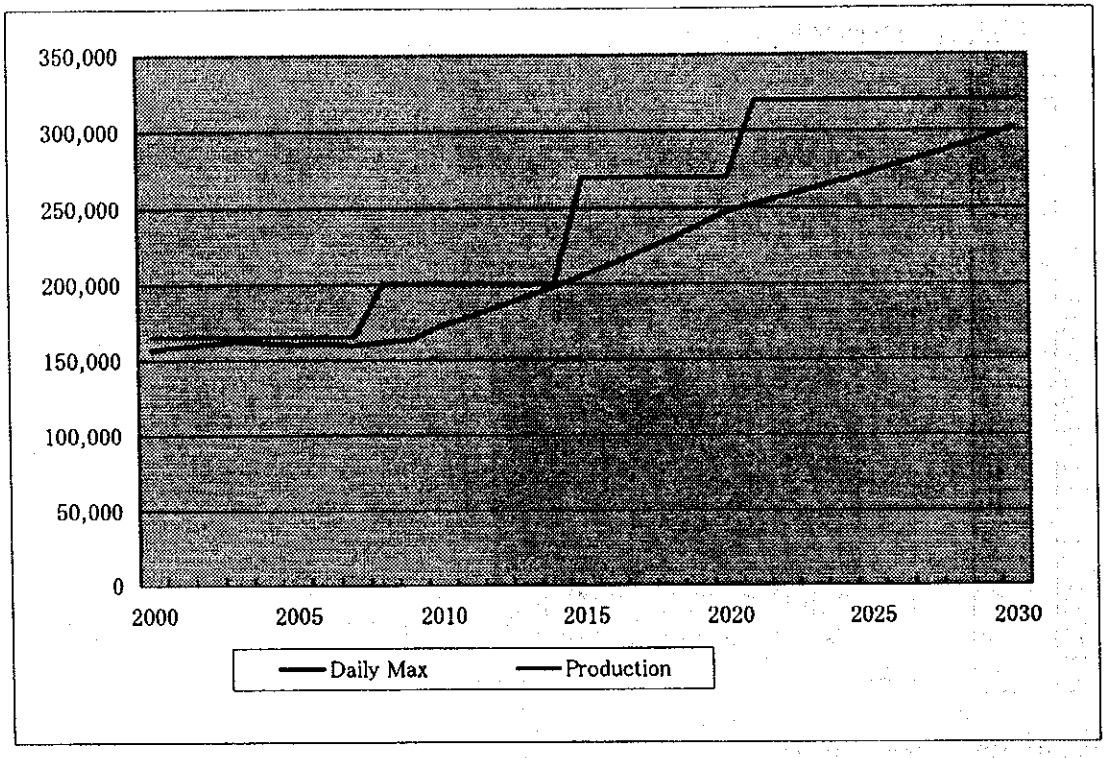
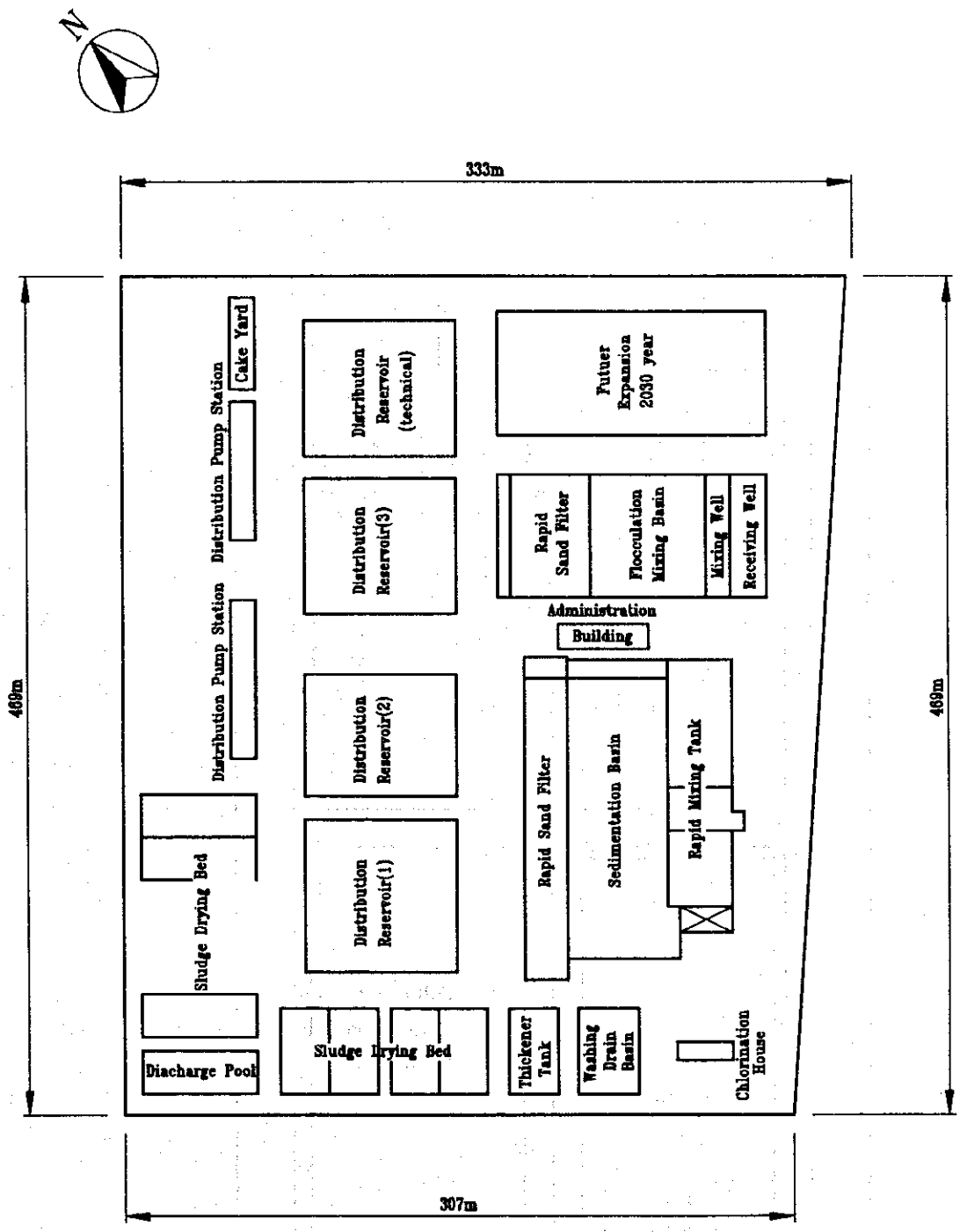


Figure F. 3. 1 Demand - Production



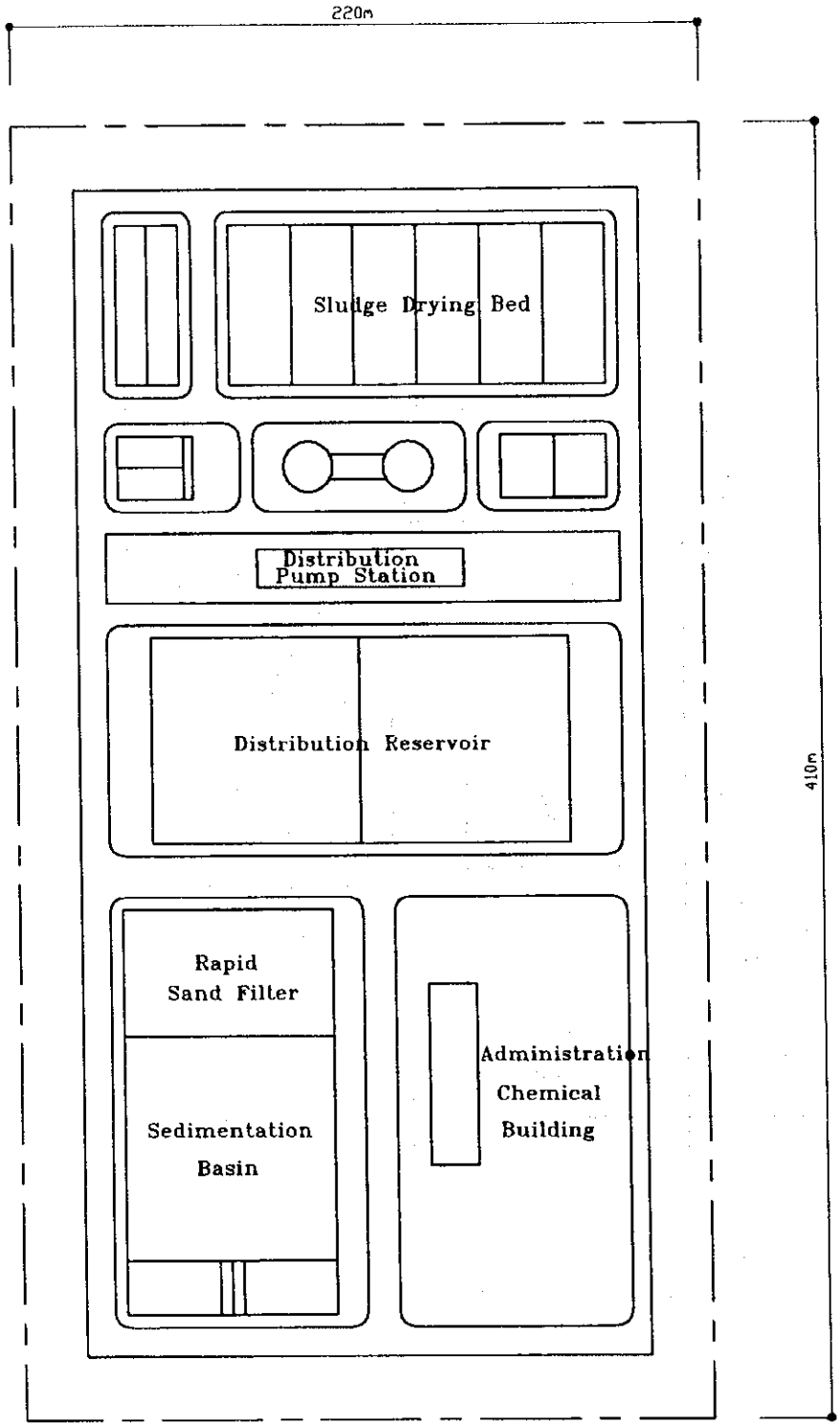
Year	Water Demand		Water Use (Daily Average)				Production				
	Daily Max	Daily Ave	Total	Domestic	Commercial	TETs	Total	Existing	No.1	No.2	No.3
2000	156,947	130,789	96,784	54,920	19,604	22,260	165,000	165,000			
2001	158,774	132,312	97,911	55,759	19,892	22,260	165,000	165,000			
2002	160,628	133,857	99,054	56,610	20,184	22,260	165,000	165,000			
2003	162,511	135,426	100,215	57,475	20,480	22,260	165,000	165,000			
2004	161,238	134,365	101,394	58,353	20,781	22,260	165,000	165,000			
2005	159,981	133,317	102,590	59,244	21,086	22,260	165,000	165,000			
2006	161,070	134,225	105,328	60,149	21,396	23,784	165,000	165,000			
2007	159,799	133,166	106,561	61,067	21,710	23,784	165,000	165,000			
2008	161,718	134,765	107,812	62,000	22,028	23,784	200,000	100,000	100,000		
2009	163,624	136,353	109,083	62,947	22,352	23,784	200,000	100,000	100,000		
2010	172,767	143,973	115,178	63,908	22,680	28,590	200,000	100,000	100,000		
2011	178,718	148,932	119,145	67,065	23,491	28,590	200,000	100,000	100,000		
2012	184,947	154,122	123,298	70,377	24,330	28,590	200,000	100,000	100,000		
2013	191,465	159,555	127,644	73,853	25,200	28,590	200,000	100,000	100,000		
2014	198,289	165,240	132,192	77,501	26,101	28,590	200,000	100,000	100,000		
2015	205,430	171,192	136,953	81,329	27,034	28,590	270,000	50,000	100,000	120,000	
2016	212,906	177,421	141,937	85,347	28,000	28,590	270,000	50,000	100,000	120,000	
2017	220,730	183,942	147,154	89,562	29,001	28,590	270,000	50,000	100,000	120,000	
2018	228,921	190,768	152,614	93,986	30,038	28,590	270,000	50,000	100,000	120,000	
2019	237,495	197,913	158,330	98,628	31,112	28,590	270,000	50,000	100,000	120,000	
2020	247,461	206,218	164,974	103,500	32,224	29,250	270,000	50,000	100,000	120,000	
2021	252,189	210,158	168,126	106,365	32,511	29,250	320,000		100,000	120,000	100,000
2022	257,040	214,200	171,360	109,310	32,800	29,250	320,000		100,000	120,000	100,000
2023	262,017	218,347	174,678	112,336	33,092	29,250	320,000		100,000	120,000	100,000
2024	267,123	222,603	178,082	115,446	33,386	29,250	320,000		100,000	120,000	100,000
2025	272,363	226,969	181,575	118,642	33,683	29,250	320,000		100,000	120,000	100,000
2026	277,739	231,449	185,159	121,927	33,983	29,250	320,000		100,000	120,000	100,000
2027	283,256	236,047	188,837	125,302	34,285	29,250	320,000		100,000	120,000	100,000
2028	288,917	240,764	192,611	128,771	34,590	29,250	320,000		100,000	120,000	100,000
2029	294,726	245,605	196,484	132,336	34,898	29,250	320,000		100,000	120,000	100,000
2030	301,632	251,360	201,088	136,000	35,208	29,880	320,000		100,000	120,000	100,000



Legend

- Existing Facilities
- Facilities will be built in 2010 (No.1)
- Facilities will be built in 2030 (No. 3)

Master Plan for the Development of the City of Astana.	Figure F.3.2 General Plan of the Existing and Proposed Water Treatment Plant (No.1 & 3)
JAPAN INTERNATIONAL COOPERATION AGENCY	



Master Plan for the Development of the City of Astana.

JAPAN INTERNATIONAL COOPERATION AGENCY

Figure F.3.3

General Plan of Proposed Water Treatment Plant (No.2)

CHAPTER G
SEWERAGE

SUPPORTING REPORT G: SEWERAGE

Contents

List of Figures

G.1 Present Condition of Sewerage

G.1.1 General

Existing sewerage system covers about 3,500 ha mostly urbanized part of Astana City, which spans 71,000 ha of total administrative area. The following table prepared by Astana Su Arancy (ASA) shows the breakdown of population according to the condition of each type of water supply and sewerage service in 1999. Norms of water consumption on each condition are also shown in the table.

Water Service Population and Type of Houses in 1999

Type of Water and Sewerage Service Condition at houses	Population registered by ASA	Water Consumption Norm (L)
Without Sewerage Service		
1) Water Consumption from outside stand pipes	76,600	22
2) Houses with central water supply without sewerage	4,100	30
With Sewerage Service		
3) Houses with central water supply and sewerage without bath	5,600	95
4) Houses with central water supply and sewerage without bathtubs, with gas supply	14,200	120
5) Houses with central water supply, sewerage and bathtubs with heaters on solid fuel	500	150
6) Houses with central water supply, sewerage and bathtubs with gas heaters.	14,500	190
7) Houses with central water supply, sewerage and bathtubs with fast gas heaters	4,500	210
8) Houses with same condition as above, and with sitting bathtubs	3,00	230
9) Houses with same condition as above, and with bathtubs at length of 1500 mm – 1700 mm, equipped with showers	172,000	250
10) Dormitories with central water supply, sewerage, without showers	3,400	85
11) Dormitories with central water supply, sewerage and public showers	1,100	110
11) Dormitories with showers in every room	1,300	110
Total	300,900	-

Data Source: Astana Su Arancy (ASA)

According to the above table, 300,900 of Astana city residents receive water supply service (Total population in Astana City is 318,000) and, out of this sum, 220,200 residents had sewerage service in 1999. The residents who live in the houses identified as Type 1) and 2) do not get sewerage service, but have septic tanks or night soil storage tanks, and subscribe to septage collection service. Collected septage and night soil are discharged to sewer pipe through manholes. It means that, theoretically, all of the wastewater generated in Astana City can

reach the existing sewage treatment plant by using the sewage collection networks and septage collection vehicles. In reality, however, considering water consumption and sewage generation amounts, it is estimated that a substantial part of the wastewater generated in Astana is discharged to public water bodies or infiltrated into soils without proper treatment.

The sewage collection networks, sewage pumping stations and the sewage treatment plant are operated and managed by ASA. ASA is carrying out repairing works of STP and small construction works for sewer installation as emergency works with their own budget.

G.1.2 Sewage Collection

(1) Present Condition of Sewage Collection System

Existing sewer mains have capacity enough to collect and transmit all the sewage generated in Astana. However, about 30 % of households are not connected to sewerage as sewer pipes are installed only in limited areas. Installation of new sewer pipes is required in order to increase sewerage connections.

The network includes sewer pipelines and 34 major pumping stations. All the sewage collected by the network is transmitted to a central sewage treatment plant (STP) located on the left bank of the Ishim river at about 7 km southwest of the city center, as shown in Figure 4.4.1.

The materials of installed sewer pipes are reinforced concrete, asbestos cement, clay, steel, cast iron, and the diameter of the pipes are between 100 mm and 1,500 mm.

According to an ASA report, one of major defects on the sewer system is blockage. Twenty to fifty incidents of blockage are reported daily. The larger number occurs mainly during the spring, especially when melted snow is flushed with rubbish into the manholes. This is equivalent to about 1,500 blockages per 100 km/year. This blockage frequency is considered very high. International experiences indicate that the frequency is normally a maximum of 50 blockages/100 km/year. A maintenance team report indicates that many blockages are the result of all sorts of rubbish, and building rubble etc. falling in open manholes of the sewerage.

(2) Present Condition of On-site Wastewater Treatment

About 30 % of the households have not been connected to the sewerage system, and have on-site treatment facilities. (septic tanks and night soil storage tanks) As there are no regulation nor design criteria for on-site

treatment facilities in Kazakstan, quality of on-site treatment facilities depends on the owners of each building. Most of the facilities are a storage type with no treatment component, such as bucket latrine or cesspools. Therefore, septage is generally required to be collected very often, once a week to once a month. Some residents are making request to the department in Astana municipality named Golkomhose to collect septage and/or night soil. About 15,000 houses have their septage collected periodically.

Fifty (50) septage collection vehicles are in operation by Golkomhouse. The charge for septage collection is 1,200 tenge/hour for vacuum vehicle operation.

G.1.3 Sewage Treatment Plant

The sewage treatment plant (STP) uses the conventional activated sludge process with a design treatment capacity of 136,000 m^3/day. However, the actual amount of influent to the STP is estimated about 100,000 m^3/day at a daily average. The effluent from STP is discharged to Taldy Kol reservoir by using pumping facilities. Until 1970 the reservoir had received wastewater directly from Astana City without any treatment. The present system was adopted in 1974, and between 1971 and 1973, the effluent treated only by a sedimentation process was discharged to the reservoir. The Taldy Kol reservoir does not have any outlet, and the water in the reservoir sometimes overflows to the surrounding lowlands, west of the reservoir, through an emergency pipe.

As the available water quality data on effluent of the STP, the activated sludge process were observed to be working well. The effluent of the STP is estimated less than BOD 20 mg/L level, which is considered a normal operation condition of an activated sludge process. The quality of the effluent is estimated to be suitable for an irrigation use. The layout of existing STP is shown in Figure G.1.1 and principal features of the STP are given below.

Principal Features of Existing Sewage Treatment Works

	Existing Dimension	Required
Inlet Pump Station	4 units x 2700 m3/hour	Replacement of pumps
Grit Chamber	4 unit	Re-construction
Primary Classifier	6 units (dia. 28 m)	Replacement of sludge pumps
Aeration Tank	4 units (28m x 105m)	Installation of blowers
Secondary Classifier	10 units (dia. 28 m)	Replacement of sludge pumps
Chlorination Channel	1 unit	No-problem
Outlet Pump Station	4 units x 2700 m3/hour	Replacement of pumps
Sludge thickener	2 units (dia. 20 m)	No-problem
Sludge Digestion Tank	2 units (dia. 18 m)	Re-construction of 1 unit
Sludge Drying Bed	34 units (25 m x 110 m)	Construction of new de-watering facilities

G.1.4 Discharge and Re-use of Treated Sewage

As mentioned in Supporting Report (A), the capacity of water resources around Astana City is limited. Consideration of reuse of treated sewage is important from the view point of effective usage of water resources.

In the old Soviet Union Era, a development plan of irrigation area around Astana City was prepared. For a positive reuse of treated wastewater for irrigation in the new development area, Kazakstan government started to construct a water transmission pipeline system between Taldy Kol impounding reservoir and Karabidaic impounding reservoir crossing the Sarkrama and Nura Rivers, as shown in Figure G.1.2. The plan of the transmission system consists of a pipeline with dia. 1000 mm, L= 22 km and a pumping station. However, the construction works were not completed. After the collapse of Soviet Union, many farmers left agricultural land. Agricultural activities around Astana, therefore, have declined and the irrigation development plan is at a stand still.

"Pre-feasibility Study for Astana City Water Supply and Sewerage System Development Project" was prepared in October, 1999 by CDC. The proposed plan in the pre-feasibility study is as shown in Figure G.1.3. This plan is also based on large irrigation water demand in the left bank of Nura River.

G.2 Basic Concept of Sewerage Development Plan

G.2.1 Framework for Sewerage System Development

(1) Sewerage Service Population and Area

The sewerage system is planned to cover all of residential districts (14,060 ha in 2030) and the industrial districts. As shown in the following table, Residential sewerage service area will increase from 3,284 ha at present to 14,060 ha in 2030, and the sewerage service population will increase from 220,100 at present to 760,000 in 2030. About 90 % of the sewage will be generated in the residential sewerage service area. Sewerage service population rate is planned to increase 73 % at present to 95 % in 2030.

Sewerage Service Area and Population

Year	Residential Sewerage Service Area (ha)	Population in Residential Sewerage Service Area	Sewerage Service Population	Sewerage Service Population Ratio per total population
1999	3,284	306,249	220,100	73 %
2010	7,535	474,537	421,400	86 %
2020	12,320	666,933	641,700	93 %
2030	14,060	780,525	760,000	95 %

*) Sewage service area excluding Industrial Area

The area located out of 2nd arterial road, including the airport, the technology parks, the new university, etc will not be covered by the sewerage system, and individual treatment facilities are to be installed for each area because of far from the STP. Even in the urban area, it is assumed that a small part of residents who get water from standpipe are not expected to use sewerage service.

(2) Sewerage Generation Forecast and Type of Sewage

Amount of sewage generation depends on the volume and types of water consumption and the sewage generation ratio. As mentioned in Supporting Report (F), two types of water supply systems, namely the potable water supply system and the technical water supply system, are operating in Astana City. Water supplied by the potable water supply system is mainly consumed by domestic, institutional and commercial water users. About 85 % of the amount of consumed water are discharged to sewer pipes at present. Water supplied by the technical water supply system is mainly consumed as cooling water for boilers, and cleaning water, and most of the

supplied technical water is not discharged to sewer pipes. For the planning of the sewerage development, sewerage generation rate is assumed as in the table below.

Sewage Generation Ratio

		Sewage Generation Ratio
Potable Water Supply	Domestic Use: with sewerage	90%
	Domestic Use: without sewerage	0%
	Public Use	90%
	Commercial Use	70%
	Industrial Use	70%
	Thermal Plant Use	30%
Technical Water Supply	Industrial Use	90%
	Thermal Plant Use	0%

The volume of sewage generated in 2010, 2020 and 2030 are forecasted considering the above conditions. The results are given below.

Sewage Generation Forecast

Year	Domestic	Institutional	Commercial	Industrial	Filtration	Total
1999	66,810	5,199		22,658	9,466	104,133
2010	69,020	5,958	10,744	16,299	10,203	112,224
2020	111,977	8,651	15,654	19,421	15,570	171,273
2030	147,492	10,003	18,781	20,853	19,713	216,842

*) Total sewage amount includes not only wastewater, but also infiltration water equal to 10 % of wastewater amount.

G.2.2 Basic Concept for Long Term Development Project

The main objectives of sewerage system are to create a suitable living environment and to preserve a suitable natural environment protected from water pollution. For preparing an appropriate plan, the following issues are considered in this Section.

- Preparation of suitable living environment in Astana
- Environmental impact of treated sewage discharge
- Effective use of water resources
- Harmonization with surrounding environment of STP
- Financial sustainability

- Consideration of Taldy Kol Reservoir

(1) Preparation of Suitable Living Environment in Astana

For preparation of a suitable living environment in Astana, all of wastewater generated in Astana City should be treated properly. The sewage service area shall be expanded to cover the entire new city development area as described in G.2.1 (1). The wastewater generated in the sewerage service area will be collected by sewer pipes and treated at the STP, and wastewater generated outside of the sewage service area will be collected by septage collection vehicles and also treated at the STP.

(2) Consideration of environmental impact of treated sewage discharge

As a design concept of the existing sewerage system, all the treated sewage is discharged to Taldy Kol reservoir, and evaporated or infiltrated from the reservoir. However, the reservoir does not have an enough capacity to accommodate all the treated sewage. Even at present, surplus water from Taldy Kol Reservoir is discharged to wet land northwest of the reservoir through an emergency outlet pipeline. Some of the surplus water reaches to Ishim River.

Taldy Kol Reservoir is expected to have an additional treatment function of STP. It is estimated that Taldy Kol Reservoir takes an important role to improve water environment around Astana City. Taldy Kol Reservoir, therefore, could not be reclaimed, and a certain amount of treated sewage will be discharged to the reservoir continuously by 2030. The wet land is also expected to work for water treatment by a natural treatment process.

Due to increase of sewage amount in future, Taldy Kol Reservoir and the wet land will get a higher load of pollution. Additional treatment process of the existing STP will be introduced in order to reduce the pollution load.

(3) Consideration of effective use of water resources

The capacity of Vyacheslavsky reservoir is estimated 87.2 MCM/year. On the other hand, the forecast amount of sewage generation amount is 79.2 MCM/year in 2030. Well-treated sewage has a big potential for a future water resource.

As mentioned in the section of Water Resources Development, future water resources for Astana City are very limited, while the effluent of STP is not

used for any purpose at present. The options of reuse of treated wastewater are shown below.

Options of Re-use of Treated Wastewater

Items	Details
Industrial Water	Cooling, boiler feed, process water
Agricultural Irrigation	Irrigation water
Landscape Irrigation	Trees in the city, Sprinkling to streets, Gardening
Sanitary Flow	(to maintain river flow)
Others	Washing water, Toilet water

About 1,700 ha of agricultural area, which is located to the south of Taldy Kol Reservoir, has been operated using treated wastewater. As recent decline of agriculture activity after the collapse of Soviet Union, the operation has stopped in 1995.

For making a proposal of reuse of treated wastewater, the demand for its use and the required water quality level should be considered.

(4) Consideration of harmonization with surrounding environment of STP

A number of residents and officials in Astana would like to have STP relocated far from the residential area, because of offensive odor, though M/P team could not find out serious situation during site survey. Especially, sludge drying beds in the existing STP are considered as a major source of offensive odor. According to the future land use plan of this Master Plan, residential areas will be developed within 3 km from the existing STP site. Residents within a few kilometer radiuses may face the impact of offensive odor, though it may depend on the wind direction.

Relocation of STP was recommended in Pre-feasibility Study Report prepared by CDC in 1999. However, the relocation option is extremely expensive, compared with the other options, and is considered not advisable. Under well-managed condition of sludge treatment, offensive odor generation from sludge drying bed can be reduced considerably.

(5) Consideration of Financially Sustainability

Suitable operation of a sewerage system depends on the financial condition of the operating agency. Considering the financial situation of the Kazakhstan government, projects with low initial costs will be appropriate and advisable.

The existing sewerage system shall be rehabilitated and utilized as much as possible, and the sewerage system will cover only urban area, which consists of all residential area and industrial area, and not the entire city.

It will be also necessary to propose suitable projects and implementation of an efficient step-wise rehabilitation and development plan, paying attention to the financial aspects.

(6) Consideration of Taldy Kol Reservoir

All the effluent of STP in Astana is presently discharged to Taldy Kol Reservoir with a surface area of 21.3 km^2. While the reservoir was designed to evaporate all the effluent, it does not have an enough capacity for the volume of present influentce. The reservoir is constructed over a mashy terrain with dykes around, and thus the normal water level is higher than the surrounding ground.

There is a widespread conception that Taldy Kol Reservoir is a heavy polluted water body, as it receives effluent of STP. In reality, the water quality of Taldy Kol Reservoir is much better than it is generally conceived, due to the proper treatment of wastewater at STP and additional natural treatment process in effect in the reservoir. According to the results of the site survey of the Study Team, it is confirmed that there is no offensive odor while a number of wild birds are to be seen in the reservoir. Taldy Kol Reservoir nonetheless poses some issues regarding the development of Astana City, due to the following reasons.

- Taldy Kol Reservoir occupies a large area near the center of Astana City.
- Infiltrating and overflowing water from Taldy Kol Reservoir creates swamps around the reservoir. Due to future development of Astana City, amount of the outgoing water is expected to increase.

The volume of discharge water to Taldy Kol Reservoir shall be reduced.

G.2.3 Alternative Study for Sewerage Development Plan

Sewerage system development plans have been prepared in the existing Master Plan prepared by a Saudi group and a Pre-Feasibility Study for Astana City, Water and Sewerage System Development Project, 1999, as shown in Figure G.1.3. The proposed plans of each report are summarized below.

Comparison of Existing Plan of Sewerage System Development

	Saudi Grout Master Plan	Pre F/S prepared by CDC
Target Year	2030	2010
Location of STP	Same as existing STP site	New site near the Nura River
Treatment Process	Secondary Treatment Process (Activated Sludge Process) + Advanced Treatment Process (Rapid Sand Filter)	Secondary Treatment Process (Activated Sludge Process)
Final Discharge Point	Land in summer and the Nura River and Ishim River in winter (No structural plan is established)	The Nura River through Karabidaic impounding reservoir
Sludge Treatment Method	Sludge thickening + Sludge Digestion + De-watering process (centrifuge type)	Sludge thickening + Sludge Digestion + De-watering process (centrifuge type)
Reuse plan of treated sewage	-	Irrigation mainly left bank of the Nura River

Referring to the above plans, an alternative study of alternatives was carried out in this Section.

(1) Discharge of Effluent of Sewage Treatment Plant

All of the treated sewage is discharged into the Taldy Kol Reservoir and the surplus water of the reservoir is discharged to the wet land. Surplus water would increased due to the projected increase of sewage generation amount in future. The amount of sewerage generation in Astana is estimated at 216,842 m^3/day in 2030. Even if re-use of treated wastewater is promoted, it is not realistic to use up all the effluent from STP in Astana City. In any case, a large part of the effluent of the STP is discharged to Taldy Kol Reservoir, and the surplus water from Taldy Kol Reservoir shall need some area to be discharged. The amount of surplus water from Taldy Kol Reservoir can roughly be estimated by the following formula.

(Surplus Water Discharge) = (Sewage Generation Amount)

- (Volume of Treated Sewage Reuse)

- (Evaporation and Infiltration from Taldy Kol Reservoir)

Under the condition mentioned above, locations for discharging of treated sewage should also be considered. Alternatives of final discharge point of large amount of treated sewage are as shown in Figure G.2.1 and below.

- Wet Land
- Taldy Kol Reservoir (after expansion of capacity of Taldy Kol Reservoir to evaporate and infiltrate all of treated sewage.)

- The Ishim River and/or The Nura River
- Agricultural Land

1) Discharge to Wet Land

Discharge to the adjoining wet land west of Taldy Kol Reservoir is virtually just the same as the present condition, which is acceptable for a temporary measures. However, the discharge shall be stopped in future because of the reason described in G.2.2 (6).

It is believed in Kazakh experts, that treated wastewater discharge to the wet land is not preferred from an environmental point of view. Though even at present large amount of treated wastewater is discharged to the wet land, any kinds of environmental impacts have not been reported at present.

The wet land is used as pasture at present. Watering to pasture is one of most popular re-use method of treated wastewater in the world.

2) Taldy Kol Reservoir

About 36.5 million m^3/year of treated sewage is discharged to Taldy Kol Reservoir, and about 9.6 million m^3/year of surplus water of the reservoir is discharged to the wet land using the emergency pipe with the capacity of 115,000 m^3/day in about 60 days a year. About 29.9 million m^3/year of treated sewage are evaporated or filtrated in the reservoir.

In this alternative, the existing Taldy Kol Reservoir is assumed to be expanded so that there will be no discharging of treated sewage to a river occurs. In order to deal with 79.2 million m^3/year of treated sewage generated in 2030, the area of the reservoir should be expanded to about 2.7 times of the present area. This alternative plan of Taldy Kol Reservoir expansion was found to be difficult, from the view point of cost and future land use in Astana.

3) Ishim River

Basically, direct discharge of treated sewage to a river is not allowed in Kazakhstan The master plan prepared by a Saudi Group proposed that effluent of STP be discharged to the Ishim River only in flood season, when the river flow is enough to receive it without serious impact.

Generally, well-treated sewage is discharged to public water bodies in many countries, including Japan, United States and European countries. To maintain river flow at a favorable level, well-treated sewage discharge to a river is considered as one of the sound and useful methods. In Japan, there are several small rivers, in which all the river flows are from well-treated and well-disinfected effluent of sewage treatment plants, and children can play in these water bodies. Compared with Japanese standard for water bodies, Kazakhstan standard is stricter.

From view point of water balance of Ishim River, discharge to Ishim River is recommendable. Discharge of poorly treated sewage may cause deterioration of public water bodies unless enough precautions are enforced. Kazakhstan government therefore does not allow the treated sewage discharge directory to a river.

4) Nura River

The plan to discharge to the Nura River is one of the plans recommended by the Kazakhstan side. However, costs of installation of transmission pipes and pump operation are more costly, compared with the Ishim River option. In addition, this plan has environmental impacts on water quality and might cause water balance problem of Tengiz lake. The lake is an environmental conservation area located 150 km downstream from the proposed discharge point, and is famous for flamingos and other wild animals.

Impact on water quality in the Nura River is not expected to be relatively serious, because of the large amount of river flow in Nura River, compared with the Ishim River. This option of discharge to the Nura River does not have any apparent merits other than this.

5) Agriculture Land

At present, there are no any agricultural lands, prepared to accept treated wastewater around Astana. However, there is large potential of land activity around Taldy Kol Reservoir for agricultural land. Irrigation water use will be discussed in the next sub-section.

(2) Re-use of Effluent of Sewage Treatment Plant

From the view points of effective use of limited water resources and discharge of treated wastewater, re-use of treated sewage is conceived as important. In this section, possibility and tentative re-use promotion plan of the irrigation water use, industrial water use, river sanitary flow and other water uses are to be considered.

1) Irrigation Water Use

Though agricultural activities around Astana City have declined due to collapse of Soviet Union, Ministry of Agriculture has a plan to rehabilitate the irrigation system with a total area of 6,548 ha.

Irrigation use of treated sewage has been considered since the Soviet Union era. However, only 1,700 ha of irrigation by using water from Taldy Kol Reservoir has been realized and collapsed around Astana. Over head sprinkling machines were introduced to the irrigation system. It is recorded that the following crops are taken for cultivation.

Potato:	20,000 kg/ha
Corn for silage:	37,900 kg/ha
Forage Crop:	21,000 kg/ha

As the unit water demand for the irrigation area is estimated at 4,000 m^3/ha /year by Ministry of Agriculture, water demand for 1,700 ha of irrigated area is roughly estimated at 6.8 million m^3/year for the six months between May and December. The daily average demand in the 6 months is calculated at 37,260 m^3/day, while on the other hand, the water demand in winter season between December and April becomes nil.

There is a big potential to develop agriculture land to the south of Taldy Kol Reservoir. It is recommendable that about 1,700 ha of agriculture land, equal to have the previous agriculture land, will be developed for re-use of the treated sewage as a pilot project by 2010, prior to the large-scale development.

2) Industrial Water Use (Technical Water Supply)

Presently, about 120,000 m^3/day of water is supplied for the industrial water use without any treatment from the Ishim River, of which a 95% is supplied to the thermal plant. In case of reuse of treated sewage for