No.

JAPAN INTERNATIONAL COOPERATION AGENCY
MINISTRY OF ECONOMY AND BUDGET PLANNNING
ASTANA CITY GOVERNMENT
CAPITAL DEVELOPMENT CORPORATION

THE DETAILED DESIGN STUDY OF THE WATER SUPPLY AND SEWERAGE SYSTEM FOR ASTANA CITY IN THE REPUBLIC OF KAZAKHSTAN

FINAL REPORT

VOLUME II

MAIN REPORT

DECEMBER 2003

NJS CONSULTANTS CO., LTD.
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LIST OF REPORTS

Vol. I	**SUMMARY**
Vol. II	**MAIN REPORT**
Vol. III	**DATA & SUPPORTING REPORT**

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PREFACE

In response to a request from the Government of the Republic of Kazakhstan, the Government of Japan decided to conduct a detailed design study of the Water Supply and Sewerage System for Astana City in the Republic of Kazakhstan and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA selected and dispatched a study team headed by Mr. Masatoshi Momose of NJS Consultants Co., Ltd. and consist of NJS Consultants Co., Ltd., and Nihon Suido Consultants Co., Ltd. to Kazakhstan, two times between August 2002 and October 2003.

The team held discussions with the officials concerned of the Government of Kazakhstan, and conducted field surveys at the study area. Upon returning Japan, the team conducted further studies and prepared this final report.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

Finally, I wish to express my sincere appreciation to the officials concerned of the Government of Kazakhstan for their close cooperation extended to the teams.

December 2003

Kazuhisa Matsuoka

Vice-President

Japan International Cooperation Agency

December 2003

Mr. Kazuhisa Matsuoka
Vice-President
Japan International Cooperation Agency
Japan

Dear Sir,

Letter of Transmittal

We are pleased to submit herewith the final report for the Detailed Design Study of the Water Supply and Sewerage System for Astana City in the Republic of Kazakhstan.

The Study was completed through the discussions with officials of the Government of Kazakhstan and the fieldwork during the period from August 2002 to October 2003, and the homework thereafter.

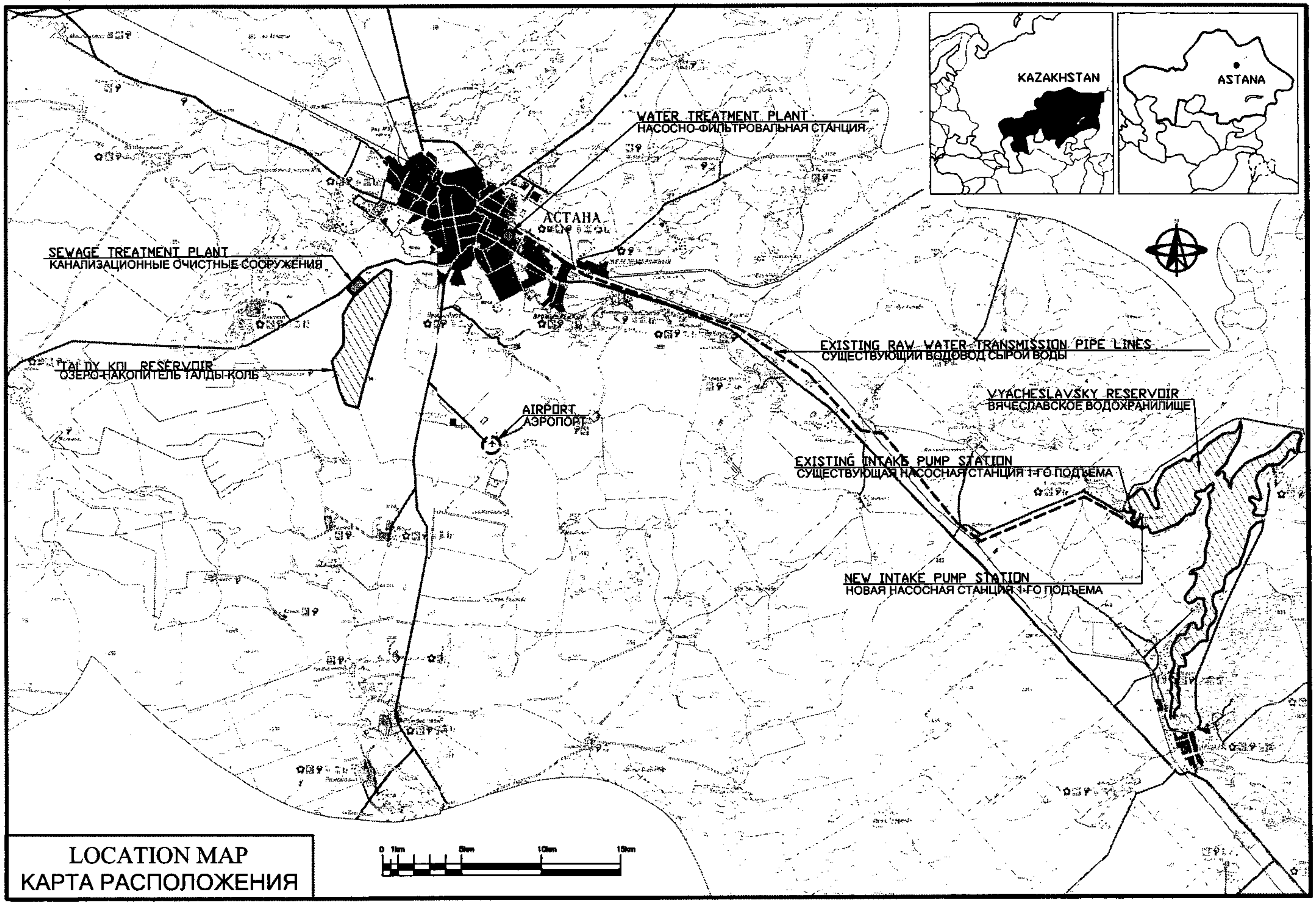
The Final Reports consist of three separate volumes and the draft tender documents: Volume I: Summary Report which succinctly describes the study and recommendations; Volume II: Main Report, which covers the review of the previous plans/studies for the Water Supply and Sewerage System in Astana City and the details of the detailed design for the above, and Volume III: Data & Supporting Report, which describes the details of the projects including detailed engineering analysis and relevant data.

We hope that the implementation of the proposed projects would greatly contribute to the improvement of water supply and sewerage services in the study area.

We wish to take this opportunity to express our sincere gratitude to the officials of your Agency and Japan Bank for International Cooperation for their kind support and advice. We also would like to show our appreciation to the officials of the Embassy of Japan in Kazakhstan for their kind cooperation and assistance throughout our field survey.

Very truly yours,

Masatoshi Momose
Team Leader
Study Team for the Detailed Design Study
of Water Supply and Sewerage System
for Astana City



LOCATION MAP
КАРТА РАСПОЛОЖЕНИЯ

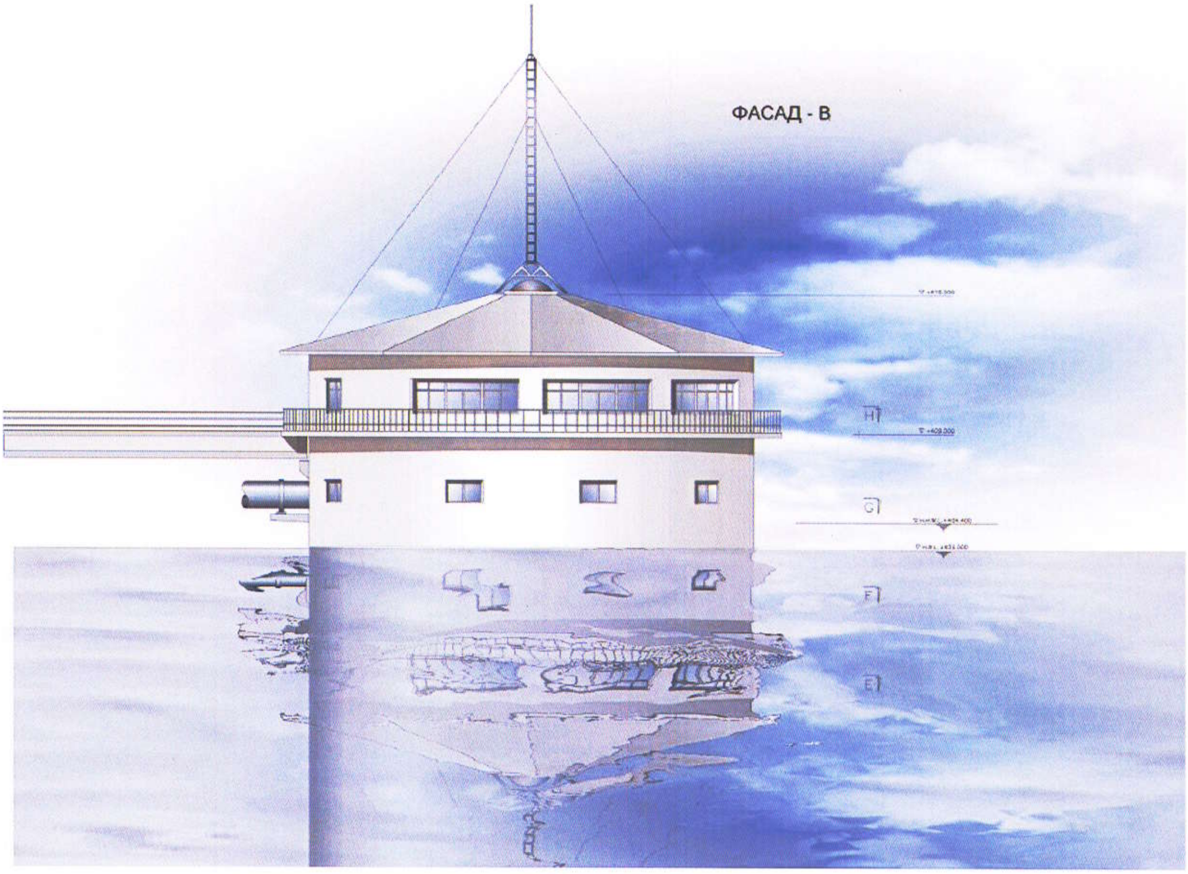


Figure P-1 Intake Tower Perspective

Figure P-2 WTP Administration Building Perspective

図 **P-3**　下水処理場汚泥棟 完成予想図

THE DETAILED DESIGN STUDY
OF
THE WATER SUPPLY AND SEWERAGE SYSTEM
FOR
ASTANA CITY IN THE REPUBLIC OF KAZAKHSTAN

DRAFT FINAL REPORT

VOL. II MAIN REPORT

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LIST OF ABBREVIATIONS

ASA	Astana Su Arnasy
BOD	Biochemical Oxygen Demand
BOQ	Bill of Quantity
CDC	Capital Development Corporation
CIF	Cost including Insurance and Freight
COD	Chemical Oxygen Demand
CPI	Consumer Price Index
Dia	Diameter
DIP	Ductile Iron Pipe
DO	Dissolved Oxygen
DS	Dry Solid
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return
FIRR	Financial Internal Rate of Return
FOB	Free On Board
GOST	Industrial Standards
ICB	International Competitive Bidding
JBIC	Japan Bank for International Cooperation
JICA	Japan International Cooperation Agency
JPY	Japanese Yen (Monetary Unit)
¥	Japanese Yen (Monetary Unit)
KZT	Kazakhstan Tenge (Monetary Unit)
MLSS	Mixed Liquor Suspended Solids
O&M	Operation and Maintenance
PS	Pump Station
PVC	Polyvinyl Chloride Pipe
Q_{DA}	Daily Average Flow
Q_{DM}	Daily Maximum Flow
Q_{HM}	Hourly Maximum Flow
RC	Reinforced Concrete
RCP	Reinforced Concrete Pipe
RK	Republic of Kazakhstan
SNiP	Construction Norms and Regulations
SS	Suspended Solid
STP	Sewage Treatment Plant
Tenge	Kazakhstan Tenge (Monetary Unit)
TG	Kazakhstan Tenge (Monetary Unit)
US$	United States Dollars (Monetary Unit)

USD	United States Dollars (Monetary Unit)
VAT	Value Added Tax
WHO	World Health Organization
WTP	Water Treatment Plant

CHAPTER 1 INTRODUCTION

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1.1 Project Background

The Astana City is geographically located in the center of Republic of Kazakhstan. The city was determined as the capital of the country in 1997. The government of Kazakhstan had been developing the city to meet the required function as a capital city. During the course of the development the Government of Kazakhstan requested Japanese Government to prepare Master Plan for theoretical and effective development of the city in provision of functional requirements and landscaping as the capital city.

In reply to the request from Government of Kazakhstan, Government of Japan through JICA extended assistance in January 2000 to conduct "The Study on the Master Plan for the Development of the City of Astana". In the master plan the improvement and expansion of water supply and sewerage systems in the city was given a high priority among infrastructure development. Then, "The Feasibility Study on Water Supply and Sewerage in the City of Astana" was started from July 2000. The study with a target year of 2010 covered construction of water intake tower, expansion of Water Treatment Plant, replacement and construction of distribution pipelines, provision of water meter, rehabilitation of Sewage Treatment Plant and replacement of sewers. In consideration of the urgency of the project implementation, detailed design study for the Project through the technical assistance of JICA was requested by the Government of Kazakhstan to the Government of Japan in August 2001.

The detailed design study for the requested project on water supply and sewerage systems in Astana city was carried out from August 2002 to October 2003. The loan agreement between JBIC and the Government of Kazakhstan was signed in July 2003.

1.2 Project Purpose

The purpose of the Project includes the following two major targets.

1) Stable water supply and sewerage services shall be provided in capital city of Astana in provision of rehabilitation and expansion of existing deteriorated water supply and sewerage facilities.

2) Water supply environment with adequate water consumption by the people shall be promoted in provision of water meter and other countermeasures.

1.3 Subject Area for the Project

The subject area for the Project is shown in Figure 1.3.1, which covers water intake facilities at the Vyacheslavsky Reservoir about 50 km east far from the city proper, transmission line, water distribution and sewage collection facilities in the built up area of the City and sewage treatment plant located near the Taldy Kol reservoir.

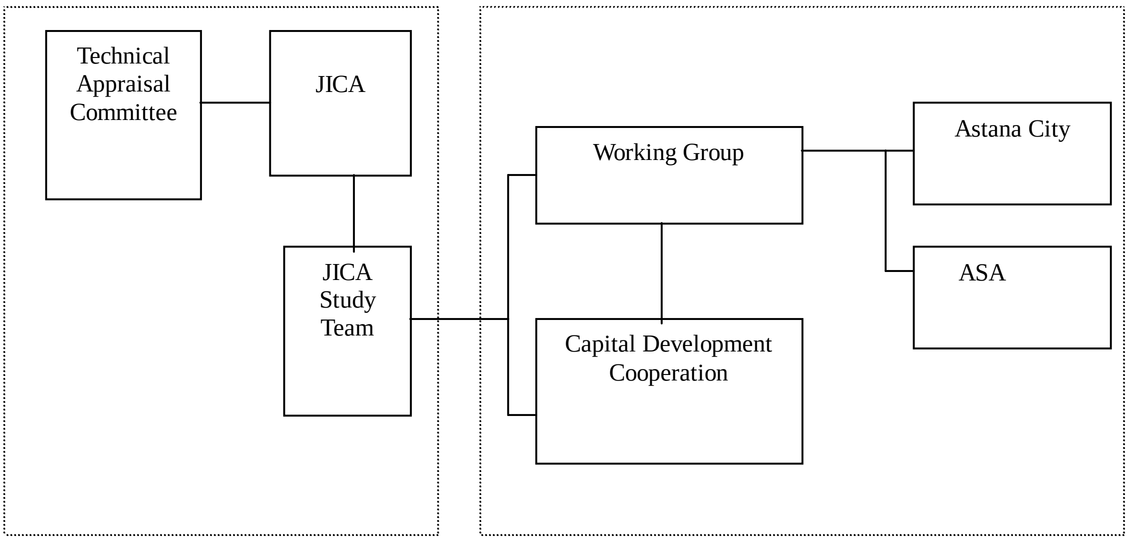
1.4 Composition of Reports and Staff Organization

(1) The outputs for water supply and sewerage components prepared through detailed design work include the following:

- Report: Summary Report (English, Japanese & Russian); Main Report (English & Russian); Supporting & Data Report (English & Russian)
- Tender Documents: Tender Documents (English & Russian); Drawings (English & Russian)

(2) Study Organizations and Staffing

The CDC and Working group being staffed from the Astana city and the ASA acted as the counterpart to Japanese Study Team and also coordinated through the Study period. The following figure shows the relationship between Japanese and Kazakhstan sides.



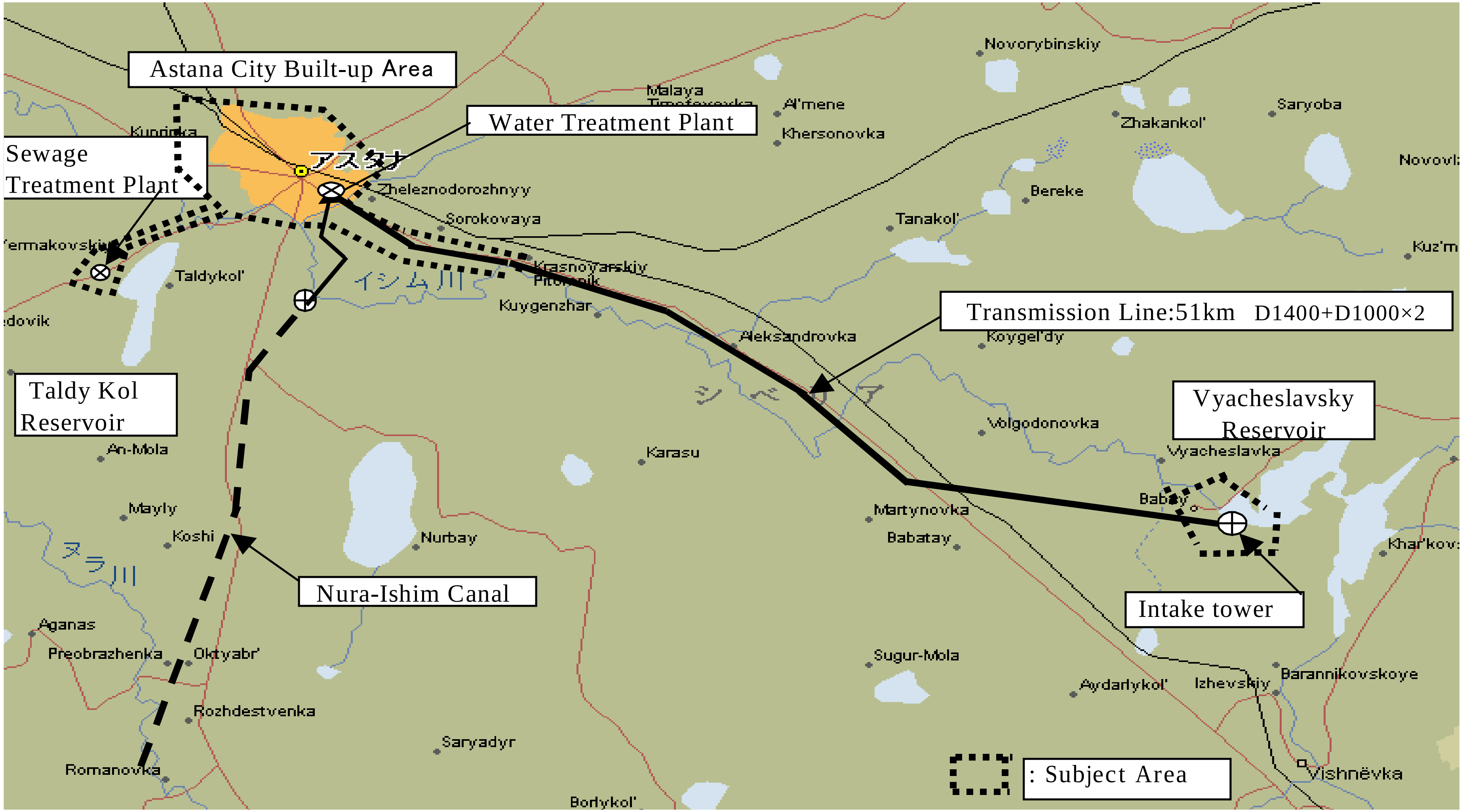


Figure 1.3.1 Location Map of Subject Area

The compositions of the Study Team and Technical Appraisal Team are as follows:

Member of the Study Team

Name	Assignment
Mr. Masatoshi Momose	Project Manager
Mr. Takafumi Kiguchi	Deputy P/M /Water Supply Planning
Mr. Takeo Yasuda	Intake Facility Design
Mr. Masao Fujiwara	Water Treatment Plant
Mr. Yasuhiro Aoki	Water Supply Pipeline 1
Mr. Junichi Watanabe	Water Supply Pipeline 2
Mr. Shinichi Osaka	Water Supply Mechanical Engineering
Mr. Akira Miura	Water Supply Electrical Engineering
Mr. Takashi Fuji	Deputy P/M /Sewerage Planning
Mr. Toru Yagi	Sewage Treatment Plant Design
Mr. Akira Shigemi	Sewer Design
Mr. Shoji Sasakura	-do- (successor)
Mr. Masami Azegami	Sewerage Mechanical Engineering
Mr. Akio Natsui	Sewerage Electrical Engineering
Mr. Yasuhiko Takahashi	Remote Control and Monitoring System
Mr. Makoto Kato	-do- (successor)
Mr. Takashi Watanabe	Construction Plan/ Cost Estimate 1
Mr. Kazuhiko Nakamura	Construction Plan/ Cost Estimate 2
Mr. Isao Masui	Equipment Plan
Mr. Ryuji Sakaguchi	Architectural Engineering 1
Mr. Kozo Ishikawa	Architectural Engineering 2
Mr. Ryunan Matsue	Environmental Impact Assessment
Mr. Hiroyoshi Yamada	Soil Investigation
Mr. Toru Hamano	Tender Document Preparation 1
Mr. Hideki Asada	Tender Document Preparation 2
Mr. Keiji Matsuoka	Operation and Maintenance of Facilities
Mr. Viktor Kouprianov	Financial/ Accounting
Mr. Toru Baba	Interpreter

Member of Technical Appraisal Committee

Name	Organization/Authority
Ms. Keiko Yamamoto	Leader Institute for International Cooperation, JICA
Dr. Toshikatsu Omachi	Executive Director Infrastructure Development Institute-Japan
Mr. Junji Tada	Senior Technical Counselor Infrastructure Development Institute-Japan
Mr. Hayato Sasai	Deputy Director Infrastructure Development Institute-Japan
Mr. Hiroo Oda	Senior Counselor Infrastructure Development Institute-Japan

CHAPTER 2 UPDATED INFORMATION ON THE WATER SUPPLY AND SEWERAGE FACILITIES

CHAPTER 2 UPDATED INFORMATION ON THE WATER SUPPLY AND SEWERAGE FACILITIES

2.1 General

Prior to this detailed design study, F/S was prepared in March 2001 through JICA technical assistance. Data and information bases are those in the year 2000. To cope with deteriorated existing water supply and sewerage facilities, ASA has conducted rehabilitation work including pumps, electrical devices, water distribution pipelines and sewers.

Under the above-mentioned conditions, the Study Team has investigated existing facilities concerned to update the status of the facilities upon commencement of the basic design study.

2.2 Existing Water Supply System

2.2.1 Intake Facilities

(1) Present Condition of Facilities

The existing intake pump station is located at the lakeside of the Vyacheslavsky reservoir. The outline of existing facilities is presented in Table 2.2.1.

Table 2.2.1 Outline of Existing Intake P/S

Facilities	Location/Type	Dimension
Pump Loading Room	RC, Ground Floor	L 18m x W 8m x H 9m
Operation Room	RC, 1st Basement Floor	L 34m x W 12m x H 7.3m
Pump Room	RC, 2nd Basement Floor	L 34m x W 12m x H 9.4m
Pump	Centrifugal Pump	6,300 m^3/hr x 95mH x 2,000 kW x 3 units (2 units stand-by)

Present conditions of existing intake facilities and Vyacheslavsky reservoir are as follows;

i) Intake facilities

Existing Intake facilities have been operated for last 32 years since 1970 as described below.

Structure: Rectangular type (Width 32m x Length 34 m x Depth 16.7 m) RC structure

Ground floor and two basement floors:

Ground floor (+406.5m): Management room, workshop and a space for handling of equipment

1st Basement floor: Electrical room

2nd Basement floor (+387.7m): Pump room

Most of major equipment is installed below the water level of the reservoir. In 2000, an ultrasonic flow meter at the discharge pump area was installed to measure discharge flow rate, and all of the three (3) units of intake pump with motor were replaced in 2002.

Presently, two pumps are often operated simultaneously as the demand increases. In this case, however, control of flow rate by means of a valve located outside is necessary to lessen flow rate to meet an acceptable amount level at the WTP.

A raw water transmission pipeline with a nominal diameter of 1400 mm (No. III) was constructed in 2001 between the Intake and the WTP sites. At that time, the discharge pipe from No. III pipeline was connected to the existing 1000 mm dia. raw water transmission pipeline (No. II), and the discharge pipe from the No. II line was also re-connected to the No. I raw water transmission pipeline.

ii) Vyacheslavsky Reservoir

The Vyacheslavsky reservoir, which has a catchment area of 4,470 km^2, is located 51km southeast of Astana. The storage volume is 410.9 million m^3 at the normal high water level. Water bloom is observed covering entire surface of the reservoir.

The water level of the Reservoir dropped to the critical level in 2000 and 2001. Therefore, supplementary water use from Irtish-Karaganda Canal was planned (by pumping water from the Canal to the Isim River Basin). The connection facilities were constructed in 2001. However, the canal has not ever been operated, because the water level of the Reservoir had recovered to safety the required level after its construction.

(2) Collected Data

i) Topographic and soil survey

The Study Team collected some topographic data and soil survey results presented in Feasibility Study (F/S). The boring data obtained at three points are shown in the Table 2.2.2 and those investigation points are shown in Figure 2.2.1.

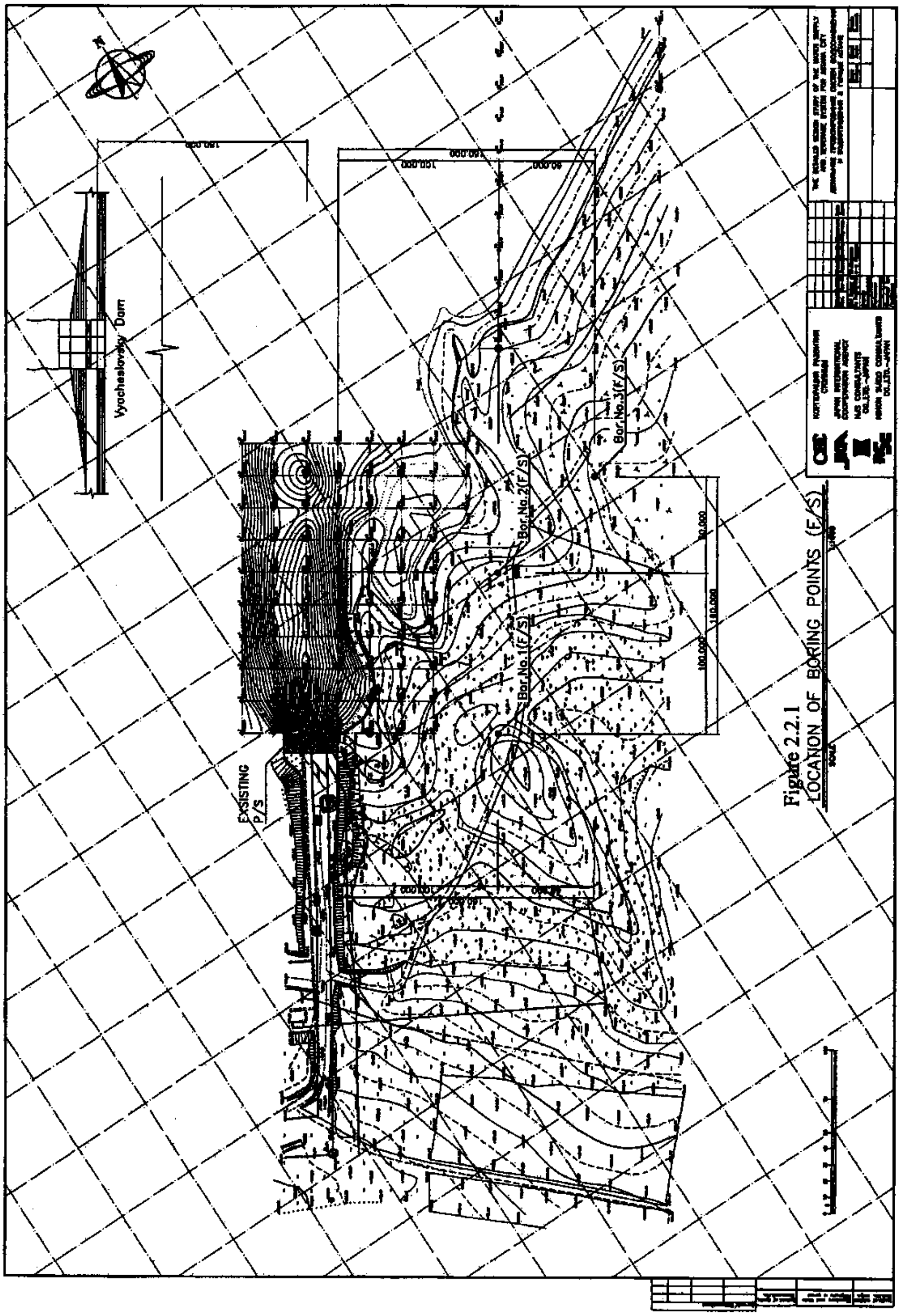


Figure 2.2.1
LOCATION OF BORING POINTS (F/S)

Table 2.2.2 Boring Data of F/S Stage

Layer	Location Number			Specific Gravity	Cohesion	Internal friction angle	Bearing capacity of ground
	No.1 (m)	No.2 (m)	No.3 (m)	(ton/m^3)	(ton/m^2)	(degree)	(ton/m^2)
pd Q $_{II-III}$	397.96 - 401.66 385.86 - 394.36	385.02 - 398.52	397.98 - 400.48 393.58 - 394.28 385.58 - 392.98	1.96	0.25	21	21
pd Q $_{II-III}$	394.36 - 397.96		394.28 - 397.98 392.98 - 393.58	2.03	0.22	18	19
e Mz	384.86 - 385.86	384.22 - 385.02	385.28 - 385.58	2.11	0.48	24	30
O_1a	< 384.86	< 384.22	< 385.28	-	-	-	100

A layer O_1a was adopted for the hardpan of the intake structure judging from the bearing capacity of layer. The level of this layer is approximate 384 m as the result from the investigation in F/S. The level of foundation supporting layer was finally decided after the investigation in B/D. Soil of this district of Kazakhstan have commonly strong corrosive tendency not only to metal but also concrete facilities. Therefore, the corrosion test was conducted and it was revealed that the tendency of corrosion to concrete was weak but that the one to carbon steel was aggressive. Supplemental topographic survey and soil investigation was carried out for examination on the location of structure, and these data are necessary for excavation of front channel.

ii) Water quality

Two water samples were collected from upper and bottom layers at the existing facility to examine raw water quality. The examination results showed that the raw water quality was not so different from those measured in F/S. The data on raw water quality from January 1998 to September 2002 was also obtained from ASA. Characteristics of raw water can be summarized as follows:

- Value of turbidity is high from May to July. The fluctuation of turbidity is shown in the Figure 2.2.2.
- Concentrations of nitrogen and phosphate as the indexes of eutrophication, and BOD and pH are relatively high as shown in the Table 2.2.3. Therefore, eutrophication is in progress in the Reservoir. The fluctuation of pH is shown in Figure 2.2.3.

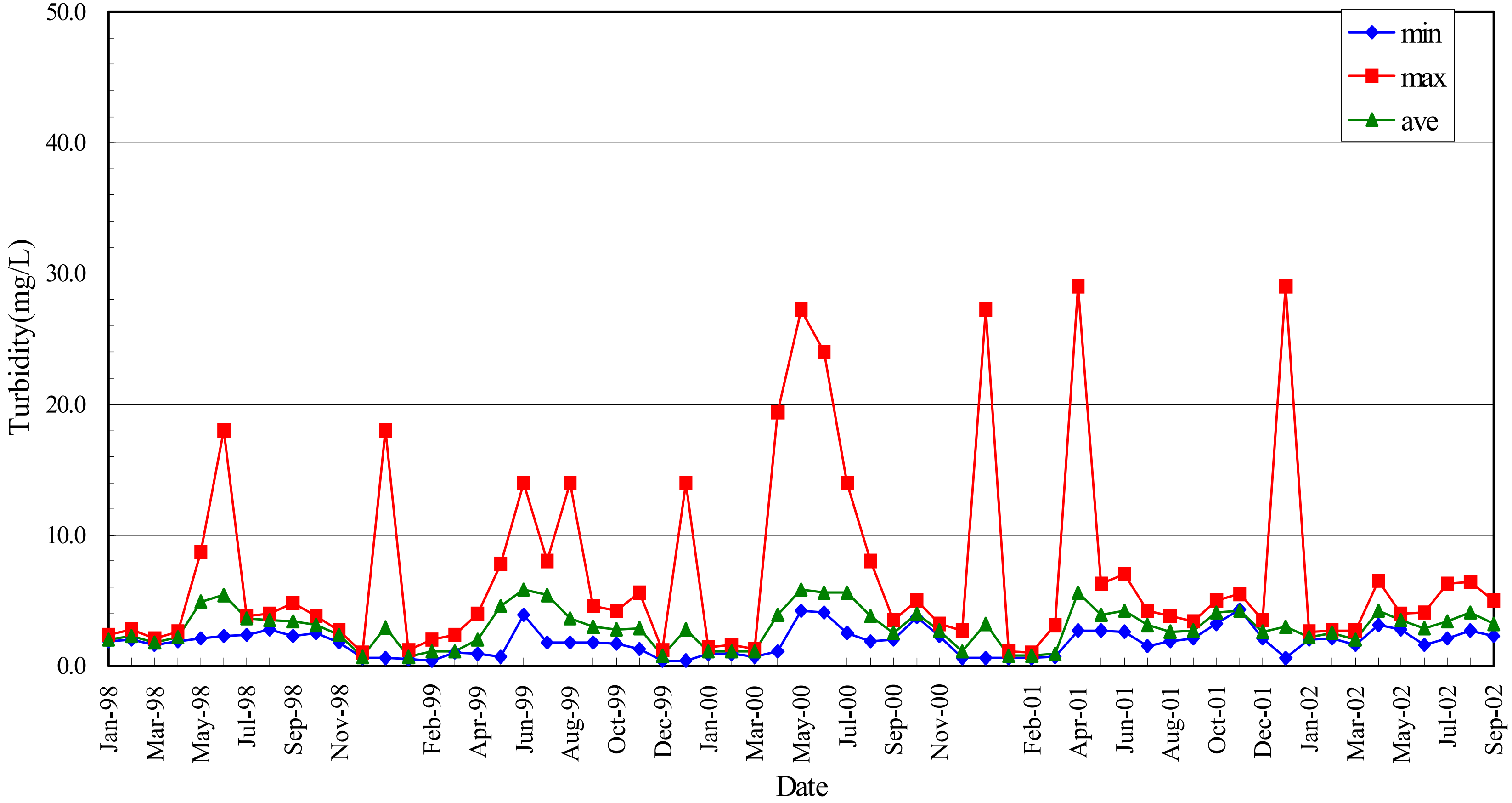


Figure 2.2.2 Fluctuation of Turbidity

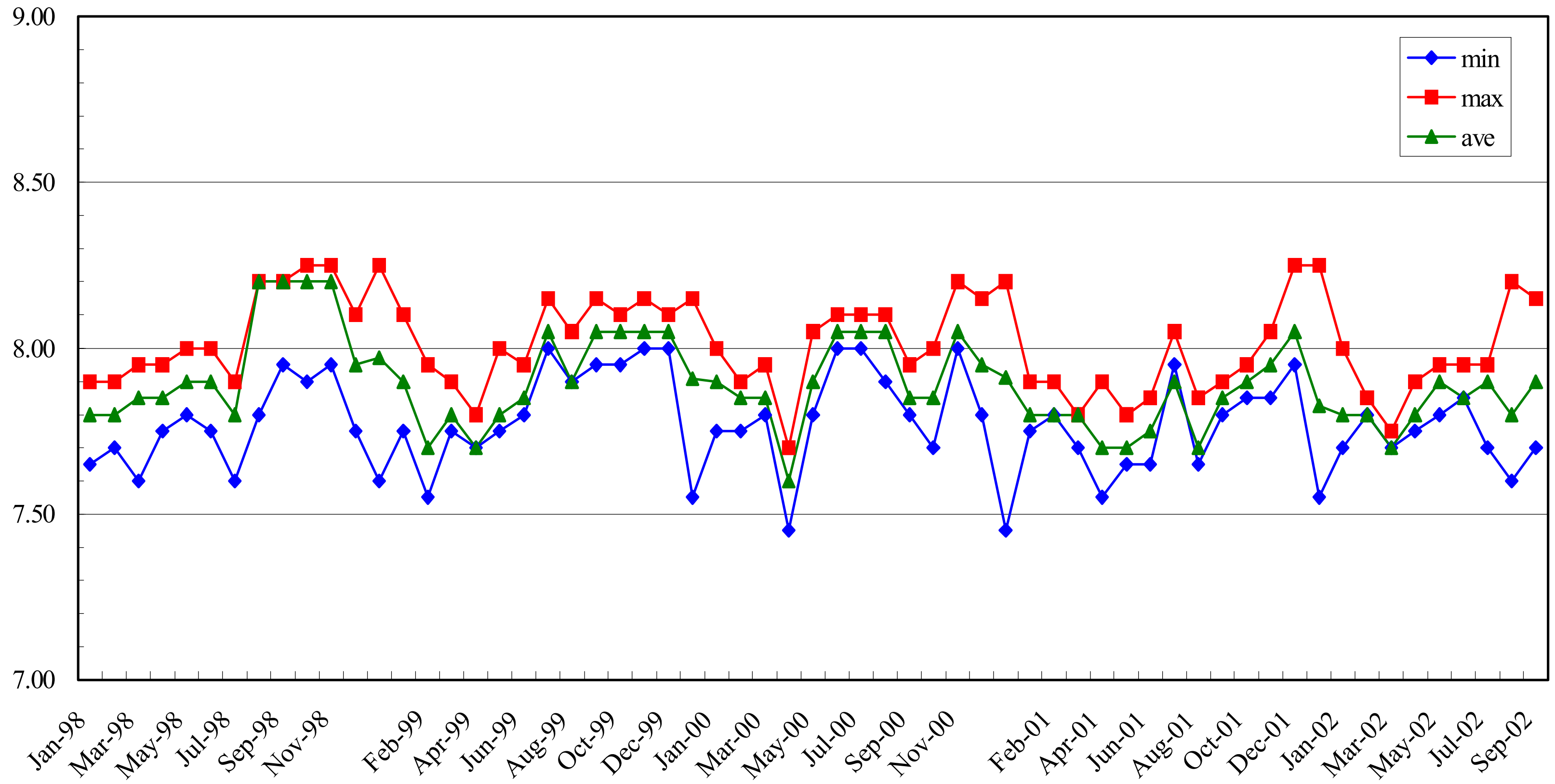


Figure 2.2.3 Fluctuation of pH

Table 2.2.3 Raw Water Quality of Vyacheslavsky Reservoir

Item	Unit	F/S			D/D	
Sampling Date		09/Sep/00	26/Sep/00	19/Oct/00	08/Oct/02	25/Feb/02
pH	-	8.27	8.10	8.33	7.9 / 7.7	7.6 / 7.4
CODcr	mg/L	24	24	31	46.9 / 38.4	32.0 / 26.4
BOD_5	mg/L	2.2	2.4	2.1	2.4 / 1.6	1.8 / 2.2
Total-N	mg/L	1.71	1.76	0.66	0.56 / 0.53	0.50 / 0.54
Total-P	mg/L	0.026	0.028	0.025	0.020 / 0.018	0.026 / 0.020
Remarks		-	-	-	Depth 1m / 6m	

(3) Issues on Existing Facilities

i) Issues from Structural viewpoint

Major important equipment is installed below water level. This fact implies a serious damage in case of immersion.

Quality of reinforced concrete structure is not satisfactory, so that surface of concrete structure has been neutralized to some extent and its aggregate is exposed.

Existing pipes and valves are so aged and deteriorated that there is a fear of immersion accident. If it happened, a long period would be necessary to recover water supply for the capital area.

ii) Issues from Maintenance viewpoint

Workers in the Intake Structure have a feel of unrest to go down to floors below water level together with physical fatigue.

Existing pumps and motors are too large to introduce an automatic flow control system instead of present manual control by a valve, which causes cavitations at the valve section. There is a high possibility of destruction of valve sooner or later, if it is continuously operated through the future.

2.2.2 Raw Water Transmission Pipeline

Three pipelines for raw water transmission exist at present as follows:

I D1000mm (51km) pipeline: SP/CIP, installed in 1969

II D1000mm (51km) pipeline: CIP, installed in 1980-1986

III D1400mm (45.8km) + D1000mm (5.2km) pipeline: SP, installed in 2001

According to the information obtained from ASA, only pipeline No. III is used at present. Pipeline No. I and No. II have not been used since completion of the pipeline No. III because the pipeline No.I is very old and seriously deteriorated. ASA intends not to use this pipeline in the future. Upon field investigation conducted by the Study Team and ASA, the pipeline No. II was judged to be rehabilitated.

Pipeline No. III is connected to a one-way surge tank with a capacity of 1,000m^3 located on the peak 5.2km upstream of WTP. But this tank is not used presently because of trouble of inlet float valves.

2.2.3 Water Treatment Plant

(1) Present Condition of Facilities

General

Existing water treatment plant was constructed in 1969 and expanded in 1982. Combined design treatment capacity of the plant was 200,000 m^3/day. However, presently the capacity is discounted at 165,000 m^3/day due to deterioration of process facilities. Layout plan of existing facilities is presented in Figure 2.2.4.

The treatment process consists of rapid chemical mixing, flocculation, sedimentation and rapid sand filter. All of the water treatment facilities are accommodated in the building for protection against cold climate. Clear water reservoirs are insulated with soil mound surrounding the reservoirs. Present treatment flow diagram is shown in Figure 2.2.5. Outline of existing facilities in the plant is shown in Table 2.2.4.

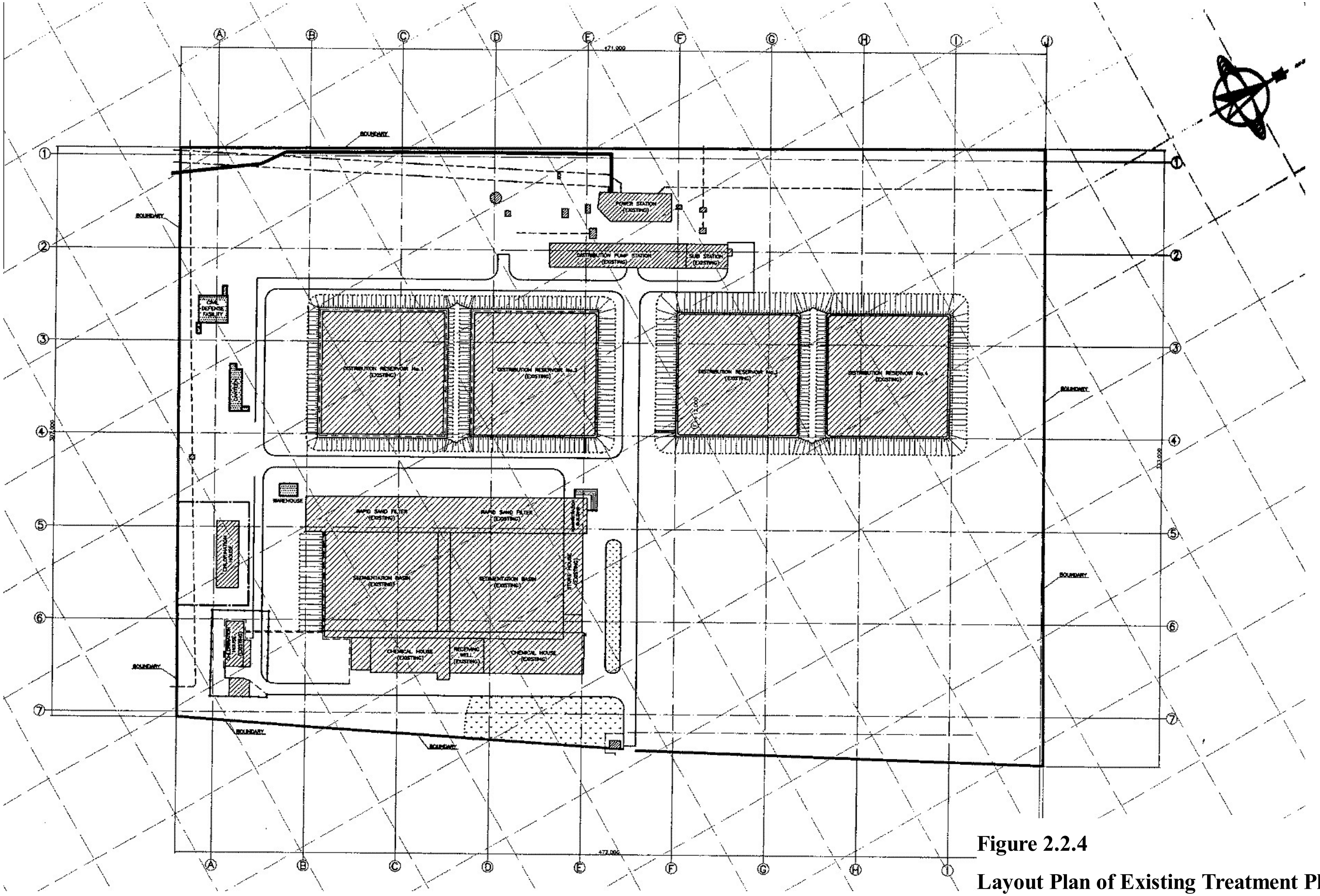


Figure 2.2.4

Layout Plan of Existing Treatment Plant

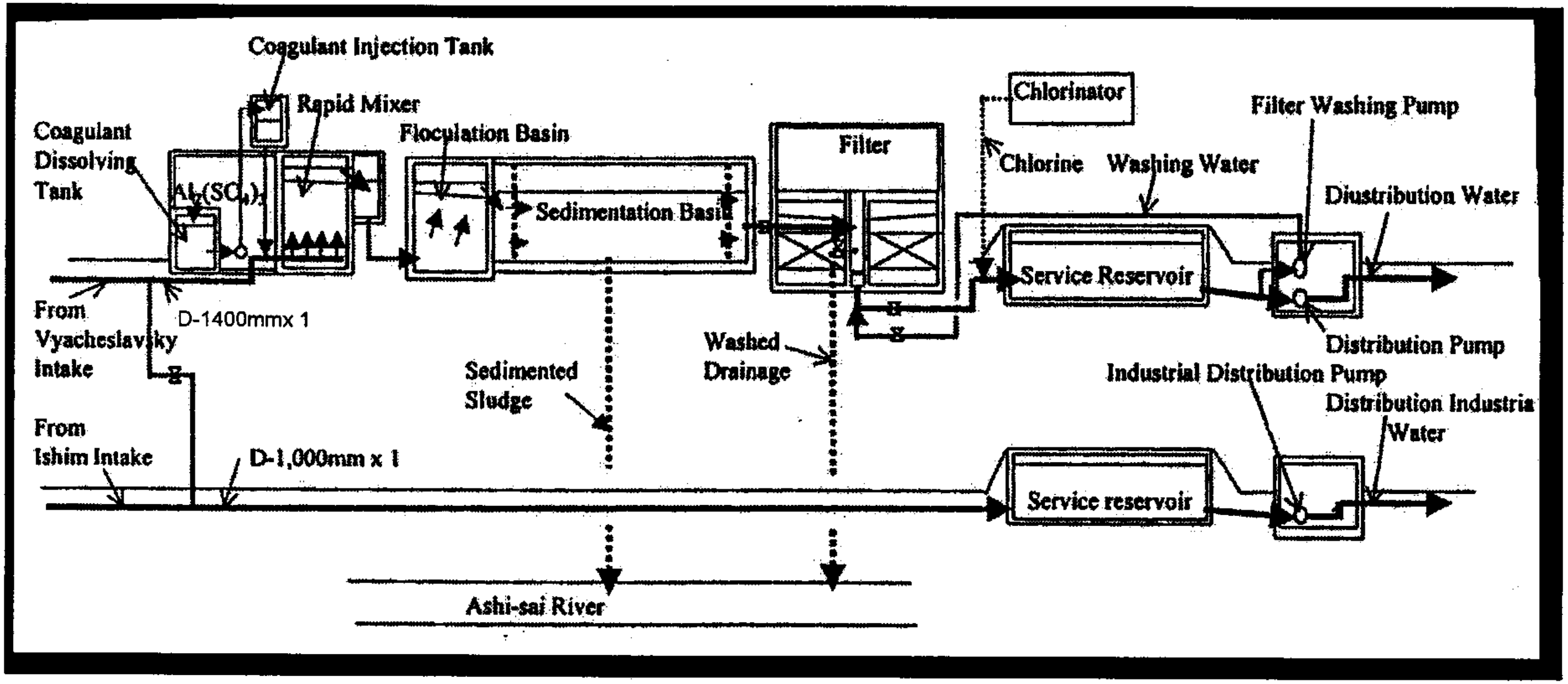


Figure 2.2.5 Process Flow Diagram of Existing Treatment Facilities

Table 2.2.4 Outline of Existing Water Treatment Plant

Facilities	Type	Dimension	Loading for 200,000m^3/d
Receiving and Chemical Mixing Tank	RC Tank	L12.0m x W6.0 x H3.2m (upper part) L (12.0 to 1.25)m x W4.21m x H12.0m (lower) x 1units (2compartments)	4.1 min
Flocculation Basin	RC Tank	L 3.6m x W 6.0m x H 6.0m x 20units	18.7 min
Sedimentation Basin	RC Tank	L 49.6m x W 6.0m x H 4.2m x 20units	3.0 hr
Rapid Sand Filter	RC Tank	L 10.5m x W 5.1m x 2beds x 10units	186.7 m/d
Clear Water Reservoir	RC Tank	(Drinking Water) 20,000 m^3 x 3 units	7.2 hr
		(Technical Water) 20,000 m^3 x 1 unit	-
Administration Building	RC, 3 stories	L 12m x W 16m x 3 stories	
Distribution Pumps	Centrifugal Pump	(Drinking Water) 1,600 m^3/hr x 90mH x 500 kW x 1 unit (2002) 2,500 m^3/hr x 64mH x 500 kW x 1 unit (2001) 1,500 m^3/hr x 64mH x 500 kW x 1 unit (1987) 6,300 m^3/hr x 64mH x 1,000 kW x 1 unit (1985) 3,200 m^3/hr x 64mH x 630 kW x 2 units (1987) 3,200 m^3/hr x 64mH x 630 kW x 1 unit (2002) 3,200 m^3/hr x 64mH x 630 kW x 1 unit (1980)	
		(Technical Water) 1,500 m^3/hr x 64mH x 320 kW x 3 units	
Backwash Pumps	Centrifugal Pump	6,300 m^3/hr x 27mH x 500 kW x 1 unit 5,000 m^3/hr x 32mH x 500 kW x 1 unit	

Receiving and Chemical Mixing Tank

Coagulant is dosed into inlet pipe laid at the bottom of the tank. However, mixing effect is not sufficient because of the lack of mixing device.

Sedimentation Basin

The basin is horizontal flow type. The basin is covered with concrete slab so that it is difficult to observe running conditions of the basin. Effluent from the basin is not collected by trough. It flows out through an outlet pipe.

Settled sludge is washed out by manpower after the high turbid season which includes the period of snowmelt-runoff into the Vyacheslavsky reservoir. Washed-out sludge is discharged into an adjacent river without treatment.

Rapid Sand Filter

The filters constructed at the expansion/second stage are inclined and subsided due to poor construction work.

Backwash is carried out by backwashing water only. Any supplemental system such as surface washing or air scouring is not provided. Characteristics of filter media are not satisfactory. Its specific gravity is too small with frail strength and uniformity coefficient is too high. It is observed at the time of cleaning work that lots of sand is settled in the clear water reservoir. It indicates that filter materials have been flown-out during operation. It implies defects of filter beds. Present filtration rate against treatment flow of 165,000 m^3/day is 154 m/day.

Clearwater Reservoir

There are four clearwater reservoirs in the existing plant. These reservoirs have also been used as distribution reservoir.

As mentioned above, sludge, sand and gravel were observed in the reservoir when reservoirs were cleaned. The depth of consolidated sediment at the entrance was approximately 10 cm.

One of two clear water reservoirs for industrial water use is under re-arrangement for drinking water use. As a result, three clear water reservoirs will be used for drinking water supply.

Pipelines

There are three (3) inlet raw water transmission pipelines with a nominal diameter of 1,000 mm. The part of in-plant pipelines is under arrangement for change of water use of the existing clear water reservoir from industry to domestic/drinking purpose.

Laboratory

Water quality examination laboratory is under improvement. Water quality examination facilities for drinking water specified in SANPiN and GOST standard are installed, but these are already deteriorated.

Chemical Dosing Facilities

A new chlorination building is under construction providing chlorine-feeding equipment. Solid aluminum sulfate and polyacrylamide polymer are used as coagulation chemicals. Activated carbon powder was dosed during summer 5 years ago to eliminate offensive odor, however, there is no use at present. Chemical dosing facilities seem to be sound condition at present.

Miscellaneous

Fence leans everywhere causing insecurity and spoiling aesthetical view. Drainage facility is not provided in the premises. The area located left side of the main gate with an area of 3,399m^2 (103mx33m) is used as parking lots.

(2) Collected Data

1) Topographic and soil survey

The data on topographic survey and soil investigation conducted in F/S are available. Through this project, soil investigation, spot exploring excavation along existing in-plant pipelines, and soil corrosion test are carried out.

2) Chemical dosing

The data on dosing amount of chemicals, i.e. aluminum sulfate, polyacrylamide, and chlorine from 1998 to 2002 are obtained. Maximum, minimum and average dosing amounts of each chemical are summarized in Table 2.2.5. Two types of polyaclylamide flocculants have been used at the WTP. One is cationic polymer and the other anionic polymer. Former is used for high turbid raw water and the latter is used for low turbid or high algae containing raw water. Powdered activated carbon had been dosed to deodorize raw water for one month five years ago. Its dosing rate was 5 to 20 mg/L. The WTP has a plan to stock each chemical with an amount equivalent to three months of maximum dosing rate.

Table 2.2.5 Present Status of Chemicals Dosing Rates

		Maximum (mg/L)	Average (mg/L)	Minimum (mg/L)	Dosing Point
Coagulant	Aluminum Sulfate	50	4.74	1.0	Chemical Mixing Tank
Flocculant	Polyacrylamide	0.1	0.05	0.025	ditto
Deodorizer	Powdered Activated Carbon	20	-	5	ditto
Chlorine	Pre-chlorination	3.68	1.83	1.16	ditto
	Post chlorination	1.23	0.61	0.39	Clearwater Reservoir

3) Water quality

a) Water quality standard

The water quality standard is specified in SANPiN 3.01.067-97 and analysis methods of each item are specified in GOST 2487-82. A total of 44 quality items are specified for water quality standard as summarized in Table 2.2.6.

Most of these items are analyzed at the WTP. While strontium, pesticides and radioactive substances are measured at Sanitary and Epidemiological Services (SES). Items measured at the WTP and SES are shown in Table 2.2.7.

Table 2.2.6 Comparison of Water Quality Standards

No	Item	Kazakhstan		WHO		Japan	
		Unit	Value	Unit	Value	Unit	Value
1	Smells	Number	2	-	None	-	None
2	Taste	Number	2	-	None	-	None
3	Color	Degree	20	TCU	15	Degree	5
4	Turbidity	mg/L	1.5	NTU	5	Degree	2
5	pH value	pH	6 - 9	-	-	pH	5.8 - 8.6
6	Mineralisation	mg/L	1,000	mg/L	1,000	mg/L	500
7	Hardness	mmol/L	7.0	-	-	mg/L	300
8	Permanganate oxidation	mg/L	5.0	-	-	mg/L	3
9	Petroleum products, total	mg/L	0.1	-	-	-	-
10	Anionic surface active agent	mg/L	0.5	-	-	mg/L	0.2
11	Phenol index	mg/L	0.25	-	-	mg/L	0.005
12	Aluminum (Al^{3+})	mg/L	0.5	mg/L	0.2	mg/L	0.2
13	Barium (Ba^{2+})	mg/L	0.1	mg/L	0.7	-	-
14	Beryllium (Be^{2+})	mg/L	0.0002	-	-	-	-
15	Boron (B, total)	mg/L	0.5	mg/L	0.5	mg/L	1
16	Iron (Fe, total)	mg/L	0.3	mg/L	0.3	mg/L	0.3
17	Cadmium (Cd, total)	mg/L	0.001	mg/L	0.003	mg/L	0.01
18	Manganese(Mn, total)	mg/L	0.1	mg/L	0.5	mg/L	0.05
19	Copper(Cu, total)	mg/L	1.0	mg/L	2	mg/L	1.0
20	Molybdenum (Mo, total)	mg/L	0.25	mg/L	0.07	mg/L	0.07
21	Arsenic (As, total)	mg/L	0.05	mg/L	0.01	mg/L	0.01
22	Nickel (Ni, total)	mg/L	0.1	mg/L	0.02	mg/L	0.01
23	Nitrates (on NO_3)	mg/L	45	mg/L	50	-	-
24	Mercury(Hg, total)	mg/L	0.0005	mg/L	0.001	mg/L	0.0005
25	Lead (Pb,total)	mg/L	0.03	mg/L	0.01	mg/L	0.01
26	Selenium(Se,total)	mg/L	0.01	mg/L	0.01	mg/L	0.01
27	Strontium (Sr^{2+})	mg/L	7.0	-	-	-	-
28	Sulphates(SO_4^{2-})	mg/L	500	mg/L	250	-	-
29	Fluorides(F)	mg/L	1.2	mg/L	1.5	mg/L	0.8
30	Chlorides(Cl)	mg/L	350	mg/L	250	mg/L	200
31	Chromium (Cr^{6+})	mg/L	0.05	mg/L	0.05	mg/L	0.05
32	Cyanides (CN)	mg/L	0.035	mg/L	0.07	mg/L	0.01
33	Zinc (Zn^{2+})	mg/L	5.0	mg/L	3.0	mg/L	1.0
34	γ- BHC (Lindane)	mg/L	0.002	mg/L	0.002	-	-
35	DDT (sum of isomers)	mg/L	0.002	mg/L	0.002	-	-
36	2,4-D	mg/L	0.03	mg/L	0.03	mg/L	0.03
37	Total α activity	Bq/L	0.1	Bq/L	0.1	-	-
38	Total β activity	Bq/L	1	Bq/L	1	-	-
39	Thermotolerant colibacillus	Number / 100mL	Absence	Number / 100mL	Absence	Number / 100mL	Absence
40	Common colibacillus	Number / 100mL	Absence	Number / 100mL	Absence	Number / 100mL	Absence
41	General number of bacteria	Number / mL	50 or less	-	-	Number / mL	100
42	Coli-bacteriophage	Plaque forming unit(PFU) / 100mL	Absence	-	-	-	-
43	Spores of sulphite-reducing clostridia	Number / 20 mL	Absence	-	-	-	-
44	Cysts of lamblia	Number / 50L	Absence	-	-	-	-

Table 2.2.7 Treated Water Quality Data for 1999-2001

No.	Item	Standard	1999		2000		2001	
			min	max	min	max	min	max
1	Turbidity, mg/l	1.5	0.1	0.7	0.1	0.8	0.3	0.6
2	Colour, degree	20	5	10	5	10	10	10
3	pH value	6.0-9.0	7.55	7.70	7.05	7.85	7.40	7.65
4	Alkaliniy, millimole/l	4	2.4	3.0	2.6	3.3	2.1	2.8
5	Oxidation, mgO_2/l	5	1.3	2.4	1.6	2.7	1.0	3.1
6	Hardness, mmole/l	7	4.3	5.8	5.8	6.4	4.3	6.8
7	Chlorides, mg/l	350	102.6	138.0	143.4	170.4	101.1	196.4
8	Sulphates, mg/l	500	65.2	112.0	106.5	150	70	182.4
9	Solid residual, mg/l	1000	466	592.2	585	777	374	679
10	Ammonia, mg/l	2.0	<0.05	0.24	<0.05	0.23	ND	0.14
11	Nitrites, mg/l	3.0	<0.003	0.004	<0.003	0.003	ND	0.004
12	Nitrates, mg/l	45.0	<0.5	1.6	<0.5	1.7	<0.5	2.0
13	Fluorine, mg/l	1.2	0.32	0.51	0.33	0.55	0.26	0.50
14	Iron, mg/l	0.3	<0.1	0.25	<0.1	0.13	<0.1	0.16
15	Copper, mg/l	1.0	0.02	0.04	<0.02	0.05	<0.02	0.03
16	Lead, mg/l	0.03	ND	0.001	<0.0005	0.01	ND	0.001
17	Arsenic, mg/l	0.05	ND	<0.01	<0.01	<0.01	ND	<0.01
18	Manganese, mg/l	0.1	0.01	0.036	<0.01	0.026	<0.01	0.026
19	Zink, mg/l	5.0	No Analysis					
20	Molybdenum, mg/l	0.25	No Analysis					
21	Beryllium, mg/l	0.0002	No Analysis					
22	Slenium, mg/l	0.01		0.001		<0.0001		0.00015
23	Total number of bacteria	50		2		1		1
24	Thermotolerant bacteria	ND	No Analysis					
25	Total coliform bacteria	ND	No Analysis					

ND: No Detective

b) Raw water and treated water quality

The data on raw water and treated water qualities are available at ASA.

Raw Water

Items that exceed drinking water quality standard are turbidity, color, iron and manganese.

- High turbidity from May to July

  Raw water showed high turbidity from May to July affected by the inflow of snowmelt turbid water, which contains much suspended substances. Maximum value was 29.0mg/L during last four years from 1998 to 2001. It does not cause serious influence on water treatment process.

- Water bloom at Vyacheslavsky reservoir

  Lots of algae and water bloom were observed in the Vyacheslavsky reservoir. In case many algae are contained in raw water, they become to be an obstacle in the treatment process. In addition, a deodorization process may be needed depending on a kinds of propagated algae.

- Color, Iron and Manganese

  There are two possible reasons for high color value, one is existence of metal (iron, manganese) and the other is existence of organic substance (humic substance, humic acid and others). As shown in Figures 2.2.6 and 2.2.7, there is a correlation between value of color and metals (iron and manganese) concentration. Metal-oriented color can be removed by oxidation with chlorine to satisfy the drinking water standard. The laboratory of the WTP, however, does not have data about humic substances nor chloroform. Chloroform is major component of trihalomethane produced in reactions between organic substances and chlorine, and it implies contamination degree by organic substances. Therefore, influence of organic substances to color is uncertain. Hence, when the laboratory can analyze the chloroform or other toriharomethanes, operation and degree of pre- or intermediate chlorination process shall be examined by analyzing the concentration of organic substances in the raw water in future.

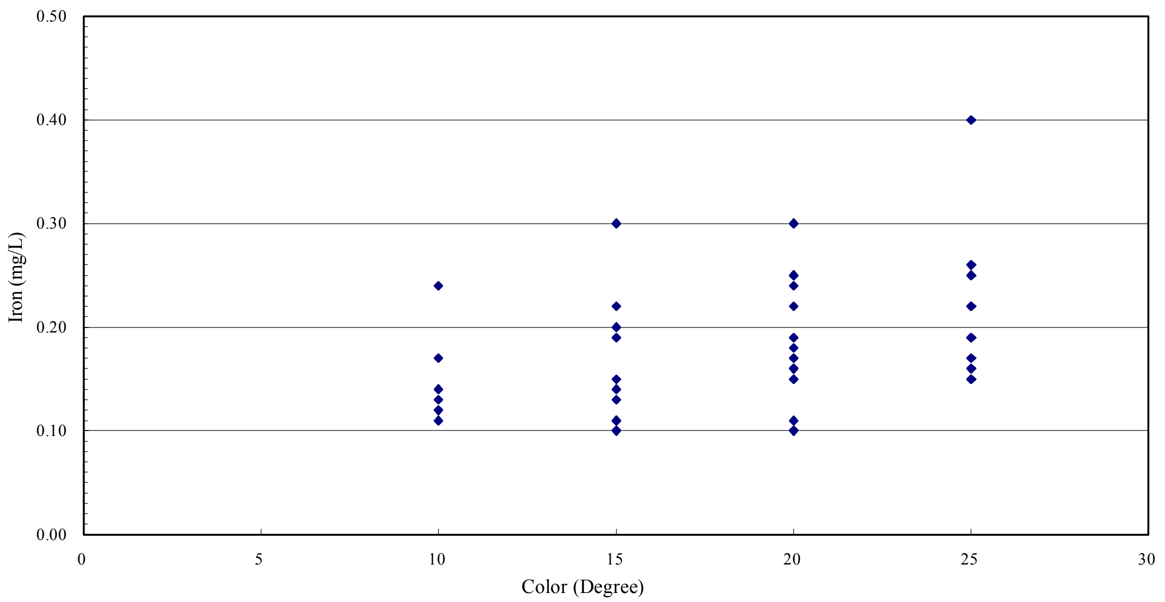


Figure 2.2.6 Correlation between Iron and Color

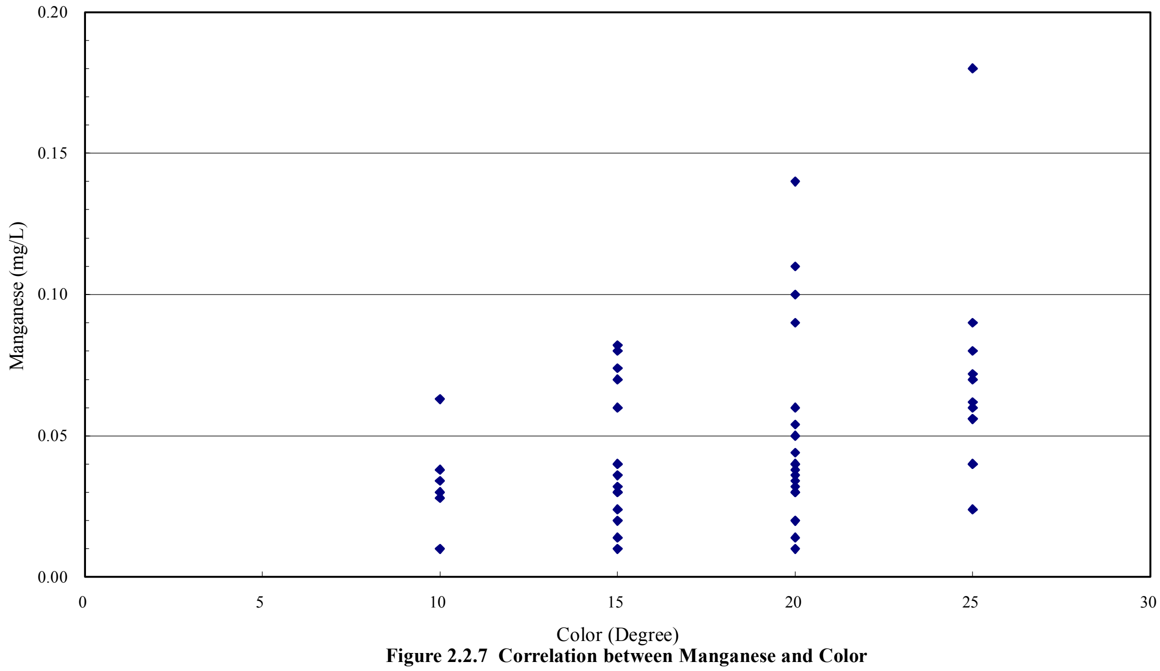


Figure 2.2.7 Correlation between Manganese and Color

Treated Water

Though treated water quality has been satisfied the drinking water standard, it contains relatively high ammonium nitrogen, iron ion and manganese ion, which consume chlorine.

(3) Issues on Existing Facilities

1) Receiving and Chemical Mixing Tank

Coagulant is dosed into the inlet pipe. However, mixing effect is not sufficient because the shape of tanks is not suitable to have such a effect.

2) Flocculation Basin

Since there is no sufficient flocculation process, good flocculation effect is not expected.

3) Sedimentation Basin

Sedimentation basin is covered with concrete slab so that it is impossible to observe the situation on the processing. Flow velocity at inlet point is so fast that flock may be destroyed.

Outlet is composed of only a pipe with nominal diameter of 500 mm so that settled sludge may be carried-over. Settled sludge in the basins is washed out manually after high turbidity season. It is quite hard work to clean up all of 20 basins in a short period.

4) Rapid Sand Filter

Sedimentation basins are not functioning sufficiently so that rapid sand filter has been suffering from poor treatment efficiency. Backwash effect is also poor because surface wash facility or air scouring facility is not provided.

The filter media shows quite low specific gravity, frail strength and uniformity coefficient. In addition, there may be damages of underdrain system in the fact that flowing out of sand and gravel to the clear water reservoir was observed.

5) Distribution Pump Facility

Pump capacities such as pump head and discharge flow rate vary unit by unit so that operation is not easy. Currently, pumps are operated manually referring to discharge pressure of the pump.

Control of both water flow rate and pressure in distribution network seems to be inadequate so that excessive pressure is loaded resulted in water leakage of distribution pipes. In order to lessen such leakage, pump discharge pressure is controlled with valve at approximately 5

kg/cm^2, which implies loss of energy and power cost.

6) In-plant Pipelines

Inlet pipelines are installed in a complicated manner that equalized distribution of water to both existing and new plants may be difficult. Diameter of pipelines used for existing facility is relatively small so that head loss of them is high.

7) Chemical Dosing Facilities

Pipeline length for chlorine dosing from new chlorine dosing facility to new plant, which is under construction, is approximately 300m, which implies a need of countermeasures.

8) Laboratory

Currently, pesticide and radioactive substances, which are in the list of drinking water standards, are analyzed at Sanitary and Epidemiological Services once a year, while the laboratory of the WTP does not have any plan to measure them. Some of metals and organic substances, however, have not been measured anywhere so that the laboratory needs equipment such as gas chromatography, atomic absorption spectrophotometer, mercury measuring equipment, fluorospectrophotometer, microbial medium equipment and others.

2.2.4 Distribution Pipelines

There are two districts in Astana city, Sararkinskyi district in the west and Almatinskyi district in the east. The distribution P/S at the WTP and the No.7 Booster P/S serve the whole water supply service area. Figure 2.2.8 shows the general plan of the existing drinking water distribution system.

According to the F/S, current distribution pressure is 5.5 kg/cm^2 (=0.56 MPa), which is controlled by valves to decrease leakage from pipelines.

Most of the existing pipelines have sufficient capacity to cope with water demand. Deteriorated pipes, however, need their replacement to decrease water leakage.

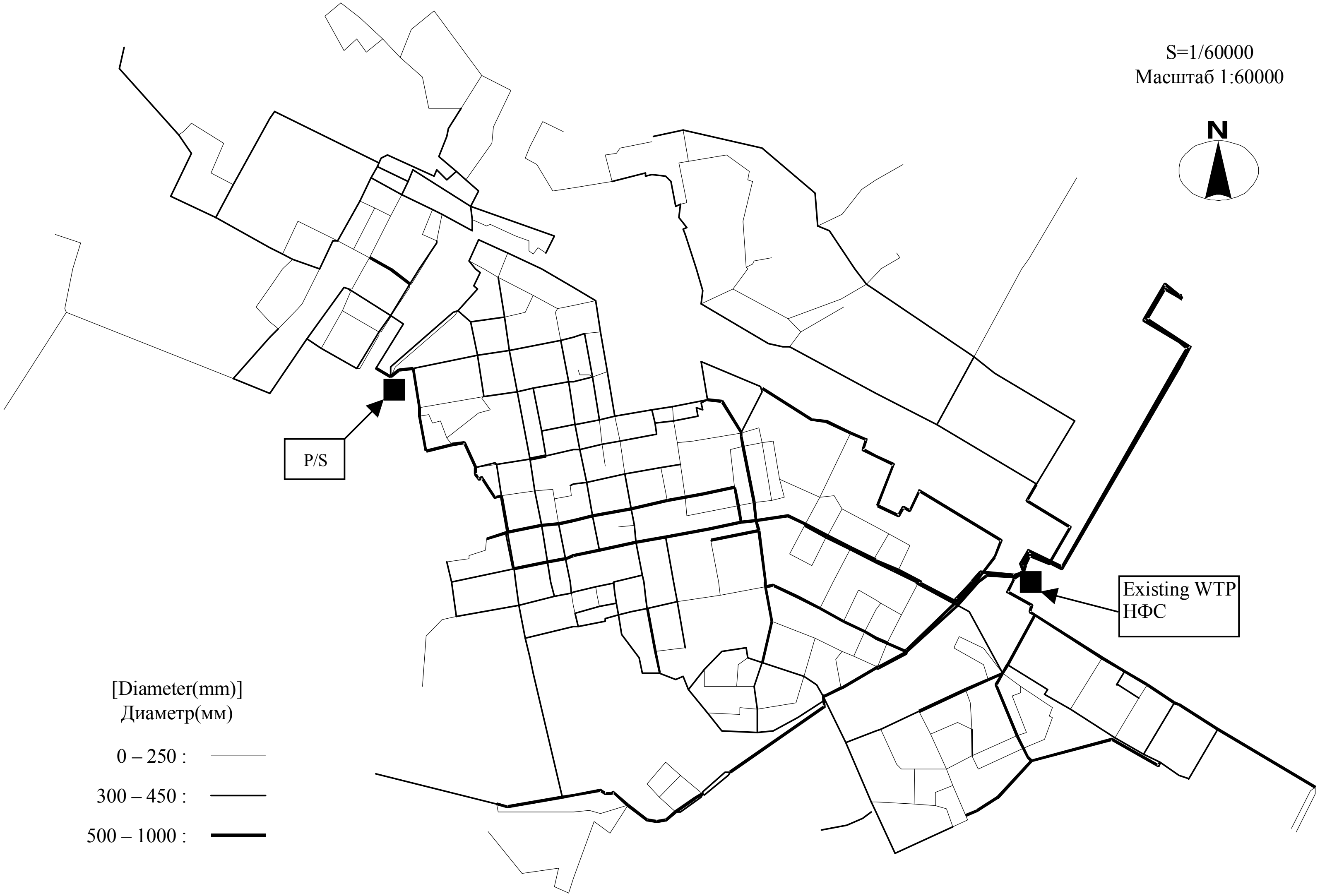


Figure 2.2.8 General Plan of the Existing Water Distribution System

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2.3 Existing Sewerage System

2.3.1 General

Existing sewerage system in Astana city was constructed in 1959 by former Soviet Union, and the facilities have been expanded to meet the city area expansion. The facilities were constructed in application of Russian standards as well as in use of the products in Russia.

Service area at present is approximately 3,500 ha and nominal daily maximum capacity of the sewage treatment plant (STP) is 136,000m^3/day, which is the same capacity for this proposed project. Existing sewerage system consists of sewers with a total length of 227 km, 39 intermediate pump stations and a sewage treatment plant (called “Aeration Station” in Russian expression).

Daily average inflow into the STP is about 100,000m^3/d during years 2000 and 2001. While, daily maximum inflow of 158,000m^3/d was recorded in 2001 during the spring thaw. Effluent from the STP is discharged into Taldy Kol reservoir that has an area of approximately 21 km^2 with the capacity of 36million m^3 in the southwest of city center. The reservoir has no outlet to the river except for emergency discharge into the Ishim River through the siphon passing through the marshland. The effluent undergoes evaporation and infiltration into the soil.

General condition of the existing sewerage system is described in this sub-section based on the examination of the collected data from Astana city and field investigation. General plan of sewerage system in Astana city is shown in Figure 2.3.1. Flow chart diagram of total sewerage system is shown in Figure 2.3.2.

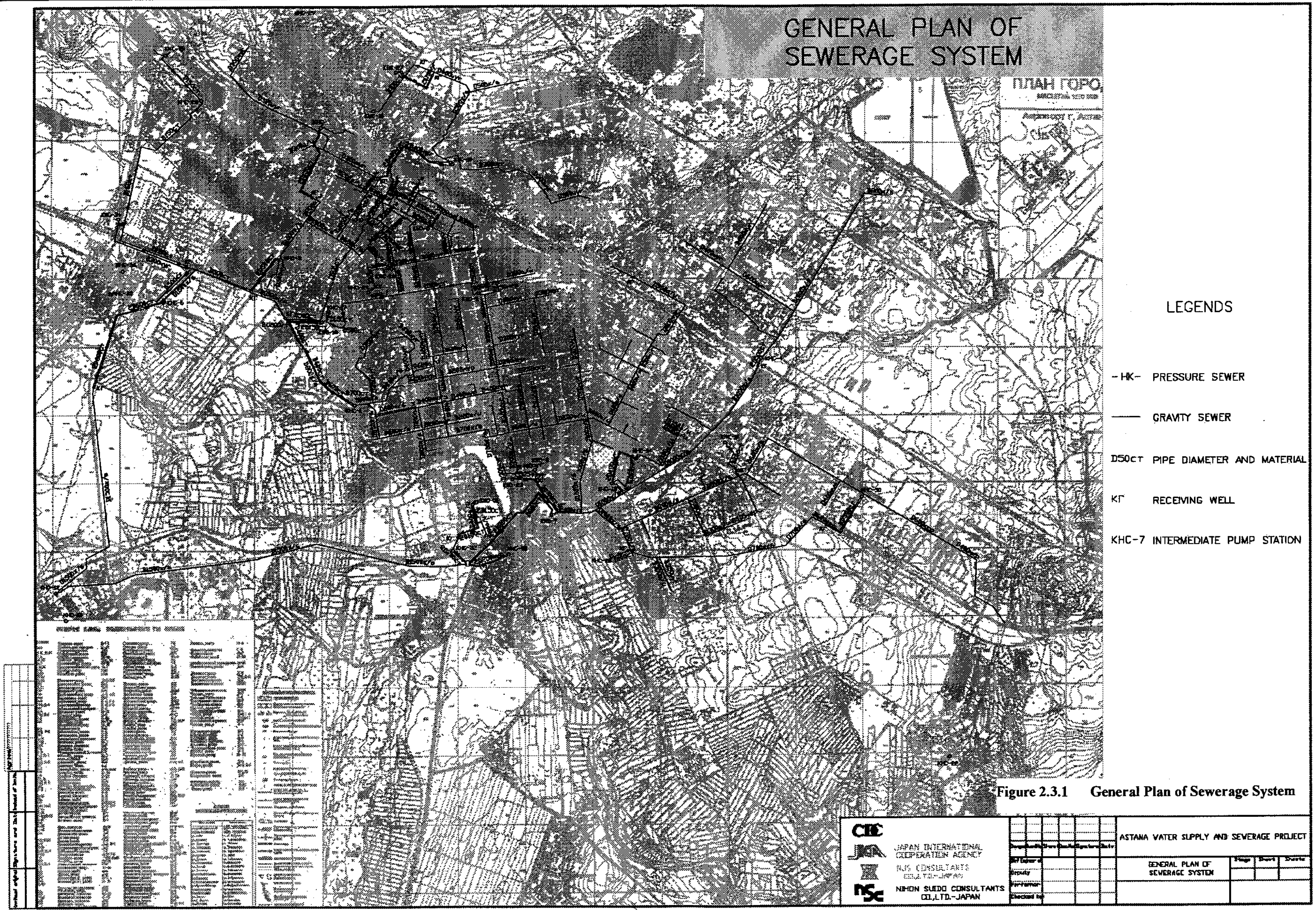

Figure 2.3.1 General Plan of Sewerage System

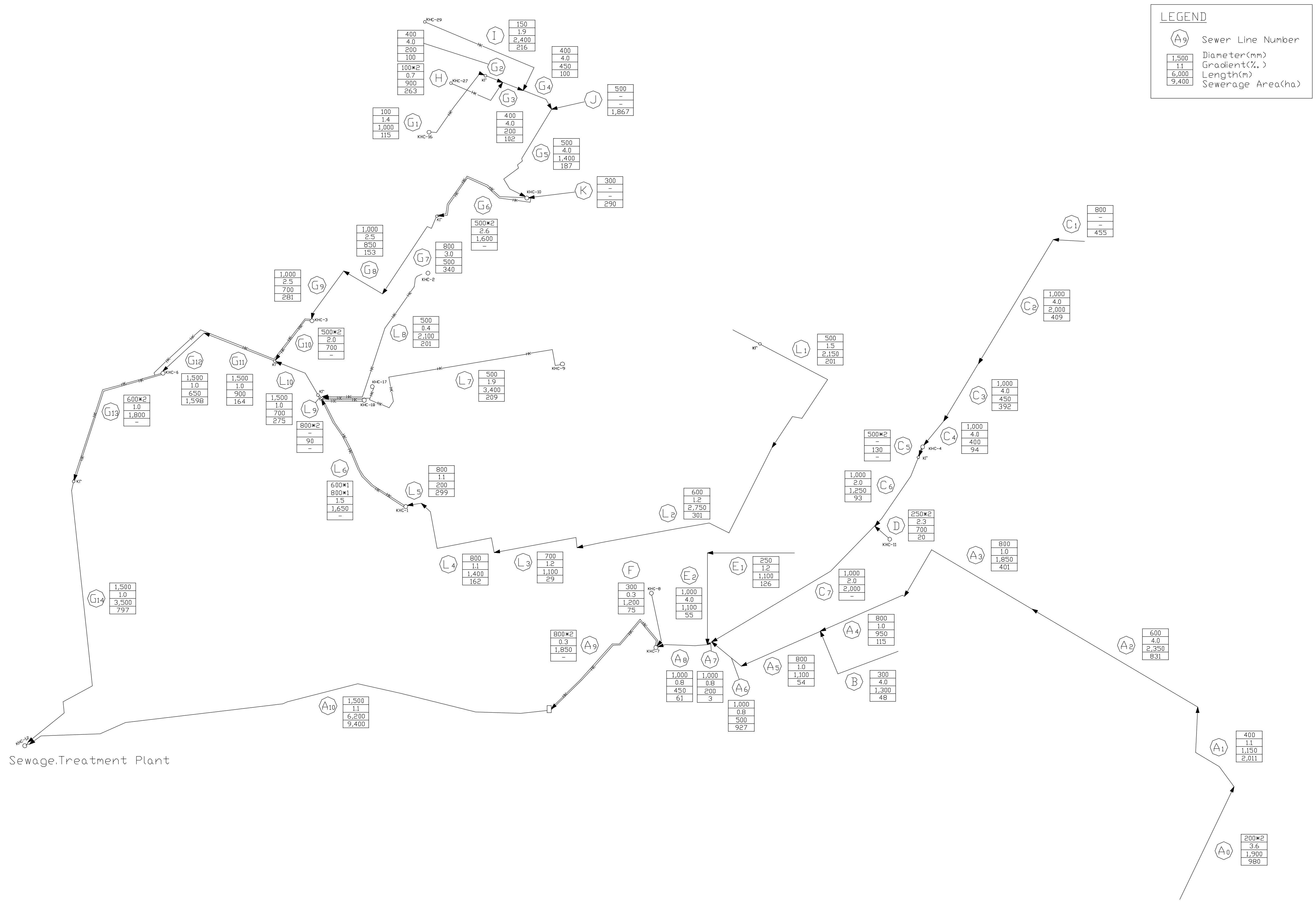

Figure 2.3.2 Flow Diagram of Sewer System