6.6 Mechanical Facility

Based on the process design in this chapter, detailed design for mechanical equipment for the intermediate pump station and sewage treatment plant was prepared.

6.6.1 Intermediate Pump Station

(1) Capacity of the Pump

Among the 37 existing intermediate pump stations identified in the field investigation, 17 intermediate pump stations are subject to rehabilitation in this project. Both No.12 and No.13 pump stations located in the sewage treatment plant are also included in the project as rehabilitation of sewage treatment plant.

The intermediate pump stations proposed by ASA are listed in Table 6.6.1. The capacity of respective intermediate pump station was designed in accordance with the capacity requested by ASA.

Table 6.6.1 Intermediate Pump Station

Classification	Pump Station	Structure(m)		Existing (m^3/hr)				Rehabilitation(m^3/hr)				
		Dia.	Depth	Cap.	Duty	Standby	Nominal	Cap.	Duty	Standby	Total	Head(m)
Large type	7	24	10.6	3500	0	2	2,500	-	-	-	5,700	-
				1600	1	1		1600	2	1		11.0
				800	1	0		800	2	0		11.0
				450	2	0		450	2	0		11.0
Middle type	10	16	8.0	800	0	1	400	-	-	-	1,350	-
				450	2	2		450	3	2		11.0
	1	16	9.8	800	1	2	9,600	800	2	2	1,600	10.0
				450	1	0		-	-	-		-
	3	16	7.8	650	2	2	1,750	800	3	2	2,400	9.0
				450	1	0		-	-	-		-
	4	12	7.8	800	0	1	400	-	-	-	900	-
				450	1	3		450	2	1		7.0
	6	12	4.9	1600	1	2	2,800	1600	2	2	3,200	10.0
				800	1	0		-	-	-		-
	2	9	7.7	450	1	1	700	450	2	1	900	7.0
				368	1	0		-	-	-		-
Small type	11	6	6.5	144	1	0	180	-	-	-	228	-
				114	0	1		114	2	1		8.0
	15	6	6.5	250	1	0	250	250	2	1	500	11.0
				114	0	1		-	-	-		-
	16	6	7.3	114	1	1	100	80	2	1	160	24.0
	21	6	6.4	250	1	1	250	200	1	1	200	19.0
	24	4	6.9	80	1	0	80	80	1	1	80	15.0
	17	3	5.1	114	1	1	114	250	1	1	250	18.0
Manhole type	28	2.5	5.0	50	1	0	50	50	1	1	50	28.0
	34	2.5	4.0	50	1	0	50	50	1	1	50	15.0
	37	2.5	5.0	50	1	0	50	50	1	1	50	14.0
	IH	2.5	7.1	50	1	0	50	50	1	1	50	15.0

Pump head for each pump station was calculated by the head loss of each pressure main. Since existing intermediate pump stations were designed by standard design of former Soviet, both the capacity and head are found to be excessive in most cases from the investigation conducted.

(2) Pump Selection

All the pumps in 17 pump stations shall be replaced in consideration of the structure, pump head and pump efficiency. Basically the pump type is the same type as the existing one according to F/S, because the existing structure of the pump stations limits the type of the pump to be installed. The majority of the existing pumps are horizontal end-suction centrifugal type. Majority of them, 13 of 17 intermediate pump stations, shall install horizontal type.

Submersible pumps are applied for small 4 intermediate pump stations that shall be completely rehabilitated with manhole pump type structure. Submersible pump is used for No.28, No.34, No.37 and IH.

Horizontal end-suction centrifugal pump applied for this replacement has the following advantages;

- Easy access - the pumps are installed in the dry pit and operators have easy access to monitor pumps for operation and maintenance.

- Easy maintenance - ASA maintenance crews are accustomed to the maintenance of horizontal type of pumps, which are of similar type as in the existing facilities.

- High efficiency - Horizontal end-suction centrifugal pump has higher efficiency than submersible type, and that means the lower consumption of electricity.

(3) Pump Control System

The pumps shall be automatically operated in response to the change of the water level in the wet pit. The contents of control are start and stop of pump operation, number of the pumps to be operated and emergency stop for low water level.

(4) Auxiliary Devices for Intermediate Pump Stations

Major works in this works include the items as follows;

a) Replacement of mechanical screens, where the existing screens were installed

b) Replacement of all piping in pump stations

c) Replacement of sump drain pumps

d) Repair/replacement of hoisting devices, if necessary

6.6.2 Influent Pump Station

(1) Fine Screen

Three mechanical fine screens shall be provided in the inflow channels in the existing Inlet Pump Station. The mechanical screen consists of a screen and raking mechanism. The screens have 6 mm clearance between bars.

As replacement of the existing mechanical screens, the Double chain operated rake was adopted. Comparative examination of the type of mechanical screen is shown in Table 6.6.2.

The proposed specifications for the Double chain operated rake are as follows:

1)	Type	:	Double chain operated rake
2)	Capacity	:	4,200 m^3/hour
3)	Channel	:	1.68 m W x 2.0 m D
4)	Number	:	3 sets (including 1 set for standby)

Double chain-operated rake has the same mechanism as the existing equipment. It is recommended due to the advantages of easy maintenance.

(2) Inlet Pump

Inlet pumps are planned to lift hourly maximum flow of 200,000 m^3/day. The proposed specifications for the influent pumps are as follows:

1)	Type	:	Vertical mixed flow centrifugal pump with dry sump
2)	Capacity	:	Large: 54.0 m^3/min (3,420 m^3/hour) Small: 27.0 m^3/min (1,620 m^3/hour)
3)	Head	:	15.0 m
4)	Number	:	Large: 3 sets (1set of existing pump shall be remained as standby) Small: 2 sets

As illustrated in Table 6.6.3, vertical mixed flow pumps, vertical mixed flow centrifugal pumps, end-suction centrifugal pumps and submersible pumps could be used for the Project. The proposed pump shall have the following specific advantages:

- Less installation space – Since the motors are located on the upper floor of the pump station, the space requirement for the pump room is minimized;

- Easy access – Since the pumps are installed in a dry well, operators have easy access to monitor pumps for operation and maintenance;

Table 6.6.2 Mechanical Screen (1/2)

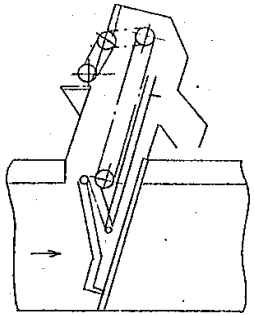
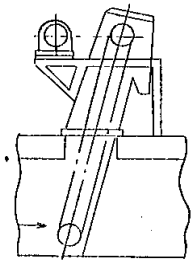
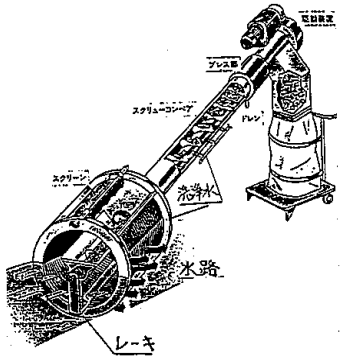
Item \ Type	Reciprocating Rake	Double Chain Operated Rake	Drum Screen
Structure			
Principle	Above water, a rake equipped on double chains or gears runs along guide rails, and scrapes floating objects courted by screen in sewage.	Rakes equipped on double chains run from bottom to top of screen and scrapes floating objects courted by screen in sewage.	A rake runs on a cylindrical screen, and scrapes floating objects courted by screen in sewage. Collected screenings are lifted by screw conveyer connected to a rake. Screenings are dewatered in the conveyer up to 60 to 70 % of water content. Screenings can be washed and reduced the volume by an additional washing device.
Operation	Remote control Continuous automatic operation	Remote control Continuous automatic operation	Remote control Continuous automatic operation
Application	Coarse Screen Fine screen	Fine screen	Fine screen

Table 6.6.2 Mechanical Screen (2/2)

Item \ Type	Reciprocating Rake	Double Chain Operated Rake	Drum Screen
Installation Space	This type of machine is comparatively higher than other types. Influent channel can be fully covered.	This type of machine can be limited the height within 4 m. Influent channel can be fully covered.	This type of machine needs longer channels than other types. Influent channel can be fully covered.
Maintenance	All mechanical parts are located above water, so that it is rather easy for maintenance.	Some mechanical parts are located in water, so that it is rather difficult to maintain the submerged part.	Some mechanical parts are located in water, so that it is rather difficult to maintain the submerged part.
Raking Screenings	All floating objectives caught on screen can be properly removed. Raking is carried out approximately every five minutes.	Floating objectives caught on the lowest part of screen are hardly removed. Raking is carried out every thirty seconds.	All floating objectives caught on screen can be properly removed. Raking is carried out approximately every two minutes.
Supply Records	Many	Many	Less, but increasing
Construction Cost	100	100	120
Running Cost	100	100	100

Table 6.6.3 Main Pump (1/2)

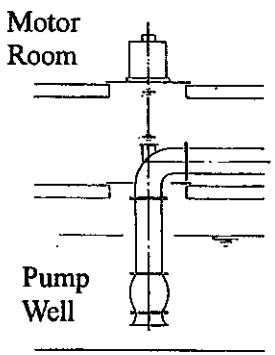
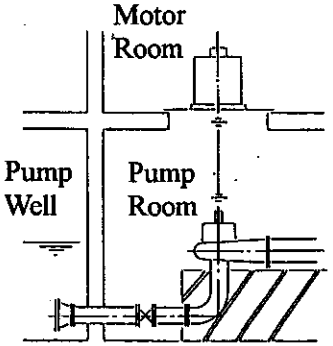
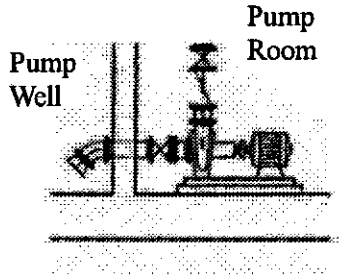
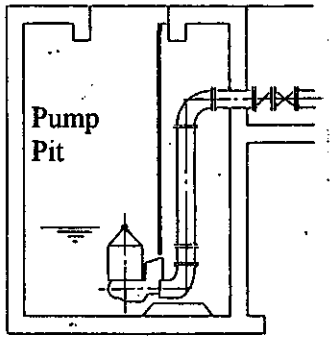
Item \ Type	Vertical Mixed Flow Pump	Vertical Mixed Flow Centrifugal Pump	End-Suction Centrifugal Pump	Submersible Pump
Structure				
Performance Characteristic	1. H-Q curve is steep rightward down. Variation of discharge is small against head change. 2. Power variation against discharge is less, but maximum shaft power required at no discharge	1. H-Q curve is mildly rightward down. Variation of discharge is large against head change. 2. Power variation against discharge is less. 3. Minimum shaft power required at no discharge and maximum	Same as left	Same as left
Applicable Head	Approximately 5 to 50 m	Approximately 5 to 20 m	Approximately 5 to 50 m	Approximately 5 to 30 m
Diameter	More than 300 mm (more than400 mm for sewage toavoid clogging)	More than 300 mm	More than 100 mm	Less than 800 mm
Pump Efficiency	Approximately 70 to 85 %	Approximately 72 to 79 %	Approximately 65 to 80 %	Approximately 50 to 70 %
Flow Control	Flow can be controlled by speed, operating pump number, discharge valve opening etc.	Same as left	Same as left	Same as left

Table 6.6.3 Main Pump (2/2)

Item \ Type	Vertical Mixed Flow Pump	Vertical Mixed Flow Centrifugal Pump	End-Suction Centrifugal Pump	Submersible Pump
Installation Space	Pump is installed in pump room, so large space is required. (More than two floors)	Pump is installed in pump room, so large space is required. (More than two floors)	Horizontal pump is installed in pump room, so largest space is required.	Pump is installed in pump pit, so minimum space is required.
Maintenance	Major part of pump is located in water, so inspection is difficult and all pars below driving shaft have to be dismantled and be lifted for maintenance.	Major part of pump is located in pump room, so inspection is easy and all pars below driving shaft have to be dismantled for maintenance.	Major part of pump is located in pump room, so inspection is easy and only limited pars have to be dismantled.	All part of pump/motor is located in pump pit, so inspection is difficult, but all can be easily lifted for maintenance.
Operation (Shut-off Operation)	Possible	Possible	Possible	Possible
(Variation of Discharge Water Level)	Pump can afford the variation by varying water level of pump pit , if it is within total head of the pump.	Same as left	Same as left	Same as left
(Variation of Pump Head)	Discharge flow varies according to H-Q curve. (Total head increase makes discharge flow decrease.)	Same as left	Same as left	Same as left
Construction Cost	80		100	40
Running Cost	90		100	80
Supply Records	Many for storm water and sewage	Many for sewage	Less	Many for sewage at small size relay pump stations

- Easy maintenance – ASA maintenance crews are accustomed to the proposed type of pumps, which are of similar type as in the existing facilities.

- High efficiency - dry well vertical mixed flow centrifugal pump has higher efficiency than submersible pump.

All piping materials and auxiliary equipment for inlet pumps, such as sealing water supply unit as well as overhead cranes and ventilation system shall be repaired or replaced.

The temporary removable submersible pumps (3 units) are newly installed. Therefore, construction of an inlet pump station can be easily constructed.

(3) Pump Control System

The pumps are automatically operated according to the water level of wet pit. Number of the pumps to be operated and emergency stop for low water level shall be controlled.

6.6.3 Grit Chamber

Grit chambers are designed to remove grit such as sand or other heavy solid materials that have specific gravities greater than those of the organic solids in sewage.

For selection of the type of grit chamber, the following several types were compared in Table 6.6.4.

- Horizontal-flow grit chamber
- Aerated grit chamber
- Vortex-type grit chamber

Vortex-type grit chamber was recommended due to the following specific advantages

- Less installation space - Vortex type has high efficient, thus the required space is minimized;

- Low cost – Grit collection and removal require only small devices than other types, and it shall incur low cost;

Table 6.6.4 Grit Chamber (1/2)

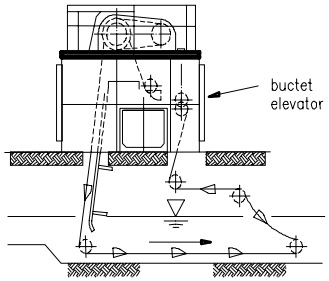
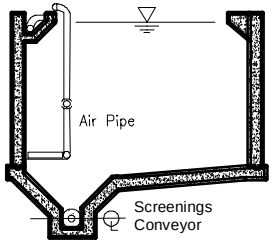
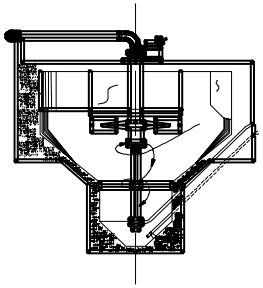
Item \ Type	Horizontal Flow Grit Chamber	Aerated Grit Chamber	Vortex Grit Chamber
Structure			
Principle	Velocity-controlled, horizontal flow grit chamber is designed to maintain a certain velocity and to provide sufficient time for grit solids to settle to the bottom of the channel. The flow is designed to carry most organic particles through the chamber and to permit the heavier grit to settle out. Grit removal is accomplished by a conveyor with scraper, buckets, or plows.	Air introduced along one side near the bottom causes a spiral roll velocity pattern perpendicular to the flow through the tank. The heavier particles with their correspondingly setting velocities drop to the bottom, while the roll suspends the lighter organic particles, which are eventually carried out of the tank. Some devices, such as chain and bucket collectors, are provided to remove grit from the trough or hopper.	Mechanically induced vortex captures grit solids in the center hopper of a circular tank. At the center of the chamber rotating paddles maintain the proper circulation within the chamber for all flows, and the spiraling, doughnut-shaped flow pattern tends to lift lighter organic particles and settle the grit. Grit solids are removed from the center hopper by air lift or recessed impeller pumps.
Design Criteria	Detention Time: 1 minute (at peak flow)	Detention Time: 3 minutes (at peak flow)	Detention Time: 0.5 minutes (at average flow)

Table 6.6.4 Grit Chamber (2/2)

Item \ Type	Horizontal Flow Grit Chamber	Aerated Grit Chamber	Vortex Grit Chamber
Advantages	1. No unusual construction is required.	1. The same efficiency of grit removal is possible over a wide flow range. 2. Head loss through the grit chamber is minimal. 3. Flexibility to remove grit can adapt to varying field conditions. 4. Pre-aeration may alleviate septic conditions in incoming wastewater to improve performance of downstream treatment units.	1. Effective over a wide flow variation. 2. No submersed bearings or parts that required maintenance. 3. Requires a minimum of space, thus reducing construction costa. 4. Minimal head loss. 5. Energy efficiency 6. Removes high percentage of fine grit.
Disadvantages	1. Difficulty in maintaining proper velocity over a wide range of flows. 2. Excessive wear on submerged chain, flight and bearings. 3. At low flow, channels shall remove significant quantities of organic material requiring grit washing and classifying.	1. Power consumption is higher than other grit removal processes. 2. Additional labor is required for maintenance and control of aeration system. 3. Some confusion exists about design criteria necessary to achieve a good spiral roll pattern and proper hopper and grit removal system. 4. Significant quantities of potentially harmful volatile organics and odors may be released from wastewater donating those constituents.	1. Paddles may collect rags. 2. Grit sump may become compacted and clog; requires high-pressure agitation water or air, air lift pumps are often not effective in removing grit from the sump
Supply Records	Many	Less	Many
Construction Cost	100	120	80
Running Cost	100	120	90

- Easy maintenance - Simple operation and structure for the vortex type grit chamber does not require special devices and materials for repair or maintenance.

The proposed specifications for the grit chamber are follows:

1)	Type	:	Vortex-type grit chamber
2)	Capacity	:	4,200 m^3/hour
3)	Dimension	:	7.3 m Dia. x 2.00 m D
4)	Number	:	2 sets

The rotating turbine shall be continuously operated, while a grit pump or an airlift pump shall be operated intermittently to remove grit settled in the hopper.

6.6.4 Primary and Secondary Sedimentation Tanks

Six existing primary sedimentation tanks are circular type of 28 m diameter with peripheral driven sludge scrapers. The existing sludge scrapers shall be repaired, while two more tanks with the same type of scrapers shall be constructed.

The scope of major repair works for the primary sedimentation tanks are;

a) Replacement of drive units and rubber tires of six existing scrapers for smooth operation

b) Installation of v-notch weir plate to make uniform effluent

c) Replacement of six scum skimmers (only for six primary sedimentation tanks)

d) Replacement of four primary sludge pumps with piping materials within the pump room (only for primary sedimentation tanks)

The proposed specifications for the return sludge pumps are as follows:

1)	Type	:	Non-Clog sludge pump
2)	Capacity	:	1.0 m^3/min
3)	Head	:	9.0 m
4)	Number	:	4 sets (including 2 sets for standby)

As for secondary sedimentation, ten existing sedimentation tanks are circular type with peripheral driven sludge scrapers. The existing sludge scrapers are repaired on the above items a) and b), while two more tanks with same type of scrapers shall be newly constructed.

6.6.5 Discharge Pump Station

All necessary repairs and replacement shall be implemented to improve operation reliability of discharge pump station. Major works in this project shall be as follows;

a) Repair and procurement of spare parts for discharge pumps

b) Replacement of all piping materials at discharge pump station

c) Replacement of seal water unit for discharge pumps

d) Replacement of Bridge crane

e) Repair/replacement of ventilation system

The temporary removable submersible pumps (3 units) shall be installed in the intermediate manhole for rehabilitation work of the discharge pump station.

6.6.6 Blower House

(1) Air Blower

Air blowers with auxiliary devices shall be replaced to improve durability and reliability of air supply to aeration tanks. As air blowers for this project, the following major types were examined as per Table 6.6.5.

a) Multi-stage turbo blower

b) High speed single turbo blower

c) Rotary blower

The proposed specifications for the air blower are as follows:

1)	Type	:	Multi-stage turbo blower
2)	Capacity	:	255 Nm^3/min
3)	Pressure	:	5,000 mmAq, (49 kPa)
4)	Number	:	5 sets (including 2 sets for standby)

Multi-stage turbo blower is recommended due to the following specific advantages:

- Easy maintenance – Multi-stage turbine blowers are operated with low speed rotation and the machine requires less maintenance than high-speed single turbo blower.
- Less installation space – There are 7 blower bases in the existing blower house, however 7 rotary blowers cannot accommodate the air flow requirement

Table 6.6.5 Comparison of Air Blower (1/2)

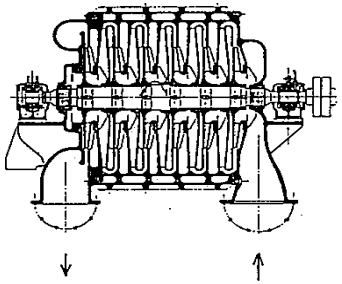
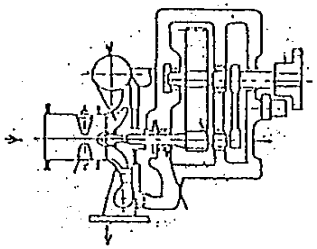
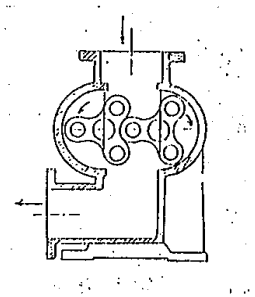
Item \ Type	Multi Stage Turbo Blower	High Speed Single Turbo Blower	Root Blower
Structure			
Applicable Range (Pressure) (Flow) (Speed)	3,000 to 8,000 mm Aq more than 80 m^3/min 3,000 or 3,600 rpm	4,000 to 18,000 mm Aq 40 to 140 m^3/min 10,000 or 18,000 rpm	1,000 to 10,000 mm Aq 5 to 40 m^3/min 600 or 1,200 rpm
Driving Method	Direct coupled with motor (wound-rotor induction motor)	Speed increaser	V-belt coupled with motor
Noise Level	Less than 80 phones	Less than 80 phones	Less than 90 phones
Operation Characteristic	Flow varies with pressure change. (centrifugal type)	Same as left	Flow does not vary with pressure change. (positive displacement type)

Table 6.6.5 Comparison of Air Blower (2/2)

Item \ Type	Multi Stage Turbo Blower	High Speed Single Turbo Blower	Root Blower
Flow Control	Flow can be controlled by closing delivery valve. Operation range is wide.	Same as left Operation range is narrow and some devices to protect surge shall be provided.	Flow can be controlled by speed control motor or relief valve. V-belt coupled type without speed control is not suitable for flow control.
Efficiency	Adiabatic efficiency: 60 t0 75 % Total efficiency: 60 t0 75 %	Adiabatic efficiency: 70 t0 85 % Total efficiency: 62 t0 77 %	Adiabatic efficiency: 55 t0 70 % Total efficiency: 52 t0 57 %
Suction/Delivery Pipe	Suction: Bottom Delivery: Top	Suction: Side Delivery: Bottom	Suction: Top Delivery: Side
Blower Building	Basement is required to install piping and auxiliary devices.	Same as left	Same as left
Lubrication Device	Lubrication device is required. Oil feeding devise and head tank or accumulator is also required for power failure.	Lubrication device is required. Oil feeding devise is equipped and head tank or accumulator is not required for power failure.	Bearings have oil boxes and no lubrication device is required.
Maintenance	Filling lubricant: annual Bearing metal replacement: every 5 to 10 years	Filling lubricant: annual Bearing metal replacement: every 5 to 10 years Gear greasing: annual	Filling lubricant: annual Bearing metal replacement: every 5 years
Construction Cost	100	80	15
Running Cost	100	100	80

(2) Auxiliary Devices for Air Blowers

Major works in this works shall be as follows;

a) Replacement of five air filters

b) Replacement of lubrication system

c) Replacement of air flow control system

d) Repair/replacement of air piping

e) Replacement of bridge crane, if necessary

6.6.7 Return Sludge and Waste Sludge Pump

(1) Return Sludge Pump

A new house for sludge return pumps shall be constructed in the area between aeration tanks and secondary sedimentation tanks. Both return sludge pumps and waste sludge pumps are installed in this house.

The proposed specifications for the return sludge pumps are as follows:

1)	Type	:	Vertical mixed flow Centrifugal pump
2)	Capacity	:	32.0 m^3/min
3)	Head	:	6.0 m
4)	Number	:	5 sets (including 2 sets for standby)

The pump shall be continuously operated to return some amount of settled activated sludge in secondary sedimentation tanks to aeration tanks. The return flow shall be controlled by speed control motor as required for proper treatment.

(2) Waste Sludge Pump

The proposed specifications for the waste sludge pumps are as follows:

1)	Type	:	Non-Clog sludge pump
2)	Capacity	:	4.7m^3/min
3)	Head	:	10.0 m
4)	Number	:	2 sets (including 1 set for standby)

The pump shall be operated to remove some settled activated sludge as waste sludge from secondary sedimentation tanks and send to waste sludge storage tank for thickening.

6.6.8 Gravity Thickener

In order to install a GRP dome to prevent odor emission at 2 existing gravity thickeners of 20 m diameter, the peripheral driven sludge scrapers shall be changed to centre sludge scraper type. The existing sludge scrapers shall be repaired. The scope of major repair work is;

a) Replacement of drive units and rubber tires of two existing scrapers for smooth operation,

b) Installation of v-notch weir plate to make uniform effluent, and

c) Replacement of two thickened sludge pumps with piping materials within the pump room.

The proposed specifications for the thickened sludge pumps is as follows;

1)	Type	:	Non-Clog sludge pump
2)	Capacity	:	1.0 m^3/min
3)	Head	:	5.0 m
4)	Number	:	2 sets (including 1 set for standby)

6.6.9 Mechanical Thickener

(1) Mechanical Thickener

A new building for mechanical thickeners shall be constructed next to the secondary sedimentation tanks. This building shall have a merged function together with sludge dewatering units. The mechanical thickeners thicken waste sludge settled in the secondary sedimentation tanks that is sent from return sludge pump station.

The proposed specifications for the mechanical thickeners are as follows:

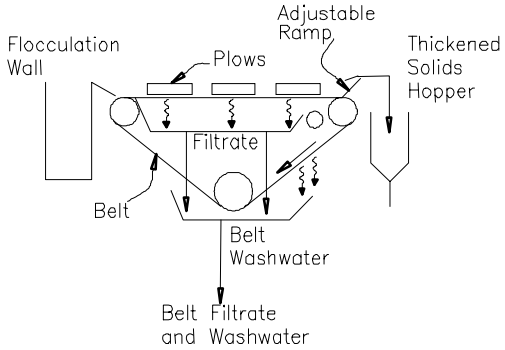
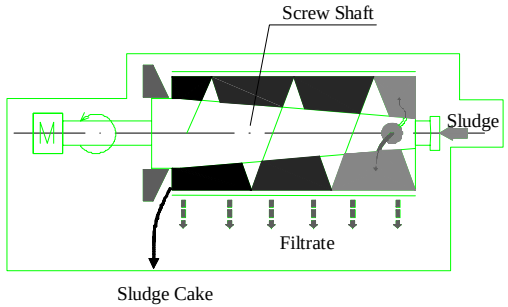
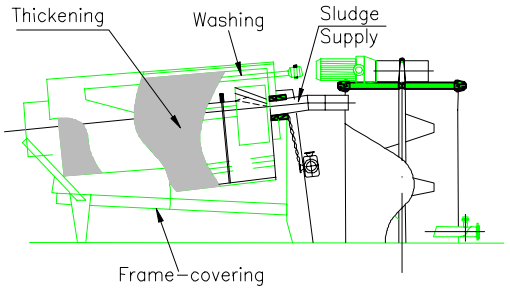
1)	Type	:	Screw press thickener
2)	Capacity	:	75 m^3/hr
3)	Dimension	:	0.7 m Dia. (3.0 m^2)
4)	Number	:	3 sets (including 1 set for standby)

As illustrated in Table 6.6.6, solid bowl centrifuge, screw type drum thickener and gravity belt thickener could be used for the Project. The proposed mechanical thickener has the following specific advantages:

- Less installation space – Screw type drum thickener consists of compact flocculation tank and thickening drum, and it requires less space than gravity belt thickener;

- Easy operation – Full automatic operation with durable material and minimum odor emission.

Table 6.6.6 Mechanical Thickener

Item \ Type	Gravity-belt Thickener	Screw Press Thickener	Rotary Drum Thickener
Structure			
Principle	The development of gravity-belt thickeners stemmed from the application of belt presses for sludge dewatering. The equipment developed for thickening consists of a gravity belt that moves over rollers driven by a variable-speed drive unit.	The sludge is conveyed by a rotating screw inside and Thickened while passing through an opening gradually reduced between body and screw.	Prior to thickening, sludge and polymer are mixed in a flocculator. The flocculated sludge flows into the inclined cylindrical drum covered by wire mesh. The rotation of the drum thickens the sludge by eliminating free water liberated from the sludge by flocculation action.
Solids Concentration	Maximum of 5 to 7 percent	Between 3 and 8 percent by weight	Between 3 and 6 percent by weight
Advantages	Particularly for smudges having solids concentrations less than 2 percent, effective thickening occurs in the gravity drainage section of the press.	Higher thickening efficiency obtained by feeding steam inside the screw Easy to maintain and save energy	Higher loading can be used with dissolved-air flotation thickeners than are permissible with gravity thickeners, because of the rapid separation of solids from the wastewater.
Disadvantages	Polymer addition is required.	Few cases to be adopted for a state-of-art technology	Polymer addition is required.

- Easy maintenance – Screw type drum thickener operated with low speed rotation and the machine requires less maintenance than solid bowl centrifuge.

(2) Auxiliary Devices for Mechanical Thickener

Major work shall be as follows;

a) Installation of waste sludge supply system

b) Installation of polymer dosing system

c) Installation of thickened sludge transfer system

d) Installation of utility water supply system (common for sludge dewatering)

e) Installation of ventilation system

f) Installation of overhead crane

6.6.10 Digester

(1) Digester Mixing

Two existing digesters shall be replaced. The existing digesters are using circulation pump for mixing. Regarding digester, several types of mixing system were examined as per Table 6.6.7.

The proposed specifications for the mixing device for new digester are as follows:

1)	Type	:	Pump mixing
2)	Capacity	:	5.5m^3/min
3)	Head	:	12 m
4)	Number	:	2 sets (including 1 set for standby)

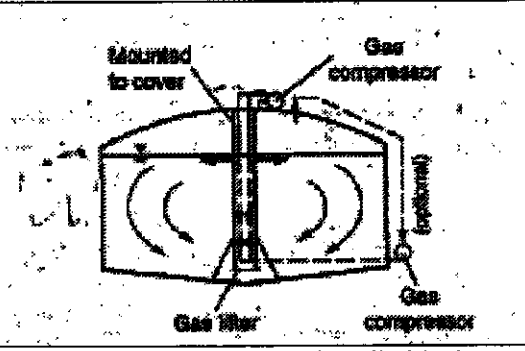
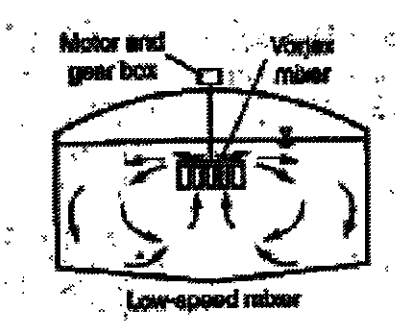
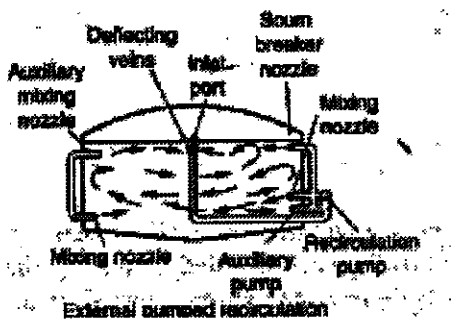
The proposed Pump mixing shall have the following specific advantage:

- High efficiency – Applying a draft tube at the center of the digester, the Pump mixer can provide smooth mixing of sludge in whole part of the digester.

Two existing digesters shall be repaired, and the scope of major repair work is as follows:

- Replacement of steam diffusing devices
- Replacement of sludge circulation pumps
- Replacement of ventilation system

Table 6.6.7 Digester Mixing System

Item \ Type	Gas Injection	Mechanical Stirring	Mechanical Pumping
Structure			
Principle	Gas-injection systems used in cylindrical tanks are classified as unconfined or confined. In confined gas systems, gas is collected at the top of the digesters, compressed, and discharged through confined tube.	Mechanical stirring systems commonly use low-speed turbines or mixers. In both systems, the rotating impeller displaces the sludge, mixing the digester contents. Low-speed turbine systems usually have one cover-mounted motor with two turbine impellers located at different sludge depth.	Most mechanical pumping systems consist of propeller-type pumps mounted in internal or external draft tubes, or axial-flow or centrifugal pumps and piping installed externally. The circulation of sludge promotes mixing. Mechanical pumping systems are suitable for digesters with fixed covers.
Advantages	Better mixing and gas production and better movement of bottom deposits lances.	Good mixing efficiency	Good top-to-bottom mixing
Disadvantages	Corrosion of gas piping and equipment. High maintenance for compressor. Potential gas sealing problems if foam gets inside.	Wear of impellers and shaft. Bearing failures. Gas leaks at shaft seal.	Sensitive to liquid level. Corrosion and wear of impeller,
Cost	85	100	80

- Repair/replacement of sludge pipes

(2) Coal Boiler

There are two coal-boiler and one gas boiler in the existing boiler house. The coal boiler provides the digester and utilities with thermal energy for heating. The existing two coal-boilers shall be replaced with the necessary appurtenances such as condenser, hot water pump, coal crusher and conveyer.

The proposed specifications for the coal boiler are as follows:

1)	Type	:	Coal boiler
2)	Capacity	:	4.0ton/hr
3)	Number	:	1 set

(3) Gas Holder

Two existing gasholders shall be repaired. One gasholder is on duty and another is completely out of order. Installation of desulphurisation unit shall be considered.

(4) Auxiliary Devices for Coal Boilers

Major work is as follows:

a) Repair/replacement of auxiliary devices for boilers, such as blowers etc

b) Repair of coal supply system

c) Repair of ash transfer system

d) Repair/replacement of make-up water supply system

6.6.11 Sludge Dewatering

(1) Sludge Dewatering Machine

A new building for sludge dewatering machines shall be constructed next to the secondary sedimentation tanks as mentioned above. Digested Sludge shall be supplied to sludge dewatering machines.

The proposed specifications for the sludge dewatering machines are as follows:

1)	Type	:	Screw press
2)	Capacity	:	450 kg-ds/hr (3 m^3)
3)	Dimension	:	Diameter 0.9 m
4)	Number	:	3 sets (including 1 set for standby)

The types of dewatering machine available are referred to Table 6.6.8. The proposed dewatering machine has following advantages:

- Less installation space – Screw press consists of compact main body and flocculation tank, and it requires less space than other types.

- Easy operation – The rotation speed of the drum is very low and operation is made on 24-hour basis. The main body with the coagulation tank is covered against the odor emission.

(2) Auxiliary Devices for Sludge Dewatering

Major work is as follows;

a) Installation of digested sludge supply system

b) Installation of polymer dosing system

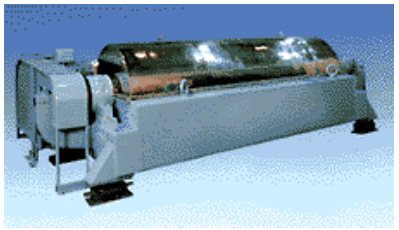
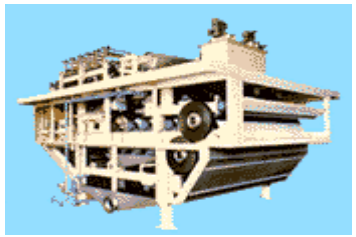
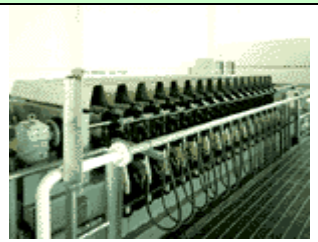
c) Installation of dewatered sludge transfer system

d) Installation of utility water supply system (common for sludge dewatering)

e) Installation of ventilation system

f) Installation of overhead crane

Table 6.6.8 Sludge Dewatering Machine

Item Type	Centrifuges	Belt Press	Recessed-plate Filter Press	Screw Press
Schematic Illustration				
Outline of the method	The sludge is dewatered by centrifugal force. With the employment of the high performance coagulation system, the sludge fed into the spinning drum is efficiently flocculated.	Belt press forms the cakes out of sludge by two dewatering steps. The first step is gravitational dewatering by a thickening filer, and the second step is compressive dewatering by two dewatering filters.	The sludge is fed between filter plates through cloth filters and a filter press reduces the water content by pressing the filter plates.	The sludge is conveyed by a rotating screw inside and dewatered while passing through an opening gradually reduced between body and screw.
Advantages	1. Clean appearance, good odor containment, fast startup and shutdown capabilities	1. Low energy requirements 2. Relatively low capital and operating costs 3. Less complex mechanically and easier to maintain	1. Highest cake solids concentration 2. Low suspended solids in filtrate	Higher dewatering efficiency obtained by feeding steam inside the screw Easy to maintain and save energy
Disadvantages	Scroll wear potentially a high maintenance problem Skilled maintenance personnel required	High odor potential Very sensitive to incoming sludge feed characteristics	Batch operation High equipment cost High labor cost	Few cases to be adopted for a state-of-art technology
Cost	100	100	120	80

6.7 Electrical Facility

6.7.1 General

Electrical systems for sewerage facilities should adhere to the following basic requirements to provide stable disposal of sewage.

Reliability - The sewerage system requires a high degree of reliability. The selection of equipment and instruments shall be made in terms of the appropriateness, high performance and high durability. Electrical systems to be adopted is duplex system with a back-up system.

Safety - Electrical systems prioritize the safety of the human life, and shall be designed to prevent any outbreak of fire or an electrification accident. The fail-safe system shall be adopted, if necessary.

Economy - Electrical systems shall be designed by taking into account the future development plans, in order to reduce initial investments and to maximize the use of the facilities already installed in the next stage of construction. The operation and maintenance costs shall be minimized by optimizing the system, entailing energy-saving and labor-saving devices.

Control and Operation - Control and operation shall be programmed to operate simply and easily, avoiding operational failures. The automatic and linked operation systems shall be taken into consideration, as appropriate.

Maintenance - Equipment shall be selected for easy maintenance and periodic checking. The type of equipment and instruments shall be unified and standardized as much as possible, and should be compatible.

Moreover, the electrical designs should be carried out in conjunction with the civil, mechanical, and other designs and are able to make the entire plant operational at any instant.

All electrical installations will be designed in accordance with the requirement of SNiP and GOST regulations. The equipment will comply with ISO, IEC, and JIS standards.

6.7.2 Power Supply

(1) Main Power Supply

The power supply to existing STP consists of three lines to the inlet pump station, the blower house, and the effluent pump station with respective duplex incoming system, 3-phase 3-wire, 6kV, 50Hz from the Astanaenergoservice (AES). A new sludge treatment building and new

electrical house are built in this project and they need new 6kV duplex power supply. Accordingly, new sub-stations are allocated in the new sludge treatment building and the new electrical house. New power is supplied to the sub-station in the sludge treatment building at duplex, 3-phase, 3-wire, 6 kV, 50 Hz from the AES, and then the existing power supplies to the plant are disconnected. The received power at the sludge treatment building is distributed to the blower house and the new electrical house at 6 kV. Since the existing 6kV switchgears in the blower house have been used long time, they are replaced with new equipment in this project. Meanwhile, the existing 6kV switchgears in the inlet pump station and the discharge pump station with the existing cables between the A ES and the two pump stations are remained as they are for future use.

The power distribution diagram is shown in the Figure 6.7.1. The intermediate pump stations that are rehabilitated have the same system as existing system. The details of power supply system are shown in "6.7.7 Rehabilitation".

(2) UPS Power Supply

The UPS power supply equipment receives the AC power from low voltage distribution board. The AC power is converted to the DC power through the rectifier, which charges the storage batteries. When the main power supply interruption happens, the DC power from the batteries is converted to the AC power through the inverter. Then, the UPS will continue to supply the AC power without an interruption.

In the proposed plant, the UPS power supply will be required for operation or control of:

- High voltage substation facilities;
- Protection relays of the high tension metal-enclosed switchgear;
- Air circuit breaker (ACB) of the low voltage switchboard;
- SCADA (Supervisory Control and Data Acquisition) system;
- PLC (Programmable Logic Controller); and
- Where even a momentary service interruption is not permissible.

The UPS will be a cathode absorption seal, lead-acid battery (MSE) type, 220V output, with 30-minute backup time.

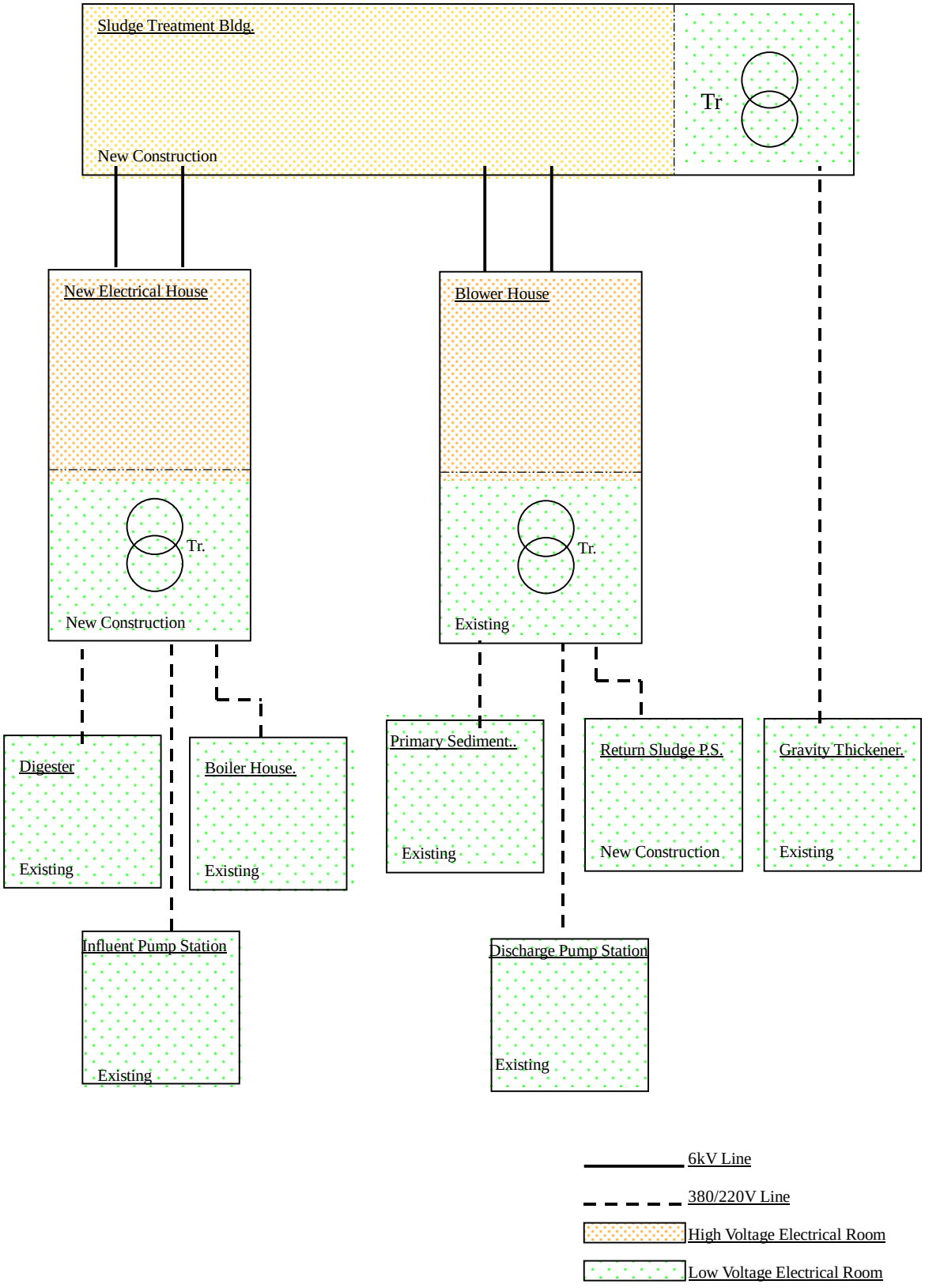


Figure 6.7.1 Power Distribution Diagram

6.7.3 Power Device

(1) Bus Bars

The type of high-tension bus bar will be the duplex incomer and the single bus bar type with a tiebreaker. The current capacity of the bus bar should endure the electric power demand of the whole plant.

(2) Circuit Breakers

Vacuum circuit breakers (VCB) will be adopted for high-tension circuit breakers for ease of maintenance. The breaking capacity at receiving point will be 150MVA at 6kV. The breaking current rating of VCB's should be 20kA at 6kV.

(3) Transformers

In the treatment plant, the type of main transformers will be the molded dry type transformer with metal enclosure for fire-proof, crack-proof, dust and moisture-proof, which is smaller, lighter and stronger than the oil immersed transformer. Meanwhile, an oil immerse type transformer is adopted in the intermediate pump stations, because the equipment for the pump stations is replaced with same type as existing one as aforementioned.

Some of 6kV power supply from networks shall be stepped down to 380V by a minimum of 2 units of transformers. There two transformers, one for duty and the other stand-by, so that when one transformer is unserviceable or under repair, the other transformer is capable of taking over the power supply for the plant. The capacity of the main transformers shall be determined in accordance with the maximum demand of the plant and a minimum surplus capacity of 10 % to the demand. The capacity of the main transformers is listed as follows.

Sub-station	Capacity (kVA)	Number of Units
Sludge Treatment Building	2000	2
Blower House	400	2
Electrical House	1500	2
Intermediate Pump station No.4	250	1
Intermediate Pump station No.6	250	1
Intermediate Pump station No.7	630	1

(4) Lightning Arrester

Indoor-type lightning arresters will be installed in the power-receiving panel to protect in-plant electrical equipment from lightning, induced on the networks power line.

(5) Metering and Protection

The electricity-metering device, which comprises VCT and kWh-meter, is installed on the 6kV side by the AES.

An over-current relay is provided in the power-receiving panel to protect the electrical equipment from electrical faults such as over-currents.

The grounding system is the isolated neutral system at 6kV system. A GPT (Grounding Potential Transformer) is provided to sense the grounding fault current and a grounding over-current relay will be provided to protect the electrical equipment from grounding fault.

The low voltage grounding system will be the earthed neutral system, type TN-S system, in which neutral and protective functions are separated two conductors throughout the system. In this system, a grounding over-current relay is provided to protect the electrical equipment from grounding fault.

(6) Low Voltage Distribution

The power from the transformers will be distributed at 380-220V, 3-phase, 4-wire to the low voltage distribution boards.

Low voltage bus bars are provided to carry the full load current of the transformers and designed to endure the full short circuit load of the transformers.

In principle, all outgoing feeders are installed with grounding over-current relays to protect the electrical equipment from faults such as grounding fault.

(7) Power-factor Improvement

Power-factor improvement will be achieved by static capacitor, and the compensated power-factor is or better than 95 %. The capacitors for power-factor improvement are provided with series reactor to restrain higher harmonics.

The capacitors will be installed individually at each motor starter panel for above 55kW loads. The collective capacitors are installed at high voltage bus bars for other loads. The power-factor is adjusted automatically by APFC (Automatic Power Factor Controller), which will be installed at the receiving panel in the sludge treatment building.

6.7.4 Motor Control

(1) Motor Voltage

Generally, 3-phase motor voltages should be provided in accordance with the following specifications as shown in Figure 6.7.2. In this project, the motor voltage is used for 6kV and 380V. Motors up to 300kW will be provided with 380V and for motors over 300kW, 6kV will be provided.

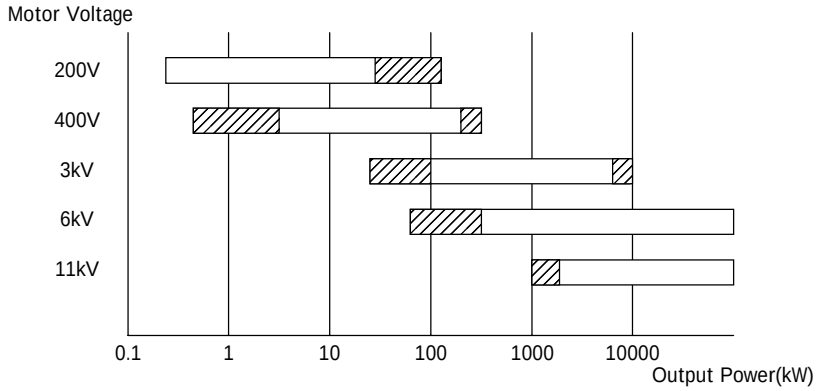


Figure 6.7.2 Economical Range of Every Voltage for Motor

Accordingly, the voltage for main motors is listed as follows

Plant Loads Name	Motor Output (kW)	Applied Voltage
Blowers	315	6 kV
Influent Pumps, Discharge Pumps,	200	380 V
Temporary Influent Pumps, and Temporary Discharge Pumps,	110	380 V

(2) Motor Starters

All motors are provided with starting as follows:

- up to 7.5kW - full voltage starting
- 7.5kW to 30kW - star delta starting
- above 30kW (Low volt.)- auto transformer starting
- above 300 kW (High volt.) - reactor starting

All motor starters should be installed in separate cubicles, and provided with over current protection.

(3) Combination Starter

Combination starters are provided for 6kV motor starter panels. These panels are divided into a power fuse and a vacuum contactor; the former is for a short breaking function and the latter is for a switching operation function. A circuit breaker is not suitable for frequent

switching operation of a load and it is also economically disadvantageous.

(4) Motor Control Center

Motor control centers are provided to supply power for loads up to 55kW. Motor control centers are composed of draw-out type units, which are assembled with circuit breakers, magnetic contactors and similar control devices.

Motors or equipment shall be controlled by auxiliary hard relays and PLCs' software. Auxiliary hard relays and PLCs have manual-mode operation and auto-mode operation control circuits, respectively.

(5) Motor Protection

All motors are protected from damage by faults such as overload, grounding fault, lack of phase, reverse of phase, and imbalance of the three phases, which are detected by thermal relays, solid state overload relays, earth leakage relays or peak power cut relays.

(6) Local Control Switches

Local control panel are provided adjacent to all process equipment. Each panel has a key switch for "LOCAL-CENTRAL" controls or "SINGLE-LINK" controls, "ON-OFF" switch positions, etc. All motors are controlled by manual operation at the local control panel installed beside motors.

(7) Distribution and Cabling

Generally, all sub-main cabling are laid using multi-core XLPE PVC cables. When cables are wired into the ground, concrete trenches or rigid corrugated PVC pipes with concrete manhole are provided. All cables are fully protected from UV degradation.

6.7.5 Instrumentation Equipment

(1) General

Instrumentations, which are the minimum requirements for automatic control, and operation and maintenance of the plant, are provided. The selection of instrumentations needs to adhere to the following requirements.

1) The purpose of measuring and reading accuracy

Selected subject to the appropriateness and the cost.

2) Environmental condition at measuring point

Selected in consideration of the reliability and durability against the adverse environmental conditions such as high or low temperature, high humidity, or presence of corrosive atmosphere.

3) Maintenance

The type of instrumentations should be unified and standardized as much as possible for easy maintenance.

4) Measuring range

When the measuring range is smaller in first stage and larger in the other future stages, instrumentations will have to be altered to reflect the full operation range in each stage.

(2) Measuring Items

Conceivable measuring items and types are shown in Table 6.7.1. .

Table 6.7.1 Measuring Items and Types

Measuring Items	Types
Pump Station Reservoir level	Submersible, hydrostatic level (pressure) meter
Temporary influent pump reservoir	Float, micro switch type
Influent sewage flow	Ultrasonic flow meter
Influent sewage pH	Glass electrode, immersion type
Aeration tank pH (Out of scope)	
Aeration tank temperature (Out of scope)	
Aeration tank DO (Out of scope)	
Aeration tank MLSS (Out of scope)	
Primary sludge flow	Electromagnetic flow meter
Primary sludge density	Ultrasonic attenuation type
Blower flow	Orifice flow meter
Blower pressure	Semi-conductor transmitter type
Air temperature	Resistance bulb type
Clear water tank temperature	Resistance bulb type
Return sludge flow	Electromagnetic flow meter
Sludge holding tank level	Pressure gauge
Mechanical thickener sludge flow	Electromagnetic flow meter
Gravity thickener flow	Electromagnetic flow meter
Thickener polymer tank level	Ultrasonic type
Thickened sludge holding tank	Pressure gauge
Digester flow	Electromagnetic flow meter
Digester pressure	Pressure gauge
Digester level	Pressure gauge
Distribution tank level for Digester	Pressure gauge
Gas holder level	Float type
Digested sludge holding tank	Pressure gauge
Digested dewatering sludge density	Ultrasonic attenuation type
Dewatering unit polymer tank level	Ultrasonic type
Digested Dewatering sludge flow	Electromagnetic flow meter
Cake hopper weight	Load cell type

6.7.6 Control and Supervisory System

(1) Concept of System

In principle, the hierarchy system or horizontally distributed control system will be adopted. The hierarchy system is useful in saving labor and easy to operate due to supervision of the whole set of equipment from one place, whereas the horizontally distributed control system improves the reliability of the control system.

The supervisory control levels are further classified into three levels. They are the site level, electrical room level, and central monitoring room level. The detail of each level is shown

in the following;

(2) Site Level

In the site level, local operation panels are installed for manual operation such as single operation, unit test or adjustment test. Accordingly, to carry out it securely, it is necessary for the manual operation to be assembled with a hard relay, even if abnormal conditions happened to the PLC of the upper class system.

The process values, such as electric current, water level or water pressure etc., that are needed for single site operation will be indicated on the local operation panel. These process values shall be branched off from the instrumentation converter directly, without passing through the PLC.

The failure display lamps, such as over load and/or mechanical failure, are installed on the local control panel along with the group failure indicating lamps. Also, the condition status indicating lamps, such as high and low water level is installed on the local control panel, at the same location.

(3) Electrical Room Level

The electrical room level has a function of the main control and local supervisory. On this level, a control of each load is carried out by hard relays and controllers. The PLCs work for the automatic and linked control system, and the hard relays will work for the manual control system.

In the distributed control system, a failure risk will be dispersed by control devices that are installed in each electrical room, and reliability of the control will be improved. Furthermore, in order to cope with a failure of a single PLC, manual operation circuits for motors is composed of auxiliary hard relays instead of the PLCs' software.

The instrumentation panel is installed in this room. It is composed of indicator, controller, setting device and so on. All measuring values of instrumentation can be checked on this panel.

(4) Central Supervisory Room Level

The system is designed to facilitate the monitoring of the whole plant and processing the data at the central monitoring room level. All of important items such as alarm or status of pumps can be monitored and recorded comprehensively from central monitoring room.

The collected information in each PLC is sent to the upper class computer. This computer is a man-machine interface to monitor the whole plant through a graphical interface.

Furthermore, the processed data by the computer will be accumulated to the server. And the server will be connected to the logging and the alarm processing printers by the upper information LAN.

Since all the existing plant loads are replaced with new equipment, the sewage treatment plant is monitored fully by the new monitoring system.

(5) Monitoring System for the 17 Intermediate Pump Station

It was planned in the basic design stage that a radio communication system connects the ASA headquarters and intermediate pump stations to alert automatically in an emergency case such as pump failure or water level abnormality.

The rehabilitation of 17 intermediate pump stations is scope of work in this project, while there exist additional 122 pump stations in the city. Meanwhile operation and maintenance information equipment is listed in the procurement program of O & M Equipment.

The idea of the entire monitoring system for all the pump stations raised after the careful studies. The entire monitoring system was discussed between ASA and the JICA study team, and the unified system for all PSs was recommended. The entire monitoring system will be established by ASA using the operation and maintenance information equipment.

(6) Monitoring System Diagram

The monitoring system diagram is shown in Figure 6.7.3

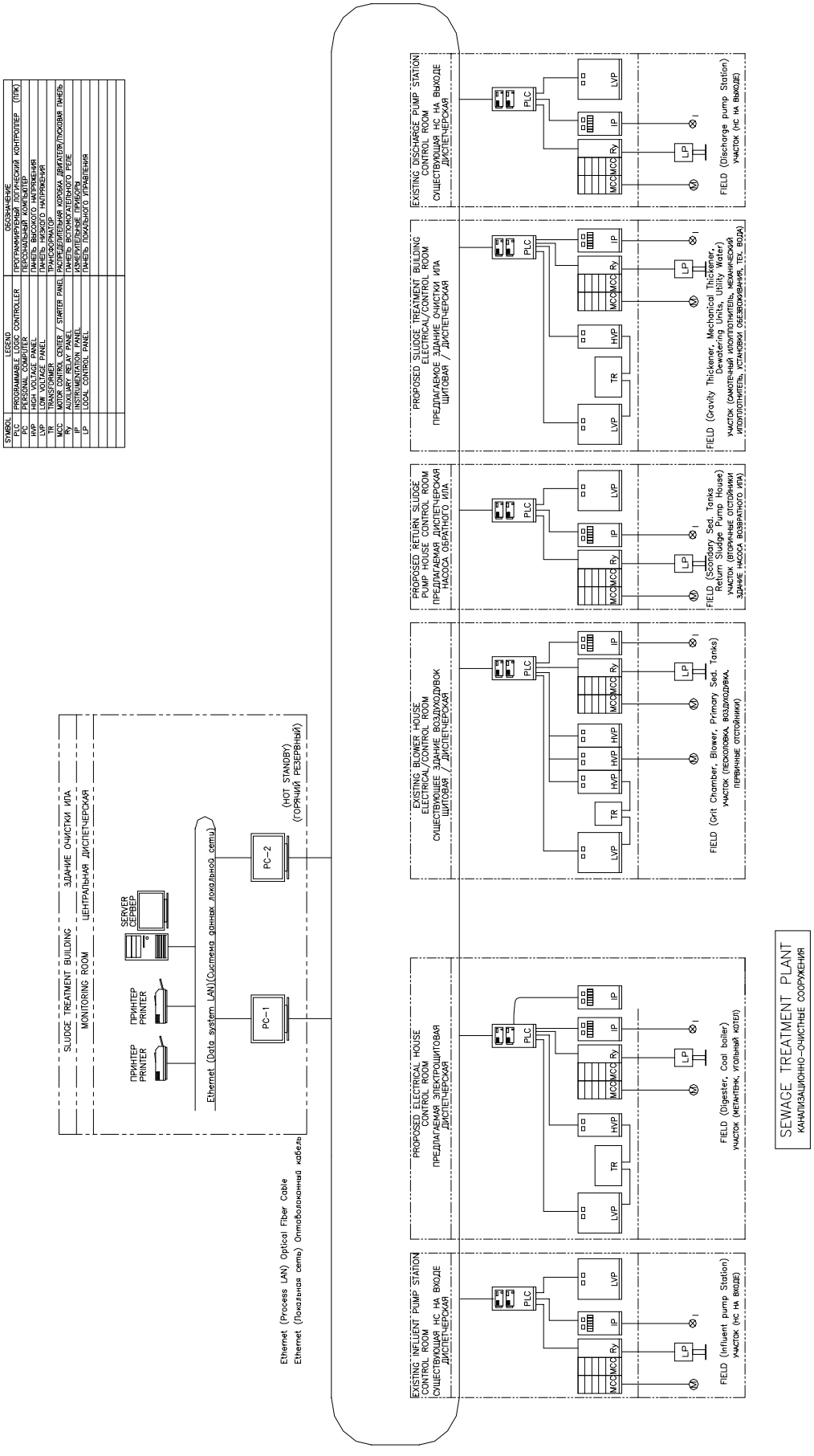


Figure 6.7.3 Monitoring System Diagram

6.7.7 Rehabilitation

(1) 6kV Power System

There are three 6kV sub-stations in the existing plant; the inlet pump station, the blower house and the effluent pump station. Among these three, those in the inlet pump station and the effluent pump station were already rehabilitated in 2001, but the one in the blower house need to be rehabilitated. All the incoming cables have not been rehabilitated. The present incoming cables are distributed individually to three sub-stations from AES.

In this project, a new sludge building is constructed and 6kV sub-station is necessary in this building. The new electrical house is also constructed in this project. Then, the sub-station allocated in the sludge treatment building shall be considered to be a master sub-station and distribute 6kV lines to other sub-stations, the blower house and the new electrical house, from there. In this case, it is possible to operate and maintain from one place.

(2) 380V Power System

Sewage - The 6kV/380V transformers are installed in the Blower house and the new electrical house, and 380 V power stepped down by the transformers is distributed to the low voltage electrical room in the Blower house and the Return sludge pump house.

Sludge - The 6kV/380V transformers are installed in the Sludge treatment building and 380 V power is distributed to the low voltage electrical room in the Sludge treatment building.

(3) Control and Operation Equipment

Since most of the mechanical equipment are rehabilitated, the electrical equipment are also rehabilitated, such as starter panels, control panels, local operation panel, wiring, monitoring etc. However, 6 kV switchgears in both the inlet pump station and the discharge pump station are remained as they are. Equipment to be rehabilitated is listed in Table 6.7.2.

Table 6.7.2 Electrical Equipment for Rehabilitation

Facility	Replacement Equipment	Q'ty	Remarks
1. Influent pump station			
1.1	Motor Control Centers for 3-distribution gates, 3-raked screens, 14-motor valves, 1-sump drain pump, 2-vantuilations fans, 1-overhead crane	7	
1.2	Local panel for 3-distribution gates	1	
1.3	Local panel for 3-raked screens	1	
1.4	Local panel for 5-main pumps	5	
1.5	Local panel for 14-motor valves	3	
1.6	Local panel for 1-sump drain pump	1	
1.7	Local panel for 2-vantuilation fans	1	
1.8	Inlet flow meter	1	
1.9	Pump well level meter	1	
1.10	Power cable for above equipments	1 lot	
1.11	Control cable for above equipments	1 lot	
2. Primary sedimentation tank			
2.1	Control panel for 4-sludge scrapers	2	
2.2	Control panel for 2-primary sludge pumps, 1-sump drain pump, 1-vantuilation fan	2	
2.3	Power cable for above equipments	1 lot	
2.4	Control cable for above equipments	1 lot	
3. Blower house			
3.1	6kV duplex incoming cable	1	
3.2	6kV switchgears	7	
3.3	Starter panels for blowers	5	
3.4	6kV/380V transformer	2	
3.5	380V distribution boards	2	
3.6	Motor Control Centers for valves and other replaced equipments	6	
3.7	Local panel for 5-blowers	5	
3.8	Power cable for above equipments	1 lot	
3.9	Control cable for above equipments	1 lot	
4. Return sludge pump house			New construction
4.1	Motor Control Centers for 3-return sludge pumps, 2-waste water sludge pumps, 1-sump drain pump, 1-ventilation, 10-sludge collectors	7	
4.2	Local panel for 3-return sludge pumps	1	
4.3	Local panel for 2-waste water pumps	1	
4.4	Power cable for above equipments	1 lot	
4.5	Control cable for above equipments	1 lot	

5. Secondary sedimentation tank			
5.1	Local panel for a sludge scraper	10	
5.2	Control cable for above equipments	1 lot	
6. Effluent pumping station			
6.1	Motor Control Centers for 14-motor valves, 1-sump drain pump, 2-vantuilations fans, 1-overhead crane	4	
6.2	Local panel for 5-main pumps	5	
6.3	Local panel for 14-motor valves	3	
6.4	Local panel for 1-sump drain pump	1	
6.5	Local panel for 2-vantuilation fans	1	
6.6	Pump well level meter	1	
6.7	Power cable for above equipments	1 lot	
6.8	Control cable for above equipments	1 lot	
7. Gravity thickener			
7.1	Control panel for 2-sludge scraper, 2-thichened sludge pumps, 1-sump drain pump, 1-vantuilation fan	1	
7.2	Power cable for above equipments	1 lot	
7.3	Control cable for above equipments	1 lot	
8. Sludge digester			New construction
8.1	Motor Control Centers for 3-mixing pumps, 2-steam injection units, 1-sump drain pump, 2-vantuilations fans	4	
8.2	Local panel for 3-mixing pumps	1	
8.3	Local panel for 1-sump drain pump	1	
8.4	Local panel for 2-vantuilation fans	1	
8.5	Power cable for above equipments	1 lot	
8.6	Control cable for above equipments	1 lot	
9. Boiler House			
9.1	380V distribution boards	1	
9.2	Control panel for a coal boiler	2	
9.3	Power cable for above equipments	1 lot	
9.4	Control cable for above equipments	1 lot	
10. IPS No.1			
10.1	380V distribution boards	1	
10.2	Starter and control panel	5	
10.3	Power cable for above equipments	1 lot	
10.4	Control cable for above equipments	1 lot	

11. IPS No.2			
11.1	380V distribution boards	1	
11.2	Starter and control panel	4	
11.3	Power cable for above equipments	1 lot	
11.4	Control cable for above equipments	1 lot	
12. IPS No.3			
12.1	380V distribution boards	1	
12.2	Starter and control panel	6	
12.3	Power cable for above equipments	1 lot	
12.4	Control cable for above equipments	1 lot	
13. IPS No.4			
13.1	380V distribution boards	1	
13.2	Starter and control panel	5	
13.3	Power cable for above equipments	1 lot	
13.4	Control cable for above equipments	1 lot	
13.5	3.5km 10kV overhead line	1 lot	
14. IPS No.6			
14.1	380V distribution boards	1	
14.2	Starter and control panel	5	
14.3	Power cable for above equipments	1 lot	
14.4	Control cable for above equipments	1 lot	
14.5	Arrangement of 10kV standby power supply	1 lot	
15. IPS No.7			
15.1	6kV/380V transformer	1	
15.2	380V distribution boards	1	
15.3	Starter and control panel	4	
15.4	Power cable for above equipments	1 lot	
15.5	Control cable for above equipments	1 lot	
16. IPS No.10			
16.1	380V distribution boards	1	
16.2	Starter and control panel	6	
16.3	Power cable for above equipments	1 lot	
16.4	Control cable for above equipments	1 lot	
17. IPS No.11			
17.1	380V distribution boards	1	
17.2	Starter and control panel	3	
17.3	Power cable for above equipments	1 lot	
17.4	Control cable for above equipments	1 lot	

18. IPS No.15			
18.1	380V distribution boards	1	
18.2	Starter and control panel	3	
18.3	Power cable for above equipments	1 lot	
18.4	Control cable for above equipments	1 lot	
19. IPS No.16			
19.1	380V distribution boards	1	
19.2	Starter and control panel	3	
19.3	Power cable for above equipments	1 lot	
19.4	Control cable for above equipments	1 lot	
20. IPS No.17			
20.1	380V distribution boards	1	
20.2	Starter and control panel	3	
20.3	Power cable for above equipments	1 lot	
20.4	Control cable for above equipments	1 lot	
21. IPS No.21			
21.1	380V distribution boards	1	
21.2	Starter and control panel	3	
21.3	Power cable for above equipments	1 lot	
21.4	Control cable for above equipments	1 lot	
22. IPS No.24			
22.1	380V distribution boards	1	
22.2	Starter and control panel	3	
22.3	Power cable for above equipments	1 lot	
22.4	Control cable for above equipments	1 lot	

CHAPTER 7 CONTRACT PACKAGE AND PROCUREMENT PROCEDURE

CHAPTER 7 CONTRACT PACKAGE AND PROCUREMENT PROCEDURE

7.1 Contract Package

Under the procurement clause, measures to be adopted, in the Agreement between JBIC and Kazakhstan side, one single lot for the construction contract through International Competitive Bidding is presented. The following are abstraction on the concerned.

"Goods and Services shall be procured in one (1) single lot through International Competitive Bidding (ICB) in accordance with the "Guidelines for Procurement under JBIC ODA loans, October 1999". The pre-qualification of the contractors shall be conducted in accordance with the Guideline."

The contract will consist of civil works, supply and installation of equipment for construction and rehabilitation works of the Astana water supply and sewerage facilities stipulated in the contract documents.

7.2 Pre-Qualification Documents

7.2.1 Prequalification for the Project under JBIC ODA Loans

The Japan Bank for International Cooperation (hereinafter called as JBIC) will finance a part of Astana Water Supply and Sewerage Project (hereinafter called as the Project). The Project will construct water supply and sewerage system which consists of new raw water intake, new water treatment plant, installation and rehabilitation of distribution pipes, rehabilitation of sewage treatment plant, replacement of sewerage pressured pipes, rehabilitation of sewerage pumping facilities, and other associated works.

The construction work will be executed by single contract to be bound through an international competitive bidding (hereinafter called as ICB) in accordance with the minutes of discussion between JBIC and the government of Republic of Kazakhstan. The bidding procedure, documents preparation, and evaluation of bids will be conducted in accordance with the Guidelines for Procurement under JBIC ODA Loans (hereinafter called as Procurement Guidelines). JBIC has also prepared guides and sample documents in accordance with the provisions of the Procurement Guidelines.

Available guide and sample document for pre-qualification are as follows:

- Sample Pre-qualification Documents under JBIC ODA Loans, November 1999
- Evaluation Guide for Pre-qualification and Bidding Under JBIC ODA Loans, June 2000

In addition, on-going projects financed by JBIC ODA loan in this country conform to the

Procurement Guidelines and apply the guides and the samples to the project documentation.

The pre-qualification and the bidding documents for the project should be prepared in accordance with the Procurement Guidelines and relevant guides and sample documents consequently.

In pre-qualification, the applicant is examined whether he has ability to complete the work financially and technically. Thus, pre-qualification documents will be prepared to examine the applicant's ability in the followings respects:

(a) Eligibility

Having the both quality and environmental management system certified by International Organization for Standardization (ISO) or equivalent

(2) Accomplishment of the minimum requirements:

- Required amount of annual turnover
- Having successful experiences in water supply and sewerage project
- Having enough experience in specific construction method or manufacturing specific equipment (if not applicant, for nominated sub-contractor or manufacturer)

(3) Proposal and Demonstration for:

- Operating the firm in financially sound position
- Providing competent personnel and appropriate equipment to the works
- Providing enough finance to secure completion of the works

7.2.2 Prequalification Procedure

Pre-qualification will be announced to public with at least one English language and local newspaper of wide circulation in this country and to diplomatic representations from foreign countries. Pre-qualification documents will be distributed to applicants at suitable price and after filled submitted to the executing agency for the project before the deadline.

Evaluation of the application is carried out in following procedure:

- Stage-1: Examination of eligibility (Quality management certificate, Single, Joint-venture, Consortium)
- Stage-2: Accomplishment of the minimum requirement (Annual turnover, Successful project experience of similar nature and complexity, Experience in Specialized Works,)

- Stage-3: Detailed examination of proposal and explanation (Personnel capability, Equipment capability, Financial positions)
- Stagae-4: Consideration of litigation history

Pass-or-fail criteria will be applied to the stage-1, 2, and 4 Stage. Scoring points evaluation will be applied to the Stage 3.

7.2.3 Requirements for Qualification

The followings are tentative requirements and subject to review after completion of the basic design.

A. Eligibility (Pass/Fail Criteria)

Item	Requirement	Remarks
1. Eligible Source Country	The applicant must be from eligible source country	
2. Free From Conflict	The applicant must be free from conflict of interest for the project.	
3. Quality and Environmental Management System	The applicant must have the both quality and environmental management systems certified by ISO 9000 series and ISO 14000 or equivalent.	9001, 9002, 9001:2000, 14000
4. In case of Joint Venture	A lead partner's share of the work must not be less than 40 % of the total contract amount. Each member partner's share of work must not be less than 20 % of the total contract amount.	
5. Subcontracting	The applicant may nominate subcontractor(s) if necessary. In the event a part of the works undertaken by subcontractor(s), the amount of one subcontract shall not exceed 20 % of the total contract amount. The applicant should attach commitment letter(s) for subcontract from the nominated subcontractor(s) (hereinafter called as the named subcontractor(s)). During construction, the Contractor shall not subcontract without prior approval of the Employer.	

B. Minimum Requirement

Item	Requirements	Remarks
1. General Experience (Pass/Fail Criteria)		
Average annual turnover in the last five (5) years.	At least 800 million US$ for a single applicant or a lead partner of a joint venture and at least 200 million US$ for each member partner of a joint venture.	
2. Experience in particular works (Pass/Fail Criteria)		
Experience in Water Supply and/or Sewage project. For a single applicant or a partner of a joint venture.	At least three (3) successful projects in the last ten (10) years of water treatment facility including water supply and/or sewage projects with capacity more than 100,000 m^3/day. The above projects must include: At least one (1) water treatment plant project employing self-washing filters controlled by a siphon system, At least one (1) sewage treatment, and At least two (2) projects at outsides of the applicant's home country.	
3. Experience in Particular Works (Pass/Fail Criteria)		
For a single applicant or a partner of a joint venture or a named sub-contractor or manufacturer: (Successful experience as a sub-contractor or a manufacturer or a supplier)	The applicant or named subcontractor or manufacturer must have following particular experience: At least one (1) successful experiences in construction of concrete caisson structures larger than diameter 10 m and deeper than 10 m in penetration. At least three (3) successful experiences in pipe jacking for main pipe diameter 1000 mm and larger and jacking length 30 m and longer. Having been engaged in more than five (5) years in manufacturing screw press type sludge dewatering machines. At least one (1) successful experience in manufacturing and installation of the machines with capacity more than 450 kg/hour of dry solid at the works outside of the manufacturer's home country.	

C. Proposal and Explanation for detailed evaluation (Scoring Points)

Item	Requirements	Remarks
1. Personnel Capabilities	Project Manager Civil Works Manager Mechanical Works Manager Electrical Works Manager Logistic and Administrative Manager Experts or Engineers	
(a) Total Experience	Project Manager: 20 years Other: 15 years	
(b) In similar works	Project Manager: 15 years Other: 10 years	
(c) As the proposed position	Project Manager: 10 years Other: 5 years	
2. Equipment Capabilities	Required equipment Bulldozer Excavator Loader Roller Ramer Pile Driver Compactor Trailer Truck Damp Truck Crane Truck Crane Engine Generator Welder Drain Pump Plumbing Tools Jack Pipe Jacking Equipment Concrete Mixer Concrete Pump Concrete Agitator Truck Concrete Batch Plant	own, hire, lease, purchase
3. Financial Position a. Access/available line of credit	Amount: 200 million US$	
b. Average working capital	Average working capital in the last five years must be more than 30 million USD	
4. Litigation History	Information on any history of litigation or arbitration resulting from contracts in the last 5 years.	

7.2.4 Prequalification Schedule

Pre-qualification will require at least four (4) months in a total after approval of the pre-qualification documents and its evaluation criteria by JBIC. Breakdown of the required time for the process is as follows:

- Preparation of pre-qualification documents by applicants: 2 months
- Evaluation on the application by executing agency: 1 month
- Approval process within the executing agency side and JBIC: 1 month

7.3 Bid Documents

7.3.1 Bid Documents (Contents of Bid Documents, Explanation on each document)

The bid documents were prepared in accordance with the Procurement Guidelines.
Bid documents are composed of four volumes, and contents of them are as follows:

VOLUME I

Section 1 Instruction to Bidders

Section 2 Part I – General Conditions

Section 3 Part II – Conditions of Particular Application

Section 5 Form of Bid, Appendix, Bid Security, and List of Eligible Countries of JBIC ODA Loans

Section 7 Sample Form of Agreement

Section 8 Sample Form of Securities

Section 9 Schedule of Supplementary Information

VOLUME II

Section 4 Technical Specifications

VOLUME III

Section 6 Bill of Quantities

VOLUME IV

Section 10 Drawings

Regarding general conditions of contract, the 4th edition of Conditions of Contract for Works of Civil Engineering Construction published by Fédération Internationale des Ingénieurs Conseils (FIDIC) in 1987 and amended in 1992 is used for the conditions of the contract as recommended in the guides and the sample documents prepared by JBIC in accordance with the provisions of the Procurement Guidelines. Other on-going projects financed by JBIC ODA Loans in this country also apply the FIDIC conditions mentioned above to the contract.

In view of applying ICB, technical specifications especially for plant and equipment are prepared on the basis of ISO and supplemented by other internationally accepted standards such as JIS, ASTM, BS and/or GOST taking local conditions into account.

Bidding documents were finalized at the final stage of the study in incorporating the output of the detailed design works as summarized in the Section 9 Schedule of Supplementary Information which are prepared for bid evaluation purpose.

7.3.2 Technical Specifications

The Volume II Technical Specifications consist of two sections i.e. Section 4.1 Particular Specifications and Section 4.2 Standards Specifications. The Section 4.1 stipulates particular instructions to the works in this project, however, instructions described in the Section 4.2 are generally applicable to construction work of water supply and sewerage facilities. The Section 4.1 shall prevail over the Section 4.2 if any inconsistency between them.

7.3.3 Drawings

The Volume IV Drawings consists of two sections i.e. Section 10.1 Water Supply Facilities and Section 10.2 Sewerage Facilities. Each section comprises (i) civil, architectural, and structural works; (ii) mechanical and electrical works; and (iii) pipelines works in Section 10.1 or intermediate pump stations and sewers in Section 10.2.

7.3.4 Bill of Quantities

The objectives of Bill of Quantities (BOQ) are;

- To provide sufficient information on the quantities of works to be performed by a contractor to enable bids to be prepared sufficiently and accurately; and
- When a Contract is entered into, to provide a priced BOQ for use in the periodic valuation of works executed.

(1) Contents of BOQ

As construction works can be classified into two categories namely; 1) civil and architectural works; and 2) mechanical and electrical works, and the mechanical and electrical works are further classified into supply of equipment/materials and installation, the BOQ will be prepared by each category.

(2) Principle of BOQ

The format of the BOQ is such that it allows a Tenderer to insert rates both local currency (Kazakhstan Tenge [Tg]) and foreign currency (Japanese Yen [¥]) components for each item. For specific items of imported goods, further columns are provided for the Contractor to insert the rate (in Kazakhstan Tenge) payable on each item for customs duty etc. The Study Team will also prepare BOQ based on the following principles.

(3) Civil and Architectural Work

The exact nature and extent of the work to be performed shall be ascertained by reference to the Drawings, the Specifications, the Tendering Conditions and the Conditions of Contract as the case may be, read in conjunction with the matters listed against the relevant heading and item description as described in the BOQ.

All items of work specified and/or shown on the drawings shall be valued by measurement of such items only as are included in the BOQ, which shall cover all costs incurred by a Contractor in fulfillment of his obligations under the Contract.

Notwithstanding any limits which may be implied by wording of individual items and/or explanation in a preamble, it is to be clearly understood by the Contractor that the rates and sums which are entered in the BOQ shall be the full inclusive value for the work, finished complete in every respect, whether separately or specifically described in the Contract Documents or not. The Contractor shall be deemed to have taken full account of all requirements and obligations, whether expressed or implied, covered by all parts of this Contract, and to have priced the items herein accordingly. The rates and sum must include all incidental and contingent expenses and risks of every kind necessary to construct, complete and maintain the whole of works in accordance with the Contract.

(4) Mechanical and Electrical Works

The supply of equipment, piping and materials shall be valued by the measurement of such items only as are included in the BOQ. If no specific item is provided then the work is deemed to be included in the Contractor's other rates. The work shall include product design, manufacturing, inspection and testing, provision of specified accessories and spare parts, packing, shipment, expenses for custom clearance and other taxes, inland transportation, delivery to the place at site designated by the Engineer, who is the representative of the client, safeguarding and protection from inclement conditions during storage prior to, and after, installation. Payment shall be full compensation to cover all the Contractor's obligations under the Contract for furnishing all materials, labor, tools, equipment, and incidentals necessary to complete the said works.

The installation works of the supplied equipment, piping and materials specified above shall be valued by the measurement of such items only as are included in the BOQ. If no specific item is provided then the work is deemed to be included in the Contractor's other rates. The work shall include all multiple handling necessary prior to installation, including during storage and carrying in to the site, installation including all necessary permanent and temporary supports, building in, painting, calibration, performance testing, and any other works necessary to meet the requirements shown on the drawings and/or specified. Payment shall be full compensation to cover all the Contractor's obligations under the Contract for providing all materials, labor, tools, equipment, and incidentals necessary to complete the said works.

CHAPTER 8 MATERIAL AND EQUIPMENT PROCUREMENT PLAN

CHAPTER 8 MATERIALS AND EQUIPMENT PROCUREMENT PLAN

8.1 General

The proposed materials and equipment are required in two stages, construction stage and operation and maintenance stage. The requirements in construction stage include raw construction materials such as cement, steel-bars, steel frames, bricks, glass, fittings for building, pipes, water service and drainage equipment, glass, electric cables, lighting equipment and others. Adding to these, construction machineries, mechanical equipment and electrical equipment are required to construct water supply and sewerage facilities. These materials and equipment are listed up, and their appropriate procurement route, accounting qualities, quantities, service conditions and costs are thoroughly investigated.

Required equipment for operation and maintenance work is quite different depending on direct undertakings by ASA. If ASA undertakes major repair work, they need many kinds of machineries and equipment. While, if ASA contracts out major repair work to the private sector, needed kinds and number of equipment can be minimized. According to the current practices worldwide, operation and maintenance body shall not undertake major repair work to minimize the redundant costs for manpower and equipment. In this regard, equipment needed for O&M of pipeline network, such as water leakage detection, flow measurement, water quality analysis, and checking and adjusting instrument, was given a higher priority.

Laboratories for the water treatment plant and the sewage treatment plant are very important because it is essential to comply with the water quality standard for drinking water and treated sewage.

8.2 Manner of Procurement of Materials and Equipment for Construction

8.2.1 Construction Materials

(1) List of construction material

Construction materials are listed in Table 8.2.1.

Table 8.2.1 List of Construction Materials

Work Type	Facilities	Classification	Materials
Civil Structures and Buildings	-Intake pump station -Water treatment plant -Sewage treatment plant -Sewage pump station	Basic material	Sand, graded gravel, cement, steel bar, steel frame, paint, pipes and connectors, valves, fitting for building, glass plate
		Lighting and Electric wiring	Lights and accessory, cable and electrical pipes, electrical parts, electrical panels
		Drainage	Pipes, drainage equipment and accessories, pit
		Water service	Pipes, water service equipment and accessories, lagging materials
		Ventilation	Air-conditioner, ventilation fan, ducts, electrical panel
Pipeline	-Transmission main -Distribution Pipes -Sewer line	Pipes and backfill materials	Pipes and connectors, valves and accessories, manhole materials, paint, sand and gravel

(2) Procurement of construction materials

Basically, construction materials should be procured from the production sites as nearest to the construction site as possible considering the transportation costs. However, the materials must meet the requirements of quality. In this connection, market research is important to ensure the lowest procurement cost under equivalent quality specified. Table 8.2.2 shows the nearest production sites and the proposed procurement sites at the detailed design stage.

Table 8.2.2 List of Materials and Production/Procurement Sites

Classification	Material Name	Proposed Production/Procurement Sites
Basic Materials	Sand	Astana City
	Graded gravel	Kazakhstan (200km)
	Cement	Kazakhstan (500km)
	Steel bar	Russia
	Steel frame	Russia
	Prefabricated Concrete Block	Astana City
	Brick	Astana City
	Paint	Japan, Turkey, Europe
	Steel Pipes	Japan, Turkey, Europe
	Ductile Iron Pipes	Japan, Turkey, Europe
	Manual valves	Japan, Turkey, Europe
	Fitting for buildings	Turkey, Europe
	Glass plate	Russia, Turkey, Europe
Lighting and Electric Wiring	Light and accessories	Turkey, Europe
	Cable and pipes	Turkey, Europe
	Electrical parts	Turkey, Europe
	Electrical panels	Turkey, Europe

Drainage	PVC-Pipes	Turkey, Europe
	Steel Pipes	Russia, Turkey, Europe
	Drainage equipment	Turkey, Europe
	Pits	Astana City
Water Service	Water service equipment	Russia, Turkey, Europe
	Pipes and connectors	Russia, Turkey, Europe
	Lagging materials	Russia, Turkey, Europe
Ventilation	Air-conditioners	Turkey, Europe
	Ventilation fan	Turkey, Europe
	Ducts	Russia, Turkey, Europe
	Lagging materials	Russia, Turkey, Europe
Pipeline	Backfill materials	Astana City
	Steel Pipes	Japan, Turkey, Europe
	Ductile Iron Pipes	Japan, Turkey, Europe
	Valves and accessories	Japan, Turkey, Europe
	Manhole materials	Japan, Turkey, Europe

8.2.2 System Equipment

(1) List of equipment

Equipment needed for water supply and sewerage system are listed in Table 8.2.3.

Table 8.2.3 List of Equipment

Facilities	Machineries and Equipment
Intake pump station	Pumps, auto-valves, gates, screens, crane, electric power facilities, electric control facilities, electric observation facilities, information facilities, electrical power and signal cables
Water treatment plant	Pumps, Auto-valves, gates, cranes, electric power facilities, electric control facilities, electric observation facilities, information facilities, electrical power and signal cables, coagulant facilities, chlorination facilities, rapid mixer, sludge collector for sedimentation tank, sludge collector for sludge thickener, rapid sand filter facilities
Sewage treatment plant	Pumps, Auto-valves, gates, cranes, electric power facilities, electric control facilities, electric observation facilities, information facilities, electrical power and signal cables, coarse screens, fine screens, mixers for grit chambers, mixers of digestion tanks, and sludge storage tanks, sludge collectors for preliminary clarifier and final clarifier, sludge collectors of thickener, aeration blower, sludge mechanical thickener, boilers, dewatering machines, polymer injection facilities for mechanical thickeners and dewatering machines, sludge conveyors, sludge hoppers
Sewage pump station	Pumps, screens, gates, cranes, electric power facilities, electric control facilities, electric observation facilities, information facilities, electrical power and signal cables
Outside pipeline	Water flow and pressure measurement equipment

(2) Procurement of equipment

Equipment should be procured considering required quality, procurement cost including transportation cost. Additionally, the availability of after-service for the equipment is essential to maintain the equipment sound conditions in a long-term. Table 8.2.4 shows nearest procurement countries/areas at the detailed design stage.

Table 8.2.4 List of Equipment and Potential Procurement Countries

Facility	Equipment		Proposed Production/Procurement Country/Area
Common facilities	Pumps	Submerged	Japan, Europe
		Water	Japan, Europe
		Sludge	Japan, Europe
		Flow adjustment of water	Japan, Europe
		Flow adjustment of sludge	Japan, Europe
	Auto-valves		Japan, Europe
	Gates		Japan, Europe
	Cranes		Japan, Europe
	Electric Panel		Japan, Europe
	Electric power facilities		Japan, Europe
	Electric control facilities		Japan, Europe
	Monitoring facilities		Japan, Europe
	Information facilities		Japan, Europe
	Electric power and signal cable		Japan, Europe
Intake P/S	Screens		Russia, Turkey
Water treatment plant	Steel tank and structure		Russia, Turkey
	Coagulant and chemical mixer		Japan, Europe
	Coagulant and chemical injection pumps		Japan, Europe
	Chlorine storage equipment		Russia, Turkey
	Chlorinators		Japan, Europe
	Sludge collectors for sedimentation tanks		Japan, Europe
	Rapid sand filtration facilities		Japan, Europe
	Siphon equipment		Japan, Europe
	Sludge collectors for thickeners		Japan, Europe
Sewage treatment plant	Inlet screens		Japan, Europe
	Mixer for grit chamber		Japan, Europe
	Aeration blower		Japan, Europe
	Sludge collector for preliminary clarifier		Russia, Turkey
	Sludge collector for final clarifier		Russia, Turkey
	Sludge collector for thickener		Russia, Turkey
	Mixer for digestion tank		Japan, Europe
	Equipment for digestion tank		Japan, Europe
	Boilers	By Coal	Russia
		By Gas	Russia
	Steel tanks and structure		Russia, Turkey
	Mixer and feeder for dissolving tanks		Japan, Europe
	Polymer injection pumps		Japan, Europe
	Mechanical thickener		Japan, Europe

	Dewatering machine	Japan, Europe
	Sludge cake hoppers	Russia, Turkey
	Cake conveyors	Russia, Turkey
Sewage P/S	Screens	Russia, Turkey

8.3 Procurement Manner of Equipment for Operation and Maintenance

8.3.1 Equipment for Operation and Maintenance

(1) Present O&M practices by ASA and available equipment

ASA has been undertaking operation and maintenance of the water supply and sewerage systems and have been conducting almost all repair work as well. Thus, ASA owns numerous vehicles namely, special trucks; dump trucks, and construction machineries such as, excavators, cranes, bull-dozers, pipe layers, steam cars, vacuum cars, trailers and pump cars and others. ASA also owns measurement instruments. Equipment currently owned by ASA is shown in Table 8.3.1.

All vehicles and equipment were purchased before 1993 with the average use of more than 10 years as of today, which means these vehicles/equipment need to be replaced. In other words, if ASA continues the work in the same manner and extents as practiced as of now, all existing vehicles/equipment shall be replaced. However, the scope of work for the ASA may be limited to O&M work in the future as the policy of the Government to promote private sector undertaking, especially for the construction of facilities.

(2) Vehicles/construction machineries/equipment proposed by ASA

ASA prepared a proposal of O&M equipment, including vehicles/construction machineries /equipment, to be procured under this Project. As this proposal of the ASA contains heavy construction machineries, leakage detection equipment, pipe connecter, laboratory units, it seems that this proposal was prepared based on ASA's intention to undertake majority of repair work. Table 8.3.2 shows the comparison between those proposed by ASA and considered in F/S.

As aforementioned, ASA must act as "Management Entity of water supply and sewerage system of Astana City". Due to the budgetary limitation, work efficiency must be maximized and therefore, major repair work shall be contracted out to private contractors with smaller budgets compared with those consumed by ASA's own work. In this connection, necessary O&M equipment and the list is summarized in Table 8.3.3.

Table 8.3.1 Existing Major Equipment of ASA (1/2)

No.	Classification	Model	Procured Year	Unit	Total
1	Car	GAZ-31029	1993	1	14
2		GAZ-2411	1992	1	
3		VAZ-2121	1993	1	
4		VAZ-2121	1992	3	
5		UAZ-2206	1995	1	
6		UAZ-3741	1993	1	
7		UAZ-3962	1993	1	
8		UAZ-3303-06	1993	1	
9		UAZ-330-36	1993	2	
10		IZe-2715	1990	1	
11		UAZ-3362-01	1989	1	
12	Bus	LAZ-695	1993	1	3
13		Tajikistan-5	1986	1	
14		KAVZ-3270	1987	1	
15	Truck	GAZ-5204	1981	1	6
16		GAZ-3307	1992	1	
17		KAMAZ-5320	1983	1	
18		KAMAZ-53202	1992	1	
19		GAZ-53b	1991	1	
20		GAZ-5205	1988	1	
21	Dump Truck	ZIL-4503	1992	2	8
22		ZIL-4503TeSM	1992	2	
23		AIL-4503	1993	1	
24		KAMAZ-5511	1986	1	
25		KAMAZ-5511	1982	1	
26		MAZ-555	1991	1	
27	Water Tank Car	ZIL-130PM	1981	1	4
28		ZIL-4314-12	1988	1	
29		ZIL TeSM-4503	1993	1	
30		ZIL-130	1981	1	
31	Vacuum Car	GAZ-53a	1992	1	11
32		GAZ-5313	1992	1	
33		KO-503	1989	1	
34		GAZ-53	1991	1	
35		GAZ-53-12 Avv	1990	1	
36		GAZ-53	1988	1	
37		GAZ-53	1983	1	
38		GAZ-53	1981	1	
39		GAZ-53	1990	1	
40		KO-512 KAMAZ KO504	1985	1	
41		KO-512 KAMAZ 53213	1991	1	
42	Emergency Car	GAZ-3307	1991	1	10
43		GAZ-3307	1992	3	
44		GAZ-3307	1993	1	
45		GAZ-53	1979	1	
46		GAZ-53	1987	1	
47		GAZ-53	1989	2	
48		GAZ-53b	1991	1	

Table 8.3.1 Existing Major Equipment of ASA (2/2)

No.	Name	Model	Procured Year	Unit	Total
49	Emergency Car	GAZ-52	1986	1	16
50		GAZ-52	1988	1	
51		GAZ-52	1989	2	
52		ZILTeSM-4502	1991	1	
53		ZIL-4314-12	1991	1	
54		GAZ-66	1990	1	
55		GAZ-66	1991	1	
56		GAZ-66	1992	2	
57		GAZ-6611	1989	1	
58		GAZ-6611	1991	1	
59		GAZ-6614	1991	1	
60		GAZ-5201	1985	1	
61		GAZ-5201	1988	1	
62		GAZ-3307	1988	1	
63	Truck Crane	MAZ-5337	1992	1	3
64		ZIL-130 Ks-2561dn	1986	1	
65		ZIL-130 Ks-2561	1983	1	
66	Auto Tower	ZIL-130 AGP-22	1989	1	1
67	Semi-trailer	ZIL-4415-10	1991	1	3
68		ZLL-130	1988	1	
69		MAZ-5551	1992	1	
70	Trailer	TuMZAP-5208	1983	1	5
71		ODAZ-9357	1984	1	
72		ODAZ-9357	1987	1	
73		TuMZAP-93853	1989	1	
74		TuMZAP-5208	1988	1	
75	Fuel Truck	ZIL-130	1984	1	1
76	Steam Engine	GAZ-66	1977	1	2
77		GAZ-66	1991	1	
78	Tractor for Ice with caterpillar	T-170	1982	1	8
79		T-170	1885	1	
80		T-170	1988	2	
81		T-170	1989	2	
82		DT-75	1989	2	
83	Excavator with Caterpillar	E-4121	1988	2	2
84	Tractor	K-701	1989	1	2
85		K-701	1991	1	
86	Excavator with wheel	UDS114	1988	1	7
87		ATJK-4321V	1993	1	
88		EO-3323	1991	1	
89		EO-3322	1982	1	
90		EO-2621JMZ-6l	1979	1	
91		EO-2621JMZ-6l	1985	1	
92		EO-2621JMZ-6l	1988	1	
93	Pump with wheel	T-40	1988	1	5
94		LTZ-55	1989	1	
95		MTZ-80	1993	2	
96		MTZ-80	1988	1	
	Total				111

Table 8.3.2 Comparison of ASA's Proposal and F/S (1/2)

Proposed by ASA				F/S Plan			
No.	Item	Specification	Nr.	No.	Item	Specification	Nr.
1	Bucket Loader	Bucket 4m^3	2	1	Tractor shovel for sludge loading	1.2 m^3	4
2	Ditto	Bucket 2m^3	1				
3	Excavator	Bucket 0.35-0.65	2	2	Excavator	0.3 m^3	5
4	Excavator	Bucket 1.5m^3	1	3	Excavator, large with crawler	1.0 m^3	2
5	Ditto	Bucket 1m^3	2	4	Excavator, large with tire	1.0 m^3	4
6	Ditto	Bucket 0.6m^3	8				
7	Ditto	Bucket 1.0m^3	8				
8	Drag-line Excavator	Bucket 1m^3	1				
9	Crawler ice/asphalt Breaker		8	5	Crawler ice/asphalt Breaker		3
10	Wheel ice/asphalt Breaker		2	6	Wheel ice/asphalt Breaker		1
11	Ditto	Blade Length 2.8m	2				
12	Steam Generator		4	7	Mobile boiler for melting ice		3
13	Bulldozer	With ripper	2	8	Bulldozer	D5	
				9	Bulldozer middle with ripper	D5	1
				10	Bulldozer, large	D7	3
14	Dump truck	Loading 10t	16	11	Dump truck	10 ton	5
15	Wagon Truck	Loading 5t	15	12	Cargo truck, to be coupled with dump truck	10 ton	5
				13	Cargo truck	2 ton	10
16	Truck Crane	Load 20t	2	14	Truck crane	20 ton	4
17	Ditto	Load 16t	2				
18	Ditto	Load 10t	3				
19	Truck Crane	Loading ?t	4				
20	Trailer	Loading 40t	3	15	Trailer	20 ton	2
21	Ditto	Loading 60t	1	16	Trailer, large	40 ton	2
22	Channel Washing Machine	Base Kamaz	2	17	Pressure jet equipment with vehicle for Cleaning pipe		4
23		Base Zil	2				
24		Base Kamaz	2				
25	Sewer Washing Machine	Base Zil53016	2				
26	Vacuum Car		20	18	Truck with vacuum pump and tank		10
27	Flusher	Base Zil-5301	2	19	Road sweeper		1
28	Off-Road Car		5	20	4 wheel drive car for patrol		5
29	Concrete mixer	Base Kamaz	1	21	Mobile concrete mixer		2
30	Horizontal Drilling Unit	D=0-600mm	1	22	Oil hydraulic jack		2
31	Trenchless Pipelayer	D-50mm	2				
32	Ditto	D-600mm	1				
33	Pipe Layer	6-12t	3	23	Pipe fitter	12 ton	3
34	Compressor	10kg/cm^3	5	24	Compressor		2
35	Welding Transformer		10	25	Engine welder	20KVA	7
36	Generator	2.2kW	10				
37	Ditto	4.5kW	10				
38	Ditto	13kW	2				
39	Ditto	75kW	2				

Table 8.3.2 Comparison of ASA's Proposal and F/S (2/2)

Proposed by ASA				F/S Plan			
No.	Item	Specification	Nr.	No.	Item	Specification	Nr.
40	Power Grader		1				
41	Polling Press	Small	1				
42	Ditto	Medium	1				
43	Submergible Pump	20-100m^3/h	50	26	Mobile engine pump	200m^3/h	3
44	Pump + generator	200m^3/hr	1				
45	Ditto	500m^3/hr	1				
46	Plastic Welder	0-400mm	1				
47	Polyethylene Pipe Connector	15-200mm	1				
48	Gas Tank Truck	Base GAZ	1				
49	Ditto	Base Kamaz	1				
50	Trace Detecting Machine		2				
51	Leakage detecting Machine		2				
52	Laying on flow meter		8	27	Potable flow meter, supersonic		3
53	Flowmeter gravity and canals	D300-800	2				
54	Mobile Laboratory	Truck Base	1				
55	Water Meter testing stand	D15-50mm	1				
56	Boring Machine	Base MTZ-82	1				
57	Auto-tower	Boom22m	1				
58	Fixed Electric Laboratory		1				
59	Passenger Bus		2				
60	Laboratory for teleinspection of Pipes		1				
61	GPS		1				
	Total						
For Workshop				For Workshop			
1	Maintenance and repair Center		1	28	Work shop equipment for WTP/WWTP and ASA center		3
2	Vertical Turning lathe		1				
3	Horizontal-milling		1				
4	Vertical-milling		1				
5	Hydraulic Press	P-200-599bar	3				
6	Vertical-drilling Lathe		3				
7	Tool-grinding desk Machine		5				
8	Screw-cutting Lathe		4				
9	Screw-cutting Lathe		3				
10	Slotting Machine		2				
11	Jig saw		2				
12	Guillotine Crank shears		2				
	Total						
	Sum-Total						

Table 8.3.3 Proposed O&M Equipment

No.	Item	Type	Specification	No.
1	Bucket Loader	B-138	Bucket - 2m^3	1
2	Excavator	UDS-114A, Truck Base	Bucket – 0.35-0.65m^3	2
3	Excavator	Komatsu	P110-R1	3
4	Frozen Ground Excavator		Blade Length 2.0m	2
	Ditto	MTZ	Blade Length 1.6m	1
	Ditto	Tractor T170 Base	Blade Length 2.0m	1
5	Steam Generator	Base of off-URAL 5557	1500 kg/hr	2
6	Dump-truck	KAMAZ	Loading 10t	5
7	Wagon Truck	GAZ 3307	MAVR	5
8	Truck Crane (KAMAZ base)	Boom Length 25m	Load 16t	1
	Ditto (MAZ base)		Load 14t	2
9	Trailer		Loading 40t	1
	Ditto		Loading 20t	1
10	Channel Washing Machine	KO-514	Base Kamaz	2
	Ditto	KO-514	Base Zil	2
	Ditto	KO-560	Base Kamaz-53329	2
11	Sewer Washing Machine	DKT-260	Base Zil53016	1
12	Vacuum Vehicle	KO-503V	GAZ 3307	10
13	Flusher	KO-829-1	Base Zil-5301	2
14	Off-road Vehicle	Toyota	Land Cruiser	1
			Mini-bus	1
			Pickups	3
15	Pipe Layer	TP12.04, T170 Base	Load – 6-12t	2
16	Compressor	PKCD-1.75	10kg/cm^3	2
17	Welding Transformer	TDM-401		5
18	Generator	ADC-8-230 РЯ	Up to 2.2kW	2
	Ditto	ADC-10-T400 РЯ	Up to 4.5kW	2
	Ditto	ADC-135-T400 ЖН	Up to 13kW	1
	Ditto	ADC-100C T400PM2	Up to 100kW	1
19	Sub-merged Pump	GNOM Type	20-100m^3/h	10
20	Pump + generator		200m^3/hr	1
	Ditto		500m^3/hr	1
21	Detecting Machine	FM5860 XT		2
22	Leakage Detecting Machine	6 DKL 1506		2
23	Potable Ultrasonic Water Meter	UDM 100		8
24	Flow Meter gravity and canals	V3 LET RCL	D300-800	2
25	Mobile Laboratory	ETL-35	Truck Base	1
26	Water Meter Testing Factory	UPC Ж400/400V	D15-400mm	1
27	Passenger Bus	PAZ 3205		2
28	Truck Crane	AGP 22.04	Boom length up to 22m	1
29	Maintenance and Repair Center			1
30	Laboratory for Pipe Teleinspection	SEBA		1
31	Horizontal Boring Machine	UGB-3A Robbins HDD 6015 TMSC	D=0-600mm	1
32	Trenchless Pipe Layer	-	D=50-600mm	1
33	Groundwater Level Reduction Unit		Up to 15 m	2
34	Earth Boring Machine	Base GAZ 330 B		1
35	Polyethylene Pipe Welder	GPY 90/315	D=90-315mm	2
36	Monitoring and Communication Equipment			1
Equipment for the Workshop for Maintenance and Repair of the Pump Equipment and Valves				
37	Vertical Turning Lathe	M-1532		1
38	Horizontal-milling Lathe	M-6T82G		1
39	Vertical-milling Lathe	M-6T13		1
40	Hydraulic Press	M-P6330	P-200-599bar	1
41	Vertical-drilling Lathe	M-2S132		3

42	Tool-grinding Desk Machine	M-3L631		5
43	Screw-cutting Lathe	M-16VT20P.02		4
44	Screw-cutting Lathe	M-1M63N		3
45	Slotting Machine	M-7402		2
46	Jig saw	M-8725		2
47	Guillotine Crank Shears	M-NG-13		2

8.3.2 Instruments for Laboratory

Each one laboratory is located within the respective premises of water treatment plant and sewage treatment plant to analyze raw and treated water/sewage quality. The analysis results are referred to for confirmation of the safety of drinking water and maintaining the discharge standard of treated sewage. The results are also used for plant operation.

A new laboratory will be constructed at the water treatment plant, while the existing laboratory will be improved at the sewage treatment plant. In this regard, current practice and situation of laboratories, such as analysis items including future planning, analysis methods and existing and necessary analysis instruments were examined.

(1) Laboratory at Water Treatment Plant

To maintain the safety of drinking water, proper water analysis and management of water quality is essential. Sufficient number of skilled analysts must be assigned to the laboratory and adequate instruments and materials must be procured to meet target water indices to be analyzed.

The existing laboratory can cover almost all water quality indices required by SNiP excluding three items, which are analyzed by a different laboratory on a contract basis. The detailed information is shown in Table 8.3.4. The chief of laboratory is planning to increase water quality indices.

Table 8.3.5 shows analysis methods for each item and Table 8.3.6 shows major analysis instruments at existing laboratory, respectively. Most of these instruments were purchased 10 to 15 years ago and some of them have already been deteriorated and therefore they should be replaced at this opportunity.

Table 8.3.4 Current Analysis Indices

Division	No.	Indices	Division	No.	Indices
Analyzing under Contract	1	Pesticides	Analyzing in Laboratory in WTP	22	Aluminum
	2	Strontium		23	Beryllium
	3	Radiation α , β		24	Selenium
Analyzing in Laboratory in WTP	1	Turbidity		25	Molybdenum
	2	Color		26	Lead
	3	Odor		27	Arsenic
	4	pH		28	Manganese
	5	Alkalinity		29	Fluorine
	6	Oxidability		30	Residual active chlorine
	7	DO		31	Thermostable bacteria
	8	BOD		32	General coliform bacteria
	9	PAV(surface active agent)		33	General microbial number
	10	Polyphosphates		34	Free carbonic acid
	11	Hardness	Future Planning	1	Phenol
	12	Calcium		2	Chloroform
	13	Chlorides		3	Mercury
	14	Sulfates		4	Sodium
	15	Solid residual		5	Potassium
	16	Ammonia		6	Iodine
	17	Nitrites		7	Bromine
	18	Nitrates		8	Cadmium
	19	Iron		9	Chrome
	20	Copper		10	Cobalt
	21	Zinc		11	Aromatic hydrocarbon

Table 8.3.5 Analysis Methods

Method	Indices
Photometrical	Turbidity, PAV(surface active agent), Ammonia, Nitrites, Nitrates, Iron, Copper, Aluminum, Lead, Arsenic, Manganese,
Visual	Color, Zinc, Molybdenum,
Electromretric	PH
Titrimetric	Alkalinity, hardness, Chlorides, Residual chloride
Organpoleptical	Odor
Vinkler	DO, BOD
Turbidimetric	Sulfate
Filtration	SS
Fluorometric	Beryllium、Selenium
Potentiometric	Fluorine

Table 8.3.6 Existing Analysis Instruments

No.	Name	Specifications	Number
1	Air sterilizer	60-200 deg.C.	1
2	Electric round Desiccators	40-200 deg.C.	1
3	Sterilizing heating box	85-180 deg.C.	1
4	Dry-air electric Thermostat	28-55 deg.C.	5
5	Electric muffle furnace	Max1000 deg.C.	1
6	Steam-sterilizer	2.0±0.2 deg.C.	2
7	Distilling apparatus	4L/hr	1
8	Refrigerator	V=240dm^3	1
9	Wall bactericidal irradiator	7 piece	1
10	Microscope	Magnification 84-1350	1
11	Microscope	Magnification 100-1000	1
12	Mechanic-optical accessory	Magnification 50-1125	1
13	Vacuum Pump	0.2-0.3mmHg Pa	1
14	Water Jet Pump HB	0.8-0.95L/min	1
15	Centrifuge	6000min^{-1}	1

Proposed analysis instruments for the new laboratory are shown in Table 8.3.7 based on the proposal by laboratory staff members.

Table 8.3.7 Proposed Analysis Instruments

No.	Name	Type	Specification	Nr.
1	Drying oven	Heating	99L, 40 to 260 deg.C., heater 1.3kw	2
2	Instruments Dryer		445L, +5 to 60 deg.C., heater 1.3kw	2
3	Drying sterilizing box		99L, +5 to 260 deg.C., heater 1.2kw	5
4	Autoclave		20L, 0.18MPa, 105 to 128 deg.C.	1
	Ditto		47L, 0.2MPa, 105 to 128 deg.C.	2
5	Washing machine	Automatic	100L,with Pump & heater	1
	Washing accessory		For beaker and tube	1
6	Ultrasonic pipette washer		Dia.128mm	1
7	Ultrasonic washer		V=20L, 320W	1
8	Incubator	Low Temp.	27L, 0 to 60 deg.C., accuracy 1 deg.C.	1
			159L, 0 to 80 deg.C., accuracy 1 deg.C.	5
9	Muffle furnace		7.5L, 100 to 1150 deg.C., accuracy 2 deg.C.	1
10	Water bath		1 hole, 3.7L, +5 to 95 deg.C.	1
	Ditto		1 hole, 7L, +5 to 95 deg.C.	1
11	Electric stove	Ordinary	For cooking, 4 heater	3
12	Hot Plate		+5 to 80 deg.C., w450xL300	2
13	Magnetic stirrer with hot plate		Max 3L, 250 deg.C., 0-1500rpm	1
14	Magnetic mixer		Max 2L 80-1500rpm	5
15	Shaker	For test tube	shaking 20-200rpm table 400x400mm,with stopper for tube	1
	Ditto	For flask	shaking 20-200rpm,table 400x400mm	1
16	Analytical balance		Max210g, readability 0.1mg	2
17	Spectrophotometer	КФК-3	315-990nm, band-pass 3nm	2
18	Turbidity-tester		Tubidimetic method	1
19	Transparency tester		H=1000mm	10
20	Water collector		Bottle1L, with chain	1
21	Water collector with vessel		Bottle1L, with chain	1
22	pH meter	on desk	Range 0-14, accuracy 0.01, ORP	3

23	Electro-conductivity meter	on desk	0-200mS/cm	1
24	Centrifuge		5000rpm, capacity 1litter	1
	Ditto		5000rpm, 8 cells	1
25	Microscope	Binocular	Magnification100-1500	3
26	Refrigerator for laboratory		400L, 1box(2-14 deg.C.)+1box(-30 deg.C.)	4
27	Ditto		350L, transparency window	2
28	Rotary evaporator		1Lfrask, 20-180rpm, +5 to 95 deg.C.	1
29	Residual chlorine meter	Portable	0-2.5ppm, accuracy 0.03ppm	1
30	Water Purification apparatus		1.8L/hr, Distillation + Ion exchange	1
31	Vacuum pump		10L/min, 0.8kPa	1
	Ditto		20L/min, 0.8kPa	1
32	Thermometer		Digital, -50to150 deg.C.	2
33	Timer		Digital, 10hr	2
34	Thermometer & humidity meter		-30to50 deg.C.,0-100%	1
35	Liquid analyzer	02-3M	Luminescent and photometrical method, Work range of spectrum, 200-650nm	1
36	Gas chromatograph	Г а л с - 311	Plasma-ionizing: $5x10^{-12}$g/sec, Electronic capture: $5x10^{14}$g/sec, Heat-conduction: $5x10^{-8}$ g/sm^3, Range of temperature: 50 to 399 deg.C.	1
37	Atomic absorption spectrophotometer	М Г А-915	Automatic test (drying of sample, pyrolysis, atomization and cleaning of cuvette), with electrothermal atomization and Zeeman correction Spectral range 190-550nm, Spectral resolution: 2nm.	1
38	Apparatus for bacteriological cultivation and colony calculation	Standard set	including sterile nutrient medium, vacuum filtration system, steel forceps, metering syringe, 50 of casing syringe filter/Minisart, CAN , apparatus of colony calculation, filter 10,000 and others	1
39	Apparatus of colony counting		With dector sets and incubator, for 5type of bacillus	1
40	Jar tester		6 paddles, variable speed (10-300rpm)	2
41	Exhaust hood	with Fan	W1500xL750xH2350	3
42	Laboratory table	Central	With sink+shelf, W1500xL3600xH800	1
43	Ditto	Ditto	With sink+shelf, W1500xL2400xH800	1
44	Laboratory table	Side	With shelf W1800xL750xH800	3
45	Ditto	Ditto	W1800xL750xH800	14
46	Ditto	Ditto	W1200xL750xH800	3
47	Ditto	Ditto	W900xL750xH800	1
48	Work bench		W1800xL750xH800	3
49	Ditto		W1500xL750xH800	3
50	Table Corner		950x950x800	4
51	Sink		W1200xL750xH800 Partly sink	1
52	Ditto		W1200xL750xH800 Full sink	3
53	Ditto		W600xL750xH800 Full sink	3
54	Storage cabinet		W1760xL400xH1800	7
55	Ditto		W880xL400xH1800	3
56	Balance Table		W900xL600xH750	2
57	Van lack case		W844xL320xH1790	1
58	Laboratory cabinet		W485xL620xH1800	1
59	Steel shelf		W1800xL600xH1800	5
60	Steel shelf		W1200xL600xH1800	4
61	Furniture		Tables, Lockers, shelves, others	1
62	Glass-ware			1
63	Reagent			1

(2) Laboratory in Sewage Treatment plant

The sewage treatment plant accepts sewage generated in Astana City, and the sewage is biologically treated and discharged into Taldy-Kol reservoir. Therefore, the discharged treated sewage quality must meet the quality standard enacted by the regulation in Kazakhstan.

At laboratory in sewage treatment plant, quality analysis of raw sewage, treated sewage and Taldy-Kol reservoir water is currently conducted. For appropriate analysis accuracy, sufficient number of skilled analysts must be assigned and adequate instrument and materials must be provided according to sewage quality indices to be analyzed.

Current analysis indices are shown in Table 8.3.8 and the chief of laboratory is planning to add mercury as analysis items.

Table 8.3.8 Current Analysis Indices

No.	Indices	No.	Indices
1	Suspended Solids	14	Synthetic surface active agent
2	PH	15	Total Chromium
3	COD	16	Oil and Grease
4	BOD_5	17	Nickel
5	DO	18	Phosphates
6	Nitrites	19	Total hardness
7	Nitrates	20	Transparency
8	Ammonia Nitrogen	21	Temperature
9	Sulfates	22	E-coli.
10	Chlorides	23	Toxicity
11	Iron	24	Vital ova of helminthes
12	Solid residual	25	Alkalinity
13	Zinc		

Table 8.3.9 shows analysis methods for each item. Table 8.3.10 shows major instruments for analysis in existing laboratory. Most of those instruments were purchased 20 years ago, therefore they should be replaced in this opportunity of new construction of laboratory.

Decided instruments for the new laboratory are shown in Table 8.3.11 based on the proposal by laboratory staffs.

Table 8.3.9 Analysis Methods

No.	Indices	Code and name of the Normative Documentation
1	pH	GOST 26449.1-85 Electrometric method for determination of pH.
2	Temperature	Technological control method of wastewater treatment facilities.
3	SS	GNPOPE "Kazmekhanobr" Methodology of the gravimetric determination.
4	COD	RD 204.2.08-91 Method of determination of COD in wastewater.
5	BOD_5	RD 204.2.07-91 Method of determination of BOD.
6	Dissolved oxygen	RD 204.2.11 Determination method by Vinkler.
7	T-N	GNPOPE "Kazmekhanobr" Photocolorimetric determination with the Griss reagent.
8	NO_3	Visual test with the natrium salicylate.
9	NH4-N	Visual test with the Nesler reagent.
10	Phosphates	GOST 26449.1-85 Photocolorimetric determination with the ascorbic acid.
11	Chlorides (Cl)	GOST 26449.1-85 Mercurrometric method.
12	Sulphates (SO_4)	RD 52.24.53-88 Method of the titrimetric determination with the lead salt.
13	Solid residual	GOST 26449.2-85 Gravimetric determination.
14	Surface active agents	RD 204.2.09.2-91 Method for determination of synthetic surface active agents.
15	Oil & Grease	GOST 26449.1-85 Gravimetric determination method.
16	Chromium Cr	RD 204.2.03-91 Method for determination of the total chromium.
17	Zinc (Zn)	Visual test with reagent.
18	Ferrous (Fe)	GOST 26449.1-85 Photocolorimetric determination method with the sulphate-salicylate acid.
19	Nickel	GOST 26449.1-85 Photocolorimetric determination of nickel.
20	Alkalinity	GOST 26449.1-85 Titrimetric method.
21	Hardness	GOST 26449.1-85 Complexometric method.
22	DAE	AKKh, K.O. Panfilov. Moscow 1985.
23	Helminthes	Methodical instruction MUK 4.2.668-97.
24	E-coliform	SanPiN 3.01.067-97 MUK 4.2.671-97.
25	Sludge dose by weight, volume, sludge index, hydro-biological analysis.	Recommendations on conduction of the operative hydro-biological control at the facilities of the biological treatment of aeration tanks. Moscow 1987.
26	Moisture, ash content, sand content, factious composition	Method of the technological control of operation of the treatment facilities of the city sewerage system.

Table 8.3.10 Existing Analysis Instruments

No.	Name	Procured Year	Number
1	Universal ion meter EV-74	1982	2
2	Laboratorial ion meter E-130	1989	1
3	Photoelectrical colorimeter KFK-2	1987	3
4	Dry-air thermostat TS-80M-2	1992	1
5	Thermostat with a water-jacket 3Ts-1125 M-	1977	1
6	Thermostat "Biotest"	2002	1
7	Drying-sterile box Shss-80P	1977	1
8	Laboratory scales 2 kl VRL-200	1985	3

9	Quadrant scales 4 kl VLKT-500	1988	2
10	Technical scales	1977	1
11	Draft hood	1977	2
12	Drying box up to 200 degree	1971	2
13	Muffle furnace SNOL-1,6.2,5.1/9-E4	1990	1
14	Glass twice-distiller BS	1991	1
15	Aqua-distiller DE-4-2 M	1993	1
16	Medicine centrifuge Opn-8	1985	1
17	Stereoscopic microscope MBS-9	1985	1
18	Refrigerator	1998	1
19	Autoclave VK-75	1988	1

Table 8.3.11 Proposed Analysis Instruments

No.	Name	Type	Specification	Nr.
1	Drying oven	Heating	162L, 40 to 260 deg.C.	3
2	Autoclave		32L, 0.2MPa,105 to 128 deg.C., heater 1.7kW	1
3	Incubator	Low Temp.	43L, 0 to 60 deg.C.	1
4	Muffle furnace		17.5L, 100-1150 deg.C.	1
5	Water bath		4 hole, 9L, with heater	2
6	Water Purification apparatus	DЭ- 25	25L/hr, 18kW	1
7	Microscope	Binocular	Magnification 100-1500, with light	1
8	Liquid analyzer	02-3M	Luminescent and photometrical method, Work range of spectrum, 200-650nm	1
9	Dish-washing machine	Semi-auto	100L,heater 1kW	1
	Washing accessory		for beaker and tube	1
10	Instruments Dryer		445L, +5 to 60 deg.C., heater 1.3kW	1
11	Drying carts		W820xL540xH900	2
12	pH meter	on desk	Range 0-14, accuracy 0.01, glass electrode, ORP measurement	1
	Ditto	Portable	Ditto	2
13	Mercury analyzer	РЛ-915	For measuring mercury contents in water and solid	1
14	Apparatus for bacteriological cultivation and colony calculation	Sartorious Standard	Standard set: sterile nutrient medium, vacuum filtration system, steel forceps, metering syringe, 50 of casing syringe filter/Minisart, CAN, apparatus of colony counting	1
15	Analytical balance	Top loading	Max100g, readability0.1mg	2
16	Technical balance	Electronic	Max1kg, readability1mg	1
17	Magnetic stirrer		80-1500rpm, Max 2L	2
	Ditto		70-1300rpm, Max 5L	2
18	Spectrophotometer	КФК-3	315-990nm, band-pass 3nm	2
19	BOD-tester	Portable	0-20mg/L	1
20	COD-tester	Automatic	30-1500mg/L	1
21	DO meter	Desktop	0-60mg/L, Temp.-5to50 deg.C.	3
22	Bottle heater	ПЭ-4010	V=500mL, 400 deg.C.	2
23	Electric range	Hot Plate	Over 0.75kw	4
24	Extractors,	ПЭ-8000		1
	Ditto	ПЭ-8010		1
	Ditto	ПЭ-8010		1
25	Rotary evaporator		1Lfrask, 20-180rpm, +5to95 deg.C.	1
26	Personal Computer		For Reporting, desk top	2
27	Refrigerator	Ordinary	Over300L	3

28	Electric stove		For cooking, 4 heater	1
29	Apparatus for Kjeldahl nitrogen determination	Auto-type	Digesting system complete with lift motor, For100ml tube	1
30	Residual chlorine meter	Portable	0-2.5ppm, accuracy 0.03ppm,	3
31	GOST samples of contents of water solutions		30itmes	1
32	Centrifuge	Desktop	4000rpm, 8cell	1
33	Exhaust hood	with Fan	W1500xL750xH2350	3
34	Laboratory table	Central	With sink+shelf, W2400xL1500xH800	3
35	Ditto	Side	With shelf, W1800xL750xH800	3
36	Ditto	Side	W1800xL750xH800	4
37	Ditto	Side	W1200xL750xH800	6
38	Work bench		W1500xL750xH800	2
39	Table corner		W950xL950xH800	6
40	Sink	Side	W1500xL750xH800	2
41	Sink	Side	W1200xL750xH800	1
42	Storage cabinet		W1760xL400xH1800	3
43	Ditto		W880xL400xH1800	4
44	Van lack case		W840xL320xH1790	1
45	Laboratory cabinet		W485xL620xH1800	1
46	Steel shelf		W1800xL600xH2400	2
47	Steel shelf		W1200xL600xH2400	1
48	Balance Table		W900xL750xH800	3
49	Water purification apparatus		Ion exchange and distillation	1
50	Transparency tester		Visual observation transparency tester	7
51	Furniture		Tables, Lockers, shelves, others	1
52	Glass-ware			1
53	Reagent			1

CHAPTER 9 OPERATION AND MAINTENANCE PROGRAM

CHAPTER 9 OPERATION AND MAINTENANCE PROGRAM

9.1 Present Operation and Maintenance System

9.1.1 Operation and Maintenance for Water Supply System

(1) Water Supply System

The schematic drawing of Astana water supply system is shown in Figure 9.1.1. The system is divided into two, namely drinking water system and technical water system.

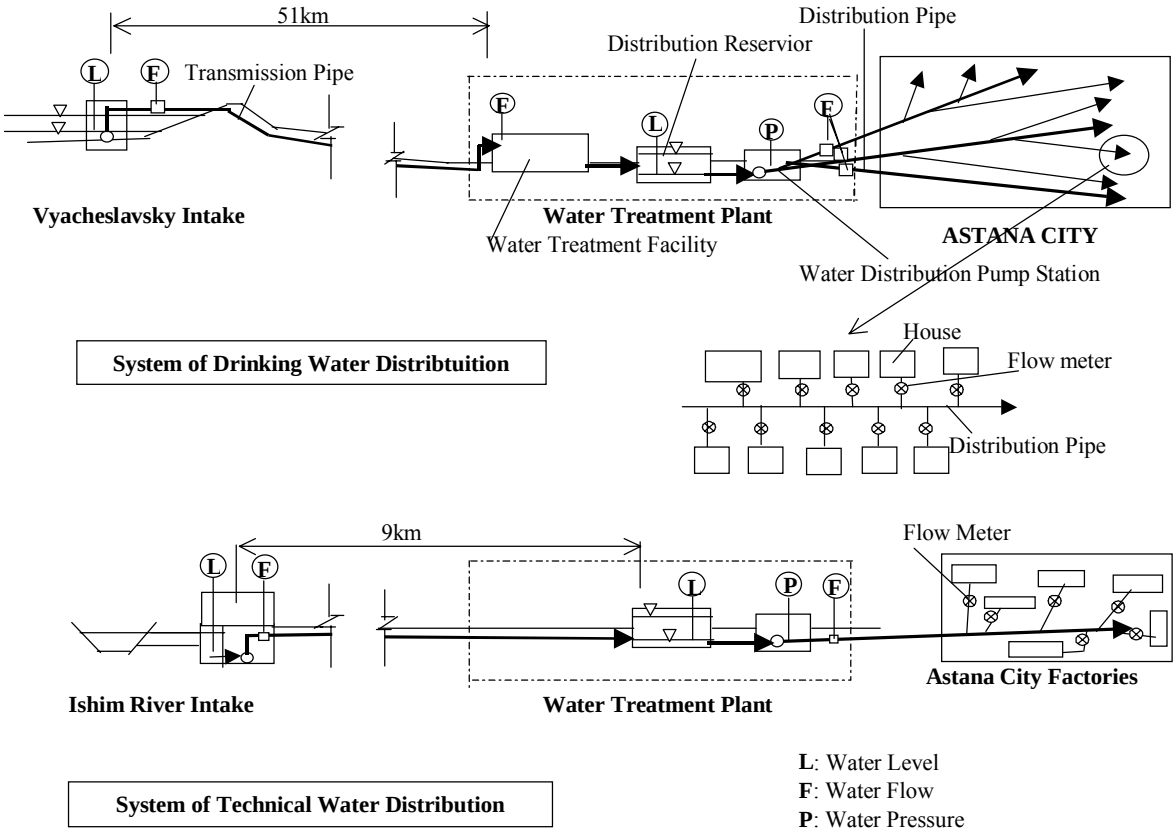


Figure 9.1.1 Water Supply System in Astana City

The drinking water system is deriving water from the Vyacheslavsky reservoir and sending raw water to the water treatment plant (WTP) in Astana City through raw water transmission pipeline with length of around 51km. The coagulation-sedimentation process and the rapid sand filter treat raw water. The treated water flows in the distribution reservoirs and is distributed to the consumers through distribution pump station.

Every housings and entities are served by distributed water. Water meters have already been installed to some of housings and most of large consumers including apartment buildings,

while most of detached houses and flats of apartments have not been installed yet. Water tariff is calculated based on consumed water amount measured by individual water meter, while fixed rate based on assumed water consumption is charged to consumers without individual water meter. In case of bulk meter installed in distribution main supplying water to apartment buildings, tariff is distributed based on the number of family member.

The relation between several water amount classifications is shown below:

$Q_1=Q_2+q_1=Q_3+q_1+q_2$

Q_1: Intake water amount

Q_2: Distributed water amount

Q_3: Revenue earning water amount

q_1: Leakage in transmission pipe + utility and loss in WTP

q_2: Leakage in distribution pipe (upstream of water meter) + water meter error + illegal connection consumption

The rate of Q_2/Q_1, Q_3/Q_2 and Q_3/Q_1 should be smaller for saving water source and expense for water treatment, transmission and distribution. Currently, the rate of Q_2/Q_1 is assumed 0.95 to 0.93 and Q_3/Q_2 is estimated around 0.7.

Technical water system is taking water from the Ishim River and transmitted to WTP through raw water transmission pipeline with length of 9 km. Raw water is not treated and flows into the distribution reservoir of technical water. Technical water is distributed to factories in Astana City.

(2) Staff Assignment

Staff for operation, maintenance and repair work of water supply facilities are assigned in intake pump station, WTP, two booster pump stations and ASA central office. Current staff number excluding that of booster pump stations are shown in Table 9.1.1 and Table 9.1.2. As shown in these tables, numbers of staff for intake pump station and WTP are more than those of similar facilities in other countries that is operated with only 1/2 to 1/3 staff of those assigned in former two facilities.

The shift workers are assigned as follows: One team work 12 hours a day and next day, they are off-duty. Therefore the number of teams is four. Two staff per shift are assigned in Vyacheslavsky intake and seven staff including engineer are assigned in WTP. In WTP, additional stand-by staff are assigned for all shifts and two laboratory shift staff are also assigned.

Table 9.1.1 Staff Number for Water Supply Facilities

Work Role	Position	Vyacheslavsky Intake	WTP
Administration Staff	Manager	1	1
	Engineer	1	4
	Total	2	5
Shift workers (4 Teams)	Engineer		4
	Specialist	8	25
	Total	8	29
Laboratory	Chief		1
	Engineer		3
	Analyst		8
	Shift Staff		9
	Total		21
Repair	Staff	3	20
Others	Staff	2	9
Total		15	84

Table 9.1.2 shows staff for transmission and distribution network assigned in ASA central office. These staff are assigned for operation and maintenance, repair, emergency countermeasure and construction work. They are working for both of water supply and sewerage system. Total number of staff assigned in facilities and ASA central office is very huge from viewpoint of scale of water work, however they can cover the most of maintenance and repair work.

Table 9.1.2 Staff Number of ASA for Water Supply

Work Role	Staff No.	Note
Water Network-zone1	15	
Water Network-zone2	15	
Emergency Team	24	Common with Sewage
Workhop	10	Ditto
Mechanical section	150	Ditto
Electrical section	60	Ditto
Repair/construction	34	Ditto
Total	308	

This number can be drastically reduced if most of repair work contract out to private companies.

(3) Present Operation and Maintenance Status

1) Quantitative control

The quantitative control of drinking water is practiced as follows:

- Transmission water amount is decided by the shift-working engineer in WTP based on the water level in distribution reservoir and assumption of expected water consumption. The engineer informs the estimated water amount to intake P/S through radio communication

equipment when he plans to change the transmission water amount.

- When operators of intake P/S receives the instruction from the engineer, they control water amount by changing operating pump unit number and control the valve opening ratio. In case of valve squeezing to reduce the transmission water amount, high pump discharge pressure and huge electricity consumption are caused.
- The transmitted water flows into rapid mixing tank in WTP, and then water flows into sedimentation basins, rapid sand filters and finally reaches to distribution reservoirs. Total flow control is not executed in these treatment processes, however, control of each basin is conducted, especially in rapid sand filters.
- Chlorine is injected to treated water and then water is distributed to the city through the distribution P/S. The water pressure in distribution pipe is controlled by controlling the number of pumps on-duty. Control of operation pump unit number and valves are conducted to meet the required pressure range of 5.0 to 5.5 kg/cm^2. The daily-distributed water amount fluctuates from 120,000 m^3/day to 160,000 m^3/day.

2) Qualitative control

Since the water quality control for drinking water is quite important, analysis of necessary water quality indices is the most responsible obligation required for WTP operation.

The current practice of water quality indices analyzed at WTP is shown in Table 9.1.3. Those are divided into four cases. Sampling points and frequencies of analysis is shown in Table 9.1.4. These analysis indices, sampling points and frequency are corresponding to SNiP.

Table 9.1.3 Analysis Indices for Water Supply Facilities

Division	No.	Item	Case			
			1	2	3	4
Analyzing under Contract	1	Pesticides				V
	2	Strontium				V
	3	Radiation α , β				V
Analyzing in Laboratory of WTP	1	Turbidity	v	V		
	2	Color	v	v		
	3	Odor	v	v		
	4	pH	v	v		
	5	Alkalinity	v	v		
	6	Oxidability	v	v		
	7	DO	v	v		
	8	BOD	v			
	9	PAV (surface active agent)	v			
	10	Polyphosphates	v			
	11	Hardness	v			
	12	Calcium	v			
	13	Chlorides	v			

	14	Sulfates	v	v		
	15	Solid residual	v	v		
	16	Ammonia	v			
	17	Nitrites	v			
	18	Nitrates	v			
	19	Iron	v			
	20	Copper	v			
	21	Zinc	v			
	22	Aluminum	v			
	25	Molybdenum	v			
	26	Lead	v			
	27	Arsenic	v			
	28	Manganese	v			
	29	Fluorine	v	v		
	30	Residual active chlorine	v	v		
	31	Free carbonic acid	v			
	32	Thermostable bacteria	v			
	33	General coliform bacteria	v			
	34	General microbial number	v			
	35	Beryllium			v	
	36	Selenium			v	

Table 9.1.4 Analysis Points and Frequencies in Water Supply System

Division	Point	Frequency	Analysis Items
Water Source	Vyacheslavsky Reservoir	Monthly	Case1
		Annually	Case3
	Ishim River Intake	Monthly	Case1
		Annually	Case3
	Wells in suburb	2 times/year	Case1
Water Treatment Plant	Rapid Mixer No.1, 2	12 times/day	Turbidity
		2 times/day	Case2
	Outlet of sedimentation	2 times/day	Case2
	Outlet of Filter	6 times/day	Turbidity
		2 times/day	Case2+2+30 in Table9.1.3
		1 time/week	32 to 34 in Table9.1.3
	Distribution water	24 times/day	Residual active chlorine
		12 times/day	Turbidity
		2 times/day	Case2
		1 times/day	22+32 to 34 in Table9.1.3
		Annually	Case4
In the City	5 Distribution P/S	Monthly	Case1
		Annually	Case3

As shown in the tables, the quality analysis in Astana City has been soundly practiced, however those analysis results must be reflected to the operation of WTP.

In WTP, quality control is basically performed by the control of coagulant and chlorine dosing rates. The chlorination can be properly controlled by control of injection rate based on

the results of hourly water quality analysis. Coagulant injection rate should be determined by the result of coagulation test. The procedure of coagulation test is as follows:

i) Some rates of coagulant are poured in one litter beakers filled with raw water.
ii) Then mix properly by the same mixing rate adopted in rapid mixer and flocculation basin.
iii) Analyst observes condition of formulating flocks and settling tendency, and decides proper coagulant injection rate.

This coagulation test is called as "Jar Test". At present, this kind of test is not conducted and injection rates are decided based on site visual observation of flocculation situation and past practices.

3) Maintenance and repair work

Necessary operation and maintenance work for the water supply system is shown in Table 9.1.5. Deteriorated structures and malfunctioning equipment shall be repaired or replaced. Potential targets are tabulated in Table 9.1.6.

As shown in abovementioned Tables 9.1.1 and 9.1.2, many staff are assigned for maintenance and repair work. These staff can undertake almost all the work.

Table 9.1.5 Operation and Maintenance Work Items for Water Supply System

Facility	Operation	Maintenance
Intake Pump Station	- Control of intake flow - Monitoring of flow, water level, pressure, temperature and electric consumption - Emergency shut down of pumps - Switching intake gate - Adjustment of valves - Making report - Report to the water treatment plant	- Periodic and irregular check of function for each and total equipment and facilities - Patrol of facility and finding of abnormal phenomenon - Adjustment of equipment and facilities - Oiling and replacement of oil - Making report - Report to upper organizations - Repair troubled equipment if possible - Requirement repair team - Cleaning
Water Treatment Plant	- Control of discharge water pressure - Control of distribution flow - Control of Intake flow (decision of flow and order to intake station) - Control of coagulant and chlorine injection rate - Analysis of water qualities - Confirmation of distribution water - Control of inlet flow rate of each sedimentation tank and rapid sand filter - Control of backwashing of rapid sand filters - Control of sludge withdraw interval of sedimentation tank and sludge thickener - Control of washing drain basin and discharge pool - Control of sludge drying bed - Discharge dried sludge - Monitoring of flow, water level pressure, temperature, chemical and electricity consumption - Making report - Report to ASA - Ordering chemical and consumption articles	- Periodic and irregular check of function for each and total equipment and facilities - Patrol of facility and finding of abnormal phenomenon - Taking record of measured results - Analysis of operation record and use for improvement of operation - Adjustment of equipment and facilities - Oiling and replacement of oil - Making report - Report to upper organizations - Repair troubled equipment if possible - Requirement repair team - Cleaning and Painting
Transmission Pipe	- Monitoring water flow and pressure	- Patrol along Pipes - Implementation of leakage detection if leakage is found
Distribution Pipe	- Monitoring water flow and pressure	- Patrol along Pipes - Implementation of leakage detection if leakage is found
Water Meter	- Meter reading	- Regular replacement of meters - Check of meters by meter reading

Table 9.1.6 Structures and Equipment to be Repaired or Replaced (Water Supply System)

Facility Name	Facilities
Intake Pump Station	Civil structure of pump station, Management buildings, Pumps, Pipes, Auto-valves, Gates, Screens, Cranes, Electric power facilities, Electric control facilities, Electric observation facilities, Information facilities, Electrical power and signal cables
Water Treatment Plant	Civil structures of flocculation basin, sedimentation basin, distribution reservoir and sludge treatment basins, Buildings of administration, coagulant, cover for rapid mixer and send filter, distribution pumps and chlorination facilities, Pumps, Pipes, Auto-valves, Gates, Cranes, Rapid sand filter facilities, Electric power facilities, Electric control facilities, Electric observation facilities, Information facilities, Electrical power and signal cables, Coagulation facilities, Chlorination facilities
Transmission and Distribution Pipes	Pipes, Valves, Boxes
Meters	Water meters for individual house and apartment

(4) Power and Chemical Consumption

1) Power consumption

The power and chemical consumption and their costs at water supply system for both of drinking and technical water in 1999 to 2000 are shown in Table 9.1.7. The No.7 pump station is a booster P/S for northern part of the city. As shown in the table, the Vyacheslavsky intake P/S consumed 44% of total electricity, while WTP consumed 37%. These two facilities consumed almost 80 % of the total electricity consumed by the whole water supply system. Pumps in these facilities are consuming most of the power.

2) Chemical consumption

Consumption and costs of alum, polymer as coagulant and chlorine as disinfection agent is also shown in Table 9.1.7. The average alum dozing rate is very low. General alum dosing rate is ranging from 20 to 40mg/L. While that of chlorine is relatively high.

(5) Key Issues on Present Status

Key issues on present status of water supply system are as follows:

1) Difficulty in volumetric control on transmission water of Vyacheslavsky intake P/S

The discharge volume of existing intake pumps is very large, with volume of 6,300 m^3/hr or 151,200 m^3/d, and it makes volumetric control difficult. Additionally, when valve squeezing is performed for volumetric control, high pump discharge pressure and huge electricity consumption are caused.

Table 9.1.7 Power and Chemical Consumption of Water Supply System in Astana City

Item		Electricity					Alum	Polymer	Chlorine
Unit Cost		3.8					11	27.5	80
Plant Name		WTP	Vyacheslavsky	Ishim	No.7 P/S	Total	WTP		
Unit		kWh/day					kg/day	kg/day	kg/day
1999	September	35,216	46,659	4,584	5,300	91,759	1,218	0	450
	October	36,545	54,578	7,627	5,300	104,050	1,178	0	404
	November	38,367	52,775	8,964	5,300	105,405	1,215	0	385
	December	32,899	34,411	23,673	5,300	96,283	1,510	0	336
2000	January	35,907	35,579	19,723	5,300	96,509	210	0	296
	February	37,496	33,955	23,552	5,300	100,303	232	0	290
	March	35,886	34,049	14,586	5,300	89,821	252	0	282
	April	35,815	30,998	20,158	5,300	92,271	783	90	336
	May	34,732	34,359	13,486	5,300	87,877	1,346	87	417
	June	33,633	43,140	10,195	5,300	92,268	2,667	90	569
	July	34,016	55,834	5,947	5,300	101,097	2,122	87	518
	August	34,835	55,658	6,751	5,300	102,544	1,399	44	538
Total		12,880,798	15,549,552	4,847,070	1,934,500	35,211,920	411,091	18,147	148,060
Average		35,290	42,602	13,280	5,300	96,471	1,126	50	406
Expense: KZT		48,947,031	59,088,298	18,418,867	7,351,100	133,805,296	4,521,998	499,042	11,844,780
Annual Water Volume (m^3)		56,214,845	40,277,570	18,860,894	6,132,000	56,214,845	48,731,537	48,731,537	48,731,537
Consumption per Water kWh/m^3, (mg/L)		0.23	0.39	0.26	0.32	0.63	(8.43)	(0.37)	(3.04)
Expense (KZT/m^3)		0.87	1.47	0.98	1.20	2.38	0.09	0.01	0.24

2) Proper determination of coagulant dosing rate

Based on the field inspection, turbidity of incoming water of rapid sand filter should be lowered. Proper determination of coagulant dosing rate based on the results of Jar Test is indispensable.

3) Deteriorated facilities

Existing Vyacheslavsky intake P/S and WTP have already been deteriorated. New intake P/S will be constructed in this project but facilities in the existing WTP shall be maintained continuously for emergency use in the future. Therefore, appropriate operation and maintenance work, including repair work for those facilities shall be continuously conducted.

4) Low efficiency of existing facilities

For efficient plant operation, polymer shall be adopted as coagulant but according to the current practice, only alum is used. The efficiency of existing sedimentation basin is low, since the basin has no outlet weir necessary to prevent overflow of floc. If modification of sedimentation tank will not be undertaken by ASA, polymer shall be utilized to relieve said problem for upgrading the treatment efficiency.

9.1.2 Operation and Maintenance for Sewerage System

(1) Sewerage System

Figure 9.1.2 shows the schematic drawing of Astana sewerage system.

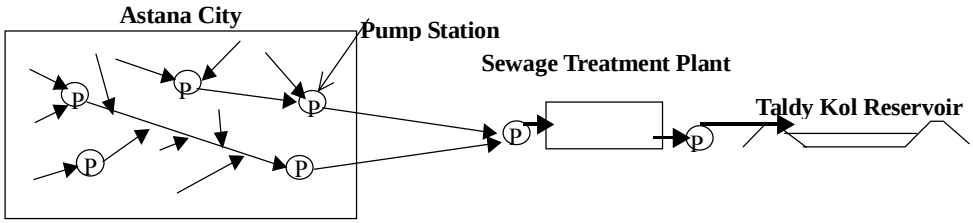


Figure 9.1.2 Sewerage System of Astana City

Sewage is collected by pipeline network by gravity and pressure. Since Astana City has flat terrain, intermediate pump stations to lift up sewage are necessary to avoid deep sewer pipe installation. Total number of pump stations was 37 as of 2003.

Sewage is treated in the sewage treatment plant by conventional activated process. The effluent is discharged to the Taldy Kol Reservoir without disinfection.

Sludge generated in STP is treated in digesters and sludge drying beds, and dried sludge cake is disposed within the STP premises.

(2) Staff Assignment

Staff assignment in STP is shown in Table 9.1.8.

Table 9.1.8 Staff Assignment in STP

Work Role	Position	STP
Administration	Manager	1
	Engineer	3
	Total	4
Shift working (4team)	Engineer	4
	Specialist	40
	Total	44
Laboratory	Chief	1
	Engineer	2
	Analyst	8
	Total	15
Repair	Staff	21
Others	Staff	10
Total		90

Based on F/S report, 108 staff are assigned for the maintenance work of the sewer pipelines and the sewage pump stations. 278 staff are assigned in the ASA central office and they are working for both water supply and sewerage system. Staff assignment list is shown on Table 9.1.9.

Table 9.1.9 Staff Assignment of ASA Central Office

Work Role	Staff No.	Note
Sewer network	108	
Emergency Team	24	for water supply and sewerage
Workhop	10	Ditto
Mechanical section	150	Ditto
Electrical section	60	Ditto
Repair/construction	34	Ditto
Total	278	

(3) Present Operation and Maintenance Status

1) Quantitative control

Sewage flow rate is affected by snow melting in spring. It increases rapidly in May as shown in Figure 9.1.3.

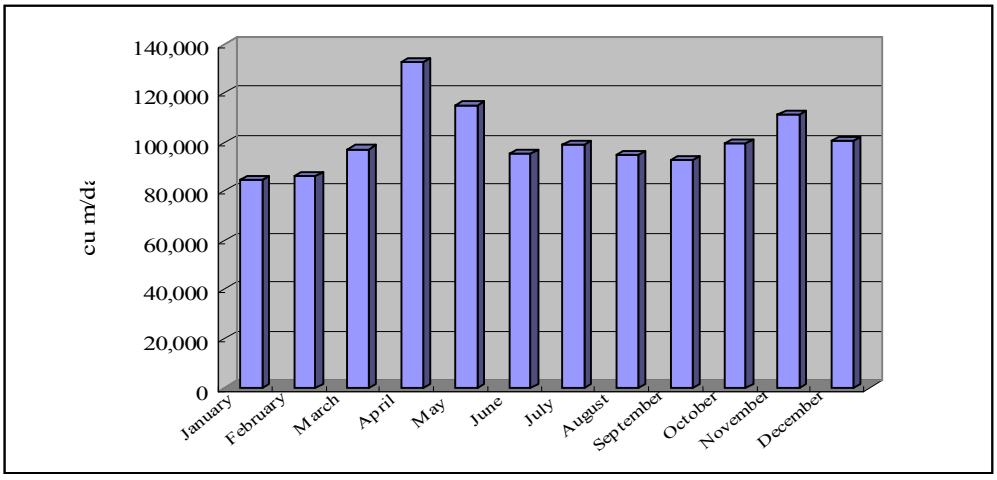


Figure 9.1.3 Average Daily Sewage Flow in 2001.

2) Qualitative control

Quality control of STP is carried out by as follows:

- Regulation of air volume (aeration tank)
- Regulation of return sludge rate (aeration tank)
- Control feeding sewage amount for each treatment basin

For sewage quality analysis, samples are taken from nine points within the plant and Taldy Kol reservoir as shown in Table 9.1 10. Sampling frequency and indices are also shown below. Analysis indices and contents of case 1, case 2 is shown in Table 9.1.11, 12 and 13.

Table 9.1.10 Analysis Points and Frequencies in STP

Sampling Point	Frequency	Sample No.	Analysis Indices
Inlet pump station	Everyday	1	Case 1 (see Table 9.1.12)
Outlet grit chamber	3times/month	1	All items
	Everyday	1	Case 1 (see Table 9.1.12)
Outlet preliminary clarifier	3times/month	1	All items
	Everyday	1	Case 1 (see Table 9.1.12)
	2times/week	6	SS
In Aeration tank	Everyday	2	Case 2 (see Table 9.1.13)
	2times/week	2	Microscopic exam. E. C. +Vital ova of helminthes
Distribution chamber for final clarifier	Everyday	1	Case 2 (see Table 9.1.13)
Outlet final clarifier	3times/month	1	All items
	2times/week	8	SS, phosphates
	Everyday	1	Case 1 (see Table 9.1.12)
Return sludge	Everyday	2	Case 2 (see Table 9.1.13)
Discharge pump station	Everyday	1	Case 1 (see Table 9.1.12)
Taldy Kol reservoir	3times/month	1	All items

Table 9.1.11 Analysis Indices for Sewage

No.	Indices	No.	Indices
1	Odor	15	Zinc
2	Color	16	Synthetic surface active agent
3	Suspended Solids	17	Total Chromium
4	PH	18	Oil and Grease
5	COD_{Cr}	19	Nickel
6	BOD_5	20	Phosphates
7	DO	21	Total hardness
8	Nitrites	22	Transparency
9	Nitrates	23	Temperature
10	Ammonia Nitrogen	24	E-coli.
11	Sulfates	25	Toxicity
12	Chlorides	26	Vital ova of helminthes
13	Iron	27	Alkalinity
14	Solid residual		

The indices of SV30, concentration of sludge (SS), total dissolved solid, and microscopic examination are also conducted for control of MLSS and return sludge. SV30 and microscopic examination is especially important to determine the condition of activated sludge.

Table 9.1.12 Daily Water Analysis Indices

No.	Indices
1	Odor
2	Color
3	Suspended Solids
4	PH
5	COD_{Cr}
6	DO
7	Chlorides
8	Transparency
9	Temperature

Table 9.1.13 Daily Sludge Analysis Indices

No.	Indices
1	SV30
2	DO
3	Concentration of Sludge
4	Total dissolved Solid

3) Maintenance and repair work

Necessary operation and maintenance work for the sewerage system are shown in Table 9.1.14. Structures and equipment for the rehabilitation are shown in Table 9.1.15.

Table 9.1.14 Operation and Maintenance Work Items for Sewerage System

Facility	Operation	Maintenance
Sewer Lines	---	- Patrol along Pipes - Check manhole covers
Intermediate Pump Station	- Monitoring of emergency alarm - Emergency shut down of pump	- Periodic and irregular check of function for each and total equipment and facilities - Patrol of facility and finding of abnormal phenomenon - Removing of screening - Making patrol report - Report to ASA abnormal operation
Sewage Treatment Plant	- Monitoring of flow, water level, pressure, temperature, electricity and materials consumption - Operations of pumps, blowers, screens, gates, valves, boilers, electrical equipment and others - Operation of aeration tanks through control of operating, blower units, air diffuse volume, return sludge rate and withdrawing excess sludge volume - Operation of grit chamber through final clarifier - Operation of digestion tank through control of sludge volume of throwing into digestion tank and withdrawing from the tank, and control of temperature of the tank - Operation of sludge drying bed through control of throwing into beds and discharge from beds - Operation of sludge drying bed through control of throwing into beds and discharge from beds - Taking record of operation status - Making report of operation - Report to ASA	- Periodic and irregular check of function for each and total equipment and facilities - Patrol of facility and finding of abnormal phenomenon - Taking record of measured results - Removing of screening - Removing of settled sand by grit chamber - Taking record of measured results - Analysis of operation record and use for improvement of operation - Adjustment of equipment and facilities - Oiling and replacement of oil - Making report for maintenance - Report to upper organizations - Repair troubled equipment if possible - Requirement repair team - Cleaning and Painting

(4) Power Consumption

The power consumption and electricity in STP on 2001 is shown in Table 9.1.16. The average power consumption per treated water was 0.5 kW/m^3, which is much larger than the value of 0.3 to 0.4 kWh/m^3 for the typical sewage treatment plant. The reasons of this high power consumption can be related to the presence of discharge pump, high return sludge rate (100%) and to the low efficiency of blower.

The coal boiler is used for heating of digester and buildings. Annual coal consumption is around 6,200 ton/year, and approximately 4,500 ton is consumed in six month during winter

season. Total cost is calculated in Table 9.1.16.

Table 9.1.15 Structures and Equipment to be Repaired or Replaced (Sewerage System)

Facility Name	Facilities
Sewer line	Concrete and steel pipes, Manholes
Sewage pump station	Structure of P/S including upper building, Pumps, Screens, Pipes, Valves, Gates, Cranes, Electric power facilities, Electric control facilities, Electrical power and signal cables
Sewage treatment plant	Civil structures of a intake P/S, grit chambers, preliminary clarifies, aeration tanks, final clarifiers, a discharge P/S, sludge thickeners, digestion tanks and sludge drying beds, Buildings of administration, blower, boiler, workhop and others, Pumps, Auto-valves, Gates, cranes, an electric sub-station, Electric power facilities, Electric control facilities, Electric observation facilities, Information facilities, Electrical power and signal cables, Inlet screens, Sludge collectors for preliminary clarifier, final clarifier, Sludge collectors of thickener, Aeration blower, Boilers

Table 9.1.16 Incoming Sewage Amount and Power Consumption in STP

Month		Incoming Sewage Amount (m^3)		Electricity Consumption (kWh)		Unit consumption
		Monthly	Daily	Monthly	Daily	kWh/m^3
January		2,628,740	84,798	1,494,960	48,225	0.57
February		2,416,950	86,320	1,356,960	48,463	0.56
March		3,012,810	97,187	1,614,720	52,088	0.54
April		3,979,820	132,661	1,641,120	54,704	0.41
May		3,561,930	114,901	1,735,440	55,982	0.49
June		2,860,117	95,337	1,400,160	46,672	0.49
July		3,072,817	99,123	1,449,600	46,761	0.47
August		2,935,340	94,688	1,475,280	47,590	0.50
September		2,784,912	92,830	1,362,000	45,400	0.49
October		3,082,020	99,420	1,513,440	48,821	0.49
November		3,336,010	111,200	1,617,360	53,912	0.48
December		3,119,240	100,621	1,672,480	53,951	0.54
Total		36,790,706		18,333,520		
Average		3,065,892	100,796		50,229	0.50
Cost	Mil.T/y			69.67		
	T/m^3					1.89

Note) Mil. T = Million Tenge

6,200 ton/year x 1600 Tenge/t = 9.92 million Tenge

9.92 / 36.79 = 0.26 Tenge/m^3 (per incoming sewage amount)

(5) Key issues of Present Status

Key issues of present sewerage system status are as follows:

1) Low efficiency and deterioration of intermediate pump stations

   Existing intermediate pump stations have already been superannuated and half of them are subject to the rehabilitation by this project.

2) Increasing of incoming sewage in spring

   Melted snow is entering into sewers and sewage flow rate to STP sharply increases during April and May as shown in Figure 9.1.3.

3) Deterioration of STP facilities

   Structures and equipment of STP have been deteriorated and some of them have already ceased their operation. The STP is operated almost by manual because of breakdown of electrical equipment.

4) High power consumption

   As aforementioned, power consumption of STP is relatively high. The biggest assumption is made by blowers.

5) Absence of monitoring and control

   There is no monitoring and control system for the equipment in STP. All equipment are operated manually.

6) Odor generated by sludge thickeners and drying beds

   Odor emission from the sludge thickeners and drying beds has been public nuisance.

9.2 Operation and Maintenance System after Completion of the Project

9.2.1 Operation and Maintenance for Water Supply System

(1) Improved Water Supply System

The improved water supply system after completion of the project is shown in Figure 9.2.1.

1) Vyacheslavsky intake P/S

In Vyacheslavsky Intake P/S, water level of reservoir and transmitting raw water amount are measured, calculated in a panel in control room and recorded. Discharge capacity of each pump is relatively small, and therefore, discharge water volume is controlled by manual control of pump operation number and automatic control of a discharge valve on the interconnection pipeline . When a pump operator intends to change the water transmission volume, the operator shall check the number of pumps on-duty and set the control device to the designated water flow. Radio will be the communication measure between the P/S and WTP.

2) WTP

In WTP, inlet raw water pressure and flow, operation status of rapid filters, water levels of distribution reservoirs, distribution water pressure and flow, and others, are measured, calculated and indicated on panels at the central monitoring room in the administration building and then recorded.

Inlet water will be diverted to the old and the new plant at the distribution chamber. The water volume to be treated at the new plant shall be adjusted to its full capacity by manual control weir for effective use of the new plant.

Dosing rate of coagulant must be determined based on the result of “jar test”. Alum is hauled to WTP every two months in the shape of lump. Alum is dissolved by the existing dissolving tank and the dissolved alum will be transmitted to new coagulant storage tanks and injected in new treatment plant. Same injection and regulation method employed in the existing plant is adopted.

Injection of chlorine will be conducted by same method adopted in the existing system. Regulation of distribution water amount will be conducted to meet a range of 5 kg/cm^2 to 5.5 kg/cm^2 by pump operation number and valve control.

3) Distribution network

About 100 km of distribution pipes are planed to be replaced, therefore water leakage will be reduced and low water pressure area in fringe of the city will be relieved.

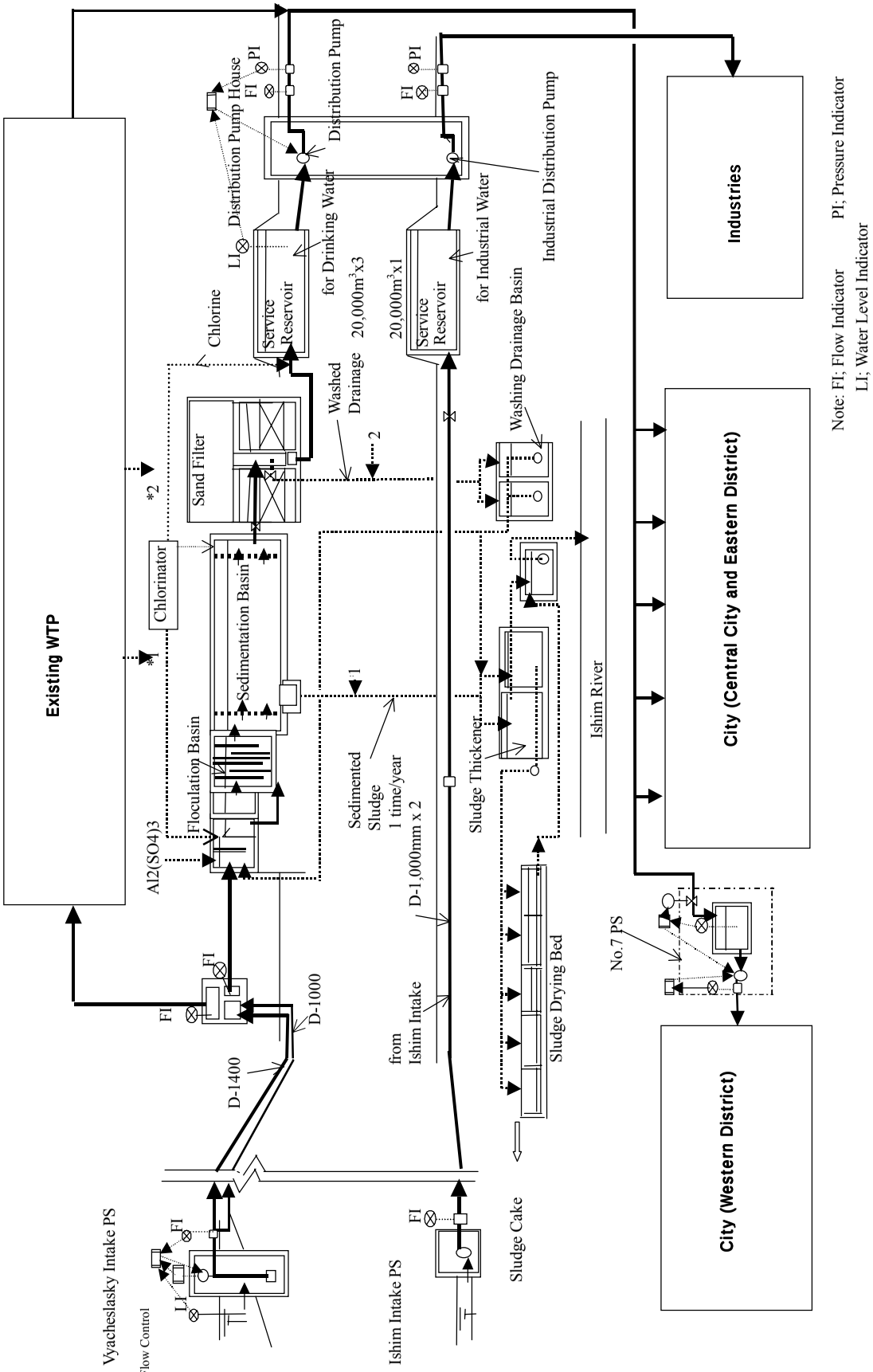


Figure 9.2.1 Improved Water Supply System in Astana

4) Water meter

As water meters will be installed by the project for all consumers, water tariff will be collected based on their water consumption.

Therefore, ASA must establish the system for meter reading, tariff correction, meter checking and adjusting.

(2) Recommendation of Staff Assignment

1) Vyacheslavsky Intake P/S

Currently 15 staff are working in Vyacheslavsky Intake P/S. When the new plant is commissioned, a manager, a sub-manager and 8 shift staff, two staff are the minimum requirement especially in night shift, will be necessary. Staff for repair work can be reduced but drivers and cleaners will be necessary. Additional two staff for maintenance of existing P/S will be needed. Proposed staff assignment is shown below:

Table 9.2.1 Number of Staff in Vyacheslavsky Intake P/S

Work Role	Position	Present	Proposed
Administration	Manager	1	1
	Engineer	1	1
	Total	2	2
Shift working (4teams)	Specialist	8	8
	Total	8	8
Repair	Staff	3	1
Others	Staff	2	2
Existing P/S	Staff		2
Total		15	15

2) WTP

Number of staff assigned in the existing WTP is 63. The new treatment plant will be constructed within the premises of the existing WTP. Current distribution amount from the existing WTP is around 165,000 m^3/day at maximum and the treatment capacity of the new plant is planned by 100,000 m^3/day. Therefore existing plant must be continuously operated.

Since the existing plant has already been deteriorated, function has also been declined. Malfunctioning and breakdown of equipment have occurred frequently and thus present operation staff in the existing plant will be needed through the future. Necessary staff for the new plant are recommended as shown in Table 9.2.2. Present assigned staff for administration, laboratory, repair and others will not be increased but they must work for the existing and new plant.

Table 9.2.2 Proposed Staff Assignment for New Plant

Division	Position	Daytime	1-shift	Total	Engineer
Daytime Staff	Chief Engineer	1	----	1	1
	Electric Engineer	1	----	1	1
	Machine Engineer	1	----	1	1
	Assistant Engineer	1	----	1	
	Cleaning	1	----	1	
	Cook	1	----	1	
	Total	6	----	6	3
Shift Staff	Chief	1	1	4	4
	Electric	1	1	4	1
	Filter, coagulant	1	1	4	
	Chlorination	1	1	4	
	Total	4	4	16	5
Total		10		22	8

3) Water Meters

Since 152,000 water meters will be installed by this project, maintenance and repair for meters is essential matter. Water meter maintenance team shall be formulated and staff assignment is recommended as Table 9.2.3. In this case, manufacturer will conduct meter repair.

Table 9.2.3 Staff for Meter Maintenance Team

Work Role	Position	Number
Administration	Chief	1
Stand-by	Chief	1
	Staff	10
Total		12

(3) Operation and Maintenance Methods

1) Quantitative control

As shown in Figure 9.2.1, quantitative control will be necessary for intake water and distribution water.

The shift engineer assigned in the new central monitoring room determines the intake water amount. He shall watch present inflow amount (intake amount) and water level of distribution reservoir, and shall estimate expected water consumption to decide the intake water amount.

The intake water amount shall be instructed to the intake P/S. The operator of intake P/S shall control the pump discharge volume in accordance with the instructed intake amount.

Treated water is distributed to the city in some range of water pressure.

The distribution water pressure will be controlled at 5. kg/cm^2 in daytime and 4 kg/cm^2 in nighttime. For this pressure control, number control of pumps on-duty and motor speed control of one pump are. Introduced.

2) Qualitative control

Quality control can be achieved by the present practices. However, a coagulant injection rate shall be determined based on the results of the jar test, as mentioned before.

3) Maintenance and repair work

O&M work items will be almost the same as proposed for the existing WTP, which is shown in Table 9.1.5. However, since new facilities, such as sludge treatment facility and water meter, will be constructed/installed through this project, additional O&M items will be needed.

Proposed additional items are shown in Table 9.2.4. Target structures and equipment for repair work are shown in Table 9.2.5.

Table 9.2.4 Additional Operation and Maintenance Items

Facility	Operation	Maintenance
Sludge Treatment Facilities in WTP	- Control of sludge withdraw interval of sedimentation tank and sludge thickener - Control of washing drain basin and discharge pool - Control of sludge drying bed - Discharge dried sludge	- Periodic and irregular check and patrol of function for sludge treatment facilities - Taking record of measured results and analysis of operation record - Adjustment and oiling of equipment and facilities - Making report and report to upper organizations - Requirement repair team - Cleaning and Painting
Water Meters		- Check of function (by meter reading staff) - Replacement for meters broken down - To order repairs to maker - Making report and to report ASA

Table 9.2.5 Target Structures and Equipment for Repair Work (Water Supply System)

Facility Name	Facilities
Intake Pump Station	Civil structure of pump station, Management buildings, Pumps, Pipes, Auto-valves, Gates, Screens, Cranes, Electric power facilities, Electric control facilities, Electric observation facilities, Information facilities, Electrical power and signal cables
Water Treatment Plant	Civil structures of flocculation basin, sedimentation basin, distribution reservoir and sludge treatment basins, Buildings of administration, coagulant, cover for rapid mixer and send filter, distribution pumps and chlorination facilities, Pumps, Pipes, Auto-valves, Gates, Cranes, Rapid sand filter facilities, Electric power facilities, Electric control facilities, Electric observation facilities, Information facilities, Electrical power and signal cables, Coagulation facilities, Chlorination facilities
Transmission and Distribution Pipes	Pipes, Valves, Boxes
Wat. Meters	Water meters for individual house and apartment

(4) Power Consumption

Present unit power consumption per cubic meter of sewage is compared with estimated unit

power consumption after the project completion.

Power consumption will only change by pumps of Vyacheslavsky Intake P/S. Present unit consumption of pumps is 0.39 kWh/m^3.

After introduction of mew pumps with pump head of 35 m, electricity consumption will be as follows:

Power Consumption =0.163 x QH/(η x 60) =0.163 x 1 x 35/(0.7 x 60) = 0.14 kWh/m^3

Q: Discharge volume = 1 m^3/min

H: Pump head = 35 m

η: pump efficiency = 0.7

Reduction of power consumption and electric charge is shown below:

Reduction of consumption :0.39 - 0.14 =0.25 kWh/m^3

Reduction of electric charge: 0.25 kWh/m^3 x 3.8 KZT/kWh = 0.95 KZT/m^3

Thus, when the intake water volume is 210,000 m^3/day, about KZT 6 million per month is expected to be saved at the intake P/S.

9.2.2 Operation and Maintenance for Sewerage System

(1) Rehabilitated Sewerage System

Rehabilitation and improvement will be conducted in the existing STP, 17 sewage booster pump stations and a part of sewer pipelines. The work is mainly composed of rehabilitation work. Therefore, same operation and maintenance work practiced in the existing facilities will be continued. Thus, the study on O & M is carried out only for the STP.

The rehabilitated STP system after the completion of the project is shown in Figure 9.2.2. Major contents of rehabilitation and improvement and their advantages are as follows:

1) Replacement

Proposed equipment replacement is as follows:

Fine screens, influent pumps, grit chambers, blowers, sludge collectors of primary sedimentation tank, secondary sedimentation tank, sludge thickener, blowers, sludge pumps, final clarifiers, sludge thickener, discharge pumps, digesters, boilers, gas holders, electrical panels, electrical cables, instruments for laboratory and others.

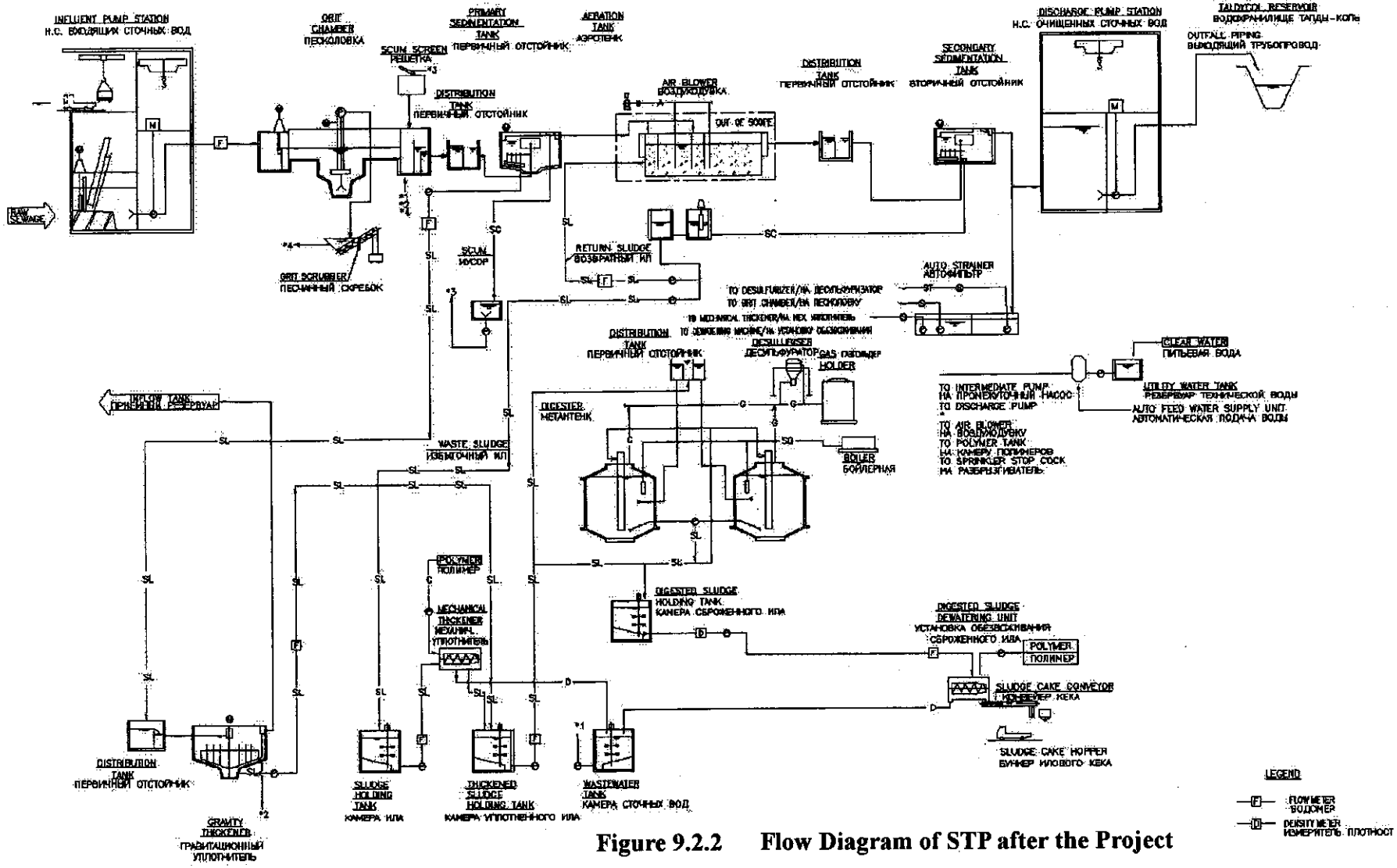


Figure 9.2.2 Flow Diagram of STP after the Project

2) New construction

Proposed construction of new facilities is as follows:

Grit chamber of voltex type, two units of additional sludge collectors for both of primary and secondary sedimentation tanks, a sludge treatment building accommodating tanks, pumps, mechanical thickener, polymer feeding equipment and dewatering units, hopper house and central monitoring facilities.

3) System improvement

System for STP will be improved as follows:

- Installation of central monitoring panel in monitoring room

  Alarm of equipment breakdown, operation of major equipment, and measured data shown in Figure 9.2.2 will be monitored at monitoring room.

- Grit chamber

  A vortex type grit chamber is introduced with automatic control.

- Construction of additional sludge collectors

  Two primary and two secondary sludge collectors will be constructed to ensure stable operation.

- Replacement of blowers

  Multi-stage turbo type blowers with high efficiency are introduced.

- Installation of cover for sludge thickener

  GRP dome covers will be installed on sludge thickener to mitigate odor.

- Installation of mechanical thickener and dewatering units

  Screw type mechanical thickener will be installed for thickening of waste sludge. Screw type dewatering units will also be installed for dewatering of digested sludge. Both equipment will be installed in the sludge treatment building with biological deodoring scrubber. The hopper house will be constructed to store dewatered sludge cake next to the sludge treatment building to avoid odor problem in the sludge treatment building.

(2) Staff Assignment

After the project, operation status of equipment and major sewage flows will be monitored in the monitoring room located in the sludge treatment building. Some staff members can be reduced and be converted to the mechanical sludge treatment process. For example, it is

possible to convert shift staff for grit chamber, sludge drying beds and blowers to other part or to stop nightshift.

Necessary staff for sludge treatment are shown in Table 9.2.6. The table also shows possible staff conversion from the existing process to the new sludge treatment process.

Table 9.2.6 Staff Assignment Plan after Project Completion.

Work Role	Position	Present	Converted	Total	Daytime	1-Shift
Administration	Manager	1		1	1	
	Engineer	3	1	2	2	
	Total	4	1	3	3	
Shift working (4team)	Engineer	4		4	1	1
	Specialist	40	12	28	7	7
	Total	44	12	32	8	8
Laboratory	Chief	1		1	1	
	Engineer	2		2	2	
	Analyst	8		8	8	
	Total	11		11	11	
Sludge Daytime Staff	Chief /Engineer			1	1	
	Chemical			1	1	
	Thickener			1	1	
	Dewatering			1	1	
	Sludge Cake			1	1	
	Operator, Driver			2	2	
	Shovel Car Operator			1	1	
	Cleaning			1	1	
	Total	0		9	9	
Sludge Shift staff	Thickener, Chemical			4	1	1
	Dewatering			4	1	1
	Sludge Cake			5	1	1
	Total	0		13	3	
Repair	Staff	21		21	21	
Others	Staff	10	2	8	8	
Total		90	15	97	63	11

(3) Recommendation on Operation and Maintenance

1) Control of STP

After the project completion, the control of STP will be carried out from the monitoring room located in the sludge treatment building. Operators can monitor the flows and failure of equipment. However, each assigned facility operator must patrol facilities periodically for safety.

According to the information, shift engineer and head of shift team can determine and order the countermeasure for the incident.

2) Control of Sludge Treatment Facility

Schematic flow of mechanical thickeners and sludge dewatering units is illustrated in shown in Figure 9.2.3.

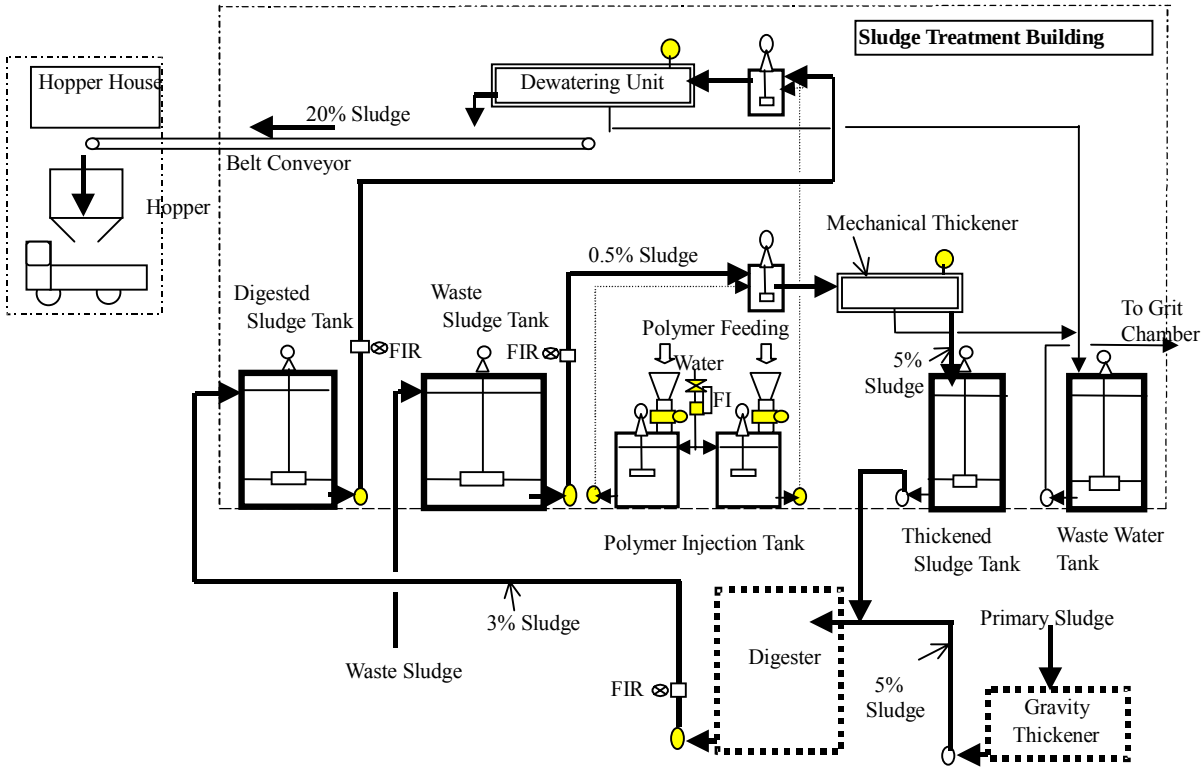


Figure 9.2.3 Sludge Treatment System

Equipment and corresponding control items are shown in Table 9.2.7.

Since control of mechanical thickening and dewatering are relatively complicated, observation and adjustment of sludge treatment process shall be made as required as indicated in Table 9.2.8.

Table 9.2.7 Equipment and Control Items

Division	No.	Equipment	Control Item
Mechanical Thickener	1	Sludge feeding pump	Flow
	2	Polymer injection Pump	Flow
	3	Polymer Auto-feeder	Volume
	4	Thickener Revolution Control	Revolution
Dewatering Unit	5	Sludge withdraw pump	Flow
	6	Sludge feeding pump	Flow
	7	Polymer injection Pump	Flow
	8	Polymer Auto-feeder	Volume
	9	Unit Revolution Control	Revolution
Water	10	Water meter and Valve	Flow

Table 9.2.8 Necessary Control for Sludge Treatment Process

No.	Item	Base of Decision
1	Regulation of withdrawing sludge quantity from primary clarifier	Total solid generation, Concentration of sludge, Inlet and outlet SS of primary clarifier
2	Regulation of excess sludge quantity	Total solid generation, Inlet SS to aeration tank, Concentration of excess sludge
3	Regulation of sludge feeding rate for mechanical thickener	Excess sludge quantity, Excess sludge concentration, Capacity of dewatering unit
4	Regulation of polymer injection rate for mechanical thickener	Result of beaker test for polymer injection, Excess sludge concentration, Separated water SS, Thickened sludge concentration
5	Regulation of revolution speed for mechanical thickener	Separated water SS, Thickened sludge concentration
6	Regulation of withdrawing Sludge quantity from sludge digestion tank	Concentration of sludge, Effluent water quality of digestion tank, Capacity of dewatering units
7	Regulation of sludge feeding rate for dewatering unit	Concentration of digested sludge, Result of beaker test, Capacity of dewatering units
8	Regulation of polymer injection rate for dewatering unit	Result of beaker test for polymer injection, Digested sludge concentration, Separated water SS, Dewatered sludge concentration
9	Regulation of revolution speed for dewatering unit	Separated water SS, Dewatered sludge concentration

3) Operation, maintenance and repair work

Contents of operation, maintenance and repair workhown in Table 9.1.14 and 9.1.15 will not change after the project completion.

Proposed operation and maintenance work and potential targets for repair work in sludge treatment system are shown in Tables 9.2.9 and 9.2.10, respectively.

Table 9.2.9 Proposed Operation and Maintenance Works for Sludge Treatment Process

Facility	Operation	Maintenance
Sludge Treatment Facilities in STP	- Investigation and decision-making for sludge treatment including beaker test for decision for polymer injection rate - Operations of pumps, mixers, polymer feeders, water distribution units, mechanical thickeners, sludge dewatering units, belt conveyers - Regulation of withdraw quantities from primary clarifiers and digestion tanks, excess sludge, feeding rate for mechanical thickeners and dewatering units, polymer injection rate for mechanical thickeners and dewatering units, water flow of polymer dissolving tanks, revolution speed of mechanical thickeners and dewatering units - Feeding polymer to hopper - Accepting of polymer - Ordering of polymer - Loading sludge cake to dump truck - Discharging sludge cake to dump site - Taking record of operation status - Making report of operation	- Periodic and irregular check of function for each and total equipment and facilities - Patrol of facility and finding of abnormal phenomenon - Taking record of measured results - Removing of screening - Taking record of measured results - Analysis of operation record and use for improvement of operation - Adjustment of equipment and facilities - Oiling and replacement of oil - Making report for maintenance - Report to upper organizations - Repair troubled equipment if possible - Requirement repair team - Cleaning and Painting

Table 9.2.10 Structures and Equipment to be Repaired or Replaced (Sludge Treatment Process)

Facility	Structures and Equipment
Sludge Treatment Facilities	Sludge treatment building including sludge tanks, Civil structures of a digestion tank, Sludge cake storage house, Pumps, Pipes and valves, Polymer feeding facility, mixers, Mechanical thickeners, Sludge dewatering units, Hoists, Belt conveyer, Electric power facilities, Electric monitoring facilities, Electric measuring facilities, Electric cables

(4) Power and Chemical Consumption

1) Power consumption

Power consumption of the new sludge treatment system was estimated approximately 3,500 kWh/day based on the design treatment capacity. The unit consumption of the sludge treatment is:

3,500 kWh/day /136,000 m^3/day=0.026 kWh/m^3

Based on the maintenance data, present unit power consumption is 0.5 kWh/m^3 that is much larger than the figure stated above. The increased power consumption by the newly employed sludge treatment process is assumed be equivalent to the expected power consumption reduction by improvement of efficiency of new blowers.

Present annual coal consumption is 6,200 ton/year. This consumption of coal will not change after the completion of the project.

2) Chemical consumption

For mechanical sludge thickening and dewatering, polymer must be dosed. Unit cost of polymer per one cubic meter of sewage is assumed to be as follows:

Average SS concentration of influent water: 200mg/L

SS Removal rate in Primary clarifier: 40%

SS conversion rate to solid in aeration tank: 1.0 kg/kg

Organic material rate of inlet of digestion tank: 75%

Digestion rate of digestion tank: 50% to organic materials

Polymer injection rate of mechanical thickener for excess sludge: 0.4% to solid

Polymer injection rate of dewatering unit for digested sludge: 0.4% to solid

0.2 kg/m^3 x {(1-0.4) x 0.004 + (1 - 0.75 x 0.5) x 0.004} =1.00 x 10^{-3} kg/m^3

Estimated cost of polymer = 1,000 KZT/kg.

1.00 x 10^{-3} kg/m^3 x 1,000 T/kg =1.00 KZT/m^3

The calculated cost of polymer is almost equivalent to electricity cost, 1.89 KZT/m^3. This calculation result implies that there will be a high possibility of doubling the direct treatment cost of sewage after introduction of the mechanical sludge dewatering process. Therefore, utmost effort to finding out the polymer with less unit cost shall be made to lessen the treatment cost.

CHAPTER 10 PROJECT COST

CHAPTER 10 PROJECT COST

10.1 Conditions and Assumptions for Cost Estimates

(1) Project Execution Manner

The construction work will be executed on a contract base. The contractor selected through ICB will provide the construction equipment, materials and labor required for the Project, together with procurement of equipment. The selected consultants shall undertake the construction supervisory service throughout the project implementation period.

(2) Cost Estimation Method

As for Civil/Architectural works, project cost estimation was prepared based on the Kazakhstan manner, namely method stipulated on SNiP Norm of 4.02-91 and 4.05-91, applying computer program developed by the relevant authority. The outline of this cost estimation program is as follows:

The cost for Civil/Architectural works was calculated facility wise, namely Water Intake, Treatment Plant, Distribution Network, Sewage Treatment Plant, Sewer Network, and Intermediate Sewage Pump Stations.

The base cost was estimated according to the Standard Design of each facility prepared by the Ministry of Construction of USSR in 1984, and the base cost of the standard facilities was set at the year of 1991.

Calculated base cost was inflated to convert it into the recent price level by adding the additional costs accounting the price increase in construction materials, wages and transportation.

While Mechanical/Electrical Work, the equipment and installation costs were estimated by the quotations obtained from European and Japanese manufacturers. Then the total cost was calculated by combining the cost estimates for above major work.

The cost estimate on ICB basis was also made in consideration of undertakings by foreign contractors. The cost basis is Bill of Quantities from detailed design of facilities and unit cost for civil work/mechanical & electrical equipment investigated from experienced contractors/manufacturers. It was confirmed that the cost requirements derived from this estimate and those according to Kazakhstan method as aforementioned above are almost same level.

10.2 Water Supply System

The project components for water supply system are summarized in Table 10.2.1.

Table 10.2.1 Project Component Facilities for Water Supply System

Category No.	Facilities	Specification	Quantity	Unit
101	Water Intake Facility	Q = 210,000 m^3/day		
	Intake Tower		1	unit
	Access Road		300	m
	Mechanical Equipment	Q = 36.5 m^3/min	6	units
	Power Receive and Distribution Facility		1	L.S.
102	Raw Water Transmission Pipeline			
	Rehabilitation of Existing Pipeline	Steel Pipe, Dia. 1,000 mm	Not Appli-cable	m
103	Water Treatment Plant	Q = 100,000 m^3/day		
	Distribution Tank		1	unit
	Receiving Well		2	units
	Chemical Mixing Tank		2	units
	Flocculation Basin		6	units
	Sedimentation Basin		6	units
	Rapid Sand Filter		12	units
	Sludge Thickener		2	units
	Washing Drain Basin		2	units
	Sludge Drying Bed		6	units
	Cake Yard		1	unit
	Discharge Pool		2	units
	Chemical Feeding Facility		1	L.S.
	Chlorination Feeding Facility		1	L.S.
	Administration Building		1	L.S.
	Measurement/Examination Equipment		1	L.S.
	Power Receiving and Distribution Facility		1	L.S.
	In-plant Pipeline	Dia. = 75 to 1,600 mm	1	L.S.
	Monitoring & Control System		1	L.S.
104	Distribution Network			
	Distribution Pipelines	Dia. = 100 to 1,000 mm	100.1	km
	Distribution Pipeline to New Government Area	Dia. = 1,000 mm	5.6	km
	Distribution Pump Station		1	L.S
105	Installation of Water Meter			
	Individual Water Meter		152,000	units
	Bulk Water Meter		1,900	units
106	Mechanical Work		1	L.S.
107	Electrical Work		1	L.S.

10.3 Sewerage System

The project components for the sewerage system are shown in Table 10.3.1.

Table 10.3.1 Project Component for Sewerage System

Category No.	Facilities	Specification	Quantity	Unit
151	Sewage Treatment Plant	Q= 136,000m^3/d		
	Influent P/S	Replacement/Rehabilitation	1	L.S.
	Grit Chamber	New Construction	1	unit
	Primary Sedimentation Tank (1)	New Construction	2	units
	Primary Sedimentation Tank (2)	Replacement/Rehabilitation	6	units
	Primary Sludge P/S	Replacement/Rehabilitation	1	L.S.
	Blower House	Replacement/Rehabilitation	1	L.S.
	Return Sludge P/S	New Construction	1	L.S.
	Secondary Sedimentation Tank (1)	New Construction	2	units
	Secondary Sedimentation Tank (2)	Replacement/Rehabilitation	10	units
	Discharge P/S	Replacement/Rehabilitation	1	L.S.
	Gravity Sludge Thickener	Replacement/Rehabilitation	1	L.S.
	Thickened Sludge P/S	Replacement/Rehabilitation	1	L.S.
	Mechanical Sludge Thickener	New Installation	1	L.S.
	Sludge Treatment Building	New Construction	1	L.S.
	Sludge Digestion Tank	Replacement/Rehabilitation	1	L.S.
	Boiler House	Replacement/Rehabilitation	1	L.S.
	Sludge Dewatering Machine	New Installation	1	L.S.
	Electric House	New Construction	1	L.S.
	Interconnecting Pipeline	Dia. = 200 to 2,000 mm	1	L.S.
	Measurement & Examination Equip.	New Installation	1	L.S.
	Monitoring & Control System	New Installation	1	L.S.
152	Sewage Collection Network			
	Rehabilitation of Existing P/S	Rehabilitation/New Construction	17	units
	Replacement of Existing Sewer Pipeline	Dia. = 100 to 800 mm	20.9	km
	Replacement of Existing Manhole Cover	Cast Iron Manhole Cover	5,300	units
153	Mechanical Work		1	L.S.
154	Electrical Work		1	L.S.

10.4 Operation and Maintenance Equipment

To ensure the stable and sustainable system O&M activities, procurement of operation and maintenance equipment is considered as stated in previous Chapter 8.

10.5 Cost Estimation

The project cost consists of direct construction cost and indirect cost. Table 10.5.1 shows assumption basis for the components of indirect cost

Table 10.5.1 Assumptions on Indirect Cost

No.	Indirect Cost	Calculation
1	Land Acquisition Cost	Not accounted *
2	Administrative Cost	2% of the direct cost (DC) including contingencies
3	Engineering Services**	from Loan Agreement with JBIC
4	Physical Contingency	(2+5) x 10%
5	Price Contingency	2.2% p.a. to F/C and L/C of DC
6	Import Tax	10% to imported materials and equipment
7	V.A.T.	(DCC+2+3+5+6) x 16%

*) The Kazakhstan Government will provide the needed land.

**) Physical and Price Contingencies are also subject to Engineering Services.

The result of cost estimate in this Detailed Design is shown in Table 10.5.2. Expected disbursement schedule is presented in Table 10.5.3.

Table 10.5.2 Summary of Project Cost

Code	Cost Item	Project Cost (x1,000 US$)	Equivalent (x1,000 KZT)
I	**Direct Construction Cost**		
100	Water Supply		
101	Water Intake	16,013	2,361,393
102	Raw Water Trans. Pipeline	-	-
103	Water Treatment Plant	34,290	5,056,746
104	Distribution Network	39,742	5,860,694
105	Installation of Flow Meter	6,368	939,118
	Subtotal of 101 to 105	**96,413**	**14,217,951**
150	Sewerage		
151	Sewage Treatment Plant	49,111	7,242,458
152	Sewer Network	15,086	2,224,762
	Subtotal of 151 to 152	**64,198**	**9,467,220**
200	Operation and Maintenance Equipment	**4,833**	**712,782**
	Total of Direct Construction Cost	**165,444**	**24,397,953#**
II	**Indirect Cost**		
301	Land Acquisition Cost	-	-
302	Administrative Cost	4,243	626,763
303	Engineering Services*	13,632	2,010,370
304	Physical Contingency	18,049	2,661,616
305	Price Contingency	15,042	2,218,205
306	Import TAX	9,430	1,391,595
307	V.A.T.	33,878	4,995,993
	Subtotal of 301 to 307	**94,274**	**13,902,542**
	Total Project Cost	**259,717**	**38,300,495**

Note) #: The cost estimated in Kazakhstan manner assessed and revised by the State Appraisal Organization was Tenge 24,044,350 thousand (98.6% of above estimates).

*: Including contingencies

**: Due to rounding, total is different to sum of each item.

Costs by facility are based on BOQ and unit cost investigated.

Exchange Rate: US$ 1= KZT 147.47= JPY116.60

Table 10.5.3 Annual Fund Requirements

(Unit: F/C, million JPY, L/C, million US$)

No	Item	Total				2003		2004		2005		2006		2007		2008	
		Total(JPY)	Total(USD)	F/C	L/C	F/C	L/C	F/C	L/C	F/C	L/C	F/C	L/C	F/C	L/C	F/C	L/C
	Engineering Cost																
1	Base Cost (as of Sep. 2003)	1,323.89	11.35	710.06	5.26	-	-	106.51	0.79	146.89	1.09	169.86	1.26	208.84	1.55	77.97	0.58
2	Price Escalation (F/C, L/C 2.2%)	121.15	1.04	64.98	0.48	-	-	4.74	0.04	9.91	0.07	15.45	0.11	24.01	0.18	10.87	0.08
3	Physical Contingency (10%)	144.50	1.24	77.50	0.57	-	-	11.12	0.08	15.68	0.12	18.53	0.14	23.28	0.17	8.88	0.07
4	Sub-total (1+2+3)	1,589.54	13.63	852.54	6.32	-	-	122.37	0.91	172.47	1.28	203.84	1.51	256.13	1.90	97.73	0.72
	Construction Cost																
5	Base Cost (as of Sep. 2003)	19,290.71	165.44	12,108.42	61.60	-	-	1,816.26	9.24	2,246.75	10.40	3,579.11	18.51	3,363.99	18.10	1,102.30	5.35
6	Price Escalation (F/C, L/C 2.2%)	1,753.87	15.04	1,098.30	5.62	-	-	80.79	0.41	151.57	0.70	325.51	1.68	386.68	2.08	153.74	0.75
7	Physical Contingency (10%)	2,104.46	18.05	1,320.67	6.72	-	-	189.71	0.97	239.83	1.11	390.46	2.02	375.07	2.02	125.60	0.61
8	Sub-total (5+6+7)	23,149.04	198.53	14,527.40	73.94	-	-	2,086.76	10.62	2,638.16	12.21	4,295.09	22.22	4,125.74	22.20	1,381.65	6.70
9	SUB-TOTAL (4+8) Eligible for JBIC	24,738.57	212.17	15,379.94	80.26	-	-	2,209.14	11.52	2,810.63	13.49	4,498.92	23.73	4,381.87	24.10	1,479.37	7.42
10	Administration Cost (2% of 9)	494.77	4.24		4.24		-		0.61		0.75		1.25		1.23		0.40
11	Import Tax (10% for Imported Goods)	1,099.50	9.43		9.43		-		0.20		2.99		2.78		2.61		0.86
12	VAT (16%) (excl. physical cont.)	3,950.18	33.88		33.88		-		4.46		6.46		9.95		9.80		3.20
13	(Construction)	3,718.97	31.90		31.90		-		4.18		6.05		9.42		9.21		2.97
14	(Consulting Service)	231.21	1.98		1.98		-		0.28		0.40		0.47		0.60		0.23
15	Grand Total (9-12)	30,283.03	259.72	15,379.94	127.81	-	-	2,209.14	16.79	2,810.63	23.68	4,498.92	37.71	4,381.87	37.74	1,479.37	11.88
16	Total (F/C + L/C) ($ million)				259.72		-		35.74		47.39		76.30		75.32		24.57

Note: Exchage Rate: US$1 = JPY116.60 Advanced Payment Engineering Cost; 15%, Construction Cost; 15%

Disbursement Schedule

(Unit: US$, million US$, (JPY); million JPY)

Fund	Total		2003		2004		2005		2006		2007		2008	
	US$	(JPY)	US$	(JPY)	US$	(JPY)	US$	(JPY)	US$	(JPY)	US$	(JPY)	US$	(JPY)
JBIC Fund (Yen 21,361mil max) (100% of Eng., 85% of Construct.,incl. physical contingency)	183.20	21,361.00	-	-	27.24	3,175.97	33.76	3,936.98	55.82	6,508.14	55.34	6,452.90	11.04	1,287.01
Kazakhstan Fund	76.52	8,922.02	-	-	8.50	991.10	14.02	1,635.28	20.48	2,388.11	19.98	2,329.41	13.53	1,578.12
Total	259.72	30,283.03	-	-	35.74	4,167.07	47.79	5,572.26	76.30	8,896.24	75.32	8,782.31	24.57	2,865.13

CHAPTER 11 IMPLEMENTATION PLAN

CHAPTER 11 IMPLEMENTATION PLAN

11.1 Implementation Schedule

11.1.1 Pre-construction Stage

Detailed design was prepared through the technical assistance of JICA by the end of 2003. While, Kazakhstan side will select consultants for construction supervision in the year 2003.

After the selection of the consultant, pre-qualification and tendering are planned for the selection of the contractor according to the following schedule.

- Pre-Qualification: approximately four (4) months
- Tendering: approximately seven (7) months

Therefore, it is expected to award the construction contract in the forth quarter of the year 2004. The implementation schedule is tentatively planned as shown in Figure 11.1.1.

11.1.2 Construction Stage

The project entails many component work. Procurement and construction periods depend on the scope of the work for respective components. As the weather of Astana City is very severe especially during winter season from December to March, some construction works, such as earthwork, concrete work and other outdoor work, cannot be carried out fully. Construction work for civil structures and buildings is affected by this weather condition.

The construction schedule for each component is presented in Figure 11.1.1 considering the said condition. As shown in the figure, total construction period including test operation period is estimated at 42 months to complete the Project by the middle of year 2008.

Figure 11.1.1 Project Implementation Program

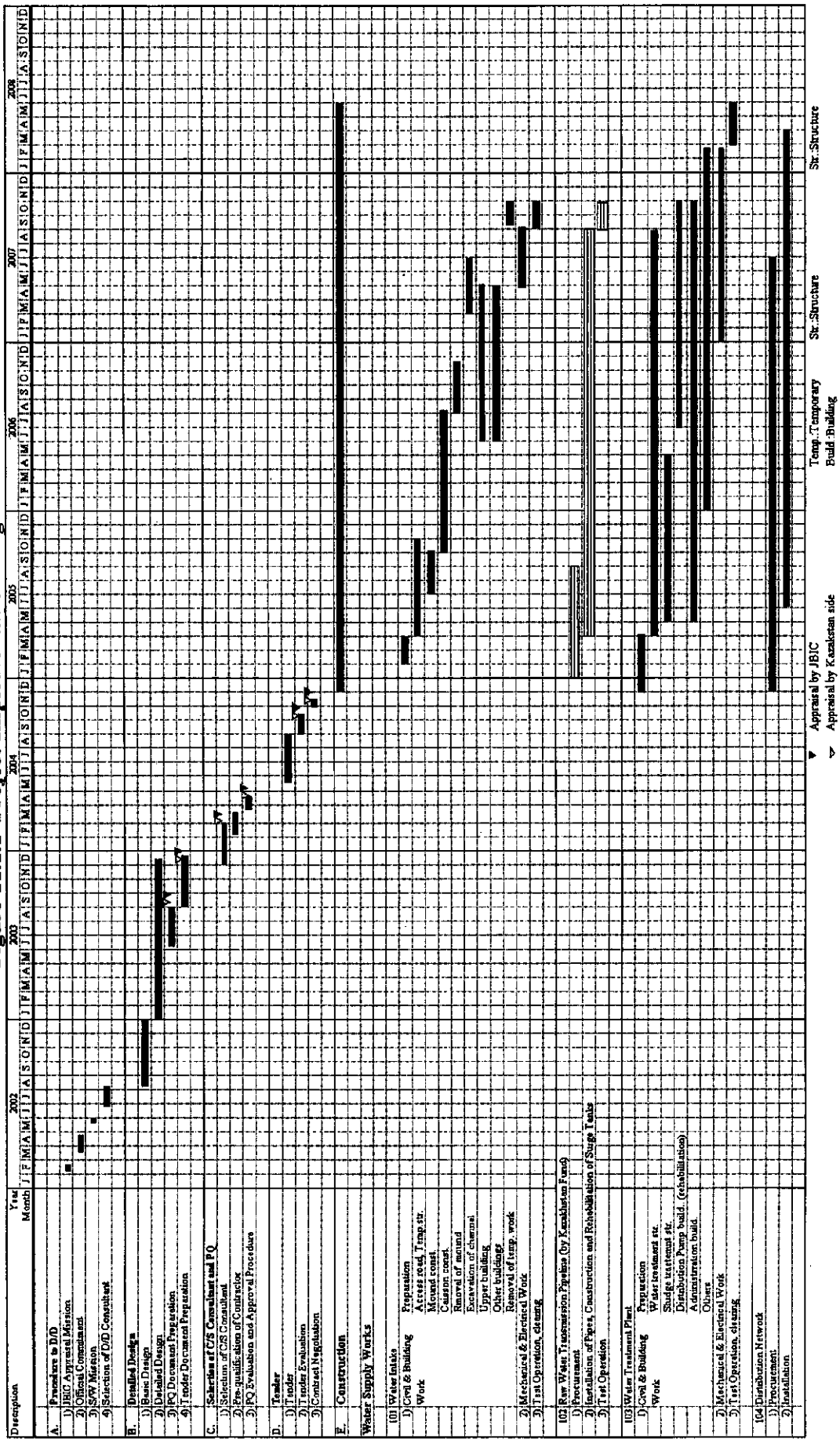
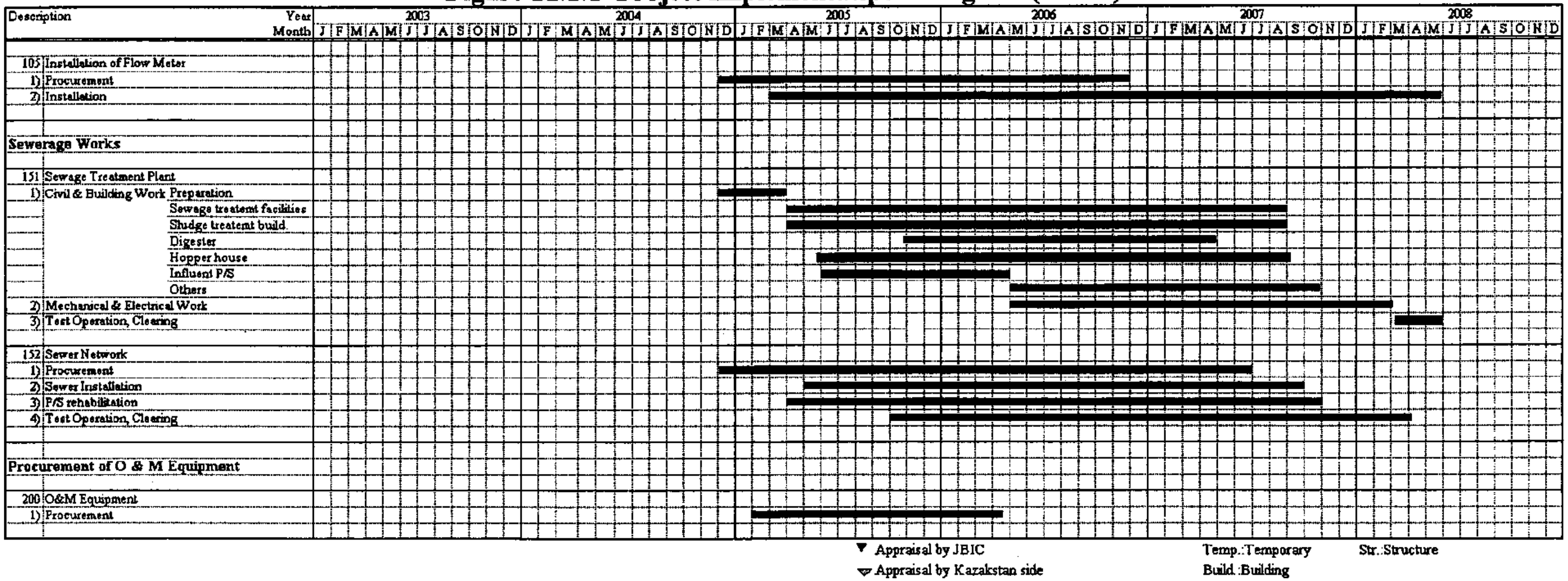


Figure 11.1.1 Project Implementatipon Program (cont'd)



11.2 Construction Work Plan

11.2.1 Construction Items

Facilities to be constructed through this project and their locations are shown in Table 11.2.1

Table 11.2.1 Target Facilities and their Locations

Category	Facilities	Location
Water Supply	Vyacheslavsky Intake P/S	Vyacheslavsky Reservoir
	WTP	WTP site in Astana City
	Distribution Pipeline	Distributed in Astana City
	Water Meters	Distributed in Astana City
Sewerage	Sewer	Distributed in Astana City
	Pump Stations	Distributed in Astana City
	STP	STP site in Astana City

Civil and architectural structures and mechanical and electrical equipment to be constructed/improved/installed are shown in Table 11.2.2.

11.2.2 Conditions to be Considered for Construction Work and Required Measures

Problem areas during construction of facilities are summarized in Table 11.2.3. Among them, cold weather is a major condition to be considered, especially for the following work.

- Excavation work for frozen soil
- Concrete work
- Outdoor work

Excavation work, concrete work and outdoor work is difficult during mid-winter from December to February. Measures to be provided against the problem areas are shown in Table 11.2.4.

Table 11.2.2 Structures and Equipment

Category	Facilities	Structures, Buildings	Major Equipment
Water Supply	Vyacheslavsky Intake P/S	Intake pumping station	Pumps, Electrical equipment, Traveling hoist, Antenna tower
		Admin. house	(superstructure of tower)
		Access road	Pipes, Flow control valve
		Guard house	
		Surge control house	Air vessels
		Substation	Power receiving and transforming equip.
		Fence	
	WTP	Distribution Chamber	Weirs, Flow meters, Control valves
		Receiving well	
		Rapid mixing chamber	
		Flocculation basin	
		Sedimentation basin	Sludge collector
		Rapid sand filter	Filtering and backwashing equipment
		Chlorination basin	
		Chemical room	Coagulant dosing equipment
		Chlorination room	Chlorinator
		Washing drain basin	Pumps
		Sludge thickener	Sludge collector, Pumps
		Discharge pool	Pumps
		Sludge drying bed	Filtering material
		Distribution P/S	Pumps, Cranes
		Administration building	Electrical power and monitoring equipment, Laboratory, Antenna tower
		Substation	Power receiving and transforming equip.
		Guard house	ITV
		Gate and Fence	
	Distribution pipes	Pipes	Pipes and valves
	Meters	Meters	Meters, strainers, valves and pipes
Sewerage	STP	Influent Pipe	Pipes
		Influent pump station	Gates, Fine screen, Pumps, Crane
		Grit chamber	Mixers, Gates, Sand pumps, Grit collector
		Primary sediment. tank	Sludge collectors, Sludge pumps
		Blower house*	Blowers
		Secondary sediment. tank	Sludge collectors
		Discharge pump station	Gates, Pumps, Crane
		Return sludge pump house	Sludge pumps
		Gravity thickener*	Sludge collectors, GRP dome, Sludge pumps
		Digester	Mixer, Pumps, Heater
		Boiler house*	Boilers
		Sludge treatment building	Mixers, Sludge and water feeding pumps, Polymer feeding equipment, Mechanical thickeners, Sludge dewatering units, Conveyors, Deodoring scrubber, Cranes, Power distribution and control units, Monitoring system
		Hopper house	Hoppers
		Electrical house	Power distribution and control unit for digester
	Sewer	Pipes	Pipes
	Intermediate P/S	P/S structure*	Pumps

Note: *Partial improvement

Table 11.2.3 Problem Areas at Construction Sites

Location	Problem Areas
Vyacheslavsky Intake P/S	Cold weather, Deep structure, Working in reservoir (filled water), Influence of turbid water during construction works.
WTP Site	Cold weather, Work in narrow site, Influent of construction to operating WTP, Operation interruption of existing WTP by switching of water and electricity, High groundwater level
Pipelines in Astana City	Cold weather, Influence to traffic, Deep excavation, High groundwater level
Sewage P/S	Cold weather, Replacement of operating equipment
STP Site	Cold weather, Influence of construction to operating STP, Operation interruption of existing STP by switching water and electricity, High groundwater level, Replacement of operating equipment, Deep excavation for sludge treatment building
Water Meters	Complain from consumers

Table 11.2.4 Measures against Problem Areas

Facility	Problem Areas	Countermeasures
Common	Cold weather	Avoid mid-winter, Protect concrete from freezing.
	Influence of construction to operation facility	Proper planning of work, Temporary facilities to protect existing facilities, Sufficient communication with operators
	Replacement of operating equipment	Replacement from stand-by equipment one by one
	Interruption of operation of existing facility	Proper planning of work, Working in minimum time, Temporary facilities to protect existing facilities, Sufficient communication with operators
	High groundwater level	Introduction of well point method, Proper sheathing
Intake P/S	Deep structure	Introduction of caisson method
	Working in reservoir	Introduction of caisson method, Construction of land surrounded by steel sheet piles.
	Influence of turbid water	To prevent by silt protector sheet
WTP Site	Small site	Proper planning of work, Preparation of material storage site outside of site
Pipelines	Influence to traffic	Assign traffic inducement staffs, Prepare detours
	Deep excavation	Introduction of well point method, Proper sheathing
STP Site	Deep excavation	Introduction of well point method, Proper sheathing
Water Meters	Difficult condition	Select better connection method to adopt the case, Convince consumers to introduce unusual methods

CHAPTER 12 ENVIRONMENT IMPACT ASSESSMENT (EIA) AND ENVIRONMENTAL PROTECTION

CHAPTER 12 ENVIRONMENTAL IMPACT ASSESSMENT (EIA) AND ENVIRONMENTAL PROTECTION

12.1 Current Environmental Situations in the Study Area

12.1.1 Air

The major sources of air pollution load in Astana City are industry (especially thermal power plants, TETs-1 and 2 which use coal as fuel to generate the electric power and heat) and automobile (31,000 registered vehicles, in 1999). The results of air quality monitoring carried out at intersections of main road from June 6 to July 14, 2003 are summarized in Table 12.1.1.

Table 12.1.1 The Results of Air Quality Monitoring in Astana City

Parameter	Concentration (mg/m^3)[1)]	Kazakhstan Standard[2)]	Measured Value/Standard
Sulfate Dioxide (SO_2)	0.21	0.5	0.4
Nitrogen Dioxide (NO_2)	0.0147	0.085	0.2
Carbon Monoxide (CO)	4.4	5.0	0.9
Lead (Pb)	0.00192	0.0003	6.4
Total suspended particulate matter (TSP)	1.87	0.5	3.7

1): Source: National Scientific Research Center of the Air Protection, Northern-Kazakhstan State University
2): Maximum admissible concentration (MAC)

As shown in Table 12.1.1, the results of air quality monitoring indicate that the concentrations of sulfate dioxide (SO_2), nitrogen dioxide (NO_2) and carbon monoxide (CO) in the air are within the Kazakhstan air quality standards which are more stringent than that of WHO. However, the concentrations of lead (Pb) and total suspended particulate matter (TSP) have exceeded the Kazakhstan standards, which may result from the increasing number of vehicles in Astana City.

12.1.2 Water

(1) Vyacheslavsky Reservoir

Vyacheslavsky Reservoir, located 51 km away from Astana City, was constructed in 1970 for water supply to Astana City and its surrounding areas. The major characteristics of Vyacheslavsky Reservoir are summarized in Table 12.1.2.

Table 12.1.2 Major Characteristics of Vyacheslavsky Reservoir

Item	Contents
Surface Area	54.3 km^2 at normal water level 403.0m (11.2 km in length and 9.8 km at maximum width)
Depth	Maximum depth: 25m Average depth: 7.2m
Water Level	Maximum level: 404.40m Normal water level: 403.00m Low water level: 391.00m
Volume	Total volume: 390 million m^3 at normal water level 403.0m Effective volume: 358.8 million m^3 at normal water level 403.0m
Residence Time	Approximately 2 years
Catchment Area	5,310 km^2
No. of Inlet River	3 rivers
Inflow Volume	38-540, average 197.5 million m^3/year (1970 to 1999)
No. of Outlet River	1 river (with flow-rate control gate)
Design Discharge	0-320, average 95.2 million m^3/year (1970 to 1999), 67.2 million m^3/year at 95 % dependability
Purpose of Reservoir	Drinking water supply (primary use) Irrigation, sanitary flow for Ishim River
Water Quality	Parameter — Value — Standard BOD_5 (mg/l) — 0.2 – 3.0 — 3.0 COD_{Cr} (mg/l) — 1 – 65 — 15 DO (mg/l) — 6.4 – 12.6 — 6 T–N (mg/l) — 0.66 – 1.71 — - T–P (mg/l) — 0.025 – 0.028 — - E. Coli. (MPN/100 ml) — 1 — 10 Water Pollution Index (WPI) — 0.55 – 1.02 (average 0.7) — 1
Issues and Problems	1) COD: COD concentration (1999 and 2000) in Vyacheslavsky Reservoir showed a relatively high level that has exceeded the Maximum Allowable Concentration (MAC, 15 mg/l) for domestic use, although BOD concentration was less than the MAC (3 mg/l). 2) Potential Eutrophication Problem: In Kazakhstan there are no standards on T-N and T-P that are important parameters for evaluating eutrophication situation of lake and reservoir. Based on the surface water standards in Japan, T-N concentration in Vyacheslavsky Reservoir can be classified as Class IV (0.6 mg/l) to V (1 mg/l), while T-P concentration can be classified as Class III (0.03 mg/l). Furthermore, the Carlson Index of the water quality in Vyacheslavsky Reservoir ranges from 50 to 80, which indicates that the eutrophication in Vyacheslavsky Reservoir has a relatively high level recently.

Source: JICA M/P report and F/S report1[1), 3)].

(2) Ishim River

Ishim River originates in Niaz Mountain and flows into Russian Federation after passing through Oblasts of Akmola and north Kazakhstan. Spring thaw contributes about 80 to 85% of the annual resources to the basin. The major characteristics of Ishim River are summarized in Table 12.1.3.

Table 12.1.3 Major Characteristics of Ishim River

Item	Contents			
Length from the Mouth (km)	Vyacheslavsky Reservoir 2,300		Astana City 2,241	Atbasar City 1,871
Catchment Area (km^2)	5,310		7,400	47,300
Flow Rate (m^3/s)				
Average	6.38		7.60	31.10
50%	5.41		6.45	26.4
75%	3.06		3.67	12.3
90%	1.02		1.24	2.50
Purpose of the River	Technical water use Drinking water supply (in case of emergency) Irrigation, sanitary, recreation and landscaping			
Water Quality (Telman: 3 km Upstream of Astana City; Kirov: 8 km Downstream of Astana City)	Parameters	Telman	Kirov	Standard
	BOD_5 (mg/l)	0.5 – 3.5	1.0 – 4.0	3.0
	COD_{Cr} (mg/l)	10 – 45	10 – 45	15
	DO (mg/l)	7.2 – 12.8	5.8 – 14.8	4
	T–N (mg/l)	1.4 – 2.3	0.8 – 1.3	-
	T–P (mg/l)	0.01 – 0.02	0.03 – 0.06	-
	E. Coli. (MPN/100ml)	1	1 – 1.5	10
	WPI (average)	0.95	1.3	-
Issues and Problems	1) BOD: BOD concentration in Ishim River showed an increase when the River flows through Astana City. 2) COD: COD concentrations (1999 and 2000) both in the upstream and downstream of Ishim River showed a relatively high level which has exceeded the Maximum Allowable Concentration (MAC, 15 mg/l) for domestic use. 3) WPI (Water Pollution Index) Finally, according to WPI values the water in Ishim River has been polluted gradually from Vyacheslavsky Reservoir (0.7) down to Kirov Village (1.3) located in the downstream of Astana City.			

Source: JICA M/P report and F/S report1[1), 3)].

(3) Taldy Kol Reservoir

Taldy Kol Reservoir, located 7 km southwest of the city center, was constructed for receiving the treated sewage of sewage treatment plant (STP) of Astana City. The major characteristics of Taldy Kol Reservoir are summarized in Table 12.1.4.

Table 12.1.4 Major Characteristics of Taldy Kol Reservoir

Item	Contents
Surface Area	21.3 km^2 (10 km in length and 2 km in width) (current surface area: 15 km^2)
Average Depth	2.1 m
Design Capacity	45 million m^3 (current capacity: 36 million m^3)
Inflow	36.5 million m^3/year (discharge of the effluent from STP, 1999)
Evaporation etc.	29.6 million m^3/year (in case of Taldy Kol Reservoir being full)
Discharge	6.9 million m^3/year (discharge from Taldy Kol Reservoir to wetland in flood season, 1999)
Purpose of Reservoir	Receiving the effluent of STP
Water Quality (1999 to 2000)	Parameters / Effluent of STP / Taldy Kol / Efficiency BOD_5 (mg/l) 8.3 6.0 13.3% COD_{Cr} (mg/l) 77 62 19.5% T-N (mg/l) 15.5 7.27 53.1% T-P (mg/l) 1.79 1.37 23.5% FC (No/100ml) 8,361 342 95.9% TC (No/100ml) 4E+06 1.7E+05 95.8% SS (mg/l) 10 7 30.0%
Issues and Problems	As an exclusive reservoir for receiving the effluent of STP, Taldy Kol Reservoir actually functioned as an advanced treatment of the effluent of STP especially for the removal of nutrients (nitrogen and phosphorus). 1) Reuse of the Water in Taldy Kol (irrigation): In the past, the water in Taldy Kol was used for irrigation of the agricultural land in the south area of Astana City. However, the water volume used for irrigation has sharply decreased recently. 2) Area Occupation: Taldy Kol now occupies a large area near the center of Astana City. 3) High Water Level: About 29.6 million m^3/year of the effluent from STP was designed to be evaporated and infiltrated in Taldy Kol. However, with the development of Astana City, the sewage volume keeps increasing (36.5 million m^3/year in 1999), which resulted in the water level in Taldy Kol getting the rise. As the countermeasures, the following alternatives were proposed in the Master Plan Study and Feasibility Study of JICA: a) Agricultural use (with Taldy Kol Reservoir); b) Discharging the effluent of STP to Ishim River after an advanced treatment (without Taldy Kol Reservoir), and c) Discharging the effluent of STP to Nura River after an advanced treatment (without Taldy Kol Reservoir). In addition, Akim also implemented a study for Taldy Kol Reservoir and proposed the following alternatives[5]: a) To construct an advanced treatment facilities to treat the effluent of STP and the water of Taldy Kol simultaneously, then to discharge the treated water into the rivers; b) To construct an advanced treatment facilities only to treat the effluent of STP and then discharge the treated water into other rivers. While the water in Taldy Kol will be diverted to another location or existing lake. c) To discharge both the effluent of STP and the water of Taldy Kol into another existing or new constructed lake.

Source: JICA M/P report and F/S report1[1), 3)], Akimat[5)]

12.1.3 Solid Waste

In Kazakhstan, the law regarding solid waste disposal is "Landfill of Municipal Solid Waste and Industrial Waste". Solid wastes are classified as following three categories:

1) Municipal Solid Waste (MSW, or domestic solid waste);

2) Industrial Solid Waste (ISM, categorized as Class I, II, III, IV and V), and

3) Hospital Solid Waste (HSW)

City Communal Management (Gorcommunkhoz), a state enterprise under the Akimat, is responsible for the solid waste management of Astana City. According to the Master Plant of JICA, 463,000 m^3 of domestic solid wastes, 44,000 m^3 of industrial solid wastes and 7,800 m^3 of hospital solid wastes are generated from Astana City in 2000[1)].

The existing landfill site, having operated from 1972, is located in northeast part (10 km) of the city center. Mixed (domestic and industrial-Class III, IV and V) wastes are now disposed by open dumping without any reprocessing (such as classifying, recovery, covering with soil to avoid offensive odor etc.). Furthermore, there are no leachate collection and treatment systems as well as monitoring system in the existing landfill site. The groundwater contamination in the surrounding areas of existing landfill site has been reported by Department of Environmental Protection.

Due to the rapid development of the city, waste generation volume has need increased sharply, which results in that the site will have to be closed before 2004. In 2000, a Spanish company has completed a feasibility study on "Modernization of Domestic Solid Waste and Improvement of Environment Situation of Astana City"[2)]. The new solid waste disposal site (Landfill-1) is now under construction and will be put into operation in 2004.

The major features of the existing landfill site and planned solid disposal sites in Astana City are summarized in Table 12.1.5. However, only non-hazardous waste indicated in SNiP will be accepted at the new sanitary landfill site, moreover, domestic solid waste and industrial solid waste is planned to be dumped separately in different sections.

Table 12.1.5 Summary of Solid Waste Disposal in Astana City

Conditions of Solid Disposal Site	Existing	Spanish Plan (Landfill-1)	Landfill-2 (Phase 1+2)
Location	Northern part (10 km from the City center)	Near the existing landfill site	Near the existing landfill site
Area (ha)	65.6	15	64.3
Depth/Height (m)	12-35	30	15
Capacity (Million m^3)	15.4	4.32	6.75
Annual Disposal Volume (Million m^3/year)	0.515 (1999)	0.819	1.648
Used Volume (Million m^3)	10.43 (in Nov. of 1999)	-	-
Startup Year	1972	2002	2012
Designed Available Year (up to)	2010	2012	2030
Type of Dumping	Open dumping	Sanitary landfill	Sanitary landfill
Leachate Measures	None	With	With
Monitoring for Groundwater	None (three wells were constructed in 2002)	Yes	Yes

Source: JICA's M/P Report and Akimat[2)], JICA Study Team.

12.1.4 Noise

Major noise sources in Astana City are considered to be "Airport", "Railway Transport" and "Auto Transport". According to the Kazakhstan standard, the permissible noise level is set at 45 dB in new developed residential areas and 60 dB in existing residential areas. Existing data show that the noise levels along the eight (8) main streets exceeded 70 dB, while the noise levels along the railway track (100 m away) are estimated to be 46 to 80 dB[1)].

The Department of State Sanitary-epidemiological Control in Astana City is responsible for noise monitoring. However, at this moment there is not periodic monitoring system on noise level in the city.

12.1.5 Description of the Project "Development of the Water Supply and Sewerage System in Astana City"

(1) Water Supply System

The proposed water supply system in the stage of Detailed Design (D/D) consists of water intake, raw water transmission, and water treatment plant and water distribution facilities. The details are summarized in Table 12.1.6.

Direct construction cost of proposed water supply system is estimated to be US$110 million, according to the results of project cost estimation in the stage of Basic Design.

Table 12.1.6 Summary of the Proposed Water Supply System

Component	Contents	Remark
Water Supply System		
1. Intake Facilities	Intake pump station (210,000 m^3/d) at Vyacheslavsky reservoir including intake tower, access road, mechanical equipment, power receive and distribution facilities	New construction
2. Transmission Facilities	Replacement of pipeline with a total length of 15 km and diameter of 1,000 mm between Vyacheslavsky reservoir and the WTP (4 sections)	Out of the scope of JICA's Detailed Design
3. Water Treatment Plant	Water treatment facilities (100,000 m^3/d) including receiving well, chemical mixing tank, flocculation basin, sedimentation basin, rapid sand filter, as well as sludge treatment facilities	New construction
4. Distribution Facilities	Diameter of main pipelines: 1,000 mm Total length of main pipelines: 5,900 m Diameter of replaced pipelines: 100 to 1,000 mm Total length of replaced pipelines: 100,000 m Water meters: domestic water meters (152,000 units) bulk water meters (1,900 units)	New installing Replacement Newly installation

Source: JICA Interim Report [7)]

(2) Sewerage System

The proposed sewerage system in the stage of Detailed Design (D/D) consists of sewage collection system and sewage treatment. The details are summarized in Table 12.1.7.

Direct construction cost of proposed sewerage system is estimated to be US$51.9 million, according to the results of project cost estimation in the stage of Basic Design.

Table 12.1.7 Summary of the Proposed Sewerage System

Component	Contents	Remark
1. Sewer	Diameter of sewage pipelines: 100 to 800 mm Total length of sewage pipelines: 20,600 m (16 sections)	New installing and replacement
2. Intermediate Pump Station	Rehabilitation of 17 pump stations including mechanical/ electrical equipment	Rehabilitation
3. Manhole Cover	Rehabilitation of 5,300 manhole covers	Replacement
4. Sewage Treatment Plant	Sewage and sludge treatment facilities (136,000 m^3/d) including measuring/examination equipment, electrical facilities and in-plant landscaping	Rehabilitation and expansion

Source: JICA Interim Report [7)]

Total project cost including direct construction cost, indirect cost and the cost of operation and maintenance equipment is estimated to be US$255.4 million. However, This amount will be somewhat revised with the evolvement of Detailed Design.

12.2 Law and Regulations related to Environmental Protection

The major laws and regulations relevant to the environmental protection in Kazakhstan are listed in Table 12.2.1.

Table 12.2.1 Summary of Environmental Protection Laws in Kazakhstan

Law/Regulation	Contents	Jurisdictional Authority
General Environmental Protection		
Law of the Republic of Kazakhstan on Environmental Protection, 15.07.1997. No. 160-1 (Amended by the Laws issued on 24.12.98, 11.05.99 No. 381-1; 29.11.99 No. 488-1)	Regulations for environmental conservation and management	Parliament of the Republic of Kazakhstan
Temporary Instruction on the Order of Carrying out Environmental Impact Assessment of the Planned Economic Activities (EIA) (RND 03.02.01-93)	EIA guideline	Ministry of the Environmental Protection
Law on the Ecological Appraisal, 18.03.97 No.85-1 (Changes and amendments made by the Laws 24.12.98; 11.05.99 No.381-1)	-	Ditto
Water		
Water Code of the Republic of Kazakhstan, 31.03.93 No.2061-12 (Amended by the Laws issued on 24.12.96 No.58-1; 11.05.99 No 381-1)	Basic concept for water resource use and conservation	Parliament of the Republic of Kazakhstan
Regulations of Surface Water Protection of the Republic Kazakhstan (RND 1.01.03-94)	DO, pH, SS, BOD, COD, Coliform etc. requirements for domestic, public and fishery water resources	Ministry of the Environmental Protection
Sanitary Norms and Regulations for the Protection of Surface Waters from Pollution SanPin No. 4630-88 (Adopted by Kazkhstan)	Maximum Allowance Concentration (MAC) of some toxic substances (NO_3, NO_2, NH_4, P, SO_4 and heavy metals) for domestic, public and fishery water resources	Agency of Public Health
Drinking Water Quality Standards (SanPin 2.1.4559-96, Russia, adopted by Kazakhstan 3.01.067-97)	Maximum Permissible Concentration (MPC) of general items (pH, odor, color, turbidity etc.), inorganic substances, bacteria items and radioactive substances	Agency of Public Health
Wastewater		
Calculation Method of Maximum Permissible Discharge (MPD) of Pollutants with Wastewater into Water Bodies	The method for calculation of the value of MPD	Ministry of the Environmental Protection
Regulations for Industrial Wastewater Discharge of Astana City	The regulations for industrial wastewater discharge to public sewerage system	Astana City
Air		
Atmosphere Environment Protection (GOST 17.2.3.02-78)	Maximum Permissible Concentration (MPC) of the pollutants to the atmosphere	Ministry of the Environmental Protection
Methodology for Estimation of Concentration of Detrimental Substances in the Ambient Air in the Industrial Emissions (RND 211.2.01-97)	The method for calculation of the value of MPE	Ministry of the Environmental Protection
Solid Wastes		
SNiP on "Landfill of Municipal Solid Waste and Industrial Waste"	Classification of solid wastes	Ministry of the Environmental Protection
Noise and Vibration		
Maximum Allowable Noise Levels in the Rooms of Residential and Public Buildings and the Territory of Residential Buildings (SanPin RK No. 3.01.035-97)	Noise standards on different areas	Health Care Ministry, Department of National Sanitary-epidemiologic Service
Maximum Allowable Vibration Levels in Residential Houses (SanPin RK No. 3.01.032-97)	Vibration standards on different areas	Ditto

Source: Department of Environmental Protection and Department of Sanitary-epidemiological Control, Akimat

12.3 Regulations on EIA in Kazakhstan

The Ministry of Ecology and Bio-resources (now, Ministry of the Environmental Protection) issued the "temporary Instruction on the Order of Carrying Out Environmental Impact Assessment of the Planned Economic Activities (EIA)" (RND 03.02.01-93). This Instruction is designed with consideration of International Convention of Environmental Impacts Assessment in transboundary contract (accepted by the countries of European Economic Commission on Feb. 25th, 1991 in Finland), the recommendations of World Bank on the EIA in Central and Eastern Europe and CIS countries (Geneva, 1992), and Russian EIA guideline (Moscow, 1992).

The Instruction stipulates the procedures for the mandatory environmental impact assessment (review of the environmental conditions, pre-EIA and EIA), the assessment items, public participation, the contents of EIA documents. The Instruction also stipulates that an environmental monitoring system should be established to monitor the negative impacts of the proposed projects on the environment, if necessary. In this case, the "Customer" (the operation organization of the project) should defray the expenses of post-project environmental monitoring.

12.4 Initial Environmental Examination (IEE)

The IEE is defined as an examination undertaken at the outset of the development project planning stage to determine the environmental impacts that may be created by the proposed projects based on existing information and data. Therefore, the major objectives of the IEE in the stage of Basic Design (B/D) are:

1) To identify the current environmental situations in the Study area and to estimate probable negative environmental impacts of the proposed projects based on available information and data;
2) Consequently, to evaluate whether the EIA study is necessary for the proposed projects; and
3) To define the scope, evaluation items and methods of the EIA study.

As mentioned before, the Instruction on the EIA in Kazakhstan stipulates that a pre-EIA is necessary to determine the contents of further EIA study, which is similar to JICA Environmental Guidelines. However, There is no detailed pre-EIA guidelines or formats for water supply and sewerage projects. Actually, the pre-EIA in Kazakhstan always is bypassed. In this Study, JICA Environmental Guidelines related to the projects of water

supply and sewerage systems are applied to conduct the IEE.

12.4.1 Results of IEE

The results of the IEE for the proposed projects are summarized in Table 12.4.1 (water supply system) and Table 12.4.2 (sewerage system), respectively. Moreover, a survey primary check is conducted to identify the noise impact of proposed water distribution networks and sewers on the environment. Table 12.4.3 and Table 12.4.4 show the primary check results.

12.4.2 Scope and Evaluation Items of EIA

Based on the results of IEE and the comments given from the Department of Environmental Protection, the following items are taken up for the EIA Study:

1) Noise, Vibration and Traffic Congestion (interference to hospitals, schools and inhabitants due to the construction of WTP, water distribution pipelines, and sewers);
2) Soil and Sludge (soil pollution due to the disposal of the dewatered sludge from WTP and STP in case of the sludge being disposed for agricultural purpose);
3) Water Pollution (pollution on water resource due to the construction of proposed intake facilities, groundwater pollution around the existing landfill site due to the disposal of the sludge from WTP); and
4) Air (dust generated from WTP, water distribution pipeline and sewers construction sites, and odor generated from STP)

Table 12.4.1 IEE Checklist for Water Supply System

No.	Environmental Items	Evaluation	Contents	Further Study
Social Environment				
1.	Resettlement	C	The proposed WTP is located inside the existing WTP site. Moreover, no settlement exists along the transmission pipeline and distribution pipelines. Hence, no resettlement will be required.	
2.	Economic/Land Ownership	C	Economic loss will be not carried out due to the construction of the proposed projects.	
3.	Traffic/Public Facilities	B	The construction of transmission pipeline and distribution pipelines may create the impacts on traffic congestion. Therefore, the impacts of traffic congestion should be considered.	EIA
4.	Split of Communities	C	This impact will not occur.	
5.	Culture Property	C	The project sites are located within the existing WTP site and along the existing transmission and distribution pipelines. Hence no impacts on valuable cultural/archeological property will be expected.	
6.	Water Rights and Rights of Common	C	Vyacheslavsky Reservoir is an exclusive water resource for Astana City. Therefore, the impacts of water rights are not expected.	
7.	Public Health Condition	C	Sanitation conditions will be improved after completion of the proposed projects.	
8.	Waste	B	The impacts of dried sludge from WTP on the groundwater of landfill site where the sludge will be disposed, and on the soil when the sludge is used for agriculture should be considered.	EIA
9.	Hazards (Risk)	C	The proper structural design (aseismatic design etc.) will be considered in the basic design and detailed design.	
Natural Environment				
10.	Topography and Geology	C	The scale of the proposed projects is small. Therefore, the change of topography and geology due to excavation and earthfill will be quite limited.	
11.	Soil Erosion	C	The scale of the proposed projects is small. The impacts of soil erosion will be insignificant.	
12.	Groundwater	B	As mentioned in the item of "Waste", in case of dried sludge being disposed at the existing landfill site, groundwater contamination by leachate may occur.	EIA
13.	Hydrological Situation	C	An appropriate intake plan of the raw water will be prepared taking account the hydrological conditions of Vyacheslavsky Reservoir. So the impacts on the Reservoir are considered to be insignificant.	
14.	Coastal Zone	C	No such area.	
15.	Fauna and Flora	C	No precious fauna and flora in/ around the proposed projects sites are observed.	
16.	Meteorology	C	The proposed projects will not affect the local meteorological conditions due to its small scale.	
17.	Landscape	C	The impact of the WTP on the unique landscape and on the view from main viewpoints will be considered in the design.	
Pollution				
18.	Air Pollution	C	No air pollution will be caused by the proposed projects.	
19.	Water Pollution	B	The impacts of the construction of intake facilities on the water quality of Vyacheslavsky Reservoir should be considered.	EIA
20.	Soil Pollution	B	In case of the sludge from WTP being used for agriculture, the impacts of the sludge on the soil should be considered.	EIA
21.	Noise and Vibration	B	During the construction stage of the proposed WTP, raw water transmission pipeline, and distribution pipelines, the impacts of the noise and vibration created by construction equipment and vehicles on the hospitals and surrounding residents may occur. Therefore, the detailed survey and evaluation should be conducted.	EIA
22.	Land Subsidence	C	No groundwater will be used as the resource of water supply.	
23.	Offensive Odor	C	The chlorine disinfectant storage and injection facilities will be designed in such a way as not to endanger staff and the environment. An appropriate operation and maintenance will be conducted.	

Note: Evaluation categories:
A: Serious impact (EIA is necessary)
B: Somewhat impact (EIA is necessary)
C: Light or no impact (EIA is not necessary)

Table 12.4.2 IEE Checklist for Sewerage System

No.	Environmental Items	Evaluation	Contents	Further Study
Social Environment				
1.	Resettlement	C	The proposed STP is located within the existing STP site. Moreover, no settlement exists along the sewers. Hence, no resettlement will be required.	
2.	Economic/Land Ownership	C	Economic loss will be not carried out.	
3.	Traffic/Public Facilities	B	The construction of the replaced sewers may create the impacts on traffic congestion. Therefore, the impacts of traffic congestion should be considered.	EIA
4.	Split of Communities	C	This impact will not occur.	
5.	Culture Property	C	Almost project sites are located within the existing STP site and along the existing sewers. The impacts of new installing sewers on valuable cultural/archeological property are considered to be insignificant.	
6.	Water Rights and Rights of Common	C	The treated sewage from the proposed STP will be discharged into Taldy Kol Reservoir that is designed to exclusively receive the effluent of STP. Therefore, the impacts of water use are not expected.	
7.	Public Health Condition	C	Sewerage service rate will increase after the completion of the proposed projects. So the impacts of the proposed projects will be positive.	
8.	Waste	B	The impacts of sewerage sludge from STP on the groundwater of the landfill site in case of the sludge being disposed the existing landfill site, and on the soil in case of the sludge is used for agriculture should be considered.	EIA
9.	Hazards (Risk)	C	The proper structural design (aseismatic design etc.) will be considered in the basic design and detailed design.	
Natural Environment				
10.	Topography and Geology	C	The scale of the proposed projects is small. Therefore, the change of topography and geology due to excavation and earthfill is quite limited.	
11.	Soil Erosion	C	The scale of the proposed projects is small. The impacts of soil erosion will be insignificant.	
12.	Groundwater	B	As mentioned in the item of "Waste", in case of sewerage sludge being disposed at the existing landfill site, the groundwater contamination created by leachate may occur.	EIA
13.	Hydrological Situation	C	Taldy Kol Reservoir is designed to exclusively receive the effluent of STP. So the impacts on hydrology are considered to be insignificant.	
14.	Coastal Zone	C	No such area.	
15.	Fauna and Flora	C	Almost project sites are located within the existing STP site and along the existing sewers.	
16.	Meteorology	C	The proposed projects will not affect the local meteorological conditions due to its small scale.	
17.	Landscape	C	The impact of the STP on the unique landscape and on the view from main viewpoints will be considered in the design.	
Pollution				
18.	Air Pollution	C	No air pollution will be caused by the proposed projects.	
19.	Water Pollution	C	It is estimated that the pollution load discharged to Taldy Kol Reservoir will be not increased.	
20.	Soil Pollution	B	In case of the sewage sludge from STP being used for agriculture, the impacts of the sludge on the soil should be considered.	EIA
21.	Noise and Vibration	B	During the construction stage of the replaced sewers, the impacts of the noise and vibration created by construction equipment and vehicles on the hospitals, schools and surrounding residents may occur. Therefore, the detailed survey and evaluation should be conducted.	EIA
22.	Land Subsidence	C	No groundwater extraction will be expected.	
23.	Offensive Odor	C	Although odor will be emitted from STP and sludge treatment facilities during operation of the proposed STP, the nearest residential area is more than 2 km far from the proposed STP site. Thus the impacts of odor on nearby inhabitants will not be serious.	

Note: Evaluation categories:

A: Serious impact (EIA is necessary) B: Somewhat impact (EIA is necessary) C: Light or no impact (EIA is not necessary)

Table 12.4.3 Primary Checklist on the Noise Impact of Water Distribution Pipelines

No.	D (mm)	Location (Name of Str.)	Evaluation	Reason	Further Plan
1	700	ХАЛЖИМУКАНА МАНАЙТПАСОВА	C	Few buildings located along this route, are far from the road. The impact of noise is not significant.	
2	300	МИРЗОЯНА	C	Few buildings located along this route, are 40-50m far from the road. The impact of noise is not significant.	
3	800	КЕННСАРЫ	B	There are one school and one college located along this route. The impacts of noise and vibration on the schools and residents should be considered accordingly.	EIA (SW-1 SW-2 SW-3)
4	700	СЕЙФУППИНА	C	There are not hospitals and schools. Hence, the impacts of noise are considered to be insignificant.	
5	400	ПУШКИНА	B	A military hospital exists 20-30 m from the proposed pipeline route. Therefore, the impacts of noise should be considered.	EIA (SW-4)
6	300	ДЖАНГИЛЬДИНА	B	There is a school along the proposed pipeline route. Hence the impacts of noise should be considered.	EIA (SW6)
7	300	ЖЕЛТОКСАН	B	A hospital is located along the proposed pipeline route. Therefore, the impacts of noise should be evaluated.	EIA (SW-5)
8	800	КУМИСБЕКОВА	C	There are few house located along this route. Therefore, the impacts of noise are considered to be insignificant.	
9	700	БОГЕМБАЯ	C	There are not hospitals and schools located along the proposed pipeline route. Hence, the impacts of noise and vibration are considered to not be significant.	
10	300	МОСКОВСКАЯ	C	There are not hospitals and schools located along the proposed pipeline route. Hence, the impacts of noise and vibration are considered to not be significant.	
11	400	9 МАЯ	B	A hospital exists 40 m from the proposed pipeline routs. So more detailed survey will be necessary to evaluate the impact of noise on this hospital.	EIA (SW-7 SW-10)
12	300	АКЖКАИЫК	B	A school is located along this route. Moreover, there are many buildings along the street which's width is narrow (17m). Therefore, the impact of noise should be considered.	EIA (SW-8 SW-9)
13	700	ЛИНЕЙНАЯ	C	There are not hospitals and schools located along the proposed pipeline route. Hence, the impacts of noise and vibration are considered to not be significant.	.
14	300	ГЕТЕ	C	There are not hospitals and schools located along the proposed pipeline route. Hence, the impacts of noise and vibration are considered to not be significant.	
15	300	КАРАСАЙ БАТЫРА	C	Few buildings located along this route, are 40-50m far from the road. The impact of noise is not significant.	
16	300	КОНСТИТУЦИИ	C	Few buildings located along this route, are 40-50m far from the road. The impact of noise is not significant.	
17	300	ПОБЕДЫ	C	There are not hospitals and schools located along the proposed pipeline route. Hence, the impacts of noise and vibration are considered to not be significant.	

Note: Evaluation categories:
A: Serious impact
B: Somewhat impacts
C: No significant impact

Table 12.4.4 Primary Checklist on the Noise Impact of Sewage Pipelines

Line	D (mm)	L (m)	Evalua-tion	Reason	Further Plan
1 (1-2)	700	460	B	Municipal School No.1 exists near this route (35 m). There also are a few buildings along the route. The impacts of noise and vibration on the school and residents should be considered accordingly.	More detailed EIA is necessary.
2 (2-1)	250	1,100	C	There are few houses are located along this replaced sewer. Hence, the impacts of noise and vibration are considered to be insignificant.	
3 (2-2)	250x2	700x2	B	This new installing sewer will traverse Mozhaiskogo St. (a main street). Therefore, the impacts of traffic congestion, noise and vibration should be considered.	More detailed EIA on traffic is necessary.
4 (2-3)	800	2,000	B	There are two hospitals exist near the route 2-3 (about 80m), and moreover, there are a few buildings are located along this route. Hence the impacts of noise and vibration should be considered.	More detailed EIA is necessary.
5 (3-2)	100	1,000	C	There are few buildings are located along the route of the replaced sewer, therefore, the impacts of noise and vibration are considered to be insignificant.	
6 (3-3)	200x2	1,900 x2	C	There are few buildings are located along the route of the replaced sewer, therefore, the impacts of noise and vibration are considered to be insignificant.	
7 (3-4)	100	900	C	There are few buildings are located along the route of the replaced sewer, therefore, the impacts of noise and vibration are considered to not be significant.	
8 (4-1)	200x2	1,900 x2	C	This new installing sewer is located in the suburbs of the City and there are few houses are located along the route of the sewer. Hence, the impacts of noise and vibration are considered to be insignificant.	
9 (4-2)	150	2,400	C	This new installing sewer is located in the suburbs of the City and no residential buildings exist along this route. So the impacts of noise and vibration could be negligible.	
10 (4-3)	500	1,600	C	This replaced sewer will be constructed along a stream. The impacts of noise and vibration are considered to be insignificant.	
11 (5-1)	300	800	B	A primary school exists near this route. Moreover, the distance from centerline of the sewer to the nearest building is only 8 m. Therefore, the impacts of noise and vibration should be considered.	More detailed EIA is necessary.
12 (5-3)	600	1,200	C	There are few buildings are located along this replaced sewer. The impacts of noise and vibration are considered to be insignificant	
13 (5-2)	300	1,200	C	This route is located in the suburbs of the City. So the impacts of noise and vibration could be negligible.	
14 (6-2)	250	400	C	There are few buildings are located along this route, therefore, the impacts of noise and vibration are considered to be insignificant.	
15 (6-1)	250	800	C	There are few buildings are located along the route of this new installing sewer, therefore, the impacts of noise and vibration are considered to be insignificant.	
16	400	320	C	No impact of noise will be expected.	

Note: Evaluation categories:
A: Serious impact
B: Somewhat impacts
C: No significant impact

12.5 Environmental Impact Assessment (EIA)

12.5.1 Introduction

(1) Objective of EIA study

The main objectives of the EIA study are:

1) To review the existing environmental conditions in the EIA study area;
2) To assess environmental impacts of the proposed projects, including its potential negative environmental impacts during construction and operation period and its probable positive impacts based on collected materials and field survey; and
3) To propose countermeasures (short-term and long-term) for mitigating impacts and environmental monitoring plan.

(2) The Regulations Used in EIA Study

The major regulations used in the EIA study are showed as follows:

1) Noise standard (SanPin RK No. 3.01.035-97)
2) Drinking water quality standards (SanPin 2.1.4559-96, Russia, adopted by Kazakhstan 3.01.067-97)
3) Regulations of surface water protection of the Republic Kazakhstan (RND 1.01.03-94)
4) Sanitary norms and regulations for the protection of surface waters from pollution SanPin No. 4630-88 (adopted by Kazkhstan)
5) Atmosphere Environment Protection (GOST 17.2.3.02-78)
6) EU standard on sludge (86/278/EC, Appendix 1B)
7) EU standard on soil (86/278/EC, Appendix 1A)

(3) EIA Implementing Organization

The EIA study is carried out by entrusting a qualified local EIA organization, National Scientific Research Center of the Air Protection, Northern-Kazakhstan State University.

12.5.2 Impact Assessment on Air

(1) During Construction Stage (Dust)

During construction stage of WTP, water distribution pipelines and sewers, the operation of construction machinery and earthwork may lead to the generation of dust. Considering the fact that total suspended particulate matter (TSP) in the air has exceeded Kazakhstan standard, following countermeasures are recommended to take during construction, although the impacts of the dust on the residents living in the vicinity of roads or WWTP are temporary:

1) Covering stored materials with plastic or other materials
2) Covering trucks
3) Spraying exposed areas with water
4) Minimizing traffic over freshly exposed surfaces, etc.

(2) During Operation Stage (Odor from STP and Air Pollution)

1）Odor from STP

For any sewage treatment plants, offensive odors could be emitted from sewage and sludge treatment facilities during operation. Odors at sewage and sludge treatment facilities generally result from inorganic gases and vapors. The most common inorganic vapors are hydrogen sulfide (H_2S) and ammonia (NH_3). The diffusion, transmission and attenuation of odors in the air are affected mainly by geographical features (such as distance and land type etc.) and meteorological conditions (such wind direction, wind speed, and air temperature and humidity etc.). Normally, the area of influence is within a radius of 1 to 3 km.

The existing STP is located about 7 km southwest of the city center. The nearest village is located at about 2 km away from the existing STP. The major source of odors in the existing STP is considered to be sludge-drying beds having a total area of 8.3 ha (32 beds). In this EIA study, the concentration of odorants (NH_3 and H_2S) is measured, at the same time a sensory test of odor is also carried out to evaluate odor lever in/around the existing STP. The results of odor survey are shown in Table 12.5.1.

Table 12.5.1 Results of Odor Survey

Location	OS1* (Borderline of STP)	OS2* (700m Downwind)	OS3* (1,500m Downwind)	Remark
NH_3 (mg/m^3)	8.3	3.4	3.0	Odor Level
H_2S (mg/m^3)	ND (<0.002)	ND (<0.002)	ND (<0.002)	0: Odorless
Odor Level	3	1	0	1: Just able to sense
Tempe. (^{0}C)	19.0	18.5	18.5	2: Smell but don't know
Humidity (%)	66	69	69	which one
Atmospheric Pressure (mmHg)	727.5	718.5	727	3: Easily sensed smell 4: Strong smell
Others	Sampling Time: July 16, 2003; Wind Direction: SW			5: Very offensive smell

Note: Sampling locations of odor survey are shown in Figure. 12.5.1

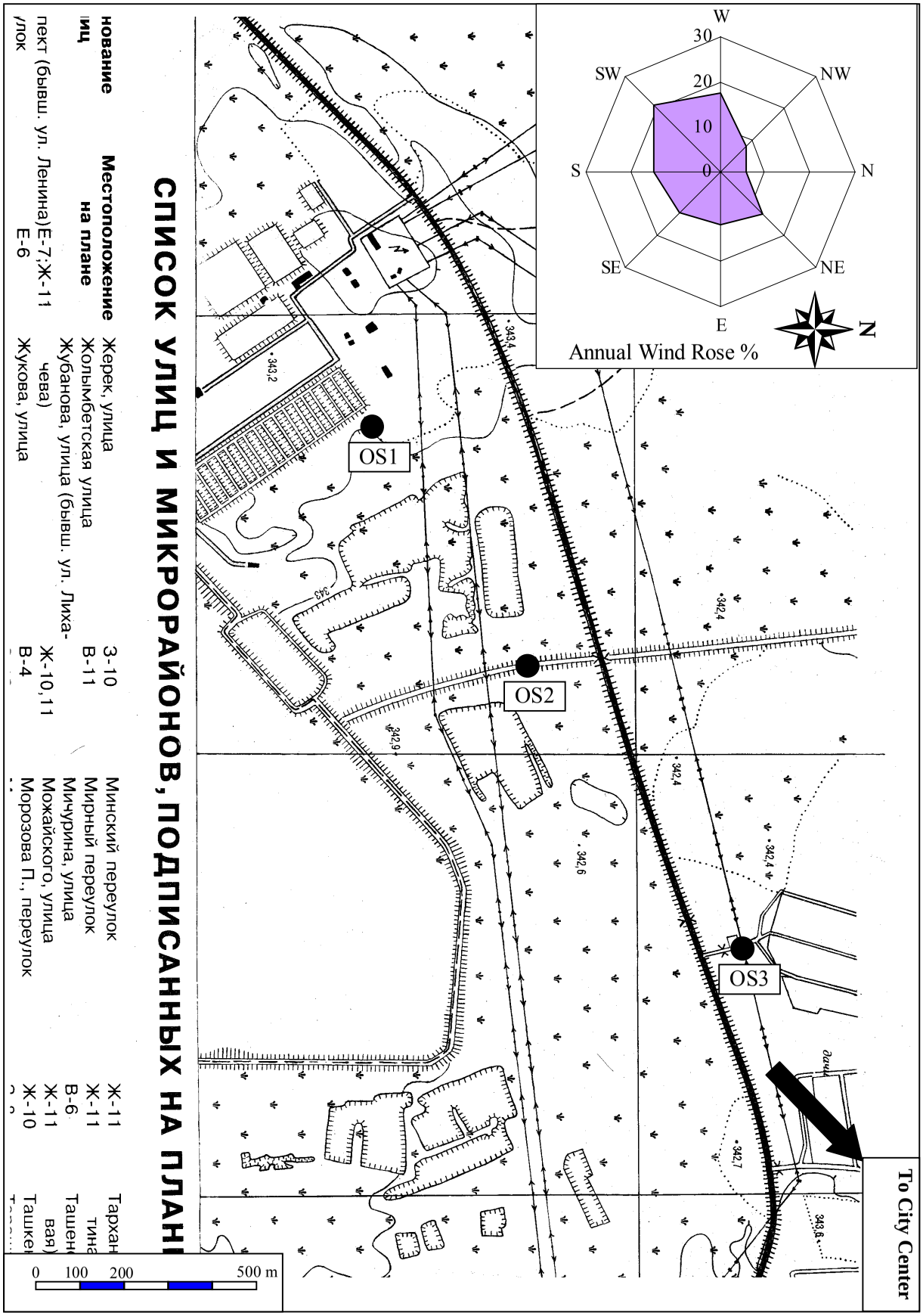


Figure 12.5.1 Location Map of Odor Survey

The survey results reveal that the concentration of NH_3 and odor level on the borderline of STP have a high level. At the location of 1,500 m downwind, although odor level is declined to a level of odorless, the concentration of NH_3 still has a relatively high level. Moreover, the residents at nearest village report that they can smell an offensive odor sometimes. Therefore, the impact of offensive odors generated from the existing STP on the surrounding area cannot be neglected.

In the proposed project, mechanical dewatering system (screw press) will be installed to replace existing sludge-drying beds. Therefore, odors generated from sludge-drying beds will be decreased to be an acceptable level. Furthermore, to enhance odor control it is recommended to take the following measures:

i) To plant a tree belt around the existing STP site to mitigate the impact of offensive odors on nearby inhabitants;

ii) To set a buffer zone (where the construction of residential houses will be not allowed) of 500m to 1,000m around the existing STP;

iii) To add calcium hypochlorite or hydrated lime to the sludge as it is discharged to the drying beds before proposed project being implemented, if necessary; and

iv) To establish a monitoring system to check the odors level in/around STP, especially at nearby inhabitants. (for details see section **12.5.7**)

2) Air Pollution (WTP and STP)

Heat of the existing WTP is supplied by center heat supply system. For proposed WTP, heat will also be supplied by center heat supply system. Therefore, air pollution generated from boiler at the proposed WTP will not be occurred. As regards air pollution resulting from chlorination, the storage capacity of chlorine cylinder at chlorination house is designed to be low two tons due to safety reason. Moreover, a neutralization system (lime) is installed at chlorination house for neutralization of chlorine gas in case of emergency, hence, no significant impact on air will be expected.

In the existing STP, there are two coal boilers and one gas boiler for supplying heat. In this project the existing two coal boilers (4.5 ton/hr) shall be replaced, and the capacity of new boiler will be same as existing one. Air pollutants generated from boilers at the proposed STP, thus, will be same as existing one. Calculation of maximum concentrations of pollutants in the air in/around STP shows that none of the pollutants will exceed the standards of Kazakhstan in future.

12.5.3 Impact Assessment on Surface-water and Groundwater

(1) During Construction Stage (Intake Facilities)

In proposed project, a new intake station with a capacity of 210,000 m^3/d will be constructed at Vyacheslavsky reservoir including access road, intake tower, mechanical equipment, and power receive and distribution facilities. The construction works of access road (about 300 m in length) and intake tower (type: round shape with a radius of 11.5 m, construction method: open caisson) may generate some negative impacts on the existing intake facility. The most important item is that turbid water generated during construction period may cause an increase of turbidity in raw water for existing intake facility.

In this EIA Study, a survey on water quality at existing and proposed intake sites is conducted. The results indicate that the turbidity in upper, middle and bottom layers at both sites has a relatively low level (7 to 10 NTU). According to the results of raw water quality monitoring curried out by ASA, the maximum value of turbidity in the period of 1989 to 2002 was lower than 30 NTU. Therefore, it is desired to keep the turbidity in raw water of existing intake facility to not be over 30 NTU.

In Detailed Design stage, following countermeasures are taken into consideration to prevent existing intake facility from turbid water generated during the construction of proposed access road and intake tower:

1) The excavation method to minimize water contamination will be applied;
2) A polyester fence will be installed in the water around construction site to prevent existing intake from turbid water caused by the construction of proposed intake tower and access road; and
3) Furthermore, it is recommended to establish a monitoring system to check the turbidity of water in/around existing intake tower. (for details see section **12.5.7**)

In addition, the construction works of access road and intake tower will be completed within several months, thus the impact of turbid water on existing intake facility is considered to be not significant.

(2) During Operation Stage (Vyacheslavsky Reservoir, Landfill Site and STP)

1) Vyacheslavsky Reservoir

As mentioned in Table 12.12, although BOD5 and DO concentrations in the reservoir water were within Kazakhstan standards, COD, T-N and T-P concentrations shown a relatively high level in 1999 and 2000. Based on the surface water standards in Japan, T-N concentration in Vyacheslavsky Reservoir can be classified as Class IV (0.6 mg/l) to V (1 mg/l), while T-P concentration can be classified as Class III (0.03 mg/l). Furthermore, the Carlson Index of

the water quality in Vyacheslavsky Reservoir ranges from 50 to 80, which indicates that the eutrophication in Vyacheslavsky Reservoir has a relatively high level.

Such a high level of nutrients (nitrogen and phosphorous) may stimulate excessive growth of algae (including blue-green algae) that would result in taste and odor problems and impede the regular operation of WTP. Especially, blue-green algae may become toxic to organisms and humans. Actually, according to the results of water quality survey carried out JICA study team in Basic Design stage (February 2003), *Microcystis aeruginosa*, a kind of toxic algae that may produce toxic substance-*Microcystin*, was detected to a certain extent. Following countermeasures on eutrophication control of Vyacheslavsky Reservoir, therefore, are recommended.

1) To conduct a synthetic and detailed survey on water quality and sedimentation in Vyacheslavsky Reservoir, water quality at the mouths of inflow-rivers, and pollution sources (point and non-point) in the catchment area of Vyacheslavsky Reservoir, in order to take more effective countermeasures;
2) To set a buffer zone (where livestock farming will be not allowed) at the bank of Vyacheslavsky Reservoir, even inflow-rivers, considering the fact that a lot of livestock's feces are observed at the bank of Vyacheslavsky Reservoir, and banks of inflow-rivers, which is considered to be one of major pollution sources;
3) To enhance environmental education for residents by using the media (TV, newspaper, poster etc.) to decrease the generation and discharge of pollutants including the wastes from livestock;
4) As a short-term countermeasure, to scatter copper sulfate in the surface of water area near intake when excessive growth of algae occurs;
5) As long-term countermeasures, to construct wastewater treatment facilities in towns or villages located within the catchment area of Vyacheslavsky Reservoir to treat domestic and industrial wastewaters, and to apply the direct purification technology (such as wetland, pre-sedimentation of influent water from rivers, aquatic plant purification, and aeration of lake-water) to inflow-rivers and Vyacheslavsky Reservoir; and
6) To establish a monitoring system to monitor the water and sediment quality in Vyacheslavsky Reservoir, the water quality at the mouths of inflow-rivers in order to grasp the newest progress of eutrophication in Vyacheslavsky Reservoir. (for details see section **12.5.7**)

2) Landfill Site

It is estimated that the dried sludge production from the proposed WTP is 1.2 m^3/day or 438 m^3/year in average with 75 % of water content. In order to evaluate the heavy metals contents in the sludge from new WTP, in this EIA study the concentration of heavy metals in the sludge, which is sampled by collecting the sediments of backwashing effluent in the existing WTP, is analyzed. The results are shown in Table 12.5.2.

Table 12.5.2 Heavy Metals Concentrations of Sludge in WTP

Heavy Metals (mg/kg dry-weight)	Sludge[1)]	EU Standard[2)] (Soil)	USA Standard[3)] (Soil)
Arsenic (As)	0.02	-	20.5
Cadmium (Cd)	ND	1-3	19.5
Copper (Cu)	0.145	50-140	750
Lead (Pb)	0.045	50-300	150
Mercury (Hg)	ND	1-1.5	8.5
Zinc (Zn)	0.505	150-300	1,400

1): Sediment of backwashing effluent at the existing WTP.
2): Maximum admissible concentration of soil for EU countries, 86/278/EC, Appendix 1A
3): Maximum admissible concentration of soil in USA

The analysis results show that the concentrations of heavy metals in the sludge of the existing WTP are at a very low level. Therefore, it is recommended to reuse the dried sludge from WTP for agricultural purpose or as raw materials of cement and brick. Before the reuse method of the dried sludge is established, the dried sludge from WTP could be disposed at the existing landfill site of solid waste.

To evaluate the impact of the dried sludge from WTP on groundwater around the existing landfill site, in this EIA study, a survey on groundwater quality is conducted. Four samples are taken from the wells located around the existing landfill site (Figure 12.5.2), and results are summarized in Table 12.5.3.

Table 12.5.3 The Results of Groundwater Quality around Existing Landfill Site

Item	Unit	Location				Standard[1)]
		WW1	GW1	GW2	GW3	
pH	-	6.8	6.5	7.0	**5.0**	6-9
Odor Intensity	-	2	**3**	0	3	2
Color	Degree	20	20	15	**30**	20
Turbidity	mg/l	>**4**	>**4**	>**4**	>**4**	1.5
$KMnO_4$ Consumption	mg/l	6.1	-	-	-	5.0
Iron (Fe)	mg/l	**0.44**	**0.36**	**0.58**	**0.72**	0.3
Arsenic (As)	mg/l	**0.199**	ND	**0.147**	**0.147**	0.05
Cadmium (Cd)	mg/l	0.001	0.001	0.001	0.001	0.001
Copper (Cu)	mg/l	0.360	0.191	0.107	0.220	1.0
Lead (Pb)	mg/l	**0.094**	0.023	0.019	0.011	0.03
Mercury (Hg)	mg/l	0.0004	ND	ND	ND	0.0005
Zinc (Zn)	mg/l	0.112	0.071	0.094	0.085	5.0

1): Standard for drinking water quality, SanPin 3.01.067-97.
2): Values shown as **5.0** are over standard.

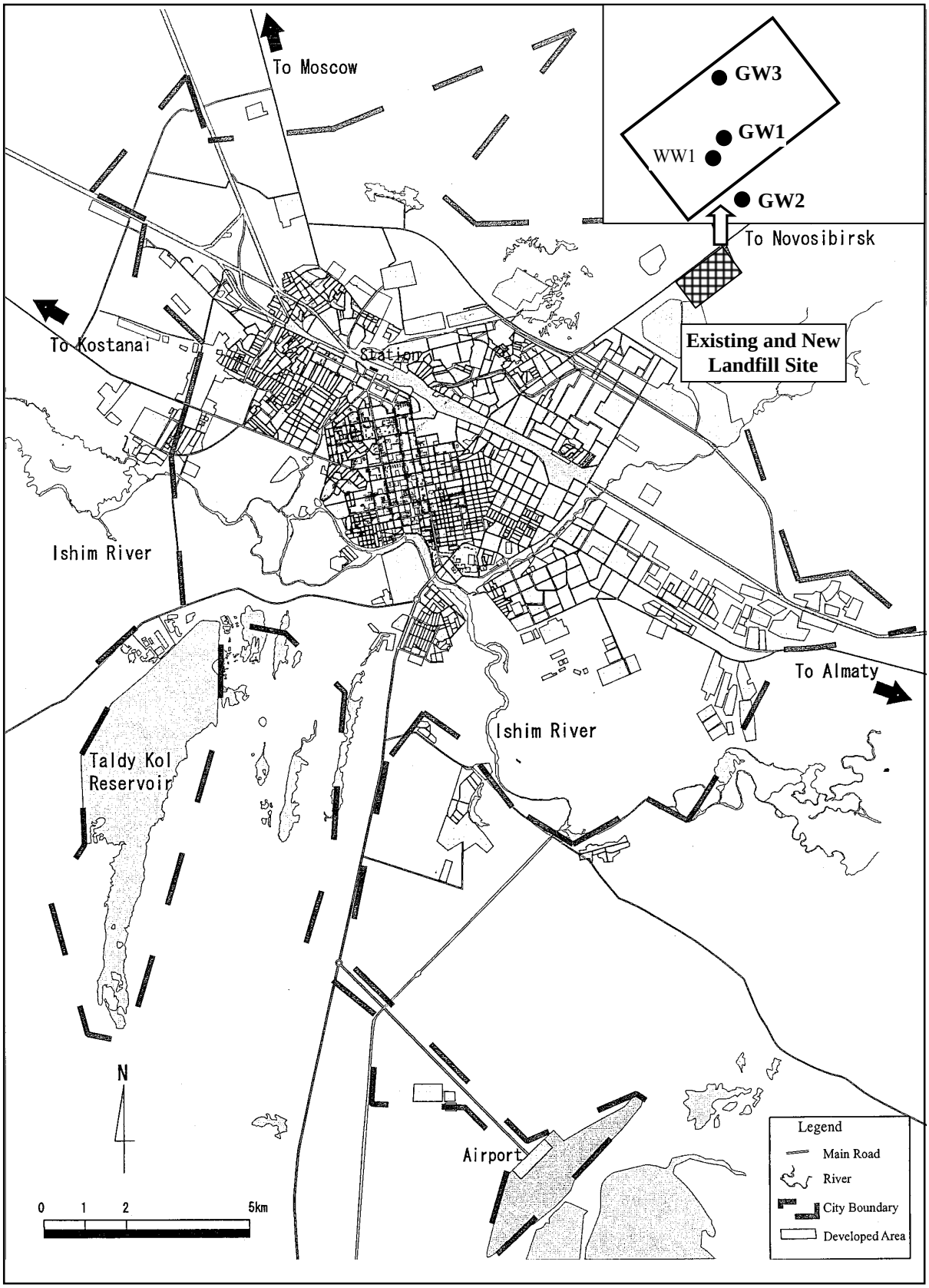


Figure 12.5.2 Location Map of Groundwater Quality Survey

As shown in Table 8.2.2, groundwater in the surrounding area of existing landfill site has been polluted to a certain extent. However, a new solid waste landfill site with leachate collection and treatment system is now under construction, and will be put into operation in 2004.

Consequently, disposing the dried sludge from WTP at the new landfill site will not generate significant impact on the groundwater quality.

12.5.4 Impact Assessment on the Soil

It is estimated that dewatered sludge production of the proposed STP is 73.5 m^3/day or 26,828 m^3/year with 80 % of water content. So far, dried sludge from sludge-drying beds in the existing STP has been stored at open space of STP because it is not allowed to dispose dried sludge to existing landfill site. Therefore, the best reuse or disposal option has to be selected by analyzing the end products for their impacts on the environment as well as their costs. Current major reuse or disposal methods including:

1) Agricultural use

2) Incineration

3) Landfilling

Residual sludge generated from STP contains usually organic matter that may enhance soil quality and chemical elements such as nitrogen (N), phosphorus (P) and potassium (K) that may supply nutrients for plant growth. However, the concentration of heavy metals in residual sludge always limits agricultural use.

In order to estimate the concentration of heavy metals in dewatered sludge from STP and to evaluate whether dewatered sludge could be reused for agricultural land, a survey on current heavy-metal levels in the dried sludge of the existing STP and in the soil of candidate sites for agricultural use is conducted in this EIA Study. The results are summarized in Table 12.5.4.

Table 12.5.4 Heavy Metals Concentrations of Dried Sludge and Agricultural Land

Heavy Metals (mg/kg dry-weight)	Dried Sludge[1)]	Soil[2)]	EU Standard[3)] (Sludge)	EU Standard[4)] (Soil)	USA Standard[*5)] (Sludge)	USA Standard[5)] (Soil)
Arsenic (As)	2.8	0.6	-	-	41-75	20.5
Cadmium (Cd)	0.05	0.01	20-40	1-3	39-85	19.5
Copper (Cu)	3.0	1.0	1,000-1,750	50-140	1,500-4,300	750
Lead (Pb)	0.8	0.2	750-1,200	50-300	300-840	150
Mercury (Hg)	0.014	ND	16-25	1-1.5	17-57	8.5
Zinc (Zn)	4.0	0.7	2,500-4,000	150-300	2,800-7,500	1,400

1): The average concentration of two dried sludge samples at the existing STP (Figure 12.5.3).
2): The average concentration of two soil samples taken from the farmland 2 km west of the existing STP (Figure 12.5.3).
3): Maximum admissible concentration for EU countries, 86/278/EC, Appendix 1B
4): Maximum admissible concentration for EU countries, 86/278/EC, Appendix 1A
5): Maximum admissible concentration in USA

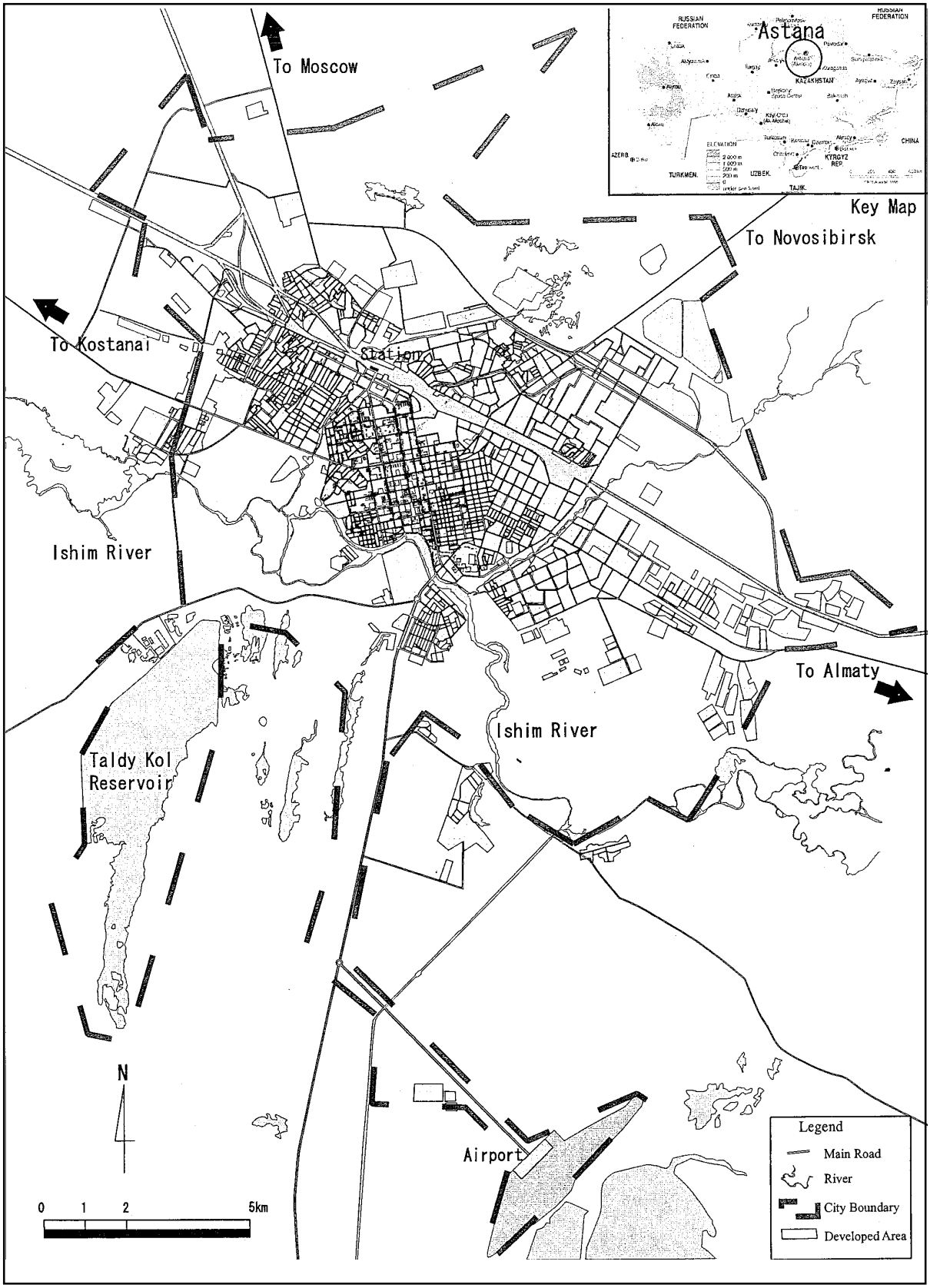


Figure 12.5.3 Location Map of Soil and Sludge Survey

The survey results show that the concentrations of heavy metals both in dried sludge and agricultural land have a low level, which can be explained by the fact that in Astana the quantity of industrial wastewater is extremely small. Therefore, it is recommended to select agricultural use as final disposal method of dewatered sludge, considering lower heavy metals concentrations of dewatered sludge, transportation costs, and the background that an increase in agricultural utilization as well as a reduction of landfill for sewage sludge is forecasted in EU countries.[8)]

In this EIA study, a plan for agricultural use of dewatered sludge is proposed in accordance with EU standards and USA standards. To estimate necessary area of agricultural land, and average annual applied quantity of dewatered sludge, following assumptions and preconditions are used based on the results of BD and existing data:

1) The quantity of dewatered sludge is 73.5 m^3/day or 26,828 m^3/year;
2) Water content of dewatered sludge is 80%;
3) Specific gravity of soil in agricultural land is 1.5 ton/m^3;
4) Application period of agricultural use is 10 years; and
5) The depth of soil layer where dewatered sludge is mixed is 0.1 m.

Table 12.5.5 shows the results of calculation for necessary area of agricultural land and average annual applied quantity of dewatered sludge and evaluation on heavy metals concentrations in the soil of agricultural land.

Table 12.5.5 The Results of Calculation and Evaluation

	Dried Sludge	Soil	Permitted Load in EU Countries[1)]	Heavy Metals Concentrations in Soil after 10 Years	MAC of Soil in EU Countries
	mg/kg	mg/kg	Kg/ha/year	mg/kg	mg/kg
Arsenic (As)	2.8	0.6	0.15	1.18	1-3[2)]
Cadmium (Cd)	0.05	0.01	0.15	0.02	1-3
Copper (Cu)	3.0	1.0	12	1.5	50-140
Lead (Pb)	0.8	0.2	15	0.4	50-300
Mercury (Hg)	0.014	ND	0.1	0.005	1-1.5
Zinc (Zn)	4.0	0.7	30	1.5	150-300
Available application quantity of dewatered sludge: 268 m^3/ha/year Total necessary area of agricultural land: 100 ha					

1): Permitted load in EU countries, 86/275/EC, Appendix 1C
2): Decided by referencing permitted load and MAC in USA.

As mentioned above, to ensure heavy metals concentration of the soil in agricultural land being low than MAC of soil, available application quantity of dewatered sludge is estimated to be 268 m^3/ha/year. Moreover, in order to dispose dewatered sludge generated from STP, a total area of 100 ha will be necessary. The results of evaluation on heavy metals

concentrations in the soil of agricultural land indicate that heavy metals concentrations in the soil of agricultural land will be within MAC after an application period of 10 years.

Furthermore, following items should be noted when the dewatered sludge is reused in agricultural land:

1) It is recommended for STP to establish a cooperating system to supply technical information (such as application method, the concentrations of organic matters, nutrients and heavy metals, and level of pathogenic risk etc.) to users, and to accept their requirements on product quality;
2) To register the application of dewatered sludge with related government offices;
3) To ensure enough space for storing dewatered sludge, considering the fact that fertilizer demand always varies with the season;
4) To establish a distribution system of dewatered sludge previously;
5) In order to save the transportation costs to the disposal site, site storage costs, and application costs, it is recommended to dispose firstly dewatered sludge from mechanical dewatering system at existing sludge-drying beds to decrease water content of dewatered sludge from 80% to 60%. In this case, it is estimated that the transportation costs to the disposal site, site storage costs, and application costs could be reduced by 50%; and
6) To establish a monitoring system to check the concentrations of heavy metals in dewatered sludge from STP and the soil of agricultural land (for details see section **12.7**)

12.5.5 Impact Assessment on Noise

(1) WTP Construction Stage

There are some hospitals (such as Mental Asylum, Inter-regional Hospital and Orthopedic Hospital) and schools (such as Medical College) located around the existing WTP. During the construction stage of new WTP that is located inside the existing WTP site, noise and vibration generated by the operation of construction equipment (such as pile hammer, bulldozer etc.) and heavy vehicles would disturb the amenity of hospitals especially Mental Asylum that is located just 100 m away from the existing WTP. In this EIA study, a survey on noise and vibration in/around WTP is carried out in order to evaluate the impact of noise generated at construction stage on Mental Asylum and nearby school as well as residents.

Equivalent continuous A sound level (L_{aeq}) is used to assess noise level. The location map of measuring points, which are selected by referring Kazakhstan standards and the results of IEE

(Initial Environmental Examination), is shown in Figure 12.5.4. To estimate the noise level at Mental Asylum during new WTP construction period, following conditions are considered:

1) Major noise sources are pile hammers (2.5t, 5 sets), backhoes (1 m^3, 2 sets), bulldozers (8t, 2 sets), tractor shovels (1.6 m^3, 2 sets), truck cranes (25t, 2 sets) and dump trucks (4t, 2sets);

2) The noise levels of selected pile hammer, backhoe, bulldozer, tractor shovel, truck crane and dump truck are estimated to be 115 dB(A), 100 dB(A), 100 dB(A), 95 dB(A), 95 dB(A), and 100 dB(A) respectively; and

3) The noise declines only caused by distance, trees and ground are considered when the noise levels at sound receiving points are calculated.

The results of estimation on the noise levels at survey points are summarized in Table 12.5.6.

Table 12.5.6 The Results of Estimation on Noise Levels around WTP

Location	Existing Noise Level	Estimated Noise Level during Piling Work[1)]	Estimated Noise Level during Earthwork[2)]	Kazakhstan Standard on Noise	Remark
	dB (A)	dB (A)	dB (A)	dB (A)	
ST-1	55	122	107	-	WTP
ST-2	60	122	106	-	WTP
ST-3	55	69	58	50 (65)[3)]	Hospital
ST-4	49	65	52	50 (65)[3)]	Hospital

1): Used construction equipment during piling work will be pile hammers (2 sets)
2): Used construction equipment during earthwork will be backhoes (2 sets), bulldozers (2 sets), tractor shovels (2 sets), truck cranes (2 sets) and dump trucks (2 sets).
3): Maximum noise level (L_A)

As shown in Table 12.5.6, the noise level at Mental Asylum is estimated to be 52 to 69 dB(A) during the construction stage of new WTP, which has exceed Kazakhstan standard on the noise at hospital area. During earthwork period, the noise level at Mental Asylum is estimated to be 52 to 58 dB(A), which means that the noise level increases only by 3 dB(A) comparing the existing noise level. However, during pile driving period, the noise level at Mental Asylum will be 65 to 69 dB(A), which has exceeded the existing noise level by 14-16 dB(A). Although the impact of noise generated by new WTP construction on Mental Asylum is not serious, following countermeasures are recommended to mitigate the impact:

1) Contractor should prepare a detailed plan for noise control (especially during piling work) before construction starting;

2) Before construction starting, the contractor should notify the construction plan of new WTP to Mental Asylum and to hear their opinions and requirements on noise;

3) Construction schedule and methods should be arranged reasonable in order to properly disperse equipment and vehicles at the construction site;

Figure 12.5.4 (1) Location Map of Noise and Traffic Survey (1/3)

Figure 12.5.4 (2) Location Map of Noise and Traffic Survey (2/3)

Figure 12.5.4 (3) Location Map of Noise and Traffic Survey (3/3)

4) The use of construction equipment should be prohibited during 22:00 to 07:00, and construction works on Sunday and holiday should also be prohibited; and

5) During construction stage, noise levels should be checked at least once a month in daytime at the borderline of WTP and the nearest building of Mental Asylum. (for details see section **12.7**)

Consequently, the impact of noise generated by new WTP construction work on vicinity area is considered to be acceptable, taking into account the fact that the countermeasures mentioned above will be taken, and new WTP construction works will be completed within several months.

Besides noise, the results of vibration survey indicate that the measured values are lower than detecting limitation of vibration equipment in spite of heavy trucks passed by. Therefore, the impact of vibration caused by construction work on nearby area will be not expected.

(2) Water Distribution Pipelines and Sewers Construction

1) Noise and Vibration

As mentioned in Table 12.1.6 and 12.1.7, the proposed projects include replacement or new installation of water distribution pipelines of 100 km and sewers replacement works of 20.6 km. The construction works of water distribution pipelines and sewers almost cover the center area of Astana City. Noise and vibration generated by the operation of construction equipment and heavy vehicles would disturb the inhabitants' living environment. In order to evaluate the impact of noise generated at construction stage on hospitals, schools and residential area, a survey on noise and vibration is carried out in this EIA study.

Equivalent continuous A sound level (L_{aeq}) is used to assess noise level. The location map of measuring points, which are selected by referring Kazakhstan standards and the results of IEE, is shown in Figure 12.5.4.(1) to (4). To estimate the noise level during construction period at each selected point, following conditions are considered:

1) Major noise sources backhoe (0.3 m^3, 1 set), tractor shovel (1 m^3, 1 set), truck crane (5t, 1 set), dump truck (2t, 1 set) and tamper (60 kg, 1 set);

2) The noise levels of selected backhoe, tractor shovel, truck crane, dump truck and tamper are estimated to be 85 dB(A), 90 dB(A), 85 dB(A), 90 dB(A), and 90 dB(A) respectively;

3) The noise declines only caused by distance and obstacles (such as trees and wall etc.) are considered when the noise levels at sound receiving points are calculated; and

Following two cases of construction equipment operation are considered when the noise

levels at sound receiving points are calculated.

Case 1: All construction equipment being operated.

Case 2: Only one kind of construction equipment being operated.

The results of estimation on the noise levels at each selected point are summarized in Table 12.5.7.

Table 12.5.7 The Results of Estimation on Noise Levels

Location	Construction Works	Existing Noise Level	Estimated Noise Level in Case 1[1)]	Estimated Noise Level in Case 2[2)]	Kazakhstan Standard	Remark
		dB (A)	dB (A)	dB (A)	dB (A)	
Water Distribution Pipelines						
SW-1	ϕ800mm	65	66	65	50 (65)	Inside School
SW-2	ϕ800mm	72	**80**	74	60 (75)	Outside School
SW-3	ϕ700mm	72	96	85	-	Road
SW-4	ϕ400mm	69	72	69	50 (65)	Hospital
SW-5	ϕ300mm	62	70	64	50 (65)	Hospital
SW-6	ϕ300mm	57	66	59	60 (75)	Outside School
SW-7	ϕ400mm	64	96	85	-	Road
SW-8	ϕ300mm	74	78	74	60 (75)	Residential Area
SW-9	ϕ300mm	61	73	65	60 (75)	Outside School
SW-10	ϕ400mm	55	65	57	50 (65)	Hospital
Sewers						
SS-1	ϕ700mm×460m	53	**80**	69	60 (75)[3)]	Residential Area
SS-2	ϕ700mm×460m	54	65	57	50 (65)	Inside School
SS-3	ϕ800mm×2,000m	61	62	61	50 (65)	Hospital
SS-4	ϕ800mm×2,000m	66	96	85	-	Road
SS-5	ϕ800mm×2,000m	56	61	57	50 (65)	Hospital
SS-6	ϕ800mm×2,000m	58	71	62	60 (75)	Residential Area
SS-7	ϕ300mm×800m	46	**87**	76	60 (75)	Residential Area
SS-8	ϕ300mm×800m	43	65	54	60 (75)	Outside School
SS-9	P/S	43	67	57	60 (75)	Residential Area

1): Case 1: All construction equipment being operated.
2): Case 2: Only one kind of construction equipment being operated.
3): Maximum noise level (L_A)
4): Values shown as **80** are over standard by 20 dB(A) or more.

As shown in Table 12.5.7, the noise levels at almost selected points are estimated to be over Kazakhstan standard to a certain extent during the construction of proposed water distribution pipelines and sewers. Especially at SS-1, SS-7 and SW-2, the noise levels will exceed standard more than 20 dB(A) if all construction equipment are operated. Although the impact of noise generated by construction works on hospitals, schools and residential areas is not so serious, following countermeasures are recommended to mitigate the impact:

1) Contractor should prepare a detailed plan for noise control before construction starting;

2) Before construction starting, the residents, hospitals and schools should be informed through newspaper or poster for understanding with short-term disturbances;

3) Construction schedule and methods should be arranged reasonable in order to properly disperse equipment and vehicles at the construction site;

4) Dump trucks and other heavy vehicles should be operated at reasonably low speed so as to prevent unnecessary noise and vibration along the routes. Construction workers also should be educated to pay attention on noise and traffic control; and

5) The use of construction equipment should be prohibited during 22:00 to 07:00, and construction works on Sunday and holiday should also be prohibited.

Consequently, the impact of noise generated by construction works on residents, hospitals and schools is considered to be acceptable, taking into account the fact that the countermeasures mentioned above will be taken, and construction works at each selected points will be completed within one week.

2) Traffic

The proposed projects contain newly installation and replacement of water distribution pipelines (100 km long, 100 to 1,000 mm in diameter) and replacement of sewers (20.6 km long, 100 to 800 mm in diameter). Some of them are located in the center area of the city. According to construction plan, open-cut method will be adopted except a portion of the water distribution pipelines and sewers crossing railway and river. Thus, installation of the water distribution pipelines and sewers will no doubt create interference to road traffic.

In this EIA study, a survey on vehicle flow at main road to which the water distribution pipelines and sewers will be installed crossing over. The results are shown in Table 12.5.8.

Table 12.5.8 The Results of Vehicle Flow Survey

Location[1)]		Vehicle Flow (No./hr)	Vehicle Classification	Remark (route)
Sewers	SV-1	2,120	Passenger car, bus, truck	Line 3 (2-2)
	SV-2	1,700	Passenger car, bus, truck	Line 11 (5-1)
Water Distribution Pipelines	WV-1	1,380	Passenger car, bus, truck	ϕ300mm
	WV-2	3,200	Passenger car, bus, truck	ϕ400mm
	WV-3	2,830	Passenger car, bus, truck	ϕ700mm
	WV-4	2,460	Passenger car, bus, truck	ϕ700mm

1): Location of each point is shown in Figure 12.5.4.

As shown in Table 8.6.3, the values of vehicle flow at selected points are very high, therefore, following countermeasures are recommended to mitigate public traffic interference during the installation of the water distribution pipelines and sewers crossing roads:

1) The contractor should notify the citizens of the construction plan of proposed the water distribution pipelines and sewers by media (such as TV, newspapers and posters etc.);

2) The contractor should examine carefully the construction plan for the sections crossing

roads (especially main road), and make an effort to finish constructions works within the shortest period (such as within one or two days);

3) The contractor should prepare a detailed plan for traffic control during construction period. For instance, necessary personnel should be arranged for the traffic control during construction;

4) The construction works of the water distribution pipelines and sewers crossing main road should be carried out on Saturday and Sunday when the volume of traffic usually is lower than that of working day; and

5) The excavation and installation works should be carried out by half-span of the road.

12.5.6 Recommendation on Countermeasures

The items of probable negative impacts of the proposed projects on the environment and proposed countermeasures to prevent or mitigate these negative environmental impacts are summarized in Table 12.5.9.

Table 12.5.9 The Probable Negative Environmental Impacts and Countermeasures

Probable Impact Item	Source	Proposed Countermeasures
During Construction Stage		
Air Pollution	WTP, Water Distribution Networks and Sewers (dust)	1) Covering stored materials with plastic or other materials. 2) Covering trucks, and spraying exposed areas with water. 3) Minimizing traffic over freshly exposed surfaces, etc.
Water Pollution	Intake	1) Reasonable excavation method minimizing water contamination. 2) Installation of turbid water preventing fence. 3) Water quality monitoring system. (for details see section **12.5.7**)
Noise	WTP	1) Preparation of a detailed plan for noise control. 2) Notification of the construction plan. 3) Reasonable construction schedule and methods. 4) Limitation of construction equipment operation time. 5) Noise levels monitoring system. (for details see section **12.5.7**)
	Water Distribution Networks and Sewers	1) Preparation of a detailed plan for noise control. 2) Notification of the construction plan. 3) Reasonable construction schedule and methods. 4) Limitation of the speed of vehicles, environmental education for workers. 5) Limitation of construction equipment operation time.
Public Traffic Interference	Water Distribution Networks and Sewers	1) Notification of the construction plan. 2) Reasonable construction schedule and methods. 3) Selection of reasonable construction time. (Saturday and Sunday) 4) The excavation works should be carried out by half-width of the road. 5) Preparation of a detailed plan for traffic control.
During Operation Stage		
Air Pollution	STP (odor)	1) Installation of a tree belt around the existing STP site. 2) Installation of a buffer zone where the construction of residential houses will be not allowed. 3) To add calcium hypochlorite or hydrated lime for controlling odor, if necessary, before proposed project being implemented. 4) Odor monitoring system. (for details see section **12.5.7**)
Water Pollution	Vyacheslavsky Reservoir	1) To conduct a synthetic and detailed survey on pollution sources, inflow pollution load and water quality in the reservoir. 2) To set a buffer zone where livestock farming will be not allowed. 3) To enhance environmental education for residents. 4) Application of copper sulfate when excessive growth of algae occurs, if necessary. 5) Construction of wastewater treatment facilities and direct purification facilities to treat the water of inflow-rivers and the reservoir. 6) Water and sediment quality monitoring system. (for details see section **12.5.7**)
Soil Pollution	STP (sludge)	1) To establish a cooperating system to supply technical information to users, and to accept their requirements on product quality. 2) To register the application of dewatered sludge with related government offices. 3) To ensure enough space for storing dewatered sludge. 4) To establish a distribution system of dewatered sludge previously. 5) To decrease water content of dewatered sludge from 80% to 60% to save transportation costs. 6) Heavy metals monitoring system of sludge and soil. (for details see section **12.5.7**)

12.5.7 Monitoring Plan

It is recommended to establish a monitoring system to check the impacts on environment during construction stage and operation stage of the proposed projects. Recommended monitoring plan (monitoring points, frequency and items etc.) are summarized in Table 12.5.10.

Table 12.5.10 Proposed Environmental Monitoring Plan

Monitoring Item	Monitoring Point	Monitoring Frequency	Proposed Monitoring Item (at least)
During Construction Stage			
Water quality at Vyacheslavsky Reservoir	2-3 points (between existing intake tower and turbid water prevention fence)	3-4 times/month (during the period of new intake construction)	Turbidity
Noise at WTP	3 points (1 at WTP borderline and 2 at Mental Asylum)	1-2 times/month (during the period of new WTP construction)	Equivalent continuous A sound level (L_{aeq})
During Operation Stage			
Odors level around STP	3 points (one at STP borderline and two at the area between STP and the City)	2-3 times/year (in summer season)	H_2S, NH_3 and odor levels
Heavy metals of dewatered sludge and soil	2 composite samples (1 for dewatered sludge and 1 for soil of agricultural land where dewatered sludge is disposed)	1-2 times/year	As, Cd, Cr, Cu, Hg, Pb, Zn
Water quality at Vyacheslavsky Reservoir	3 points (at the mouths of 3 inflow rivers)	2 times/year (wet season and dry season)	pH, DO, Water Temp., SS, BOD, COD, NH_4-N, NO_2-N, NO_3-N, T-N, PO_4-P, T-P, Coliform, and typical heavy metals etc.
	1 point (composite sample) (at the center area of the reservoir)	2 times/year (wet season and dry season)	pH, DO, Water Temp., transparency, SS, BOD, COD, NH_4-N, NO_2-N, NO_3-N, T-N, PO_4-P, T-P, Chlorophyll-a, Plankton, and Coliform etc.
Sediment quality at Vyacheslavsky Reservoir	1 points (composite sample) (at the center area of the reservoir)	2 times/year (wet season and dry season)	Water content, COD, T-P, T-N

12.5.8 Conclusions

Based on the results of the EIA study, the following conclusions can be drawn:

1) The proposed projects as a whole have positive environmental impacts on the water environment and the public health of the residents in Astana;

2) The impact of odors generated from sludge-drying beds of the existing STP will be improved considerably due to the implementation of the proposed STP;

3) The impact of turbid water caused by the construction of intake tower and access road on existing intake facilities is not expected because some reasonable countermeasures (including turbid water preventing fence) will be taken;

4) However, a special attention should be paid to potential eutrophication problem of Vyacheslavsky Reservoir, although the problem is not caused by the proposed projects;

5) The dried sludge from the proposed WTP is estimated having a very low level of heavy metals. Therefore, this sludge could be reused for agricultural purpose or as raw materials of cement and brick. The disposal of this sludge at new landfill will not be considered to generate negative environmental impacts;

6) The dewatered sludge from the proposed STP also has a low level of heavy metals. In consequence, it is recommended to dispose and reuse this sludge at agricultural land, considering the fact that the dewatered sludge of STP contains usually organic matter and nutrients (N, P, K etc.). In this case, available application quantity of the dewatered sludge is estimated to be 268 m^3/year, and a total area of 100 ha will be necessary for 10 years application;

7) During the construction stage of proposed WTP, the noise levels in nearest hospital (Mental Asylum) are estimated to be 52 dB(A) to 69 dB(A). Although the noise level during construction will exceed the Kazakhstan noise standard on hospital area, the impact will be temporary and acceptable;

8) During the construction period of proposed water distribution pipelines and sewers, the noise levels at selected points are estimated to be 54 dB(A) to 87 dB(A), which have exceed Kazakhstan noise standards. However, the impact of noise generated by construction works on hospitals, schools and residential area will be within an acceptable range, considering the fact that some reasonable countermeasures will be taken and the impact period will be very short (within one week);

9) During the construction period of proposed water distribution pipelines and sewers, the public traffic interference may occur, especially at the sections crossing main road. However, the public traffic interference is considered to be not significant due to some proper countermeasures will been taken to mitigate these negative impacts, and the impact period on each section will be very short (one to two days); and

10) It is recommended to establish a monitoring system to check the impacts on the environment during construction and operations stages.

12.5.9 Approval of EIA Study

The results of EIA study have been submitted to Municipal Territorial Department of the Environment Protection of Astana City, Ministry of the Environmental Protection for evaluating and judging. On August 6, 2003, Municipal Territorial Department of the Environment Protection of Astana City gave an approval to EIA on the detailed design of the proposed projects. (No. 193)

12.5.10 Reference

1. Kisho Kurokawa Architect & Associates, Nippon Koei Co., LTD., International Development Center of Japan: The Study on the Master Plan for the development of the City of Astana in the Republic of Kazakhstan, Final Report, June 2001.
2. Equip Tecnic Stanandreu S.A.: Modernization of Domestic Solid Waste and Improvement of Environment Situation of Astana City, Final Report, 2002
3. Kisho Kurokawa Architect & Associates, Nippon Koei Co., LTD., International Development Center of Japan: The Feasibility Study on Water Supply and Sewerage in the City of Astana in the Republic of Kazakhstan, Final Report, March 2001.
4. Ministry of Ecology and Bio-resources of the Republic of Kazakhstan: Temporary Instruction on the Order of Carrying Out Environmental Impacts Assessment of the Planned Economic Activities (EIA) in the Republic of Kazakhstan, RND 03.02.01-93.
5. Dar al-Handasah in association with Design Company ORTA and Kuwaiti Engineering Group: Astana Infrastructure Project, Stage II-Activity 2: Rehabilitation of Existing Sewerage Treatment Plant, Preliminary Design Report on Drainage of Taldy Kol Lake, June 2002.
6. NJS Consultants Co., LTD. And NIHON SUIDO Consultants Co., LTD.: The Detailed Design Study of the Water Supply and Sewerage System for Astana City in the Republic of Kazakhstan, Basic Design Report, February 2003.
7. NJS Consultants Co., LTD. And NIHON SUIDO Consultants Co., LTD.: The Detailed Design Study of the Water Supply and Sewerage System for Astana City in the Republic of Kazakhstan, Interim Report, March 2003.
8. Peter Mathews and K. H. Lindner: European Union, A Global Atlas of Wastewater Sludge and Biosolids Use and Disposal, IAWQ Scientific and Technical Report No.4, 1997.

CHAPTER 13 FINANCE AND ACCOUNTING FOR ASA

CHAPTER 13 FINANCE AND ACCOUNTING FOR ASA

This chapter was prepared based on the findings and recommendations contained in the F/S Report in 2001 and JICA Experts Report on Financial and Accounting Improvement in March 2002 (these are referred to as the "previous studies"). In addition, the following are referred to: financial statements of ASA, interview results and relevant information obtained from ASA, CDC, the Astana City Government (the "Akimat"), the Agency for Regulation of Natural Monopolies and Protection of Competition (the "Antimonopoly Agency") of the Republic of Kazakhstan, and from other stakeholders. The purpose of the conducted Financial and Accounting study was to support on-going improvements in ASA through discussions, monitoring and a seminar, as well as to provide recommendations for further medium-term improvements.

13.1 Project Finance

(1) JBIC Loan

A number of decisions regarding the Project financing have been recently finalized. Thus the Loan Agreement between JBIC and the Government of the Republic of Kazakhstan to support the Project totaling JPY 21,361 million (the "Loan Agreement") was signed on July 8, 2003. The proceeds of this JBIC Loan will be available for financing of approximately 75% of the Project costs. The Repayment Period /Grace Period for the JBIC Loan are 30/10 years for the goods and services and 40/10 for the consulting services. The interest rates are 2.2% and 0.75% p.a. respectively.

(2) Decisions by the Republic of Kazakhstan

The Loan Agreement was signed by the Kazakhstan side based on the Decision 228 of the Government of the RK dated March 7, 2003. This Decision stipulates that a loan agreement in the amount of JPY 21,361 million should be signed by the Government of the RK and that this loan would be re-paid from the funds of the Republican Budget of the RK.

The Government of the RK decided also in the above-mentioned Decision 228, that the Akimat should provide funds for the Project co-financing in the City Budget and that the Akimat should fulfill the function of the Executing Agency for the Project. Thus, the Akimat will have to take into account the Project fund requirements (co-financing part) while drafting and approving the City's annual budgets for the years from 2004 through to 2008. The budgeting process in the City of Astana is carried out in accordance with the Law of the RK on the

Budgetary System. However, it should be stated that owing to the capital status of the City of Astana, its financial well-being depends primarily on the political and macroeconomic situation in the country, rather than on other factors.

13.2 Current Financial Situation in ASA

(1) Background

ASA has a legal status of a state self-supporting enterprise. However, *de facto* ASA is still in the process of transition to the self-supporting system. A number of outstanding financial, legal, management, technical, etc. issues should be resolved in order to achieve this objective through the future.

(2) Financial Statements of ASA

Statutory Financial Statements of ASA, prepared in accordance with the Kazakhstan Accounting Standards, are summarized in Table 13.2.1 and reviewed in Chapter 13.2.3. Also, ASA's Annual Budget in application of the tariffs valid from 2002 is shown as a reference.

Table 13.2.1 Statutory Financial Statements of ASA

(Unit: KZT million)

Income Statements	Year 2000	Year 2001	Year 2002	Annual Budget *)	Jan.-June 2003
①Sales	1,083	905	810	1,086	453
②Direct Operating Costs	909	886	802	958	421
③***Gross Income*** (① - ②)	***174***	***19***	***8***	***128***	***32***
④ General & Admin. Costs	191	117	181	75	56
⑤***Operating Income*** (③ - ④)	***-17***	***-98***	***-172***	***53***	***-24***
⑥ Non-Tariff Income**)	193	123	182	0	-15
⑦***Net Income*** (⑤+⑥)	***176***	***25***	***10***	***53***	***-39***
Balance Sheets	**Dec. 31, 2000**	**Dec. 31, 2001**	**Dec. 31, 2002**		**June 30, 2003**
Fixed Assets	2,704	2,915	3,222		3,158
Accounts Receivable	560	599	471		498
Other Current Assets	413	388	343		355
Total Assets	***3,678***	***3,901***	***4,036***		***4,011***
Capital	1,000	1,810	2,135		2,135
Retained Earnings	1,594	1,619	1,616		1,577
Liabilities	1,084	472	285		299
Total Equity and Liabilities	***3,678***	***3,901***	***4,036***		***4,011***

*) Annual Budget figures were approved by the Antimonopoly Agency for the tariffs applied by ASA since January 1, 2002.

**) Non-Tariff Income represents a net balance of non-operating revenue and expenditures. Subsidies received from the Akimat by ASA in 2000-2001 and net results from construction activities are included in this line.

(3) Review of ASA Financial Statements

As it can be seen from Table 13.2.1, ASA's financial situation, in general, has remained difficult: ASA's sales have reduced (about 10% against previous year), operating losses from water supply and sewerage services increased, and net income decreased.

Certain achievements are seen in the tariff collection. The accounts receivable balance has slightly decreased, to KZT 498 million as of June 30, 2003; however, it still represents about seven months of the sales revenue, a very high figure. Approximately KZT 100 million, included in this balance, is considered by the management of ASA to be not collectible. The majority of these bad debts occurred more than three years ago and they should have been written off to losses, if the financial statements of ASA were prepared in accordance with the International Accounting Standards.

On the other hand, it should be stressed that during the past 2 - 3 years ASA has been able to sharply reduce its liabilities to suppliers. The net working capital during this period was positive and ASA was able to cover its working capital requirements. Also, the interim results of ASA for the six months of 2003 reveal that the cost saving measures and other improvements, which are being undertaken by the management of ASA, have resulted in keeping the costs under control.

Financial results of ASA were affected by two major factors, namely by (i) an increase of the tariffs and (ii) non-tariff income sources. Those factors are discussed below.

(4) Tariffs

The present tariffs of ASA have been effective since January 1, 2002 as follows:

Table 13.2.2 Tariffs of ASA (KZT/cu.m.)

Type	Tariff *)
Water	23.57
Sewerage	16.97
Technical Water	12.16

According to the above tariff table, all customers of ASA currently pay 40.54 KZT/cu.m. for water & sewerage services (approximately 0.27 USD/cu.m. at the current exchange rate), while they paid 30.0 KZT/cu.m. before 2002. It should be mentioned that the percentage allowed by the authorities for the latest increase of tariffs of ASA (35%) was significantly

*) Inclusive of VAT 16%.

lower than that of ASA expected.

Even though the absolute amount of the tariff of ASA looks very low compared to that in industrialized countries, it is worth mentioning that it is above the average in the RK and above that in the neighboring Russia. According to the official statistical data, the average annual income per capita in Astana in 2002 accounted for KZT 174,764, i.e. as low as about USD 100 per month.

Following the tariff approval procedures adopted in the RK, ASA plans to implement the next adjustment of tariffs on April 1, 2004.

(5) Non-Tariff Income of ASA

Another major factor, which affected ASA's financial position, was the decision of the Akimat of Astana to suspend providing subsidies to ASA for reimbursement of operating losses starting from 2002, since it was believed that the new tariffs should be sufficient for ASA to operate the system and to change its financial status. According to the information from the Department of Finance of the Akimat, no subsidies to ASA are allocated for the year 2003, nor planned in the future.

Since 2002, construction activities have been the major source of non-tariff revenue for ASA, which allowed ASA to operate near the break-even. However, referring to an ambiguous provision in legislation, which allows natural monopoly enterprises to run only those supplementary businesses which are "technologically linked" to the core business, the authorities believe that the construction activities of ASA might be considered as illegal. While lawyers try to resolve this collision, it is worth mentioning that without additional income from construction activities, ASA's financial position would significantly deteriorate.

(6) Conclusions on the Financial Situation in ASA

The following conclusions could be drawn from the above provided overview of the financial situation in ASA:

The present tariffs are not sufficient for full recovery of costs (including operations, adequate maintenance, depreciation, etc.) and thus ASA is not able to generate appropriate income from operations. Only owing to the non-tariff sources of revenue (subsidies from the Akimat until 2001 and income from construction activities since 2002), ASA has been able to avoid posting net losses;

The present financial capacity of ASA is very limited, well below the funding requirements for necessary investments in the water supply and sewerage system in the City; and

In the longer term, in order for ASA to realize self-supporting, in addition to the externally financed investments, (i) the reform of the tariff system should be continued and (ii) efficiency of ASA's operation should be improved significantly. Respective measures are discussed in the subsequent sections.

13.3 Achievement Status to the Recommendations by the Previous Studies for Improvement of Water Tariff

(1) Restrictions Imposed by the Legislation on the Tariff Policy of ASA

Being a natural monopoly enterprise, ASA is legally obliged to follow the tariff policy and procedures adopted in the RK. Since the tariff system reform in the water supply and sewerage sector for the City is controlled by the antimonopoly regulations of the RK, any changes can be accepted only to the extent that they are in line with the national tariff policy. Such tariff policy is developed by the Antimonopoly Agency of the RK, and thus only this Agency has enough authority to consider the recommendations of JICA for applying them to all water supply and sewerage systems.

The tariff system for all natural monopolies in the RK is at the moment under review in accordance with a governmental program for the tariff policy improvement for 2002 - 2004. In accordance with this Program, the Antimonopoly Agency, amongst other regulations, prepared a new Methodology for Setting Tariffs for the Water Supply and Sewerage Services (the "Methodology"), which was approved on August 15, 2003, and upon its registration with the Ministry of Justice of the RK has become mandatory for ASA, as well as for all other water utilities in the RK. In the process of drafting and discussing this Methodology, the Antimonopoly Agency considered, amongst others, the recommendations proposed by the previous studies, which were aimed at reforming of the tariff system in the RK.

Earlier, the Antimonopoly Agency expressed its opinion on the recommendations proposed in the previous studies in a number of official letters, including the letter to CDC dated December 2, 2002, which was signed by the Chairman of the Antimonopoly Agency of the RK Mr. E. Dosaev. In the above-mentioned letter, the Antimonopoly Agency of the RK places an emphasis on that (a) the tariffs for water supply and sewerage services in Astana must be calculated in accordance with the legislation of the RK and with the approved methodologies and that (b) the level of tariffs of ASA will change within the limits determined by the Indicative Plan of Development of the RK [*)] and will not be affected by the Loan repayment requirements.

[*)] About 7% p.a. in nominal terms.

(2) Current Status of the Recommendations

The current status of findings and recommendations of the previous studies, which were aimed at changing of the present tariff system, is summarized below in Table 13.3.1. The current status is divided into four categories: (i) Achieved, (ii) Follow-up required to achieve, (iii) Limited possibility to achieve in the future, and (iv) Not possible by the law.

Table 13.3.1 Achievement Status to the Recommendations by the Previous Studies for Improvement of the Water Tariff System

Item	Recommendations	Current achievement status
Usage-based water charge system, water meters	Install water meters and introduce a usage-based water charge system in Astana.	**Follow-up required:** There is agreement about importance of installation of water meters and introduction of the usage-based water charge system. The major controlling factor at the moment is the lack of funds for meters installation. Will be solved by the project. *Estimated achievement - 25%.*
Increase of tariffs	To make the project financially feasible, the tariffs for domestic use should be increased approximately 2 times and for commercial/ industrial use - 4 times.	**Limited possibility:** This proposal was refused by all concerned authorities of the RK for political, economic and social reasons. It is believed that such an increase would cause social problems, lead to growing of unpaid water fees, and have other negative consequences. ASA plans to increase its tariffs in accordance with the legislation from April 1, 2004, which will be much less than it was recommended. *Estimated achievement - 0%.*
Progressive tariff	With a limited availability of water resources in the City, it was recommended to introduce a progressive type of water tariff table.	**Limited possibility (with change of current law):** The Antimonopoly Agency believes that this recommendation is premature, because its practical application is impossible without sufficient provision of water meters and reliable data about actual water consumption, and also because of difficulties with practical implementation. Thus, using of progressive tariffs is so far not allowed by the national legislation. *Estimated achievement - 0%.*
Basic water charge	To recover the fixed customer costs, basic water charges should be adopted.	**Follow-up required:** The proposed recommendation has been taken into account by the Antimonopoly Agency. Basic water charges have been allowed under the new Methodology for the tariff setting. *Estimated achievement - 50%.*
Connection fee system	To introduce connection fees due to the increase of customers requiring additional capacity of the existing facilities.	**Limited possibility (with change of current law):** The Antimonopoly Agency does not have principal objections against adopting the connection fees, but the matter needs to be further investigated. Thus, this recommendation was taken for consideration in the future. Currently, it is not allowed. *Estimated achievement - 0%.*

Differentiate tariffs for domestic and commercial/ industrial use	It was recommended to double the tariffs for commercial/ industrial use compared to those for domestic use (return to cross-subsidies).	**Not possible:** Under the current circumstances, this recommendation is not acceptable by the authorities because it contradicts the Antimonopoly Law of the RK applicable to all natural monopolies, and also because it does not comply with the adopted policy for support of business development in the country. *Estimated achievement - 0%.*

(3) Affordability and Willingness to Pay

Water and wastewater charges currently account for less than 2 % of average household income in Astana, with international donor agencies evaluating affordability on the basis of 4% to 5%. This means that the average household in Astana should be able to afford the current charges and could sustain some increase in tariffs. On the other hand, the Public Awareness Survey, which was conducted during the F/S, revealed that many of ASA customers were not satisfied with the quality of water and that their willingness to pay was lower than the water charges. Thus, given the existing normative system of tariffs it was concluded in the F/S Report that "it will be difficult for ASA to raise the tariffs higher than the level of increasing of households' income". This conclusion was made just before ASA raised its tariffs by 35% from the beginning of 2002. Meanwhile, according to the official statistics, nominal average income per capita in Astana increased in 2002 by 13.5% compared to the previous year. Therefore, conditions for the above-cited conclusion of the F/S have not changed and thus it should still be valid.

(4) Social Safety Net

Total utility charges account for 10% of average household income in Astana, according to the official statistical data. However, for low-income groups, such as for instance pensioners, water and wastewater bills are well above the affordable level of 5% of their income. In order to provide better assistance for the poorest part of citizens of Astana, the Astana City Department of Labor, Employment and Social Protection of Population has widened the category of people who are entitled for the housing allowances since July 1, 2003. Currently, the households with the paid utility charges exceeding 20% of the total monthly household's income (earlier - 30%) are entitled for this allowance.

(5) Conclusions on the Status of Improvement of Water Tariffs

The major conclusions, which could be drawn from the above discussion on the status of im-

provement of the water tariffs, are summarized below:

The present tariff policy of ASA does not allow for the full recovery of costs from the collected user charges. However, the antimonopoly legislation of the RK, which is supposed to protect the interests of consumers of services of natural monopolists, does not give leeway for ASA to change the present tariff policy and procedures;

The recommendations of the previous studies for the water tariff reform were based on the assumption that the Project costs would be recovered from water charges collected by ASA. However, the Government of the RK has taken a political decision that under the current circumstances the existing water tariff system and the level of tariffs for ASA should not be changed and that the Project costs would be recovered from the funds of the Republican Budget and the Astana City Budget rather than from water charges; and

Since ASA will never be able to properly rehabilitate its facilities and provide better service without the tariffs, which would allow for the full cost recovery, further reforms of the tariffs system are unavoidable. Thus, the recommendations, which were given to the Kazakhstan side in the previous studies, remain valid for consideration for tariff reforms in the future.

13.4 Achievement Status to the Recommendations by the Previous Studies for Management and Organization Improvement in ASA

(1) Current Status

The management of ASA constantly works on improvements of the Financial & Accounting systems, collection of water charges and reduction of costs, taking into consideration the recommendations proposed in the previous studies. The Assistance for Financial/Accounting Improvement, conducted within the Scope of this DD Study, has been constantly focused on building capacities of the counterpart staff encouraging them to take initiative and to implement the recommendations without assistance. However, taking into account that when the First Fieldwork started, only a few of JICA recommendations had been realized (for instance, public hearings, strengthening of the legal department, creating customers' database), a Short-Term Action Plan for ASA with specific actions, deadlines and responsible persons was included in the BD Study Report in order to cope with the outstanding recommendations.

During the first six months of 2003, between the First and the Second Fieldworks of the DD Study, the management of ASA, working in accordance with the above-mentioned Short-Term Action Plan, has achieved visible progress in practical implementation of the outstanding recommendations of the previous studies.

Based on the civil legislation of the RK, ASA has agreements signed with all customers where the possibilities of charging penalties for late payments in the amount of 0.1% per day of delay, disconnection after 3 months of non-payments and other legal actions are stipulated (See Appendix C-3).

The achievement status to the recommendations by the previous studies, in view of the correcting actions discussed in the BD Study Report, is summarized below in Table 13.4.1. The current status is divided into four categories: (i) Achieved, (ii) Follow-up required to achieve, (iii) Limited possibility to achieve, and (iv) Not possible by the law.

Table 13.4.1 Achievement Status to the Recommendations by the Previous Studies for Management and Organization Improvements in ASA

Item	Recommendations	Current status
Customers data base	Complete encoding data into the integrated database of customers to start using it for the day-to-day monitoring of the customers' accounts.	**Achieved:** The customers' database has been created. A problem of the customers' base completeness still exists (the estimated number domestic customers of ASA is much less than the number of inhabitants in Astana); however, this problem will be mitigated by installation of water meters and by application of the usage-based tariffs. *Estimated achievement - 100%.*
Management of debtors	Develop internal procedures for dealing with accounts receivable based on their age. Penalties for late payments and disconnecting should be applied for the customers in arrears.	**Achieved:** Internal procedures for dealing with accounts receivable based on their age have been drafted. Agreements with customers stipulate a 0.1% per day penalty for delay and give ASA a right to disconnect the customers with overdue payments. **Follow-up required:** In practice, ASA has started charging penal-ties and suspending water only for enterprises in arrears, but plans to apply the same mea-sures for all customers in the nearest future. *Estimated achievement - 30%.*
Bad debts	Write off bad debts of ASA and claim respective compensation from the Akimat of Astana.	**Follow-up required:** According to the management, ASA continues attempts to recover all receivables, including bad ones. As the result, the accounts receivable balance is gradually reducing. However, the total estimated amount of non-recoverable debts remains at the same level of approx. KZT 100 million. ASA complained on insufficient staffing of the court officers in Astana to enforce ASA's legal actions against the customers in arrears. **Not possible:** ASA does not plan to claim any bad debt compensation from the Akimat, since charge collection is under responsibility of ASA. *Estimated achievement - 10%.*

Diversify revenue sources	Consider a possibility for ASA of being engaged in other businesses that would complement the core business, for instance development of recycling of treated sewage and sludge.	**Follow-up required:** ASA is still not involved in any complementary business, except for the construction activities. Currently, referring to an ambiguous provision of the antimonopoly legislation, the legality of ASA's construction activities is being disputed. *Estimated achievement – 10-20%.*
Branch offices	Establish ASA service branch offices, especially in the New Development Area.	**Follow-up required:** ASA has only two branch offices apart from the head office. A decision to establish the third branch office in 2003 has been taken and it is being implemented. *Estimated achievement - 30%.*
Customers awareness	Carry out the customers awareness program, especially on the water saving, water fees and water meter installation.	**Follow-up required:** ASA carries out the water saving and water fees campaign using mass media, invoices, etc. However, ASA has temporary suspended promoting water meters due to the lack of funds for their installation. *Estimated achievement - 50%.*
Management accountability	Public hearings on the revision of the tariff should be held. A special customer service should be established in ASA.	**Follow-up required:** Public hearings are obligatory for ASA and took place in 2001. The function of customer service is fulfilled by the Sales Department. *Estimated achievement - 50%.*
Managerial map	Use a managerial electronic map to reduce the number of unregistered customers.	**Achieved:** ASA has recently obtained and started using the housing map from the Dept. of Architecture and City Planning. *Estimated achievement - 100%.*
Bookkeeping system improvements	Improve the quality of the accounting records by applying all provisions of Kazakhstan Accounting Standards (KAS), inflation accounting, updating of the accounting software, etc.	**Limited possibility:** There have not recently been any significant changes in the accounting system of ASA, except for the "Bank-Client" system being installed. The major controlling factor is lack of funds. Inflation accounting possibilities are prescribed by KAS. **Follow-up required:** KAS are not always followed by ASA. *Estimated achievement - 5%.*
Target reaching management	Promotion of the "target reaching management", which means that numeric indicators based on the sector's benchmark figures should be used for management of ASA.	**Follow-up required:** There are no publicly available data for the water supply and sewerage sector. However, the Association of Water Supply and Sewerage Enterprises of the RK was established in 2002. One of the tasks of this Association is collection and exchange of information. A system of target indicators at ASA is not used so far. *Estimated achievement - 10%.*

Staff development	Strengthen the staff development, especially training in the areas of business development, management, IT, HR and legal.	**Achieved:** The legal department of ASA has been recently strengthened by newly hired employees. A Staff Development Plan has been prepared by ASA and it is being followed. **Limited possibility:** Further staff development is limited due to the antimonopoly regulations and due to the lack of funds. *Estimated achievement - 50%.*
Staff motivation	Develop a system for motivation of employees of ASA. Relaxation of regulation on wages and salaries of ASA's employees by the Akimat and the Antimonopoly Agency.	**Not possible:** The relaxation of regulation of wages and salaries is not possible under the current legislation. **Follow-up required:** A system of motivation for ASA's inspectors is being finalized as the first step towards the development of the motivation system for all ASA employees. *Estimated achievement - 50%.*

(2) Control of Costs

While taking care of the revenue side, ASA should also pay due attention to control of its Operating & Maintenance costs. This requirement was briefly discussed in the previous studies. However, poor financial results confirm importance of the cost control measures. Thus, the Cost Reduction Program for 2003, which was recommended in the BD stage for Short-Term Action Plan for ASA, has been adopted by ASA. Fulfillment of this Program is under control of the management of ASA.

It should be noted that all Operating & Maintenance costs of ASA have been always closely controlled by the Akimat and by the Antimonopoly Agency. Therefore, there are reasons to believe that reserves for further reduction of Operating & Maintenance costs of ASA without substantial investments aimed at modernization and rehabilitation of the existing obsolete and deteriorated facilities and machinery are very limited.

Replacement of obsolete and deteriorated systems and implementation of newer technologies upon the Project completion will lead to significant savings of Operating & Maintenance costs for ASA. For instance, it has been estimated that using of new pumps will allow ASA to save as much as KZT 60 million (at current prices) per year in energy costs. Reduction of the leakage of water by replacement of the existing pipes in the distribution network will also contribute to significant future cost savings.

(3) Conclusions on the Status of Management and Organization Improvement in ASA

The major conclusions, which could be drawn from the above discussion on the status of management and organization improvements in ASA, are the following:

1) The majority of the recommendations on management and organization improvement, which were given to ASA in the previous studies, have already been implemented or they are currently in the process of being implemented by the management of ASA. The tasks and their priorities have therefore changed since the previous studies;

2) The main controlling factors for further management and organization improvements are: (i) the lack of funds, and (ii) restrictions imposed by the existing legislation; and

3) There is still much scope for further improvements in ASA, including in Finance & Accounting. Moreover, the Project execution and those financial arrangements, which were made for the Project's financing, have widened significantly possibilities for future improvements due to the fact that ASA's future cash flows will not be committed to financing of the Project's investments.

13.5 Proposed Medium-Term Financial & Accounting Improvement Program for ASA

(1) Preface

The proposed Medium-Term Financial & Accounting Improvement Program for ASA ("Financial Program") was prepared in collaboration with the management of ASA based on analysis of the present financial status of ASA, as well as the legal environment in the RK. The Financial Program covers the period starting from the 2003 through to 2008, when the Project is planned to be completed. Consumption metering as a tool for demand management by water meter purchase and installation will be implemented throughout the Project execution by the year 2008.

The objective of the proposed Financial Program is to provide a list of realistic short- and medium-term guidelines for ASA aimed at the staged establishing of the self-supporting system in the longer term. The main target for the Financial Program is to provide stable recovery of all O&M costs.

(2) Commercial Operations System

Further development of the commercial operations system of ASA will take place. It will allow ASA for more effective consumers and collection management, with a special attention being paid to improvements in the following areas:

1) Move to mainly consumption-based billing will be carried out keeping pace with the wa-

ter meters installation by the year 2008;

2) In order to minimize the number of unregistered connections and users, ASA's inspectors will continue their efforts by all means, including usage of the electronic map. Meanwhile, importance of the existing problem with unregistered domestic customers in the City will be gradually mitigated by the year 2008 by the means of consumption metering;

3) In order to improve the data reliability with respect to billing and collections, an inventory and ageing analysis of all customers' debts will be made until the end of 2003, and all non-collectible debts will be written-off in accordance with the Kazakhstan Accounting Standards. In the subsequent years, the inventory of accounts receivable will be carried out annually as a routine accounting procedure preceding the book closing;

4) ASA will further improve collection of water charges. Thus, by the end of 2003, ASA will start charging penalties to domestic customers in arrears, and will implement in practice all other measures listed in the developed Procedures on Management of Debtors for 2003. Since that, ASA will charge penalties to all customers in arrears and will strictly enforce disconnections and take other legal actions against them. The Procedures on Management of Debtors will be updated by ASA annually;

5) In order to timely respond to the problems relating to the water supply and sewerage services, ASA will gradually decentralize the customer service from the head office to branch offices. For this purpose, ASA will continue opening new branch offices throughout the City, especially in the Newly Developed Area. Thus, in 2003, the third branch office will be opened. In the subsequent years, ASA will continue opening more branch offices with consideration of the needs and financial limitations; and

6) ASA will further bring in consumers in its decision-making. Thus, ASA will continue the practice of public hearings when adjusting the tariffs. Also, ASA will continue information campaigns to raise awareness of the need to pay timely for improving and proper maintaining the water supply system and also the need to conserve water. The same campaigns will support the efforts of getting water meters accepted by the customers. ASA will periodically conduct consumer opinion surveys. Also, ASA will consider setting up advisory public committees incorporating customer representatives and NGOs.

(3) Accounting System

Further development of the accounting system adequate for the needs of ASA and the capacity of its personnel is essential. The following steps will be taken:

1) ASA will start following in all aspects the Kazakhstan Accounting Standards in its gen-

eral accounts system ("1C Bookkeeping"), including the requirements for valuation of fixed assts, accounts receivable, inflation accounting rules, etc. This would provide the management of ASA as well as external stakeholders with timely, relevant and reliable accounting information; at the same time, ASA will continue to meet the accounting and reporting requirements under the applicable national regulations;

2) ASA will further develop the computer-based cost accounting system, which will enable ASA to generate more timely, accurate and relevant information required for decision-making at management and unit levels. This should enable tracking of performance by units, activities, and for control of actual cost as compared to the budgeted performance;

3) ASA will develop a comprehensive computer-based financial model for budgeting, which will incorporate ASA's production, sales, costs, investments, cash flows and financing plans, as well as allow comparing actual figures with the budget;

4) ASA will introduce an appropriate computer-based asset management system, that includes titling, registration, valuation, maps/plans, etc.; and

5) ASA will review the hard- and software used in the accounting systems and will prepare a long-term plan for their upgrade with consideration of the needs and financial limitations.

(4) Tariff Policy of ASA

In the longer-term, the pricing of ASA services should be transformed to a transparent system based on the full cost-recovery principle. The following steps will be taken to this objective in the medium-term:

1) ASA will periodically adjust its tariffs in accordance with the present legislation, providing recovery of costs to the maximum allowable level. The next tariff adjustment is planned as of April 1, 2004;

2) Upon water meters installation, ASA will consider, while setting new tariffs, introducing of fixed charges, which have been allowed by the new Methodology;

3) ASA will consider introducing of connection fees, if this is allowed by the national legislation in the future;

4) Since the incentive for water conservation becomes stronger when the tariff is progressive, ASA will consider introducing a system of progressive tariffs, if this is allowed by the national legislation in the future; and

5) ASA will consider differentiating tariffs for domestic and for industrial/commercial use ("cross-subsidies"), if this is allowed by the national legislation in the future.

(5) Non-Tariff Revenue

Diversification of revenue sources in order to maximize returns on the assets employed and improve cash flows is of crucial importance for ASA. ASA in collaboration with the Akimat will carry out proper market surveys of the alternative businesses technologically linked with the core business in such fields as, for example: plumbing and repairs, small agricultural business, sale of treated wastewater to agriculture, sale of processed sludge as fuel or as fertilizer, etc. As an immediate measure, ASA will continue its efforts to resolve in its own favor the collision on legality of construction activities, which was recently originated by the Antimonopoly Agency. It is expected that the non-tariff revenue would account for at least 10% to 20% of the total revenue for ASA.

(6) Costs Reduction and Operation Management Improvement

In the result of the Project execution by 2008, performance of networks, water and wastewater treatment plants will be improved, thus significantly reducing leaks, energy costs, repair costs, etc. Meanwhile, during the project execution, in order to improve the quality of service and reduce Operating & Maintenance costs, ASA will make better use of the existing systems and will continue its efforts to improve the operational efficiency in a least-cost manner. For this purpose:

1) ASA will annually update the Cost Reduction Program based on review of the costs and will control its fulfillment;
2) ASA will co-operate with the Association of Water Supply and Sewerage Enterprises of the RK "Kazakhstan Su Arnasy" in its work aimed at sharing of data between water supply utilities; and
3) ASA will select and monitor a number of appropriate operational performance indicators (for instance, indicators of unaccounted for water, metering level, frequency of customers complaints, pipe breaks, etc.), comparing them to the baseline, targets and industry benchmark figures. Financial Performance Indicators are discussed below in details.

(7) Human Resources Management

ASA will continue to modernize and improve its human resources management:

1) ASA will continue reviewing the present organizational structure, job profiles and descriptions and staff numbers within in order to further streamline and improve them;
2) ASA will continue development of the system of staff motivation for all categories of

employees; and

3) ASA will work in accordance with the prepared plan for staff development, with consideration of the limited funds available.

(8) Strengthen ASA Institutional Capacity

Following decentralization of municipal services, ASA was granted a legal status of a state self-supporting enterprise. With the goal to achieve truly independent, financially self-sufficient operation in the future, ASA will enjoy the full scope of rights in accordance with ASA's charter and the legislation of the RK. The important task in this direction for ASA will be to re-consider its relationships with the Akimat and the Antimonopoly Agency, which should allow for professional management of ASA, unencumbered by political interference, yet responsive to the legitimate interest of the state for efficiency in management and operations and consumer orientation.

(9) Social Safety Net Development

The Akimat will continue its policy for support of low-income population paying out housing and other kinds of allowances. The tariff subsidy policy will be aimed at more effective safety net through further development and implementation of appropriate and viable arrangements to provide relief and assistance to the poorest segments of ASA's customers.

(10) Financial Performance Indicators for ASA

A number of Financial Performance Indicators have been selected for ASA to benchmark the progress of the Financial Program. These Indicators, provided in Table 13.5.1, will be used for monitoring current financial achievements compared to the baseline (year 2002) and target figures. For this purpose, the management of ASA will need to set specific targets for each of the Financial Indicators through to the year 2008 based on the company's medium-term development plans.

Table 13.5.1 Financial Performance Indicators

Indicators	Baseline 2002	Target 2003	Target 2004	Target 2005	Target 2006	Target 2007	Target 2008
Tariff Rate [1]	40.54	◦	◦	◦	◦	◦	◦
Progressive Tariffs [2]	No	◦	◦	◦	◦	◦	◦
Connection Fee [3]	No	◦	◦	◦	◦	◦	◦
Differentiation of Industrial and Residential Tariffs [4]	No	◦	◦	◦	◦	◦	◦
Fixed Component of Tariff [5]	No	◦	◦	◦	◦	◦	◦
Collection Period [6]	7.0	◦	◦	◦	◦	◦	◦
Current Ratio [7]	2.86	◦	◦	◦	◦	◦	◦
Operating Ratio [8]	1.21	◦	◦	◦	◦	◦	◦
Return on Equity [9]	0.27%	◦	◦	◦	◦	◦	◦
Debt Service Coverage [10]	0.2%	◦	◦	◦	◦	◦	◦

(11) Financial Program Summary

Major items of the above-described Financial Program for ASA, covering the period through to the year 2008, when the Project is planned to be executed, are summarized in Table 13.5.2. The main objective of the Financial Program is to ensure at least stable recovery of O&M costs. Those areas, where further assistance of external engineers, management and financial consultants during the period of the Project's construction might be especially beneficial, are marked with the "◄" sign.

[1] Average water & wastewater tariffs, inclusive of VAT (KZT/cu.m.)

[2] Progressive type of tariffs implemented (Yes/No)

[3] Connection Fee implemented (Yes/No)

[4] Industrial/commercial and residential tariffs are differentiated (Yes/No)

[5] Fixed component of the residential tariff ("Basic water charges") implemented (Yes/No)

[6] Year-end accounts receivable / Total annual operating revenues * 12 (Months)

[7] Current assets / Current liabilities

[8] Total annual operating costs / Total annual operating revenues

[9] Net income / Equity (%)

[10] Total annual debt service / Total annual operating revenues (%)

Table 13.5.2 ASA Financial Program Summary

No	Item
1.	Commercial operations system: • Consumption-based billing; • Minimize number of unregistered users; • Inventory of customers' debts; • Management of debtors; • Branch offices; • Management accountability; and • Customers' awareness. ◄
2.	Improve accounting system: • Follow Kazakhstan Accounting Standards in all aspects, including bad debts accounting, valuation of assets, etc; • Cost accounting system; ◄ • Financial modeling and budgeting; ◄ • Assets management system; and • Upgrade of the accounting hard- and software.
3.	Tariff policy: • Adjust tariffs to provide O&M costs recovery; • Consider basic water charges; • Consider connection fees, if allowed by law; • Consider progressive tariffs, if allowed by law; and ◄ • Consider cross-subsidies, if allowed by law.
4.	Non-tariff revenue. ◄
5.	Costs reduction and operation management improvement: • Costs reduction program; ◄ • Sharing information with other water utilities; and • Operational performance indicators. ◄
6.	Human resources management: • Streamline organizational structure; ◄ • Staff motivation; and • Staff development.
7.	Strengthen ASA institutional capacity.
8.	Social safety net development.
9.	Long-term development plan. ◄
10.	Financial performance indicators. ◄

In consideration of the above-required assistance to ASA (especially those items marked with ◄) and Akimat during the construction stage, draft TOR for the Consulting services is attached in Appendix C-4.

13.6 Long-Term Financial Scenarios for ASA

(1) Preface

A number of possible long-term financial development scenarios could be drawn for ASA.

However, any long-term financial forecasting is complicated by multiple uncertainties associated mainly with the average level of tariffs, which could be allowed for ASA by the authorities of the RK. There are also significant uncertainties associated with change of the actual water demand upon installation of water meters and development of new areas in the City, with tax treatment of the Project assets, with changes in the structure of O&M costs upon the Project completion, etc. Nevertheless, several key scenarios, which are provided below, have been developed. Development of the actual long-term financial strategy to be followed by ASA remains a prerogative of the authorities of the RK.

(2) General Assumptions

It is assumed that all measures proposed in the Medium-Term Financial & Accounting Improvement Program for ASA will be realized by 2008. As the result, ASA will get over the break-even point by that time. Accordingly, the tariffs are assumed to be adjusted during the period through to 2008 in accordance with the current legislation and thus will become sufficient for recovery of ASA's existing costs. The current price level is assumed, i.e. inflation is excluded from all calculations. Meanwhile, the Project is also planned to be completed in 2008.

(3) Hypothetical Case 1 - "Dependent to Others: Assets Not Booked by ASA"

It is assumed in this hypothetically possible Case 1 that the new assets will not be booked at all by ASA upon the Project completion, remaining instead in the accounts of the Akimat or another entity.

Under this Case, ASA could be legally assigned responsible only for O&M of the new assets, but not for their rehabilitation, because depreciation charges for them will never be covered by tariffs. Since the cost estimate for the Project exceeds approximately 10 times the total book value of all ASA's fixed assets (about KZT 3 billion as of June 30, 2003), only as little as 10% of the total cost of water supply and sewerage assets in the City will be reflected in ASA's books upon the Project completion.

In the result, ASA as a separate legal entity will be able to continue operating without losses. However, in accordance with the legislation, the tariffs will effectively allow ASA to recover only a minor part of the total capital costs. Therefore, similar recurring projects, financed from the budgetary funds, will be necessary for rehabilitation of the vast majority of the City's water supply and sewerage assets when they become worn out in the future.

(4) Hypothetical Case 2 - "Financial Collapse: Assets Booked by ASA, Tariffs Stable"

It is assumed in Case 2 that the assets will be booked by ASA upon the Project completion in 2008, and that the tariffs will be kept on the same level as that in 2008 (i.e. will be adjusted for inflation only) in the foreseeable future.

Under asset-booked case by ASA, ASA's depreciation cost will soar in 2008 as high as approximately 10 times compared to the current level. Such a sharp rise of depreciation cost will result in doubling of ASA's production costs. In accordance with the current legislation, this will necessitate doubling of the tariffs. Another factor, which will necessitate increasing of the tariffs, is the property tax, which ASA will have to pay annually at the rate of 1% of the cost of new assets. The amount of tax will account for more than 30% of the current annual revenue of ASA.

However, it is assumed in this Case that despite the legality of ASA's claims to raise tariffs in accordance with the increased costs, the tariffs are assumed not to be changed by the authorities using administrative measures. Two sub-cases, when an exemption from the property tax in respect of the new assets is granted to ASA (either by applying certain provisions of the Tax Code or simply by subsidizing ASA in the amount of the additionally paid by ASA property tax) and when it is not granted, are possible.

As the result, ASA's financial position will sharply deteriorate in 2008; and ASA will start posting accounting losses. Depending on whether the tax exemption is granted or not, the losses will be about KZT 1.0 billion or KZT 1.3 billion per year, respectively. The situation with cash flows of ASA will differ much more depending on the tax exemption. If it is granted, the accounting losses will be caused solely by the increase of non-monetary depreciation charges; therefore, ASA will have enough cash for current operations and thus will be able to continue its operations for a certain period of time, as long as no cash is required for capital investments for rehabilitation of the assets. If the property tax exemption is not granted, ASA's cash deficit from current operations will be growing by the amount of the additionally paid tax. Since ASA's self-financing capacity is very limited in Case 2, similar recurring projects, financed from the budgetary funds, will be required for rehabilitation of the vast majority of the City's water supply and sewerage assets when they become worn out in the future.

(5) Hypothetical Case 3 - "Drastic Self-Support: Assets Booked by ASA, Tariffs Increased at Once"

The main assumptions for Case 3 are that the assets will be booked by ASA upon the Project completion in 2008 and that the tariffs will be adjusted at once to cover the increased costs.

After 2008, the tariffs will remain on the same level in real terms.

In this Case, in order to provide for the full cost recovery, the single required increase of the average tariffs in 2008, should be approximately 2.0 times or 2.3 times, depending on whether the property tax exemption is granted or not, respectively. The above figures were assessed simply based on the requirement to recover the cost of all new assets (KZT 30 billion), assuming their weighted average depreciation period to be 30 years, as well as to recover the additionally paid property tax. These average figures of increase are in line with the results of calculations made by the previous studies*), taking into consideration the limited adjustments of tariffs, which are expected to be made until 2008. It should be pointed out also that the recommendations by the previous studies regarding the tariff system improvements (progressive tariffs, connection fees and cross-subsidies) could be considered in Case 3, if allowed by the legislation.

Thus, Case 3 represents, with certain limitations, the self-financing case. However, it presumes a heavy pressure on consumers in 2008, with all possible negative consequences.

(6) Hypothetical Case 4 - "Extended Self Support: Assets Booked by ASA, Tariffs Increased Annually"

It is assumed in Case 4, similar to Case 3, that the assets will be booked by ASA upon the Project completion in 2008 and that the tariffs will be adjusted to cover the increased costs; however, the tariffs will be increased not at once, but annually, throughout 30 years starting from 2008.

In order to provide for the full cost recovery within the 30-year period, the required annual increase of the tariffs should be on average, depending on whether the property tax exemption is granted or not, approximately 4.2% or 5.0% respectively. It should be stressed that these percentages are in real terms; the nominal figures should be higher. Similar to the previous case, the recommendations by the previous studies regarding the tariff system improvements could be considered, if allowed by the legislation.

Thus, Case 4 will also ensure the self-support of ASA within 30 years, but in a softer way than Case 3. However, there are two significant drawbacks under this Case compared to the previous one: the tariffs by the end of the 30-year period will have to be almost twice as high as in Case 3 and ASA will have cash deficit for a number of consecutive years until the tariffs become sufficient to cover the additionally paid tax, if the property tax exemption is not granted.

*) 2.8 times on average was recommended in JICA Experts Report.

(7) Recommended Long-Term Scenario for Recovery of the Costs of Mechanical and Electrical Equipment

There are a lot of possible long-term scenarios located between Hypothetical Cases 1 & 2 (preserving of the status quo in the tariffs), on the one extreme, and Cases 3 & 4 (aggressive raising of the tariffs), on the other. However, only scenarios, which represent some modification of Cases 3 & 4 or their combination, can provide for the full cost recovery for ASA within 30 years. Other scenarios, which do not assume adequate raising of tariffs, will not lead to the self-financing system within the 30-years period, but nevertheless they might represent a step towards establishing of such a system in the farther future.

The following major assumptions, in addition to the general assumptions described above in Chapter 13.6 (2) have been made for development of a longer-term Scenario for ASA for the period of 15 years starting from the Project's completion in 2008:

- As the first and possible step to establish the self-financing system, ASA is suggested to replace at least Project's mechanical and electrical equipment when it becomes worn out.
- The average useful life of the mechanical and electrical equipment is about 15 years and its estimated cost - approximately KZT 10 billion (USD 65 million);
- ASA has to manage at least all O&M costs and its cash balance has to be positive every year;
- The volume of water sold by ASA will follow the rate of flow forecasted in the M/P Report;
- Non-tariff revenue of ASA will stay at the level of the year 2002;
- Bad debts are ignored;
- Consumption of electricity and chemicals will be reduced as the result of the Project's execution as planned;
- Labor costs, General & Administration and other fixed costs will stay in real terms at the level of the year 2002;
- Non-monetary costs, which are added back for the cash flow calculation, are represented by depreciation charges only;
- The property tax rate is 1%; and
- ASA will have no financial borrowings.

(Please refer to Appendix C-4 for further details about the assumptions made.)

As it follows from the calculations provided in Appendix C-5, if the property tax exemption in respect of the Project's mechanical and electrical equipment is not granted, the required annual increase of the tariffs for the full recovery of the cost of this equipment should be approximately 4.2% for the 15 years after the Project's completion. If the property tax exemption is granted, it is required to raise the tariffs annually by approximately 3.4%. Alternatively, instead of the annual increasing, the tariffs could be raised at once in 2008 by about 45% or 35% for the cases when the tax is paid or the tax exemption is granted respectively, and remain stable afterwards. According to this Scenario, ASA will be appropriating accounting losses for a number of consecutive years due to the increased depreciation costs, but will have sufficient amount of cash for operating activity. It should be stressed that similar to the previously described Hypothetical Cases, the above percentages are in real terms; the nominal figures should be higher. Also, the recommendations by the previous studies regarding the tariff system improvements could be considered, if allowed by the legislation.

Table 13.6.1 demonstrates sensitivity of the required increase of tariffs (in real terms) depending on the percentage of recovery of the costs of mechanical and electrical equipment. Please refer to Appendix C-5 for more details and for the assumptions made.

Table 13.6.1 Required Increase of Tariffs to Recover the Costs of the Mechanical & Electrical Equipment after 15 Years if the Property Tax Is Paid (Exemption is Granted)

Percentage of cost recovery / Increased	30% (KZT 3 billion)	50% (KZT 5 billion)	100% (KZT 10 billion)
Annually	No (No)	1.3% (0.2%)	4.2% (3.4%)
At once	No (No)	12% (2%)	45% (35%)

As it follows from Table 13.6.1, recovery of 30% of the costs of the Project's mechanical and electrical equipment will be possible even under the present level of tariffs. It is because the Project's execution will lead to substantial reduction of the O&M costs.

(8) Requirements for Realization of the Recommended Scenario

For the Scenario recommended above in Chapter 13.6 (7) to be successfully realized, the following general conditions are required by the year 2008:

1) The Project shall be completed as planned;

2) Implementation of the Medium-Term Financial Program for ASA shall result in stable recovery of all O&M costs;

3) Detailed long-term financial plan shall be developed based on the updated forecasts and financial data;

4) The issue of transferring to ASA of only those assets, which are supposed to be replaced in the future by ASA, shall be legally resolved; the sources of finance for replacement of all remaining assets shall be found; and

5) Possibility of adequate adjusting of water tariffs shall be provided in the national Indicative Plans for Development, if necessary.

Furthermore, it is required that during the 15 years after the Project's completion (from 2008 through to 2022):

6) Rehabilitation of all deteriorated water supply & sewerage assets, other that the Project's electrical and mechanical equipments, shall be financed from the sources, other than the cash internally generated by ASA, in accordance with requirement 4);

7) The actual tariffs shall be adjusted in accordance with Table 13.6.1 (excluding inflation), depending on the selected targets;

8) Volumes of the water sold shall increase at least by 56% by the year 2022 compared to the current level (year 2002);

9) Rate of collection shall not deteriorate compared to the level achieved by 2008;

10) Non-tariff revenue of ASA shall not drop below the current level (excluding inflation);

11) Unit consumption of electricity, chemicals and other materials shall be reduced by 2022 as planned, approximately by 20% compared to the current level; and

12) Labor, General & Administration and other fixed costs shall not exceed the current level (excluding inflation).

The above-described Scenario is only one example in a wide range of the possible ones. Selection of the actual targets for the water and sewerage supply system in Astana is the responsibility of the concerned authorities in the RK. Attention of the Akimat of Astana has been drawn to the problems associated with the long-term planning of tariffs and finance for ASA. Importance of this matter has been acknowledged and it is being discussed internally. As the result of this discussion, all concerned authorities shall become committed to follow the selected long-term financial development targets.

CHAPTER 14 COMPREHENSIVE EVALUATION AND RECOMMENDATIONS

CHAPTER 14 COMPREHENSIVE EVALUATION AND RECOMMENDATIONS

The project for expansion and rehabilitation of water supply and sewerage systems was designed to suite for the locality and along with international practices as much extent as possible. However, there are some requirements to be undertaken by concerned parties through the implementation of the project.

In this connection, this section refers to comprehensive evaluation and recommendations for the implementation of the Project, which include those raised during basic design stage. Technical issues and problems in designing facilities and essential items for construction work to achieve design purposes are also included. Aside from technical considerations, recommendations are made on the improvement need for ASA in terms of financial, accounting and management aspects.

Design criteria and conditions shown in SNiP were given priority in designing facilities, although comparative study with international standards/practices was made. It seems that SNiP standards consider much allowance for some facilities design. In this connection, among facility design concerned, economical recommendation was made for water treatment process.

14.1 Water Supply Project

(1) Vyacheslavsky Reservoir

The eutrophication in the Vyacheslavsky Reservoir was confirmed. This phenomenon is proved not only by water quality especially in T-N (0.5mg/L) and T-P (0.02mg/L), but also existence of water bloom. Eutrophication of water have increased algae in water and brought about deterioration of water quality. In the end, special treatment such as ozone injection, activated carbon dosing, or other high cost treatment will be required.

In Japan, the standard water quality of lake water for normal water treatment is legally decided at 0.2mg/L or less for Total Nitrogen (T-N) and 0.01mg/L or less for Total Phosphorus (T-P). Those of the Vyacheslavsky reservoir at present are beyond the said standard quality.

Although treated water at present meet the drinking water quality standard in Kazakhstan, it will be deteriorated in the future, if timely measures are not taken to conserve water quality. Since water sources for the city are limited, conservation of the Vyacheslavsky Reservoir and its basin is essential.

Pollution sources of the reservoir water consist of natural and artificial substances. Relevant authorities shall make utmost efforts to eliminate the artificial pollution sources such as pasturage and housing from the basin of the reservoir together with continuous monitoring of water quality of the reservoir.

(2) Water Intake Facility

Construction of the new intake tower and operational switch of new pump facilities will be made without stopping existing pump operation. Measures to protect from water pollution for the intake of water at existing pumps station shall be provided. Operation plan of pump facilities to switch from existing pump to new one shall be carefully prepared and carried out.

It is planned that existing intake facilities are not used in routine work after construction of the new intake facilities. A periodic operation and maintenance of the pump facilities at the existing intake tower shall be conducted for emergency use of them. In this connection, an operation and maintenance manual shall be prepared for the existing pump station.

At the new pump station, the torque transmission devices between pumps and motors are very long, and therefore, they need periodic careful maintenance work to avoid failure of them/ malfunction of the new pump station.

(3) Raw Water Transmission Pipeline

There exist three raw water transmission pipelines, the oldest one of which is no more used. Remaining two pipelines shall be used through the future in provision of adequate operation and maintenance.

The rehabilitation work of one of the raw water transmission pipelines was eliminated from the scope of work for the JBIC project. However, it is expected to use the rehabilitated raw water transmission pipeline simultaneously, as mentioned above, with the recently constructed (year 2001) pipeline to lessen the energy consumption.

The following are recommended rehabilitation work as shown in Chapter 5.2, which shall be undertaken by Kazakhstan side.

a) Pipe Rehabilitation Work (Pipeline No.II):

A total of 15 km for the four sections are determined for the replacement of the existing pipes (lengths of the sections are 1.5km, 7.5km, 2.5km and 3.5km).

b) Water hammer protection facilities:

- The existing one-way surge tank at point 1 (P1: surface area = 265m^2 and water level = +384m) shall be rehabilitated.
- A new one-way surge tank at point 2 (P2: surface area = 265m^2 and water level = +410m) shall be constructed.
- In addition to above, new air-vessels at point 3 (P3: surface area = 20m^2 x 2 and initial water level = +409m) are proposed to be provided under the project as the requirement for new intake pump facilities

The following countermeasures shall be taken for potential operation cases in use of the pipelines.

1) Two pipelines are used at the same time: Pump head at the intake pump station can be reduced considerably comparing with present operation of the pump facilities. In this connection, rehabilitation of the pipeline in this project is very important.

   Aforementioned rehabilitation work shall be completed before inauguration of the P/S. During the rehabilitation work, one-way surge tank shall also be constructed at the peak (P2), 8 km from the Intake P/S, to avoid destruction of pipeline.

2) Operation of only one pipeline: In case of the operation of only the newest pipeline under emergency case, a higher pump head similar to current head (more than 90m) is required, which affects not only additional O&M cost but also leakage problems along the pipeline. In this case, since the pump capacities for the proposed intake pump station were decided on the condition of said pipelines, existing pump station must be used.

3) Construction of the fourth pipeline shall be studied in the future in application of a different pipeline route to avoid topographically high areas and a larger pipe diameter than existing one. The measure may allow for considerable saving of O&M cost, and eliminating the damage by water hammer phenomenon and leakage problem (less pump head may be adopted).

(4) Water Treatment Plant

Application of SNiP standards makes the facilities relatively larger in size than those designed based on the standards in Japan and other countries. In order to decrease project cost, modification of SNiP on the design of facilities, especially for sedimentation basins and filters, was made. Further improvement shall be made for the expansion work in the

future.

After construction of distribution chamber, connection to existing transmission pipe from the chamber is made. The connection pipes from the distribution pump station to the new distribution main pipe is also conducted. In this regard, operation plan during the work shall be carefully prepared to minimize the influence to the operation of the existing water treatment facilities.

Operation of existing plant is scheduled to be ceased after completion of proposed and future additional plants. Rehabilitation for revival of existing plant, however, shall be considered before final decision to implement future plant, because surplus capacity and enough time for rehabilitation is ensured after completion of the proposed plant. Rapid mixing basins, sedimentation basins and filters may be rehabilitated. Until completion of future plant, existing plant will be operated. In this regard, it is recommended to prepare O&M manual for existing plant for proper operation and maintenance.

As mentioned above, required measures against eutrophication in the reservoir shall be studied through the future, in conduct of continuous monitoring on the water quality in the reservoir.

Filter materials for rapid sand filter shall be carefully procured to meet the requirements. They may be procured in Kazakhstan; however, detailed conditions/instructions in the technical specifications shall be complied with.

Presently drinking water quality standard of Kazakhstan does not include trihalomethane and major agricultural chemicals, though old-fashioned agro-chemicals are included. Contamination by trihalomethane and agricultural chemicals are one of major issues in the field of water supply. It is recommended to include these items for periodic water quality examination.

(5) Distribution Pipes

Information on the existing pipes is not managed properly by ASA as of today. In this regard, it is very important to accumulate relevant information on the pipes and other underground utilities during replacement/construction of distribution pipes through this project. Improvement of recording manner for the pipes and other utilities is also required to make expansion plan and conduct O&M of the distribution system effectively. Information sharing among concerned authorities is a requisite for economical and effective implementation of the project.

With regard to pipe materials, steel pipe was adopted for the pipe with a diameter of 900

mm or larger from economical viewpoint as discussed in F/S. Although steel material is commonly used for water supply provided with proper lining and coating inside and outside of pipe, an attention shall be paid for poor workmanship in welding for connection of pipes. To avoid failure of welding work, sample nondestructive test after welding work, and pressure test after completion shall be conducted. Sampling ratio shall be decided taking into account of workmanship level in Kazakhstan.

There are some river/railway crossings in the built up area of the city. Construction schedule and manner of construction shall be prepared under sufficient cooperation with concerned authorities/parties.

The master plan, which is the basis of detailed design, was prepared referring to the existing distribution network. As a result, one network covering whole service area is maintained. However, it is recommended to introduce subdivisions dividing whole area into several service blocks in provision of isolated valves. By introducing the block service system, there are advantages in the following items:

- Monitoring on water supply conditions by service block
- Collection of data on water demand by block and its projection
- Control of water supply pressure
- Control of water leakage
- Maintenance service by reducing area of interruption of water supply

Introduction of the block service system shall be implemented based on the master plan to be updated/revised in the future to reflect land development in Astana City.

(6) Water Meter

To ensure sound management of the water supply system by ASA, provision of water meter shall be given first priority. In this regard, not only campaign to the people for promotion of beneficiary's paid for principle, but also legal arrangements shall also be recommended entailing penalty and disconnection to bad debt users.

14.2 Sewerage Project

(1) Countermeasures to Taldy Kol Liquidation Project

Taldy Kol liquidation project is going to be implemented by Akimat this year (2003) upon approval from State Evaluation Committee on the F/S for the advanced treatment of

sewage effluent from existing STP and the treatment of bottom sludge of the Taldy Kol Lake. If the project schedule is kept as mentioned above, this project starts earlier than JBIC assisted project. A close cooperation of the two projects is a requisite, since the both project sites are located in the existing STP area. The following are directly related work.

a) Pipes/channels surrounding the existing aeration tank: Adjustment on inflow/outflow channels to and from aeration tank, sludge pipe and blower plumbing

b) Blower: Additional two units of aeration tank will be constructed by Akimat. Then, additional one unit of blower is planned to be installed in the same building of JBIC project. Since there is a room to accommodate the unit, detailed arrangements shall be made.

c) Effluent Pump facilities: Treated sewage is presently discharged into Taldy Kol reservoir through effluent pump station. The effluent will be sent to the planned advanced treatment plant. In this regard specifications of pump facilities shall be adjusted.

d) Operation and maintenance practices: Rearrangements of operation method for those related aeration tank should be made by the advanced treatment project.

(2) Sludge Disposal

Currently dried sludge is placed at the northeastern side of the STP. Under the limited land availability and odor problem, preparation of sludge disposal program shall be made before completion of this project, which entails reuse of digested sludge as fertilizer.

(3) Rehabilitation of Intermediate Pump Station

The rehabilitation work for the intermediate pump stations shall be done without disturbing inflow sewage. The work shall be scheduled to be conducted during minimal sewage flow period experienced through the year. For small-size pump stations, vacuum car or small sludge pump to temporary transfer sewage into outlet sewer may be used. While, for a larger pump station, part of the existing sewage reserving pit (isolate the working part with partition) may be used to storage inflow sewage during rehabilitation work. Another measure is to operate pump facility making the pump water level low during the rehabilitation work.

(4) Sewer Installation

There are some crossings for Ak-Bulak river and railway. Detailed arrangements for scheduling and manner of construction shall be made with concerned parties.

A lot of underground utilities such as electric power line, telephone line, hot water supply pipe, water supply pipe and sewers exist along planned sewer routes. Field confirmation shall be made, especially for electric power line.

For connection of pressured pipe to intermediate pump station, flexible joint shall be installed at the side of the pump station.

14.3 Common to Water Supply and Sewerage Project

(1) Legal Requirements for the Contractor

According to the construction law put into practice from July 2001, technical prop osal submitted by the contractor shall be approved by the Local Expertise Commit tee. In this regard, Akimat shall coordinate with the concerned authorities for sm ooth implementation of the project.

(2) Taxation

A new tax code was implemented in January 2002, which affects taxation to the contractor. According to the Note exchanged between the government of Kazakhstan and the government of Japan on March 29, 2002, the Japanese companies and their employees will be exempted from all fiscal levies and taxes imposed in Kazakhstan with respect to their income, and import and re-export of their own equipment. In this connection, clarification on the taxation to the Contractor shall be made prior to the project implementation.

(3) Cost Estimates

Since JBIC requires to obtain goods and services through ICB, well experienced intern ational contractors will be considered as the Contractor and major facilities/equipment with proper quality will be supplied from international markets, as well as locally avai lable materials to be supplied in Kazakhstan. Previous two JBIC loan projects experie nced that locally estimated price based on SNiP brought far underestimation of project c ost. Results of tender for abovementioned projects were too low to cover the original s cope of work, and considerable scope was eliminated or large amount of additional local

fund was secured. In this regard appropriate measures shall be sought for the project.

14.4 Finance and Accounting for the ASA

The previous studies (M/P and F/S) recommended to adopt a number of changes to the present tariff system such as introducing: (i) progressive tariffs, (ii) basic water charges, (iii) connection fees, and (iv) different tariffs for domestic and industrial/commercial use. ASA is legally obliged to follow the tariff-setting procedures adopted in the RK. Such procedures are developed by the Antimonopoly Agency of the RK, and thus only the Antimonopoly Agency has enough authority to consider the above listed recommendations and to apply them for all water supply and sewerage systems.

During M/P and F/S stage, it was assumed that ASA would implement not only O&M of existing facilities, but also expand/construct facilities in use of loan application. However, due to the policy of Antimonopoly Agency to control water charges on a lower price level, national government and Akimat will shoulder the capital cost for this project.

Currently, ASA manages at least direct operation cost using water charges collected. However, to cover general administration cost, ASA needs supplemental income, such as that obtained through construction work. The unstable income to meet the cost required for O&M of the facilities shall be improved through the future.

Of the recommended items by previous studies, there are some items, which were already conducted and not yet implemented requiring to follow up through the future. The items that will contribute to the increase of income and decrease of expenditures, and are possible to realize are tabulated below. Achievement percentage as of today is also shown in the table.

Item	Achievement Status	
	%	Description
Increase of tariffs	0	35% was increased in 2002, but this is only adjustment of inflation rate experienced before year 2001.
Provision of Water Meter	25	There is no improvement recently, the percentage is same as before. Upon completion of the Project, it will become about 100%
Adoption of Progressive tariffs	0	It is recommended to review the tariff setting procedures controlled by the antimonopoly legislation in order to make them more flexible. After provision of water meter it is possible to adopt this manner.

Management of debtors	30	Procedure was developed by ASA. Follow up is necessary.
Bad debt's write-off	10	Procedure was developed by ASA. Collection ratio slightly improved.
Diversify revenue sources	10-20	In the last 3 years, 10-20% to overall income.
Branch Offices	30	One of 3 recommended is being operated.
Customers Awareness	50	A campaign was conducted, but need to conduct continuously.
Management Accountability	50	Public hearing was conducted, but need to continue.
Bookkeeping System	5	Discussed on the improvement method, but not yet implemented due to lack of budget.
Target Reaching Management	10	Only general idea was explained to ASA and Water and Sewerage Association.
Staff Development	50	The plan was developed. It is necessary to follow up for implementation.
Staff Motivation	50	The plan was developed for inspectors. It is necessary to develop for other field staff.
Cost Reduction Program	60	The program for 2003 was adopted. It shall be adopted annually through the future.

It is very important for ASA to prepare several scenarios to realize self-support as independent organization through the future. In this regard, medium/long term financial improvement plan was prepared to ensure not only collection of cost for O&M, but also some investment cost recovery such as the purchase cost for mechanical and electrical equipment, longevity of which is 10-15 years.

Problems could occur during the project execution caused by unwillingness of some domestic customers to install individual water meters. Amendments to the legislation are recommended to promote installation of the meters installation.