B.2 Wastewater Treatment Plant Design - 2010

B.2.1 Introduction

The design for the WWTP has been carried out using the parameters presented on Table B.2.1.1. All the assumptions made will have to be verified during detailed design.

Table B.2.1.1 Basic Design Parameters for WWTP

Connected Population	393,280			
Peak Day factor	1.2			
Design Loads	**Per capita load**	**Total DWF**	**Peak day**	
Flow	238 lpc	93,520	112,224	m^3/day
BOD_5 Loads	55 g BOD_5/day	21,683	26,020	kg BOD_5/day
Sludge	0.9 kg DS/kg BOD	19,515	23,418	kg DS/day
Suspended Solids	65 g SS/day	25,563	30,676	kg/day
	Influent Concentration	**Effluent Concentration**	**Pollution removed/day**	
BOD_5	156 mg/l	9 mg/l	25,000	kg/day
Sludge			0.0075	kg DS/m3
Suspended Solids	184 mg/l	10 mg/l		

B.2.2 Inlet Arrangement

The 2 main sewers from the City arrives at an underground receiving well, a single pipe connects this well to the underground chamber housing the screens and pump station. A bypass pipe is proposed to connect the inlet collectors to a new inlet manifold to be constructed just upstream of the pumps' suction pipe.

(1) Screens

New penstocks will be provided to replace the corroded ones. Three new screens with 6mm openings are to be provided. Each screen is to be capable of passing 2 times the design flow in its clean condition. Isolation of each screen individually and all together should be possible. The finer screens will produce more screenings than is presently produced and screening handling equipment including screw compactor and conveyor belts will be provided.

The building housing the screen require some rehabilitation and access will be improved.

The calculations for the design of the screens are presented on Table B2.2.1

Table B.2.2.1 Design of Screens

Operating Parameters	Design Parameters	Typical Design Values	Calculated Parameters
No of duty screens	1		
Total No of Screens	3		
Channel Width	1.6 m		
Bar Spacing	6 mm		
Maximum Depth	1.5 m		
Approach Velocity		0.2 – 0.7	0.5 m/s
Estimated Screenings			1,683 m^3/day

(2) Inlet pumping station

There is no sump at the inlet pump station to regulate the variation in flow to the WWTP. Large pumps make it very difficult to regulate the flow using different numbers of pumps. There are two approach to resolving the problem, either provide a mixture of small and large capacity pumps or provide variable speed pumps. The latter solution requires installation of electronic equipment for which spare parts may be difficult to find locally. It is proposed that smaller pumps are provided in conjunction with larger capacity pumps. Table B.2.2.2 presents the design for the replacement pumps.

Table B2.2.2 Design of Inlet Pump Station

Operating Parameter	Design Parameters	Typical Design Values	Calculated Parameter
Peak Day Flow	1,300 l/s		
No of small pumps	2		
Small pumps	450 l/s		
No of large pumps	2		
Large pumps	900 l/s		
Head	18 m		
Minimum Capacity		30% - 50%	33% of peak day flow
Maximum Capacity		200 – 300%	200% of peak day flow

The pumping station delivers the wastewater to the distribution chamber at the grit channels through 3 Nos 800mm diameter concrete pipes.

(3) Flow Metering

The existing flow metering facilities has just been installed and should last for at least 5 years when replacement will have to be considered.

B.2.3 Grit Removal

(1) Grit Trap

Two new grit trap using the horizontal flow principle and scrapers are to be provided. Each grit trap shall be designed to pass the full design flow. The grit shall be removed from the channel using grit pumps and washed to remove attached organic material. The washings shall be returned to the grit channel. Table 2.3.1 presents the design for the grit channels.

Table B2.3.1 Design of Grit Channels

Operating Parameter	Design Parameters	Typical Design Values	Calculated Parameter
No of Duty Channels	1		
Total No of Channel	2		
Width	10 m		
Depth of flow	1 m		
Length of channel	10 m		
Flow per Channel			112,224 m^3/day
Scour Velocity		0.2	0.13 m/s
Settlement Velocity		0.02	0.013 m/s
Retention Time		1	1.3 minutes

(2) Grit Disposal

Washed grit from the grit channel will be sufficiently clean for drying on the existing beds. On drying the grit can be disposed to landfill or for use on footpaths at the WWTP.

B2.4 Primary Settlement

(1) Settlement Tanks

Rehabilitation of the distribution chambers is necessary to ensure even loading to the primary settlement tanks.

Two additional primary settlement tanks are necessary to maintain the loading of the tanks at appropriate level. The existing tanks themselves require some rehabilitation of the mechanical equipment. Table B.2.4.1 presents the design of the primary settlement tanks.

Table B2.4.1 Design of Primary Settlement Tanks

Operating Parameter	Design Parameters	Typical Design Values	Calculated Parameter
No of Tanks Used	8		
Tank Diameter	28 m	10 - 50	
Depth	3.5 m	2.5 - 5	
Area of each tank			616 m^2
Perimeter of overflow weir			81.7 m
Surface loading		0.6 - 1.2	0.9 m/hr
Retention		0.5 - 3	3.7 hrs
Weir flow per m length		125-500	172 m^3/d
Scour Velocity for organic particles		0.03 - 0.06	0.04 m/s
Scraper Peripheral Velocity		0.02 - 0.05	0.045 rotation/minute

(2) Primary Sludge Pump Station

The primary sludge pumping stations require rehabilitation. Desludging of the tanks are started manually. A timer facility will improve the operation of the pumps by automatic desludging of each tank. It is proposed that the primary sludge is pumped to thickening tanks to reduce the volume further. Table B.2.4.2 provides details of the primary sludge pump station.

Table B.2.4.2 Design of the Primary Sludge Pump Stations

Operating Parameters	Design Parameters	Typical Design Values	Calculated Parameters
No of tanks in use	8		
Pump capacity	80 m^3/hr		
Duration of operation	0.5 hr each		
No of duty pumps	1		
No of pumps provided	2		
Volume of primary Sludge		300 -500	320 m^3/day

B.2.5 Biological Treatment

(1) Aeration Tanks

The aeration capacity available at the plant is more than sufficient for the horizon year 2010. It is proposed that the 4 presently available tanks be rehabilitated and equipped for use. The existing hazards will be eliminated to improve safety for workers and visitors. The existing process appears to be producing the required quality of effluent and therefor there is no necessity to change the process. The air supply system including diffusers will be rehabilitated.

Table B2.5.1 presents the design for the aeration tanks.

Table B2.5.1 Design of Aeration Channels

Operating Parameters	Design Parameters	Typical Design Values	Calculated Parameters
No of lanes used	3		
No of lanes available	4		
Length	119 m		
Breadth	8 m	8 - 10	
Depth	4 m	3 - 5	
No of Stabilisation Compartment	1		
No of Contact Compartment	3		
Length/ width ratio		10 -20	45
Stabilisation Tank Volume			11,424 m^3
Contact Tank Volume			34,272 m^3
Sludge Loading (F/M ratio)			0.2 Per day
Retention - Stabilisation		1 - 2	2.4 hr
Retention - Contact		1 - 2	7.3 hr

(2) Blower House

The existing air blowers are to be replaced with 5 new units of the same capacity of which 2 will be on standby. The efficiency of the new blowers will be much improved when compared with the old ones.

The structure requires rehabilitation. Table B.2.5.2 presents the design of the air supply system.

Table B.2.5.2 Design of the Air Supply System

Operating Parameters	Design Parameters	Typical Design Values	Calculated Parameters
Rated Air Supply/unit	20,100 Nm^3/hr		
Rated Power Consumption/unit	265 Kwh/hr		
No of units in use	4		
No of units provided	5		
BOD removal in primary tanks	30%		
Rated Normalised Air Supply			80,400 Nm^3/hr
Rated Power Consumption			1,060 Kwh/hr
BOD Removed			729 kg/hr
Oxygen requirement			1,072 kg/hr
Air supplied		45 - 90	110 $Nm^3/kg\ BOD_5$
Standard oxygen yield		0.02 - 0.025	0.013 kg O_2/Nm^3 of air
Standard oxygen Yield		1.4 - 2.0	1.01 kg O_2/Kwh
BOD Removal Yield		0.6 - 1.9	0.69 kg BOD_5/kwh
Energy Consumption		0.06 - 0.3	0.23 kwh/m^3

(3) Final Settlement Tanks

Two additional final settlement tanks are to be provided to maintain a surface laoding of 0.6 $m^3/m^2/hr$. Rehabilitation of the tanks is also necessary for the same reasons as presented for the primary tanks. Thin plate weirs with baffles are to be provided.

The design of the final settlement tanks is provided on Table B.2.5.3.

Table B2.5.3 Design of Final Settlement Tanks

Operating Parameters	Design Parameters	Typical Design Values	Calculated Parameters
No of Tanks Used	12		
Tank Diameter	28 m	10 - 50	
Depth	3.5 m	2.5 - 5	
Area of each tank			616 m^2
Perimeter of overflow weir			81.7 m
Surface loading		0.4 - 0.8	0.6 m/hr
Retention		0.5 - 3	5.5 hrs
Weir flow per m length		125-500	114.5 m^3/d
Scour Velocity for organic particles		0.03 - 0.06	0.04 m/s
Scraper Peripheral Velocity		0.02 - 0.05	0.045 rotation/minute

(4) Return Activated Sludge Pump Station

The recycle ratio for the WWTP can vary depending on the concentration of the settled activated sludge from the final settlement tanks. It is proposed that 5 duty and 2 standby pumps be provided. This combination will permit varying the recycle ratio between 20% and 100%.

The building housing the return activated sludge pumping station is structurally in good condition and can be rehabilitated but the building may not be sufficiently large to house 7 pumps. Table B.2.5.4 presents the design for the return activated sludge pump station.

Table B2.5.4 Design of the Return Activated Sludge Pump Station

Operating Parameters	Design Parameters	Typical Design Values	Calculated Parameter
Capacity of pump	950 m^3/hr		
Number of duty pumps	3		
Total No of pumps provided	5		
Sludge recirculation ratio		50% - 200%	61%

B.2.6 Sludge Treatment

(1) Gravity thickening tanks

The gravity thickening tanks should be converted to receive primary sludge of which about 360 m^3 are expected every day. The capacity of the tanks are too high and the high retention will result in an odour problem. It is proposed that only one of the tank is used with the other one used for thickening of surplus activated sludge. In addition to contain the potential odour problem a cover is to be provided for the tanks. Table B.2.6.1 presents the design for the thickening tanks.

Table B.2.6.1 Design of the Gravity Thickening Tanks

Operating Parameters	Design Parameters	Typical Design Values	Calculated Parameters
No of Tanks Used	1		
Tank Diameter	20 m		
Depth	3.1 m		
Primary Sludge	360 m^3/day		
Surface Area			314 m^3
Volume of Tank			974 m^3
Surface Loading		4 - 6	2.9 Kg DS/m^2/hr
Retention		3 - 5	2 days

(2) Activated Sludge Thickening Facility

Surplus activated sludge is very difficult to thicken by gravity and it is therefore proposed that mechanical sludge thickening facility be provided. Storage will be provided at one of the existing gravity thickening tank. Polyelectrolyte dosing is required to improve the thickening process. It is expected that with mechanical thickening a DS content of 6% can be achieved. The design capacity of the belt thickener must be related to the capacity of the transfer pump. The design for the surplus activated sludge pumping station and of the belt thickening facility is provided on Table B.2.6.2.

Table B.2.6.2 Design of the Surplus Activated Sludge PS and Belt Thickener

Operating Parameters	Design Parameters	Typical Design Values	Calculated Parameters
No of tanks in use	12		
Pump capacity	80 m^3/hr		
Duration of operation	24 hrs		
No of duty pumps	2		
No of pumps provided	3		
Capacity of belt thickening facility	160 m^3/hr		
No of duty belt thickener	2		
No of belt thickener provided	3		
Volume of Surplus Activated Sludge		1500 -3000	2,800 m^3/day

(3) Digestors

The existing digestors operate as a single stage system where digestion, mixing and settlement occurs in the same vessel. This makes control of the process difficult. It is proposed that the system be converted to a two stage operation by construction of a storage and settlement vessel to which is transferred the disgested sludge where further digestion occurs. The existing two digestors will be rehabilitated with addition of mechanical mixers and thermophilic process be maintained to minimize the pathogenic content of the digested sludge to enable disposal to agricultural land. Table2.6.3 presents the design for the digestors.

Table B.2.6.3 Design of Digestors

Operating Parameters	Design Parameters	Typical Design Values	Calculated Parameters
No of Tanks Used	3		
Tank Diameter	17.5 m	6 - 30	
Depth	8 m	7 - 15	
Volatile Solids/Dry solids	70%		
VSS reduction	50%		
Volume of Tank			7,216 m^3
Retention for thermophilic		10 - 15	18 days
Solids Loading (High Rate)		1.6 – 3.2	2.27 kg/m^3/day
Estimated Gas Production			9,180 m^3/day

(4) Boiler House

Rehabilitation of the boiler house is necessary to extend its life. Some areas need reconstruction because of corroded reinforcement. Two of the three boilers require replacement. The heating requirement is similar to the present requirements and therefore similar capacity boilers will be sufficient. The design of the boiler capacity is provided on Table B.2.6.4

Table B.2.6.4 Design of Heating Equipment

Operating Parameters	Design Parameters	Calculated Parameters
No of boilers	1	
Quantity of steam each	4.5 tonnes/hour	
Pressure	13 bars	
Gas consumption	3.5 kg gas/tonne steam	
Operating temperature	50 deg. C	
Wastewter temperature	10 deg. C	
Heat transfer efficiency	50%	
Assumed heat loss	1.2 degree C/day	
Specific heat of sludge	4,200 j/kg/deg.C	1.2 kwh/m^3/deg.C
Gas energy coefficient	35,800 kj/m^3	9.94 kwh/m^3
Energy requirement		2,018 kwh/hour
Boiler Capacity provided		2,823 kwh/hour
Energy provided by gas		3,804 kwh/hour

(5) Sludge drying beds

5 additional beds similar in design to the 5 recently constructed beds are proposed to improve the dried sludge storage capacity. Details of the proposed sludge drying beds are presented on Table B.2.6.5.

Table B.2.6.5 Design of Sludge Drying Beds

Operating Parameters	Design Parameters	Typical Design Values	Calculated Parameters
Number	10		
Length	100 m		
Width	70 m		
Depth	1 m		
Area each	7,000 m^2		
Volume each	7,000 m^3		
Dried Sludge	30% DS		59 m^3 DS/day
Area Available			70,000 m^2
Volume available			70,000 m^3
Retention Digested Sludge			538 days
Retention Dried Sludge			1,794 days
Loading		125	61 kg DS/m^2/year
Loading		0.1	0.18 m^2/pe

Note: DS, Dried Solids; pe, population equivalent

B.2.7 Effluent Pump Station

The effluent pumping station is similar in capacity to the inlet pumping station and it is proposed that similar pumps suggested for the inlet pump station be provided. Table B.2.7.1 shows the design for the effluent pump station.

Table B.2.7.1 Design of Effluent Pump Station

Operating Parameters	Design Parameters	Typical Design Values	Calculated Parameters
Peak Day Flow	1,300 l/s		
No of small pumps	2		
Small pumps	450 l/s		
No of large pumps	2		
Large pumps	900 l/s		
Head	18 m		
Minimum Capacity		30% - 50%	33% of peak day flow
Maximum Capacity		200 – 300%	200% of peak day flow

The effluent pump station is similar in design to the inlet pump station and with the same number of similar pumps. The static lift for the pump station is about 11m and the hydraulic losses about 3m making a required head of 14m much lower than the 26.5m design head. The operation of the pump station is similar to the inlet pump station requiring the throttling of the downstream valve to increase the head on the pump. The throttling of the valves will make even worse the rated efficiency of the installed pumps, which are already a low 49%.

B.3 Evaluation of Agricultural Potential for the Area to the South of Astana

B.3.1 Treated Effluent Reuse in Agriculture

(1) Past History of Agricultural use of Treated Water in the Region

There is a history of treated effluent reuse for irrigation in the area to the south of Astana. Treated wastewater stored in Taldy Kol reservoir was used for irrigation of 1,706 ha of agricultural land, mostly of the Yenbek-Koshi ASU 154/3 agricultural enterprise using 1.3 million m^3 per year until 1995, when the agricultural sector was reorganized and the agricultural enterprises in the area were privatized. The following examines the future potential of reviving this practice.

(2) Availability of Treated Wastewater

The availability of treated wastewater at the horizon years is given on Table B.3.1.1

Table B.3.1.1 Availability of Treated Wastewater for Irrigation Use

million m^3

Year	1999	2010	2020	2030
Total Annual Average	31.7	34.1	52.1	66.0

(3) Treated Wastewater and Soil Characteristics

The quality of the treated wastewater was evaluated by several methods including Sanitary Norms 33-2.202-86 and the sodium adsorption ratio of the US Department of Agriculture. The treated wastewater is considered suitable with a small hazard of soil salinization.

The nature of the soil makes it essential to adopt crop rotation in order to maintain soil fertility. The Alva crop rotation system making use of eight fields growing fodder crops such as corn, barley, oats, peas and alfafa is proposed.

The soil characteristics dictate the use of overhead irrigation. A suitable system is the Frigate irrigation system, which is based on centre pivot machines with a diameter of 800m and an irrigated area of 50 ha per machine. The water requirement for each crop is different and an average of about 4,000m^3/ha is necessary for the above crop rotation system.

(4) Potential Crops

Crops produced in the past on land irrigated using treated effluent from Taldy Kol reservoir were all for animal feed and include potatoes, corn and other fodder crops

The Ministry of Health prohibits the use of treated wastewater for production of food for human consumption. This is a particularly strict regulation not substantiated by practice in many countries, treated wastewater is commonly used in China, Western Europe, Northern Africa and the United States for human food production. The World Health Organisation has published recommendations in 1989 for the use of

treated effluent which are based on a managed risk approach rather than on the zero risk approach previously adopted and still used in Kazakstan. It is recommended that the Ministry of Health reconsiders its regulation in order to increase the variety of crops which can be produced and thus improve the economic viability of the project.

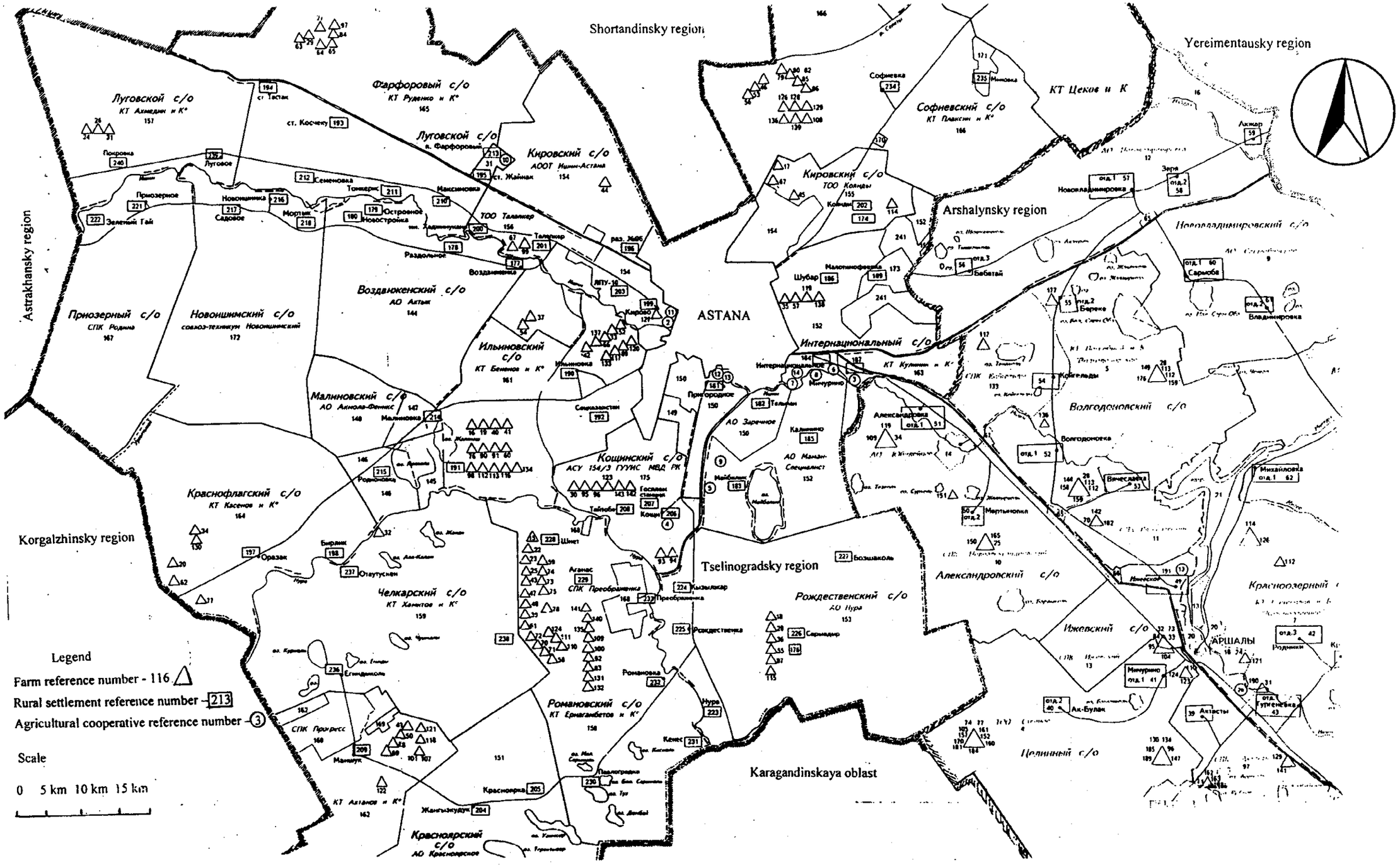
(5) Agricultural Enterprises

Astana is within the Tselinogradski agricultural region with 22 agricultural enterprises registered on 1st January 1998. Nine of these enterprises have used irrigation in the past but only two still carry on with this practice. A total of 9,445 ha of irrigable land are available but only 601 ha are actually irrigated. Figure B.3.1.1 shows the agricultural enterprises operating in the region and Figure B.3.1.2 shows the areas which had been irrigated in the past.

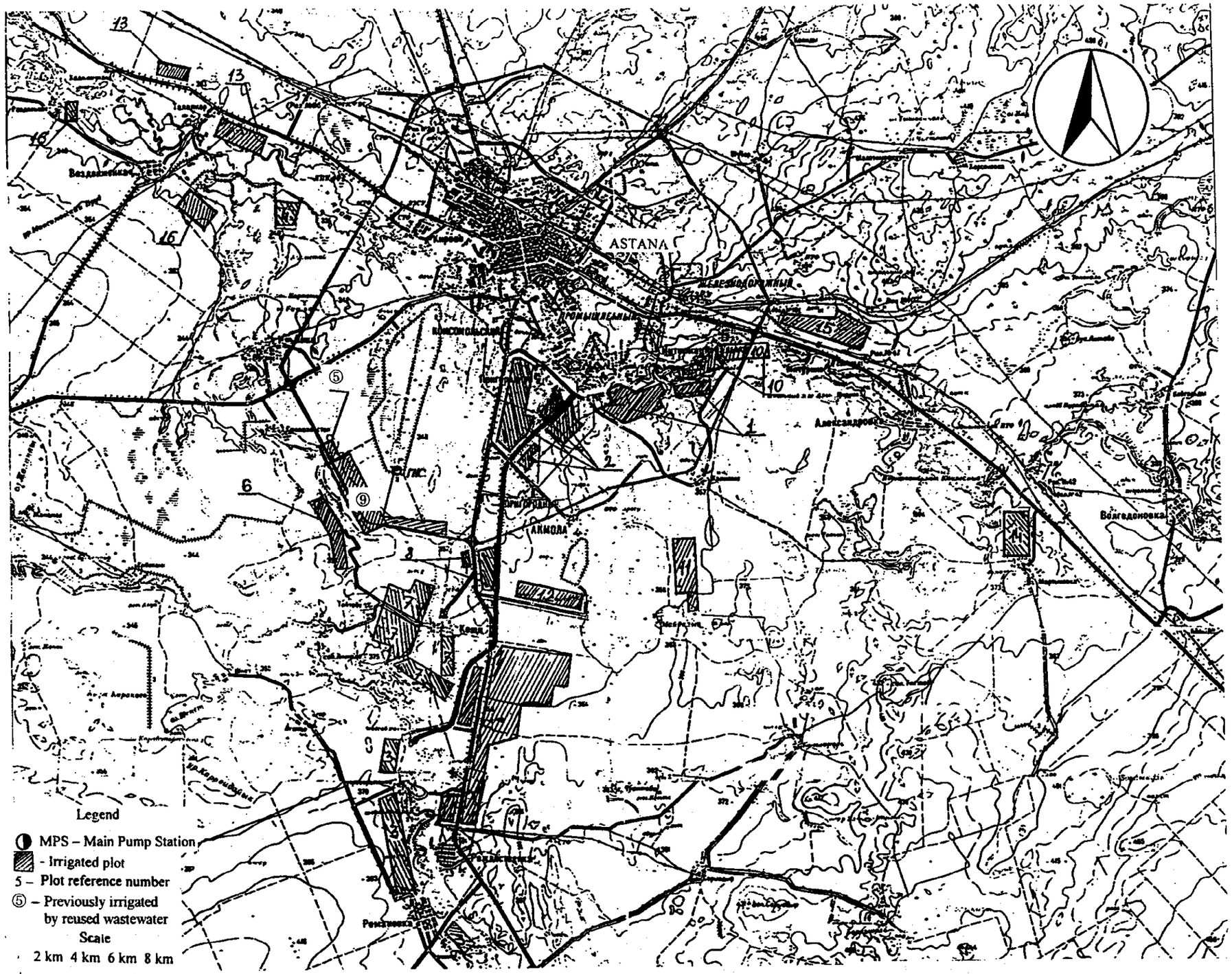
(6) Availability of Land

Large areas of suitable land are necessary for the reuse of treated effluent from Astana. Two large agricultural enterprises, Ermagambetov & Co and Yenbek-Koshi RSE 121 to the south of Astana, have been identified as holding large areas (33,000 ha and 7,000 ha respectively) of moderately arid steppe land which can be developed for agricultural production if irrigation is provided. Irrigation using treated wastewater was introduced and abandoned on the renamed Yenbek-Koshi RSE 121 farm as indicated previously. These enterprises were identified in the agricultural development plan of 1989 as being suitable for development using treated wastewater from Astana. The two projects were amongst many others covering a total area of 562,000 ha was identified for the first five years of a ten year programme (1991-2000) for land reclamation and development. This programme was abandoned when it was realized that there is insufficient water for many of the schemes and the cost of implementation was beyond affordability.

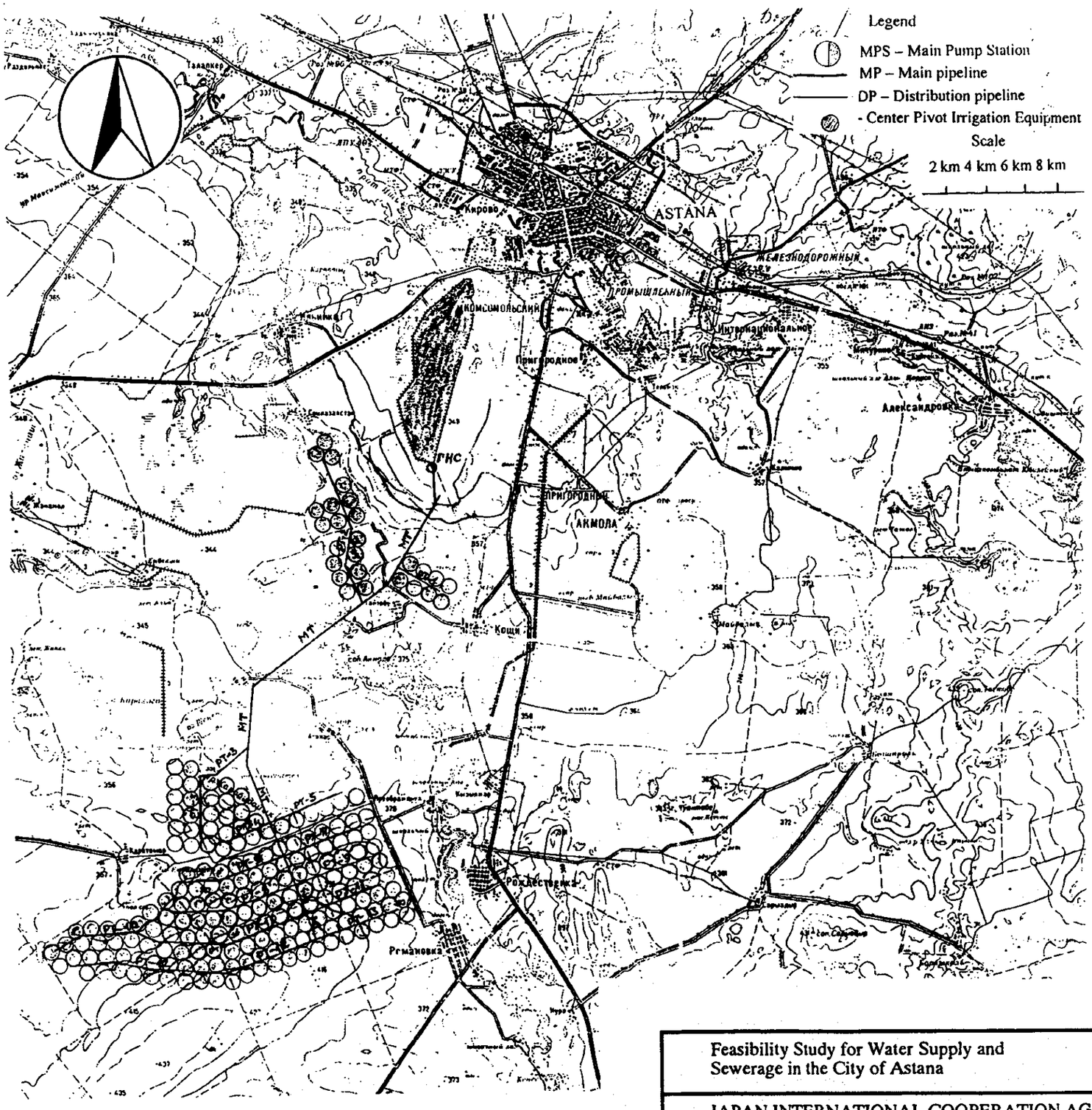
Given that availability of water is the limitation on the irrigation potential, maximum use of the available treated wastewater must be considered. Based on the available volume of treated wastewater the area of land which can be developed for irrigation at the horizon years are presented on Table B.3.1.2. The areas are calculated on the basis of 4,000 m^3 per ha. 350 ha can be developed on the land holding of Yenbek-Koshi RSE 121 and the rest on that of Ermagambetov & Co and Kamitov & Co. Figure B.3.1.3 shows the location of the 8,500 ha of land which can be potentially developed in the first stage.



Feasibility Study for Water Supply and Sewerage in the City of Astana	Figure B.3.1.1 Location of Agricultural Enterprises in the Region
JAPAN INTERNATIONAL COOPERATION AGENCY	



Feasibility Study for Water Supply and Sewerage in the City of Astana	Figure B.3.1.2 Areas Developed for Irrigation in the Past
JAPAN INTERNATIONAL COOPERATION AGENCY	



Feasibility Study for Water Supply and Sewerage in the City of Astana	Figure B.3.1.3 Proposed Irrigation Development using Treated Wastewater
JAPAN INTERNATIONAL COOPERATION AGENCY	

Table B.3.1.2 Area to be developed for Irrigation

Unit: hectares

Year	1999	2010	2020	2030
Area of Irrigation	8,000	8,500	13,000	16,500

(7) Past Studies

Recent studies carried out between 1994 and 1995 in Kazakstan for the World Bank show that agricultural enterprises provided with irrigation for their land can be economically viable. As a result of these studies the World Bank has provided in 1996 a loan for 80 Million USD (IBRD No 4041Kz) to the Government of Kazakstan for the restructuring of the agricultural sector. 22 projects with a total area of 40,000 ha located in 11 Oblasts were selected for implementation. Three of the 22 projects were located in Akmola Oblast. Detailed design and tender documents have been in preparation for the three projects (Nura, Kaigendar and Kaiser farms) but only one of the project is proceeding at present. The Nura farm project preparation was completed to detailed stage in 1998 but the project was stopped because of contamination of the proposed water source by mercury. An alternative project with the objective to decontaminate the water source is under way. One enterprise did not wish to proceed with the project. Project preparation is proceeding for the 1,404 ha of Kaiser farm. In 1998 the Asian Development Bank has agreed provide a loan of 40 M USD to fund an irrigation project covering 32,500 ha in the Jetisaiski Oblast of Southern Kazakstan.

The feasibility study carried out for the reconstruction of the 1,938 ha of irrigated land of the Nura JSC agricultural enterprise to the south east of the city showed that production can be greatly improved with irrigation. This agricultural enterprise is situated immediately to the east of the agricultural enterprises targeted for treated wastewater reuse. It is therefore expected that for the targeted farms this project can be economically and financially viable. However a full feasibility study is necessary to confirm this proposal. Table B.3.1.3 shows the present production and the improvements expected after rehabilitation.

Table B.3.1.3 Improvements in Agricultural Production at the Nura JSC after Rehabilitation

Units: tonnes

Produce	Without Rehabilitation	After Rehabilitation
Barley	70	185
Potato	600	6,290
Root Fodder		1,920
Corn Fodder	800	11,100
Green Fodder		17,830
Grass seeds		4
Other Fodder	790	6,018
Milk	145	2,800
Meat (live weight)	23	234

These studies indicate a large potential for irrigation in the agricultural sector.

(8) Description of Proposed Project

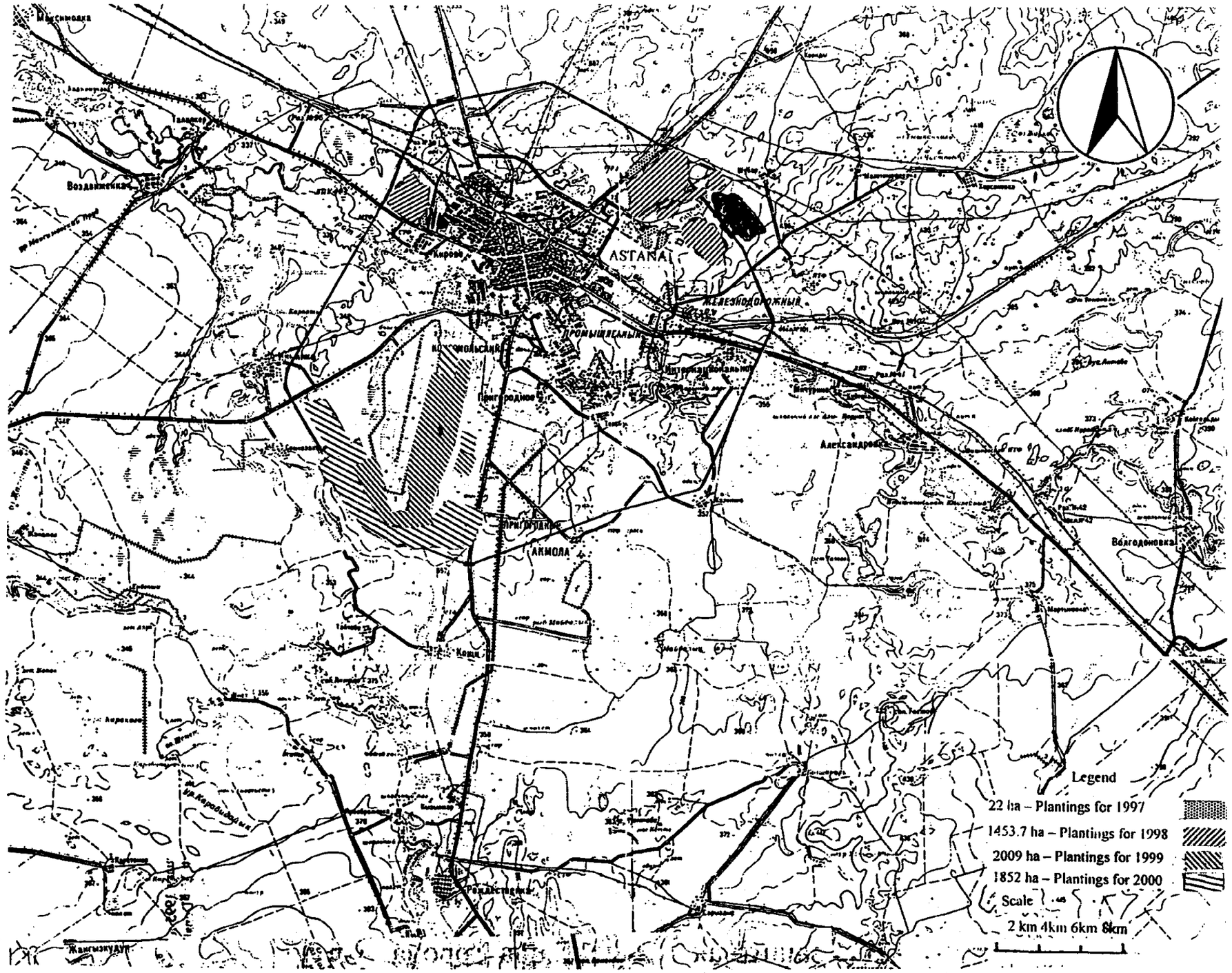
The proposed project as shown on Figure B.3.3 consists of the following:

- 1,300 l/s transfer pump station
- 30 million m^3 storage reservoir
- 35 km of 1,000mm diameter transfer pipeline
- 80 km of distribution canals
- 209 centre pivot irrigation system with pump station
- Drainage system

Retention of Taldy Kol reservoir is necessary to regulate the flow of treated wastewater and store it during the winter months. Another important feature of Taldy Kol reservoir is its function as a facultative pond, which further improves the quality of the treated wastewater especially helmith removal. Maintenance of the reservoir is therefore important for the success of the irrigation project. Integrity of the embankment is therefore important and detailed regular inspection by a dam specialist is recommended.

B.3.2 Forestry Watering

Large areas of forest (5,337 ha over the last 4 years) have been planted around the City and mostly (3,861 ha) around Taldy Kol reservoir. The original design was based on species which are resistant to the climatological conditions in Astana and do not require watering. Surveys carried out on these plantings in 1998 indicated that about 50% of the saplings do not survive. The Ministry of Agriculture has decided in July 2000 to amend its policy and watering of these new plantations is now promoted. The watering requirement was specified as 120 litres per sapling in the first year reducing to 30 litres in later years. This is equivalent to an average of about 100 m^3/ha/year. It is recommended that water from Taldykol Lake be used for such purpose. The area of forest close to Taldy Kol reservoir is approximately 4,000 ha which will require about 400,000 m^3/year. The area of forest already planted is shown on Figure B.3.2.1.



Feasibility Study for Water Supply and Sewerage in the City of Astana	Figure B.3.2.1 Development of Forest Area
JAPAN INTERNATIONAL COOPERATION AGENCY	

C. ENVIRONMENT

C.1 Regulations and Norms for Water Resource Conservation

Category	Title	Jurisdiction	Outline
Primary law and regulation	The Law of the Republic of Kazakhstan on Environmental Protection	Parliament of the Republic of Kazakhstan	Regulation for environmental conservation and management.
	Water Code of Republic Kazakhstan (No.2061-12)	Parliament of the Republic of Kazakhstan	Basic concept for water resource use and conservation.
Surface water and Ground water	Regulations of Surface Water Protection of the Republic of Kazakhstan. (RND 1.01.03-94)	Ministry of Natural Resources and Environmental Protection	The regulations of hygienic requirements for domestic and public water resource.
	Sources of Centralized Economic-Drinking Water Supply. Sanitary and Technical Requirements and Rules of Selection. (GOST 2761-84)	Agency of Public Health	The regulation of hygienic requirements for drinking water.
	Sanitary Norms and Regulation. Surface Water Protection. (SanPin No.4630-88)	Agency of Public Health	The regulation of MAC and hygienic requirements for domestic and public water resource.
Drinking water	Hygenic Requirements for Water Quality of Centralized Systems of Water Supply. Drinking water. (SanPin No.2.1.4.559-96)	Agency of Public Health	The regulation of hygienic requirements for drinking water.
Fishery	Generalized List of Maximum Allowable Concentrations and Tentative Safety Impact Levels of Pollutants for Water in Fishery Reservoirs.	Ministry of Natural Resources and Environmental Protection	The regulation of MAC for fishery.
Agriculture	Sanitary Norms and Regulations for Arrangement and Utilization of Agricultural Irrigation Fields.	Agency of Public Health	The regulation of wastewater and sediments reuse for irrigation
Wastewater discharge	Method of Calculation of Maximum Allowable Discharge (MAD) of pollutants with Wastewater into Water Bodies	Ministry of Natural Resources and Environmental Protection	The regulation of Maximum Allowable Discharge (MAD) calculating
	Regulations for Industrial Wastewater Discharge System of Astana City.	Astana City	The regulation for industrial wastewater discharge to wastewater treatment system

C.2 Surface Water Quality Standards

Table C.2.1 Representative Maximum Allowance Level of Several Substances

Unit : mg/l

Substance	Maximum Allowance Concentration		Hazard Class	WHO Guideline for potable water source
	Domestic and Public	Fishery		
Nitrate (NO_3)	45	40	3rd	50
Nitrite (NO_2)	3.3	0.08	2nd	0.2
Ammonium (NH_4)	2.0	0.5	3rd	–
Phosphorus	0.0001*	–	1st	–
Sulfate (SO_4)	500	100	4th	–
Arsenic (As)	0.05	–	2nd	0.01
Chloride	350	300	4th	250
Cadmium (Cd)	0.001	0.005	2nd	0.003
Lead (Pb)	0.03	0.1	2nd	0.01
Chrome(VI) (Cr)	0.05	0.001	3rd	0.05
Zinc (Zn)	4	0.01	3rd	3
Mercury (Hg)	0.0005	0.00001	1st	0.001

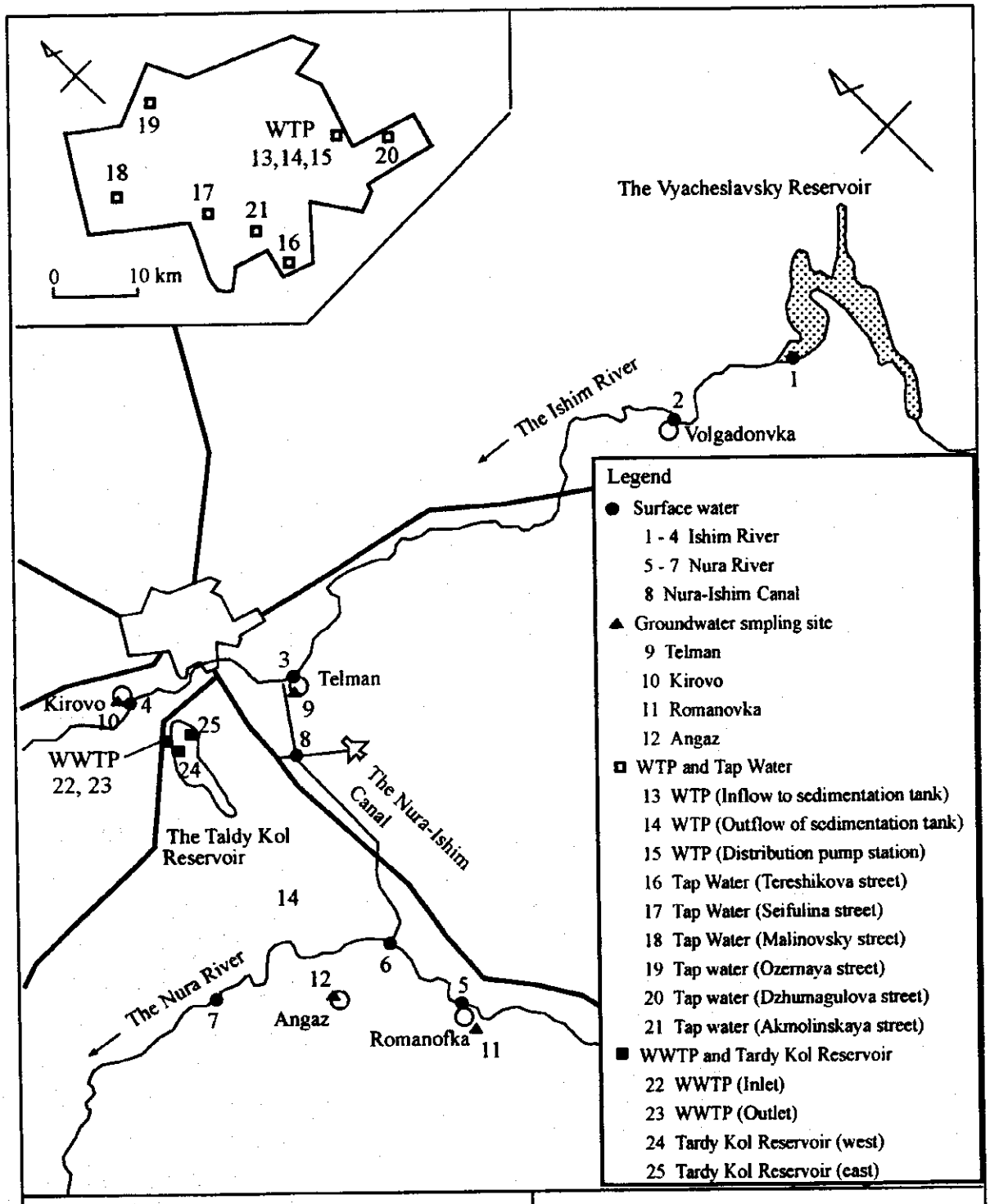
Note : 1) * the amount of element
2) Hazard class is categorized by 4 degrees. First (1st) means most hazardous substance.
Source : SanPin No.4630-88

Table C.2.2 Outline of General Standards of Water Characteristics

Item	Water Use		
	Domestic	Public	Fishery
Suspended Solid	≦0.25 mg/l *	≦0.75 mg/ l *	≦0.25 mg/ l *
Oil	Skim from oil products, grease and accumulation of other pollutants must not be revealed on water surface.		
pH	6.5 – 8.5		
Mineral	≦1000mg/l (including chlorides – 350 mg/l, sulfates – 500 mg/l)	It is normalized in accordance with "taste" indicator.	It is normalized according to toxicity of the fishery water bodies.
DO	≧4 mg/l		≧6 mg/l (≧4 mg/l in winter)
BOD	≦3mg / l	≦6 mg / l	≦3mg / l
COD	≦15 mg /l	≦30 mg /l	–
Coliform	≦100MPN / l	≦100MPN / l	–

Note : * In reference to the standard of suspend solid, the figures are applied in case of wastewater discharging. The regulation prescribes that a entrepreneur should not increase the concentration of suspend solid in water bodies more than the figures shown in the table after wastewater discharging.
Source: RND 1.01.03 –94

C.3 Sampling Site of Water Quality Survey



Feasibility Study for Water Supply and Sewerage in the City of Astana	Figure C.3 Sampling Site of Water Quality Survey
JAPAN INTERNATIONAL COOPERATION AGENCY	

C.4 Sampling Record

C.4.1(1) Sampling Record

No.		Sample Name	Sampling Date	Sampling Site					Location
				S.W.	G.W.	WTP	D.W.	WWTP	
1	1st Survey	PPRSA	8/Sept. 10:20			●			Pump station
2		PPFOA	8/Sept. 10:40			●			Outflow of filtration tank
3		PPSOA	8/Sept. 11:20			●			Inflow to sedimentation tank
4		SPINA	8/Sept. 14:20					●	Grit ckamber (Influent to WWTP)
5		TKR1A	8/Sept. 15:00	●					Western part of the Taldy Kol Reservoir
6		TKR2A	8/Sept. 15:50	●					Estern part of the Taldy Kol Reservoir
7		SPTRA	8/Sept. 16:30					●	Pump station of treated water (Effluent)
8		PPDS1	8/Sept. 17:20				●		Komsomolsky village, Tereshkova street
9		PPDS2	8/Sept. 18:00				●		Seifulina street, Astana city
10		PPDS3	8/Sept. 18:45				●		Malinovsky street, Astana city
11		PPDS4	8/Sept. 19:20				●		Ozernaya street, Astana city
12		ISVRA	9/Sept. 10:50	●					Vyacheslavsky Reservoir
13		ISAUA	9/Sept. 11:50	●					Volgodonovka, Ishim River
14		GID1A	9/Sept. 16:00		●				K. Marx street, western part of Telman village
15		ISALA	9/Sept. 17:30	●					Telman village, Ishim River
16		PPDS5	9/Sept. 18:40				●		Private house of S. Dzhumagulova, Astana city
17		PPDS6	9/Sept. 19:20				●		Akmolinskaya street, Astana city
18		ISADA	10/Sept. 10:10	●					Kirov village, Ishim River
19		GID2A	10/Sept. 10:50		●				Novostroika street, Kirov village
20		NIC2A	10/Sept. 11:50	●					Crossing point with the Astana-Airport road
21		GNL1A	13/Sept. 11:30		●				3km south from the eastern part of Romanovka
22		NUR1A	13/Sept. 12:40	●					Romanovka village, Nura River
23		NIC1A	13/Sept. 14:00	●					The parting of Nura-Ishim canal, Nura River
24		GNL2A	13/Sept. 14:30		●				Tsentralnya street, Aganas village
25		NUR2A	13/Sept. 16:40	●					6km northwest from Shenet village
26	2nd Survey	ISVRS	26/Sept. 10:50	●					Vyacheslavsky Reservoir
27		ISAUS	26/Sept. 12:00	●					Volgodonovka, Ishim River
28		ISALS	26/Sept. 14:10	●					Telman village, Ishim River
29		GID1S	26/Sept. 14:50		●				K. Marx street, western part of Telman village
30		ISADS	26/Sept. 15:40	●					Kirov village, Ishim River

C.4.1(2) Sampling Record

No.		Sample Name	Sampling Date	Sampling Site					Location
				S.W.	G.W.	WTP	D.W.	WWTP	
31	2nd Survey	GID2S	26/Sept. 16:10		●				Novostroika street, Kirov village
32		TKR1S	27/Sept. 11:30	●					Western part of the Taldy Kol Reservoir
33		TKR2S	27/Sept. 11:50	●					Estern part of the Taldy Kol Reservoir
34		SPINS	27/Sept. 15:20					●	Pump station of treated water (Effluent)
35		SPTRS	27/Sept. 15:50					●	Grit ckamber (Influent to WWTP)
36		GNL1S	28/Sept. 10:30		●				3km south from the eastern part of Romanovka
37		NUR1S	28/Sept. 11:10	●					Romanovka village, Nura River
38		NIC1S	28/Sept. 12:30	●					The parting of Nura-Ishim canal, Nura River
39		GNL2S	28/Sept. 13:40		●				Tsentralnya street, Aganas village
40		NUR2S	28/Sept. 14:50	●					6km northwest from Shenet village
41		NIC2S	28/Sept. 16:40	●					Crossing point with the Astana-Airport road
42	3rd Survey	PPRSO	17/Oct. 10:10			●			Pump station (Treated Water to the City)
43		PPFOO	17/Oct. 10:30			●			Outflow of filtration tank
44		PPSOO	17/Oct. 10:50			●			Inflow to sedimentation tank
45		NIC1O	17/Oct. 11:40	●					The parting of Nura-Ishim canal, Nura River
46		GID1O	17/Oct. 14:00		●				K. Marx street, western part of Telman village
47		ISALO	17/Oct. 14:30	●					Telman village, Ishim River
48		ISADO	17/Oct. 15:30	●					Kirov village, Ishim River
49		GID2O	17/Oct. 16:00		●				Novostroika street, Kirov village
50		TKR1S	18/Oct. 10:10	●					Western part of the Taldy Kol Reservoir
51		TKR2S	18/Oct. 10:50	●					Estern part of the Taldy Kol Reservoir
52		SPINS	18/Oct. 11:20					●	Pump station of treated water (Effluent)
53		SPTRS	18/Oct. 11:40					●	Grit ckamber (Influent to WWTP)
54		GNL1O	18/Oct. 14:00		●				3km south from the eastern part of Romanovka
55		NUR1O	18/Oct. 14:30	●					Romanovka village, Nura River
56		GNL2O	18/Oct. 15:30		●				Tsentralnya street, Aganas village
57		NUR2O	18/Oct. 16:20	●					6km northwest from Shenet village
58		NIC1O	18/Oct. 17:50	●					The parting of Nura-Ishim canal, Nura River
59		ISVRO	19/Oct. 10:30	●					Vyacheslavsky Reservoir
60		ISAUO	18/Oct. 11:40	●					Volgodonovka, Ishim River
Total Number of Samples				30	12	6	6	6	-

Note) S.W.: Surface Water, G.W.: Groundwater, WTP.: Water Purification Plant, D.W.: Distribution Water, WWTP: Wastewater Treatment Plant

C.5 Results of Water Quality Survey

Table C.5.1(1) Analysis Data of Water Quality Survey (Surface Water)

	Sampling Point	Sampling Date	1 pH [-]	2 DO [mg/l]	3 BOD_5 [mg/l]	4 COD [mg/l]	5 SS [mg/l]	6 T-N [mg/l]	7 NO_3 [mg/l]	8 NO_2 [mg/l]	9 NH_4 [mg/l]	10 T-P [mg/l]	11 Cd [μg/l]	12 SO_4 [mg/l]	13 T-S [mg/l]	14 CN [μg/l]
Ishim River	Vyacheslavsky Reservoir	Sept. 9	8.27	6.4	2.2	24	9.8	1.71	<2.2	0.015	0.1	0.026	1.6	122	45	<26
		Sept. 26	8.1	10.4	2.4	24	15.6	1.76	<2.2	0.015	0.2	0.028	1.4	121	41	<26
		Oct. 19	8.33	12.6	2.1	31	13.2	0.66	<2.2	<0.01	<0.1	0.025	1.6	128	42	<26
	Volgodonovka village	Sept. 9	8.04	8.4	3.4	24	14.0	1.76	<2.2	<0.01	<0.1	0.019	2.0	160	55	<26
		Sept. 26	8.15	12.4	2.4	24	11.2	2.60	3.1	<0.01	<0.1	0.016	1.8	153	53	<26
		Oct. 19	8.25	13.2	3.0	22	18.4	0.53	<2.2	<0.01	<0.1	0.010	2.0	139	48	<26
	Telman village	Sept. 9	7.93	7.2	2.4	64	31.2	1.89	<2.2	<0.01	<0.1	0.020	3.2	274	92	<26
		Sept. 26	8.07	10.8	2.0	48	12.8	2.25	<2.2	<0.01	<0.1	0.019	1.8	164	57	<26
		Oct. 17	8.21	12.8	3.3	58	16.6	1.40	<2.2	<0.01	<0.1	0.013	2.4	201	68	<26
	Kirovo village	Sept. 10	7.85	5.8	4.0	48	22.6	1.34	<2.2	<0.01	0.15	0.054	3.8	370	135	<26
		Sept. 26	7.95	10.4	2.8	32	15.2	1.34	<2.2	<0.01	<0.1	0.062	3.2	339	120	<26
		Oct. 17	8.28	14.8	3.3	54	23.8	0.84	<2.2	0.025	<0.1	0.034	3.6	320	108	<26
Nura River	Romanovka village	Sept. 13	8.46	9.6	5.8	24	43.6	1.69	<2.2	<0.01	0.2	0.24	4.2	399	135	<26
		Sept. 28	8.25	11.4	2.9	16	41.4	1.2	<2.2	<0.01	<0.1	0.17	3.0	356	130	<26
		Oct. 18	8.5	13.6	5.0	21	45.6	0.8	<2.2	<0.01	<0.1	0.10	3.2	386	128	<26
	Nura river, the parting of Nura-Ishim canal	Sept. 13	8.44	10.4	7.0	40	21.0	2.24	<2.2	<0.01	0.25	0.17	4.6	399	135	<26
		Sept. 28	8.2	11.6	2.8	44	60.6	1.34	<2.2	<0.01	<0.1	0.14	3.0	379	129	<26
		Oct. 18	8.45	14.4	4.8	52	55	0.66	<2.2	<0.01	<0.1	0.07	3.4	376	129	<26
	6km northwest from Shenet village	Sept. 13	8.22	9.2	6.6	32	27.6	2.24	<2.2	<0.01	0.4	0.15	4.6	394	132	<26
		Sept. 28	8.25	11.8	2.0	32	44.0	1.40	<2.2	<0.01	<0.1	0.12	3.0	357	139	<26
		Oct. 18	8.4	9.0	4.8	34	57.2	0.66	<2.2	<0.01	<0.1	0.08	3.6	365	127	<26
Nura-Ishim	Crossing point with the Astana-Air Port road	Sept. 10	7.93	8.0	4.4	16	16.8	1.84	<2.2	<0.01	0.15	0.03	3.8	404	137	<26
		Sept. 28	8.25	11.4	2.2	25	11.2	1.26	<2.2	<0.01	<0.1	0.03	3.4	300	129	<26
		Oct. 17	8.46	13.8	2.6	22	13.2	0.66	<2.2	<0.01	<0.1	0.02	3.8	417	139	<26
Kazakhstan standard (Domestic use)			6.5-8.5	4.0	3	15	bg+0.25	-	45	3.3	2	-	1	500	-	50
Kazakhstan standard (Fishery use)			6.5-8.5	6.0	3	-	bg+0.25	-	40	0.08	0.5	-	5	100	-	35
Japanese standard (River water) 1)			6.5-8.5	5-7.5	1-3	-	25	-	10	10	-	-	10	-	-	ND

note 1) The standard values are adopted to drinking water source.
2) ND : not detected

Table C.5.1(2) Analysis Data of Water Quality Survey (Surface Water)

Sampling Point		Sampling Date	15 Pb [μg/l]	16 Cr(VI) [μg/l]	17 As [μg/l]	18 Zn [mg/l]	19 Hg [μg/l]	20 T-Mineral [mg/l]	21 Cl [mg/l]	22 T-Coliforms [MPN/100ml]	23 O & G [mg/l]	24 EC μS/cm	25 Phenols [μg/l]	26 Water Temp. [℃]	27 Air Temp. [℃]
Ishim River	Vyacheslavsky Reservoir	Sept. 9	20	<2	<10	<0.01	<0.2	574	147	1.0	<0.03	1,032	<1	18	17
		Sept. 26	20	<2	<10	0.11	<0.2	534	146	1.0	<0.03	996	<1	9	1
		Oct. 19	20	<2	<10	0.01	<0.2	530	149	1.0	0.03	970	<1	4	0
	Volgodonovka village	Sept. 9	20	<2	<10	<0.01	<0.2	718	202	1.0	<0.03	1,284	<1	18	22
		Sept. 26	20	<2	<10	0.025	<0.2	688	201	1.0	<0.03	1,230	1	5	4
		Oct. 19	20	<2	<10	0.01	<0.2	568	174	1.0	0.04	1,097	<1	3	0
	Telman village	Sept. 9	30	<2	<10	<0.01	<0.2	1,156	293	<1.0	<0.03	1,839	<1	18	22
		Sept. 26	20	<2	<10	<0.01	<0.2	752	187	1.0	0.04	1,253	2	6	8
		Oct. 17	20	<2	<10	0.01	<0.2	770	199	<1.0	0.03	1,369	2	2	0
	Kirovo village	Sept. 10	30	<2	16	<0.01	<0.2	1,528	444	1.0	<0.03	2,459	<1	15	20
		Sept. 26	20	<2	<10	<0.01	<0.2	1,396	412	1.5	0.05	2,267	2	6	4
		Oct. 17	25	<2	<10	0.01	<0.2	1,262	375	<1.0	0.04	2,078	2	2	0
Nura River	Romanovka village	Sept. 13	20	<2	<10	<0.01	<0.2	1,316	318	3.0	<0.03	1,968	<1	14	17
		Sept. 28	30	<2	<10	0.01	<0.2	1,240	310	1.1	0.04	2,069	2	2	6
		Oct. 18	30	<2	<10	0.01	<0.2	1,210	313	<1.0	0.09	2,000	2	2	2
	Nura river, the parting of Nura-Ishim canal	Sept. 13	30	<2	<10	<0.01	<0.2	1,336	321	3	<0.03	1,976	<1	16	18
		Sept. 28	20	<2	<10	<0.01	<0.2	1,338	309	2.2	0.06	2,046	1	4	6
		Oct. 18	30	<2	<10	0.01	<0.2	1,270	311	1.0	0.07	1,927	1	1	0
	6km northwest from Shenet village	Sept. 13	30	<2	<10	<0.01	<0.2	1,322	319	3.0	<0.03	1,981	<1	14	21
		Sept. 28	30	<2	<10	<0.01	<0.2	1,212	307	1.0	0.04	1,996	<1	5	10
		Oct. 18	30	<2	<10	0.01	<0.2	1,236	309	<1.0	0.1	1,876	2	2	2
Nura-Ishim	Crossing point with the Astana-Air Port road	Sept. 10	30	<2	16	<0.01	<0.2	1,382	336	1.0	0.07	2,184	<1	16	21
		Sept. 28	30	<2	<10	<0.01	<0.2	1,246	328	1.1	0.04	2,140	<1	6	10
		Oct. 17	30	<2	<10	0.01	<0.2	1,332	336	<1.0	0.06	2,179	1	2	-1
Kazakhstan standard (Domestic use)			30	50	50	5	0.5	1,000	350	100	0.3	-	1	-	-
Kazakhstan standard (Fishery use)			100	10	50	0.01	0.1	-	300	-	0.3	-	1	-	-
Japanese standard (River water) 1)			10	50	10	15	0.5	-	-	50-5,000	-	-	-	-	-

note 1) The standard values are adopted to drinking water source.

2) ND : not detected

Table C.5.2 Analysis Data of Water Quality Survey (Ground Water)

	Sampling Point	Sampling Date	1 pH [-]	2 DO [mg/l]	3 BOD_5 [mg/l]	4 COD [mg/l]	5 SS [mg/l]	6 T-N [mg/l]	7 NO_3 [mg/l]	8 NO_2 [mg/l]	9 NH_4 [mg/l]	10 T-P [mg/l]	11 Cd [μg/l]	12 SO_4 [mg/l]	13 T-S [mg/l]	14 CN [μg/l]
Groundwater	Telman village	Sept. 9	7.35	4.0	1.8	32	23.2	81.24	334	<0.01	<0.1	0.025	3.6	541	183	<26
		Sept. 26	7.55	4.4	0.8	28	10.4	85.7	344	<0.01	<0.1	0.028	3.2	485	171	<26
		Oct. 17	7.60	6.4	2.1	31	19.4	79	343	<0.01	<0.1	0.038	3.8	459	157	<26
	Kirov village	Sept. 10	6.97	0.8	3.8	96	69.4	12.24	35	<0.01	0.6	0.048	12.0	966	338	<26
		Sept. 26	7.15	2.4	1.2	96	80.4	9.65	39	<0.01	0.7	0.041	7.8	1,020	354	<26
		Oct. 17	7.25	1.2	1.3	102	56	11.4	47	<0.01	0.2	0.029	7.1	1,036	352	<26
	3km south from the estern part of Romanovka village	Sept. 13	7.59	6.8	1.2	32	7.4	1.74	<2.2	<0.01	0.1	0.034	3.6	312	106	<26
		Sept. 28	7.70	7.6	1.4	48	11.6	1.1	<2.2	<0.01	<0.1	0.019	3.0	300	101	<26
		Oct. 18	7.90	6.4	2.3	38	12.9	1.06	<2.2	<0.01	<0.1	0.014	3.2	298	103	<26
	Aganas village	Sept. 10	7.69	4.0	2.8	24	0.6	26.24	97	0.03	0.1	0.025	3.6	317	108	<26
		Sept. 26	7.63	5.2	1.2	32	11.6	23	86	<0.01	<0.1	0.021	3.0	305	107	<26
		Oct. 18	7.80	5.4	1.2	28	11.6	24.25	98	<0.01	<0.1	0.033	3.1	333	110	<26

	Sampling Point	Sampling Date	15 Pb [μg/l]	16 Cr(VI) [μg/l]	17 As [μg/l]	18 Zn [mg/l]	19 Hg [μg/l]	20 T-Mineral [mg/l]	21 Cl [mg/l]	22 T-Coliforms [MPN/100ml]	23 O & G [mg/l]	24 EC [μS/cm]	25 Phenols [μg/l]	26 Water Temp. [℃]	27 Air Temp. [℃]
Groundwater	Telman village	Sept. 9	40	<2	11	<0.01	<0.2	1,754	169	0.3	<0.03	2,473	<1	6	26
		Sept. 26	30	<2	<10	0.31	<0.2	1,728	153	1	<0.03	2,331	1	7	4
		Oct. 17	30	2.3	<10	0.15	<0.2	1,574	152	<0.3	<0.03	2,219	2	6	-1
	Kirov village	Sept. 10	60	<2	<10	0.04	<0.2	3,386	970	0.4	<0.03	5,008	<1	6.5	21
		Sept. 26	60	<2	<10	0.01	<0.2	3,514	967	1	0.03	4,894	1	5	6
		Oct. 17	60	<2	<10	0.01	<0.2	3,526	1,003	<0.3	0.04	4,891	1	4	0
	3km south from the estern part of Romanovka village	Sept. 13	20	<2	<10	<0.01	<0.2	1,236	308	0.3	<0.03	1,928	<1	8	16
		Sept. 28	20	<2	<10	<0.01	<0.2	1,238	302	0.6	<0.03	1,958	2	6	8
		Oct. 18	20	<2	<10	0.01	<0.2	1,154	304	<0.3	0.07	2,035	3	5.5	2
	Aganas village	Sept. 10	30	<2	<10	<0.01	<0.2	1,256	269	0.3	<0.03	1,839	<1	7	20
		Sept. 26	20	<2	<10	<0.01	<0.2	1,208	266	0.3	0.03	1,960	2	6	10.5
		Oct. 18	30	<2	<10	0.01	<0.2	1,194	271	<0.3	0.05	1,921	1	6	2

Table C.5.3 Analysis Data of Water Quality Survey (Vyacheslavsky Reservoir and WTP)

Sampling Point		Sampling Date	1 pH [-]	2 DO [mg/l]	3 BOD_5 [mg/l]	4 COD [mg/l]	5 SS [mg/l]	6 T-N [mg/l]	7 NO_3 [mg/l]	8 NO_2 [mg/l]	9 NH_4 [mg/l]	10 T-P [mg/l]	11 Cd [μg/l]	12 SO_4 [mg/l]	13 T-S [mg/l]	14 CN [μg/l]
Vyacheslavsky Reservoir		Sept. 9	8.27	6.4	2.2	24	9.8	1.71	<2.2	0.015	0.1	0.026	1.6	122	45	<26
		Sept. 26	8.1	10.4	2.4	24	15.6	1.76	<2.2	0.015	0.2	0.028	1.4	121	41	<26
		Oct. 19	8.33	12.6	2.1	31	13.2	0.66	<2.2	<0.01	<0.1	0.025	1.6	128	42	<26
WTP	Inflow to sedimentation tank	Sept. 8	8.17	12.0	5.0	32	14.8	1.15	<2.2	<0.01	0.5	0.029	2.4	135	45	<26
		Oct. 17	7.95	11.6	1.5	46	14.4	0.76	<2.2	<0.01	<0.1	0.037	1.8	137	47	<26
	Outflow of Filtration Tank	Sept. 8	7.94	10.0	8.0	48	12.4	0.19	<2.2	<0.01	0.1	0.014	2.6	135	45	<26
		Oct. 17	7.70	11.8	1.4	50	17.2	0.66	<2.2	<0.01	<0.1	0.020	1.7	127	45	<26
	Pump Station	Sept. 8	7.50	17.2	7.7	32	16.2	1.12	<2.2	<0.01	<0.1	0.013	2.8	139	59	<26
		Oct. 17	7.55	12.2	1.7	46	15.2	0.62	<2.2	<0.01	<0.1	0.027	1.9	129	45	<26
Distribution Water	Teresikowa Street	Sept. 8	7.83	14.0	2.2	48	21.4	1.84	<2.2	<0.01	0.15	0.013	2.8	144	48.4	<26
	Seifulina Street	Sept. 8	7.88	10.4	1.8	32	10.6	1.89	<2.2	<0.01	<0.1	0.013	2.6	139	46.4	<26
	Malinoski Street	Sept. 8	6.68	9.8	2.2	48	15.2	1.89	<2.2	<0.01	<0.1	0.010	2.6	139	46.6	<26
	Ozerunaya Street	Sept. 8	7.66	12.0	1.8	32	6.4	0.19	<2.2	<0.01	<0.1	<0.010	2.6	139	46.4	<26
	Microrayon Area	Sept. 9	7.78	8.0	2.2	16	10.6	1.44	<2.2	<0.01	0.1	0.019	1.6	132	46.3	<26
	Akmolinskaya Street	Sept. 9	7.75	8.4	4.0	48	14.4	1.19	<2.2	<0.01	0.1	0.110	1.6	129	45.7	<26
Kazakhstan standard (Domestic use)			6.5 - 8.5	4.0	3	15	bg+0.25	-	45	3.3	2	-	1	500	-	50
Kazakhstan standard (Drinking water)			6 - 9	-	-	-	-	-	45	3.3	2.0	-	1	500	-	35
WHO Standard (Drinking water)			-	-	-	-	-	-	50	3	-	-	3	-	-	70
Japanese Standard (Drinking water)			5.8 - 8.6	-	-	-	-	-	10	0.05	-	-	10	-	-	10

Sampling Point		Sampling Date	15 Pb [μg/l]	16 Cr(VI) [μg/l]	17 As [μg/l]	18 Zn [mg/l]	19 Hg [μg/l]	20 T-Mineral [mg/l]	21 Cl [mg/l]	22 T-Coliforms [MPN/100ml]	23 O & G [mg/l]	24 [illegible] [μS/cm]	25 Phenols [μg/l]	26 Water Temp. [℃]	27 Ambient Air Temp. [℃]
Vyacheslavsky Reservoir		Sept. 9	20	<2	<10	<0.01	<0.2	574	147	1.0	<0.03	1,032	<1	18	17
		Sept. 26	20	<2	<10	0.11	<0.2	534	146	1.0	<0.03	996	<1	9	1
		Oct. 19	20	<2	<10	0.01	<0.2	530	149	1.0	0.03	970	<1	4	0
WTP	Inflow to sedimentation tank	Sept. 8	20	<2	<10	<0.01	<0.2	648	156	2.2	0.04	982	<1	16	19
		Oct. 17	20	<2	<10	0.01	<0.2	608	157	<1.0	0.09	1,035	1	4	12
	Outflow of Filtration Tank	Sept. 8	20	<2	<10	<0.01	<0.2	594	156	<1.0	<0.03	970	<1	19	19
		Oct. 17	20	<2	<10	<0.01	<0.2	504	153	<0.3	0.03	1,013	<1	6	7
	Pump Station	Sept. 8	20	<2	<10	<0.01	<0.2	676	167	<0.3	<0.03	1,050	<1	19	20
		Oct. 17	20	<2	<10	0.01	<0.2	542	159	<0.3	0.03	1,028	<1	6	12
Distribution Water	Teresikowa Street	Sept. 8	20	<2	<10	<0.01	<0.2	686	174	<0.3	<0.03	1,047	<1	18	23
	Seifulina Street	Sept. 8	20	<2	<10	<0.01	<0.2	658	171	<0.3	<0.03	1,000	<1	19	23
	Malinoski Street	Sept. 8	20	<2	<10	<0.01	<0.2	666	166	<0.3	<0.03	1,022	<1	19	22
	Ozerunaya Street	Sept. 8	20	<2	<10	<0.01	<0.2	650	159	<0.3	<0.03	1,043	<1	17	22
	Microrayon Area	Sept. 9	20	<2	<10	0.46	<0.2	600	161	<0.3	<0.03	1,028	<1	14	22
	Akmolinskaya Street	Sept. 9	20	<2	<10	<0.01	<0.2	600	159	<0.3	<0.03	1,037	<1	18	22
Kazakhstan standard (Domestic use)			30	50	50	5	0.5	1,000	350	100	0.3	-	1	-	-
Kazakhstan standard (Drinking water)			30	50	50	5	0.5	1,000	350	<0.3	0.1	-	1.0	-	-
WHO Standard (Drinking water)			10	50	10	3	1	1,000	250	n.d.	-	-	0.2	-	-
Japanese Standard (Drinking water)			50	50	10	1	0.5	500	200	n.d.	-	-	5	-	-

Table C.5.4 Analysis Data of Water Quality Survey (WWTP and Tardy Kol Reservoir)

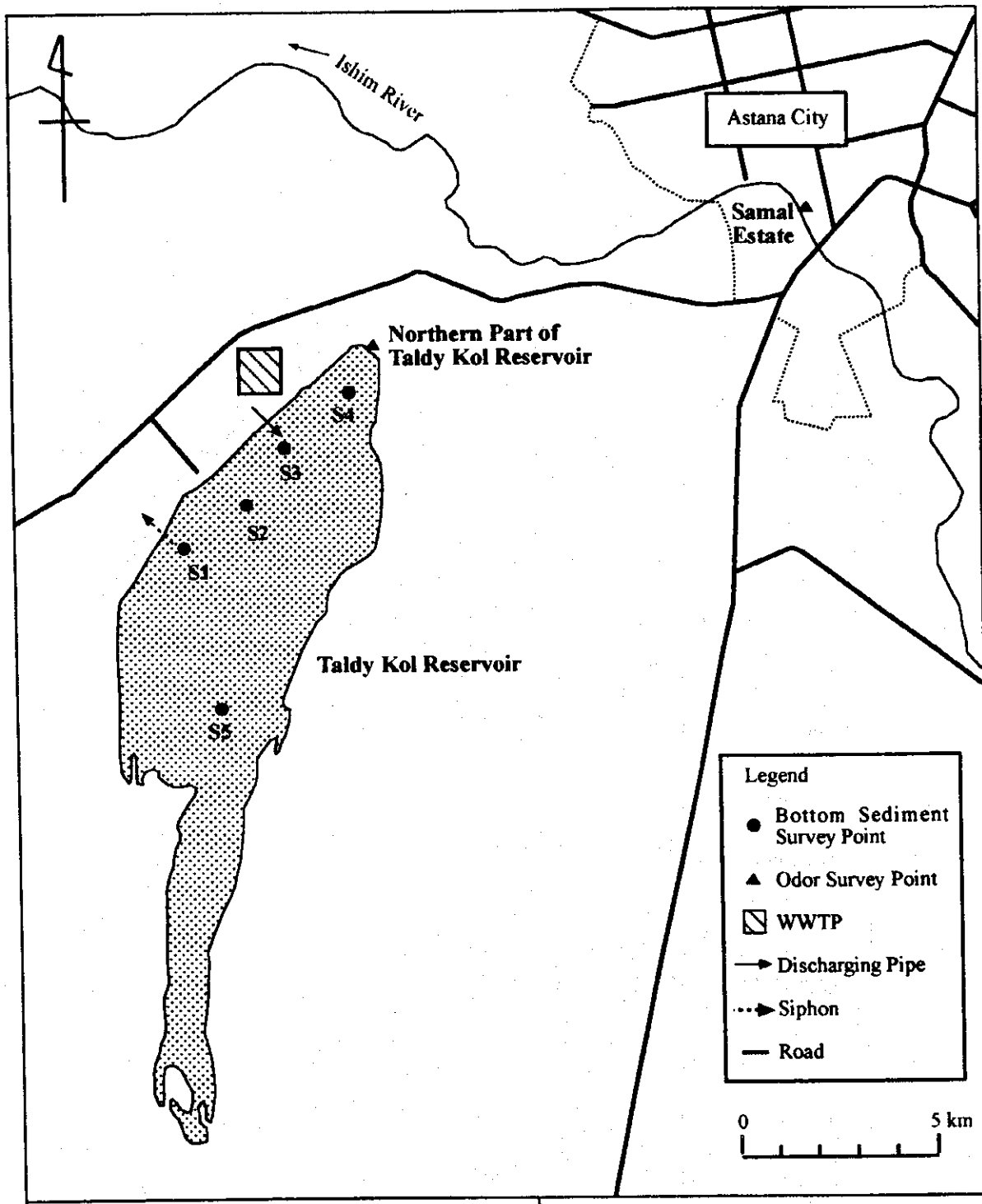
Sampling Point		Sampling Date	1 pH [-]	2 DO [mg/l]	3 BOD_5 [mg/l]	4 COD [mg/l]	5 SS [mg/l]	6 T-N [mg/l]	7 NO_3 [mg/l]	8 NO_2 [mg/l]	9 NH_4 [mg/l]	10 T-P [mg/l]	11 Cd [μg/l]	12 SO_4 [mg/l]	13 T-S [mg/l]	14 CN [μg/l]
WWTP	Inlet	Sept. 8	7.53	2.0	240	480	310.8	58	<2.2	<0.01	75.0	6.8	3.6	225	80.5	27
		Sept. 27	7.45	1.6	133.4	284	354.4	28	<2.2	<0.01	28.0	3.3	3.2	215	76.1	<26
		Oct. 18	7.52	6.6	83.4	200	335.0	17	<2.2	0.3	17.0	1.9	3.1	240	83.0	<26
	Outlet	Sept. 8	7.43	4.2	6.0	80	18.4	19	41.0	0.4	9.0	2.3	2.8	233	78.4	<26
		Sept. 27	7.25	10.6	5.6	52	14.4	18	67.1	0.8	<0.1	1.7	2.0	219	75.4	<26
		Oct. 18	7.52	9.2	8.6	84	15.4	17	73.5	0.2	<0.1	1.0	2.4	197	74.0	<26
Taldy Kol Reservoir	Western part of the Reservoir	Sept. 8	8.58	7.0	7.0	64	16.0	4.99	6.4	0.3	1.4	1.5	3.0	252	84	<26
		Sept. 27	8.05	10.8	6.8	70	14.8	3.80	4.2	0.3	1.7	1.6	2.6	234	80	<26
		Oct. 18	8.2	12.0	9.4	88	13.6	3.65	10.3	0.3	1.3	1.0	2.8	251	85	<26
	Eastern part of the Reservoir	Sept. 8	8.40	10.4	6.2	64	10.6	3.99	4.0	0.2	1.0	1.5	3.0	256	87	<26
		Sept. 27	8.25	10.6	6.6	56	12.4	3.60	4.3	0.3	1.7	1.4	3.0	232	82	<26
		Oct. 18	8.26	12.2	7.2	90	14.0	3.04	7.5	0.3	1.7	1.1	2.8	253	85	<26
Kazakhstan standard (Domestic use)			6.5 - 8.5	4.0	3	15	bg+0.25	-	45	3.3	2	-	1	500	-	50
Kazakhstan standard (Fishery use)			6.5 - 8.5	6.0	3	-	bg+0.25	-	40	0.08	0.5	-	5	100	-	35

Sampling Point		Sampling Date	15 Pb [μg/l]	16 Cr(VI) [μg/l]	17 As [μg/l]	18 Zn [mg/l]	19 Hg [μg/l]	20 T-Mineral [mg/l]	21 Cl [mg/l]	22 T-Coliforms [MPN/100ml]	23 O & G [mg/l]	24 EC [μS/cm]	25 Phenols [μg/l]	26 Water Temp. [℃]	27 Air Temp. [℃]
WWTP	Inlet	Sept. 8	30	4	12	0.085	<0.2	1,195	250	1,300	0.16	1,812	20	20	24
		Sept. 27	30	<2	<10	0.12	<0.2	950	233	1,300	1.18	1,728	15	16	10
		Oct. 18	20	<2	<10	0.035	<0.2	972	249	2,000	2.54	1,642	12	11	11
	Outlet	Sept. 8	30	<2	<10	0.01	<0.2	1,062	260	60	<0.03	1,687	<1	19	24
		Sept. 27	20	<2	<10	0.01	<0.2	968	242	20	0.40	1,608	3	16	10
		Oct. 18	20	<2	<10	0.01	<0.2	856	241	60	0.54	1,548	3	11	15
Taldy Kol Reservoir	Western part of the Reservoir	Sept. 8	30	<2	<10	<0.01	<0.2	1,164	260	60	<0.03	1,655	<1	18	24
		Sept. 27	30	<2	<10	<0.01	<0.2	1,102	256	20	0.07	1,776	4	6	8
		Oct. 18	20	<2	<10	0.01	<0.2	1,082	259	60	0.07	1,751	5	2	2
	Eastern part of the Reservoir	Sept. 8	30	6	<10	<0.01	<0.2	1,132	261	60	<0.03	1,677	<1	19	24
		Sept. 27	20	<2	<10	<0.01	<0.2	1,094	256	20	0.08	1,726	4	5.5	6
		Oct. 18	20	<2	<10	0.01	<0.2	1,036	259	60	0.08	1,724	4	2	2
Kazakhstan standard (Domestic use)			30	50	50	5	0.5	1,000	350	100	0.3	-	1	-	-
Kazakhstan standard (Fishery use)			100	10	50	0.01	0.1	-	300	-	0.3	-	1	-	-

Table C.5.5 Analysis Data of Water Quality Survey (Pesticides and Related Products)

Sampling Point		Sampling Date	Pesticides and Related Products						
			α -(GHCG) [μg/l]	γ -(GHCG) [μg/l]	4,4-DDT [μg/l]	4,4-DDE [μg/l]	Trichlorfon [μg/l]	Metaphos [μg/l]	Carbophos [μg/l]
Ishim River	Vyacheslavsky Reservoir	Sept. 9	<1	<1	<1	<1	<5	<2	<5
		Sept. 26	<1	<1	<1	<1	<5	<2	<5
		Oct. 19	<1	<1	<1	<1	<5	<2	<5
	Volgodonovka village	Sept. 9	<1	<1	<1	<1	<5	<2	<5
		Sept. 26	<1	<1	<1	<1	<5	<2	<5
		Oct. 19	<1	<1	<1	<1	<5	<2	<5
	Telman village	Sept. 9	<1	<1	<1	<1	<5	<2	<5
		Sept. 26	<1	<1	<1	<1	<5	<2	<5
		Oct. 17	<1	<1	<1	<1	<5	<2	<5
	Kirovo village	Sept. 10	<1	<1	<1	<1	<5	<2	<5
		Sept. 26	<1	<1	<1	<1	<5	<2	<5
		Oct. 17	<1	<1	<1	<1	<5	<2	<5
Taldy Kol Reservoir	Western part of the Reservoir	Sept. 8	<1	<1	<1	<1	<5	<2	<5
		Sept. 27	<1	<1	<1	<1	<5	<2	<5
		Oct. 18	<1	<1	<1	<1	<5	<2	<5
	Eastern part of the Reservoir	Sept. 8	<1	<1	<1	<1	<5	<2	<5
		Sept. 27	<1	<1	<1	<1	<5	<2	<5
		Oct. 18	<1	<1	<1	<1	<5	<2	<5
Nura River	Romanovka village	Sept. 13	<1	<1	<1	<1	<5	<2	<5
		Sept. 28	<1	<1	<1	<1	<5	<2	<5
		Oct. 18	<1	<1	<1	<1	<5	<2	<5
	6km northwest from Shenet village	Sept. 13	<1	<1	<1	<1	<5	<2	<5
		Sept. 28	<1	<1	<1	<1	<5	<2	<5
		Oct. 18	<1	<1	<1	<1	<5	<2	<5
Nura-Ishim canal	Crossing point with the Astana-Air Port	Sept. 10	<1	<1	<1	<1	<5	<2	<5
		Sept. 28	<1	<1	<1	<1	<5	<2	<5
		Oct. 17	<1	<1	<1	<1	<5	<2	<5
	Nura river, the parting of Nura-Ishim canal	Sept. 13	<1	<1	<1	<1	<5	<2	<5
		Sept. 28	<1	<1	<1	<1	<5	<2	<5
		Oct. 18	<1	<1	<1	<1	<5	<2	<5
Groundwater	Telman village	Sept. 9	<1	<1	<1	<1	<5	<2	<5
		Sept. 26	<1	<1	<1	<1	<5	<2	<5
		Oct. 17	<1	<1	<1	<1	<5	<2	<5
	Kirov village	Sept. 10	<1	<1	<1	<1	<5	<2	<5
		Sept. 26	<1	<1	<1	<1	<5	<2	<5
		Oct. 17	<1	<1	<1	<1	<5	<2	<5
	3km south from the estern part of Romanovka village	Sept. 13	<1	<1	<1	<1	<5	<2	<5
		Sept. 28	<1	<1	<1	<1	<5	<2	<5
		Oct. 18	<1	<1	<1	<1	<5	<2	<5
	Aganas village	Sept. 10	<1	<1	<1	<1	<5	<2	<5
		Sept. 26	<1	<1	<1	<1	<5	<2	<5
		Oct. 18	<1	<1	<1	<1	<5	<2	<5
WWTP	Inlet	Sept. 8	<1	<1	<1	<1	<5	<2	<5
		Sept. 27	<1	<1	<1	<1	<5	<2	<5
		Oct. 18	<1	<1	<1	<1	<5	<2	<5
	Outlet	Sept. 8	<1	<1	<1	<1	<5	<2	<5
		Sept. 27	<1	<1	<1	<1	<5	<2	<5
		Oct. 18	<1	<1	<1	<1	<5	<2	<5
WTP	Pump Station	Sept. 8	<1	<1	<1	<1	<5	<2	<5
		Oct. 17	<1	<1	<1	<1	<5	<2	<5
	Outflow of Filtration Tank	Sept. 8	<1	<1	<1	<1	<5	<2	<5
		Oct. 17	<1	<1	<1	<1	<5	<2	<5
	Inflow to sedimentation tank	Sept. 8	<1	<1	<1	<1	<5	<2	<5
		Oct. 17	<1	<1	<1	<1	<5	<2	<5
Distribution Water	Teresikova Street, Astana	Sept. 8	<1	<1	<1	<1	<5	<2	<5
	Seifullina Street, Astana	Sept. 8	<1	<1	<1	<1	<5	<2	<5
	Malinovski Street, Astana	Sept. 8	<1	<1	<1	<1	<5	<2	<5
	Ozernaya Street, Astana	Sept. 8	<1	<1	<1	<1	<5	<2	<5
	Microrayon Area, Astana	Sept. 9	<1	<1	<1	<1	<5	<2	<5
	Almalinskaya Street, Astana	Sept. 9	<1	<1	<1	<1	<5	<2	<5

C.6 Sampling Site of Bottom Sediment and Odor Survey



Feasibility Study for Water Supply and Sewerage in the City of Astana	Figure C.6 Sampling Site of Odor Measurement and Reservoir Bottom Survey
JAPAN INTERNATIONAL COOPERATION AGENCY	

C.7 Result of Odor Measurement and Bottom Sediment Survey

Table C.7.1 Results of Odor Measurement

Samal Estate						Tardy Kol Reservoir					
Date	Sampling Time	NH_3 [ppm]	H_2S [ppm]	Sensory Evaluation	Wind Direction	Date	Sampling Time	NH_3 [ppm]	H_2S [ppm]	Sensory Evaluation	Wind Direction
Sept. 14, 2000	7:15 – 8:25	0.15	< 0.002	Marsh odor	NE	Sept. 15, 2000	8:00 – 9:40	0.17	< 0.002	Sewage odor	SW
	13:00 – 14:25	0.20	< 0.002	No odor	S		13:00 – 14:40	0.13	< 0.002	Slight sewage	WSW
	16:55 – 20:00	0.06	< 0.002	No odor	SW		17:05 – 18:50	0.08	< 0.002	Slight sewage	WSW
Oct. 12, 2000	8:00 – 9:50	0.07	< 0.002	No odor	NE	Oct. 13, 2000	9:05 – 10:45	0.11	< 0.002	Slight sewage	WSW
	13:00 – 14:55	0.07	< 0.002	No odor	Calm		13:00 – 14:40	0.11	< 0.002	Slight sewage	S
	17:00 – 18:45	0.11	< 0.002	No odor	ENE		17:00 – 18:40	0.12	< 0.002	Sewage odor	WSW

Table C.7.2 General Characteristics of Taldy Kol Reservoir Bottom Sediment

Parameter	Unit	S1 Near the Siphon	S2 Between the Discharge Point and Siphon	S3 Near the Discharge Point	S4 Northern Part of the Reservoir	S5 Central Part of the Reservoir	General Consentration (1)
pH	–	8.0	7.9	8.3	7.4	7.4	–
Water Content	%	11.2	7.6	4.7	7.4	12.3	–
Ignition Loss	%	22.5	19.6	11.9	23.8	39.2	–
Organic Carbon	mg/g	81.7	62.7	33.0	80.5	179.6	–
Total-N	mg/g	6.7	5.8	7.3	8.2	13.8	2
Total-P	mg/g	1.6	1.2	0.9	1.6	1.2	0.8
Total-S	mg/g	11.6	8.9	6.5	10.7	6.9	0.7

Table C.7.3 Heavy metal concentration of Taldy Kol Reservoir Bottom Sediment

unit : μg/g

Parameter	S1 Near the Siphon	S2 Between the Discharge Point and Siphon	S3 Near the Discharge Point	S4 Northern Part of the Reservoir	S5 Central Part of the Reservoir	Sediment Quality Guideline (1)
Cr	110	120	93	110	87	370
Cu	38.0	40.0	38.0	39.0	37.0	270
Zn	190	120	110	180	100	410
Hg	0.190	0.060	0.240	0.120	0.068	0.71

Source : (1) United States Geological Survey

C.8 Environmental Evaluation Based on the JICA Environmental Guidelines

Table C.8.1 Environmental Impact by Implementation of Proposed Water Supply Projects

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

Note) B : Some impacts are expected. C : No significant impact is expected.

Table C.8.2 Environmental Impact by Implementation of Proposed Wastewater Treatment Project

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

Note) B : Some impacts are expected. C : No significant impact is expected.

D. COST ESTIMATE

D.1 Unit Prices for Cost Estimation

item no	Work Item	unit	Unit Price				
			Foreign Currency		Local Currency		
			Unit	Ratio	Unit	Ratio	Total
1	**Earthwork**						
	Excavation, ordinary soil	m3	3.7	65%	2.0	35%	5.7
	Excavation, ordinary soil : with shoring by sheet pile	m3	31.0	65%	16.7	35%	47.7
	Backfilling	m3	6.6	65%	3.6	35%	10.1
	Filling of embankment	m3	6.6	65%	3.6	35%	10.2
	Remove exsisting embankment	m3	3.7	65%	2.0	35%	5.7
	Gravel bed	m3	10.4	65%	5.6	35%	16.0
	Gravel for filter	m3	24.1	65%	13.0	35%	37.0
	Sand bed	m3	8.0	65%	4.3	35%	12.3
	Sand for filter	m3	17.6	65%	9.5	35%	27.0
	Sheet pile for deep excavation, w=400	m2	44.1	90%	4.9	10%	49.0
	Cofferdam	m	127.9	90%	14.2	10%	142.1
2	**Structural Work**						
	Foundation pile (RC 300mm SQ, L=5m)	nos	109.9	65%	59.2	35%	169.1
	Levelling concrete, fc=14 Mpa	m3	49.9	65%	26.9	35%	76.8
	Invert Concrete	m3	55.7	65%	30.0	35%	85.8
	Structural concrete, fc=21 Mpa	m3	76.7	65%	41.3	35%	118.1
	Form work	m2	7.6	65%	4.1	35%	11.7
	Reinforcing bar	ton	751.6	90%	83.5	10%	835.1
	Slope protection concrete T=150mm	m2	19.5	65%	10.5	35%	30.0
	Asphalt surface protection T=150mm	m2	15.1	65%	8.1	35%	23.2
	Rip-rap	m3	24.3	65%	13.1	35%	37.3
	Administration building	m2	714.7	50%	714.7	50%	1,429.4
	Electric & pump room	m2	500.3	50%	500.3	50%	1,000.6
	Repair of pump station building	m2	100.0	50%	100.0	50%	200.0
3	**Pipe Work (unit prices are various for diameter, detail rate is shown in Table D.4 and D.5)**						
	Installation of pipe, CSP 1,600mm dia	m	18.4	30%	42.9	70%	61.4
	Supply of pipe, CSP 1,600mm dia	m	316.4	90%	35.2	10%	351.5
	Installation of pipe, DIP, 600 mm dia	m	2.1	30%	4.8	70%	6.9
	Supply of pipe, DIP, 600 mm dia	m	222.9	90%	24.8	10%	247.6
	Supply and installation of pipe, RCP 1000 mm dia	m	87.8	65%	47.3	35%	135.1
	Supply and installation of pipe, PVC 150 mm dia	m	30.2	75%	10.1	25%	40.3
4	**Others**						
	Water proof (epoxy) inside basin	m2	171.9	90%	19.1	10%	191.0
	Water proof (mortar) inside basin	m2	19.5	65%	10.5	35%	30.0
	Supply and setting of manhole cover	nos	435.6	90%	48.4	10%	484.0
	GRP cover	m2	32.4	90%	3.6	10%	36.0
	Ladder	m	6.9	90%	0.8	10%	7.7
	Handrail	m	5.1	90%	0.6	10%	5.7
	Operating stage	m2	38.1	90%	4.2	10%	42.3
	Asphalt road including base course	m2	22.8	65%	12.3	35%	35.0
	Demolision of existing road	m2	0.4	30%	1.0	70%	1.4
	Restoration of road	m2	16.7	65%	9.0	35%	25.7
	River crossing by pipe jacking, L=200m	nos	1,350,000.0	90%	150,000.0	10%	1,500,000
	Provision of individual flowmeter	nos	37.8	90%	4.2	10%	42.0
	Various imported machinary and equipment	l.s	****	90%	****	10%	****
		**** unit prices are various by item, rate is shown in Table D.4 and D.5					

D.2 Breakdown of Direct Construction Cost for Water Supply

unit : 1,000 UD$

	Work Item	General		Civil		Building		M & E		Pipe Supply		Total		
		F.C.	L.C	F.C.	L.C	F.C.	L.C	F.C.	L.C	F.C.	L.C	F.C.	L.C	total
101	**Intake Facility**	**0**	**0**	**2,128**	**1,010**	**155**	**155**	**5,961**	**662**	**0**	**0**	**8,243**	**1,827**	**10,070**
102	**Water Treatment Plant**													
	Appurtenance	0	0	1,198	1,041	0	0	0	0	0	0	1,198	1,041	2,239
	Water treatment	0	0	8,158	1,812	55	55	9,798	1,089	0	0	18,011	2,955	20,967
	Washing drain basin	0	0	1,058	347	40	40	144	16	0	0	1,243	403	1,646
	Thickener tank	0	0	918	353	40	40	1,335	148	0	0	2,293	541	2,834
	Sludge drying bed	0	0	2,717	592	0	0	0	0	0	0	2,717	592	3,310
	Discharge pool	0	0	1,473	512	40	40	78	9	0	0	1,590	560	2,151
	Buildings	0	0	0	0	1,672	1,672	0	0	0	0	1,672	1,672	3,345
	Operation equipment	2,131	570	0	0	0	0	0	0	0	0	2,131	570	2,701
	Power receiving and distributi	0	0	0	0	0	0	4,334	482	0	0	4,334	482	4,815
	Interconnecting piping	0	0	818	539	0	0	0	0	1,772	197	2,590	736	3,326
	102 Subtotal	**2,131**	**570**	**16,340**	**5,195**	**1,847**	**1,847**	**15,689**	**1,743**	**1,772**	**197**	**37,780**	**9,552**	**47,332**
103	**Distribution Network**													
	Temporary and General	0	0	765	765	0	0	0	0	0	0	765	765	1,530
	Replacement existing pipe	0	0	3,785	2,287	0	0	0	0	7,293	811	11,078	3,098	14,175
	New development area	0	0	3,034	1,864	650	650	3,903	434	8,540	949	16,127	3,898	20,025
	103 Subtotal	**0**	**0**	**7,584**	**4,917**	**650**	**650**	**3,903**	**434**	**15,832**	**1,760**	**27,970**	**7,760**	**35,730**
104	**Individual Flow Meter**	**2,476**	**275**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	2,476	275	2,751
	Total	**4,607**	**845**	**26,052**	**11,121**	**2,652**	**2,652**	**25,553**	**2,839**	**17,604**	**1,957**	**76,468**	**19,415**	**95,883**

D.3 Breakdown of Direct Construction Cost for Wastewater

unit : 1,000 UD$

	Work Item	General		Civil				Building				M & E				Pipe Supply		Total		
				New		Repair		New		Repair		New		Repair						
		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.	F.C.	L.C.	F.C.	L.C.	Total
151	**Wastewater Treatment Plant**																			
	Appurtenance	0	0	719.4	561.9	0	0	0	0	0	0	0	0	0	0	0	0	719	562	1,281
	Inlet PS No12	0	0	0	0	112	60	0	0	90	90	0	0	1,240	138	0	0	1,442	288	1,729
	Grit channel	0	0	181	71	0	0	0	0	0	0	457	51	0	0	0	0	638	122	760
	Primary sedimentation tank	0	0	619	273	2	8	0	0	0	0	181	20	181	20	0	0	984	321	1,305
	Primary sludge pump station	0	0	0	0	0	0	0	0	2	8	0	0	107	12	0	0	109	20	129
	Aeration tank	0	0	0	0	20	80	0	0	0	0	0	0	0	0	0	0	20	80	100
	Air blower	0	0	0	0	0	0	0	0	1	4	0	0	864	96	0	0	865	100	965
	Return activated sludge pump	0	0	0	0	0	0	79	77	0	0	265	29	0	0	0	0	344	107	450
	Final sedimentation tank	0	0	969	464	8	30	0	0	0	0	181	20	181	20	0	0	1,340	534	1,874
	Effluent PS No13	0	0	0	0	0	0	0	0	36	144	0	0	714	79	0	0	750	223	974
	Sludge thickening tank	0	0	0	0	24	8	0	0	0	0	0	0	156	17	0	0	179	25	205
	Thickened sludge pump station	0	0	0	0	0	0	0	0	2	8	0	0	100	11	0	0	102	19	122
	Sludge belt thickener facility	0	0	0	0	0	0	127	124	0	0	1,035	115	0	0	0	0	1,162	239	1,401
	Blended sludge storage tank	0	0	86	31	0	0	0	0	0	0	19	2	0	0	0	0	105	33	138
	Digestor	0	0	405	144	4	16	0	0	0	0	2,731	303	5	1	0	0	3,145	464	3,609
	Boilor house	0	0	0	0	0	0	0	0	4	16	0	0	27	3	0	0	31	19	50
	Sludge drying bed	0	0	1,937	1,004	0	0	0	0	0	0	0	0	0	0	0	0	1,937	1,004	2,942
	Interconnecting piping	0	0	144	81	0	0	0	0	0	0	5	1	0	0	606	67	755	148	903
	Operation equipment	1,995	225	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1,995	225	2,220
	151 Subtotal	**1,995**	**225**	**5,061**	**2,630**	**169**	**202**	**206**	**201**	**135**	**270**	**4,875**	**542**	**3,575**	**397**	**606**	**67**	**16,622**	**4,534**	**21,156**
152	**Sewerage Collection Network**																			
	Temporary and General	0	0	1,070	1,070	0	0	0	0	0	0	0	0	0	0	0	0	1,070	1,070	2,139
	New pump Station	0	0	1,672	900	0	0	650	650	0	0	1,153	128	0	0	0	0	3,475	1,679	5,154
	Repair of existing pump station	0	0	0	0	0	0	0	0	130	519	0	0	3,793	422	0	0	3,923	941	4,863
	New main sewer pipe	0	0	14,996	6,797	0	0	0	0	0	0	0	0	0	0	0	0	14,996	6,797	21,793
	New secondary sewer pipe	0	0	5,235	2,817	0	0	0	0	0	0	0	0	0	0	0	0	5,235	2,817	8,052
	Manhole for new sewer collection	0	0	4,498	2,230	0	0	0	0	0	0	0	0	0	0	0	0	4,498	2,230	6,728
	River crossing	0	0	2,700	300	0	0	0	0	0	0	0	0	0	0	0	0	2,700	300	3,000
	Replace existing sewer pipe	0	0	0	0	4,212	1,007	0	0	0	0	0	0	0	0	758	408	4,971	1,415	6,386
	Repair of existing manhole	0	0	0	0	2,359	284	0	0	0	0	0	0	0	0	0	0	2,359	284	2,642
	152 Subtotal	**0**	**0**	**30,170**	**14,115**	**6,571**	**1,291**	**650**	**650**	**130**	**519**	**1,153**	**128**	**3,793**	**422**	**758**	**408**	**43,226**	**17,533**	**60,759**
	Total	**1,995**	**225**	**35,231**	**16,745**	**6,740**	**1,493**	**856**	**851**	**265**	**789**	**6,028**	**670**	**7,368**	**819**	**1,365**	**476**	**59,848**	**22,067**	**81,915**

D.4 Detailed Breakdown of Direct Construction Cost for Water Supply

item no	Work Item	unit	Q'ty	F.C. portion		L.C. portion		Total
				unit rate (US$)	amount (US$)	unit rate (US$)	amount (US$)	amount (US$)
101	**Water Supply**							
	(Civil Work)							
	General							
101A1	Temporary work	l.s	1	186,000.00	186,000	186,000.00	186,000	372,000
	New Access Road							
101A2	Soil filling for new access road	m3	70,000	7.06	494,200	3.80	266,000	760,200
101A3	Asphalt road including base course	m2	4,000	22.76	91,000	12.26	49,000	140,000
	Raw Water Intake Channel							
101A4	Cofferdam	m	70	127.88	9,000	14.21	1,000	10,000
101A5	Excavation	m3	8,700	3.72	32,400	2.00	17,400	49,800
101A6	Rip-rap	m3	650	24.25	15,800	13.06	8,500	24,300
101A7	Blinding concrete	m3	230	49.89	11,500	26.87	6,200	17,700
	New Intake Pump Station							
101A8	Production of concrete caisson for new pump house	l.s	1	533,650.00	533,700	287,350.00	287,400	821,100
101A9	Installation of concrete caisson for new pump house	l.s	1	754,264.00	754,300	188,566.00	188,600	942,900
	(Subtotal of Civil Work)				*2,127,900*		*1,010,100*	*3,138,000*
	(Building Work)							
101A10	Building work for new pump house	l.s	1	154,500.00	154,500	154,500.00	154,500	309,000
	(Subtotal of Building Work)				*154,500*		*154,500*	*309,000*
	(M&E Work)							
101A11	Intake pump, chroline injection incl. power receiving	l.s	1	5,708,880.00	5,708,900	634,320.00	634,300	6,343,200
101A12	Flow meter, 1400mm dia	nos	2	126,000.00	252,000	14,000.00	28,000	280,000
	(Subtotal of M&E)				*5,960,900*		*662,300*	*6,623,200*
	Subtotal of 101				**8,243,300**		**1,826,900**	**10,070,200**
102	**Water Treatment Plant**							
	(Civil Work)							
	Appurtenance							
102A1	Temporary work	l.s	1	857,000.00	857,000	857,000.00	857,000	1,714,000
102A2	Asphalt road including base course	m2	15,000	22.76	341,400	12.26	183,900	525,300
	Subtotal of Appurtenance (Civil Work)				*1,198,400*		*1,040,900*	*2,239,300*
	Water Treatment Basin							
	(Civil Work)							
102B1	Foundation pile (RC 300mm SQ, L=5m)	nos	2,080	109.92	228,600	59.19	123,100	351,700
102B2	Excavation, ordinary soil : with shoring by sheet pile	m3	12,000	31.03	372,400	16.71	200,500	572,900
102B3	Backfilling	m3	2,500	6.60	16,500	3.55	8,900	25,400
102B4	Gravell bed	m3	4,260	10.41	44,300	5.60	23,900	68,200
102B5	Levelling concrete, fc=14 Mpa	m3	390	49.89	19,500	26.87	10,500	30,000
102B6	Structural concrete, fc=21 Mpa	m3	14,190	76.75	1,089,100	41.33	586,500	1,675,600
102B7	Concrete invert	m3	440	55.75	24,500	30.02	13,200	37,700
102B8	Concrete encase	m3	40	55.75	2,200	30.02	1,200	3,400
102B9	Form work	m2	38,370	7.62	292,400	4.10	157,300	449,700
102B10	Reinforcing bar	ton	1,710	751.57	1,285,200	83.51	142,800	1,428,000
102B11	Water proof (epoxy) inside basin	m2	27,490	171.88	4,725,000	19.10	525,100	5,250,100
102B12	Manhole cover, 600 x 600	nos	20	351.99	7,000	39.11	800	7,800
102B13	Manhole cover, 1,000 x 1,000	nos	20	416.31	8,300	46.26	900	9,200
102B14	Gravel for filter	m3	790	24.06	19,000	12.96	10,200	29,200
102B15	Sand for filter	m3	530	17.56	9,300	9.46	5,000	14,300
102B16	Handrail	m	1,990	5.15	10,200	0.57	1,100	11,300
102B17	Ladder	m	650	6.95	4,500	0.77	500	5,000
	(Building Work)							
102B18	Electric & pump room	m2	110	500.30	55,000	500.30	55,000	110,000
	(M&E Work)							
102B19	Filteration equipment incl.chroline injection, chemical injection and misc. pipe and valve	l.s	1	9,798,300.00	9,798,300	1,088,700.00	1,088,700	10,887,000
	Subtotal of Water Treatment Basin (Civil Work)				*8,158,000*		*1,811,500*	*9,969,500*
	Subtotal of Water Treatment Basin (Building Work)				*55,000*		*55,000*	*110,000*
	Subtotal of Water Treatment Basin (M&E Work)				*9,798,300*		*1,088,700*	*10,887,000*

D.4 Detailed Breakdown of Direct Construction Cost for Water Supply

item no	Work Item	unit	Q'ty	F.C. portion		L.C. portion		Total
				unit rate (US$)	amount (US$)	unit rate (US$)	amount (US$)	amount (US$)
	Washing Drain Basin							
	(Civil Work)							
102C1	Foundation Pile (RC 300mm SQ, L=5m)	nos	350	109.92	38,500	59.19	20,700	59,200
102C2	Excavation, ordinary soil : with shoring by sheet pile	m3	9,700	31.03	301,000	16.71	162,100	463,100
102C3	Backfilling	m3	4,100	6.60	27,100	3.55	14,600	41,700
102C4	Gravell bed	m3	290	10.41	3,000	5.60	1,600	4,600
102C5	Levelling concrete, fc=14 Mpa	m3	80	49.89	4,000	26.87	2,100	6,100
102C6	Structural concrete, fc=21 Mpa	m3	1,660	76.75	127,400	41.33	68,600	196,000
102C7	Invert concrete	m3	280	55.75	15,600	30.02	8,400	24,000
102C8	Form work	m2	2,700	7.62	20,600	4.10	11,100	31,700
102C9	Reinforcing bar	ton	200	751.57	150,300	83.51	16,700	167,000
102C10	Water proof (epoxy) inside basin	m2	2,150	171.88	369,500	19.10	41,100	410,600
102C11	Handrail	m	190	5.15	1,000	0.57	100	1,100
102C12	Ladder	m	40	6.95	300	0.77	0	300
	(Building Work)							
102C13	Electric & pump room	m2	80	500.30	40,000	500.30	40,000	80,000
	(M&E Work)							
102C14	Pump and panel (10m3/min x 2 nos)	l.s	1	144,180.00	144,200	16,020.00	16,000	160,200
	Subtotal of Washing Drain Basin (Civil Work)				*1,058,300*		*347,100*	*1,405,400*
	Subtotal of Washing Drain Basin (Building Work)				*40,000*		*40,000*	*80,000*
	Subtotal of Washing Drain Basin (M&E Work)				*144,200*		*16,000*	*160,200*
	Thickener							
	(Civil Work)							
102D1	Foundation pile (RC 300mm SQ, L=5m)	nos	260	109.92	28,600	59.19	15,400	44,000
102D2	Excavation, ordinary soil : with shoring by sheet pile	m3	13,000	31.03	403,400	16.71	217,200	620,600
102D3	Backfilling	m3	6,900	6.60	45,500	3.55	24,500	70,000
102D4	Gravel bed	m3	210	10.41	2,200	5.60	1,200	3,400
102D5	Levelling concrete, fc=14 Mpa	m3	60	49.89	3,000	26.87	1,600	4,600
102D6	Structural concrete, fc=21 Mpa	m3	1,130	76.75	86,700	41.33	46,700	133,400
102D7	Concrete encase	m3	70	55.75	3,900	30.02	2,100	6,000
102D8	Form work	m2	1,740	7.62	13,300	4.10	7,100	20,400
102D9	Reinforcing bar	ton	140	751.57	105,200	83.51	11,700	116,900
102D10	Water proof (epoxy) inside basin	m2	1,290	171.88	221,700	19.10	24,600	246,300
102D11	Handrail	m	160	5.15	800	0.57	100	900
102D12	Ladder	m	20	6.95	100	0.77	0	100
102D13	Operating stage	m2	100	38.08	3,800	4.23	400	4,200
	(Building Work)							
102D14	Electric & pump room	m2	80	500.30	40,000	500.30	40,000	80,000
	(M&E Work)							
102D15	Desludgeing equipment incl. pump and panel (1.24m3/min x 2 nos)	l.s	1	1,334,880.00	1,334,900	148,320.00	148,300	1,483,200
	Subtotal of Thickener (Civil Work)				*918,200*		*352,600*	*1,270,800*
	Subtotal of Thickener (Building Work)				*40,000*		*40,000*	*80,000*
	Subtotal of Thickener (M&E Work)				*1,334,900*		*148,300*	*1,483,200*
	Sludge Drying Bed							
	(Civil Work)							
102E1	Foundation pile (RC 300mm SQ, L=5m)	nos	1,900	109.92	208,800	59.19	112,500	321,300
102E2	Excavation, ordinary soil	m3	19,700	3.72	73,300	2.00	39,400	112,700
102E3	Backfilling	m3	2,970	6.60	19,600	3.55	10,500	30,100
102E4	Gravel bed	m3	1,610	10.41	16,800	5.60	9,000	25,800
102E5	Levelling concrete, fc=14 Mpa	m3	410	49.89	20,500	26.87	11,000	31,500
102E6	Structural concrete, fc=21 Mpa	m3	2,380	76.75	182,700	41.33	98,400	281,100
102E7	Form work	m2	5,920	7.62	45,100	4.10	24,300	69,400
102E8	Reinforcing bar	ton	290	751.57	218,000	83.51	24,200	242,200
102E9	Water proof (epoxy) inside basin	m2	10,470	171.88	1,799,600	19.10	200,000	1,999,600
102E10	PVC pipe supply and install'n, 75 mm dia,perforated	m	2,400	7.18	17,200	2.39	5,700	22,900
102E11	PVC pipe supply and install'n, 200 mm dia	m	710	35.70	25,300	11.90	8,400	33,700
102E12	Gravel for filter	m3	2,950	24.06	71,000	12.96	38,200	109,200
102E13	Sand bed	m3	1,110	17.56	19,500	9.46	10,500	30,000
	Subtotal of Sludge Drying Bed (Civil Work)				*2,717,400*		*592,100*	*3,309,500*

D.4 Detailed Breakdown of Direct Construction Cost for Water Supply

item no	Work Item	unit	Qty	F.C. portion		L.C. portion		Total
				unit rate (US$)	amount (US$)	unit rate (US$)	amount (US$)	amount (US$)
	Discharge Pool							
	(Civil Work)							
102F1	Foundation pile (RC 300mm SQ, L=5m)	nos	250	109.92	27,500	59.19	14,800	42,300
102F2	Excavation, ordinary soil : with shoring by sheet pile	m3	17,000	31.03	527,500	16.71	284,100	811,600
102F3	Backfilling	m3	8,600	6.60	56,800	3.55	30,500	87,300
102F4	Gravell bed	m3	230	10.41	2,400	5.60	1,300	3,700
102F5	Levelling concrete, fc=14 Mpa	m3	60	49.89	3,000	26.87	1,600	4,600
102F6	Structural concrete, fc=21 Mpa	m3	2,060	76.75	158,100	41.33	85,100	243,200
102F7	Invert concrete	m3	190	55.75	10,600	30.02	5,700	16,300
102F8	Form work	m2	3,720	7.62	28,300	4.10	15,300	43,600
102F9	Reinforcing bar	ton	250	751.57	187,900	83.51	20,900	208,800
102F10	Water proof (epoxy) inside basin	m2	2,730	171.88	469,200	19.10	52,100	521,300
102F11	Handrail	m	190	5.15	1,000	0.57	100	1,100
102F12	Ladder	m	50	6.95	300	0.77	0	300
	(Building Work)							
102F13	Electric & pump room	m2	80	500.30	40,000	500.30	40,000	80,000
	(M&E Work)							
102F14	Pump and panel (1.0m3/min x 2 nos)	l.s	1	77,760.00	77,800	8,640.00	8,600	86,400
	Subtotal of Discharge Pool (Civil Work)				*1,472,600*		*511,500*	*1,984,100*
	Subtotal of Discharge Pool (Building Work)				*40,000*		*40,000*	*80,000*
	Subtotal of Discharge Pool (M&E Work)				*77,800*		*8,600*	*86,400*
	Administration Building							
	(Building Work)							
102G15	Administration building	m2	2,340	714.72	1,672,400	714.72	1,672,400	3,344,800
	Subtotal of Administration Building (Building Work)				*1,672,400*		*1,672,400*	*3,344,800*
	Operation Equipment							
	(General)							
102H1	Laboratory, tools spare parts, etc	l.s	1	1,530,900.00	1,530,900	170,100.00	170,100	1,701,000
102H2	Leak detector equipment	l.s	1	450,000.00	450,000	50,000.00	50,000	500,000
102H3	Heating pipe	l.s	1	150,000.00	150,000	350,000.00	350,000	500,000
	Subtotal of Operation Equipment (General)				*2,130,900*		*570,100*	*2,701,000*
	Power Receiving and Distribution							
	(M&E Work)							
102I1	Power receiving and distribution	l.s	1	4,333,500.00	4,333,500	481,500.00	481,500	4,815,000
	Subtotal of Power Receiving and Distribution (M&E Work)				*4,333,500*		*481,500*	*4,815,000*
	Interconnecting Pipe							
	(Civil Work)							
102J1	Excavation, ordinal soil	m3	60,990	3.72	226,900	2.00	122,000	348,900
102J2	Backfilling	m3	39,333	6.60	259,600	3.55	139,600	399,200
102J3	Sand bed	m3	21,650	7.99	173,000	4.30	93,100	266,100
102J4	Supply and installation of pipe, PVC 200mm dia	m	1,470	35.70	52,500	11.90	17,500	70,000
102J5	Supply and installation of pipe, PVC 250mm dia	m	690	57.64	39,800	19.21	13,300	53,100
102J6	Installation of pipe, DIP 450mm dia	m	1,030	1.80	1,900	4.19	4,300	6,200
102J7	Installation of pipe, DIP 700mm dia	m	760	2.30	1,700	5.36	4,100	5,800
102J8	Installation of pipe, CSP 1,000mm dia	m	490	8.50	4,200	19.83	9,700	13,900
102J9	Installation of pipe, CSP 1,100mm dia	m	960	9.51	9,100	22.20	21,300	30,400
102J10	Installation of pipe, CSP 1,400mm dia	m	650	12.44	8,100	29.04	18,900	27,000
102J11	Installation of pipe, CSP 1,600mm dia	m	920	18.41	16,900	42.95	39,500	56,400
102J12	Installation of pipe, CSP 1,800mm dia	m	1,230	19.38	23,800	45.22	55,600	79,400
	(Pipe Supply)							
102J13	Supply of pipe, DIP 450mm dia	m	1,030	148.18	152,600	16.46	17,000	169,600
102J14	Supply of pipe, DIP 700mm dia	m	760	284.56	216,300	31.62	24,000	240,300
102J15	Supply of pipe, CSP 1,000mm dia	m	490	137.48	67,400	15.28	7,500	74,900
102J16	Supply of pipe, CSP 1,100mm dia	m	960	168.95	162,200	18.77	18,000	180,200
102J17	Supply of pipe, CSP 1,400mm dia	m	650	242.04	157,300	26.89	17,500	174,800
102J18	Supply of pipe, CSP 1,600mm dia	m	920	316.38	291,100	35.15	32,300	323,400
102J19	Supply of pipe, CSP 1,800mm dia	m	1,230	401.69	494,100	44.63	54,900	549,000
102J20	Miscellaneous fitting etc. (15% of above)				231,200		25,700	256,900
	Subtotal of Interconnecting pipe (Civil Work)				*817,500*		*538,900*	*1,356,400*
	Subtotal of Interconnecting pipe (Pipe Supply)				*1,772,200*		*196,900*	*1,969,100*

D.4 Detailed Breakdown of Direct Construction Cost for Water Supply

item no	Work Item	unit	Q'ty	F.C. portion		L.C. portion		Total
				unit rate (US$)	amount (US$)	unit rate (US$)	amount (US$)	amount (US$)
	Total of 102 (General)				2,130,900		570,100	2,701,000
	Total of 102 (Civil Work)				16,340,400		5,194,600	21,535,000
	Total of 102 (M&E Work)				15,688,700		1,743,100	17,431,800
	Total of 102 (Building Work)				1,847,400		1,847,400	3,694,800
	Total of 102 (Pipe Supply)				1,772,200		196,900	1,969,100
	Total of 102				**37,779,600**		**9,552,100**	**47,331,700**
103	**Distribution Network**							
	Temporary and General							
	(Civil Work)							
103A1	Temporary work	l.s	1	765,000.00	765,000	765,000.00	765,000	1,530,000
	Subtotal of General				*765,000*		*765,000*	*1,530,000*
	Replacement of Existing Pipe							
	(Civil Work)							
103B1	Excavation, ordinal soil	m3	330,000	3.72	1,227,600	2.00	660,000	1,887,600
103B2	Demolision of existing road	m2	13,500	0.43	5,800	1.00	13,500	19,300
103B3	Backfilling	m3	280,000	6.60	1,848,000	3.55	994,000	2,842,000
103B4	Sand bed	m3	43,000	7.99	343,600	4.30	184,900	528,500
103B5	Installation of pipe, DIP, 100 mm dia	m	10,000	0.99	9,900	2.31	23,100	33,000
103B6	Installation of pipe, DIP, 200 mm dia	m	52,000	1.22	63,400	2.84	147,700	211,100
103B7	Installation of pipe, DIP, 300 mm dia	m	21,000	1.44	30,200	3.37	70,800	101,000
103B8	Installation of pipe, DIP, 500 mm dia	m	16,000	1.92	30,700	4.48	71,700	102,400
103B9	Restoration of road	m2	13,500	16.72	225,700	9.01	121,600	347,300
	(Pipe Supply)							
103B10	Supply of pipe, DIP, 100 mm dia	m	10,000	35.88	358,800	3.99	39,900	398,700
103B11	Supply of pipe, DIP, 200 mm dia	m	52,000	48.58	2,526,200	5.40	280,800	2,807,000
103B12	Supply of pipe, DIP, 300 mm dia	m	21,000	79.63	1,672,200	8.85	185,900	1,858,100
103B13	Supply of pipe, DIP, 500 mm dia	m	16,000	170.96	2,735,400	19.00	304,000	3,039,400
103B14	Miscellaneous fitting etc. (15% of above)				0		0	0
	Subtotal of Replacement of Existing pipe (Civil Work)				*3,784,900*		*2,287,300*	*6,072,200*
	Subtotal of Replacement of Existing pipe (Pipe Supply)				*7,292,600*		*810,600*	*8,103,200*
	Installation of New Development Area							
	(Civil Work)							
103C1	Excavation, ordinal soil	m3	274,700	3.72	1,021,900	2.00	549,400	1,571,300
103C2	Blackfilling	m3	224,500	6.60	1,481,700	3.55	797,000	2,278,700
103C3	Sand bed	m3	50,200	7.99	401,100	4.30	215,900	617,000
103C4	Installation of pipe, DIP, 150 mm dia	m	3,900	1.14	4,400	2.65	10,300	14,700
103C4	Installation of pipe, DIP, 200 mm dia	m	15,600	1.22	19,000	2.84	44,300	63,300
103C4	Installation of pipe, DIP, 250 mm dia	m	6,900	1.33	9,200	3.10	21,400	30,600
103C4	Installation of pipe, DIP, 300 mm dia	m	19,200	1.44	27,600	3.37	64,700	92,300
103C4	Installation of pipe, DIP, 400 mm dia	m	12,540	1.67	20,900	3.91	49,000	69,900
103C5	Installation of pipe, DIP, 500 mm dia	m	9,590	1.92	18,400	4.48	43,000	61,400
103C6	Installation of pipe, DIP, 600 mm dia	m	1,140	2.06	2,300	4.82	5,500	7,800
103C8	Installation of pipe, DIP, 800 mm dia	m	2,010	2.58	5,200	6.03	12,100	17,300
103C9	Installation of pipe, CSP, 900 mm dia	m	1,850	7.71	14,300	17.98	33,300	47,600
103C10	Installation of pipe, CSP, 1,600 mm dia	m	10	18.41	200	42.95	400	600
103C11	Installation of pipe, CSP, 1,800 mm dia	m	400	19.38	7,800	45.22	18,100	25,900
	(Pipe Supply)							
103C12	Supply of pipe, DIP, 150 mm dia	m	3,900	35.88	139,900	3.99	15,600	155,500
103C12	Supply of pipe, DIP, 200 mm dia	m	15,600	48.58	757,800	5.40	84,200	842,000
103C12	Supply of pipe, DIP, 250 mm dia	m	6,900	63.50	438,200	7.06	48,700	486,900
103C12	Supply of pipe, DIP, 300 mm dia	m	19,200	79.63	1,528,900	8.85	169,900	1,698,800
103C12	Supply of pipe, DIP, 400 mm dia	m	12,540	125.40	1,572,500	13.93	174,700	1,747,200
103C13	Supply of pipe, DIP, 500 mm dia	m	9,590	170.96	1,639,500	19.00	182,200	1,821,700
103C14	Supply of pipe, DIP, 600 mm dia	m	1,140	222.87	254,100	24.76	28,200	282,300
103C16	Supply of pipe, DIP, 800 mm dia	m	2,010	349.27	702,000	38.81	78,000	780,000
103C17	Supply of pipe, CSP, 900 mm dia	m	1,850	123.74	228,900	13.75	25,400	254,300
103C19	Supply of pipe, CSP, 1,600 mm dia	m	10	316.38	3,200	35.15	400	3,600
103C19	Supply of pipe, CSP, 1,800 mm dia	m	400	401.69	160,700	44.63	17,900	178,600
103C20	Miscellaneous fitting etc. (15% of above)				1,113,900		123,800	1,237,700
	(Building Work)							
103C21	Distribution pump station building	m2	1,300	500.30	650,400	500.30	650,400	1,300,800

D.4 Detailed Breakdown of Direct Construction Cost for Water Supply

item no	Work Item	unit	Qty	F.C. portion		L.C. portion		Total
				unit rate (US$)	amount (US$)	unit rate (US$)	amount (US$)	amount (US$)
	(M&E Work)							
103C22	Distribution pump, 3x38.9m3/min & 2x19.5m3/min	l.s	1	3,633,120.00	3,633,100	403,680.00	403,700	4,036,800
103C23	Flow meter, 1800mm dia	nos	1	162,000.00	162,000	18,000.00	18,000	180,000
103C24	Flow meter, 1200mm dia	nos	1	108,000.00	108,000	12,000.00	12,000	120,000
	Subtotal of New Development Area Pipe (Civil Work)				*3,034,000*		*1,864,400*	*4,898,400*
	Subtotal of New Development Area Pipe (Pipe Supply)				*8,539,600*		*949,000*	*9,488,600*
	Subtotal of New Development Area pipe (Building Work)				*650,400*		*650,400*	*1,300,800*
	Subtotal of New Development Area Pipe (M&E Work)				*3,903,100*		*433,700*	*4,336,800*
	Total of 103 (Civil Work)				7,583,900		4,916,700	12,500,600
	Total of 103 (Pipe Supply)				15,832,200		1,759,600	17,591,800
	Total of 103 (Building Work)				650,400		650,400	1,300,800
	Total of 103 (M&E Work)				3,903,100		433,700	4,336,800
	Total of 103				**27,969,600**		**7,760,400**	**35,730,000**
104	**Provision of Individual Flow Meter**							
104A1	Provision of individual flowmeter	nos	65,500	37.80	2,475,900	4.20	275,100	2,751,000
	Subtotal of Provision of Flow Meter				*2,475,900*		*275,100*	*2,751,000*
	Total of 104				**2,475,900**		**275,100**	**2,751,000**
100	**Total of Water Supply**				**76,468,400**		**19,414,500**	**95,882,900**

D.5 Detailed Breakdown of Direct Construction Cost for Wastewater

item no	Work Item	unit	Qty	F.C. portion		L.C. portion		Total
				unit rate (US$)	amount (US$)	unit rate (tenge)	amount (tenge)	amount (US$)
151	**Waste Water Treatment Plant**							
	Plant Site General							
	(Civil Work)							
151A1	Temporary work	Ls	1	378,000.00	378,000	378,000.00	378,000	756,000
151A2	Asphalt road including base course	m2	15,000	22.76	341,400	12.26	183,900	525,300
	Subtotal of Appurtenance (Civil Work)				*719,400*		*561,900*	*1,281,300*
	Inlet Pump Station No.12							
	(Civil Work, Replace/Repair)							
151B1	Provision of bypass to screens, RCP1400mm dia	m	100	180.62	18,100	97.26	9,700	27,800
151B2	Provision of diversion chambers 2,000x4,000x7,000depth	nos	3	31,200.00	93,600	16,800.00	50,400	144,000
	(Building Work, Repair)							
151B3	Repair of pump station building	m2	900	100.00	90,000	100.00	90,000	180,000
	(M&E Work, Replace/Repair)							
151B4	Replacement of 6mm screens, penstock and isolation valve	nos	3	108,000.00	324,000	12,000.00	36,000	360,000
151B5	Replacement of screening handling equipment	nos	1	164,160.00	164,200	18,240.00	18,200	182,400
151B6	Replacement of pump, 27m3/min, H=15m	nos	2	149,580.00	299,200	16,620.00	33,200	332,400
151B7	Replacement of pump, 54m3/min, H=15m	nos	2	226,260.00	452,500	25,140.00	50,300	502,800
	Subtotal of Inlet Pump Station (Civil Work,				*111,700*		*60,100*	*171,800*
	Subtotal of Inlet Pump Station (Building Work, Repair)				*90,000*		*90,000*	*180,000*
	Subtotal of Inlet Pump Station (M&E Work, Replace/Repair)				*1,239,900*		*137,700*	*1,377,600*
	Grit Channel							
	(Civil Work)							
151C1	Foundation pile (RC 300mm SQ, L=5m)	nos	90	109.92	9,900	59.19	5,300	15,200
151C2	Excavation, ordinary soil	m3	210	3.72	800	2.00	400	1,200
151C3	Backfilling and land filling	m3	1,070	6.60	7,100	3.55	3,800	10,900
151C4	Gravell bed	m3	120	10.41	1,200	5.60	700	1,900
151C5	Levelling concrete, fc=14 Mpa	m3	30	49.89	1,500	26.87	800	2,300
151C6	Structural concrete, fc=21 Mpa	m3	630	76.75	48,400	41.32	26,000	74,400
151C7	Form work	m2	2,100	7.62	16,000	4.10	8,600	24,600
151C8	Reinforcing bar	ton	80	751.57	60,100	83.51	6,700	66,800
151C9	Water proof (mortar) inside basin	m2	1,800	19.50	35,100	10.50	18,900	54,000
151C10	Handrail	m	240	5.15	1,200	0.57	100	1,300
	(M&E Work)							
151C11	Degritting equipment with scrapers and hydraulic grit pumps	nos	2	125,280.00	250,600	13,920.00	27,800	278,400
151C12	Grit washing equipment and organics return pumps	nos	2	84,780.00	169,600	9,420.00	18,800	188,400
151C13	Ultrasonic depth measurement	nos	2	18,360.00	36,700	2,040.00	4,100	40,800
	Subtotal of Grit Channel (Civil, New)				*181,300*		*71,300*	*252,600*
	Subtotal of Grit Channel (M&E, New)				*456,900*		*50,700*	*507,600*
	Primary Sedimentation Tank							
	(Civil Work for New 2 Tanks)							
151D1	Fundation pile (RC 300mm SQ, L=5m)	nos	380	109.92	41,800	59.19	22,500	64,300
151D2	Excavation, ordinary soil : with shoring by sheet pile	m3	5,667	31.03	175,800	16.71	94,700	270,500
151D3	Backfilling and land filling	m3	13,000	6.60	85,800	3.55	46,200	132,000
151D4	Gravell bed	m3	310	10.41	3,200	5.60	1,700	4,900
151D5	Levelling concrete, fc=14 Mpa	m3	80	49.89	4,000	26.87	2,100	6,100
151D6	Structural concrete, fc=21 Mpa	m3	1,400	76.75	107,500	41.32	57,800	165,300
151D7	Invert concrete	m3	110	55.75	6,100	30.02	3,300	9,400
151D8	Form work	m2	1,700	7.62	13,000	4.10	7,000	20,000
151D9	Reinforcing bar	ton	180	751.57	135,300	83.51	15,000	150,300
151D10	Water proof (mortar) inside basin	m2	2,100	19.50	41,000	10.50	22,100	63,100
151D11	Handrail	m	200	5.15	1,000	0.57	100	1,100
151D12	Ladder	m	20	6.95	100	0.77	0	100
151D13	Operating stage	m2	110	38.08	4,200	4.23	500	4,700
	(M&E Work for New 2 Tanks)							
151D14	Desludging equipment with scraper, D= 28m	nos	2	90,720.00	181,400	10,080.00	20,200	201,600
	(Civil Work, Repair)							0
151D15	Repair on 2 distribution chambers	Ls	1	1,000.00	1,000	4,000.00	4,000	5,000
151D16	Repair on primary sedimension tank	Ls	1	1,000.00	1,000	4,000.00	4,000	5,000

D.5 Detailed Breakdown of Direct Construction Cost for Wastewater

item no	Work Item	unit	Qty	F.C. portion		L.C. portion		Total
				unit rate (US$)	amount (US$)	unit rate (tenge)	amount (tenge)	amount (US$)
	(M&E Work, Replacement)							
151D17	Replacement of desludging equipment with scraper,D=28m	nos	2	90,720.00	181,400	10,080.00	20,200	201,600
	Subtotal of Primary Sedimentation Tank (Civil, New)				*618,800*		*273,000*	*891,800*
	Subtotal of Primary Sedimentation Tank (M&E, New)				*181,400*		*20,200*	*201,600*
	Subtotal of Primary Sedimentation Tank (Civil, Repair)				*2,000*		*8,000*	*10,000*
	Subtotal of Primary Sedimentation Tank (M&E, Replace)				*181,400*		*20,200*	*201,600*
	Primary Sludge Pump Station							
	(Building Work, Repair)							
151E1	Repair of pump station building	m2	50	40.00	2,000	160.00	8,000	10,000
	(M&E Work, Replace/Repair)							
151E2	Replacement of primary sludge pump,1.33m3/min, H15m	nos	4	26,730.00	106,900	2,970.00	11,900	118,800
	Subtotal of Primary Sludge Pump Station (Building, Repair)				*2,000*		*8,000*	*10,000*
	Subtotal of Primary Sludge Pump Station (M/E, Replace)				*106,900*		*11,900*	*118,800*
	Aeration Tanks							
	(Civil Work)							
151F1	Repair on damaged concrete	l.s	1	20,000.00	20,000	80,000.00	80,000	100,000
	Subtotal of Aeration Tank (Civil, Repair)				*20,000*		*80,000*	*100,000*
	Air Blower House							
	(Building Work, Repair)							
151G1	Repair of air blower building	m2	25	40.00	1,000	160.00	4,000	5,000
	(M&E Work, Replace/Repair)							
151G2	Replacement of air blower, 20,100Nm3/hour, h=15m)	nos	5	172,800.00	864,000	19,200.00	96,000	960,000
	Subtotal of Air Blower House (Building, Repair)				*1,000*		*4,000*	*5,000*
	Subtotal of Air Blower House (M&E, Replace)				*864,000*		*96,000*	*960,000*
	Return Activated Sludge Pump Station							
	(Building Work for New Pump Station)							
151H1	Founation pile (RC 300mm SQ, L=5m)	nos	38	109.86	4,200	59.15	2,200	6,400
151H2	Pump house building	m2	150	500.31	75,000	500.31	75,000	150,000
	(M&E Work for New Pump)							
151H3	Activated sludge pump (900m3/hr,h=8m)	nos	5	52,920.00	264,600	5,880.00	29,400	294,000
	Subtotal of Return Activated Pump Station (Building, New)				*79,200*		*77,200*	*156,400*
	Subtotal of Return Activated Pump Station (M&E, New)				*264,600*		*29,400*	*294,000*
	Final Sedimentation Tank							
	(Civil Work for New 2 Tanks)							
151I1	Foundation pile (RC 300mm SQ, L=5m)	nos	380	109.92	41,800	59.19	22,500	64,300
151I2	Excavation, ordinary soil : with shoring by sheet pile	m3	17,000	31.03	527,500	16.71	284,100	811,600
151I3	Backfilling	m3	13,000	6.60	85,800	3.55	46,200	132,000
151I4	Gravell bed	m3	310	10.41	3,200	5.60	1,700	4,900
151I5	Levelling concrete, fc=14 Mpa	m3	80	49.89	4,000	26.87	2,100	6,100
151I6	Structural concrete, fc=21 Mpa	m3	1,400	76.75	107,500	41.32	57,800	165,300
151I7	Invert concrete	m3	110	55.75	6,100	30.02	3,300	9,400
151I8	Form work	m2	1,700	7.62	13,000	4.10	7,000	20,000
151I9	Reinforcing bar	ton	180	751.57	135,300	83.51	15,000	150,300
151I10	Water proof (mortar) inside basin	m2	2,100	19.50	41,000	10.50	22,100	63,100
151I11	Handrail	m	200	5.15	1,000	0.57	100	1,100
151I12	Ladder	m	20	6.95	100	0.77	0	100
151I13	Operating stage	m2	110	27.50	3,000	14.81	1,600	4,600
	(M&E Work for New 2 Tanks)							
151I14	Desludging equipment with scraper	nos	2	90,720.00	181,400	10,080.00	20,200	201,600
	(Civil Work, Repair)							
151I15	Repairs on 3 distribution chamber	l.s	1	1,500.00	1,500	6,000.00	6,000	7,500
151I16	Repairs on final existing sedimentation tank	l.s	1	6,000.00	6,000	24,000.00	24,000	30,000
	(M&E Work, Replacement)							
151I17	Replacement of desludging equipment with scraper,D=28m	nos	2	90,720.00	181,400	10,080.00	20,200	201,600
	Subtotal of Final Sedimantation Tank (Civil, New)				*969,300*		*463,500*	*1,432,800*
	Subtotal of Final Sedimantation Tank (M&E, New)				*181,400*		*20,200*	*201,600*
	Subtotal of Final Sedimantation Tank (Civil, Repair)				*7,500*		*30,000*	*37,500*
	Subtotal of Final Sedimantation Tank (M&E, Replace)				*181,400*		*20,200*	*201,600*

D.5 Detailed Breakdown of Direct Construction Cost for Wastewater

item no	Work Item	unit	Qty	F.C. portion		L.C. portion		Total
				unit rate (US$)	amount (US$)	unit rate (tenge)	amount (tenge)	amount (US$)
	Treated Effluent Pump Station No.13							
	(Building Work, Repair)							
151J1	Repair of pump station building	m2	900	40.00	36,000	160.00	144,000	180,000
	(M&E Work, Replace/Repair)							
151J2	Replacement of effluent pump,27m3/min, H=15m	nos	2	129,060.00	258,100	14,340.00	28,700	286,800
151J3	Replacement of effluent pump,54m3/min, H=15m	nos	2	203,040.00	406,100	22,560.00	45,100	451,200
151J4	Replacement of wash water pump,1.33m3/min, H=40m	nos	2	25,110.00	50,200	2,790.00	5,600	55,800
	Subtotal of Effluent Pump Station (Building, Repair)				***36,000***		***144,000***	***180,000***
	Subtotal of Effluent Pump Station (M&E, Replace)				***714,400***		***79,400***	***793,800***
	Sludge Thickening Tank							
	(Civil Work, Repair)							
151K1	Repairs on 1 distribution chamber	ls	1	400.00	400	1,600.00	1,600	2,000
151K2	Repairs on final existing thickening tank	ls	1	1,000.00	1,000	4,000.00	4,000	5,000
151K3	Provision of covers on existing thickening tank	ls	1	22,500.00	22,500	2,500.00	2,500	25,000
	(M&E Work, Replace/Repair)							
151K4	Replacement of desludging equipment with scraper,D=20m	nos	2	77,760.00	155,500	8,640.00	17,300	172,800
	Subtotal of Sludge Thickened Tank (Civil, Repair)				***23,900***		***8,100***	***32,000***
	Subtotal of Sludge Thickened Tank (M&E, Repair)				***155,500***		***17,300***	***172,800***
	Thickened Sludge Pump Station							
	(Building Work, Repair)							
151L1	Repair of pump station building	m2	50	40.00	2,000	160.00	8,000	10,000
	(M&E Work, Replace/Repair)							
151L2	Replacement of primary sludge pump,1.33m3/min, H15m	nos	4	25,110.00	100,400	2,790.00	11,200	111,600
	Subtotal of Thickened Sludge Pump Station (Building, Repair)				***2,000***		***8,000***	***10,000***
	Subtotal of Thickened Sludge Pump Station (M&E, Replace)				***100,400***		***11,200***	***111,600***
	Sludge Belt Thickener Facility							
	(Building Work for New Facility)							
151M1	Foundation pile (RC 300mm SQ, L=5m)	nos	60	109.92	6,600	59.19	3,600	10,200
151M2	Sludge belt thickener building	m2	240	500.31	120,100	500.31	120,100	240,200
	(M&E Work)							
151M3	Sludge belt thickener (80m3/hr) with polyelectrolyte dosing , air scrubber unit and pumps	nos	3	345,060.00	1,035,200	38,340.00	115,000	1,150,200
	Subtotal of Sludge Belt Thickener Facility (Building, New)				***126,700***		***123,700***	***250,400***
	Subtotal of Sludge Belt Thickener Facility (M&E, New)				***1,035,200***		***115,000***	***1,150,200***
	Blended Sludge Storage Tank							
	(Civil Work for New Storage Tank)							
151N1	Foundation pile (RC 300mm SQ, L=5m)	nos	70	109.92	7,700	59.19	4,100	11,800
151N2	Excavation, ordinary soil	m3	140	3.72	500	2.00	300	800
151N3	Backfilling	m3	20	6.60	100	3.55	100	200
151N4	Gravell bed	m3	40	10.41	400	5.60	200	600
151N5	Levelling concrete, fc=14 Mpa	m3	10	49.89	500	26.87	300	800
151N6	Structural concrete, fc=21 Mpa	m3	280	76.75	21,500	41.32	11,600	33,100
151N7	Invert concrete	m3	20	55.75	1,100	30.02	600	1,700
151N8	Form work	m2	870	7.62	6,600	4.10	3,600	10,200
151N9	Reinforcing bar	ton	40	751.57	30,100	83.51	3,300	33,400
151N10	Water proof (mortar) inside basin	m2	570	19.50	11,100	10.50	6,000	17,100
151N11	GRP cover	m2	200	32.40	6,500	3.60	700	7,200
	(M&E Work for New Storage Tank)							
151N12	Submergible mixer, 5kw	nos	2	9,450.00	18,900	1,050.00	2,100	21,000
	Subtotal of Blended Sludge Storage Tank (Civil, New)				***86,100***		***30,800***	***116,900***
	Subtotal of Blended Sludge Storage Tank (M&E, New)				***18,900***		***2,100***	***21,000***

D.5 Detailed Breakdown of Direct Construction Cost for Wastewater

item no	Work Item	unit	Q'ty	F.C. portion		L.C. portion		Total
				unit rate (US$)	amount (US$)	unit rate (tenge)	amount (tenge)	amount (US$)
	Digestor							
	(Civil Work for New Digestor)							
151O1	Foundation pile (RC 300mm SQ, L=5m)	nos	290	109.92	31,900	59.19	17,200	49,100
151O2	Excavation, ordinary soil	m3	1,320	3.72	4,900	2.00	2,600	7,500
151O3	Backfilling and land filling	m3	910	6.60	6,000	3.55	3,200	9,200
151O4	Gravell bed	m3	70	10.41	700	5.60	400	1,100
151O5	Levelling concrete, fc=14 Mpa	m3	20	49.89	1,000	26.87	500	1,500
151O6	Structural concrete, fc=21 Mpa	m3	1,900	76.75	145,800	41.32	78,500	224,300
151O7	Invert concrete	m3	70	55.75	3,900	30.02	2,100	6,000
151O8	Form work	m2	2,140	7.62	16,300	4.10	8,800	25,100
151O9	Reinforcing bar	ton	230	751.57	172,900	83.51	19,200	192,100
151O10	Water proof (mortar) inside basin	m2	1,120	19.50	21,800	10.50	11,800	33,600
	(M&E Work for New Digestor)							
151O11	Mechanical work in digestor	l.s	1	2,730,780.00	2,730,800	303,420.00	303,400	3,034,200
	(Civil work, Repair)							
151O12	Repair of 2 existing digestor	l.s	1	4,000.00	4,000	16,000.00	16,000	20,000
	(M&E Work, Replace/Repair)							
151O13	Replacement of equipment in existing digestor	nos	2	0.00		0.00		0
151O14	Replacement of heat exchanger, 1,000kw/hr	nos	2	0.00	included in M&E work in digestor	0.00		0
151O15	Replacement of recirculation unit, 1.33m3/min	nos	4	0.00		0.00		0
151O16	Replacement existing piping	l.s	1	0.00		0.00		0
151O17	Repair of existing steel gas holders	l.s	1	4,500.00	4,500	500.00	500	5,000
151O18	Provision of surplus gas flare, 1,000m3/hr	nos	1	included in M&E work in digestor				0
	Subtotal of Digestor (Civil, New)				*405,200*		*144,300*	*549,500*
	Subtotal of Digestor (M&E, New)				*2,730,800*		*303,400*	*3,034,200*
	Subtotal of Digestor (Civil, Repair)				*4,000*		*16,000*	*20,000*
	Subtotal of Digestor (M&E, Repair)				*4,500*		*500*	*5,000*
	Boiler House							
	(Building Work, Repair)							
151P1	Repair of pump station building	m2	100	40.00	4,000	160.00	16,000	20,000
	(M&E Work, Replace and Repair)							
151P2	Replacement of gas/coal steam boiler, 4.5 t/hr	nos	2	included in M&E work in digestor				0
151P3	Replacement of pipe	l.s	1	27,000.00	27,000	3,000.00	3,000	30,000
	Subtotal of Boiler House (Building, Repair)				*4,000*		*16,000*	*20,000*
	Subtotal of Boiler House (M&E, Repair)				*27,000*		*3,000*	*30,000*
	Sludge Drying Bed							
	(Civil Work)							
151Q1	Remove existing embankment	m3	40,000	3.72	148,800	2.00	80,000	228,800
151Q2	Remove existing sludge	m3	68,000	3.72	253,000	2.00	136,000	389,000
151Q3	Filling of embankment	m3	20,600	6.60	136,000	3.55	73,100	209,100
151Q4	Gravel bed	m3	140	10.41	1,500	5.60	800	2,300
151Q5	Levelling concrete, fc=14 Mpa	m3	33	49.89	1,600	26.87	900	2,500
151Q6	Structural concrete, fc=21 Mpa	m3	580	76.75	44,500	41.32	24,000	68,500
151Q7	Form work	m2	2,370	7.62	18,100	4.10	9,700	27,800
151Q8	Reinforcing bar	ton	70	751.57	52,600	83.51	5,800	58,400
151Q9	PVC pipe supply and install'n, 200 mm dia	m	2,200	35.70	78,500	11.90	26,200	104,700
151Q10	Gravel for filter	m3	8,600	24.06	206,900	12.96	111,500	318,400
151Q11	Gravel bed	m3	12,110	24.06	291,400	12.96	156,900	448,300
151Q12	Asphalt surface protection T=150mm	m2	18,560	15.05	279,300	8.11	150,500	429,800
151Q13	Slope protection concrete T=150mm	m2	21,800	19.50	425,100	10.50	228,900	654,000
	Subtotal of Sludge Drying Bed (Civil, New)				*1,937,300*		*1,004,300*	*2,941,600*
	Interconnecting Pipe							
	(Civil Work)							
151R1	Conc channel from grit channel to primary settlement tank	m	50	136.50	6,800	73.50	3,700	10,500
151R2	Excavation, ordinary soil	m3	2,950	3.72	11,000	2.00	5,900	16,900
151R3	Backfilling	m3	2,149	6.60	14,200	3.55	7,600	21,800
151R4	Sand bed	m3	801	7.99	6,400	4.30	3,400	9,800
151R5	Supply and installation of pipe, PVC 150mm dia	m	1,250	30.23	37,800	10.08	12,600	50,400
151R6	Supply and installation of pipe, PVC 200mm dia	m	1,150	35.70	41,100	11.90	13,700	54,800
151R7	Installation of pipe, DIP 700mm dia	m	1,350	2.30	3,100	5.36	7,200	10,300
151R8	Supply and installation of pipe, RCP 1,200mm dia	m	140	109.17	15,300	58.79	8,200	23,500
151R9	Installation of pipe, SCP 1,500mm dia	m	310	16.50	5,100	38.50	11,900	17,000
151R10	Installation of pipe, SCP 1,800mm dia	m	140	19.38	2,700	45.22	6,300	9,000
	(Pipe Supply)							
151R11	Supply of pipe, DIP 700mm dia	m	1,350	284.56	384,200	31.62	42,700	426,900
151R12	Supply of pipe, CSP 1,500mm dia	m	310	279.21	86,600	31.02	9,600	96,200
151R13	Supply of pipe, CSP 1,800mm dia	m	140	401.69	56,200	44.63	6,200	62,400
151R14	Miscellaneous fitting etc. (15% of above)				79,100		8,800	87,900

D.5 Detailed Breakdown of Direct Construction Cost for Wastewater

item no	Work Item	unit	Qty	F.C. portion		L.C. portion		Total
				unit rate (US$)	amount (US$)	unit rate (tenge)	amount (tenge)	amount (US$)
	(M&E Work)							
151R15	Power distribution, 400V	m	600	9.00	5,400	1.00	600	6,000
	Subtotal of Interconnecting Pipe (Civil,New)				*143,500*		*80,500*	*224,000*
	Subtotal of Interconnecting Pie (pipe Supply)				*606,100*		*67,300*	*673,400*
	Subtotal of Interconnecting Pipe (M&E Work)				*5,400*		*600*	*6,000*
	Operation Equipment and System							
	(General)							
151S1	Laboratory equipment	Ls	1	18,000.00	18,000	2,000.00	2,000	20,000
151S2	Work shop equipment	Ls	1	18,000.00	18,000	2,000.00	2,000	20,000
151S3	Updated map of waste water collection network	Ls	1	18,000.00	18,000	2,000.00	2,000	20,000
151S4	Supply of software for sewer network database	Ls	1	18,000.00	18,000	2,000.00	2,000	20,000
151S5	Supply of software for sewer pump database	Ls	1	18,000.00	18,000	2,000.00	2,000	20,000
151S6	Supply of software for detailed inventory lists	Ls	1	45,000.00	45,000	5,000.00	5,000	50,000
151S7	Management information system (hardware/software)	Ls	1	1,800,000.00	1,800,000	200,000.00	200,000	2,000,000
151S8	Inspection of Taldy Kol Reservoir embankment	Ls	1	15,000.00	15,000	5,000.00	5,000	20,000
151S9	Provision of CCTV equipment	Ls	1	45,000.00	45,000	5,000.00	5,000	50,000
	Subtotal of Operation Equipment (General)				*1,995,000*		*225,000*	*2,220,000*
	Total of 151 (General)			0.00	1,995,000		225,000	2,220,000
	Total of 151 (Civil, New)			0.00	5,060,900		2,629,600	7,690,500
	Total of 151 (Civil, Repair)			0.00	169,100		202,200	371,300
	Total of 151 (Building, New)			0.00	205,900		200,900	406,800
	Total of 151 (Building, Repair)			0.00	135,000		270,000	405,000
	Total of 151 (M&E, New)			0.00	4,874,600		541,600	5,416,200
	Total of 151 (M&E, Replace)			0.00	3,575,400		397,400	3,972,800
	Total of 151 (Pipe Supply)			0.00	606,100		67,300	673,400
	Subtotal of 151				**16,622,000**		**4,534,000**	**21,156,000**
152	**Wastewater Collection Pipes**							
	Temporary and General							
	(Civil Work)							
152A1	Temporary work	Ls	1	1,069,500.00	1,069,500	1,069,500.00	1,069,500	2,139,000
	Subtotal of Temporary and General				*1,069,500*		*1,069,500*	*2,139,000*
	New Pump Station							
	(Civil Work)							
152B1	Temporary work	Ls	1	3,900.00	3,900	2,100.00	2,100	6,000
152B2	Asphalt road including base course	m2	5,000	22.76	113,800	12.26	61,300	175,100
152B3	Casting and install concrete ring caisson	Ls	1	1,554,150.00	1,554,200	836,850.00	836,900	2,391,100
	(Building Work)							
152B2	Building work	m2	1,300	500.30	650,400	500.30	650,400	1,300,800
	(M&E Work)							
152B3	Macerator with screen, 73.5 m3/min	nos	1	221,400.00	221,400	24,600.00	24,600	246,000
152B4	Macerator with screen, 37.5 m3/min	nos	1	167,400.00	167,400	18,600.00	18,600	186,000
152B5	Macerator with screen, 15 m3/min	nos	1	111,240.00	111,200	12,360.00	12,400	123,600
152B6	Submergible pump, 24.5 m3/min, H=18m for KHC50	nos	3	108,000.00	324,000	12,000.00	36,000	360,000
152B7	Submergible pump, 12.5 m3/min, H=18m for KHC51	nos	3	70,200.00	210,600	7,800.00	23,400	234,000
152B8	Submergible pump, 5 m3/min, H=16m for KHC52	nos	3	39,420.00	118,300	4,380.00	13,100	131,400
	Subtotal of New Pump Station (Civil Work)				*1,671,900*		*900,300*	*2,572,200*
	Subtotal of New Pump Station (Building Work)				*650,400*		*650,400*	*1,300,800*
	Subtotal of New Pump Station (M&E Work)				*1,152,900*		*128,100*	*1,281,000*
	Existing Pump Station							
	(Building Work, Repair)							
152C1	Repair of pump station building, KHC-2	m2	127	40.00	5,100	160.00	20,300	25,400
152C2	Repair of pump station building, KHC-4	m2	226	40.00	9,000	160.00	36,200	45,200
152C3	Repair of pump station building, KHC-9	m2	57	40.00	2,300	160.00	9,000	11,300
152C4	Repair of pump station building, KHC-11	m2	57	40.00	2,300	160.00	9,000	11,300
152C5	Repair of pump station building, KHC-14	m2	25	40.00	1,000	160.00	4,000	5,000
152C6	Repair of pump station building, KHC-15	m2	57	40.00	2,300	160.00	9,000	11,300
152C7	Repair of pump station building, KHC-16	m2	57	40.00	2,300	160.00	9,000	11,300
152C8	Repair of pump station building, KHC-17	m2	14	40.00	600	160.00	2,200	2,800
152C9	Repair of pump station building, KHC-21	m2	57	40.00	2,300	160.00	9,000	11,300
152C10	Repair of pump station building, KHC-24	m2	25	40.00	1,000	160.00	4,000	5,000
152C11	Repair of pump station building, KHC-28	m2	14	40.00	600	160.00	2,200	2,800
152C12	Repair of pump station building, KHC-33	m2	7	40.00	300	160.00	1,000	1,300
152C13	Repair of pump station building, KHC-34	m2	25	40.00	1,000	160.00	4,000	5,000
152C14	Repair of pump station building, KHC-1A	m2	400	40.00	16,000	160.00	64,000	80,000
152C15	Repair of pump station building, KHC-6	m2	900	40.00	36,000	160.00	144,000	180,000
152C16	Repair of pump station building, KHC-7	m2	900	40.00	36,000	160.00	144,000	180,000
152C17	Repair of pump station building, KHC-10	m2	300	40.00	12,000	160.00	48,000	60,000

D.5 Detailed Breakdown of Direct Construction Cost for Wastewater

item no	Work Item	unit	Q'ty	F.C. portion		L.C. portion		Total
				unit rate (US$)	amount (US$)	unit rate (tenge)	amount (tenge)	amount (US$)
	(M&E Work, Replace)							
152C18	Replacement of pump, 8m3/min, H=22m for KCH-2	nos	3	79,380.00	238,100	8,820.00	26,500	264,600
152C19	Replacement of pump, 8m3/min, H=22m for KCH-4	nos	3	79,380.00	238,100	8,820.00	26,500	264,600
152C20	Replacement of pump, 4m3/min, H=22m for KCH-4	nos	2	60,480.00	121,000	6,720.00	13,400	134,400
152C21	Replacement of pump, 4m3/min, H=22m for KCH-9	nos	3	52,380.00	157,100	5,820.00	17,500	174,600
152C22	Replacement of pump, 2m3/min, H=22m for KCH-11	nos	2	39,960.00	79,900	4,440.00	8,900	88,800
152C23	Replacement of pump, 2m3/min, H=10m for KCH-14	nos	2	25,110.00	50,200	2,790.00	5,600	55,800
152C24	Replacement of pump, 2m3/min, H=22m for KCH-15	nos	2	39,960.00	79,900	4,440.00	8,900	88,800
152C25	Replacement of pump, 2m3/min, H=22m for KCH-16	nos	2	39,960.00	79,900	4,440.00	8,900	88,800
152C26	Replacement of pump, 2m3/min, H=11m for KCH-17	nos	2	39,960.00	79,900	4,440.00	8,900	88,800
152C27	Replacement of pump, 2m3/min, H=22m for KCH-21	nos	2	39,960.00	79,900	4,440.00	8,900	88,800
152C28	Replacement of pump, 1m3/min, H=20m for KCH-24	nos	2	25,110.00	50,200	2,790.00	5,600	55,800
152C29	Replacement of pump, 1m3/min, H=15m for KCH-28	nos	2	21,060.00	42,100	2,340.00	4,700	46,800
152C30	Replacement of pump, 1m3/min, H=11.5m for KCH-33	nos	2	18,090.00	36,200	2,010.00	4,000	40,200
152C31	Replacement of pump, 1m3/min, H=11.5m for KCH-34	nos	2	18,090.00	36,200	2,010.00	4,000	40,200
152C32	Replacement of pump, 15m3/min, H=22.5m for KCH-1A	nos	2	134,460.00	268,900	14,940.00	29,900	298,800
152C33	Replacement of pump, 8m3/min, H=22.5m for KCH-1A	nos	2	92,340.00	184,700	10,260.00	20,500	205,200
152C34	Replacement of pump, 30m3/min, H=22.5m for KCH-6	nos	2	202,500.00	405,000	22,500.00	45,000	450,000
152C35	Replacement of pump, 15m3/min, H=22.5m for KCH-6	nos	2	134,460.00	268,900	14,940.00	29,900	298,800
152C36	Replacement of pump, 50m3/min, H=22m for KCH-7	nos	2	271,080.00	542,200	30,120.00	60,200	602,400
152C37	Replacement of pump, 30m3/min, H=22m for KCH-7	nos	2	149,040.00	298,100	16,560.00	33,100	331,200
152C38	Replacement of pump, 12m3/min, H=22m for KCH-10	nos	3	100,980.00	302,900	11,220.00	33,700	336,600
152C39	Replacement of pump, 6m3/min, H=22m for KCH-10	nos	2	76,680.00	153,400	8,520.00	17,000	170,400
	Subtotal of Existing Pump Station (Building, Repair)				*130,100*		*518,900*	*649,000*
	Subtotal of Existing Pump Station (M&E, Replace)				*3,792,800*		*421,600*	*4,214,400*
	New Main Sewer Pipe							
	(Civil Work)							
152D1	Excavation, ordinary soil	m3	936,226	3.72	3,482,800	2.00	1,872,500	5,355,300
152D2	Backfilling	m3	878,934	6.60	5,801,000	3.55	3,120,200	8,921,200
152D3	Sand bed	m3	57,292	7.99	457,800	4.30	246,400	704,200
152D4	Sheet pile for deep excavation, w=400	m2	67,440	44.10	2,974,100	4.90	330,500	3,304,600
152D5	Supply and installation of pipe, RCP 350 mm dia	m	2,820	33.01	93,100	17.77	50,100	143,200
152D6	Supply and installation of pipe, RCP 400 mm dia	m	2,450	38.51	94,300	20.74	50,800	145,100
152D7	Supply and installation of pipe, RCP 500 mm dia	m	12,430	49.52	615,500	26.67	331,500	947,000
152D8	Supply and installation of pipe, RCP 600 mm dia	m	5,880	59.74	351,300	32.17	189,200	540,500
152D9	Supply and installation of pipe, RCP 800 mm dia	m	3,340	74.98	250,400	40.38	134,900	385,300
152D10	Supply and installation of pipe, RCP 900 mm dia	m	2,610	81.39	212,400	43.83	114,400	326,800
152D11	Supply and installation of pipe, RCP 1000 mm dia	m	3,120	87.80	273,900	47.28	147,500	421,400
152D12	Supply and installation of pipe, RCP 1200 mm dia	m	2,200	109.17	240,200	58.79	129,300	369,500
152D13	Supply and installation of pipe, RCP 1500 mm dia	m	1,200	124.04	148,800	66.79	80,100	228,900
	Subtotal of New Main Sewer Pipe (Civil)				*14,995,600*		*6,797,400*	*21,793,000*
	New Secondary Sewer Pipe							
	(Civil Work)							
152E1	Excavation, ordinary soil	m3	263,344	3.72	979,600	2.00	526,700	1,506,300
152E2	Backfilling	m3	214,581	6.60	1,416,200	3.55	761,800	2,178,000
152E3	Sand bed	m3	48,763	7.99	389,600	4.30	209,700	599,300
152E4	Supply and installation of pipe, RCP 300 mm dia	m	28,300	27.50	778,300	14.81	419,100	1,197,400
152E5	Supply and installation of pipe, RCP 400 mm dia	m	38,900	38.51	1,498,000	20.74	806,800	2,304,800
152E6	Supply and installation of pipe, RCP 500 mm dia	m	3,500	49.52	173,300	26.67	93,300	266,600
	Subtotal of Sewer Pipe for new development (Civil)				*5,235,000*		*2,817,400*	*8,052,400*
	Manhole for New Sewer Collection							
	(Civil Work)							
152F1	Supply and Install of manhole, approx 1.5mx1.5mx3mD	m3	3,000	228.10	684,300	122.83	368,500	1,052,800
152F2	Supply and Install of manhole, approx 2mx2mx5mD	m3	5,600	241.76	1,353,900	130.18	729,000	2,082,900
152F3	Supply and Install of manhole, approx 3mx3mx7mD	m3	7,800	257.84	2,011,200	138.83	1,082,900	3,094,100
152F4	Supply and setting of manhole cover	nos	1,030	435.61	448,700	48.40	49,900	498,600
	Subtotal of Manhole for New Sewer Collection (Civil)				*4,498,100*		*2,230,300*	*6,728,400*
	River Crossing							
	(Civil Work)							
152G1	River crossing by pipe jacking, L=200m	nos	2	1,350,000.00	2,700,000	150,000.00	300,000	3,000,000
	Subtotal of River Crossing (Civil, New)				*2,700,000*		*300,000*	*3,000,000*

D.5 Detailed Breakdown of Direct Construction Cost for Wastewater

item no	Work Item	unit	Q'ty	F.C. portion		L.C. portion		Total
				unit rate (US$)	amount (US$)	unit rate (tenge)	amount (tenge)	amount (US$)
	Replacement of Existing Sewer Pipe							
	(Civil Work)							
152H1	Excavation, ordinary soil	m3	70,000	3.72	260,400	2.00	140,000	400,400
152H2	Demolision of existing road	m2	2,800	0.93	2,600	0.50	1,400	4,000
152H3	Backfilling	m3	59,000	6.60	389,400	3.55	209,500	598,900
152H4	Sand bed	m3	9,400	7.99	75,100	4.30	40,400	115,500
152H5	Sheet pile for deep excavation, w=400	m2	64,400	44.10	2,840,000	4.90	315,600	3,155,600
152H6	Supply and installation of pipe, PVC 150 mm dia	m	5,100	30.23	154,200	10.08	51,400	205,600
152H7	Supply and installation of pipe, PVC 200 mm dia	m	3,800	35.70	135,700	11.90	45,200	180,900
152H8	Supply and installation of pipe, PVC 250 mm dia	m	700	57.64	40,300	19.21	13,400	53,700
152H9	Installation of pipe, DIP 300 mm dia	m	4,100	1.44	5,900	3.37	13,800	19,700
152H10	Installation of pipe, DIP 500 mm dia	m	1,600	1.92	3,100	4.48	7,200	10,300
152H11	Installation of pipe, DIP 700 mm dia	m	1,100	2.30	2,500	5.36	5,900	8,400
152H12	Supply and installation of pipe, RCP 300 mm dia	m	600	27.50	16,500	14.81	8,900	25,400
152H13	Supply and installation of pipe, RCP 600 mm dia	m	1,500	59.74	89,600	32.17	48,300	137,900
152H14	Supply and installation of pipe, RCP 800 mm dia	m	2,000	74.98	150,000	40.38	80,800	230,800
152H15	Restoration of road	m2	2,800	16.72	46,800	9.01	25,200	72,000
	(Pipe Supply)							
152H16	Supply of pipe, DIP 300mm dia	m	4,100	57.51	235,800	30.97	127,000	362,800
152H17	Supply of pipe, DIP 500mm dia	m	1,600	123.47	197,600	66.48	106,400	304,000
152H18	Supply of pipe, DIP 700mm dia	m	1,100	205.52	226,100	110.66	121,700	347,800
152H19	Miscellaneous fitting etc. (15% of above)				98,900		53,300	152,200
	Subtotal of Replacement of existing sewer (Civil, Repair)				*4,212,100*		*1,007,000*	*5,219,100*
	Subtotal of Replacement of existing sewer (Pipe Supply)				*758,400*		*408,400*	*1,166,800*
	Repair of Existing Manholes							
	(Civil Work for Repair)							
152I1	Replacement for cast iron manhole cover	nos	5,300	435.69	2,309,200	48.41	256,600	2,565,800
152I2	Clearance of blockage and sediments inside manhole	nos	500	10.69	5,300	5.75	2,900	8,200
152I3	Adjustment of levels of manhole top to suite pavement	nos	1,000	27.22	27,200	14.66	14,700	41,900
152I4	Repair on cracks of manhole	nos	200	86.04	17,200	46.33	9,300	26,500
	Subtotal of Manholes for Existing Sewer (Civil, Repair)				*2,358,900*		*283,500*	*2,642,400*
	Total of 152 (Civil, New)				30,170,100		14,114,900	44,285,000
	Total of 152 (Civil, Repair)				6,571,000		1,290,500	7,861,500
	Total of 152 (Building, New)				650,400		650,400	1,300,800
	Total of 152 (Building, Repair)				130,100		518,900	649,000
	Total of 152 (M&E, New)				1,152,900		128,100	1,281,000
	Total of 152 (M&E, Replace)				3,792,800		421,600	4,214,400
	Total of 152 (Pipe Supply)				758,400		408,400	1,166,800
	Subtotal of 152				**43,225,700**		**17,532,800**	**60,758,500**
150	**Total of Wastewater**				**59,847,700**		**22,066,800**	**81,914,500**