CHAPTER 3
WATER SUPPLY

CHAPTER 3 WATER SUPPLY

3.1 Current Status of Water Supply System and Facilities

(1) General

In the 1950's, Astana City was served by a rural water supply system using groundwater but it was replaced by a comprehensive water supply system that was constructed in the 1960's. Figure 3.1.1 shows the location map of the existing water supply system. The major water source, the Vyacheslavsky reservoir is located to the east, 50 km away from the City center. Water supply facilities consist of an intake pump station (P/S) at the Vyacheslavsky Reservoir, a raw water transmission line, and an intake P/S at the Ishim River and a water treatment plant (WTP). At present, the major service area is the right bank area of the Ishim River, where most of the existing city area is located. The service area will be expanded to the left bank of the river in future. In addition to the future water demand increase caused by the above urban development, outstanding drought phenomenon at the Vyacheslavsky Reservoir has also been observed in recent years. Therefore, improvement of the water supply system, including a water resource conservation scheme, is strongly requested.

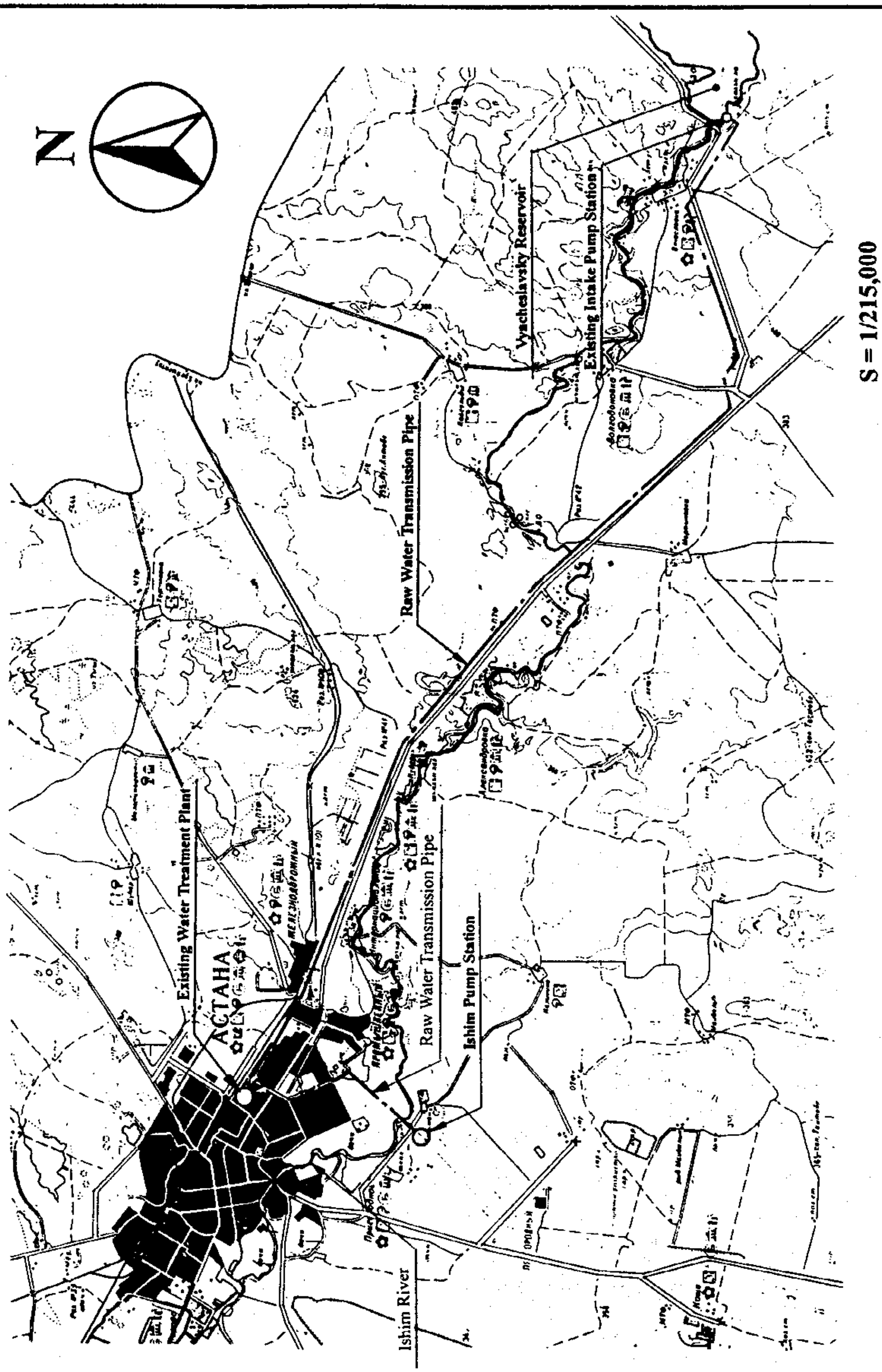
(2) Current Status of Water Supply Service

The water supply service ratio of Astana City has reached close to, but not quite 100%, including the service of "Stand-point Faucet", which occupies 27% of the whole rate. Water tankers and wells cover the remaining non-serviced areas. The service is managed, operated and maintained by Astana Su Arnacy (ASA), a state enterprise. ASA also manages the water tariff billing and collection.

One of the most significant managerial issues of ASA is to solve the problem of "Leakage and Wastage". Rates of leakage from the distribution pipelines and wastage by consumers are estimated at 26 % and 20 %, respectively. Such leakage and wastage shall immediately be eliminated from the viewpoint of efficient water use and water resource conservation.

(3) Unit Water Demand

The F/S Team examined the results of water-meter reading conducted by ASA to confirm the current domestic water consumption. Table 3.1.1 shows the results of water-meter readings.



Feasibility Study for Water Supply and Sewerage in the City of Astana	**Figure 3.1.1** **Location Map of the Existing Water Supply System in Astana City**
JAPAN INTERNATIONAL COOPERATION AGENCY	

Table 3.1.1 Comparison of Domestic Per Capita Water Consumption

Items	Bulk Water Meter (l/c/d)	Individual Water Meter (l/c/d)
Minimum	83.6	51.7
Maximum	742.4	750.0
Average (Ratio)	294.8 (2.22)	132.5 (1.00)

The water consumption measured by bulk meters is much larger than that by individual meters, and it is envisaged that the former case contains much more leakage and wastage incurred by the consumers than the latter case. Such leakage and wastage should be reduced as soon as possible and full-scale provision of individual meters will be an efficient countermeasure.

(4) Current Status and Problems of the Existing Water Supply Facilities

The following are the specifications of the existing major facilities:

- Vyacheslavsky Reservoir Intake P/S, Q = 197,000 m^3/day
- Ishim Intake P/S, Q=38,000 m^3/day
- Raw Water Transmission Pipe (Vyacheslavsky), ϕ 1,000mm x 2, L = 51 km
- Raw Water Transmission Pipe (Ishim), ϕ 1,000mm, L = 9 km
- Water Treatment Plant, Q = 165,000 m^3/day
- No.7 Booster P/S, Q = 36,000 m^3/day
- Alyuviy Booster P/S, Q = 9,600 m^3/day
- Distribution Pipeline, L = 489 km

Among these, improvement and construction works are needed for the following facilities:

1) Work A

All civil structures and equipment of Vyacheslavsky Intake P/S have deteriorated and its operational life will terminate around 2010. Construction of a new P/S is a prerequisite to a secure water supply system.

2) Work B

Most of the facilities of the existing WTP have deteriorated and its treatment capacity has been declining accordingly. Due to the structural deficit, treatment capacity will not be dramatically improved even if rehabilitation work is conducted. Construction of new WTP is therefore proposed for stable water treatment and water distribution in future. The existing WTP shall also be properly maintained by ASA to secure the necessary treatment capacity to cover the water demand until the commissioning of the new WTP.

3) Work C

Some of the existing pipelines have already heavily deteriorated and should be replaced to minimize leakage.

4) Work D

Full-scale individual water meter installation is proposed to eliminate wastage by consumers.

Considering the significance and effect on the whole system, top priority shall be given to Work D, followed by Work C, A then B.

3.2 Plan of Future Water Supply System

(1) Planning Policy

The following points represent the basic policy upon which future system planning is based:

- Emphasis for future development of water supply is placed on the improvement of existing facilities. Expansion plans shall be limited to a minimum on both the existing city and areas to the left and right side of the Ishim River.
- An appropriate plan for establishment of water supply facilities and expansion shall be based on a water conservation policy requiring reduction of water leakage and wastage of water.
- Rational facility design of water supply system to establish easier operation and maintenance for sustainable operation.

(2) Water Demand Projection

Water demand projection was carried out based on the following assumptions:

1) Drinking Water

- The only validated data on water consumption is an average of 132.5 l/c/d being the average value measured in 1999 for "houses with bathtubs and district hot water supply system", water demand type No.4. It is projected that the water consumption for this housing type which is the largest group in Astana will increase to 159 l/c/d in 2010, an annual growth of 1.8%. Based on this data the water consumption for the other housing types were estimated using experience gained from measured flows for similar housing types in other countries. The adopted per capita consumption and the daily domestic consumption requirements for 2010 are presented on Table 3.2.1. An overall average daily domestic per capita consumption of 130 l/c/d can be calculated. This overall per capita consumption value compares well with consumption in other countries.

Table 3.2.1 Target Domestic Unit Water Demand in 2010

No.	Water Consumer Type	Population	Unit Water Demand (l/c/d)	Water Demand (m^3/day)
1	Public Faucets	77,600	25	1,940
2	Houses with no bathtubs	47,800	103	4,923
3	Houses with bathtubs and Individual water heaters	42,100	137	5,768
4	Houses with bathtubs and district hot water supply systems	322,500	159	51,278
Total		490,000		63,909
Average Unit Water Demand			130	

- Public, Industry and Commercial water are calculated based on the water consumption data of ASA.
- Future thermal plant demand is projected based on the past consumption of 22,260 m^3/day from 1994 to 1999 and annual population increase ratio.

2) Technical Water

- Technical water demand was determined based on the water consumption record of Thermal Plant, future expansion plan of the plant and future demand increase in technical sector.

Overall water demand projection is shown in Table 3.2.2.

Table 3.2.2 Water Demand Projection

Items	Year	1999	2010
Drinking Water	Unit		
Population	(person)	300,800	490,000
Public		36,100	61,900
Industry		15,900	28,000
Commercial		95,300	164,900
Water Volume	(m^3/day)	96,783	115,180
Domestic		54,920	63,908
Public		4,814	5,520
Industry		14,790	2,550
Commercial			14,610
Thermal Plant		22,260	28,590
Leakage	(m^3/day)	34,599	28,800
Ratio		26%	20%
Total Water Demand		131,100	144,000
Total Drinking Water Distribution Per Capita	(l/c/d)	436	294

(3) Facility Planning

As aforementioned in the previous section, the following works will be implemented under the Project to secure the necessary capacity of water supply system through the future:

- Full-scale individual water meter installation
- Replacement of deteriorated distribution pipelines
- Construction of new Vyacheslavsky Reservoir Intake P/S
- Construction of new WTP

Table 3.2.3 shows the current and proposed WTP capacity and water demand.

Table 3.2.3 WTP Capacity and Water Demand

Items		2000	2010
WTP Capacity (m^3/d)	Existing WTP	165,000	82,000
	New WTP (No.1)	—	100,000
	Total	165,000	182,000
Daily Maximum Demand		165,000	173,000

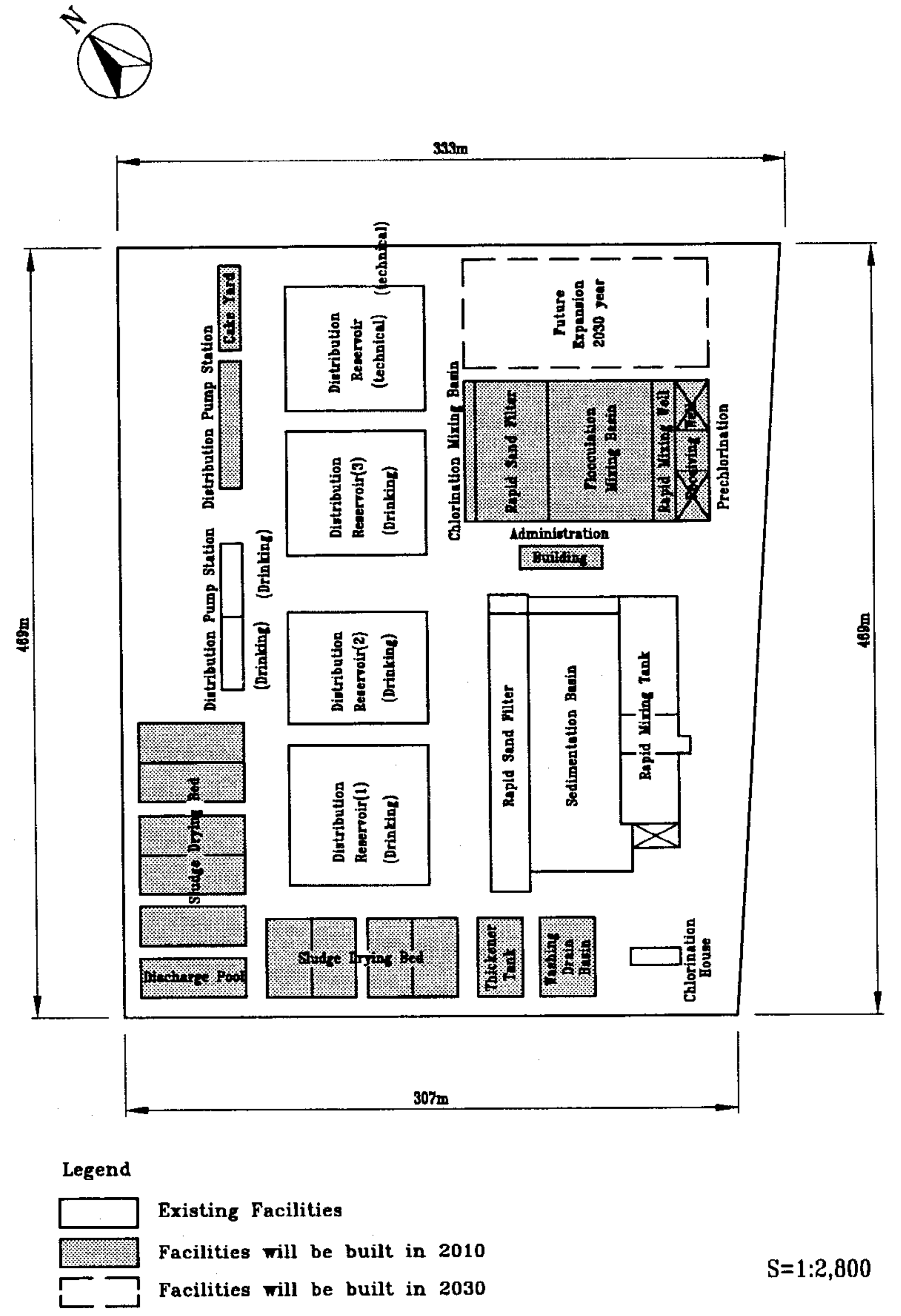
A new WTP (No.1) with a capacity of 100,000 m^3/day will be constructed within the existing WTP premises to meet the demand in 2010. Water production of the existing WTP is assumed to reduce due to structural deterioration. Layout of the existing and proposed WTP is shown in Figure 3.2.1.

According to the system development plan prepared by the JICA Master Plan Team, after 2010, the target year of F/S, the construction of two WTPs is proposed. New WTP (No.2) is proposed to be constructed on the left bank of the Ishim River and new WTP (No.3) is planned to be constructed within the confines of the existing WTP. Figure 3.2.2 shows the location map of these proposed WTPs.

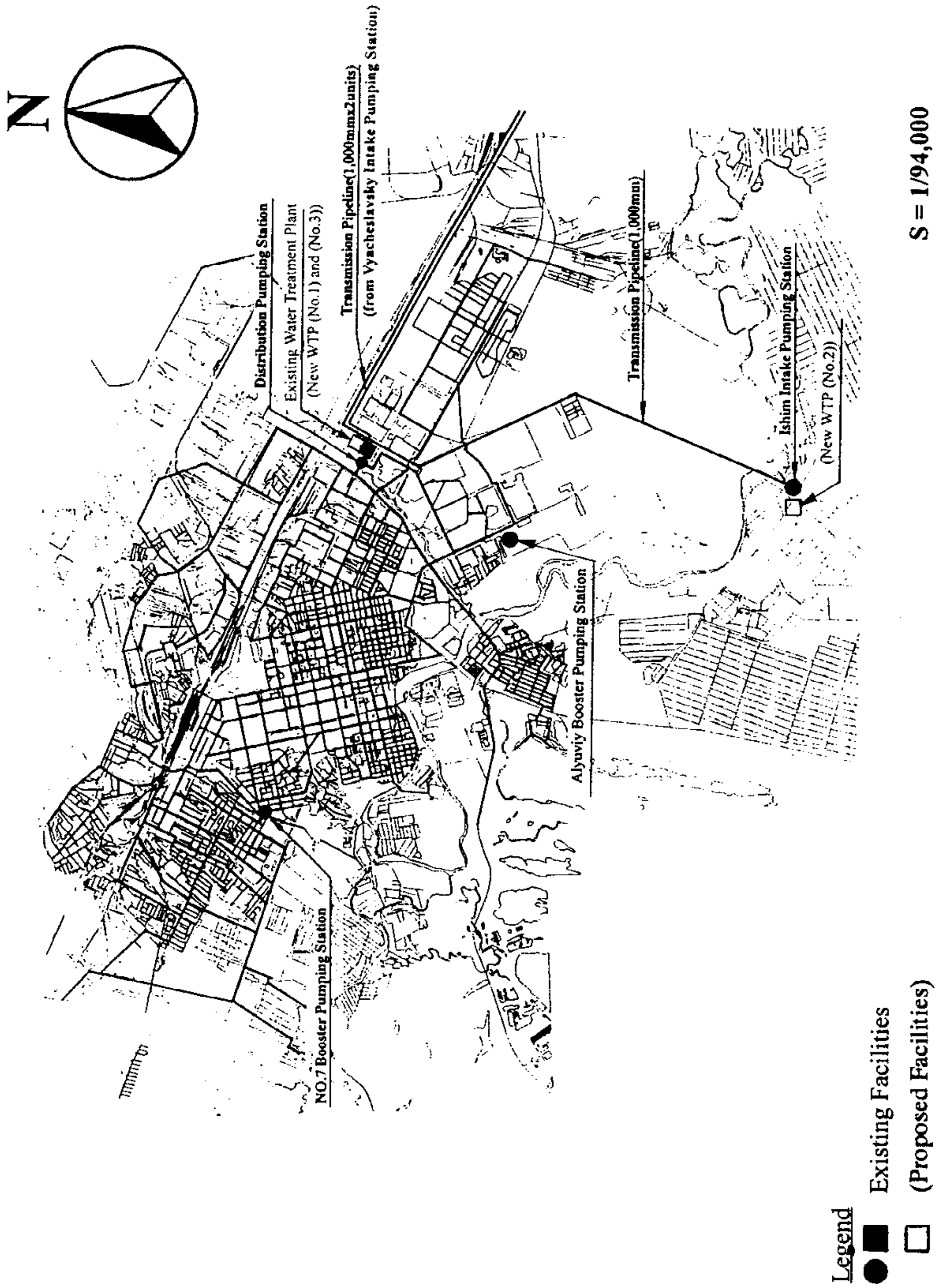
To cope with the expansion of water service area, the following work will also be conducted by this Project:

- Installation of new distribution pipelines

Facilities to be rehabilitated or constructed under this Project are tabulated in Table 3.2.4.



Feasibility Study for Water Supply and Sewerage in the City of Astana	Figure 3.2.1 Layout of the Existing and Proposed WTP
JAPAN INTERNATIONAL COOPERATION AGENCY	



Feasibility Study for Water Supply and Sewerage in the City of Astana	**Figure 3.2.2** **General Plan of the Existing and Proposed Water Supply System in Astana City**
JAPAN INTERNATIONAL COOPERATION AGENCY	

Table 3.2.4 Major Component of Works

Facilities	Type	Specifications
Rehabilitation Works		
R-1. Replacement of Existing Distribution Pipelines		
Existing Pipeline	CIP, SP, ACP	Total Length = 97,541 m
Construction Works		
C-1. Individual Water Meter Installation		
Water Meter	N = 65,500 units	
C-2. New Vyacheslavsky Reservoir Intake P/S		
Pump Room	RC Cason	W 30m x L 10m x D 27m
Pump	Vertical Pump	35 m^3/min x 57 m x 470 kW x 5 units
C-3. New WTP (No.1)		
Receiving Well		2 units
Rapid Mixing Tank		2 units
Flocculation Tank		6 channels
Sedimentation Basin		6 units
Rapid Sand Filter		12 units
Administration Building		3 story
Distribution Pump Building		Ground and Basement Floor
Sludge Thickener Tank		2 units
Back-washing Water Receiving Tank		2 units
Discharging Pool		2 units
Sludge Drying Bed		9 units
Dry Cake Yard		1 unit
C-4. Distribution Pipeline		
New Pipeline	DCIP, SP	Total Length = 73,128 m

Note) CIP : Cast Iron Pipe, SP : Steel Pipe, ACP : Asbestos Cement Pipe
DCIP : Ductile Cast Iron Pipe

Top implementation priority shall be given to Work C-1, followed by R-1, C-2, C-3 and C-4.

CHAPTER 4
WASTEWATER

CHAPTER 4 WASTEWATER

4.1 Background

This chapter presents the existing situation and the development plan concerning wastewater collection, treatment and disposal of effluent and sludge. The condition of the system is discussed and proposals for rehabilitation are made. Extension of the system is analysed to determine the necessary infrastructure to satisfy demand in the Year 2010.

The first wastewater collection system around the railway station was constructed in the 1950's by the railway administration. With the introduction of the Virgin Land agricultural development scheme Tselinograd (Astana's name at the time) was adopted as the key town for this ambitious project. A wastewater collection system complete with treatment facilities was thus planned and construction started in 1959. The wastewater treatment plant (WWTP) was completed in 1970.

Gorvodocanal was created in 1964 as a municipal trust to run the water and wastewater system. The statute and name of Gorvodocanal has recently been changed to that of communal enterprise, Astana Su Arnacy (ASA).

A separate system exists for surface water and drainage and this system is managed by Gorkomkhoz, a communal enterprise under the responsibility of Astana municipality.

4.2 Existing Situation

The wastewater system consists of a collection system, a wastewater treatment plant and a treated water storage reservoir. There was no flowmeter on the wastewater system until the recent installation of flowmeters at the WWTP thus making quantitative analysis difficult. The flows in the system have therefore been determined on the basis of limited flow measurements carried out at the WWTP and the water consumption analysis. The estimated average daily flows and pollution loads expected at the WWTP are shown on Tables 4.2.1 and 4.2.2.

The main features of the wastewater collection system are summarized on Table 4.2.3. The relatively high proportion of the population using cesspits and septic tanks can be noted. There is also an unusually high number of pump stations.

Table 4.2.1 Existing Wastewater Flow at WWTP

Wastewater Discharge	1999 Average (m^3/d)
Domestic	55,700
Others	23,400
Total	**79,100**
Infiltration estimate	7,900
Total Discharge	**87,000**
Wastewater treatment capacity	136,000

Table 4.2.2 Existing Pollutant Discharge

Key Pollutant	Quantity of Pollutant (Kg/d)
BOD_5	15,600
SS	17,600
COD	34,800

Table 4.2.3 Existing Wastewater System Features

Characteristics	Year 2000
Coverage area	3,500 ha
Service connections	61,000
Service coverage	70% of households
Cesspits and Septic Tanks	30% of households
Length of sewers	306 km
Number of manholes	5,300
Number of pump stations	32

The pipe materials and diameters on the wastewater collection system are summarized on Table 4.2.4.

Table 4.2.4 Existing Wastewater Pipelines

Unit: metre

Material	Clay	Asbestos Cement	Reinforced Concrete	Steel	Cast Iron	Polyethylene	Total
Diameter, mm							
<=150	15,935	15,294		3,490	32,092	2,240	**69,051**
200 - 300	13,170	27,158	296	2,392	37,573		**80,589**
325 - 600	3,597	3,232	1,840	24,431	15,317		**48,417**
700 -900		52	10,732	1,952			**12,736**
1000 - 1500			15,062				**15,062**
Total	**32,702**	**45,736**	**27,930**	**32,265**	**84,982**	**2,240**	**225,855**
Local System							**80,000**
Total							**305,855**

The capacity of the existing main collectors has been verified against existing flows and is considered to be adequate. However, many deficiencies were noted and the major deficiencies noted on the system are as follows:

- No replacement programme for old pipelines
- Use of unprotected steel pipeline for pumping mains (25-50 defects/100km/year)
- Poor quality manhole covers allowing surface water inflow
- Broken or missing manhole covers allowing debris to fall in
- Large number of blockages (approximately 1,500/100km/year)
- Old and inefficient sewage pumps (30% - 50%)
- Frequent breakdowns at pump stations (1.5 defect/pump/year)
- Old electromechanical plant

The wastewater treatment plant is based on the activated sludge method to provide biological treatment. The plant has a design capacity of 136,000 m^3/day, which is in excess of the average flow expected as given on Table 4.2.1. The following process units are available:

- Three mechanically raked screens with 16mm bar spacing
- Inlet P/S with five pumps each with rated capacity of 750 l/s
- 10 grit traps, 15m long, 2m wide
- Six primary settlement tanks, 28 m diameter
- Four aeration lanes, 476m long, 8m wide
- 10 final settlement tanks, 28m diameter
- Treated effluent P/S with five pumps each with capacity 750 l/s

Thermophilic anaerobic digestion is used to treat sludge which is then dried in asphalt lined beds. The process units available are as follows:

- Two thickening tanks, 20m diameter
- Two thermophilic digestors, 2,500m^3 each
- Three boilers, 4.5 tonnes of steam/hour each (also serves for district heating)
- Two gas holders, 1,000m^3 each
- Sludge drying beds (2x 7,000+ 11x 2,700m^2)

Treated effluent is disposed to Taldy Kol Reservoir with the intention of reuse in agriculture. However the irrigation scheme was not completed and as a temporary measure excess water from Taldy Kol reservoir is discharged to marshland to the west of the reservoir during the spring thaw. The treated water quality and the water quality in Taldy Kol reservoir is presented on Table 4.2.5.

Table 4.2.5 Average Treated Wastewater Quality

Key Pollutant	Treated Effluent (mg/l)	Taldy Kol Reservoir (mg/l)
BOD_5	8.3	6.0
SS	10.0	7.0
COD	77	62

The WWTP is generally performing as designed, however, deficiencies have been noted and the most important ones are presented below:

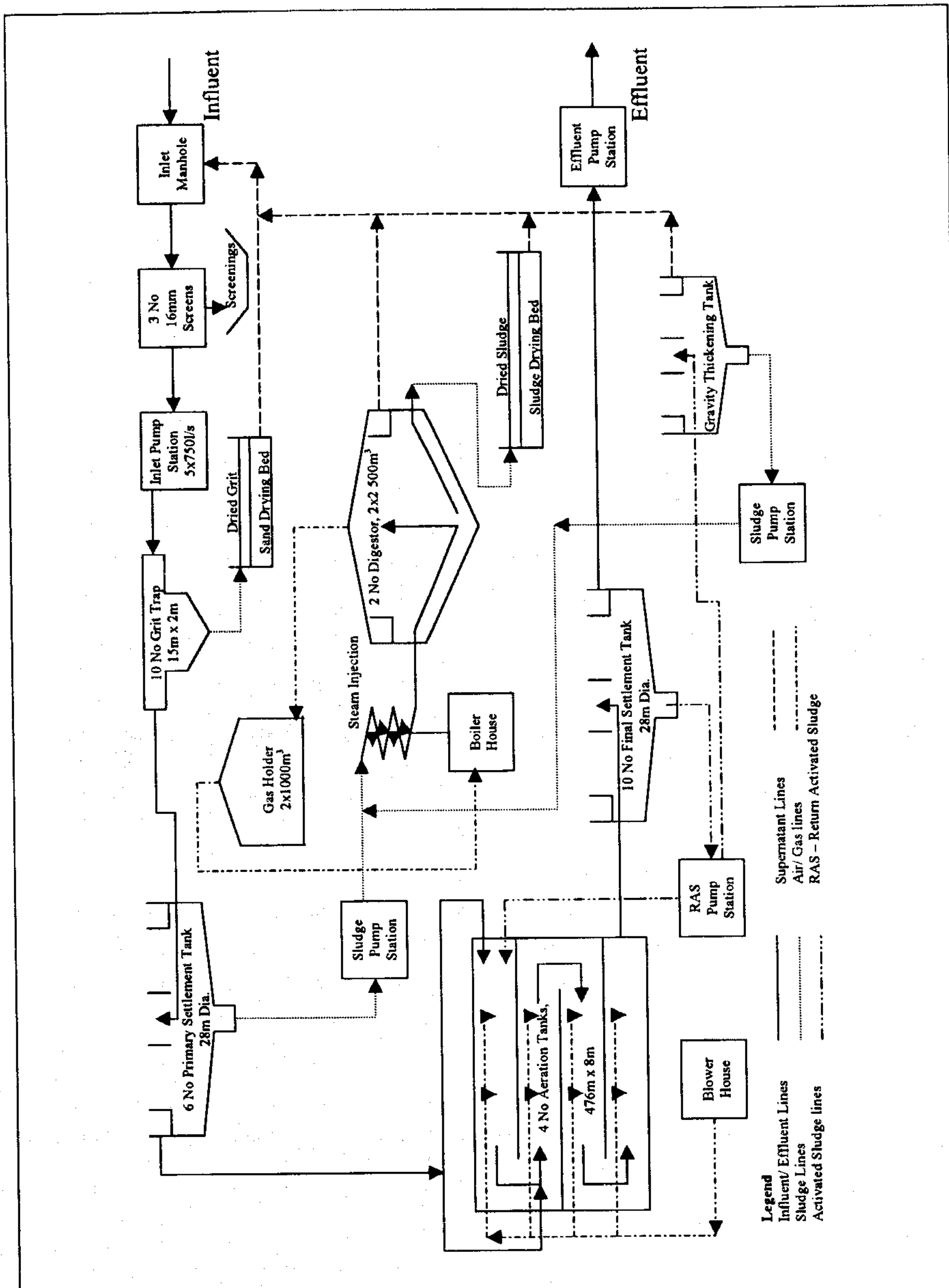
- Poor concrete condition of grit channels
- Poor efficiency of inlet and effluent pumps
- Old and unreliable electromechanical equipment
- Old and unreliable air blowers
- Old and unreliable return activated sludge pumps
- Insufficient thickening of sludge and short retention in digestors
- Insufficient number of sludge drying beds
- Insufficient number of primary and final tanks
- Old and unreliable boilers

Figure 4.2.1 presents a schematic of the process used at the WWTP.

4.3 Development Plan

The proposed development plan is based on the reuse and rehabilitation of existing facilities, wherever possible, as a priority objective. Rapid urban expansion resulting from the change of status of the city to that of Capital of Kazakhstan is expected and therefore expansion of the wastewater collection network in new development area is also a priority. The target horizon year for this feasibility study is 2010 and the proposed works has therefore been designed for this target year.

The projected wastewater peak flows used for the design of the system have been calculated on the basis of the water demand projections and are presented in Table 4.3.1. Values for 1999 are shown for reference.



Feasibility Study for Water Supply and Sewerage in the City of Astana	**Figure 4.2.1**
JAPAN INTERNATIONAL COOPERATION AGENCY	**Process Schematic of the Wastewater Treatment Plant**

Table 4.3.1 Projected Wastewater Peak Day Flows

Unit: m^3/d

Item	1999	2010	2020	2030
Domestic	66,800	69,000	112,000	147,500
Others	27,900	33,000	43,800	49,600
Total	**94,700**	**102,000**	**155,800**	**197,100**
Infiltration, 10%	9,500	10,200	15,600	19,700
Total at WWTP	**104,200**	**112,200**	**171,400**	**216,800**
Population	300,800	490,000	690,000	800,000

The design domestic pollution loads for the WWTP were calculated on the basis of per capita pollution load provided in SNiP 2.04.02-85 whilst commercial and industrial loads were based on measured average concentrations. The projected loads are shown on Table 4.3.2. Values for 1999 are indicated for reference.

Table 4.3.2 Projected Wastewater BOD_5 Loads

Units: kg BOD_5/day

Category	1999	2010	2020	2030
Domestic	11,005	20,760	31,740	38,225
Commercial (Value for 1999 inc. in industries)	-	537	900	1,240
Industrial	1,575	1,922	2,380	2,640
Total	**12,580**	**23,219**	**35,021**	**42,104**

(1) Wastewater Collection System

The diagnostic carried out on the wastewater collection system using projected flows in the system concluded that, generally, the capacity of the existing system is sufficient for the areas served. However, because of the age of the system, rehabilitation is required as described below.

1) Existing Pipelines

Replacement of about 21 km of pipeline is necessary to reduce repair costs and to reduce the risk of pipe failure as detailed in Table 4.3.3. Repairs to about 5,300 manholes are also proposed.

Table 4.3.3 Existing Pipeline to be Replaced

Diameter (mm)	Length (m)
150 - 300	14,300
500 - 800	6,600
Total	**20,900**

2) Existing Pump Stations

The rehabilitation of 17 medium and large pump stations is required to ensure a secure operation. Replacement of electromechanical equipment and an overhaul of the buildings are proposed.

3) Extension of Service Area

Consolidation of the level of service for wastewater collection is expected in the existing urban areas. Population presently using cesspits and septic tanks will gradually connect to the wastewater collection system. Other peripheral settlements will also get connected as the urban areas expand and bring them within distance of the main collection system.

Urban expansion of Astana is expected and it is therefore essential that the wastewater collection system be extended to cover the proposed extension area. Expansion of the wastewater collection system is necessary to cover the 1,600 ha of new development proposed on the left bank of the Ishim River. A total of about 36 km of main collectors is required as detailed in Table 4.3.4.

Table 4.3.4 Proposed Main Collectors

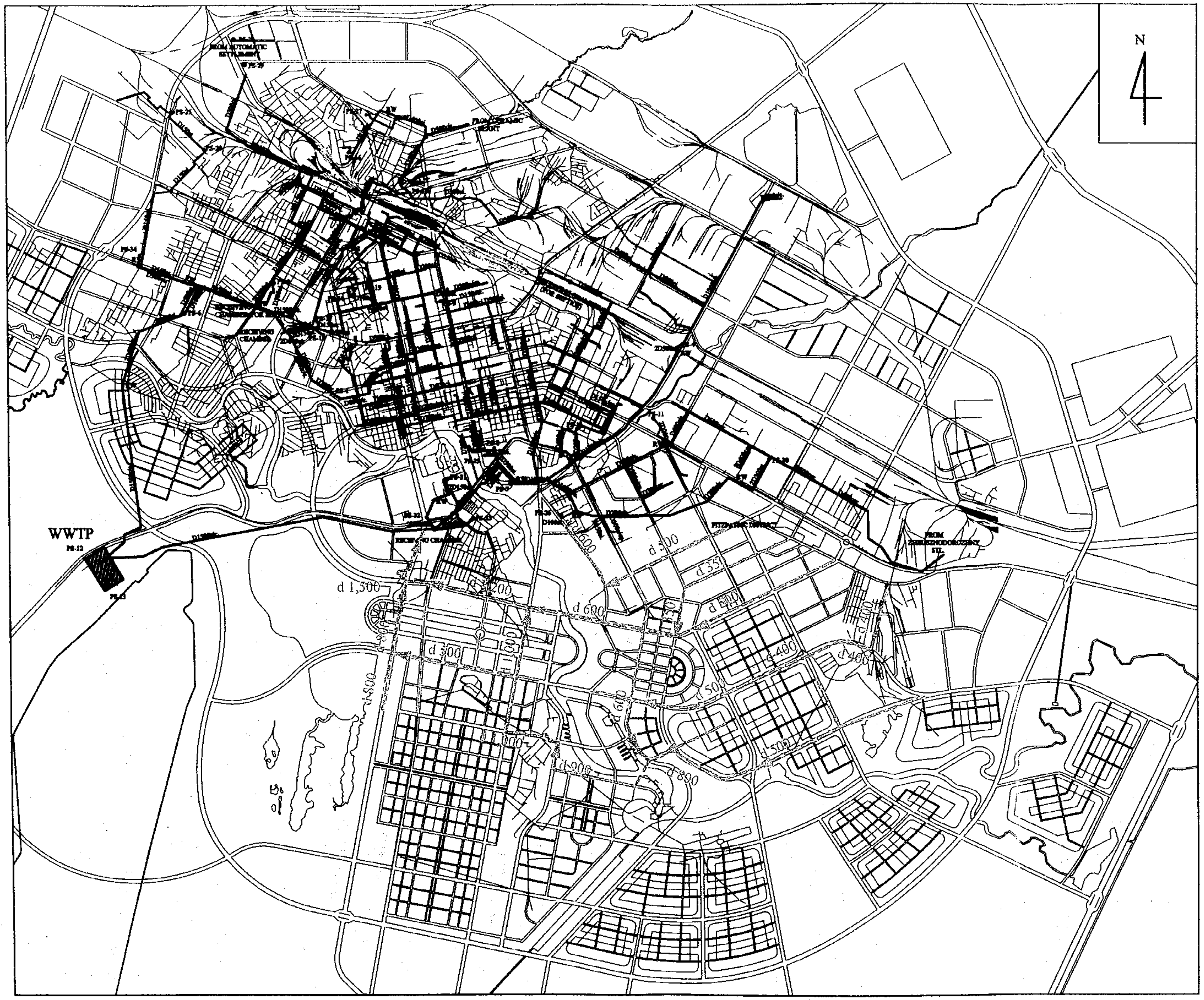
Diameter (mm)	Length (m)
350-500	17,700
600-900	11,830
1,000-1,500	6,520
Total	**36,050**

Two river crossings, to be carried out by horizontal pipejacking and three new pump stations are also necessary. The pump stations capacities are shown on Table 4.3.5.

Table 4.3.5 Capacity of Proposed Pumping Stations

Reference No	Duty Capacity m^3/min	Installed Capacity m^3/min	Head m	Installed kW
KHC 50	49.0	73.5	14	283
KHC 51	25.0	37.5	13	145
KHC 52	10.0	15.0	18	80

Figure 4.3.1 presents the proposed main collectors in the extension area.



Legend
- ● Existing pump station
- ○ Proposed pump station
- Existing collector
- Proposed wastewater collection system for 2010

0 1km 2km 5km

The Feasibility Study on Water Supply and Sewerage in the City of Astana	Figure 4.3.1 Proposed Wastewater Collection System in 2010
JAPAN INTERNATIONAL COOPERATION AGENCY	

(2) Wastewater Treatment

A large proportion of the existing population relies on cesspits and septic tanks for treatment and disposal of wastewater. In future it is expected that in the urban area this proportion will decrease. However, given the rural area surrounding Astana, it is expected that there will still be a small proportion of the population in outlying districts who will continue to rely on cesspits and septic tanks. Some settlements and development such as the airport will still be quite a distance from the wastewater collection system and it is proposed that small package treatment plants be provided in such circumstances.

Diagnostic of existing WWTP showed that the overall capacity of the existing WWTP is sufficient for the horizon year 2010. However, rehabilitation and improvements are necessary to increase the reliability of the plant. It is therefore proposed that the WWTP be retained for the foreseeable future. Rehabilitation and improvements includes the following:

- Replacement of screens and pumps at the inlet works
- Reconstruction of the grit channels, 2 x 10m diameter horizontal flow
- Construction of additional primary and final settlement facilities, 4 x 28m diameter
- Reconstruction of the return activated sludge pump station, 5 x950m^3/hr
- Replacement of air blowers, 6 x 20,100 Nm^3/hr

The development plan for the wastewater treatment plant is shown on Figure 4.3.2

(3) Sludge Treatment

The existing sludge treatment facility is not capable of properly treating the sludge resulting from treatment. It is therefore proposed that the sludge treatment facility be upgraded by improved thickening of the sludge prior to thermophilic digestion. The thicker sludge will allow a higher retention time within the digestors. Improved settling of the digested sludge is also proposed by construction of a secondary digestor. Additional sludge drying beds are also required to improve the sludge drying and storage capacity. The following rehabilitation and improvement works are therefore proposed:

- Replacement of sludge transfer pumps
- Replacement of 2 boilers (2 x 4.5 tonnes steam/hour)
- Rehabilitate existing digestors
- New belt thickener plant, 3x 80m^3/hr
- New secondary digestor, 2,500m^3

- Five additional sludge drying beds

A schematic of the improved sludge treatment process is presented on Figure 4.3.3.

(4) Treated Wastewater Disposal and Reuse

The original development plan for disposal of treated effluent was to have been reuse for irrigation following storage in Taldy Kol reservoir. However, as a result of perestroika the treated effluent reuse project has been stopped during this period of transition for the agricultural sector. A review of the options available for disposal of treated effluent is therefore necessary.

A preliminary study for reuse of treated wastewater has been carried out and concluded that reuse in agriculture offers the most potential. Other uses such as forestry and landscape watering, technical water, aquaculture and recreational is limited mainly because of the small quantities which can be reused.

The study indicated a high potential for reuse in agriculture to irrigate fodder crops but a feasibility study of the agricultural development is required to confirm this permanent disposal route. A total of 8,500 ha of land suitable for irrigation from the 39,000 ha holdings of the two targeted agricultural enterprises (Ermagambetov & Co and Yenbek-Koshi RSE 121) to the south of Astana will be required for this purpose.

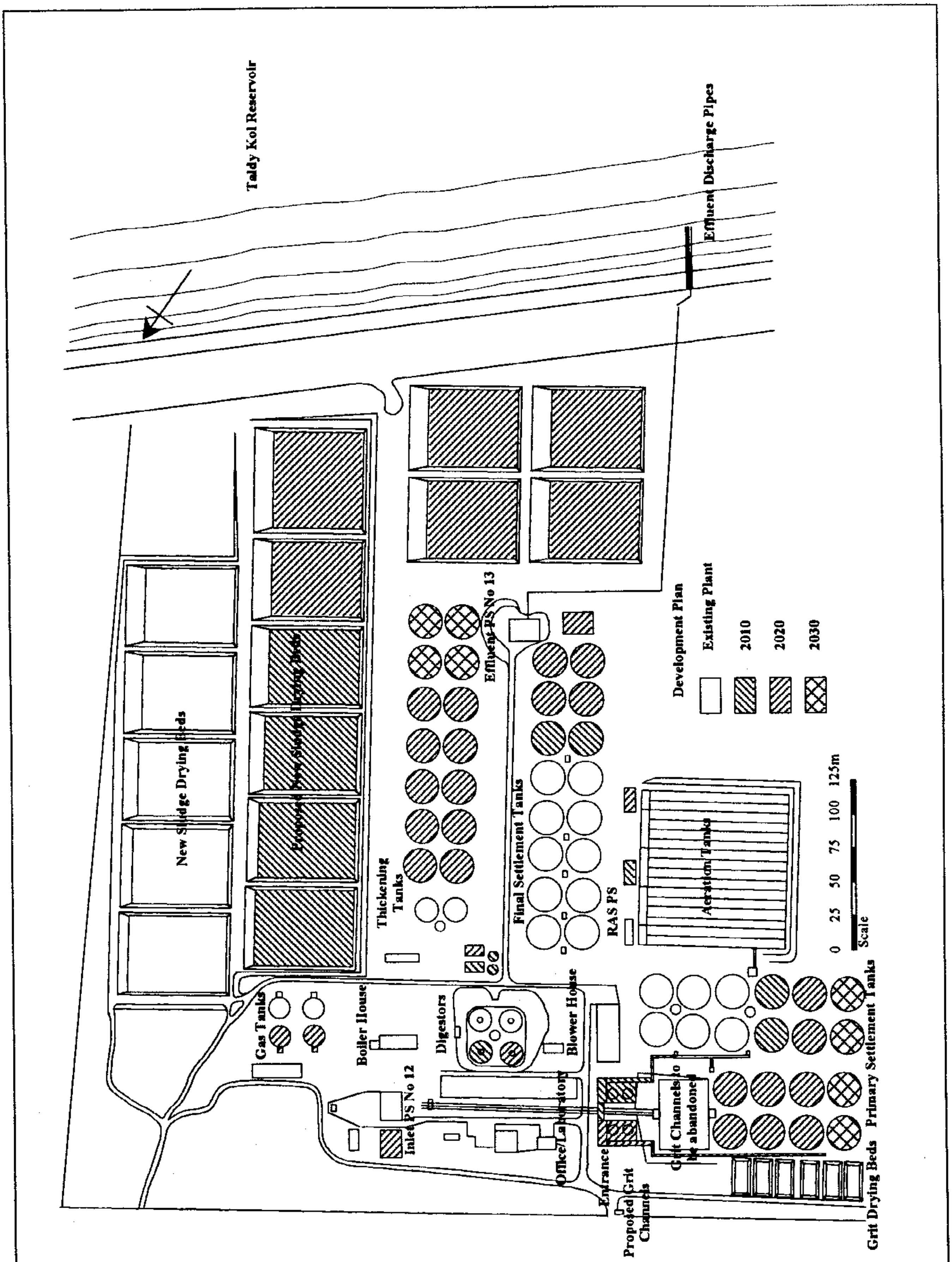
Other disposal routes have been investigated and are limited because of the following:

- Low flows in all rivers during most of the year restricting the dilution potential
- High water table preventing extensive use of infiltration fields

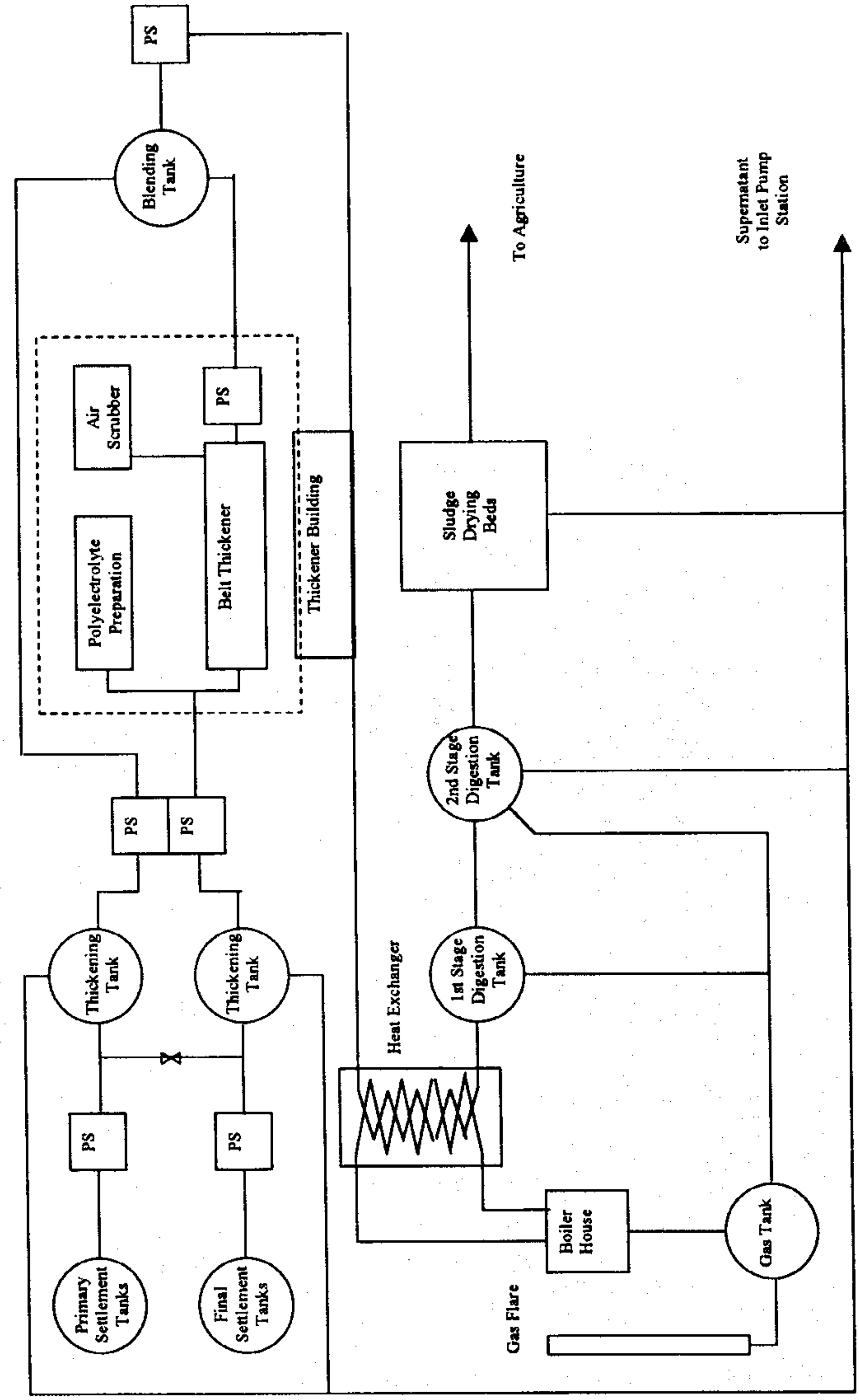
The limited dilution available in the rivers prevents direct discharge of biologically treated effluent. Costly advanced treatment, using filtration, activated carbon and disinfection is necessary to improve the treated effluent quality to that suitable for direct discharge.

With the limitations described above, five scenarios have been identified as follows:

1. Retain Taldy Kol reservoir and reuse of treated effluent for irrigation and agricultural use in the area to the south of Astana
2. Introduction of advanced treatment to achieve desired surface water quality for disposal to Ishim River
3. Introduction of advanced treatment to achieve desired surface water quality for disposal to Nura River



Feasibility Study for Water Supply and Sewerage in the City of Astana	**Figure 4.3.2**
JAPAN INTERNATIONAL COOPERATION AGENCY	**Development Plan for the Wastewater Treatment Plant**



Feasibility Study for Water Supply and Sewerage in the City of Astana	Figure 4.3.3
JAPAN INTERNATIONAL COOPERATION AGENCY	Process Schematic for Proposed Sludge Treatment

4. Introduction of advanced treatment to achieve desired surface water quality for disposal to Selety River
5. Relocation of the existing wastewater treatment plant

The advantages and disadvantages as well as the cost estimate for each scenario are presented on Figures 4.3.4 to 4.3.6.

Scenario 1 is the least costly option and is therefore recommended for implementation. Should the agricultural development feasibility study, proposed above, indicate that the project is not feasible, disposal to the Ishim River after advanced treatment is the next recommended scenario.

(5) Sludge Disposal

The following sludge disposal options for dried digested sludge (equivalent to about 12 tonnes of dry solids per day) have been investigated:

- Direct agricultural and forestry use
- Composting
- Fertilizer production
- Pelletisation
- Incineration
- Landfill

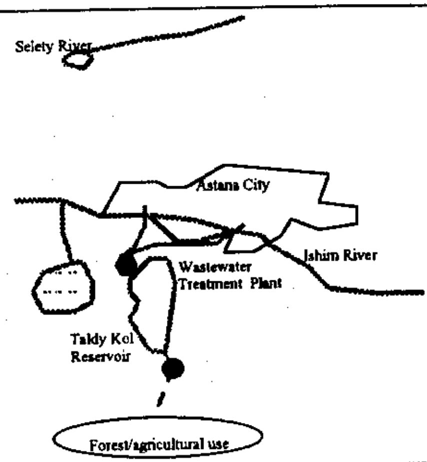
Disposal to agriculture is the method of disposal recommended in most countries. However, careful planning is necessary to avoid excessive application of heavy metal to the same fields over the long term.

Composting, fertilizer production and pelletisation require creation of a market for the finished product and is costly to set up. Incineration is a costly option and has its own environmental drawbacks. Landfill is less costly than incineration, composting or pelletisation but it also has environmental impacts which has to be controlled.

It is therefore recommended that dried digested sludge be disposed to agricultural land.

Scenario 1

Required Works
- Rehabilitate existing wastewater treatment plant
- Irrigation system is required for irrigation and agricultural use in the area south of Astana



Advantages
- Least cost solution for wastewater discharge
- Reuse of treated effluent in the Tselinogradskogo region for irrigation an agriculture

Disadvantages
- Uncertain irrigation and agriculture usage
- Crop irrigation depend on treated effluent quality

Cost Estimate (Excluding cost of irrigation system)

WWTP Rehabilitation	20.4
Advanced Treatment	-
Pipeline	7.1
Pump Station	0.9
Total Capital Costs	**28.4 M USD**

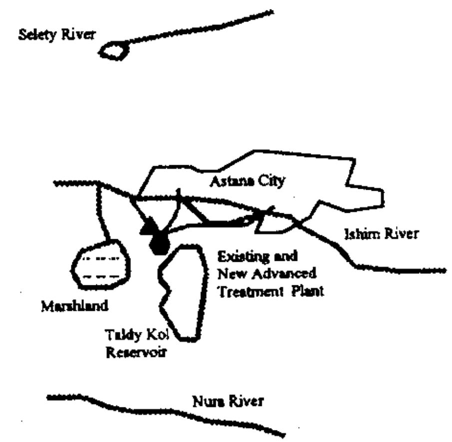
Annual Operating Cost - 0.75 M USD

Evaluation

Scenario totally dependent on irrigation and agricultural use. Further studies are necessary

Scenario 2

Required Works
- Rehabilitate existing WWTP
- Advanced Treatment Plant including rapid gravity filters, granular activated carbon filters and ultraviolet disinfection
- Discharge pipeline



Advantages
- Water quality maintained in Ishim river
- Improved low flows in the Ishim River
- Better quality water for irrigation downstream of the Ishim River

Disadvantages
- High cost of tertiary treatment
- Higher tariffs for water

Cost Estimate

WWTP Rehabilitation	20.4
Advanced Treatment	32.7
Pipeline	1.1
Pump Station	0.2
Total Capital Costs	**54.4 M USD**

Annual Operating Cost - 2.05 M USD

Evaluation

High capital and operating cost.

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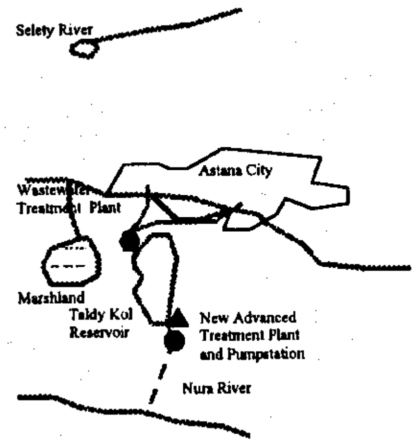
Figure 4.3.4

Wastewater Treatment and Disposal Scenarios 1 and 2

Scenario 3

Required Works

- New treated effluent pumping station
- Advanced wastewater treatment
- New 35 km pipeline



Advantages

- Water quality maintained in the Nura River
- Improved flow in the Nura River
- Potential for reuse downstream of the Nura River

Disadvantages

- Costly advanced treatment
- High capital and operating costs
- Uncertain condition of existing pipeline

Cost Estimate

WWTP Rehabilitation	20.4
Advanced Treatment	32.7
Pipeline	7.1
Pump Station	0.8
Total Capital Costs	**61.0 M USD**

Annual Operating Cost - 2.50 M USD

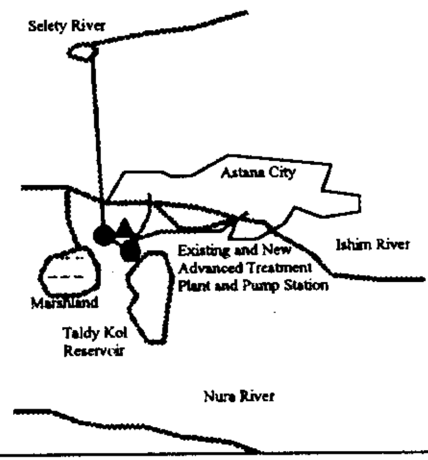
Evaluation

More costly than Scenario 2, but improved condition in Nura River

Scenario 4

Required Works

- New treated wastewater pumpstation
- Advanced wastewater treatment
- New 50km effluent pipeline



Advantages

- Water quality maintained in the Selety River
- Potential reuse in the northern part of the city

Disadvantages

- Costly advanced treatment
- Very long effluent pipeline
- High capital and operating costs

Cost Estimate

WWTP Rehabilitation	20.4
Advanced Treatment	32.7
Pipeline	9.0
Pump Station	1.0
Total Capital Costs	**63.1 M USD**

Annual Operating Cost - 2.63 M USD

Evaluation

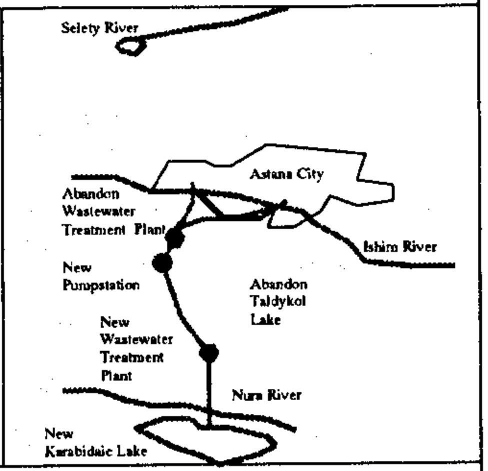
. Very distant discharge and costly scenario

Figure 4.3.5

Wastewater Treatment and Disposal Scenarios 3 and4

Scenario 5

Required Works
- New pumpstation
- New transfer pipeline (35 km, 1m dia.)
- New wastewater treatment plant
- New reservoir (50 million m^3)



Advantages
- Development land released
- Resolution of reported but unconfirmed odour nuisance
- Reuse of treated effluent for irrigation and agricultural use

Disadvantages
- Extension to infrastructure such as collectors and power supply are required
- Very costly new plant
- Relocation of Taldykol reservoir necessary if treated effluent is reused
- Additional cost necessary for advanced treatment if discharge to rivers

Cost Estimate

New WWTP	87.0
Advanced Treatment	-
Pipeline	35.0
Pump Station	10.0
Reservoir	10.0
Total Capital Costs	**142 M USD**

Annual Operating Cost - 0.75 M USD

Evaluation

Most costly scenario, additional cost for advanced treatment is necessary for discharge to rivers

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

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Figure 4.3.6

Wastewater Treatment and Disposal Scenario 5

(6) Operation and Maintenance

The manning level of the direct operation and maintenance departments responsible for wastewater collection and treatment is high when compared with modern water and wastewater enterprises. Improvements in the reliability of the pipelines, pump stations and wastewater treatment plant will reduce the level of effort necessary for direct operation and maintenance. It is therefore expected that staffing level can be reduced as follows:

Department	Present	Proposed 2010
Wastewater Collection	125	88
Wastewater Treatment	115	68
Total	**240**	**156**

The effective operation and maintenance of any wastewater system requires efficient access to information on the available assets, the productivity of the asset etc. Access to essential information about the wastewater collection system is at present very difficult because there is no systematic and coordinated gathering of information or organisation to make accessible the gathered information. It is recommended that a management information system be provided to collect and make information easily available.

CHAPTER 5
ENVIRONMENT

CHAPTER 5 ENVIRONMENT

5.1 Environmental Impact Assessment (EIA) of Proposed Projects

The scope of EIA in this Study is to assess the negative environmental impacts of the proposed water supply and wastewater treatment projects and recommend requisite countermeasures to mitigate negative impacts.

In Kazakhstan, the "Tentative Instruction on Procedure for Environmental Impact Assessment of Planned Activities in the Republic of Kazakhstan (EIA) / RND 03.02.01-1993", which stipulates the procedure of EIA, was adopted in 1993. According to the instruction, EIA is carried out by the implementing organization of the project, undertaken with public hearings during the progress of project planning.

Although there is a basic framework of EIA procedure in Kazakhstan, EIA of this Study was carried out in accordance with JICA Environmental Guidelines for the following reasons:

- At present, the project is only at proposal stage, therefore it is difficult to hold a public hearing by mass media by the organizer of the project (ASA).
- In regard to environmental items to be considered in EIA, the items required by Kazakhstan law as defined in RND 03.02.01, are covered by JICA Environmental Guidelines (see Table 7.1.3).

5.2 EIA of Proposed Water Supply Projects

The summarized result of environmental impacts for consideration is shown in Table 5.2.1. The entire list of all items of the JICA environmental guidelines are shown in Table 5.2.2. Although the main factor to be considered is increase in the water intake amount from the Vyacheslavsky Reservoir, it is considered that significant impact will be prevented by the appropriate operation of the dam at the reservoir by the following estimate, based on the Master Plan Study.

- The daily maximum water demand in 2010 is under the daily yield of the Vyacheslavsky Reservoir.

Overall, the proposed projects do not impact the environment significantly except noise and vibration during the construction work and the dried sludge disposal for which the degree of impact is not estimated. After confirmation of the detail of the proposed plan, these impacts should be considered and the necessary countermeasures should be recommended in case that the expected impacts are significant. The possible countermeasures are as follows.

- In regard to noise and vibration during the construction, the construction work will be confined in the night time.
- In regard to the dried sludge disposal, the landfill will be carried out in accordance with the waste management plan which is proposed by the Master Plan Study if the sludge will not be reused for purposes such as the forestation.

Table 5.2.1 Selection of Environmental Impacts for Water Supply Projects

Factor Caused by Project			Remark	Item to be Considered
Construction phase		Construction work of new pump station	- No settlement exists in and around the site.	-
		Construction work of new WTP	- A clinic exists near the proposed construction site.	Noise and Vibration
		Construction work of distribution facilities	- The rehabilitation of existing pipelines will be conducted in the urban area.	Noise and Vibration
Land occupation by new facilities		New pump station	- Alteration area is not large. - Any significant natural environment does not exist in the site.	-
		New WTP	- Construction site is in existing facilities site.	-
Operation phase	Intake	Increase of water intake amount	- Water intake amount is within the yield of the Vyacheslavsky Reservoir based on Master Plan Study	-
	Purifi-cation	Increase of sludge amount	- The method of dried sludge disposal should be considered.	Waste (Dried Sludge)

5.3 EIA of Proposed Wastewater Projects

The summarized result of environmental impacts considered is shown in Table 5.3.1. The entire list of all items of the JICA environmental guidelines are shown in Table 5.3.2. Although the main factor to be considered considerable factor is increase the amount of the treated effluent, it is considered that significant impact will not be expected due to the following.

- The treated effluent will continue to be discharged to the Taldy Kol Reservoir which was designed as the discharging point of the treated effluent. It means that the effluent will not affect the Ishim River directly. The daily maximum effluent quantity in 2010 is estimated at approximately 112,000 m^3 / day, as compared to approximately 104,000 m^3 / day at present. However, it is considered that the pollution load will not increase significantly due to the improvement of effluent quality by rehabilitation and development of WWTP.

Table 5.2.2 Environmental Impact by Implementation of Proposed Water Supply Projects

Item			Evaluation	Remark
Social environment	1	Resettlement	-	- No settlement exists in and around the proposed construction site of the new pump station. - The new WTP will be constructed within the existing WTP site.
	2	Economic Activities	-	- No economic activity is carried out in and around the proposed construction site of the new pump station. - The new WTP will be constructed in the site of existing WTP.
	3	Traffic and Public Facilities	-	- No public facilities in and around the proposed construction site of the new pump station. - The new WTP will be constructed within the existing WTP site.
	4	Separation of Communities	-	- No Large scale of construction will be done.
	5	Cultural Property	-	- No cultural property exists in and around the proposed construction site of the new pump station. - The new WTP will be constructed within the existing WTP site.
	6	Water Rights and Rights of Common	-	- Water intake amount will be within the yield of the Vyacheslavsky Reservoir based on Master Plan Study.
	7	Public Health Condition	-	- No Large scale of construction to affect to the public health will be done.
	8	Waste	+	- The way of dried sludge disposal should be considered.
	9	Hazard (Risk)	-	- No Large scale of construction will be done.
Natural Environment	10	Topography and Geology	-	- Extensive alteration of topography will not be conducted.
	11	Soil Erosion	-	- Extensive excavation will not be conducted.
	12	Groundwater	-	- Groundwater will not be used for the project.
	13	Hydrological Situation	-	- Water intake amount will be within the yield of the Vyacheslavsky Reservoir based on Master Plan Study.
	14	Coastal Zone	-	- There is no coastal zone.
	15	Fauna and Flora	-	- No notable natural environment exists in and around the proposed construction site of the new pump station. - The New WTP will be constructed in the site of existing WTP.
	16	Meteorology	-	- No Large scale of construction will be done.
	17	Landscape	-	- The proposal site of the new pump station is flat, and the area for landscape preservation does not exist around the site. - The New WTP will be constructed in the site of existing WTP.
Pollution	18	Air Pollution	-	- No Large scale of construction to affect to the air pollution will be done.
	19	Water Pollution	-	- The polluted load to the Ashi-sai River will be decrease with decrease the amount of sludge and supernatant disposal.
	20	Soil Contamination	-	- The polluted leachate will not be generated by the project.
	21	Noise and Vibration	+	- The clinic exists near the proposed construction site. - The rehabilitation of the existing pipelines will be conducted in the urban area.
	22	Land Subsidence	-	- Groundwater will not be used for the project.
	23	Offensive Odor	-	- No activity to affect to offensive odor will not be proposed by the project.

Note) + : Some impacts are expected. - : No significant impact is expected.

- In regard to the impact of surplus treated effluent discharging to the surrounding area, significant impact is not expected because of the naturally occurring purification in marshland such as the assimilation of nitrogen and phosphorous by plants in marsh land and absorption of organic substances or suspend materials by soil. This marshland area is not be planned to develop as urban area in the Master Plan Study until 2030, so the natural purification ability of the marshland is expected to continue. Additionally, the discharge point is about 5 km from the Ishim River, so the surplus treated effluent will not affect the river directly.

Overall, the proposed projects do not impact the environment significantly except noise and vibration during the construction work and the dried sludge disposal, the degree of impact of which is not estimated. After the confirmation of the detail of the proposed plan, these impacts should be considered and the necessary countermeasures should be recommended. The possible countermeasures are mentioned in the above section.

Table 5.3.1 Selection of Environmental Impacts for Wastewater Treatment Projects

Factor			Remarks	Item to be Considered
Construction phase		Construction work of wastewater collection facilities	- The rehabilitation of existing pipelines will be conducted in the urban area.	Noise and Vibration
		Construction work of new facilities in WWTP	- No settlement exists in and around the site.	-
Land occupation by new facilities		New facilities in WWTP	- Construction site is in existing facilities site.	-
Operation phase	Wastewater treatment	Offensive odor from sludge drying bed	- Presently, offensive odor is not significant impact.	-
	Treated effluent and sludge disposal	Increasing the amount of the treated effluent and sludge	- The pollution load to the Taldy Kol Reservoir will not be increased even if the amount of treated effluent increase. - The method of dried sludge disposal should be considered.	Waste (Dried Sludge)

Table 5.3.2 Environmental Impact by Implementation of Proposed Wastewater Treatment Project

Item			Evaluation	Remark
Social environment	1	Resettlement	-	- A set of new facilities will be constructed within the existing WWTP site.
	2	Economic Activities	-	- No economic activity is carried out in and around the existing WWTP site..
	3	Traffic and Public Facilities	-	- A set of new facilities will be constructed within the existing WWTP site.
	4	Separation of Communities	-	- No Large scale of construction will be done.
	5	Cultural Property	-	- No cultural property exists in and around the existing WWTP site.
	6	Water Rights and Rights of Common	-	- The treated effluent will be discharged to the Tardy Kol Reservoir of which water is not used any activities.
	7	Public Health Condition	-	- No Large scale of construction to affect to the public health will be done.
	8	Waste	+	- The way of dried sludge disposal should be considered.
	9	Hazard (Risk)	-	- No Large scale of construction will be done.
Natural Environment	10	Topography and Geology	-	- Extensive alteration of topography will not be conducted.
	11	Soil Erosion	-	- Extensive excavation will not be conducted.
	12	Groundwater	-	- Groundwater will not be used for the project.
	13	Hydrological Situation	-	- The treated effluent will be discharged to the Tardy Kol Reservoir, which is the same situation as the current treatment.
	14	Coastal Zone	-	- There is no coastal zone.
	15	Fauna and Flora	-	- A set of new facilities will be constructed within the existing WWTP site.
	16	Meteorology	-	- No Large scale of construction will be done.
	17	Landscape	-	- A set of new facilities will be constructed within the existing WWTP site, and the area for landscape preservation does not exist around the site.
Pollution	18	Air Pollution	-	- No Large scale of construction to affect to the air pollution will be done.
	19	Water Pollution	+	- The pollution load to the Tardy Kol Reservoir will not be increased even if the amount of treated effluent increase.
	20	Soil Contamination	-	- The toxic substances such as heavy metals does not exist significantly in the surplus treated effluent discharged to the surrounding area.
	21	Noise and Vibration	+	- The rehabilitation of the existing pipelines will be conducted in the urban area.
	22	Land Subsidence	-	- Groundwater will not be used for the project.
	23	Offensive Odor	-	- Presently, offensive odor is not significant impact, and it will decrease by constant operation of the digestion chamber.

Note) + : Some impacts are expected. - : No significant impact is expected.

CHAPTER 6
ORGANIZATION AND INSTITUTION

CHAPTER 6 ORGANIZATION AND INSTITUTION

6.1 Institutional Framework

The institutional framework within Kazakhstan for the development, monitoring and enforcement of laws and regulations in the water sector is still in a state of flux. The principal regulatory agencies such as basin organizations and environmental protection departments are already in existence. However many of these agencies have seen their position within the framework changed a few times since independence.

The main stakeholders in this town water supply and sewerage project for Astana are:

- Astana Municipality (Akimat)
- Astana Su Arnasy (ASA)
- State Sanitary and Epidemiological Supervision
- Department of Environmental Protection, Astana

Akimat is the state agency responsible for the provision of water supply and sewerage services and it has delegated its responsibilities to ASA, a state enterprise entirely owned by Akimat. Whilst ownership of all capital assets remain with Akimat, their beneficial use has been transferred to ASA.

ASA is responsible for self financing provision of the water supply and sewerage services including the billing and collection of water charges.

The other two organizations are responsible for monitoring and enforcing laws and regulations with regard to the quality of water provided to the citizens of Astana and the quality of the effluent from the wastewater treatment plant and in the rivers.

Other organizations, which are indirectly concerned, include the following:

- Department of Regulation of Natural Monopolies
- Ishim Water Basin Inspection, Water Resources Committee
- Capital Development Corporation (CDC)
- Construction Committee, Ministry of Economy, Trade and Industry

The Department of Regulation of Natural Monopolies provides authorization for any request for tariffs increases which is put forward by ASA.

The Ishim Water Basin Inspection controls the amount of water which can be extracted from Vyacheslavsky Reservoir and the Ishim River by ASA.

CDC has been created with the mission of attracting funds from foreign governments and international funding agencies to develop the infrastructure for the expansion of Astana City. It is also responsible for coordinating the various local organizations and for facilitating the task of the funding agencies.

The Construction Committee is responsible for the planning approval of all construction projects and for issue of construction licenses.

6.2 Legal Framework

Since independence a series of basic laws have been enacted to protect the right of the population to have access to a clean and wholesome water environment. The two main basic laws are:

- The Law of the Republic of Kazakhstan on Environmental Protection (Parliament of the Republic of Kazakhstan)
- Water Code of Republic of Kazakhstan, No.2061-12 (Parliament of the Republic of Kazakhstan)

In addition to these basic laws other laws governing the management of state enterprises have also been implemented. The two main ones are:

- The Decree of the President of the Republic of Kazakhstan "On State Enterprise"(No.2335 issued on June 19, 1995 and revised on January 1, 2000)
- The Law of the Republic of Kazakhstan "on Natural Monopoly" (No. 413-1, revised on July 13, 1999)

In support of the basic laws many regulations and standards exist to provide detailed interpretation of the requirements of the basic laws. Most of these regulations are from the Soviet system. These main regulations and standards can be grouped as follows:

- GOST, State Standards from the Soviet System
- SNiP, Construction Norms from the Soviet System
- SanPin, Sanitary Norms from the Soviet system and some from the new Kazakhstan Agency for Public Health

The most important regulations are listed below:

- RND 1.01.03 – 94, Regulation of Surface Water Protection of the Republic of Kazakhstan, Ministry of Natural Resources and Environmental Protection
- GOST 2761-84, Sources of Centralized Economic – Drinking Water Supply, Sanitary and Technical Requirement and Rules of Selection
- SanPin No. 4630-88, Sanitary Norms and Regulation of Surface Water

Protection

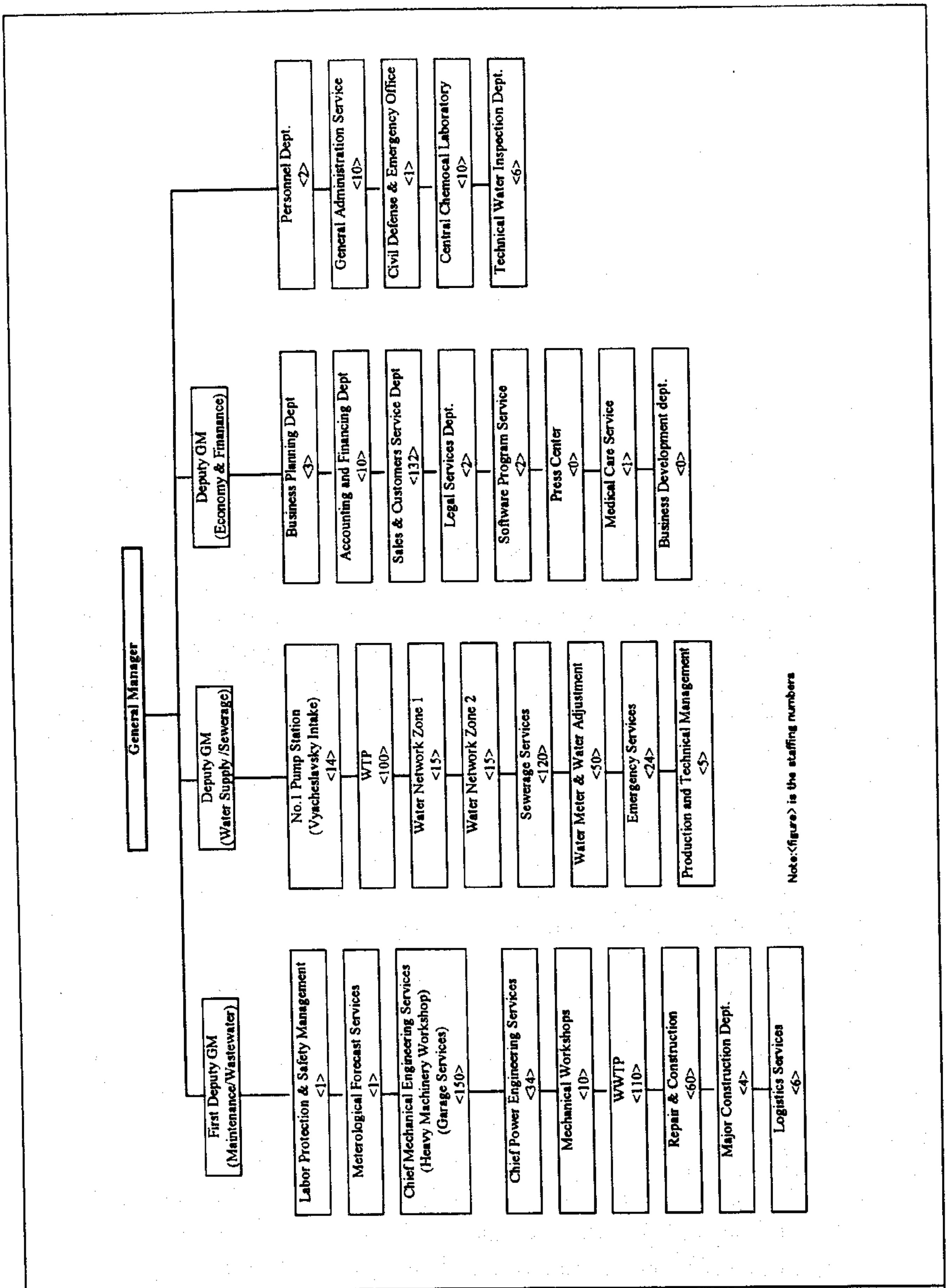
- SanPin No. 2.1.4.559-96, Hygienic Requirement for Water Quality of Centralized System of Water Supply for Drinking Use, Agency of Public Health
- SNiP 2.04.02-84, External Water Supply Systems and Facilities
- SNiP 2.04.03-85, External Sewerage System and Facilities
- Resolution for Industrial Wastewater Discharge System of Astana City (Astana City)

6.3 Existing Situation

Although institutional and legal frameworks exist, the application and enforcement of all rules and regulations is very complex. The old Soviet Union had aspired to a very high standard in all matters from sanitary protection to design and construction. But these high standards have been incorporated into the regulations without regard to enforceability or local conditions. This complexity and high standard are made even worse by the strict "to-the-letter" application and interpretation of all regulations. Such situation can and has led to impossible impasses where any risk is considered unacceptable. For example use of water, which would have been considered suitable for some activities in more developed countries, is rejected because of a remote health risk. A more pragmatic risk assessment based approach should be adopted instead of the present restrictive attitude.

The capacity of ASA, one of the major stakeholders, is of concern. Although ASA is free to manage itself on a day to day basis, Akimat still retain some important decision making rights such as investment planning, staffing levels, tariff levels and salary levels. ASA has always relied on Akimat for subsidies to cover its negative cashflows. The total number of staff is considered high at 902. This is so because of high operational and maintenance requirements resulting from obsolete and unreliable equipment. The low management and planning staff ratios are hindering the development of ASA. This weak capacity is not even allowing it to collect and interpret the available information so as to support a tariff increase request. The organization structure for ASA is provided on Figure 6.3.1

The Regulation Agency for Natural Monopolies is only accepting very strict interpretations of existing rules and thus making it very difficult for ASA to apply full cost recovery tariffs as permitted under the Decree on State Enterprise of January 2000. This approach is endangering the financial independence of ASA if it



Feasibility Study for Water Supply and Sewerage in the City of Astana	**Figure 6.2.1**
JAPAN INTERNATIONAL COOPERATION AGENCY	**Organizational Structure of ASA**

is not corrected.

There is at present no involvement of the private sector in the water industry and therefore much of the experience gained by the private sector in management of water companies and improved efficiencies cannot benefit ASA.

6.4 Capacity Building

Although the management weaknesses mentioned above are directed mainly at ASA, similar remarks can be made about the other state organizations. An ongoing project is presently under way to improve the management capability of all water basin inspection. The capacity building proposals described below are therefore mainly for ASA, although other organizations can benefit through working with ASA.

In order to overcome the weak management, capacity building activities such as development of human resources, the enhancement of skills, the adoption of up-to-date thinking and improvement of knowledge base are needed within ASA.

The need to build confidence between the various institutions and the public has to be addressed. To this effect a transparent management and financial system has to be developed. Proper auditing procedures will have to be installed. A management information system has to be set up to permit the correct level of data collection and analysis required at each management level. None of these is presently available within ASA.

Partnerships with the private sector need to be encouraged so as to benefit from management skill developed in the private sector.

6.5 Action Plan

To implement the changes proposed it is recommended that a review committee be set up to implement the required changes to the institutional set up and to oversee the capacity building of ASA. The core membership of the committee shall include Akimat, ASA and Regulating Agency of Natural Monopolies. Working groups will also be set up to study the problems in detail and propose solutions acceptable to all. Selected members from the working groups will also sit on the review committee. In order to protect the interest of consumers and staff the working groups shall also include representatives or NGO representing professional staff, manual workers, and both household and industrial consumers. The review committee will meet regularly to review the findings of the working groups and provide recommendations to Akimat and ASA to implement.

Five such working groups are proposed one for each of the five areas where improvements are necessary. The five areas are as follows:

- Tariff System Reform
- Revenue Collection and Customer Services
- Business development
- Staff Development
- Management Strengthening

The issues to be covered by each working group are provided below:

(1) Tariff System Reform

- Development of a tiered tariff structure
- Establishment of a new guideline for tariff reforming
- Examination of government subsidy for consumers in low income class
- Preparation of practical time schedule

(2) Revenue Collection and Customer Service

- Introduction of the new service contracts incorporating a penalty to strengthen of legal position.
- Strengthen the managerial function and information system in ASA to support debt management and the establishment of customer database.
- Establishment of ASA's branch service offices
- Study on introduction of banking system for tariff collection
- Survey of the accurate service population
- Customer awareness campaign

(3) Business Development

- Deregulation of "doing other business" by the Regulation Agency of National Monopolies
- Strengthening the business development function in ASA
- Administrative support and cooperation by Akimat
- Introduction of private sector partnership

(4) Staff Development

- Relaxation of regulation on wage and salary of ASA's employees
- Strengthening the human resources management and organization of ASA
- Introduction of new technology, up to date thinking, methods etc

(5) Management Strengthening

- Strengthening of managerial function through staff training
- Introduction of management information system
- Promotion of "target reaching management"

The timetable for the action plan is presented on Figure 6.4.1

Action Item	2001	2002	2003	2004	2005	2006	2007
A. Establishment of Review Committee and Working Groups							
a) Review of working groups findings and recommendations							
B. Tariff System Reform Working Group							
a)Development of a tiered tariff structure							
b) Establishment of a new guidelines for tariff reform							
c) Examination of government subsidy for consumers in low income class							
C. Revenue Collection and Customer Service							
a) Introduction of new service contracts							
b) Strengthening managerial function and information system							
c) Establishment of ASA's branch service office							
d)Introduction of banking system for tariff collection							
e)Survey of Accurate service population							
f) Consumer awareness campaign							
D. Business Development							
a) Deregulation of "doing other business"							
b) Strengthening business development function							
c) Administrative support and cooperation by Akimat							
d) Introduction of private secotor partnership							
E. Staff Development							
a)Relaxation of regulation on wage and salary of ASA's employees							
b) Strengthening human resources and organizational development							
c)Introduction of new technology, up to date thinking, methods etc.							
F. Management Strengthening							
a) Relaxation of regulation on wages and salaries of ASA employees							
b) Strengthening human resources and organizational development							
c) Establishment of human resources training programme							

Figure 6.4.1 Timetable of Action Plan

CHAPTER 7
CONSTRUCTION PLAN
AND COST ESTIMATE

CHAPTER 7 CONSTRUCTION PLAN AND COST ESTIMATE

7.1 Construction Plan

It is assumed in this Study that the Project will require international funding for implementation and the contractor for each package of the Project is to be selected through International Competitive Bidding (ICB). This will be a requirement of the international funding agency.

The works to be constructed have been organized into seven packages based on the type of construction work, location and expected contract value.

The implementation schedule includes four stages, 1) Financial Procurement Stage, 2) Detail Design Stage, 3) Contractor Procurement Stage and 4) Construction Stage as shown in Figure 7.1.1. The first three stages are expected to last for 15, 12 and 12 months respectively, durations which are usual for project with international funding and ICB. Construction is expected to last about 3 years and 8 months. Many of the packages are to be implemented in parallel in order to complete construction as early as possible.

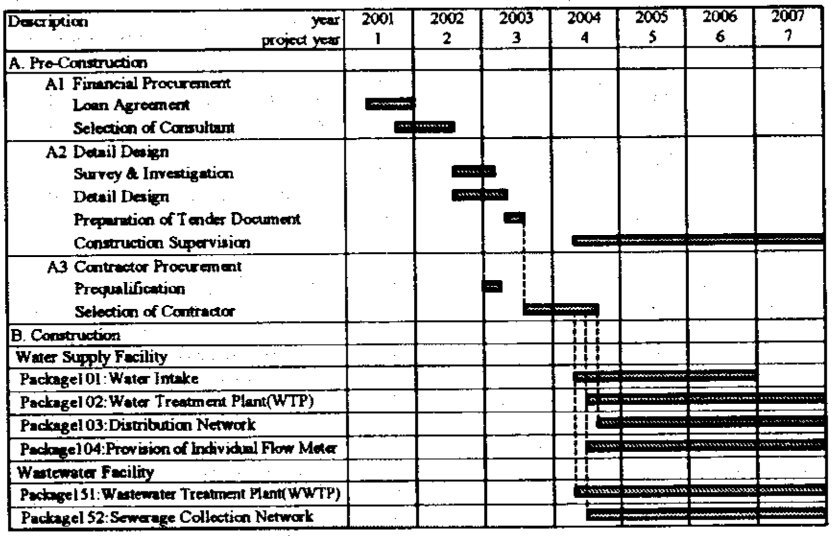


Figure 7.1.1 Project Implementation Schedule

7.2 Construction Packages

Seven construction packages have been identified, four water supply packages, two for wastewater and one for O & M equipment. Major components of each contract package and the required quantities are summarized in Table 7.2.1.

Table 7.2.1 Project Components in Each Package

Package	Work Item	Specification	Unit	Q'ty
101	Water Intake	200,000m^3/d capacity		
	Intake Pump	Q=35 m3/min, vertical type, centrifugal	units	5
	Pump Station	10 m x 30 m x 34 m height	unit	1
	Access Road	asphalt surface	m	400
102	Water Treatment Plant	Rapid Sand Filtration Method		
	Receiving Well	Q=52,500 m3/d/unit	units	2
	Rapid mixing Well	Q=52,500 m3/d/unit	units	2
	Flocculation Basin	Q=17,500 m3/d/unit	units	6
	Sedimentation Basin	Q=17,500 m3/d/unit	units	6
	Rapid Sand Filter	Q=8,750 m3/d/unit	units	12
	Chlorine Mixing Basin	Q=100,000 m3/d/unit	unit	1
	Washing Drain Basin	Q=1,200 m3/unit	units	2
	Thickening Tank	7 m^3/day/unit	units	2
	Sludge Drying Bed	1.6 m^3/day/unit	units	9
	Administration Building	15 m x 60 m x 3 stories	unit	1
103	Distribution Network			
	Replacement of Existing Pipe	diameter of 100 to 500 mm	km	98
	New Distribution Network	diameter of 150 to 1,800 mm	km	73
	Distribution Pump	Q=32.4 m3/min, D=450mm, H=55m	units	3
		Q=16.5 m3/min, D=400mm, H=55m	units	2
104	Provision of Individual Flow Meter	Supply of Flow Meter	units	65,500
151	Wastewater Treatment Plant	Activated Sludge Treatment Method		
	Inlet Pump Station No.12	Replacement of existing pump	units	4
	Grit Channel	new horizontal flow grit trap, 10 m	units	2
	Primary Settling Tank	diameter	units	2
		new settling tank, 28 m diameter	units	2
	Aeration Tank	rehabilitation of existing settling tank	units	4
		rehabilitation of existing aeration tank	units	5
	Final Settling Tank	replacement of air blower	units	2
		new settling tank, 28 m diameter	units	2
	Sludge Treatment	rehabilitation of existing settling tank	units	3
		new belt thickener, 80m3/h	units	2
		new sludge storage tank, 500m3	units	2
		rehabilitation of existing thickening tank	unit	1
		new digestion tank, 2,500m3	units	2
		rehabilitation of existing digestion tank	units	2
		replacement of existing boiler	units	5
		sludge drying bed, 100m x 70m		
152	Wastewater Collection pipes			
	New Pump Station			
	Existing Pump Station	14m x 22m x 13mD	unit	1
		11m x 17m x 15mD	unit	1
		11m x 17m x 9mD	unit	1
		replacement pumps	nos	48
	New Main Collector	diameter 350 to 1,500 mm	km	36
	New Secondary Collector	diameter 300 to 500 mm	km	71
	River Crossing	diameter 1500mm, L=200m	places	2
	Replacement of Existing Pipe	diameter 150 to 800 mm	km	21
	Existing Manhole	replacement of cover	nos	5,300

A short description of each package is provided below:

Package101 "Water Intake" is comprised of construction of a new Vyacheslavsky Reservoir intake pump station with vertical centrifugal pumps of 200,000m^3/d including mechanical and electrical work, access road to the pump station, intake channel and pump house building.

Package102 "Water Treatment Plant" is comprised of construction of a new WTP with rapid sand filtration of 100,000m^3/d including drain disposal facility, sludge treatment facility, administration building and interconnection pipes within the existing WTP premises.

Package103 "Distribution Network" is comprised of replacement of existing pipes, installation of new distribution pipes in the left bank of the Ishim River area and construction of a new distribution pump station.

Package104 "Provision of Individual Flow Meter" includes procurement and installation of individual flow meters to improve the water loss and wastage subsequent accurate water tariff collection management.

Package151 "Wastewater Treatment Plant" is comprised of rehabilitation and construction of the inlet pump station No.12, grit channel, primary sedimentation tank, aeration tank, final sedimentation tank, treated effluent pump station and sludge treatment facility within the existing WWTP premises. Treatment method of wastewater is planned to be by activated sludge treatment method, as currently exists.

Package152 "Wastewater Collection Pipes" is comprised of 1) construction of new pump stations and sewer collection pipes, 2) rehabilitation of the existing pump stations and manholes and 3) replacement of the existing sewer collection pipes.

Package190 "O&M Equipment " includes supply of workshop tools, trailers, mobile crane, patrol mobiles, etc. required for the O&M works by ASA.

7.3 Cost Estimate

The following conditions and assumptions were assumed whilst carrying out the cost estimate.

(1) Project Procurement Method

All the proposed works will be procured through contracts to be let by public tender. The contractors will be selected by ICB.

(2) Price Level

The price level is in the middle of November in 2000.

(3) Exchange Rate

The exchange rate adopted for the estimation of costs is US$ 1.0 = 108 JPY = 144 Tenge

(4) Unit Price

The direct construction cost is estimated on the unit cost basis, which includes equipment, materials and labor cost. The unit costs are prepared referring to similar unit cost or work items in Kazakhstan, Japan, Turkey, France and U.K. It should be noted that although the unit construction costs are defined by SNiP 4.02-91 and 4.05-91, they have not been revised since 1991 and cannot be applicable for this Study due to drastic escalation during the term.

(5) Administrative Expense

The cost of administrative expenses to the government and related agencies is estimated at 2% of the direct construction cost

(6) Engineering Services

The cost of engineering services is estimated on man-month basis including topographic and geological surveys, inventory and reconnaissance surveys, detail design, preparation of tender document and construction supervision.

(7) Physical Contingency

Physical contingency is estimated at 10% of the direct construction cost.

(8) Price Contingency

Price contingency is estimated at 2.2% of the total cost.

(9) VAT

VAT is estimated at 20% of total cost.

(10) Import Tax

Import Tax is estimated at 10% of import materials

Using the above basis the foreign currency (F.C.) costs and the local currency (L.C.) portion have been calculated for each package. A summary of these costs is presented on Table 7.3.1

Table 7.3.1 Project Cost Estimate

Cost Item	F.C. (Mil US$)	L.C. (Mil US$)	Total (Mil US$)
Direct Construction Cost			
- Package101 Water Intake	8.24	1.83	10.07
- Package102 WTP	37.78	9.55	47.33
- Package103 Distribution Network	27.97	7.76	35.73
- Package104 Individual Flow Meter	2.48	0.28	2.76
- Package151 WWTP	16.62	4.53	21.15
- Package152 Wastewater Collection Pipes	43.22	17.54	60.76
- Package190 O&M Equipment	8.00	2.00	10.00
Total of Direct Construction Cost	144.31	43.49	187.80
Indirect Cost	39.52	72.78	112.30
Project Cost	183.83	116.27	300.10

The project cost is estimated at US$ 300.1 Million, comprising of F.C. portion of US$ 183.8 Million (61%) and L.C. portion of US$ 116.3(26%) Million.

O & M costs have been estimated at 507.7 Million Tenge (US$ 3.53 Million) by 2010. This estimate is based on the operation and maintenance plan proposed by this Study, the present annual O&M cost of ASA.

7.4 Alternative Project with Reduced Scope

In order to verify the effect of reduction in the scope of the project, an alternative project assuming an absolutely minimum extension of the water supply and wastewater networks has been evaluated. All the reduction in costs are in the water distribution and wastewater collection pipes. Table 7.4.1 presents a summary of the costs for this alternative.

Table 7.4.1 Project Cost Estimate for Alternative Project

Cost Item	F.C. (Mil US$)	L.C. (Mil US$)	Total (Mil US$)
Direct Construction Cost			
- Package101 Water Intake	8.24	1.83	10.07
- Package102 WTP	37.78	9.55	47.33
- Package103 Distribution Network	26.00	7.24	33.24
- Package104 Individual Flow Meter	2.48	0.28	2.76
- Package151 WWTP	16.62	4.53	21.15
- Package152 Wastewater Collection Pipes	30.47	11.40	41.87
- Package190 O&M Equipment	8.00	2.00	10.00
Total of Direct Construction Cost	129.59	36.83	166.42
Indirect Cost	36.56	62.55	99.11
Project Cost	166.15	99.38	265.53